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

[Diagram showing aerosol and cloud interactions]

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 (Sefert and Beheng 2006)

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

• 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.

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

Impact of SO₂ emission on CCN?

WITH volcanic SO₂ emissions

NO volcanic SO₂ emissions

SO₂ in ppb

2010/05/06 23 UTC, 1 km height

Nₐ in cm⁻³

CCN(0.1%) in cm⁻³

The emission of SO₂ leads to an increase in the number concentration of particles in the Aitken mode followed by an increase of CCN.

Impact of ash particles on clouds?

Δ number grid points

Δ ice crystals in L⁻¹

ice crystals inside the plume in L⁻¹

total activated particles in cm⁻³

Impact of SO₂ emission on CCN?

WITH volcanic SO₂ emissions

NO volcanic SO₂ emissions

SO₂ in ppb

2010/04/16 5 UTC, 6 km height

Nₐ in cm⁻³

CCN(0.1%) in cm⁻³

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