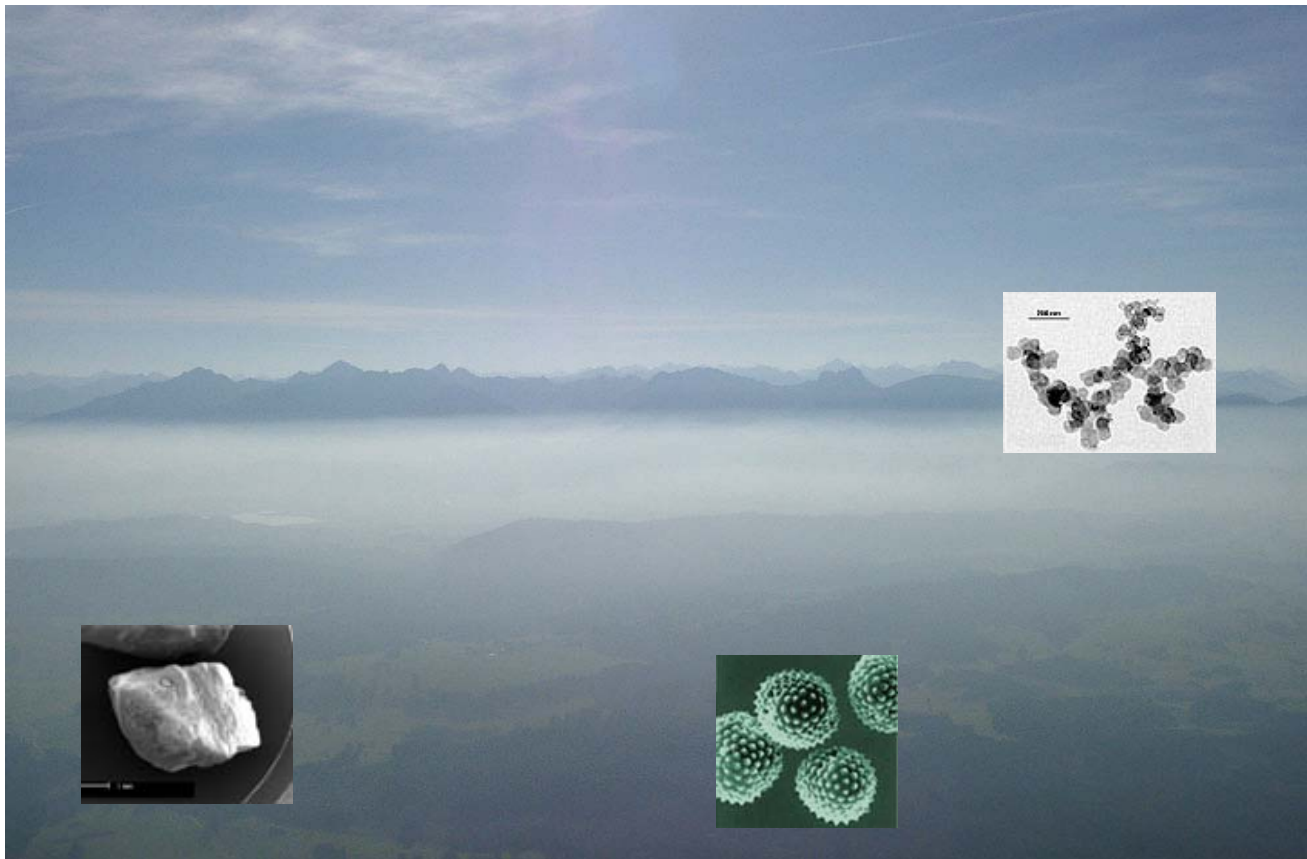


COSMO LM-ART

Aerosols and Reactive Trace Gases within LM



Dominique Bäumer
Max Bangert
Kristina Lundgren
Rayk Rinke
Tanja Stanelle
Bernhard Vogel
Heike Vogel

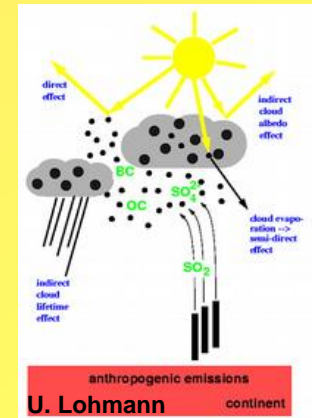
Aerosols and Climate Processes

Aerosols have an impact on human health,

BUT they have also an impact on climate (and weather).

by:

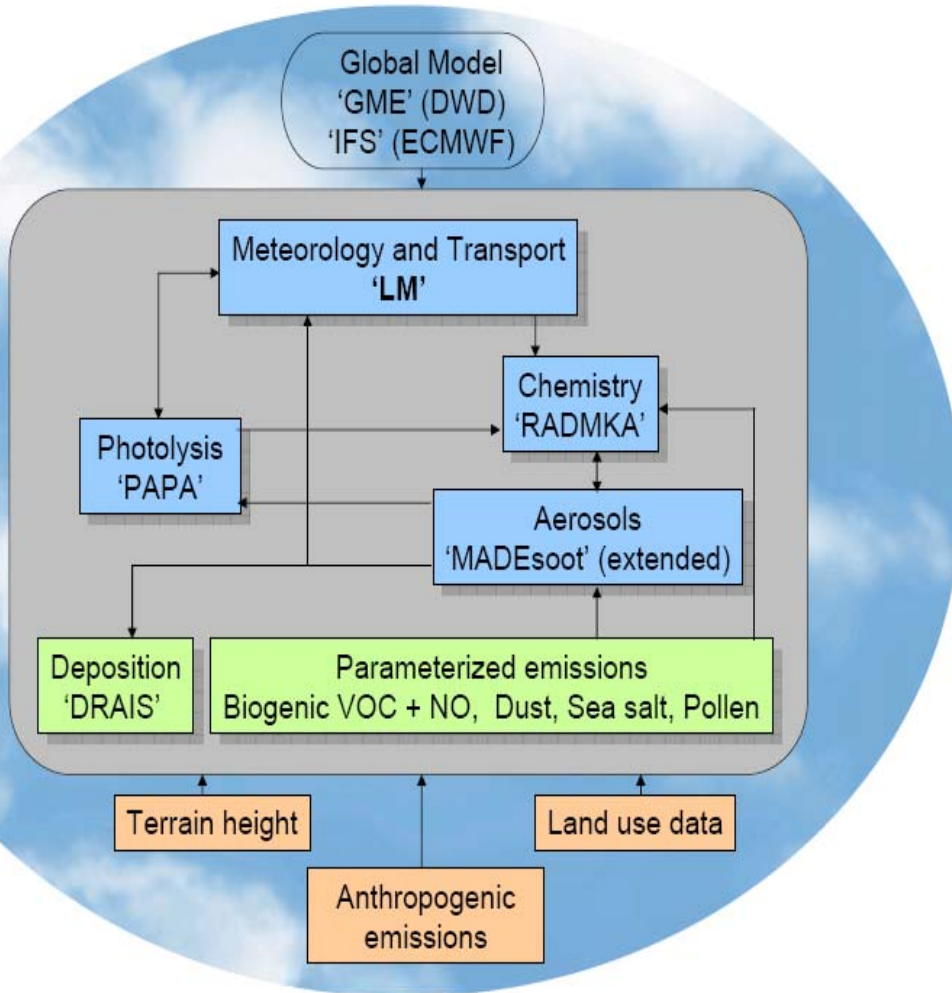
modifying the atmospheric radiation (direct effect),
modifying cloud formation (indirect effect),
and mixtures of both.



AND:

They are changing the chemical composition of the atmosphere.

COSMO LM – ART (ART = Aerosols and Reactive Trace Gases)



Concept:

LM_ART is **Online** coupled.

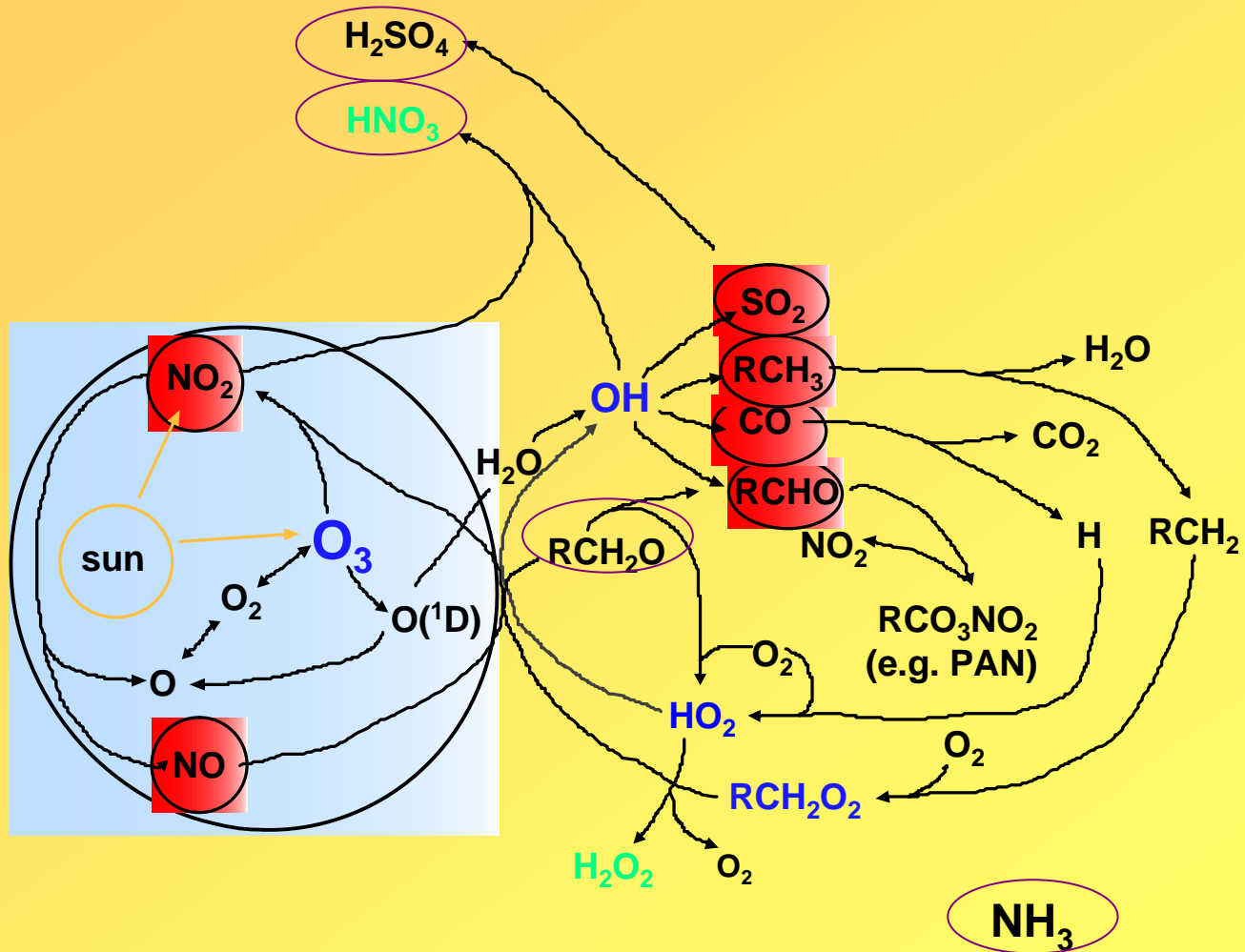
Identical methods are applied for all scalars as temperature, humidity, and concentrations of gases and aerosols to calculate the transport processes.

It has a **modular** structure.

Therefore **LM-ART** can easily be used in the **forecast mode**.

Thanks to all colleagues of DWD

Photochemistry



Staehelin und Dommen (1994)

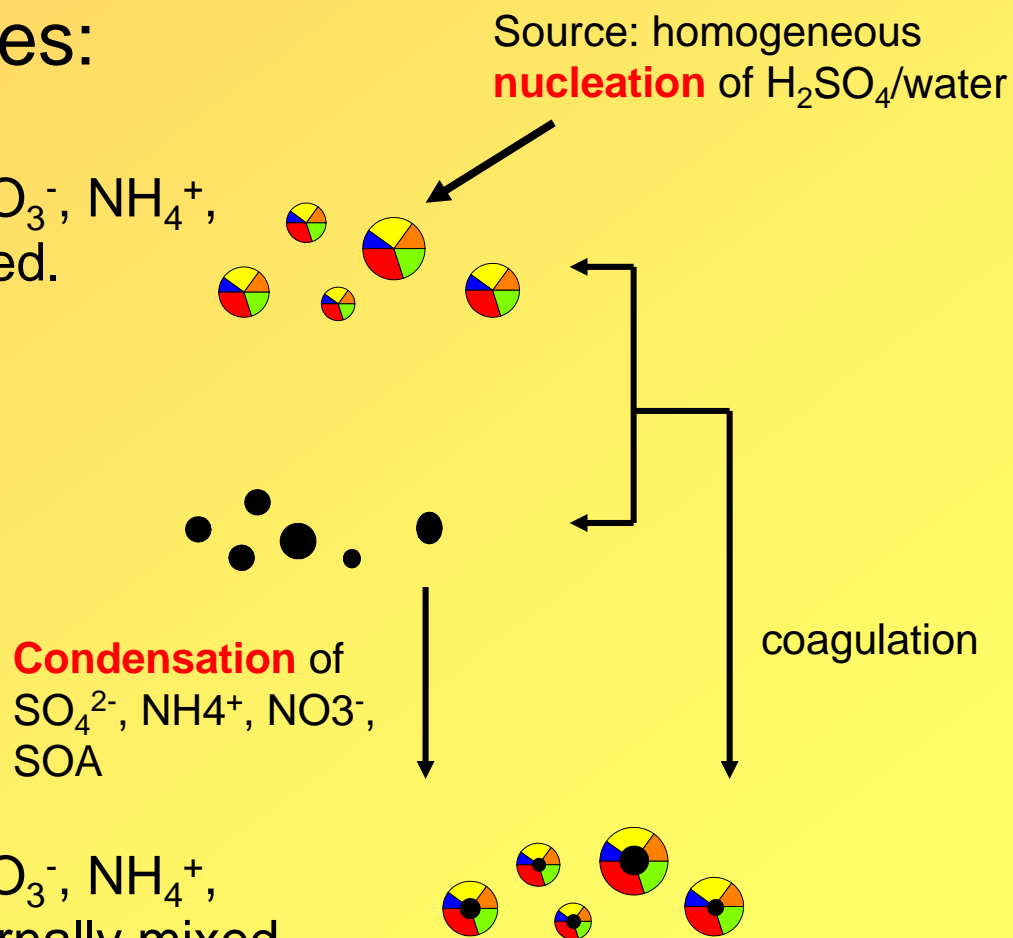
Treatment of the Aerosol Particles

Interaction of five modes:

- **Two modes** for SO_4^{2-} , NO_3^- , NH_4^+ , H_2O , SOA, internally mixed.

- **One mode** for pure soot.

- **Two modes** for SO_4^{2-} , NO_3^- , NH_4^+ , H_2O , SOA, and soot internally mixed.



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

COSMO LM – ART (ART=Aerosols and Reactive Trace Gases)

Gas phase chemistry: **58** transported variables,
Aerosol: **77** transported variables

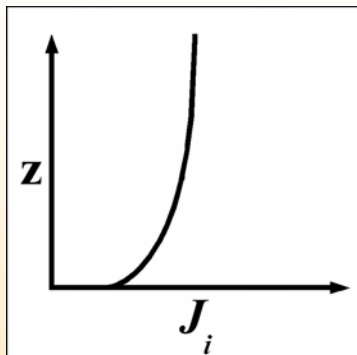
Nesting option is currently realized in collaboration with U. Schättler

Future Developments:

Interaction of aerosols and clouds

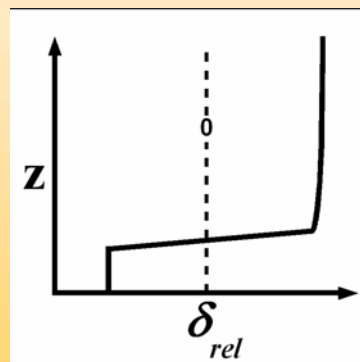
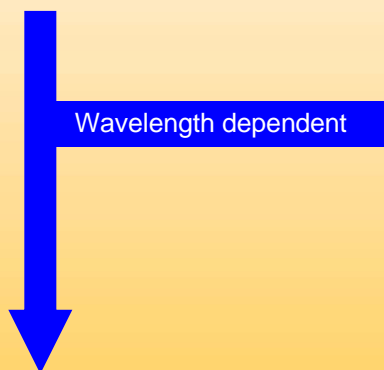
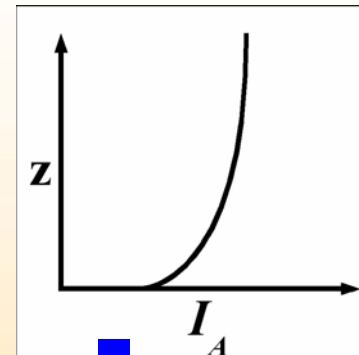
Wet phase chemistry

Parameterizations of the Photolysis Frequencies



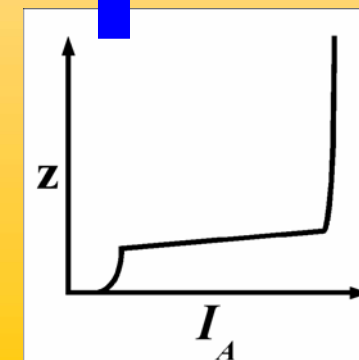
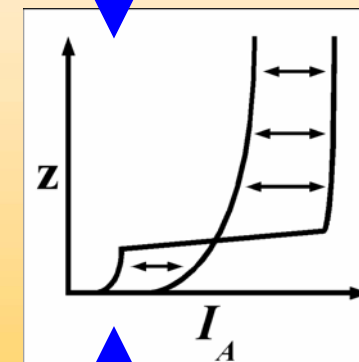
Pre - calculated profiles
For identical conditions with
STAR and GRAALS (LM)

Cloud free, no aerosols, sea level



In LM-ART
Online coupled

Accounts for
clouds, aerosol,
terrain height, albedo



Emissions of Sea Salt Particles

◆ **Mårtensson**
et al. [2003]: $\frac{dF_0}{d \log D_p} = \Phi \cdot 3.84 \cdot 10^{-6} \cdot U_{10}^{3.41}$, $\Phi = \Phi(T_w, D_p)$

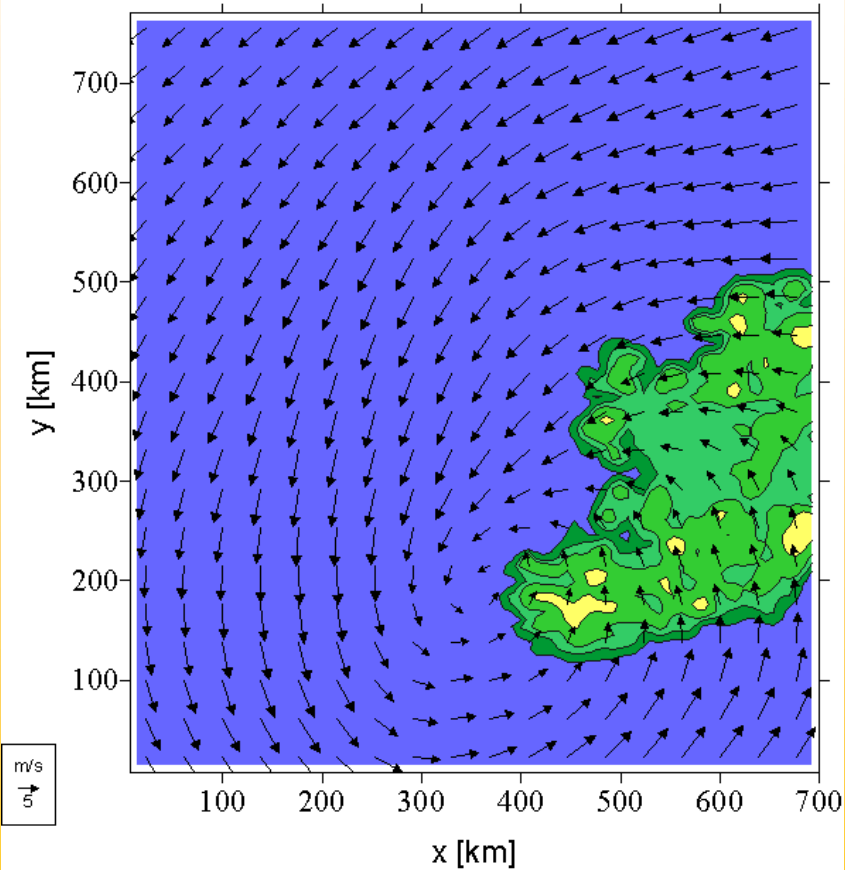
◆ **Monahan**
et al. [1986]: $\frac{dF_0}{dr_{80}} = 1.373 U_{10}^{3.41} r_{80}^{-3} \left(1 + 0.057 r_{80}^{1.05}\right) \cdot 10^{1.19e^{-B^2}}$

◆ **Smith**
et al. [1993]: $\frac{dF_0}{dr_{80}} = \sum_{i=1,2} A_i \exp\left(-f_i \left(\ln \frac{r_{80}}{r_{0i}}\right)^2\right)$, $A_i = A_i(U_{10})$

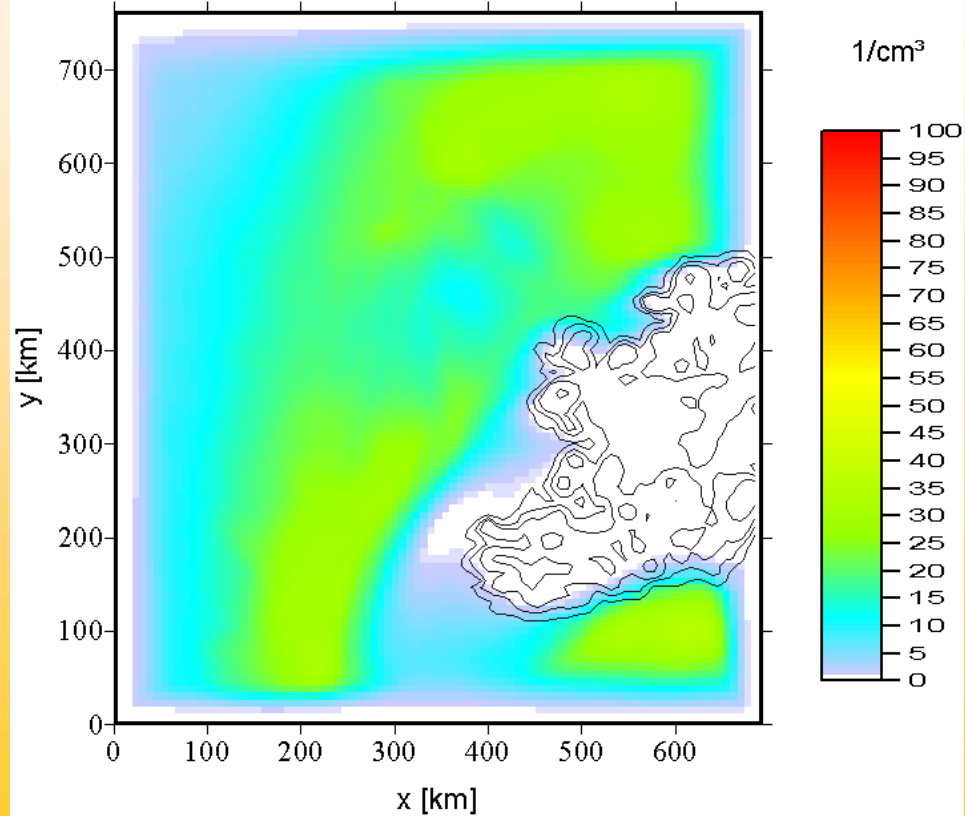
Lewis and Schwartz [2005]: $r_{RH} = (r_d) \left(\frac{4.0}{3.7}\right) \left(\frac{2.0 - RH}{1 - RH}\right)^{\frac{1}{3}}$

Wind and Number Density

Wind , 28.05.05, 00 UTC



number concentration, 28.05.05, 01 UTC



Parameterisation of the Source Function

$$F_p = c_p \cdot \frac{q_p}{LAI \cdot h} \cdot u_* \cdot K_e$$

F_p : flux of pollen grains

c_p : plant specific factor

q_p : total pollen number of a season per m^{-2}

LAI: leaf area index

h: canopy height

u_* : friction velocity

K_e : meteorological correction factor

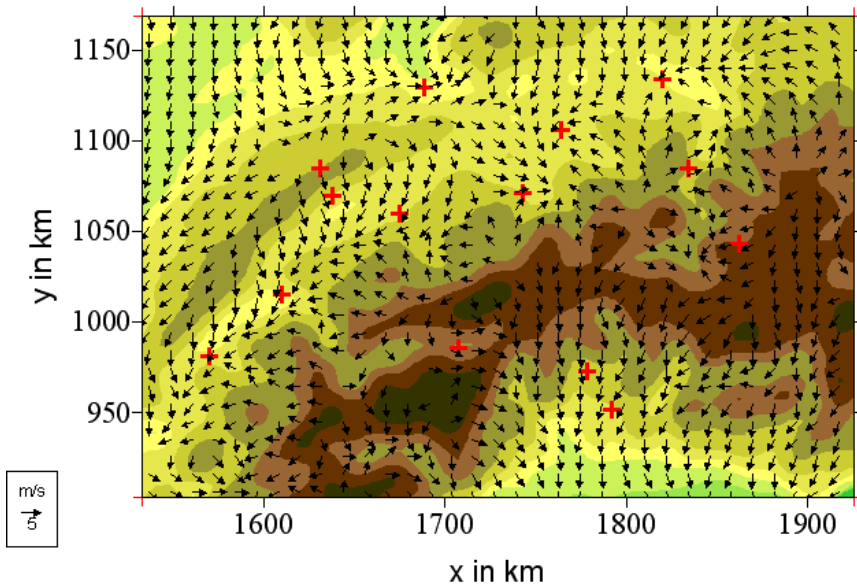
Birch Pollen Episode in Switzerland

In collaboration with A. Pauling, Meteoswiss

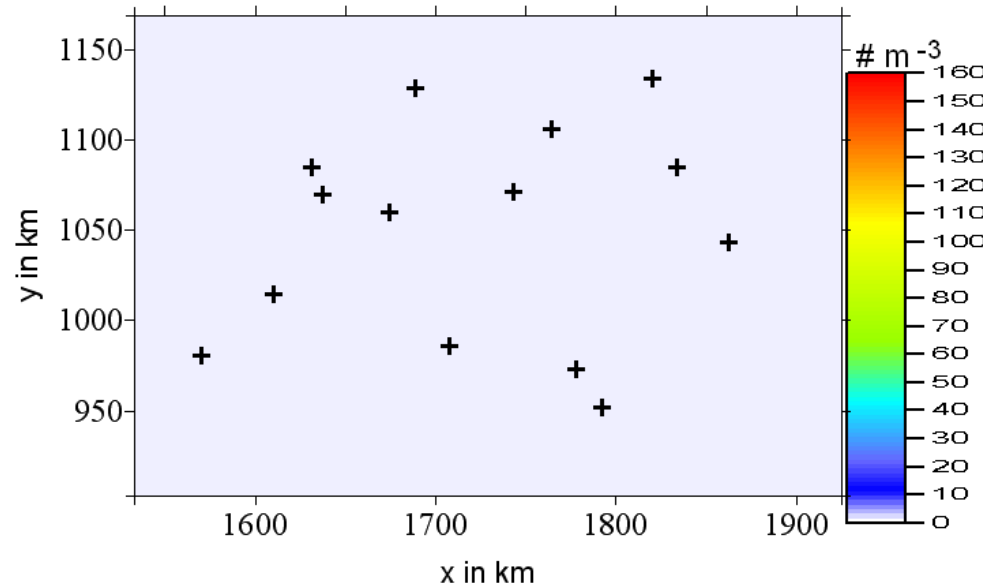


Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera

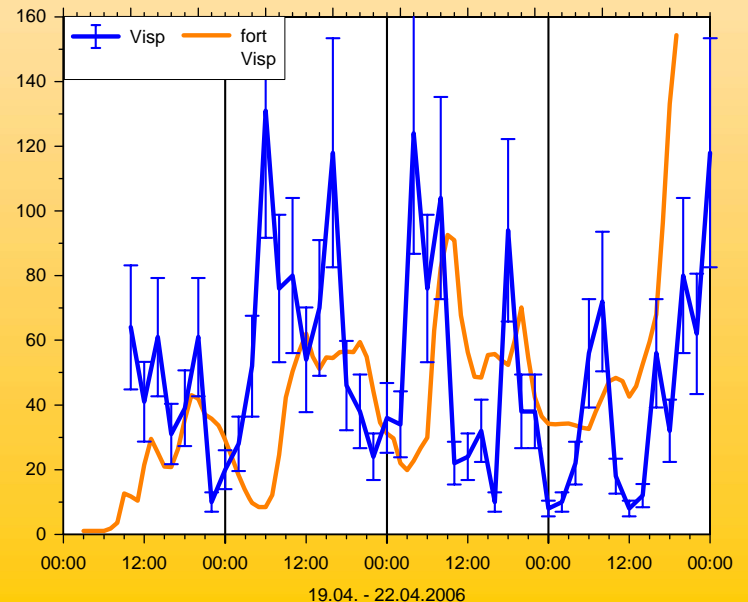
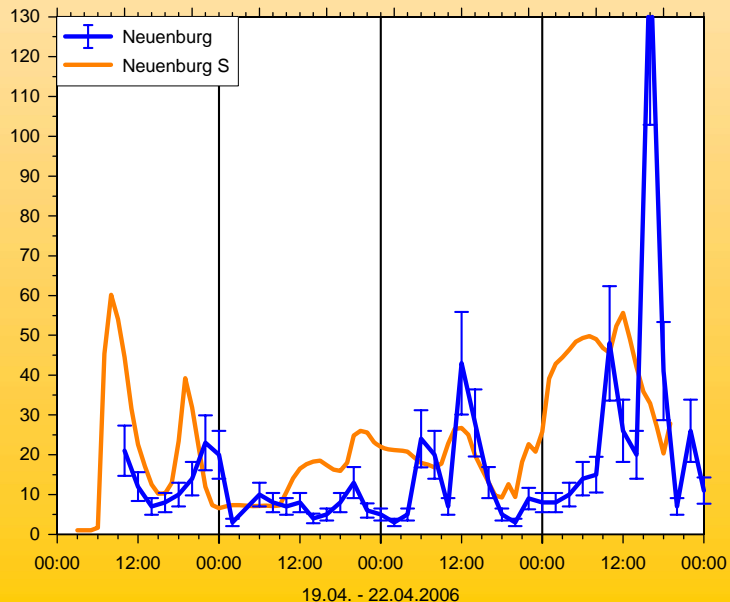
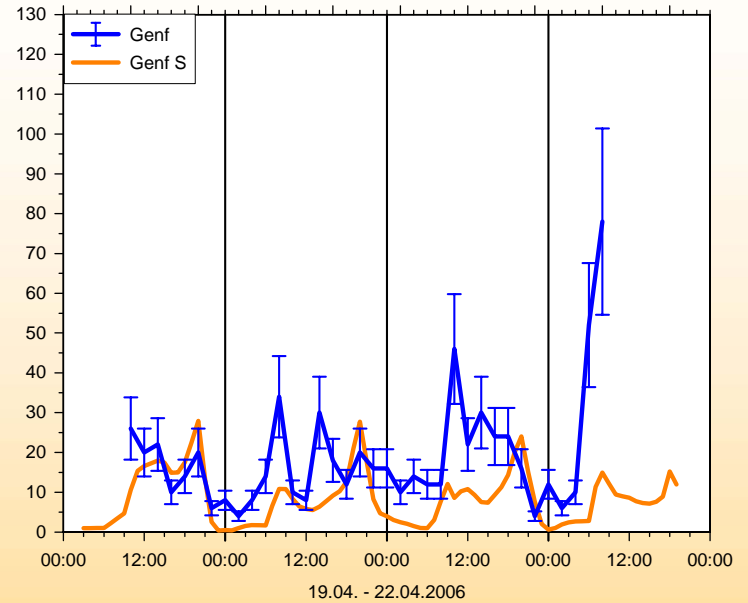
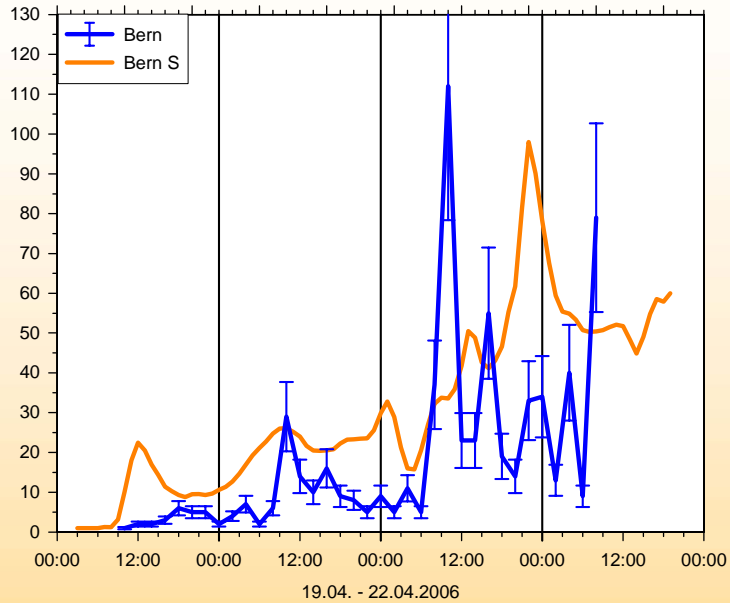
Wind , 19.04.2006, 01 UTC



Pollen, 19.04.2006, 01 UTC



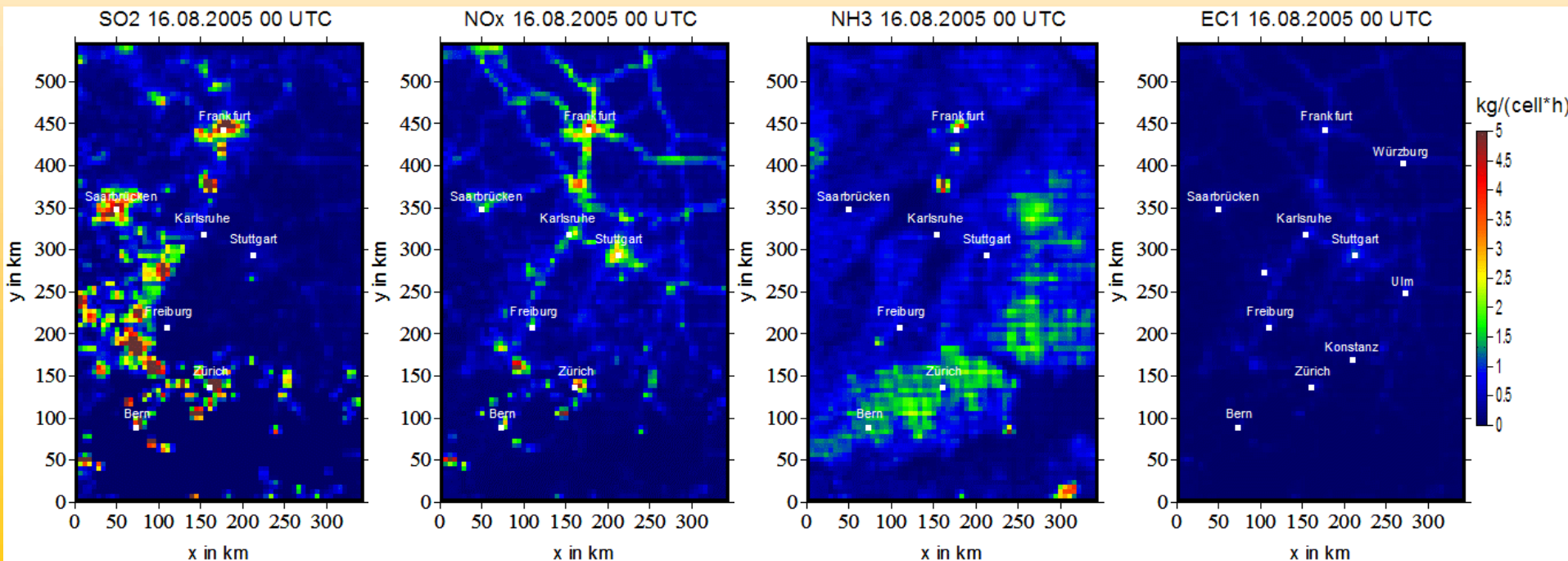
Comparison with Observations



Emissions

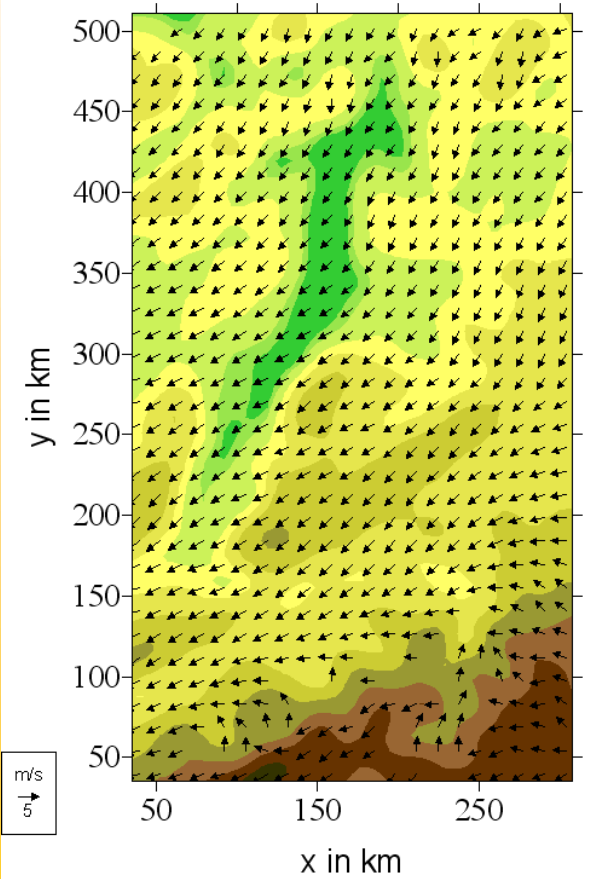
(Pregger et al., IER, Uni Stuttgart)

- Discrimination of point and area sources.
- Temporal resolution 1h, spatial resolution 1km x 1km
- 20 gas phase species (5 inorganic species, 15 VOC's)
- Primary particle emissions as EC and PM
- Biogenic emissions calculated online

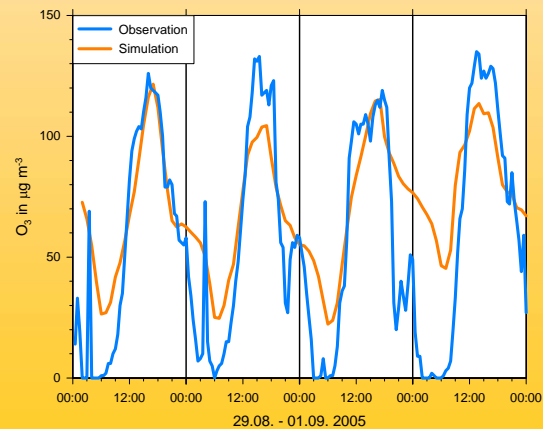
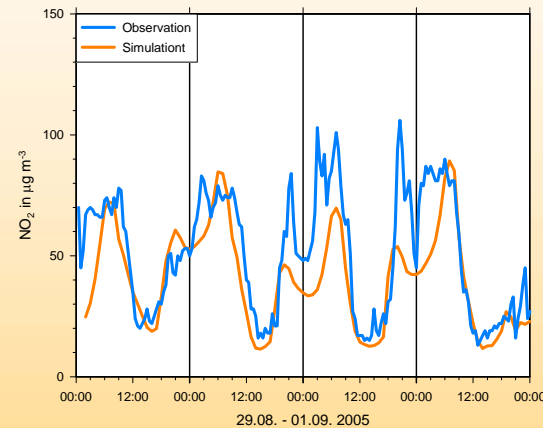
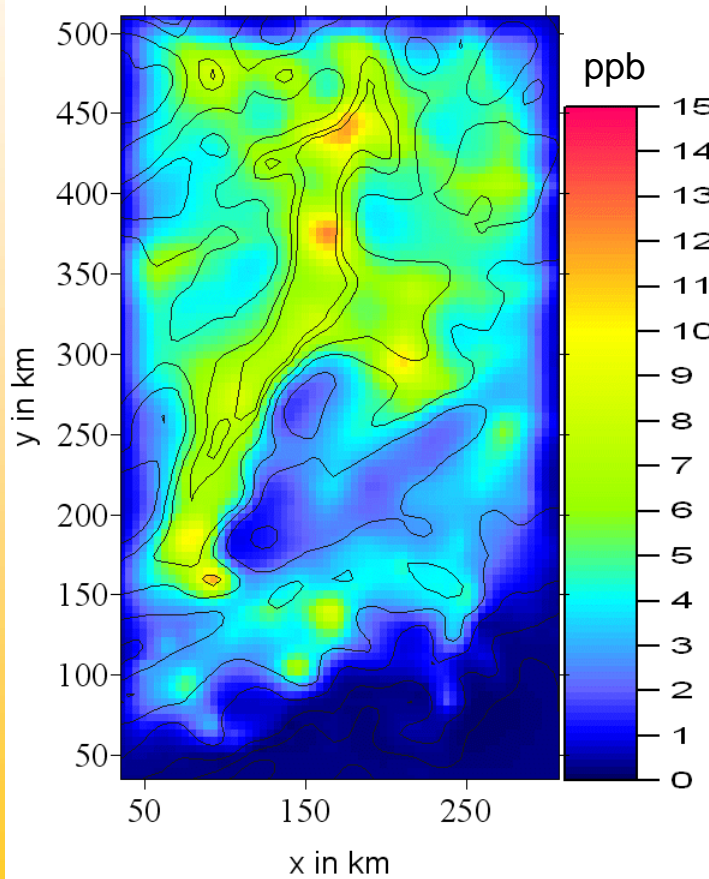


Simulated Wind and Concentration Distribution

Wind , 29.08.2005, 00 UTC



NO₂, 29.08.2005, 01 UTC



Outlook

LM-ART will become available to **COSMO** members
as soon as possible.