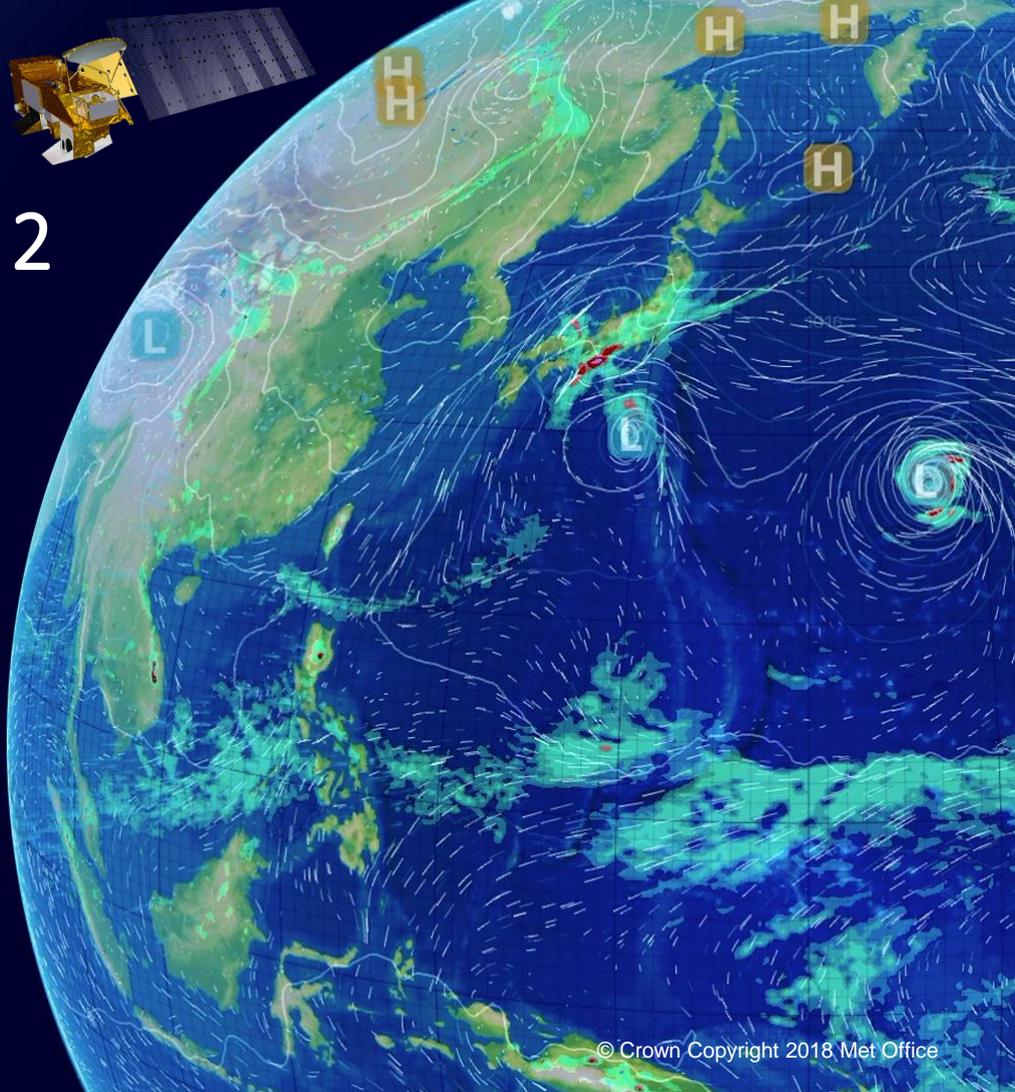


# Met Office update – Part 2

## Satellite observations

10<sup>th</sup> ICAP Working Group Meeting  
Met Office, Exeter. 6-8 June 2018

Yaswant Pradhan and Malcolm Brooks

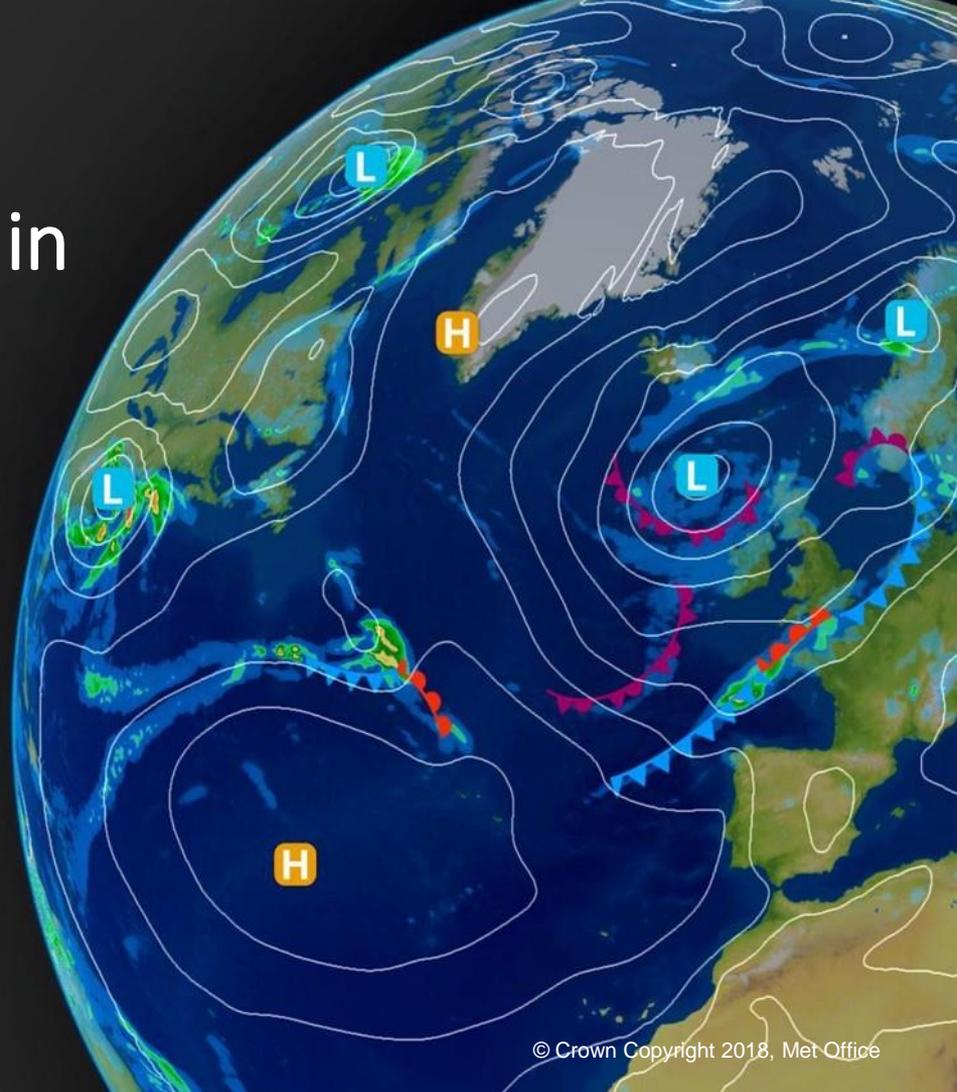


# Content

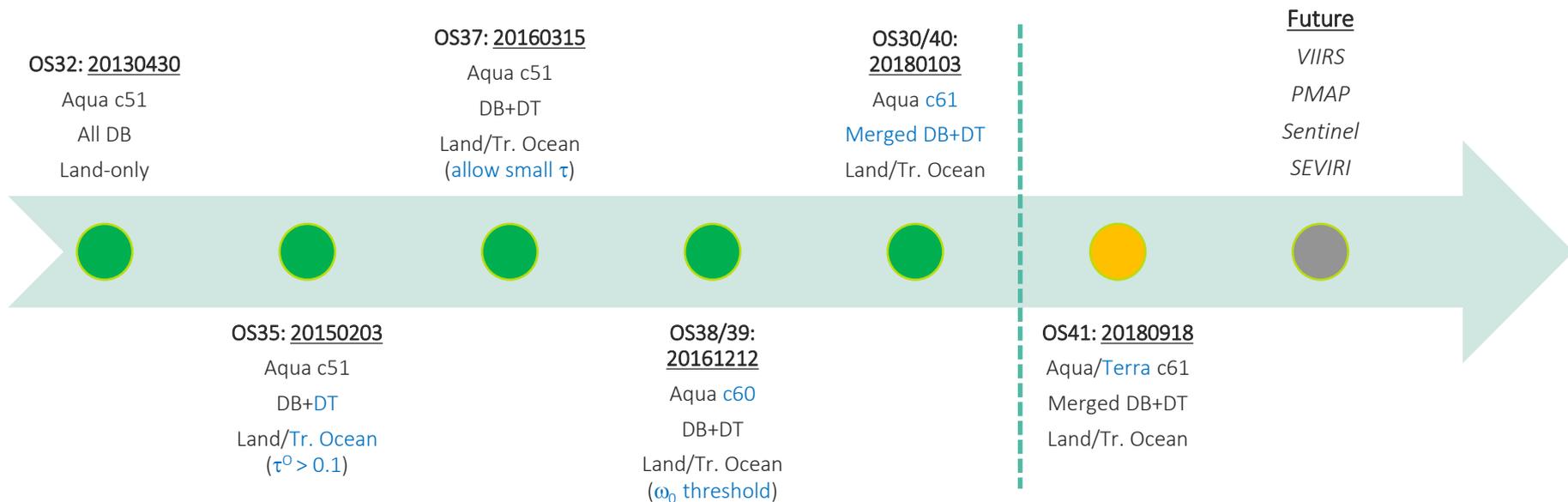
1. Satellite AOD observation in the MetUM-NWP
2. Recent observation changes (since last ICAP)
3. Satellite dust/AOD R&D
4. Future plans

# Satellite dust observations in MetUM-NWP

History and motivation



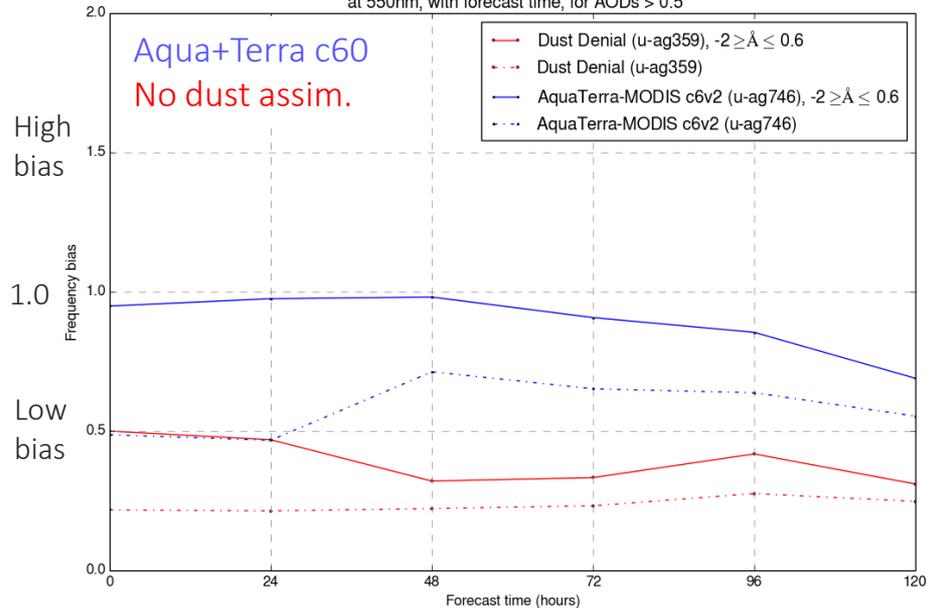
# Timeline



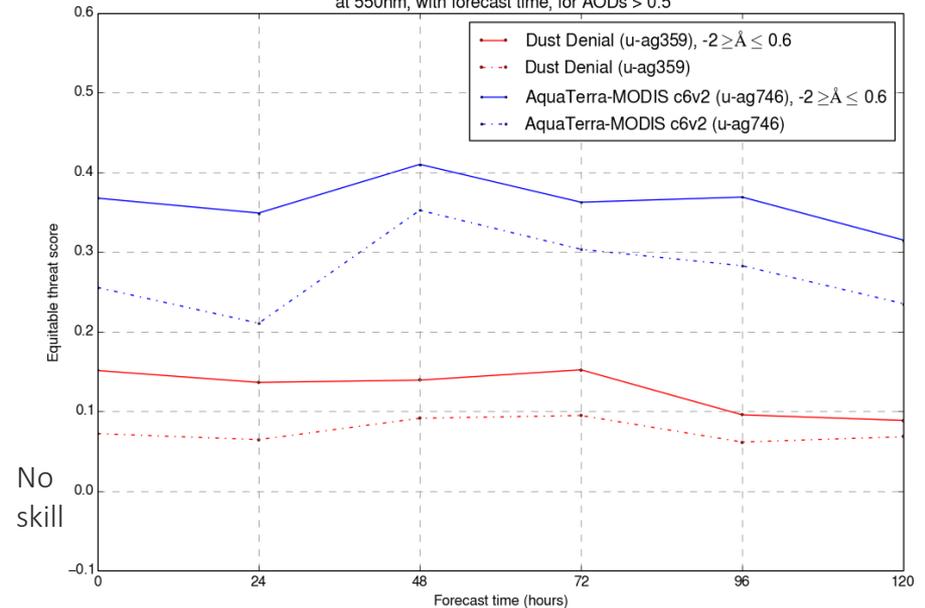
# Motivation

## Impact of MODIS DA in Global NWP dust forecast

Frequency bias vs AERONET L1.5 AOD observations at 550nm, with forecast time, for AODs > 0.5



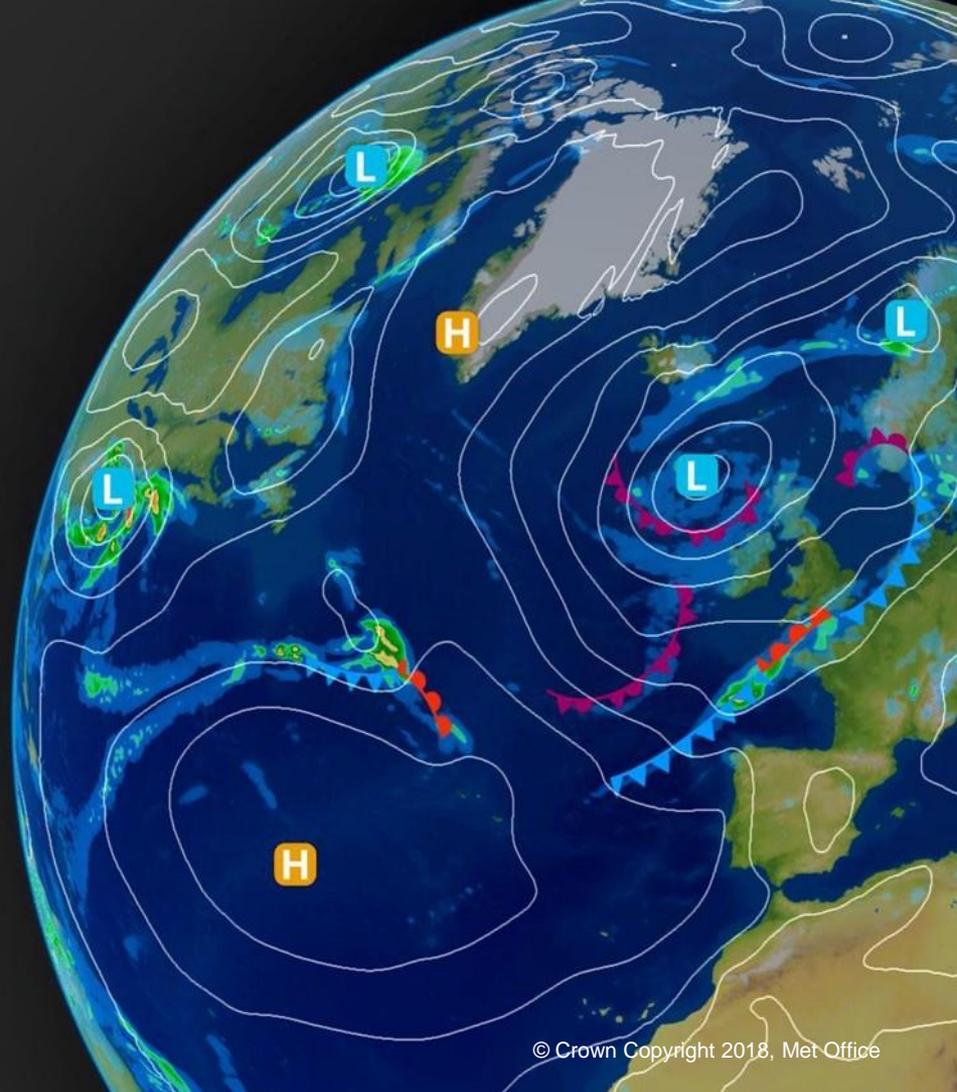
Equitable threat score vs AERONET L1.5 AOD observations at 550nm, with forecast time, for AODs > 0.5



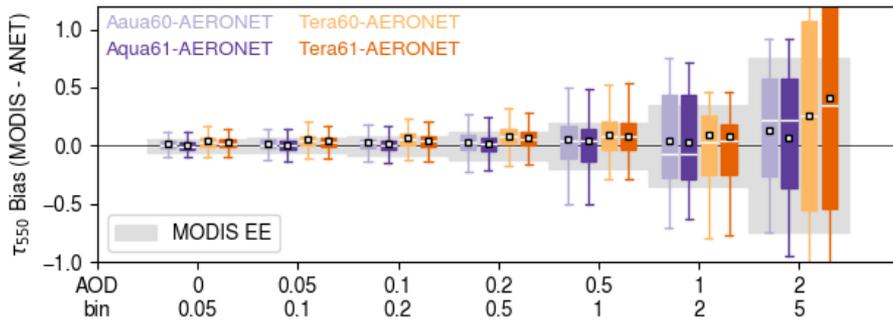
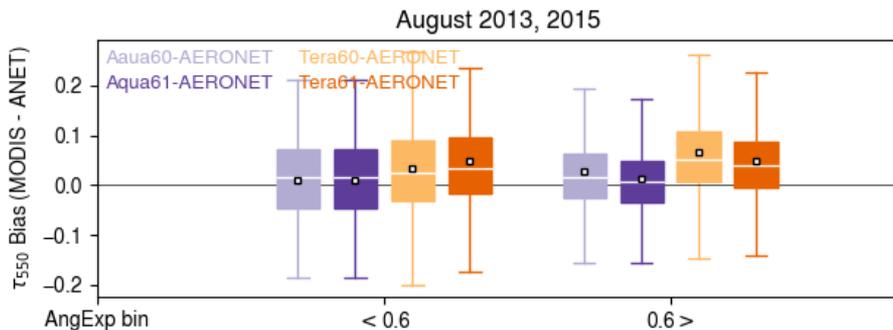
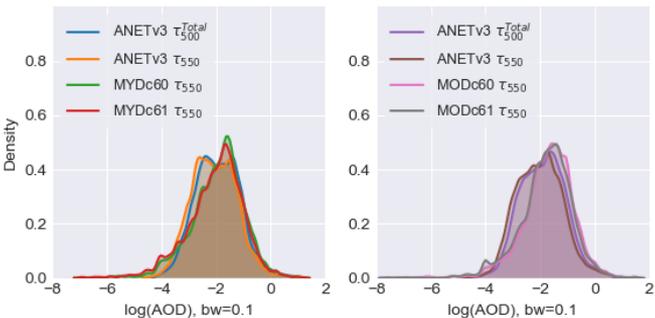
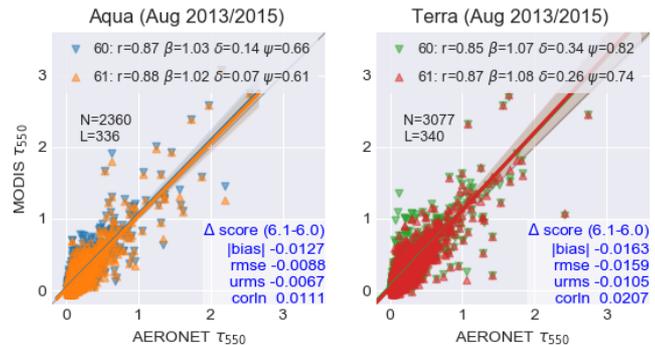
# Recent obs. changes

Migration to MODIS collection 6.1 (c61)

Special thanks to Andy Sayer for MODIS c61 test data

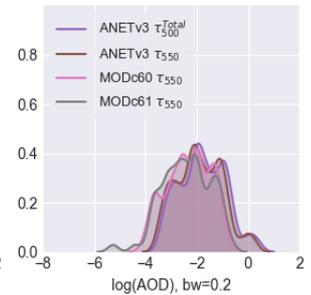
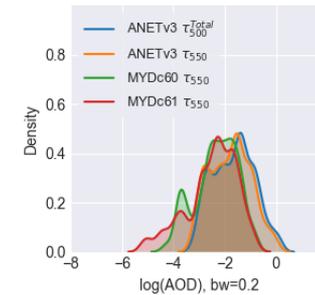
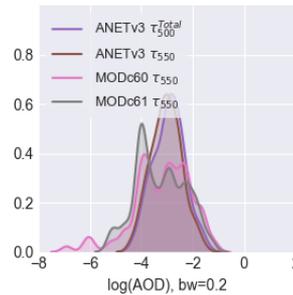
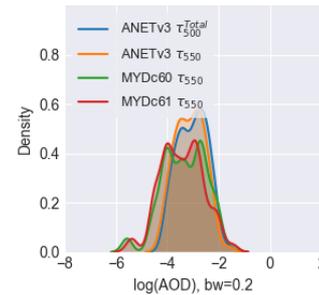
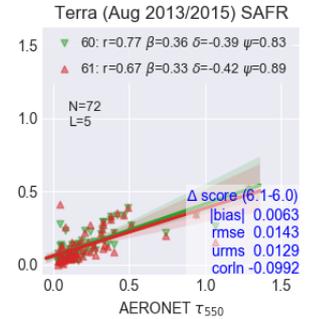
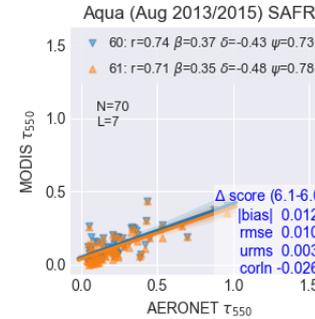
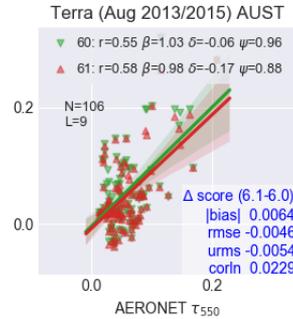
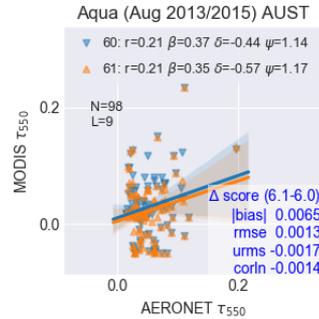


# MODIS c60 → c61: merged DB+DT v AERONET v3



# MODIS c60 → c61

- On a global scale c61 compares better with AERONET
- c61 marginally worse over Australia and S. Africa.
- c61 AOD > c60 AOD over the Arabian peninsula (no AERONET during test period)



# Our dust selection criteria

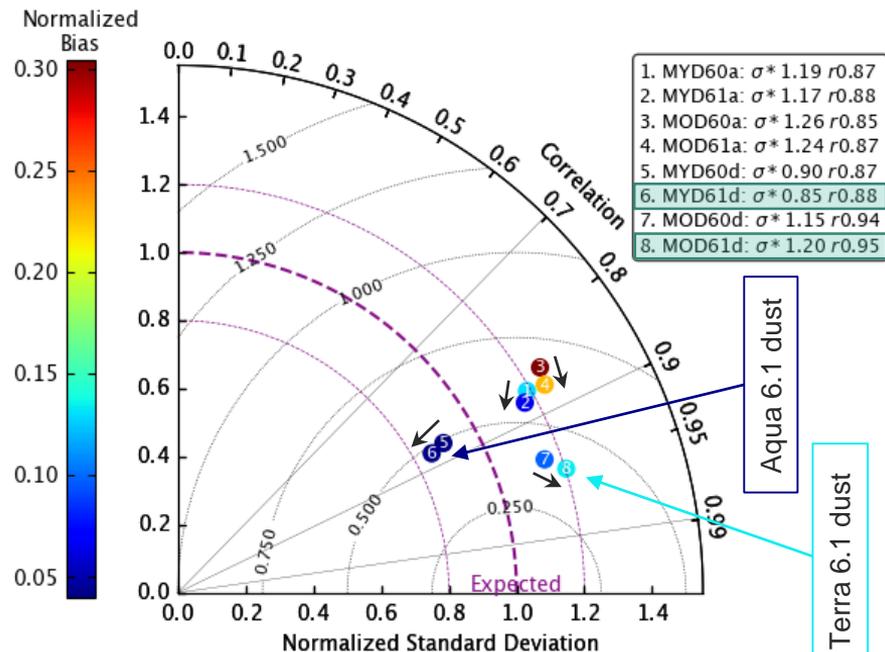
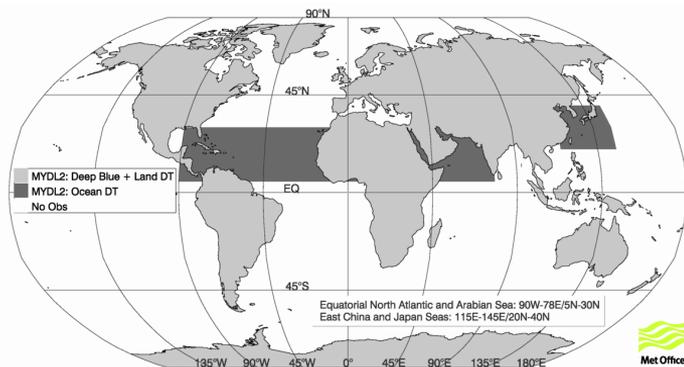
*FineMode Fraction*  $\leq 0.4$

*Angstrom Exponent*  $\leq 0.6$

*Effective Radius*  $> 1\mu\text{m}$

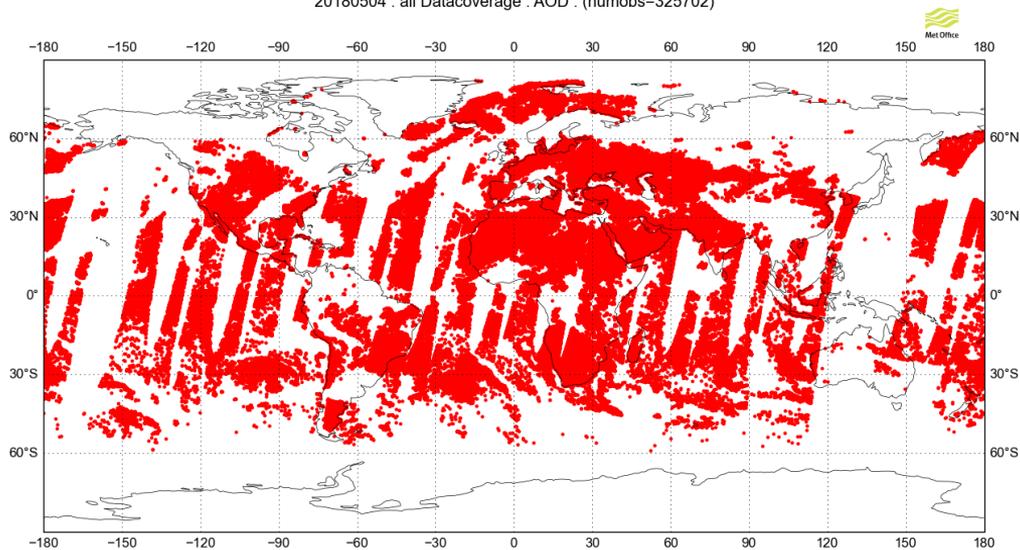
*Single Scattering Albedo at 470nm:* (0.878, 0.995)

*AODthreshold:*  $\begin{cases} \tau_{550}^{OB} < 0.1 & \text{if } \tau_{550}^{BG} > 0.1, \\ \tau_{550}^{OB} \geq 0.1 & \text{otherwise} \end{cases}$

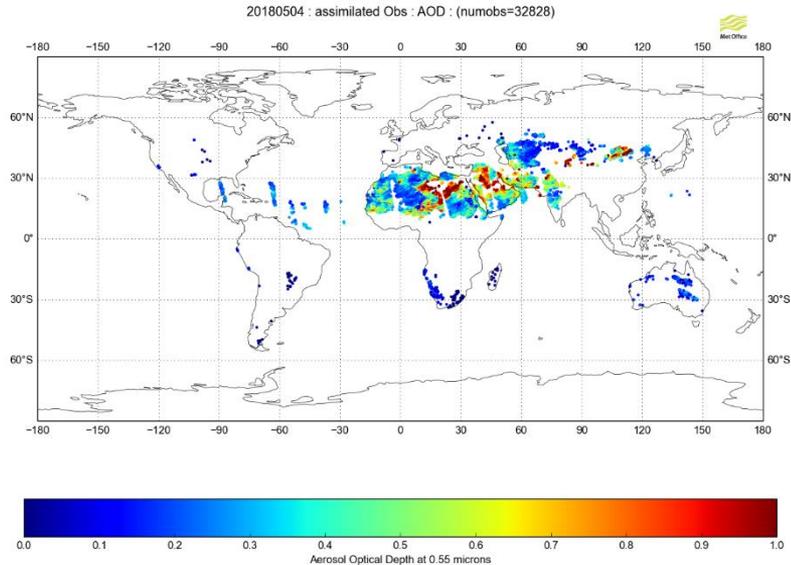


# Used ~10% of best obs.

20180504 : all Datacoverage : AOD : (numobs=325702)

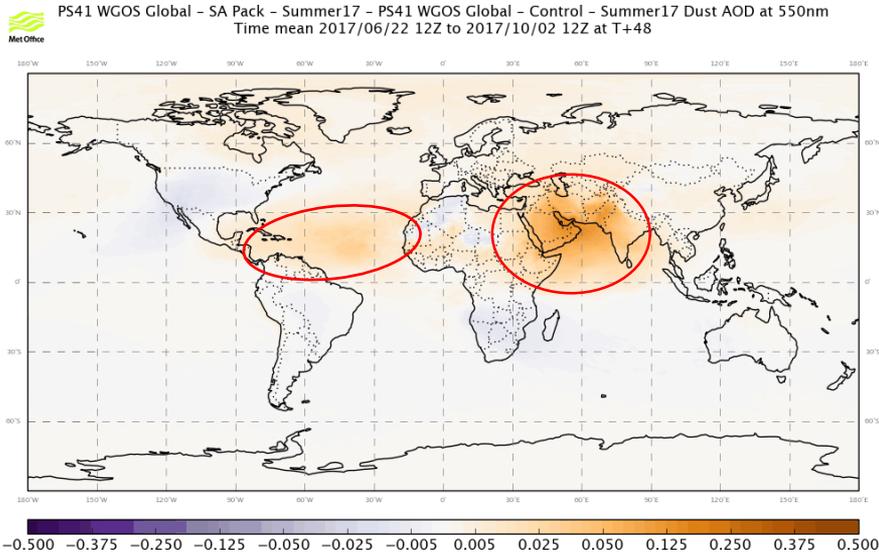


20180504 : assimilated Obs : AOD : (numobs=32828)

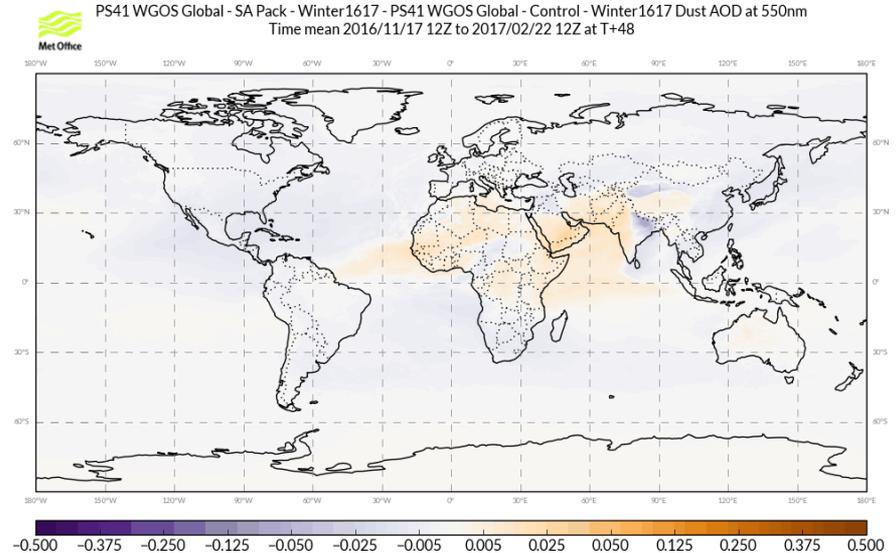


# MODIS c61 impact: T+48 diff

Summer: Ctrl (Aqua c60) · Expt (Aqua+Terra c61)

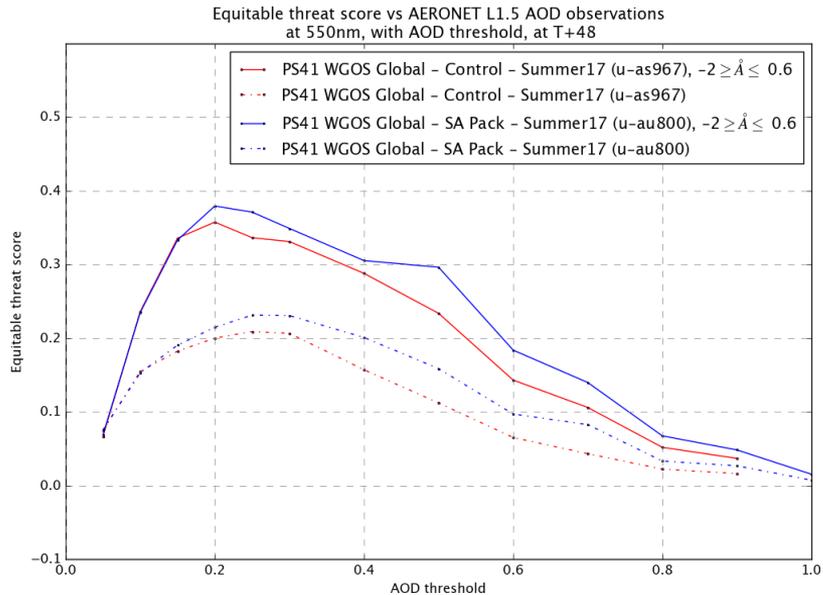


Winter: Ctrl (Aqua c51/c60) · Expt (Aqua+Terra c61)

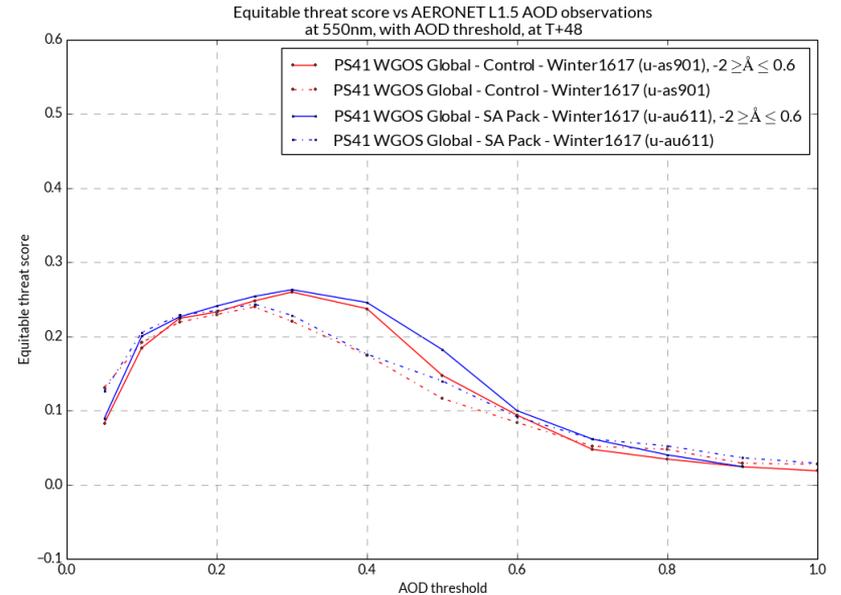


# MODIS c61 impact: T+48 skill

Summer: Ctrl (Aqua c60) · Expt (Aqua+Terra c61)



Winter: Ctrl (Aqua c51/c60) · Expt (Aqua+Terra c61)

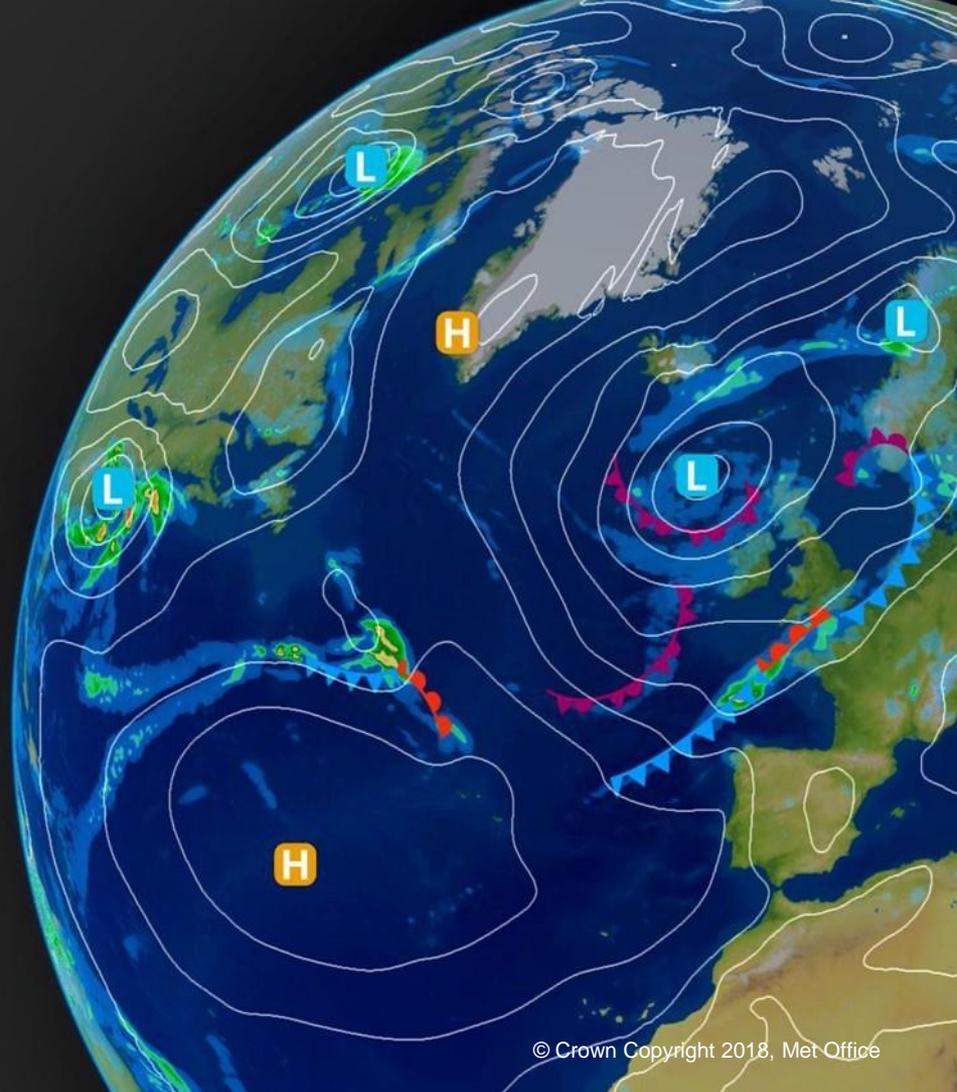


# Summary

- In Summer:
  - Adds slightly more dust over the Arabia and tropical Atlantic
  - Marginally better forecast skills for moderate-high AOD loading
- In Winter:
  - Reduced model drift over India, Saudi Arabia and Western USA (not shown)
  - Neutral impact on dust forecast skills
- Overall impact: neutral/slightly positive (reminder: these are low-res runs)

## Other activities

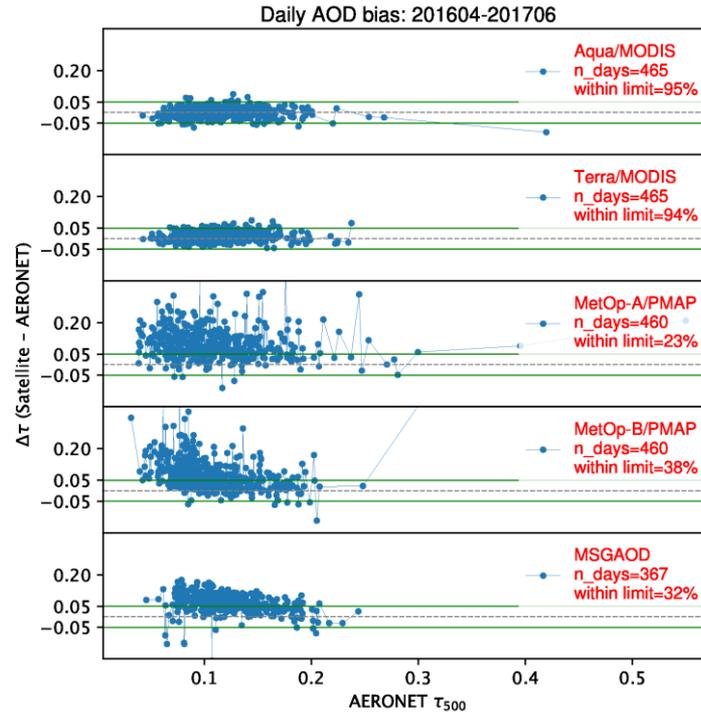
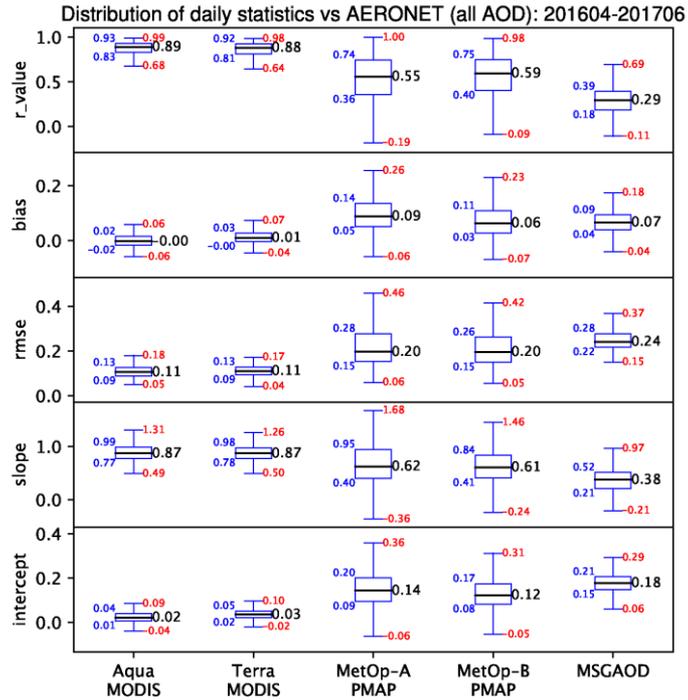
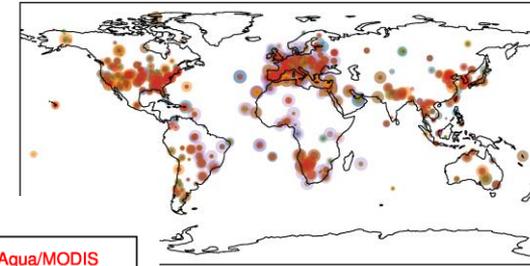
- Assessment of PMAP v2.0, and MSGAOD v1.0 alongside MODIS c6.0
- New! SEVIRI 1DVar dust



# AOD verification: 2016-2017

- MODIS c6.0 (Science)
  - Combined DB+DT
- PMAP v2.0 & 2.1 (NRT)
  - Polar Multi-sensor Aerosol Product is a combined aerosol product based on measurements by the GOME-2, AVHRR and IASI instruments on MetOp satellite series.
  - AOD over ocean already used in CAMS experiment → **minimal impact on the analysis and subsequent forecast.**
- MSGAOD v1.0 (Met Office)
  - Dust optical thickness retrieved from empirical relationship between SEVIRI infrared (10.8  $\mu\text{m}$ ) radiance and aerosol optical depth at 550nm. (see <https://sds-was.aemet.es/forecast-products/dust-observations/msg-2013-u.k.-met-office>)

# AOD verification: 2016-2017



Daily median

# Summary

- Neither PMAP nor MSGAOD is close enough to MODIS AOD retrieval accuracy
- PMAP data are but they being monitored to assess readiness for operational implementation
- By design MSGAOD should perform better over arid regions when dust not too close to the ground – currently being used for event monitoring
  
- What was overlooked at this point – VIIRS

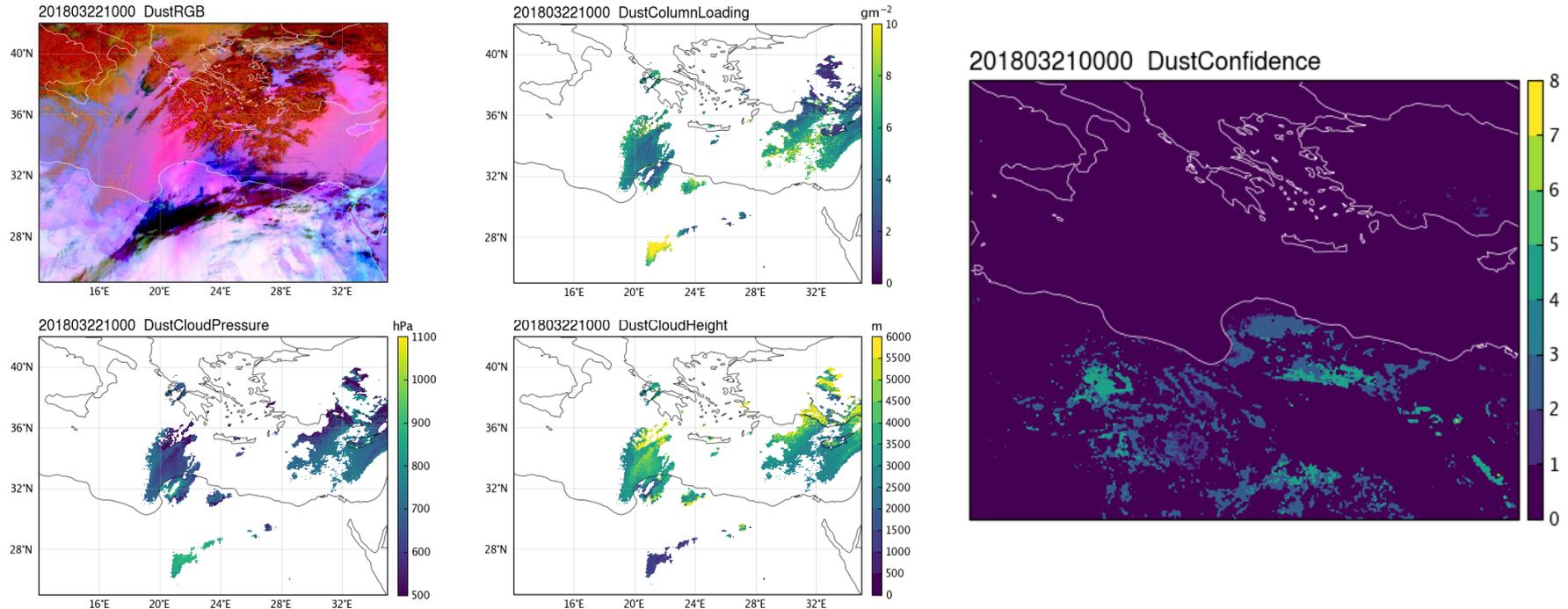
# Dust properties from SEVIRI: 1D-Var retrieval

- State vector: dust column loading, dust layer pressure, dust effective radius
- Retrieval scheme mainly based on: Francis *et al* (2012) for volcanic ash, with few adjustments for dust such as:
  - Dust refractive index: Volz (1972), number of IR channels selection, dust detection and first guesses

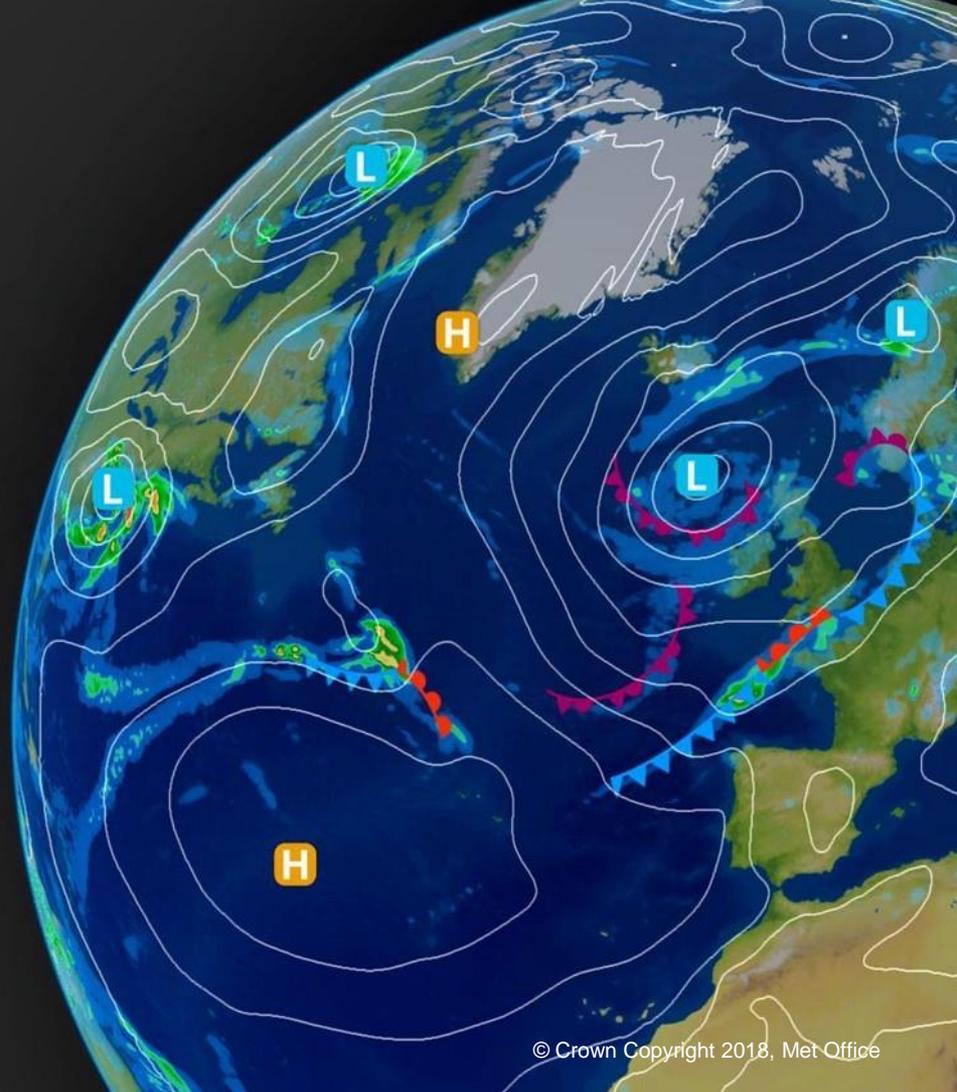
As of now:

- Both column loading and height retrievals compares reasonably with aircraft data (although height retrieval seems sensitive to dust pressure first guess)
- Extending AOD at visible is challenging – too sensitive to retrieved size

# SEVIRI 1D-Var retrieval example: Crete dust



# Future plans



# Things under the radar

- Continue assessment of PMAP and include VIIRS?, Sentinel (future)
- Improve SEVIRI Dust 1D-Var product?
- Test ORAC retrieval scheme using SEVIRI
- ...and perform more experiments...

# Thanks for your attention!

For more information, please contact



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