# 2.3 ASSIMILATION OF HRDI LINE-Of-SIGHT WINDS

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## 1 Abstract

The High Resolution Doppler Imager (HRDI) provides direct global scale measurement of the stratospheric and upper troposphere wind field. We have incorporated these observations into the GEOS-DAS assimilation system and present here results on the impact of these observations on the stratospheric wind analyses. While HRDI Line-of-Sight (LOS) observations have relatively large errors, they can be separated by observational parameters (eg. Absorption band), and the observation error for some data subsets have substantially smaller errors than the entire set of observations. Further, direct assimilation of LOS winds removes the retrieval into (U,V) wind components so that a more accurate determination of the observation errors can be made. Accurate knowledge of observation errors is as important to assimilation as the accuracy of the observations themselves. We show that the HRDI observations have significant on the analysis winds and that the short term assimilation results indicate that there is some promise for increasing the accuracy of stratospheric wind fields.

## 2 Introduction

HRDI is a limb sounding instrument which measures the Doppler shift in daytime $O_2$ absorption bands along the telescope viewing direction, which alternates between either $45^o/135^o$ or $225^o/315^o$ relative to the satellite direction of travel. The telescope zenith angle zenith angle is varied so that the line of sight tangent point varies from 10 to 40 km in 2.5 km intervals. This measurement includes contributions from the entire line of sight, with the peak contribution coming from the region at and near the tangent point. Since LOS wind is not a state variable, an observation operator has been constructed it to U and V winds. The forward operator consists of projection followed by vertical averaging by contribution functions of the UV winds. We have previously carried out an extensive analysis of the errors associated with the HRDI LOS winds by separating the observations into a number of measurement parameters and calculating O-F (observed minus forecast) statistics (Tangborn, *et al.* 2001).

Impact studies of HRDI LOS observations have been carried out for the period 3-15-97 to 3-18-97 on the GEOS-DAS assimilation system. The experiment was carried out using radiosonde wind measurements only and again using both radiosonde and HRDI LOS winds. The results in the next section are presented in terms of the difference between these two experiments.

## 3 Analysis Increments

An important indicator of the impact of a given data type is the impact that it has on the analysis field. This can be demonstrated by the change in analysis increment values that occurs when the observations are added. Figure 1 shows the maximum analysis increment as a function of pressure level with and without HRDI observations. There is a significant increase in the maximum increment value for heights above 300 mb, since

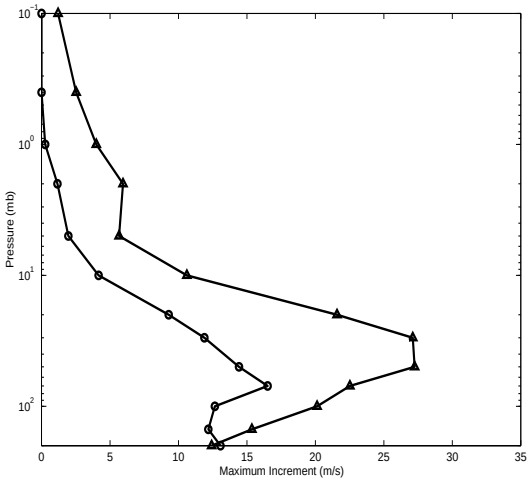


Figure 1: Maximum analysis increment as a function of pressure in the Stratosphere with (triangles) and without (circles) HRDI observations

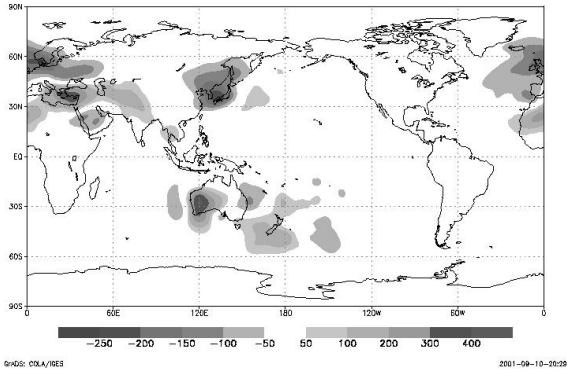

Figure 2: Change in height analysis at 300 mb with the addition of HRDI LOS observations after a 24 hour assimilation

the HRDI LOS winds are the only observations at these levels. The changes in height and zonal winds after a 24 assimilation at the 300 mb level (Figures 2 and 3) have maximum values of 500 m and 50 m/s, respectively.

## 4 O-F Statistics

While it is difficult to assess the success of the assimilation over the short periods covered so far, changes to the O-F statistics are a good indicator its potential. Figures 4, 5 show the O-F mean and standard deviation as a function of pressure level. Figure 4 uses only radiosonde wind measurements and figure 5 assimilates both radiosonde and HRDI LOS winds. At altitudes above 200 mb, the assimilation that includes HRDI observations shows a lower O-F standard deviation while it is larger below 200 mb. HRDI observations therefore have a primarily positive impact in the stratosphere and a negative impact in the troposphere.

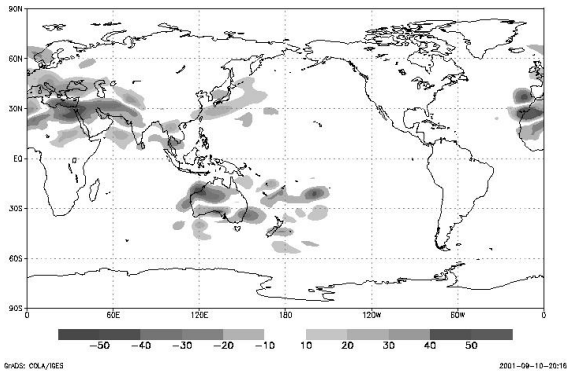

Figure 3: Change in zonal wind analysis at 300 mb with the addition of HRDI LOS observations after a 24 hour assimilation

## 5 Conclusions

Initial short term assimilation of HRDI LOS wind observations show that this data will

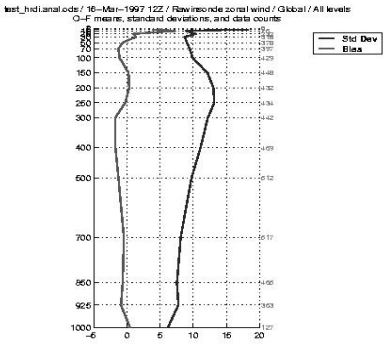


Figure 4: O-F Statistics as a function of pressure level in the absence of HRDI LOS observations.

have significant impact on stratospheric analyses. Prior to including HRDI winds into the GEOS-DAS assimilation system, the few observations in the lower stratosphere produced essentially no analysis increments at altitudes above 10 mb and relatively small increments above 100 mb. O-F statistics suggested that, in the short term, HRDI observations make a positive impact on stratospheric analyses and a negative impact in the troposphere. However, the latter effect may be due to a still miss-specified observational error statistics in this part of the atmosphere.

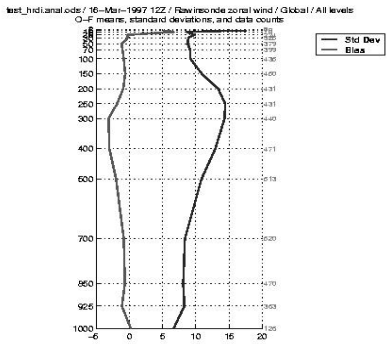


Figure 5: O-F Statistics as a function of pressure with HRDI observations included. The standard deviation curve shows that the errors are reduced above 150 mb and increase below 150 mb.

# 6 References

A. Tangborn, Menard, R. and Ortland, D. Bias Correction and Random Error Characterization for the Assimilation of HRDI Line-of-Sight Velocity Measurements, *Journal of Geophysical Research - Atmospheres*, submitted, 2001.