

First steps towards aerosol cloud interactions within COSMO-ART



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WG Aerosol, Trace Gases and Climate Prozesses

**Quantifying the effect of aerosol
on regional climate and weather.**

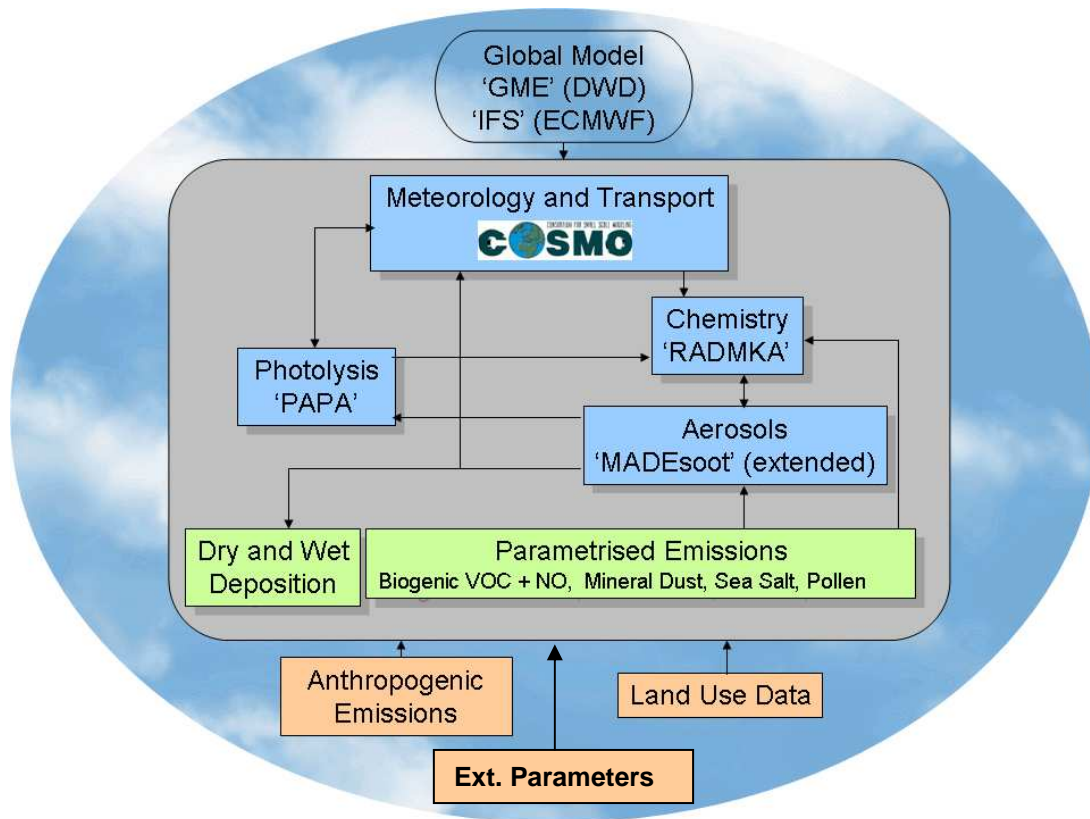
Newly developed model system **COSMO-ART**.

Direct aerosol effect already included in COSMO-ART.



**Implementation of Aerosol-Cloud-Interactions in
COSMO-ART.**

COSMO-ART (ART = Aerosols and Reactive Trace Gases)



Concept:

COSMO-ART is **online** coupled.

Identical methods are applied for all scalars as temperature, humidity, and concentrations of gases and aerosols to calculate the transport processes.

It has a **modular** structure.

Therefore **COSMO-ART** can (easily) be used in the **forecast mode**.

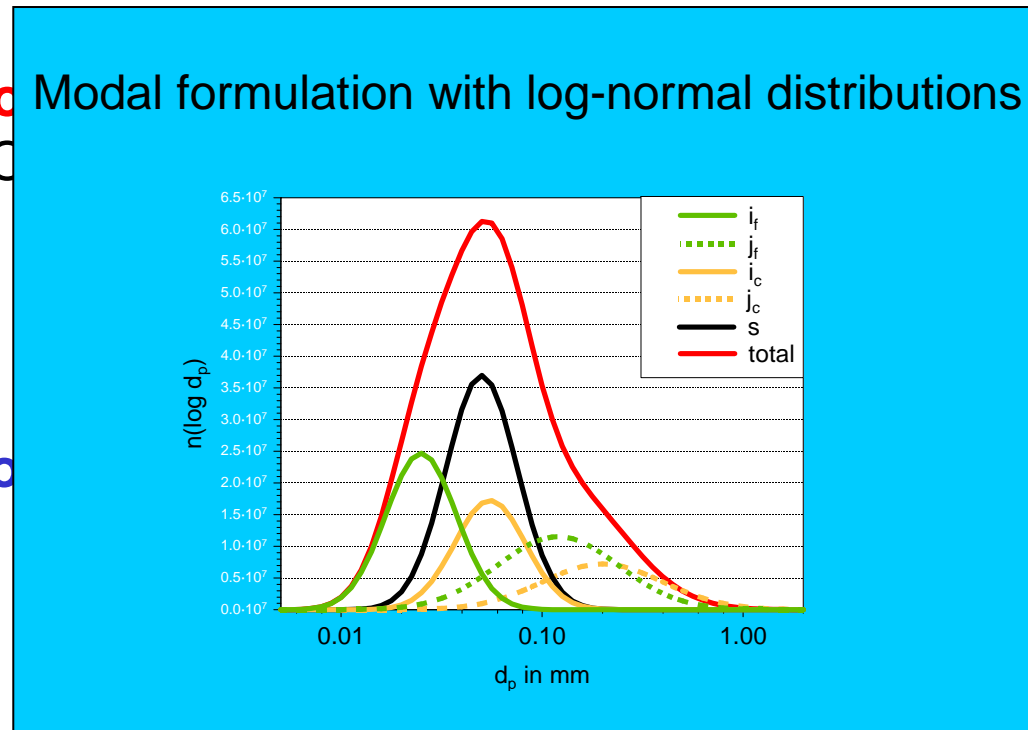
Treatment of Aerosol Particles in COSMO-ART

Interaction of five modes:

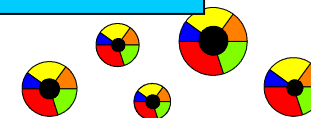
Source: homogeneous
nucleation of H₂SO₄/water

- **Two modes** Modal formulation with log-normal distributions
H₂O, SO₄

- **One mode**

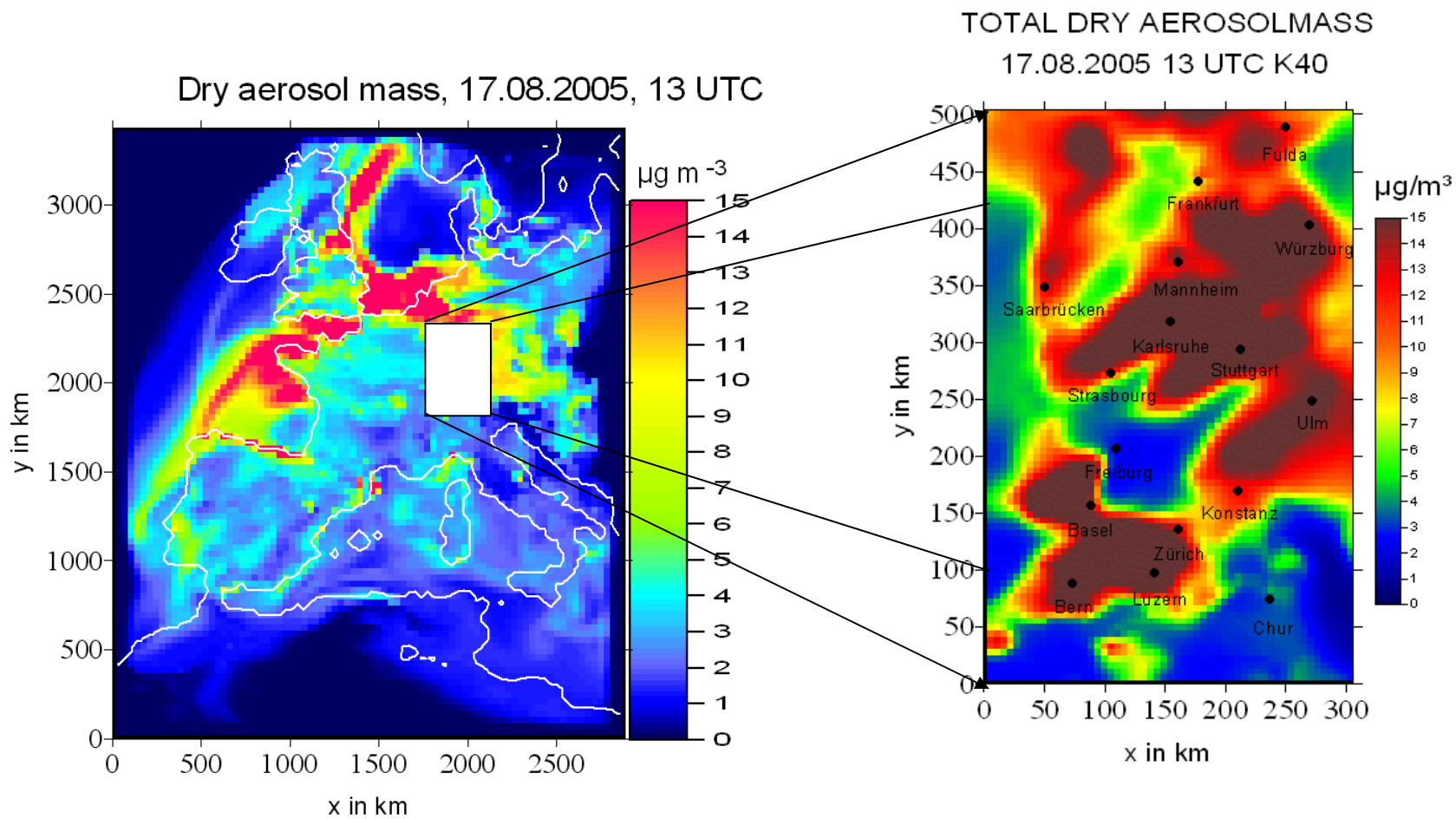


- **Two modes** for SO₄²⁻, NO₃⁻, NH₄⁺, H₂O, SOA, and soot internally mixed.

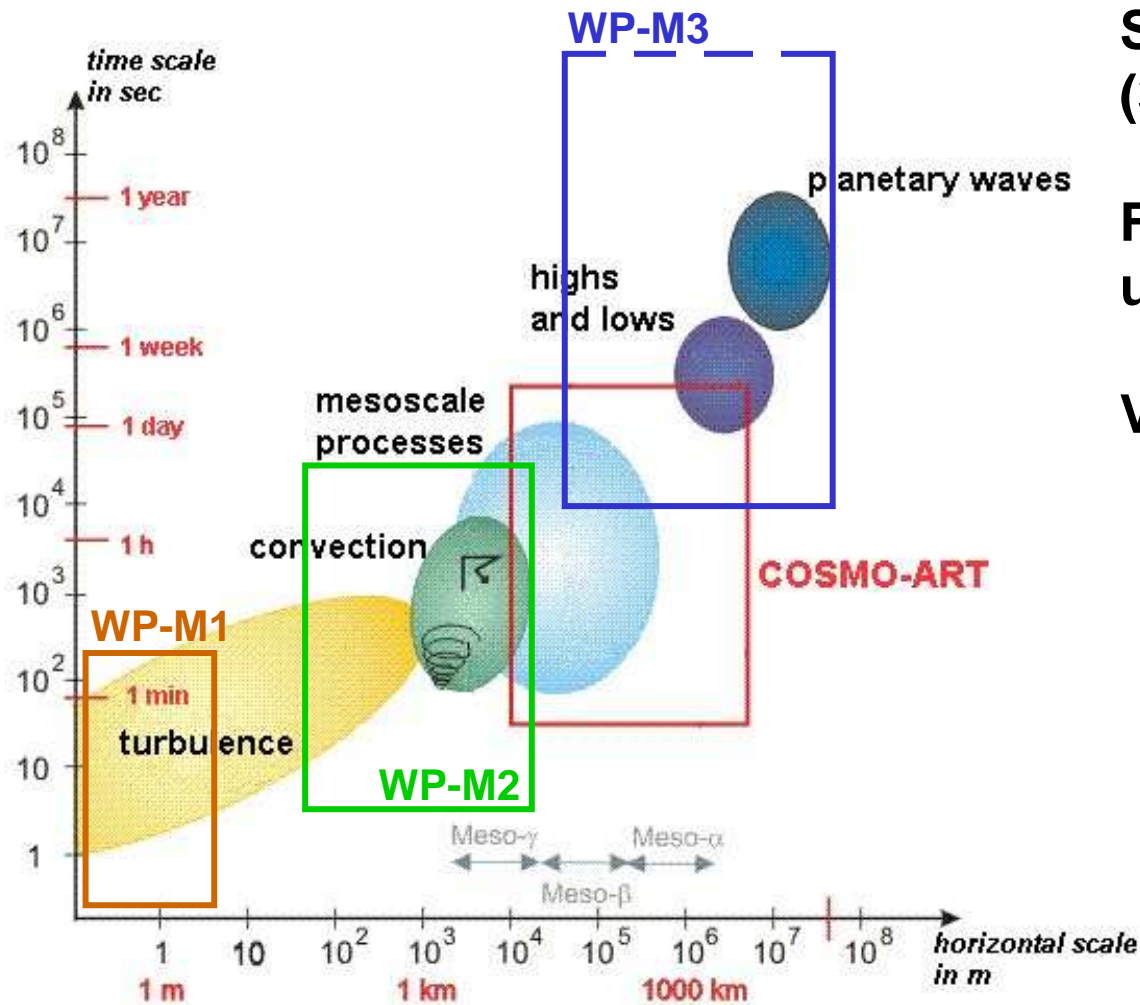


(**Three** modes for **mineral dust** particles + **Three** modes for **sea salt** particles + **Pollen**)

Nesting of COSMO-ART in COSMO-ART



Scales of VI-ACI Modelling Projects



Spatial Resolutions
(3 km) 7km 14 km

Focus on regional
up to continental scales

Various domains:

South-West Germany

Europe

Africa

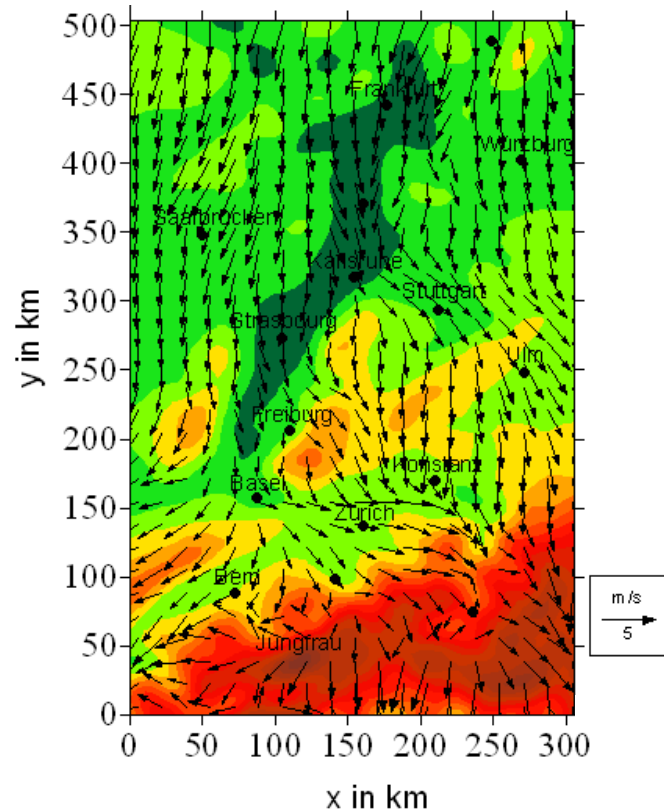
Mediterranean Area

...

Orography, Wind and Emissions

Orography and Wind

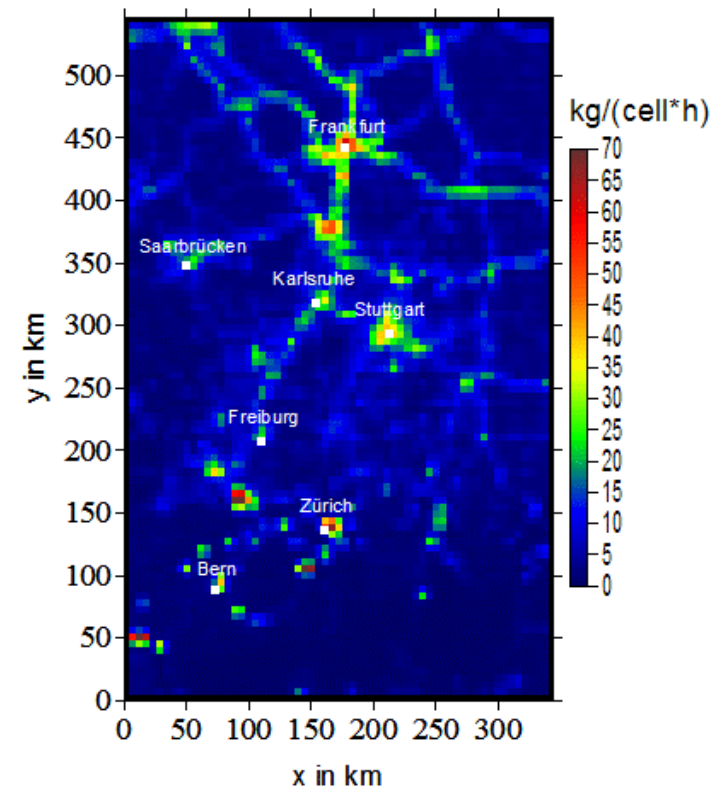
Windvektor 16.08.2005 05 UTC



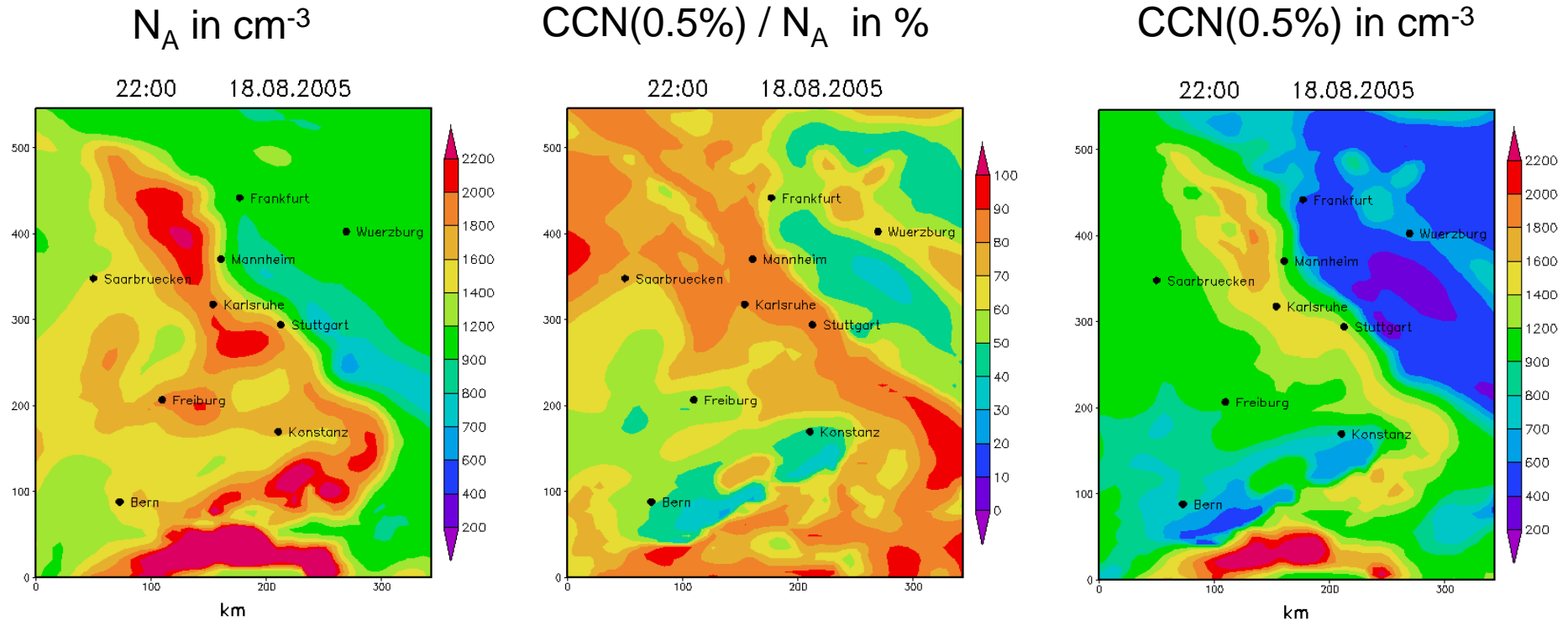
Emissions

(Pregger et al., IER, Uni Stuttgart)

NO_x 16.08.2005 00 UTC



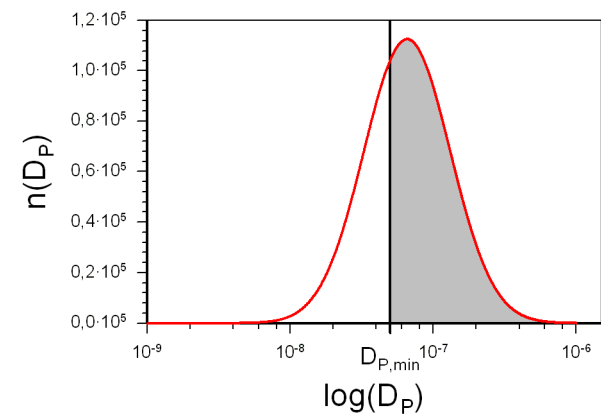
CCN(0.5%) Influence of Aerosol Properties



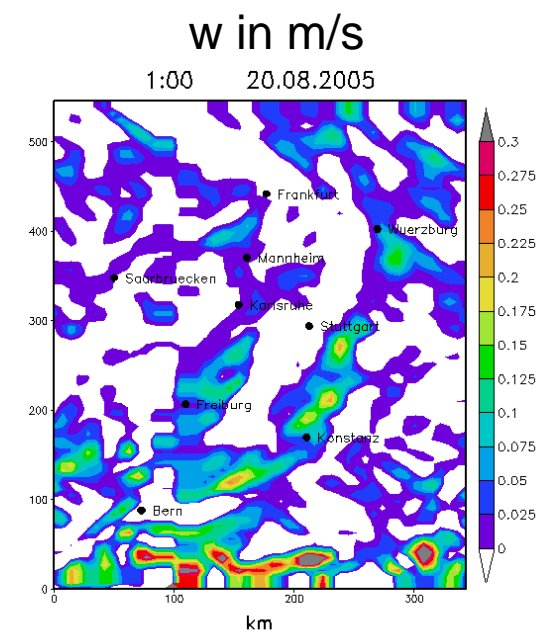
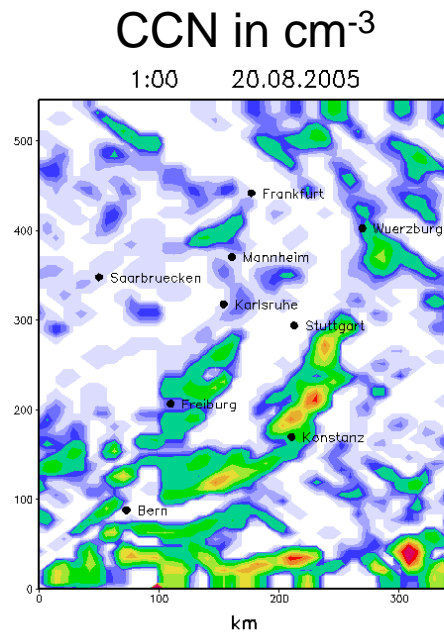
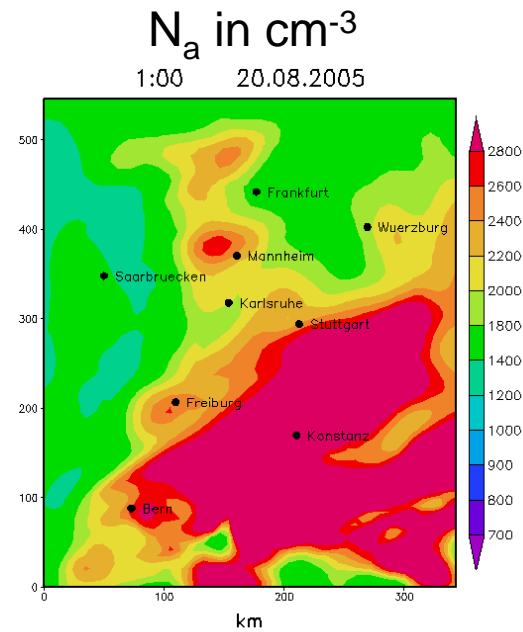
Calculation of **minimum dry diameter** $D_{P,min}(s)$ for activation, using **Köhler-equations** (Pruppacher & Klett).

Assumptions: ideal solution, organic components fully soluble, surface tension of pure water.

Integration of the **four internally mixed modes** from $D_{P,min}(s)$ to infinity.



Simulated CCN concentrations

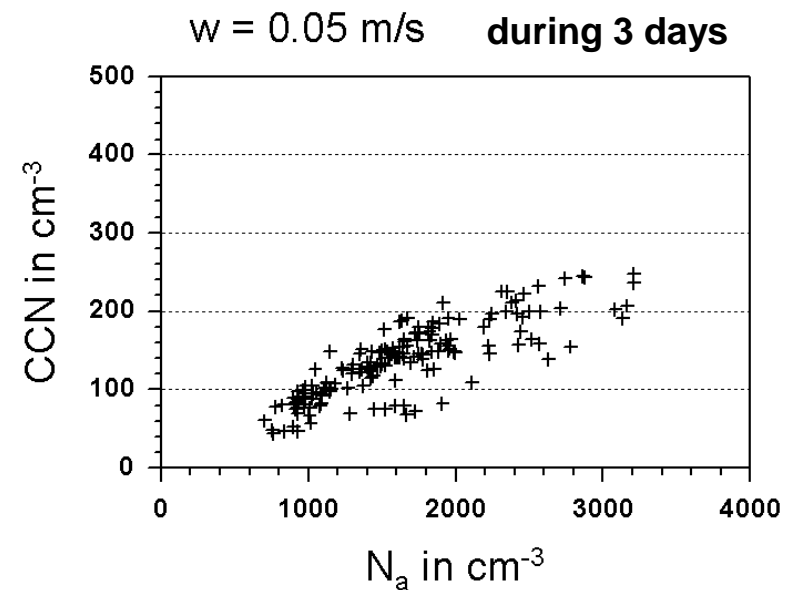


Segal & Khain 2006

Detailed Look-up-tables

Single log-normal distribution

Mean chemical property



Current Work and Next Steps

expandend bulk cloud microphysics:

- operational (DWD) COSMO cloud scheme, (water, ice, rain, snow; saturation adjustment)
- additional budget-equation for cloud droplet number density,
- budget-equations for scavenged aerosol mass in cloud.

different activation parameterisations:

- Abdul-Razzak & Ghan 2000,
- Segal & Khain 2006,
- ... any proposals?!

Full online coupled model system including warm phase aerosol cloud interactions for regional applications.

→ Wet chemistry, IN,

A dramatic landscape photograph capturing a sunset or sunrise. The sky is filled with large, dark, billowing clouds that are illuminated from below, creating a strong contrast with the bright orange and yellow light of the sun. The sun is positioned in the upper left quadrant, partially obscured by a cloud. Below the clouds, a thin layer of orange light stretches across the horizon. In the foreground, the silhouettes of an industrial facility with several tall smokestacks and a range of mountains are visible against the bright horizon. The overall mood is one of industrial activity amidst nature's grandeur.

Thank You for Your Attention!

VI-ACI

Highly interested in:

- new parameterizations of CCN and IN.
- improved treatment of organic components.
- efficient cloud microphysics.

Possible Contributions:

- link between process/cloud modeling
and climate modeling

- Studies on aerosol cloud interactions on a regional
scale: effect of anthropogenic emissions,...

Summary

- Full online coupled model system **COSMO-ART**:
 - 12 aerosol modes,
 - self nesting ability,
 - detailed emissions (1 hour time resolution),
 -

- Focus on regional scales:
 - orographic effects,
 - anthropogenic effects,
 -

- supplement for VI-ACI
 - Regional studies
 - Link between the scales of cloud modeling and global climate modeling
 - ... ?