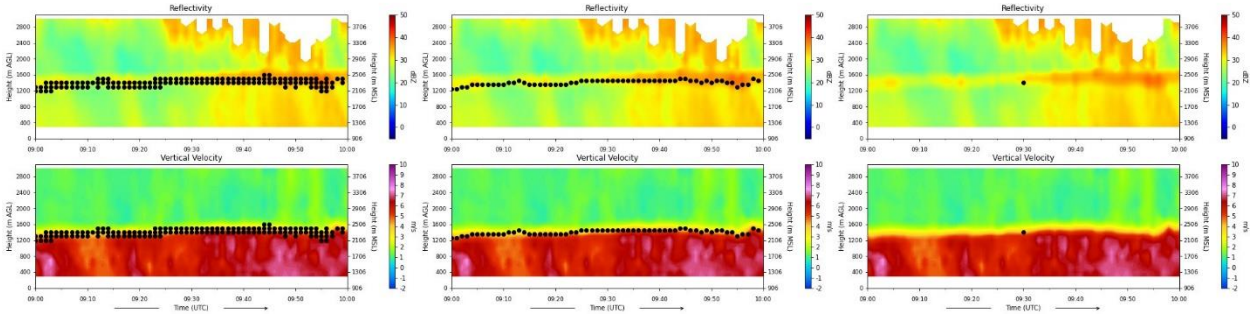
CW3E MRR Bright Band Detection Algorithm

Peter Yao, Anna Wilson
Center for Western Weather and Water Extremes (CW3E)
Scripps Institution of Oceanography, UC San Diego
1 July 2025

Data from the Micro Rain Radars (MRRs) deployed by CW3E are processed using an algorithm based on Maahn and Kollias 2012 but modified to improve the representation of heavy rain. The bright band detection algorithm then determines the bright band height, if present, at hourly and 15-minute resolutions. The algorithm is based on methods from White et al., 2002 and Massman et al., 2017 and outlined briefly here. First, vertical gradients of reflectivity are calculated at each time step (one-minute resolution), where a positive gradient means that values increase as height increases. Then, the algorithm identifies the band of heights where the reflectivity gradient is positive and exceeding a specified threshold and the vertical velocity gradient is negative and below a threshold (leftmost panel in the figure shown below). This horizontal band corresponds to the bottom of the melting layer below the height of peak reflectivity, where the reflectivity drops and vertical velocity increases moving downward as snow transitions to rain (see Figure 2 in White et al., 2002).

This is the same approach described in White et al., 2002, but with thresholds tuned to the MRR. The next step in their method is to identify the height of peak reflectivity within a certain height above this region; however, prior work has shown that the MRR does not display a well-defined local maxima in reflectivity within the melting layer compared to the NOAA FMCW or SPROF radars (Massman et al., 2017). Thus, the approach for the CW3E MRRs has been modified here: after identifying all heights meeting the above criteria, the median of those heights is found at each time step (middle panel). Then, if at least 50% of time steps within each averaging interval (either hourly or 15-minute) meets the previous criteria, the median of the identified heights within the interval becomes the bright band height (rightmost panel). Finally, basic QC checks are performed to filter out erroneously high or low values.

The algorithm has been improved (Yao et al., 2024) with the addition of the 15-minute resolution data and updated thresholds obtained by comparing co-located MRR and SPROF radars placed in Cazadero, CA, located in the coastal mountains north of San Francisco, from December 2014 to March 2015 as part of the Chilean Coastal Orographic Precipitation Experiment. In the future, we hope to further assess the accuracy of the detection algorithm by co-locating an MRR with a NOAA FMCW or SPROF radar to create a comparison dataset over a longer period.



Left: identifying all heights meeting reflectivity and vertical velocity gradient thresholds at all time steps, middle: finding the median height of identified heights at each time step, right: if at least 50% of time steps have an identified height, find the median height across all time steps.

Data is available on the CW3E datashare website. Processed 5-min resolution MRR data is available in netCDF format, and bright band height values are provided in CSV format, in both hourly and 15-minute resolutions. Figures are available as daily plots and 2-day versions that include tables of the snow level.