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The primary purpose of this grant was to support analysis of the limb scattering data taken during the 1997 flight of the SOLSE (**S**huttle **O**zone **L**imb **S**ounding **E**xperiment) and LORE (**L**imb **O**zone **R**etrieval **E**xperiment) instruments. Work was done to assess the performance of the retrieval algorithms for cloudy and clear sky cases in preparation for a poster presentation (Flittner *et al.*, 1998). The nadir-viewing data were also compared to coincident GOME (**G**lobal **O**zone **M**onitoring **E**xperiment) data and to radiative transfer calculations. An algorithm similar to the TOMS (**T**otal **O**zone **M**apping **S**pectrometer) ozone retrieval algorithm was developed to infer the ozone column amount from the SOLSE nadir data. Comparison with coincident TOMS ozone column data confirmed that column ozone could be derived successfully from SOLSE nadir radiances, and also revealed significant changes in the SOLSE wavelength resolution and absolute radiometric calibration that were subsequently confirmed by comparing the post-flight instrument characterization to the pre-flight characterization, indicating a potentially useful method for monitoring instrument behavior in-flight.

Another key focus of the grant was to prepare for the proposed re-flight of the SOLSE and LORE instruments. The re-flight has been postponed many times (it is currently scheduled for 2002), but these delays have not halted algorithm development work. Many radiative transfer calculations have been performed to assist in the reconfiguration of the instruments. In addition, the original retrieval algorithms have been completely reworked to accommodate data from the new instruments, and to allow a large series of sensitivity studies to be performed on the ozone retrieval algorithm. A manuscript describing these sensitivity studies is nearly complete. This paper provides a general description of the limb scattering ozone retrieval algorithm, and demonstrates the sensitivity of the retrieved ozone profile to a variety of realistic perturbations (e.g., noisy measurements, inaccurate pointing information, incorrect ancillary data, etc.). The algorithm sensitivity study expands upon the brief descriptions given in Flittner *et al.* (2000a) and McPeters *et al.* (2000).

In addition, a great deal of effort has been put into developing a limb scattering ozone retrieval algorithm for the SAGE (Stratospheric Aerosol and Gas Experiment) III instrument. Since the limb scatter mode is a new use of that instrument, a valuable exchange of information has taken place: Simulations made by our University of Arizona research group have helped to guide the additional pre-flight instrument characterization work done at NASA LaRC (Langley Research Center) to support the added limb scatter measurement capability, while the instrument and orbital characteristics provided by the NASA LaRC team have helped guide our simulations of the expected radiances and algorithm performance. Studies of the effect of the SAGE III instrument polarization sensitivity and of possible changes in the instrument pointing during a limb scan on the ozone retrieval have been completed, and were incorporated in a poster (Flittner *et al.*, 2000b). The SAGE III launch is currently scheduled for December 2001, and we continue to prepare for the variety of limb scattering observations that will be possible with this instrument.

These activities in support of future limb scattering missions have also led me to an advisory role for the OOAT (Ozone Operational Algorithm Team). A limb scattering instrument was chosen as part of the OMPS (Ozone Mapping and Profiling Suite) to be flown on the NPOESS (National Polar-orbiting Operational Environmental Satellite System) orbiters. The OOAT is charged with monitoring the progress of and offering technical advice to the contractors who build the instrument and design the required retrieval algorithms. Collaborative efforts with OOAT members from NRL (Naval Research Laboratory) are underway to provide an independent assessment of the contractors' ozone retrieval algorithm development efforts.

The unexpected delays in the launch schedules of SOLSE/LORE and SAGE III have left more time than expected for other activities. A long-standing project came to fruition with the publication of Petropavlovskikh *et al.* (2000). In this work, the results produced by the spherical atmosphere radiative transfer models of Herman *et al.* (1994) and Herman *et al.* (1995) are compared to those obtained from the more approximate pseudo-spherical atmosphere radiative transfer models developed by Dave (1964), Dave (1972a) and Dave (1972b). Significant differences are found, and these differences cause the ozone profile retrieved using the Umkehr method to change appreciably, suggesting useful improvements for the standard Umkehr retrieval method.

Another area of interest has involved study of GOME data to determine whether useful ozone information can be obtained from backscattered radiances at visible wavelengths (in the

Chappuis absorption bands). We hope to use this experience to develop an ozone retrieval algorithm based on visible radiance measurements for the Triana instrument. Due to its unique orbit at the Lagrange-1 neutral gravity point (on the near side of the Earth's orbit, between the Earth and the sun), the Triana instrument will view the poles obliquely. The performance of typical ultraviolet-based ozone retrieval algorithms degrades in this viewing geometry, inspiring a search for alternate approaches. Sorting out true changes in radiance from instrument artifacts in the GOME data has proven to be challenging, and the measured GOME spectra still contain many features that are not explained by the current forward models. But preliminary results suggest that the non-Lambertian reflection properties of ice (which are not accounted for in the forward model used so far) may explain some of these discrepancies. These findings were presented in a poster (Loughman *et al.*, 2000).

In addition, a series of radiative transfer calculations was made using MODTRAN to investigate the potential of inferring trace gas profiles by measuring the transmission of solar radiation through the limb of the atmosphere from the Lagrange-2 neutral gravity point (on the far side of the Earth's orbit). This work produced promising results, and has inspired instrument development activities at Goddard that might produce useful results in the long term.

However, development of a general limb scattering ozone retrieval algorithm and preparation of a manuscript describing its properties are the primary accomplishments of the present contract period. The case for continuation of the contract rests primarily on the many slips that have occurred in the expected launch dates for instruments that will measure limb scattered radiances (described above). In the most likely scenario, little or no data will be available for analysis before the current contract ends. Analysis of real-world data is, of course, the purpose of all efforts up to this point. This data analysis promises to be an extremely challenging and fruitful project, and I look forward to pursuing this portion of the job that we have begun.

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