Chapter 3.

Estimates of Melting-Level Height from WSR-88D and Vertically-Pointing Radar

In mountainous areas, real-time estimates of the melting level are important in discriminating between areas where surface precipitation is liquid and can immediately form runoff, and where it is frozen. Radar observations, which are affected in various ways by precipitation phase, could be used to augment estimates from radiosonde and automated surface station, as shown here.

A comparison was made between the melting level indicated by a Doppler profiling radar located near Astoria, Oregon (White et al. 2002) and Vertical Profile of Reflectivity (VPR) output from the RCA and CSSA algorithms using WSR-88D observations from the Portland, Oregon unit (KRTX). The melting level from the RCA was determined from the height of the highest reflectivity indicated by the true VPR at each volume scan. The melting level from the profiler was determined based on the vertical distribution of signal-to-noise ratio and vertical velocity.

In theory the melting level observed by the profiler and the radar is slightly lower than the height of the 0° C isotherm because it takes some time for snowflakes to start melting, and hence become more reflective, as they fall through the freezing level. This effect was obviously visible in both the profiler and WSR-88D data and consistent between the two data in our comparison.

A set of time-height plots show that the melting levels correspond reasonably well between the RCA output and the profiler observations. In each set, melting-level estimates are plotted on backgrounds of signal-to-noise ratio (SNR, top panel), and vertical velocity (lower panel). The melting level is indicated by a maximum in the SNR profile, and a steep gradient in the vertical velocity profile, where snowflakes begin to melt and fall more rapidly.

Three cases were used to assess RCA’s skill in estimating the melting level. They were January 23, 2004 from 0000 UTC to 1800 UTC (Fig. 1), January 28, 2004 from 0600 UTC to January 29, 2004 0000 UTC (Fig. 2), and March 25, 2004 from 1200 UTC to March 26, 2004 0000 UTC (Fig. 3). Profiler estimates (circles) were made only when precipitation was indicated over the profiler site. WSR-88D estimates (crosses) could be made only when there was sufficient precipitation coverage within the KRTX umbrella. The height of the freezing level interpolated from the upper air data was slightly higher than the bright band heights, as anticipated.

Direct comparison of the two sets of melting-level height estimates is complicated by factors such as temperature profile differences between the Astoria site and the center of the KRTX umbrella volume, which are about 86 km apart. Also, the RCA-estimated brightband height is based on all samples within the radar’s scanning domain whereas the profiler-estimated height of the melting layer is point-specific. As such, the comparison is subject to significant spatial variability. Also, because we are modeling the mean VPR using only about 14 to 16 fixed layers, the vertical resolution for the true profile is rather coarse. Thus within any one time sequence there were some significant differences between the profiler and WSR-88D traces.

However, both radars clearly indicated the same general magnitude and time trends in the melting-level height. Within the data sample as a whole, consisting of 37 hourly estimates, there was a fairly high linear correlation (R^2 of 0.90) between the two sets of estimates. A plot of WSR-88D vs. profiler estimates, for all cases combined, is shown in Fig. 4.

The experience described above suggests that a more useful comparison of profiler-estimated height of the melting layer is not with the RCA-estimated brightband height (whose resolution suffers from the fixed and limited number of layers), but with vertically-smoothed raw reflectivity profiles. The time-height representation of such profiles might be considered a part of the RCA product suite that, in an operational setting, can be augmented wherever and whenever available by profiler observations. The above observations also suggest limiting the sampling domain of WSR-88D data-based estimation of brightband height to the profiler location and its vicinity so as to minimize the effects of spatial variability. Once the point-specific comparison of estimated freezing level is established between the WSR-88D and profiler data, the effects of spatial variability may be assessed by comparing the point-specific freezing level estimates from the WSR-88D with the radar umbrella-wide estimate.

Acknowledgements

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Reference

White, A. B., D. J. Gottas, E. T. Strem, F. M. Ralph, and P. J. Neiman, 2002: An automated brightband height detection algorithm for use with Doppler radar spectral moments. *J. Atmos. Ocean. Tech.*, **19**, 687-697.

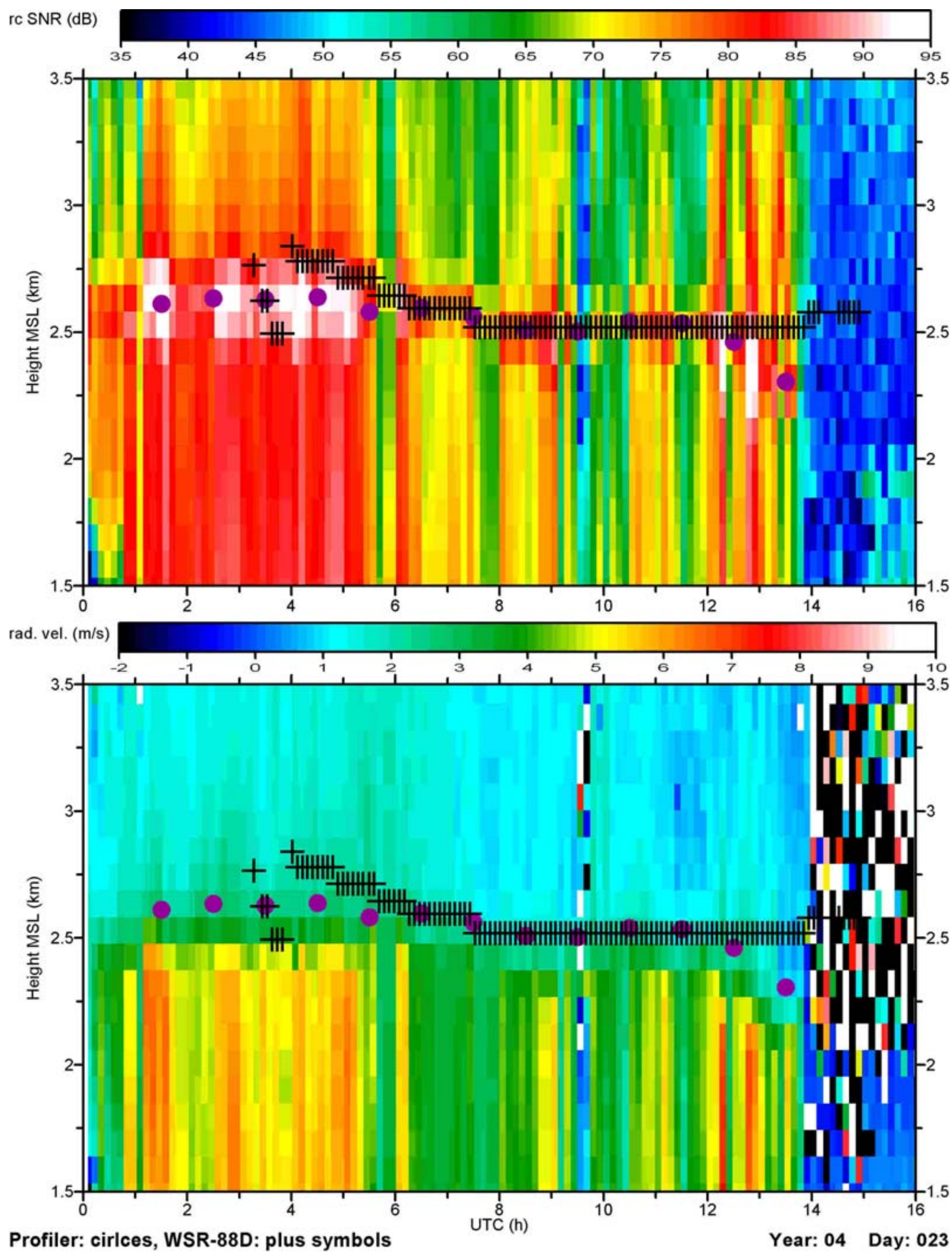

Figure 1. Radar estimates of melting level height from Doppler profiler (circles) and WSR-88D range correction algorithm (crosses), 23 January 2004. Estimates are from Astoria OR profiler and Portland OR WSR-88D. Background of top panel is profiler signal-to-noise ratio, background of lower panel is vertical velocity.

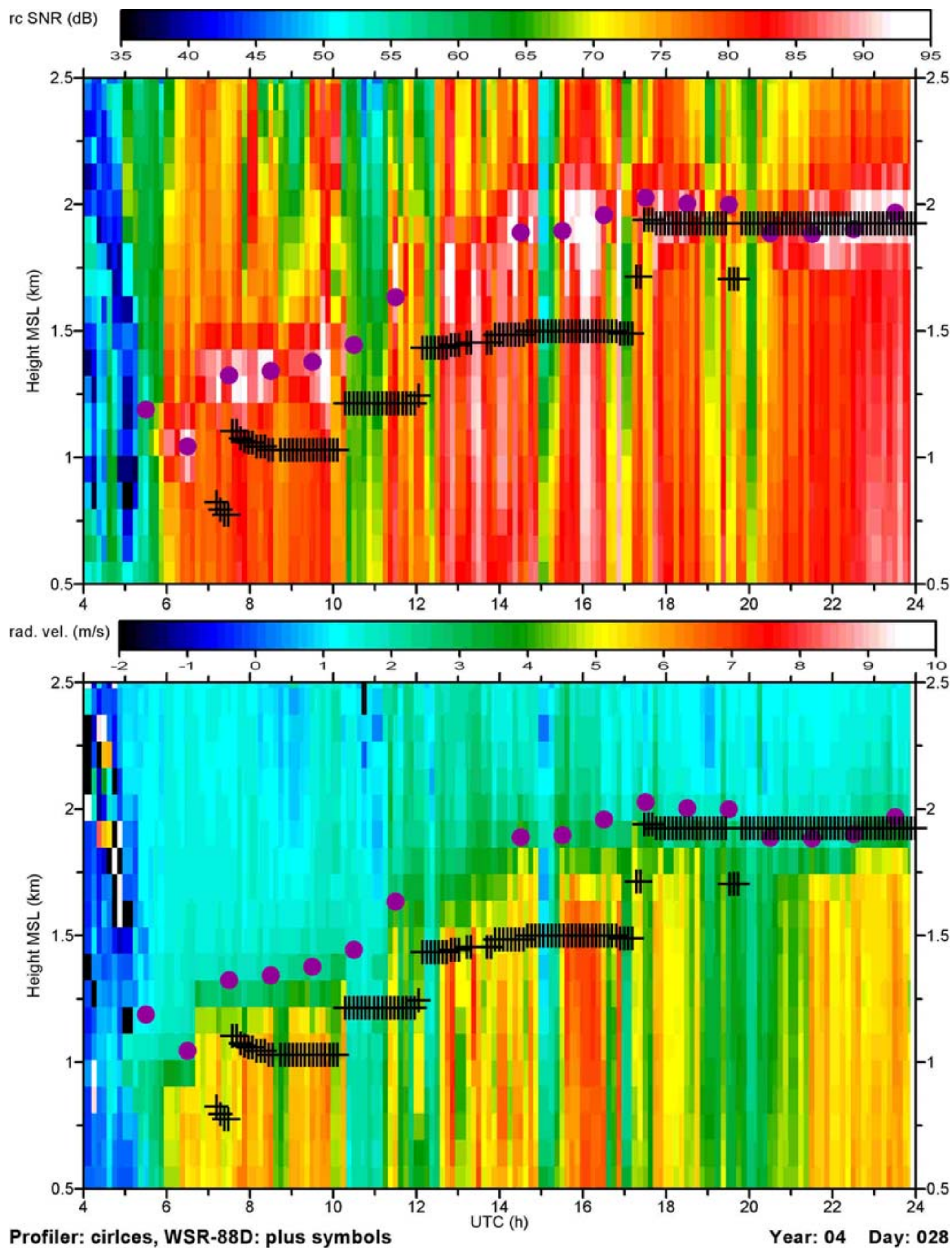

Figure 2. As in Fig. 1, except for 28-29 January 2004**.**

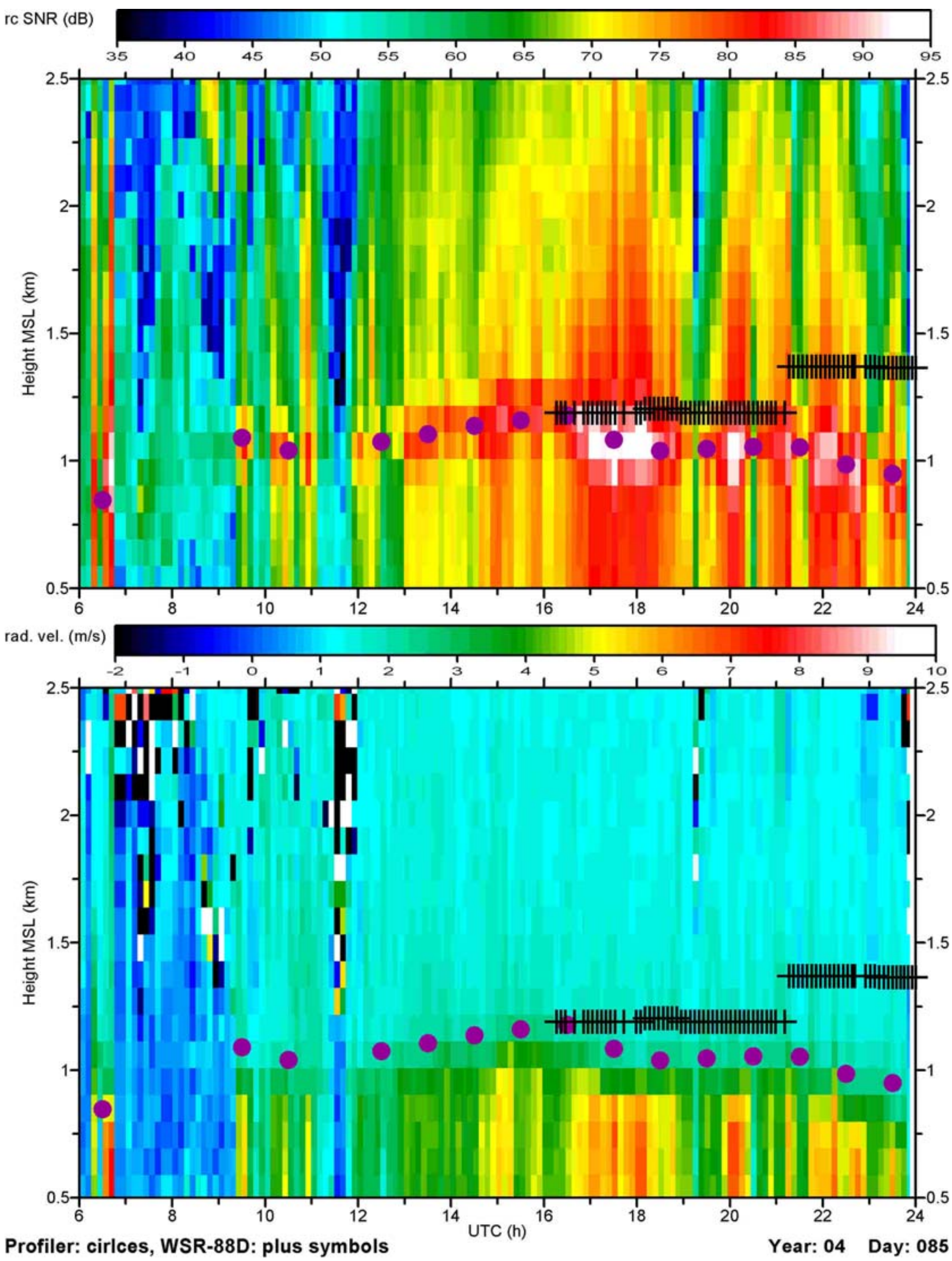

Figure 3. As in Fig. 1 except for 25-26 March 2004.

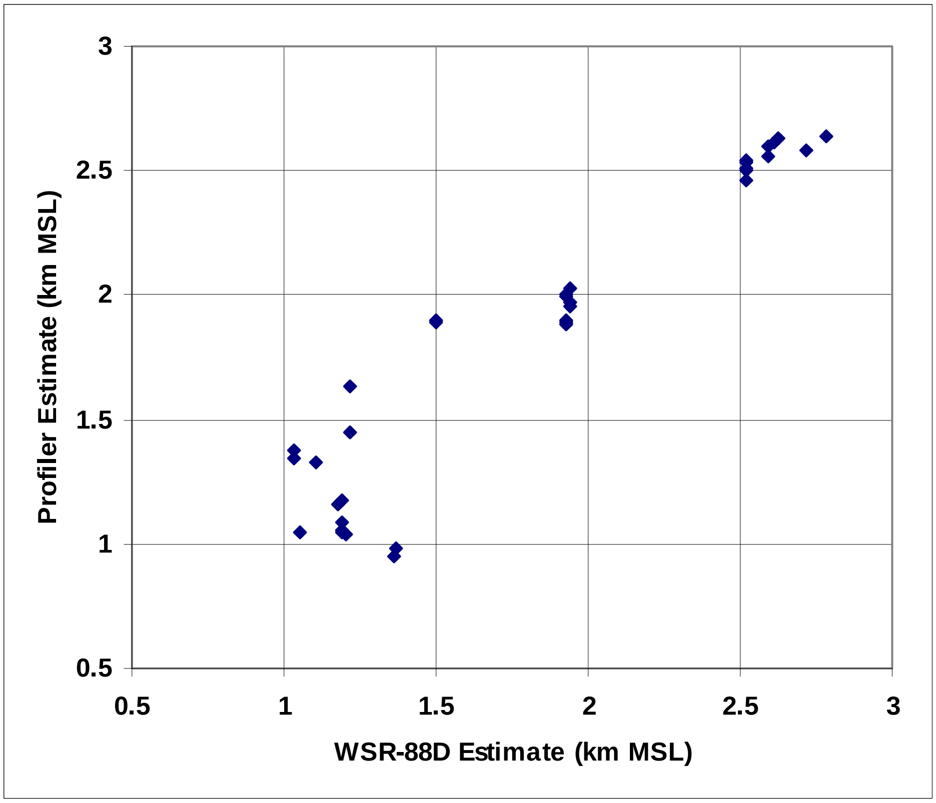

Figure 4. Profiler estimates of melting-level height (ordinate) vs. WSR-88D estimates (abscissa) for the three cases described.