Producing decadal predictions using HadCM3 (James Murphy and Doug Smith, Met Office, September 2004)

This note briefly summarises a methodology used to produce a recent set of experimental decadal hindcasts using HadCM3.

In order to generate initial conditions for hindcasts HadCM3 was run in assimilation mode continuously from 1st January 1979 until 1st December 1993. This period was chosen because the ECMWF reanalyses (ERA15) data, which are needed for initialising the atmosphere, are available. Hindcasts were started on 1st March, June, September and December in each of the 15 years. Each hindcast was run for 10 years and consisted of an ensemble of 4 members initialised from the hindcast start date plus the three preceding days.

The assimilation run was started from from the "all forcings" (or "all bells and whistles" (ABW)) simulation described by Stott et al (2000). By including variations in greenhouse gases, anthropogenic sulphur emissions, tropospheric and stratospheric ozone, total solar irradiance and volcanic aerosol, the ABW simulation achieves a very credible reproduction of the observed variability in near surface air temperature throughout the twentieth century. The forcings in the assimilation run were the same as in the ABW simulation. The forcings in the hindcasts were also the same as in ABW, following the SRES B2 scenario. Exceptions to this are the solar irradiance and volcanic aerosol, which would not be known accurately for true predictions. The solar irradiance in the hindcasts was estimated by repeating the previous 11 year solar cycle (Lean et al, 1995), and the volcanic aerosol was specified to decay exponentially from the value at the start of each hindcast with a time scale of one year (Sato et al, 1993). This means, for example, that the effects of the Mt Pinatubo eruption were included in hindcasts started after the eruption, but not in hindcasts started before.

In assimilation mode both the atmosphere and ocean were initialised with observations. Observations were assimilated as anomalies with respect to the model climate in order to minimise climate drift when the assimilation is switched off. The model climate was obtained from the ABW simulation.

In the atmosphere, 6 hourly ERA data consisting of surface pressure together with theta and u and v wind components on each model level were assimilated. Relative humidity was not assimilated because doing so was found to introduce large biases in the surface fluxes (here bias is measured relative to the climatology of the HadCM3 when run without assimilation of observed anomalies).

In the ocean, monthly mean analyses of temperature and salinity on each model level were assimilated. These analyses were created by four-dimensional multivariate optimal interpolation of salinity and subsurface temperature observations from the World Ocean Database 2001 (Conkright et al, 2002) and sea surface temperature from HadISST (Rayner et al, 2003). Covariances required by the optimal interpolation were computed locally from the ABW HadCM3 integration (Smith et al, 2004).

We assimilated both the atmosphere and ocean data using a simple scheme in which model fields were linearly relaxed towards the analysed observations (interpolated to the model timestep). We used a relaxation timescale of three hours in the atmosphere and six hours in the ocean.

References

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