Climate change and Agriculture

LabEx BASC
Biodiversité, Agroécosystèmes, Société, Climat

LABORATOIRE DES SCIENCES DU CLIMAT ET DE L'ENVIRONNEMENT

Institut Pierre Simon Laplace

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UNIVERSITÉ DE VERSAILLES

université PARIS-SACLAY

- Climate Change: What are we certain about ? What are the remaining uncertainties?
- How can climatologists and the agricultural world work together to anticipate and adapt?

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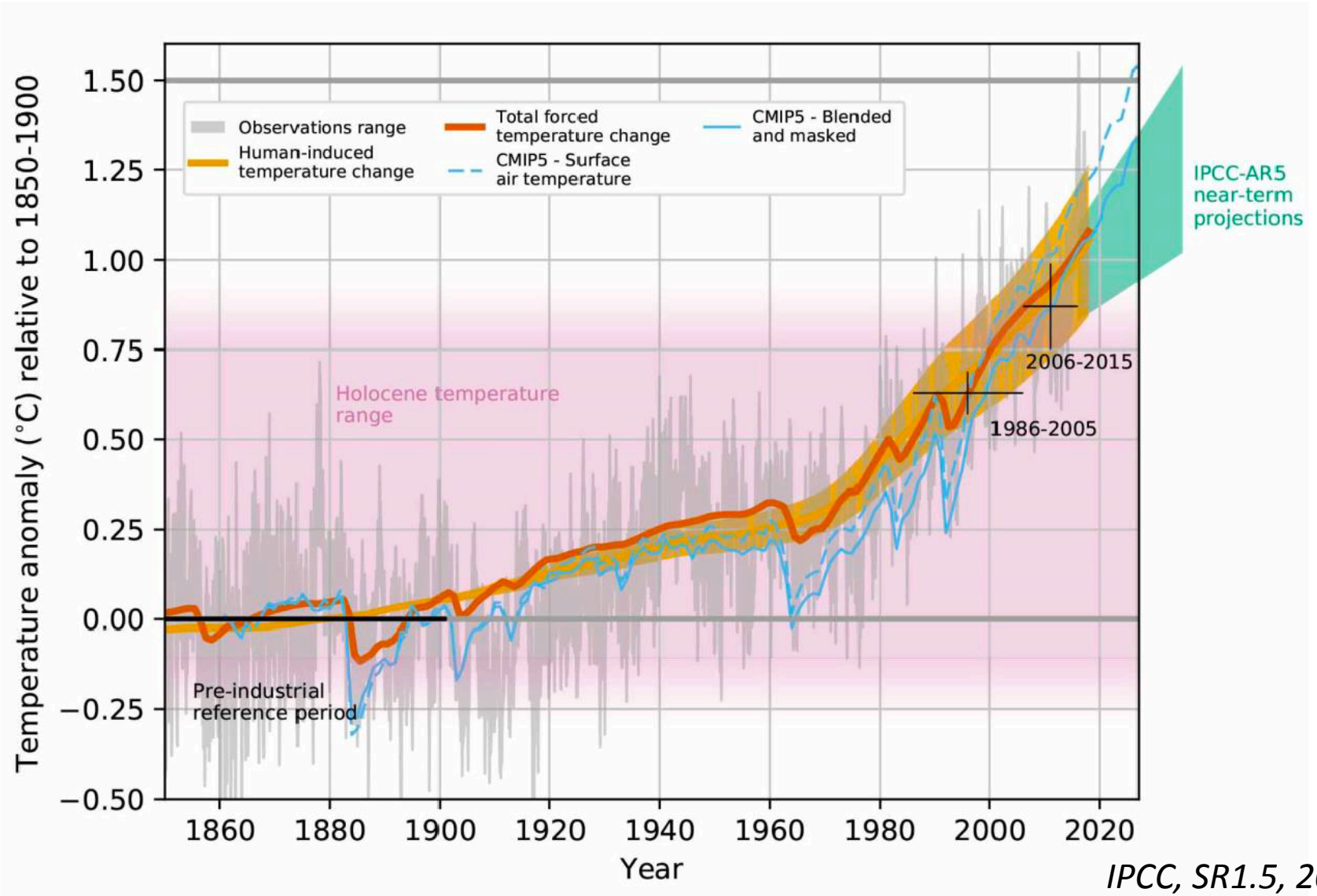
outline

- **Our Climate is changing**
  - An unchallenged reality
  - The role of Human actions
  - What has happened at the scale of our countries (example: France)
- **Don’t mix up: climate change and climate variability are not the same**
- **Climate has already imprinted the farming sector**
- **What futures for our climate?**
  - In the world?
  - In France?
- **How can you and climatologists work together ? ➔ the development of climate services**

We've already reached 1°C of global warming



IPCC, SR1.5, 2018

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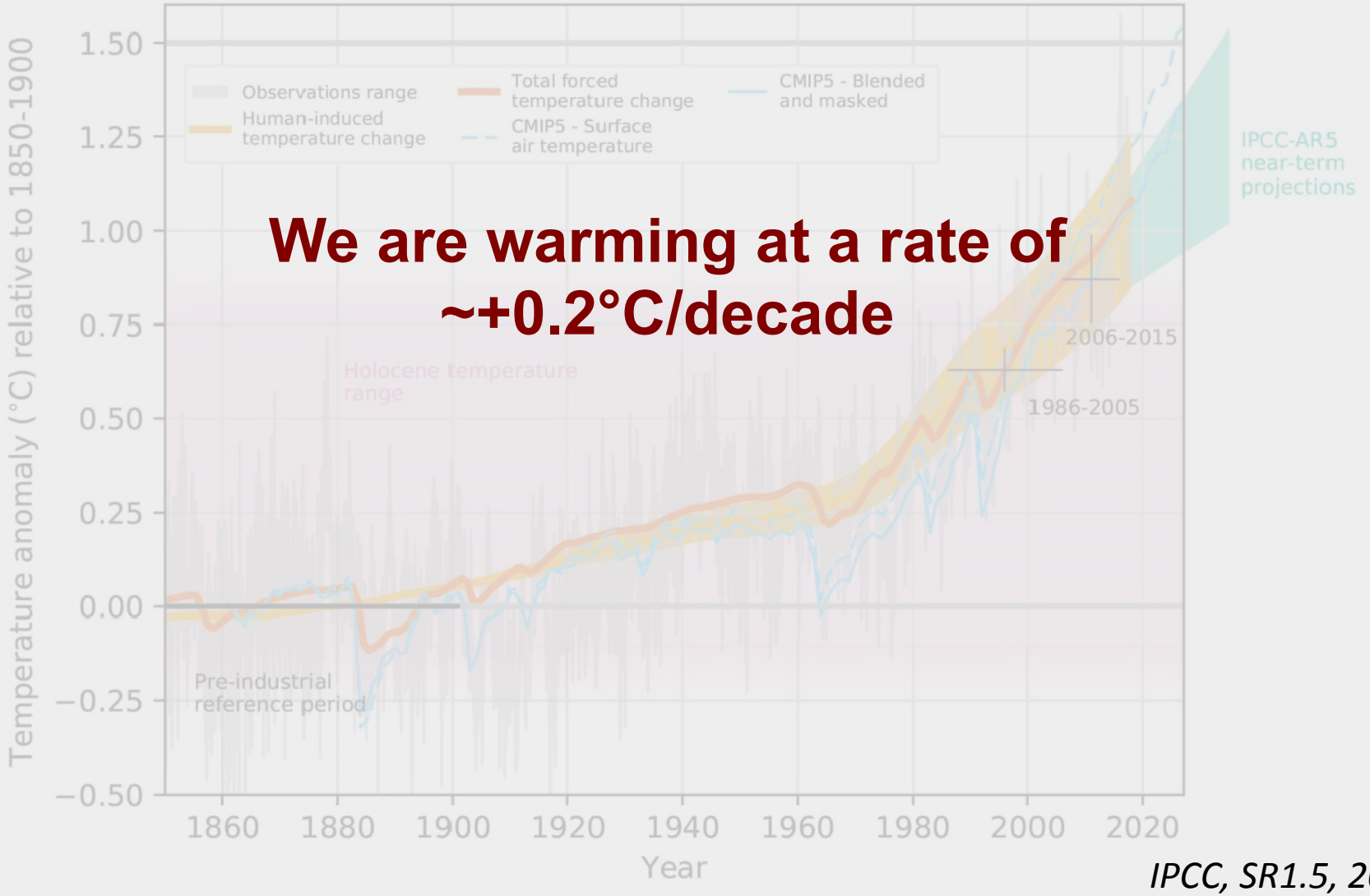
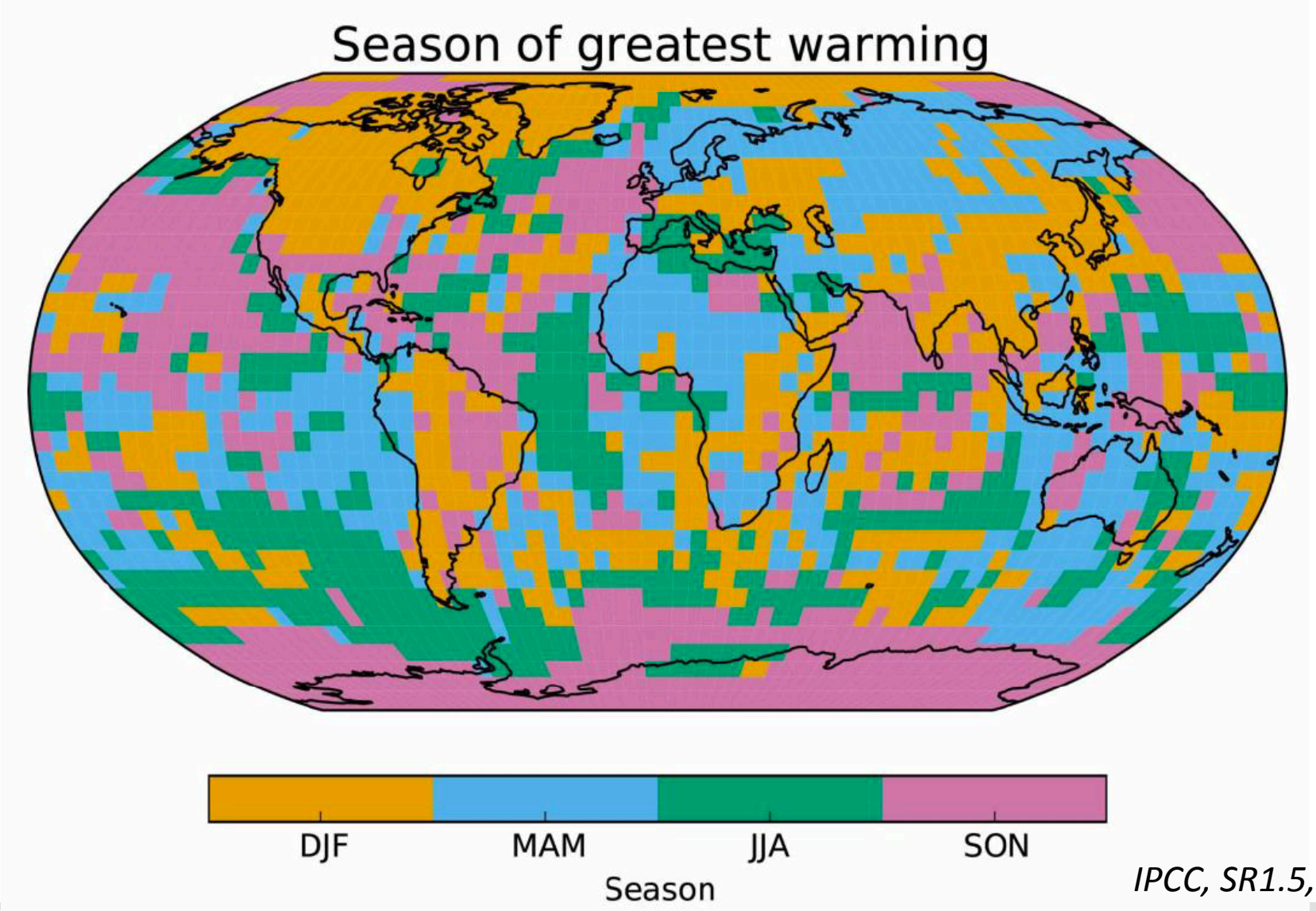


We are warming at a rate of ~+0.2°C/decade

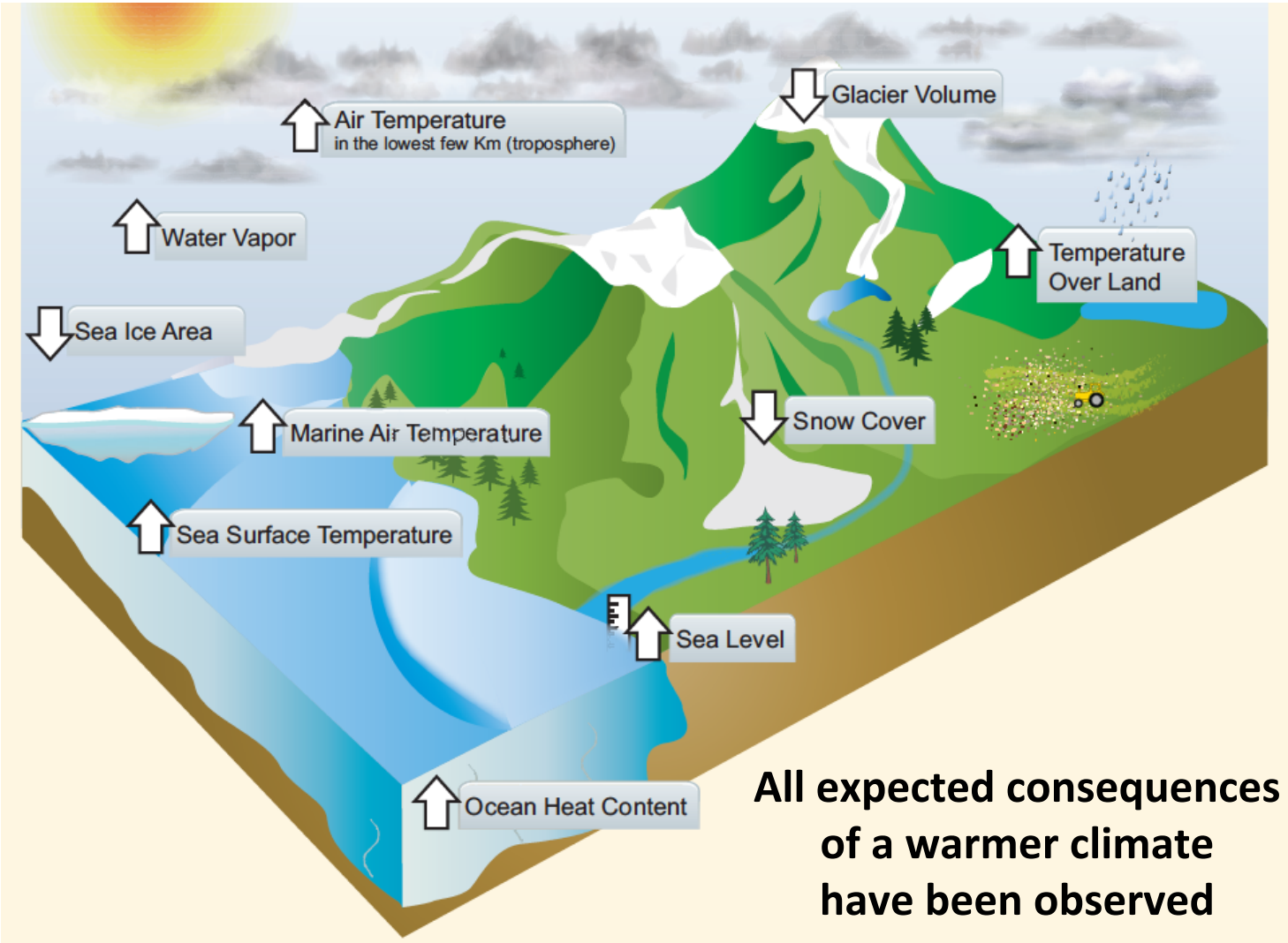
IPCC, SR1.5, 2018

We've already reached 1°C of global warming



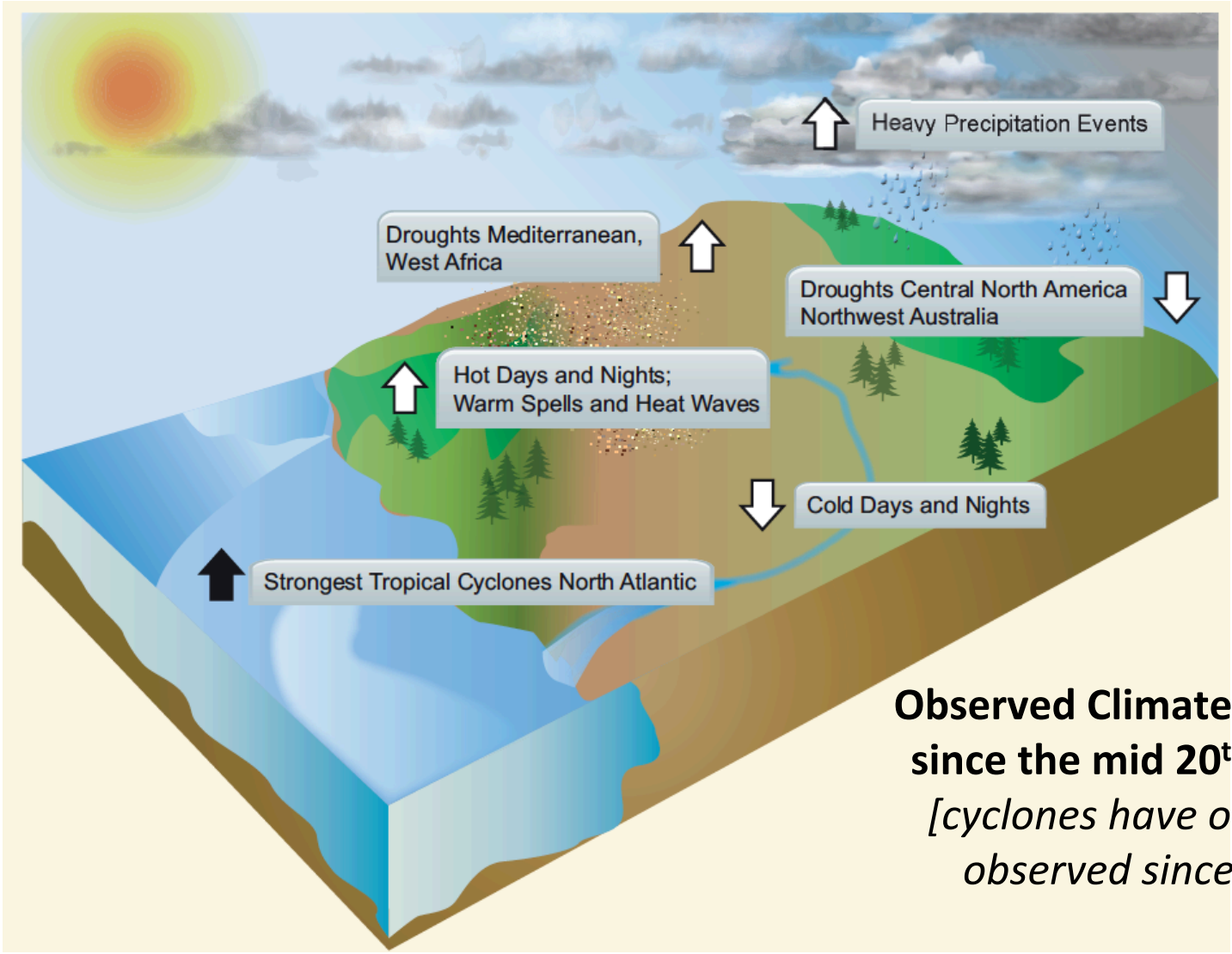
IPCC, SR1.5, 2018

Climate change: an unchallenged reality



IPCC, 2013

Climate change: an unchallenged reality



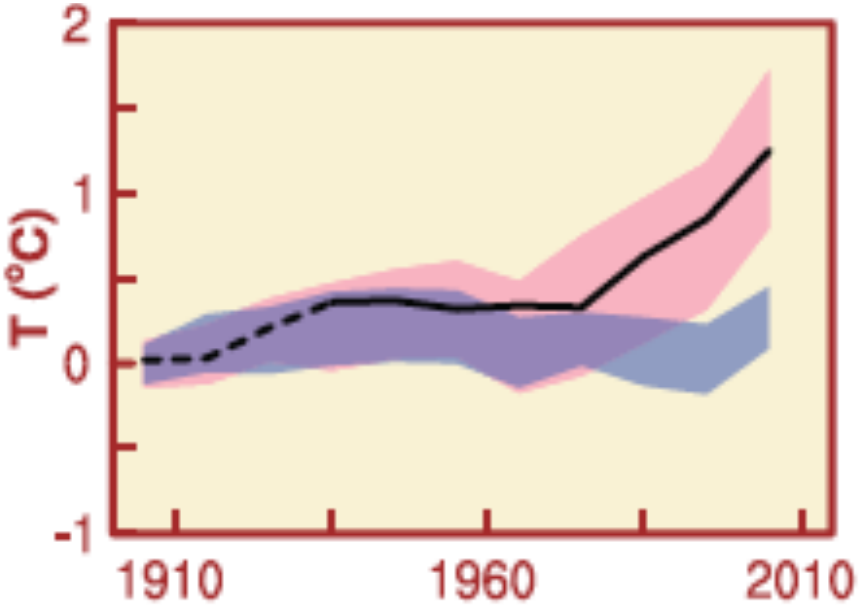
Observed Climate extremes since the mid 20th century

[cyclones have only been observed since 1970]

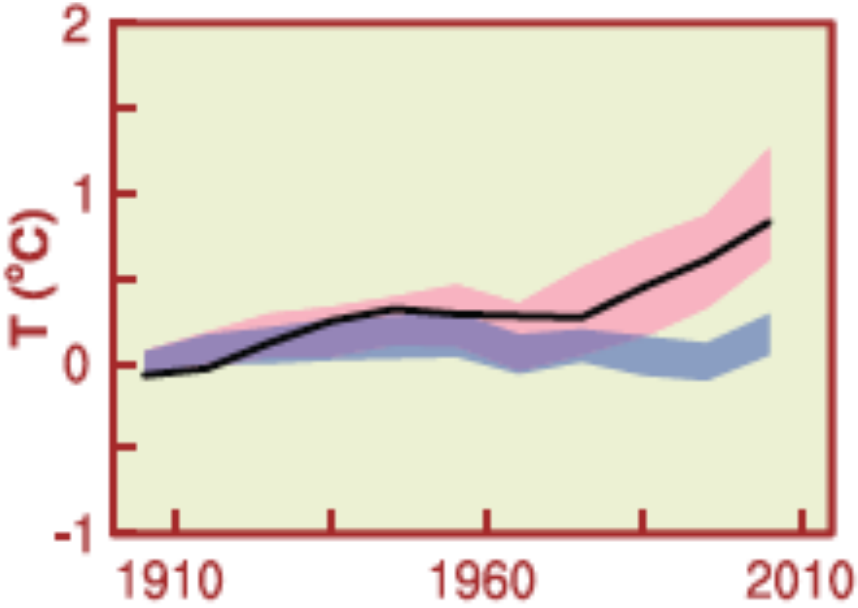
IPCC, 2013

Climate change: attribution to human causes

Time evolution of surface temperature change − over continents



Time evolution of surface temperature change − over the globe



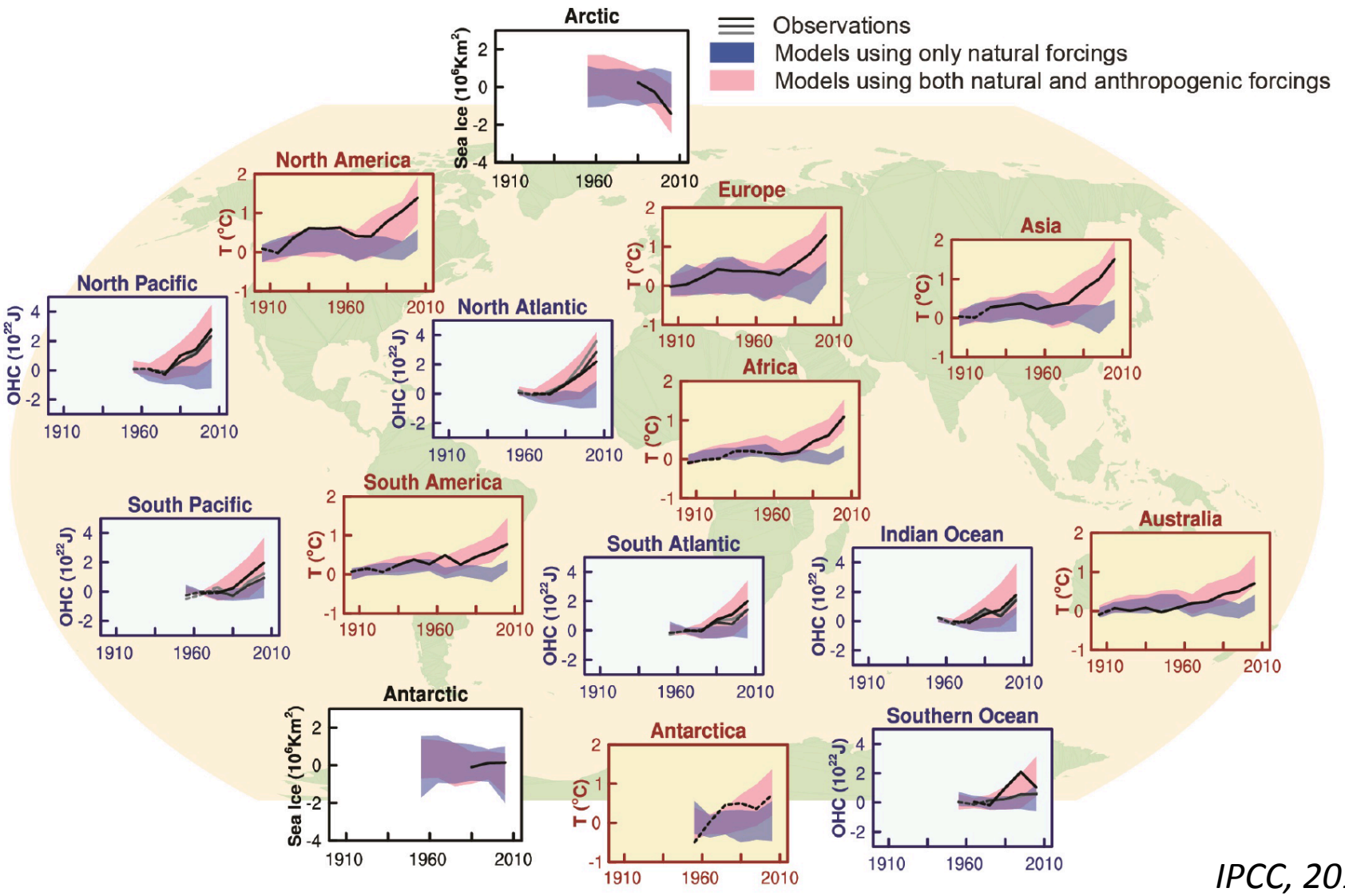
Observations

Models using only natural forcings

Models using both natural and anthropogenic forcings

IPCC, 2013

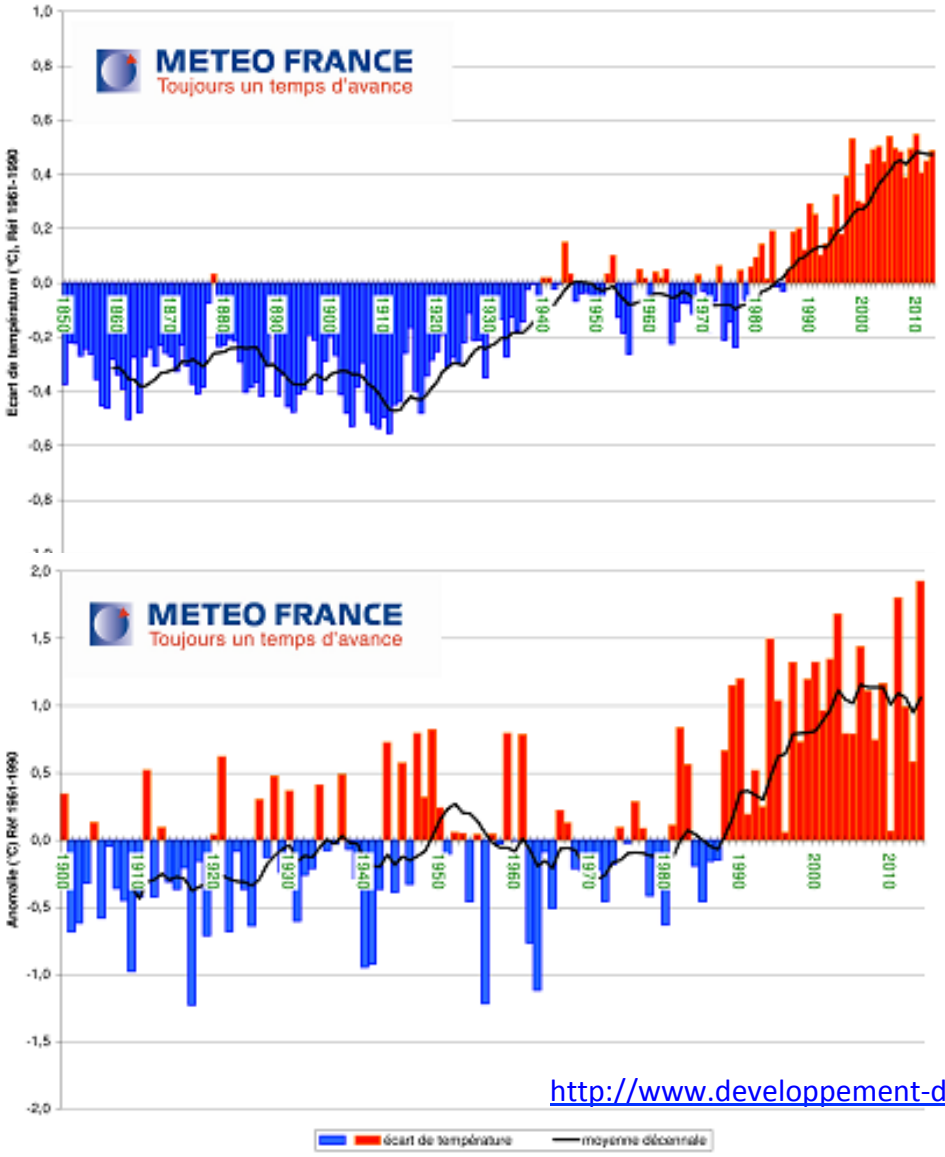
Climate change: attribution to human causes



IPCC, 2013

Source : IPCC AR5 (2013) Fig. SPM6.

Climate change: what happened in France?



Global mean annual temperature increases
Δtemp. compared to 1961-1990

And so does the mean annual temperature in France … *even more*

http://www.developpement-durable.gouv.fr/-Impacts-du-changement-climatique,2907-.html

Climate change: what happened in France?

Changes in mean annual temperature between 1900 and 2006

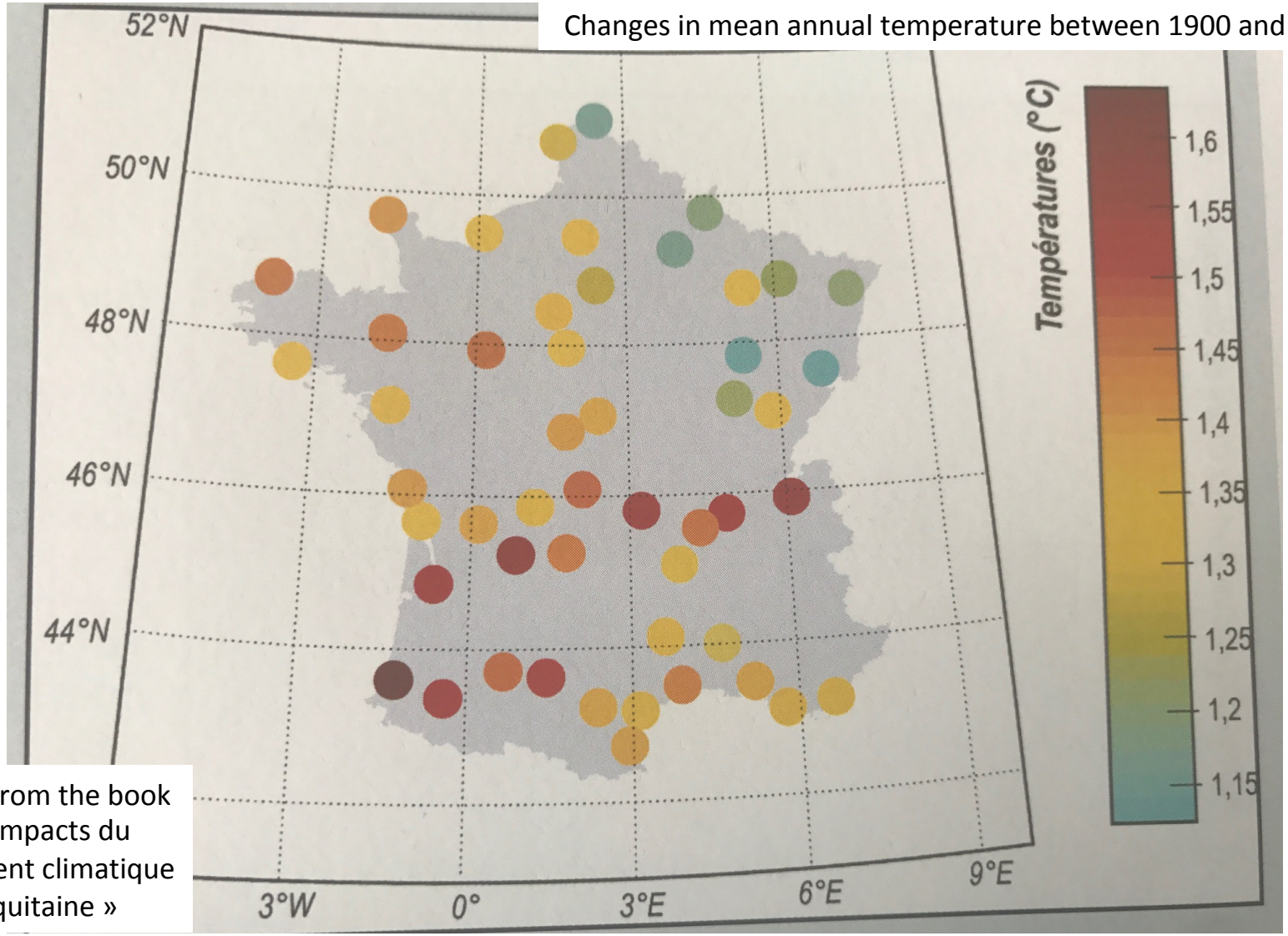
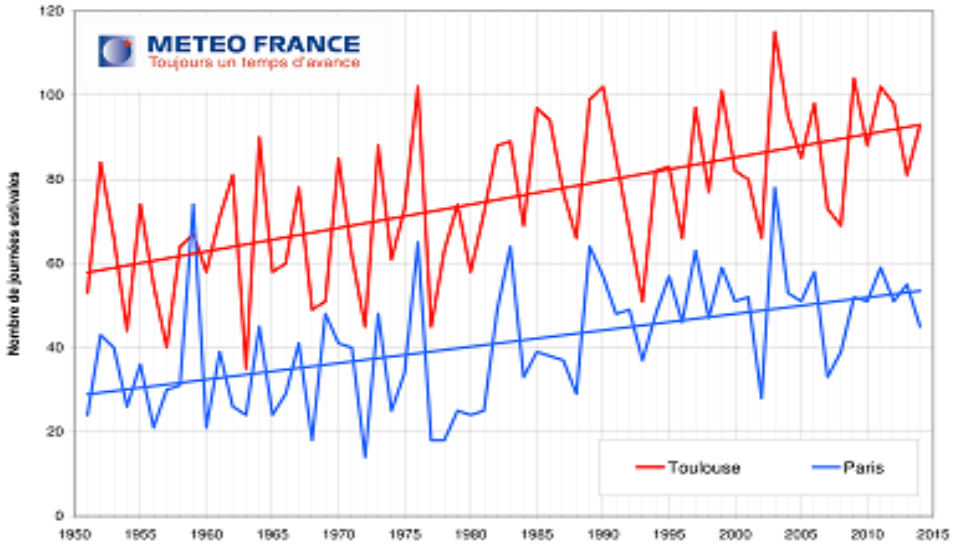


Figure 6 from the book « Les impacts du changement climatique en Aquitaine »

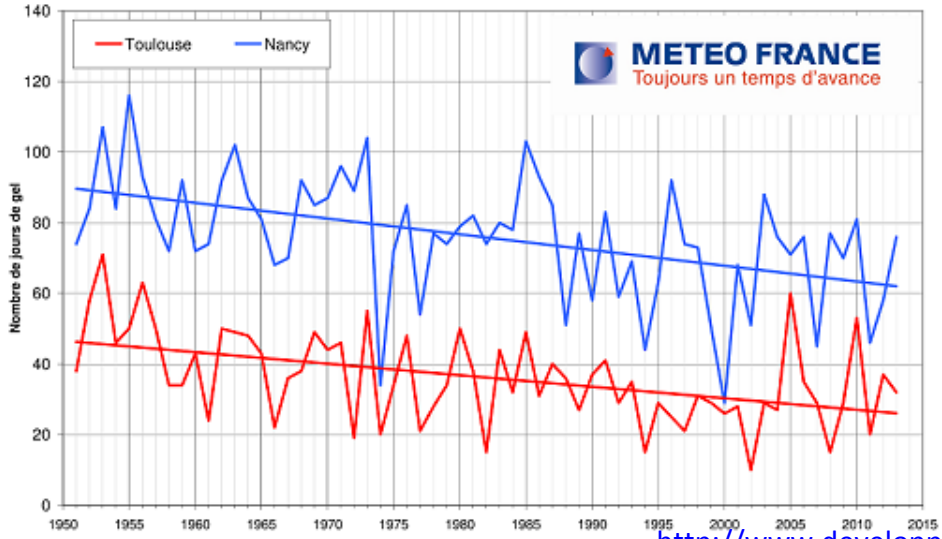
Climate change: what happened in France?



+6 days / decade, Toulouse

Number of summer days – T ≥ 25°C

+4 days / decade, Paris



-5 days / decade, Nancy

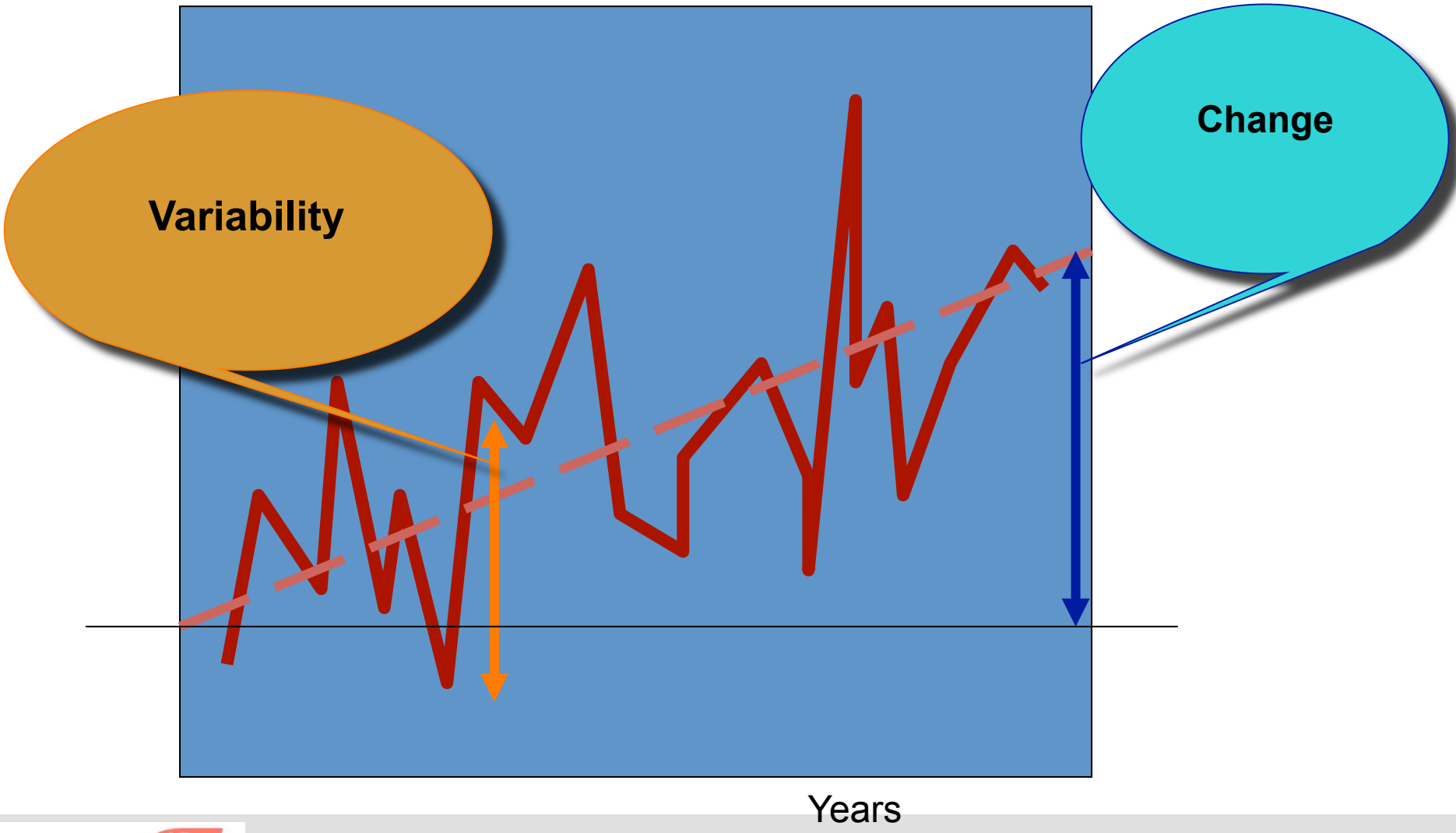
Number of frost days – T < 0°C

-3 days / decade, Paris

http://www.developpement-durable.gouv.fr/-Impacts-du-changement-climatique,2907-.html

Climate change ≠ climate variability

Time evolution of a climate variable



Climate change ≠ climate variability

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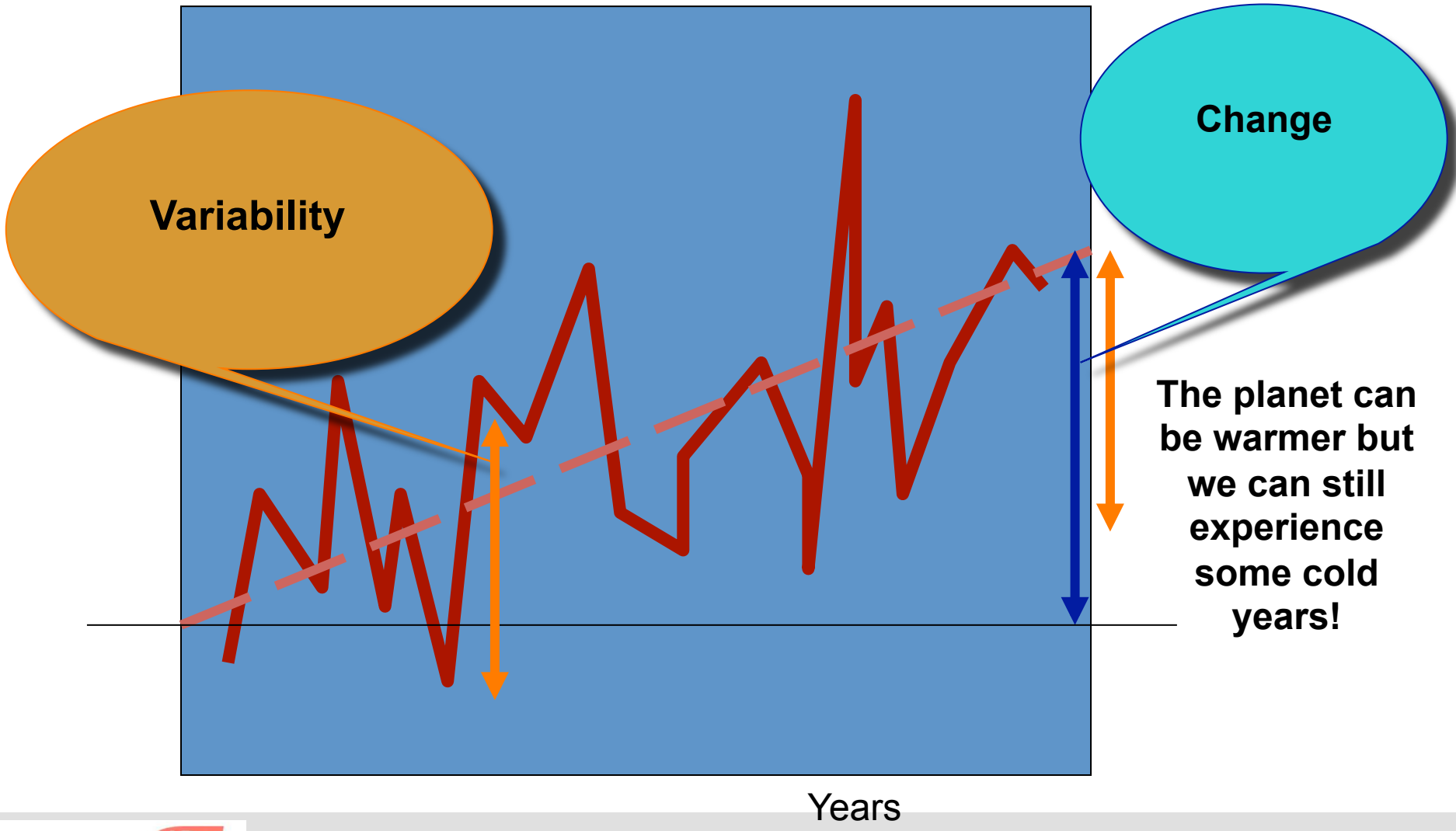
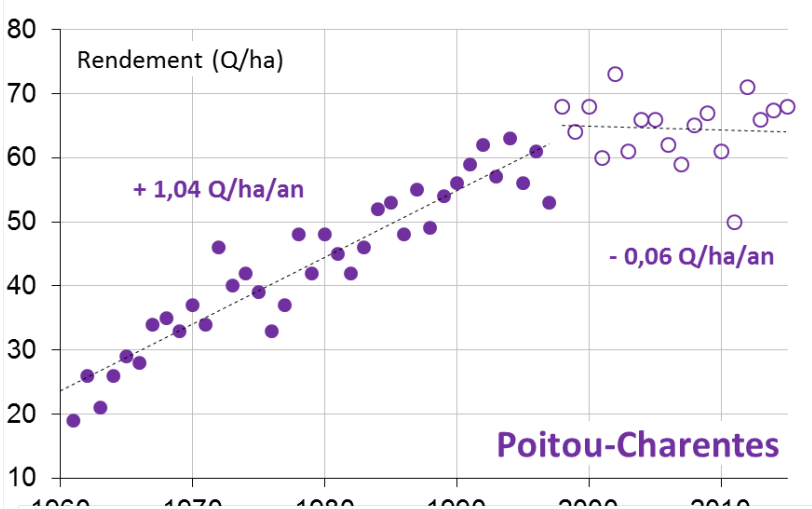
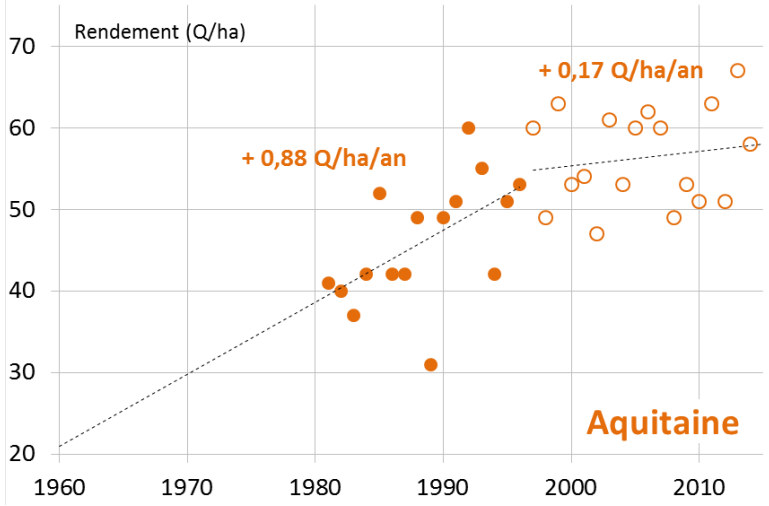
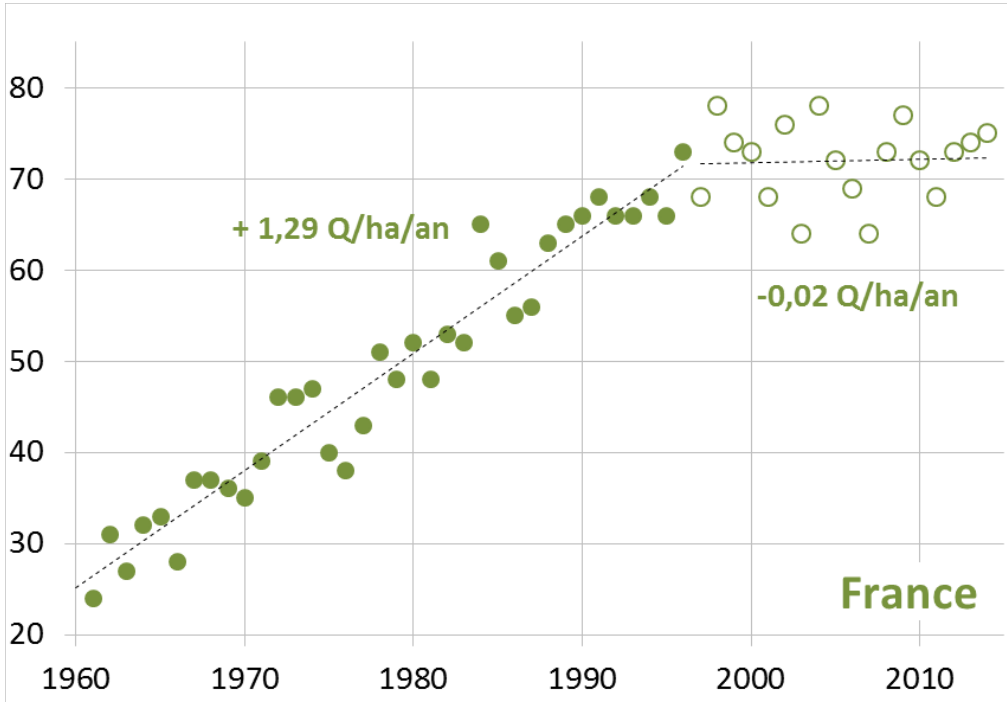


The imprint of climate change in the farming sector

Common Wheat: yields







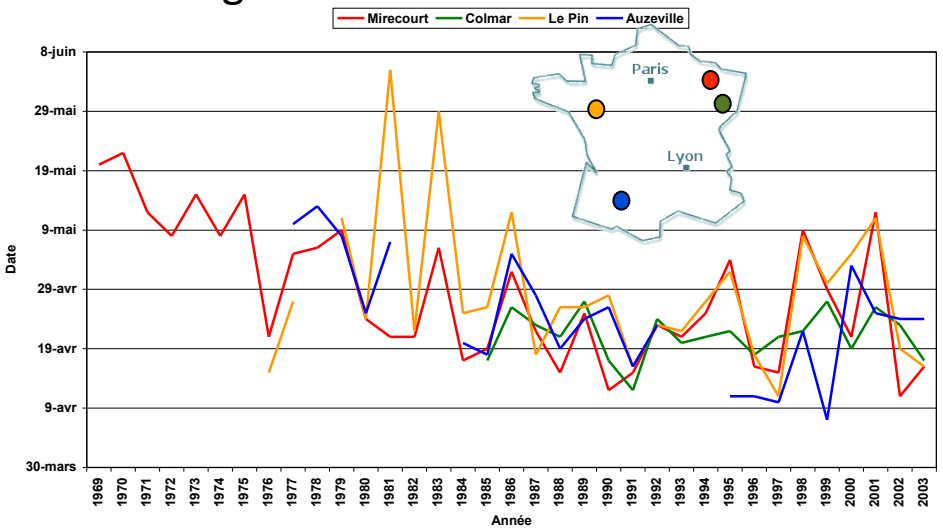
Brisson et al. 2010

Observed yields in Aquitaine, Poitou-Charentes, France.
Data from France Agri Mer.

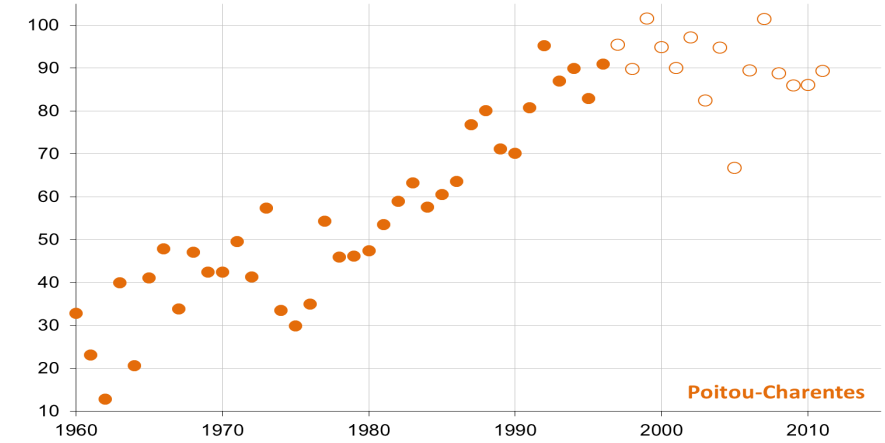
The imprint of climate change in the farming sector

Corn - Maize

Sowing dates

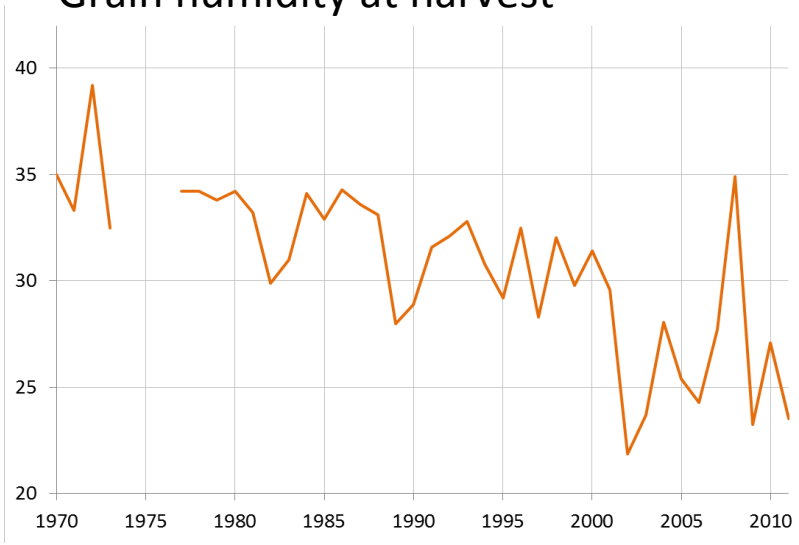


Yield



Observed yield since 1960 in Poitou-Charentes.
Data from France AgriMer

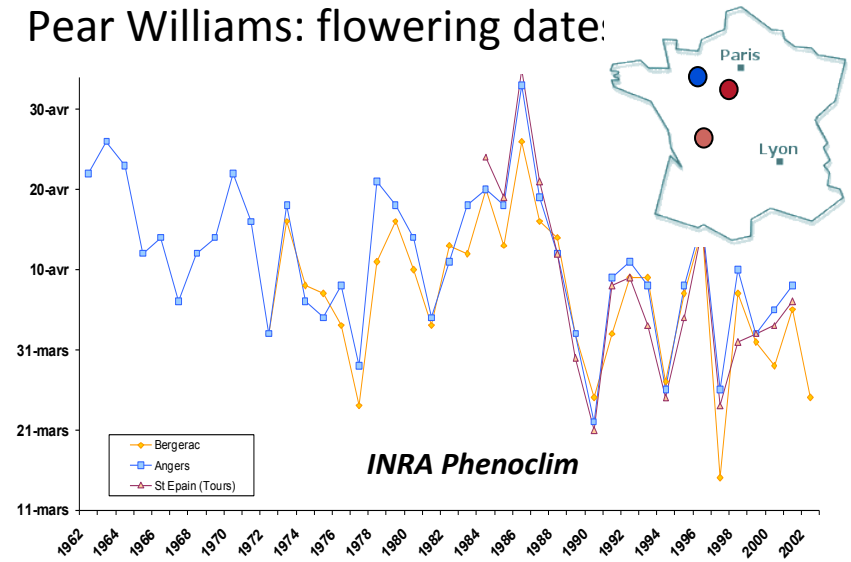
Grain humidity at harvest



Observed from a number of farms
in Poitou-Charentes
Data from Coop de France Poitou-Charentes.

The imprint of climate change in the farming sector

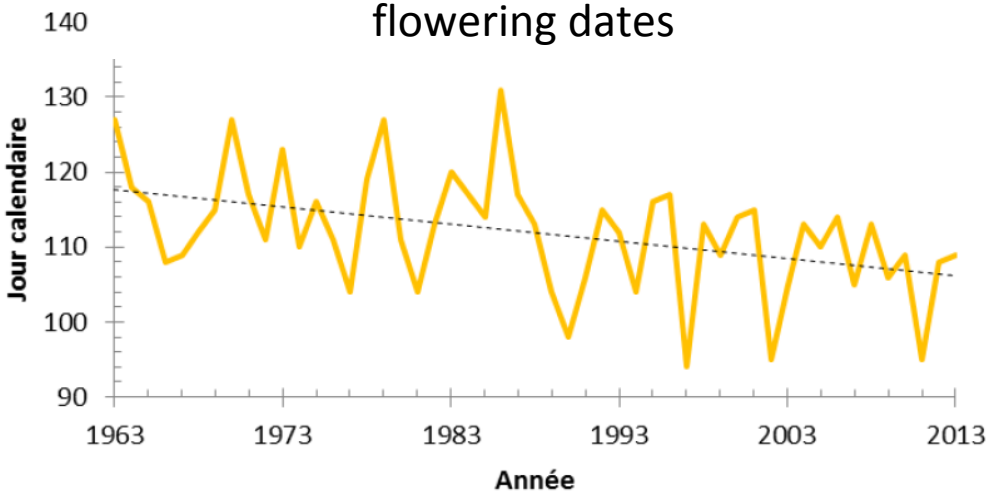
Pear Williams: flowering dates



Dates of flowering and end of dormancy

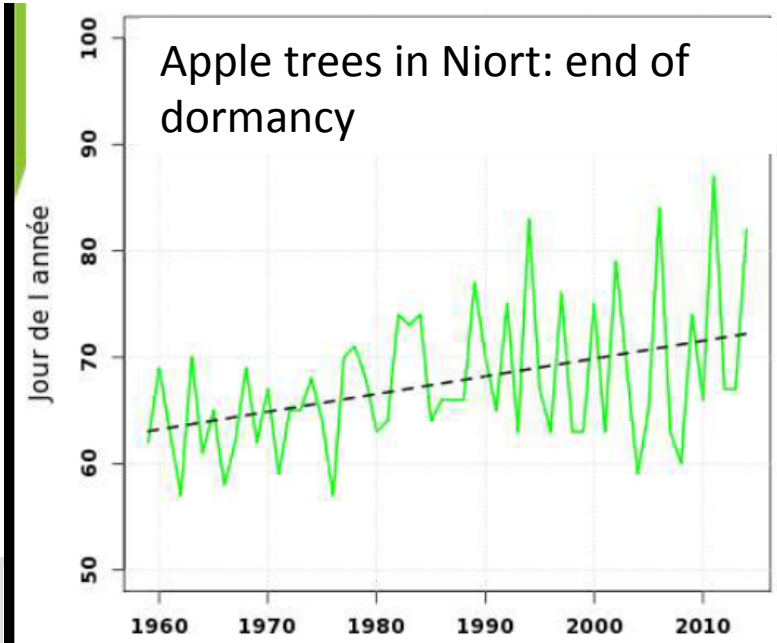
Oracle

Apple trees in Angers (Golden delicious) flowering dates



Data from CTIFL / INRA

Apple trees in Niort: end of dormancy



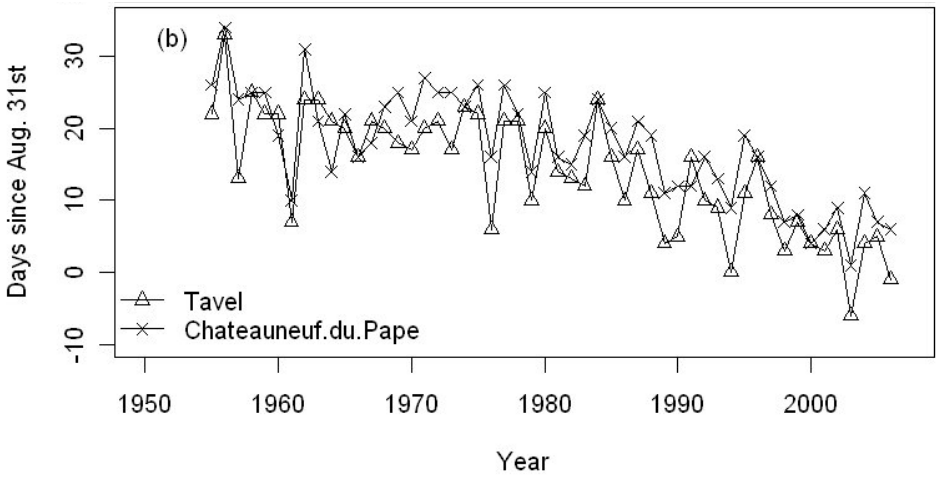
Data from Meteo France / SQR

The imprint of climate change in the farming sector

Grapevine

Phenology –harvest dates

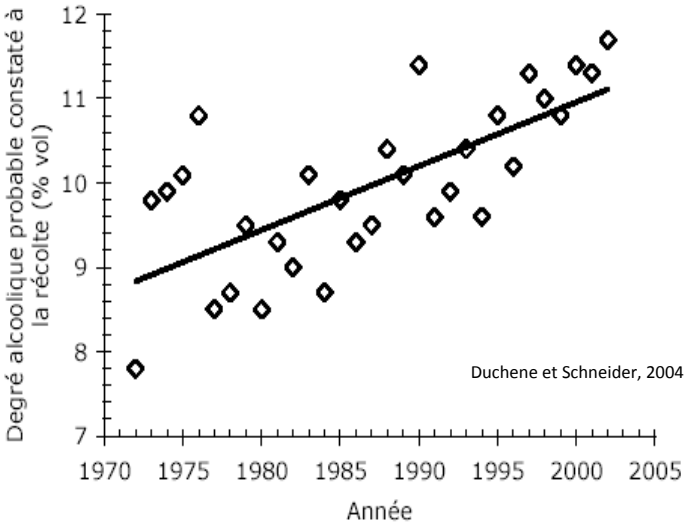
Château neuf du Pape & Tavel



-30 days (earlier by ~1 month) in 50 years

Quality

Sugar - Riesling (Alsace)



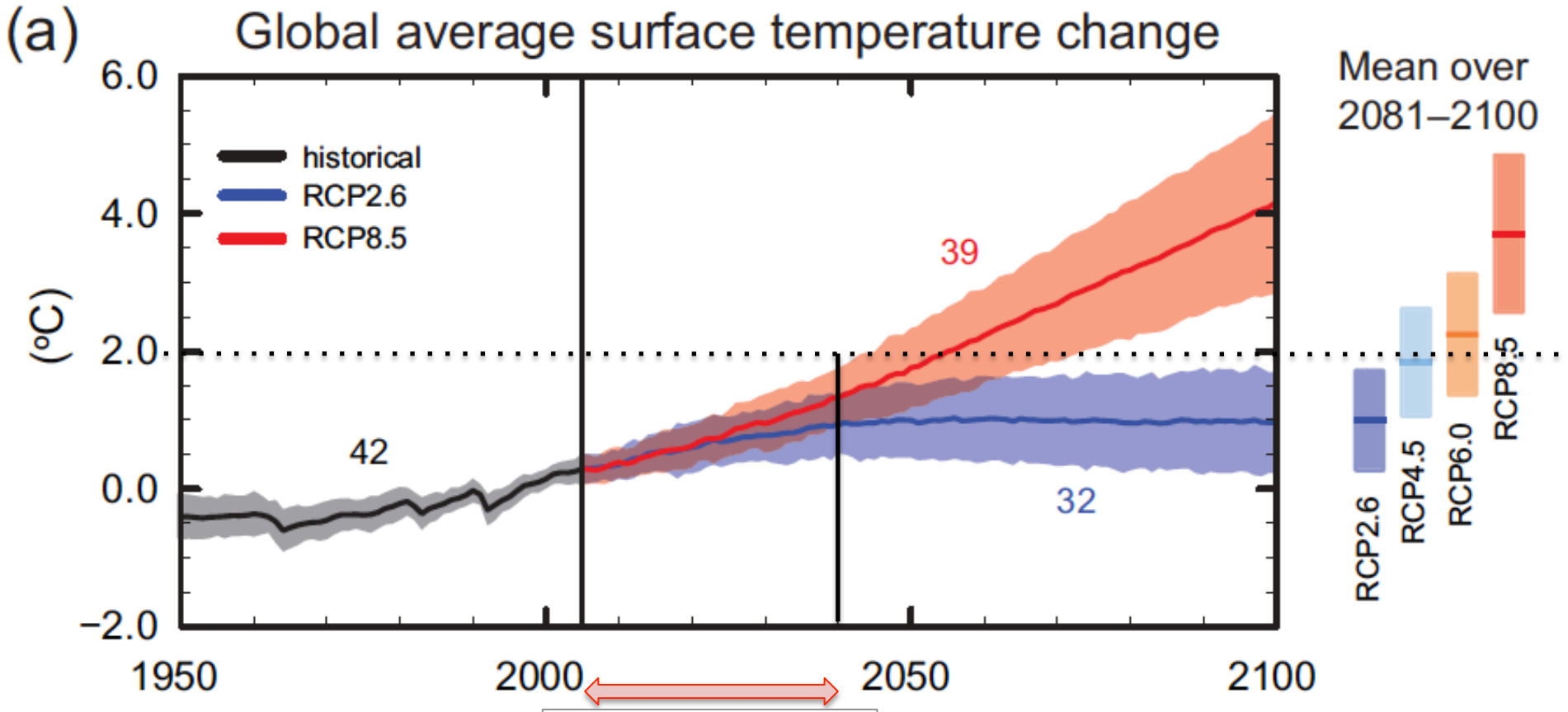
<u>Sugar</u>

Languedoc : +1° / decade
Côtes du Rhône : +0.6° / decade
Val de Loire : +0.5 - 1° /decade
Alsace : +0.9° / decade

http://phenoclim.org/fr

Climate change: the future, at global scale

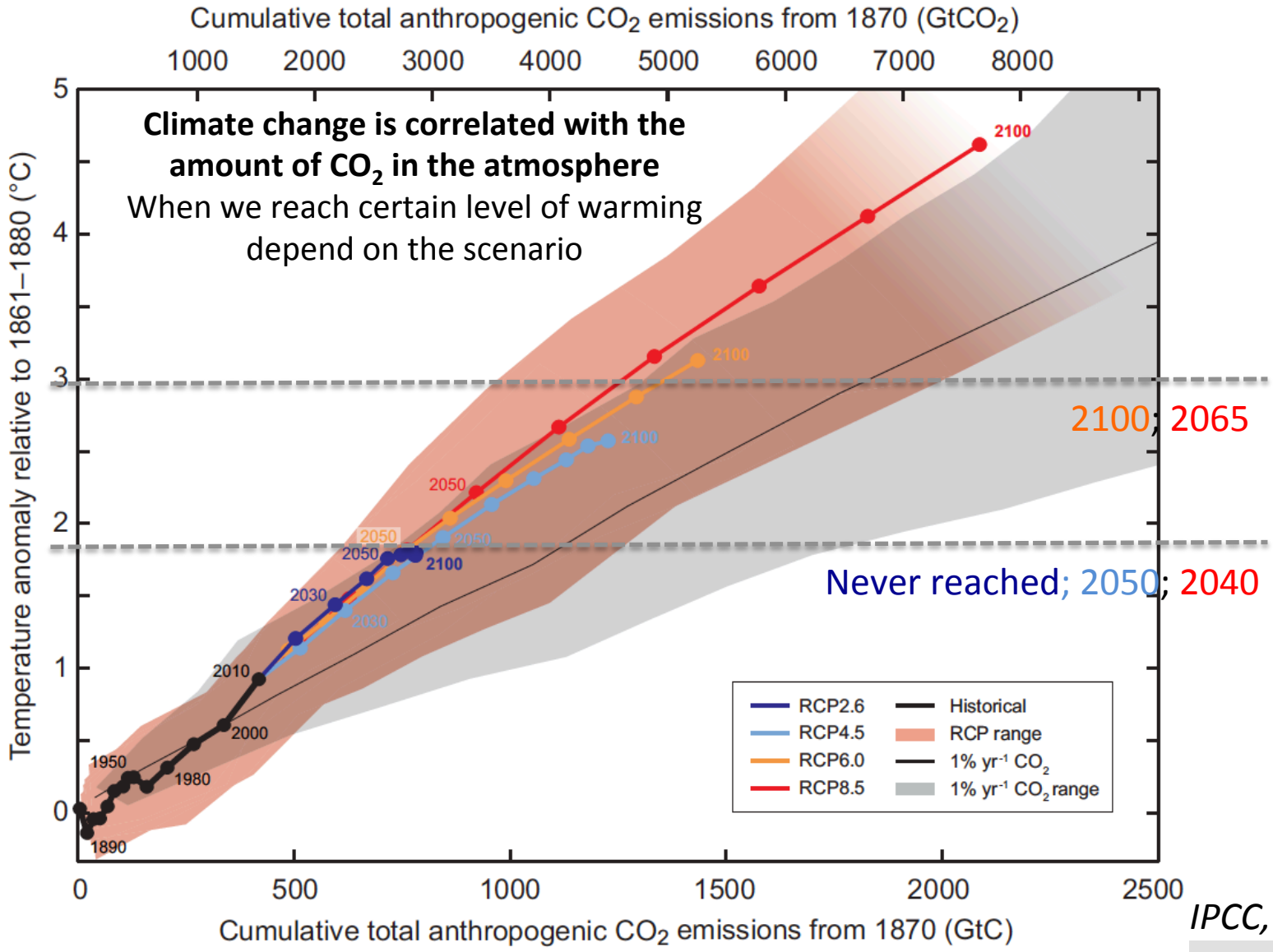
Socio-économic scenarios (demography, societal choices, technical progress)
➔ different trajectories of global warming



Whatever our socio-economic choices, what will happen during this time period is already 'written'

IPCC, 2013

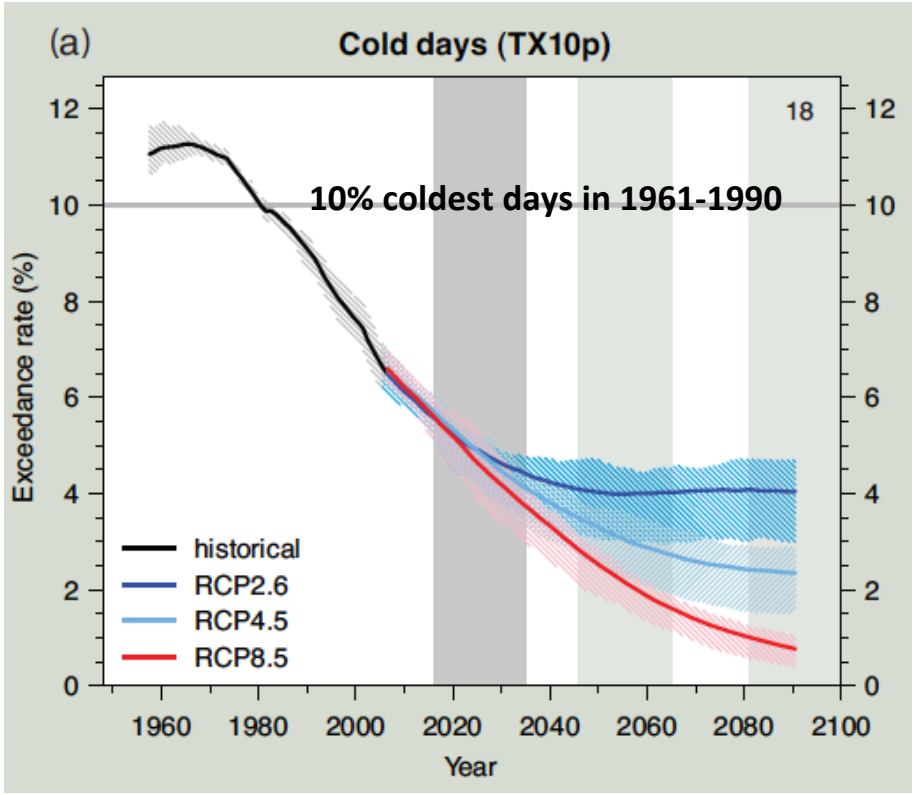
Climate change: the future, at global scale



IPCC, 2013

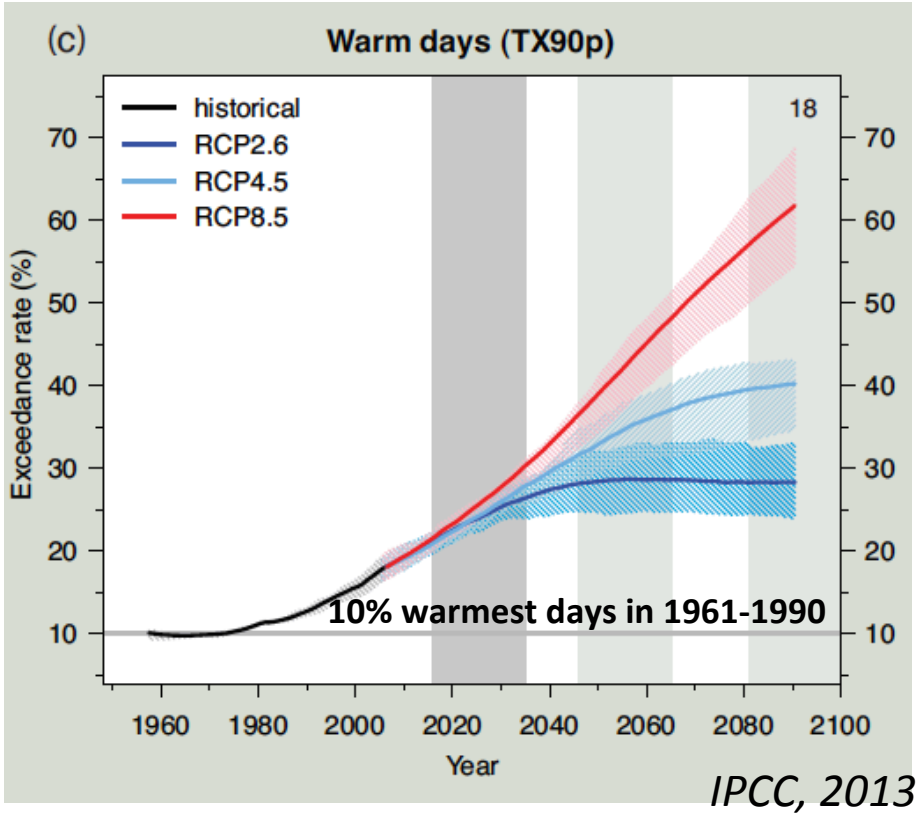
Climate change: the future, at global scale

Strong decrease in the number of cold days



The evolution of climate extremes is proportionnal to the level of warming

Strong increase in the number of warm days

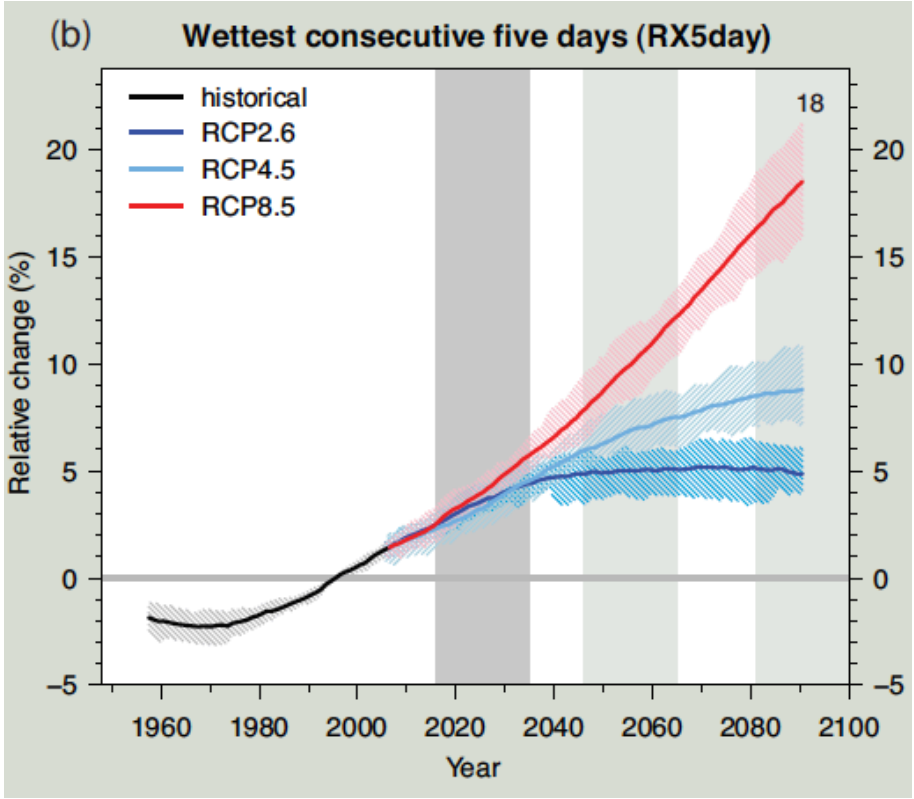


RCP 8.5 **RCP 4.5** **RCP 2.6**

IPCC, 2013

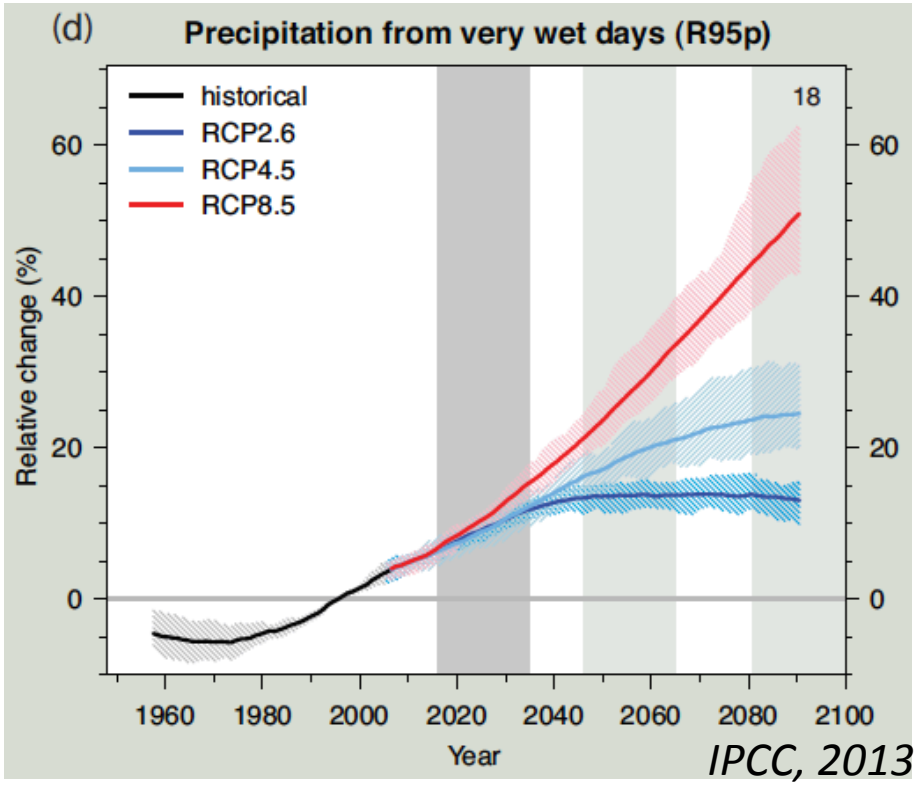
Climate change: the future, at global scale

Rainfall amounts from 5 consecutive rainy days increase with global warming



The evolution of climate extremes is proportionnal to the level of warming

Intensity of precipitation of the 5% rainiest days increases with global warming



IPCC, 2013

RCP 8.5 **RCP 4.5** **RCP 2.6**

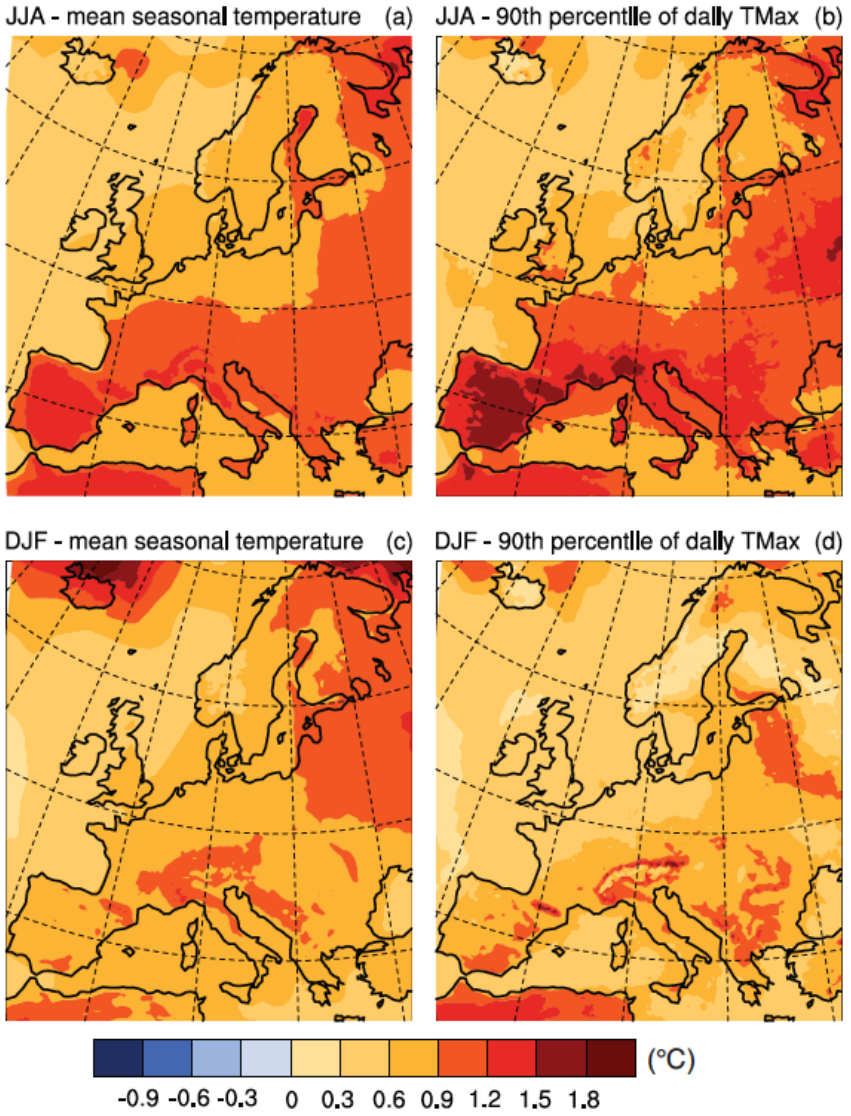
Climate change: the future, western Europe

Temperature change

Mean seasonal values (left) and extremes (right; 10% warmest temperature per season)

Summer

Winter



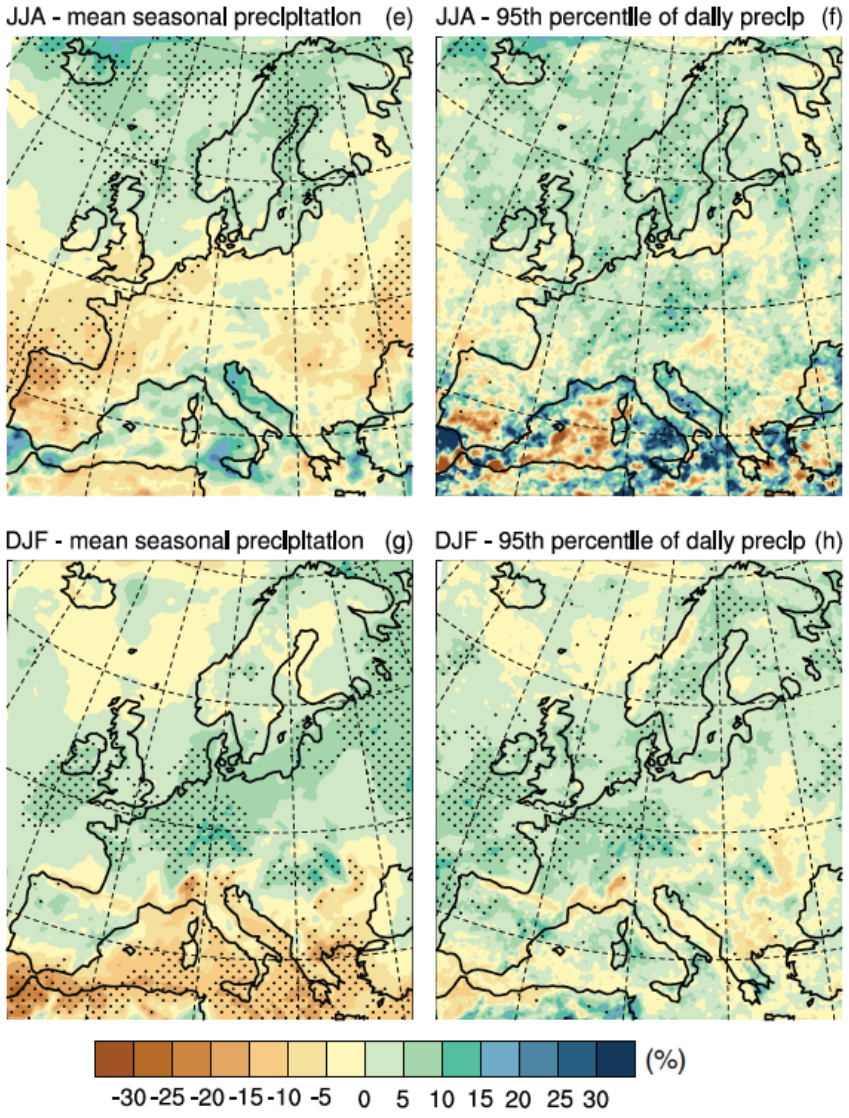
Climate change: the future, western Europe

Rainfall change

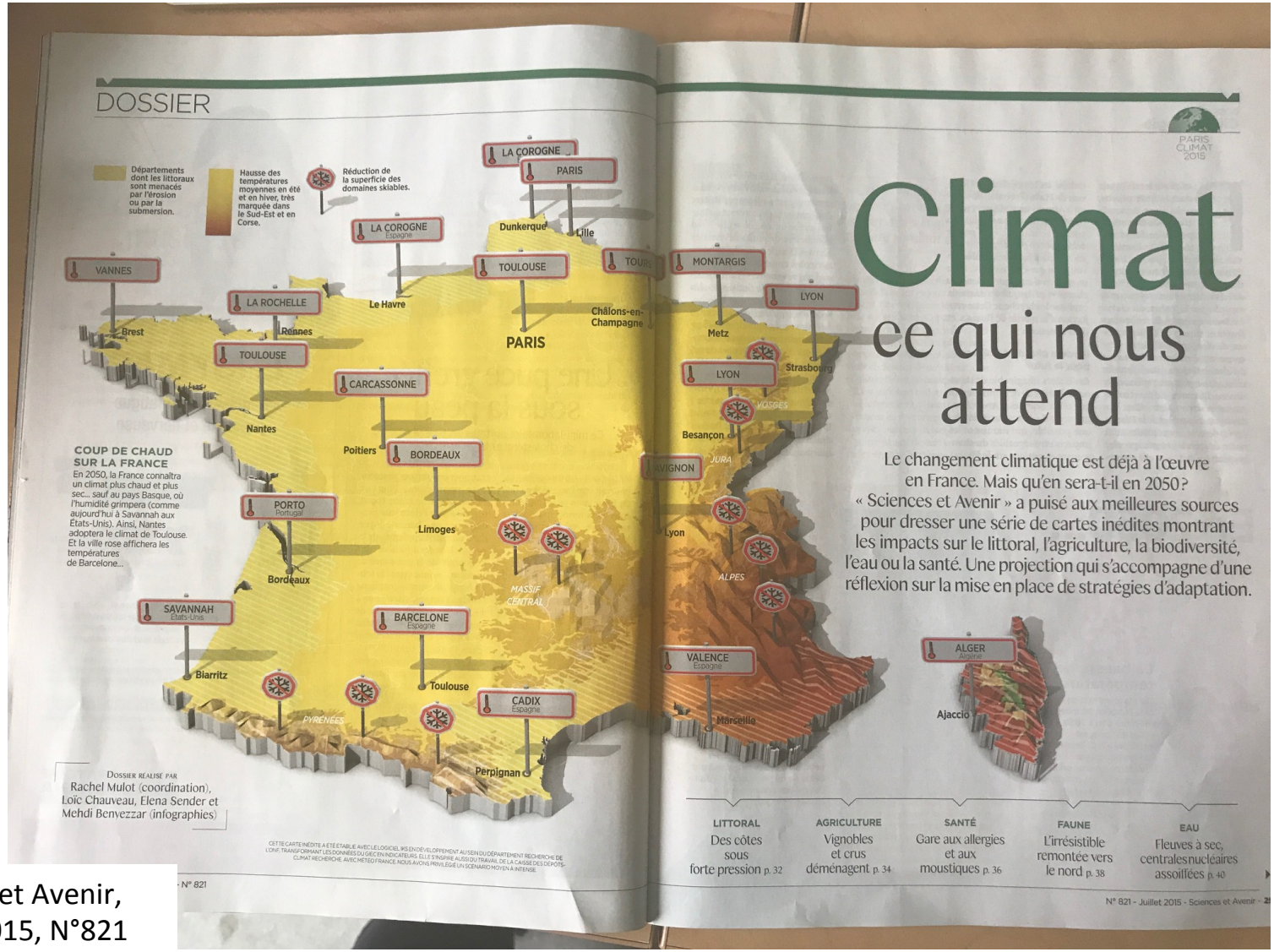
Mean seasonal values (left) and extremes (right; 5% wettest events per season)

Summer

Winter



Climate change: the future, France



Science et Avenir, Juillet 2015, N°821

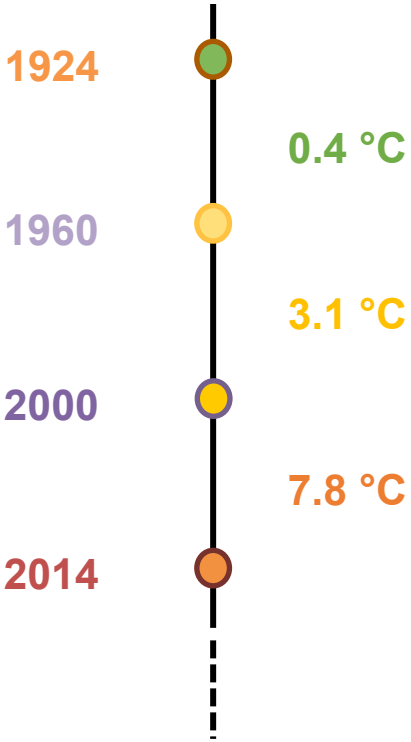
How can we work together? ➔ Climate Services

All **the information and services** which allow to:

- **estimate and qualify** the past, present and future **climate**,
- **estimate the vulnerability** of economic activities, environment and society **to climate change**,
- And **supply elements to undertake measures of mitigation and adaptation**

An example of climate services: Olympic Games

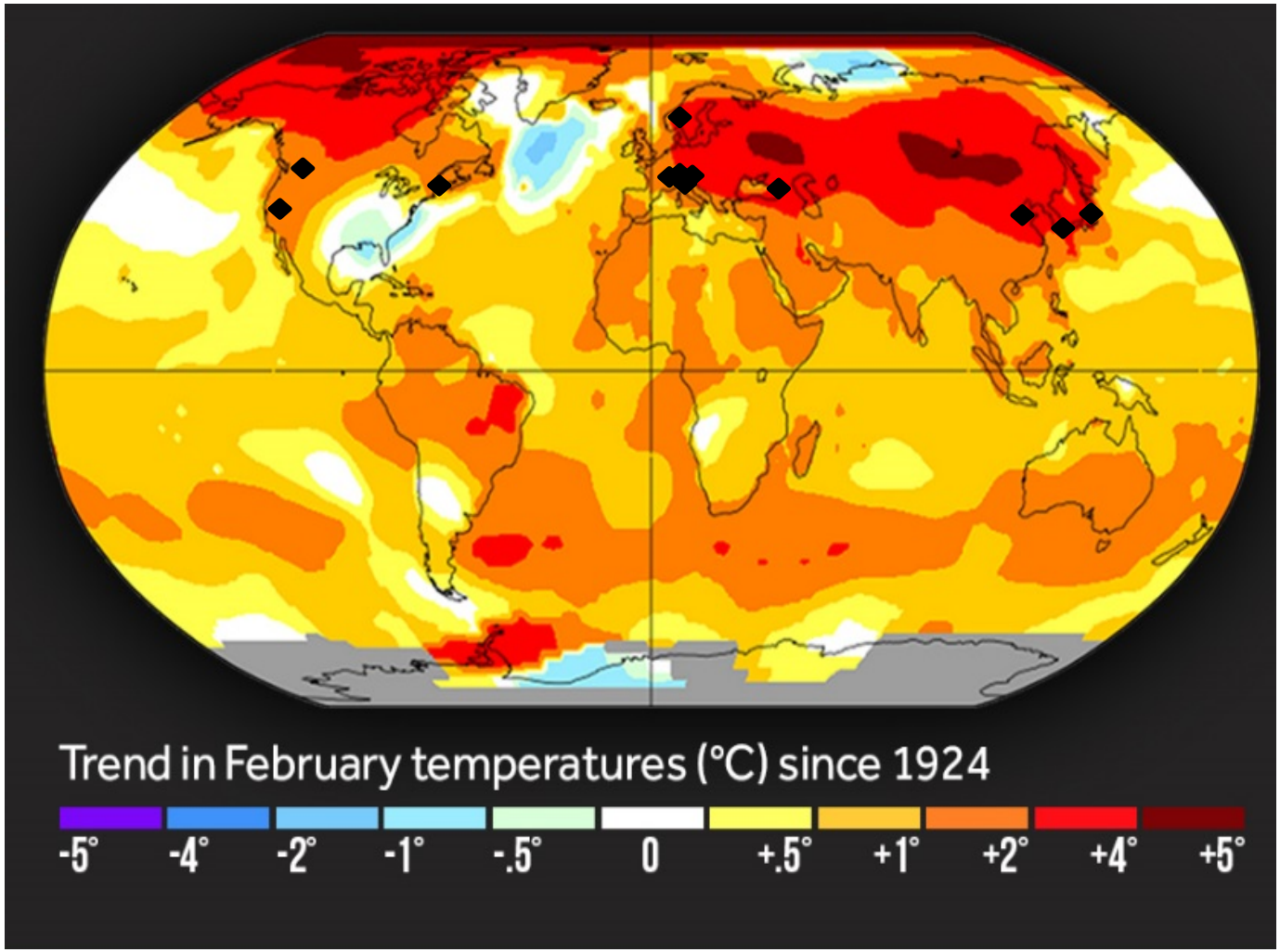
Mean of maximum temperature in February, from all Olympic cities



Scott et al. (2018)

Changes in February temperature since 1924

Black diamonds = olympic games cities



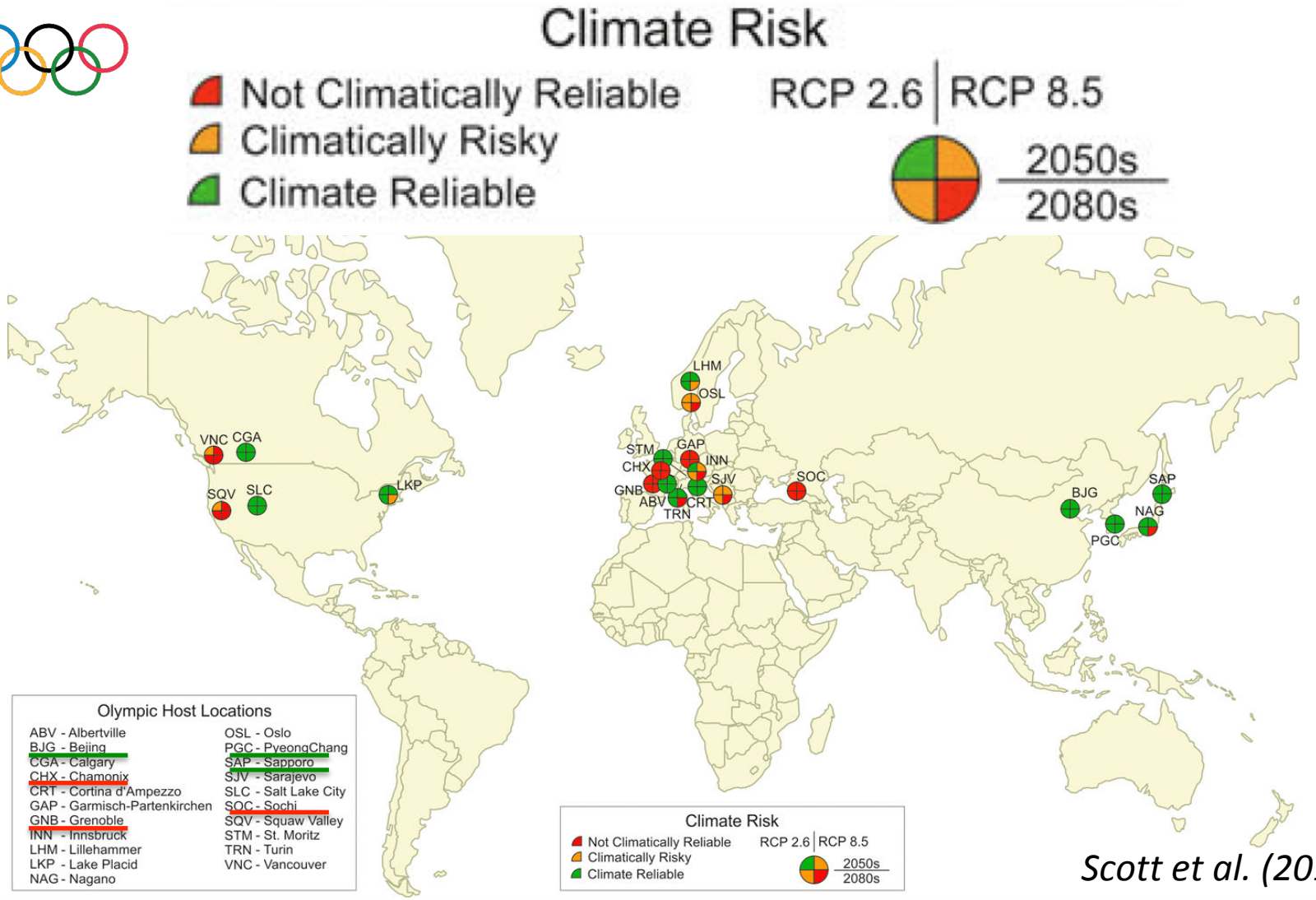
An example of climate services: Olympic Games

Design of 2 indicators to anticipate future potential

1. Probability that mean daily temperature remain below 0°C

2. Probability that snow depth will remain above 30cm, with or without snow farming

An example of climate services: Olympic Games



Scott et al. (2018)

Climate services for Agriculture: the case of corn

The future of Corn

2 varieties:
Meribel (early)
dkc7583 (late)

Fig. 1. The two studied areas of France.

Caubel et al. (2017)

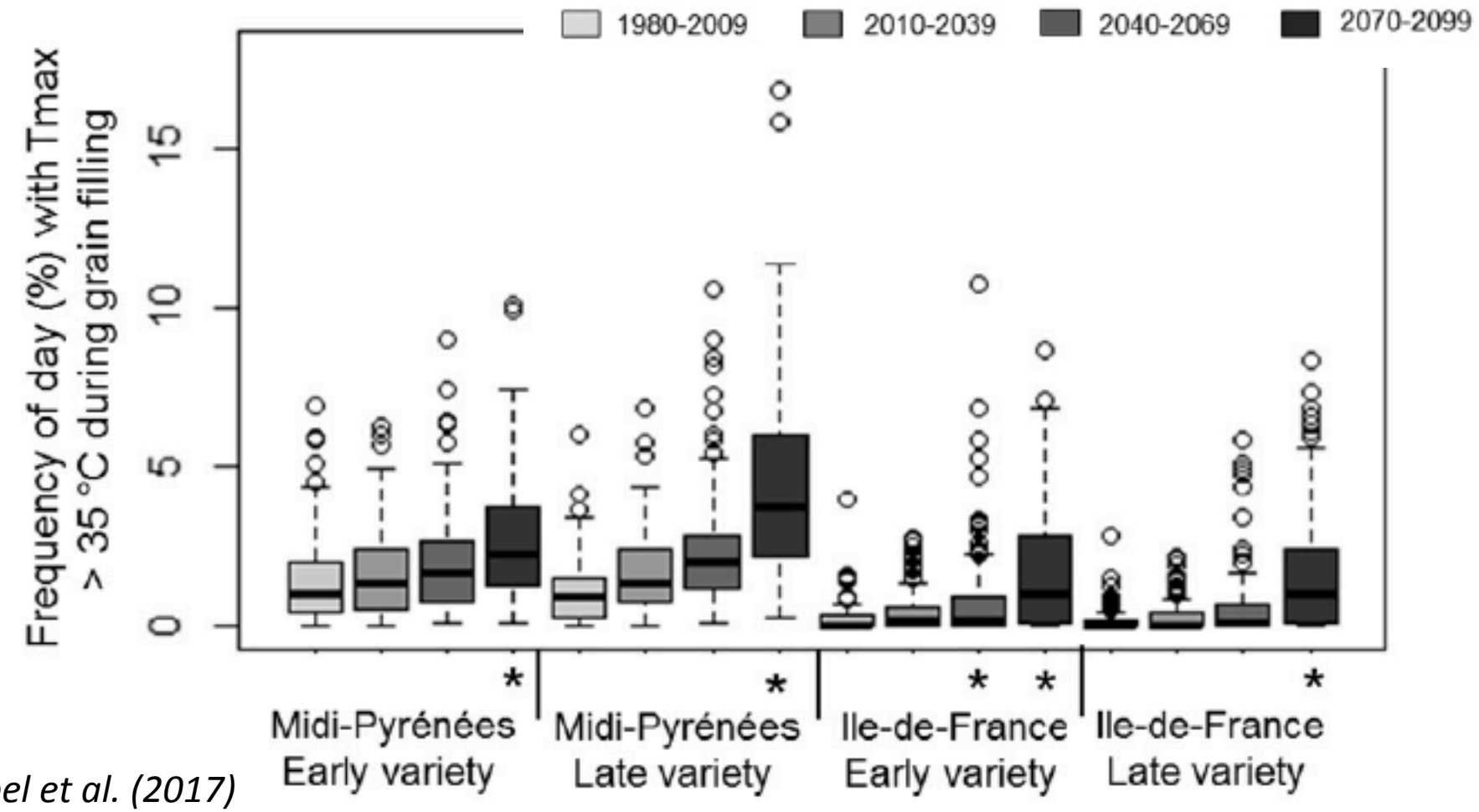
Climate services for Agriculture: the case of corn

Dates	Early Variety			Late Variety		
Changes compared to 1980-2009 (days)	**2010-2039**	**2040-2069**	**2070-2099**	**2010-2039**	**2040-2069**	**2070-2099**
Midi Pyrénées *Change in sowing dates*	earlier 12 days	earlier 21 days	earlier 30 days	earlier 12 days	earlier 21 days	earlier 30 days
Midi Pyrénées *Change in length of the growing season [from emergence to maturity]*	+ 1 day	+ 1 day	+ 4 days	-2 days	-3 days	-4 days
Ile de France *Change in sowing dates*	earlier 6 days	Earlier 8 days	Earlier 16 days	Does not complete its growth cycle	Does not complete its growth cycle	mid-April
Ile de France *Change in length of the growing season [from emergence to maturity]*	-8 days	-15 days	-19 days	Does not complete its growth cycle	Does not complete its growth cycle	146 days

Caubel et al. (2017)

Climate services for Agriculture: the case of corn

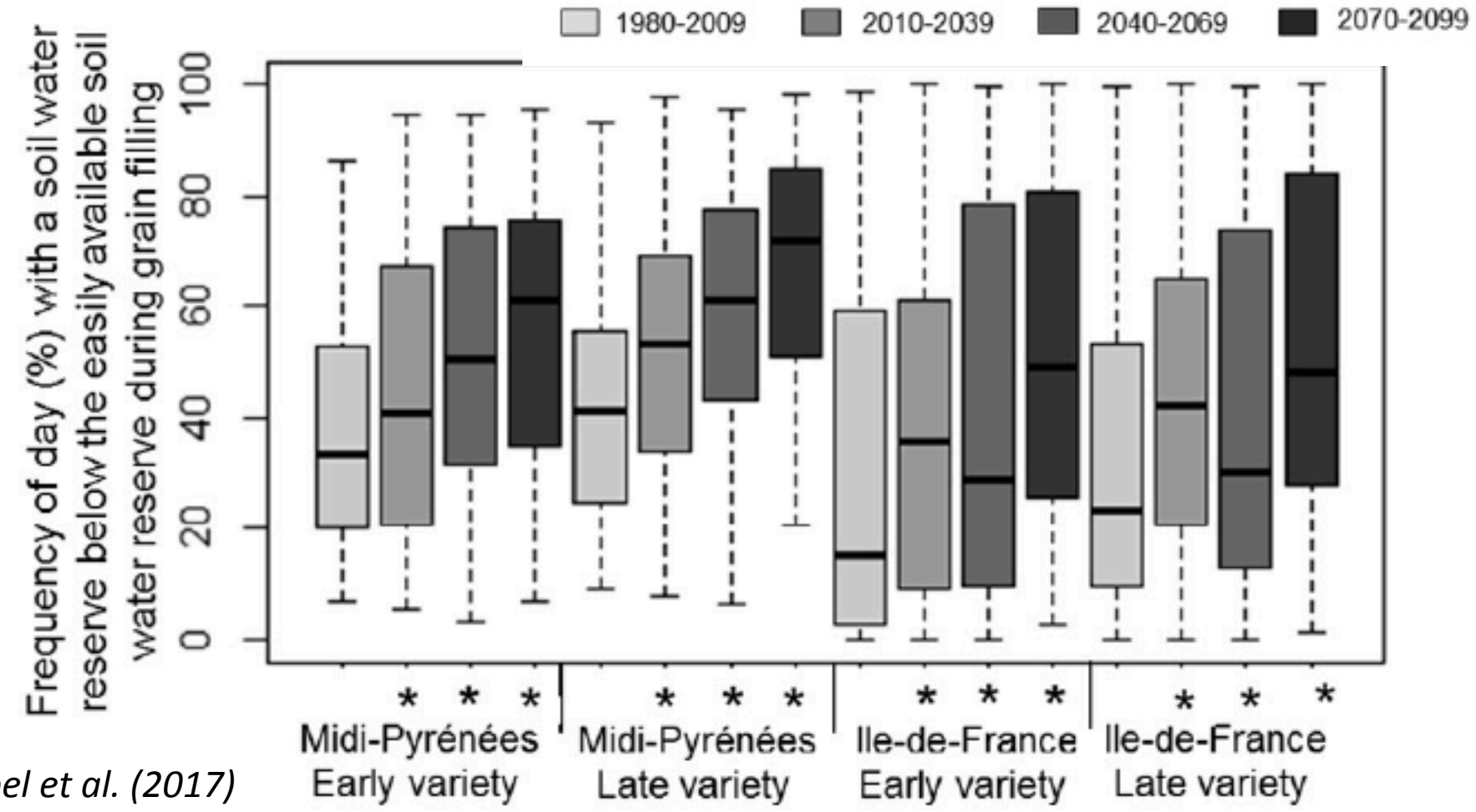
Frequency of days, during grain filling, with maximum temperature > 35°C



Caubel et al. (2017)

Climate services for Agriculture: the case of corn

Frequency of days, during grain filling, with low soil water



Caubel et al. (2017)

Concluding remarks

- Climate change
  - We've already reached +1°C since ~1850
  - Global warming is correlated to anthropogenic emissions of CO_2
  - Hot temperature extremes, extreme rainfall events increase with warming
  - Changes over continental areas are larger than global mean

- Agriculture
  - The imprint of climate change is already visible (large-scale crops, grapes, fruit trees)
  - We can build tools to anticipate what will happen ➔ climate services
  - Example of corn:
    - Earlier sowing dates with warming
    - It will be possible to grow late season variety in northern France
    - But extreme (lethal?) temperatures will be more frequent during grain filling period
    - Number of days with insufficient soil water during grain filling may double before the end of the 21st century