Volume 1 Annex V1-7 Type A Water Licence Applications

Package P5-1

Climate Change Analysis Approach Report,
Hope Bay Project

TMAC RESOURCES

Climate Change Analysis Approach Report, Hope Bay Project

Prepared for

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Prepared by

SRK Consulting (Canada) Inc.
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Climate Change Analysis Approach Report, Hope Bay Project

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Change Log

The following table provides an overview of material changes to this report from the previous version issued as Appendix V3-2A as part of the DEIS for Phase 2 of the Hope Bay Project dated December 2016.

Changes by Section

Information Request, Technical Comment, or Other Change	Section	Comments
Other	4.2.9 / 4.3.9	Included Lake Evaporation as a forecasted parameter

1 Introduction

1.1 Background

The Hope Bay Project (the Project) is a gold mining and milling undertaking of TMAC Resources Inc. The Project is located 705 km northeast of Yellowknife and 153 km southwest of Cambridge Bay in Nunavut Territory, and is situated east of Bathurst Inlet. The Project comprises of three distinct areas of known mineralization plus extensive exploration potential and targets. The three areas that host mineral resources are Doris, Madrid, and Boston.

The Project consists of two phases: Phase 1 (Doris project), which is currently being carried out under an existing Water Licence, and Phase 2 (Madrid-Boston project) which is in the environmental assessment and regulatory stage. Phase 1 includes mining and infrastructure at Doris, while Phase 2 includes mining and infrastructure at Madrid and Boston located approximately 10 and 60 km due south from Doris, respectively

Surface infrastructure required to support Madrid-Boston includes Phase 1 infrastructure. Phase 1 construction started in 2007, and commercial production is scheduled to start in 2017. The transition to Madrid-Boston production will occur seamlessly after about five years (2022), and will continue till about 2036. Active mine closure will take about two years (ending in 2038), following which post-closure monitoring is expected to continue for another five years (ending in 2043). Infrastructure design life to support the Project is therefore about 40 years for Phase 1 infrastructure, and about 25 years for Madrid-Boston.

1.2 Objectives

There is agreement within the engineering community that climate change is occurring, and that climate change needs to be integrated into engineering designs. This report describes how climate change will be integrated into the design of the Project infrastructure, and provides the climate change projections for key climatic and hydrologic design parameters for use in Project engineering designs.

1.3 Report Layout

Section 2 of this report describes the procedure used to predict climate change, and assess what design elements should include consideration of climate change. Section 3 describes the Project elements, and presents the results of the screening analysis on these elements. The climate change projections are presented in Section 4, and Section 5 lists a summary of the key conclusions of this work. There are microclimate differences between Doris and Boston as a result of the geographic spread, which necessitates separate climate change predictions for these areas. In contrast, the close proximity of Madrid to Doris suggests that the Doris climate change projections are applicable at Madrid.

2 Procedure

2.1 Context

There are few best practices and no common standards of practice that provide a prescribed and/or consistent process for incorporating climate change into engineering design (IAIA, 2010). This shortcoming has been identified as a barrier in the ability to address the impacts of climate change to infrastructure (CSA, 2012).

SRK Consulting (Canada) Inc. has developed a Standardized Procedure for Climate Change Integration into Engineering Design (*Procedure*). This *Procedure* was specifically developed to provide a practical, transparent and consistent approach for establishing defensible climate change design criteria for integration into engineering design. The process recognizes that engineering judgement is required, and ensures that these decisions are properly documented.

It is important to note that this *Procedure* is in addition to normal engineering best practices that are already implemented as a matter of course during engineering design. Such best practices already account for climate using historical records and projected trends, with consideration of site-specific scientific and engineering investigations, design codes, and the use of safety factors, risk management and professional judgement.

The *Procedure* is a systematic four part process as illustrated in Figure 2.1. It includes select elements from EARG (1998) and PIEVC (2011), but is essentially a revised fit-for-purpose process.

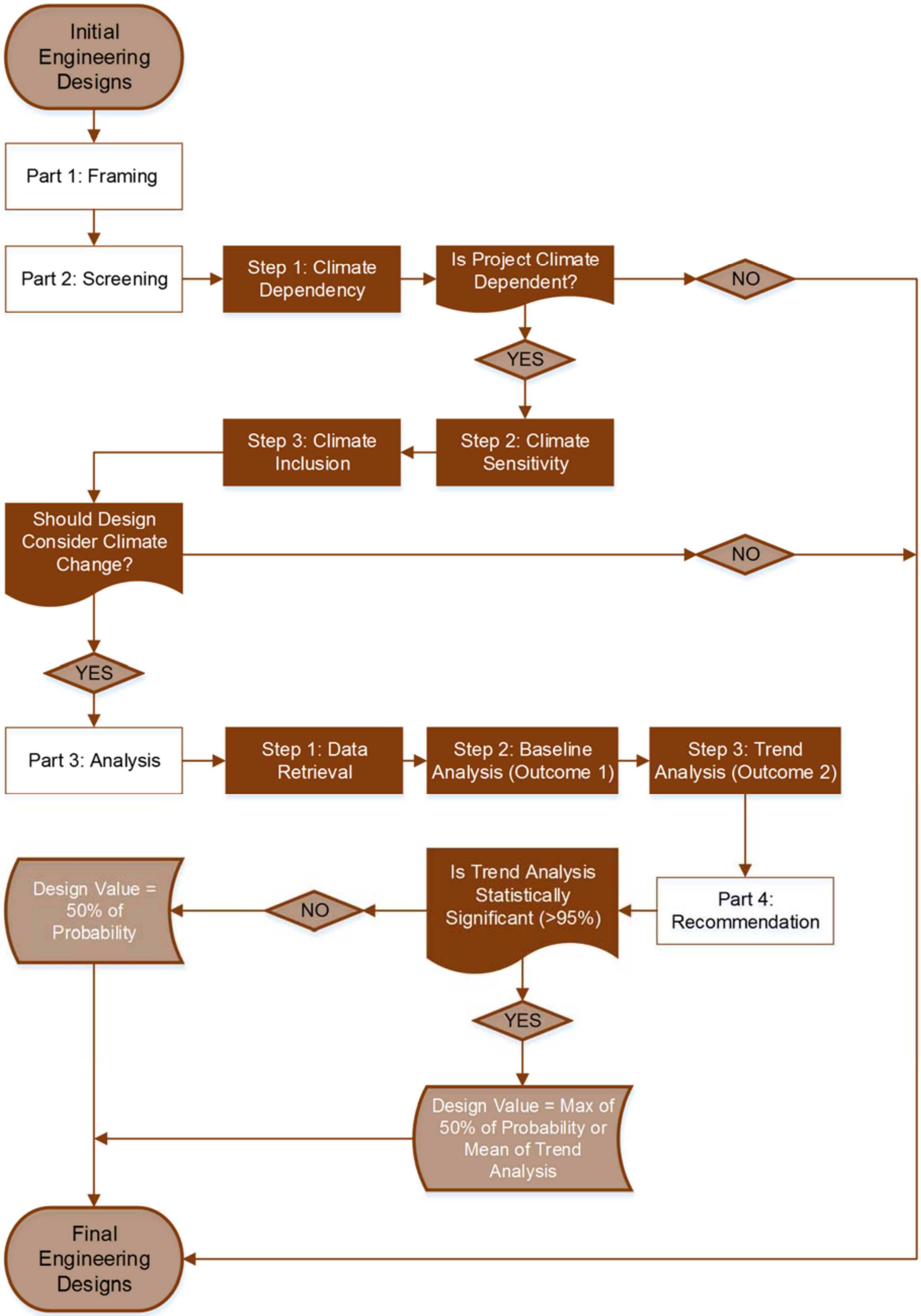

Figure 2.1: Procedure for Climate Change Integration for Engineering Design

2.2 Part 1: Project Framing

The objective of Part 1 is to define the design elements of the Project, such that during Part 2, appropriate screening can be undertaken. Items requiring definition include:

- Geographic location;
- Level of engineering;
- Project stages, and associated infrastructure and components;
- Project specific performance expectations, beyond the normal function of the infrastructure; and
- Need for high level integration of climate change.

2.3 Part 2: Project Screening

2.3.1 Process

The screening process is a qualitative risk assessment that identifies infrastructure systems and components that may be adversely affected by climate change. For each component, the likelihood of climate change to negatively impact the infrastructure performance and the potential consequence of failure are assessed. Engineering best practices are considered to be adopted as a matter of course, and the evaluation is based on the current level of site-specific science and engineering studies completed for the Project. The screening process also determines which level of climate change analysis is required, and which climate parameters are of importance.

2.3.2 Step 1: Climate Dependency

In this step, each of the infrastructure elements and components identified in Part 1 are evaluated to determine whether the design is dependent on climate parameters. A dependency is assumed to exist if the climate parameter is determined to potentially have a measureable impact on infrastructure performance. If no dependency is identified, climate change does not need to be considered in the design.

2.3.3 Step 2: Climate Sensitivity

This step assesses the relative sensitivity of each climate parameter to impact infrastructure performance. The Likelihood and potential Consequences of each identified dependency is independently scored using the criteria listed in Table 2.1 and Table 2.2. Risk is calculated by multiplying Likelihood and Consequence.

Table 2.1: Likelihood Scale Factors

Scale	Likelihood	Probability
1	Improbable (*aka* Very Unlikely, Rare)	<1% chance of happening in timeframe
2	Remote (*aka* Unlikely)	1% to 10% chance of happening in timeframe
3	Occasional (*aka* Possible)	10% to 50% chance of happening in timeframe
4	Probable (*aka* Likely)	50% to 90% chance of happening in timeframe
5	Certain (*aka* Frequent, Very Likely)	>90% chance of happening in timeframe

Table 2.2: Consequence Scale Factors

Scale	Consequence	Context
1	Negligible (*aka* Insignificant)	No measurable impact of any nature
2	Minor (*aka* Marginal)	Short term minor impact to operation, potential for low impact to environment
3	Major (*aka* Critical)	Loss of infrastructure performance, potential for high impact to environment
4	Catastrophic	Loss of infrastructure performance, immediate response required, potential for long-term environmental impact

2.3.4 Step 3: Climate Inclusion

The last step in the screening process determines if rigorous quantitative analysis of climate change is required for the design of each infrastructure system. This assessment is based on the calculated risk score as outlined in Table 2.3. For low risk relationships (risk score below 7), there is no need for inclusion of climate change in the engineering design. For high risk infrastructure, rigorous integration of climate change in engineering design is required, and Part 3 of this *Procedure* should be initiated.

Table 2.3: Risk Score Outcomes from Screening Process

Likelihood	Consequence			
	Catastrophic	Major	Minor	Negligible
Certain	20	15	10	5
Probable	16	12	8	4
Occasional	12	9	6	3
Remote	8	6	4	2
Improbable	4	3	2	1

2.4 Part 3: Analysis

2.4.1 Process

This part entails conducting climate change analysis for each identified climate parameters in Part 2 to determine the required climate change design parameters. This includes collating and evaluating baseline climate data, querying available climate change prediction models and making forecasting climate trends. Part 3 entails three steps as illustrated in Figure 2.1 and outlined in Sections 2.4.2 through 2.4.4.

2.4.2 Step 1: Data Retrieval

The first step is to identify the availability of the climate change models for each climate parameter of significance. Environment Canada (EC) provides access to monthly climate change modeling predictions for any location in the world from the following climate change Assessment Reports:

- Canadian Regional Climate Model (CRCM) (EC, 2015), *aka* First Assessment Report (AR1);
- Second Assessment Report (AR2) (IPCC, 1995);
- Third Assessment Report (AR3) (IPCC, 2001);
- Fourth Assessment Report (AR4) (IPCC, 2007); and
- Fifth Assessment Report (AR5) (IPCC, 2014).

Information for the first four Assessment reports is available from 1960 to 2100 for the meteorological variables listed in Table 2.4; however, there are significant gaps depending on the Assessment Report, scenario evaluated, and variable assessed. Information for the Fifth Assessment Report is available for the years 1900 to 2100, but only includes mean temperature and total precipitation.

As part of the *Procedure*, data from the five Assessment reports were downloaded from Environment Canada for the site being evaluated based on latitude and longitude. This process is automated through a purpose built script developed using “R” Software (CRAN, 2015).

The meteorological parameters covered in the Assessment reports are used, though application of empirical models to calculate climate change design parameters for other parameters such as intensity duration frequency curves (i.e., extreme storm events), snowpack thickness, evaporation, etc. are used.

Table 2.4: Metrological Parameters Listed in AR1 through AR4

Parameter	Base Parameter	Details
Air Temperature	Temperature	Mean (T_{mean}), Mean Max (T_{max}), Mean Minimum (T_{min}), and Extreme Range at 2 m above ground surface
Heat Wave Duration Index	Temperature	Maximum period >5 consecutive days with T_{max} >5°C above the baseline T_{max} normal
Frost Days	Temperature	Total number of frost days (days with absolute minimum temperature <0°C)
Growing Season Length (GSL)	Temperature	Growing season length is defined as the time period each year between when T_{mean} >5°C for more than 5 days and when T_{mean} <5°C for more than 5 days
Air Temp. Extreme Range	Temperature	Intra-annual extreme temperature range is the difference between the highest temperature and lowest temperature of the same calendar year.
Total Precipitation	Precipitation	Total precipitation including rainfall and snowfall as snow water equivalent
Days with Rain >10 mm	Precipitation	Days with rain greater than or equal to 10 mm/day
Simple Daily Intensity Index	Precipitation	Annual total precipitation divided by the number of precipitation days greater than or equal to 1 mm/day
Dry Days	Precipitation	Max amount of consecutive dry days (precipitation <1 mm)
Fraction of Total Annual Precipitation >95th Percentile	Precipitation	Annual precipitation >95th percentile
Wind Speed	Wind Speed	Mean, Meridional, and Zonal wind speed at 10 m above ground surface
Solar Radiation	Radiation	Shortwave surface downwelling
Humidity	Humidity	Relative and specific humidity at 2 m above ground surface
Sea Level Pressure	Air Pressure	Mean sea level pressure

2.4.3 Step 2: Baseline Analysis (Outcome 1)

Climate change models presented in the Assessment reports assume application of radiative forces (energy flux) through different anthropogenic sources which results in discharge of varying concentrations of atmospheric greenhouse gases. These radiative forces are not constant through time, as it is based on global anthropogenic behavior such as environmental policies, population growth, economic growth, energy sources, land use, hydrocarbon usage, etc. Each individual climate change model presented in the Assessment reports represent these non-linear radiative forces differently and thus present a different climate change scenario, underscored by its own model assumptions and boundary conditions.

None of these individual models are inherently superior or inferior to others, and likewise, the newer generation of Assessment reports are not necessarily more reliable than older versions, but rather represent more detailed consideration of global anthropogenic forces. Therefore, the user is forced to make a judgement call on which individual model, or generation of models are the most suitable to use in design, which invariably leads to bias. This *Procedure* is specifically aimed at eliminating this bias by analysing all of the available climate change models with equal weight, and presenting a single climate change design parameter based on a rational statistical evaluation of the overall cumulative results.

Using each and every climate change model available in the five Assessment reports, the projected change with respect to a set baseline condition can be calculated using Equation 2.1.

$$\boldsymbol{Change\ with\ respect\ to\ set\ baseline\ condition}\ (\%) = \frac{\boldsymbol{Projection - Baseline}}{\boldsymbol{Baseline}}$$ **Equation 2.1**

In Equation 2.1, the *Baseline* and *Projection* periods have a minimum timeframe of 30 years, which is generally recognized as being the minimum acceptable period length of record that is statistically significant (WMO, 2007). These periods can be defined as follows:

- *Baseline* is the time frame associated with the past, i.e. estimation of the climate data based on the climate change models. For the purpose of this *Procedure*, this period is fixed from 1975 to 2005, which coincides with the baseline adopted for AR5.
- *Projection* is the future time frame where climate change models are applied, reflecting climate change predictions. Three *Projection* periods are applied: from 2011 to 2040, from 2041 to 2070, and from 2071 to 2100. These 30-year periods are based on convention as stipulated in WMO (2007).

It is important to note that climate change model predictions are currently presented up to the year 2100 (IPCC, 2014), which is deemed that maximum reasonable timeframe to extend predictions to. As a result this is the maximum timeframe for which this *Procedure* applies.

Equation 2-1 is automatically processed using a script developed in “R”. An example result is presented in Figure 2.2, which represents the outcome at a hypothetical site for the meteorological parameter Mean Air Temperature. For this example the *Projection* period is representative of 2041 to 2070.

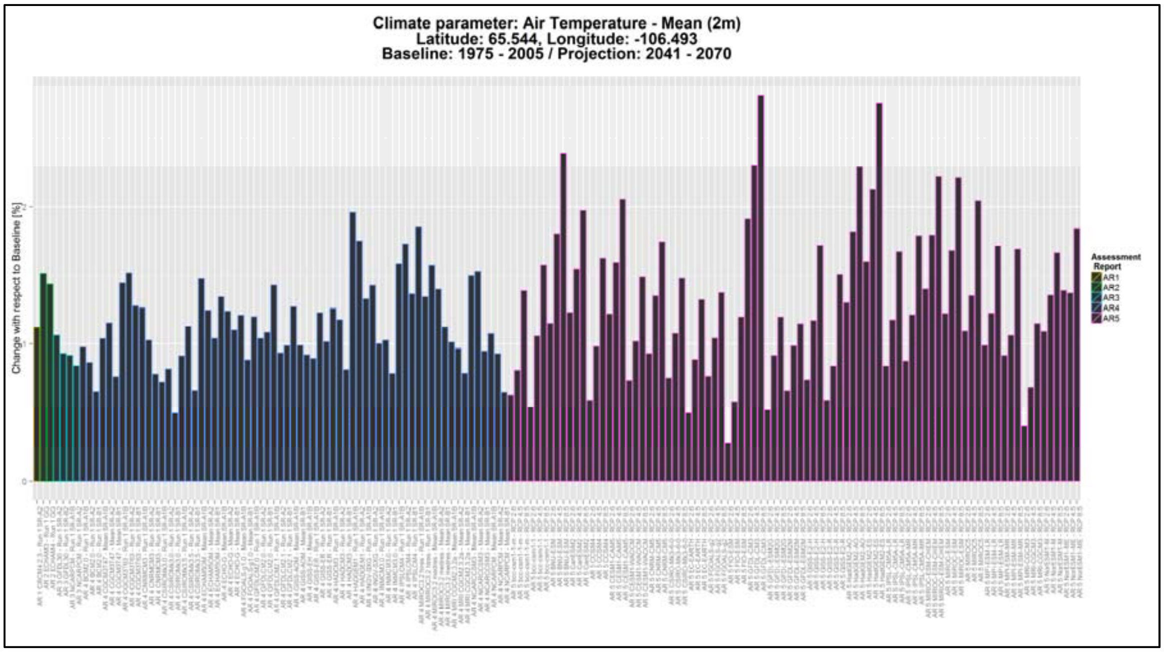

Figure 2.2: Example outcome for hypothetical site showing results of change to baseline conditions for individual climate change models associated with each of the five Assessment reports for a projection period from 2041 to 2070.

The analysis presented in Figure 2.2 can be presented as a box-whisker plot as illustrated in Figure 2.3. The change with respect to baseline conditions for each individual Assessment Report is summarized, together with an overall summary representing all the Assessment Reports combined. The centerline of the box represents the median value, while the upper and lower borders represent the first and third quartile values respectively. The whiskers extend to the maximum and minimum values, provided these values are less than 1.5 times the total range of the box (i.e., the third quartile minus first quartile). If the maximum or minimum values are greater than 1.5 the total range of the box, the range of the box is used as the whisker limit. If values exist outside the whisker limits, they are presented as dots.

The results in Figure 2.3 can also be presented as a cumulative probabilistic curve as illustrated in Figure 2.4. In order to weigh all climate change models equally, only the cumulative probabilistic curve associated with combined data from all Assessment Reports are considered. The overall spread of results as presented by the collection of box-whisker plots in Figure 2.3 illustrates why this is deemed appropriate.

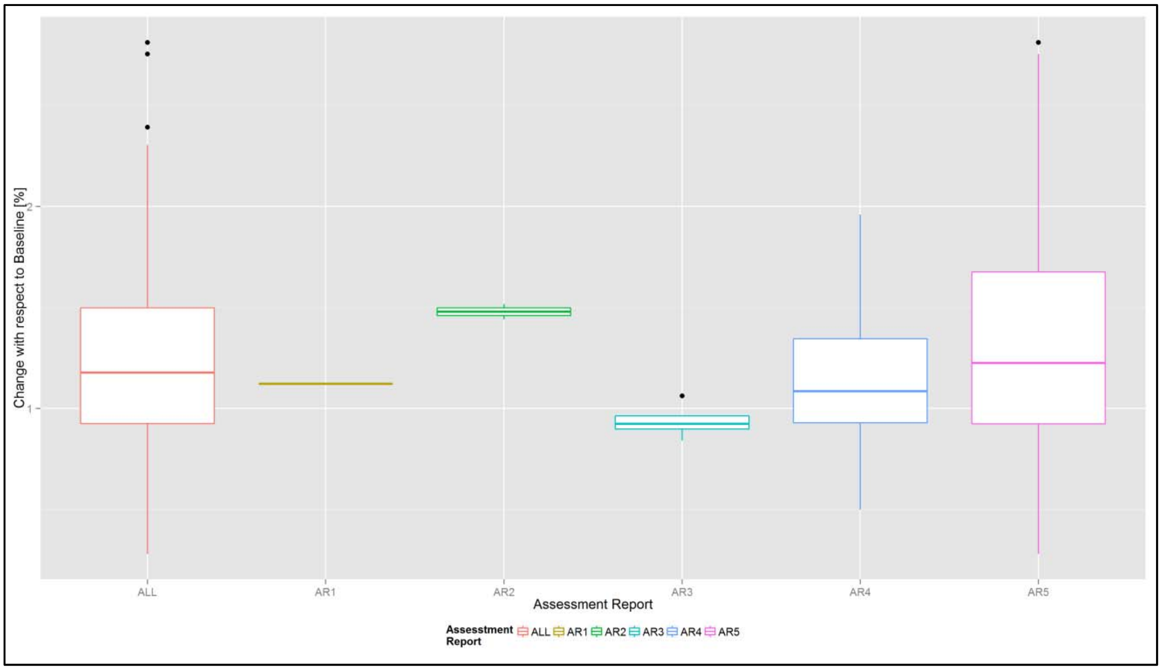

Figure 2.3: Combined box-whisker plot of change to baseline conditions for the individual climate change models presented in the Figure 2.2 example.

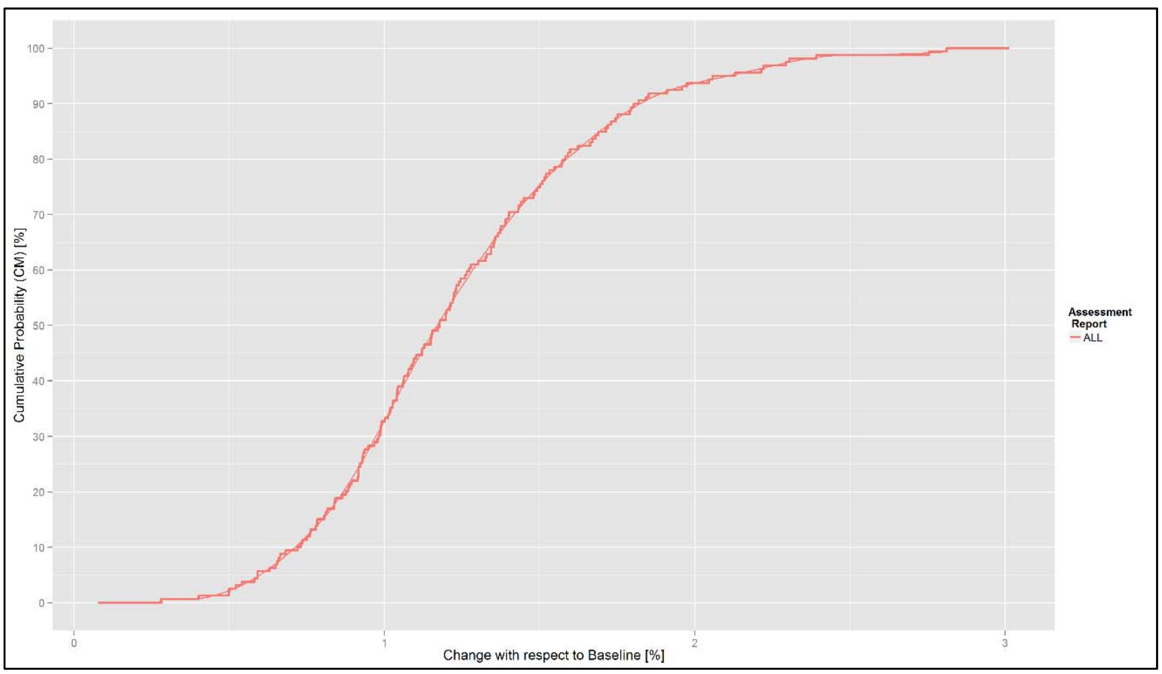

Figure 2.4: Cumulative probability curve of climate change prediction models from all Assessment reports expressed as a percentage of change against baseline conditions.

2.4.4 Step 3 – Trend Analysis (Outcome 2)

As discussed in Section 2.4.3, climate change models consider global anthropogenic forces which are not constant in time. Irrespective of such forces, the science of hydrology estimates predicts future meteorological conditions through consideration of historic trends. Therefore, to facilitate selection of climate change parameters for design, a trend analysis approach is used as a reality check.

To best represent the historical trend, a global climatic model reanalysis approach is used, rather than relying on regional meteorological stations for historic data, since the availability and timespan of records vary greatly. Reanalysis combines satellite information, land records and numerical models that simulate the earth's climatic conditions. Typically reanalysis extends for several decades and covers the entire planet. State-of-the-art publicly available reanalysis data from ERA-Interim produced by the European Center for Medium-Range Weather Forecast (ECMWF) was used in this *Procedure* (ECMRWF, 2015). ERA-Interim includes twice daily data from 1979 to present (2015) for the entire world, based on a 0.75 degree latitude by 0.75 degree longitude grid.

The ERA-Interim data trend analysis entailed two parts: first, identification of the trend, and second, estimation of the statistical significance of the trend. Five different trend analysis methodologies were considered:

- Ordinary least square (Maidment, 1993);
- Quantile regression (Koenker, 1978);
- Mann-Kendall and Theil Sen (Mann, 1945 and Sen, 1968);
- Zhang (Zhang, 2000); and
- Yue and Pilon (Yue and Pilon, 2002).

Figure 2.5 presents the outcome of the reanalysis for the hypothetical example site presented in Figure 2.2 through Figure 2.4. In this case each regression method has a statistical significance value over 95%; however, this may not always be the case and the meaning of that is described further in Part 4.

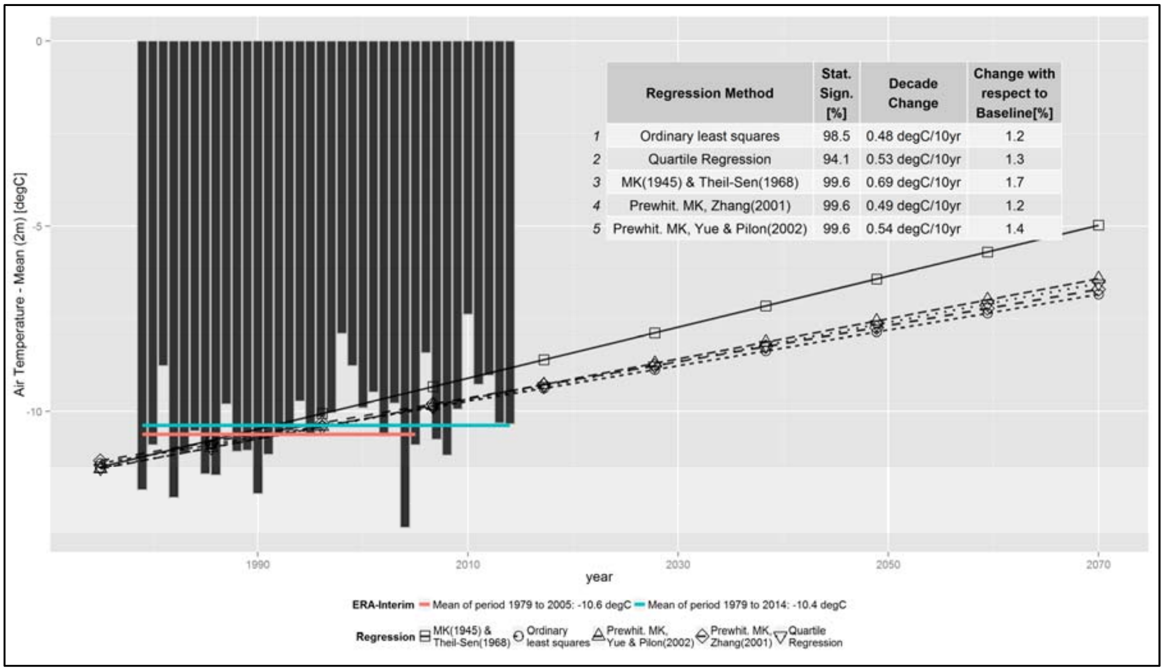

Figure 2.5: Trend analysis outcome based on reanalysis evaluation for hypothetical site presented in Figure 2.2.

2.5 Part 4: Recommendations

Following completion of Part 3, a design recommendation for each identified climate change parameter is presented. Part 3 produces two outcomes as follows:

- Outcome 1 is a cumulative probability curve representing change relative to baseline conditions based on the Part 3, Step 2 analysis; this is also illustrated by the example in Figure 2.4.
- Outcome 2 is the five separate regression analysis results from the Part 3, Step 3 trend analysis, again representing change relative to baseline conditions, as illustrated in the example in Figure 2.5. The statistical significance of each regression analysis is calculated during this step and must yield a value greater than 95% to be deemed statistically significant.

As illustrated in Figure 2.1, if the trend analysis shows no regression of statistical significance (i.e. greater than 95%), the climate change design parameter is the 50% cumulative probability value based on the Part 3, Step 2 baseline analysis. If on the other hand, one or more of the trend analyses suggest trends of statistical significance, the climate change parameter is the maximum of either the 50% cumulative probability value based on the Part 3, Step 2 baseline analysis, or the mean of all the trend analysis values with statistical significance. Equation 2.2 provides an expression for this criteria.

$$\boldsymbol{Recommended\ Climate\ Change\ Design\ Parameter} = \mathbf{Maximum}(\mathbf{50\%}\ \boldsymbol{Cumulative\ Probability},\ \boldsymbol{Mean}\ \{\boldsymbol{Regression}_{\boldsymbol{Stat.Sign} \geq 95\%}\}) \quad \textbf{Equation 2.2}$$

3 Project Framing and Screening

3.1 Project Framing

The Project framing is presented in Appendix A, and is summarized in Table 3.1.

Table 3.1: Proposed Surface Infrastructure System and Components for the Project

System	Component
Doris Tailings Impoundment Area	North Dam
	South and West Dams
	Reclaim Pond
	Closure Cover
Boston Tailings Impoundment Area	Dry Stack
	Closure Cover
Waste Rock Pile(s)	Waste Rock Pile
	Pad
Ore Stockpile Area(s)	Ore Pile
	Pad
Event Ponds (Contact Water)	Contact Water Containment Berms
	Basin
Sedimentation Ponds	Non-Contact Water Berms
Water Diversions	Non-Contact Water Diversion Berm
	Contact Water Diversion Berm
Fuel Containment Areas	Secondary Containment Areas
All-Weather Airstrips	Airstrip and Apron
	Culvert (non-fish bearing)
	Culvert (fish bearing)
All-Weather Roads	Road
	Bridges
	Culvert (non-fish bearing)
	Culvert (fish bearing)
Building Foundation/ Laydown Pads	Pads
	Culvert (non-fish bearing)
	Culvert (fish bearing)

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3.2 Project Screening

Table 3.2 provides a summary of the Project screening, listing the climate parameters for which each component should consider climate change in their design. Appendix B contains the details of the assessment.

Table 3.2: Summary of Screening (Risk Assessment) for the Project

Proposed Surface Infrastructure		Climate Parameters[1]
Doris Tailings Impoundment Area	North Dam	Air temperature, precipitation (rainfall, snowfall and extreme events), wind speed, growing season length
	South and West Dams	Air temperature, precipitation (rainfall), wind speed,
	Reclaim Pond	Precipitation (rainfall, snowfall and extreme events), wind speed, evaporation
	Closure Cover	Air temperature, precipitation (rainfall)
Boston Tailings Impoundment Area	Dry Stack	Air temperature
	Closure Cover	Precipitation (rainfall)
Waste Rock Pile(s)	Waste Rock Pile	None
	Pad	Air temperature
Ore Stockpile Area(s)	Ore Pile	None
	Pad	Air temperature
Event Ponds (Contact Water)	Contact Water Containment Berms	Air temperature, precipitation (rainfall, extreme events)
	Basin	None
Sedimentation Ponds	Non-Contact Water Berms	None
Water Diversions	Non-Contact Water Diversion Berm	None
	Contact Water Diversion Berm	Precipitation (rainfall, snowfall)
Fuel Containment Areas	Secondary Containment Areas	None
All-Weather Airstrips	Airstrip and Apron	None
	Culvert (non-fish bearing)	None
	Culvert (fish bearing)	None
All-Weather Roads	Road	None
	Bridges	None
	Culvert (non-fish bearing)	None
	Culvert (fish bearing)	None
Building Foundation/ Laydown Pads	Pads	None
	Culvert (non-fish bearing)	None
	Culvert (fish bearing)	None

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Notes:

(1) Climate parameters that should consider climate change during design.

4 Climate Change Projections

4.1 Use of Climate Change Projections

The sections below provide tables with climate change predictions, including predicted climate values, and percent change from baseline. These table were developed using the “R” analysis tool, and the baseline (1979-2005) and current reality (1979-2014) values provided are obtained from reanalysis (Appendix C). Baseline climate values for some parameters (e.g., mean annual air temperature and mean annual precipitation) developed from site measurements and regional analysis are provided in SRK (2017a), where available climate parameters based on site measurements should be used rather than the reanalysis values.

Climate change over certain time periods can be applied to site measurements using the percent change provided in the prediction tables (Table 4.1 to Table 4.16, Table 4.20 to Table 4.38 and Table 4.43 to Table 4.45) and Equation 4.1.

$$\boldsymbol{SiteValue_{2020s}} = \boldsymbol{SiteValue} \times \boldsymbol{PercentChange_{2020s}} \qquad \textbf{Equation 4.1}$$

Climate change projections for temperature are based on units of Kelvin. Equation 4.2 shows the appropriate conversion necessary to yield degrees Celsius.

$$\boldsymbol{SiteTemp._{2020s}}\,[°\mathrm{C}] = (\boldsymbol{SiteTemp.}\,[°\mathrm{C}] + \mathbf{273.15}) \times \boldsymbol{PercentChange_{2020s}} - \mathbf{273.15} \qquad \textbf{Equation 4.2}$$

4.2 Doris and Madrid

4.2.1 Long Term Temperature Trends

The mean annual air temperature (MAAT) at Doris, which includes Madrid, is expected to increase by about 6.8°C over the next century (Table 4.1). With MAAT of −8.8°C, −6.7°C, and −4.6°C in the 2020s, 2050s and 2080s respectively. These predictions compare well with those presented by other studies. The International Panel on Climate Change (IPCC) projects a 5°C to 6°C increase in the temperature in Northern Canada for 2100 relative to the 1980 to 1999 temperatures (IPCC, 2007).

Table 4.1 though Table 4.8 present additional temperature related projections for the Doris and Madrid areas, which suggest longer summers, shorter winters and less variation in temperature between winter and summer.

Table 4.1: Mean Annual Air Temperature at Doris and Madrid

Timeline	Context	Value (°C)	Change (°C)	Change (%)[1]
1979-2005	Baseline	−11.4	-	-
1979-2014	Current Reality	−11.1	0.3	0.11%
2011-2040	2020s	−8.8	2.6	0.99%
2041-2070	2050s	−6.7	4.7	1.80%
2071-2100	2080s	−4.6	6.8	2.60%

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Note(s):

(1) Percent change based on baseline temperatures in units of Kelvin.

(2) Site values can be developed as described in SRK (2017a), and should be used in place of the reanalysis values.

Table 4.2: Mean Maximum Air Temperature at Doris and Madrid

Timeline	Context	Value (°C)	Change (°C)	Change (%)[1]
1979-2005	Baseline	-8.89	-	-
1979-2014	Current Reality	-8.63	0.26	0.10%
2011-2040	2020s	-8.97	-0.08	0.89%
2041-2070	2050s	-9.04	-0.15	1.70%
2071-2100	2080s	-9.11	-0.22	2.50%

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Note(s):

(1) Percent change based on baseline temperatures in units of Kelvin.

(2) Site values can be developed as described in SRK (2017a), and should be used in place of the reanalysis values.

Table 4.3: Mean Minimum Air Temperature at Doris and Madrid

Timeline	Context	Value (°C)	Change (°C)	Change (%)[1]
1979-2005	Baseline	-13.7	-	-
1979-2014	Current Reality	-13.5	0.2	0.08%
2011-2040	2020s	-13.8	-0.1	1.00%
2041-2070	2050s	-14.0	-0.3	1.90%
2071-2100	2080s	-14.1	-0.4	2.70%

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Note(s):

(1) Percent change based on baseline temperatures in units of Kelvin.

(2) Site values can be developed as described in SRK (2017a), and should be used in place of the reanalysis values.

Table 4.4: Intra-Annual Temperature Range(1) at Doris and Madrid

Timeline	Context	Value (°C)	Change (°C)	Change (%)[2]
1979-2005	Baseline	65.1	-	-
1979-2014	Current Reality	65.6	0.5	0.15%
2011-2040	2020s	64.5	-0.6	-0.18%
2041-2070	2050s	63.3	-1.8	-0.54%
2071-2100	2080s	63.0	-2.1	-0.62%

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Note(s):

(1) The difference between the highest temperature of the year and the lowest temperature of the year.

(2) Percent change based on baseline temperatures in units of Kelvin.

(3) Site values can be developed as described in SRK (2017a), and should be used in place of the reanalysis values.

Table 4.5: Daily Minimum Air Temperature (90th Percentile) at Doris and Madrid

Timeline	Context	Value (%)	Change (%)[1]	Change (%)
1979-2005	Baseline	10.0	-	-
1979-2014	Current Reality	10.7	0.7	7.00%
2011-2040	2020s	14.2	4.2	42.00%
2041-2070	2050s	19.5	9.5	95.00%
2071-2100	2080s	26.0	16.0	160.00%

Source: \\van-svr0\Projects\01_SITES\Hope.Bay\1CT022.004_Phase 2 DEIS - Engineering Support\Task 230_Climate_Change\[ClimateChangeCompilation_Spreadsheet_1CT022-004_20160108.xlsx]

Note(s):

(1) Percentage change with respect to baseline

Table 4.6: Growing Season Length(1) at Doris and Madrid

Timeline	Context	Value (days)	Change (days)	Change (%)
1979-2005	Baseline	44	-	-
1979-2014	Current Reality	47.1	3.1	7.05%
2011-2040	2020s	47.5	3.5	7.90%
2041-2070	2050s	50.6	6.6	15.00%
2071-2100	2080s	53.7	9.7	22.00%

Source: \\van-svr0\Projects\01_SITES\Hope.Bay\1CT022.004_Phase 2 DEIS - Engineering Support\Task 230_Climate_Change\[ClimateChangeCompilation_Spreadsheet_1CT022-004_20160108.xlsx]

Note(s):

(1) Growing season length is the number of days between the first five consecutive days of the year with a mean air temperature above 5°C, and the last five such days of the year.

(2) Site values can be developed as described in SRK (2017a), and should be used in place of the reanalysis values.

Table 4.7: Heat Wave Duration Index(1) at Doris and Madrid

Timeline	Context	Value (days)	Change (days)	Change (%)
1979-2005	Baseline	126	-	-
1979-2014	Current Reality	129	3.0	2.38%
2011-2040	2020s	186	60.5	48%
2041-2070	2050s	277	151.2	120%
2071-2100	2080s	365	239.4	190%

Source: \\van-svr0\Projects\01_SITES\Hope.Bay\1CT022.004_Phase 2 DEIS - Engineering Support\Task 230_Climate_Change\[ClimateChangeCompilation_Spreadsheet_1CT022-004_20160108.xlsx]

Note(s):

(1) The maximum period for the year of at least five consecutive days with the maximum air temperature at least 5°C warmer than the daily climatology baseline.

(2) Site values can be developed as described in SRK (2017a), and should be used in place of the reanalysis values.

Table 4.8: Frost Days(1) at Doris and Madrid

Timeline	Context	Value (days)	Change (days)	Change (%)
1979-2005	Baseline	263	-	-
1979-2014	Current Reality	261	-2.0	-0.76%
2011-2040	2020s	255	-7.6	-2.90%
2041-2070	2050s	247	-16.3	-6.20%
2071-2100	2080s	237	-25.8	-9.80%

Source: \\van-svr0\Projects\01_SITES\Hope.Bay\1CT022.004_Phase 2 DEIS - Engineering Support\Task 230_Climate_Change\[ClimateChangeCompilation_Spreadsheet_1CT022-004_20160108.xlsx]

Note(s):

(1) Total number of days with an absolute minimum temperature less than 0°C.

(2) Site values can be developed as described in SRK (2017a), and should be used in place of the reanalysis values.

4.2.2 Long Term Precipitation Trends

The total precipitation (rainfall and snow water equivalent) at Doris and Madrid is forecasted to increase 14 mm (6.4%) during the mine life (2011 to 2040), and 42 mm (19%) by 2100 (Table 4.9).

Table 4.9: Total Precipitation at Doris and Madrid

Timeline	Context	Value (mm)	Change (mm)	Change (%)
1979-2005	Baseline	220	-	-
1979-2014	Current Reality	224	4.0	1.82%
2011-2040	2020s	234	14.1	6.40%
2041-2070	2050s	249	28.6	13.00%
2071-2100	2080s	262	41.8	19.00%

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Notes:

(1) Site values are available for this parameter in SRK (2017a), and should be used in place of the reanalysis values.

4.2.3 Frequency of Drought

Climate change projections suggest that consecutive dry days will decrease by up to 16% by 2100 (Table 4.10). The clear increasing MAAT trend (Table 4.1), along with the increasing precipitation trend (Table 4.9) and decreasing consecutive dry day trend (Table 4.10), suggest that the frequency of drought should be decreasing.

Table 4.10: Consecutive Dry Days[(1)] at Doris and Madrid

Timeline	Context	Value (days)	Change (days)	Change (%)
1979-2005	Baseline	14.3	-	-
1979-2014	Current Reality	14.2	-0.1	-0.70%
2011-2040	2020s	13.4	-0.9	-6.30%
2041-2070	2050s	12.9	-1.4	-10.00%
2071-2100	2080s	12.0	-2.3	-16.00%

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Note(s):

(1) Maximum number of consecutive dry day is a year, days with less than 1 mm of precipitation are considered dry days.

4.2.4 Frequency of Rainfall

The simple daily precipitation intensity index at Doris and Madrid is projected to increase by 2.7% during the mine life and by 10% in the next century (Table 4.11). The simple daily precipitation intensity index is the mean annual precipitation (MAP) divided by the total number of wet days. Therefore, the total number of wet days (Table 4.12) can be estimated from the simple daily precipitation intensity index values and the total precipitation.

The total number of wet days is projected to increase by a similar amount, with a 3.6% increase during the mine life and an 8.2% increase during the next century.

Table 4.11: Simple Daily Precipitation Intensity Index[(1)] at Doris and Madrid

Timeline	Context	Value (mm/year)	Change (mm/year)	Change (%)
1979-2005	Baseline	4.08	-	-
1979-2014	Current Reality	4.05	-0.03	-0.74%
2011-2040	2020s	4.19	0.11	2.70%
2041-2070	2050s	4.35	0.27	6.50%
2071-2100	2080s	4.49	0.41	10.00%

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Note(s):

(1) The total annual precipitation divided by the total number of wet days in a year.

Table 4.12: Total Number of Wet Days[(1)] at Doris and Madrid

Timeline	Context	Value (days)	Change (days)	Change (%)
1979-2005	Baseline	53.9	-	-
1979-2014	Current Reality	55.3	1.4	2.6%
2011-2040	2020s	55.9	1.9	3.6%
2041-2070	2050s	57.2	3.3	6.1%
2071-2100	2080s	58.3	4.4	8.2%

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Note(s):

(1) The total number of wet days is not directly developed from the “R” analysis, but rather calculated based on the values in Table 4.9 and Table 4.11.

4.2.5 Heavy Rainfall

Heavy rainfall, expressed as a fraction of annual precipitation greater than the 95th percentile, is projected to increase by 24% over the next century at Doris and Madrid (Table 4.13), and the number of days with more than 10 mm of rainfall is projected to increase by 60% (Table 4.14). The change in heavy precipitation and days with more than 10 mm of rain is projected to be 7% and 9% respectively during the mine life (2011 to 2040). Similarly, the maximum total precipitation for a five-day period will increase by 24% over the next century and 2.7% over the mine life (2011 to 2040), as shown in Table 4.15. Therefore, it can be concluded that the volume and frequency of high precipitation events will tend to increase.

Table 4.13: Fraction of Annual Precipitation >95th Percentile[(1)] at Doris and Madrid

Timeline	Context	Value (%)	Change (%)	Change (%)
1979-2005	Baseline	5.01	-	-
1979-2014	Current Reality	4.97	-0.04	-0.80%
2011-2040	2020s	5.35	0.34	7%
2041-2070	2050s	5.76	0.75	15%
2071-2100	2080s	6.21	1.20	24%

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Note(s):

(1) Percentage of days with precipitation greater than the 95th percentile calculated for wet days from the baseline period.

Table 4.14: Days with Precipitation Greater than or Equal to 10 mm at Doris and Madrid

Timeline	Context	Value (days)	Change (days)	Change (%)
1979-2005	Baseline	2.15	-	-
1979-2014	Current Reality	2.2	0.0	1.86%
2011-2040	2020s	2.3	0.2	9.00%
2041-2070	2050s	2.9	0.7	34.00%
2071-2100	2080s	3.4	1.3	60.00%

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Table 4.15: Greatest Five Days Total Rainfall at Doris and Madrid

Timeline	Context	Value (mm)	Change (mm)	Change (%)
1979-2005	Baseline	24.0	-	-
1979-2014	Current Reality	24.5	0.5	2.08%
2011-2040	2020s	24.6	0.6	2.70%
2041-2070	2050s	26.6	2.6	11.00%
2071-2100	2080s	29.8	5.8	24.00%

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Intensities of short duration rainfall events at Doris and Madrid were projected for the 2020s (Table 4.16), based on an evaluation of the projected values for greatest five-day total precipitation, consecutive dry days, simple daily intensity index, days with rain greater than 10 mm, and fraction of total annual precipitation greater than the 95th percentile value. The Precipitation Duration Frequency (PDF) values predicted SRK 2017a, Table 8 estimated at Cambridge Bay A should be increased by 10% to account for climate change from 2011 to 2040.

Table 4.16: Predicted Short Duration Rainfall Intensities at Doris and Madrid (mm), for 2011 to 2040

Duration	Return Period (years)					
	2	5	10	25	50	100
5 minute	1.3	2.3	2.9	3.6	4.3	4.8
10 minute	1.8	3.0	3.9	4.8	5.6	6.4
15 minute	2.2	3.6	4.6	5.8	6.7	7.6
30 minute	3.1	4.7	5.8	7.3	8.3	9.4
1 hour	4.6	6.7	8.1	9.9	11.2	12.5
2 hour	6.6	9.8	11.9	14.5	16.5	18.5
6 hour	10.8	16.1	19.6	23.9	27.2	30.4
12 hour	13.6	21.3	26.5	33.0	37.8	42.6
24 hour	15.6	26.0	32.8	41.4	47.9	54.1

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4.2.6 Snow Accumulation

Projections of snow accumulation were developed by coupling the climate change model projections for precipitation, temperature, and wind speed with the energy snowmelt model by Walter *et al*. (2005).

The monthly average snow depth at Doris and Madrid is expected to decrease over the next century (Table 4.17). In the time periods 1979 to 2005 and 1979 to 2014, the January snow depth is noted as being less than the December snow depth, which is due to the density of the snow increasing during the winter months.

Table 4.17: Monthly Average Snowpack at Doris and Madrid

Timeline	Snow Depth (cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1979-2005	16	17	21	24	25	17	0	0	5	13	16	17
1979-2014	16	17	21	24	24	16	0	0	5	12	16	17
2011-2040	14	15	18	20	19	4	0	0	2	9	13	14
2041-2070	12	13	15	17	14	1	0	0	1	7	11	12
2071-2100	12	12	14	15	10	0	0	0	0	6	10	12

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4.2.7 Snowmelt

The energy snowmelt model by Walter *et al*. (2005) was used for predictions of snow melt by coupling the climate change model projections for precipitation, mean annual air temperature, and wind speed.

The daily maximum snowmelt in an average year at Doris and Madrid is listed in Table 4.18, and the months in which these maximum values are obtained are listed in Table 4.19. These predictions forecast freshet in May, and decreasing maximum daily snowmelt over the next century. The predicted maximum daily snowmelt in 2071 to 2100 is half that of the snowmelt 1979 to 2005 (Table 4.18). This decreasing snowmelt is likely in part due to the decreasing snow depth presented in Table 4.17.

These predictions do not consider the possibility of rain-on-snow events creating larger daily maximum snowmelts as the distribution of precipitation events in the future is unknown.

Table 4.18: Maximum Daily Snowmelt in Average Year at Doris and Madrid

Timeline	Daily Maximum Snowmelt (mm)
1979-2005	20
1979-2014	17
2011-2040	12
2041-2070	10
2071-2100	10

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Table 4.19: Daily Maximum Snowmelt per Month at Doris and Madrid

Timeline	Snow Melt (mm/day)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1979-2005	0	2	3	24	25	17	0	0	1	4	3	2
1979-2014	0	2	2	24	24	16	0	0	1	4	3	2
2011-2040	2	3	4	19	19	4	0	0	0	4	5	3
2041-2070	2	5	6	14	14	1	0	0	0	4	5	4
2071-2100	3	5	6	10	10	0	0	0	0	3	5	4

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4.2.8 Wind Speed

The mean annual wind speed at Doris and Madrid is projected to increase by 11% over the next century (Table 4.20). The predominant change will be in the meridional (east-west) any direction as can be seen in Table 4.21. Material changes in zonal wind speed between 2011 and 2100 are not expected.

Table 4.20: Mean Wind Speed at Doris and Madrid

Timeline	Context	Value (m/s)	Change (m/s)	Change (%)
1979-2005	Baseline	4.81	-	-
1979-2014	Current Reality	4.81	0.00	0.00%
2011-2040	2020s	5.01	0.20	4.20%
2041-2070	2050s	5.16	0.35	7.20%
2071-2100	2080s	5.34	0.53	11.00%

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Note(s):

Site values can be developed as described in SRK (2017a), and should be used in place of the reanalysis values.

Table 4.21: Meridional(1) Wind Speed at Doris and Madrid

Timeline	Context	Value (m/s)	Change (m/s)	Change (%)
1979-2005	Baseline	-0.95	-	-
1979-2014	Current Reality	-0.92	0.02	-2.53%
2011-2040	2020s	-0.82	0.12	-13.00%
2041-2070	2050s	-0.83	0.11	-12.00%
2071-2100	2080s	-0.82	0.12	-13.00%

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Note(s):

(1) Meridional refers to the east-west direction.

Table 4.22: Zonal(1) Wind Speed at Doris and Madrid

Timeline	Context	Value (m/s)	Change (m/s)	Change (%)
1979-2005	Baseline	0.93	-	-
1979-2014	Current Reality	0.83	-0.10	-10.73%
2011-2040	2020s	0.98	0.04	4.80%
2041-2070	2050s	0.98	0.05	5.40%
2071-2100	2080s	0.94	0.01	0.81%

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Note(s):

(1) Zonal refers to the north-south direction.

4.2.9 Lake Evaporation

From the Climate and Hydrological Parameters Summary Report (SRK, 2017a), the mean annual lake evaporation at Doris is projected to increase by +0.8 mm by year. This annual trend was identified from the monthly Morton evaporation estimations from 1984 to 2016 and was shown to be statistically significant (P-value < 0.05). This increasing rate is constant over the next century (Table 4.23).

Table 4.23: Mean Annual Lake Evaporation

Timeline	Context	Value (mm/yr)	Change (mm/yr)	Change (%)
1984-2016	Current Reality	284	-	-
2011-2040	2020s	294.7	10.7	3.8%
2041-2070	2050s	315.6	31.6	11.1%
2071-2100	2080s	339.6	55.6	19.6%

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4.3 Boston

4.3.1 Long Term Temperature Trends

The MAAT at Boston is expected to increase by about 5.5°C over the next century (Table 4.24). With MAAT of –9.4°C, −7.7°C, and −5.9°C in the 2020s, 2050s and 2080s respectively. These predictions compare well with those presented by other studies. The International Panel on Climate Change (IPCC) projects a 5°C to 6°C increase in the temperature in Northern Canada for 2100 relative to the 1980 to 1999 temperatures (IPCC, 2007).

Table 4.25 through Table 4.31 present additional temperature related climate projections for the Boston area. These tables predict longer summers, shorter winters and less variation in temperature between winter and summer.

Table 4.24: Mean Annual Air Temperature at Boston

Timeline	Context	Value (˚C)	Change (˚C)	Change (%)[1]
1979-2005	Baseline	-11.4	-	-
1979-2014	Current Reality	-11.2	0.2	0.08%
2011-2040	2020s	-9.4	2.0	0.78%
2041-2070	2050s	-7.7	3.7	1.40%
2071-2100	2080s	-5.9	5.5	2.10%

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Note(s):

(1) Percent change should be applied to baseline temperatures in units of Kelvin.

Table 4.25: Mean Maximum Air Temperature at Boston

Timeline	Context	Value (˚C)	Change (˚C)	Change (%)[1]
1979-2005	Baseline	-8.63	-	-
1979-2014	Current Reality	-8.44	0.19	0.07%
2011-2040	2020s	-8.70	-0.07	0.84%
2041-2070	2050s	-8.76	-0.13	1.50%
2071-2100	2080s	-8.83	-0.20	2.30%

Source: \\van-svr0\Projects\01_SITES\Hope.Bay\1CT022.004_Phase 2 DEIS - Engineering Support\Task 230_Climate_Change\[ClimateChangeCompilation_Spreadsheet_1CT022-004_20160108.xlsx]

Note(s):

(1) Percent change should be applied to baseline temperatures in units of Kelvin.

(2) Site values can be developed as described in SRK (2017a), and should be used in place of the reanalysis values.

Table 4.26: Mean Minimum Air Temperature at Boston

Timeline	Context	Value (˚C)	Change (˚C)	Change (%)[1]
1979-2005	Baseline	-13.8	-	-
1979-2014	Current Reality	-13.7	0.1	0.04%
2011-2040	2020s	-13.9	-0.1	0.74%
2041-2070	2050s	-14.0	-0.2	1.40%
2071-2100	2080s	-14.1	-0.3	2.00%

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Note(s):

(1) Percent change should be applied to baseline temperatures in units of Kelvin.

(2) Site values can be developed as described in SRK (2017a), and should be used in place of the reanalysis values.

Table 4.27: Intra-Annual Temperature Range at Boston[(1)]

Timeline	Context	Value (°C)	Change (°C)	Change (%)[2]
1979-2005	Baseline	69.5	-	-
1979-2014	Current Reality	70.0	0.5	0.15%
2011-2040	2020s	68.8	-0.7	-0.19%
2041-2070	2050s	67.4	-2.1	-0.60%
2071-2100	2080s	67.4	-2.1	-0.62%

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Note(s):

(1) The difference between the highest temperature of the year and the lowest temperature of the year.

(2) Percent change should be applied to baseline temperatures in units of Kelvin.

(3) Site values can be developed as described in SRK (2017a), and should be used in place of the reanalysis values.

Table 4.28: Daily Minimum Air Temperature (90th Percentile) at Boston

Timeline	Context	Value (%)	Change (%)[1]	Change (%)
1979-2005	Baseline	10.0	-	-
1979-2014	Current Reality	10.5	0.5	5.00%
2011-2040	2020s	14.2	4.2	42.00%
2041-2070	2050s	19.5	9.5	95.00%
2071-2100	2080s	26.0	16.0	160.00%

Source: \\van-svr0\Projects\01_SITES\Hope.Bay\1CT022.004_Phase 2 DEIS - Engineering Support\Task 230_Climate_Change\[ClimateChangeCompilation_Spreadsheet_1CT022-004_20160108.xlsx]

Note(s):

(1) Percent deviation with respect to baseline

Table 4.29: Growing Season Length(1) at Boston

Timeline	Context	Value (days)	Change (days)	Change (%)
1979-2005	Baseline	38.4	-	-
1979-2014	Current Reality	41.3	2.9	7.55%
2011-2040	2020s	44.2	5.8	15.00%
2041-2070	2050s	48.0	9.6	25.00%
2071-2100	2080s	55.3	16.9	44.00%

Source: \\van-svr0\Projects\01_SITES\Hope.Bay\1CT022.004_Phase 2 DEIS - Engineering Support\Task 230_Climate_Change\[ClimateChangeCompilation_Spreadsheet_1CT022-004_20160108.xlsx]

Note(s):

(1) Growing season length is the number of days between the first five consecutive days of the year with a mean air temperature above 5°C, and the last five such days of the year.

(2) Site values can be developed as described in SRK (2017a), and should be used in place of the reanalysis values.

Table 4.30: Heat Wave Duration Index(1) at Boston

Timeline	Context	Value (days)	Change (days)	Change (%)
1979-2005	Baseline	125	-	-
1979-2014	Current Reality	128	3.0	2.40%
2011-2040	2020s	185	60.0	48.00%
2041-2070	2050s	275	150.0	120.00%
2071-2100	2080s	363	237.5	190.00%

Source: \\van-svr0\Projects\01_SITES\Hope.Bay\1CT022.004_Phase 2 DEIS - Engineering Support\Task 230_Climate_Change\[ClimateChangeCompilation_Spreadsheet_1CT022-004_20160108.xlsx]

Note(s):

(1) The maximum period for the year of at least five consecutive days with the maximum air temperature at least 5°C warmer than the daily climatology baseline.

(2) Site values can be developed as described in SRK (2017a), and should be used in place of the reanalysis values.

Table 4.31: Frost Days(1) at Boston

Timeline	Context	Value (days)	Change (days)	Change (%)
1979-2005	Baseline	265	-	-
1979-2014	Current Reality	264	-1.0	-0.38%
2011-2040	2020s	257	-7.7	-2.90%
2041-2070	2050s	249	-15.9	-6.00%
2071-2100	2080s	239	-25.7	-9.70%

Source: \\van-svr0\Projects\01_SITES\Hope.Bay\1CT022.004_Phase 2 DEIS - Engineering Support\Task 230_Climate_Change\[ClimateChangeCompilation_Spreadsheet_1CT022-004_20160108.xlsx]

Note(s):

(1) Total number of days with an absolute minimum temperature less than 0°C.

(2) Site values can be developed as described in SRK (2017a), and should be used in place of the reanalysis values.

4.3.2 Long Term Precipitation Trends

The total precipitation (rainfall and snow water equivalent) at Boston is projected to increase 17 mm (6.4%) during the mine life (2011 to 2040) and 47 mm (18%) by 2100 (Table 4.32).

Table 4.32: Total Precipitation at Boston

Timeline	Context	Value (mm)	Change (mm)	Change (%)
1979-2005	Baseline	260	-	-
1979-2014	Current Reality	264	4.0	1.54%
2011-2040	2020s	277	16.6	6.40%
2041-2070	2050s	294	33.8	13.00%
2071-2100	2080s	307	46.8	18.00%

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Note(s):

(1) Site values can be developed as described in SRK (2017a), and should be used in place of the reanalysis values.

4.3.3 Frequency of Drought

Similar to Doris and Madrid, climate change projection models suggest consecutive dry days at Boston will decrease by up to 16% by 2100 (Table 4.33).The clear MAAT increase trend (Table 4.24) along with the increasing precipitation trend (Table 4.32) and decreasing consecutive dry day trend (Table 4.33), suggests the frequency of drought should be decreasing.

Table 4.33: Consecutive Dry Days[(1)] at Boston

Timeline	Context	Value (days)	Change (days)	Change (%)
1979-2005	Baseline	18.5	-	-
1979-2014	Current Reality	17.7	-0.8	-4.32%
2011-2040	2020s	17.2	-1.3	-6.90%
2041-2070	2050s	16.7	-1.8	-9.60%
2071-2100	2080s	15.5	-3.0	-16.00%

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4.3.4 Frequency of Rainfall

The simple daily precipitation intensity index at Boston is projected to increase by 3.0% during the mine life and by 10% in the next century (Table 4.34). The total number of wet days (Table 4.35) is also projected to increase, with a 3.3% increase during the mine life and a 7.3% increase during the next century.

Table 4.34: Simple Daily Precipitation Intensity Index(1) at Boston

Timeline	Context	Value (mm/year)	Change (mm/year)	Change (%)
1979-2005	Baseline	4.1	-	-
1979-2014	Current Reality	4.04	-0.06	-1.46%
2011-2040	2020s	4.22	0.12	3.00%
2041-2070	2050s	4.37	0.27	6.60%
2071-2100	2080s	4.51	0.41	10.00%

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Note(s):

(1) The total annual precipitation divided by the total number of wet days in a year.

Table 4.35: Estimated Total Number of Wet Days(1) at Boston

Timeline	Context	Value (days)	Change (days)	Change (%)
1979-2005	Baseline	63.4	-	-
1979-2014	Current Reality	65.3	1.9	3.0%
2011-2040	2020s	65.5	2.1	3.3%
2041-2070	2050s	67.2	3.8	6.0%
2071-2100	2080s	68.0	4.6	7.3%

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Note(s):

(1) The total number of wet days is not directly developed from the "R" analysis, but rather calculated based on the values in Table 4.9 and Table 4.11.

4.3.5 Heavy Rainfall

The fraction of annual rainfall greater than the 95th percentile is projected to increase by 0.4% (7.9% change) over the life of the Project, and 1.1% (change of 22%) by 2100 (Table 4.36). The days with precipitation greater than or equal to 10 mm and the greatest five-day total rainfall, is also projected to increase over the Project lifetime (Table 4.37 and Table 4.38).

Based on an evaluation of the projected values for the greatest five-day precipitation, consecutive dry days, simple daily intensity index, days with rain greater than 10 mm, and fraction of total annual precipitation greater than the 95th percentile values intensities of short duration, rainfall events were estimated for the 2020s (Table 4.39). The values predicted in the 2020s are 12% greater than the 2014 values.

Table 4.36: Fraction of Annual Precipitation >95th Percentile(1) at Boston

Timeline	Context	Value (%)	Change (%)	Change (%)
1979-2005	Baseline	4.99	-	-
1979-2014	Current Reality	5.00	0.01	0.20%
2011-2040	2020s	5.38	0.39	7.90%
2041-2070	2050s	5.69	0.70	14.00%
2071-2100	2080s	6.09	1.10	22.00%

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Note(s):

(1) Percentage of days with precipitation greater than the 95th percentile calculated for wet days from the baseline period.

Table 4.37: Days with Precipitation Greater Than or Equal to 10 mm at Boston

Timeline	Context	Value (days)	Change (days)	Change (%)
1979-2005	Baseline	2.43	-	-
1979-2014	Current Reality	2.57	0.1	5.76%
2011-2040	2020s	2.72	0.3	12.00%
2041-2070	2050s	3.26	0.8	34.00%
2071-2100	2080s	3.91	1.5	61.00%

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Table 4.38: Greatest Five Days Total Rainfall at Boston

Timeline	Context	Value (mm)	Change (mm)	Change (%)
1979-2005	Baseline	30.6	-	-
1979-2014	Current Reality	30.2	-0.4	-1.31%
2011-2040	2020s	32.0	1.4	4.50%
2041-2070	2050s	34.0	3.4	11.00%
2071-2100	2080s	38.9	8.3	27.00%

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Table 4.39: Predicted Short Duration Rainfall Intensities at Boston (mm), for 2011 to 2040

Duration	Return Period (years)					
	2	5	10	25	50	100
5 minute	1.3	2.4	2.9	3.7	4.4	4.9
10 minute	1.8	3.0	3.9	4.9	5.7	6.5
15 minute	2.2	3.7	4.7	5.9	6.8	7.7
30 minute	3.1	4.8	5.9	7.4	8.4	9.5
1 hour	4.7	6.8	8.3	10.1	11.4	12.8
2 hour	6.7	10.0	12.1	14.8	16.8	18.8
6 hour	11.0	16.4	19.9	24.3	27.7	30.9
12 hour	13.9	21.7	27.0	33.6	38.5	43.3
24 hour	15.9	26.4	33.4	42.1	48.7	55.1

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4.3.6 Snow Accumulation

The monthly average snow pack at Boston (Table 4.40), is projected to be slightly higher than the snow pack at Doris. Similar to the predictions of snow depth at Doris, the snow depth in December is predicted to be greater than the snowpack in January, which is because the density of the snow increases over the winter months.

Table 4.40: Monthly Average Snowpack at Boston

Timeline	Snow Depth (cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1979-2005	19	21	23	28	30	19	0	0	5	15	19	20
1979-2014	19	21	23	28	29	18	0	0	5	15	19	21
2011-2040	18	19	22	26	25	8	0	0	3	12	16	19
2041-2070	16	16	18	21	19	2	0	0	2	9	14	16
2071-2100	15	16	18	20	15	0	0	0	1	8	13	15

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4.3.7 Snowmelt

The energy snowmelt model by Walter *et al*. (2005) was used for developing snowmelt predictions. The daily maximum snowmelt in an average year to Boston can be seen in Table 4.41 and the month in which these maximum values are obtained from can be seen in Table 4.42. These projections forecast freshet in May and decreasing maximum daily snowmelt.

These projections do not consider the possibility of rain-on-snow events creating larger daily maximum snowmelts as the distribution of precipitation events in the future is unknown.

Table 4.41: Maximum Daily Snowmelt in Average Year at Boston

Timeline	Daily Maximum Snowmelt (mm)
1979-2005	21
1979-2014	18
2011-2040	18
2041-2070	18
2071-2100	14

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Table 4.42: Daily Maximum Snowmelt per Month at Boston

Timeline	Snow Melt (mm/day)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1979-2005	0	0	4	7	9	21	0	0	2	3	2	2
1979-2014	0	0	4	7	10	18	0	0	2	4	0	2
2011-2040	2	0	3	5	18	5	0	0	1	4	5	3
2041-2070	4	5	6	8	18	1	0	0	0	5	6	3
2071-2100	3	5	7	8	14	0	0	0	0	3	6	4

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4.3.8 Wind Speed

The mean annual wind speed at Boston is projected to increase by 2.7% over the next century (Table 4.43). Table 4.44 and Table 4.45 provide the projected change in wind direction for the meridional (east-west) direction and the zonal (north-south) direction. While the meridional wind speed is expected to steadily decrease in the next century (Table 4.44); the projections for the zonal wind speed are more uncertain (Table 4.45).

Table 4.43: Mean Wind Speed at Boston

Timeline	Context	Value (m/s)	Change (m/s)	Change (%)
1979-2005	Baseline	4.72	-	-
1979-2014	Current Reality	4.71	-0.01	-0.21%
2011-2040	2020s	4.76	0.04	0.80%
2041-2070	2050s	4.83	0.11	2.40%
2071-2100	2080s	4.85	0.13	2.70%

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Note(s):

(1) Site values can be developed as described in SRK (2017a), and should be used in place of the reanalysis values.

Table 4.44: Meridional Wind Speed at Boston

Timeline	Context	Value (m/s)	Change (m/s)	Change (%)
1979-2005	Baseline	-0.603	-	-
1979-2014	Current Reality	-0.56	0.04	-6.80%
2011-2040	2020s	-0.55	0.05	-8.20%
2041-2070	2050s	-0.54	0.07	-11.00%
2071-2100	2080s	-0.53	0.07	-12.00%

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Table 4.45: Zonal Wind Speed at Boston

Timeline	Context	Value (m/s)	Change (m/s)	Change (%)
1979-2005	Baseline	1.35	-	-
1979-2014	Current Reality	1.27	-0.08	-5.93%
2011-2040	2020s	1.42	0.07	5.50%
2041-2070	2050s	1.48	0.13	9.60%
2071-2100	2080s	1.39	0.04	2.80%

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4.3.9 Lake Evaporation

From the Climate and Hydrological Parameters Summary Report (SRK, 2017a), the mean annual lake evaporation at Boston is projected to increase by +0.7 mm by year. This annual trend was identified from the monthly Morton evaporation estimations from 1984 to 2016 and was shown to be statistically significant (P-value < 0.05). This increasing rate is constant over the next century (Table 4.46).

Table 4.46: Mean Annual Lake Evaporation

Timeline	Context	Value (mm/yr)	Change (mm/yr)	Change (%)
1984-2016	Current Reality	291.0	-	-
2011-2040	2020s	301.0	10.0	3%
2041-2070	2050s	318.7	27.6	10%
2071-2100	2080s	339.6	48.6	17%

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Note(s):

Site values can be developed as described in SRK (2017a), and should be used in place of the reanalysis values.

4.4 Site Wide

4.4.1 Permafrost

Permafrost at the Project extends to depths of about 570 m. The ground temperature near the depth of zero annual amplitude ranges from −9.8 to −5.6°C, with an average of −7.6°C. Active layer depth, based on ground temperatures measured in overburden soil averages 1.0 m, with a range from 0.5 to 1.7 m. The average geothermal gradient is 0.021°C/m (SRK, 2017b).

Permafrost is sensitive to climate change and an increase in air temperature is likely to cause natural permafrost degradation. Smith and Burgess (1998, 2004) assessed the sensitivity of permafrost to climate change in Canada by categorizing the response of ground thermal conditions to climate, and the effects of permafrost thaw on terrain stability. At the Project site, permafrost is regionally predicted to be thermally sensitive to climate change, with low physical response resulting from thaw (Smith and Burgess, 2004). Permafrost; however, will be locally thaw-sensitive where ice-rich soils and massive ground ice are present. The Project; however, is predicted to stay within the zone of continuous permafrost (ACIASC, 2005).

4.4.2 Active Layer Thickness

Widespread increases in active layer depth are projected for most permafrost regions. The thin active layer of permafrost responds immediately to temperature changes, and climate change is likely to accelerate the increase in depth due to increasing air temperatures and changes in surface conditions. Thaw season (summer) temperatures are most influential on active layer depth. By the year 2100, active layer thickness is estimated to increase by 0.93 m for clay overburden, as determined using the long-term air temperature trends applied to numerical thermal conduction models.

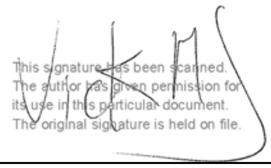
5 Summary of Overall Climate Change Trends

Climate change effects develop over very long timescales relative to the Project life and, as such, the trends (Table 5.1) will manifest as minimal increases and decrease over the length of the Project.

Table 5.1: Overall Project Climate Change Trends

Climate Factor	Trend	Justification
Frequency of Drought	Unknown	While MAAT and MAP have clearly increasing trends, and the number of consecutive dry days is found to be decreasing, there is not sufficient information to predict the future frequency of drought. The anecdotal information does however suggest that frequency of drought is likely decreasing.
Frequency of Extreme Temperatures	Unknown	Possible increase in extreme temperatures, but the strength of the trend is unknown.
Frequency of Rainfall	Increasing	Trend is assumed to increase due to increasing trends in precipitation days and total precipitation.
Heavy Rain	Increasing	Increase in heavy rainfall of 24% and 22% at Doris (and Madrid), and Boston, respectively.
Total Rainfall	Increasing	Increase in total precipitation of 42 mm (19%) and 47 mm (18%) by 2100 at Doris (and Madrid), and Boston respectively.
Snow Accumulation	Unknown	Snow depth appears to be decreasing, but the trend is unclear due to unknown distribution of precipitation events in the future.
Snowmelt	Unknown	There is a predicted decrease in maximum daily snowmelt in an average year and the maximum daily snowmelt per month for both Doris (and Madrid), and Boston. However, the overall trend in snowmelt is unclear due to unknown distribution of precipitation events in the future. Rain on snow events could increase the predicted snow melt.
Floods and Storms	Unknown, likely increasing	Increasing temperature, precipitation, and heavy rainfall trends to 2100 and increasing storm intensities in the 2011-2040 time period suggest that storms are increasing. Therefore it is likely reasonable to assume that storms and floods will increase by 2100.
Lake Evaporation	Increasing	Increase in annual evaporation is expected in +0.8 mm/yr and +0.7 mm/yr for Doris (and Madrid), and Boston, respectively.
Average Temperature	Increasing	Increase in MAAT of 5.5°C and 6.8°C by 2100 at Doris (and Madrid), and Boston, respectively.
Active Layer	Increasing	Active layer thickness is expected to increase as temperatures are expected to increase. The depth and extent of this increase will be variable as it is dependent on many factors including material, and snow cover.

This final report, “Hope Bay Project Climate Change Analysis”, was prepared by SRK Consulting (Canada) Inc.



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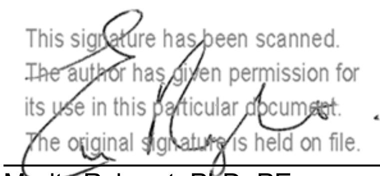

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All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

6 References

Arctic Council and International Arctic Science Committee (ACIASC). 2005. Arctic Climate Impact Assessment. Website: http://www.acia.uaf.edu/.

Comprehensive R Archive Network (CRAN). 2015. Download, source code for the language R. Website: https://cran.r-project.org/.

Canadian Standards Association (CSA). 2012. National Survey of Canada's Infrastructure Engineers about Climate Change. Report Prepared for the Canadian Standards Association for Engineers Canada.

Environmental Adaptation Research Group (EARG). 1998. Climate Change Impacts on Permafrost Engineering Design. Funding provided by Panel on Energy Research and Development (PERD). 42 pp.

Environment Canada (EC). 2015. The Canadian Regional Climate Model (CRCM), website: http://www.ec.gc.ca/ccmac-cccma/default.asp?lang=en&n=82DD0FCC-1.

European Centre for Medium-Range Weather Forecast (ECMRWF). 2015. Era Interim. Website: http://www.ecmwf.int/en/research/climate-reanalysis/era-interim.

International Association for Impact Assessment (IAIA). 2010. Climate Change and Impact Assessment. Special Symposium. Washington, D.C. Symposium Report.

Intergovernmental Panel on Climate Change (IPCC). 1995. IPCC Second Assessment Climate Change 1995. A report of the intergovernmental panel on climate change.

Intergovernmental Panel on Climate Change (IPCC). 2001. Climate Change 2001: Synthesis Report. A Contribution of Working Groups I, II, and III to the Third Assessment Report of the Intergovernmental Panel on Climate Change [Watson, R.T. and the Core Writing Team (eds.)]. Cambridge University Press, Cambridge, United Kingdom, and New York, NY, USA, 398 pp.

Intergovernmental Panel on Climate Change (IPCC). 2007. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp.

Intergovernmental Panel on Climate Change (IPCC). 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

Koenker, R. W. and Bassett, G. W. 1978. Regression quantiles, *Econometrica*, Vol N°46, 33–50.

Maidment, D. 1993. Handbook of Hydrology. McGraw-Hill.

Mann, H.B. 1945. Non-parametric tests against trend, Econometrica Vol N°13:163-171.

Public Infrastructure and Engineering Vulnerability Committee (PIEVC). 2011. PIEVC Engineering Protocol for Climate Change Infrastructure Vulnerability Assessment. Version 10 Beta.

Sen, P.K., 1968. Estimates of the Regression Coefficient Based on Kendall's Tau. Journal of the American Statistical Association Vol. 63, No. 324: 1379-1389.

Smith, S.L., and Burgess, M.M. 1998. Mapping the sensitivity of Canadian permafrost to climate warming, Current Research Geological Survey of Canada 1998-E. p. 163–191.

Smith, S.L., and Burgess, M.M. 2004. Sensitivity of permafrost to climate warming in Canada. Geological Survey of Canada Bulletin 579. 24 p.

SRK Consulting (Canada) Inc. 2017a. Hope Bay Project: Climate and Hydrological Parameters Summary Report. Memo prepared for TMAC Resources Inc. Project No.: 1CT022.013. November 2017.

SRK Consulting (Canada) Inc. 2017b. Hope Bay Project: Lake Talik Configuration. Memo prepared for TMAC Resources Inc. Project No.: 1CT022.013. November 2017.

Walter, M.T., E.S. Brooks, D.K. McCool, L.G. King, M. Molnau and J. Boll. 2005. Process- based snowmelt modeling: does it require more input data than temperature-index modeling? Journal of Hydrology. 300 (2005) pp. 65- 75.

World Meteorological Organization (WMO). 2007. The Role of Climatological Normals in a changing climate. WCDMP-No 61.

Yue, S., Pilon, P., Phinney, B., and Cavadias, G. 2002. The influence of autocorrelation on the ability to detect trend in hydrological series. Hydrological Processes, 16: 1807-1829.

Zhang, X., Vincent, L.A., Hogg, W.D. and Niitsoo, A. 2000. Temperature and Precipitation Trends in Canada during the 20th Century. Atmosphere-Ocean 38(3): 395-429.

Appendix A – Project Framing

Standardized Procedure for Climate Change Integration into Engineering Design

Part 1: Framing

Proposed Surface Infrastructure			Engineering Stage				Critical Project Stage				Site and System (by Component or Element) Design Considerations			
System	**Component**	**Element**	**Scoping**	**Pre-Feasibility**	**Feasibility**	**Detailed Engineering**	**Construction**	**Operation**	**Closure**	**Post Closure**	**Design Life**	**Performance Expectation(s)** *[this is a summary of how the component or element is intended to function over the design life]*	**Site Considerations** *[this is a summary of the site specific conditions as it pertains to the component or element]*	**Design Considerations** *[this is a summary of the design criteria included to attain the performance expectations of each component or element]*
Doris North TIA	North Dam	Foundation				x		x			40 Yr.	Create seal between frozen core of structure and permafrost to contain water.	Existing structure, construction completed 2012. Thick, ice rich permafrost overburden. Construction material limited to geochemically suitable quarry rock or waste rock and geosynthetics.	Frozen core dam. Required life longer than the original 25 year design life, adjustments to existing structure may be required to accommodate the longer design life. Dam breached at closure.
		Key Trench				x		x						
		Frozen Core				x		x						
		GCL				x		x						
		Transition Zone				x		x						
		Shell				x		x						
		Thermosyphons				x		x						
		Instrumentation				x		x						
		Capacity				x		x						
		Freeboard				x		x						
	South and West Dams	Foundation		x						x	> 100 Yr.	Create seal between water retaining elements of structure and permafrost to minimize leakage and seepage. Avoid progressive permafrost damage post closure.	Thick, ice rich permafrost overburden. Construction material limited to geochemically suitable quarry rock or waste rock and geosynthetics.	Frozen foundation dams with minimum fill thicknesses and key trench depth determined based on thermal model results. These are permanent structures that will remain post-closure.
		Key Trench		x						x				
		Liner		x						x				
		Transition/Filter Zone		x						x				
		Shell		x						x				
		Riprap		x						x				
		Instrumentation		x						x				
		Capacity		x						x				
		Freeboard		x						x				
	Reclaim Pond	Shoreline		x				x			40 Yr.	Store process water and contact water from tailings, up to the probable maximum flood (PMF). Minimize permanent permafrost degradation of shoreline.	Thick, ice rich permafrost overburden. Closed tailk under former lake bed. Reclaim pond will thaw permafrost above the former lake level and permanent permafrost degradation will be exposed at closure/post-closure. Construction material limited to geochemically suitable quarry rock or waste rock and geosynthetics.	Designed to store PMF. Changing water level combined with permafrost thaw could cause erosion and increase in potential suspended solids. Geotextile and rip-rap placed on steep portions of shoreline (>6%) to prevent erosion. Geotextile and rip-rap may be placed on entire thawed shoreline at closure.
		Capacity		x				x						
	Closure Cover	Material		x						x	> 100 Yr.	Avoid progressive slope or foundation movement. Prevent contact with tailings. Cover is not designed to reduce infiltration or freeze the tailings	Construction material limited to geochemically suitable quarry rock or waste rock.	Designed as a isolation cover, to prevent dust and surface erosion.
		Drainage		x						x				
		Landform		x						x				

Standardized Procedure for Climate Change Integration into Engineering Design

Part 1: Framing

Proposed Surface Infrastructure			Engineering Stage				Critical Project Stage				Site and System (by Component or Element) Design Considerations			
System	**Component**	**Element**	**Scoping**	**Pre-Feasibility**	**Feasibility**	**Detailed Engineering**	**Construction**	**Operation**	**Closure**	**Post Closure**	**Design Life**	**Performance Expectation(s)** *[this is a summary of how the component or element is intended to function over the design life]*	**Site Considerations** *[this is a summary of the site specific conditions as it pertains to the component or element]*	**Design Considerations** *[this is a summary of the design criteria included to attain the performance expectations of each component or element]*
Boston TIA	Dry Stack	Foundation		x						x	>100 Yr.	Avoid progressive slope or foundation movement. Prevent/reduce neutral metal leaching.	Thick, ice rich permafrost overburden. Construction material limited to geochemically suitable quarry rock or waste rock and geosynthetics.	Geomembrane cover over tailings to reduce infiltration of water. Differential settlement of tailings under cover could cause damage and failure of cover.
		Slopes		x						x				
		Drainage		x						x				
		Tailings		x						x				
	Closure Cover	Material		x						x				
		Drainage		x						x				
		Landform		x						x				
Waste Rock Storage Area(s)	Waste Rock	Foundation		x				x			20 Yr.	Maintain stable foundation and prevent permafrost degradation. Provide barrier between waste rock and ground surface.	Thick, ice rich permafrost overburden. Construction material limited to geochemically suitable quarry rock or waste rock.	No cut, waste rock located on 1 m thick run-of-quarry material pad. No stripping of organics or tundra vegetation prior to material placement. Waste rock relocated to underground prior to closure, pad remains in perpetuity. Final landform should shed show and water.
		Slopes		x				x						
		Drainage		x				x						
	Pad	Material		x				x			>100Yr.			
		Landform		x				x						
Ore Stockpile Area(s)	Ore	Foundation		x				x			20 Yr.	Maintain stable foundation and prevent permafrost degradation. Provide barrier between ore and ground surface.	Thick, ice rich permafrost overburden. Construction material limited to geochemically suitable quarry rock or waste rock.	No cut, ore located on minimum 1 m thick run-of-quarry material pad. No stripping of organics or tundra vegetation prior to material placement. Ore processed prior to closure, pad remains in perpetuity. Final landform should shed show and water.
		Slopes		x				x						
		Drainage		x				x						
	Pad	Material		x				x			>100 Yr.			
		Landform		x				x						
Event Ponds (Contact Water)	Contact Water Containment Berms	Foundation		x				x			20 Yr.	Create seal between water retaining elements of structure and permafrost to minimize leakage and seepage. Avoid progressive permafrost damage post closure.	Thick, ice rich permafrost overburden. Construction material limited to geochemically suitable quarry rock or waste rock and geosynthetics.	Fill structure within minimum fill thickness to ensure contact between geomembrane and foundation soils remains frozen. Excavation into tundra only at the geomembrane tie-in, in this area tundra vegetation and organic material is removed to create a clean contact between the geomembrane and the foundation soils. Dams breached at closure, remainder of dam remains in perpetuity.
		Key Trench		x				x						
		Liner		x				x						
		Shell		x				x						
		Instrumentation		x				x						
		Capacity		x				x						
		Freeboard		x				x						
	Basin	Foundation		x				x			20 Yr.	Maintain vegetation to prevent degradation of permafrost, to avoid permafrost damage during operations which would continue to degrade in the closure and post-closure phases.	Thick, ice rich permafrost overburden, with tundra vegetation.	Storage of water within the pond, ponds should be pumped dry immediately after a storm event. Care should be taken during construction and operation to prevent damage to tundra vegetation and the underlying permafrost. Unlined ponds.
		Vegetation		x				x						
		Instrumentation		x				x						
Sedimentation Ponds	Non-Contact Water Berms	Foundation		x				x			20 Yr.	Allow the slow seepage of water through the berm to reduce sediments. Avoid progressive permafrost damage.	Thick, ice rich permafrost overburden. Construction material limited to geochemically suitable quarry rock or waste rock and geosynthetics.	Fill construction only, with no stripping of tundra vegetation or organics prior to fill placement. Berm breached at closure, with remainder of fill remaining in perpetuity.
		Shell		x				x						
		Capacity		x				x						

Standardized Procedure for Climate Change Integration into Engineering Design

Part 1: Framing

Proposed Surface Infrastructure			Engineering Stage				Critical Project Stage				Site and System (by Component or Element) Design Considerations			
System	**Component**	**Element**	**Scoping**	**Pre-Feasibility**	**Feasibility**	**Detailed Engineering**	**Construction**	**Operation**	**Closure**	**Post Closure**	**Design Life**	**Performance Expectation(s)** *[this is a summary of how the component or element is intended to function over the design life]*	**Site Considerations** *[this is a summary of the site specific conditions as it pertains to the component or element]*	**Design Considerations** *[this is a summary of the design criteria included to attain the performance expectations of each component or element]*
Water Diversions	Non-Contact Water Diversion Berm(s)	Foundation		x				x			20 Yr.	Create seal between water retaining elements of structure and permafrost to minimize leakage and seepage. Avoid progressive permafrost damage post closure.	Thick, ice rich permafrost overburden. Construction material limited to geochemically suitable quarry rock or waste rock and geosynthetics.	Fill structure within minimum fill thickness to ensure contact between geomembrane and foundation soils remains frozen. Excavation into tundra only at the geomembrane tie-in, in this area tundra vegetation and organic material is removed to create a clean contact between the geomembrane and the foundation soils. Berms breached at closure, remainder of berm remains in place for perpetuity.
		Fill		x				x						
		Riprap		x				x						
		Liner		x				x						
		Capacity		x				x						
	Contact Water Diversion Berm(s)	Foundation		x				x						
		Fill		x				x						
		Riprap		x				x						
		Liner		x				x						
		Capacity		x				x						
Fuel Containment Areas	Secondary Containment Areas	Foundation		x				x			30 Yr.	Contain all water from design events and fuel leaks, avoid progressive permafrost damage post-closure.	Thick, ice rich permafrost overburden. Construction material limited to geochemically suitable quarry rock or waste rock and geosynthetics.	Tank portion founded on bedrock, located on infrastructure pads. Provides containment for 110% of largest fuel tank and water from the 1 in 100 year, 24 hour storm event plus the average maximum daily runoff.
		Liner		x				x						
		Surfacing Material		x				x						
		Capacity		x				x						
		Sump		x				x						
All-Weather Airstrips	Airstrip and Apron	Foundation		x				x			25 Yr.	Limit increase in depth of active layer so as to minimize ongoing airstrip and apron maintenance during operation and avoid progressive permafrost damage post closure.	Thick, ice rich permafrost overburden. Construction material limited to geochemically suitable quarry rock or waste rock.	Fill construction only, unless in bedrock, with no stripping of tundra vegetation or organics prior to fill placement. Minimum fill thickness of 2 m. Fill remains in place in perpituity.
		Cut		x				x						
		Fill		x				x						
		Availability		x				x						
	Culvert (non-fish bearing)	Foundation		x				x			25 Yr.	Pass design flood. Limit increase in depth of active layer so as to minimize ongoing airstrip and apron maintenance during operation and avoid progressive permafrost damage post closure.	Thick, ice rich permafrost overburden. Construction material limited to geochemically suitable quarry rock or waste rock.	Mild steel or PVC culverts, which are placed directly on the tundra, with no cut into overburden materials or removal of tundra vegetation and organics. Culverts are removed at closure. Placement of culverts under the airstrip should be avoided if possible.
		Material		x				x						
		Capacity		x				x						
	Culvert (fish bearing)	Foundation		x				x			25 Yr.	Pass design flood. Allow fish passage. Limit increase in depth of active layer so as to minimize ongoing airstrip and apron maintenance during operation and avoid progressive permafrost damage post closure.	Thick, ice rich permafrost overburden. Construction material limited to geochemically suitable quarry rock or waste rock.	Mild steel or PVC culverts, which are placed directly on the tundra, with no cut into overburden materials or removal of tundra vegetation and organics. Culverts are removed at closure. Placement of culverts under the airstrip should be avoided if possible.
		Material		x				x						
		Capacity		x				x						

Standardized Procedure for Climate Change Integration into Engineering Design

Part 1: Framing

Proposed Surface Infrastructure			Engineering Stage				Critical Project Stage				Site and System (by Component or Element) Design Considerations			
System	**Component**	**Element**	**Scoping**	**Pre-Feasibility**	**Feasibility**	**Detailed Engineering**	**Construction**	**Operation**	**Closure**	**Post Closure**	**Design Life**	**Performance Expectation(s)** *[this is a summary of how the component or element is intended to function over the design life]*	**Site Considerations** *[this is a summary of the site specific conditions as it pertains to the component or element]*	**Design Considerations** *[this is a summary of the design criteria included to attain the performance expectations of each component or element]*
All-Weather Roads	Road	Foundation		x				x			20 Yr.	Limit increase in depth of active layer so as to minimize ongoing road maintenance during operation and avoid progressive permafrost damage post closure.	Thick, ice rich permafrost overburden. Construction material limited to geochemically suitable quarry rock or waste rock.	Fill construction only, unless in bedrock, with no stripping of tundra vegetation or organics prior to fill placement. Minimum fill thickness of 1 m. Fill remains in place in perpetuity.
		Cut		x				x						
		Fill		x				x						
	Bridges	Foundation		x				x			20 Yr.	Pass design event. Limit increase in depth of active layer so as to minimize ongoing maintenance during operation and avoid progressive permafrost damage post closure.	Thick, ice rich permafrost overburden. Construction material limited to geochemically suitable quarry rock or waste rock.	Prefabricated steel girder bridges with maximum length of 20 m. Minimum fill thickness of 2 m at bridge abutments. Pad or end bearing pile foundations depending on stream geometry. Bridges and headwall removed at closure, and piles cut and covered. Abutment fill remains in place in perpetuity.
		Rip-rap		x				x						
		Wall		x				x						
		Material		x				x						
		Capacity		x				x						
	Culvert (non-fish bearing)	Foundation		x				x			20 Yr.	Pass design flood, and allow for fish passage, if fish bearing crossing. Limit increase in depth of active layer so as to minimize ongoing road maintenance during operation and avoid progressive permafrost damage post closure.	Thick, ice rich permafrost overburden. Construction material limited to geochemically suitable quarry rock or waste rock.	Mild steel or PVC culverts, which are placed directly on the tundra, with no cut into overburden materials or removal of tundra vegetation and organics. Maximum slope based on fish passage requirements. Culverts are removed at closure.
		Material		x				x						
		Capacity		x				x						
	Culvert (fish bearing)	Foundation		x				x			20 Yr.	Pass design flood, and allow for fish passage, if fish bearing crossing. Limit increase in depth of active layer so as to minimize ongoing road maintenance during operation and avoid progressive permafrost damage post closure.	Thick, ice rich permafrost overburden. Construction material limited to geochemically suitable quarry rock or waste rock.	Mild steel or PVC culverts, which are placed directly on the tundra, with no cut into overburden materials or removal of tundra vegetation and organics. Maximum slope based on fish passage requirements. Culverts are removed at closure.
		Material		x				x						
		Capacity		x				x						
Building Foundation/ Laydown Pads	Pads	Foundation		x				x			20 Yr.	Limit increase in depth of active layer so as to minimize ongoing pad maintenance during operation and avoid progressive permafrost damage post closure.	Thick, ice rich permafrost overburden. Construction material limited to geochemically suitable quarry rock or waste rock.	Fill construction only, unless in bedrock, with no stripping of tundra vegetation or organics prior to fill placement. Minimum fill thickness of 1 m. Heated buildings should be raised above ground surface to allow airflow or include foundation insulation to prevent permafrost thaw. Fill remains in place in perpetuity.
		Cut		x				x						
		Fill		x				x						
	Culvert (non-fish bearing)	Foundation		x				x			20 Yr.	Pass design flood. Limit increase in depth of active layer so as to minimize ongoing pad maintenance during operation and avoid progressive permafrost damage post closure.	Thick, ice rich permafrost overburden. Construction material limited to geochemically suitable quarry rock or waste rock.	Mild steel or PVC culverts, which are placed directly on the tundra, with no cut into overburden materials or removal of tundra vegetation and organics. Maximum slope based on fish passage requirements. Culverts are removed at closure.
		Material		x				x						
		Capacity		x				x						
	Culvert (fish bearing)	Foundation		x				x			20 Yr.	Pass design flood. Allow fish passage. Limit increase in depth of active layer so as to minimize ongoing pad maintenance during operation and avoid progressive permafrost damage post closure.	Thick, ice rich permafrost overburden. Construction material limited to geochemically suitable quarry rock or waste rock.	Mild steel or PVC culverts, which are placed directly on the tundra, with no cut into overburden materials or removal of tundra vegetation and organics. Maximum slope based on fish passage requirements. Culverts are removed at closure.
		Material		x				x						
		Capacity		x				x						

Appendix B – Project Screening

Standardized Procedure for Climate Change Integration into Engineering Design

Part 2: Screening

Proposed Surface Infrastructure — Climate Parameter / Event

System	Component	Element	Air Temperature: Will Parameter Impact Design?	Likelihood (L)	Consequence (C)	Define Consequence *[summarize what consequence are being considered to provide context]*	Risk [R = L x C]	Should Design Consider Climate change?	Precipitation (Rainfall): Will Parameter Impact Design?	Likelihood (L)	Consequence (C)	Define Consequence *[summarize what consequence are being considered to provide context]*	Risk [R = L x C]	Should Design Consider Climate change?
Doris North TIA	North Dam	Foundation	Y	2	4	Warming leading to leakage and/or deformation	8	Yes	N	2	3	Rainfall change energy balance which changes thermal response	6	No
		Key Trench	Y	2	4	Warming leading to leakage	8	Yes	N				0	No
		Frozen Core	Y	3	4	Thawing leading to leakage	12	Yes	Y	2	3	Rainfall change energy balance which changes thermal response	6	No
		GCL	N				0	No	N				0	No
		Transition Zone	N				0	No	N				0	No
		Shell	N				0	No	N				0	No
		Thermosyphons	Y	5	2	Increased winter air temperature reduces effectiveness	10	Yes	N				0	No
		Instrumentation	N	3	2		6	No	N				0	No
		Capacity	Y	2	3	Increase in ice entrainment	6	No	Y	2	4	More rain leads to overtopping	8	Yes
		Freeboard	Y	2	3	Increase in ice entrainment	6	No	Y	2	4	More rain leads to overtopping	8	Yes
	South and West Dams	Foundation	Y	3	4	Warming leading to leakage and/or deformation	12	Yes	Y	2	3	Rainfall change energy balance which changes thermal response	6	No
		Key Trench	N				0	No	N				0	No
		Liner	Y	2	4	deformation leading to liner failure	8	Yes	N				0	No
		Transition/Filter Zone	N				0	No	N				0	No
		Shell	N				0	No	N				0	No
		Riprap	N				0	No	N				0	No
		Instrumentation	N				0	No	N				0	No
		Capacity	Y	2	3	Increase in ice entrainment	6	No	Y	2	2	More rain leads to overtopping	4	No
		Freeboard	Y	2	3	Increase in ice entrainment	6	No	Y	2	2	More rain leads to overtopping	4	No
	Reclaim Pond	Shoreline	N				0	No	Y	3	3	More rain leads to larger area thawing	9	Yes
		Capacity	Y	1	3	Decreased temperature leads to thicker ice thickness, which could lead to overtopping during spring events	3	No	Y	3	4	More rain leads to overtopping	12	Yes
	Closure Cover	Material	Y	3	3	Increased air temperature could increase oxidation	9	Yes	Y	2	3	Decreased precipitation could increase metals concentrations in runoff	6	No
		Drainage	Y	3	2	Increased temperature can result in local thaw settlement, resulting in local ponding	6	No	N				0	No
		Landform	Y	3	2	Melting ice causes settlement	6	No	Y	4	2	Increased precipitation increases erosion	8	Yes
Boston TIA	Dry Stack	Foundation	Y	3	3	Thaw leading to failure	9	Yes	N				0	No
		Slopes	Y	2	3	Thaw leading to failure	6	No	N				0	No
		Drainage	N				0	No	N				0	No
		Tailings	N				0	No	Y	1	1	Decreased rainfall could lead to increase in dust	1	No
		Material	Y	5	1	Thicker active layer increases oxidation zone	5	No	N				0	No

System	Component	Element	Precipitation (Snowfall): Will Parameter Impact Design?	Likelihood (L)	Consequence (C)	Define Consequence *[summarize what consequence are being considered to provide context]*	Risk [R = L x C]	Should Design Consider Climate change?	Precipitation (Extreme Events): Will Parameter Impact Design?	Likelihood (L)	Consequence (C)	Define Consequence *[summarize what consequence are being considered to provide context]*	Risk [R = L x C]	Should Design Consider Climate change?
Doris North TIA	North Dam	Foundation	Y	3	2	More or less snow could affect insulation	6	No	N				0	No
		Key Trench	N				0	No	N				0	No
		Frozen Core	Y	3	2	More or less snow could affect insulation	6	No	N				0	No
		GCL	N				0	No	N				0	No
		Transition Zone	N				0	No	N				0	No
		Shell	N				0	No	N				0	No
		Thermosyphons	N				0	No	N				0	No
		Instrumentation	N				0	No	N				0	No
		Capacity	Y	2	4	Higher snowfall may cause overtopping	8	Yes	Y	2	4	Increased precipitation leads to overtopping	8	Yes
		Freeboard	Y	2	4	Higher snowfall may cause overtopping	8	Yes	Y	2	4	Increased precipitation leads to overtopping	8	Yes
	South and West Dams	Foundation	Y	3	2	More or less snow could affect insulation	6	No	N				0	No
		Key Trench	N				0	No	N				0	No
		Liner	N				0	No	N				0	No
		Transition/Filter Zone	N				0	No	N				0	No
		Shell	N				0	No	N				0	No
		Riprap	N				0	No	N				0	No
		Instrumentation	N				0	No	N				0	No
		Capacity	Y	2	2	Higher snowfall may cause overtopping	4	No	Y	2	2	Larger storms could lead to erosion damage	4	No
		Freeboard	Y	2	2	Higher snowfall may cause overtopping	4	No	Y	2	2	Larger storms could lead to erosion damage	4	No
	Reclaim Pond	Shoreline	N				0	No	Y	3	2	Larger storms could lead to erosion damage	6	No
		Capacity	Y	3	3	Higher snowfall may cause overtopping	9	Yes	Y	2	4	Larger storms/ higher PMP could lead to overtopping	8	Yes
	Closure Cover	Material	N				0	No	N				0	No
		Drainage	Y	2	2	Higher snowfall may block drainage channels	4	No	N				0	No
		Landform	Y	3	2	Increased snowmelt may lead to increased erosion	6	No	Y	3	2	Larger storms could lead to erosion damage	6	No
Boston TIA	Dry Stack	Foundation	N				0	No	N				0	No
		Slopes	N				0	No	N				0	No
		Drainage	N				0	No	Y	2	2	Larger storms could lead to erosion damage	4	No
		Tailings	N				0	No	N				0	No
		Material	N				0	No	N				0	No

System	Component	Element	Evaporation: Will Parameter Impact Design?	Likelihood (L)	Consequence (C)	Define Consequence *[summarize what consequence are being considered to provide context]*	Risk [R = L x C]	Should Design Consider Climate change?	Wind Speed: Will Parameter Impact Design?	Likelihood (L)	Consequence (C)	Define Consequence *[summarize what consequence are being considered to provide context]*	Risk [R = L x C]	Should Design Consider Climate change?
Doris North TIA	North Dam	Foundation	Y	1	2	energy balance which affects thermal response	2	No	Y	1	2	change snow distribution and insulation	2	No
		Key Trench	N				0	No	N				0	No
		Frozen Core	Y	2	2	Evaporation changes energy balance which affects thermal response	4	No	N	2	2	Different winds can change snow distribution and insulation	4	No
		GCL	N				0	No	N				0	No
		Transition Zone	N				0	No	N				0	No
		Shell	N				0	No	N				0	No
		Thermosyphons	N				0	No	Y	2	2	Lower wind speed could lead to lowered performance	4	No
		Instrumentation	N				0	No	N				0	No
		Capacity	Y	2	2	Lower evaporation leading to overtopping	4	No	Y	2	4	Higher wind leads up to wave run-up overtopping	8	Yes
		Freeboard	Y	2	2	Lower evaporation leading to overtopping	4	No	Y	2	4	Higher wind leads up to wave run-up overtopping	8	Yes
	South and West Dams	Foundation	Y	1	2	Evaporation changes energy balance which affects thermal response	2	No	N				0	No
		Key Trench	N				0	No	N				0	No
		Liner	N				0	No	N				0	No
		Transition/Filter Zone	N				0	No	N				0	No
		Shell	N				0	No	N				0	No
		Riprap	N				0	No	Y	2	4	Higher wind may cause erosion leading to piping failure	8	Yes
		Instrumentation	N				0	No	N				0	No
		Capacity	Y	1	2	Lower evaporation leading to overtopping	2	No	Y	1	2	High wind speed may cause erosion which leads to failure	2	No
		Freeboard	Y	1	2	Lower evaporation leading to overtopping	2	No	Y	1	2	High wind speed may cause erosion which leads to failure	2	No
	Reclaim Pond	Shoreline	N				0	No	Y	3	2	Higher winds increases waves and erosion	6	No
		Capacity	Y	2	4	Lower evaporation leading to overtopping	8	Yes	N				0	No
	Closure Cover	Material	N				0	No	N				0	No
		Drainage	N				0	No	N				0	No
		Landform	N				0	No	N				0	No
Boston TIA	Dry Stack	Foundation	N				0	No	N				0	No
		Slopes	N				0	No	N				0	No
		Drainage	N				0	No	N				0	No
		Tailings	Y	1	2	Higher evaporation leads to more dust	2	No	Y	2	3	Increased wind speed results in more dust during operations	6	No
		Material	N				0	No	N				0	No

System	Component	Element	Growing Season Length: Will Parameter Impact Design?	Likelihood (L)	Consequence (C)	Define Consequence *[summarize what consequence are being considered to provide context]*	Risk [R = L x C]	Should Design Consider Climate change?
Doris North TIA	North Dam	Foundation	N				0	No
		Key Trench	N				0	No
		Frozen Core	N				0	No
		GCL	N				0	No
		Transition Zone	N				0	No
		Shell	N				0	No
		Thermosyphons	Y	5	2	Longer growing season, likely means a shorter operational period	10	Yes
		Instrumentation	N				0	No
		Capacity	N				0	No
		Freeboard	N				0	No
	South and West Dams	Foundation	N				0	No
		Key Trench	N				0	No
		Liner	N				0	No
		Transition/Filter Zone	N				0	No
		Shell	N				0	No
		Riprap	N				0	No
		Instrumentation	N				0	No
		Capacity	N				0	No
		Freeboard	N				0	No
	Reclaim Pond	Shoreline	N				0	No
		Capacity	N				0	No
	Closure Cover	Material	N				0	No
		Drainage	N				0	No
		Landform	N				0	No
Boston TIA	Dry Stack	Foundation	N				0	No
		Slopes	N				0	No
		Drainage	N				0	No
		Tailings	N				0	No
		Material	N				0	No

Standardized Procedure for Climate Change Integration into Engineering Design

Part 2: Screening

Proposed Surface Infrastructure / Climate Parameter / Event

Proposed Surface Infrastructure			Air Temperature						Precipitation (Rainfall)					
System	Component	Element	Will Parameter Impact Design?	Likelihood (L)	Consequence (C)	Define Consequence [summarize what consequence are being considered to provide context]	Risk [R = L x C]	Should Design Consider Climate change?	Will Parameter Impact Design?	Likelihood (L)	Consequence (C)	Define Consequence [summarize what consequence are being considered to provide context]	Risk [R = L x C]	Should Design Consider Climate change?
	Closure Cover	Drainage	Y	2	2	Increased temperature can result in local thaw settlement, resulting in local ponding	4	No	N				0	No
		Landform	Y	2	2	Melting ice causes settlement	4	No	Y	4	2	More rainfall leads to higher erosion	8	Yes
Waste Rock Storage Area(s)	Waste Rock	Foundation	Y	2	3	Thaw leading to failure	6	No	N				0	No
		Slopes	Y	2	3	Thaw leading to failure	6	No	N				0	No
		Drainage	N				0	No	N				0	No
	Pad	Material	Y	4	1	Increased temperature will result in higher oxidation rates	4	No	N				0	No
		Landform	Y	4	2	Thaw leading to settlement	8	Yes	N				0	No
Ore Stockpile Area(s)	Ore	Foundation	Y	2	3	Thaw leading to failure	6	No	N				0	No
		Slopes	Y	2	3	Thaw leading to failure	6	No	N				0	No
		Drainage	N				0	No	N				0	No
	Pad	Material	Y	4	1	Increased temperature will result in higher oxidation rates	4	No	N				0	No
		Landform	Y	4	2	Thaw leading to settlement	8	Yes	N				0	No
Event Ponds (Contact Water)	Contact Water Containment Berms	Foundation	Y	5	4	Thaw leading to leakage	20	Yes	N				0	No
		Key Trench	Y	5	4	Thaw leading to leakage	20	Yes	N				0	No
		Liner	N				0	No	N				0	No
		Shell	N				0	No	N				0	No
		Instrumentation	N				0	No	N				0	No
		Capacity	N				0	No	Y	2	4	More rain leads to overtopping	8	Yes
		Freeboard	N				0	No	Y	2	4	More rain leads to overtopping	8	Yes
	Basin	Foundation	Y	3	2	Thaw leading to permanent degradation	6	No	Y	2	2	More rain leads to more periods of inundation	4	No
		Vegetation	N				0	No	Y	2	2	More rain leads to more periods of vegetation inundation	4	No
		Instrumentation	N				0	No	N				0	No
Sedimentation Ponds	Non-Contact Water Berms	Foundation	Y	4	1	Increased temperature will	4	No	N				0	No
		Shell	N				0	No	N				0	No
		Capacity	N				0	No	Y	1	2	More rain leads to overtopping	2	No
Water Diversions	Non-Contact Water Diversion Berm(s)	Foundation	Y	4	1	Increased temperature will cause permafrost degradation	4	No	N				0	No
		Fill	N				0	No	N				0	No
		Riprap	N				0	No	N				0	No
		Liner	N				0	No	N				0	No
		Capacity	N				0	No	Y	3	2	Higher rainfall may cause overtopping	6	No
	Contact Water Diversion Berm(s)	Foundation	Y	4	1	Increased temperature will cause permafrost degradation	4	No	N				0	No
		Fill	N				0	No	N				0	No
		Riprap	N				0	No	N				0	No
		Liner	N				0	No	N				0	No
		Capacity	N				0	No	Y	3	3	Higher rainfall may cause overtopping	9	Yes

Proposed Surface Infrastructure			Precipitation (Snowfall)						Precipitation (Extreme Events)					
System	Component	Element	Will Parameter Impact Design?	Likelihood (L)	Consequence (C)	Define Consequence [summarize what consequence are being considered to provide context]	Risk [R = L x C]	Should Design Consider Climate change?	Will Parameter Impact Design?	Likelihood (L)	Consequence (C)	Define Consequence [summarize what consequence are being considered to provide context]	Risk [R = L x C]	Should Design Consider Climate change?
	Closure Cover	Drainage	Y	2	2	Higher snowfall may block drainage channels	4	No	N				0	No
		Landform	N				0	No	N				0	No
Waste Rock Storage Area(s)	Waste Rock	Foundation	N				0	No	N				0	No
		Slopes	N				0	No	N				0	No
		Drainage	N				0	No	N				0	No
	Pad	Material	N				0	No	N				0	No
		Landform	N				0	No	N				0	No
Ore Stockpile Area(s)	Ore	Foundation	N				0	No	N				0	No
		Slopes	N				0	No	N				0	No
		Drainage	N				0	No	N				0	No
	Pad	Material	N				0	No	N				0	No
		Landform	N				0	No	N				0	No
Event Ponds (Contact Water)	Contact Water Containment Berms	Foundation	N				0	No	N				0	No
		Key Trench	N				0	No	N				0	No
		Liner	N				0	No	N				0	No
		Shell	N				0	No	N				0	No
		Instrumentation	N				0	No	N				0	No
		Capacity	Y	3	3	Higher snowfall may cause overtopping	9	Yes	Y	3	4	Increased precipitation leads to overtopping	12	Yes
		Freeboard	Y				0	No	N				0	No
	Basin	Foundation	N				0	No	N				0	No
		Vegetation	N				0	No	N				0	No
		Instrumentation	N				0	No	N				0	No
Sedimentation Ponds	Non-Contact Water Berms	Foundation	N				0	No	N				0	No
		Shell	N				0	No	N				0	No
		Capacity	Y	3	2	Higher snowfall may cause overtopping	6	No	Y	2	2	Large precipitation event leads to overtopping	4	No
Water Diversions	Non-Contact Water Diversion Berm(s)	Foundation	N				0	No	N				0	No
		Fill	N				0	No	N				0	No
		Riprap	N				0	No	N				0	No
		Liner	N				0	No	N				0	No
		Capacity	Y	3	2	Higher snowfall may cause overtopping	6	No	Y	2	2	Large precipitation event leads to overtopping	4	No
	Contact Water Diversion Berm(s)	Foundation	Y	1	1	More or less snow could affect insulation	1	No	N				0	No
		Fill	N				0	No	N				0	No
		Riprap	N				0	No	N				0	No
		Liner	N				0	No	N				0	No
		Capacity	Y	3	3	Higher snowfall may cause overtopping	9	Yes	Y	2	3	Large precipitation event leads to overtopping	6	No

Proposed Surface Infrastructure			Evaporation						Wind Speed						Growing Season Length					
System	Component	Element	Will Parameter Impact Design?	Likelihood (L)	Consequence (C)	Define Consequence [summarize what consequence are being considered to provide context]	Risk [R = L x C]	Should Design Consider Climate change?	Will Parameter Impact Design?	Likelihood (L)	Consequence (C)	Define Consequence [summarize what consequence are being considered to provide context]	Risk [R = L x C]	Should Design Consider Climate change?	Will Parameter Impact Design?	Likelihood (L)	Consequence (C)	Define Consequence [summarize what consequence are being considered to provide context]	Risk [R = L x C]	Should Design Consider Climate change?
	Closure Cover	Drainage	N				0	No	N				0	No	N				0	No
		Landform	N				0	No	N				0	No	N				0	No
Waste Rock Storage Area(s)	Waste Rock	Foundation	N				0	No	N				0	No	N				0	No
		Slopes	N				0	No	N				0	No	N				0	No
		Drainage	N				0	No	N				0	No	N				0	No
	Pad	Material	N				0	No	N				0	No	N				0	No
		Landform	N				0	No	N				0	No	N				0	No
Ore Stockpile Area(s)	Ore	Foundation	N				0	No	N				0	No	N				0	No
		Slopes	N				0	No	N				0	No	N				0	No
		Drainage	N				0	No	N				0	No	N				0	No
	Pad	Material	N				0	No	N				0	No	N				0	No
		Landform	N				0	No	N				0	No	N				0	No
Event Ponds (Contact Water)	Contact Water Containment Berms	Foundation	N				0	No	N				0	No	N				0	No
		Key Trench	N				0	No	N				0	No	N				0	No
		Liner	N				0	No	N				0	No	N				0	No
		Shell	N				0	No	N				0	No	N				0	No
		Instrumentation	N				0	No	N				0	No	N				0	No
		Capacity	N				0	No	N				0	No	N				0	No
		Freeboard	N				0	No	Y	1	4	High wind speed may cause erosion which leads to failure	4	No	N				0	No
	Basin	Foundation	N				0	No	N				0	No	N				0	No
		Vegetation	N				0	No	N				0	No	Y	1	2	Decreased growing season could result in poor plant survival	2	No
		Instrumentation	N				0	No	N				0	No	N				0	No
Sedimentation Ponds	Non-Contact Water Berms	Foundation	N				0	No	N				0	No	N				0	No
		Shell	N				0	No	N				0	No	N				0	No
		Capacity	N				0	No	N				0	No	N				0	No
Water Diversions	Non-Contact Water Diversion Berm(s)	Foundation	N				0	No	N				0	No	N				0	No
		Fill	N				0	No	N				0	No	N				0	No
		Riprap	N				0	No	N				0	No	N				0	No
		Liner	N				0	No	N				0	No	N				0	No
		Capacity	N				0	No	N				0	No	N				0	No
	Contact Water Diversion Berm(s)	Foundation	N				0	No	N				0	No	N				0	No
		Fill	N				0	No	N				0	No	N				0	No
		Riprap	N				0	No	N				0	No	N				0	No
		Liner	N				0	No	N				0	No	N				0	No
		Capacity	N				0	No	N				0	No	N				0	No

Standardized Procedure for Climate Change Integration into Engineering Design

Part 2: Screening

Proposed Surface Infrastructure / Climate Parameter / Event

System	Component	Element	Air Temperature: Will Parameter Impact Design?	Likelihood (L)	Consequence (C)	Define Consequence *[summarize what consequence are being considered to provide context]*	Risk [R = L x C]	Should Design Consider Climate change?	Precipitation (Rainfall): Will Parameter Impact Design?	Likelihood (L)	Consequence (C)	Define Consequence *[summarize what consequence are being considered to provide context]*	Risk [R = L x C]	Should Design Consider Climate change?
Fuel Containment Areas	Secondary Containment Areas	Foundation	N				0	No	N				0	No
		Liner	N				0	No	N				0	No
		Surfacing Material	N				0	No	N				0	No
		Capacity	N				0	No	Y	1	4	Higher rainfall may cause overtopping	4	No
		Sump	N				0	No	Y	1	2	insufficient sump capacity	2	No
All-Weather Airstrips	Airstrip and Apron	Foundation	Y	4	1	Increased temperature will cause permafrost degradation	4	No	N				0	No
		Cut	N				0	No	N				0	No
		Fill	N				0	No	N				0	No
		Availability	N				0	No	N				0	No
	Culvert (non-fish bearing)	Foundation	Y	4	1	Increased temperature will cause permafrost degradation	4	No	N				0	No
		Material	N				0	No	N				0	No
		Capacity	Y	1	2	Colder temperatures will cause more ice blockage	2	No	Y	2	2	Increased rainfall may results in localized flooding	4	No
	Culvert (fish bearing)	Foundation	Y	4	1	Increased temperature will cause permafrost degradation	4	No	N				0	No
		Material	N				0	No	N				0	No
		Capacity	Y	1	2	Colder temperatures will cause more ice blockage	2	No	Y	2	2	Increased rainfall may results in localized flooding	4	No

System	Component	Element	Precipitation (Snowfall): Will Parameter Impact Design?	Likelihood (L)	Consequence (C)	Define Consequence *[summarize what consequence are being considered to provide context]*	Risk [R = L x C]	Should Design Consider Climate change?	Precipitation (Extreme Events): Will Parameter Impact Design?	Likelihood (L)	Consequence (C)	Define Consequence *[summarize what consequence are being considered to provide context]*	Risk [R = L x C]	Should Design Consider Climate change?
Fuel Containment Areas	Secondary Containment Areas	Foundation	N				0	No	N				0	No
		Liner	N				0	No	N				0	No
		Surfacing Material	N				0	No	N				0	No
		Capacity	Y	1	4	Higher snowfall may cause overtopping	4	No	Y	1	4	Large precipitation event coincides with fuel leak and leads to overtopping	4	No
		Sump	Y	1	2	insufficient sump capacity	2	No	Y	1	2	insufficient sump capacity	2	No
All-Weather Airstrips	Airstrip and Apron	Foundation	N				0	No	N				0	No
		Cut	N				0	No	N				0	No
		Fill	N				0	No	N				0	No
		Availability	N				0	No	N				0	No
	Culvert (non-fish bearing)	Foundation	N				0	No	N				0	No
		Material	N				0	No	N				0	No
		Capacity	Y	2	2	Increased snowfall may result in blockage and localized flooding	4	No	Y	3	2	Large precipitation event may lead to localized flooding	6	No
	Culvert (fish bearing)	Foundation	N				0	No	N				0	No
		Material	N				0	No	N				0	No
		Capacity	Y	2	2	Increased snowfall may result in blockage and localized flooding	4	No	Y	3	2	Large precipitation event may lead to localized flooding	6	No

System	Component	Element	Evaporation: Will Parameter Impact Design?	Likelihood (L)	Consequence (C)	Define Consequence *[summarize what consequence are being considered to provide context]*	Risk [R = L x C]	Should Design Consider Climate change?	Wind Speed: Will Parameter Impact Design?	Likelihood (L)	Consequence (C)	Define Consequence *[summarize what consequence are being considered to provide context]*	Risk [R = L x C]	Should Design Consider Climate change?	Growing Season Length: Will Parameter Impact Design?	Likelihood (L)	Consequence (C)	Define Consequence *[summarize what consequence are being considered to provide context]*	Risk [R = L x C]	Should Design Consider Climate change?
Fuel Containment Areas	Secondary Containment Areas	Foundation	N				0	No	N				0	No	N				0	No
		Liner	N				0	No	N				0	No	N				0	No
		Surfacing Material	N				0	No	N				0	No	N				0	No
		Capacity	N				0	No	N				0	No	N				0	No
		Sump	N				0	No	N				0	No	N				0	No
All-Weather Airstrips	Airstrip and Apron	Foundation	N				0	No	N				0	No	N				0	No
		Cut	N				0	No	N				0	No	N				0	No
		Fill	N				0	No	N				0	No	N				0	No
		Availability	Y	1	2	Increased fog	2	No	Y			Higher winds may decrease availability due to plane limitations	0	No	N				0	No
	Culvert (non-fish bearing)	Foundation	N				0	No	N				0	No	N				0	No
		Material	N				0	No	N				0	No	N				0	No
		Capacity	N				0	No	N				0	No	N				0	No
	Culvert (fish bearing)	Foundation	N				0	No	N				0	No	N				0	No
		Material	N				0	No	N				0	No	N				0	No
		Capacity	N				0	No	N				0	No	N				0	No

Standardized Procedure for Climate Change Integration into Engineering Design

Part 2: Screening

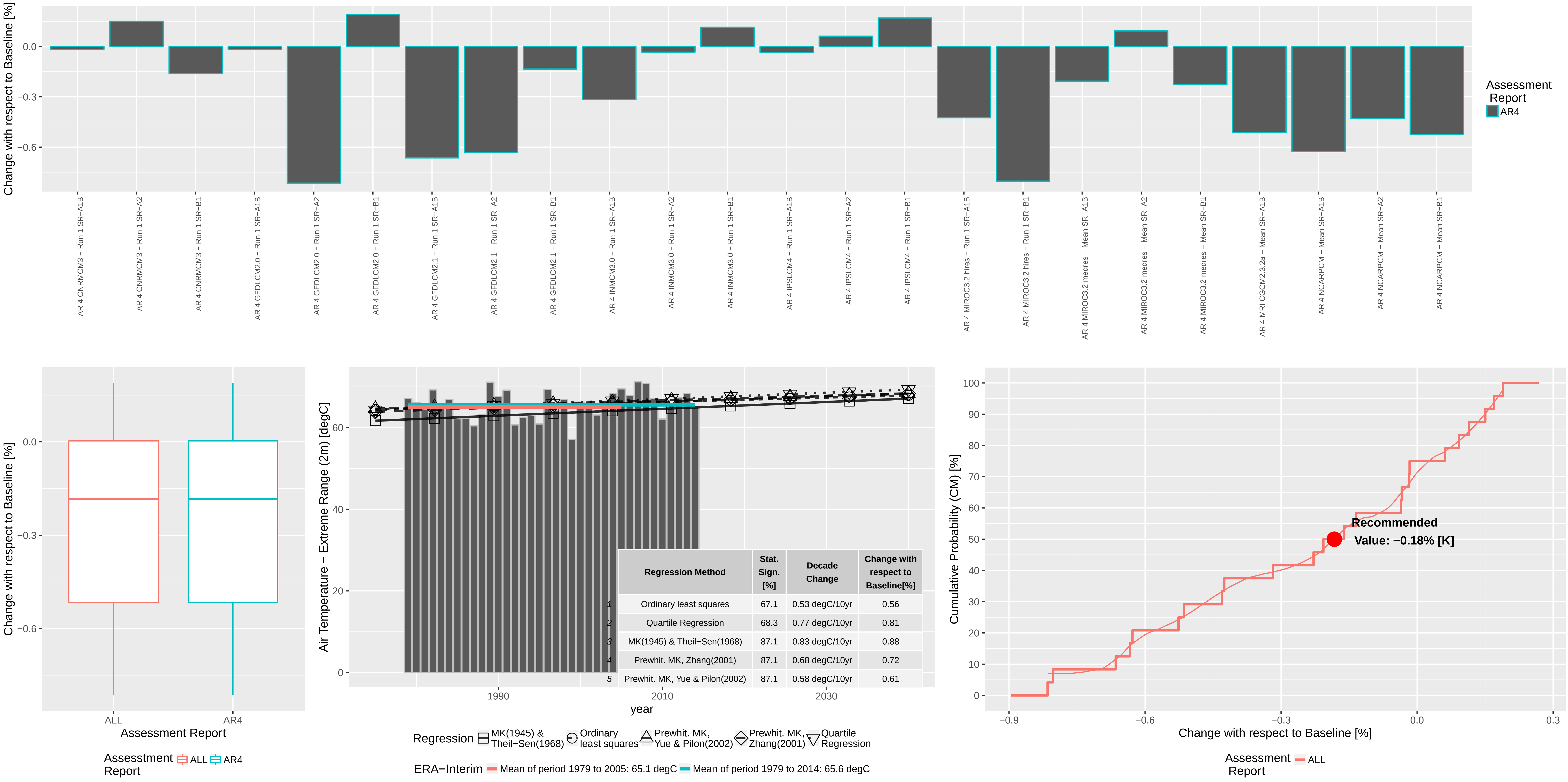
Proposed Surface Infrastructure			Climate Parameter / Event																	
			Air Temperature						Precipitation (Rainfall)						Precipitation (Snowfall)					
System	Component	Element	Will Parameter Impact Design?	Likelihood (L)	Consequence (C)	Define Consequence *[summarize what consequence are being considered to provide context]*	Risk [R = L x C]	Should Design Consider Climate change?	Will Parameter Impact Design?	Likelihood (L)	Consequence (C)	Define Consequence *[summarize what consequence are being considered to provide context]*	Risk [R = L x C]	Should Design Consider Climate change?	Will Parameter Impact Design?	Likelihood (L)	Consequence (C)	Define Consequence *[summarize what consequence are being considered to provide context]*	Risk [R = L x C]	Should Design Consider Climate change?
All-Weather Roads	Road	Foundation	Y	4	1	Increased temperature will cause permafrost degradation	4	No	N				0	No	Y	2	1	More or less snow could affect insulation	2	No
		Cut	N				0	No	N				0	No	N				0	No
		Fill	N				0	No	N				0	No	N				0	No
	Bridges	Foundation	Y	4	1	Increased temperature will cause permafrost degradation	4	No	N				0	No	Y	1	1	More or less snow could affect insulation	1	No
		Rip-rap	N				0	No	N				0	No	N				0	No
		Wall	N				0	No	N				0	No	N				0	No
		Material	N				0	No	N				0	No	N				0	No
		Capacity	Y	1	2	Colder temperatures may cause more ice blockage	2	No	Y	2	2	Increased rainfall may results in localized flooding	4	No	Y	2	2	Increased snowfall may result in blockage and localized flooding	4	No
	Culvert (non-fish bearing)	Foundation	Y	4	1	Increased temperature will cause permafrost degradation	4	No	N				0	No	Y	1	1	More or less snow could affect insulation	1	No
		Material	N				0	No	N				0	No	N				0	No
		Capacity	Y	1	2	Colder temperatures will cause more ice blockage	2	No	Y	2	2	Increased rainfall may results in localized flooding	4	No	Y	2	2	Increased snowfall may result in blockage and localized flooding	4	No
	Culvert (fish bearing)	Foundation	Y	4	1	Increased temperature will cause permafrost degradation	4	No	N				0	No	Y	1	1	More or less snow could affect insulation	1	No
		Material	N				0	No	N				0	No	N				0	No
		Capacity	Y	1	2	Colder temperatures will cause more ice blockage	2	No	Y	2	2	Increased rainfall may results in localized flooding	4	No	Y	2	2	Increased snowfall may result in blockage and localized flooding	4	No
Building Foundation/ Laydown Pads	Pads	Foundation	Y	4	1	Increased temperature will cause permafrost degradation	4	No	N				0	No	N				0	No
		Cut	N				0	No	N				0	No	N				0	No
		Fill	N				0	No	N				0	No	N				0	No
	Culvert (non-fish bearing)	Foundation	Y	4	1	Increased temperature will cause permafrost degradation	4	No	N				0	No	N				0	No
		Material	N				0	No	N				0	No	N				0	No
		Capacity	Y	1	2	Colder temperatures will cause more ice blockage	2	No	Y	2	2	Increased rainfall may results in localized flooding	4	No	Y	2	2	Increased snowfall may result in blockage and localized flooding	4	No
	Culvert (fish bearing)	Foundation	Y	4	1	Increased temperature will cause permafrost degradation	4	No	N				0	No	N				0	No
		Material	N				0	No	N				0	No	N				0	No
		Capacity	Y	1	2	Colder temperatures will cause more ice blockage	2	No	Y	2	2	Increased rainfall may results in localized flooding	4	No	Y	2	2	Increased snowfall may result in blockage and localized flooding	4	No

Proposed Surface Infrastructure			Climate Parameter / Event																							
			Precipitation (Extreme Events)						Evaporation						Wind Speed						Growing Season Length					
System	Component	Element	Will Parameter Impact Design?	Likelihood (L)	Consequence (C)	Define Consequence *[summarize what consequence are being considered to provide context]*	Risk [R = L x C]	Should Design Consider Climate change?	Will Parameter Impact Design?	Likelihood (L)	Consequence (C)	Define Consequence *[summarize what consequence are being considered to provide context]*	Risk [R = L x C]	Should Design Consider Climate change?	Will Parameter Impact Design?	Likelihood (L)	Consequence (C)	Define Consequence *[summarize what consequence are being considered to provide context]*	Risk [R = L x C]	Should Design Consider Climate change?	Will Parameter Impact Design?	Likelihood (L)	Consequence (C)	Define Consequence *[summarize what consequence are being considered to provide context]*	Risk [R = L x C]	Should Design Consider Climate change?
All-Weather Roads	Road	Foundation	N				0	No	N				0	No	N				0	No	N				0	No
		Cut	N				0	No	N				0	No	N				0	No	N				0	No
		Fill	N				0	No	N				0	No	N				0	No	N				0	No
	Bridges	Foundation	N				0	No	N				0	No	N				0	No	N				0	No
		Rip-rap	N				0	No	N				0	No	N				0	No	N				0	No
		Wall	N				0	No	N				0	No	N				0	No	N				0	No
		Material	N				0	No	N				0	No	N				0	No	N				0	No
		Capacity	Y	2	3	Large precipitation event may lead to localized flooding	6	No	N				0	No	N				0	No	N				0	No
	Culvert (non-fish bearing)	Foundation	N				0	No	N				0	No	N				0	No	N				0	No
		Material	N				0	No	N				0	No	N				0	No	N				0	No
		Capacity	Y	3	2	Large precipitation event may lead to localized flooding	6	No	N				0	No	N				0	No	N				0	No
	Culvert (fish bearing)	Foundation	N				0	No	N				0	No	N				0	No	N				0	No
		Material	N				0	No	N				0	No	N				0	No	N				0	No
		Capacity	Y	3	2	Large precipitation event may lead to localized flooding	6	No	N				0	No	N				0	No	N				0	No
Building Foundation/ Laydown Pads	Pads	Foundation	N				0	No	N				0	No	N				0	No	N				0	No
		Cut	N				0	No	N				0	No	N				0	No	N				0	No
		Fill	N				0	No	N				0	No	N				0	No	N				0	No
	Culvert (non-fish bearing)	Foundation	N				0	No	N				0	No	N				0	No	N				0	No
		Material	N				0	No	N				0	No	N				0	No	N				0	No
		Capacity	Y	3	2	Large precipitation event may lead to localized flooding	6	No	N				0	No	N				0	No	N				0	No
	Culvert (fish bearing)	Foundation	N				0	No	N				0	No	N				0	No	N				0	No
		Material	N				0	No	N				0	No	N				0	No	N				0	No
		Capacity	Y	3	2	Large precipitation event may lead to localized flooding	6	No	N				0	No	N				0	No	N				0	No

Appendix C – “R” Analysis Tables

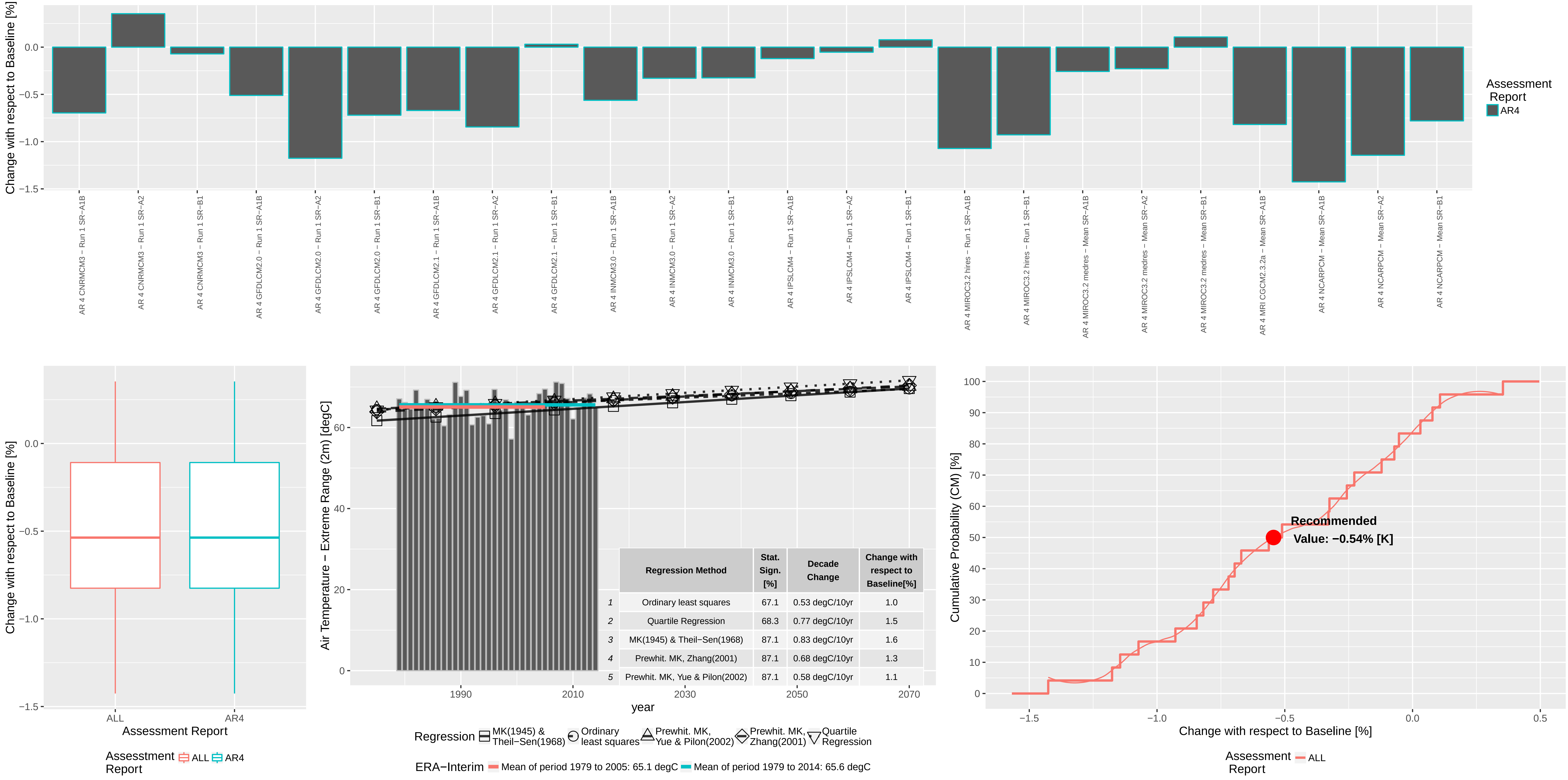
Appendix C1 – Doris “R” Analysis Tables

Climate parameter: Air Temperature − Extreme Range (2m)
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2011 − 2040



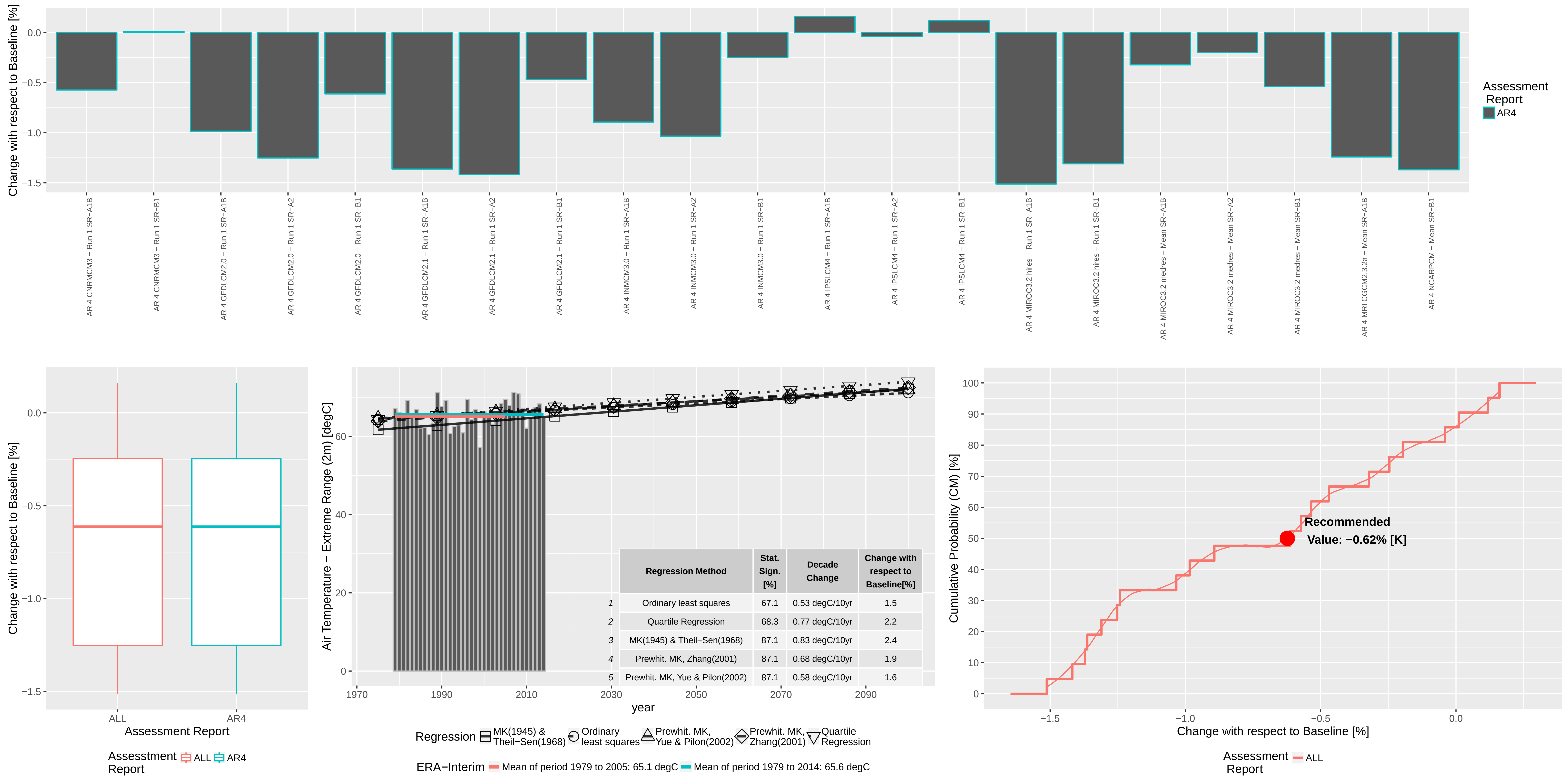
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	67.1	0.53 degC/10yr	0.56
2	Quartile Regression	68.3	0.77 degC/10yr	0.81
3	MK(1945) & Theil−Sen(1968)	87.1	0.83 degC/10yr	0.88
4	Prewhit. MK, Zhang(2001)	87.1	0.68 degC/10yr	0.72
5	Prewhit. MK, Yue & Pilon(2002)	87.1	0.58 degC/10yr	0.61

Climate parameter: Air Temperature − Extreme Range (2m)
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2041 − 2070



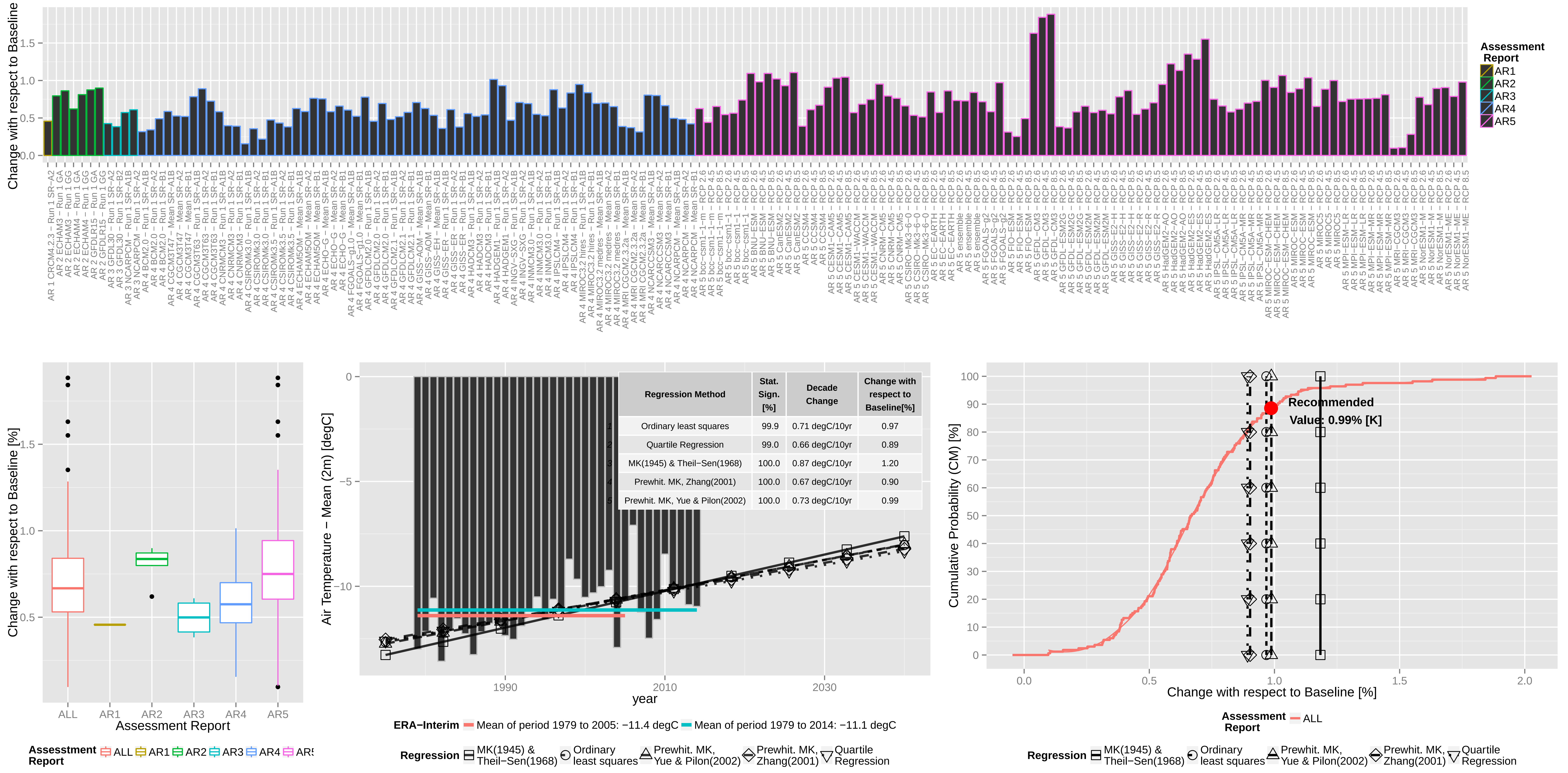
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	67.1	0.53 degC/10yr	1.0
2	Quartile Regression	68.3	0.77 degC/10yr	1.5
3	MK(1945) & Theil−Sen(1968)	87.1	0.83 degC/10yr	1.6
4	Prewhit. MK, Zhang(2001)	87.1	0.68 degC/10yr	1.3
5	Prewhit. MK, Yue & Pilon(2002)	87.1	0.58 degC/10yr	1.1

Climate parameter: Air Temperature − Extreme Range (2m)
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2071 − 2100



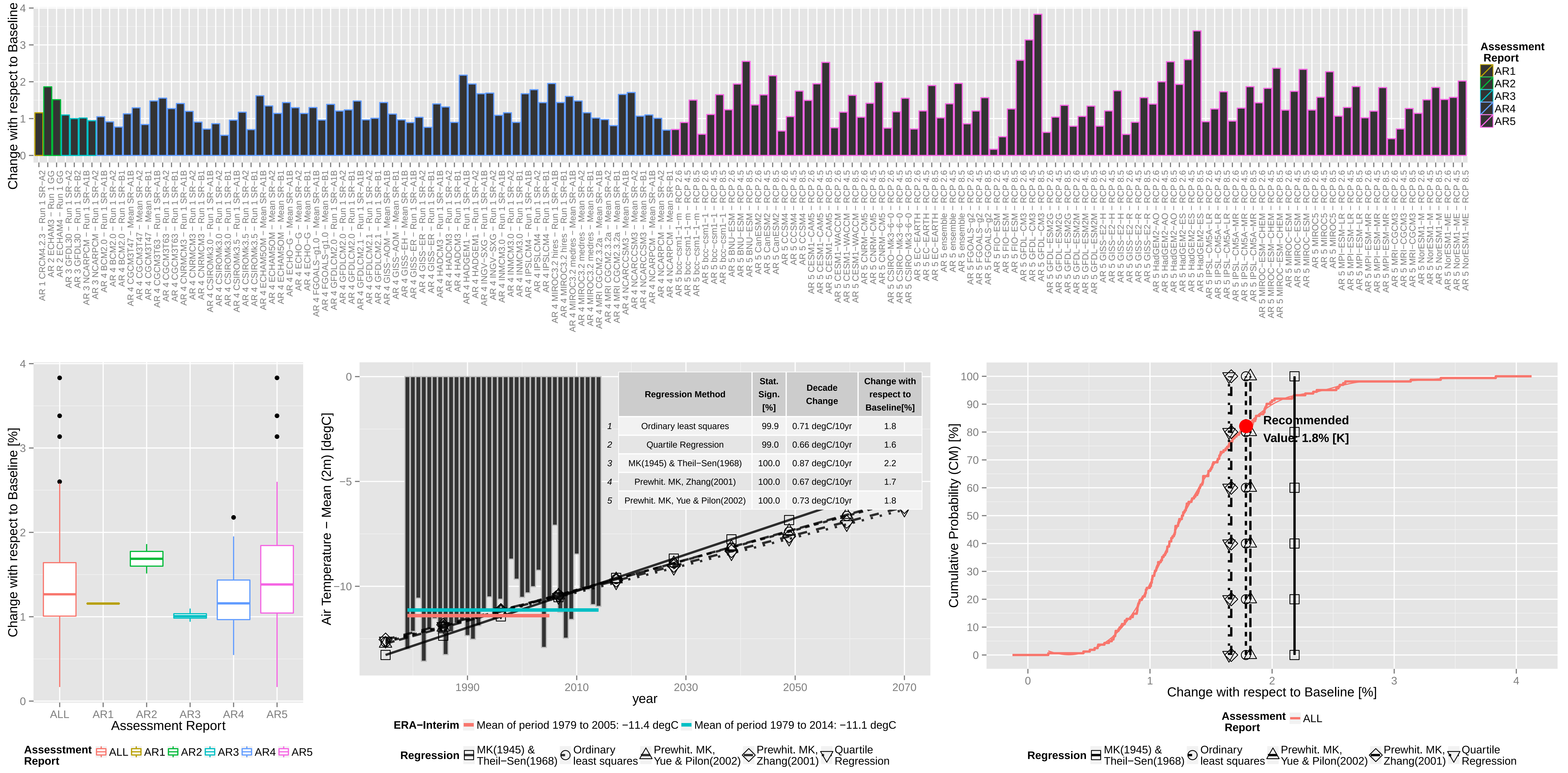
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	67.1	0.53 degC/10yr	1.5
2	Quartile Regression	68.3	0.77 degC/10yr	2.2
3	MK(1945) & Theil−Sen(1968)	87.1	0.83 degC/10yr	2.4
4	Prewhit. MK, Zhang(2001)	87.1	0.68 degC/10yr	1.9
5	Prewhit. MK, Yue & Pilon(2002)	87.1	0.58 degC/10yr	1.6

Climate parameter: Air Temperature − Mean (2m)
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2011 − 2040



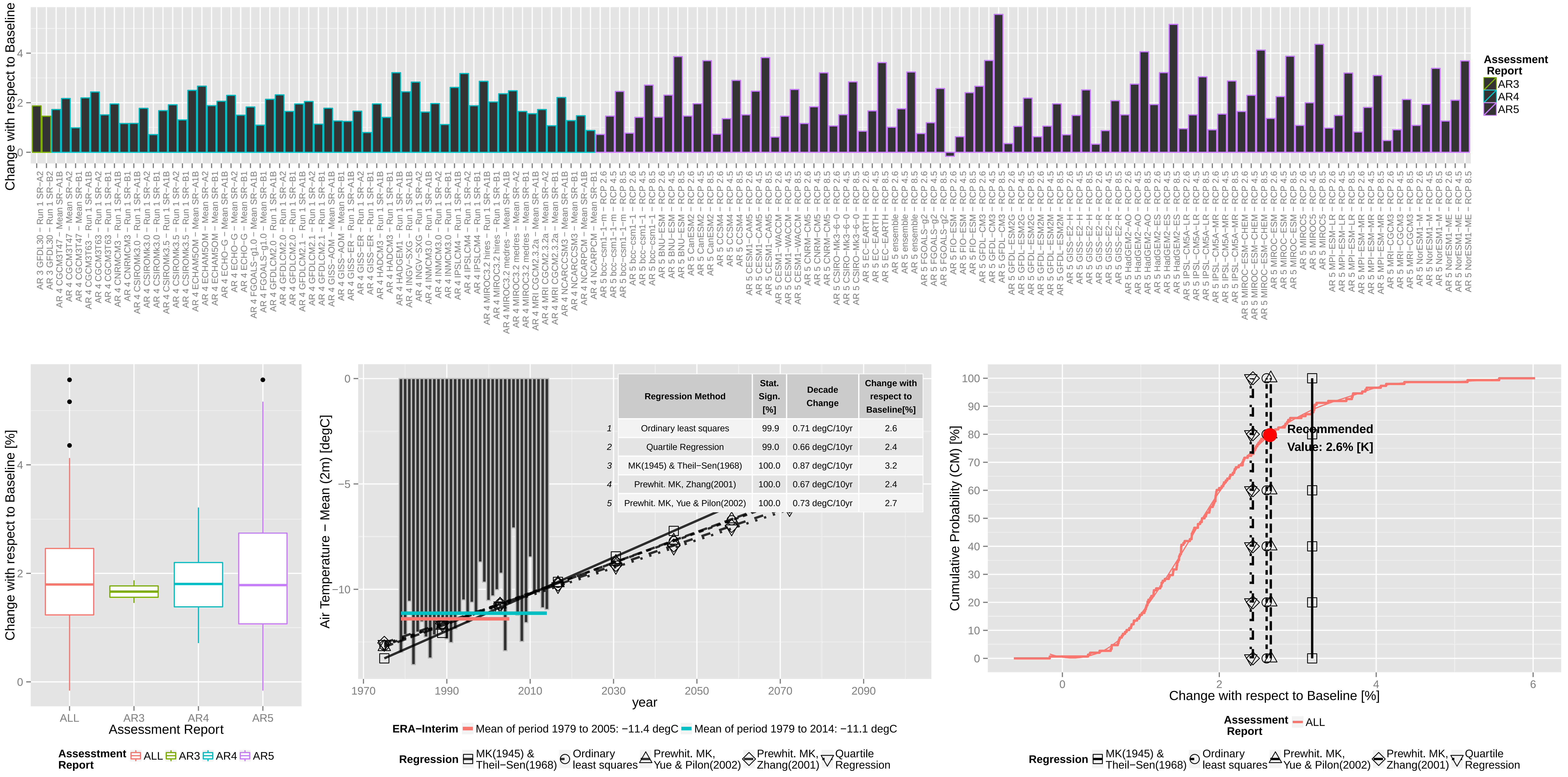
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	99.9	0.71 degC/10yr	0.97
2	Quartile Regression	99.0	0.66 degC/10yr	0.89
3	MK(1945) & Theil−Sen(1968)	100.0	0.87 degC/10yr	1.20
4	Prewhit. MK, Zhang(2001)	100.0	0.67 degC/10yr	0.90
5	Prewhit. MK, Yue & Pilon(2002)	100.0	0.73 degC/10yr	0.99

Climate parameter: Air Temperature − Mean (2m)
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2041 − 2070



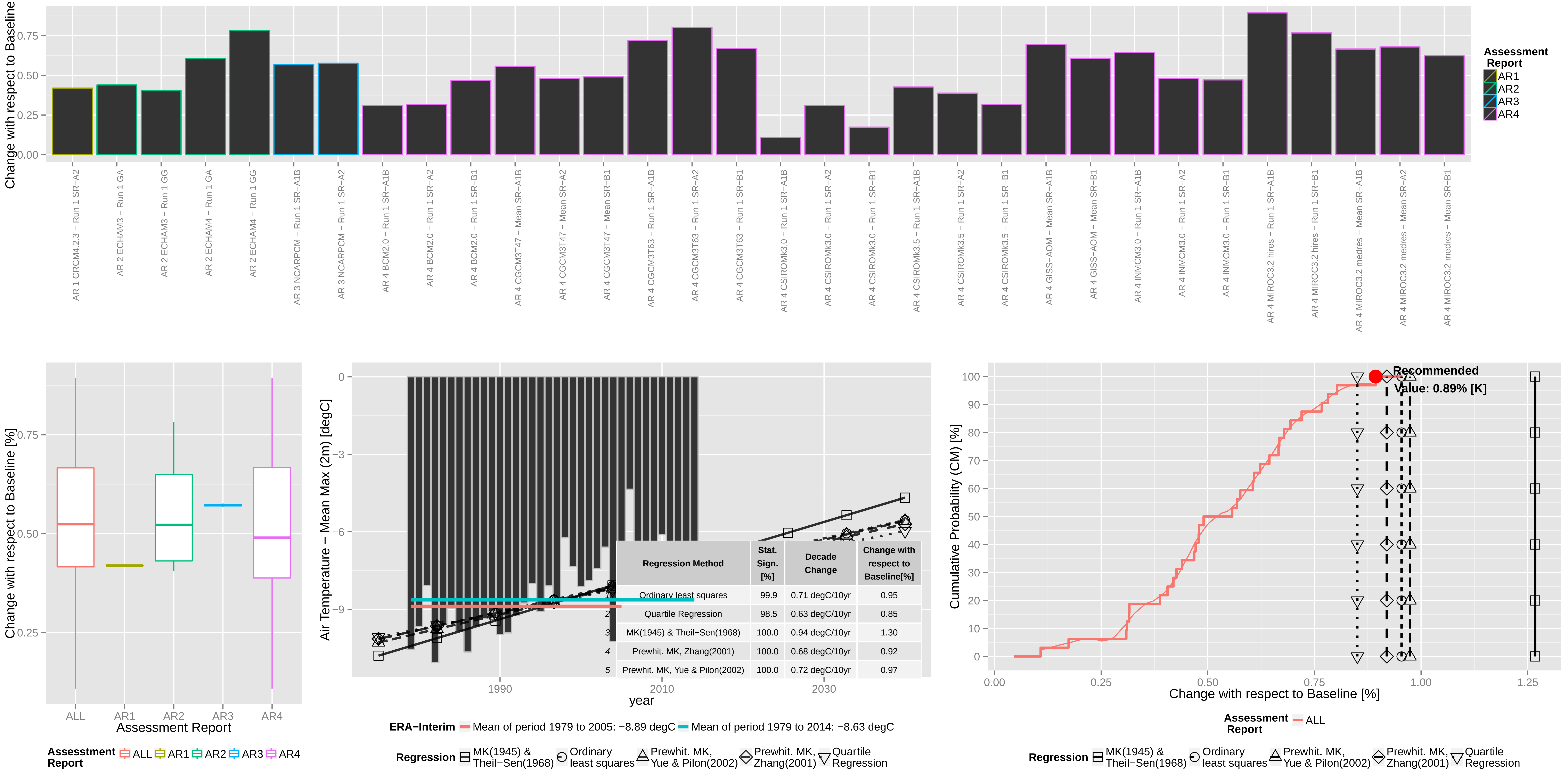
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	99.9	0.71 degC/10yr	1.8
2	Quartile Regression	99.0	0.66 degC/10yr	1.6
3	MK(1945) & Theil−Sen(1968)	100.0	0.87 degC/10yr	2.2
4	Prewhit. MK, Zhang(2001)	100.0	0.67 degC/10yr	1.7
5	Prewhit. MK, Yue & Pilon(2002)	100.0	0.73 degC/10yr	1.8

Climate parameter: Air Temperature − Mean (2m)
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2071 − 2100



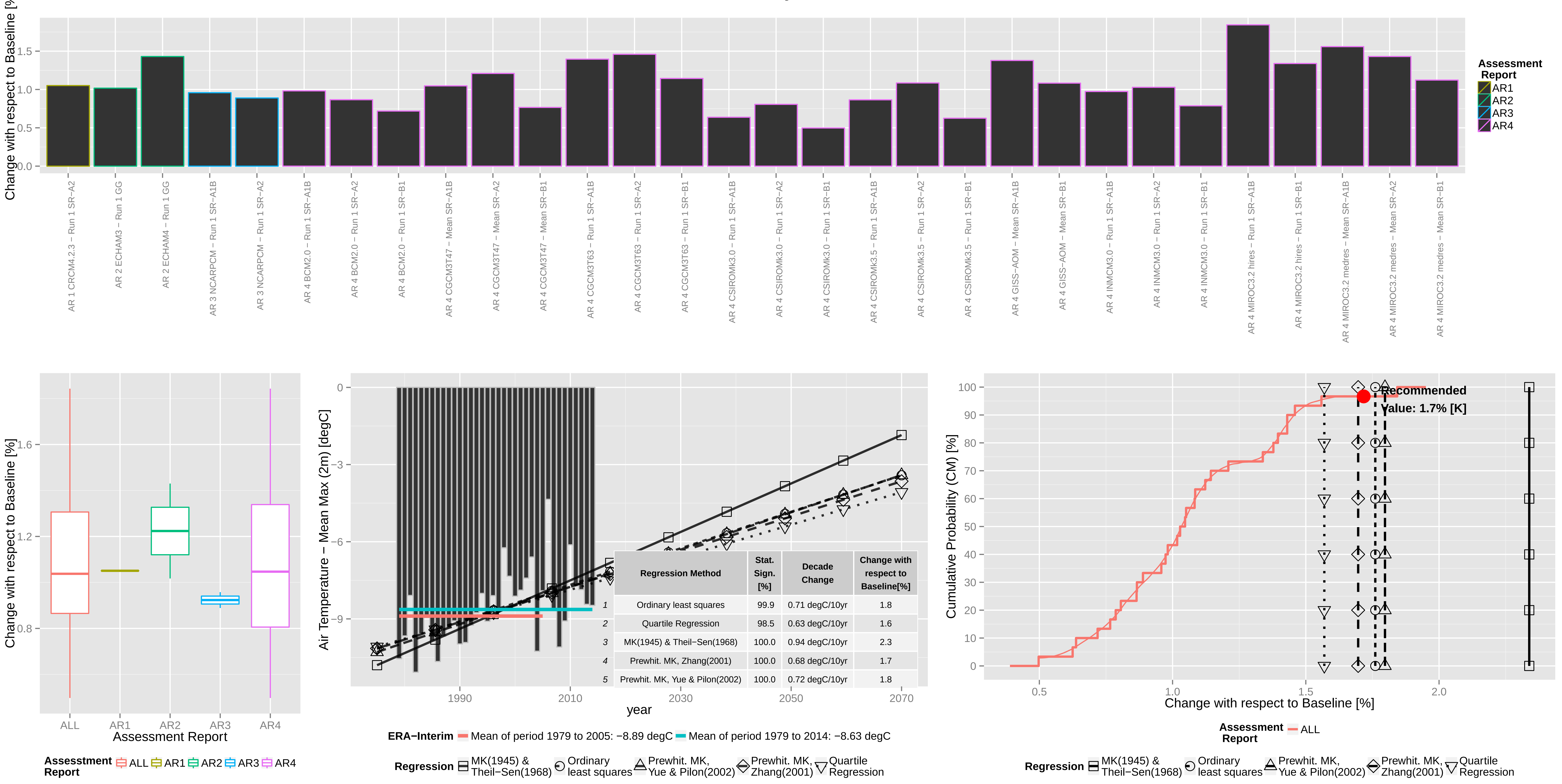
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	99.9	0.71 degC/10yr	2.6
2	Quartile Regression	99.0	0.66 degC/10yr	2.4
3	MK(1945) & Theil−Sen(1968)	100.0	0.87 degC/10yr	3.2
4	Prewhit. MK, Zhang(2001)	100.0	0.67 degC/10yr	2.4
5	Prewhit. MK, Yue & Pilon(2002)	100.0	0.73 degC/10yr	2.7

Climate parameter: Air Temperature − Mean Max (2m)
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2011 − 2040



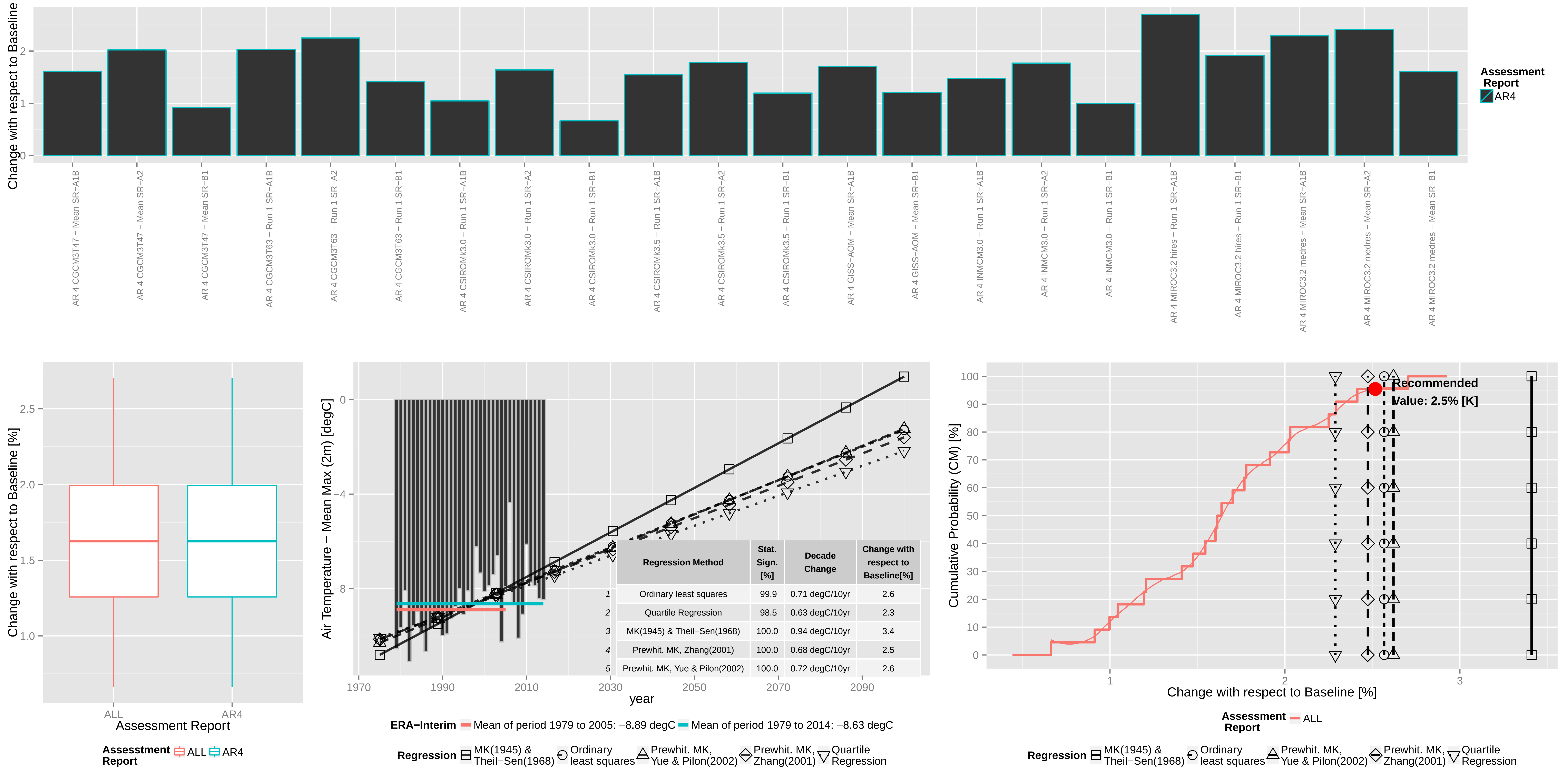
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	99.9	0.71 degC/10yr	0.95
2	Quartile Regression	98.5	0.63 degC/10yr	0.85
3	MK(1945) & Theil−Sen(1968)	100.0	0.94 degC/10yr	1.30
4	Prewhit. MK, Zhang(2001)	100.0	0.68 degC/10yr	0.92
5	Prewhit. MK, Yue & Pilon(2002)	100.0	0.72 degC/10yr	0.97

Climate parameter: Air Temperature − Mean Max (2m)
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2041 − 2070



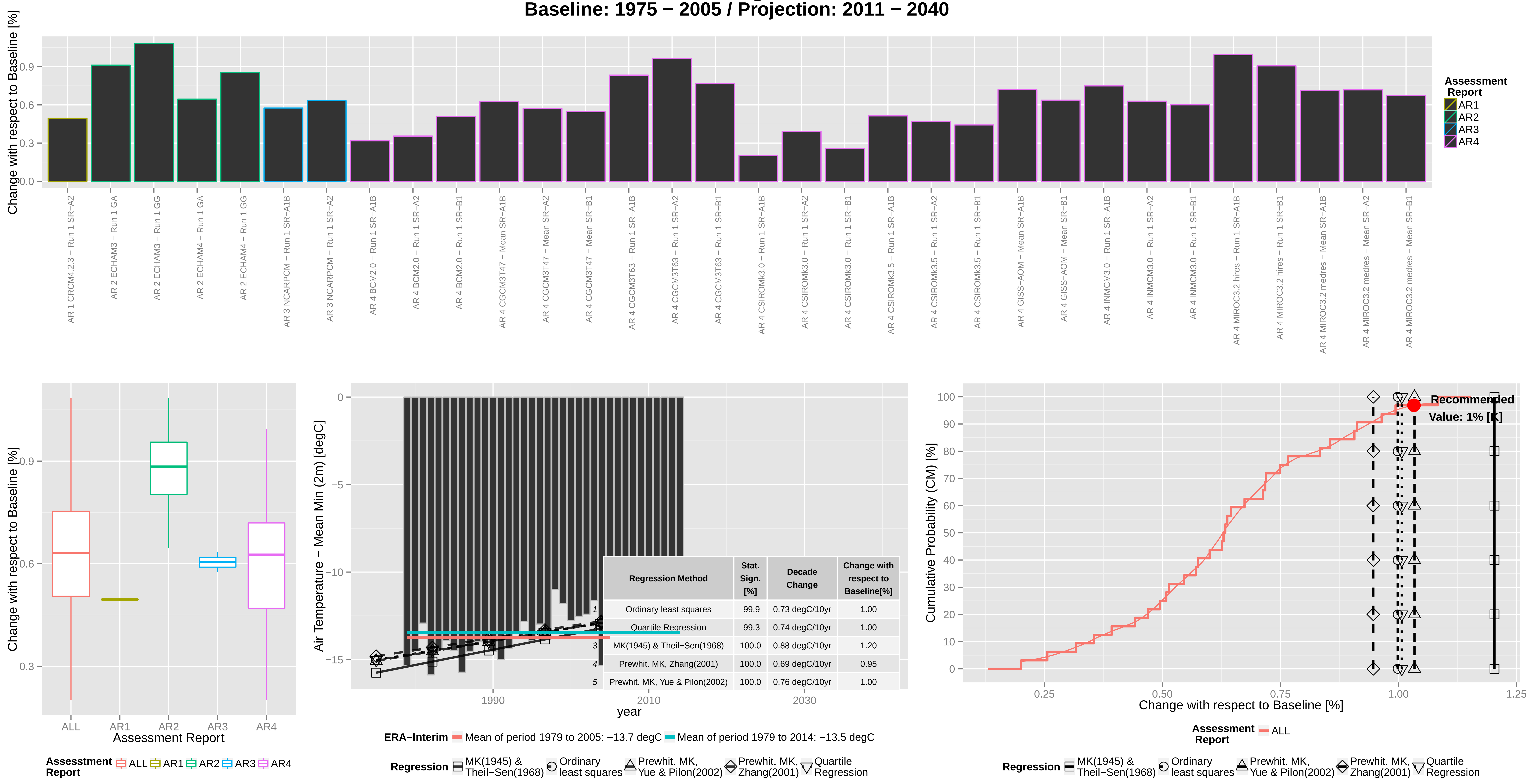
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	99.9	0.71 degC/10yr	1.8
2	Quartile Regression	98.5	0.63 degC/10yr	1.6
3	MK(1945) & Theil−Sen(1968)	100.0	0.94 degC/10yr	2.3
4	Prewhit. MK, Zhang(2001)	100.0	0.68 degC/10yr	1.7
5	Prewhit. MK, Yue & Pilon(2002)	100.0	0.72 degC/10yr	1.8

Climate parameter: Air Temperature − Mean Max (2m)
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2071 − 2100

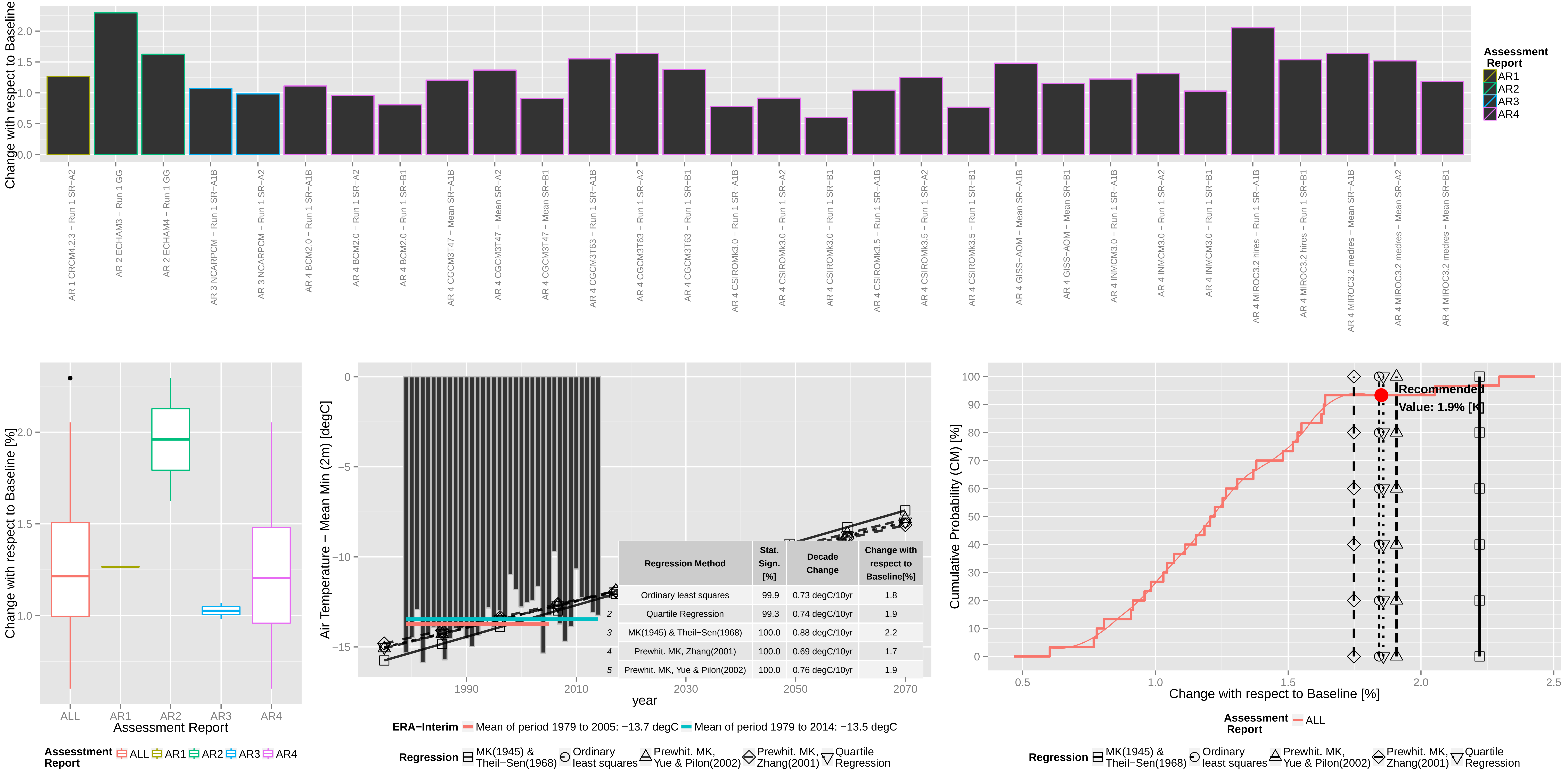


	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	99.9	0.71 degC/10yr	2.6
2	Quartile Regression	98.5	0.63 degC/10yr	2.3
3	MK(1945) & Theil−Sen(1968)	100.0	0.94 degC/10yr	3.4
4	Prewhit. MK, Zhang(2001)	100.0	0.68 degC/10yr	2.5
5	Prewhit. MK, Yue & Pilon(2002)	100.0	0.72 degC/10yr	2.6

Climate parameter: Air Temperature − Mean Min (2m)
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2011 − 2040

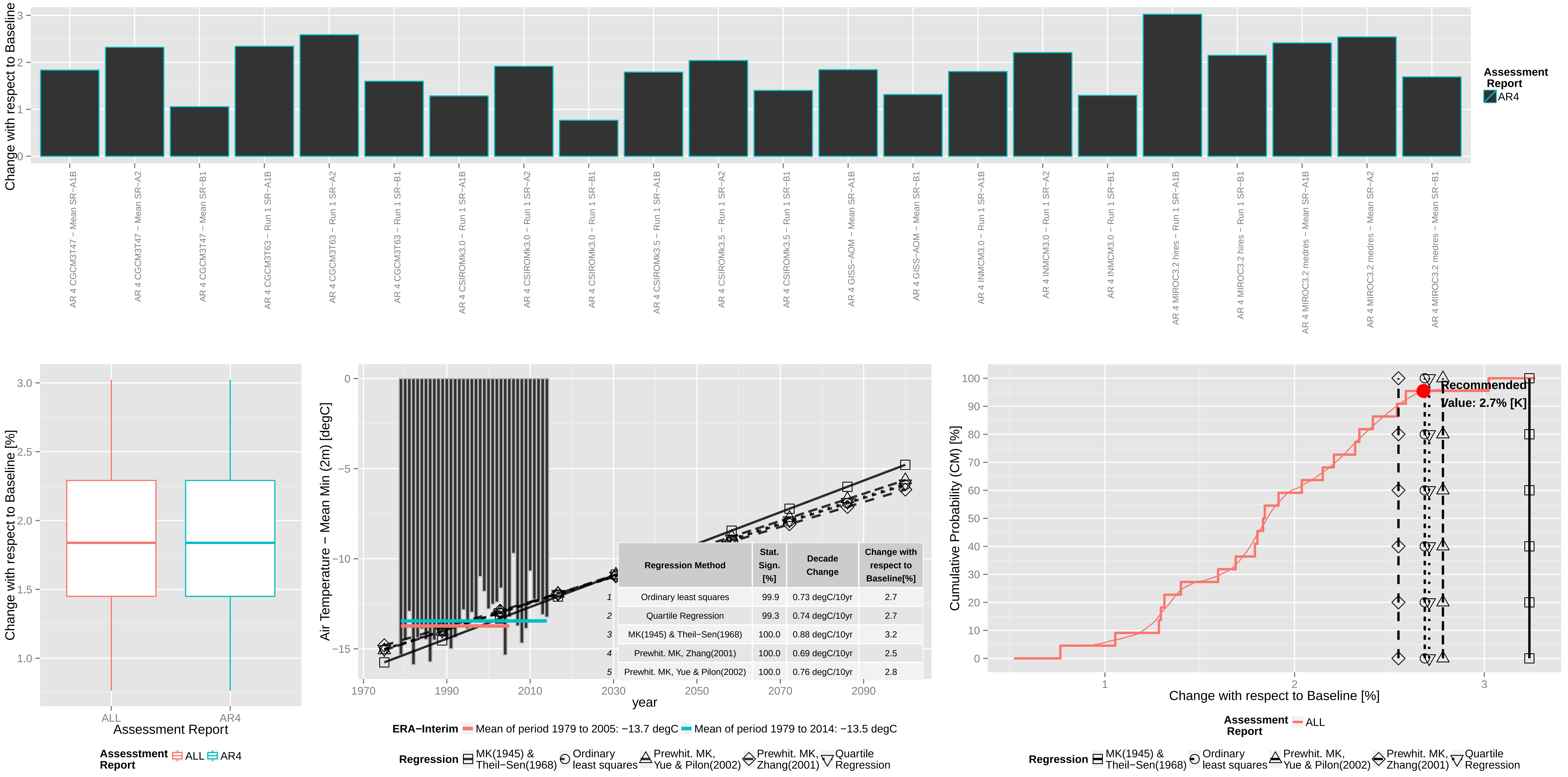


Climate parameter: Air Temperature − Mean Min (2m)
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2041 − 2070



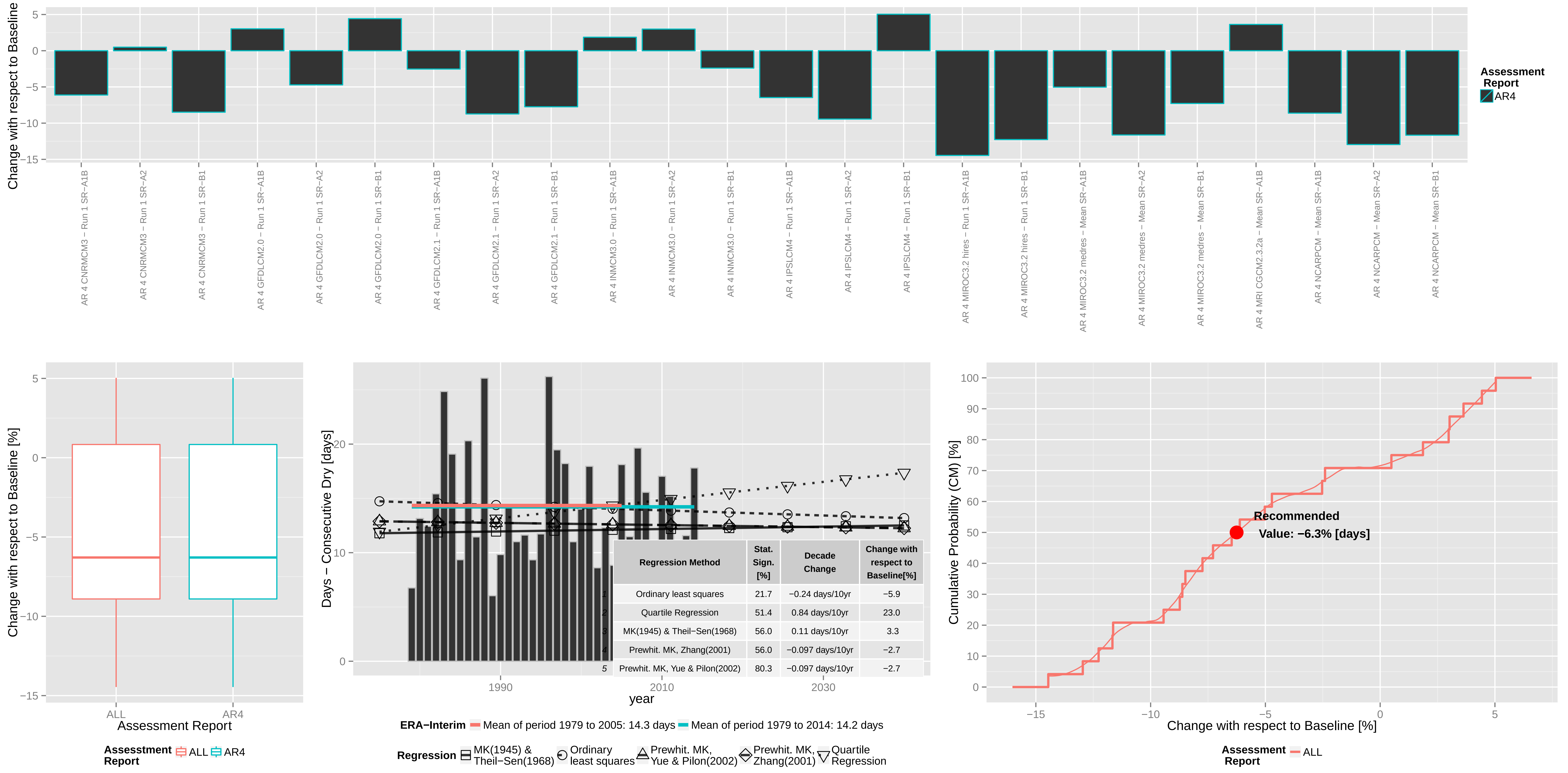
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
	Ordinary least squares	99.9	0.73 degC/10yr	1.8
2	Quartile Regression	99.3	0.74 degC/10yr	1.9
3	MK(1945) & Theil−Sen(1968)	100.0	0.88 degC/10yr	2.2
4	Prewhit. MK, Zhang(2001)	100.0	0.69 degC/10yr	1.7
5	Prewhit. MK, Yue & Pilon(2002)	100.0	0.76 degC/10yr	1.9

Climate parameter: Air Temperature − Mean Min (2m)
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2071 − 2100

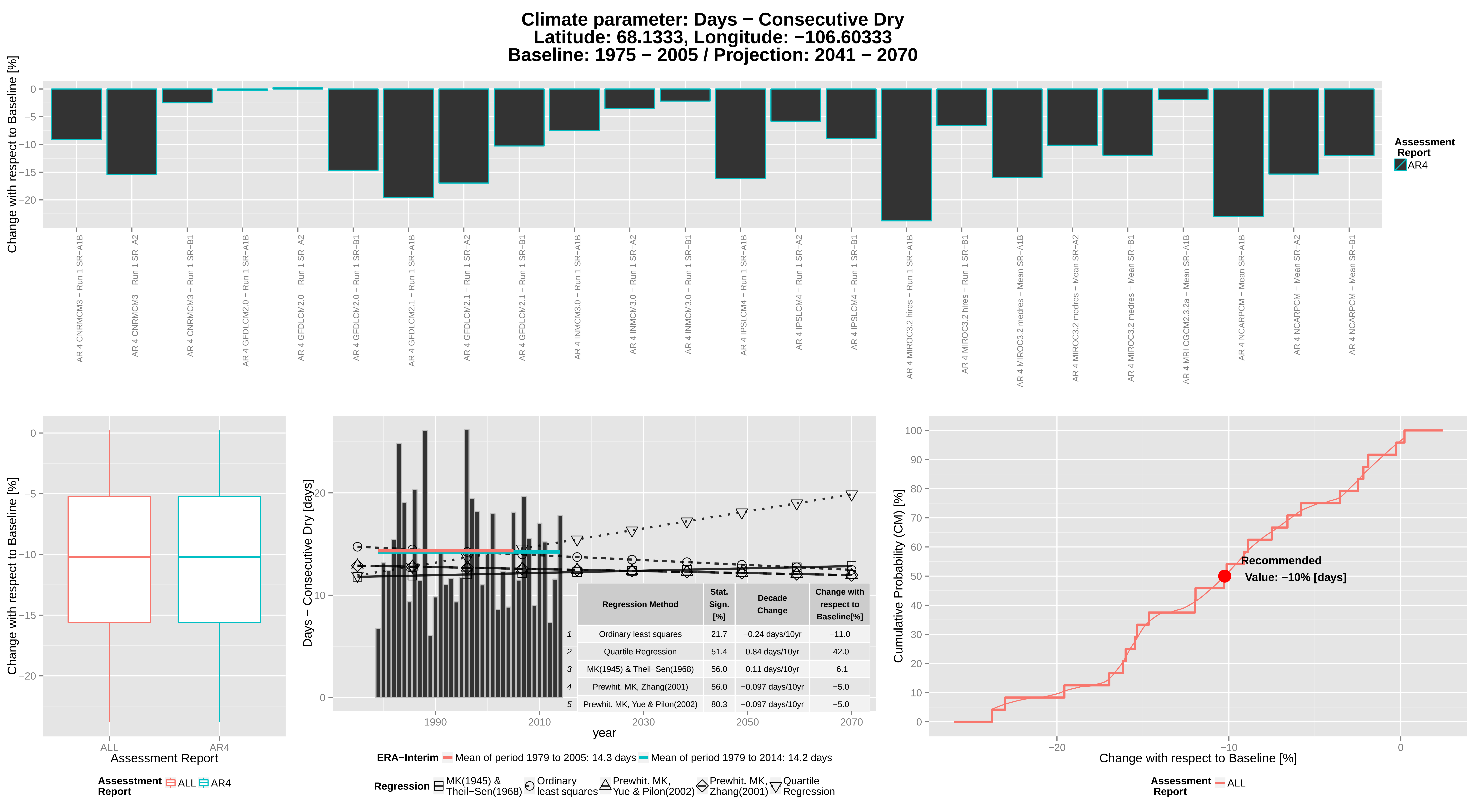


	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	99.9	0.73 degC/10yr	2.7
2	Quartile Regression	99.3	0.74 degC/10yr	2.7
3	MK(1945) & Theil−Sen(1968)	100.0	0.88 degC/10yr	3.2
4	Prewhit. MK, Zhang(2001)	100.0	0.69 degC/10yr	2.5
5	Prewhit. MK, Yue & Pilon(2002)	100.0	0.76 degC/10yr	2.8

Climate parameter: Days − Consecutive Dry
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2011 − 2040

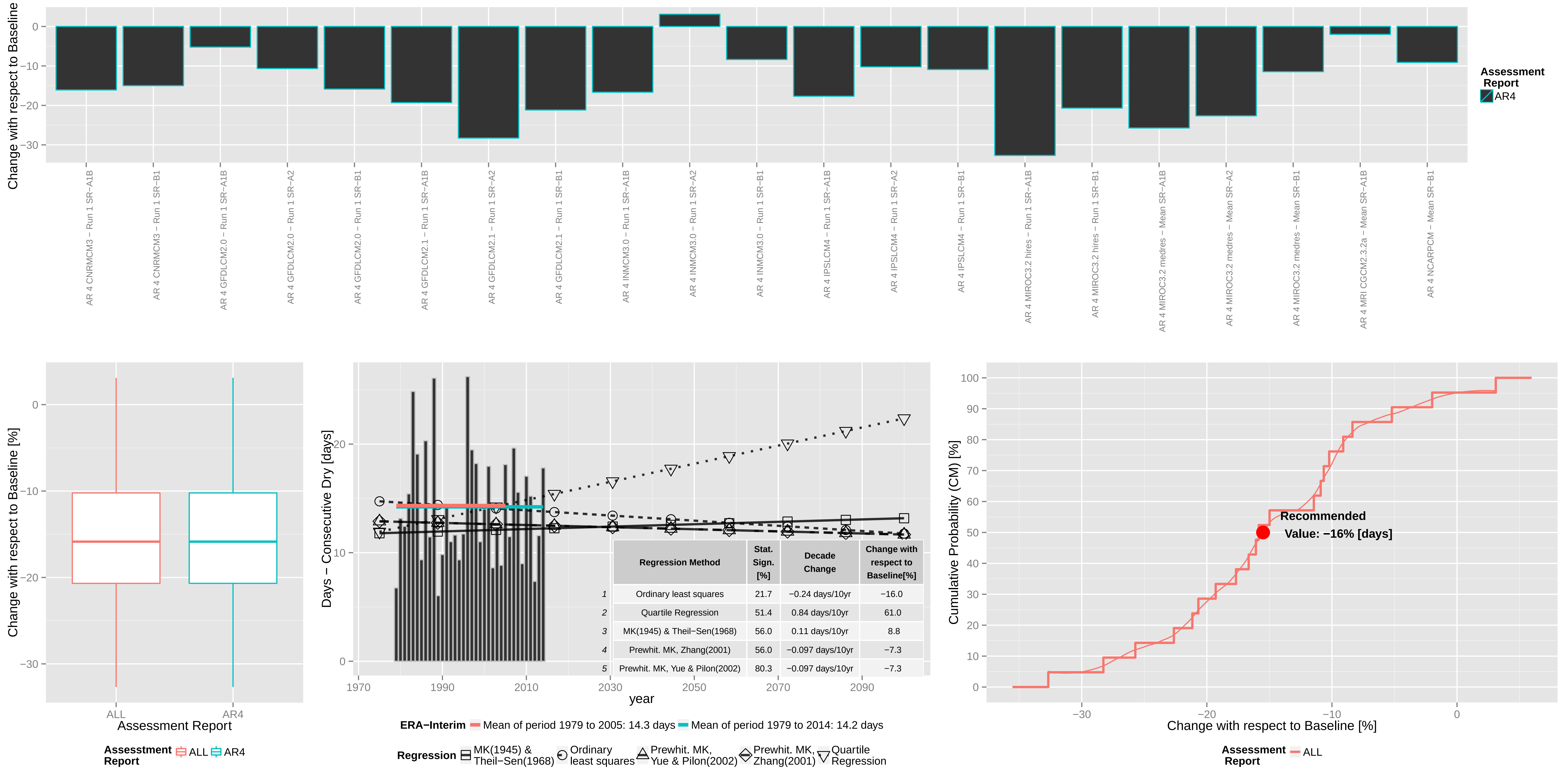


	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	21.7	−0.24 days/10yr	−5.9
2	Quartile Regression	51.4	0.84 days/10yr	23.0
3	MK(1945) & Theil−Sen(1968)	56.0	0.11 days/10yr	3.3
4	Prewhit. MK, Zhang(2001)	56.0	−0.097 days/10yr	−2.7
5	Prewhit. MK, Yue & Pilon(2002)	80.3	−0.097 days/10yr	−2.7



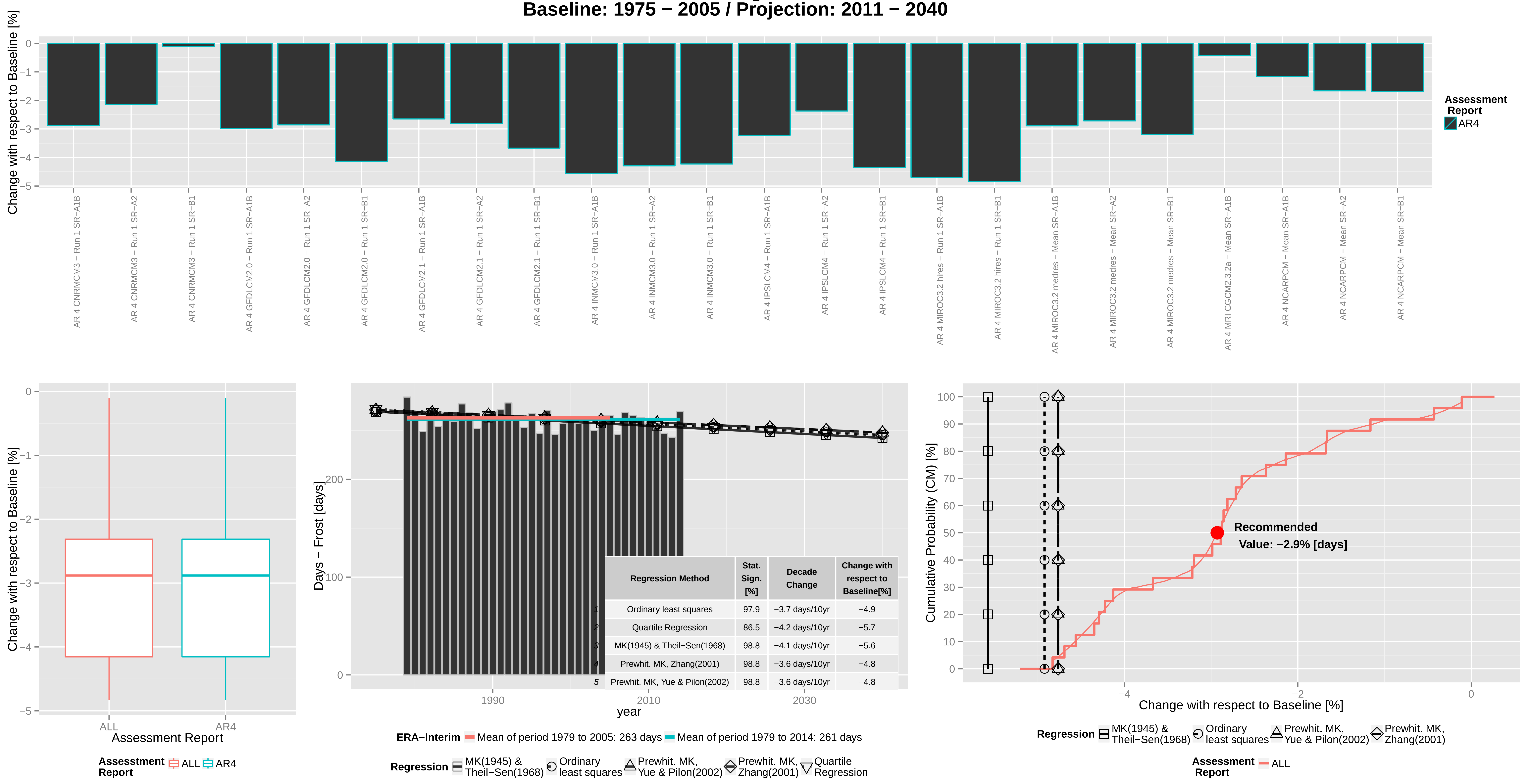
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	21.7	−0.24 days/10yr	−11.0
2	Quartile Regression	51.4	0.84 days/10yr	42.0
3	MK(1945) & Theil−Sen(1968)	56.0	0.11 days/10yr	6.1
4	Prewhit. MK, Zhang(2001)	56.0	−0.097 days/10yr	−5.0
5	Prewhit. MK, Yue & Pilon(2002)	80.3	−0.097 days/10yr	−5.0

Climate parameter: Days − Consecutive Dry
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2071 − 2100

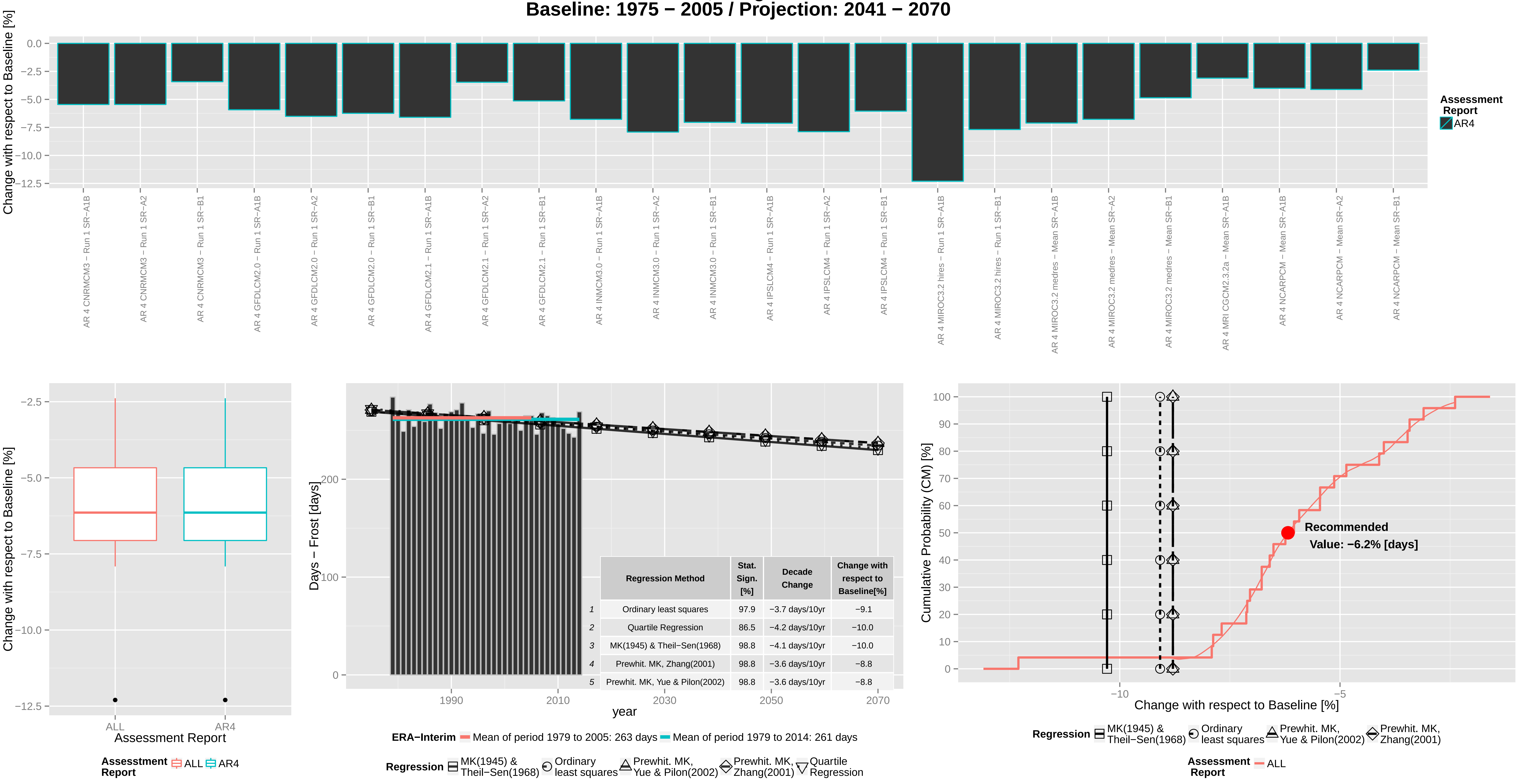


	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	21.7	−0.24 days/10yr	−16.0
2	Quartile Regression	51.4	0.84 days/10yr	61.0
3	MK(1945) & Theil−Sen(1968)	56.0	0.11 days/10yr	8.8
4	Prewhit. MK, Zhang(2001)	56.0	−0.097 days/10yr	−7.3
5	Prewhit. MK, Yue & Pilon(2002)	80.3	−0.097 days/10yr	−7.3

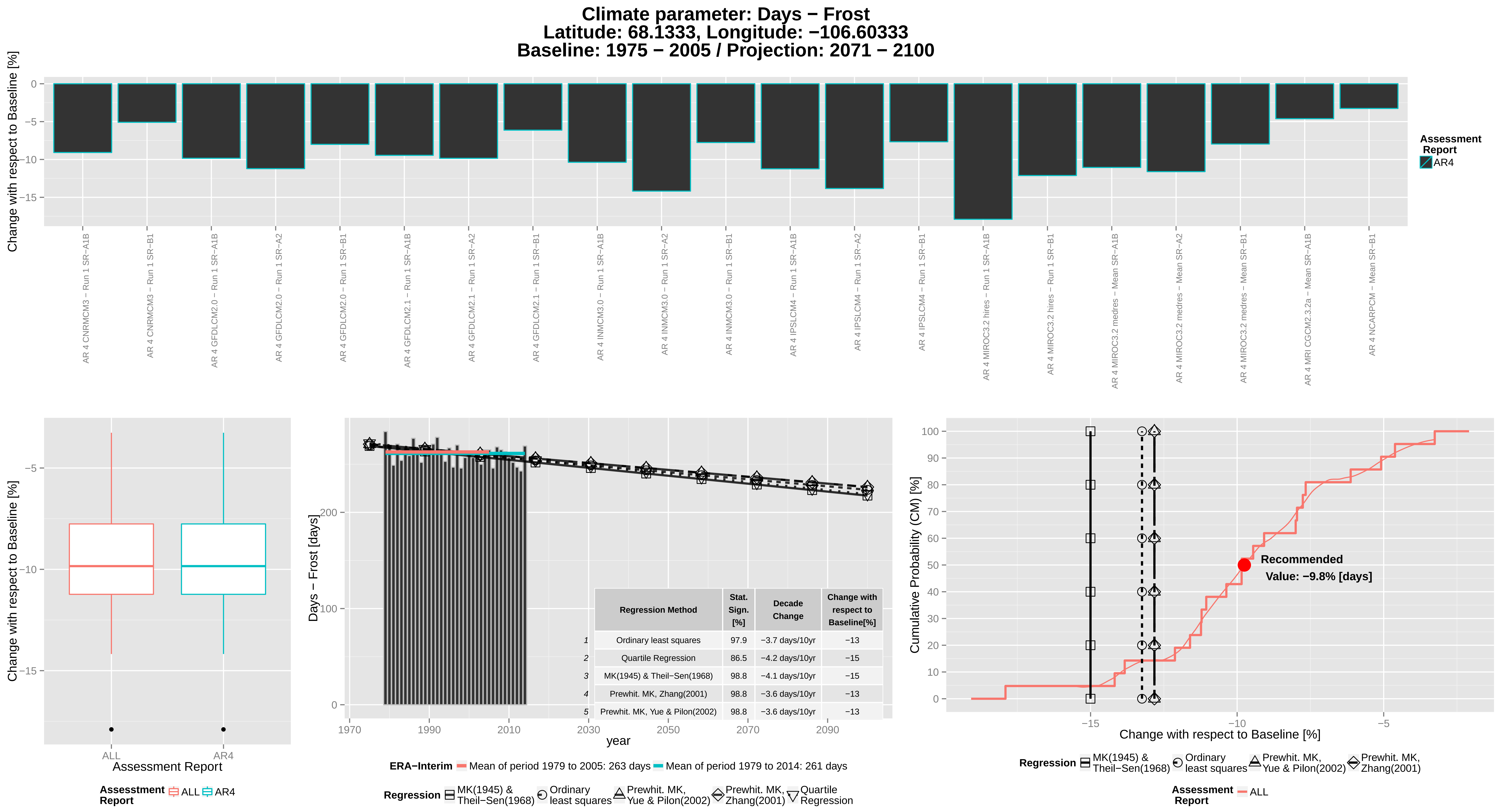
Climate parameter: Days − Frost
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2011 − 2040



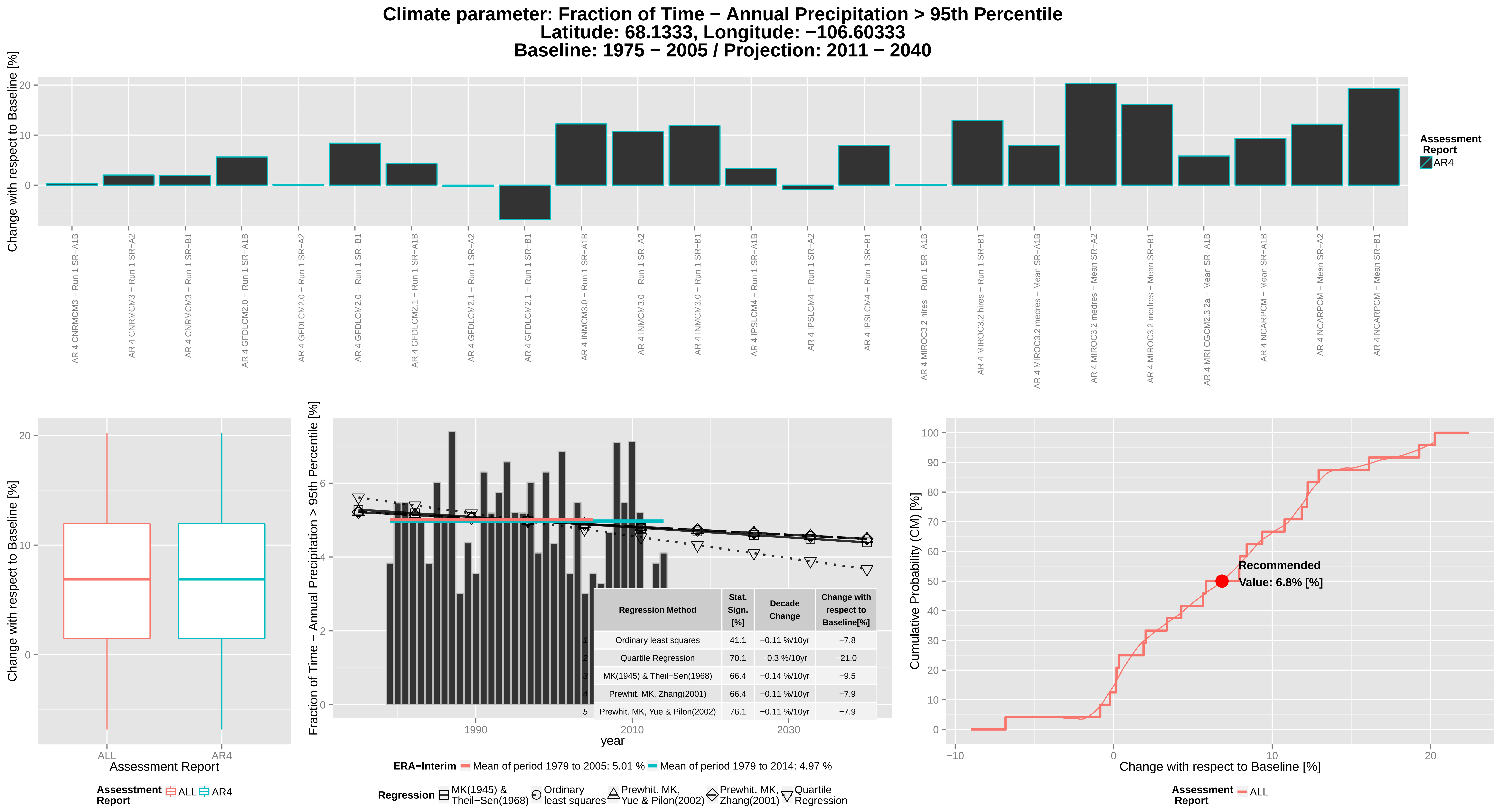
Climate parameter: Days − Frost
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2041 − 2070



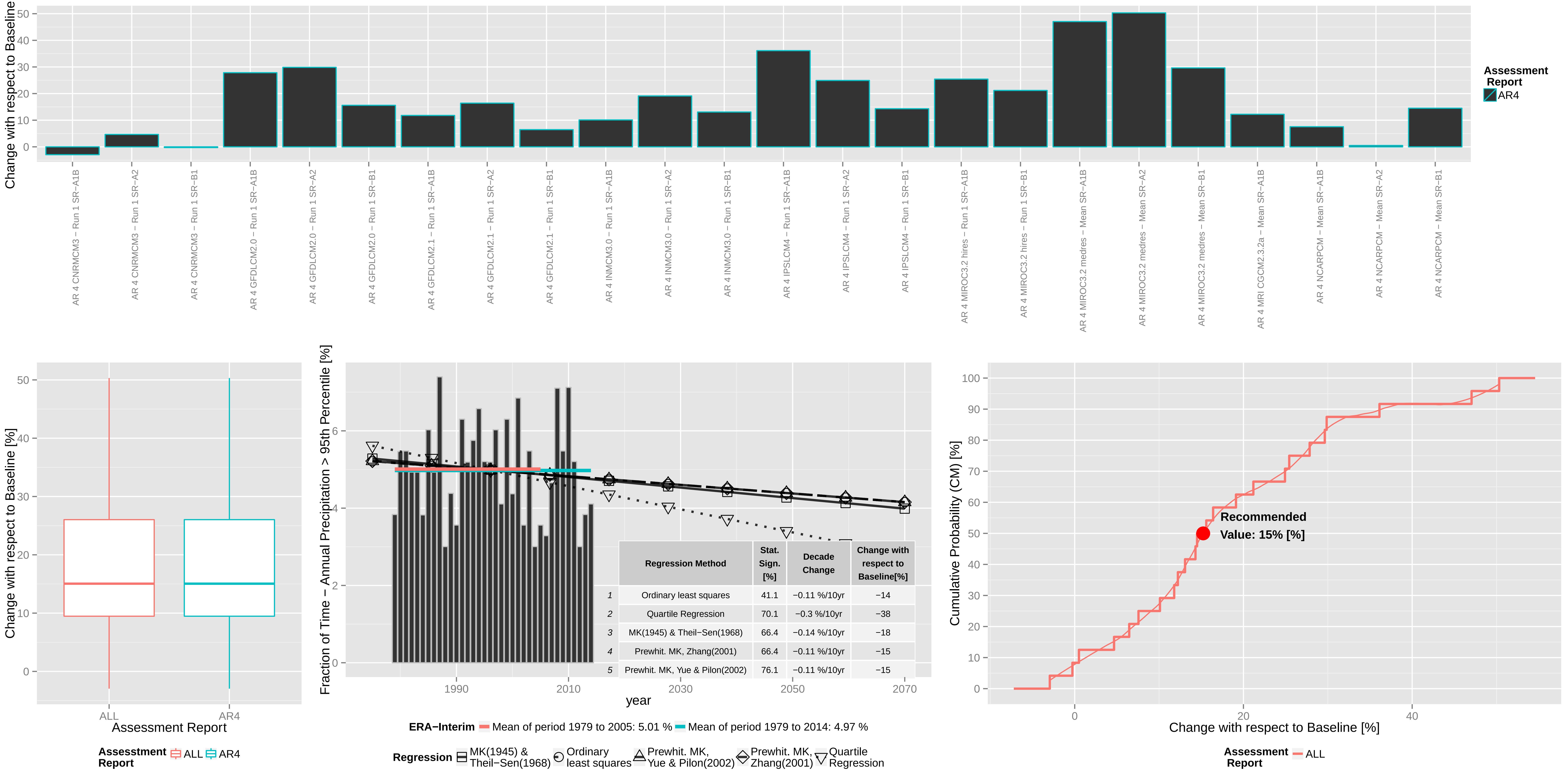
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	97.9	−3.7 days/10yr	−9.1
2	Quartile Regression	86.5	−4.2 days/10yr	−10.0
3	MK(1945) & Theil−Sen(1968)	98.8	−4.1 days/10yr	−10.0
4	Prewhit. MK, Zhang(2001)	98.8	−3.6 days/10yr	−8.8
5	Prewhit. MK, Yue & Pilon(2002)	98.8	−3.6 days/10yr	−8.8



	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	97.9	−3.7 days/10yr	−13
2	Quartile Regression	86.5	−4.2 days/10yr	−15
3	MK(1945) & Theil−Sen(1968)	98.8	−4.1 days/10yr	−15
4	Prewhit. MK, Zhang(2001)	98.8	−3.6 days/10yr	−13
5	Prewhit. MK, Yue & Pilon(2002)	98.8	−3.6 days/10yr	−13

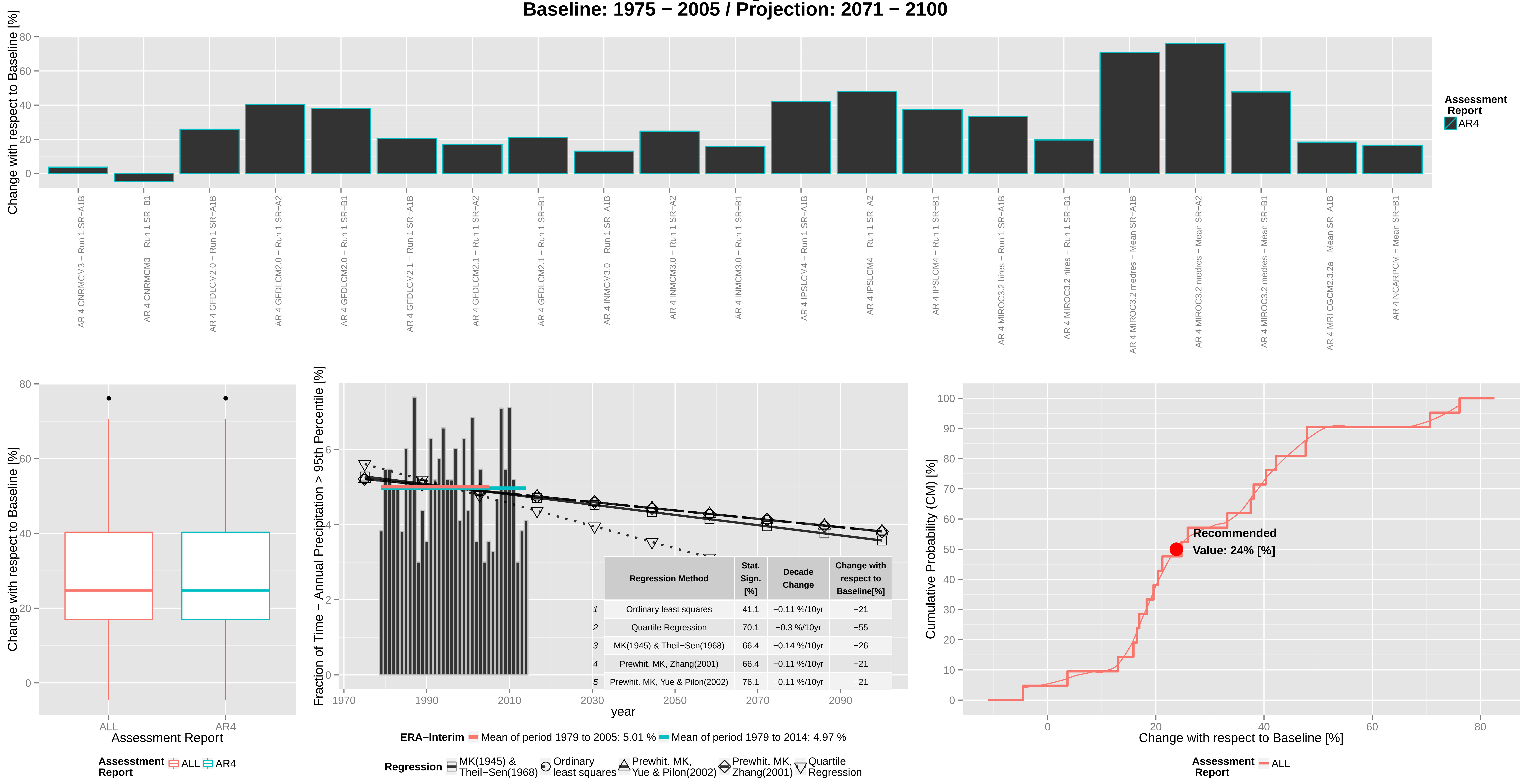

Climate parameter: Fraction of Time − Annual Precipitation > 95th Percentile
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2011 − 2040
Change with respect to Baseline [%]
Assessment Report
AR4
AR 4 CNRMCM3 − Run 1 SR−A1B
AR 4 CNRMCM3 − Run 1 SR−A2
AR 4 CNRMCM3 − Run 1 SR−B1
AR 4 GFDLCM2.0 − Run 1 SR−A1B
AR 4 GFDLCM2.0 − Run 1 SR−A2
AR 4 GFDLCM2.0 − Run 1 SR−B1
AR 4 GFDLCM2.1 − Run 1 SR−A1B
AR 4 GFDLCM2.1 − Run 1 SR−A2
AR 4 GFDLCM2.1 − Run 1 SR−B1
AR 4 INMCM3.0 − Run 1 SR−A1B
AR 4 INMCM3.0 − Run 1 SR−A2
AR 4 INMCM3.0 − Run 1 SR−B1
AR 4 IPSLCM4 − Run 1 SR−A1B
AR 4 IPSLCM4 − Run 1 SR−A2
AR 4 IPSLCM4 − Run 1 SR−B1
AR 4 MIROC3.2 hires − Run 1 SR−A1B
AR 4 MIROC3.2 hires − Run 1 SR−B1
AR 4 MIROC3.2 medres − Mean SR−A1B
AR 4 MIROC3.2 medres − Mean SR−A2
AR 4 MIROC3.2 medres − Mean SR−B1
AR 4 MRI CGCM2.3.2a − Mean SR−A1B
AR 4 NCARPCM − Mean SR−A1B
AR 4 NCARPCM − Mean SR−A2
AR 4 NCARPCM − Mean SR−B1
Fraction of Time − Annual Precipitation > 95th Percentile [%]
year
Regression Method | Stat. Sign. [%] | Decade Change | Change with respect to Baseline[%]
1 Ordinary least squares | 41.1 | −0.11 %/10yr | −7.8
2 Quartile Regression | 70.1 | −0.3 %/10yr | −21.0
3 MK(1945) & Theil−Sen(1968) | 66.4 | −0.14 %/10yr | −9.5
4 Prewhit. MK, Zhang(2001) | 66.4 | −0.11 %/10yr | −7.9
5 Prewhit. MK, Yue & Pilon(2002) | 76.1 | −0.11 %/10yr | −7.9
ERA−Interim Mean of period 1979 to 2005: 5.01 % Mean of period 1979 to 2014: 4.97 %
Regression MK(1945) & Theil−Sen(1968) Ordinary least squares Prewhit. MK, Yue & Pilon(2002) Prewhit. MK, Zhang(2001) Quartile Regression
Cumulative Probability (CM) [%]
Recommended Value: 6.8% [%]
Assessment Report ALL AR4

Climate parameter: Fraction of Time − Annual Precipitation > 95th Percentile
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2041 − 2070



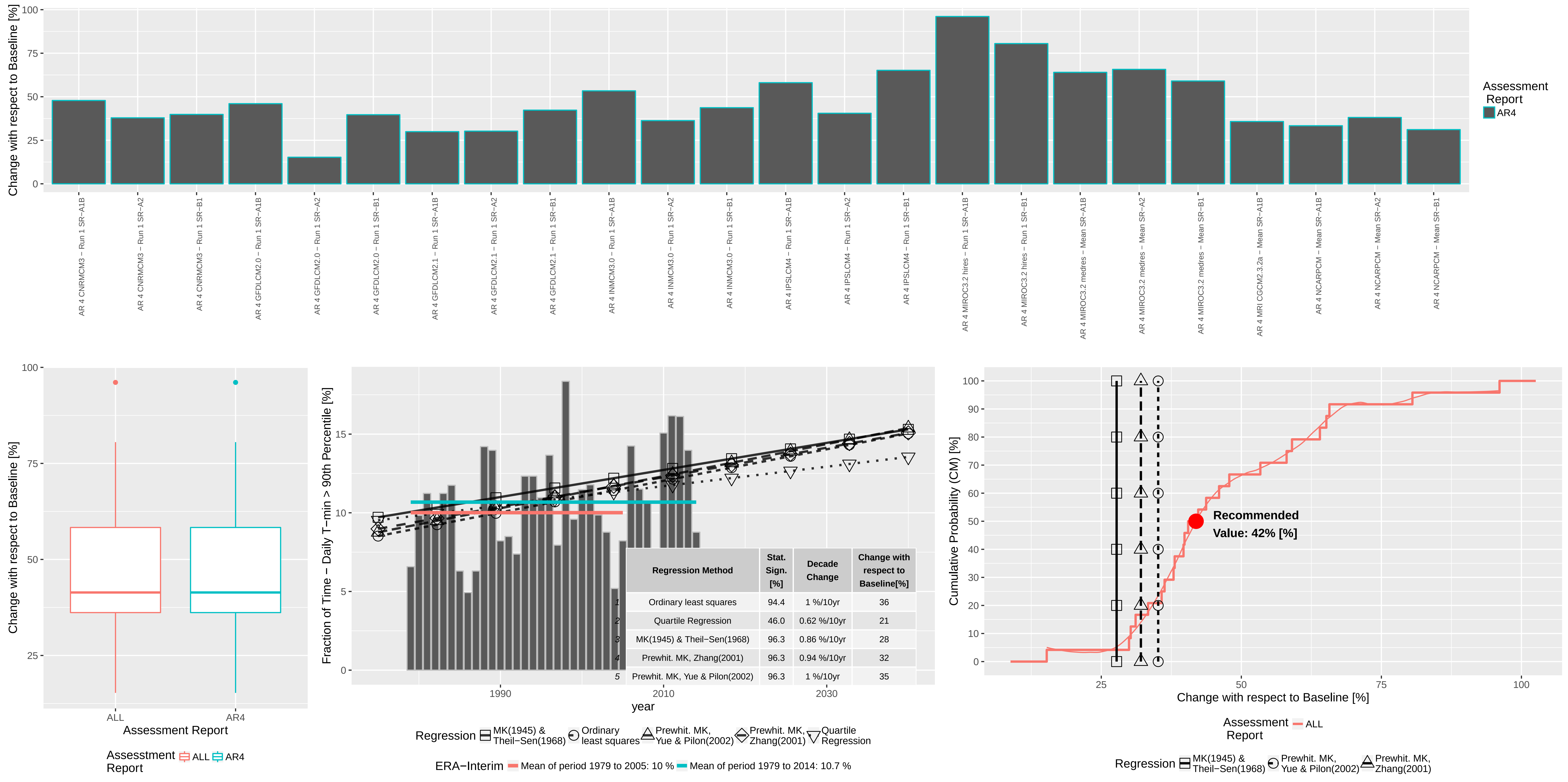
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	41.1	−0.11 %/10yr	−14
2	Quartile Regression	70.1	−0.3 %/10yr	−38
3	MK(1945) & Theil−Sen(1968)	66.4	−0.14 %/10yr	−18
4	Prewhit. MK, Zhang(2001)	66.4	−0.11 %/10yr	−15
5	Prewhit. MK, Yue & Pilon(2002)	76.1	−0.11 %/10yr	−15

Climate parameter: Fraction of Time − Annual Precipitation > 95th Percentile
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2071 − 2100



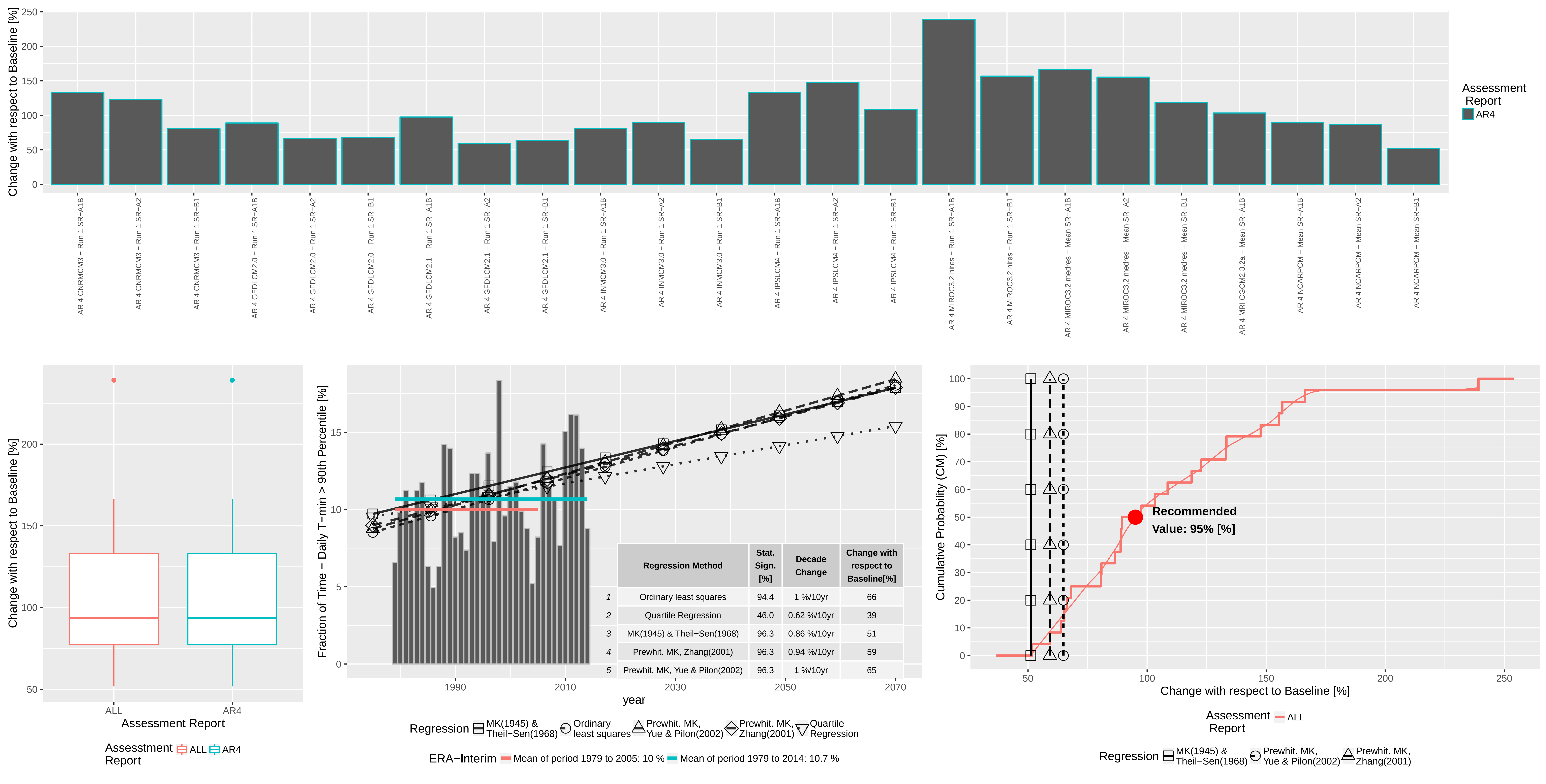
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	41.1	−0.11 %/10yr	−21
2	Quartile Regression	70.1	−0.3 %/10yr	−55
3	MK(1945) & Theil−Sen(1968)	66.4	−0.14 %/10yr	−26
4	Prewhit. MK, Zhang(2001)	66.4	−0.11 %/10yr	−21
5	Prewhit. MK, Yue & Pilon(2002)	76.1	−0.11 %/10yr	−21

Climate parameter: Fraction of Time − Daily T−min > 90th Percentile
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2011 − 2040



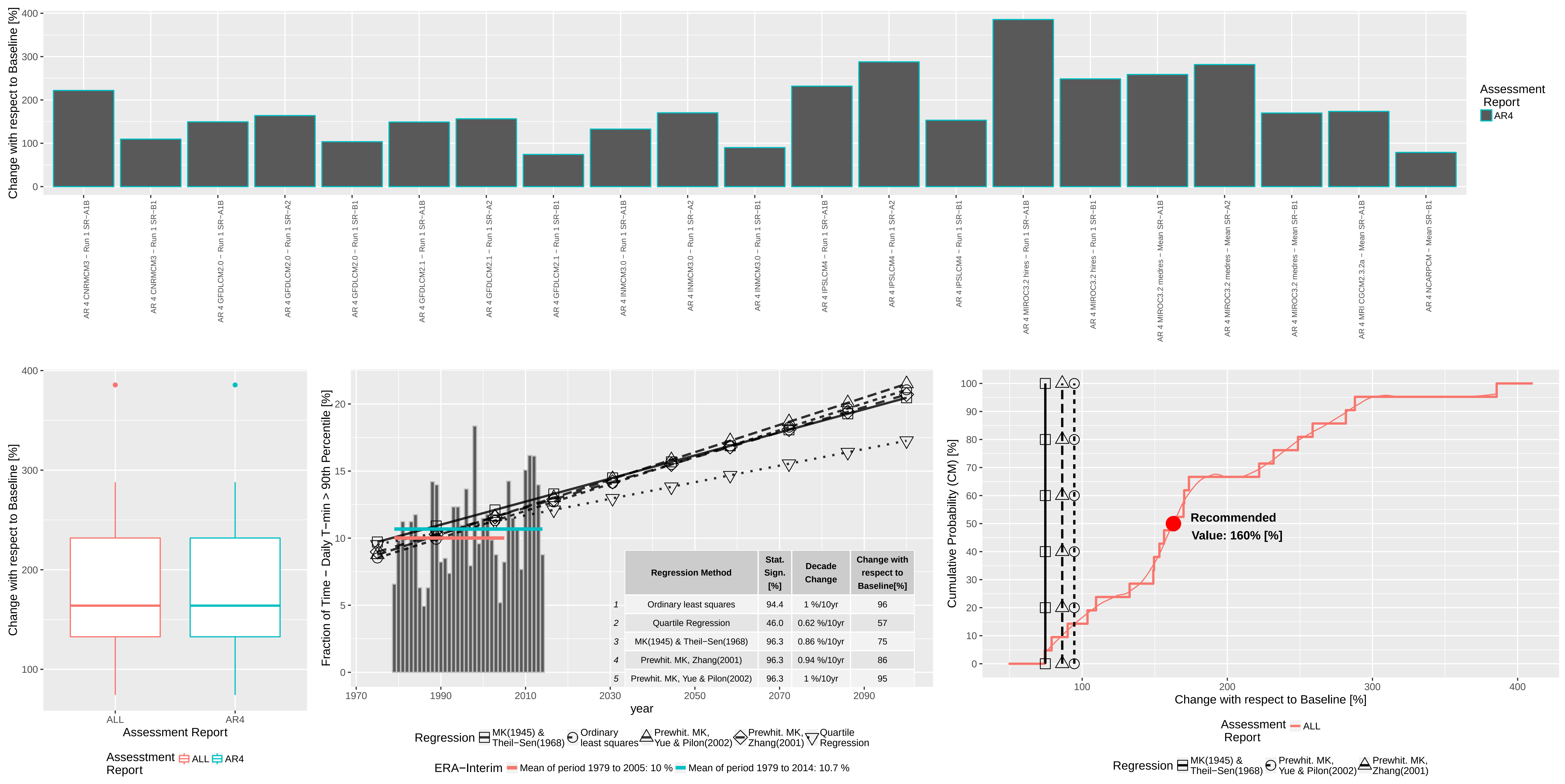
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	94.4	1 %/10yr	36
2	Quartile Regression	46.0	0.62 %/10yr	21
3	MK(1945) & Theil−Sen(1968)	96.3	0.86 %/10yr	28
4	Prewhit. MK, Zhang(2001)	96.3	0.94 %/10yr	32
5	Prewhit. MK, Yue & Pilon(2002)	96.3	1 %/10yr	35

Climate parameter: Fraction of Time − Daily T−min > 90th Percentile
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2041 − 2070

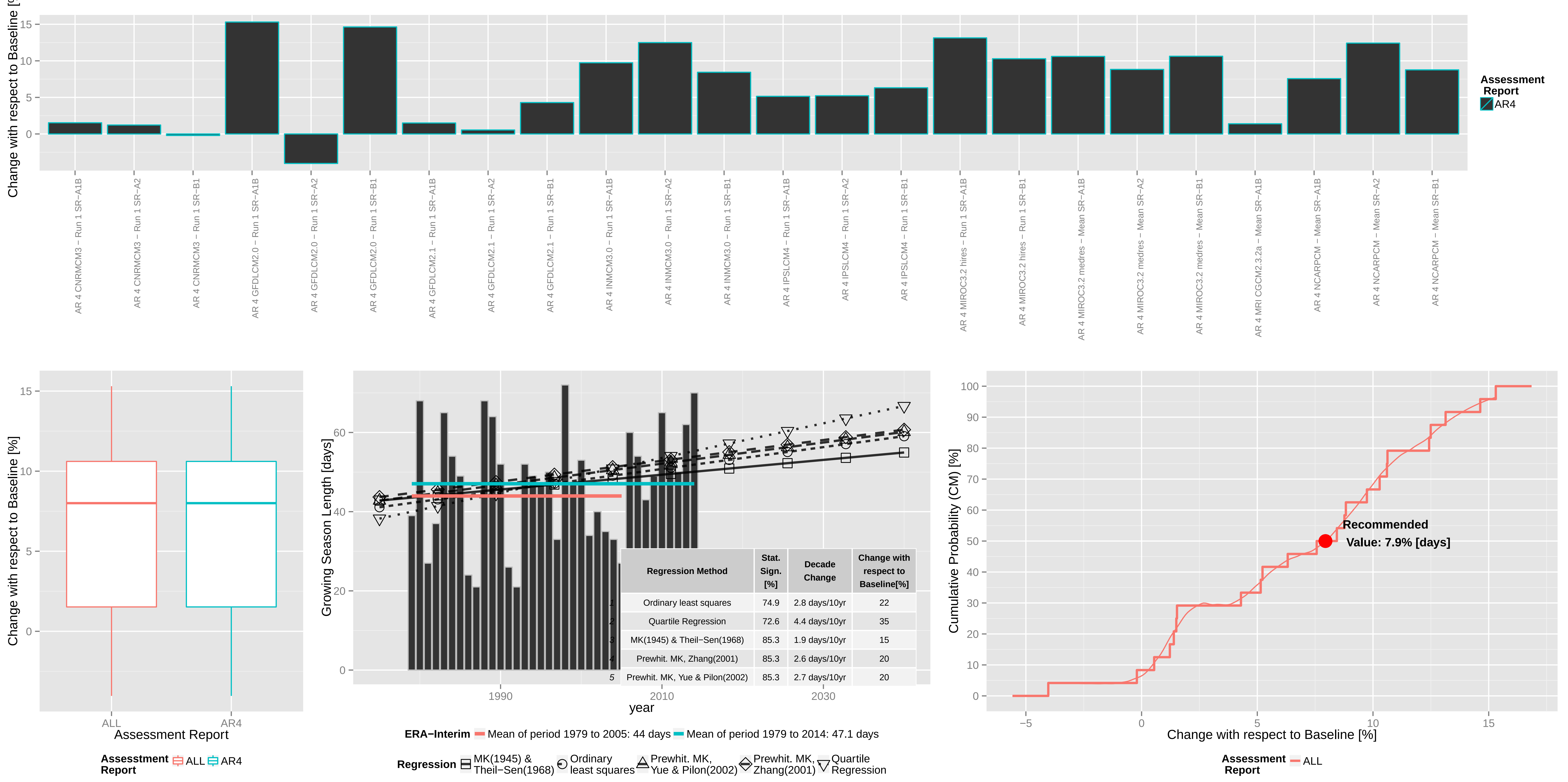


	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	94.4	1 %/10yr	66
2	Quartile Regression	46.0	0.62 %/10yr	39
3	MK(1945) & Theil−Sen(1968)	96.3	0.86 %/10yr	51
4	Prewhit. MK, Zhang(2001)	96.3	0.94 %/10yr	59
5	Prewhit. MK, Yue & Pilon(2002)	96.3	1 %/10yr	65

Climate parameter: Fraction of Time − Daily T−min > 90th Percentile
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2071 − 2100

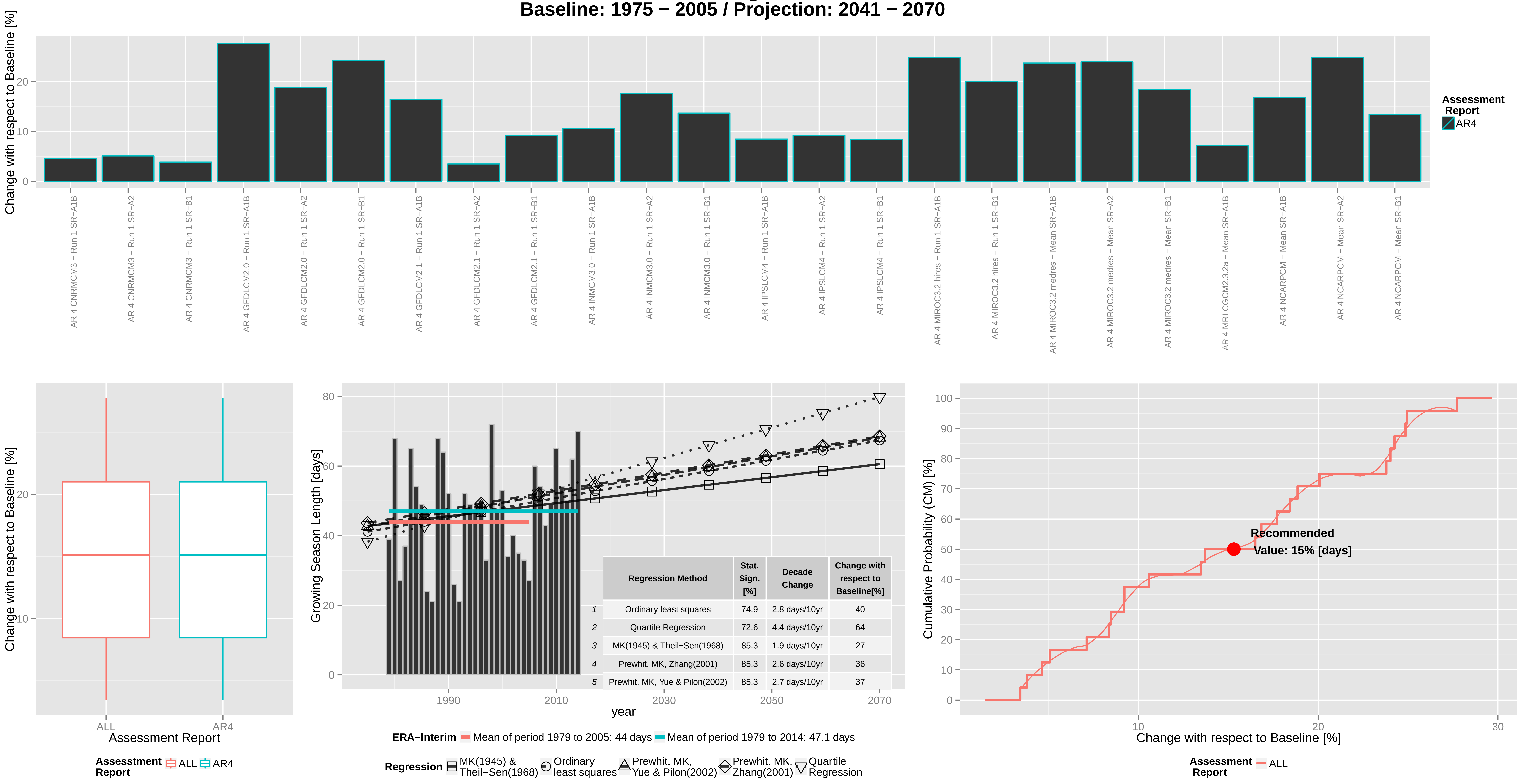


Climate parameter: Growing Season Length
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2011 − 2040

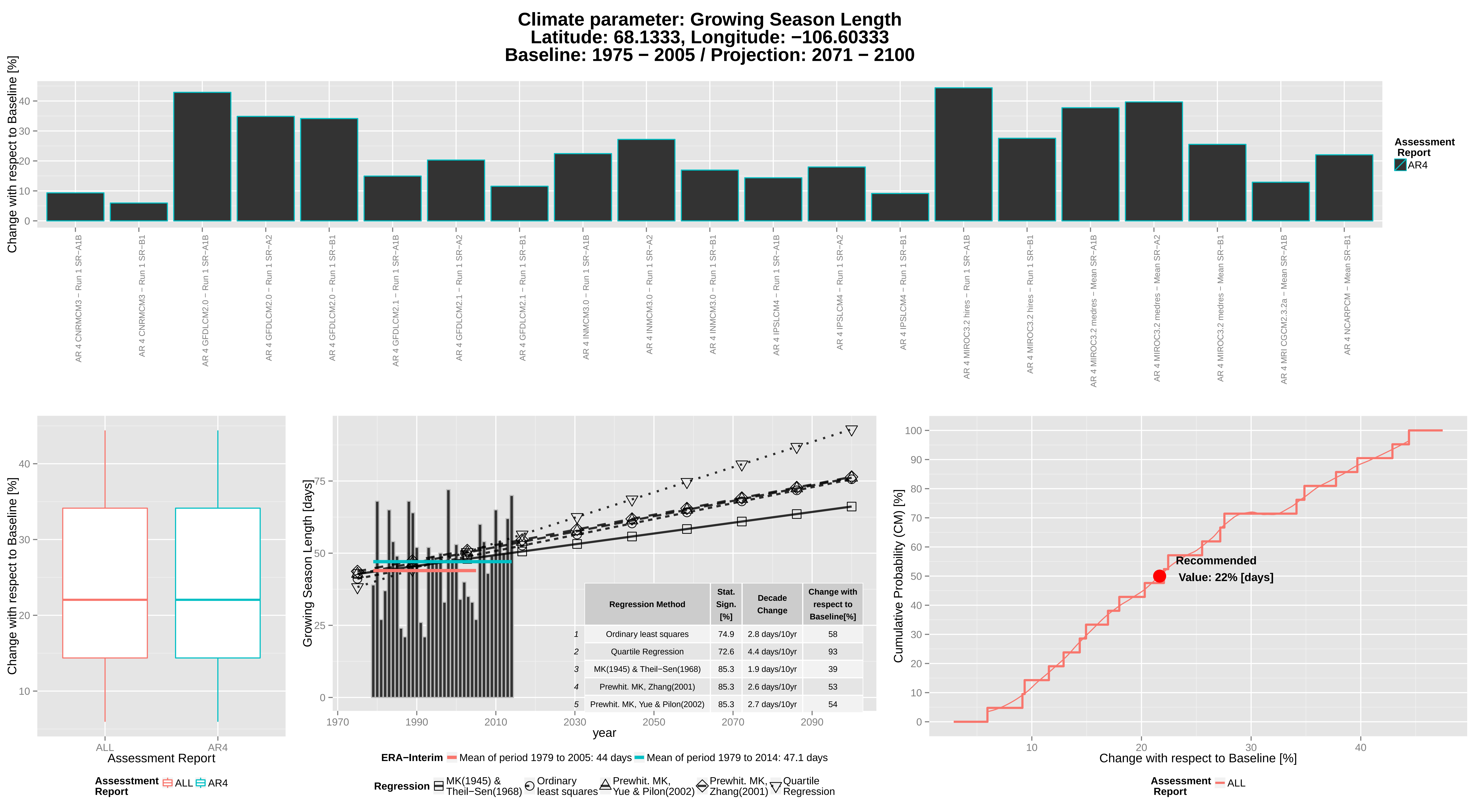


	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	74.9	2.8 days/10yr	22
2	Quartile Regression	72.6	4.4 days/10yr	35
3	MK(1945) & Theil−Sen(1968)	85.3	1.9 days/10yr	15
4	Prewhit. MK, Zhang(2001)	85.3	2.6 days/10yr	20
5	Prewhit. MK, Yue & Pilon(2002)	85.3	2.7 days/10yr	20

Climate parameter: Growing Season Length
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2041 − 2070

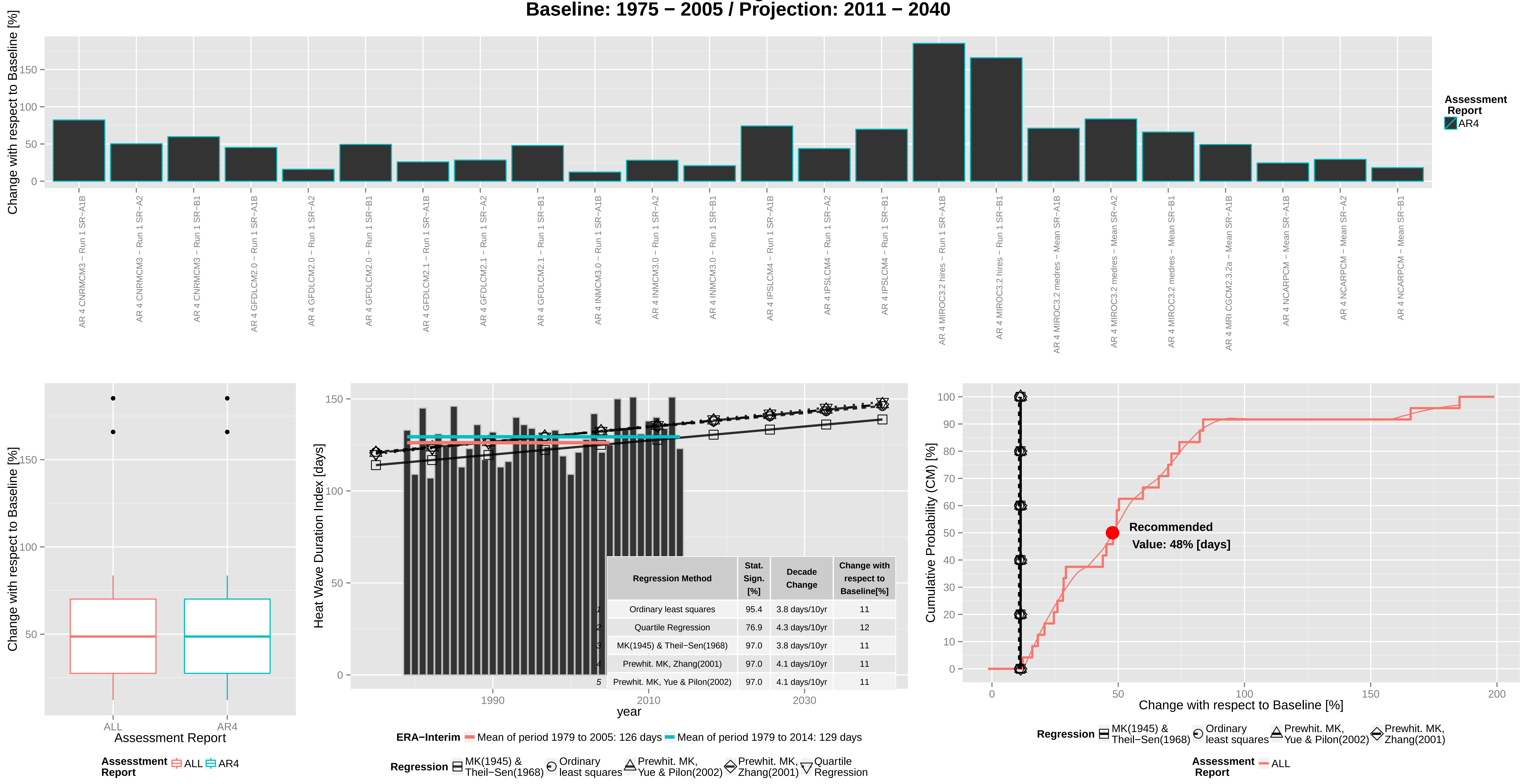


	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	74.9	2.8 days/10yr	40
2	Quartile Regression	72.6	4.4 days/10yr	64
3	MK(1945) & Theil−Sen(1968)	85.3	1.9 days/10yr	27
4	Prewhit. MK, Zhang(2001)	85.3	2.6 days/10yr	36
5	Prewhit. MK, Yue & Pilon(2002)	85.3	2.7 days/10yr	37



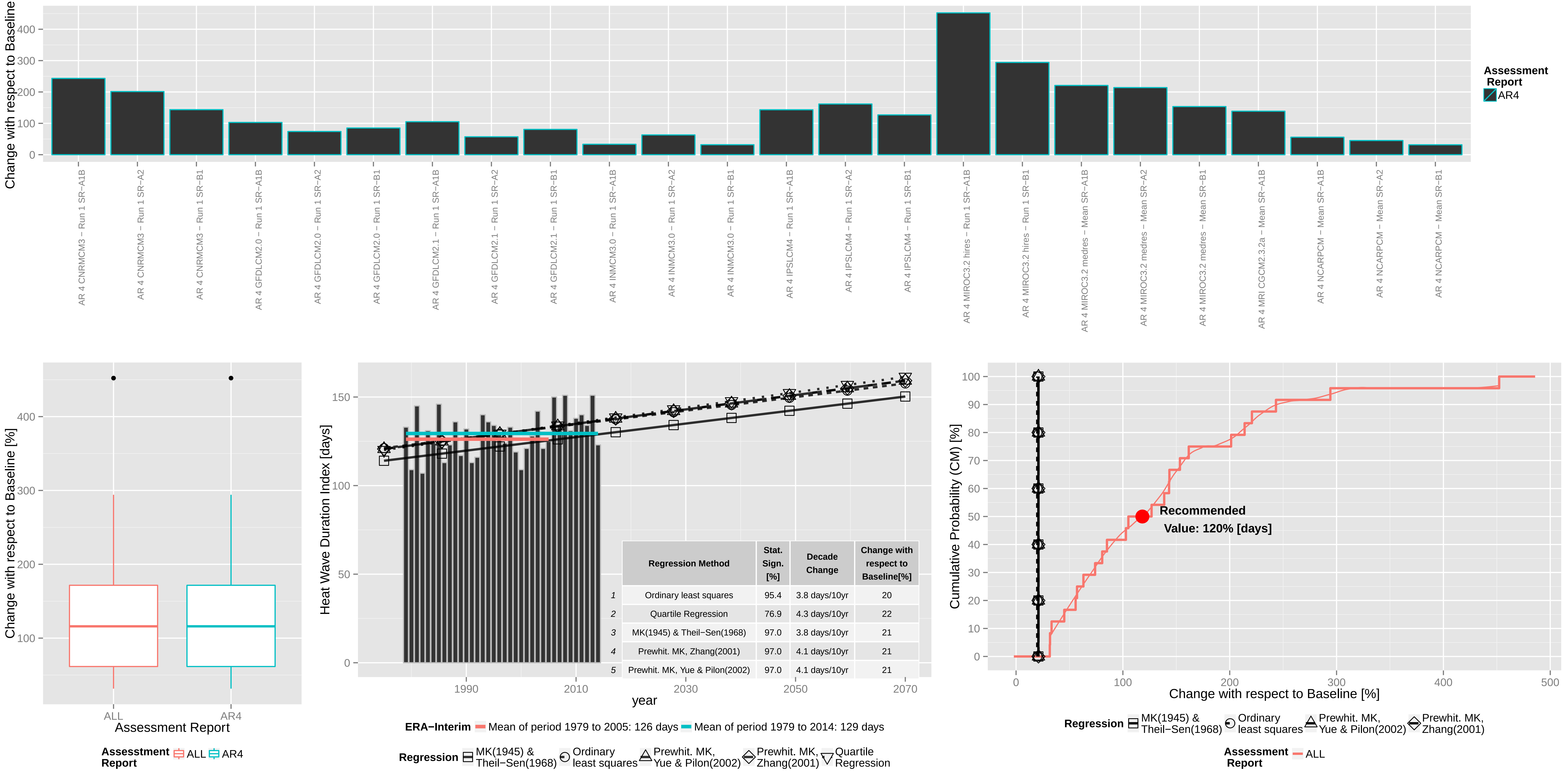
Climate parameter: Growing Season Length
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2071 − 2100
Change with respect to Baseline [%]
Assessment Report
AR4
AR 4 CNRMCM3 − Run 1 SR−A1B
AR 4 CNRMCM3 − Run 1 SR−B1
AR 4 GFDLCM2.0 − Run 1 SR−A1B
AR 4 GFDLCM2.0 − Run 1 SR−A2
AR 4 GFDLCM2.0 − Run 1 SR−B1
AR 4 GFDLCM2.1 − Run 1 SR−A1B
AR 4 GFDLCM2.1 − Run 1 SR−A2
AR 4 GFDLCM2.1 − Run 1 SR−B1
AR 4 INMCM3.0 − Run 1 SR−A1B
AR 4 INMCM3.0 − Run 1 SR−A2
AR 4 INMCM3.0 − Run 1 SR−B1
AR 4 IPSLCM4 − Run 1 SR−A1B
AR 4 IPSLCM4 − Run 1 SR−A2
AR 4 IPSLCM4 − Run 1 SR−B1
AR 4 MIROC3.2 hires − Run 1 SR−A1B
AR 4 MIROC3.2 hires − Run 1 SR−B1
AR 4 MIROC3.2 medres − Mean SR−A1B
AR 4 MIROC3.2 medres − Mean SR−A2
AR 4 MIROC3.2 medres − Mean SR−B1
AR 4 MRI CGCM2.3.2a − Mean SR−A1B
AR 4 NCARPCM − Mean SR−B1
Change with respect to Baseline [%]
ALL
AR4
Assessment Report
Assessment Report ALL AR4
Growing Season Length [days]
year
Regression Method | Stat. Sign. [%] | Decade Change | Change with respect to Baseline[%]
1 Ordinary least squares | 74.9 | 2.8 days/10yr | 58
2 Quartile Regression | 72.6 | 4.4 days/10yr | 93
3 MK(1945) & Theil−Sen(1968) | 85.3 | 1.9 days/10yr | 39
4 Prewhit. MK, Zhang(2001) | 85.3 | 2.6 days/10yr | 53
5 Prewhit. MK, Yue & Pilon(2002) | 85.3 | 2.7 days/10yr | 54
ERA−Interim Mean of period 1979 to 2005: 44 days Mean of period 1979 to 2014: 47.1 days
Regression MK(1945) & Theil−Sen(1968) Ordinary least squares Prewhit. MK, Yue & Pilon(2002) Prewhit. MK, Zhang(2001) Quartile Regression
Cumulative Probability (CM) [%]
Recommended Value: 22% [days]
Change with respect to Baseline [%]
Assessment Report ALL

Climate parameter: Heat Wave Duration Index
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2011 − 2040



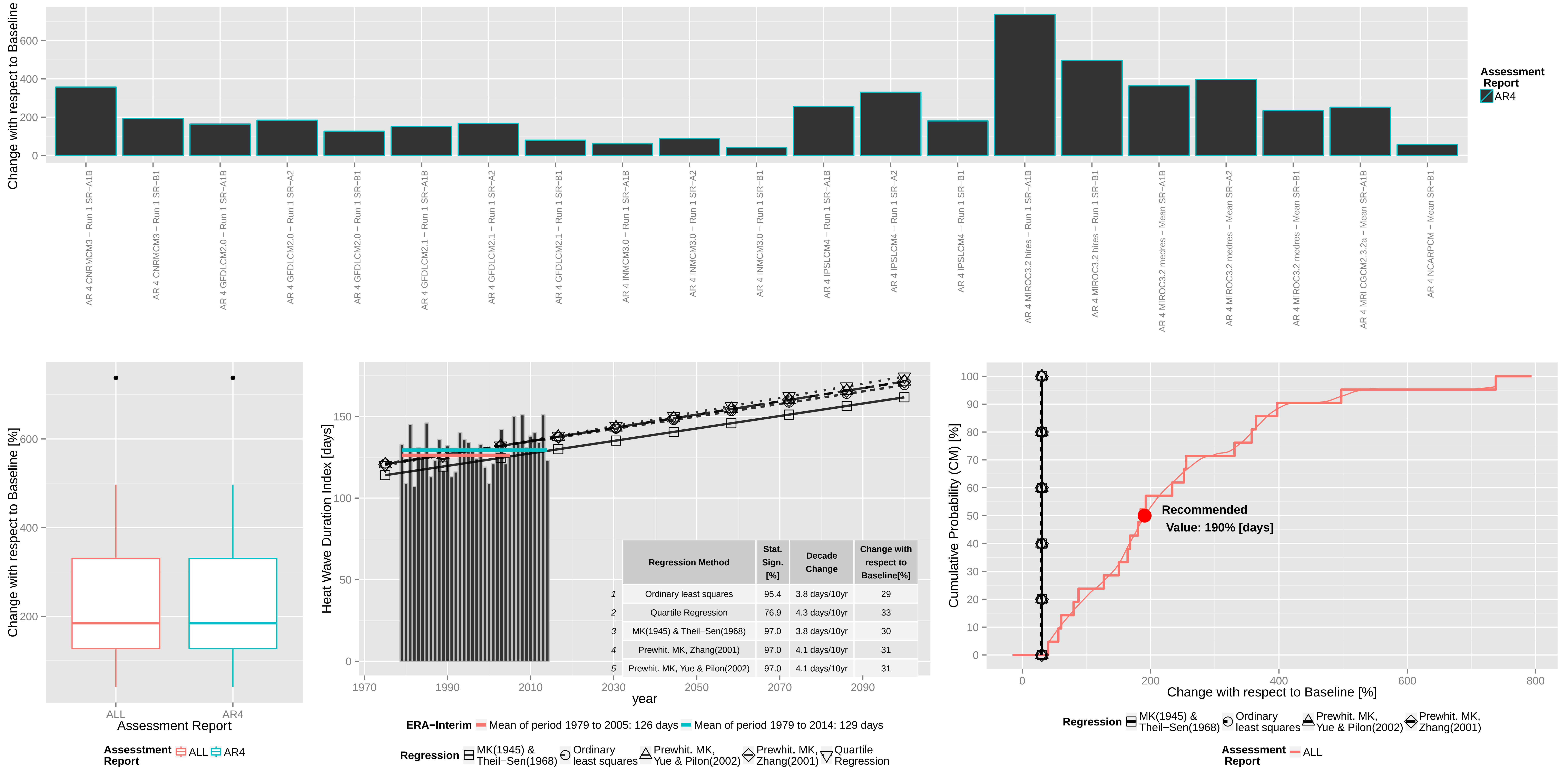
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	95.4	3.8 days/10yr	11
2	Quartile Regression	76.9	4.3 days/10yr	12
3	MK(1945) & Theil−Sen(1968)	97.0	3.8 days/10yr	11
4	Prewhit. MK, Zhang(2001)	97.0	4.1 days/10yr	11
5	Prewhit. MK, Yue & Pilon(2002)	97.0	4.1 days/10yr	11

Climate parameter: Heat Wave Duration Index
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2041 − 2070



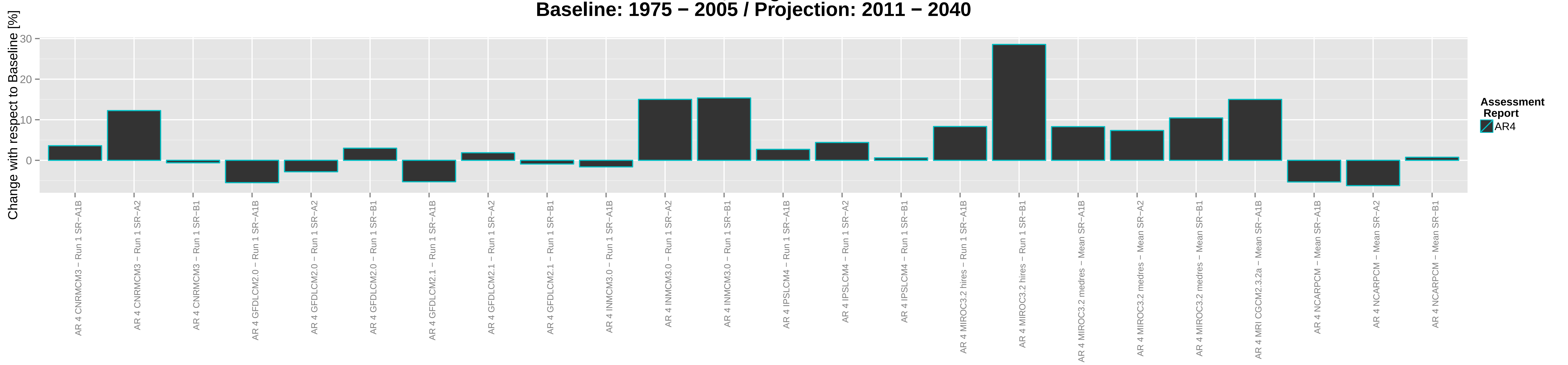
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	95.4	3.8 days/10yr	20
2	Quartile Regression	76.9	4.3 days/10yr	22
3	MK(1945) & Theil−Sen(1968)	97.0	3.8 days/10yr	21
4	Prewhit. MK, Zhang(2001)	97.0	4.1 days/10yr	21
5	Prewhit. MK, Yue & Pilon(2002)	97.0	4.1 days/10yr	21

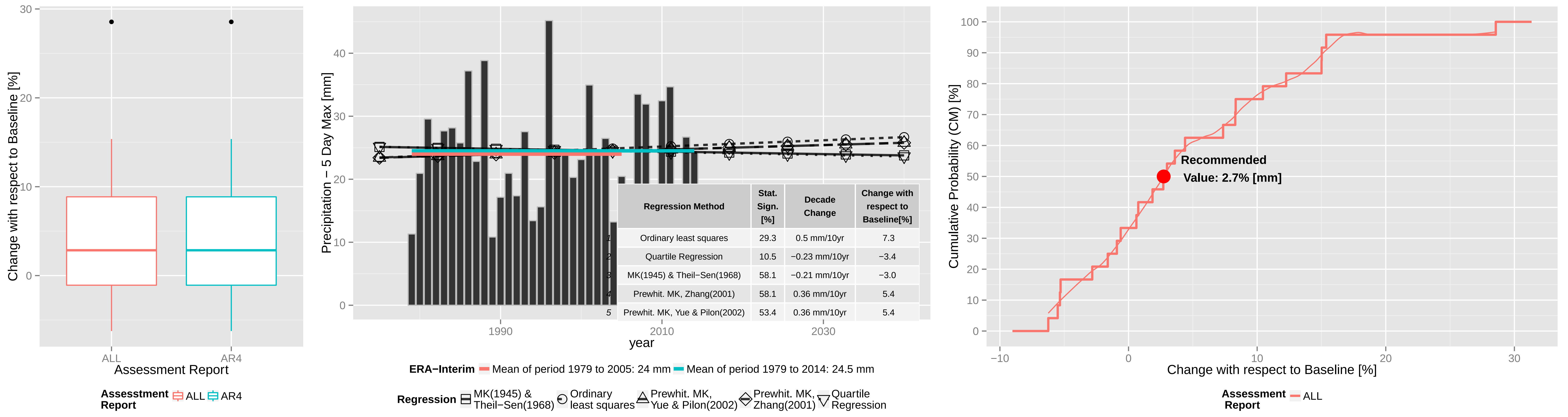
Climate parameter: Heat Wave Duration Index
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2071 − 2100



	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	95.4	3.8 days/10yr	29
2	Quartile Regression	76.9	4.3 days/10yr	33
3	MK(1945) & Theil−Sen(1968)	97.0	3.8 days/10yr	30
4	Prewhit. MK, Zhang(2001)	97.0	4.1 days/10yr	31
5	Prewhit. MK, Yue & Pilon(2002)	97.0	4.1 days/10yr	31

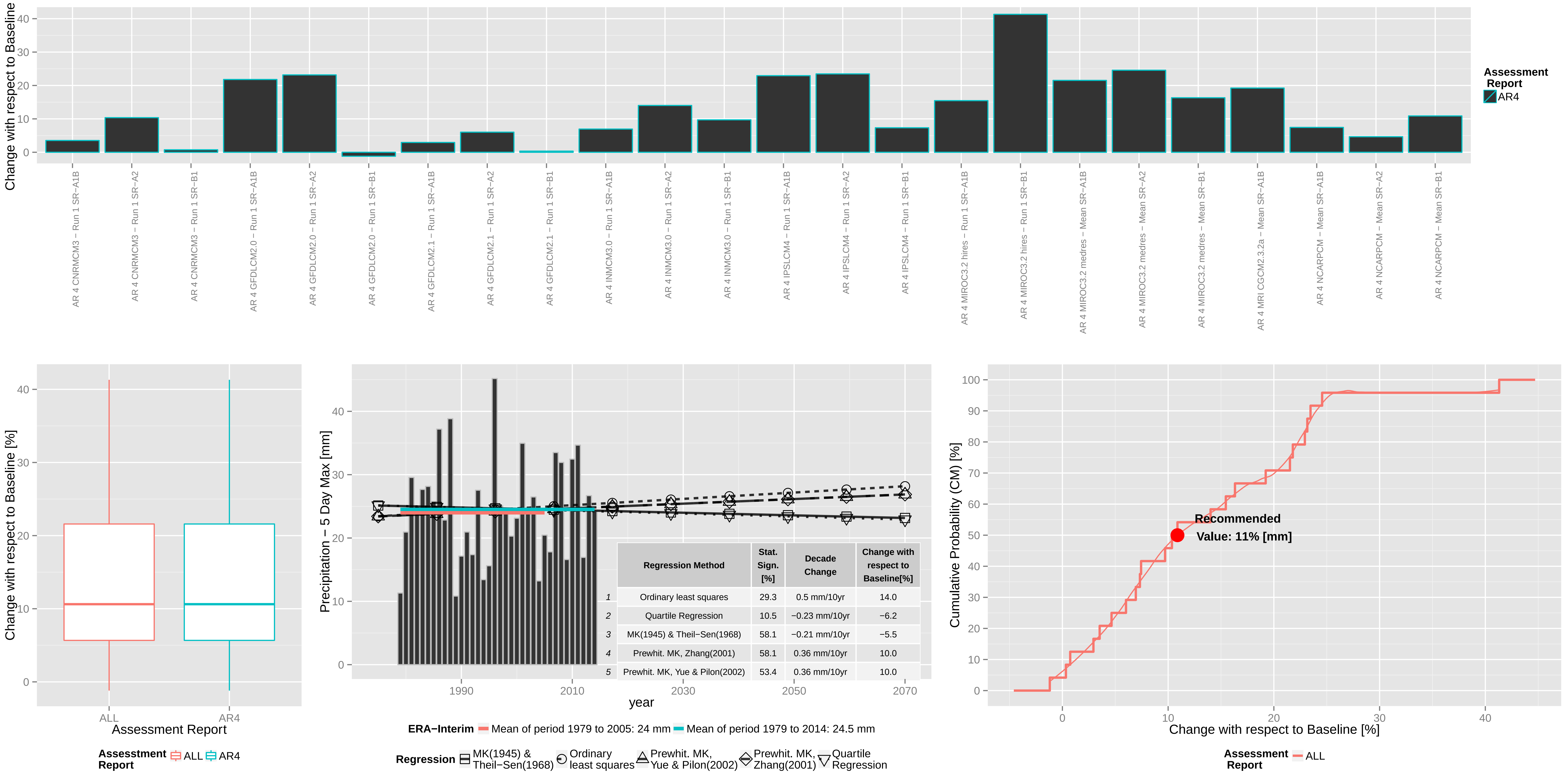
Climate parameter: Precipitation − 5 Day Max
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2011 − 2040





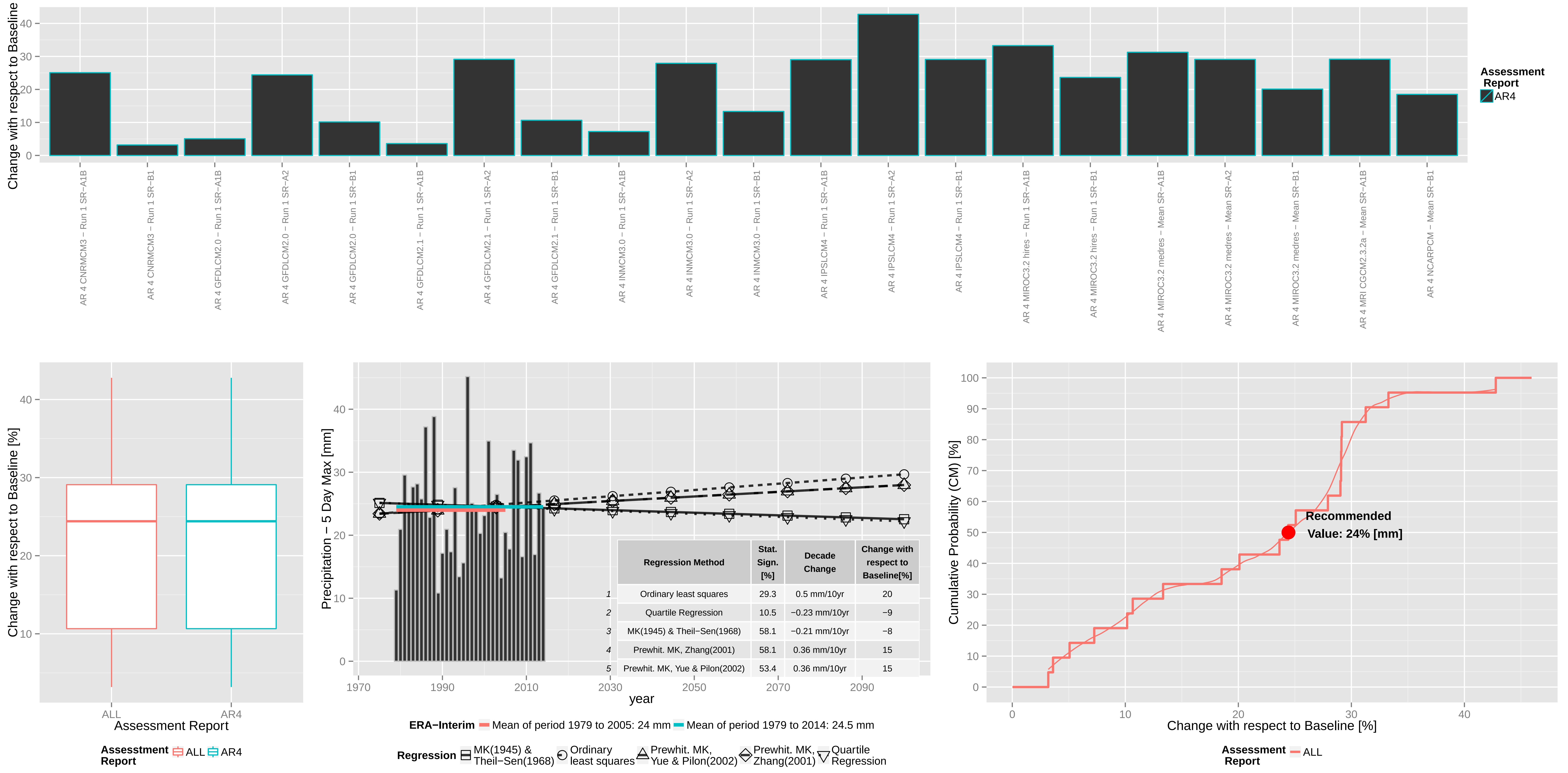
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	29.3	0.5 mm/10yr	7.3
2	Quartile Regression	10.5	−0.23 mm/10yr	−3.4
3	MK(1945) & Theil−Sen(1968)	58.1	−0.21 mm/10yr	−3.0
4	Prewhit. MK, Zhang(2001)	58.1	0.36 mm/10yr	5.4
5	Prewhit. MK, Yue & Pilon(2002)	53.4	0.36 mm/10yr	5.4

Climate parameter: Precipitation − 5 Day Max
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2041 − 2070



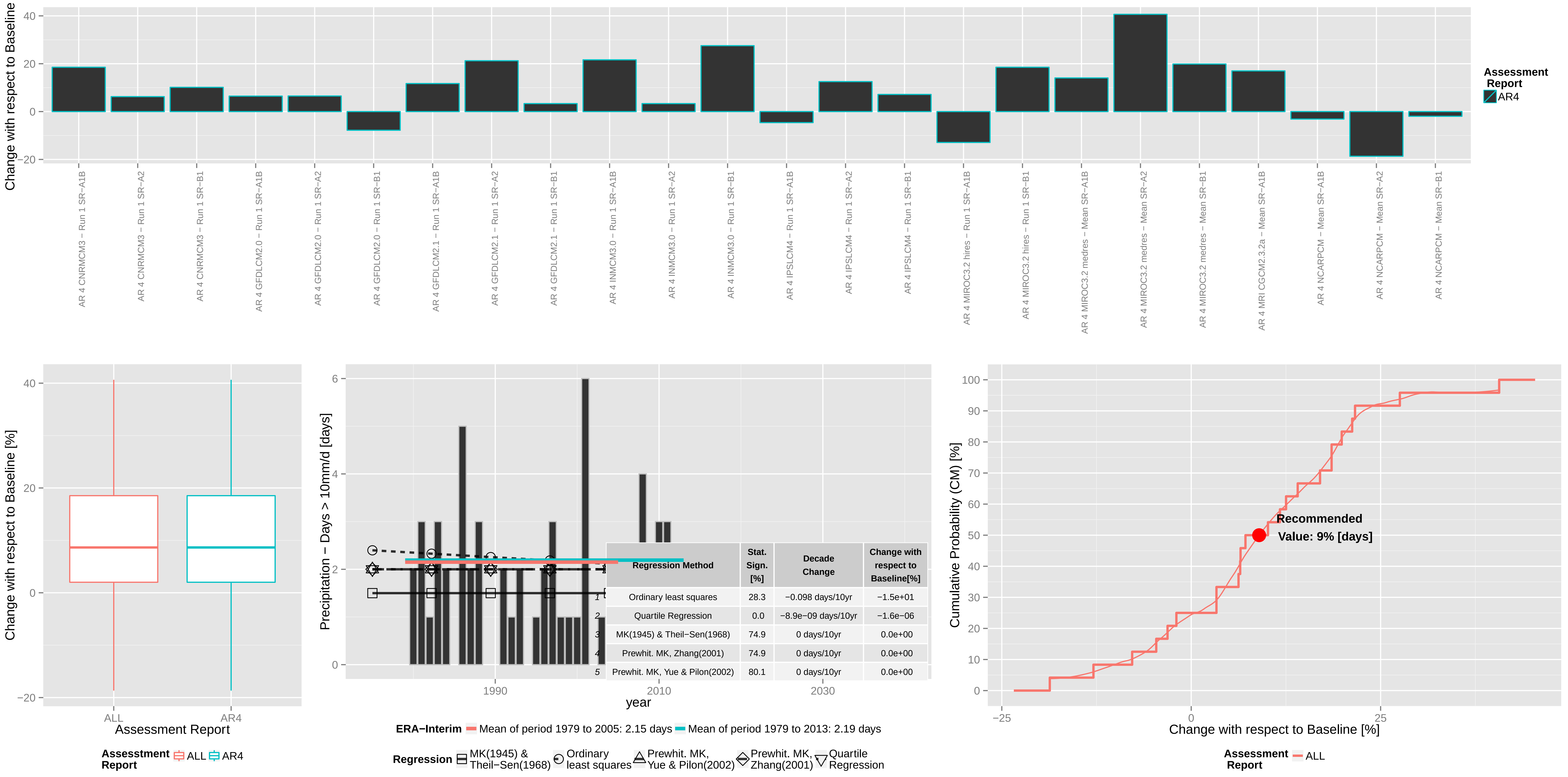
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	29.3	0.5 mm/10yr	14.0
2	Quartile Regression	10.5	−0.23 mm/10yr	−6.2
3	MK(1945) & Theil−Sen(1968)	58.1	−0.21 mm/10yr	−5.5
4	Prewhit. MK, Zhang(2001)	58.1	0.36 mm/10yr	10.0
5	Prewhit. MK, Yue & Pilon(2002)	53.4	0.36 mm/10yr	10.0

Climate parameter: Precipitation − 5 Day Max
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2071 − 2100



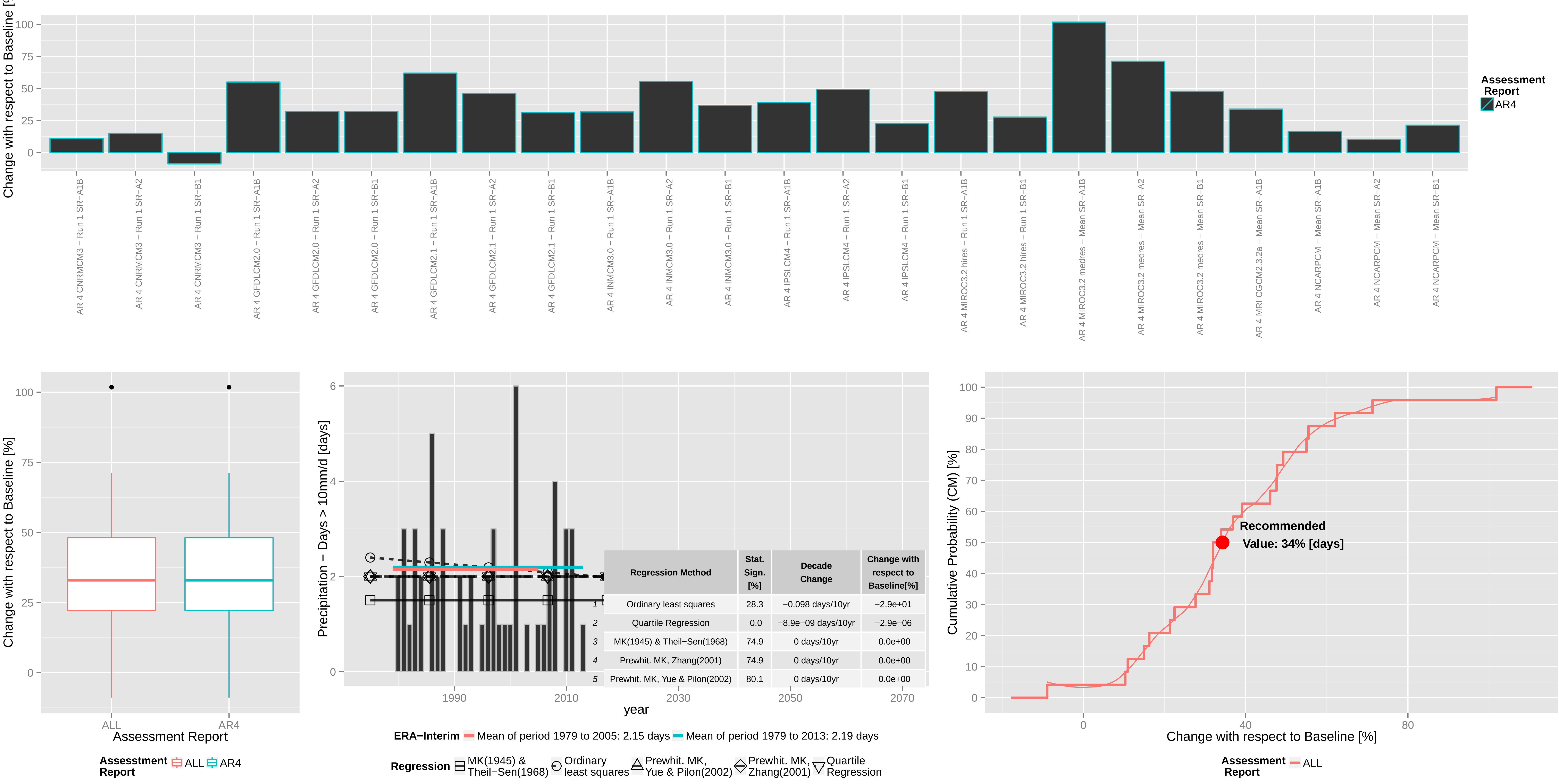
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	29.3	0.5 mm/10yr	20
2	Quartile Regression	10.5	−0.23 mm/10yr	−9
3	MK(1945) & Theil−Sen(1968)	58.1	−0.21 mm/10yr	−8
4	Prewhit. MK, Zhang(2001)	58.1	0.36 mm/10yr	15
5	Prewhit. MK, Yue & Pilon(2002)	53.4	0.36 mm/10yr	15

Climate parameter: Precipitation − Days > 10mm/d
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2011 − 2040



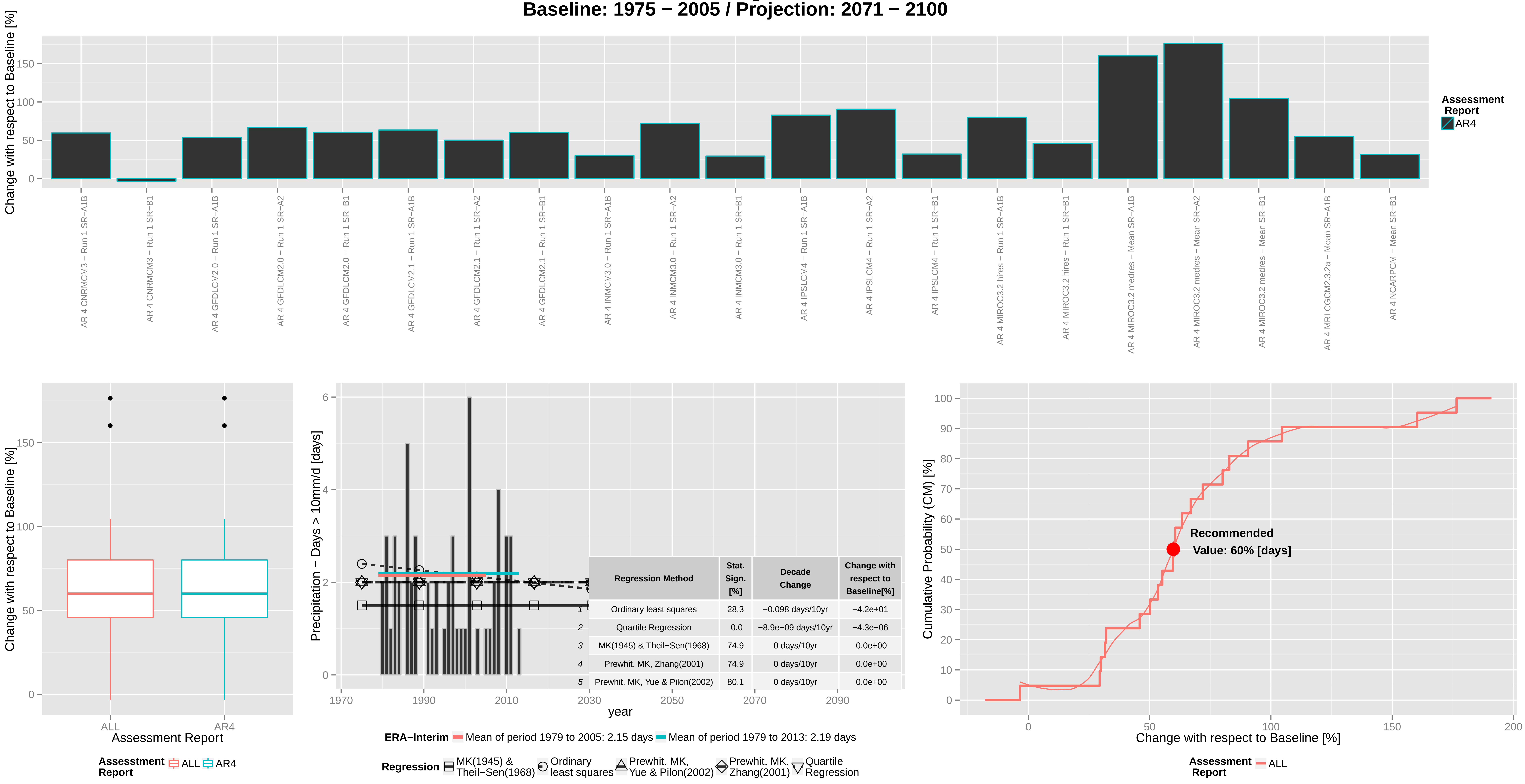
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	28.3	−0.098 days/10yr	−1.5e+01
2	Quartile Regression	0.0	−8.9e−09 days/10yr	−1.6e−06
3	MK(1945) & Theil−Sen(1968)	74.9	0 days/10yr	0.0e+00
4	Prewhit. MK, Zhang(2001)	74.9	0 days/10yr	0.0e+00
5	Prewhit. MK, Yue & Pilon(2002)	80.1	0 days/10yr	0.0e+00

Climate parameter: Precipitation − Days > 10mm/d
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2041 − 2070



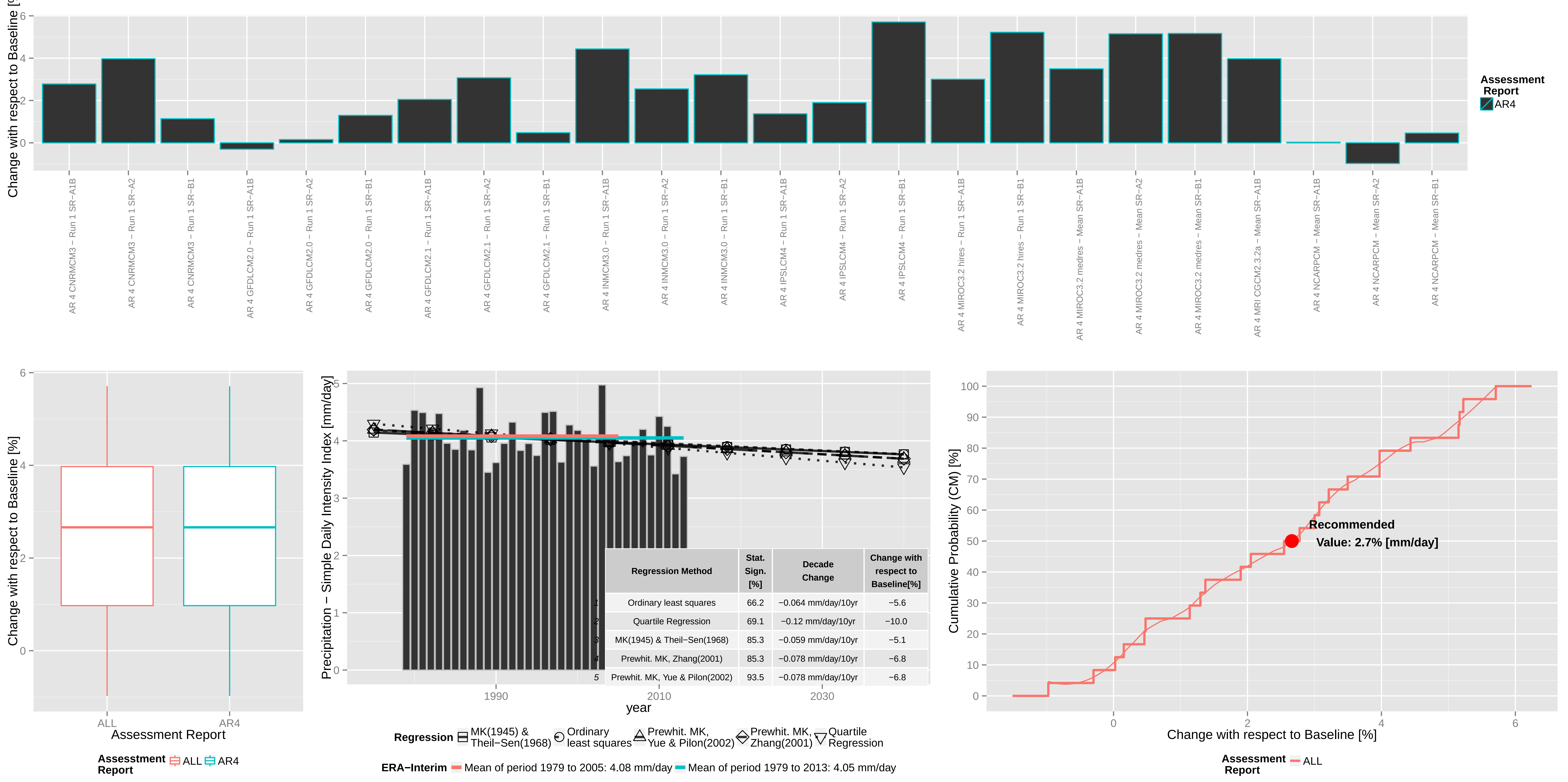
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	28.3	−0.098 days/10yr	−2.9e+01
2	Quartile Regression	0.0	−8.9e−09 days/10yr	−2.9e−06
3	MK(1945) & Theil−Sen(1968)	74.9	0 days/10yr	0.0e+00
4	Prewhit. MK, Zhang(2001)	74.9	0 days/10yr	0.0e+00
5	Prewhit. MK, Yue & Pilon(2002)	80.1	0 days/10yr	0.0e+00

Climate parameter: Precipitation − Days > 10mm/d
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2071 − 2100



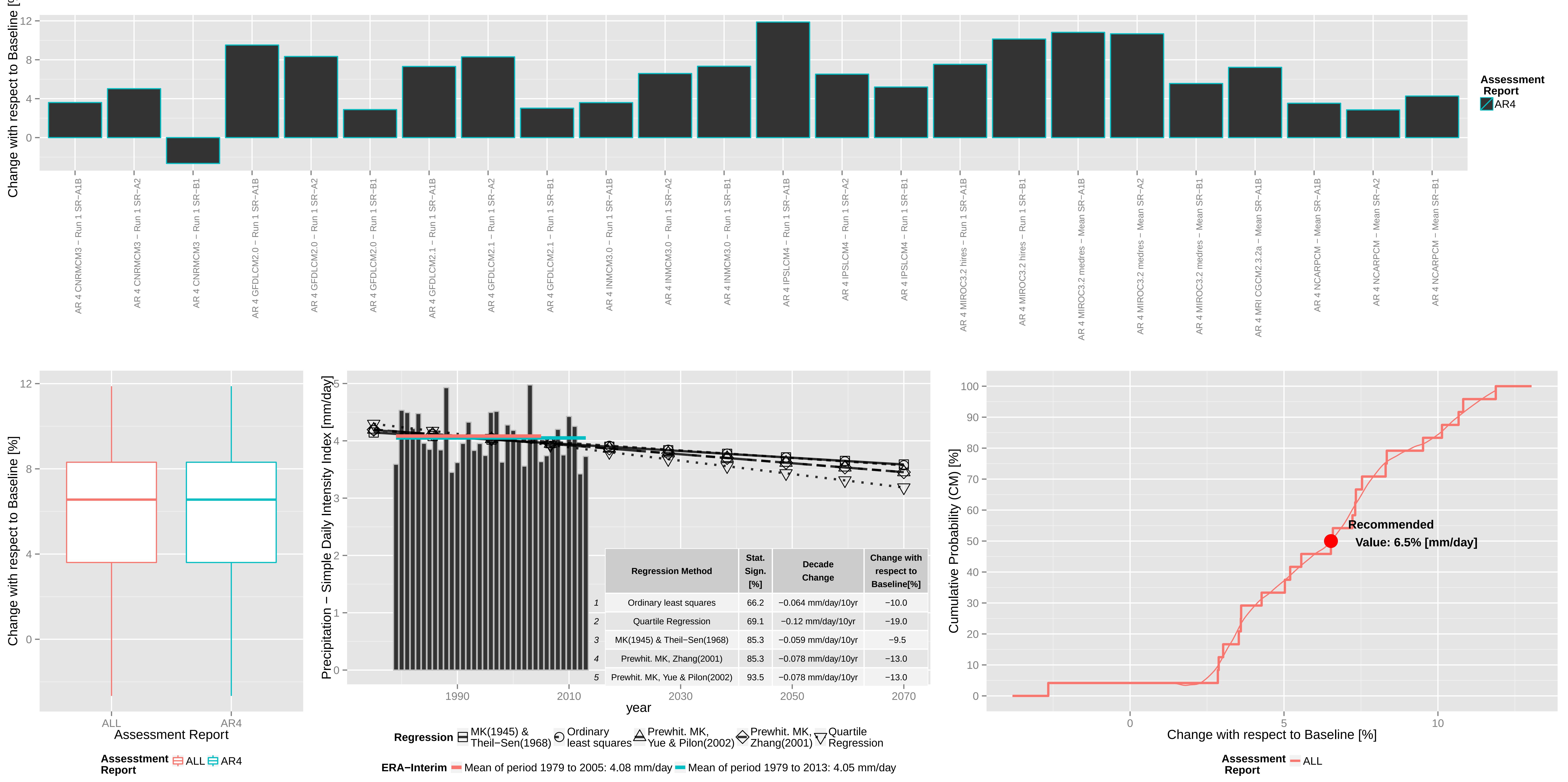
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	28.3	−0.098 days/10yr	−4.2e+01
2	Quartile Regression	0.0	−8.9e−09 days/10yr	−4.3e−06
3	MK(1945) & Theil−Sen(1968)	74.9	0 days/10yr	0.0e+00
4	Prewhit. MK, Zhang(2001)	74.9	0 days/10yr	0.0e+00
5	Prewhit. MK, Yue & Pilon(2002)	80.1	0 days/10yr	0.0e+00

Climate parameter: Precipitation − Simple Daily Intensity Index
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2011 − 2040



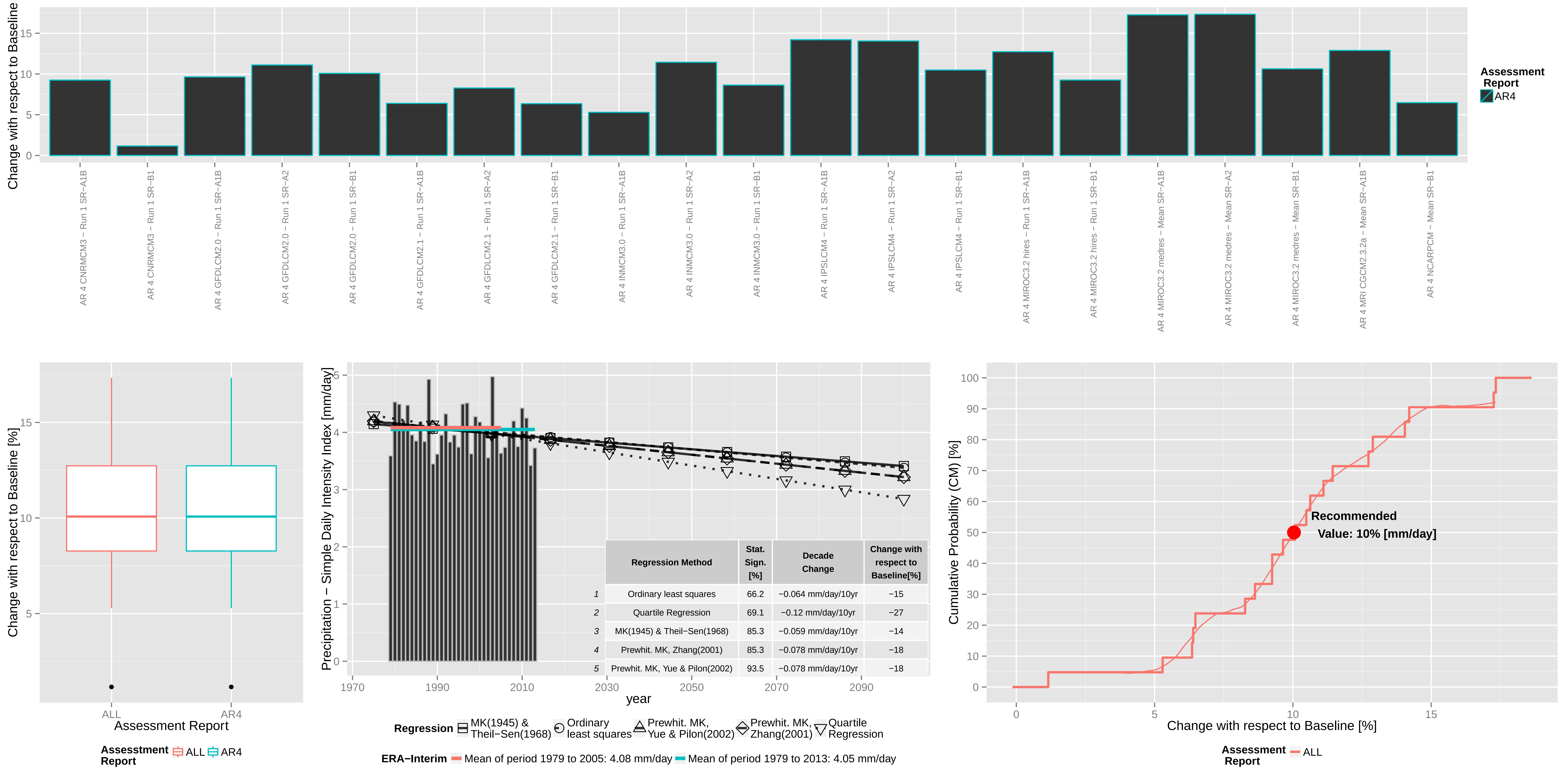
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	66.2	−0.064 mm/day/10yr	−5.6
2	Quartile Regression	69.1	−0.12 mm/day/10yr	−10.0
3	MK(1945) & Theil−Sen(1968)	85.3	−0.059 mm/day/10yr	−5.1
4	Prewhit. MK, Zhang(2001)	85.3	−0.078 mm/day/10yr	−6.8
5	Prewhit. MK, Yue & Pilon(2002)	93.5	−0.078 mm/day/10yr	−6.8

Climate parameter: Precipitation − Simple Daily Intensity Index
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2041 − 2070

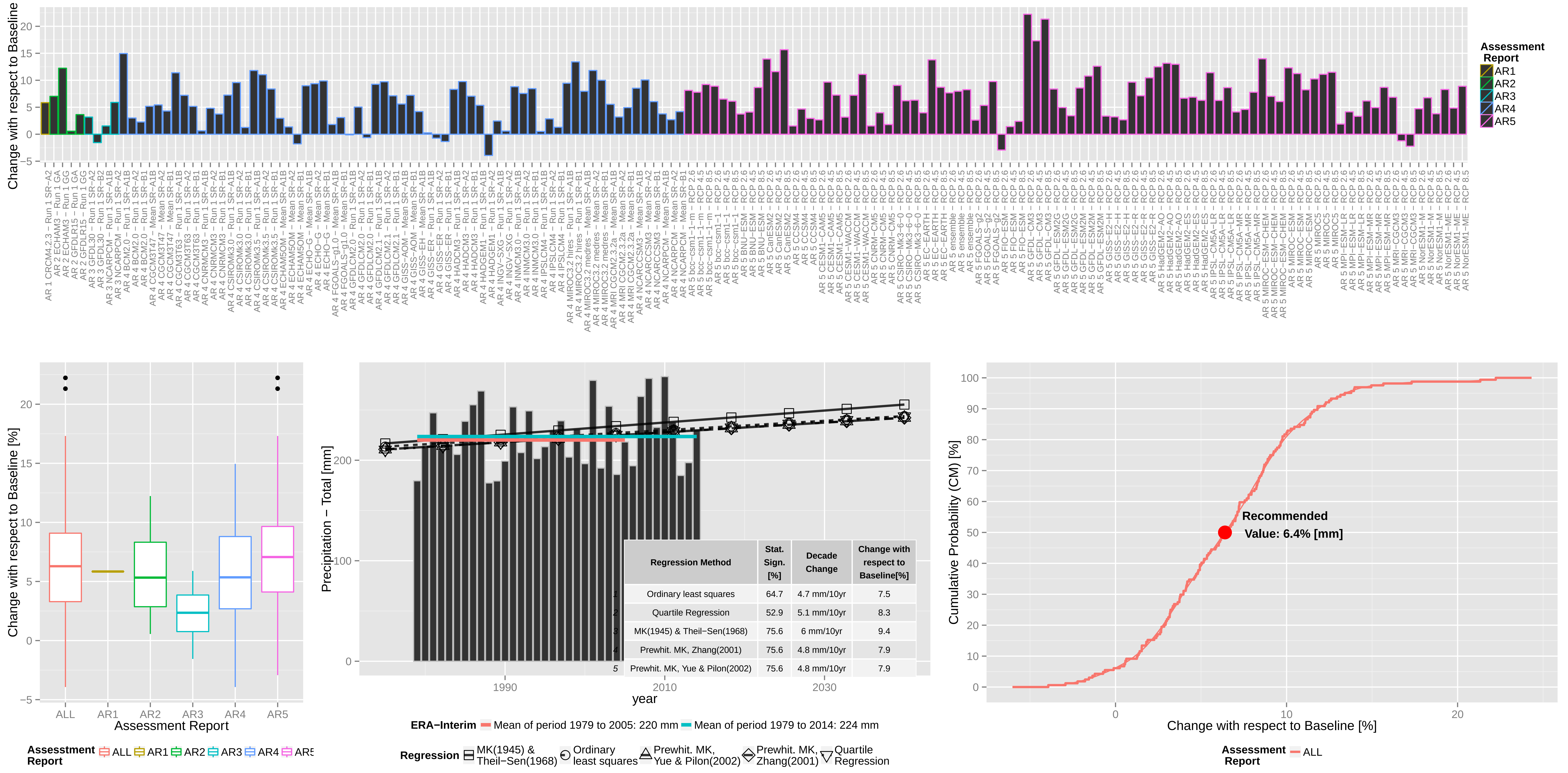


	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	66.2	−0.064 mm/day/10yr	−10.0
2	Quartile Regression	69.1	−0.12 mm/day/10yr	−19.0
3	MK(1945) & Theil−Sen(1968)	85.3	−0.059 mm/day/10yr	−9.5
4	Prewhit. MK, Zhang(2001)	85.3	−0.078 mm/day/10yr	−13.0
5	Prewhit. MK, Yue & Pilon(2002)	93.5	−0.078 mm/day/10yr	−13.0

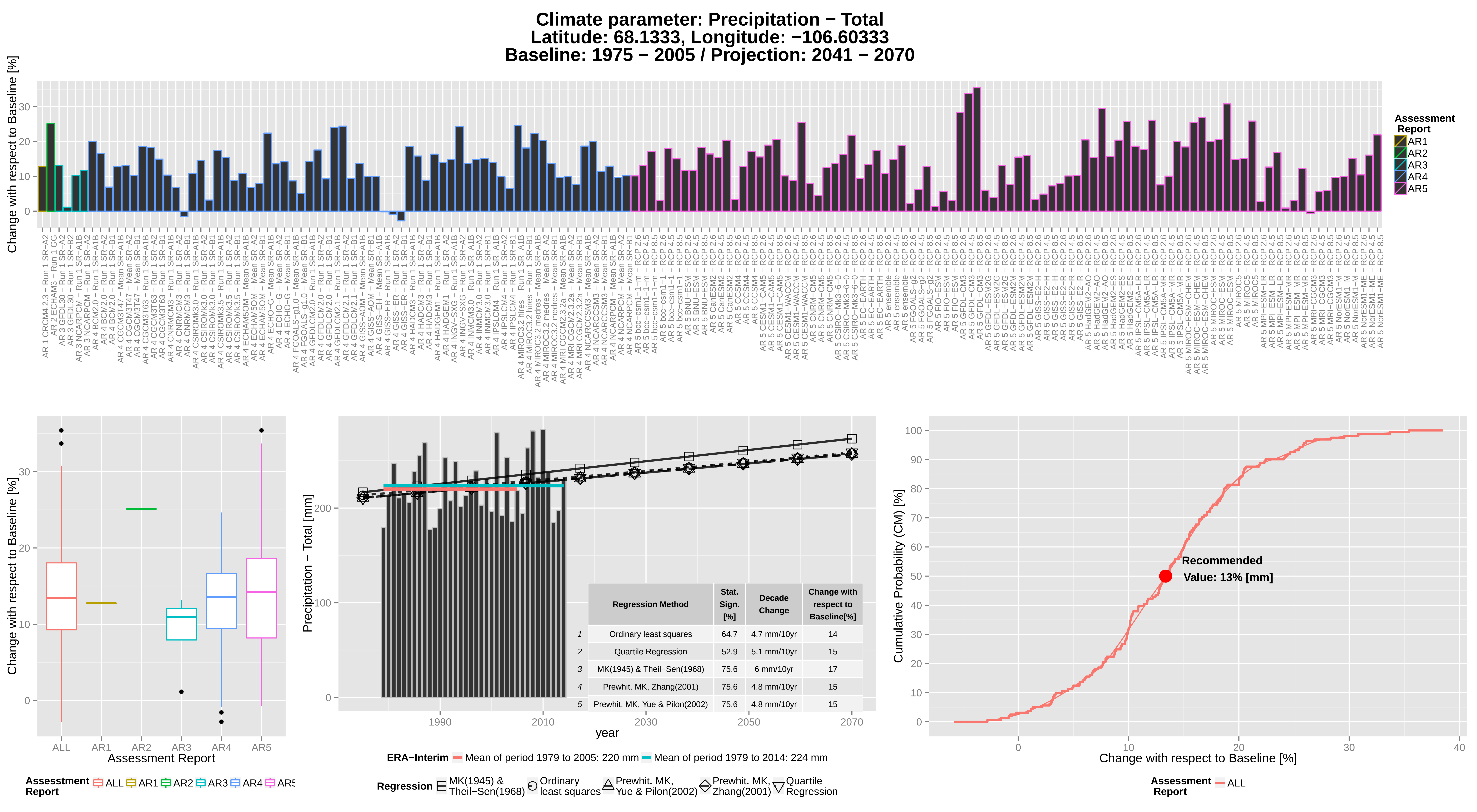
Climate parameter: Precipitation − Simple Daily Intensity Index
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2071 − 2100



Climate parameter: Precipitation − Total
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2011 − 2040

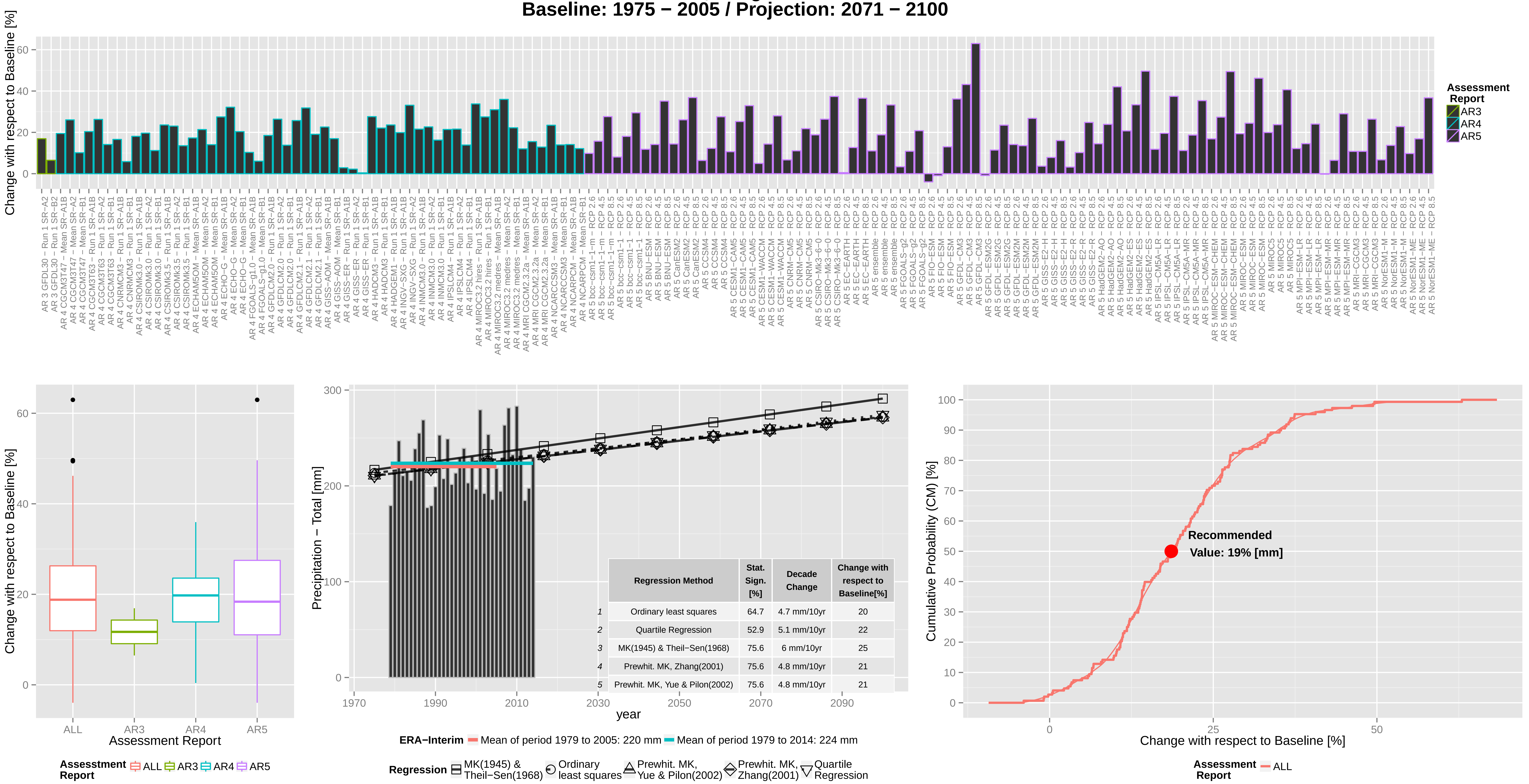


	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	64.7	4.7 mm/10yr	7.5
2	Quartile Regression	52.9	5.1 mm/10yr	8.3
3	MK(1945) & Theil−Sen(1968)	75.6	6 mm/10yr	9.4
4	Prewhit. MK, Zhang(2001)	75.6	4.8 mm/10yr	7.9
5	Prewhit. MK, Yue & Pilon(2002)	75.6	4.8 mm/10yr	7.9



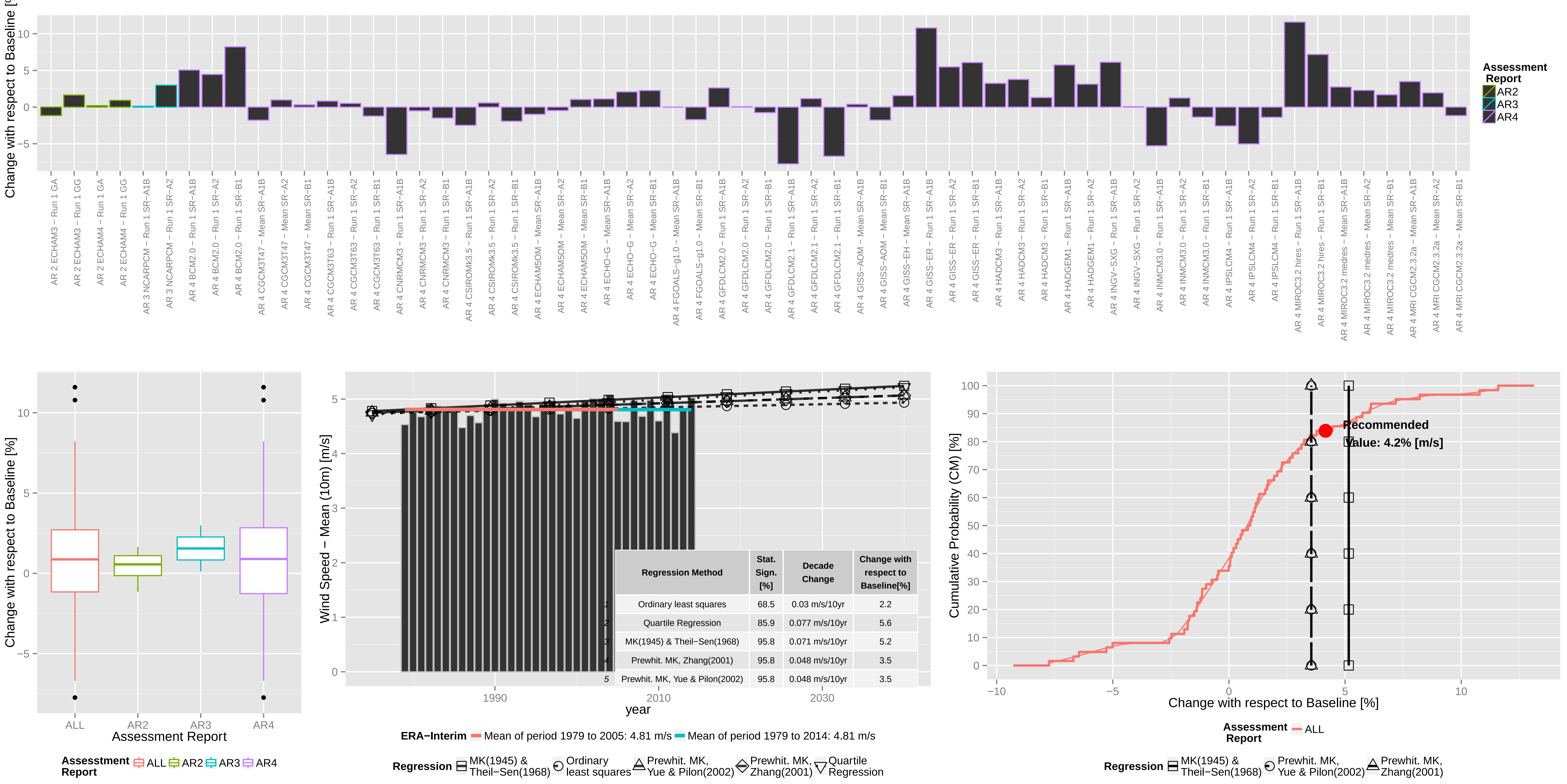
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	64.7	4.7 mm/10yr	14
2	Quartile Regression	52.9	5.1 mm/10yr	15
3	MK(1945) & Theil−Sen(1968)	75.6	6 mm/10yr	17
4	Prewhit. MK, Zhang(2001)	75.6	4.8 mm/10yr	15
5	Prewhit. MK, Yue & Pilon(2002)	75.6	4.8 mm/10yr	15

Climate parameter: Precipitation − Total
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2071 − 2100



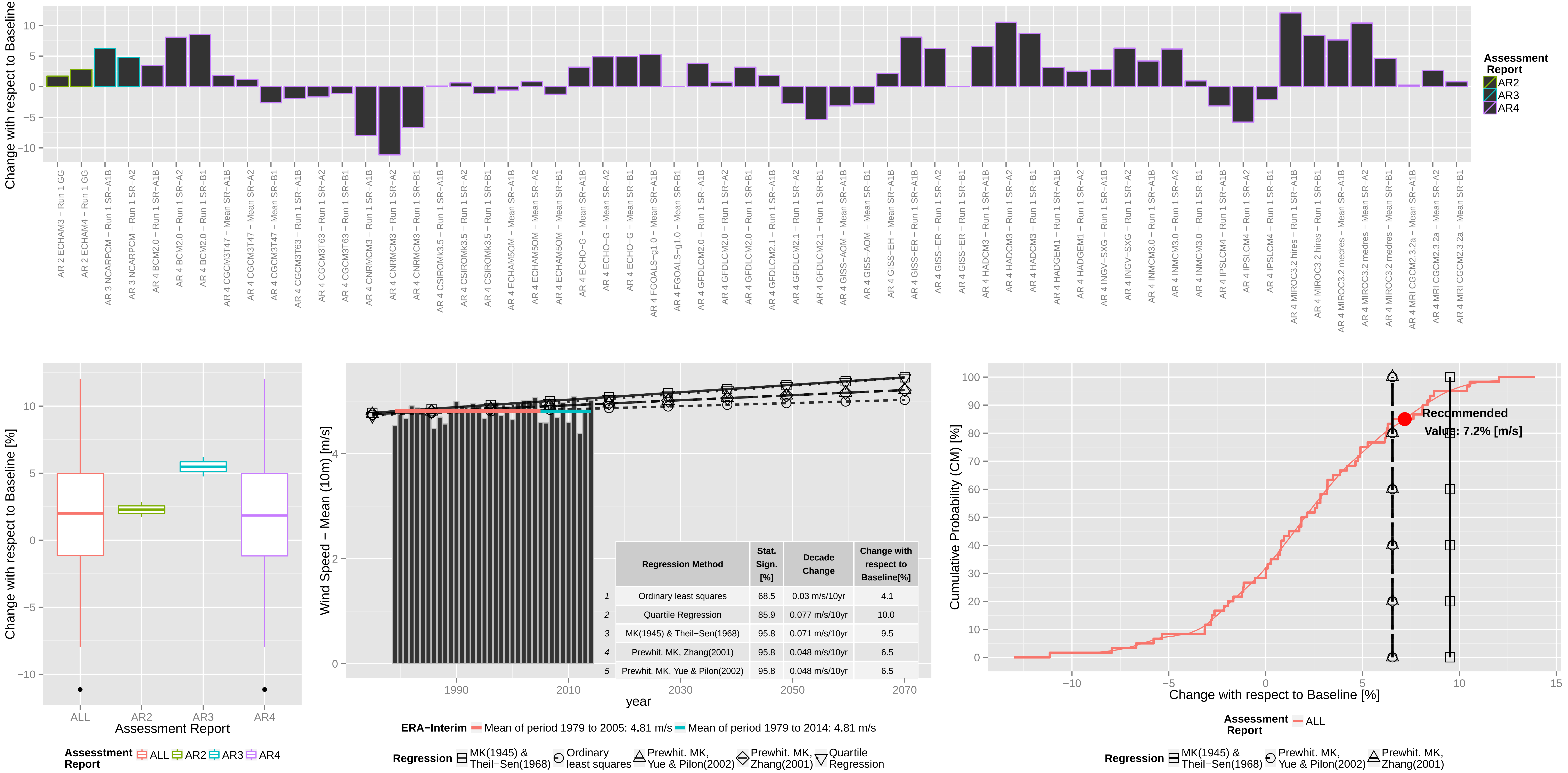
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	64.7	4.7 mm/10yr	20
2	Quartile Regression	52.9	5.1 mm/10yr	22
3	MK(1945) & Theil−Sen(1968)	75.6	6 mm/10yr	25
4	Prewhit. MK, Zhang(2001)	75.6	4.8 mm/10yr	21
5	Prewhit. MK, Yue & Pilon(2002)	75.6	4.8 mm/10yr	21

Climate parameter: Wind Speed − Mean (10m)
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2011 − 2040



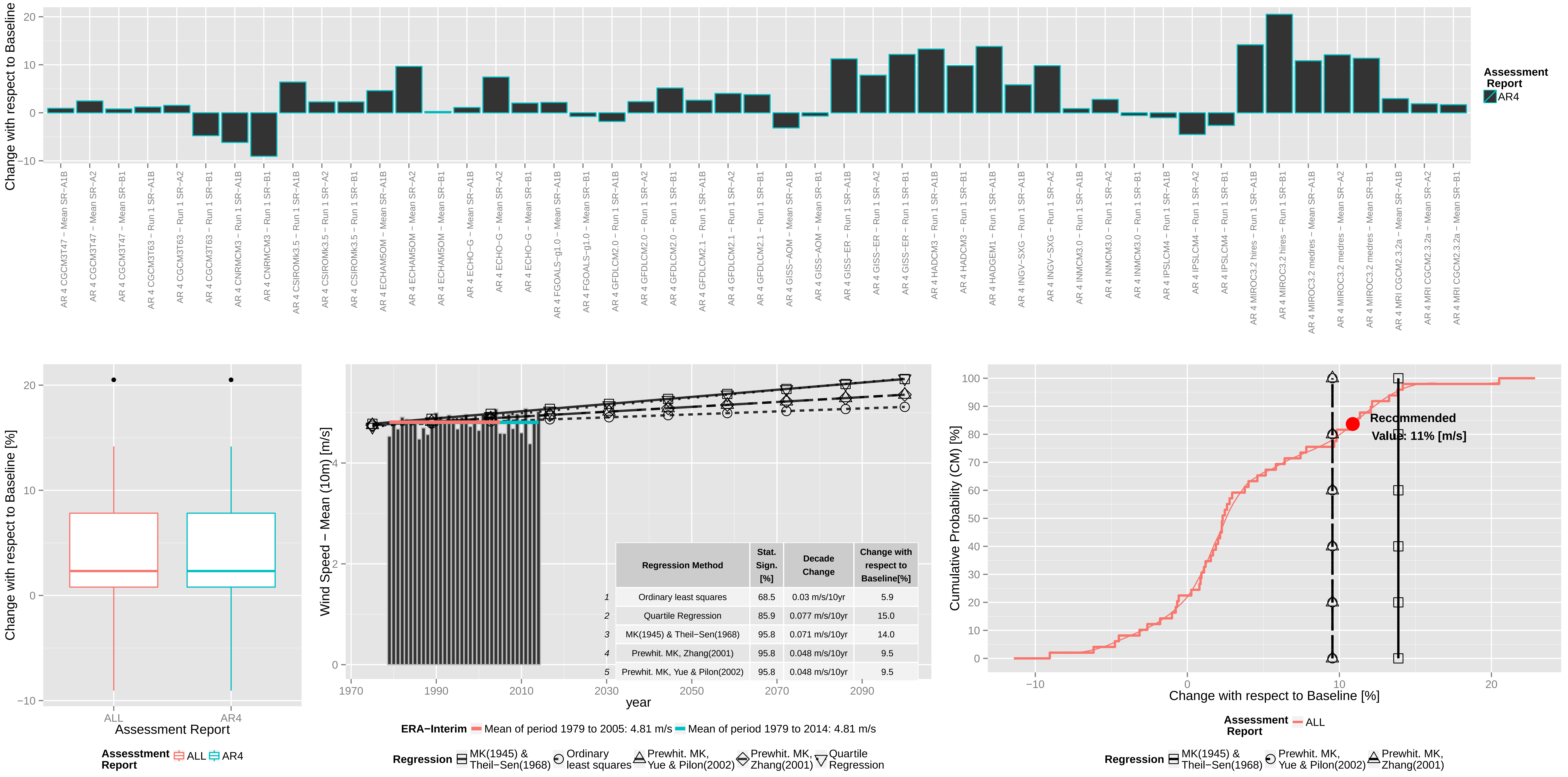
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	68.5	0.03 m/s/10yr	2.2
2	Quartile Regression	85.9	0.077 m/s/10yr	5.6
3	MK(1945) & Theil−Sen(1968)	95.8	0.071 m/s/10yr	5.2
4	Prewhit. MK, Zhang(2001)	95.8	0.048 m/s/10yr	3.5
5	Prewhit. MK, Yue & Pilon(2002)	95.8	0.048 m/s/10yr	3.5

Climate parameter: Wind Speed − Mean (10m)
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2041 − 2070



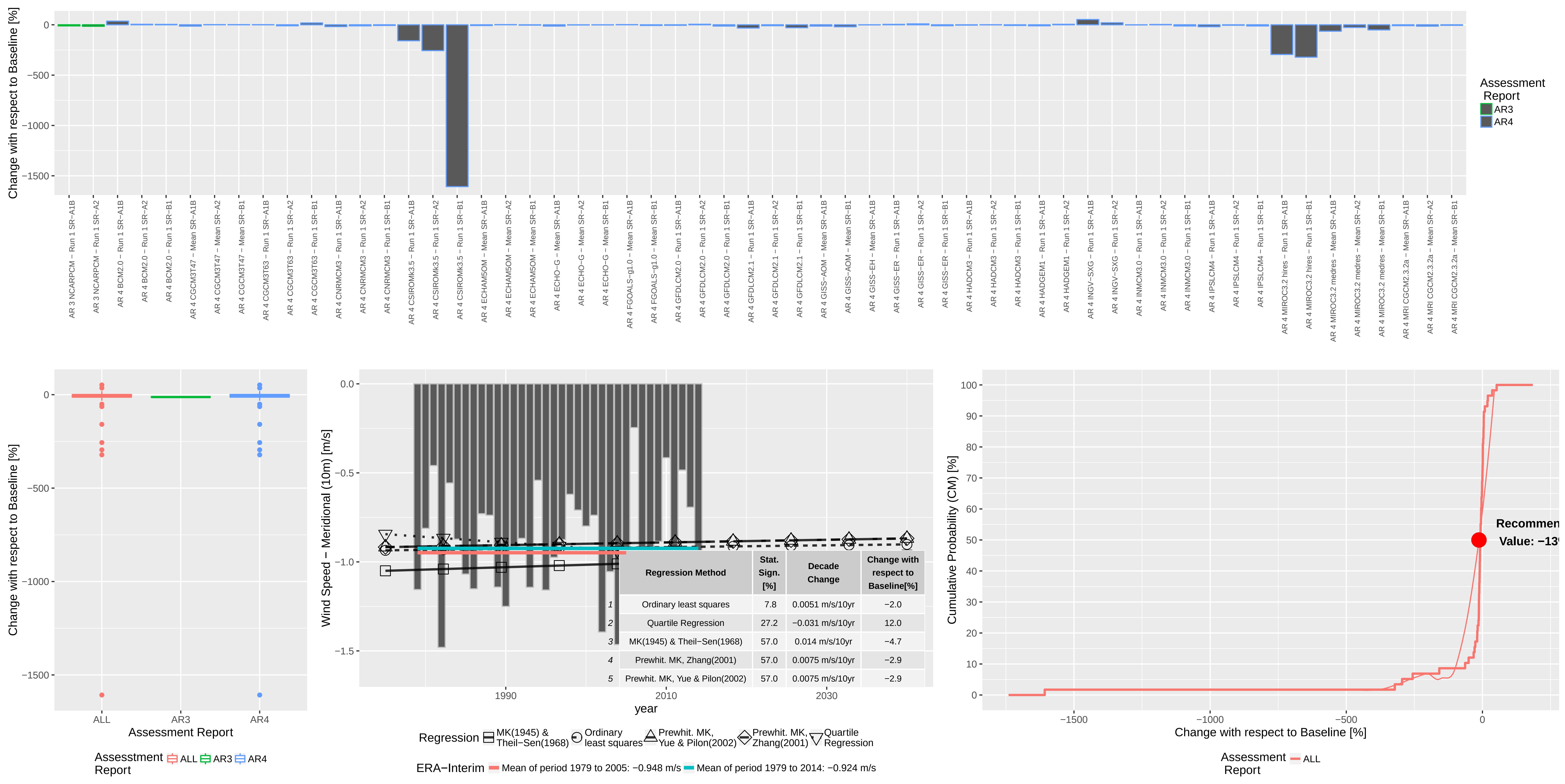
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	68.5	0.03 m/s/10yr	4.1
2	Quartile Regression	85.9	0.077 m/s/10yr	10.0
3	MK(1945) & Theil−Sen(1968)	95.8	0.071 m/s/10yr	9.5
4	Prewhit. MK, Zhang(2001)	95.8	0.048 m/s/10yr	6.5
5	Prewhit. MK, Yue & Pilon(2002)	95.8	0.048 m/s/10yr	6.5

Climate parameter: Wind Speed − Mean (10m)
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2071 − 2100



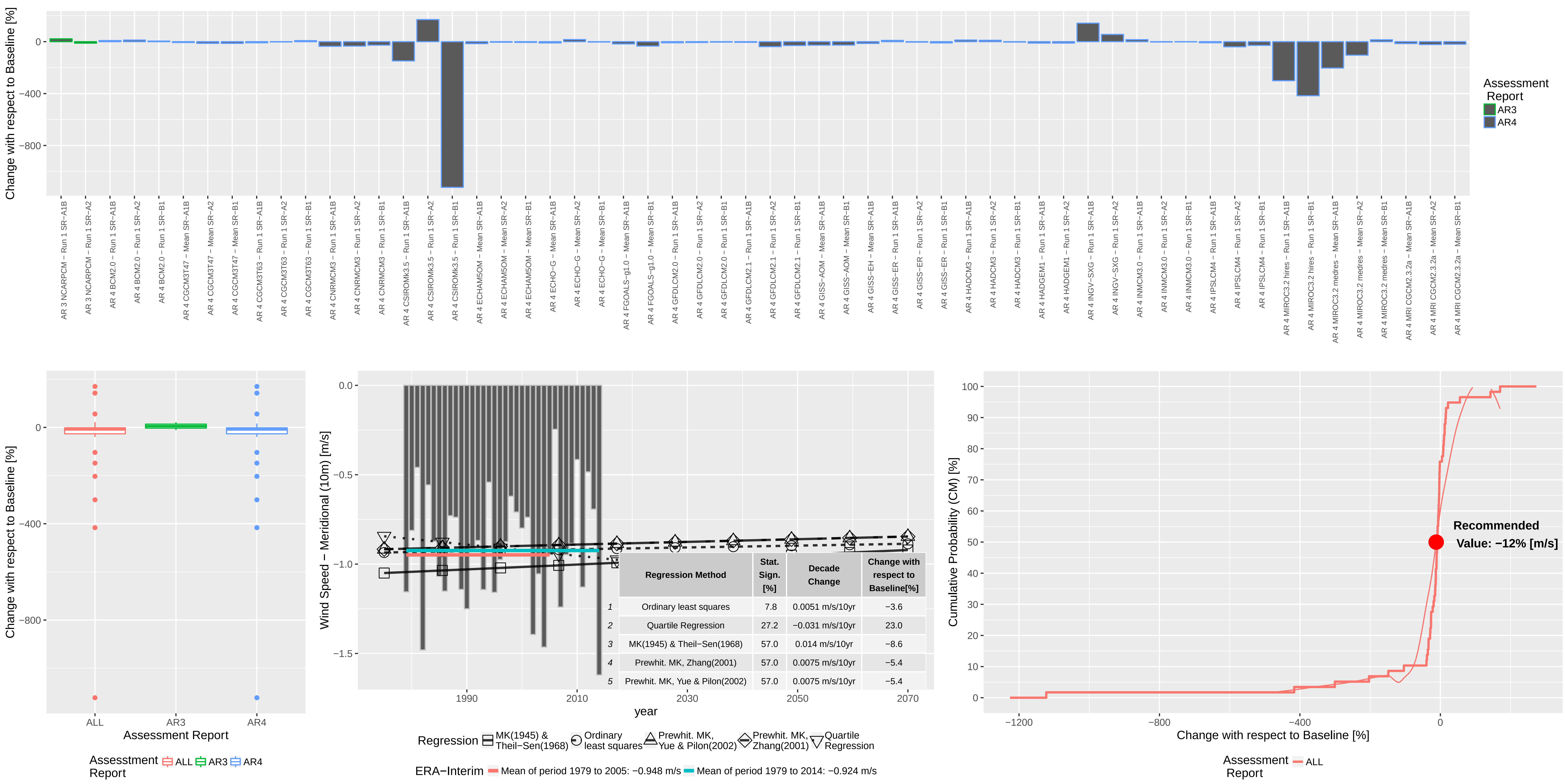
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	68.5	0.03 m/s/10yr	5.9
2	Quartile Regression	85.9	0.077 m/s/10yr	15.0
3	MK(1945) & Theil−Sen(1968)	95.8	0.071 m/s/10yr	14.0
4	Prewhit. MK, Zhang(2001)	95.8	0.048 m/s/10yr	9.5
5	Prewhit. MK, Yue & Pilon(2002)	95.8	0.048 m/s/10yr	9.5

Climate parameter: Wind Speed − Meridional (10m)
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2011 − 2040

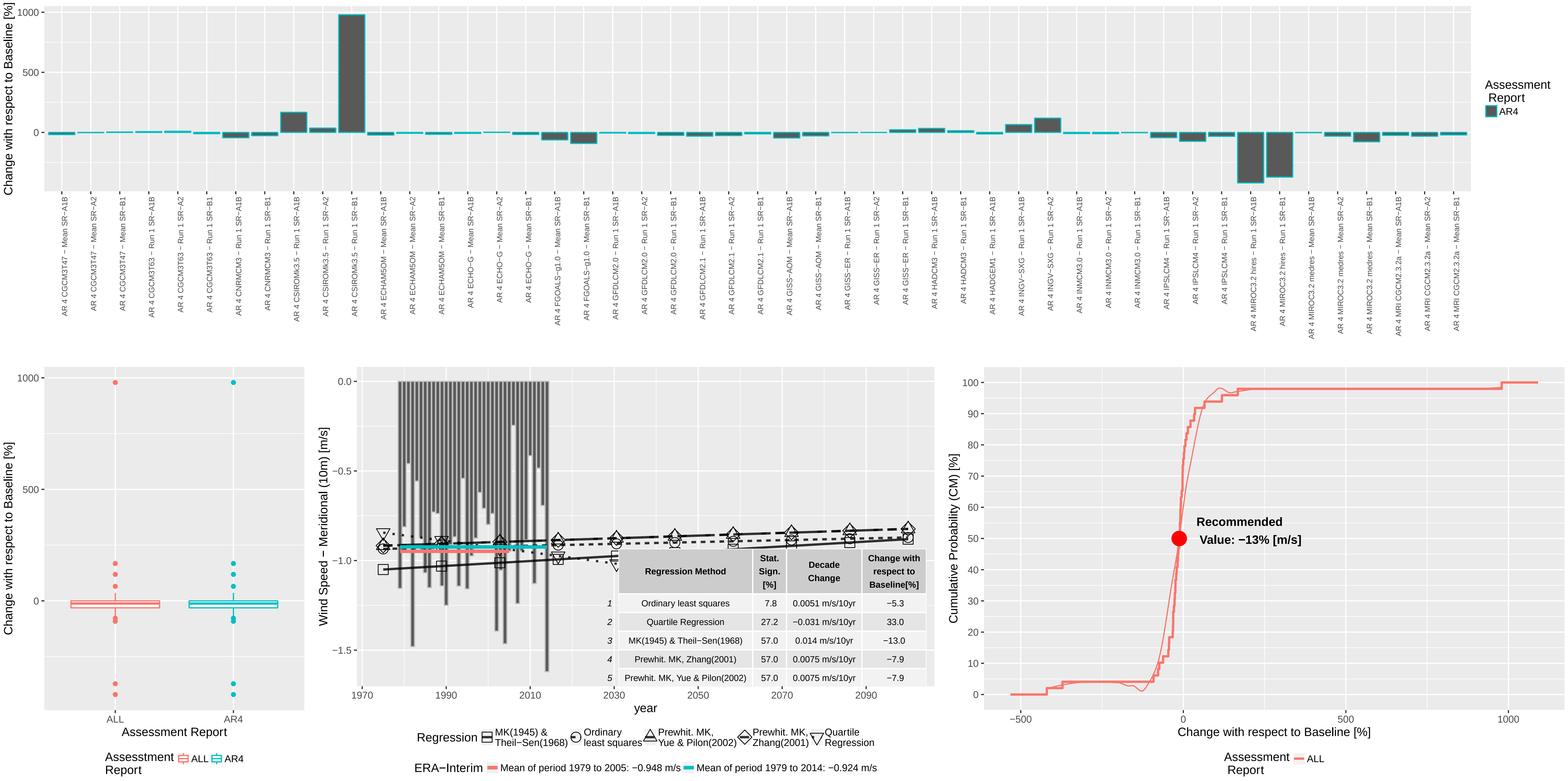


	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	7.8	0.0051 m/s/10yr	−2.0
2	Quartile Regression	27.2	−0.031 m/s/10yr	12.0
3	MK(1945) & Theil−Sen(1968)	57.0	0.014 m/s/10yr	−4.7
4	Prewhit. MK, Zhang(2001)	57.0	0.0075 m/s/10yr	−2.9
5	Prewhit. MK, Yue & Pilon(2002)	57.0	0.0075 m/s/10yr	−2.9

Climate parameter: Wind Speed − Meridional (10m)
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2041 − 2070

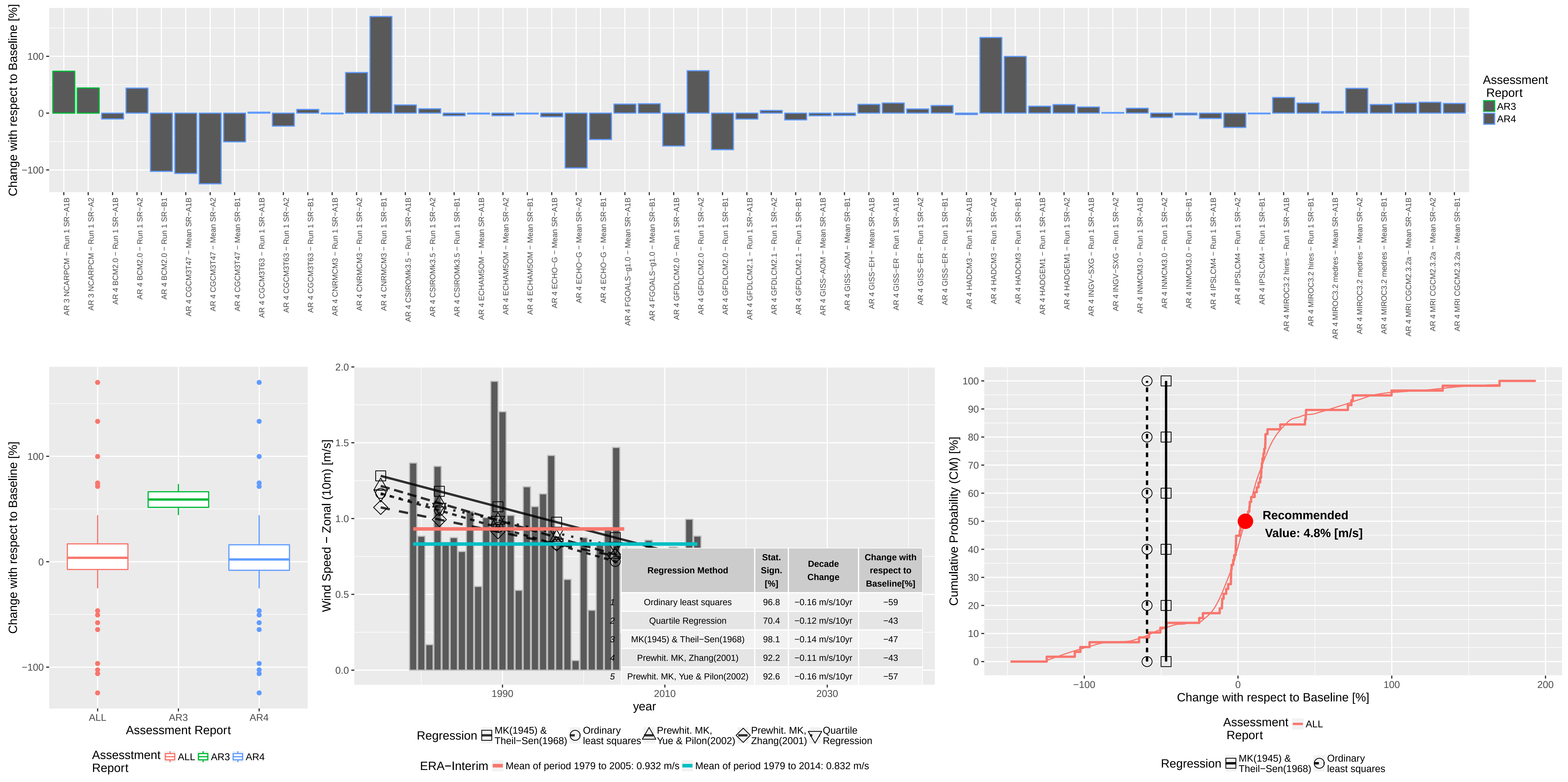


Climate parameter: Wind Speed − Meridional (10m)
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2071 − 2100



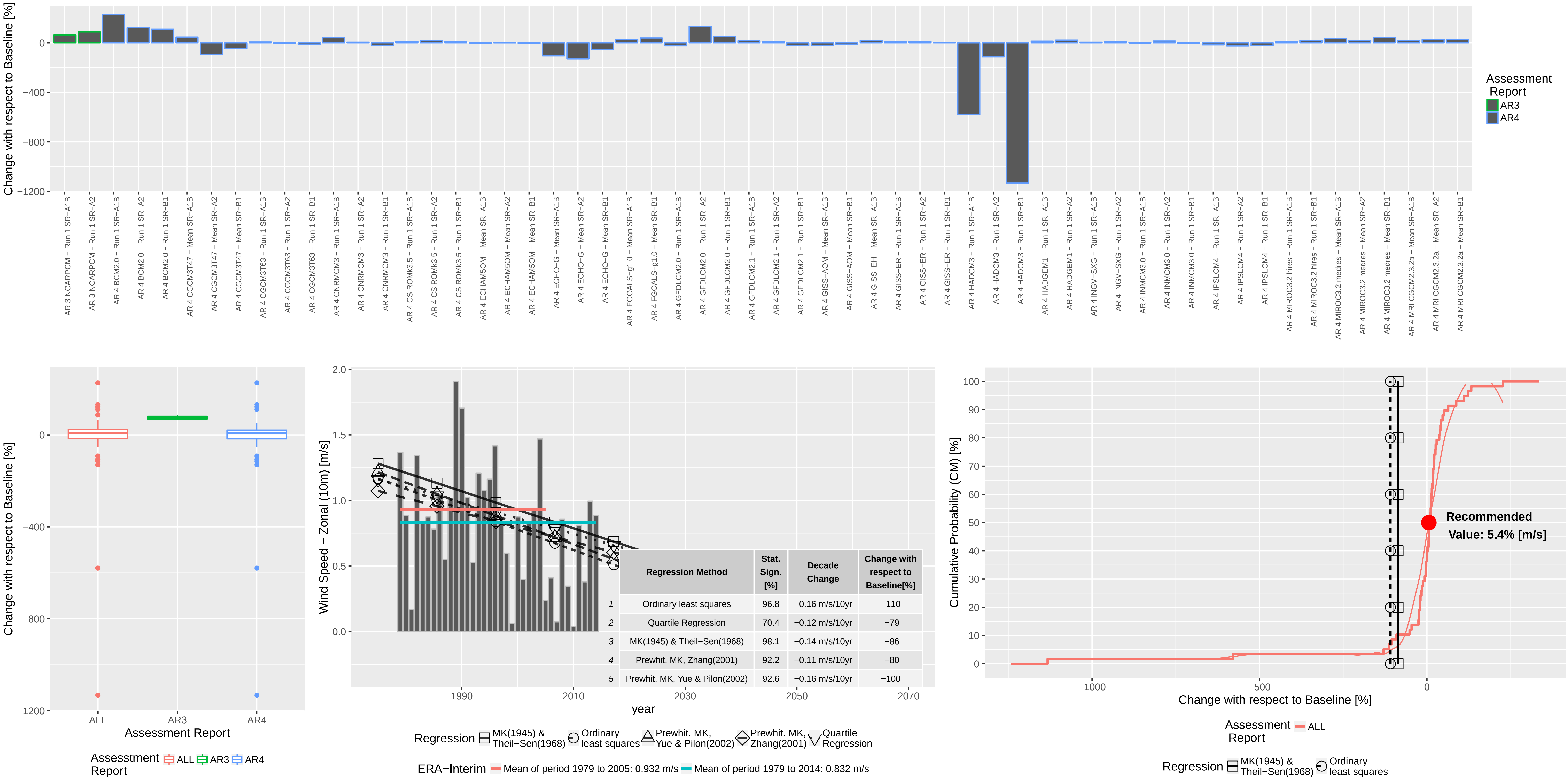
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	7.8	0.0051 m/s/10yr	−5.3
2	Quartile Regression	27.2	−0.031 m/s/10yr	33.0
3	MK(1945) & Theil−Sen(1968)	57.0	0.014 m/s/10yr	−13.0
4	Prewhit. MK, Zhang(2001)	57.0	0.0075 m/s/10yr	−7.9
5	Prewhit. MK, Yue & Pilon(2002)	57.0	0.0075 m/s/10yr	−7.9

Climate parameter: Wind Speed − Zonal (10m)
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2011 − 2040



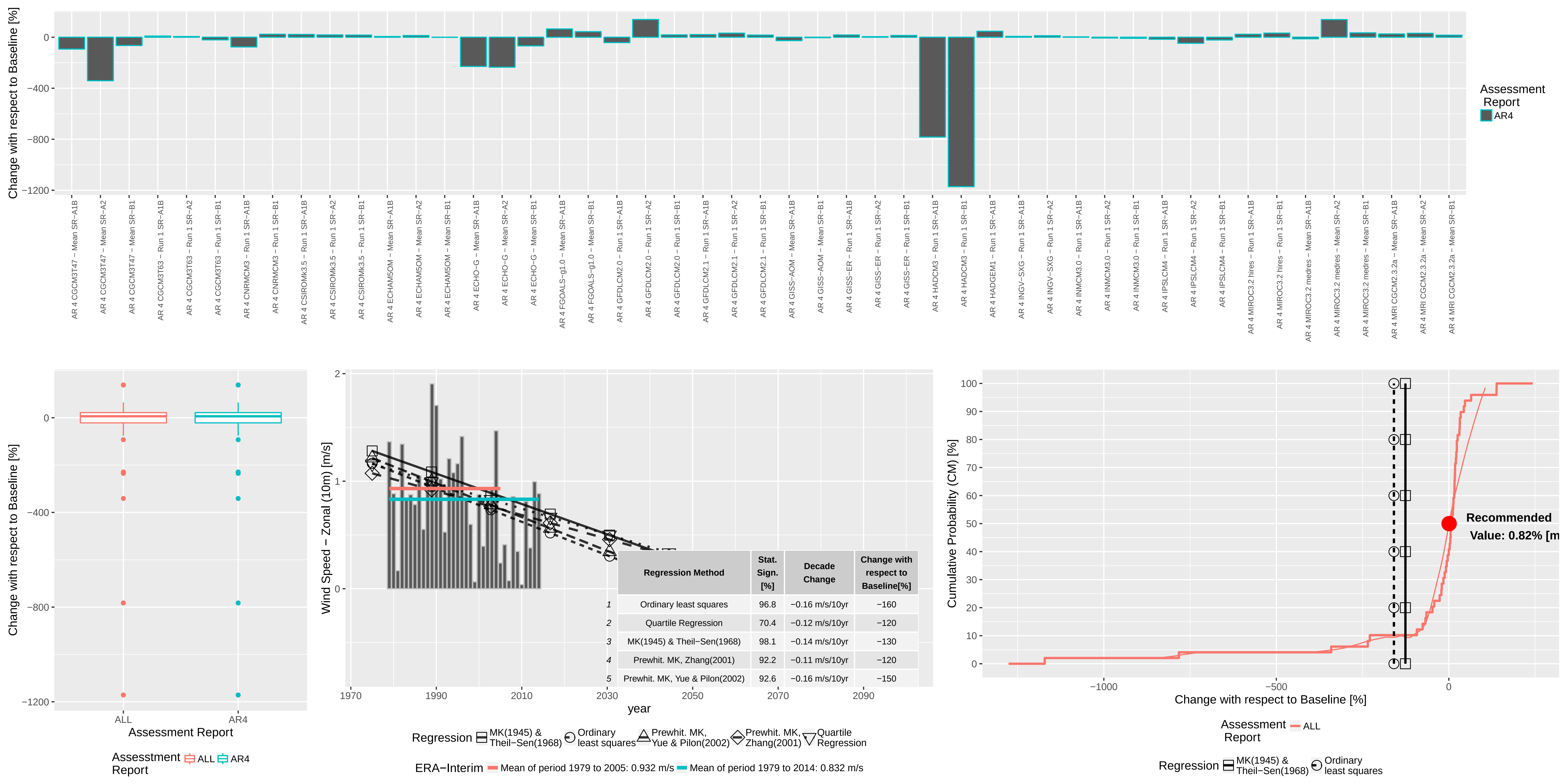
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	96.8	−0.16 m/s/10yr	−59
2	Quartile Regression	70.4	−0.12 m/s/10yr	−43
3	MK(1945) & Theil−Sen(1968)	98.1	−0.14 m/s/10yr	−47
4	Prewhit. MK, Zhang(2001)	92.2	−0.11 m/s/10yr	−43
5	Prewhit. MK, Yue & Pilon(2002)	92.6	−0.16 m/s/10yr	−57

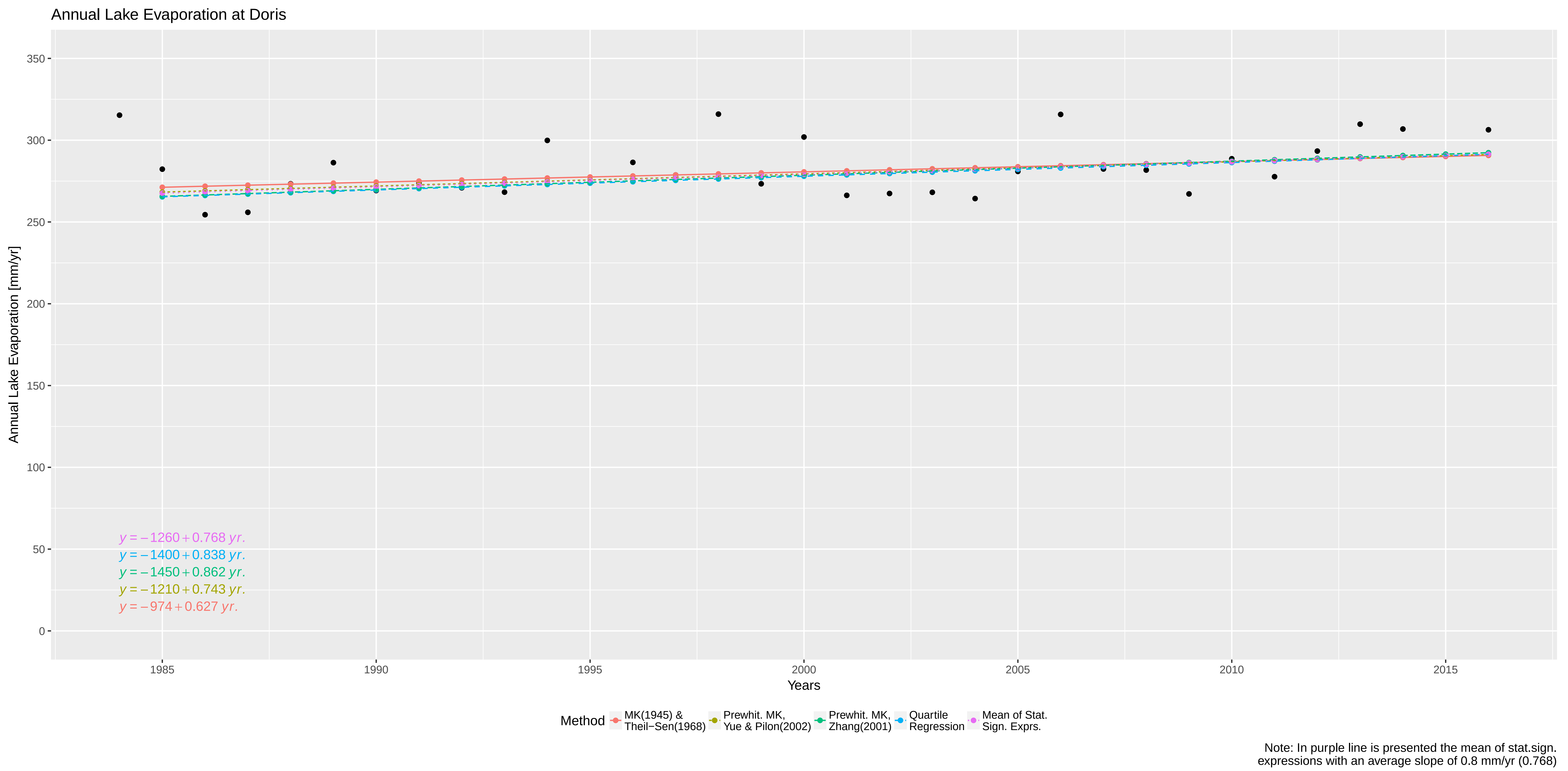
Climate parameter: Wind Speed − Zonal (10m)
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2041 − 2070



	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	96.8	−0.16 m/s/10yr	−110
2	Quartile Regression	70.4	−0.12 m/s/10yr	−79
3	MK(1945) & Theil−Sen(1968)	98.1	−0.14 m/s/10yr	−86
4	Prewhit. MK, Zhang(2001)	92.2	−0.11 m/s/10yr	−80
5	Prewhit. MK, Yue & Pilon(2002)	92.6	−0.16 m/s/10yr	−100

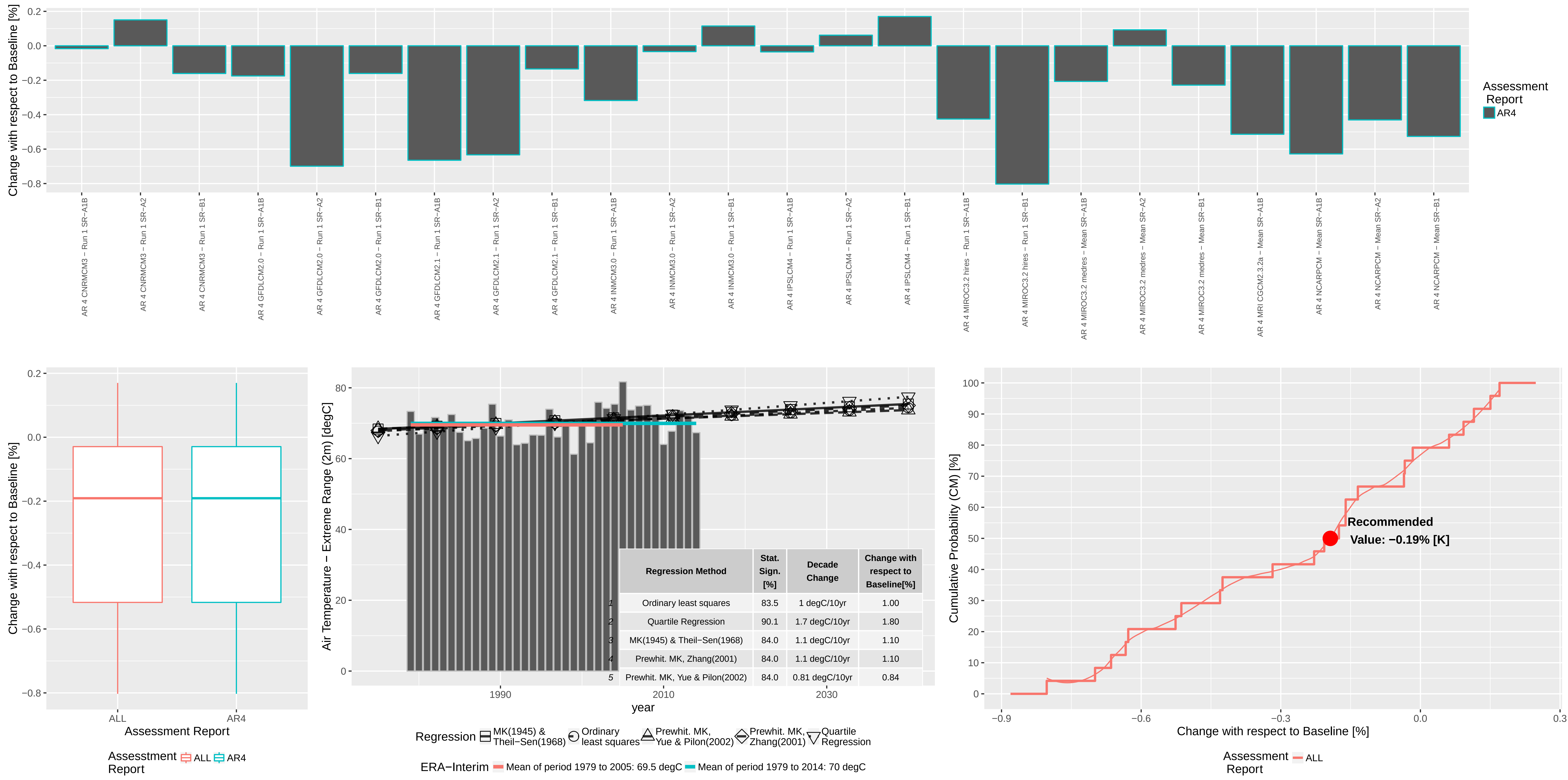
Climate parameter: Wind Speed − Zonal (10m)
Latitude: 68.1333, Longitude: −106.60333
Baseline: 1975 − 2005 / Projection: 2071 − 2100




Annual Lake Evaporation at Doris
Annual Lake Evaporation [mm/yr]
350
300
250
200
150
100
50
0
$y = -1260 + 0.768\ yr.$
$y = -1400 + 0.838\ yr.$
$y = -1450 + 0.862\ yr.$
$y = -1210 + 0.743\ yr.$
$y = -974 + 0.627\ yr.$
1985
1990
1995
2000
2005
2010
2015
Years
Method
MK(1945) & Theil−Sen(1968)
Prewhit. MK, Yue & Pilon(2002)
Prewhit. MK, Zhang(2001)
Quartile Regression
Mean of Stat. Sign. Exprs.
Note: In purple line is presented the mean of stat.sign. expressions with an average slope of 0.8 mm/yr (0.768)

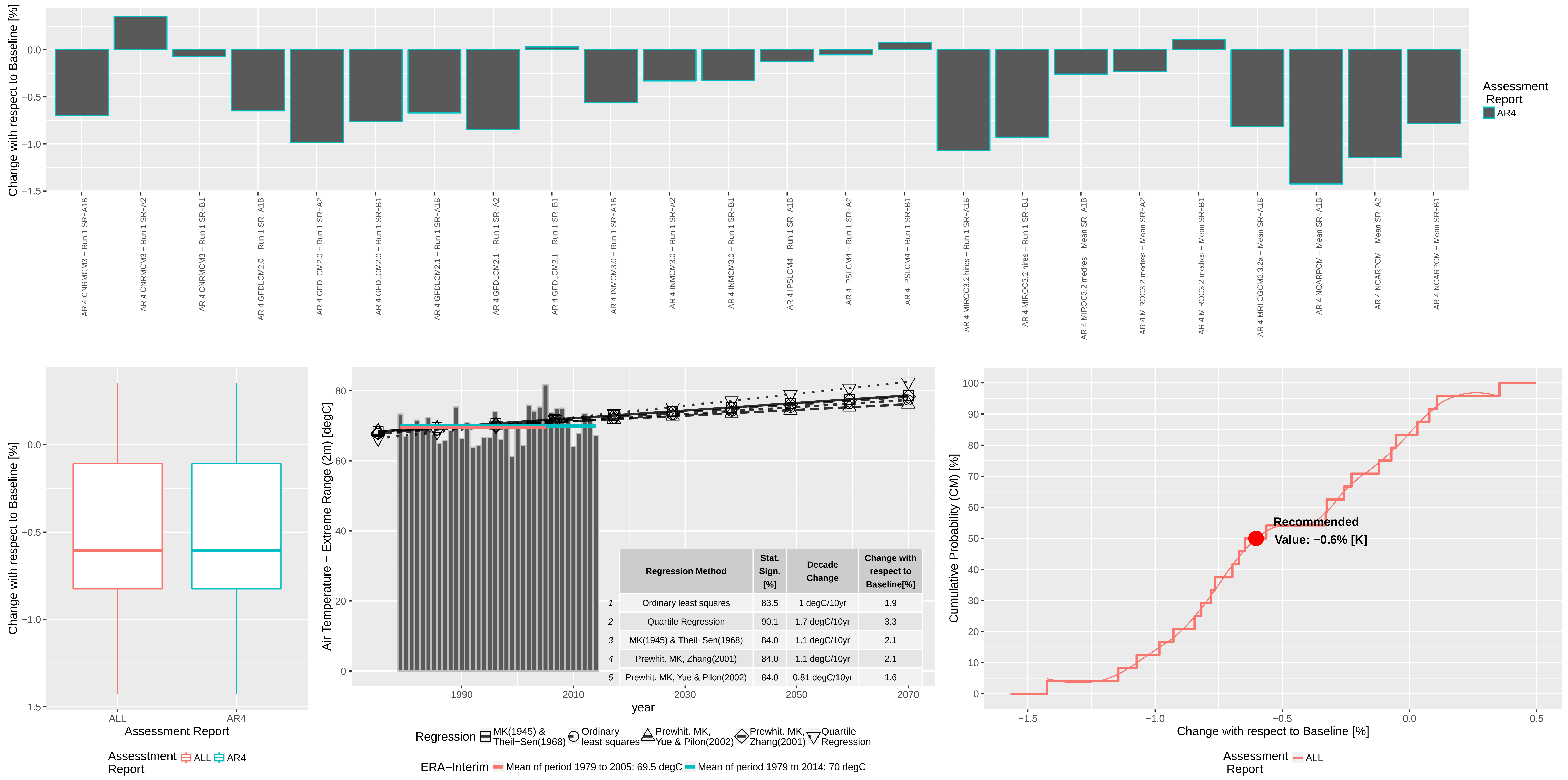
Appendix C2 – Boston “R” Analysis Tables

Climate parameter: Air Temperature − Extreme Range (2m)
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2011 − 2040



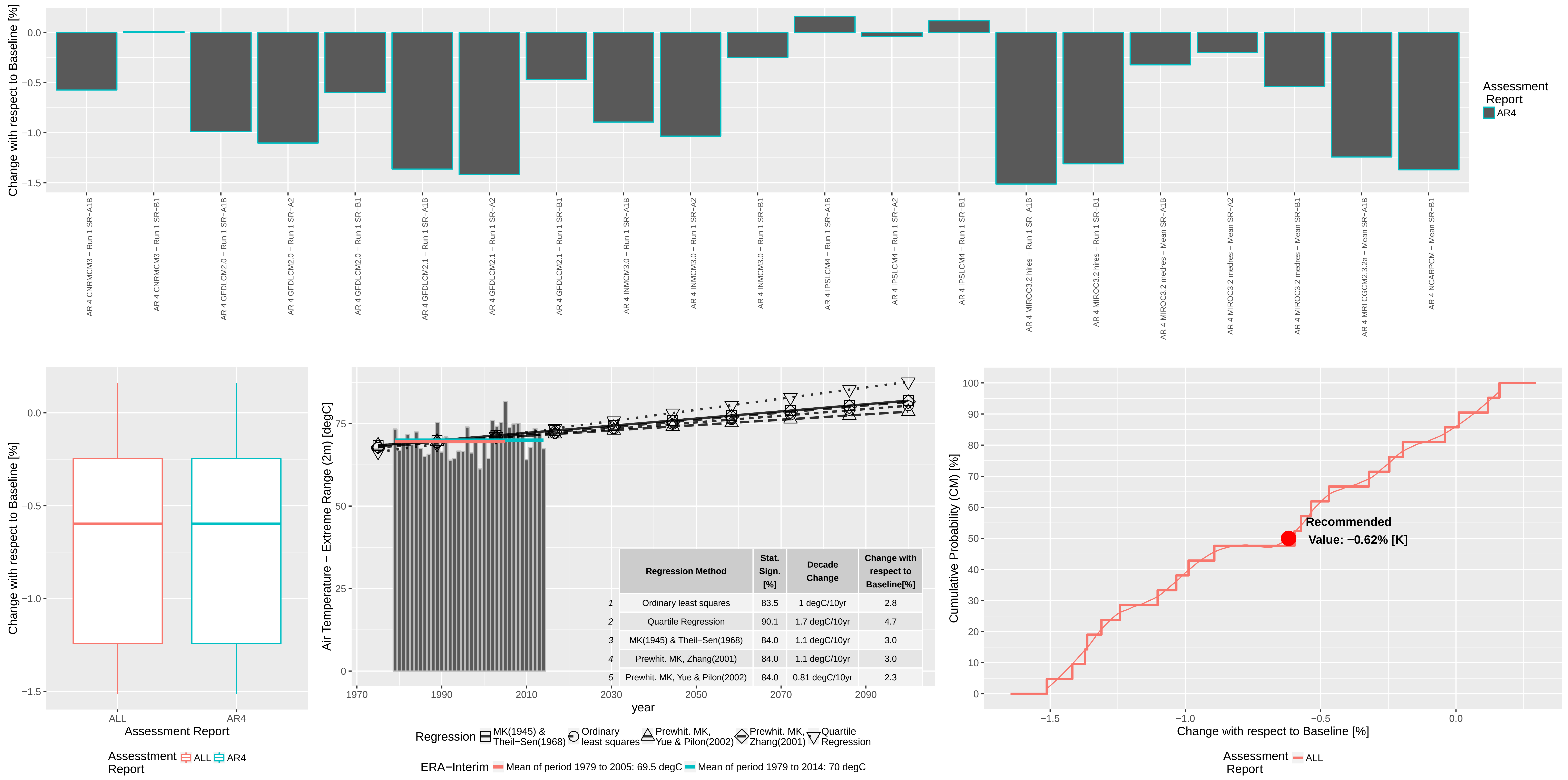
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	83.5	1 degC/10yr	1.00
2	Quartile Regression	90.1	1.7 degC/10yr	1.80
3	MK(1945) & Theil−Sen(1968)	84.0	1.1 degC/10yr	1.10
4	Prewhit. MK, Zhang(2001)	84.0	1.1 degC/10yr	1.10
5	Prewhit. MK, Yue & Pilon(2002)	84.0	0.81 degC/10yr	0.84

Climate parameter: Air Temperature − Extreme Range (2m)
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2041 − 2070



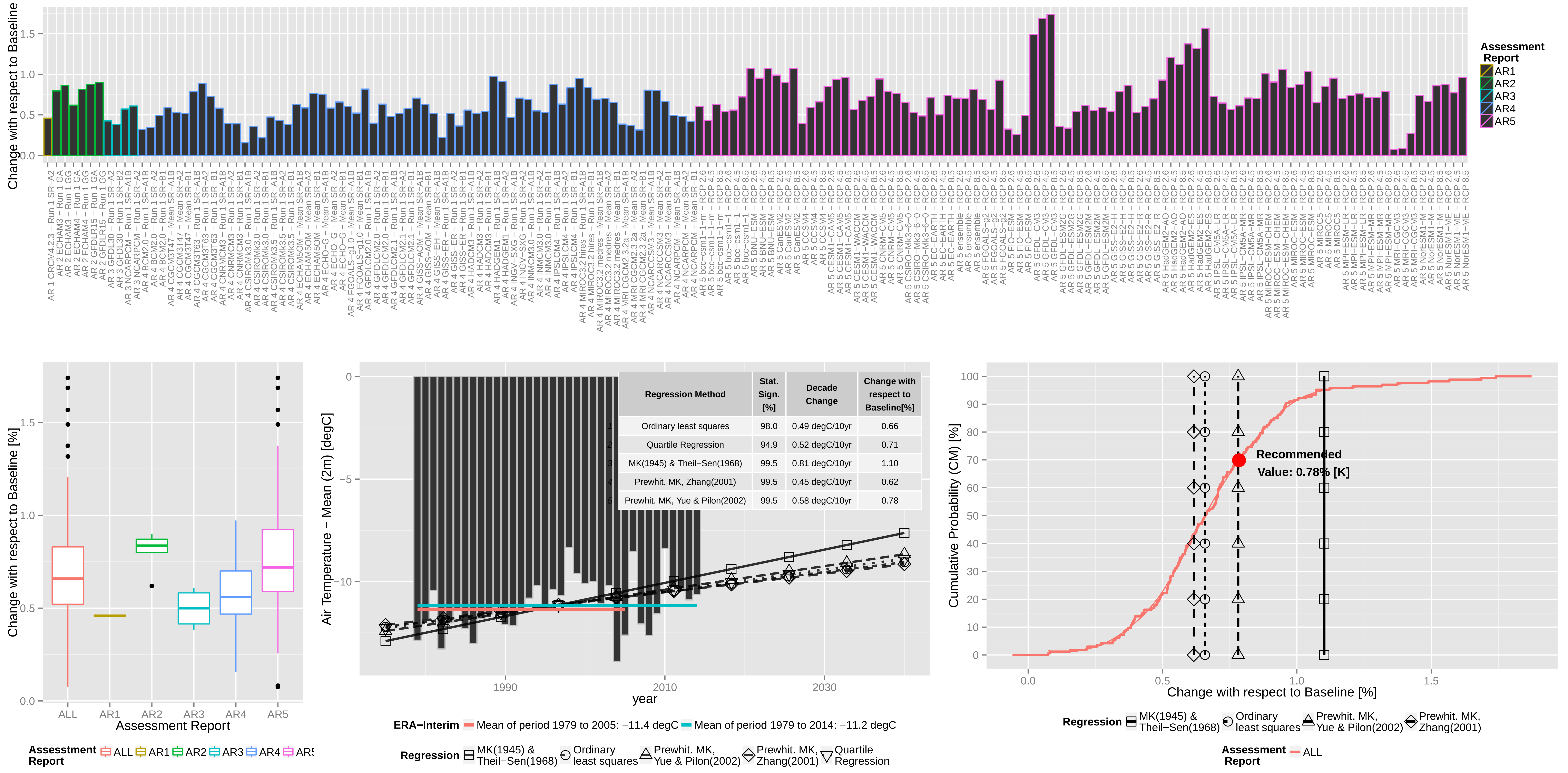
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	83.5	1 degC/10yr	1.9
2	Quartile Regression	90.1	1.7 degC/10yr	3.3
3	MK(1945) & Theil−Sen(1968)	84.0	1.1 degC/10yr	2.1
4	Prewhit. MK, Zhang(2001)	84.0	1.1 degC/10yr	2.1
5	Prewhit. MK, Yue & Pilon(2002)	84.0	0.81 degC/10yr	1.6

Climate parameter: Air Temperature − Extreme Range (2m)
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2071 − 2100



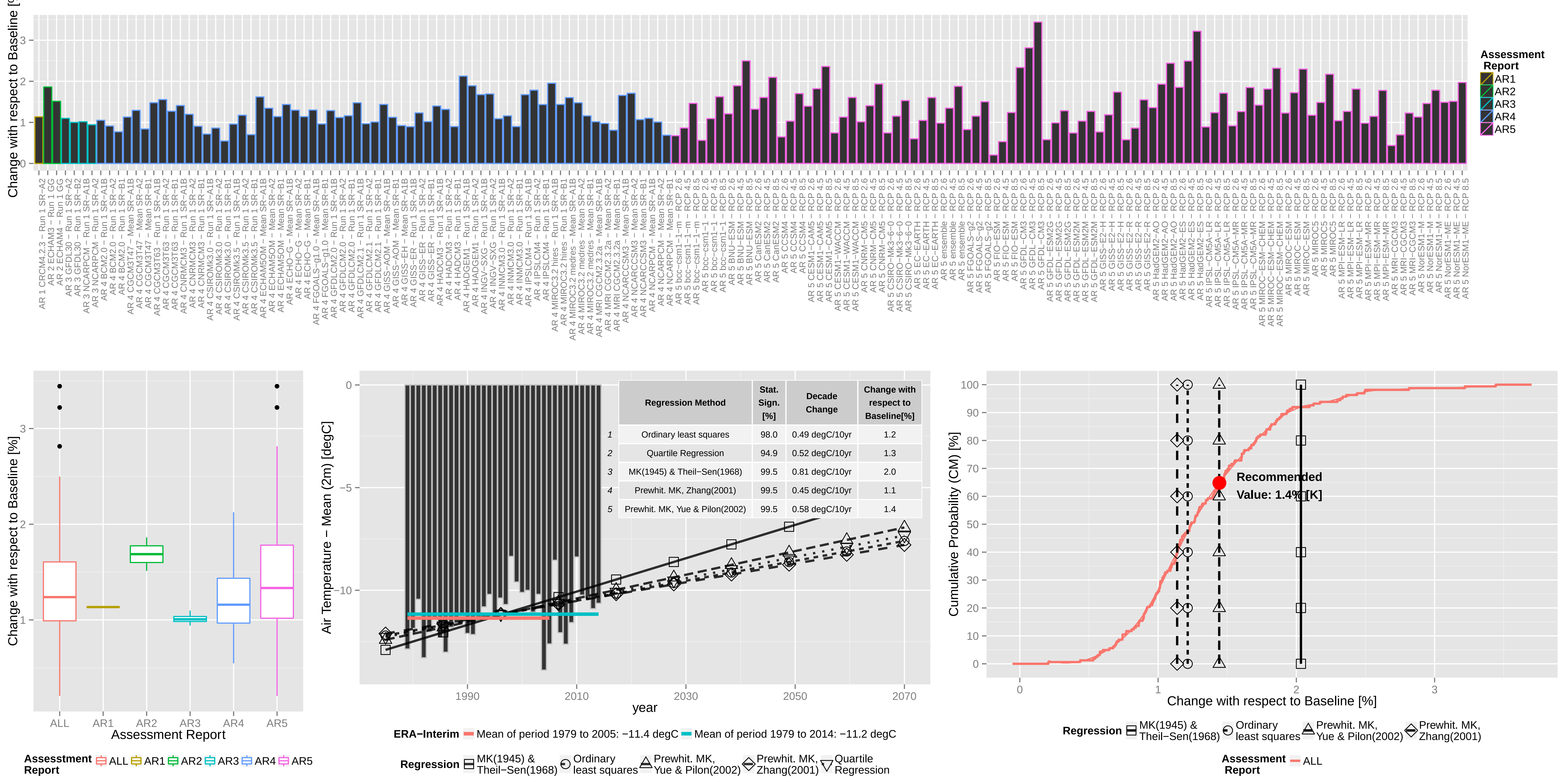
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	83.5	1 degC/10yr	2.8
2	Quartile Regression	90.1	1.7 degC/10yr	4.7
3	MK(1945) & Theil−Sen(1968)	84.0	1.1 degC/10yr	3.0
4	Prewhit. MK, Zhang(2001)	84.0	1.1 degC/10yr	3.0
5	Prewhit. MK, Yue & Pilon(2002)	84.0	0.81 degC/10yr	2.3

Climate parameter: Air Temperature − Mean (2m)
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2011 − 2040



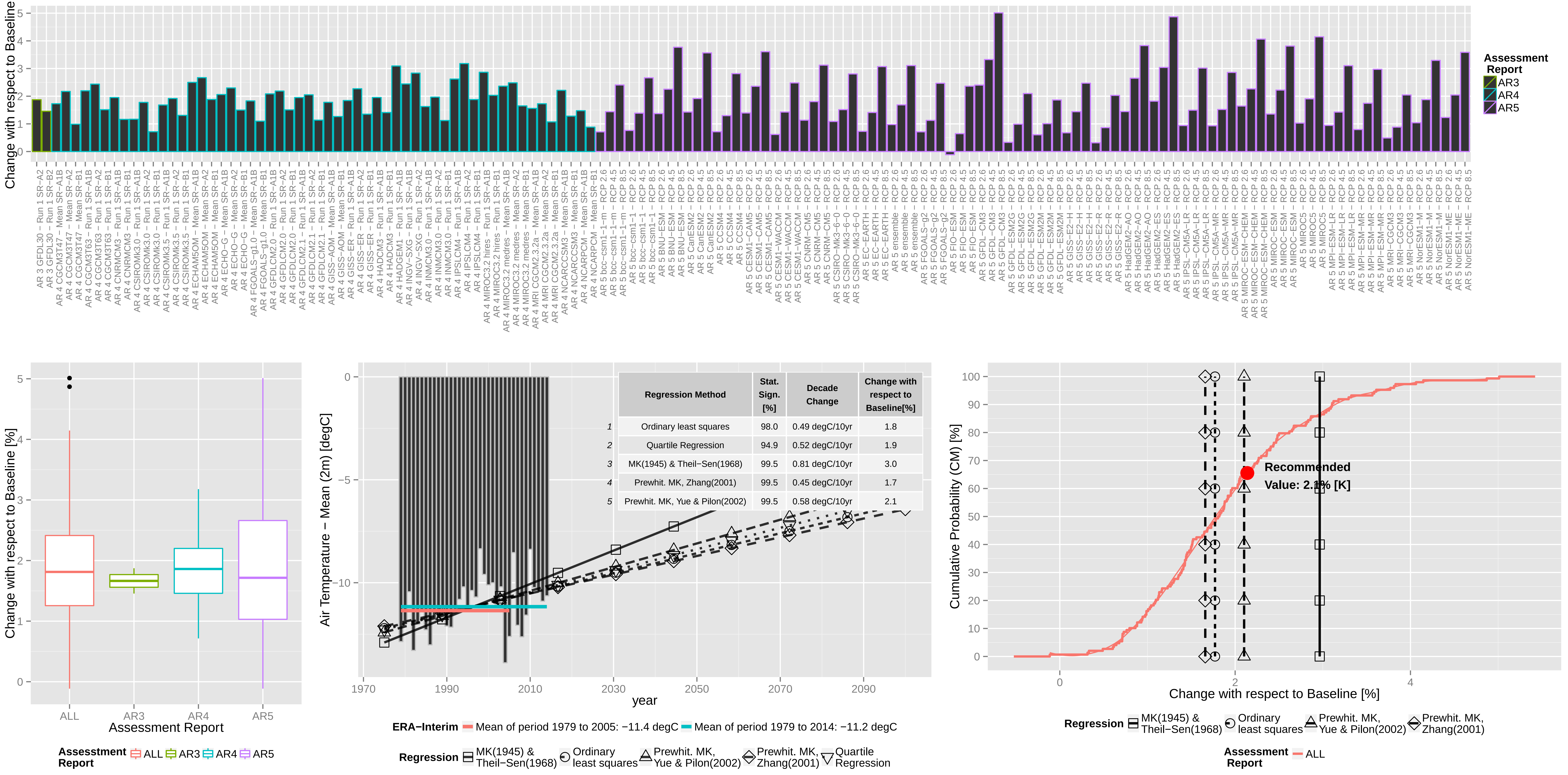
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	98.0	0.49 degC/10yr	0.66
2	Quartile Regression	94.9	0.52 degC/10yr	0.71
3	MK(1945) & Theil−Sen(1968)	99.5	0.81 degC/10yr	1.10
4	Prewhit. MK, Zhang(2001)	99.5	0.45 degC/10yr	0.62
5	Prewhit. MK, Yue & Pilon(2002)	99.5	0.58 degC/10yr	0.78

Climate parameter: Air Temperature − Mean (2m)
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2041 − 2070

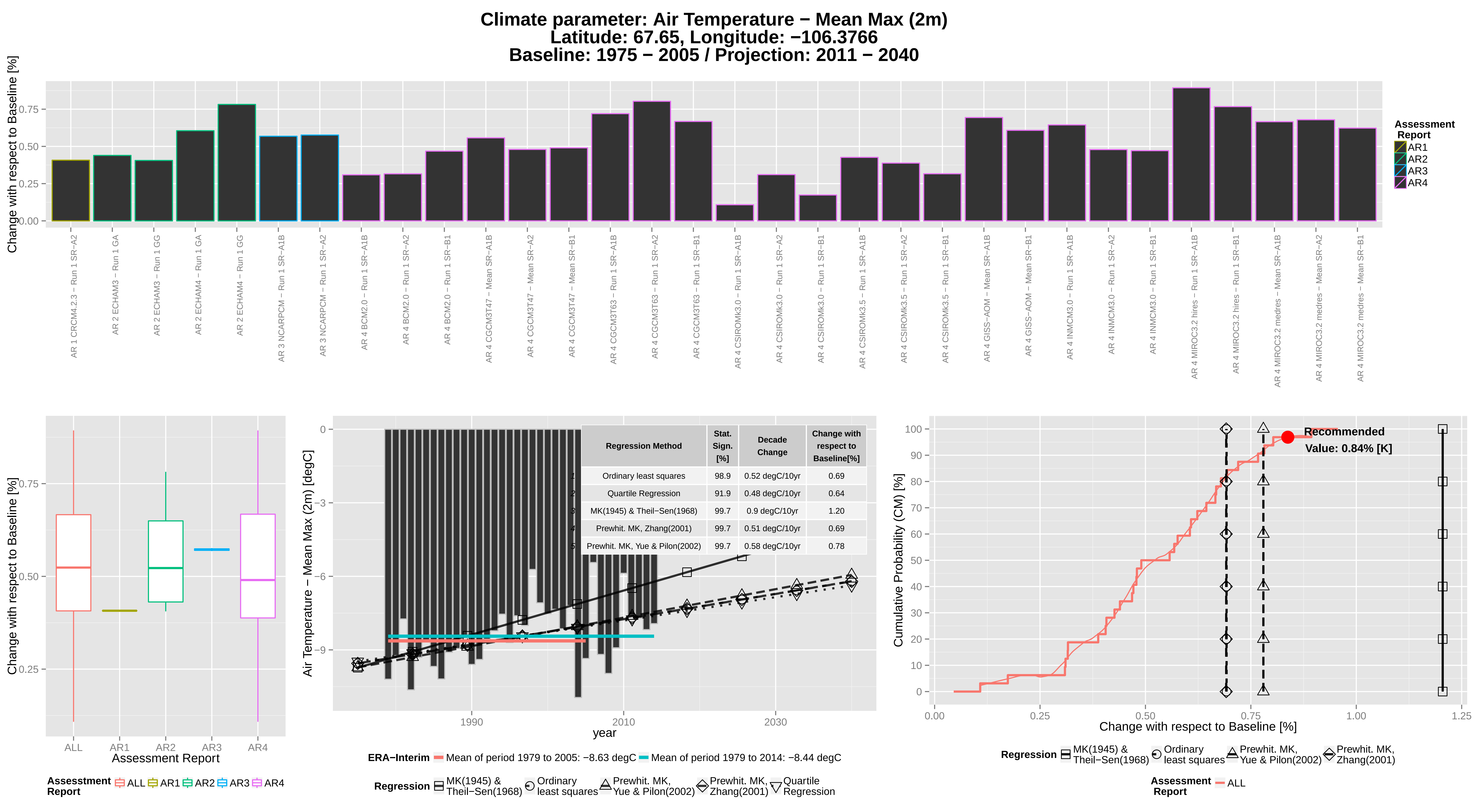


	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	98.0	0.49 degC/10yr	1.2
2	Quartile Regression	94.9	0.52 degC/10yr	1.3
3	MK(1945) & Theil−Sen(1968)	99.5	0.81 degC/10yr	2.0
4	Prewhit. MK, Zhang(2001)	99.5	0.45 degC/10yr	1.1
5	Prewhit. MK, Yue & Pilon(2002)	99.5	0.58 degC/10yr	1.4

Climate parameter: Air Temperature − Mean (2m)
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2071 − 2100

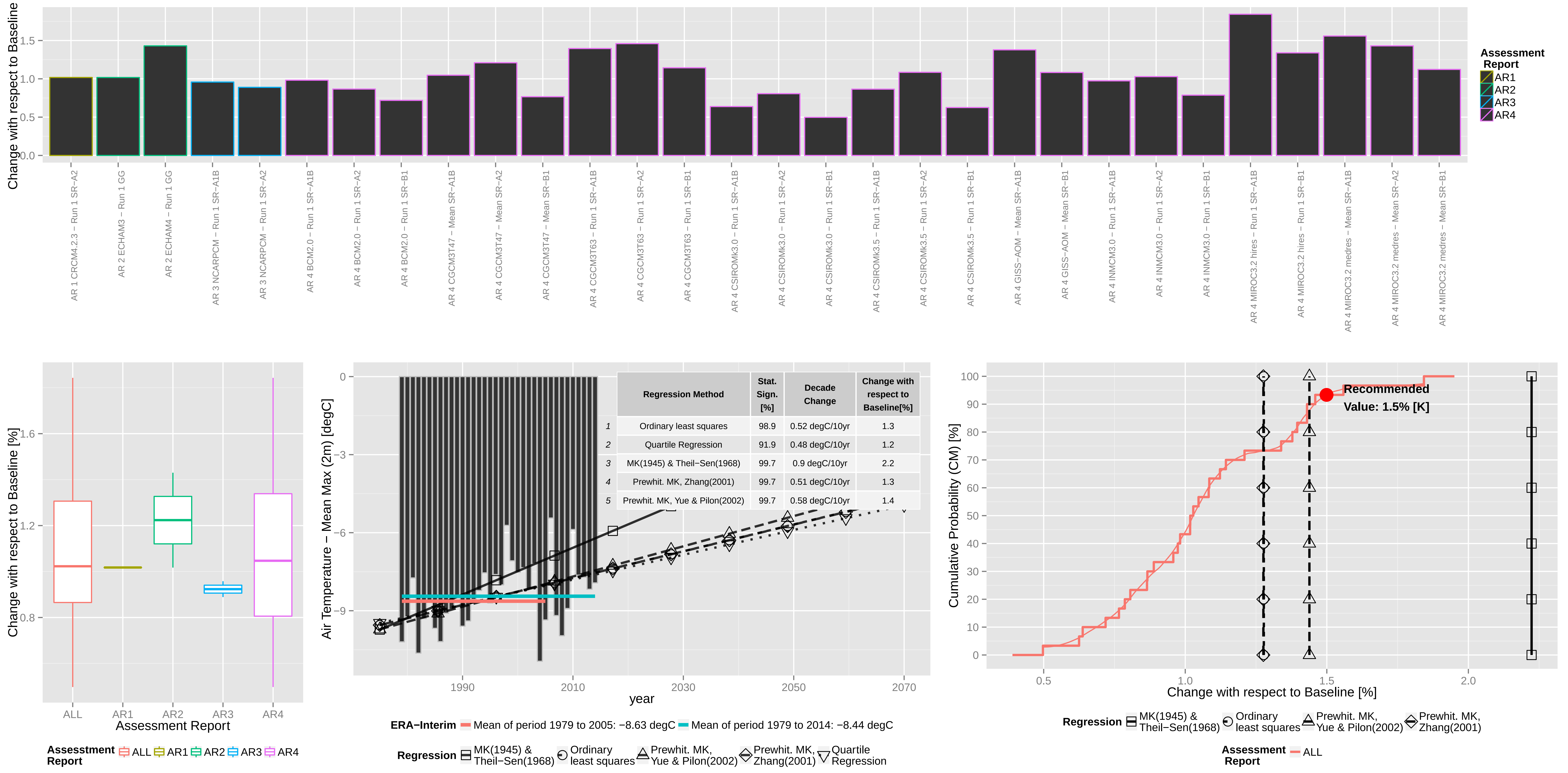


	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	98.0	0.49 degC/10yr	1.8
2	Quartile Regression	94.9	0.52 degC/10yr	1.9
3	MK(1945) & Theil−Sen(1968)	99.5	0.81 degC/10yr	3.0
4	Prewhit. MK, Zhang(2001)	99.5	0.45 degC/10yr	1.7
5	Prewhit. MK, Yue & Pilon(2002)	99.5	0.58 degC/10yr	2.1



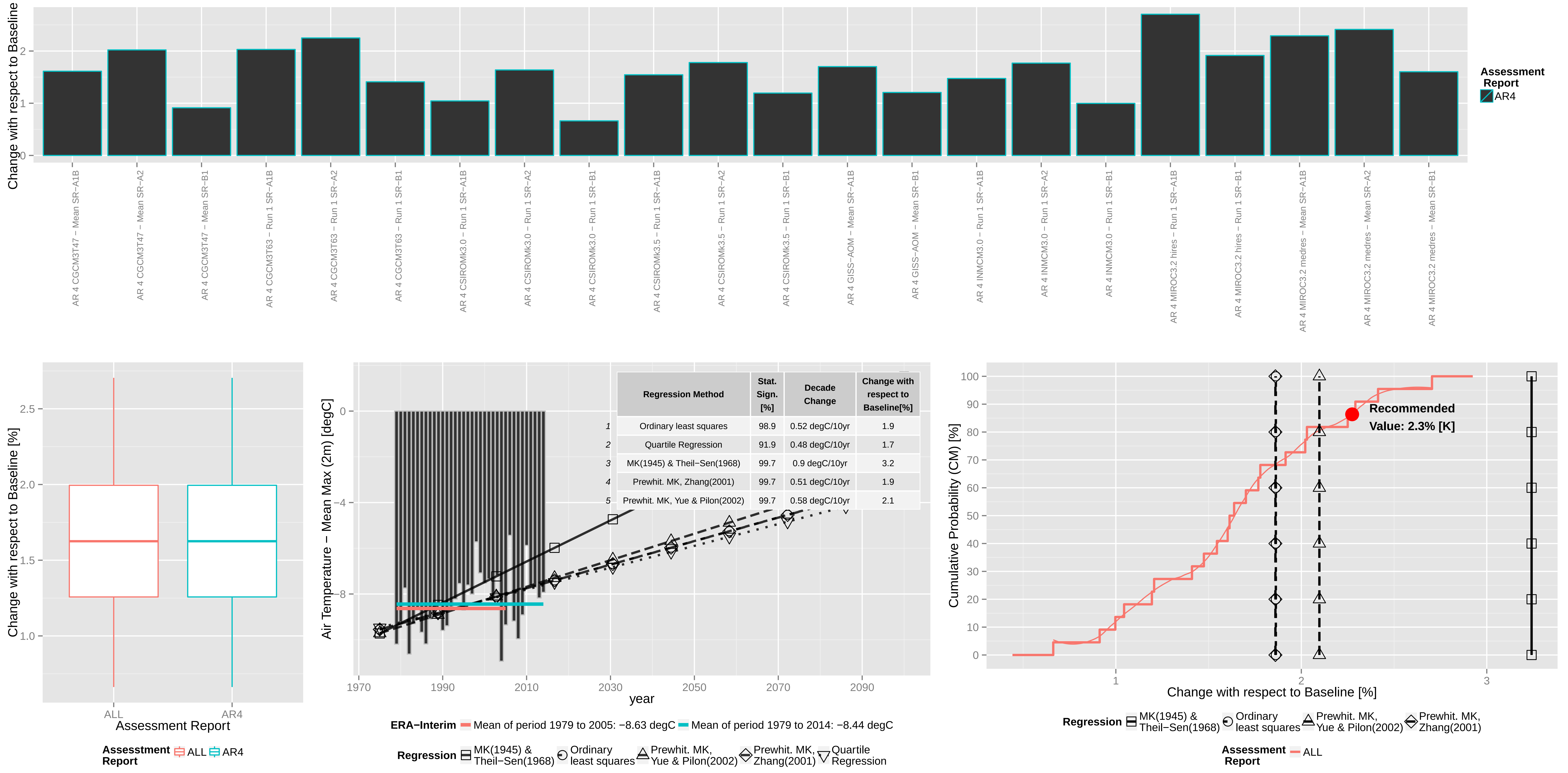
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	98.9	0.52 degC/10yr	0.69
2	Quartile Regression	91.9	0.48 degC/10yr	0.64
3	MK(1945) & Theil−Sen(1968)	99.7	0.9 degC/10yr	1.20
4	Prewhit. MK, Zhang(2001)	99.7	0.51 degC/10yr	0.69
5	Prewhit. MK, Yue & Pilon(2002)	99.7	0.58 degC/10yr	0.78

Climate parameter: Air Temperature − Mean Max (2m)
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2041 − 2070



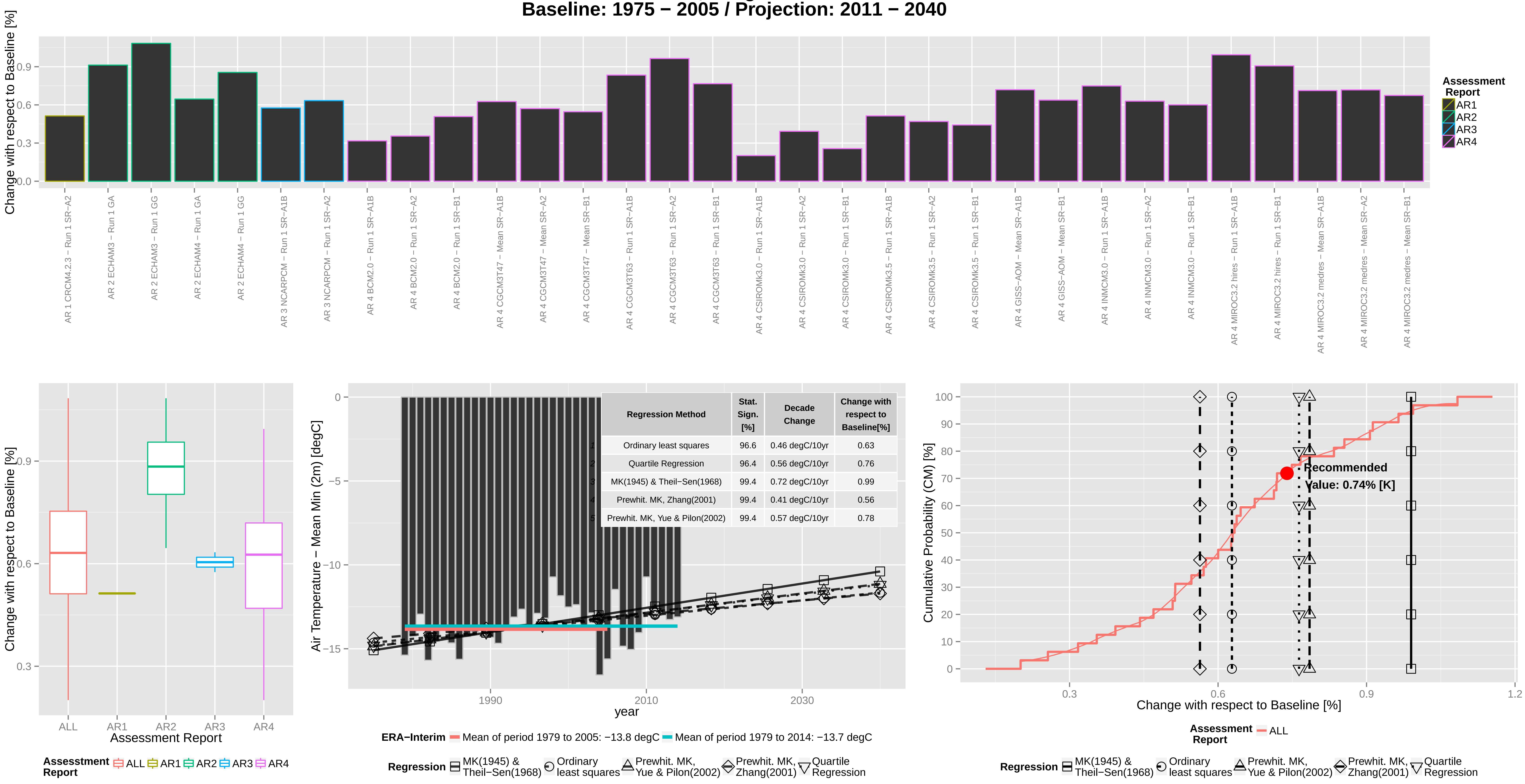
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	98.9	0.52 degC/10yr	1.3
2	Quartile Regression	91.9	0.48 degC/10yr	1.2
3	MK(1945) & Theil−Sen(1968)	99.7	0.9 degC/10yr	2.2
4	Prewhit. MK, Zhang(2001)	99.7	0.51 degC/10yr	1.3
5	Prewhit. MK, Yue & Pilon(2002)	99.7	0.58 degC/10yr	1.4

Climate parameter: Air Temperature − Mean Max (2m)
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2071 − 2100



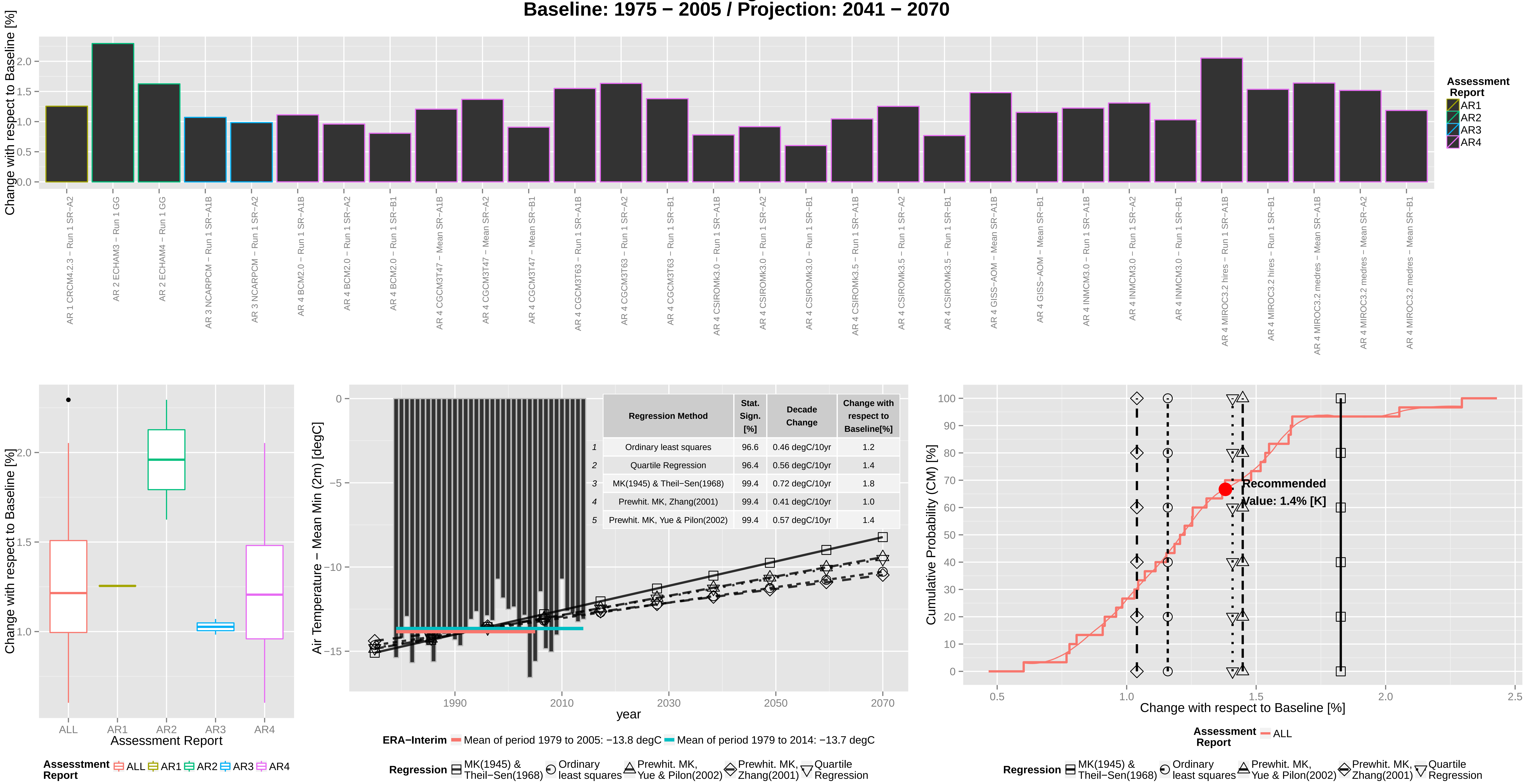
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	98.9	0.52 degC/10yr	1.9
2	Quartile Regression	91.9	0.48 degC/10yr	1.7
3	MK(1945) & Theil−Sen(1968)	99.7	0.9 degC/10yr	3.2
4	Prewhit. MK, Zhang(2001)	99.7	0.51 degC/10yr	1.9
5	Prewhit. MK, Yue & Pilon(2002)	99.7	0.58 degC/10yr	2.1

Climate parameter: Air Temperature − Mean Min (2m)
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2011 − 2040



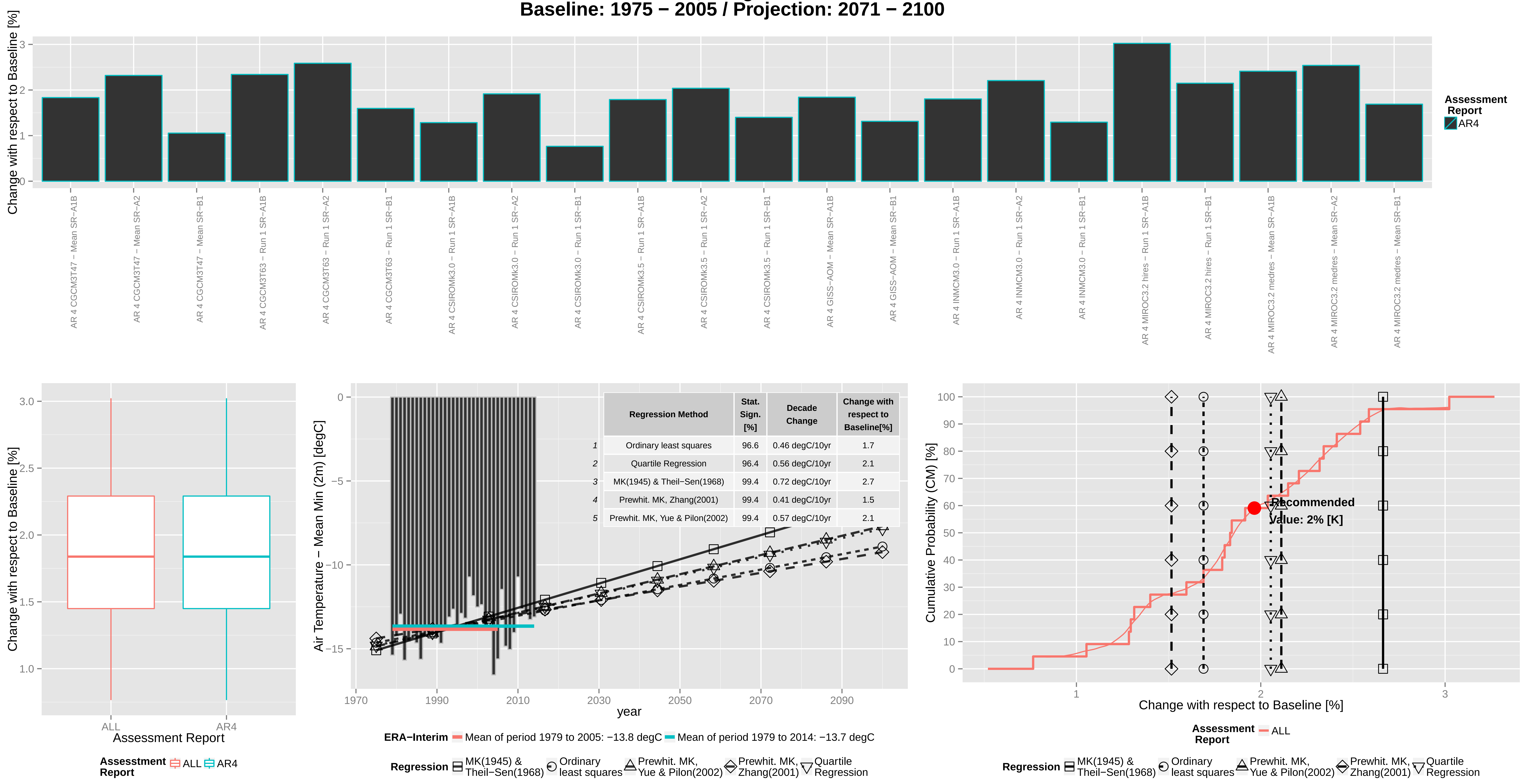
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	96.6	0.46 degC/10yr	0.63
2	Quartile Regression	96.4	0.56 degC/10yr	0.76
3	MK(1945) & Theil−Sen(1968)	99.4	0.72 degC/10yr	0.99
4	Prewhit. MK, Zhang(2001)	99.4	0.41 degC/10yr	0.56
5	Prewhit. MK, Yue & Pilon(2002)	99.4	0.57 degC/10yr	0.78

Climate parameter: Air Temperature − Mean Min (2m)
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2041 − 2070



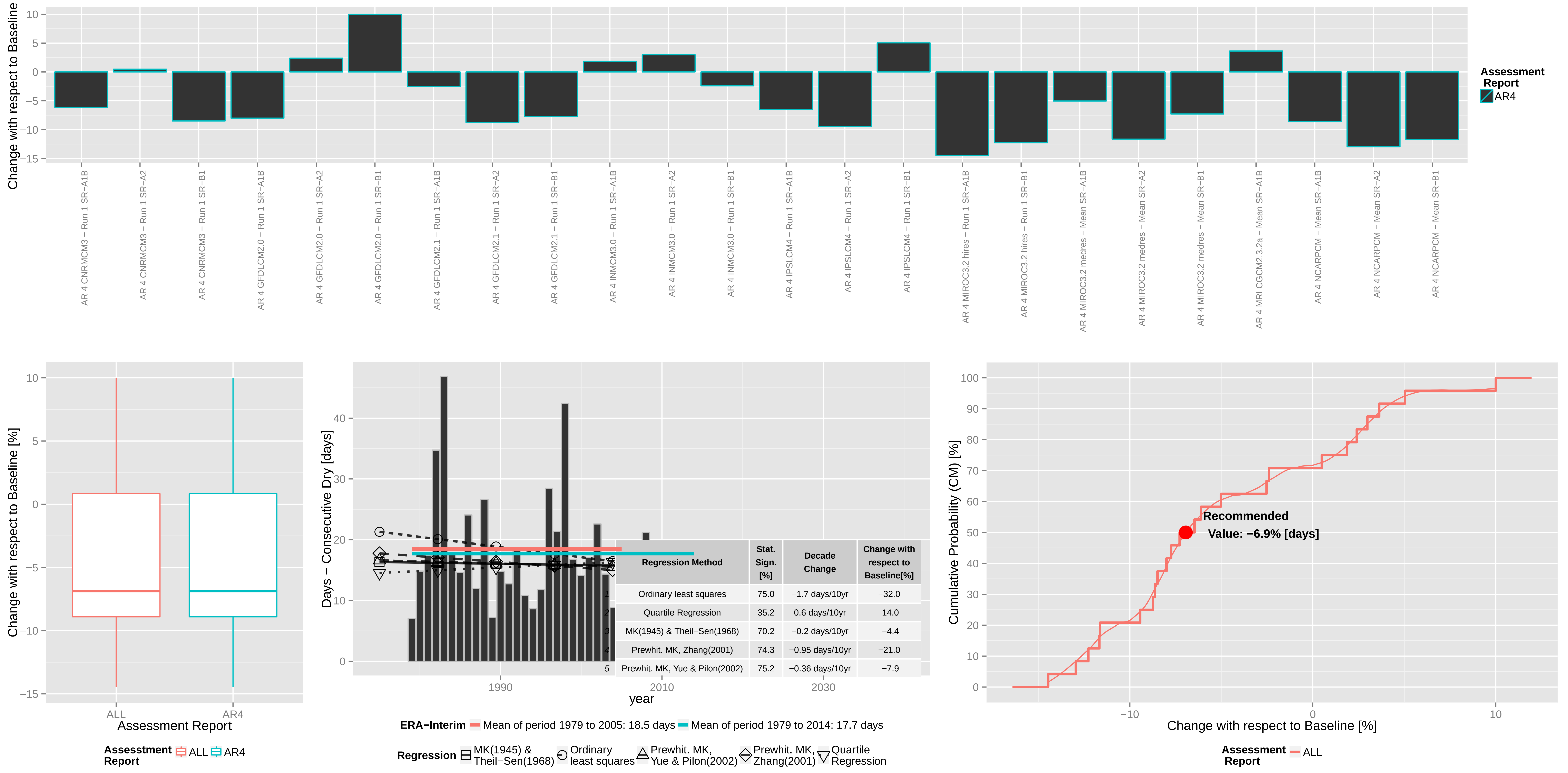
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	96.6	0.46 degC/10yr	1.2
2	Quartile Regression	96.4	0.56 degC/10yr	1.4
3	MK(1945) & Theil−Sen(1968)	99.4	0.72 degC/10yr	1.8
4	Prewhit. MK, Zhang(2001)	99.4	0.41 degC/10yr	1.0
5	Prewhit. MK, Yue & Pilon(2002)	99.4	0.57 degC/10yr	1.4

Climate parameter: Air Temperature − Mean Min (2m)
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2071 − 2100



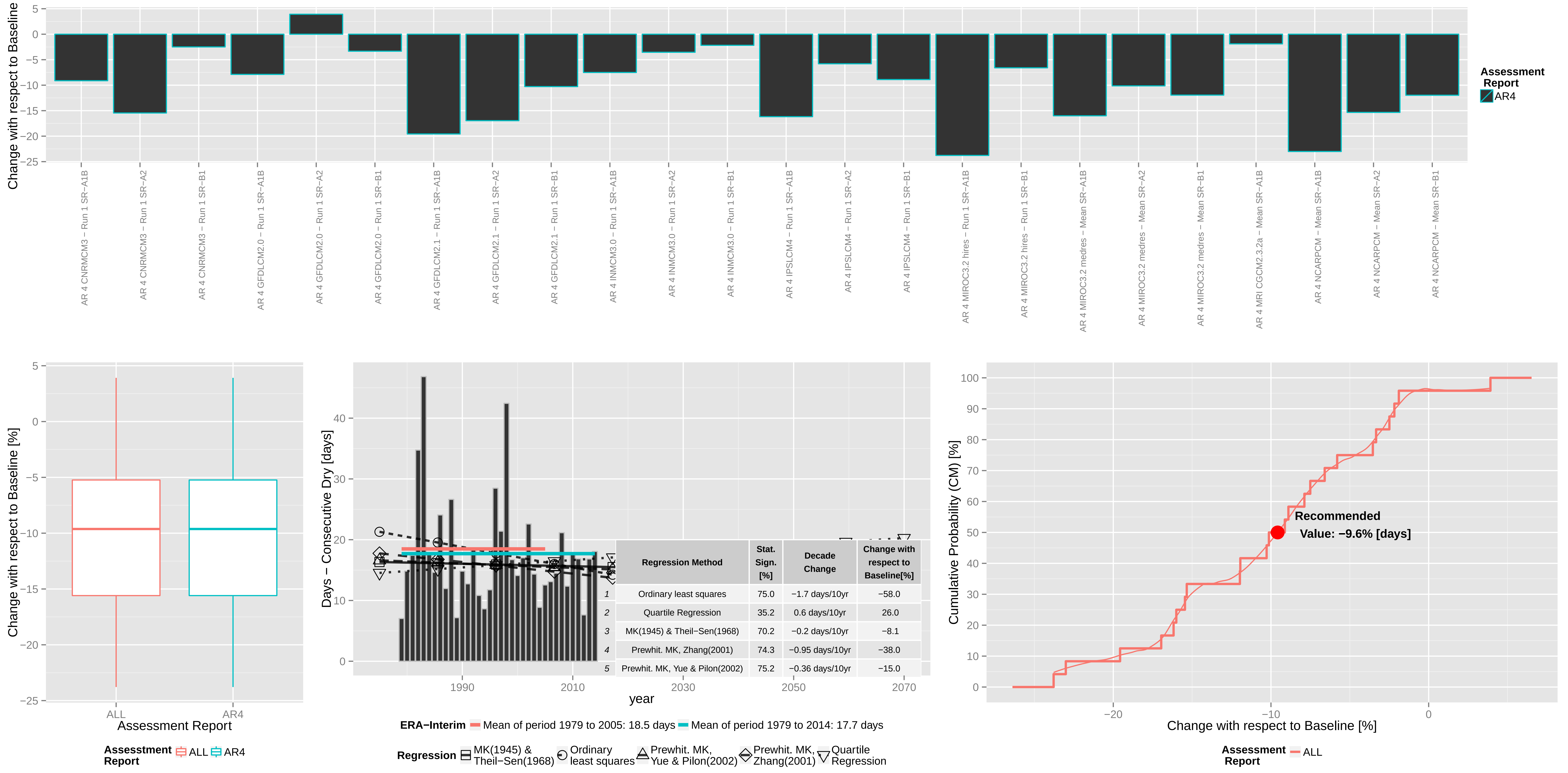
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	96.6	0.46 degC/10yr	1.7
2	Quartile Regression	96.4	0.56 degC/10yr	2.1
3	MK(1945) & Theil−Sen(1968)	99.4	0.72 degC/10yr	2.7
4	Prewhit. MK, Zhang(2001)	99.4	0.41 degC/10yr	1.5
5	Prewhit. MK, Yue & Pilon(2002)	99.4	0.57 degC/10yr	2.1

Climate parameter: Days − Consecutive Dry
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2011 − 2040



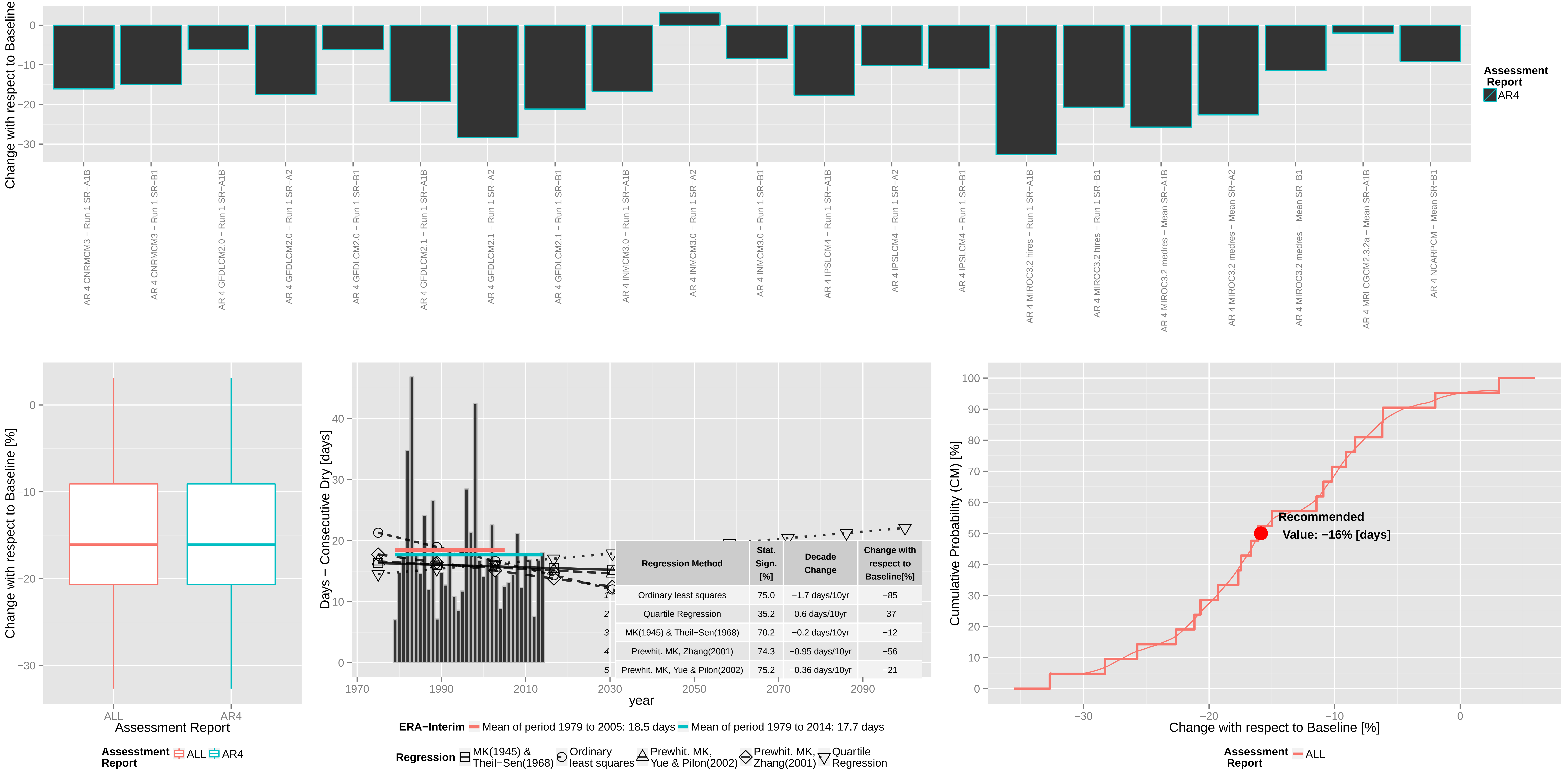
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	75.0	−1.7 days/10yr	−32.0
2	Quartile Regression	35.2	0.6 days/10yr	14.0
3	MK(1945) & Theil−Sen(1968)	70.2	−0.2 days/10yr	−4.4
4	Prewhit. MK, Zhang(2001)	74.3	−0.95 days/10yr	−21.0
5	Prewhit. MK, Yue & Pilon(2002)	75.2	−0.36 days/10yr	−7.9

Climate parameter: Days − Consecutive Dry
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2041 − 2070



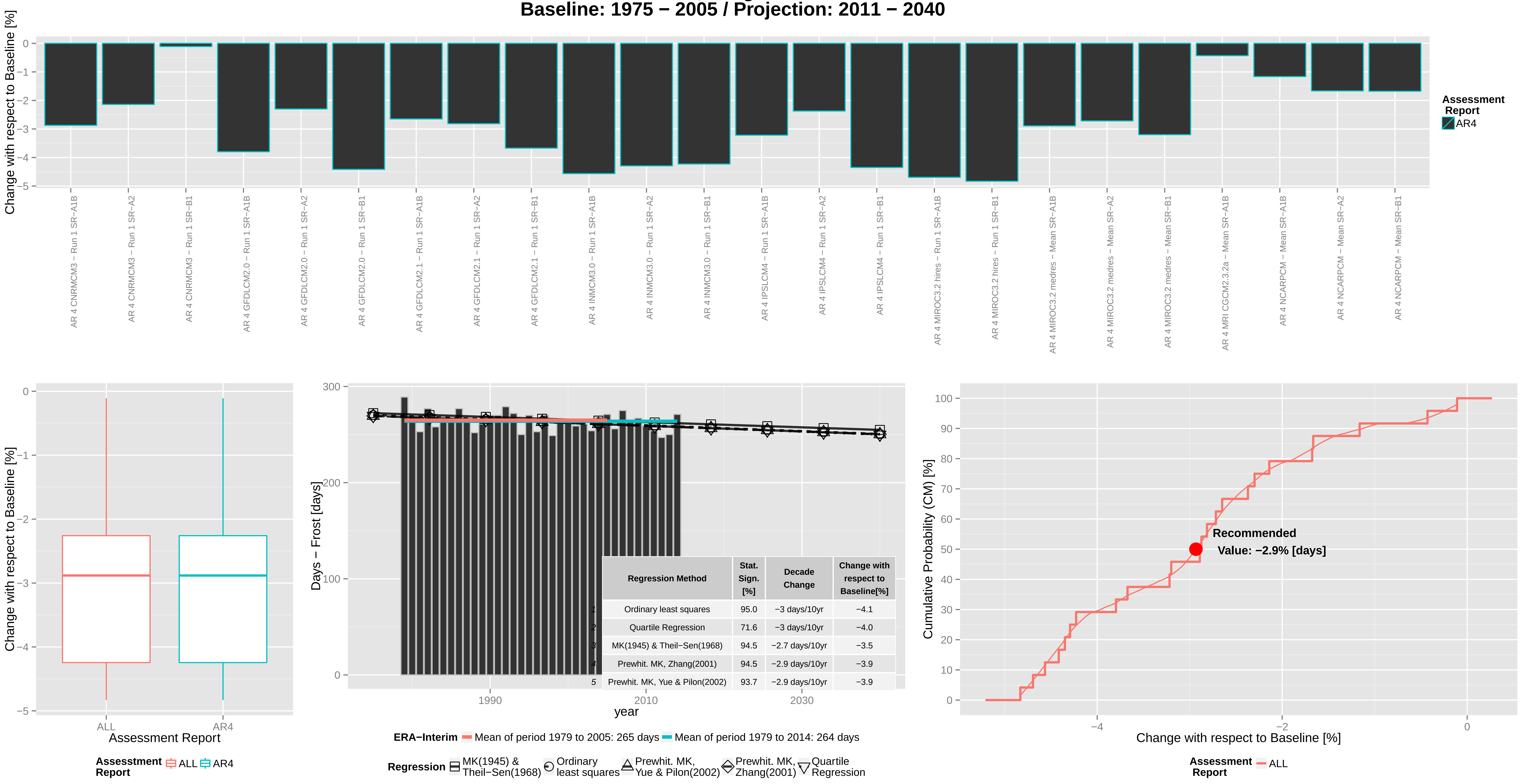
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	75.0	−1.7 days/10yr	−58.0
2	Quartile Regression	35.2	0.6 days/10yr	26.0
3	MK(1945) & Theil−Sen(1968)	70.2	−0.2 days/10yr	−8.1
4	Prewhit. MK, Zhang(2001)	74.3	−0.95 days/10yr	−38.0
5	Prewhit. MK, Yue & Pilon(2002)	75.2	−0.36 days/10yr	−15.0

Climate parameter: Days − Consecutive Dry
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2071 − 2100



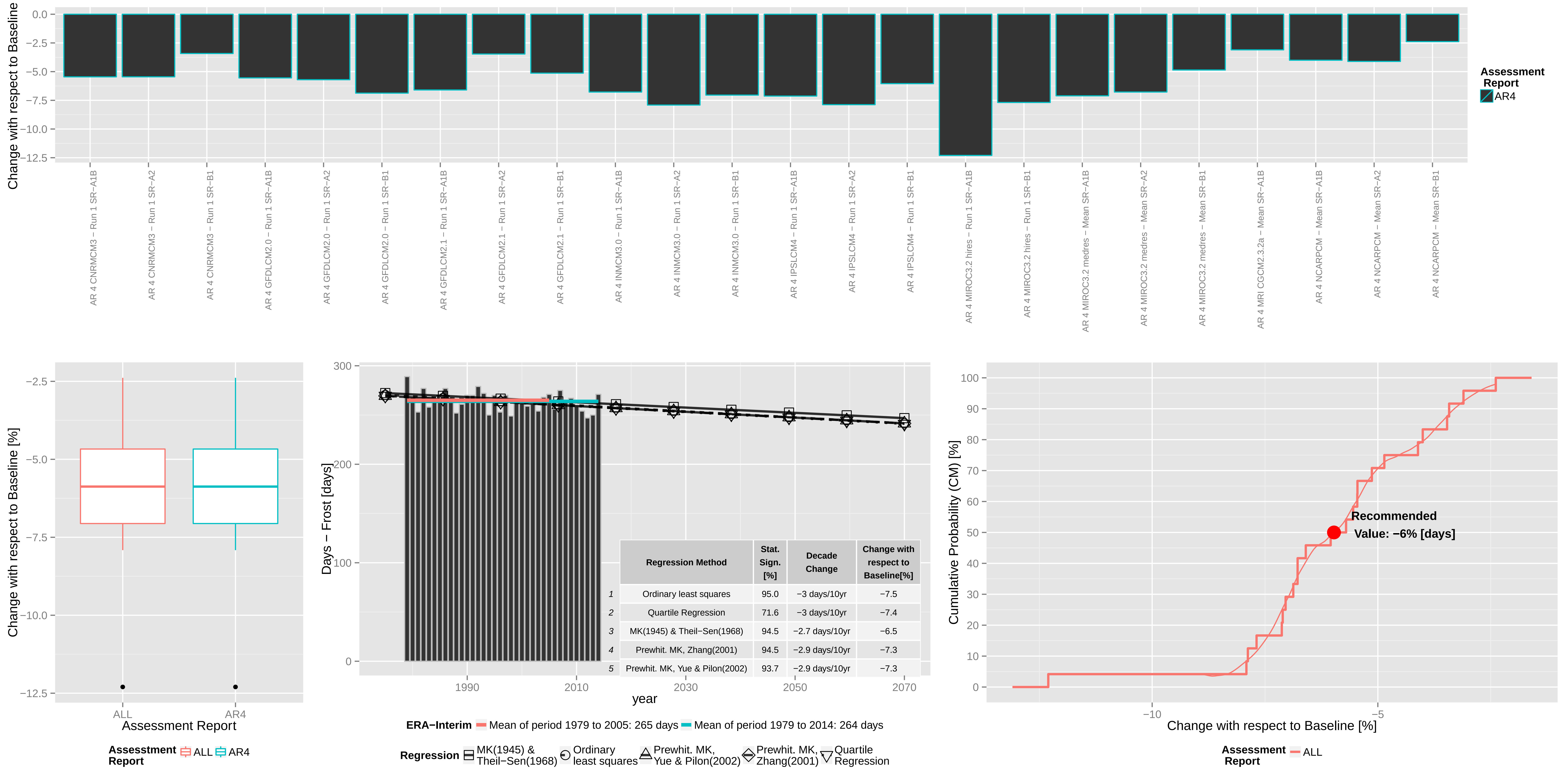
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	75.0	−1.7 days/10yr	−85
2	Quartile Regression	35.2	0.6 days/10yr	37
3	MK(1945) & Theil−Sen(1968)	70.2	−0.2 days/10yr	−12
4	Prewhit. MK, Zhang(2001)	74.3	−0.95 days/10yr	−56
5	Prewhit. MK, Yue & Pilon(2002)	75.2	−0.36 days/10yr	−21

Climate parameter: Days − Frost
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2011 − 2040



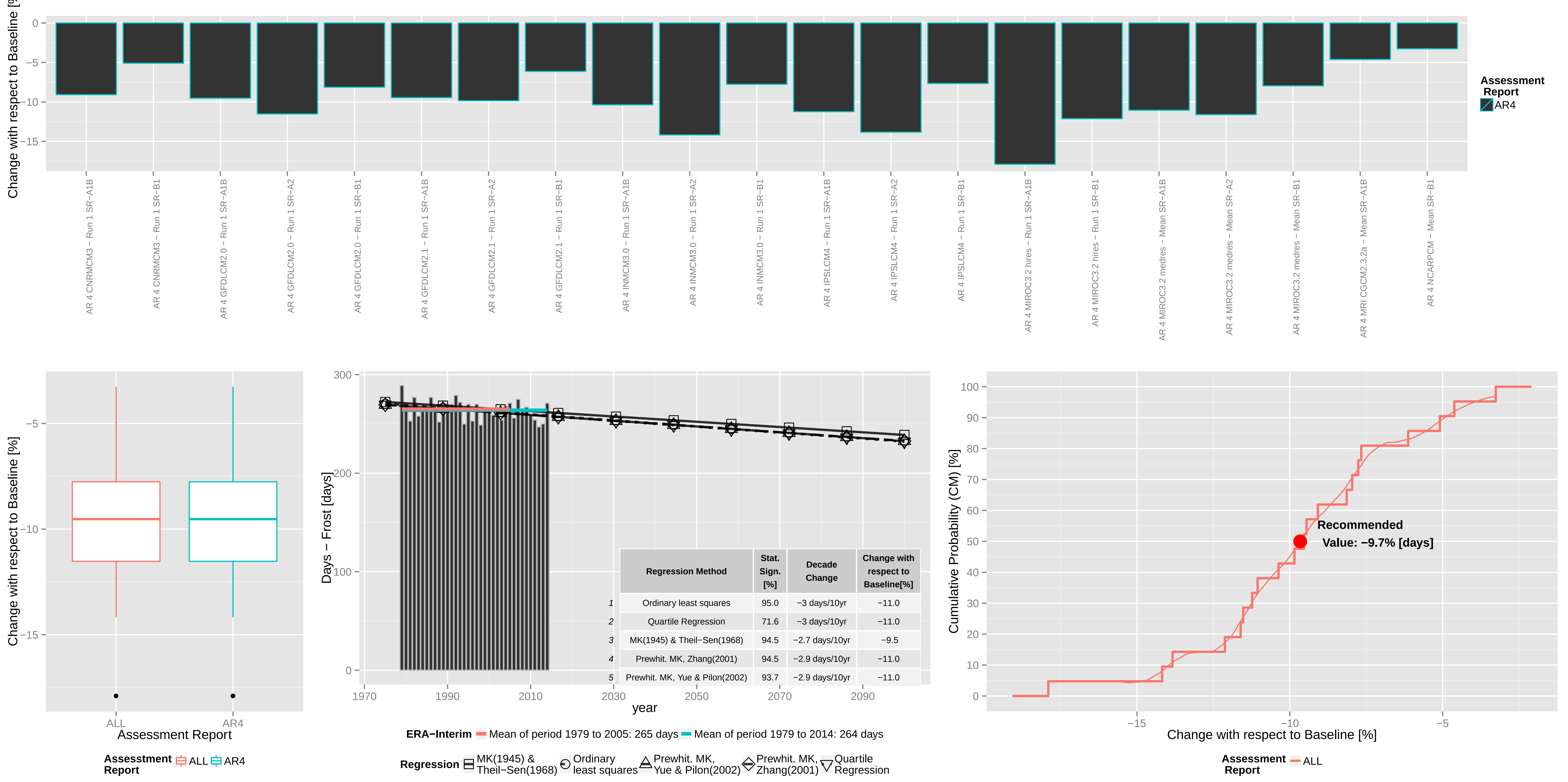
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	95.0	−3 days/10yr	−4.1
2	Quartile Regression	71.6	−3 days/10yr	−4.0
3	MK(1945) & Theil−Sen(1968)	94.5	−2.7 days/10yr	−3.5
4	Prewhit. MK, Zhang(2001)	94.5	−2.9 days/10yr	−3.9
5	Prewhit. MK, Yue & Pilon(2002)	93.7	−2.9 days/10yr	−3.9

Climate parameter: Days − Frost
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2041 − 2070



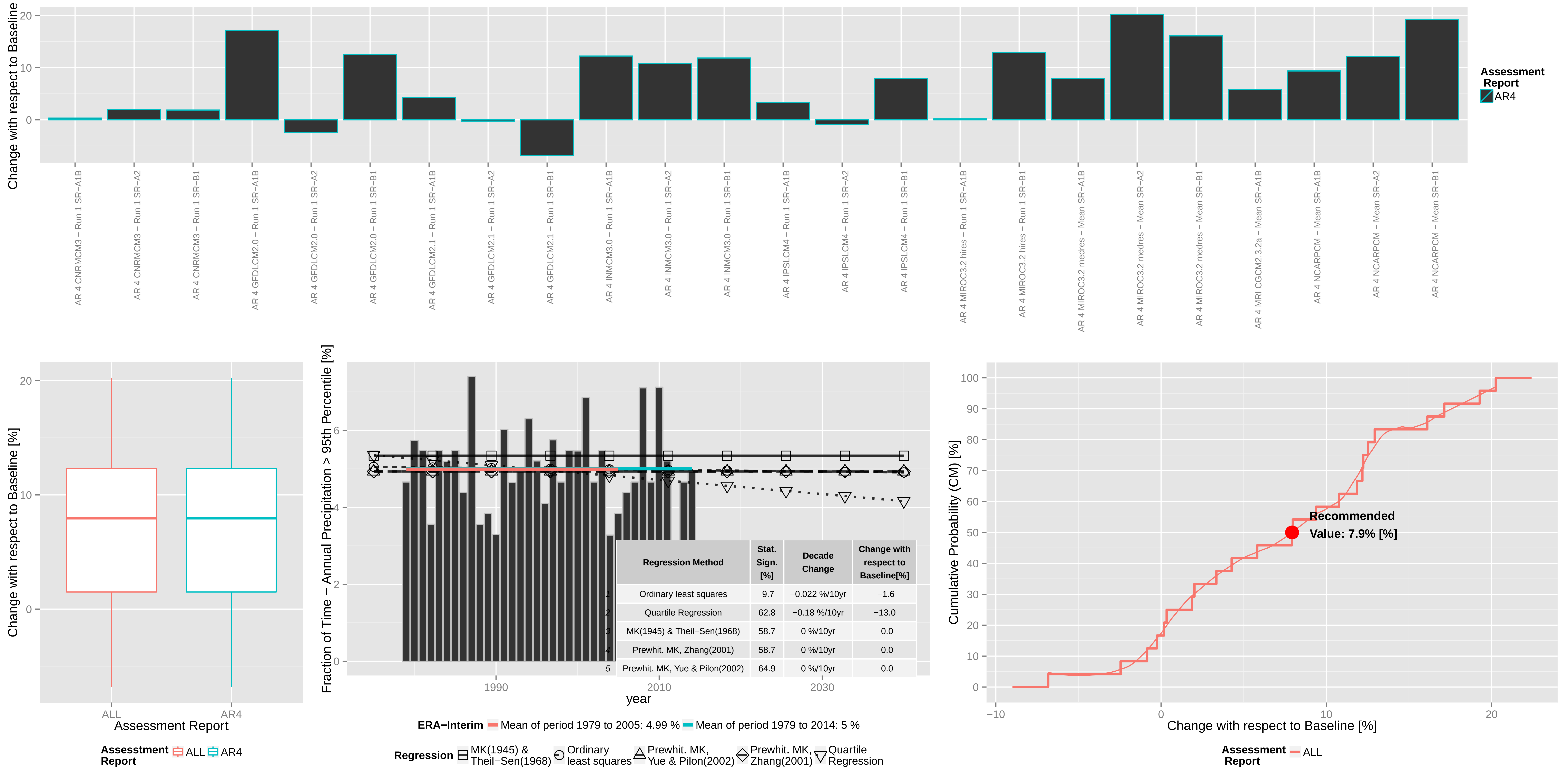
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	95.0	−3 days/10yr	−7.5
2	Quartile Regression	71.6	−3 days/10yr	−7.4
3	MK(1945) & Theil−Sen(1968)	94.5	−2.7 days/10yr	−6.5
4	Prewhit. MK, Zhang(2001)	94.5	−2.9 days/10yr	−7.3
5	Prewhit. MK, Yue & Pilon(2002)	93.7	−2.9 days/10yr	−7.3

Climate parameter: Days − Frost
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2071 − 2100



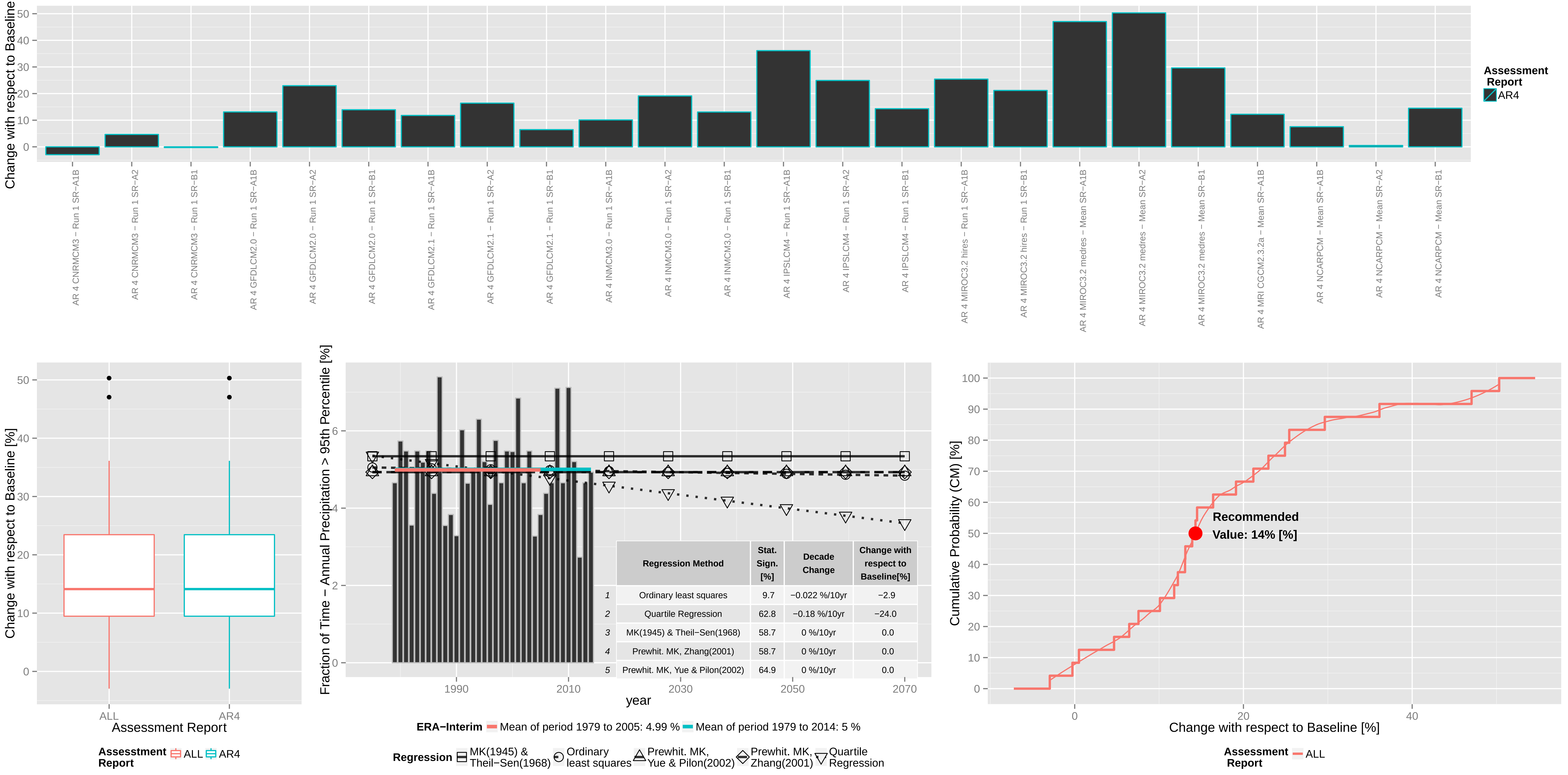
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	95.0	−3 days/10yr	−11.0
2	Quartile Regression	71.6	−3 days/10yr	−11.0
3	MK(1945) & Theil−Sen(1968)	94.5	−2.7 days/10yr	−9.5
4	Prewhit. MK, Zhang(2001)	94.5	−2.9 days/10yr	−11.0
5	Prewhit. MK, Yue & Pilon(2002)	93.7	−2.9 days/10yr	−11.0

Climate parameter: Fraction of Time − Annual Precipitation > 95th Percentile
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2011 − 2040



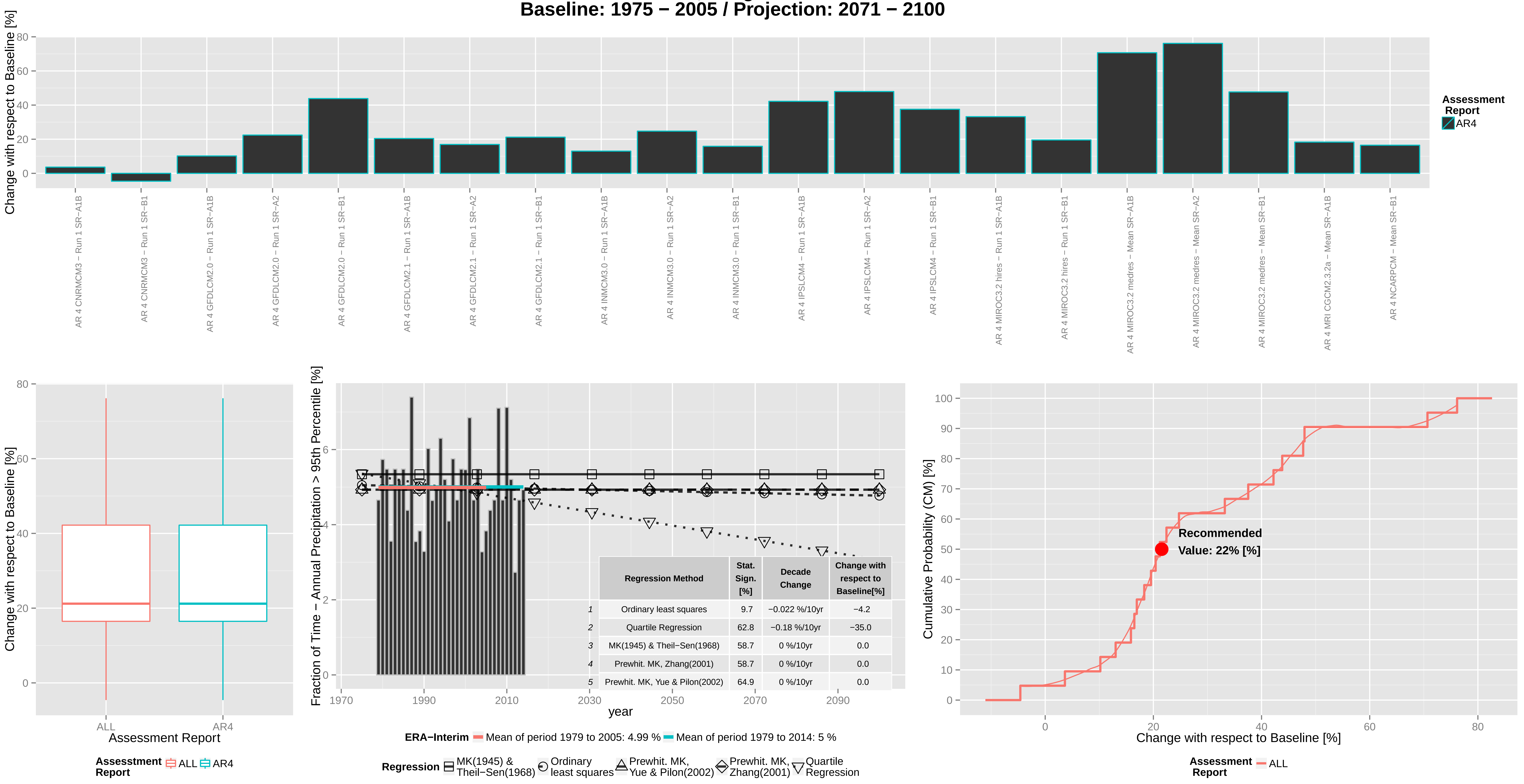
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	9.7	−0.022 %/10yr	−1.6
2	Quartile Regression	62.8	−0.18 %/10yr	−13.0
3	MK(1945) & Theil−Sen(1968)	58.7	0 %/10yr	0.0
4	Prewhit. MK, Zhang(2001)	58.7	0 %/10yr	0.0
5	Prewhit. MK, Yue & Pilon(2002)	64.9	0 %/10yr	0.0

Climate parameter: Fraction of Time − Annual Precipitation > 95th Percentile
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2041 − 2070



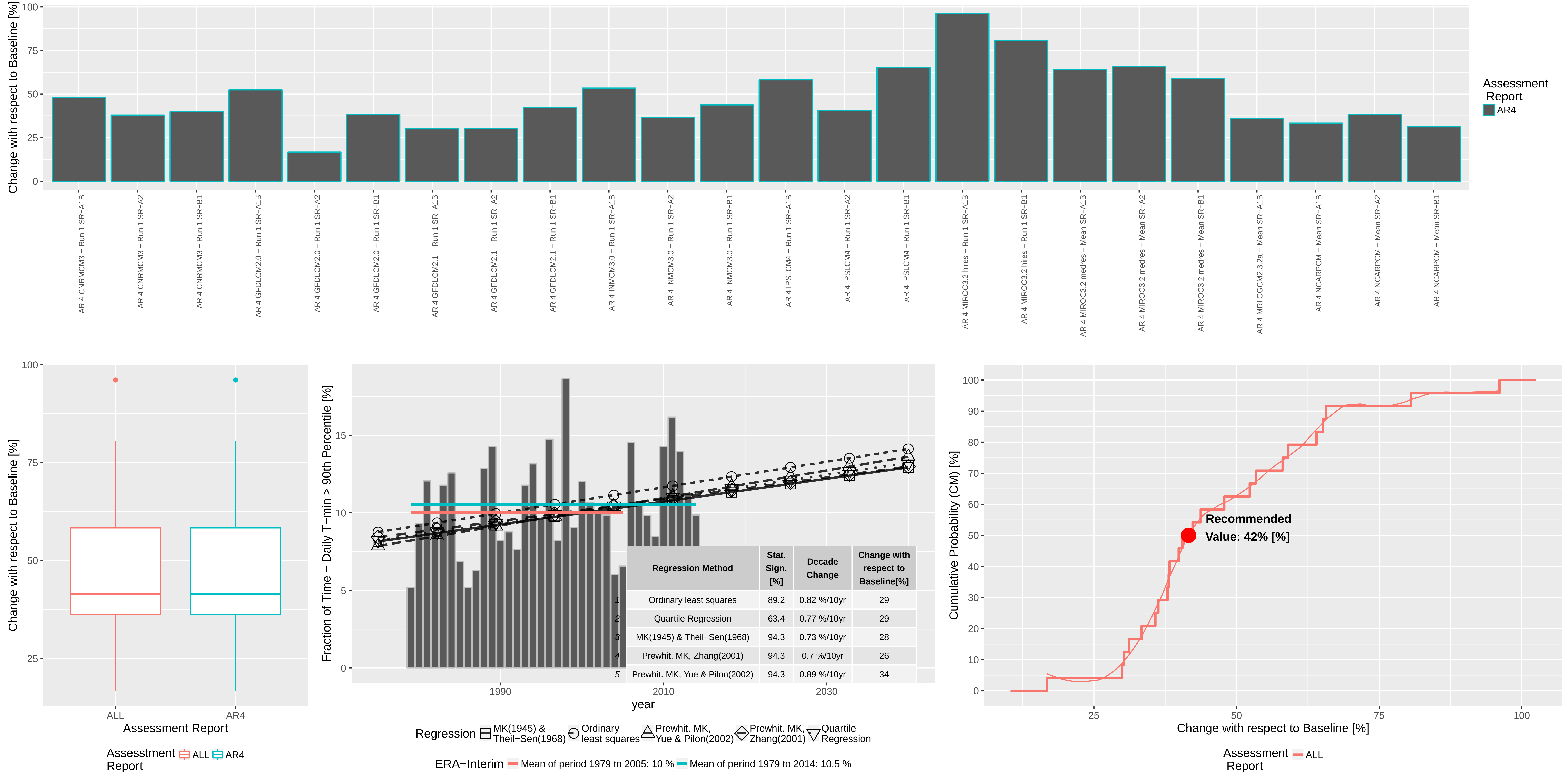
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	9.7	−0.022 %/10yr	−2.9
2	Quartile Regression	62.8	−0.18 %/10yr	−24.0
3	MK(1945) & Theil−Sen(1968)	58.7	0 %/10yr	0.0
4	Prewhit. MK, Zhang(2001)	58.7	0 %/10yr	0.0
5	Prewhit. MK, Yue & Pilon(2002)	64.9	0 %/10yr	0.0

Climate parameter: Fraction of Time − Annual Precipitation > 95th Percentile
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2071 − 2100



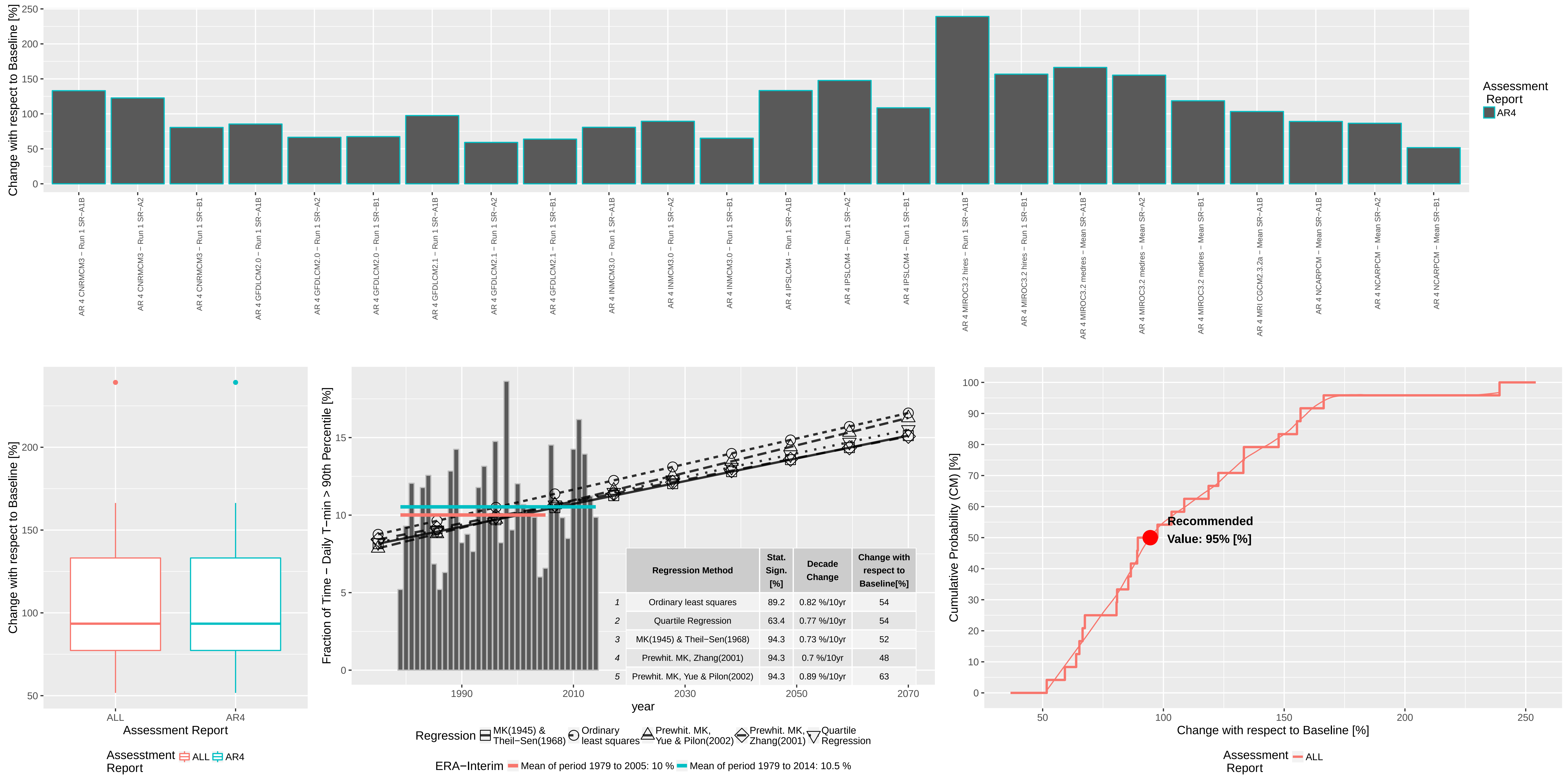
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	9.7	−0.022 %/10yr	−4.2
2	Quartile Regression	62.8	−0.18 %/10yr	−35.0
3	MK(1945) & Theil−Sen(1968)	58.7	0 %/10yr	0.0
4	Prewhit. MK, Zhang(2001)	58.7	0 %/10yr	0.0
5	Prewhit. MK, Yue & Pilon(2002)	64.9	0 %/10yr	0.0

Climate parameter: Fraction of Time − Daily T−min > 90th Percentile
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2011 − 2040



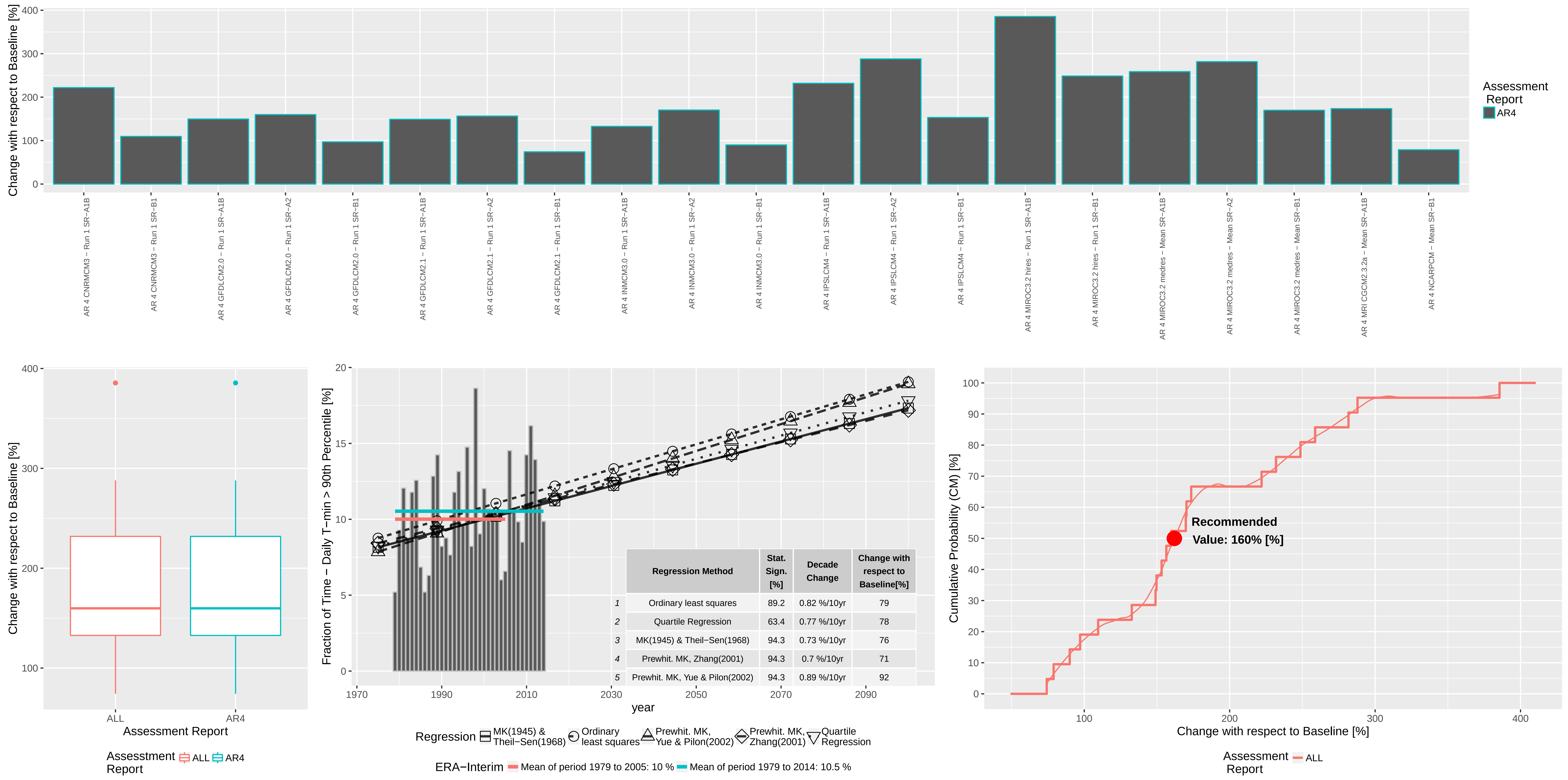
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	89.2	0.82 %/10yr	29
2	Quartile Regression	63.4	0.77 %/10yr	29
3	MK(1945) & Theil−Sen(1968)	94.3	0.73 %/10yr	28
4	Prewhit. MK, Zhang(2001)	94.3	0.7 %/10yr	26
5	Prewhit. MK, Yue & Pilon(2002)	94.3	0.89 %/10yr	34

Climate parameter: Fraction of Time − Daily T−min > 90th Percentile
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2041 − 2070



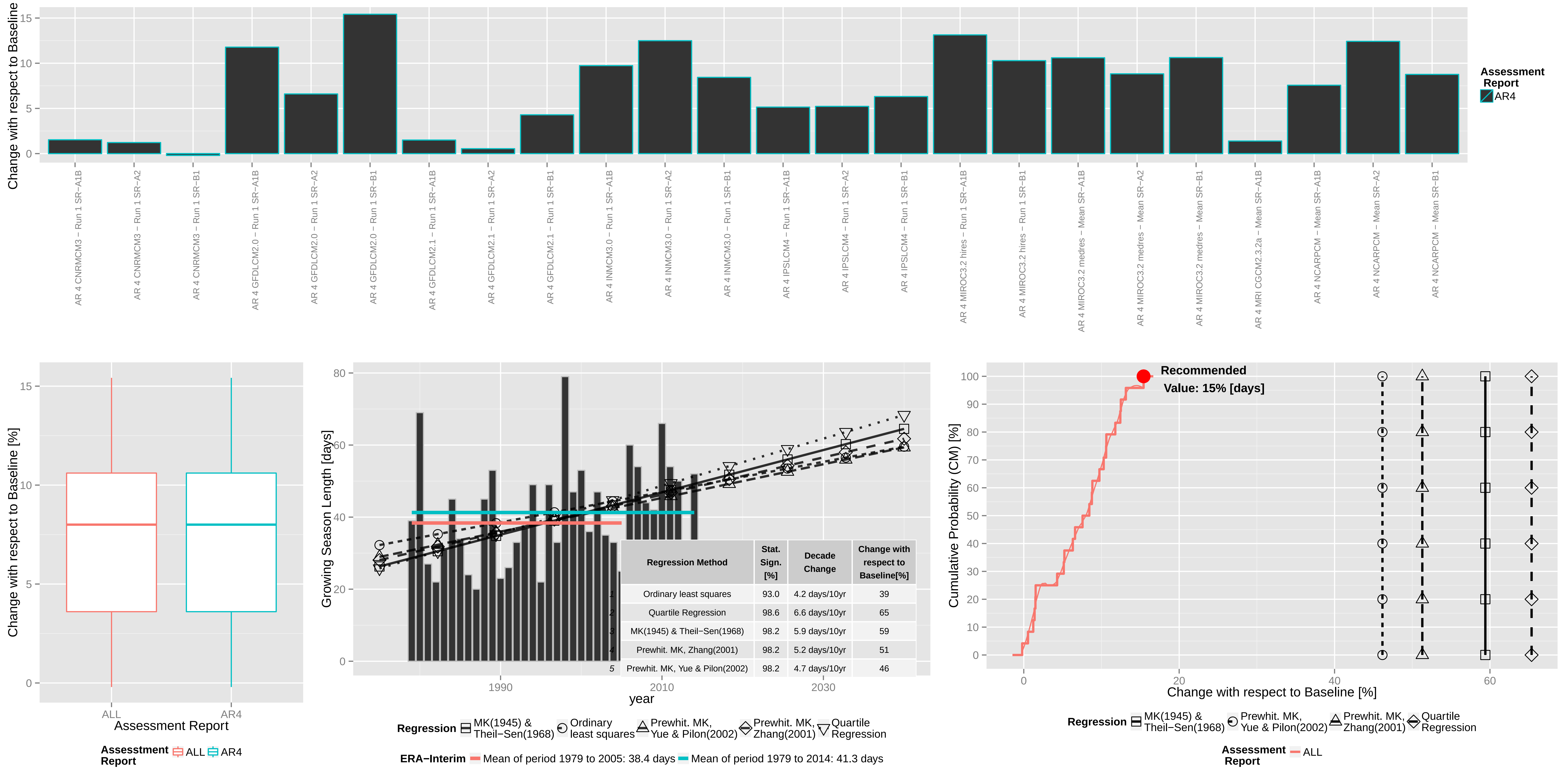
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	89.2	0.82 %/10yr	54
2	Quartile Regression	63.4	0.77 %/10yr	54
3	MK(1945) & Theil−Sen(1968)	94.3	0.73 %/10yr	52
4	Prewhit. MK, Zhang(2001)	94.3	0.7 %/10yr	48
5	Prewhit. MK, Yue & Pilon(2002)	94.3	0.89 %/10yr	63

Climate parameter: Fraction of Time − Daily T−min > 90th Percentile
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2071 − 2100



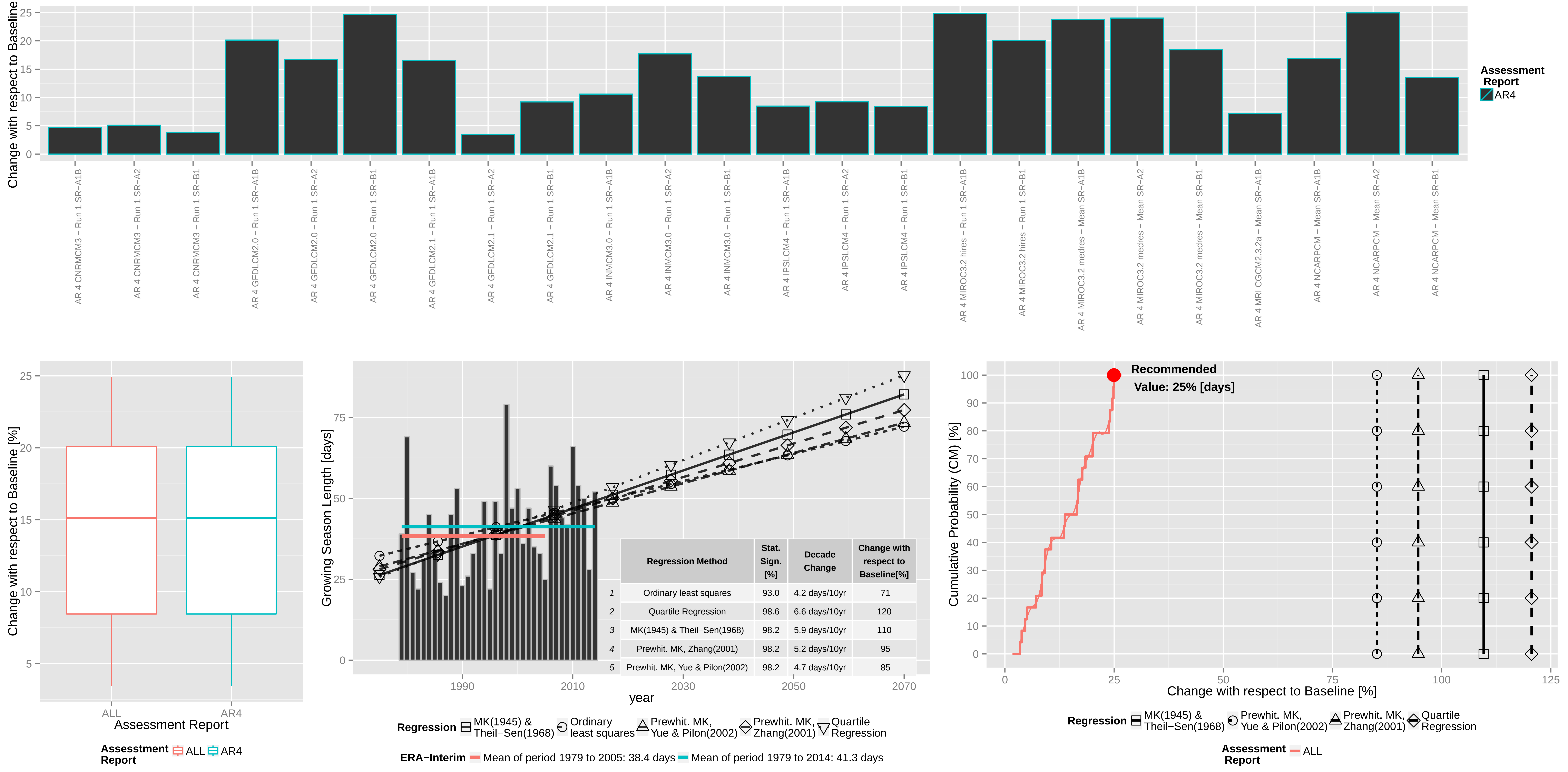
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	89.2	0.82 %/10yr	79
2	Quartile Regression	63.4	0.77 %/10yr	78
3	MK(1945) & Theil−Sen(1968)	94.3	0.73 %/10yr	76
4	Prewhit. MK, Zhang(2001)	94.3	0.7 %/10yr	71
5	Prewhit. MK, Yue & Pilon(2002)	94.3	0.89 %/10yr	92

Climate parameter: Growing Season Length
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2011 − 2040



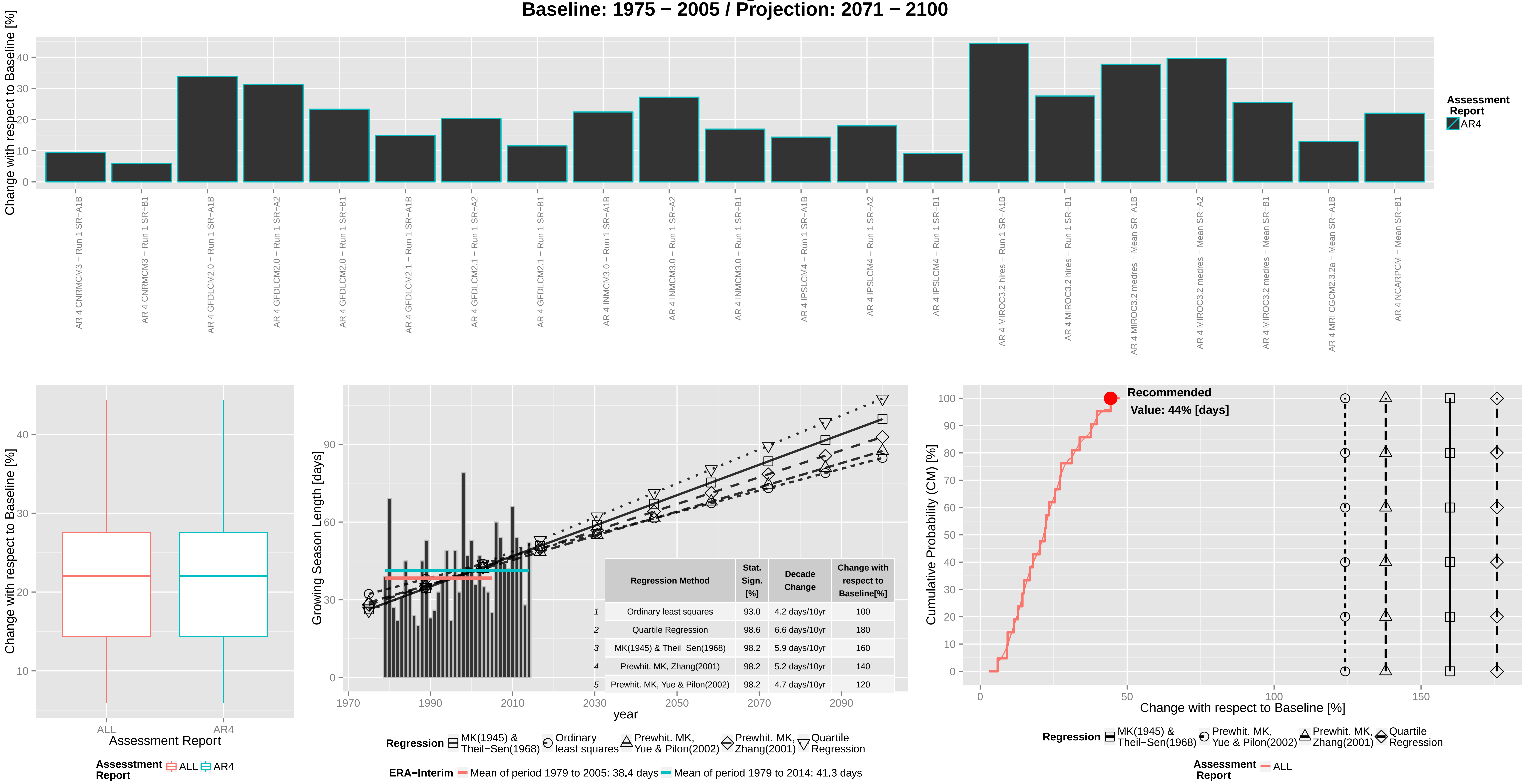
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	93.0	4.2 days/10yr	39
2	Quartile Regression	98.6	6.6 days/10yr	65
3	MK(1945) & Theil−Sen(1968)	98.2	5.9 days/10yr	59
4	Prewhit. MK, Zhang(2001)	98.2	5.2 days/10yr	51
5	Prewhit. MK, Yue & Pilon(2002)	98.2	4.7 days/10yr	46

Climate parameter: Growing Season Length
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2041 − 2070



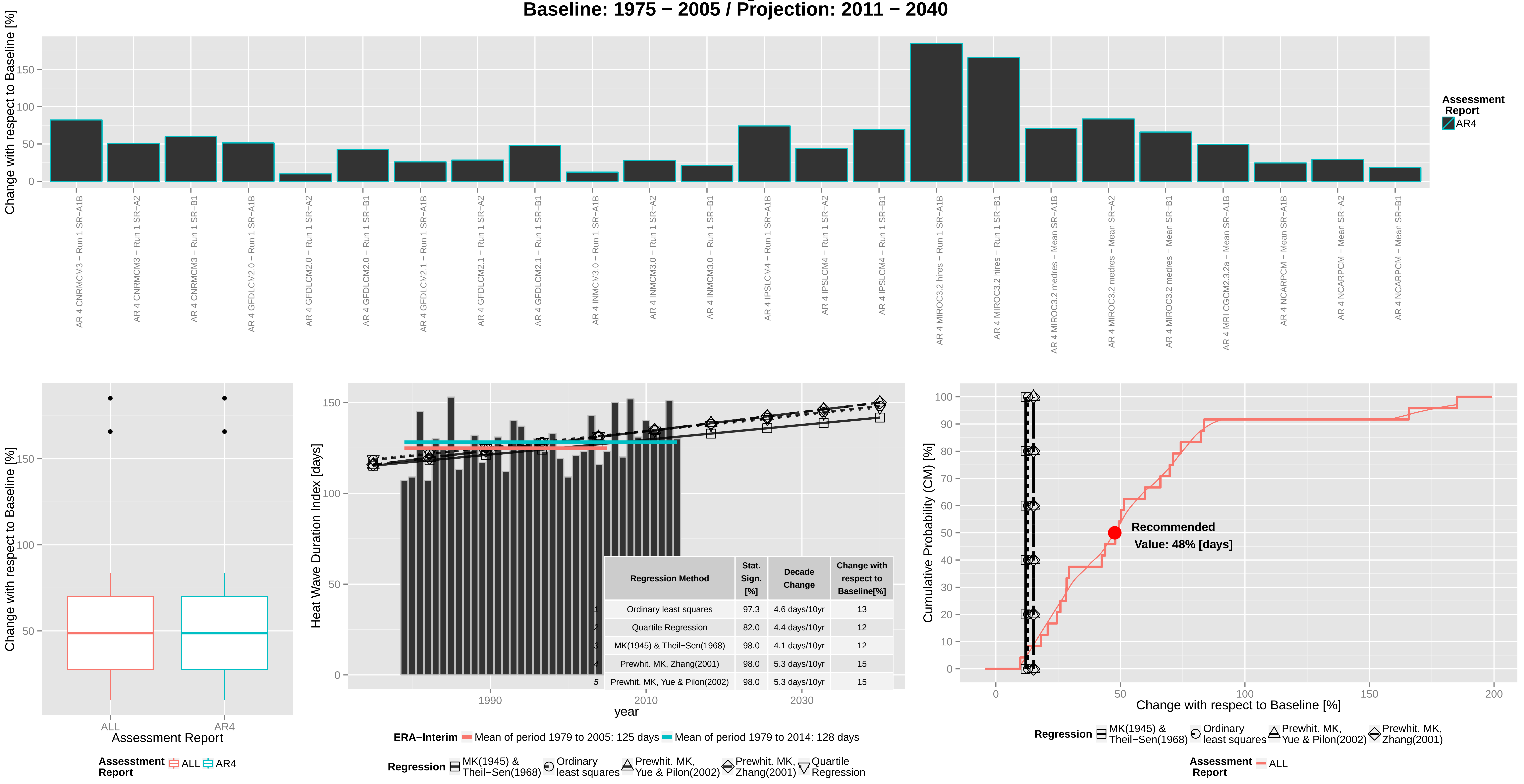
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	93.0	4.2 days/10yr	71
2	Quartile Regression	98.6	6.6 days/10yr	120
3	MK(1945) & Theil−Sen(1968)	98.2	5.9 days/10yr	110
4	Prewhit. MK, Zhang(2001)	98.2	5.2 days/10yr	95
5	Prewhit. MK, Yue & Pilon(2002)	98.2	4.7 days/10yr	85

Climate parameter: Growing Season Length
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2071 − 2100



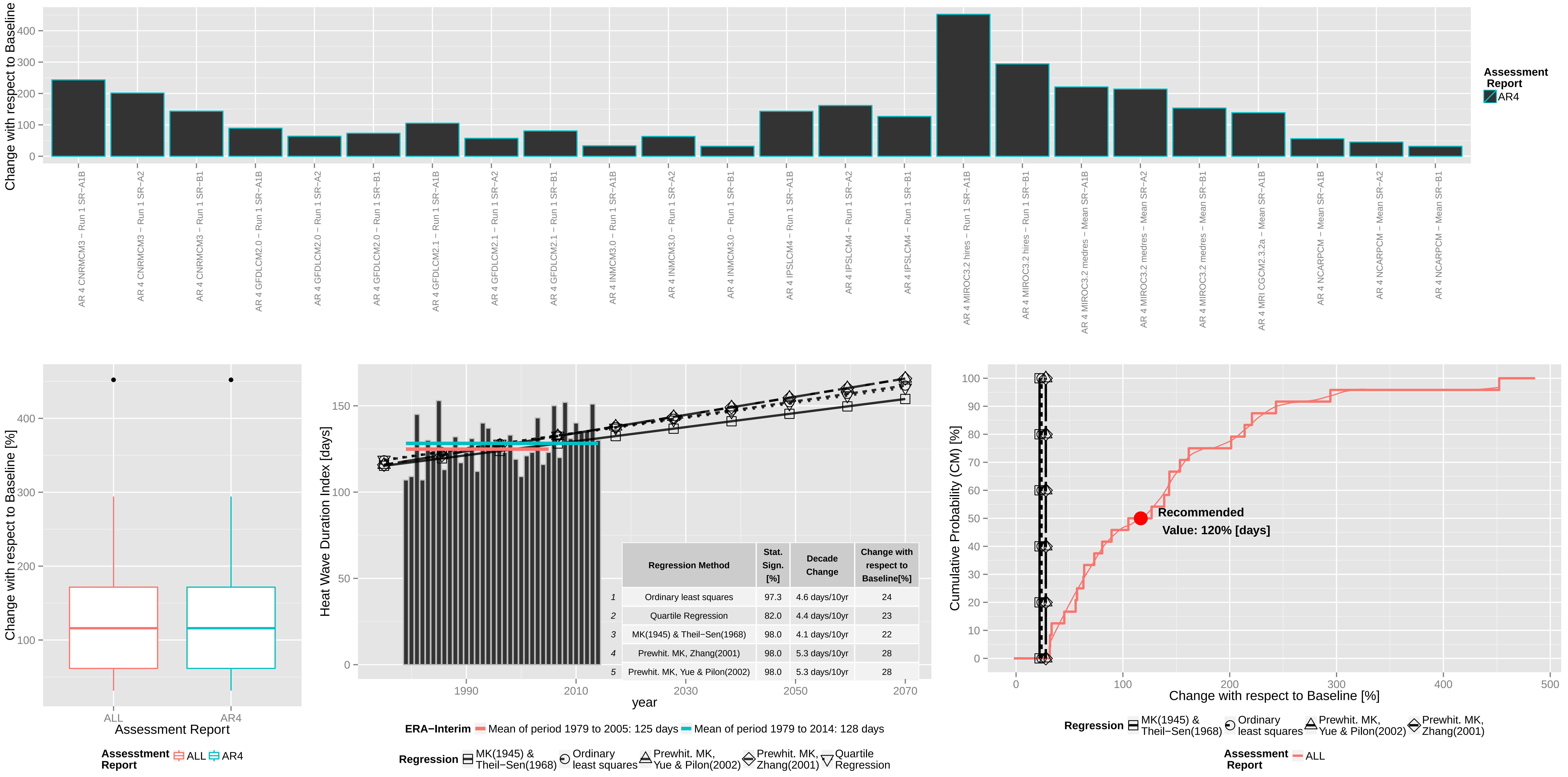
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	93.0	4.2 days/10yr	100
2	Quartile Regression	98.6	6.6 days/10yr	180
3	MK(1945) & Theil−Sen(1968)	98.2	5.9 days/10yr	160
4	Prewhit. MK, Zhang(2001)	98.2	5.2 days/10yr	140
5	Prewhit. MK, Yue & Pilon(2002)	98.2	4.7 days/10yr	120

Climate parameter: Heat Wave Duration Index
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2011 − 2040



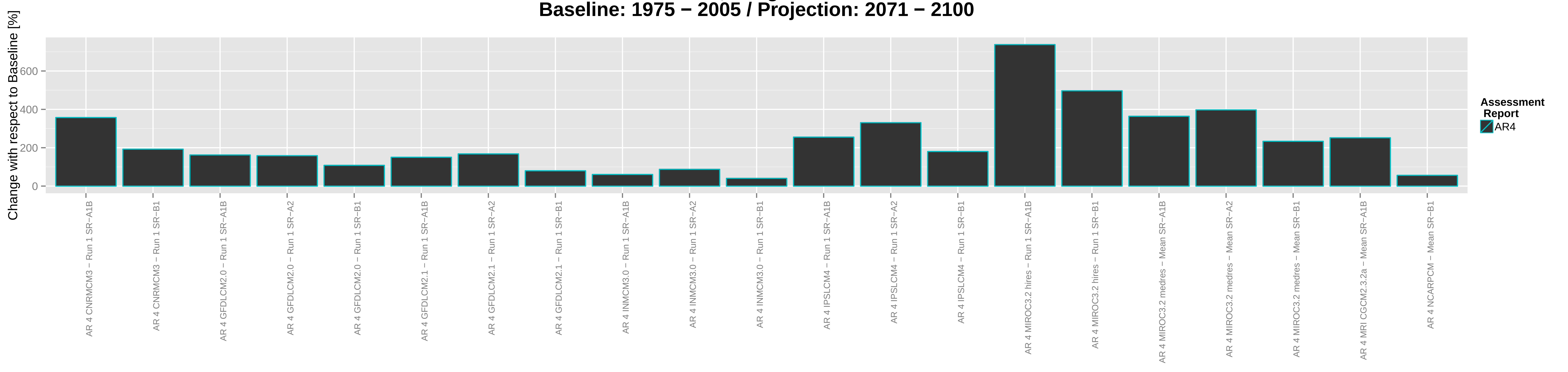
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	97.3	4.6 days/10yr	13
2	Quartile Regression	82.0	4.4 days/10yr	12
3	MK(1945) & Theil−Sen(1968)	98.0	4.1 days/10yr	12
4	Prewhit. MK, Zhang(2001)	98.0	5.3 days/10yr	15
5	Prewhit. MK, Yue & Pilon(2002)	98.0	5.3 days/10yr	15

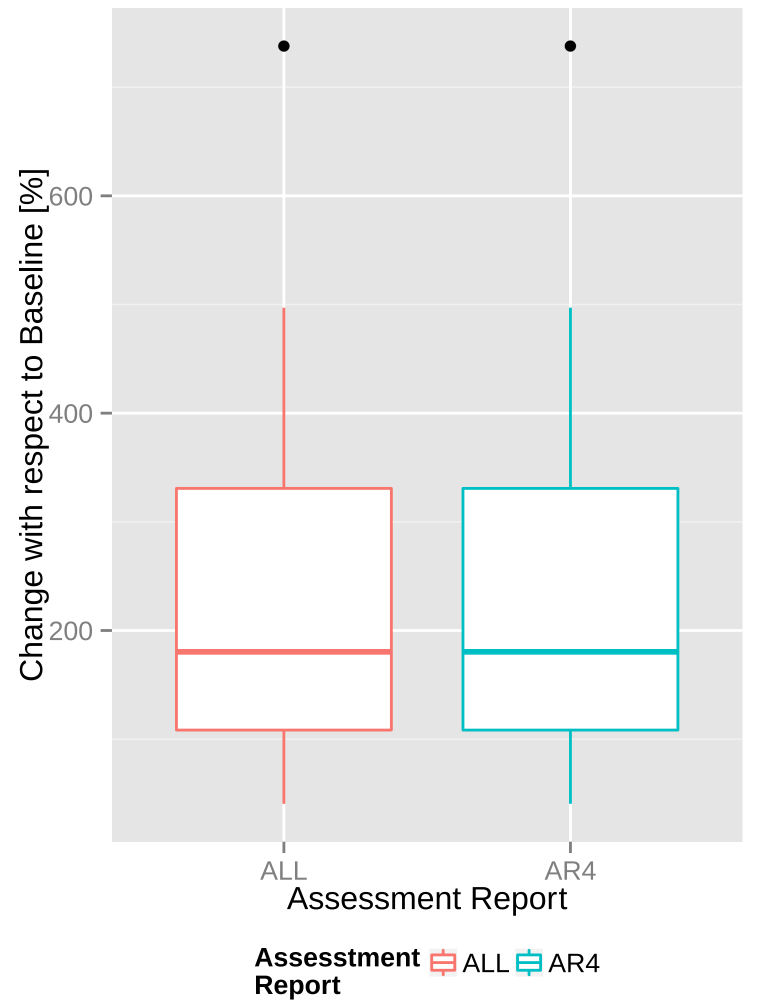
Climate parameter: Heat Wave Duration Index
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2041 − 2070

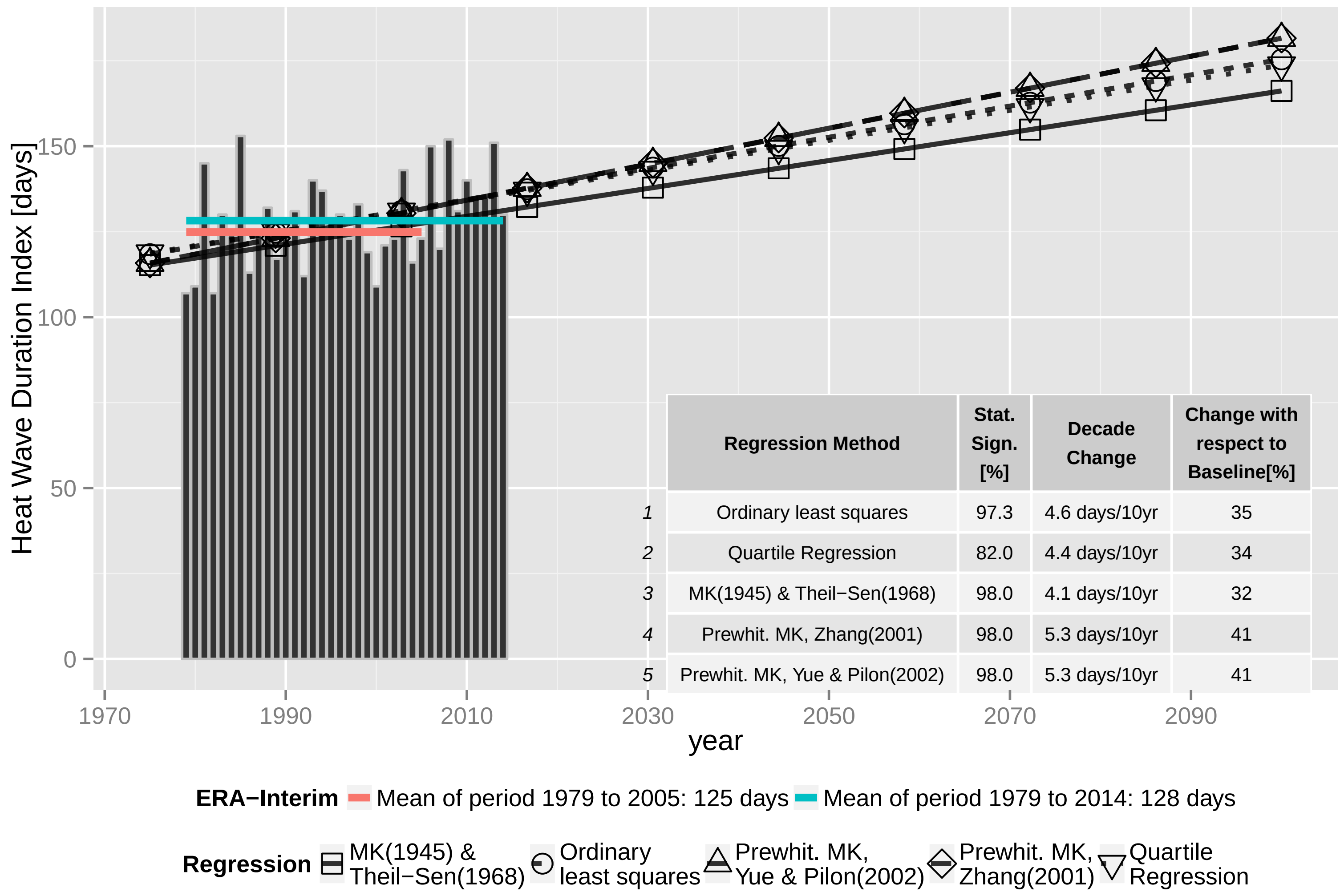


	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	97.3	4.6 days/10yr	24
2	Quartile Regression	82.0	4.4 days/10yr	23
3	MK(1945) & Theil−Sen(1968)	98.0	4.1 days/10yr	22
4	Prewhit. MK, Zhang(2001)	98.0	5.3 days/10yr	28
5	Prewhit. MK, Yue & Pilon(2002)	98.0	5.3 days/10yr	28

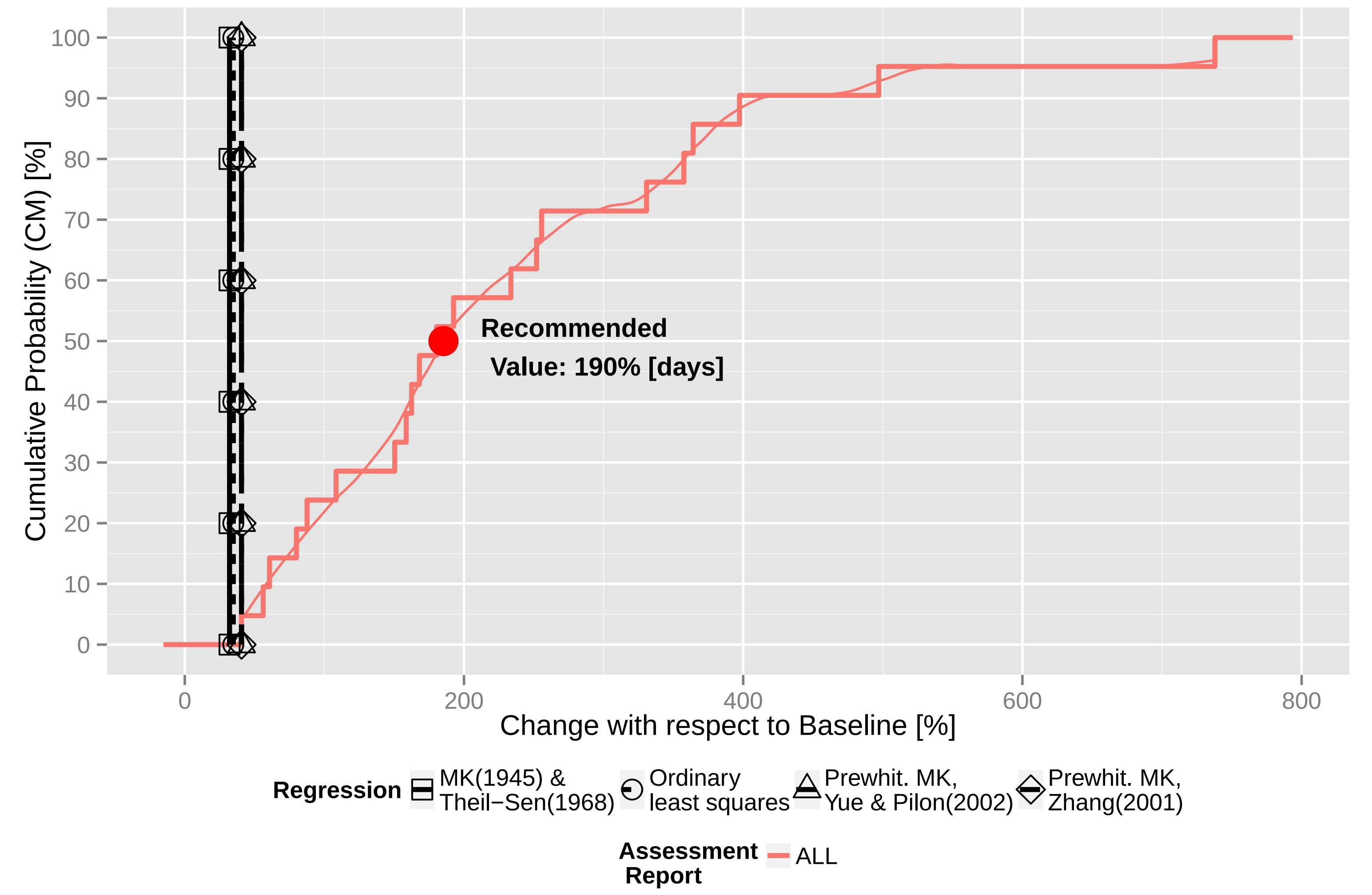
Climate parameter: Heat Wave Duration Index
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2071 − 2100



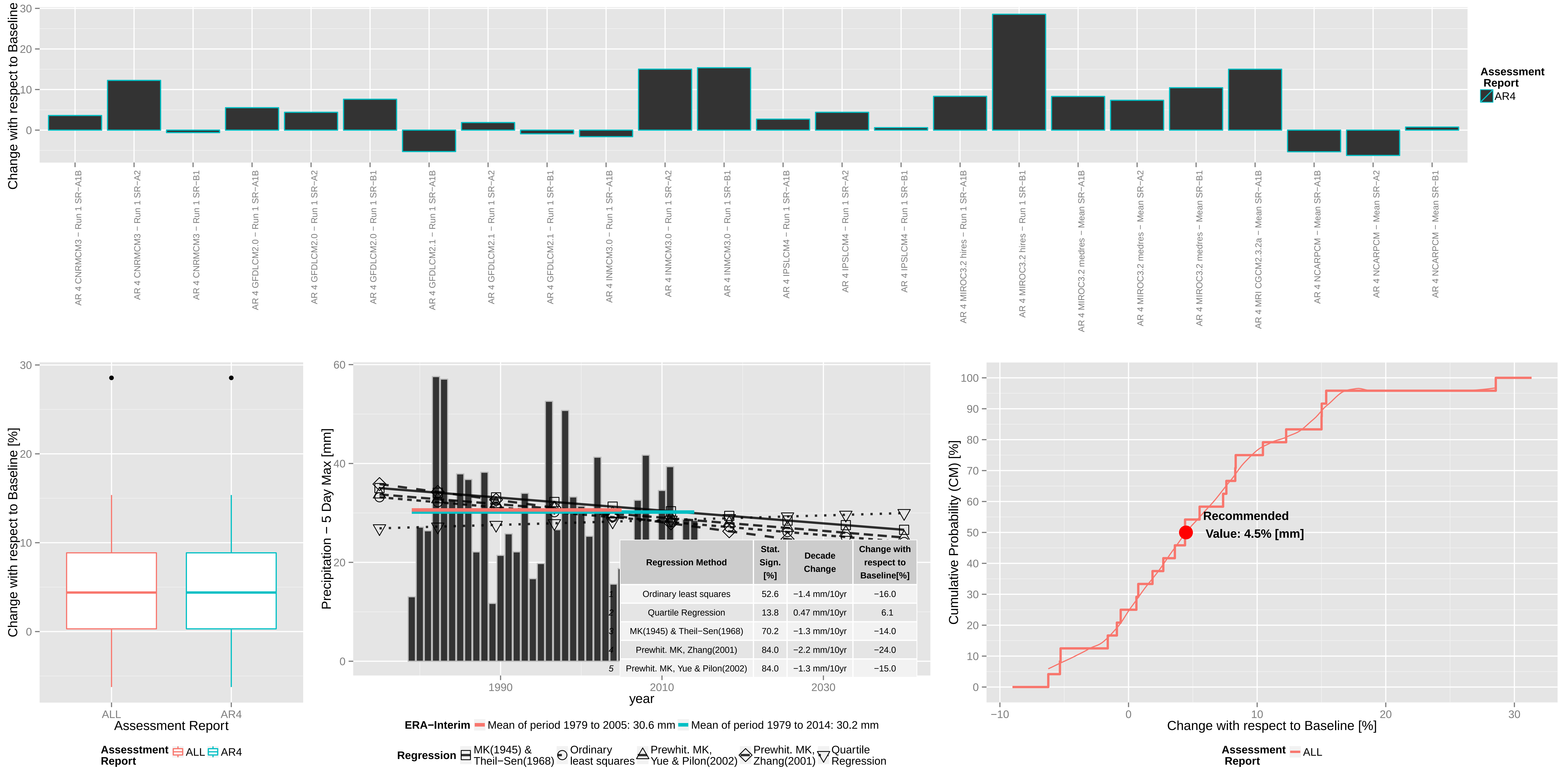




	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	97.3	4.6 days/10yr	35
2	Quartile Regression	82.0	4.4 days/10yr	34
3	MK(1945) & Theil−Sen(1968)	98.0	4.1 days/10yr	32
4	Prewhit. MK, Zhang(2001)	98.0	5.3 days/10yr	41
5	Prewhit. MK, Yue & Pilon(2002)	98.0	5.3 days/10yr	41

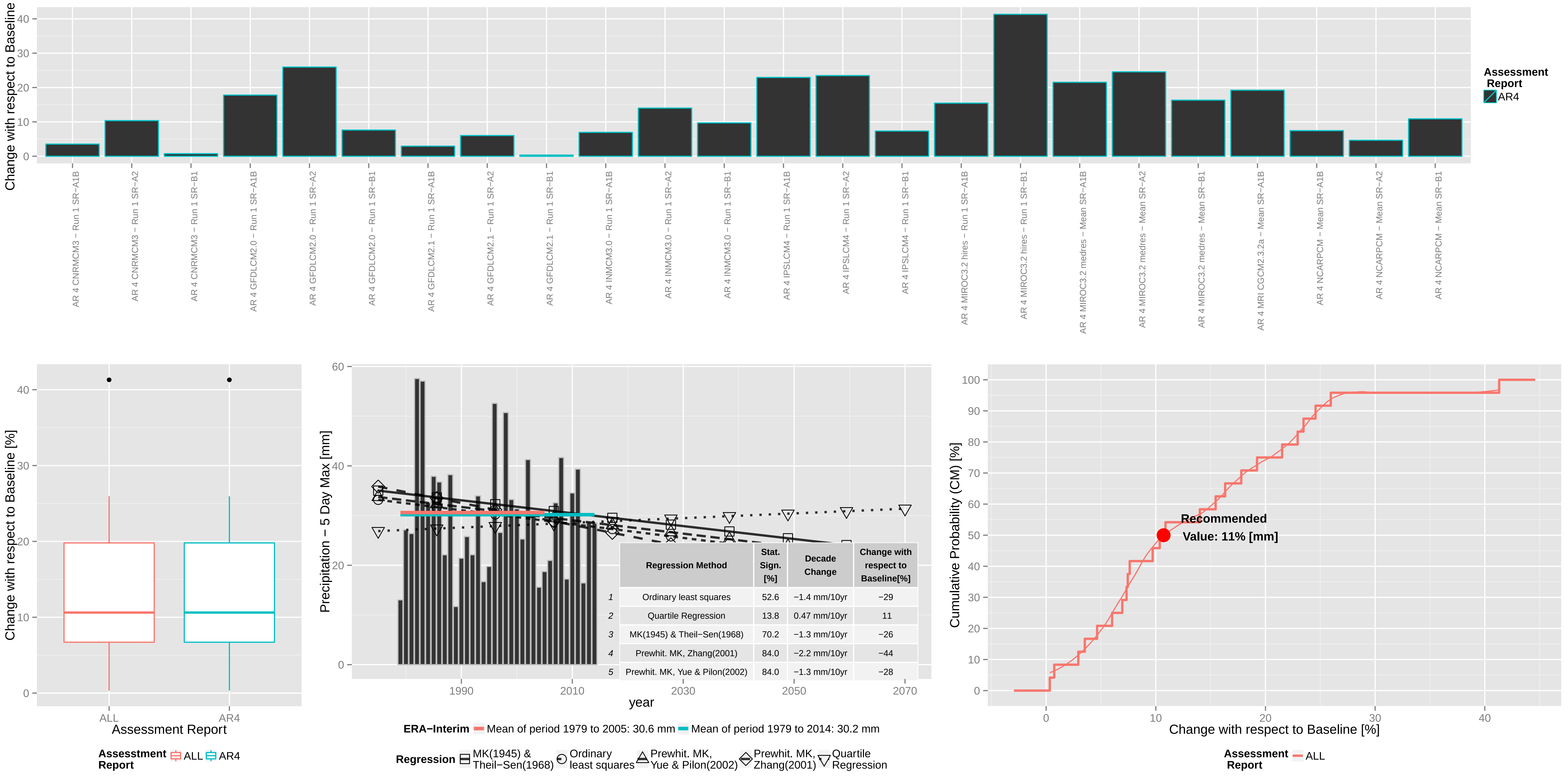


Climate parameter: Precipitation − 5 Day Max
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2011 − 2040



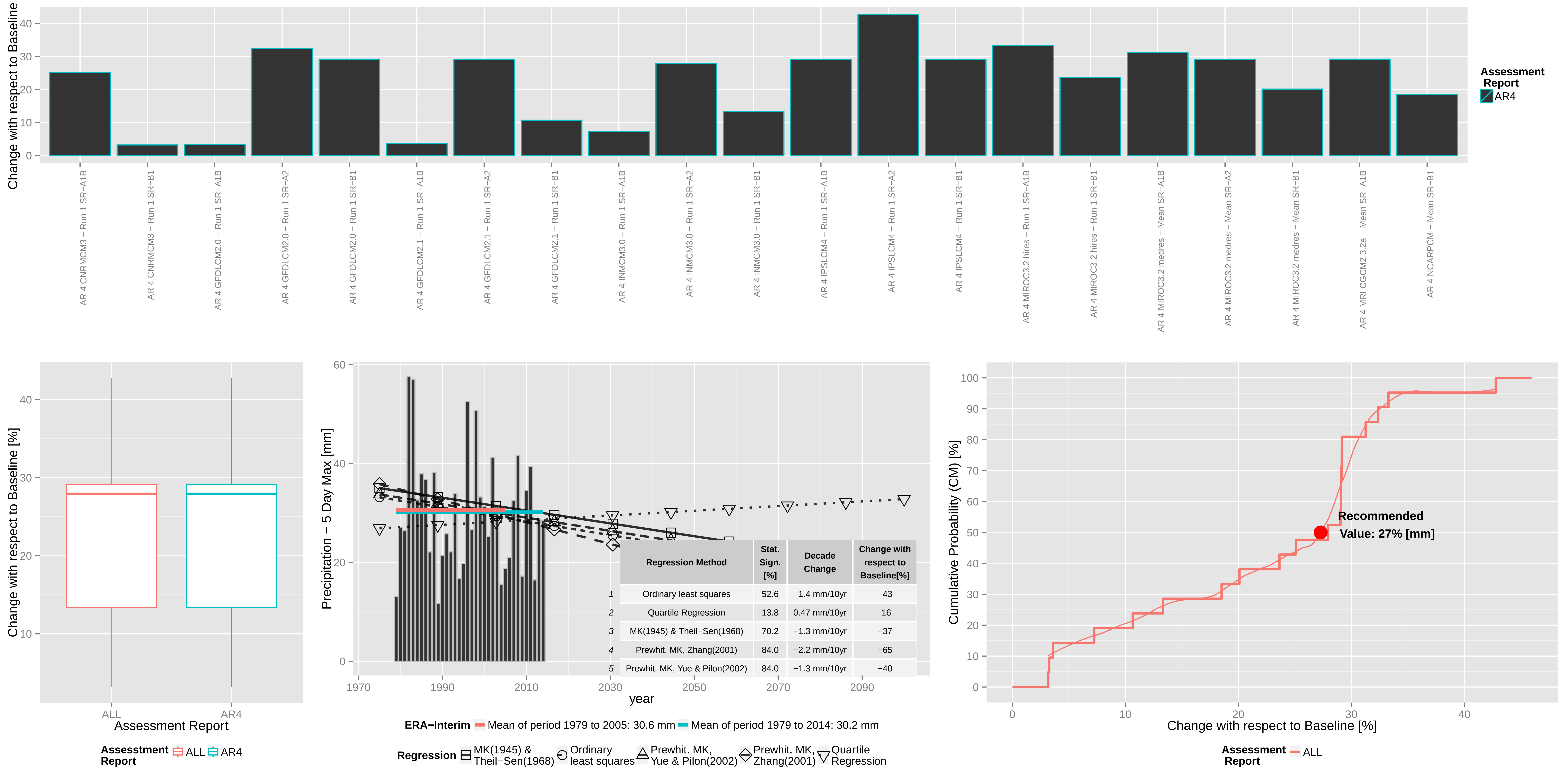
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	52.6	−1.4 mm/10yr	−16.0
2	Quartile Regression	13.8	0.47 mm/10yr	6.1
3	MK(1945) & Theil−Sen(1968)	70.2	−1.3 mm/10yr	−14.0
4	Prewhit. MK, Zhang(2001)	84.0	−2.2 mm/10yr	−24.0
5	Prewhit. MK, Yue & Pilon(2002)	84.0	−1.3 mm/10yr	−15.0

Climate parameter: Precipitation − 5 Day Max
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2041 − 2070



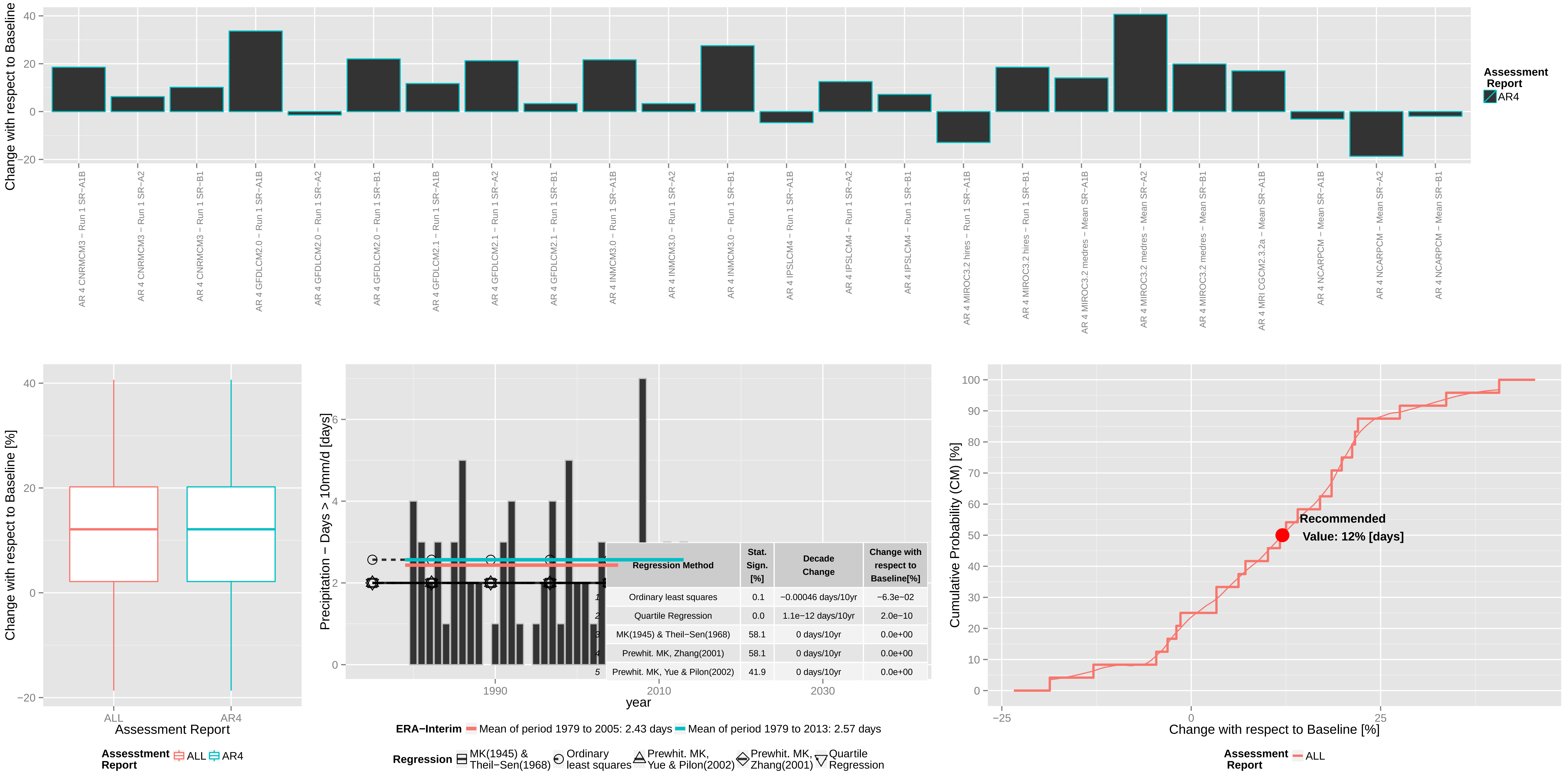
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	52.6	−1.4 mm/10yr	−29
2	Quartile Regression	13.8	0.47 mm/10yr	11
3	MK(1945) & Theil−Sen(1968)	70.2	−1.3 mm/10yr	−26
4	Prewhit. MK, Zhang(2001)	84.0	−2.2 mm/10yr	−44
5	Prewhit. MK, Yue & Pilon(2002)	84.0	−1.3 mm/10yr	−28

Climate parameter: Precipitation − 5 Day Max
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2071 − 2100



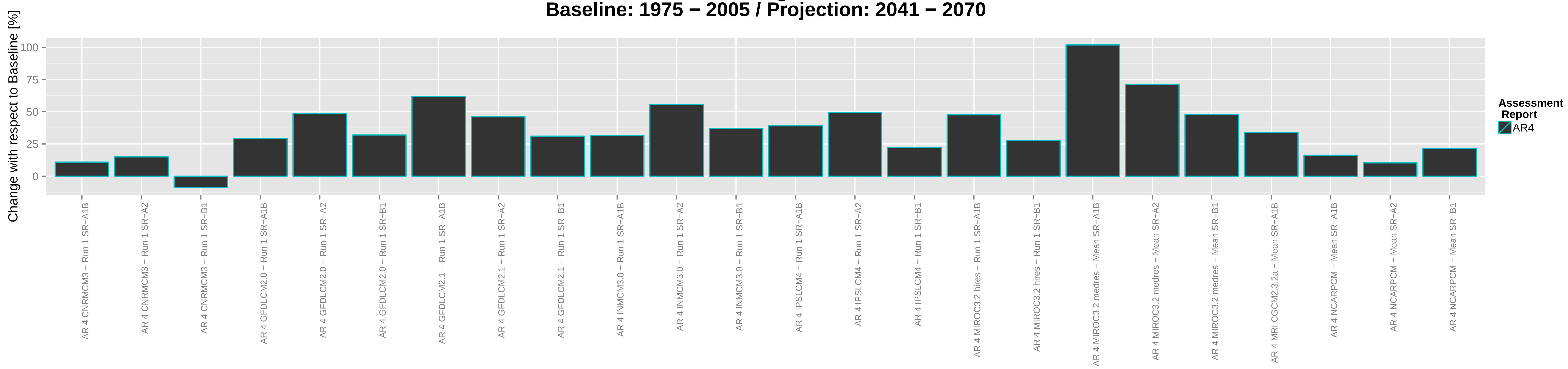
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	52.6	−1.4 mm/10yr	−43
2	Quartile Regression	13.8	0.47 mm/10yr	16
3	MK(1945) & Theil−Sen(1968)	70.2	−1.3 mm/10yr	−37
4	Prewhit. MK, Zhang(2001)	84.0	−2.2 mm/10yr	−65
5	Prewhit. MK, Yue & Pilon(2002)	84.0	−1.3 mm/10yr	−40

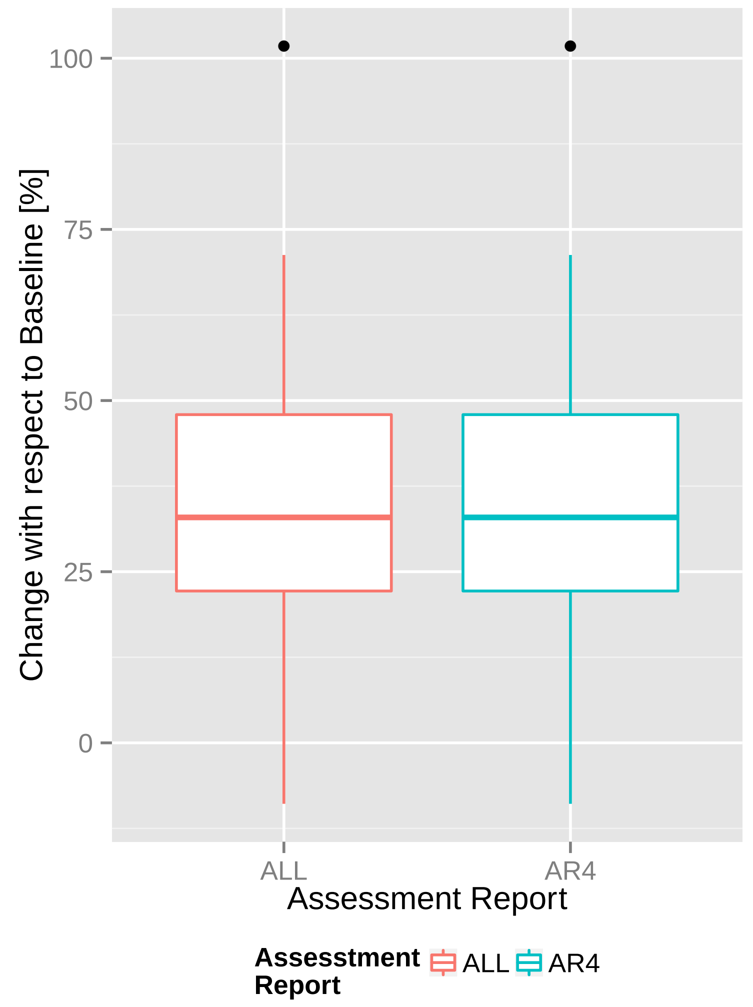
Climate parameter: Precipitation − Days > 10mm/d
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2011 − 2040

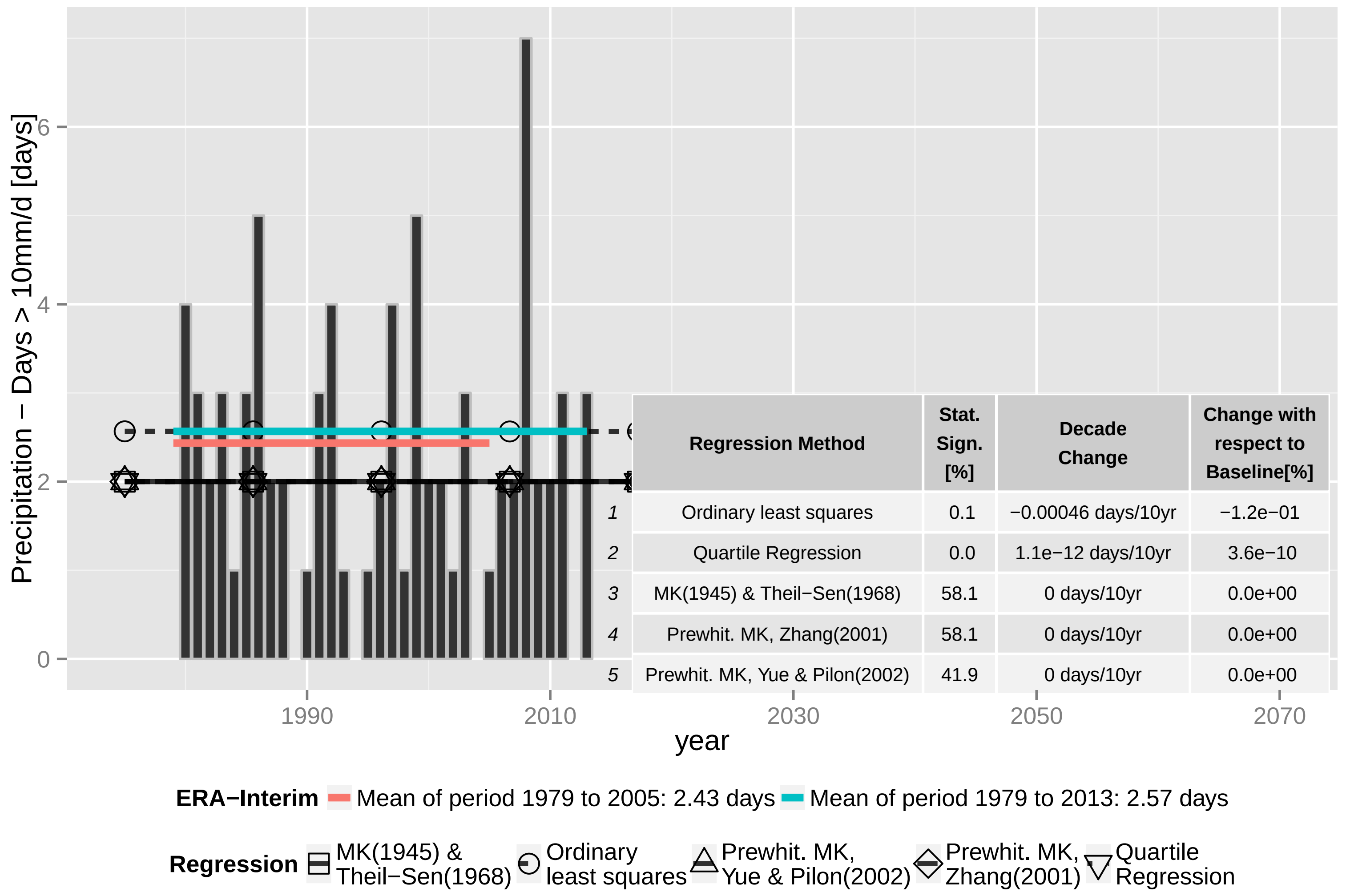


	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	0.1	−0.00046 days/10yr	−6.3e−02
2	Quartile Regression	0.0	1.1e−12 days/10yr	2.0e−10
3	MK(1945) & Theil−Sen(1968)	58.1	0 days/10yr	0.0e+00
4	Prewhit. MK, Zhang(2001)	58.1	0 days/10yr	0.0e+00
5	Prewhit. MK, Yue & Pilon(2002)	41.9	0 days/10yr	0.0e+00

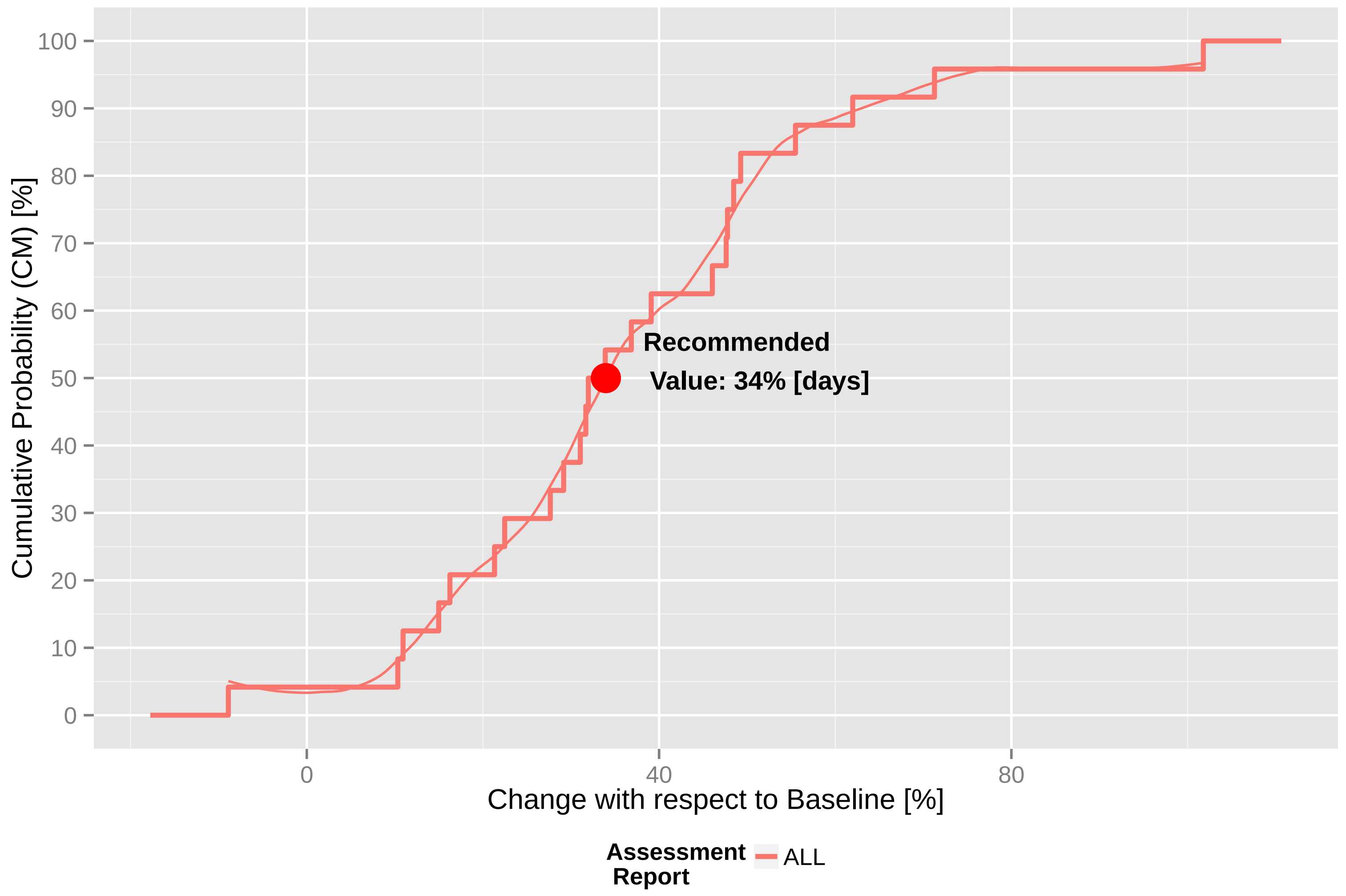
Climate parameter: Precipitation − Days > 10mm/d
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2041 − 2070



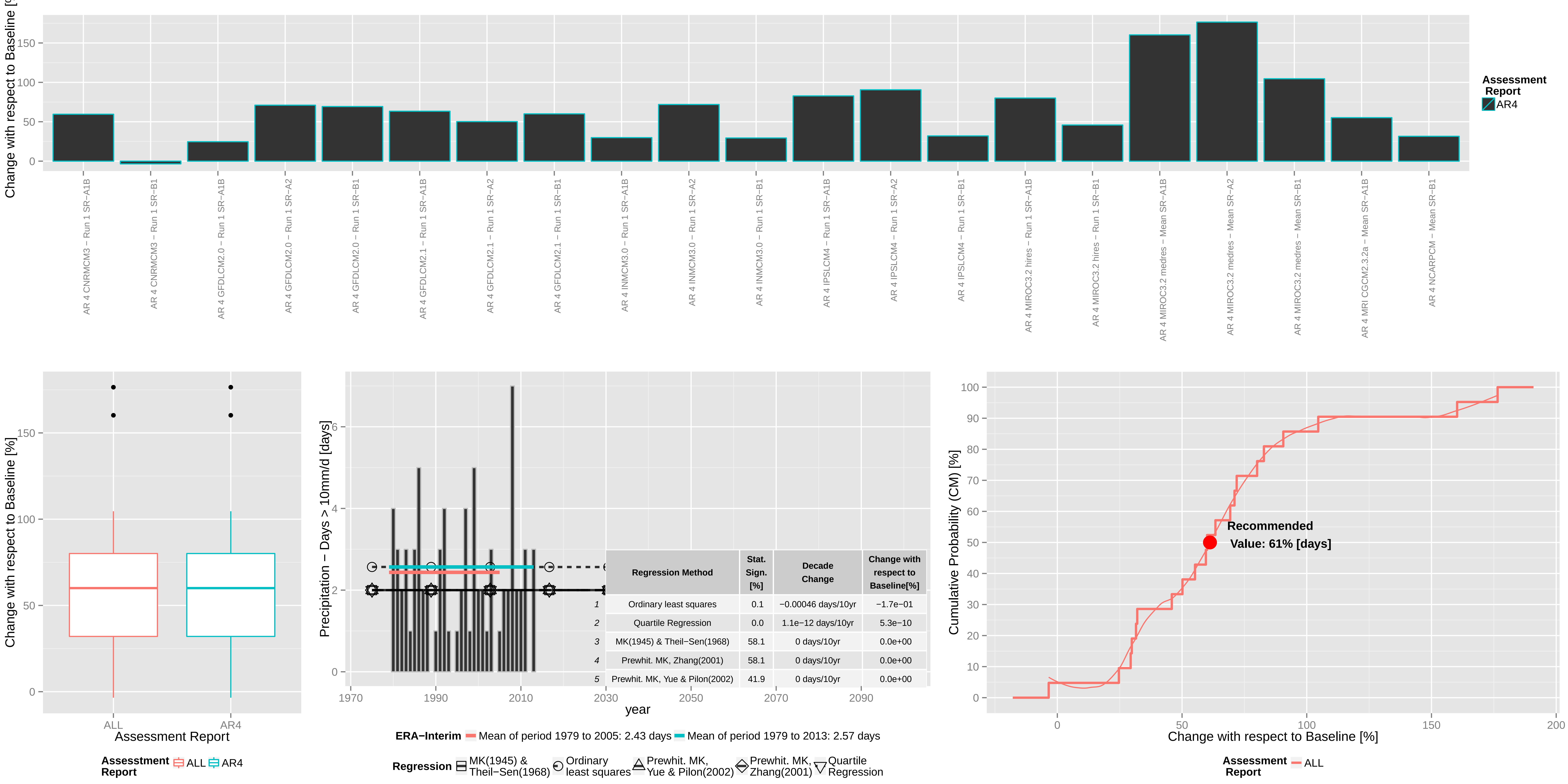




	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	0.1	−0.00046 days/10yr	−1.2e−01
2	Quartile Regression	0.0	1.1e−12 days/10yr	3.6e−10
3	MK(1945) & Theil−Sen(1968)	58.1	0 days/10yr	0.0e+00
4	Prewhit. MK, Zhang(2001)	58.1	0 days/10yr	0.0e+00
5	Prewhit. MK, Yue & Pilon(2002)	41.9	0 days/10yr	0.0e+00

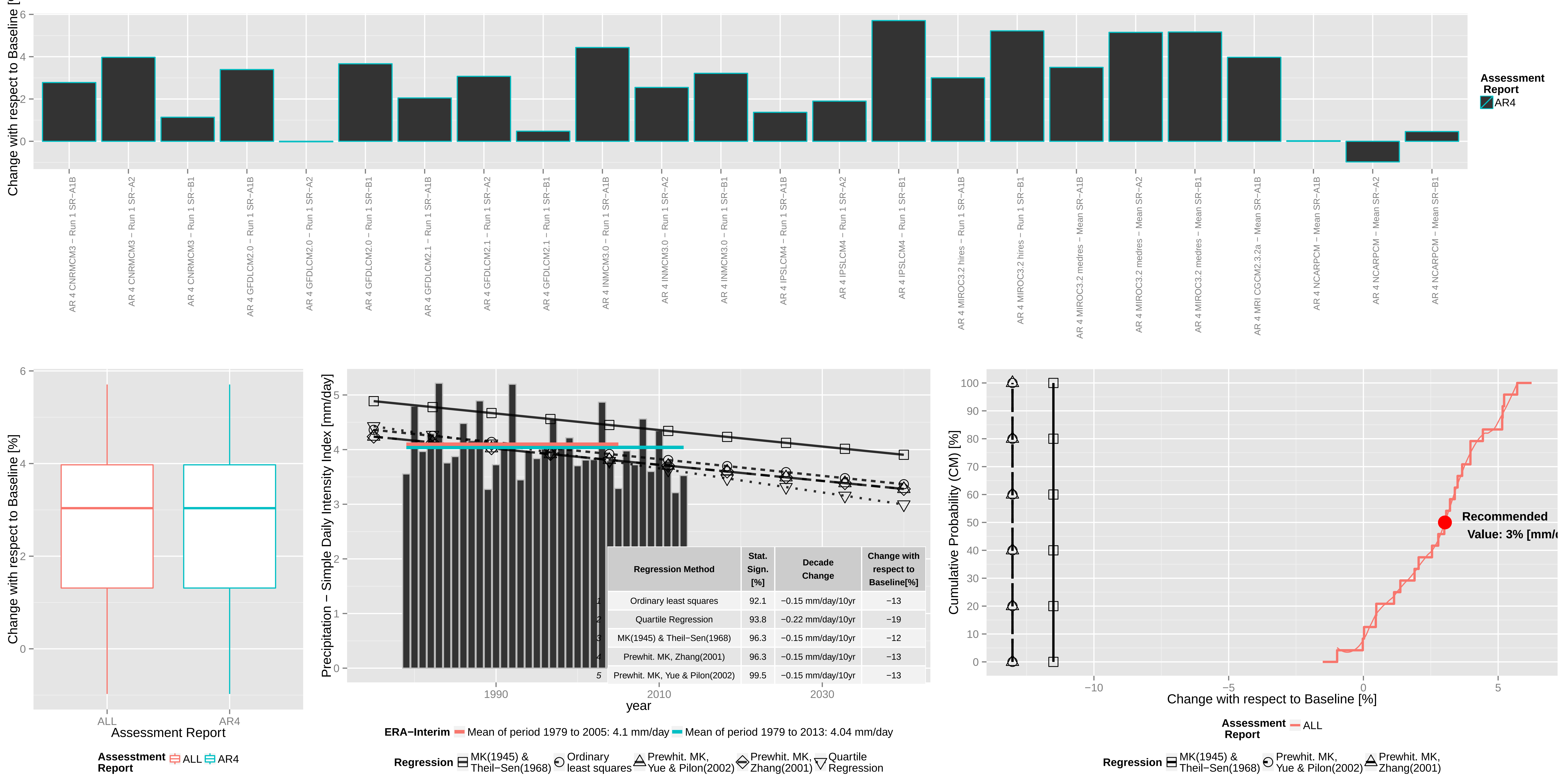


Climate parameter: Precipitation − Days > 10mm/d
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2071 − 2100



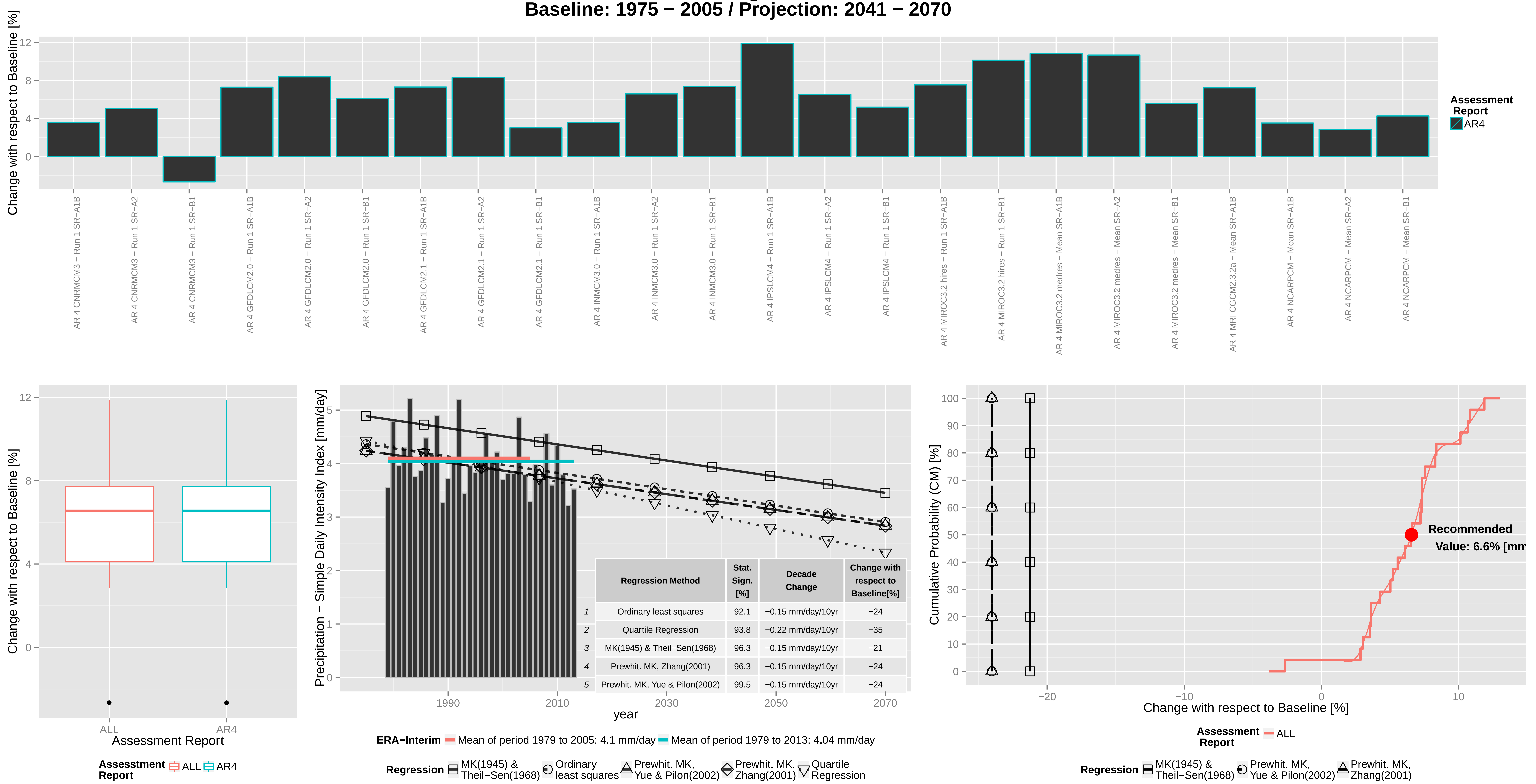
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	0.1	−0.00046 days/10yr	−1.7e−01
2	Quartile Regression	0.0	1.1e−12 days/10yr	5.3e−10
3	MK(1945) & Theil−Sen(1968)	58.1	0 days/10yr	0.0e+00
4	Prewhit. MK, Zhang(2001)	58.1	0 days/10yr	0.0e+00
5	Prewhit. MK, Yue & Pilon(2002)	41.9	0 days/10yr	0.0e+00

Climate parameter: Precipitation − Simple Daily Intensity Index
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2011 − 2040

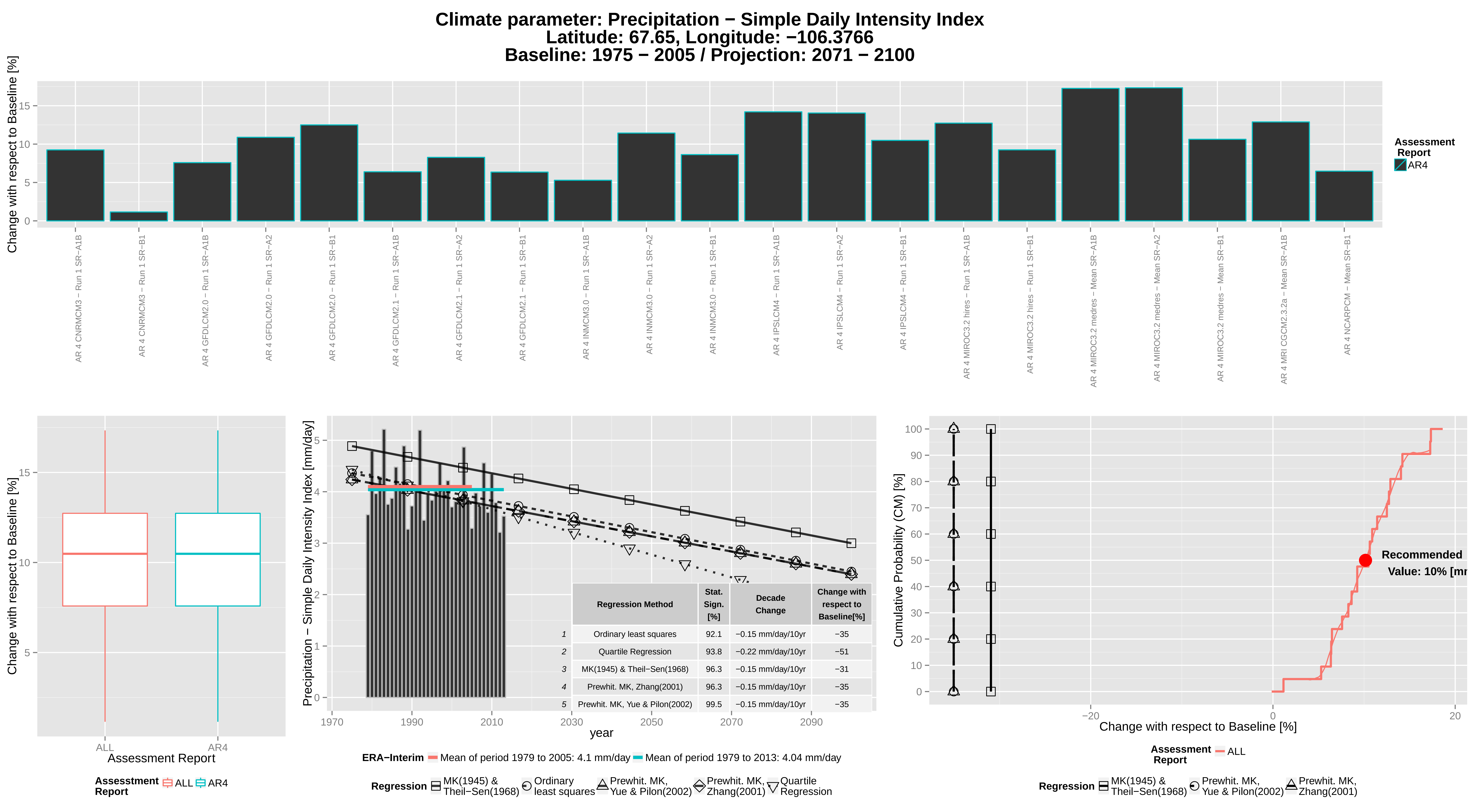


	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	92.1	−0.15 mm/day/10yr	−13
2	Quartile Regression	93.8	−0.22 mm/day/10yr	−19
3	MK(1945) & Theil−Sen(1968)	96.3	−0.15 mm/day/10yr	−12
4	Prewhit. MK, Zhang(2001)	96.3	−0.15 mm/day/10yr	−13
5	Prewhit. MK, Yue & Pilon(2002)	99.5	−0.15 mm/day/10yr	−13

Climate parameter: Precipitation − Simple Daily Intensity Index
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2041 − 2070

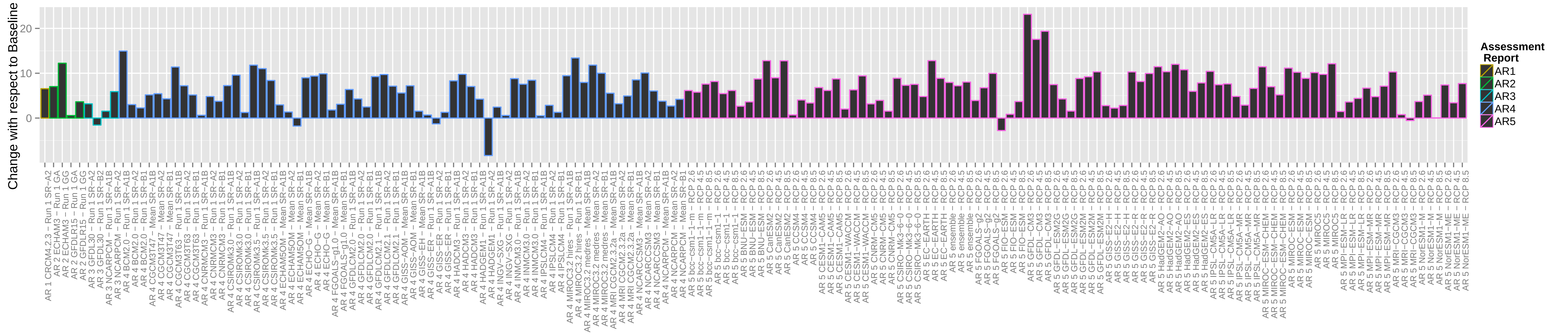


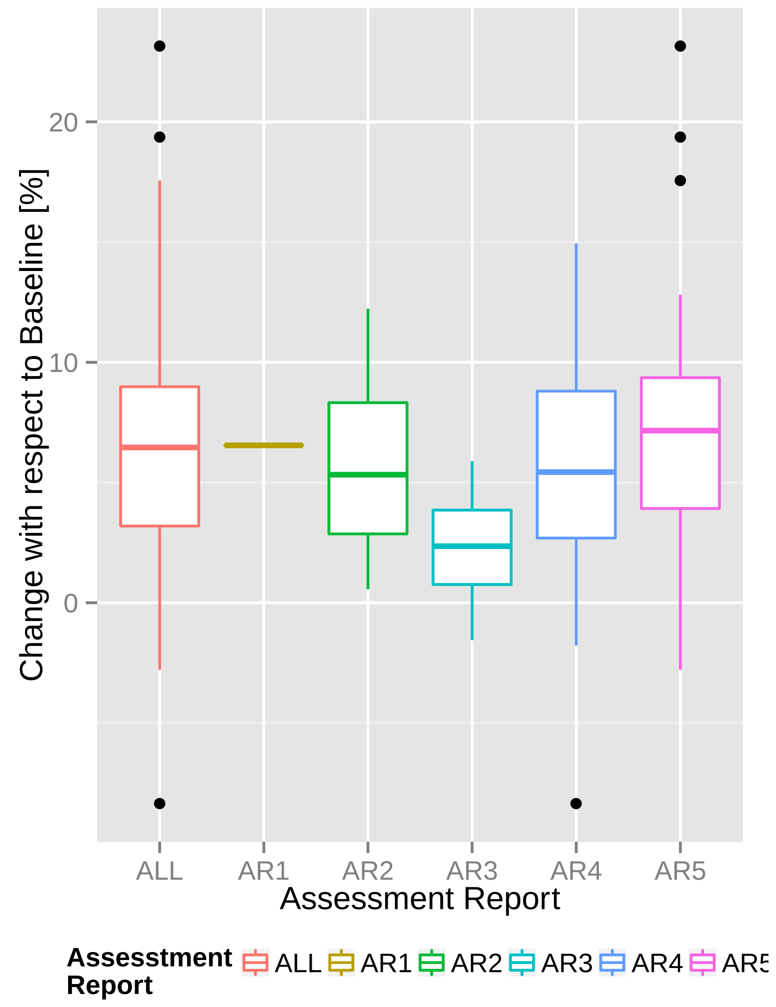
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	92.1	−0.15 mm/day/10yr	−24
2	Quartile Regression	93.8	−0.22 mm/day/10yr	−35
3	MK(1945) & Theil−Sen(1968)	96.3	−0.15 mm/day/10yr	−21
4	Prewhit. MK, Zhang(2001)	96.3	−0.15 mm/day/10yr	−24
5	Prewhit. MK, Yue & Pilon(2002)	99.5	−0.15 mm/day/10yr	−24

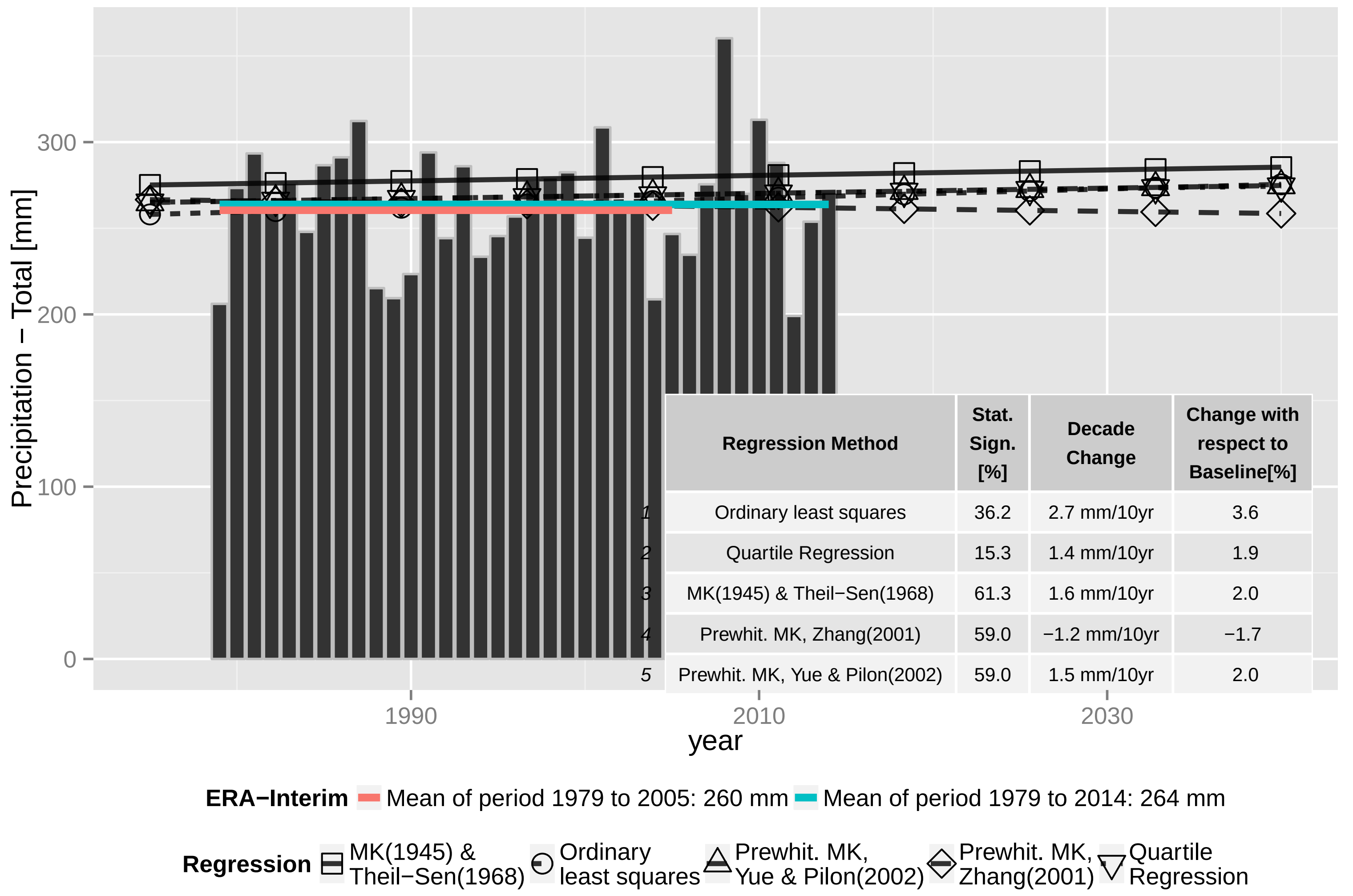


	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	92.1	−0.15 mm/day/10yr	−35
2	Quartile Regression	93.8	−0.22 mm/day/10yr	−51
3	MK(1945) & Theil−Sen(1968)	96.3	−0.15 mm/day/10yr	−31
4	Prewhit. MK, Zhang(2001)	96.3	−0.15 mm/day/10yr	−35
5	Prewhit. MK, Yue & Pilon(2002)	99.5	−0.15 mm/day/10yr	−35

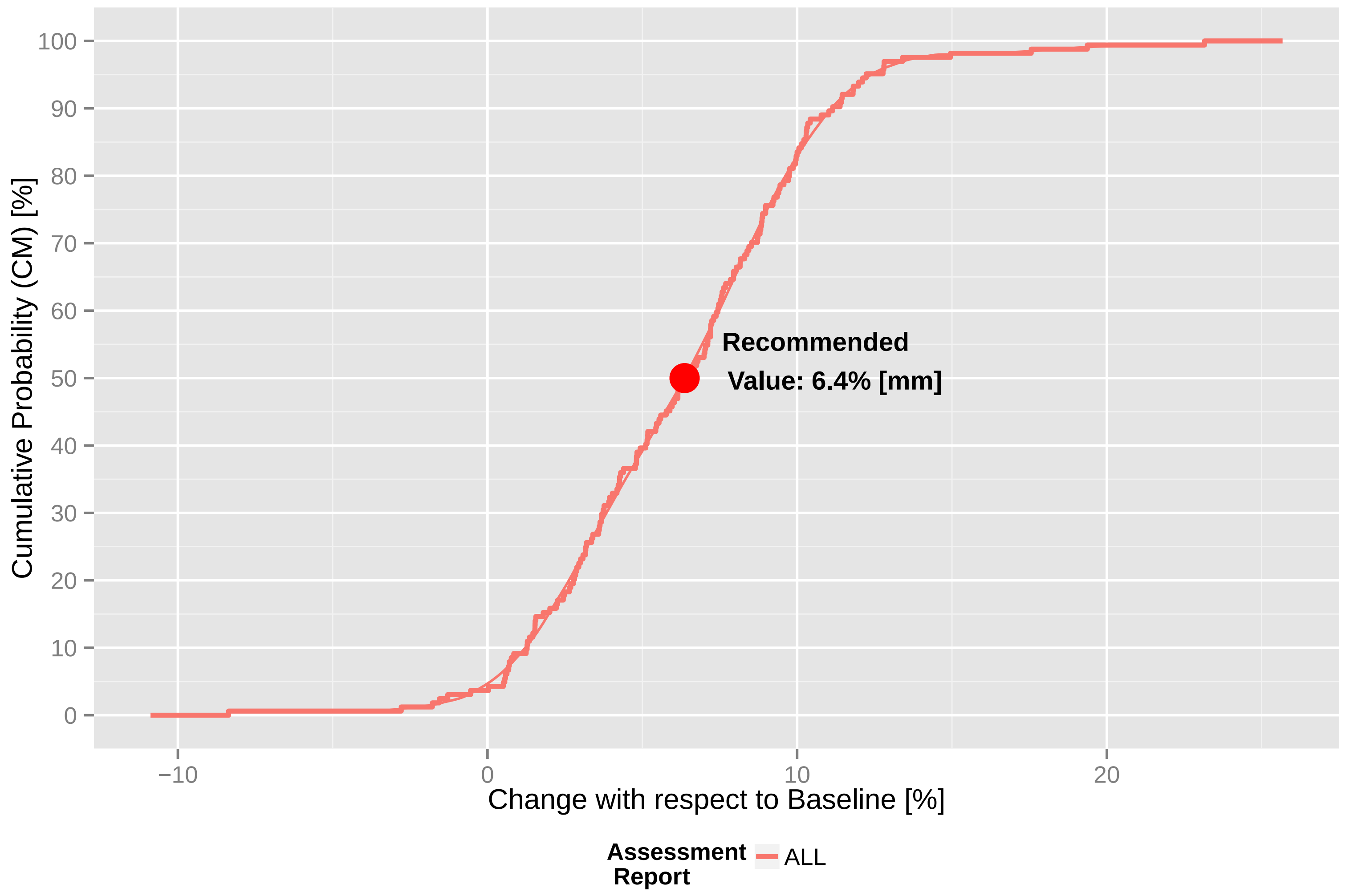
Climate parameter: Precipitation − Total
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2011 − 2040



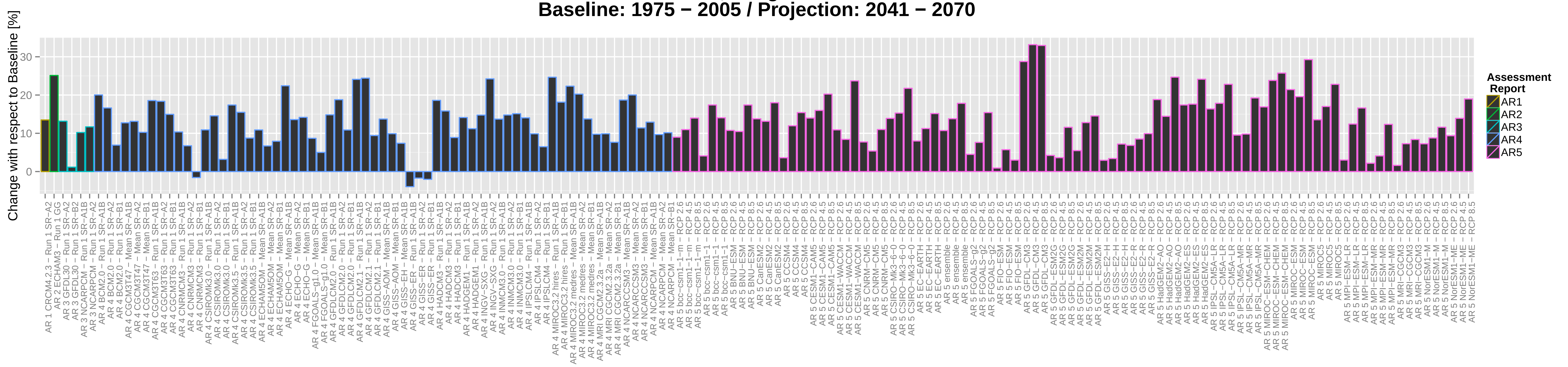


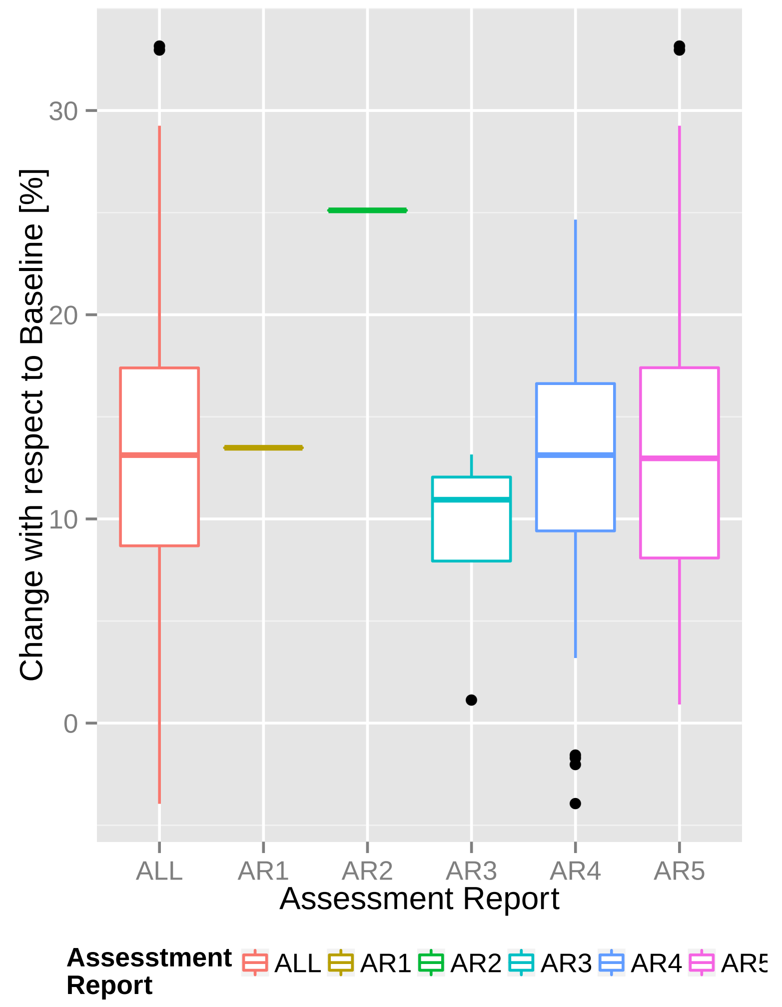


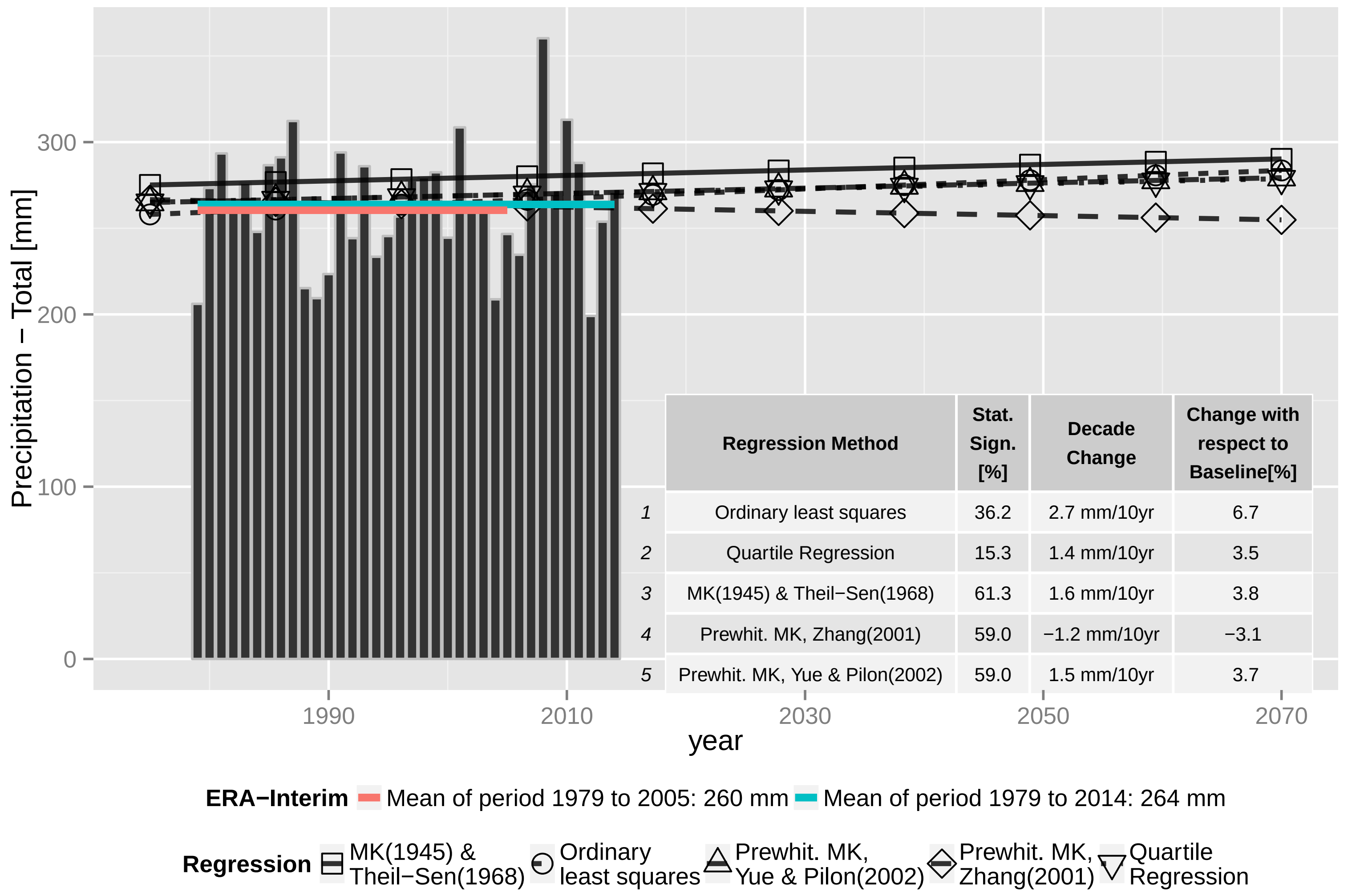
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	36.2	2.7 mm/10yr	3.6
2	Quartile Regression	15.3	1.4 mm/10yr	1.9
3	MK(1945) & Theil−Sen(1968)	61.3	1.6 mm/10yr	2.0
4	Prewhit. MK, Zhang(2001)	59.0	−1.2 mm/10yr	−1.7
5	Prewhit. MK, Yue & Pilon(2002)	59.0	1.5 mm/10yr	2.0



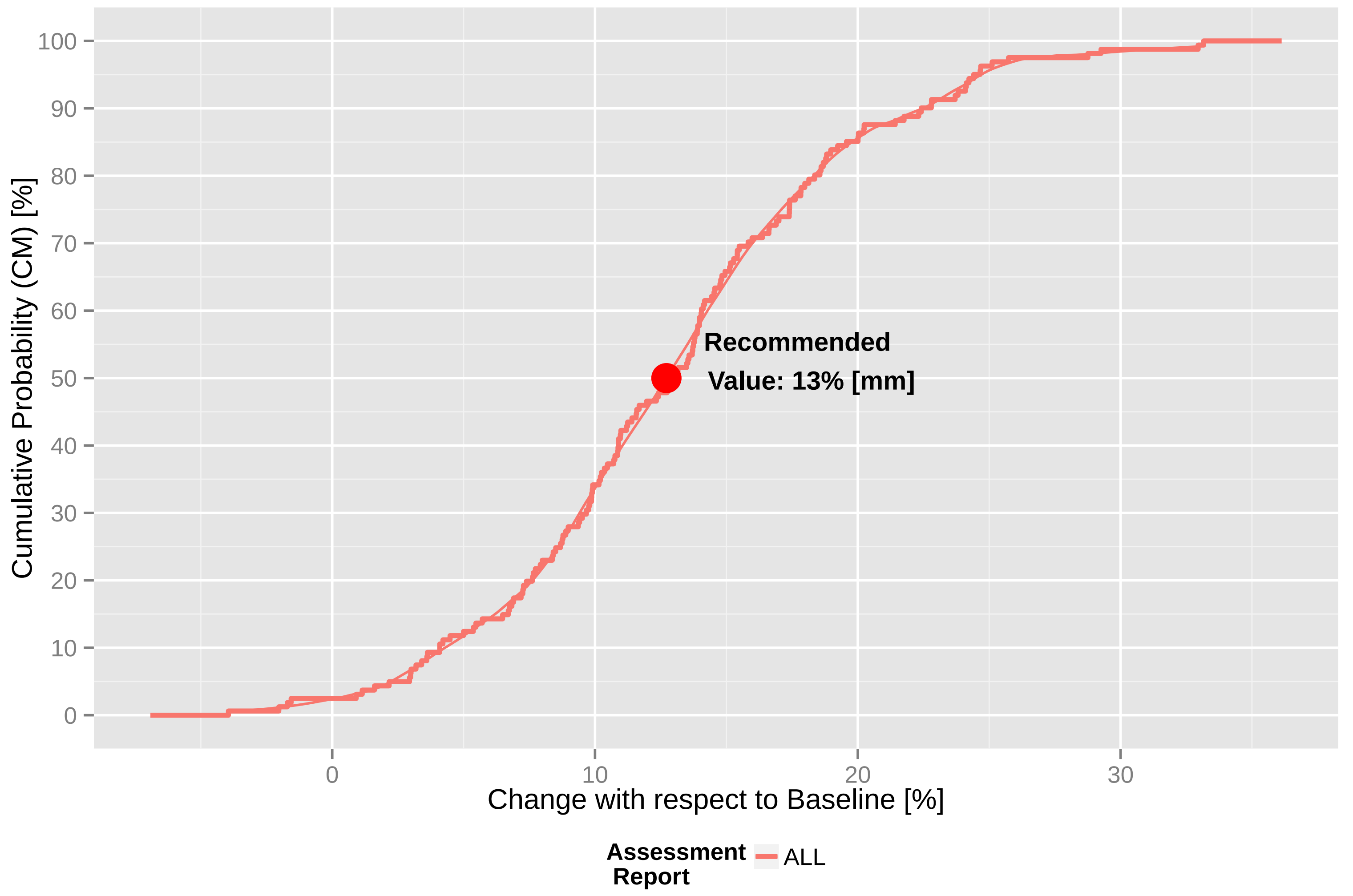
Climate parameter: Precipitation − Total
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2041 − 2070



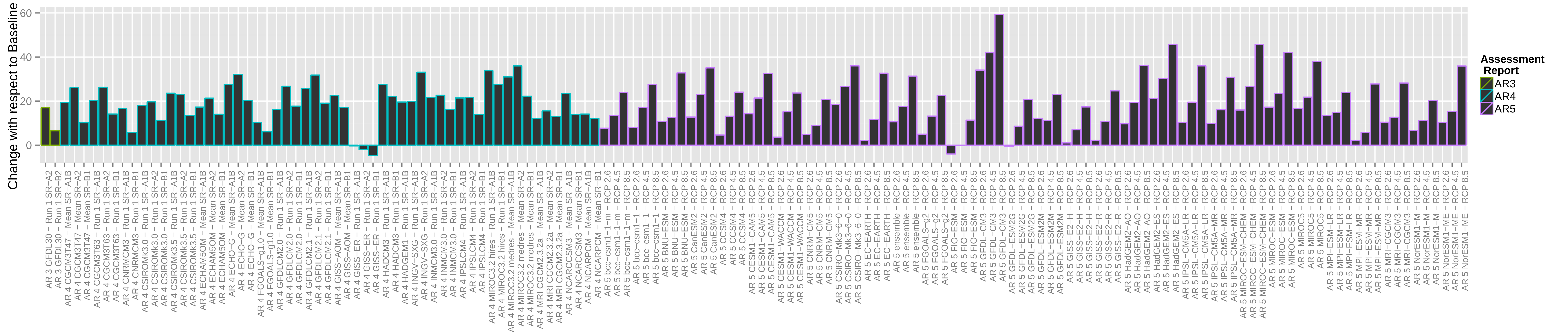


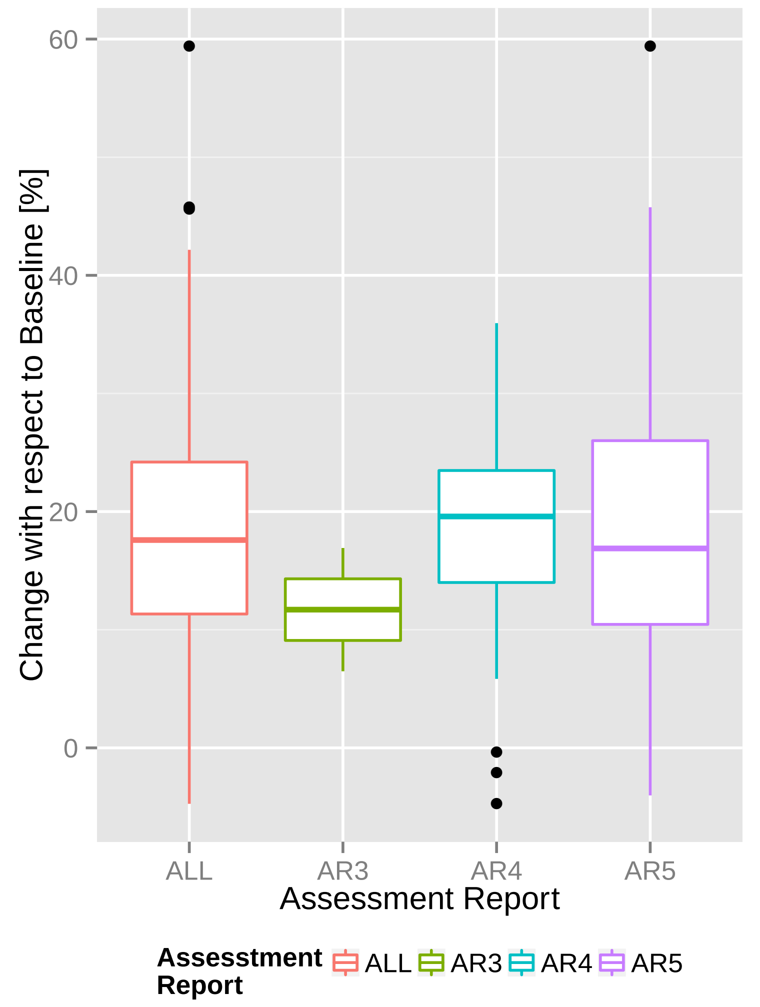


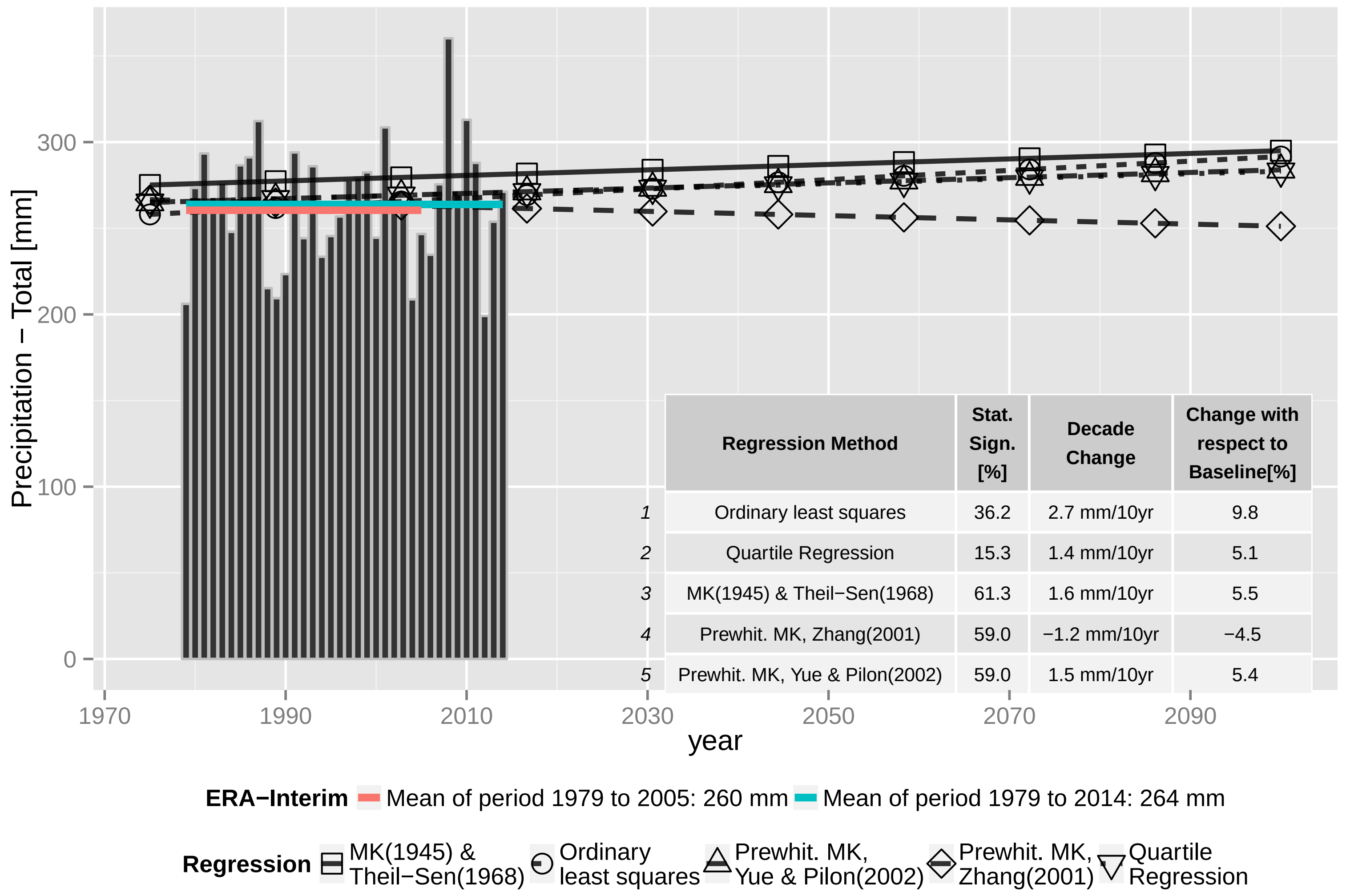
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	36.2	2.7 mm/10yr	6.7
2	Quartile Regression	15.3	1.4 mm/10yr	3.5
3	MK(1945) & Theil−Sen(1968)	61.3	1.6 mm/10yr	3.8
4	Prewhit. MK, Zhang(2001)	59.0	−1.2 mm/10yr	−3.1
5	Prewhit. MK, Yue & Pilon(2002)	59.0	1.5 mm/10yr	3.7



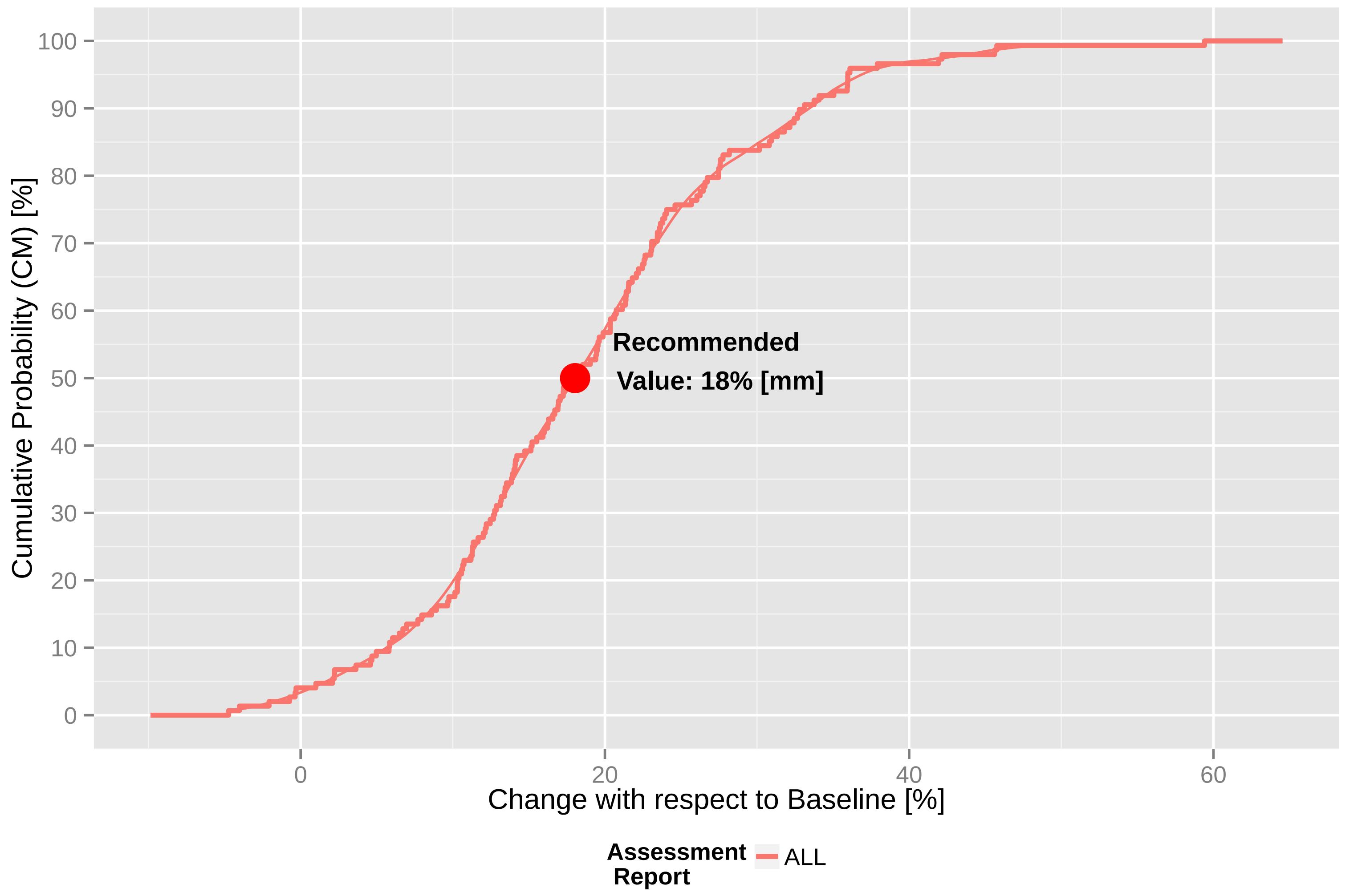
Climate parameter: Precipitation − Total
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2071 − 2100



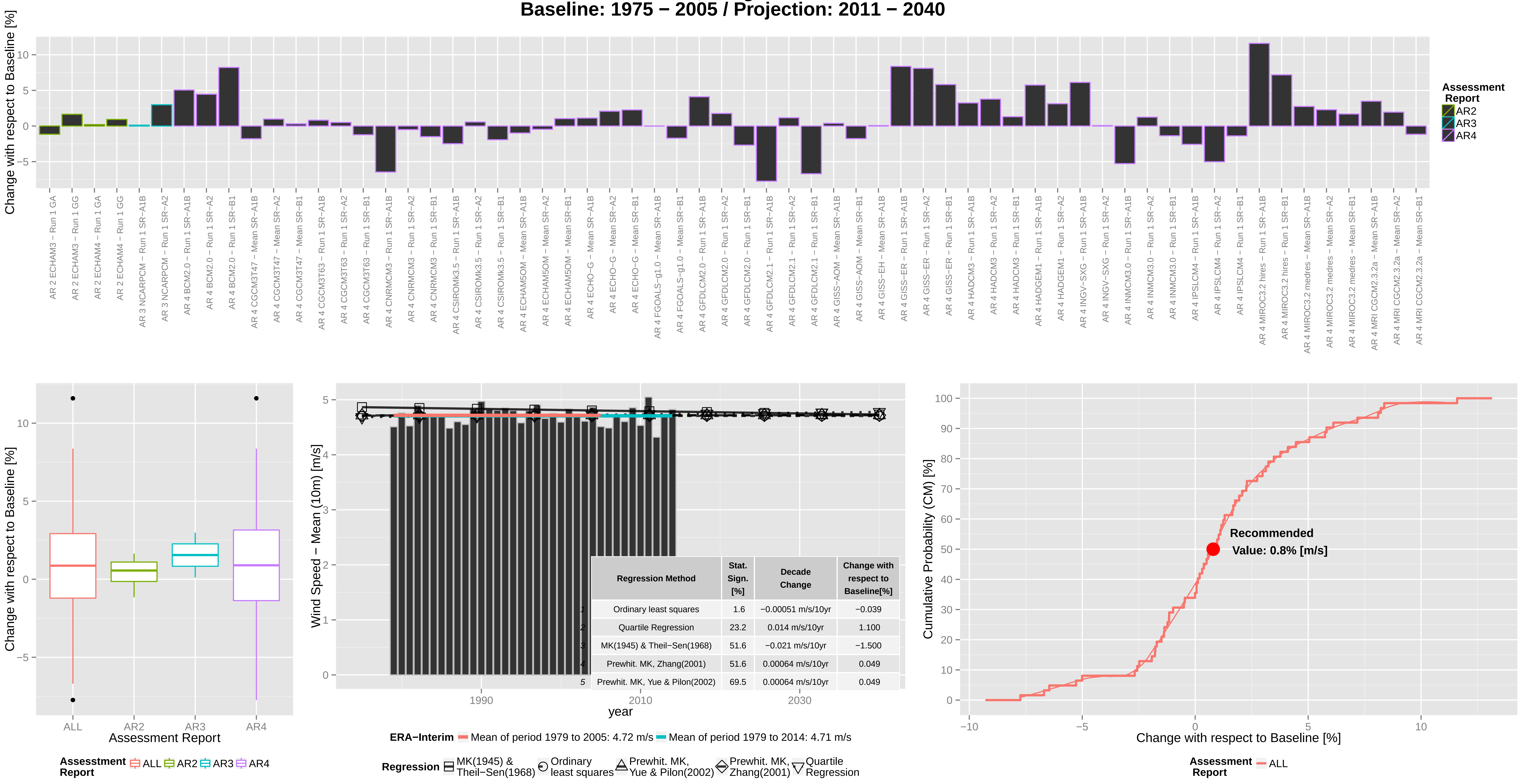




	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	36.2	2.7 mm/10yr	9.8
2	Quartile Regression	15.3	1.4 mm/10yr	5.1
3	MK(1945) & Theil−Sen(1968)	61.3	1.6 mm/10yr	5.5
4	Prewhit. MK, Zhang(2001)	59.0	−1.2 mm/10yr	−4.5
5	Prewhit. MK, Yue & Pilon(2002)	59.0	1.5 mm/10yr	5.4

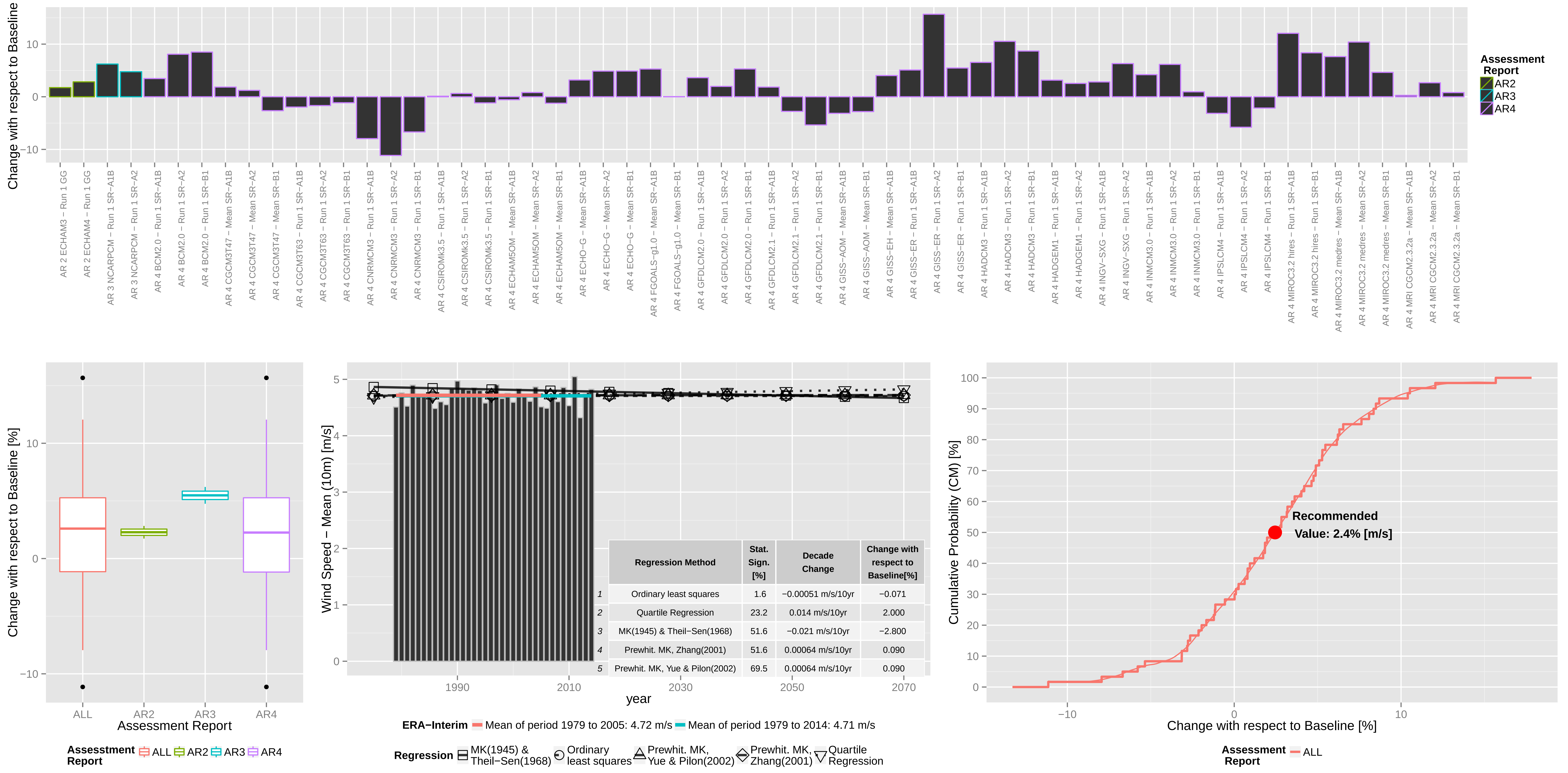


Climate parameter: Wind Speed − Mean (10m)
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2011 − 2040



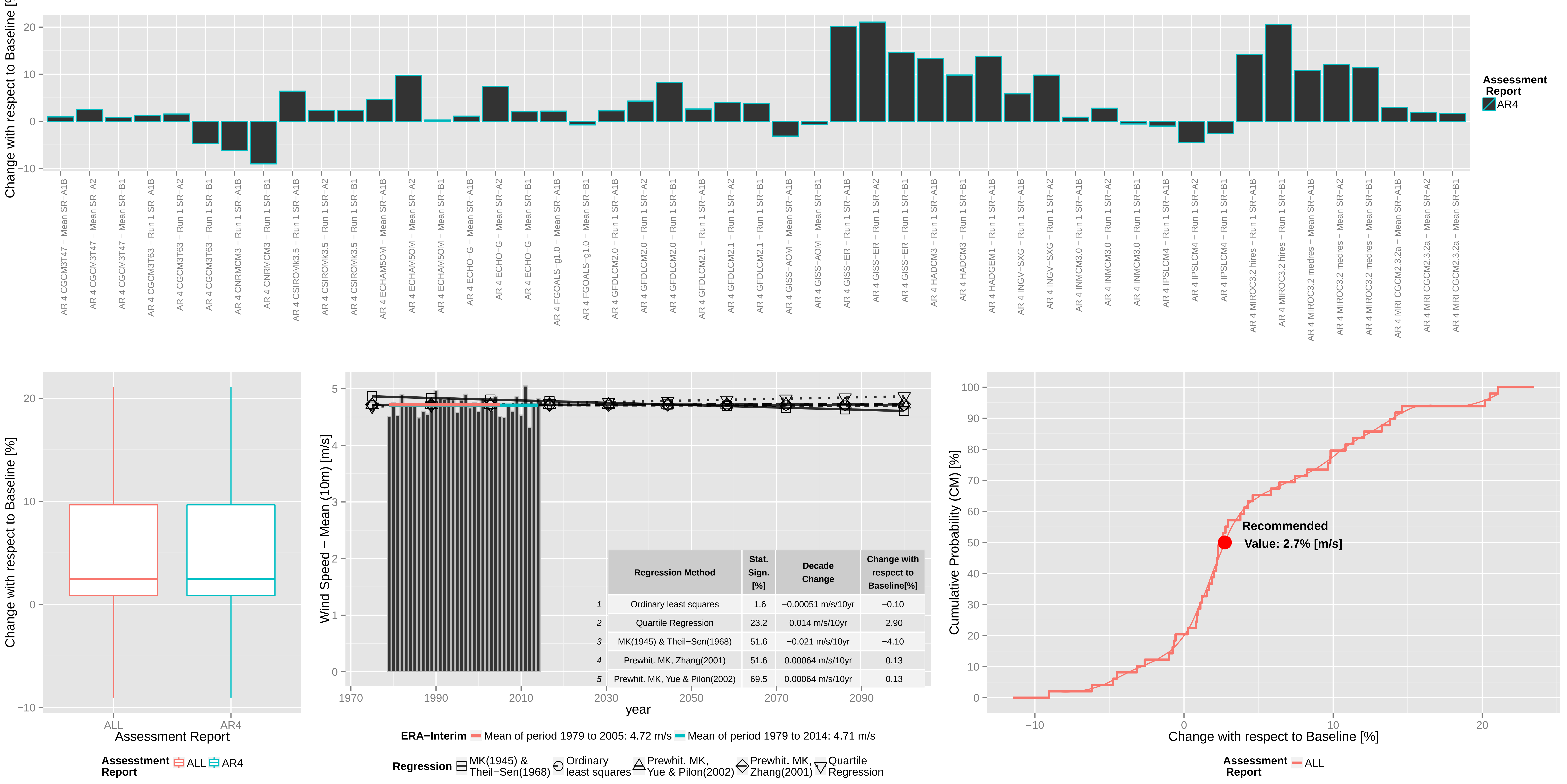
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	1.6	−0.00051 m/s/10yr	−0.039
2	Quartile Regression	23.2	0.014 m/s/10yr	1.100
3	MK(1945) & Theil−Sen(1968)	51.6	−0.021 m/s/10yr	−1.500
4	Prewhit. MK, Zhang(2001)	51.6	0.00064 m/s/10yr	0.049
5	Prewhit. MK, Yue & Pilon(2002)	69.5	0.00064 m/s/10yr	0.049

Climate parameter: Wind Speed − Mean (10m)
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2041 − 2070



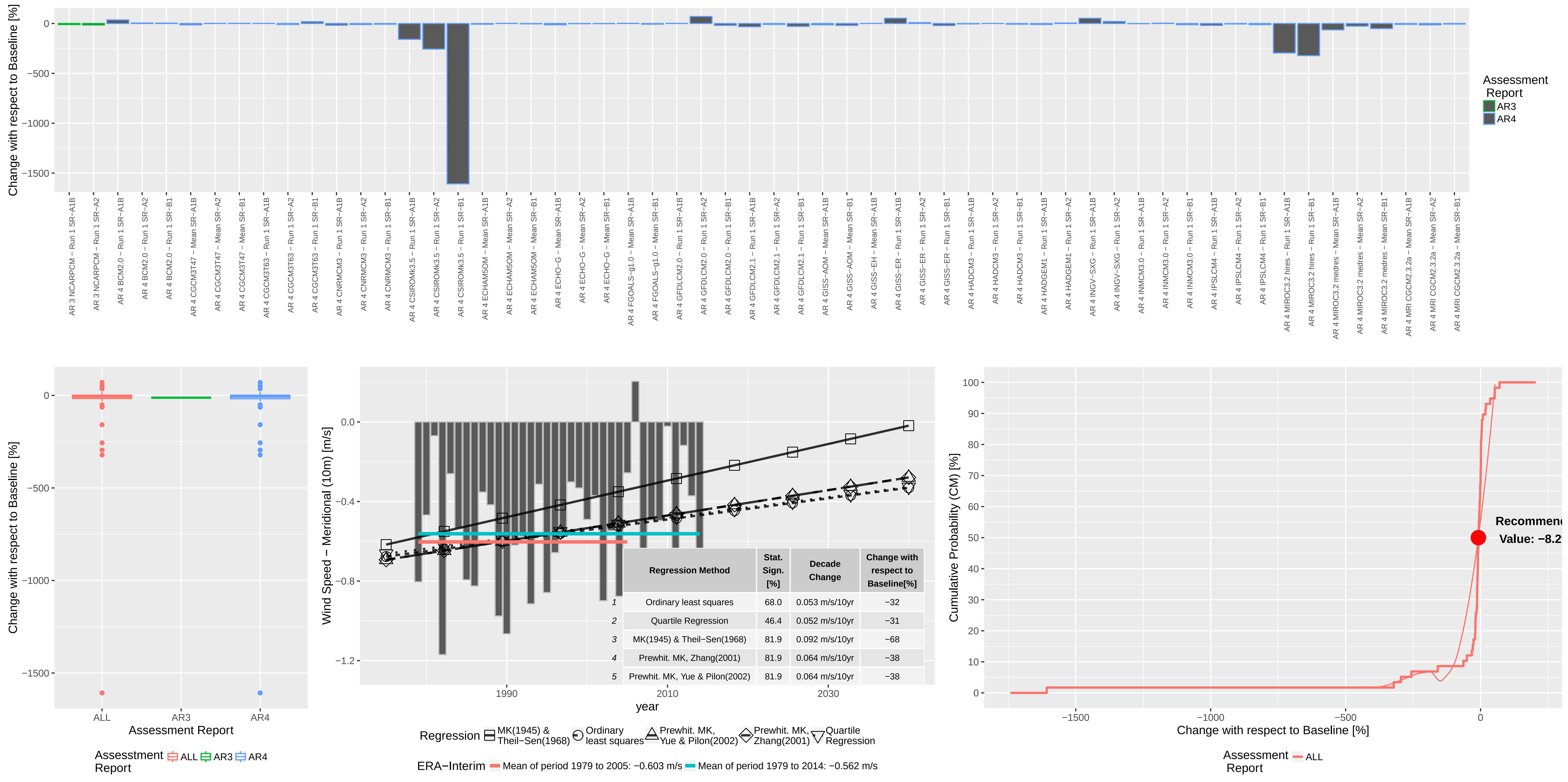
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	1.6	−0.00051 m/s/10yr	−0.071
2	Quartile Regression	23.2	0.014 m/s/10yr	2.000
3	MK(1945) & Theil−Sen(1968)	51.6	−0.021 m/s/10yr	−2.800
4	Prewhit. MK, Zhang(2001)	51.6	0.00064 m/s/10yr	0.090
5	Prewhit. MK, Yue & Pilon(2002)	69.5	0.00064 m/s/10yr	0.090

Climate parameter: Wind Speed − Mean (10m)
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2071 − 2100



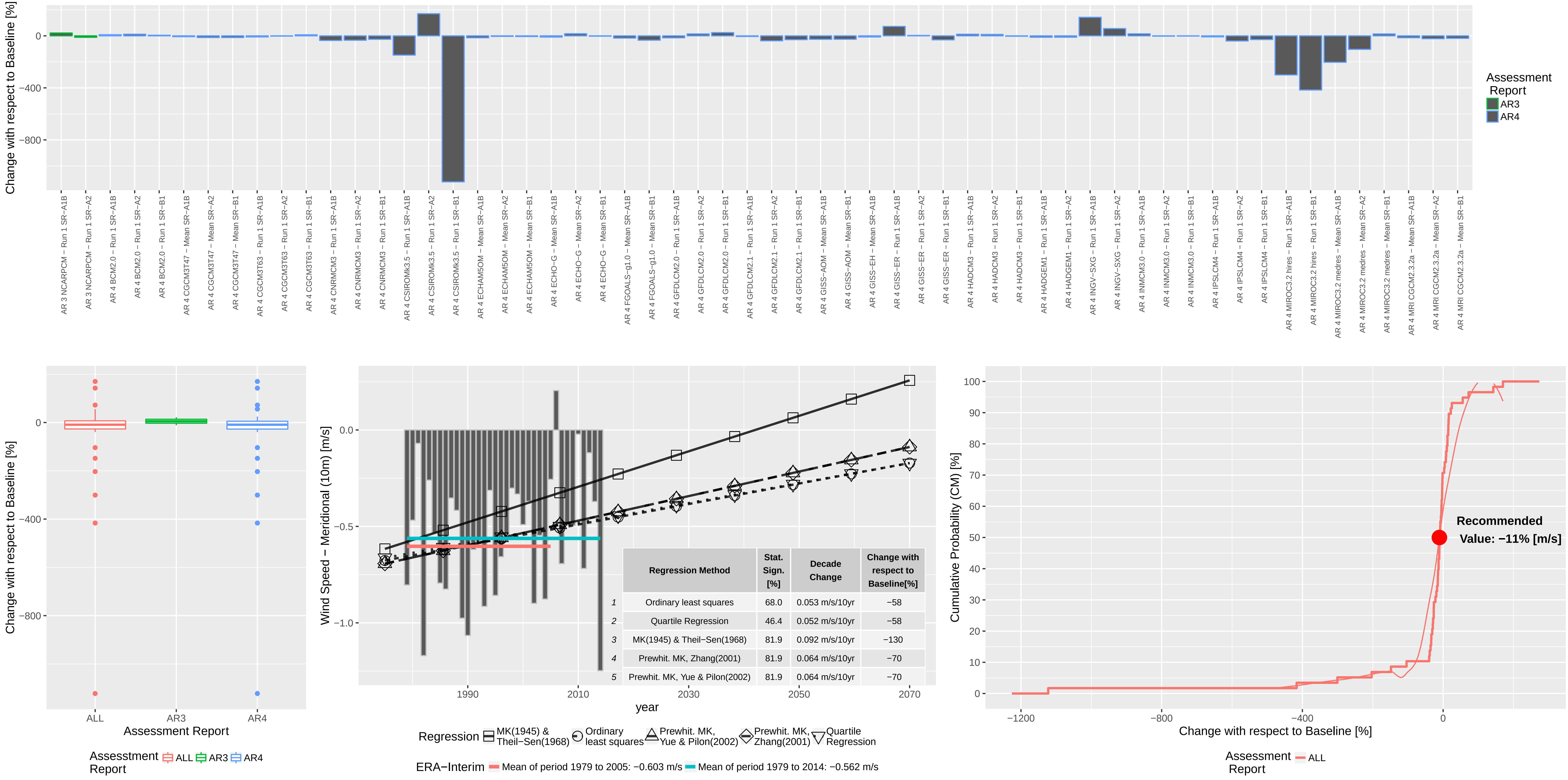
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	1.6	−0.00051 m/s/10yr	−0.10
2	Quartile Regression	23.2	0.014 m/s/10yr	2.90
3	MK(1945) & Theil−Sen(1968)	51.6	−0.021 m/s/10yr	−4.10
4	Prewhit. MK, Zhang(2001)	51.6	0.00064 m/s/10yr	0.13
5	Prewhit. MK, Yue & Pilon(2002)	69.5	0.00064 m/s/10yr	0.13

Climate parameter: Wind Speed − Meridional (10m)
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2011 − 2040



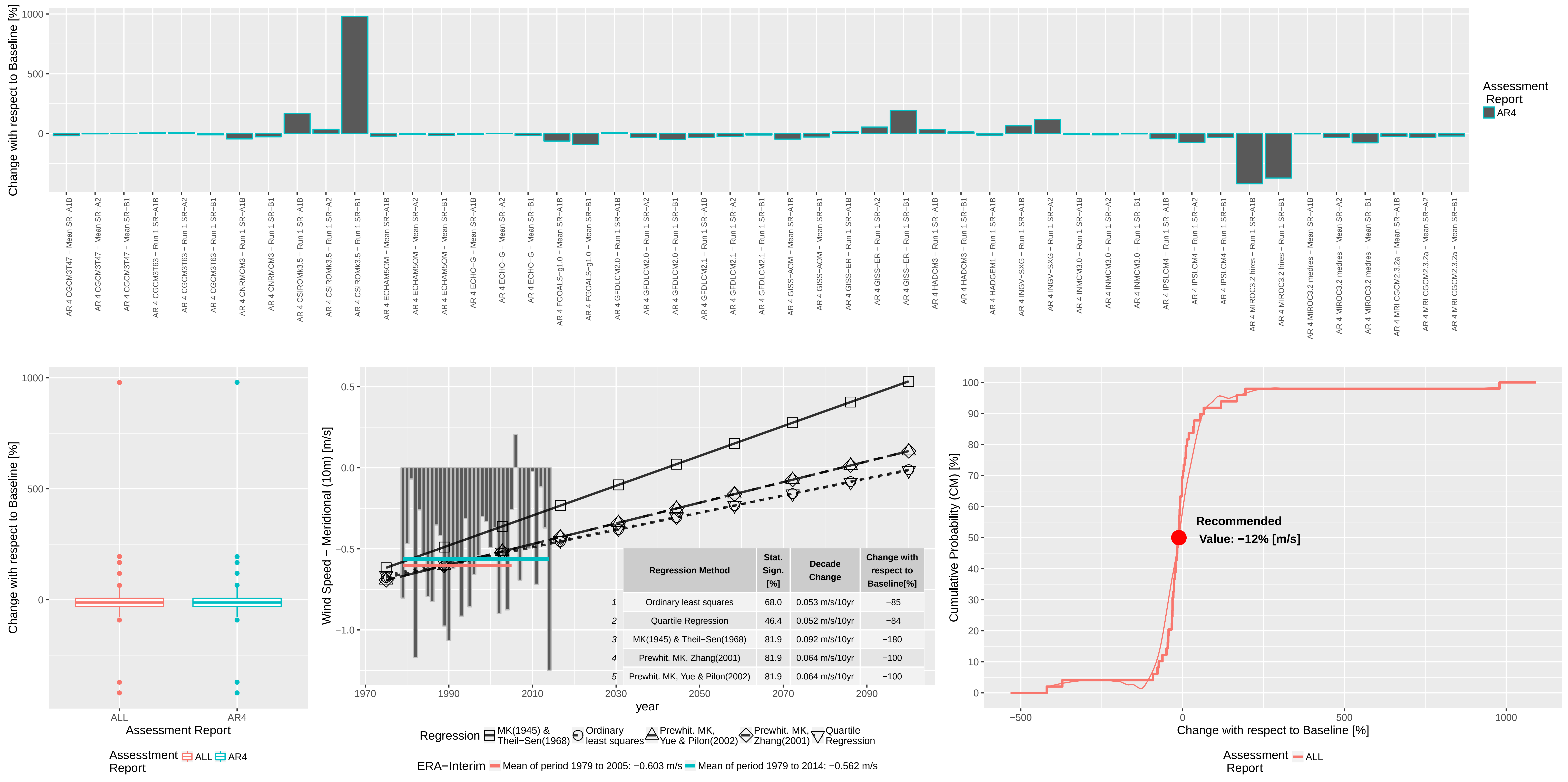
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	68.0	0.053 m/s/10yr	−32
2	Quartile Regression	46.4	0.052 m/s/10yr	−31
3	MK(1945) & Theil−Sen(1968)	81.9	0.092 m/s/10yr	−68
4	Prewhit. MK, Zhang(2001)	81.9	0.064 m/s/10yr	−38
5	Prewhit. MK, Yue & Pilon(2002)	81.9	0.064 m/s/10yr	−38

Climate parameter: Wind Speed − Meridional (10m)
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2041 − 2070



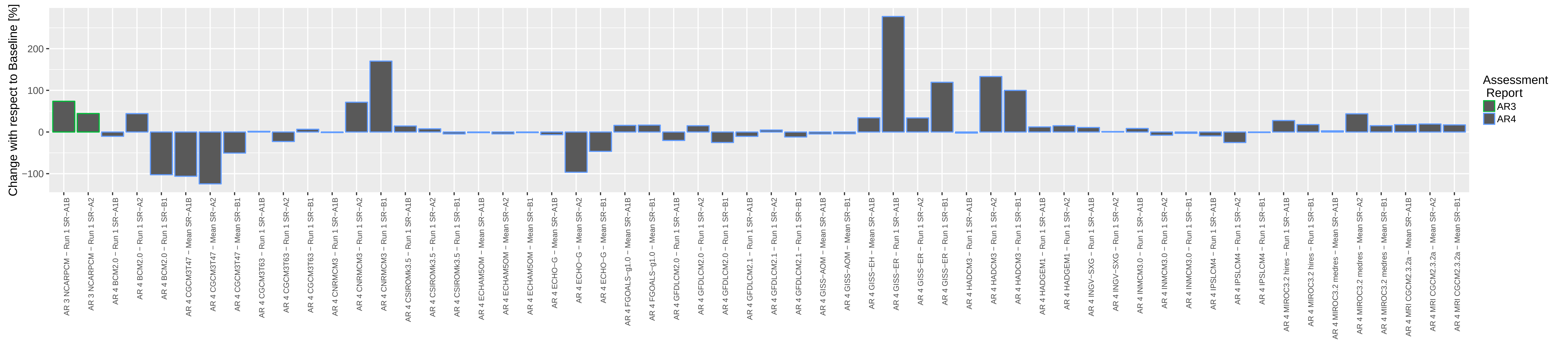
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	68.0	0.053 m/s/10yr	−58
2	Quartile Regression	46.4	0.052 m/s/10yr	−58
3	MK(1945) & Theil−Sen(1968)	81.9	0.092 m/s/10yr	−130
4	Prewhit. MK, Zhang(2001)	81.9	0.064 m/s/10yr	−70
5	Prewhit. MK, Yue & Pilon(2002)	81.9	0.064 m/s/10yr	−70

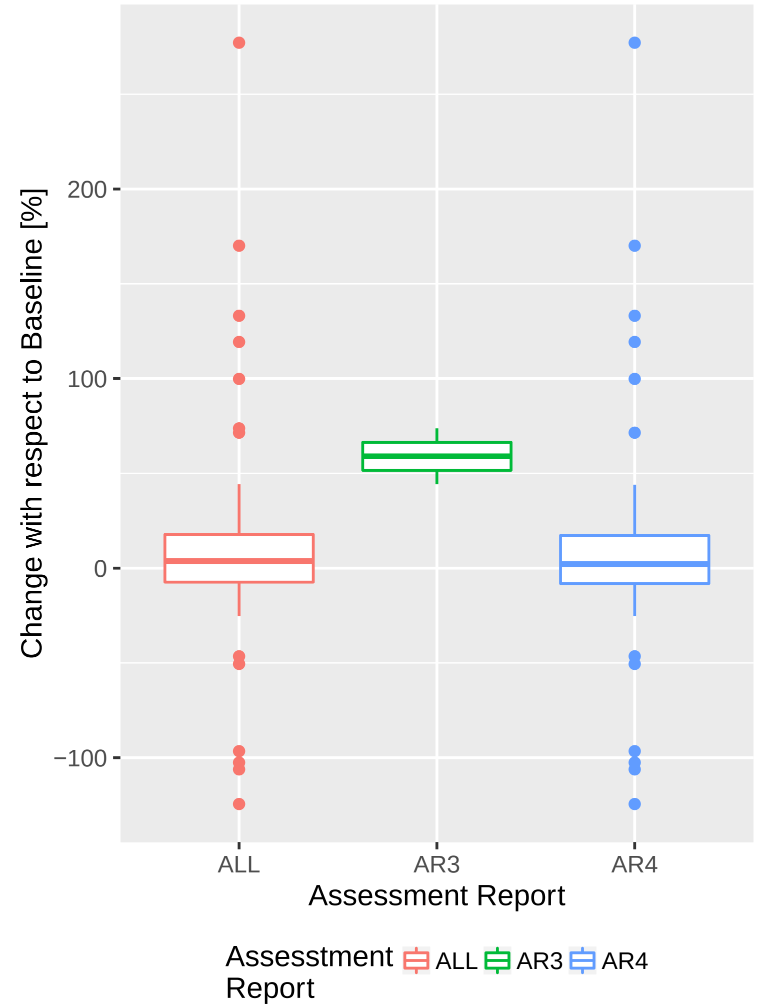
Climate parameter: Wind Speed − Meridional (10m)
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2071 − 2100

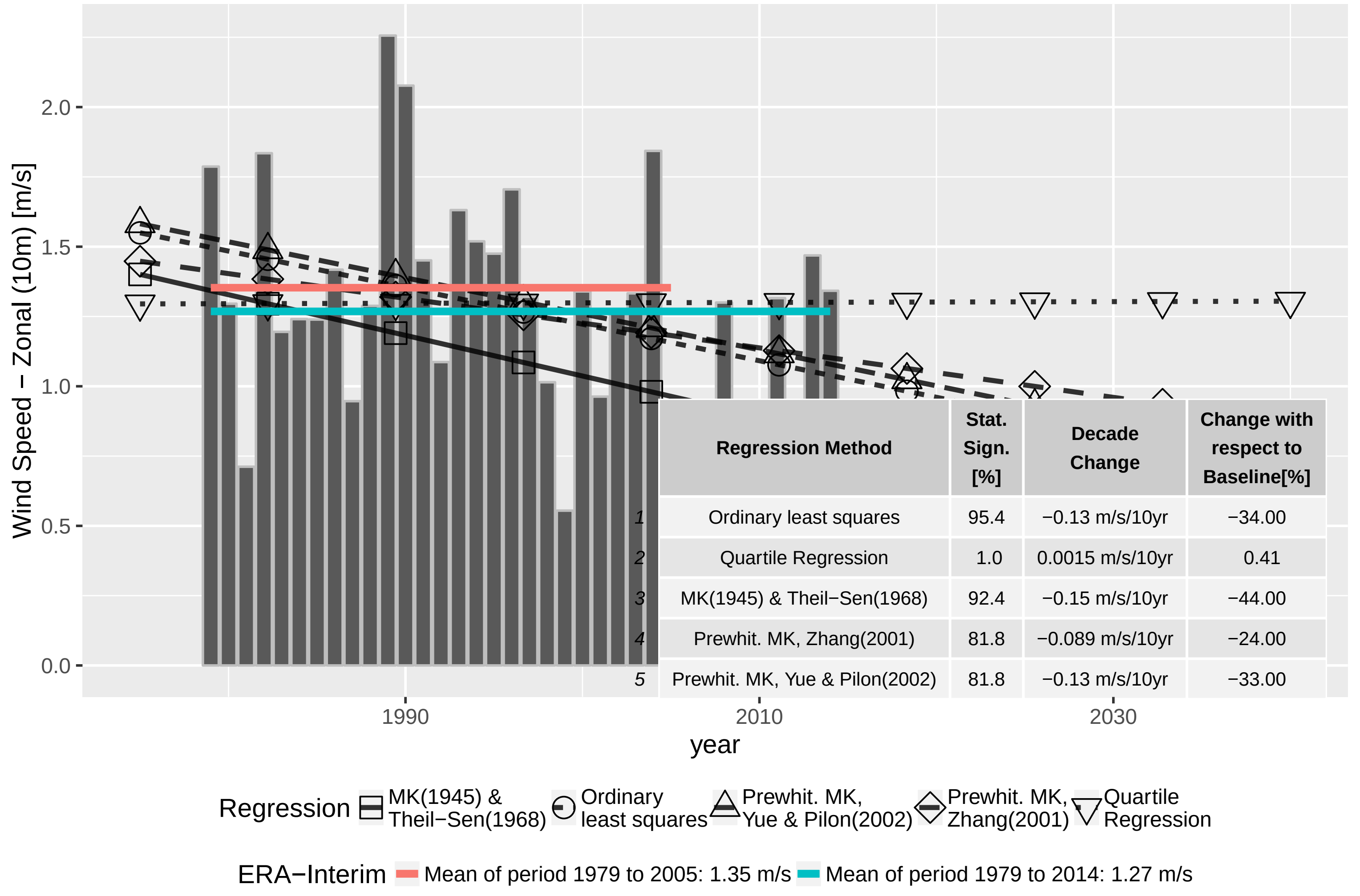


	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	68.0	0.053 m/s/10yr	−85
2	Quartile Regression	46.4	0.052 m/s/10yr	−84
3	MK(1945) & Theil−Sen(1968)	81.9	0.092 m/s/10yr	−180
4	Prewhit. MK, Zhang(2001)	81.9	0.064 m/s/10yr	−100
5	Prewhit. MK, Yue & Pilon(2002)	81.9	0.064 m/s/10yr	−100

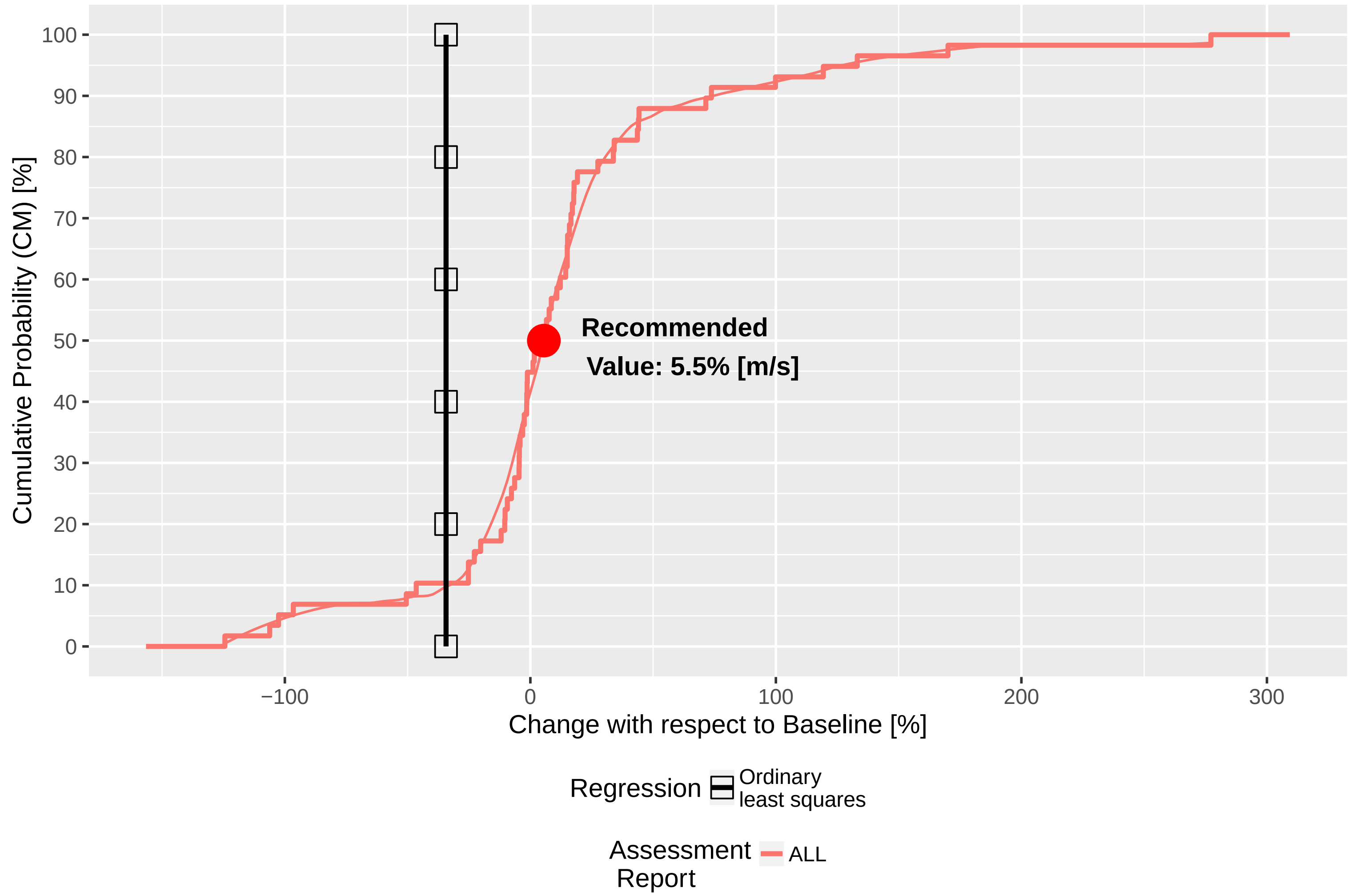
Climate parameter: Wind Speed − Zonal (10m)
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2011 − 2040



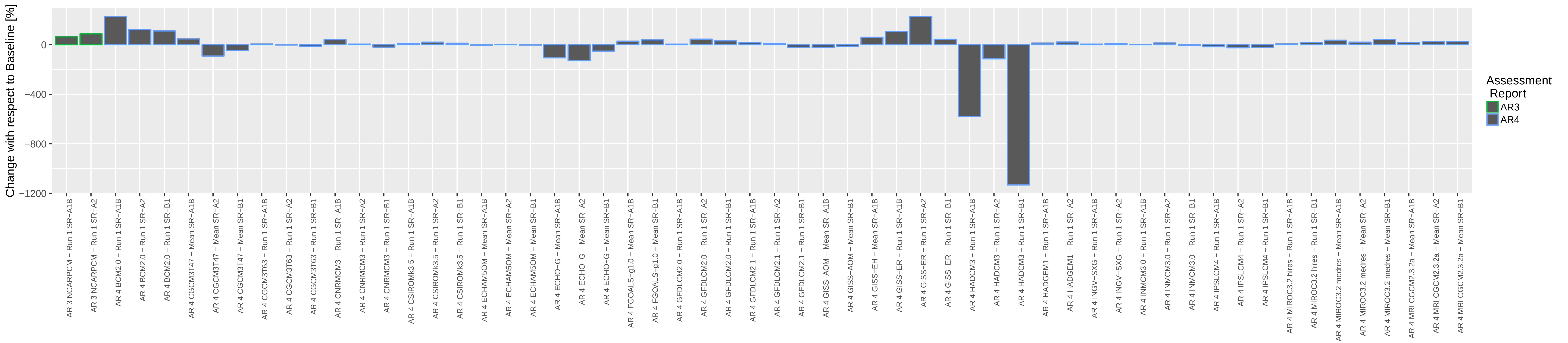


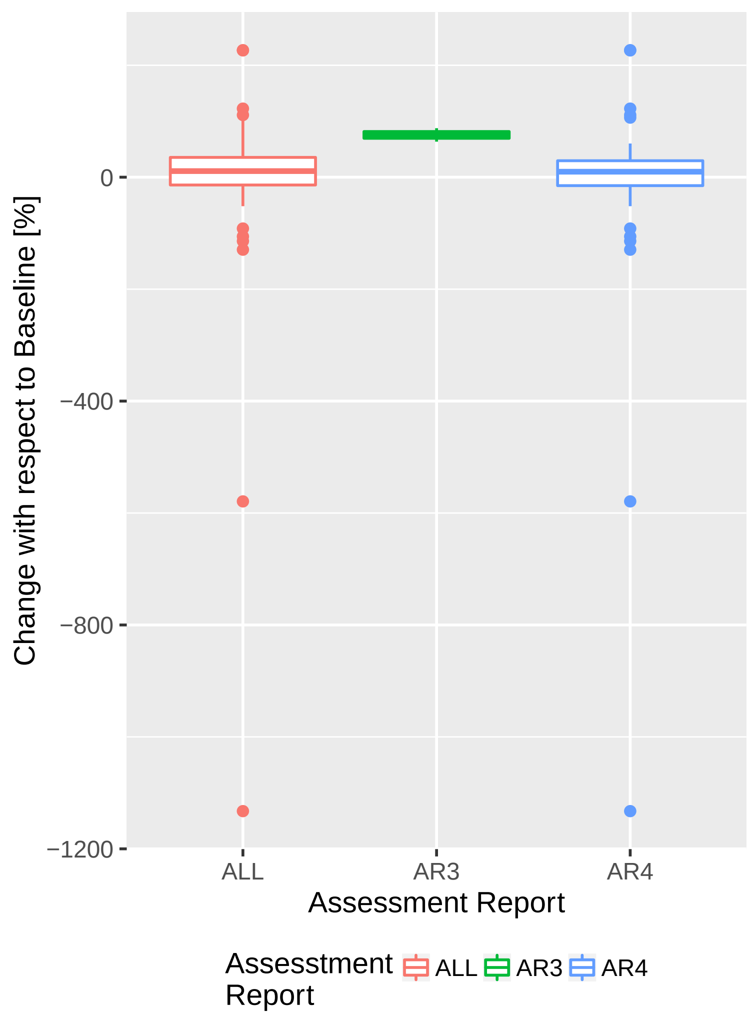


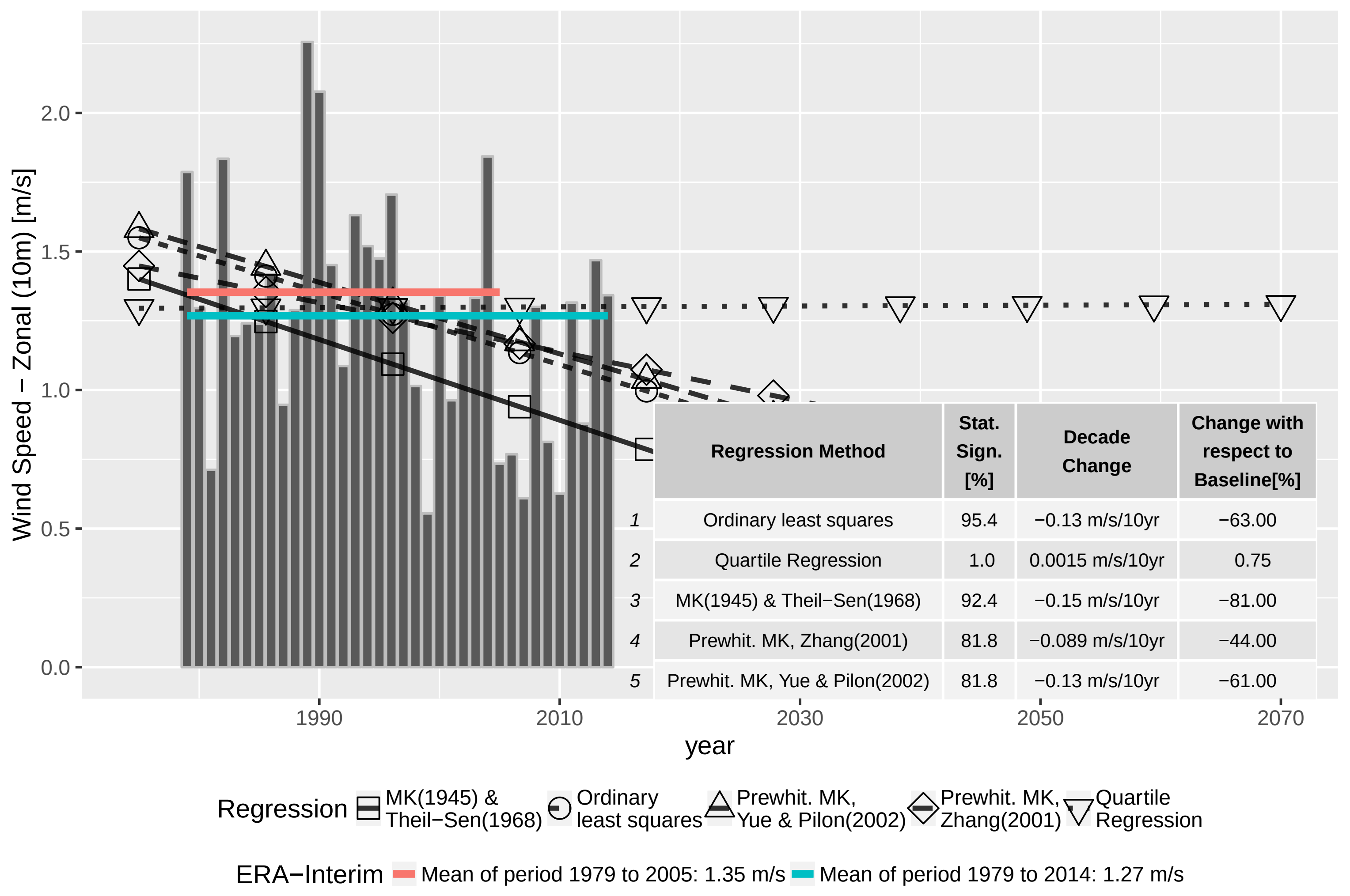
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	95.4	−0.13 m/s/10yr	−34.00
2	Quartile Regression	1.0	0.0015 m/s/10yr	0.41
3	MK(1945) & Theil−Sen(1968)	92.4	−0.15 m/s/10yr	−44.00
4	Prewhit. MK, Zhang(2001)	81.8	−0.089 m/s/10yr	−24.00
5	Prewhit. MK, Yue & Pilon(2002)	81.8	−0.13 m/s/10yr	−33.00



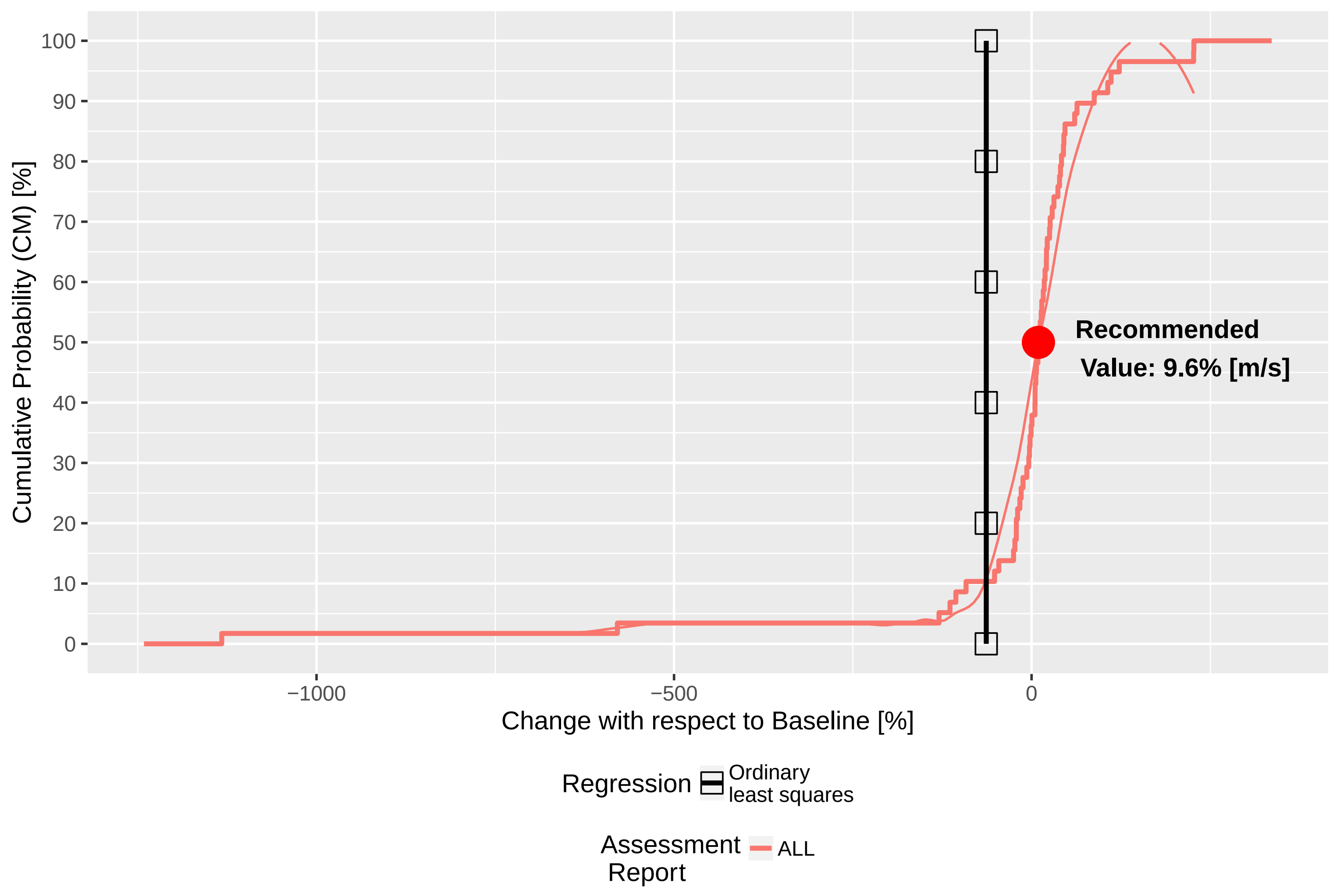
Climate parameter: Wind Speed − Zonal (10m)
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2041 − 2070



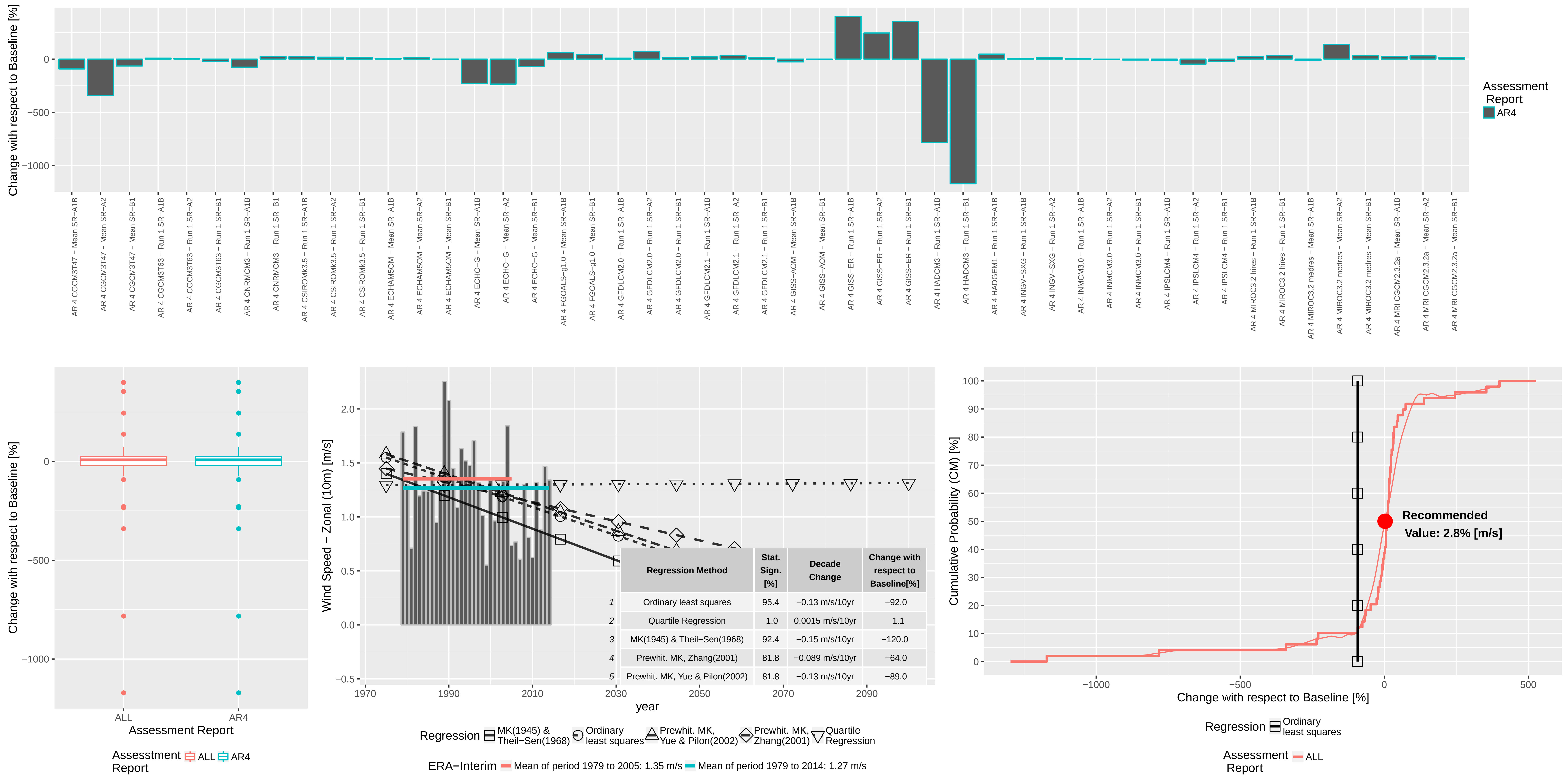




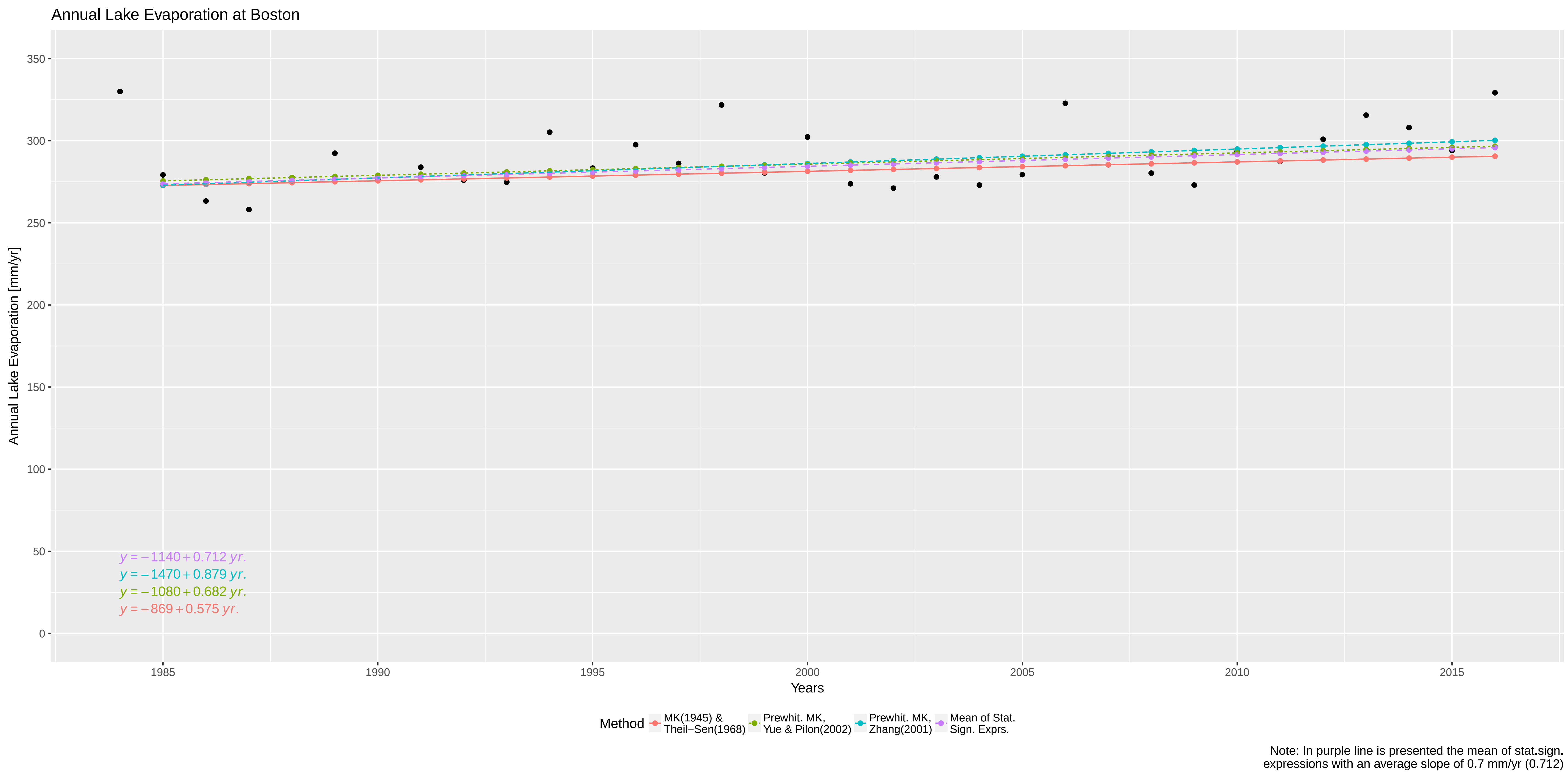
	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	95.4	−0.13 m/s/10yr	−63.00
2	Quartile Regression	1.0	0.0015 m/s/10yr	0.75
3	MK(1945) & Theil−Sen(1968)	92.4	−0.15 m/s/10yr	−81.00
4	Prewhit. MK, Zhang(2001)	81.8	−0.089 m/s/10yr	−44.00
5	Prewhit. MK, Yue & Pilon(2002)	81.8	−0.13 m/s/10yr	−61.00



Climate parameter: Wind Speed − Zonal (10m)
Latitude: 67.65, Longitude: −106.3766
Baseline: 1975 − 2005 / Projection: 2071 − 2100



	Regression Method	Stat. Sign. [%]	Decade Change	Change with respect to Baseline[%]
1	Ordinary least squares	95.4	−0.13 m/s/10yr	−92.0
2	Quartile Regression	1.0	0.0015 m/s/10yr	1.1
3	MK(1945) & Theil−Sen(1968)	92.4	−0.15 m/s/10yr	−120.0
4	Prewhit. MK, Zhang(2001)	81.8	−0.089 m/s/10yr	−64.0
5	Prewhit. MK, Yue & Pilon(2002)	81.8	−0.13 m/s/10yr	−89.0



Annual Lake Evaporation at Boston
Annual Lake Evaporation [mm/yr]
350
300
250
200
150
100
50
0
1985
1990
1995
2000
2005
2010
2015
Years
y = −1140 + 0.712 yr.
y = −1470 + 0.879 yr.
y = −1080 + 0.682 yr.
y = −869 + 0.575 yr.
Method
MK(1945) & Theil−Sen(1968)
Prewhit. MK, Yue & Pilon(2002)
Prewhit. MK, Zhang(2001)
Mean of Stat. Sign. Exprs.
Note: In purple line is presented the mean of stat.sign. expressions with an average slope of 0.7 mm/yr (0.712)