# UKMO Update

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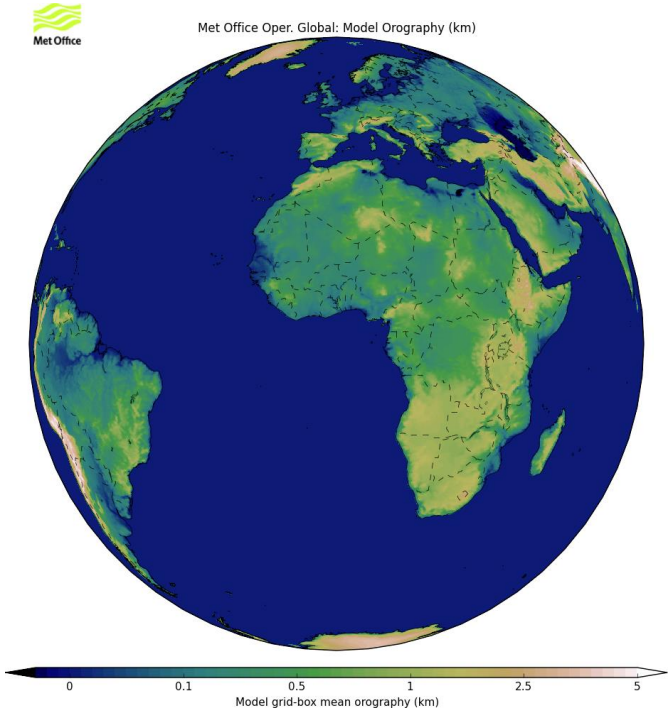
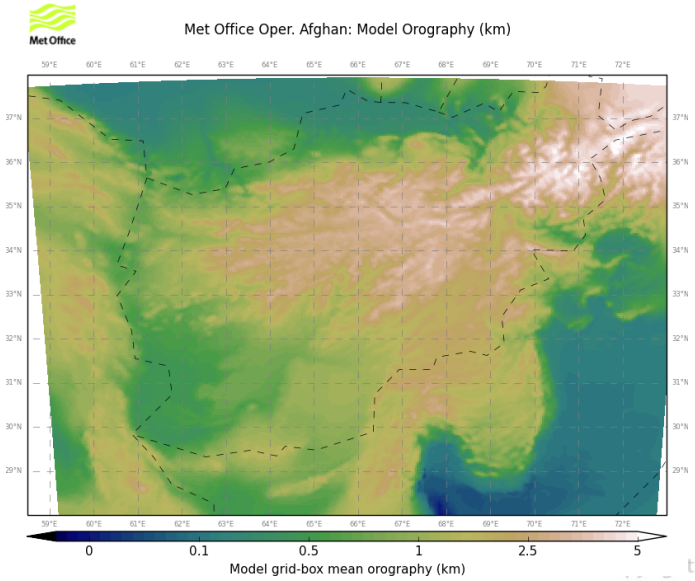
# Contents

# Introduction

UKMO runs dust forecasts in:

- Operational global model:
  - Deterministic at 0.23ºx 0.15º (~17 km)
  - Ensemble at 0.45ºx 0.4º (~30 km)
  - Assimilates dust AOD from MODIS
- 4 km LAMs covering hot dusty places of interest



# Impact of recent changes

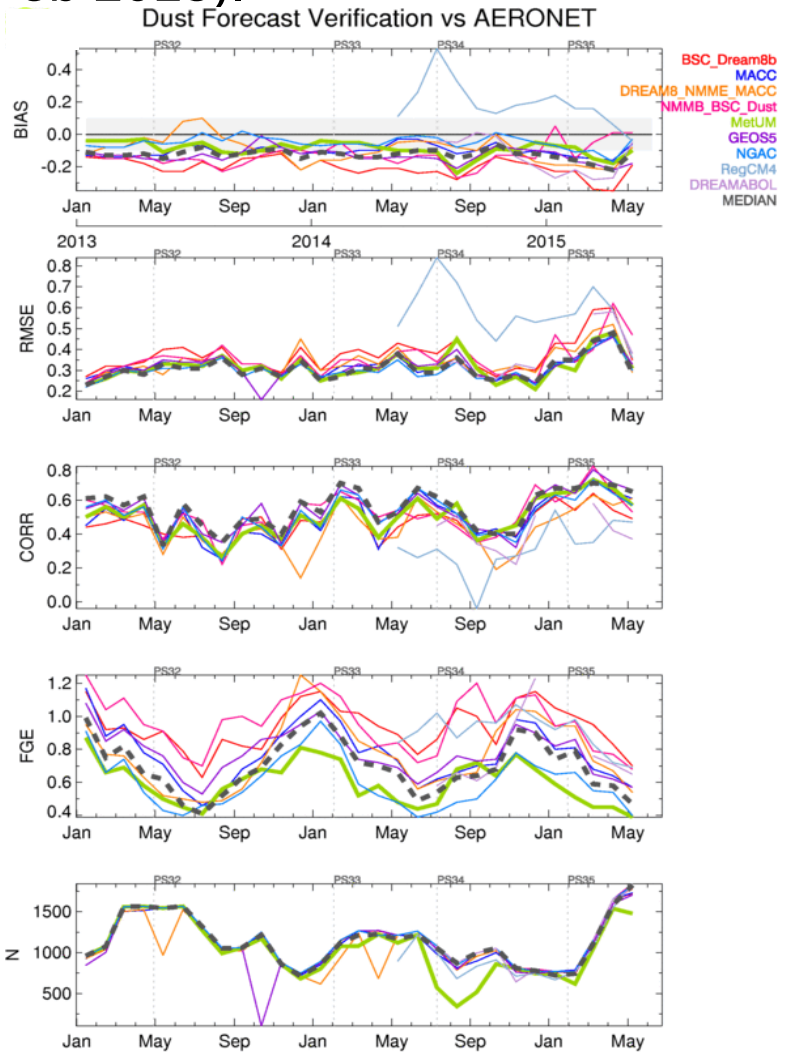
Last major change was inclusion of MODIS MYDAOD over ocean (operational 15 Feb 2015).

Change demonstrated skill score improvement in Summer trials.
(Yaswant's previous talk)

Too early to see difference vs AERONET relative to other models. Seasonal trend dominant.
(WMO-SDS comparisons)

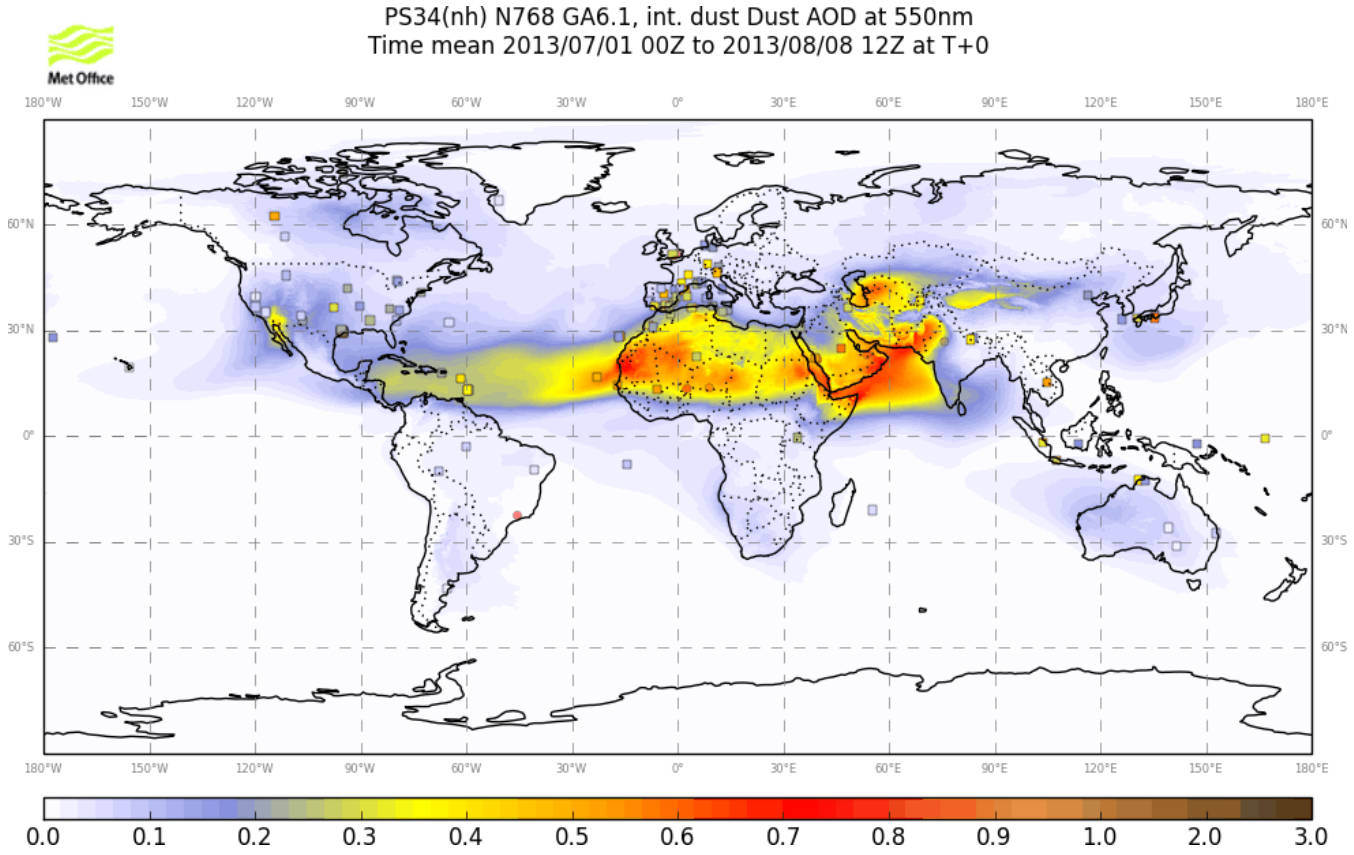
Question: N for UKMO? What's going on?

Summer 2014 period UKMO migration to new control software. Recent drop



# Current model biases

Oceanic MYDAOD assimilation gives a better view of model biases.



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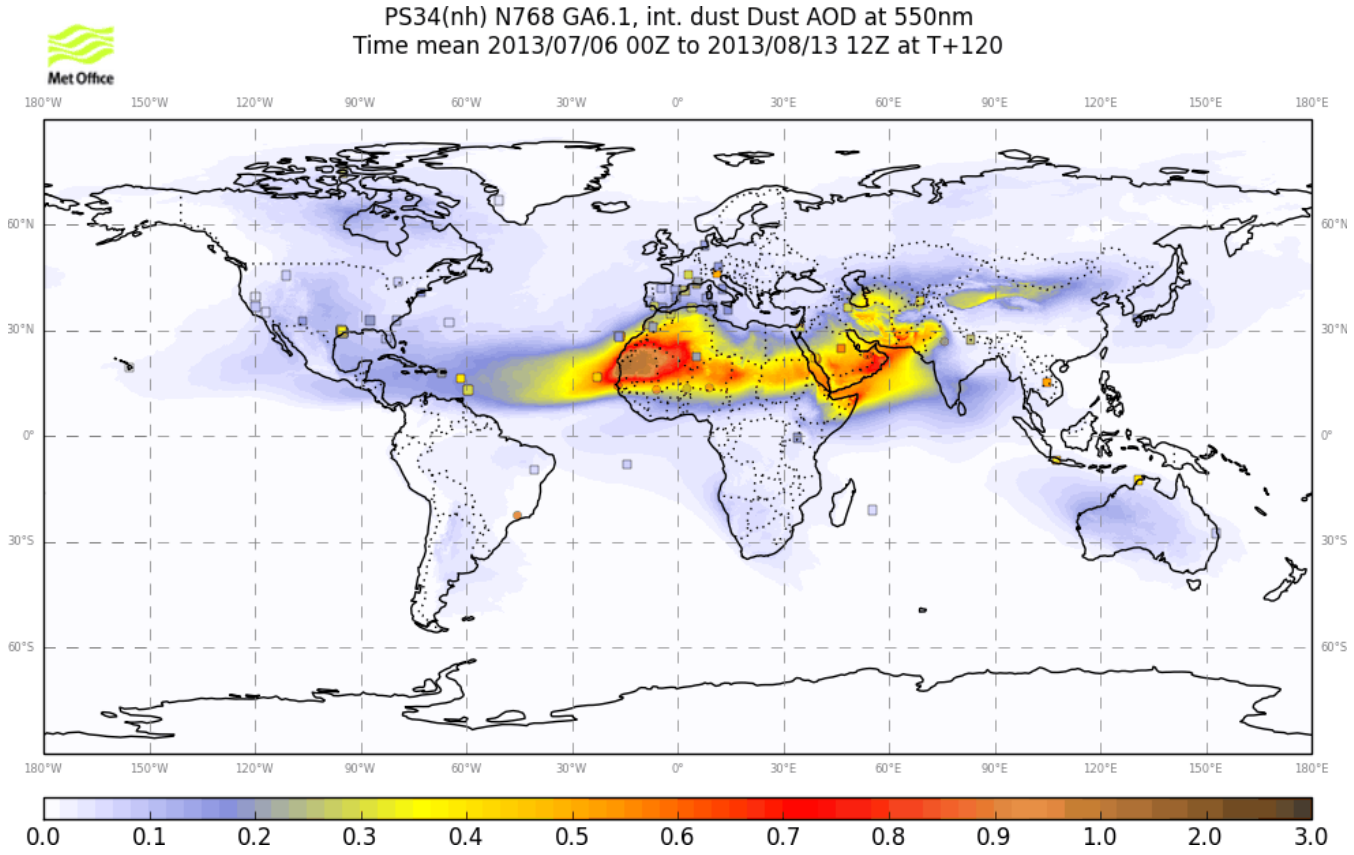

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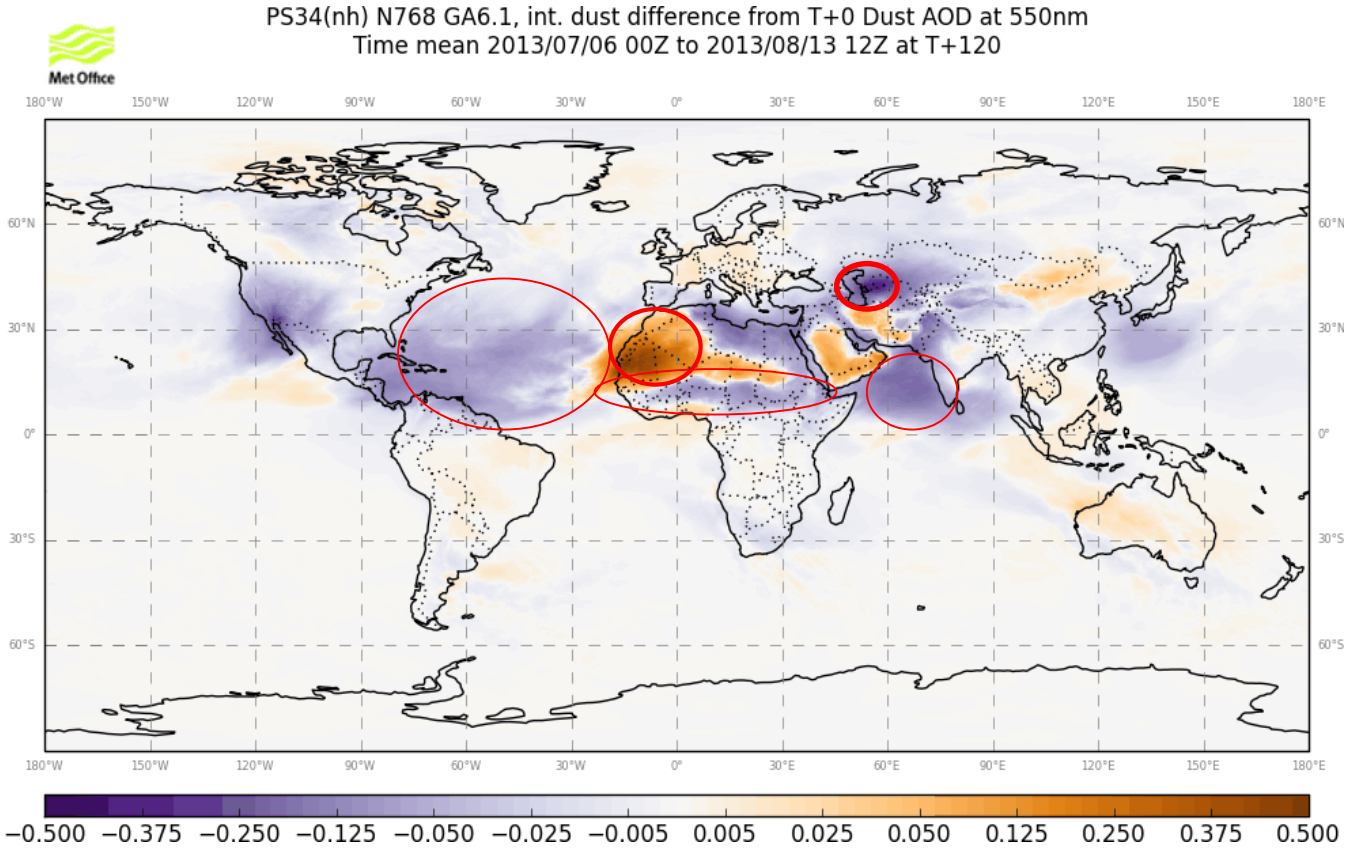

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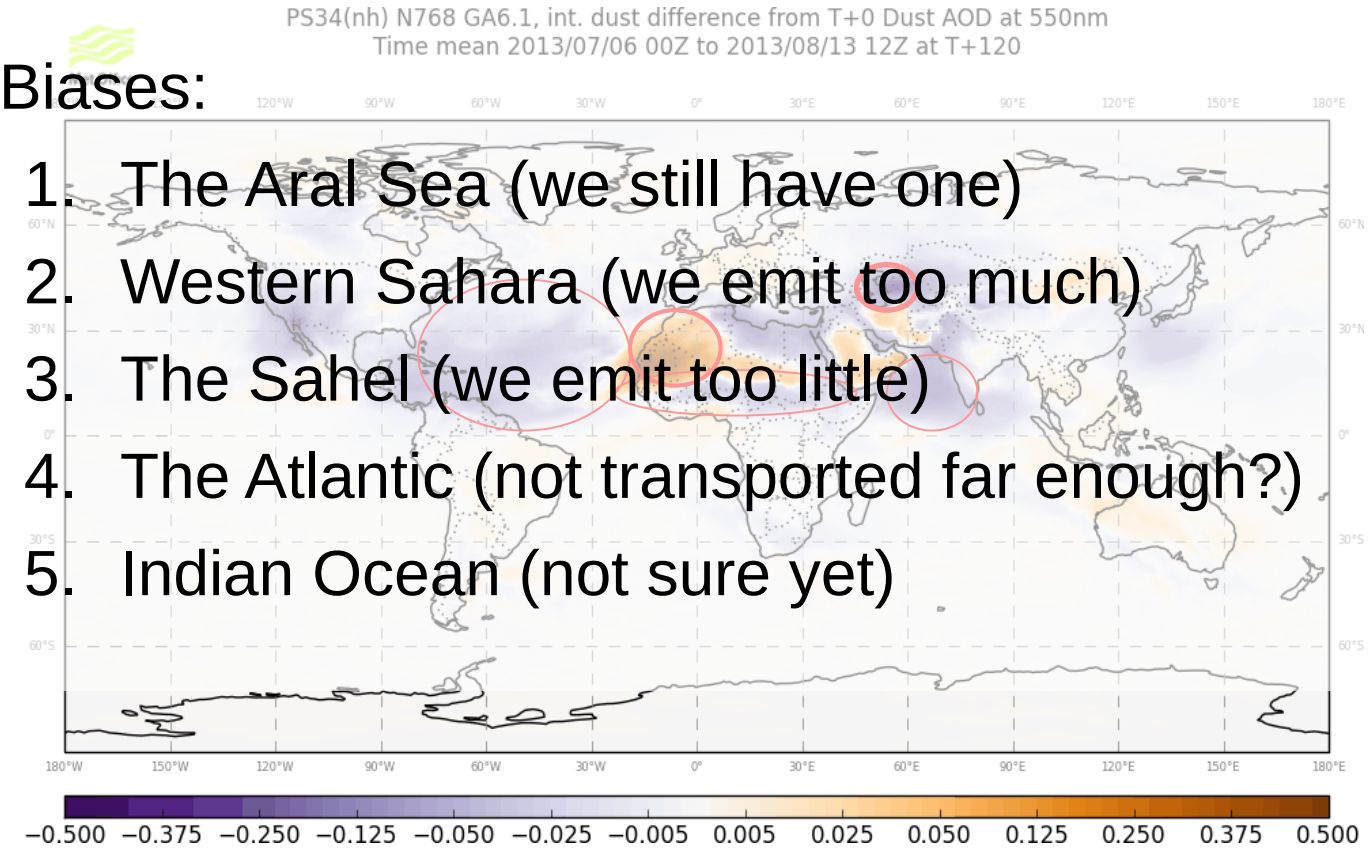
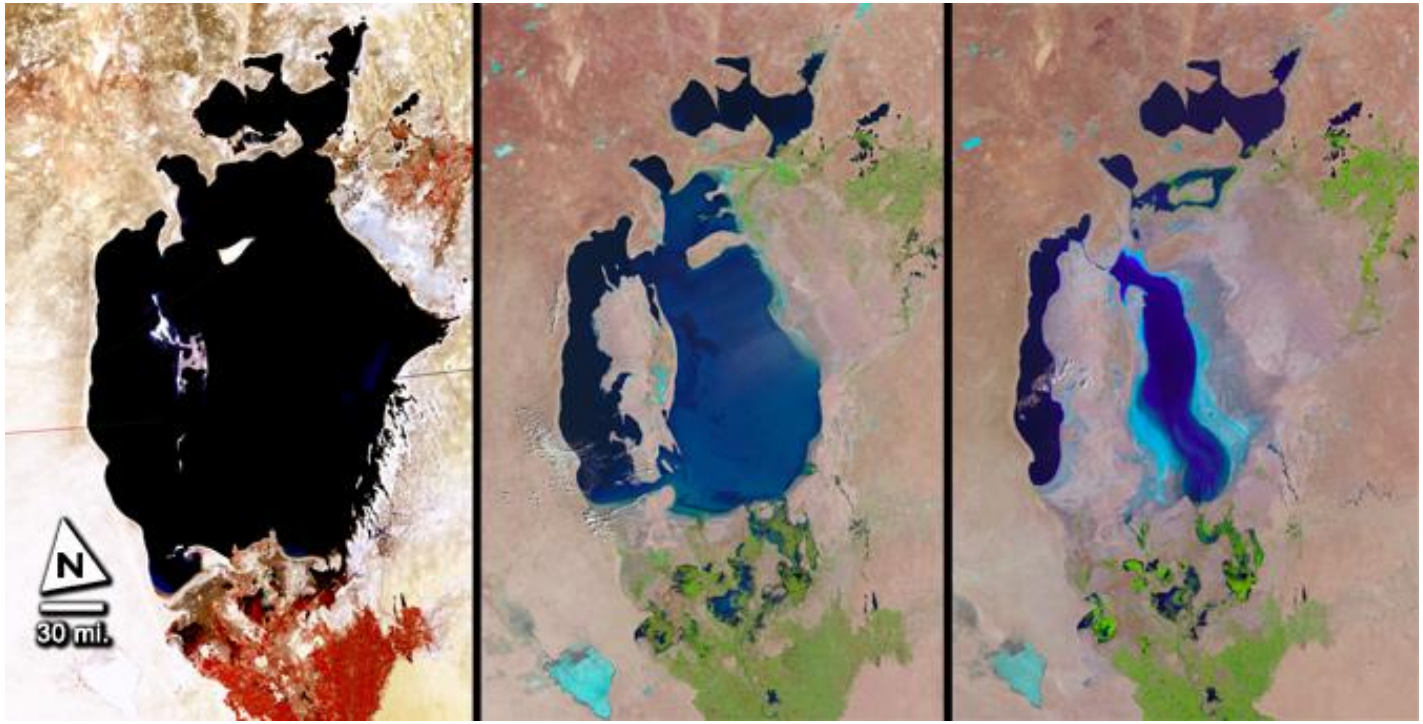



Biases:

1. The Aral Sea (we still have one)
2. Western Sahara (we emit too much)
3. The Sahel (we emit too little)
4. The Atlantic (not transported far enough?)
5. Indian Ocean (not sure yet)

# Upcoming/future model changes

Bias 1) The Aral Sea (+ve bias)



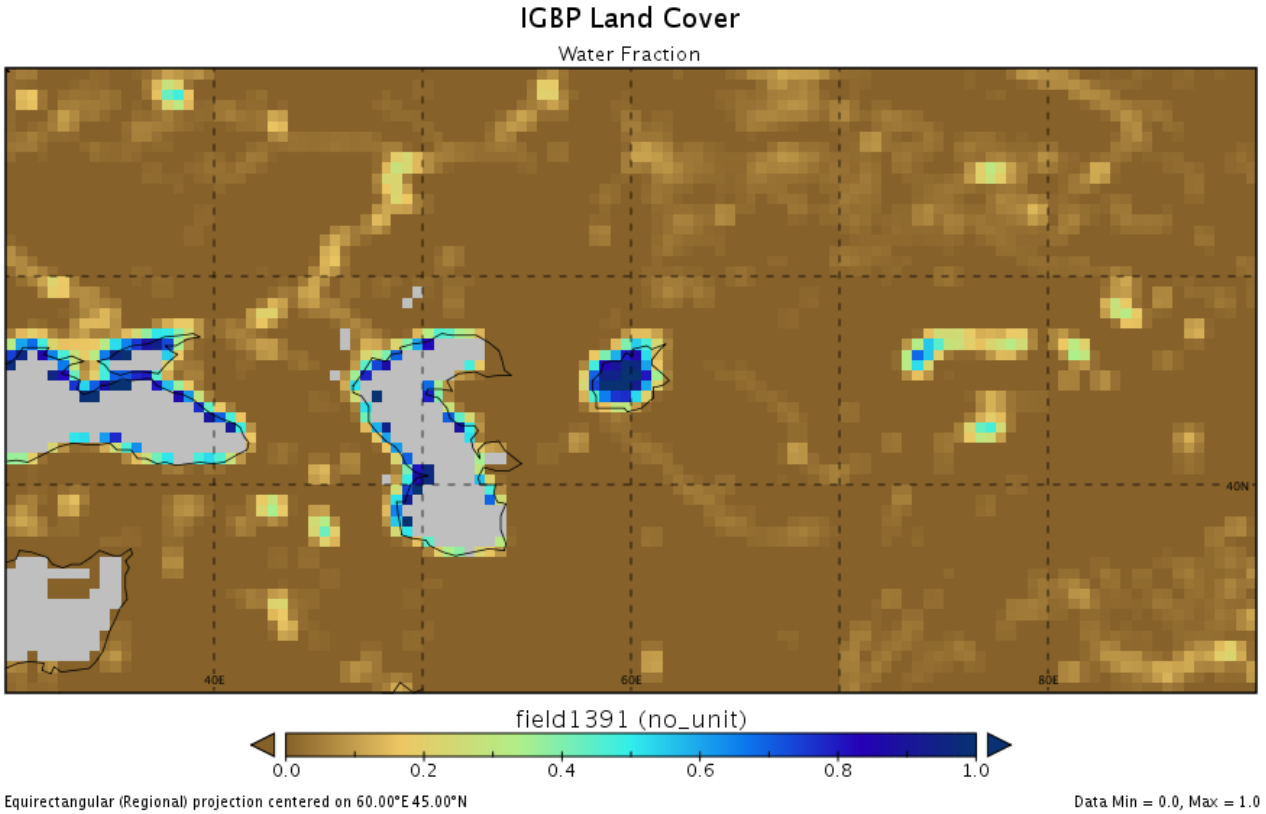

1977 1998 2010

Credit: NASA Landsat

# Upcoming/future model changes

Bias 1) The Aral Sea.

Extensive lake coverage in IGBP land use dataset
(note: low resolution gridded data!)

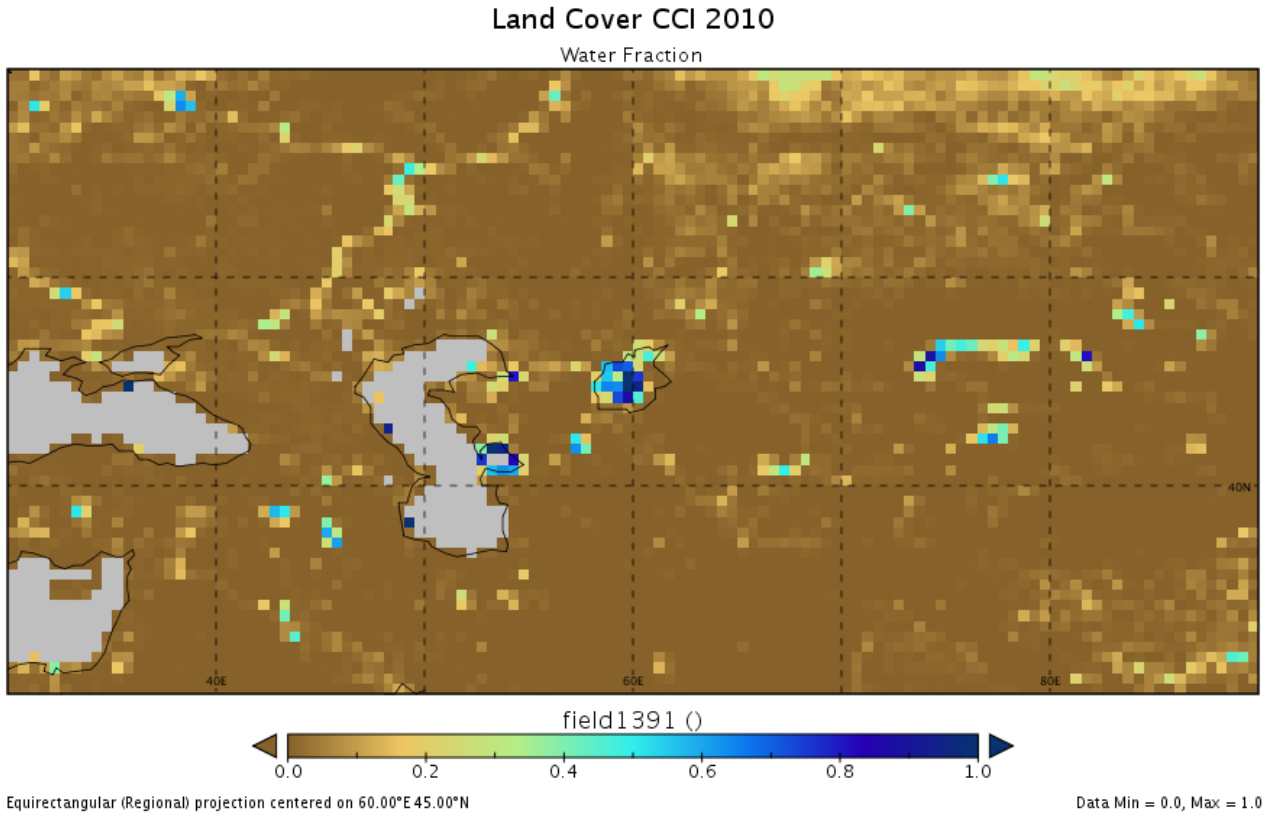



Credit: Andrew Hartly

# Upcoming/future model changes

Bias 1) The Aral Sea.

Much reduced lake coverage in Landcover CCI (low resolution gridded data!)




Credit: Andrew Hartly

# Upcoming/future model changes

Bias 1) The Aral Sea.

Using land cover CCI data, this gives *maximum* lake extent over 2000 - 2010.

Current work: Land Cover CCI currently in testing for global (GA8) physics package.

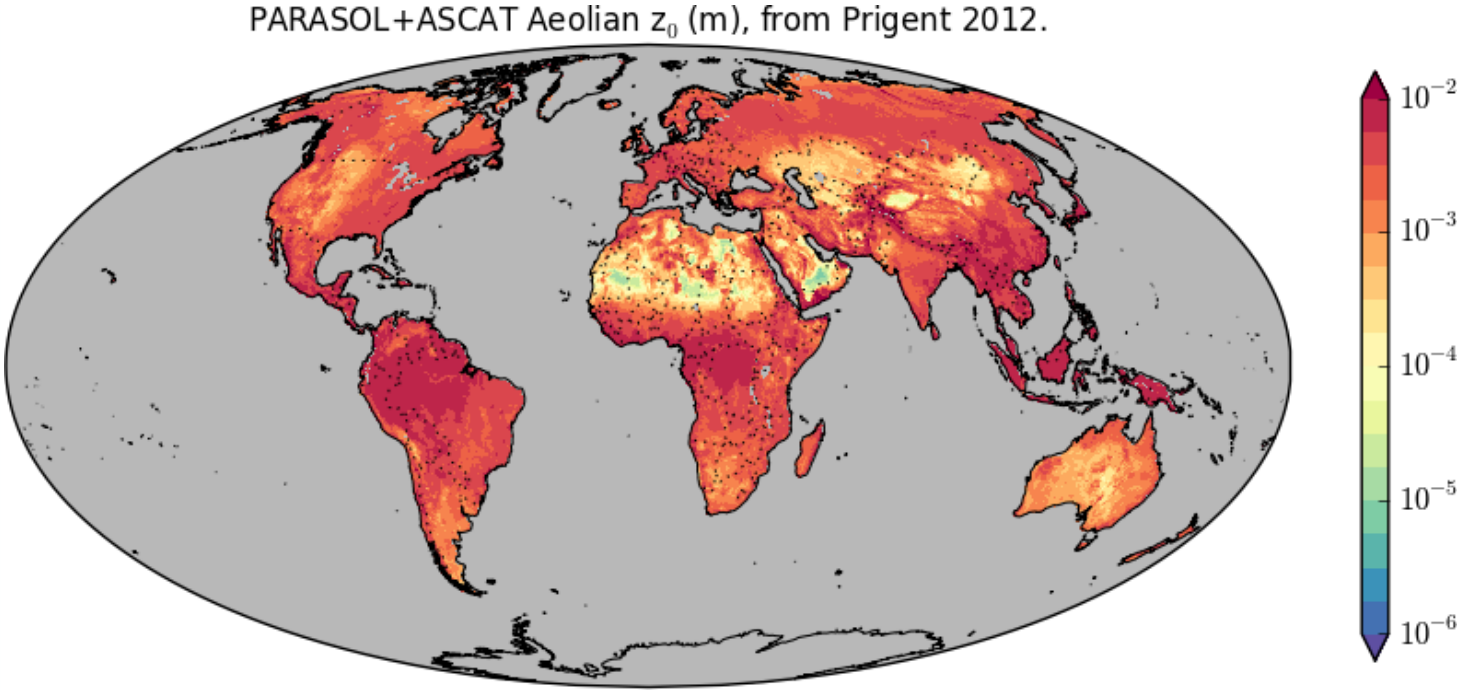
- Aral Sea, Lake Urmia are in decline
- Others vary a lot year by year (Sistan Basin).
- Dust emitted by these features in dry periods currently missing.

Land Cover CCI to include a class to indicate seasonal/ephemeral/occassional water bodies.

Long term: Uses this indicator in land surface DA to model seasonal/ephemeral water bodies better.

# Upcoming/future model changes

Bias 2) Western Sahara (+ve bias) – impact of bare soil z0

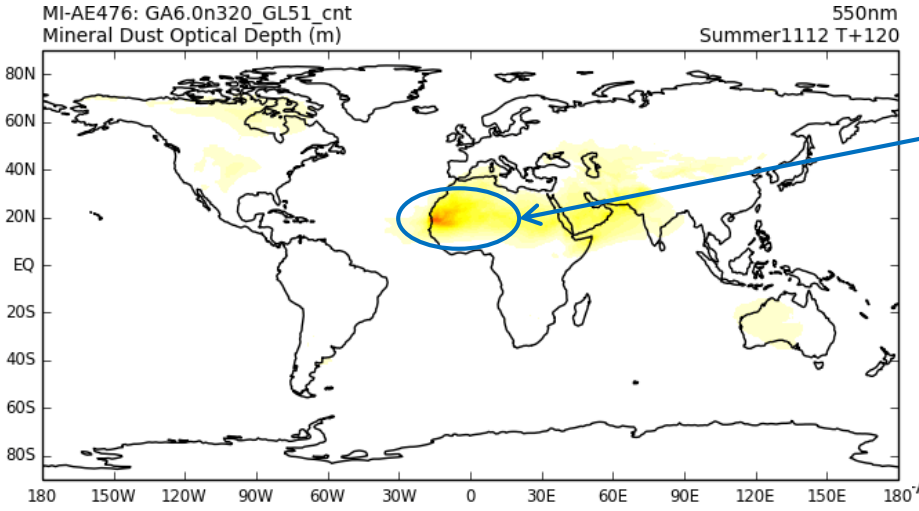



Bare soil z0 from Prigent et al. 2012 (doi:10.5194/amt-5-2703-2012)

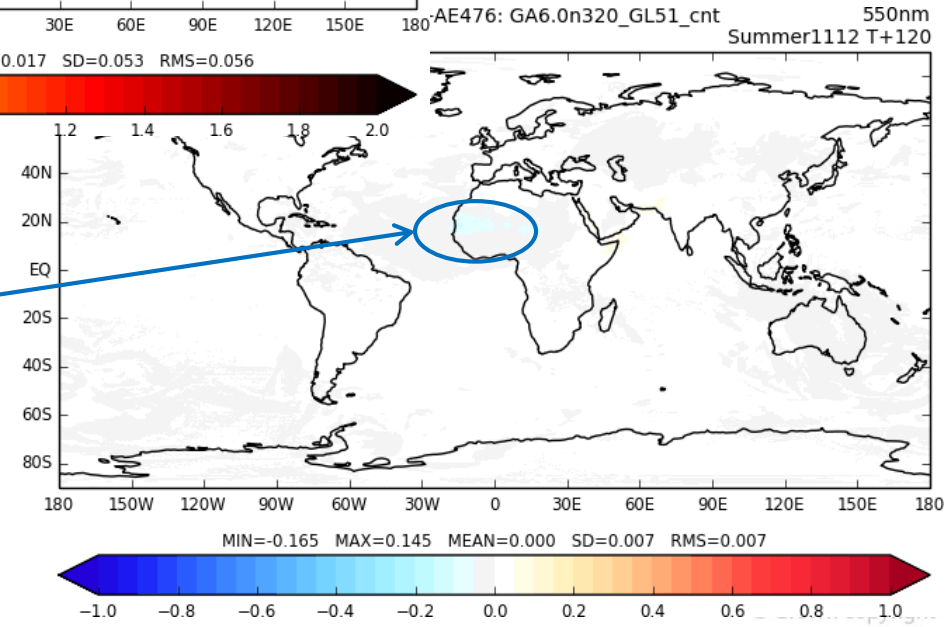
In testing as part of global (GA8) physics package.

# Upcoming/future model changes

## Bias 2) Western Sahara – impact of bare soil z0 obs.




Max mean AOD ~1.0

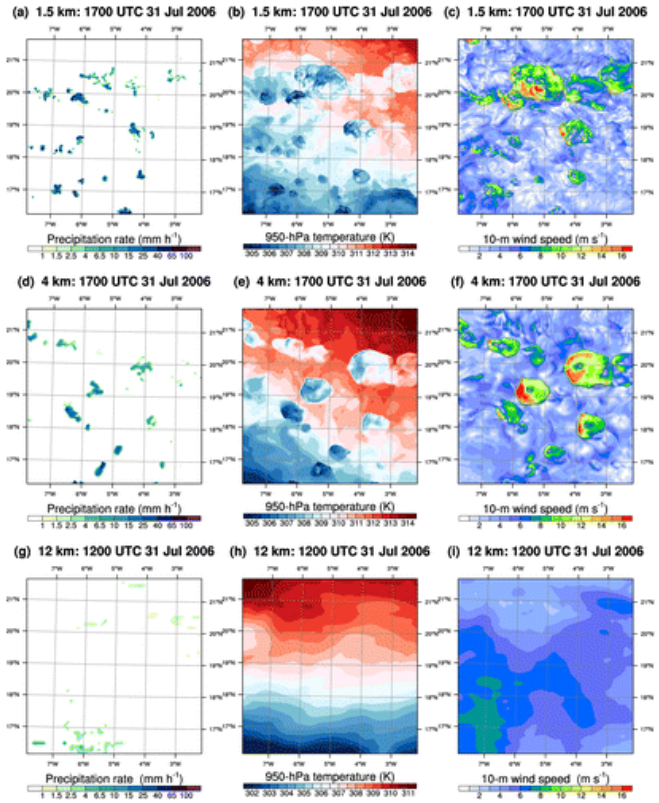



Reduced by ~0.1

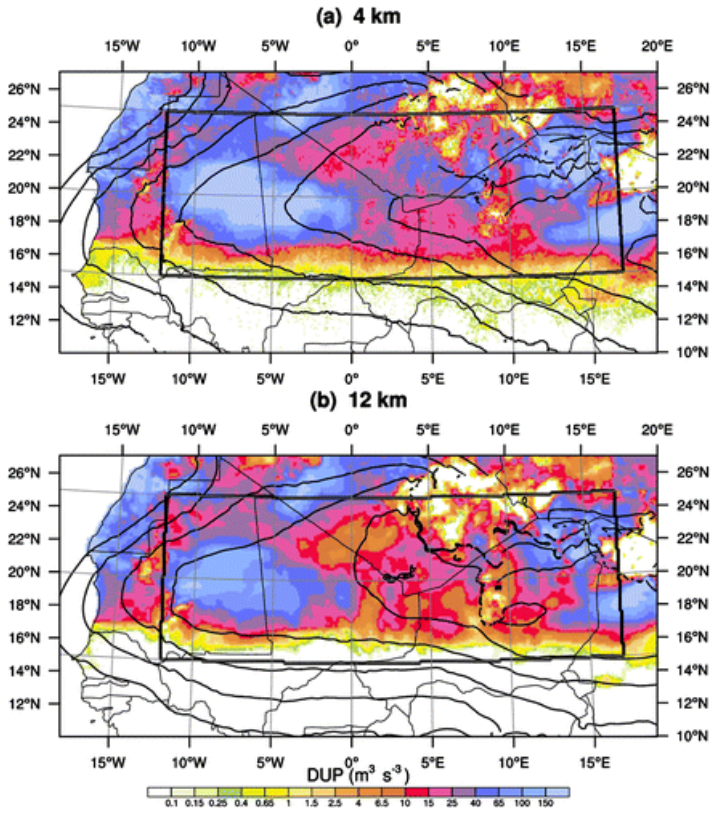
# Upcoming/future model changes

## Bias 3) The Sahel (-ve bias)

Pantillon 2015 (doi:10.1175/JAS-D-14-0341.1) suggests lack of haboobs contributes to this.




1.5, 4 and 12km runs
Precip, 950hPa T, 10m wind.

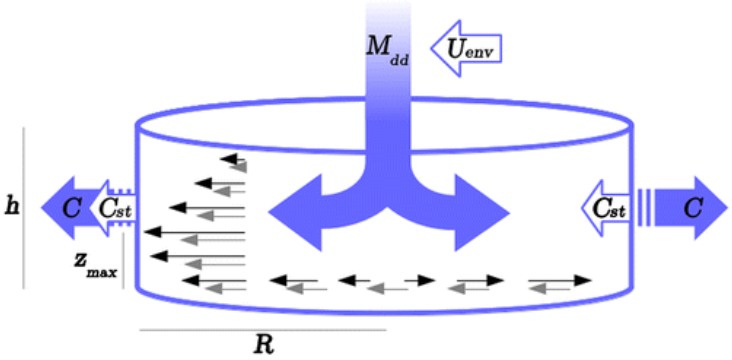



4 and 12km runs
Dust uplift potential diagnostic

# Upcoming/future model changes

Bias 3) The Sahel (-ve bias)

Pantillon 2015 (doi:10.1175/JAS-D-14-0341.1) also propose a parameterisation to connect downdraught mass flux to dust emission.




Relies on the model's convection scheme (which is far from perfect).

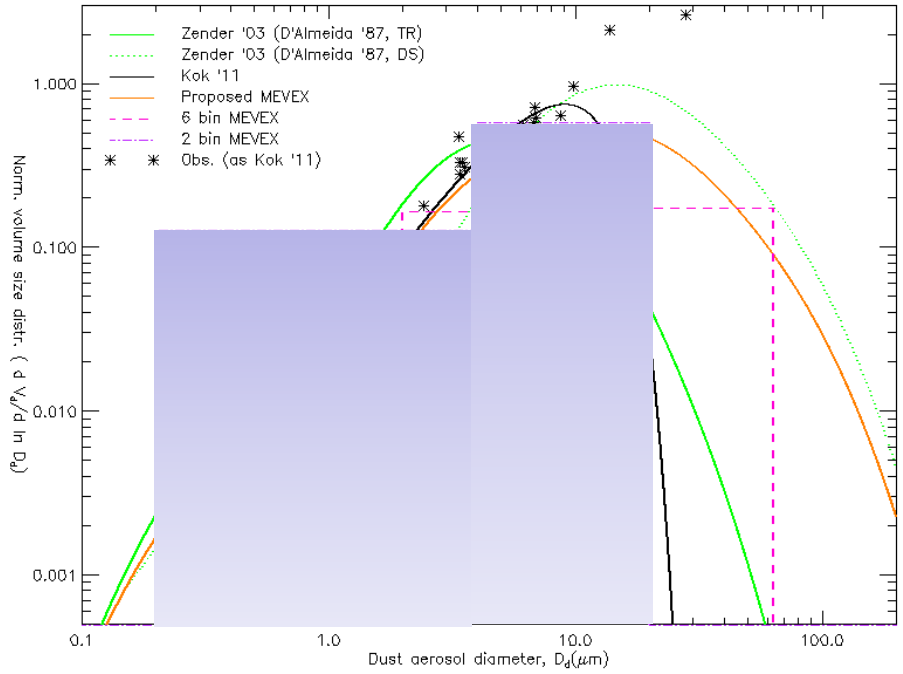
PACADOM Proposal submitted to ERC, with Peter Knippertz, John Marsham, Angela Benedetti and myself, to implement this in Met Office and ECMWF models.

# Upcoming/future model changes

Bias 4) The Atlantic (-ve bias)

A transport issue:

- Emission size distribution too large? (FENNEC results seem to say the opposite)
- How well does a 2 bin scheme handle sedimentation?



# Upcoming/future model changes

Bias 4) The Atlantic (-ve bias)

A transport issue:

- something else going?
  - SALTRACE and SAMUN hints at this.
  - Electrostatic processes?
  - In cloud processing, re-aggregatting very fine particles?
  - More flight campaigns needed on this!
- Short term: tweak the sedimentation coefficients.
- Longer term: understand any new processes and represent them properly.

# Upcoming/future model changes

Bias 5) The Indian Ocean(-ve bias)

Dust sources in Somalia seem to underemitting.

- Caution needed: some climate runs produce very large dust sources here.
- Very variable source region in the model – perhaps in real world too?
- More investigation needed on this.

# Longer term plans

# Cray migration

Current operational models run on IBM Power 7:

- total of 38912 cores, 1.2 Pflops

Migration to Cray XC40 underway right now:

- stage 1a: total of 39168 cores, 1.4 Pflops
  - Migration to be completed by Sept. 2015.

- stage 1b increases this to: 218880 cores, 7.9 Pflops
  - should be available early 2016.

- stage 2 increases this 486224 cores, 20 Pflops
  - available early 2017 (needs a new building!)

# Longer term plans

**Non-aerosol:**

- Global model resolution to 12km, 10km?
- Convection parameterization a major focus
- Ensemble DA TODO: something for the DA update.
- Atmosphere-Ocean coupled forecast.

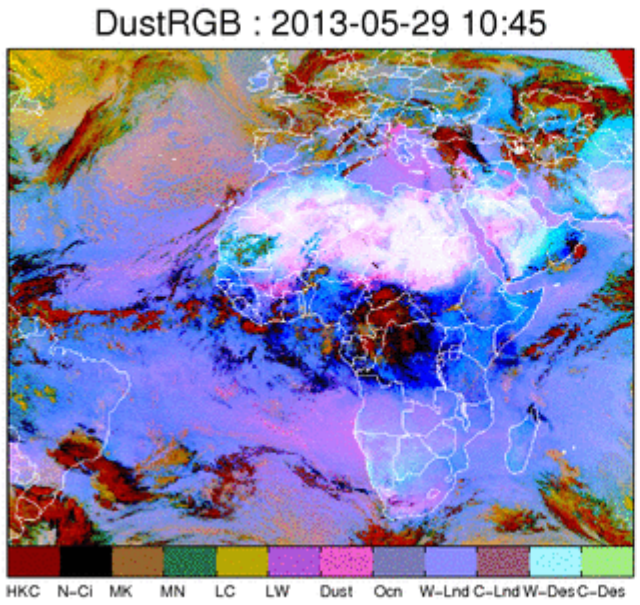
**Aerosol:**

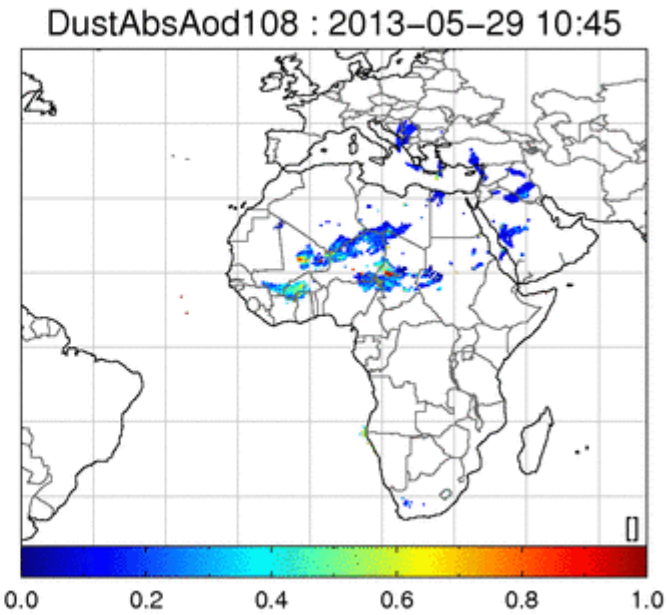
- Migration to GLOMAP/UKCA mode aerosol model.
  - A focus on European air quality
  - Will need a global driving model
  - A variable level of complexity in the model. Simplified down to minimum number of tracers.
  - Appropriate level of complexity to be decided.

# SEVIRI 1D VAR Dust retrieval

Yaswant Pradhan

# SEVIRI 1DVar dust (Yaswant Pradhan)

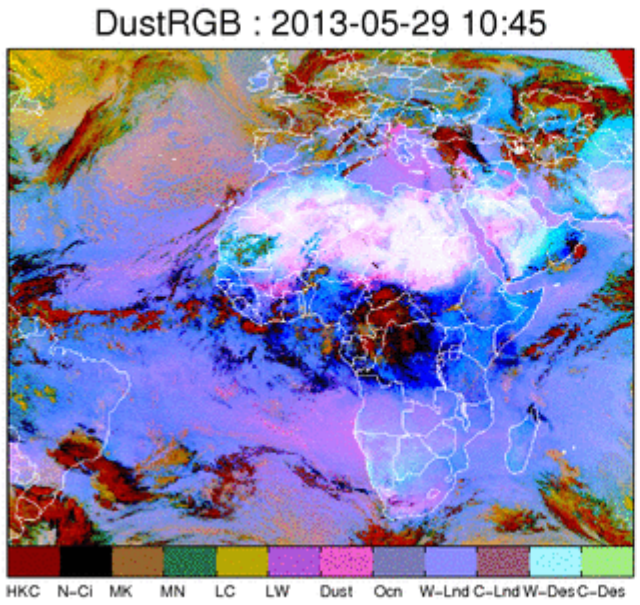


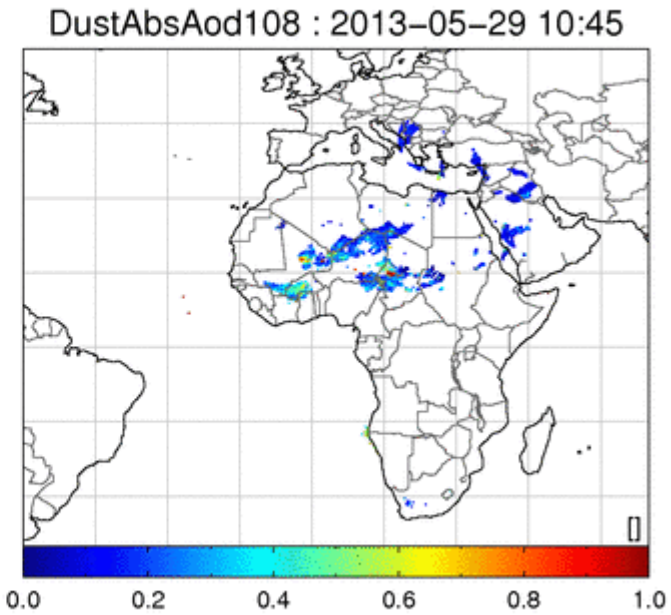




- On dust detected pixels only
- Retrieves Dust Abs AOD at 1080 nm
  - + dust cloud height, column loading, effective radius, plus associated errors)

- Met Office 1DVar retrieval scheme (Francis et al 2012, doi:10.1029/2011JD016788.)

# SEVIRI 1DVar dust (Yaswant Pradhan)

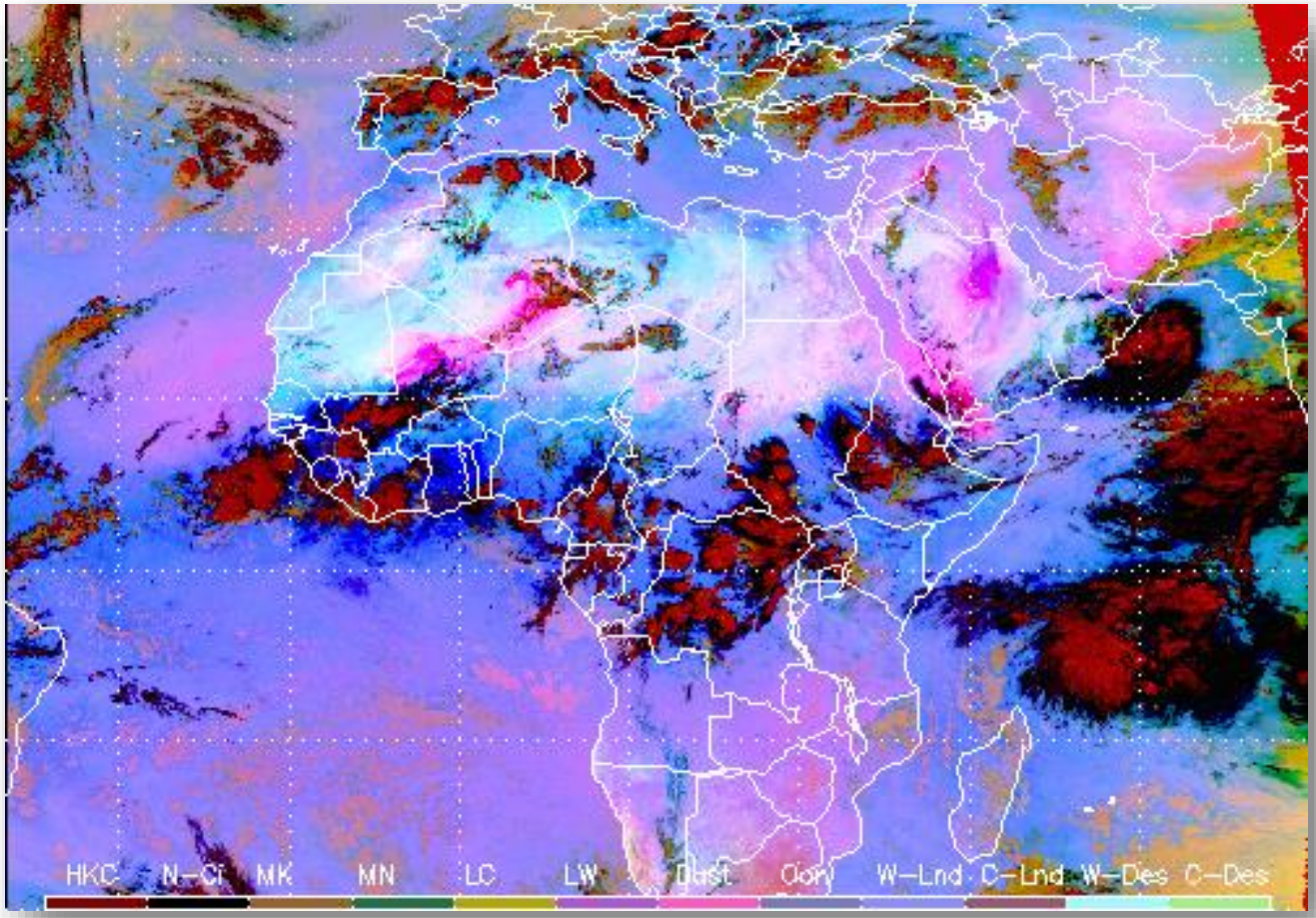


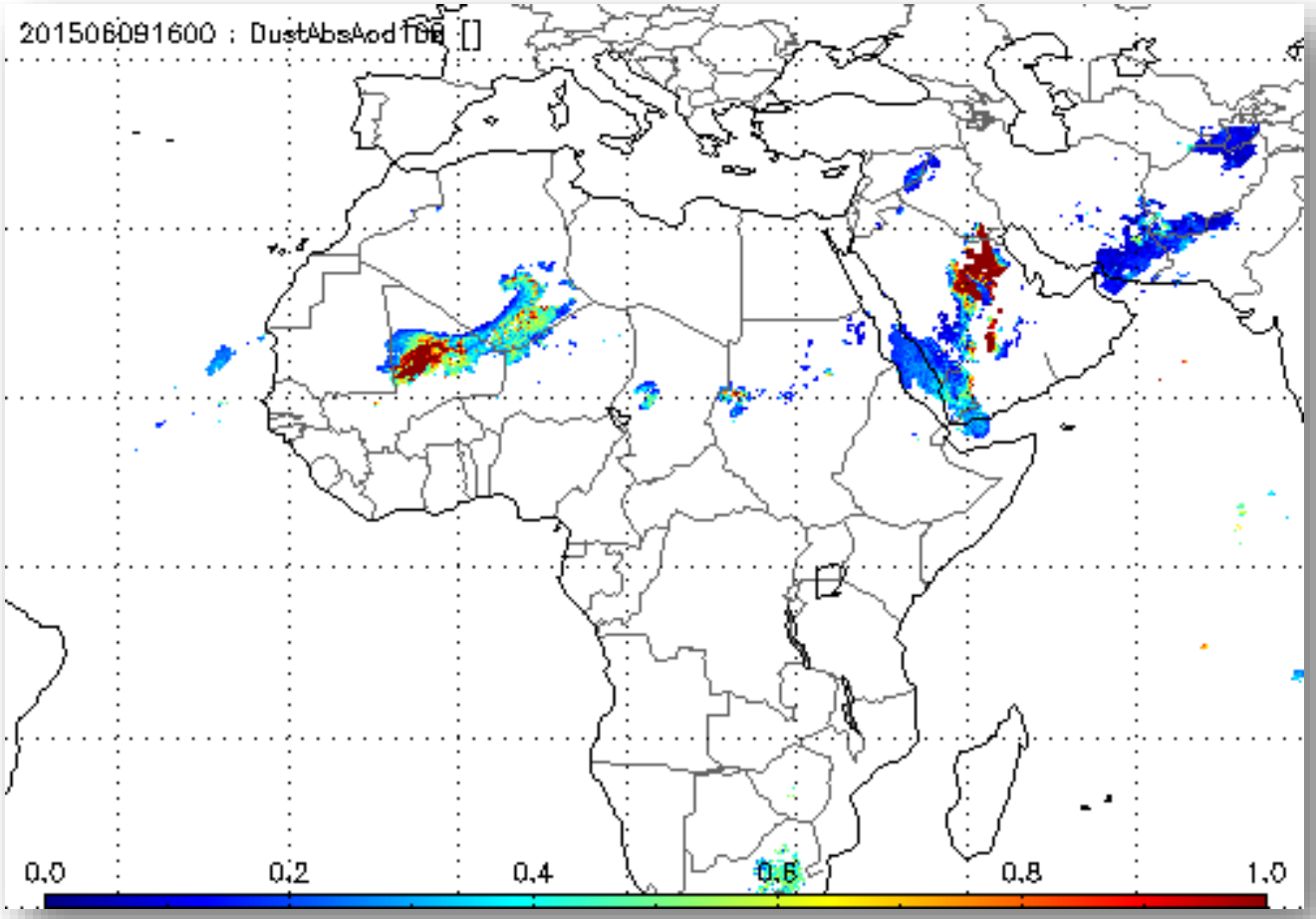

- Issues around the edge of the disk, night-time detection (as the detection tries to mimic the dust RGB)

- Planned Validation with upcoming AER-D campaign data

# Dust RGB



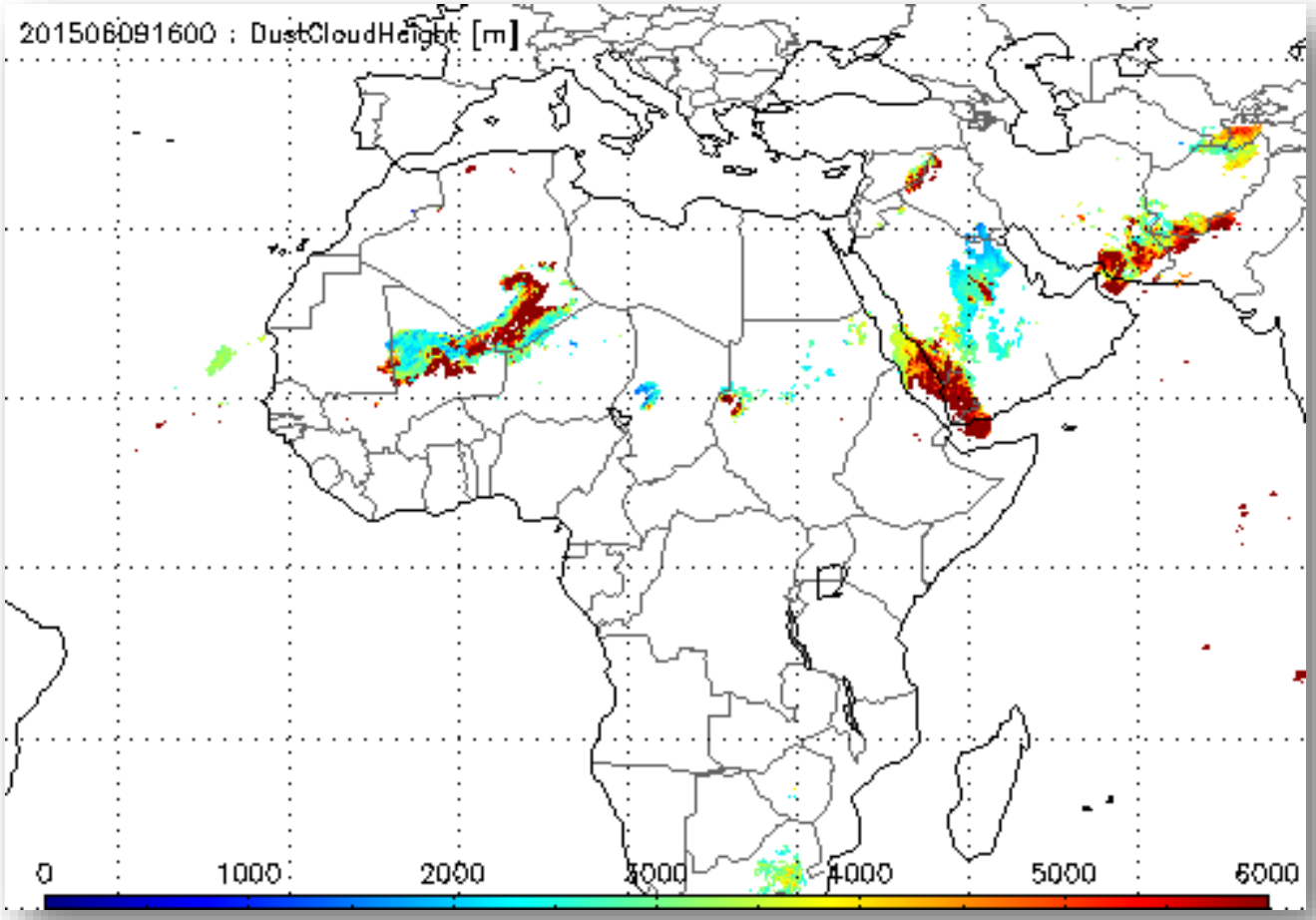
# Dust AAOD @10.8um




Met Office

www.metoffice.gov.uk

# Dust cloud height (m)

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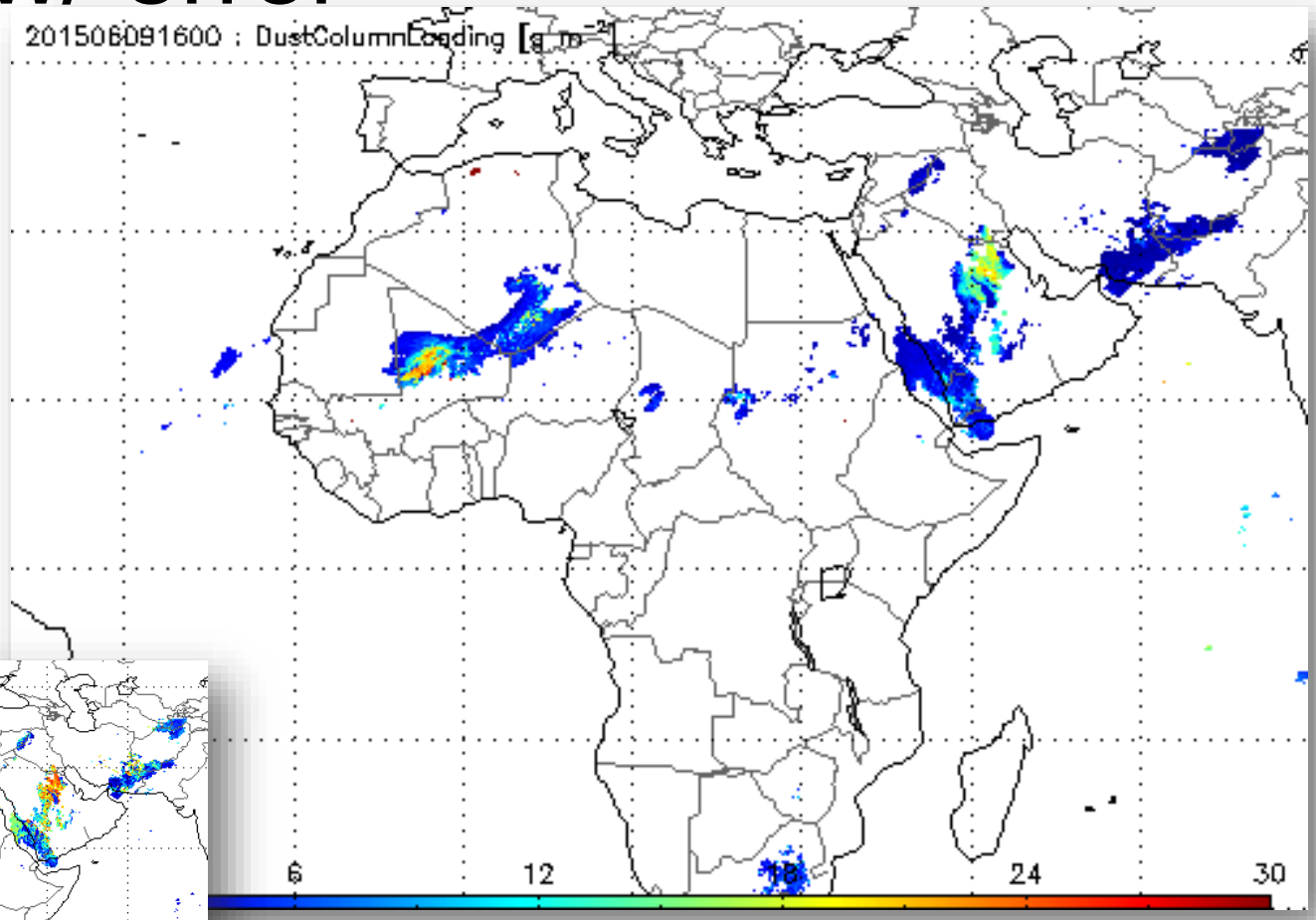
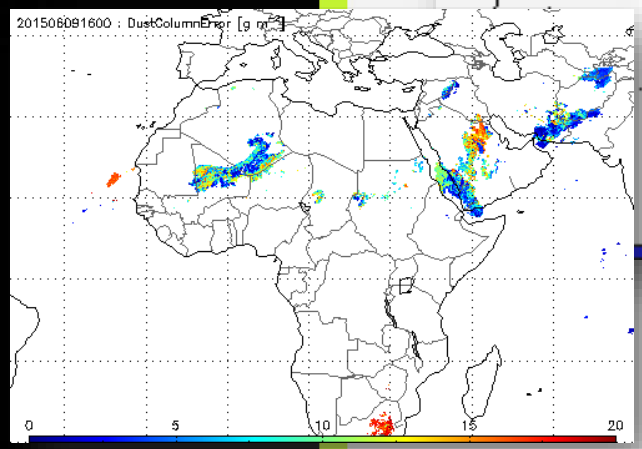
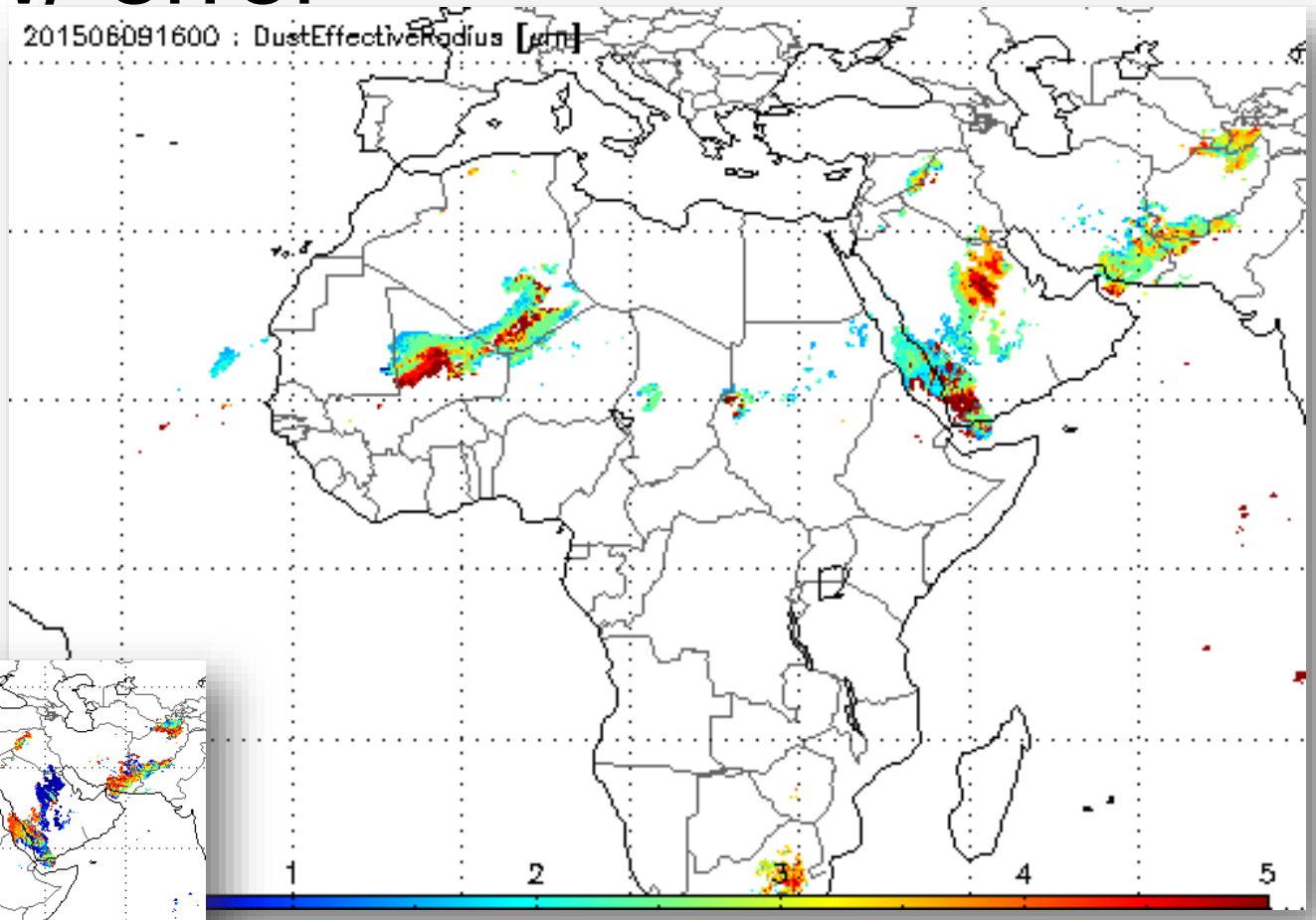
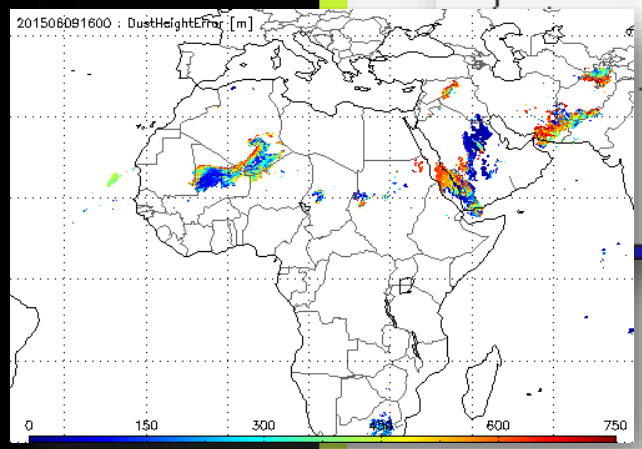
# Dust column loading (g $m^{-2}$) w/ error



# Dust effective radius (um) w/ error



# Conclusions

# Conclusions

1. Global dust performance should be improved with more dust DA.
    a) Too early to tell this against AERONET.
2. More DA improved the analysis, better view of model biases:
    a) The Aral Sea (we still have one)
        - New land cover (soon)
        - Lake inundation model and DA (long term)
    b) Western Sahara (we emit too much)
        - Bare soil roughness length (2016?)

# Conclusions

c) The Sahel (we emit too little)

- Convective downdraughts in dust emission (project proposal submitted)

d) The Atlantic (not transported far enough?)

- Short term fix?
- Needs more in-situ obs near source and downwind.

e) Indian Ocean

- Don’t know yet!

# Conclusions

3. Cray XC supercomputer large increase in compute
    a) Global resolution to 12 or 10 km.
    b) Ensemble size and Ensemble DA
    c) Move to GLOMAP/UKCA MODE aerosol.

4. SEVIRI 1D VAR dust retrieval making good progress.
    a) Dust AOD, height, Re, column loading
    b) Validation planned in AER-D campaign.

Met Office

# Questions, and answers