Monthly forecasting at ECMWF

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1. The ECMWF monthly forecasting system

The main goal of the ECMWF monthly forecasting system is to produce forecasts from day 10 to day 30, in order to fill the gap between the medium-range forecasts and the seasonal forecasts. Therefore, the monthly forecasting system has been built as a combination of the medium-range EPS and the seasonal forecasting system. It contains features of both systems and, in particular, is based on coupled ocean-atmosphere integrations, as is the seasonal forecasting system.

The ECMWF monthly forecasts are based on an ensemble of 51 coupled ocean-atmosphere integrations (one control and 50 perturbed forecasts). The length of the coupled integrations is 32 days, and the frequency of the monthly forecasts is currently every 2 weeks. The atmospheric component is IFS, with the same cycle as ECMWF operational forecast. Currently, the atmospheric model is run at TL159 resolution with 40 vertical levels in the vertical. The oceanic component is the same as for the current ECMWF seasonal forecasting system based on HOPE from MPI. The ocean and atmosphere communicate with each other through a coupling interface (OASIS from CERFACS). The atmospheric fluxes of momentum, heat and fresh water are passed to the ocean every hour.

The 51-member ensemble is generated by perturbing the atmospheric initial conditions using singular vectors (in the extratopics but also in some tropical regions) and the oceanic initial conditions by applying SST perturbations to 5 different ocean analyses. In addition, stochastic perturbations are applied throughout the atmospheric integrations. In order to calibrate the system, a 5-member ensemble hindcast is run with the same starting day and month as the real time forecast for each of the past 12 years.

2. Verification

The ECMWF monthly forecasting system is running every 2 weeks since March 2002. Products include anomaly, probability and tercile maps of 2-meter temperature, surface temperature, mean sea-level pressure and precipitation averaged over 4 weekly periods (days 5-11, days 12-18, days 19-25 and days 26-32). 30 real-time cases have been verified.

For all 30 real-time cases, the anomaly correlation and RMS scores of the ensemble mean have been calculated, along with probabilistic scores such as Brier skill scores, ROC areas or potential economic value.

Results suggest that during the 10 first days of the forecast, the skill of the monthly forecasting system is close to that of the EPS. Over the period days 12-18, the monthly forecasting system produces forecasts that are generally better than climatology or persistence (see example in Figures 1 and 2). Therefore, the monthly forecasting system is probably useful for forecasts at this time-range. Summer seems to be a difficult season as in the medium-range and probabilistic scores over Europe are generally lower than over other regions like North America or Asia.

During the two following weeks (from day 19 to day 32), the coupled model performs generally better than persistence. At this time range, the model's skill increases with higher thresholds. The model displays some skill over some areas like North America and the Southern Extratropics.

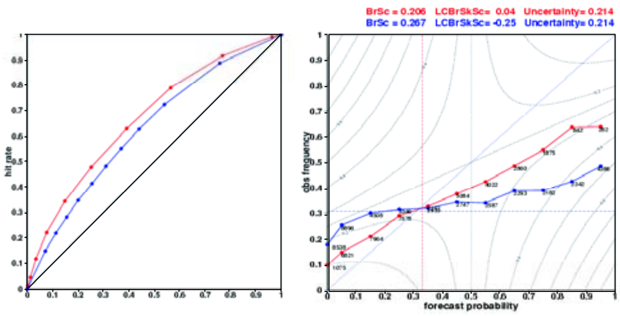

Figure 1: ROC (left panel) and reliability (right panel) diagrams of the probability that the 2-metre temperature is in the upper tercile. Only land points in the Northern Hemisphere have been considered. The red curves represent the diagrams obtained with the monthly forecasting system. The blue curves (closest to the diagonal in the left panel and the most horizontal in the right panel) correspond to the diagrams obtained by persisting the anomalies from the previous week (days 5-11). For the ROC diagram, the closer the curve is to the top left corner, the better is the forecast. For the reliability diagram, the closer the curve is to the diagonal, the most is reliable the forecast.

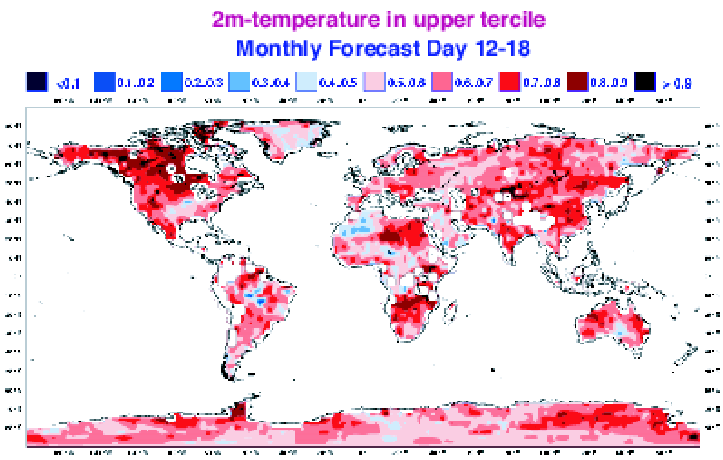

Figure 2: Map of ROC areas of probability that the 2-metre temperature anomaly is in the upper tercile. The verification period is March 2002-May 2003. The red color-scale corresponds to ROC scores higher than 0.5 (better than climatology). The blue color-scale corresponds to ROC scores lower than 0.5 (worse than climatology). In this figure, the red colour is largely dominating, indicating that the model performs better than climatology at this time-range(for colour graphics, see the version of this paper on the web).