PRIMAVERA

PRocess-based climate sIMulation: AdVances in high-resolution modelling and European climate Risk Assessment

Climate predictions and projections

A climate prediction or climate forecast attempts to produce a most likely description or estimate of the actual evolution of the climate in the future, at lead times of months to decades ahead. A climate projection is the response of the climate system to different future greenhouse gas (GHG) scenarios, often based upon simulations by climate models. The emission or concentration scenario used to make the projection is based on assumptions, that ultimately may or may not be realized. Within PRIMAVERA we focus on climate projections.

Climate prediction

A climate prediction or forecast is a statement about the future evolution of the climate system, encompassing both internal variability and changes due to the increases of GHGs. Climate predictions do not attempt to forecast the actual day-to-day changes of the system. Instead they try to predict whether seasonal, annual or decadal averages or extremes will be higher, lower or the same as climatological averages. These predictions can be given for a particular location, region or for the global average. While seasonal forecasts are routinely issued in many regions, climate predictions at longer time-scales (decadal) are currently more of a research activity, although the operational systems are being advanced, e.g. within the CMIP6 climate modelling community and the MiKlip project. In the same way as weather forecasts depend on the ***initial state*** of the atmosphere (the weather of tomorrow is very dependent on the weather of today), climate predictions depend on an accurate description of the initial state, mainly in the oceans (Figure 1), and are limited to timescales from (sub)seasonal to decadal.

Climate projection

In contrast to predictions, projections are not initialized using observations for the current situation. They typically start their simulations in the past, ranging from pre-industrial, to 1950 or even more recent times. These historical simulations are driven (or forced) by estimates of past human-induced and natural climate forcing agents (concentrations of GHGs), and the projections are obtained by forcing the climate models with scenarios for future GHG emissions or concentrations. These GHG emission or concentration scenarios are called the ***boundary conditions*** under which the simulations take place (Figure 1). In former days the SRES scenarios (Special Report on Emission Scenarios) were used and since the IPCC Fifth Assessment Report (2013), the Representative Concentration Pathway (RCP) scenarios have been used for climate projections. Climate projections often simulate the future climate until 2100 or even beyond.

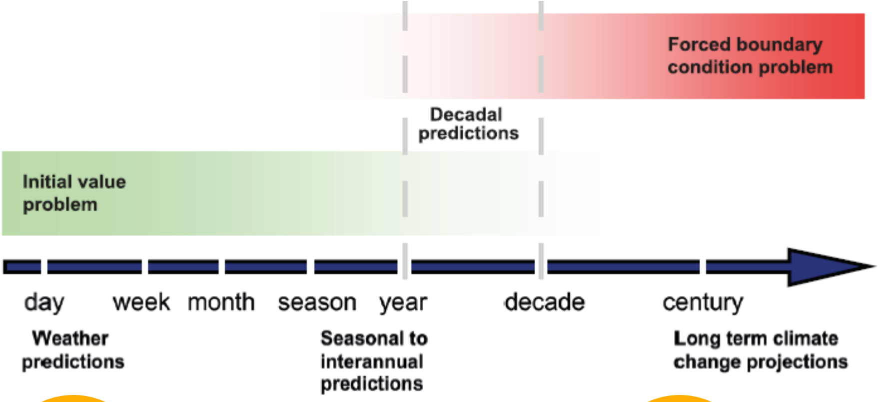

Figure 1. A schematic illustration of the factors influencing the representation of the climate system in models at different prediction/projection lead times: from an initial-value based prediction at short time scales to the forced boundary condition problem of climate projections at long time scales (Based on Meehl et al., 2009).

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Info

Media

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PRIMAVERA is a collaboration between 19 leading European research and technology organisations with complementary expertise in climate science, climate change modelling, and high performance computing.

The project is led by the Met Office and the University of Reading.

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S2D

The gap between weather forecasts (up to 2 weeks ahead) and climate projections (decades ahead) is filled in by (sub)seasonal-to-decadal (S2D* see note below) predictions, also known as climate predictions. A range of stakeholders (e.g. from insurance, tourism, agriculture, energy) is interested in forecasts with some measure of probability for time scales ranging from a month to a decade into the future. Figure 2 gives some examples of applications in the fisheries sector, and their time horizons of interest.

Difference between predictions and projections

Forecasts or predictions indicate ***what will happen probably*** in some time in the future in a certain location or region. Model-based weather forecasts, depending on locations, may have limited reliability beyond a week, because the atmosphere is an inherently chaotic system. Small changes in observed initial conditions, which are fed into the model regularly, can produce completely different weather forecasts a week into the future, because the atmosphere is so dynamic. This is called the initial value problem (see Fig. 1).

In a ***climate projection***, climate variables are generated for every day, but we cannot rely on the output for a given day being correct so far into the future. Instead, we are interested in questions such as whether the ***long term statistics*** are correct ***for a given location and/or season***. This does not depend on the initial conditions of the simulation – it depends on the parameters in the model itself and the provided forcings such as GHGs (boundary condition problem – see Fig. 1).

At lead times of weeks to seasons ahead, predictions are especially initial value problems. Climate predictions such as seasonal outlooks, El Niño forecasts, and seasonal hurricane outlooks fall into this category. The initial value is represented by the initial states of the climate system, including ocean heat content, and surface snow and ice cover. For annual to decadal predictions both the initial values and the boundary conditions are important (Fig. 1).

Within PRIMAVERA we focus on climate projections.

* Although conventionally S2D indicates seasonal to decadal time scale, we are using S2D here to mean (sub)seasonal to decadal time scale.

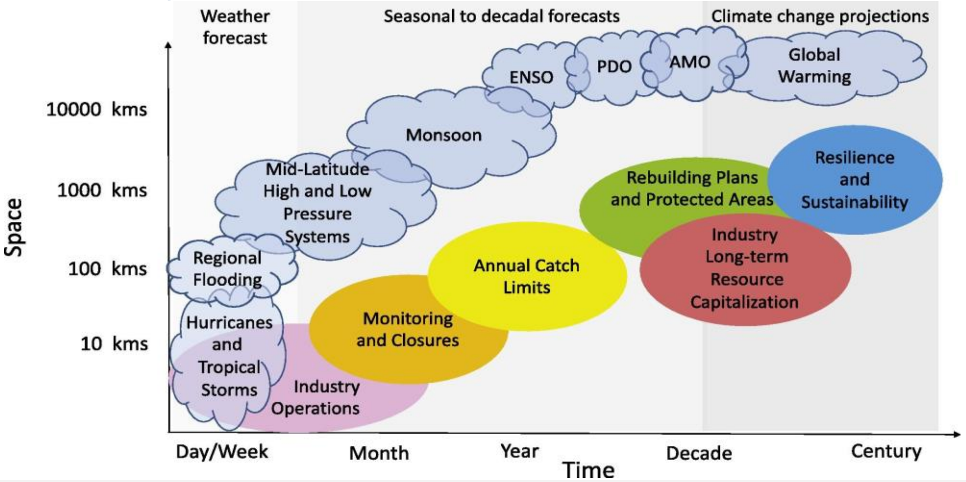

Figure 2. Temporal and spatial scales of fisheries decisions (circles) and atmospheric weather phenomena (Tommasi et al., 2017).

References

IPCC, 2013. Climate change: the physical science basis. WG1, Fifth Assessment Report

Meehl et al., 2009. Decadal Prediction: Can It Be Skillful? Bull. Amer. Meteorol. Soc., Oct. 2009 p. 1467-1485.

PRIMAVERA factsheet on “Types of uncertainties”

Tommasi et al., 2017. Managing living marine resources in a dynamic environment: The role of seasonal to decadal climate forecasts. Progr. in Oceanography, Vol. 152, p.15-49.

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