Setting the scene:
Climate Change in Europe

Emmanuel Cloppet
Météo-France

INTERNATIONAL CONFERENCE
Tackling climate change:
the contribution of forest scientific knowledge
21 - 24 May, 2012, Tours (France)

METEO FRANCE
Toujours un temps d'avance

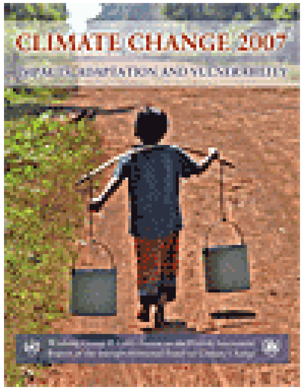
Foreword: Climate

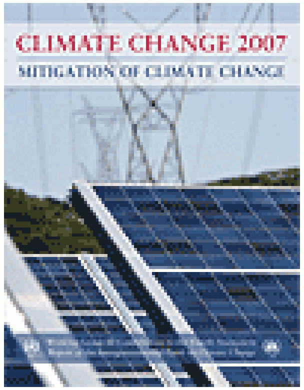
To begin with….

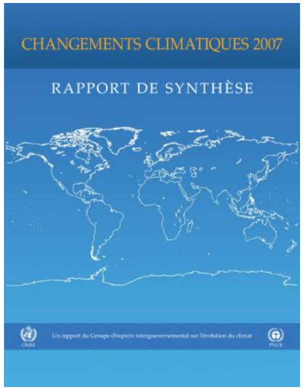
- Climate is commonly defined as the weather averaged over a long period. The standard averaging period is 30 years (WMO).
- Climate varies continually on all time scales, from months to thousands or millions of years.
- Variability may be due to natural internal processes within the climate system (internal variability), to variations in natural external forcing (astronomical parameters, solar activity, volcanic activity) or anthropogenic external forcing (external variability).

IPCC Fourth Assessment Report, Climate Change 2007

Technical Summary and Summary for Policymakers





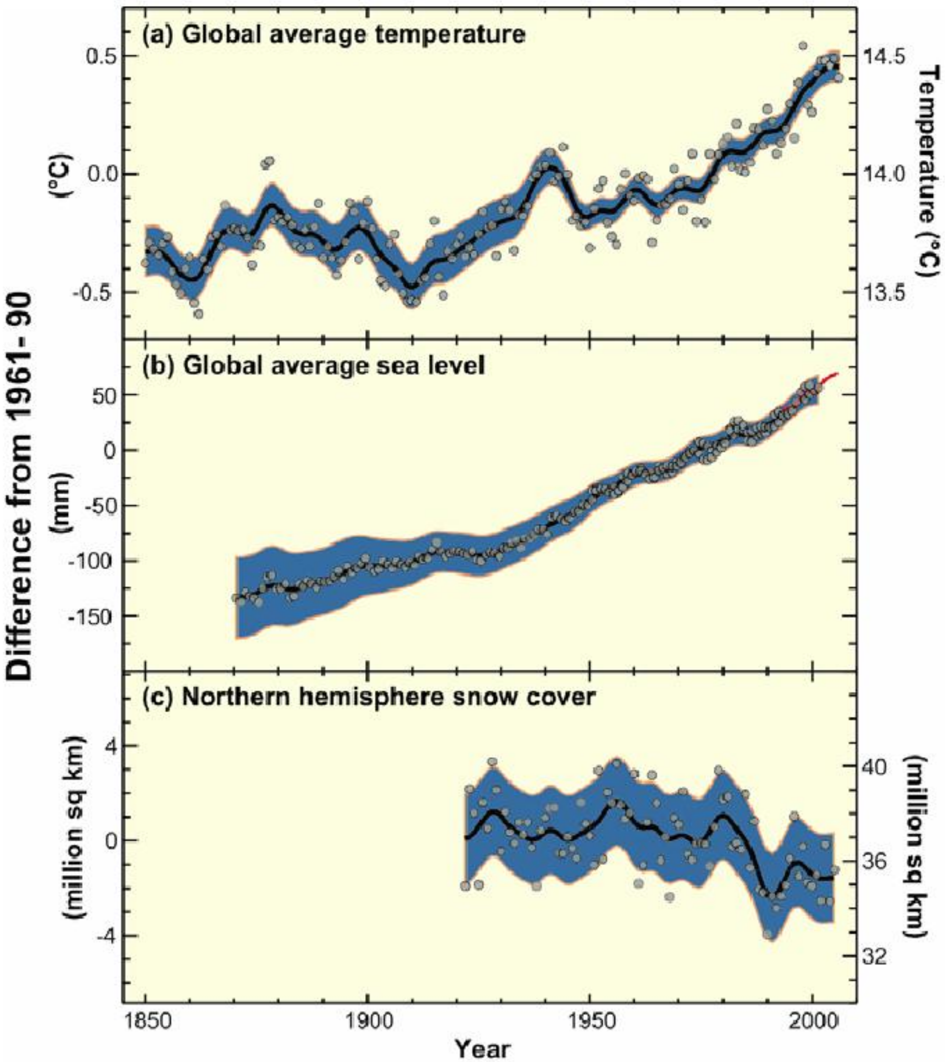


Assessment reports

Available on:
www.ipcc.ch

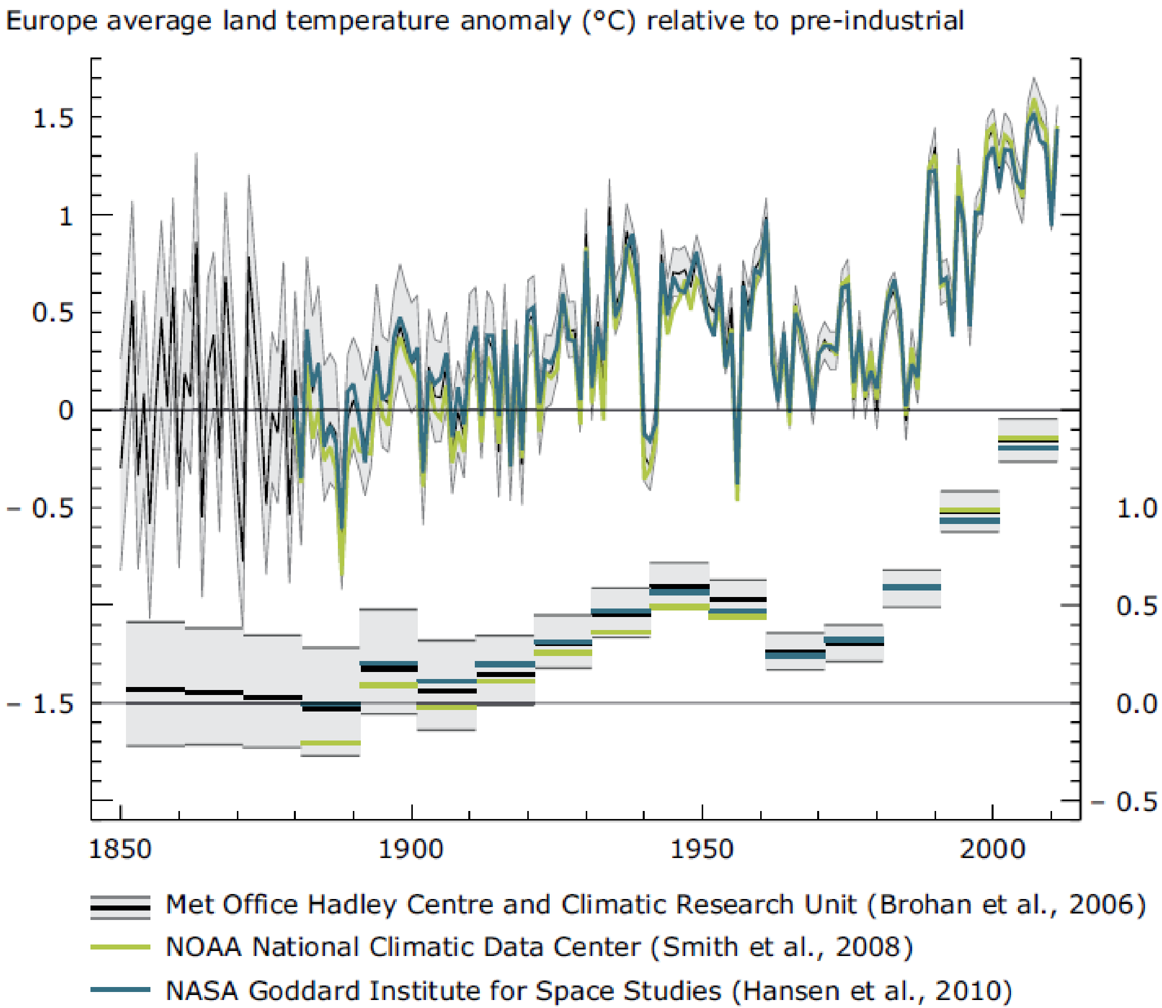
METEO FRANCE
Toujours un temps d'avance

Changes in temperature, sea level, and Northern Hemisphere snow cover



- Source: IPCC, Climate change 2007, syntheses report, summary for policy makers.
- Warming in the climate system is unequivocal.
- Most of the observed increase in global averaged temperature is very likely due to increase in GHG concentrations.

Europe average land temperature anomaly relative to pre-industrial



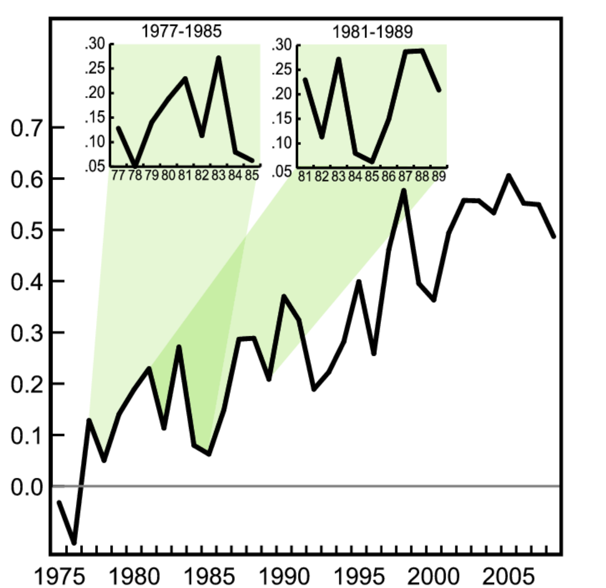
Source: CSI 12 indicator.

- Europe has warmed more than the global average.
- Decadal average temperature over European land areas increased by approximately 1.3°C between pre-industrial times and the decade of 2002 to 2011.
- Considering the European land area, 9 out the last 12 years were among the warmest years since 1850 (Environmental indicator report 2012).

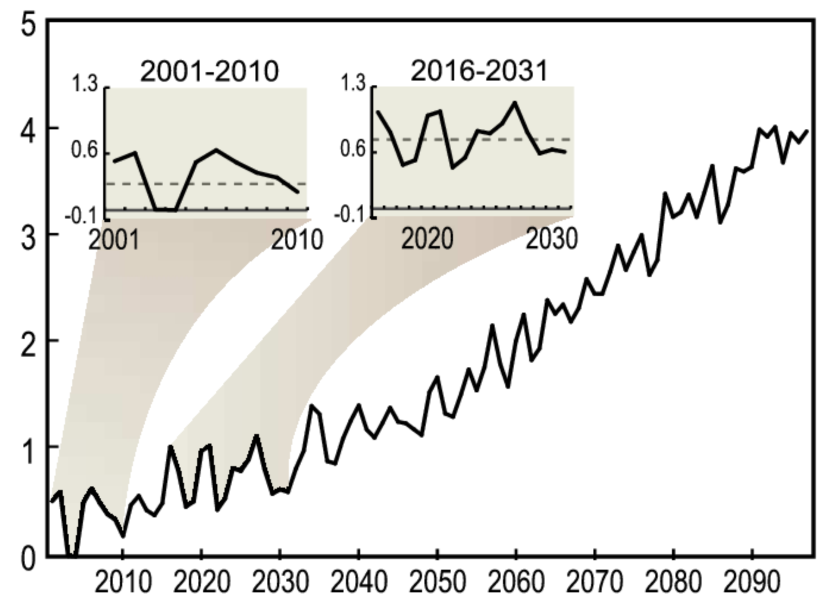
What climate researchers never said:

- Climate reserchers never said that every new year will be warmer than the previous ones - climate variability should be understood as a superimposition of external forced response + internal variability. The latter may temporally cancel out the anthropogenic effects, especially at regional scale.

- Climate reserchers never tried to predict the phase of the internal decadal variability that modulates the trend, because so far numerical simulations were designed to estimate the sole forced response : the copenhague hold-up (Cassou 2011).



Observations de 1975 à 2008

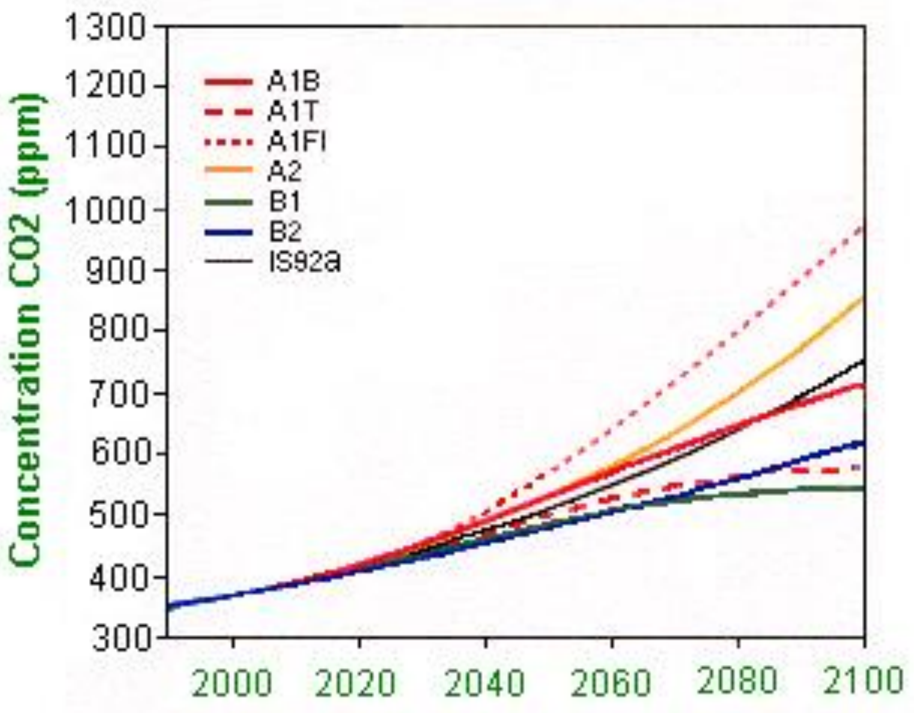


Global mean temperature (Easterling et Wehner, 2009)

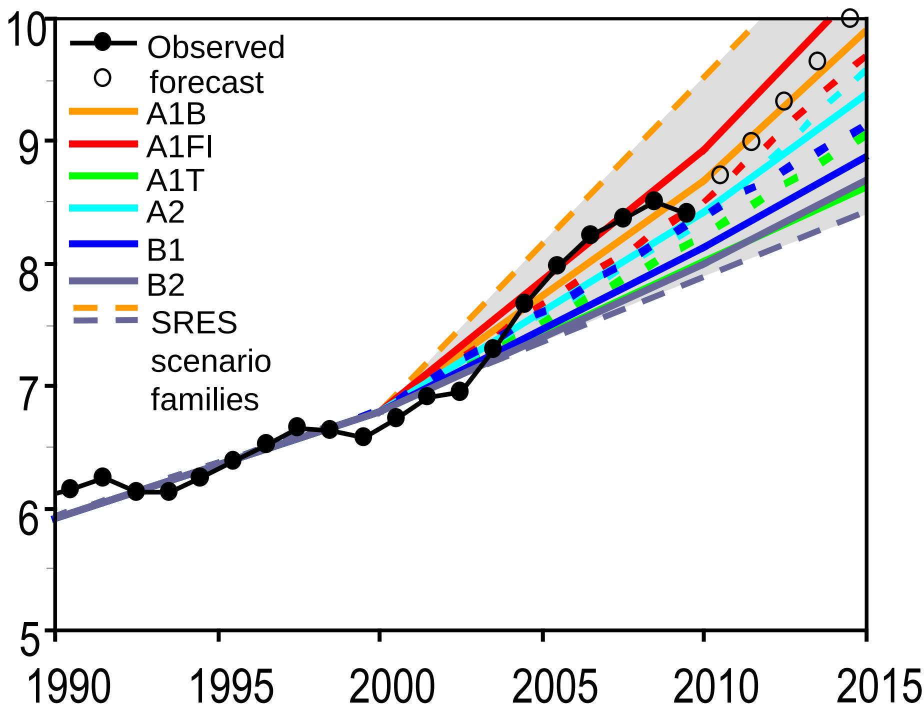
Projection de 2000 à 2100, scénario A2

SRES scenario families for the 21st century (IPCC 2000)

CO_2 concentration (ppm) from SRES scenarios

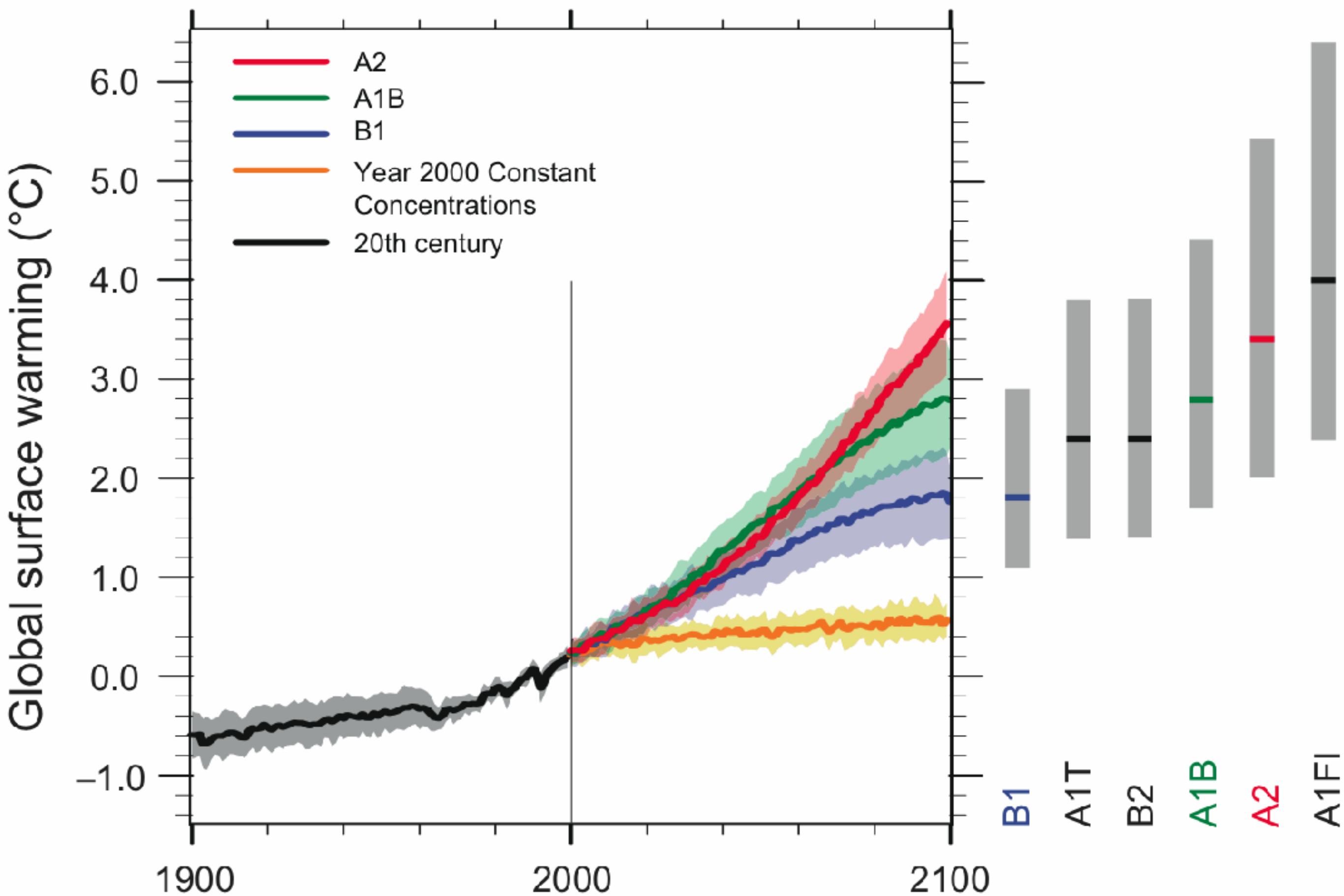


Observed global CO_2 emission and SRES scenarios (Global Carbon project, 2011)



Climate projections (IPCC 2007)

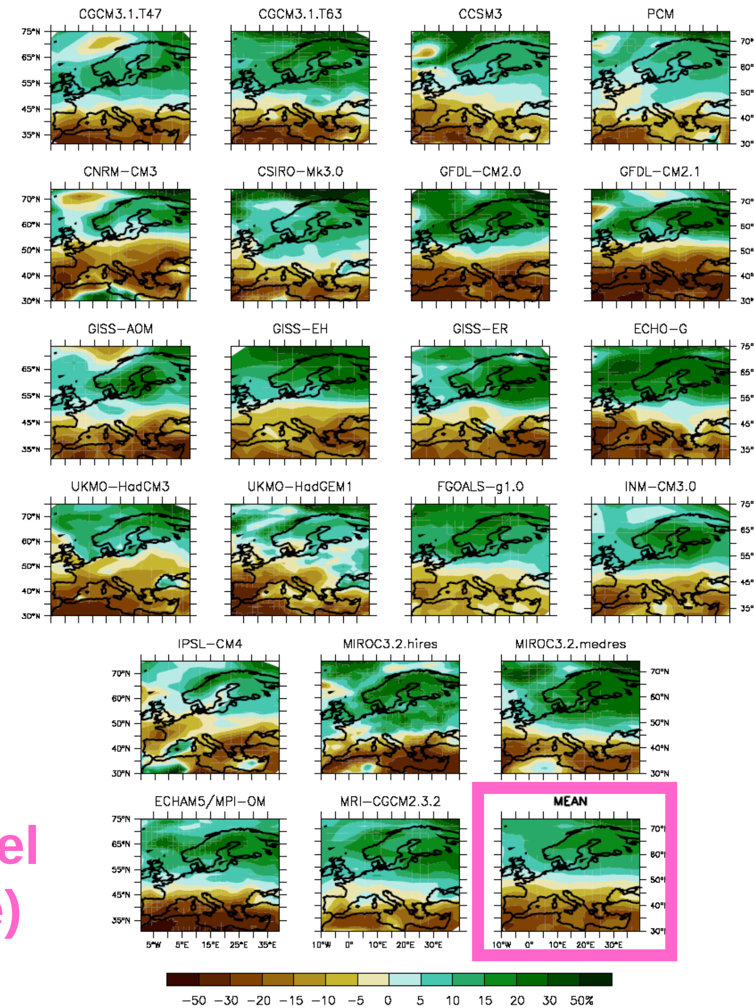
Projected multi-model global average surface warming at the end of the 21st century (relative to 1980–1999)



- Likely range is 2°C to 4,5°C
- Best estimate: +3°C
- The uncertainties for the next two decades depend on low-frequency natural fluctuations rather than on the scenario.
- A challenging issue tackled for the first time in the next IPCC report.

Changes in annual temperature and precipitation 2080-2099 vs 1980-1999, A1B scenario

Multi-model (ensemble) mean



Annual mean for the different IPCC climate models and Multi-model (ensemble) mean(source: IPCC AR4) (Somot 2011)

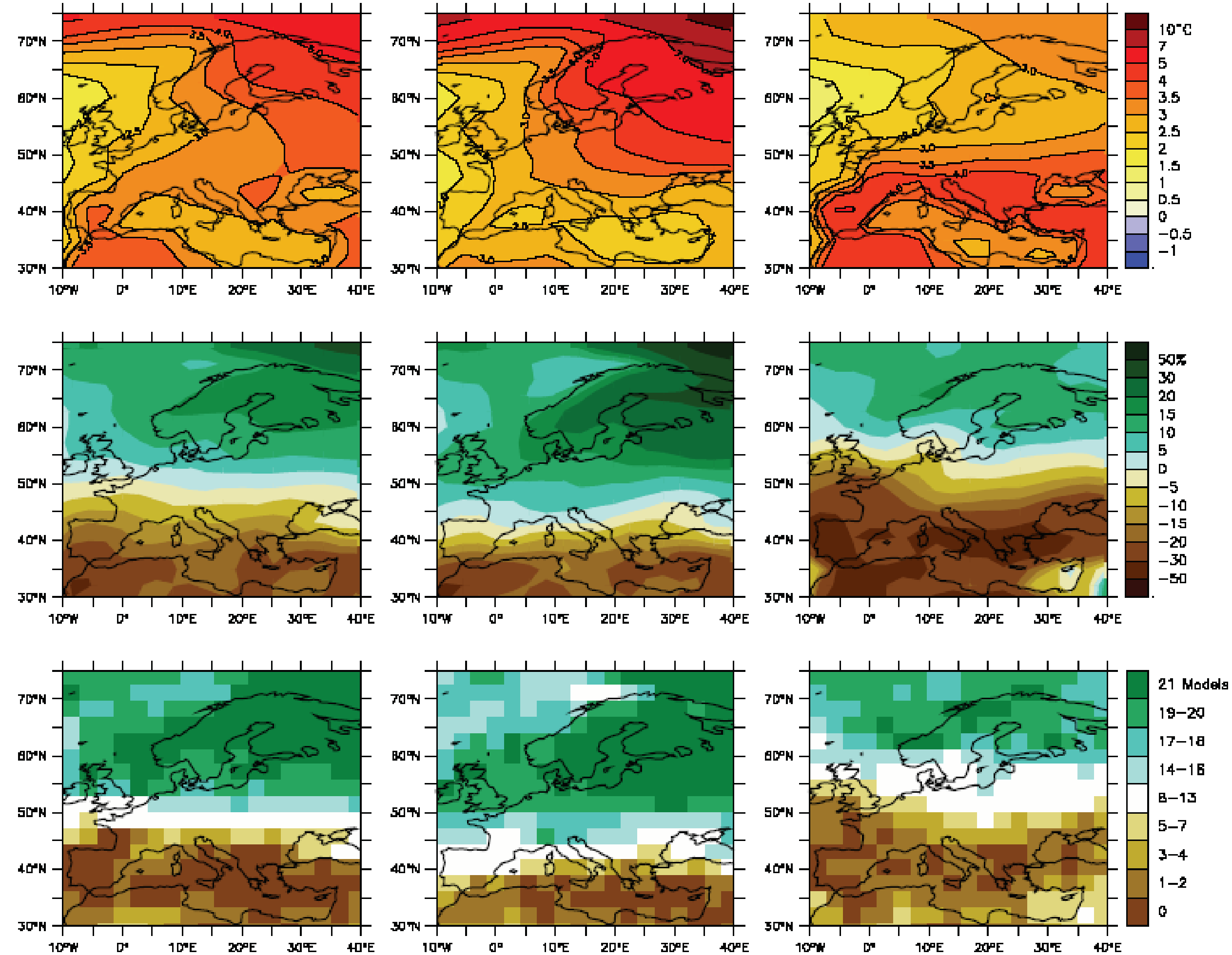
Changes in seasonal temperature and precipitation 2080-2099 vs 1980-1999, A1B scenario

Annual mean | Winter (DJF) | Summer (JJA)

Temperature (°C) (ensemble mean)

Precipitation (%) (ensemble mean)

Number of models modelling a rainfall amount increase



source: IPCC AR4 (Somot 2011)

Climate change in Europe

- Likely or very likely
  - The warming is stronger over land areas than over the sea
  - A stronger summer warming and a smaller winter warming.
  - In summer, stronger warming is predicted in Southern Europe
  - In winter, stronger warming is predicted in Eastern Europe
  - A decrease in annual precipitation in Southern Europe
  - An increase in annual precipitation in Northern Europe
  - More frequent heat waves
- We don't know
  - Where is the limit between + / - precipitation
  - The evolution of strong winds associated with depressions
  - Extreme rainfall events trends
  - Assessing and summarizing uncertainties in relation with downscaling

ENSEMBLES http://ensembles-eu.metoffice.com/
CECILIA http://www.cecilia-eu.org/
CIRCE http://www.circeproject.eu/
CORDEX http://wcrp.ipsl.jussieu.fr/RCD_CORDEX.html
HyMeX http://www.hymex.org/
Charmex http://charmex.lsce.ipsl.fr/
MERMEX http://mermex.com.univ-mrs.fr/
SCAMPEI http://www.cnrm.meteo.fr/scampei/

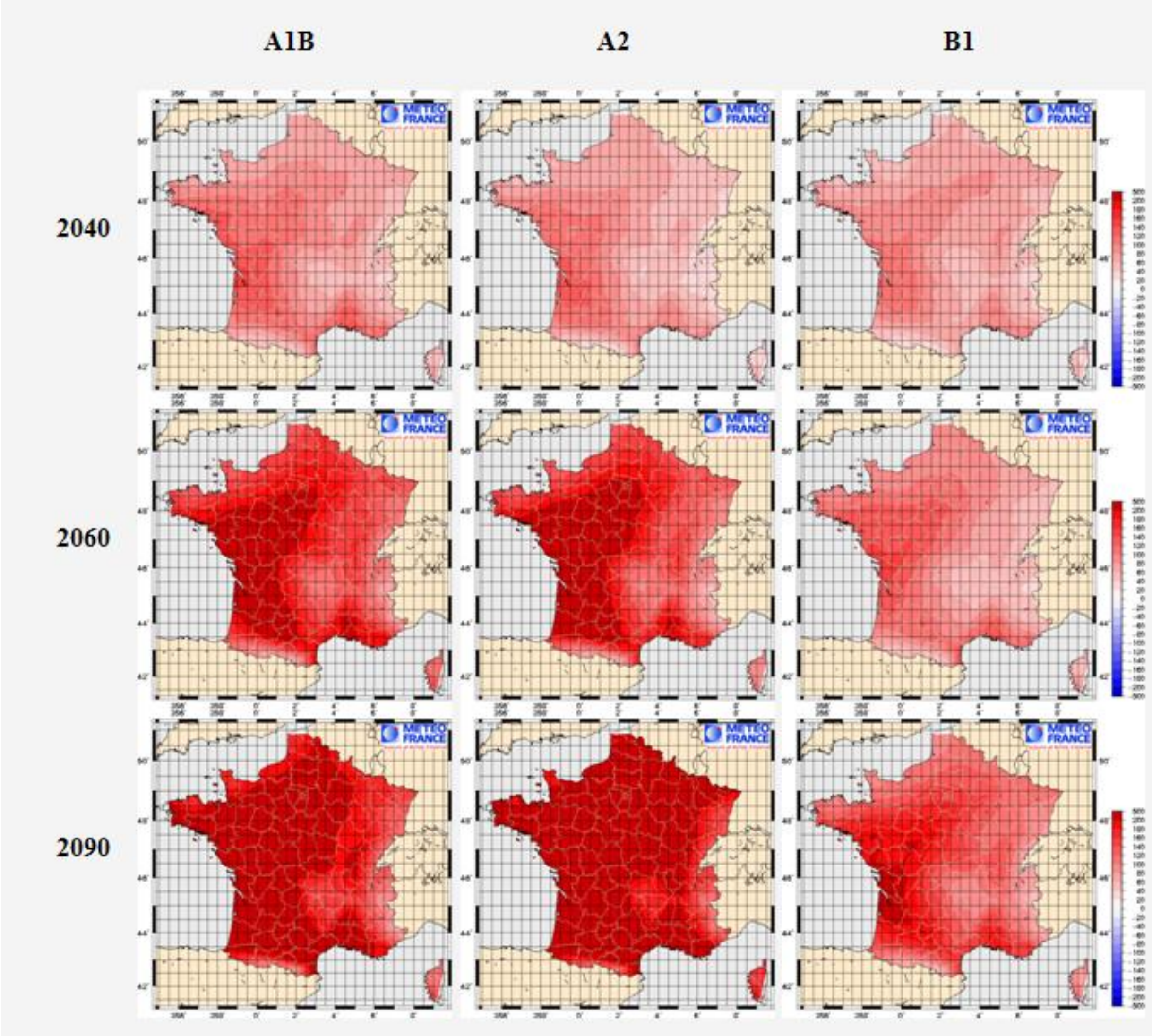
(Somot 2011)

Changes in annual Potential Evapotranspiration

Annual sum:
+60 mm / +80 mm

Annual sum:
+80 mm / +150 mm

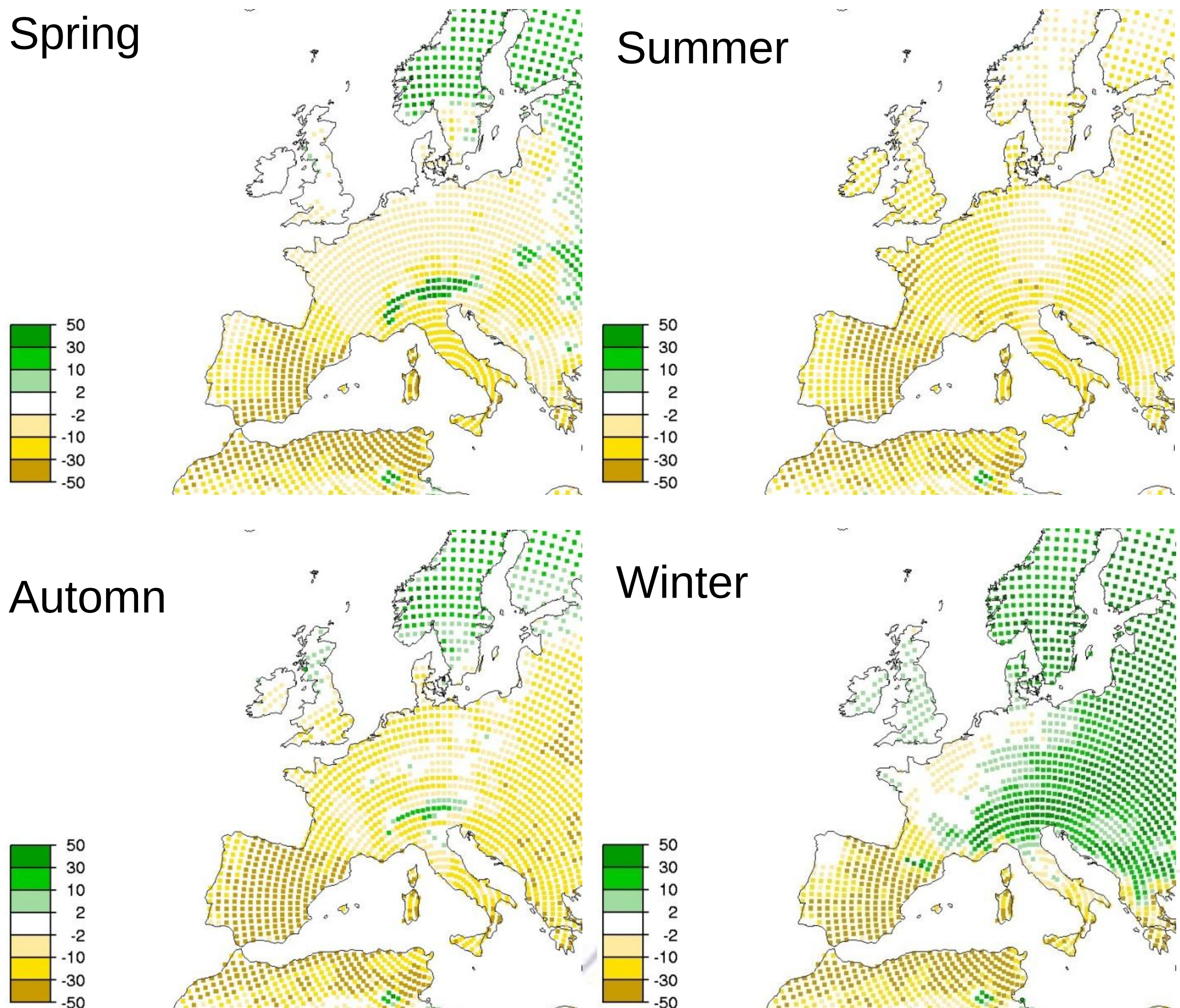
Annual sum:
+120 mm / +250 mm



Evolution of seasonal soil liquid water content over Europe

Mean soil liquid water content anomalies in mm between 2070-2099 and 1960-1989 periods simulated by the variable resolution forced model ARPEGE-Climat (2003) – B2 scenario

- In winter, soil water content may increase by 10-50 mm over Eastern and Northern Europe and decrease over Spain, Italy and Greece.
- During other seasons a decrease in soil wetness is observed except for Northern Europe.
- In summer ARPEGE model suggests a general decrease in soil water content which ranges between 2 and 50 mm.

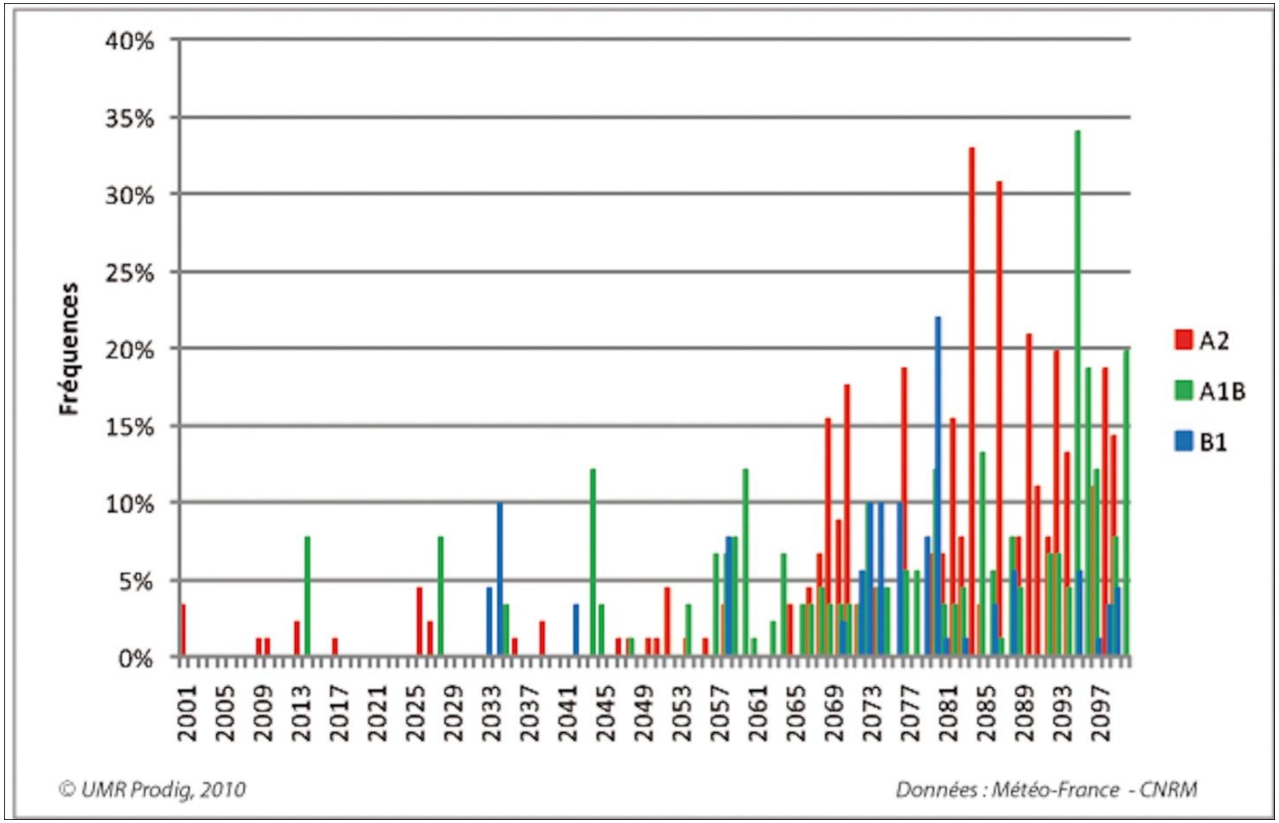


Climate Change and variability

Future climate scenarios show not only possible changes in the mean climate of the Earth system but also changes in extreme weather and climate events.

Possible future changes in intensity and/or frequency of extreme events need new adaptation and risk management strategies taking into account how the statistics of extreme events may change.

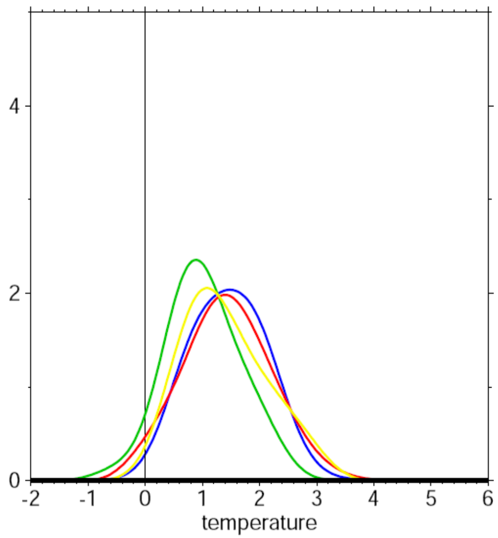
Frequency of daily temperature above 35°C from June to August over Marne region. ARPEGE Climat V4 Model with 3 SRES scenarios.



Managing uncertainties: probabilistic approach for Paris (ENSEMBLES project)

Scénario A1B, 25 km, 16 simulations, 2021-2050 vs 1961-1990

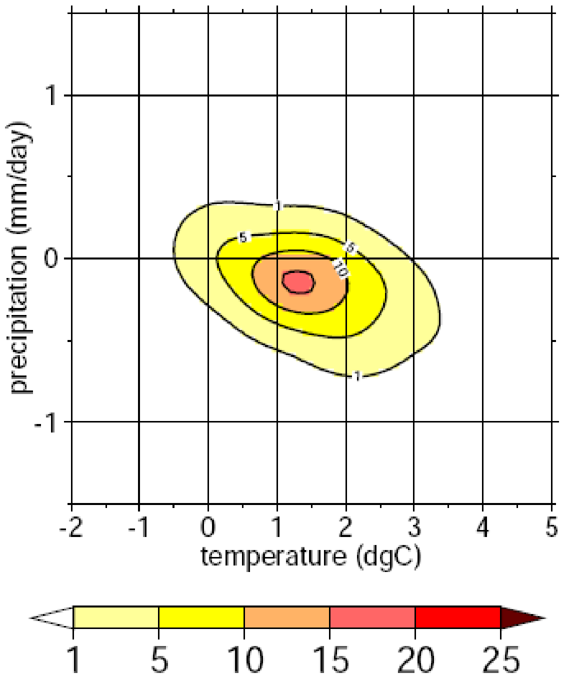
Change in surface temperature



Probability Density Function (10^{-2} °C^{-1})

DJF (blue), MAM (green), JJA (red), SON (yellow)

Change in temperature and precipitation in summer

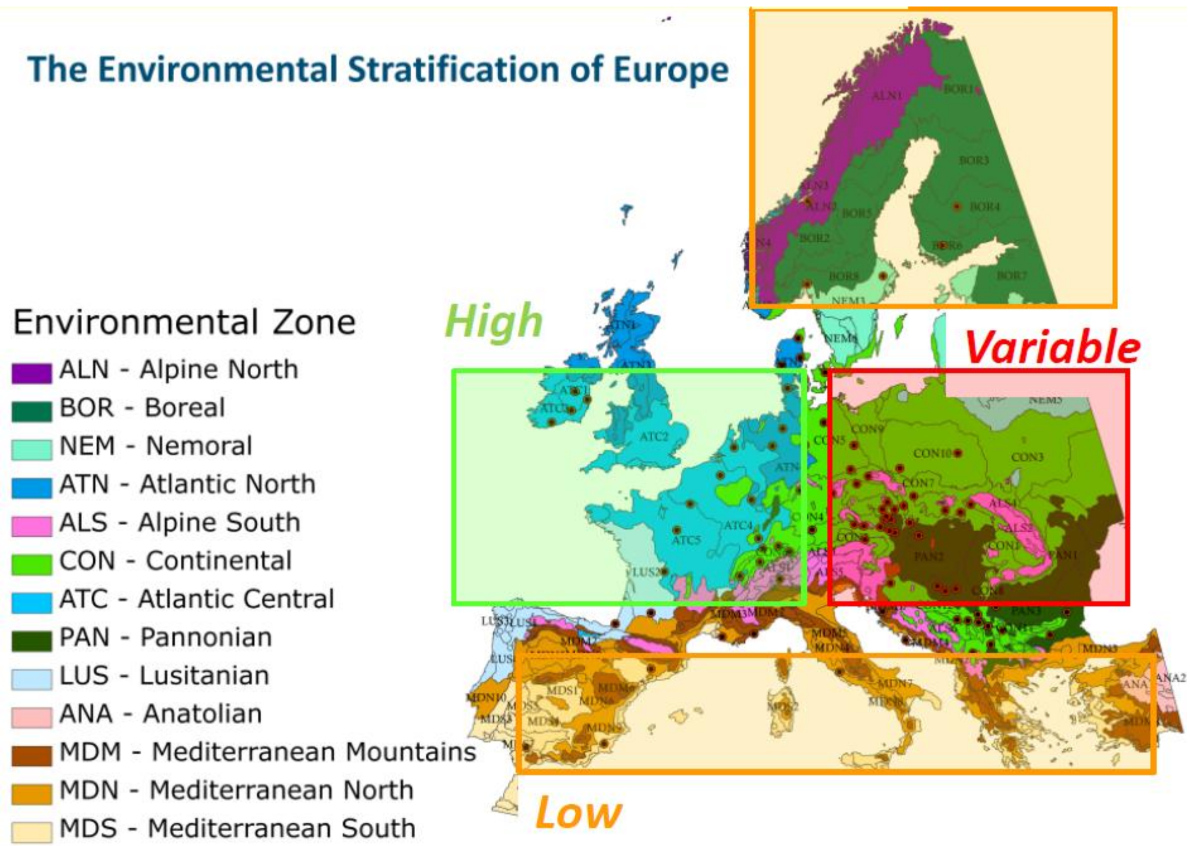


bivariate probability density function (10^{-4} °C^{-1}.mm^{-1}.jour)

Source: ENSEMBLES http://ensembles-eu.metoffice.com/

Focus on agroclimatic conditions

Environnemental zones – rainfed productivity



Trnka, M., Olesen, J. E., Kersebaum, K. C., Skjelvag, A. O., Eitzinger, J., Seguin, B., Peltonen-Sainio, P., Rotter, R., Iglesias, A., Orlandini, S., Dubrovsky, M., Hlavinka, P., Balek, J., Eckersten, H., Cloppet, E., Calanca, P., Gobin, A., Vucetic, V., Nejedlik, P., Kumar, S., Lalic, B., Mestre, A., Rossi, F., Kozyra, J., Alexandrov, V., Semeradova, D. and Zalud, Z. (2011), Agroclimatic conditions in Europe under climate change. Global Change Biology, 17

- A study based on indices which provide a general picture of agroclimatic conditions in western and central Europe in terms of the basic weather elements that govern yield potentials and crop management.
- A more specific assessment of the agroclimatic conditions affected by climate change.

Focus on agroclimatic conditions

- The regions that are already relatively warm and dry will likely experience an increase in the severity of drought deficit and a more substantial water deficit during the critical part of the growing season.
- A chance of deteriorating conditions for spring sowing due to increasingly unfavourable weather (too dry or too wet soils).

+ 5°C standardized scenario

Environmental Zone	Effective global radiation change (%)			Effective growing days change (days)			Huglin index change (%)			Date of the last frost change (days)			Proportion of dry days in AMJ change (%)		
	E	H	N	E	H	N	E	H	N	E	H	N	E	H	N
ALN	17	17	14	93	70	105	81	106	126	-33	-37	-40	-22	-22	-13
BOR	63	26	47	56	26	43	78	148	96	-22	-35	-25	-5	8	6
NEM	13	6	27	57	25	72	79	135	83	-31	-30	-33	-14	-8	-12
ATN	1	6	11	30	24	47	64	92	71	-43	-46	-52	3	-5	1
ALS	-22	-16	13	-23	-25	13	71	97	61	-50	-53	-50	-3	-3	-9
CON	-26	-25	2	-5	-6	14	66	95	63	-31	-39	-35	1	1	-7
ATC	-16	-26	-16	-7	-12	-6	62	92	59	-45	-59	-56	20	25	13
PAN	-47	-36	-22	-21	-6	-6	62	89	58	-31	-31	-27	24	23	8
LUS	-53	-51	-32	-83	-74	-55	71	94	57	-50	-52	-50	46	51	32
MDM	-42	-35	-11	-38	-31	-5	71	85	58	-15	-16	-13	34	27	10
MDN	-41	-31	-13	-41	-26	-13	51	68	44	-37	-39	-36	40	37	20
MDS	-53	-59	-17	-27	-30	-10	48	67	45	-54	-52	-51	26	25	17

- The harvesting conditions in June are not projected to improve beyond the present level, making the planning of an effective harvest time more challenging.
- Rainfed agriculture might indeed face more climate-related risks. The risk of extremely unfavourable years, which result in poor economic returns, is likely to increase in many zones.

Climate change and Fire Weather Index

- The Fire Weather Index (FWI) is a numeric rating of fire intensity. Fire meteo indices provide efficient guidance tools for prevention and early warning of forest fires. These indices are only based on meteorological input data.

- Impact of Climate change on FWI : the French Interministerial Mission on the extension of areas subject to forest fires (2009-2010)

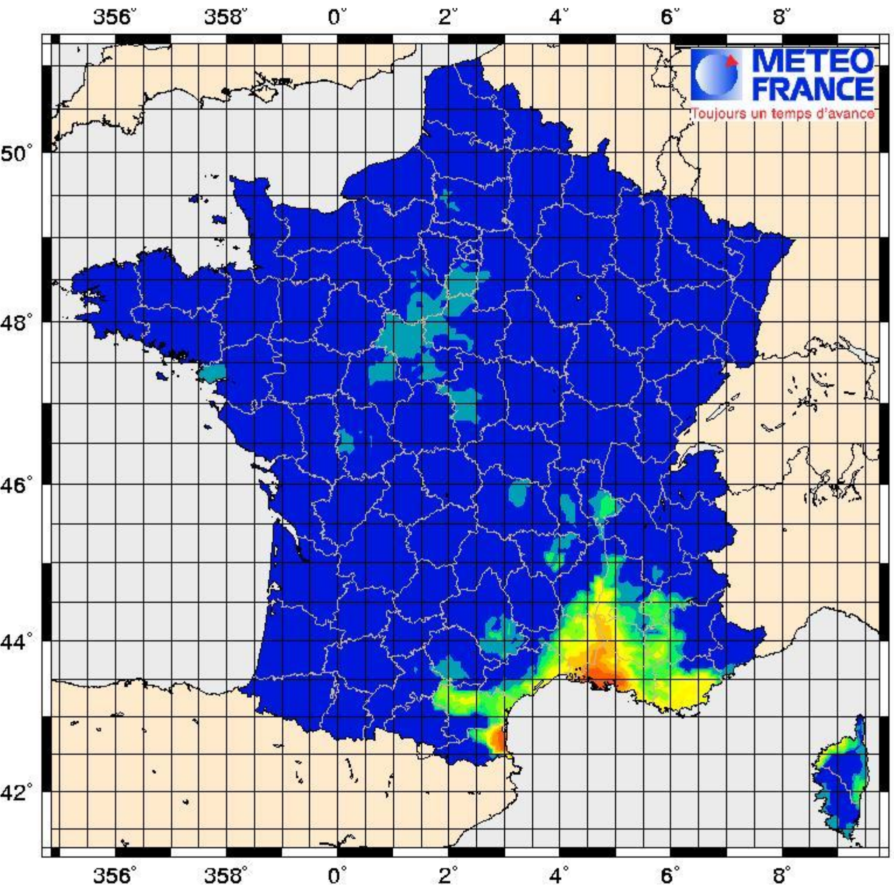
- A strong increase in fire meteorological danger in 2060: a 75% increase (reference period:1961-2000) is predicted for A1B and A2 emissions scenarios.

- Typical Mediterranean meteorological fire danger conditions could be observed all over the French area. Those results suggest an extension of French area prone to forest fires Year 2003 could be considered as a consistent reference for 2060.

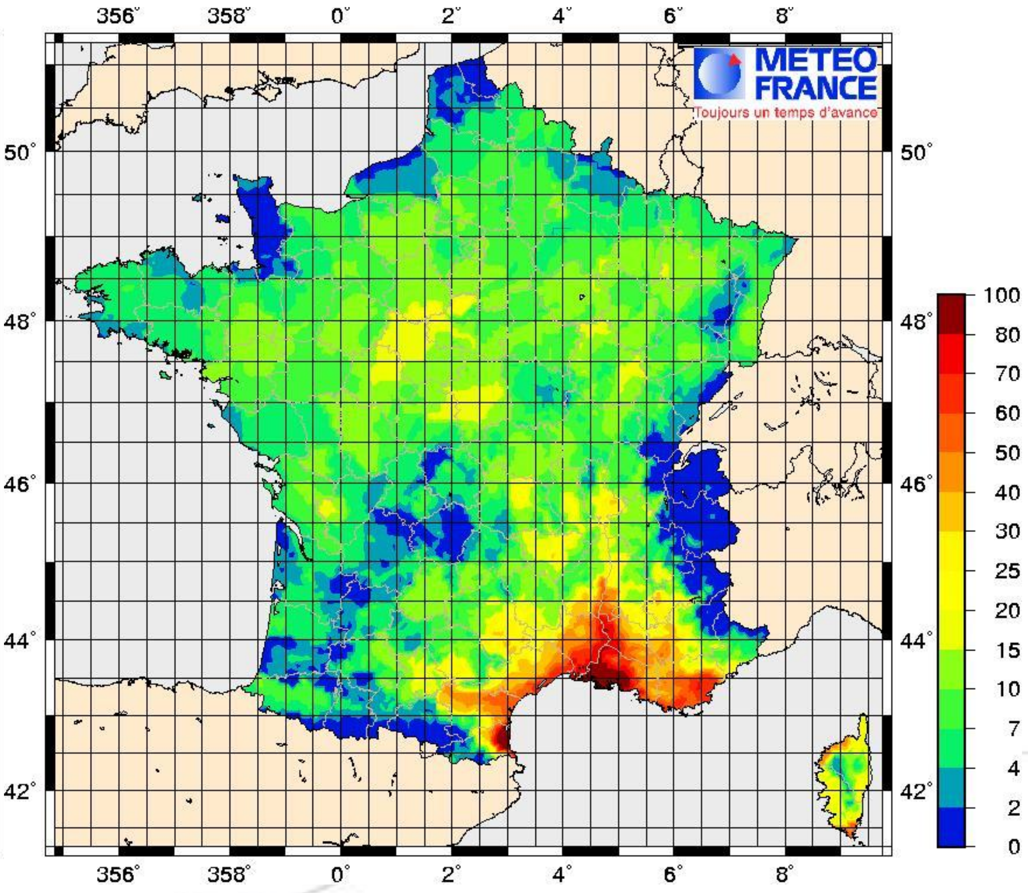
Number of days per year with a strong fire meteorological danger (FWI > 40)

- From 1.8 days to 10.1 days per year in 2060 (average at national level) with a strong fire meteorological danger (FWI >40)

1961-1980 reference period

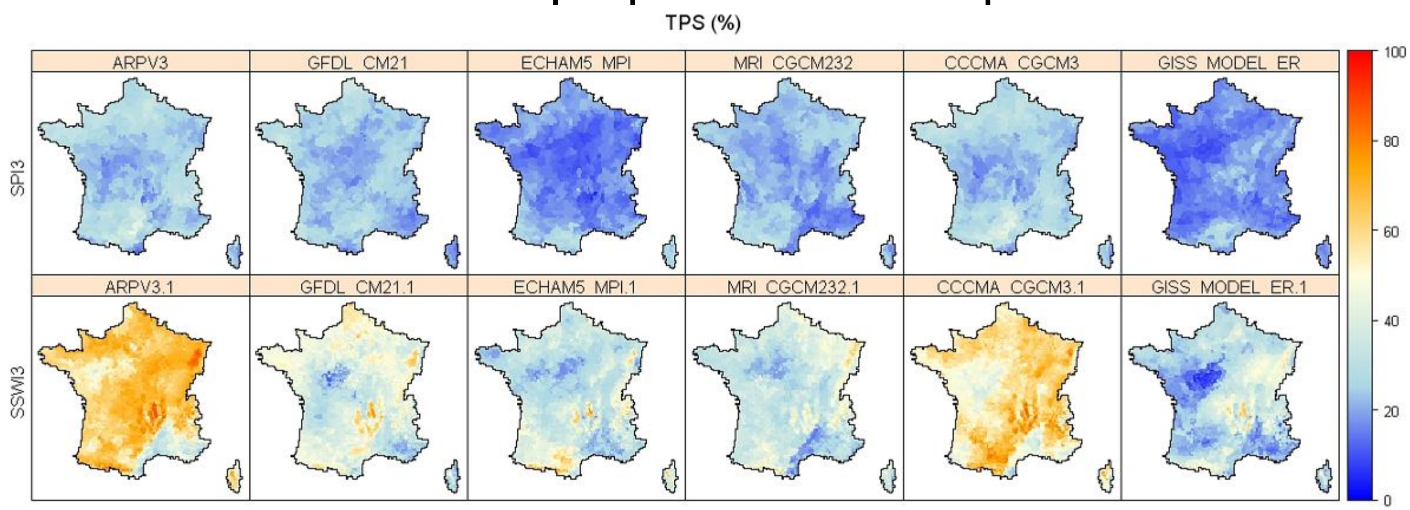


2060 – A1B scenario



Climate change and drought

- Climsec project : a 2-year project: “Impact of climate change on drought and soil moisture in France”.
- Experimental drought indices based on multilevel drought reanalysis : SPI for meteorological drought and SSWI for agricultural drought.
- Non-linear changes expected during the 21th century and a rapid enhancement of drought in the second half of the century to be taken into account in the preparation of adaptation measures

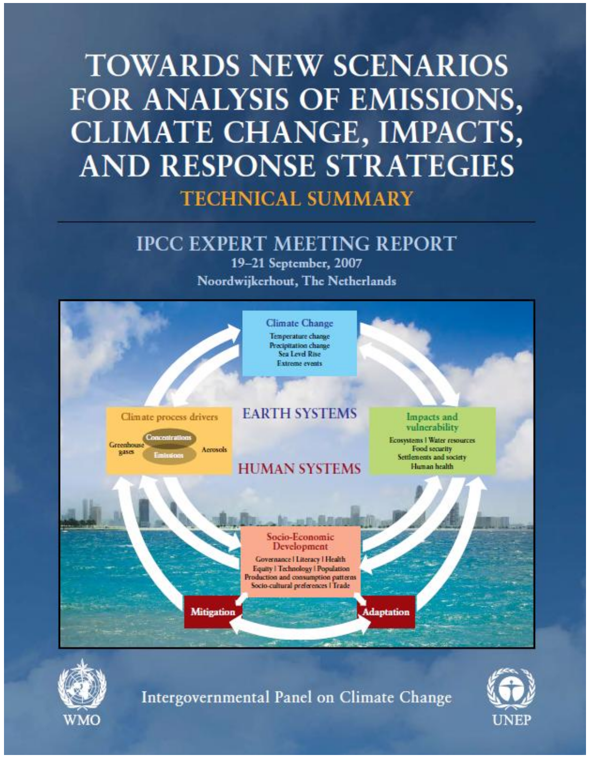


Spatial distribution of time spent in meteorological and agricultural drought, integrated over 12 months for 6 models of IPCC AR4 (2045-2065 period, A1B scenario)

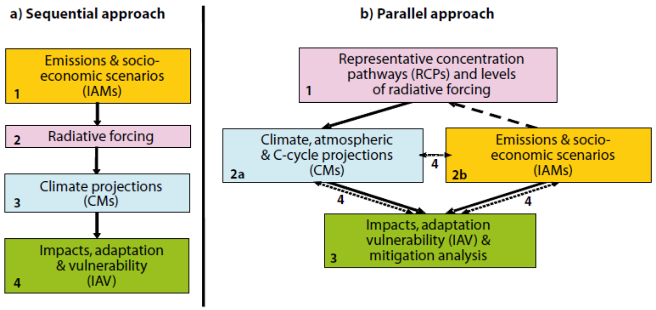
METEO FRANCE
Toujours un temps d’avance

Next step : new scenarios for AR5

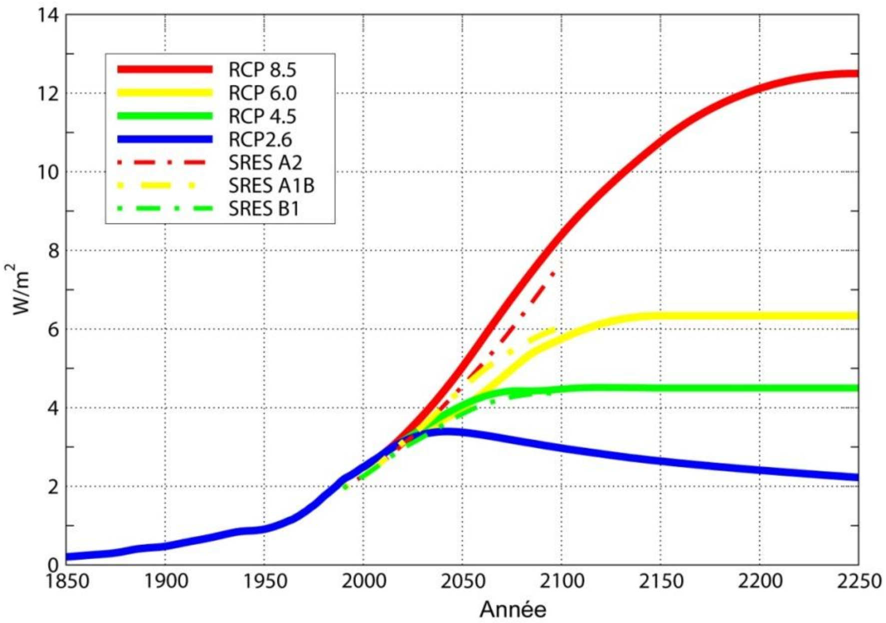
- New scenario development: from SRES scenarios to RCPs (Representative Concentration Pathways)
- SRES did not consider explicit climate policies – these are needed
- Climate models are becoming “Earth system” models with greater demands on forcing scenarios (higher spatial resolution, more species, land use)
- Four RCPs, well separated and corresponding to one of four radiative forcing characteristics: Business as Usual, stabilisation at two levels, peak and decline.



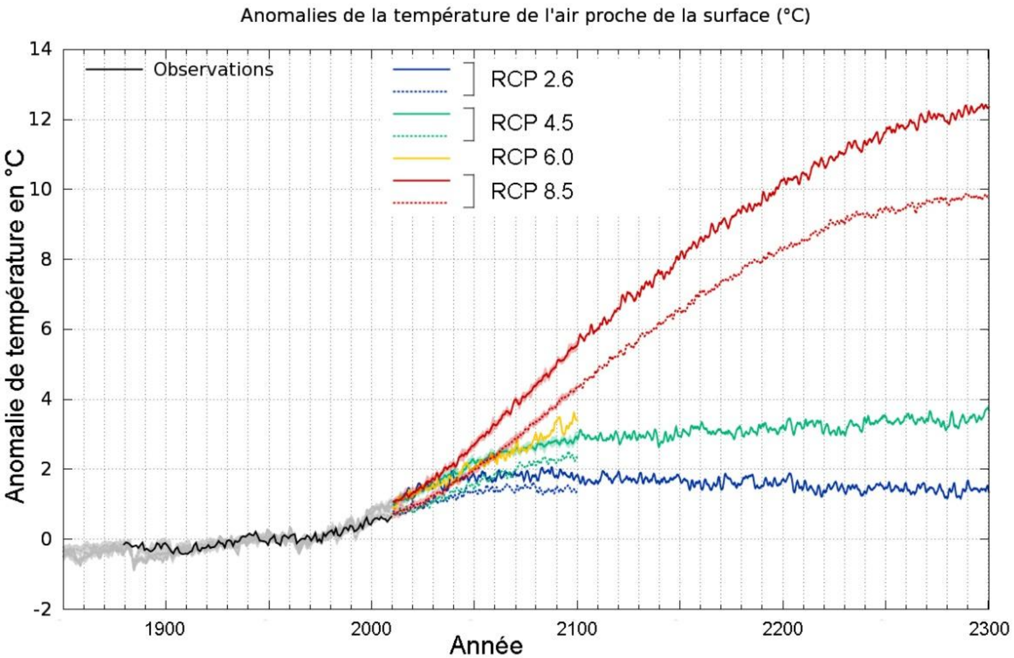
Name	Radiative Forcing[1]	Concentration[2]	Pathway shape
RCP8.5	>8.5 W/m² in 2100	> ~1370 CO_2-eq in 2100	Rising
RCP6	~6 W/m² at stabilization after 2100	~850 CO_2-eq (at stabilization after 2100)	Stabilization without overshoot
RCP4.5	~4.5 W/m² at stabilization after 2100	~650 CO_2-eq (at stabilization after 2100)	Stabilization without overshoot
RCP3-PD[3]	peak at ~3W/m² before 2100 and then decline	peak at ~490 CO_2-eq before 2100 and then decline	Peak and decline



RCP based climate projections: a first preview



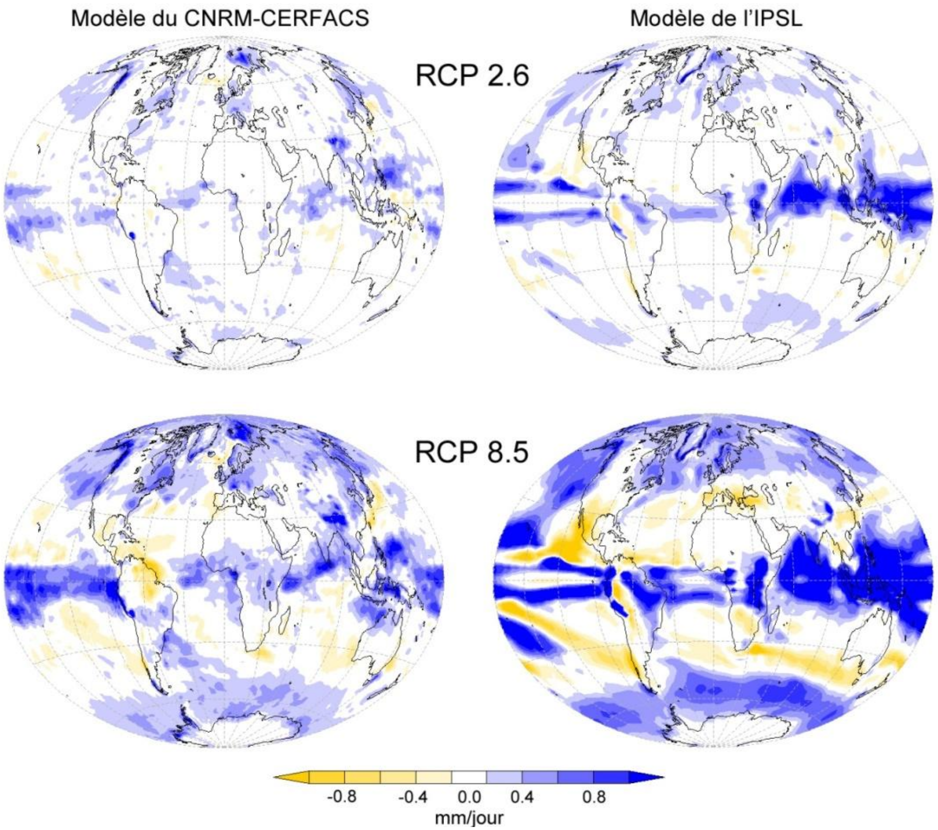
Evolution of radiative forcing (W/m^2) from 1850 to 2250



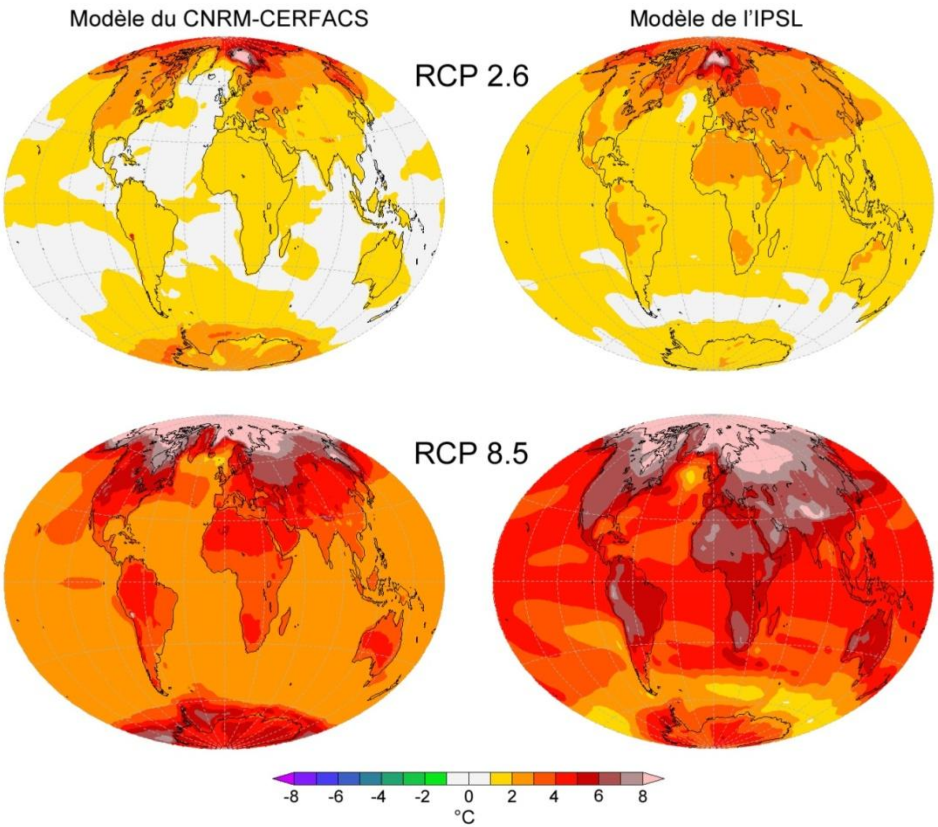
Projected global average surface warming from 1850 to 2300 with CNRM-CERFACS model (dashed line) and IPSL model (solid line) © LSCE/IPSL (CEA/CNRS/UVSQ)

RCP based climate projections: a first preview

Changes in annual precipitation
2071-2100 vs 1961-1990



Changes in annual surface temperature
2071-2100 vs 1961-1990



METEO FRANCE
Toujours un temps d'avance

Thank you for your attention

Emmanuel.cloppet@meteo.fr

Serv-agro@meteo.fr