HFIP ENSEMBLE TEAM PLANS

Zoltan Toth (ESRL) zoltan.toth@noaa.gov

Carolyn Reynolds (NRL) carolyn.reynolds@nrlmry.navy.mil

Sim Aberson (HRD) Sim.Aberson@noaa.gov

Tom Hamill (ESRL) tom.hamill@noaa.gov

Jeff Whitaker (ESRL) Jeffrey.S.Whitaker@noaa.gov

Fuqing Zhang (PSU) fzhang@psu.edu

Yuejian Zhu (EMC) Yuejian.Zhu@noaa.gov

Jun Du (EMC) Jun.Du@noaa.gov

Mike Brennan (NHC) Michael.J.Brennan@noaa.gov

Mrinal K Biswas (FSU) Mrinal.K.Biswas@noaa.gov

Krish (FSU) tkrishnamurti@fsu.edu

GOALS

- Develop more reliable and useful automated probabilistic numerical guidance for hurricane track, intensity, structure, rainfall, storm surge, and other associated weather elements through improved ensemble forecasting systems and improved post-processing methods.

- Work closely with HFIP data assimilation group on development and use of ensemble-based data assimilation techniques for initializing ensemble predictions.

- Work with verification team on developing and using ensemble / probabilistic measures

- Work with Products Team to develop ensemble / probabilistic products

FY09 Accomplishments: Overview

- ESRL: EnKF-FIM ensembles (20-member 30km, on TACC) outperformed NCEP and UK operational ensemble for limited 2009 case set.

- NCEP: GFS T574 (23km) 5-member ensembles run on TACC. Promising results for new GEFS.

- CIRA/EMC: MLEF-HWRF is interfaced with the HWRF system and with the GSI observation operator .

- NRL: NOGAP resolution experiments for 2008 almost complete. T239 (55km) ensembles for 2008-2009 underway.

- AOML: Work on evaluation of global model impact on regional model ensemble spread, development of algorithms for ensemble evaluation.

FY10: Specific Objectives

- Test/compare different methods of initialization (initial conditions, lateral boundary conditions), including the ensemble Kalman filter (EnKF) approach. Work closely with DA group to develop methods of initial perturbations that are consistent with analysis uncertainty.

- Test new methods for representing the effects of model errors on ensemble predictions

  - Run ensembles at increased resolution (and examination of tradeoffs vs. ensemble size, domain size). Evaluate and compare high-resolution ensembles from different systems.

  - Develop physically based treatments of model-related uncertainties, including stochastic perturbations (stochastic convection, stochastic kinetic energy backscatter, stochastic sea spray).

  - Evaluate skill of ensembles of ensembles.

- Post-processing (in conjunction with verification team and application development/diagnostics team).

  - Apply statistical post-processing methods to ameliorate ensemble deficiencies

  - Develop tailored products of use to forecasters and develop metrics for ensemble evaluation.

  - Improve the method of determining a model consensus.

Extracts from HFIP
Data Assimilation Team Plans

Jeff Whitaker, lead

NOAA/ESRL/PSD

jeffrey.s.whitaker@noaa.gov

DA/Vortex initialization milestones, FY10

- Perform a detailed evaluation of integrated global and regional advanced data assimilation systems for hurricane prediction, using the current operational systems as a baseline. This includes testing an integrated global/regional EnKF system for GFS/FIM and HWRF/WRF-ARW. The evaluation of the global/regional EnKF systems is a joint milestone with the ensemble team.
    - Assess the value added by regional model assimilation by comparing the skill of track and intensity forecasts generated by the global model, and the regional model initialized from a regional analysis and driven by global model boundary conditions. (Stream 2)
    - Compare forecasts from NRL NOGAPS-based 4D-Var analysis with GFS-based EnKF ensemble-mean analysis (with ensemble team) report (Stream 2)

DA/Vortex initialization milestones, FY10

- Test methods for representing background errors associated with model uncertainty in EnKF systems, including multi-model, multi-parameterization ensembles and stochastic convection. This is a joint milestone with the Ensemble Team.
  - Preliminary test of stochastic convection parameterization to account for model error (with Ensemble team) report
  - Preliminary test of multi-parameterization ensembles (PBL and/or microphysics) for regional-scale EnKF system account for model error (with Ensemble team)

EXTRA SLIDES

NCEP Milestones

- Global ensembles (partly set up and run experiments):

  – High-resolution ensembles at TACC machine

- T574 (23km), 10 members (5 for GFS, 5 for FIM)

  – Test improved ensemble transform (ET) initial perturbations (FY10)

  – Test improved stochastic perturbations in physics (FY10)

- Improvement of NCEP SREF operational capability for hurricane forecast (Jun Du and Tim Marchok):

  – Continue to verify the SREF track forecast accuracy

  – Implement the GFDL's tropical cyclone tracking system to the operational SREF for NHC to use.

- High-resolution ensemble experiments for hurricane forecasts (Jun Du):

  – Build a NEMS-only high-resolution regional ensemble for hurricane tests; 10 km grid spacing; 10 members;

  – ET initial perturbations;

  – If resources allow, may test stochastic parameterized physics

- Post-processing for storm related forecasts:

  – Decompose gridded forecast errors into phase and amplitude component;

  – Evaluate, then correct bias for phase before amplitude corrections

ESRL Milestones (1)

- Work with AOML to adapt FIM/GFS EnKF code to HWRF.

  – Milestone: delivery of existing EnKF code to AOML (Jan 2010).

- Conduct sensitivity tests on 2009 EnKF initial conditions and forecasts; retrospective runs with/without bogus observations, comparison of FIM and GFS ensemble systems.

  – Milestone: finish retrospective tests by Feb 2010.

- Produce 2 journal articles on 2009 tests of EnKF, comparisons with other operational systems, effects of model resolution.

  – Milestone: submission by February 2010, June 2010.

- Conduct joint THORPEX/HFIP workshop on ensemble prediction and ensemble post-processing.

  – Milestones: workshop February 2010, white paper from workshop May 2010.

- Run quasi real-time global EnKF and global ensemble predictions during 2010 season using 30-km FIM model. Deliver ICs and LBCs to AOML to run regional EnKF and ensemble predictions.

  – Milestones: product availability <12 h after data collection.

- Test stochastic cumulus parameterization in GFS ensemble.

  – Milestone: Produce manuscript by June 2010.

ESRL Milestones (2)

- Regional ensemble development for hurricane applications Workshop Topics / Issues to be addressed
  - FY10 Deliverable - Develop plans for and start assembling software infrastructure consistent with DTC regional ensemble testbed concept in support of collaborative regional hurricane ensemble development
  - FY10 Milestone - Limited / test version of modular HWRF-based ensemble infrastructure allowing the testing of various initial condition and model-related perturbations

- Statistical post-processing - Contribute to development of NUOPC with special emphasis on multi-center hurricane forecasting; Collaborate with international community in development of Global Interactive Forecast System (GIFS) using TIGGE CXML hurricane data available from seven global NWP centers
  - FY10 Deliverable - Prototype Bayesian Processor for Ensembles (BPE) developed Contribute to development of detailed international plans for GIFS
  - FY10 Milestones - Demonstrate BEP with limited datasets

ESRL Milestones (3)

- Design and verification of probabilistic hurricane forecast products – Develop tools/methods for storing / accessing, interrogating / displaying ensemble data, and for generating / providing probabilistic products and services (in collaboration with Post-processing and Applications Team)
  - FY10 Deliverble: Assess database / interrogation / product generation experience (national, international) and software; Develop plans for how to use existing tools; Identify missing elements; Initial contributions in two of three listed elements
  - FY10 Milestone: White paper summarizing current status; Demonstrate newly developed tools

NRL Milestones

- Run ensembles for 2008/2009 season with inclusion of model uncertainty (stochastic forcing, diurnal SST forcing).

    – Milestone: Complete forecasts by May 2010.

- Quantify impact of inclusion of model uncertainty on TC track performance.

    – Milestone: Complete report by June 2010.

- Finish comparison of resolution vs. ensemble member study started in FY09.

    – Milestone: Complete report by March 2010.

- Examine different consensus configurations including the demo forecasts, and including single-model ensemble means in the consensus.

    – Milestone: Complete report by May 2010.

- Provide high-resolution deterministic COAMPS forecasts for inclusion in FSU multi-model ensemble.

    – Milestone: provide forecast output to FSU during 2010 demo period.

- Run high-resolution NOGAPS Semi-Lagrangian ensembles for the 2009 season.

    – Milestone: Complete runs and provide preliminary skill assessment, Sept. 2010.

PSU Milestones

- Rerun and evaluate the performance of single-model cloud-resolving ensemble for all 2008/2009 Atlantic cases initializing with global GFS EnKF analysis provided by Jeff Whitaker at ESRL (May 2010).

- Evaluate the performance of single-model cloud-resolving ensemble for selected real-time 2008/2009 Atlantic cases initializing with regional-scale EnKF analysis that assimilated airborne Doppler observations (May 2010).

- Continue the real-time regional-scale cloud-resolving ensemble demo experiments for 2010 Atlantic season initializing with ARW EnKF assimilating airborne Doppler and other inner core observations and/or initializing with GSF EnKF (Oct. 2010).