Decision Brief:
Upgrade to NAM/DGEX

Mesoscale Modeling Branch
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where the nation’s climate and weather services begin
Proposed Changes

- Expand computational domain by 18%
  - Requested by NWS Alaska Region to move lateral boundary further north/west
  - Requested by AWC to extend lateral boundary further east over Atlantic
  - More efficient obs pre-processing for NDAS/NAM (only dumped over new NAM domain instead of western hemisphere)
Proposed Changes to WRF-NMM Model

• Gravity Wave Drag / Mountain Blocking
• Unified (with NCAR) land-surface physics
• Modified passive advection (relax requirement for exact conservation of q, TKE, cloud water in advection step due to open inflow/outflow at the lateral boundary)
Proposed Changes to WRF-NMM Model

- Improved computation of surface longwave radiation
  - remove averaging of tendencies from two lowest layers
  - upward LW at sfc computed based on skin temp instead of average of skin T and lowest model layer T

- Bug fix for climatological values of stratospheric O₃

- August 2007 version of WRF-NMM repository code with modified array indexing (~5% speedup vs current ops code); compiled with higher optimization for further speedup (Thanks to J. Abeles and C. Pasti of IBM)
Proposed Changes to NAM GSI analysis / data assimilation

• Newer (Aug 2007) version of the GSI
• Recomputed NMM-based background error covariances
• Assimilation of new/better observation types (AIRS radiances, MODIS wind, Mesonet wind observations, Single field-of-view GOES radiances)
Other Proposed Changes

- Use 12-36 h forecast precipitation from the 00z NAM as driver for NDAS soil moisture in regions outside of CONUS rather than 3-h NDAS forecast
- New surface terrain w/modified smoothing
- Fix oversized Great Salt Lake, remove elevated water points, use climatological water temperatures for Lake Champlain
Gravity Wave Drag (GWD) & Mountain Blocking (MB)

- "Mountain blocking" (Lott & Miller, 1997)
  - Wind flow around subgrid orography
  - Low-level flow is blocked below a dividing streamline (air flows around, not over barrier)

  - Mountain wave stress, pressure drag
  - Vertical distribution of the wave stress, changes winds aloft (momentum deposition)

- Effect/influence of subgrid scale orography controlled by tuning parameter SIGFAC, via:
  - SIGFAC * Standard_deviation_of_terrain
  - Set SIGFAC=0 in 12-km NAM after extensive tuning experiments
Example of GWD impact: 12z 12/20/06 NMM test
48-72 h QPF valid 12Z 23 Dec 2006
In GWD run:
• Lower heights over eastern Canada and most of eastern US
• Flatter, more progressive ridge over mid Atlantic & New England
12Z 20 Dec 2006 Runs,
72-h SLP + 1000-500 hPa thickness

In GWD run:
• High pressure breaks down over Canada & New England
• Low pressure forms over western NC and SC
12z 20 Dec 2006 Runs, 60-h 250-hPa winds + vorticity

In GWD run vs. control:
- Jet streak displaced to the NE
- Stronger flow through weaker ridge
Example of impact of GWD on lower tropospheric vertical profiles:
Obs=black, Ops NAM=Red, New NAM=blue
Example of impact of GWD on lower tropospheric vertical profiles:
Obs=black, Ops NAM=Red, New NAM=blue

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>STA</th>
<th>CAVF</th>
<th>CINV</th>
<th>LCLF</th>
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<td>OAK</td>
<td>0</td>
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<td>1200</td>
<td>OAK</td>
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<td>0</td>
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</tr>
</tbody>
</table>

**FORECAST SOUNDING LOCATIONS**

![Map of forecast sounding locations](image)
WRF-NMM unification of land-surface physics with NCAR

- New module intended to have minor impact: some changes to cold season physics, minor changes to other parameters, and passing total incoming/net radiation
- Primary cold season change: use total soil moisture instead of frozen soil moisture to determine bare soil evaporation

- *mid-day 2-m air temperatures nearly identical for test case*: 24-JULY-2006/21z (+09-hour forecast from 12z init)

"Old module" vs "New unified module"
Impact of Modified Advection: 12z 20 Dec 2006
case: 72-h PW
example of higher PWs in the ADV runs
Impact of Modified Advection: 12Z 20 December 2006: Day 3 Precipitation

Note heavier precip in the ADV run along SE coast

Go here for precipitation scores and scroll towards the bottom. ADV run improved scores for >1” amounts.
New GSI analysis

• Recomputed NMM background errors
• Code changes:
  – Data reported with height use height, not pressure in the forward model
  – Change of analysis variable from Ln(ps) to ps
  – Use sensible temperature directly if no valid q obs
  – Extend mpi-io capability to more data input
  – Ability (not yet turned on) to utilize multiple guess files
GSI Changes: Impact of AIRS radiance assimilation

Penalty function for conventional data at end of each NDAS cycle: assimilation of AIRS leads to better 1st guess fit to conventional obs
Impact of AIRS data on forecast

RMS Vector Wind error vs CONUS RAOBS

RMS Temperature error vs CONUS RAOBS

12h FORECAST

RMS vector wind error vs. raob over the CONUS for ops NAM and pll NAM 12-h forecast from 200611201200 to 200612041200

RMS temperature error vs. raob over the CONUS for ops NAM and pll NAM 12-h forecast from 200611201200 to 200612041200

84h FORECAST

RMS vector wind error vs. raob over the CONUS for ops NAM and pll NAM 84-h forecast from 200611201200 to 200612041200

RMS temperature error vs. raob over the CONUS for ops NAM and pll NAM 84-h forecast from 200611201200 to 200612041200
GSI Changes : Tuning of Background Error

- Model/analysis changes/fixes since background error last estimated
- Adaptive tuning of ob error for the new data
- Change variance of Temp and stream function, velocity potential (wind)
GSI Changes: Tuning of Background Error

• Shown: time series of surface pressure obs RMS fit to 1st guess (3-h WRF-NMM forecast)

Black = Ops NDAS
Green = Parallel NDAS with current ops background error covariances
Red = Parallel NDAS with retuned background error covariances
GSI Changes : Tuning of Background Error

- Shown: time series of wind obs RMS fit to 1st guess (3-h WRF-NMM forecast)

Black = Ops NDAS
Green = Parallel NDAS with current ops background error covariances
Red = Parallel NDAS with retuned background error covariances
GSI analysis test results: Offline NDAS tests of individual analysis changes

<table>
<thead>
<tr>
<th>Test Period</th>
<th>GSI analysis or Observation Component Being Tested</th>
<th>Impact on Psfc</th>
<th>Impact on Temp</th>
<th>Impact on Wind</th>
<th>Impact on Moisture</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007020300-2007020912</td>
<td>Mesonet winds with use_list</td>
<td>-</td>
<td>o</td>
<td>+</td>
<td>o</td>
</tr>
<tr>
<td>200703????-200703????</td>
<td>MODIS winds</td>
<td>o</td>
<td>o</td>
<td>+</td>
<td>o</td>
</tr>
<tr>
<td>2007041800-2007042012</td>
<td>GOES 1X1 radiances</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>200705????-200705????</td>
<td>EUMETSAT winds</td>
<td>o</td>
<td>o</td>
<td>+</td>
<td>o</td>
</tr>
<tr>
<td>2007072000-2007073012</td>
<td>New background error covariances</td>
<td>+</td>
<td>+</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>2007081600-2007082412</td>
<td>New GSI</td>
<td>+</td>
<td>o</td>
<td>o</td>
<td>-</td>
</tr>
</tbody>
</table>

+++ large positive impact
++ moderate positive impact
+ slight positive impact
o neutral impact
- slight negative impact
-- moderate negative impact
--- large negative impact
In OPNL NAM, hourly precipitation analysis (a merged Stage II/Stage IV hourly product, after adjusting for bias using long-term budget history array) is used as driver for soil moisture. When/where hourly precipitation analysis is not available, or when it is snowing (large low bias in hourly obs), model precip during NDAS is used as driver for soil moisture.

This might lead to excessive OCONUS soil moisture when there is a model spin-down problem.

Solution: use 00Z cycle's NAM hourly model precip (from the 12-36h fcst) to fill in outside of Stage II/IV coverage.
Why the proposed solution would work

Monthly precip for Jul 2006
Fig. a: from NDAS (shows precip input to soil)
Fig. b: from NAM 00-24h fcst
Fig. c: from NAM 12-36h fcst

In OPNL NAM, NDAS precip is used as OCONUS soil moisture driver. Using the NAM 12-36h forecast would have alleviated much of the problem caused by the precip spin-down.
Volumetric soil moisture after one year

0-10 cm layer

100-200 cm layer
New surface terrain

• Rationale: Model “too noisy” during assimilation
• Two smoothing steps
  – 1-2-1 filter at every point (eliminates 2-delta-x noise but reduces amplitude of large-scale features
  – “Desmooth” step to restore some detail lost in step 1 at scales > 2-delta x
• For new NAM 3 passes of filters applied
New surface terrain: difference vs ops NAM
New surface terrain: difference vs ops NAM
New surface terrain: difference vs ops NAM
Noise Reduction with New Terrain

normalized BALDT, 20070420 case

- Current ops NAM
- New NAM

Lines:
- nosmooth
- peak_1pass
- peak_12pass
- smthdesmth_3pass
- peak_smthdesmth_3pass
Case studies tested with components of NAM change package

<table>
<thead>
<tr>
<th>Case Date</th>
<th>Description of Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 Jul 2006 12z</td>
<td>High dew point temperatures over Pac NW (esp coastal mountains)</td>
</tr>
<tr>
<td>21 Oct 2006 00z</td>
<td>Misplaced storm track, spurious snow storm over IA/WI/IL</td>
</tr>
<tr>
<td>7 Dec 2006 12z</td>
<td>Very warm (&gt;10C) surface temperatures over inner-mountain west</td>
</tr>
<tr>
<td>20 Dec 2006 12z</td>
<td>Subsidence along upwind side of Black Hills, winter storm over east</td>
</tr>
<tr>
<td>29 Mar 2007 12z</td>
<td>Failed to predict heavy, convective precipitation over OK/KS/TX</td>
</tr>
<tr>
<td>29 Apr 2007 12z</td>
<td>High dew point temperatures over ID, western MT</td>
</tr>
<tr>
<td>29 Jun 2007 00z</td>
<td>Missed a light precipitation event over SE TX</td>
</tr>
<tr>
<td>3 Jul 2007 12z</td>
<td>Case of interest to AQ, under-prediction of ozone over Los Angeles</td>
</tr>
<tr>
<td>9 Jul 2007 00z</td>
<td>1st of 2 cases to look at convective momentum mixing by J. Carley</td>
</tr>
<tr>
<td>16 Jul 2007 00z</td>
<td>2nd case studied by Jacob Carley to look at Cu momentum mixing</td>
</tr>
</tbody>
</table>

Each experimental set of 10 runs consisted of running the NAM prediction model (WRF-NMM) out to 84 hours using the same initial conditions as a NAM control forecast. Verification was performed by comparing both the control and experimental forecasts against observations. The complete set of statistics for the last 26 sets of experiments can be viewed at [http://www.emc.ncep.noaa.gov/mmb/bf/launcher/](http://www.emc.ncep.noaa.gov/mmb/bf/launcher/).
• Experiment 1 - Test gravity wave drag (GWD), 1-pass (1X) vs. 3-pass (3X) terrain
• Experiment 2 - Test modified advection and diffusion (All runs use GWD with SIGFAC=0, 3X terrain, original advection)
• Experiment 3 - Test different diffusion coefficients (COAC) (GWD with SIGFAC=0, 3X terrain, modified advection)
• Experiment 4 - Test convective momentum mixing (GWD, SIGFAC=0, 3X terrain, original advection)
• Experiment 5 - Test changes to cloud-radiation parameters to reduce upper-level warm biases (GWD, SIGFAC=0, 3X terrain, modified advection)
• Experiment 6 - Test changes to microphysics, convection to reduce upper-level warm, moist biases (GWD, SIGFAC=0, 3X terrain, modified advection)
• Experiment 7 - Test No GWD vs. GWD with SIGFAC=0 and SIGFAC=3 (3X terrain, modified advection)
• Experiment 8 - Test momentum mixing + reduced water loading in convection (GWD, SIGFAC=0, 3X terrain, modified advection)
• Experiment 9 - Test No GWD vs. GWD with SIGFAC=0 to SIGFAC=6 (3X terrain, modified advection)
• Experiment 10 - Test following changes to BMJ convection:
  (1) EPSPR=10 (was 1.E-7)
  (2) EPSPR=1000, increase depth of shallow convection to 400 mb at swap points
  (3) Crude parameterization of downdrafts (GWD, SIGFAC=3, 3X terrain, modified advection)
• Experiment 11 - Test GWD with SIGFAC=0 vs. GWD with SIGFAC=0 and RIC=0.505 (in MYJSFC + PBL) rather than RIC=0.25 vs. Mountain blocking only (no GWD) with SIGFAC=0 (3X terrain, modified advection)
• Experiment 12 - Test No CWM in MYJ SFC (GWD, SIGFAC=0, 3X terrain, modified advection)
• Experiment 13 - Test GFS PBL + SAS (GWD, SIGFAC=0, 3X terrain, modified advection)
• Experiment 14 - Numerous radiation tests involving RRTM LW, GSFC SW, Dudhia SW, and GFDL LW+SW (GWD, SIGFAC=0, 3X terrain, modified advection)
• Part of Experiment 14 - Reduced cloud emissivities for GFDL LW (in the Eta) (GWD, SIGFAC=0, 3X terrain, modified advection)
• Experiment 15 - Test Thompson Microphysics (GWD, SIGFAC=0, 3X terrain, modified advection) => 48-h runs made only for 2006122012, 2007032912, and 2007070312
• Experiment 16 - Test countergradient term (CT) in MYJ SFC & PBL (GWD, SIGFAC=0, 3X terrain, modified advection)
• Experiment 17 - Test changes to ETANEW microphysics and GFDL radiation (GWD, SIGFAC=0, 3X terrain, modified advection)
• Experiment 18 - Further tests of convective momentum mixing using smaller values of "fwind" (GWD with SIGFAC=0, 3X terrain, modified advection)
• Experiment 19 - Test calling physics more frequently (NPHS=2 rather than 6, GWD with SIGFAC=0, 3X terrain, modified advection)
• Experiment 20 - Test WSM5 and WSM6 microphysics, plus changes to ETANEW microphysics (GWD with SIGFAC=0, 3X terrain, modified advection)
• Experiment 21 - Test change in diagnosing 10-m winds from MYJ surface layer, compare against the CONTROL and the GFS PBL + SAS (GWD, SIGFAC=0, 3X terrain, modified advection)
• Experiment 22 - Test modified horizontal diffusion provided by Wan-Shu (GWD, SIGFAC=0, 3X terrain, modified advection)
• Experiment 23 - Test new NAMEXP code comparing LSM option 99, 2, and 2 with revised DQSDT (GWD, SIGFAC=0, 3X terrain, modified advection)
• Experiment 24 - Another round of GWD testing using new NAMEXP code for old NMM LSM option 99 and new Noah LSM option (3X terrain, modified advection)
• Experiment 25 - Test SIGFAC=-1 and TADJ=900 in GWD, 10-19-07 version of ETANEW microphysics (GWD, SIGFAC=0, 3X terrain, modified advection)
• Experiment 26 - Test background horizontal diffusion (Zavisa's "Fback" code) (GWD, SIGFAC=0, 3X terrain, modified advection)
• Final comparison - Before changes vs. After changes
• Experiment 27 - Test p_top_requested=200 vs. 5000 in namelist.input file ("NAMEXP" code, 3X terrain, SIGFAC=0 in GWD, modified advection, etc.)
## NAM Model Experiments Most Relevant to 2008Q2

### Change Package

<table>
<thead>
<tr>
<th>Exp.</th>
<th>Description</th>
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</table>
| 1 | **Test** GWD and 1X vs. 3X terrain;  
**Result**: use GWD, 3X terrain. |
| 2 | **Test** modified advection and horizontal diffusion;  
**Result**: use only modified advection. |
| 7 | **Test** SIGFAC=0 vs. 3 in GWD;  
**Result**: SIGFAC=0 produced better surface T, RH, SIGFAC=3 produced slightly better QPF and surface winds (mixed upper air results). |
| 9 | **Test** no GWD vs. with GWD with SIGFAC=0, 1, 2, 3, 4, 5, and 6;  
**Result**: GWD still showed improvements, small SIGFAC had better surface verification. This set of experiments was prompted by problems seen in the NAM parallels in late Sep – early Oct, which were due to issues unrelated to GWD. |
| 11 | **Test** GWD vs. MB only;  
**Result**: Gravity wave breaking in GWD accounted for much of the improvement in upper-air scores and in QPF. |
| 24 | **Test** different LSM configurations;  
**Result**: A corrected version of the unified Noah LSM produced slightly better forecasts than the current LSM running in the NAM. |
| 25 | **Test** further reductions in the amplitude of GWD, such as SIGFAC=−1 and slowing the time scale for adjusting momentum from 160 s (currently NAM physics time step) to 900 s. Also includes a small test to the microphysics in order to reduce tiny amounts of small hail from reaching the surface in warm-season conditions, which caused some difficulty in earlier version of the unified Noah LSM (note these were corrected).  
**Result**: Both GWD-related changes eliminated the effectiveness of GWD, and the microphysics changes were found to have a no perceptible impact. |
| Net Result | Use 3X terrain, modified advection, GWD with SIGFAC=0, and the corrected unified Noah LSM |
### Summary of overall results of NAM case study tests

<table>
<thead>
<tr>
<th>Case Date</th>
<th>Near Surface Impact</th>
<th>Precipitation Impact</th>
<th>Upper Air Impact</th>
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<tr>
<td>20 Jul 2006 12z</td>
<td>-</td>
<td>+++</td>
<td>0</td>
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<tr>
<td>21 Oct 2006 00z</td>
<td>+</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>7 Dec 2006 12z</td>
<td>--</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>20 Dec 2006 12z</td>
<td>++</td>
<td>+++</td>
<td>++</td>
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<tr>
<td>29 Mar 2007 12z</td>
<td>+</td>
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<td>29 Apr 2007 12z</td>
<td>+</td>
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<td>+</td>
</tr>
<tr>
<td>29 Jun 2007 00z</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>3 Jul 2007 12z</td>
<td>o</td>
<td>o</td>
<td>+</td>
</tr>
<tr>
<td>9 Jul 2007 00z</td>
<td>+</td>
<td>+</td>
<td>o</td>
</tr>
<tr>
<td>16 Jul 2007 00z</td>
<td>o</td>
<td>-</td>
<td>-</td>
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</table>

+++ large positive impact : ++ moderate positive impact : + slight positive impact
0 neutral impact
- slight negative impact : -- moderate negative impact : --- large negative impact

- Precipitation impact is based on 3-day cumulative scores
  (00-72 h for 00Z cycles, 12-84h for 12Z cycles)
### Summary of NAM/DGEX Test Results

<table>
<thead>
<tr>
<th>Component</th>
<th>Dates Summarized</th>
<th>Surface Impact (T/Td/V)</th>
<th>Precipitation Impact</th>
<th>Upper Air Impact</th>
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<tr>
<td>All Changes</td>
<td>29 Nov 07–10 Mar 08</td>
<td>o / - / +</td>
<td>o</td>
<td>++</td>
</tr>
<tr>
<td>All Changes</td>
<td>25 Oct -25 Nov 07</td>
<td>- / - / ++</td>
<td>o</td>
<td>+</td>
</tr>
<tr>
<td>All Changes</td>
<td>1-31 August 2007</td>
<td>o / o / o</td>
<td>o</td>
<td>+</td>
</tr>
<tr>
<td>All Changes</td>
<td>27 Feb – 31 Mar 07</td>
<td>- / - / o</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Domain expansion</td>
<td>24 Oct – 13 Dec 07</td>
<td>o / o / o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Unified LSM</td>
<td>8 – 23 Sep 07</td>
<td>o / - / o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>GWD</td>
<td>19 Oct – 5 Dec 07</td>
<td>o / - / ++</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>DGEX (all changes)</td>
<td>14 Jan – 12 Mar 08</td>
<td>o / X / -</td>
<td>N/A</td>
<td>++</td>
</tr>
</tbody>
</table>
Some cumulative verification stats for the full change package

- On all plots, ops=solid line, parallel=dashed line
- NAM Time Periods
  - 29 November 2007 – present
  - August 2007
  - March 2007
  - Shown: stats for days 1, 2, 3
- DGEX Time Period
  - 14 January 2008 – present
  - Shown: stats for days 4, 5, 6, 7, 8
CONUS RMS errors vs raobs: 29 Nov 07 – 10 Mar 08
Black=24-h fcst, Red=48-h fcst, Blue=72-h fcst

**Height**

**Vector Wind**

**Temp**

**RH**
CONUS Bias errors vs raobs: 29 Nov 07 – 10 Mar 08
Black=24-h fcst, Red=48-h fcst, Blue=72-h fcst

Temperature bias error vs. raobs over the CONUS for ops NAM and p11 NAM forecasts from 2007112900 to 2008031012

RH bias error vs. raobs over the CONUS for ops NAM and p11 NAM forecasts from 2007112900 to 2008031012

Temp

RH
Alaska RMS errors vs raobs: 29 Nov 07 – 10 Mar 08
Black=24-h fcst, Red=48-h fcst, Blue=72-h fcst
Alaska Bias errors vs raobs: 29 Nov 07 – 10 Mar 08
Black=24-h fcst, Red=48-h fcst, Blue=72-h fcst

Temperature bias error vs. raobs over Alaska for ops NAM and pl1 NAM forecasts from 2007112900 to 2008031012

RH bias error vs. raobs over Alaska for ops NAM and pl1 NAM forecasts from 2007112900 to 2008031012
CONUS RMS errors vs raobs: August 2007 retrospective
Black=24-h fcst, Red=48-h fcst, Blue=72-h fcst

Height
Vector Wind
Temp
RH
Alaska RMS errors vs raobs: August 2007 retrospective
Black=24-h fcst, Red=48-h fcst, Blue=72-h fcst

**Height**

- **Root-mean-square height error (ft)**
- **Pressure level (mb)**

**Vector Wind**

- **Root-mean-square vector wind error (knots)**
- **Pressure level (mb)**

**Temp**

- **Root-mean-square temperature error (°C)**
- **Pressure level (mb)**

**RH**

- **Root-mean-square RH error (%)**
- **Pressure level (mb)**
CONUS RMS errors vs raobs: March 2007 retrospective
Black=24-h fcst, Red=48-h fcst, Blue=72-h fcst

Height

Vector Wind

Temp

RH
Alaska RMS errors vs raobs: March 2007 retrospective
Black=24-h fcst, Red=48-h fcst, Blue=72-h fcst

- Height
- Vector Wind
- Temp
- RH
CONUS DGEX RMS errors vs raobs: 14 Jan - 10 Mar 08
Black=90h, Red=114h, Green=138h, Blue=162h, Brown=186h
Alaska DGEX RMS errors vs raobs: 14 Jan – 10 Mar 08
Black=96h, Red=120h, Green=144h, Blue=168h, Brown=192h
Cumulative QPF scores:
Equitable Threat (top) and bias (bottom) for Ops NAM (solid red) and parallel NAM (dashed blue) for 1 Dec 07 - 10 March 08
Cumulative QPF scores: Equitable Threat (top) and bias (bottom) for ops NAM (solid red) and parallel NAM (dashed blue)
NAM vs Parallel NAM Forecast Examples

- Examples of NAM “dropout” cases where parallel did better
  - Hurricane Dean
  - Ex-Hurricane Noel
  - 22 February 2008 East Coast Winter Storm
  - SLP forecast example from Mike Brennan
Time series of 36-h forecast 500 mb Height errors: NAM vs Parallel NAM
Ops NAM vs Parallel NAM vs GFS
500 mb height / 24-h QPF forecasts valid
12z 2/16/2008

Ops NAM 84-h fcst valid 12z 2/16;
500 mb RMS height error \(~75 \text{ m}\)

Parallel NAM 84-h fcst valid 12z 2/16
500 mb RMS height error \(~40 \text{ m}\)

GFS 84-h fcst valid 12z 2/16
500 mb RMS height error \(~40 \text{ m}\)
48-72 H ACPG NAM 72H FCST VALID 12Z 16 FEB 2008

48-72h NAM QPF

48-72 H ACPG NAMX 72H FCST VALID 12Z 16 FEB 2008

48-72h PII NAM QPF

48-72 H ACPG GFS 72H FCST VALID 12Z 16 FEB 2008

48-72h GFS QPF

24-h Precip Anl

CPC 1/8 deg Analysis 24h Accum (mm) Ending 2008021612
Hurricane Dean: 12z 17 August 2007 cycle
Ops NAM

Parallel NAM

SLP NAM 24H FCST VALID 12Z 18 AUG 2007

SLP NAMX 24H FCST VALID 12Z 18 AUG 2007

Hurricane Dean
13-23 August 2007

- Red: Hurricane
- Yellow: Tropical Storm
- Green: Tropical Dep.
- Purple: Extratropical
- Orange: Subtropical Storm
- Pink: Subtropical Dep.
- Black: 00 UTC Pos/Date
- Dark Green: 12 UTC Position
- PPP: Min. press (mb)
Ops NAM

Parallel NAM

SLP NAM 48H FCST VALID 12Z 19 AUG 2007

SLP NAMX 48H FCST VALID 12Z 19 AUG 2007

Hurricane Dean
13-23 August 2007

- Red: Hurricane
- Yellow: Tropical Storm
- Green: Tropical Dep.
- Purple: Extratropical
- Subtr. Storm
- Subtr. Dep.
- Black Circle: 00 UTC Pos/Date
- White Circle: 12 UTC Position
- PPP: Min. press (mb)
Ops NAM

TPC predicted position (issued 12z 8/17) valid 06z 8/21

Parallel NAM
Ex-Hurricane Noel: Better Model QPF by Parallel NAM in New England
Ops NAM vs Parallel NAM : 00z
2/20/2008 cycle
Ops NAM vs Parallel NAM : 12z
2/20/2008 cycle
Ops NAM

PRECIP TYPE NAM 45H FCST VALID 09Z 22 FEB 2008

Parallel NAM

PRECIP TYPE NAMX 45H FCST VALID 09Z 22 FEB 2008
Ops NAM

Parallel NAM

PRECIPTYPE NAM 57H FCST VALID 21Z 22 FEB 2008

PRECIPTYPE NAMX 57H FCST VALID 21Z 22 FEB 2008

OBSERVED WX TEMP VALID 21Z 22 FEB 2008
SPC Evaluation from Steve Weiss

Recommendation: Implement as proposed

SPC has concerns about initial observations of excessive return flow moisture and instability in the NAM parallel performance. This characteristic may not be a show stopper in an overall NWS sense, especially given other improvements in the parallel version. Thus, SPC cautiously supports the NAM upgrade implementation. If the early indications of a high bias in the 2-m dew point field are confirmed over a longer period of time, we ask that EMC take a closer look at this aspect of model performance.
84-h 2-m Td Forecast example from SPC valid 00z 14 March

Ops NAM

Parallel NAM

SURFACE DEW POINT TEMP VALID 00Z 14 MAR 2008
Mean diurnal trace of 2-m dewpoint for 1 Dec 07-3 Mar 08 over Eastern CONUS: Blue=ops NAM, Magenta=parallel NAM, green=obs
AWC Evaluation from Steve Silberberg

• 250 hPa jet streams, vert wind shear, & Ellrod stronger in NAM-Parallel \(\rightarrow\) improved turbulence guidance
• NAM-Parallel moisture and icing guidance equivalent to NAM-Operational
• NAM-Parallel Stability equivalent to NAM-Operational
• NAM-Parallel visibility equivalent to NAM-Operational
• NAM-Parallel surface friction velocity more realistic around topography and coastline than NAM-Operational
• NAM-Parallel composite reflectivity not as good as NAM-Operational
• AWC recommends operational implementation of NAM-Parallel
• Thank you
  – EMC for development
  – and NCO for dataflow
Suggestions to Improve Evaluation Process

• Please notify AWC 2 weeks before parallel dataflow begins
  – AWC Configuration Control Board Approval
  – AWC configuration changes to acquire and configure NAWIPS to view AWC-specific diagnostics
**HPC Evaluation from Mike Brennan**

- Subjective evaluation of the parallel NAM at HPC has shown a positive impact from the proposed changes to the model
  - Largest differences in mass fields seen in 2 to 3 day forecast period, but smaller differences seen in analysis and short-term forecasts
- HPC’s recommendation is to implement parallel NAM as scheduled
Case Example
Eastern U.S. Cyclone 5-6 March 2008

• Model forecast cycle from 12Z 3 March 2008 showed significant disagreement with the track of a cyclone moving north from the southeast into the Mid-Atlantic and Northeast in the day 2-3 time period
• Operational NAM appeared to be a western outlier with the cyclone track compared to the balance of the other deterministic guidance (GFS, ECMWF)
54-h SLP Forecast valid 18Z 5 March

12Z 3 March model cycle

Parallel NAM
Operational NAM
GFS
ECMWF

Operational NAM tracked cyclone much farther west through western NY compared to other operational models and parallel NAM with track through eastern NY and western NE
SLP Forecast Validation

HPC analysis – NAM/NAMP Forecast

- Operational NAM forecast shows much larger errors (6–8 mb) in vicinity of northeast cyclone compared to 2–4 mb errors in parallel NAM.
- NAMP SLP forecast more accurate elsewhere over central/eastern CONUS.

Warm (Cool) colors indicate positive (negative) SLP forecast error.
QPF Validation
NAM Forecast vs. QPE

- Operational NAM shows too much QPF over interior New England and not enough QPF extending south into NE PA
Parallel NAM does better job of capturing relative min of precip across NYC, LI and wrn CT

Better depicts axis of maximum precip in eastern NY and higher amounts along coast of Maine
Other HPC Comments

• NAMP verifies better than NAM for “significant” events
• Improved forecasts of 850-700 mb low strength at 72-84 hours
  – Operational NAM tend to be too strong with closed lows at 850-700 mb
  – NAMP has shown a net improvement in not forecasting 850-700 mb lows to be as intense over multiple runs/days
  – NAMP from the 5 March 00Z run had better forecast for the 850-700 mb cyclone track for big Ohio Valley heavy snow event than the operational NAM
• Consider the parallel NAM to be a net improvement, although propensity for NAM to have a high bias in cold-sector QPF of closed cyclones and low bias in the warm sector continues
We endorse the operational implementation of the experimental NAM (NAMEXP).

Specific comments-

1) In an example of a rerun of the NAM from last year’s hurricane season, the NAMXP exhibited less of a tendency for spurious tropical cyclone-like spinup over the Caribbean, which has been a chronic problem with the operational NAM.

2) A limited sample of tropical cyclone (Noel and Olga 2007) track forecasts from the NAMXP showed mostly a slight degradation in comparison to the operational NAM. However it should be noted that the NAM has historically performed much worse than models such as the GFDL, HWRF, the GFS, etc. for track.

3) The NAMEXP forecasts seem to depict a slightly faster and more accurate progression of frontal systems in the Gulf of Mexico region.

4) NAMEXP appears to make slightly more realistic forecasts of gap wind events, in particular Gulf of Tehuantepec gale events. Forecast maximum winds are slightly higher that the operational run of the NAM and closer to the observed winds.