Evaluation of GFS-driven CMAQ Predictions of $PM_{2.5}$ and O_3 at NOAA

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Objectives

- To evaluate CMAQ predictions of $PM_{2.5}$ and O_3 driven by the new GFS (GFSv15 with FV3 dynamic core) instead of NAM.
- To identify the issues associated with GFS-driven CMAQ predictions.

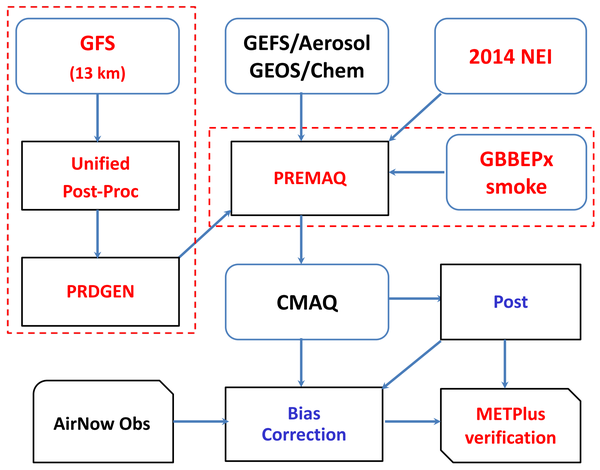

Fig.1 A flow-chart of the GFS-CMAQ system (new Changes as indicated by the red dashed boxes)

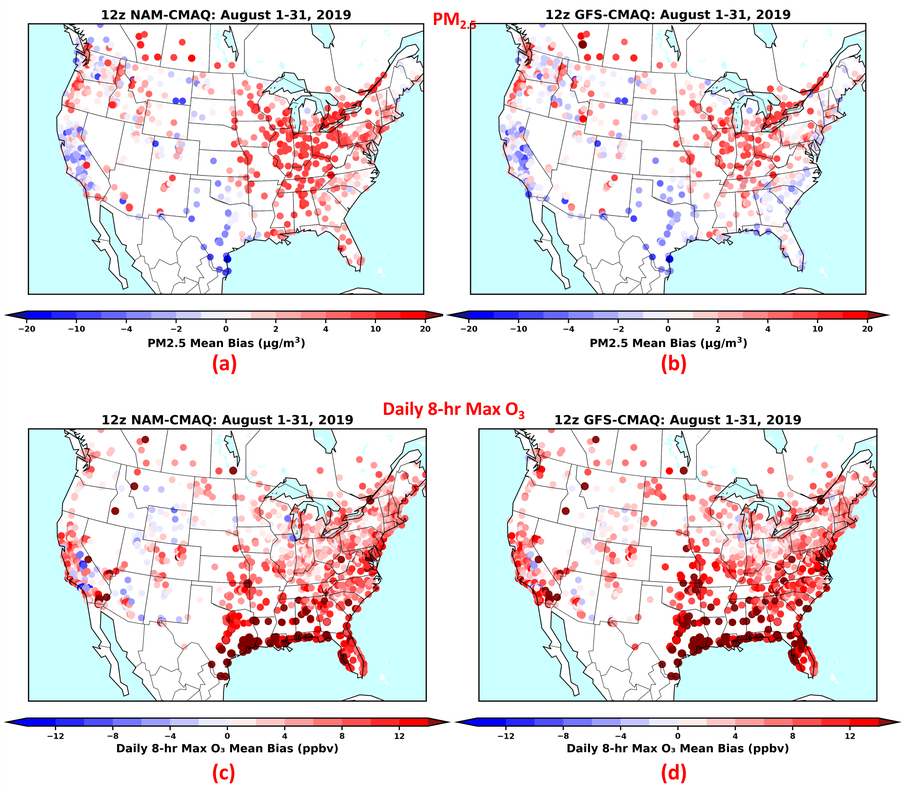

Fig.2 Comparisons of NAM-CMAQ (a and c) with GFS-CMAQ (b and d) prediction biases of monthly mean $PM_{2.5}$ and daily 8-hr maximum O_3 in August 2019 (left: NAM-CMAQ, right: GFS-CMAQ; top: $PM_{2.5}$; bottom: O_3)

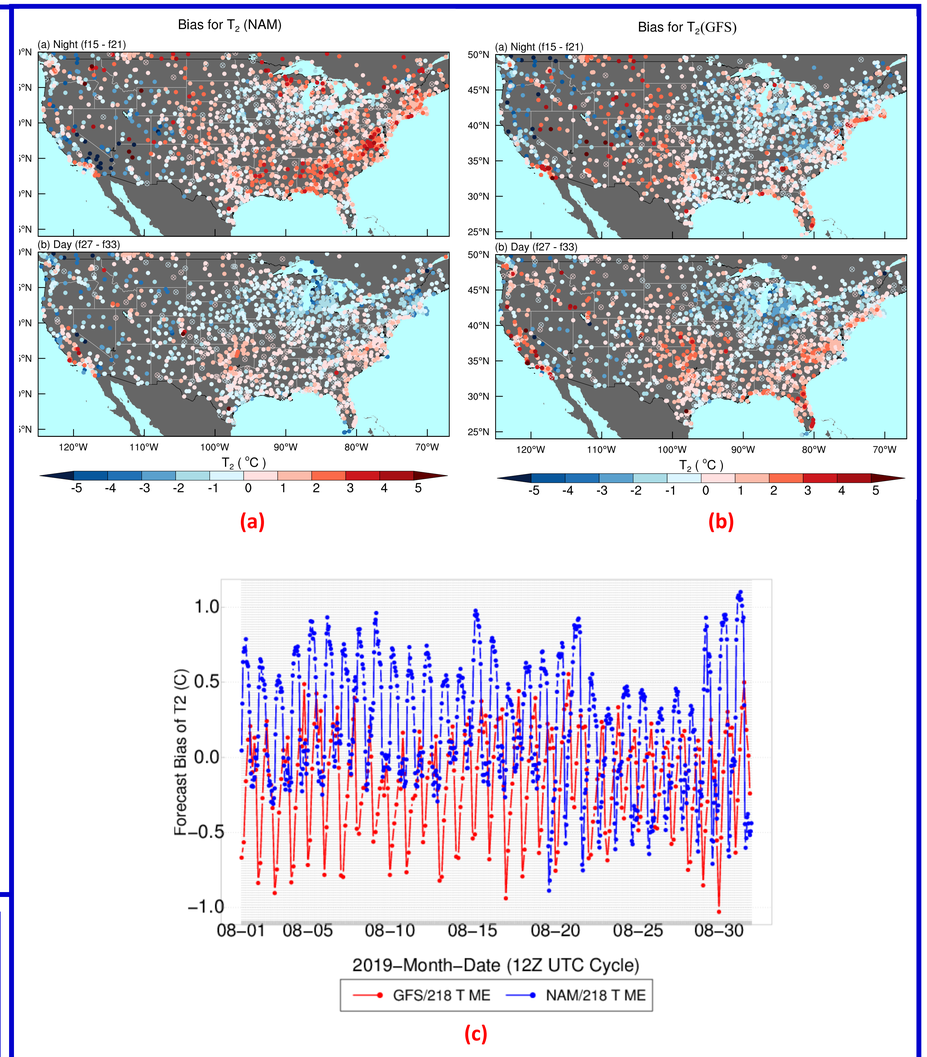

Fig.4 A comparison of prediction biases of T2 between NAM and GFS in August 2019 (a: NAM-predicted daytime and nighttime T2: b: counterparts of GFS predictions; c: forecast biases of T2)

Model Configurations and verification

• NAM-CMAQ (operational)

–**NMMB**: 12-km grid-spacing, 64 vertical layers

–**CMAQ v5.0**.2: 12-km, 35 levels

–**CB05 gas-phase chemistry & Aero-6 module**

–**Fire emissions**: Hazard Mapping System (HMS) fire product

–**NGAC LBCs** for dust only

• GFS-CMAQ (Experimental)

–**GFSv15**: 13 km, 64 levels, FV3 dynamic core

–**CMAQ v5.0.2**: 12-km, 35 levels

–**CB05 gas-phase chemistry & Aero-6 module**

–*GEFS-Aerosol LBCs* for full aerosols

–**Fire emissions**: Global Biomass Burning Emissions Product (GBBEPx)

• Anthropogenic Emissions

–NEI 2014 Mobile v2 and area sources

–BEIS v3 biogenic emissions

▪ Verification

–MetPlus verification tool

–AirNow measurements

–August 1-31, 2019

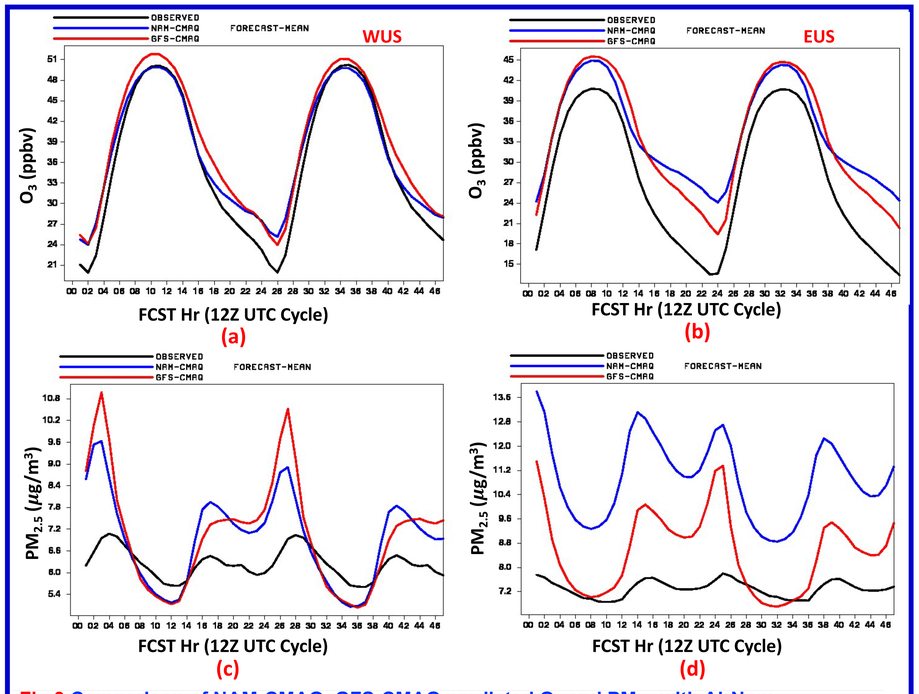

Fig.3 Comparison of NAM-CMAQ, GFS-CMAQ predicted O_3 and $PM_{2.5}$ with AirNow observations between WUS (left) and EUS (right) in Aug 2019 (upper O_3; bottom: $PM_{2.5}$)

Summary and Conclusions

–**GFS-driven CMAQ improves $PM_{2.5}$ predictions and nighttime O_3 over EUS but over-predicts both O_3 and $PM_{2.5}$ over WUS.**

–**$PM_{2.5}$ prediction is improved with GBBEPx fire emissions (figure not shown)**

–**Both NAM and GFS driven CMAQ show significant over-prediction of O_3 over SEUS especially near Gulf Coast.**

–**Significant over-predictions of $PM_{2.5}$ are found over the regions near the southern shorelines of the Great Lakes, including NY, PA, OH, IN, MI, etc.**

–**Early morning $PM_{2.5}$ prediction peak over WUS becomes more prominent when CMAQ is driven by GFS.**

–**GFS cold bias cannot explain more over-prediction of O_3. A full understanding requires further investigation.**