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HEIGHT CORRECTION OF ATMOSPHERIC MOTION VECTORS USING SATELLITE LIDAR OBSERVATIONS FROM CALIPSO

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BACKGROUND

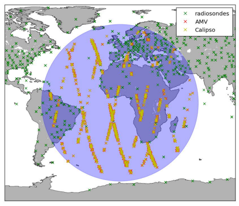
- Atmospheric Motion Vectors (AMVs) are derived by tracking clouds or water vapour structures in consecutive satellite images
- AMVs are the only wind information in many regions of the globe and are thus an essential ingredient for NWP
- Vertical height assignment issues are responsible for up to 70% of the total AMV error (Velden and Bedka, 2009)
- Lidars can provide accurate information on cloud top heights

APPROACH

- Correct the pressure heights of Meteosat-AMVs with spaceborne CALIPSO lidar observations
- Develop a height correction method for operational AMVs and improve the assimilation of AMVs by treating them as layer-averaged winds and/or including a height correction with lidar

DATA

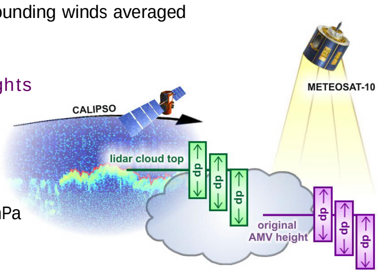
- On average about 1000-1300 collocated MSG AMVs and CALIPSO lidar observations per day (within 50 km and 30 min)



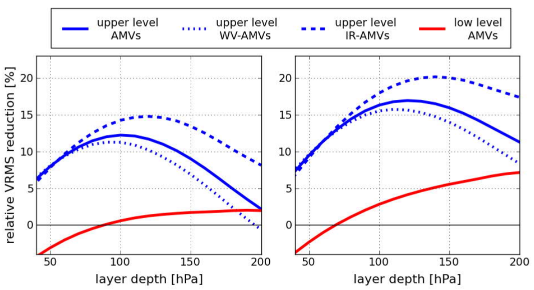
- In this study about 4500 collocated MSG AMVs, CALIPSO and radiosonde observations (for the wind verification) in an 8-month period in 2012/2013 are used

METHOD

- Compare AMV winds to sounding winds averaged over vertical layers
  - relative to the original operational AMV heights
  - relative to lidar cloud top height observations from CALIPSO
- Testing layers of 0-200 hPa
- Testing three positions:
  - centered
  - 25% above, 75%below
  - below



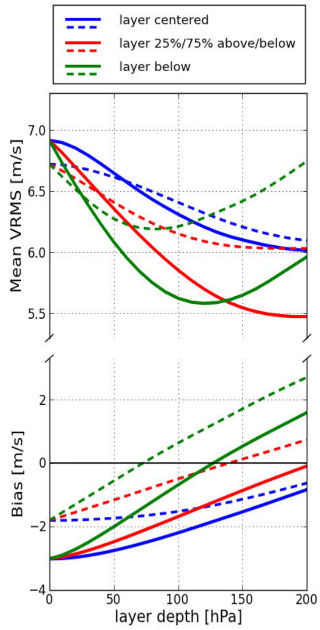
RESULTS – RELATIVE ERROR REDUCTION



- Relative reduction of VRMS differences between AMVs and radiosondes through height correction with CALIPSO lidar observations
- Results relative to (left) assigning a reference layer of the same depth centered at original AMV height and (right) assigning the AMV wind to the original discrete AMV level
- Upper level AMVs above 700 hPa (blue) show clear error reduction (12-17%) which is apparent in both high level channels IR and WV (blue dashed and dotted)
- Only small error reduction for low level AMVs below 700 hPa (red)

RESULTS – VRMS AND BIAS

- Results are verified with nearby operational radiosondes
- Mean VRMS (Vector Root Mean Square) and wind speed bias for upper level AMVs above 700 hPa (2835 AMVs) from Meteosat-9 and Meteosat-10
- Differences of AMVs and radiosonde winds for assigning layers relative to AMV heights (dashed) and layers relative to lidar cloud top observations (solid)
- Best results are achieved for 120 hPa layers below the lidar cloud top (green line) or 200 hPa layers with 25% above and 75% below the lidar cloud top (red line) with lowest VRMS differences and bias values close to zero



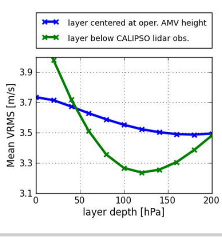
SUMMARY

- Lidar observations can significantly reduce the errors of AMVs, as they provide high-resolution cloud top observations that are expected to be independent of the height assignment method used in the AMV processing
- Wind error reduction for CALIPSO height correction with radiosonde verification
  - compared to layer centered at original AMV height: ~12%
  - compared to single level value at AMV height: ~17%
  - indication of larger reduction (>20%) with stricter verification criterion

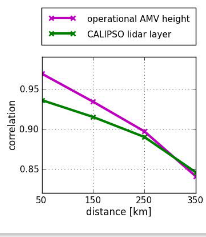
OUTLOOK: MODEL VERIFICATION

- Wind verification with model equivalents of 3h-forecast from GME (global model of the German Weather Service) for a 10-day-period in June 2013
- Confirmation of results from radiosonde verification for Meteosat-10 (13190 matches): 120-hPa layer below lidar cloud top has lowest VRMS values
- Indication of reduced error correlations for lidar-corrected and layer-averaged AMVs

Confirmation of results from radiosonde verification



Reduction of error correlations



REFERENCES

- Folger, K., and M. Weissmann, 2014: Height correction of atmospheric motion vectors using satellite lidar observations from CALIPSO. J. Appl. Meteor. Climatol., 53, 1809-1819.
- Weissmann, M., K. Folger and H. Lange, 2013: Height correction of atmospheric motion vectors using airborne lidar observations. J. Appl. Meteor. Climatol., 52, 1868–1877.