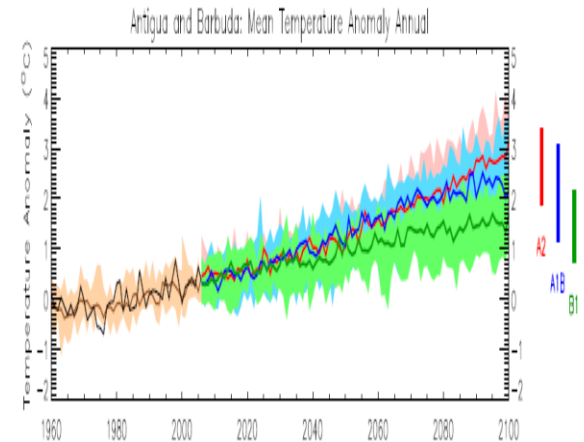
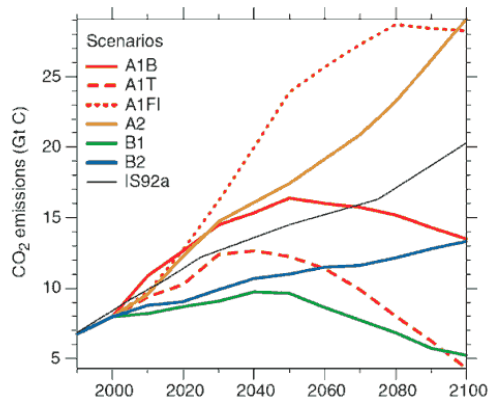


# **Model Limitations and Uncertainties**

# The equation for Future Climate



Scenarios



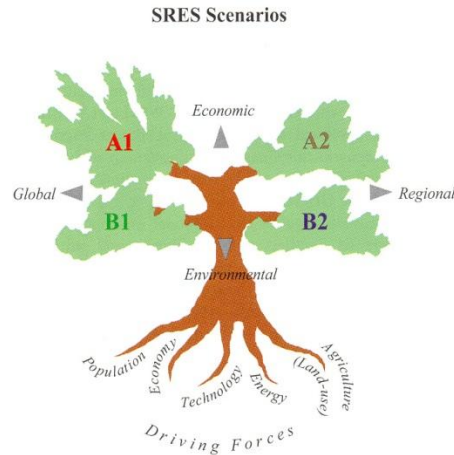
Models



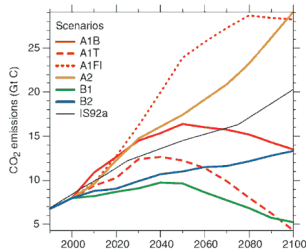
Future Climate

Temperature  
Rainfall  
Sea Level Rise

# Scenarios

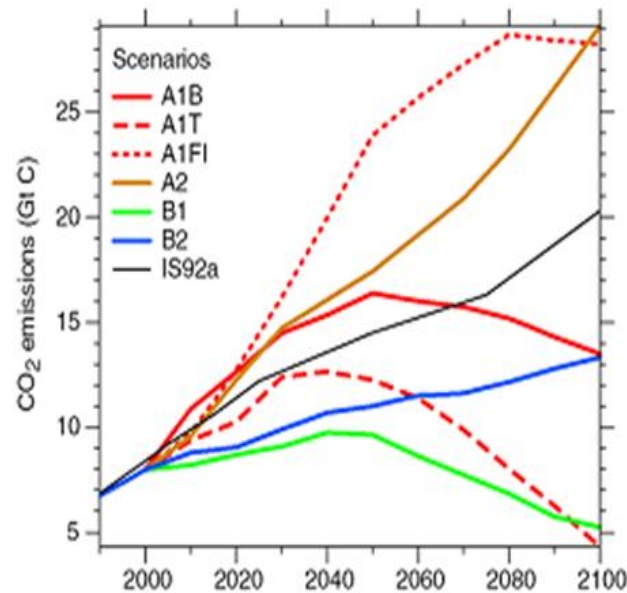


Storylines about how the world will develop



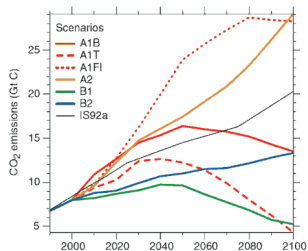
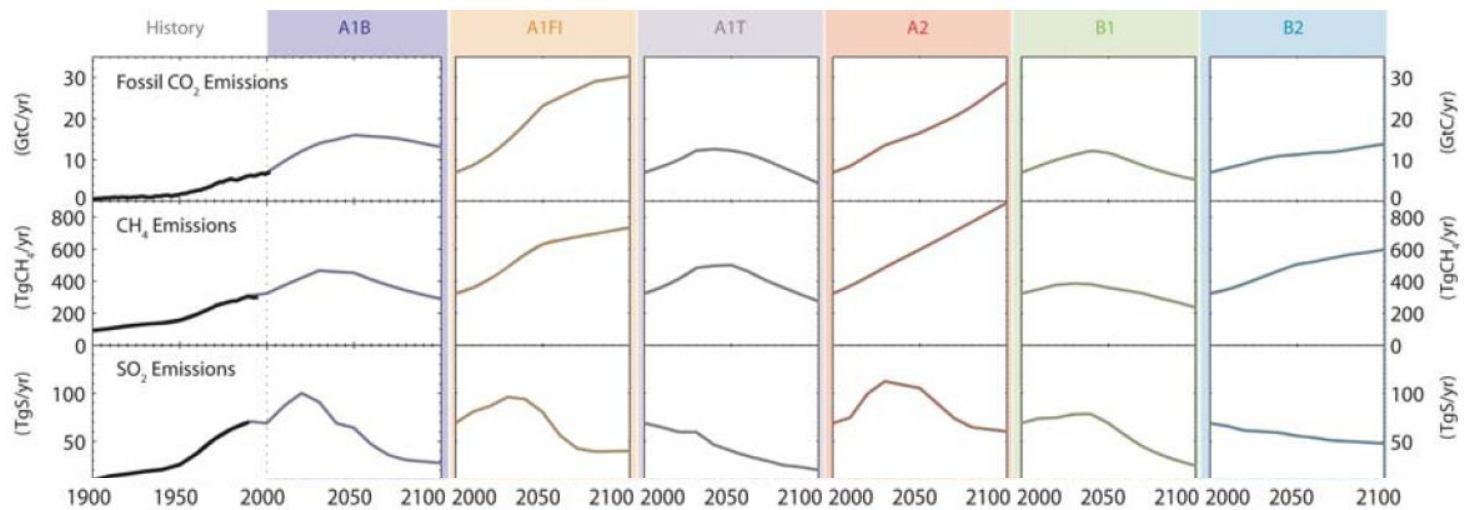
Scenarios

Please, remember the Learning Exercise using SRES

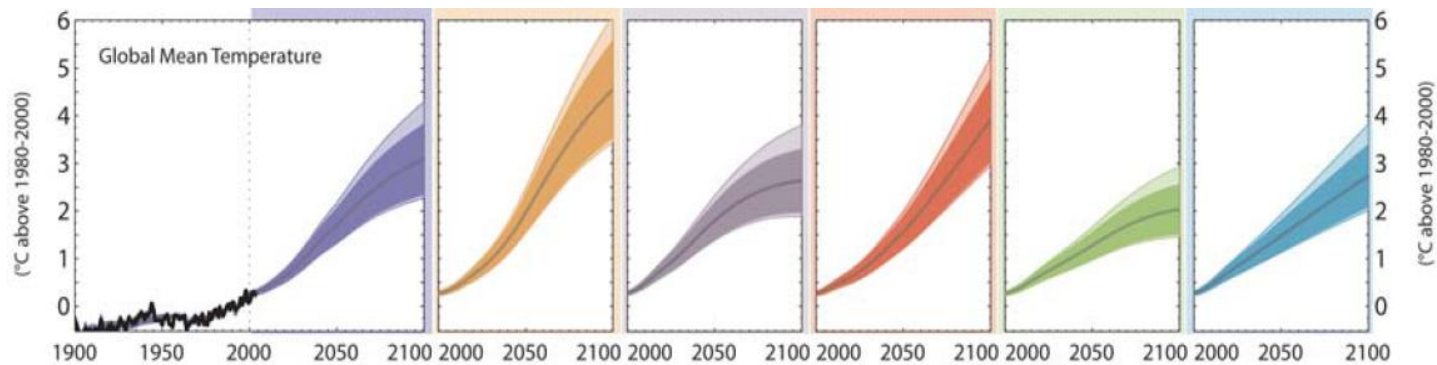


We stated that:  
Ideally we should simulate all of them to come up with the range of possible futures.

# Scenarios



## Scenarios





# The Climate Models

## There are a number of Model Limitations



**Models**

1. Subgrid scale processes and the need for parameterizations (e. g. clouds)
2. Resolution and computational resource. The need to discretize the system (spatially as well as temporally)
3. Predictability Limits associated with the non-linear system characteristic. (chaos)
4. Incomplete knowledge of the System function/limitations to incorporate all what we know

# The Climate Models

The concept of climate prediction (Lorenz 1975)



**Models**

- **Predictability of the first kind**

Initial value problem: Prediction of the evolution of the climate system (or some of its components) given some knowledge of the initial state

- **Predictability of the second kind**

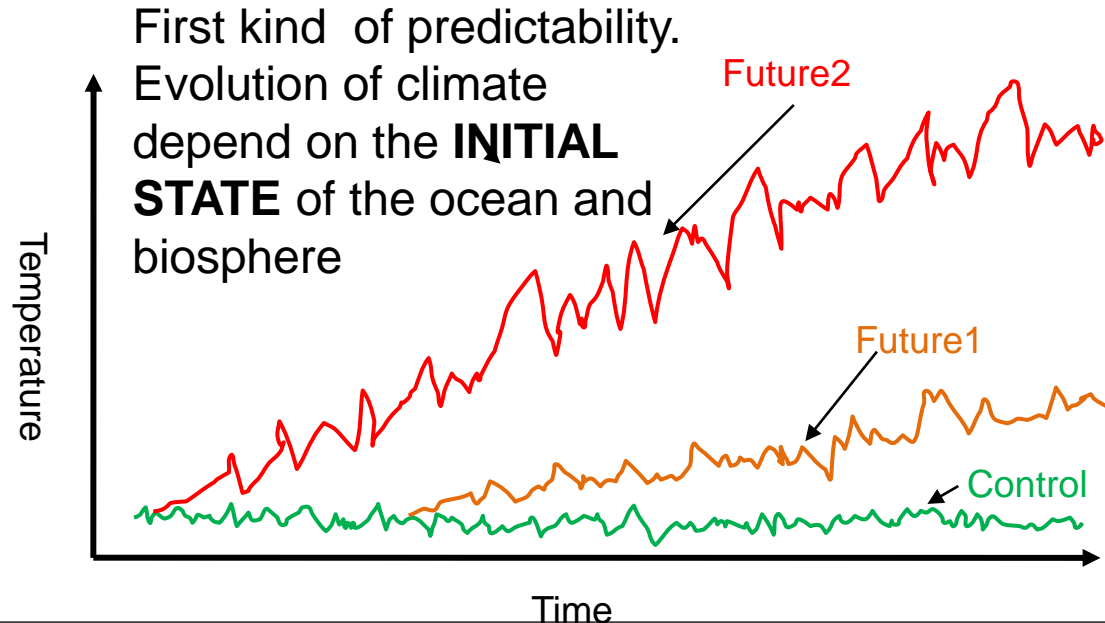
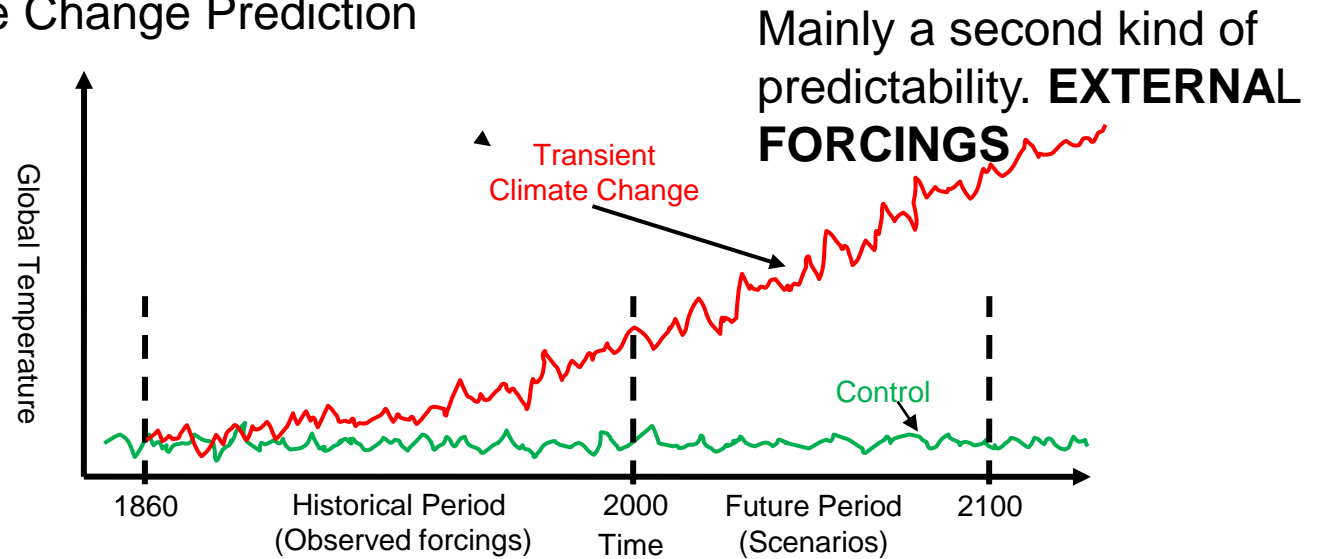
Boundary value problem: Prediction of the response of the climate system (or some of its components) to external forcings

# The Climate Models

## Anthropogenic Climate Change Prediction



Models





# The Climate Models

## Other Model Uncertainties



**Models**

**Unpredictability of natural and anthropogenic forcings:** It is impossible to predict solar activity, major volcanic eruptions or social/technological developments.

**Natural internal variability** related to non-linear processes within the climate system

# The Climate Models

## Intrinsic Model Uncertainties



**Models**

Because of the internal variability and non-linearity of the climate system and the random component of the external natural and anthropogenic forcings, many future climate states are possible, each with a certain likelihood to occur.

**Therefore, future climate change is characterized by an intrinsic level of uncertainty**

# The Climate Models

## Model Uncertainties

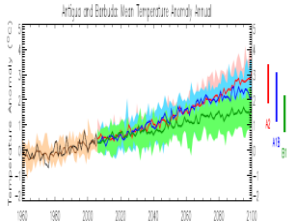
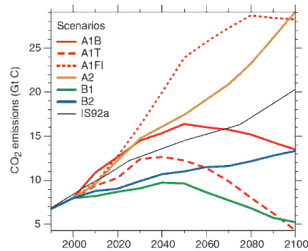


**Models**

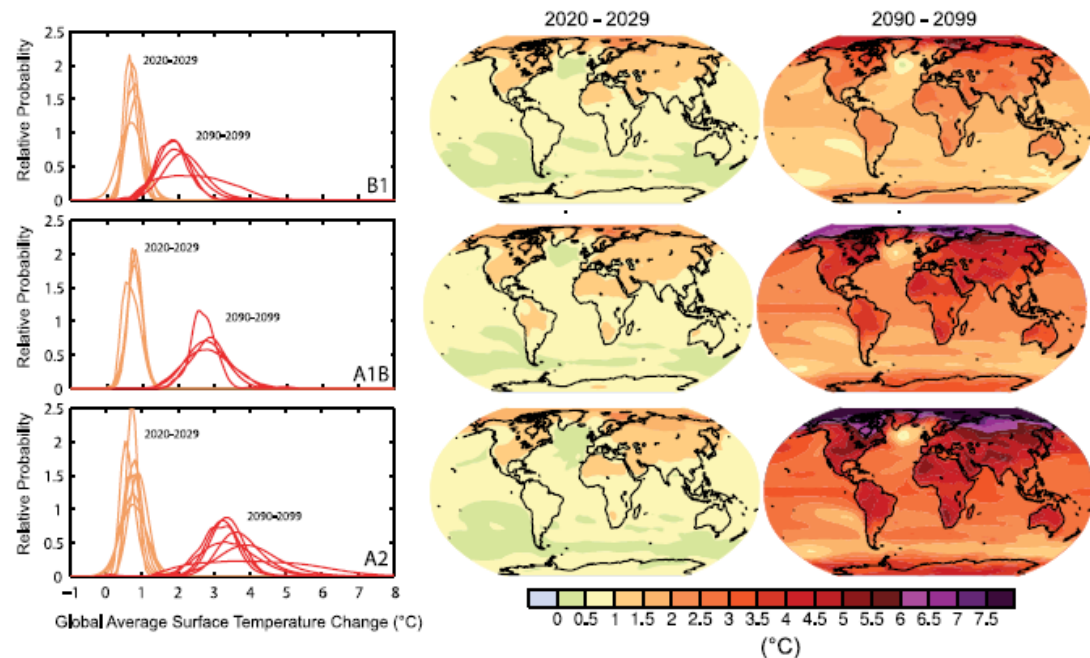
There are two kind of model uncertainties associated with:

1. The different ways that different models are developed
2. The different ways that physics parameters are represented in one model

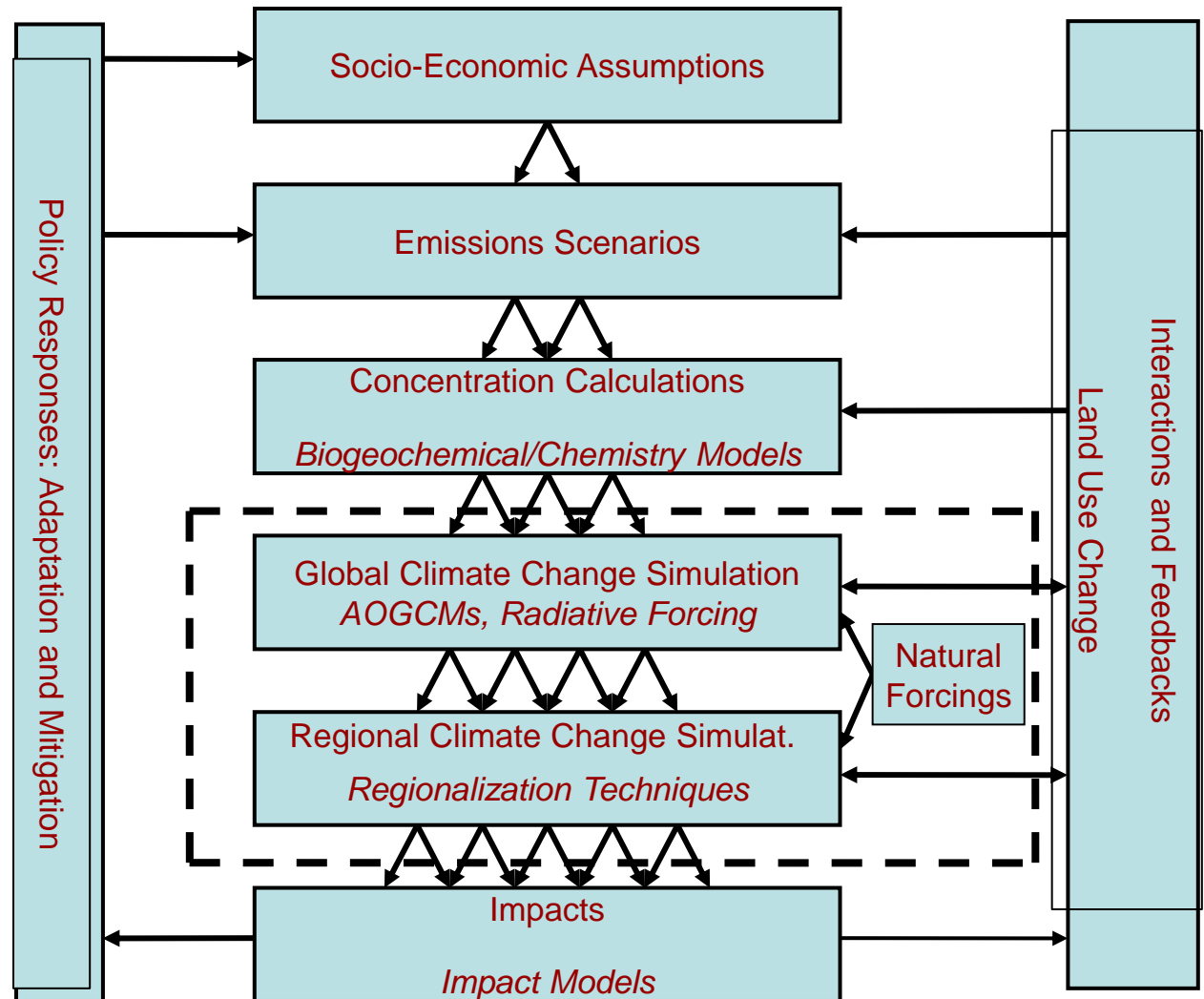
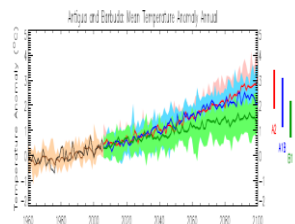
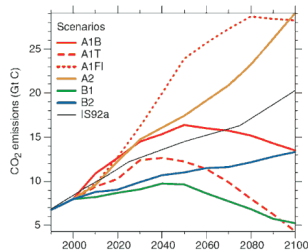
# Representing Future Climate Uncertainty



The purpose of climate prediction is to reconstruct as closely as possible the **PDF** of possible future climates reflecting the different uncertainty sources. Climate change prediction needs to be approached in a **probabilistic way, using multiple models/ensembles.**

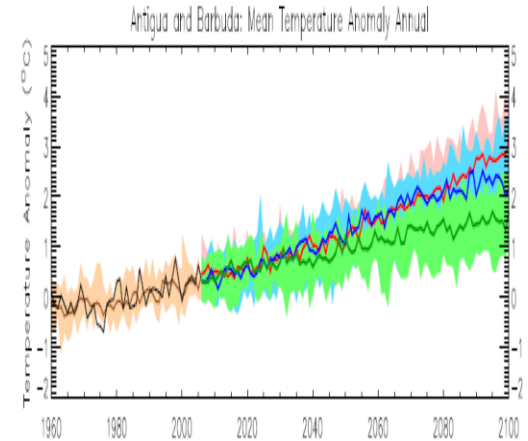
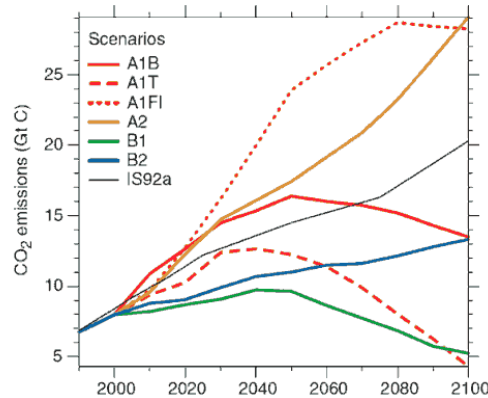


# Cascade of uncertainty in climate change prediction



# Summary

Then you have scenarios...



**Models** +

**Scenarios** =

**Futures**  
reflecting  
the different  
uncertainty  
sources.

**Thank You**