



# Global Aerosol System V1.0.0

## NEMS-GFS Aerosol Component (NGAC)

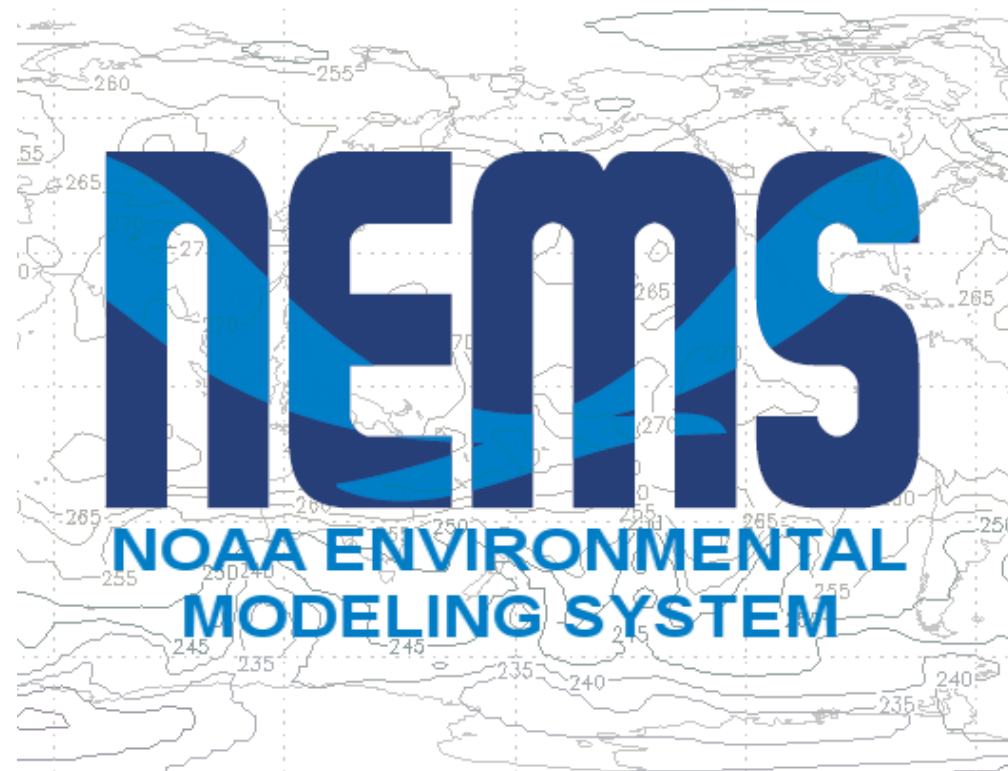
Sarah Lu

Global Climate and Weather Modeling Branch  
NOAA/NCEP/EMC Camp Springs, MD

EMC Change Configuration Board Meeting  
Jan 31, 2012

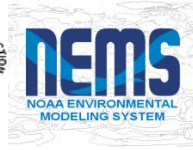
# Team efforts toward building global aerosol forecast capability at NCEP

Mark Iredell (NEMS team lead)  
Sarah Lu (aerosol modeling)  
Shrinivas Moorthi (physics)  
Yu-Tai Hou (radiation-aerosol)  
Henry Juang (dynamics)  
Jun Wang (I/O and ESMF infrastructure)  
Hui-Ya Chuang (post)  
Weiyu Yang (ESMF infrastructure)  
Perry Shafran, Fanglin Yang (verification)  
Eugene Mirvis (DTC support)  
Nicole McKee (documentation/web)  
Ho-Chun Huang (aerosol data assimilation)  
Jeff McQueen (coupling with regional AQ)  
Youhua Tang (coupling with regional AQ)  
Xu Li (SST-aerosols)



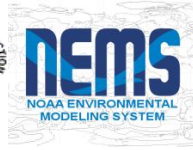
## Collaborators

**GSFC (Arlindo da Silva and Mian Chin) for aerosol modeling**  
**NESDIS (Shobha Kondragunta and Xiaoyang Zhang) for biomass emissions**  
**ECMWF (Angela Benedetti and Jean-Jacques Morcrette) for volcanic ash capability**  
**NRL (Jeff Reid, Walter Sessions) for model inter comparison**



# NEMS GFS Aerosol Component

- NCEP Annual Operating Plan milestone for Q2 FY12
- NGAC will be the first global in-line aerosol forecast system at NCEP
- NGAC will be the first global NEMS implementation at NCEP and the second NEMS implementation
- This global system provides 120-hr dust forecast daily
- New daily aerosol products in grib2 format will be produced

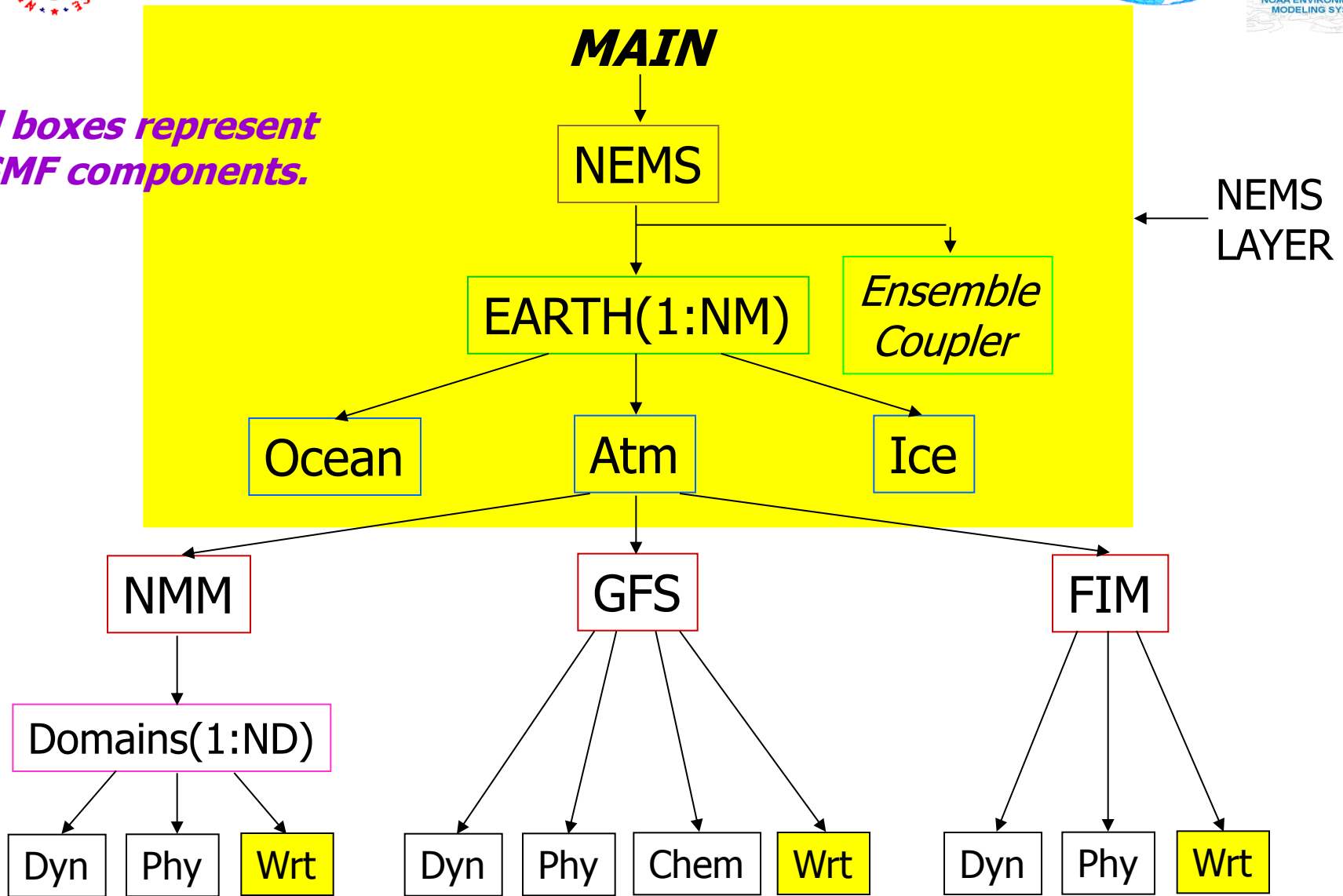


# NEMS GFS Aerosol Component

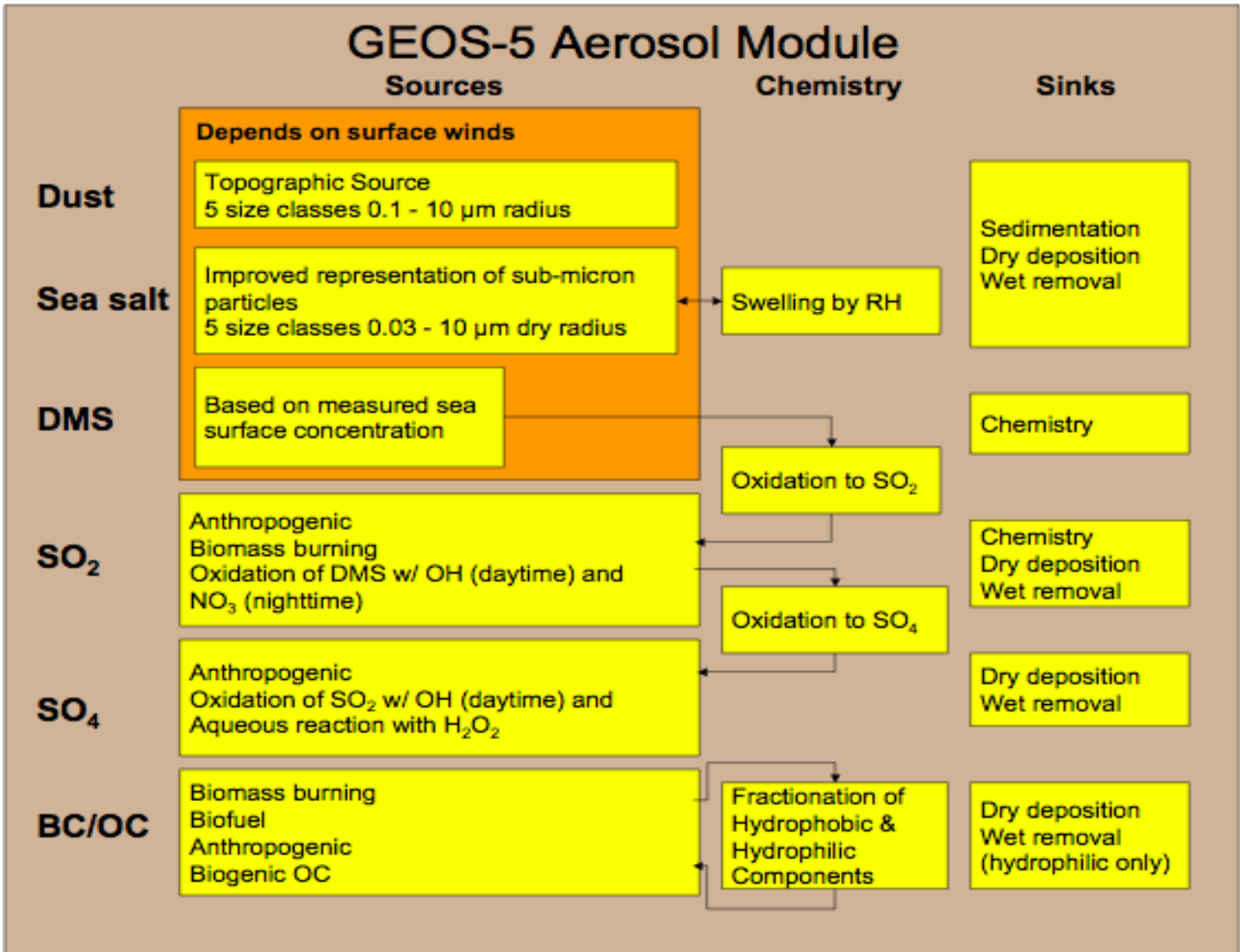
- Forecast model
  - Global Forecast System (GFS) based on NOAA Environmental Modeling System (NEMS), **NEMS-GFS**
  - A common modeling framework using Earth System Modeling Framework (ESMF)
- Aerosol model
  - NASA Goddard Chemistry Aerosol Radiation and Transport Model (**GOCART**)
  - Simulate atmospheric aerosols including dust, sulfate, black carbon (BC), organic carbon (OC), and sea salt.

# NEMS Component Structure

All boxes represent  
ESMF components.



From Mark Iredell & Tom Black presentation (2010 AMS/NWP conf.)



# GOCART Implementation

The full-aerosol package has been implemented in NEMS GFS.

NGAC/parm/Chem\_Registry.rc is the resource file to specify what constituents to be included in the simulations:

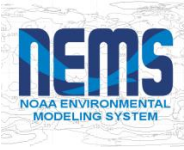
doing\_DU: **yes** # &YesNo Include mineral dust?

doing\_SS: no # &YesNo Include sea salt?

doing\_SU: no # &YesNo Include sulfates?

doing\_BC: no # &YesNo Include black carbon?

doing\_OC: no # &YesNo Include organic carbon?

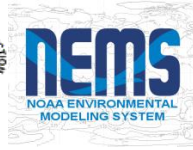


# Phased Implementation

- Phase 1: Global dust forecasts
- Phase 2: Global forecasts for dust, sea salt, sulfate, and carbonaceous aerosols
- Phase 3: Global aerosol analysis

*Only phase 1 implementation will be discussed in this CCB meeting*



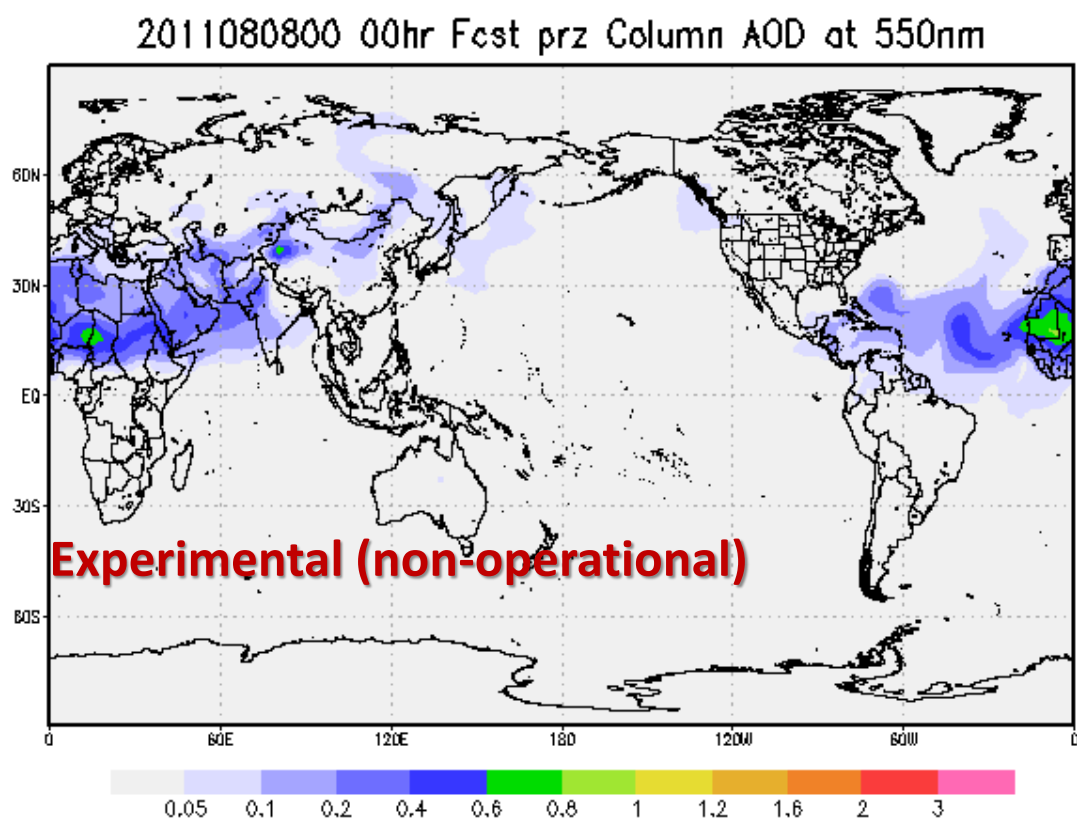


# NEMS GFS Aerosol Component

- Expected Benefits
  - Provide global short-range aerosol forecasts
  - Provide dynamic aerosol lateral boundary conditions to the National Air Quality Forecast Capability (NAQFC)
  - Include aerosol effects in medium range weather forecasts
  - Produce aerosol information needed for various applications (satellite retrievals, CPC-EPA UV index forecasts etc)

# Near-Real-Time NGAC configuration

- EMC parallel on NCEP's CCS (dev)
- **5-day dust forecast** once per day (at 00Z)
- Resolution: T126 L64
- Initialization: Aerosols from previous day forecast and meteorology from operational GDAS
- Products: 3d distribution of dust aerosols (5 bins from 0.1 – 10  $\mu\text{m}$ ) and 2d aerosol diagnosis fields (e.g., aerosol optical depth)
- Automatic output archive, post processing and web update since June 11, 2011



# Web page for NRT NGAC dust forecasts

NCEP Global Aerosols Forecast. NOAA/NWS/NCEP/EMC - Mozilla Firefox

http://www.emc.ncep.noaa.gov/gmb/sarah/NGAC/html/realtime.fcst.html

**NEMS GFS Aerosol Component**  
Experimental (Non-Operational) Dust Forecasts

Modeling domain: [Global](#) [Regional](#)

Select Aerosol Type:

Select Model:

Select Variable:

Select Model layer:

Year:  Month:  Day:

[NEMS](#)  
[NAQFC](#) [EMC](#)  
[NCEP](#) [NOAA](#)  
[NRL](#) [EPA](#)  
[Send Comments](#)

2011061700 24hr Fcst ctrl Column AOD at 550nm

0.05 0.1 0.2 0.4 0.6 0.8 1 1.2 1.6 2 3

Windows taskbar: Start, X-Session, cirrus.ccs.ncep.noaa.go..., NGAC, Inbox - Mail for sarah.lu..., Microsoft PowerPoint - [...], NCEP Global Aerosols ... 2:33 PM

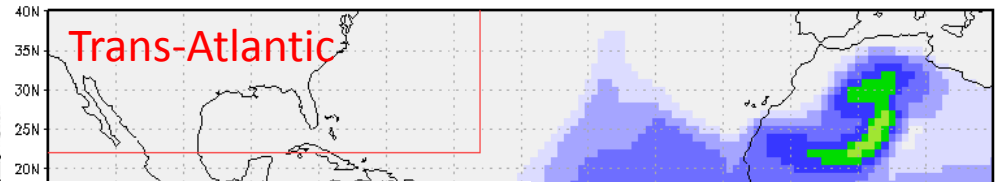
<http://www.emc.ncep.noaa.gov/gmb/sarah/NGAC/html/realtime.fcst.html>

# New web page for NRT NGAC dust forecasts

## NEMS GFS Aerosol Component

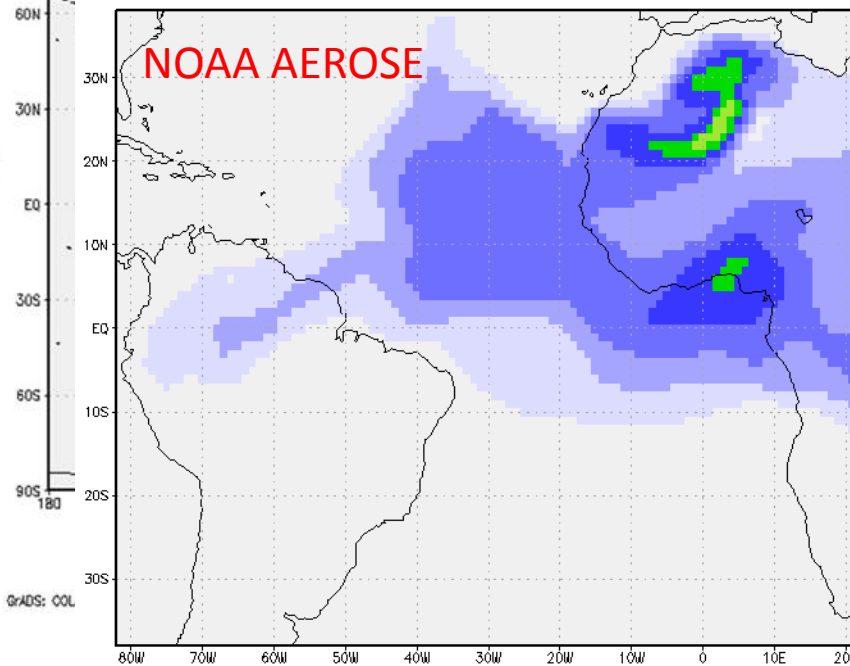
Experimental (Pre-Opera

024-hr AOD Fcst; Initialized from 00Z 2012-01-17

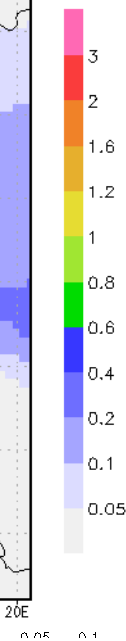
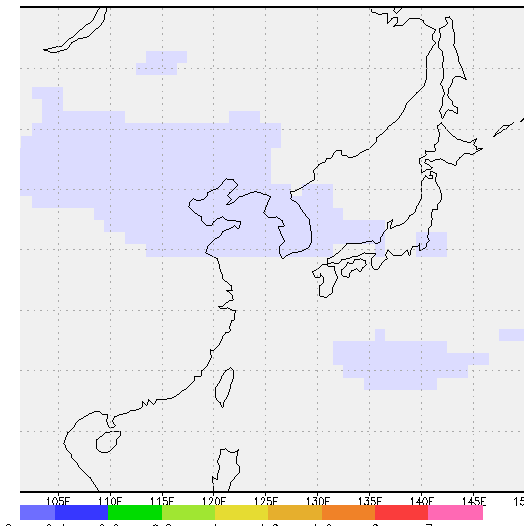


066-hr AOD Fcst; Initi

024-hr AOD Fcst; Initialized from 00Z 2012-01-17



cst; Initialized from 00Z 2012-01-17



[NEMS Home](#)  
[NGAC Home](#)  
[NGAC Verification Page](#)  
[NGAC Documentations](#)

Select Domain  
[Global](#) [Regional](#)

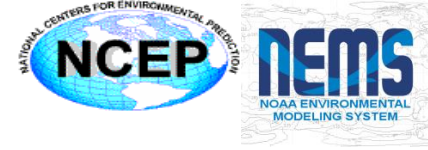
Year:  Month:  Day:

Select Field:

Related Links

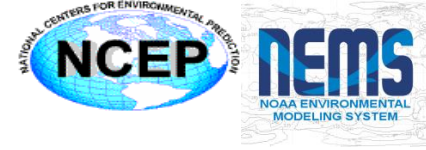
[NAQFC](#)  
[EMC](#)  
[NCEP](#)  
[NOAA](#)

[Send Comments](#)



# Test Plan

- Near-real-time testing (**prz**)
  - EMC parallel since June 2011
  - Source code from the NEMS code repository R13341
- Prediction model testing
  - Retrospective test for summer 2010
  - Year-long free forecasts for 2010
  - Issues identified in the NRT package (R13341) and changes are made in late Nov 2011 (R16499)
  - Additional near-real-time testing (**prx, pry, prw**)

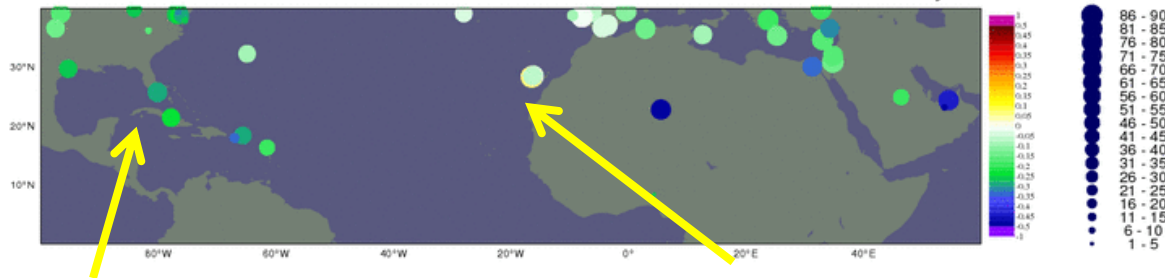


# Test Plan (cont'd)

- 4 parallel runs: prz, prx, pry, prw
  - The prz run is based on R13341
    - Dust forecast could be unstable (sedimentation)
    - RAS scheme is modified to eliminate unrealistic thin clouds
  - The prx, pry, prw are based on R16499
    - Long lifetime (~ 11 days) and very weak wet removal in the prx run indicates the convective scavenging in RAS (from GSFC) has not been implemented correctly
    - Code is modified to have both large-scale and convective scavenging done in GOCART (pry and prw)
    - Communication with GSFC early Jan, 2012 confirms the problem in tracer scavenging (the prx run).

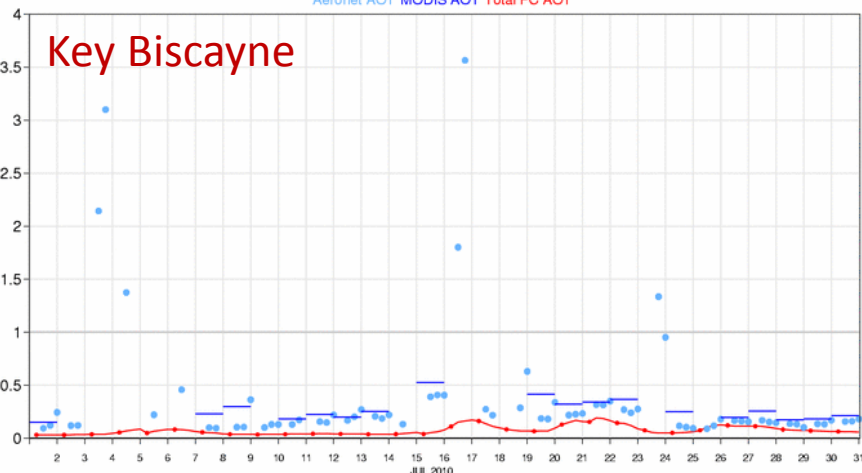
# NGAC Evaluation and Verification

FC-OBS Bias. Model (salu) AOT at 550nm against L1.5 Aeronet AOT at 500nm.  
 Mean=-0.175. Period=00Z-00Z 01-30 Jul 2010. FC start hrs=0. FCRS=T+6->24 by 6.



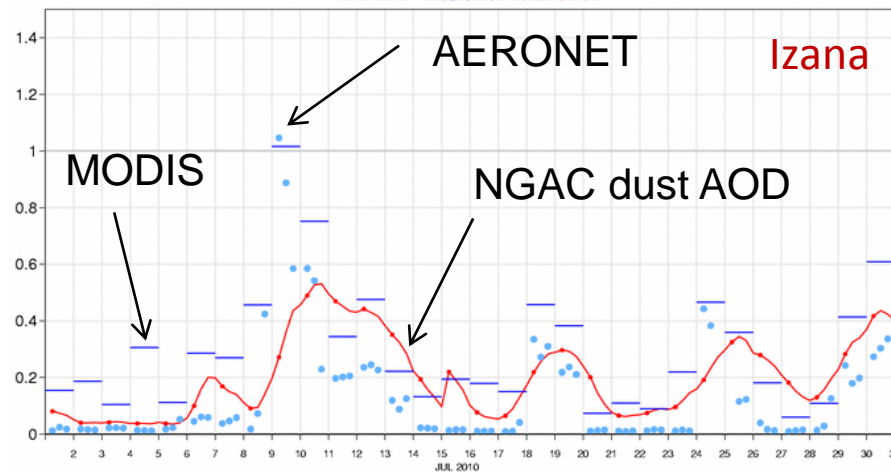
Comparison of model (salu) and MODIS AOT at 550nm and L1.5 Aeronet AOT at 500nm over Key\_Biscayne (25.73°N, 80.16°W). Model: 00UT, 1-30 Jul 2010, T+6 to T+24.

Aeronet AOT MODIS AOT Total FC AOT



Comparison of model (salu) and MODIS AOT at 550nm and L1.5 Aeronet AOT at 500nm over Izana (28.31°N, 16.5°W). Model: 00UT, 1-30 Jul 2010, T+6 to T+24.

Aeronet AOT MODIS AOT Total FC AOT



Courtesy of Luke Jones of ECMWF

We thank Philippe Goloub and Kenneth Voss for the efforts in establishing and maintaining Izana and Key Biscayne site, respectively

# NGAC Evaluation and Verification

## Dust AOD for 24-hr forecast valid 2011-07-21 00Z

Wednesday 20 July 2011 00UTC GOCART Forecast t+024  
Thursday 21 July 2011 00UTC Valid Time  
Dust Aerosol Optical Depth at 550nm

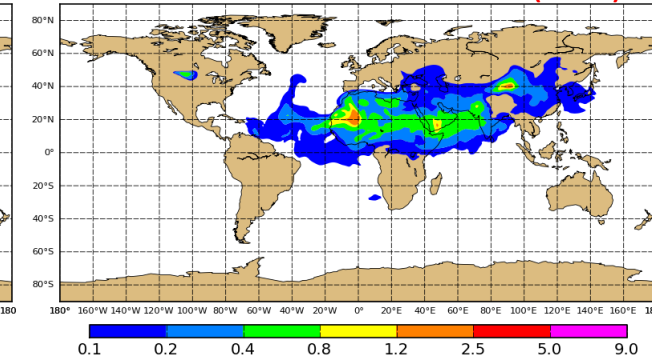
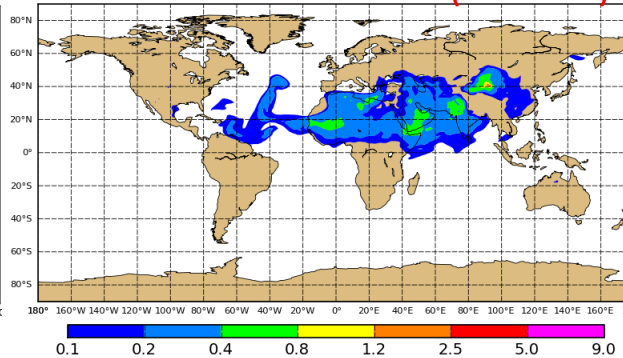
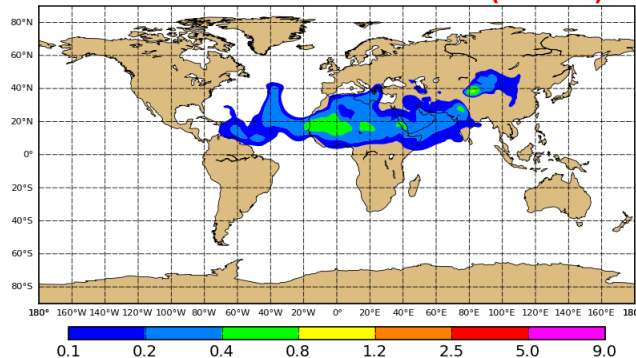
**NGAC (NCEP)**

Wednesday 20 July 2011 00UTC MACC Forecast t+024  
Thursday 21 July 2011 00UTC Valid Time  
Dust Aerosol Optical Depth at 550nm

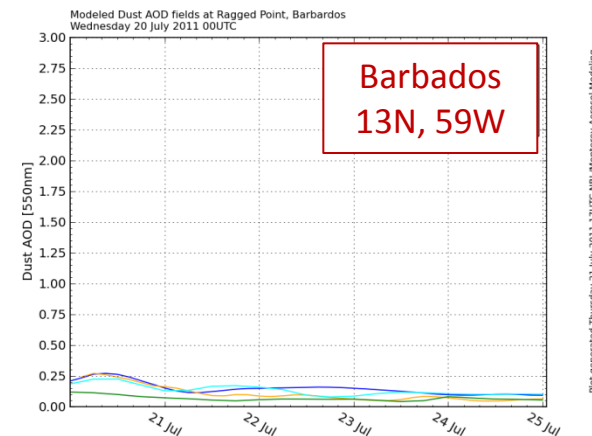
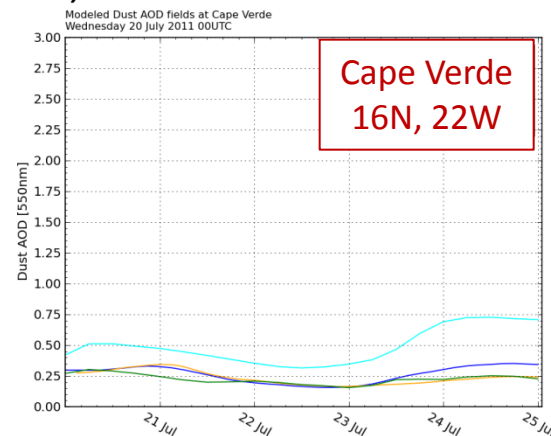
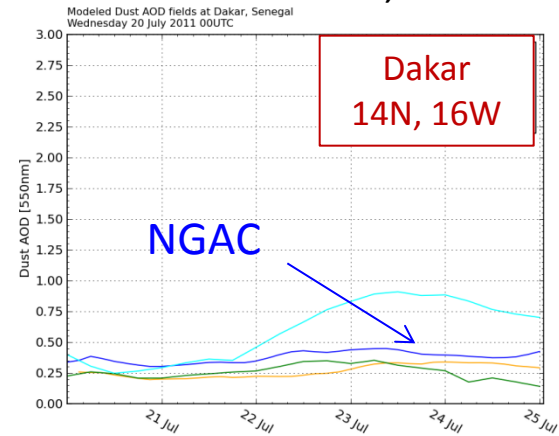
**MACC (ECMWF)**

Wednesday 20 July 2011 00UTC NAAPS Forecast t+024  
Thursday 21 July 2011 00UTC Valid Time  
Dust Aerosol Optical Depth at 550nm

**NAAPS (NRL)**



## Modeled dust AOD, 120-hr forecast, initialized from 2011-07-20 00Z



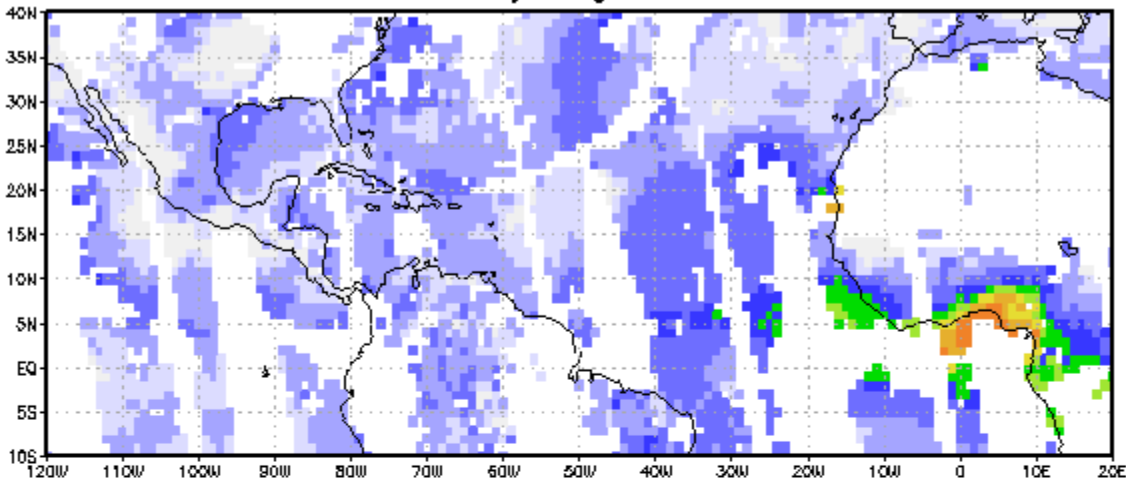
- International Cooperative for Aerosol Prediction (ICAP): Collaborations among NCEP, NRL, GSFC, ECMWF, and JMA
- Walter Sessions (NRL) fetches NGAC AOD from EMC ftp site daily for ICAP model comparison





# NGAC Evaluation and Verification

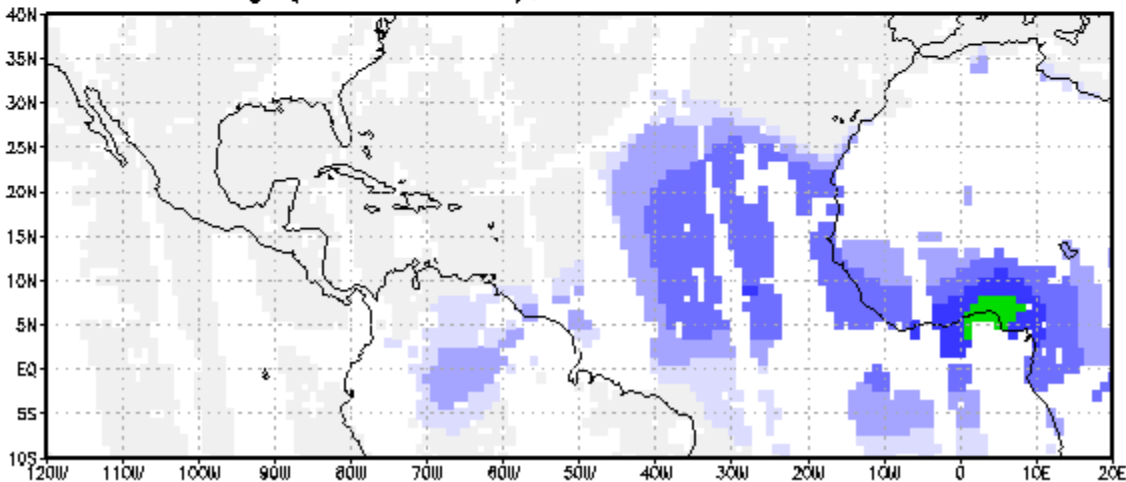
MODIS AOD; Daily Avg for 2012-01-17



MODIS total AOD  
from bufr dump

GRADS: COLA/IGES

AOD Avg (03-24 Fcst), Initialized on 2012-01-17

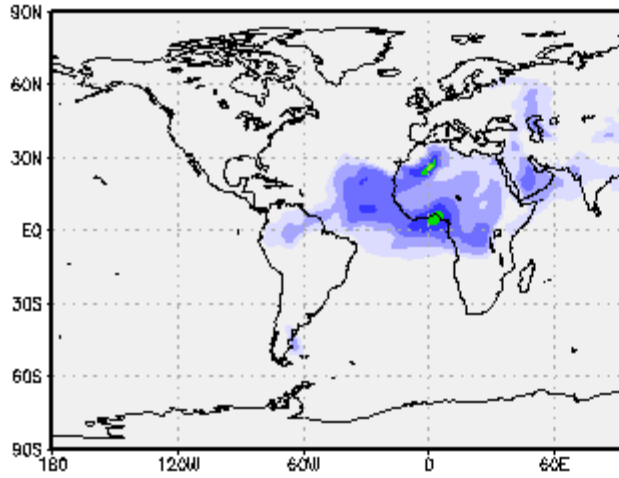


NGAC dust AOD

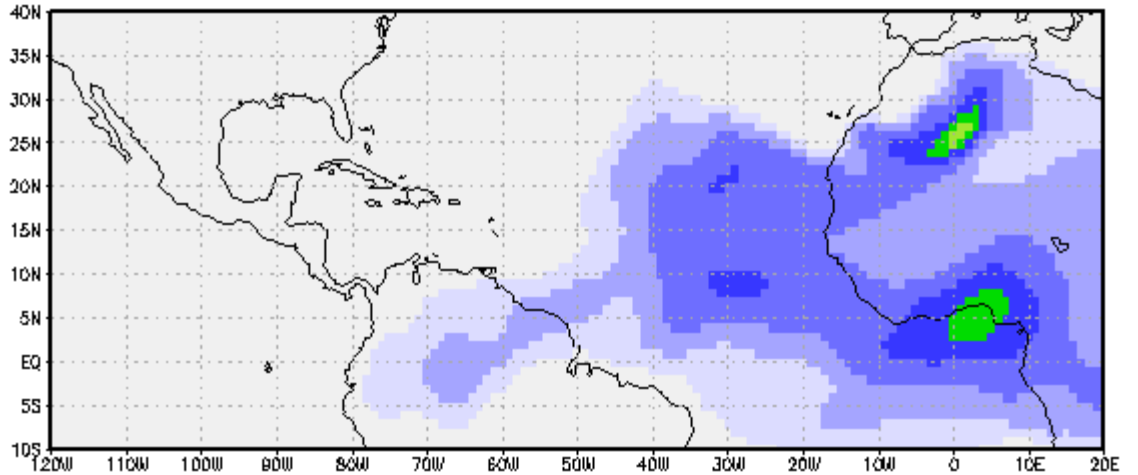


# NGAC Evaluation and Verification

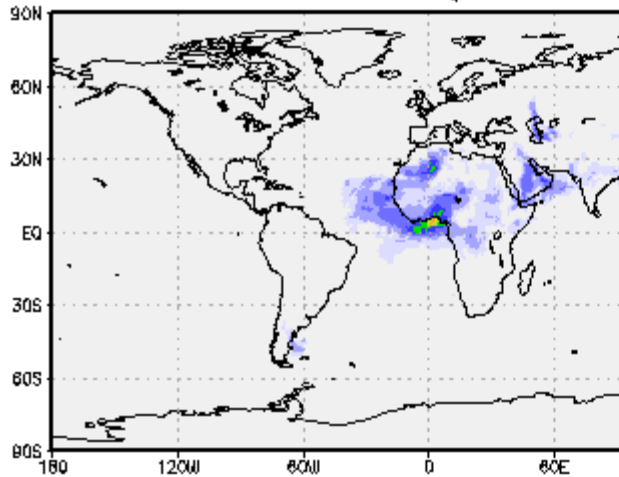
12-hr AOD fcst; Initialized from :



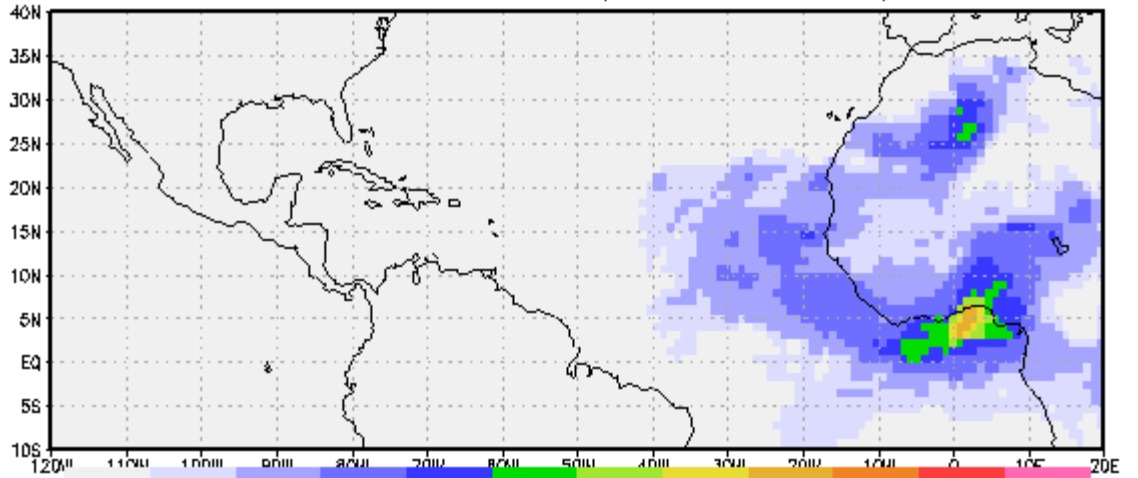
12-hr AOD fcst; Initialized from 2012-01-17



GEOS5 Dust AOD (with MODIS DA)



GEOS5 Dust AOD (with MODIS DA)



3σADS: COLA/IGES

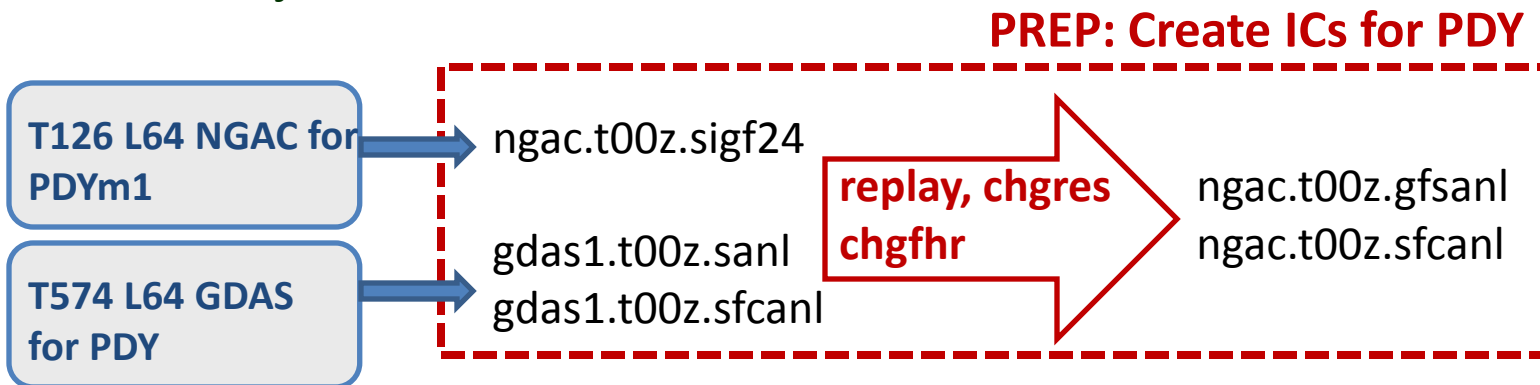
3σADS: COLA/IGES



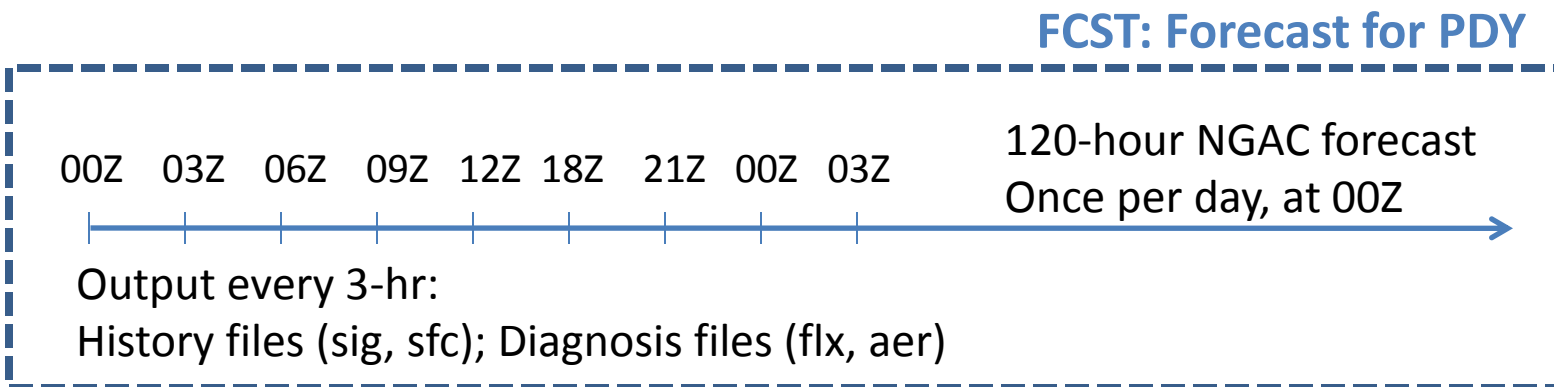
# NGAC Parallel Run Setup

Single nodes for all three jobs

1:10 min



22 min  
(20.7 min  
for fcst)



8-min to process 41 FH



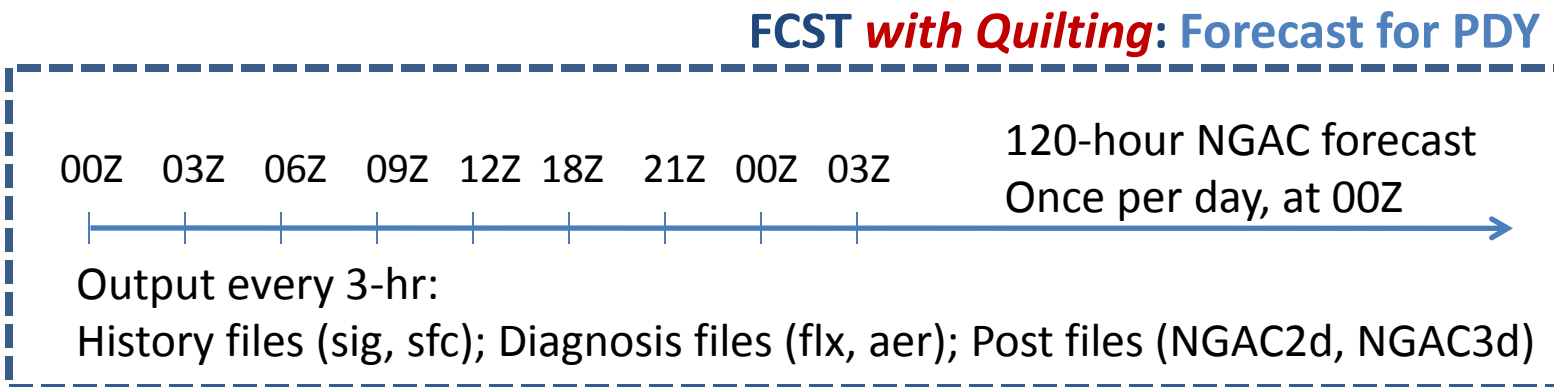
# NGAC Parallel Run Setup

Single nodes for all three jobs

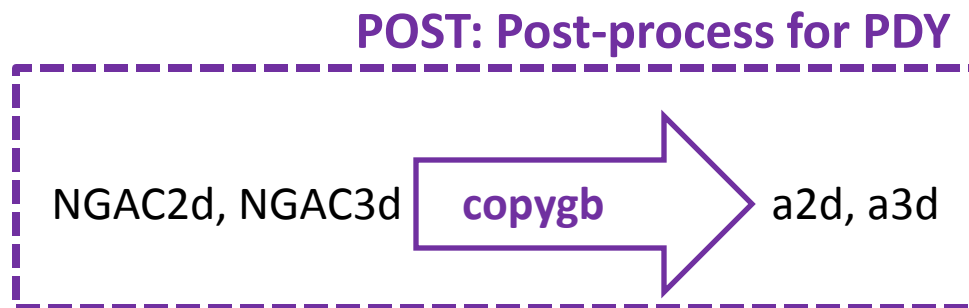
1:10 min



25 min  
(23.5 min  
for fcst)



2-min to process 41 FH



# NGAC Product Suite

- UV index forecasts**

↓
- AOD assimilation**

↙
- AVHRR SST**

↙
- AIRS retrievals**

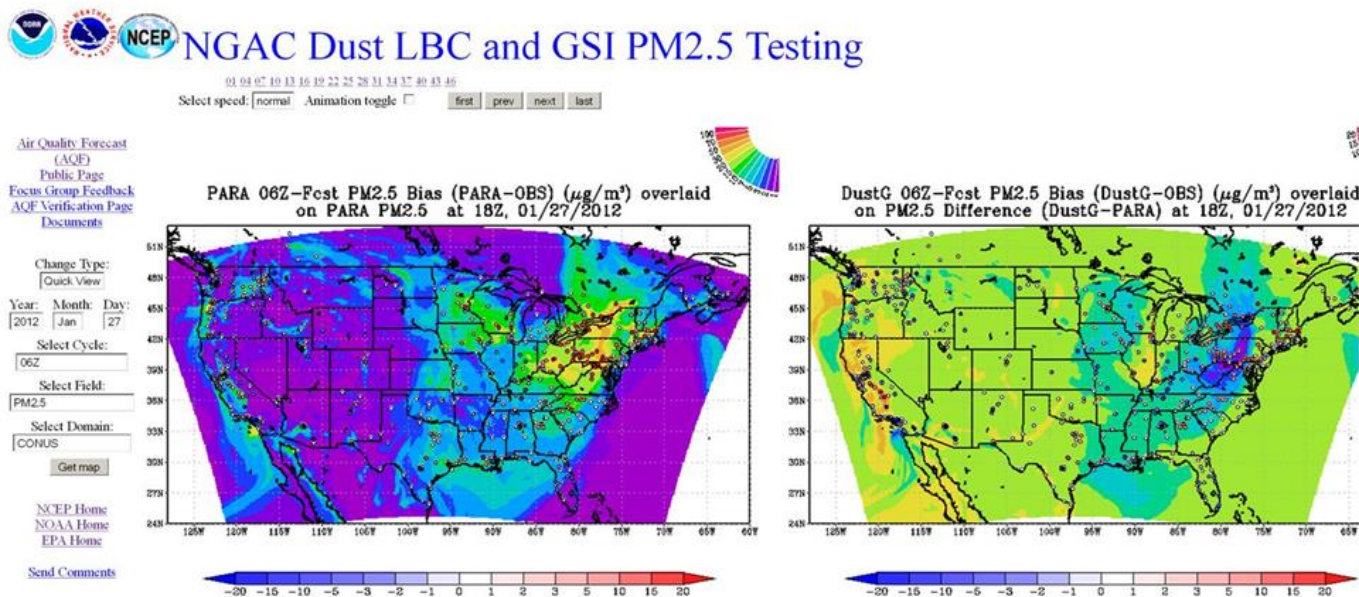
↙
- a2d files
  - AOD at 0.34, 0.44, 0.55, 0.66, 0.86, 1.63, and 11.1 micron
  - Dust emission, sedimentation, dry deposition, and wet deposition fluxes ← **Budget, ocean productivity**
  - Dust PM2.5 and PM10 surface mass concentration ← **AQ**
  - Dust PM2.5 and PM10 column mass density ← **budget**
- a3d files
  - Sfc pressures
  - (Pressure, relative humidity, air density, dust mixing ratios) at model levels ← **Satellite retrievals**

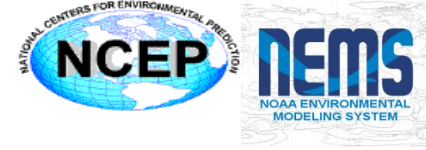
# Downstream Dependencies

- No downstream dependencies
- The coupling to NAM-CMAQ has been built
- The CMAQ para test run (with GSI and NGAC LBCs) since Dec 27, 2011 by Youhua Tang

NCEP Testing Page for Air Quality Prediction, NOAA/NWS/NCEP/EMC

<http://www.emc.ncep.noaa.gov/mmb/ytang/html-test/html/2012-dustg.html>

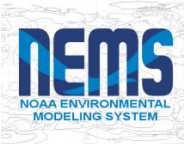




# Current Status

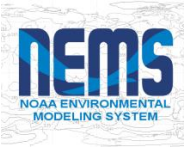
- NEMS regression test completed
- EMC SMS based parallel since Dec 22, 2011
- Grib2 definition resolved on Jan 26, 2012
  - Use Product Definition Template 4.48 for NGAC products
  - PDT 4.48 allows us to specify parameter, aerosol type, size bin, and wavelength
  - PDT 4.48 is undergoing validating testing, so we will provide this template to the NGAC users until PDT 4.48 becomes operational
- Post code merging (GSD branch and NGAC branch) in progress
- NCEP post with grib2 output in progress





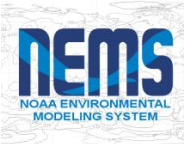
# Resource requirements

- CPU:
  - single node for all three jobs (prep, fcst, post)
  - approximately 30 min for prep-fcst-post
- Disk:
  - ICs in Gaussian grids 80 MB
  - Output files in Gaussian grids 3.6 GB
  - Post files in 1 deg x 1 deg 2.5 GB in grib1  
~ 1.5 GB in grib2
- Retention in com: 5-day
- HPSS runhistory ~ 5 GB



# Implementation Planning

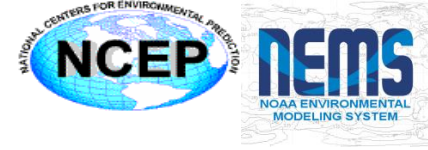
- Product generation requirements
  - New products in grib2 will be created
  - Data dissemination via FTP (operational) and EMC website (non-operational)
- Libraries:
  - Requires ESMF, NEMSIO and W3LIB
  - Requires XMLparse for grib2
- Risk:
  - No risk to any current NCEP products
- Data Flow:
  - Streaming of AERONET data files onto dcom for verification use



# NGAC Implementation Check List

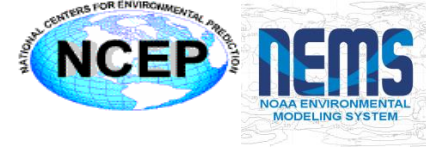
The NGAC package includes 9 RFCs

- |    |   |         |
|----|---|---------|
| 1. | NGAC_PREP (1 RFC) – scripts and replay/chgres source codes        | Lu      |
| 2. | NGAC_FCST (1 RFC) – scripts, fcst source code, fix and parm files | Lu      |
| 3. | NGAC_POST (1 RFC) – scripts                                       | Lu      |
| 4. | ESMF v3.1.0_rp2 (1 RFC) – add header file directory               | Lu      |
| 5. | W3_v2.2.3 (1 RFC) – add one routine needed for the quilting       | Wang    |
| 6. | NEMSIO_v2 (1 RFC)   | Wang    |
| 7. | XMLparse (1 RFC) – new lib; update g2tmpl                         | Wang    |
| 8. | NCEP_POST (1 RFC)   | Chuang  |
| 9. | NGAC_VRFY (1 RFC)   | Shafran |



# Plan Schedule

- Concluded schedule
  - Project kick off meeting – Dec 12, 2011
  - GOCART Pre-Implementation Meeting – Jan 11, 2012
- Remaining schedule
  - EMC CCB meeting – Jan 31, 2012
  - End-to-end test with grib2 output
  - Submit RFCs – Feb 16, 2012
  - Submit TIN – Feb 10, 2012
  - NCO parallel
  - Implementation



***THANK YOU***