2.2 WIND AND WATER VAPOR COMPARISONS DURING IHOP 2002

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1. INTRODUCTION

In 2002, the Goddard Lidar Observatory for Winds (GLOW) Doppler wind lidar and Scanning Raman Lidar (SRL) water vapor Raman lidar participated in the International H2O Project (IHOP 2002) at the Homestead profiling site in western Oklahoma. In addition to these two lidars, many different instruments including radars, other lidars*, in situ* aircraft measurements, radiosondes, profilers and radiometers took part to pursue the main objective of IHOP: to understand the distribution and time evolution of water vapor and its relation to convective processes (Weckwerth 2004).

2. GLOW and SRL

The GLOW lidar system is a mobile direct detection double-edge method Doppler lidar operating at 355 nm. Normally set up to gather wind data in the free troposphere, a reconfigured GLOW system provided boundary layer wind profiles during the IHOP experiment. Line-of-sight (LOS) winds are taken at 4 cardinal directions at elevation angles typically ranging from 15 to 45 degrees then summed to produce volumetric averaged wind speed and direction profiles. A more detailed description of the system can be found in Gentry (2000). In section 3, the elevation angle from 0:00 UTC to 3:43 UTC equaled 45 degrees and 30 degrees from 4:32 UTC to 9:00 UTC.

In complement to the GLOW Doppler wind lidar, the SRL, a mobile Raman lidar operating at 355 nm, measures aerosol extinction, backscatter, depolarization, and water vapor mixing ratio. A thorough description of the system is given in Whiteman (1999). During IHOP, problems limited the lower bound of SRL data to approximately 300 m, but the nighttime capabilities of the SRL produced profiles up to the tropopause. Although the SRL has scanning abilities, all profiles presented in Section 3 were obtained in the vertical mode.

Over the course of the six-week experiment, 75 hours of coincident wind and water vapor observations were logged, see Figure 1. In general, most of these coincident measurements resided around 0:00 UTC corresponding to 7:00 PM local time. By studying this unique coincident and collocated dataset, several interesting atmospheric phenomena can be studied.

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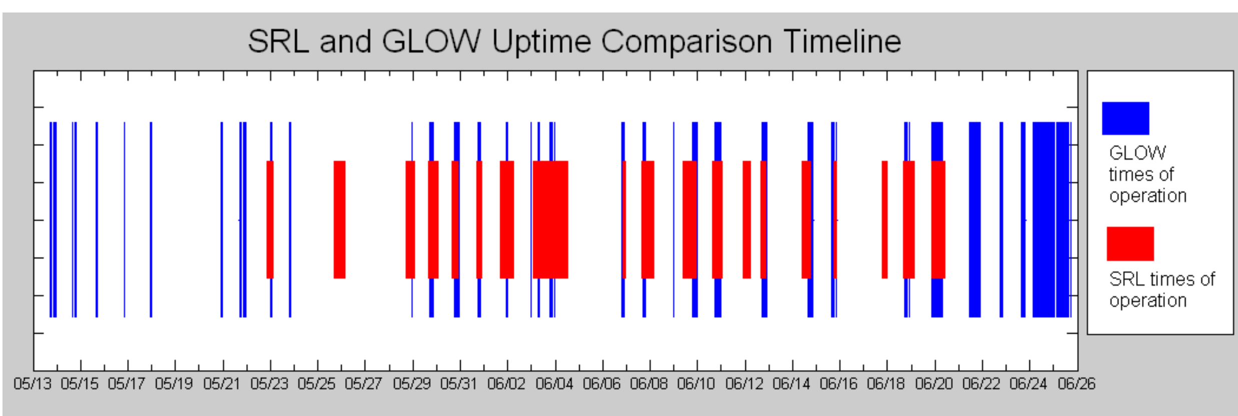

Figure 1. Timeline indicating the overlap in data acquisition times between GLOW (blue) and SRL (red).

3. LOW LEVEL JET AND BORE WAVE

At 1:30 UTC on the morning of June 20, 2002 a low level jet (LLJ) was formed over the Homestead profiling site. Examining the GLOW data in Figure 2, this feature is marked by the presence of large wind speeds (~ 20 - 30 m/s) stretching from the ground to approximately 1 km from 1:30 UTC to 3:43 UTC. The LLJ begins to fade in intensity around 3:00 UTC, but then intensifies again around 3:30 UTC. Unfortunately, GLOW data was unavailable from 3:43 to 4:32 UTC, leaving intensity of the LLJ for this period an unknown.

Signatures from the LLJ event are also present in the SRL water vapor data. Beginning at 1:30 UTC, a net drying in the water vapor field can be seen extending from 300 m to nominally 1 km. Comparing the shape of this drier region to the shape of the higher wind speed region in the wind data, a broad spatial and temporal match exists. In the LLJ region, the value of water vapor mixing ratio decreased on average 20%, from 11 to 9 g/kg. GLOW wind direction data indicates the LLJ was blowing from the south. The net drying in this region could be attributed to the advection of drier air from more arid regions south of Homestead.

At 6:00 UTC June 20, a bore wave soliton passed the Homestead profiling site, Figure 2. This bore wave, which is explained by Koch as a type of gravity wave disturbance propagating on a low-level inversion ahead of a gravity current, was triggered by outflow from a line of thunderstorms extending from Nebraska over western Kansas (Koch 2003, Flamont 2003, Flamont 2004). Based several kilometers west of Homestead, the S-POL radar data indicates growing disorganization of the bore as it propagated down from the southern Kansas/northern panhandle region of Oklahoma

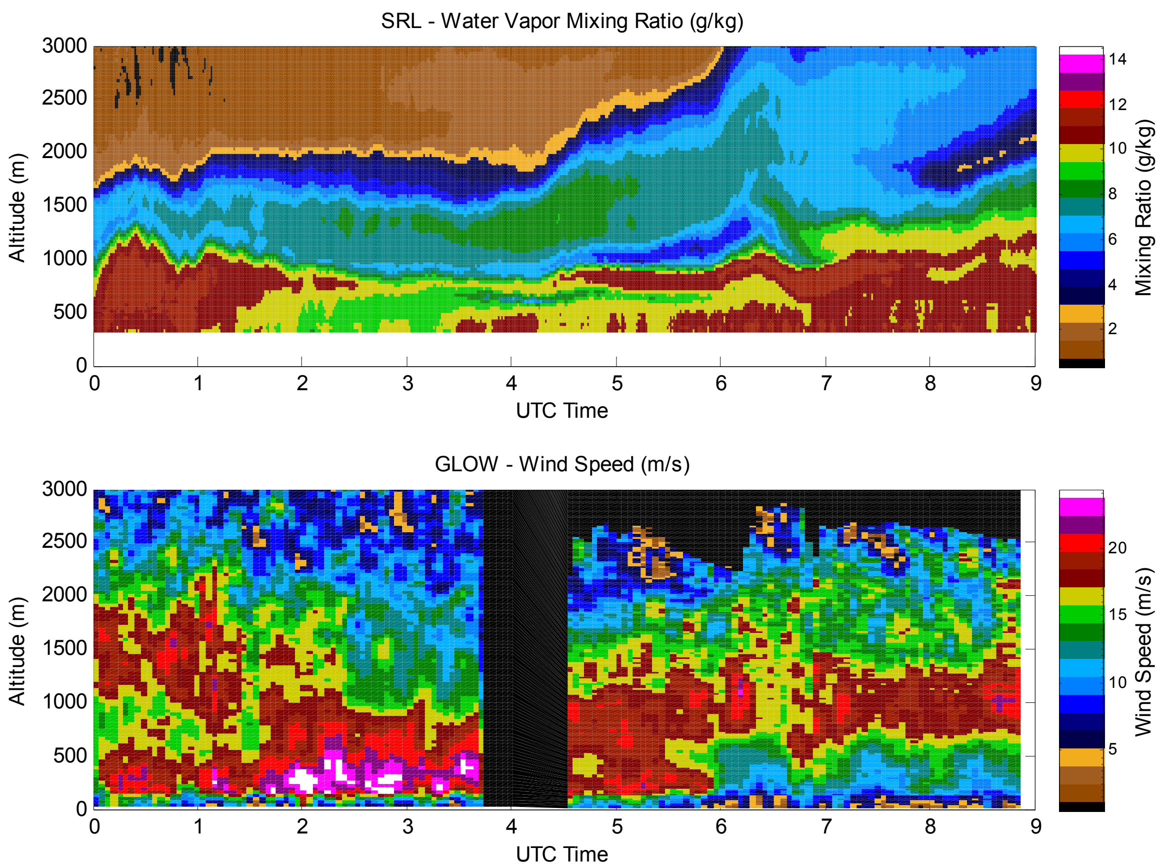

Figure 2. Shown above are GLOW wind speed (m/s), bottom panel, and SRL water vapor mixing ratio (g/kg), top panel, for June 20, 2002 at the Homestead site in western Oklahoma. LLJ begins at 1:30 UTC and extends to approximately 3:45 UTC. The three bore wave periods are shown beginning at 6:00 UTC.

towards the Homestead site. The bore can no longer be seen in the S-POL imagery by the time the wave front reaches the Homestead site.

However, the GLOW wind data shows three distinct wave periods; 6 – 645, 6:45 – 7:50 and 8 -- 9 UTC. These periods are marked by cores of decreased wind speeds (~7- 12 m/s) approximately 500 - 750 m in amplitude surrounded by a background of higher wind speed (~ 15 - 20 m/s). The bore waves are also seen in the SRL water vapor data. The first period is very distinct, with the second and third periods less prominent. The first period in the water vapor data is also recognizable above 1 km, with the wave signature even evident at 3 km. This might indicate an upward propagation of energy, and studies are ongoing at this time.

4. CONCLUSION

As with any large field campaign, IHOP 2002 provided an excellent vehicle for obtaining collocated and coincident data sets. By examining features found in the SRL water vapor and GLOW wind data sets, a better understanding of atmospheric phenomena such as bore waves and low level jets can be obtained. One such example of this was seen on June 20, 2002. Other bore events as well as drylines are the subject of future research in the hopes of gaining better scientific insight into these specific convective processes and their affect on weather and global climate change.

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