**Introduction**

The cloud and precipitation in the Tibet plateau has special microphysics characteristics that attract research attentions from global meteorological community. Weather radars in Tibet plateau play an increasingly important role in the microphysics and dynamic observation of cloud and precipitation. The existence of bright-band in radar echoes limits the performance of quantitative precipitation estimation (QPE), especially in high altitude area with complex terrain where melting layer is lower and occurrence of beam blockage happens heavily. In order to reduce the influence of the bright-band on the precipitation estimation, it is necessary to identify and correct the bright-band. This paper mainly analyze melting layer characteristics observed with the C-Chaid Chinese New Generation Weather Radar (CINRAD-CD) and Ka-band all solid-state vertical profile radar in Nyingchi during the third Tibet Plateau atmosphere science field campaigns in 2015.

**Research Instruments**

The cloud and precipitation in the Tibet plateau has special microphysics characteristics that attract research attentions from global meteorological community. Weather radars in Tibet plateau play an increasingly important role in the microphysics and dynamic observation of cloud and precipitation. The existence of bright-band in radar echoes limits the performance of quantitative precipitation estimation (QPE), especially in high altitude area with complex terrain where melting layer is lower and occurrence of beam blockage happens heavily. In order to reduce the influence of the bright-band on the precipitation estimation, it is necessary to identify and correct the bright-band. This paper mainly analyze melting layer characteristics observed with the C-Chaid Chinese New Generation Weather Radar (CINRAD-CD) and Ka-band all solid-state vertical profile radar in Nyingchi during the third Tibet Plateau atmosphere science field campaigns in 2015.

**Methods**

The principle of identifying bright-band

Different types and locations of precipitation correspond to different bright-band height. However, it usually appears in this height, below hundreds meters of O°C isotherm.

The figure 3 shows bright-band's conceptual model of average vertical profile of reflectivity. The concept of average reflectivity is, within the range of selected elevation and azimuth, the average value of all range bins' reflectivity except for invalid value:

- **Zmax**: represents the maximum of average reflectivity.
- **Zmax**: represents the height of **Zmax**.
- **Zini** represents the height of O°C isotherm (top height of bright-band).
- **Zini**: represents the bottom of bright-band.

Z(k) always decreases when it goes up to b or goes down to b along with the Zmax below hundreds meters of it.

**Identification algorithm of bright-band is as follows:**

1. **The calculating of Z(h) in the same height**

According to range bin’s height of reflectivity, the definition of height in every layer is as follows:

\[
H(h) = h - h_b \quad h = Z_{i,j,k} (1)
\]

In the formula, \(h\) is the number of layer of 100m. \(N\) is the layers of vertical direction. The maximum of \(N\) in this paper is 150 (this means the maximum detection range is 15km).

The definition of \(Z(h)\) is:

\[
Z(h) = \frac{\text{Z(in) } i,j,k}{Z(0)} = Z(0) \quad (2)
\]

- **Z(0)** is the average reflectivity at the h layer;
- **Z(in) i,j,k** is the value of reflectivity at h layer, where reflectivity is greater than a certain threshold \(Z_{\text{min}}\);
- **M** is the number at h where reflectivity is greater than threshold \(Z_{\text{min}}\);
- **N(h)** is the number of elevation layers including by volume scanning;
- **Z(h)_\text{n}\_\text{i,j,k}\_\text{0}** is the radial number including in one elevation;
- **Z(h)_\text{min}\_\text{i,j,k}\_\text{0}** is the number of range bin including in a radial. Calculate \(Z(h)_\text{n}\_\text{i,j,k}\_\text{0}\) by all 9 layers elevation (\(N(h)_\text{min}\_\text{i,j,k}\_\text{0}\)) of whole volume scanning and all reflectivity data of range bin at 360 radians (\(N(h)_\text{min}\_\text{i,j,k}\_\text{0}\)).

2. **Identification of bright-band**

Find out the height of \(Z(h)_\text{n}\_\text{i,j,k}\_\text{0}\) bins, the height of threshold \(T\) upward \(h_b\), and the height of threshold \(T\) downward \(h_b\), if meet the conditions in formula (3), then admit that there is bright-band.

\[
h - h_b > D_1 \quad h_b - h_{\text{min}} > D_2 \quad h_{\text{min}} - h_b > D_3 \quad (3)
\]

According to the analysis of precipitation progress in Nyingchi radar from Jul 2015 to Aug 2015, the identification results of bright-band can be better if these threshold are as follows: \(T_{\text{ini}} = 30^\circ\text{C}, T_{\text{ini}} = 30^\circ\text{C}, D_1 > 200^\circ\text{C}, D_3 = 1000^\circ\text{C}, D_3 = 1000^\circ\text{C}, D_3 = 1500^\circ\text{C}.

**Process design**

Firstly, identify the location of the bright-band by the CD radar and Ka band all solid-state weather radar data. Then, analyze the position of bright-band corresponding relationship with the height of O°C isotherm. The process of using CD radar to identify the bright-band is as follows: firstly, the reflectivity information is extracted from the volume scan data. Then, process of reflectivity data by vertical direction and draw the vertical profile of reflectivity according to the condition of the radar block. In particular, when data is blocked in some orientation, this orientation has no effective reflectivity. Consequently, the reflectivity at this position is not involved in calculating \(Z(h)_\text{n}\_\text{i,j,k}\_\text{0}\) at this height, that is to say, the \(Z(0)\) in the formula (3) only represents the reflectivity of none blockage position at a certain height. Finally, according to the judgment condition of (3) formula, obtain the information about bright-band (the bottom, top, peak, and fadings of bright-band) and draw it. Because Ka-band radar works in the scanning mode of vertical pointing, select the corresponding radial data at the same time and do the attenuation correction, and the position of bright-band can be identified according to the judgment condition from (3). The height of O°C layer corresponding to sounding data can be read from the file of sounding data.

**Results of identification and analysis**

According to the data of CD radar in Nyingchi on Aug 17, 2015, 13:10, select the 55th radial data of Ka-band radar at 13:10 on Aug 17, 2015 at the time of 12:30-13:30 to calculate the bright-band. The results are shown below:

**Conclusions**

Bright-band identification of the two kinds of radar are validated through temperature profile captured with radiosonde at the closest time in Nyingchi. Based on the observation data within a month, the following conclusions are drawn: (1)Two radars are able to consistently identify the bright-band (2)The mean height of peak reflectivity value in bright-band is from ten meters to several hundred meters lower than the height of O°C isotherm. (3)Differ from other low altitude areas, the bright-band peak height of Nyingchi is more closer to the height of O°C isotherm, and its thickness is smaller. (4)The vertical reflectivity factor is larger in the bright-band range.