Technical content: medium

SPECS Fact sheet 4

Climate prediction with multiple sources of information

March 2015

Most decisions in life require a process of weighing up and synthesizing information/advice from a variety of sources. For example, selecting a hotel from trip advisor reviews, or deciding on a medical treatment option following differing opinions from several medical doctors. Synthesising information on prospects for the next season or decade ahead is no exception. Predictions are available from numerous centres each running sophisticated computer models of the climate system. Each model may give valid advice on future climate prospects, but because the model construction and procedural details differ between centres the advice they give is often different. To generate a single consolidated prediction we can combine the predictions from all models. An essential step in this is to interpret each model's prediction in light of its past performance – a process known as calibration. It is rather like using trip advisor – if we know one reviewer gives valid reviews but tends to be over critical, we can make an adjustment (i.e. a calibration) when we weigh that reviewer's advice together with that of other reviewers (which we should also calibrate).

A consolidated, single climate prediction can be obtained by calibrating and combining all contributing predictions to obtain a unified view.

Why do physically based dynamical model predictions need calibration?

As a simplified representation of the real world, physically based dynamical models are far from perfect, meaning that their predictions for the future may deviate from what is observed to occur. Nevertheless if the deviations are systematic in some sense – like the reviewer who was systematically too critical – this can be corrected for and the predictions are still useful. Consider Figure 1. The climate of the real world is represented by the grey ellipse and a real world timeline, indicated by a sequence of events (e.g. several sequential monthly rainfall totals), is represented by the dashed red line - from an initial time t=0 to a later time t=T. Model 1´s climate is represented by the orange ellipse. It may be seen that Model 1's "view of the world" is not truly aligned with reality – the orange ellipse is displaced relative to the grey one. This has impacts on Model 1's predictions. Three ensemble predictions (orange lines) for the observed sequence are shown – all displaced from reality (red dashed line) in the same sense as the ellipse. Thus Model 1's predictions need to be calibrated. We can use what we know about Model 1's errors in its view of the world (e.g. the direction and amount of displacement in the ellipse) to adjust each new prediction made with the model. Model 2 also needs some calibration to adjust for a different set of systematic errors – note different displacement of the ellipse. In real terms the calibration (adjustment) procedure is performed by comparing past model predictions (of the order of 15 or more past years) with the corresponding past observations.

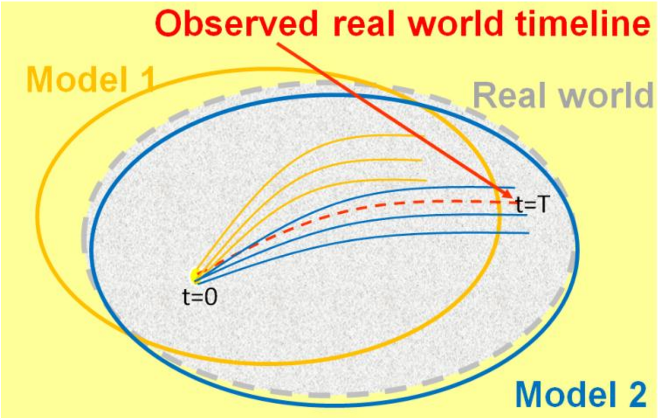

Figure 1: Illustration of climate model predictions produced by two climate models.

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Why combining predictions from different models?

Different models have different abilities to predict the observed climate in distinct climate situations and regions (i.e. models prediction abilities can be complementary). For example, for a particular climate situation and region one model may be better able to reproduce the observed climate than another. However, the best model is not always the same model (i.e. prediction ability depends on many factors). Besides, the relatively short historical model predictions currently available prevents an unequivocal identification of the best model. So combining predictions from different and complementary models helps improve our predictive ability without needing to know in detail the ability dependencies of all models, which is very complex. All these facts, plus the empirical evidence that on average it is better to use multiple sources (as when one seeks diagnostics from different medical doctors), makes the combination of different climate model predictions advantageous and advisable.

An example of current multiple source climate prediction practice

Mathematical procedures can be used to produce a consolidated (or integrated) prediction by combining the multiple information sources currently available, including empirical and physically based dynamical models. As discussed, different prediction methods may be complementary in terms of their predictive ability. In climate prediction it is common to give equal importance to all prediction sources, although experience built in collaboration with users might help assigning distinct relative importance to a reduced number of information sources. Figure 2 illustrates an integrated (calibrated and combined) precipitation seasonal prediction for South America produced by consolidating one empirical and three European coupled ocean-atmosphere physically based dynamical models (ECMWF System 4, Météo-France System 4 and UK Met Office GloSea5) into a unified view.

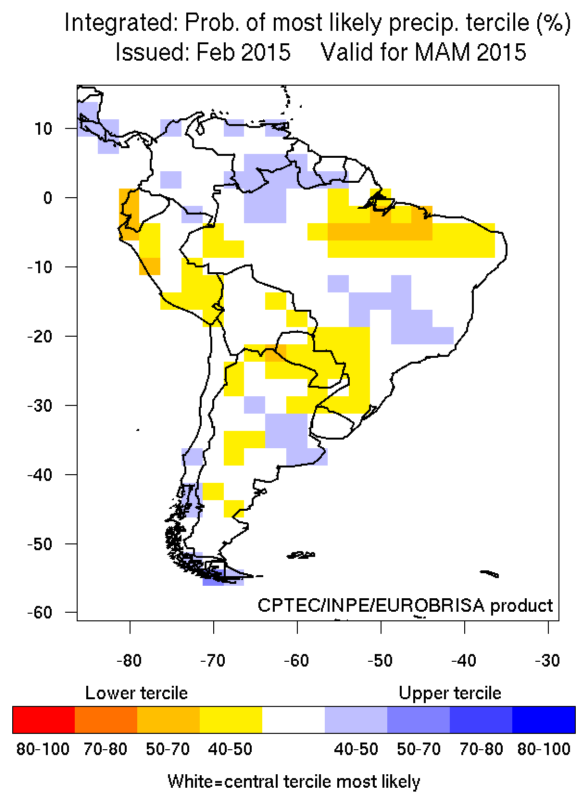

Figure 2: Illustration of integrated seasonal precipitation prediction for South America produced in the context of EUROBRISA (A EURO-BRazilian Initiative for Improving South American seasonal forecasts, http://eurobrisa.cptec.inpe.br), which is currently supported by SPECS. Excess (deficit) precipitation is predicted as most likely over the regions in blue (yellow and orange). This is an example of probabilistic prediction. Seasonal forecasts are sometimes also presented as deterministic predictions, normally giving by the ensemble mean (i.e. the average) of a collection of climate model predictions.

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