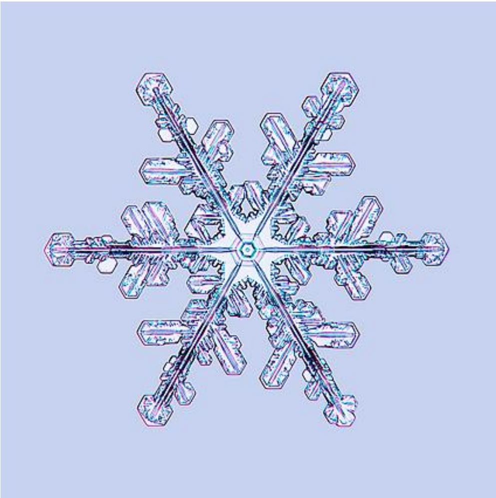
Evaluating Microphysics Schemes in COAMPS®-TC

Yi Jin, James Doyle,
Shouping Wang, Jason Nachamkin,
Rich Hodur, Teddy Holt,
Jon Moskaitis, Jerry Schmidt
NRL, Monterey, CA

Greg Thompson
NCAR-RAP, Boulder, Colorado

HFIP Physics Workshop
Maryland
9-11 August 2011



Introduction

- **COAMPS microphysics**:
- single-moment, bulk, cloud, ice, rain, snow and graupel (derived from Rutledge and Hobbs 1983-84; Lin et al. 1983)
- optional two moment drizzle parameterization (Khairoutdinov and Kogan 2000)

- **COAMPS microphysics updates**:
- thermodynamic constants dependent on temperature and pressure
- vapor deposition rate updated
- ice nuclei (Demott et al. 1994)

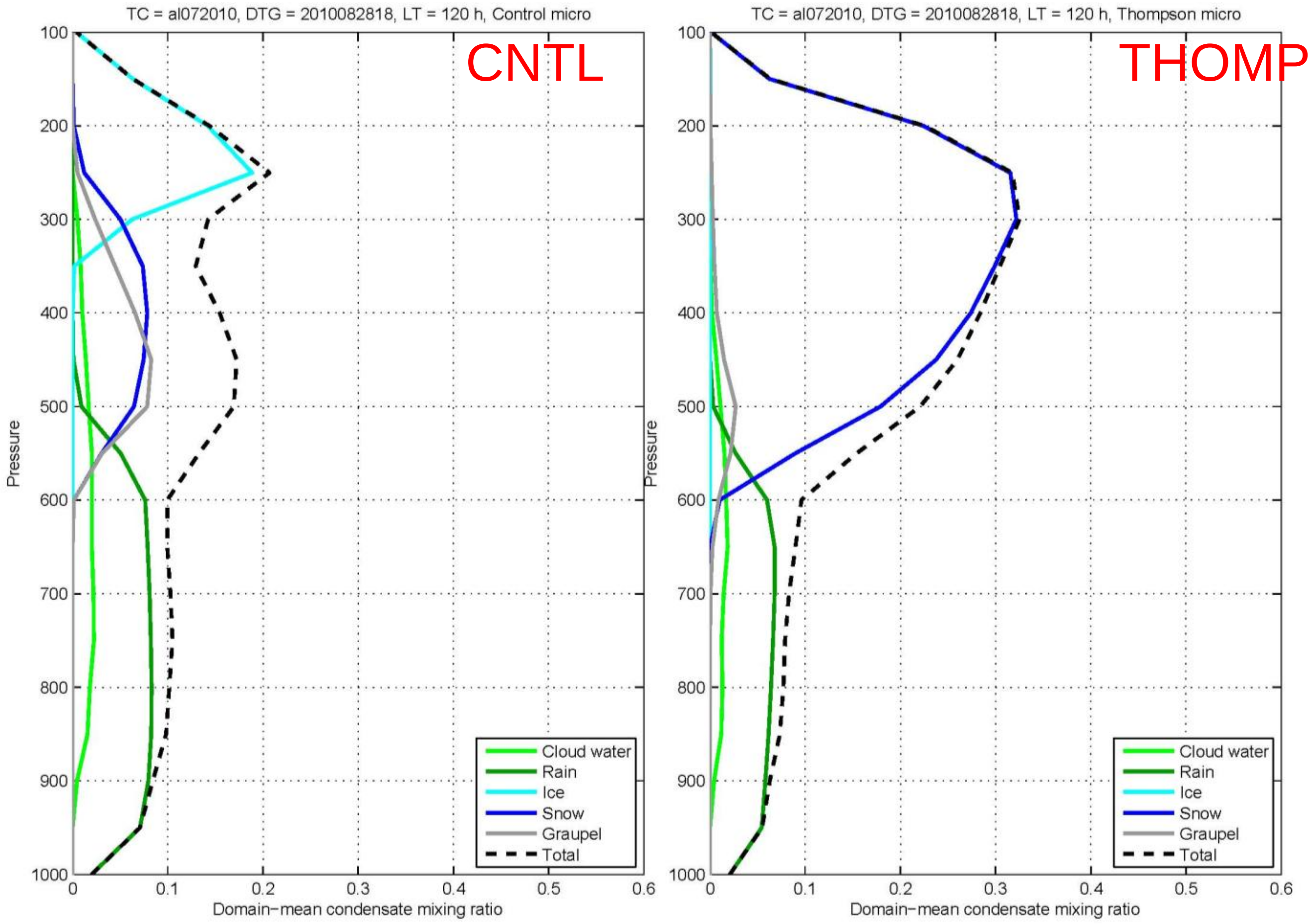
- **Thompson (2008) V3.3** (updated July 2011):
- two-moment for cloud ice and rain
- single-moment for cloud water, snow, and graupel
- prescribed number of cloud droplets (100 cm^{-3})

Model Setup

- Three nested-domains with 45km, 15km and 5km grid spacing and 40 vertical levels
- New SAS activated in all 3 nests
- Fu-Liou radiation scheme
- Mellor-Yamada PBL with Bougeault mixing length
- “CNTL” runs using COAMPS microphysics
- “THOMP” runs using Thompson V3.3
- Vertical mixing for all hydrometeors in “CNTL”
- No vertical mixing for rain, snow and graupel in “THOMP”
- Update cycles for 5 storms of 2010 (Earl, Richard, Karl, Megi, Lionrock)

Domain Average (5-km domain)

Vertical distribution of hydrometeors 120 h forecasts for Earl initialized at 18 UTC 28 Aug 2010

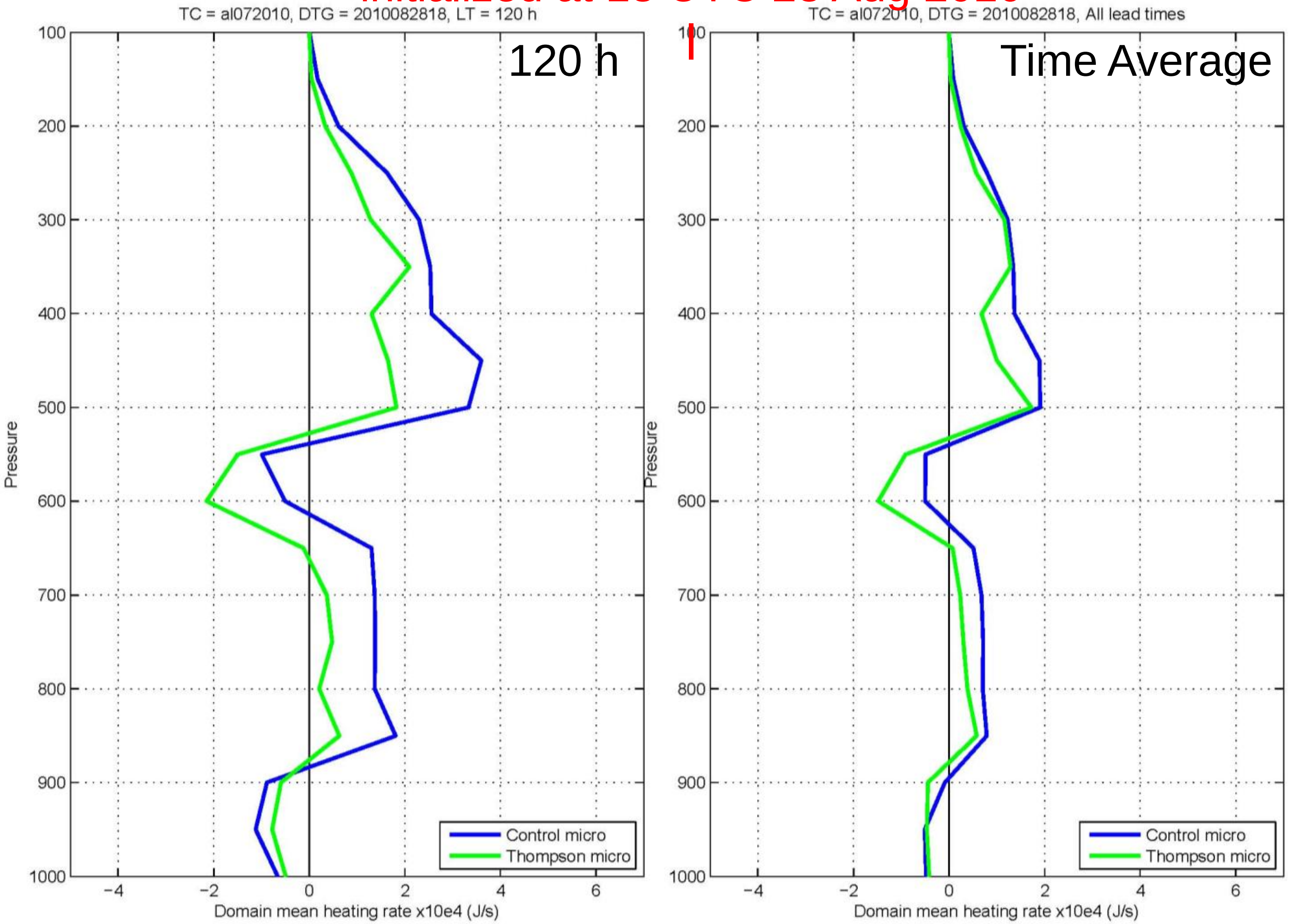


•The THOMP run has much more snow at upper levels, and much less ice and graupel than CNTL

•Similar amount of cloud water and rain between these two runs.

Domain Average (5-km domain)

Vertical distribution of latent heating rate for Ear initialized at 18 UTC 28 Aug 2010

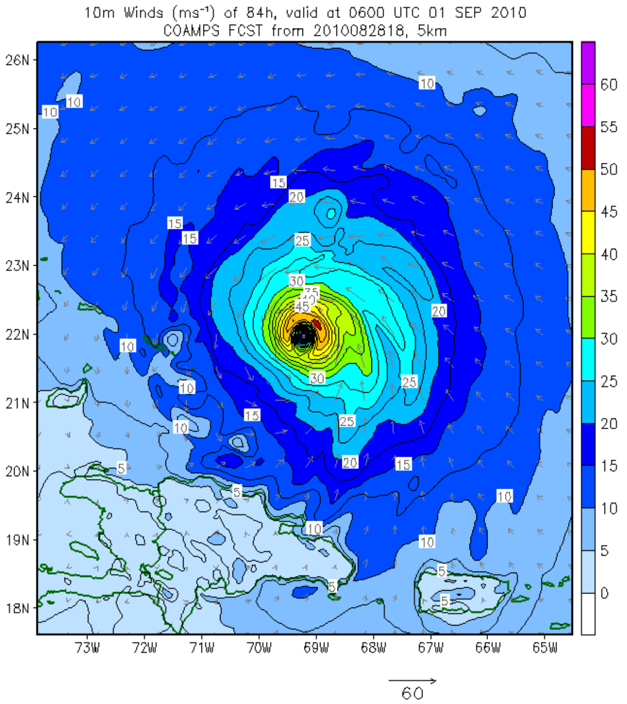


- The THOMP run has more cooling at mid levels, and double peaks of heating from mid to upper levels.
- The CNTL run has higher heating rate (less cooling rate) than THOMP.

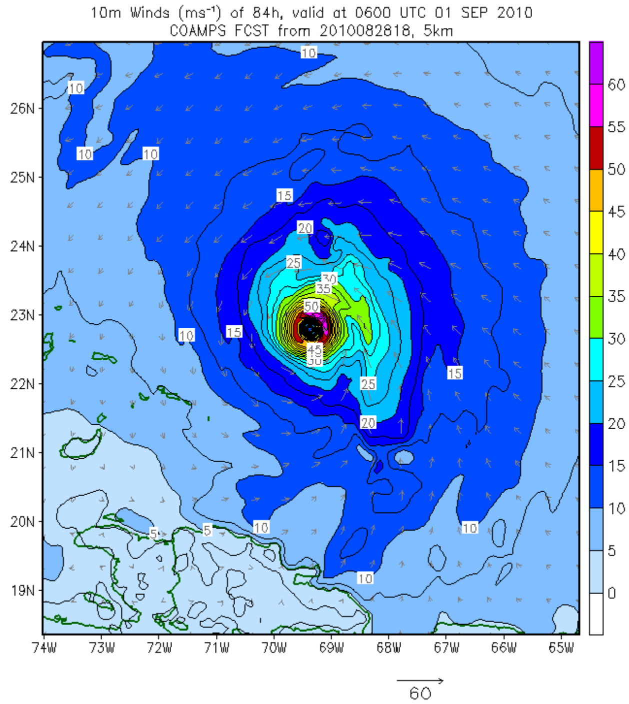
Small scale (5-km domain)

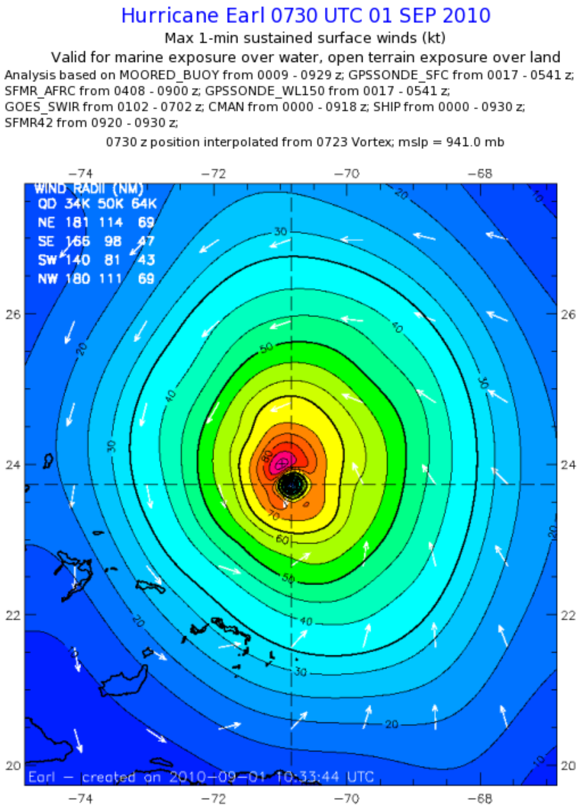
Early 10-m winds (m s^{-1}) 84 h forecasts

CNTL



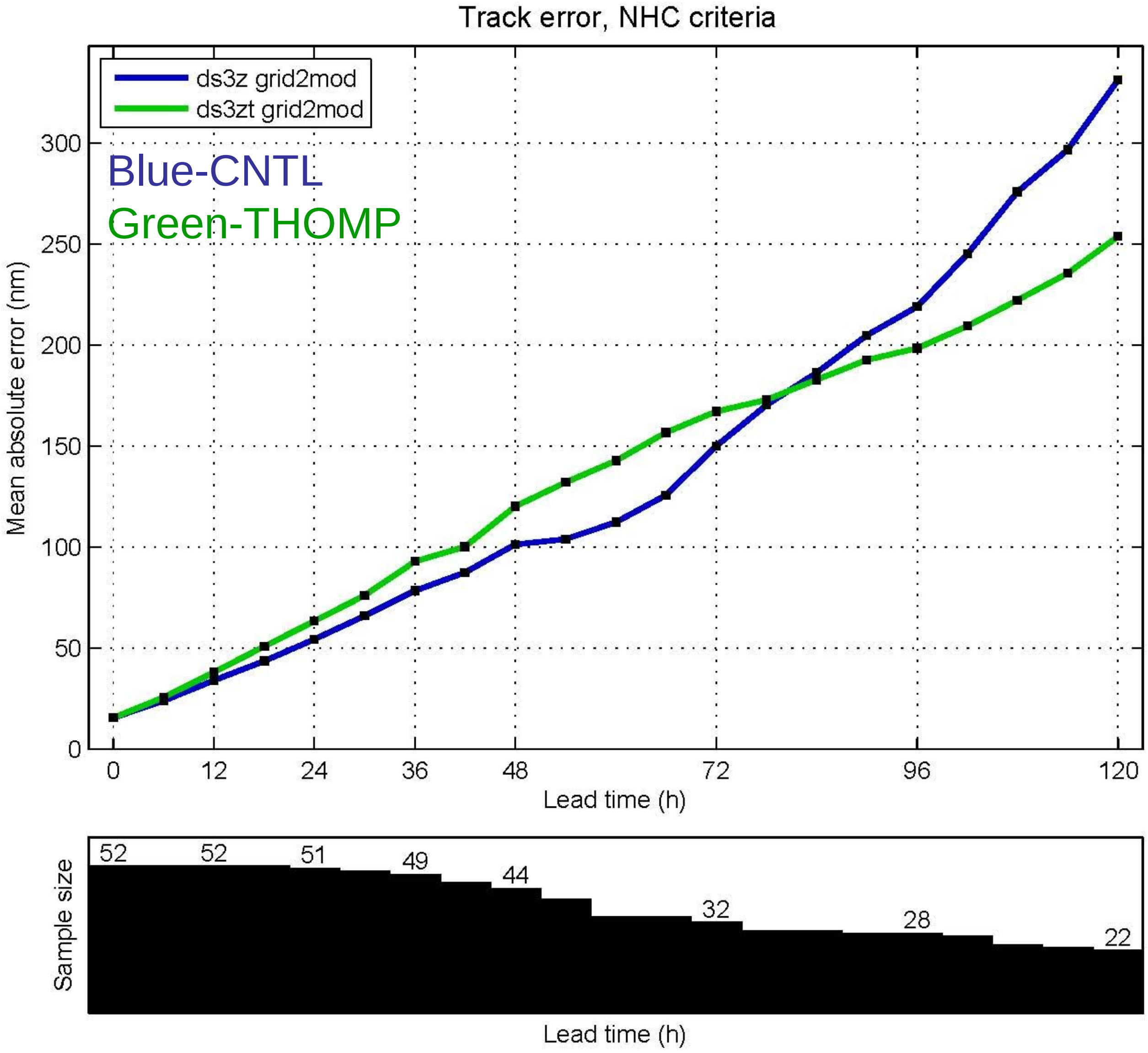
THOMP



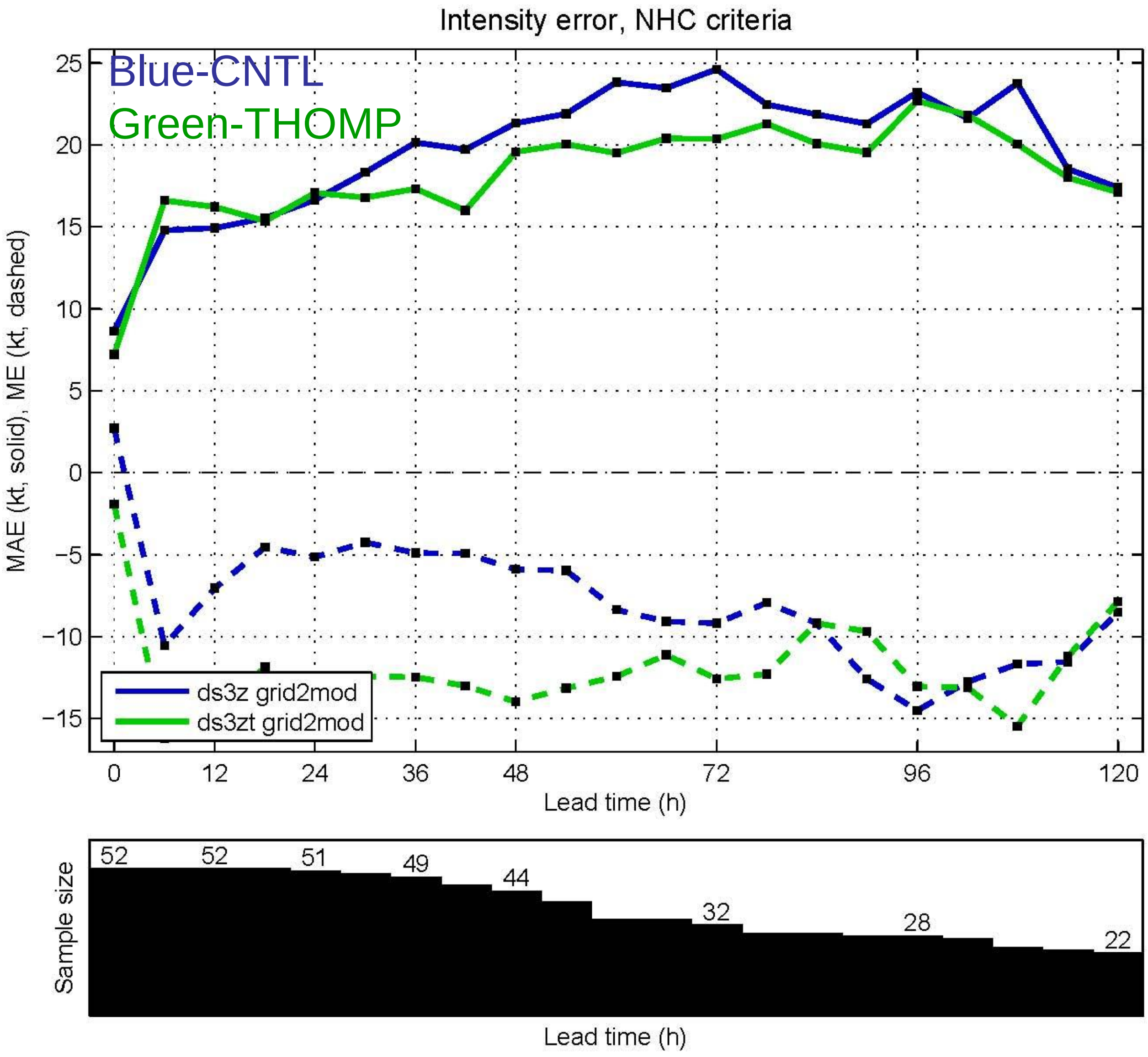


• The THOMP run has strong MSW and tighter gradients than the CNTL run.

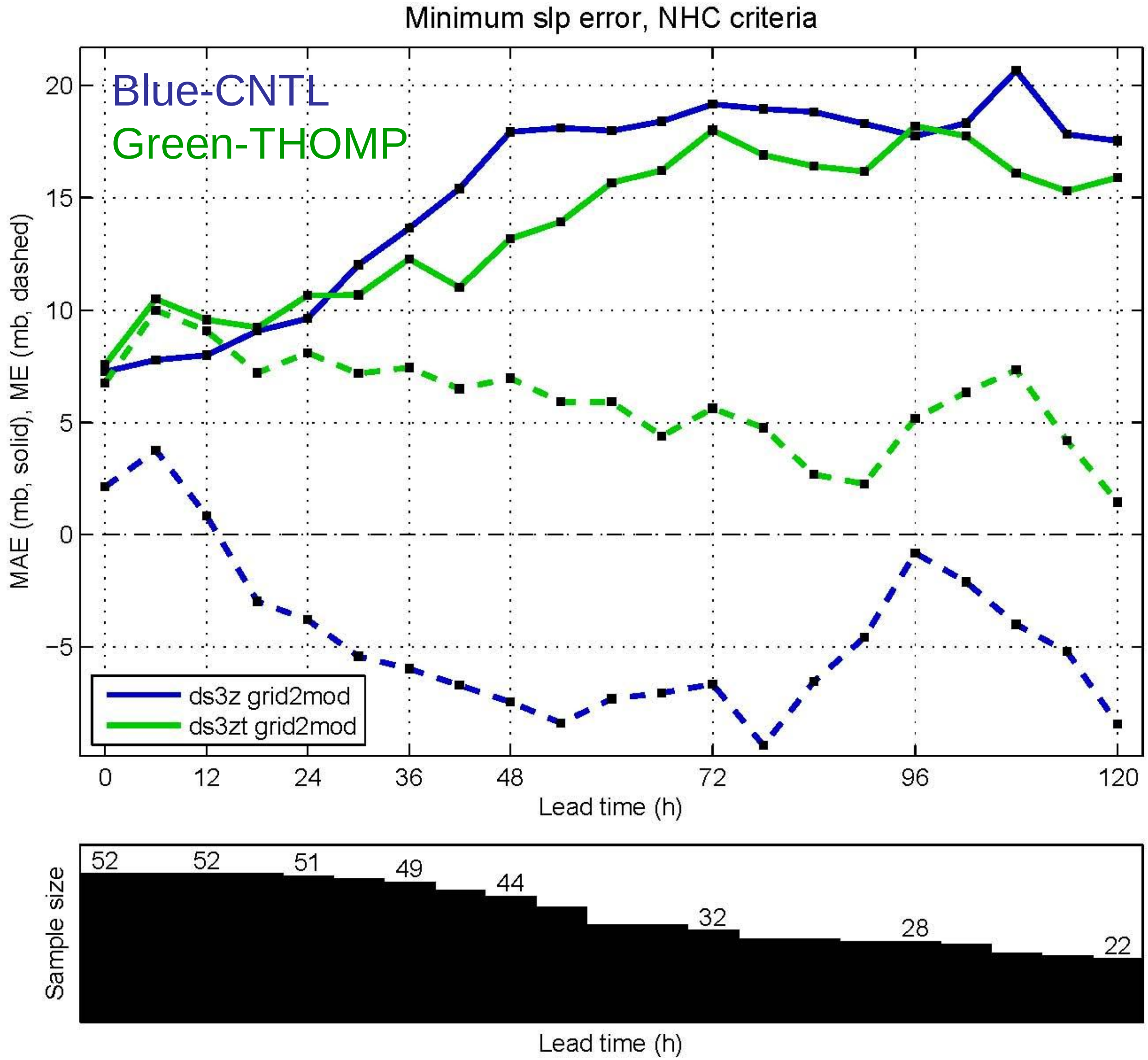
Track Errors (5 Storms)



Intensity (MSW) Errors (5 Storms)



Intensity Errors (5 Storms)



Summary

- The Thompson microphysics scheme (V3.3) has been implemented in COAMPS® and evaluated for TCs (as well as stratus clouds over the southeast Pacific and convections over CONUS).
- Compared to the control run, the THOMP run produced much less graupel at mid to upper levels, but much more snow at upper levels.
- The intensification rate during the first 24 h of forecast from the CNTL run is faster than that from the THOMP run.
- The TC inner core from the THOMP run has a much tighter structure than the CNTL run, leading to different pressure-wind relationship between these two runs.
- The Thompson scheme requires more CPU time (about 30-40% due to implementation and scheme)

COAMPS Microphysics Scheme