AEROCOM: Global Aerosol Models Tested Against Surface Observations

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Strategy

Adress the multi-parameter aerosol problem from the angle of multi-model evaluation with observations from the surface (e.g. AERONET, IMPROVE, EMEP, GAW,…)

Models / measurements comparisons :

- model output to 366 station locations
- collection of observational data (from web sites)
- analysis of time series, global maps and scatter plots

Considered parameters :

Sulfate, sea-salt, black carbon and POM surface concentrations

Optical depth at 550 nm

Angstrom coefficient

All comparisons available on

http://nansen.ipsl.jussieu.fr/AEROCOM/DATA/surfobs.html

Participating Models

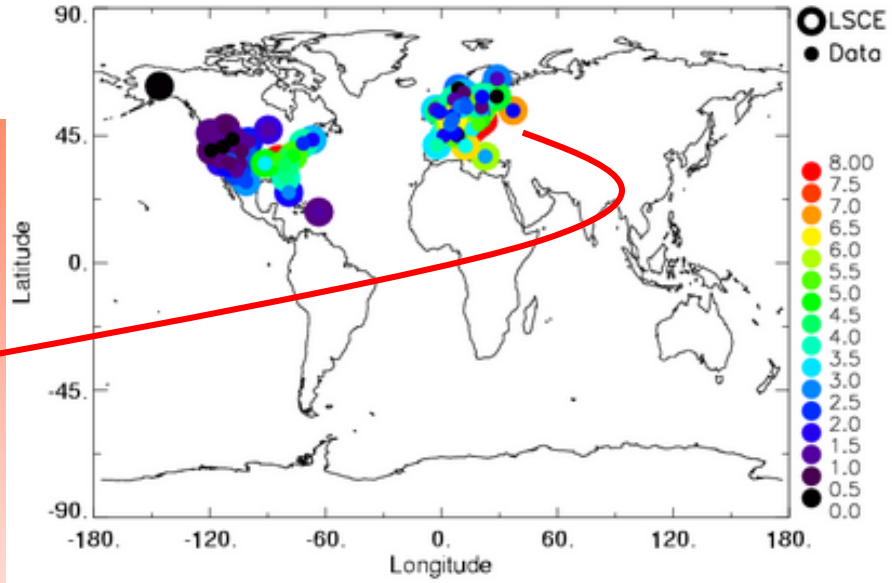
Currently 12 models in AEROCOM but choice of
5 models with output in 2000 (reference year)
+ 1 model with climatological run (example)

Sprintars KYU	LOA Lille	INCA	MATCH	MIRAGE	ULAQ
University of Tokyo, Japan T. Takemura	LOA CNRS / USTL, France O. Boucher S. Reddy	LSCE, France D.Hauglustaine M. Schulz Y. Balkanski C. Textor	NCAR, Boulder, US D. Fillmore W. Collins P. Rasch D. Bundy A. Conley	PNNL, US R. Easter S. J. Ghan	Univ. Aquila, Italy G. Pitari E. Mancini V.Montanaro

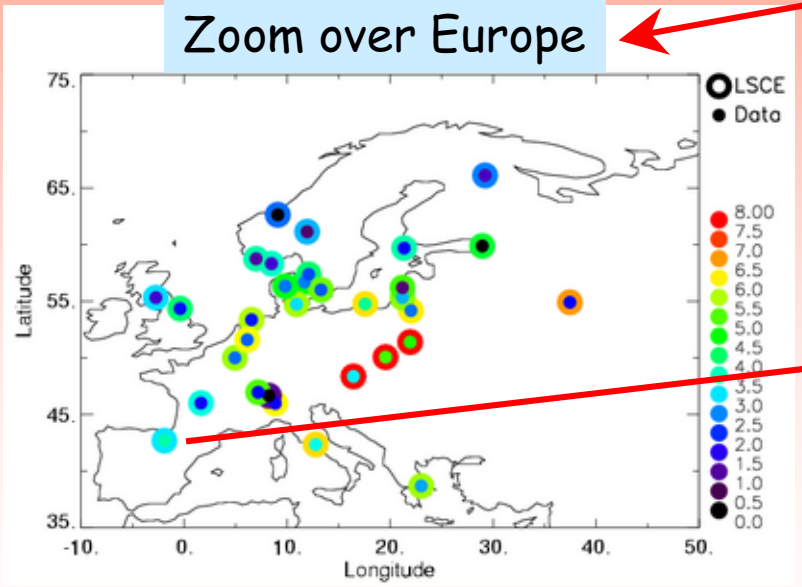
SO_4 surface concentration : map

Models versus surface observations (EMEP, IMPROVE) world, yearly average values

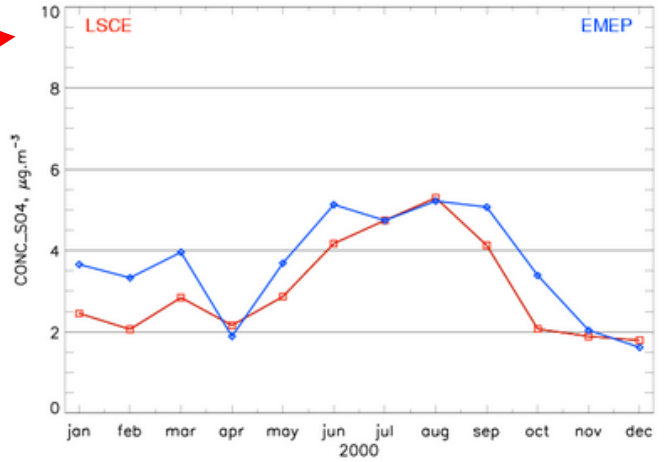
SO_4 concentration ($\mu g.m^{-3}$) for 2000



Zoom over Europe



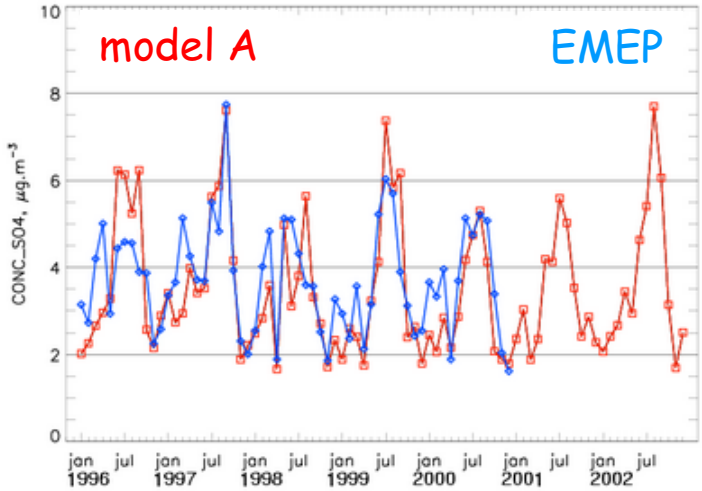
Logrono, Spain



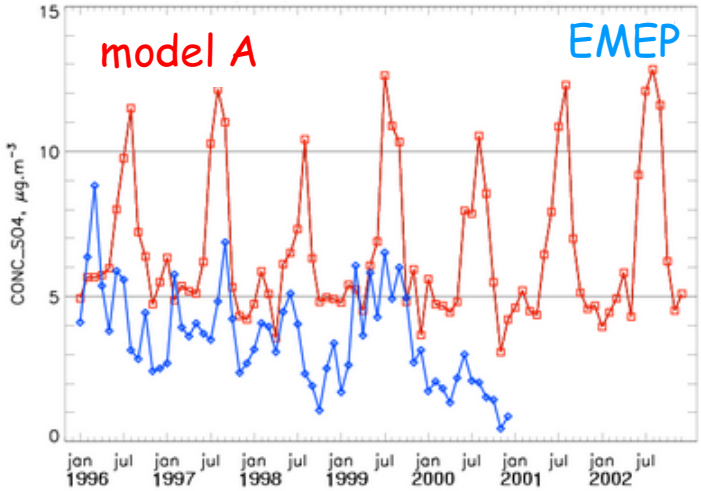
time series comparison for 2000

SO_4 surface concentration: time series

Logrono, Spain : 1996-2002

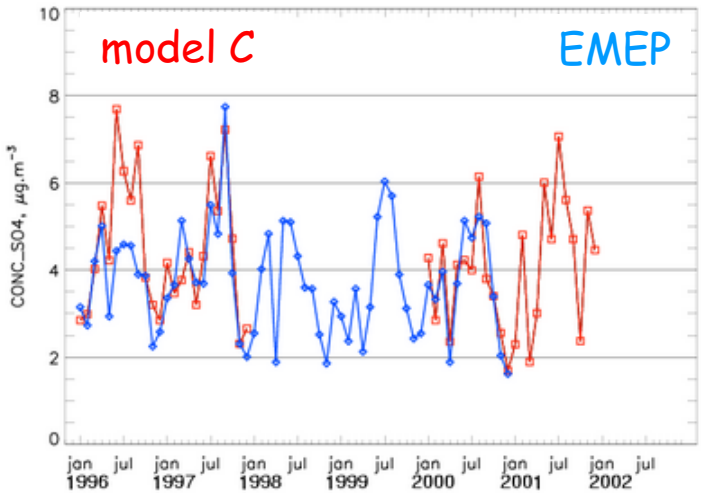


Ispra, Italia : 1996-2002

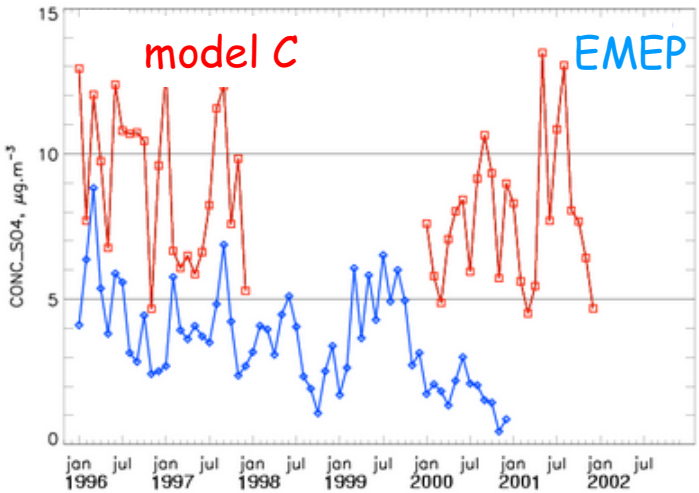


Use of same SO_4 emission data each year $\Rightarrow$ problem with emission scenarios ?

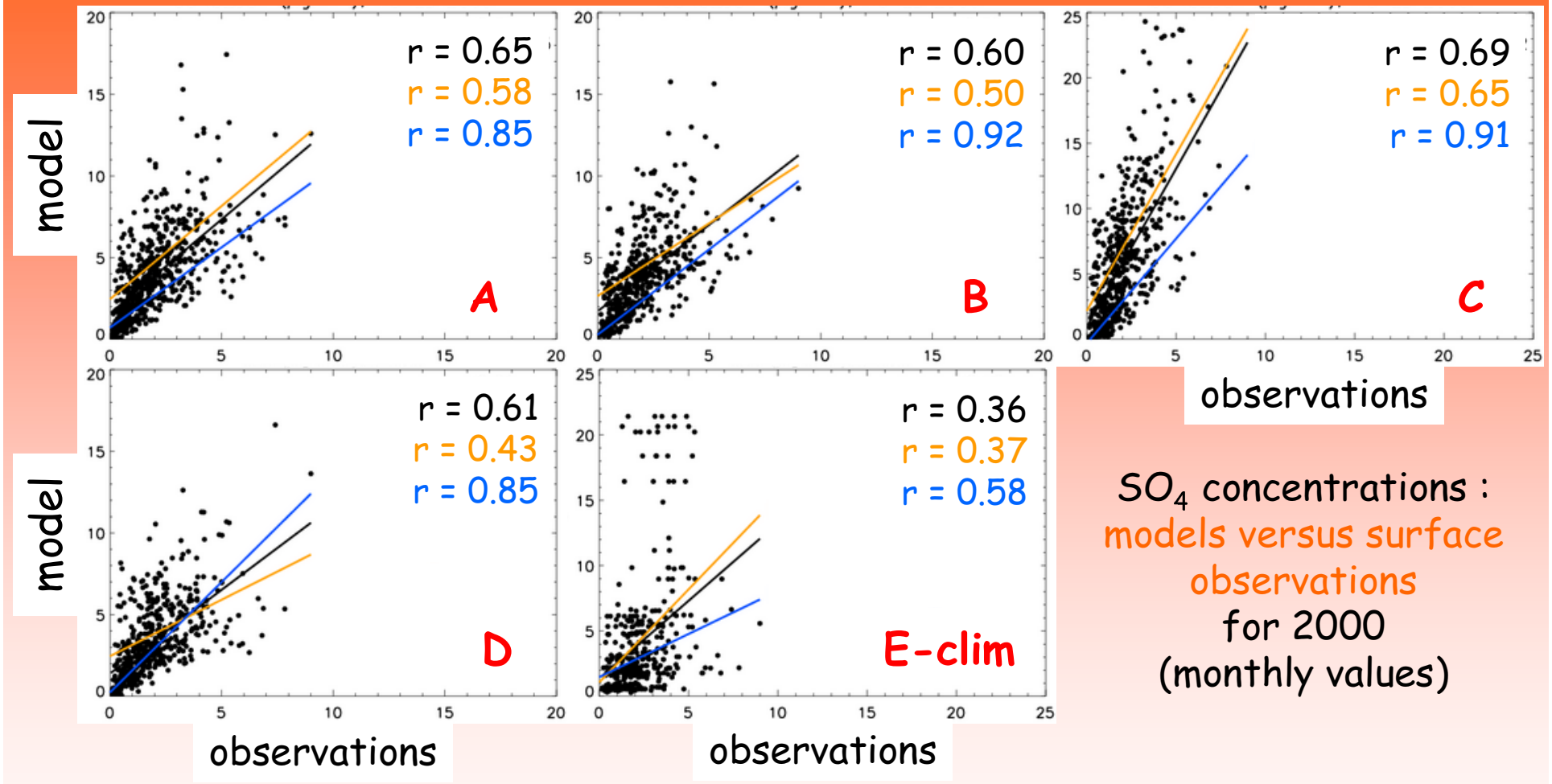
Logrono, Spain : 1996-2002



Ispra, Italia : 1996-2002



SO_4 surface concentration: scatter plots



SO_4 concentrations : models versus surface observations for 2000 (monthly values)

≈500# **Global** : slightly overestimated (within 20%) except model C

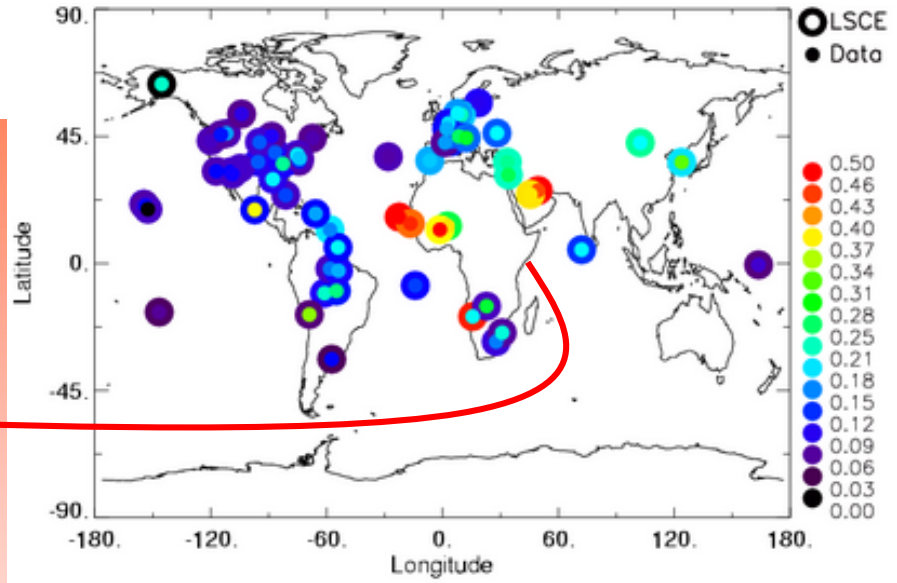
≈350# **Europe** : dominates global results

≈150# **North America** : better agreement than in Europe except D

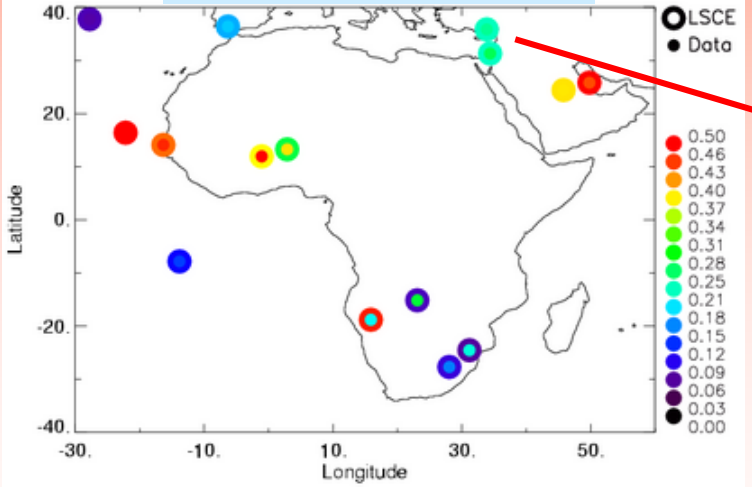
Optical depth at 550 nm : map

Models versus AERONET
surface observations
world, yearly average values

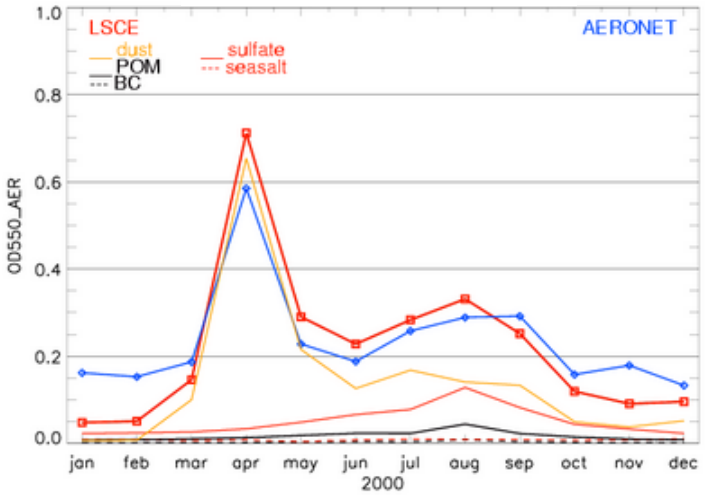
AOD at 550 nm for 2000



Zoom over Africa

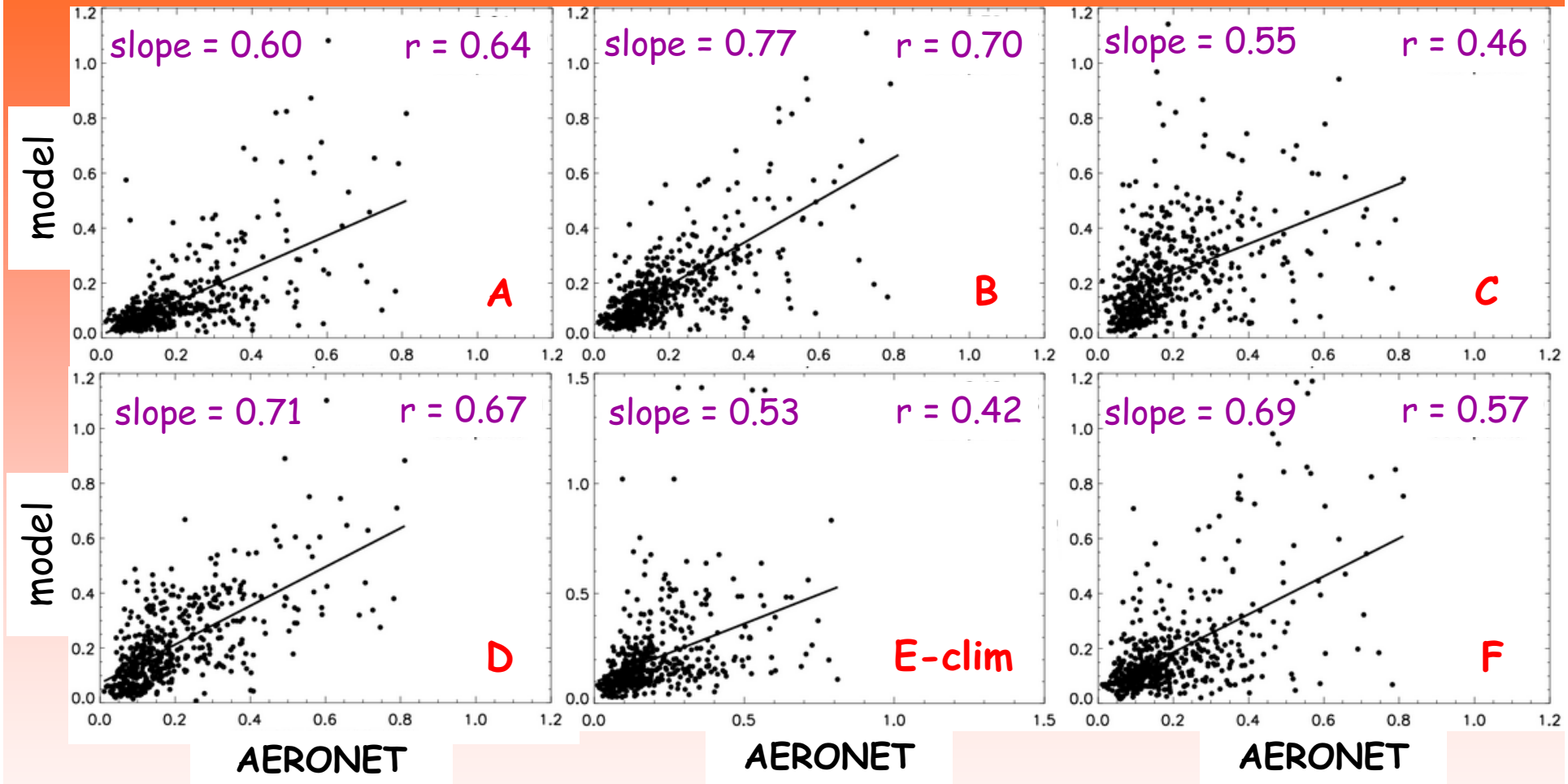


Erdemli, Turkey



time series comparison for 2000

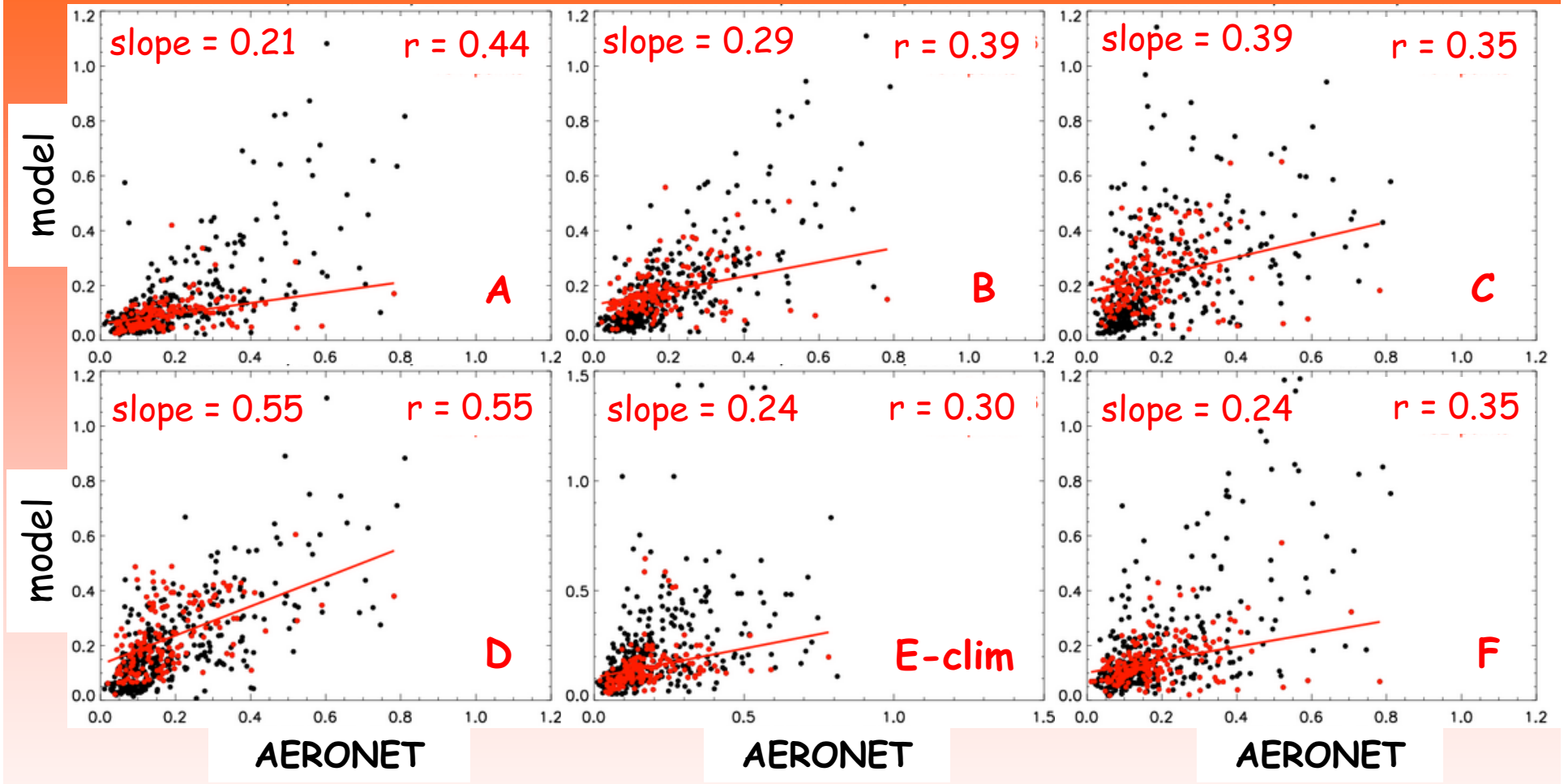
Optical depth at 550 nm : scatter plots



models versus AERONET observations for 2000 (monthly values)
Global, 506 points

⇒ **small underestimation of AOD by all models**

Optical depth at 550 nm : SO_4 dominated



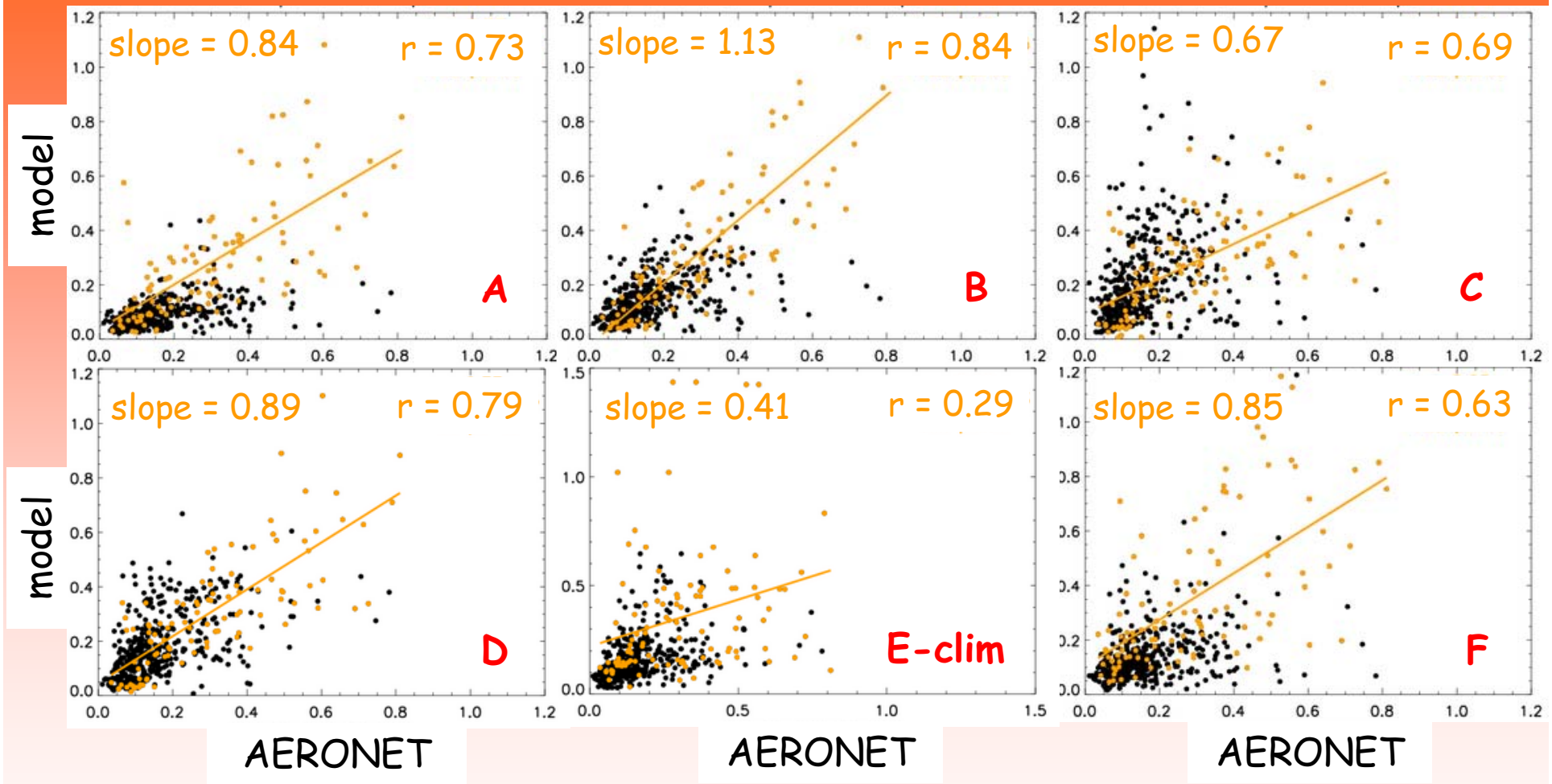
subsample of cases where modelled $\overline{SO_4\ OD} > 50\%\ \overline{total\ OD}$, 182#

⇒ AOD underestimated at least by 50% by all models

BUT SO_4 surface concentration better matched

↳ Problem with optical properties ? ↳ Problem with physical processes ?

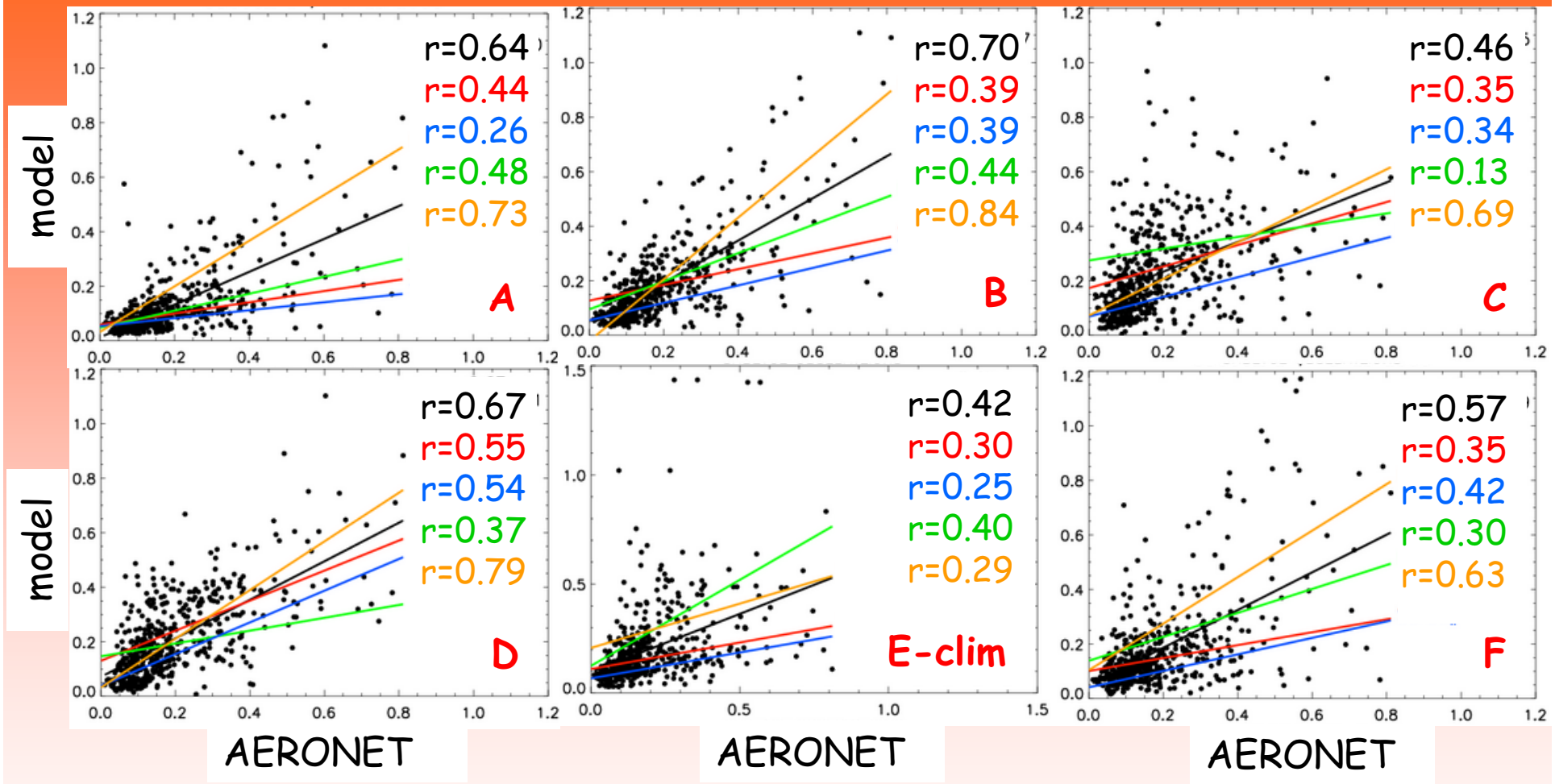
Optical depth at 550 nm : dust dominated



subsample of cases where modelled $\overline{\text{Dust OD}} > 40\% \ \overline{\text{total OD}}$, 102#

⇒ good agreement of AOD between models and obs
except for climatological run

Optical depth at 550 nm : all components



GLOBAL + species conditions

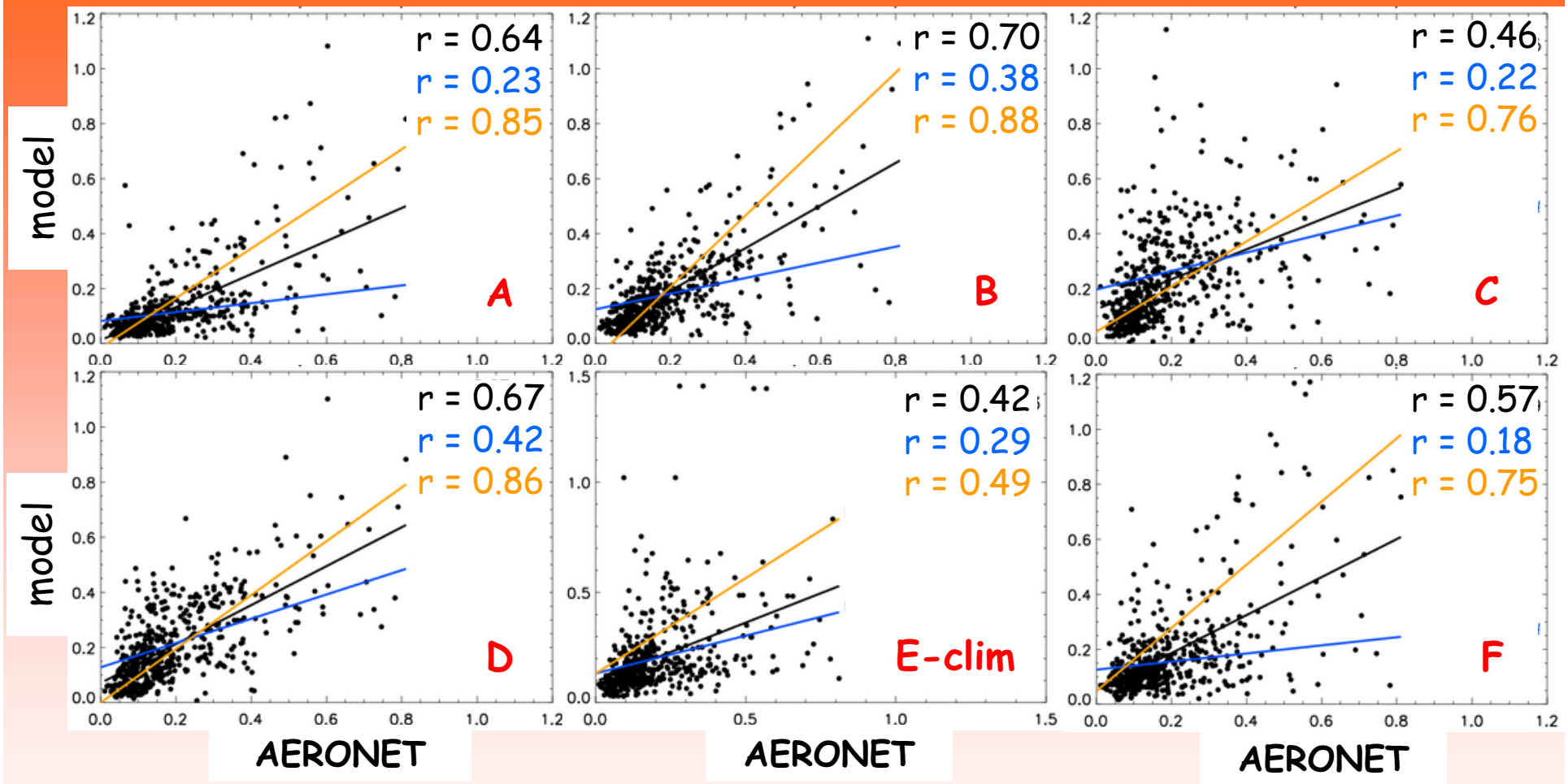
SO_4 OD > 50% total OD, 182 points

SS OD > 20% total OD, 53 points

BC+POM OD > 40% total OD, 71 points

Dust OD > 40% total OD, 102 points

Optical depth at 550 nm : particle size



GLOBAL + 2 subsamples based on AERONET r_{eff}

r_{eff} < 0.5 μm, 167# r_{eff} > 0.5 μm, 68#

⇒ underestimation of AOD predicted for small particles (SO_4, BC+POM ?)

⇒ good agreement of AOD predicted for large particles (cf dust)

Conclusion

Work in progress !!

- so far 6 of ~12+x? global aerosol models compared to observations

Significant differences in model performance appear

(correlation coef to monthly AOD Aeronet Obs ranges from 0.42-0.70)

Higher resolution does not improve results a priori (model C)

Different emission scenarios make evaluation difficult

(motivation for AEROCOM Experiment B prescribed sources)

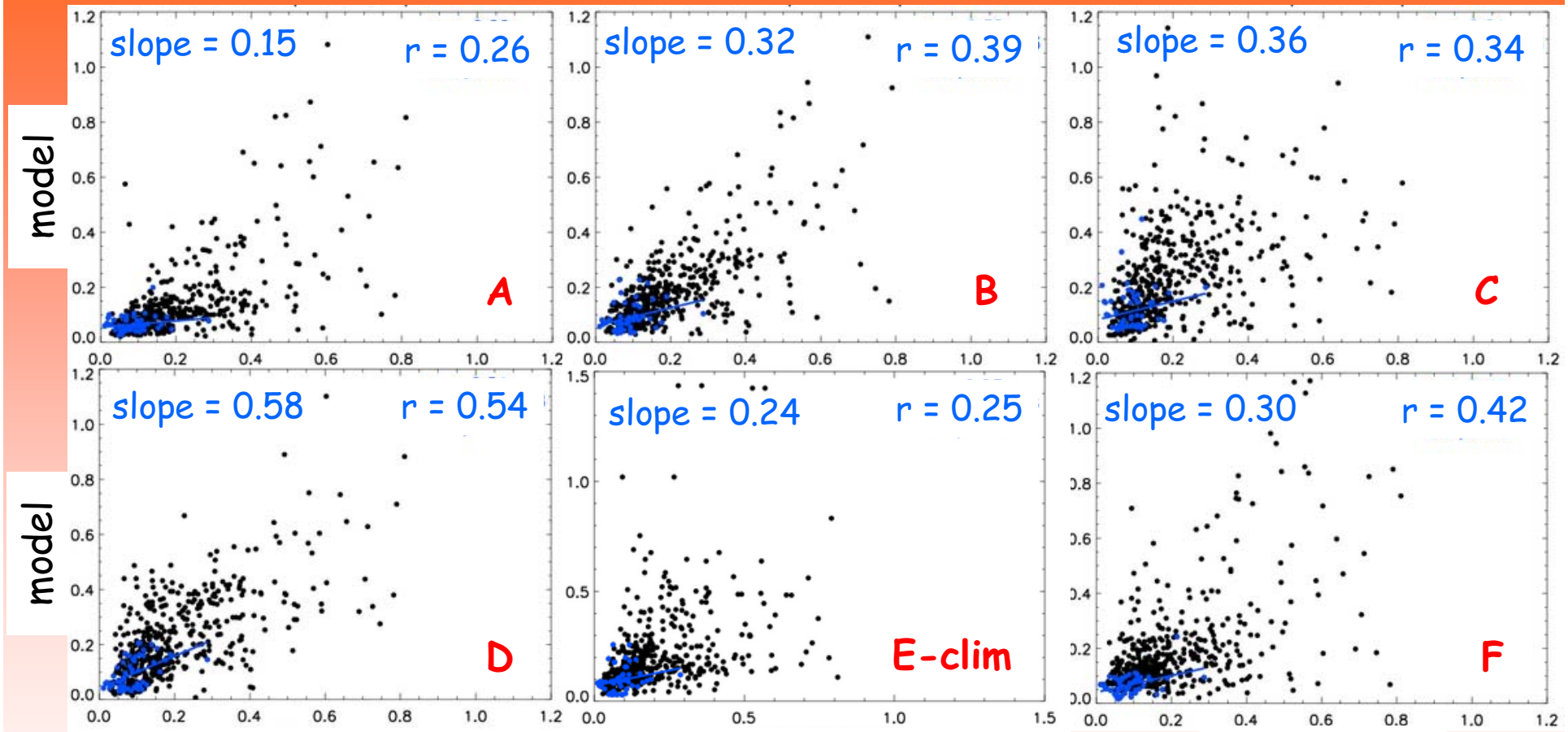
BUT some features reappear:

* Trend of regional surface sulfate concentrations (eg Europe) is not captured with currently used emission scenarios
* Surface sulfate concentrations slightly overestimated BUT SO4-AOD dominated cases underestimated
* DUST-AOD dominated cases correlate best to AERONET as well as cases with coarse aerosol (based on AERONET obs.)

Perspective:

more data / Exp B / other parameters / process analysis / satellite data / regional analysis / discussion during AEROCOM workshop /

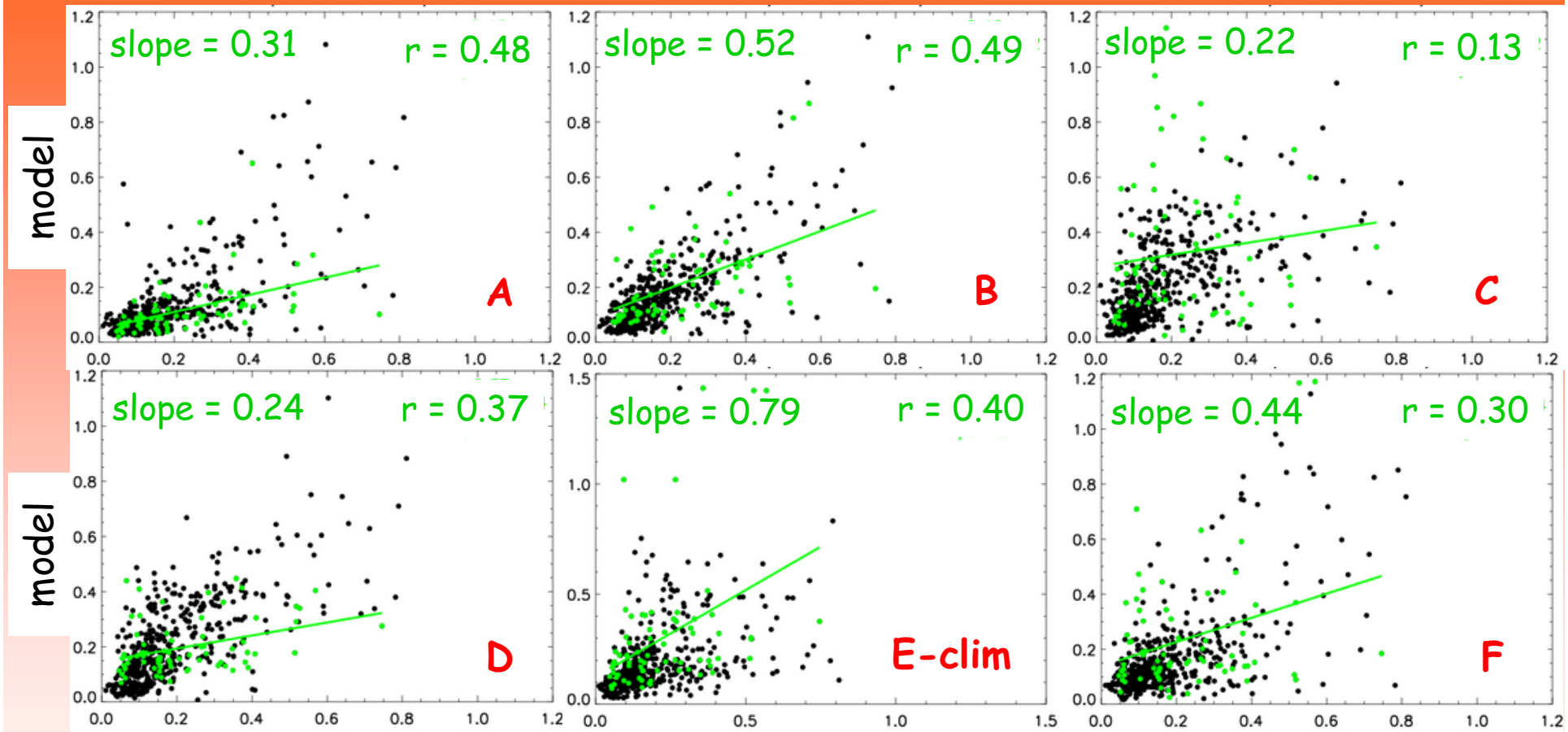
Optical depth at 550 nm : sea-salt dominated



subsample of cases modelled where $\overline{\text{SS OD}} > 20\% \ \overline{\text{total OD}}$, 53 points

⇒ large underestimation of AOD by all models

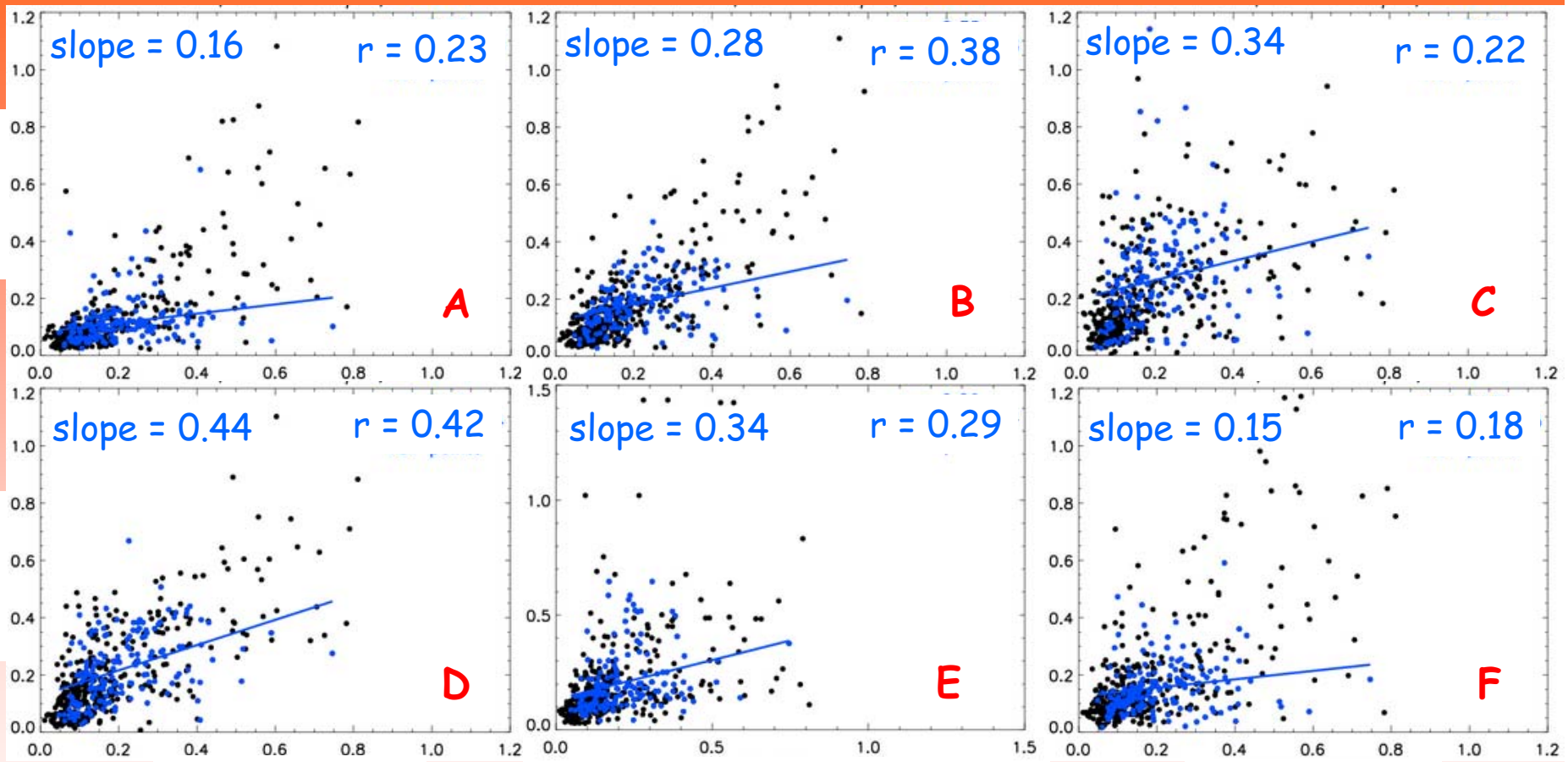
Optical depth at 550 nm : BC+POM dominated



subsample of cases modelled where $\overline{\text{BC+POM OD}} > 40\% \ \overline{\text{total OD}}$, 71#

⇒ AOD underestimated at least by 50% by all models except for climatological run

Optical depth at 550 nm

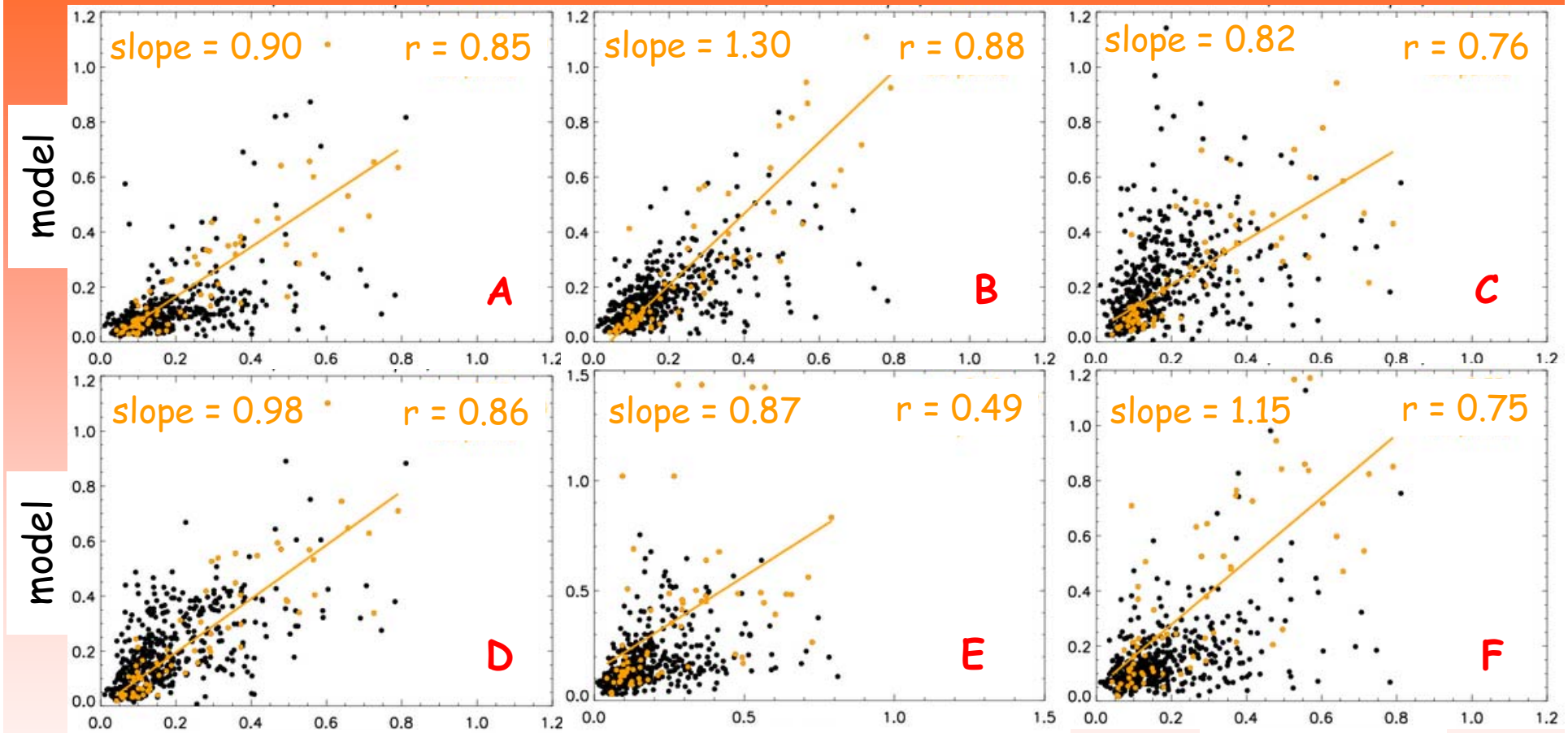


subsample of observations with

$r_{eff} < 0.5$ μm

167points

Optical depth at 550 nm



subsample of observations with

$r_{eff} > 0.5$ μm

68 points