

# **On the definition of a benchmark test for global dust models**

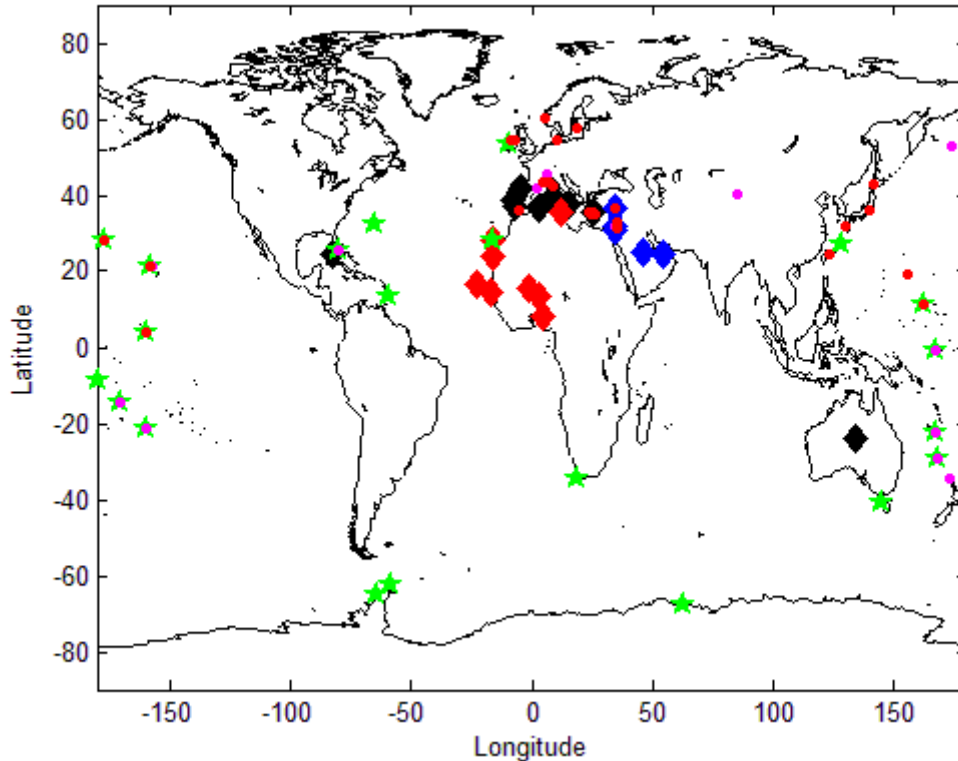
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# Setup

- Goal: Define a benchmark to evaluate model performance and/or improvement of the dust cycle
- AeroCom A Models + ECMWF GEMS
- Year 2000 (AeroCom) & 2003 (ECMWF)
- Surface concentration, Total dust deposition, Optical depth & Angström exponent
- Monthly Averages (Surface concentration, Optical Depth & Angström esponent)
- Yearly Average (Dust deposition)
- Measurment years: 2000 & 2003 (AERONET) and climatological (all)

# Measurement Networks



Surface Concentration  
(AEROCE, Univ. Of Miami)



Optical Depth 550 nm  
(AERONET)



Angström Exponent  
(AERONET)



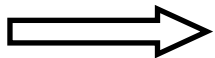
Dust Deposition  
(Ginoux et al, 2001)



Dust Deposition  
(F. Dulac)



Dusty sites: AERONET Sites with a predominance of dust in the total optical depth during most of the year (at least 4 month)



African sites (red) & Middle east (blue)

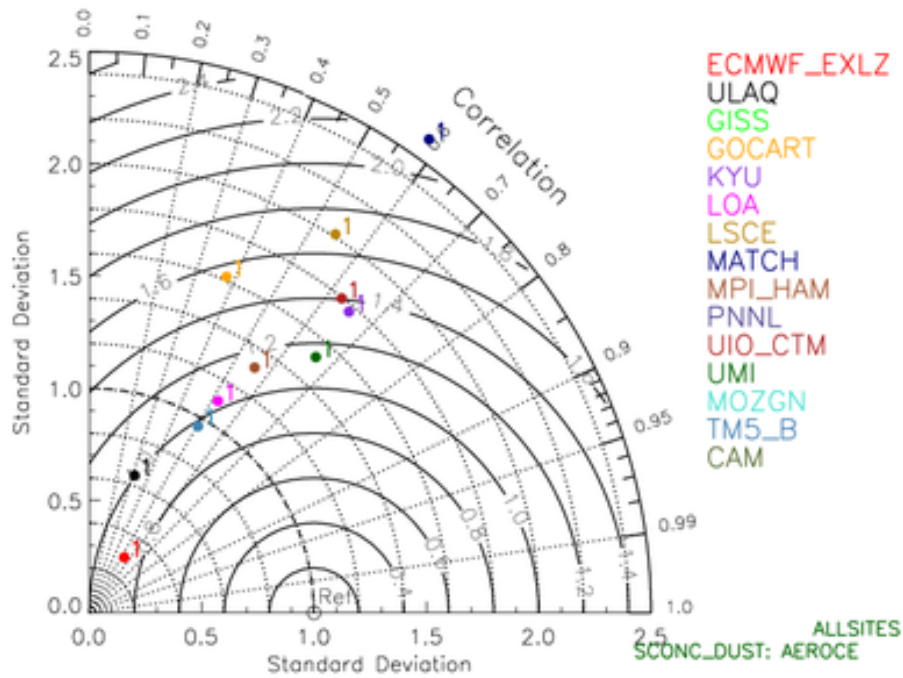
# Statistical Parameters

```
ECMWF_EXLZ 2003 AERONET_sun_2.0 2003
only Stations below 500m
# of valid observations:          1082
OBS mean                          0.229
MODEL mean                        0.252
Spearman Rank Correlation         0.666
Pearson Correlation Coefficient   0.661
Spatial yearly mean Corr Coeff   0.682
Seasonal Anomaly Corr Coeff     0.748
RMS error                         0.138
Slope fit forced through zero    0.906
Regression coefficient, Slope     0.891
Regression Constant, Offset:     0.005
STDDEV(Model)/STDDEV(Data):      0.742
Score (mean relative bias )      44%
Taylor Score                      0.800
```

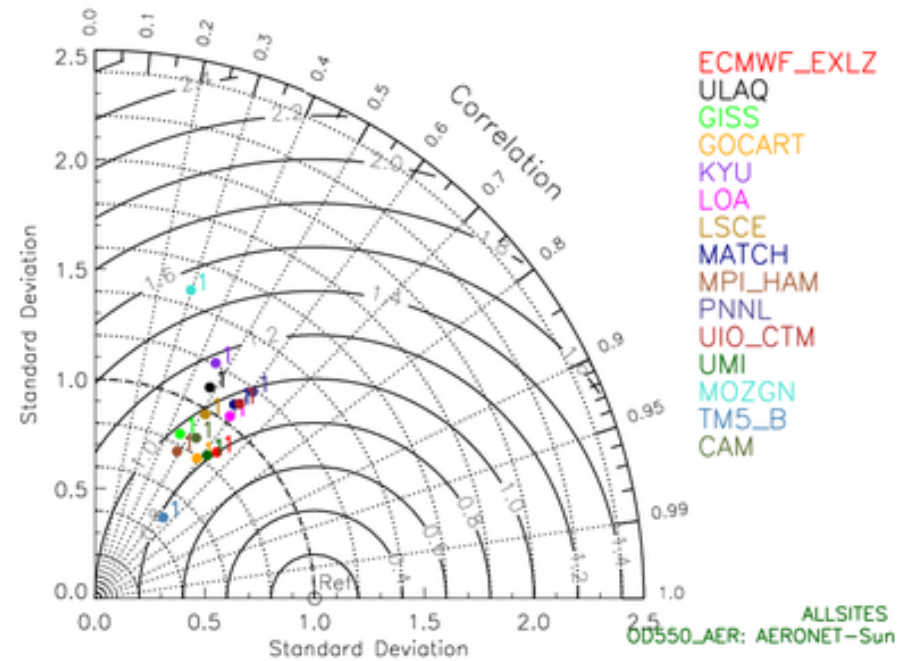
+           Relative Error  
            Grade

<http://nansen.ipsl.jussieu.fr/AEROCOM>

# Model-Observation comparison

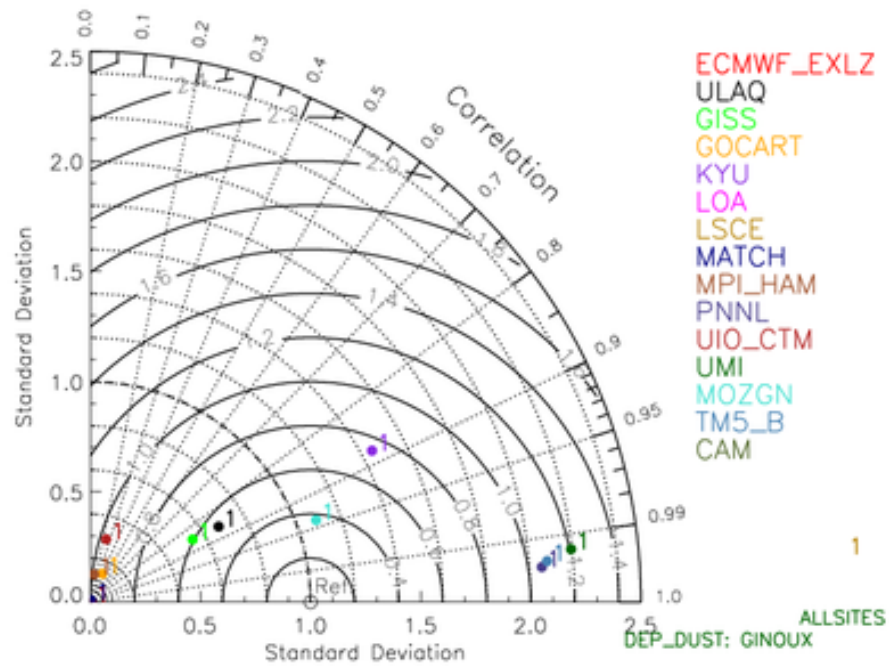


Surface concentration

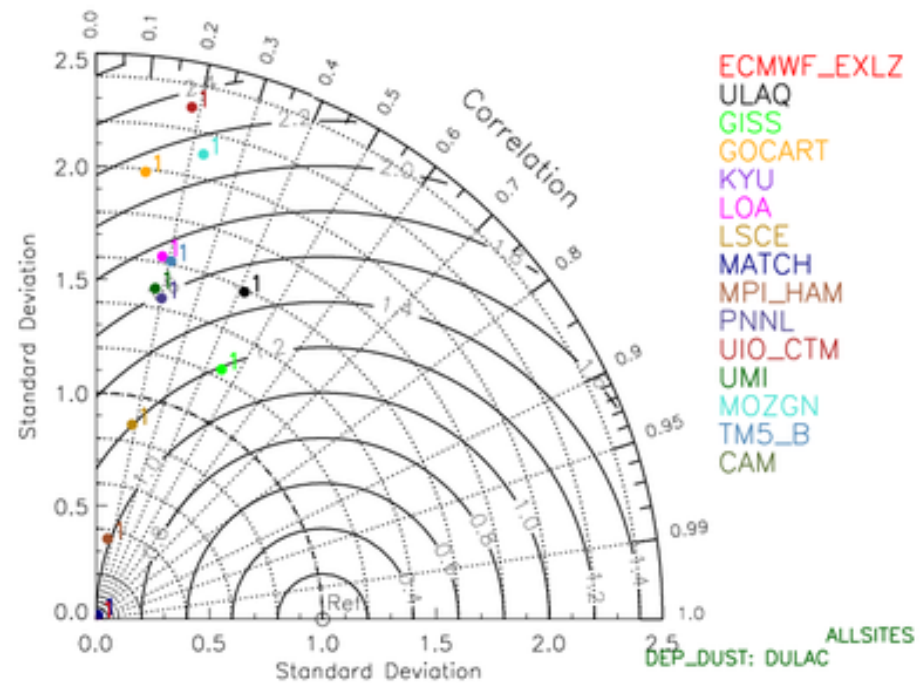


Optical Depth  
(Climatology)

# Model-Observation comparison



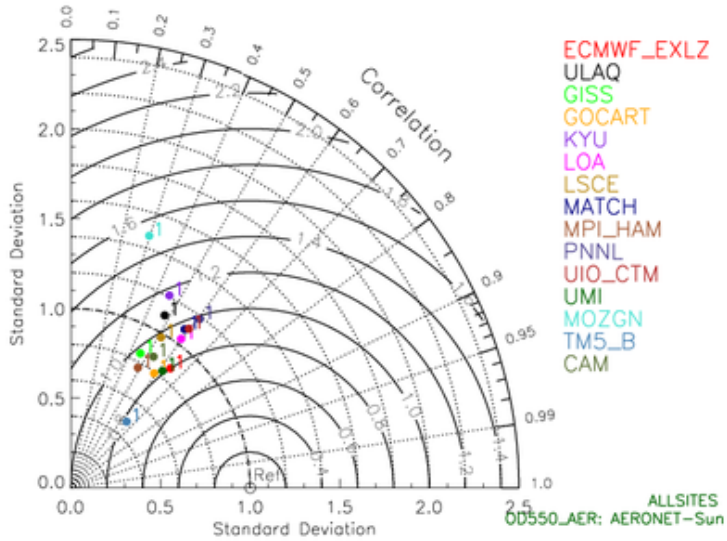
Dust Deposition (Ginoux)



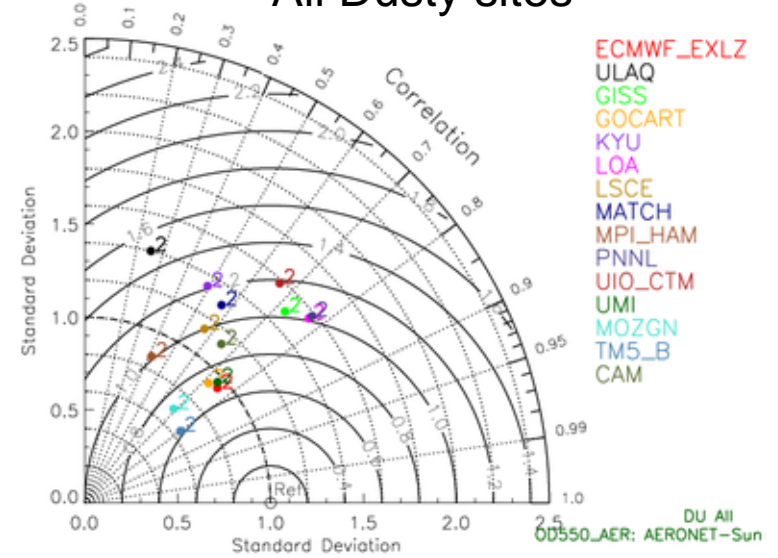
Dust Deposition (Dulac)

# Dusty Sites analysis: Optical Depth

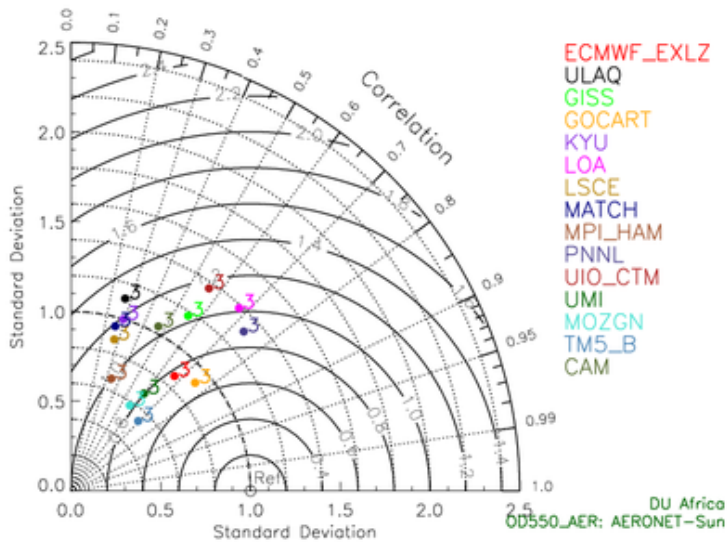
## All Aeronet sites



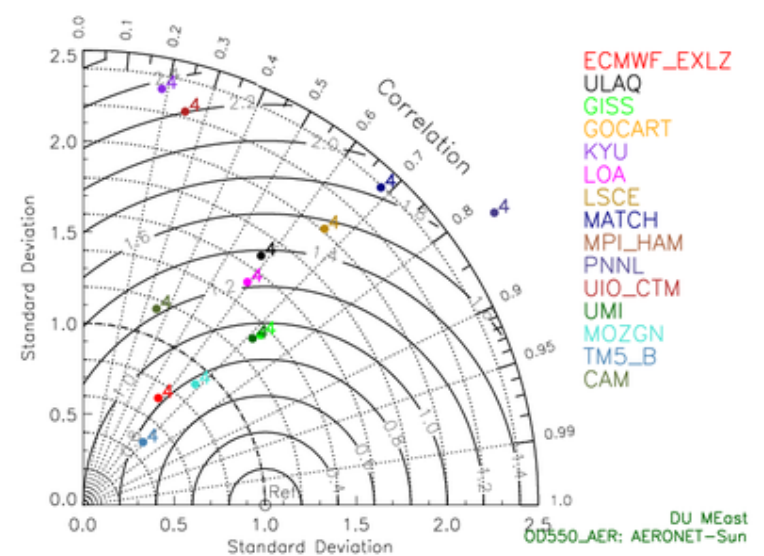
## All Dusty sites



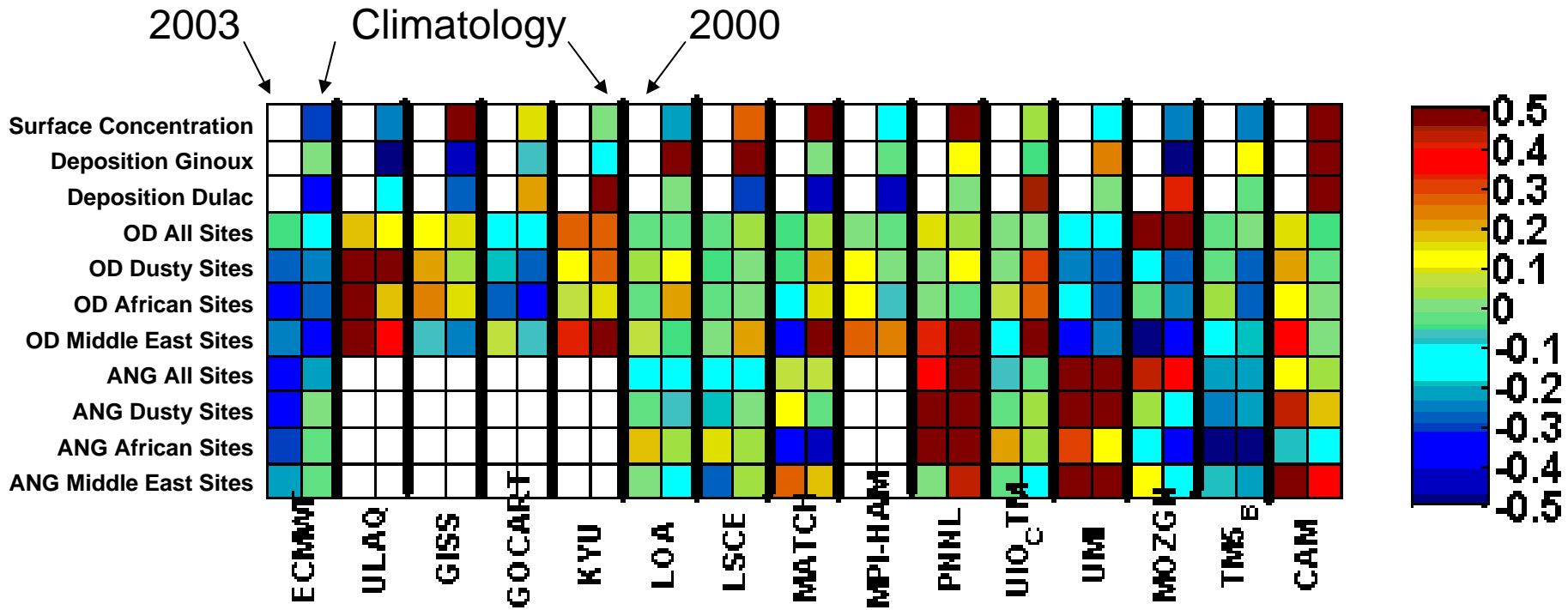
## African sites



## Middle East sites



# Relative Error Score



$$S_i = \frac{RMS_i - RMS_{ref}}{RMS_{ref}}$$

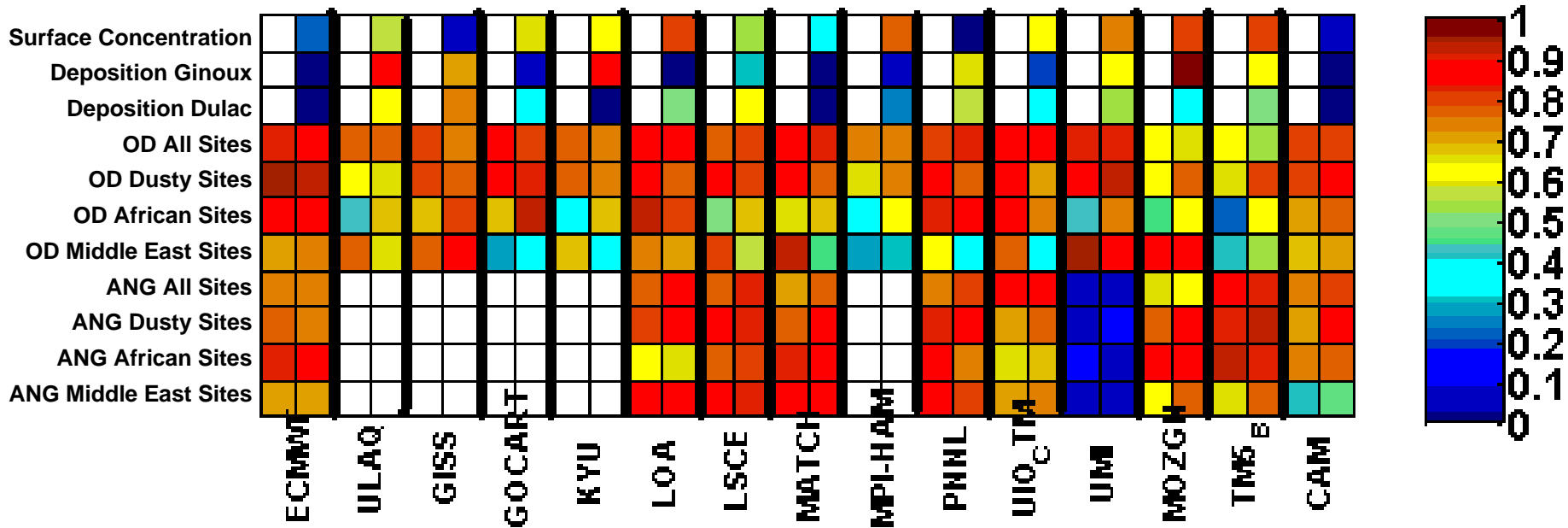
$RMS_i$ : RMS of model  $i$

$RMS_{ref}$ : Median RMS of the 15 Model RMS errors

Approach from Gleckler et al. (2008)



# Taylor Score



$$S = \frac{4(1 + R)}{(1 + R_x)(\sigma + \sigma^{-1})^2}$$

$R$ : Correlation

$R_x$ : Maximal attainable correlation

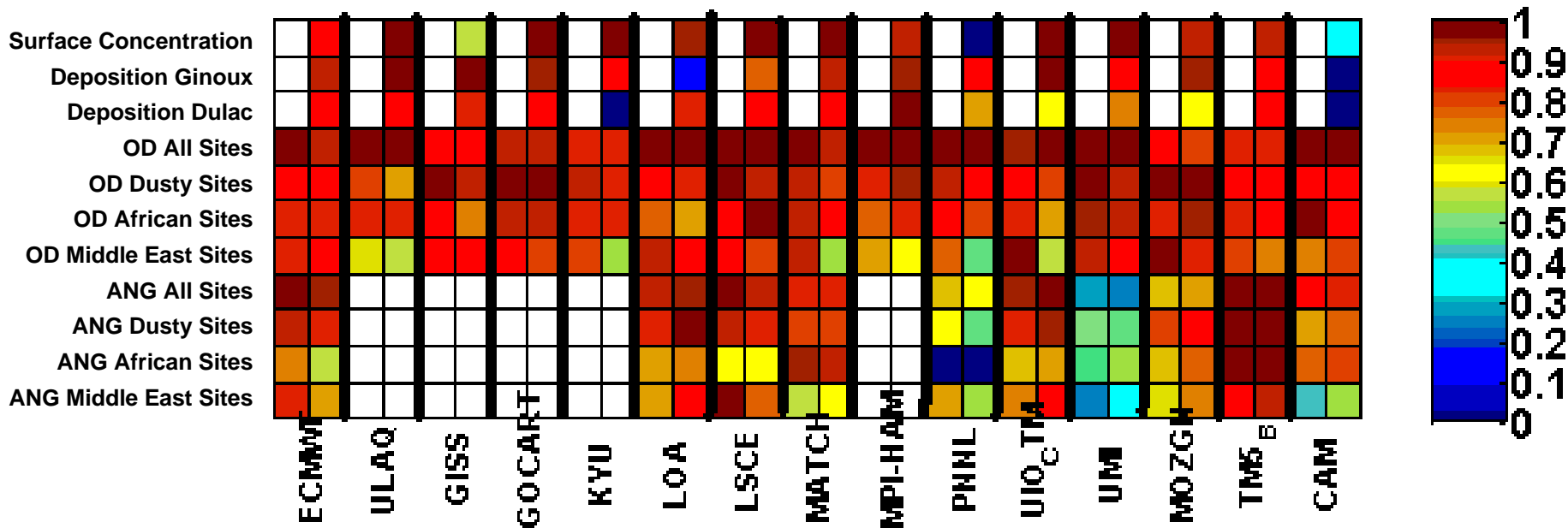
$$\sigma = \sigma_M / \sigma_O$$

$\sigma_M$  = Model Standard deviation

$\sigma_O$  = Observation Standard deviation

Taylor (2001)

# Grade Score



Approach from Waugh and Eyring (2008)

$$S_i = 1 - \frac{1}{n_g} \frac{|\overline{M} - \overline{O}|}{\sigma_{obs}}$$

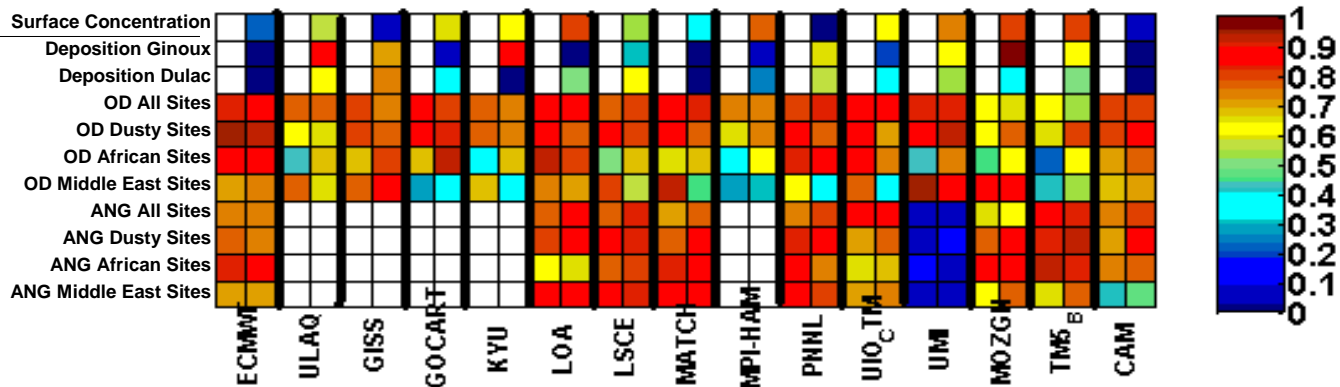
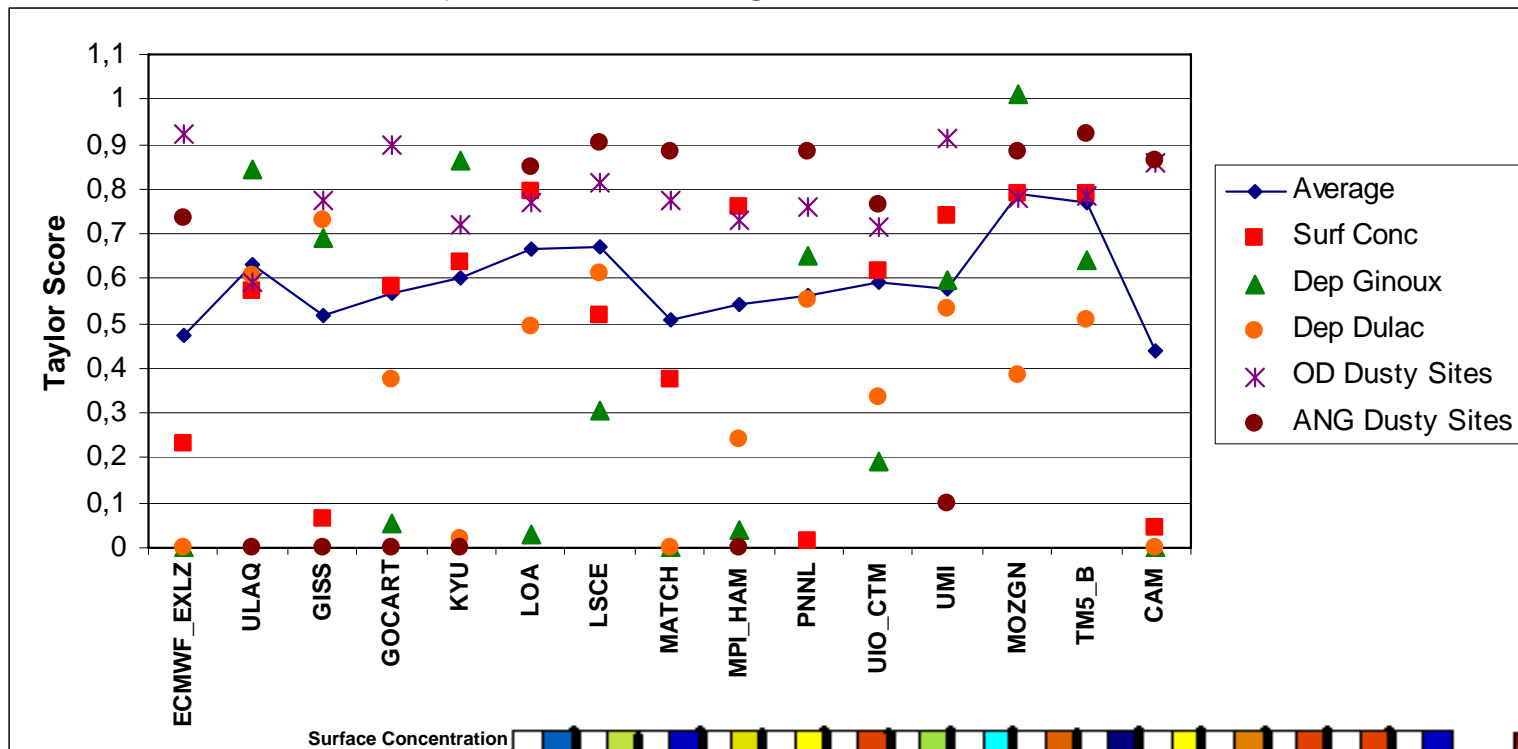
$\overline{M}$  = Model mean

$\overline{O}$  = Observation mean

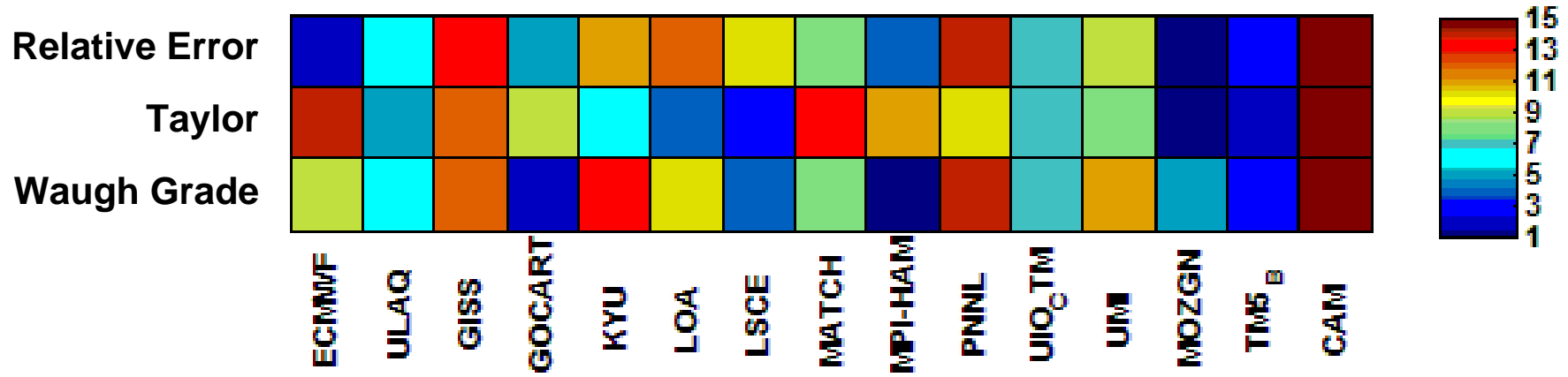
$n_g$  = scaling factor

# Average Taylor score

Average Taylor score: Average from surface concentration & Dust deposition & Optical depth at dusty sites and Angström exponent



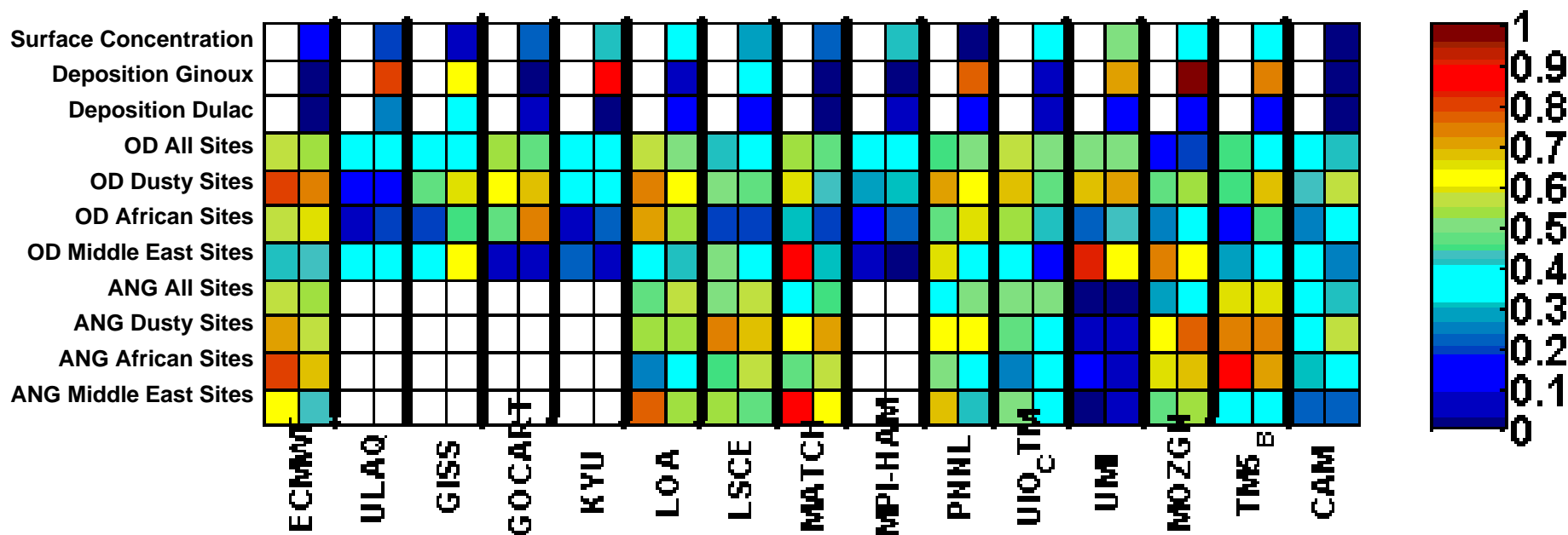
# Model Ranking



# Summary/Conclusions

- AeroCom & ECMWF models were compared to surface and integrated measurements.
- Model performance was tested through different scores.
- Better overall performance in optical depth and angström performance than with surface concentration and dust deposition.
- Performance is score dependant.
- No model outperforms all the other ones in all analyzed parameters.
- Subjective definition of average model score. It can hide large spread in variable to variable performance.
- Model ranking is sensitive to the definition of the score.

# Taylor 2 Score



$$S2 = \frac{4(1+R)^4}{(1+R_x)^2(\sigma + \sigma^{-1})^4}$$

Models with low correlation are penalized