An Evaluation of the Capability of HIRDLS to Measure Thin Ozone Filaments During Tropopause Folding Events in the Extra-tropical UTLS Using Co-Located Ozonesonde and Lidar Measurements

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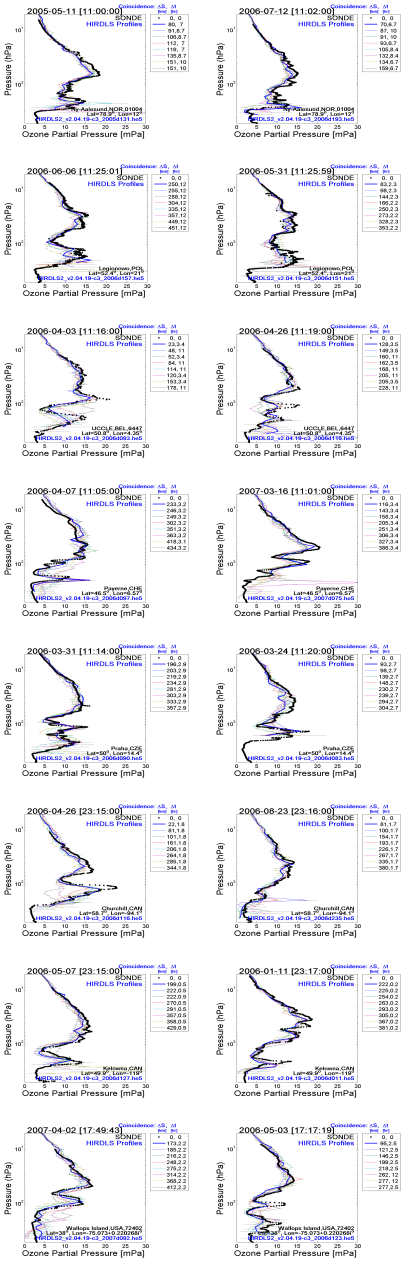
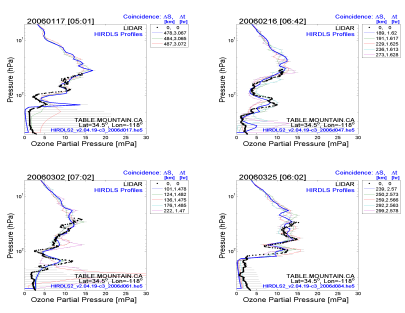
Below: coincident ozone profiles measured with HIRDLS (V004, to-be released, v2.04.19 internally) and with WOUDC ozonesondes during UTLS lamina events.

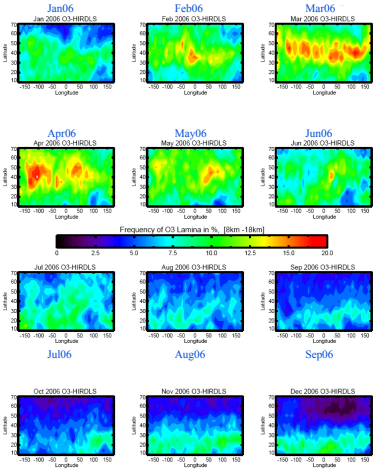


Below: HIRDLS V004 ozone profiles compared with coincident LIDAR profiles from Table Mountain Facility [TMF].



Abstract Stratosphere-troposphere exchange and a related poleward transport of extra-tropical upper tropospheric air into the lower stratosphere appear to occur frequently along fast moving tropopause folding events. Folding events are especially prevalent in Northern Hemisphere late winter and early spring. The High Resolution Dynamic Limb Sounder (HIRDLS) on board the Aura satellite has a demonstrated ability to measure ozone with approximately 1 km vertical resolution into the upper troposphere / lower stratosphere (UTLS) region often to better than 200 hPa. It is the first satellite instrument with sufficient vertical resolution and coverage to observe many such events in the UTLS. HIRDLS measurements of ozone and temperature during folding events show the typical features of low ozone pockets above relatively ozone rich layers. Presented here are measurements of HIRDLS ozone profiles on multiple such events compared with coincident WOUDC-site ozonesonde profiles and Table Mountain lidar ozone profiles. We use these co-located measurements to provide an assessment of the ability of HIRDLS to detect these events.

Frequency of Lamina Occurrence



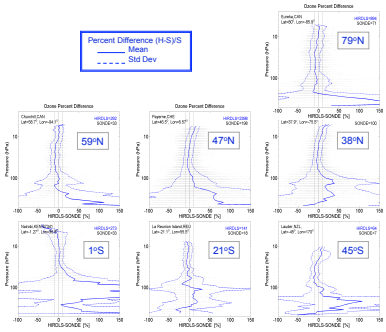
The frequency of lamina occurrence as measured with HIRDLS ozone, is determined by counting profiles where the ozone mixing ratio falls below a threshold value at the 100 hPa pressure level. The ratio of the number of lamina profiles to the total number of profiles is plotted on Mercator Maps above for each month in 2006.

To the left are coincident ozone profiles during lamina events. Profiles are compared from eight World Ozone and Ultra Violet Data Center (WOUDC) sites in the NH at mid and high latitudes spanning range 38° - 79°N, and from the ground based lidar station at Table Mountain Facility [TMF, 34.5°N]. The coincidence criteria used are temporal and spatial separation of less than 500 km and 12 hrs respectively. The black dots are the sonde measurement and the color lines are HIRDLS profiles, the closest coincident profile being in bold-blue. One can see clearly that the large vertical ozone gradients associated with the ozone lamina are captured very well in the HIRDLS profiles.

Shown at right is the statistical difference of the lumped set of coincident lamina profiles for the three stations above-right, and the Legionowo and Wallops Island stations, in terms of partial pressure (top), volume mixing ratio (middle) and percent difference (bottom). Consistent with individual station statistics, a 10% accuracy to pressures of about 200 hPa are indicated.

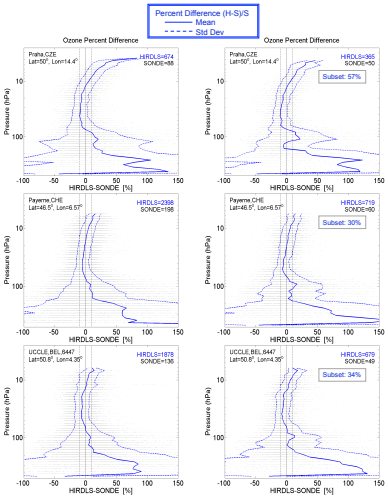
At far right are scatter plots of all profile data-points in terms of partial pressure (top) and volume mixing ratio (bottom) are shown. Correlations between the two datasets are very high, at 0.97 for VMR and 0.79 for partial pressure.

HIRDLS Ozone [V004] - Accuracy As A Function Of Latitude



Shown above is the accuracy of HIRDLS ozone, V004, as determined statistically by a average of the differences between HIRDLS and ozonesonde ozone values for 8 WOUDC sites spanning latitude range 45 degrees S to 79 degrees N. Numbered in blue and black in the upper right of each panel is the number of HIRDLS and sonde profiles, respectively, of which the dataset is comprised.

ALL coincidences Lamina cases only



Shown above are three particularly rich datasets are used to determine whether the highly structured lamina profiles produce a larger mean differences, interpretable as lower HIRDLS accuracy, during the most demanding measurement scenarios posed by the highly structured features. On the left hand side are the mean difference profiles for all coincident profiles from years 2005, 2006 and 2007 combined, for the three WOUDC sites. On the right hand side are the mean difference profiles for the same sites, but only including the coincident profiles in which lamina were present. If HIRDLS has difficulty measuring the large vertical gradients you would expect either the difference and/or the standard deviation in those regions to increase. The fact that this is not the case is evidence that HIRDLS the large vertical gradients do not cause a significant degradation in the accuracy of HIRDLS ozone.