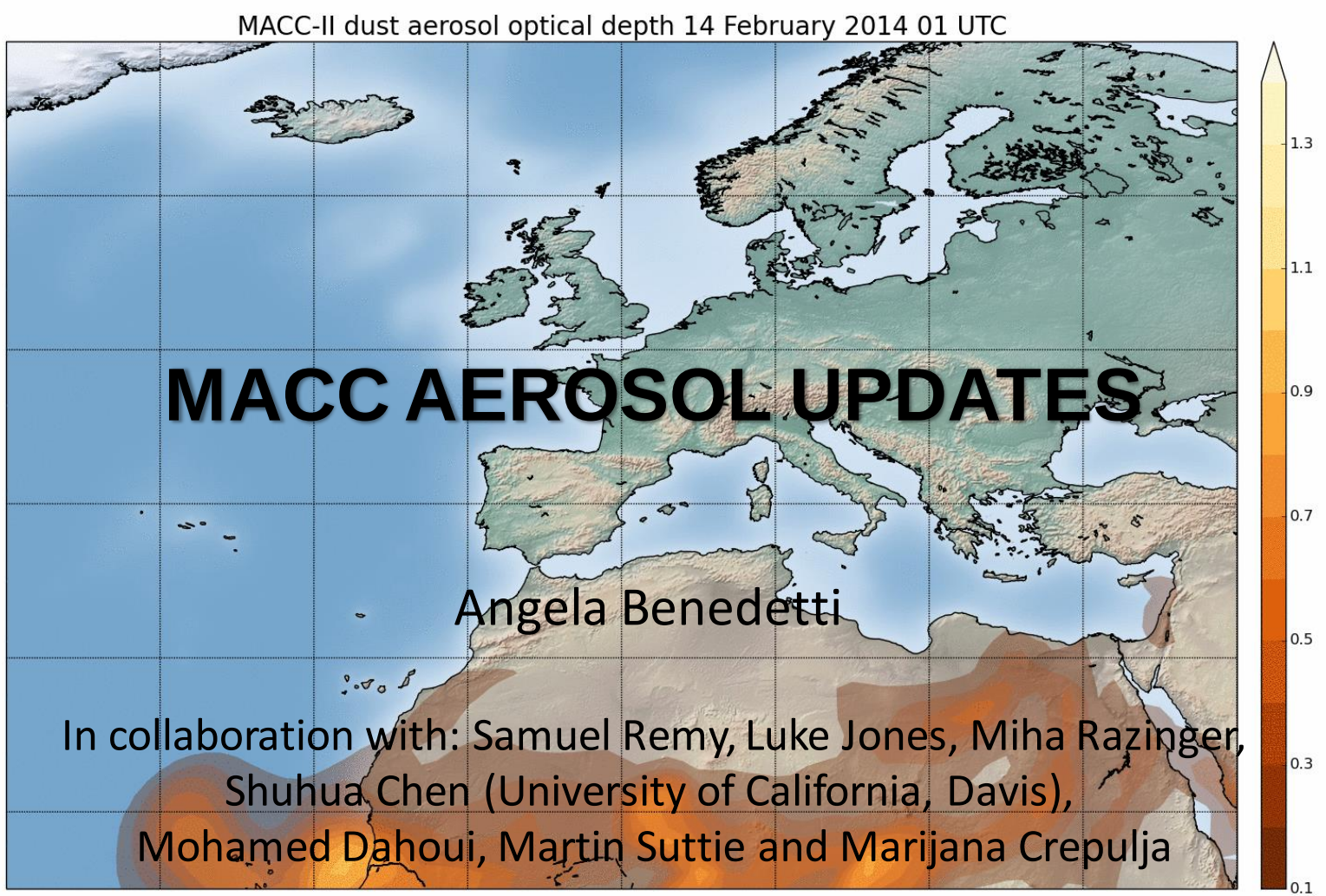


MACC AEROSOL UPDATES

Angela Benedetti

In collaboration with: Samuel Remy, Luke Jones, Miha Razinger, Shuhua Chen (University of California, Davis), Mohamed Dahoui, Martin Suttie and Marijana Crepulja

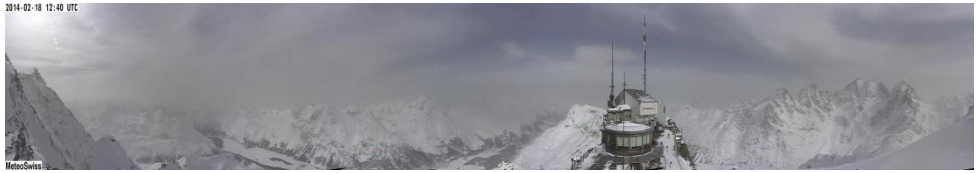
OUTLINE

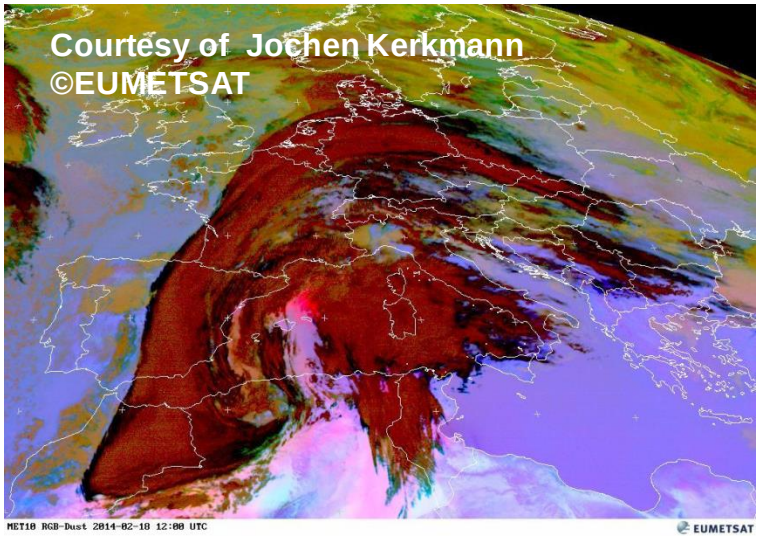
- General MACC/Copernicus news
- Interesting aerosol cases for 2014
-
- Aerosol modelling updates
- Aerosol radiative impacts (WGNE study)
- Fire emission updates
- Verification news
- AOD assimilation updates (AATSR, PMAP, CALIOP)
- Multi-wavelength AOD assimilation
- Future directions

ADMINISTRATIVE NEWS

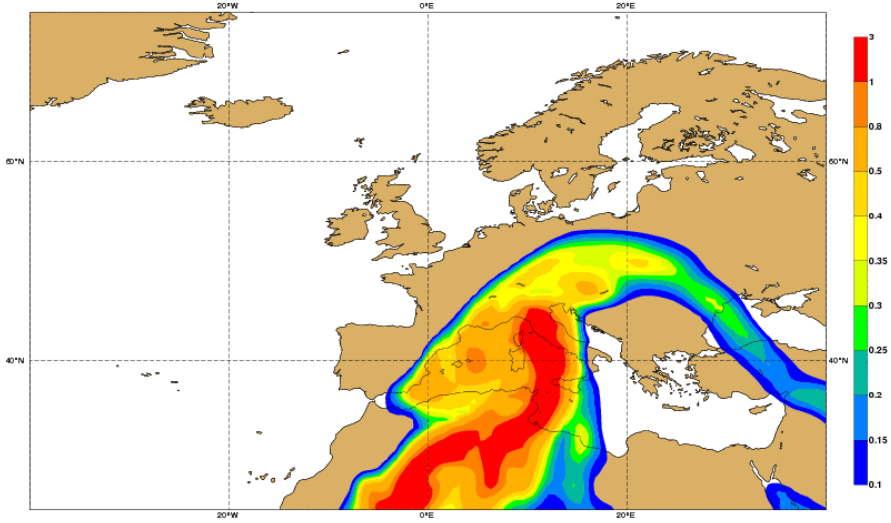
- Upgrade of HPC to CRAY (September 2014)
- Operational ECMWF suite and pre-operational MACC suite migrated to the Cray
- Implementation of fully online chemical model (C-IFS) in September 2014
- End of MACC-II (July 2014) and beginning of MACC-III (scheduled to run until March 2015)
- Delegation agreement with the European Commission to be signed by the end of October for the operational phase of the Copernicus Atmosphere Monitoring Service (CAMS)
- Several departures in the MACC aerosol group: Jean-Jacques Morcrette retired in January 2014, visiting scientist Prof. Shuhua Chen (UC Davis) left in March 2014 after 6 months of sabbatical, Samuel Remy in charge of the fire assimilation system and the aerosol modelling, left in August 2014.
- Currently recruiting for two aerosol-related positions in connection with EU-funded Projects PANDA (focus on China) and DACCIWA (focus on West Africa)
- Involvement in EU proposals to guarantee research funding (Horizon 2020) for verification position using ground-based observations
- One aerosol-related position to be funded by Copernicus (aerosol modelling)

Dust in Italy and Switzerland - Feb 19 2014

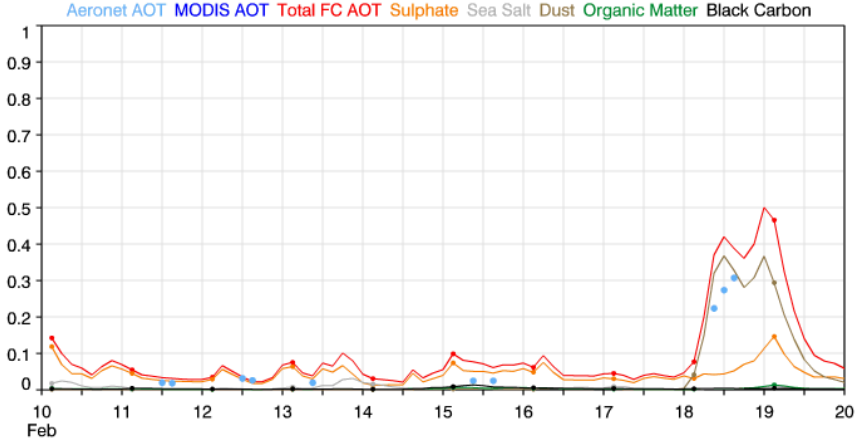




Tuesday 18 February 2014 00UTC MACC Forecast t+030 VT: Wednesday 19 February 2014 06UTC
Dust Aerosols Optical Depth at 550 nm

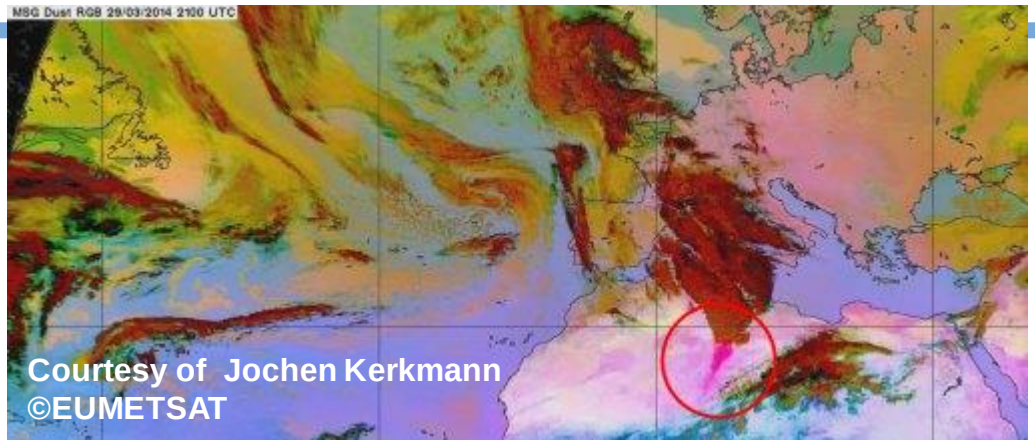


Comparison of model (fnyp) and MODIS AOT at 550nm and L1.5 Aeronet AOT at 500nm over Davos (46.81°N, 9.84°E). Model: 00UT, 10-19 Feb 2014, T+3 to T+24.

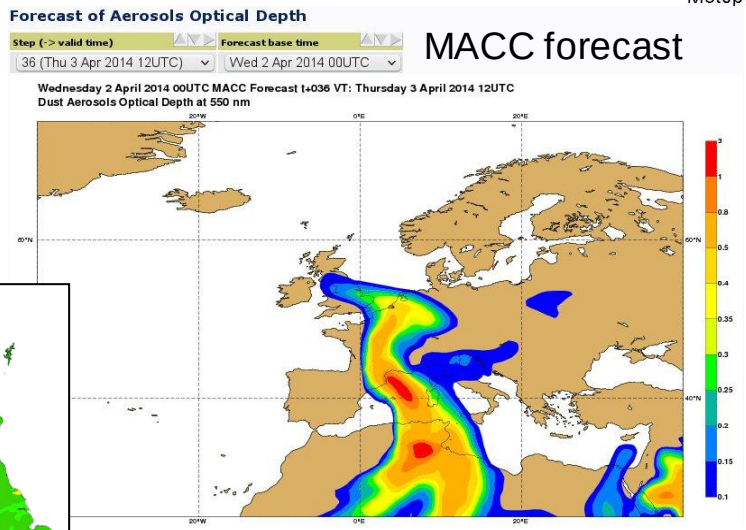


Graphycs: Miha Razinger and Luke Jones

Dust and pollution in the UK – 2-3 April 2014

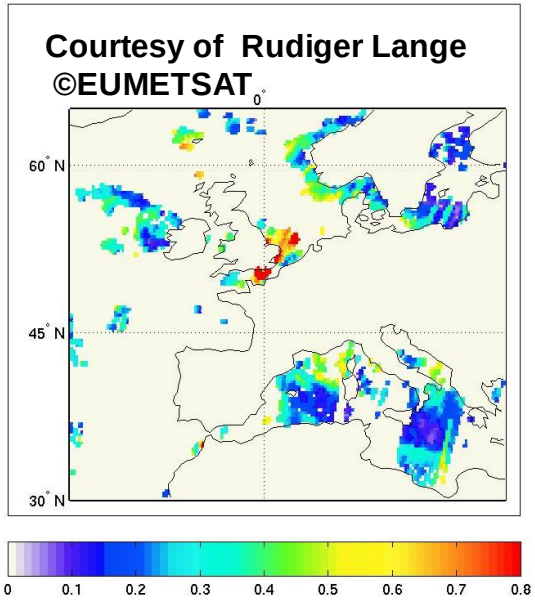


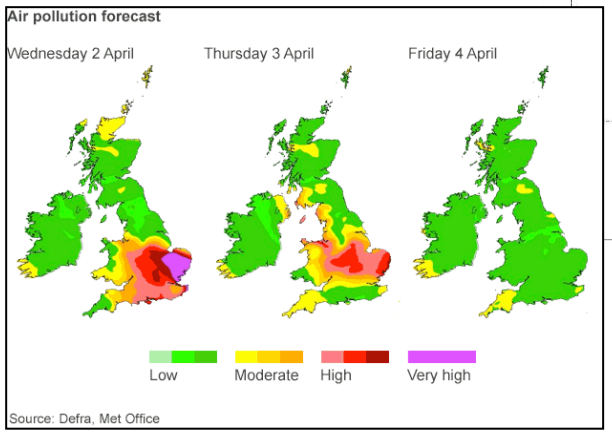
Metop-A/B PMAp Aerosol Optical Depth 20140401000256 20140402000258



MACC forecast

Graphics by Miha Razinger @ECMWF





AEROSOL MODELLING UPDATES

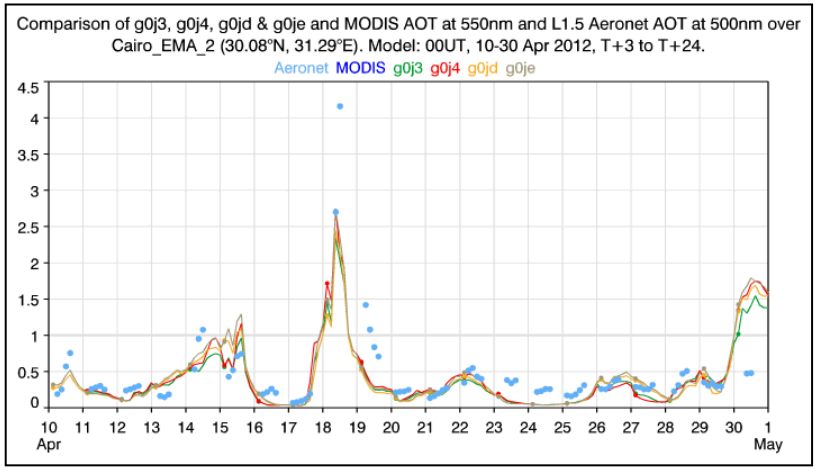
Jean-Jacques Morcrette/Samuel Remy

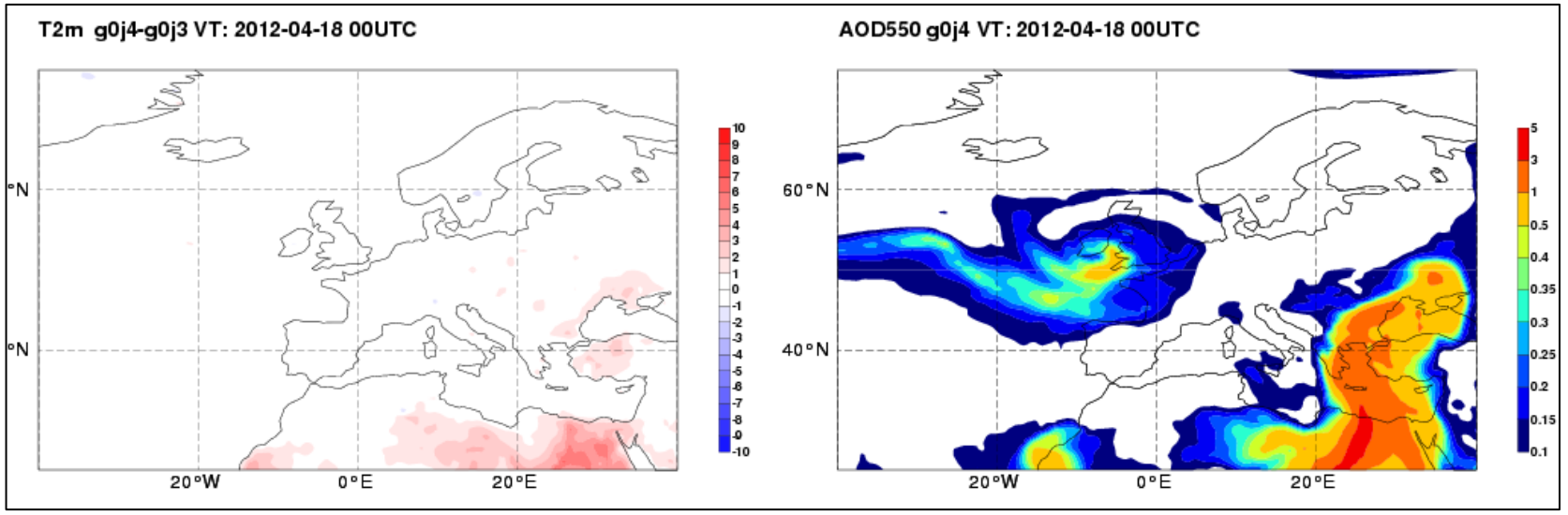
- Rebalancing of fine and coarse dust emissions (MACC model still on the high side for small dust particles) - not implemented yet
- Implementation of DMS emissions
- New 6-bin dust model (experimental)
- Impact of resolution changes: large sensitivity of all aerosol fields
- Inclusion of volcanic SO2 and volcanic ash for the stratosphere
- Volcano “atlas” & namelist parameters to input emissions and injection height
- Rise plume model to derive injection heights for biomass burning emissions
- New modal aerosol scheme (GLOMAP) in IFS – in development (U. Leeds)

AEROSOL RADIATIVE IMPACT ON NWP: DUST CASE STUDY from April 2012

Samuel Remy

- Taking into account the aerosol direct effect brings warmer night-time temperatures over land, by up to 4 degrees due to impact on long-wave radiation
- Near-perfect collocation with AOD patterns
- For most stations in desert area, it reduces a cold bias at night during the 11th to 20th of April 2012 period :
  - Cairo : mean bias from -1 to -0,6K
  - Asyut : mean bias from -0.6K to 0.3K

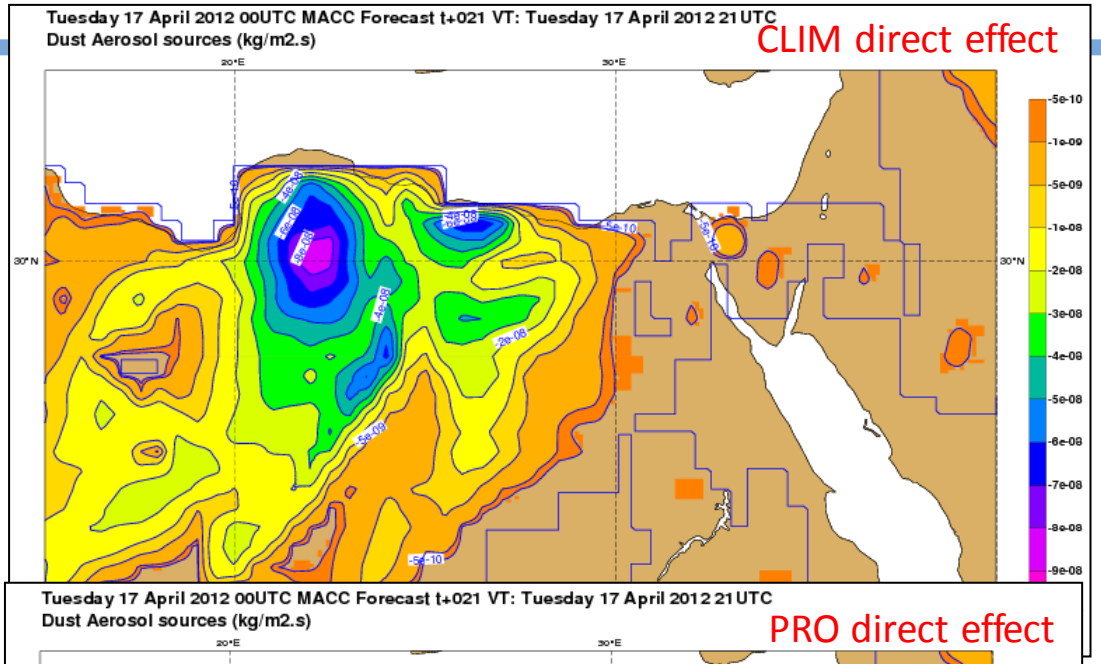


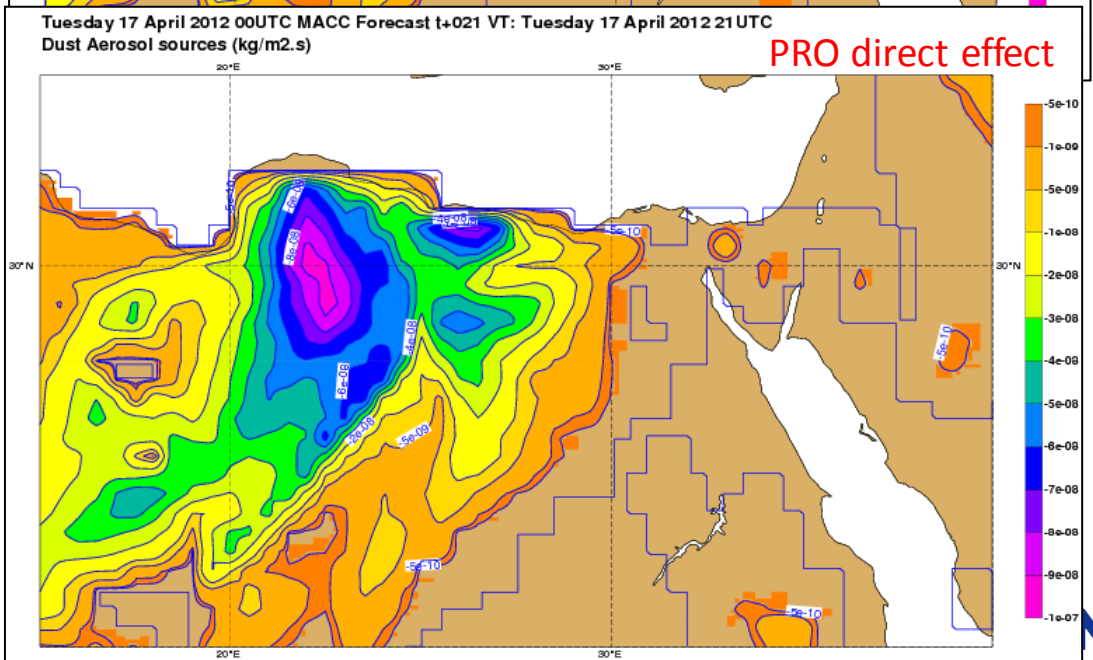


Graphycs by Miha Razinger

AEROSOL RADIATIVE IMPACT ON NWP: sources comparisons

Aerosol (ie dust) sources are much larger with prognostic aerosol direct effect



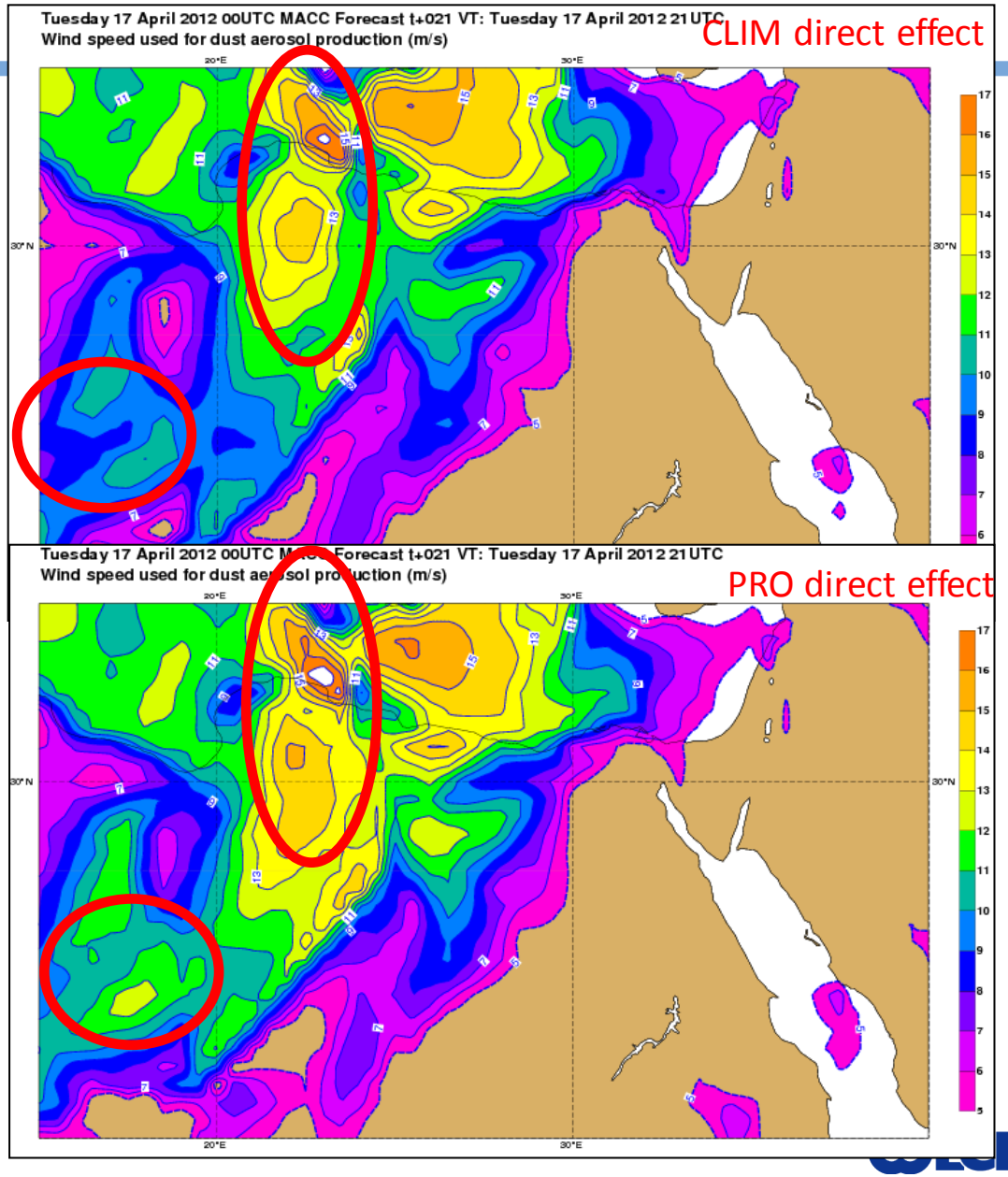


Samuel Remy

AEROSOL RADIATIVE IMPACT ON NWP: 10m wind comparisons

… Because 10m wind speed is larger with prognostic direct effect

A small increase in 10m wind speed brings a large increase in dust aerosol production through saltation (power 3 dependency to 10m wind speed)



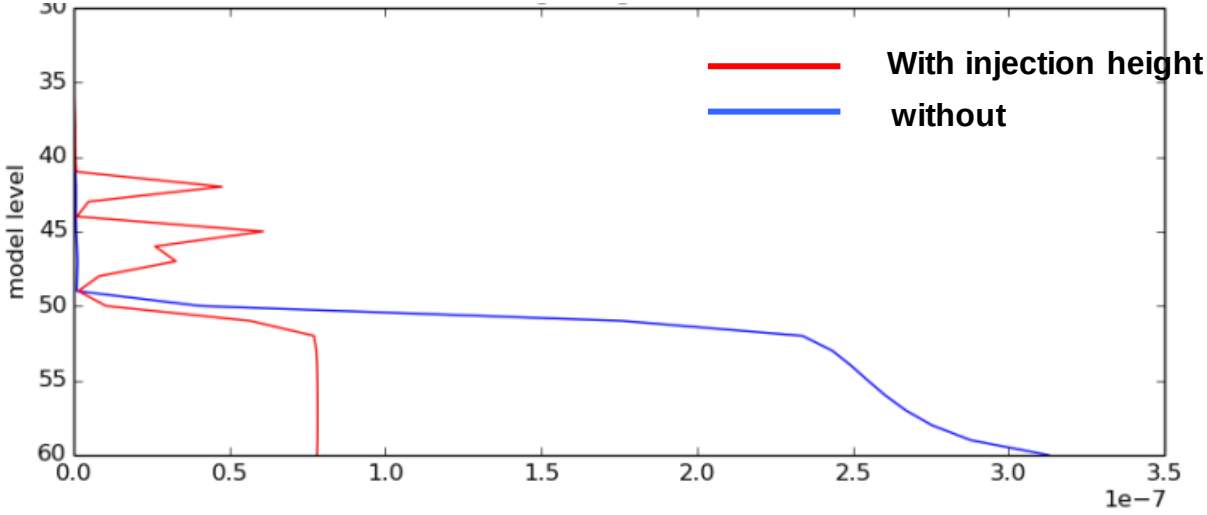
Samuel Remy

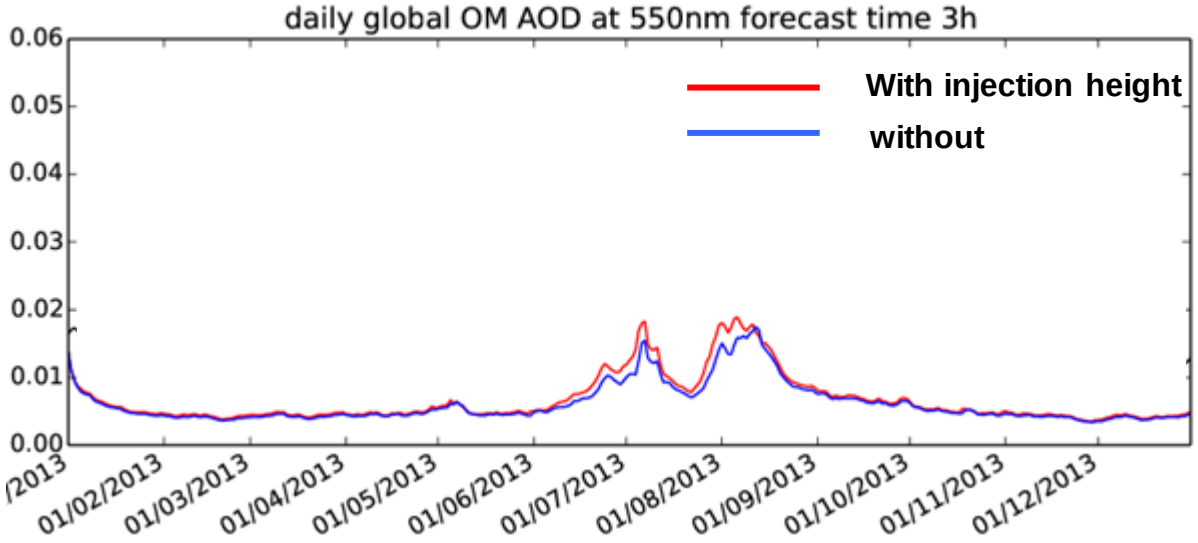
GLOBAL FIRE ASSIMILATION SYSTEM UPDATES

Samuel Remy

- Injection height for biomass burning aerosols based on plume rise model integrated in IFS
- Drastic change in Organic Matter (OM) mixing ratio profile

Profile of OM mixing ratio over Canada (52N, 77.5W) on July 6, 2013





- Increase in OM AOD when using injection height Formulation due to lower dry deposition (proportional to aerosol surface concentration)

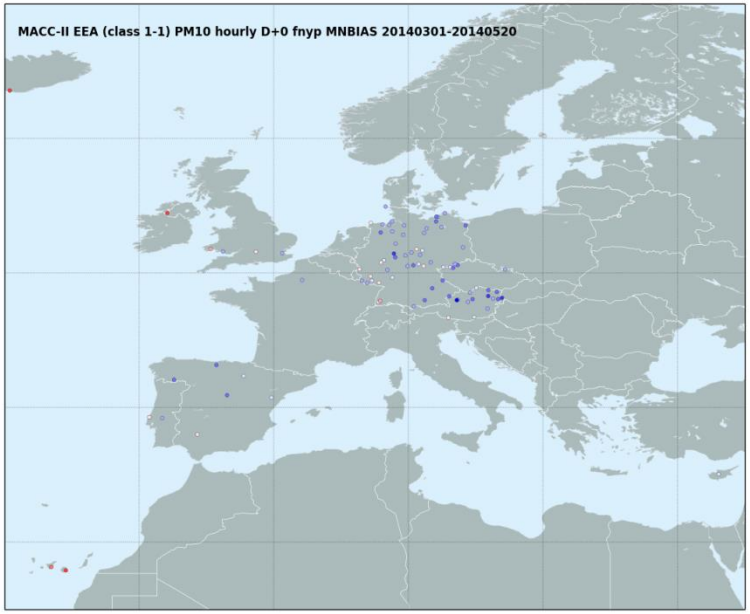
PM VERIFICATION

Miha Razinger

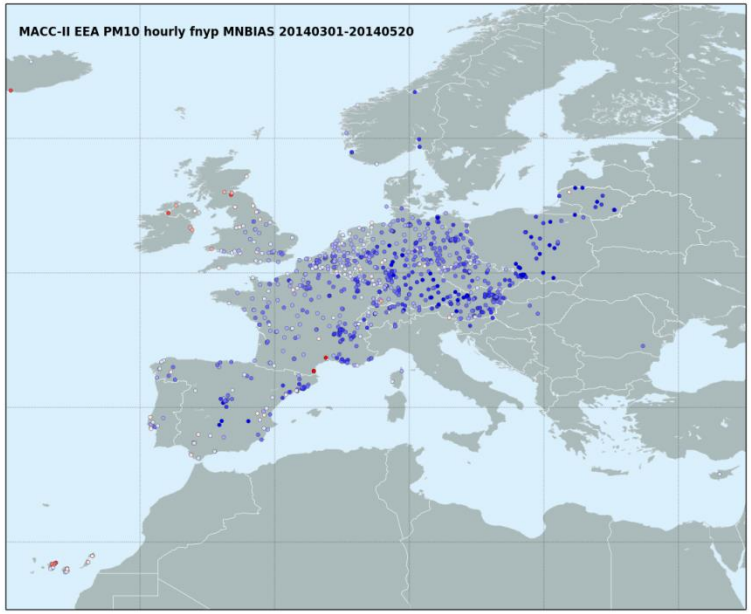
- Many users ask for PM from the global model
- How good/bad is a global aerosol model for air quality applications?
- Quality of verifying data is also not perfect
- Example from the MACC model verified using European Environment Agency observations

$$\text{Normalized Mean Bias} = \frac{2}{N}\sum_{i=1}^{N}\left(\frac{P_i - O_i}{P_i + O_i}\right)$$

Class 1 Joly-Peuch classification= background stations



All reporting stations



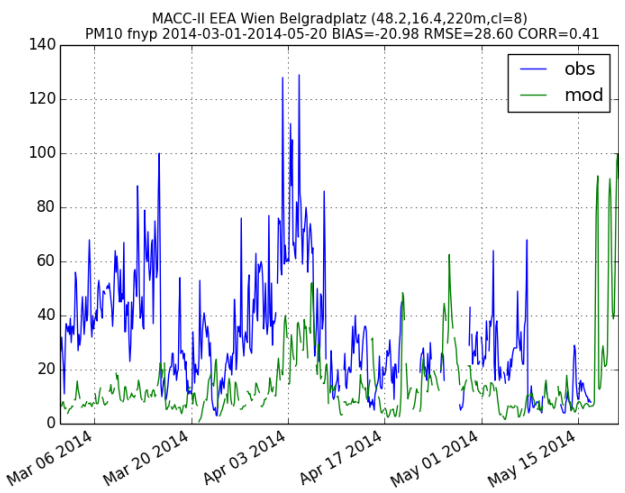
Period: 20140301-20140520

PM VERIFICATION

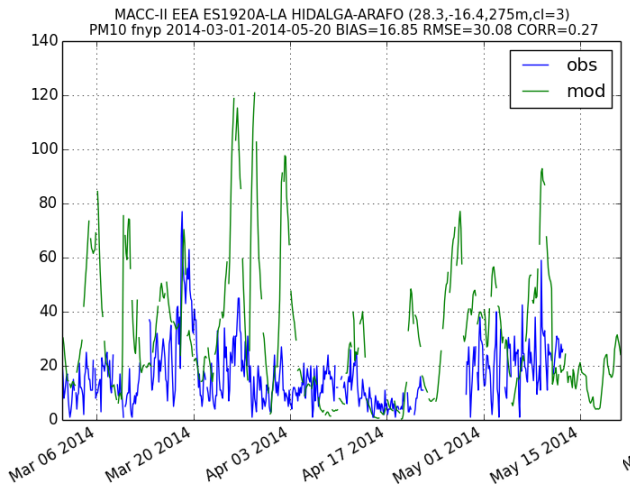
Miha Razinger

- Overall very large biases even in background stations
- General underestimation of anthropogenic component (missing emissions, low resolutions spatial resolution, etc) in urban areas and overestimation of marine contribution (!)
- Dust contribution is generally in good agreement with the observations

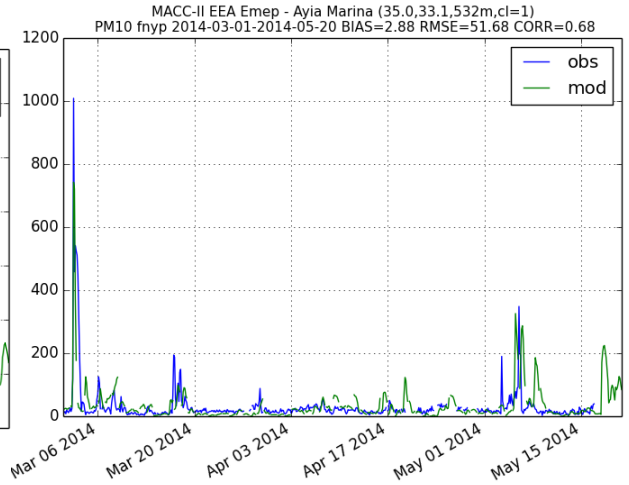
Urban station:
Vienna (48.2N,16.4E)



Marine station:
La Hidalga-Arafo (28.3N,16.4W)



Dust station:
Aya Marina (35.0N,33.1E)



obs model

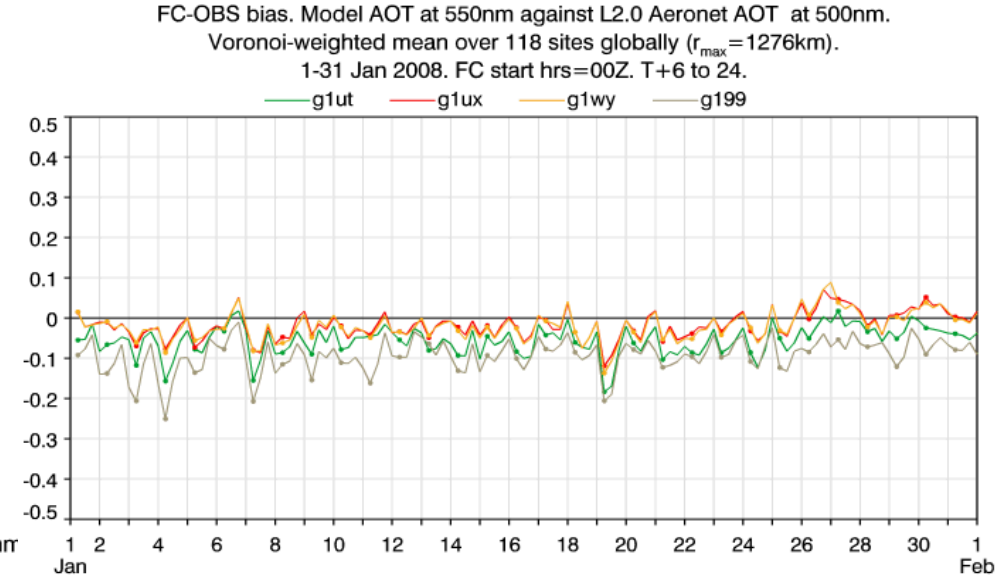
ASSIMILATION UPDATES

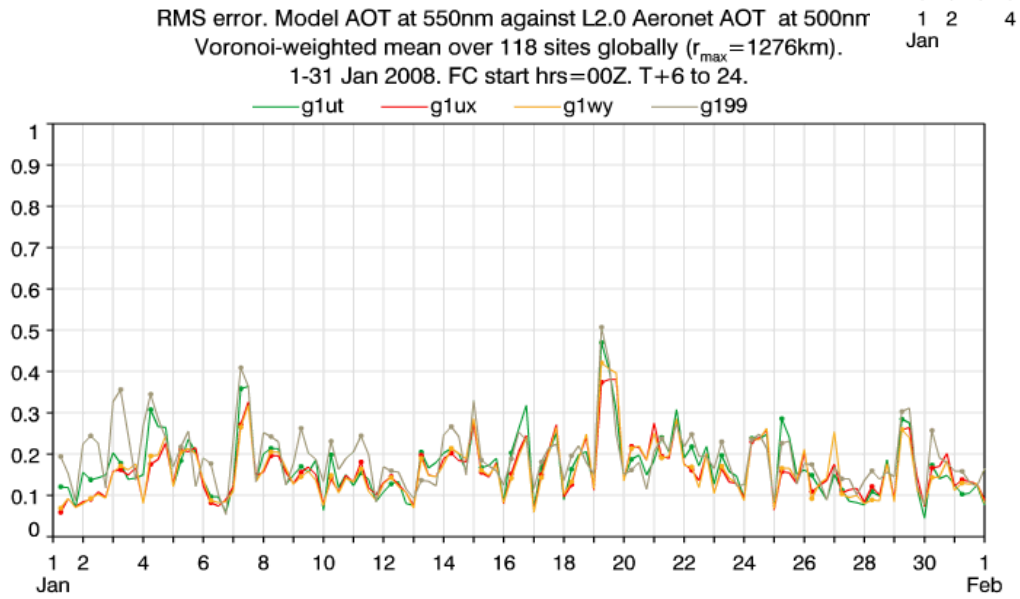
- Deep Blue will be in monitoring phase in the next experimental suite
- Addition of several new sensors in experimental mode (AATSR, PMAP)
- Work in progress to include SEVIRI, VIIRS and possibly PARASOL (GRASP retrieval, O. Dubovik)
- Work on dual control variable (fine and coarse mixing ratio)
- Assimilation of multi-wavelength AOD in collaboration with Shuhua Chen (Uni. Davis) with focus on aerosol radiative impacts on Tropical Cyclone formation
- Upgrade of lidar assimilation routine (some debugging)
- Verification of vertical profiles using MPLNET data

AATSR AOD DATA

Tested before CCI reanalysis – January 2008

- Adds value to forecast-only run as shown by comparison with AERONET data
- Does not make a big difference in the analysis with MODIS data due to the MODIS coverage
- Possible back-up - if NRT from the SLSTR sensor on Sentinel 3 - if MODIS stops working





Forecast-only run

AATSR-only run

MODIS-only run

MODIS and AATSR run

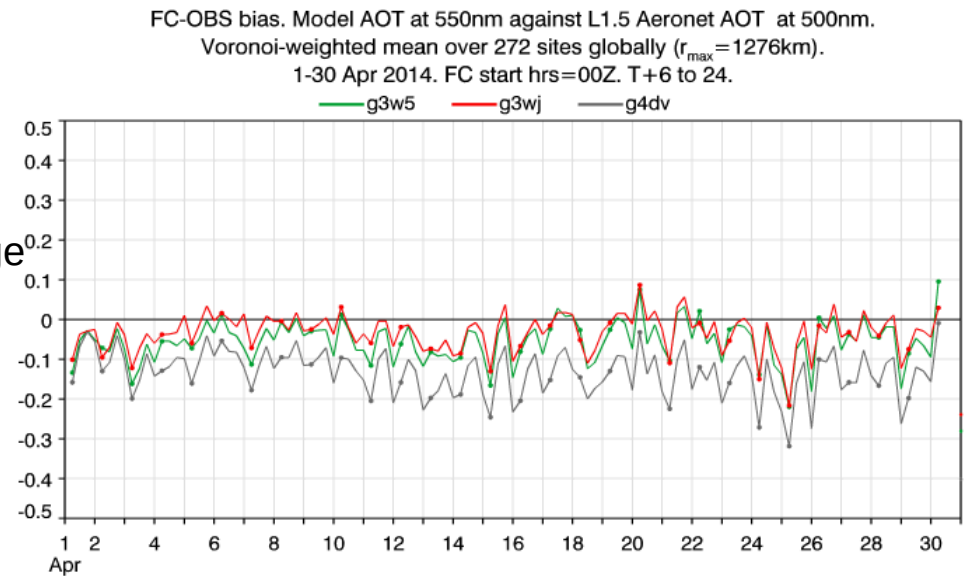
- Reprocessed AATSR AOD data from FMI were used for the MACC-II Climate Change Initiative reanalysis for 2008

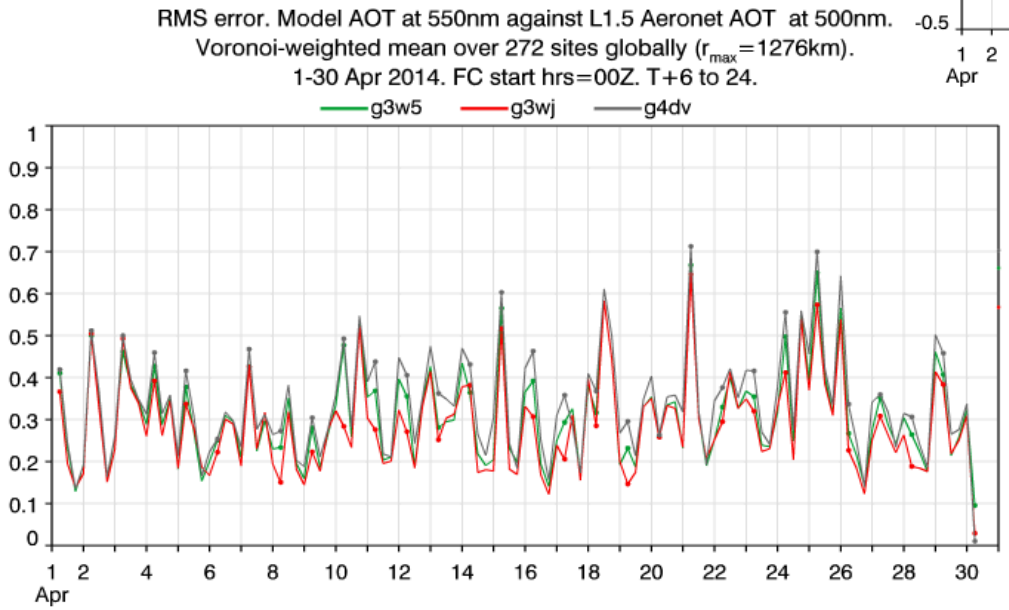
Graphics by Luke Jones

PMAP AOD DATA

Produced pre-operationally by EUMETSAT based on GOME2, AVHRR and IASI data.

- Adds value to forecast-only run as shown by comparison with AERONET data
- Comparable impact with MODIS due to coverage
- Good back-up (as it will be NRT from METOPA and METOPB) if MODIS stops working





Forecast-only run

PMAP-only run

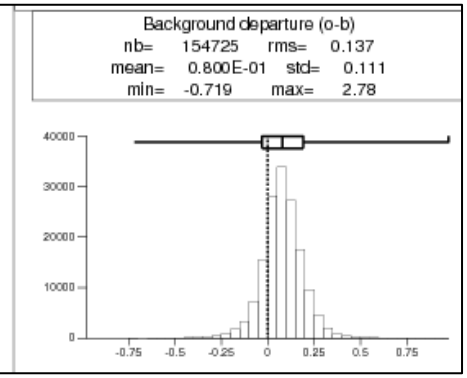
MODIS-only run

Graphics by Luke Jones

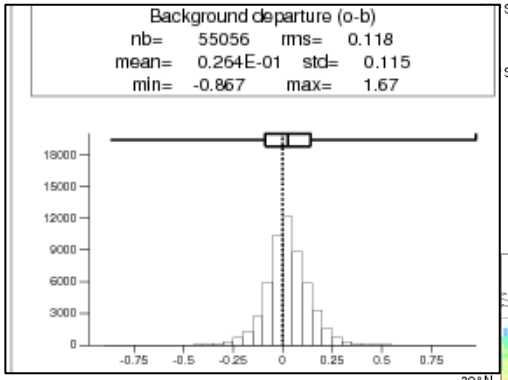
MONITORING PMAP DATA APRIL 2014

Higher bias with respect to model for METOP-B but more data points….

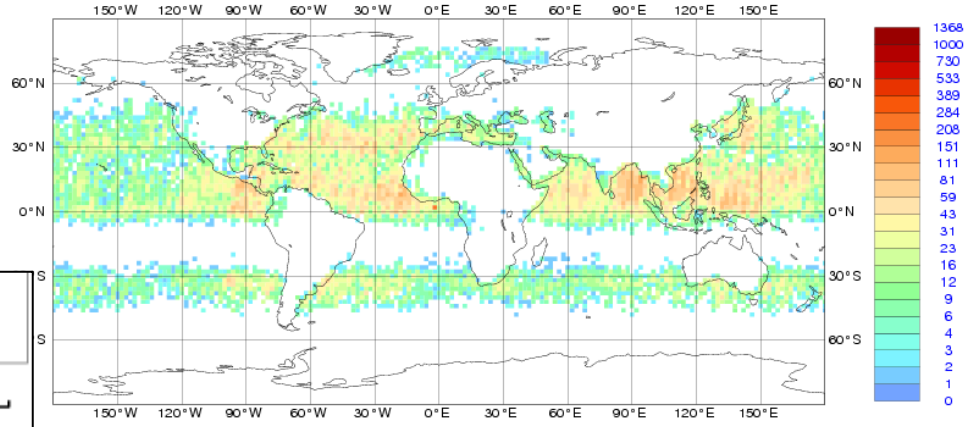
METOP-B Tropics



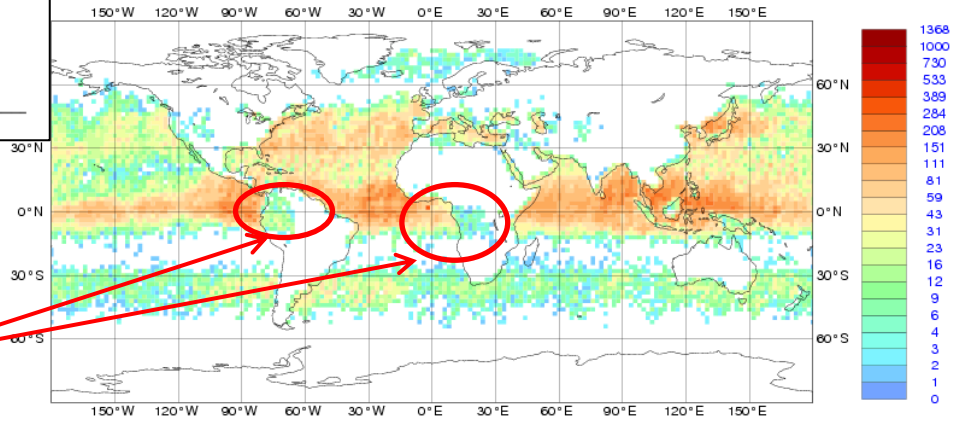
METOP-A Tropics



METOP-A



METOP-B

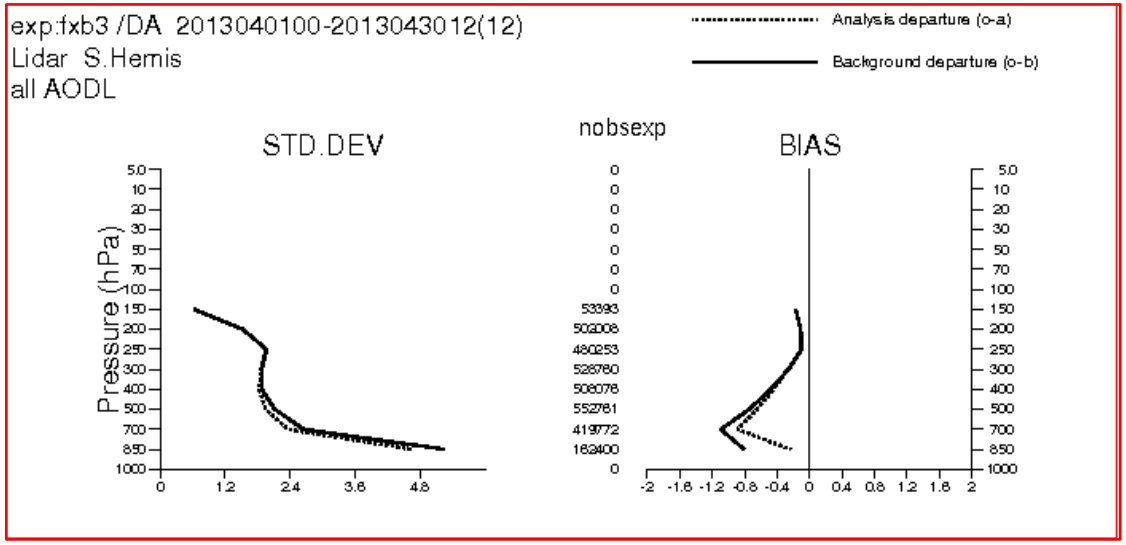


Ocean-only retrieval,
but a few points over land

- Monitoring, and eventually assimilation, of PMAP data will continue.

ASSIMILATION OF LIDAR SIGNAL

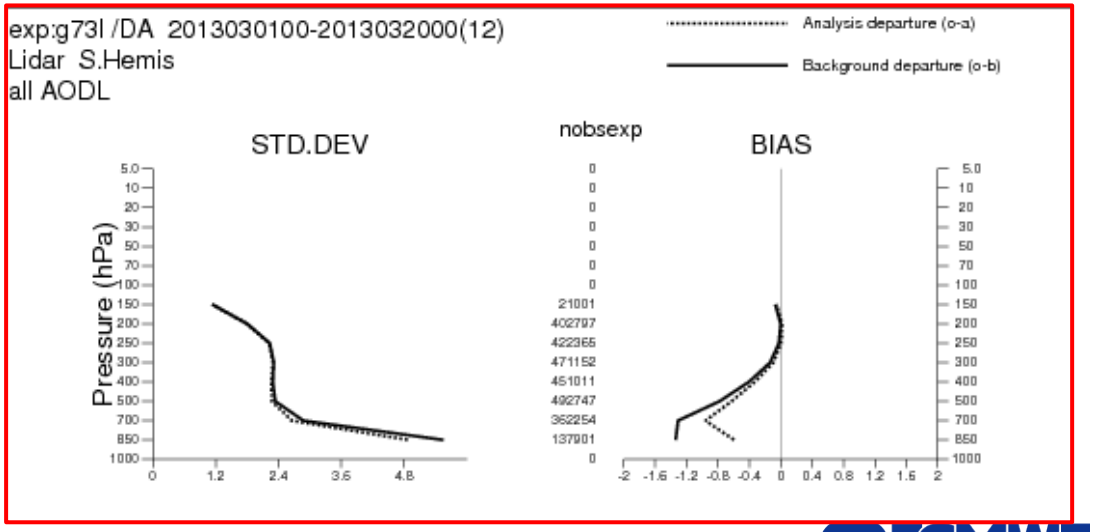
Last year, CY38R2



Data: all operational data plus MODIS AOD and CALIOP Level 1.5 backscatter

This year, CY40R2

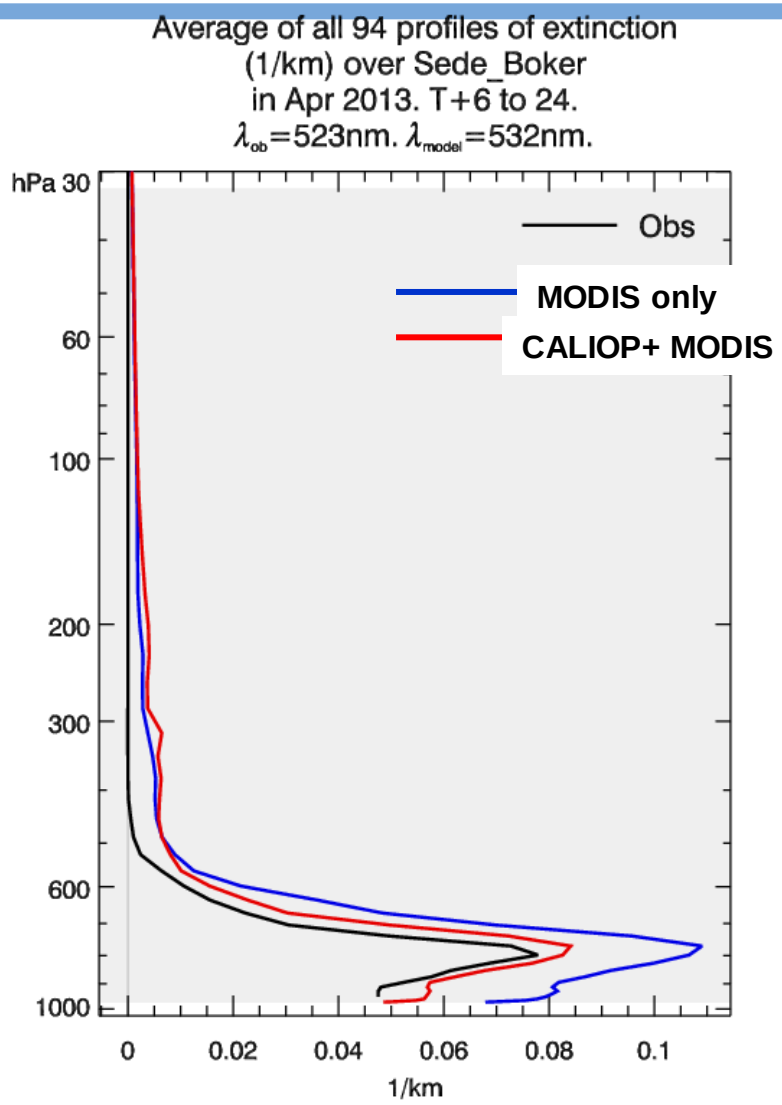
Lidar backscatter x 1e7 (sr m)-1



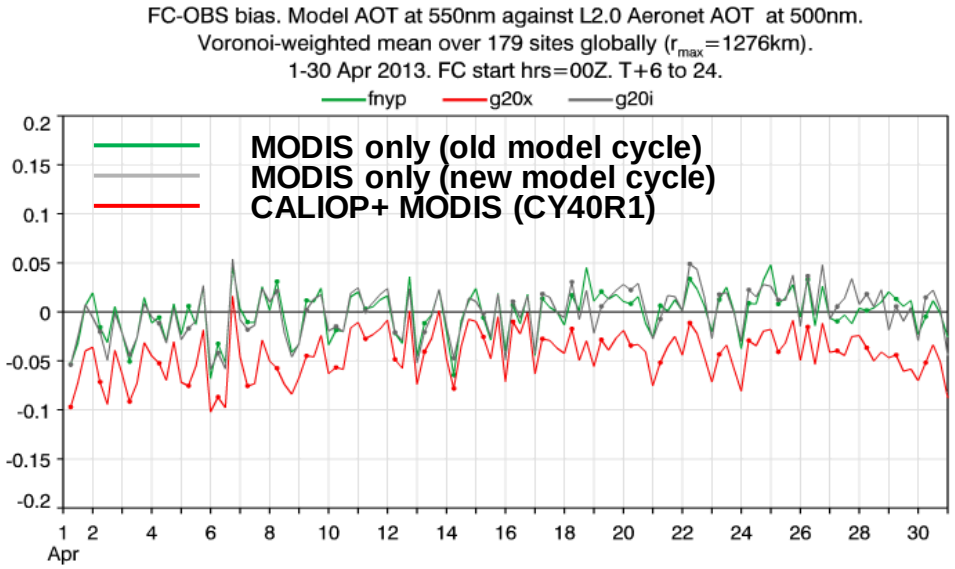
- Very similar structure in the two cycles.

- Molecular backscatter very biased - data are not used above 12 km (temperature bias in the stratosphere)?

VERIFICATION OF LIDAR ASSIMILATION EXPERIMENTS



Good impact of CALIPSO data from CALIOP instrument on vertical profiles at Sede Boker, but…



…AERONET verification shows that globally lidar assimilation underperforms with respect to MODIS only analysis for April 2013.

(**) Lidar data are courtesy of Arnon Karnieli. Special thanks to Simone Lolli, Judd Welton and the MPLNET team. Graphics by Luke Jones.

ASSIMILATION OF MULTI-WAVELENGTH AEROSOL OPTICAL DEPTH

- Latest model release
- Assimilate multi-wavelength AODs (ODA) with dual CVs

Dual control variables (CVs): coarse and fine aerosol mixing ratios

Observations:

- Dark Target AODs – (Terra and Aqua)

  470, 555, 659, 865, 1240, 1640, and 2130 nm

- Deep blue AOD – (Aqua)

  412, 470, 550, and 659 nm

In collaboration with visiting scientist **Prof Shuhua Chen**, UC Davies

ASSIMILATION OF MULTI-WAVELENGTH AEROSOL OPTICAL DEPTH: IMPACT ON REGIONAL T AND WINDS

AOD assimilation and direct effect

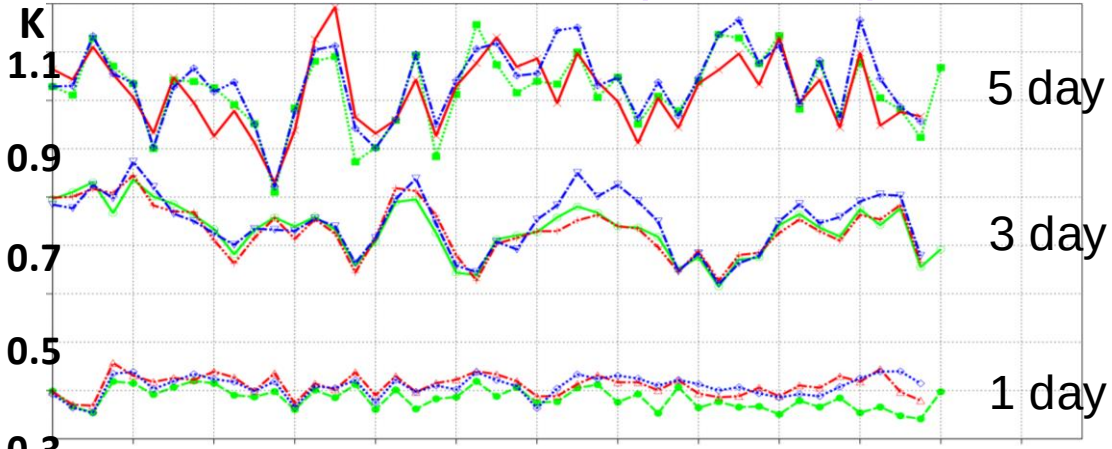
No Direct effect

No AOD assim

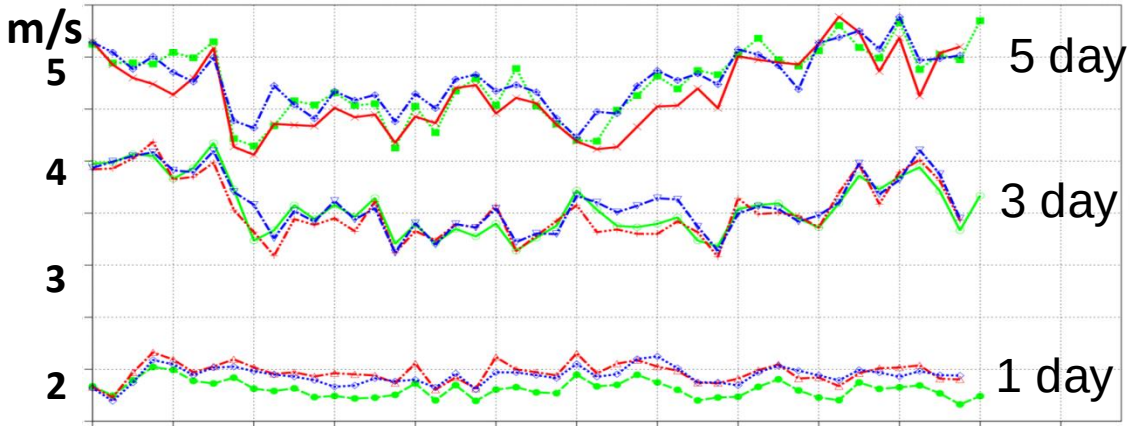
Forecast Error (Saharan)

700 hPa T

Some positive regional impact of assimilation and direct effect at day1 but less clear impact at day 3 and 5



700 hPa vector wind

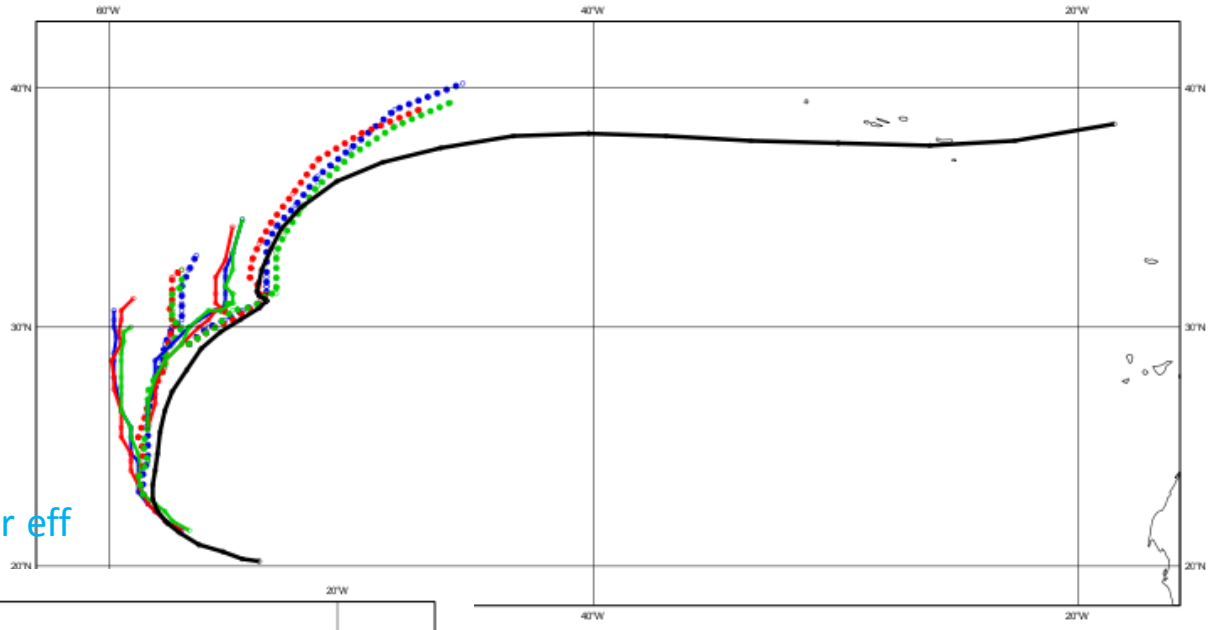


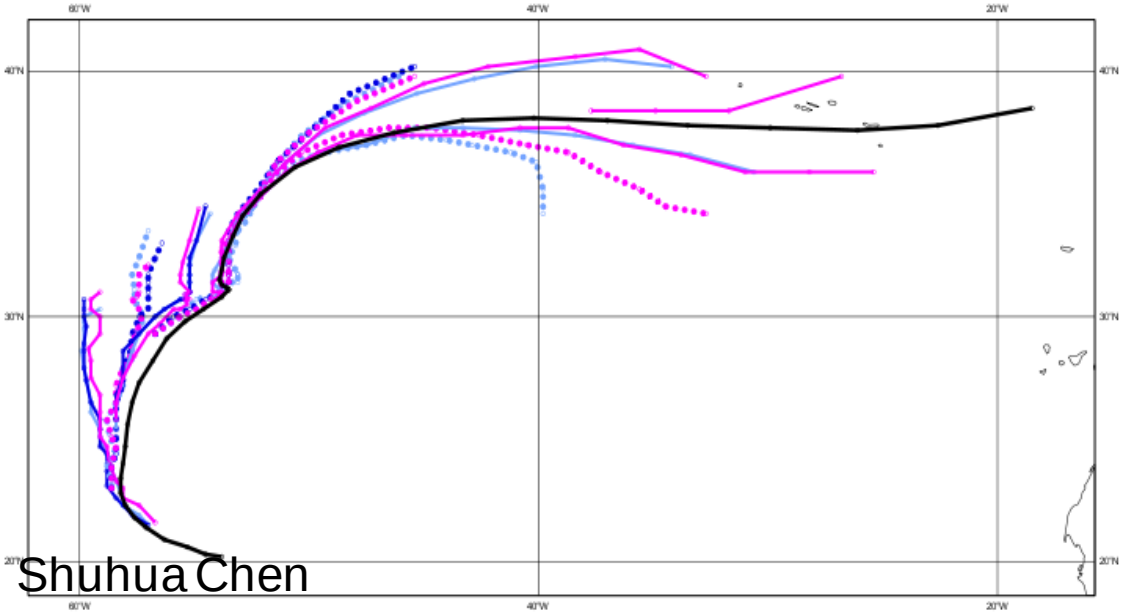
Shuhua Chen

IMPACT OF AEROSOL DIRECT EFFECT ON TC TRACK

Gordon Track Forecast (10-20 Sep 2006)

- Single wavelength AOD
- Single wavelength AOD - no direct effect
- NO AOD assimilation
- Multi-wavelength AOD
- Multi-wavelength AOD – no dir eff





- **Case shown is good but….**
- **Not always positive impact on all TCs**
- **Many factors other than aerosol radiative effects affecting TC development**
- **Multi-wavelength AOD assimilation does not always add value (but AOD assimilation does!)**
- **More research is needed!**

Shuhua Chen

FUTURE DIRECTIONS

- Shift in focus with CAMS (more operational activities)
- More integrated approach with the chemical model
- Involvement in proposals to secure funding for aerosol activities
- Scientific support to project fellows
- Refinement of emissions (including anthropogenic)
- Work on background error covariance matrix (ensemble approach with perturbed emissions – tested for CO2 and CO)
- Increase in vertical/horizontal resolution
- Planning for the next big reanalysis