Overview of BoM Operational S2S Ensemble Prediction Systems and Future Plans

Harry H. Hendon

Bureau of Meteorology Researc Program, Melbourne Australia

hhh@bom.gov.au

Abstract

The Bureau of Meteorology's S2S operational ensemble prediction system is described. Performance and ensemble products are reviewed. Plans for upgrades during the next 5 years are described.

1 Introduction

The operational S2S prediction system at BoM was upgraded in 2018 from the low resolution POAMA system to the high resolution ACCESS-S1 system. ACCESS-S1 is based on the UKMO GC2 coupled model and is similar to an earlier configuration of their GloSea5 system. The model components, hindcast set, and performance are detailed in [1].

2 ACCESS-S1 Model Description

The GC2 model is based on the UM Atmosphere Unified Model that is configured as GA6. It has 60km resolution and 85 vertical levels. The ocean model is based on NEMO ORC25, with 25 km resolution and 75 levels. The land surface model is JULES. See [1] for details of other model components.

Initial conditions for sea ice and the ocean for both hindcasts and real time predictions are provided by the UKMO and are based on NEMOVAR. Atmospheric and land surface temperature initial conditions for the hindcasts are based on ERA-Interim reanalyses. In the real time setting, they are taken from the BoM NWP system, which is based on a similar 4dVar as run at the UKMO. Soil moisture is initialized to climatology.

Hindcasts are produced 4 times per month during 1990-2012. An 11 member ensemble is used (details below). In the real time system, 33 ensemble members are run every day. The 33 member ensemble in real time is run to 2 month lead. 11 members are extended to 6 month lead time.

Ensemble perturbations are provided only for the atmosphere. Perturbations are generated by randomly sampling 10-day differences from reanalyses for U, V, T, and q. The idea of this ad-hoc approach is to provide perturbations that have structure typical of error growth in the first ~10 days of the forecast. The magnitude of the perturbations is scaled so that they have, in a root mean square sense, amplitude equivalent to observational uncertainty, which we define as the rms difference between daily sea level pressure analyses from ERA-Interim and NCEP Reanalyses. Although this approach is ad-hoc and will be replaced by the perturbations provided from a future version of our coupled ensemble assimilation method, they produce a reasonably reliable ensemble during forecast days 1-30.

Ensemble products for the real time predictions are created using 99 ensemble members. This is created by forming a lagged ensemble from the previous 2 days (33 members from 3 starts, one day apart). For the seasonal forecasts, a similar 99 member ensemble is created by using starts from the previous 8 days (11 members from 9 start times, one day a part).

3 Performance and Products Subsection

An assessment of forecast skill based on the hindcasts is provided in [1]. In general, forecast skill for a wide range of measures is improved compared to POAMA. This is especially true for forecast days 1-30, which we attribute primarily to improved atmospheric initial conditions for ACCESS-S1 compared to POAMA that had lower resolution and used a nudging method to initial the atmosphere.

Although the skill for predicting the MJO is improved in the first week compared to POAMA, the limit of predictive skill is a similar ~25 days as for POAMA. Regardless, this places the ACCESS-S1 model as the second best system (ECMWF is first) for prediction of the MJO. Similarly, prediction of the SAM is improved for days 1-30 compared to POAMA. ACCESS-S1 also provides a realistic depiction of coupling between the polar stratospheric vortex and the surface. Although not a key focus in S2S prediction, ACCESS-S1 also display a significant increase in skill for predicting ENSO for forecasts across the boreal spring.

A variety of ensemble forecast products are created from S1. For Australia, we calibrate daily temperature, rainfall, windspeed, and humidity using a quantile matching approach. These calibrated products are used as inputs to physical models of such things as pasture growth, streamflow, and livestock production. Forecast products include probability of extreme occurrences (e.g., probability of weekly mean temperature in the upper decile), meteograms, and tercile probabilities for rainfall and temperature.

4 Future Plans

ACCESS-S2 will replace S1 in early 2021. The GC2 model version will remain unchanged. The key change will be implementation of ocean assimilation at BoM, which will be a static ensemble optimum interpolation scheme operating in a coupled model environment. This switch to local ocean assimilation is necessitated to break the dependence on UKMO for ocean initial conditions. Because the assimilation will be running within the coupled model, this method also provides a consistent initialization of the land surface. Initial assessment of hindcasts indicates similar or slightly improved prediction over ACCESS-S1. Hindcasts for S2 are expected to be completed by middle of 2021. The hindcast set will extend from 1980-2018 in order Proceedings of the EMMDA International Conference (EMMDA–2020), NCMRWF (MoES), Noida, 24-26 February, 2020 to better sample ENSO, IOD, the MJO and polar stratospheric variability.

The first major upgrade will be for ACCESS-S3. This will include an upgrade of the model to GC4 (or possibly GC5). A more comprehensive coupled model ensemble assimilation will also be implemented, which will assimilate ocean temperatures and salinity observations into the coupled model. Atmospheric reanalyses will still be used to initialize the atmosphere. An ensemble of coupled model perturbed initial conditions will naturally be produced by this new approach. ACCESS-S3 will probably retain the same resolution as S1. Hindcasts are expected to begin in later half of 2021.

References

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