Error Characterization and Validation of Atmospheric Motion Vectors Derived from the GOES-16 Advanced Baseline Imager (ABI)

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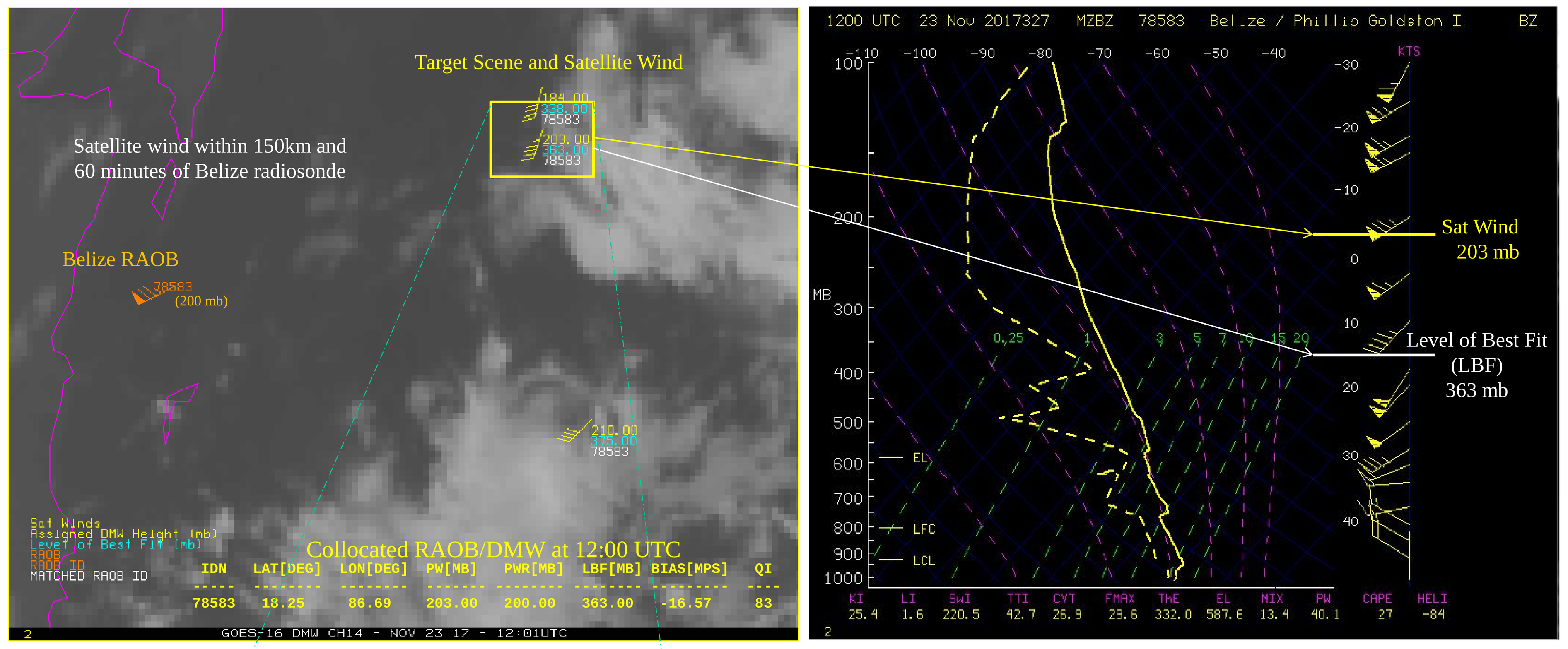
1. Introduction

Following the successful launch of the GOES-16 satellite on November 19, 2016, and subsequent Post-Launch Test (PLT) period, the ABI Level 1B products were declared provisionally operational on June 1, 2017. Throughout this PLT period, intense effort was and continues to be dedicated to validating and characterizing the performance and quality of the Derived Motion Winds (DMW) product. To that end, a number of validation and deep-dive analysis tools were developed to support this ongoing effort. More specifically, a stand-alone tool has been developed that permits deep-dive analysis of individual DMWs on a case by case basis. Another tool was developed that allows for interrogation of the DMW vs. Rawinsonde (RAOB) match verification database to identify outliers in quality. The combination of these tools and others has been and continues to be critical to understanding and characterizing errors associated with the derived winds. In depth results from the use of all the GOES-16 DMW validation and deep-dive tools are presented here.

2. Deep-Dive Case Study Analysis

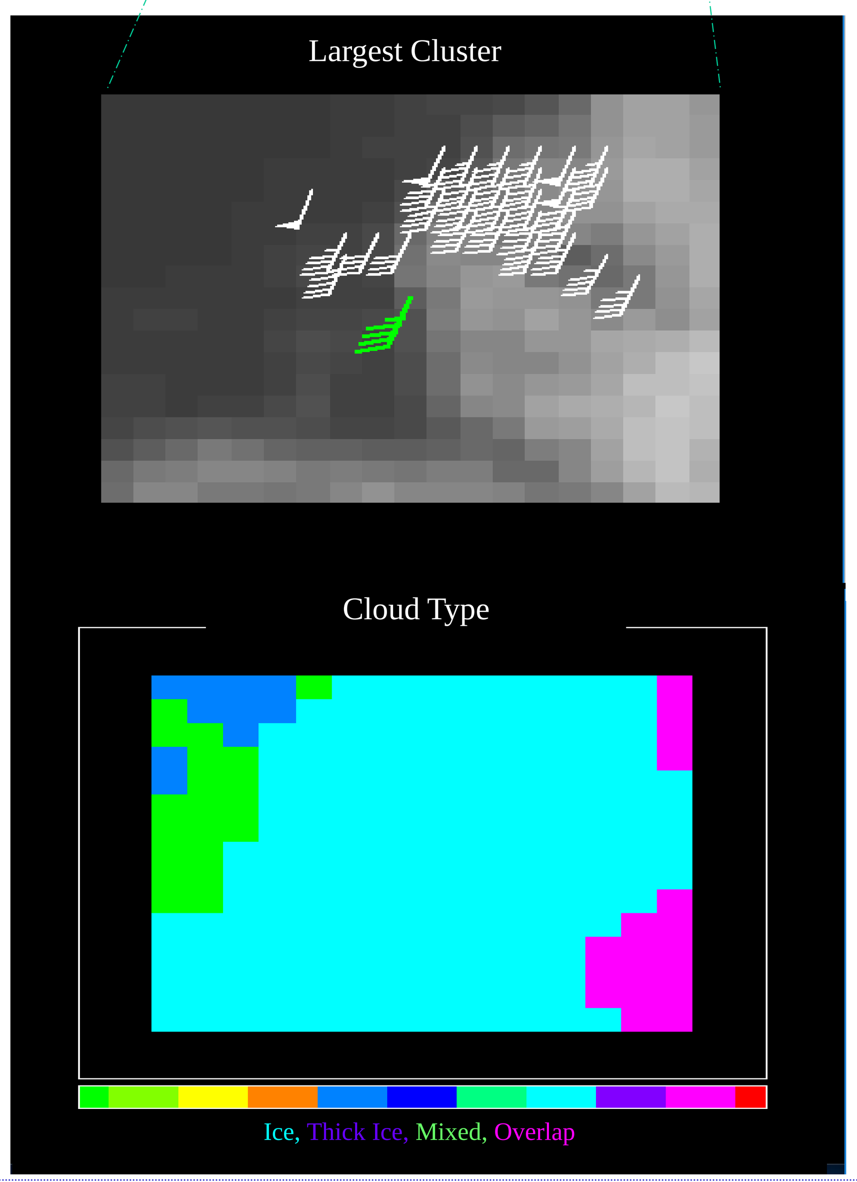
Deep-dive analysis tools, developed to both isolate outliers in the DMW vs. RAOB match verification database and evaluate detailed output from the two major components of the wind derivation process (height assignment and tracking), are utilized to better characterize DMW errors on a case by case basis. Coordination between the Winds and Cloud AWGs on these cases have led to a better understanding and improvement of overall DMW quality.

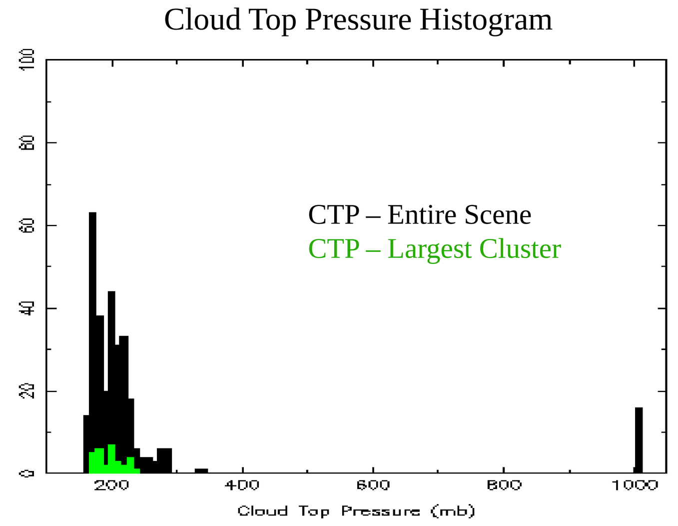
Case 1: Upper Level Slow Bias – Band 14 DMW

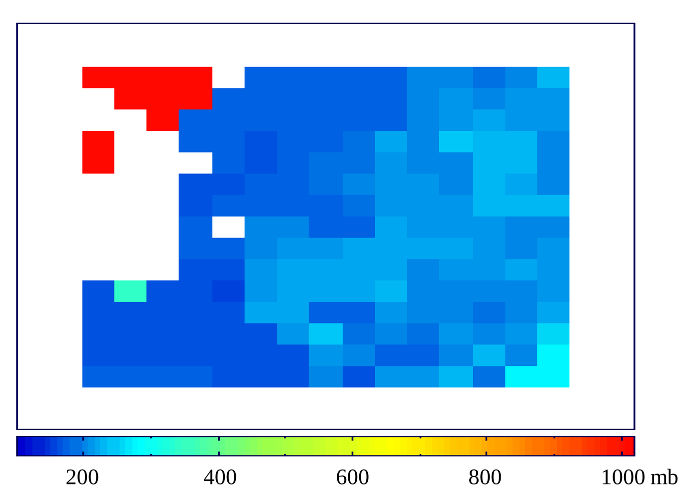


Target scene is composed primarily of a single layer cloud. Some pixels are low cloud, but these pixels are not part of the largest tracking cluster.

Retrieved cloud top pressures are around 200 mb which are too low (cloud heights too high) and not supported by the collocated Belize radiosonde observations.







2. Deep-Dive Case Study Analysis (cont.)

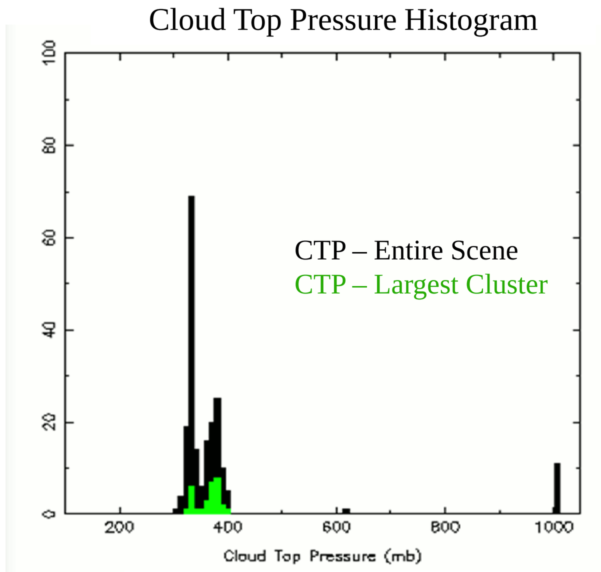
Case 1: Upper Level Slow Bias – Band 14 DMW (cont.)

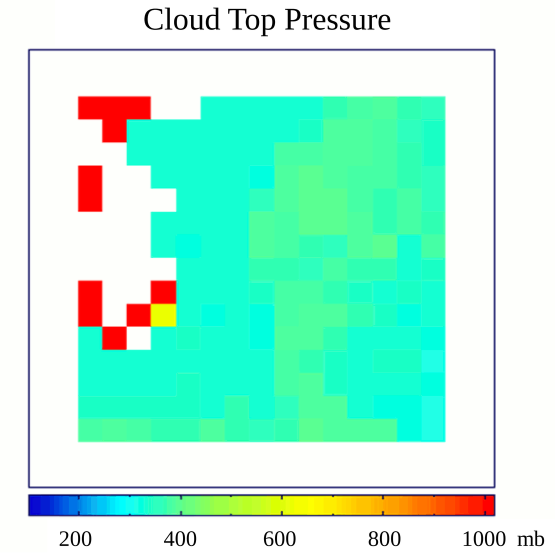
Why did the Baseline Cloud Height Retrieval fail in this case?

- Target scene is on the edge of a dissipating cloud mass typed as ice with emissivities that are low (<< 0.8).
- The ice clouds are also quite low in the atmosphere (for ice).
- The current Cloud height algorithm is an Optimal Estimation (1D VAR) approach and the first guess cloud height is important for clouds like those shown in this target scene.
- Most cirrus are near the Tropopause and the cloud height algorithm's climatological first guess overestimated the cloud height (underestimated the cloud pressure).

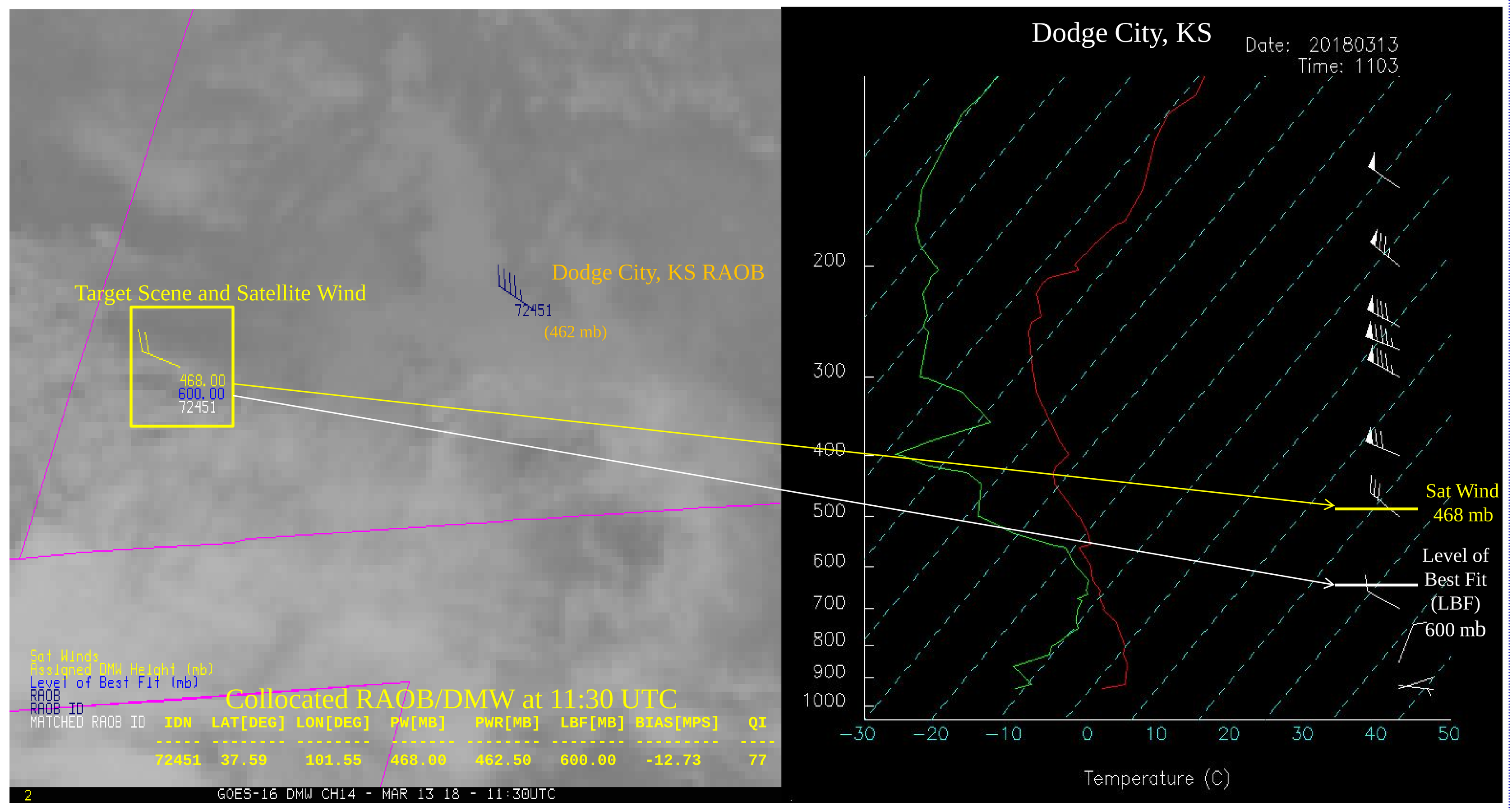
Applying latest version of the Advanced Cloud Height Algorithm (ACHA) to this case

- Latest version of cloud height algorithm produces much improved cloud top pressures (near 375mb) which are *now consistent with and supported by* the Belize radiosonde observation.
- ACHA has progressed continuously since the development of the GOES-R Ground System Baseline Algorithm and now supports many sensors and IR channel combinations.
- ACHA has implemented a more complex scheme where opaque parts of clouds are processed first and these values serve as the first guess for thinner cloud regions and edges (which often form AMV targets).
- The algorithm has also has benefitted from better Radiative Transfer and Microphysical methods implemented over the last decade.



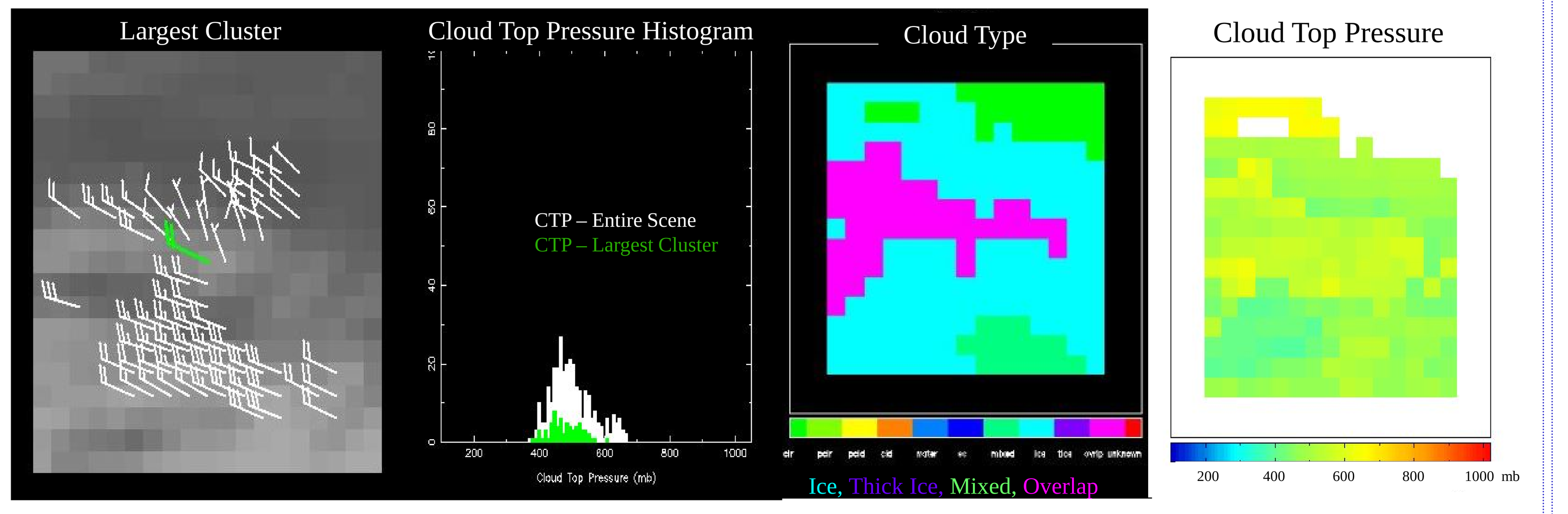


Case 2: Mid Level Slow Bias – Band 14 DMW



2. Deep-Dive Case Study Analysis (cont.)

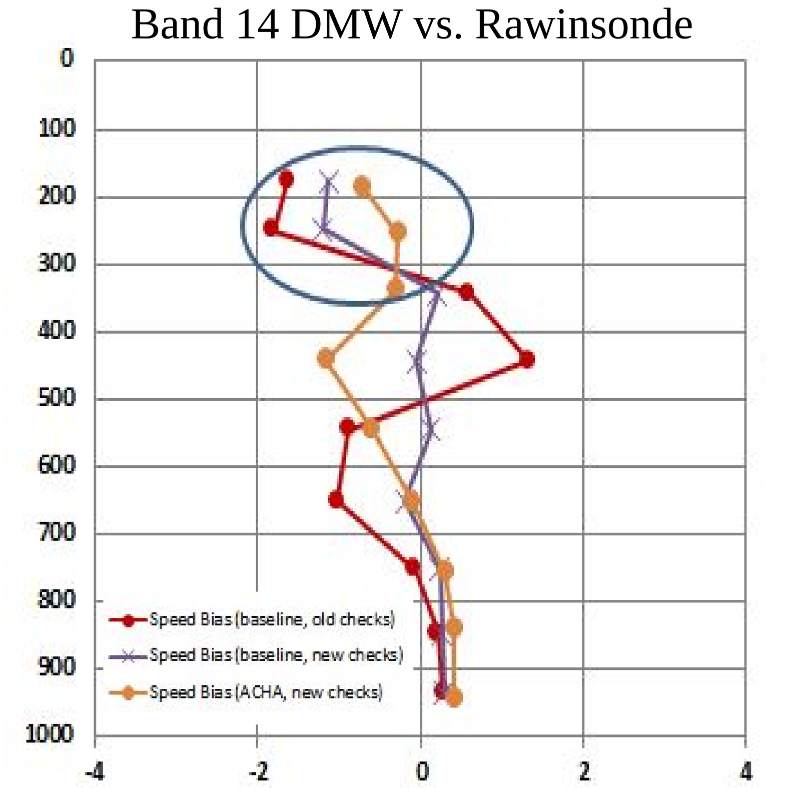
Case 2: Mid Level Slow Bias – Band 14 DMW (cont.)



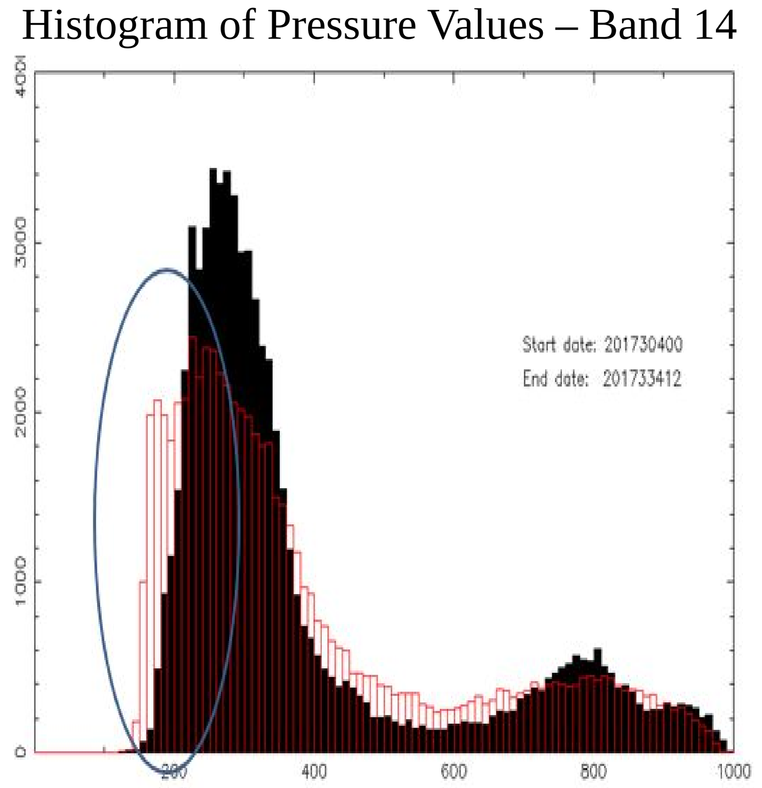
Did the Baseline Cloud Height Retrieval really fail in this case?

- Analysis of the Baseline 1D VAR cloud algorithm indicates it actually performed reasonably well in this case. Clearly, there was more than one cloud layer with overlap present in the scene and the algorithm correctly identified this.
- The 1D VAR heights show two layers and some of the estimates are closer to 600 mb near the top of the second (lower) layer in the skew-t.
- The largest cluster in the tracking solution has pixels within the overlap region. As such, this vector should have likely been flagged and avoided.
- Future implementation of an overlap check is being considered to screen out vectors similar to this.

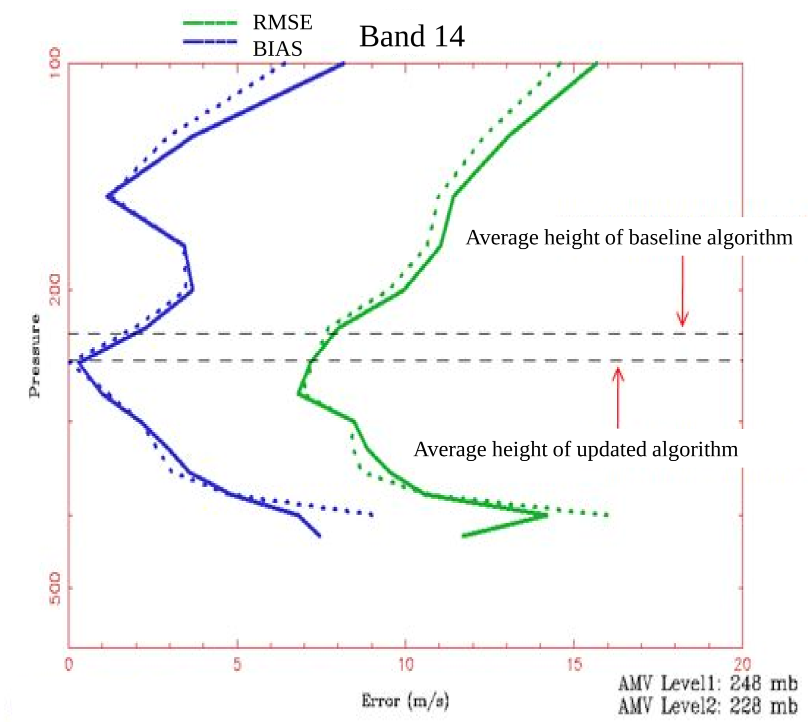
3. Minimizing the Upper Level Slow Speed Bias



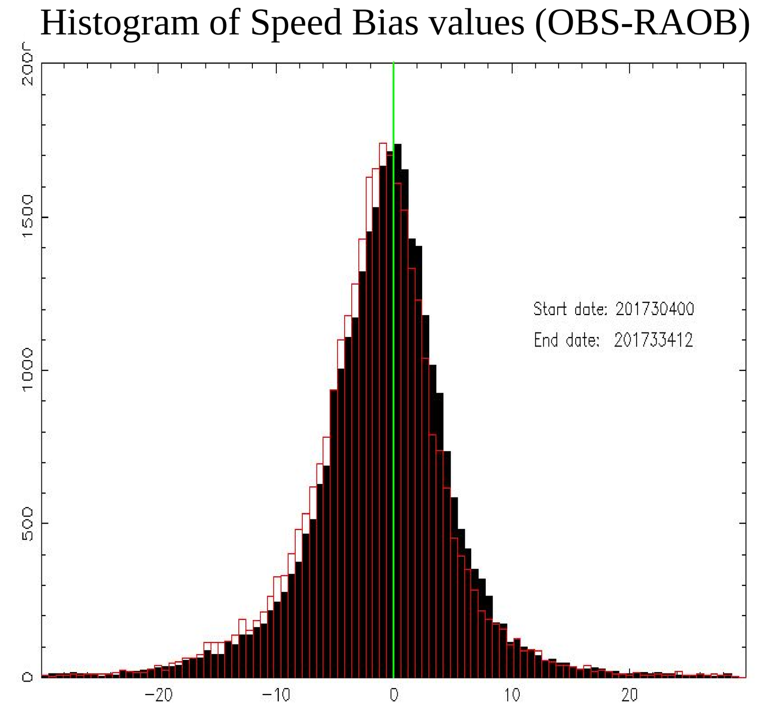
Current Baseline cloud height curve (red) shows a pronounced slow bias in the 100-300 mb layer. With a new vector difference check applied the slow speed bias is reduced (purple curve). Updates to the Baseline Cloud Height Algorithm reduces the bias even further (orange curve) .



Distribution of CTP for current Baseline Algorithm (red) and updated algorithm (black) showing a shift of the very highest sample to lower levels. Also note mid-level shift to higher levels.



Level of Best Fit profiles showing baseline (dashed) vs. updated cloud height algorithm (solid). Note that the updated cloud height algorithm minimizes the speed bias in the 100-300 mb layer.



Distribution of Speed Bias for current baseline algorithm (red) and updated algorithm (black) showing the positive shift in the bias.