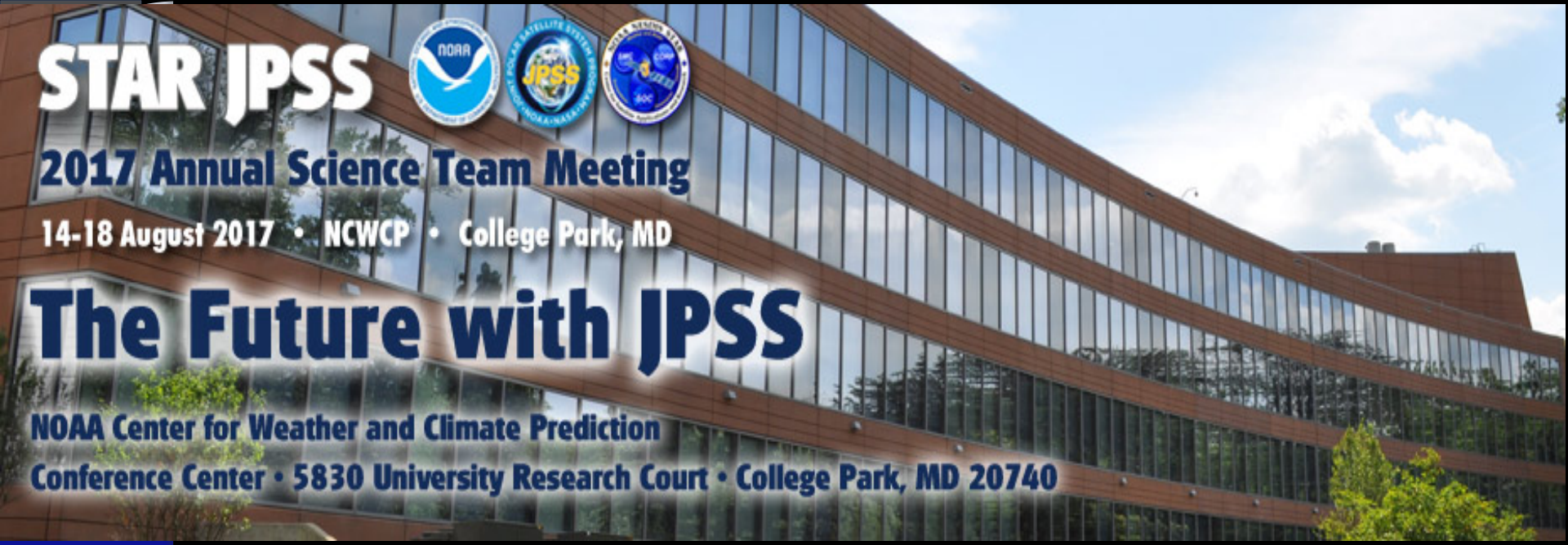
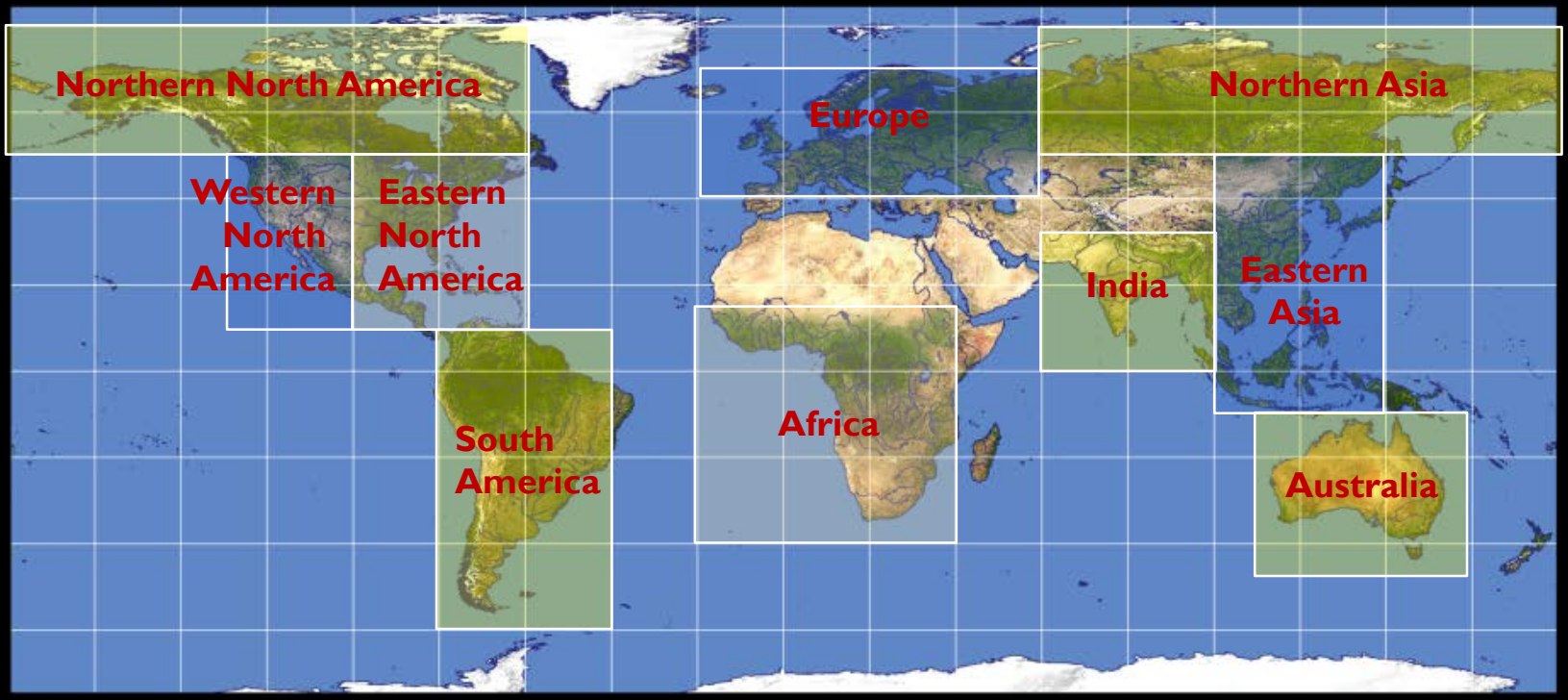


Potential Updates of the Land Aerosol Models for the EPS AOD Algorithm

Hongqing Liu

and NOAA STAR Aerosol Cal/Val Team

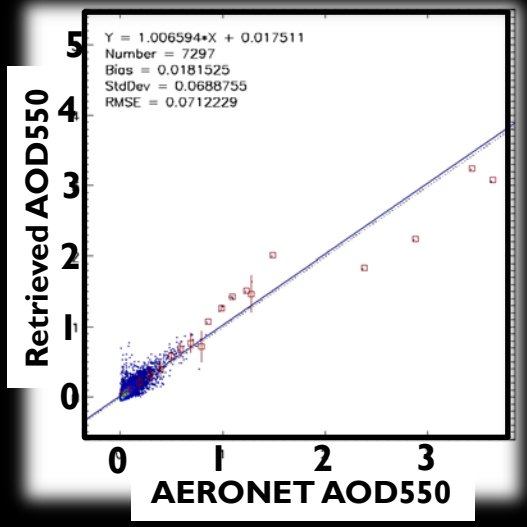
Evaluation Regions



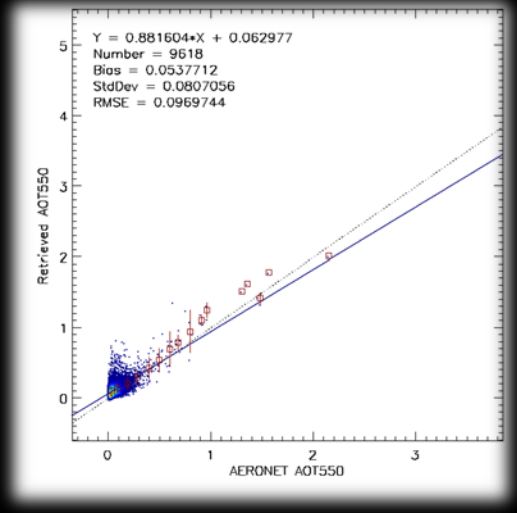
Domain	Longitude	Latitude
Northern North America	180° W - 60° W	50° N - 80° N
Northern Asia	60° E - 180° E	50° N - 80° N
Europe	20° W - 60° E	40° N - 70° N
Western North America	130° W - 100° W	10° N - 50° N
Eastern North America	100° W - 60° W	10° N - 50° N
South America	80° W - 40° W	60° S - 10° N
South Africa	20° W - 40° E	40° S - 15° N
India	60° E - 100° E	0° - 30° N
Eastern Asia	100° E - 140° E	10° S - 50° N
Australia	110° E - 160° E	50° S - 10° S

Regional Performance (1)

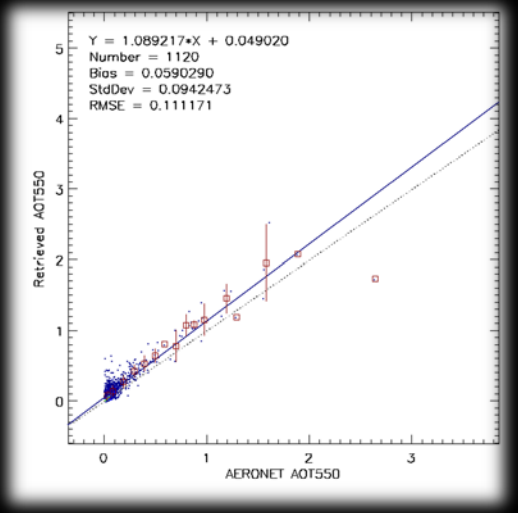
Eastern North America



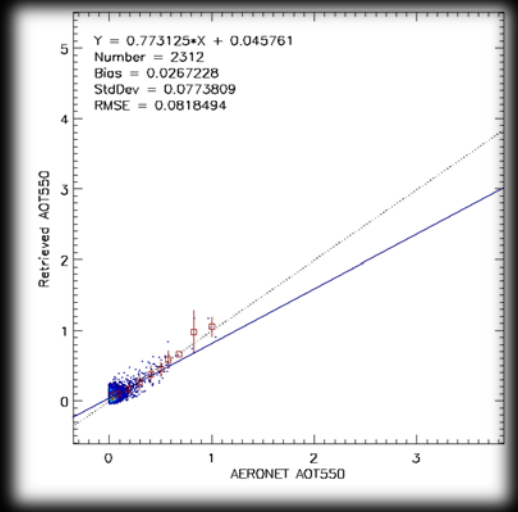
Western North America



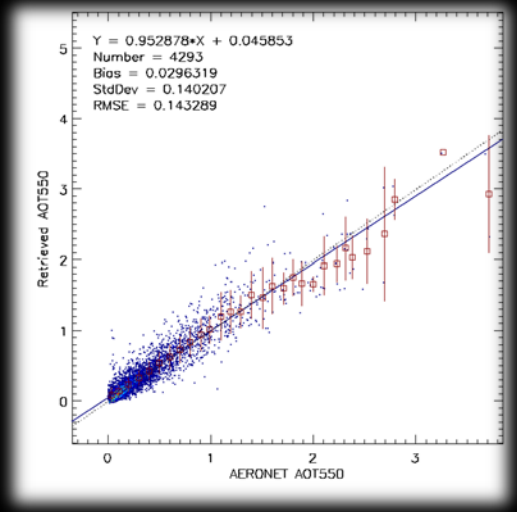
Northern North America



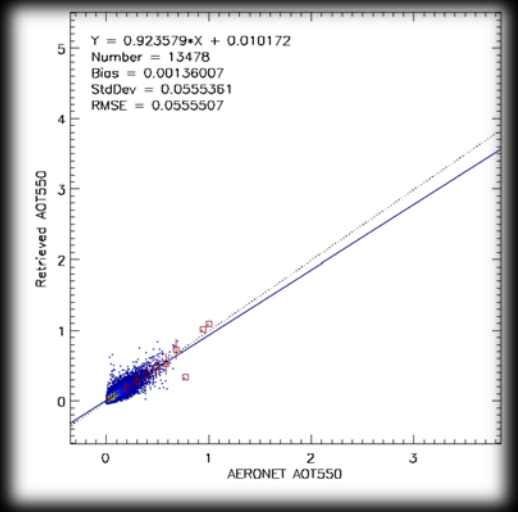
South America



Eastern Asia

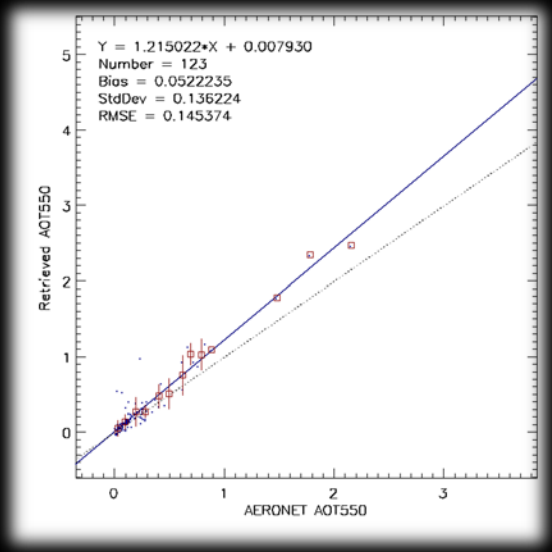


Europe

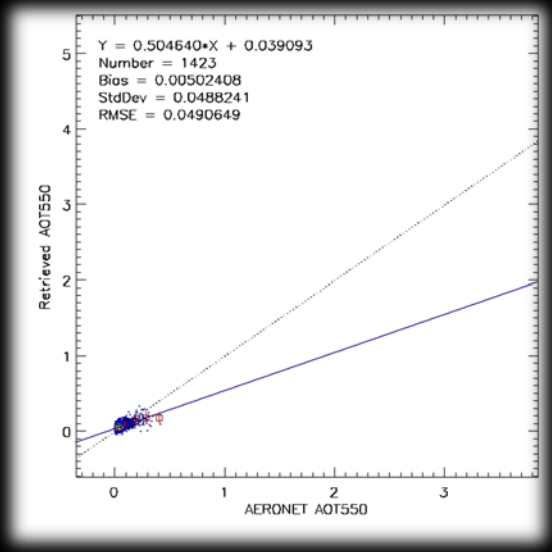


Regional Performance (2)

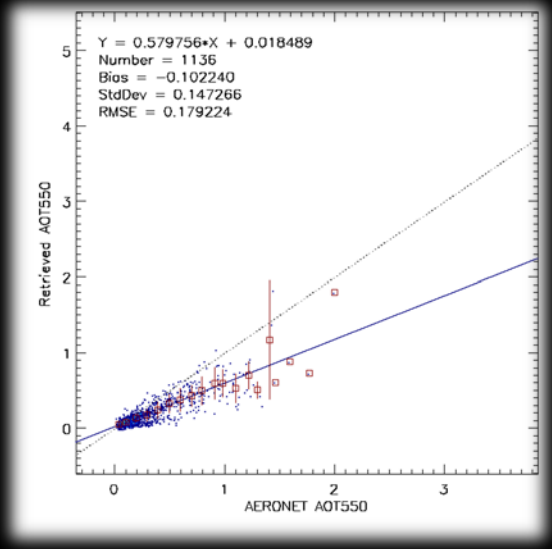
Northern Asia



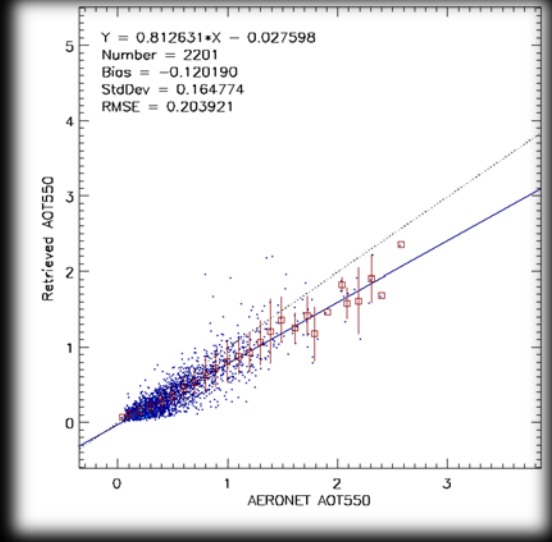
Australia



Africa

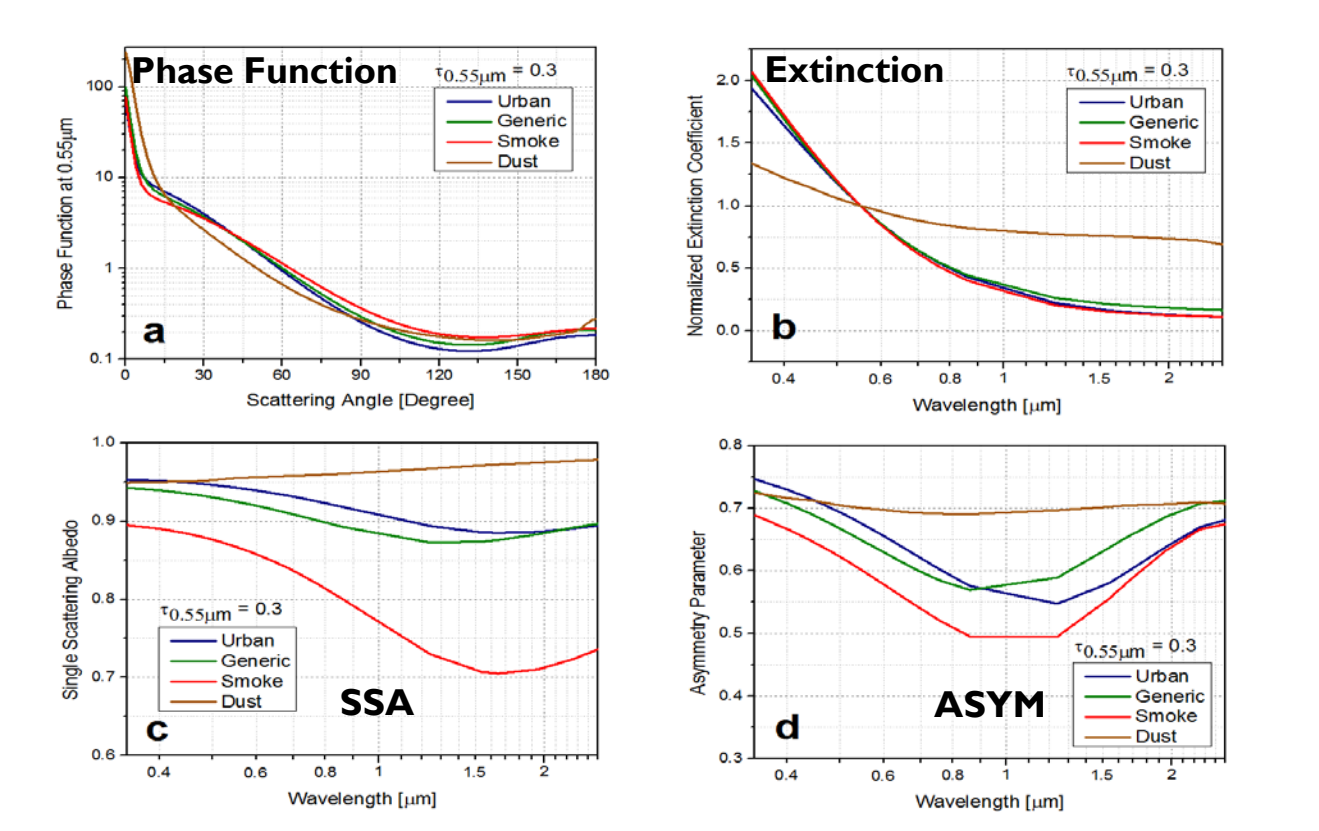


India



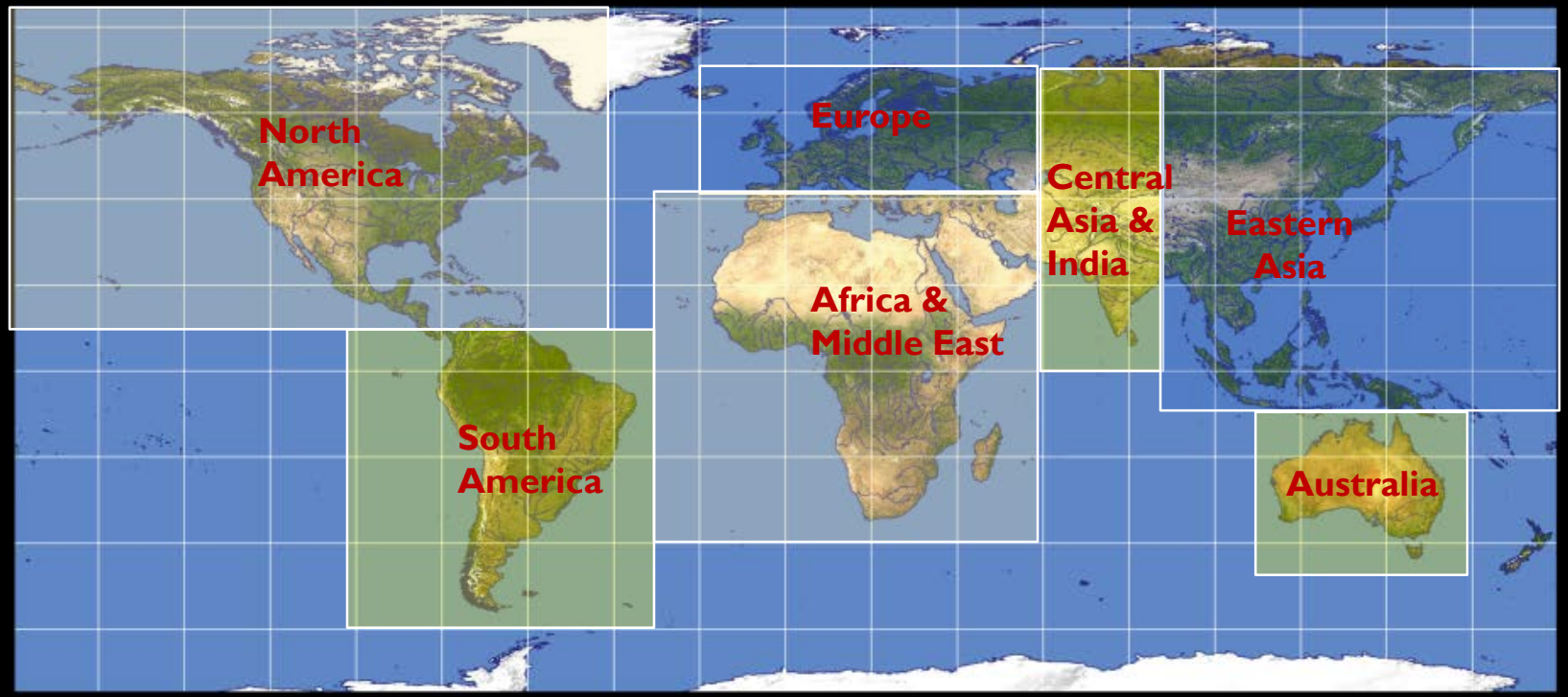
Motivation

- Current land aerosol models (four types) might not be representative enough for global aerosol retrievals
  - Large errors over Africa and India

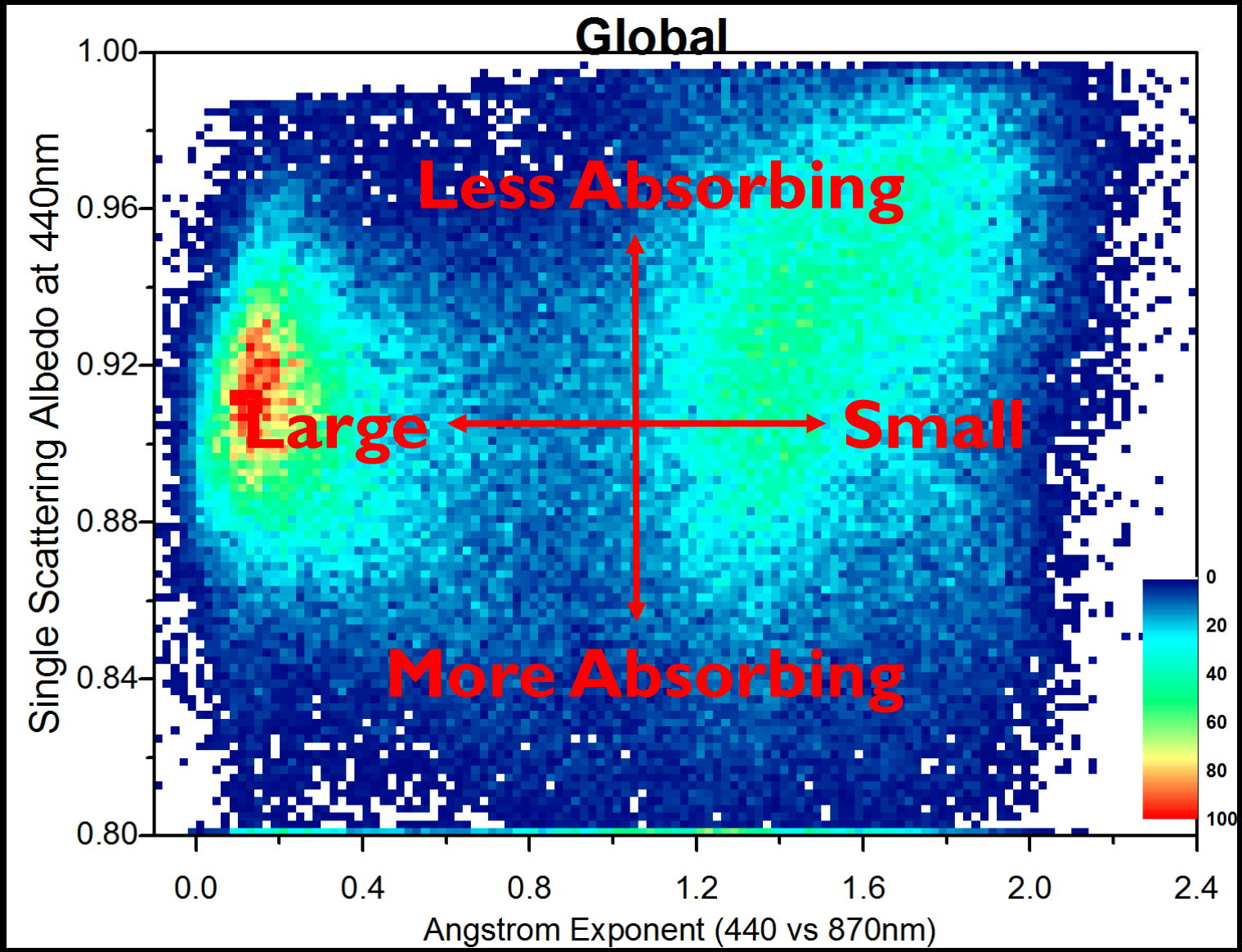


AERONET Inversions

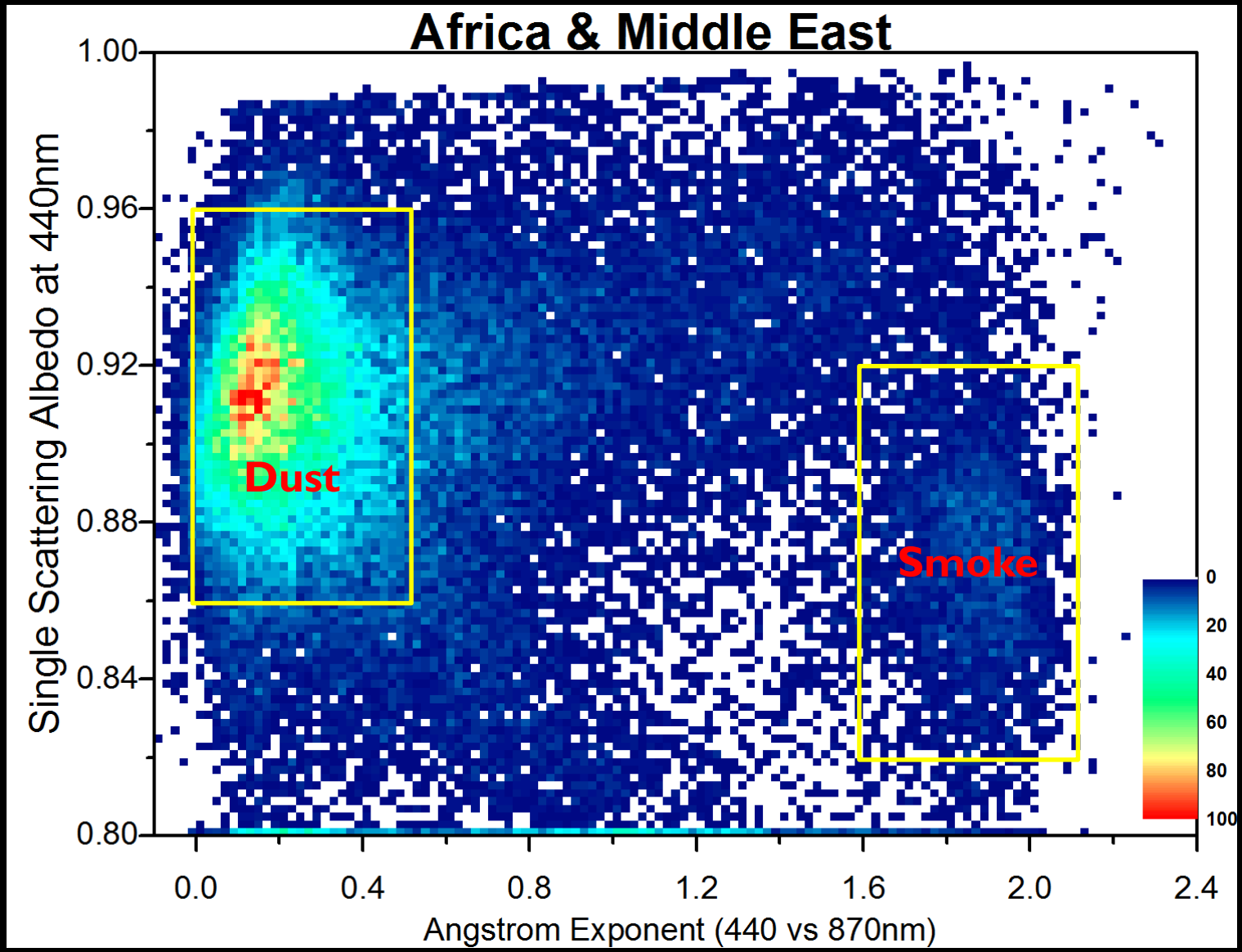
- AERONET Version 2 inversion products
  - Sun photometers measurements in almucantar and principle planes
  - Produce aerosol optical properties: single scatter albedo, size distribution, complex index of refraction, etc.



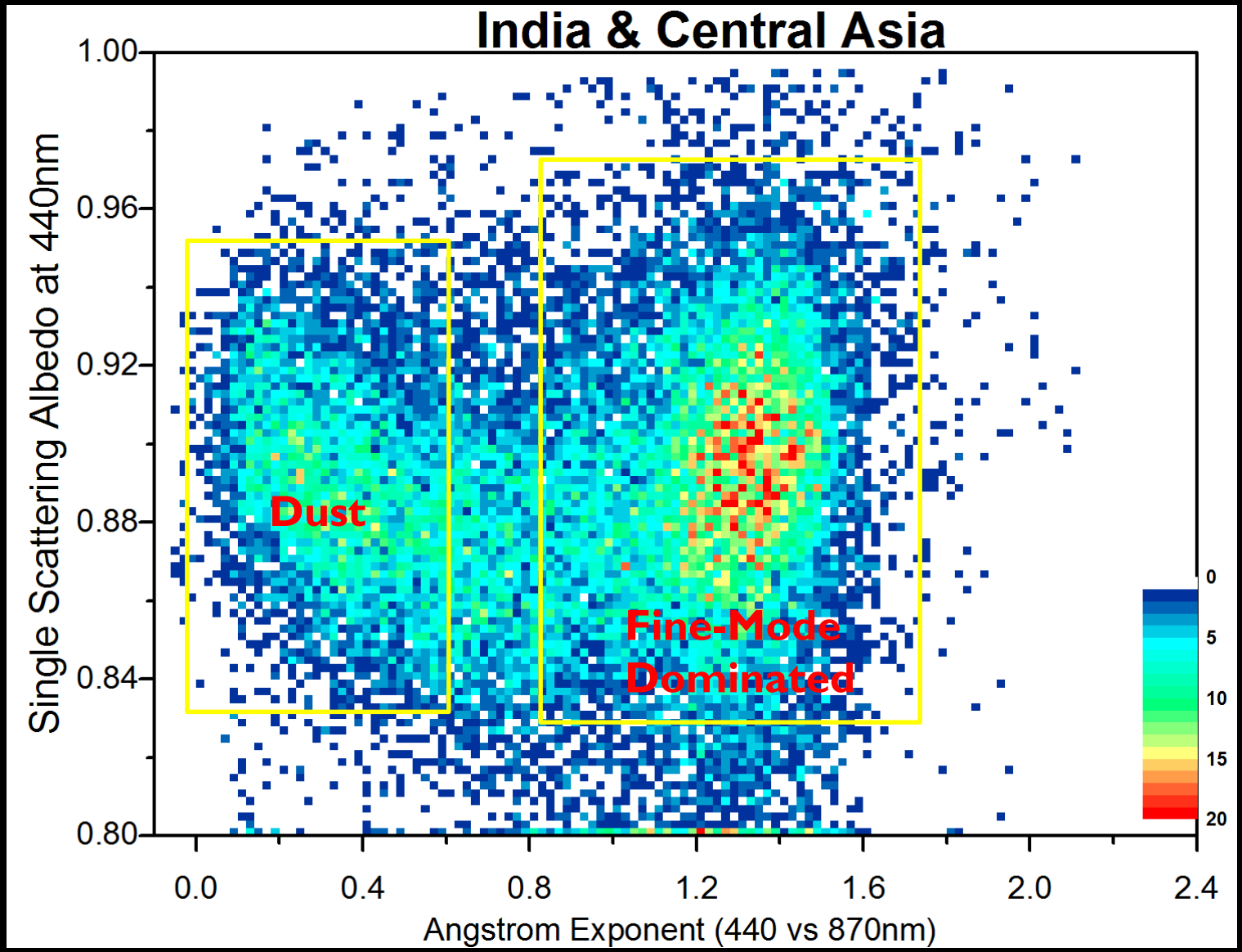
Global Aerosol Properties



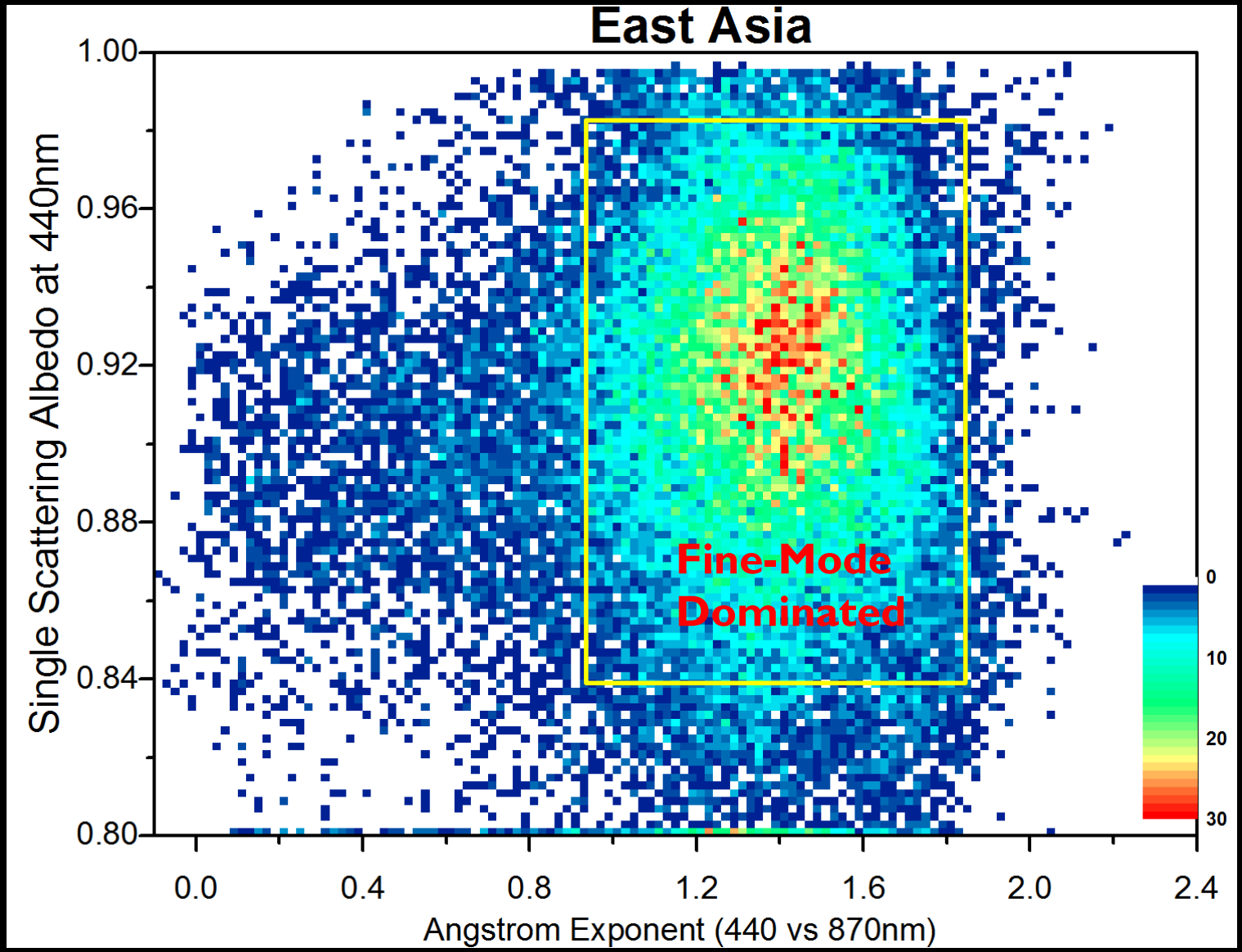
Regional Aerosol Properties (1)



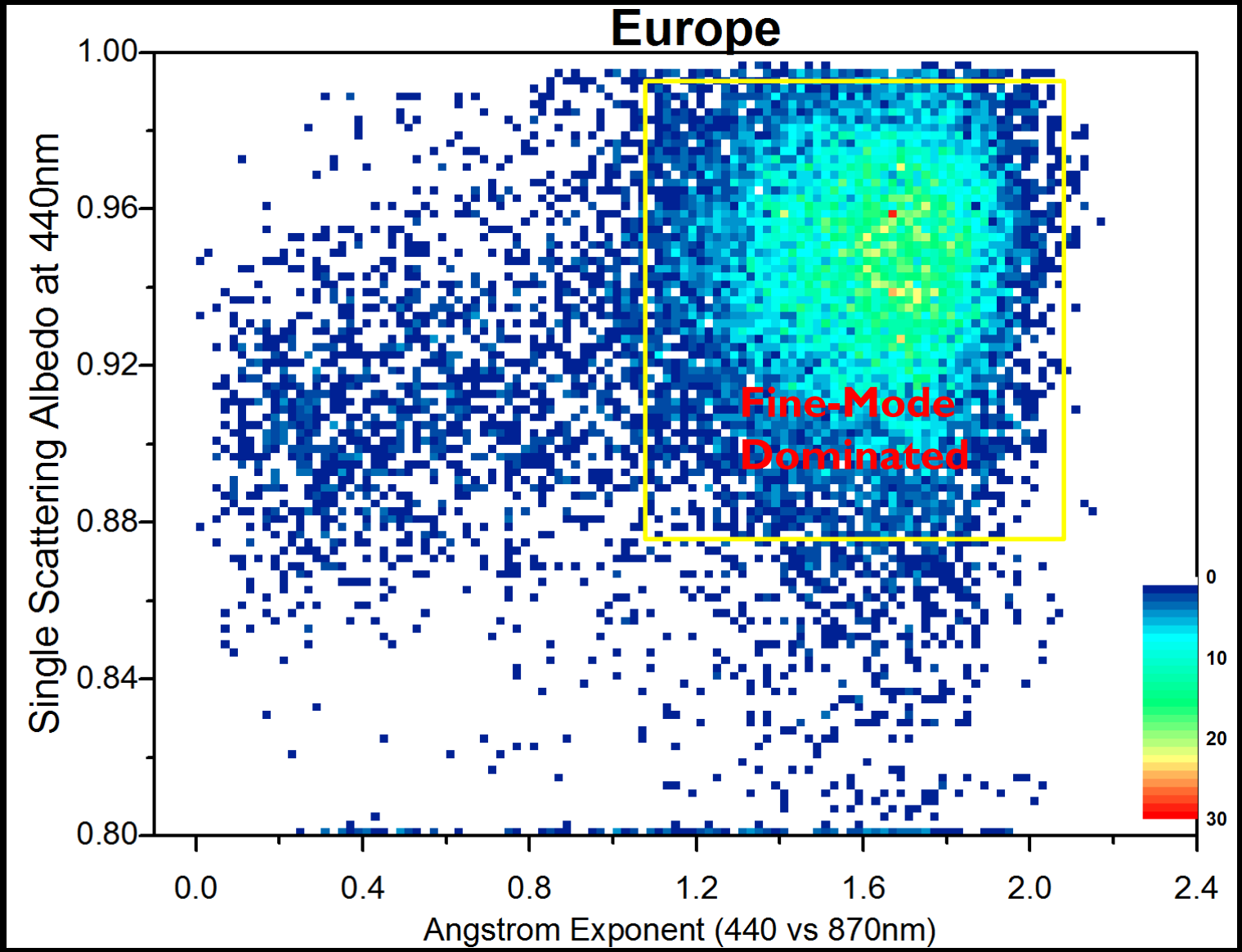
Regional Aerosol Properties (2)



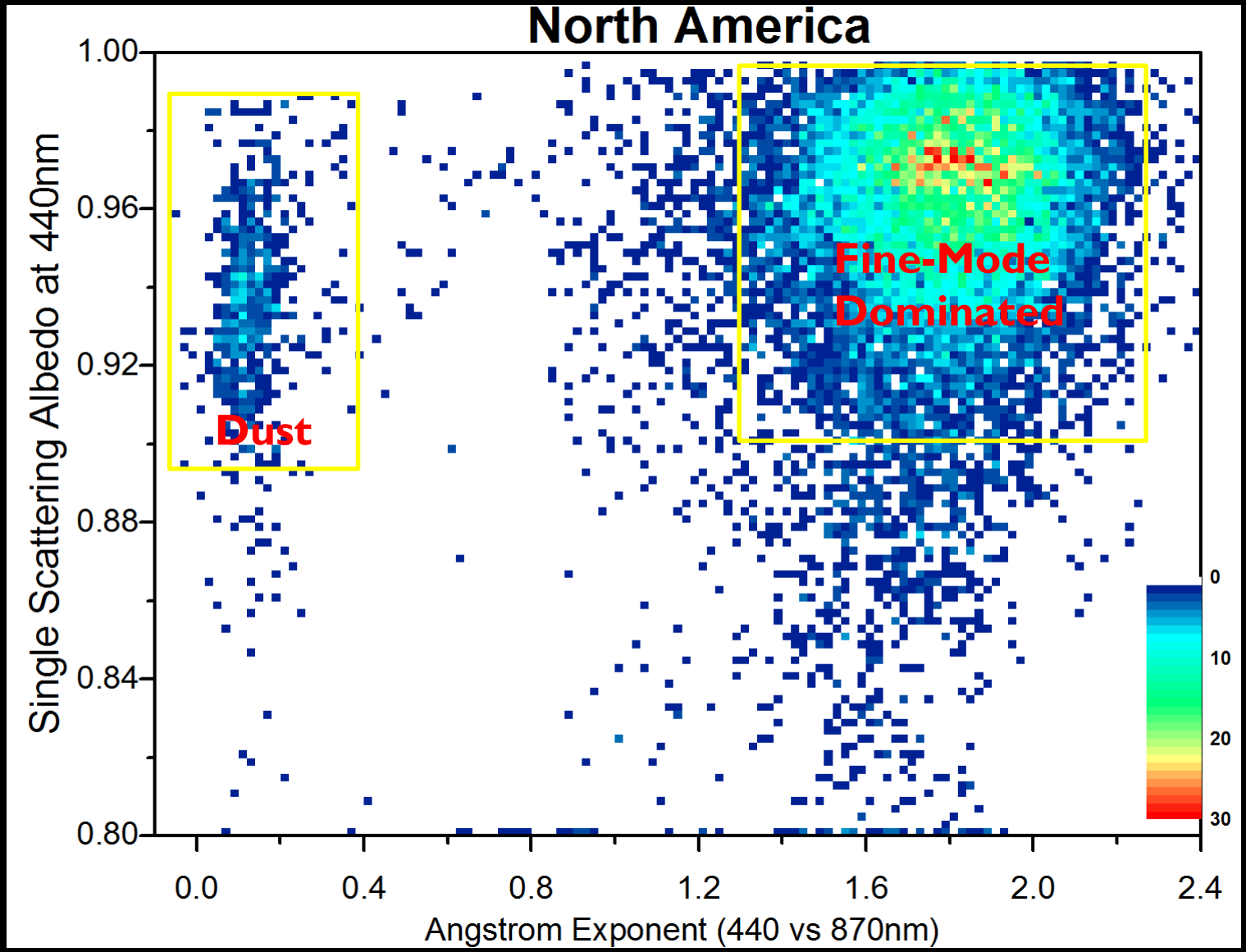
Regional Aerosol Properties (3)



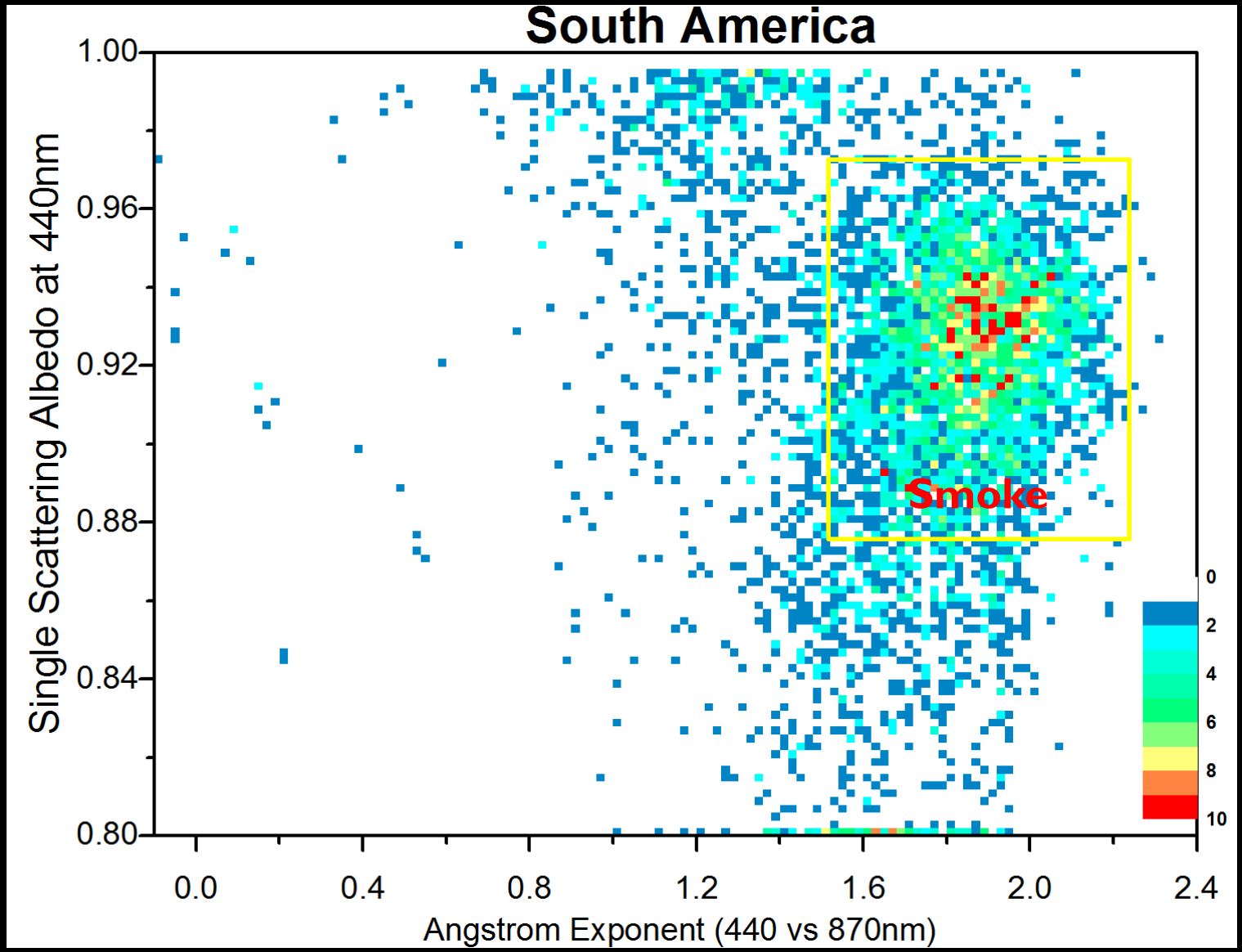
Regional Aerosol Properties (4)



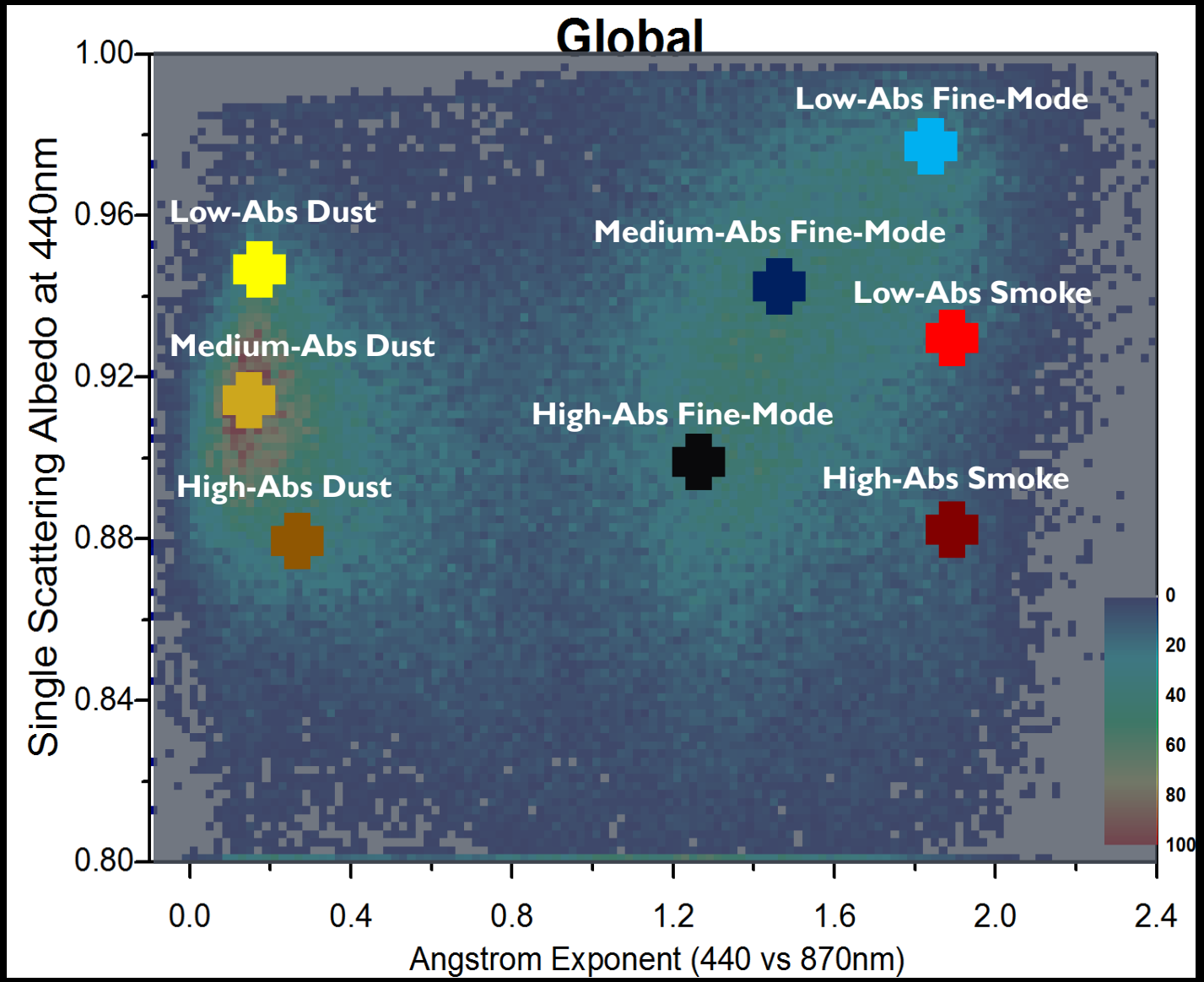
Regional Aerosol Properties (5)



Regional Aerosol Properties (6)



New Aerosol Models

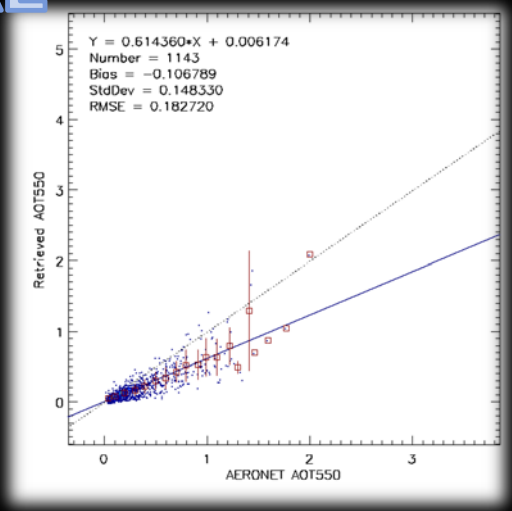


Retrieval (1)

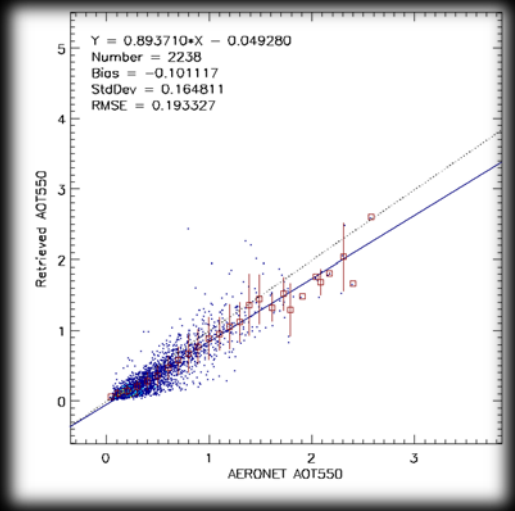
- Generate new lookup table with new land aerosol models and apply to the EPS AOD algorithm
  - Retrieval bias is reduced over Africa and India

BEFORE

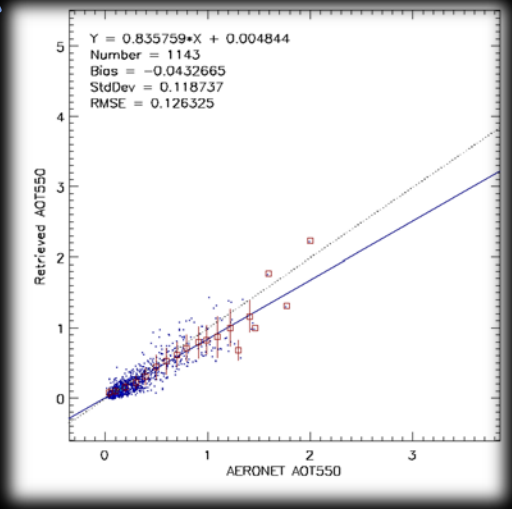
Africa

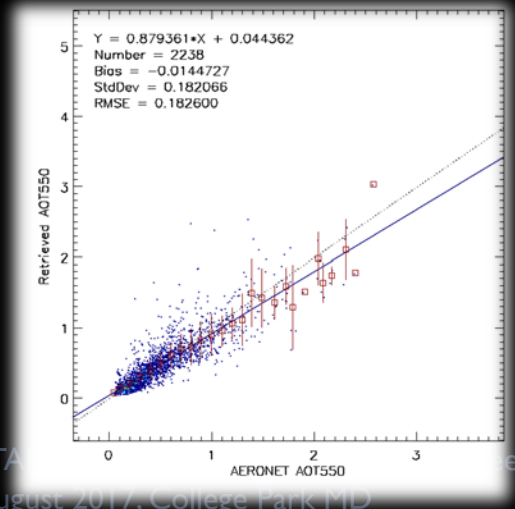


India



AFTER



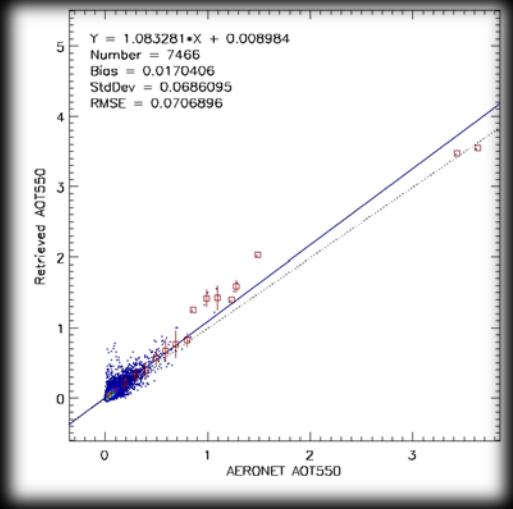


Retrieval (2)

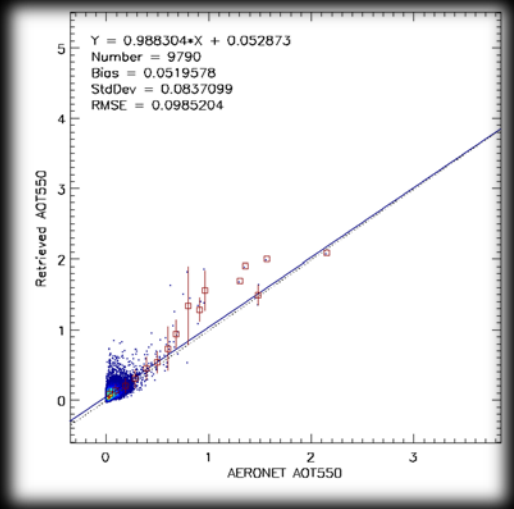
- But not so over other areas
  - Difficulty of picking right aerosol model at low AOD

BEFORE

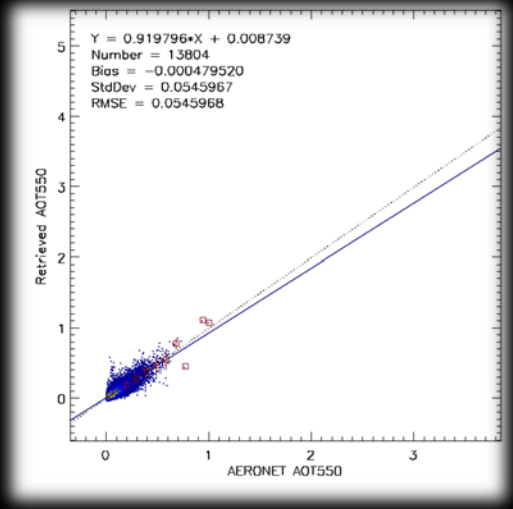
Eastern NA



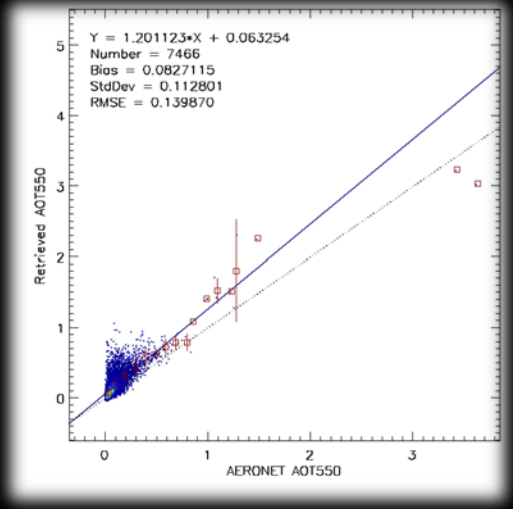
Western NA

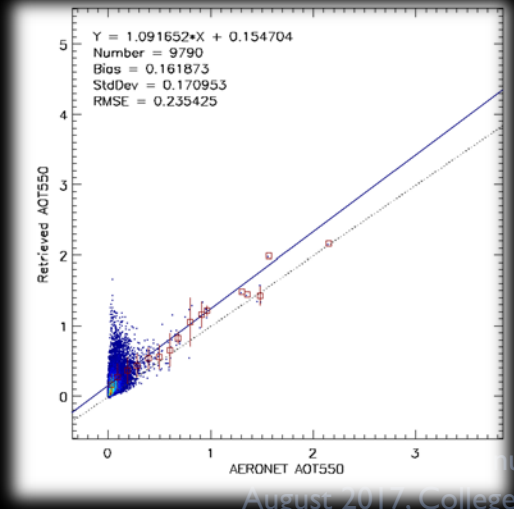


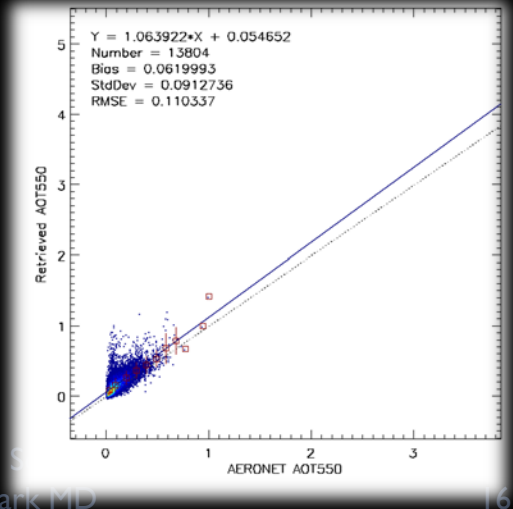
Europe



AFTER

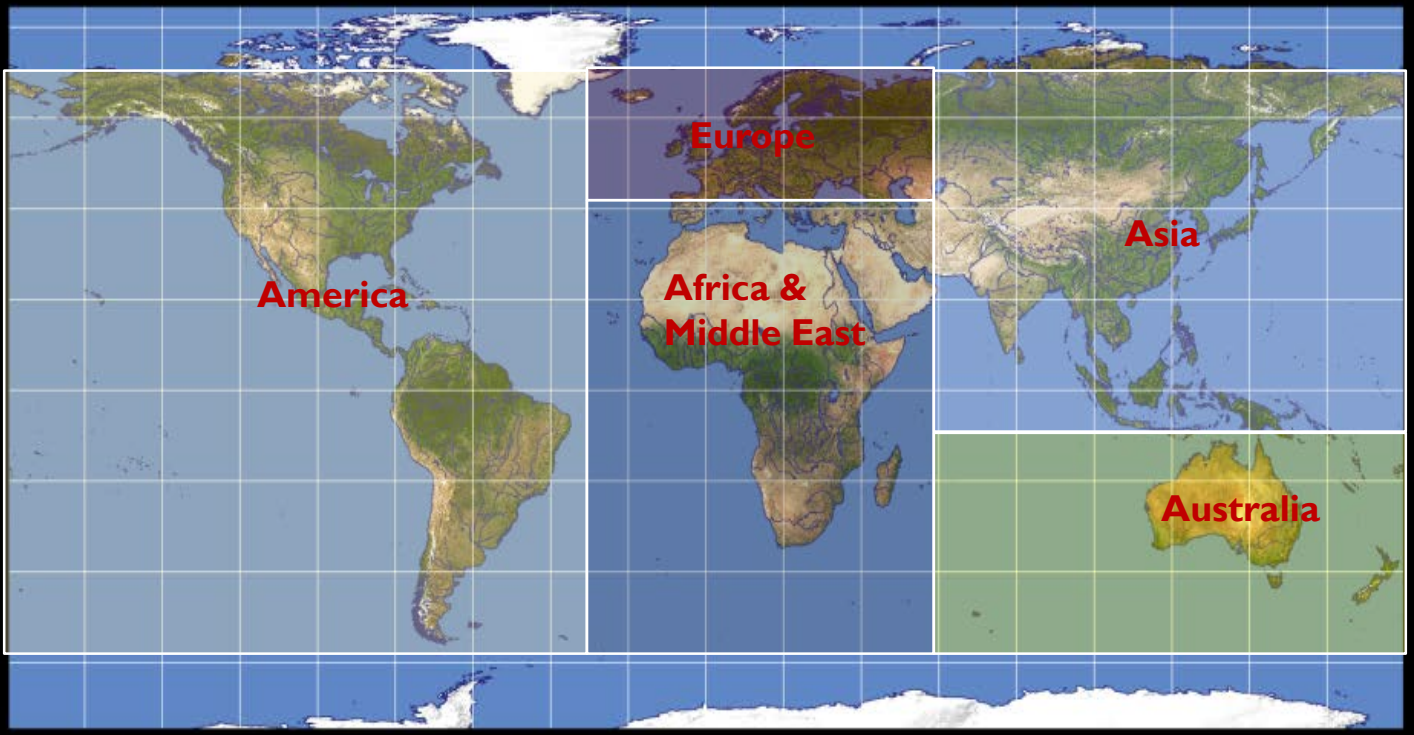






Retrieval (3)

- Candidate aerosol models are specified over land domains.



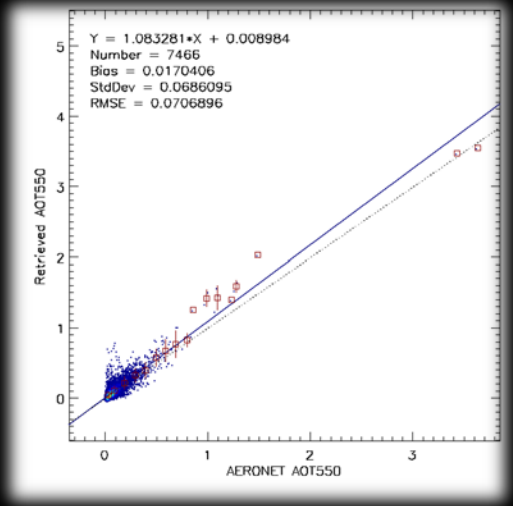
Domain	Longitude	Latitude	Aerosol Models
America	180° W - 30° W	60° S - 70° N	Fine (L,M), Dust (L), Smoke(L)
Europe	30° W - 60° E	40° N - 70° N	Fine (L,M), Dust (L), Smoke(L)
Africa & Middle	30° W - 60° E	60° S - 40° N	Fine(L), Dust(L,M,H), Smoke(L,H)
Asia	60° E - 180° E	10° S -70° N	Fine(L,M,H), Dust(M,H), Smoke(L)
Australia	60° E - 180° E	60° S - 10° S	Fine(L), Dust(L), Smoke(L)
High Latitude	180° W - 180° E	70° N - 90° N 90° S - 60° S	Fine(L)

Retrieval (4)

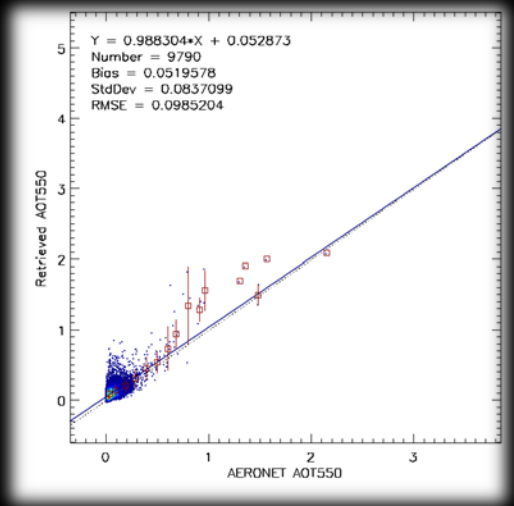
- With regional candidates of aerosol models, improvement is not significant at low AOD

BEFORE

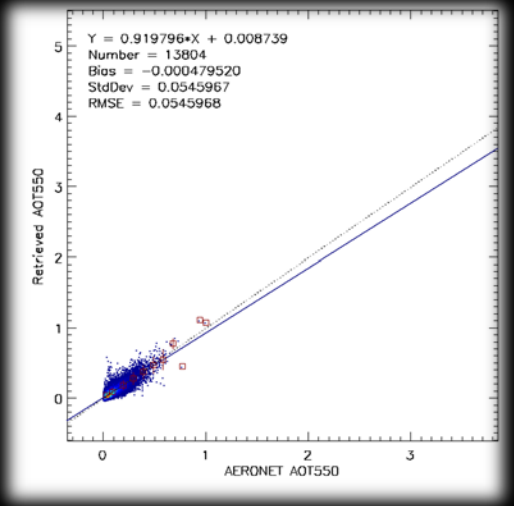
Eastern NA



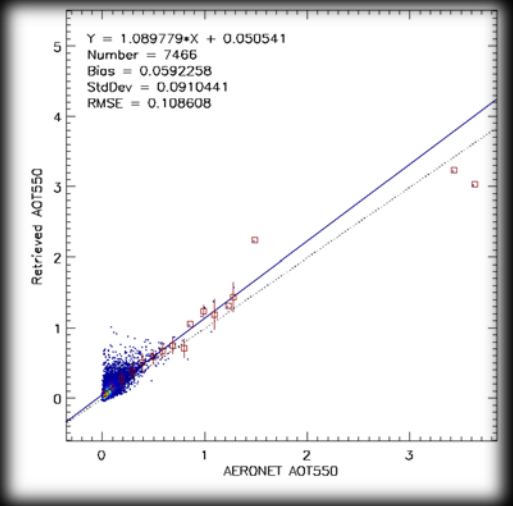
Western NA

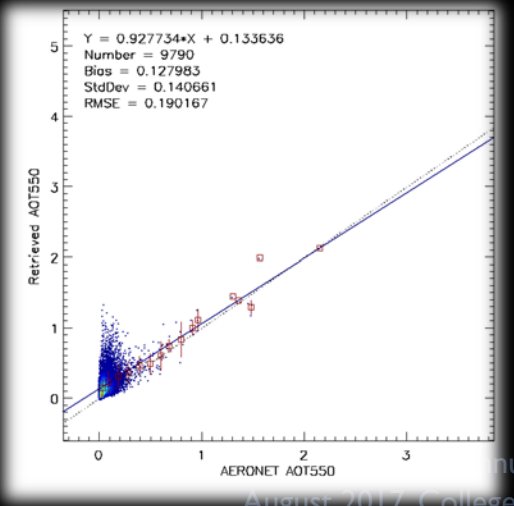


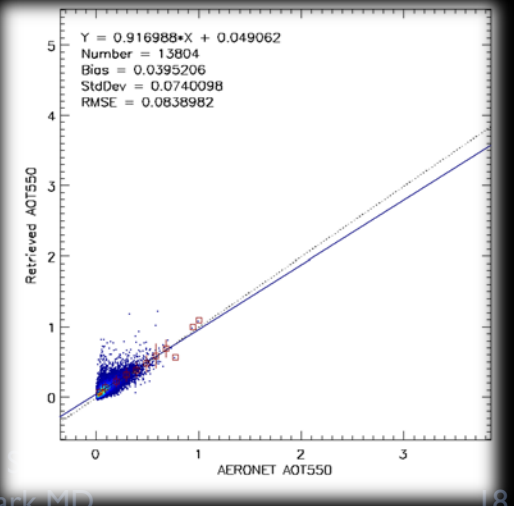
Europe



AFTER





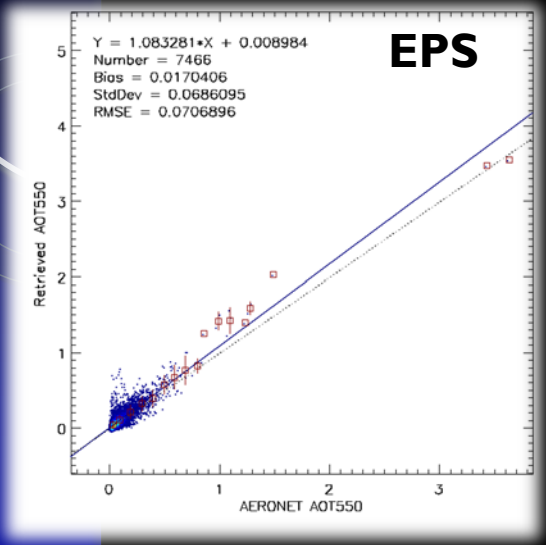


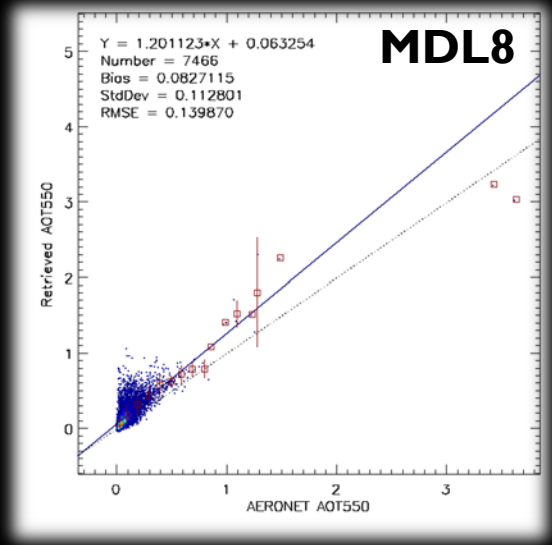
Retrieval (5)

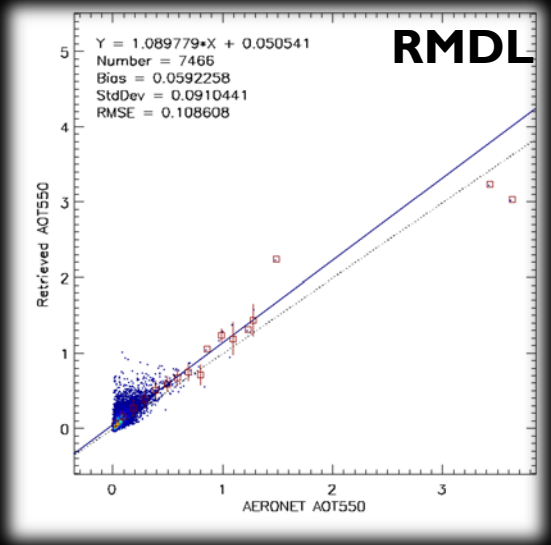
- Over-estimation at low AOD by using new aerosol models
  - Causes: picking absorbing or dust models incorrectly
  - Potential solution: using fine-mode dominated low-absorbing aerosol F(L) model if AOD is low
  - Tests: using F(L) model only if
    - Retrieved AOD < 0.1
    - Retrieved AOD < 0.4
    - Retrieved AOD < 0.8

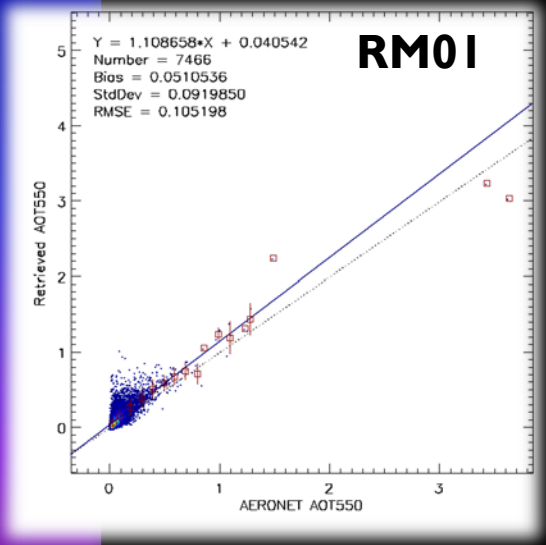
    Selecting aerosol models only if F(L) AOD is larger than the threshold

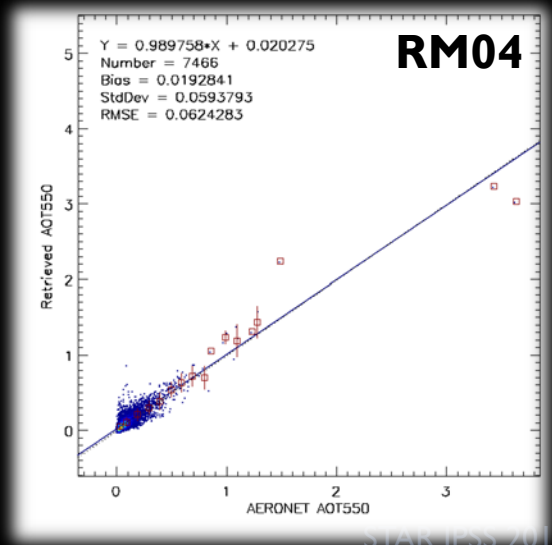
Eastern North America

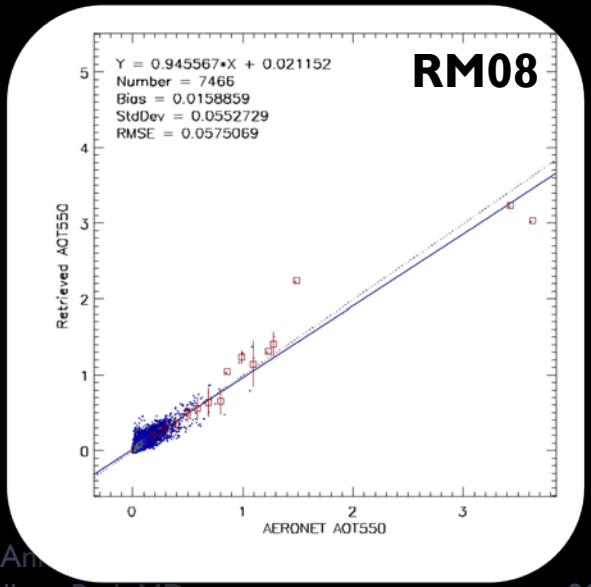




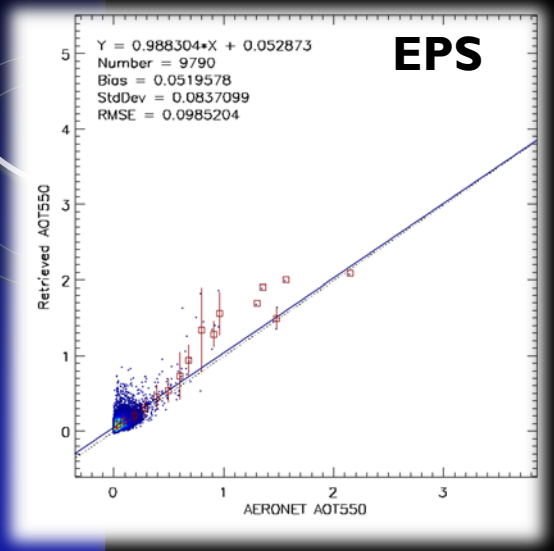


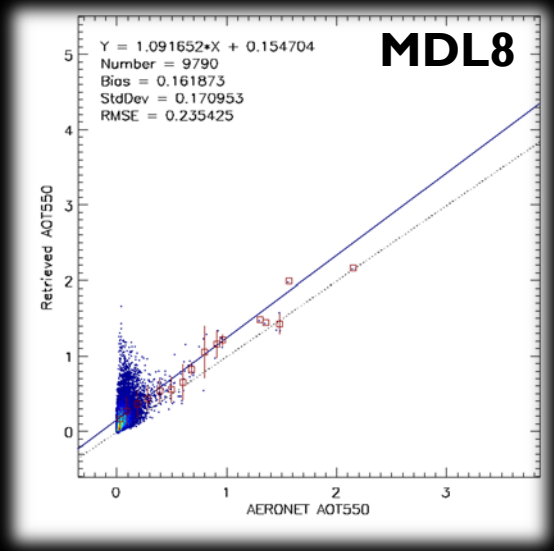


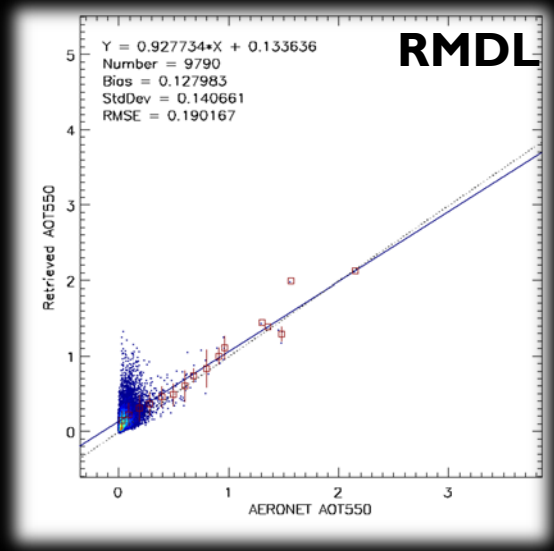


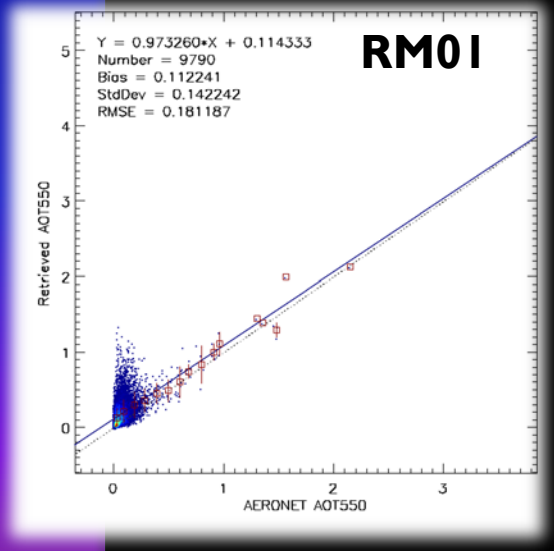


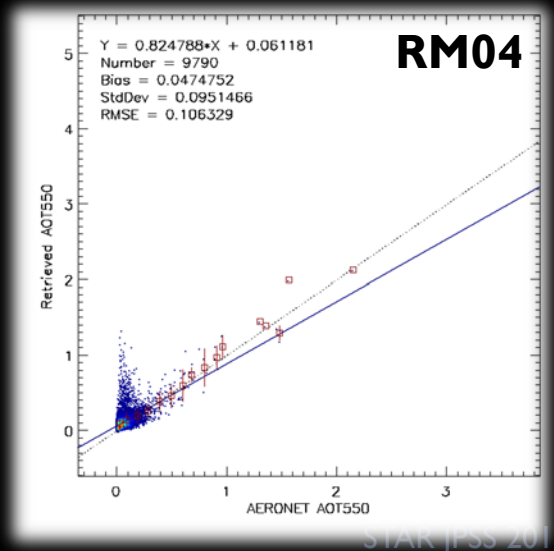
Western North America

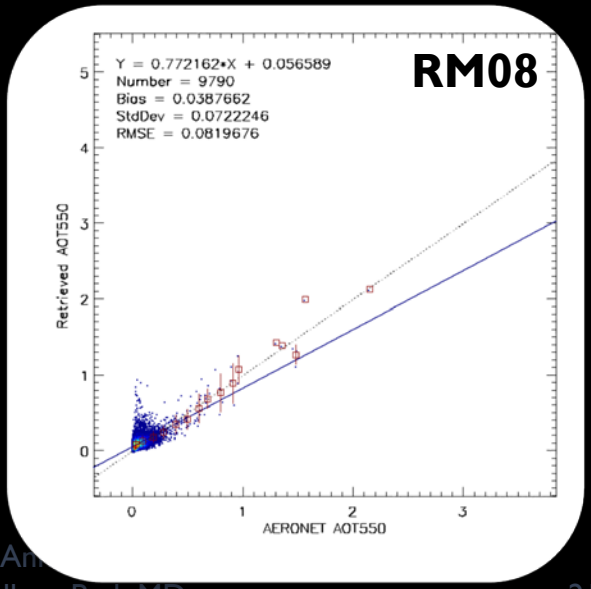




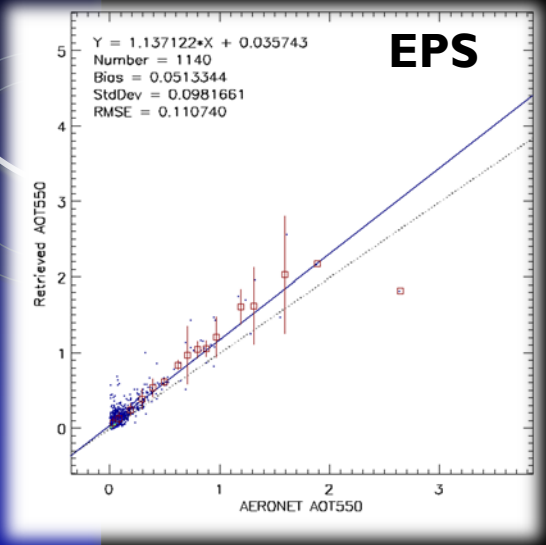


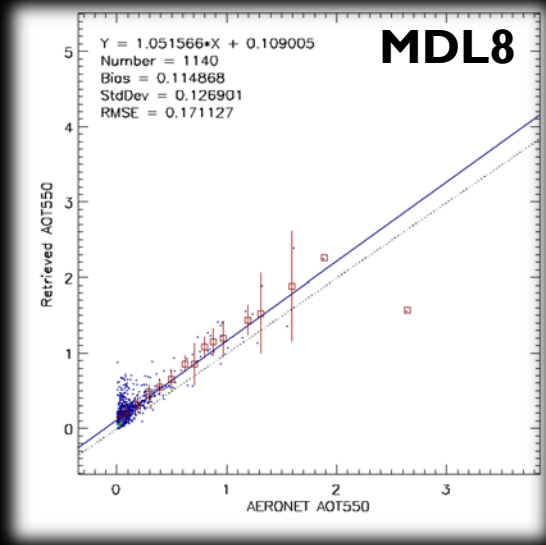


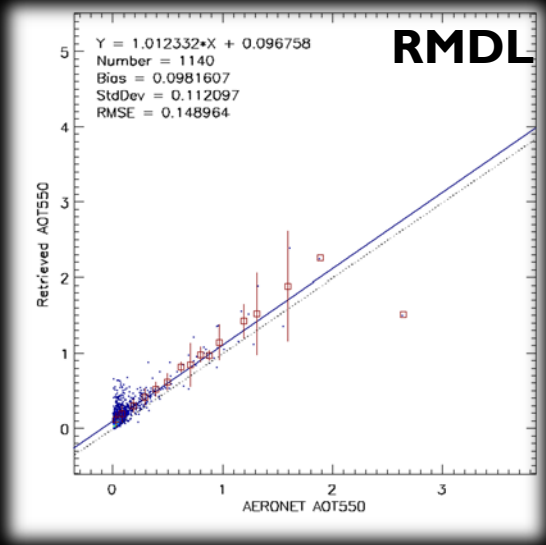


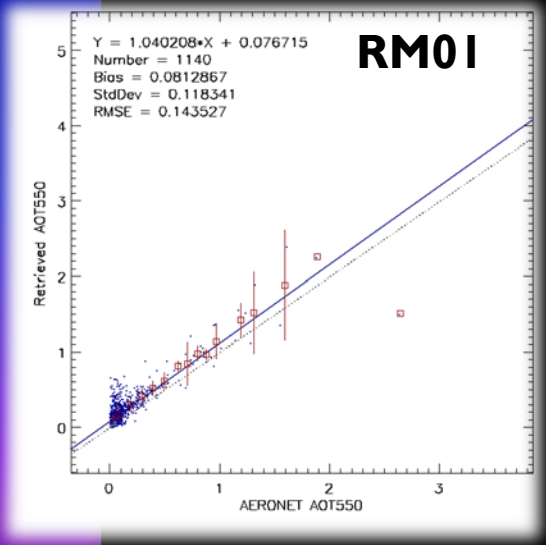


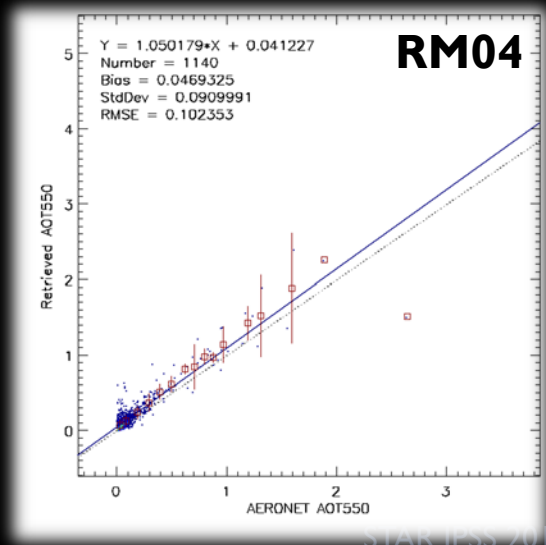
Northern North America

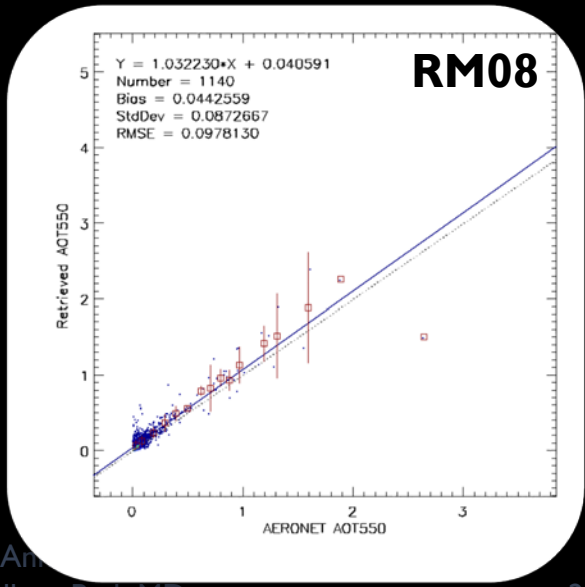




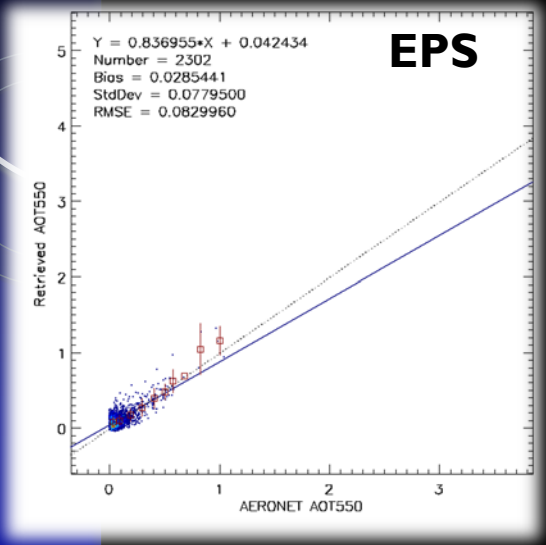


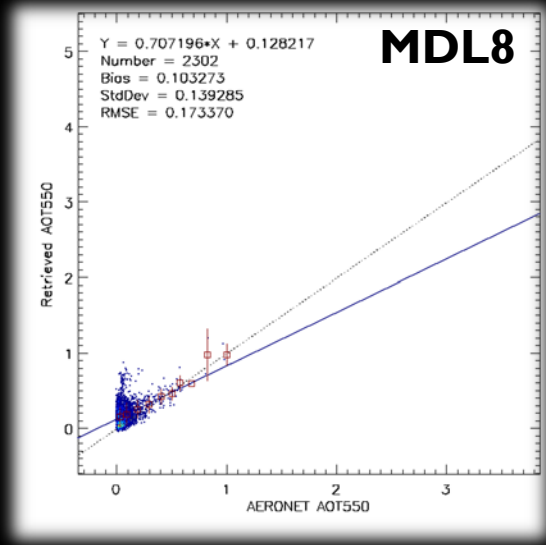


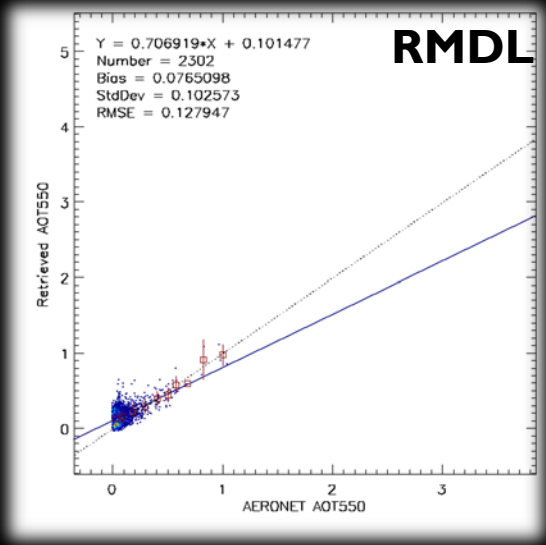


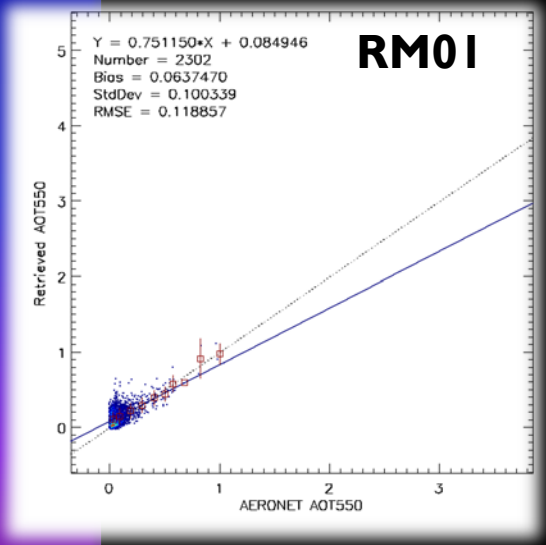


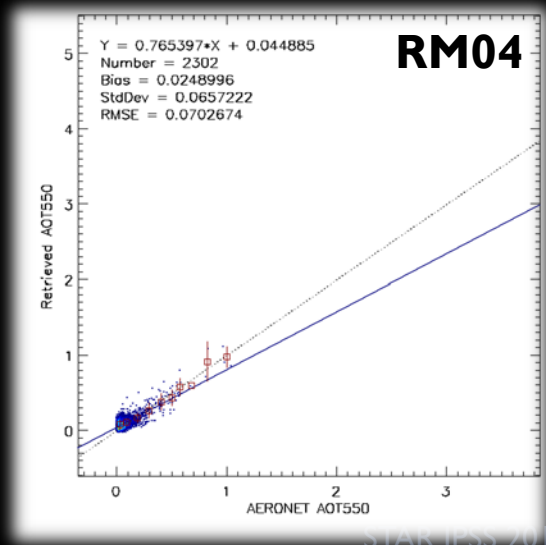
South America

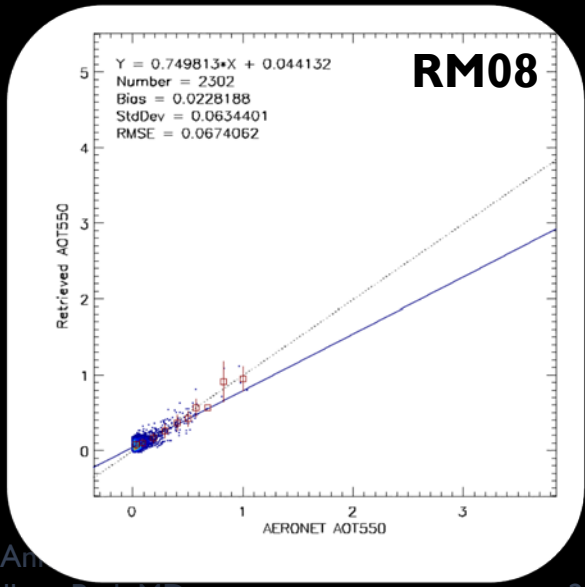




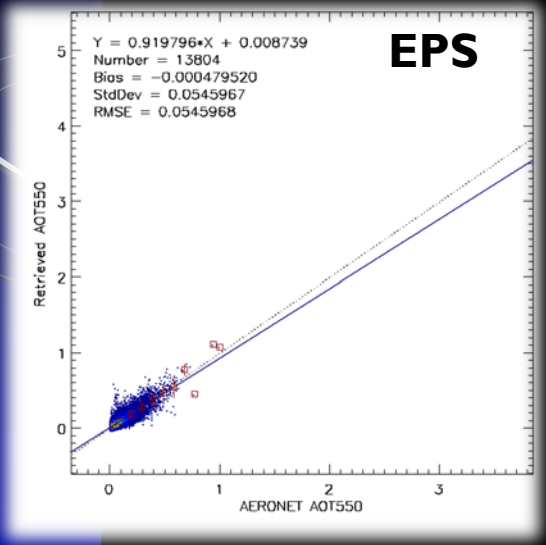


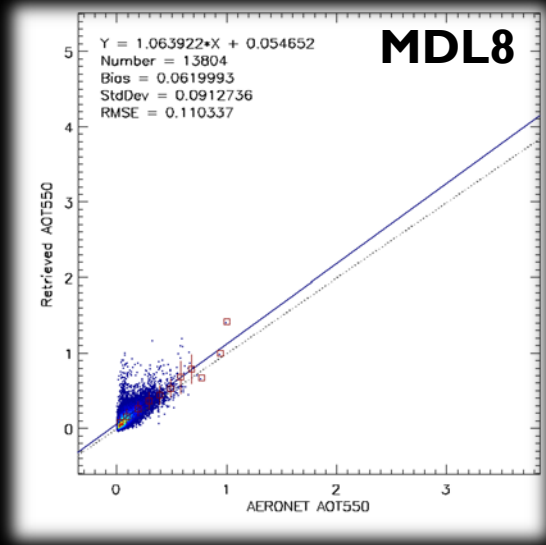


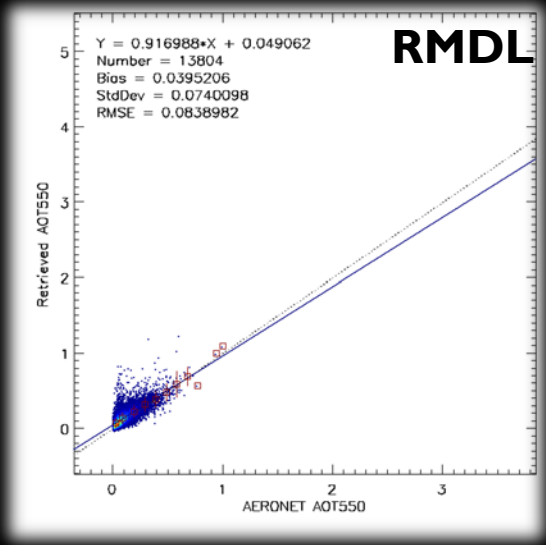


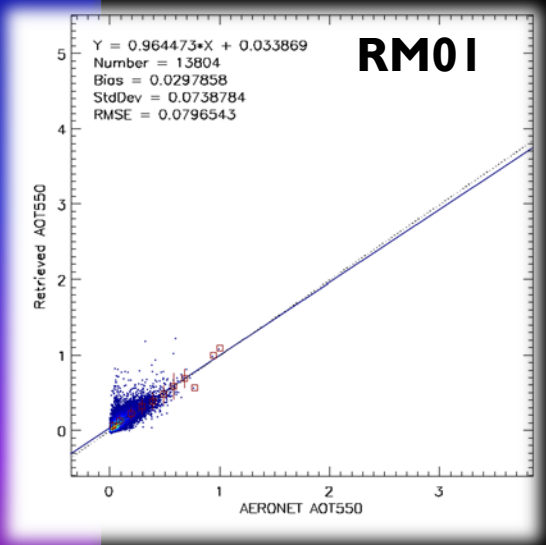


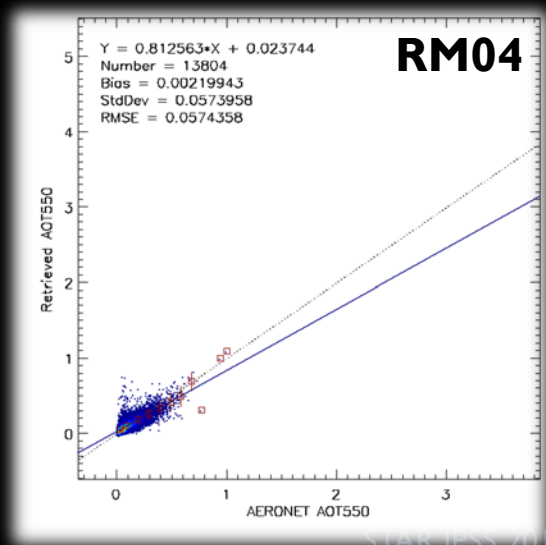
Europe

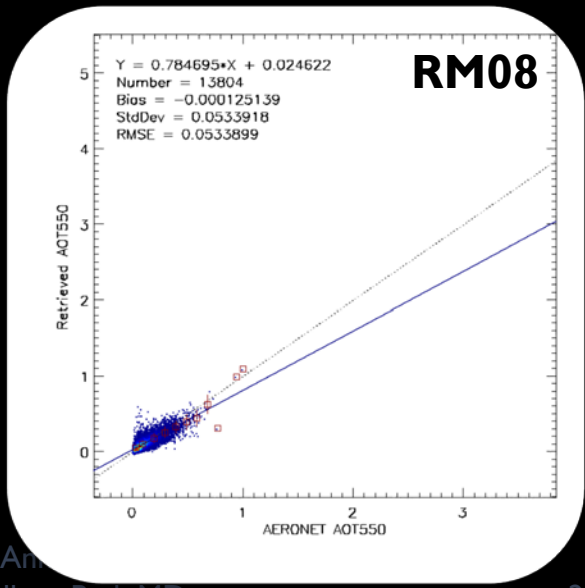

Y = 0.919796•X + 0.008739
Number = 13804
Bias = −0.000479520
StdDev = 0.0545967
RMSE = 0.0545968
EPS
Retrieved AOT550
AERONET AOT550


Y = 1.063922•X + 0.054652
Number = 13804
Bias = 0.0619993
StdDev = 0.0912736
RMSE = 0.110337
MDL8
Retrieved AOT550
AERONET AOT550

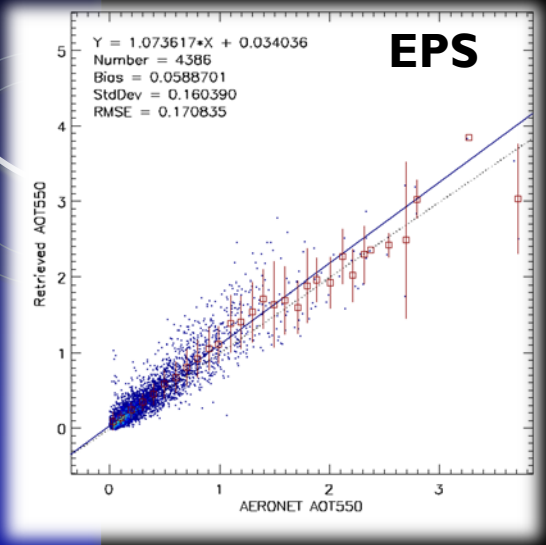

Y = 0.916988•X + 0.049062
Number = 13804
Bias = 0.0395206
StdDev = 0.0740098
RMSE = 0.0838982
RMDL
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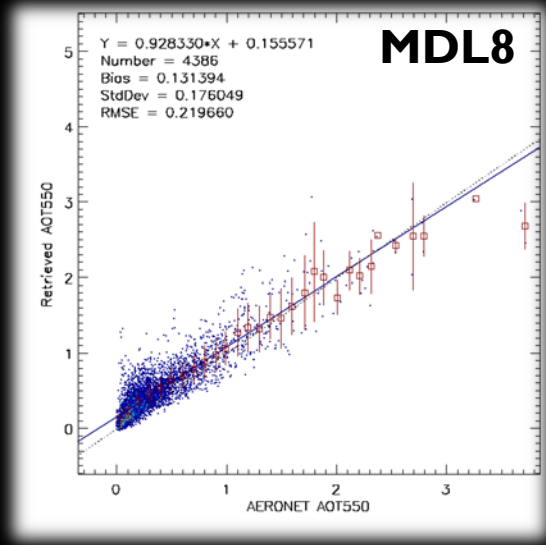

Y = 0.964473•X + 0.033869
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Bias = 0.0297858
StdDev = 0.0738784
RMSE = 0.0796543
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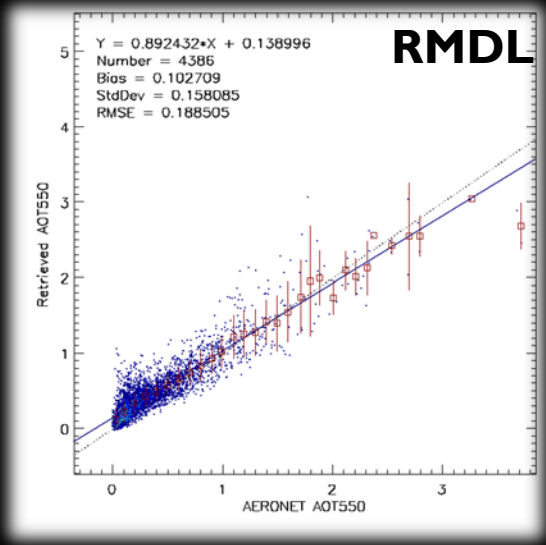

Y = 0.812563•X + 0.023744
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StdDev = 0.0573958
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RM04
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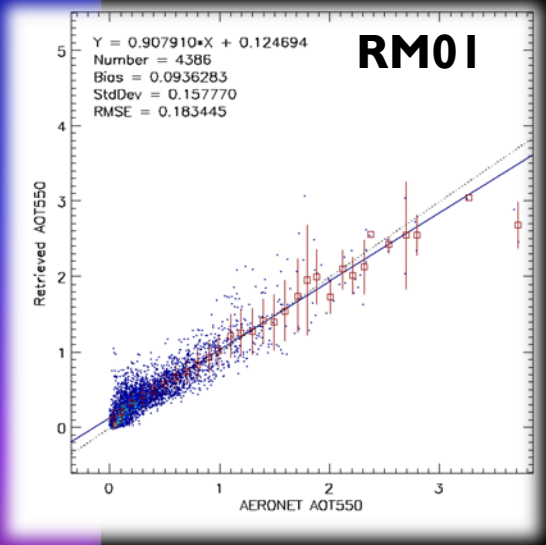

Y = 0.784695•X + 0.024622
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Bias = −0.000125139
StdDev = 0.0533918
RMSE = 0.0533899
RM08
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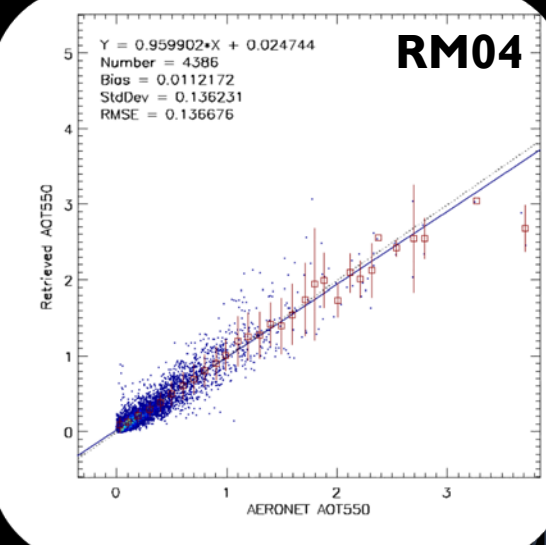
Eastern Asia

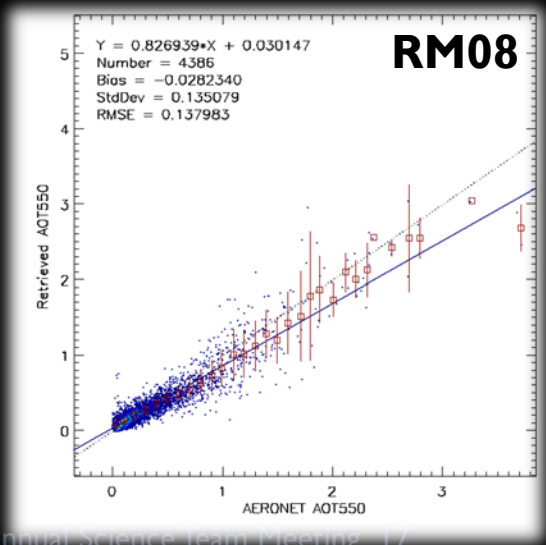




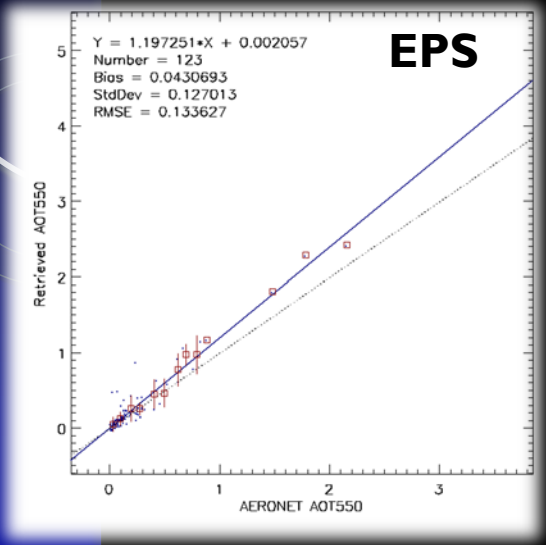


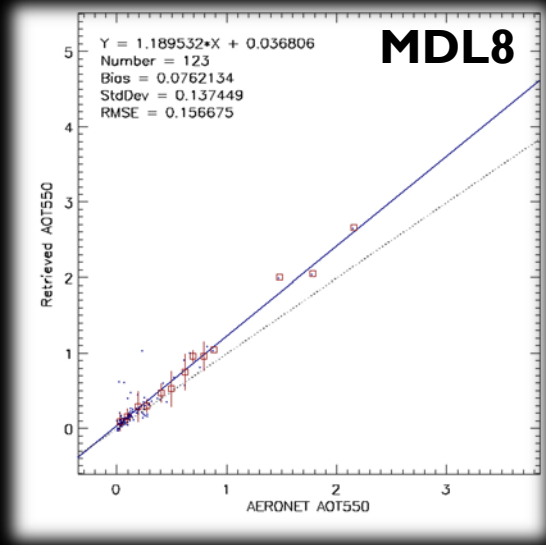


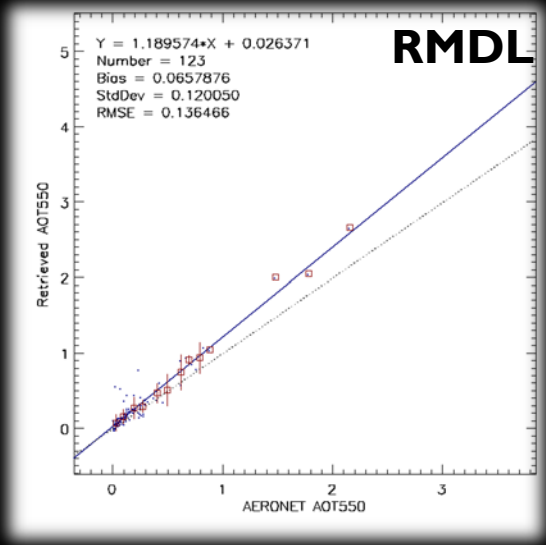


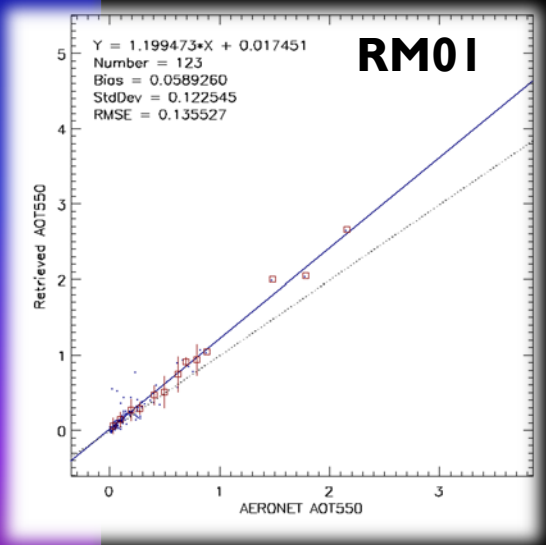


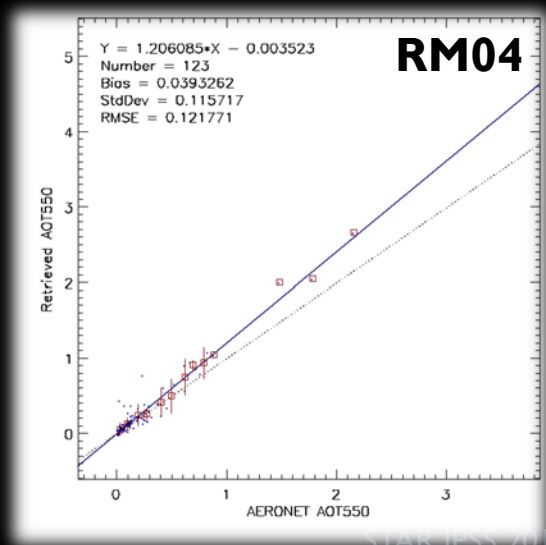
Northern Asia

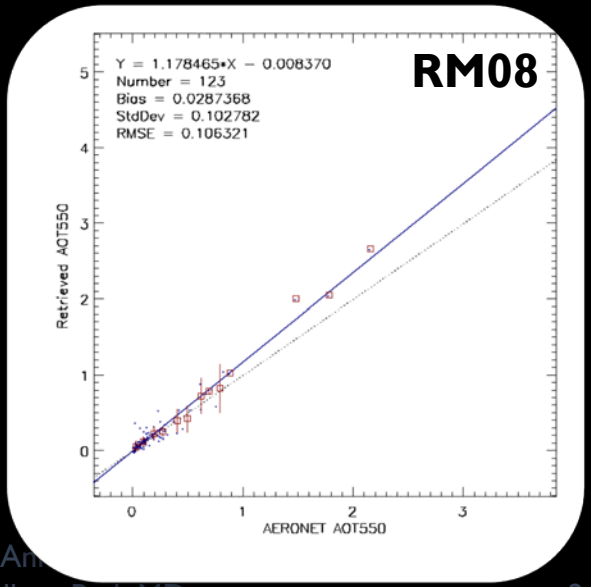




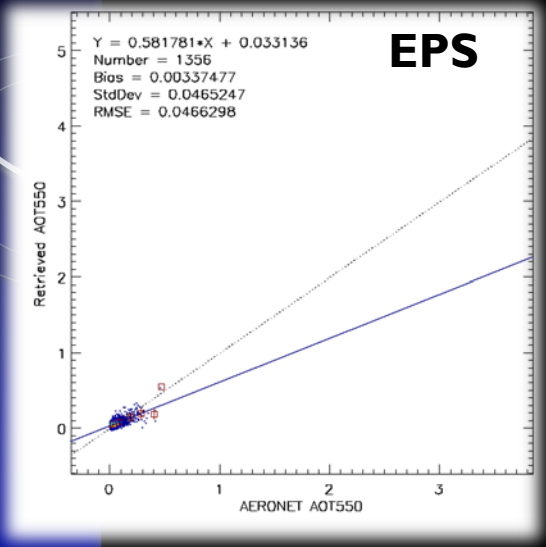


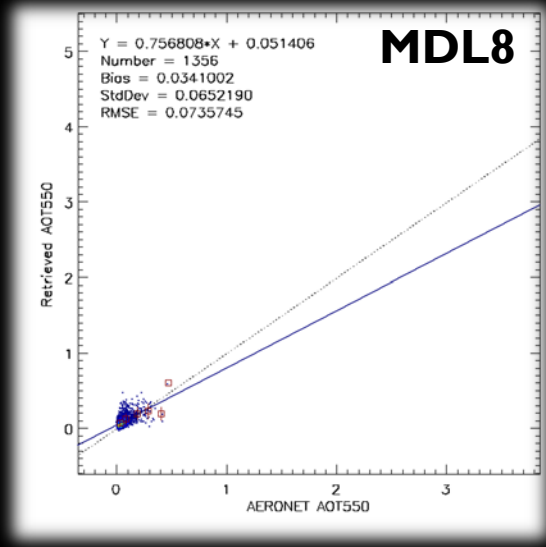


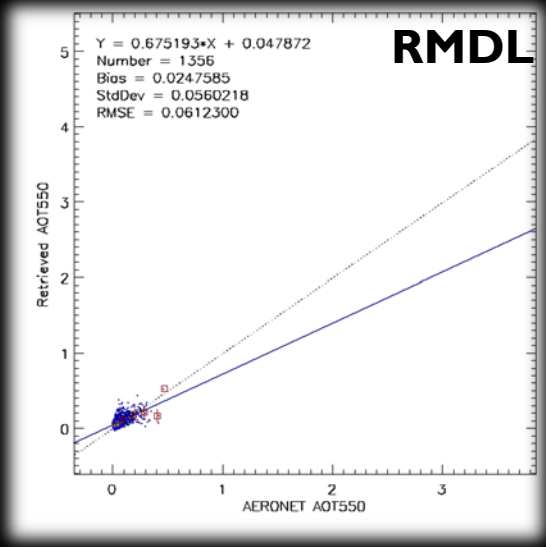


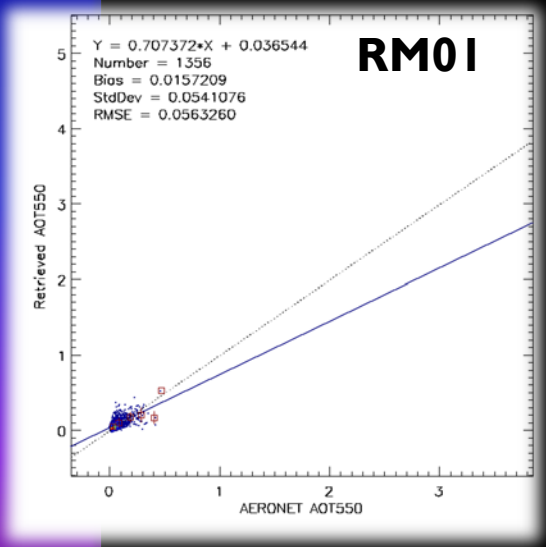


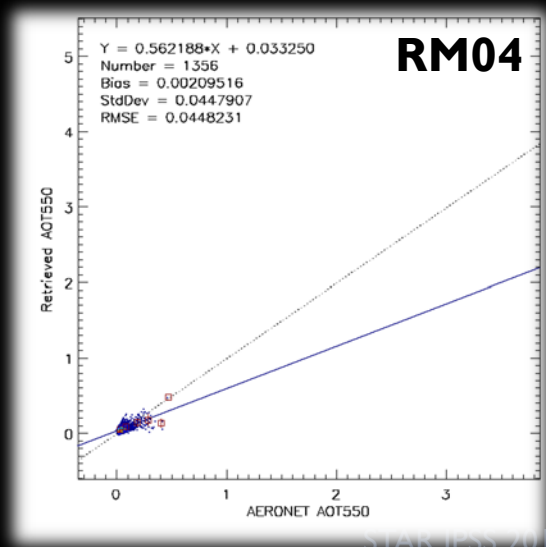
Australia

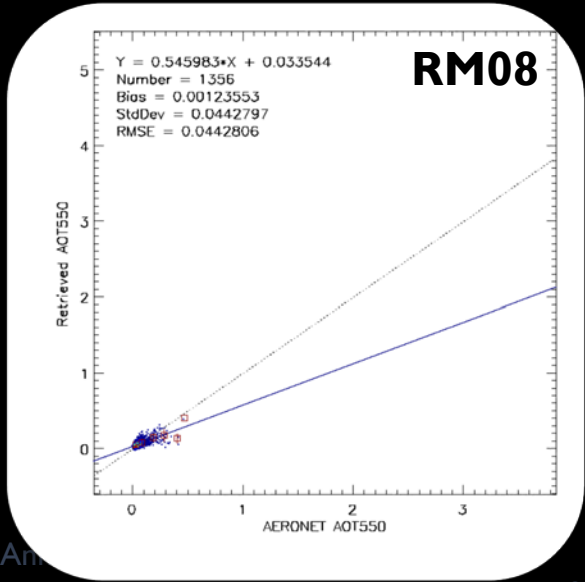

Y = 0.581781•X + 0.033136
Number = 1356
Bias = 0.00337477
StdDev = 0.0465247
RMSE = 0.0466298
EPS
Retrieved AOT550
AERONET AOT550


Y = 0.756808•X + 0.051406
Number = 1356
Bias = 0.0341002
StdDev = 0.0652190
RMSE = 0.0735745
MDL8
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AERONET AOT550

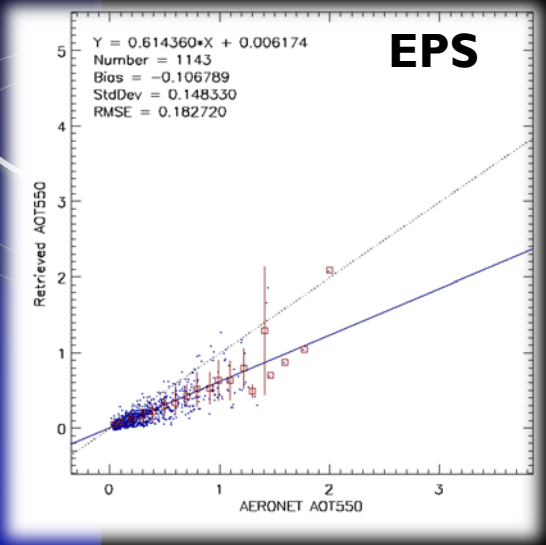

Y = 0.675193•X + 0.047872
Number = 1356
Bias = 0.0247585
StdDev = 0.0560218
RMSE = 0.0612300
RMDL
Retrieved AOT550
AERONET AOT550

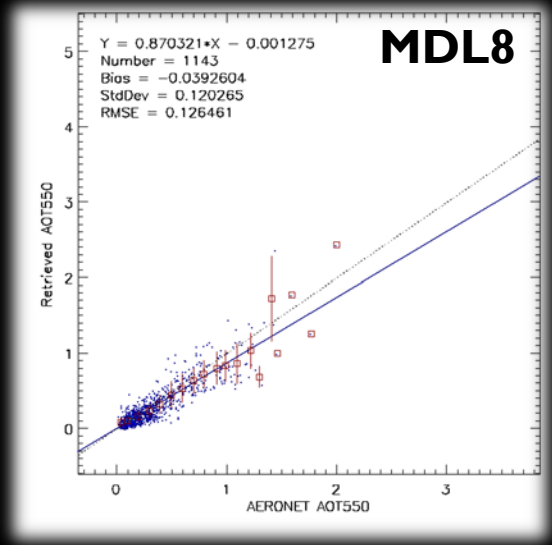

Y = 0.707372•X + 0.036544
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StdDev = 0.0541076
RMSE = 0.0563260
RM01
Retrieved AOT550
AERONET AOT550

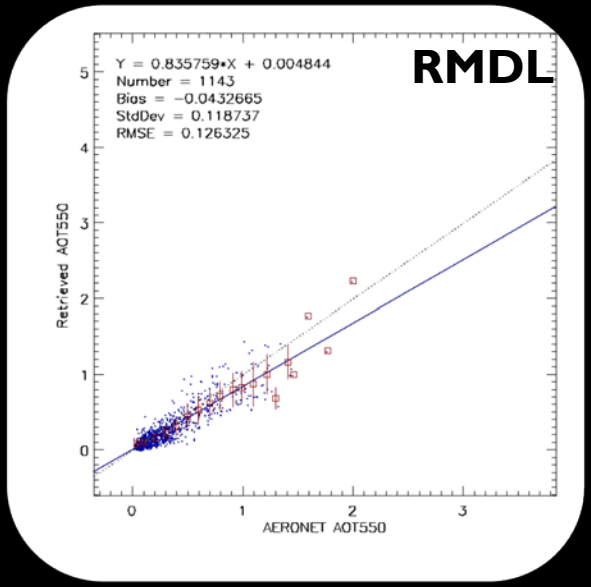

Y = 0.562188•X + 0.033250
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StdDev = 0.0447907
RMSE = 0.0448231
RM04
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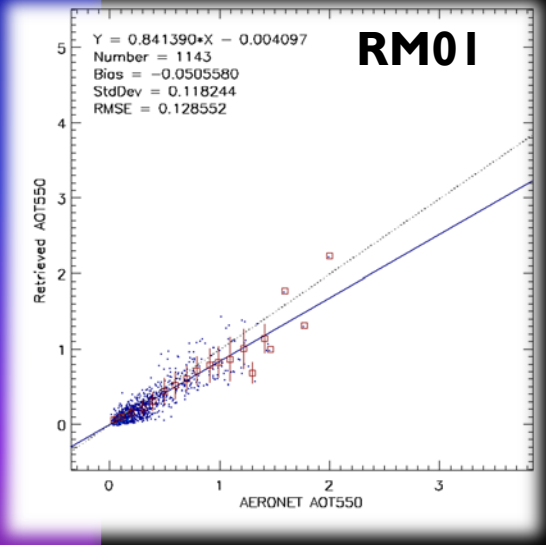

Y = 0.545983•X + 0.033544
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Bias = 0.00123553
StdDev = 0.0442797
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RM08
Retrieved AOT550
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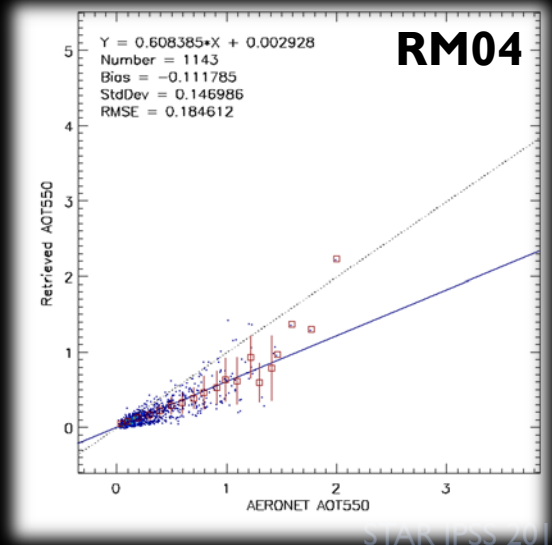
Africa

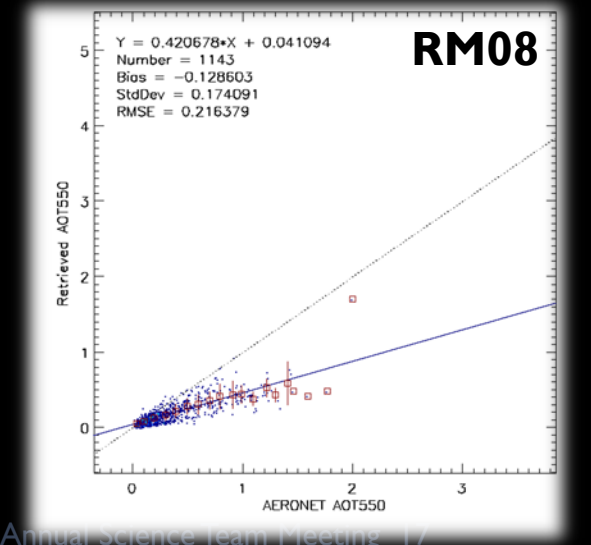

Y = 0.614360•X + 0.006174
Number = 1143
Bias = −0.106789
StdDev = 0.148330
RMSE = 0.182720
EPS
Retrieved AOT550
AERONET AOT550


Y = 0.870321•X − 0.001275
Number = 1143
Bias = −0.0392604
StdDev = 0.120265
RMSE = 0.126461
MDL8
Retrieved AOT550
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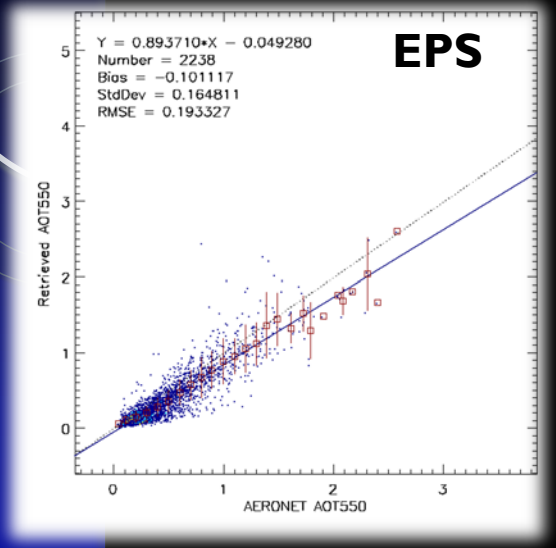

Y = 0.835759•X + 0.004844
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Bias = −0.0432665
StdDev = 0.118737
RMSE = 0.126325
RMDL
Retrieved AOT550
AERONET AOT550

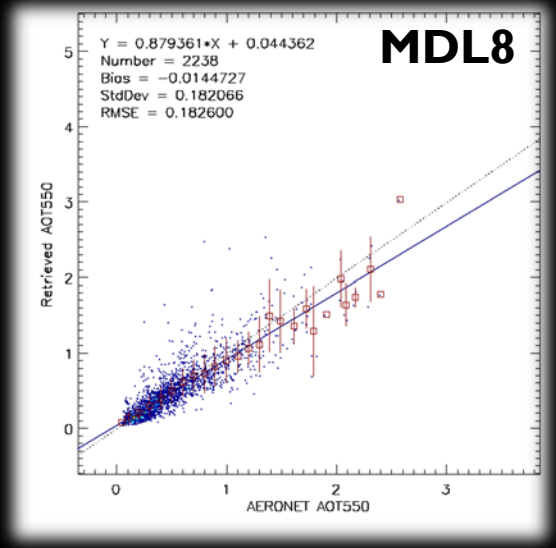

Y = 0.841390•X − 0.004097
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StdDev = 0.118244
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RM01
Retrieved AOT550
AERONET AOT550

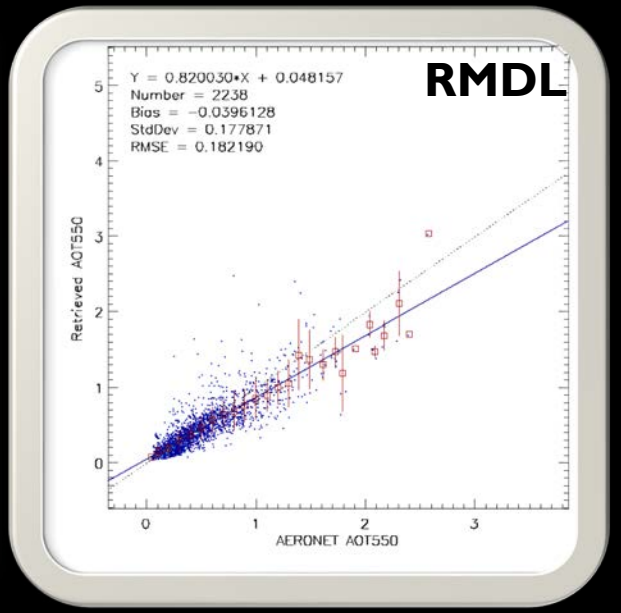

Y = 0.608385•X + 0.002928
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Bias = −0.111785
StdDev = 0.146986
RMSE = 0.184612
RM04
Retrieved AOT550
AERONET AOT550

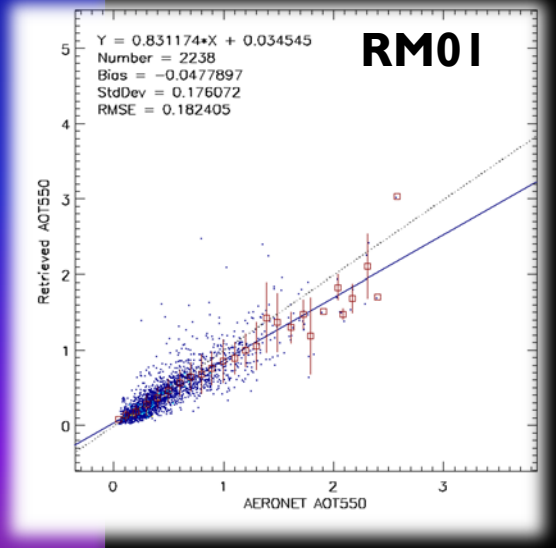

Y = 0.420678•X + 0.041094
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StdDev = 0.174091
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RM08
Retrieved AOT550
AERONET AOT550

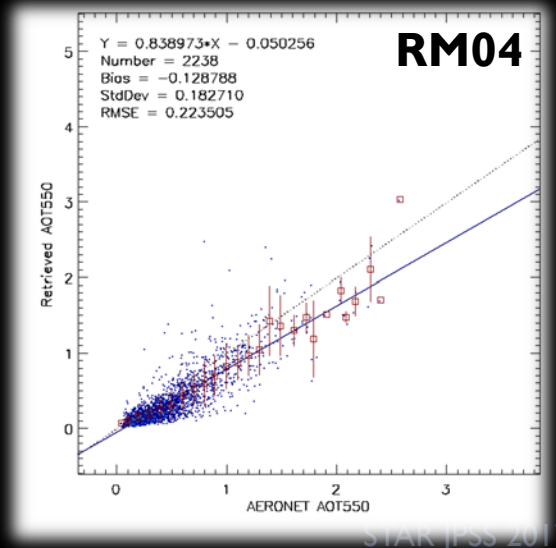
India

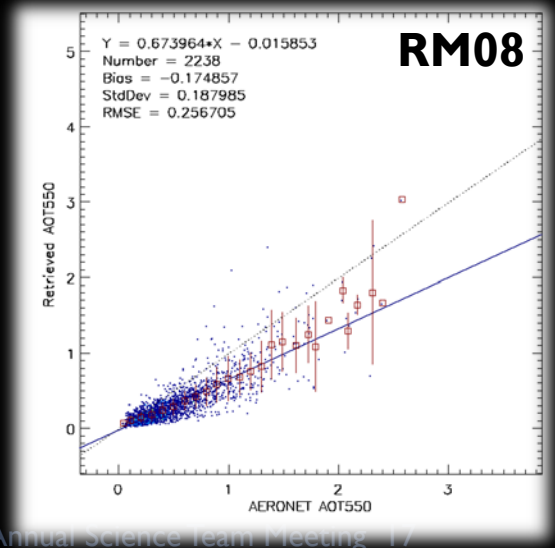

Y = 0.893710•X − 0.049280
Number = 2238
Bias = −0.101117
StdDev = 0.164811
RMSE = 0.193327
EPS
Retrieved AOT550
AERONET AOT550


Y = 0.879361•X + 0.044362
Number = 2238
Bias = −0.0144727
StdDev = 0.182066
RMSE = 0.182600
MDL8
Retrieved AOT550
AERONET AOT550

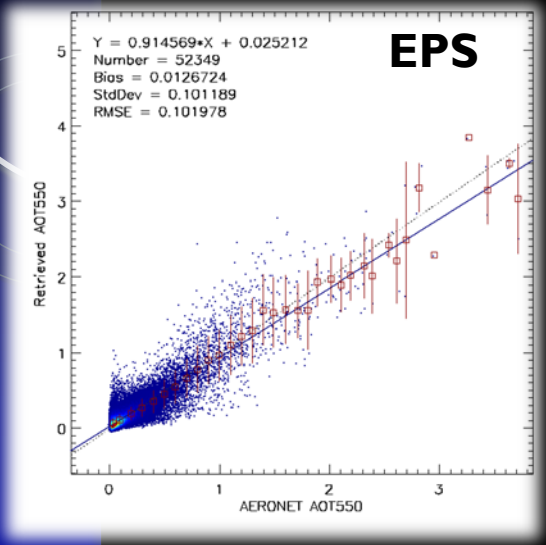

Y = 0.820030•X + 0.048157
Number = 2238
Bias = −0.0396128
StdDev = 0.177871
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RMDL
Retrieved AOT550
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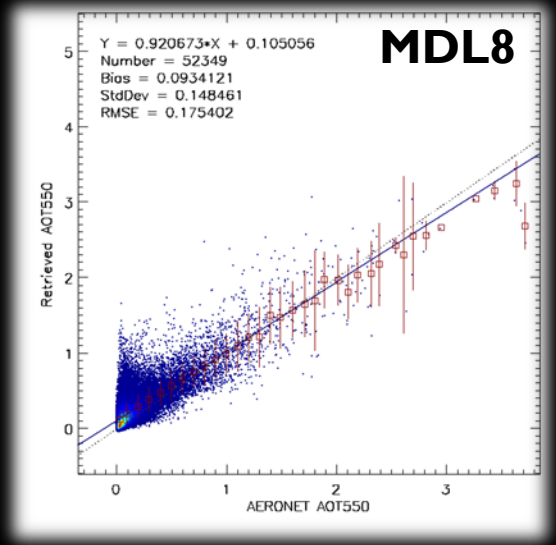

Y = 0.831174•X + 0.034545
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Bias = −0.0477897
StdDev = 0.176072
RMSE = 0.182405
RM01
Retrieved AOT550
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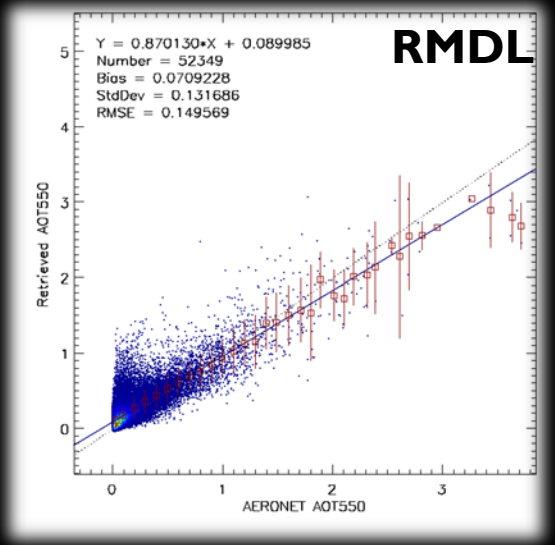

Y = 0.838973•X − 0.050256
Number = 2238
Bias = −0.128788
StdDev = 0.182710
RMSE = 0.223505
RM04
Retrieved AOT550
AERONET AOT550

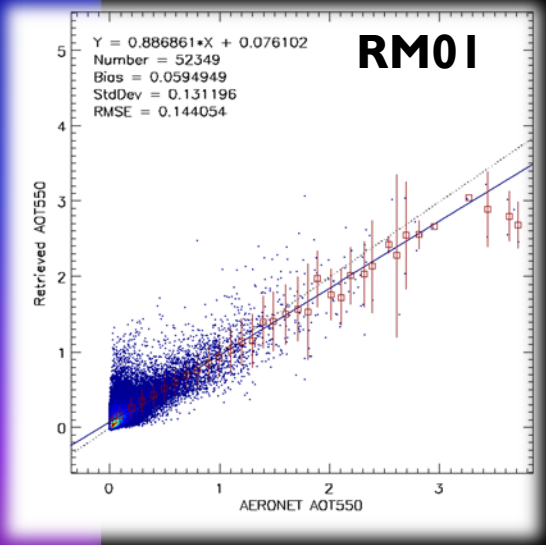

Y = 0.673964•X − 0.015853
Number = 2238
Bias = −0.174857
StdDev = 0.187985
RMSE = 0.256705
RM08
Retrieved AOT550
AERONET AOT550

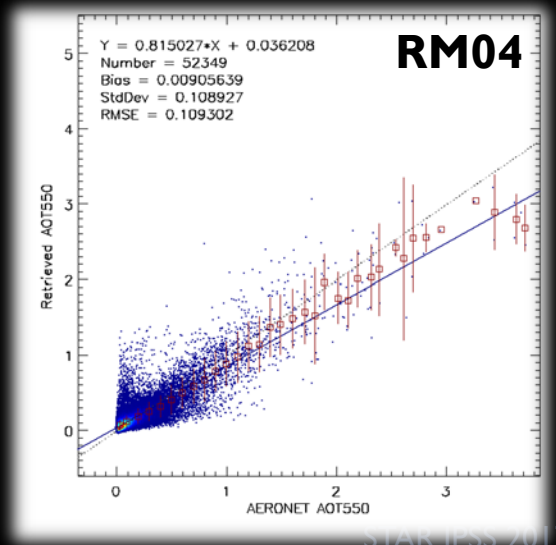
Global

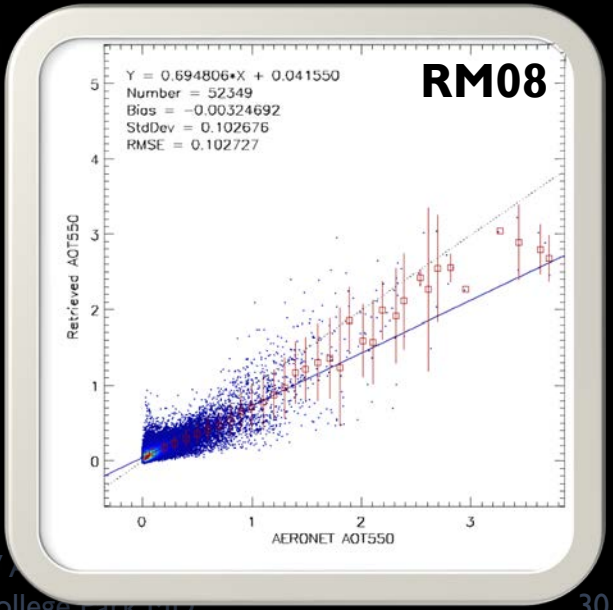

Y = 0.914569•X + 0.025212
Number = 52349
Bias = 0.0126724
StdDev = 0.101189
RMSE = 0.101978
EPS
Retrieved AOT550
AERONET AOT550


Y = 0.920673•X + 0.105056
Number = 52349
Bias = 0.0934121
StdDev = 0.148461
RMSE = 0.175402
MDL8
Retrieved AOT550
AERONET AOT550


Y = 0.870130•X + 0.089985
Number = 52349
Bias = 0.0709228
StdDev = 0.131686
RMSE = 0.149569
RMDL
Retrieved AOT550
AERONET AOT550

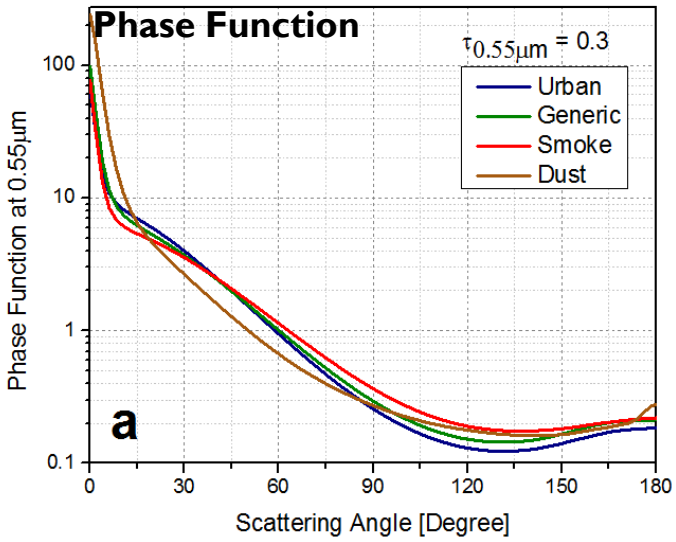

Y = 0.886861•X + 0.076102
Number = 52349
Bias = 0.0594949
StdDev = 0.131196
RMSE = 0.144054
RM01
Retrieved AOT550
AERONET AOT550

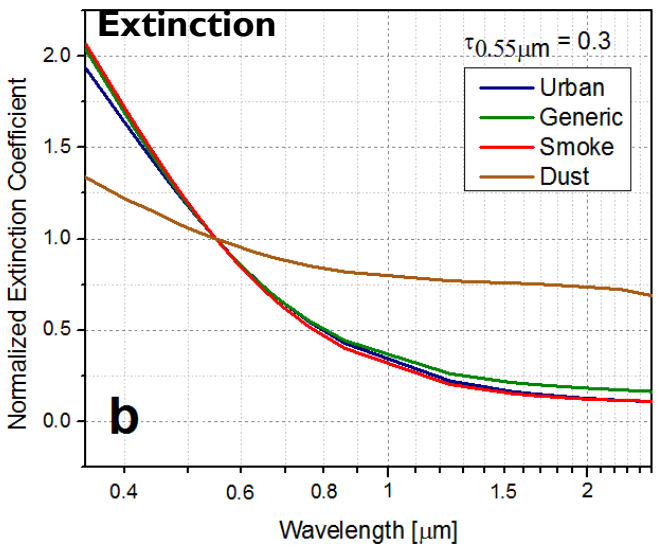

Y = 0.815027•X + 0.036208
Number = 52349
Bias = 0.00905639
StdDev = 0.108927
RMSE = 0.109302
RM04
Retrieved AOT550
AERONET AOT550

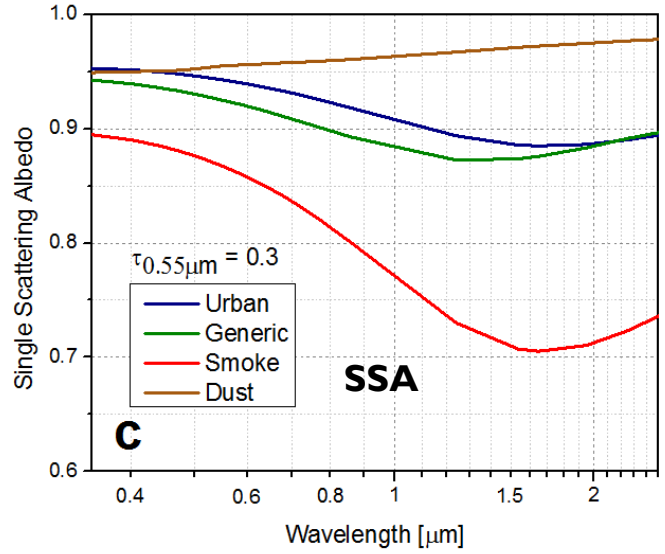

Y = 0.694806•X + 0.041550
Number = 52349
Bias = −0.00324692
StdDev = 0.102676
RMSE = 0.102727
RM08
Retrieved AOT550
AERONET AOT550

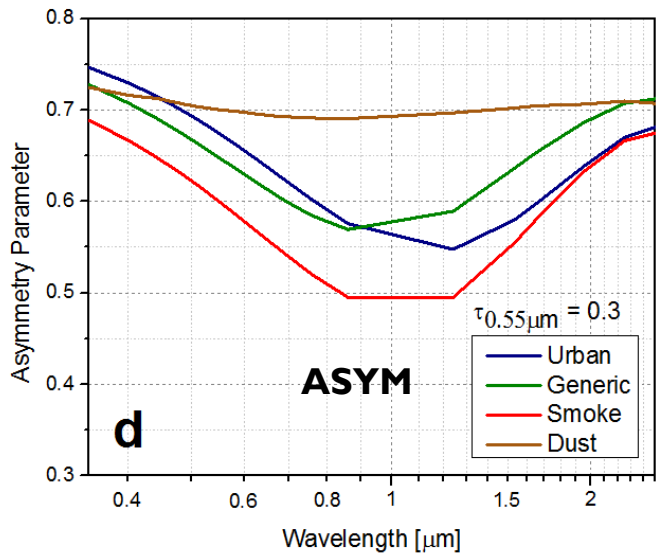
Summary

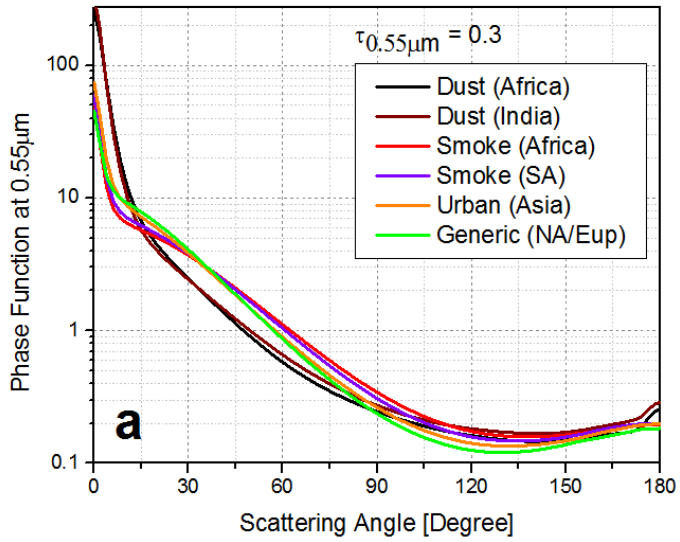
- New land aerosol models are derived from AERONET inversions
  - Dust: low/medium/high absorbing
  - Smoke: low/high absorbing
  - Fine-mode Dominated: low/medium/high absorbing
- Potential updates on the EPS AOD algorithm is investigated
  - Dynamic selection among all/subset of aerosol models at all/high AOD cases
  - Algorithm has the difficulty to pick the right aerosol model at low AOD cases

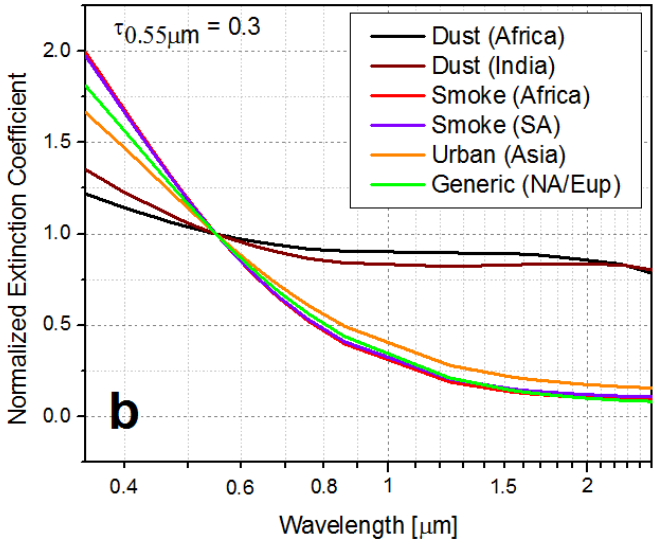

Phase Function
$\tau_{0.55\mu m}$ = 0.3
Urban
Generic
Smoke
Dust
Phase Function at 0.55μm
Scattering Angle [Degree]
a

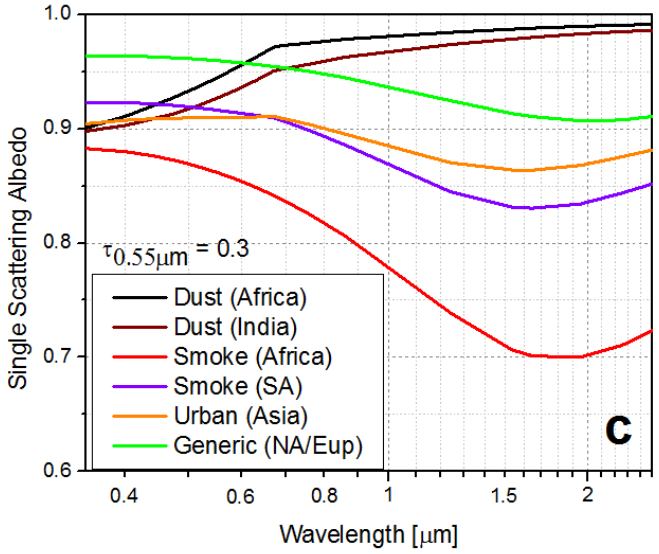

Extinction
$\tau_{0.55\mu m}$ = 0.3
Urban
Generic
Smoke
Dust
Normalized Extinction Coefficient
Wavelength [μm]
b

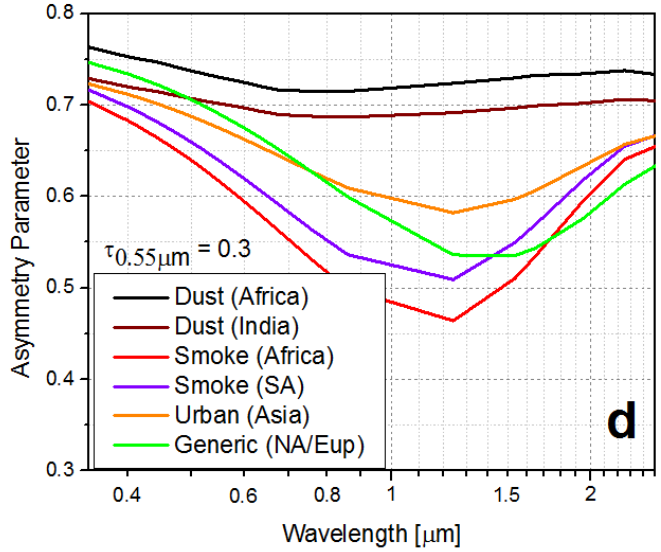

$\tau_{0.55\mu m}$ = 0.3
Urban
Generic
Smoke
Dust
SSA
Single Scattering Albedo
Wavelength [μm]
c


$\tau_{0.55\mu m}$ = 0.3
Urban
Generic
Smoke
Dust
ASYM
Asymmetry Parameter
Wavelength [μm]
d


τ0.55μm = 0.3
Dust (Africa)
Dust (India)
Smoke (Africa)
Smoke (SA)
Urban (Asia)
Generic (NA/Eup)
Phase Function at 0.55μm
Scattering Angle [Degree]
a


τ0.55μm = 0.3
Dust (Africa)
Dust (India)
Smoke (Africa)
Smoke (SA)
Urban (Asia)
Generic (NA/Eup)
Normalized Extinction Coefficient
Wavelength [μm]
b


τ0.55μm = 0.3
Dust (Africa)
Dust (India)
Smoke (Africa)
Smoke (SA)
Urban (Asia)
Generic (NA/Eup)
Single Scattering Albedo
Wavelength [μm]
c


τ0.55μm = 0.3
Dust (Africa)
Dust (India)
Smoke (Africa)
Smoke (SA)
Urban (Asia)
Generic (NA/Eup)
Asymmetry Parameter
Wavelength [μm]
d