P5B.6 NEGATIVE SCANNING FROM A HIGH ELEVATION RADAR: OPERATIONAL EXAMPLES

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1. INTRODUCTION

Mountainous terrain provides particularly challenging circumstances for weather radars. Radar scans are severely blocked at valley bottom locations and commonly overshoot important low-elevation phenomena for mountaintop locations. For one mountaintop radar in southern British Columbia the operational scanning strategy includes a Doppler scan taken at negative elevation angles. In this presentation the advantages of negative scanning are demonstrated for detecting lower valley phenomena. Operational examples include winter stratus/snow, low valley virga, and gust front propagation from thunderstorms.

2. DATA SOURCES

Radar data are obtained from a C-band unit located atop Mt. Silver Star in southern British Columbia, Canada (Figure 1). The radar is located at 50°22'N., 119°04'W., and an elevation of 1880 m, and is part of the Meteorological Service of Canada's network (Joe and Lapczak, 2002). Doppler scans are taken during a 10-minute cycle, at elevation angles of -0.5°, 1.5°, and 3.5°, a maximum range of 112 km, a range resolution of 0.5 km, and an angular resolution of 0.5°. For each scan, uncorrected and corrected reflectivities are recorded as well as radial velocities. For the rest of the cycle a series of 24 scans with elevation angles between 0.0° and 24° are obtained with maximum range of 256 km but only uncorrected reflectivity are recorded. Effective beam width is 1.1°.

The lowest elevation angle Doppler scan of –0.5° corresponds to the lowest observable local application angle (LOLAA). This elevation angle is determined using an analysis of a digital elevation model for the surrounding terrain. The LOLAA is intended to see low-level precipitation in the area of greatest interest. For the Silver Star Radar this is the populated Okanagan Valley, which extends north-south 20 km to the west. The center of the beam is set at the radar horizon. A slant range-height diagram for the LOLAA is given in Figure 2. For a –0.5° elevation angle the center of the beam drops about 300 m relative to the radar at a range of 75 km. The apparent rise of the beam at longer ranges is due to the curvature of the earth.

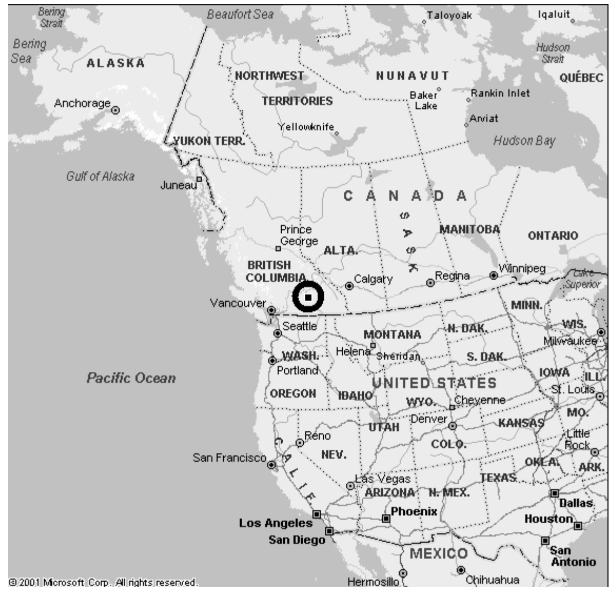

Figure 1A: Location of Mt. Silver Star radar relative to North America.

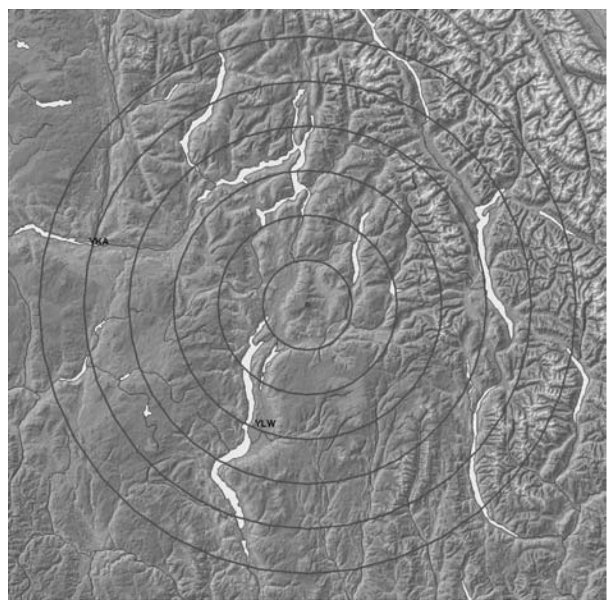

Figure 1B: Terrain surrounding the Mt. Silver Star radar. Range rings are at 20 km intervals.

Radar data are operationally processed and analyzed using the Unified Radar Processing software (URP; see www.msc-smc.ec.gc.ca/projects/nrp/Samples_e.cfm for sample products).

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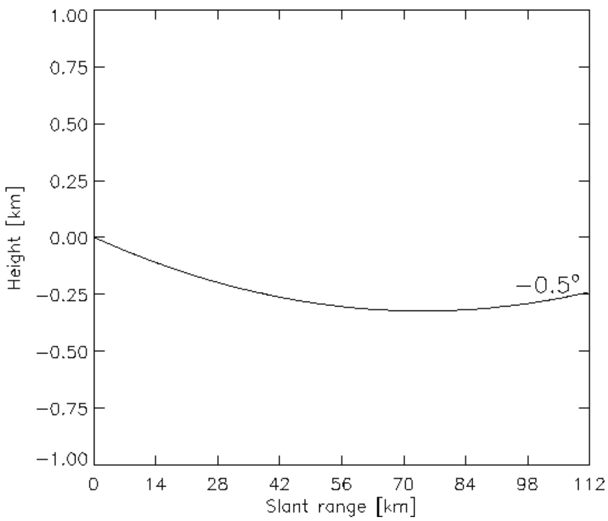

Figure 2: Slant-range height diagram for an elevation angle of –0.5°.

3. RESULTS

3.1 Winter stratus/snow of 13 January 2003

On this day the area was located under an upper ridge of high pressure with weak winds. Visible satellite pictures revealed low clouds covering the Okanagan Valley but not the nearby ridges and mountaintops. The Kelowna Airport (YLW), located 50 km south-southwest of the radar, reported very light northerly winds and light snow in the morning hours between 1700-1800Z. Figure 3 shows the LOLAA radial velocities for 1600Z. Echoes with weak away velocities are seen over Okanagan Lake north of Kelowna. It appears that nighttime radiative cooling over the mountaintops, where skies were clear, yielded cold air drainage flows that converged over the relatively warm lake waters. it is hypothesized that sufficient convergence and moisture input allowed boundary-layer flurries to develop that drifted south in the light northerly flow at valley bottom. Radar echoes were detected in the period 1500-1700Z; that is they largely dissipated at beam height before the snow particles reached the valley bottom. With an estimate of snow particle fall speeds and the height of the LOLAA scan known it would be possible to anticipate when the snow reaches valley stations. Importantly, this low-level precipitation event was not detected at all by any of the higher elevation angle scans, even at 0.0°.

3.2 Low valley virga of 25 May 2003

Strong unidirectional shear and an unstable air mass resulted in training convection occurring over southern BC. Figure 4 shows a Doppler reflectivity PPI taken at 2300Z for an elevation angle of 1.5° and Figure 5 is for the LOLAA scan. Note that precipitation which has drifted over the southern Okanagan Valley (Figure 4) has largely evaporated before it reaches the valley bottom (Figure 5). Showers were observed over the ridges southeast of the Kelowna Airport at that time, but not at the airport itself until 0100Z on 26 May. Other products based on higher elevation angle scans also suggested a more continuous precipitation event. The LOLAA scan better discriminated between valley bottom precipitation and virga.

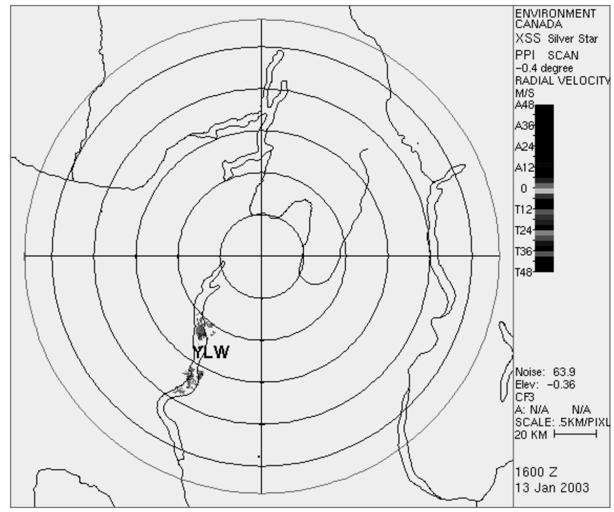

Figure 3: LOLAA radial velocities from the Silver Star Radar at 1600Z, 13 January 2003.

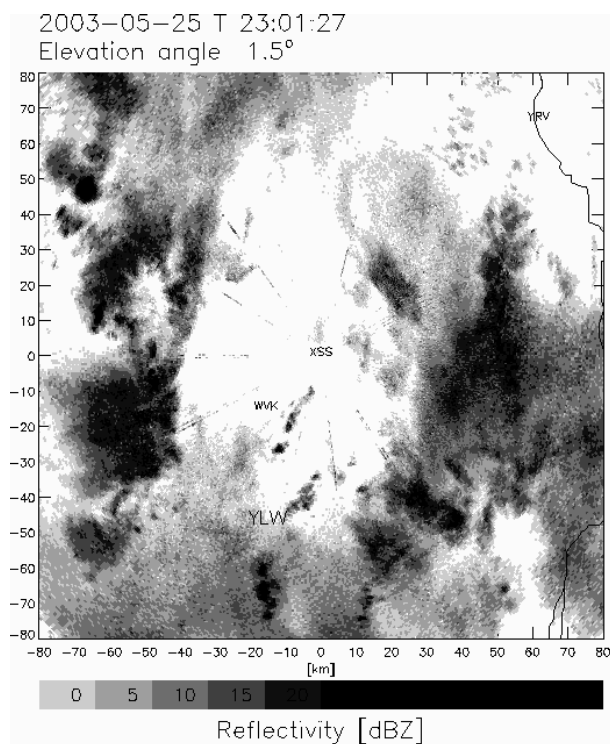

Figure 4: Doppler reflectivity PPI taken at elevation angle 1.5°.

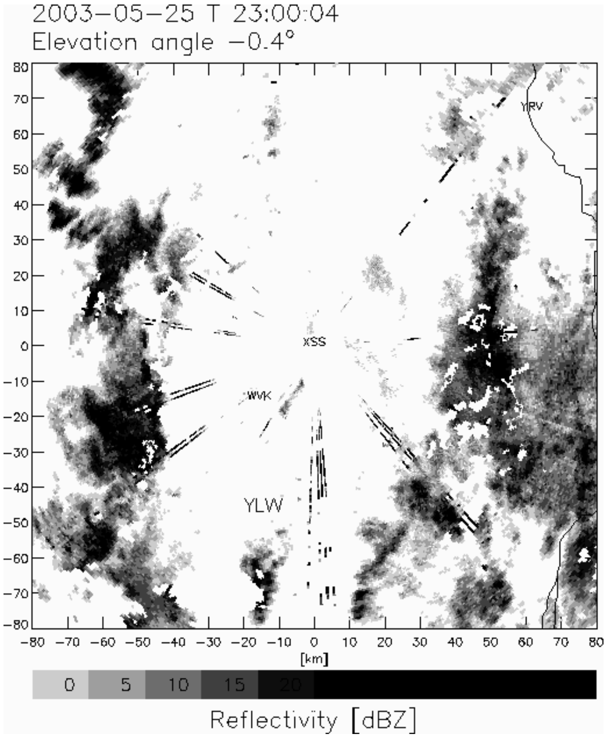

Figure 5: Doppler reflectivity LOLAA PPI.

3.3 Gust front from thunderstorm of 9 June 2003

Summer severe weather occurred northwest of Mt. Silver Star Radar during the late afternoon of 9 June 2003. A gust front emanating from a thunderstorm went through Kamloops (YKA), 100 km west-northwest of the radar, at 0011Z on 10 June with maximum wind gusts to 80 km/h causing minor damage. Figure 6 displays LOLAA radial velocities for 0130Z on 10 June. The gust front that affected Kamloops earlier has been detected 50 km northwest of the radar according to an algorithm that searches for contiguous areas of convergent radial shear (Joe et al., 1995). Another detection algorithm (Joe et al., 1995) identifies microbursts by searching for areas with strong divergent radial shear in the LOLAA radial velocity scan. Three such areas have been detected for the scan taken at 0140Z on 10 June, and these are indicated in Figure 7.

4. SUMMARY

Negative scanning from a mountaintop radar has shown promise in diagnosing various phenomena for adjacent valleys. Reflectivity fields indicate the presence of low-level precipitation processes or, conversely, the occurrence of virga. Radial velocity fields help detect low-level convective processes that are likely to be missed by higher scanning angles. The Mt. Silver Star radar commenced operations in October 2002, and future work will consider more cases with low-level mesoscale features.

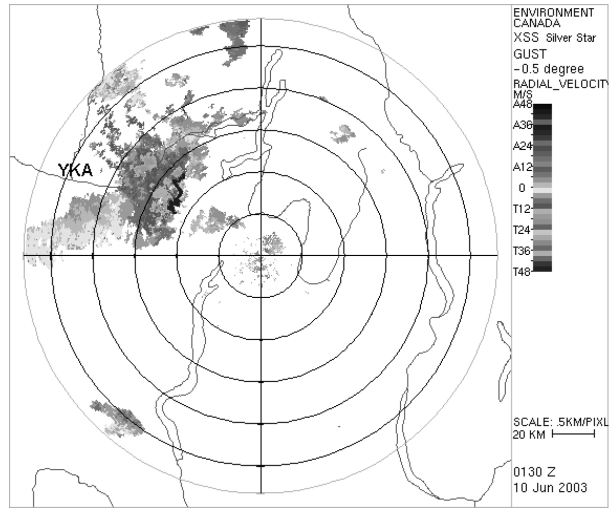

Figure 6: Radial velocities from the LOLAA scan at 0130Z 10 June with a gust front diagnosed 50 km northwest of the radar.

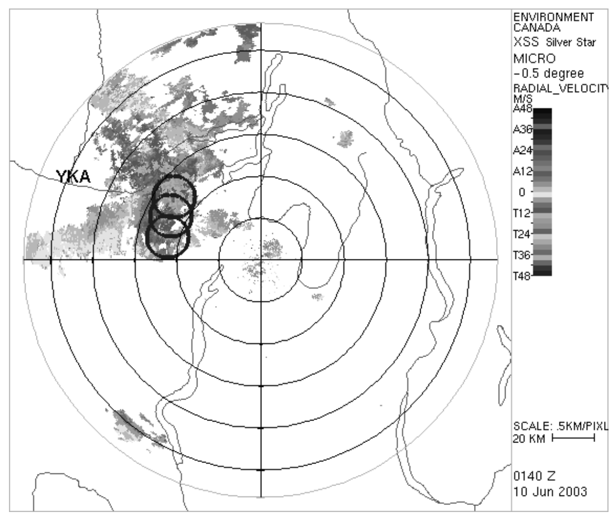

Figure 7: Radial velocities from the LOLAA scan at 0140Z 10 June with the microburst detection algorithm circling three areas 50 km west-northwest of the radar.

5. REFERENCES

Joe, P., C. Crozier, N. Donaldson, D. Etkin, E. Brun, S. Clodman, J. Abraham, S. Siok, H.-P. Biron, M. Leduc, P. Chadwick, S. Knott, J. Archibald, G. Vickers, S. Blackwell, R. Drouillard, A. Whitman, H. Brooks, N. Kouwen, R. Verret, G. Fournier, and B. Kochtubajda, ‘Recent progress in the operational forecasting of summer severe weather’, *Atmos.-Ocean*, **33**, 249-302.

Joe, P., and S. Lapczak, 2002: Evolution of the Canadian operational radar network. ERAD Publication Series, Vol. 1, ISBN 3-936586-04-7, 370-382.