Radiation-aerosol-atmosphere feedbacks on the regional scale

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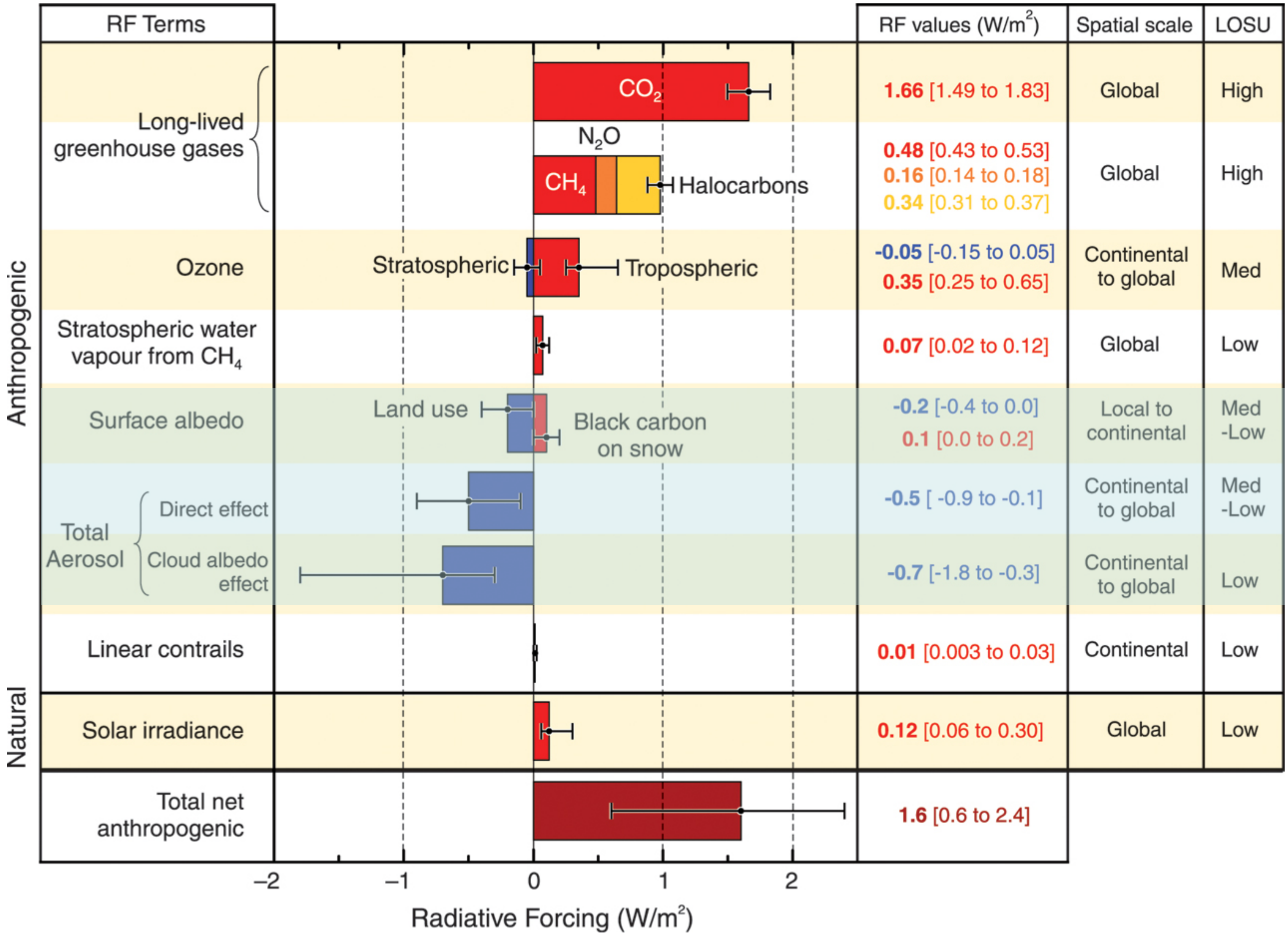
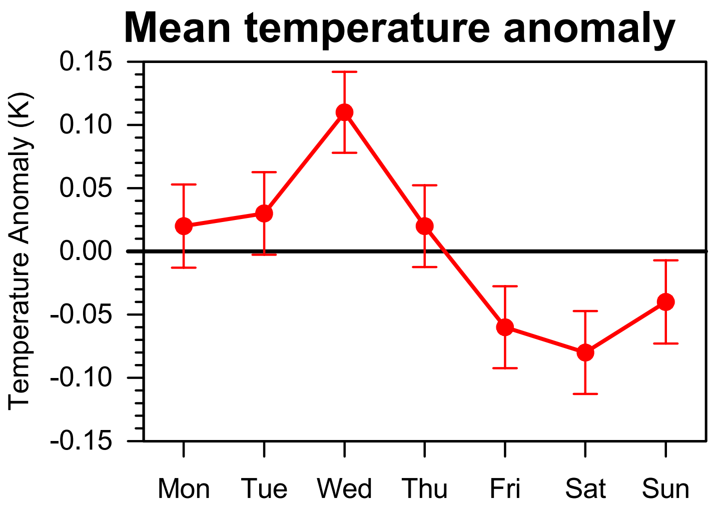
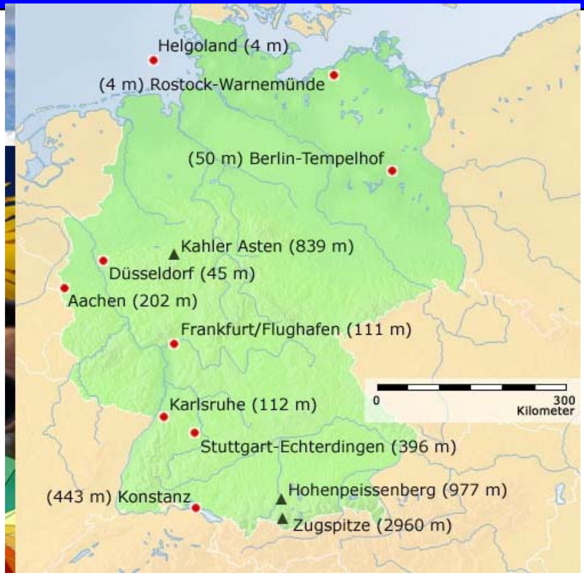
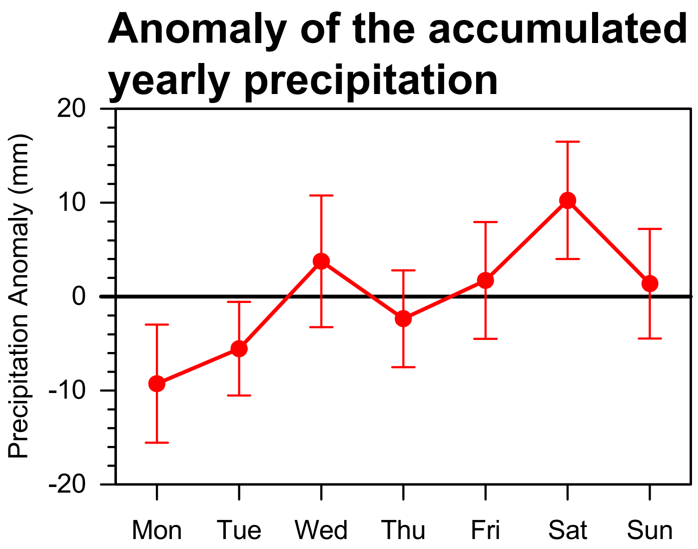
Global radiative forcing

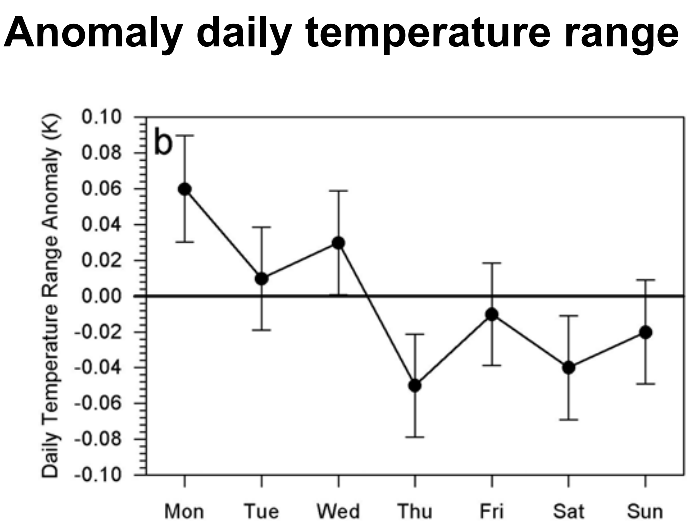


Weekly cycles of atmospheric variables?



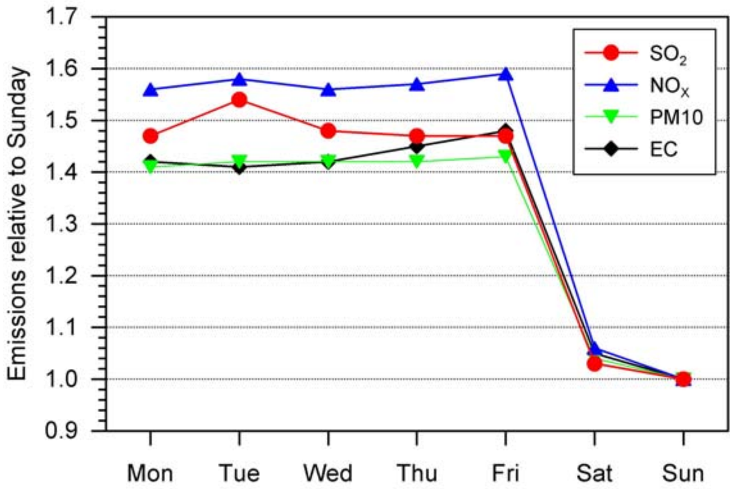




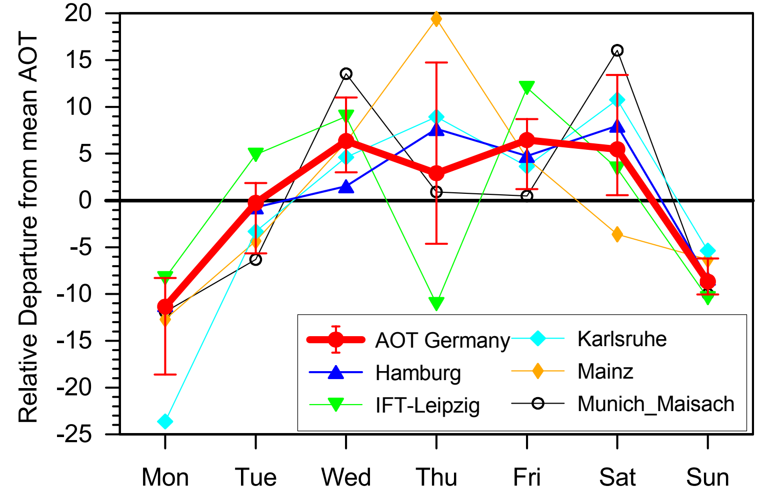


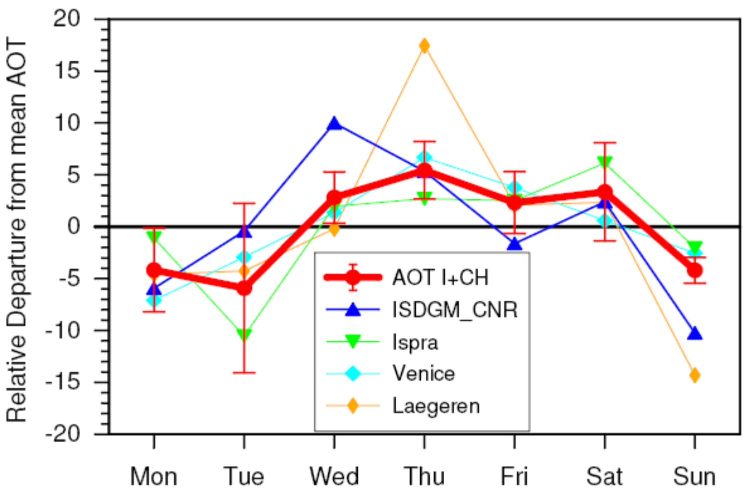
Bäumer and Vogel, 2007a

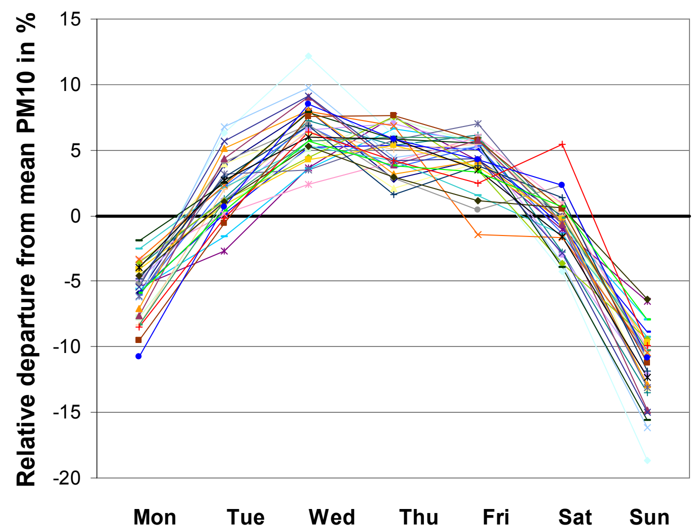
Weekly cycles of emissions, AOT, and PM10



Weekly cycle of AOT

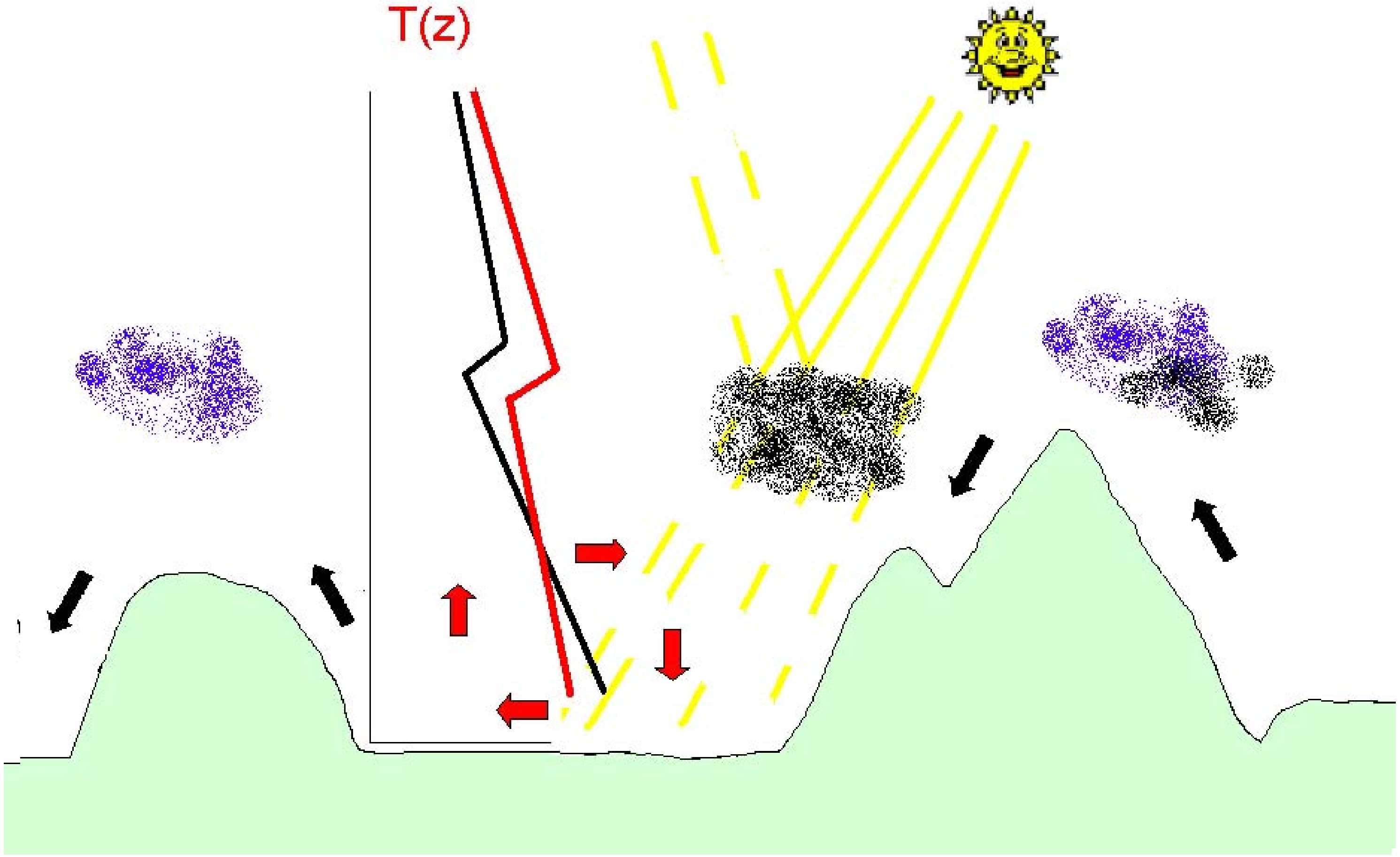




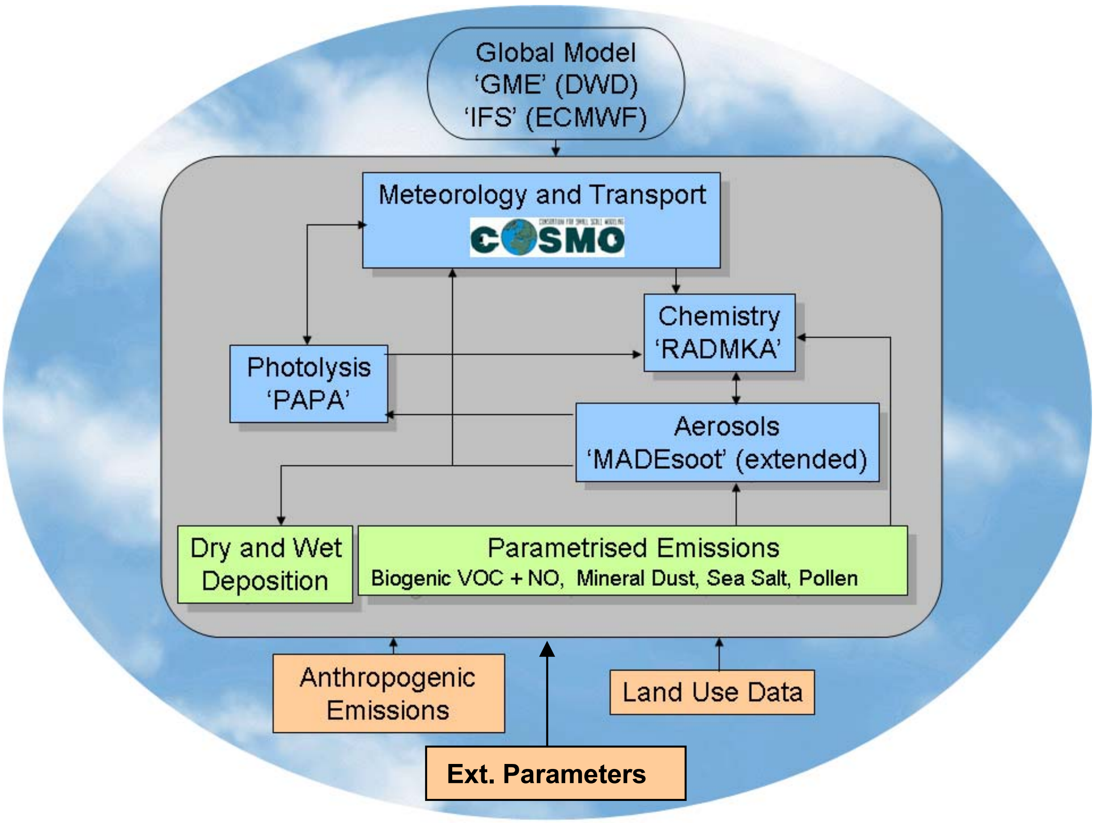


Bäumer and Vogel, 2007b

Feedback processes



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.
This includes the treatment of deep convection (Tiedtke Scheme).

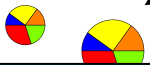
It has a modular structure.

Vogel et al., 2009

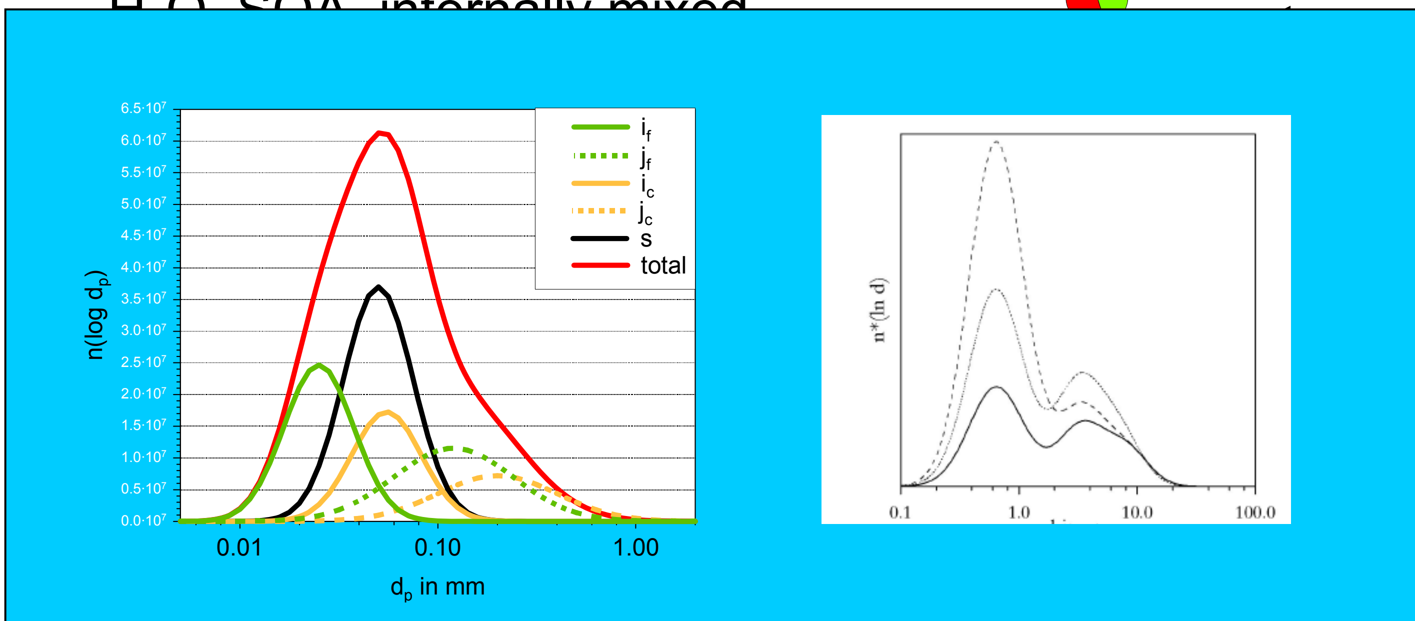
Treatment of the aerosol

Interaction of five modes:

Source: homogeneous **nucleation** of H_2SO_4/water

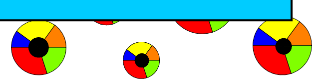


- **Two modes** for SO_4^{2-}, NO_3^-, NH_4^+, H_2O, SOA, internally mixed.



coagulation

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**

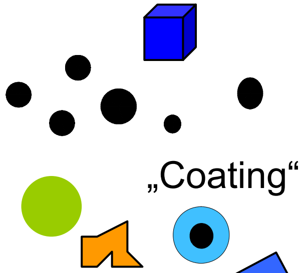
Optical Properties of the Aerosols

Refractive index of aerosols

Mie ↓ Calculations

Single scattering albedo (ω), specific extinction coefficient (b_s), asymmetry parameter (g)

Emissions, Transport, Transformations, Sedimentation, Deposition



Size distribution, chemical composition of each mode

New Routine in COSMO-ART:

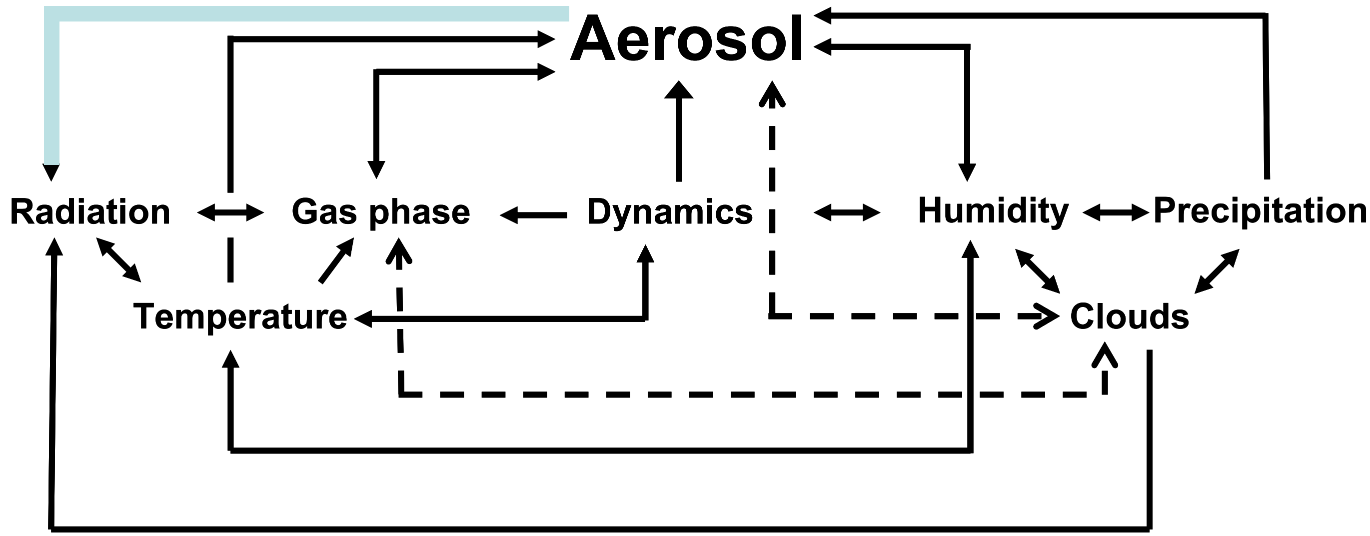
Computation of ω, b, g for prevailing aerosol concentration

ω, b, g

Modified radiation in COSMO:

Substitution of climatological optical properties based on current aerosol concentrations in GRAALS

Feedback processes



Modellergebnisse

Simulation periods:

16.08.05 - 20.08.05 HC

28.08.05 - 01.09.05 LC

Simulation domain:

Europe

Δx, Δy: 14km

Input data:

Meteorology: ECMWF

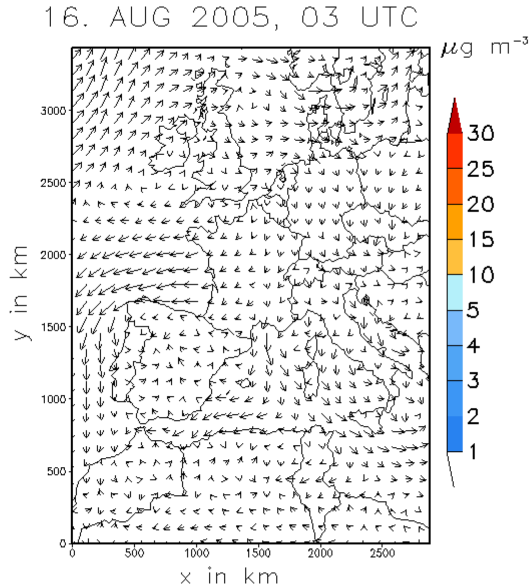
Emission data (IER,Stuttgart)

Land use (JRC-IES,Ispra)

Run R: Reference

Run F: Feedback

$\vec{v}$, c



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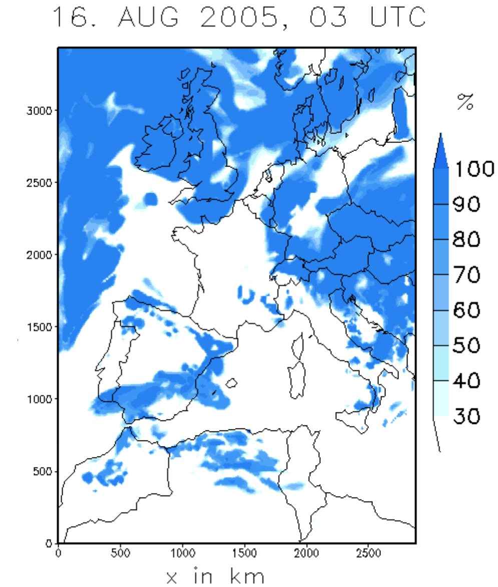
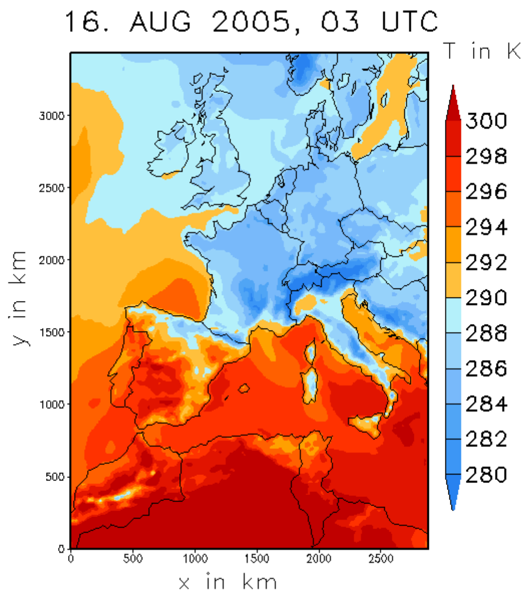
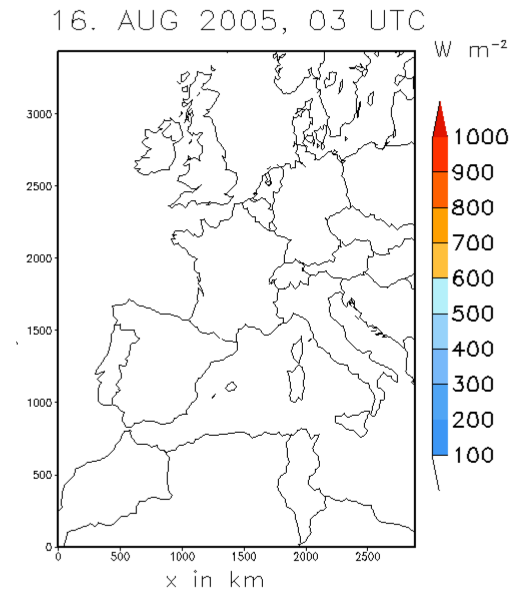


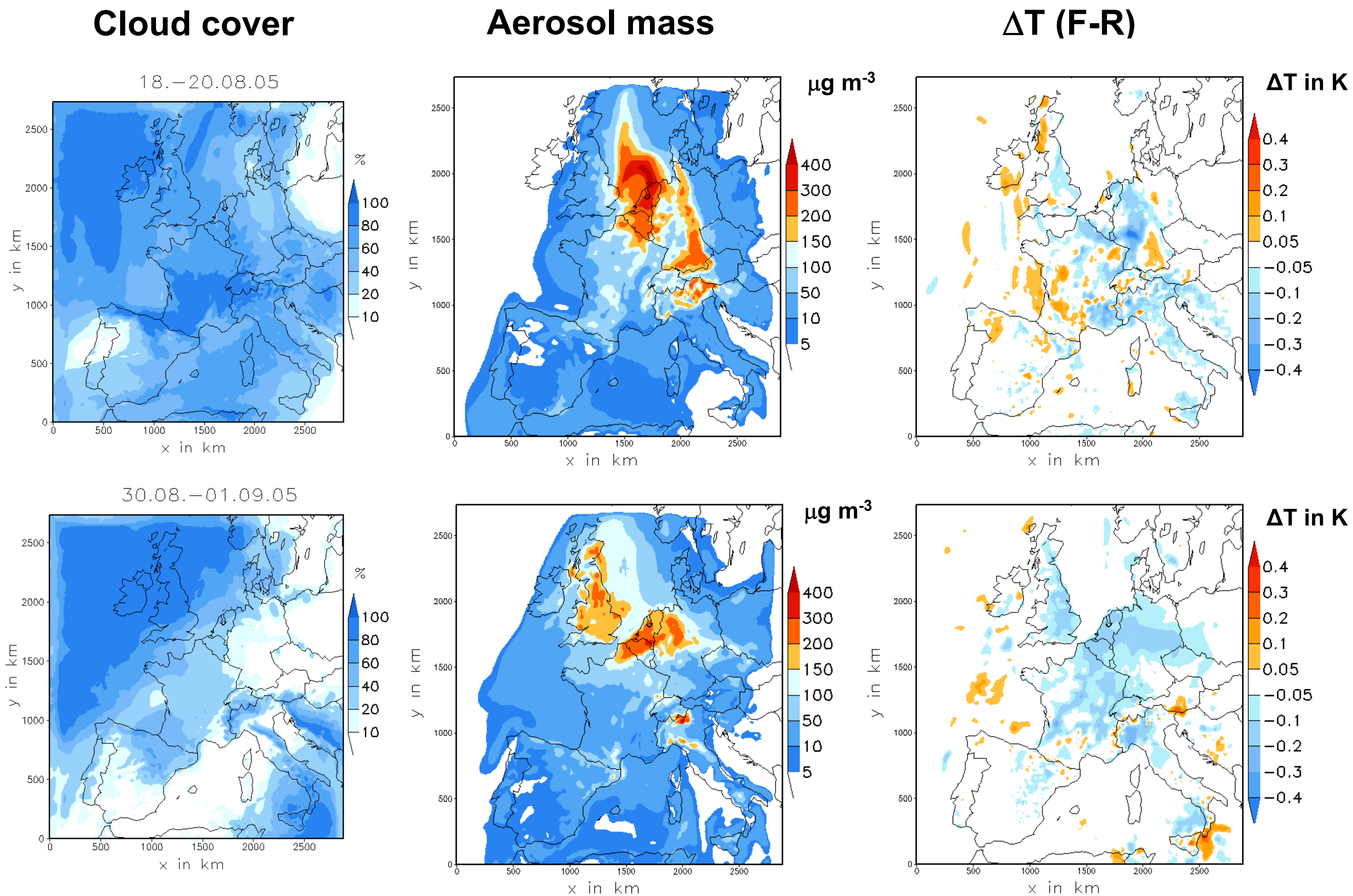
T



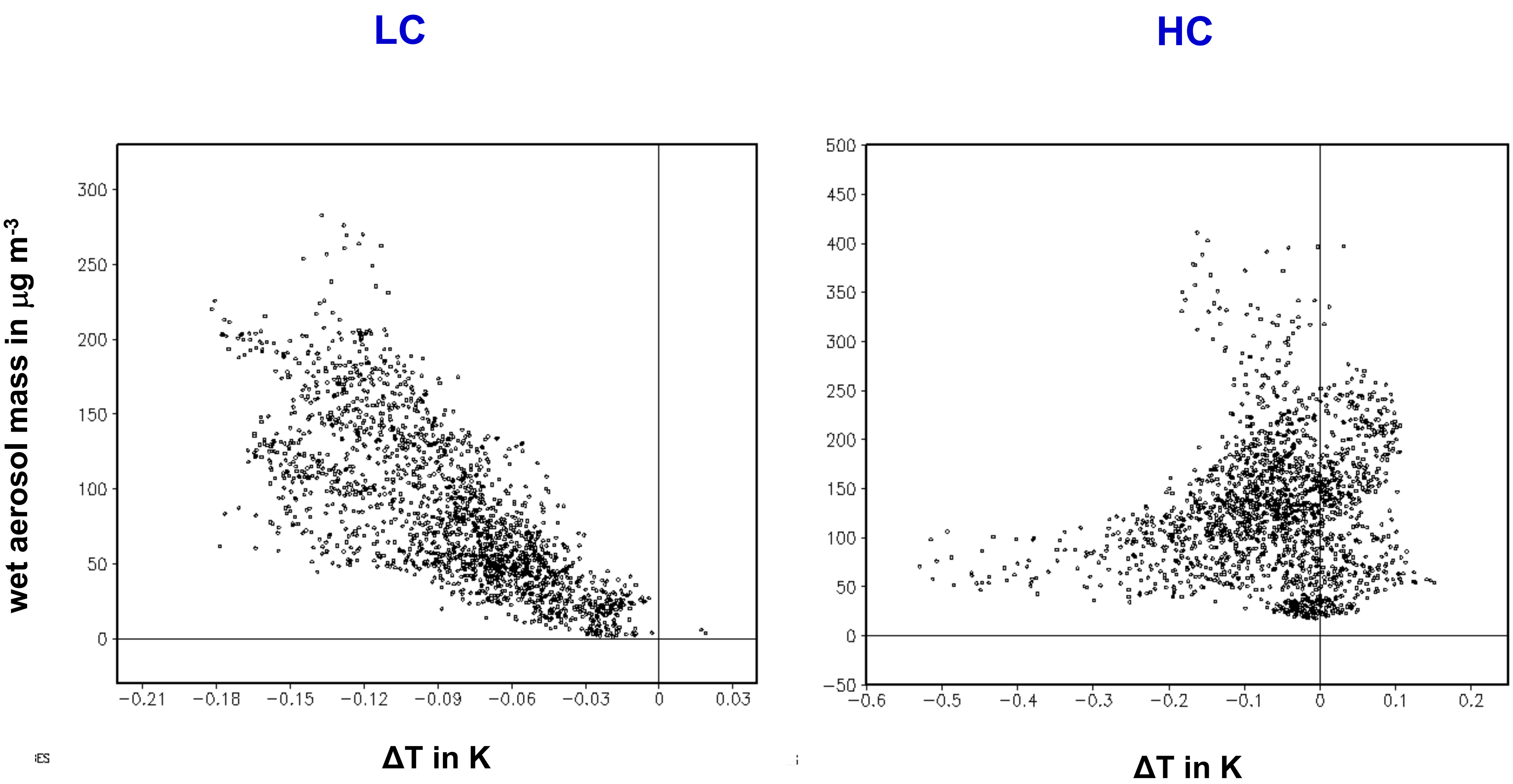
G



Average over Three Days



Average over Three Days (Germany)



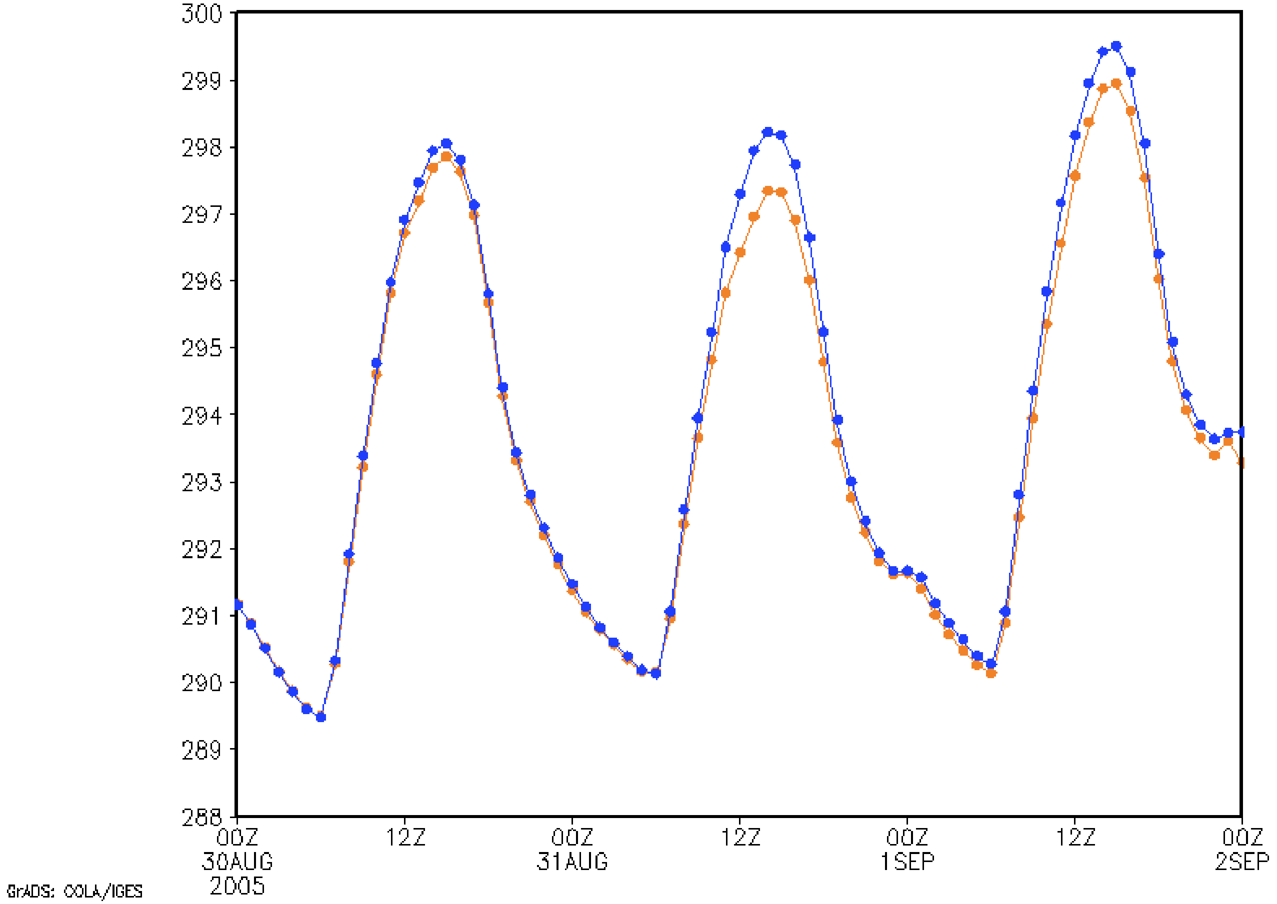
Average over Three Days (Germany)

	LC	HC
AOT	0.172	0.590
ΔE_G in W m^{-2}	-5.43	-6.01
ΔT in K	-0.10	-0.08

Episode	day	TR in K (run R)	TR in K (run F)	ΔTR in K
LC	30.08.2005	7.63	7.53	-0.10
	31.08.2005	10.13	9.98	-0.15
	01.09.2005	11.42	11.25	-0.17
HC	18.08.2005	11.31	11.22	-0.09
	19.08.2005	9.02	8.91	-0.11
	20.08.2005	2.57	2.39	-0.18

Observed average weekly cycles: $\Delta T \approx 0.2$ K, $\Delta TR \approx 0.11$ K

Daily cycles of temperature south of Milan



Conclusion and Outlook

- **Aerosols modify atmospheric radiation. This initializes feedback mechanisms that are currently neglected in operational weather forecast models.**
- **As long as no clouds are present there is a close link of the spatial distribution of the aerosol and the spatial distribution of e.g. the temperature change.**
- **When clouds are present the radiative effect of aerosols is superimposed by other processes and there is no linear relation between aerosol load and changes in temperature.**
- **The simulated changes in temperature and temperature range for two three days episodes are in the same order of magnitude as the observed weekly cycles.**
- **What is the role of the feedback between aerosol particles and cloud microphysics?**

People behind COSMO-ART