Components and capabilities of the UAH Mobile Integrated Profiling System (MIPS)

The MIPS is a mobile (e.g., setup time ~5 min) profiling system with the following components and capabilities:

a) *Radian* 915 MHz 5-beam Doppler profiling radar (samples from ~120 m through the depth of precipitating systems, or 3-4 km in "clear tropical" air) – collects Doppler spectra, calculates the spectrum moments (vertical particle motion W, return power or reflectivity factor Z, and spectral width σ_v), determines wind profiles at 1-60 min intervals, acquires vertically-pointing data at 40-60 s time resolution (every other beam is vertical) and 60, 105 or 210 m vertical resolution;

b) *Radian* 2 kHz Doppler sodar (50 m to 200-500 m AGL) – determines wind profiles (15 min), w and backscatter power (proportional to C_T^2) at 20 s time resolution and 25 m vertical resolution;

c) Radio Acoustic Sounding System (RASS) – using the sodar as the acoustic source, the profile of T_v can be determined from ~120 m to 0.5-1.5 km AGL, dependent on water vapor content, wind speed and turbulence.

d) *Vaisalla* 0.906 μm lidar ceilometer – determines cloud base and provides a good estimate of the lidar backscatter (or extinction coefficient) from aerosols, clouds and precipitation.

e) *Radiometrics* 12-channel microwave radiometer – measures profiles of T, water vapor, cloud water, and column integrated values of water vapor and cloud water, at 10 min intervals up to 10 km, with highest vertical resolution at low levels. This system also includes an infrared pyranometer which measures cloud base temperature.

f) Zenith cloud imaging system (in progress) -- This will consist of an upward directed, computer controlled, digital camera system that will provide visible images of the sky (~40 deg field of view) at user-selected intervals.

g) surface instrumentation – T, relative humidity, wind (uvw anemometer or wind vane) pressure, solar radiation, and rainfall rate, all at 1-s resolution. An improved aspiration system designed for rainy high-wind conditions has been designed for accurate measurements of T and RH.

Measured variables and derived products:

- Wind profile, 1-60 min averages to 2-4 km altitude (915 MHz profiler and sodar)
- Vertical motion, 60 s time resolution, to 2-4 km altitude (915 MHz profiler and sodar)
- Refractive index structure function, C_n^2 (915 MHz profiler)
- Temperature structure function (C_T^2) estimate (sodar)
- Cloud base height at 15 s resolution, to 7.5 km altitude (lidar ceilometer)
- Vertical profile of aerosol backscatter (lidar ceilometer)
- Cloud base temperature to –60 K (infrared pyranometer, part of 12-channel microwave radiometer)
- Temperature profile to 10 km altitude (12-channel microwave radiometer)
- Water vapor density profile to 10 km altitude (12-channel microwave radiometer)
- Cloud water profile (12-channel microwave radiometer)
- Vertically integrated water vapor and cloud water (12-channel microwave radiometer)
- Cloud coverage fraction, classification and structure (zenith cloud imaging system + ceilometer)

- Surface meteorology at 1 Hz: T, RH, p, wind (10 m), rainfall, total solar radiation (direct + diffuse can also be measured)

Other derived parameters & phenomena:

- CAPE (utilizing other sources of upper tropospheric T, such as from model or GOES)
- CIN
- Sharp inversions (from 915 backscatter)
- Boundary layer depth
- Boundary layer turbulence (e.g., σ_w)
- Gravity waves
- Density currents / gust fronts (example)

Future additions under consideration:

Sonic anemometer (3-D): fluxes of momentum and T_v

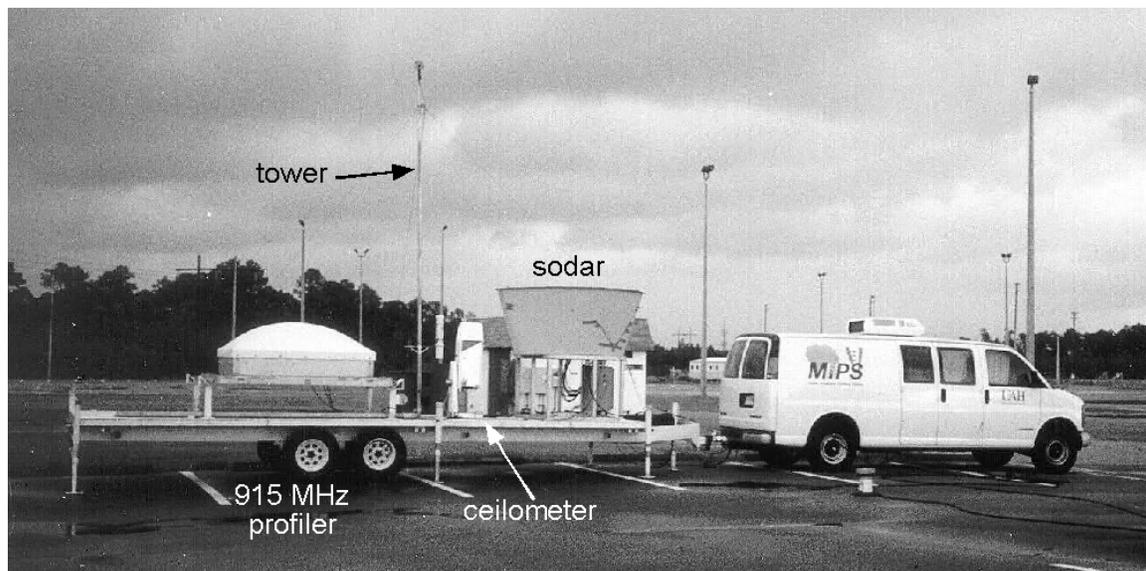Fast response T or RH sensor (fluxes of T, water vapor)

Fig. 1. MIPS components with the exception of the 12-channel microwave radiometer. This is the "mobile mode" in which clutter panels are not used. Set-up time is about 5 min.

Example measurements of a relatively vigorous gust frontal passage are shown below. These include only 915 MHz profiler and surface measurements. The return power (Fig. 2a) shows layers of enhanced return, presumably from stable layers. Note that the ABL top appears to be pushed upwards as the gust front moves over the MIPS. The vertical motion pattern consists of the leading and trailing updrafts, with a vigorous downdraft (defining the downward branch of a rotor circulation) in between. Peak updraft (30 s average) is 7 m/s, and peak downdraft is 9 m/s (the scales on the right are incorrect). Oscillations in w are apparent behind the gust front, and weak subsidence exists well in advance of the gust front. Rainfall arrived at the site about 30 min after the gust frontal passage. The surface measurements (Fig. 3) also show some interesting behavior, including (a) the pressure rise well in advance of the gust front, and (b) the lag in temperature fall behind the gust front wind shift, and (c) the weak subsidence (10's of cm/s) well in advance of the gust front.
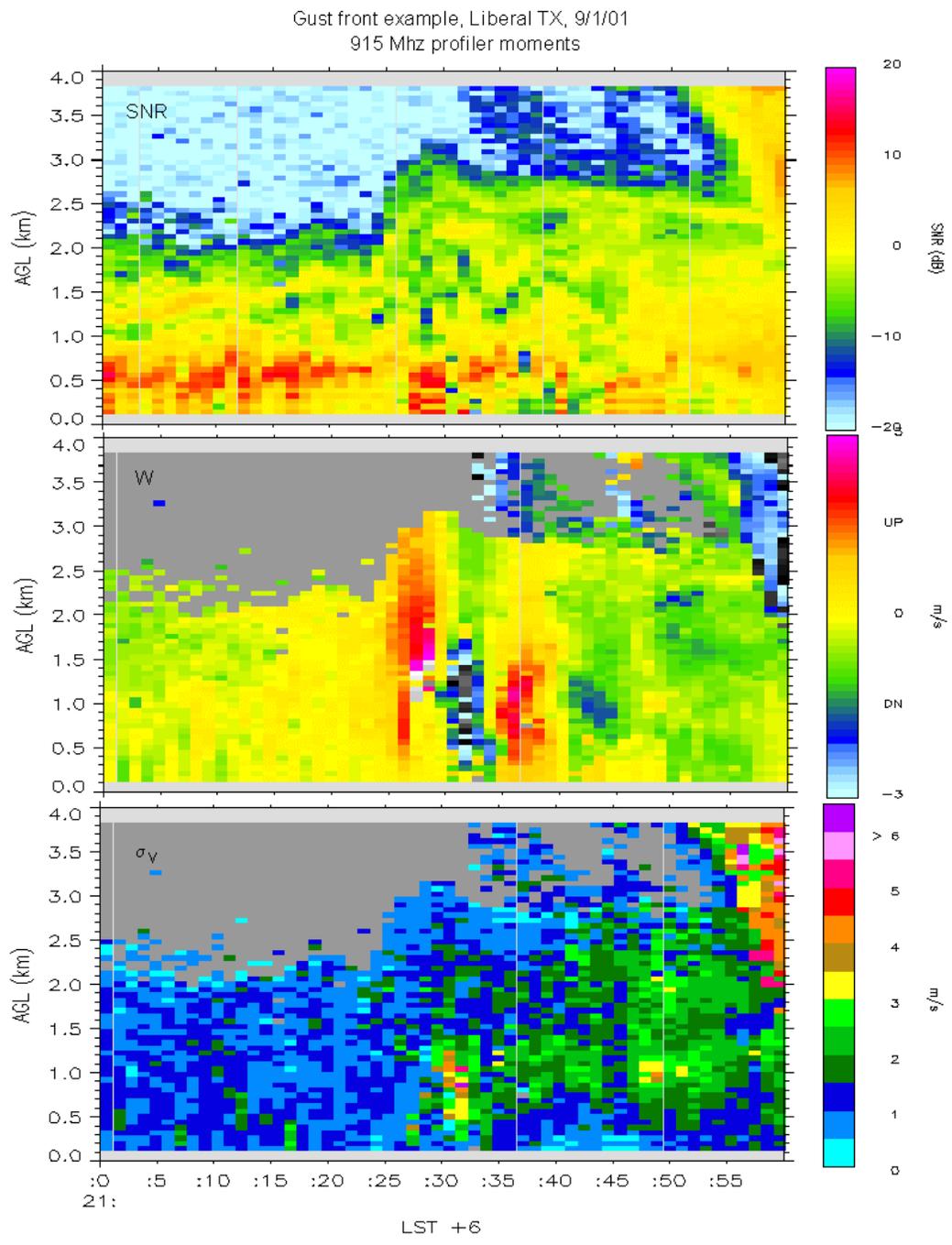
Figure 2. 915 MHz profiler moments for a gust frontal passage near Liberal, TX on 9/1/00. Additional information is provided in Fig. 3.
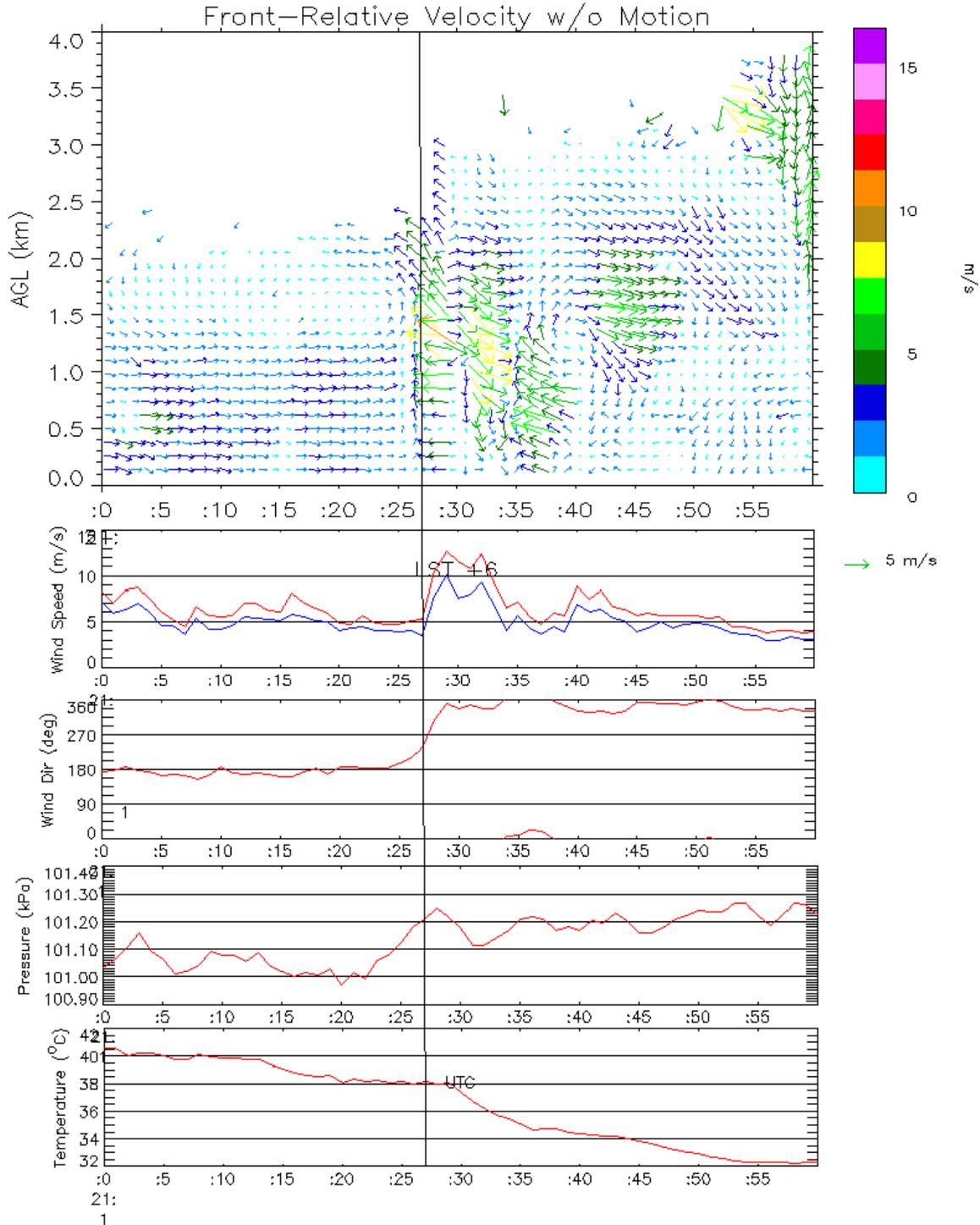
Figure 3. Analysis of wind vectors in the a time vs. height plane. Gust front movement was towards the south, so increasing time is towards the north in a time-to-space conversion. This analysis incorporates no averaging of radial winds along each beam to highlight the fine scale features of the gust front circulation. Surface parameters are shown in the bottom panels.