COSMO-Meeting

18.-21. September, Athen, Greece

The importance of aerosol water for air pollution effects on weather and climate - a new concept

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View from Wiesbaden to Mainz, S. Metzger, 6. April 2007

Weather forecast model - COSMO (LM)

Aerosol-cloud coupling

- New Aerosol-cloud routine (fast)
- Two new prognostic variables for bulk aerosol mass (QA) and aerosol water (QW)
- Codensed water distributed over 3 (QW, QC, QI) phases instead of the two cloud phases (QC, QI)
- Allows to resolve aerosol-cloud interactions (cloud cover, initial cloud water and ice content)

Severe Hailstrom- 28 June 2006
Villingen-Schwenningen, Germany
tennis ball sized hails

EC(NEST) Project Antistrom: Aerosol-Cloud Feedback ?

Anthropogenic Aerosols Triggering and Invigorating Severe Storms

http://antistorm.isac.cnr.it/

2 Experiments

1. Dust case
2. Urban air pollution
   (no dust)

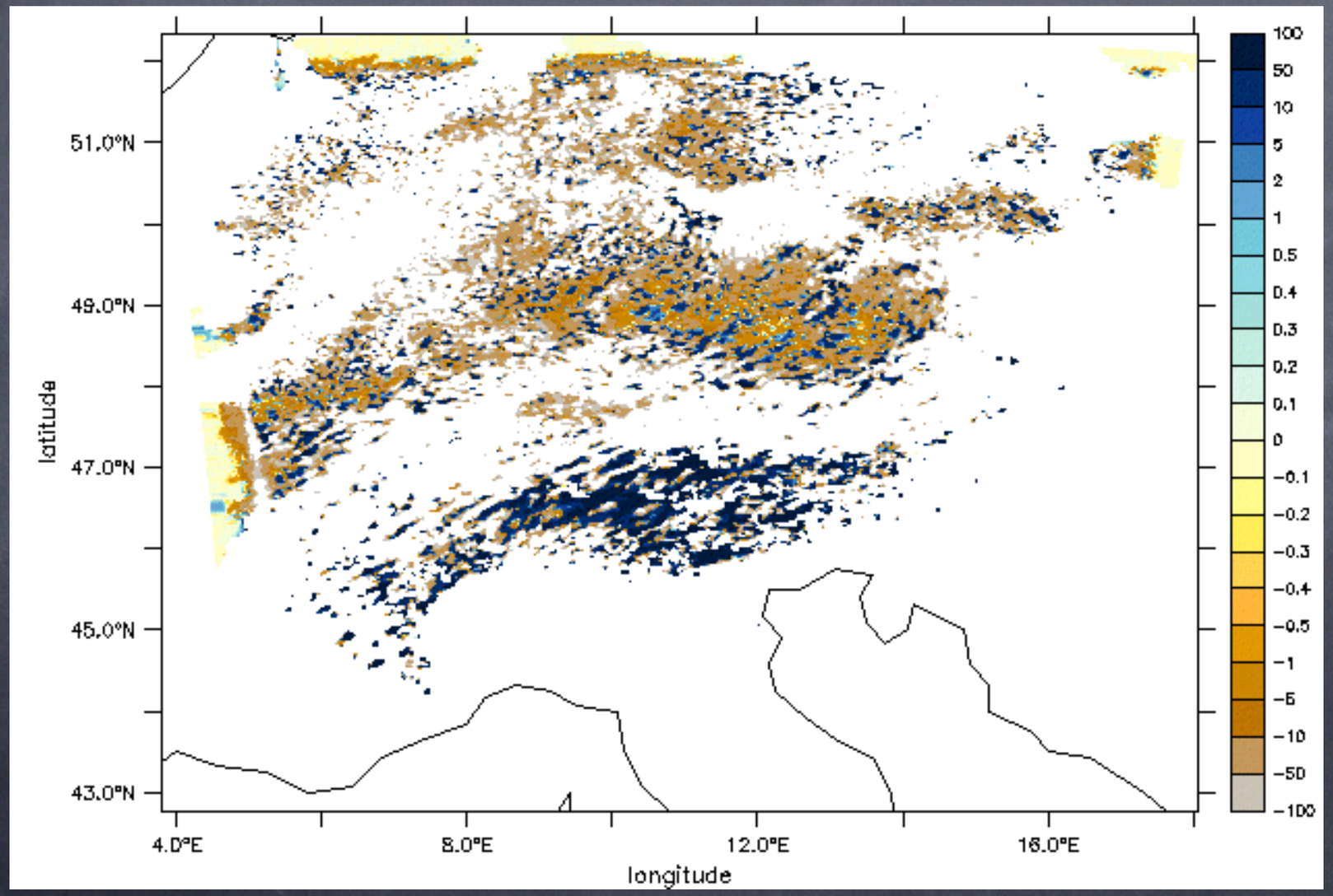
Result: dust more ice !

but both more and less precipitation !

COSMO (LMK)

28. June 2006, 21.30 hr UTC

Relative Change Aerosol-Cloud Feedback: EXP1-EXP2



Total Precipitation Change [%]

Aerosol-Cloud Coupling

http://antistorm.isac.cnr.it/

- Result: dust more ice => both more and less precipitation !
- Exp1: dust (e.g. $CaSO_4$) less soluble => lower T_{ice}
- Exp2: urban air pollution [e.g. $(NH_4)SO_4$, NH_4NO_3 NH_4Cl] relatively more soluble => larger T_{ice}
- Freezing point depression $T_{ice} \sim n_{sol}(T,RHD)$
- Exp1 => air must rise less high before droplets can freeze compared to Exp2 (pollution aerosols)
- Also Important: Orography and aerosol load !

Aerosol-Cloud Coupling

Metzger, S., and J. Lelieveld, ACP, 2007

Reformulating Atmospheric Aerosol Thermodynamics and Hygroscopic Growth into Fog, Haze and Clouds
http://www.atmos-chem-phys.net/7/3163/2007/acp-7-3163-2007.html

- Initial cloud water/ice depends on aerosol water mass
- Aersol water mass depends on aerosol mass and type
- Aerosol type characterized by aerosol hygroscopicity
- Hygroscopicity causes water uptake (solute hydration)
- Water uptake limited by satruation water vapor mass (T)
- Excess aerosol Water = cloud Water / ice (T_{ice})
- Cloud cover (aerosol + cloud water/ice) ~ aerosol load

Every day Observations

Contrails <=> Example for air pollution effects on:

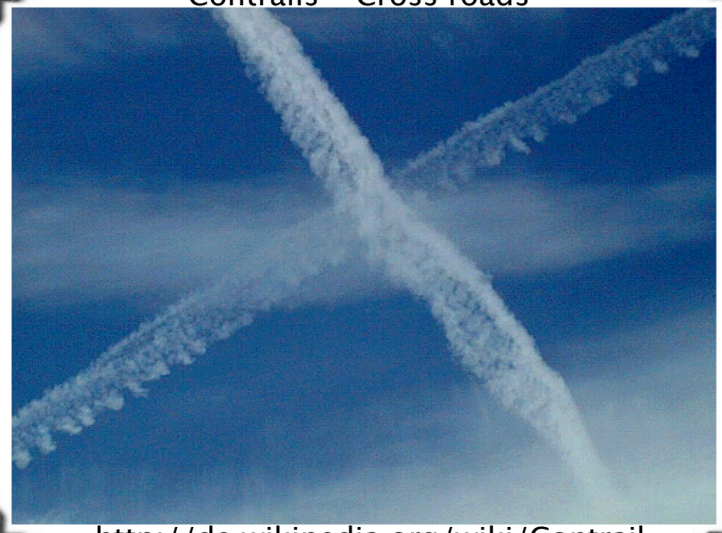
- Aerosol-cloud coupling via
- Hygroscopic growth: Water ~ Aerosol mass

=> Cloud cover and initial cloud water/ice mass

Single 4 Stream Jet Contrails

http://de.wikipedia.org/wiki/Contrail

Contrails - Cross roads

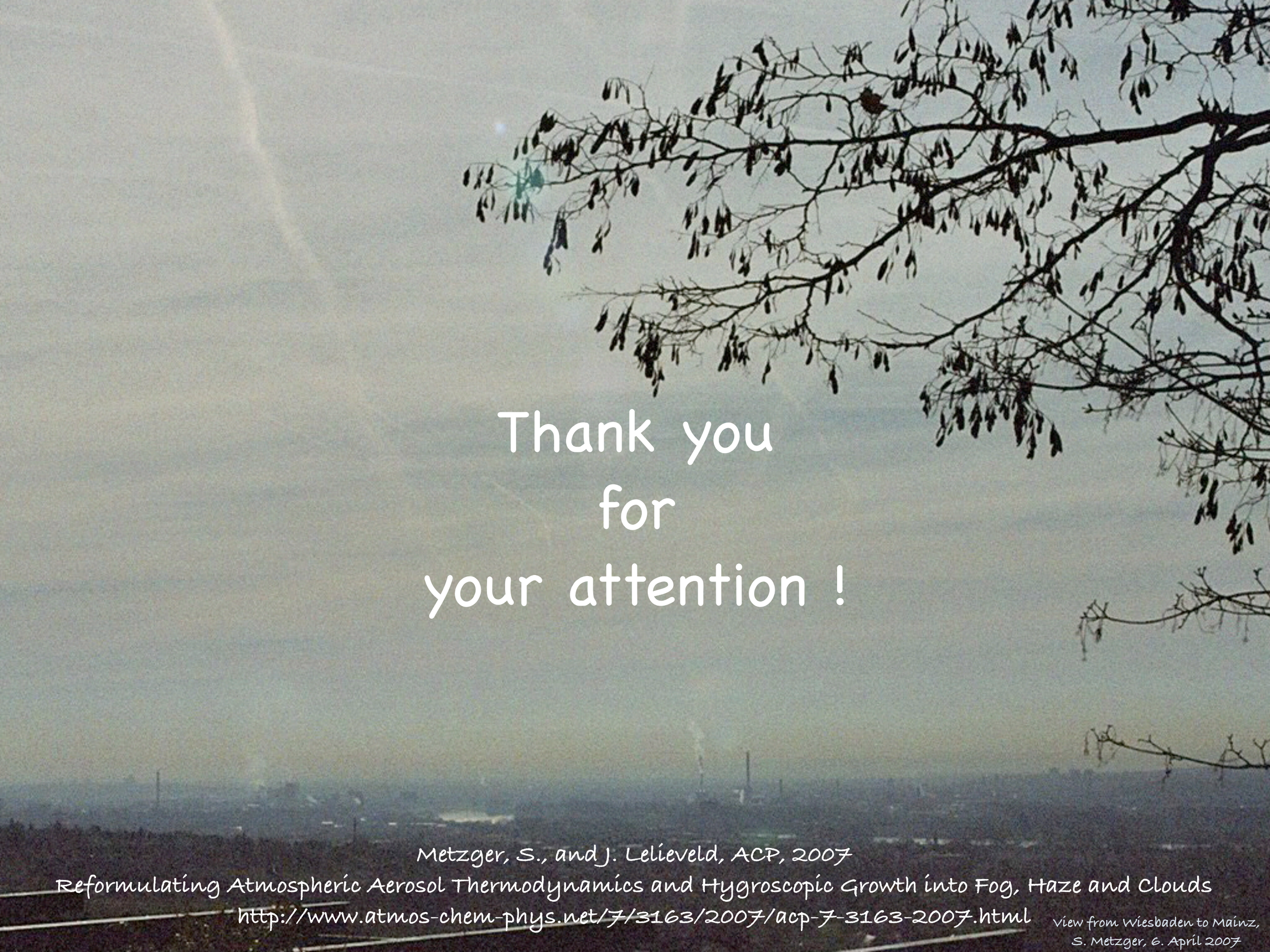


http://de.wikipedia.org/wiki/Contrail

Take home message

Aerosol water links
air pollution,
weather and climate

=> chemistry drives
ambient
size-distributions !



Thank you for your attention !

Metzger, S., and J. Lelieveld, ACP, 2007
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