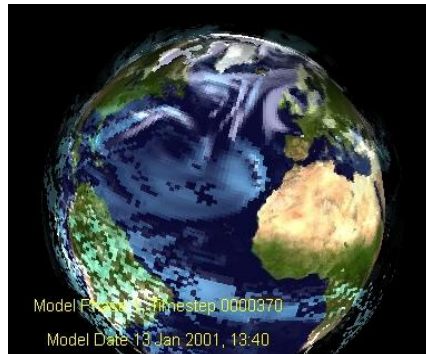


Climate Science: What We Know, How We Communicate It.

Dave Stainforth

Environmental Change Institute, Oxford University
The Tyndall Centre for Climate Change Research
Department of Geography, Exeter University
Centre for the Analysis of Timeseries, London School of Economics



Climateprediction.net Chief Scientist

**Climate Change: Scientific
Briefing Day for Artists
Friday 1st June 2007**



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Climate Science and Society



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Uncertainty



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What do we Know?

The climate is changing. The changes will continue and will lead to very significant problems for global society and societies around the globe.



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What do we Know?

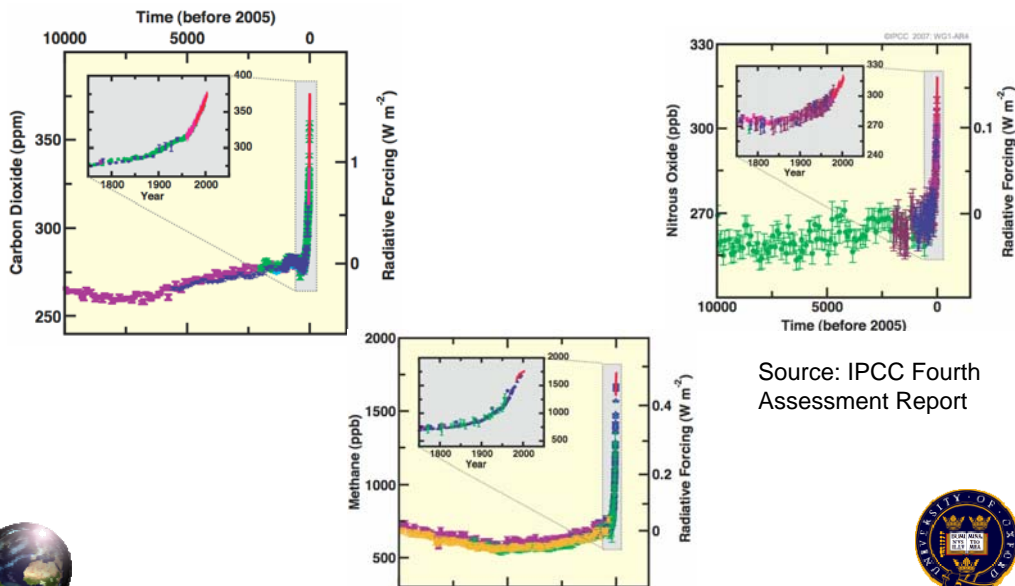
Basic physics tells us that increasing atmospheric greenhouse gases should lead to global warming.



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Atmospheric Greenhouse Gases Are Increasing



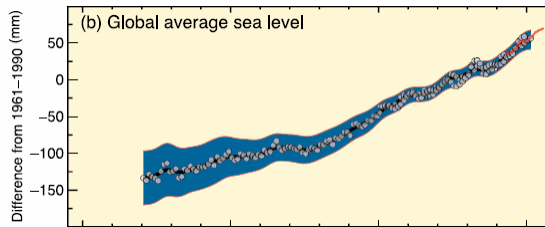
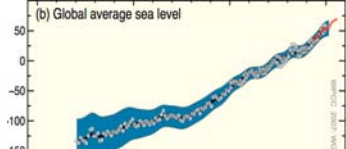
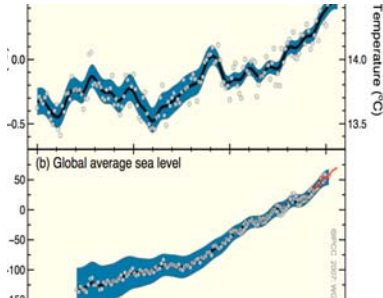
Source: IPCC Fourth Assessment Report



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And Global Temperature (and sea level) Is Rising



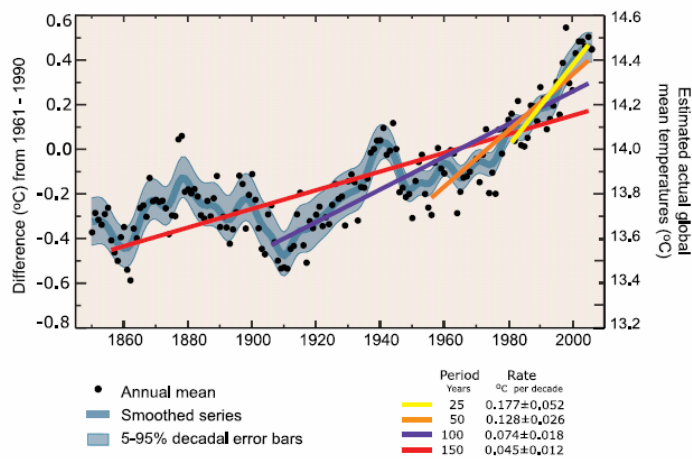
Source: IPCC Fourth Assessment Report



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The Rate of Rise Depends on When You Measure It



Source: IPCC Fourth Assessment Report



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Conclusions of the Inter-Governmental Panel on Climate Change, 2007

“Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global mean sea level.”

“Most of the observed increase in globally averaged temperatures since the mid-20th century is very likely (>90%) due to the observed increase in anthropogenic greenhouse gas concentrations.”

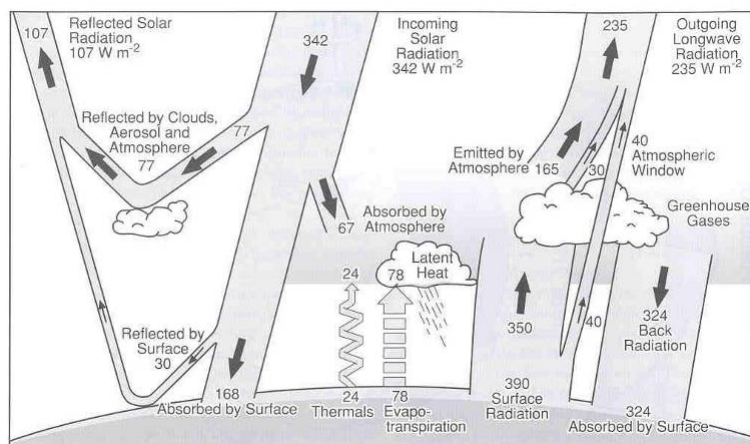


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Source: IPCC Fourth
Assessment Report



No surprise



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Source: IPCC Second Assessment Report



Feedbacks

Feedbacks are captured in the concept of “climate sensitivity” – the equilibrium change in global average temperature with a doubling of atmospheric CO₂. The IPCC say:

“the equilibrium climate sensitivity is likely to be in the range 2°C to 4.5°C, with a best estimate value of about 3°C. It is **very unlikely** to be less than 1.5°C. Values substantially higher than 4.5°C cannot be excluded”



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Source: IPCC Fourth Assessment Report

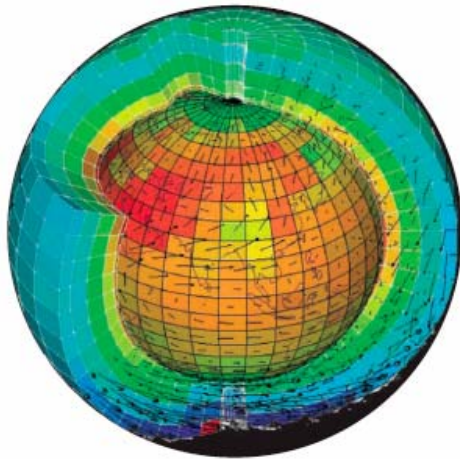


Climate Models

Complex, 3-dimensional, Atmosphere /Ocean General Circulation Models (AOGCMs)

Climate Models are the principle tools for climate prediction.

Most impacts studies are based on the predictions of AOGCMS.



A Hierarchy of Climate Models

		Ocean			
Dimension		0	1	2	3
Atmosphere	0	point EBM pulse response models seesaw models	box models advection-diffusion models	thermohaline models (lat/z): deep ocean models	OGCM
	1	EBM (lat) rad.-conv. model (z)	–	ocean (lat/z) + EBM (lat)	–
	2	EBM (lat/long)	stat. dynam. atm. + diffusive ocean	ocean (lat/z) + stat. dyn. atm (lat/long)	OGCM + EBM (lat/long) OCGM + QG atm.
	3	AGCM + SST	AGCM + mixed layer	ACGM + slab ocean	A/OGCM



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Courtesy of Thomas Stocker, University of Bern.

Confidence and Uncertainty

“Climate change presents a very real risk. It seems worth a very large premium to insure ourselves against the most catastrophic scenarios. Denying the risk seems utterly stupid. Claiming we can calculate the probabilities with any degree of skill seems equally stupid.”

Prof.C. Wunsch, MIT, 2007.



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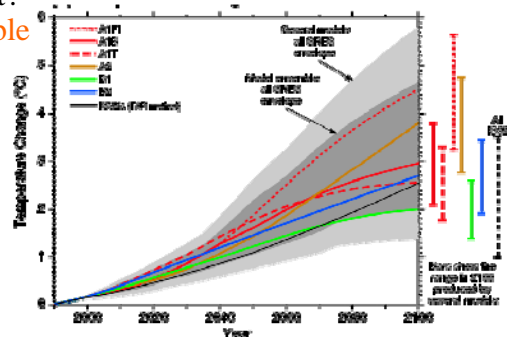
Source: IPCC Fourth Assessment Report



Sources of Uncertainty

and How to Include Them In a Climate Forecast

- **Forcing uncertainty:**
Changes due to factors external to the climate system e.g. greenhouse gas emissions (natural and anthropogenic), solar radiation etc.
How much will mankind emit?
Solution: **Scenarios for possible futures.**



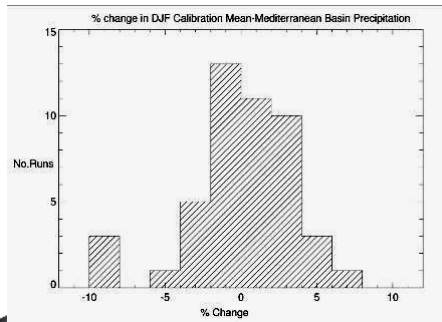
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Source: IPCC, Third Assessment

Sources of Uncertainty

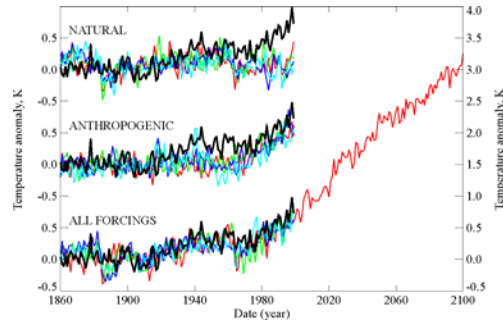
and How to Include Them In a Climate Forecast

- **Initial Condition Uncertainty**
How is the prediction is affected by our imprecise knowledge of the current state of the system at even the smallest scales?
Response: **Initial Condition Ensembles**



Source: Large (50 member) IC ensemble from climateprediction.net.

climateprediction.net

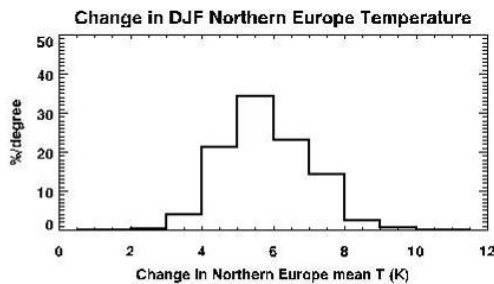


Source: IPCC, Third Assessment

Sources of Uncertainty

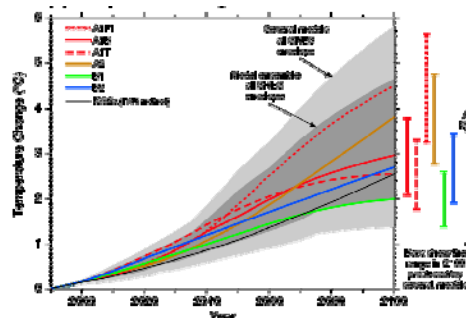
and How to Include Them In a Climate Forecast

- **Model uncertainty:**
Different models could be as good at simulating the past but give a different forecast for the future?
Solution: **Perturbed-Physics Ensembles**



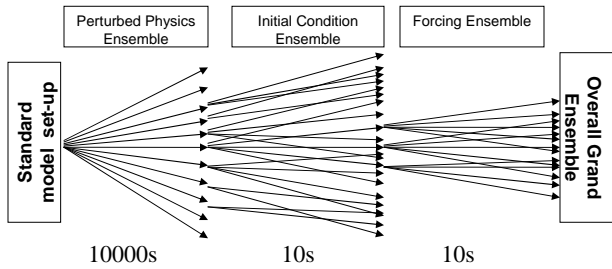
Stainforth et al.2006

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Source: IPCC, Third Assessment

Exploring Uncertainty: The Climateprediction.net Experiment



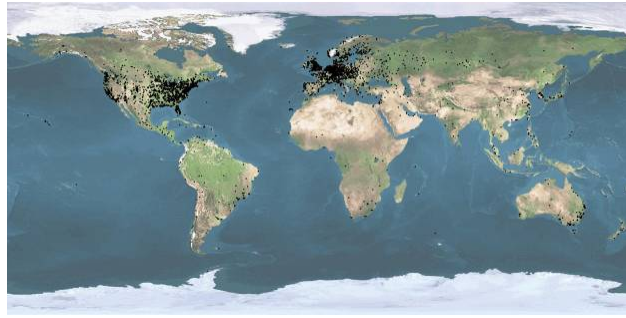
- To quantify uncertainty we need 100s of thousands of simulations.
- Impossible with super computers but possible with distributed computing.
- At www.climateprediction.net people can download the model to their PC.
- Using the latest, complex model means we can get regional detail as well as global averages.

Latest Statistics

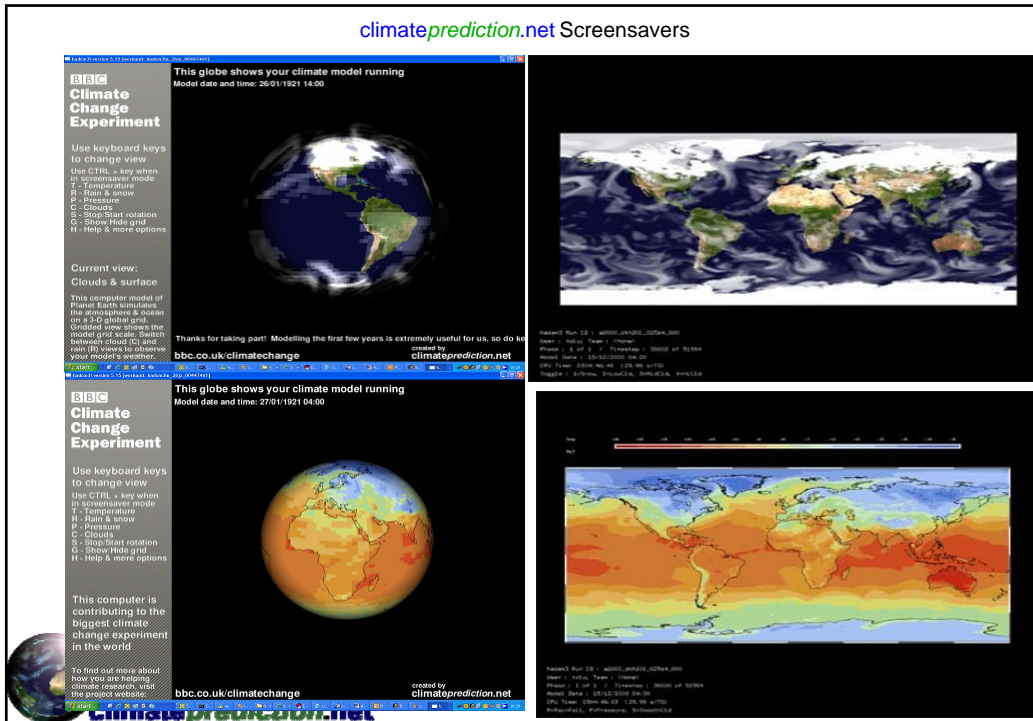
- > 300,000 participants.
- > 24M years simulated.
- > 110,000 completed simulations. (Each 45years of model time)
- 10000 years of computing time.



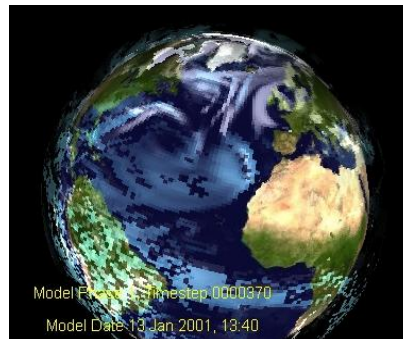
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ClimatePrediction.net : What it looks like.

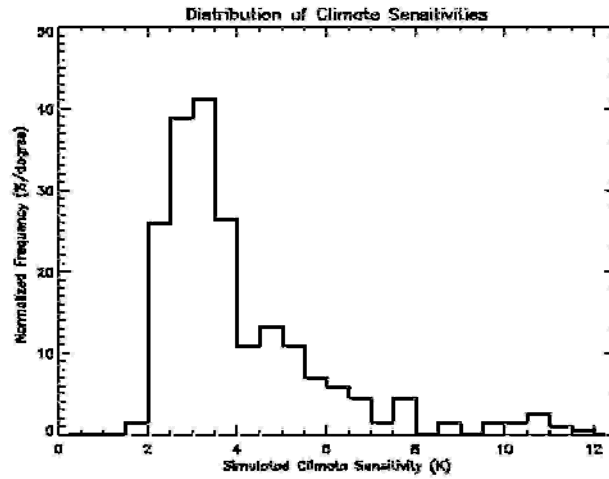


Visualization - Seasonal



First Results in Terms of Climate Sensitivity

Climate sensitivity is defined as the equilibrium global mean surface temperature change for a doubling of CO₂ levels.



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Source: Stainforth et al. Nature, 2005

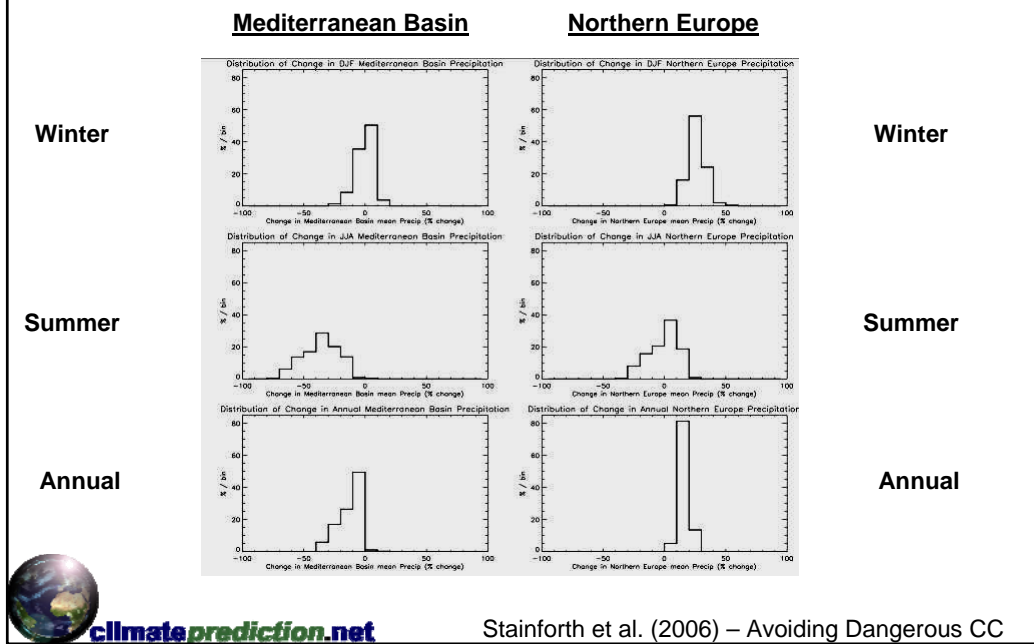
Communication / Knowledge Transfer Is Tricky

Even more so is identifying what is useful and relevant in different sectors of society.



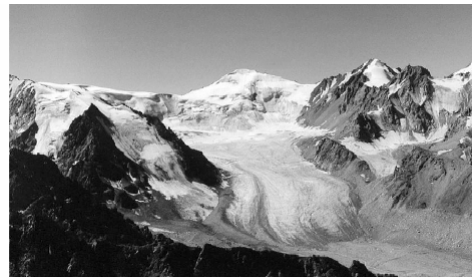
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Regional Behaviour – European Rain and Snowfall

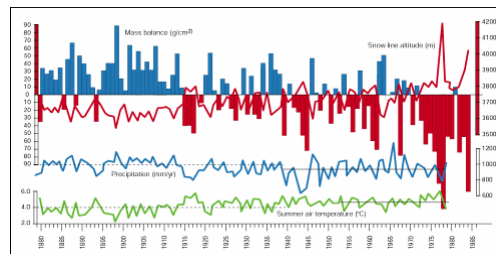


Some Things We know

- Mitigation is critical if we are going to maintain a habitable planet; preferably without descending into conflict.
- Adaptation will be necessary.
- We can't yet say what will happen locally but in the next 10-15 years we may be able to do better.
- Global temperatures will rise.
- Sea level will rise.
- Most glaciers will continue to retreat.



Tuyuksu Glacier, Kazakhstan: a vital water source



"We need to treat climate change not as a long term threat to our environment, but as an immediate threat to our security and prosperity,"

John Ashton, UK Climate Ambassador.

September 2006.



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