FINAL REPORT

Title: Synoptic Mapping of Chemical Composition, Thermal Structure, and Air Motion from UARS Observations

NASA Grant Number: NAG5-2852

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An operational mapping algorithm was developed to process measurements of individual species observed by different satellite instruments on board UARS. Based on Fast Fourier Synoptic Mapping (FFSM), the algorithm accounts for the precessing orbit of UARS, the error of individual instruments, and gaps associated with instrument duty cycle and the satellite yaw maneuver (Sassi and Salby, 1998a). It provides synoptic structure and evolution on periods as short as 1 day, derived collectively from all observations of an individual species.

The algorithm was applied to synoptically map temperature, thickness, and several chemical constituents observed by the instruments: MLS, CLAES, ISAMS, and HALOE. Each field variable observed by these instruments was mapped twice-daily in continuous global time series several months long.

Mapped behavior produced via FFSM was compared against standard archived products generated via Kalman filtering. The standard map products reveal similar behavior, but are limited to features of larger scale. Tracer structure that develops through flow deformation and attending transport is therefore represented in those products more coarsely, eventually being sheared down to scales that are no longer represented properly.

The synoptic time series also reveal a diurnal cycle for several of the constituents, one that emerges clearly in their space-time spectra. The zonal and meridional structure of diurnal variability was mapped by filtering the space-time spectrum, an intermediate product of FFSM, to those scales resolved by the UARS sampling (Sassi and Salby, 1999). Geographical variations of the diurnal cycle have also been evaluated in its seasonal-mean structure by compositing

distributions at individual local times. Both were compared to diurnal variations in chemical models and in dynamical models that account for transport by the diurnal tide.

Diurnal variations were found to introduce spurious behavior into the archived products generated via Kalman filtering, behavior that is misrepresented in those synoptic time series (Sassi and Salby, 1998b). Aliasing by undersampled diurnal variations introduces a bias into the time-mean structure of archived products. That systematic error is manifested as anomalous wave structure in the time-mean fields. By contrast, synoptic time series generated via FFSM faithfully represent such behavior as varying diurnally, so it does not corrupt time-mean structure.

Tracer structure mapped via the above algorithm was being applied to determine the Brewer-Dobson circulation of the stratosphere through Lagrangian considerations (Juckes and Salby, 1994). Preliminary results are encouraging: They reveal diabatic ascent in the tropics, balanced by diabatic descent over the winter hemisphere. This Lagrangian description of transport derived from UARS tracer measurements would be potentially valuable for diagnosing interannual changes of transport, specifically, in relation to interannual changes of total ozone. Regrettably, support was reduced to 50% of the approved funding level, leaving this component incomplete.

References

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