Introduction
The JPL MkIV interferometer is a Fourier Transform Spectrometer that measures the composition of the Earth’s atmosphere by solar occultation spectrometry. The MkIV has completed 21 balloon flights since 1989, each measuring profiles of 30+ trace gases simultaneously, with high accuracy and vertical resolution. In this presentation, we show results from 18 years of MkIV measurements. Although these measurements are very sparse, we show that, by careful use of tracers (e.g., N$_2$O), dynamical variations can be largely eliminated allowing useful trend information to be discerned. Results are shown for HCl, HF, CFCs, HCN, CH$_4$, and H$_2$O at various N$_2$O isochores in the stratosphere and upper troposphere. We also use MkIV data for non-coincident validation of the Atmospheric Chemistry Experiment (ACE), a spaceborne occultation FTS very similar to MkIV.

The MkIV Balloon Interferometer
The JPL MkIV interferometer is a Fourier Transform Infra-Red (FTIR) Spectrometer, designed and built at the Jet Propulsion Laboratory, to remotely sense the composition of the Earth’s atmosphere by the technique of solar absorption spectrometry. Its design was based on that of the ATMOS instrument.

The MkIV Balloon Flights
The JPL MkIV interferometer has performed 21 balloon flights since 1989. Flights are 6-30 hours duration depending on wind conditions and provide one or two occultation events covering altitudes from the PBL or cloud tops to the balloon (35-40 km) at 2-3 km vertical resolution. The majority of the MkIV balloon flights have been from Ft Sumner, New Mexico (~35N), but there have also been 6 flights from Exrarge, Sweden and Fairbanks, Alaska (~65N), in 1997, 1999, 2000, 2002, and 2003.

Trend Studies
The 18 year baseline of the MkIV measurements make them valuable for trend studies. The major drawback is their sparsity (only 21 flights in 18 years). With dynamically induced variations larger than the trends for many gases, the representativeness of the MkIV measurements can be an issue. We therefore used a tracer, N$_2$O, to minimize the impact of dynamically-induced variations that otherwise would hinder trend estimation.

Non-Coincident Validation of ACE
The Atmospheric Chemistry Experiment (ACE), on board SCISAT, is a solar occultation FTS very similar to MkIV. ACE acquires up to 30 occultations per day (~10,000 per year). The ACE profiles are becoming much more widely used for validation (e.g., Aura). The MkIV is the perfect instrument for ACE validation since it measures the same gases in the same spectral regions using the same technique. MkIV also has a long heritage of satellite validation going back to the UARS era.

To date, the MkIV balloon profiles have not been used much for ACE validation. This is because all the MkIV flights performed since ACE launched (2003) have been from Ft Sumner, New Mexico (35N), in late September, which unfortunately falls in a hole in the ACE coverage (right). The nearest ACE measurements are 2-3 weeks later than those of MkIV and therefore fail any sort of a co-incidence criterion.

A method of non-coincident validation was therefore employed. A surface is fitted to the Version 2.2 values of the MkIV measurements. The resulting interpolated ACE profiles are compared with MkIV profiles (colored squares) with a zonal mean of the ACE results (black dashes) acquired within 5° of latitude and 6 weeks of the MkIV, gives poor agreement. But the ACE data, color-coded by their Equivalent Latitude (EqL), match well MkIV observations of the same color/EqL. EqL was calculated for ACE and MkIV data using the procedures described in Manney et al., 2007.

Comparing MkIV profiles (colored squares) with a zonal mean of the ACE results (black dashes) acquired within 5° of latitude and 6 weeks of the MkIV gives poor agreement. But the ACE data, color-coded by their Equivalent Latitude (EqL), match well MkIV observations of the same color/EqL. [EqL was calculated for ACE and MkIV data using the procedures described in Manney et al., 2007].

Figure 1. The JPL MkIV Interferometer: Photograph and Optics Diagram

Figure 2. MkIV balloon launch from Ft. Summer, New Mexico, on Sep 20, 2005.

Figure 3. Trends at N$_2$O levels: 150 ppb (~27 km), 200 ppb (~24 km), 250 ppb (~21 km)

Figure 4. ACE occultation/latitude: sunset/sunrise.

Figure 5. N$_2$O (left) and CH$_4$ (right) profiles from ACE and MkIV color-coded by EqL.

Figure 6. N$_2$O (left) and CH$_4$ (right) profiles from MkIV and ACE (2-D interpolated). Insert shows differences.

Figure 7. ACE occultation/latitude: sunset/sunrise.

Figure 8. ACE occultation/latitude: sunset/sunrise.

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