Recent Development in the NCEP/EMC global modeling branch for 2001

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1. Major implementations

During 2001, the EMC Global Modeling Branch completed two major implementations that have contributed to significant improvements to the operational forecasts using the Medium-Range Forecast (MRF) model. We will describe the changes made and the impact to the skill of the forecasts.

On 13 February 2001, we started to ingest the following satellite data: NOAA-16 AMSU/A and AMSU/B radiances, NOAA-15 AMSU/B radiances and GOES-10 radiances. In addition, we also started to assimilate precipitation estimates from the SSM/I satellite and the HIRS channel 12 over land. The AMSU/B data provide us significant information on the mid and upper troposphere water vapor field. While the impact to the forecast is marginally favorable, we feel that this implementation has improved our ability to assimilate all observations in the tropics and has led to more realistic analysis of the tropical circulation.

On 15 May 2001, we changed the MRF model to include a prognostic equation for cloud water and ice. This change is based on the version implemented in the eta model a few years ago by Zhao and Carr. In addition to the separate condensation and precipitation algorithm, we also made extensive changes to the radiation physics such that the optical path and the emissivity calculations are based on the predicted cloud water and ice. The convection parameterization scheme is also modified to detrain cloud water/ice in addition to water vapor. In order to ensure a more realistic cloud water distribution in the tropics, we also modified the convection scheme to generate randomly selected cloud tops. This set of changes has a dramatic impact on the circulation forecasts of the summer hemisphere. It also led to minor improvement in the winter hemisphere circulation forecasts.

In addition to the cloud water package, we have also included a change to the convection scheme. The reason for the change is a need to reduce the false alarm tropical storm predictions in the MRF forecasts. The inclusion of the cumulus momentum exchange in the convection package led to a dramatic reduction of the false alarm storms while preserving most of the real storms. While the pressure gradient effect of the momentum exchange package is very crudely parameterized as an entrainment effect, this package was included with the cloud water package. We plan to further improve the momentum mixing in the future.

2. Primary impacts

In Fig. 1, the frequency distribution of the 5-day anomaly correlation scores for the period July-September 2001 for both hemispheres is shown. It can be seen that the majority of the forecasts verified in the .6 to .9 ranges with few if any forecasts below the .6 mark. The key to medium-range forecasts for all operational centers these days is to be consistent in the day-to-day skills. It is particularly difficult to do this for the summer hemisphere as convection plays a bigger role in the forecasts.

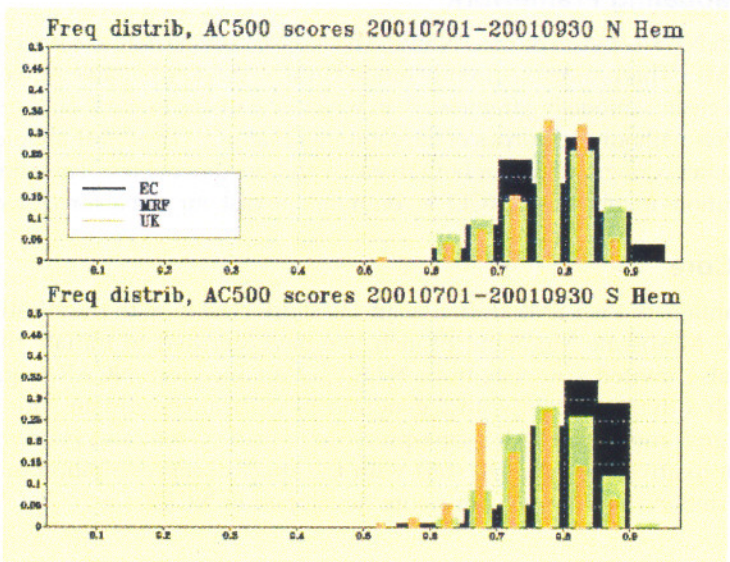

Fig. 1

In Fig. 2, we show two 132-hour forecasts for the tropics from the 0000 UTC 22 September 2001 initial condition. The first forecast is with the cumulus momentum mixing turned off (Fig. 2a) and the second with the mixing scheme turned on (Fig. 2b). It can be seen that there are three tropical storms in Fig. 2a and only one in Fig. 2b. It turns out that the only storm developed in reality is the one in Fig. 2b. While it is very difficult to determine the reason the cumulus momentum mixing stops certain storms from forming, it is likely that the modification of the vorticity fields near the vicinity of the convection altered the feedback between heating and the circulation. This aspect of the model change deserves much scrutiny in the future.

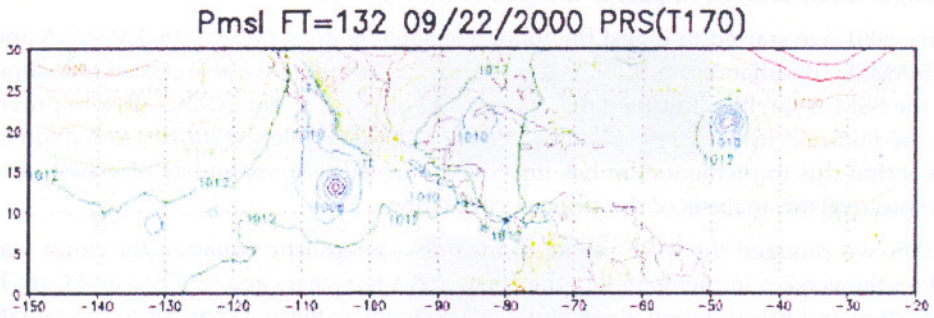

Fig. 2a

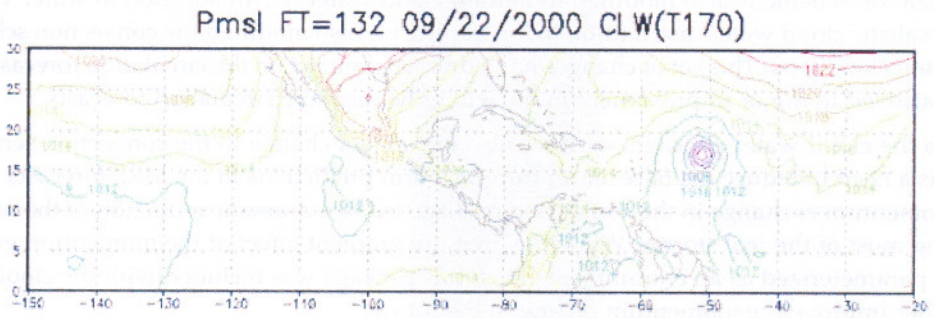

Fig. 2b

3. Other implementations

A T62 version of the MRF with several different physical parameterizations is now running routinely at NCEP making monthly predictions out to seven months. This version of the model is called the Seasonal Forecast Model (SFM) and is used to provide information to the Climate Prediction Center (CPC) forecasters for monthly and seasonal predictions. A set of 21-year hindcasts is also run to provide calibrations for the seasonal predictions.

4. Earth System Modeling Framework

NCEP is collaborating with NASA/DAO, NASA/NSIPP, MIT, GFDL, and NCAR in a project to create an Earth System Modeling Framework (ESMF). This project is currently funded by a NASA Cooperative Agreement Negotiation contract. The idea of the ESMF is to create a modeling framework in which scientists can work on the scientific issues of the complicated earth system models without the worries of the computer platform. The ESMF should provide efficient message passing for different computer configurations for both research and operational use. This should allow for better collaborations amongst all institutions involved and NCEP is committed to cast our global forecast system into this framework.

5. New Dynamic Core

In order to take full advantage of the ESMF initiative and to work closely with the Weather Research and Forecast (WRF) effort in the EMC Mesoscale Modeling Branch, we have decided to initiate the development of a new dynamic core. We have also invited scientists from NASA/DAO and from NCAR to participate in the development. We plan to develop a dynamic core with a generalized vertical coordinate. This will allow us to move in steps from the current sigma coordinate to a sigma-pressure hybrid system and possibly to a sigma-theta hybrid system. For horizontal derivatives, we plan to start with the spectral representation but test the semi-Lagragian system currently been tested in the WRF dynamic core developed in NCEP.

References

Zhao, Q, and F. H. Carr, 1997: A prognostic cloud scheme for operational NWP models. *Mon. Wea. Rev.* **125**, 1931-1953