Poster 1205

Session 3

28th WAF/ 24th NWP

NMMB Model Changes as Part of the NAMv4 Upgrade

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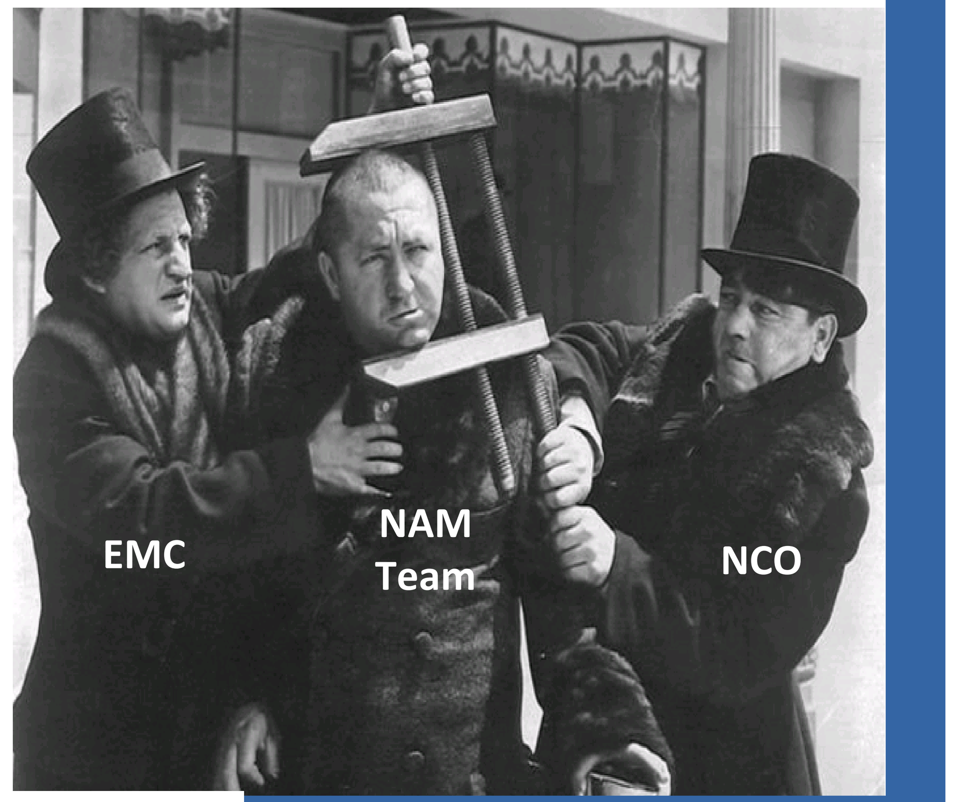
INTRODUCTION

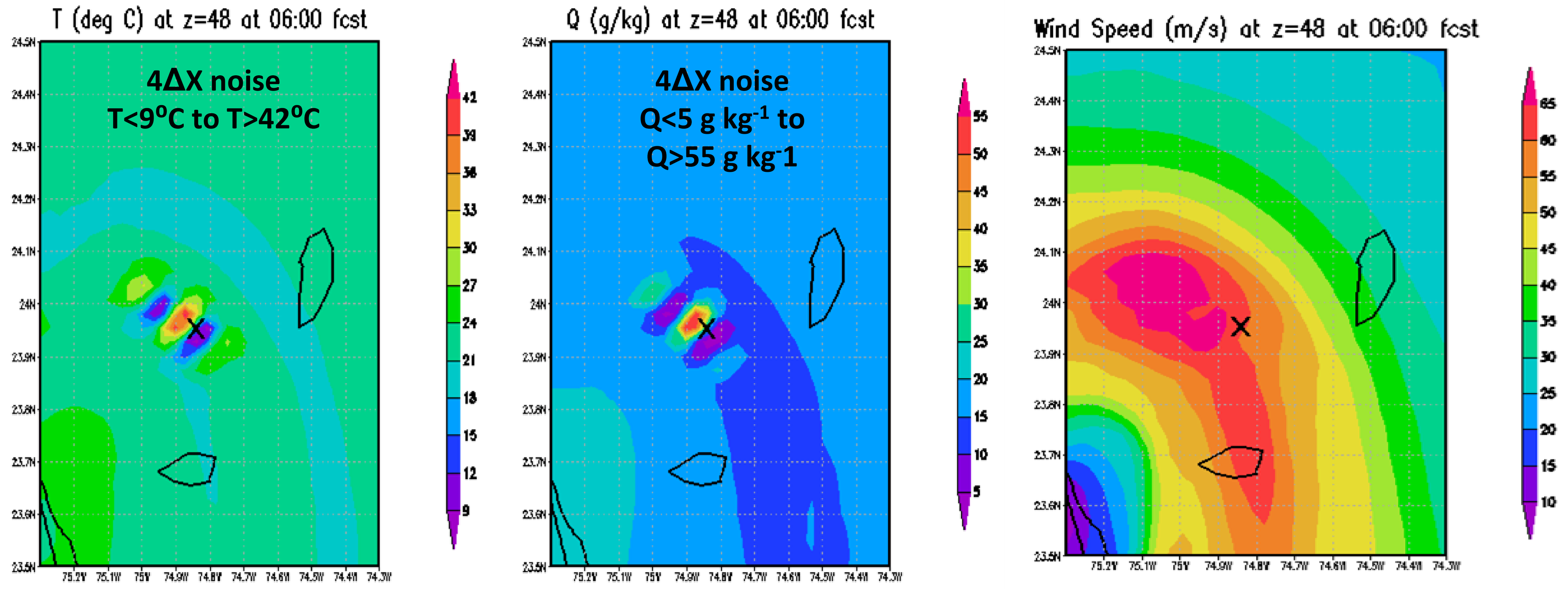
Needed to make changes to the NMMB model to fix:

- Three failures (aborted runs) of the production 4-km NAM CONUS nest occurred with Hurricane Joaquin (20150929 – 20151002).
- There was also a failure in the 3-km real-time parallel NAM nest.



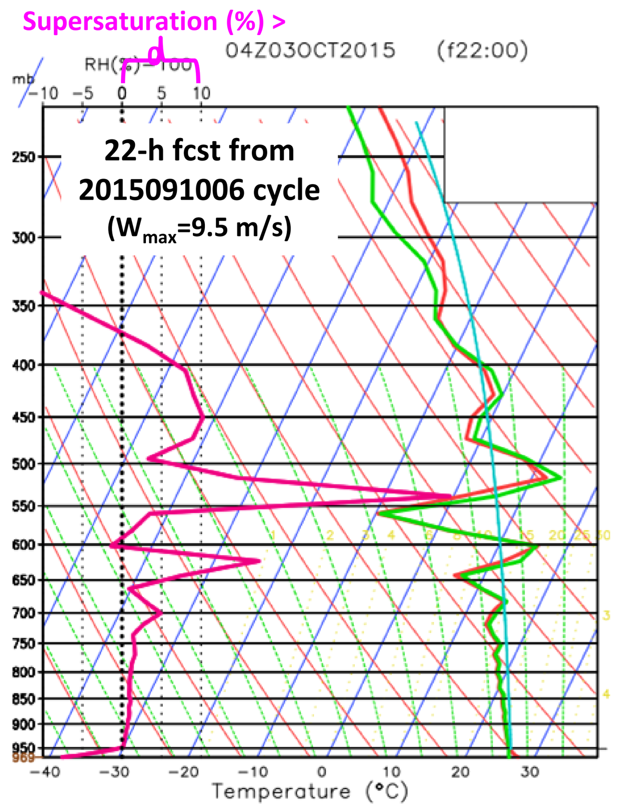
RESOLUTION

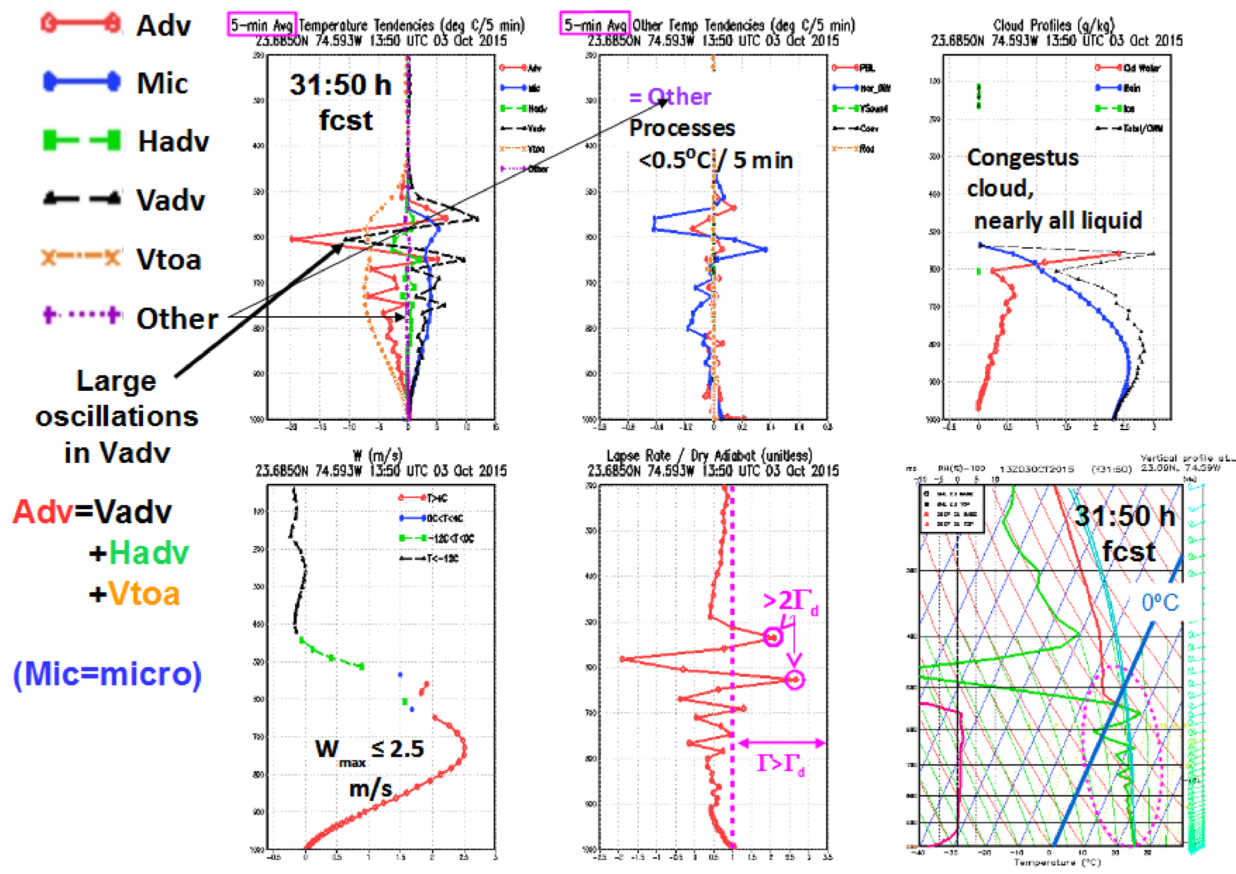
Large instabilities at 880 – 950 hPa



- Instability (left, center) occurred along the outer edge of a local wind maximum (right).
- Eliminated when advecting specific humidity every time step.
- This instability likely led to model failures.
- Likely due to lack of resolution for treating explicit convection.

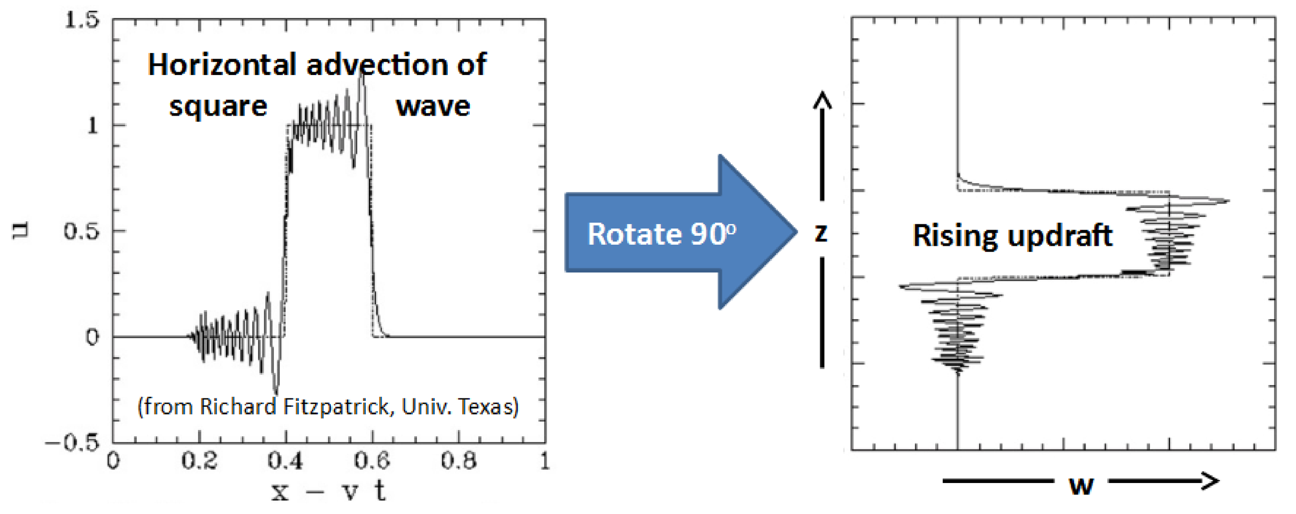
- But temperature (T) oscillations remained, even when all fields were advected and moist processes were updated every time step.
- T oscillations were brief, lasting ≤ 15 min.
- Seen in other runs & different physics options.
- Large supersaturations (>20%) w/r/t water were found in tiny areas of strong ascent.
- Hundreds of runs were made with 5-min output to study cause(s).





5-min T changes (and oscillations) were dominated by vertical advection (Vadv) over horizontal advection (Hadv), microphysics (Mic), omega-alpha (Vtoa), turbulence & radiation (not shown).

T oscillations were associated with vertical advection, occurring in areas with rapidly rising updrafts and sharp vertical gradients.



"… all *central difference* schemes for solving the advection equation suffer from a similar problem."

Changes to dynamics, turbulence, and the addition of parameterized convection did not remove T oscillations. 10,000s of profiles were analyzed from 5-min forecast output at locations of domain-maximum updraft velocities, surface rainfall rates, lapse rates, and supersaturations. The T profiles were stabilized only when layers with large lapse rates ($\Gamma > \Gamma_d$) were mixed out using the following method.

1. Only mix layers above the surface layer
2. Between highest & lowest unstable ($\partial\theta/\partial z<0$) layers:
   - (a) Mix (average) θ_{k+1}, θ_k, & θ_{k-1} if $\Delta\theta_{k+1/2} < \varepsilon$ & $\Delta\theta_{k-1/2} < \varepsilon$, $\varepsilon = -0.01^{\circ}C$
   - (b) Mix θ_{k+1} & θ_k if $\Delta\theta_{k+1/2} < \varepsilon$ & $\Delta\theta_{k-1/2} \geq \varepsilon$
   - (c) Mix θ_k & θ_{k-1} if $\Delta\theta_{k+1/2} \geq \varepsilon$ & $\Delta\theta_{k-1/2} < \varepsilon$
3. Iterate until all layers have been stabilized

θ_{k+1}

$\Delta\theta_{k+1/2}=\theta_{k+1}-\theta_k$

θ_k

$\Delta\theta_{k-1/2}=\theta_k-\theta_{k-1}$

θ_{k-1}

- Water supersaturation was removed by updating cloud condensation every other time step when moist physics was not called.

FINAL REMARKS

These changes helped improve North American Mesoscale v4 (NAMv4) model forecasts along with changes discussed in presentations below:

- Rogers *et al.* (3B.4, 1/23) describes the full NAMv4 upgrade.
- Aligo *et al.* (4B.4, 1/24) describes microphysics improvements.
- Carley *et al.* (next poster, 1204) describes nest improvements.
- Liu *et al.* (Session 9.5 of IOAS Conf., 1/25) describes radar & lightning data assimilation.