Climate Change: How Bad Will it Be?

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News & views

Climate change

Short-term tests for long-term estimates

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Book Reviews | Fiction | Non-Fiction | Children's Books | Short Story Club | Book Shop | Ways Wit

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The game is up for climate change believers

Charles Moore reviews The Age of Global Warming by Rupert Darwall (Quartet)

Power station emitting steam and smoke Photo: Reuters

By Charles Moore
9:42PM BST 06 Apr 2014
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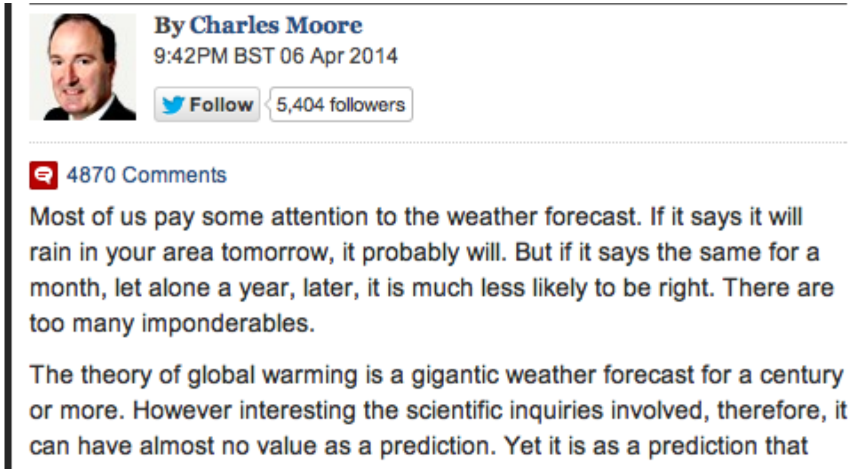

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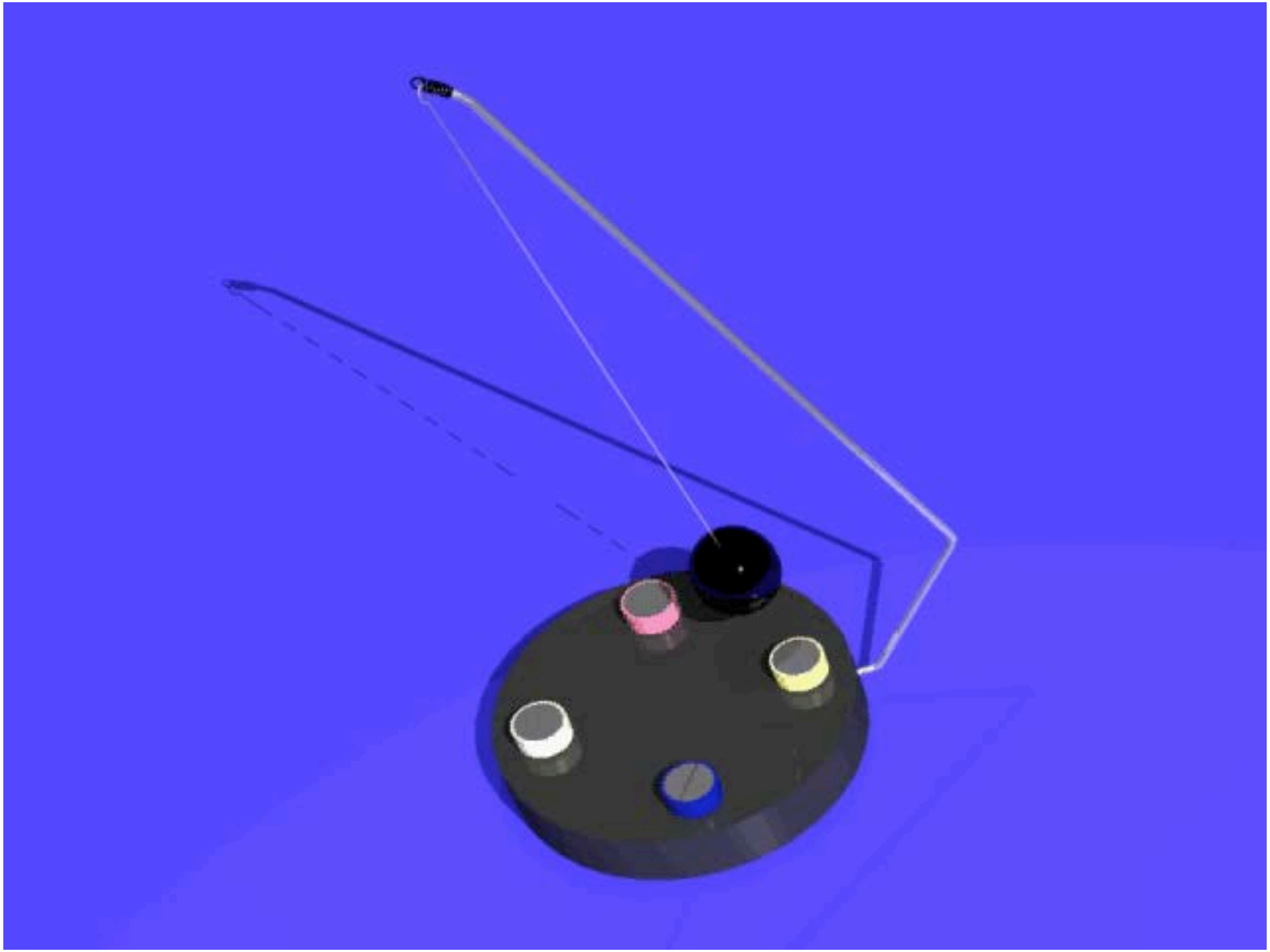
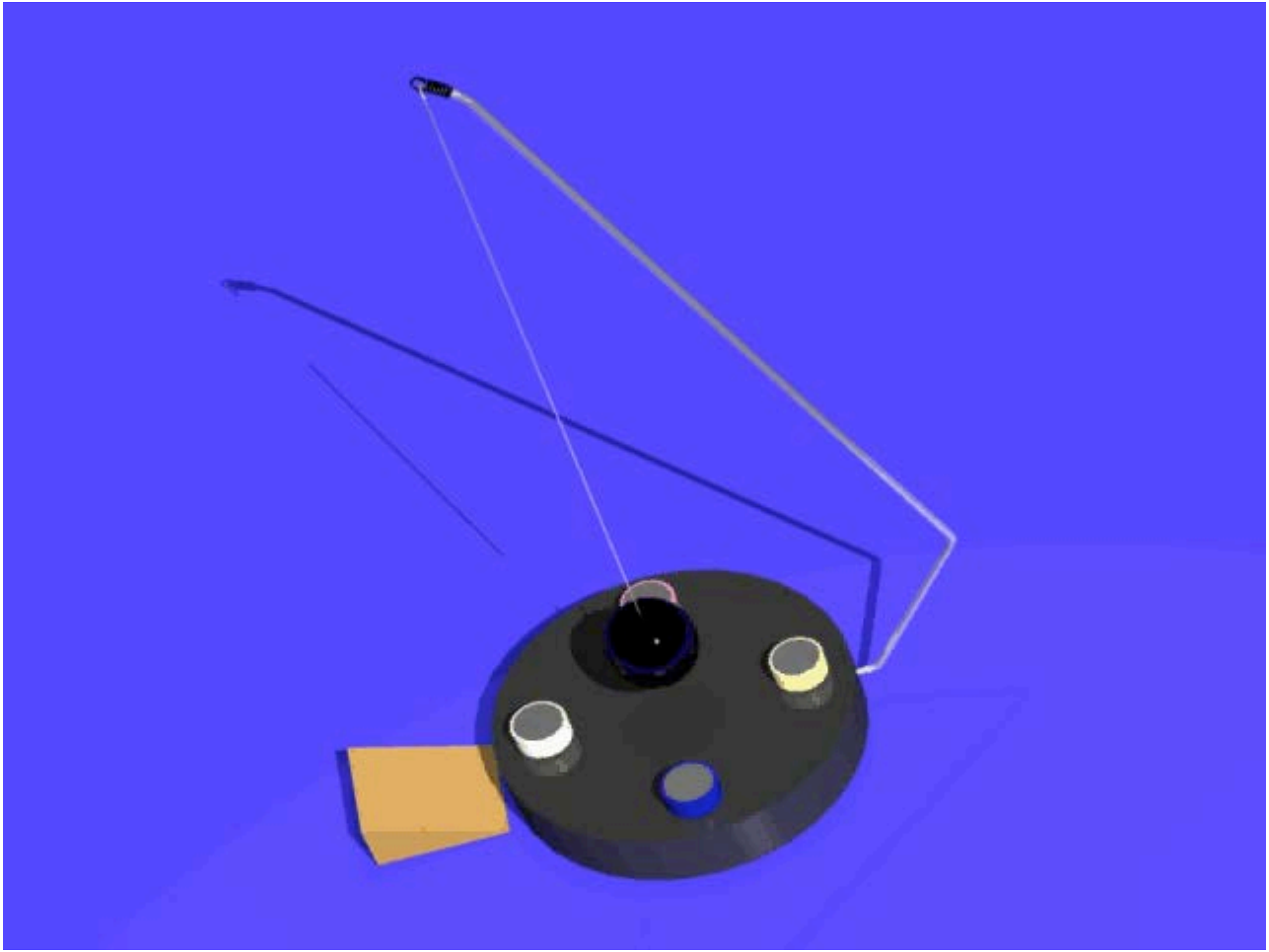
Most of us pay some attention to the weather forecast. If it says it will rain in your area tomorrow, it probably will. But if it says the same for a month, let alone a year, later, it is much less likely to be right. There are too many imponderables.

The theory of global warming is a gigantic weather forecast for a century or more. However interesting the scientific inquiries involved, therefore, it can have almost no value as a prediction. Yet it is as a prediction that

"The theory of global warming is a gigantic weather forecast for a century or more…therefore it can have almost no value as a prediction. "





What makes climate-change prediction difficult is not chaos, but the question:

How Thick is the Wedge?

Potential Amplifiers of the effect of anthropogenic carbon emissions

Water Vapour

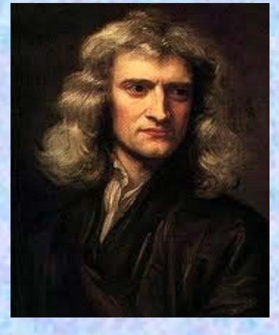
Clouds

Ice albedo

Carbon cycle

Methane

Comprehensive weather and climate models are based on the primitive laws of physics eg



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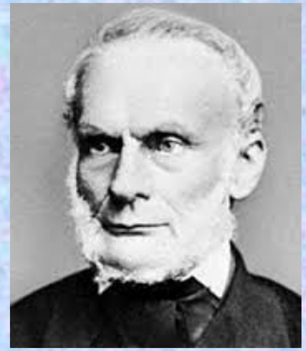

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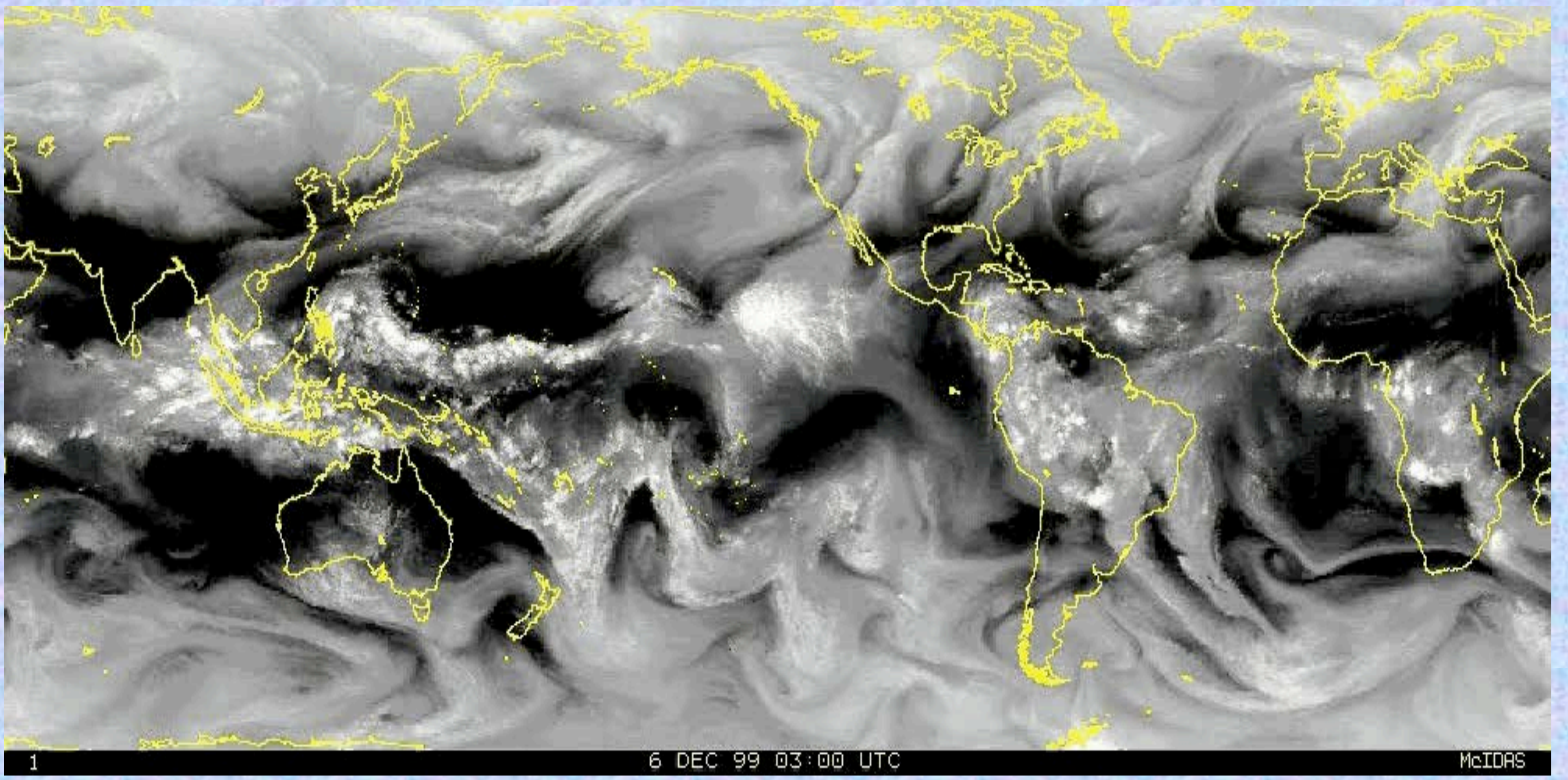
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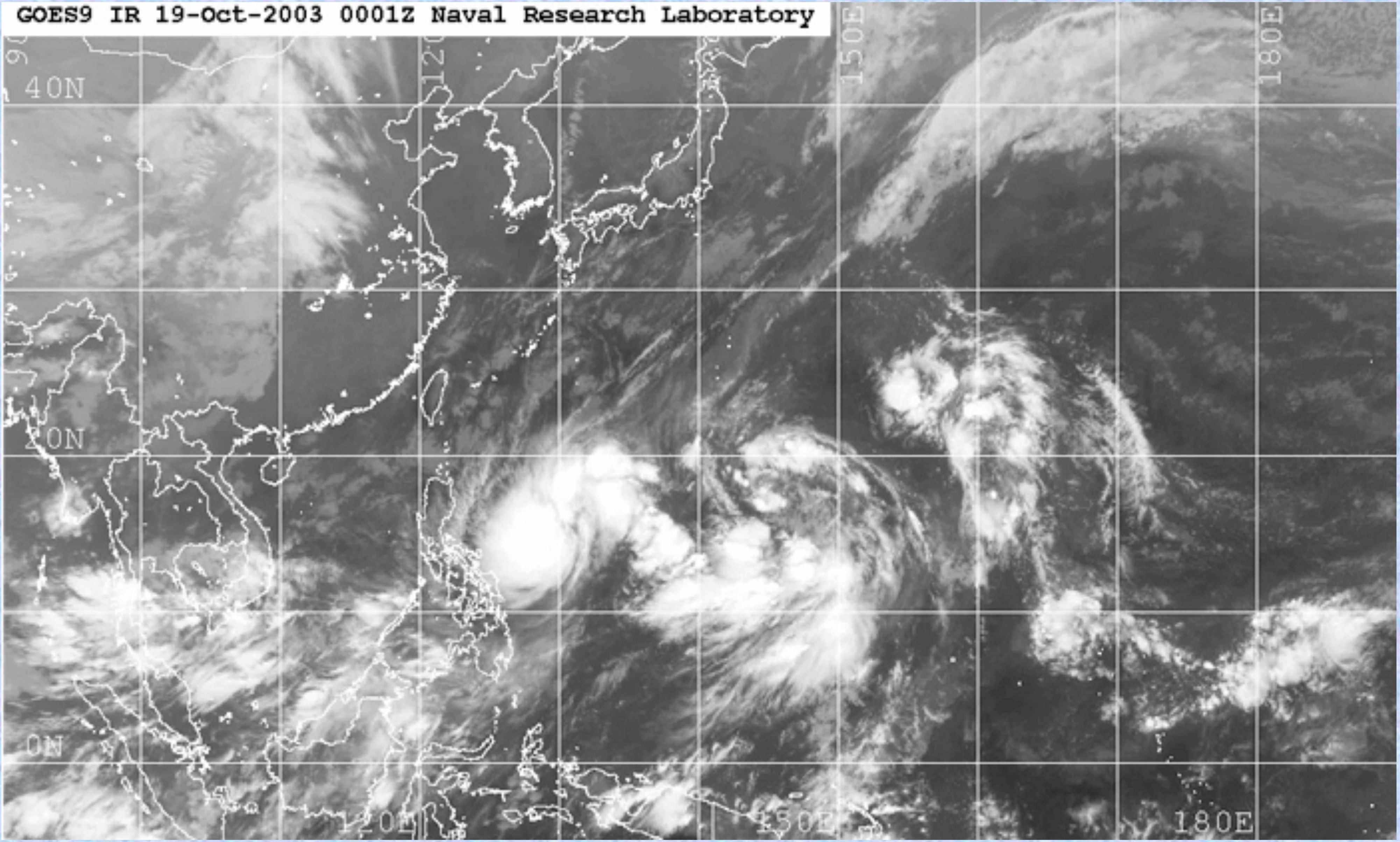
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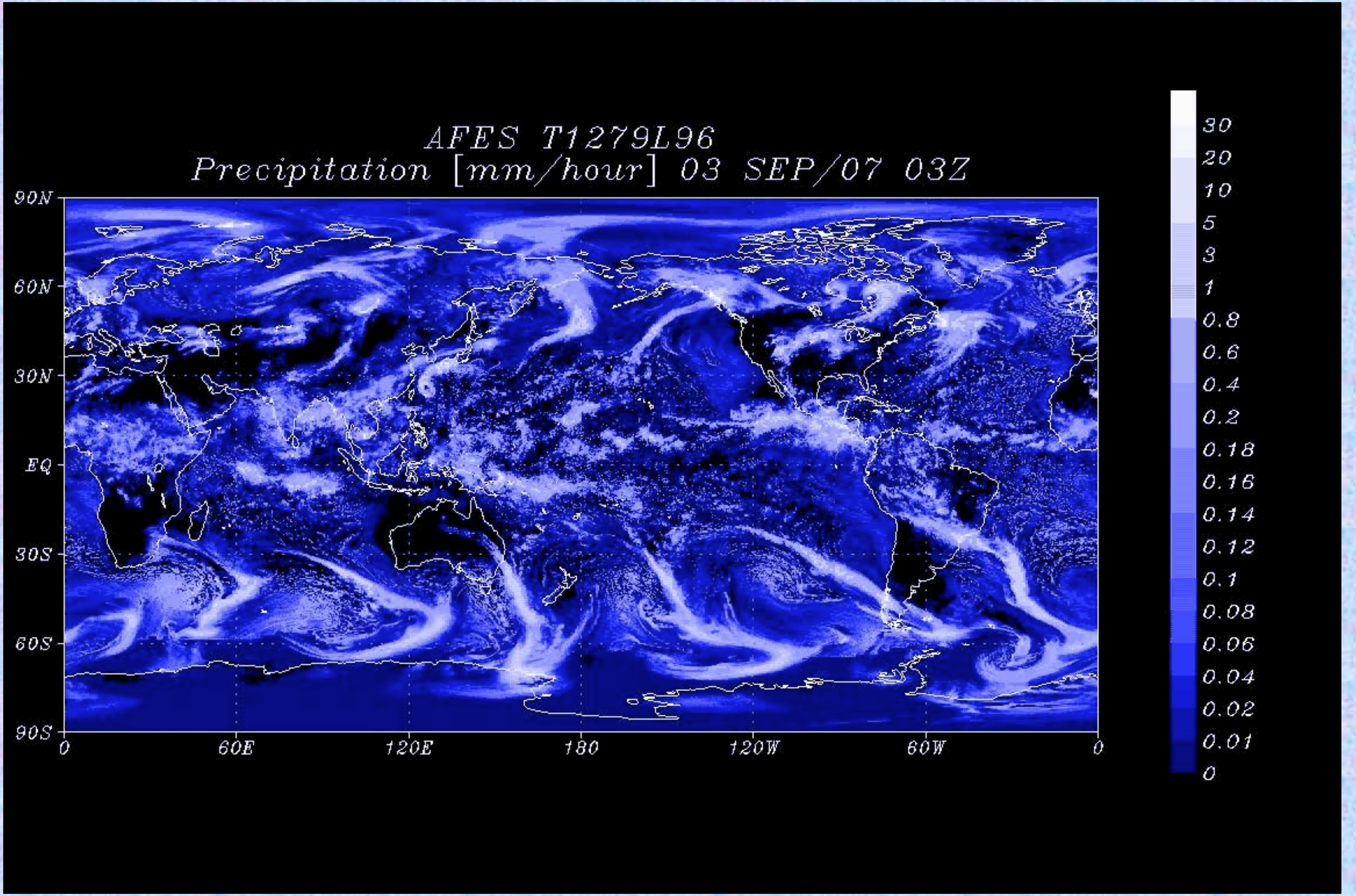
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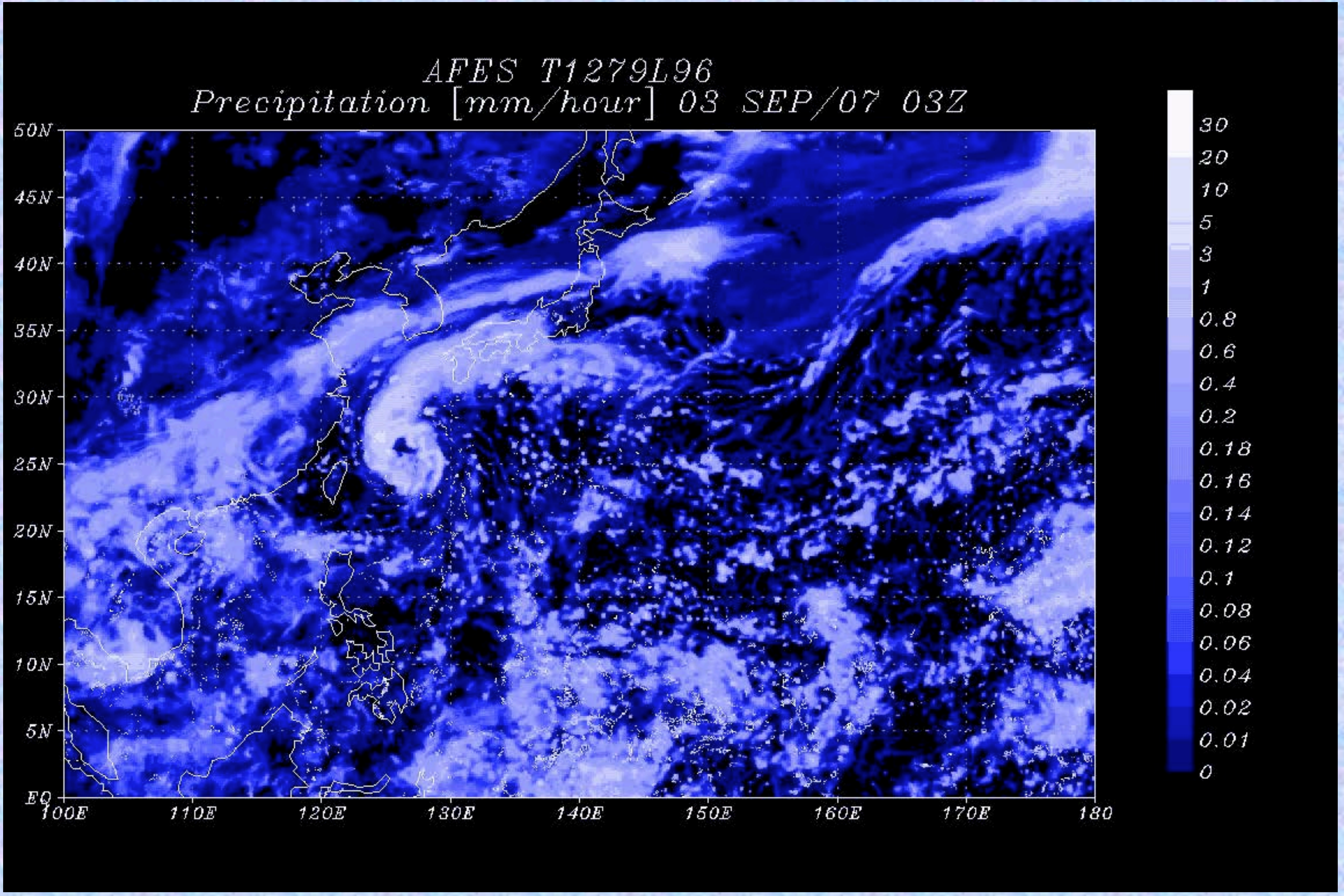
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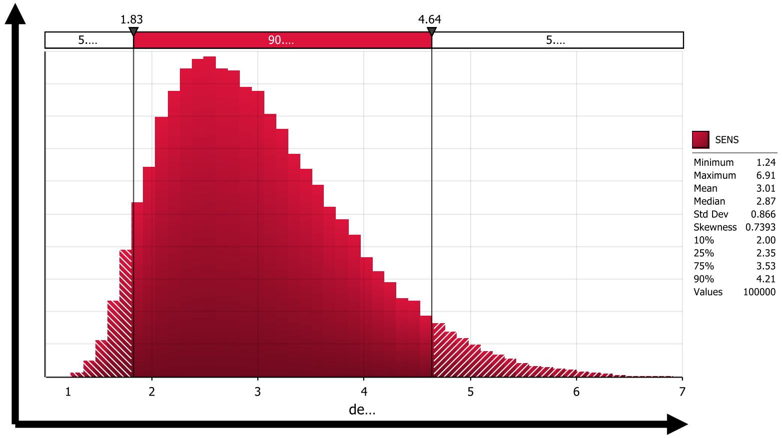
The Scientific Consensus

Probability of warming



Amount of warming

Amount of warming for a doubling of CO_2 (Climate Sensitivity)

- The scientific consensus about climate change refers to a general agreement about this probability distribution.

- Hence there is a consensus in the scientific community of a substantial risk of dangerous (say >2K) climate change.

- Claiming climate change will be something definite (either “catastrophe, hoax or lukewarm”) is inconsistent with science.

- A number of the latest generation of climate models (which will feed into the IPCC 6th assessment report) are suggesting climate sensitivities > 5C. Hence the tail may be much fatter than we previously thoughts. Are these latest results believable?

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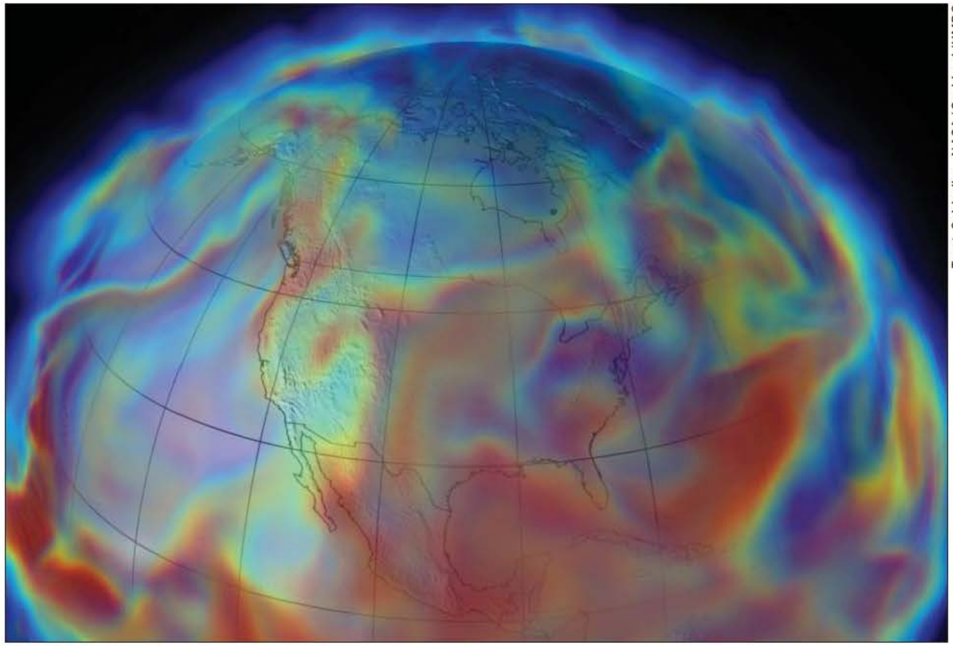
Why do we need accurate climate models?

- **Mitigation** (How bad is climate change going to get and how quickly will it get there, with and without emissions cuts? Can we rely on sucking CO_2 out of the air at a later date, or will we pass a significant tipping point making negative emissions technology completely ineffective?)
- **Adaptation** (What will be the regional effects of climate change – including changes to extremes of weather? How can we make society more resilient to these changes?)
- **Geoengineering** (Is this really a Plan B? Could we inadvertently divert the monsoons, or the moisture supply to the rainforests, by spraying sulphuric acid into the stratosphere?)
- **Early-warning systems** (How far ahead can we reliably predict extreme weather events. How proactive can we be in providing aid ahead of possible extreme weather events – e.g. Red Cross/Red Crescent Forecast Based Finance?)
- **Attribution** (How more likely can we expect some observed extreme event to become in the future?)

A CERN for climate change

Providing reliable predictions of the climate requires substantial increases in computing power. Tim Palmer argues that it is time for a multinational facility fit for studying climate change



Trent Schindler, NASA/Goddard/UMBC

A global approach to a global problem Modelling the climate may require a unified strategy for computing.

This winter has seen unprecedented levels of travel chaos across Europe and the US. In particular, the UK experienced some of the coldest December temperatures on record, with snow and ice causing many airports to close. Indeed, George Osborne, the UK's Chancellor of the Exchequer, attributed the country's declining economy in the last quarter of 2010 to this bad weather. A perfectly sensible question to ask is whether this type of weather will become more likely under climate change? Good question, but the trouble is we do not know the answer with any great confidence.

The key point is that the cold weather was not associated with some "global cooling" but with an anomalous circulation pattern that brought Arctic air to the UK and other parts of Europe. This very same circulation pattern also brought warm temperatures to parts of Canada and south-east Europe. Global mean temperatures were barely affected.

Weather-forecast models, which only have to predict a few days ahead at a time, are able to represent this level of detail very well. Global climate models, however, such as those used in the fourth assessment report by the Intergovernmental Panel on Climate Change (IPCC) to predict weather

adapt to. This uncertainty arises, primarily, not because we do not know the relevant physics of the problem, but rather because we do not have the computing power to solve the known partial differential equations of climate science with sufficient accuracy.

In a nonlinear system, which the climate certainly is, getting the detail right can be important for understanding the large-scale structures. A manifestation of this problem is that no contemporary climate model can simulate the Earth's climate without systematic errors in its wind, temperature and rainfall fields. These systematic errors are

to be able to resolve deep convective cloud systems, known to be crucial in transporting heat moisture and momentum from the planet's surface into the high troposphere, a climate simulator needs to have a grid-point spacing of at least 1 km. But we cannot say, short of actually doing the numerical experiments with such a grid, how much more accurate a climate simulator would be if these deep convective clouds could be properly represented by the laws of physics, rather than represented as part of the set of relatively crude parametrized closure formulae, as is currently the situation.

Shaping Europe's digital future

POLICY

Destination Earth (DestinE)

PAGE CONTENTS

The objective of the Destination Earth initiative is to develop a very high precision digital model of the Earth to monitor and simulate natural and human activity, and to develop and test scenarios that would enable more sustainable development and support European environmental policies.

Destination Earth (DestinE) will contribute to the European Commission's Green Deal and Digital Strategy. It will unlock the

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Destination Earth break-throughs

1. <u>Extreme-scale computing and data handling</u>:
   = *much more realistic models + better combination of simulations + observations*

2. <u>Full integration of policy sectors</u> in workflow for ***actionable information incl. quality***
   = *Earth-system + energy + food + water + finance*

3. <u>Open and interactive access</u> to data, software and workflows for users
   = *non-expert access and intervention*

Conclusions I

- How bad climate change will be depends critically on how cloud cover adjusts to increasing CO_2 concentrations.
- Some of the latest generation of climate models with the latest representations of cloud suggest a significantly greater degree of warming than previously thought.
- Support for these latest results comes from the fact that weather forecasts with these new cloud representations are accurate.

Conclusions II

- More accurate climate models (e.g. where cloud systems are represented explicitly) are needed. This will require much higher resolution – only possible with dedicated exascale supercomputing.
- We need a ”CERN for Climate Change” where human and computational resources are pooled.
- Something like this should emerge from the EU’s Destination Earth programme, part of the EU Green Deal.