CLOUD TOP, CLOUD CENTRE, CLOUD LAYER – WHERE TO PLACE AMVs?

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Outline

- SimulAMV2 study - introduction
- Model clouds and alternative AMV vertical locations
- Statistics AMV / model equivalent winds
- Conclusions

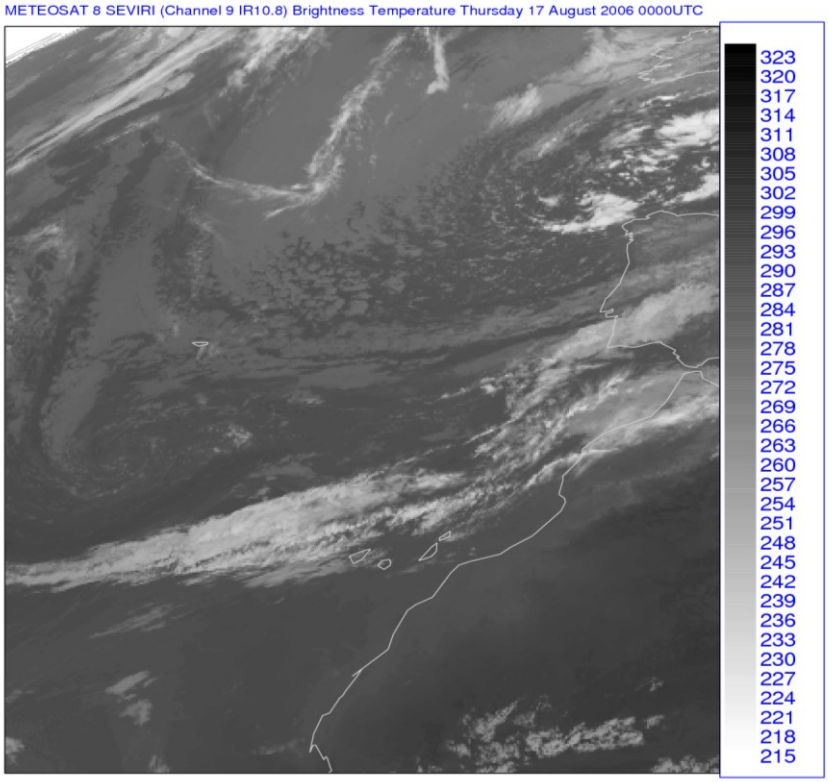
SimulAMV2 study

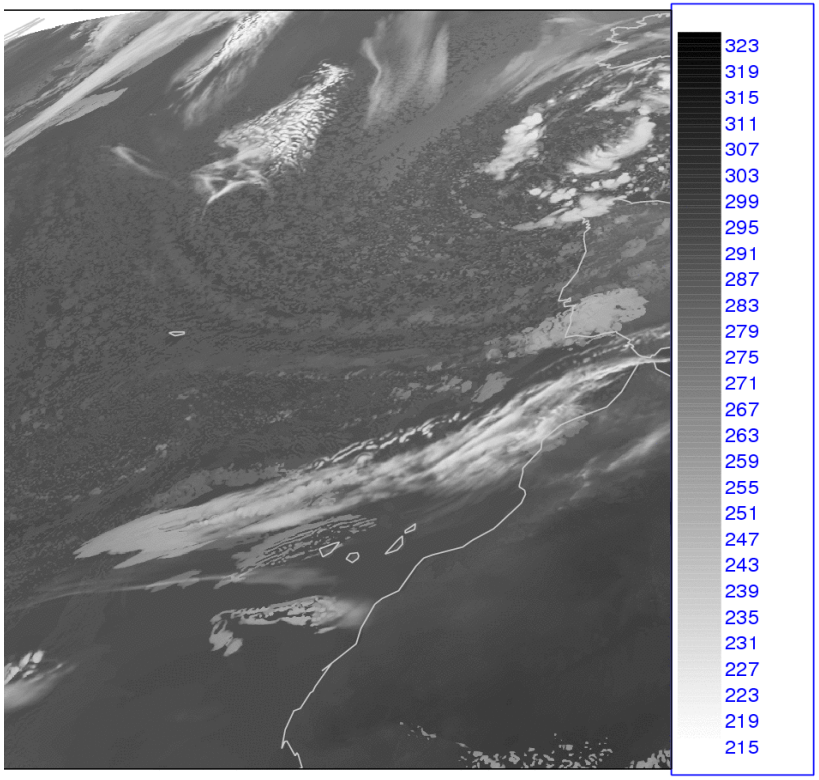
- ECMWF / EUMETSAT / CIMSS, concluded in 2012.
- Part of the results presented at IWW11:
  - AMV as vertical (and horizontal) averages of wind .
- Results after IWW11 presented here:
  - Where to place AMVs in relation to (model) clouds?
- Approach: simulation framework.
- Main objective:
  - To improve our understanding of AMV errors, to improve AMV use in NWP.
- Details in JAMC papers Bormann et al. (2014) and Hernandez-Carrascal and Bormann (2014).

SimulAMV2 study: model simulation + AMV derivation

- **Model simulation (details in slides at the end):**
  - **WRF 2.2 regional model (Skamarok et al., 2005)**
  - **Study period is 24 hours, a 6-30 h forecast - spin up 6 h.**
  - **Area: 58.8 N / 80 W / 58.8 S / 80 E.**
  - **Horizontal resolution 3 km at equator.**
  - **52 vertical levels.**
  - **Data available every 15 mins.**
- **SEVIRI simulated images (radiative transfer model RTTOV9).**
  - **Meteosat-8: almost full view, slightly chopped at N and S.**
- **AMVs derived by EUMETSAT: IR10.8, WV6.2, only cloudy scenes. Prototype of CCC method used.**

SimulAMV2 study: model simulation





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SimulAMV2 study: part presented at IWW11

- **Interpretation of AMVs as single-level winds at pAMV.**
  - **Comparisons simulated AMV / model similar characteristics than comparisons real AMV / model first guess, but errors larger!**
- **Reassigning AMVs to lower heights:**
  - **Large improvement (bias and RMSVD).**
  - **Best $\Delta p \sim 90$ hPa for AMVs from IR10.8 imagery.**
  - **… and around 60-80 hPA for high-level WV AMVs**
- **Interpreting AMVs as vertical averages:**
  - **Improvement in the agreement AMVs / model equivalent:**
    - **Up to ~5% for high-level AMVs and 20% for low-level AMVs.**

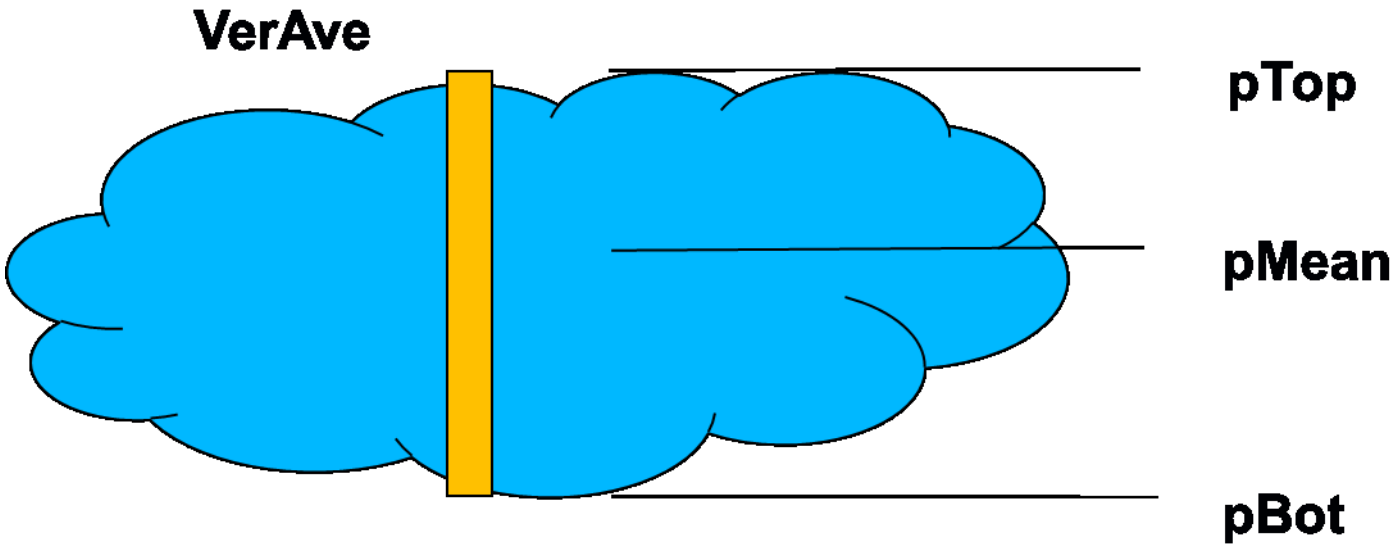
AMV vertical locations and model clouds

- **Simulated AMVs: "true atmosphere" available.**
  - **Profiles of u, v, specific humidity, …**
  - **Also cloud variables: ice mixing ratio, liquid water mixing ratio, cloud cover.**
- **Model clouds (truth) known. Used to explore alternative vertical locations for AMVs.**
- **Also to classify AMVs according to the cloud profile – and avoid multilayer scenes.**

	IR 10.8 (%)	WV 6.2 (%)
Clear	6.4	29.9
Ice1	11.7	**43.6**
Liq1	**29.9**	2.2
Multilayer	52.0	24.3

AMV vertical locations and model clouds

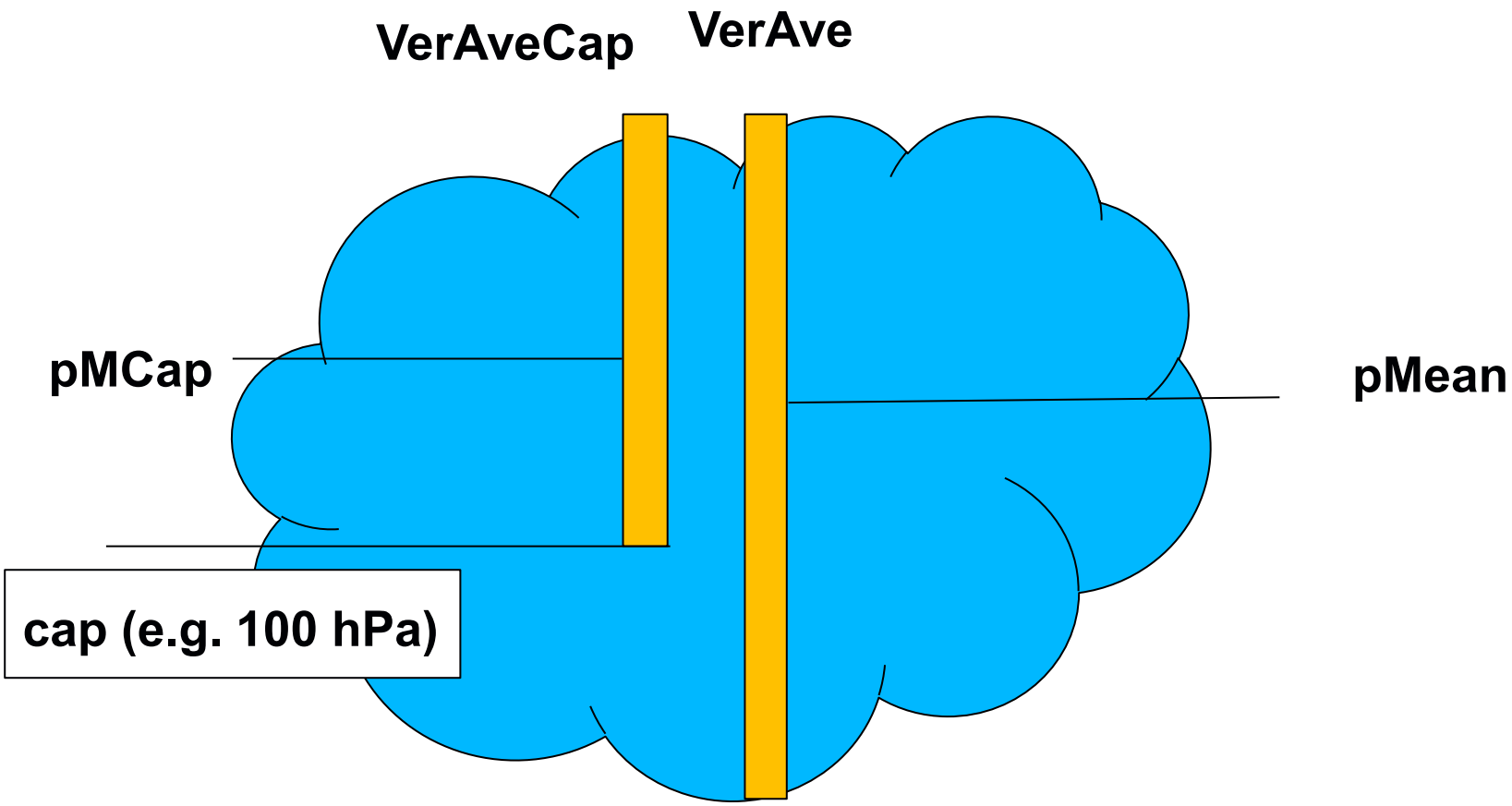
- **Different interpretations of AMVs -observation operators in data assimilation.**



- **pMean** – weighed mean of model levels within the cloud, with weights proportional to ice (or liquid water) contents.
- **Note**: these locations are independent of pressure assigned during derivation.

AMV vertical locations and model clouds

- Sometimes clouds are deep: variants pMCap, VerAveCap.



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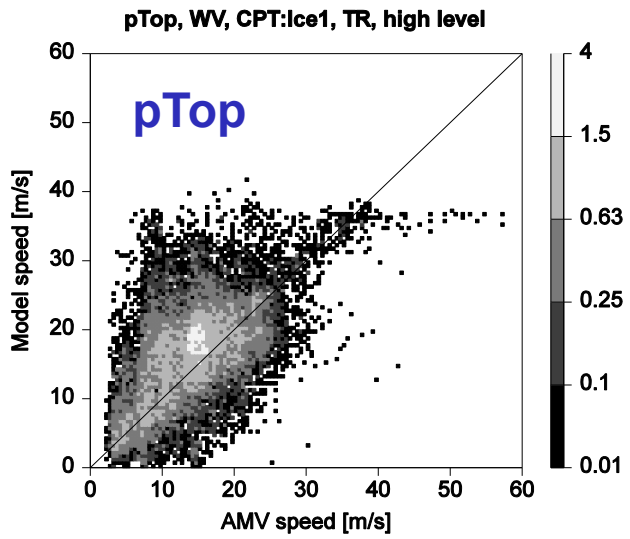
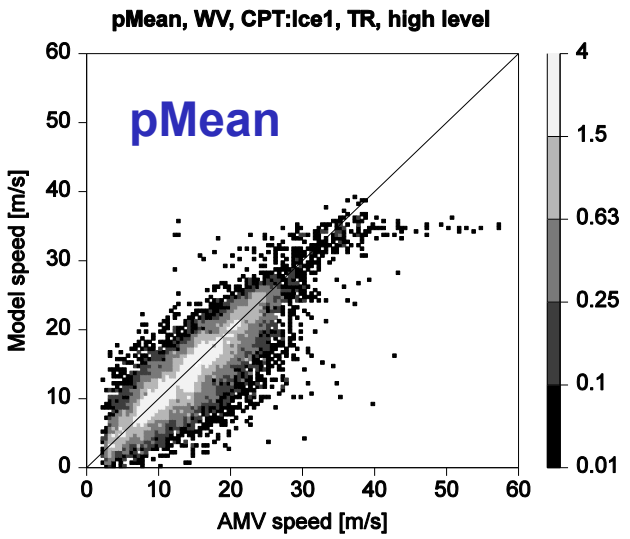
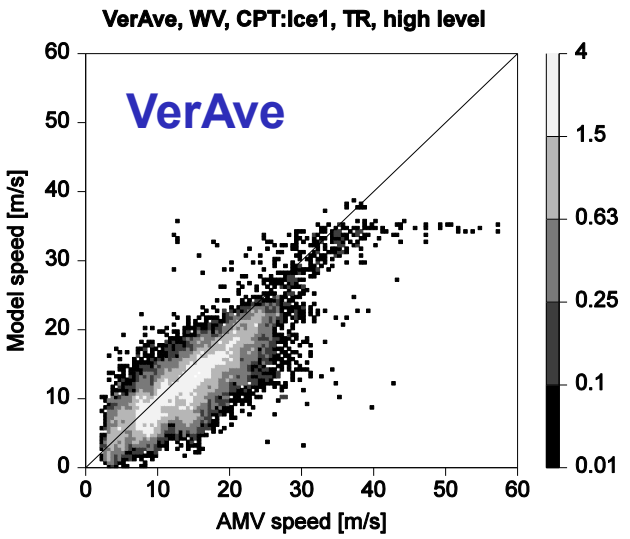
AMV vertical locations and model clouds

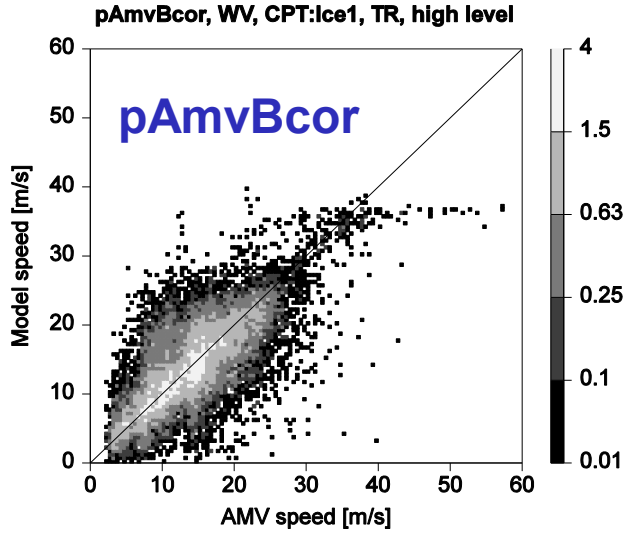
- **Other levels used for reference:**
  - **pAmv: pressure assigned during the derivation.**
  - **pAmvBcor is corrected pAmv, i.e.**
    - **+70 hPa for WV6.2 AMVs .**
    - **+100hPa for IR10.8 AMVs.**
  - **pLBF: Level of Best Fit.**

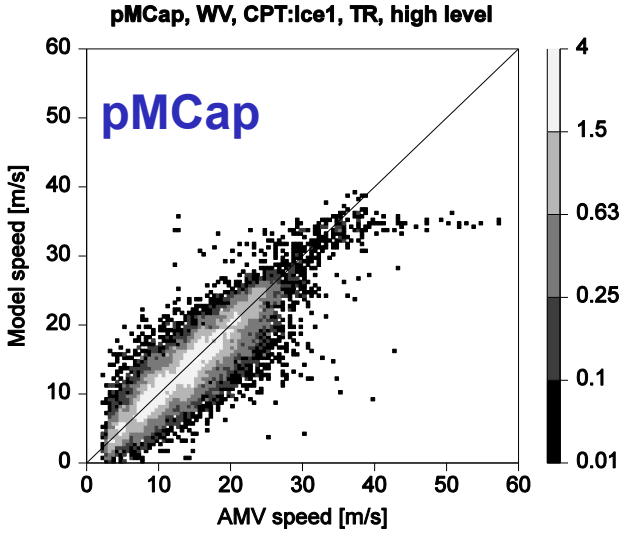
Stats for different AMV interpretations: high, WV, TR, ICE1, speed

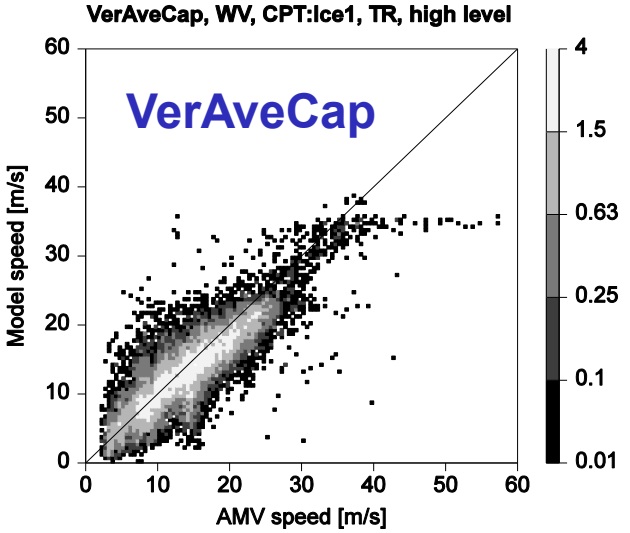












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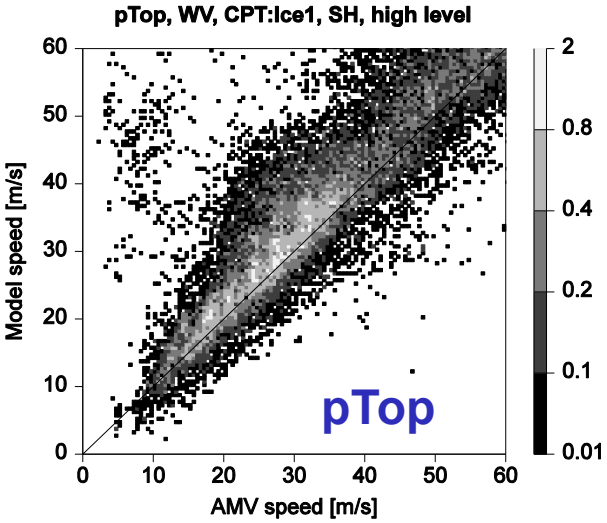
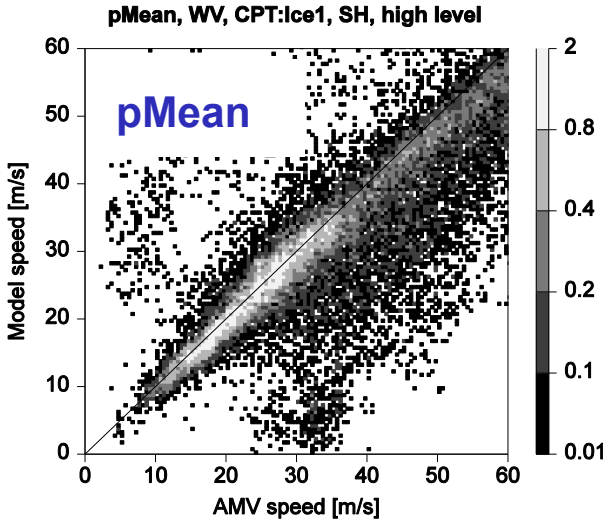
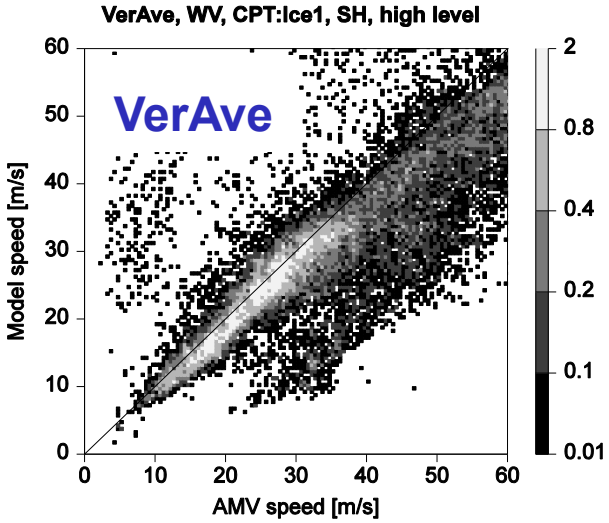
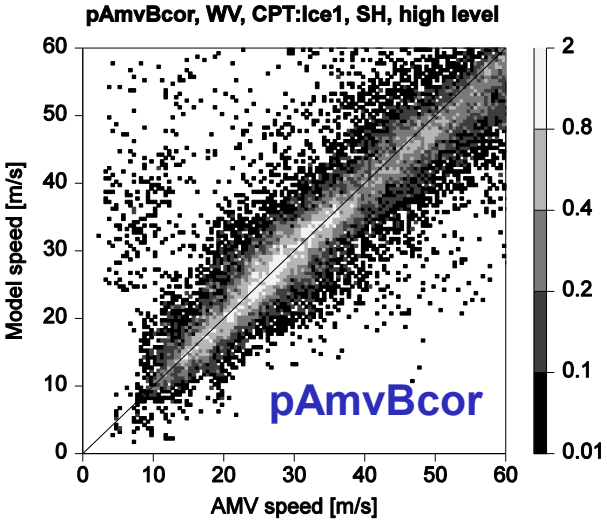
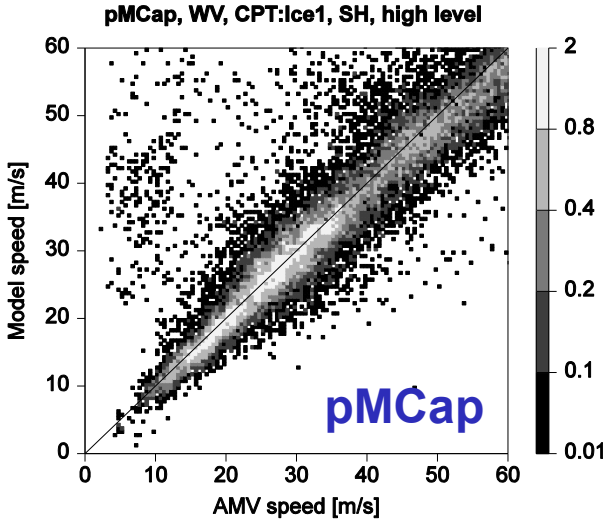
Stats for different AMV interpretations: high, WV, SH, ICE1, speed

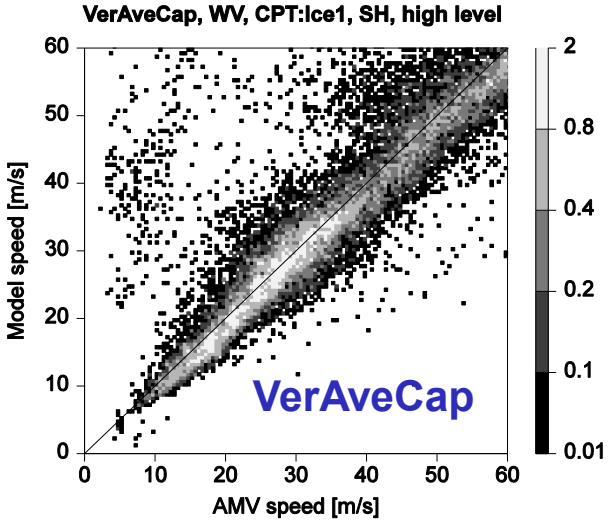












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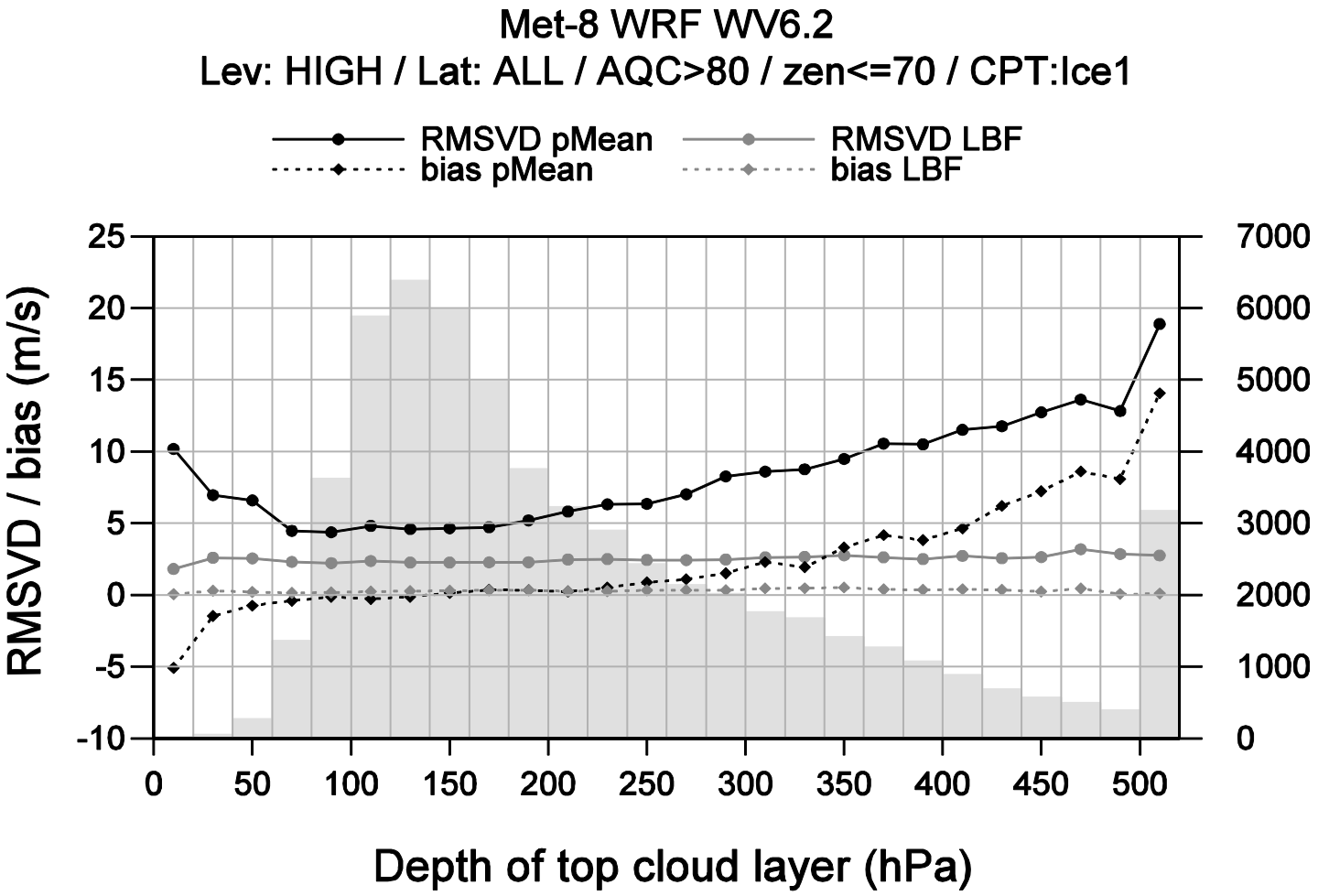
Stats for different AMV interpretations: high, WV, ICE1

WRF WV6.2 AMVs: HIGH LEVEL, QI > 80%, ICE1						
	NH	TR	SH	NH	TR	SH
Number	11693	22538	25117			
AMV speed (m/s)	21.7	14.4	36.5			
	Speed bias (m/s)			RMSVD (m/s)		
pAmvBcor	0.2	0.0	0.5	7.1	6.6	8.4
pTop	-3.2	-2.4	-4.0	8.7	9.2	11.6
pMean	-0.1	0.6	3.4	6.4	4.3	10.4
pMCap	-0.5	0.4	0.0	6.3	4.0	7.3
VerAve	1.1	2.0	4.5	6.6	5.1	10.2
VerAveCap	0.1	0.8	0.2	6.2	4.4	7.4

Stats for different AMV interpretations: high level / WV

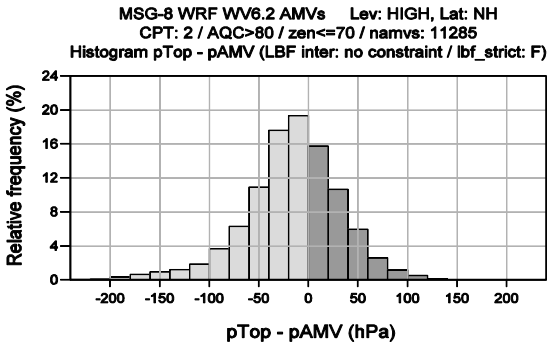


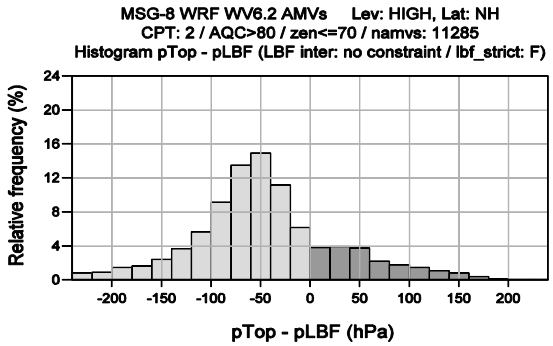
Stats for different AMV interpretations: high level / WV

pTop – pAMV

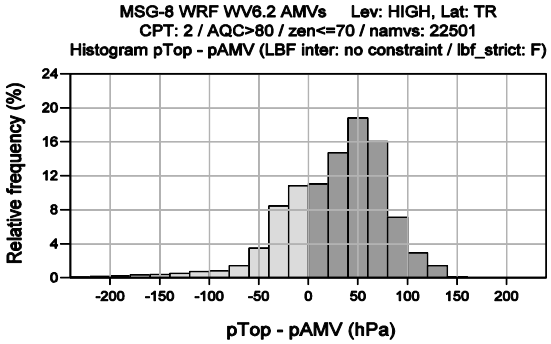
pTop – pLBF

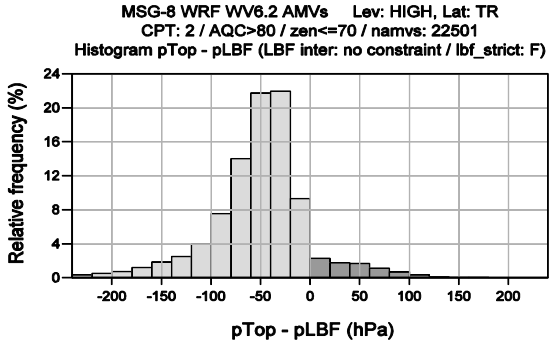
NH



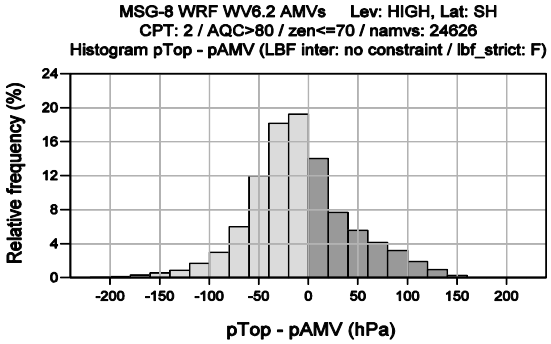


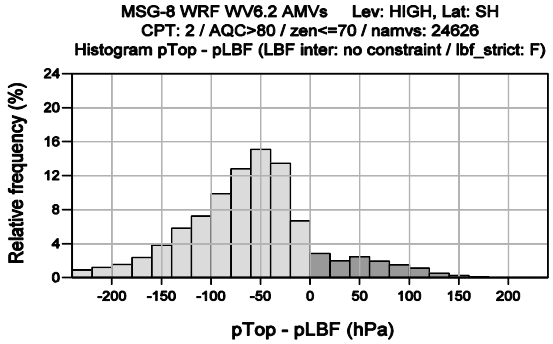
TR





SH





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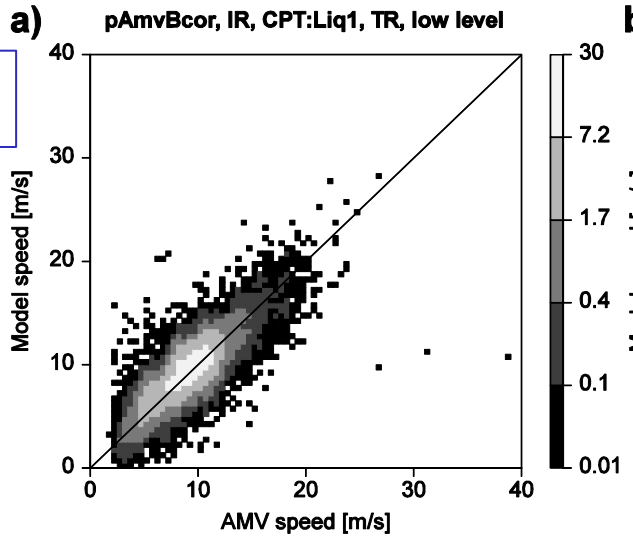
Stats for different AMV interpretations: low level / IR10.8

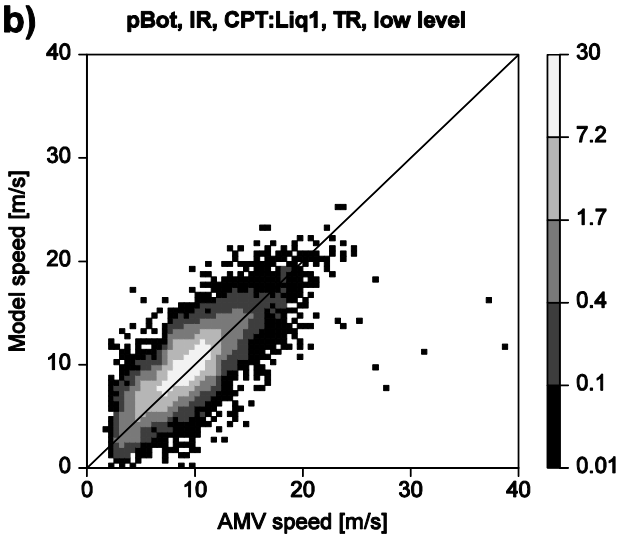
WRF IR10.8 AMVs: LOW LEVEL, QI > 80%, LIQ1						
	NH	TR	SH	NH	TR	SH
Number	6116	61731	24132			
AMV speed (m/s)	8.5	9.0	8.2			
	Speed bias (m/s)			RMSVD (m/s)		
pAmvBcor	-0.2	0.3	0.0	2.3	2.2	2.4
pBot	-0.3	-0.5	-0.1	2.6	2.4	2.5
pTop	-0.2	0.1	-0.1	2.5	2.7	2.8
pMean	-0.2	-0.5	-0.3	2.2	2.1	2.3
VerAve	-0.1	-0.4	-0.1	1.8	1.6	1.8

Stats for different AMV interpretations: low, IR10.8, TR, LIQ1, speed

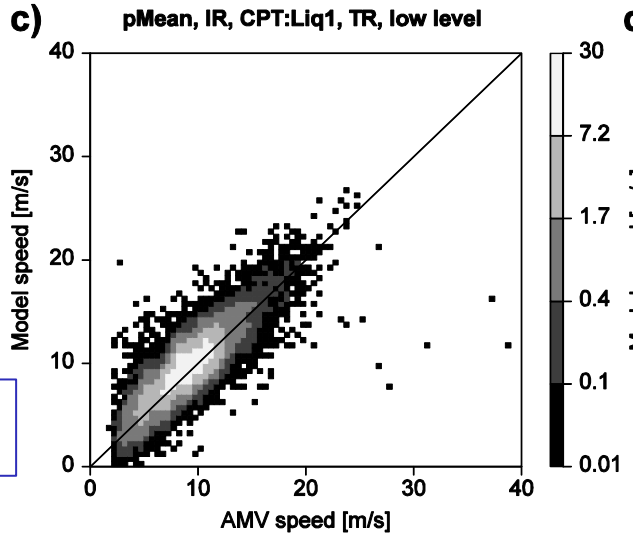
pAmvBcor



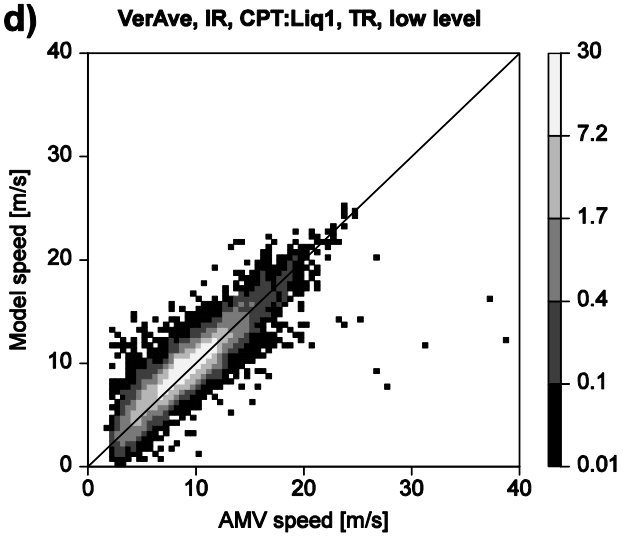
pBot



pMean



VerAve



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Conclusions

- **Alternative interpretations of high level AMVs (and ice clouds):**
  - **Assignment to pTop:**
    slow speed bias and large RMSVD – very similar to pAmv!
  - **Best agreement when AMVs are interpreted as**
    - **the wind at a level within the cloud (pMean) or**
    - **an average wind over the cloud (VerAve).**
  - **For deep cloud layers, it is beneficial to limit the pressure interval to the top part of the cloud layer (e.g. 100 hPa)**
    - **Best: pMCap, VerAveCap.**

Conclusions

- **Alternative interpretations of low level AMVs and liquid water clouds:**
  - **Best when AMVs are interpreted as layer averages of wind (VerAve).**
  - **AMVs interpreted as a wind at a level within the cloud (pMean) is second best.**
  - **AMVs interpreted as wind at the cloud top (pTop) or at the cloud bottom (pBot) worse (and similar to each other).**

Food for thought

- **Potential implications for use of real AMVs as single-level wind observations:**
  - **Current situation:**
    - **General cloud top products are increasingly used for HA of AMVs at high levels.**
    - **Users interpret the assigned pressure as representative height.**
  - **Would it be beneficial to re-assign AMVs to a lower height? Should users do an empirical height correction?**
  - **Should AMV producers instead aim to estimate the representative height, rather than the cloud top?**
- **AMVs as layer-averages?**
  - **How do we determine the best layer to average over for each AMV when we do not have the full cloud information?**

Thank you for your attention

Any questions?

References

- Bormann et al., 2014: Atmospheric Motion Vectors from Model Simulations. Part I: Methods and Characterization as Single-Level Estimates of Wind. Journal of Applied Met. and Climatology, vol 53, pp 47-64.
- Hernandez-Carrascal and Bormann, 2014: Atmospheric Motion Vectos from Model Simulations. Part II: Interpretations as Spatial and Vertical Averages of Wind and Role of Clouds. Journal of Applied Met. and Climatology, vol 53, pp 65-82.
- Otkin et al. 2009: Validation of a Large-Scale Simulated Brightness temperature Dataset Using SEVIRI Satellite Observations. J. Appl. Meteor. and Clim., 48, 1613-1626.
- Skamarok et al. 2005: A description of the Advanced Research WRF version 2. NCAR Tech. Note TN-4681STR, 88 pp.

Details

- **WRF simulation details:**
  - Forecast model: v 2.2 of the WRF regional model (Skamarok et al., 2005).
    - Model area: 58.5 N / 80 W / 58.5 S / 80 E.
    - Horizontal res: 3 km at equator to 1.7 km at N and S boundaries.
    - 52 vertical levels, model top at 28 hPa.
    - Clouds explicitly resolved.
  - Existing simulation used (Otkin et al., 2009), kindly provided by CIMSS (Steve Wanzong).
  - Simulation is a 6-30 h forecast – spin up period 6 h.
  - Initialization: 15 Aug 2006 at 18 UTC from 1 deg analyses from GDAS.
  - Study period is 24 h starting 16 Aug 2006 at 00.

Details

- **Clouds from the model:**
  - **Neighbourhood considered cloudy at a model level if:**
    1. **the % of cloudy grid points is 15 % or more, and**
    2. **the ice (or liquid water) mixing ratio is at least 10-4 g/kg.**
  - **WV6.2 images: cloud levels below 700 hPa ignored.**