

# Plurality of Confidence Criteria among Climate Modellers

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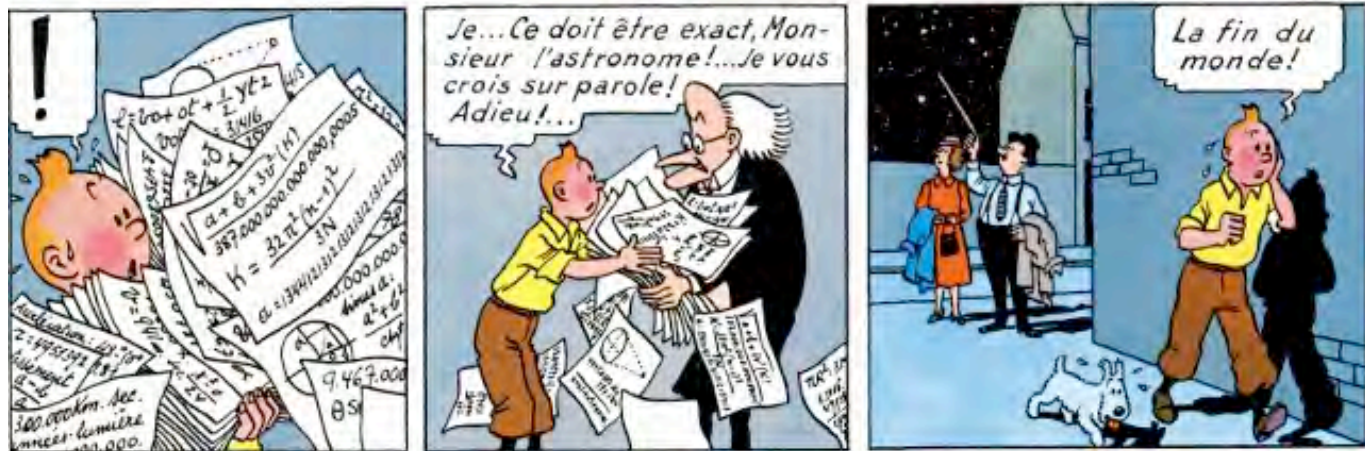
*ANR project « ClimaConf »*

***CONFIDENCE, CREDIBILITY AND AUTHORITY IN CLIMATE SCIENCES AND POLITICS***

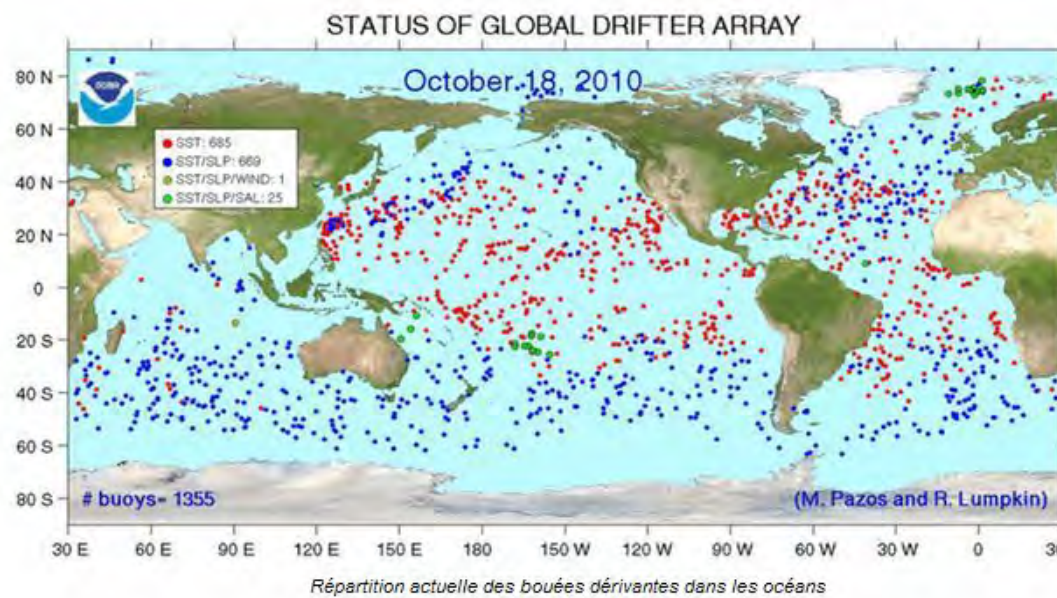
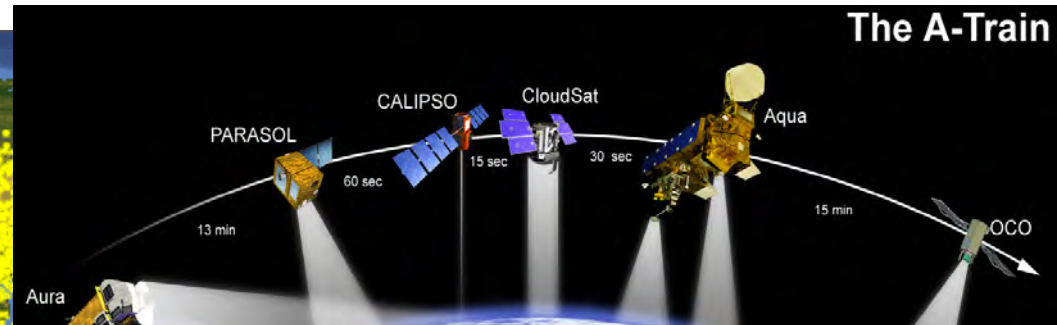
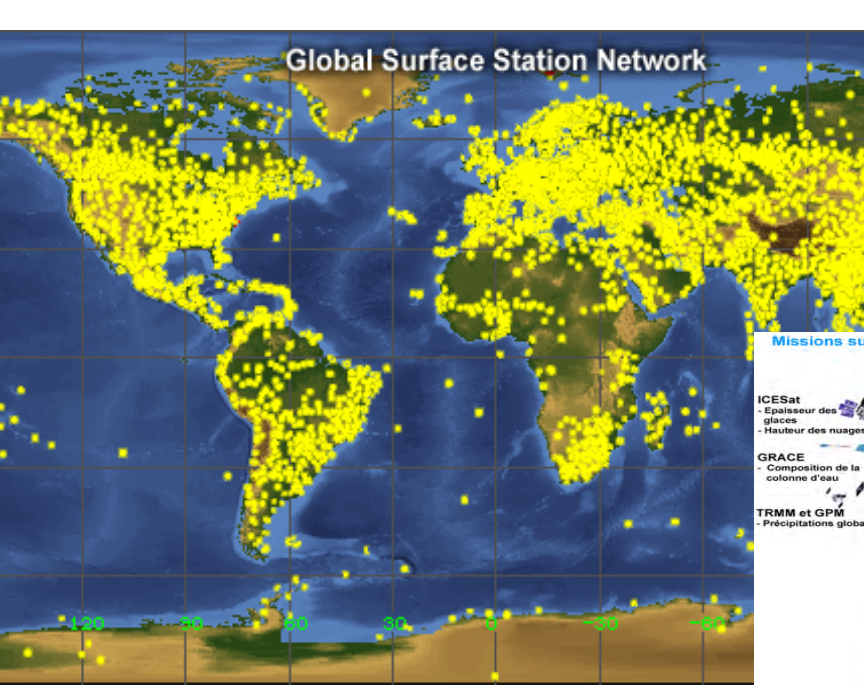
*Paris, 20-21 november 2014*

« Insofar as we are concerned with scientific knowledge, credibility should not be referred as a « fundamental » or « central » topic - from a pertinent point of view it is the *only* topic. »

*Steven Shapin, 2010*



# Global Knowledge Infrastructure



# Plurality of Confidence Criteria among Climate Modellers

- Introduction
- 1- Foundation on Physical Theories
- 2- Validation with Observational Data
- 3- Robustness of Results and Model Pluralism
- 4- Physical Understanding and Model Holism
- 5- Which Confidence in Climate Model's Future?

# Criterion 1

## Foundation on Physical Theories

The climate system is a global object constrained by the laws of physics

« One source of confidence in models comes from the fact that model fundamentals are based on established physical laws, such as conservation of mass, energy and momentum »

*IPCC AR4*

# Criterion 2

## Validation with Observational Data

Difficulties:

- Variability at all scales → comparison is statistic
- Multiplicity and entanglement of climate processes

A model is not evaluated in general; what is evaluated is its capacity to account for a particular climatic characteristic or a defined phenomenon.

Evaluations are diverse, and performed at all temporal and spatial scales

- Top-down: global evaluation of a model by comparing to global databases
- Bottom-up: validation of parameterizations by local case studies
- Others: long term effects of parameterizations, ....

There is no systematic protocol for evaluating models

- Norms of validation are defined at the same time as the facts to be validated, as well as the analysis methods to which data and models will be subjected and that allows for their comparison.

# Criterion 3

## Robustness of Results

### Model Pluralism

- Models as « fiction » (Barberousse 2000)
- « Pragmatic Integrative pluralism » (W. Parker 2006)

### Model Intercomparison Projects

- does not allow to determine the best parameterizations neither to attribute models results to its contents but...
- show that there is no “best model” → pluralism
- changed ways of working in the climate scientist community: coordination, openness, standardization...
- provide simulations for IPCC assessment reports
- allow to assess which aspects of simulations are robust and which are not

# Criterion 4

## Physical Understanding

### Philosophical views on computer simulations

- « *In many computer simulations, the dynamic relationship between the initial and final states of the core simulation is **epistemically opaque** because most steps in the process are not open to direct inspection and verification. This opacity can result in a loss of understanding ( ... )*»

**Humphreys, P.** 2004. *Extending Ourselves. Computational Sciences, Empiricism, and Scientific Method*

- « *Global models of climate face a form of **confirmation holism**. This holism makes analytic understanding of complex models of climate either extremely difficult or even impossible* »
- « *Climate models are **analytically impenetrable** in the sense that “ it is impossible to tell, by any method, where to locate the sources of the failures of our models to match known data* »

**Lenhard, J. & E. Winsberg,** 2010. « Holism and Entrenchment and the future of climate model pluralism », *Studies in History and Philosophy of Modern Physics*



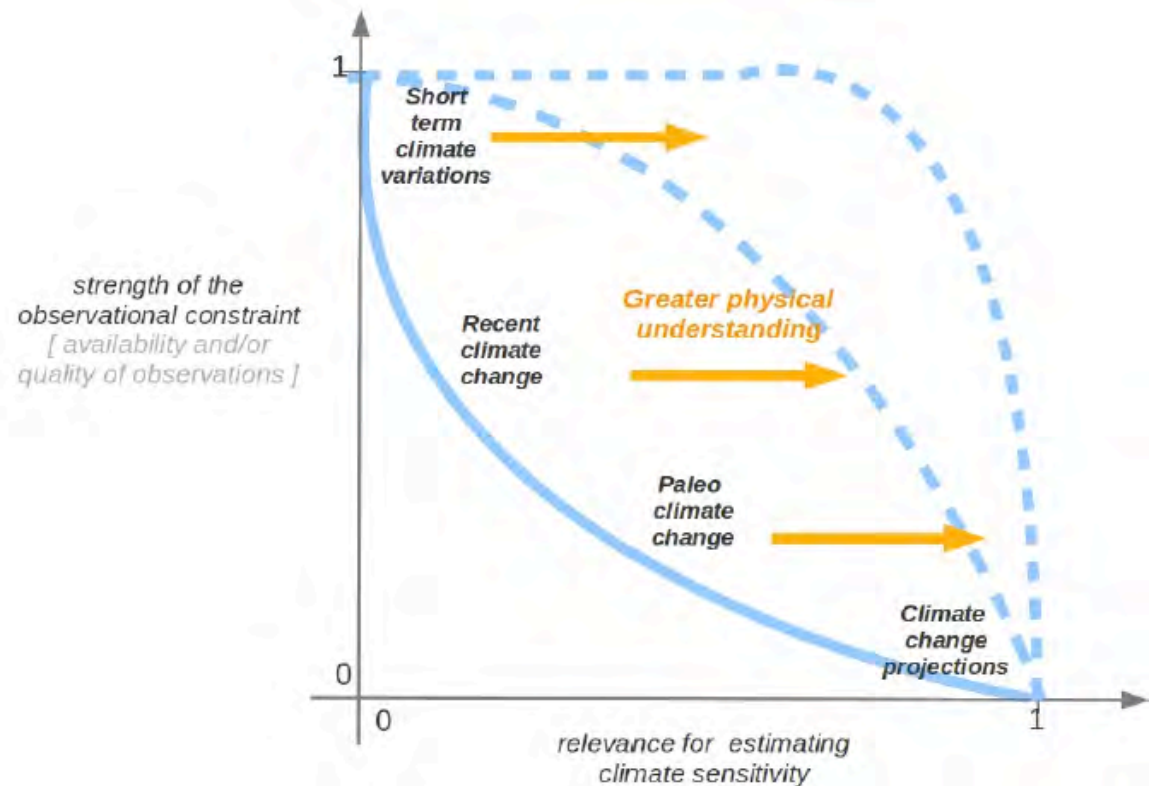
# Understanding for prediction

« Improvements of **longterm climate change assessments disproportionately depend on the development of physical understanding** »

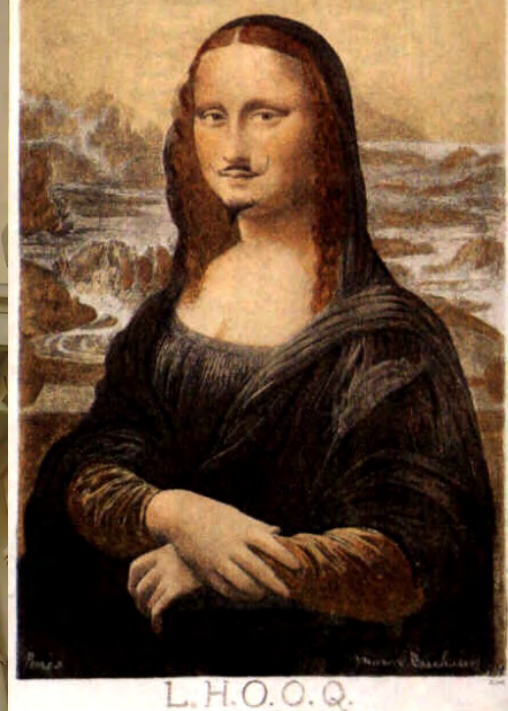
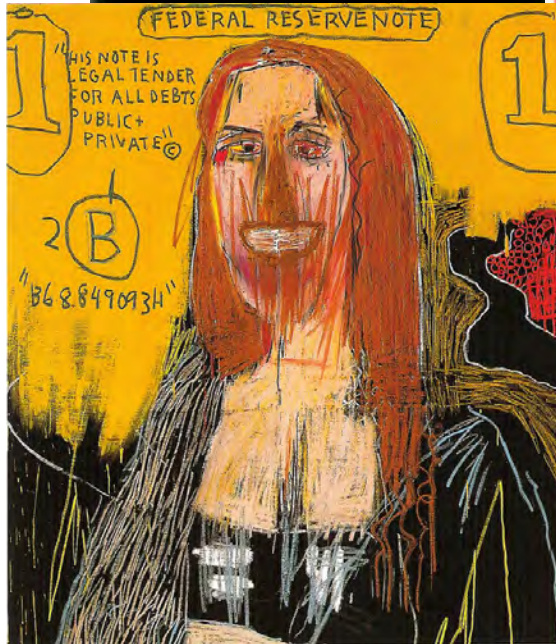
« In the foreseeable future the credibility of model projections and **our ability to anticipate future climate changes will depend primarily on our ability to improve basic physical understanding** about how the climate system works. »

*Position Paper at WCRP Open Science Conference, Denver 2011*

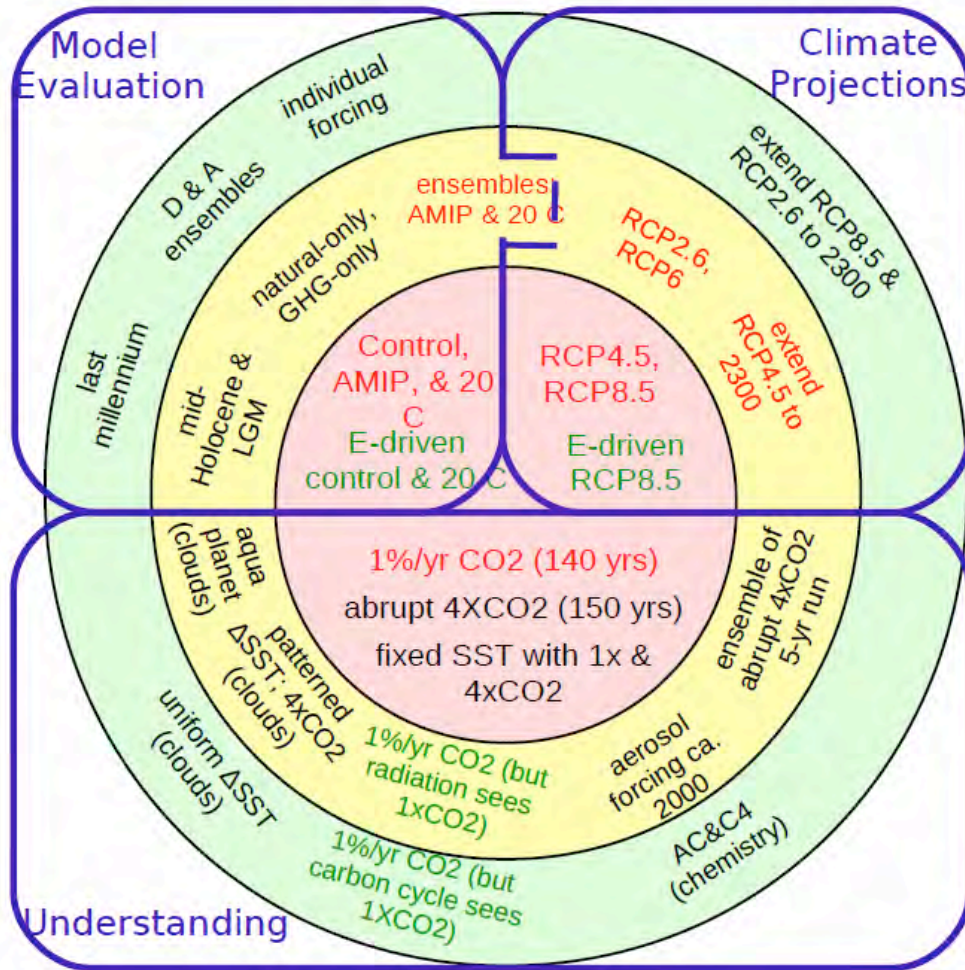
*Bony, S., et al.. « Carbon Dioxide and Climate: Perspectives on a Scientific Assessment », 2013*



# Spectrum of models of differing levels of complexity



# Coupled Model Intercomparison Project phase 5 (CMIP 5) simulations



CMIP5 involves 20 climate modeling groups

« **CMIP5** is meant to provide a framework for coordinated climate change experiments for the next five years and thus includes **simulations for assessment in the IPCC Fifth Assessment Report (AR5)**

RCP = Representative Concentration Pathway  
 GHG = Greenhouse Gas  
 SST = Sea Surface Temperature

# Merci !

