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EXAMINING NOCTURNAL JETS IN THE HUDSON VALLEY DURING HVAMS

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1. Introduction:

A low-level nocturnal jet has been observed to flow along the Hudson valley axis in fair weather (Fitzjarrald and Lala, 1989; FL89). It is thought to determine the thickness of radiation fogs in autumn and may be responsible for nocturnal advection of pollutants. FL89 presented observations made using a tethered balloon operated at Albany airport ("A1", Fig. 1). Wind maxima of 4-8 m/s were observed at 50-70 m altitude, occurring on nights when there is very little synoptic-scale pressure gradient. The horizontal extent of this jet and its temporal integrity are poorly understood. During the HVAMS (Hudson Valley Ambient Meteorology Study) intensive observation period in September and October 2003, we examined several cases of this phenomenon. Special effort was made to coordinate observations from an 18-station surface network, two sodars, two wind profilers and tethered balloon-borne instruments. Though nocturnal low-level flights were not possible in this region, measurements of the stable boundary layer made during a series of early-morning 'close approaches' by the Wyoming King Air research aircraft to small airfields were used to document the stable boundary layer (SBL) state just before convective conditions obtained. We illustrate here aspects of one of the case studies, October 17, 2003. Others will be discussed in the presentation.

2. Location and instrumentation:

The study region, the mid Hudson Valley, is located from 74.1°W-73.6°W and 41.6°N-42.8°N. Valley walls range 200-300 m, with the highest peaks reaching over 1000m along the west wall. Valley orientation is ≈ 8.5° east of north. During the intensive observation period September-October 2004, surface-based instrumentation included a network of 9 flux towers (ISSF stations) and the TAOS tethered balloon system from NCAR, and the Mobile Integrated Profiling System (MIPS) from the U. of Alabama (http://vortex.nsstc.uah.edu/mips/). Local instrumentation included and a sodar, 5 'HOBO' weather stations and a flux tower operated by SUNY.

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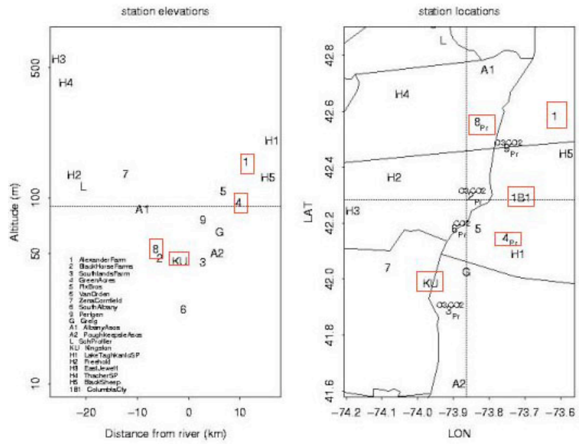

Figure 1: Location of the surface stations during HVAMS. Airports at which King Air close approaches were made shown in red boxes. Left: Station elevations. Right: geographical position of stations.

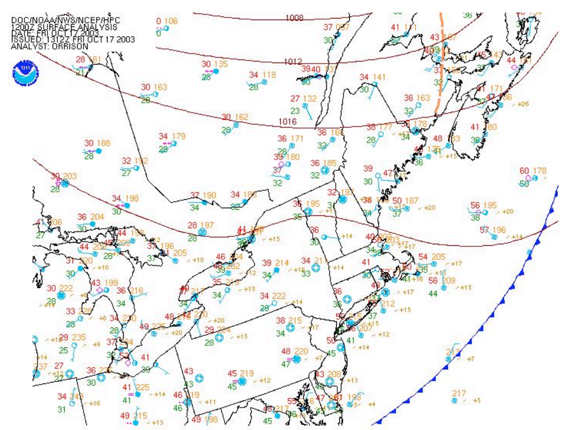

Figure 2: NWS surface weather map for the northeast U.S., 12Z, October 17, 2003.

The King Air instrumented aircraft from the Univ. of Wyoming made observations during 26 research flights comprising approximately 80 flight hours.

3. Case Study, October 17, 2003

A cold front passed was analyzed astride the mid-Hudson valley at 00Z October 17, 2003, leaving the valley with weak synoptic pressure gradient by 12Z (Fig. 2). The 12Z radiosonde launch at Albany (Fig. 3) indicated both weak low-level southerly winds and a

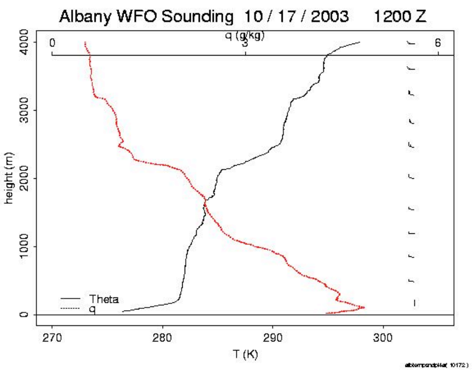

Figure 3: Albany National Weather Service sounding, 0Z, 10/17/2003, with potential temperature (black) and specific humidity (red). Winds are given by barbs at right.

stable boundary layer, but there is insufficient resolution to detect small features. At the Kingston-Ulster airport MIPS location ("KU", Fig. 1), both the profiler signal/noise ratio and the sodar echo intensity place the stable boundary layer thickness near 200 m altitude (Fig. 4). Relatively weak westerly winds above this level are detected both by the profiler and the sodar, but only the sodar resolves the southwesterly and southerly component at lower levels. Until convective conditions led to warming at approximately 13Z, the surface was nearly calm.

A series of 'close approaches' to small airports by the King Air made over a 21-minute period reveals the presence of a jet just at the base of a strong inversion at the top of the stable boundary layer (SBL), at approximately 200 m altitude (Fig. 4). Note that for this case the jet is most apparent on the east side of the river. It appears at approximately the same altitude above the river, closer to the ground at higher stations. By the time the aircraft reached the South Albany airport (13:07Z), a nascent CBL was present, and no along-valley component was evident. The thickness of the SBL is clearly indicated by an excess of CO_2, which exceeds 410 ppm at Kingston-Ulster in the first approach.

4. Conclusions

The October 17, 2003 case indicates that the jet described by FL89 is present over a wide area. Along-valley winds up to 6 m/s (22 km/h) are sufficient to transport mass appreciable distances over the night, but the presence of the jet is poorly described by standard observations. In continuing work, we will examine the dynamics of the Hudson River fair-weather jets, to understand if topographic effects make formation on the east side of the river more favorable. The jet appears to be a direct circulation to

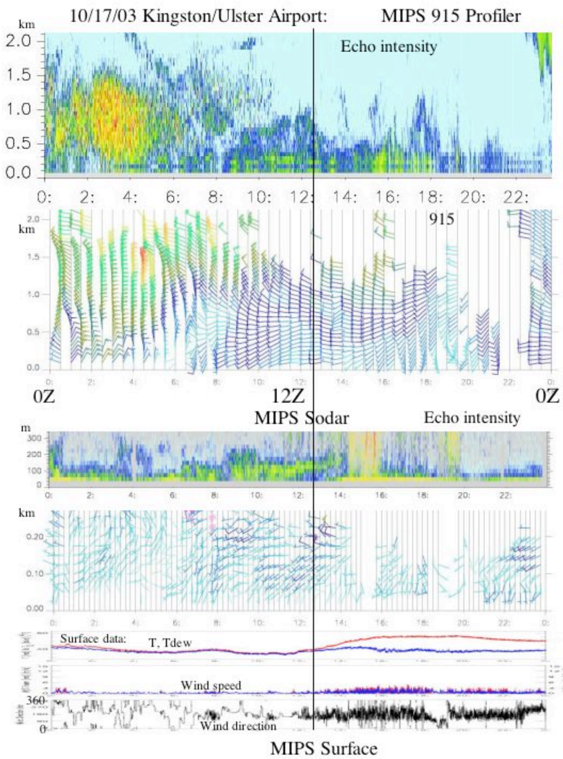

Fig. 5. Composite of data from MIPS at Kingston-Ulster airport, 10/17/03. Top: Signal/Noise ratio 915 profiler; Second: Profiler wind time-height section; Third: MIPS sodar echo intensity; Fourth: MIPS sodar wind time-height section; Fifth: Surface conditions: T, T_{dew}, wind speed, and wind direction. Continous vertical line indicates the time of the 'close approach' by the King Air (adapted from plots produced by Simon Paech and Justin Walters, Univ. of Alabama, Huntsville.)

lower pressure to the north (FL89, Gross and Wipperman, 1987; Kalthoff and Vogel, 1992). In continuing work, we aim to quantify the pressure gradients that drive this nocturnal jet and examine the record from the ISSF and ASRC flux stations in search of breakdowns of the nocturnal stable layer. A special effort is under way to study changes in the ozone concentration at various surface stations during the nocturnal period.

5. Acknowledgments:

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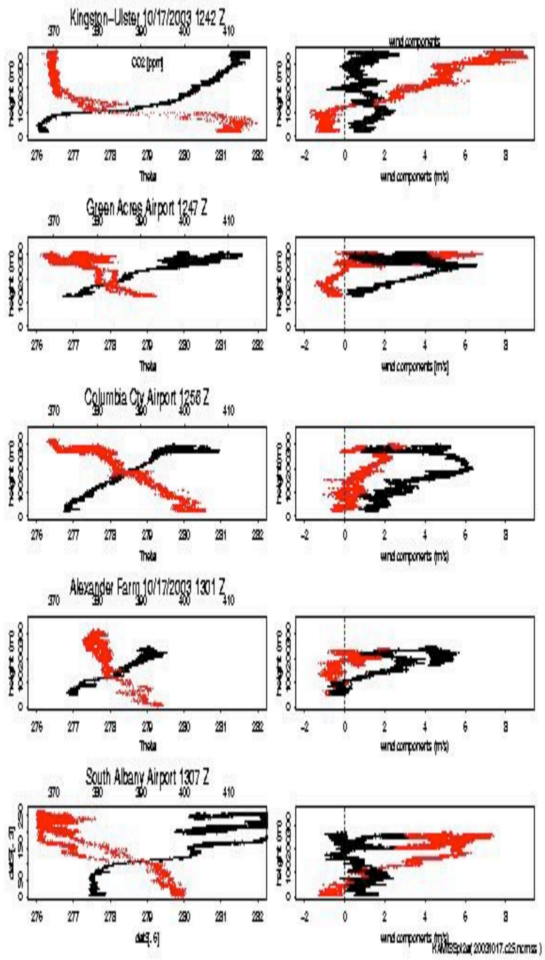

Figure 4: King Air 'close approach' soundings at five small airports, October 17, 2003. From top to bottom: Kingston-Ulster (KA) 12:47Z, Green Acres (4) 12:56Z, Columbia County airport (1B1) 12:56Z, Alexander Farm (1) 13:01Z, and South Albany airport (8) 13:07Z. Left panels: Potential temperature (K, black, bottom scale) and CO_2 concentration (ppm, red, top scale). Right panels: Along-valley wind component (black) and cross-valley wind component (red).

5. References:

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