Development toward global aerosol DA system at NCEP

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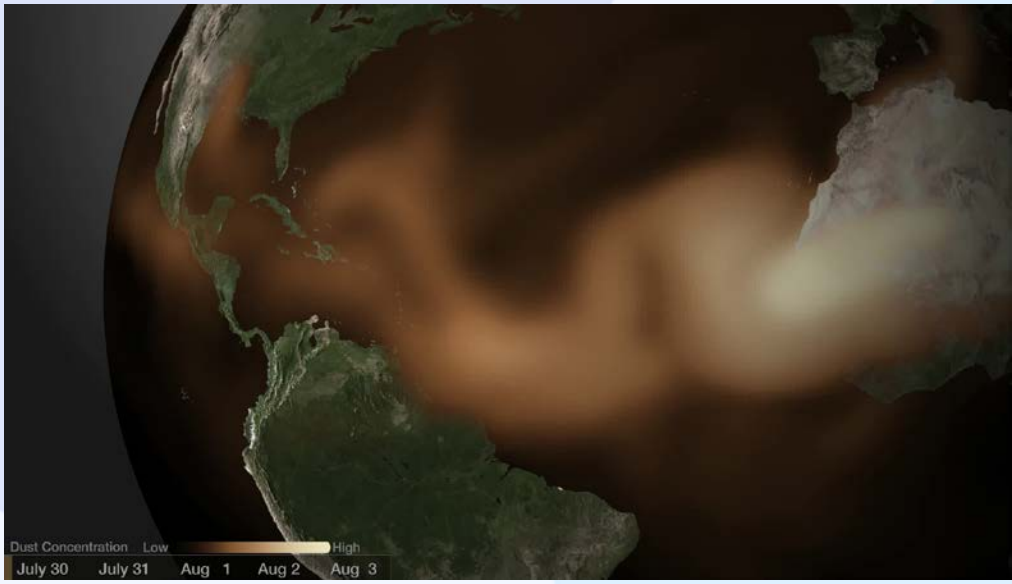
Arlindo da Silva (GSFC)

EMC GSI-EnKF group

Current Operational NEMS GFS Aerosol Component

Current State

- Near-real-time operational system
- The first global in-line aerosol forecast system at NCEP
- AGCM : NCEP's NEMS GFS
- Aerosol: GSFC's GOCART
- 120-hr dust-only forecast once per day (00Z), output every 3-hr
- ICs: Aerosols from previous day forecast and meteorology from operational GDAS
- Implemented into NCEP Production Suite in Sept 2012



Ongoing Activities and Future Plans

- Use near-real-time smoke emissions from satellites (collaborating with NESDIS /GSFC) **FY15**
- Full package implementation (dust, sea salt, sulfate, and carbonaceous aerosols) **FY16**
- Aerosol analysis using VIIRS AOD **FY17**
- Provide aerosol information for potential downstream users
  - Aerosol lateral boundary conditions for regional operational air quality model CMAQ **FY16**
  - NESDIS's SST retrievals, CPC-EPA UV index forecasts

NGAC dust verification: event Jul 30 – Aug 3, 2013

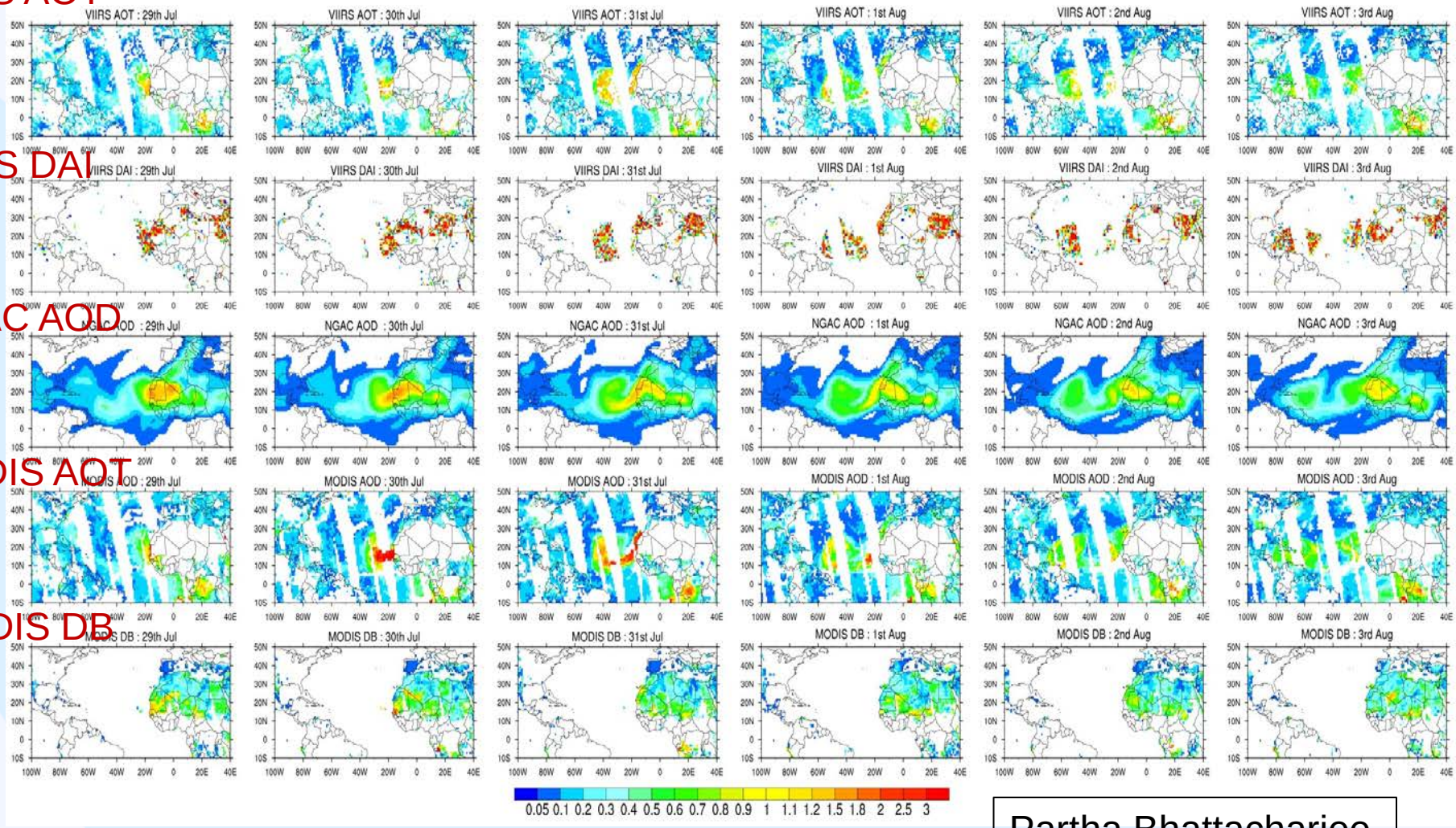
VIIRS AOT

VIIRS DAI

NGAC AOD

MODIS AOT

MODIS DB

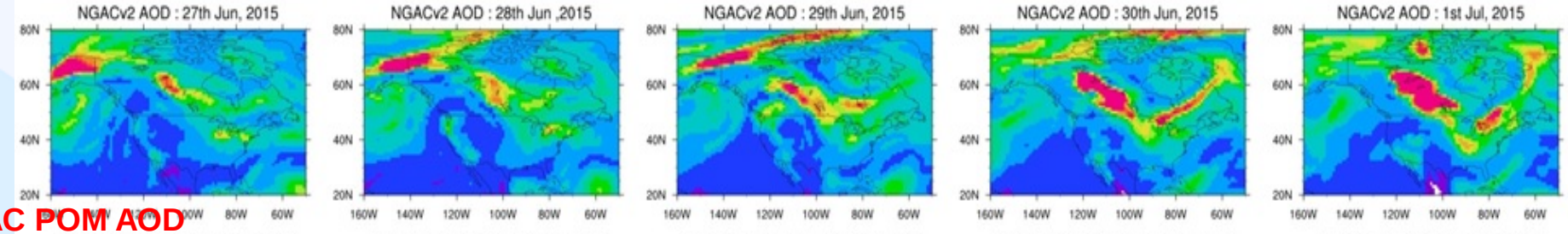


Partha Bhattacharjee

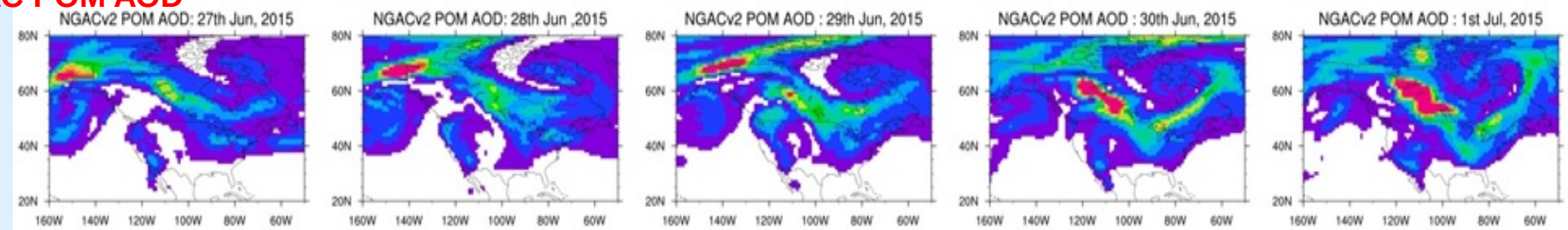
VIIRS data source:
http://www.star.nesdis.noaa.gov/smcd/emb/viirs_aerosol/products_gridded.php

Smoke Event on Jun 27- Jul 1, 2015

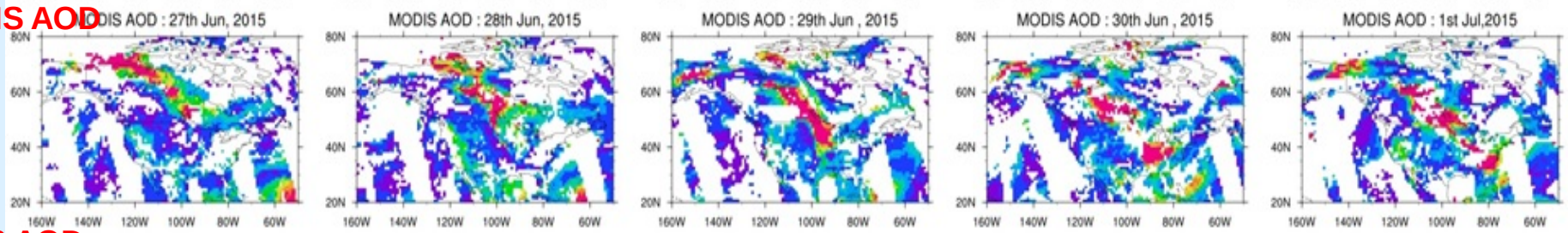
NGAC AOD



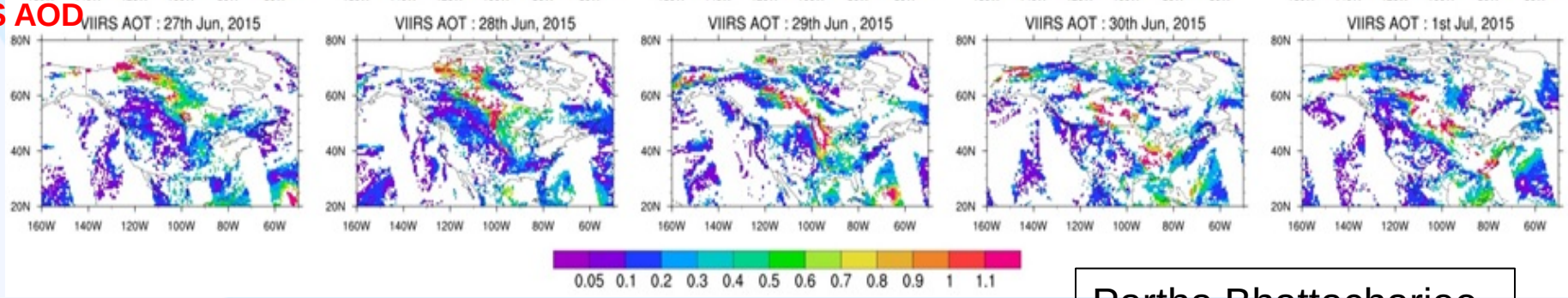
NGAC POM AOD



MODIS AOD



VIIRS AOD

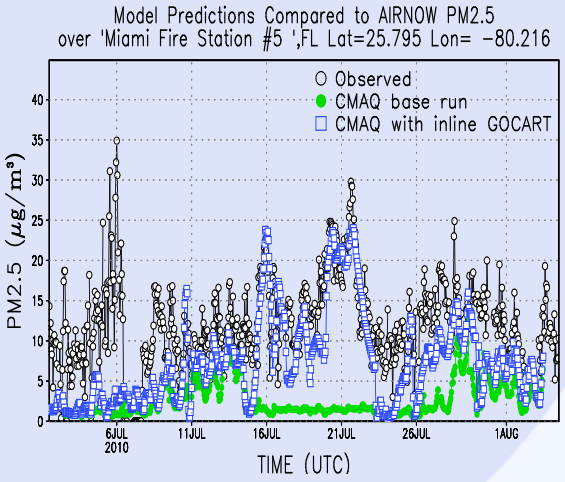


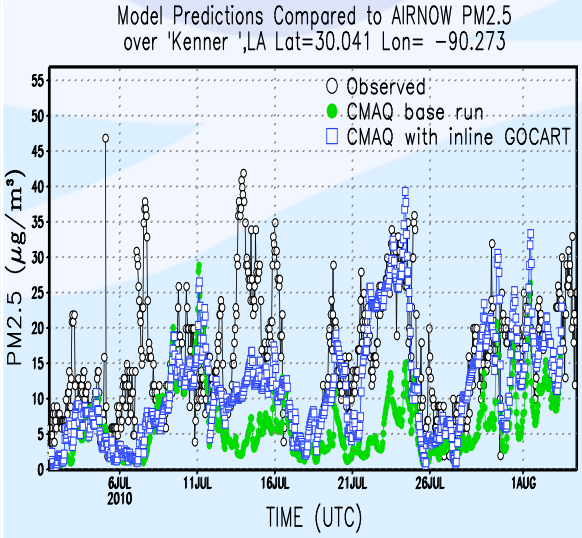
Partha Bhattacharjee

Dynamic LBCs for regional models

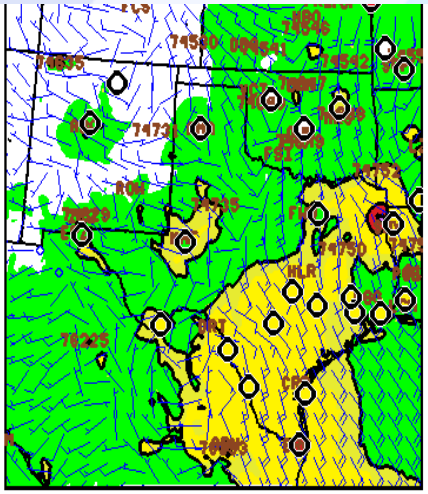
- Baseline NAM-CMAQ with static LBCs versus experimental NAM-CMAQ with dynamic LBCs from NGAC, verified against AIRNOW observations
- The inclusion of LBCs from NGAC prediction is found to improve PM forecasts, and it is in CMAQ Q12016 implementation.

	CMAQ Baseline	CMAQ Experimental
Whole domain July 1 – Aug 3	MB= -2.82 R=0.42	MB= -0.88 R=0.44
South of 38°N, East of -105°W July 1 – Aug 3	MB= -4.54 R=0.37	MB= -1.76 R=0.41
Whole domain July 18– July 30	MB= -2.79 R=0.31	MB= -0.33 R=0.37
South of 38°N, East of -105°W July 18– July 30	**MB= -4.79 R=0.27**	**MB= -0.46 R=0.41**

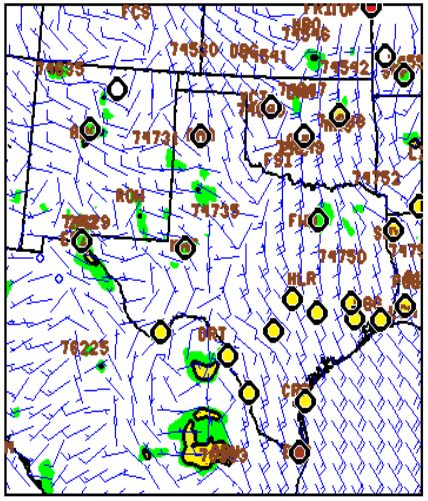




Dust event on 20150510
CMAQ PARA vs PROD



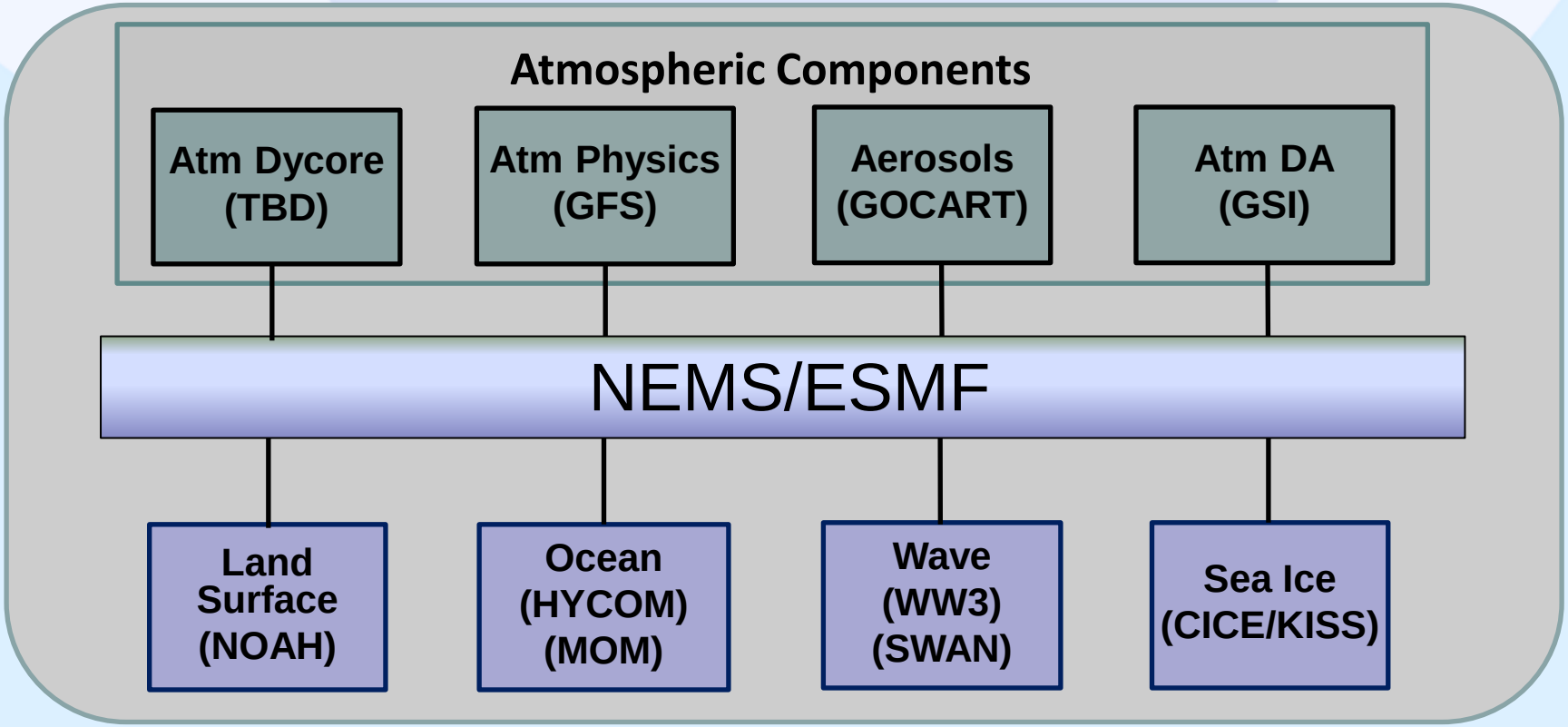
PARA1 AQM .BC SFC DAY1 PMMXO1 20150510 12Z CYCLE



PROD AQM SFC DAY1 PMMXO1 20150510 12Z CYCLE

Youhua Tang

NGGPS Prediction Model Components



- NGGPS implementation plan development includes an aerosol team
- Development of dust/aerosol capabilities is underway by universities and federal labs

Ivanka Stajner (NWS)

AEROSOL AOD Data Assimilation

- Other centers (e.g., NRL, ECMWF, GMAO) are assimilating MODIS AOD
- The assimilation of aerosol observations has proven successful in providing initialization for aerosol forecasts as well as improving aerosol forecast skills

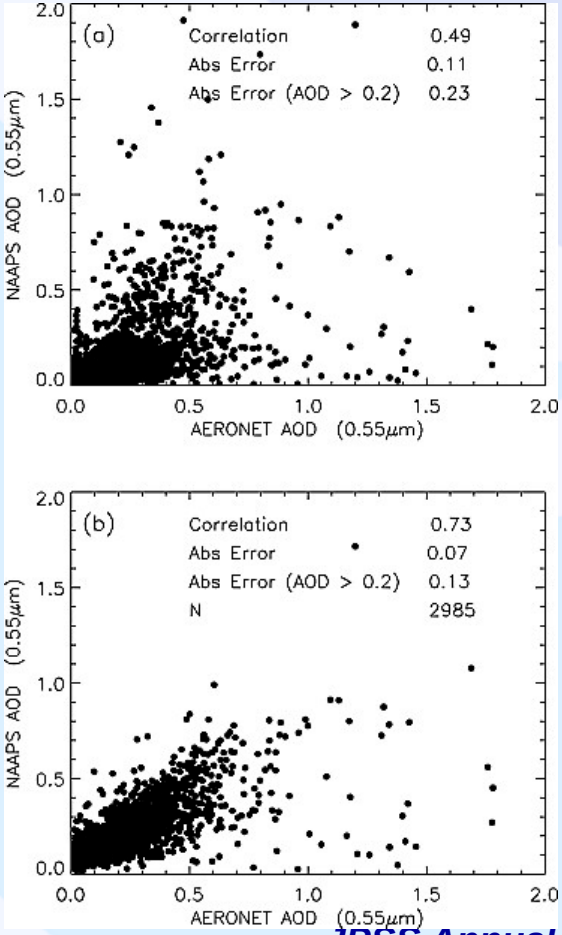


Figure 1 AERONET AOD versus NAAPS AOD for 5-month (January – May 2006) non-assimilation run (top) and NAAPS runs with the aerosol data assimilation process (bottom). Zhang, J. et al. 2008

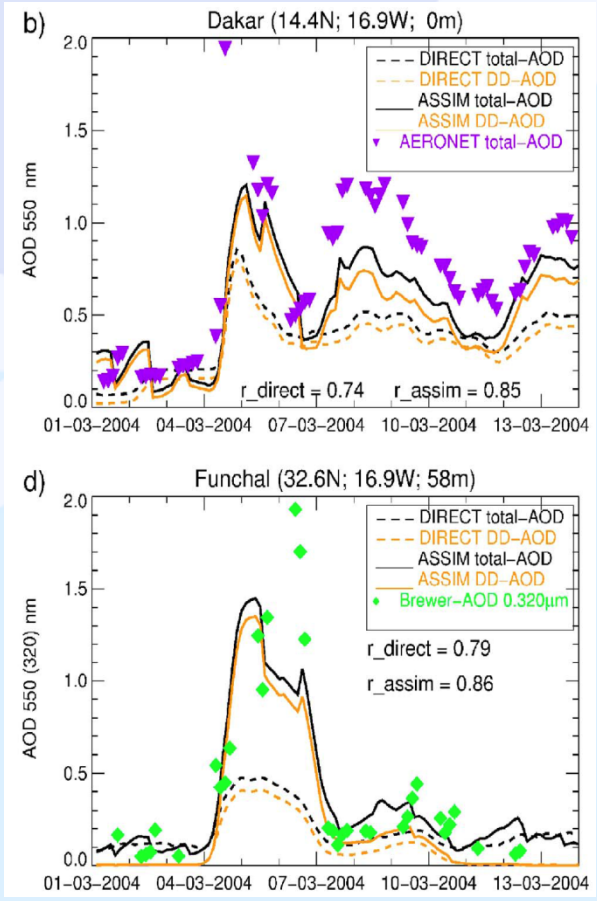


Figure 2 Time series of AOD at 550nm at 2 AERONET sites from ECMWF aerosol modeling system. Mangold, A. et al. 2011

Aerosol data assimilation development in NCEP

- NCEP operational global aerosol model was built upon multi-agency collaboration including NCEP, NASA, NESDIS and universities.
- NCEP aerosol data assimilation project was suspended in 2012 due to budgetary constraints.
- NCEP aerosol analysis development is aligned with NWS's efforts to develop the NGGPS that represents the interaction between the atmosphere, ocean, wave, sea ice, land surface, and chemistry (aerosol)
- NCEP Aerosol data assimilation is build upon existing partnership and also leverage expertise in NOAA laboratories and research communities under NGGPS program.
- NGAC aerosol data assimilation using VIIRS AOD is funded by JCSDA from 2015-2016

VIIRS AOD Data Assimilation

- Other centers (e.g., NRL, ECMWF, GMAO) are currently assessing the VIIRS aerosol products.

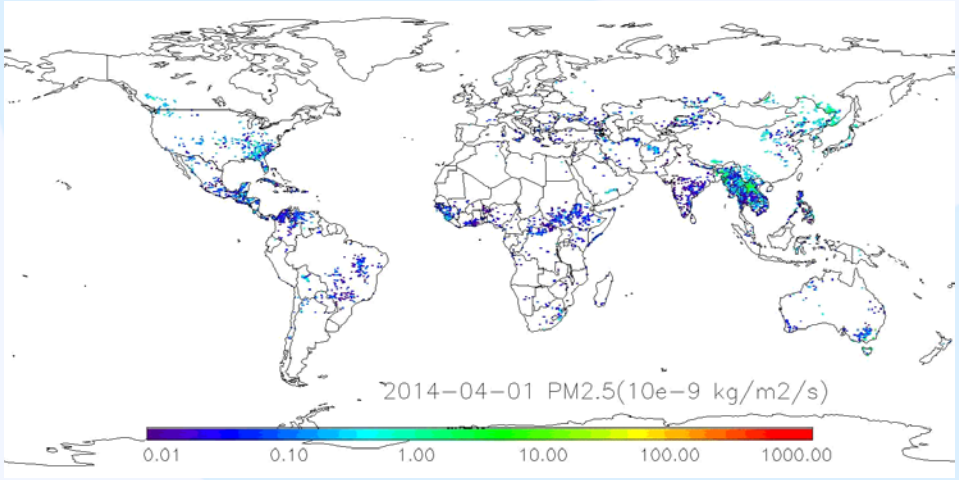
- NCEP is developing the AOD data assimilation capability and is focusing on VIIRS products (instead of the "MODIS then VIIRS" approach).

- While development work remains, ground work has been laid for building a global aerosol data assimilation capability within NGAC and Hybrid EnKF-GSI
  - Infrastructure development (CRTM supports GOCART, GSI code development for AOD DA*)
  - Near-real-time smoke emissions have been developed, implemented into operational in FY15
  - Prognostic aerosol capability has been established
  - Community aerosol modeling/assimilation efforts (ICAP, GSI)

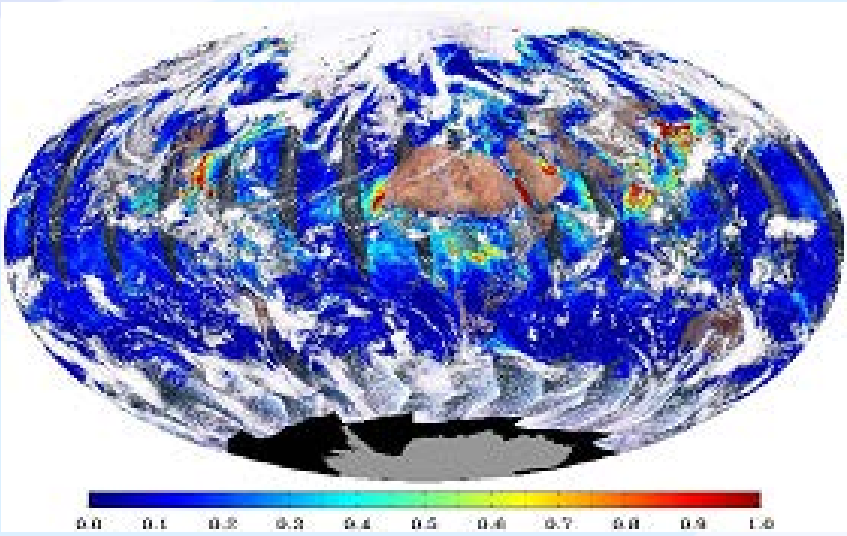
Using satellite data to improve aerosol forecasting

- Collaborations among NOAA/NCEP, NOAA/NESDIS, NASA/GSFC, and SUNYA
- Research activities:
  (1) Data assimilation of satellite aerosol observations
  (2) Near-real-time biomass burning emissions from satellite observations

Near-real-time biomass burning emissions from multiple satellites



Aerosol observations from VIIRS



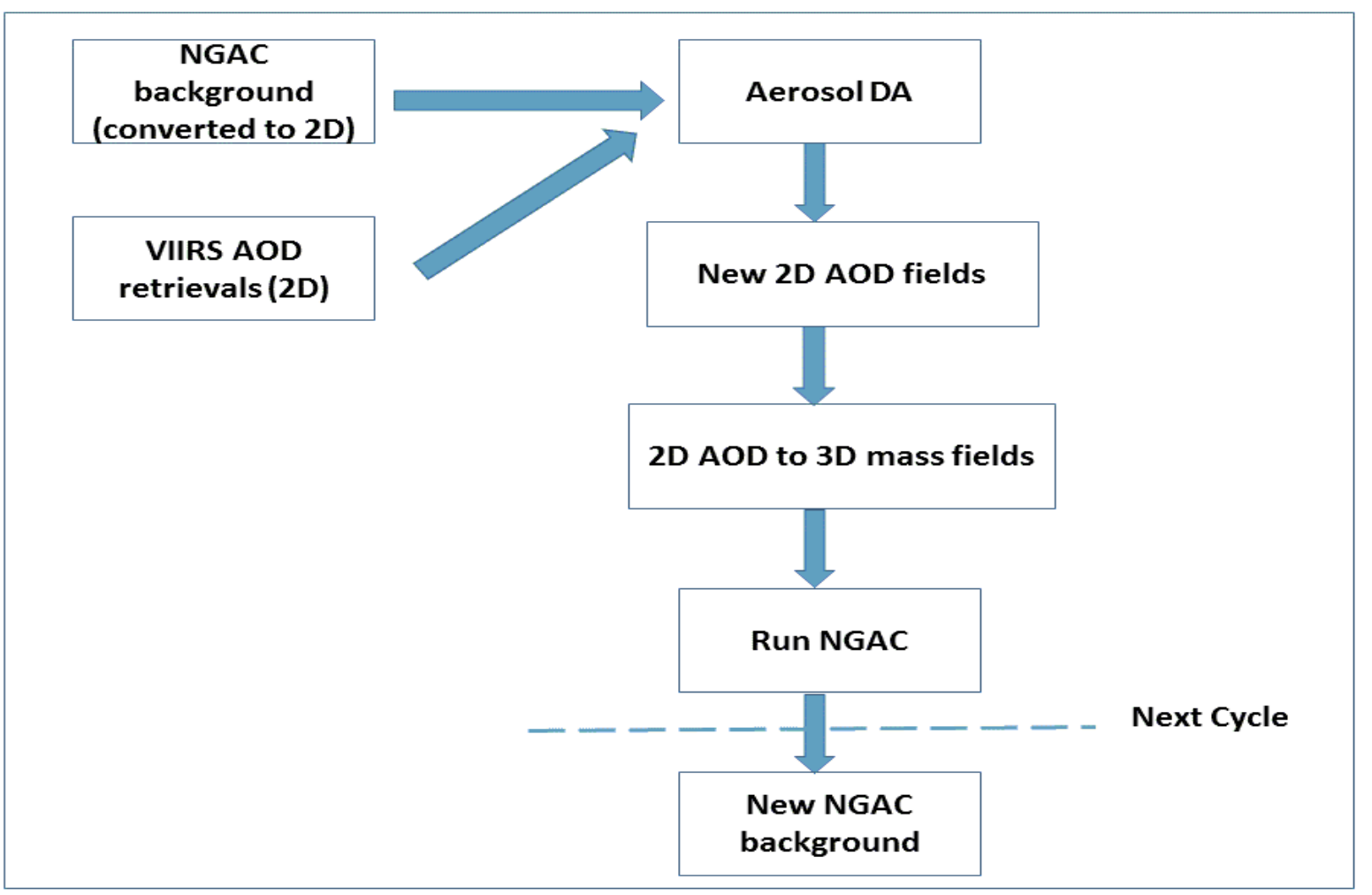
From NOAA/NESDIS/STAR website

NGAC data assimilation implementation plan

- The global aerosol analysis system at NCEP will be implemented with incremental updates
  - The first phase is based on GSI framework using VIIRS AOD as input observations and the NGAC output as first guess
  - The system will be extended to use multi-sensor and multi-platform aerosol observations and evolve to an EnKF system

- The primary outcomes include:
  - Improved operational global real-time aerosol forecasts. JPSS aerosol information will be assimilated in the NWS operational data assimilation system for the first time.
  - A prototype global coupled system with aerosol modeling and data assimilation capabilities.

NGAC Data Assimilation flow chart



Ongoing activity and Future plan

- Efforts are underway to ensure EMC's R&D and NGGPS program are aligned
  - Develop an aerosol analysis in the EnKF portion of the hybrid EnKF-GSI data assimilation system
    - using NEMS GFS Aerosol Component (NGAC, NOAA's global aerosol forecast system) output as first guess
    - aerosol measurements from MODIS and VIIRS as input observations
    - The Local Ensemble Transform Kalman Filter (LETKF)
    - Analysis weights will be computed for each vertical column in order to project 2-dimensional aerosol optical depth (AOD) information to the full 3-dimensional field.
  - The observations will be extended to include multi-sensor and multi-platform aerosol observations.

Thank You