MIPAS Volcanic Sulfate Aerosol Observations of the Nabro Eruption

29 October 2013 | S. Griessbach, L. Hoffmann, R. Spang, M. von Hobe, R. Müller, M. Riese
Envisat MIPAS

- Infrared limb sounder
  4 – 16 μm (2410 – 685 cm\(^{-1}\))
- 14 orbits per day
- Global coverage day and night
- High spectral resolution: 0.0625 cm\(^{-1}\)
- Limb geometry: 5 – 70 km
- 1.5 km vertical sampling in the UTLS

Figures: Bernd Hentschel
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IR limb emission spectra

MIPAS 2011-06-14 @ 17 - 18km

radiance in W/(cm$^2$ sr cm$^{-1}$)

wavenumber in cm$^{-1}$

CO$_2$

O$_3$  CFC11  HNO$_3$  CFC12

window

clear air

windows
IR limb emission spectra

MIPAS 2011-06-14 @ 17 - 18 km

radiance in W/(cm² sr cm⁻¹)

wavenumber in cm⁻¹

sulfate aerosol

clear air

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IR limb emission spectra

MIPAS 2011-06-14 @ 17 - 18km

radiance in W/(cm$^2$ sr cm$^{-1}$)

wavenumber in cm$^{-1}$

sulfate aerosol

ice cloud

clear air

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IR limb emission spectra

MIPAS 2011-06-14 @ 17 - 18km

radiance in W/(cm$^2$ sr cm$^{-1}$)

wavenumber in cm$^{-1}$

sulfate aerosol
ice cloud
clear air

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Aerosol-Cloud index values lower 7 indicate aerosol and clouds.
The New Sulfate Aerosol Filter

aerosol index < 7 orbit 49215 - 49217 2011-07-29

\[
\text{BT}(960 \text{ cm}^{-1}) - \text{BT}(1224 \text{ cm}^{-1}) \text{ in K}
\]

\[
\text{BT}(830 \text{ cm}^{-1}) - \text{BT}(1224 \text{ cm}^{-1}) \text{ in K}
\]
The New Sulfate Aerosol Filter

sulfate aerosol

MIPAS measurements

Simulations

ice clouds

h2so4 clouds
Sulfate Aerosol Detections

MIPAS cloud + aerosol index orbit 49508  2011-08-18 15:05 - 16:45 UTC

grey: ice
blue: clear air
pink/violet: sulfate aerosol
orange/red: NAT/STS PSCs

additionally filtered for volcanic ash

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MIPAS sulfate aerosol detections for Grimsvötn eruption in May 2011 in Iceland.
Comparison of MIPAS sulfate aerosol and AIRS SO$_2$ nadir measurements.
Detections for Grimsvötn eruption in May 2011 in Iceland.
Method Verification - Aerosol Layer Top Altitude

Lidar data by courtesy of Arnon Karnieli

Comparison with ground based and spaceborne lidar measurements:

- aerosol top altitude overestimation lower than 100 m
- aerosol top altitude underestimation up to 1500 m
MIPAS observations of Nabro eruption
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2011-06-26

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2011-07-07
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2011-07-22
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2011-07-26
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2011-07-29

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Summary

Detection Method:
- improved aerosol detection method
- particle type classification
- good agreement with other instruments (location and top altitude)
- method applicable to other IR-limb instruments e.g. GLORIA

Nabro eruption:
- sulfate aerosol observations in the UTLS
- sulfate aerosol follows circulation around the Asian monsoon and is successively entrained
- sulfate aerosol moves isentropically into the northern hemisphere stratosphere
- sulfate aerosol traces several wave breaking events