Validation of Aerosols in the MetUM

An overview of current aerosol verification tools

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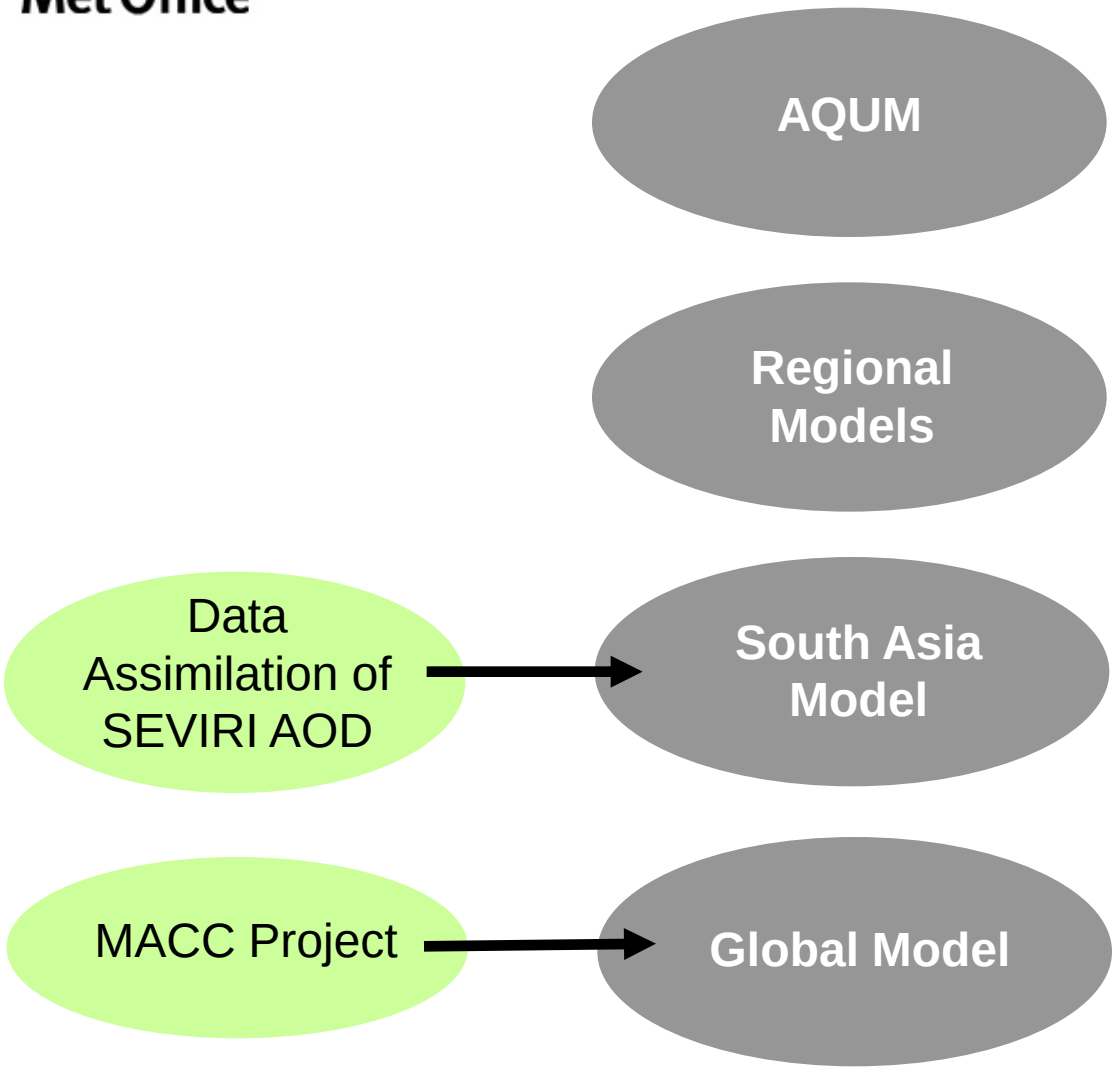
Outline

This presentation covers the following areas

- Overview of aerosol work in NWP context in the Met Office
- Overview of current verification methods for dust aerosol forecasts.
- Application of Spatial Verification Technique
- Developments in satellite retrievals and data assimilation of SEVIRI AOD into South Asian Model (SAM) (Keith Ngan)

Aerosol Forecasting



PM forecasts

See Paul Agnew's presentation yesterday

Visibility Forecasts using MURK

Operational Dust Forecasts

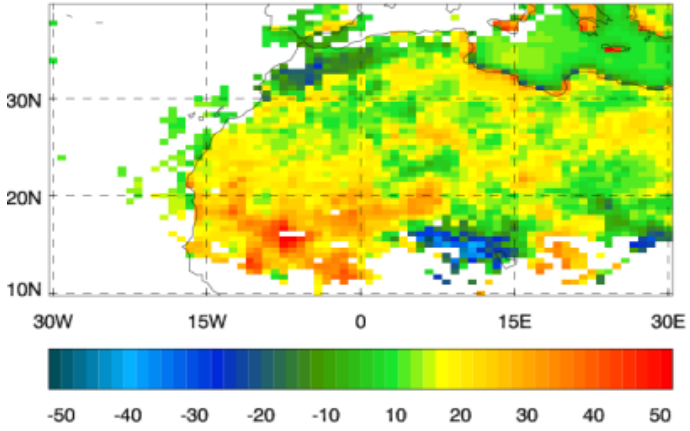
00z 12z → T+48

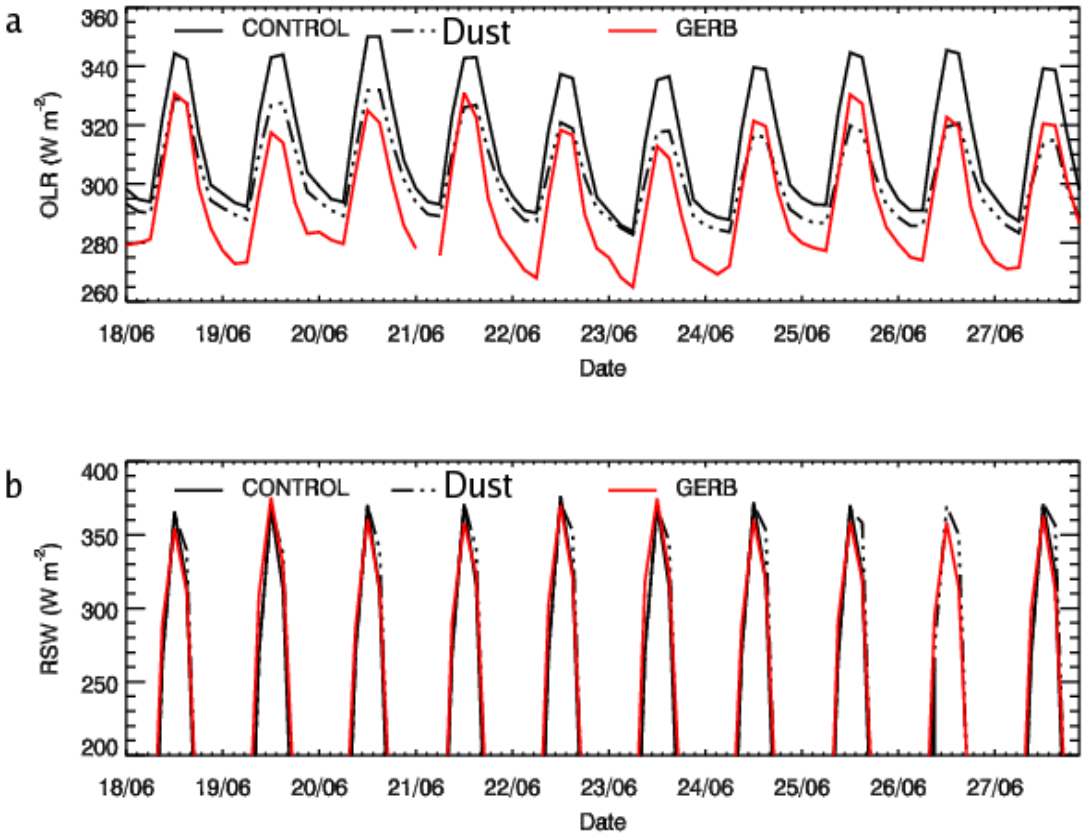
Currently using monthly mean climatologies only

Impact of dust on model radiation

Addressing systematic bias in model OLR

Model-GERB OLR





Routine near-real time evaluation of MetUM OLR and Albedo is being carried out under the SINERGEE Project (Rich Allan, Uni. Reading)

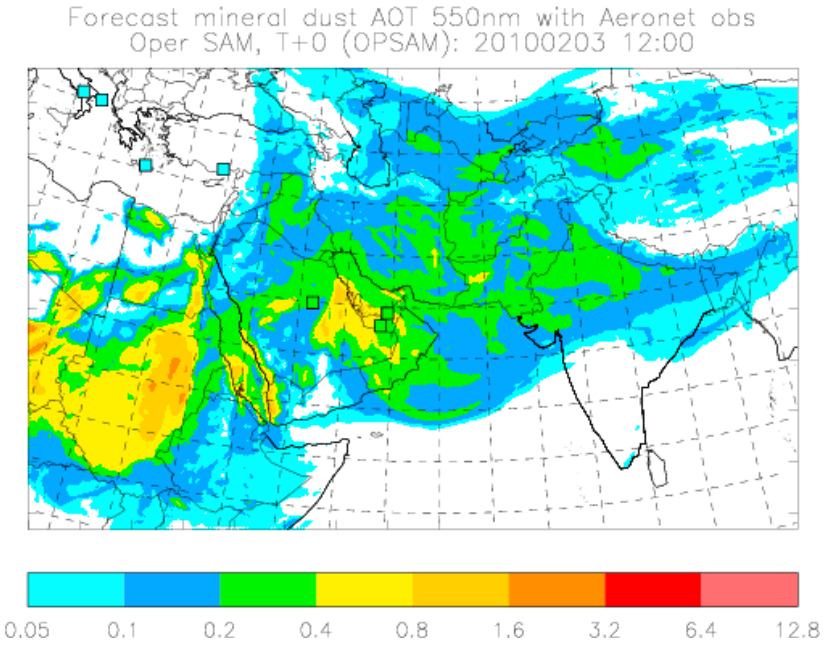
Validation using AERONET

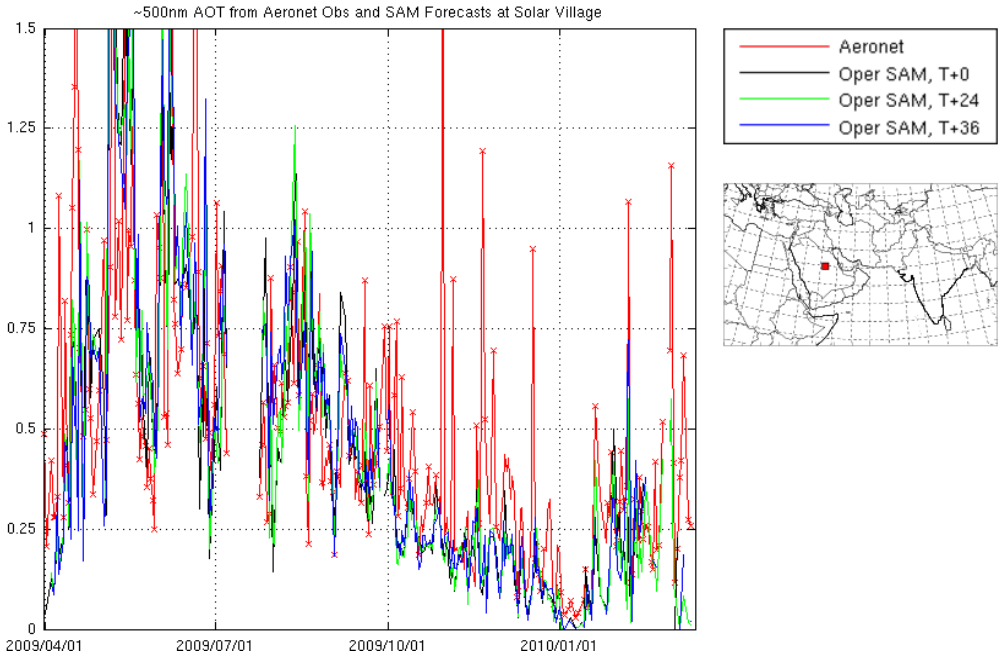
Met Office

AERONET
AEROSOL ROBOTIC NETWORK

NASA

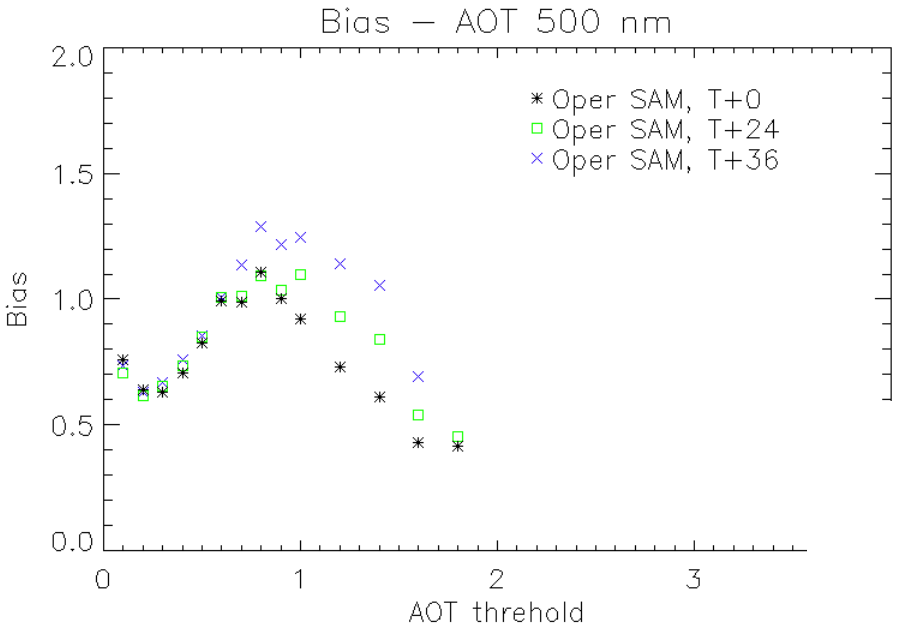
Validation of operation SAM dust forecasts

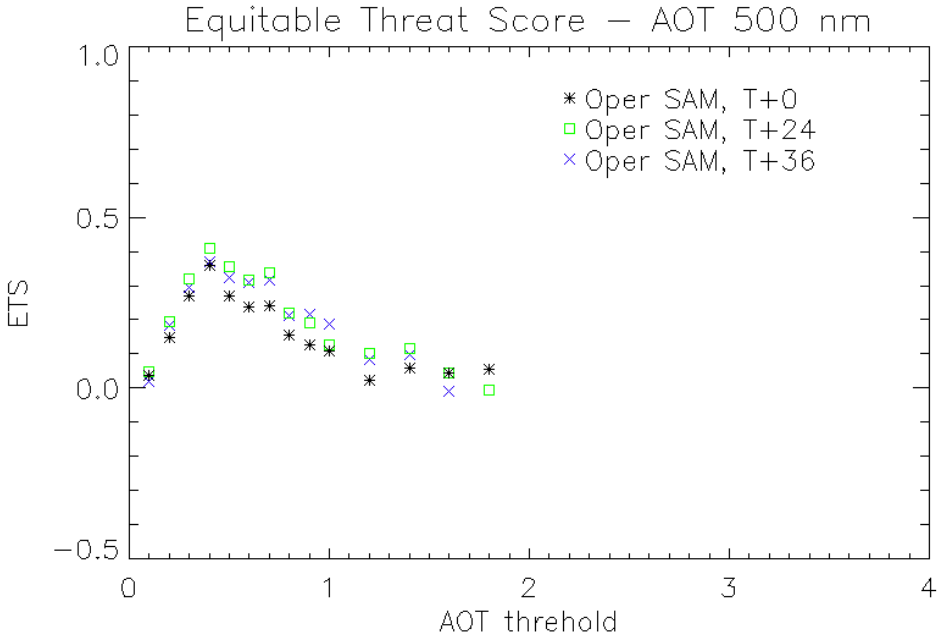




500nm AOD vs AERONET

Verification Metrics





Equitable Threat Score:

Fraction of observed events that were correctly predicted, reduced by the numbers you would expect by chance.

0 – no skill

1 – perfect

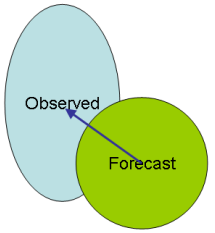
Spatial Verification using SEVIRI AOD

Ric Crocker

Spatial Verification Method

Ebert and McBride (2000)

- Point by point calculations can over-penalise forecast
- Want to assess overall skill of model and areas of strengths and weaknesses
- Use SEVIRI AOD over land (Pradhan & Saunders, 2009)
- Identify areas exceeding a threshold (an 'event'), find equivalent area in forecast and displace the feature until the best match is found.
- Decompose the resulting error into a displacement, volume and pattern error.



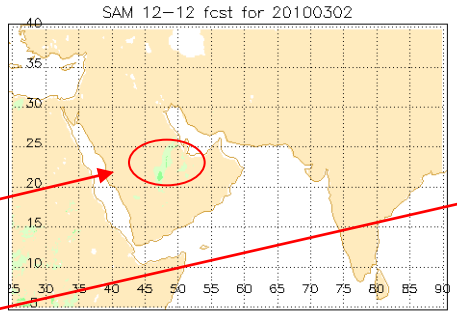
$$MSE = MSE_{\text{displacement}} + MSE_{\text{volume}} + MSE_{\text{pattern}}$$

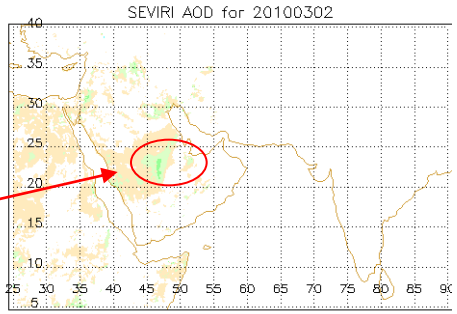
Example

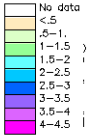
12z March 3rd 2010

Forecast Event

Observed Event





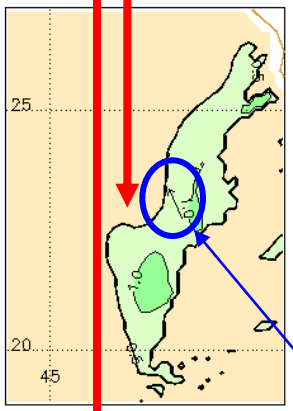


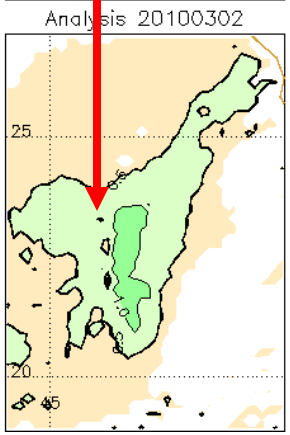
	Forecast <0.50	Forecast ≥0.50
<0.50	10515	1325
≥0.50	2328	530

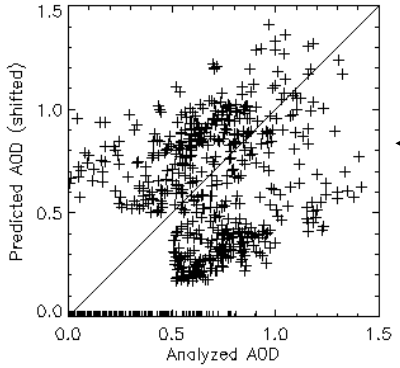
Validation statistics for 20100302 n=14698 Verif. grid=0.150°

	Analysed	Forecast
# gridpoints gt Threshold	2858	1855
Average AOD ( )	1.59	1.74
Maximum AOD ( )	2.37	1.41

Mean abs error = 0.26
RMS error = 0.36
Correlation coeff = 0.102
Bias score = 0.649
Probability of detection = 0.185
False alarm ratio = 0.714
Hanssen & Kuipers score = 0.074
Equitable threat score= 0.044







SAM 12–12 fcst 20100302 n=742
(19.10°,44.20°) to (26.90°,50.05°)
Verif. grid=0.150° CRA threshold=0.5 AOD

	Analysed	Forecast
# gridpoints ≥0 AOD	523	376
Average AOD ()	0.61	0.49
Maximum AOD ()	1.42	1.41

Displacement (E,N) = [0.30°,–0.60°]

	Original	Shifted
RMS error ()	0.46	0.36
Correlation coefficient	–0.319	0.471

Error Decomposition:

Displacement error	37.0%
Volume error	6.9%
Pattern error	56.2%

Point by point analysis AFTER displacement

Event displacement

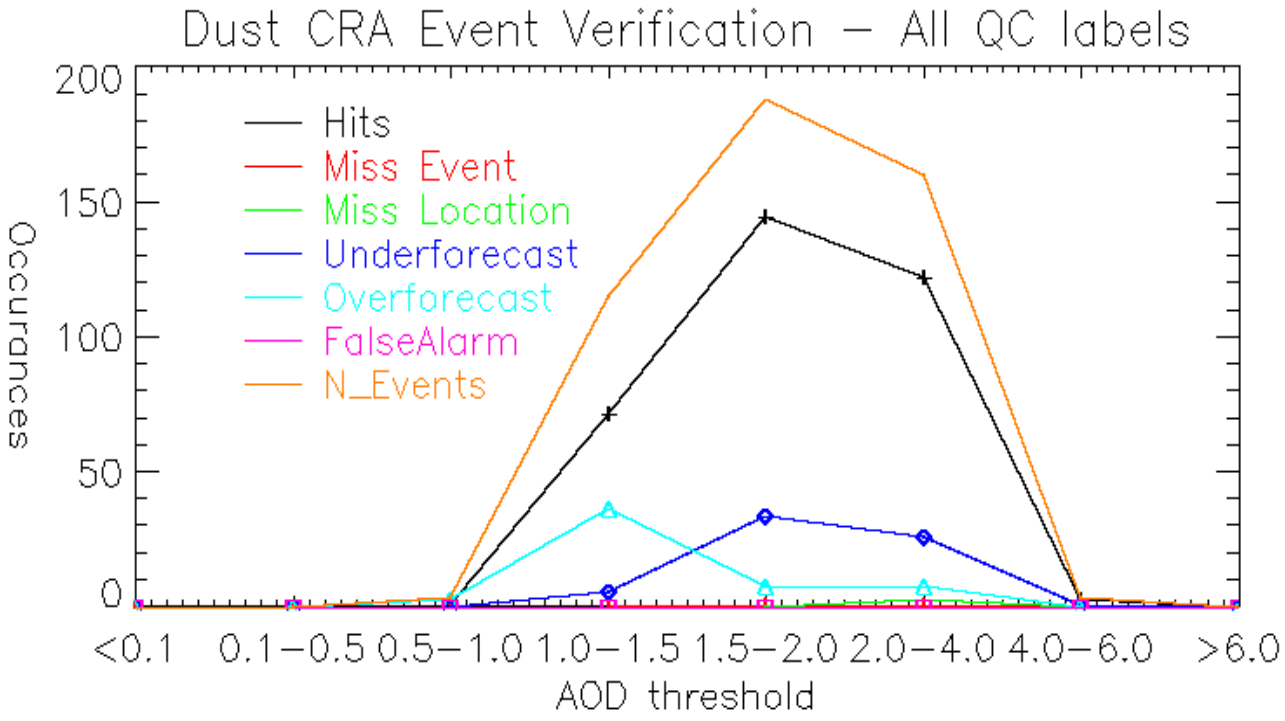
Improvement in statistics after displacement

Error Decomposition (shape of forecast event is responsible for 56% of the error)

Validation using SEVIRI AOD

Can be used to build feature contingency tables:

		Intensity		
		Too little	~ Correct	Too much
Location	Close	Undersetimate	Hit	Overestimate
	Far	Missed event	Missed location	False alarm

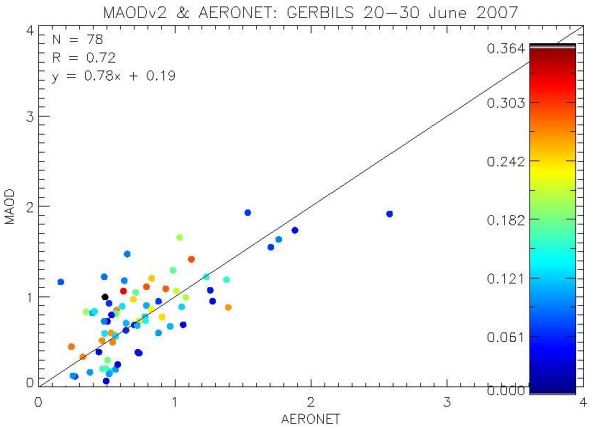


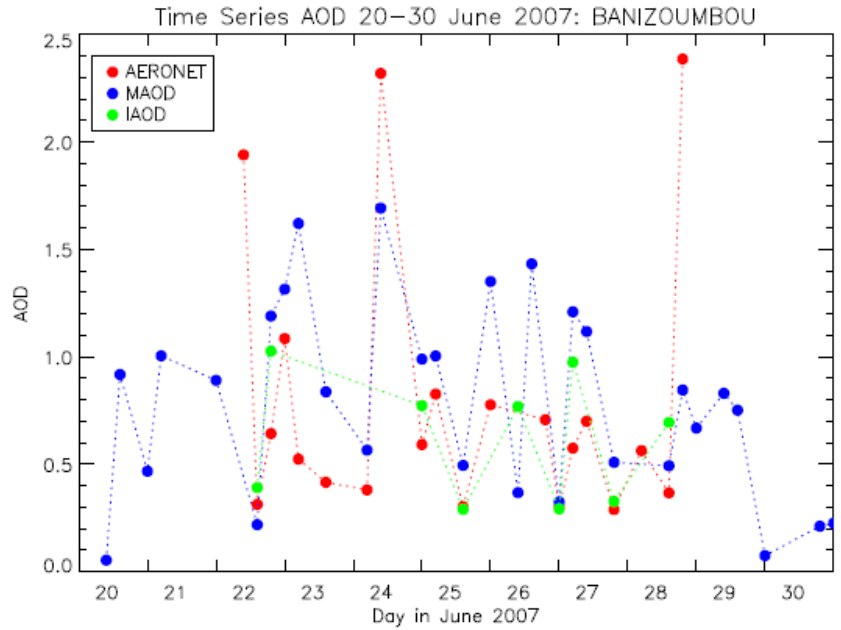
Satellite retrievals and data assimilation

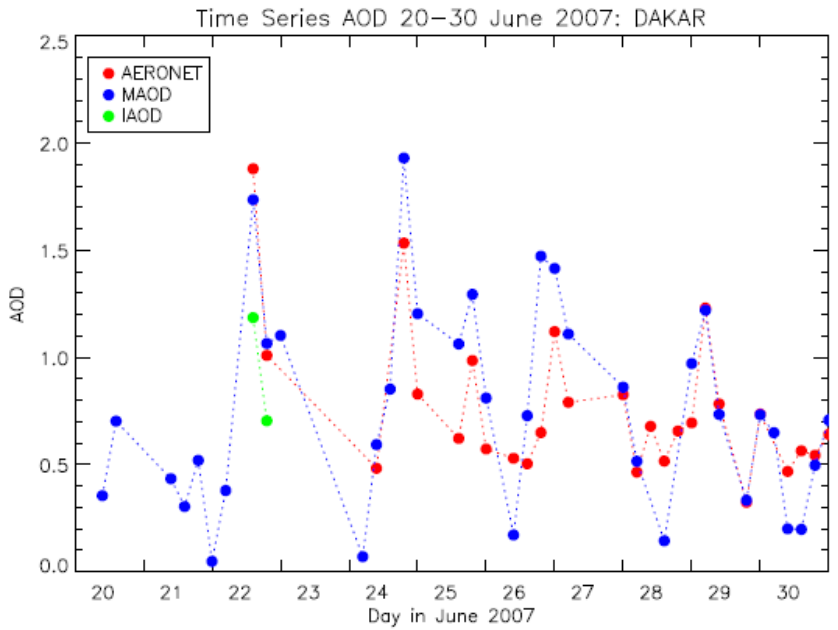
Yaswant Pradhan, Keith Ngan

MSGAOD comparison

- MSGAOD compares well against AERONET
- Atmospheric correction using UM/ECMWF forecast fields demonstrates the sensitivity of model accuracy to Tsurf and CWV







Regional desert dust forecasting system

Observations

- Use 550nm aerosol optical depth derived from SEVIRI
- **R** is assumed to be diagonal (rms error =0.37 from comparisons with AERONET)

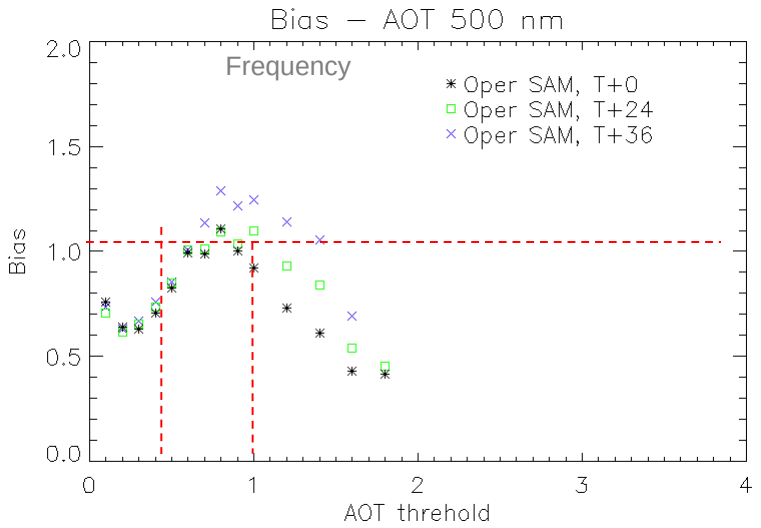
Data assimilation

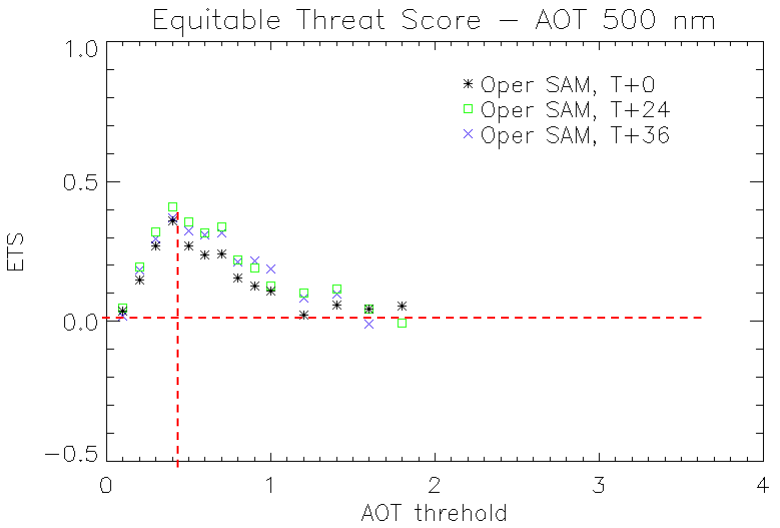
- Approach follows ECMWF's *[Benedetti et al. 2009].*
- Research system only (3d-var, LAM)

Standard diagnostics

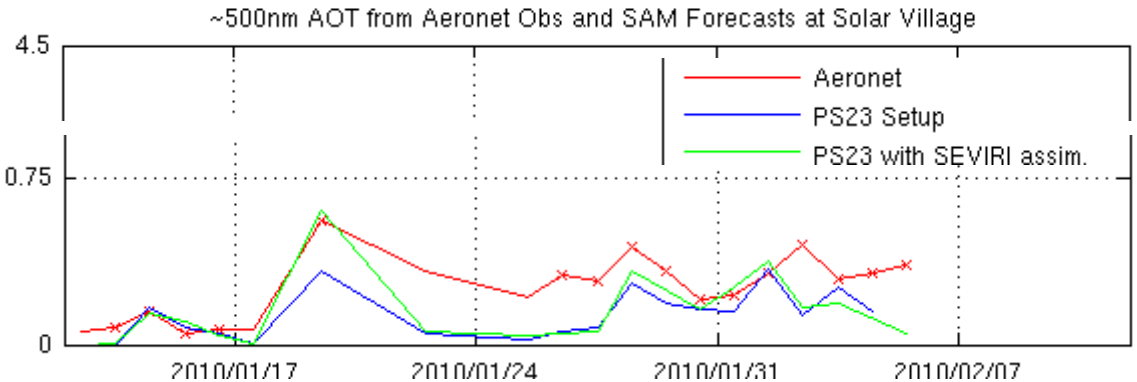
Various comparisons with AERONET have been considered

forecast



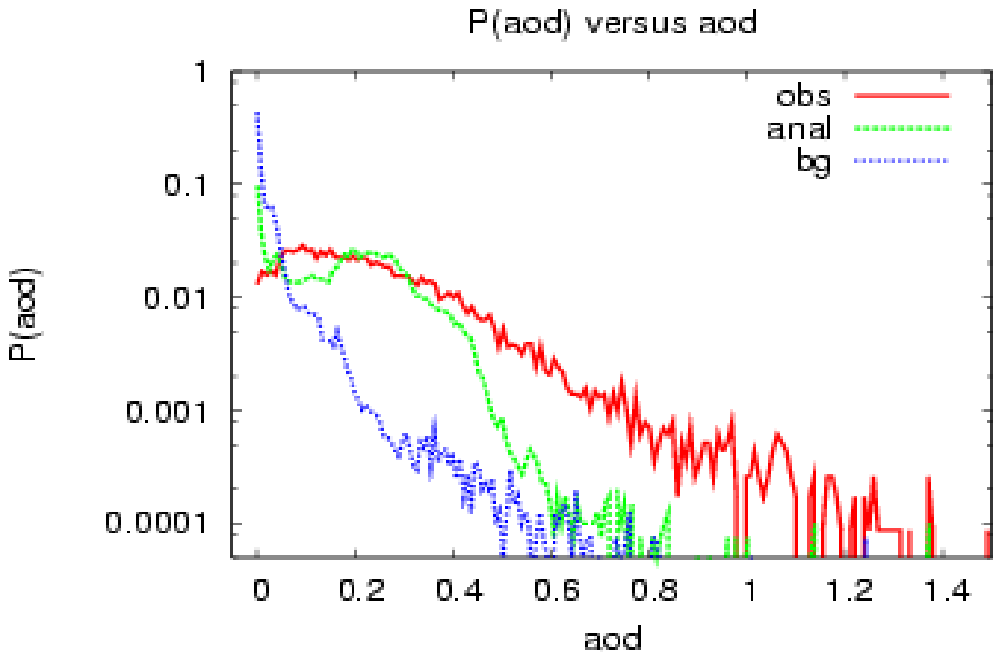


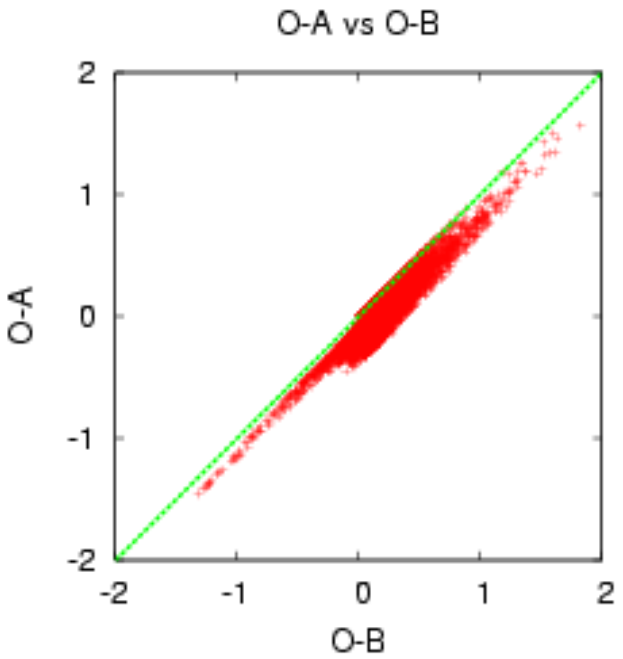
with DA



Other diagnostics

Single-cycle results: 23-Jan-2010





- Analysed pdf is intermediate between analysed and observed pdfs.
- fails to capture long tail

- Analysis error is smaller than background error for O-B>0

Summary

Please take home the following points

- Dust forecasts now an operational product in SAM.
- Working towards including aerosols in global NWP.
- Model validation crucial to the continual development and improvement of aerosol products.
- Highlighted need for informative verification metrics.

Questions