# UPDATES ON THE INTERNATIONAL COOPERATIVE FOR AEROSOL RESEARCH MULTI-MODEL ENSEMBLE (ICAP-MME)

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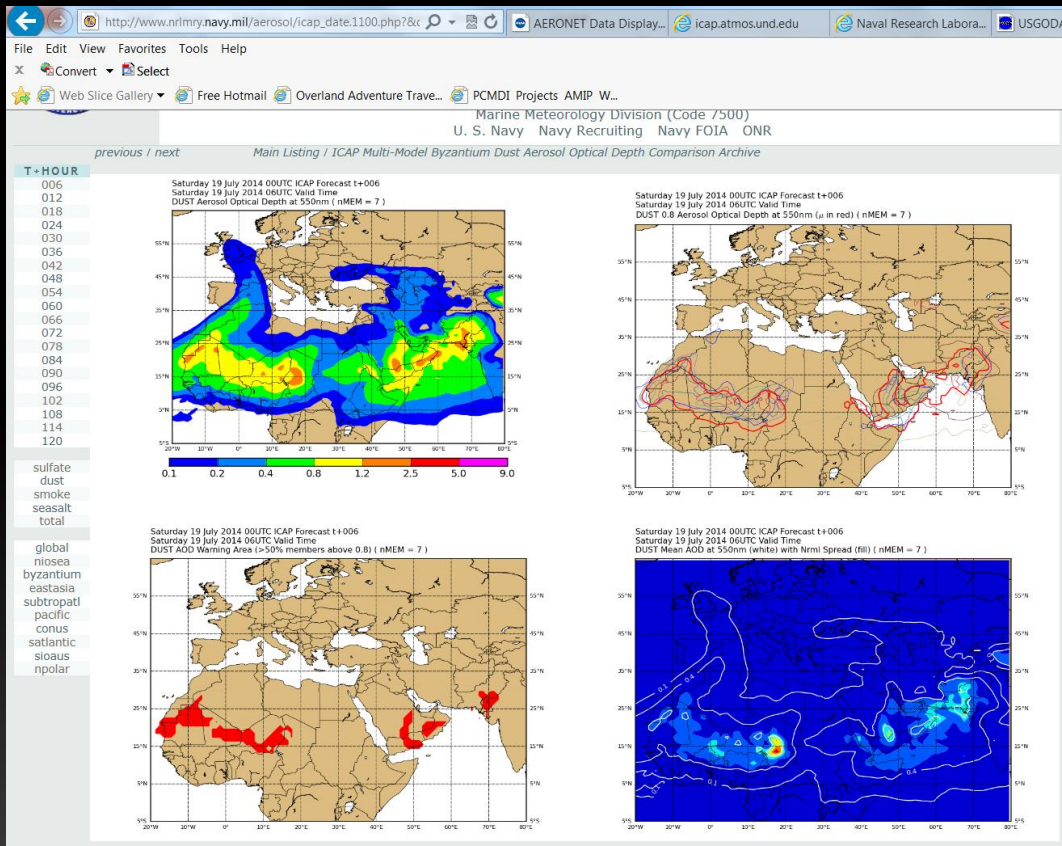
# RATIONAL FOR ICAP MME

- It provides a testbed of probabilistic aerosol forecast. Systematic errors arising from the imperfect nature of the models and sensitivity of models to initial conditions are two main sources of forecast errors. Ensemble-based predictions are shown to be able to help control for these errors. Further, multi-model ensemble forecasting for other atmospheric features, e.g., tropical cyclone track and intensity, has proven to be beneficial. What about AOT?

- It helps to identify problem areas for aerosol modeling. Areas with the largest diversity requires attention for aerosol model improvement.

- Operational aerosol forecast becomes available at many NWP centers, which enables an exploration of aerosol MME.



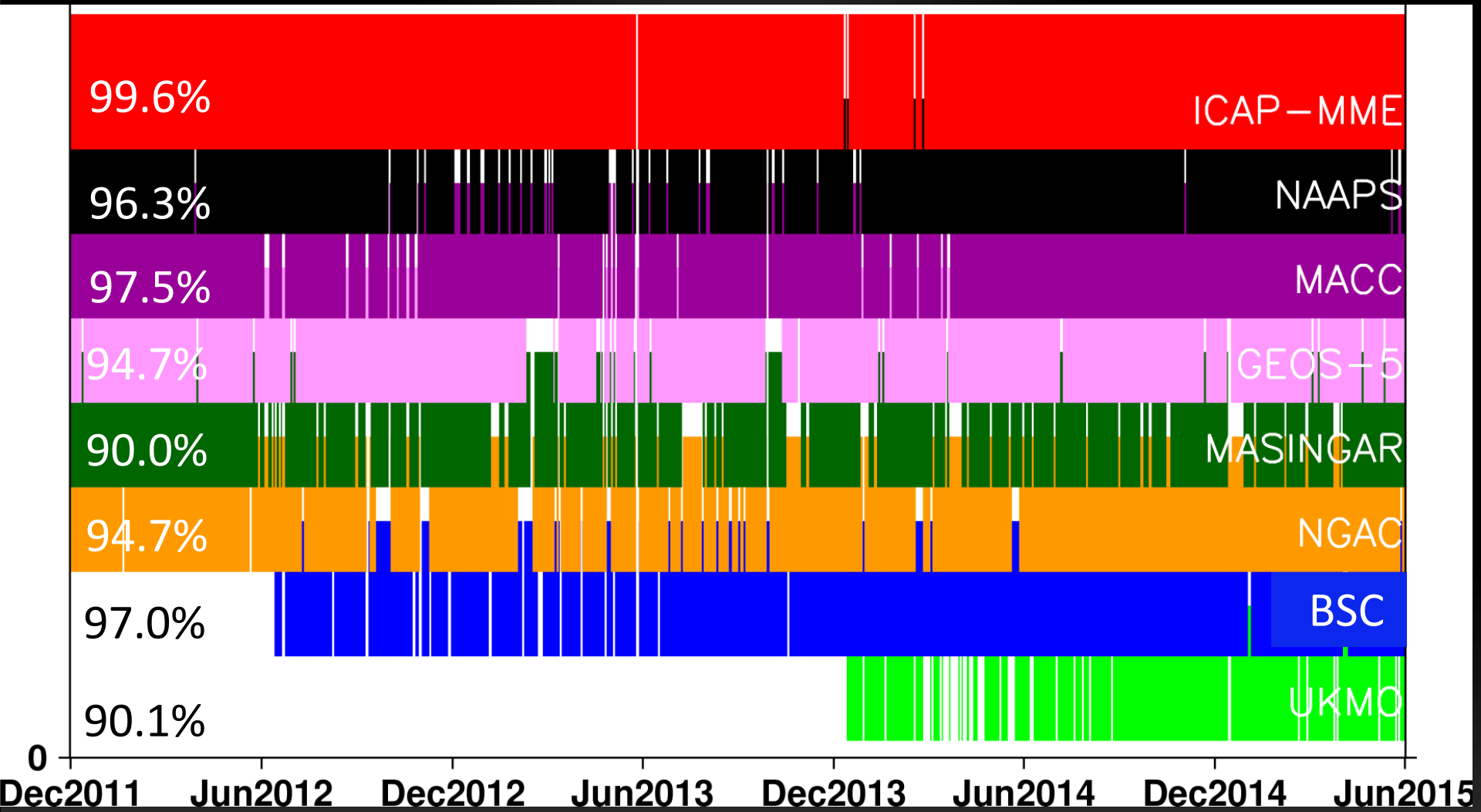
# CURRENT ICAP OPERATIONS

| | BSC NMMB | JMA MASINGAR | ECMWF MACC | NASA GEOS-5 | NOAA NGAC | Navy NAAPS | UKMO UM |
|---|---|---|---|---|---|---|---|
| Meteorology | Offline NMMB | Inline AGCM | Inline IFS | Inline GEOS-5 | Inline GFS | Offline NAVGEM | Inline UM |
| Species | Dust Sea Salt | BC Dust OC Sulfate Sea Salt | BC Dust OC Sulfate Sea Salt | BC Dust OC Sulfate Sea Salt | Dust | Anthro+bio Bio. burn. Dust Sea Salt | Dust |
| Resolution (approximate) | $0.56^o$x$0.56^o$ | $1^o$x$1^o$ | $0.8^o$x$0.8^o$ | $0.25^o$x$0.31^o$ | $1^o$x$1^o$ | $0.33^o$x$0.33^o$ +$1^o$x$1^o$ Leg | $0.23^o$x$0.15^o$ |
| $\sigma$ Levels | 24 | 40 | 60 | 72 | 64 | 30 +25 Leg | 70 |
| Bins per specie | 8 | 10 | 3 | 5 | 5 | 1 | 2 |
| Data Assim | | ENKF$^p$ | 4D Var | 3D Var | | 2D Var ENKF$^p$ | 4D Var Hy-ENKF$^p$ |

*p: Prototype demonstrated*

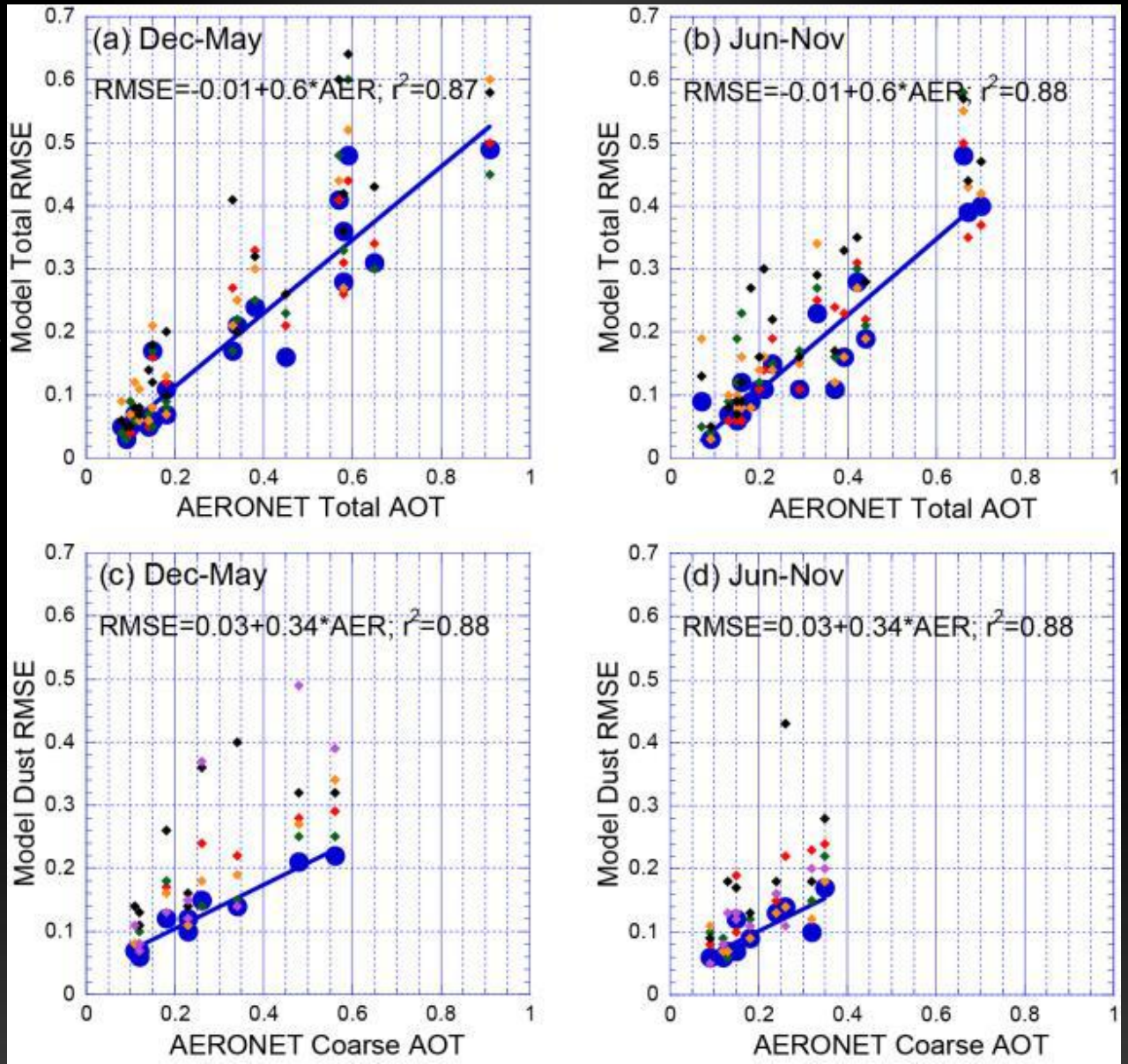
- The ICAP-MME is run daily with 1x1 degree resolution at 00Z for 6 hourly forecasts out to 120 hours with a one-day latency.
- Modal AOT (550nm) and dust AOT (550nm) data in NetCDF is available at http://usgodae.org/cgi-bin/datalist.pl?dset=nrl_icap_mme&summary=Go

# DATA FLOW OF THE ICAP MODELS



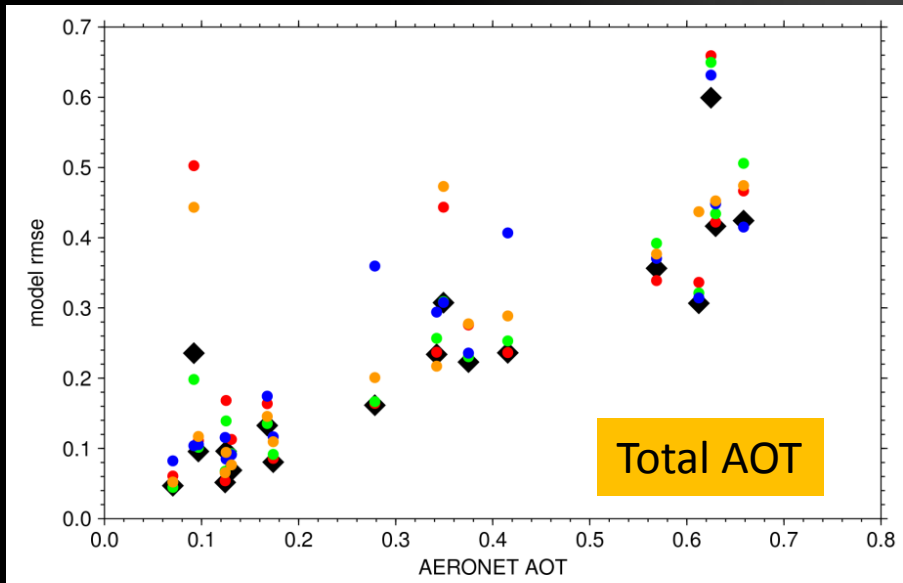
# 72 HOUR FORECAST RMSE: (2012)
# THE ICAP-MME IS THE TOP PERFORMER

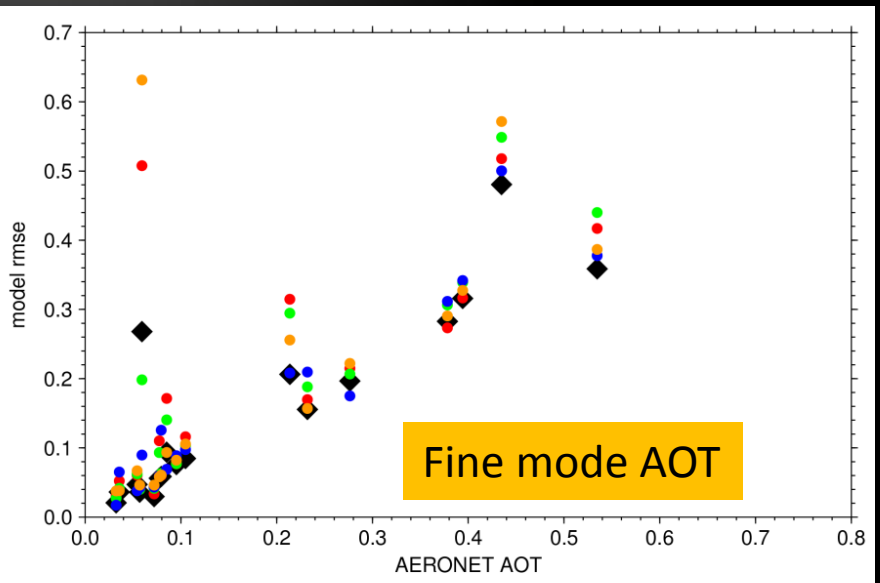
(Sessions, et al, 2015, ACP)

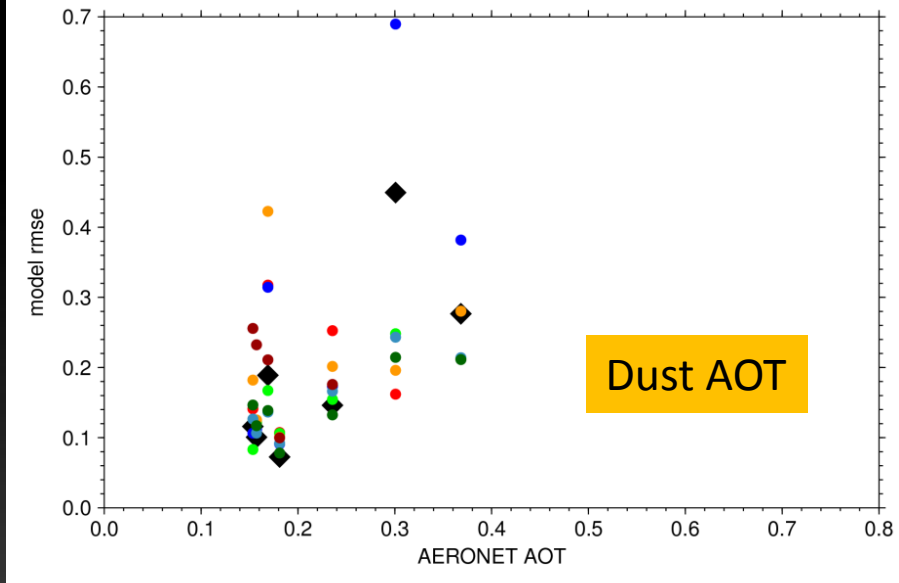


# 72 HOUR FORECAST RMSE: (2013-2014)

## THE ICAP-MME IS STILL THE TOP PERFORMER



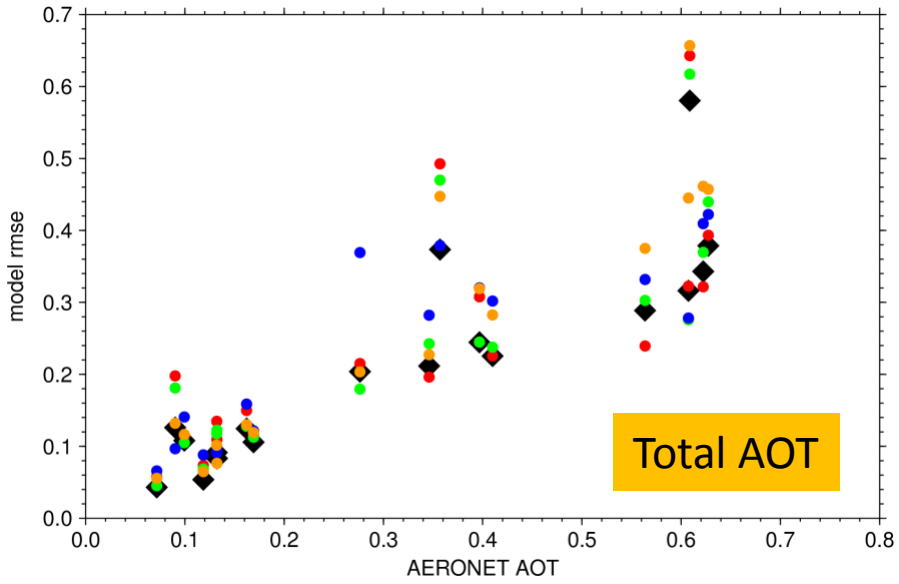



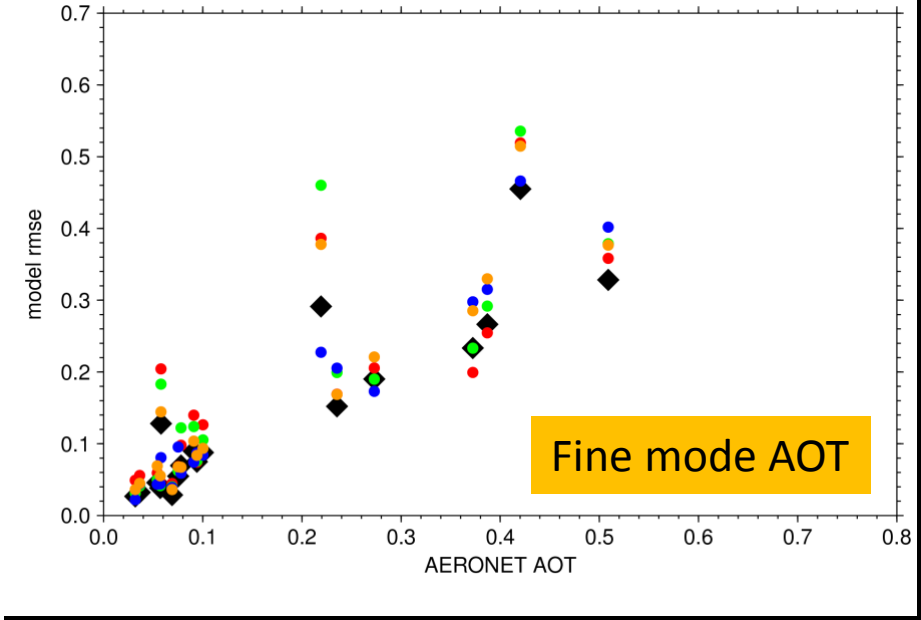



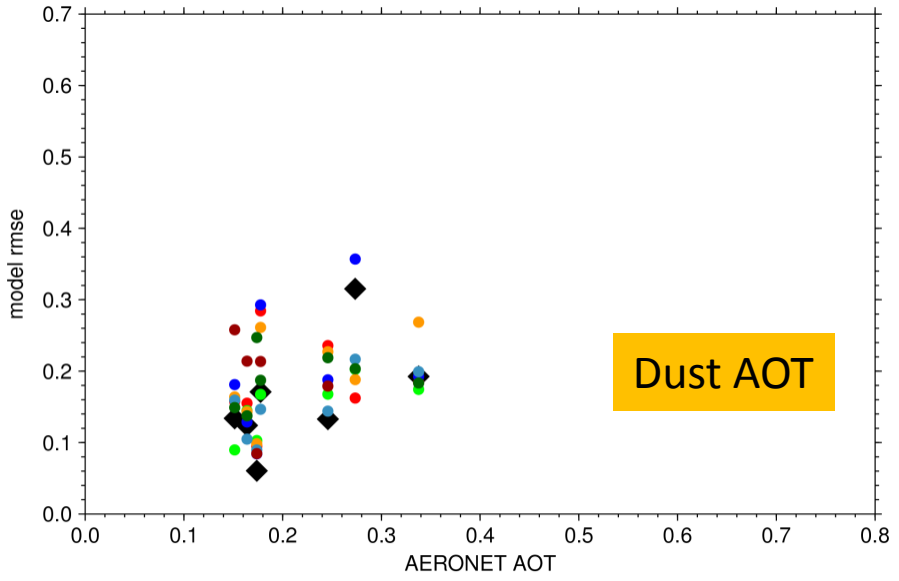

- The result is consistent with Sessions et al., (2015) for total and fine mode AOTs.
- For dust AOT, large bias exist in some models, which results in ICAP-MME ranking in the middle for some sites.

# 6-HOUR FORECAST RMSE: (2013-2014)

## THE ICAP-MME IS OVERALL THE TOP PERFORMER

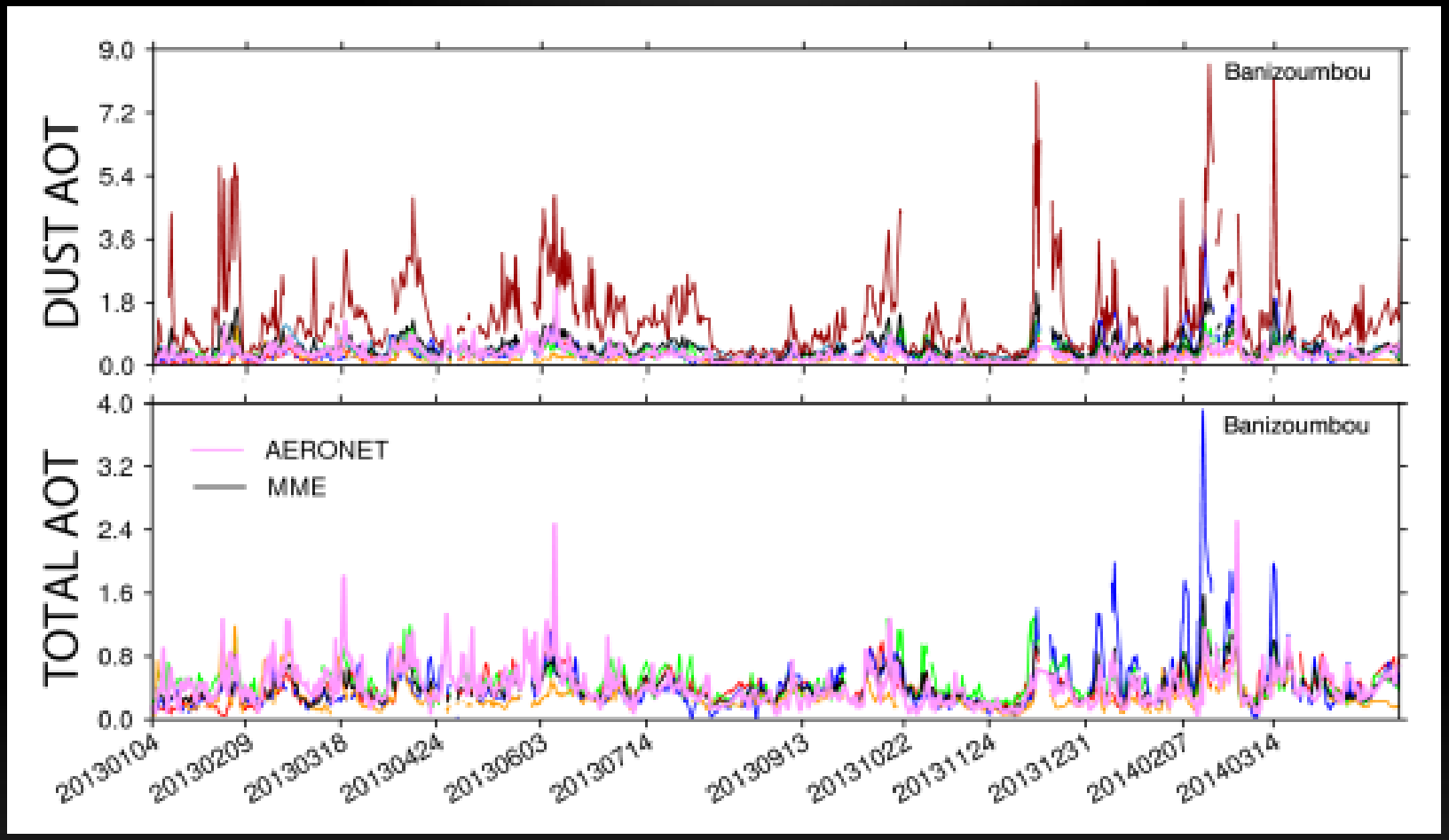


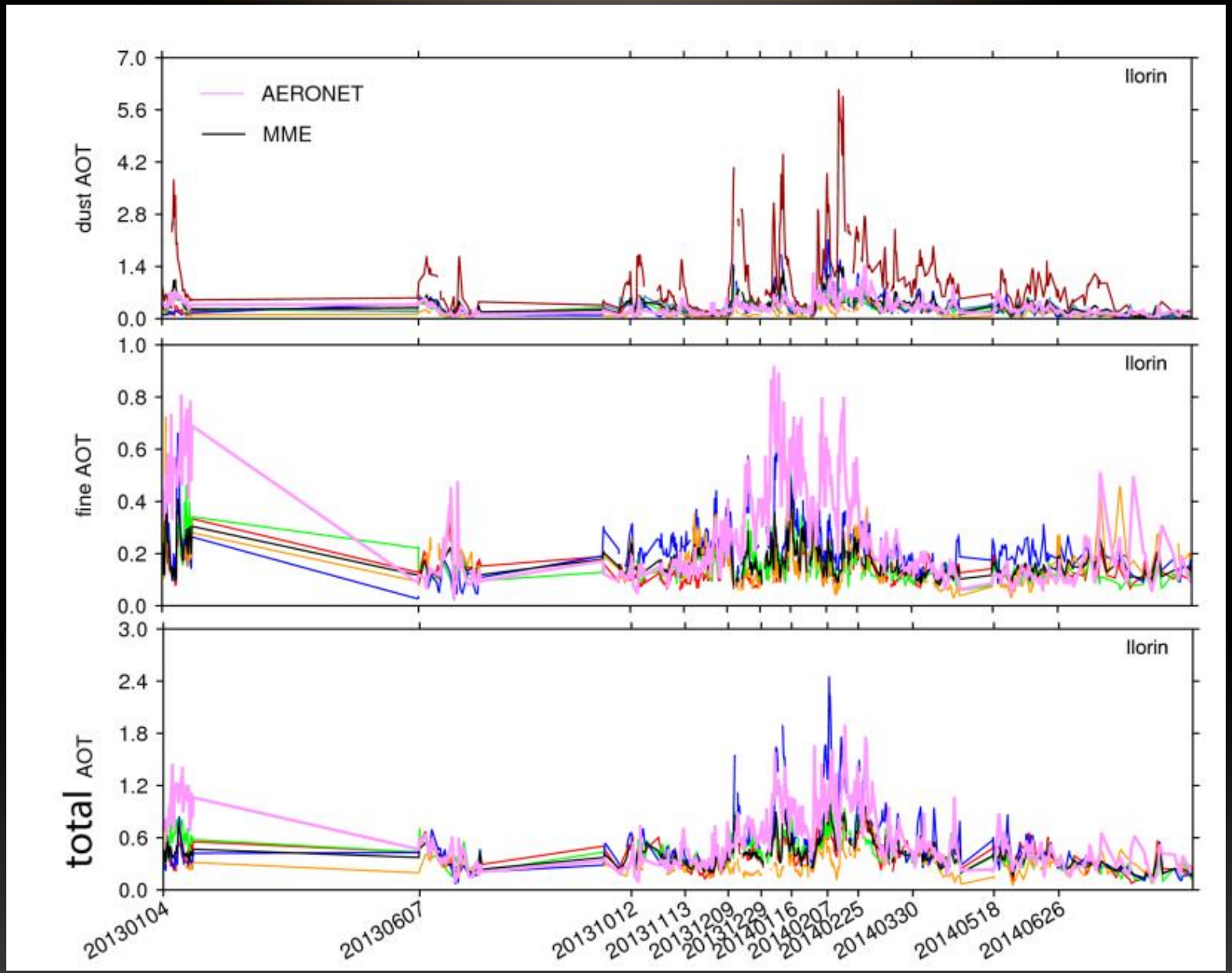




- ICAP-MME 6-hr forecast has similar behavior as 72-hr forecast w.r.t. RMSE, except with smaller spread.

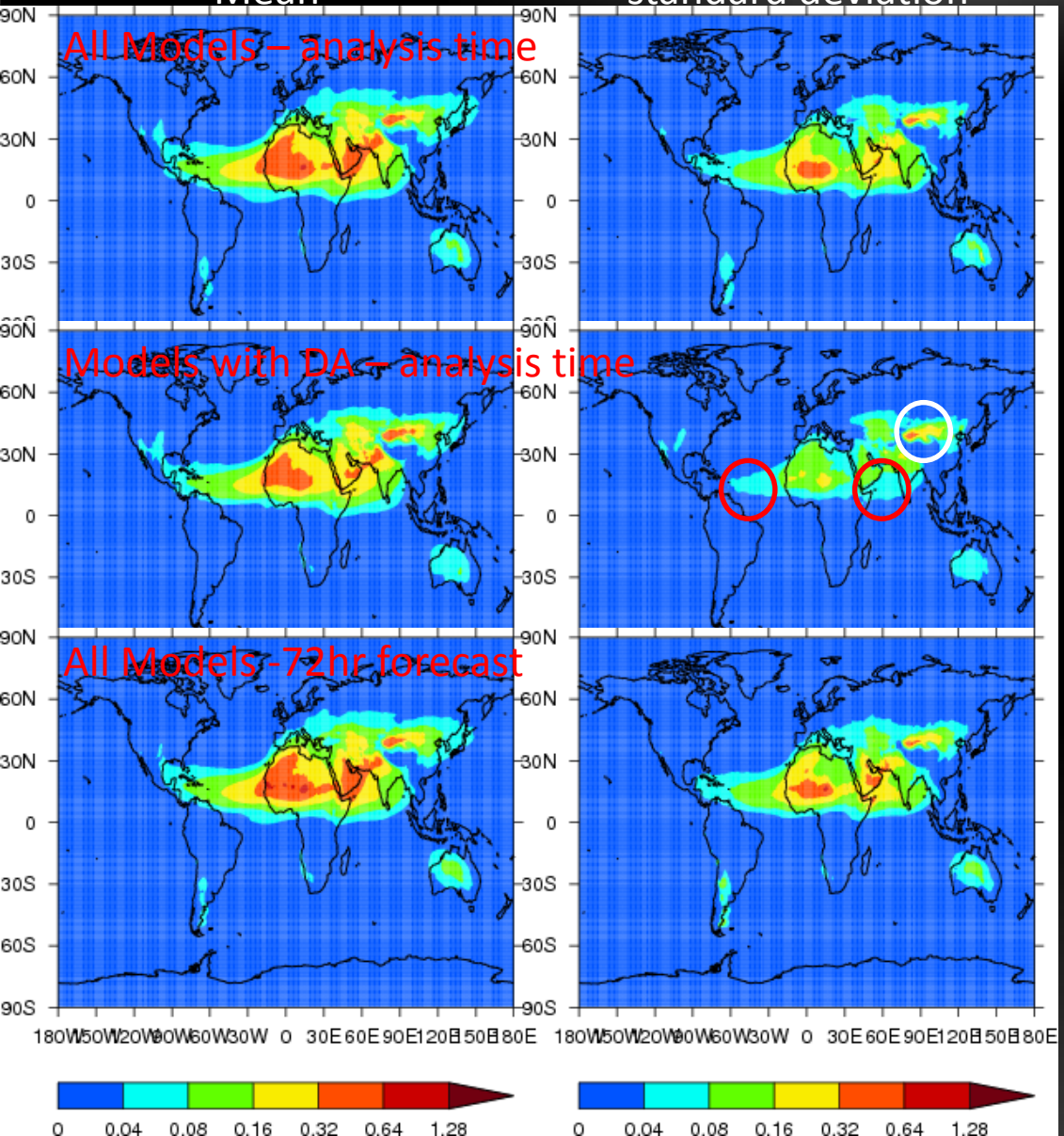
# ICAP MODELS AT BANIZOUMBOU (72-HR FCST)



# ICAP MODELS AT ILORIN (72-HR FORECAST)



# 2014 JJASON DUST MEANS AND SPREADS




AOT stdv. of the DA models at the analysis time is overall much reduced compared to all models or their forecast modes.

Over water, stdv (da) ~1/4 - ½ stdv (all)
Over land, stdv (da)~ ½ stdv (all)

But it has a regional dependency. East Asian dust region as an example.

# FUTURE VERIFICATION

- AOT: total, fine and coarse mode AOT
  - AERONET L1.5v (a NRT production of AERONET L3, better cloud screening)
  - GAW : fine and coarse surface scattering
- Surface concentration:
  - IMPROVE: http://vista.cira.colostate.edu/improve/Data/data.htm over US
  - EMEP: http://ebas.nilu.no over Europe, “acidifying” species.
  - GAW: fine and coarse modes, http://www.gaw-wdca.org
  - University of Miami : 5 oceanic sites
  - SPARTAN: an emerging global PM2.5 network
- Vertical profiles:
  - MPLNET sites currently running : GSFC, Ragged_Point, Kanpur, Singapore, EPA-NCU (25N, 121E, Taiwan), UMBC (39N, 77W).
  - EARLINET

❑ Pick up a couple of sites for verification of surface concentration and vertical profile of backscatter and extinction coefficients.