

Conditions and rules of conduct for Humanity to continue surviving on Earth

The crucial role of space

Roger-Maurice Bonnet

International Space Science Institute, Bern

Institut d'Astrophysique, Paris

Spaceship Earth



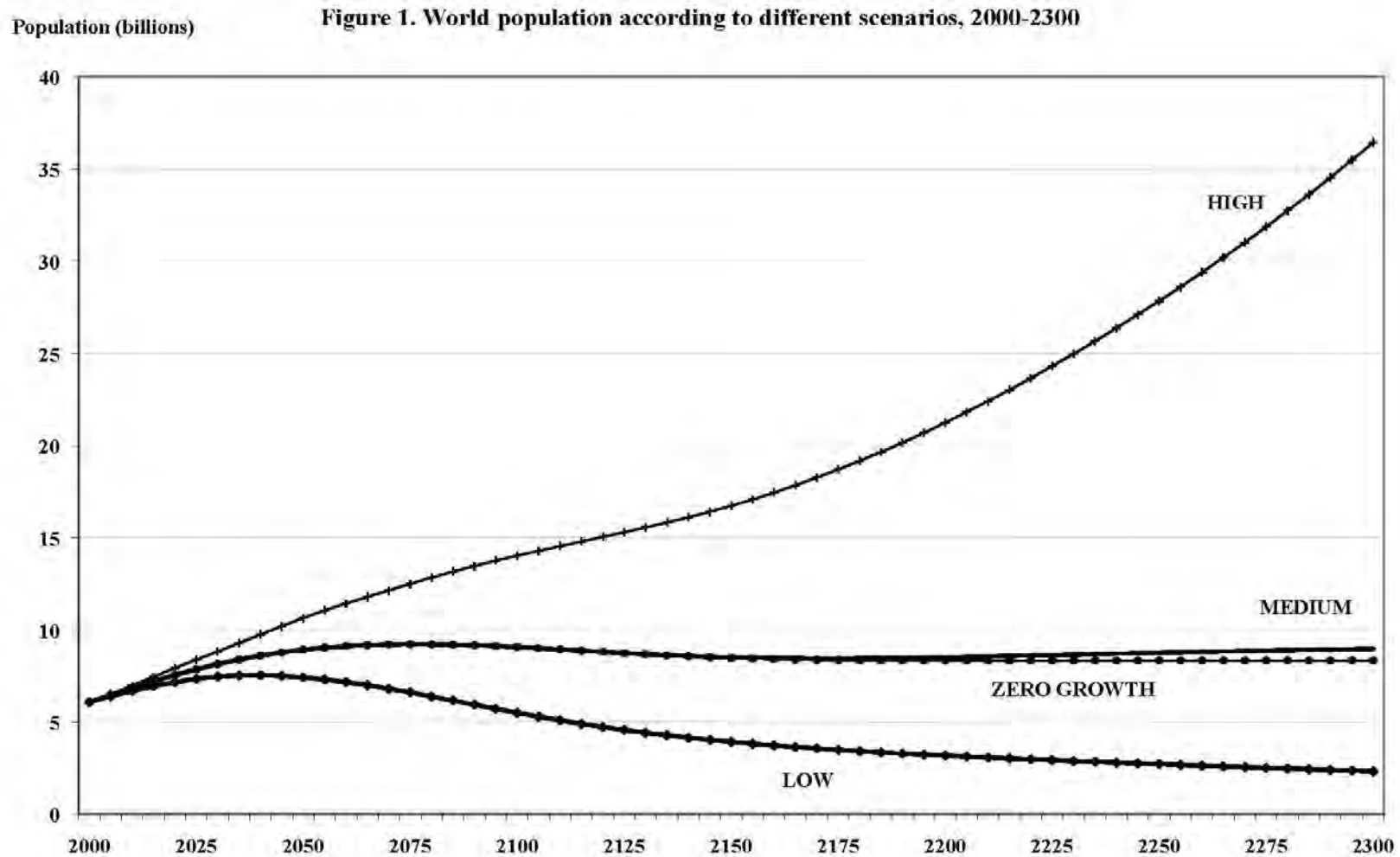
The International Space Station





The spaceship is nearly full!

The Earth spaceship is nearly full!

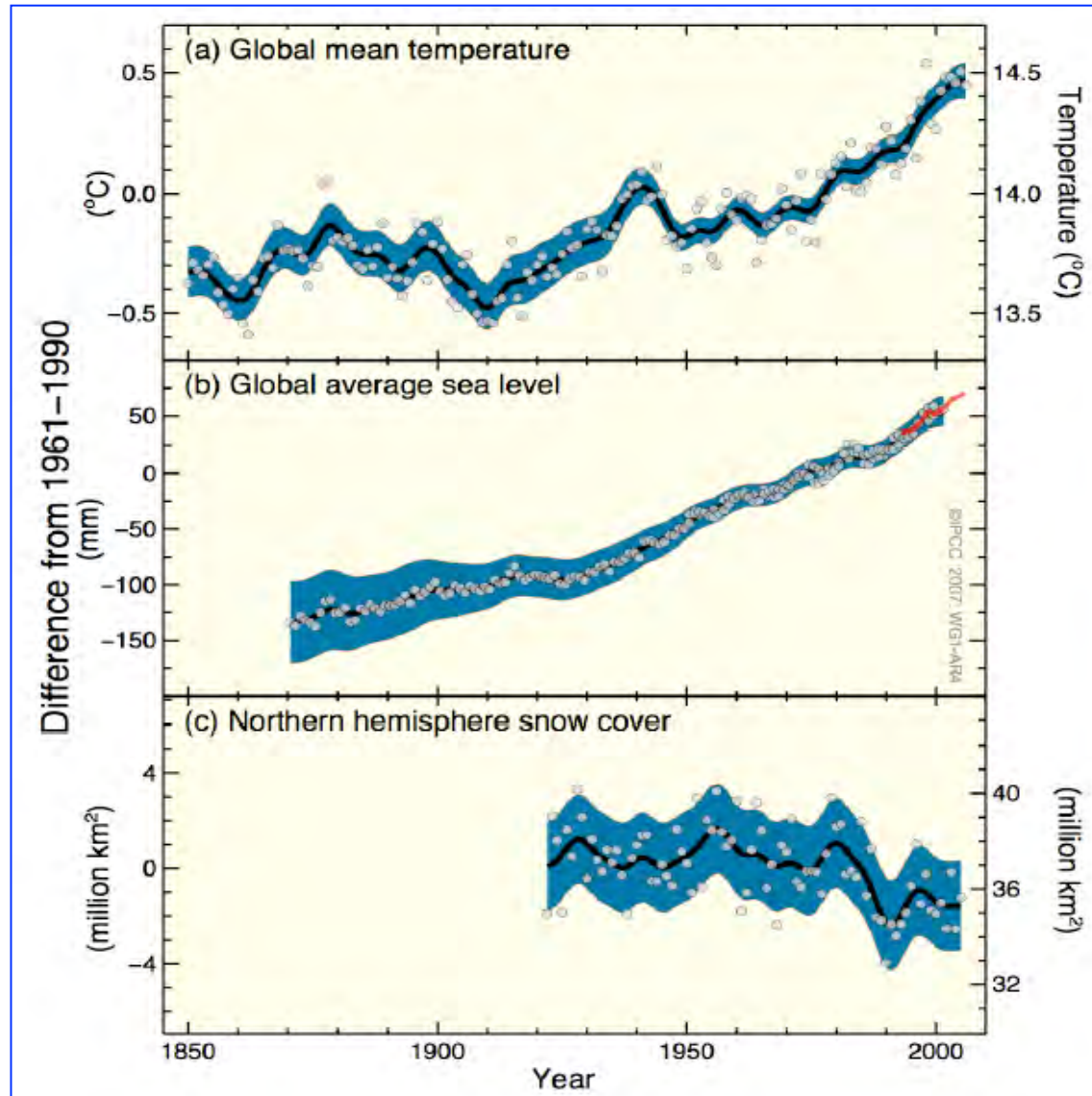


Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, *The World Population in 2300* (ESA/P/WP.187), forthcoming.

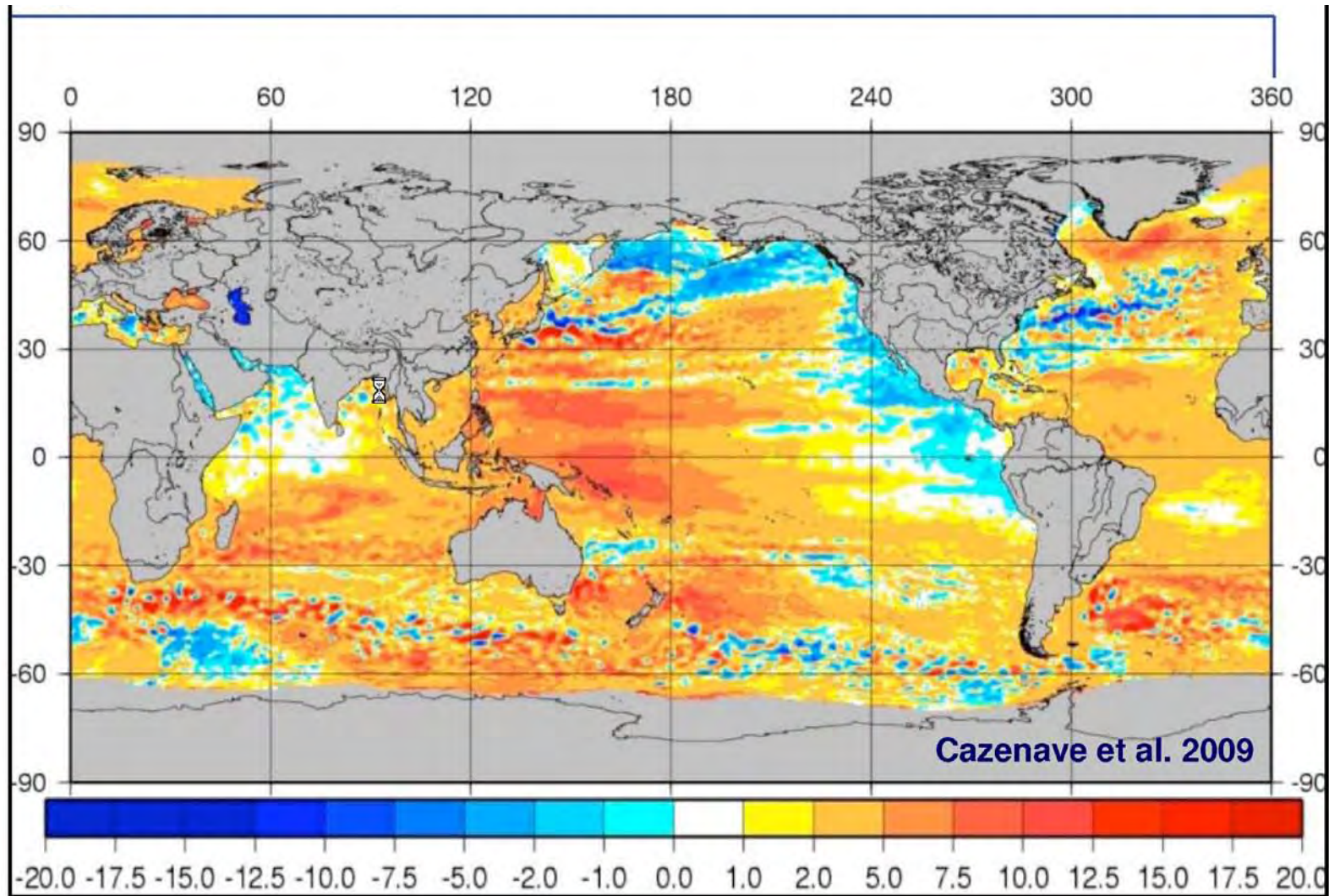
Hospitable home?



The spaceship is warming



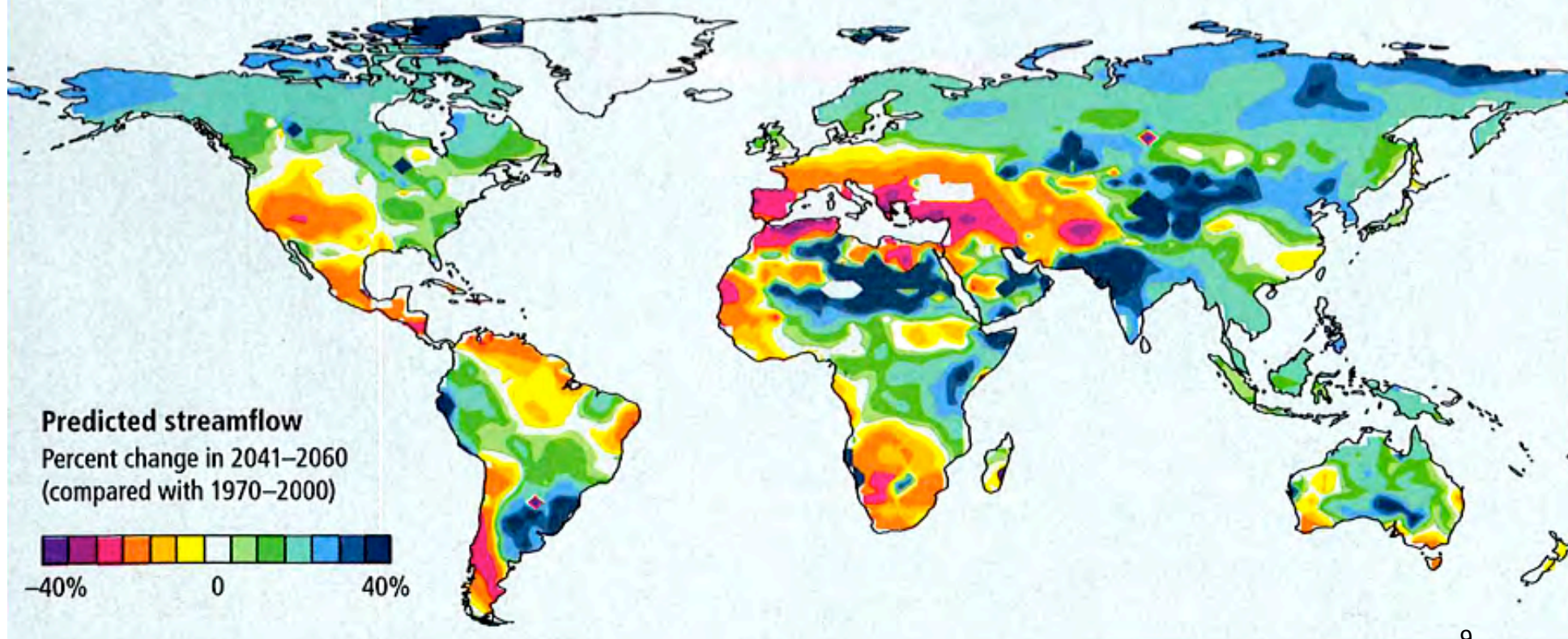
Regional sea-level trends (mm p.a.)



Effect of Global Warming on streamflow

2060 >> CHANGING THE COURSE OF A RIVER

Climate change will shift weather patterns, leading to big changes in the amount of rain that falls in any given region, as well as the amount of water flowing through streams and rivers. Scientists at the U.S. Geological Survey averaged the results of 12 climate models to predict how streamflow will alter over the next 50 years. While East Africa, Argentina and other regions benefit from more water, southern Europe and the western U.S. will suffer.



Effects of Global Warming on food availability

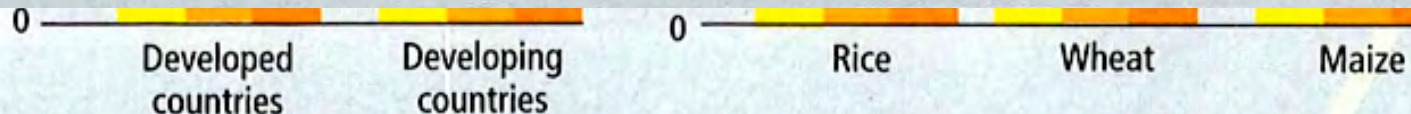
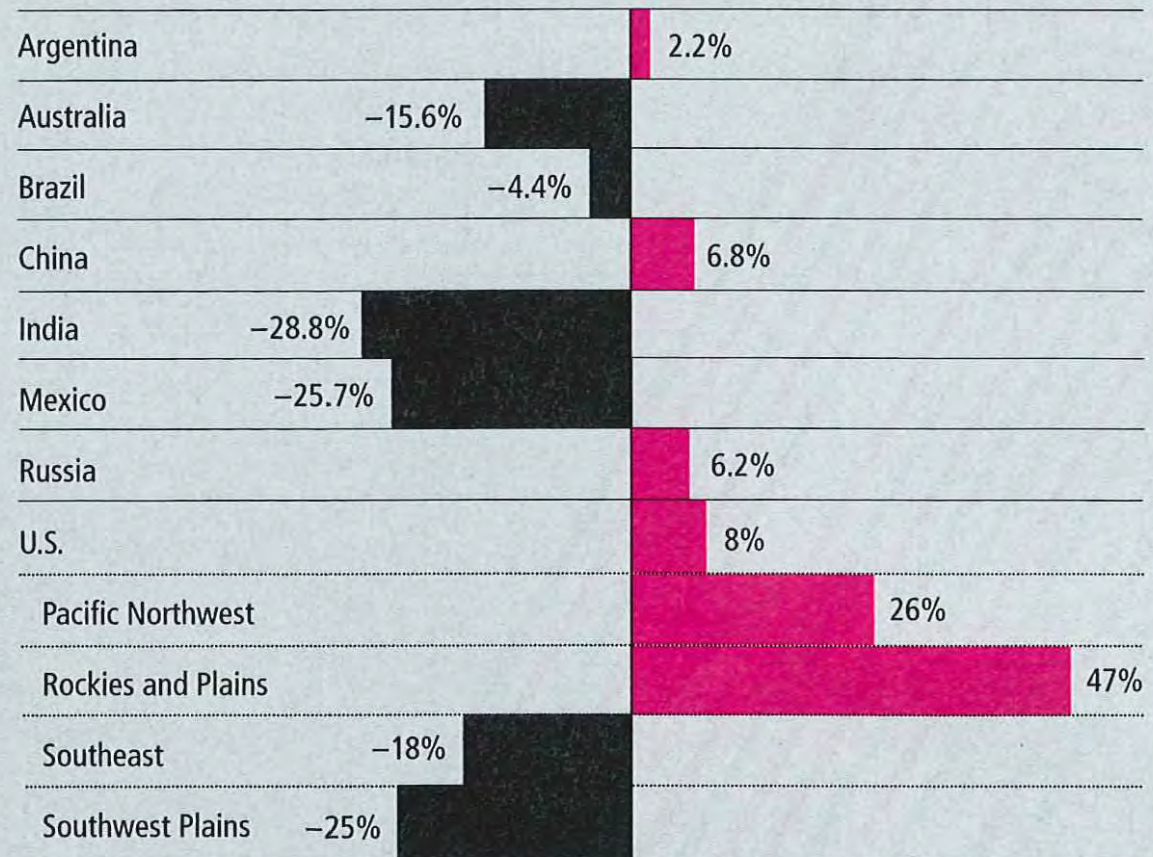
[FOOD]

2050 >> FEEDING A WARMING WORLD

Researchers have recently started to untangle the complex ways rising temperatures will affect global agriculture. They expect climate change to lead to longer growing seasons in some countries; in others the heat will increase the frequency of extreme weather events or the prevalence of pests. In the U.S., productivity is expected to rise in the Plains states but fall further in the already struggling Southwest. Russia and China will gain; India and Mexico will lose. In general, developing nations will take the biggest hits. By 2050 counteracting the ill effects of climate change on nutrition will cost more than \$7 billion a year.

The Effects of Global Warming on Agriculture

Percent change in production for the world's eight largest growers (by the 2080s)



Vanishing resources

Have we reached the Peak?

Figure 5: Oil producing countries past peak

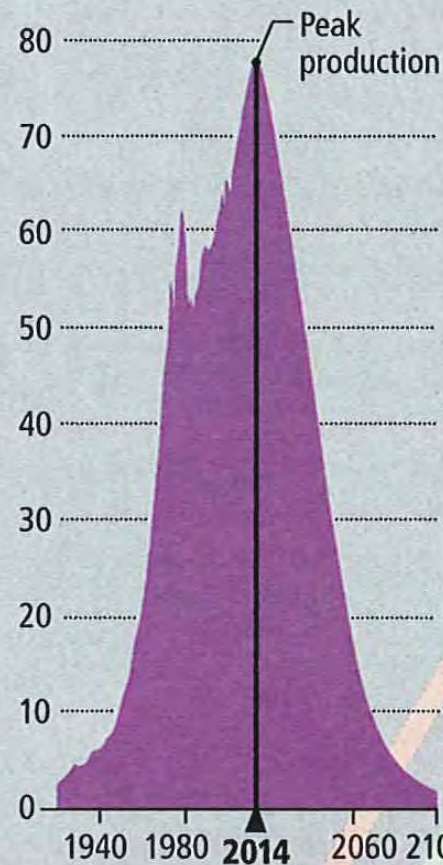
[FOSSIL FUELS]

2014 >> THE PEAK OF OIL

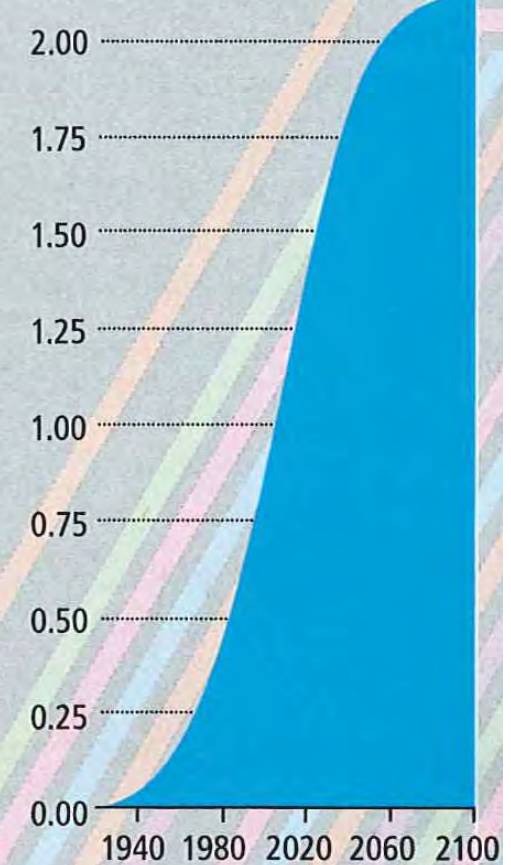
The most common answer to "how much oil is left" is "depends on how hard you want to look." As easy-to-reach fields run dry, new technologies allow oil companies to tap harder-to-reach places (such as 5,500 meters under the Gulf of Mexico). Traditional statistical models of oil supply do not account for these advances, but a new approach to production forecasting explicitly incorporates multiple waves of technological improvement.

Though still controversial, this multi-cyclic approach predicts that global oil production is set to peak in four years and that by the 2050s we will have pulled all but 10 percent of the world's oil from the ground.

World Production Rate
Million barrels per day

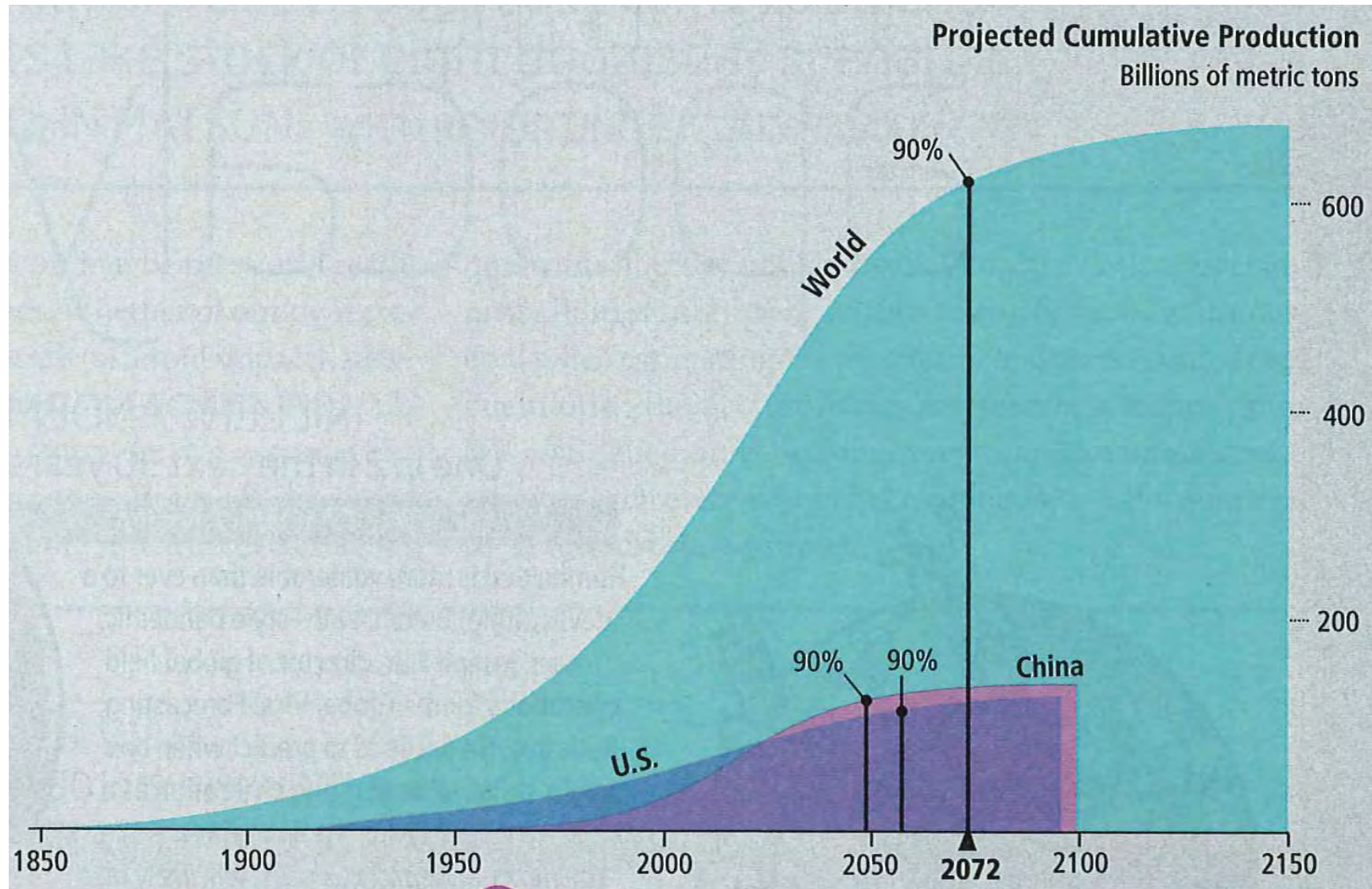


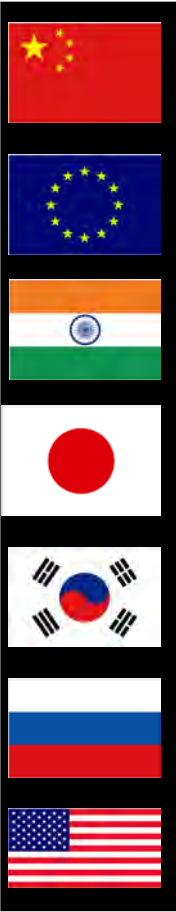
World Cumulative Production
Trillion barrels



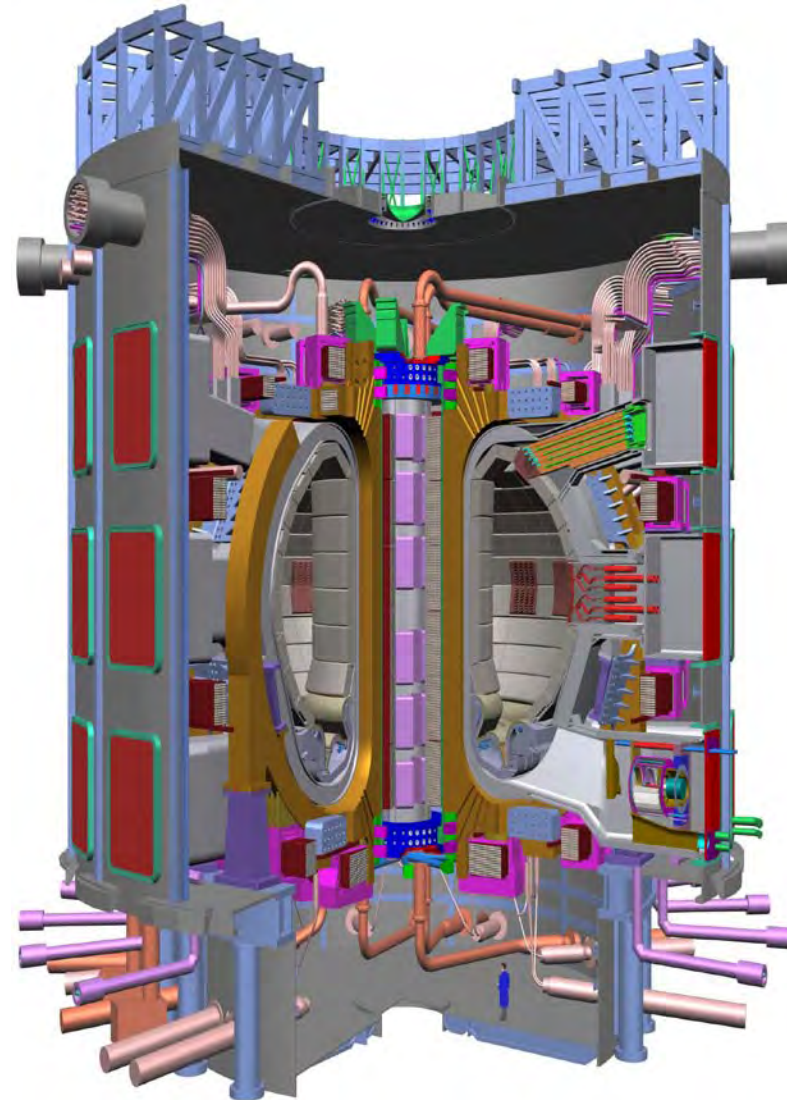
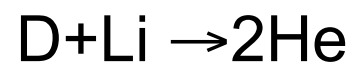
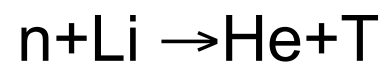
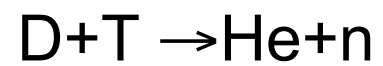
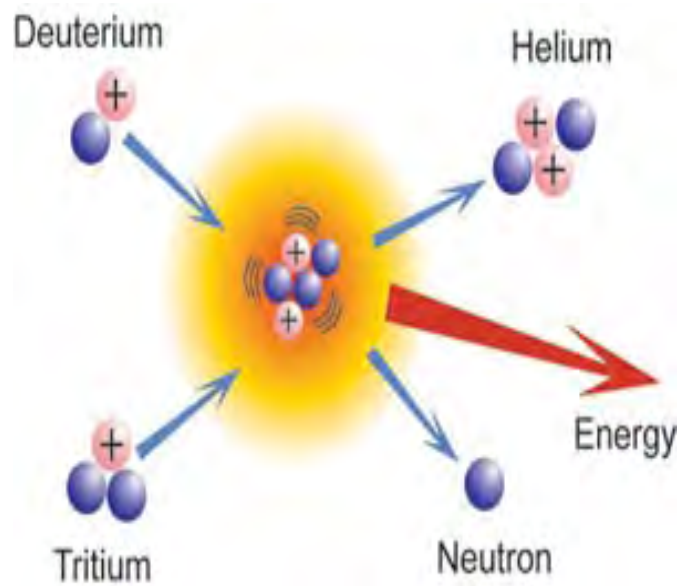
Source: IHS 2006; PEMEX, petrobras ; NPD, DTI, ENS(DK), NEB, RRC, US-EIA, January 2007
Forecast: LBST estimate, 25 January 2007

Limits of Coal





Nuclear Fusion



Solar power

- Today's consumption= 10 TW
- Solar power available on Earth= 35000 TW
- 30 m² of solar cells per person sufficient today

Water

- The problem of fresh drinking water is more a matter of piping and purification than anything else
- 40 000 km³/yr carried through by river currents
- Available: 16 000 km³
- Usable: 8 000 km³
- Needs for 11 billions : 11 000 km³
- Desalinisation: 3 000 km³ (1 % of future energy needs)

Vanishing minerals

- Gold (127,000 tons in banks= more than the current ground reserve base), Silver, Antimony, Indium, **all potentially in short supply by 2050 (USGS)**
- Around 2100, most of present resources of Cu, Zn, Pt and Pt group, Sn, F, Ta and Th would have been exhausted
- Conclusions: save and recycle!

Phosphates

- In 2008, 161 million tonnes of phosphate mined around the world (USGS)
- Demands for fertilizers predicted to grow 2.5-3% per year over next 5 years
- If that rate continues, world's reserves should last for \approx 125 years
- Solution: recovering live stock waste (population of 65 billion)

All what we have...



is this!



and may be this!

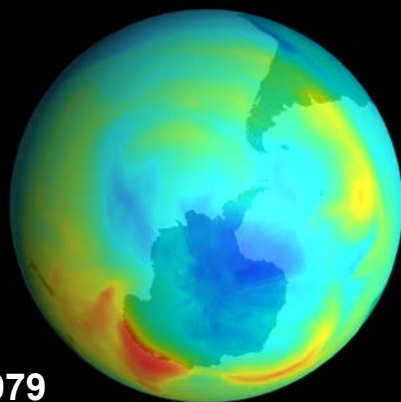
We have a problem

- No growth for the crew beyond livable limits of growth
- Water management rules are essential
- Resources management through recycling mandatory
- Alimentation and resources management and new practices are necessary
- Maintenance and repairs: a high level of engineering capability must be kept on board

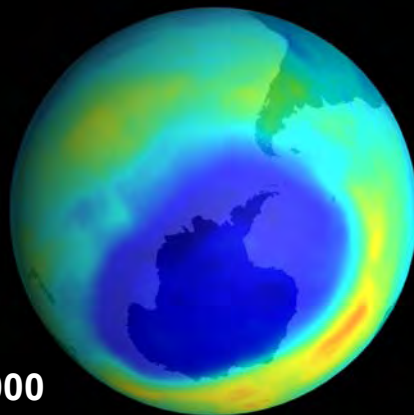
The crucial role of space

The lack of a world comprehensive Earth-space
system

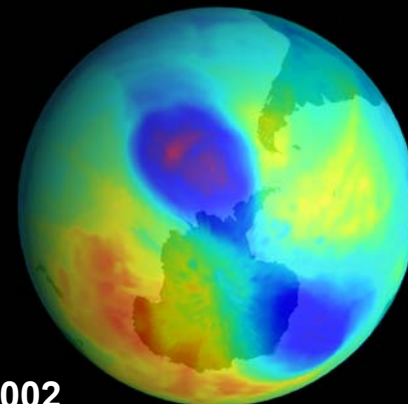
1979



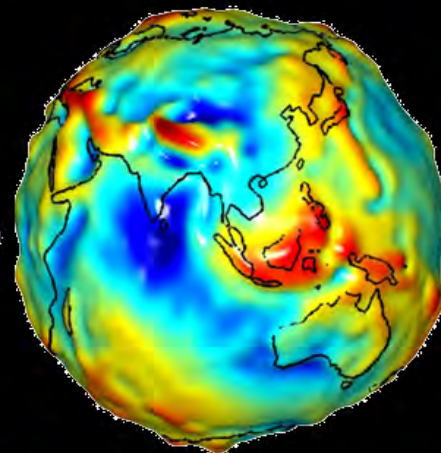
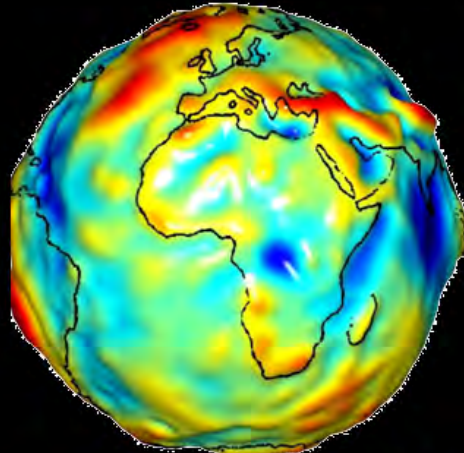
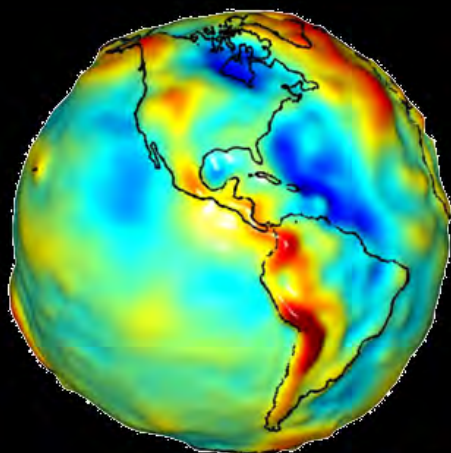
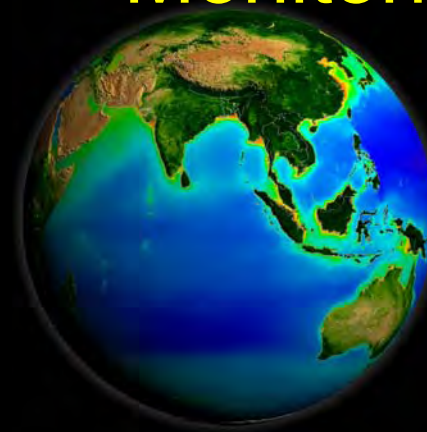
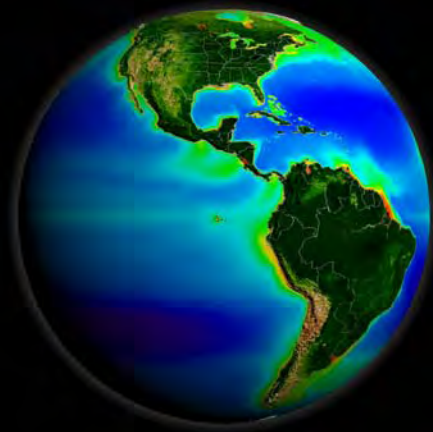
2000



2002



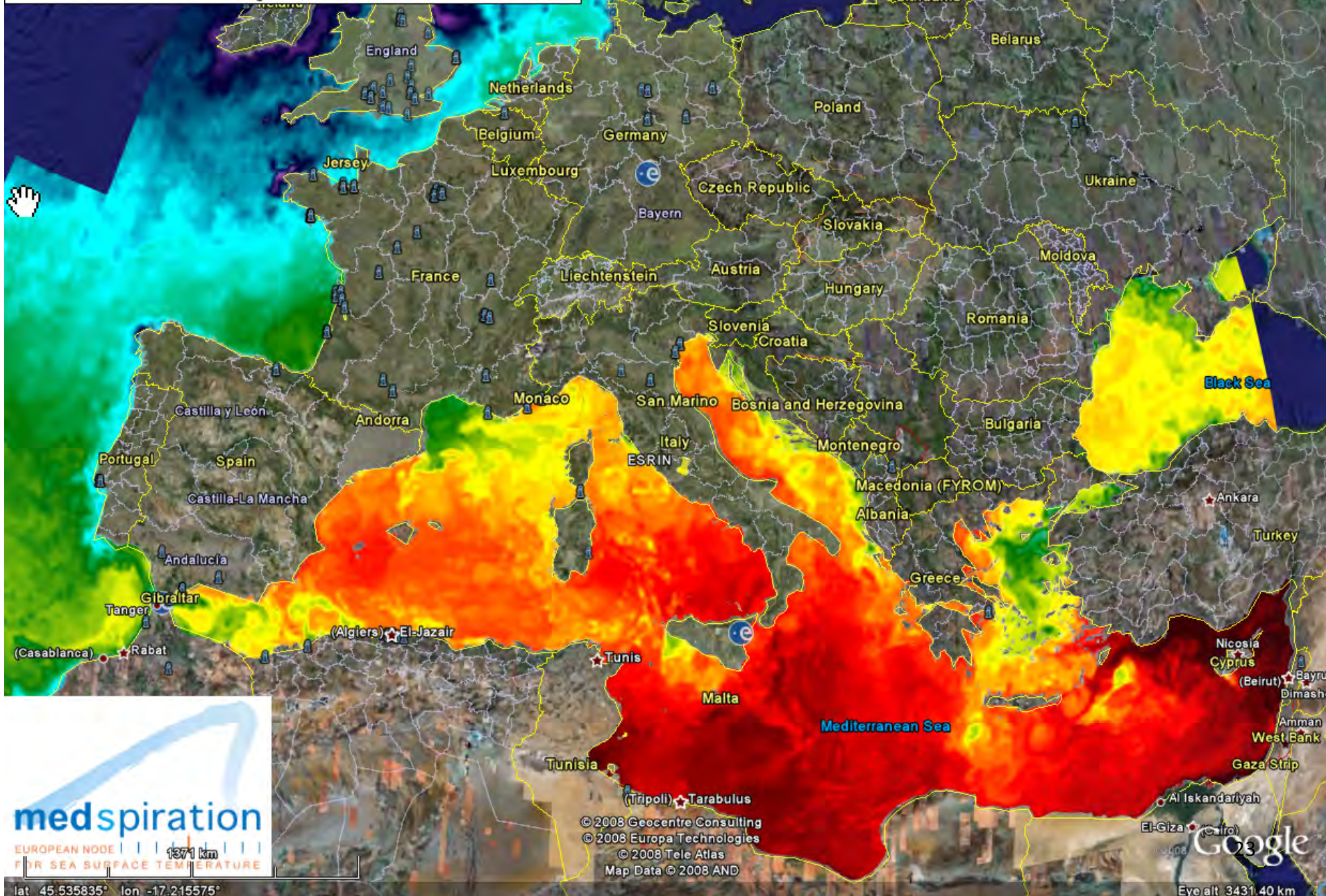
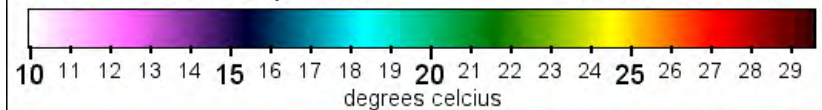
Monitoring Earth



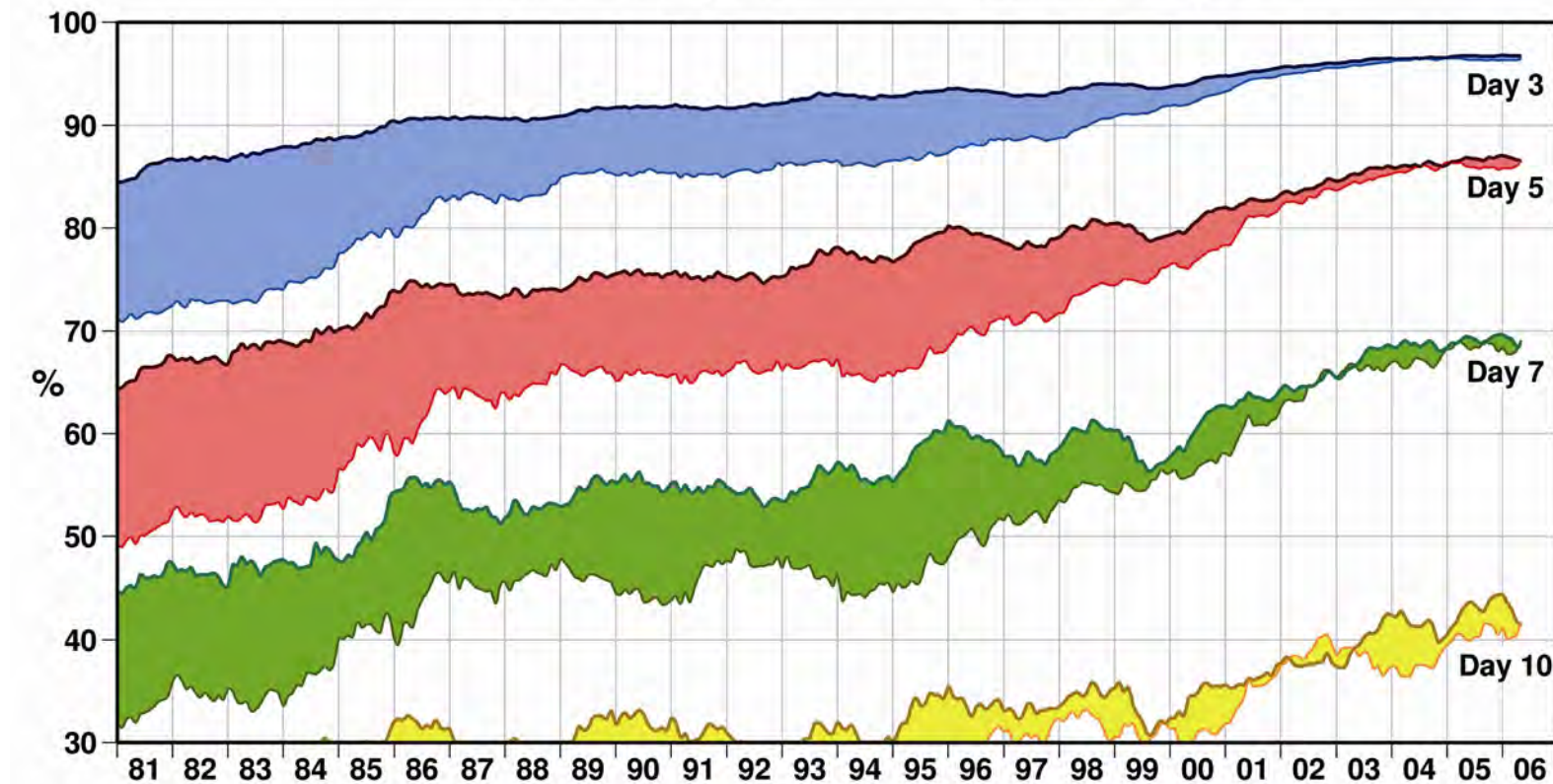
Sea Surface Temperature

2008-09-01 UTC

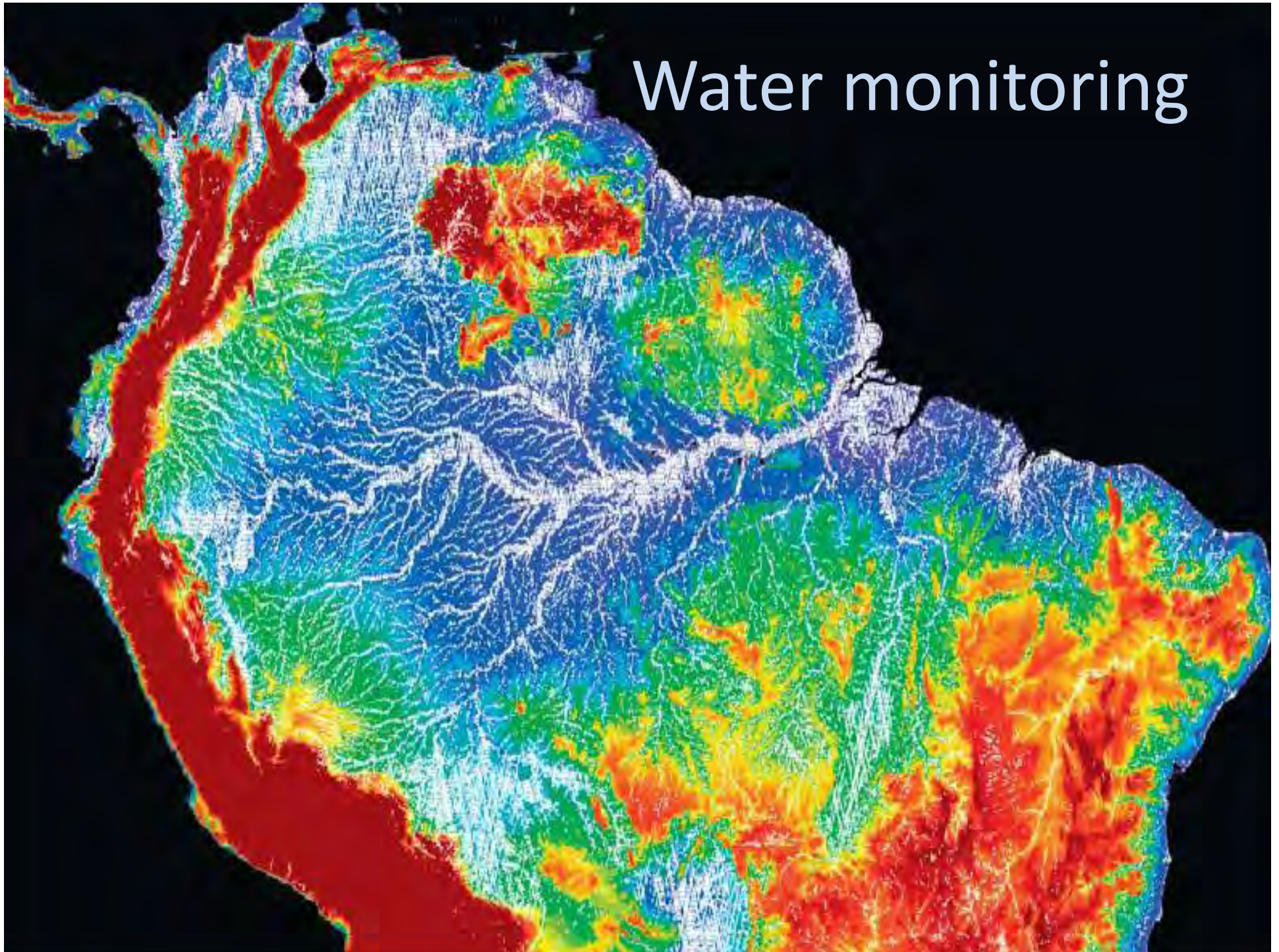
<http://www.medspiration.org>



Weather forecasting



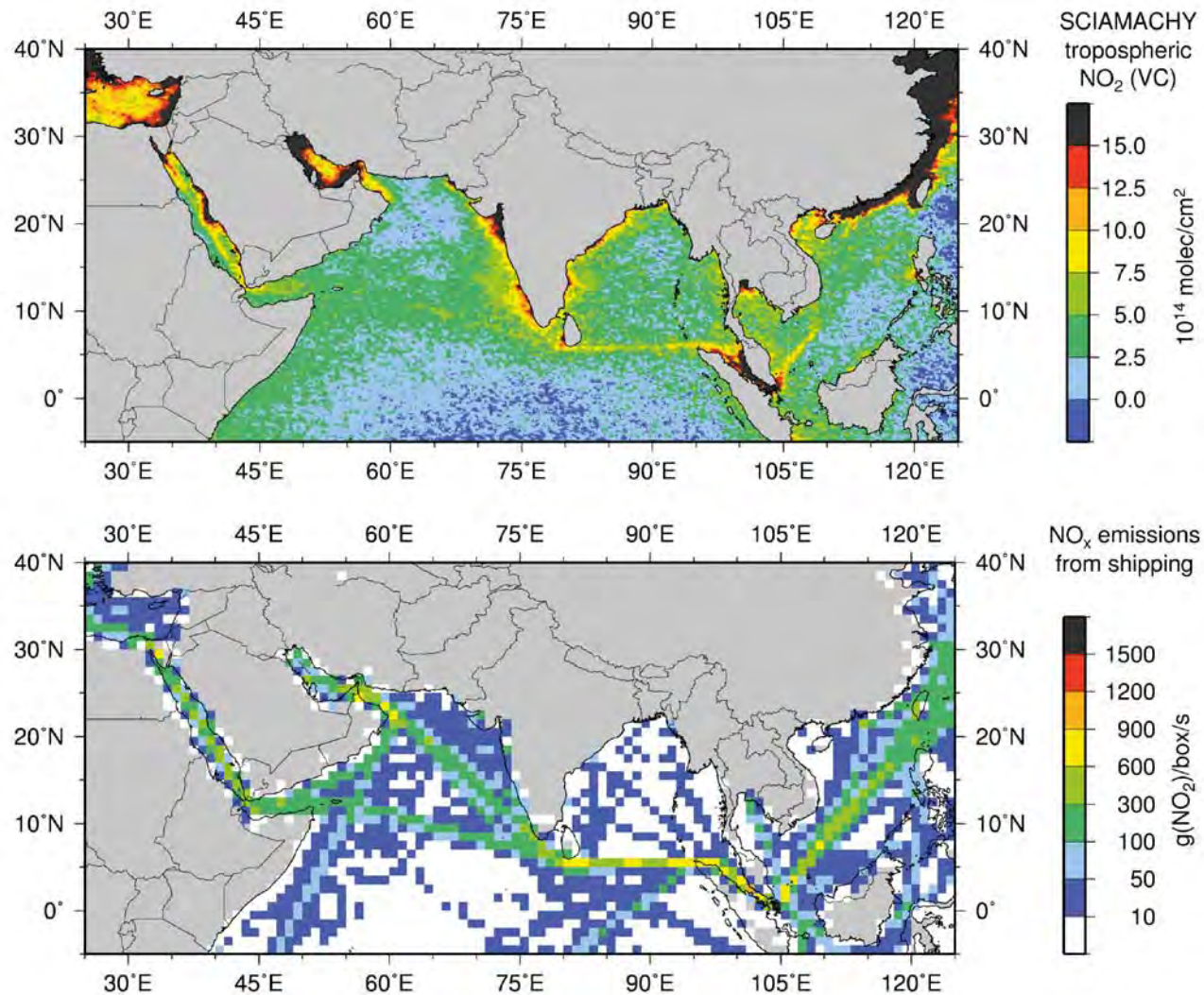
Water monitoring



A satellite image showing a large fire on a coastal landmass. Thick, dark smoke plumes are rising from the fire and drifting over the adjacent ocean. The land is a mix of brown and green, indicating a mix of vegetation and bare ground. The ocean is a deep blue. The word "Fires" is written in white text in the bottom left corner.

Fires

Anthropogenic environmental deterioration



Monitoring the Sun

1996

2006

1997

2005

2004

1998

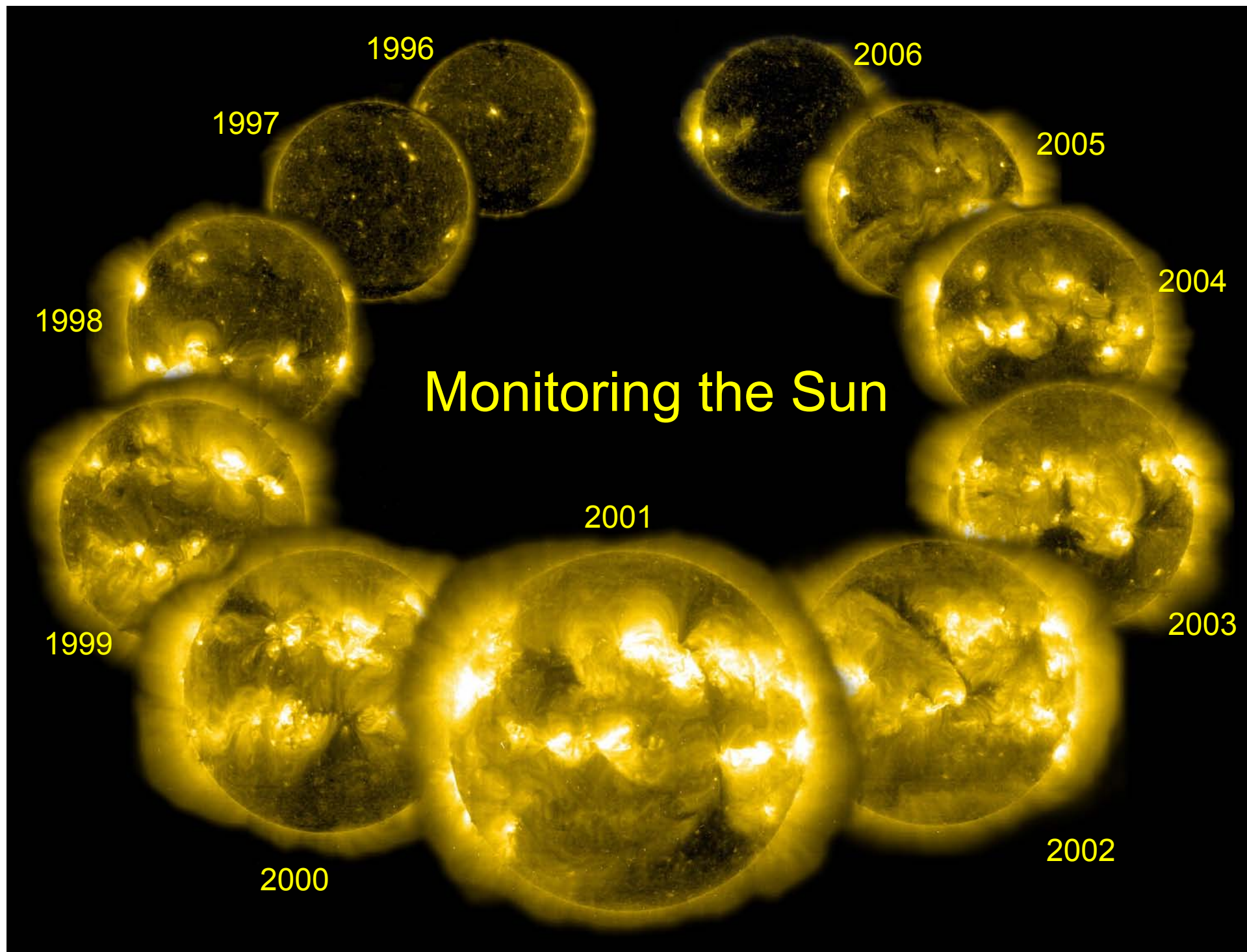
2001

2003

1999

2002

2000



Observing the heavens



Exploring new worlds



Global Management Governance(s)

ISS crew code of conduct

ISS Crew Members' conduct shall be such as to maintain a harmonious and cohesive relationship among the ISS Crew Members and an appropriate level of mutual confidence and respect through an interactive, participative and relationship-oriented approach which duly takes into account the international and multicultural nature of the crew and mission.

Marie-Jean-Antoine-Nicolas de Caritat
Marquis de Condorcet (1743-1794)



“Our hopes for the future state of the human species can be reduced to three important points: the destruction of the inequality between the nations; the progress of the equality within one people; finally the real perfection of mankind where the stupidity and the misery will be only accidental and not the usual state of a part of society.”

Esquisse d'un tableau historique des progrès de l'Esprit humain

Evolution

When our culture will no longer adapt to the changing conditions of its environment, it will face extinction (Easter Island, Roman Empire, Soviet Union).

New cultures will take over!

Universal rights to:

- Solar energy
- Fresh water
- Food
- Education
- Knowledge
- Science

Managing Earth for one and hopefully many more centuries

- Strengthen human capital
- Improve civilian protection in risky areas
- Reinforce Education
- Sustain science, technology and innovation
- Ensure availability of a world comprehensive space system