Status Update on NCEP operational Global Aerosol Forecasting System

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Contributions from:
NCEP NEMS group,
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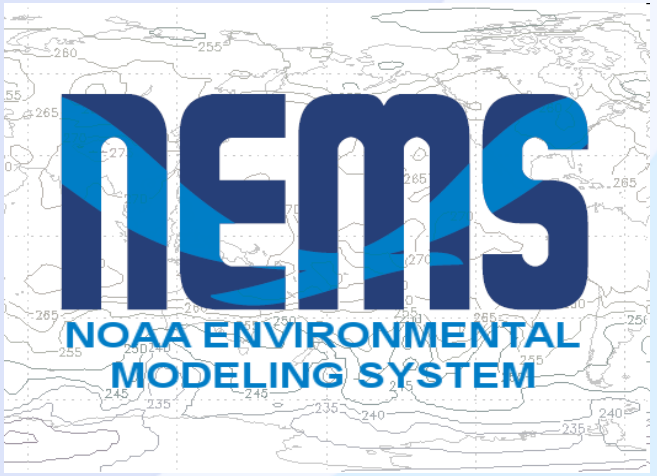
Pius Lee and Hyun Kim (ARL)

Joint efforts in NGAC research and development

NEMS team in EMC:
Atmospheric dynamics and physics
Infrastructure, I/O post
Verification
Documentation



SUNY Collaborators (Sarah Lu)
GSFC collaborators (Arlindo da Silva, Mian Chin, Peter Colarco)
NESDIS collaborators (Shobha Kondragunta, Quanhua Liu)
ICAP working group
WMO SDS-WAS experts

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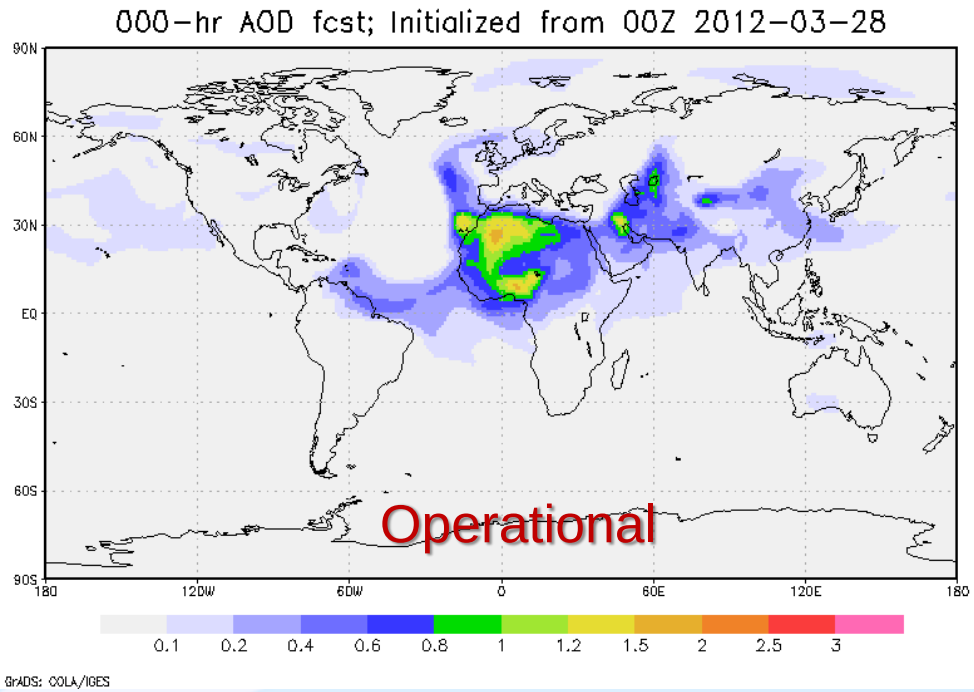
Current Operational NEMS GFS Aerosol Component

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) **FY14**
- Full package implementation (dust, sea salt, sulfate, and carbonaceous aerosols) **FY15**
- Refine the prototype volcanic ash capability (collaborating with ECMWF)
- Provide aerosol information for potential downstream users (e.g., NESDIS's SST retrievals, CPC-EPA UV index forecasts; aerosol lateral boundary conditions for regional models)

Status update at ICAP-Recent Progress in Aerosol Observability for Global Modeling

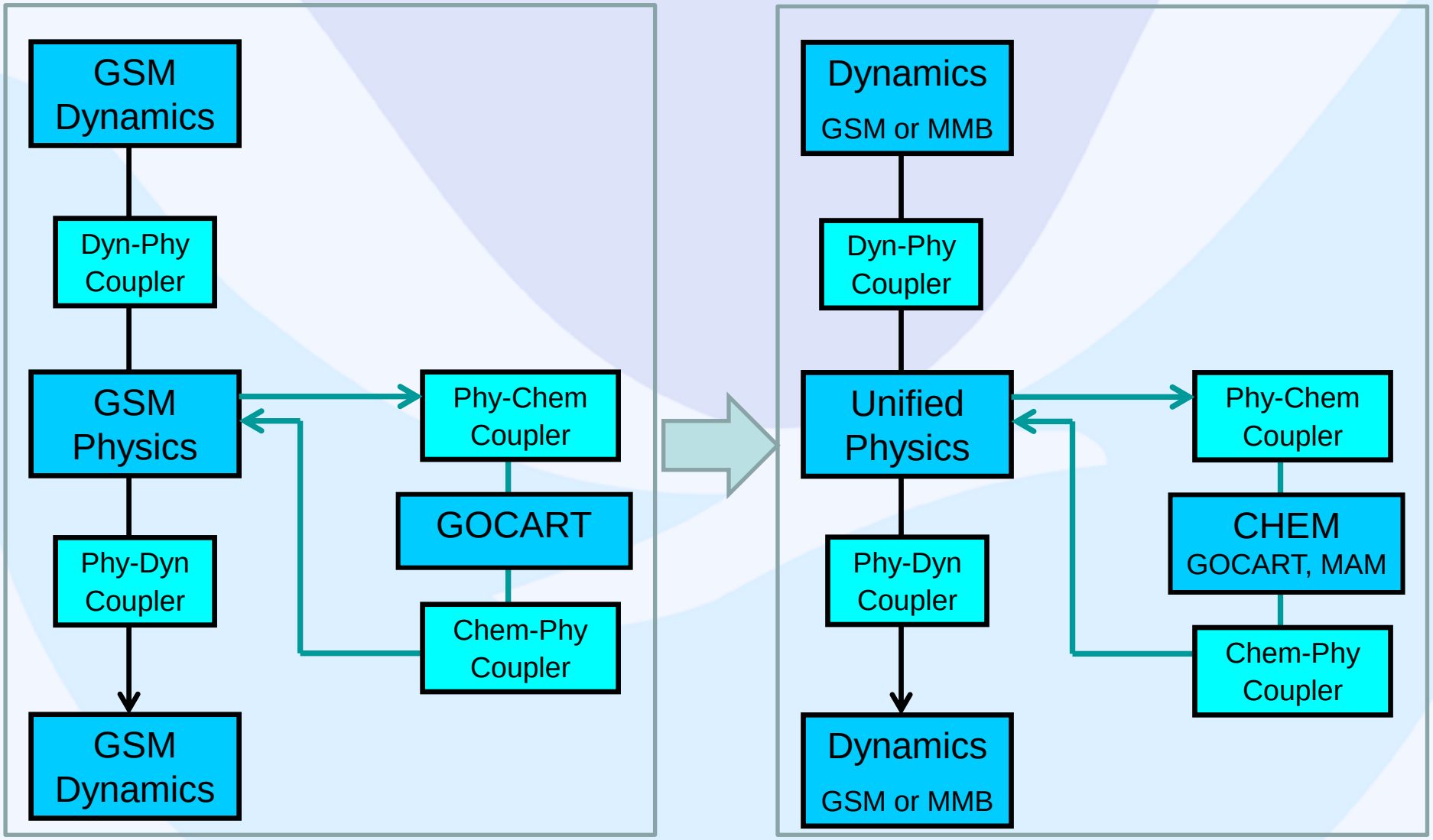
Presentation Outline

- **Next NGAC implementation in Q4FY2015**
- **Future operational requirements and applications**

FY15 Planned Implementation

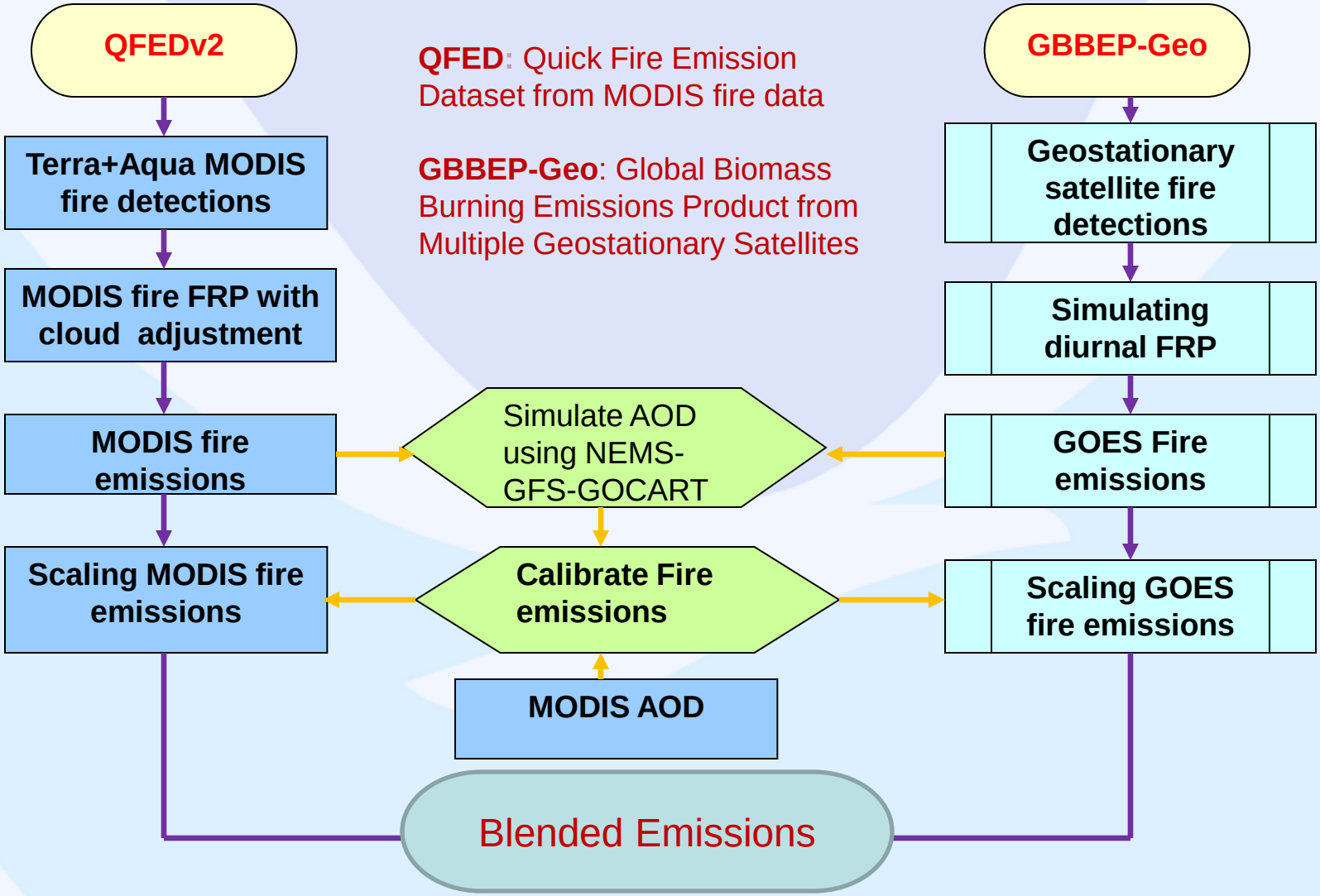
- Extend the dust-only system to include sulfate, sea salt, and carbonaceous aerosols
  - NESDIS - GSFC - NCEP collaborate to develop near-real-time biomass burning emissions
  - Aerosol model is being updated to new GOCART version
  - Atmosphere dynamics has potential to upgrade to *Semi-Lagrangian* scheme with gridded tracer
  - Atmosphere physics is upgraded to the latest operational GFS physics package
  - New products to support down stream applications
  - Verification package for diagnose aerosol products

Primary integration runstream of NGAC



CHEM: GOCART and MAM-7

Flowchart for blended Polar and Geo biomass burning emissions



- Scaling factors are region and biome dependent but static.
- Blended emissions will be generated daily at NESDIS/OSPO for NGAC.
- Scaling factors need to be re-generated only if there is a new satellite replacing an old satellite.

Shobha Kondragunta (NESDIS/STAR)

NGAC Product Suite and Applications

NGAC provides 1x1 degree products in GRIB2 format once per day

Product files and their contents include:

UV index forecasts **AOD assimilation** **AVHRR SST** **AIRS retrievals**

- **ngac.t00z.aod_$CH, CH=340nm, 440nm, 550nm, 660nm, 860nm, 1p63um, 11p1um**
  - Aerosol Optical Depth (AOD) at specified wavelength from 0 to 120 hour

- **ngac.t00z.a2df$FH, FH=00, 03, 06, ….120**
  - Total AOD at 0.55 micron
  - Fields from all species: dust, sea salt, carbonaceous aerosols, and sulfate
    - AOD
    - emission, sedimentation, dry deposition, and wet deposition fluxes
    - fine mode and coarse mode surface mass concentration
    - fine mode and coarse mode column mass density

Budget, ocean productivity

Air quality

Budget

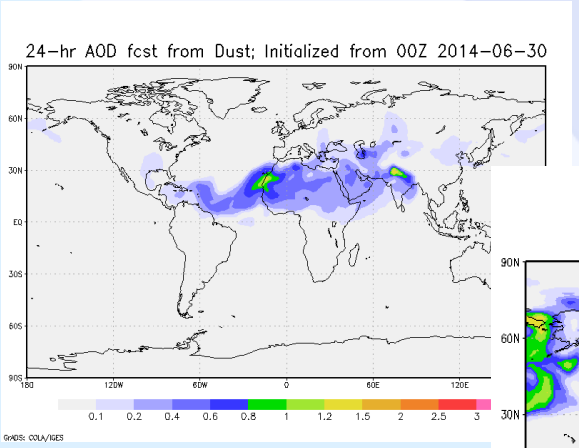
- **ngac.t00z.a3df$FH, FH=00, 03, 06, ….120** ← **Atmospheric correction**
  - Pressure, temperature, relative humidity at model levels
  - Mixing ratios for aerosol species at model levels

Potential applications for NGAC products are highlighted in red.

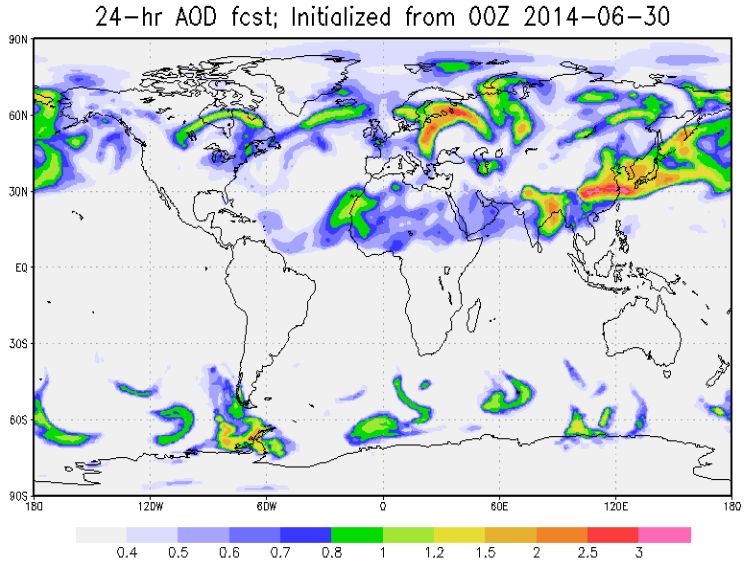
NGAC full aerosol forecasts

- NGAC has the capability to simulate dust, sulfate, sea salt, and carbonaceous aerosols.
- Near real time GBBEP-Geo biomass burning emission is fed into NGAC
- An example is given here using latest NGAC version

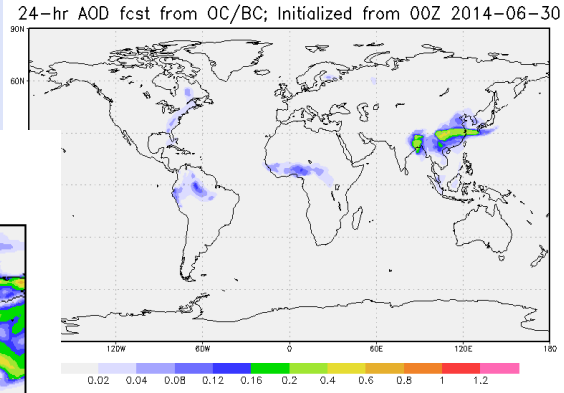
Dust aerosols



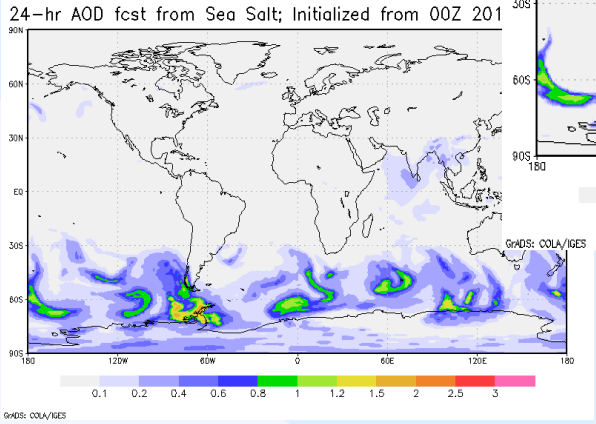
Total AOD at 550 nm



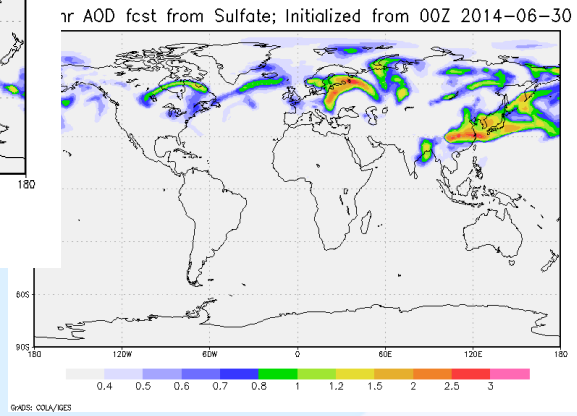
Carbonaceous aerosols



Sea Salt



Sulfate



Planned future implementation

NCEP is developing global aerosol forecasting/assimilation capability

- The aerosol project builds upon extensive collaboration with NOAA labs/centers (NESDIS) and external research community (GSFC, the ICAP working group, WMO SDS-WAS program)

- Phased implementation
  - Phase 1: Dust-only forecasts (operational) **(Implemented in Q42012)**
  - Phase 2: Forecasts for dust, sulfate, sea salt, and carbonaceous aerosols using NESDIS's GBBPEx smoke emissions (planned FY15 implementation) **(Ongoing, Q4FY2015)**
  - Phase 3: NGAC with improved aerosol representation and aerosol cloud interaction is included **(Founded by CPO,FY15-16)**
  - Phase 4: Aerosol analysis using VIIRS AOD (well-defined R2O building upon existing NCEP-NESDIS-GSFC collaboration) **(Pending support from JPSS, NWS)**

Presentation Outline

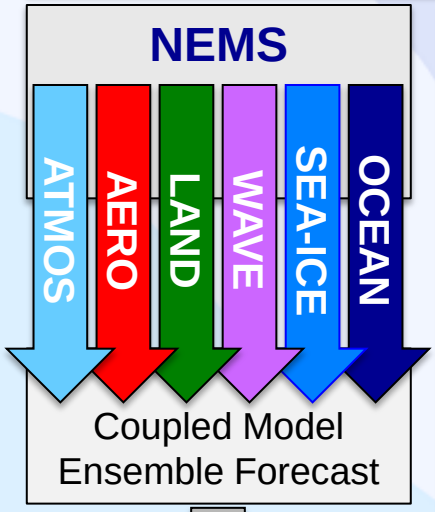
- Current Operational Configuration
- **Future operational requirements and applications**

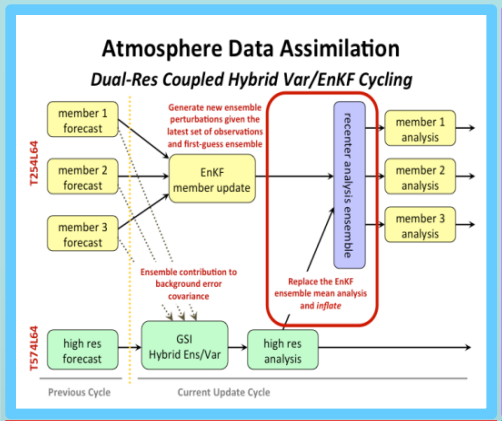
Priority System Enhancements

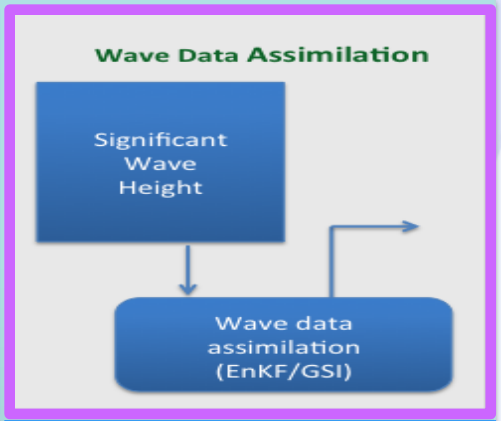
- **Ongoing activities**
  - Enable aerosol impacts on medium range high resolution weather forecasts (GFS/GDAS)
  - Build aerosol-chemistry-climate interaction in the next generation of Climate Forecast System (CFS)
  - Provide lateral aerosol boundary conditions for regional aerosol forecast system
  - Provides global aerosol information for various applications (e.g., satellite radiance data assimilation, satellite retrievals, SST analysis, UV-index forecasts, solar electricity production)

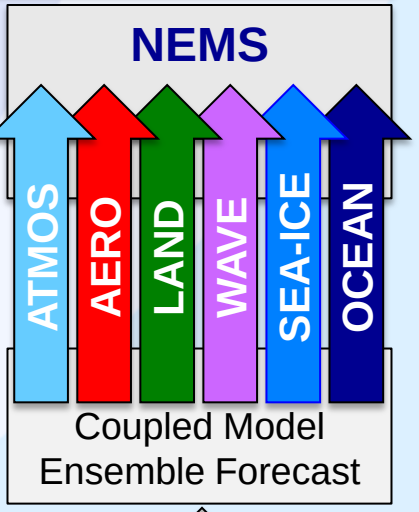
- **Long-term goal**
  - Enable global atmospheric constituents forecasting capability to improve weather and climate forecast with aerosol impacts on various time scales fully accounted
  - Provide quality atmospheric constituents forecast products to serve a wide-range stakeholders, such as health professionals, aviation authorities, policy makers, and climate scientists

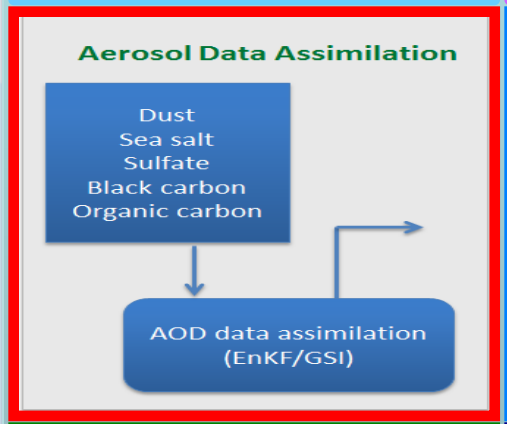
NCEP Coupled Hybrid-EnKF Data Assimilation System

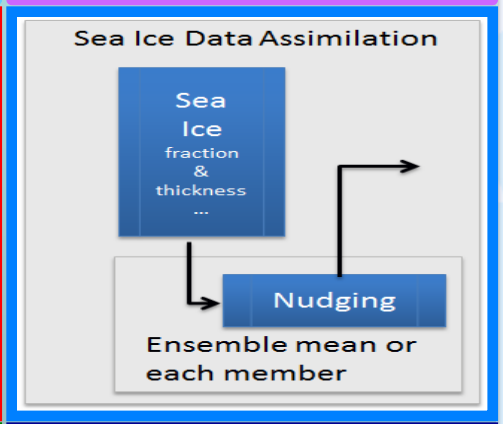


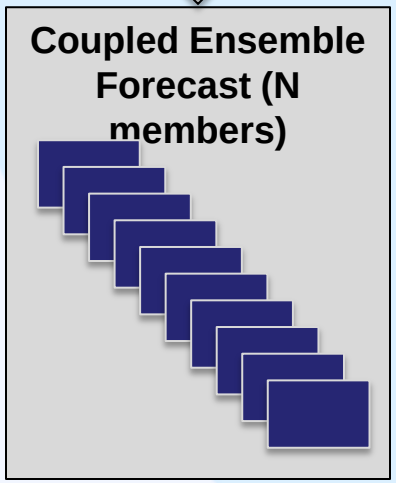


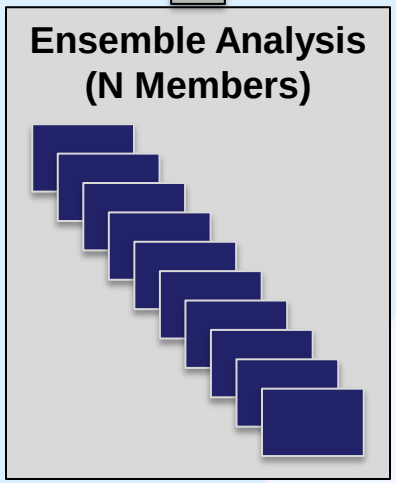


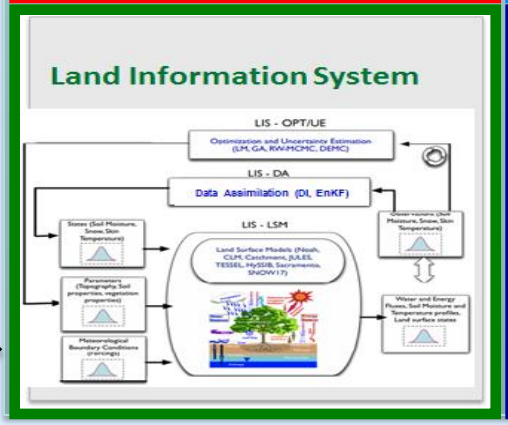


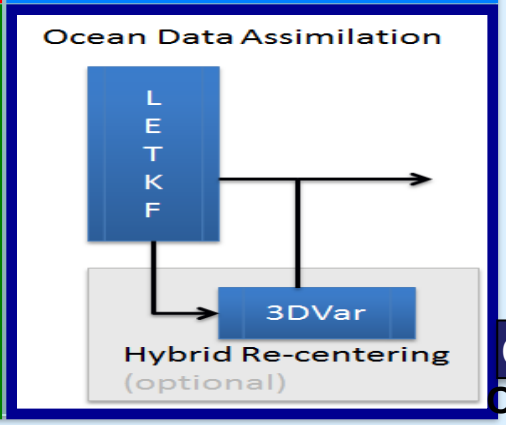












INPUT

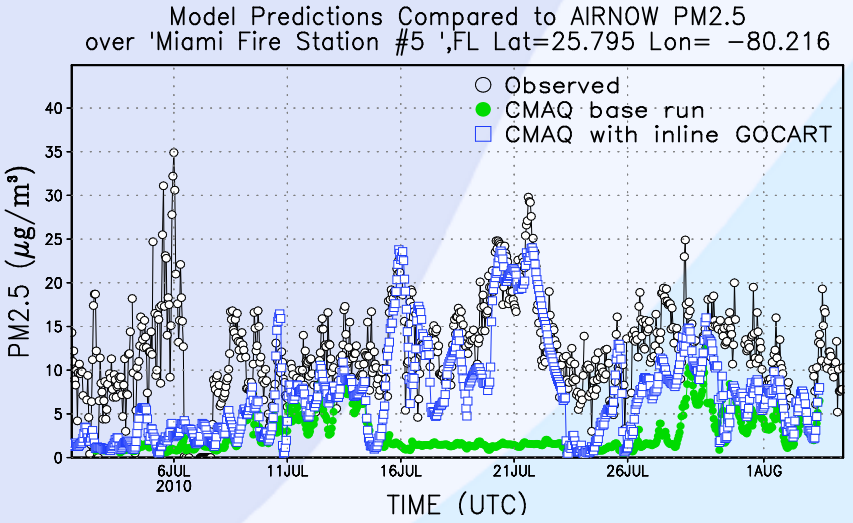
OUTPUT

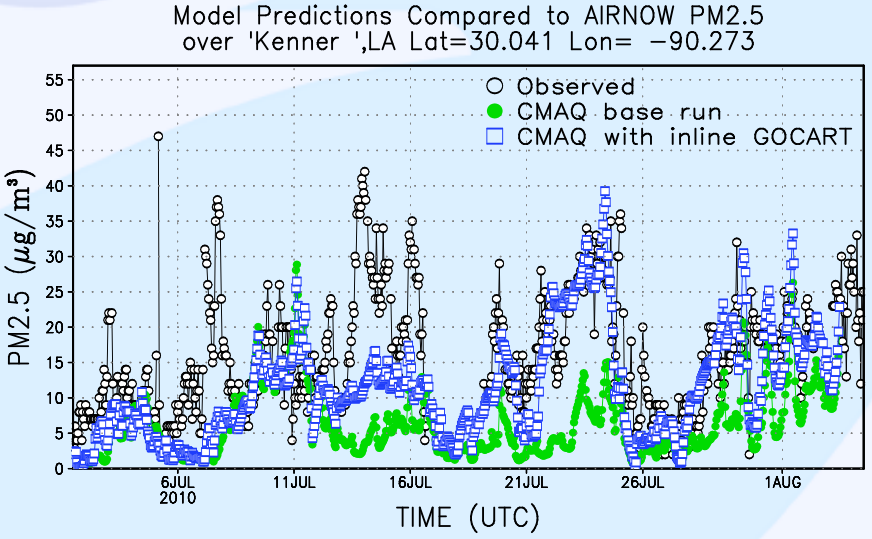
Courtesy: Suranjana Saha

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 (e.g., reduced mean biases, improved correlations)

	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**





Youhua Tang (EMC, now at NESDIS)

Challenges and Lessons Learned

- The development has been affected by uncertainties in NWS priority and resources
- The project builds up extensive collaboration with NOAA labs/centers and external community
- NCEP will continue leveraging the expertise in GSFC, NESDIS, OAR, the ICAP working group, the WMO SDS-WAS program

Thank You