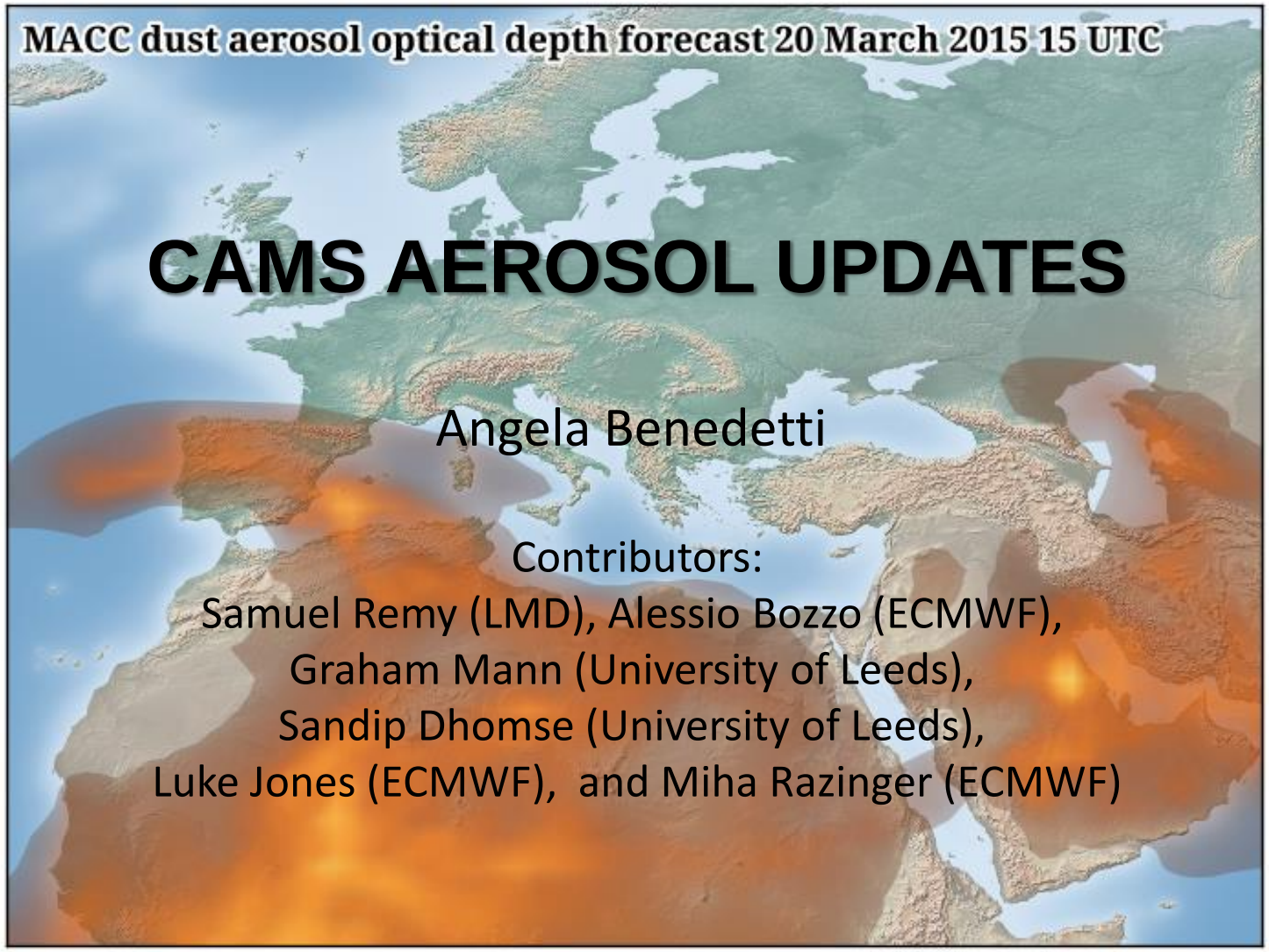

CAMS AEROSOL UPDATES

Angela Benedetti

Contributors:
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Graham Mann (University of Leeds),
Sandip Dhomse (University of Leeds),
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OUTLINE

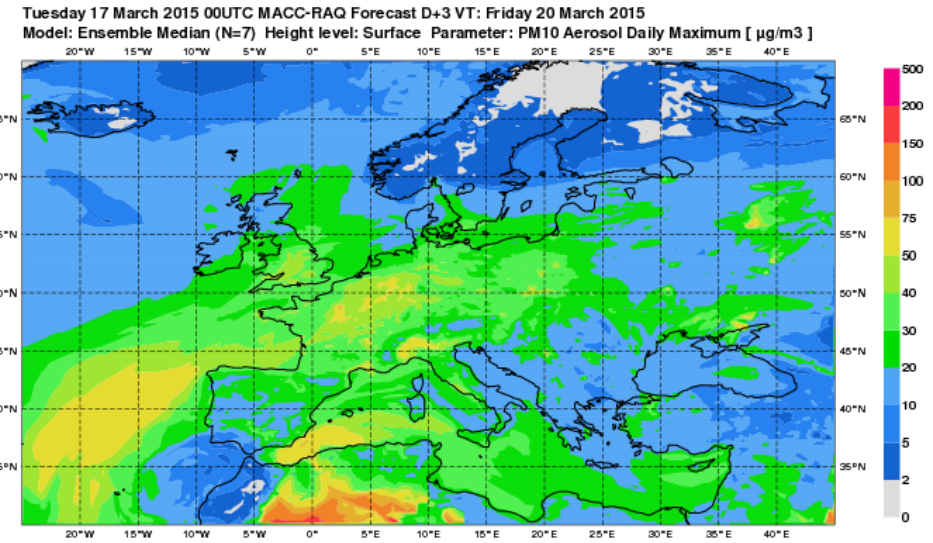
- General MACC/CAMS news
- Aerosol modelling updates
- Fire emission updates
- Model evaluation with High Spectral Resolution Lidar data
- Impact of MACC climatology on NWP forecasts

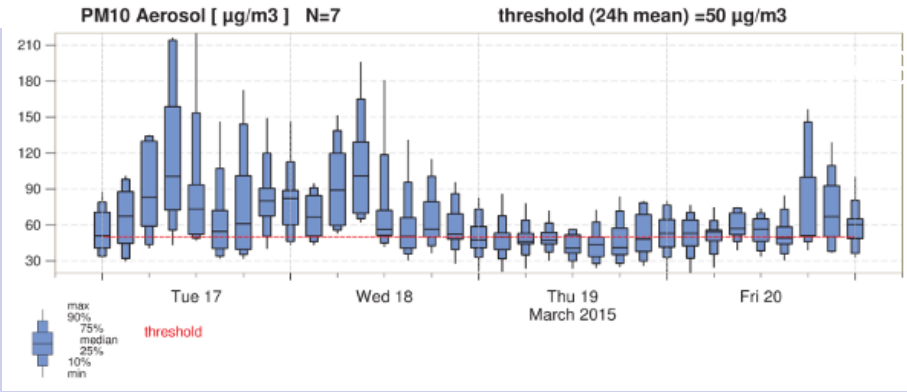
MACC/CAMS NEWS

- Copernicus Atmosphere Monitoring Service (CAMS) started officially in January 2015
- MACC-III is still running, delivering the essential services (NRT runs, regional services, validation) until the end of summer
- ECMWF is the main entity, but several services will be sub-contracted to consortia (for example the regional modelling, validation, etc.)
- Calls for proposals have been out, evaluation phase to follow
- Intensive period of recruiting
- Move to the University of Reading to happen in September
- Involvement in EU/ESA proposals to guarantee research funding

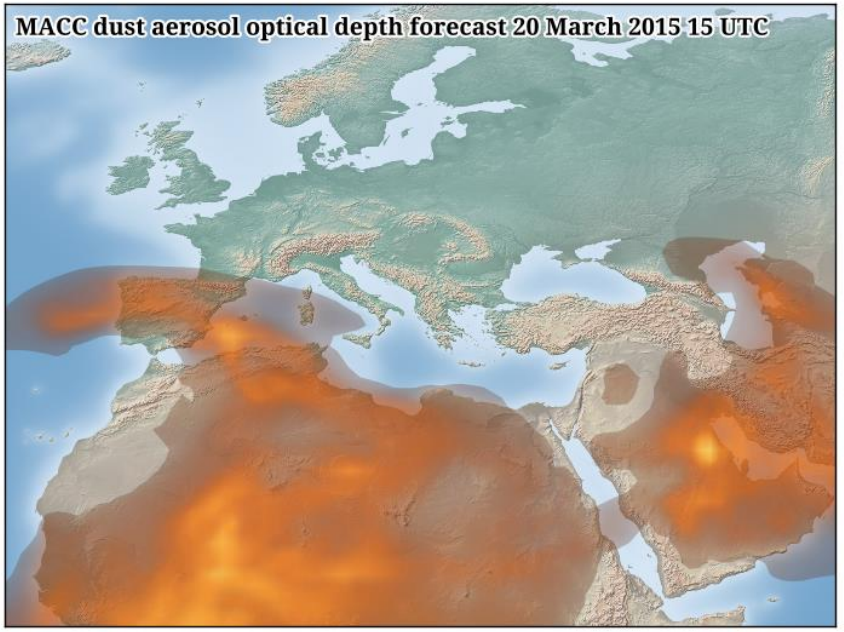
RECENT EPISODES (MARCH 2015)

Poor air quality over Western Europe





Dust advection from the Sahara



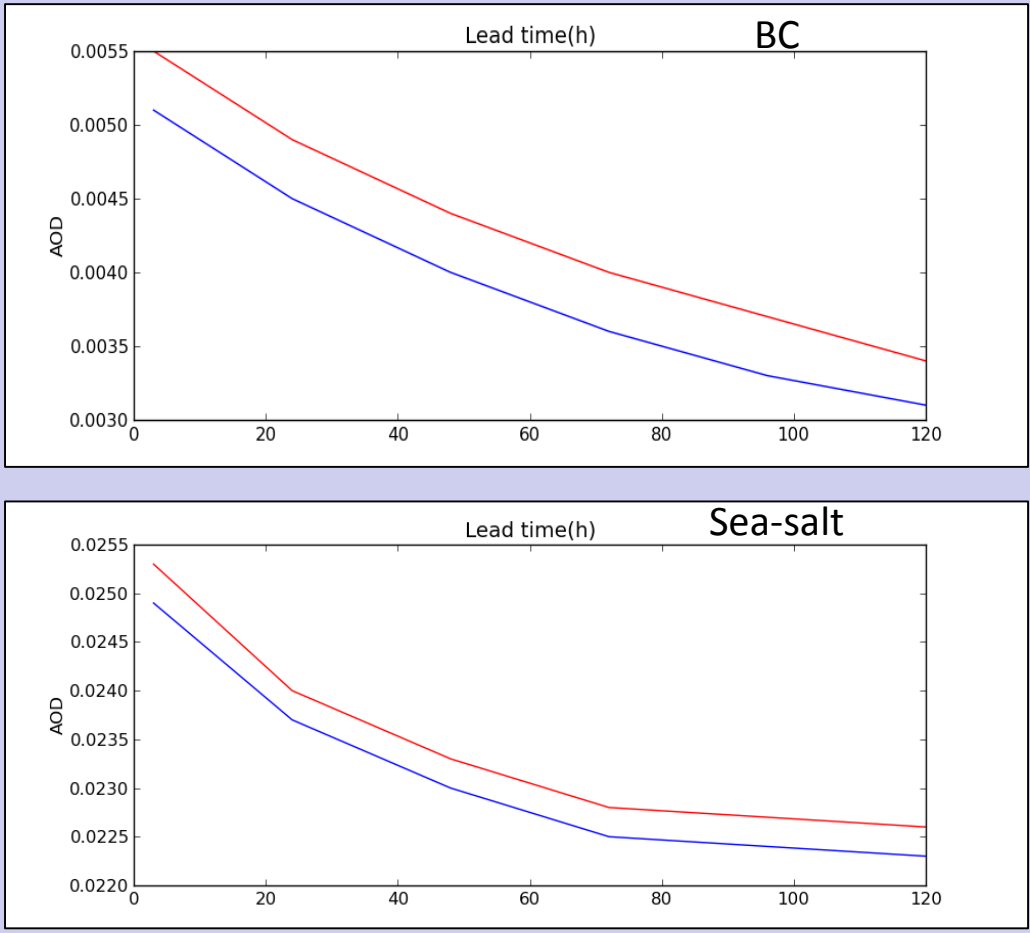
http://www.copernicus-atmosphere.eu

AEROSOL MODELLING UPDATES

- Mass fixer for aerosol species
- Rebalancing of fine and coarse dust emissions
- Impact of resolution changes: large sensitivity of all aerosol fields
- Evaluation of resolution impact with HSRL data
- Rise plume model to derive injection heights for biomass burning emissions
- Impact of injection height on AOD
- Evaluation of injection height impact with HSRL data

Use of a mass fixer for aerosol species in CIFS : why?

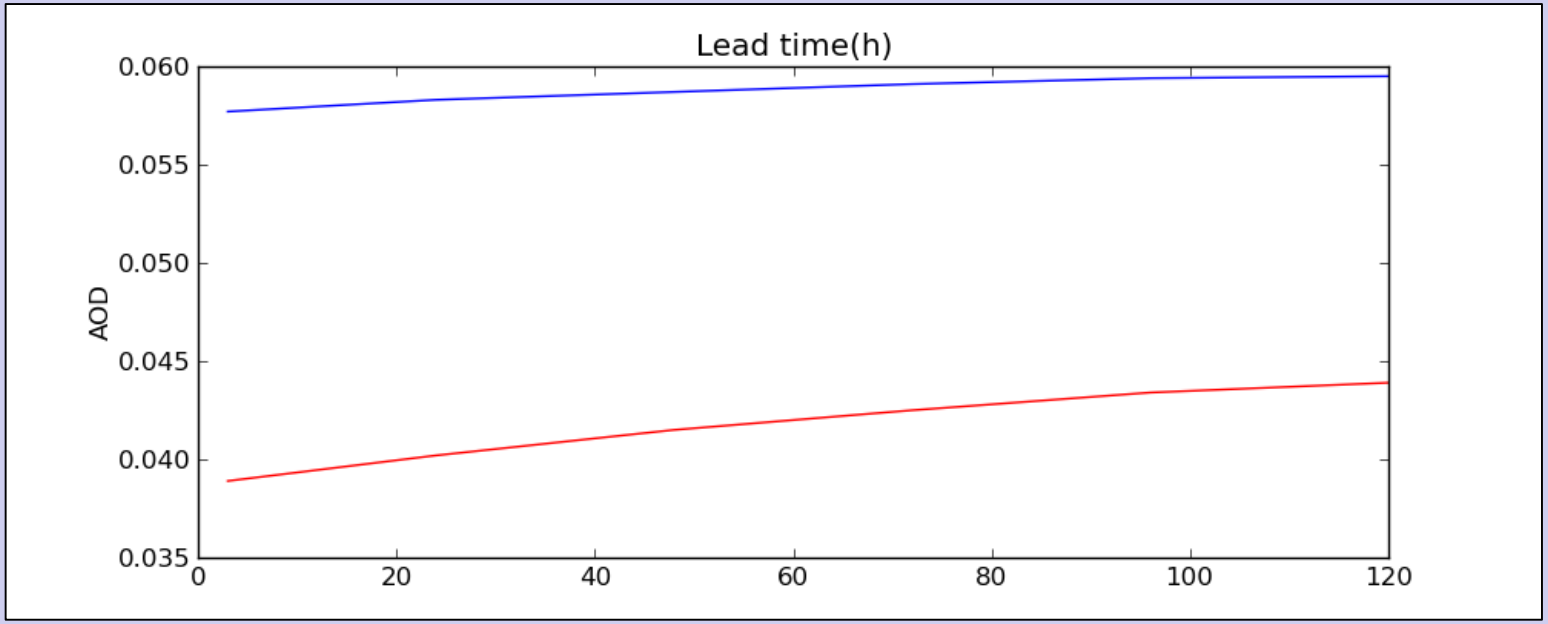
- For aerosol species as for chemical species, the Semi Lagrangian Advection (SLA) scheme is not mass conservative.
  - With the hybrid sigma-pressure system, the vertical discretization changes with surface pressure and orography.
- The GRG project already studied the impact of this phenomenon (Flemming and Huijnen, 2013, Diamantakis and Flemming, 2014) on chemical species.
- Tests with the same mass fixer as used by GRG : additive mass fixer
- Impact important on OM and BC (-10% AOD), significant on Sulfates (+3% AOD), small on total AOD (-1%)
- **It was the missing term to balance aerosol species' budgets!**



Mean global AOD for May 2014 for BC (top) and sea-salt (bottom), reference in red, with mass fixer in blue

Credits: Samuel Rémy

Dust emissions

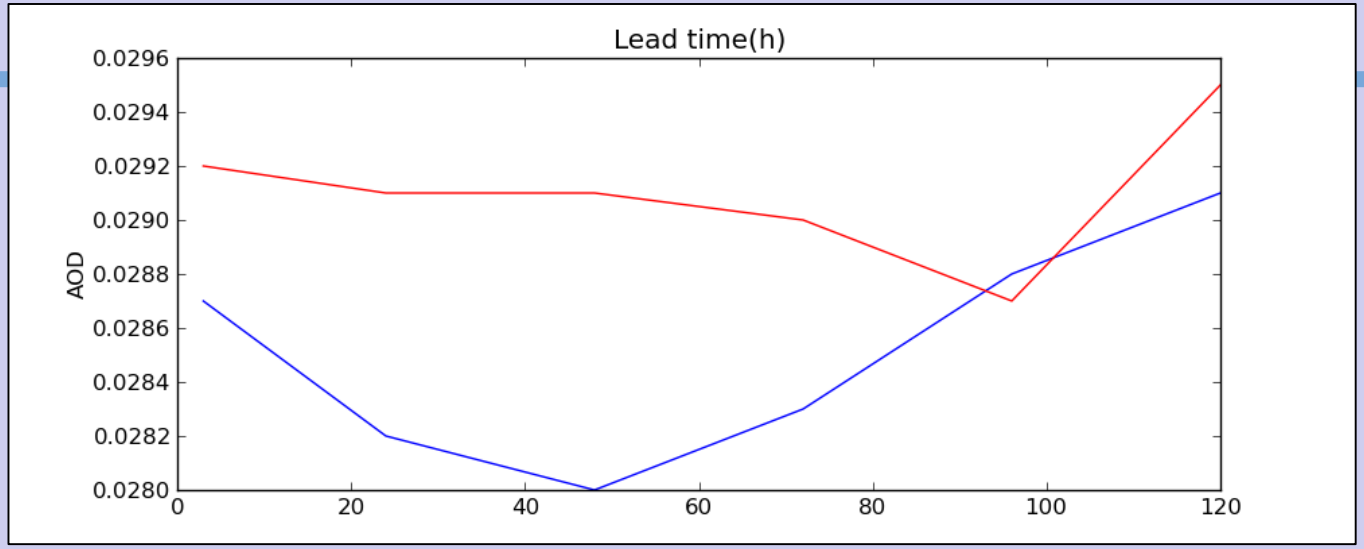


Global dust AOD for May 2014 as a function of lead time, with (red) and without (blue) data assimilation

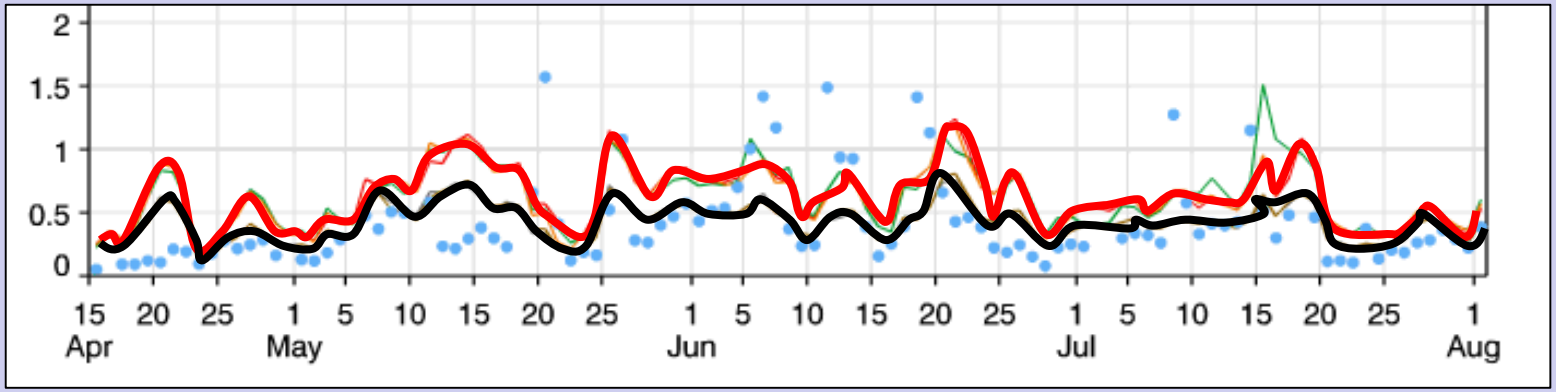
- Overestimation of dust AOD : the **aerocom average is 0.023**
- Compared to the literature and other models, the amount of larger particles in dust emissions is too low.
- => decrease of the amount of small particles in the emissions, increase the amount of larger particles

Credits: Samuel Rémy

Dust emissions



Global dust AOD for May 2014 as a function of lead time, with (red) and without (blue) data assimilation



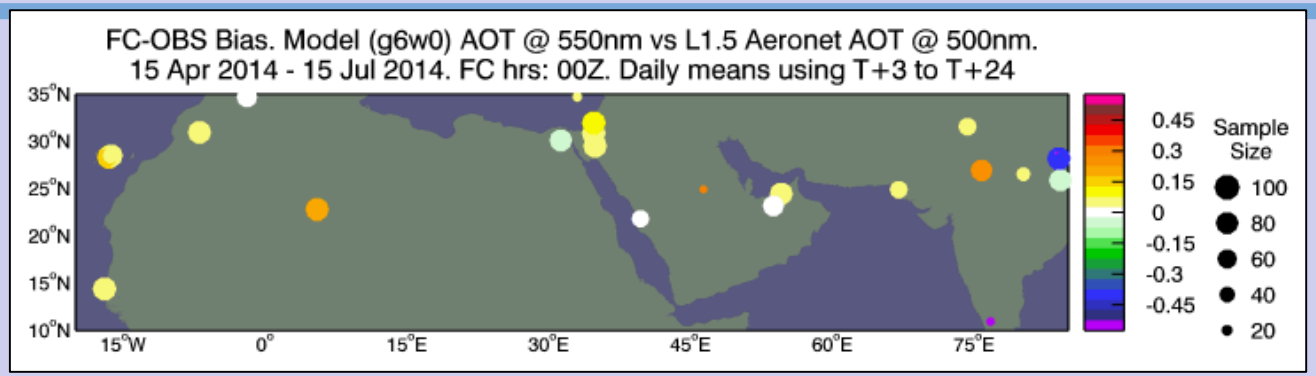
AOD at the AERONET station of Tamanrasset (Algeria), from 15/4/2014 to 1/8/2014. Observations (blue), old emissions (red) and new emissions (black)

Better balance between the model and observations

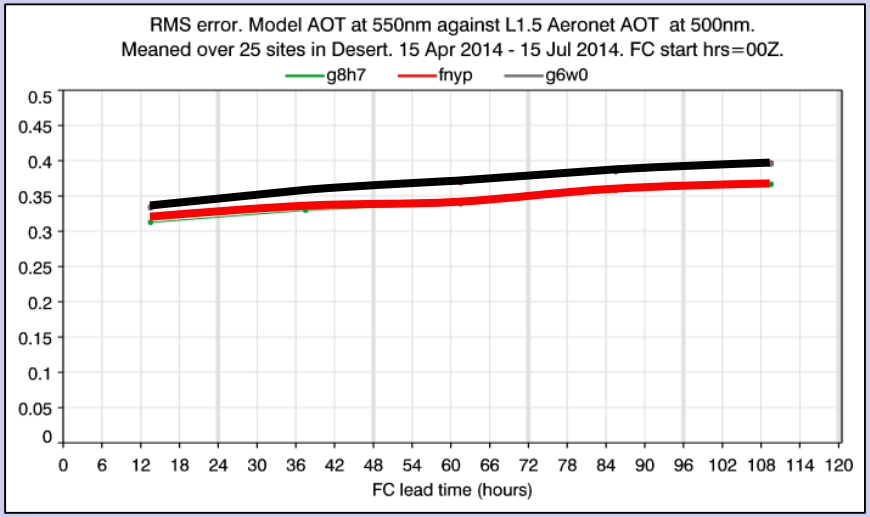
Credits: Samuel Rémy

Dust emissions : global assessment

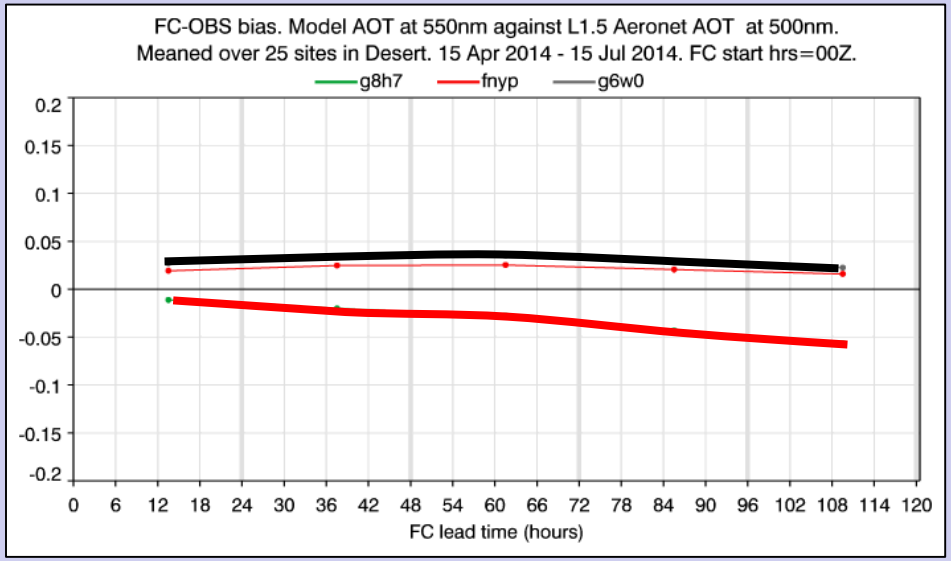
Evaluation against AERONET stations in desert regions of N hemisphere, 15/4 to 15/7 2014



Mean bias of reference run, model-obs, 15/4/2014 to 15/7/2014



Mean RMSE of reference run (black) and new dust emissions (red)



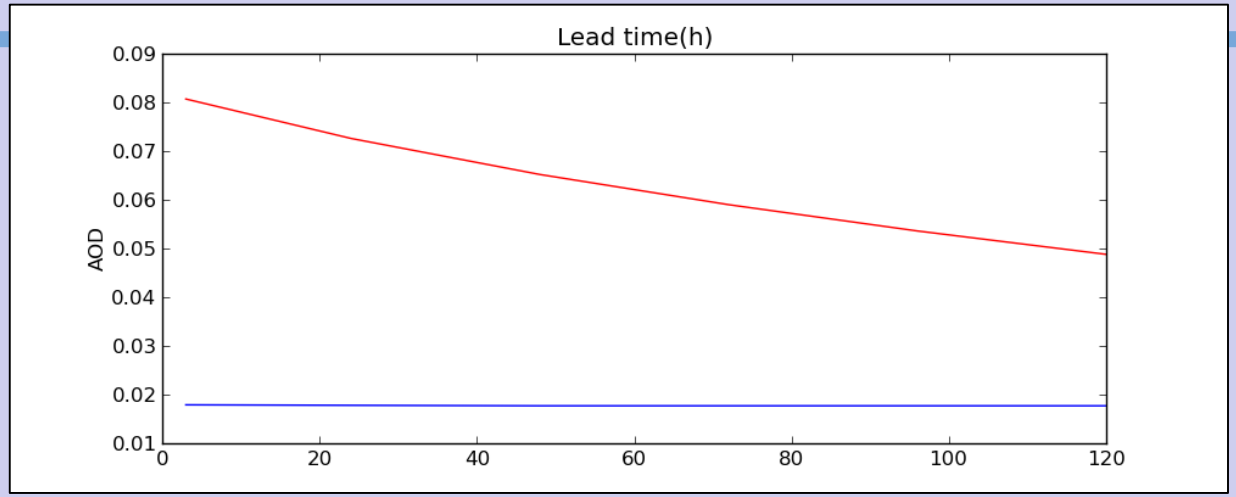
Mean bias of reference run (black) and new dust emissions (red)

Plots by Luke Jones

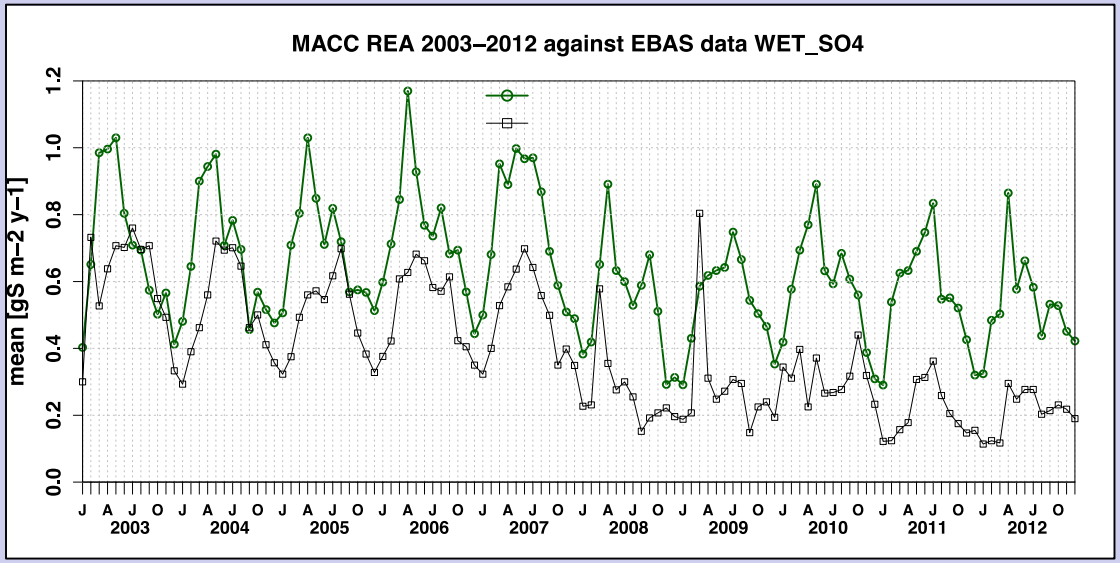
Credits: Samuel Rémy

Sulfates

Large imbalance between model and “observations” for Sulfate (**aerocom average 0.032**) :



Global sulfate AOD for May 2014 as a function of lead time, with (red) and without (blue) data assimilation

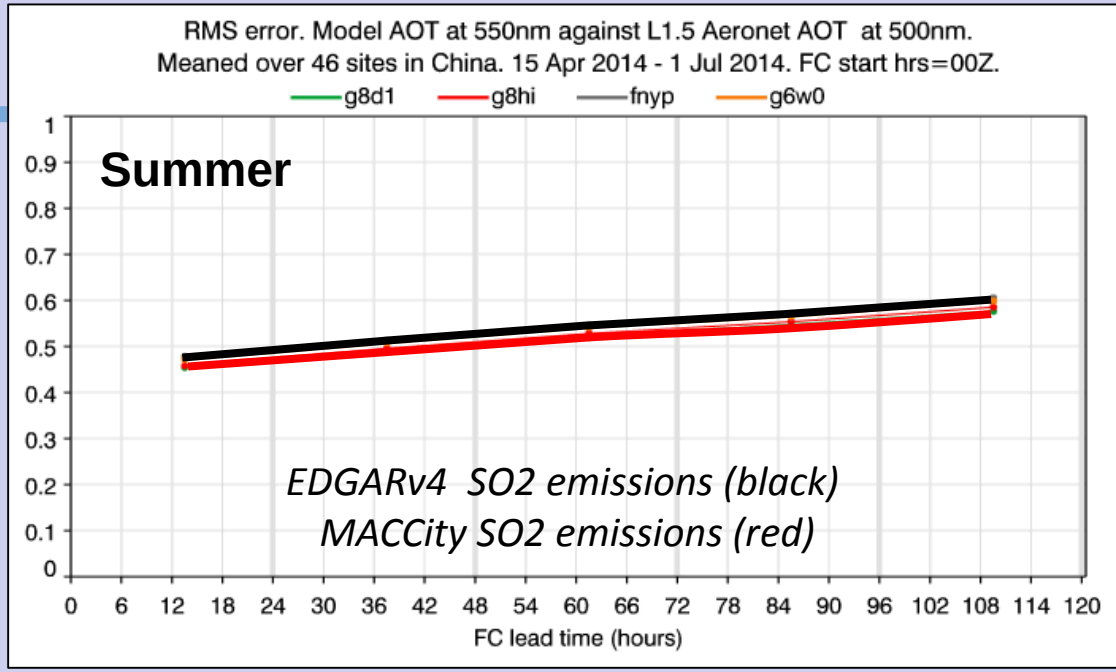


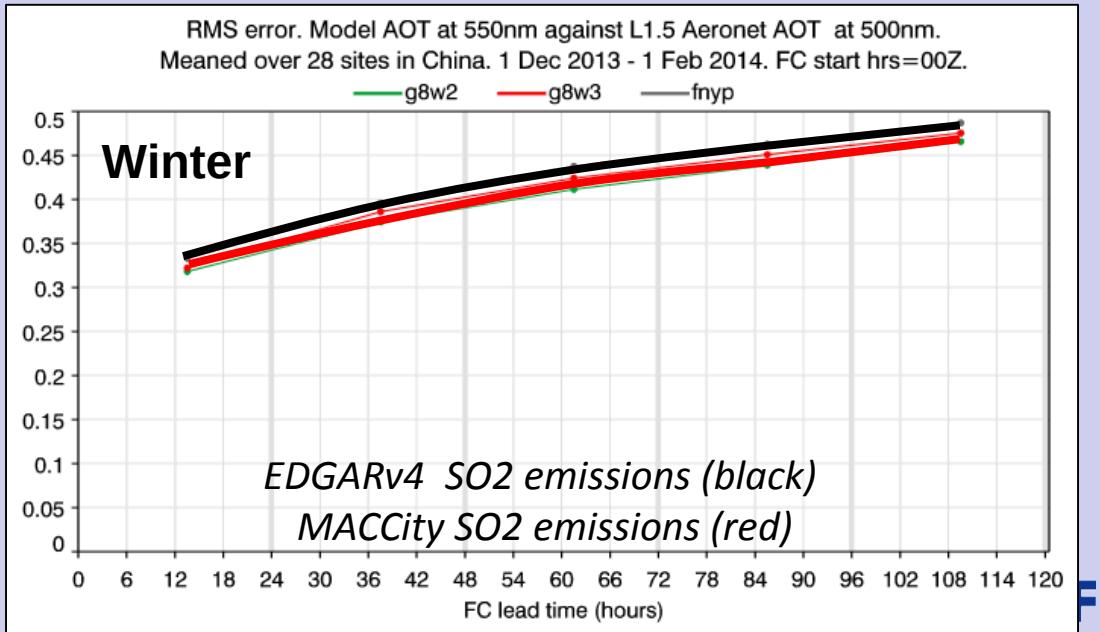
Monthly averaged surface sulphate concentrtion from observations (EBAS black) against the MACC reanalysis (green) over Europe, ***courtesy Michael Schulz, Anna Carlin Benedictow***

Sulfates : new emissions

- Two directions to solve this unbalance :
  1. Update the emissions : use of the MACCity SO2 emissions, more recent than the EDGARv4 emissions used in the operational setup.
  2. Work on the assimilation scheme : the increments for sulfates contain other aerosol types. Need to include more species to better describe the total aerosol load.

- Impact of updated emissions is more positive in winter than summer

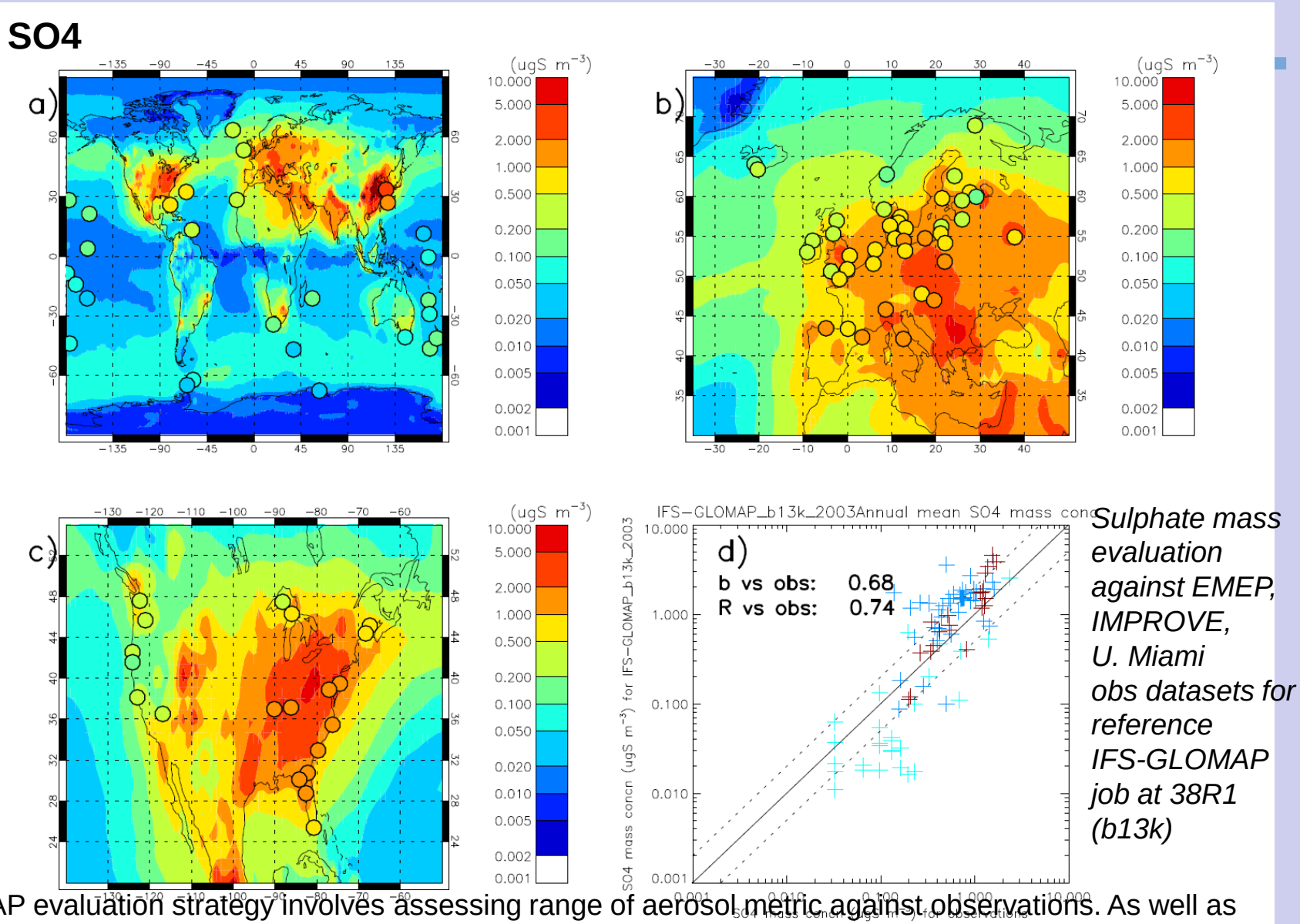




Credits: Samuel Rémy

Evaluation suite for assessing IFS-GLOMAP (also in UM, TOMCAT)

Credits: Graham Mann, Sandip Dhomse

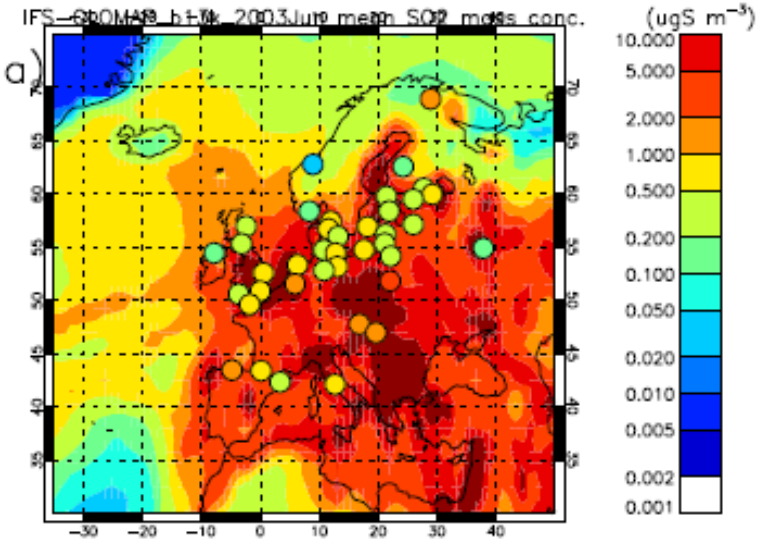


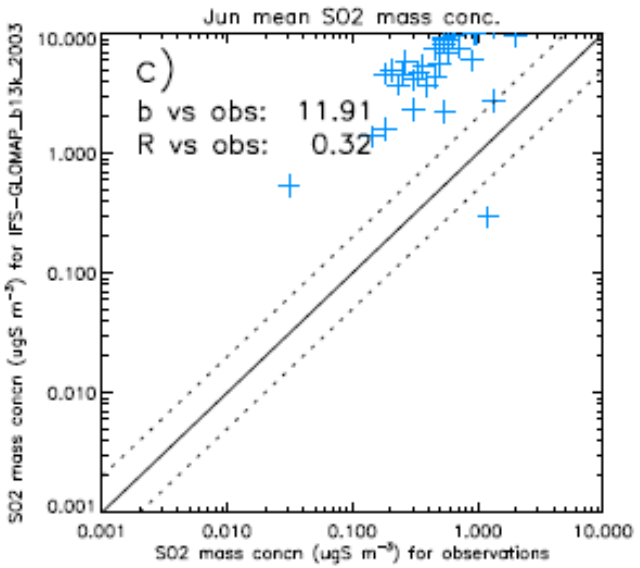
Sulphate mass evaluation against EMEP, IMPROVE, U. Miami obs datasets for reference IFS-GLOMAP job at 38R1 (b13k)

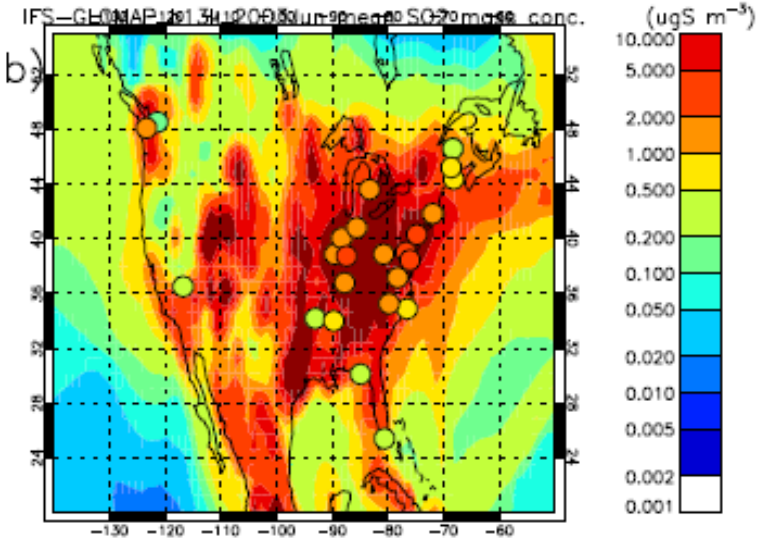
GLOMAP evaluation strategy involves assessing range of aerosol metric against observations. As well as aerosol optical depth assess speciated mass, size-resolved number concentrations are used.

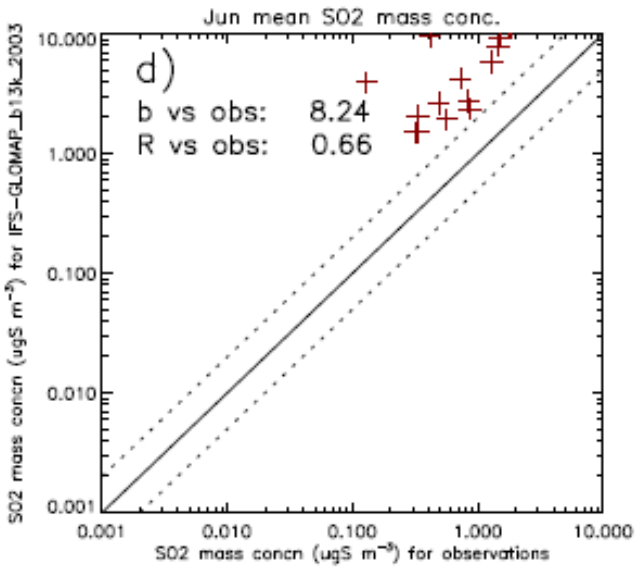
Evaluation suite for assessing IFS-GLOMAP (also in UM, TOMCAT)

SO2









Credits: Graham Mann, Sandip Dhomse

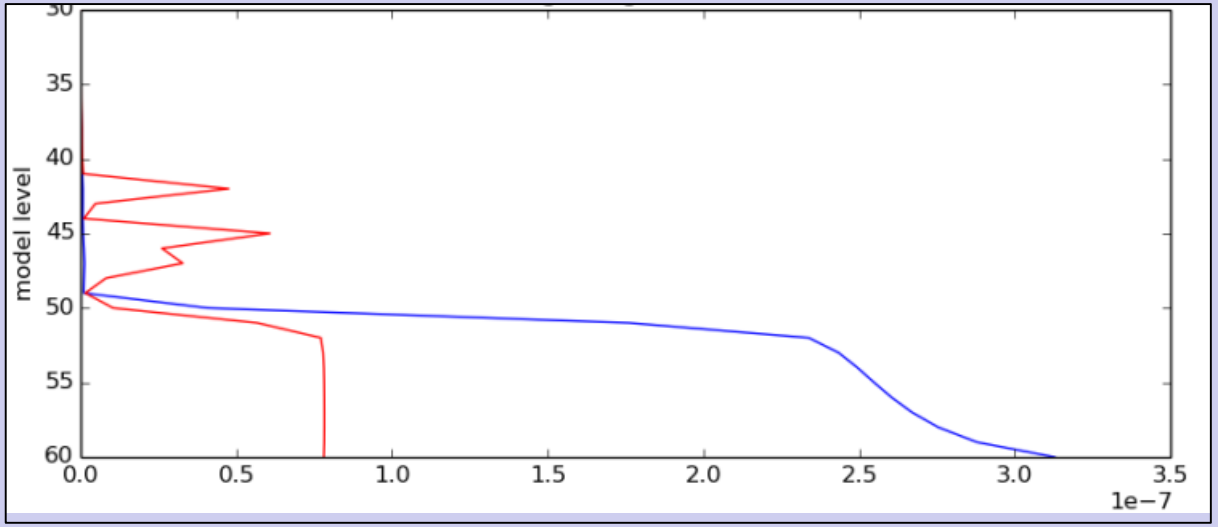
Example: SO2 evaluation against EMEP and CASTNET obs datasets for reference IFS-GLOMAP job at 38R1 (b13k)

- SO4 in good agreement but SO2 has substantial high bias.
- Ongoing work to couple with chemistry to better describe the sulphur cycle

ECMWF

Injection heights for biomass burning aerosol emissions

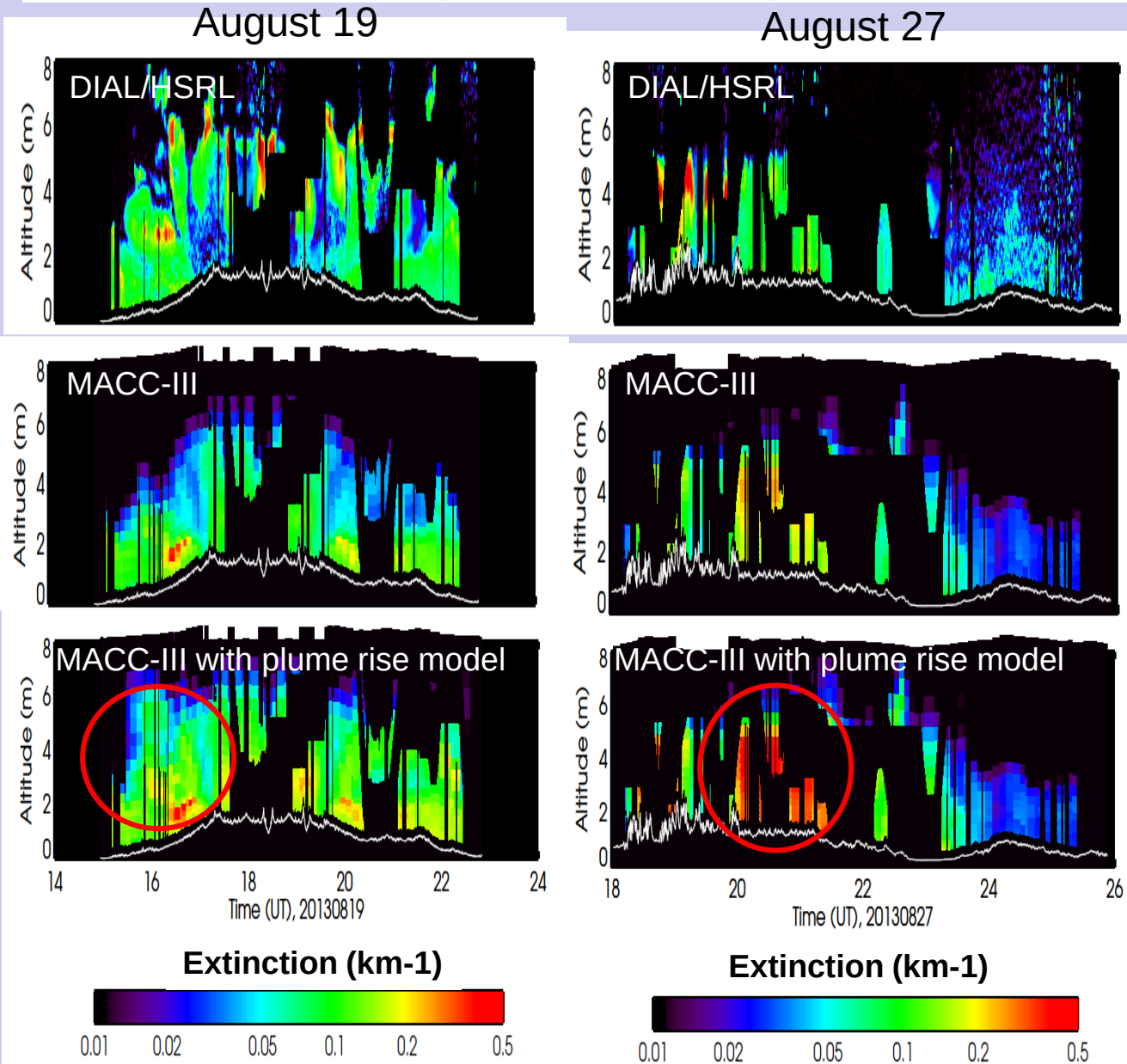
- Biomass burning emissions are currently emitted at the surface.
- Injection heights for biomass burning emissions are routinely produced by GFASv1.2., using the Plume Rise Model (Freitas et al, 2007, Paugam et al., 2015), and Sofiev's parameterization (Sofiev et al. 2012)
- Use of these injection heights was implemented in CIFS for
  - Aerosols, chemical species, greenhouse gases



Profile of OM mixing ratio over Canada (52N, 77.5W) on July 6, 2013
Blue, emissions of OM at surface, red, emissions at the injection height given by the PRM

Credits: Samuel Rémy

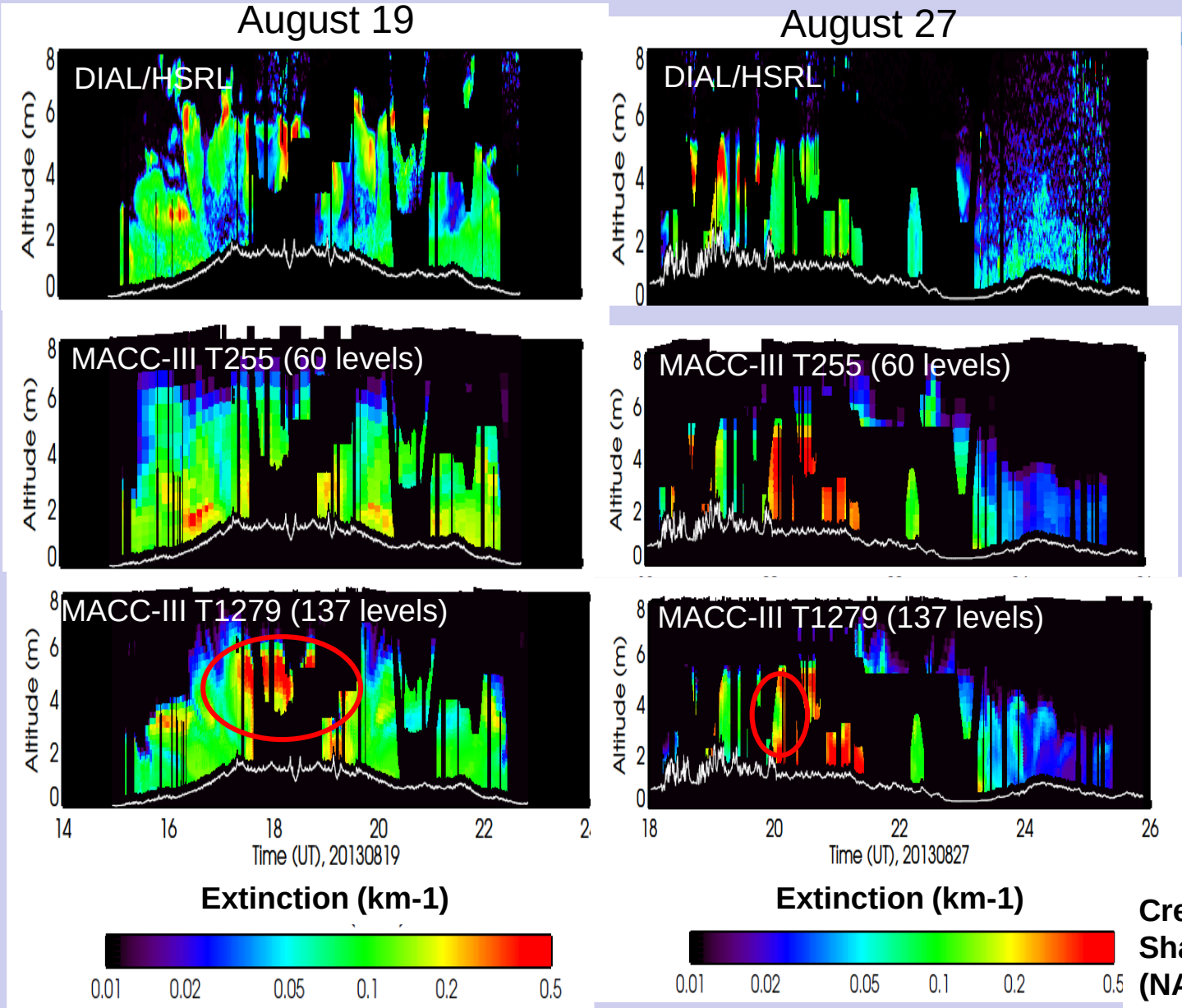
Evaluating the impacts of smoke injection heights computed from plume rise model



- Injection heights for smoke emissions are estimated using Plume rise model (Paugam et al., 2015, in preparation, based on Freitas et al., 2007)
- This plume rise model uses MODIS FRP and modelled atmospheric profiles with a shallow convection scheme to represent detrainment from fire plume
- Initial comparisons show that both aerosol extinction and AOT increase throughout the profile, not necessarily at smoke height shown in DIAL/HSRL profile

Credits: Rich Ferrare and Sharon Burton (NASA Langley)

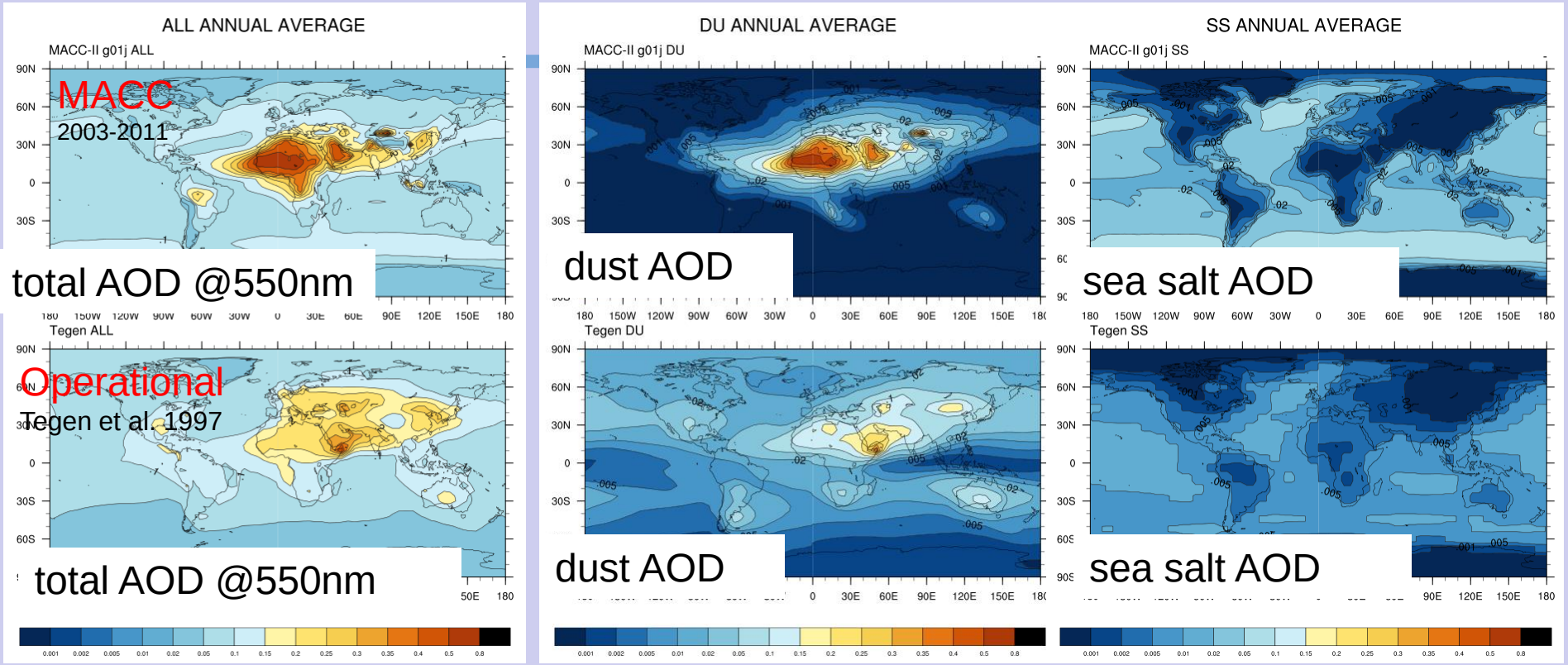
Evaluating the impact of higher model resolution



- Model resolution increased from T255 (80 km) with 60 vertical levels to T1279 (16 km) with 137 vertical levels
- Higher resolution represents smoke altitude better than assimilating MODIS AOT or using plume rise model

Credits: Rich Ferrare and Sharon Burton (NASA Langley)

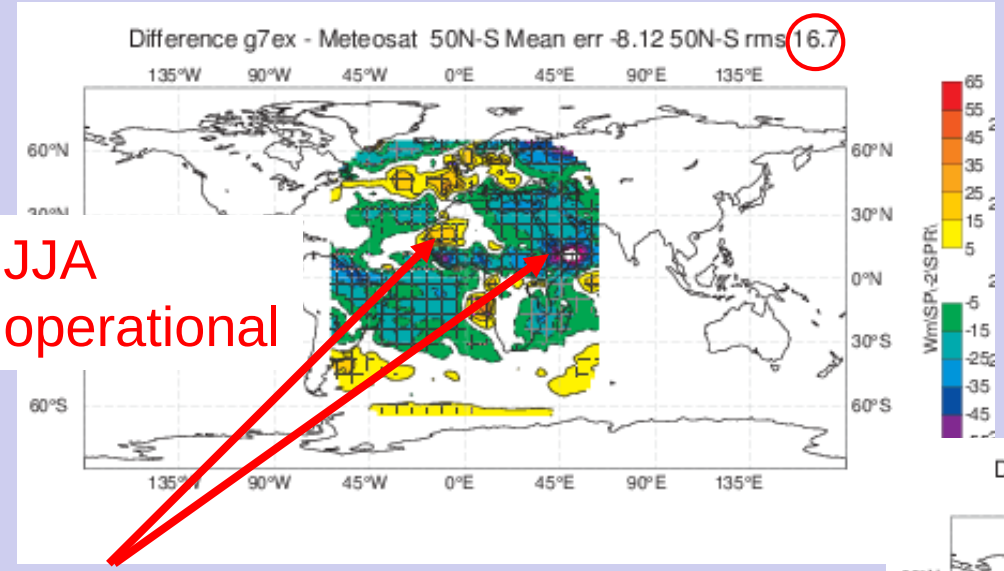
MACC vs Tegen et al. 1997 climatology



- Large differences in total AOD distribution for Sea salt, Organic, Black Carbon, Dust

Credits: Alessio Bozzo

Biases in surface solar radiation (against geostationary sat product CM SAF)

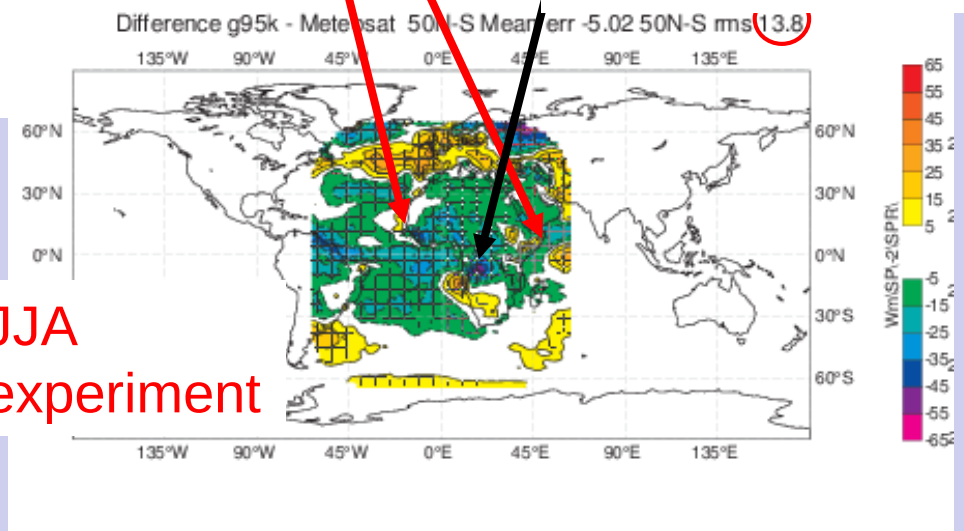


JJA operational

SW bias linked to the current climatology in dust regions

AOD from MACC reduces the bias in dust regions

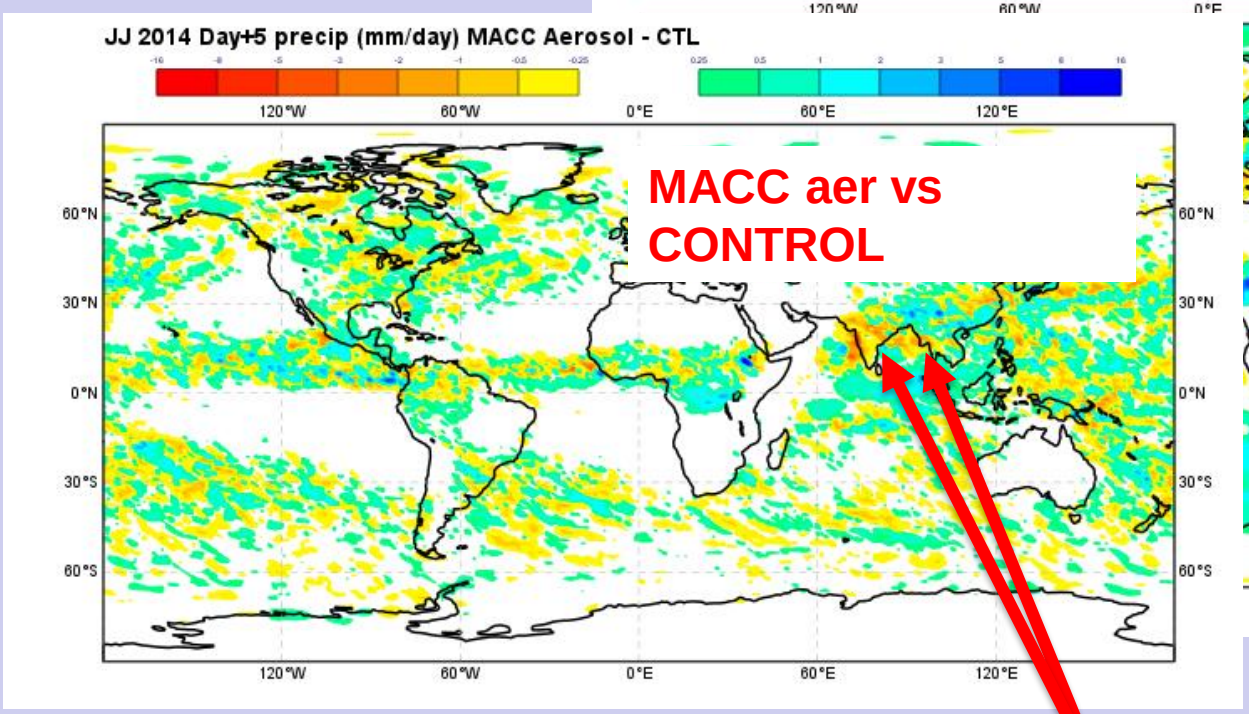
Increased bias in fire emission regions (Organic+Black Carbon)

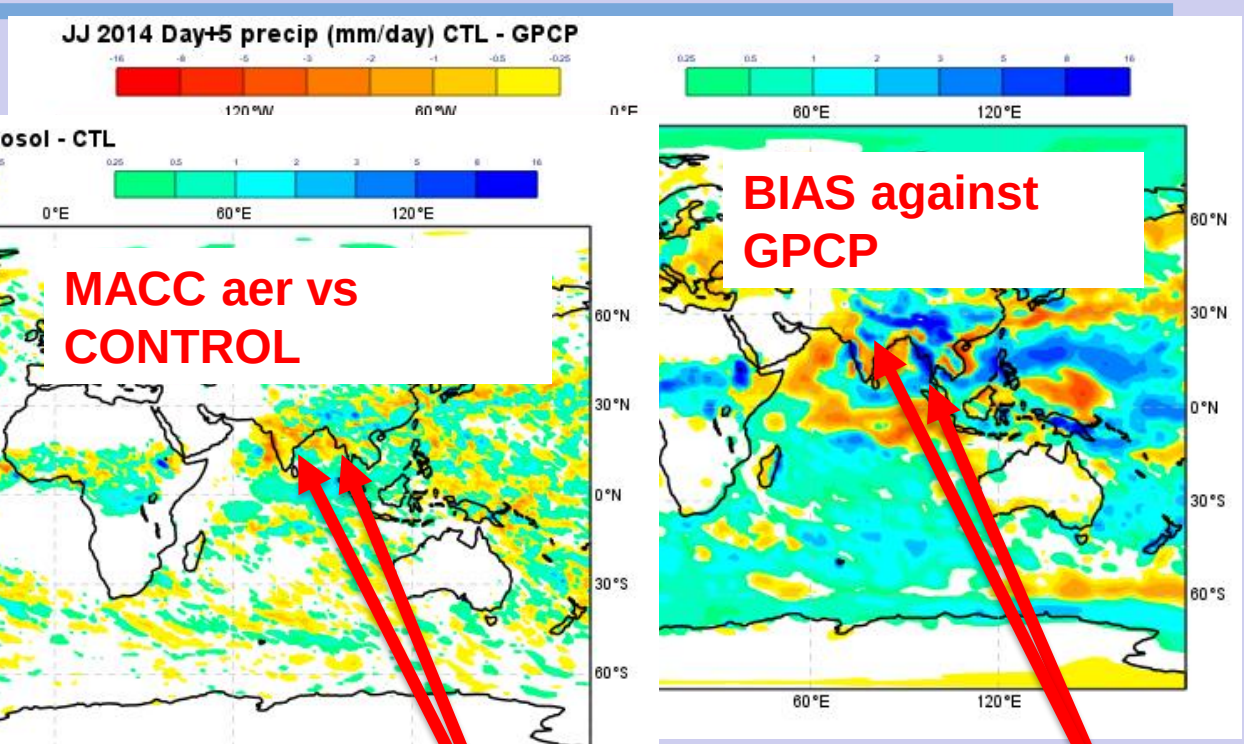


JJA experiment

Credits: Alessio Bozzo

Impact on convective precipitation – summer Indian monsoon region





Forecast day+5
reduction of the positive precipitation bias in the region (~ 20% June-July)

Credits: Alessio Bozzo

FUTURE DIRECTIONS

- Shift in focus with CAMS (more operational activities)
- More integrated approach with the chemistry (i.e. sulphur cycle)
- Other species, such as nitrates, to be added
- Increase in vertical/horizontal resolution
- Involvement in proposals to secure funding for aerosol activities (Copernicus will not fund research)