Temperature and Precipitation Response in Scenarios A1B[2] and E1[3] (WP2A.3)

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Introduction:

The aim of this study is to investigate the differences in 21st climate for scenarios with vs. without mitigation. For this purpose temperature and precipitation results are presented

- from a multi-model ensemble of 8 European fully coupled atmosphere-ocean GCMs (see right box)
- from the partners in WP2.3 (see below).
- 17 scenario simulations for the new mitigation scenario E1 (see besides)
- 17 simulations for the SRES A1B scenario was going into the analyses.

The E1[3] - Mitigation Scenario:

- A1B as baseline scenario
- IMAGE 2.4 model provided emissions/ concentrations and land use changes
- The CO_2 concentration for E1
  - peaks in the middle of the 21st century
  - converges towards 450 ppm to 2100
- Immediate decrease of the total aerosol burden

Model	CC	AT	LU	Atmosphere	Ocean
CNRM-CM3.3			x	T63L31	2°L31
ECHAM5-C	x		x	T31L19	3°L40
EGMAM2		x	x	T30L39	0.5/2.8L20
ECHAM5-OPA-C	x			T31L19	2°L31
IPSL-CM4-v2			x	N84L19	2°L31
HadGEM2-AO		x	x	N96L38	1°L40
HadCM3C	x		x	N48L38	1.25°L20
BCM2C	x			T63L19	2.4°L35

CC – Carbon Cycle; AT – Aerosol Transport; LU – Land Use Changes

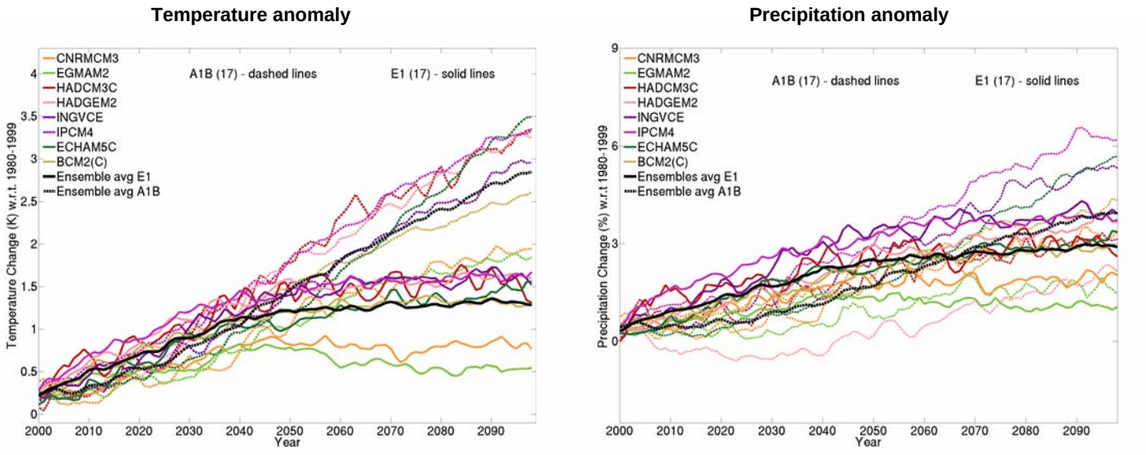


Fig.1: Time series of globally averaged (left) surface air temperature change [K] and (right) precipitation change [%] from the various coupled models of ENSEMBLES - RT2A for the scenarios A1B and E1. Numbers in parentheses following the scenario name represents the number of simulations shown. Values are annual means, relative to the 1980 -1999 average from the corresponding 20th-century simulations. A three-point-smoothing was applied. The multi-model (ensemble) mean series are shown in black. (cf. Meehl et al. 2007, p.763)

The ensemble mean warming in the first half of the 21st century in the E1 scenario exceeds the warming signal in the A1B scenario (left).

Precipitation increases due to the greenhouse gas increase in the 21st century (right). In the E1 scenario, in analogy to the global mean temperature, the slope is smaller in the second half of the century. The precipitation increase in E1 is stronger than in A1B in the first two-thirds of the century.

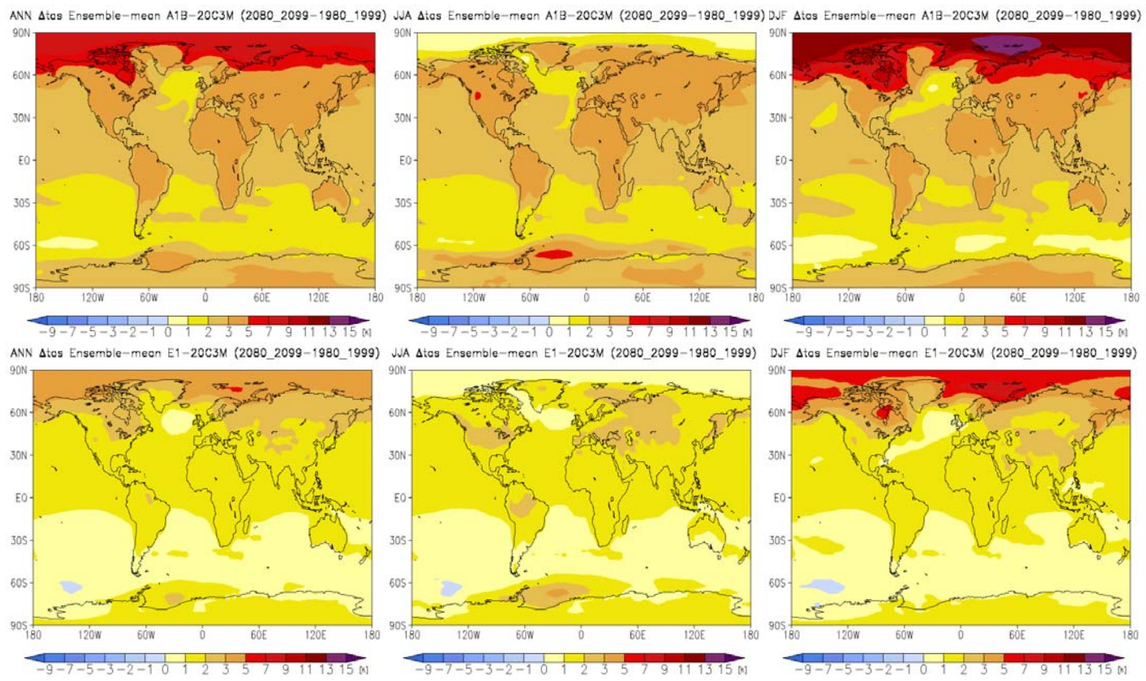


Fig.2: Multi-model mean changes in **surface air temperature** (K), annual (ANN), for boreal winter (DJF) and summer (JJA), for the time period 2080-99 relative to 1980-199 for scenarios A1B (top) and E1 (bottom).

The seasonal ensemble mean temperature change pattern (Fig. 2) shows the high-to-low-latitude contrast in northern hemispheric surface warming. The high-latitude warming is seasonal and occurs in the boreal winter.

Models agree (Fig. 3) in a precipitation increase at mid and high latitudes and in Pacific and Indic tropics in scenario A1B as well as in E1 for projected changes between 2080-99 and 1980-99.
In the E1 scenario less models agree with an increase over the southern ocean and more models show an increase in Mediterranean.

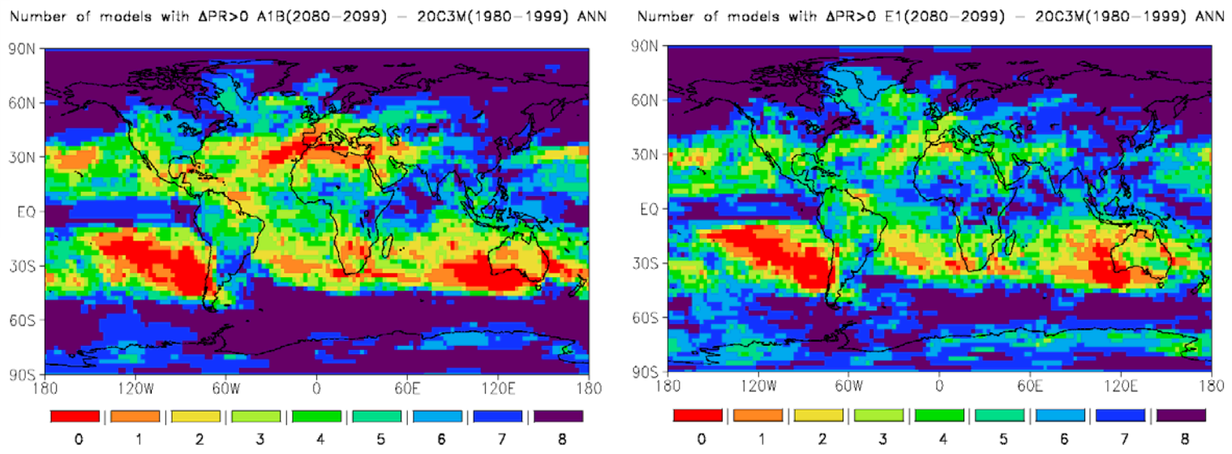
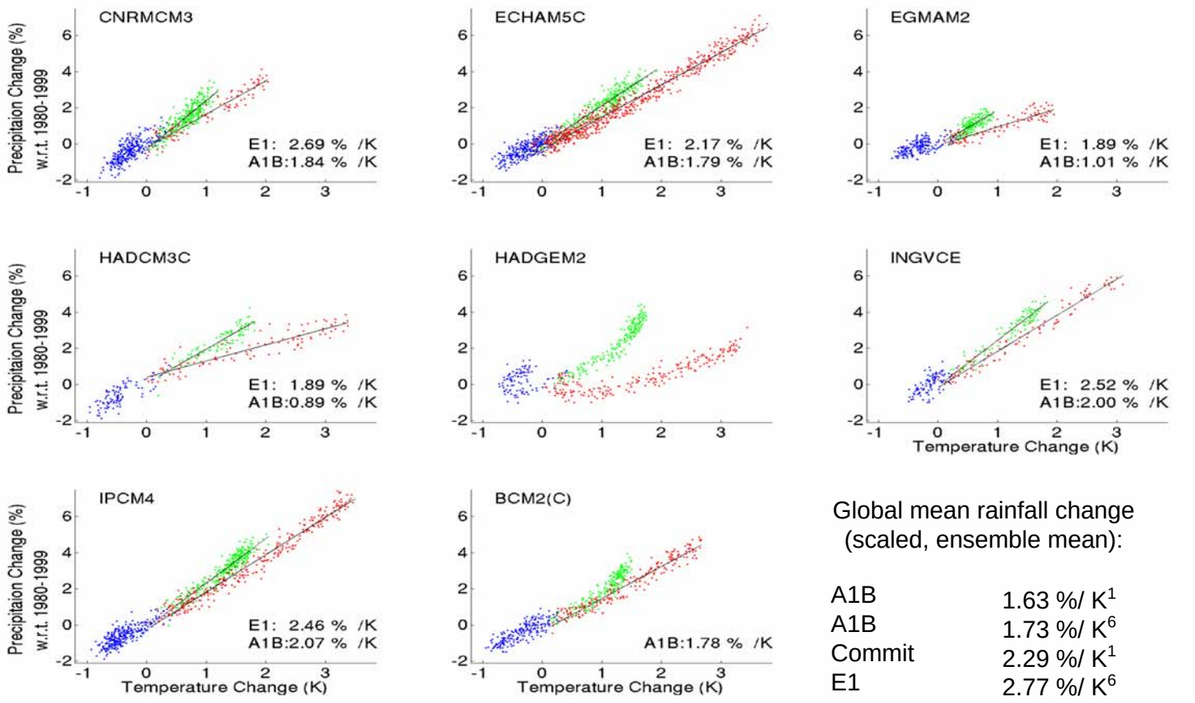


Fig.3: Number of models which simulates a precipitation increase between the time periods 2080-2099 and 1980-1999 for the scenario A1B (left) and the mitigation scenario E1 (right).



Global mean rainfall change (scaled, ensemble mean):

A1B	1.63 %/ K[1]
A1B	1.73 %/ K[6]
Commit	2.29 %/ K[1]
E1	2.77 %/ K[6]

Fig.4: Scatter plots of globally averaged precipitation change [%] and temperature change [K] relative to the 1980-1999 averages for the different models used in ENSEMBLES RT2A. (green – E1, red – A1B, blue – 20th century).

The temperature scaled global mean rainfall change for A1B is somewhat higher compared to CMIP3.[1] In analogy to the higher precipitation increase per degree temperature rise for B1 compared to A1B, the quotient for E1 exceeds the one for A1B in CMIP3 for the models employed in this project (Fig. 4).

Conclusions:

According to these models the E1 scenario seems suitable to achieve the EU-2°-target of temperature changes respective to pre-industrial times.[5,6]
The higher temperatures in E1 compared to A1B in the first half of the 21st century may be attributed to aerosols.[6]

Especially in E1 the strengthening of the Hadley cell on the southern hemisphere is indicated by more models than on the northern hemisphere.
Although the scaled precipitation change for A1B is close to the one for the CMIP3[1], for E1 it is even higher than for the COMMIT experiment of CMIP3.

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