File Revision Date:
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Data Set Description:

PI:	Gerald Nedoluha
Instrument:	Ground-based 278 GHz microwave spectrometer
Site(s):	Mauna Kea, Hawaii - moved to Mauna Loa in September 2015, returned to Mauna Kea in June 2018 Scott Base, Antarctica
Measurement Quantities:	Mixing ratio profile of ClO

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Reference Articles:

Parrish A., R.L. deZafra, P.M. Solomon, and J.W. Barrett, 1988: "A ground-based technique for millimeter wave spectroscopic observations of stratospheric trace constituents", Radio Science, Vol. 23, pp. 106-118.

Solomon P., J. Barrett, B. Connor, S. Zoonematkermai, A. Parrish, A. Lee, J. Pyle and M. Chipperfield, 2000: "Seasonal observations of chlorine monoxide over Antarctica during the 1996-1998 ozone holes and comparison with the SLIMCAT three-dimensional model", JGR 105, D23, 28,979-29001.

Nedoluha, G. E., et al., 2011: "Ground-based measurements of ClO from Mauna Kea and intercomparisons with Aura and UARS MLS", J. Geophys. Res., 116, D02307, doi:10.1029/2010JD014732.

Nedoluha, G. E. et al., 2016: "20 years of ClO measurements in the Antarctic lower stratosphere", Atmos. Chem. Phys., 16, 10725-10734, doi: 10.5194/acp-16-10725-2016.

Instrument Description:

The instrument consists of a cooled heterodyne receiver operating at 278.6 GHz, feeding a spectrometer with a total bandwidth of 506 MHz. We observe a thermally-excited rotational emission line of ClO; thus observations do not depend on the absorption or scattering of sunlight, and can be carried out day or night. To eliminate systematic instrumental artifacts such as differences in gain across the spectrometer's bandwidth, observations are made in a switched mode, the instrument looking alternately at the zenith (reference beam) and near the horizon (signal beam). The contributions to the spectrum from ClO at different altitudes are pressure broadened by different amounts, permitting the altitude distribution of ClO to be recovered from the shape of the observed spectrum. The instrument is indoors and looks at the sky through a Teflon window in the wall of the building. See Parrish et al. (1988) for details.

ClOe1 (Scott Base) and ClOe3 (Mauna Kea to August 2015) use a filterbank spectrometer consisting of 306 channels over 500 MHz. The channels are 5 MHz wide in the line wings, and 1 MHz wide near the line center where greater resolution is needed. The ClOe4 (Mauna Loa) and ClOe5 (Mauna Kea from June 2018) backends consist of Fourier Transform spectrometers (FTS) with 16384 channels over 1 GHz, providing 61 kHz resolution.

Algorithm Description:

Existing v5 (Mauna Kea) and v4 (Scott Base) retrievals are carried out using a modified Rodgers technique (Rodgers, Rev. Geophys. 14, 608, 1976). Our modification involves carrying out a series of retrievals for each spectrum, with a wide range of assumed uncertainty (errors) in the a priori profile required by the method. We calculate the residual RMS error (chi squared) between the forward calculation of the spectrum from the retrieved profile and the measured spectral line. As the assumed error gets larger, the chi squared gets smaller and approaches a minimum. We choose the retrieval just before it levels off at the minimum.

New v7.0 retrievals have been performed, or are currently in progress, with a retrieval algorithm based on optimal estimation. We are currently working on applying optimal estimation retrievals to the historical datasets.

Expected Precision/Accuracy of Instrument:

An error estimate is listed in the files, and errors are discussed in Solomon et al., (2000).

Measurement History:

Scott Base (instrument designation ClOe1): Measurements during the Antarctic Spring (August-October) from 1996-present.
Due to issues with the instrument there are no measurements for the 2018 Antarctic Spring. Measurements have since resumed after the instrument was repaired in November 2018.

Mauna Kea (instrument designation ClOe3-Rx3 from January 1992 to February 2012 and September 2012 to November 2014):
Mostly continuous measurements in very clear observing conditions.

Mauna Kea (instrument designation ClOe3-Rx4 from February 2012 to September 2012 and November 2014 to August 2015):
New Receiver (Rx4) but same optics panel and spectrometer. Continuous measurements in very clear observing conditions.

Mauna Loa (instrument designation ClOe4-Rx4 from March 2016 to June 2018):
Using Rx4, a modified version of the Mauna Kea optics panel, and AC240 FTS backend. Limited measurement capability at this site due to inconsistent periods of very clear conditions. At this stage, there are no plans to submit ClO measurements for this period to NDACC.

Mauna Kea (instrument designation ClOe5-Rx4 from June 2018 onwards):
Using Rx4 with a new optics panel and U5303a FTS backend. Continuous measurements in very clear observing conditions.