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BalticClimate

"Baltic Challenges and Chances for local and regional development generated by Climate Change"

Annex I

to

Target Area Assessments

Climate Change Support Material

(Climate Change Scenarios)

– GERMANY –

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Authors:

Gustav Strandberg, Rossby Centre, Swedish Meteorological and Hydrological Institute (SMHI)
Mattias Hjerpe, Centre for Climate Science and Policy Research, Work Package 3 Leader

1 How the analysis was done

The information presented in the following pages shows how the climate could possibly develop in the next 100 years. The material is based on calculations from climate models that use information about future changes in the atmosphere. Climate models include the relationships between physical processes in the whole system atmosphere-land-water. The results from the calculations with the climate models cover the period 1961-2100.

1.1 Emission scenarios

Emission scenarios are assumptions about the future emission of greenhouse gases. They are prepared by the UN's climate panel, IPCC (Intergovernmental Panel on Climate Change). Emission scenarios are based on the assumption of the future development of the worlds economy, population increase, globalisation, change to environmentally friendly technology, among other things. The amount of greenhouse gases that will be emitted over time depends on how the world develops. In this study two emission scenarios were used: SRES A2 (representing a rapid population growth and intensive energy use) and SRES B2 (representing a slower population growth and lower energy use). The emission of the different greenhouse gases changes in different ways between and within the different scenarios. This means that the scenario that shows the largest change in temperature in 100 years might not necessarily be the one that shows the largest change in 20 years. The emission scenarios are described in IPCC's report: Special Report on Emissions Scenarios (SRES) (2000) (www.ipcc.ch/pdf/special-reports/spm/sres-en.pdf).

1.2 Climate models

Climate models are used to calculate the future climate. Climate models are 3-dimentional representations of the atmosphere, land area, ocean, lakes and ice. In global climate models the atmosphere is separated into a grid along the earths surface and up into the air.

At every point in the grid the development of different meteorological, hydrological and climatological parameters in time are calculated. In regional models a smaller area of the earth is gridded e.g. Europe. Over a smaller area a denser grid can be created without demanding so much extra computer power so greater detail can be achieved. What happens outside the calculated area in a regional climate model is controlled by the results of the global climate model. In this way consideration is even taken to the changes that occur outside the regional model area. In this study a regional atmospheric model from the Rossby Centre in Sweden, RCA3, has been used. The model covers Europe and the size of the squares in the grid over the land area (resolution) is approximately 50x50 km.

1.3 Climate scenarios

The climate models have been run from 1961 to 2100. The meteorological period 1961-1990 was used for the validation of the models. The model results from this period are compared with measured temperature and precipitation values to determine how good the model is at representing the current climate. The period 1961-1990 is then used as a reference which the future climate is then compared to. The results for the future are often compared with the average for this reference period.

Because the results from the calculations are in the form of a grid (gridded data), this can create difficulties when comparing model results with results from measured observation which are taken at specific locations (point data). Observations describe the conditions at a specific point, while models describe conditions evenly distributed over the whole grid. One can look at the example of precipitation. If a large amount of rain falls over a very small area, it would be recorded at one measuring station. At other nearby places which might have only received small amounts of rain or no rain at all, the measurement stations will record much smaller amounts. If the same total amount of precipitation is created in the model for the grid in question it will be evenly spread over the grid. This would make it seem like it has rained evenly over the entire the grid while in reality (compared to observational measurements) the rain was much more unevenly distributed.

1.4 Scenarios are not forecasts

The results which are presented from calculations with the climate models are usually called scenarios. Climate scenarios are not weather forecasts. Climate scenarios are based on assumptions of the future and represent the statistical behaviour of weather, which we call climate. Climate scenarios do not recreate the real weather at a specific place at a specific time. Weather forecasts on the other hand give information about what is probably going to happen at the local scale during a short period in time.

1.5 Uncertainties

The results that are presented here are based on *two* emission scenarios and *one* global climate model. The global results are downscaled with *one* regional climate model. When one analyses material it is important to think that only two of the many probable model calculations that are presented. Other emission scenarios and other global and regional models can give somewhat different results. This is especially true about the quantitative results (e.g. how much rain or how much temperature will increase). For example studies have shown that ECHAM4 gives a temperature and precipitation change during winter in northern Europe that is larger than in many other climate models.

Another source of uncertainty is natural variability. It is not to be expected that the climate in the model is in phase with the real climate. On the other hand a good quality climate model should calculate good average values and characteristic variability, e.g. the right number of cold and warm winters during a 30-

year period. The cold and warm winters could nevertheless occur in another sequence than in the observed climate.

To look at results from several model simulations gives the opportunity to consider uncertainties and also to estimate which results that are robust. It might seem confusing with conflicting results, but one should use the extra information that is given. If the models give different results, then it is a uncertain result. If the models on the other hand give similar results, then the result is more certain. Besides looking at several scenarios one by one, it is possible with statistical methods and specific analyses to combine several simulations and get a result that is better than any separate simulation.

1.6 Analyses

When a target area is analysed, the results are analysed for all grids that cover the chosen district. For every point in time one takes an average value for all grids in the area; in this way one gets a time series for the area. The information in the diagrams was calculated with running 10-year annual average values for the whole time series. Maximum and minimum values are the highest respective lowest values in a particular point during the same time period.

2 Description of the figures

All parameters are plotted as annual and seasonal means and as anomalies compared to the means for the period 1961-1990. The lines are smoothed to represent a 10 year running mean. Two scenarios are plotted: A2 (green line) and B2 (red line). The shaded area marks the span of the year to year variations, also smoothed to a 10 year running mean.

3 Abbreviations

ANN	Annual (January - December)
DJF	Winter (December, January, February)
JJA	Summer (June, July, August)
MAM	Spring (March, April, May)
SON	Autumn (September, October, November)

4 Summary of the main changes of the climate parameters

4.1 Temperature

Average temperature is projected to increases with around 4°C towards the end of the century. The temperature increase is rather even in all seasons, a bit larger in winter time. The change in maximum and minimum temperature is similar. But with larger differences between the scenarios (especially in summer) in maximum temperature and smaller differences between the scenarios in minimum temperature.

4.2 Precipitation

The average annual precipitation is almost unchanged, but there is a shift in seasonal precipitation. Winter time precipitation is projected to increase with up to around 40%, while summer precipitation is projected to decrease with about as much. Maximum precipitation is projected to increase with 80% in the end of the century and increase in variability. Spring and autumn maximum precipitation is projected to increase with around 20% and summer maximum precipitation to decrease with 20%.

4.3 Snow cover

Snow cover is projected to decrease in all seasons (except summer when there is no snow) and the variability between years decreases. From around year 2050 there will be years with no snow at all during the year, and most years won't have snow in autumn and spring.

4.4 Wind

The changes in wind speed are projected to be small, less than 1m/s.

5 Projection figures of the climate parameters

Figures are shown on the following pages.

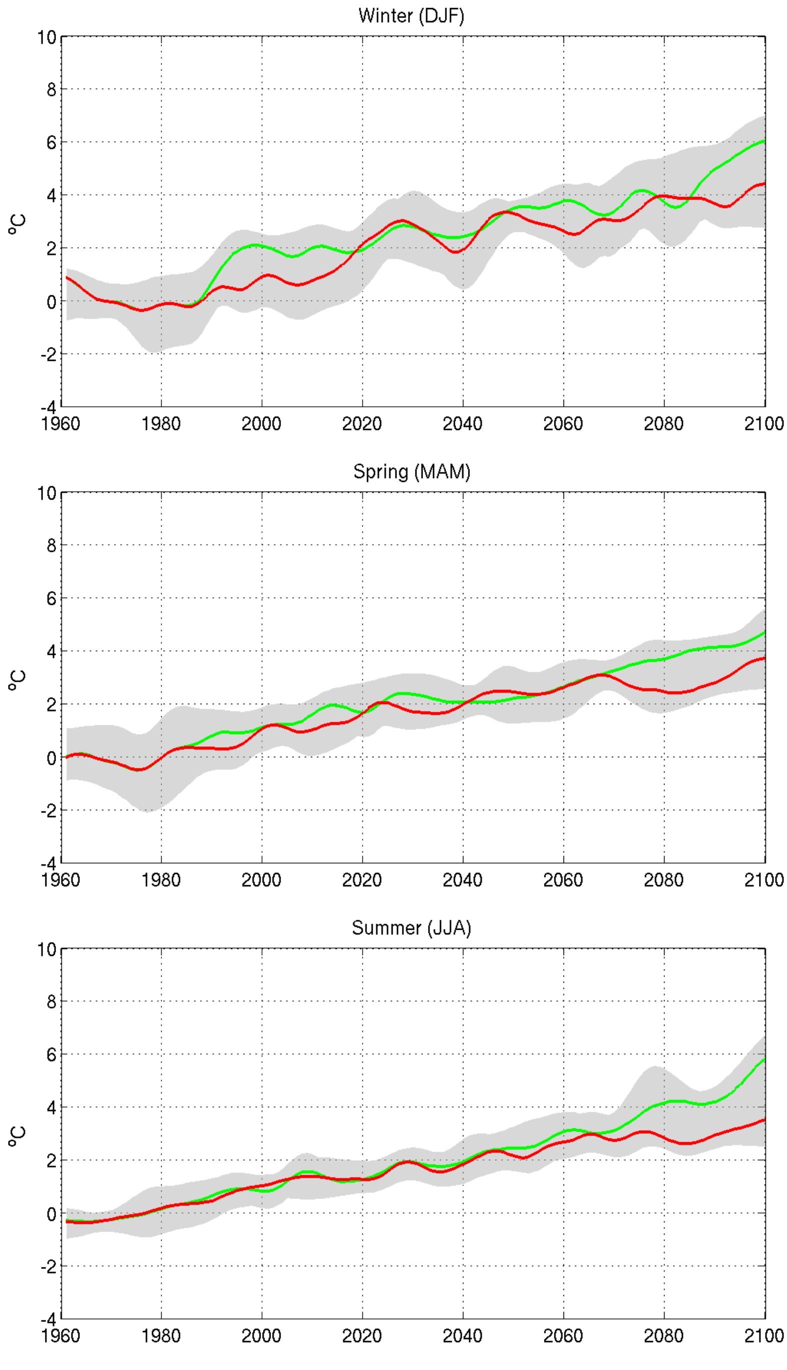

Figure 1: Averaged temperature [°C]. Anomalies to 1961-1990. Seasonal (winter, spring, summer) average. The lines are smoothed to represent a 10 year running mean. Scenarios A2 (green) and B2 (red). The shaded area marks the span of the year to year variations, also smoothed to a 10 year running mean.

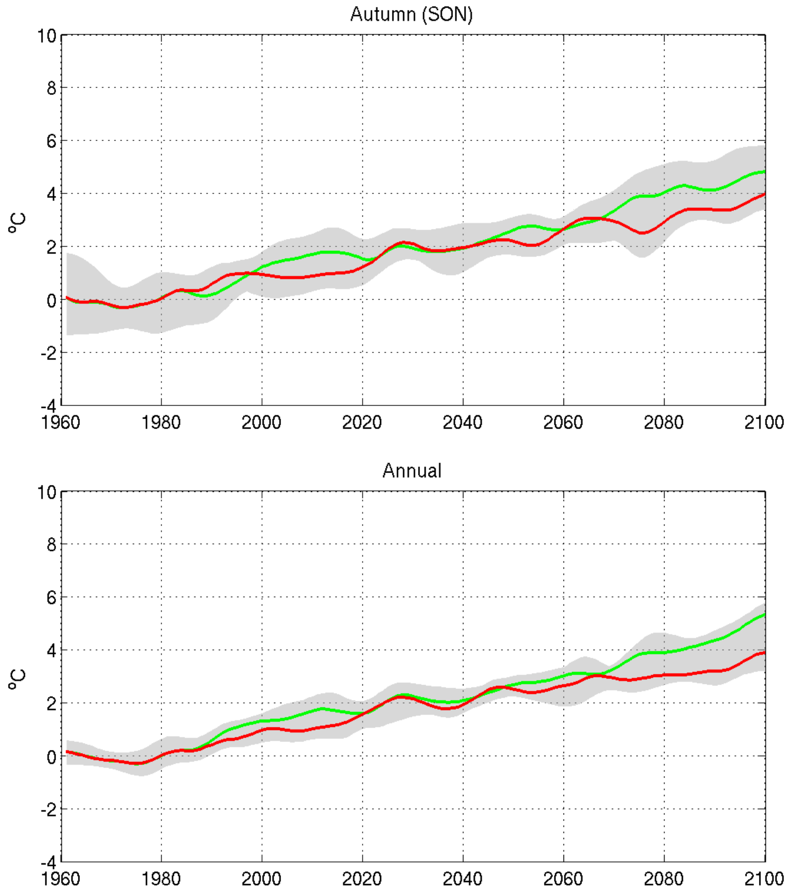

Figure 2: Averaged temperature [°C]. Anomalies to 1961-1990. Autumnal and annual average. The lines are smoothed to represent a 10 year running mean. Scenarios A2 (green) and B2 (red). The shaded area marks the span of the year to year variations, also smoothed to a 10 year running mean.

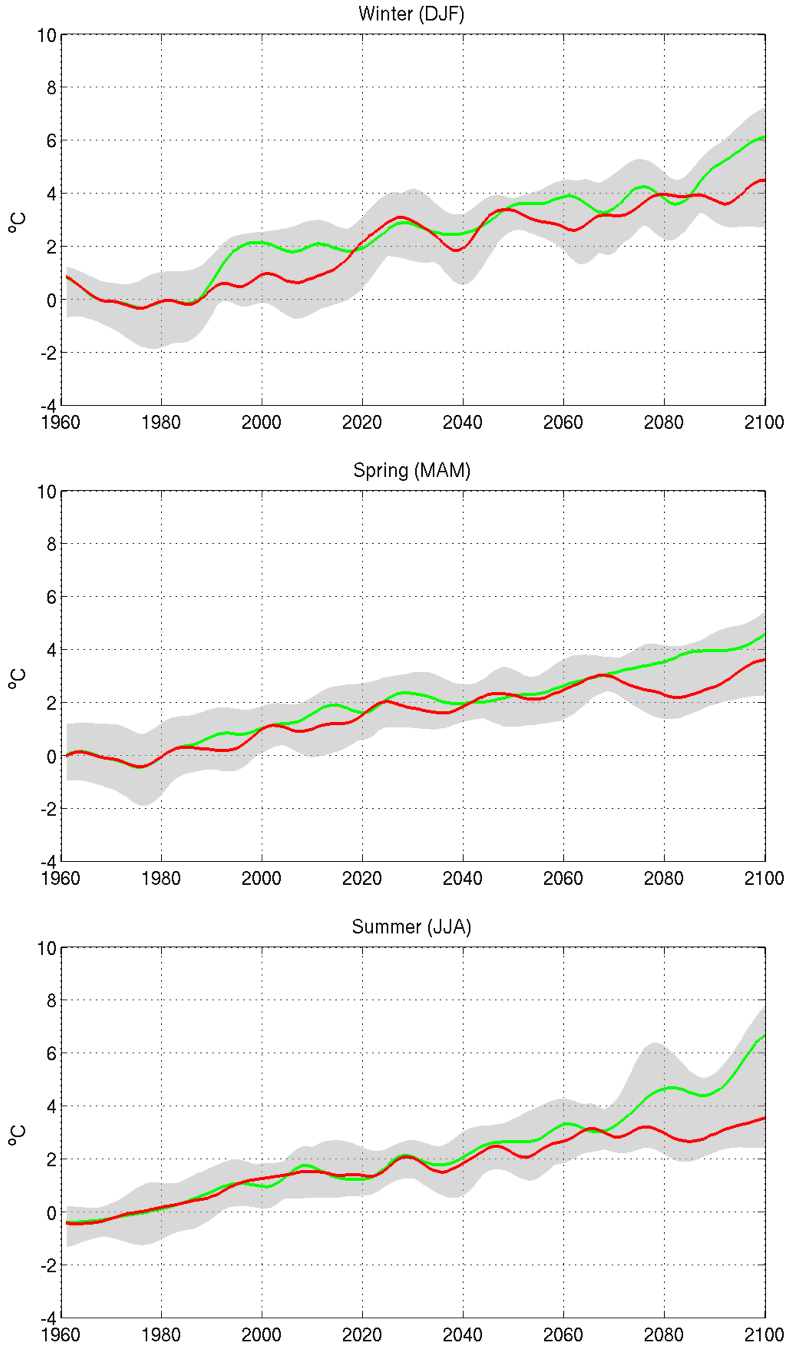

Figure 3: Averaged maximum temperature [°C]. Anomalies to 1961-1990. Seasonal (winter, spring, summer) average. The lines are smoothed to represent a 10 year running mean. Scenarios A2 (green) and B2 (red). The shaded area marks the span of the year to year variations, also smoothed to a 10 year running mean.

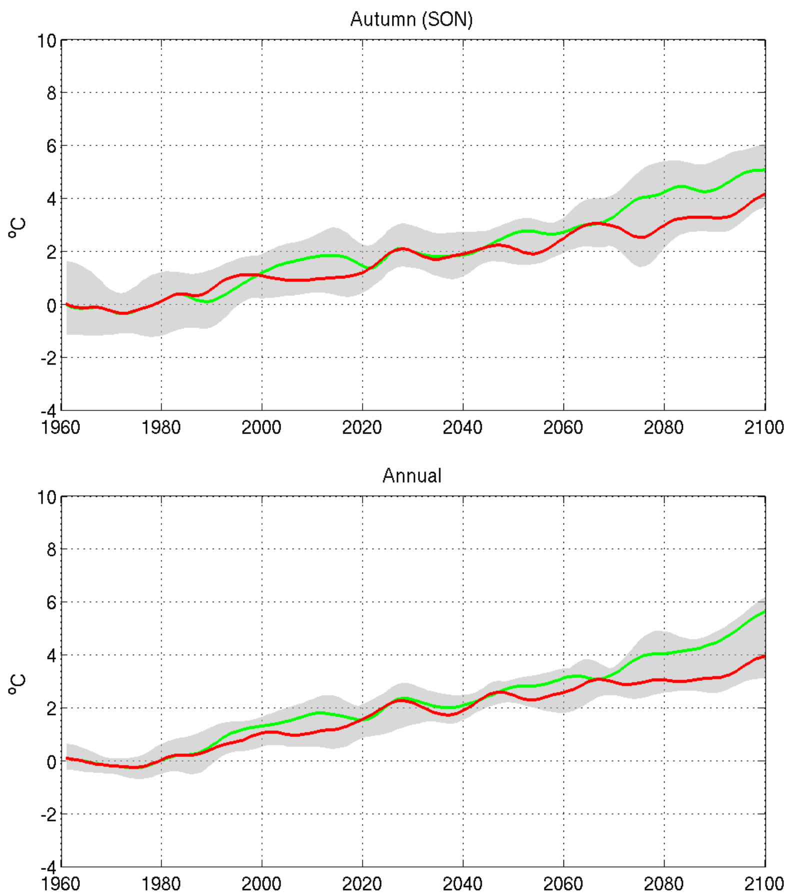

Figure 4: Averaged maximum temperature [°C]. Anomalies to 1961-1990. Autumnal and annual average. The lines are smoothed to represent a 10 year running mean. Scenarios A2 (green) and B2 (red). The shaded area marks the span of the year to year variations, also smoothed to a 10 year running mean.

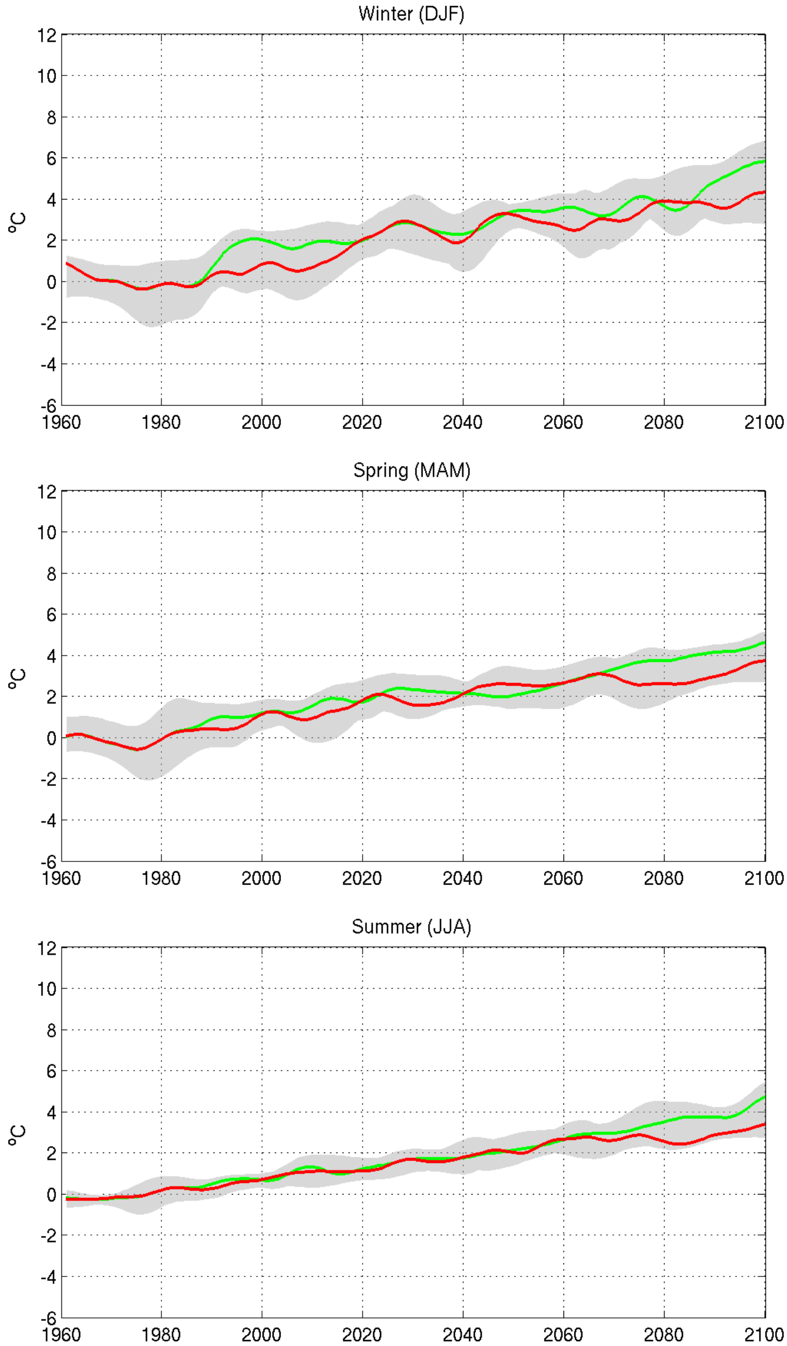

Figure 5: Averaged minimum temperature [°C]. Anomalies to 1961-1990. Seasonal (winter, spring, summer) average. The lines are smoothed to represent a 10 year running mean. Scenarios A2 (green) and B2 (red). The shaded area marks the span of the year to year variations, also smoothed to a 10 year running mean.

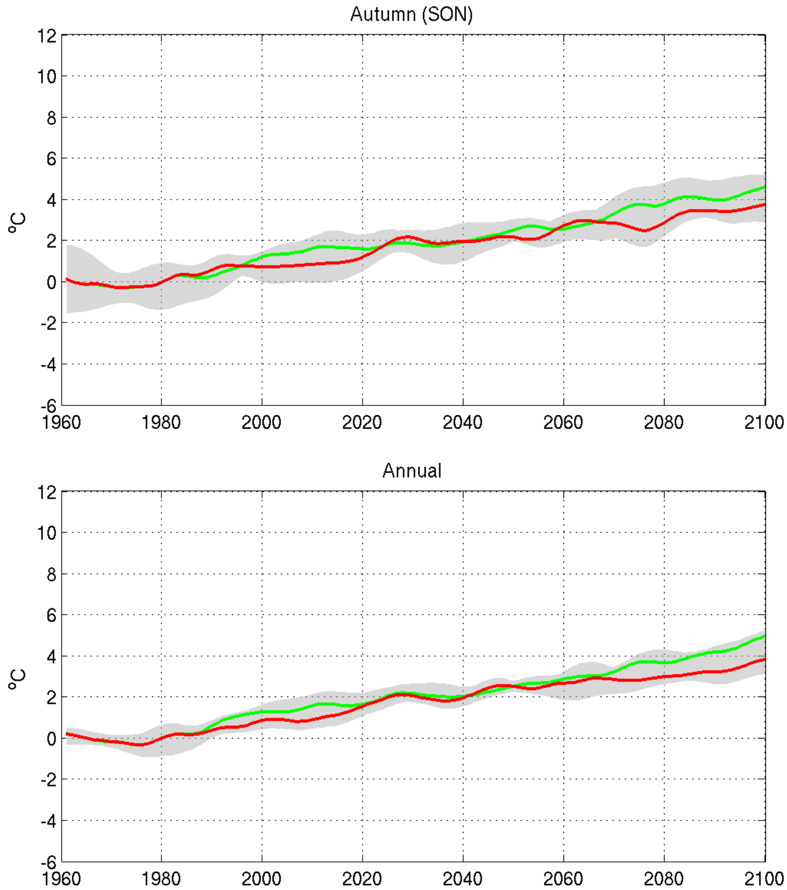

Figure 6: Averaged minimum temperature [°C]. Anomalies to 1961-1990. Autumnal and annual average. The lines are smoothed to represent a 10 year running mean. Scenarios A2 (green) and B2 (red). The shaded area marks the span of the year to year variations, also smoothed to a 10 year running mean.

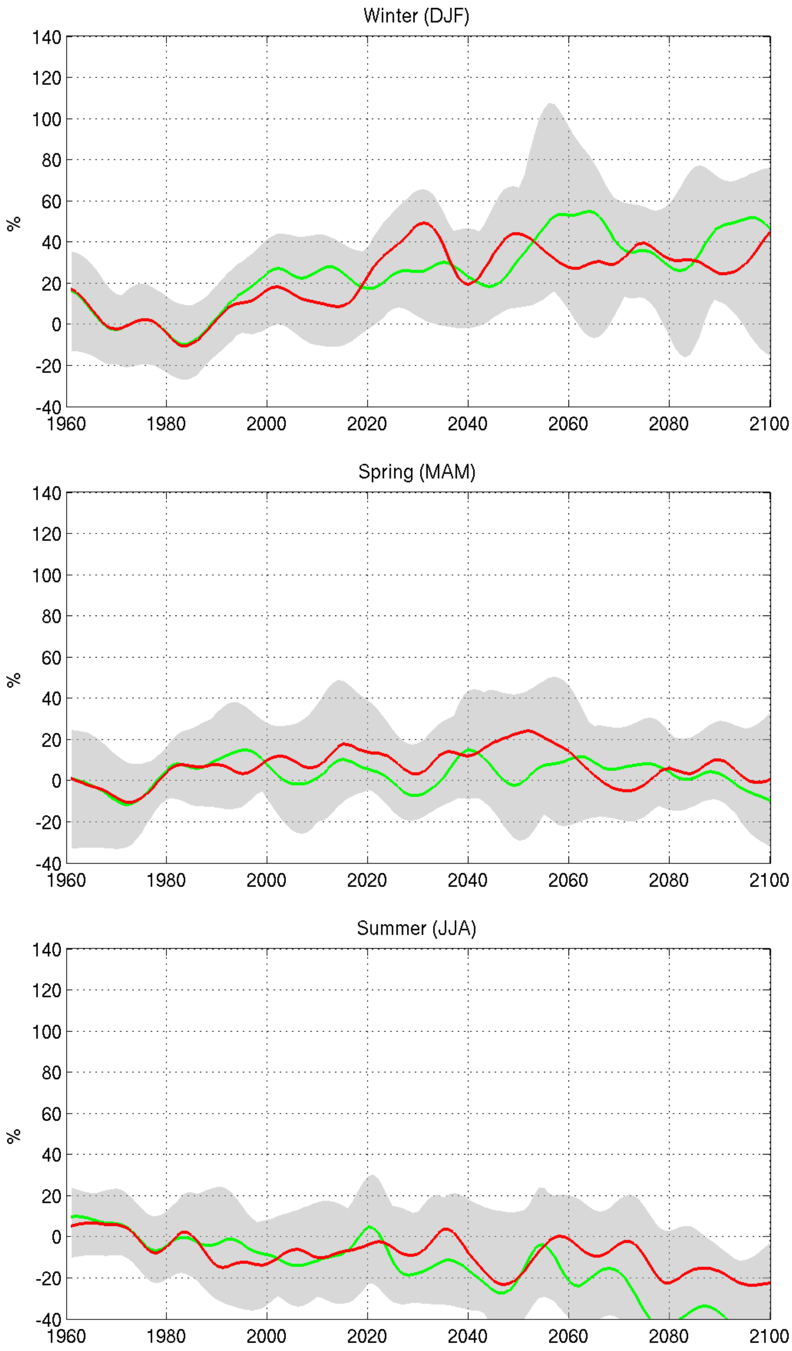

Figure 7: Averaged precipitation [%]. Anomalies to 1961-1990. Seasonal (winter, spring, summer) average. The lines are smoothed to represent a 10 year running mean. Scenarios A2 (green) and B2 (red). The shaded area marks the span of the year to year variations, also smoothed to a 10 year running mean.

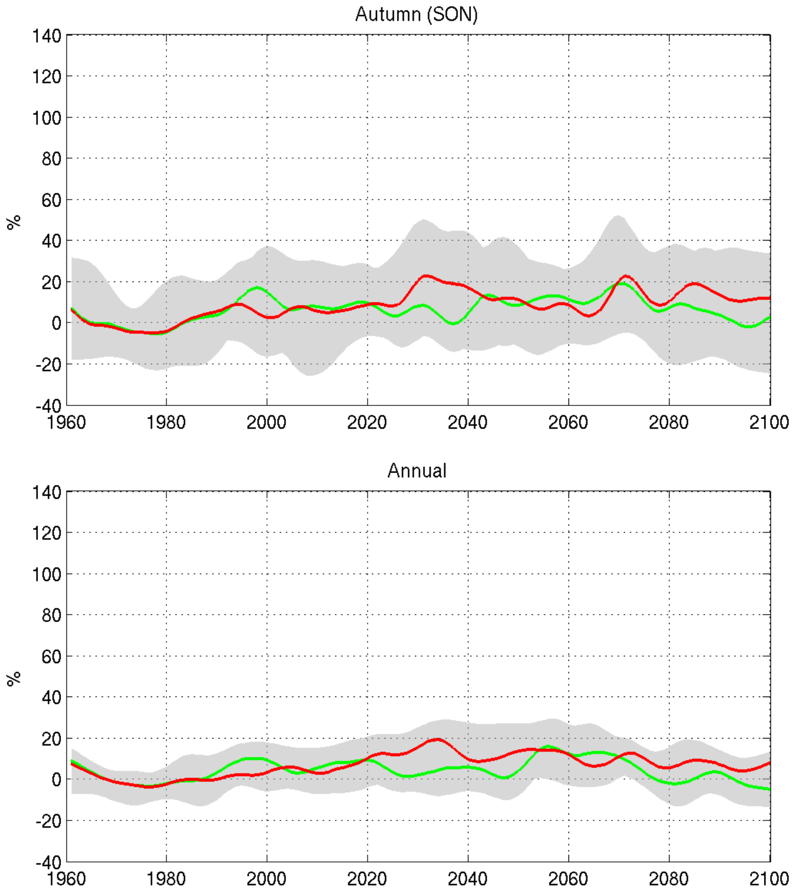

Figure 8: Averaged precipitation [%]. Anomalies to 1961-1990. Autumnal and annual average. The lines are smoothed to represent a 10 year running mean. Scenarios A2 (green) and B2 (red). The shaded area marks the span of the year to year variations, also smoothed to a 10 year running mean.

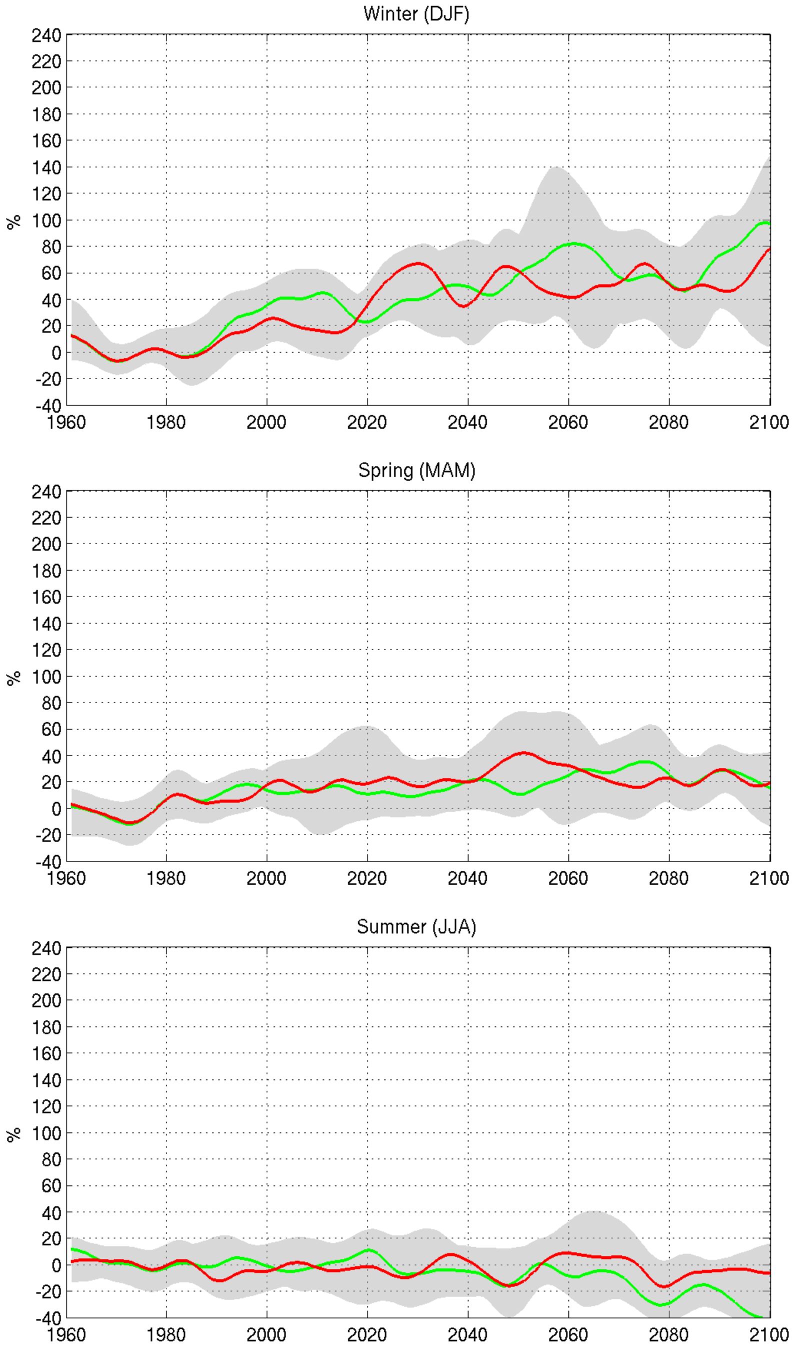

Figure 9: Averaged maximum precipitation [%]. Anomalies to 1961-1990. Seasonal (winter, spring, summer) average. The lines are smoothed to represent a 10 year running mean. Scenarios A2 (green) and B2 (red). The shaded area marks the span of the year to year variations, also smoothed to a 10 year running mean.

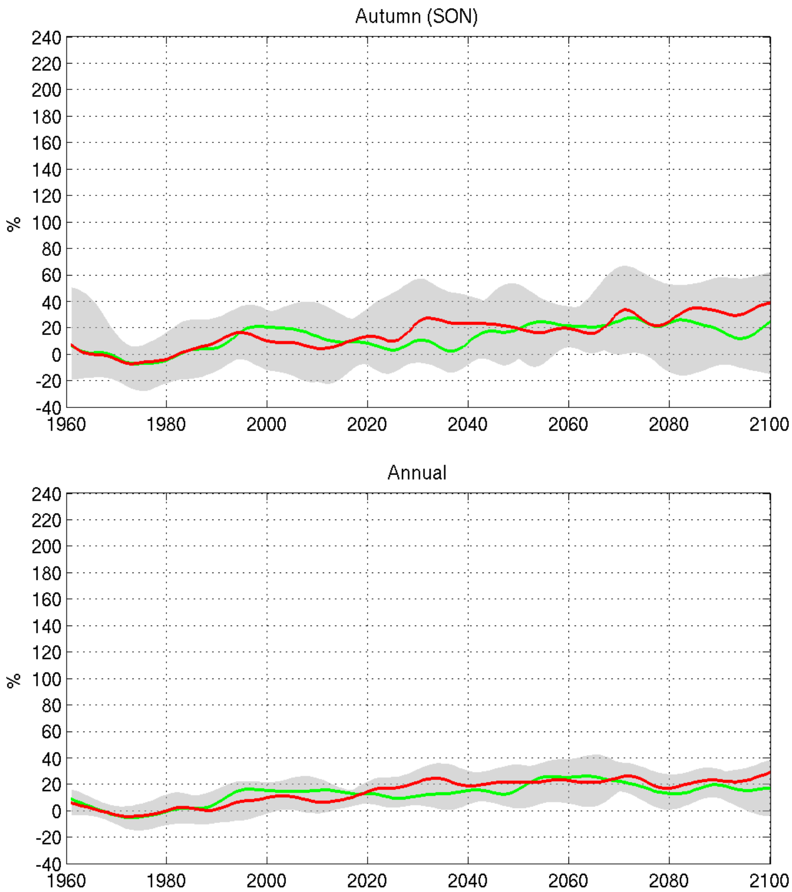

Figure 10: Averaged maximum precipitation [%]. Anomalies to 1961-1990. Autumnal and annual average. The lines are smoothed to represent a 10 year running mean. Scenarios A2 (green) and B2 (red). The shaded area marks the span of the year to year variations, also smoothed to a 10 year running mean.

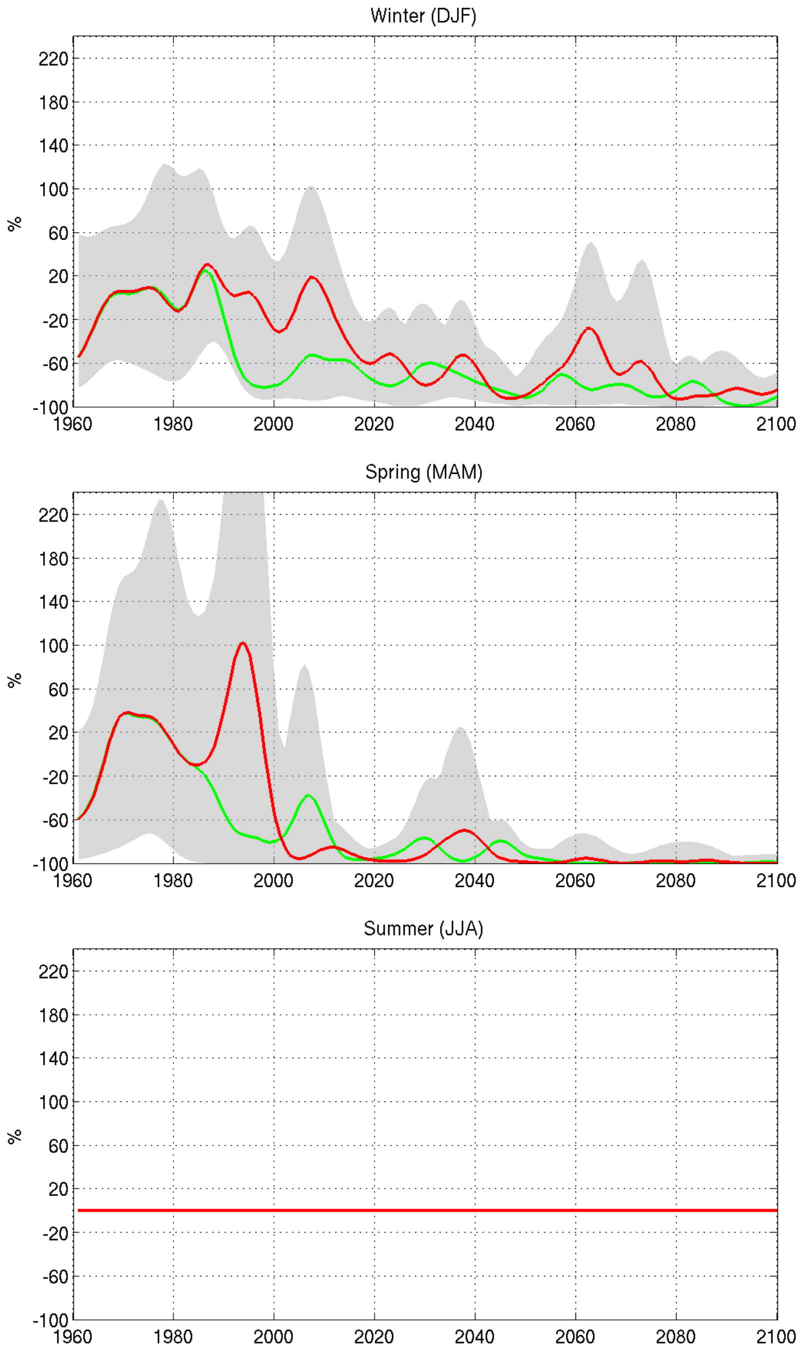

Figure 11: Averaged snowcover [%]. Anomalies to 1961-1990. Seasonal (winter, spring, summer) average. The lines are smoothed to represent a 10 year running mean. Scenarios A2 (green) and B2 (red). The shaded area marks the span of the year to year variations, also smoothed to a 10 year running mean.

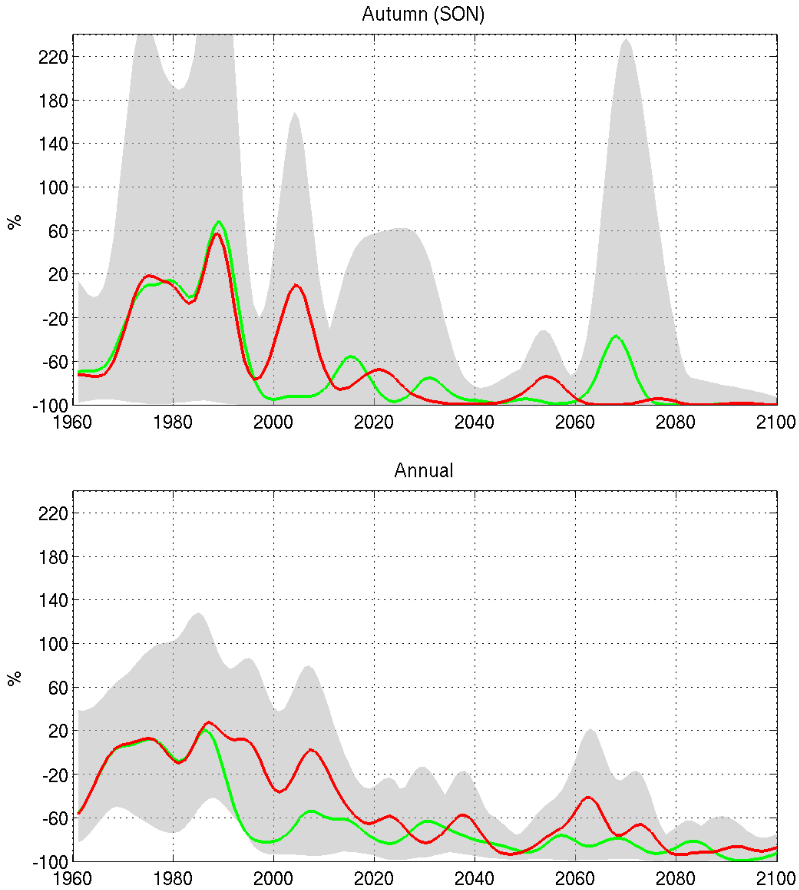

Figure 12: Averaged snowcover [%]. Anomalies to 1961-1990. Autumnal and annual average. The lines are smoothed to represent a 10 year running mean. Scenarios A2 (green) and B2 (red). The shaded area marks the span of the year to year variations, also smoothed to a 10 year running mean.

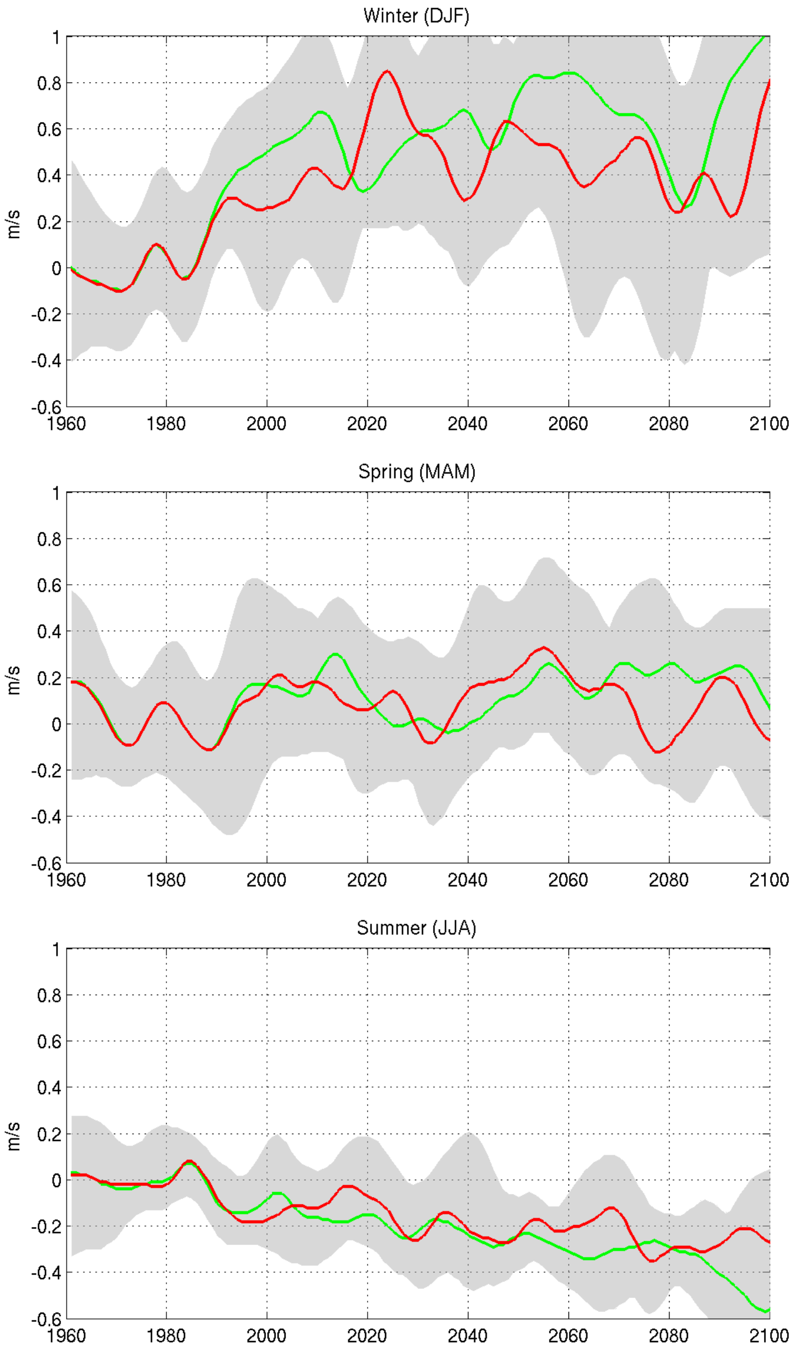

Figure 13: Averaged wind speed [m/s]. Anomalies to 1961-1990. Seasonal (winter, spring, summer) average. The lines are smoothed to represent a 10 year running mean. Scenarios A2 (green) and B2 (red). The shaded area marks the span of the year to year variations, also smoothed to a 10 year running mean.

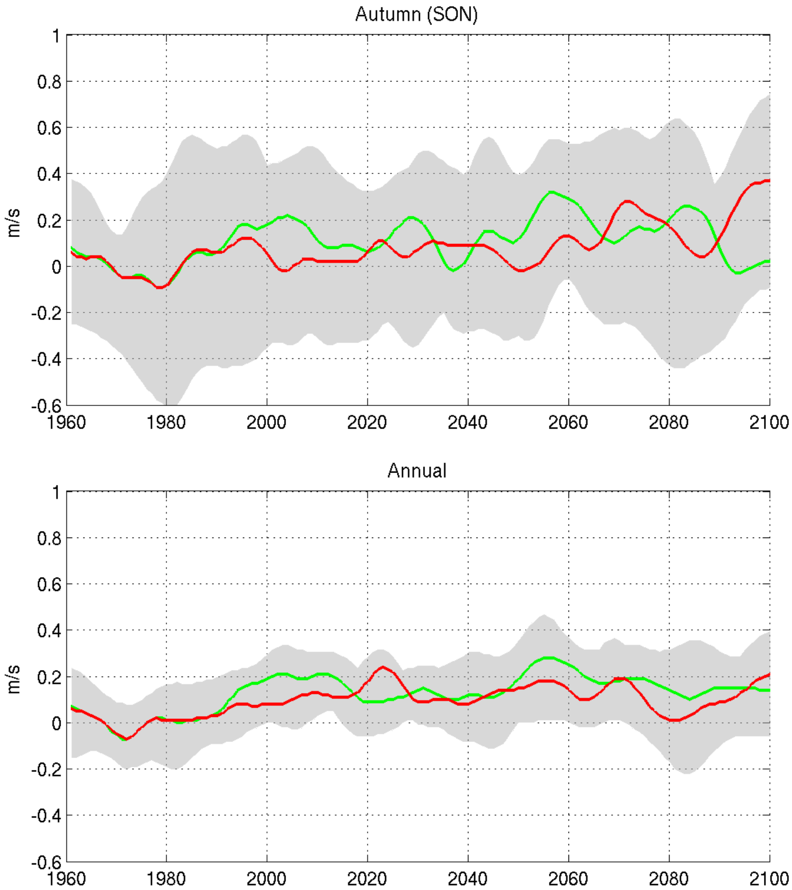

Figure 14: Averaged wind speed [m/s]. Anomalies to 1961-1990. Autumnal and annual average. The lines are smoothed to represent a 10 year running mean. Scenarios A2 (green) and B2 (red). The shaded area marks the span of the year to year variations, also smoothed to a 10 year running mean.