Optimizing Umkehr Ozone Profile Retrievals during the Mt. Pinatubo Volcanic Eruption

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The Umkehr method is based on a sequence of zenith sky observations during sunrise/sunset. NOAA Umkehr ozone profile records have been collected since the 1970s. Umkehr ozone profiles are used to monitor and guide stratospheric ozone recovery predicted by the 2050s. Current operational Umkehr profile algorithms produce data that have uncertainty on the order of ~ 5% in the stratosphere. However, when large volcanic eruptions inject aerosols into the stratosphere, the errors can be as large as 70%. In order to evaluate Umkehr records for aerosol-related and instrumental errors, we compare observations with a Hindcast simulation of the NASA Global Modeling Initiative (GMI) chemistry transport model (CTM, PI S. Strahan) that provides hourly-sampled vertical profiles of ozone and temperatures matched to the location of the Umkehr station. In addition, GMI ozone and temperature profiles are used for simulations of Umkehr observations. The biases found between the model and observations are summarized for each Dobson calibration period, thus providing a reference for homogenization of the Umkehr time series and successful removal of aerosol errors. Figure 1 demonstrates the ability of the optimized Umkehr ozone retrieval method to post-correct errors encountered by Umkehr operational retrieval during the volcanic eruption of Mt. Pinatubo (1991). The record is shown for Mauna Loa Observatory (MLO).

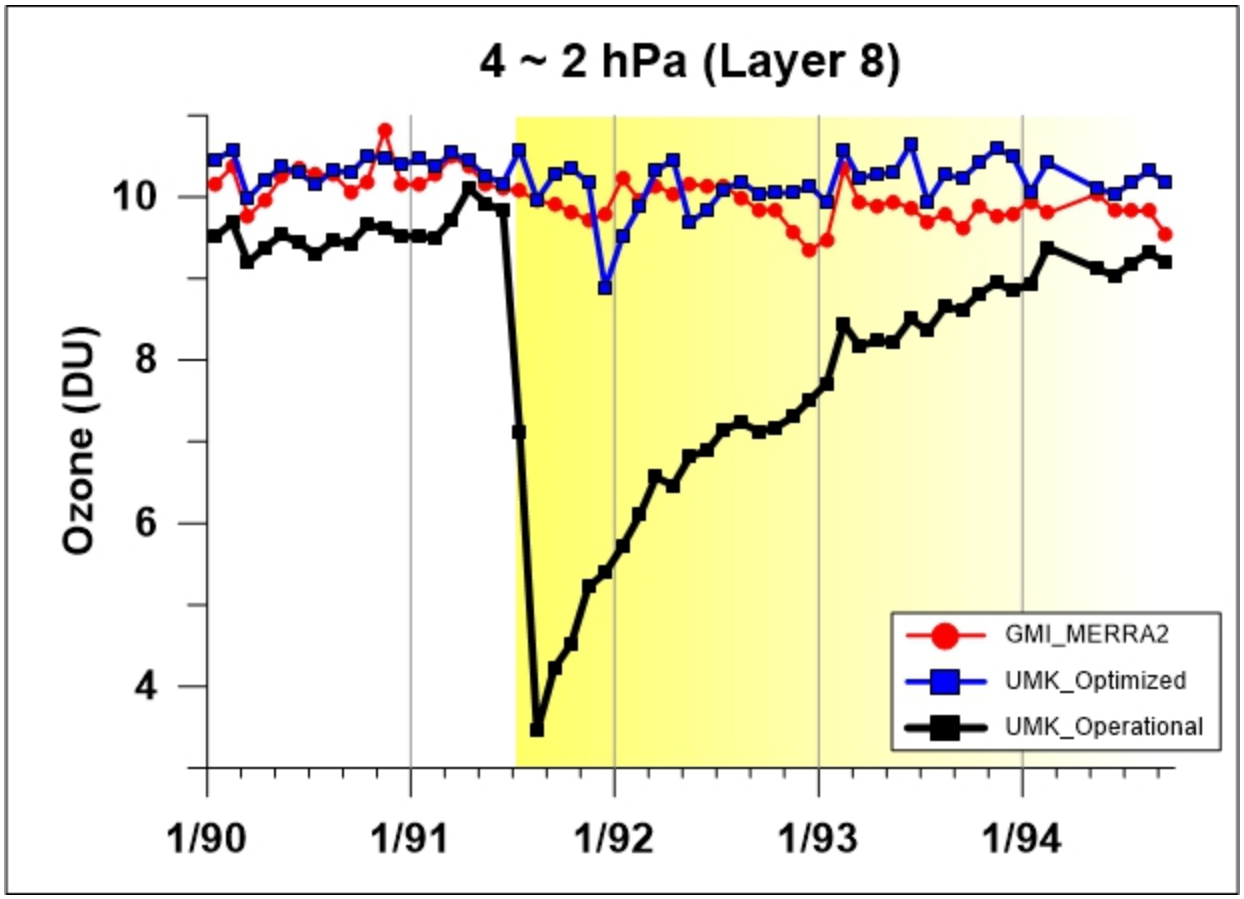

Figure 1. MLO ozone monthly-mean time series at 2–4 hPa (Umkehr layer 8) are shown for the Umkehr operational (Black), Umkehr optimized (Blue) algorithms and the station matched GMI (Red) data (NDACC Theory and Modeling group project, PI S. Strahan). The plot is focused on the period of 1991 eruption of Mt. Pinatubo volcano. A yellow grading shows a time period of enhanced aerosols that introduced large errors in the Umkehr operational ozone retrievals.