Comparison of AMV height assignment bias estimates from model best-fit pressure and lidar corrections

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Motivation

Atmospheric Motion Vectors (AMVs) are typically interpreted as single level wind observations assigned to a representative height which is cloud top for high and mid level clouds and cloud base for low level clouds.

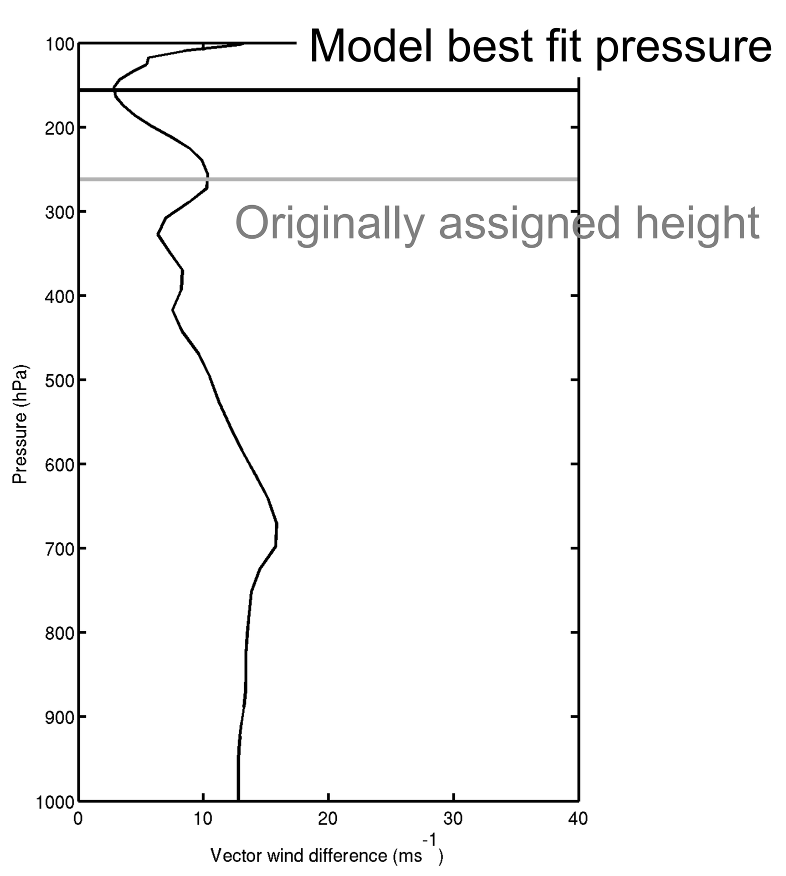
Comparison to radiosonde (Velden and Bedka, 2009) and lidar observations (Folger and Weissmann, 2014) as well as results from simulation framework (Hernandez-Carrascal and Bormann, 2013) suggest benefits from interpreting AMVs as layer averages or as single level wind but within the cloud.

Height assignment is considered to be one of the most significant error sources for AMVs. Taking into account the AMV height assignment uncertainties through situation dependent observation errors has been very beneficial in the European Centre for Medium-Range Weather Forecasts (ECMWF) system (Salonen and Bormann, 2013). Interesting question is could we further improve the use of AMVs by taking into account systematic height assignment errors?

Two independent methods to estimate systematic height errors

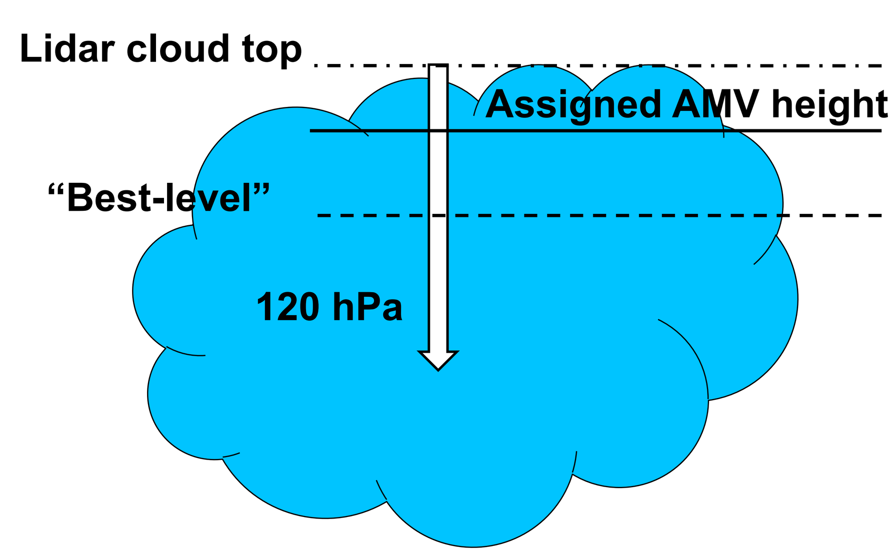
Best-fit pressure

- Pressure level where the vector difference between the observed and model wind is the smallest.
- Long-term best-fit pressure statistics can be used to estimate systematic height errors.



Lidar height correction

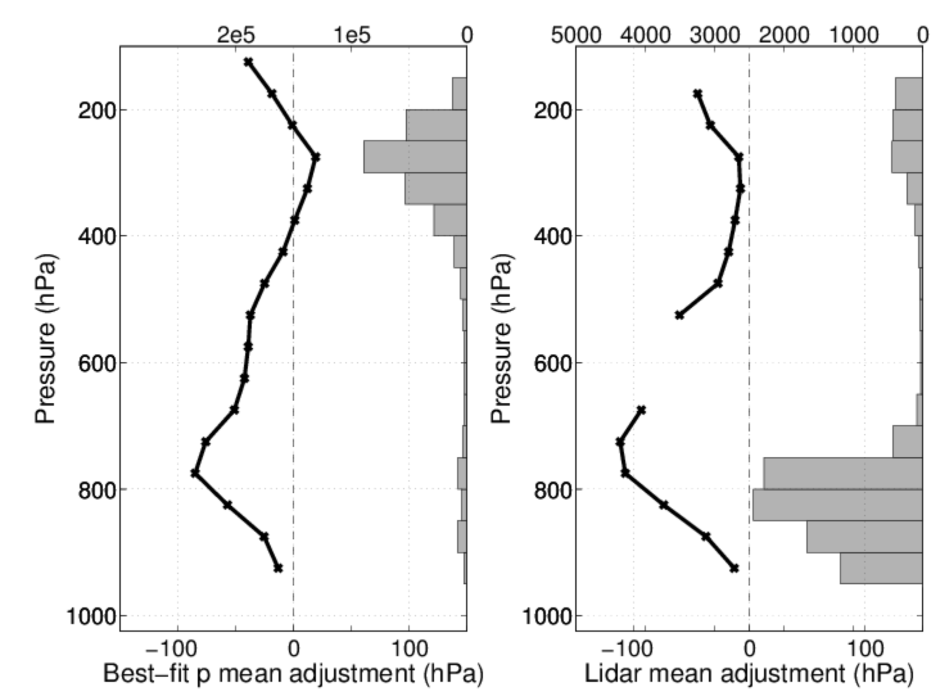
- Comparison of co-located AMV and Calipso lidar observations.
- Comparison to radiosonde wind observations indicate best fit in 120-hPa deep layer below the lidar cloud top.
- "Best level" is the mean pressure of that layer, i.e. a discrete level 60 hPa below the lidar cloud top.



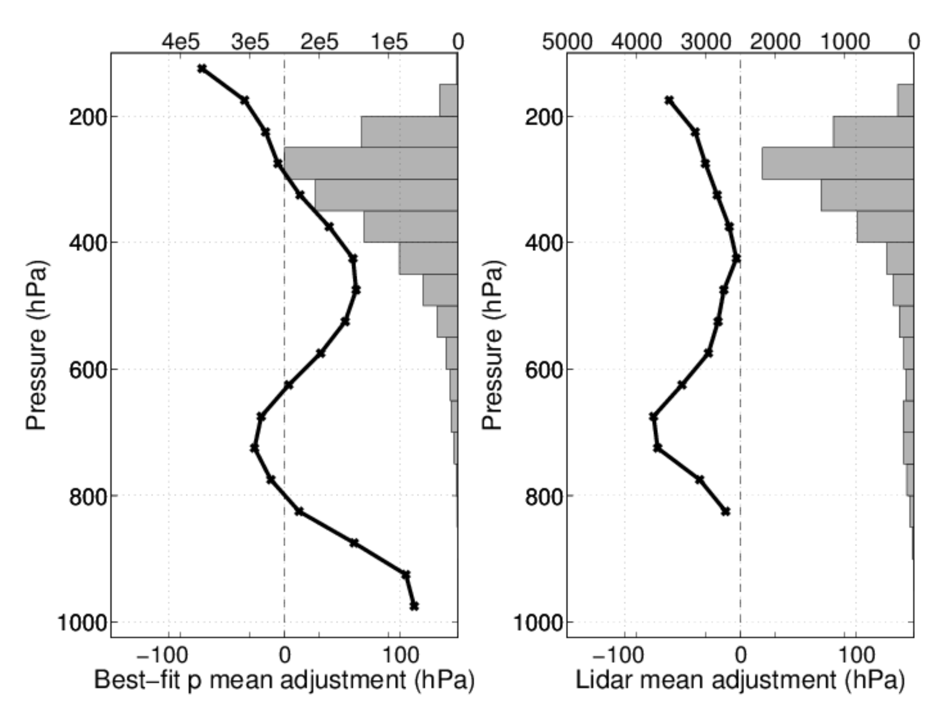
Results

- Comparison for Met-7, Met-10, MTSAT-2, GOES-13 and GOES-15.
- Considered period 1.4-13.6.2013. (CALIPSO lidar observations not available 10.4-15.4 and 16.5-27.5)
- Forecast independent QI greater than 80.

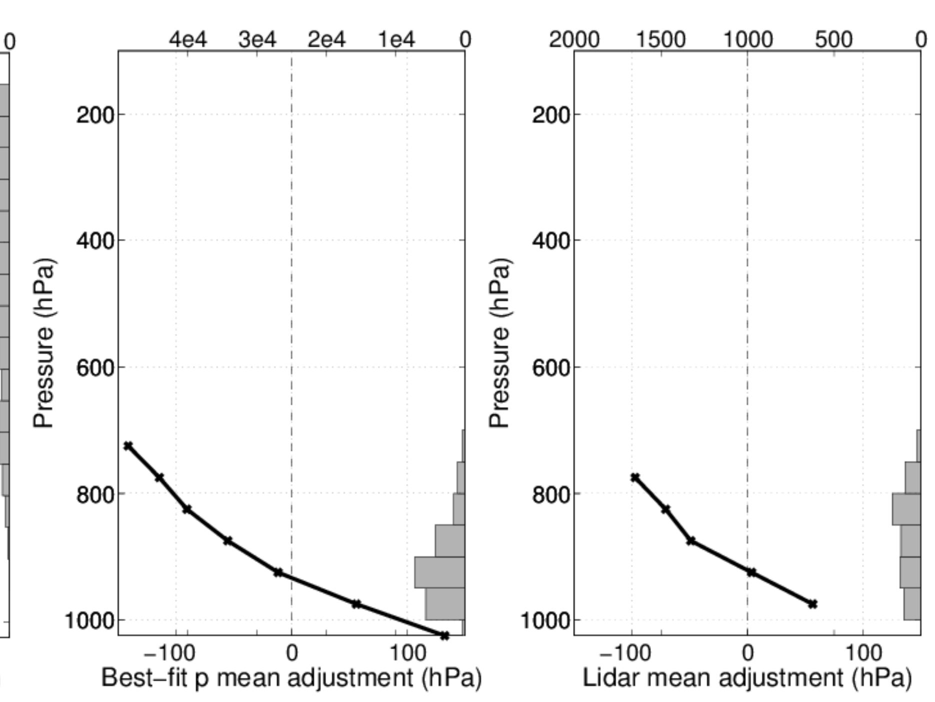
GOES-15 IR



MET-10 WV, midlatitudes



MET-7 VIS, midlatitudes



Note: Positive (negative) values indicate that the assigned AMV pressure is on average higher (lower) than the best-fit pressure/the lidar level of best fit. In terms of height that means that the observation is lower (higher) in the atmosphere than the best-fit pressure/the lidar level of best fit.

General conclusions

- Overall, the two independent methods to estimate systematic height errors for AMVs support each other.
- Generally the shapes of the curves are similar. For IR and VIS AMVs the magnitudes are also comparable especially at low levels.
- For WV winds and for high level IR winds there are some differences in the magnitude. Shifts of 20-60 hPa are seen between the methods and typically the lidar correction is indicating more negative values (placing the AMV lower in the atmosphere) than the best-fit pressure statistics.
- One possible explanation for the shift between the methods is that for lidar correction the level of best fit is considered to be 60 hPa below the lidar cloud top at all heights. Folger and Weissmann (2014) show that a 100 hPa deep layer below the lidar cloud top also achieves very good results. In practise this means that the results for a level at 50 hPa below the lidar cloud top is basically almost equivalent. This would result in lidar corrections of same shape but shifted 10 hPa to the right. If the level of best fit varies slightly at different heights, the shift seen between the methods might decrease.

References

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