Certainties and uncertainties on global warming

Part 1: Impact on Temperature and Precipitation

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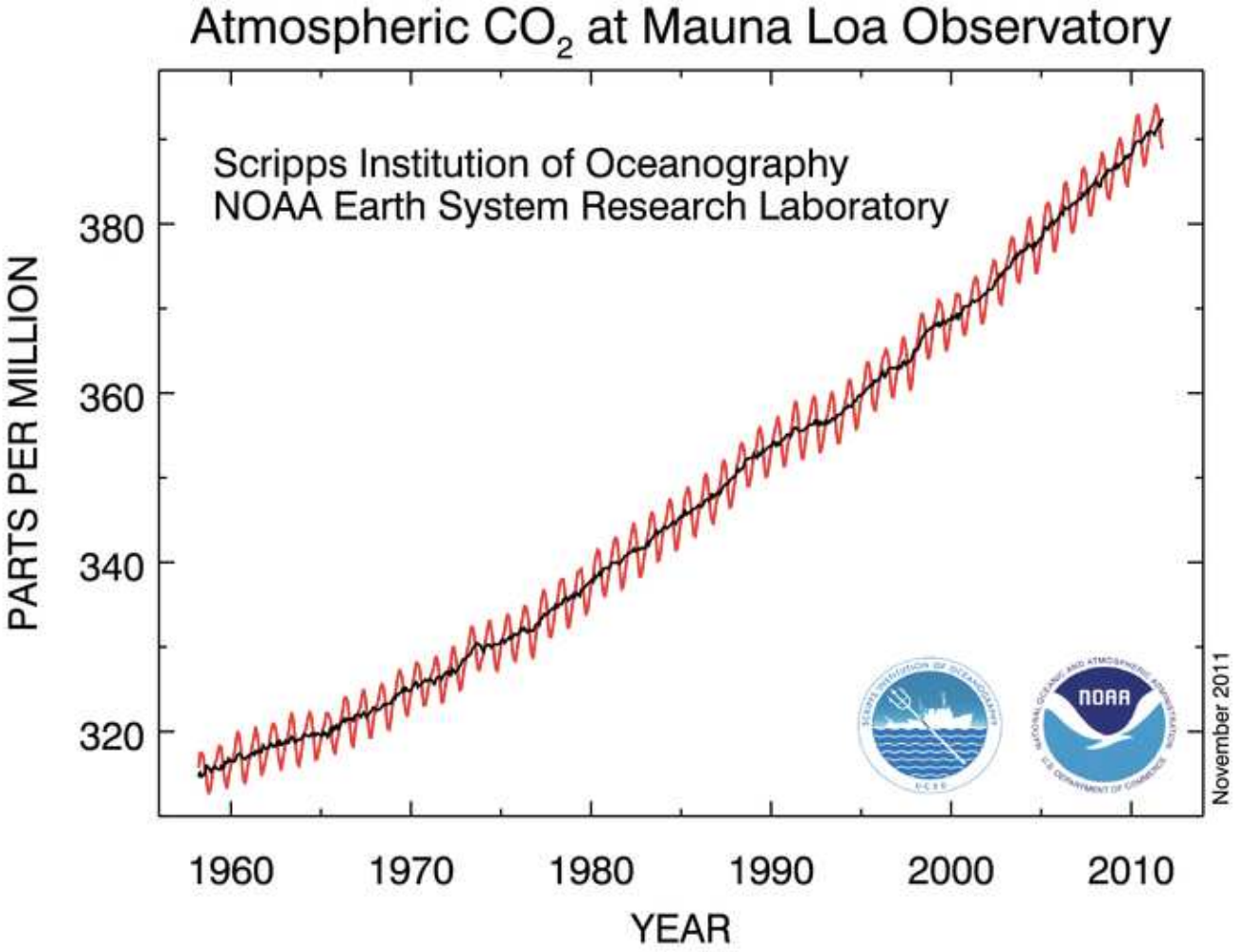
- In our mind, each of us associates the « global warming » due to the increase of greenhouse gases concentration in the atmosphere with various impacts. We can think about effects on temperature itself, precipitation rates, extreme events, sea level height, melting of glaciers or of ice sheets: all these processes have been evaluated and described in the IPCC report.
- I will choose few examples to show what is known for certain and what uncertainties remain in spite of great progress made in this complex field.

- *: “When a scientist does not know the answer to a problem, he is ignorant. When he has a hunch as to what the result is, he is uncertain. And when he is pretty damn sure of what the result is going to be, he is still in some doubt. We have found it of paramount importance that in order to progress, we must recognize our ignorance and leave room for doubt..” Feynman, 1988*

Outline

- Increase of CO_2 concentration in the atmosphere and the warming.
- Evolution of the precipitation rate: influence of atmospheric circulation
- Uncertainties on extremes events : Droughts
- Conclusions

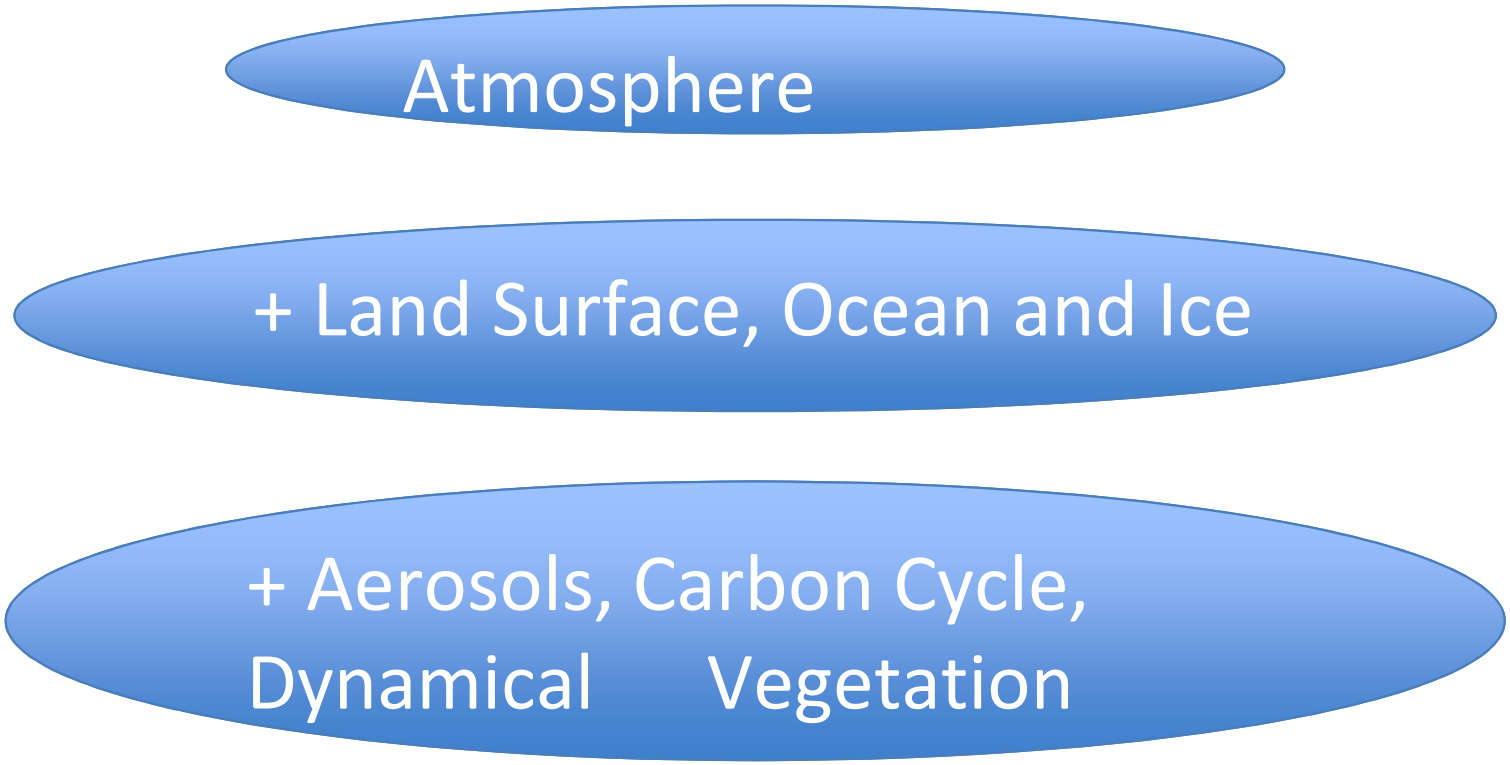


Without the absorption of the infrared radiation emitted by the surface by GHG and atmospheric CO2, , the global temperature would be 18°C lower

Charney Report:
1.5°C, 4.5°C for a doubling

Atmospheric CO_2 reaches
400 ppm in 2016

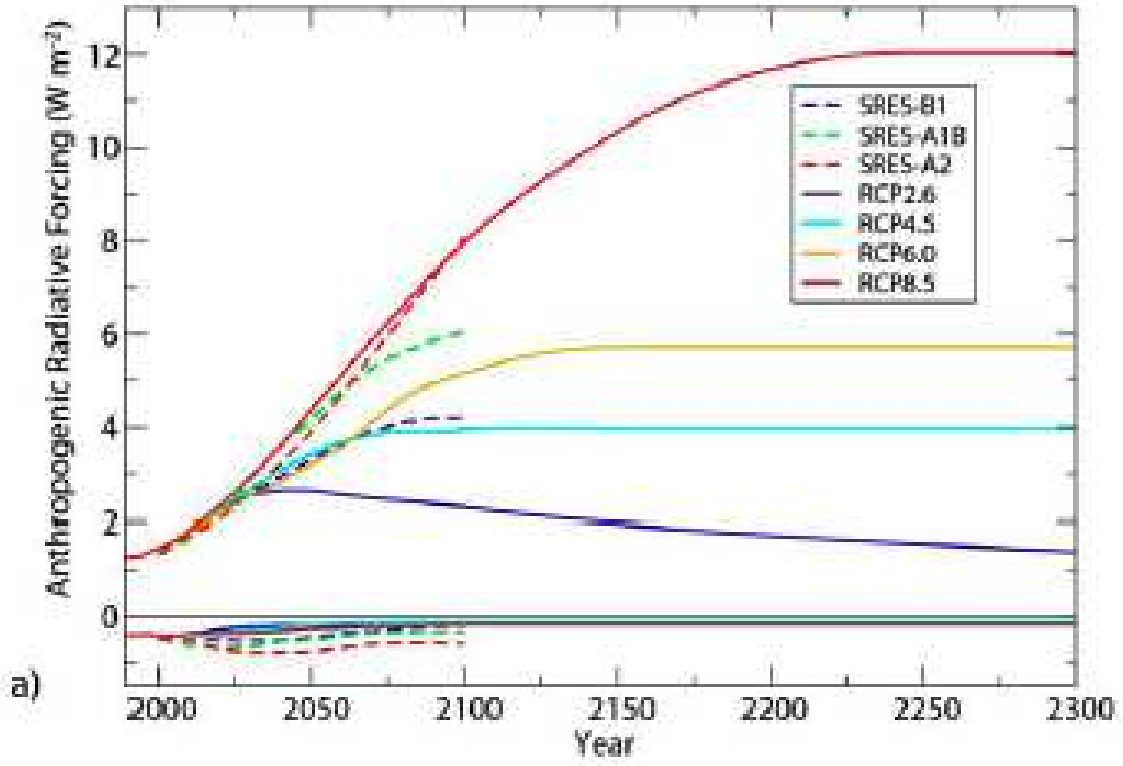
Climate Models : General Circulation Models



When can we reach this global warming of 3°C?
Where it will be more disturbing?
What is the impact on precipitation? And on extreme events?

Atmospheric Radiative Forcing

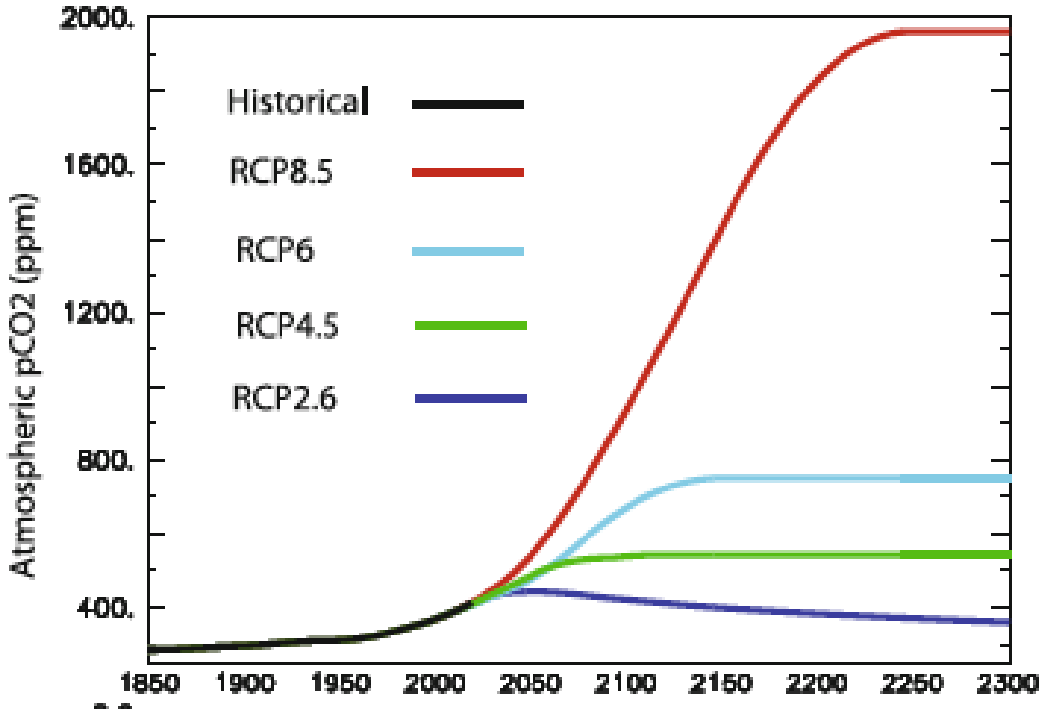
- We have to prescribe how the carbon dioxide concentration will increase. The last IPCC report uses Representative Concentration Pathways



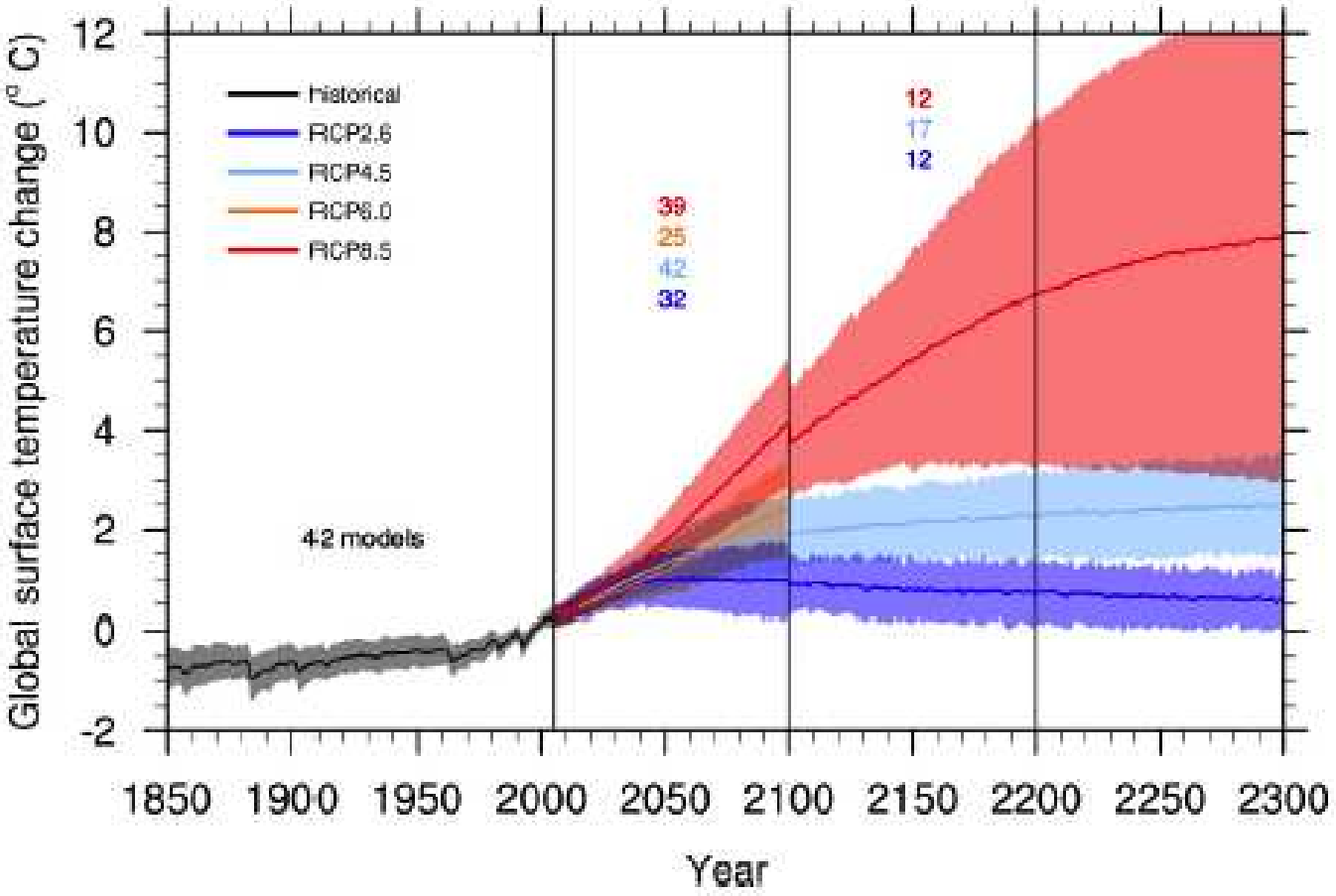
RCP 2.6
RCP 4.5
RCP 6.0
RCP 8.5
These numbers correspond to the approximate radiative forcing in 2100

Evolution of prescribed CO2 concentration for the RCPs

- For the IPSL model, increase of CO2 for these various scenarios.



The global warming simulated by models depends on scenarios.



In 2100: it might be less than 2°C for RCP 2.6
and more than 4°C for RCP 8.5

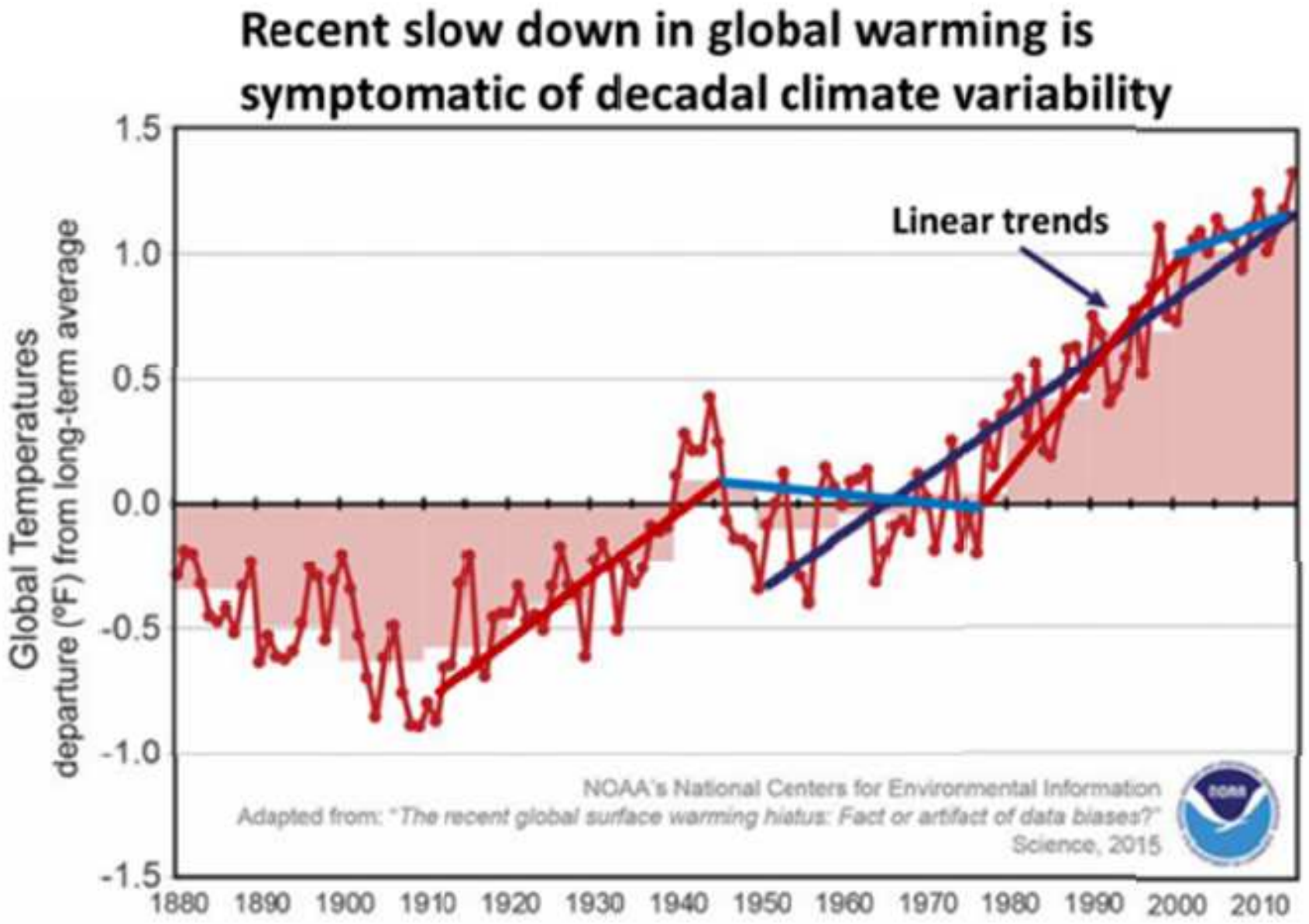
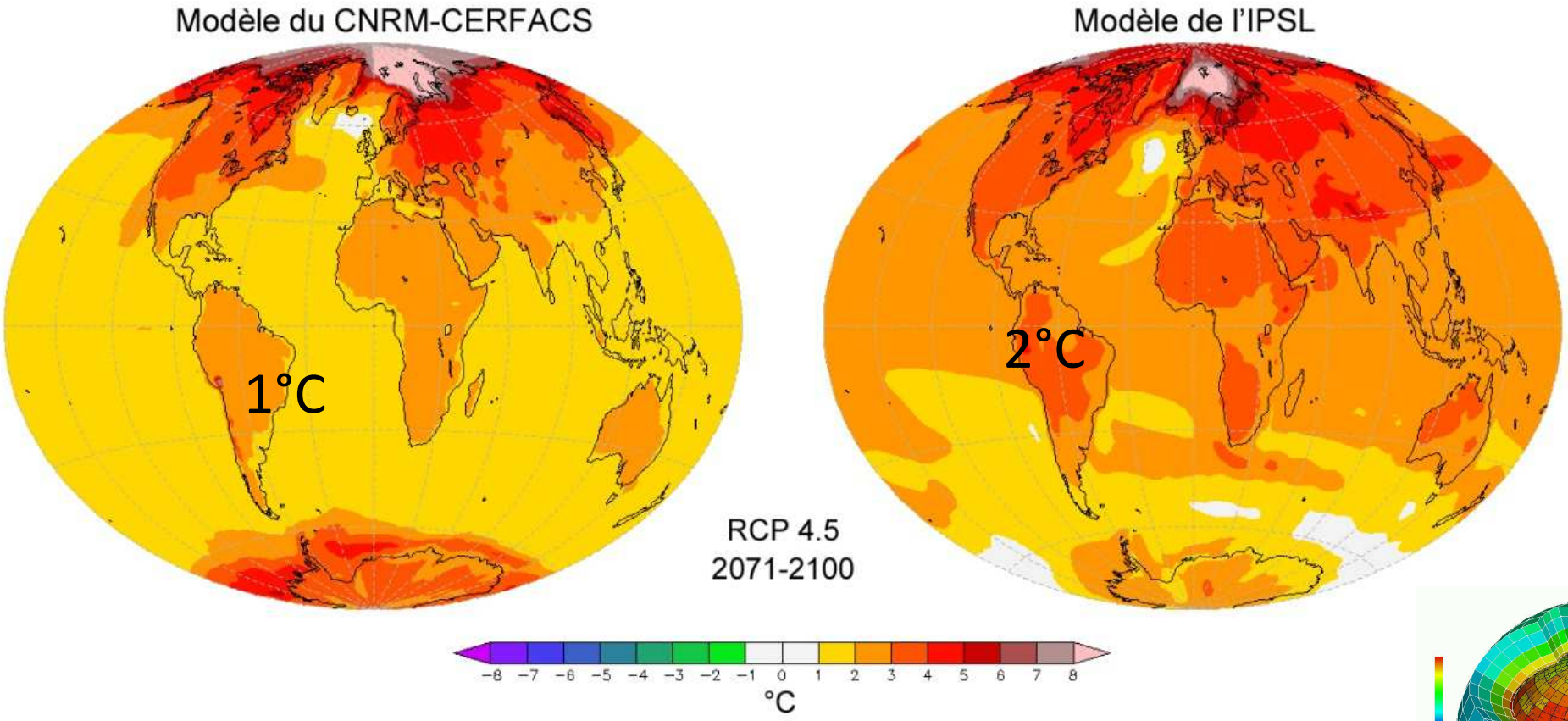
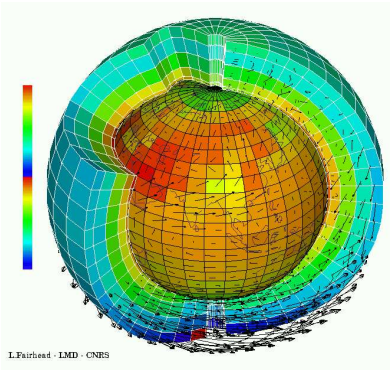


FIGURE 2 Time series of annual GMST anomalies in Fahrenheit (dots) based on data from Karl et al. (2015). NOTEs: Black line is linear trend computed from 1950 to 2014 showing long-term trend forced mainly by increasing GHGs. Red and blue lines show that the linear trend is dependent on time period chosen (in this case, positive and negative phases of the Interdecadal Pacific Oscillation (IPO), respectively). SOURCE: Meehl (2015).

Meehl, 2015

Warming at the surface simulated by 2 French GCMs
RCP 4.5





Difference between means 2071-2100 and 1971-2000

I2

Source CNRM-Cerfacs et IPSL, 2013.

Diapositive 11

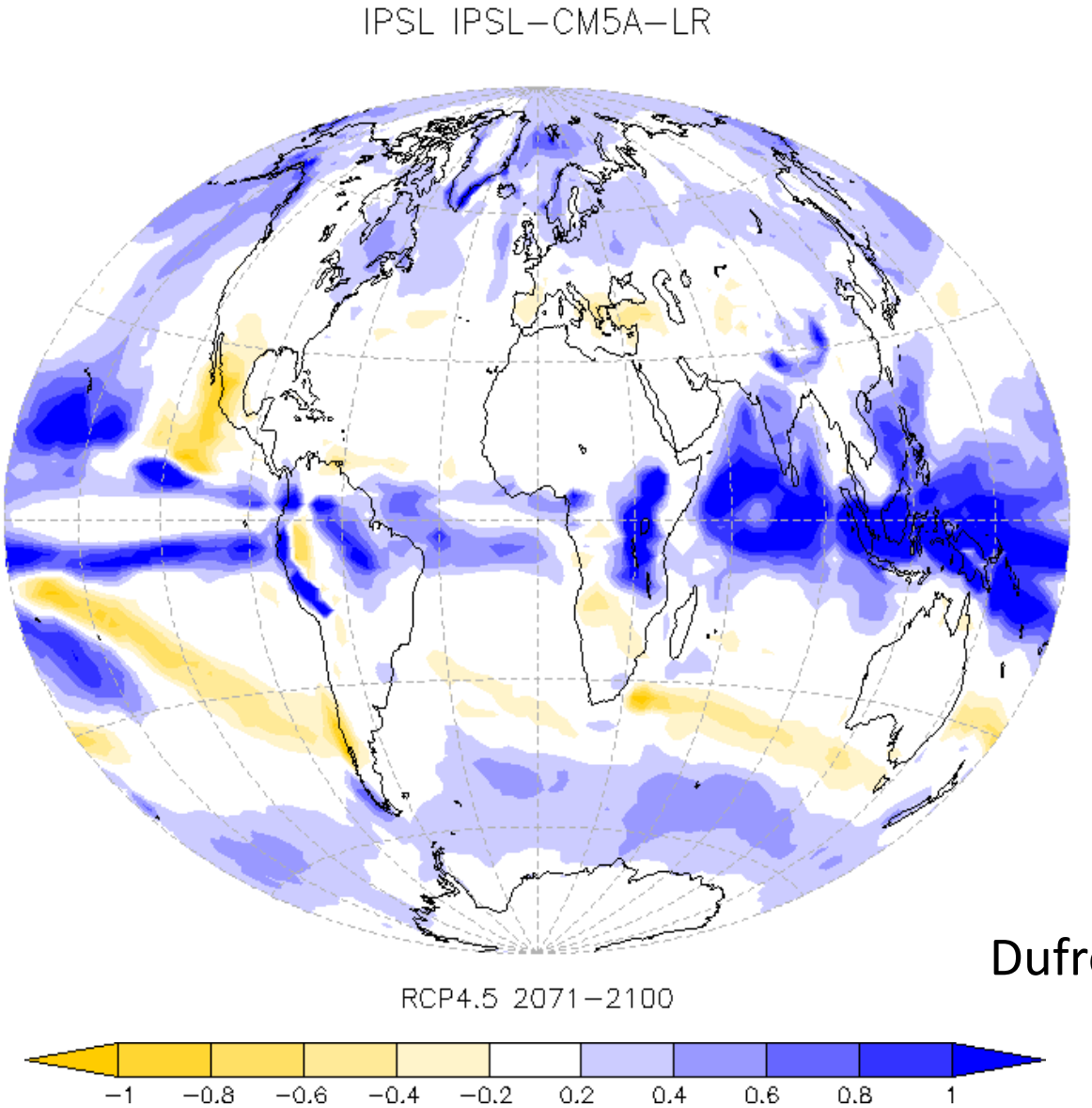
I2 Warming is higher on land than o

Katia Laval; 21/08/2016

Impact of global warming on the precipitation rate. Influence of atmospheric circulation

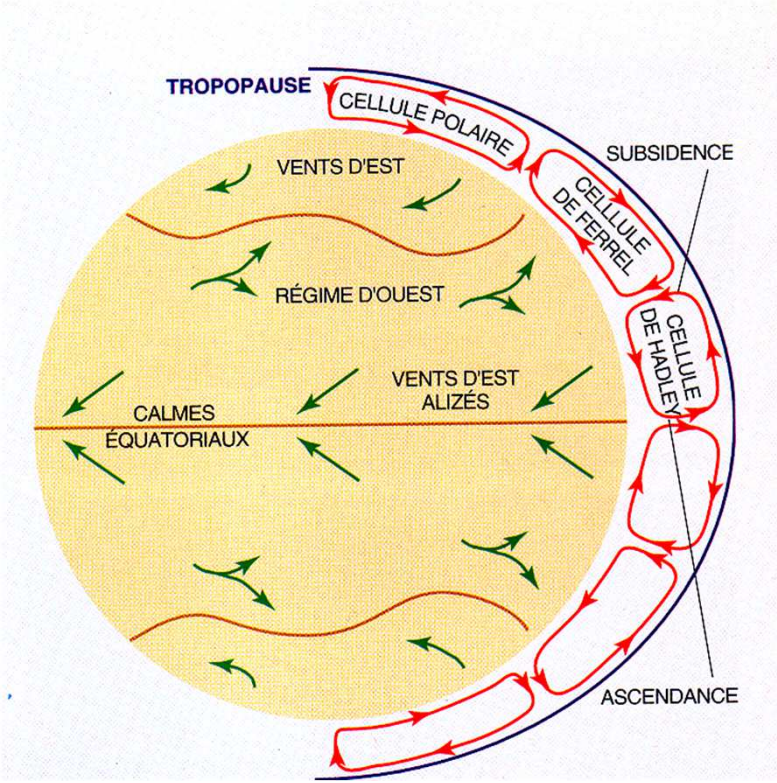
Increases in temperature leads to increases
in the moisture-holding capacity of the atmosphere
at the rate of about 7% per °C.
But the assessment by models is 2% of global
precipitation increase with one degree of global warming

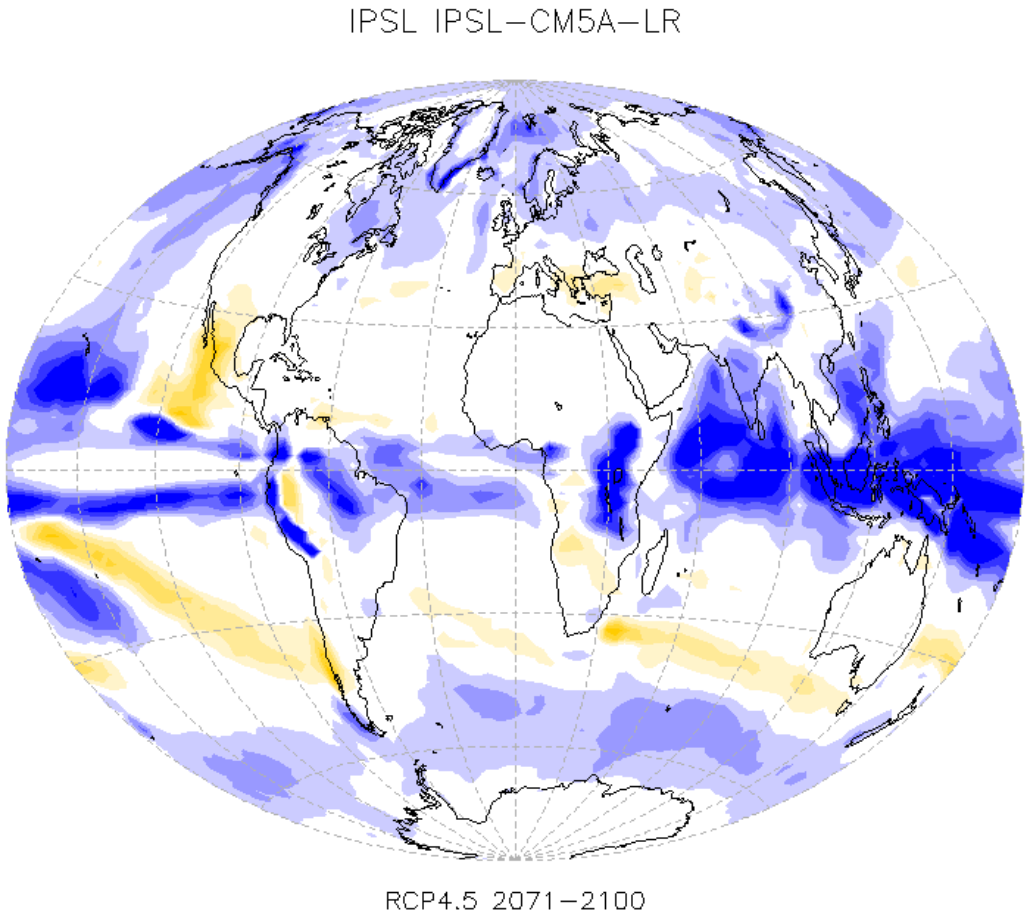
Difference of precipitation between means 2071-2100 and 1971-2000



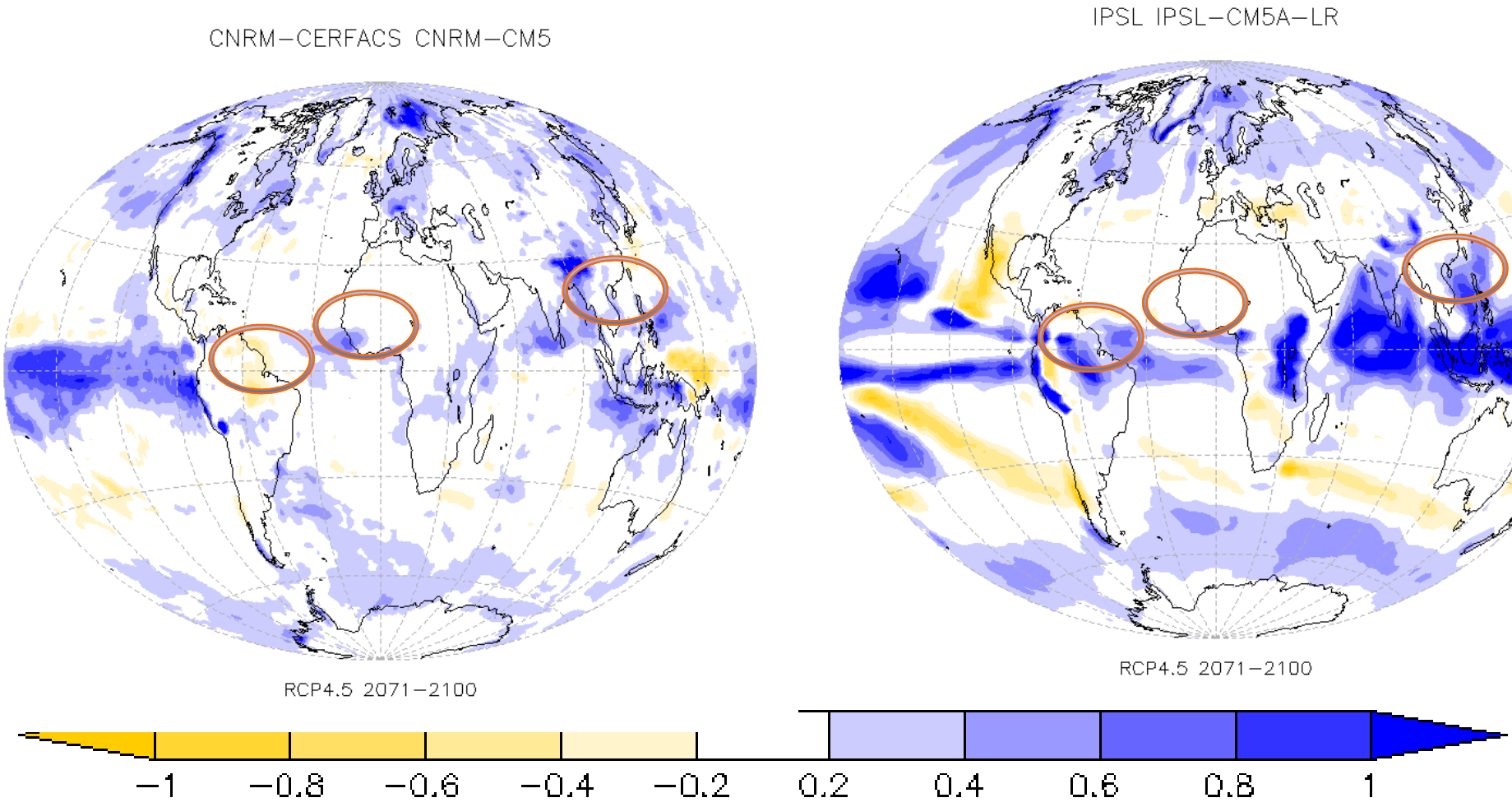
Dufresne et al, 2013

Precipitation change and atmospheric circulation



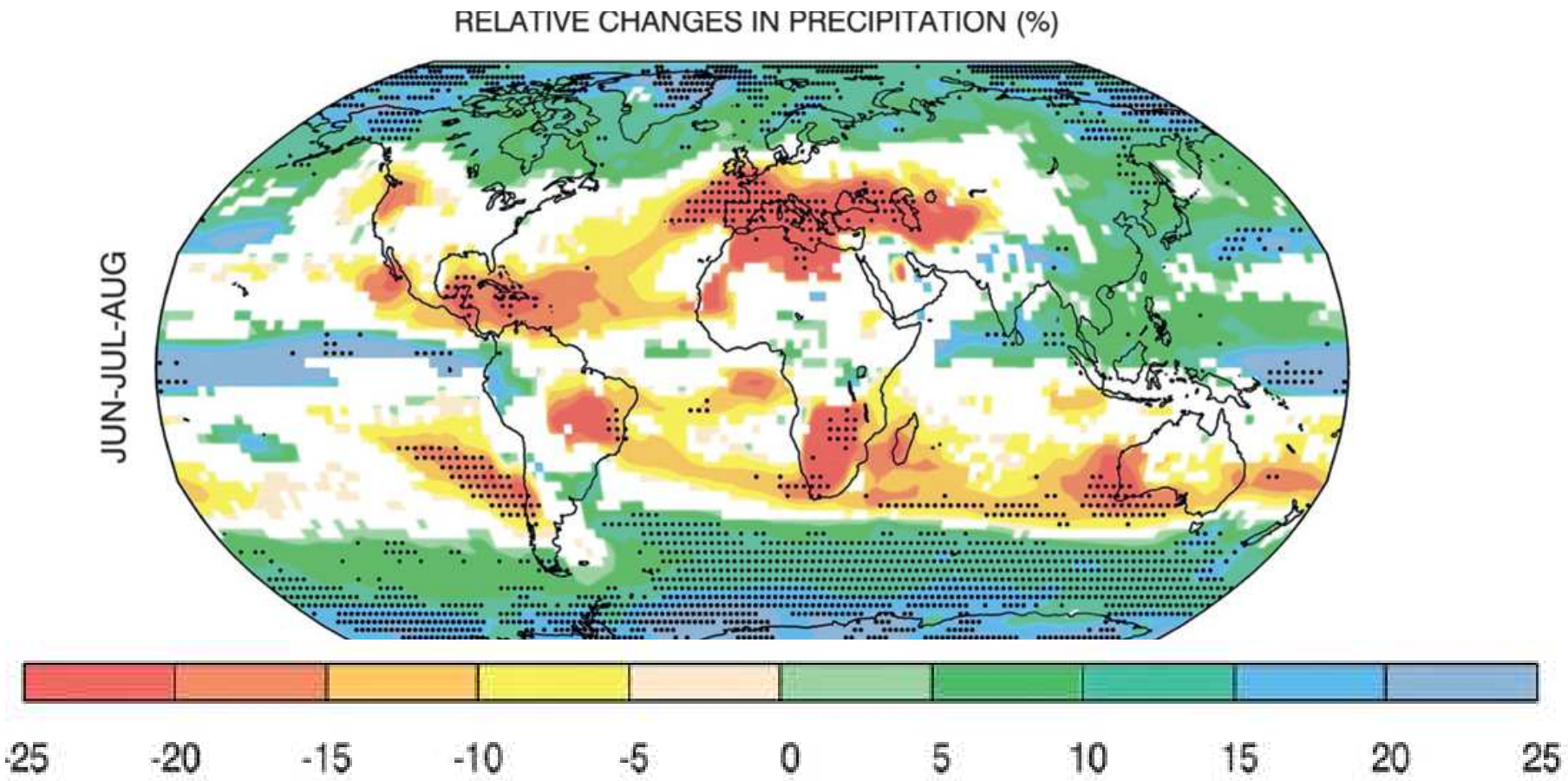


Precipitation change for 2 Models



Valloire et al, 2013

Percentage (%) change in JJA precipitation during 2090-99



Dots: in regions where 90% of the 24 models project changes agree on the sign.
Shade: areas where 66% of the 24 models project changes agree on the sign.

Power et al , 2012

Observed Precipitation rates

Confidence in precipitation change averaged over global land areas since 1951 is **medium**. Averaged over the mid-latitude areas of the NH precipitation has likely increased (high confidence after 1951).

For other latitudes area-averaged long-term positive or negative trends have **low** confidence.

IPCC Report

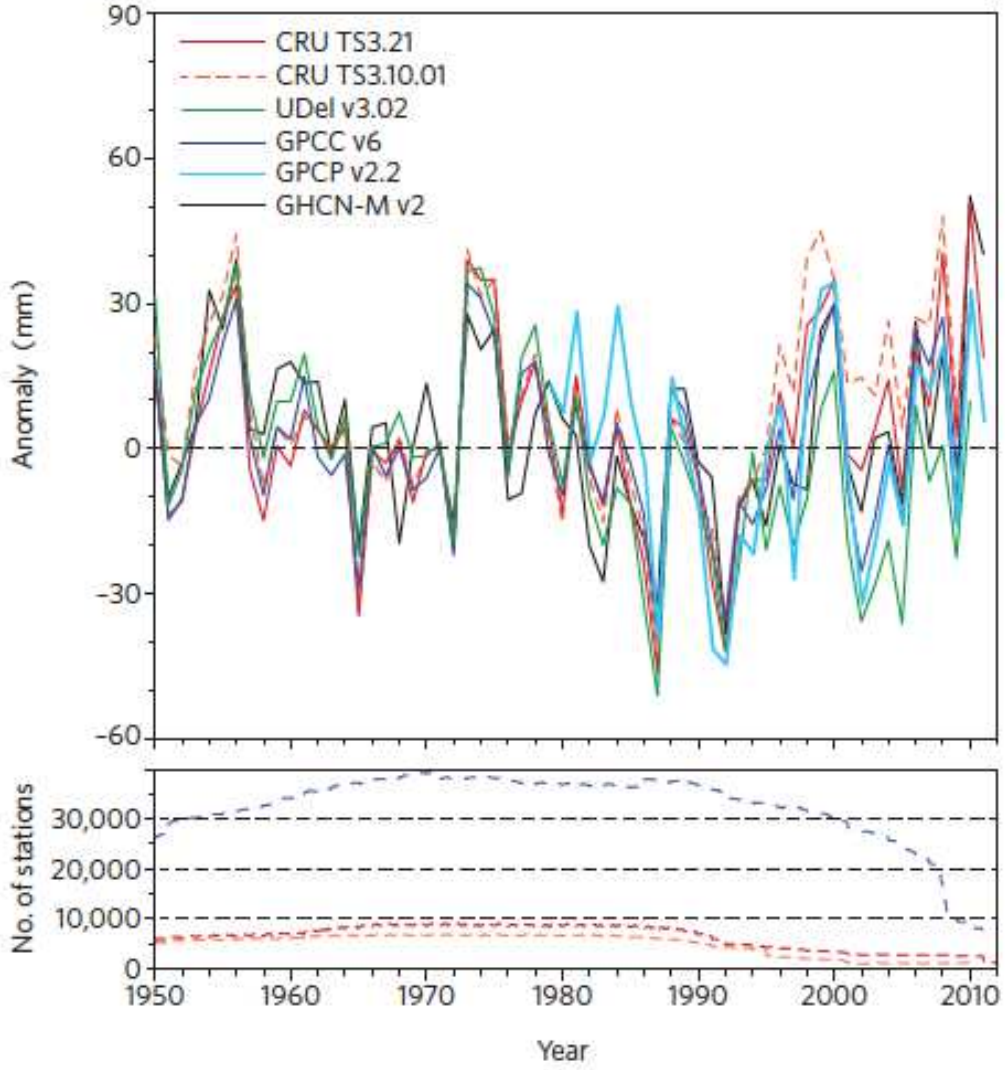


Figure 1 | Time series of global land (60° S to 75° N) precipitation departures from the annual mean for several data sets. The lower panel shows the number of stations that were used for the GPCC and CRU data sets. The base period is 1961–1990 except for GPCP, where 1981–2000 was used.

Trenberth et al, 2014

Conclusion

We know that an increase of the atmospheric CO_2 concentration induces a global warming, and also a regional increase of land temperature.

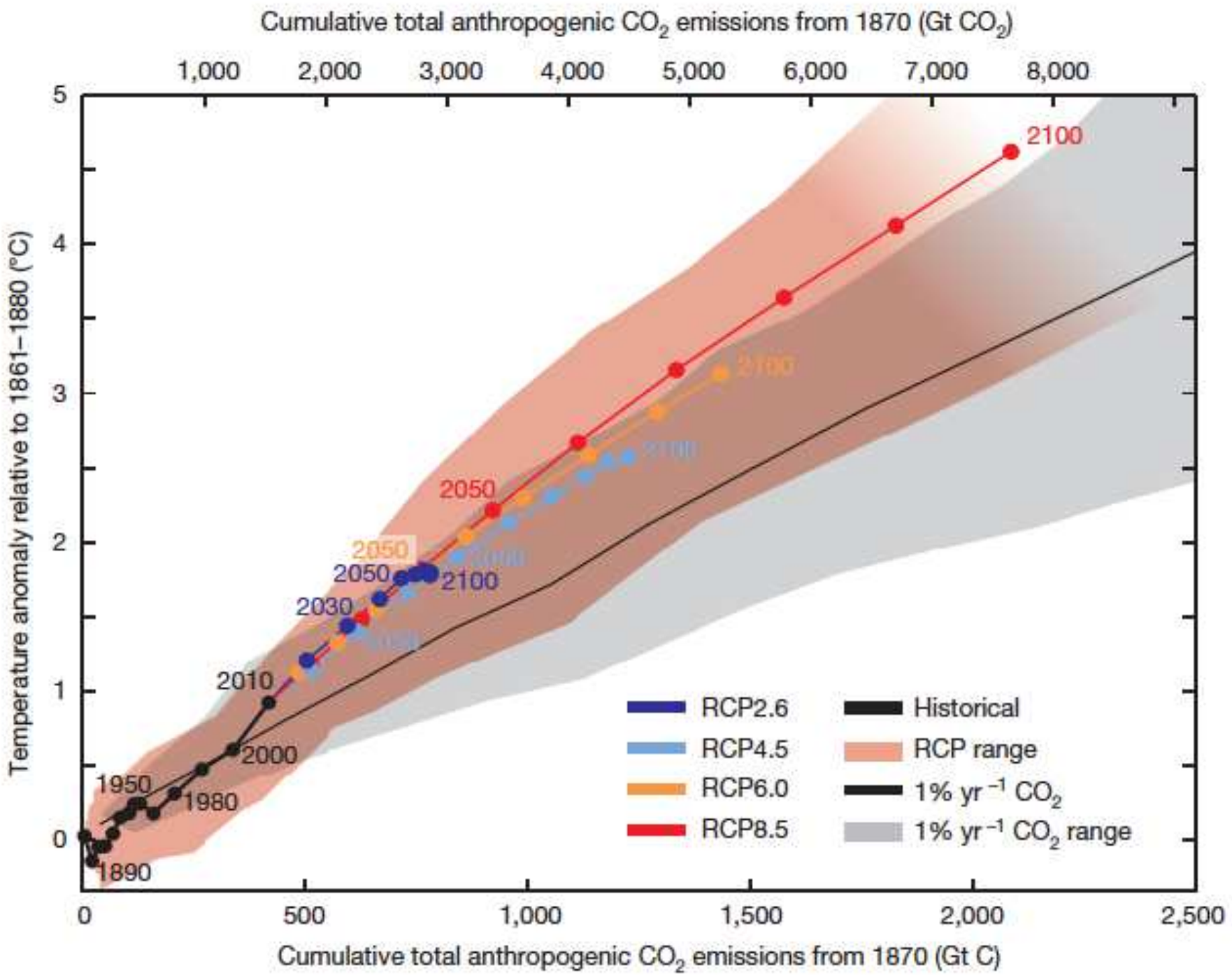
The impact on global precipitation is known but it is more difficult to assess the regional changes of precipitation rates.

La mer de Glace. Chamonix. Savoie

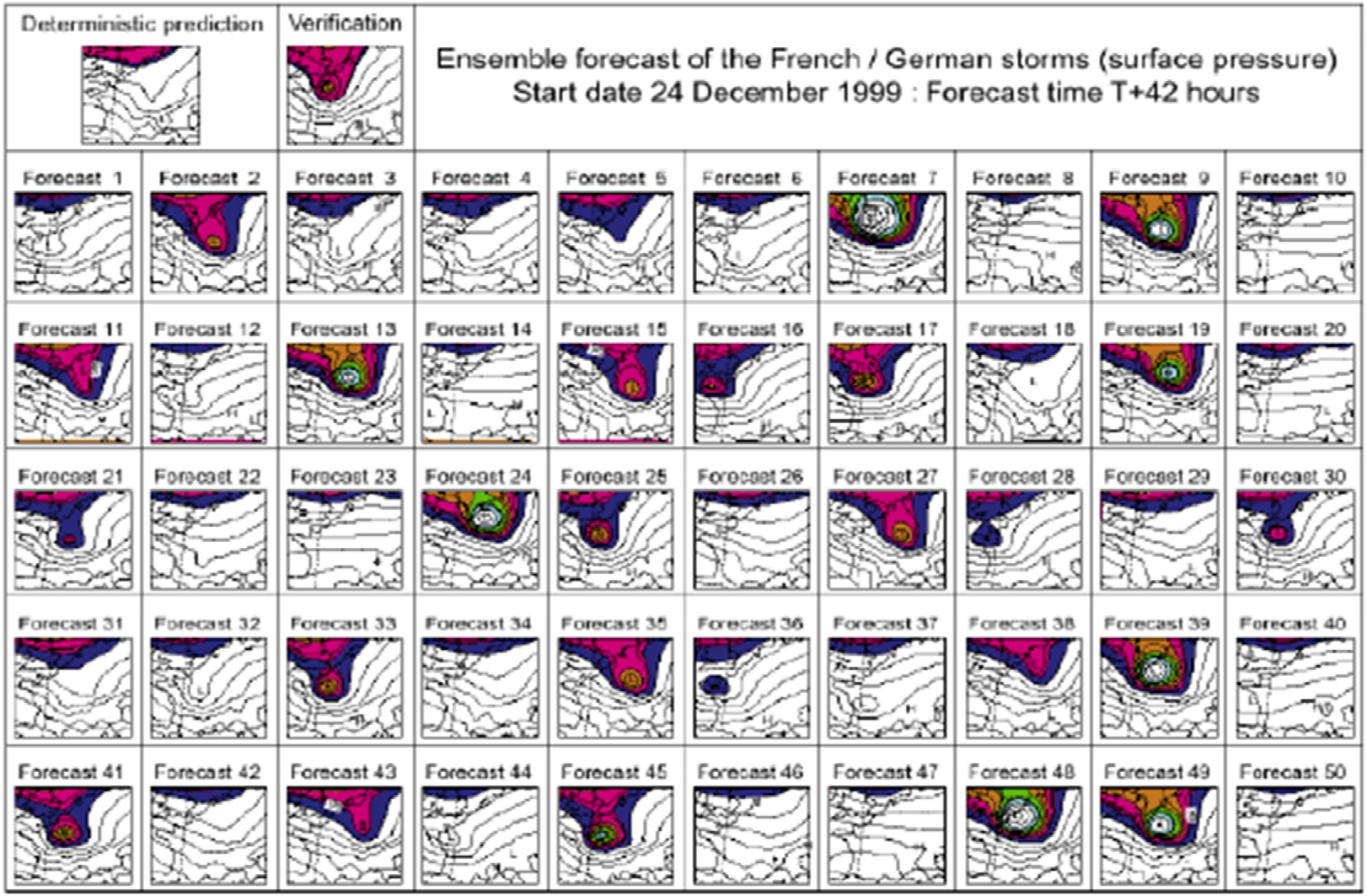
Thank you for your attention

In the long run, our credibility as scientists rests on being very careful of, and protective of our authority and expertise.

Carl Wunsch



Senevitnane,2016



Prévisions d'ensemble le 26 Décembre 1999 effectuées à partir du 24 Décembre. (Palmer, 2002).