Development and Implementation of Dynamic Scripts to Execute Cycled GSI/WRF Forecasts

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BACKGROUND

- The Weather Research and Forecasting (WRF) numerical weather prediction (NWP) model and Gridpoint Statistical Interpolation (GSI) data assimilation (DA) are the operational systems that make up the North American Mesoscale (NAM) model and the NAM Data Assimilation System (NDAS) analysis used by National Weather Service forecasters
- The Developmental Testbed Center (DTC) manages and distributes the code for the WRF and GSI, but it is up to individual researchers to link the systems together and write scripts to run the systems, which can take considerable time for those not familiar with the code
- Objective of this project is to develop and disseminate a set of dynamic scripts that mimic the unique cycling configuration of the operational NAM (Fig. 1) to enable researchers to develop new modeling and data assimilation techniques that can be easily transferred to operations
- The current version of the SPoRT GSI/WRF Scripts (v3.0.1) is compatible with WRF v3.3 and GSI v3.0

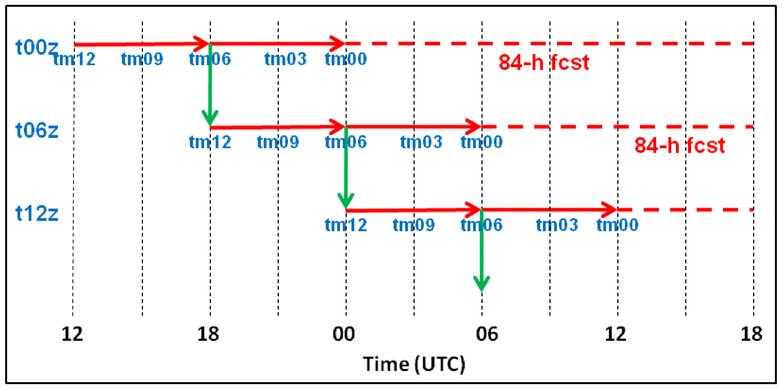

Figure 1. Schematic of NAM cycling system (DiMego, personal communication) employed by the SPoRT GSI/WRF Scripts.

APPLICATIONS

- The SPoRT GSI/WRF Cycling Scripts have been used by a number of collaborators to learn how to easily run GSI and link with WRF
- The following projects all are working in the operational NAM framework to demonstrate either a new dataset or assimilation technique

1. TESTING GSI SOURCE CODE CHANGES (SEE JCSDA 774)

- Adding new quality control procedure in to increase the yield of satellite radiances assimilated into GSI by swapping cloud top pressure (CTP) from MODIS for CTP that is generated internally by GSI (see Fig. 3)

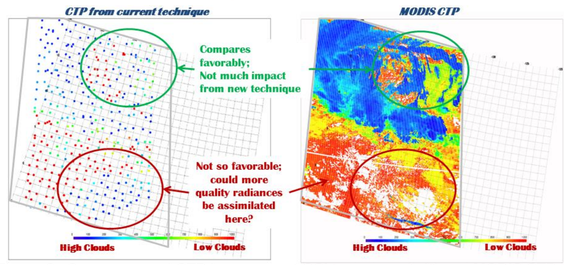

Figure 3. Comparison of CTP from current GSI technique (left) and MODIS CTP (right).

2 ASSIMILATING CrIS OBSERVATIONS (SEE WAF/NWP J8.6)

- Retrieved profiles from the Cross-track Infrared Sounder (CrIS) represent the next generation of hyperspectral observations
- Scripts are being used to investigate impact of these soundings on non-convective wind events
- Initial results indicate impact of use of CrIS profiles on forecasts (see Fig. 4)

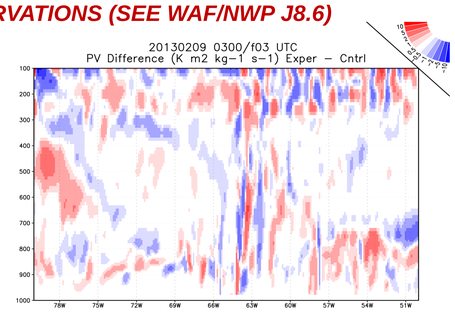

Figure 4. Potential vorticity differences between WRF forecasts with and without hyperspectral profile data to diagnose the impact of these new datasets on specific model forecasts

3. DUAL-POL RADAR ASSIMILATION (SEE WAF/NWP J8.1)

- Dual-polarimetric radar are the next generation of radar measurements
- Currently, only reflectivity and velocities are assimilated in DA systems but dual-pol adds a number of other variables that can aid in NWP of short-term, mesoscale
- Goal of this project is to assimilate dual-pol radar data from the upcoming NASA Global Precipitation Measurement Mission

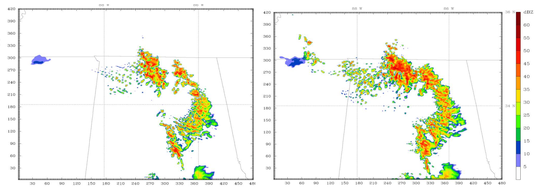

Figure 5. 2-h reflectivity (dBZ) forecast valid at 0800 UTC 2 September 2013 with (left) and without (right) assimilation of dual-pol variables

4. REAL-TIME FORECASTS TO SUPPORT LAUNCH OPERATIONS

- The NASA Applied Meteorology Unit is using the GSI/WRF scripts to run a real-time, high-resolution model over the Eastern Range (ER) and Wallops Island Flight Facility to support flight and launch operations
- Larger scale models do not resolve important mesoscale features and scripts are configured to match local weather challenges

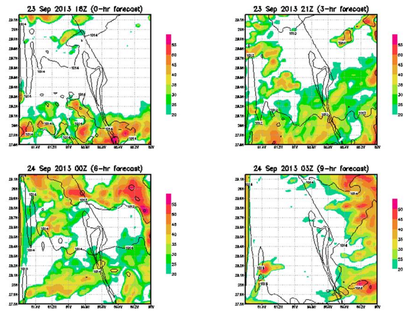

Figure 6. Simulated radar reflectivity (shaded, dBZ) and MSLP (contour, hPa) for a rain event over the ER initialized at 1800 UTC 23 September 2013.

CODE INFRASTRUCTURE

- Open source scripts written in Perl with included modules
- Able to run either ARW or NMM with either NAM or GFS BCs
- User configures WRF domain, run dates/times, and other options in runnamelist.sport.gsiwrf file and scripts generate proper namelist files for running WPS, GSI, and WRF (see Fig. 2)
- Nested domains for the final forecast (tm00) can be configured; data assimilation is performed only on outermost domain

runnamelist.sport.gsiwrf

- User configures specifics of run including WRF domain(s) and run dates/times
- Read into each Perl program to configure namelists for WPS, REAL, GSI, and WRF

driverSPoRTGSIWRFScripts.pl

- Program that is executed to run script package
- Manages the cycling dates/times as defined in the runnamelist.sport.gsiwrf file

Passes cycle and valid date/time to other programs

runWPS.pl

- Links static files needed to run WPS and WRF
- Copies large-scale model files from modelData directory and preprocesses
- Configures namelist.wps and namelist.input from templates using information passed from runnamelist.sport.gsiwrf and runs geogrid, ungrib, metgrid & real

runGSI.pl

- Links obs from BUFRObs directory and satellite files
- Configures gsiparm.anl from template and runs GSI
- Background, analysis, and diagnostic files are all archived for future investigation of observation and analysis impacts

runWRF.pl

- Configures namelist.input from template and runs WRF
- For pre-cycle, forecast file is saved in a separate directory that is then accessed for the next cycle
- Final forecast files are compressed and archived

Passes wrfinput_d01 at first cold start; otherwise pulls previous forecast for use as first guess

Passes GSI-updated ICs for WRF forecast (either next pre-cycle or long-term forecast)

Figure 2. Schematic of SPoRT GSI/WRF Scripts

HOW DO I GET THE SCRIPTS?

- ftp://geo.nsstc.nasa.gov/SPoRT/modeling/GSIWRFScripts or scan the QR code below
- User must first download and compile WRF and GSI source code from DTC (http://www.dtcenter.org)
- If you plan to use the scripts for your research please acknowledge NASA SPoRT as the script developers
- Contact Brad Zavodsky (brad.zavodsky@nasa.gov) for more information or if you have questions about the scripts and/or their use

ACKNOWLEDGMENTS

- These scripts were developed as part of a proposal funded by Tsengdar Lee through the Joint Center for Satellite Data Assimilation (JCSDA) and Short-term Prediction Research and Transition (SPoRT) Center
- Based off of cycling scripts originally written by Shih-Hung Chou (NASA/MSFC Ret.)