Ozone measurements at Ny-Ålesund, Arctic station of the Network for the Detection of Stratospheric Chance

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Instruments at Ny-Ålesund

Millimeter-Wave radiometer RAM (UB[1]/AWI[2])

High spectral resolution measurements of a pressure broadened rotational transition of ozone at 142 GHz. Volume-mixing-ratio profiles are retrieved from the shape of the line. Using the optimal estimation method, T/p-profiles, a-priori information and instrumental errors are considered.

ECC-Balloon sondes (AWI[2])

Ozone in situ measurements using a electrochemical concentration cell. Air is pumped through the reaction cell. Due to the reaction $2KJ+O_3+H_2O \rightarrow 2KOH+J_2+O_2$ a current proportional to the ozone number density is measured. Altitude information is obtained from simultaneous pressure measurements.

FTIR Fourier Transform Infra-Red (AWI[2])

Measurements of solar or lunar irradiance in the IR-region using a Fourier transform spectrometer. From the depth of known absorption features, ozone (and other trace gas) columns are derived.

DOAS Differential Optical Absorption Spectroscopy (UB[1])

Measurements of spectra of scattered sunlight. From the differential absorption structures on the spectra in the UV and/or visible range with respect to a reference spectrum from outside the atmosphere, ozone (and other trace gas) columns are derived.

LIDAR (AWI[2])

Measurement of ozone number density profiles from the backscatter signal of two laser wavelengths using the differential absorption LIDAR method. From the ratio of an ozone on-band wavelength at 308 nm and an off-band wavelength at 353 nm atmospheric extinction is separated from ozone absorption.

[1]UB: University of Bremen, Institute of Environmental Physics
[2]AWI: Alfred-Wegener-Institute for Polar and Marine Research

Instrument and retrieval properties

	temporal resolution	Altitude range, resolution	retrieved quantity	+	−
mm-wave	10 min to some h	12 - 55 km 8 - 15 km	VMR	nearly weather independent longtime stability, self calibrating measurements all year round	coarse vertical resolution no tropospheric information dependency on a-priori information
ECC-sonde	~2 flights/week	0 to ~30 km 300 m	number density	good vertical resolution	low measurement frequency maximum height around 30 km problematic absolute calibration at Ny-Ålesund (no Dobson available)
FTIR	~ 1 h	none	total column	simultaneous measurements of many trace gases	clear sky and sunlight (or moonlight) necessary, few measurements during polar night only information on columns; dependency on assumed ozone profile
DOAS	twice a day: sunrise, sunset	none	total column	simultaneous measurements of many trace gases nearly weather independent	sunlight necessary, no measurements during polar night dependency on assumed ozone profile
LIDAR	1 h - 6 h weather dependent	10 - 40 km 400 m - 2 km	number density	good vertical resolution	cloud-free conditions necessary only daytime **or** nighttime measurements generally no tropospheric information

Comparison of ozone measurements

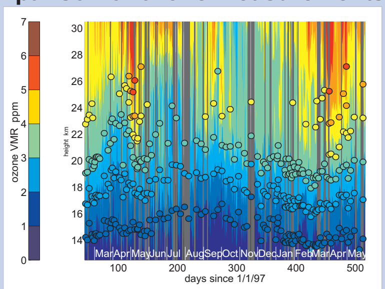

Figure 1. Comparison of RAM and sonde. RAM ozone measurements are displayed color coded. Sonde measurements were degraded to the mm-wave vertical resolution using the mm-wave averaging kernel. Sonde measurements are indicated by filled circles. Circles of the same color indicate the contour lines of the sonde measurements for 1, 2, 3, 4 and 5 ppm. The agreement is excellent.

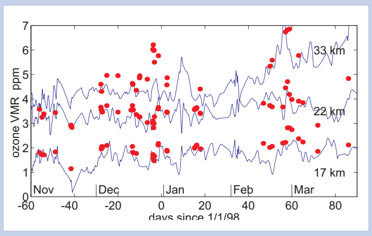

Figure 2. Comparison of RAM measurements and LIDAR measurements on three altitude levels. LIDAR measurements were degraded to the mm-wave vertical resolution. RAM measurements are indicated by the blue line and LIDAR measurements by red dots.

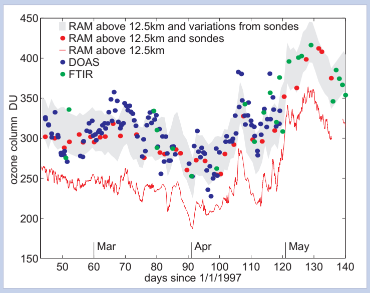

Figure 3. Comparison of total columns. Stratospheric columns from mm-wave measurements (RAM) are displayed as a red line. In the presence of sonde measurements, RAM measurements are corrected for the tropospheric ozone content (red dots). Gray shading indicates RAM-measurements and analyzed tropospheric ozone variations. DOAS measurements are indicated by blue dots and FTIR-measurements are indicated by green dots. Overall agreement is good, but the variability in DOAS and FTIR data is higher. The negative stratospheric trend in February and beginning of March observed by the RAM is not observed by the DOAS and FTIR.

Chemical ozone loss 1997/98

From mm-wave measurements at Ny-Ålesund, chemical vortex averaged ozone depletion rates on the 475 K isentropic level were derived. Depletion rates were calculated by correcting observed trends for 20 day periods with the expected ozone increase due to diabatic vertical transport. Trajectory calculations were used to make sure, that only measurements inside the vortex were considered. In early winter no significant ozone depletion was detected, but in end of February, depletion rates were higher than in 1996/97 when 20 ppb/day were observed.

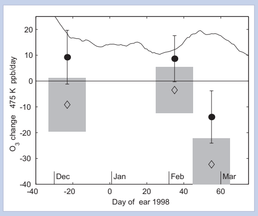

Figure 4. Observed ozone trends (circles with errorbars), expected ozone change due to diabatic cooling (solid line) and chemical ozone depletion (diamonds, gray shading corresponds to errorbars of the trend analysis).

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