NCEP Global Aerosol Forecasting System: An overview and it application for improving weather and air quality forecasts

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Introduction

- **Goal :**
  - Integration of aerosol modeling and monitoring capabilities into NOAA weather-air quality forecast system via the NCEP-GSFC-Howard University collaborations

- **Proposed enhancements:**
  - **NOAA medium range weather forecasts**
    - Climatology-based aerosol distributions are used in the GFS and background aerosol conditions are assumed in the GSI Community Radiative Transfer Model (CRTM)
    - Global aerosol products will improve the representation of aerosol distributions and variations in the GFS/GSI system
  - **NOAA air quality forecasts**
    - Default static boundary conditions are used for the developmental aerosol air quality predictions
    - Global aerosol products will provide improved aerosol lateral boundary conditions for the AQF system

Introduction (cont'd)

- **Tasks:**
  - Integration of prognostic aerosols (GOCART) in GFS
  - Utilization of NASA aerosol measurements in GSI
  - Downstream coupling
    - Regional AQF system (Lateral PM BCs)
    - SST analysis system (atmospheric correction)

- **Multiple, complementary approaches:**
  - On-line systems including GOCART:
    - **GFS/GOCART: new capability being developed**
    - GEOS-5/GOCART: NASA/GMAO real-time system
    - GFS~GEOS-5/GOCART: Hybrid model (GEOS-5 dynamics + GFS physics)
  - **Off-line GOCART CTM (NWS AQ project)**
    - Driven by GFS meteorology

- **Phased development:**
  - Development of prototype GFS-GOCART system
  - Transition to real time system
  - Transition to operational applications

Status of on-line GFS-GOCART

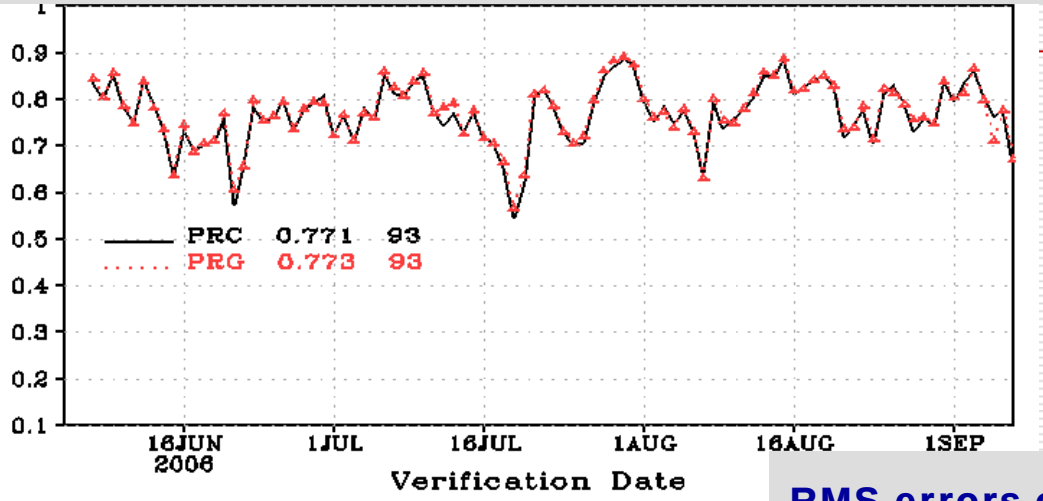
Status of offline GFS-GOCART (dust only)

The impact of aerosols on medium range weather forecasts

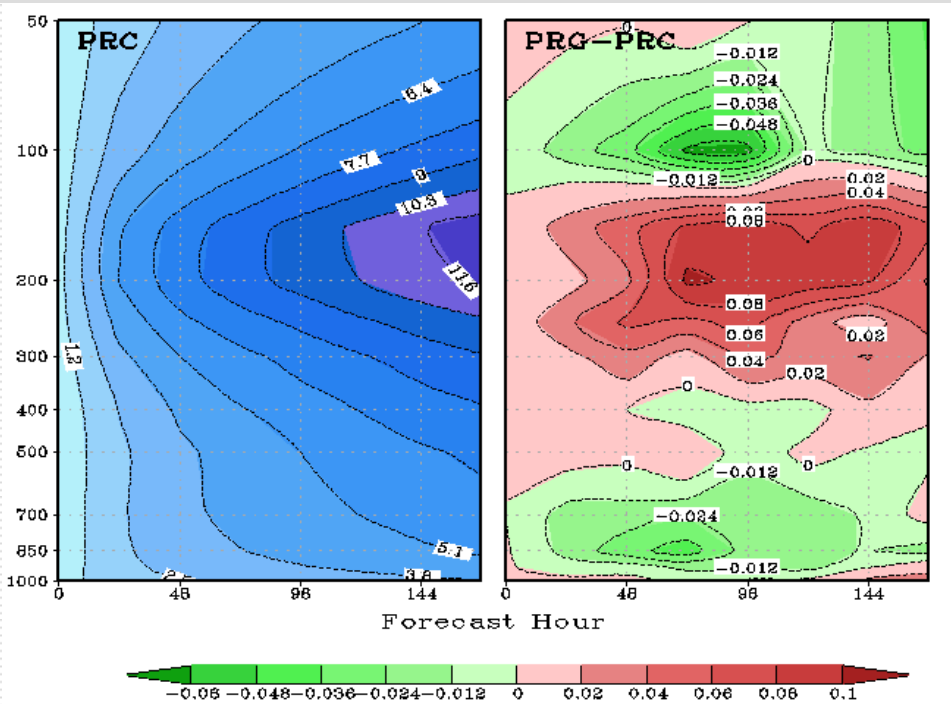
GDAS Experiments with different aerosol representations

- Model configuration: T126 L64
- Sigma-pressure hybrid coordinate
- Initialized from 2006-06-01 00Z GDAS analysis
- 14-week cycling (ending date = 2006-09-07)
- Aerosol scheme configuration
  - **PRC (climatology):** OPAC climatological scheme (5˚ x 5˚ monthly climatology)
  - **PRG (time varying):** Prognostic representation in which aerosols are transported as passive tracers and updated every 6 hour from GEOS4-GOCART analysis (1.25° x 1°)
- GEOS4-GOCART aerosol dataset is used as the proxy of our own GFS-GOCART simulations, when available.
- The experimental aerosol treatment only impacts the model results via its direct effect on the radiative forcing of the atmosphere

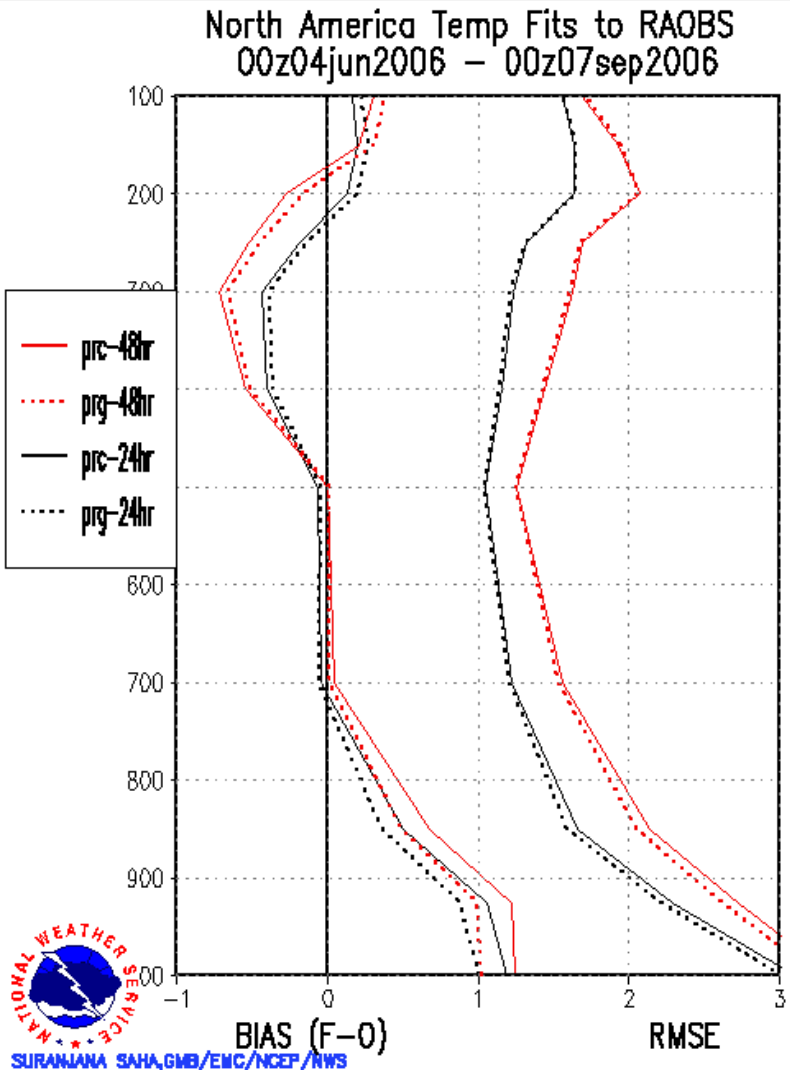
Anomaly correlation for 5-day forecasts of NH 500 mb heights

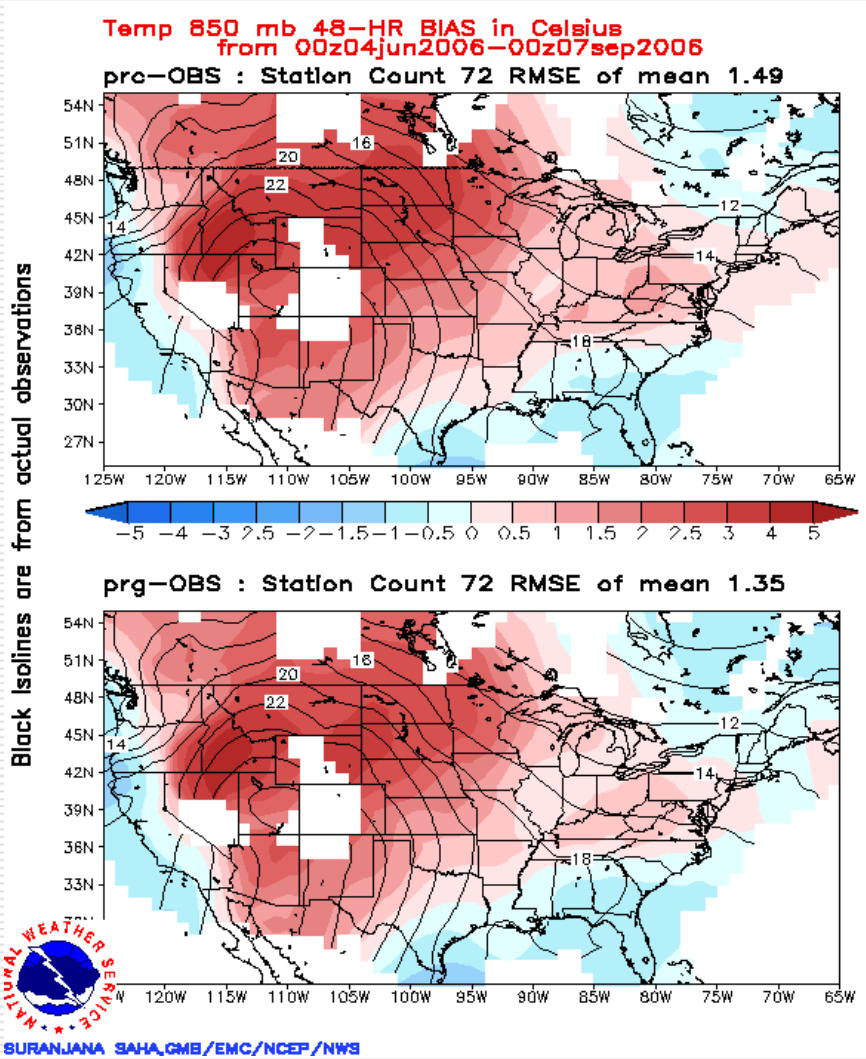


RMS errors of tropical winds for 00Z forecasts



North America temperature verification: biases and RMSE





The impact of lateral aerosol boundary conditions on PM air quality forecasts

National Air Quality Forecast Capability: WRF-NMM/CMAQ

- Driven by hourly meteorological forecasts from the operational North America Mesoscale (NAM) WRF-NMM prediction system
- The operational CMAQ system covers continental USA in 12km horizontal resolution

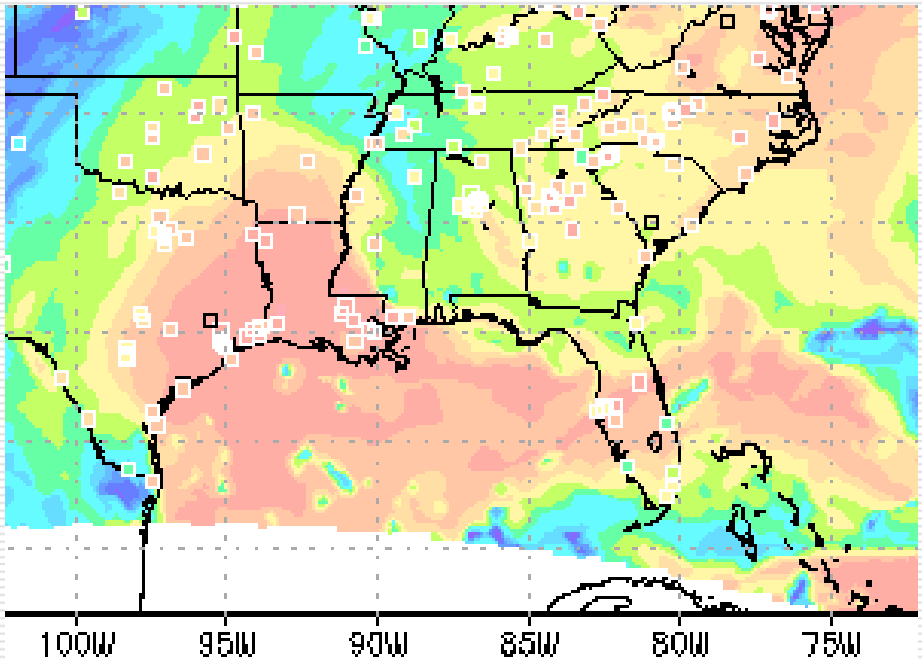
Experimental configuration: dynamic LBCs from global models

	RAQMS (Real-time Air Quality Modeling System, Pierce et al, 2003)	**Offline GFS-GOCART (dust only)**
Horizontal Resolution	2°×2°	T126 (~1°x1°)
Meteorology	GFS analysis	GFS retrospective forecasts
Anthropogenic emissions	GEIA/EDGAR with updated Asian emission (Streets et al. 2003)	Not active
Biomass burning emissions	ecosystem/ severity based	Not active
stratospheric ozone	OMI/TES assimilation (Pierce et al., 2007)	Not applicable
Input frequency to CMAQ	Every 6 hours	Every 3 hours

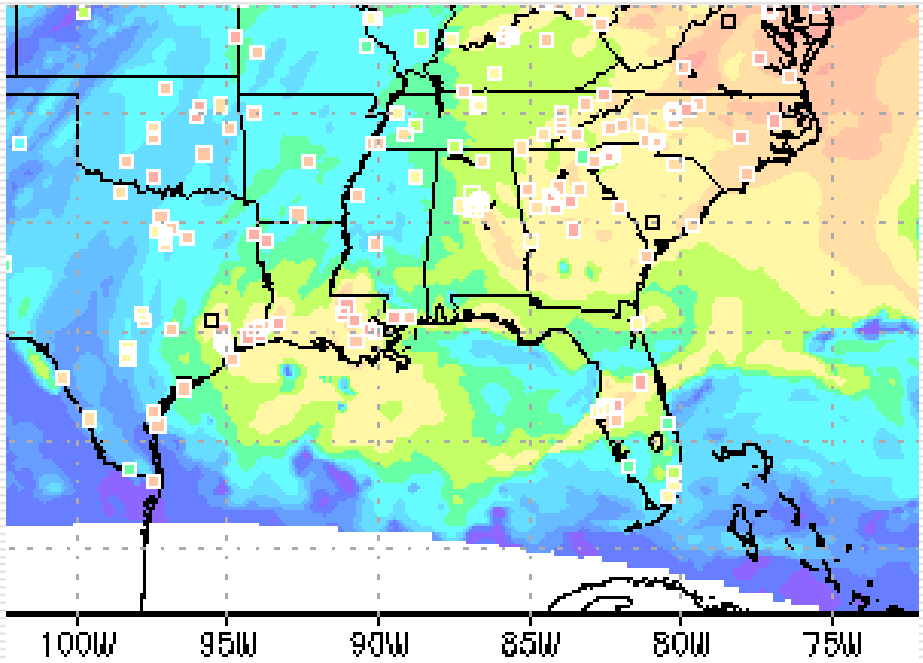
- During Texas Air Quality Study 2006, the model inter-comparison team found all 7 regional air quality models missed some high-PM events, due to trans-Atlantic Saharan dust storms.
- These events are re-visited here, using dynamic lateral aerosol boundary conditions provided from global models.

CMAQ surface PM2.5 (µg/m3) compared to AIRNOW at 18Z, 08/02/2006

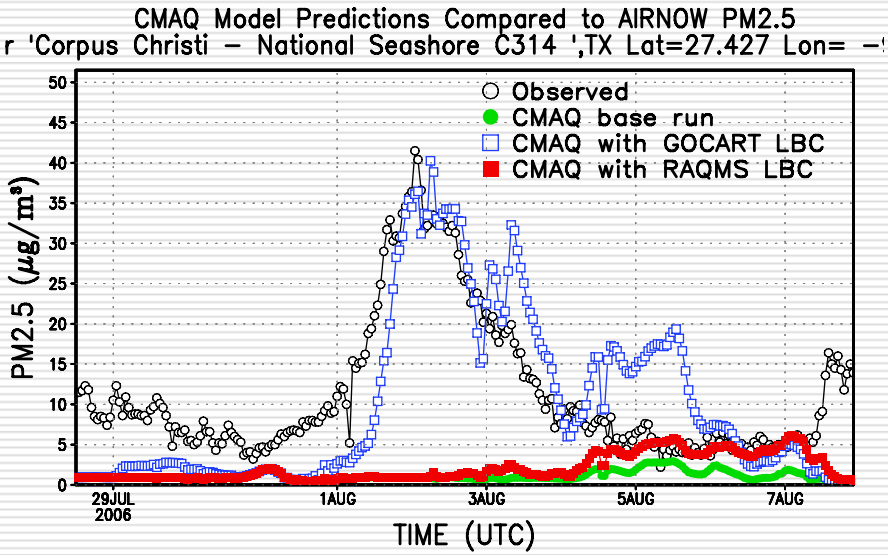
GFS-GOCART LBC

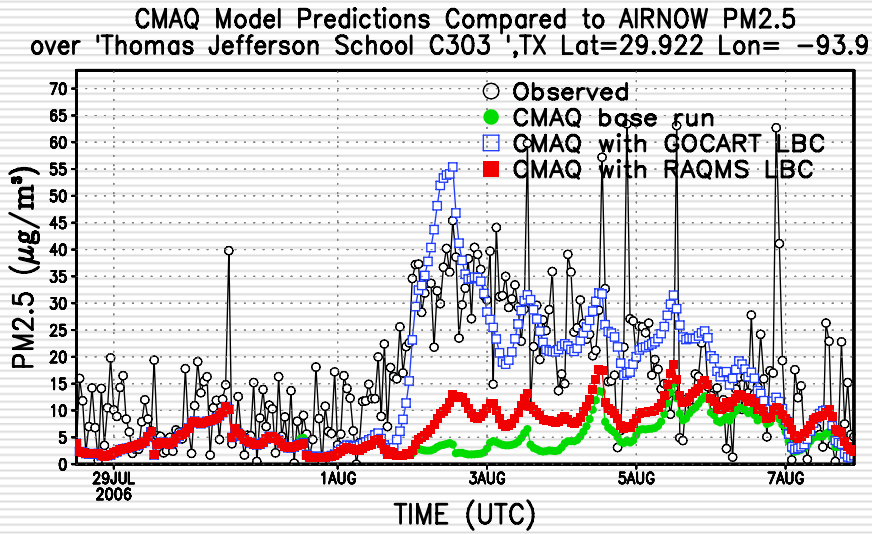


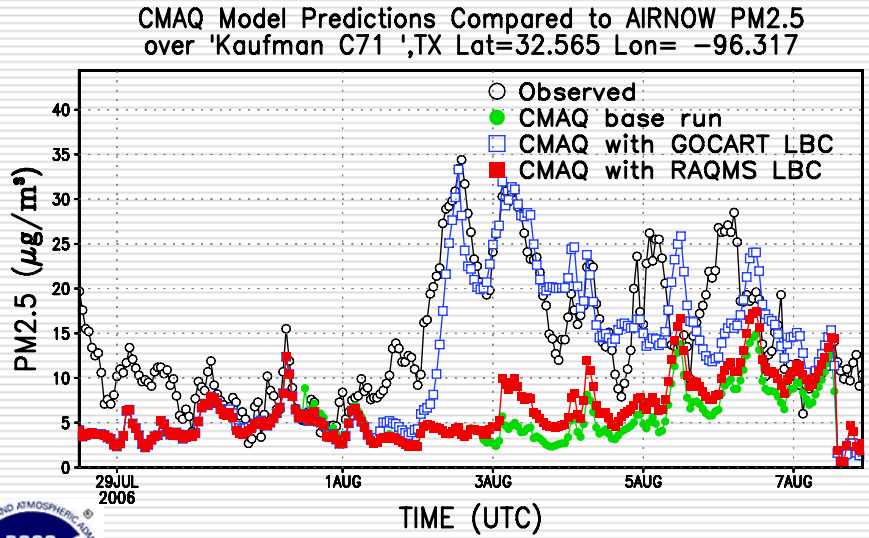
RAQMS LBC

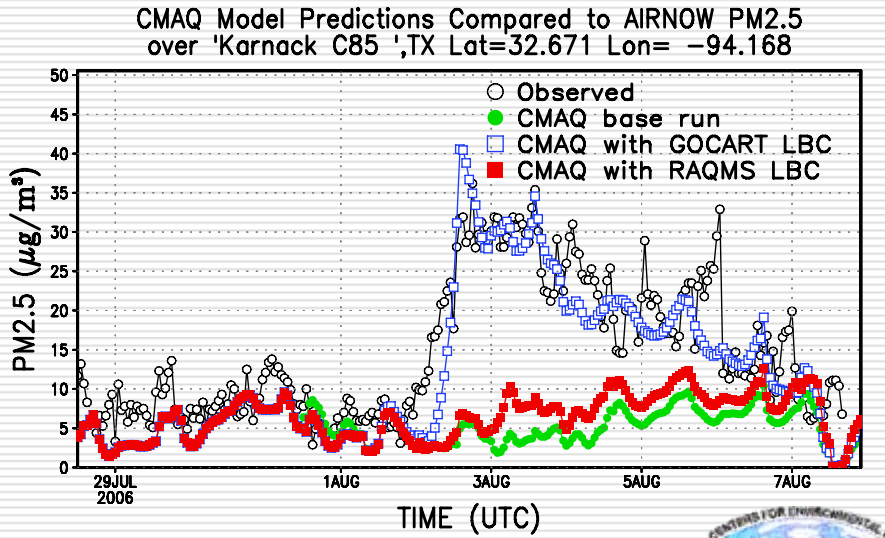


Mod-Obs comparison at 4 surface stations over Texas









Conclusions

- NCEP recently initializes the efforts to develop global aerosol forecasting and assimilation capability in GFS/GSI via the NCEP-GSFC-Howard University collaborations.
- Impact study 1:
  - GFS/GSI experiments with different aerosol representations (climatological versus prognostic aerosols) are conducted
  - Changes in model forecasts arises from the direct radiative effects
  - Overall appears to be a neutral to slight improvement
- Impact study 2:
  - Dust simulations from off-line GFS-GOCART system are used as lateral aerosol BCs for AQF (experimental configuration)
  - Verification with AIRNOW PM observations shows good improvement

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