Climatic nowcasting: incorporating model-simulated climate change to estimates of present and near-future climate

Jouni Räisänen

Department of Physics, University of Helsinki, Finland (email: jouni.raisanen@helsinki.fi)

A. Introduction

For operational purposes, climate is usually defined by using a 30-year ”normal period” from past observations, e.g. 1961-1990 or 1971-2000. For evaluating climatic extremes, even longer time series of observations are often used.

Today, the stationarity assumption behind this practice is compromised by the ongoing global climate change. Here, we present one approach for dealing with this problem. The method is described in more detail by Räisänen and Ruokolainen (2008a,b).

B. Overview of the method

We adjust past observations for the estimated effects of global climate change (Fig. **B2**). The adjustment is based on

1. The (temporally smoothed) **change of global mean temperature**, as observed this far and as simulated for the future
2. **Regression coefficients** linking the mean and interannual variability of local climates to the change in the global mean temperature, estimated from CMIP3 simulations of 20th-to-21st century climate change (Fig. **B1**). The variation of these coefficients between the CMIP3 models results in several alternative adjusted time series (grey lines in Fig. **B2**).

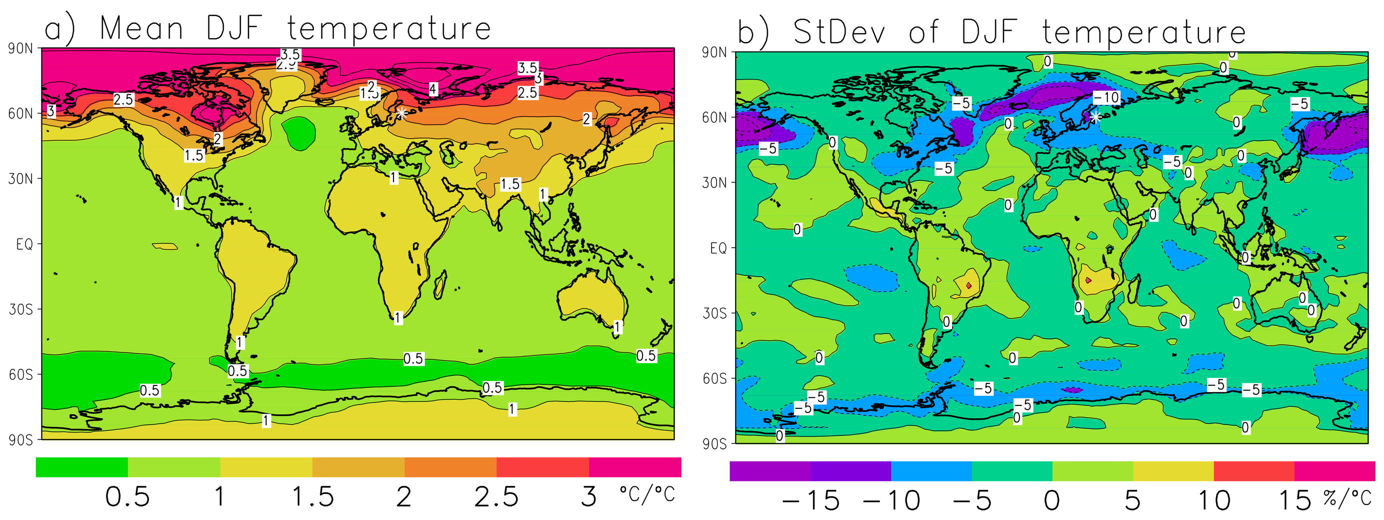

Fig. B1. 22-model mean regression coefficients for (a) the mean value (°C per °C of global warming) and (b) the interannual standard deviation of Northern Hemisphere winter (DJF) mean temperature.

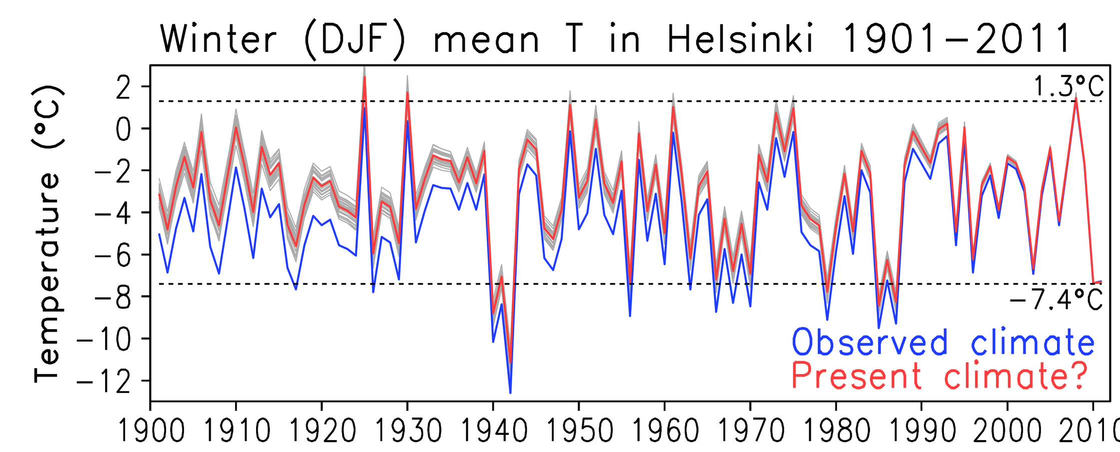

Fig. B2. Time series of winter mean temperature in Helsinki, Finland (60°N, 25°E).
Blue line: observations;
Red line: best-estimate (= 22-model mean) adjustment to present (2010) climate conditions;
Grey lines: variation of the adjustment between the 22 models
The two dotted lines mark the temperatures observed in winters 2008 and 2010 (section **E**).

C. Hindcast for the years 1991-2005

The method was used to hindcast the frequency of ”warm” months (above the median for 1961-1990) in the years 1991-2005, by only using observations from 1961-1990. The average hindcast frequency (67%) is in good agreement with CRU TS3 observations (69%) (Fig. **C1**). For both the hindcast and the observations, the frequency of warm months is highest in the tropics, where interannual temperature variability is small.

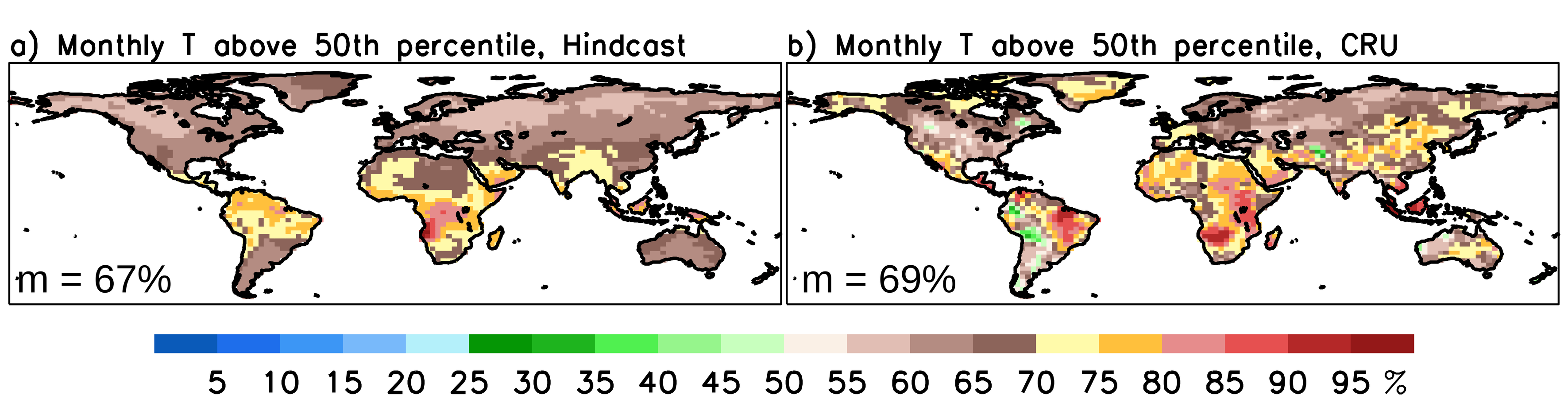

Fig. C1. Frequency of months warmer than the median for 1961-1990 during the years 1991-2005. (a) Hindcast, (b) CRU TS3 analysis. The area means are given in the lower left corners.

D. Present-day temperature climate

Fig. **D1** compares the best-estimate present-day (~2010) temperature climate with the statistics for 1971-2000.

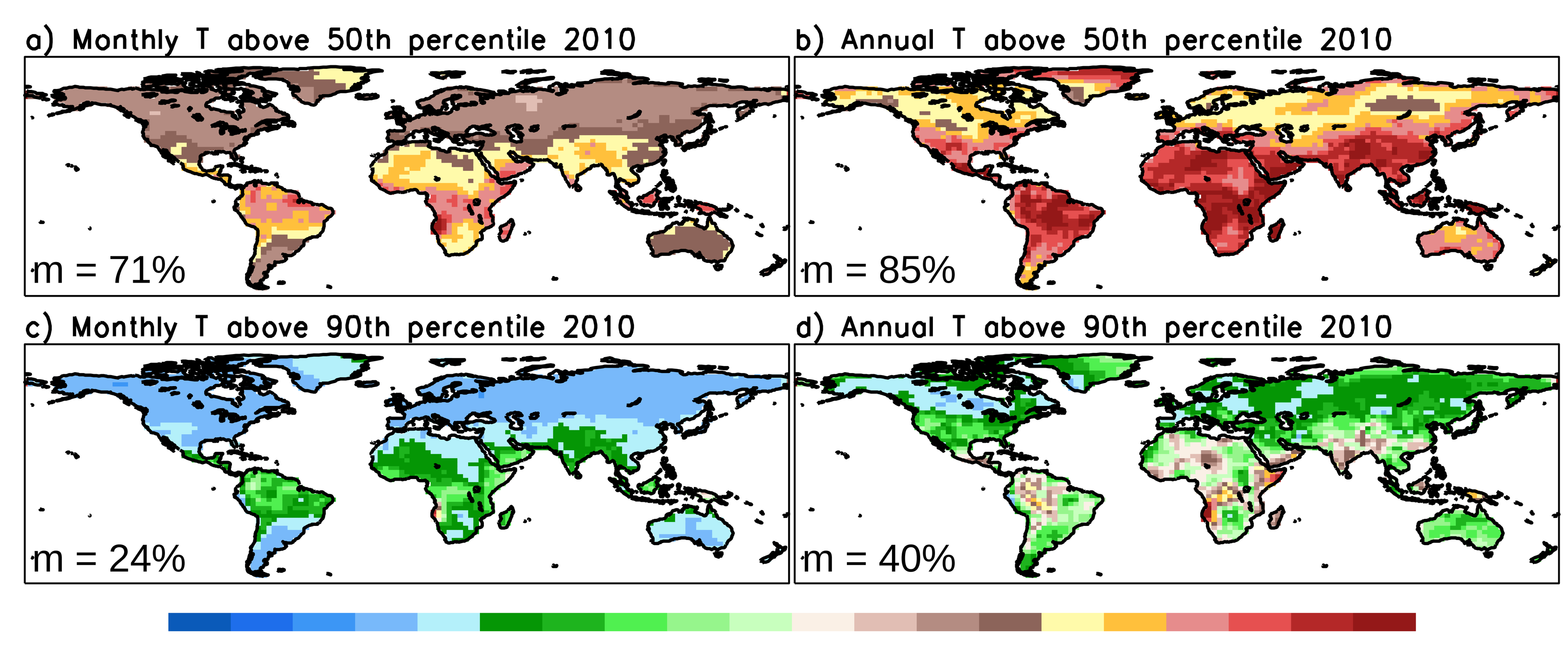

Fig. D1. Expected relative frequency of warm (above the median for 1971-2000) and very warm (above the 90th percentile) months and years in the present (around the year 2010) climate. The area means are given in the lower left corners.

E. A case study of winter temperatures in Helsinki, Finland

Winter 2008 was record warm in Helsinki, with a DJF mean temperature of +1.3°C, whereas winter 2010 was the coldest since 1987 (-7.4°C) (see **Fig. B2**). How probable are such warm / cold winters

1. As estimated directly from observations from the years1901-2005?
2. In the actual present-day climate?
3. In the future?

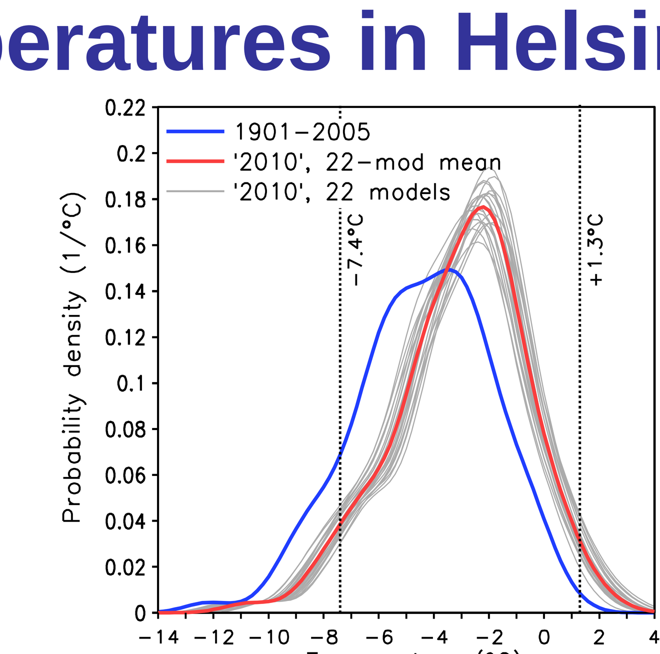

Fig. E1. Probability distributions of DJF mean temperature in Helsinki.
Blue: observations for 1901-2005
Red: best estimate for present climate
Grey: estimates based on the 22 CMIP models individually.

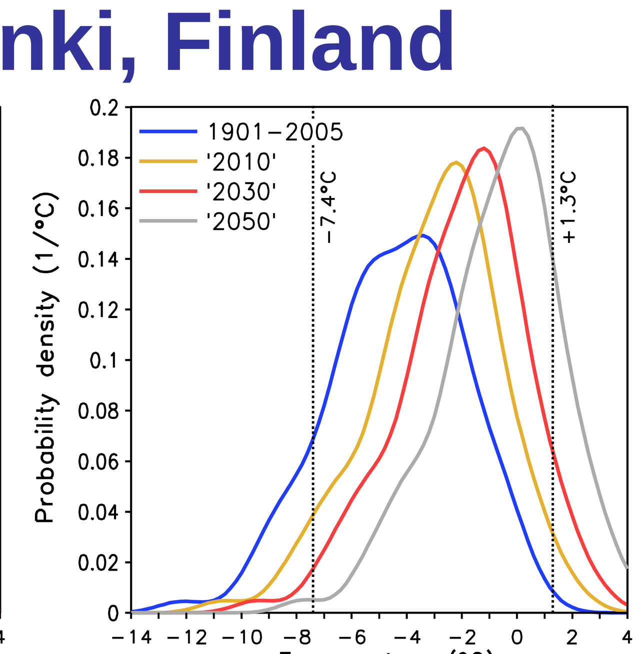

Fig. E2. As Fig. E1, but the **yellow**, **red** and **grey** lines show the best estimates for **2010**, **2030** and **2050**, respectively. For the future, SRES A1B emissions scenario was assumed.

Resulting best-estimate probabilities (2030 and 2050 for SRES A1B scenario)

	T ≤ - 7.4°C	T ≥ + 1.3°C
1901-2005	13%	0.5%
2010	6%	3%
2030	2%	7%
2050	<1%	19%

These results suggest that the ongoing climate change has already substantially affected the probability of very cold and mild winters. This effect is expected to grow larger in the future.

F. References

Räisänen J, Ruokolainen L (2008a) Estimating present climate in a warming world: a model-based approach. Climate Dynamics 31, 573-585.
Räisänen J, Ruokolainen L (2008b) Ongoing global warming and local warm extremes: a case study of winter 2006-2007 in Helsinki, Finland. Geophysica, 44, 45-65.