




**Italy and future climate change:
which information can climatologists deliver?**

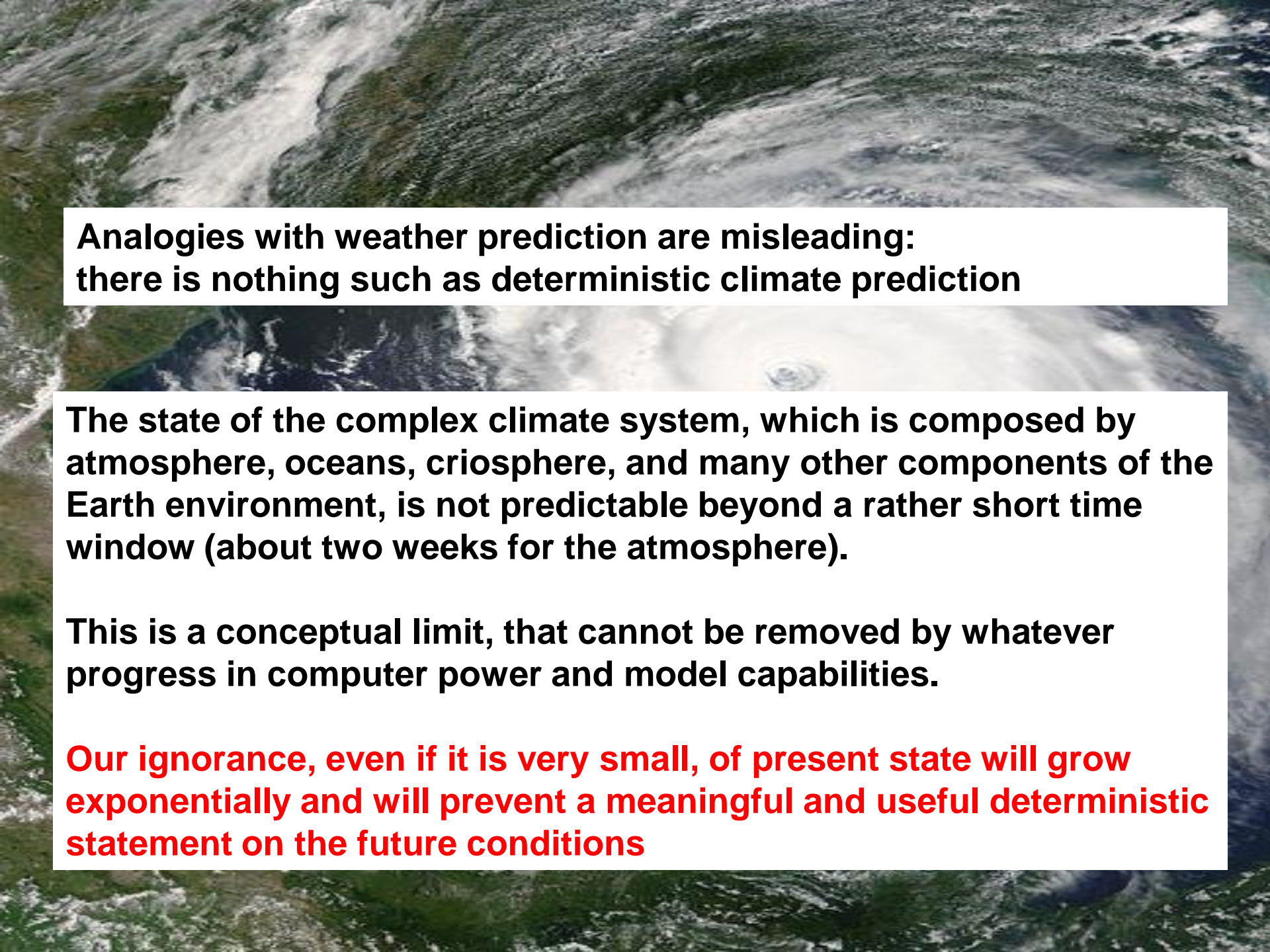
Prof. Piero Lionello



**UNIVERSITÀ
DEL SALENTO**

A satellite image of Earth showing a large, well-defined storm system (cyclone or hurricane) over the Mediterranean Sea. The storm has a clear eye and spiral cloud bands. The surrounding landmasses, including parts of Europe and Africa, are visible in shades of green and brown. The ocean is a deep blue, with white clouds from the storm contrasting sharply against it.

How will be the sequence of summer seasons in Italy during the decade 2041-2050? And 2091-2100?

An aerial photograph of Earth's surface, showing a mix of white clouds, green landmasses, and blue oceans. The perspective is from a high altitude, looking down at the planet's surface.

**Analogies with weather prediction are misleading:
there is nothing such as deterministic climate prediction**

The state of the complex climate system, which is composed by atmosphere, oceans, cryosphere, and many other components of the Earth environment, is not predictable beyond a rather short time window (about two weeks for the atmosphere).

This is a conceptual limit, that cannot be removed by whatever progress in computer power and model capabilities.

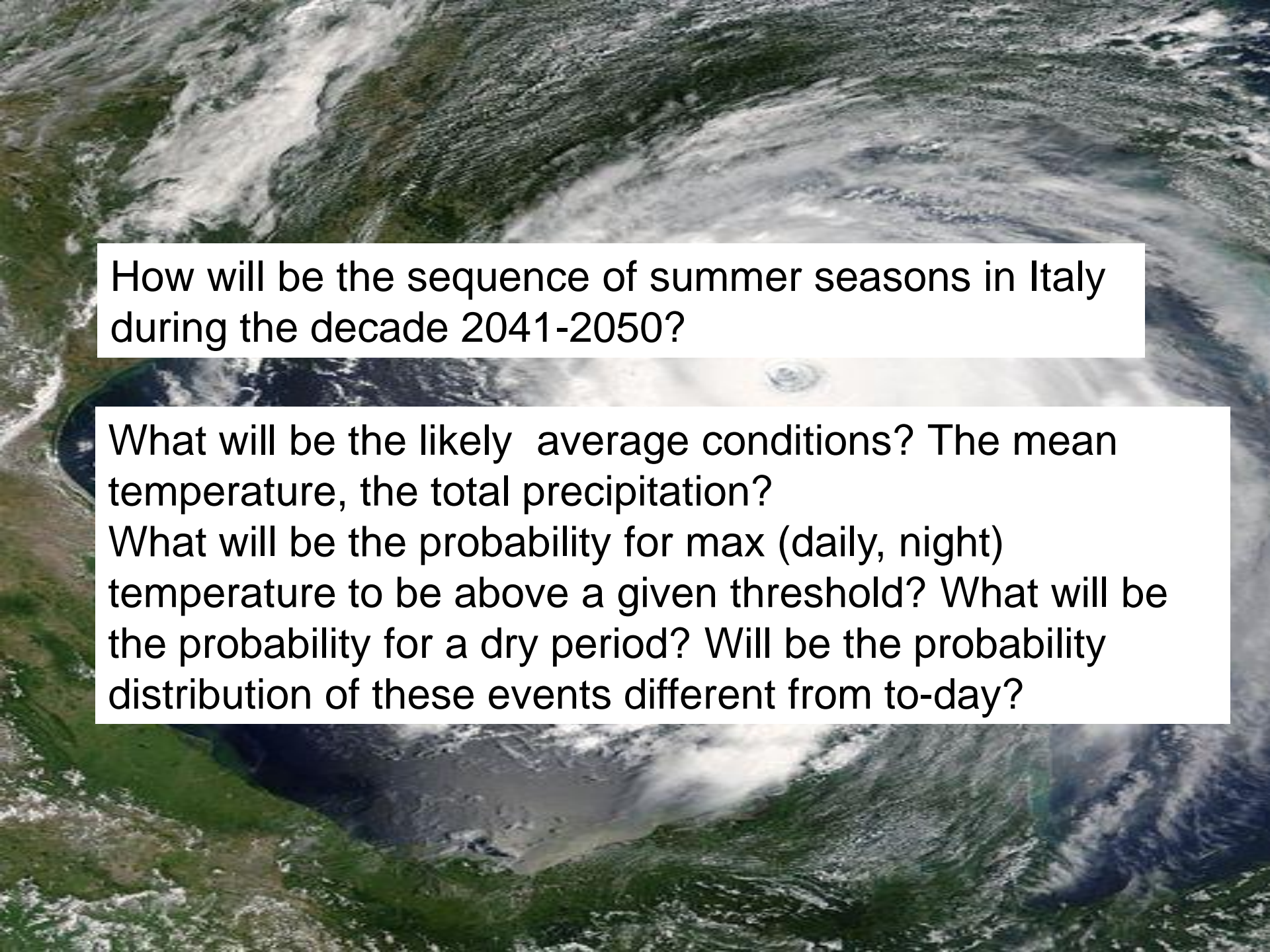
Our ignorance, even if it is very small, of present state will grow exponentially and will prevent a meaningful and useful deterministic statement on the future conditions

An aerial satellite-style photograph of Earth, showing a large, swirling storm system over the ocean. The storm has a distinct eye and is surrounded by dense, white clouds. The surrounding ocean is dark blue, and some landmasses are visible on the left side of the frame.

Climatology (initially a branch of geography) now aims at a statistical description of future weather conditions.

When discussing about climate we discuss about probability of specific environmental conditions

“Weather is about how you are going to dress today, climate about the clothes you are going to buy”

An aerial photograph of a coastal region, likely Italy, showing a large bay with a dark blue center and lighter blue outer waters. The surrounding land is covered in dense green vegetation, with some rocky outcrops visible. The sky is filled with white, fluffy clouds.

How will be the sequence of summer seasons in Italy during the decade 2041-2050?

What will be the likely average conditions? The mean temperature, the total precipitation?

What will be the probability for max (daily, night) temperature to be above a given threshold? What will be the probability for a dry period? Will be the probability distribution of these events different from to-day?

A satellite image of Earth showing a large, swirling storm system over the ocean. The storm is characterized by a dense, white cloud core with spiral bands extending outwards. The surrounding ocean is dark blue, and the landmasses are visible in shades of green and brown. The overall scene is a high-angle, top-down view of the planet's surface.

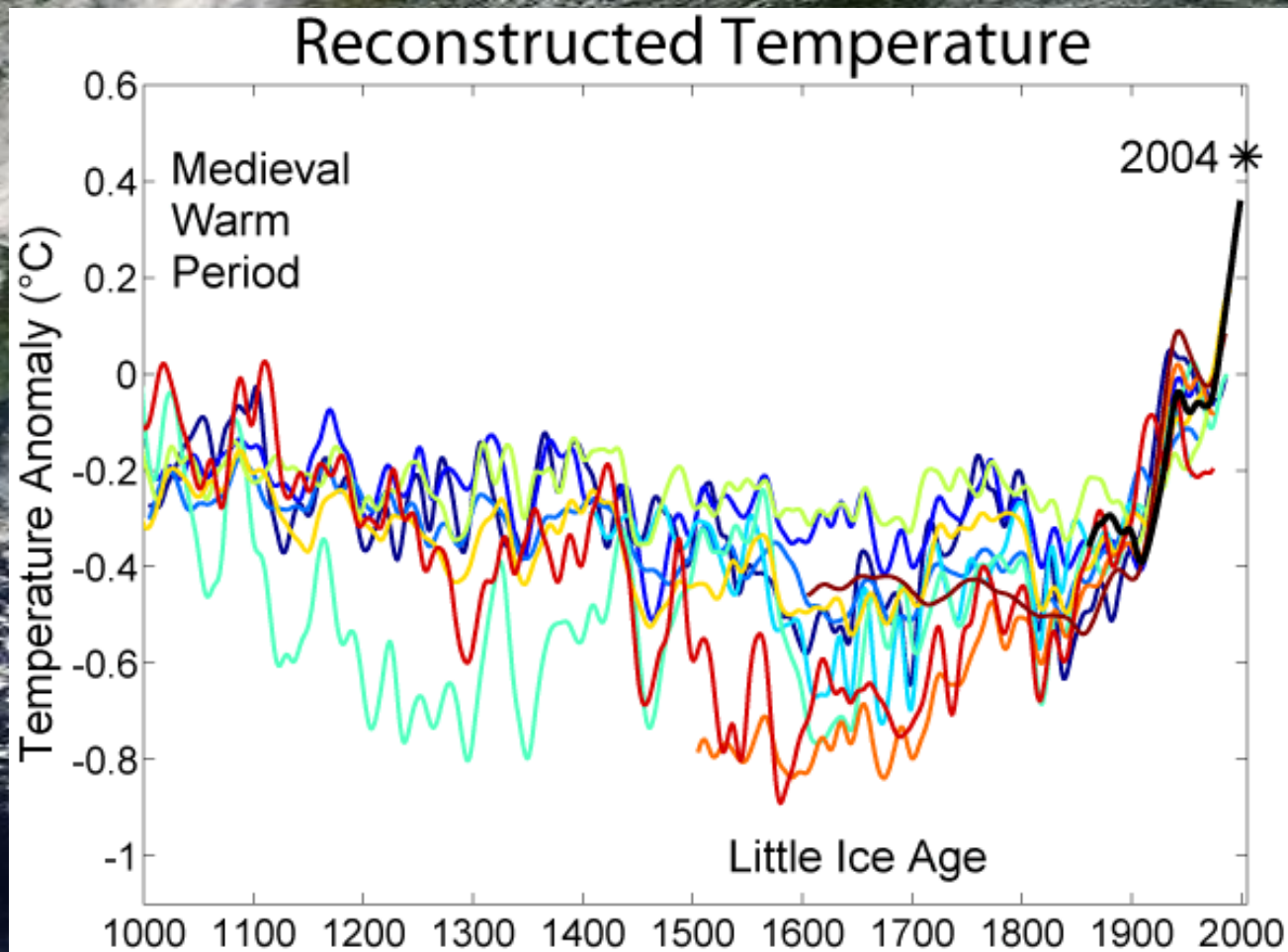
The scientific debate on climate!!!

Why (we) scientists do not agree?
Why are scientists so uncertain?

Skepticism, controversy and disagreement is an essential component of science

An aerial satellite-style photograph of a tropical cyclone, showing a well-defined eye and spiral cloud bands over a dark blue ocean. The surrounding land is green and brown. A white text box is overlaid on the image.

The controversy concerns the past climate

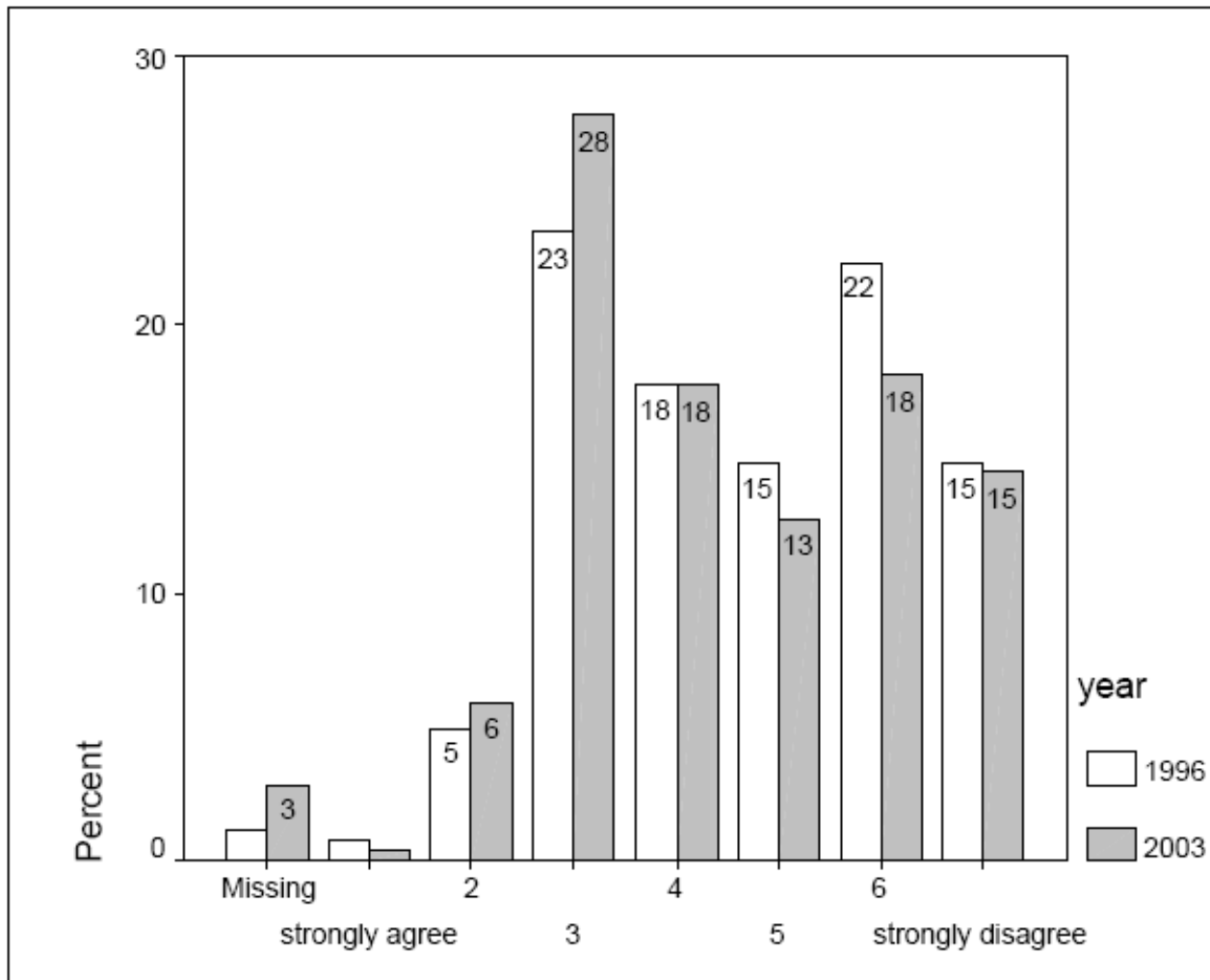


(dark blue 1000-1991): P.D. Jones, K.R. Briffa, T.P. Barnett, and S.F.B. Tett (1998).. **(blue 1000-1980):** M.E. Mann, R.S. Bradley, and M.K. Hughes (1999). , **(light blue 1000-1965):** Crowley and Lowery (2000). **(lightest blue 1402-1960):** K.R. Briffa, T.J. Osborn, F.H. Schweingruber, I.C. Harris, P.D. Jones, S.G. Shiyatov, S.G. and E.A. Vaganov (2001) **(light green 831-1992):** J. Esper, E.R. Cook, and F.H. Schweingruber (2002). **(yellow 200-1980):** M.E. Mann and P.D. Jones (2003). **(orange 200-1995):** P.D. Jones and M.E. Mann (2004). **(red-orange 1500-1980):** S. Huang (2004). **(red 1-1979):** A. Moberg, D.M. Sonechkin, K. Holmgren, N.M. Datsenko and W. Karlén (2005). **(dark red 1600-1990):** J.H. Oerlemans (2005). **(black 1856-2004):** Instrumental data was jointly compiled by the [Climatic Research Unit](#) and the [UK Meteorological Office Hadley Centre](#).

An aerial satellite-style photograph of a tropical cyclone, showing a well-defined eye and spiral cloud bands over a dark blue ocean. The surrounding land is green and brown. A white text box is overlaid on the image.

.... And the future climate

Climate models can accurately predict climatic conditions of the future.



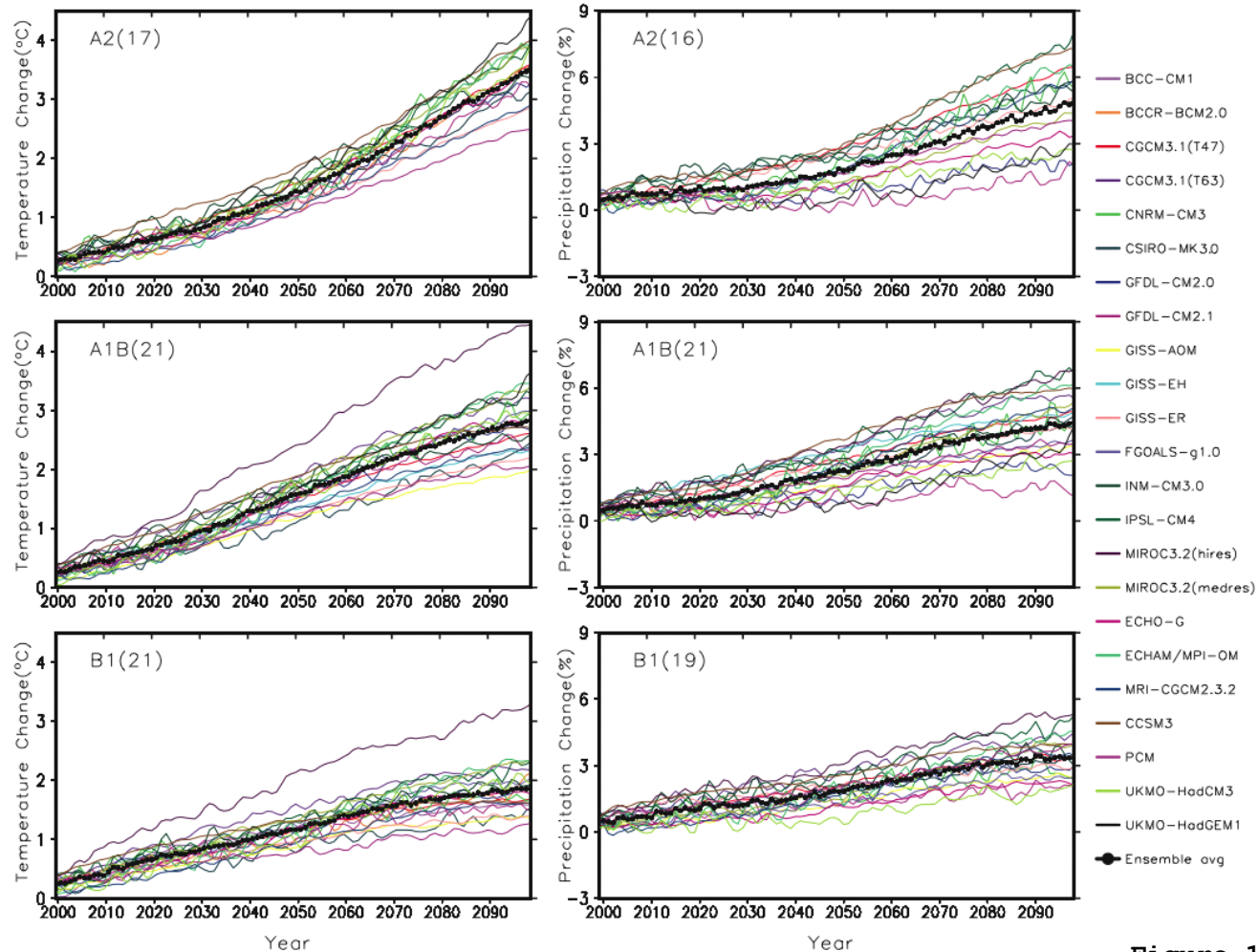


Figure 10.5

Time series of globally averaged (left) surface warming (surface air temperature change, °C) and (right) precipitation change (%) from the various global coupled models for the scenarios A2 (top), A1B (middle) and B1 (bottom). Numbers in parentheses following the scenario name represent the number of simulations shown. Values are annual means, relative to the 1980 to 1999 average from the corresponding 20th-century simulations, with any linear trends in the corresponding control run simulations removed. A three-point smoothing was applied. Multi-model (ensemble) mean series are marked with black dots. See Table 8.1 for model details.

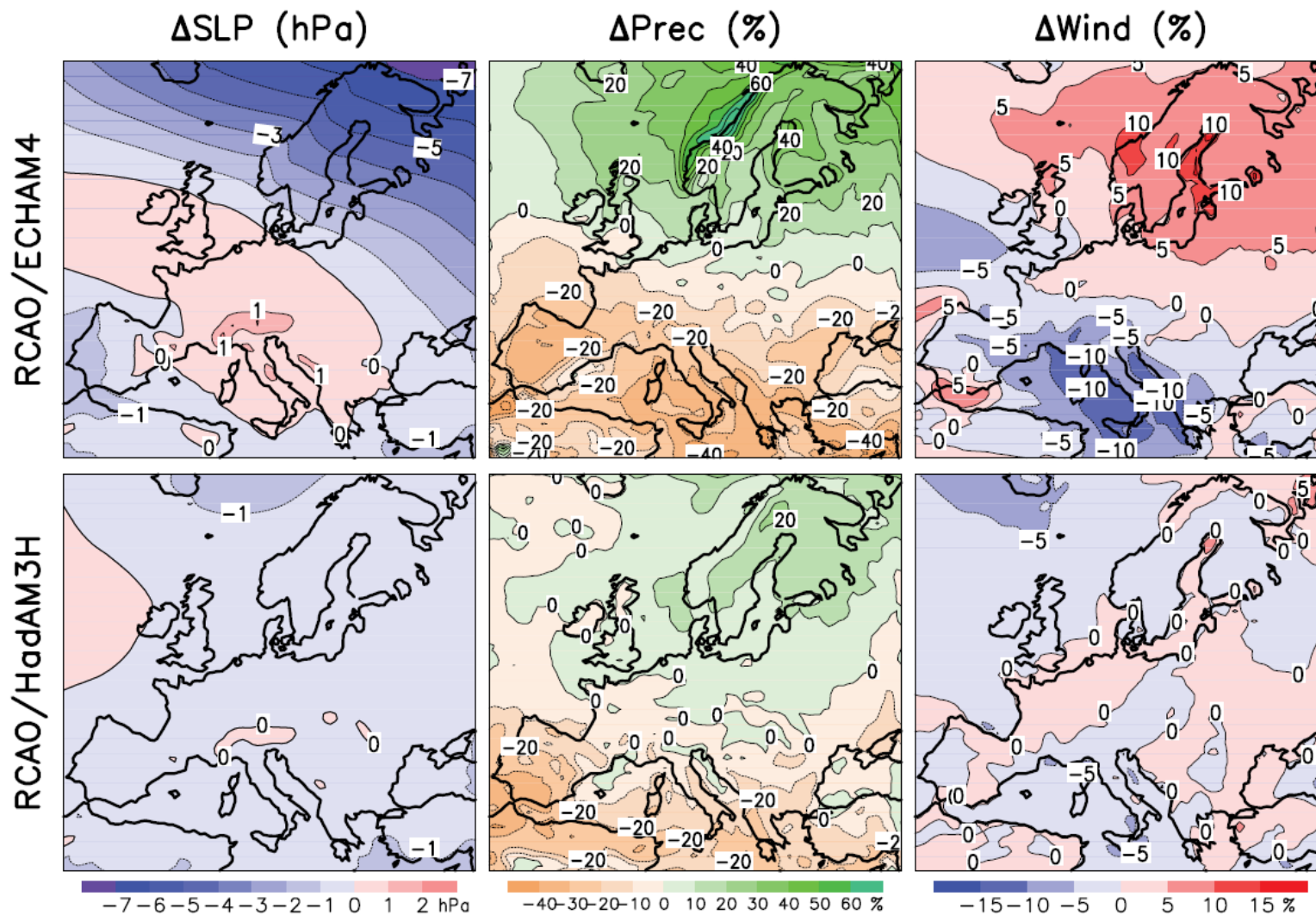
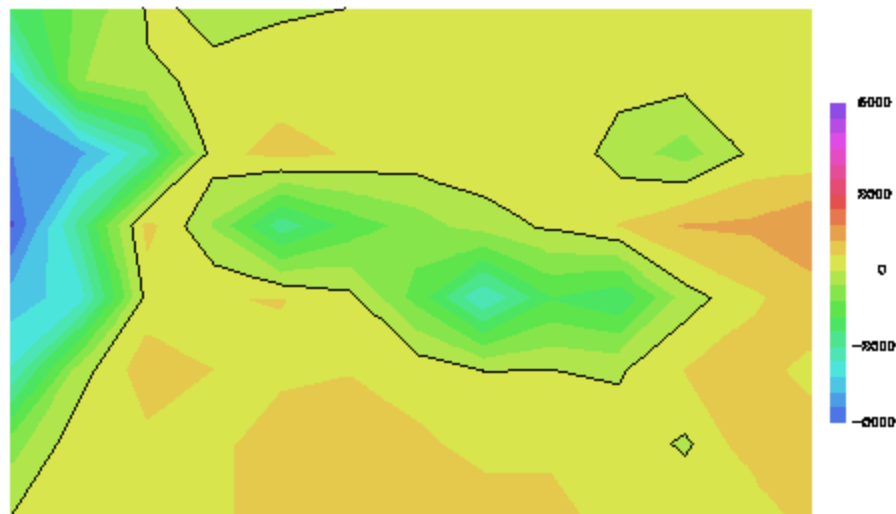


Figure 11.6. Simulated changes in annual mean sea level pressure (Δ SLP), precipitation (Δ Prec) and mean 10-m level wind speed (Δ Wind) from the years 1961 to 1990 to the years 2071 to 2100. The results are based on the SRES A2 scenario and were produced by the same RCM (Rossby Centre regional Atmosphere-Ocean model; RCAO) using boundary data from two global models: ECHAM4/OPYC3 (top) and HadAM3H (bottom) (redrawn from Rummukainen et al., 2004).

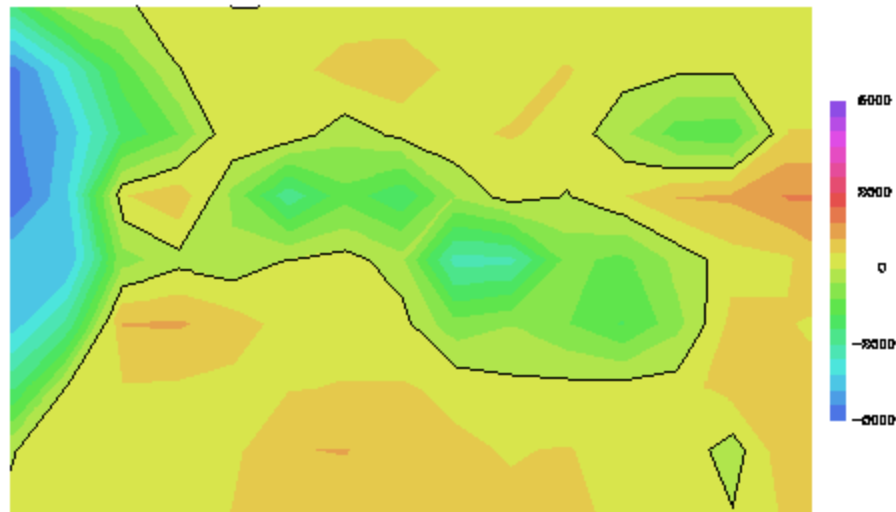
An aerial satellite-style photograph of a tropical cyclone, showing a well-defined eye and spiral cloud bands over a dark blue ocean. The surrounding land is green and brown. A white text box is overlaid on the image.

The problem of computer power and space-resolution

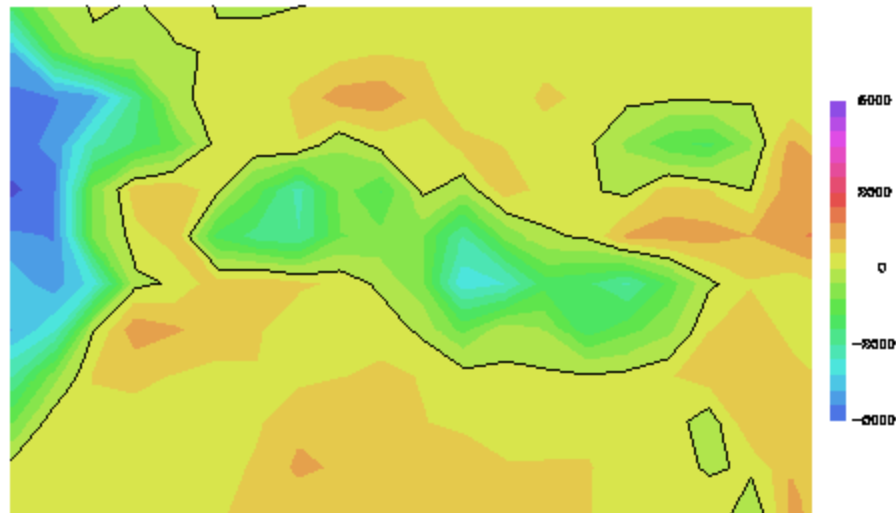
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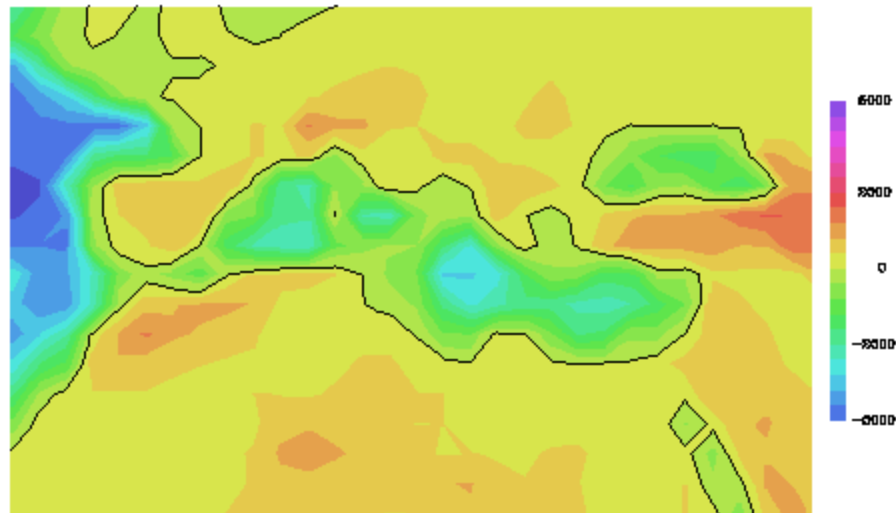
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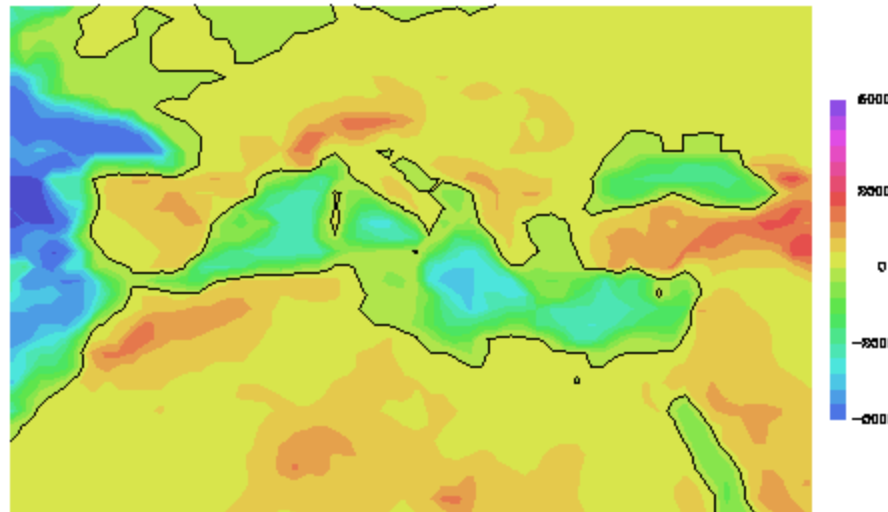
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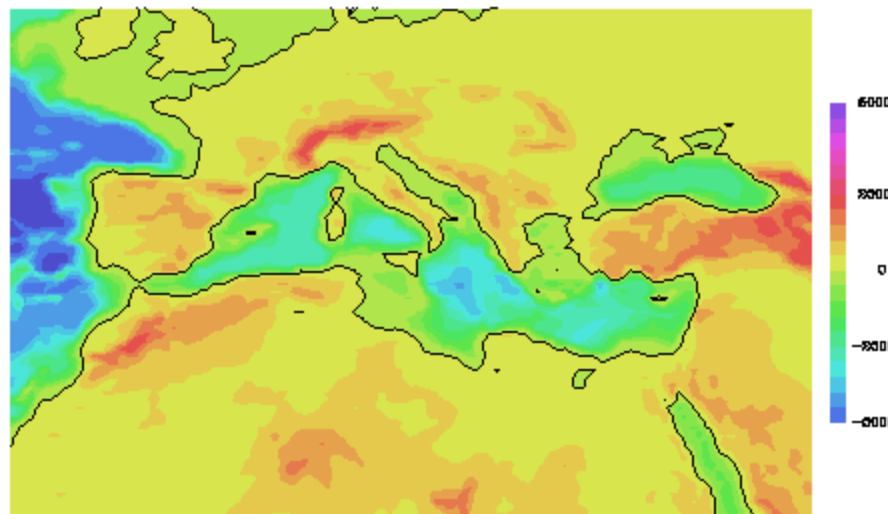
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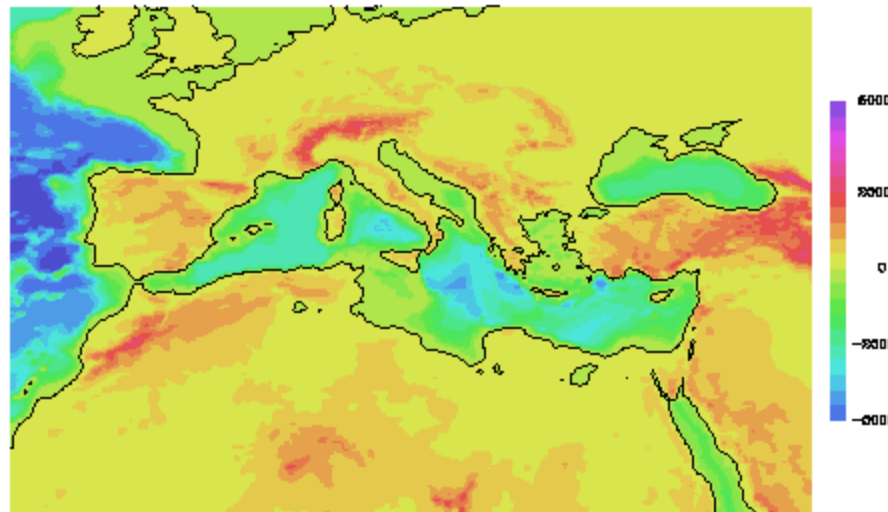
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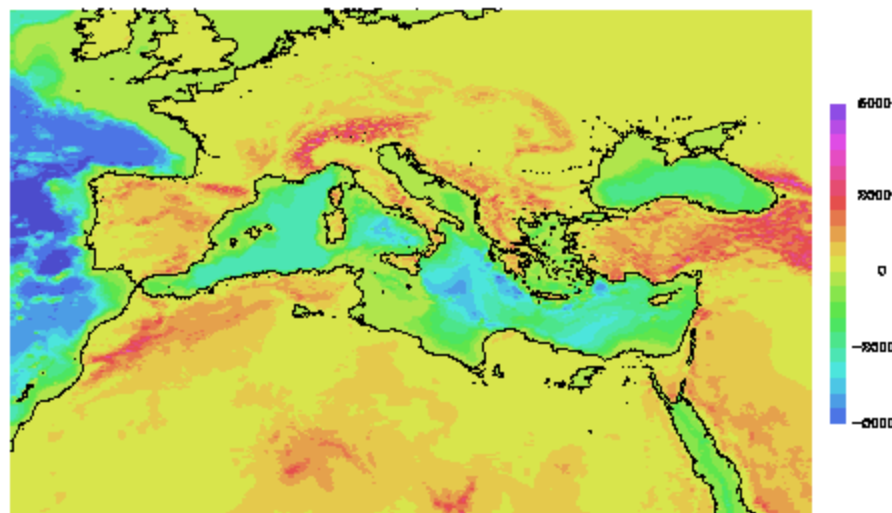
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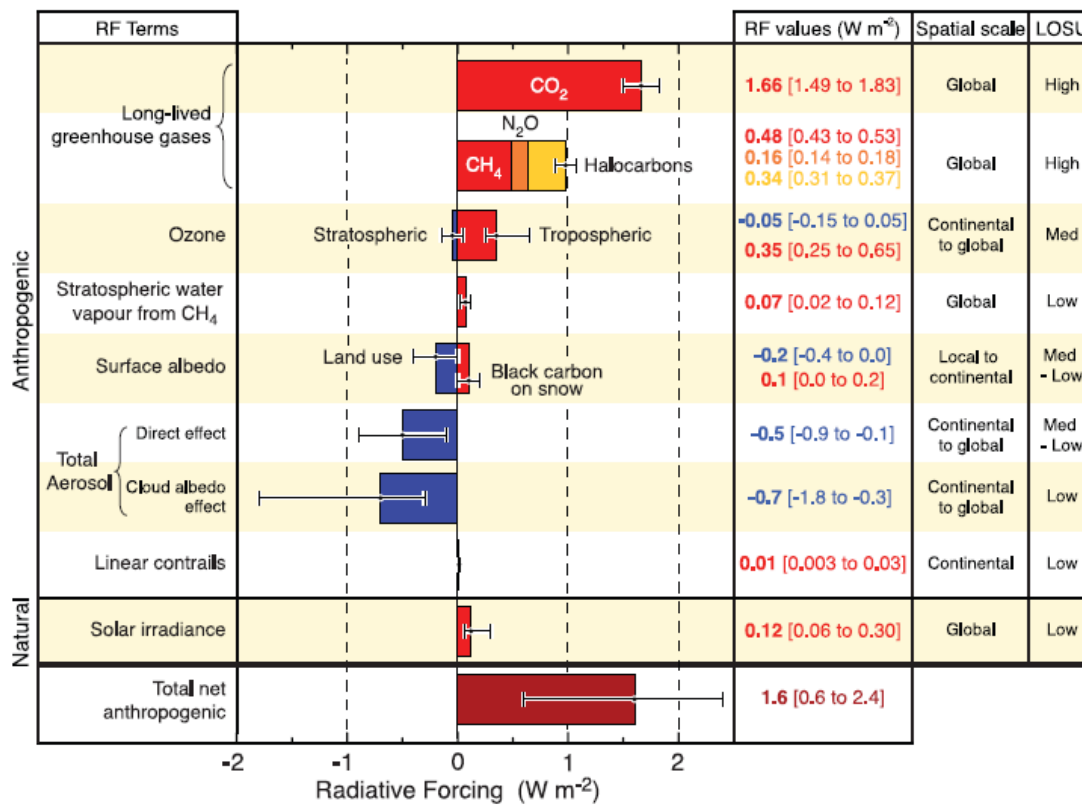
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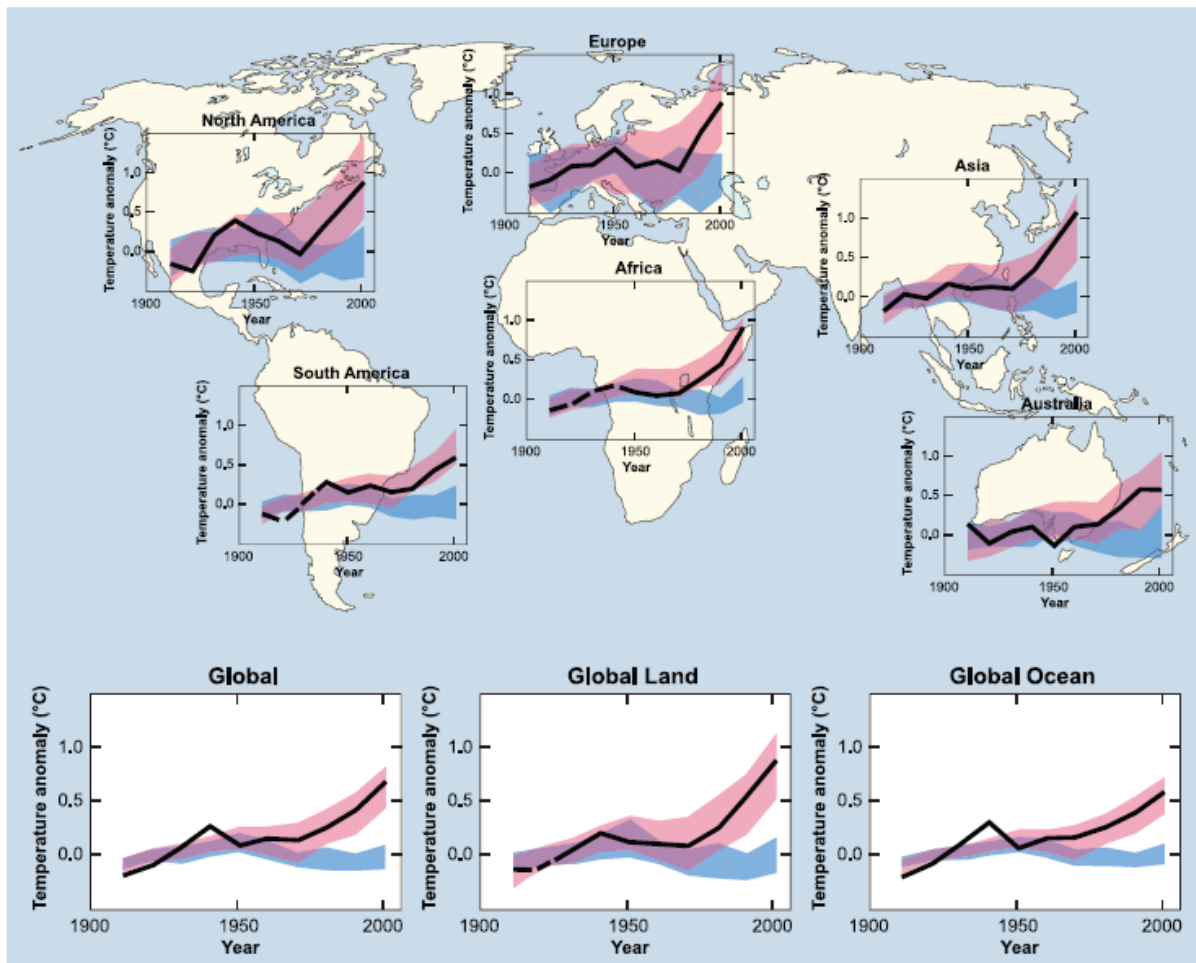
An aerial satellite-style photograph of a tropical cyclone, showing a well-defined eye and spiral cloud bands over a dark blue ocean. The surrounding landmasses are visible in shades of green and brown. A white rectangular box is overlaid on the image, containing text.

But ... I do not mean to play too hard the game of the “skeptics”

RADIATIVE FORCING COMPONENTS



GLOBAL AND CONTINENTAL TEMPERATURE CHANGE



models using only natural forcings
models using both natural and anthropogenic forcings

observations

An aerial satellite-style photograph of Earth. The image shows a large, swirling storm system over the ocean, with white clouds and dark blue water. The storm is centered in the lower right quadrant. The surrounding ocean is a deep blue, and the landmasses are visible in shades of green and brown. The text is overlaid on a white rectangular background in the center of the image.

**Human activities are affecting the climate
and climate models have some skill at
describing this effect**

A satellite image of a tropical cyclone, showing a well-defined eye and spiral cloud bands over a dark blue ocean. The surrounding landmasses are visible in shades of green and brown. A white text box is overlaid on the image.

However ... something about Italy and future climate

Precipitation change (% , 2071-2100 minus 1961-1990), MGME ensemble average, A1B scenario

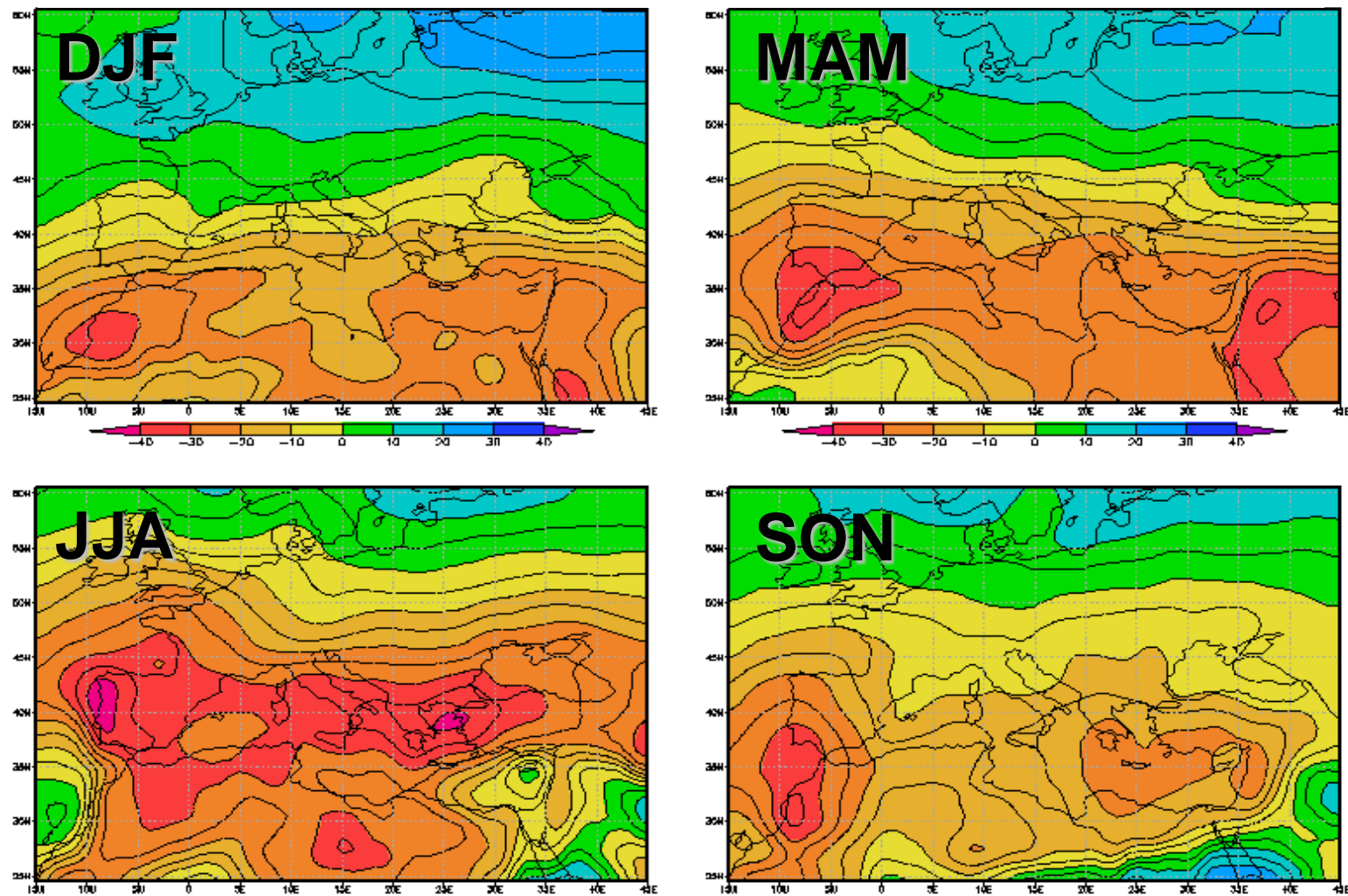


Figure 4

from Giorgi and Lionello, 2007

Temperature change (C, 2071-2100 minus 1961-1990), MGME ensemble average, A1B scenario

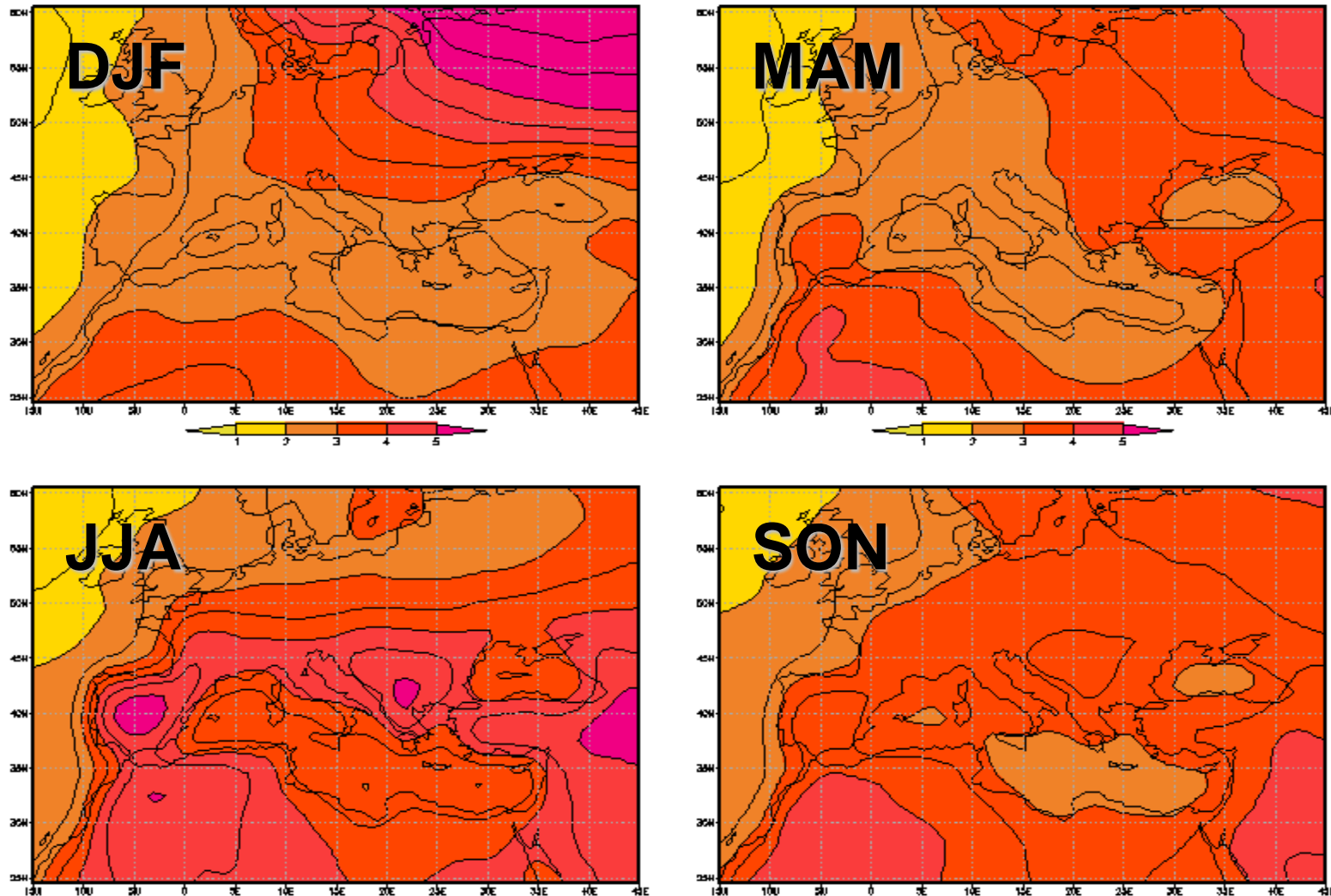


Figure 5

from Giorgi and Lionello, 2007

And about climate extremes...



The IPCC and climate extremes

"An extreme weather event is an event that is rare within its statistical reference distribution at a particular place. Definitions of 'rare' vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile. By definition, the characteristics of what is called extreme weather may vary from place to place... "

Definition of an extreme weather event; in *IPCC Working Group I Third Assessment Report Glossary*

Statistical uncertainty OFTEN precludes precise statements about trends (or climate change) of very rare events.

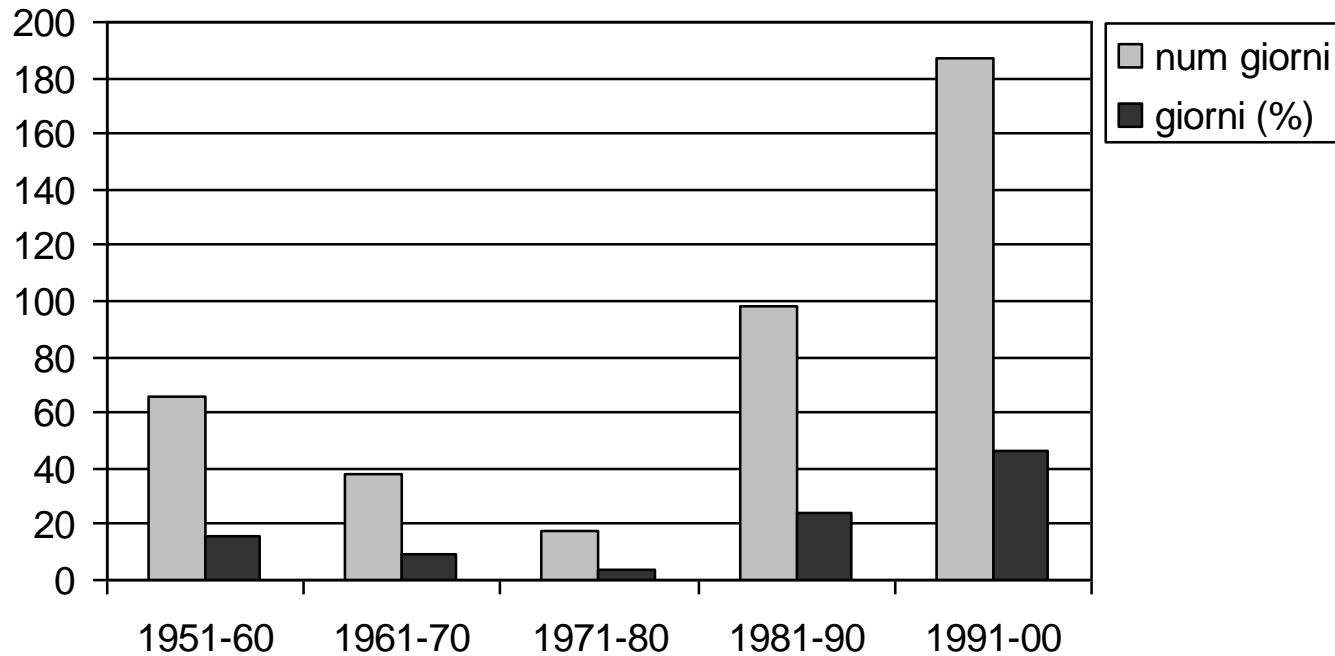
User specific extremes involves very often very nonlinear mechanisms outside climate itself. They are too specific for being a direct output of a climate model or of the analysis of a climate variable.

It is generally wrong to get conclusions on climate from a user specific extreme

It is very complicate and not univocal to get conclusions on a user specific extremes from climate dynamics alone

Catastrophic extremes are an inappropriate indicator for the detection of global climate change.

Distribuzione decennale di HW (1951-2000)



Heat wave distribution (number of days and percentage) for each decade in the period 1951-2003 (Thanks to M.Baldi)

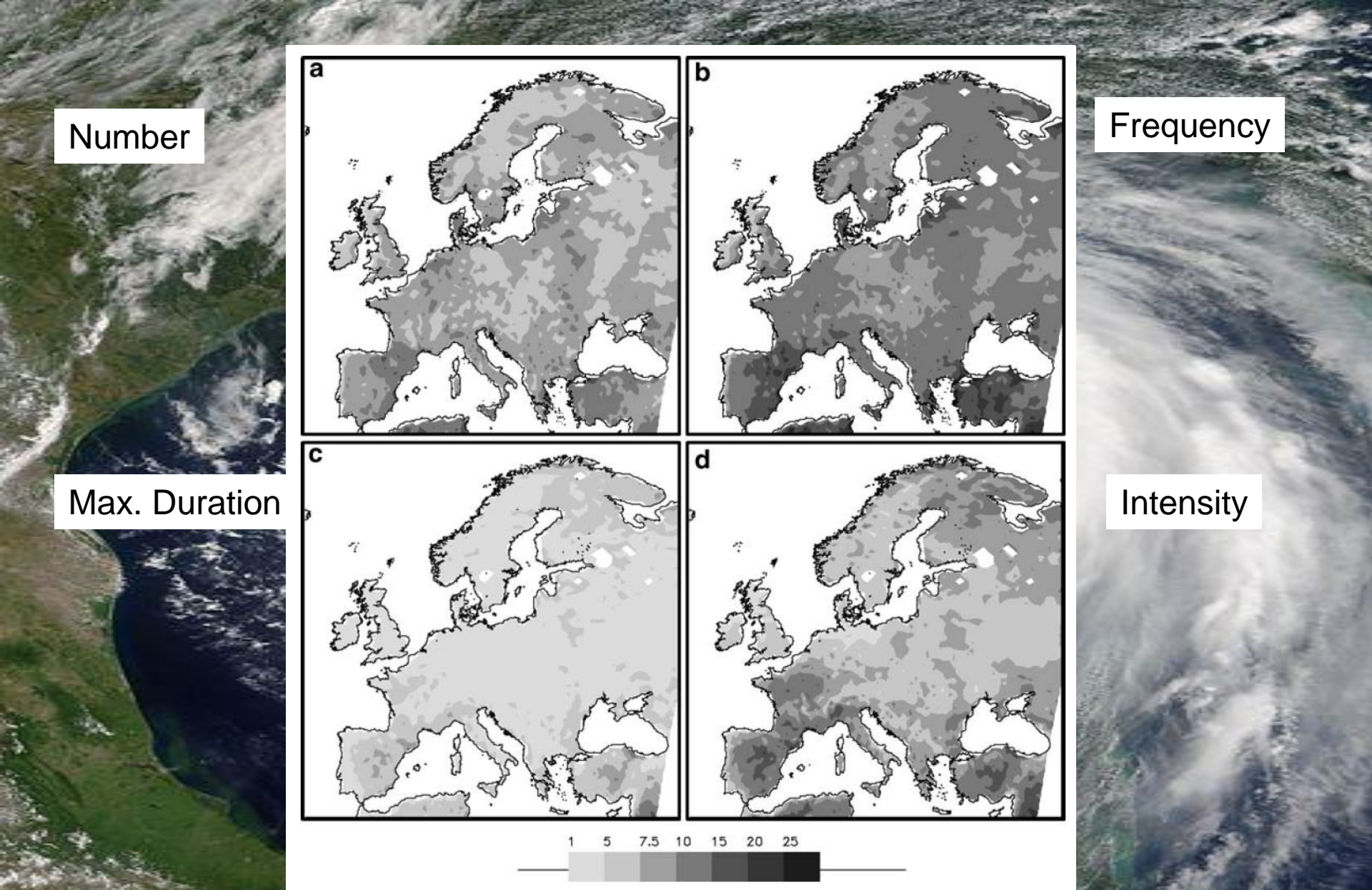
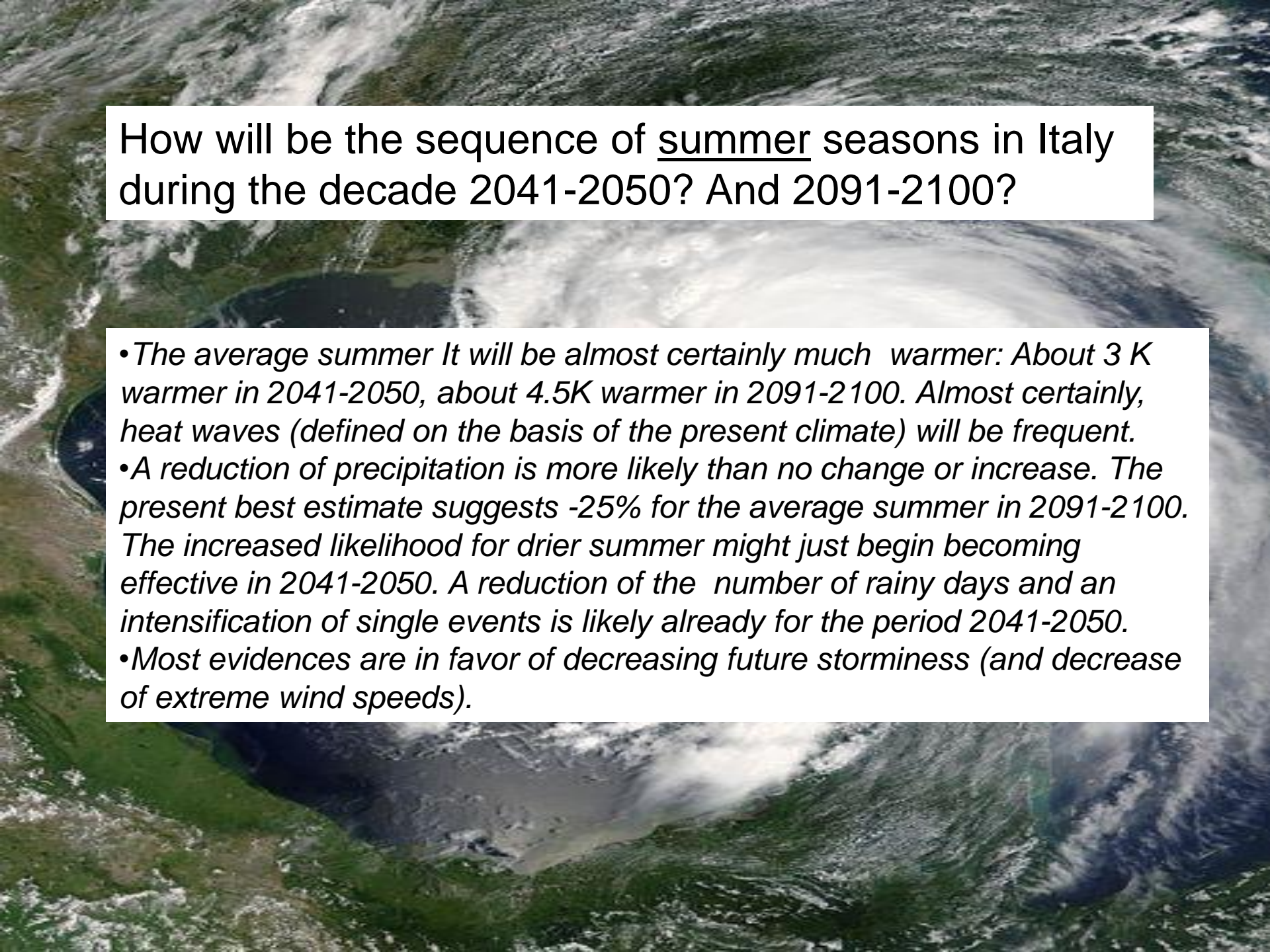


Fig. 3 Changes (expressed as a ratio) in the heat wave indices N_HW (a), HW_F (b), HW_D (c) and HW_I (d) between the 1961–1990 and 2071–2100 periods, based on HIRHAM4 simulations (Thanks to C.Goodess)

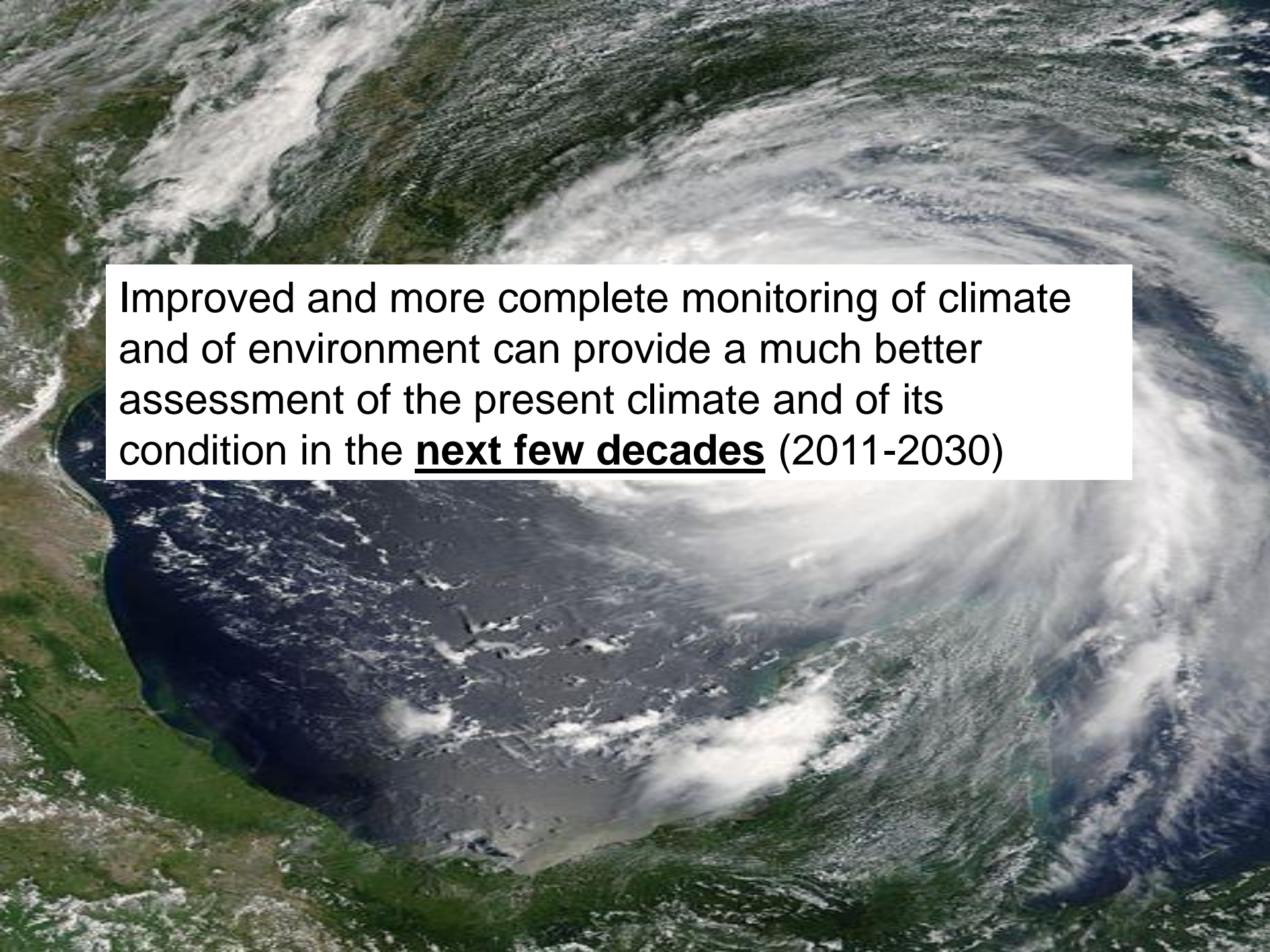


How will be the sequence of summer seasons in Italy during the decade 2041-2050? And 2091-2100?

- *The average summer It will be almost certainly much warmer: About 3 K warmer in 2041-2050, about 4.5K warmer in 2091-2100. Almost certainly, heat waves (defined on the basis of the present climate) will be frequent.*
- *A reduction of precipitation is more likely than no change or increase. The present best estimate suggests -25% for the average summer in 2091-2100. The increased likelihood for drier summer might just begin becoming effective in 2041-2050. A reduction of the number of rainy days and an intensification of single events is likely already for the period 2041-2050.*
- *Most evidences are in favor of decreasing future storminess (and decrease of extreme wind speeds).*

A satellite image of Earth showing a large, well-defined storm system over the Mediterranean region. The storm has a clear eye and spiral cloud bands. The surrounding landmasses, including parts of Europe and Africa, are visible in shades of green and brown. The ocean is a deep blue. A white text box is overlaid on the image, containing the following text:

There is a large potential for improving the models and their capability to deliver reliable projections of the future climate at regional (Italian) scale

An aerial satellite-style photograph of Earth showing a large, swirling storm system over the ocean. The storm has a distinct eye and is surrounded by dense, white clouds. The surrounding ocean is dark blue, and the landmasses are visible in shades of green and brown. The text is overlaid on a white rectangular box in the center of the image.

Improved and more complete monitoring of climate and of environment can provide a much better assessment of the present climate and of its condition in the **next few decades** (2011-2030)