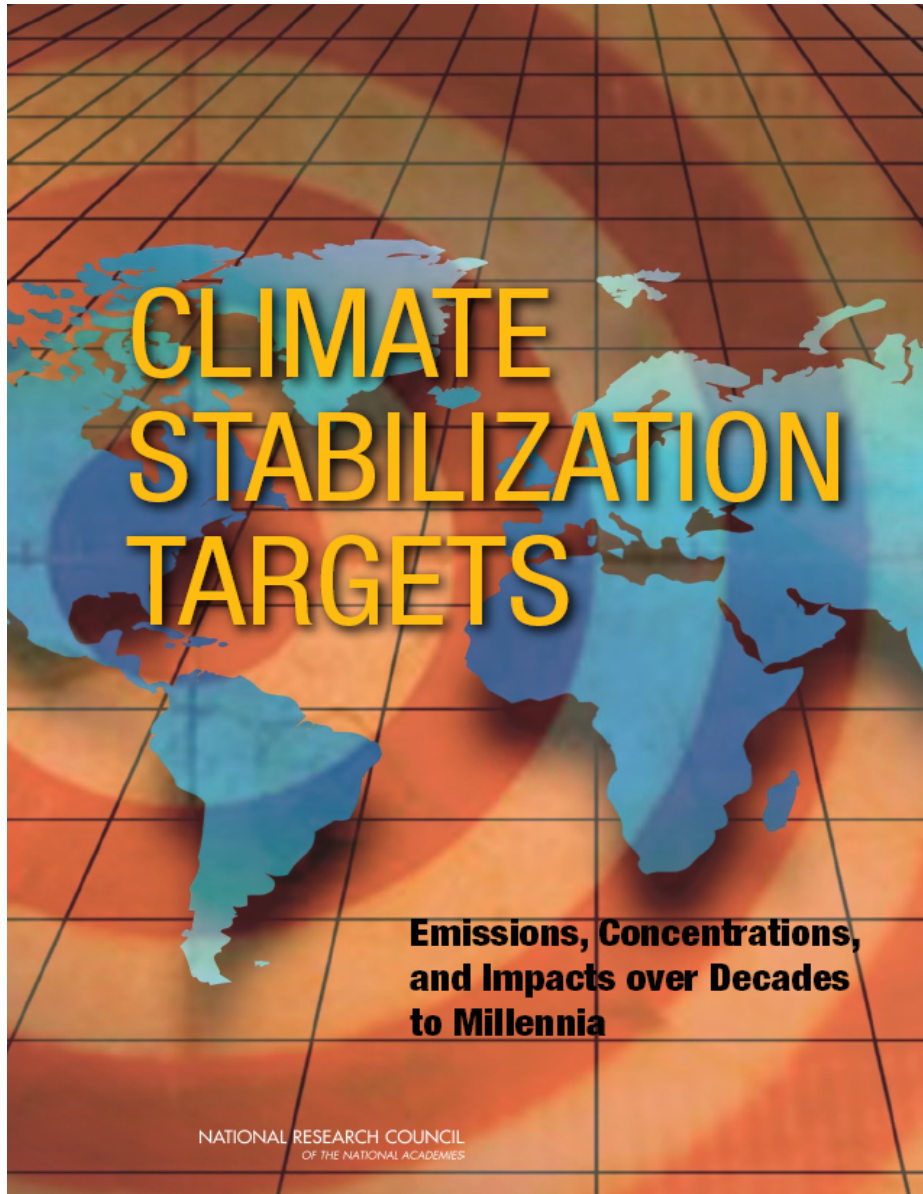


2 Grad globale Erwärmung: Was bedeutet das für unser Klima?

Daniela Jacob
Climate Service Center, Abteilung: Klimasystem

- **NAS- Bericht**
 - **Das E1 – Szenario**
 - **Klima in Europa**
 - **Zusammenfassung und Ausblick**
-



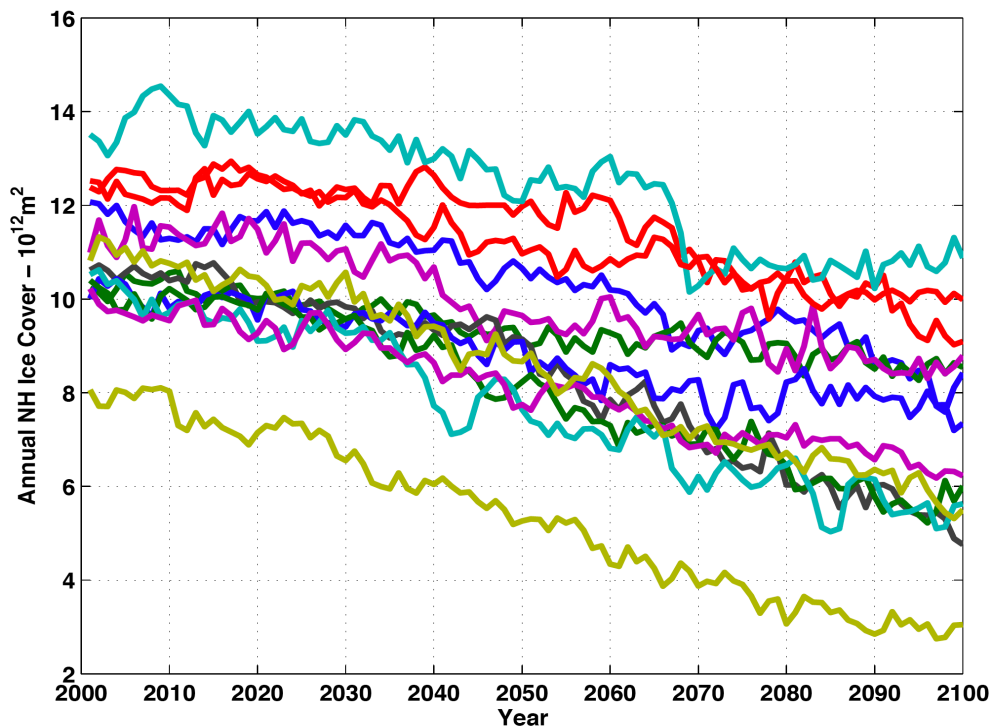
Climate Stabilization Targets:

Emissions, Concentrations, and Impacts over Decades to Millennia

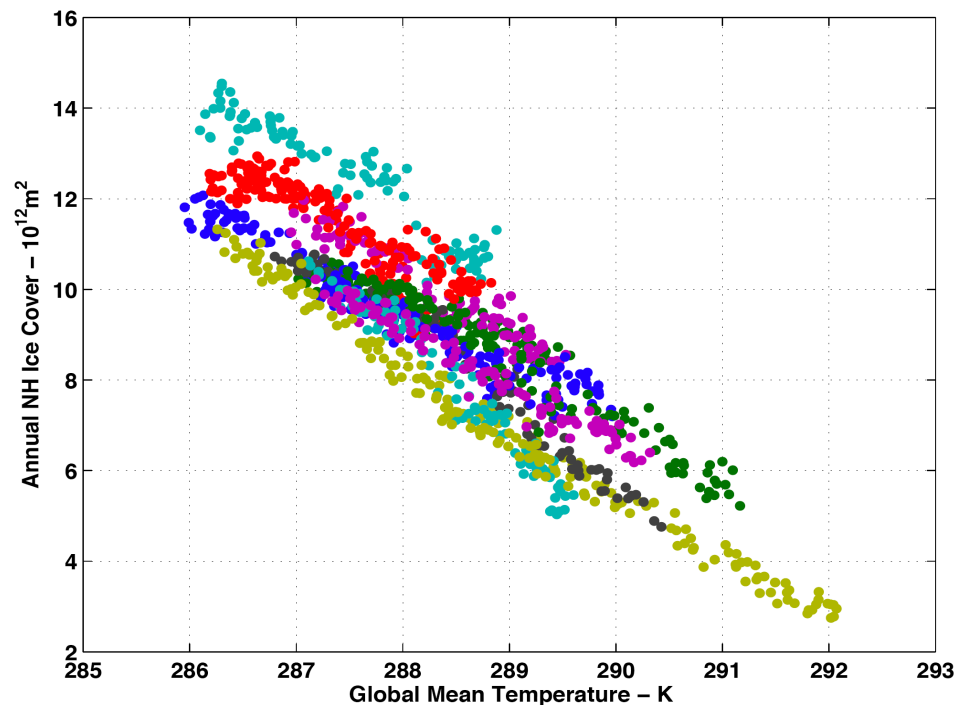
Report from The National
Academies
Board on Atmospheric Sciences
and Climate

<http://www.nationalacademies.org/basc>

Why Warming is the Primary Framework Used in This Report: One Illustrative Example



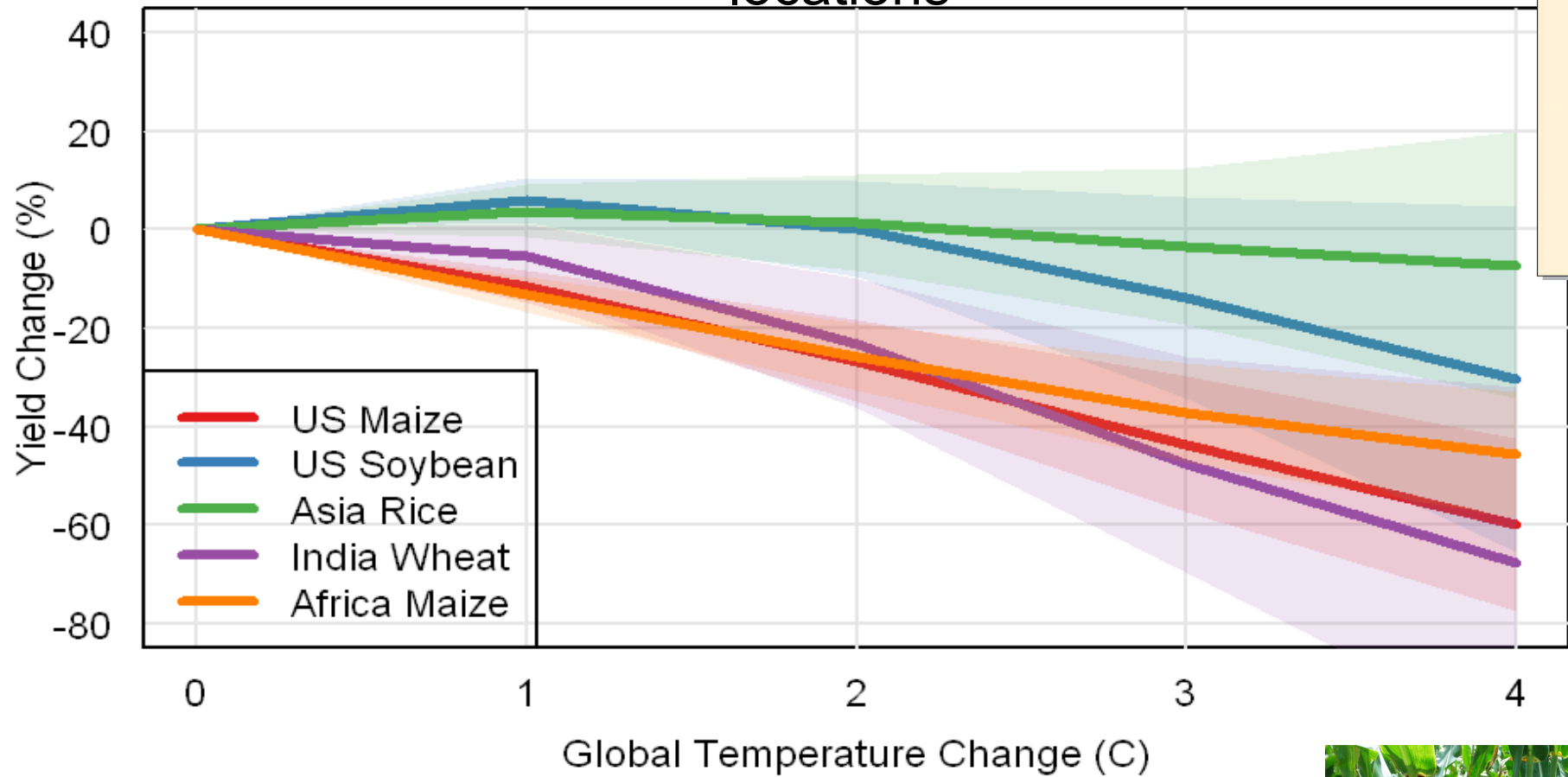
Arctic sea ice versus time:
13 different models, big differences



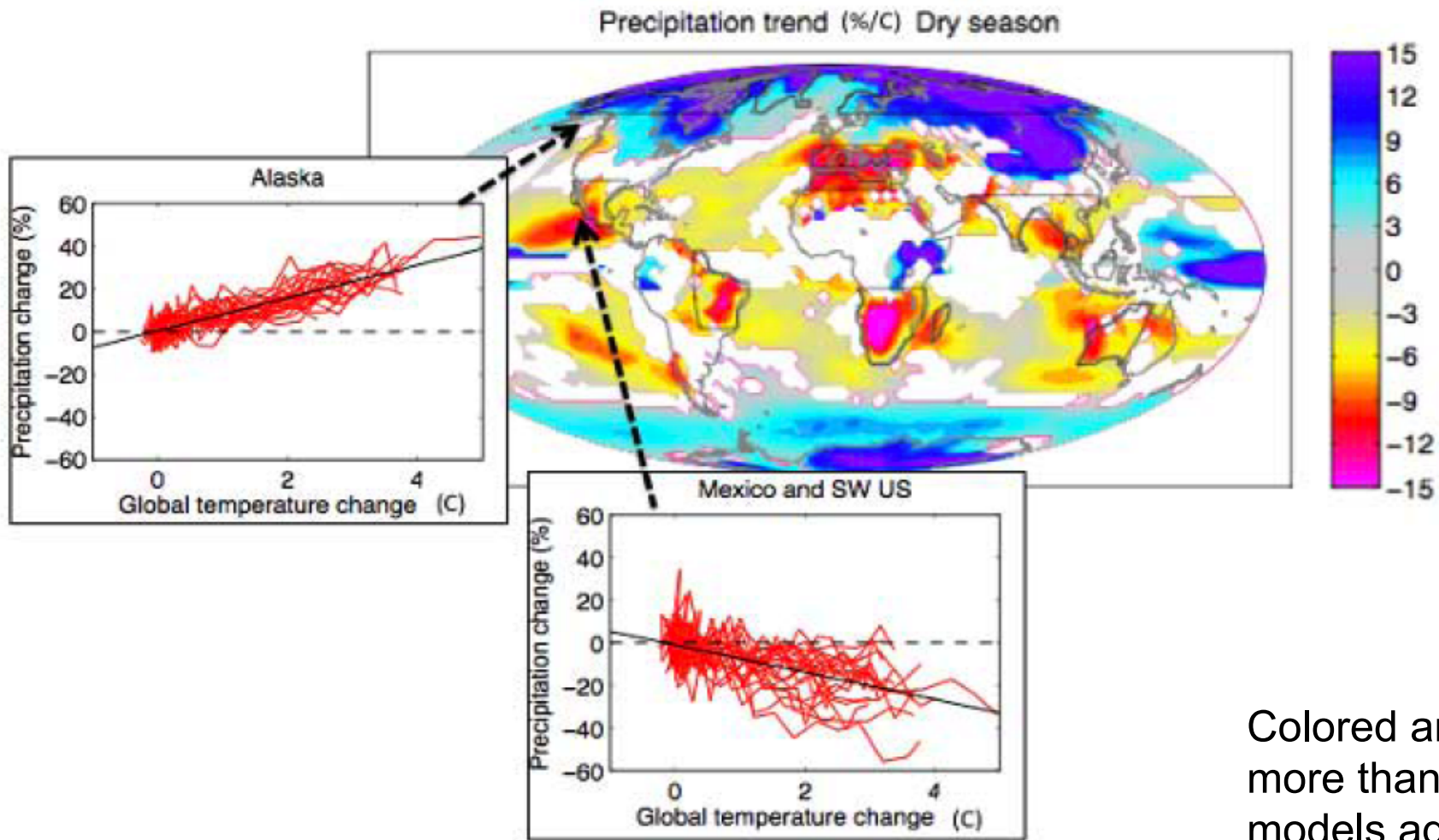
Arctic sea ice versus warming: different
models, much smaller differences

-15% per degree in annual average;
-25% per degree in September minimum

Food: Large potential decreases in certain crops and locations



Changes in future rainfall patterns



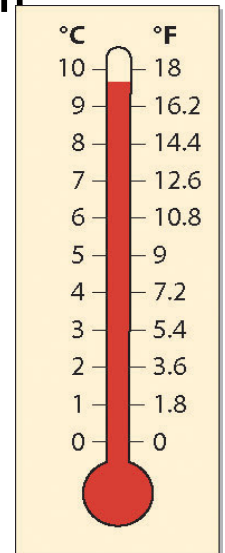
Warming and Stabilization Targets

Table 1. Relationship of Atmospheric Concentrations of Carbon Dioxide to Temperature

Stabilization CO ₂ -equivalent concentration (ppmv): range and best estimate		Equilibrium global average warming (°C)
320 ← — 340 — → 380		1
370 ← — 430 — → 540		2
440 ← — 540 — → 760		3
530 ← — 670 — → 1060		4
620 ← — 840 — → 1490		5
Note: Green and red numbers represent low and high ends of ranges, respectively; black bolded numbers represent best estimates.		
<p>The report calculates the “likely” range (66% chance) of atmospheric concentrations associated with various degrees of warming, consistent with model results¹ and roughly consistent with paleoclimate evidence. There are large uncertainties in ‘climate sensitivity’—the amount of warming expected from different atmospheric concentrations of greenhouse gas—the range is 30% below and 40% above the best estimates.</p> <p>¹The estimated “likely” range presented in this report corresponds to the range of model results in the Climate Modelling Intercomparison Project (CMIP3) global climate model archive.</p>		

How much risk is acceptable? A value judgment (not addressed in this report).

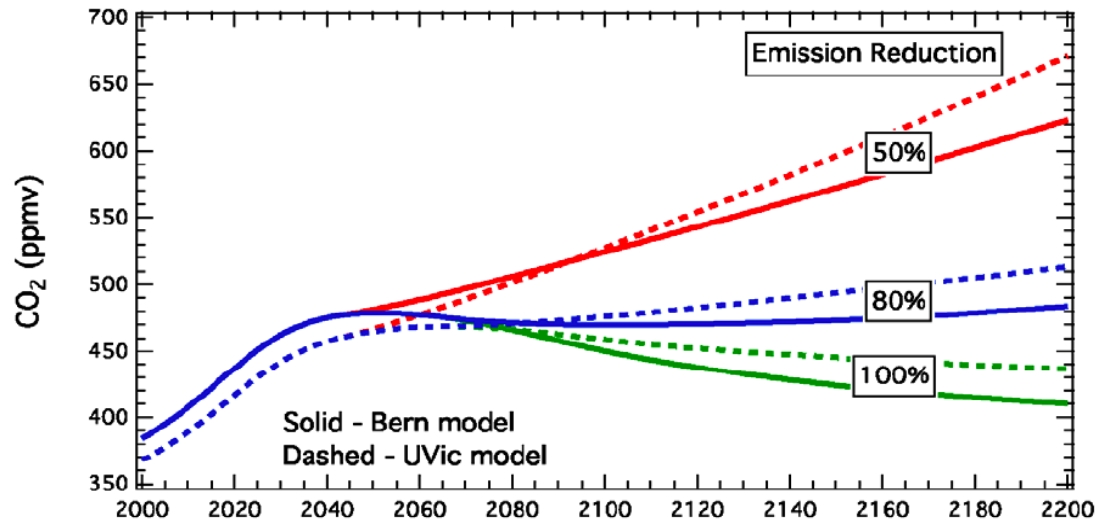
What is at risk? A science judgment (addressed as far as the scientific literature allows in this report).



And there are also unquantified risks....

IMPACT AREA	RISK OF IMPACTS INCREASES WITH TEMPERATURE	PRIMARY CLIMATE DRIVER	CONFOUNDING FACTORS
AGRICULTURE	Crop pests, weeds, and disease: shifts in geographic range and frequency	Extreme cold temperature, precipitation	Agricultural practices; herbicides & pesticides
TERRESTRIAL ECOSYSTEMS	Individual species: shifts in timing of flowering & breeding cycles, in geographic ranges, and in populations	Temperature: averages, extremes, degree-days	Landscape fragmentation
	Disturbances: changes in the frequency and timing of fire, pests, and disease	Temperature, precipitation, drought stress	Land management practices
	Forests: shifts in primary processes including nutrient cycling, transpiration, and respiration	Temperature, precipitation, carbon dioxide levels	?
COASTAL AND MARINE ECOSYSTEMS	Individual species: shifts in geographic ranges and die-off	SLR, saline and freshwater inputs, water temperature	Fishing practices?
	Corals and mollusks: declining calcification rates, more frequent bleaching events	Maximum temperature, ocean acidification	?
	Coastal upwelling zones: shifts in nutrient availability	Shifts in surface winds & ocean circulation	?
	Oxygen minimum (dead) zones: expanding geographic area and duration	Ocean temperature, circulation	Water pollution (nitrates?)
ENERGY	Increasing demand for air conditioning and decreasing demand for winter heating	Accumulated and extreme temperatures	Penetration & efficiency of air conditioning technology
INFRASTRUCTURE	In the Arctic: shortening of land, lengthening of marine transportation season	Permafrost melt, sea ice duration & extent	?
	Risk of impacts from extreme temperature, precipitation, and storms	Temperature and precipitation extremes	Shoreline development and protection
HEALTH	Increased risk of heat-related illness and death	Frequency, intensity & duration of heat waves	Extreme cold temperature, precipitation
	Shifts in timing and geographic range of allergens and vector-borne diseases	Average and extreme temperature & precipitation	Human spread, cultivation practices
WATER	Earlier peak streamflow, longer summer dry periods across much of the U.S.	Precipitation, temperature, snowpack and melt timing	Water management and demand

Warming and Stabilization Targets



Deep emissions reductions (>80%) would be required for long-term stabilization of carbon dioxide at any chosen target (450, 550, 650 ppm....).

AND

Emission reductions near 100% would be required for manmade CO₂ to decline from any peak it reaches, and for the related transient to equilibrium warming increase to be avoided.

“Overshoots” for CO₂?

Key Findings

Different stabilization levels can lock the Earth and many future generations of humans into large impacts, some of which can occur very slowly over time.

Observed climate changes as greenhouse gas emissions increase reflect only about half of the eventual total warming that would occur for stabilization at the same concentrations; deep emission reductions (>80%) would be required to stabilize carbon dioxide concentrations at any chosen target level (e.g., 450 ppmv, 550 ppmv, 650 ppmv, 750 ppmv, etc.).

Scientific progress has resulted in increased confidence in understanding how global warming levels of 2, 3, 4, 5°C, or more would affect wildfire area, Arctic sea ice retreat, reduced crop yields, coral bleaching, streamflow, rainfall patterns, and eventual sea level rise, providing improved information for science and society.

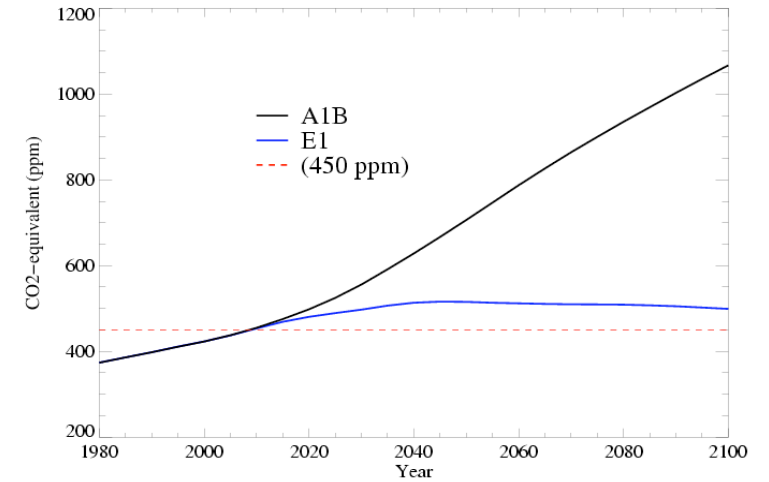
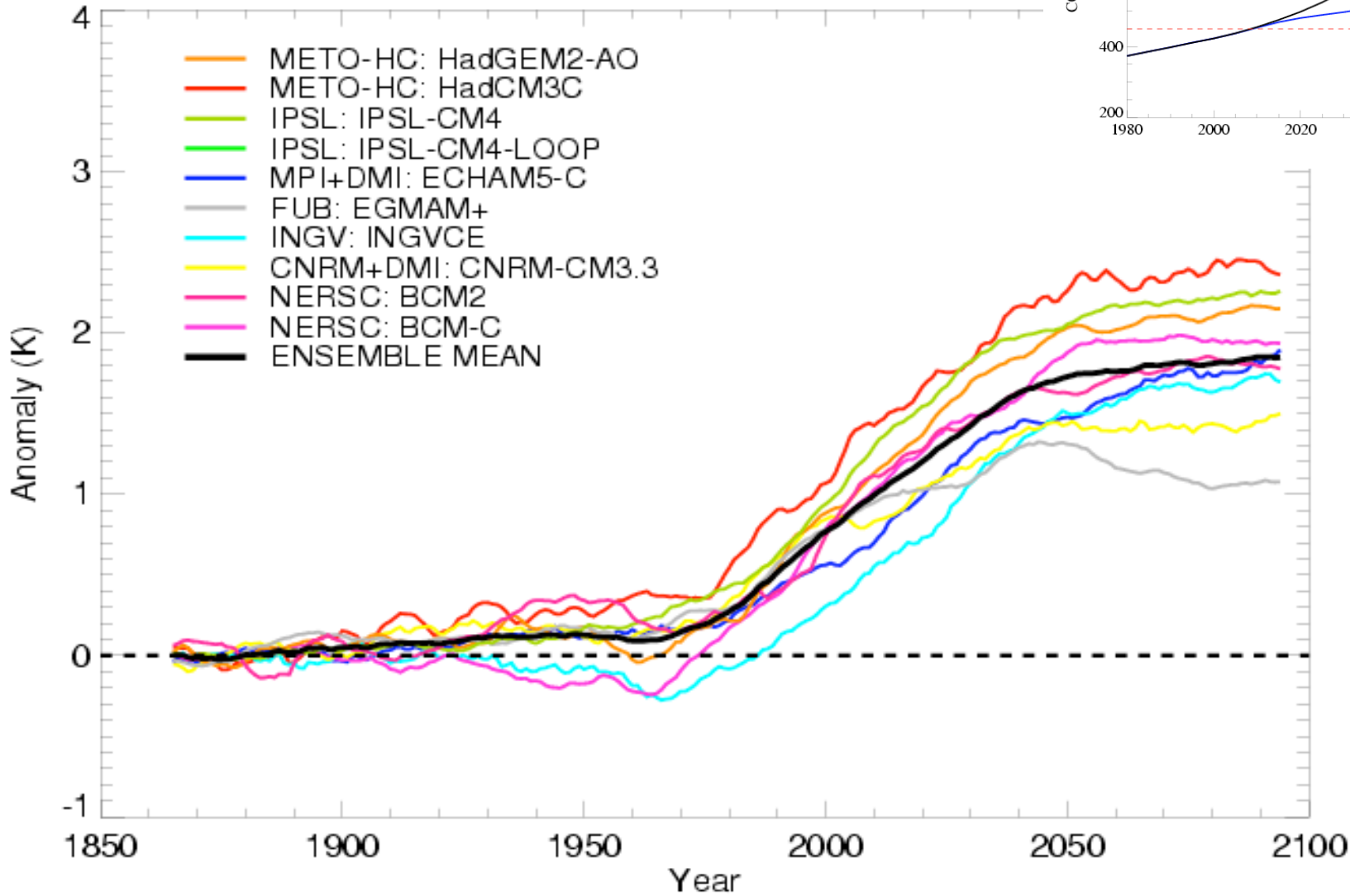
<http://www.nationalacademies.org/basc>

Gliederung

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-

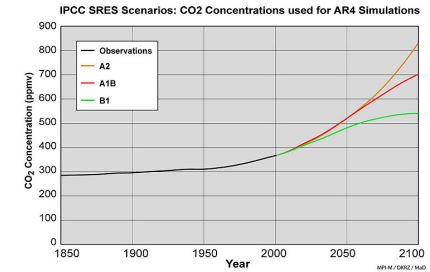
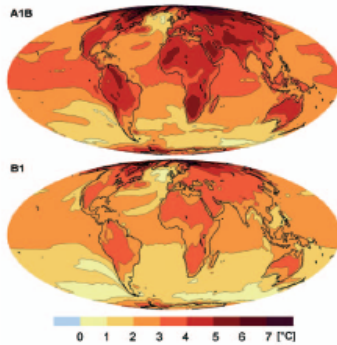
Das E1 – Szenario

ENSEMBLES Stream 2: 20C3M+E1



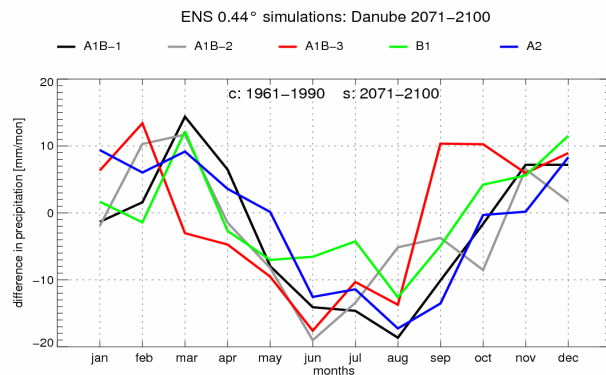
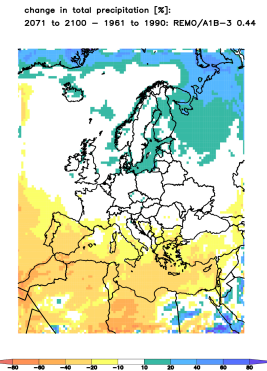
Konzept regionaler Klimaänderungssimulationen

Emissionsszenario (IPCC)



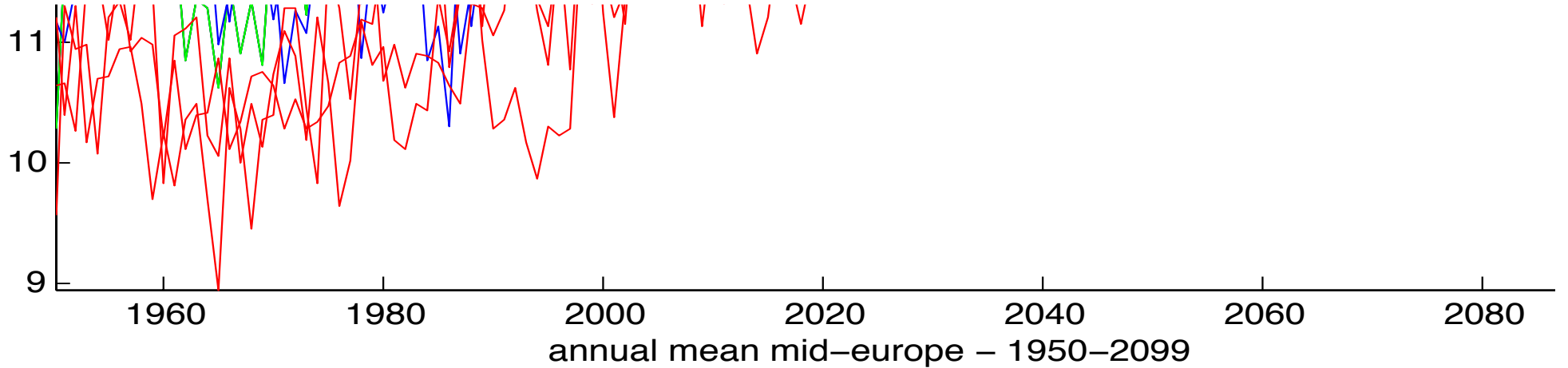
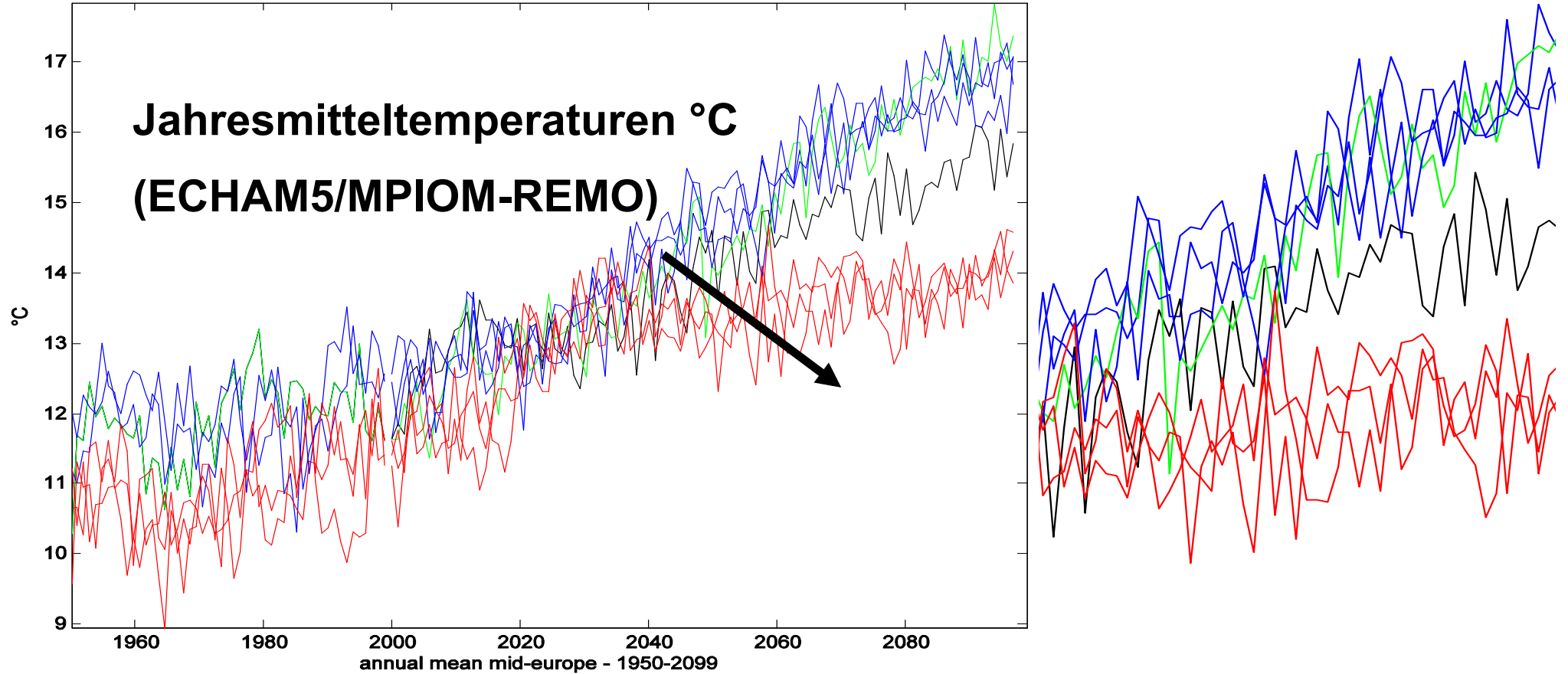
globale Klimasimulationen (GCMs)

Regionale Klimasimulationen (RCMs)



Regionale Klimaänderungssignale

ENSEMBLES 0.44° - 3 x A1B (blue), 1 x B1 (black), 1 x A2 (green), 3 x E (red)

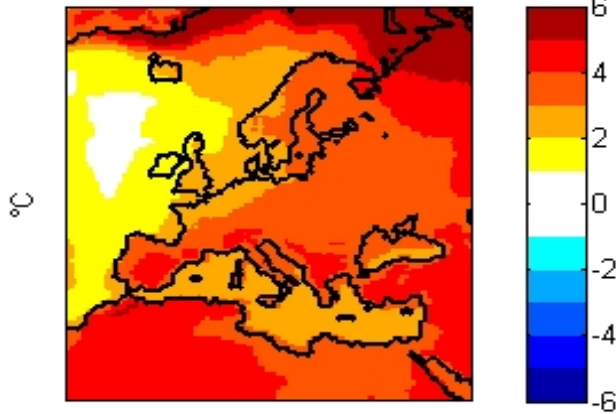


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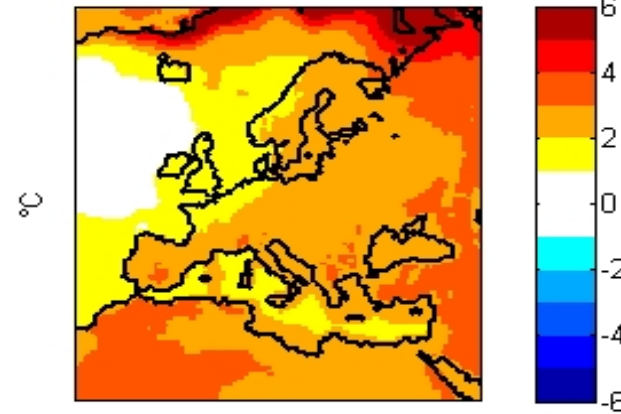
Temperaturänderungen - Jahr (C°)

ENSEMBLES 0.44° - mean A1B



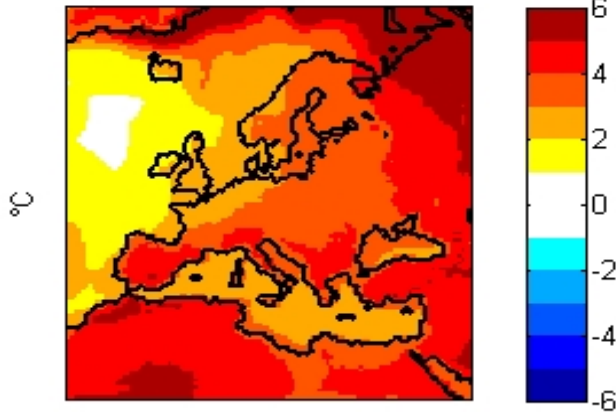
difference of annual mean - 2070-2099-1971-2000

ENSEMBLES 0.44° - mean B1



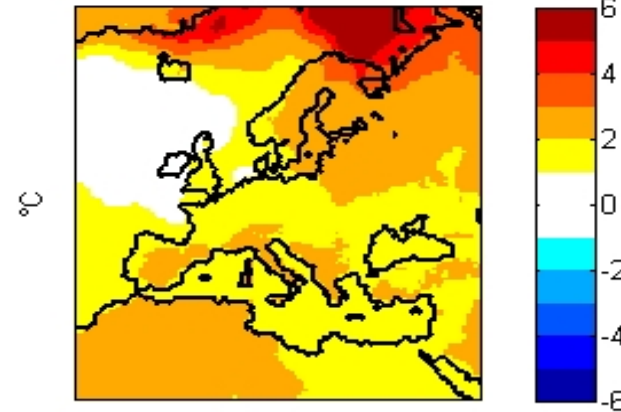
difference of annual mean - 2070-2099-1971-2000

ENSEMBLES 0.44° - mean A2



difference of annual mean - 2070-2099-1971-2000

ENSEMBLES 0.44° - mean E

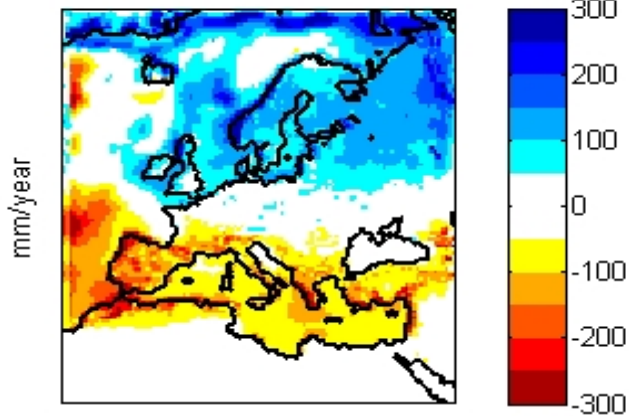


difference of annual mean - 2070-2099-1971-2000

Bis ~ 3 °C

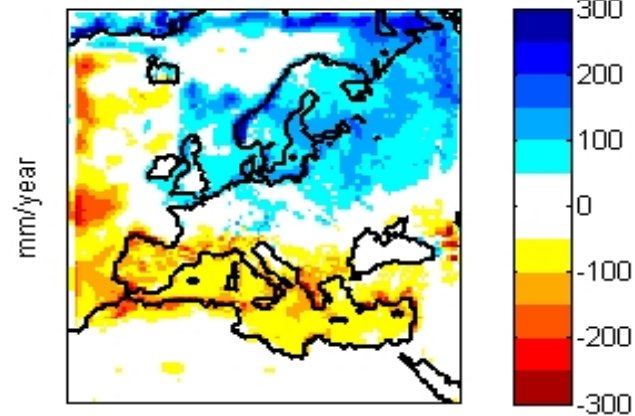
Niederschlagsänderungen - Jahr (mm/a)

ENSEMBLES 0.44° - mean A1B



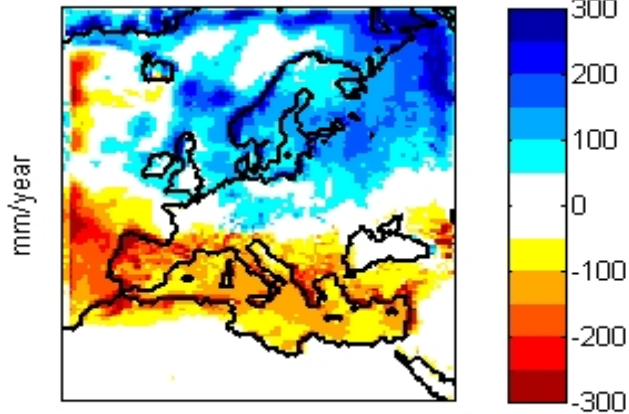
difference of annual mean - 2070-2099-1971-2000

ENSEMBLES 0.44° - mean B1



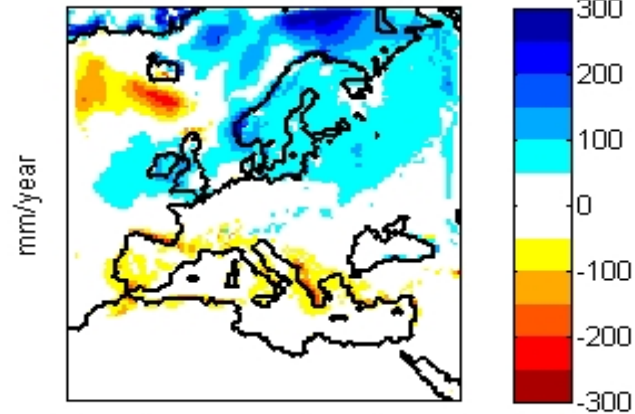
difference of annual mean - 2070-2099-1971-2000

ENSEMBLES 0.44° - mean A2



difference of annual mean - 2070-2099-1971-2000

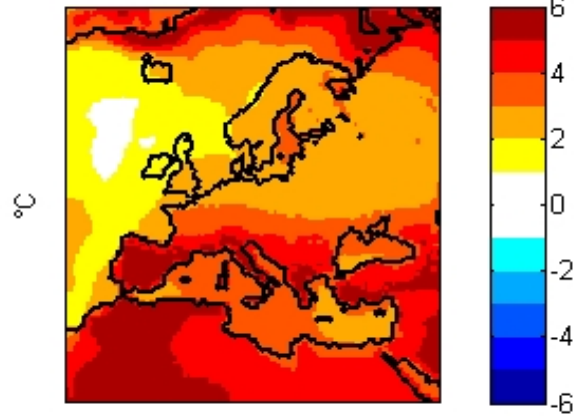
ENSEMBLES 0.44° - mean E



difference of annual mean - 2070-2099-1971-2000

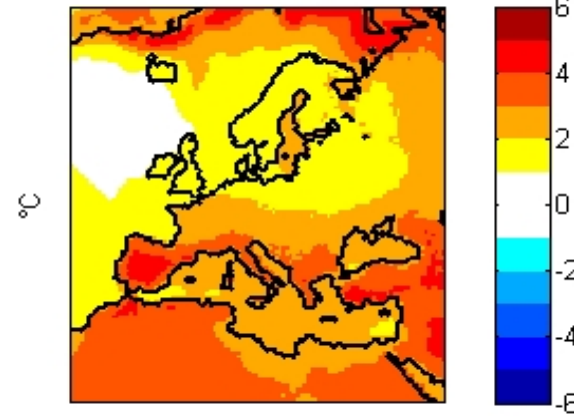
Temperaturänderungen - Sommer (C°)

ENSEMBLES 0.44° - mean A1B



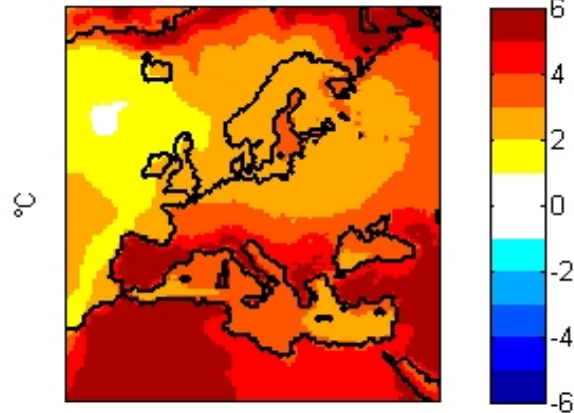
mean difference summer - 2070-2099-1971-2000

ENSEMBLES 0.44° - mean B1



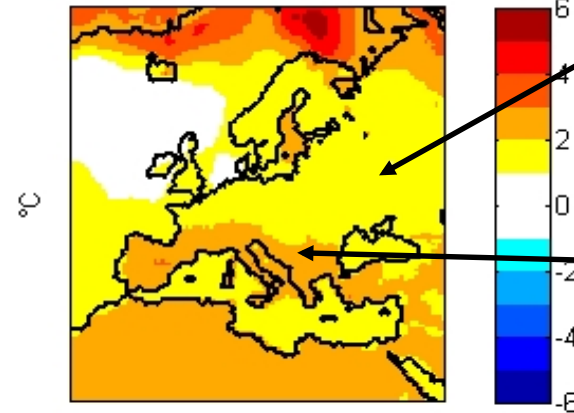
mean difference summer - 2070-2099-1971-2000

ENSEMBLES 0.44° - mean A2



mean difference summer - 2070-2099-1971-2000

ENSEMBLES 0.44° - mean E



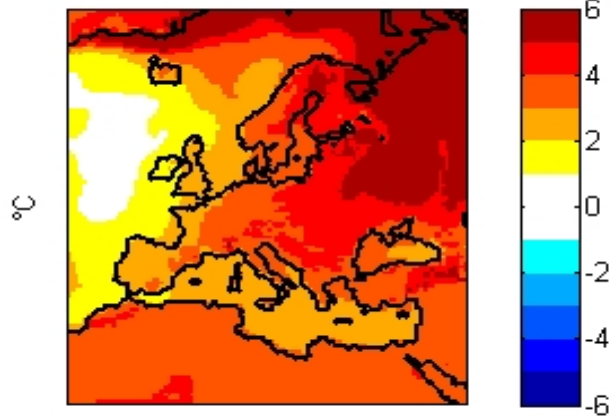
mean difference summer - 2070-2099-1971-2000

< 1°C

> 1°C

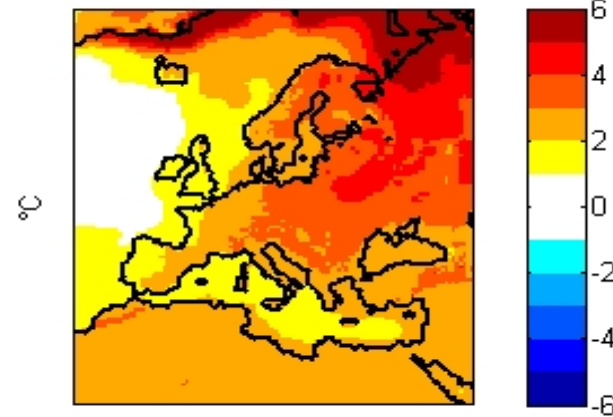
Temperaturänderungen - Winter (C°)

ENSEMBLES 0.44° - mean A1B



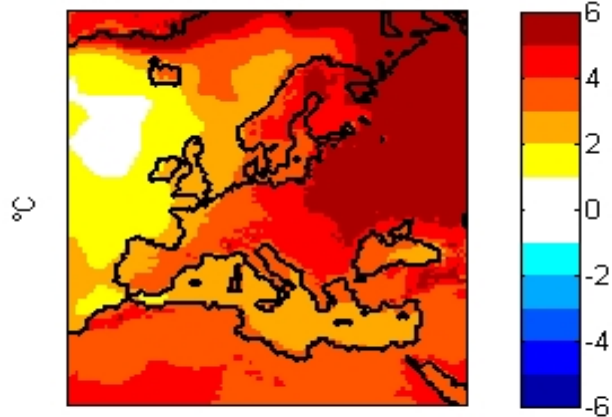
mean difference winter - 2070-2099-1971-2000

ENSEMBLES 0.44° - mean B1



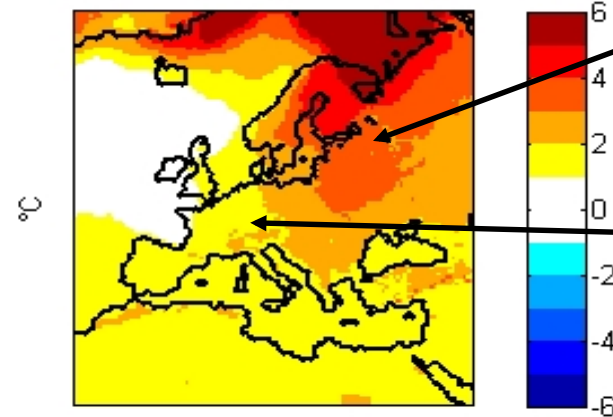
mean difference winter - 2070-2099-1971-2000

ENSEMBLES 0.44° - mean A2



mean difference winter - 2070-2099-1971-2000

ENSEMBLES 0.44° - mean E



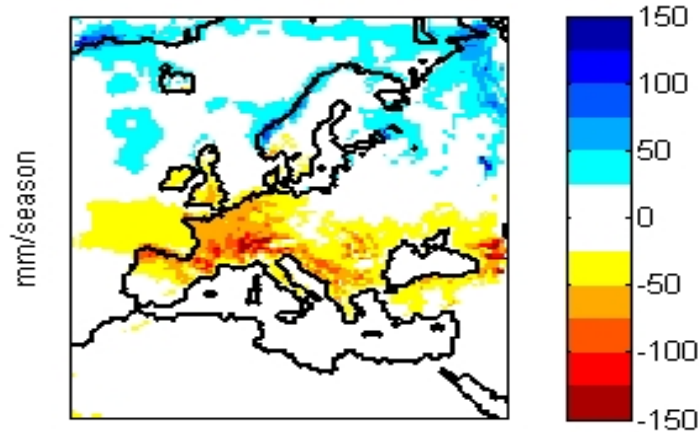
mean difference winter - 2070-2099-1971-2000

> 3°C

> 1°C

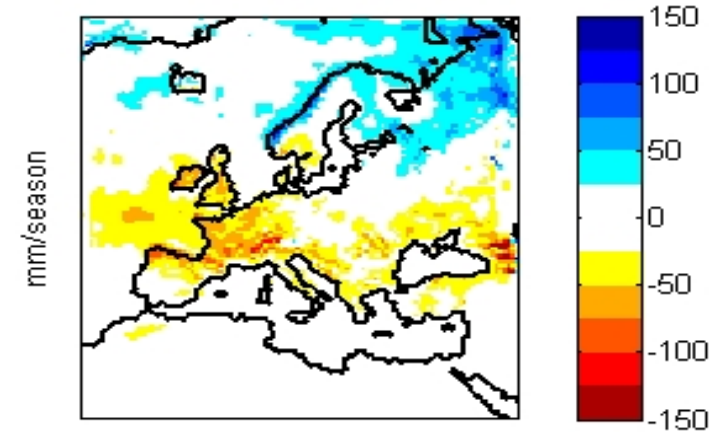
Niederschlagsänderungen: Sommer (mm/3 Monate)

ENSEMBLES 0.44° - mean A1B



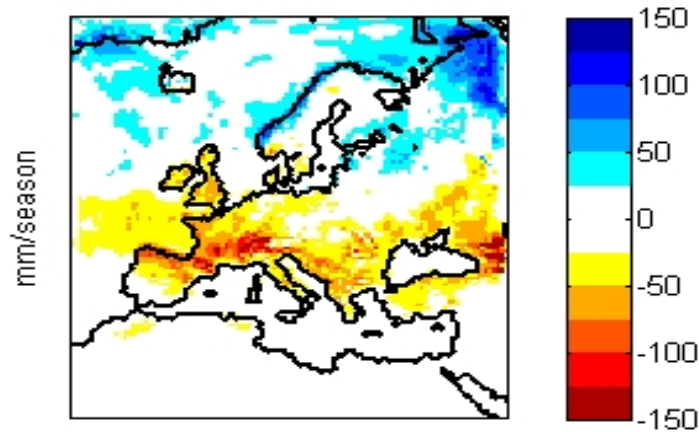
mean difference summer - 2070-2099-1971-2000

ENSEMBLES 0.44° - mean B1



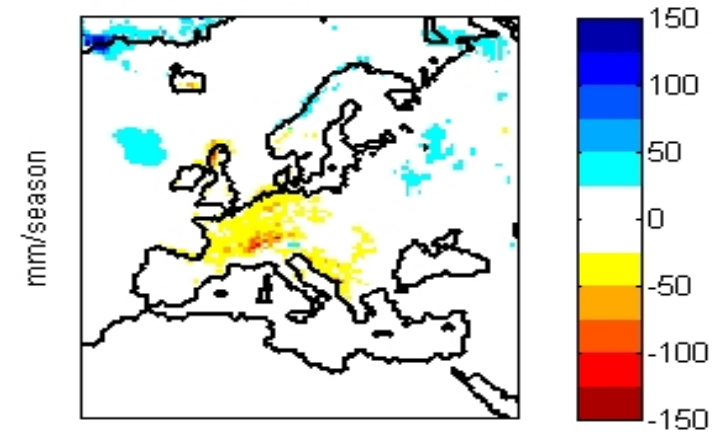
mean difference summer - 2070-2099-1971-2000

ENSEMBLES 0.44° - mean A2



mean difference summer - 2070-2099-1971-2000

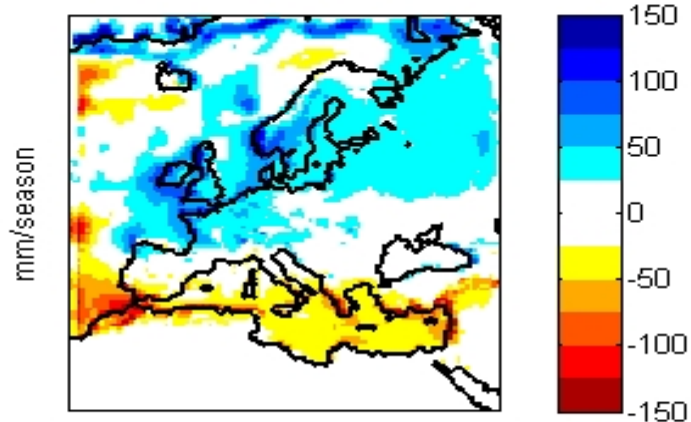
ENSEMBLES 0.44° - mean E



mean difference summer - 2070-2099-1971-2000

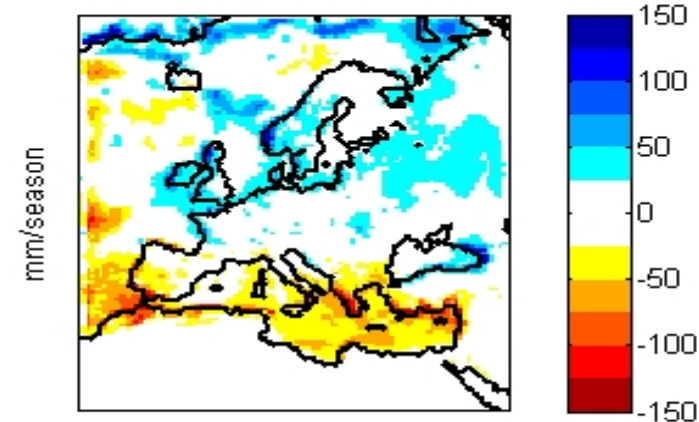
Niederschlagsänderungen: Winter (mm/3 Monate)

ENSEMBLES 0.44° - mean A1B



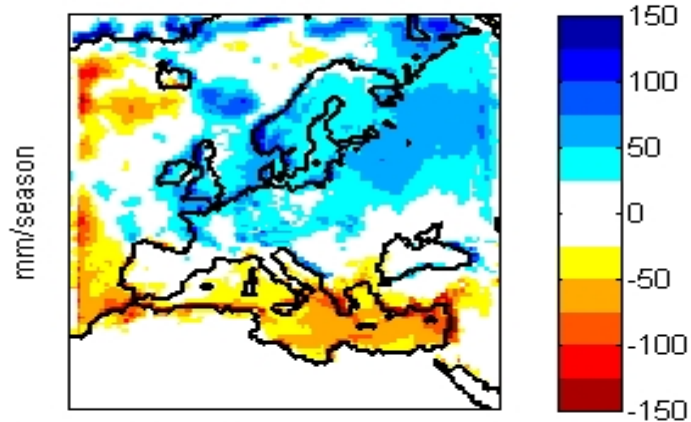
mean difference winter - 2070-2099-1971-2000

ENSEMBLES 0.44° - mean B1



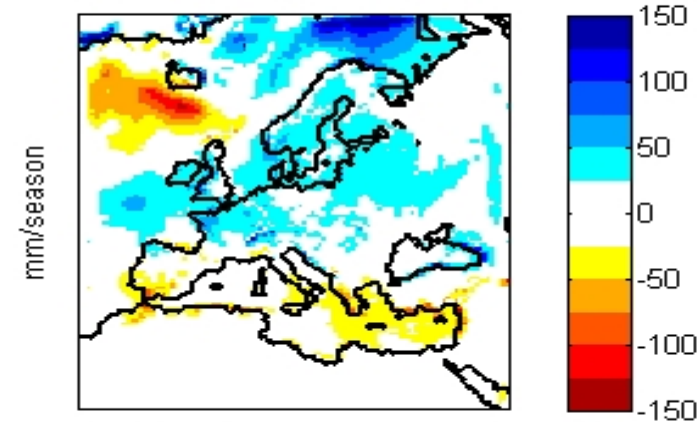
mean difference winter - 2070-2099-1971-2000

ENSEMBLES 0.44° - mean A2



mean difference winter - 2070-2099-1971-2000

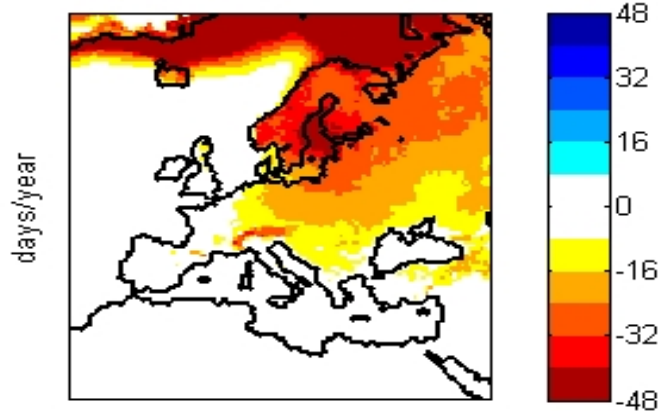
ENSEMBLES 0.44° - mean E



mean difference winter - 2070-2099-1971-2000

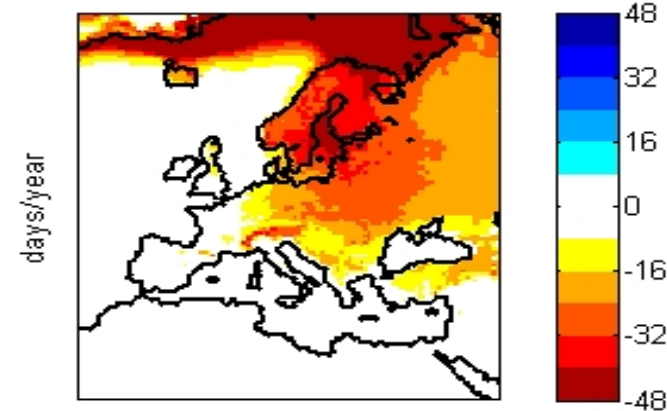
Änderungen der Zahl der Tage mit $T_{MAX} < 0^{\circ}C$

run 513/514 (E1) - days per year with $T_{max} < 0^{\circ}C$



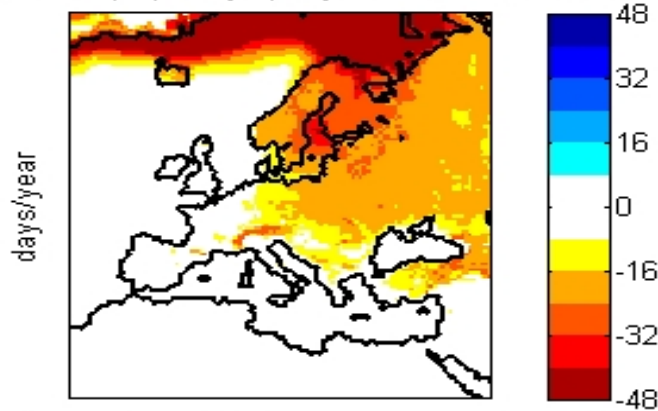
difference of annual mean - 2070-2099-1971-2000

run 521/515 (E1) - days per year with $T_{max} < 0^{\circ}C$



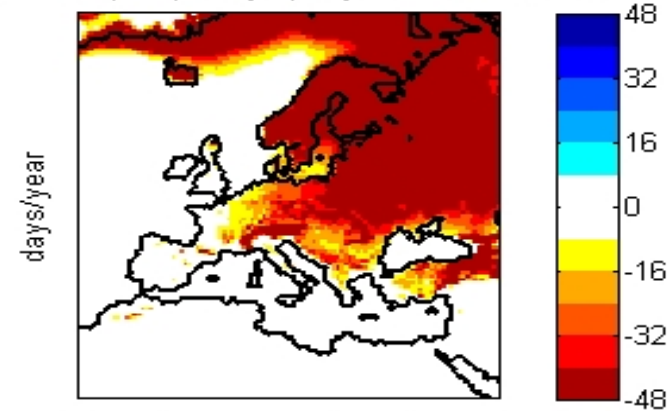
difference of annual mean - 2070-2099-1971-2000

run 522/523 (E1) - days per year with $T_{max} < 0^{\circ}C$



difference of annual mean - 2070-2099-1971-2000

run 500/501 (A1B) - days per year with $T_{max} < 0^{\circ}C$

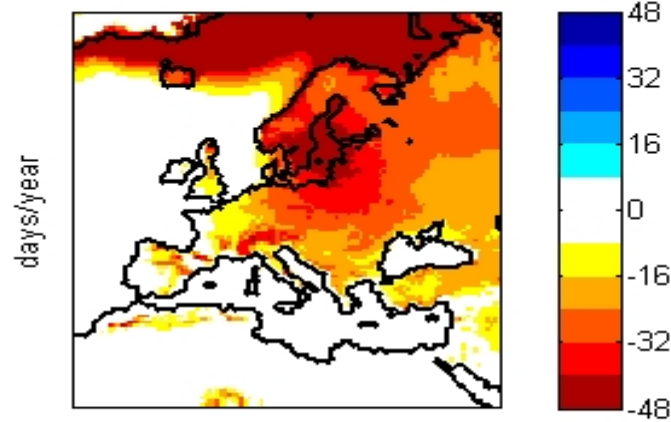


difference of annual mean - 2070-2099-1971-2000

A1B

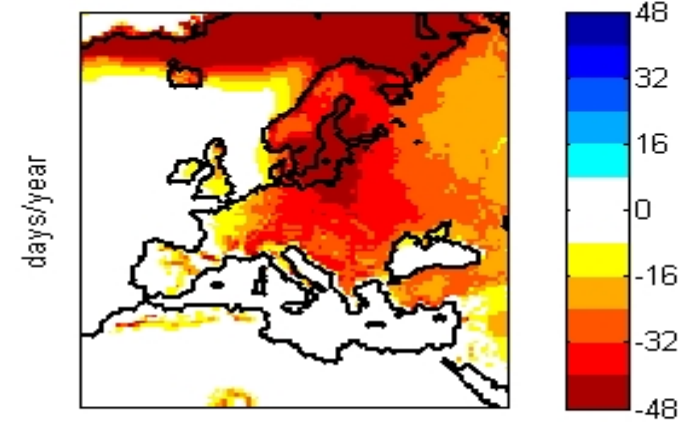
Änderungen der Zahl der Tage mit $T_{min} < 0^{\circ}C$

run 513/514 (E1) - days per year with $T_{min} < 0^{\circ}C$



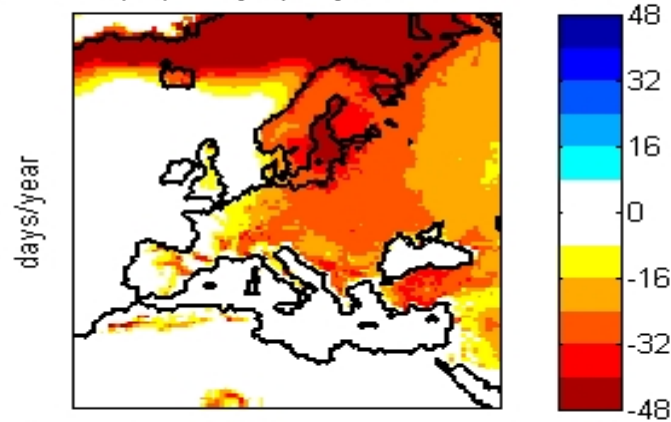
difference of annual mean - 2070-2099-1971-2000

run 521/515 (E1) - days per year with $T_{min} < 0^{\circ}C$



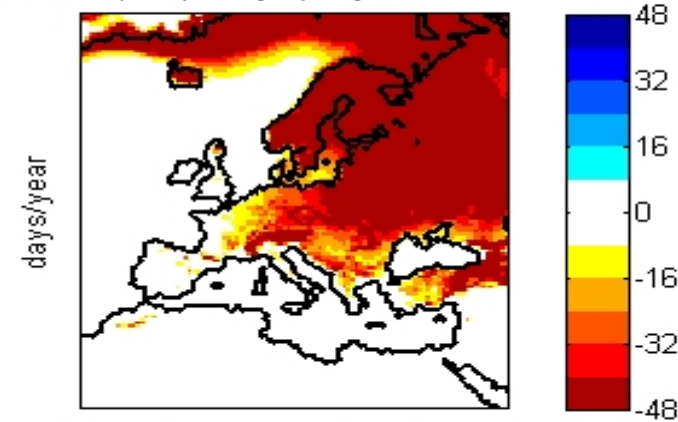
difference of annual mean - 2070-2099-1971-2000

run 522/523 (E1) - days per year with $T_{min} < 0^{\circ}C$



difference of annual mean - 2070-2099-1971-2000

run 500/501 (A1B) - days per year with $T_{min} < 0^{\circ}C$

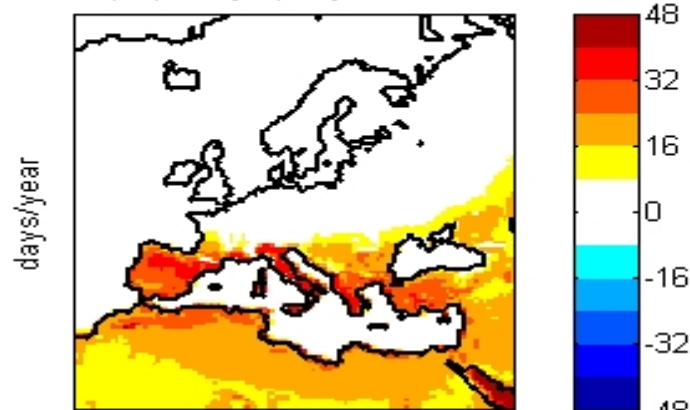


difference of annual mean - 2070-2099-1971-2000

A1B

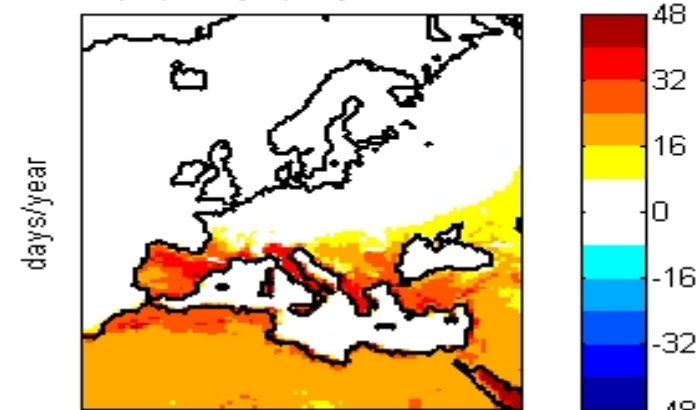
Änderungen der Zahl der Tage mit TMAX > 30°C

run 513/514 (E1) - days per year with T_{max} > 30°C



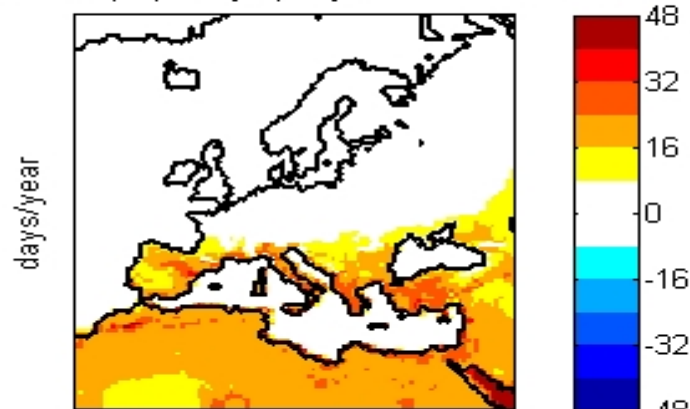
difference of annual mean - 2070-2099-1971-2000

run 521/515 (E1) - days per year with T_{max} > 30°C



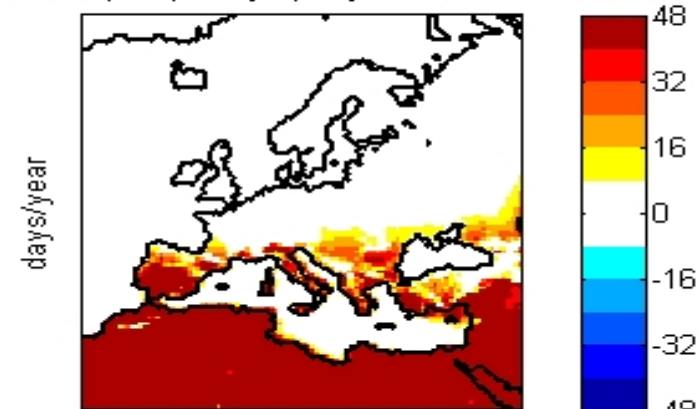
difference of annual mean - 2070-2099-1971-2000

run 522/523 (E1) - days per year with T_{max} > 30°C



difference of annual mean - 2070-2099-1971-2000

run 500/501 (A1B) - days per year with T_{max} > 30°C

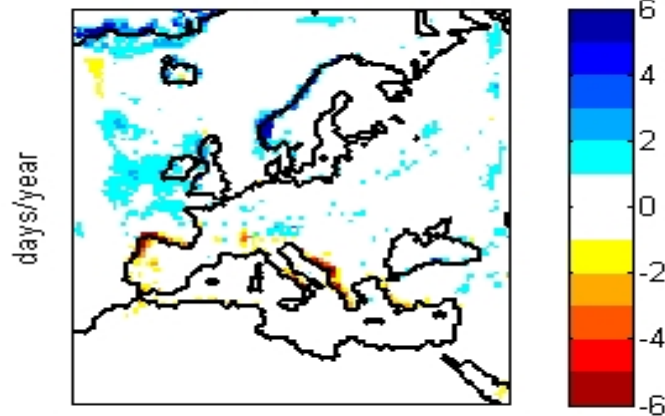


difference of annual mean - 2070-2099-1971-2000

A1B

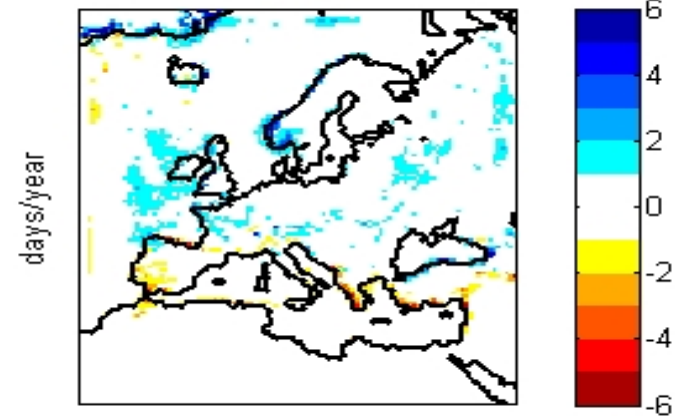
Änderungen der Zahl der Tage mit $P > 25$ mm

run 513/514 (E1) - days per year with Tprec > 25mm



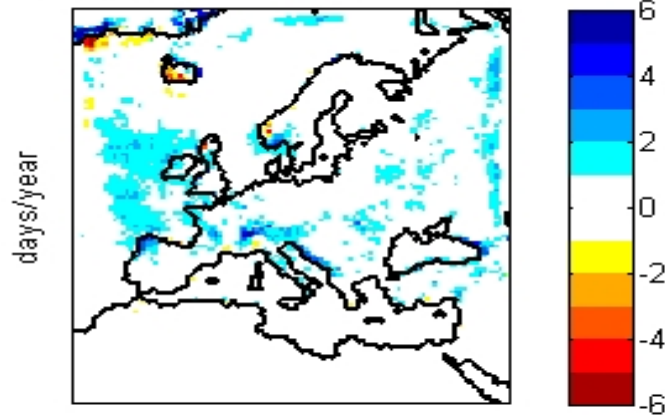
difference of annual mean - 2070-2099-1971-2000

run 521/515 (E1) - days per year with Tprec > 25mm



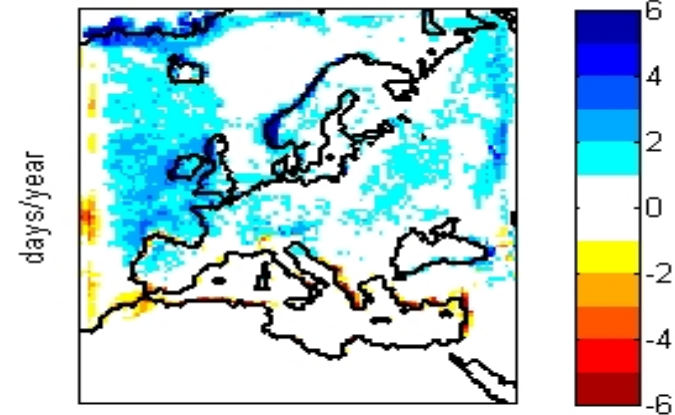
difference of annual mean - 2070-2099-1971-2000

run 522/523 (E1) - days per year with Tprec > 25mm



difference of annual mean - 2070-2099-1971-2000

run 500/501 (A1B) - days per year with Tprec > 25mm

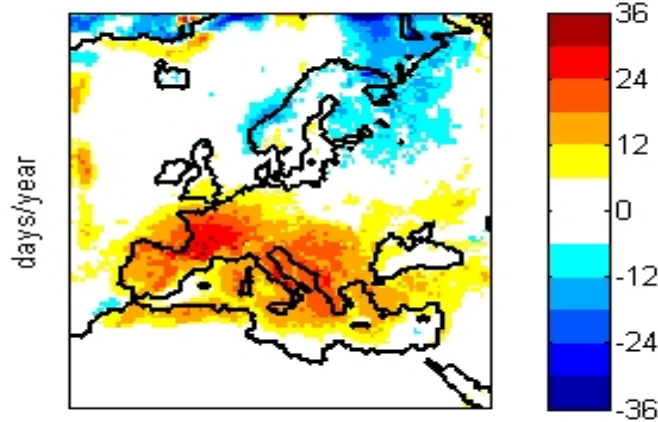


difference of annual mean - 2070-2099-1971-2000

A1B

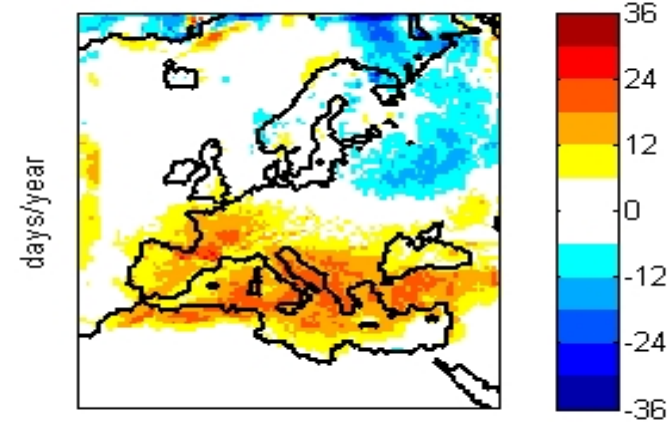
Änderungen der Zahl der Tage mit $P < 0.1$ mm

run 513/514 (E1) - days per year with $T_{prec} < 0.1$ mm



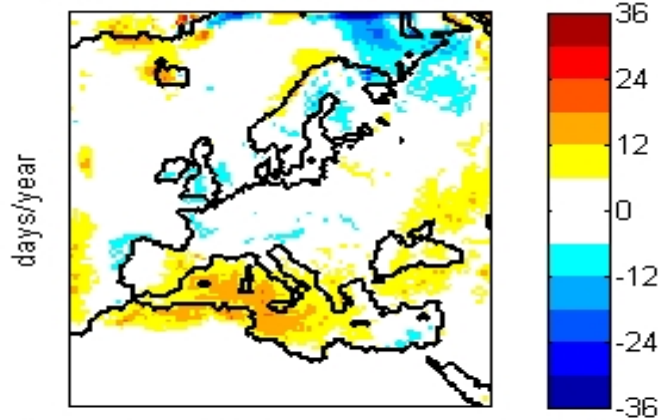
difference of annual mean - 2070-2099-1971-2000

run 521/515 (E1) - days per year with $T_{prec} < 0.1$ mm



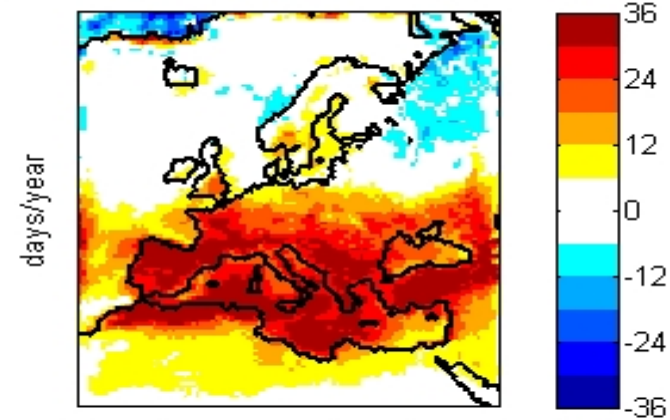
difference of annual mean - 2070-2099-1971-2000

run 522/523 (E1) - days per year with $T_{prec} < 0.1$ mm



difference of annual mean - 2070-2099-1971-2000

run 500/501 (A1B) - days per year with $T_{prec} < 0.1$ mm



difference of annual mean - 2070-2099-1971-2000

A1B

Gliederung

- NAS- Bericht
 - Das E1 – Szenario
 - Klima in Europa
 - **Zusammenfassung und Ausblick**
-

Zusammenfassung für Europa

(E1-Szenario)

Erwärmung bis etwa 3°C, aber fast keine Änderungen im Niederschlagsangebot (< 10%)

Regional und saisonal unterschiedliche Temperaturzunahmen bis etwa

4 °C im Winter in Skandinavien

3 °C im Sommer in Südeuropa

Weniger Eistage und kalte Tage (~20-30),

mehr heiße Tage (aber nur ~ 20 im Vergleich zu mehr als 40 in A1B)

mehr trockene Tage (aber nur ~10 im Vergleich zu mehr als 25 in A1B)

keine Änderungen in der Zahl der nassen Tage

Das Klima **wird sich** auch in Europa ändern,
selbst **wenn das globale 2° Ziel erreicht würde!**

Wie robust sind die regionalen Klimaänderungen?

**Bisher nur Simulationen der Modellkette ECHAM5/MPIMOM-REMO
→ andere Modellketten anwenden und Ergebnisse analysieren**

Weitere E1-Szenarien für Deutschland (3 Läufe auf ~10km auswerten)

Trotzdem:

Anpassung ist notwendig

(Optionen und Kosten hängen von Klimaänderungen ab)

ebenso wie viel mehr Maßnahmen zur Schadgasminderung!

(um Klimaänderungen zu begrenzen)
