Evaluating aerosol microphysics models: Observational datasets and plans for AEROCOM microphysics working group

Graham Mann, Ken Carslaw, Dominick Spracklen, Joonas Merikanto, Maria Frontoso, Carly Reddington
(School of Earth & Environment, University of Leeds, U.K.)
At last year’s AEROCOM workshop in Iceland, plan agreed for working group to evaluate aerosol microphysics models against range of available in-situ observations.

Evaluate & document diversity of AEROCOM models in simulated number conc’n

-- CN concentrations against CPC observations at GAW & other sites
-- CCN concentrations vs obs. from field campaigns & monitoring sites.
-- size distributions against DMPS observations at EUSAAR sites
-- size-resolved number concentrations & mean size against compilations of observed aerosol properties in literature (e.g. Heintzenberg et al, 2000, 2002).
-- vertical CN, CCN profiles from models against compilations of aircraft observations (e.g. TRACE-P, PEM-Tropics, INCA, UFA-EXPORT)

**Please suggest other similar datasets that can be used to constrain models**

Experiments:

-- Control simulation reference year 2006 (A2-CTRL-2006)
-- As CTRL but with condensation switched off (A2-SIZ1-2006)
-- As CTRL but with coagulation switched off (A2-SIZ2-2006)
-- As CTRL but with primary emissions of SO4 and BC/OC off (A2-SIZ3-2006)
-- As CTRL but with new particle formation switched off (A2-SIZ4-2006)

Use HCA-0 emissions in models to minimise differences between model simulations
Models characterise size distribution in many different ways
-- mass-only in aerosol types each with fixed size distribution (~10 aerosol tracers)
-- number & mass concentrations in size modes (20-30 aerosol tracers)
-- number & mass in concentrations size bins (100-200 aerosol tracers)

CCN observations retrieve CCN at many different supersaturations
(Not possible to make simple CCN diagnostics for models to output.)

CN measurements can use different minimum diameter (e.g. 3nm or 10nm).

Size distribution observations made across different size ranges.

**Approach settled on at last workshop:**
Instead of asking for extra complicated diagnostics, just make life simple:
Ask modelers to **write “all-aerosol-tracer” output** to AEROCOM database
And to provide README file with information on how size is handled in model.

Then can compare CN, CCN, size-resolved N ensuring consistent methodology.

**Also ask modellers to interpolate to selected sites outputting at hourly resolution**
-- makes separation into different air mass types possible
-- generate statistics of size distribution over daily cycle
-- how well do microphysics models reproduce new particle formation events?
Required output for aerosol microphysics group:

-- Monthly-mean all-aerosol-tracer output on full 3D model grid      (3D-M)
-- Daily-mean all-aerosol-tracer output over vertical profile at sites (1D-D)
-- Hourly-mean all-aerosol-tracer output at surface at sites             (0D-H)

Use CMOR tables: Aerocom_table_1DD, Aerocom_table_0DH on website.

Selected sites:

GAW & ARM sites (CPC, nephelometer, aethalometer, some with lidar)
  Alert, Barrow, Bondville, Mauna Loa, Neumayer, Samoa, South Pole,
  Southern Great Plains,

21 EUSAAR supersites (many with DMPS, AMS, lidar)
  Aspreveten, Auchenworth, Birkenes, Cabauw, Finokalia, Harwell,
  Hohenpeissenberg, Hyytiala, Ispra, Jungfraujoch, Kosetice, K-puzta,
  Mace Head, Melpitz, Montseny, Moussala, Pallas, Preila, Puy de Dome,
  Valvihill, Zeppelin.

Additional sites with observations
  Cape Grim, Cape Point, Capo San Juan, Elandsfontein, Guangzhou, Manaus,
  Monte Cimone, Mount Waliguan, Paverne, Shang Dianzi, Sonnblick, Summit,
  Tahkuse, Trinidad Head, Varrio

Need model README file giving full detail of size assumptions with model
Models intending to submit results:

Following email questionnaire, many groups committed to submit results:

<table>
<thead>
<tr>
<th>Model</th>
<th>Aerosol Dynamics</th>
<th># of aerosol tracers</th>
<th>Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLOMAP-bin</td>
<td>Bin-resolved (N,m)</td>
<td>~200</td>
<td>Dominick Spracklen (Leeds)</td>
</tr>
<tr>
<td>GLOMAP-mode</td>
<td>Modal (N,m)</td>
<td>30</td>
<td>Graham Mann (Leeds)</td>
</tr>
<tr>
<td>UKCA-UM</td>
<td>Modal (N,m)</td>
<td>30</td>
<td>Graham Mann (Leeds)</td>
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<tr>
<td>ECHAM-HAM</td>
<td>Modal (N,m)</td>
<td>25</td>
<td>Kai Zhang (MPI-Hamburg)</td>
</tr>
<tr>
<td>ECHAM-HAMMOZ</td>
<td>Modal (N,m)</td>
<td>25</td>
<td>Kai Zhang (MPI-Hamburg)</td>
</tr>
<tr>
<td>GISS-MATRIX</td>
<td>Moments (N,m)</td>
<td>60</td>
<td>Susanne Bauer (GISS)</td>
</tr>
<tr>
<td>EMAC [ECHAM-MESSy]</td>
<td>Modal (N,m)</td>
<td>30+</td>
<td>Kirsty Pringle (MPI-Mainz)</td>
</tr>
<tr>
<td>NCAR CAM4-MAM</td>
<td>Modal (N,m)</td>
<td>31/15</td>
<td>Xiaohong Liu (PNNL)</td>
</tr>
<tr>
<td>TM5</td>
<td>Modal (N,m)</td>
<td>25</td>
<td>Elisabetta Vignati (JRC)</td>
</tr>
<tr>
<td>CCCma AGCM4</td>
<td>PLA-bin (N,m)</td>
<td>240</td>
<td>Knut Van Salzen (Env Canada)</td>
</tr>
<tr>
<td>GISS-TOMAS</td>
<td>Bin (N,m)</td>
<td>~100?</td>
<td>Yunha Lee (Carnegie Mellon)</td>
</tr>
<tr>
<td>Nor-AGCM</td>
<td>Modal (N,m)</td>
<td>~20?</td>
<td>Trond Iversen (Norway Met.)</td>
</tr>
<tr>
<td>GEOS5-GOCART</td>
<td>Mode &amp; bin (m-only)</td>
<td>~20</td>
<td>Peter Colarco (NASA GSFC)</td>
</tr>
<tr>
<td>ECHAM-HAM* &amp;-SALSA</td>
<td>Mode (N,m), Bin (N,m)</td>
<td>~25, ~70</td>
<td>Risto Makkanen (Univ Helsinki)</td>
</tr>
</tbody>
</table>
Global CTM forced by 6-hourly ECMWF winds
Usually run at T42L31 (2.8°x2.8°) resolution
Sectional aerosol scheme: 20 bins, 3 nm – 20 μm
Modal scheme: 7 or 4 log-normal modes
Chemistry usually driven by offline oxidants, now coupled to CTM chemistry
Aerosol transport, new particle formation, growth by coagulation, condensation, cloud processing.
Wet and dry deposition of gases & aerosol particles
Emissions of DMS → SO₂ → H₂SO₄; monoterpenes → biogenic SOA
Primary emissions of sea salt, dust, black & organic carbon (fossil and biofuels, vegetation fires)
Nucleation via binary homogeneous nucleation of H₂SO₄-H₂O and also now implemented boundary layer nucleation mechanism

GLOMAP-bin : Spracklen et al. (2005), Spracklen et al (2008)
Example model README file for GLOMAP-mode:

The following describes the all-aerosol-tracer information for GLOMAP-mode.
Contact: Graham Mann (University of Leeds, U.K.) gmann@env.leeds.ac.uk

Model setup for AEROCOM simulations uses 7 log-normal modes
Mode 1 is soluble nucleation with cpts SO4,POM
Mode 2 is soluble Aitken with cpts SO4,BC,POM
Mode 3 is soluble accumulation with cpts SO4,BC,POM,NaCl,dust
Mode 4 is soluble coarse with cpts SO4,BC,POM,NaCl,dust
Mode 5 is insoluble Aitken with cpts BC,POM
Mode 6 is insoluble accumulation with cpts dust
Mode 7 is insoluble coarse with cpts dust

Aerosol tracers then are 19 mmrtrnn values for components (nnn=01 to 19)
4 mmrtrnn values for water-content (nnn=20 to 23)
7 concnnxx values for number concns (xx =01 to 07)

Aerosol tracer ordering in CMOR-compliant netCDF files are:
mmrtr01 --- SO4 mmr in soluble nucleation mode
mmrtr02 --- POM mmr in soluble nucleation mode
mmrtr03 --- SO4 mmr in soluble Aitken mode
mmrtr04 --- BC mmr in soluble Aitken mode
mmrtr05 --- POM mmr in soluble Aitken mode
mmrtr06 --- SO4 mmr in soluble accumulation mode
mmrtr07 --- BC mmr in soluble accumulation mode
mmrtr08 --- POM mmr in soluble accumulation mode
mmrtr09 --- NaCl mmr in soluble accumulation mode
mmrtr10 --- dust mmr in soluble accumulation mode
mmrtr11 --- SO4 mmr in soluble coarse mode
mmrtr12 --- BC mmr in soluble coarse mode
mmrtr13 --- POM mmr in soluble coarse mode
mmrtr14 --- NaCl mmr in soluble coarse mode
mmrtr15 --- dust mmr in soluble coarse mode
mmrtr16 --- BC mmr in insoluble Aitken mode
mmrtr17 --- POM mmr in insoluble Aitken mode
mmrtr18 --- dust mmr in insoluble Aitken mode
mmrtr19 --- dust mmr in insoluble coarse mode
mmrtr20 --- H2O mmr in soluble nucleation mode
mmrtr21 --- H2O mmr in soluble Aitken mode
mmrtr22 --- H2O mmr in soluble accumulation mode
mmrtr23 --- H2O mmr in soluble coarse mode
Example model README file for GLOMAP-mode:

```
conccnmode01  ---  no. conc in soluble  nucleation  mode
conccnmode02  ---  no. conc in soluble  Aitken       mode
conccnmode03  ---  no. conc in soluble  accumulation mode
conccnmode04  ---  no. conc in soluble  coarse        mode
conccnmode05  ---  no. conc in insoluble Aitken       mode
conccnmode06  ---  no. conc in insoluble accumulation mode
conccnmode07  ---  no. conc in insoluble coarse        mode

Molar masses (mm) and densities (rho) of the aerosol components used for the mmr are:
SO4   : mm=0.098  kg/mol, rho=1769 kg/m3
BC    : mm=0.012  kg/mol, rho=1500 kg/m3
POM   : mm=0.0168 kg/mol, rho=1500 kg/m3
NaCl  : mm=0.05844 kg/mol, rho=1600 kg/m3
dust  : mm=0.100  kg/mol, rho=2650 kg/m3
H2O   : mm=0.018  kg/mol, rho=1000 kg/m3

Geometric standard deviations (sigma) for the 7 modes are constant as:
sigma (soluble  nucleation  ) = 1.59
sigma (soluble  Aitken       ) = 1.59
sigma (soluble  accumulation) = 1.59
sigma (soluble  coarse        ) = 2.00
sigma (insoluble Aitken       ) = 1.59
sigma (insoluble accumulation) = 1.59
sigma (insoluble coarse        ) = 2.00

Geometric mean diameter (Dpi) for mode i is calculated as:
Dpi^3=6.0*dvoli/pi/explogsqsigma1
where explogsqsigma1=exp(4.5*aolog(sigmai)*aolog(sigmai))
and dvoli=sumj(mdi*j*mmj/(avc*rhoj))
and mdi=j=mmrtrnn*(mm_da/mm)*(aird/conccni)

(nn is the index of the tracer mmr for mode i component j).
(conccni is the number concentration in mode i)
```
In addition to scoring vs observations, evaluate diversity in simulated influence of primaries/nucleation/coagulation/condensation on simulated CN, CCN, mass, AOD

Table 2. Summary of ground level contribution from primary particles (PR), boundary layer nucleation (BLN) and upper tropospheric nucleation (UTN) to ground level total number (CN) and cloud condensation nuclei (CCN) concentrations at 0.2% and 1.0% supersaturations. The marine regions refer to west of North America (NAM), west of South America (SAM), west of North Africa (NAF), west of South Africa (SAF), and East of North-East Asia (NEA) (see Figure 7).

<table>
<thead>
<tr>
<th>Region</th>
<th>CN</th>
<th></th>
<th>CCN(1.0%)</th>
<th></th>
<th>CCN(0.2%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tot [cm⁻³]</td>
<td>PR-UTN-BLN [%]</td>
<td>Tot [cm⁻³]</td>
<td>PR-UTN-BLN [%]</td>
<td>Tot [cm⁻³]</td>
</tr>
<tr>
<td>Total Global</td>
<td>1064</td>
<td>27-25-47</td>
<td>513</td>
<td>49-33-18</td>
<td>314</td>
</tr>
<tr>
<td>Total Marine</td>
<td>758</td>
<td>19-33-48</td>
<td>331</td>
<td>41-44-15</td>
<td>204</td>
</tr>
<tr>
<td>NAM</td>
<td>596</td>
<td>20-63-18</td>
<td>384</td>
<td>28-63-8</td>
<td>396</td>
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<tr>
<td>NAF</td>
<td>1003</td>
<td>12-31-57</td>
<td>413</td>
<td>28-52-20</td>
<td>414</td>
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<tr>
<td>SAF</td>
<td>619</td>
<td>23-41-36</td>
<td>345</td>
<td>40-50-10</td>
<td>266</td>
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<tr>
<td>NEA</td>
<td>1423</td>
<td>35-35-30</td>
<td>877</td>
<td>52-35-13</td>
<td>886</td>
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<tr>
<td>Total Continental</td>
<td>1921</td>
<td>36-18-46</td>
<td>1024</td>
<td>57-23-20</td>
<td>625</td>
</tr>
<tr>
<td>Europe</td>
<td>2611</td>
<td>47-11-42</td>
<td>1647</td>
<td>63-15-22</td>
<td>932</td>
</tr>
<tr>
<td>Africa</td>
<td>1279</td>
<td>50-20-29</td>
<td>900</td>
<td>63-25-12</td>
<td>719</td>
</tr>
<tr>
<td>N. America</td>
<td>2600</td>
<td>20-12-69</td>
<td>1079</td>
<td>40-24-36</td>
<td>554</td>
</tr>
<tr>
<td>S. America</td>
<td>1713</td>
<td>36-15-49</td>
<td>922</td>
<td>61-25-14</td>
<td>613</td>
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<tr>
<td>N. Asia</td>
<td>1119</td>
<td>22-26-53</td>
<td>554</td>
<td>38-34-28</td>
<td>288</td>
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<tr>
<td>SE Asia</td>
<td>4543</td>
<td>46-14-40</td>
<td>2443</td>
<td>70-15-14</td>
<td>1384</td>
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<tr>
<td>Oceania</td>
<td>1335</td>
<td>21-20-59</td>
<td>778</td>
<td>34-31-36</td>
<td>431</td>
</tr>
</tbody>
</table>

Merikanto et al (2009)
Switching nucleation off removes observed CN peak in Upper Troposphere
Secondary aerosol particles > 50% of surface CN in almost all marine regions
Continental CN mostly from primary emissions (no BL nucleation in these runs).
30-50% surface CCN in most MBL regions from secondary aerosol
Sea-spray dominated regions and continental regions dominated by primaries.
Switching off nucleation makes no difference to simulated mass concentrations
Switching coagulation off increases CCN concentrations by > 100%.
Switching coagulation off strengthens observed CN peak in Upper Troposphere
Increases CN concentrations everywhere by ~ factor 2-10
## Sites with CN observations over several years

<table>
<thead>
<tr>
<th>Station Name</th>
<th>Location</th>
<th>Altitude (m)</th>
<th>Observation period</th>
<th>Min. cutoff diameter (μm)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Puy de Dome</td>
<td>3.0E, 45.8N</td>
<td>1465</td>
<td>2005-2008</td>
<td>3</td>
<td>Venzac et al. (2009)</td>
</tr>
<tr>
<td>Nepal C.O.</td>
<td>86.8E, 28.0N</td>
<td>5079</td>
<td>2007-2008</td>
<td>10</td>
<td>Venzac et al. (2008)</td>
</tr>
<tr>
<td>South Pole</td>
<td>24.8W, 90S</td>
<td>2841</td>
<td>1974-1999</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Pico Espejo</td>
<td>71.1W, 8.5N</td>
<td>4775</td>
<td>2007-2009</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Mount Washington</td>
<td>71.3W, 44.3N</td>
<td>1910</td>
<td>2002-2005</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

### Free troposphere

### Marine boundary layer

| Mace Head          | 350.1E, 53.3N | 0           | 2000, 2002-2007    | 10                        | O’Dowd et al. (1998)   |
| Neumayer           | 8.3W, 70.7S   | 42          | 1993-2006          | 10                        | Weller and Lampert (2008) |
| Point Barrow       | 156.6W, 71.3N | 11          | 1994-2007          | 10                        | Bodhaine (1989)        |
| Samoa              | 170.6W, 14.2S | 77          | 1977-2006          | 10                        |                        |
| Trinidad Head      | 124.2W, 41.1N | 107         | 2002-2007          | 10                        |                        |
| Cape Grim          | 144.7E, 40.6S | 94          | 1996-2007          | 3                         | Gras (1995)            |
| Sable Island       | 60.0W 43.9N   | 5           | 1992-2000          | 10                        |                        |

## Sites with CN observations over several years

<table>
<thead>
<tr>
<th>Station Name</th>
<th>Location</th>
<th>Altitude (m)</th>
<th>Observation period</th>
<th>Min. cutoff diameter (nm)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyyti’al’a</td>
<td>24.3E, 61.9N</td>
<td>180</td>
<td>2000-2004</td>
<td>3</td>
<td>Aalto et al. (2001)</td>
</tr>
<tr>
<td>Finokalia</td>
<td>25.7E, 35.3N</td>
<td>0</td>
<td>1997, 2006-2007</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Hohenpeissenberg</td>
<td>11.0E, 47.8N</td>
<td>995</td>
<td>2006-2007</td>
<td>3</td>
<td>Birmili et al. (2003)</td>
</tr>
<tr>
<td>Bondville</td>
<td>88.4W, 40.1N</td>
<td>213</td>
<td>1994-2007</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Southern Great Plains</td>
<td>97.5W, 36.6N</td>
<td>320</td>
<td>1996-2007</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Tomsk</td>
<td>85.1E, 56.5N</td>
<td>2005-2006</td>
<td>3</td>
<td>Dal Maso et al. (2008b)</td>
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</tr>
<tr>
<td>Listvyanka</td>
<td>104.9E, 51.9N</td>
<td>2005-2006</td>
<td>3</td>
<td>Dal Maso et al. (2008b)</td>
<td></td>
</tr>
<tr>
<td>Harwell</td>
<td>359.0E, 51.0N</td>
<td>60</td>
<td>2000</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Weybourne</td>
<td>1.1, 53.0N</td>
<td>0</td>
<td>2005</td>
<td></td>
<td></td>
</tr>
<tr>
<td>India Himilaya</td>
<td>79.6E, 29.4N</td>
<td>2180</td>
<td>2005-2008</td>
<td>10</td>
<td>Komppula et al. (2009)</td>
</tr>
<tr>
<td>Aspvereten</td>
<td>17.4E, 58.8N</td>
<td>25</td>
<td>2000-2006</td>
<td>10</td>
<td>Dal Maso et al. (2008a)</td>
</tr>
<tr>
<td>Ut’o</td>
<td>21.4E, 59.8N</td>
<td>8</td>
<td>2003-2006</td>
<td>7</td>
<td>Dal Maso et al. (2008a)</td>
</tr>
<tr>
<td>Varri’o</td>
<td>29.6E, 67.8N</td>
<td>400</td>
<td>1998-2006</td>
<td>8</td>
<td>Dal Maso et al. (2008a)</td>
</tr>
<tr>
<td>Thompson Farm</td>
<td>289.1E, 43.1N</td>
<td>75</td>
<td>2001-2009</td>
<td>7</td>
<td>Ziemba et al. (2007)</td>
</tr>
<tr>
<td>Castle Springs</td>
<td>71.3W, 43.7N</td>
<td>406</td>
<td>2001-2008</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>
Sites with CN observations over several years

Remote marine BL sites
Continental BL sites
Free Tropospheric sites
GLOMAP CN being evaluated against observations at GAW and ARM sites

Primaries only (no nucleation)
Enhanced primaries only (no nucleation)
Primaries & binary homogeneous nucleation (BHN)
Primaries, BHN & Boundary Layer nucleation

GLOMAP CN being evaluated against observations at GAW and ARM sites.

Spracklen et al., (2009, in preparation)

- Primaries only (no nucleation)
- Enhanced primaries only (no nucleation)
- Primaries & binary homogeneous nucleation (BHN)
- Primaries, BHN & Boundary Layer nucleation
GLOMAP CCN being evaluated against a range of worldwide observations

Note: map shows CCN at 0.2% supersaturations.
Coloured circles show observations at range of supersaturations.
GLOMAP CCN being evaluated against a range of worldwide observations

GLOMAP-mode vs. observations

GLOMAP-bin vs. observations

GLOMAP-bin vs. -mode

SS < 0.25%
SS < 0.5%
SS < 0.75%
SS > 0.75%
0–90E
90E–180E
180W–90W
90W–0W
GLOMAP size distributions being evaluated vs DMPS observations European EUSAAR supersites

See poster by Maria Frontoso and Carly Reddington (University of Leeds)
GLOMAP size distributions being evaluated vs DMPS observations European EUSAAR supersites

See poster by Maria Frontoso and Carly Reddington (University of Leeds)
May 2008 EUCAARI-LONGREX flights – track evolution of aerosol properties (DLR Falcon, UK FAAM BAe146) over Europe (N-S and E-W transects)

See poster by Maria Frontoso and Carly Reddington (University of Leeds)
GLOMAP being evaluated EUCAARI observations

GLOMAP bin

GLOMAP mode

Aerosol optical depth, AOD @ 550 nm

\[ b = 0.993 \pm 0.018 \]

\[ b = 0.40 \pm 0.004 \]

See poster by Maria Frontoso and Carly Reddington (University of Leeds)
GLOMAP being evaluated EUCAARI observations

GLOMAP bin

GLOMAP mode

Single scattering albedo

Note: BC emissions decreased by factor 3 (too strong absorption otherwise)

See poster by Maria Frontoso and Carly Reddington (University of Leeds)
AEROS Aerosol Model Uncertainty project

Aerosol Model Robustness and Sensitivity study for improved climate and air quality predictions

3y Leeds/Oxford NERC project 2010-2012

• Develop techniques for sensitivity and uncertainty analysis of complex aerosol models (structural and parametric uncertainty)

• Quantify the most important factors controlling prediction diversity and biases against observations

• Evaluate models against synthesised aircraft, ground and remote observations from recent campaigns

• Define an appropriate level of model complexity and enable future model development to be prioritised.

Close collaboration with the Met Office and AEROCOM
Establish links with MUCM project
GLOMAP, UKCA and ECHAM-HAM models
Summary

Original timeline for microphysics has slipped, but plan still the same.
-- Please submit your model’s concnxx and mmrtryy files to the AEROCOM server on 3D-M, 1D-D, 0D-H – use CMOR tables on website.
-- Please also provide your model’s README file with instructions with order of aerosol tracers & how to calculate size distribution from your model tracers.

All-aerosol-tracer 3D-M, 1D-D, 0D-H data for GLOMAP-mode submitted to AEROCOM data server for A2-CTRL-2006 simulation
-- Please copy your models files over with A2-CTRL-2006 as soon as possible.

Assembled range of CN and CCN datasets at Leeds – can make available to AEROCOM for data server (assuming data PIs happy with this).

Wide range of new size distribution datasets from EUCAARI and EUSAAR now becoming available to help constrain models

Will compare each A2-CTRL vs current set of “number observations” in Leeds.

Then start to document diversity in simulated influence of microphysics on CCN, AOD using model sensitivity simulations A2-SIZ1,SIZ2,SIZ3,SIZ4 by end 2009.

New project AEROS starting March 2010 to quantify sources of model uncertainty at process level using aircraft, ground, remote-sensed and satellite observations over EUCAARI and EMEP intensive periods.