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.

INTRODUCTION

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.

RESOLUTION

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

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

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 (\(\Gamma_0 > \Gamma_d\)) were mixed out using the following method.

1. Only mix layers above the surface layer
2. Between highest & lowest unstable (\(\partial T/\partial z < 0\)) layers:
   - Mix \(\theta_{z+1}\) & \(\theta_z\) if \(\Delta \theta_{z+1/2} < \theta_c\) & \(\Delta \theta_{z+1/2} < 0\), \(\varepsilon = -0.01^\circ C\)
   - Mix \(\theta_{z+1}\) & \(\theta_z\), if \(\Delta \theta_{z+1/2} < \theta_c\) & \(\Delta \theta_{z+1/2} \geq 0\)
   - Mix \(\theta_{z+1}\) & \(\theta_z\), if \(\Delta \theta_{z+1/2} \geq 0\) & \(\Delta \theta_{z+1/2} < \theta_c\)
3. Iterate until all layers have been stabilized

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

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.

FINAL REMARKS