

# Inter-comparing data and models in AeroCom – and beyond

## AeroCom Workshop

23/09/2013

Max Planck Institute for Meteorology  
Hamburg

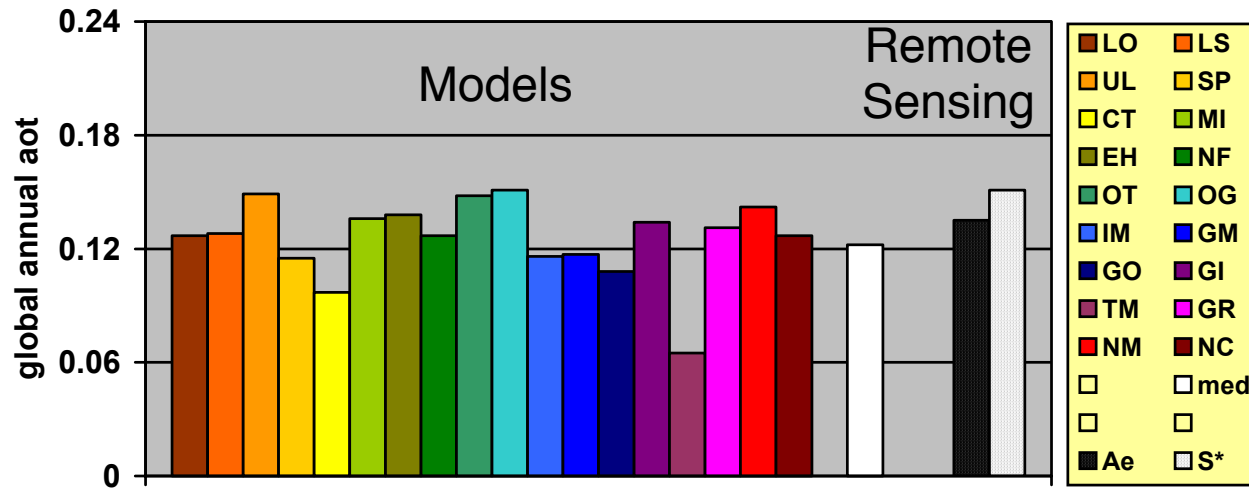
Philip Stier

Climate Processes Group  
Department of Physics  
University of Oxford



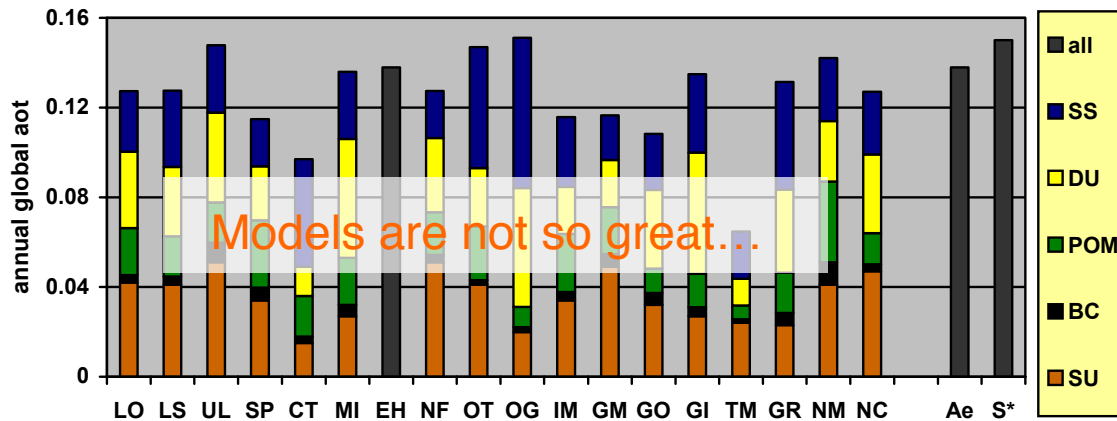
# Aerosol Radiative Properties - Early AeroCom

Aerosol Optical Depth from Models and Satellites (Kinne et al., 2006):



2005: MODEL simulations and its median (white) vs. DATA (dotted)

Fine for global annual mean



Models are not so great...

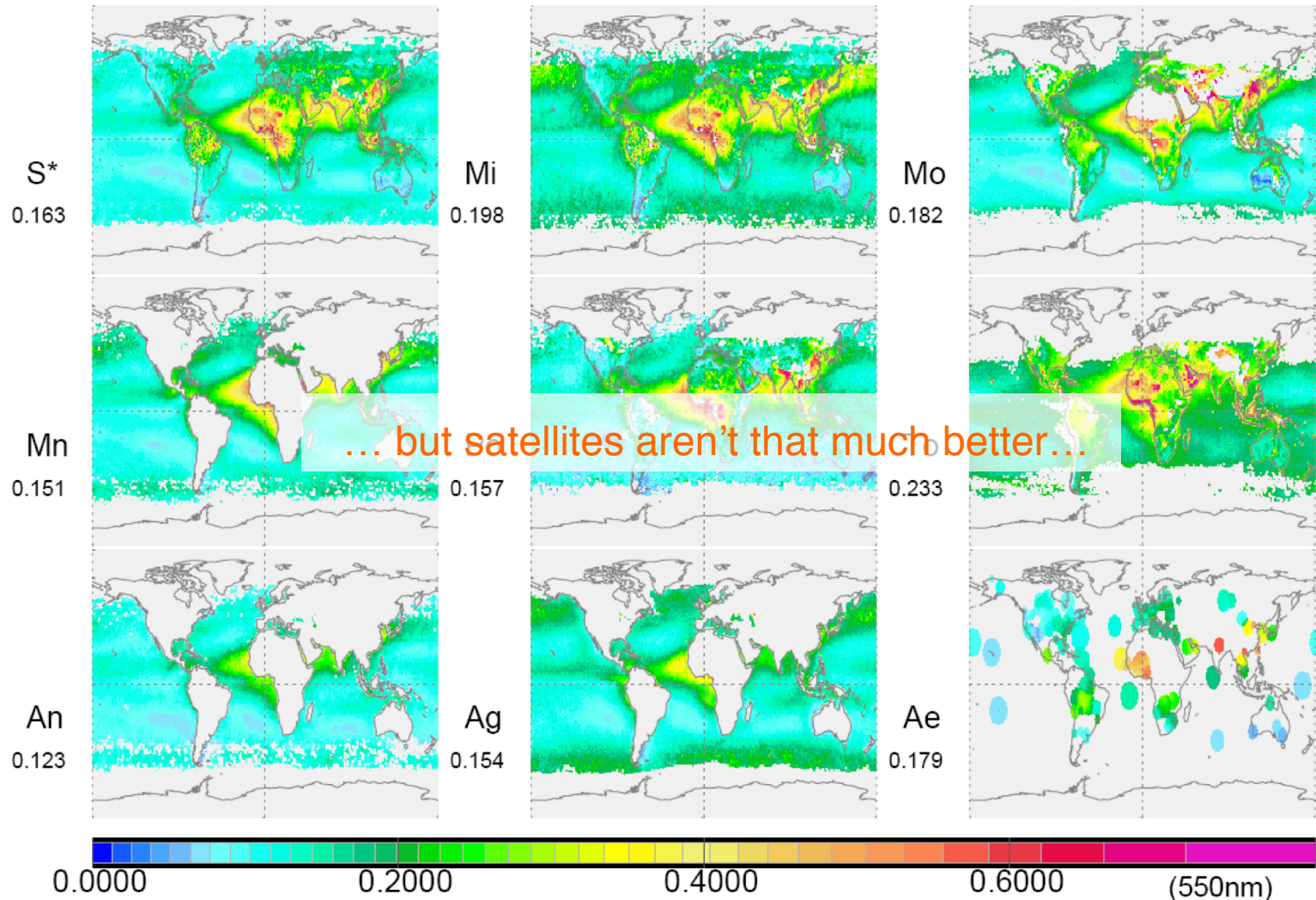
Poor agreement on component basis

# Aerosol Radiative Properties - Early AeroCom

Aerosol Optical Depth from Satellites (Kinne et al., 2006):

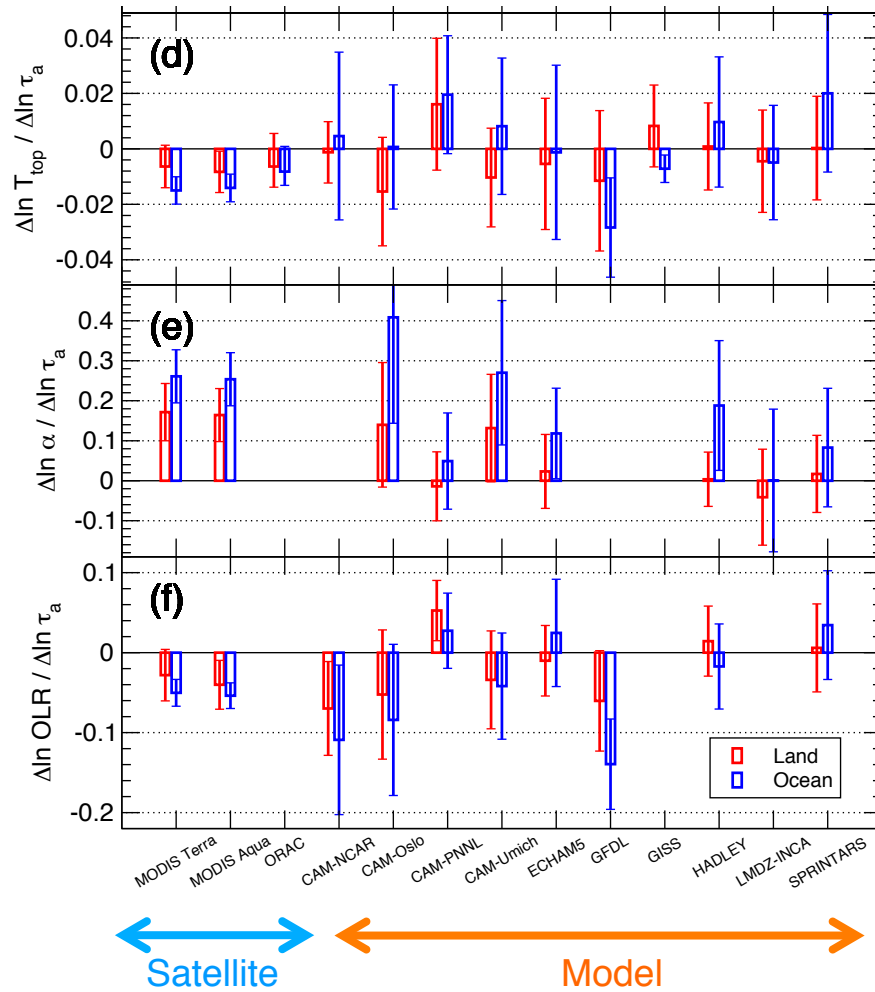
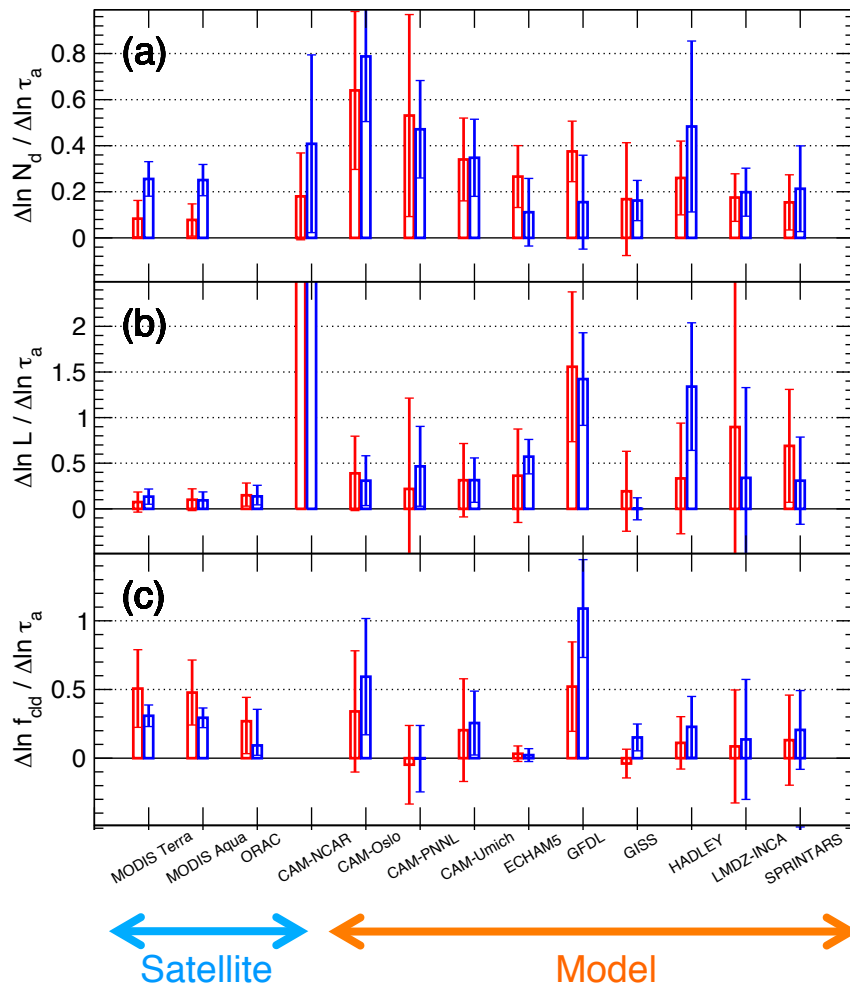
REMOTE SENSING

aerosol optical depth



# Indirect aerosol radiative effects

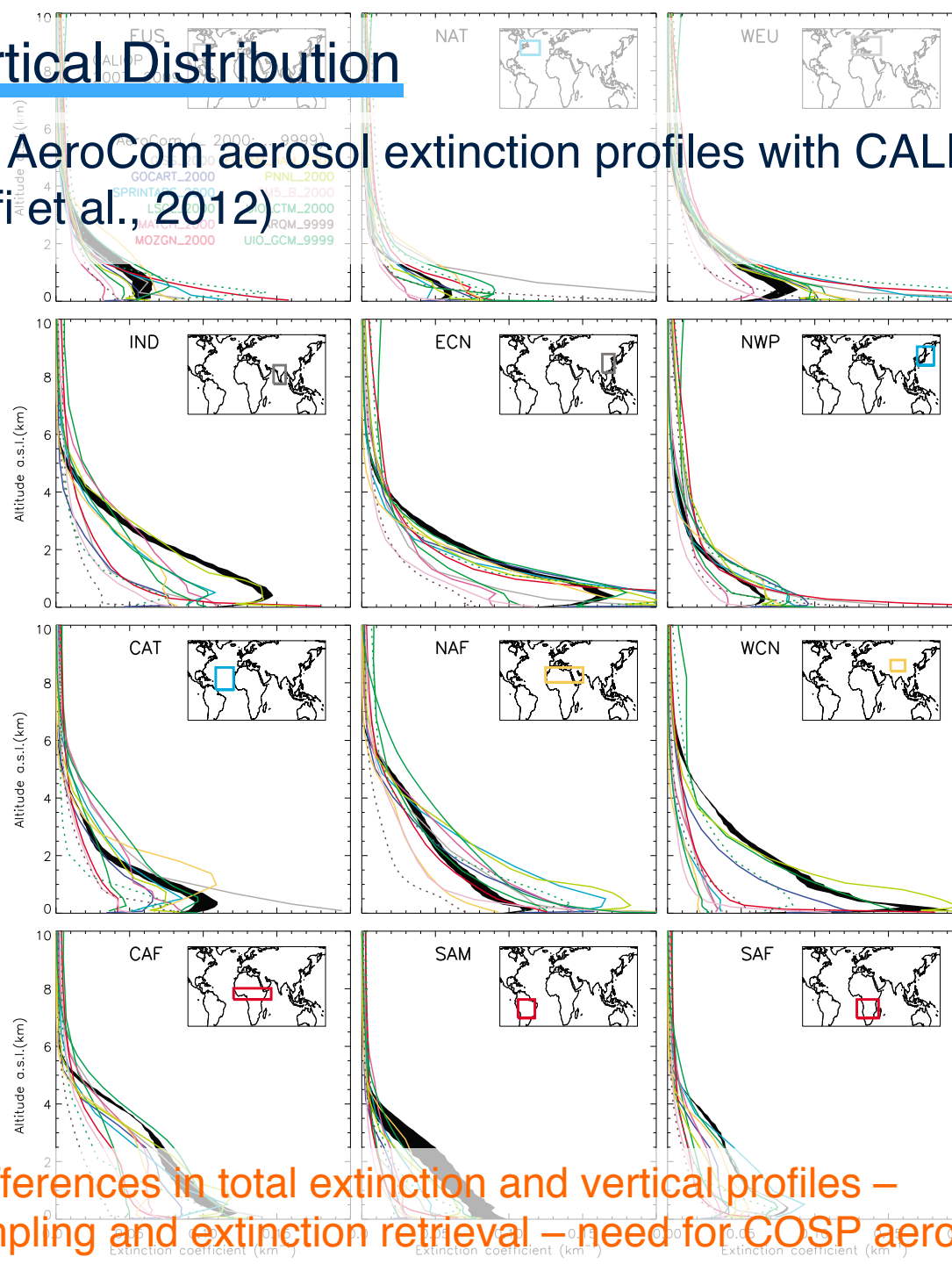
Indirect aerosol intercomparisons (Quaas et al., 2009):



Poor agreement between models and satellites – but “truth” not entirely clear...

# Aerosol Vertical Distribution

Evaluation of AeroCom aerosol extinction profiles with CALIOP lidar retrieval (Koffi et al., 2012)

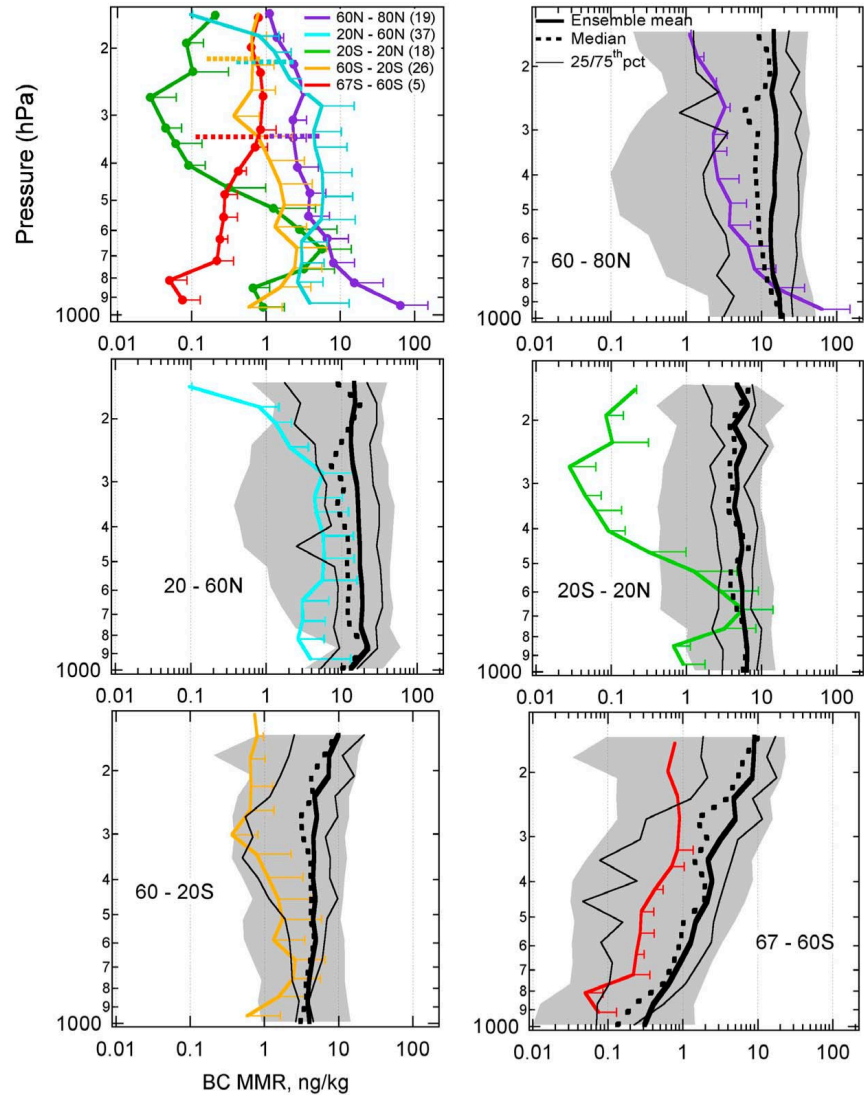


Significant differences in total extinction and vertical profiles – issues of sampling and extinction retrieval – need for COSP aerosol simulator



# Aerosol Components - Black Carbon

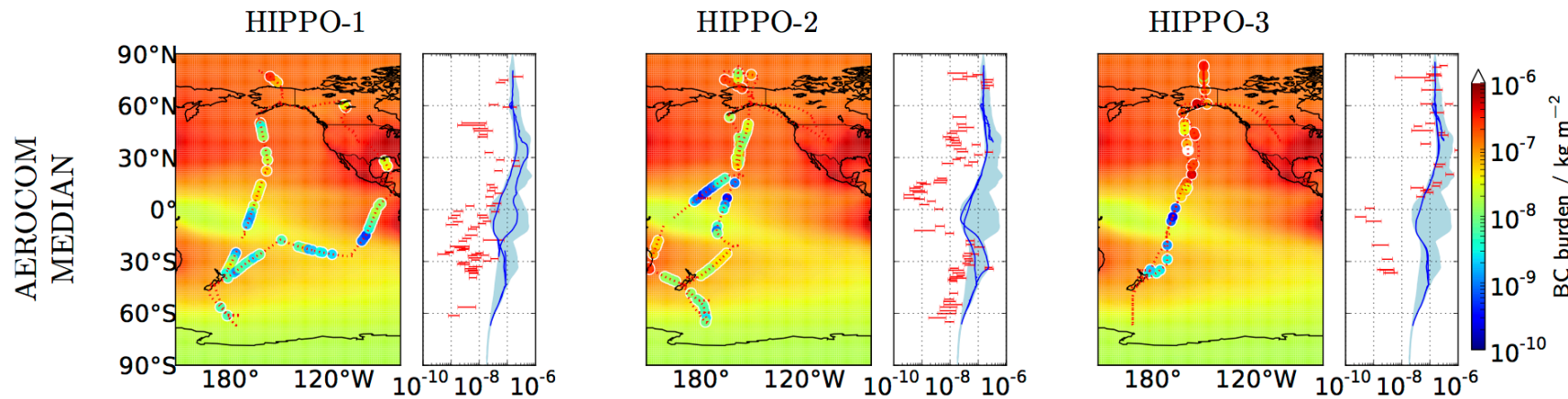
Evaluation of monthly-mean black carbon mass with HIPPO I SP2 measurements (Schwarz et al., 2010; *in prep.*):



# Aerosol Components - Black Carbon

Evaluation of AeroCom black carbon burden with data from HIPPO1-3 SP2 measurements (Kippling et al., 2013):

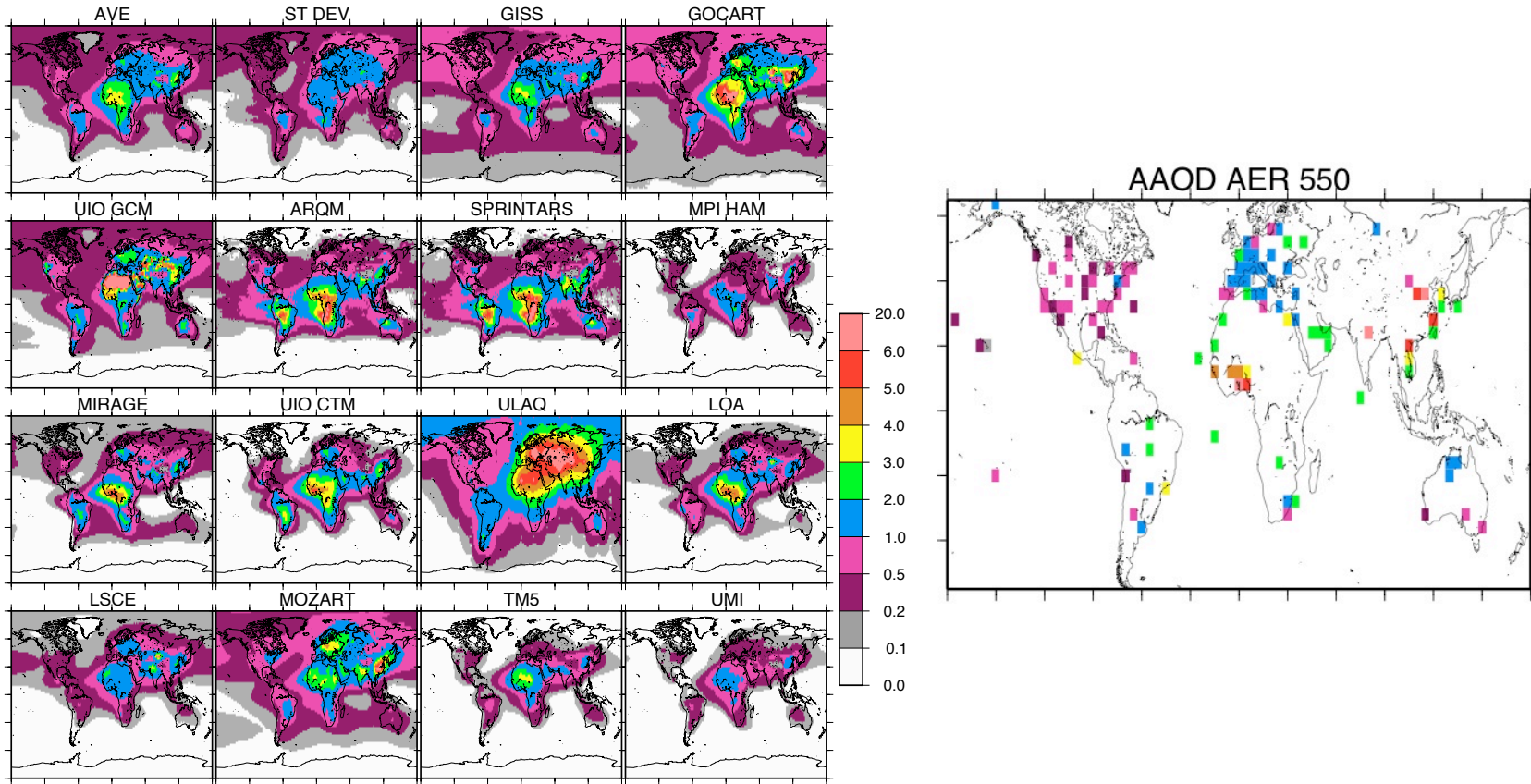
*Dense vertical sampling in HIPPO allows to estimate BC burdens*



Significant high bias of AeroCom models compared to HIPPO data (confirmed by HIPPO 1-5 see Schwarz et al. talk)

# Aerosol Components - Black Carbon

Evaluation of AeroCom absorption optical depth with AERONET sunphotometer data (Koch et al., 2009):



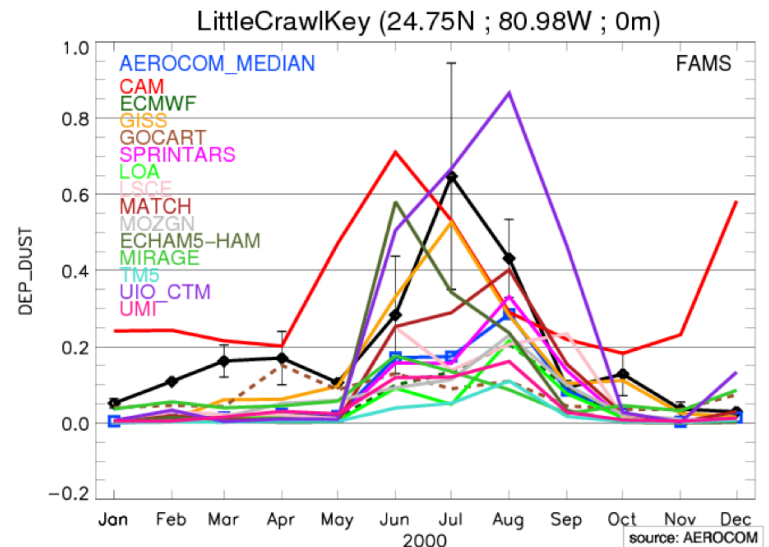
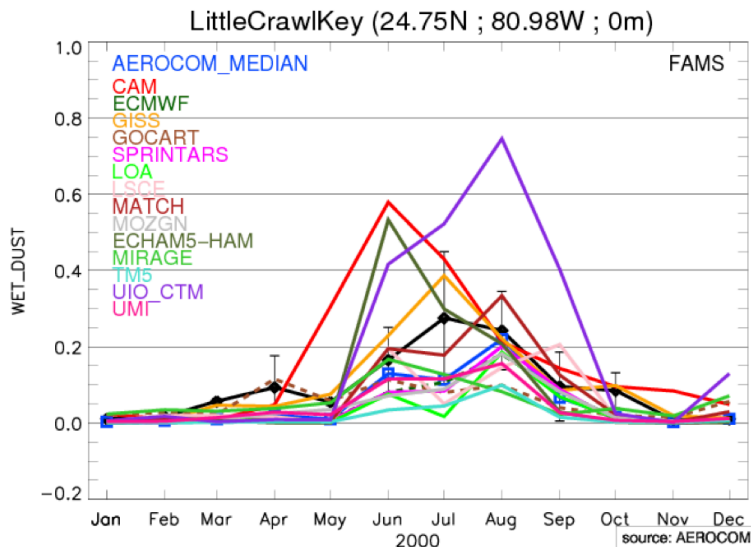
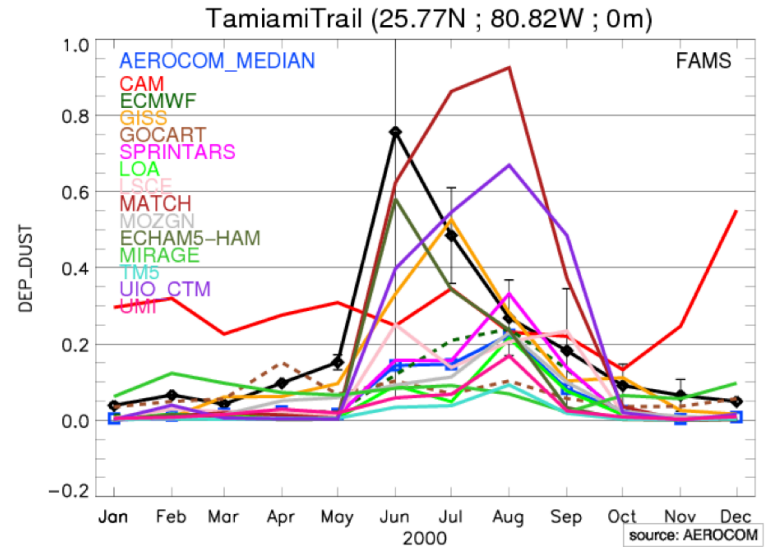
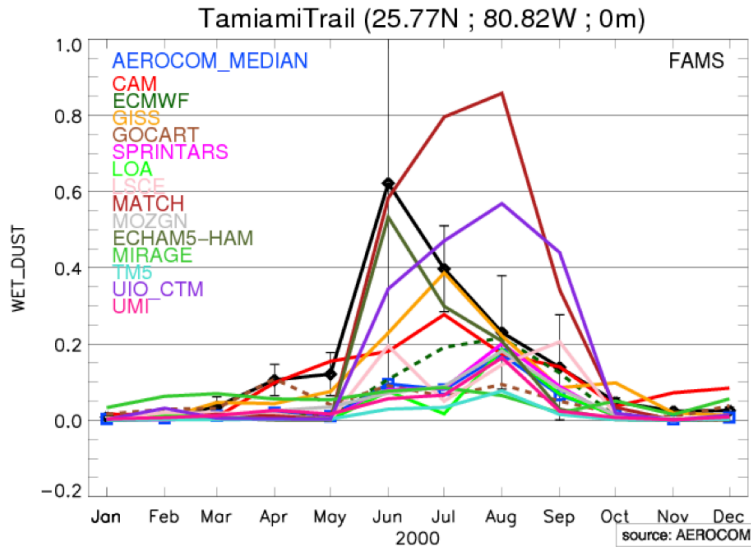
Significant low bias of AeroCom modelled Aerosol Absorption Optical Depth compared to (near source) AERONET sunphotometer data.





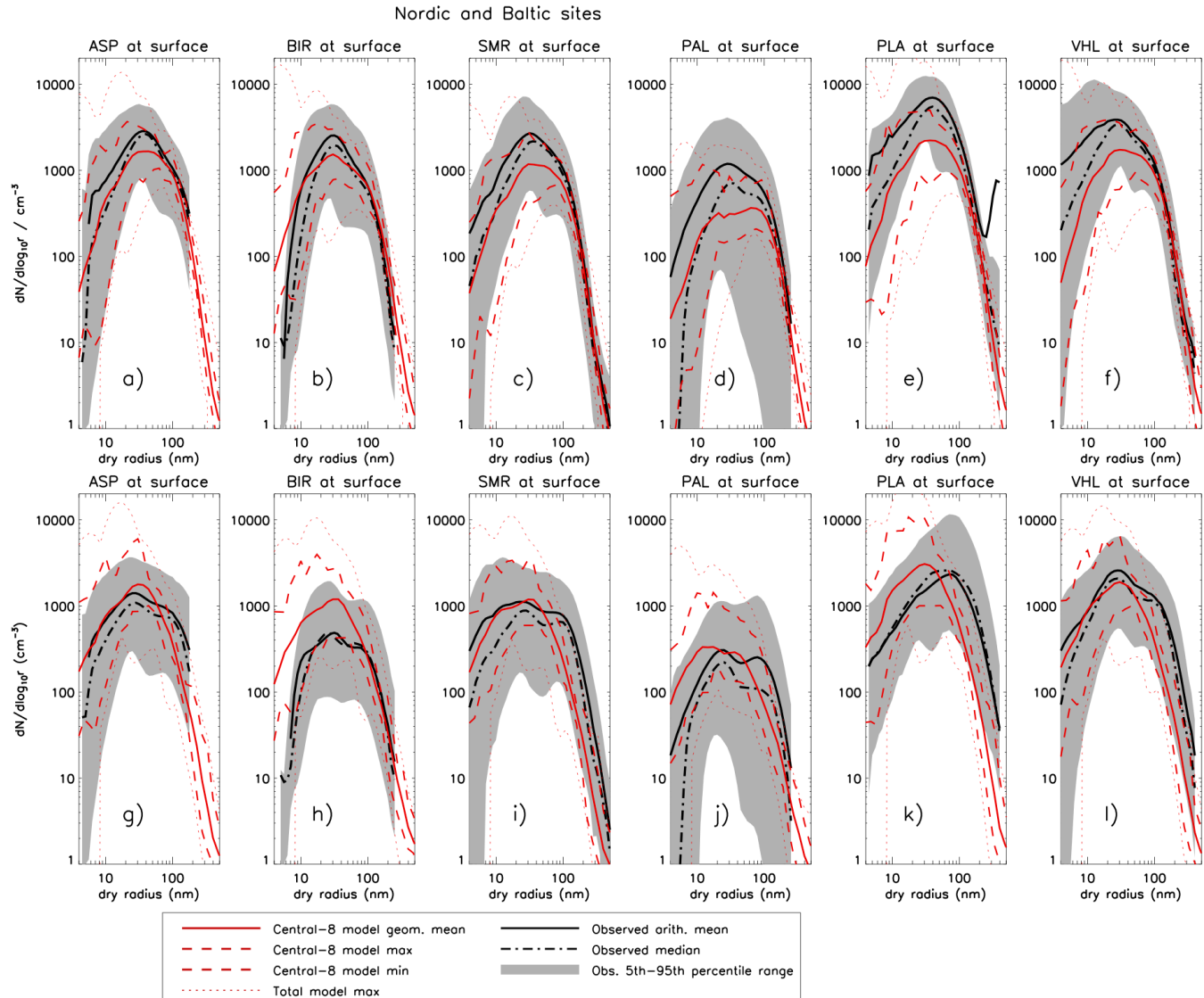
# Aerosol Components - Dust

Evaluation of AeroCom dust deposition with surface data (Huneus et al., 2011):



# AeroCom Process Studies - Microphysics

Evaluation of AeroCom size distributions with surface data  
(Mann et al., submitted):



# Intercomparing Data and Models in AeroCom

## Lessons Learned

- The scale and depth of intercomparisons is impressive  
*We have so far touched only a fraction of available data...*
- Focus in most studies has been on single parameters  
*How do we effectively integrate this knowledge?*



# Intercomparing Data and Models in AeroCom

## Lessons Learned

### Model data:

- Significant progress in harmonisation (netCDF-CF) and availability  
*AeroCom should enforce strict format requirements at submission*

### Remote sensing:

- It is easy to work with monthly mean gridded (L3) data –  
but how accurate is this?  
*Co-location in space-time is important – but tedious*  
*Diversity of data formats limits uptake*

### In-situ data:

- There exist vast amounts of in-situ measurements – but how do we get it?  
*Lack of data harmonisation and availability limits uptake*



# Data and Model Intercomparisons

## Beyond...



Global Aerosol Synthesis & Science Project  
(Leeds, Oxford, Manchester + Data Partners)

*Collection and harmonisation of unprecedented amount of in-situ aerosol measurements.*



# Data and Model Intercomparisons

## Beyond...

GASSP:

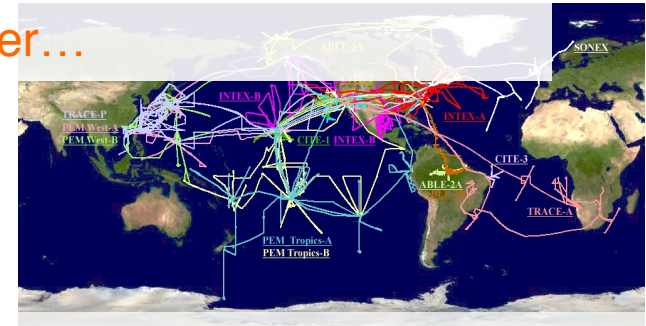
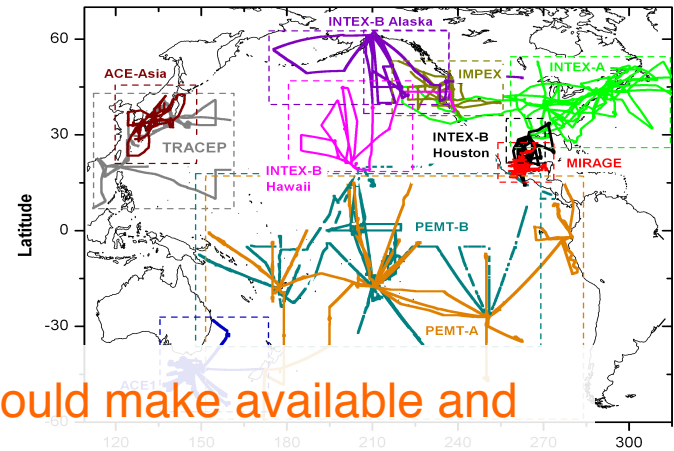
Strongest possible observational constraint on global aerosol models

Project	Date	Aircraft	Agency	Location	Data collected
VOCLAS	Oct.-Nov.2008	C130	NSF	Coast of Chile	CCN, N3, N10, N70, NSD, BC, SO4, Org
ARCTAS	Mar.-Apr.2008 June-July 2008	P3B	NASA	Arctic Pollution Boreal Fires	CCN, N3, N10, NSD, BC, SO4, Org
PASE	Aug.-Sep.2007	C130	NSF	Equatorial Pacific	CCN, N10, N50, NSD, SO4, Org
MILAGRO	Mar.2006	C130	NSF	Mexico City Pollution	CCN, N3, N10, N40, NSD, BC, SO4, Org
ACE ASIA	Apr.2001	C130	NSF	Asian Outflow North	N10, N50, NSD, SO4
INTEX-NA	June-Aug.2004	DC8	NASA	Northeast Coast USA	N3, N7, NSD
INDOEX	Feb.-Mar.1999	C130 C4	NSF	Indian Ocean	N3, N10, N50, NSD, SO4
PEMT B	Mar.-Apr.1999	P3B	NASA	Equatorial Pacific Summer	N3, N10, N50, NSD, SO4
PEMT A	Aug.-Sep.1996	P3B	NASA	Equatorial Pacific Summer	N3, N10, N50, NSD, SO4
ACE 1	Nov.-Dec.1996	P3B	NASA	Equatorial Pacific Summer	N3, N10, N50, NSD, SO4

If you have high-quality data you could make available and we have not been in touch with you – please let us know!

Project	Year	Date	Location	Data collected
DISCOVERAQ	2011	28/08/11 - 29/07/11	Washington (urban)	N3, N10, NSD, BC
ARCPAC	2008	29/03/08 - 23/04/08	Florida / Colorado / Alaska	CCN, N4, BC, SO4, Org
TexAQS	2006	31/08/06 - 15/10/06	Houston, Texas	CCN, N4, BC, SO4, Org
ITCT	2004	05/07/04 - 15/08/04	Northeastern U.S.	N5, N150
ITCT	2002	22/04/02 - 19/05/02	Eastern North Pacific near North American west coast	N4
INTEXB	2004	01/03/06 - 15/05/06	Mexico/Gulf Pollution, Houston, Hawaii, Alaska	CCN, N3, N10, NSD
TRACE P	2001	??/03/01 - 10/04/01	Asian Outflow South	N4, N10, N14, NSD, BC <sub>eq</sub>

Also have a look at the GASSP poster...



Quality control and harmonisation (netCDF-CF) is a major focus

# Data and Model Intercomparisons

## Beyond...



Global Aerosol Synthesis & Science Project  
(Leeds, Oxford, Manchester + Data Partners)

*Collection and harmonisation of unprecedented amount of in-situ aerosol measurements.*



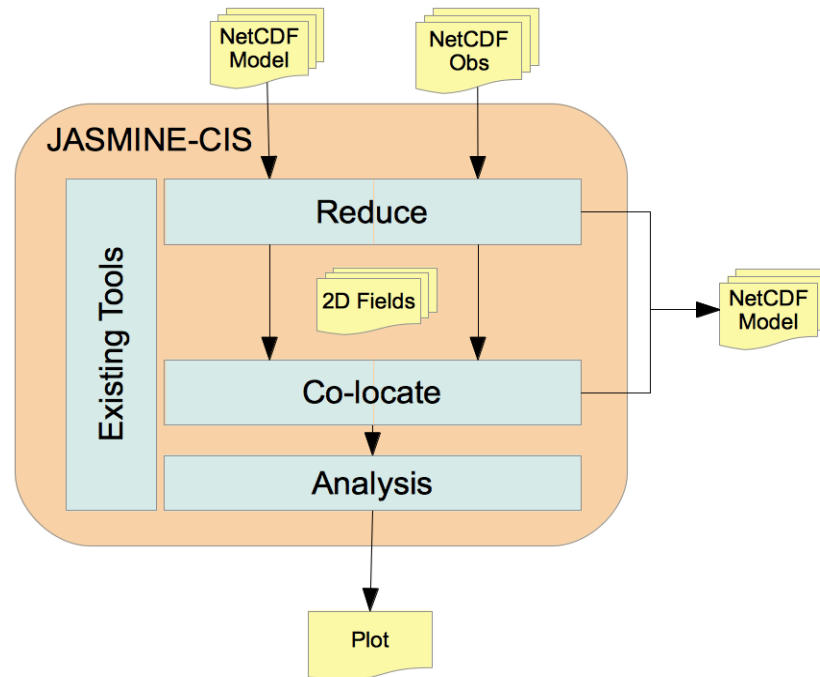
Community Intercomparison Suite  
(Oxford & Centre for Environmental Data Archival)

*Open source software tool to read, analyse, inter-compare wide range of in-situ & remote sensing observations and model data*

# Community Intercomparison Suite

Development of an automated **Community Intercomparison Suite (CIS)**

- Generic tool for analysing, visualising and collocating datasets
- Handling of complex gridded and **ungridded** data in many formats
- Simple syntax with many options
- Flexible approach through plug-ins, e.g. for new data sources



**All software (python) open source and available from project page:**  
<http://proj.badc.rl.ac.uk/cedaservices/wiki/JASMIN/CommunityIntercomparisonSuite>



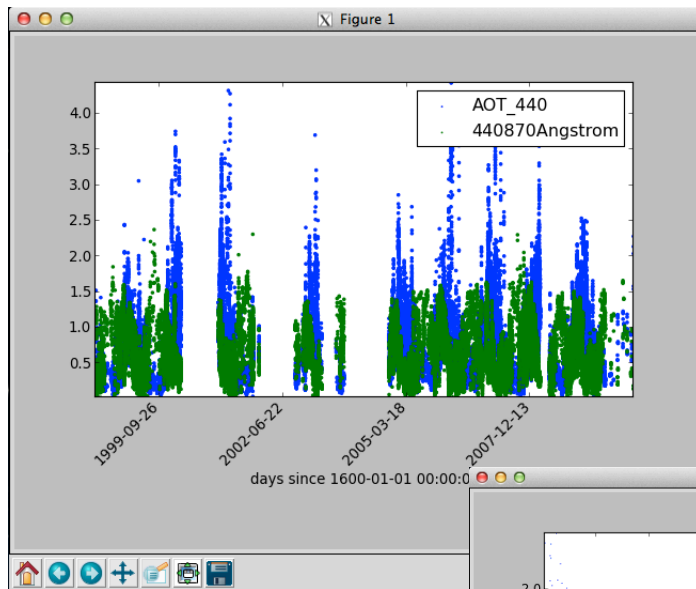
# Community Intercomparison Suite - Plotting

## CIS Plotting: time-series from AERONET ground-stations

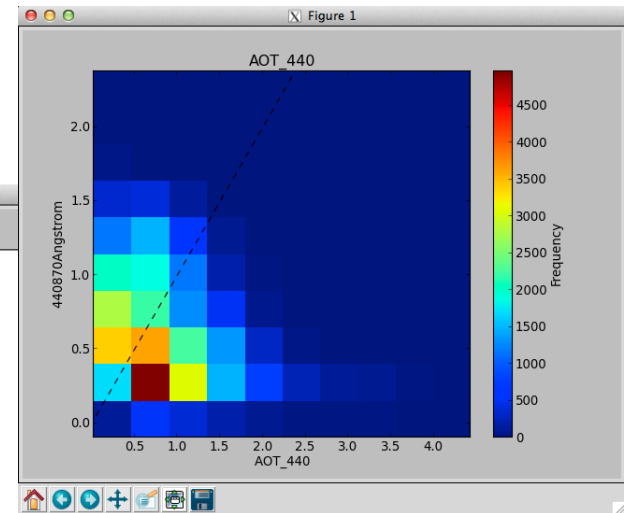
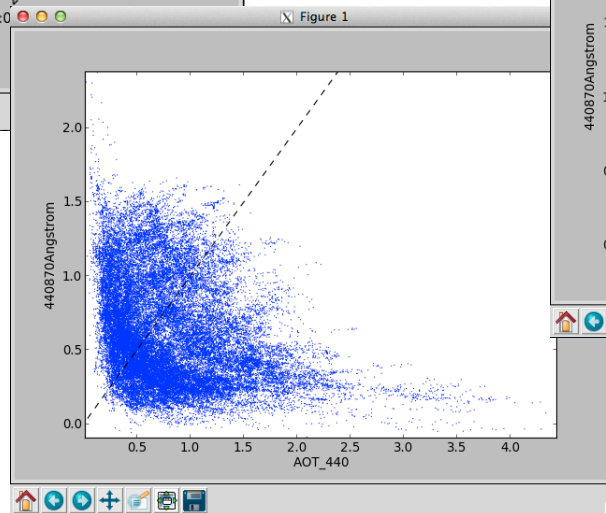
```
cis plot AOT_440:<file> 440870Angstrom:<file>
```

```
cis plot AOT_440:<file> 440870Angstrom:<file> --type comparativescatter
```

```
cis plot AOT_440:<file> 440870Angstrom:<file> --type histogram3d
```



Simple commands sufficient



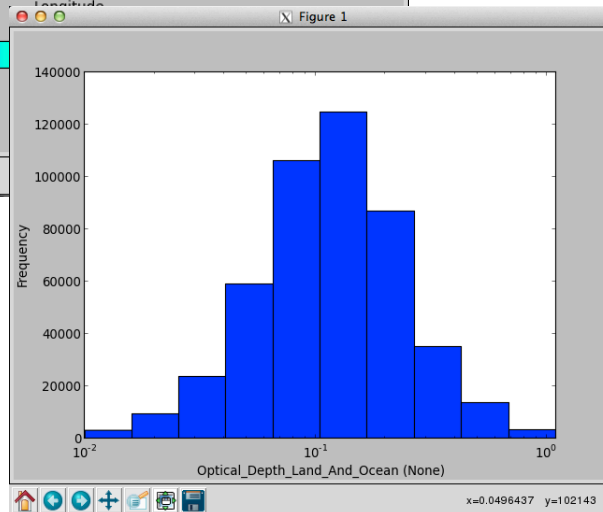
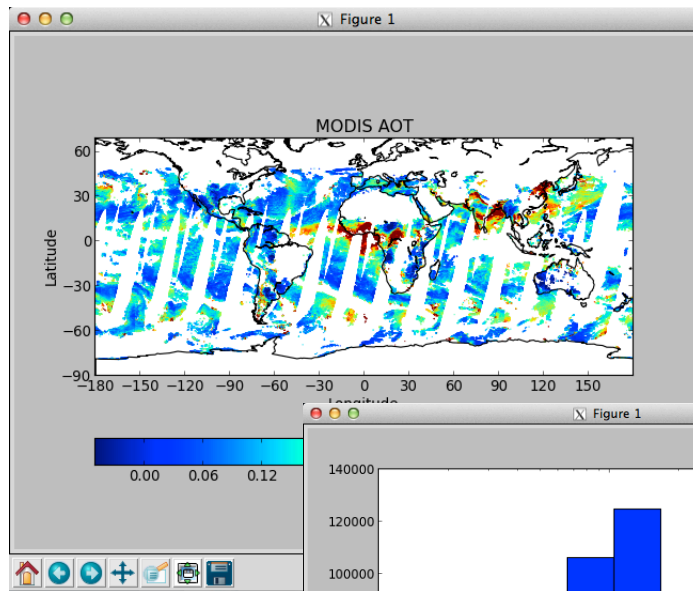
# Community Intercomparison Suite - Plotting

## CIS Plotting: Satellite observations (MODIS C5)

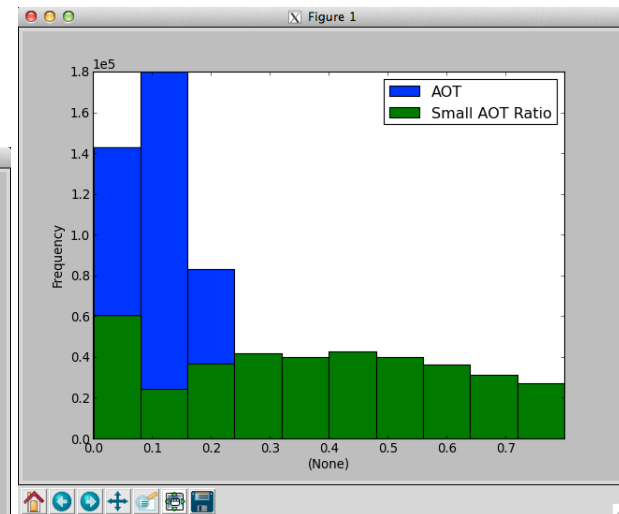
```
cis plot Optical_Depth_Land_And_Ocean:<files>
```

```
cis plot Optical_Depth_Land_And_Ocean:<files> --type histogram2d
```

```
cis plot Optical_Depth_Land_And_Ocean:<files>
Optical_Depth_Ratio_Small_Land_And_Ocean:<files>
```



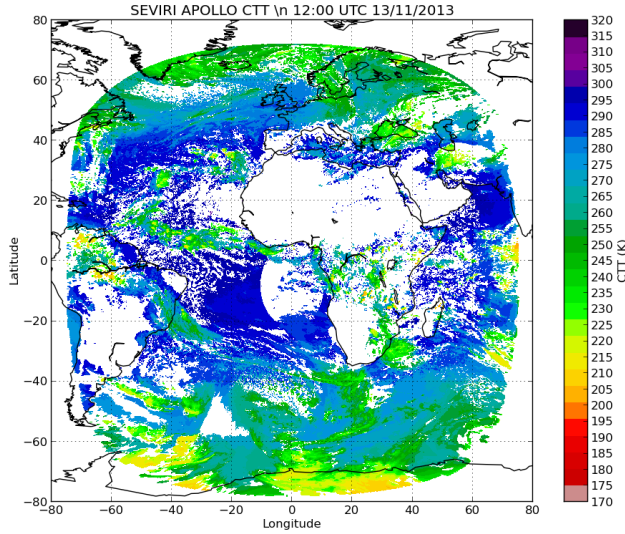
Minimal customization was used.  
Single command used to create  
single graphic from multiple files.



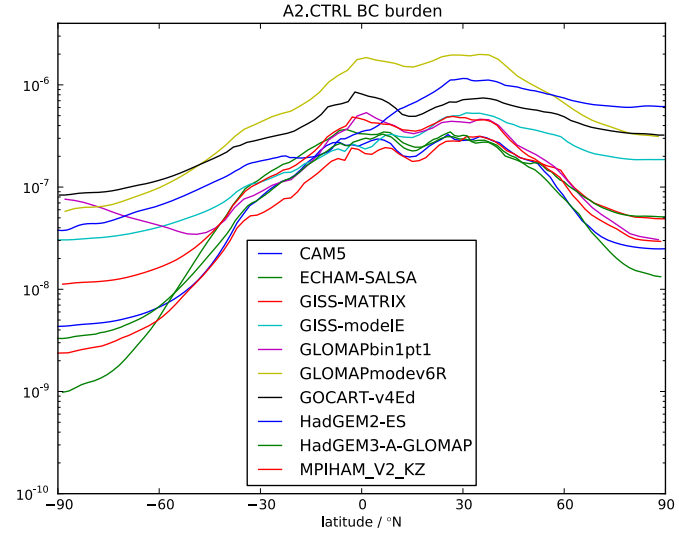
# Community Intercomparison Suite - Plotting

## CIS Plotting: More examples

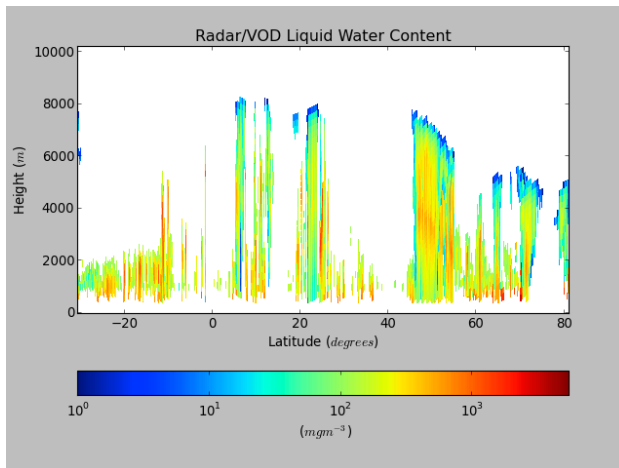
Intercomparing Data and Models



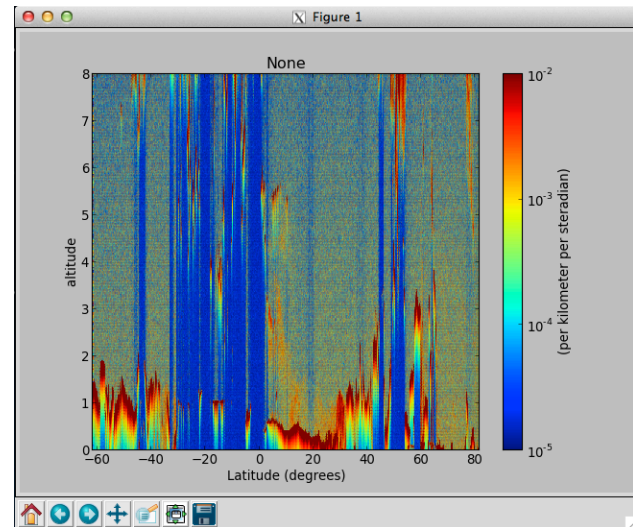
SEVIRI cloud top temperature



AeroCom Model Burdens



CloudSAT Liquid Water Content

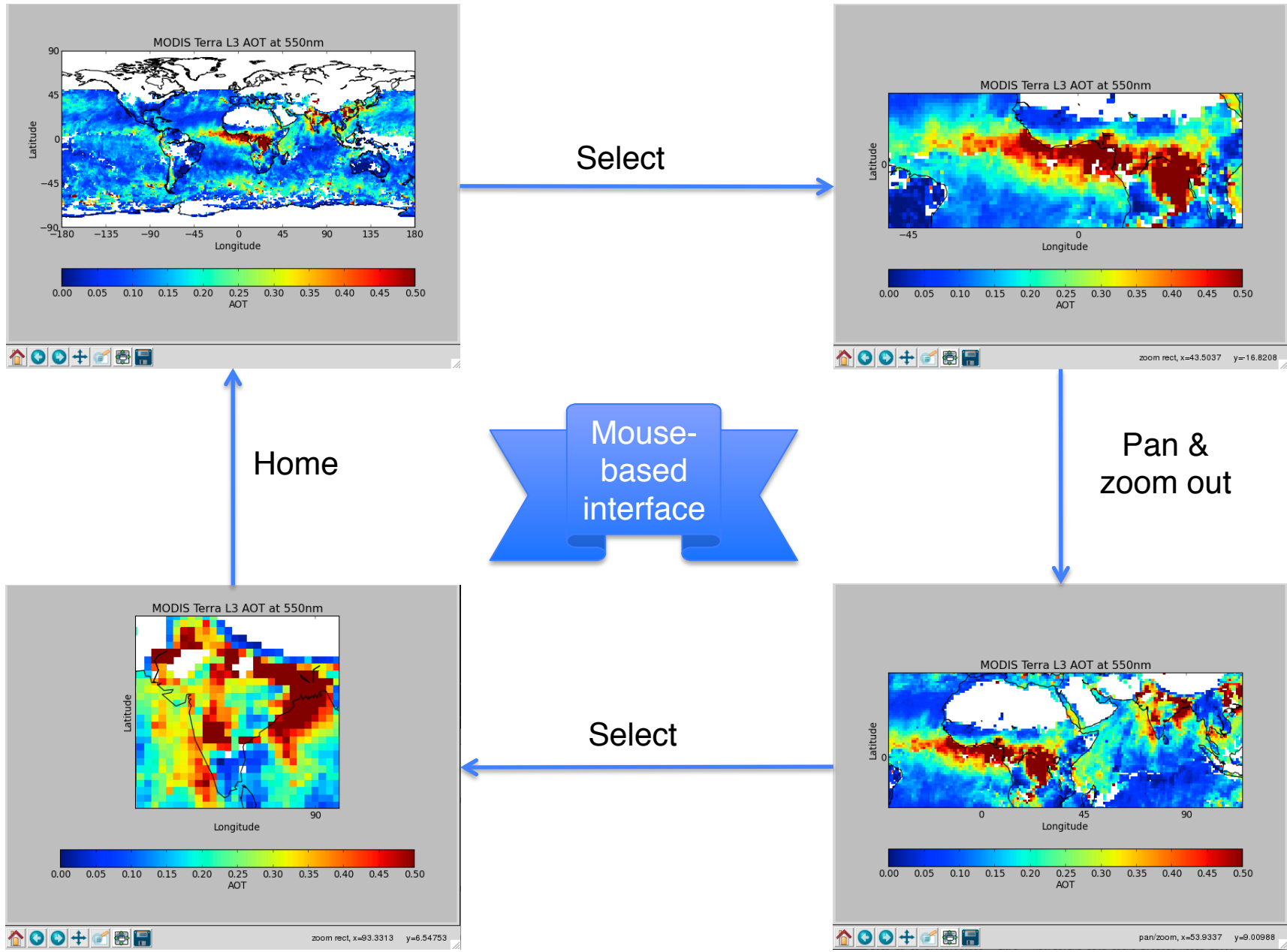


CALIOP backscatter

Many data sources in their native formate (& model netCDF-CF)

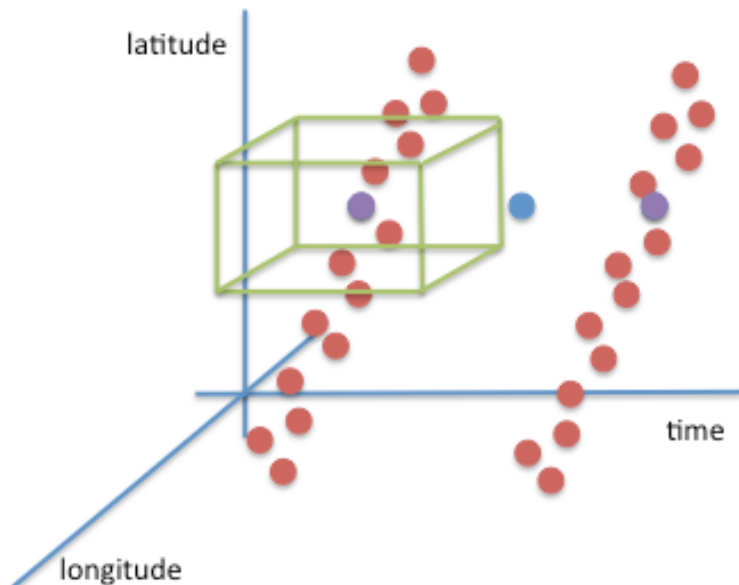


# Community Intercomparison Suite - Plotting



# Community Intercomparison Suite - Colocation

## CIS Colocation



### Colocation method:

1. Specify searchbox
  - Horizontal distance
  - Vertical distance
  - Time separation
2. Specify operation
  - Nearest neighbour (time)
  - Nearest neighbour (space)
  - Average
  - User plug-in

```
CIS col <native file> <native variable>:<native file>:<colocation method> -o <file>
```



This file provides the new spatio-temporal sampling

(e.g. AERONET lev2)



This file provides the data that will be resampled

(e.g. MODIS L2 AOT)



Nearest neighbour or linear interpolation



Output (netcdf)

# Community Intercomparison Suite & Aerocom

## Availability

- CIS is open source python and available for local installation (git-hub)  
*There will soon be a developer hub for open source contributions*

## AeroCom Database:

- CIS already runs on netCDF-CF conform AeroCom models  
*Plan: CIS fully compatible with AeroCom by spring*
- CIS will be coupled with Data Indexing Service on JASMIN data cluster (BADC), i.e. understand e.g. “MODIS V6 in lat/lon/time search-box”  
*We could consider mirroring the AeroCom database...*
- Web-interface will be developed next year

## Conclusions

- There exist great opportunities for progress with model data synergy –  
*Need for a community effort – with community tools*

