Height correction of atmospheric motion vectors (AMVs) using lidar observations

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Supported by:
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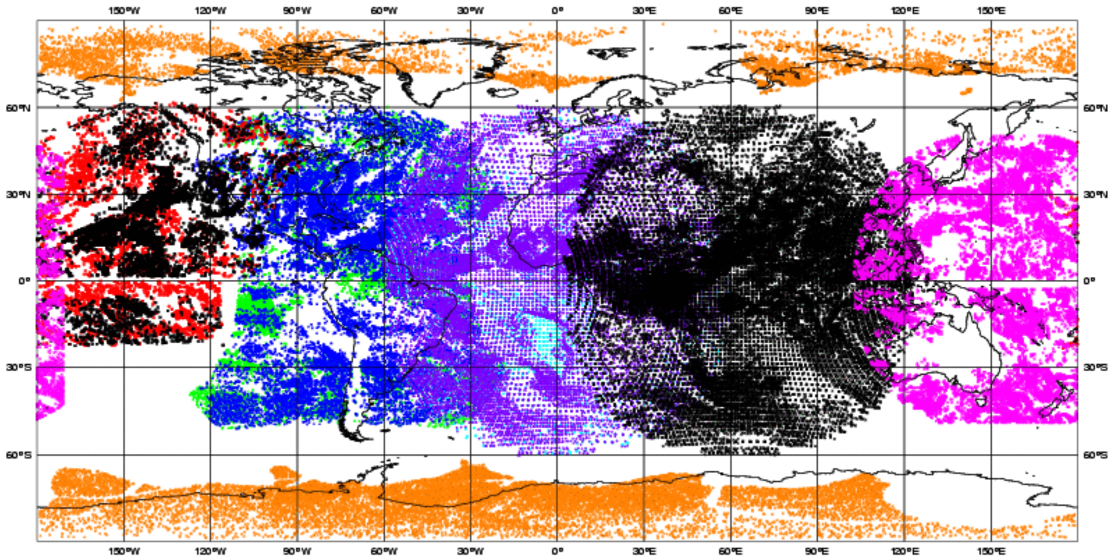
Atmospheric Motion Vectors (AMVs) in data assimilation systems



AMV coverage in 24h

+

excellent wind field coverage (almost global)

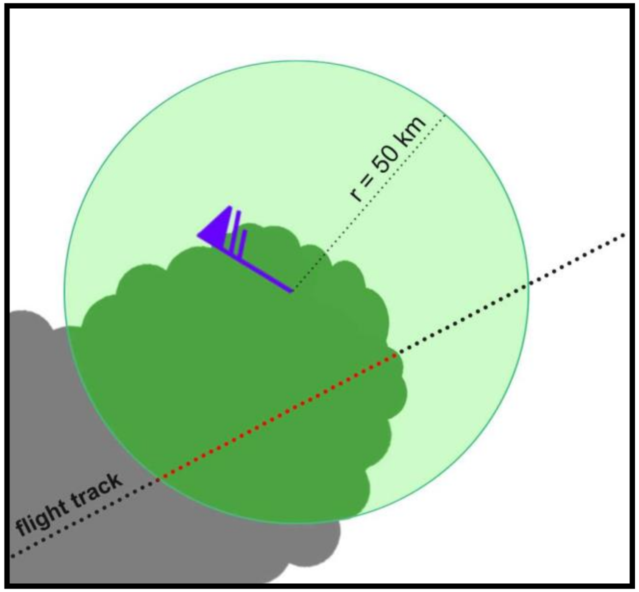
only available wind information in many regions (oceans, SH)

-

Height assigment issues and error correlations require strong thinning of available AMVs in data assimilation

AMV height assignment issues → can lidar observations help?

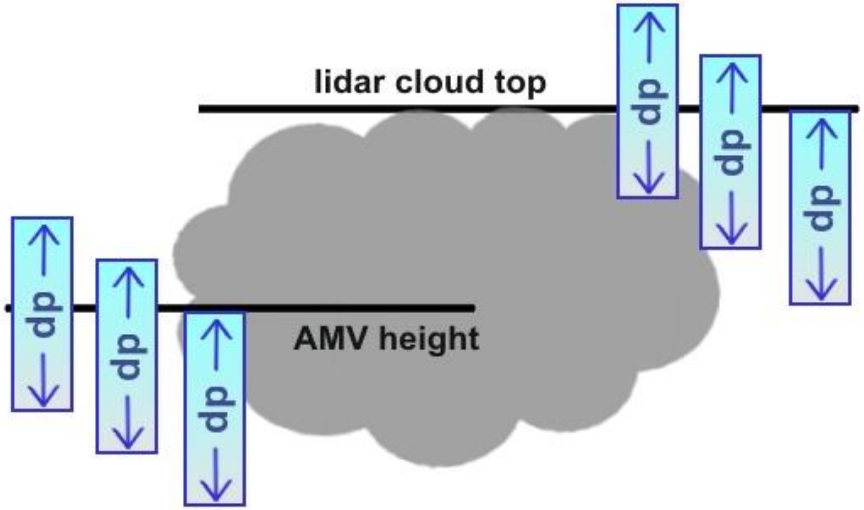
Collocation of AMV, lidar observation and dropsonde/radiosonde



Method

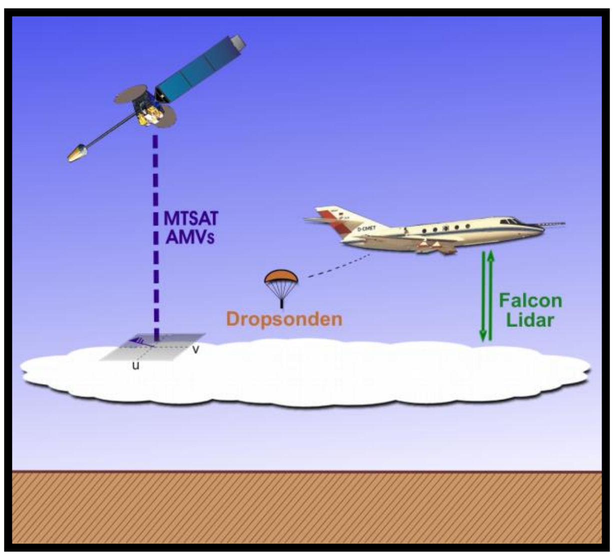
Wind layer *dp* of varying depth in three different positions

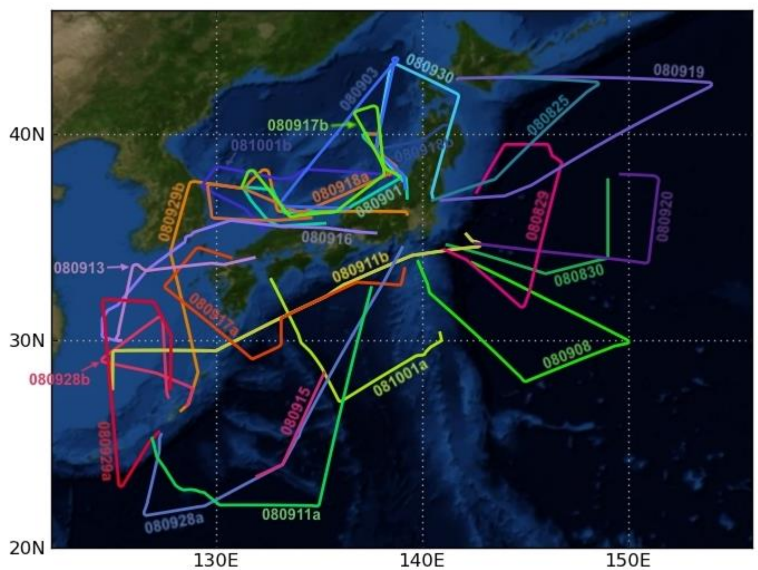
- relative to the original AMV height
- relative to lidar cloud top



AMV height correction using airborne lidar observations during THORPEX Pacific Asian Regional Campaign (T-PARC) 2008

- airborne lidar observations on 24 DLR Falcon flights
- over 300 dropsondes for verification
- MTSAT-AMVs provided by CIMSS



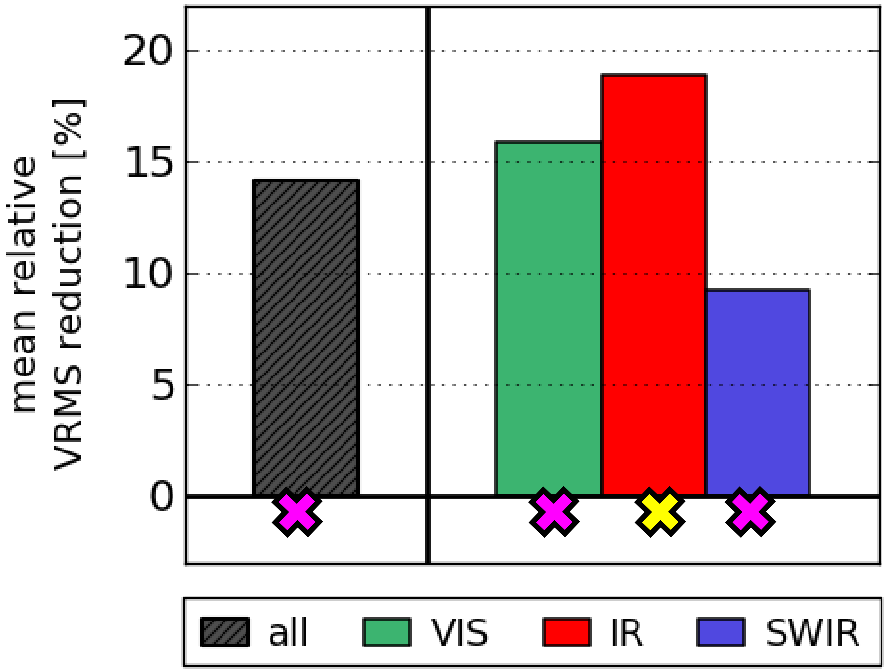


Collocation requirements:

AMV – Falcon lidar: 100 km, 60 min

AMV – dropsonde: 100 km, 60 min

AMV height correction using airborne lidar observations during T-PARC 2008



Wind error reduction for **100-hPa layers below the lidar cloud top** instead of 100-hPa layers centered at the original AMV height

significance:

95%-level

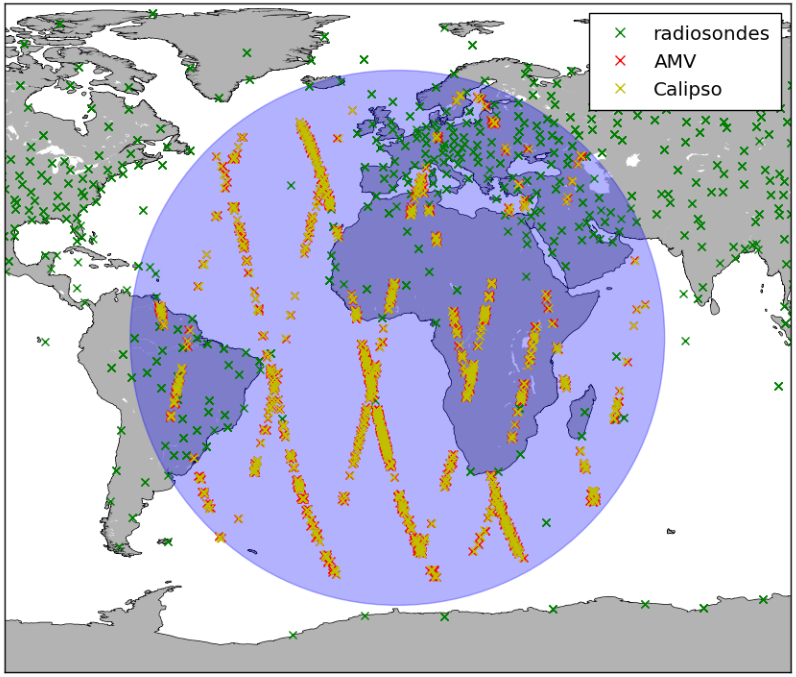
99%-level

Weissmann, M., K. Folger and H. Lange: Height correction of atmospheric motion vectors using airborne lidar observations. JAMC 2013

AMV height correction using satellite lidar observations

AMVs from Meteosat-9 and Meteosat-10 (geostationary)
lidar cloud top observations from CALIPSO (polar orbiting)

AMVs and Calipso lidar observations for 1 April 2012

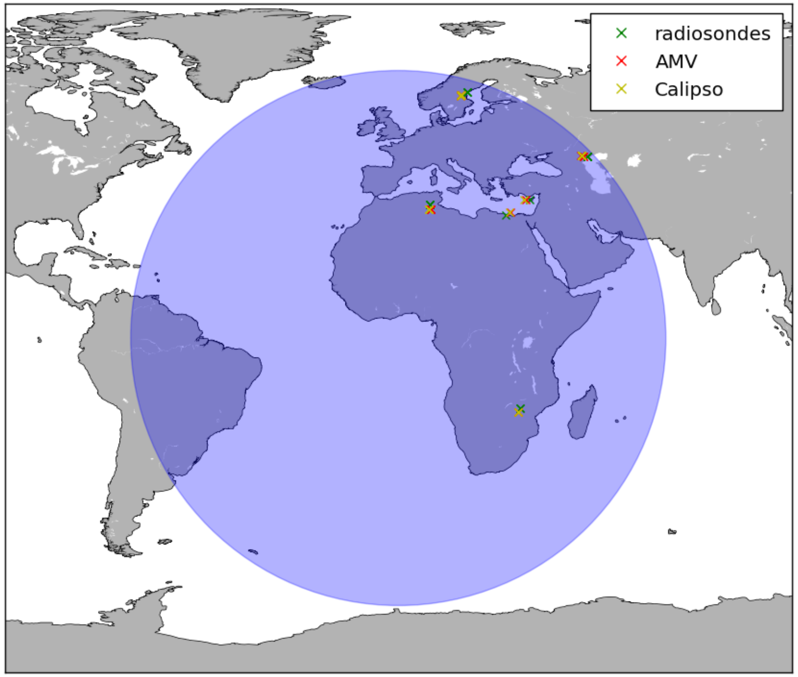


~ 1200 matches

AMV height correction using satellite lidar observations

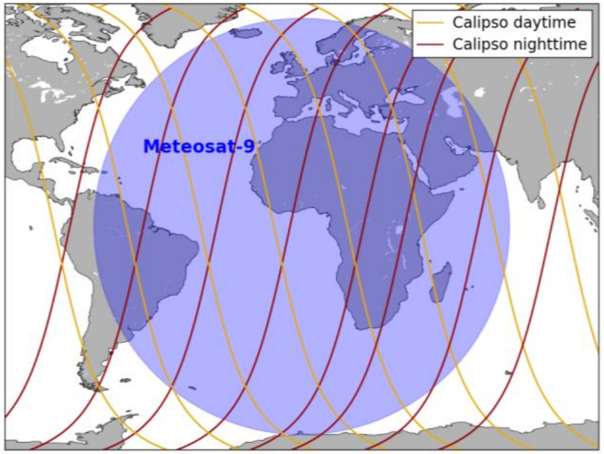
AMVs from Meteosat-9 and Meteosat-10 (geostationary)
lidar cloud top observations from CALIPSO (polar orbiting)

AMVs and Calipso lidar observations and radiosondes for 1 April 2012



~ 15 matches

AMV height correction using satellite lidar observations



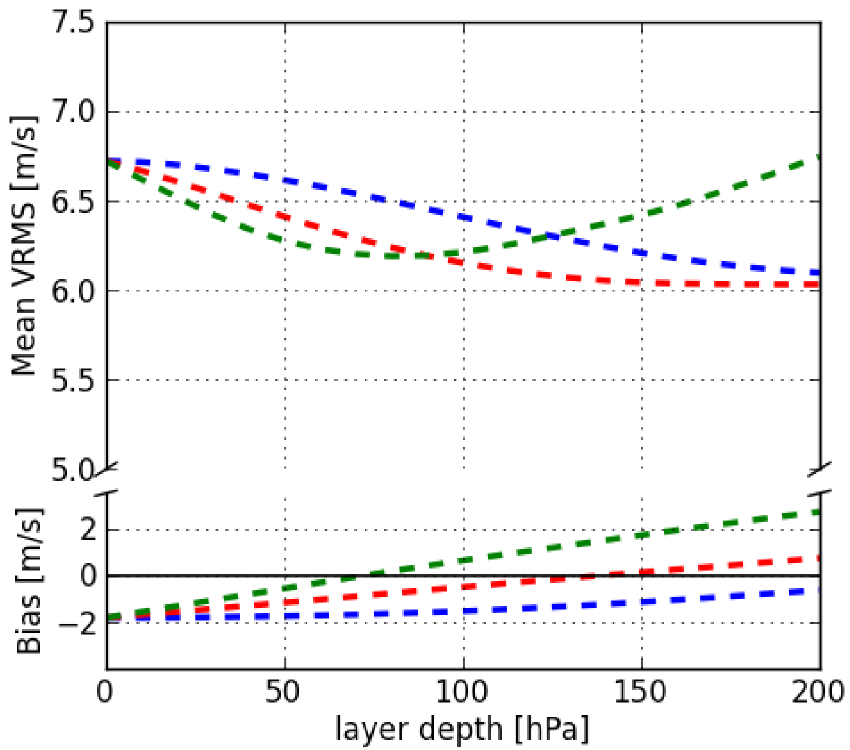
Dataset:
Hourly Meteosat AMVs (0° longitude) with collocated Calipso lidar observations and radiosondes

Time frame:
8 month period, 1 Apr. - 6 Oct. 2012
and 6 Apr. - 13 June 2013
→ 220 days

Collocation requirements:
- for AMV – Calipso lidar observation: 50 km and 30 min
- for AMV – radiosonde: 150 km and 90 min

⇨ **4478 matches**
(1424 VIS, 1167 IR, 1887 WV cloudy)

Upper level AMVs **above 700 hPa** (WV and IR, 2835 matches)

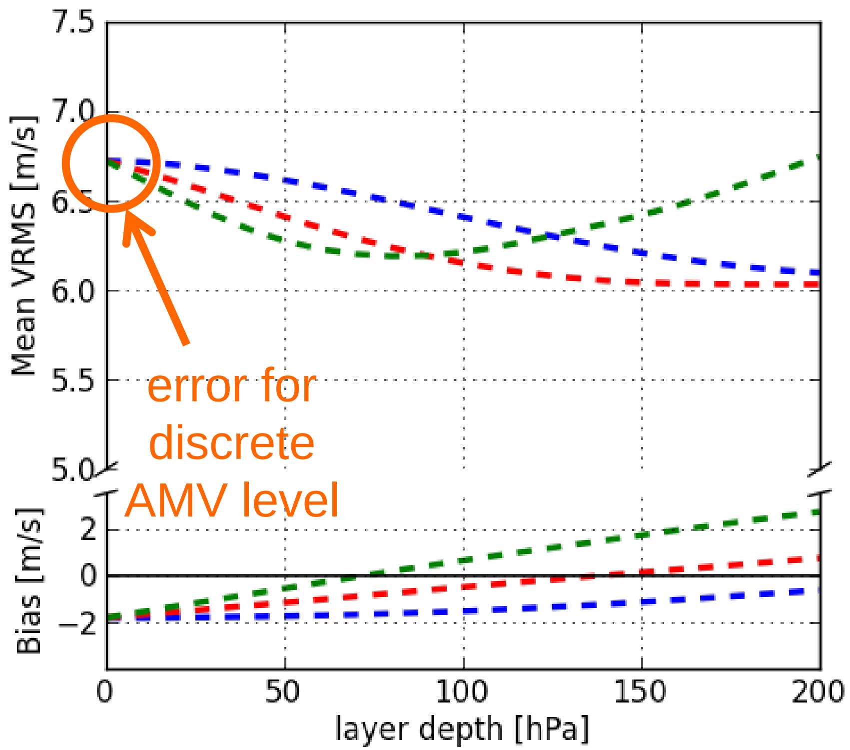


dashed = layers assigned relative to the original AMV height

solid lines = layers assigned relative to the lidar cloud top height

layer around corresponding height (blue)	layer 25% above and 75% beneath corresponding height (red)
layer beneath corresponding height (green)	

Upper level AMVs **above 700 hPa** (WV and IR, 2835 matches)



dashed = layers assigned relative to the original AMV height

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- blue: layer around corresponding height
- green: layer beneath corresponding height
- red: layer 25% above and 75% beneath corresponding height

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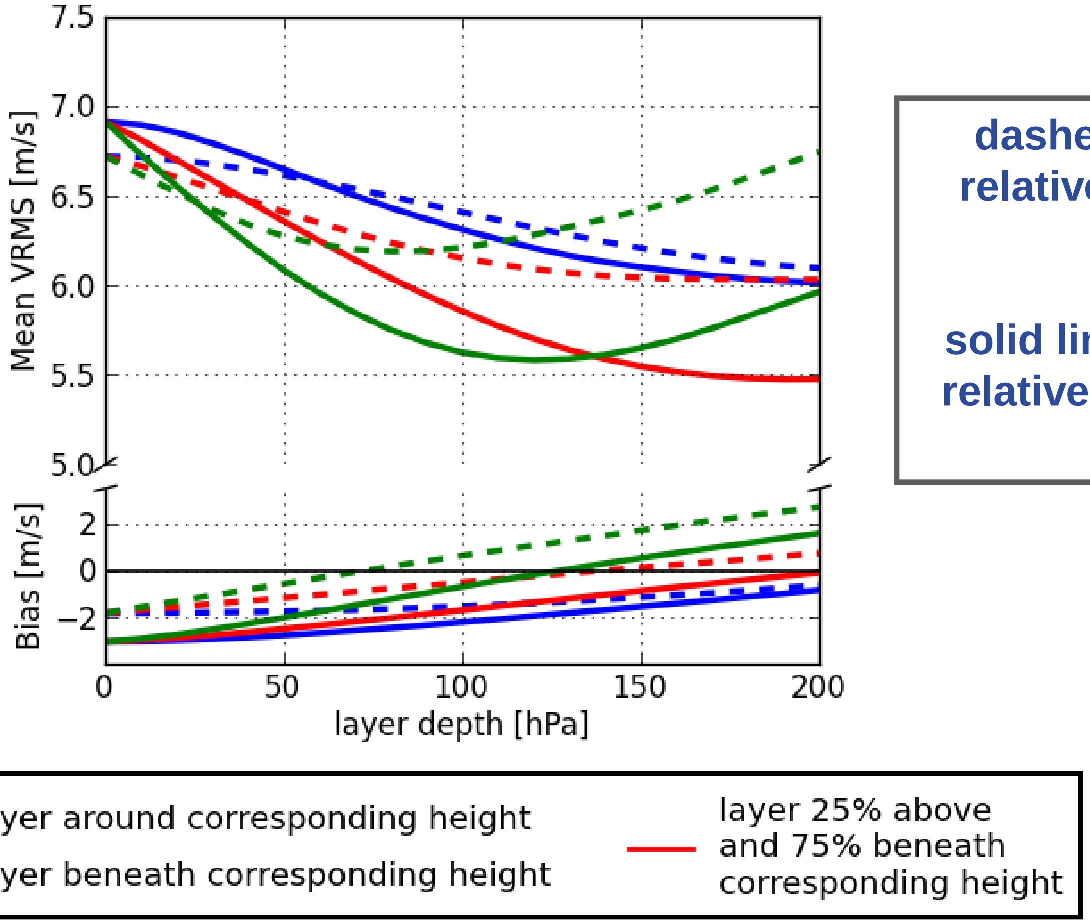

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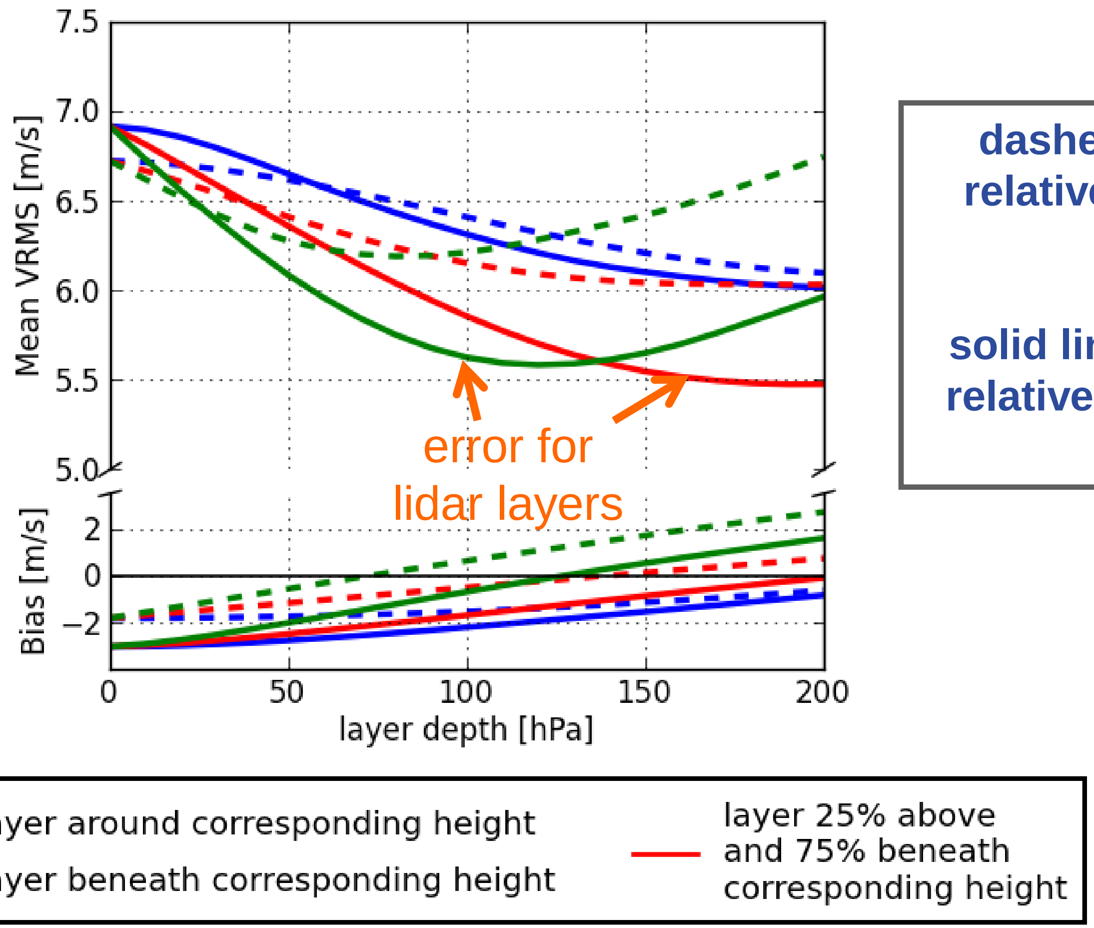

dashed = layers assigned relative to the original AMV height

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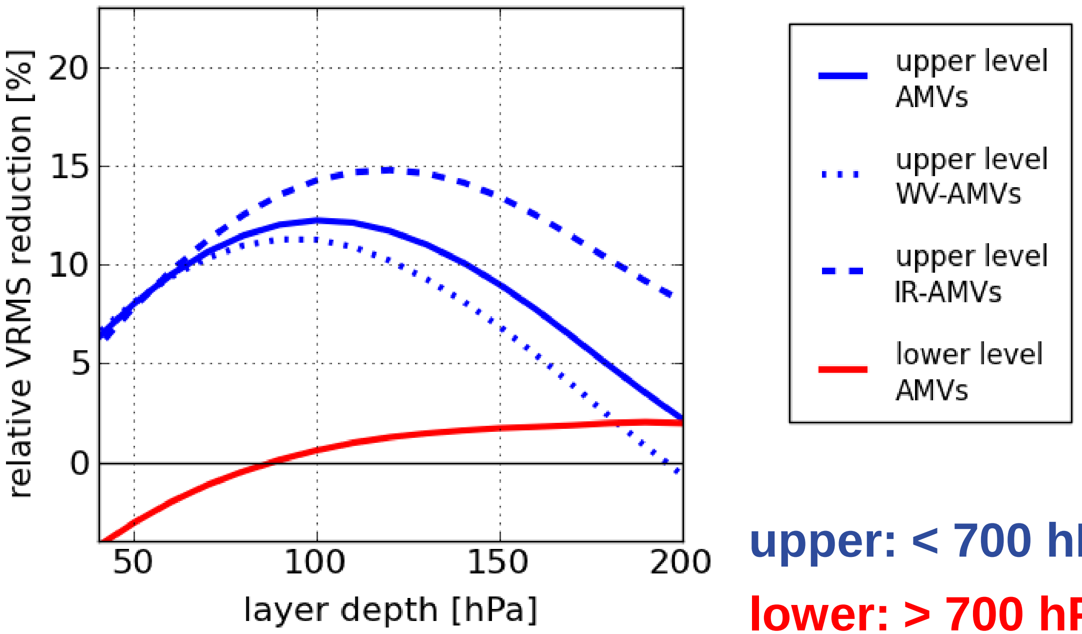
Wind error reduction for layers below the lidar cloud top relative to…

… **layers** of the same depth centered at the AMV height

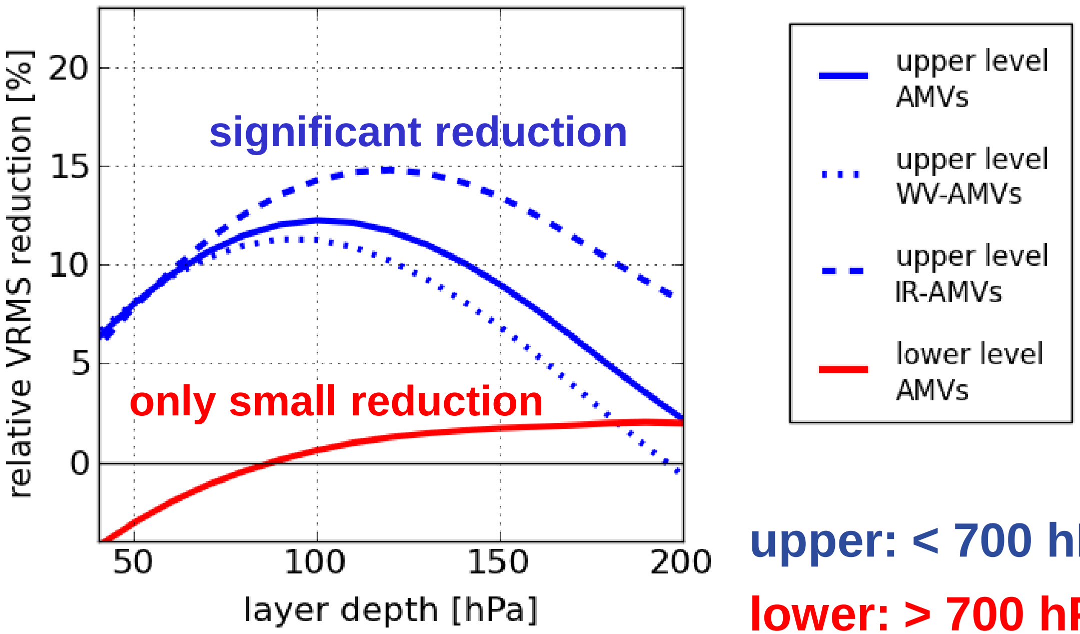


upper: < 700 hPa

lower: > 700 hPa

Wind error reduction for layers below the lidar cloud top relative to…

… **layers** of the same depth centered at the AMV height



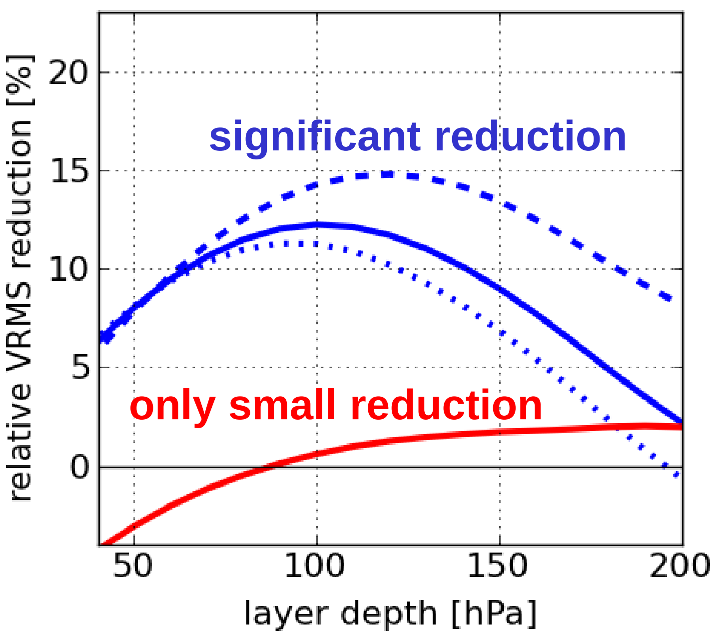
upper: < 700 hPa

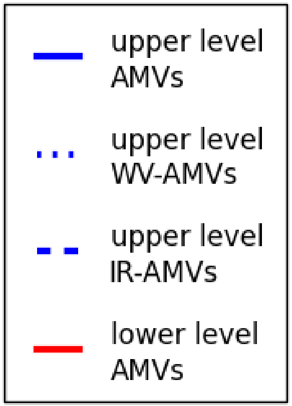
lower: > 700 hPa

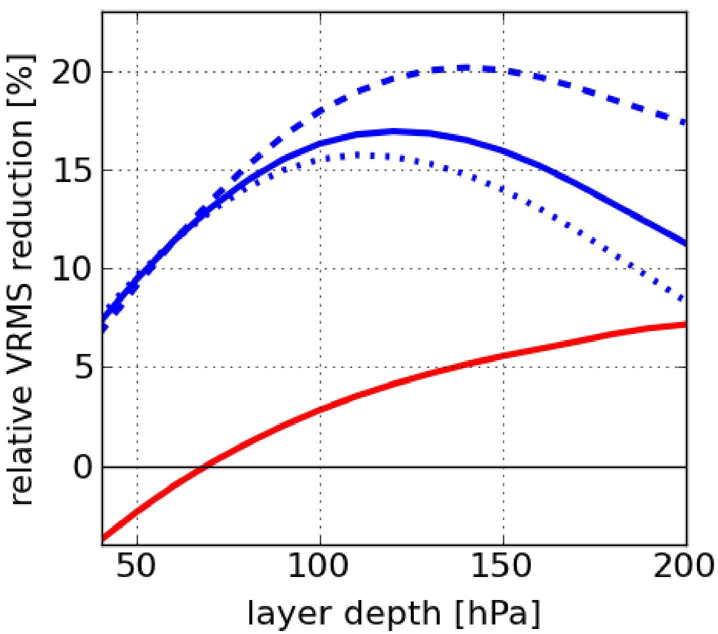
Wind error reduction for layers below the lidar cloud top relative to…

… **layers** of the same depth centered at the AMV height

… the discrete **level** of the AMV height



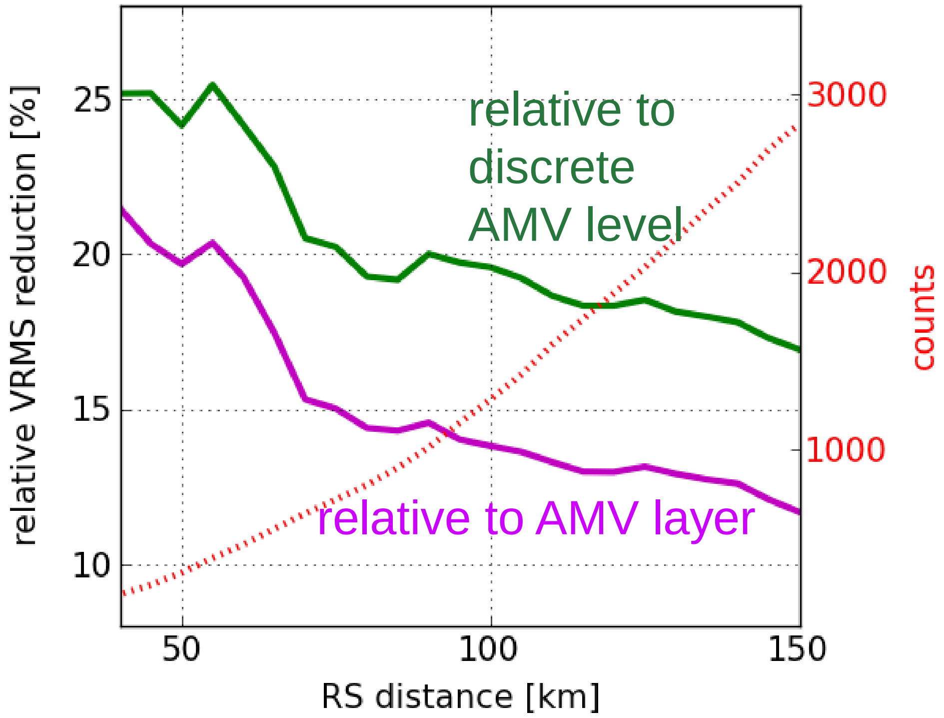




upper: < 700 hPa

lower: > 700 hPa

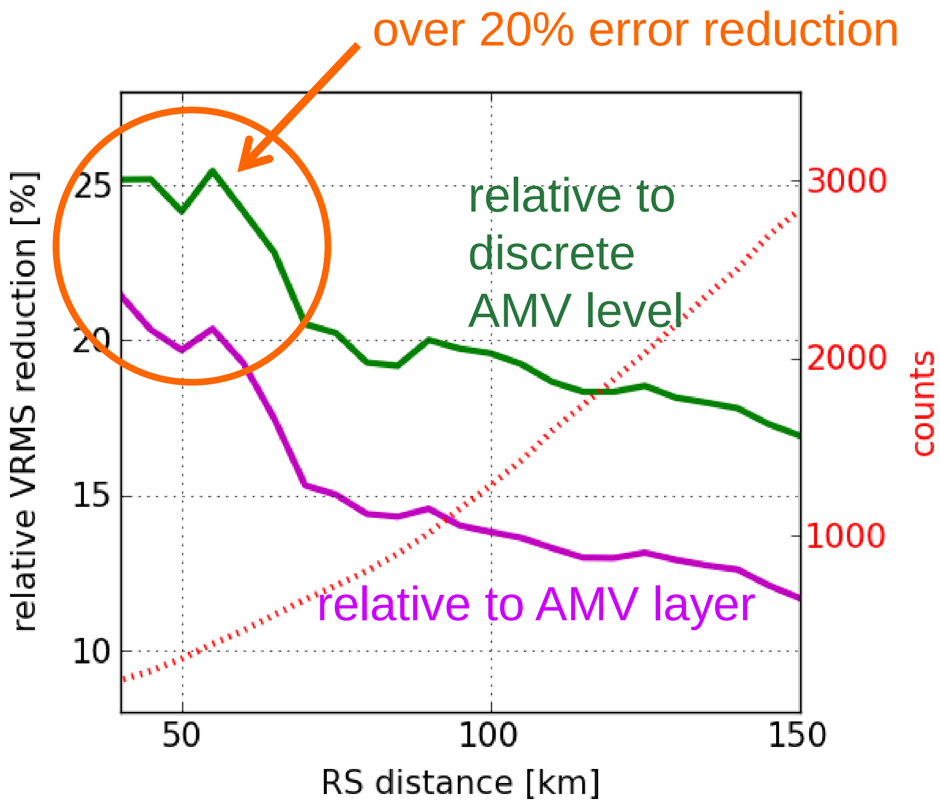
Wind error reduction for upper level AMVs as a function of horizontal distance to the verification radiosonde



temporal and spatial displacement of AMVs and radiosondes introduces additional error component

→ **underestimation of the actual error improvement** as radiosondes are not required for lidar height correction itself

Wind error reduction for upper level AMVs as a function of horizontal distance to the verification radiosonde



temporal and spatial displacement of AMVs and radiosondes introduces additional error component

→ **underestimation of the actual error improvement** as radiosondes are not required for lidar height correction itself

Summary and conclusion

AMV height correction developed using airborne lidar observations

Wind error reduction with CALIPSO height correction for AMVs

- 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

⇨ Lidar observations (as an independent data source) are expected to **reduce error correlations**

⇨ NWP may benefit from **assimilating** lidar-corrected AMVs and treating them as layer-averaged winds in the future

⇨ CALIPSO observations may be useful to **validate AMV processing algorithms** and to derive **bias correction functions**