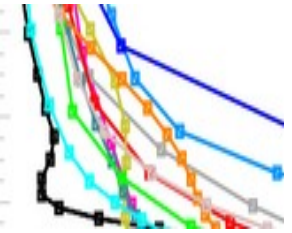


What CALIPSO data tell us about vertical distribution in modeling

Brigitte Koffi[1], Michael Schulz[2]

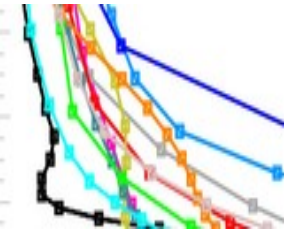
[1]Laboratoire des Sciences du Climat et de l'Environnement

[2]Norwegian Meteorological Institute

FOLLOWING UP ON THE PHASE I PAPER

Koffi, B., M. Schulz, F.-M. Bréon, J. Griesfeller, D. Winker, Y. Balkanski, S. Bauer, T. Berntsen, M. Chin, W. D. Collins, F. Dentener, T. Diehl, R. Easter, S. Ghan, P. Ginoux, S. Gong, L. W. Horowitz, T. Iversen, A. Kirkevåg, D. Koch, M. Krol, G. Myhre, P. Stier, T. Takemura (2012), **Application of the CALIOP Layer Product to evaluate the vertical distribution of aerosols estimated by global models: Part 1. AeroCom phase I results** J. Geophys. Res., 117, D10201, doi:10.1029/2011JD016858.

Method



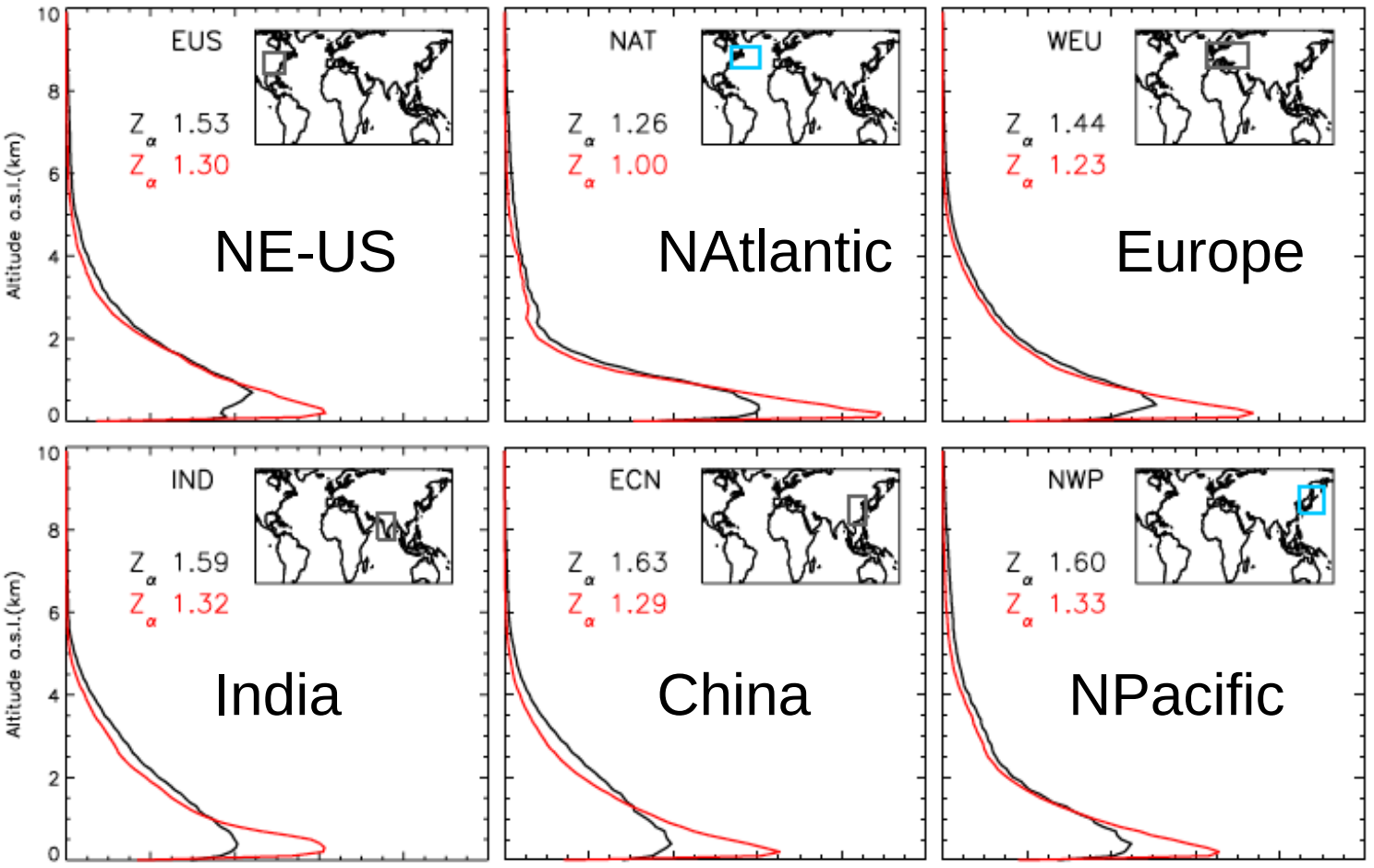
Exploiting new CALIOP version 3 (!) observations for AeroCom
From aerosol extinction layer product data 2007-2009
(Cloudy volumes omitted, aerosol free set to zero
Interpolation to 100m segments of individual profiles,
Expansion of lowest value to surface)

Averaging of MODIS for the same regions

Part II AeroCom models (ec5503D, z4d, landmask monthly)
Regional mean extinction profiles, also land and sea global means
Model profiles interpolated to 100 m segments in each grid point

Calculation of extinction weighted characteristic height of aerosol
Comparison Height below which 63% of extinction is found

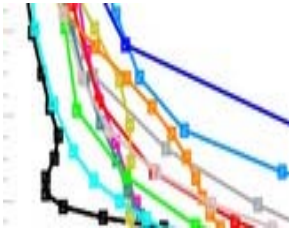
Koffi versus Winker

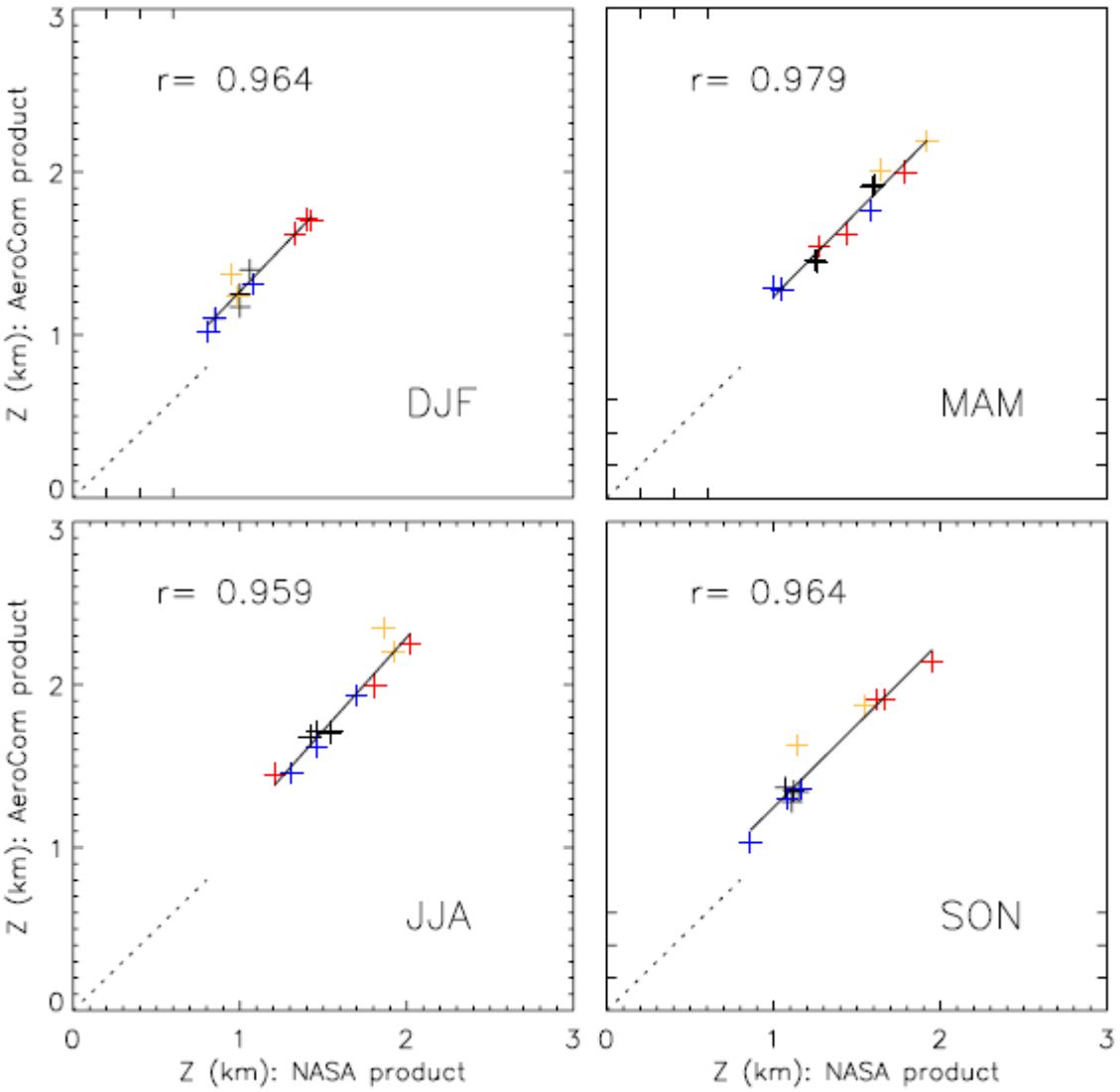


CALIOP 2007 mean annual “normalized” extinction coefficient (km-1) profiles (at 550 and 532 nm, respectively)
as derived from the present (black) and Winker et al. [2012] (red) gridded products.
The mean extinction height Zα (km) over the 0-6 km altitude range is reported

Koffi versus Winker
$Z_{\alpha\ 0\text{-}6\ km}$

(Koffi *et al.* 2012 regions; Year 2007)





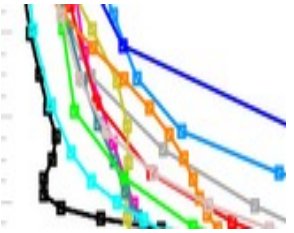
AeroCom product

NASA product

Koffi and Winker seasonal and regional $Z_{\alpha\ 0\text{-}6\ km}$ variabilities are consistent.

Koffi versus Winker positive biais of 230-270 m

Models included

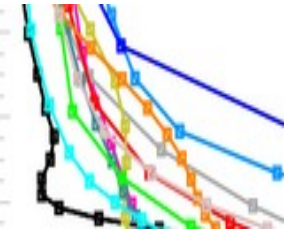


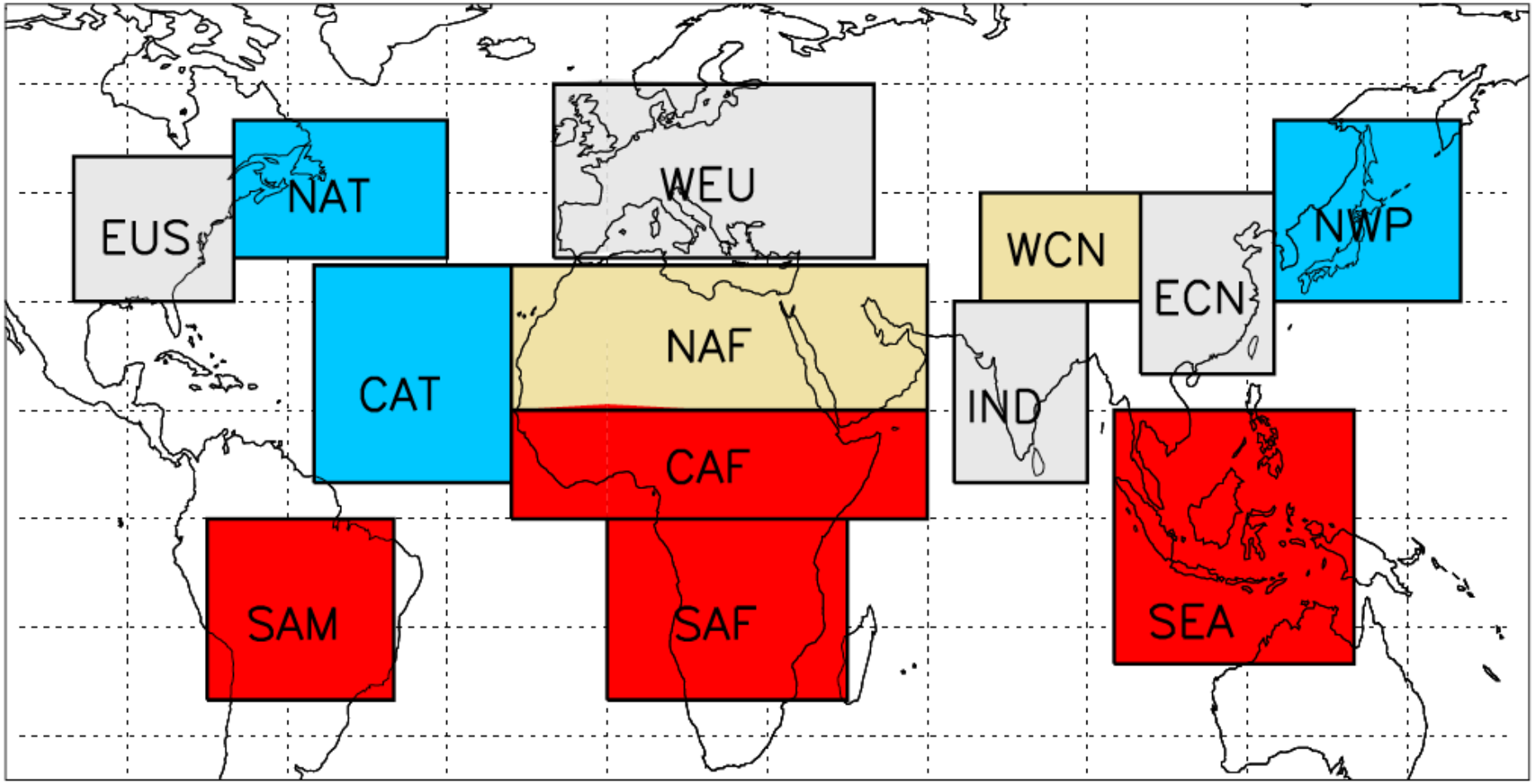
GISS model E
GISS Matrix
GOCART
SPRINTARS
LSCE
ECHAM-HAM
GMI-MERRA-v3
PNNL
Oslo CTM2
HadGEM
CAM4-Oslo

Models interested

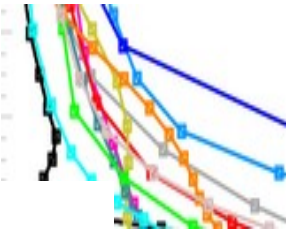
ECMWF
GFDL
+??

Regions





Global mean profiles



GLOBAL ANNUAL

$Z_{\alpha\ (0-6\ km)}$

CALIOP (2007–2009): 1.37
GISS–ModelE: 1.22
GOCART: 1.84
SPRINTARS: 0.96
LSCE: 1.51
GMI–MERRA–v3: 1.53
ECHAM–HAM: 1.32
PNNL: 1.31
SS–MATRIX: 1.03
Oslo_CTM2: 1.45
HadGEM: 1.24
CAM4_Oslo: 1.68

Problem

Problem

LOW
HiGH
LOW
HiGH
HiGH
LOW
HiGH
LOW
HiGH

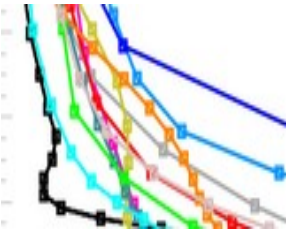
Altitude a.s.l. (km)

0 2 4 6 8 10

0.0 0.2 0.4 0.6 0.8 1.0

Normalized extinction coefficient (km^{-1})

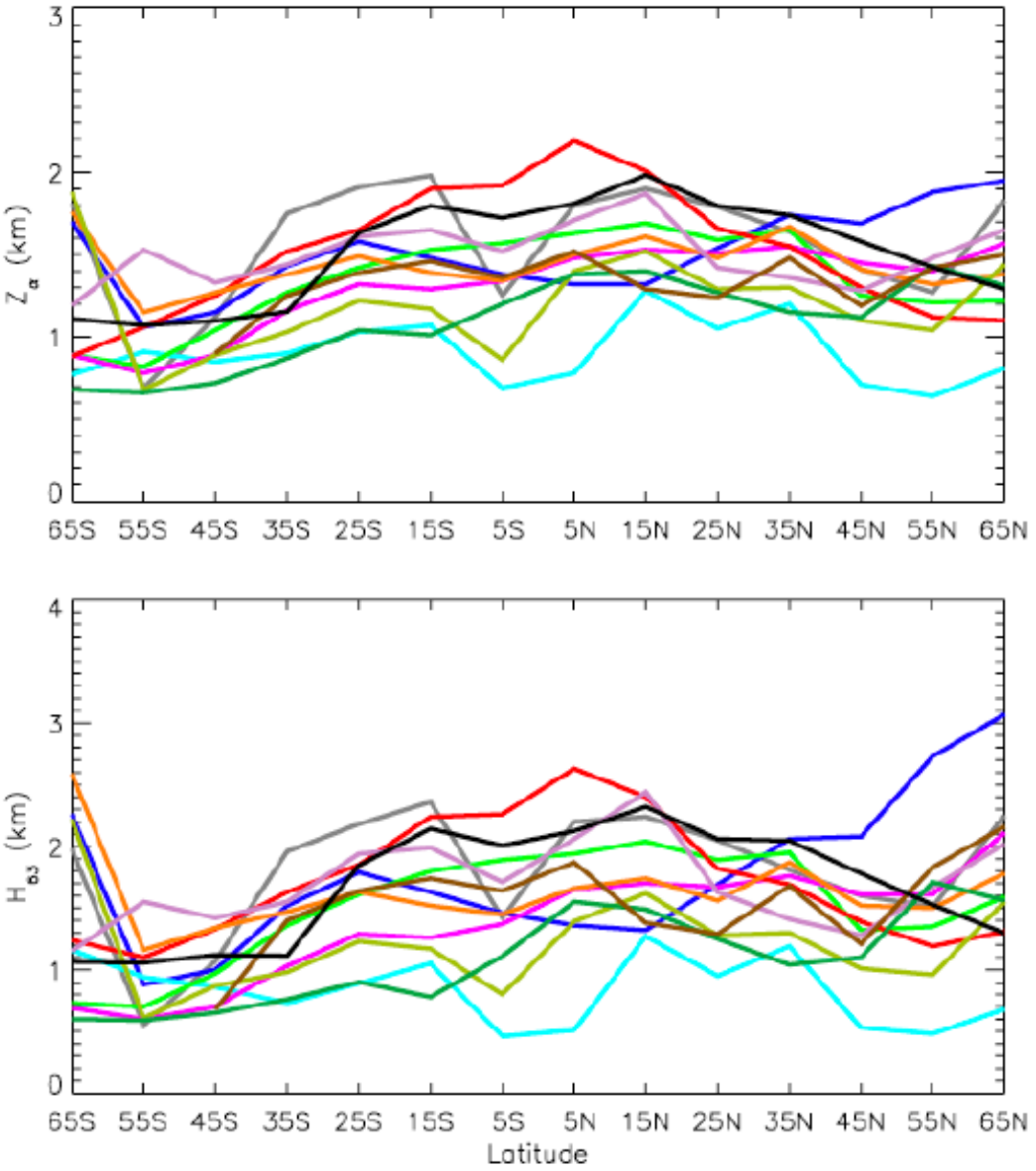
Mean Height over land versus latitude



Z_{alpha}

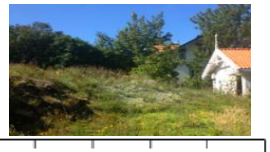
versus

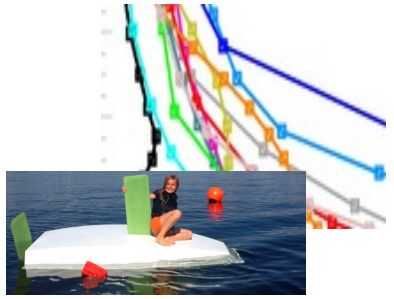
$H_{63\%}$



CALIOP vs MODELS

CALIOP vs MODELS



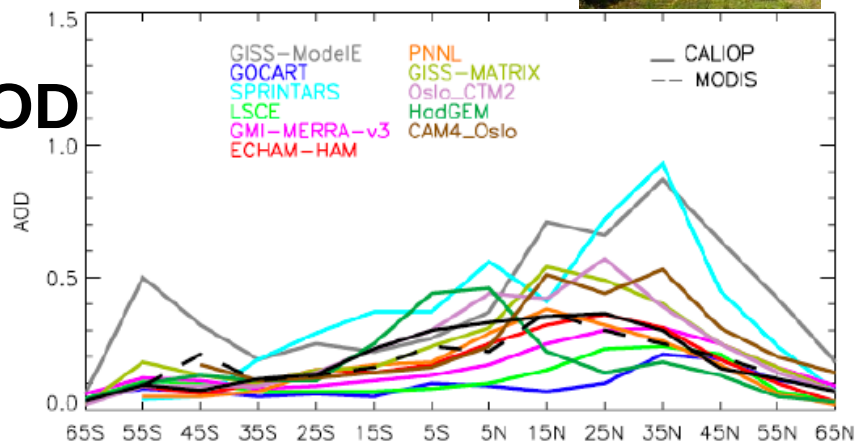


Land

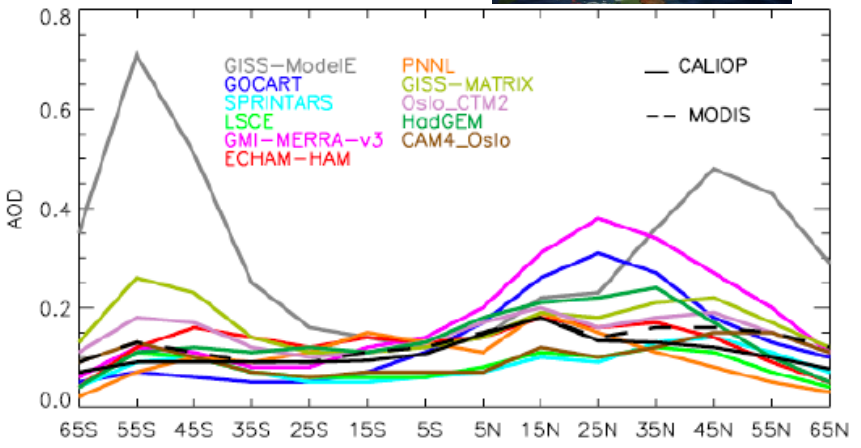
Ocean

a)

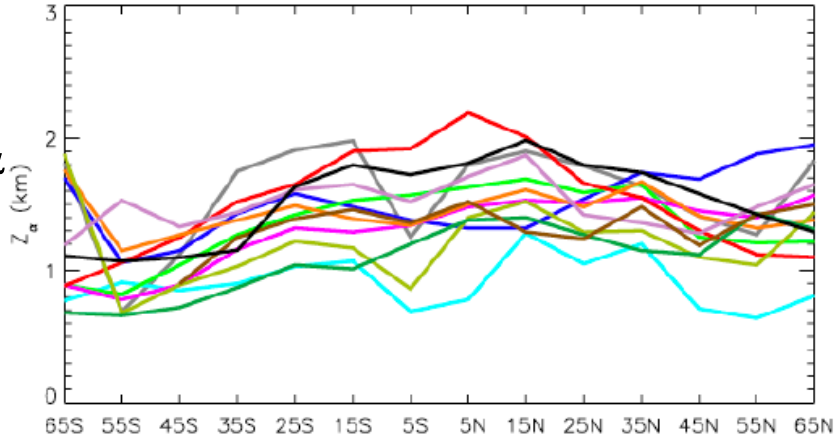
AOD

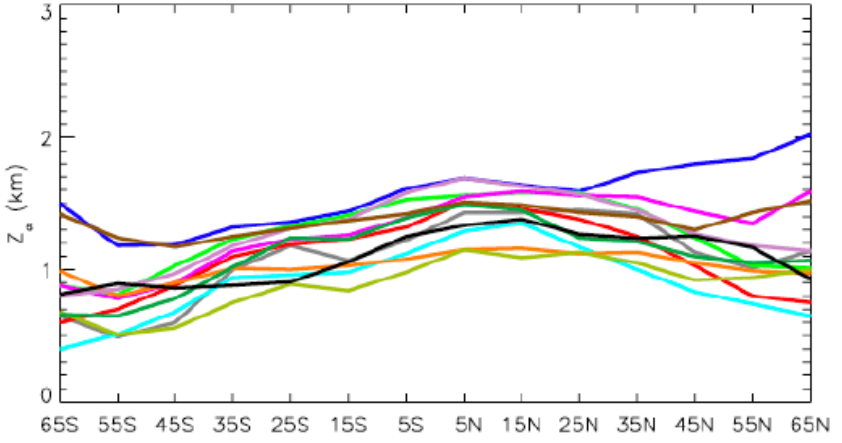


b)



Z_α



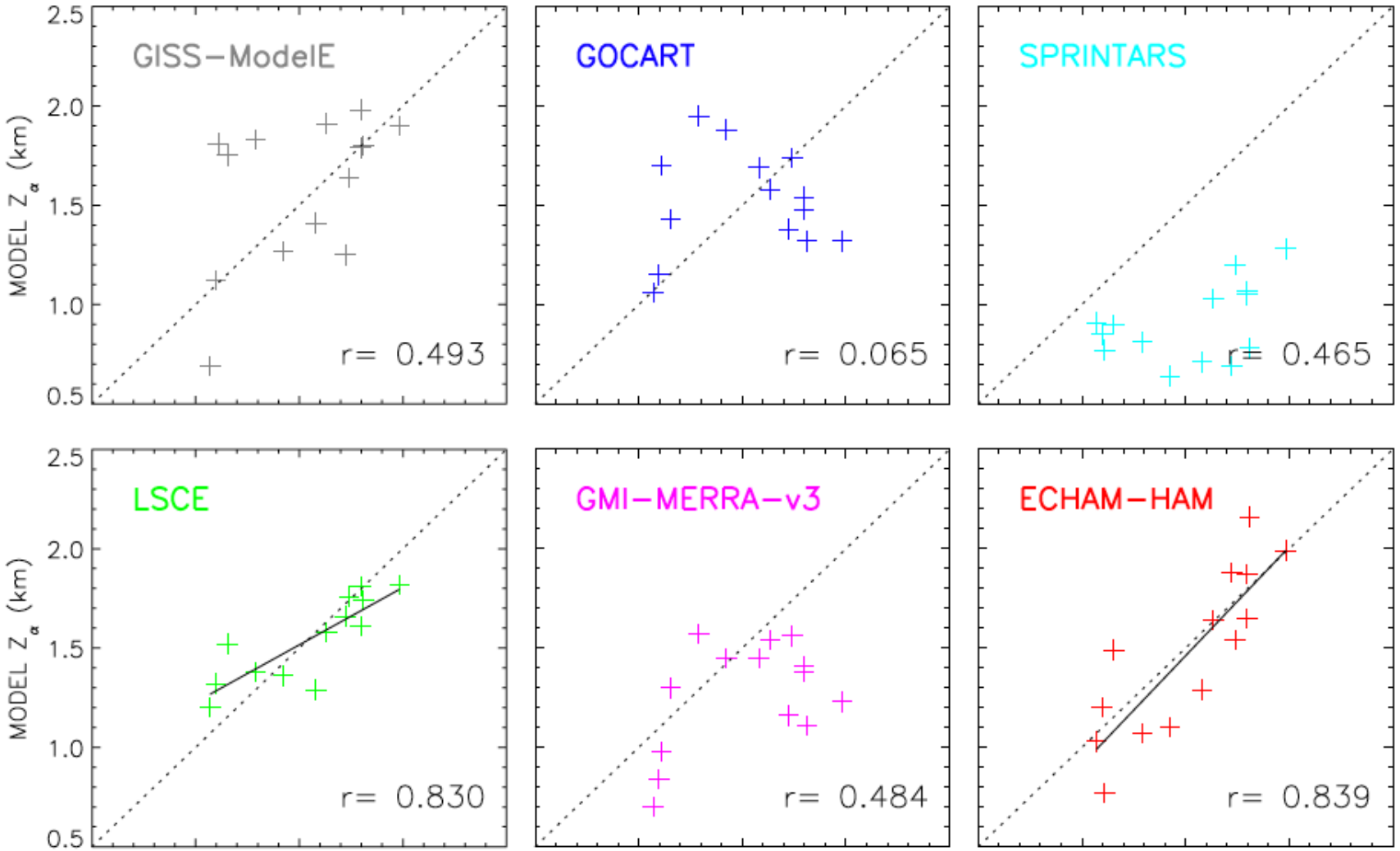


65S 0 65N

65S 0 65N

Z_α comparison 70° S to 70° N, over land

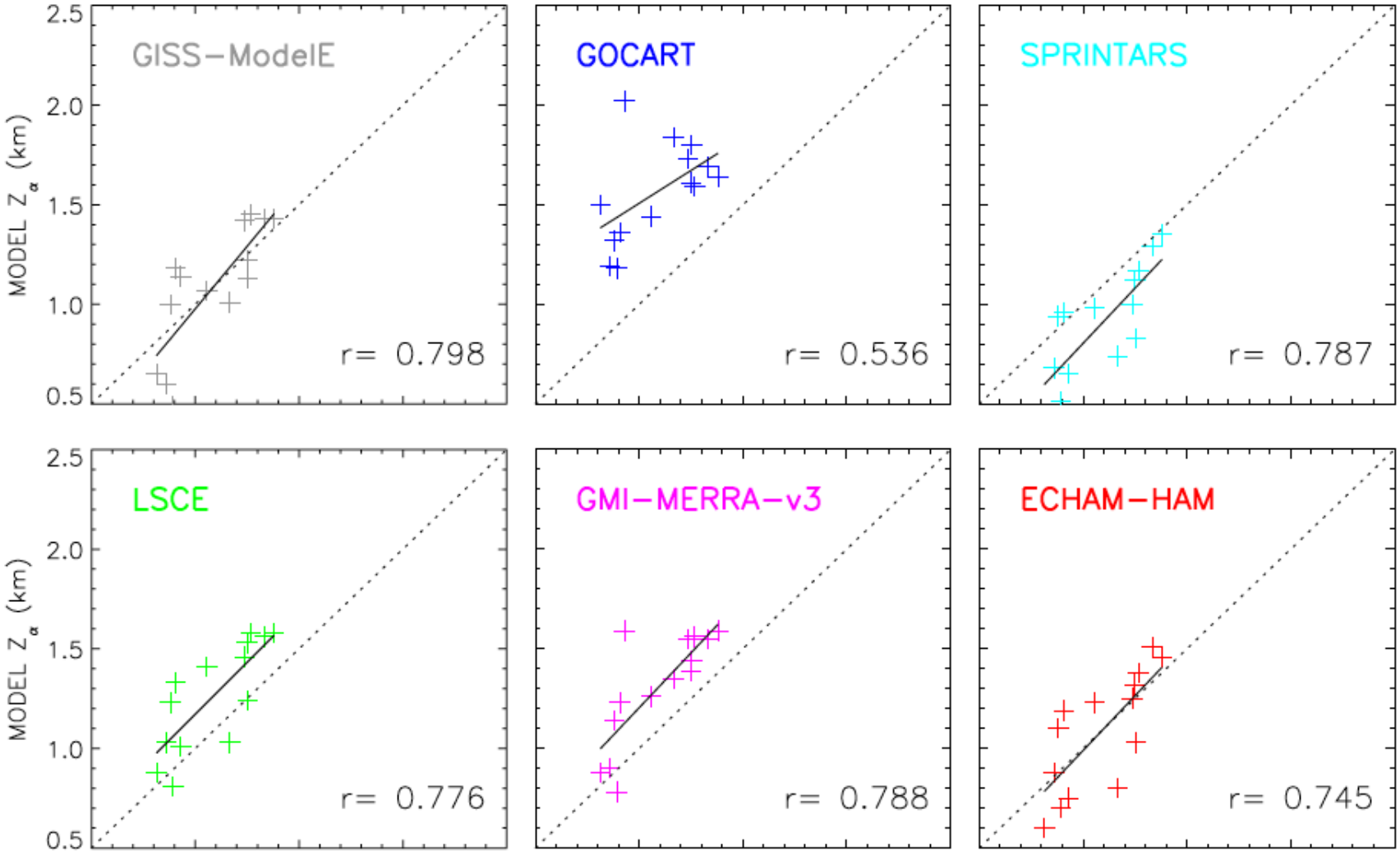
Each point one 10° Latitude band



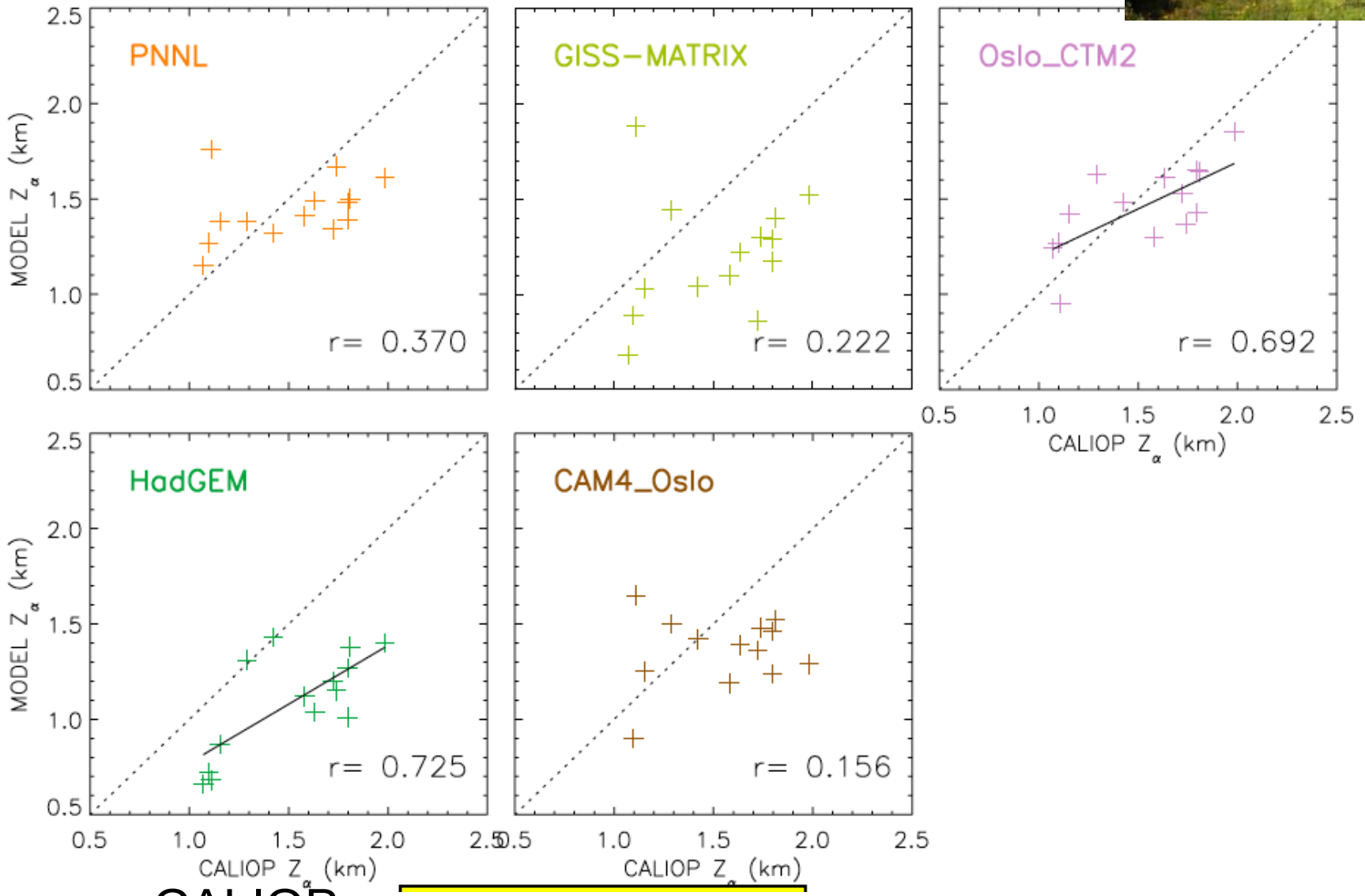
Model

CALIOP

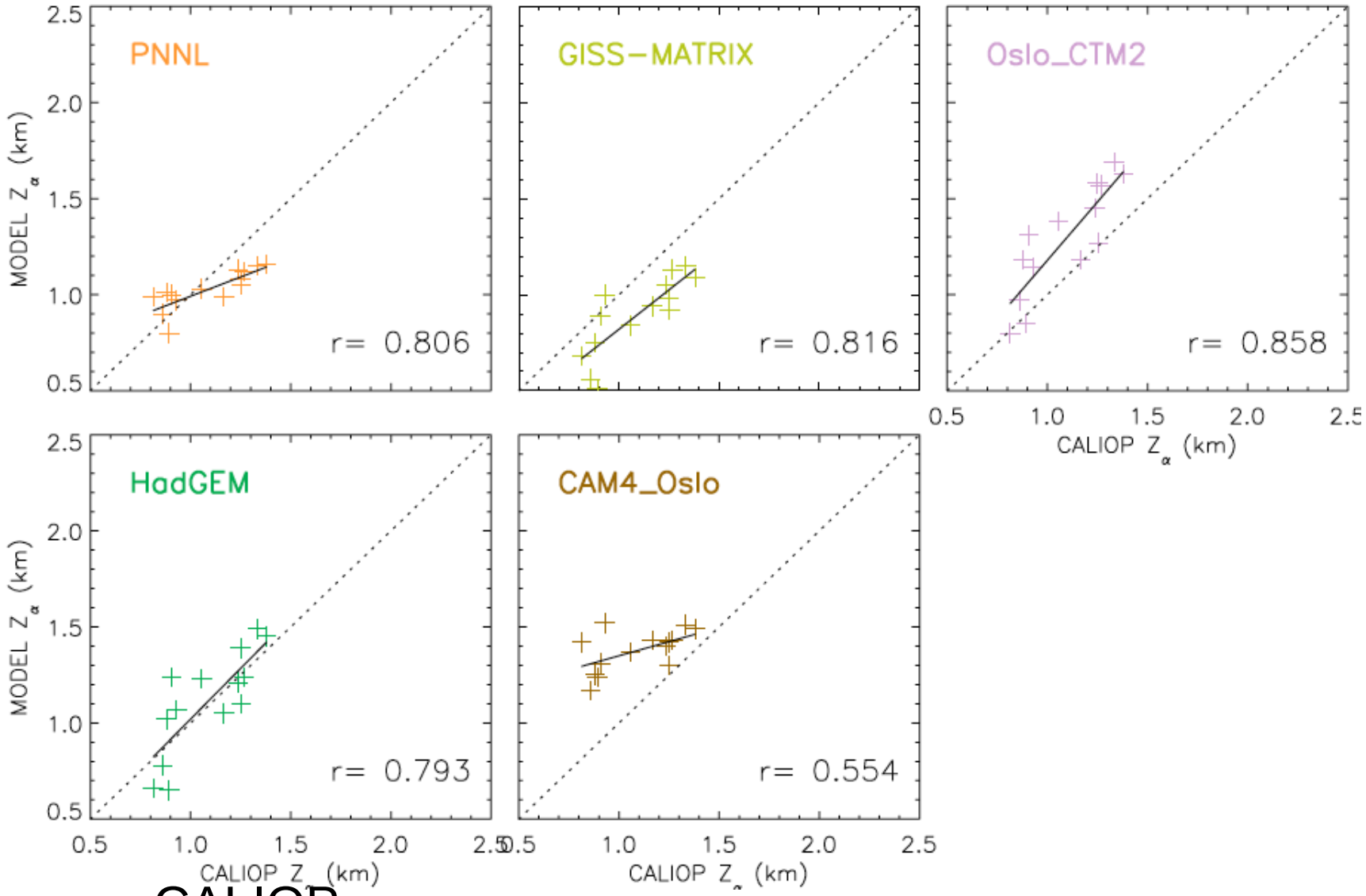
Z_α comparison 70° S to 70° N, over ocean
Each point one 10° Latitude band



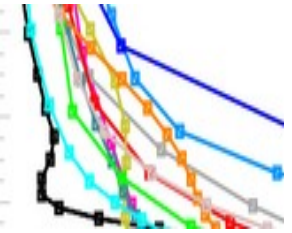
Z_α comparison 70° S to 70° N, over land
Each point one 10° Latitude band



Z_α comparison 70° S to 70° N, over ocean
Each point one 10° Latitude band



Summary



Phase II results have been processed and sent around

Upper troposphere and boundary layer pose still problem for Caliop interpretation

0-6 km Zα seems to be robust diagnostic for comparison

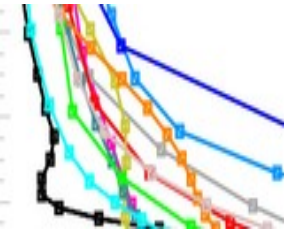
Vertical aerosol profiles over land seem to be more diffcult to capture for models (nearer to main sources, fires, convection and wet removal, hilly terrain?)

Spread in extinction height from different oceanic latitudes is better correlated to model extinction height = significant model under/over-estimates

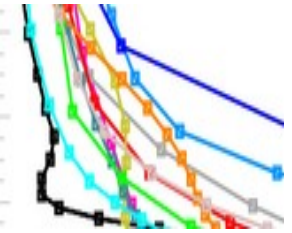
Next steps:

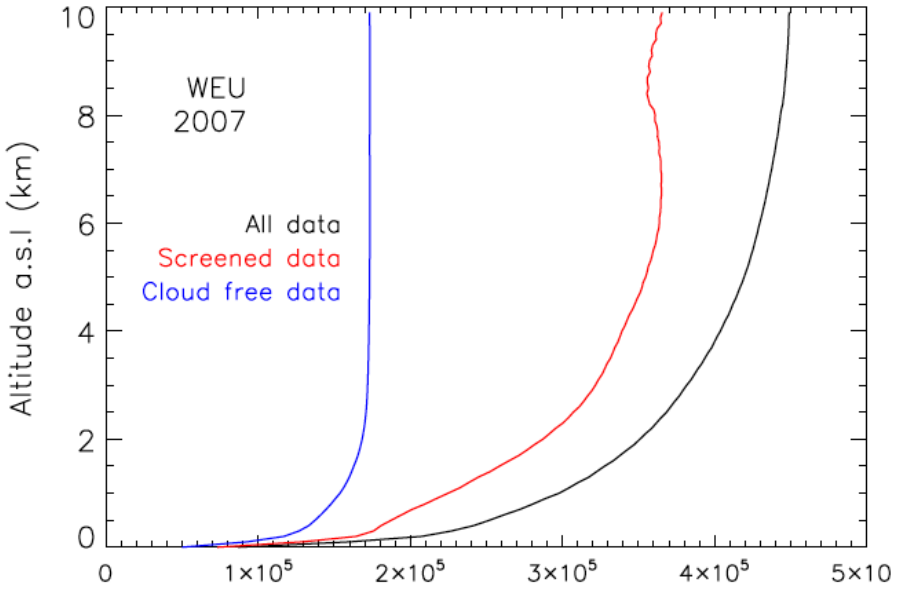
- Write up of phase II results
- Investigation of smaller regions, eg downwind of source regions

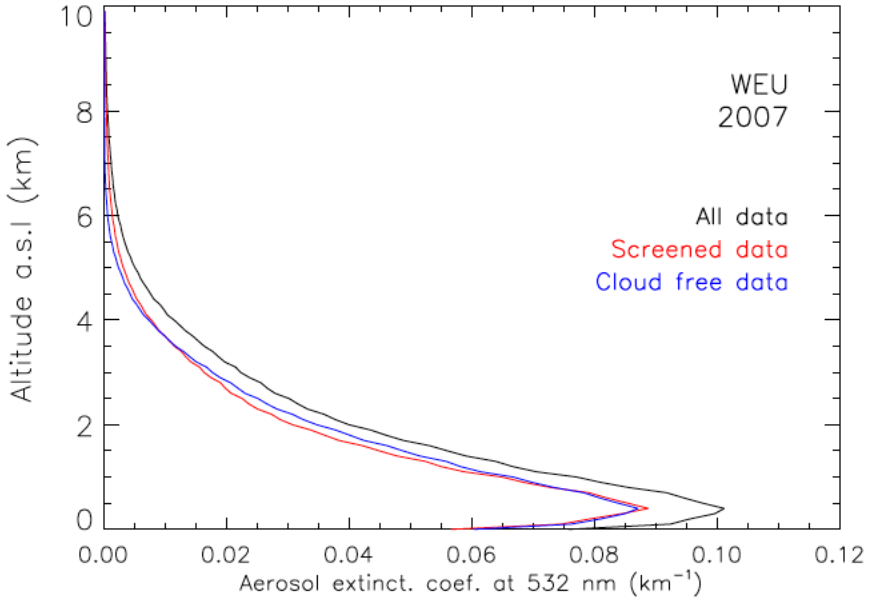
Last years graphs



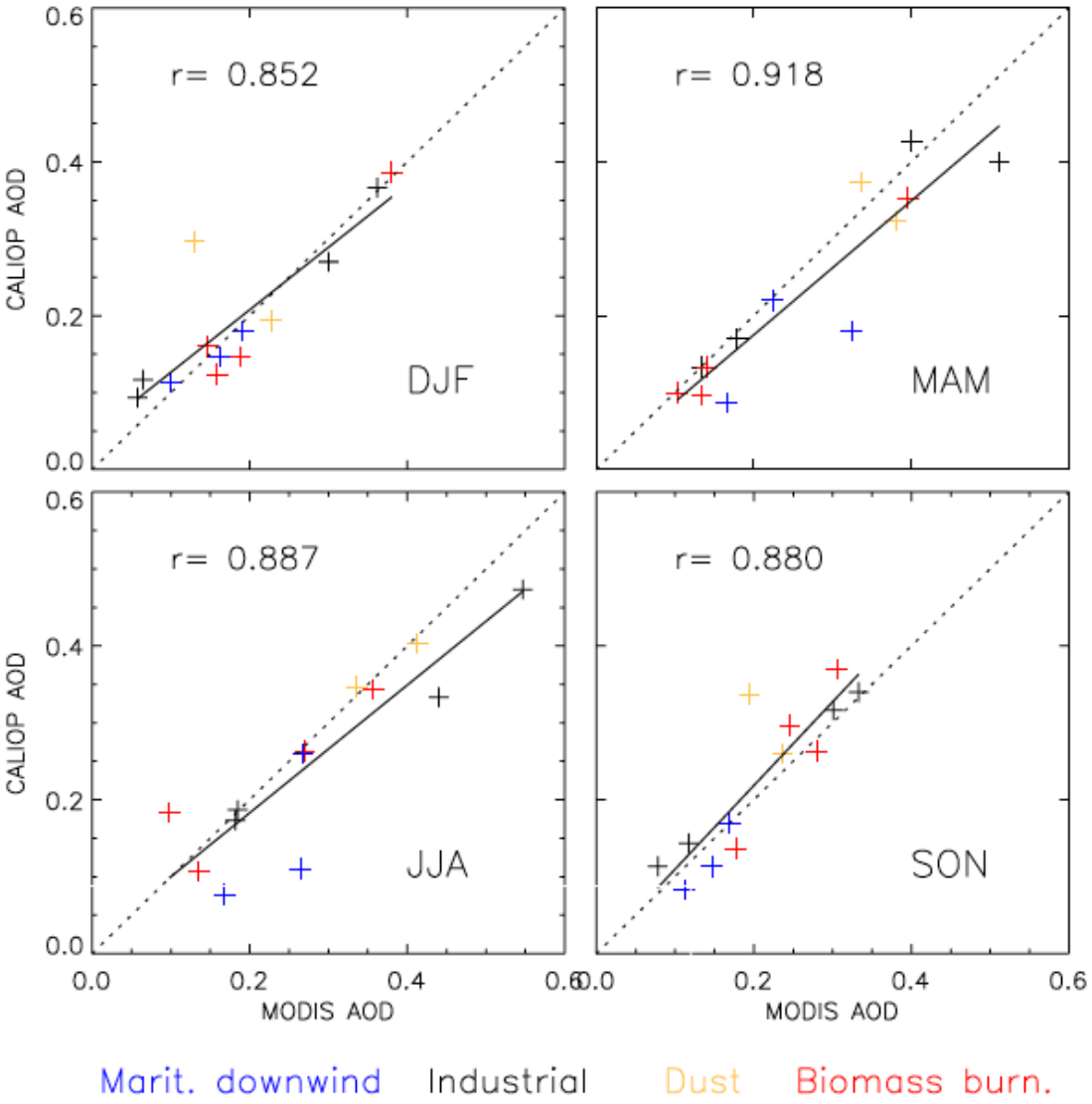
Caliop profile example Western Europe 2007



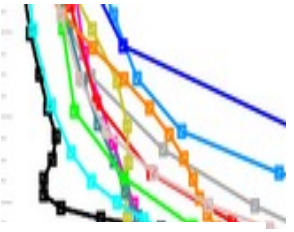


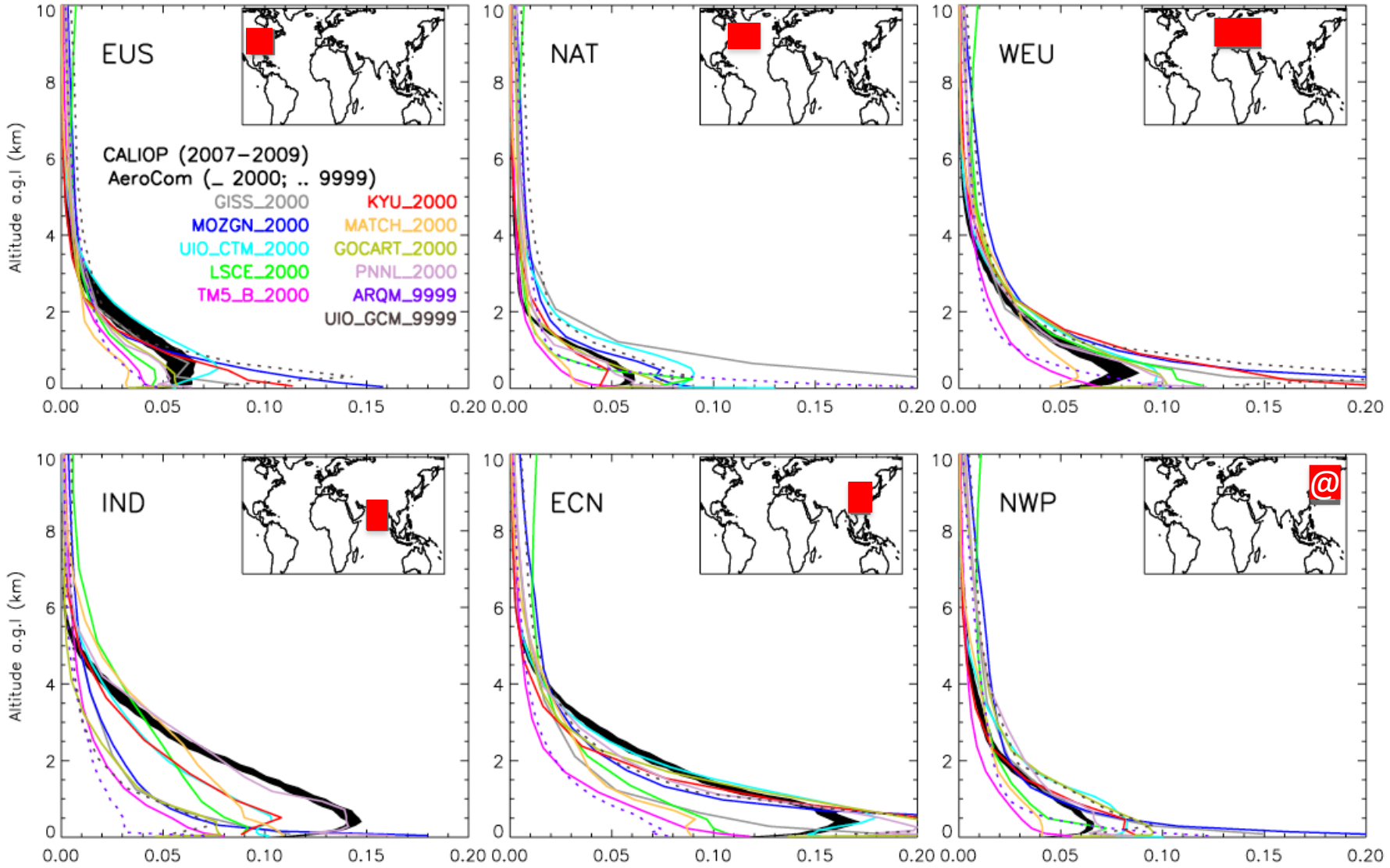


Comparison of AOD in all regions against MODIS



Mean profiles CALIOP Against model profiles

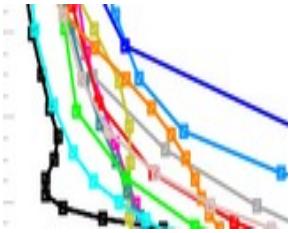


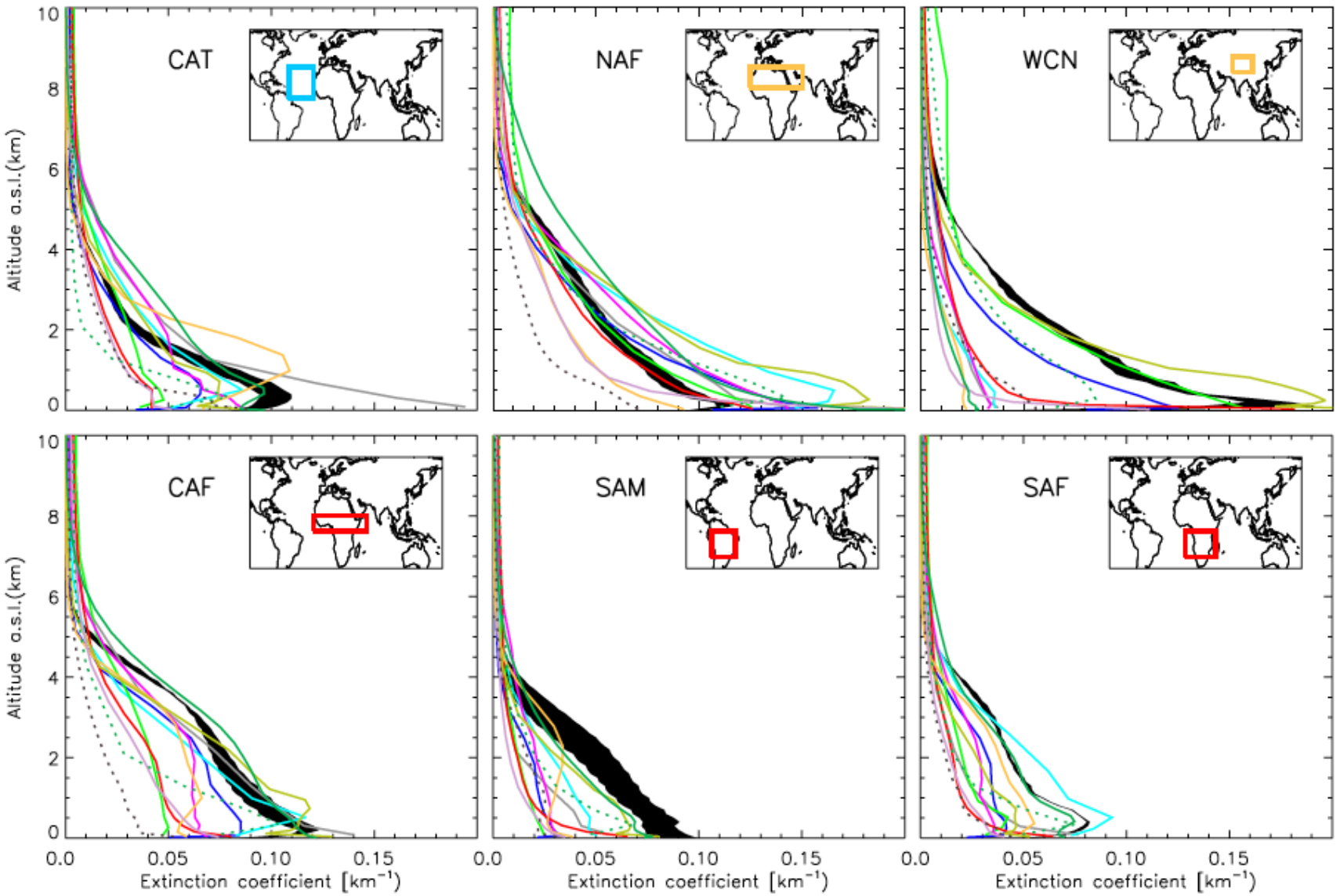


CALIOP vs MODELS

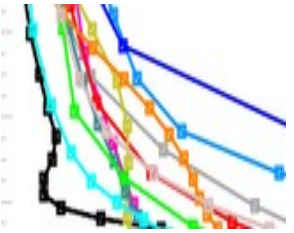
Koffi et al; submitted to JGR 2011

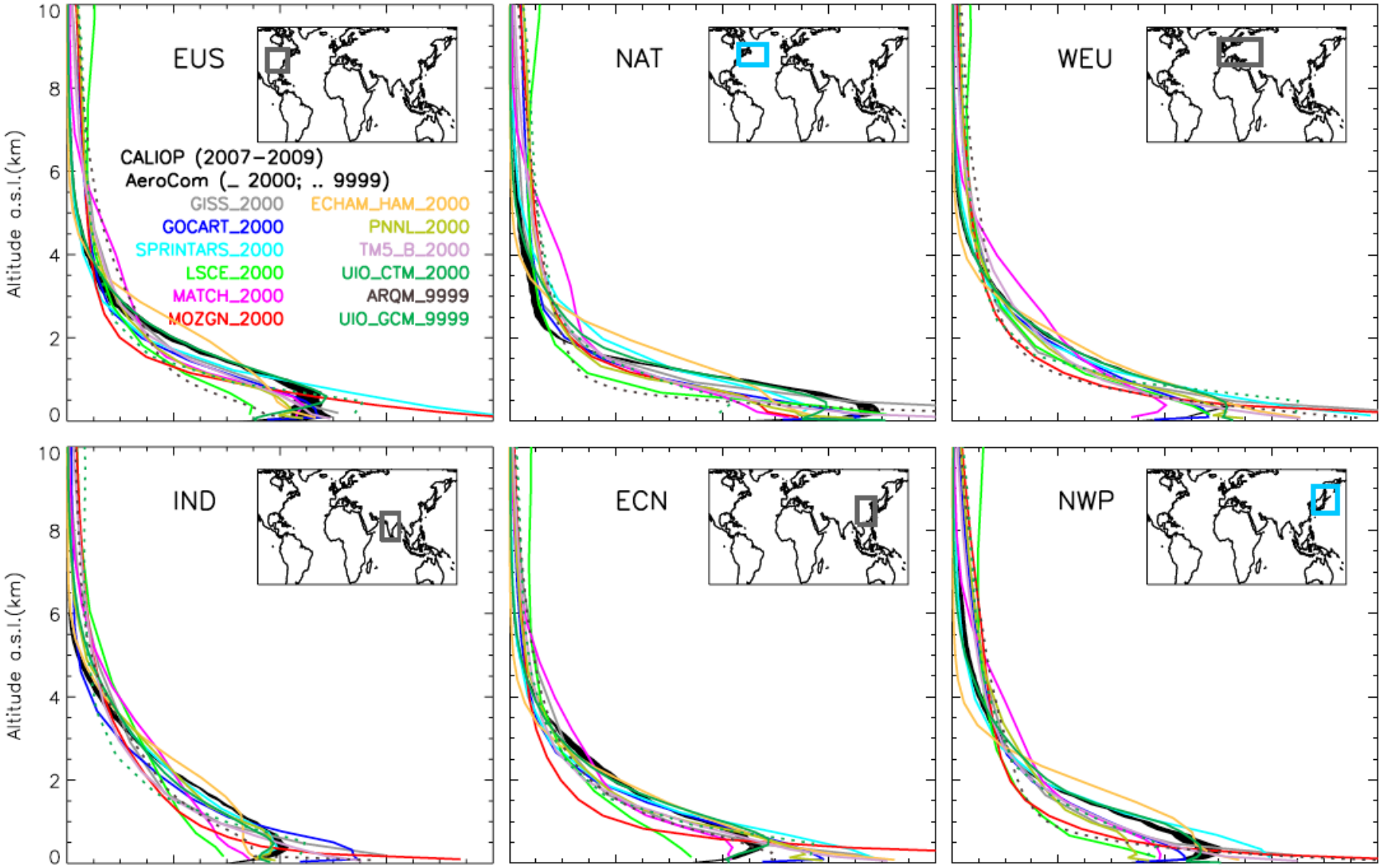
Mean profiles CALIOP
Against model profiles



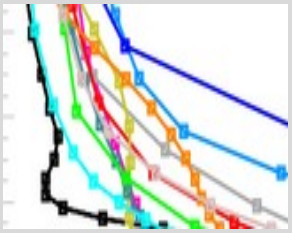


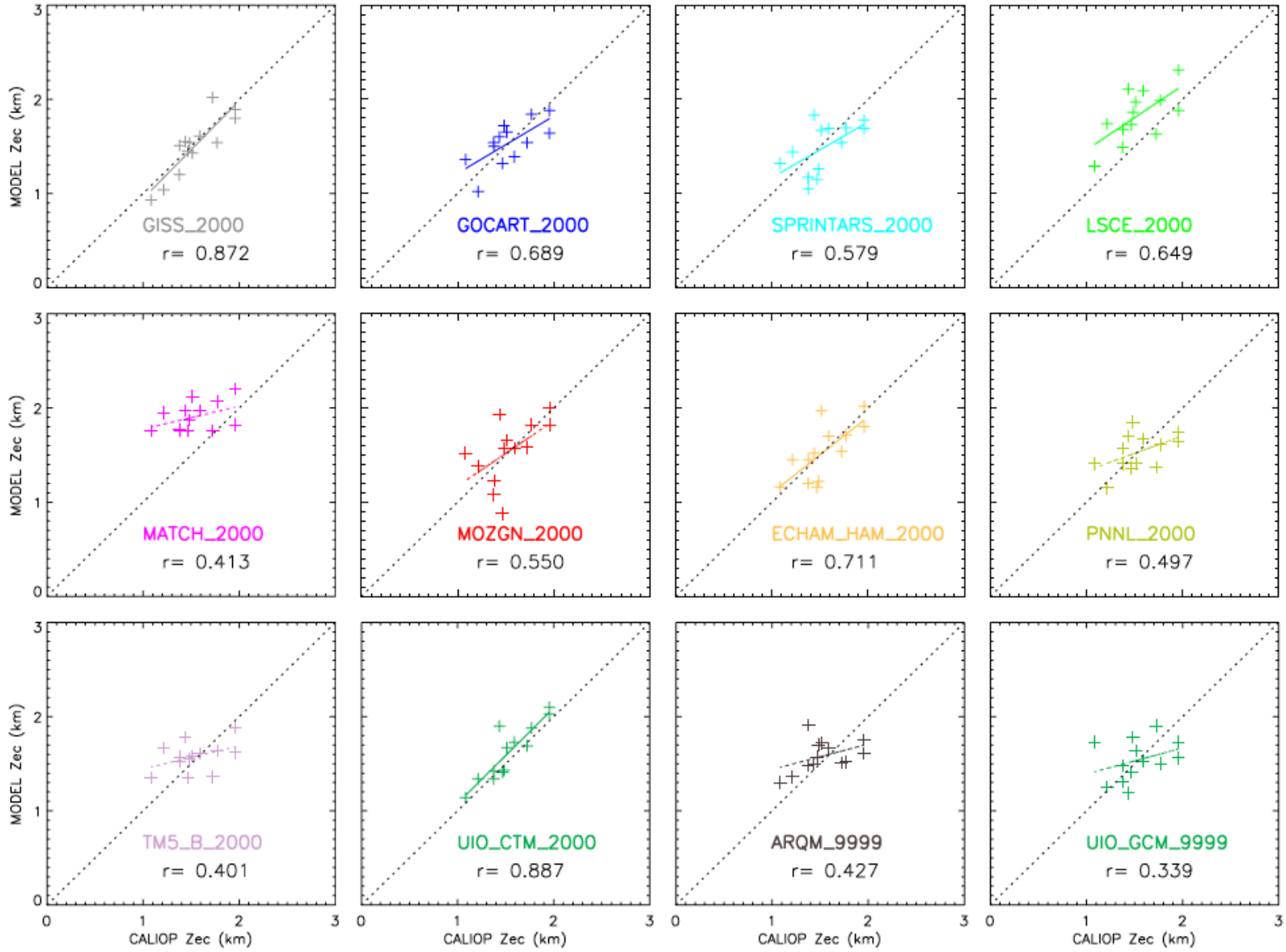
Normalized profiles CALIOP Against model profiles



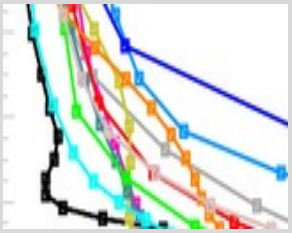


Characteristic Height of Aerosol Extinction [km] below 6 km Model vs CALIOP





Vertical distribution of aerosol particles
Advection of High Level Dust



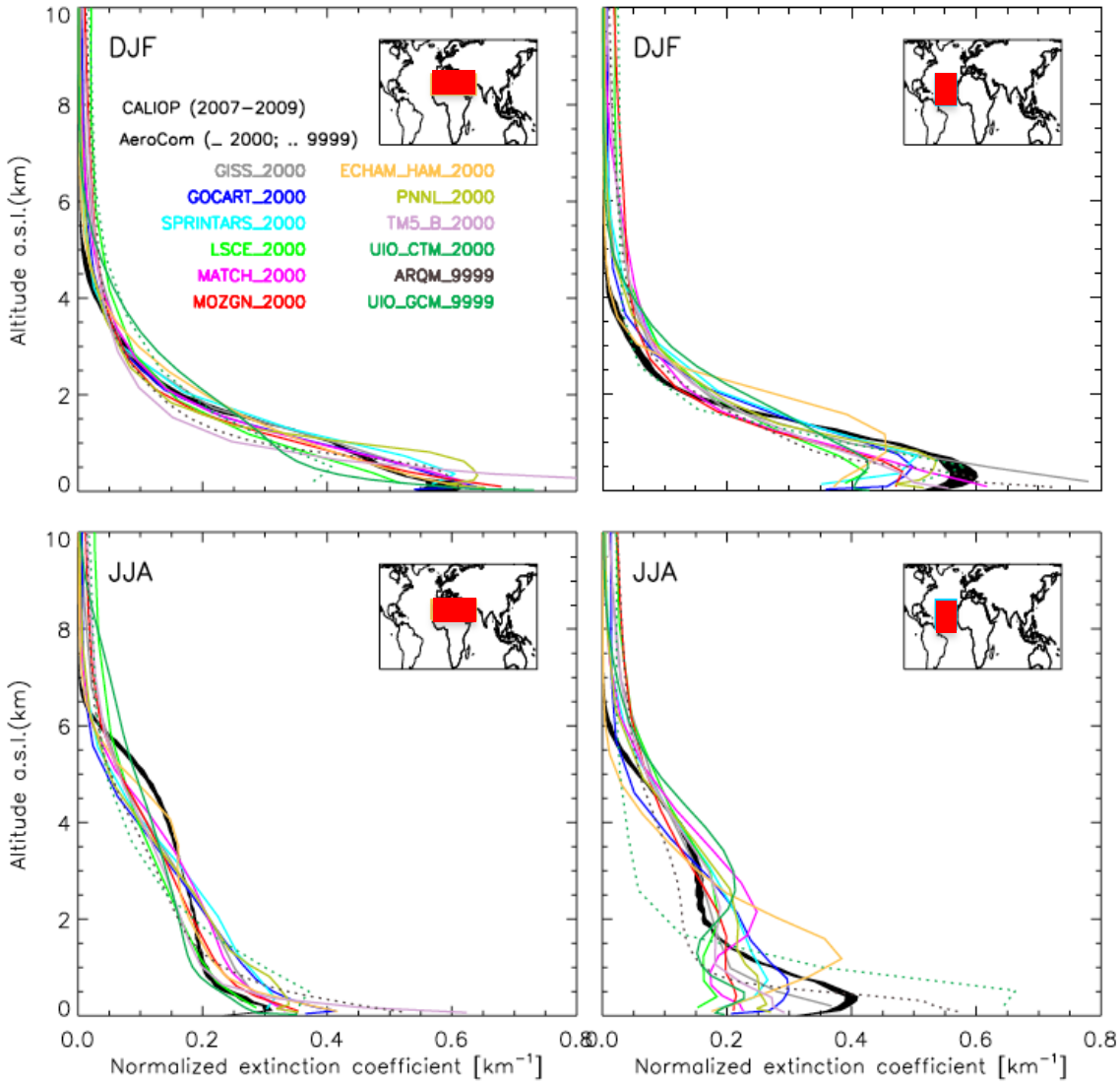
Normalized Aerosol Extinction CALIOP vs MODELS

NORTH AFRICA

CENTRAL ATLANTIC

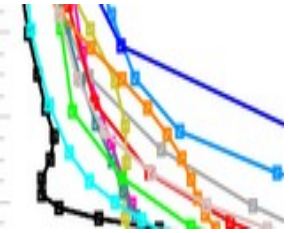
winter

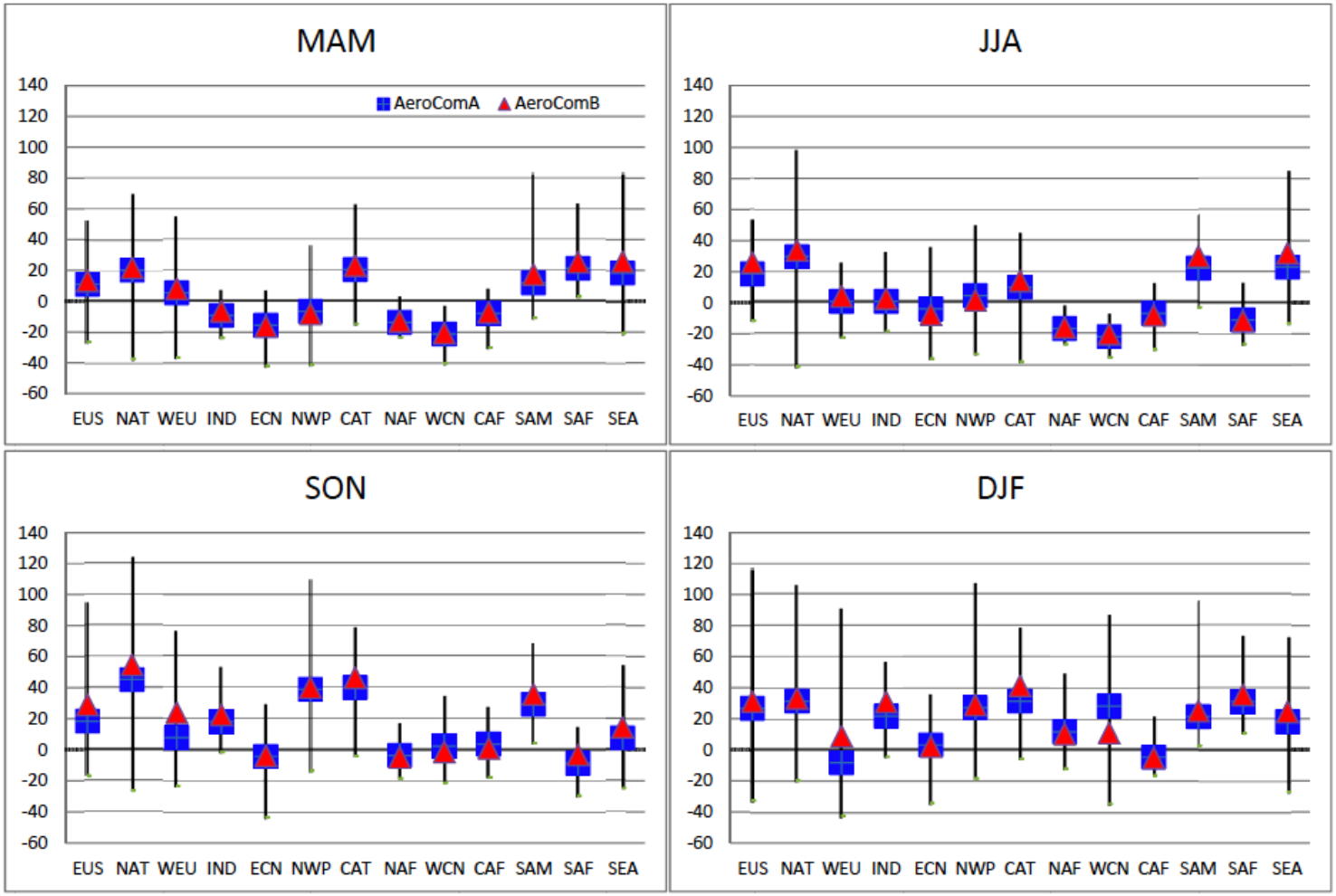
summer



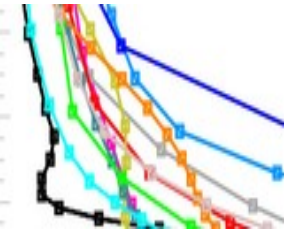
Koffi et al; submitted to JGR 2011

Characteristic Extinction Height BIAS in different regions & seasons AeroCom A versus B





Conclusions & Outlook



A robust set of Caliop extinction profiles was created, differing amazingly little in between years, being more smooth near ground using version 3.

Correlation with Modis suggests model extinction profiles can be evaluated quantitatively, eg underestimate over India in AeroCom A models

Overestimation of characteristic height in some regions by some models (profile below 6km better than upper tropospheric extinction)

Normalized profiles suggest eg differences in dust profile over Atlantic

Height is characteristic of a given model (no diff between A and B experiment)

How different is AeroCom phase II model
Which consequence for forcing of different profiles?
Which processes are responsible for diversity in profiles?