

# The ECHAM5 Aerosol Model

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1) Introduction

2) Model Description

3) Outlook

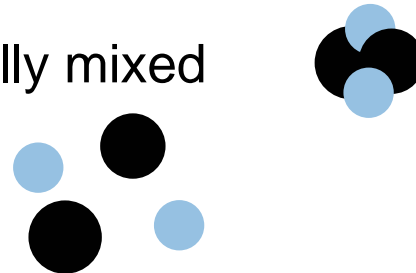
## 1) Introduction - Requirements

Prediction of size-distribution, composition and mixing-state essential

- Aerosol-cloud interaction
- Sink processes
- Radiative effects

Observations

- Aerosols predominantly internally mixed
- Externally mixed contribution



Computational constraints

- Balance in complexity: GCM vs. Aerosol Model

## 2) Model Description - Components

### ECHAM5

(Roeckner  
et al.,  
*in prep.*)

#### Sulfur Chemistry

(Feichter et al., 1996; ...)

#### Size-Dependent Dry- and Wet-Deposition

(Ganzeveld et al., 1998; Slinn and Slinn, 1980; Feichter et al., 1996, ...)

#### Online emissions of Dust, Sea Salt and DMS

(Tegen et al., 2002; Balkanski et al., 2002; Schulz et al., 2002; ...)

#### Aerosol Microphysics M7

(Vignati and Wilson, *in preparation*)

- Nucleation of sulphate particles
- Condensation of sulphate on existing particles
- Coagulation
- Transfer from insoluble to soluble modes
- Thermodynamical equilibrium with water vapour

## ECHAM5

- Spectral Model  
Horizontal resolution: T63  $\Leftrightarrow$  1.8° on Gaussian grid  
Vertical resolution: 31 levels
- Advective Transport  
Flux-form semi-Lagrangian (Lin and Rood, 1996)
- Cloud Cover  
Prognostic-statistic scheme based on PDF of total water (Tompkins, 2002)
- Cloud Microphysics  
(Lohmann and Roeckner, 1996  $\Leftrightarrow$  Lohmann et al., 1999)
- Radiation  
Long-wave: RRTM with 16 bands (Mlawer et al., 1997)  
Short-wave: 4 bands
- Improved land surface scheme

# Aerosol Representation

Resolve aerosol distribution by 7 log-normal modes

Each mode is described by three moments:

Number, Median Radius  $\leftrightarrow$  Mass, Standard Deviation (fixed)

Mixing State of the compounds:

| MODES IN M7                                                         | SOLUBLE / MIXED                                                                      | INSOLUBLE                             |
|---------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------|
| <b>NUCLEATION</b><br>( $r < 0.005 \mu\text{m}$ )                    | 1 $N_1, M_{\text{SO}_4}$                                                             |                                       |
| <b>AITKEN</b><br>( $0.005 \mu\text{m} < r < 0.05 \mu\text{m}$ )     | 2 $N_2, M_{\text{SO}_4}, M_{\text{BC}}, M_{\text{OC}}$                               | 5 $N_5, M_{\text{BC}}, M_{\text{OC}}$ |
| <b>ACCUMULATION</b><br>( $0.05 \mu\text{m} < r < 0.5 \mu\text{m}$ ) | 3 $N_3, M_{\text{SO}_4}, M_{\text{BC}}, M_{\text{OC}}, M_{\text{SS}}, M_{\text{DU}}$ | 6 $N_6, M_{\text{DU}}$                |
| <b>COARSE</b><br>( $0.5 \mu\text{m} < r$ )                          | 4 $N_4, M_{\text{SO}_4}, M_{\text{BC}}, M_{\text{OC}}, M_{\text{SS}}, M_{\text{DU}}$ | 7 $N_7, M_{\text{DU}}$                |

$\Rightarrow$  Reduction of the number of transported tracers to 28

# Dust Cycle (Ina Tegen, Martin Werner, MPI-BGC)

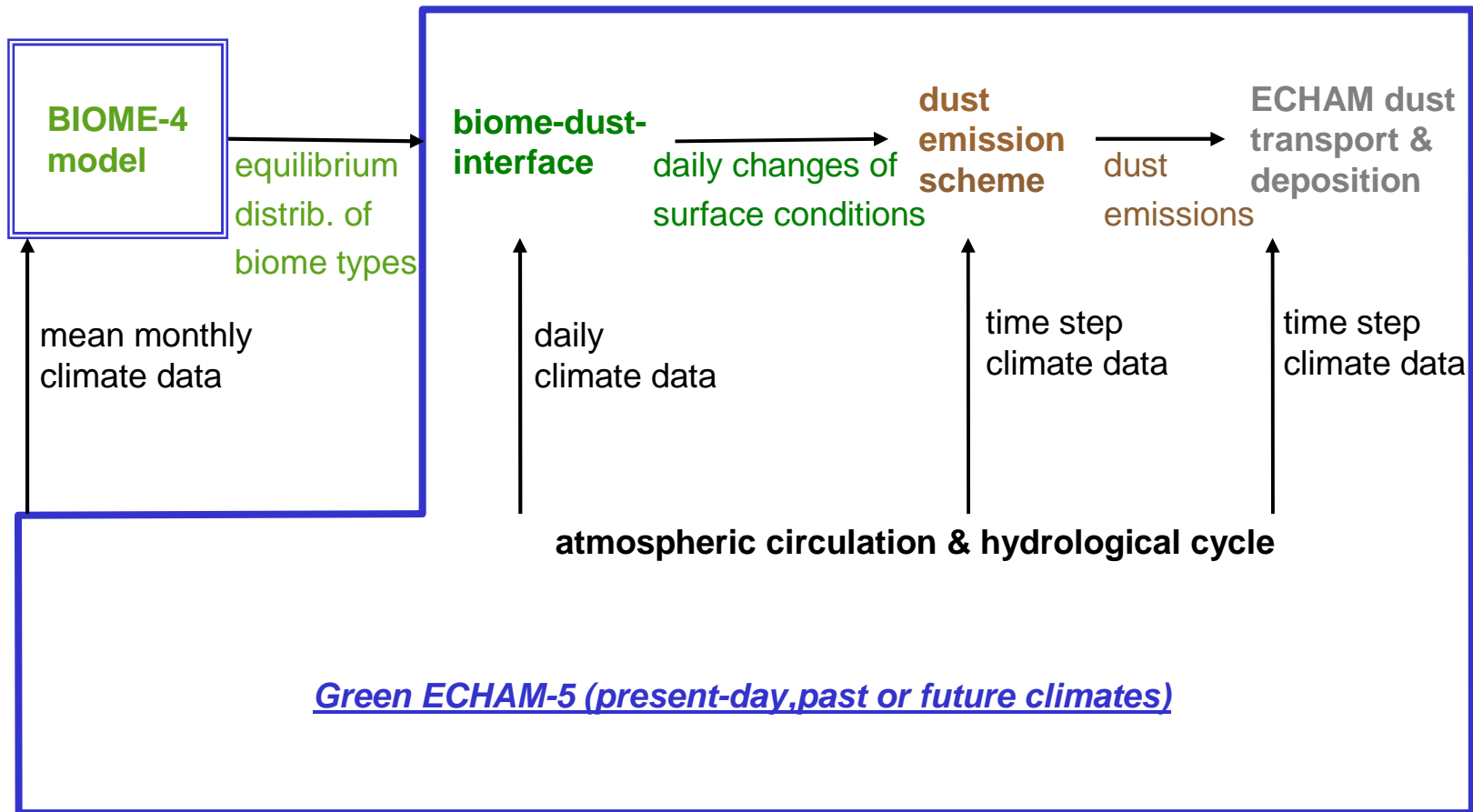


Image by courtesy of M. Werner

## 4) Outlook

- Ongoing Work
  - Further evaluation and validation with in-situ and remote sensing data
  - Optical properties (evaluation, direct radiative effects)
  - Coupling of aerosol model and cloud scheme
    - Explicit activation, impaction- and below cloud scavenging
- Status of AEROCOM runs:
  - 5 yr climatological run (1985 emissions); evaluation this summer
  - 1996-2001 nudged - emissions for reference year 2000?
- Future Work
  - Extended thermodynamics (PHOENICS)
  - Extended organic carbon parameterisations (PHOENICS)
  - Heterogeneous chemistry (MPI-Met, MPI-Chem, ...)

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