Volcanic Ash and Radiation within ICON-ART

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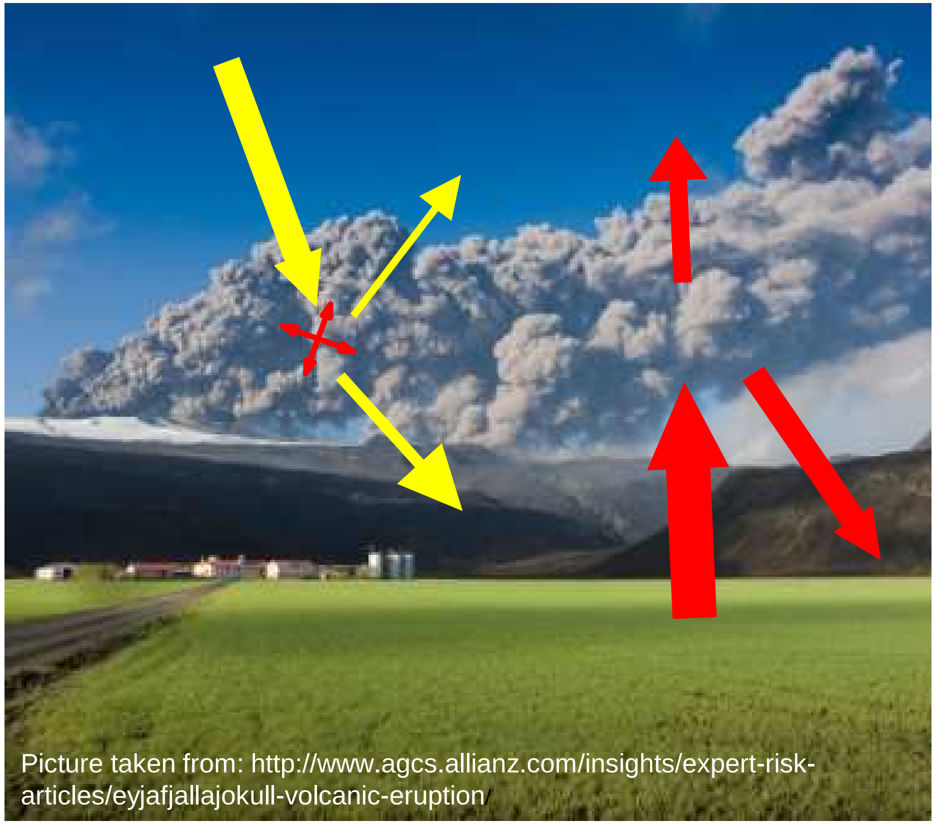
Institute of Meteorology and Climate Research

Sigurlaug Hjaltadóttir, 2010

Simulation of Radiative Effects

- Ash radiation interactions:

→ climate, weather,
plume dynamics



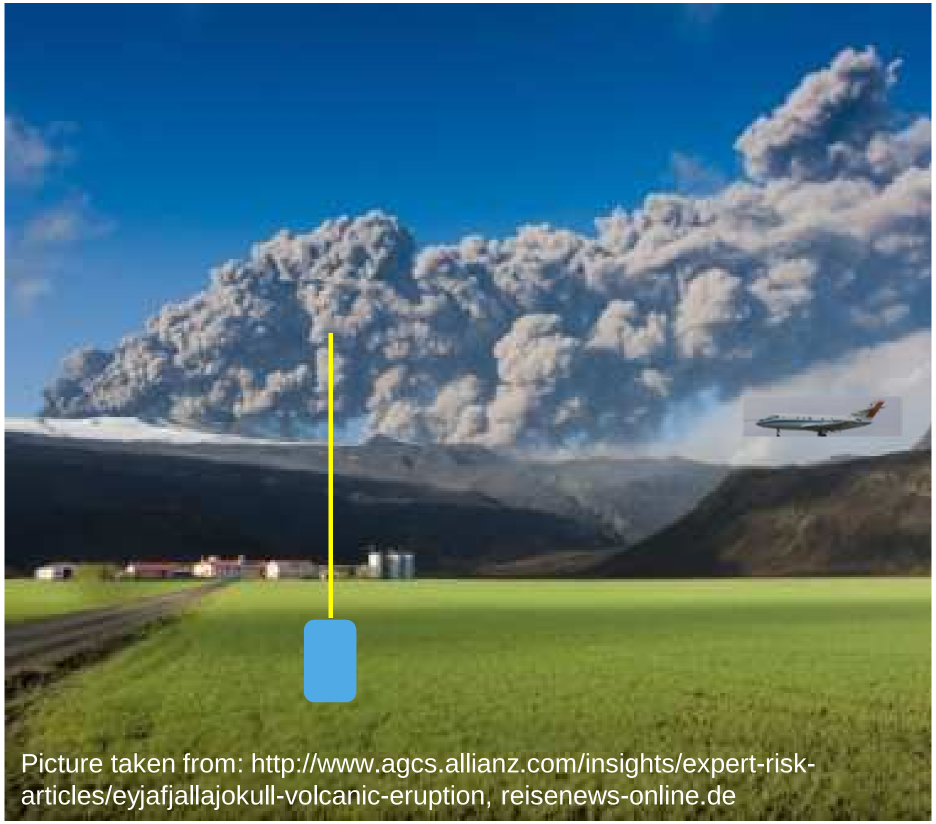
Simulation of Radiative Effects

- Ash radiation interactions:

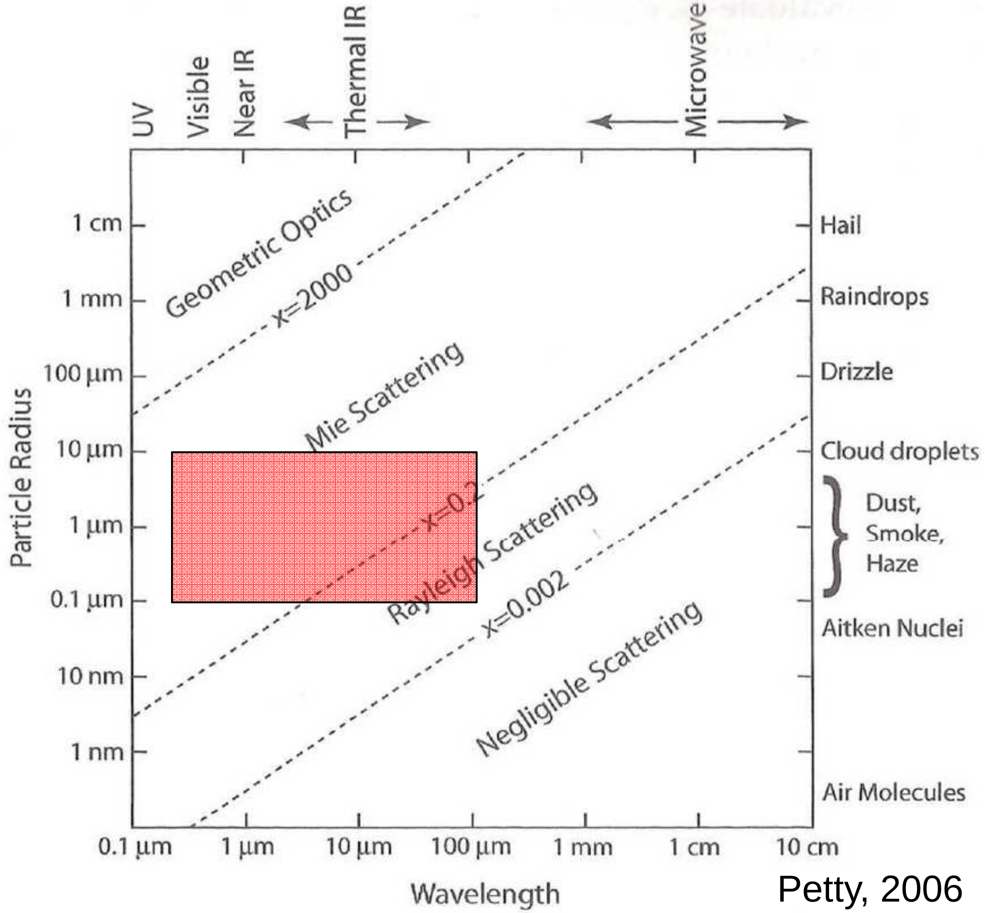
→ climate, weather,
plume dynamics

- Comparison with observations:

→ Satellite, LIDAR, Ceilometer,
AERONET



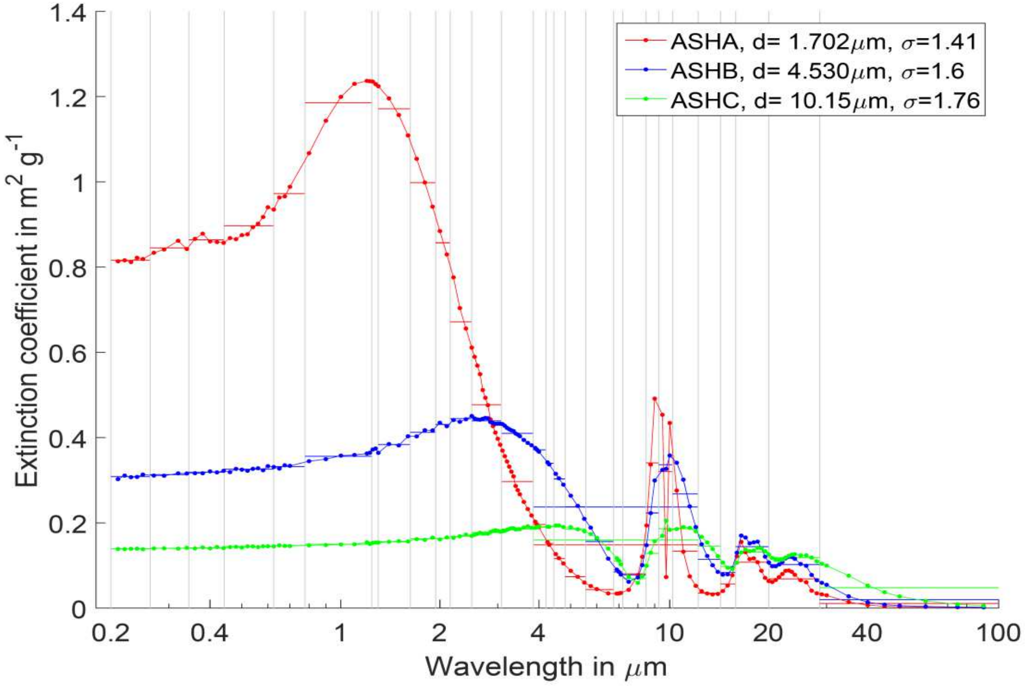
Implementation of Radiation Interactions



Petty, 2006

$$k_e(i, \lambda, f, \rho_p) = \int_0^\infty \frac{\pi D_p^2}{4M} Q_e(D_p, \lambda, f) n_{N,i}(lnD_p) dlnD_p$$

Mie Calculations



$$\alpha_{e,i}(\lambda) = k_{e,i}(\lambda) \cdot \rho \cdot m \cdot 10^{-6}$$

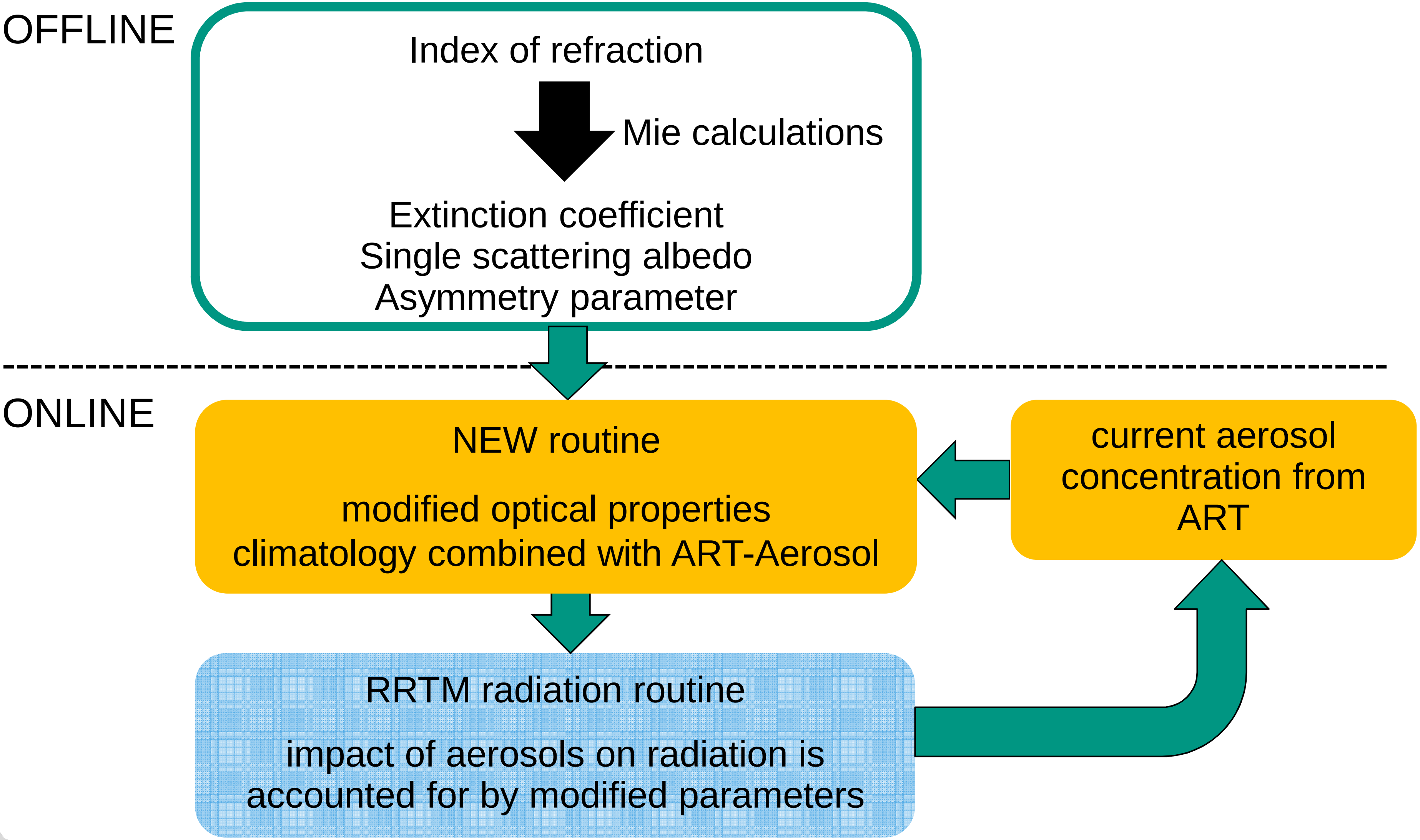
$$\alpha_{s,i}(\lambda) = \omega_i(\lambda) \cdot \alpha_{e,i}(\lambda)$$

$$\chi_i(\lambda) = \alpha_{s,i}(\lambda) \cdot g_i(\lambda)$$

$$\beta_i(\lambda) = k_{b,i}(\lambda) \cdot \rho \cdot m \cdot 10^{-6}$$

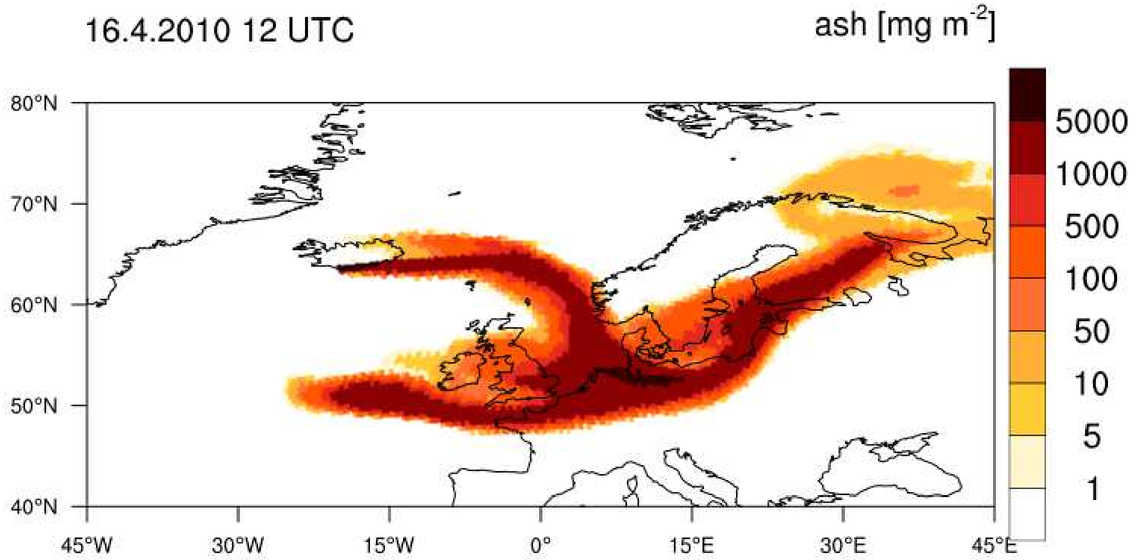
Radiation Transfer + Aerosol in ICON-ART

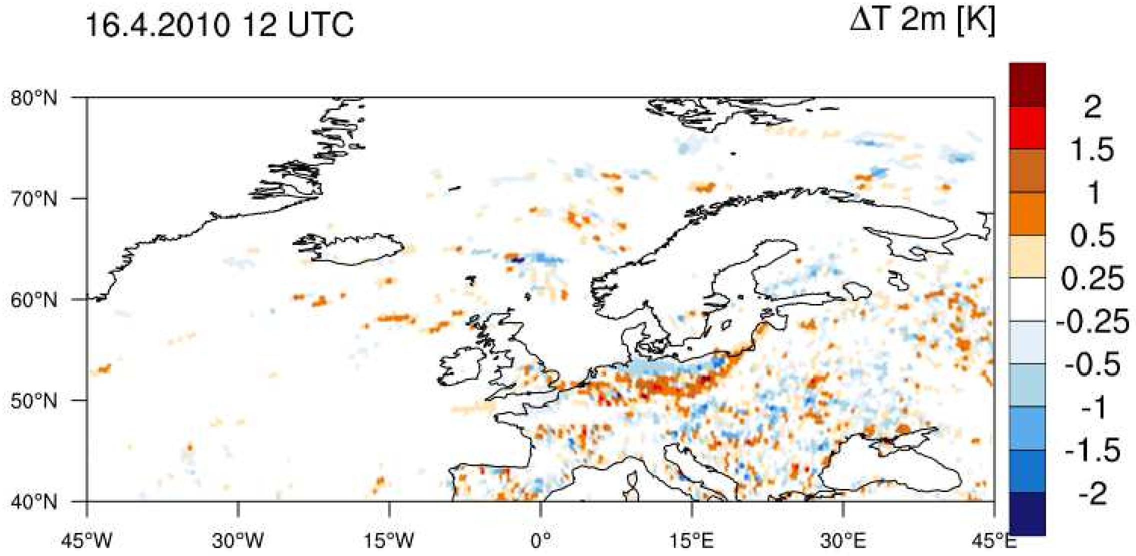
Karlsruhe Institute of Technology



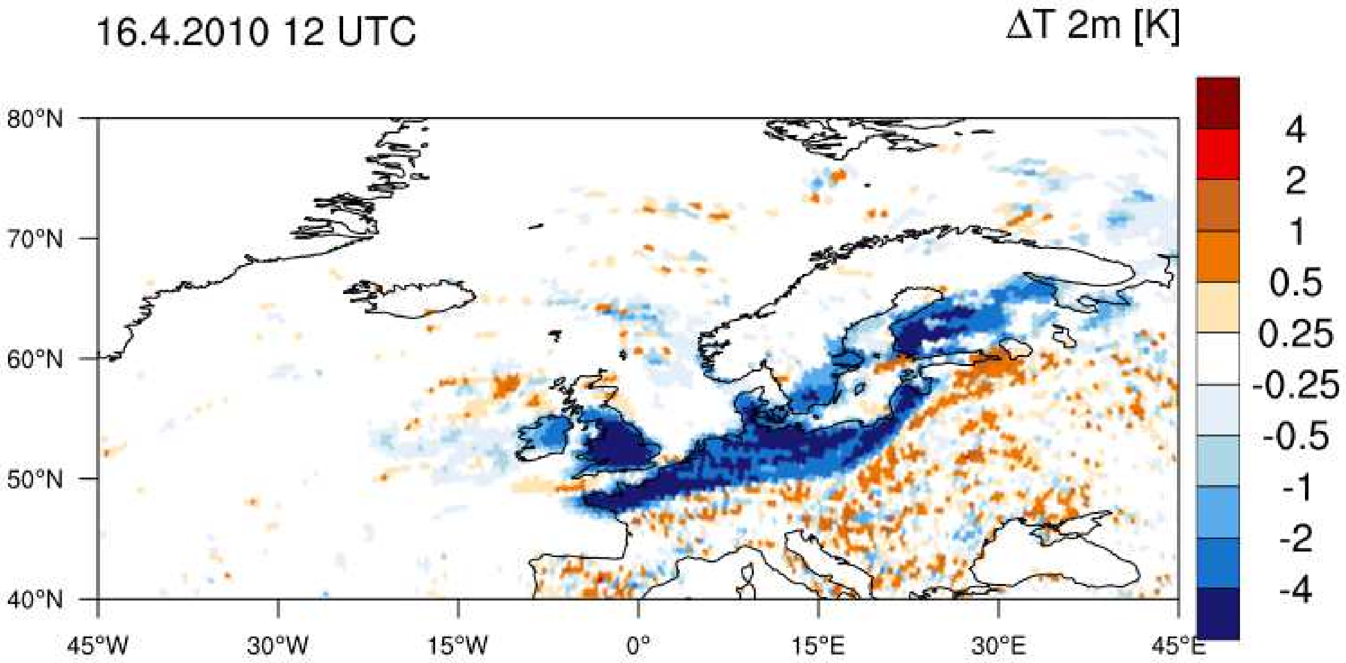
IMPACT ON THERMODYNAMICS

Eyjafjallajökull

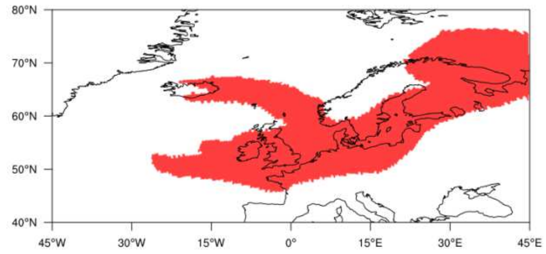


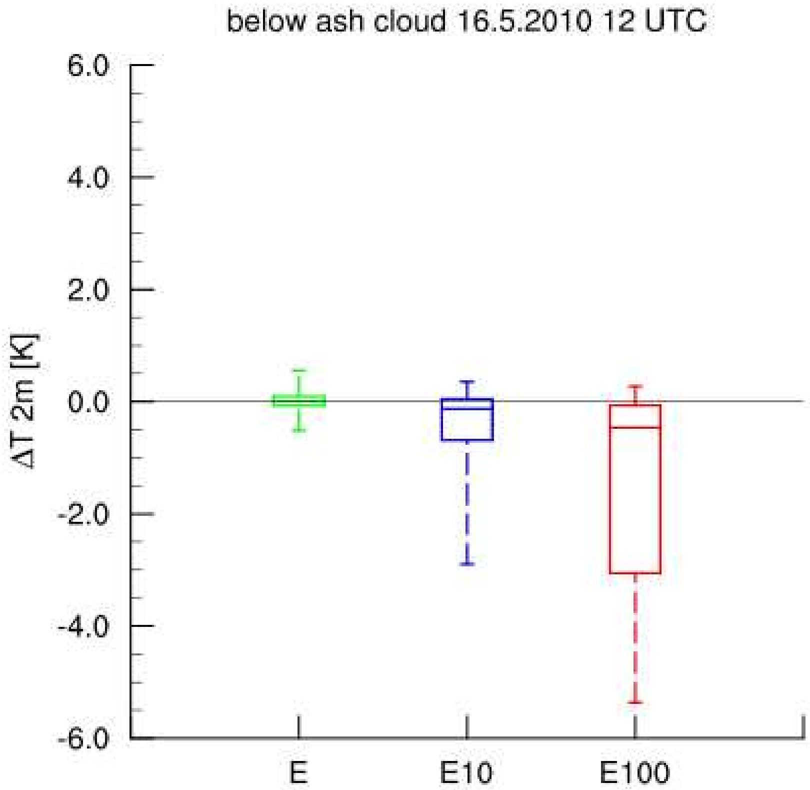


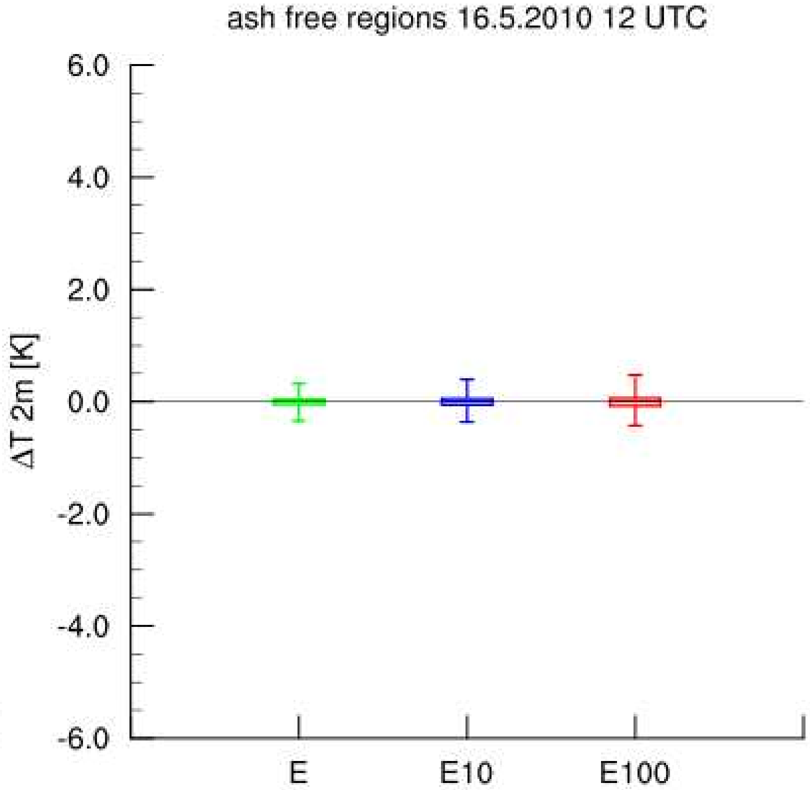
Increased Source Strength E100



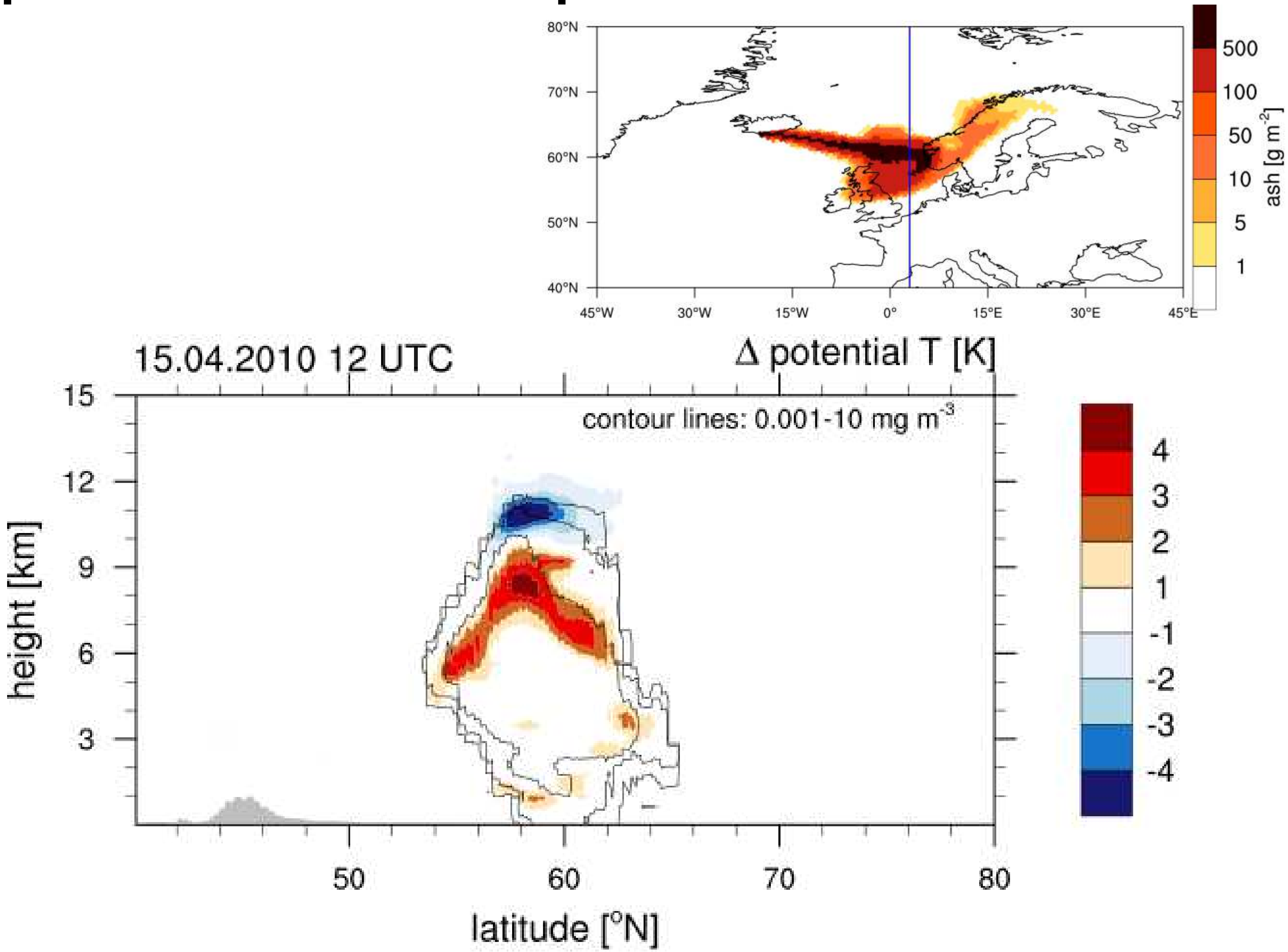
Varied Source Strength



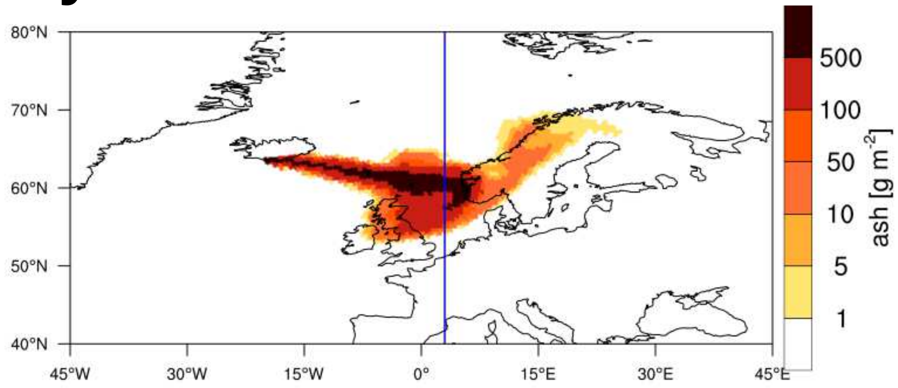


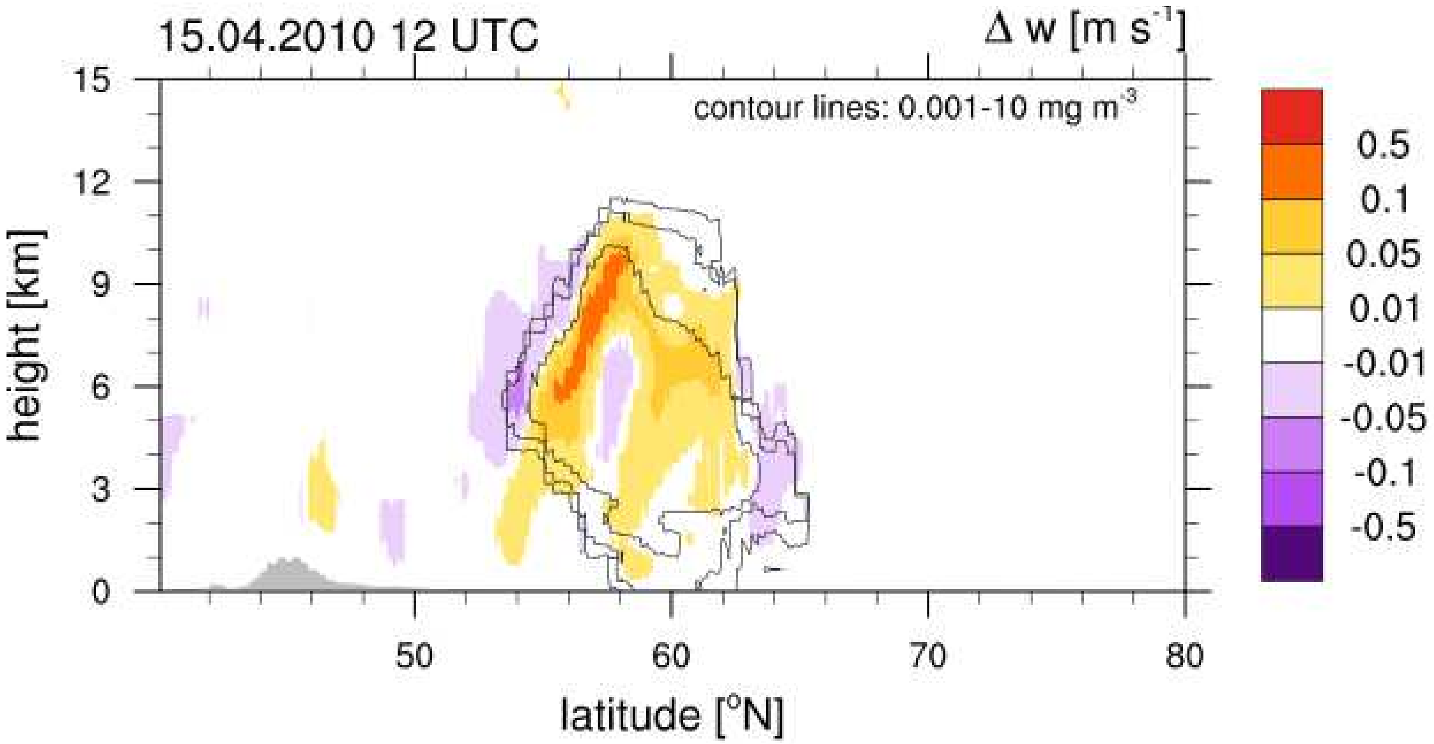


Impact on Potential Temperature

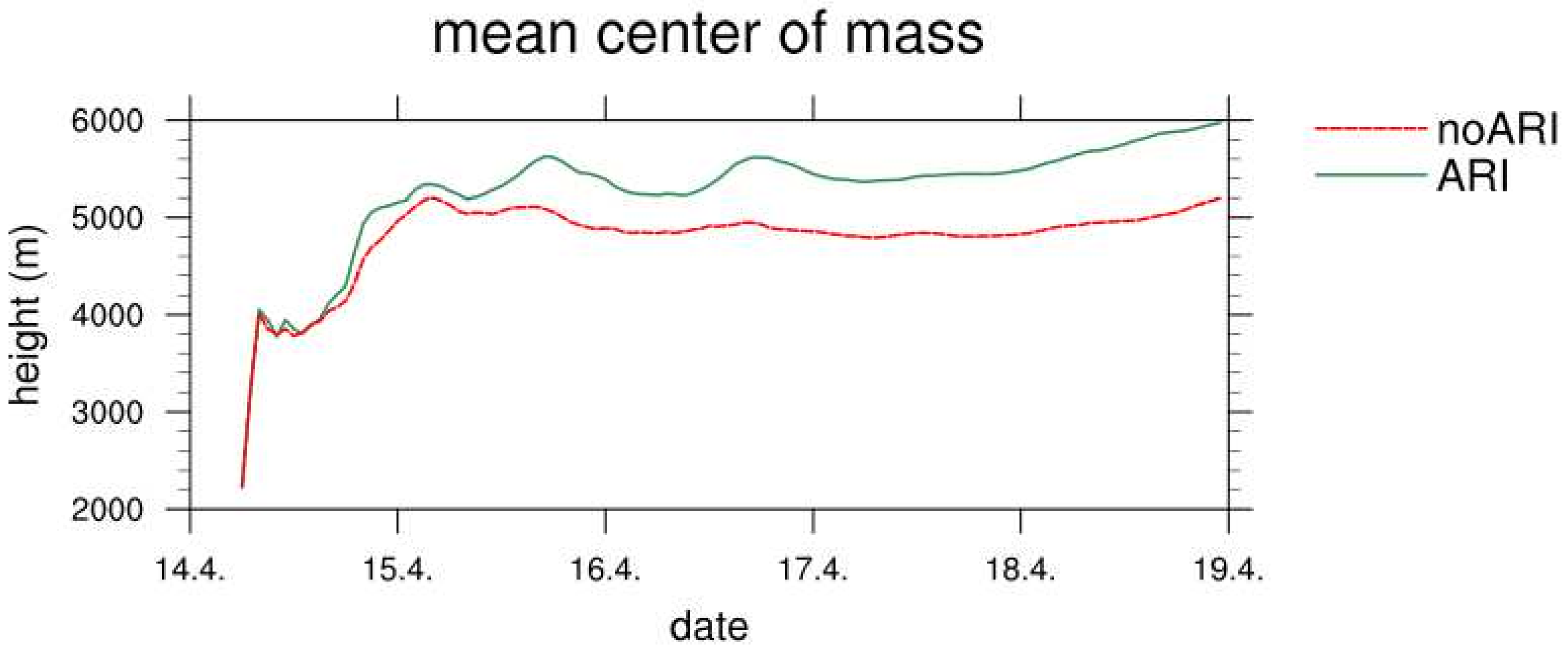


Impact on Vertical Velocity



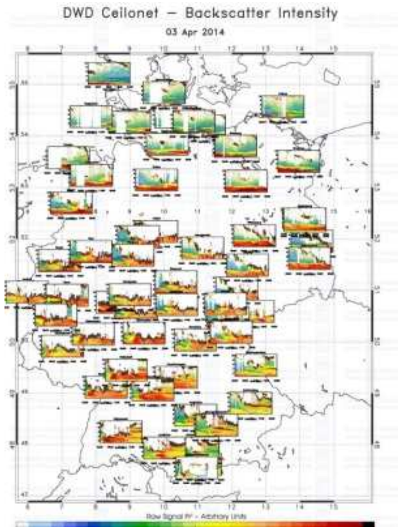


Vertical Displacement



COMPARISON WITH OBSERVATIONS

Validation, Calibration



Most forward operators use a lidar ratio S to obtain the backscatter

$$\beta(\lambda) = \frac{\alpha(\lambda)}{S}$$

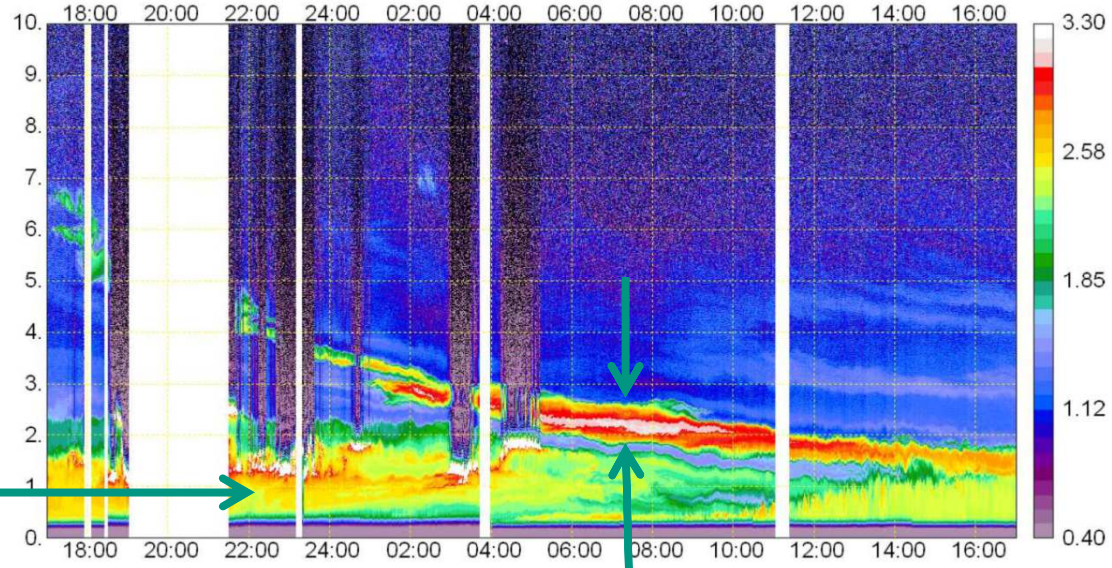
→ Direct calculation of the backscatter is preferable

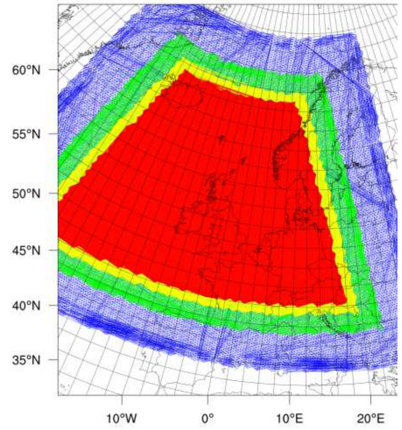
→ Lidar equation:

$$\mathrm{P}(z) = \beta\,(z) \cdot \exp(-2 \cdot \int_0^z \alpha(z')dz')$$

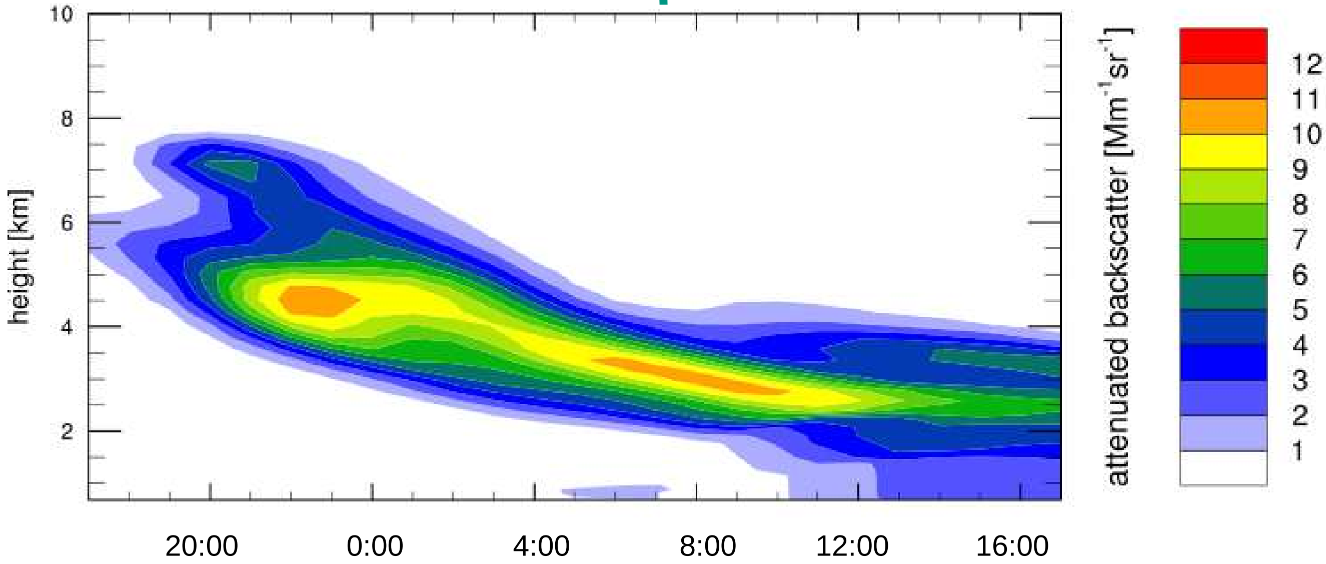
Maisach 16. and 17. April 2010

AOD





Gasteiger et al., 2011



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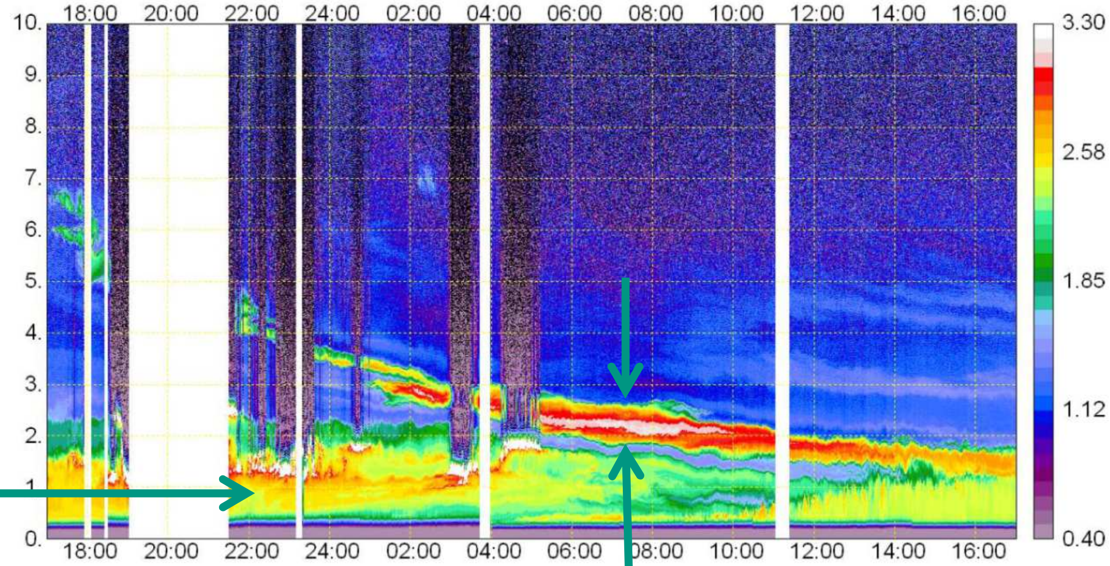

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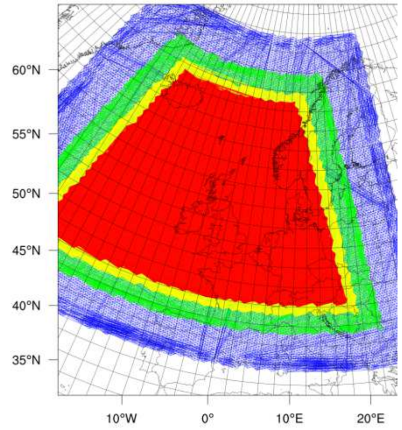

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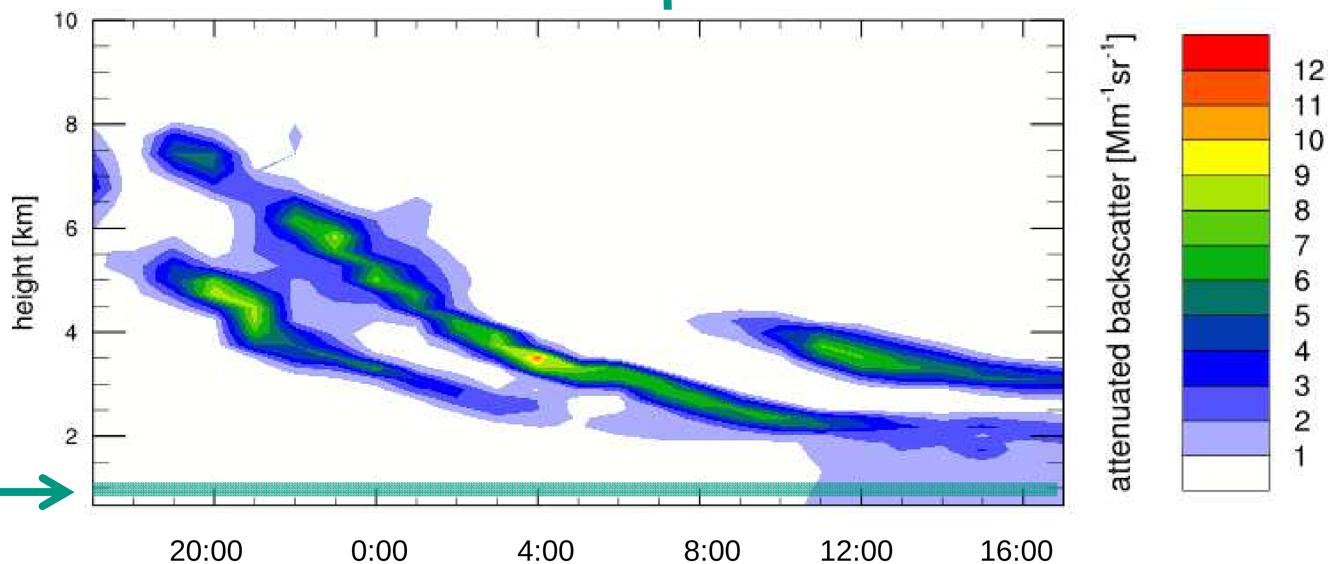

Summary

- Implementation of volcanic ash radiation interactions into ICON-ART

- Impact on plume dynamics
  - Heating in the upper part of the plume with cooling above
  - Induced secondary circulation
  - Lifted center of mass

- Simulations of the attenuated backscatter and measurements fit good