Progress on Future NCEP Production Suite

EMC Senior Staff
Overview

• National Environmental Modeling System (NEMS)
• Evolution of the NCEP Production Suite
• Visit to the UK Met Office
National Environmental Modeling System (NEMS)  
(uses standard ESMF* compliant software)

* Earth System Modeling Framework (NCAR/CISL, NASA/GMAO, Navy (NRL), NCEP/EMC), NOAA/GFDL

2, 3 etc: NCEP supported thru NUOPC, NASA, NCAR or NOAA institutional commitments
Components are: Dynamics (spectral, FV, NMM, FIM, ARW, FISL, COAMPS…)/Physics (GFS, NRL, NCAR, GMAO, ESRL…)
Planned NEMS Capabilities

• Components and capabilities of the NEMS infrastructure
  – Configuration control
    • Domain
    • Resolution (horizontal, vertical)
    • Standardized fixed field generation (WPS - topography, land use, etc)
    • Tracer definition
  – Observations ingest, formatting, QC, etc libraries
  – Nesting (static and moving, telescoping, 1-way, 2-way)
  – Concurrent ensemble execution (single executable, multiple members)
  – Data assimilation (3D-var and advanced techniques)
  – In-core updating for analysis increments and boundary conditions
  – Model dynamics and physics including
    • Atmosphere
    • Ocean
    • Land surface and hydrology
    • Air Quality and trace gases
  – Post-processor and product generator
  – Standard operational verification
  – Documentation for operational and research users
Planned NEMS Capabilities (cont)

• Modeling Research
  – Global and regional
  – Institutionally supported components
    • Atmosphere
      – GFS (NCEP)
      – NOGAPS (Navy)
      – FV (NASA, GFDL)
      – NMM (NCEP)
      – ARW (ESRL, NCAR, AFWA)
      – COAMPS (Navy)
      – FIM (ESRL)
      – FISL (NCEP)
    • Ocean
      – MOM4 (GFDL)
      – HYCOM (NCEP, Navy)
    • Land surface and hydrology
      – Noah (NCEP)
      – VIC (Princeton, U. Wash)
      – MOSAIC (NASA)
      – Sacramento (OHD)
      – Smirnova LSM (ESRL)
    • Air Quality and trace gases
      – CMAQ (EPA, ARL)
      – GOCART (NASA)
      – NAAPS (Navy)

Under construction
Will include in future
Planned NEMS Capabilities (cont)

- **Operational Models (NCEP only)**
  - Global Forecast System
    - GFS
  - Global Ensemble (GENS, NAEFS)
    - GFS
  - North American (NAM)
    - NMM
  - Short-range Ensemble (SREF)
    - NMM
    - ARW
    - Physics diversity
  - High Resolution Window (HRW)
    - NMM
    - ARW
  - Air Quality (AQ)
    - CMAQ
  - Land Surface & Hydrology (LIS)
    - Noah
  - Rapid Refresh (RR) Ensemble
    - ARW Dynamics + GSD physics
    - NMM dynamics + NCEP physics
  - Hurricane (HUR)
    - NMM for hurricanes
    - HYCOM + Wavewatch
  - Seasonal Climate Forecast (CFS)
    - GFS for climate
    - MOM4

Will include in Operational NEMS
Community-based Development

• **Strategy and roles:**
  – Focus on **single component** instead of entire model system
  – **Collaborative**, not competitive
  – NCEP/EMC
    • Maintains **primary components** for each part of Production Suite and for each application
    • Supports ESMF applications in operations
    • In collaboration with community
      – Integrates new ESMF-based components into operations
      – Performs final testing and preparation of upgrades of supported components in operations
  – **Collaborators**
    • Provide
      – Component upgrades to be tested in operational setting
      – Institutional support for their contributed components
      – Diversity and expertise complementary to operations
    • Work through DTC, JCSDA, CTB, etc.

• **Examples of current and potential collaborators**
  – **OAR/GSD**
    • Model enhancements
    • Aviation applications, including products and physics component
  – **NASA-(GMAO, HSB)**
    • Data assimilation (atmosphere, ocean, land)
    • Finite-volume (FV) model
    • Physics (aerosol, land surface)
    • ESMF-based components (e.g. physics)
  – **NRL**
    • Aerosol physics and analysis
    • ESMF-based model structure (atmosphere, ocean)
    • Physics component
    • Operational ensemble generation and processing
  – **NMFS**
    • Fishery ecosystems
  – **NCAR**
    – ARW dynamics
    – Physics components
  – **NWS/OHD**
    – Land & Hydrological models for
      – Streamflow
      – Flash floods
    – Precipitation analysis
  – **NOS**
    – Dynamic storm surge
    – Coastal ecosystems
    – Water quality
  – **Universities**
    – Specific physics upgrades
Criteria for Inclusion in NEMS

• Research
  – Adherence to ESMF standards
  – Institutional support for code
  – Participation in system evolution

• Operations
  – Research criteria plus:
  – Standard “Transition to Operations” criteria
    • NCEP: http://www.emc.ncep.noaa.gov/
      – Forecast performance benefits
      – IT compatibility
      – Efficiency
      – Sustainability
    • AMOP (Navy)
    • AFWA IPT process (USAF)
NCEP Production Suite
Weather, Ocean & Climate Forecast Systems

Next Generation Prototype
Phase 3

Computing factor: 27

6 Hour Cycle: Four Times/Day

Added
- Flash flood products
- SREF concurrent to NAM

Moved
- SREF concurrent to NAM

Expanded
- Reforecast capability

* Percent Used

0:00 0:30 1:00 1:30 2:00 2:30 3:00 3:30 4:00 4:30 5:00 5:30 6:00

Reforecast
SREF
NAM Anal
NAM
GFS Anal
GFS
HUR
GENS/NAEFS
AQ
Hydro / NIDIS/FF
AQ
RTOFS
CFS & MFS
RDAS
GDAS
NCEP Production Suite
Weather, Ocean, Land & Climate Forecast Systems

Next Generation Prototype
Phase 2

Computing factor: 9

Added
- Hydro/NIDIS products
- GFS ½ h earlier

Moved
- Hurricane & wave products

Expanded
- Multi-domain rapid updating

Percent Used

6 Hour Cycle: Four Times/Day
NCEP Production Suite
Weather, Ocean, Land & Climate Forecast Systems

Next Generation Prototype
Phase 4

Computing factor: 81

Added
- Hourly GDAS
- GFS concurrent to NAM & SREF
- Hurricane capability (hires)

Moved

Expanded

6 Hour Cycle: Four Times/Day
NCEP Production Suite
Weather, Ocean, Land & Climate Forecast Systems

Next Generation Prototype
Final Phase

Computing factor: > 240

>100% of 2015 computing

6 Hour Cycle: Four Times/Day
Global Forecast Performance
Relative to UKMO
(UKMO global index unweighted)

Worse Than UKMO

Better Than UKMO

UKMO 4D-VAR implemented

NCEP GSI implemented