Modification of cloud properties by the Eyjafjallajökull eruption

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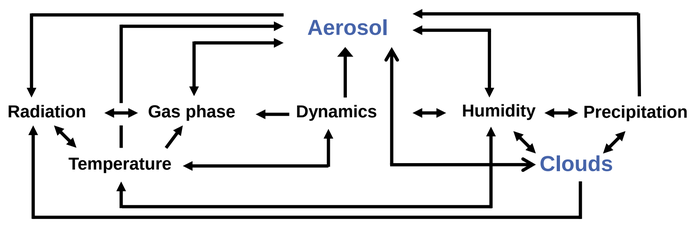
Motivation

The size distribution and chemical composition of the whole aerosol population has to be considered when assessing the impact of specific aerosol species on cloud properties.

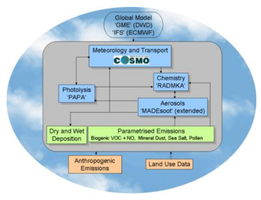
In this study we quantified the impact of the eruption of the Eyjafjallajökull in Iceland on clouds in Europe using the comprehensive online-coupled model framework COSMO-ART.

Model Framework

Considered feedbacks



Online coupled model framework **COSMO-ART**



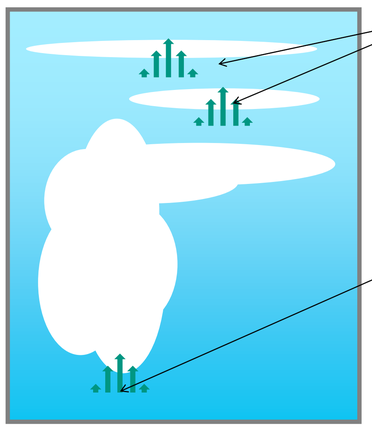
(Vogel et al. 2009).

Aerosol

- Explicit treatment of **mass and number of 11 aerosol modes** including **3 modes of dust** and **6 size classes of volcanic ash**

Cloud Microphysics (Seifert and Beheng 2006)

- Comprehensive full **two-moment cloud microphysics** including cloud water, ice, rain, snow, graupel and hail



Ice Nucleation (Barahona and Nenes 2009)

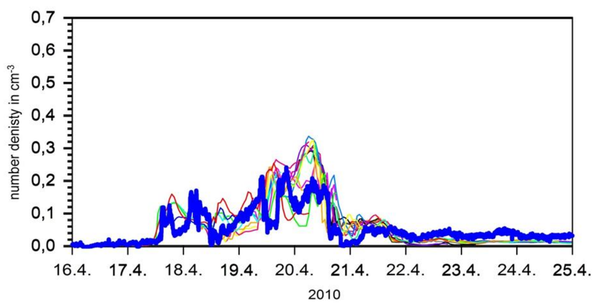
- competition of heterogeneous freezing and homogenous freezing
- dust and ash freezing (Phillips et al. 2008)

Aerosol Activation (Barahona et al. 2010, Kumar et al. 2009, Lathem et al. 2011)

- adsorption activation of dust and ash
- competition of the different aerosol particles for water vapor

Simulation of the Eyjafjallajökull plume

- Quasi-operational modeling of the Eyjafjallajökull volcanic ash episode
- Calibration with observations → realistic ash concentrations



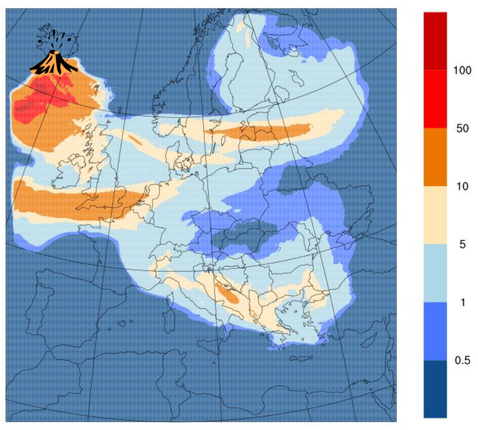
Comparison with observations at MO Hohenpeißenberg (Flentje et al. 2010)

Model runs including the **interaction of aerosol particles with clouds:**

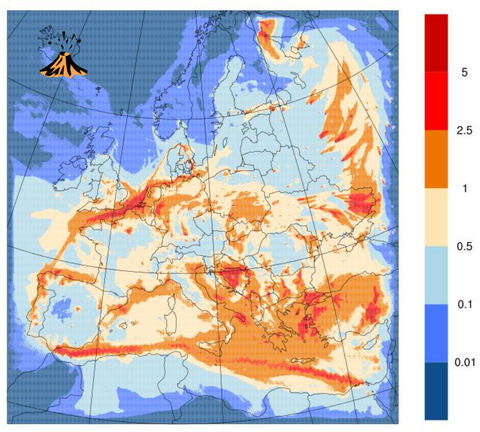
WITH interaction of ash particles with clouds

NO interaction of ash particles with clouds

N_{ash} in L^{-1}



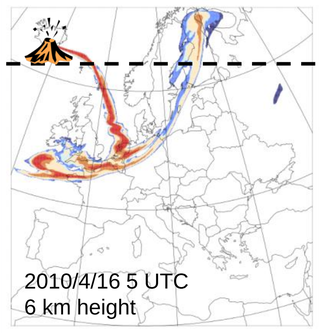
SO_2 in ppb



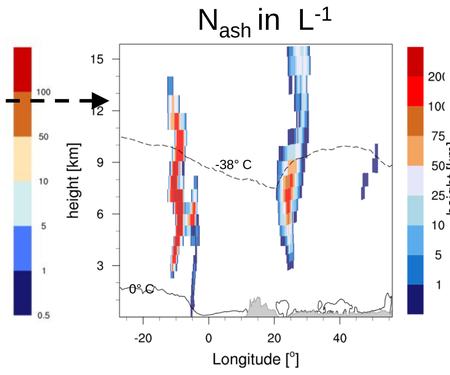
2010/4/18

Impact of ash particles on clouds?

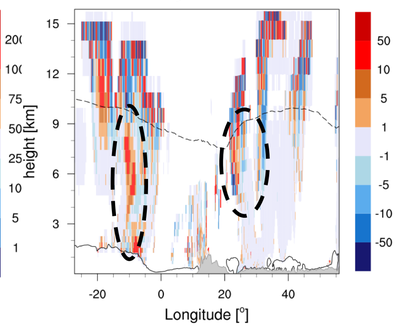
N_{ash} in L^{-1}



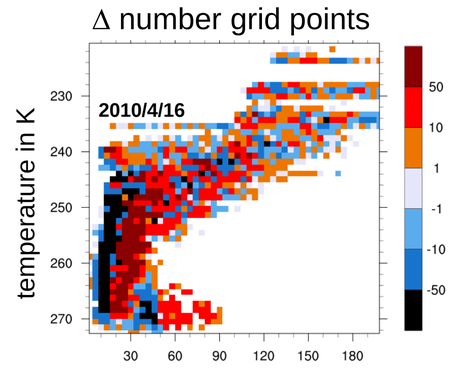
N_{ash} in L^{-1}



Δ ice crystals in L^{-1}

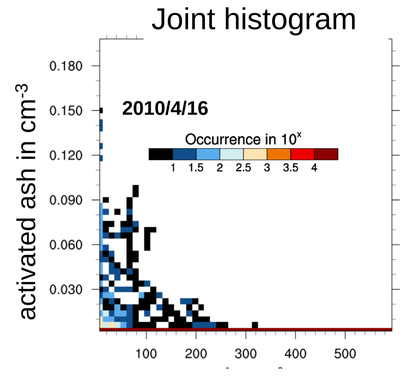


Δ number grid points



ice crystals inside the plume in L^{-1}

Joint histogram



total activated particles in cm^{-3}

- **Systematic increase of ice crystal number concentration inside the ash plume** at temperatures above -30° C. This is mainly due to the **efficient heterogeneous ice nucleation** ability of the **ash particles.**
- Impact of ash on cloud droplet number concentrations is **negligible**.

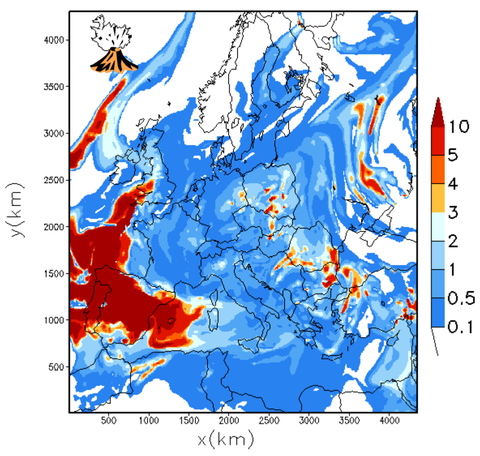
Impact of SO_2 emission on CCN?

WITH volcanic SO_2 emissions

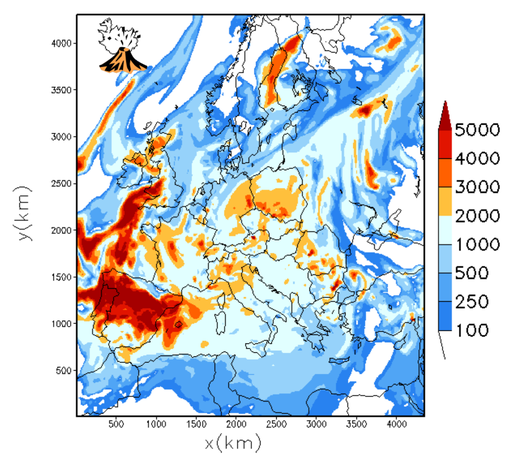
NO volcanic SO_2 emissions

2010/5/06 23 UTC, 1 km height

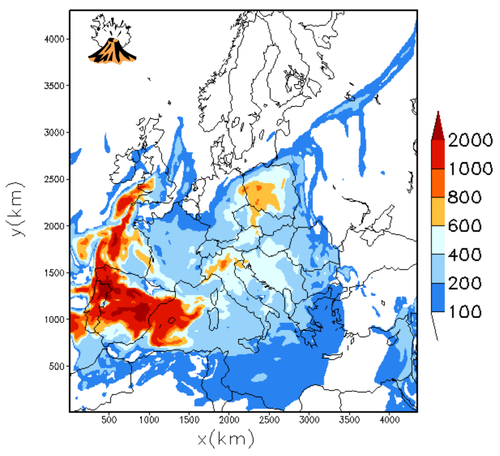
SO_2 in ppb



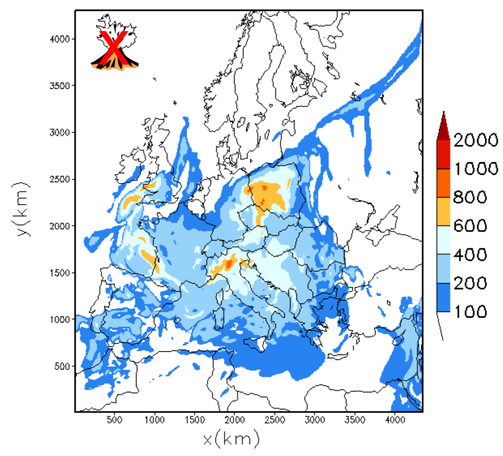
N_A in cm^{-3}



CCN(0.1%) in cm^{-3}



CCN(0.1%) in cm^{-3}



- The emission of **SO_2** leads to an increase in the number concentration of particles in the Aitken mode followed by an increase of **CCN**.

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