Studies of Ozone in the Lower Stratosphere from UARS Measurements

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Introduction

The Upper Atmosphere Research Satellite (UARS), launched in 1991, carried a payload of instruments dedicated to making complimentary measurements of a variety of geophysical parameters. The Microwave Limb Sounder (MLS) provides a long time series of ozone data, and is therefore very useful for modelling of ozone depletion in polar winters. The version 5 (v5) data offers a particularly useful improvement in altitude resolution since retrievals are performed on every UARS surface giving a height resolution of approximately 3km. Data from the Improved Stratospheric And Mesospheric Sounder (ISAMS) have been retrieved in the lower stratosphere but can suffer some error due to residual errors in correction for sulphate aerosol from Mt. Pinatubo. In addition, the correction for aerosol required use of the onion peeling optimal estimation approach to avoid vertical propagation of errors from the aerosol correction. The onion peeling approach results in poorer precision than the vector-vector version of the scheme. This aerosol did not enter into the polar vortex until mid-January 1992, and the aerosol clear region allows the vector-vector method to be employed. In addition, it is no longer necessary to correct for aerosol contamination thus removing a source of uncertainty. The re-analysed ISAMS data therefore provide an additional source of ozone data which can be compared to the MLS ozone data and ozonesonde data. The resulting validation of the datasets provides a clearer picture of the quality of satellite ozone data for Northern hemisphere winters. In addition, the data are useful for modelling studies.

ISAMS Retrievals

ISAMS ozone has been retrieved for 9th January 1992 over an altitude range between 100 - 10mb using a vector-vector optimal estimation algorithm without corrections for Pinatubo sulphate aerosol.

A low aerosol region has been identified using the v12 ISAMS 12.1µm aerosol data, thus marking the area in which this retrieved ISAMS ozone data is suitable for exploitation. This region presumably corresponds to the core of the vortex and is not symmetric with respect to the pole as might be expected for this day .

The zonal mean ratio of MLS v5 ozone to the re-analysed ISAMS ozone has been calculated for profiles in the low aerosol region only. These profiles cover a latitude range from 65 to 80 N. The zonal mean ratios show reasonable agreement between MLS and ISAMS with a hint of increasing ratios (ISAMS smaller than MLS) towards 60N at low altitudes (100 to 46mb).

Retrieved (and MLS) ozone profiles can be compared to ozonesonde profiles measured by stations in the low aerosol region during the EASOE campaign. The stations are marked on the aerosol map: Thule (76.3N, 291.6E), Egedesminde (68.7N, 307.1E) and Ny Aalesund (78.9N, 11.9E).

Results

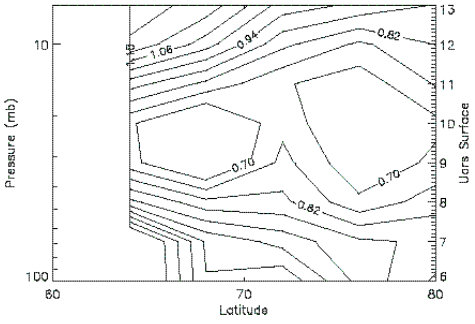

Figure 1a: Zonal mean ratio of MLS:ISAMS ozone without aerosol correction for 9th January 1992.

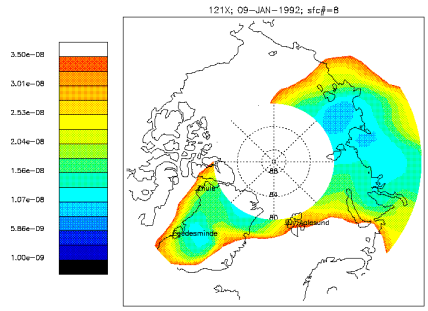

Figure 2: ISAMS v12 validated 12.1µm aerosol showing ozonesonde stations used during the EASOE campaign.

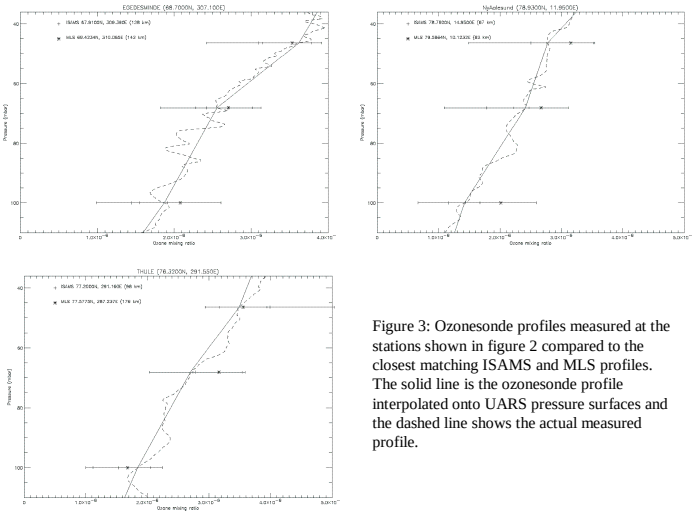

Figure 3: Ozonesonde profiles measured at the stations shown in figure 2 compared to the closest matching ISAMS and MLS profiles. The solid line is the ozonesonde profile interpolated onto UARS pressure surfaces and the dashed line shows the actual measured profile.

Conclusions

ISAMS ozone retrievals do not need corrections for Pinatubo aerosol in the low aerosol region at the core of the polar vortex in January 1992. A vector-vector approach can be employed and provides better precision than an onion peeling approach.

The ISAMS and MLS ozone are within 20% of each other in the lower stratosphere in the low aerosol region although there is a hint of a gradient with ISAMS data increasingly less than MLS data towards lower latitudes.

ISAMS (and MLS) ozone profiles are reasonably similar to the closest matching ozonesonde profiles to within an error bar of the satellite data.

Further Work

The special ISAMS retrievals will be performed for other days during this winter period to extend the comparison to both MLS and the ozonesonde data.

Further statistical analysis of the EASOE ozonesonde data is required to properly validate the ISAMS and MLS ozone data.

The ISAMS data will add to the observational base for the 1991/1992 winter which was the subject of the EASOE campaign and the UARS satellite observations. It will therefore be useful for modelling studies of this marginally cold winter with sporadic PSCs.

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