Investigation of low level AMV height assignment

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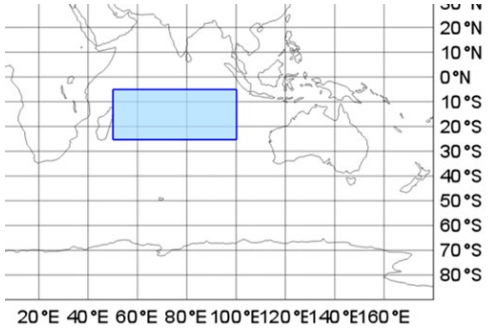
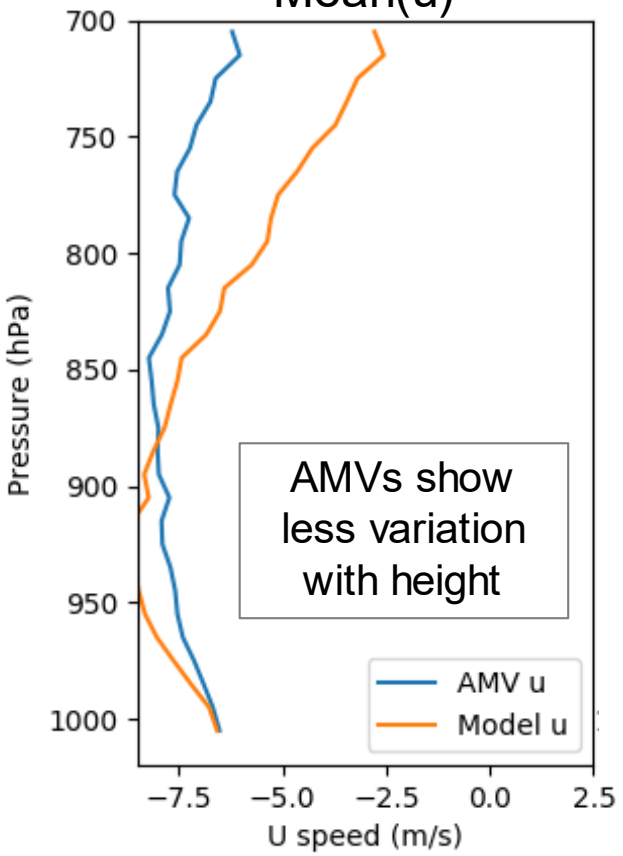
ECMWF

Motivation: Indian Ocean low level height assignment issues



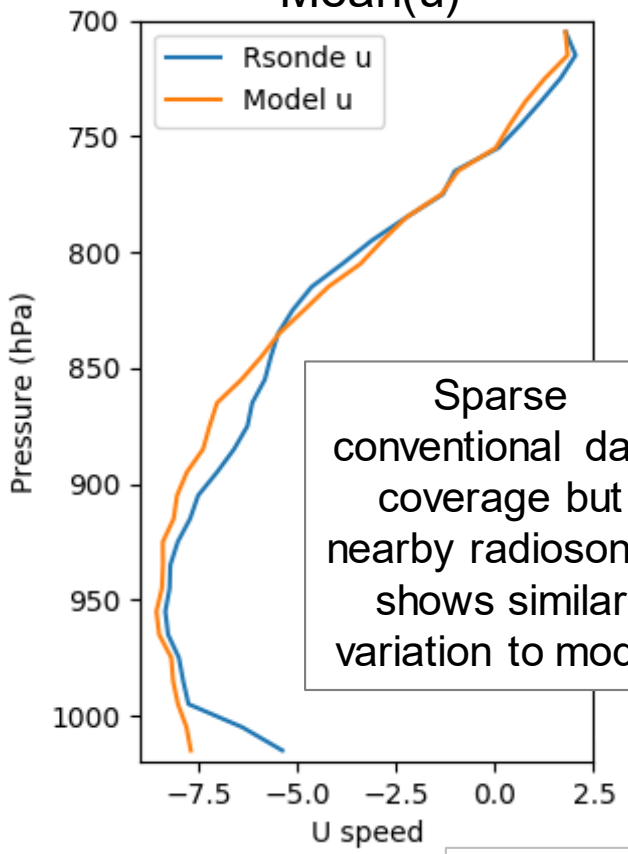
Are some AMVs around 850-700hPa being placed too high?

Met-8 visible AMVs
Mean(u)



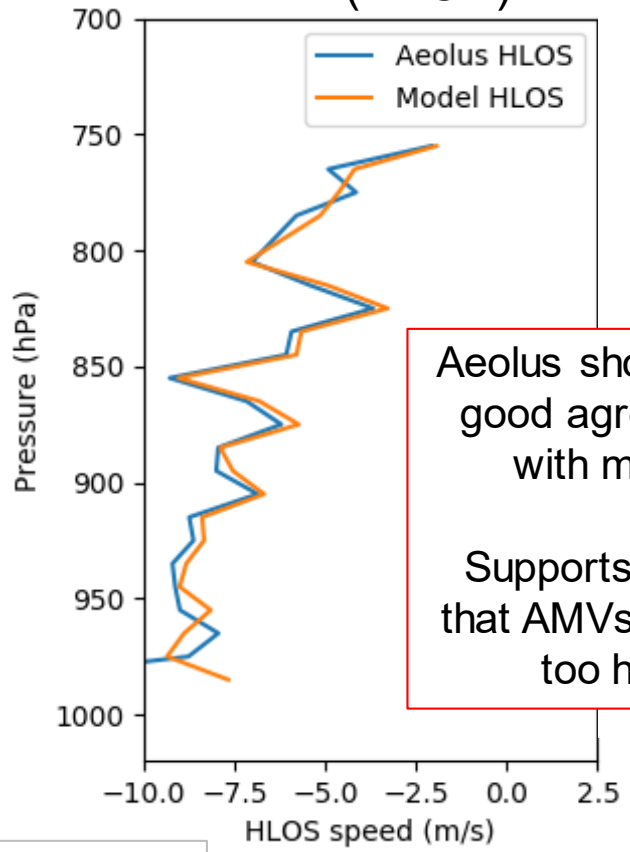
AMVs show less variation with height

Radiosonde
Mean(u)



Sparse conventional data coverage but nearby radiosonde shows similar variation to model

Aeolus (ascending)
Mean(HLOS)



Aeolus shows very good agreement with model

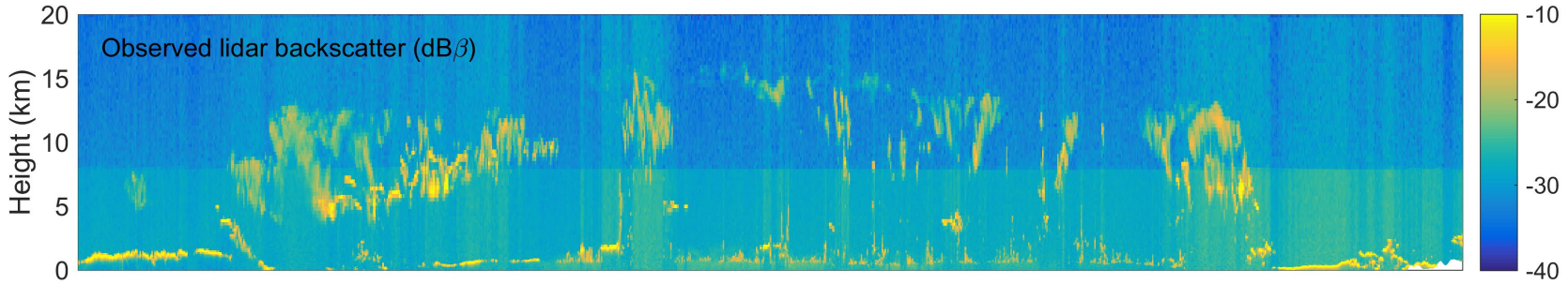
Supports theory that AMVs may be too high

14 Sept – 13 Oct 2018
'Average profiles'

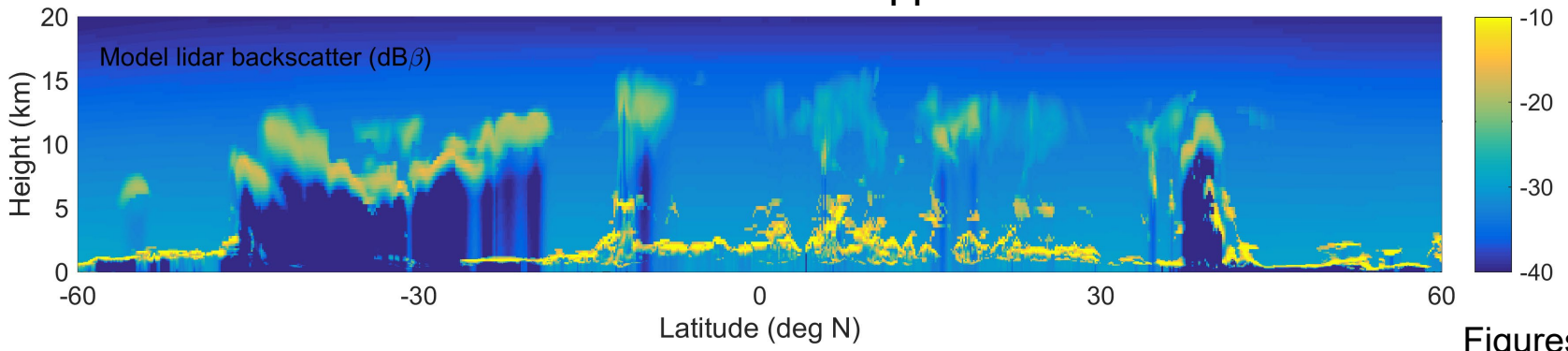
Using model cloud layer estimate to investigate AMV data quality

- Collocate AMV with model profile of cloud/temperature/humidity variables from short range forecast from previous 12-hour cycle
- Estimate location of cloud layer using criteria in IFS:
  - Cloud liquid water or Cloud ice water > 10^{-6} and cloud cover fraction > 1%

Calipso lidar backscatter averaged to model grid



Modeled backscatter - Double-column approach



Good agreement between model and Calipso, though some regional systematic errors may exist

Figures courtesy of Mark Fielding, ECMWF

Using model cloud layer estimate to investigate AMV data quality

- Collocate AMV with model profile of cloud/temperature/humidity variables from short range forecast from previous 12-hour cycle
- Estimate location of cloud layer using criteria in IFS:
  - Cloud liquid water or Cloud ice water > 10^{-6} and cloud cover fraction > 1%
- Cloud detected with AMV in ~80% cases
- Define layers of cloud and investigate assigned height of AMV in relation to cloud
- Define thin cloud as depth < 100hPa

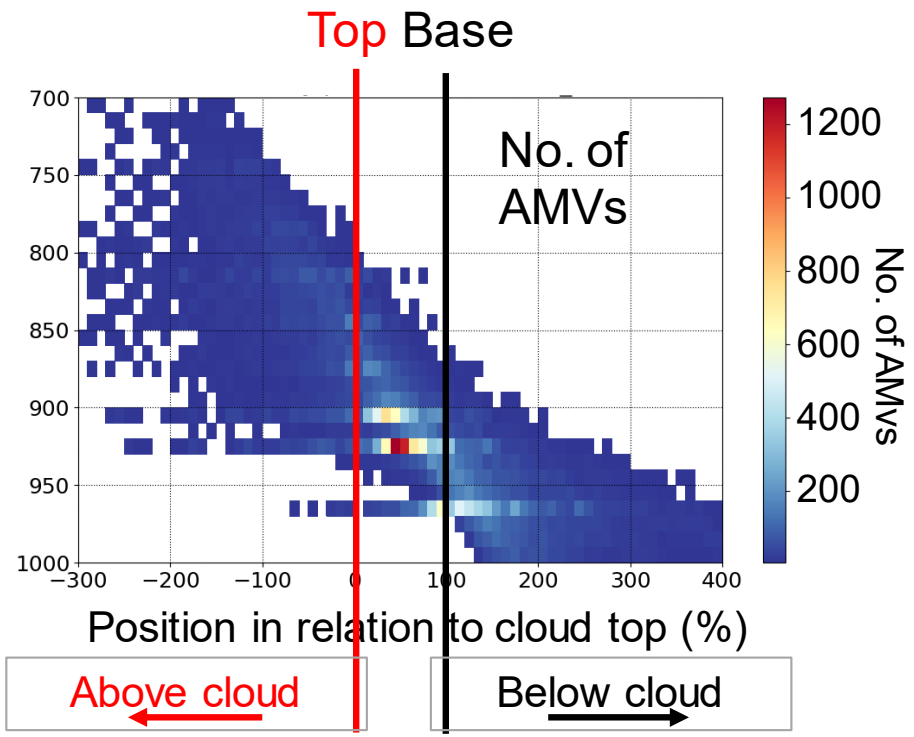
In this talk:

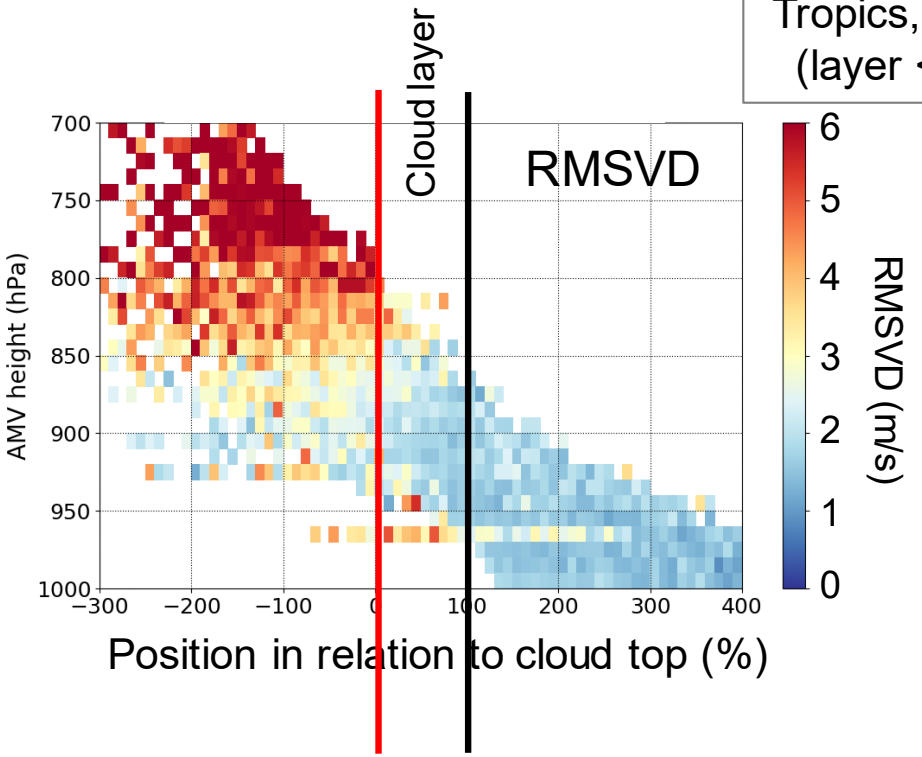
Assess first using background departure statistics (O-B)

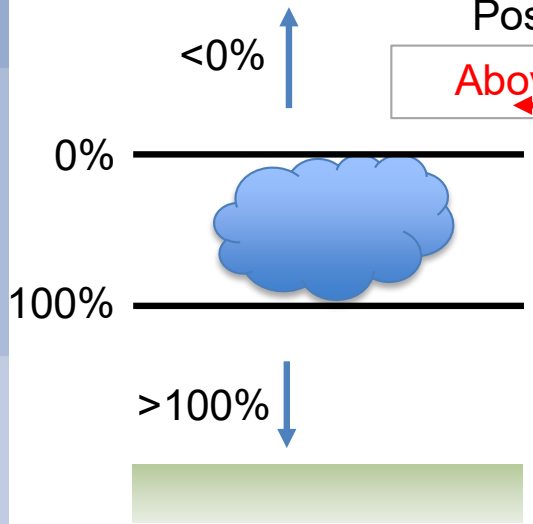
Assimilation experiments to evaluate forecast impacts from new AMV processing

Potentially negative impacts for AMVs above cloud

Meteosat-8 QI>85,
1-5th October 2018
Tropics, thin clouds
(layer < 100hPa)







More sensitivity to height assignment errors in regions of greater wind shear above cloud

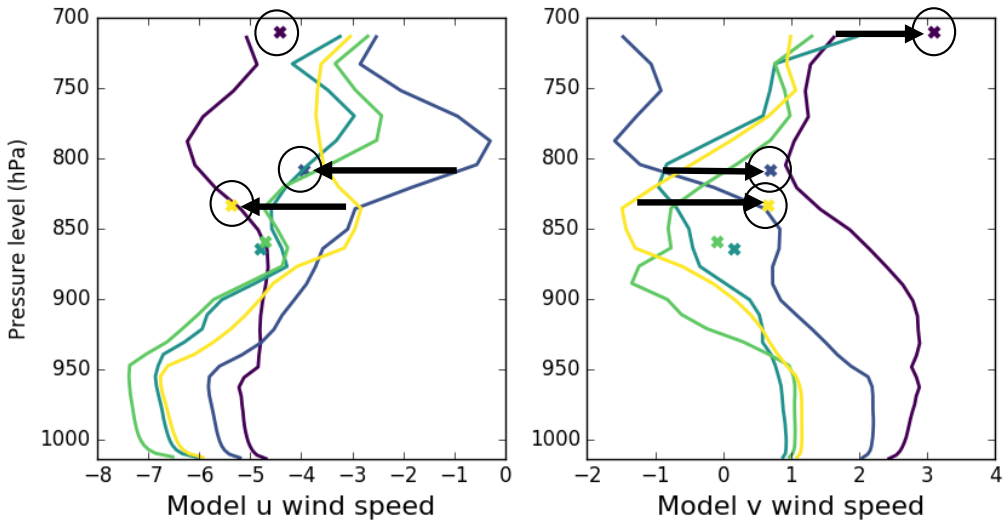
Improved statistics reassigned to cloud top/base/average pressure?

Reassign if assigned height is above model cloud and 700<P<900hPa

Example model wind profiles show potential issues

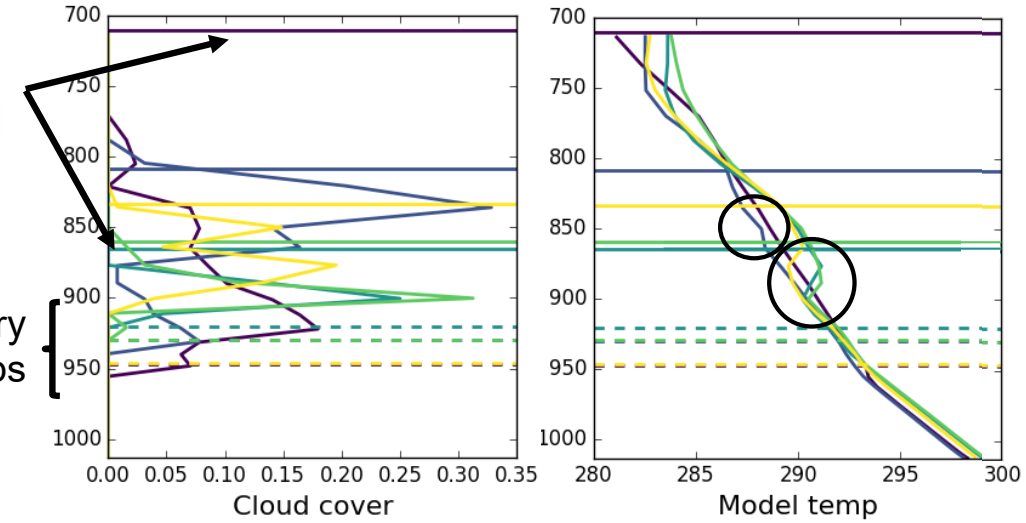
Met-8 IR 5z
04/01/2018 20-25S,
65-70E

Wind shear increases above boundary layer



Some AMVs are faster than model equivalent

AMVs are sometimes placed above where model diagnoses cloud



Is there a link with locating temperature inversions?

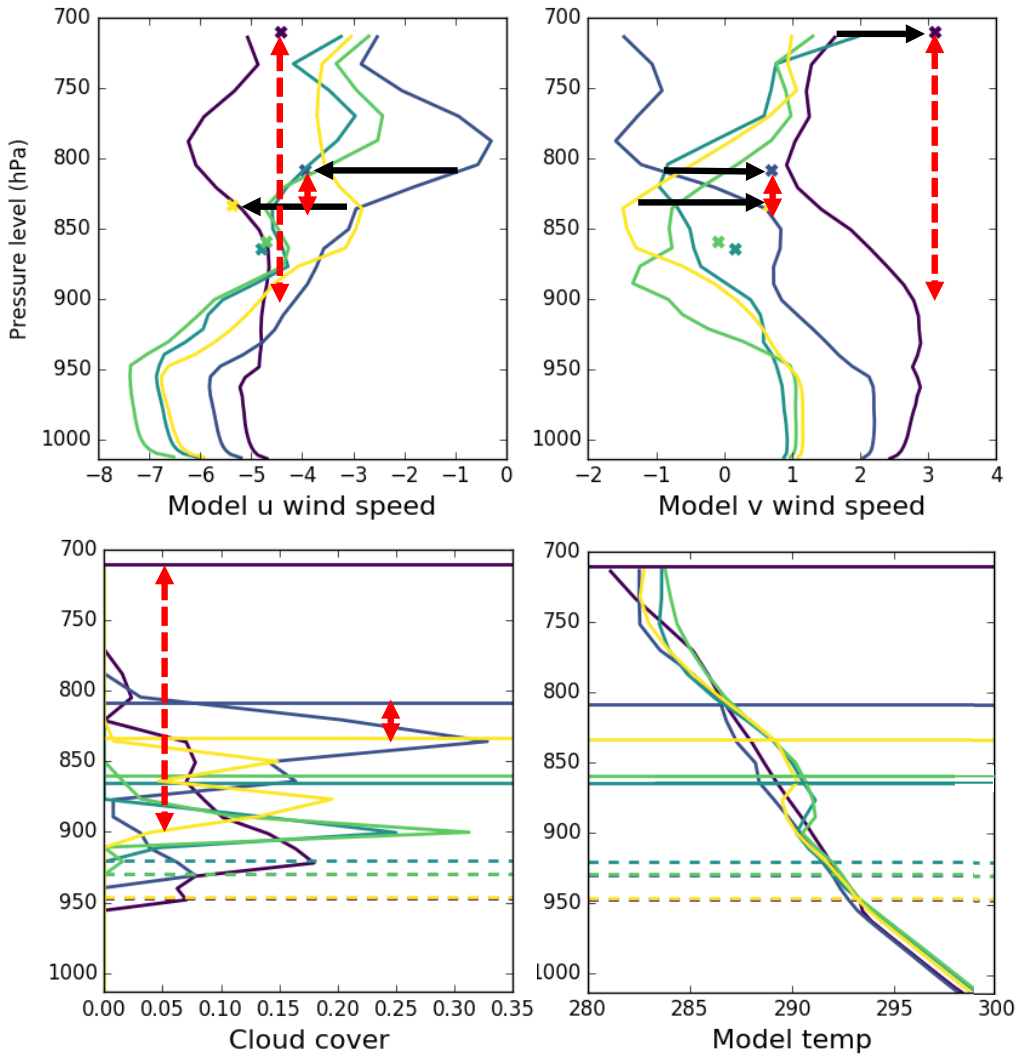
Screening or reassigning the height?

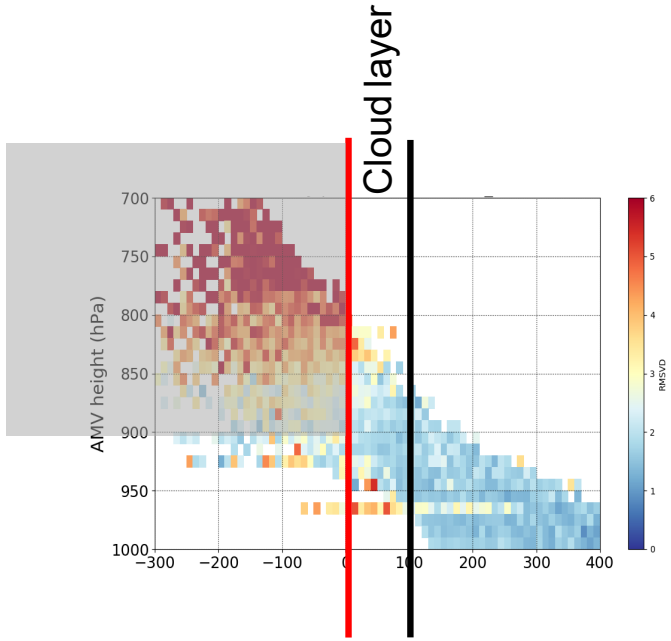
Met-8 IR 5z
04/01/2018 20-25S,
65-70E

Improved statistics if screened or reassigned to cloud top/base/average pressure?

Reassign/reject if assigned height is:

- above model cloud
- 700<P<900hPa



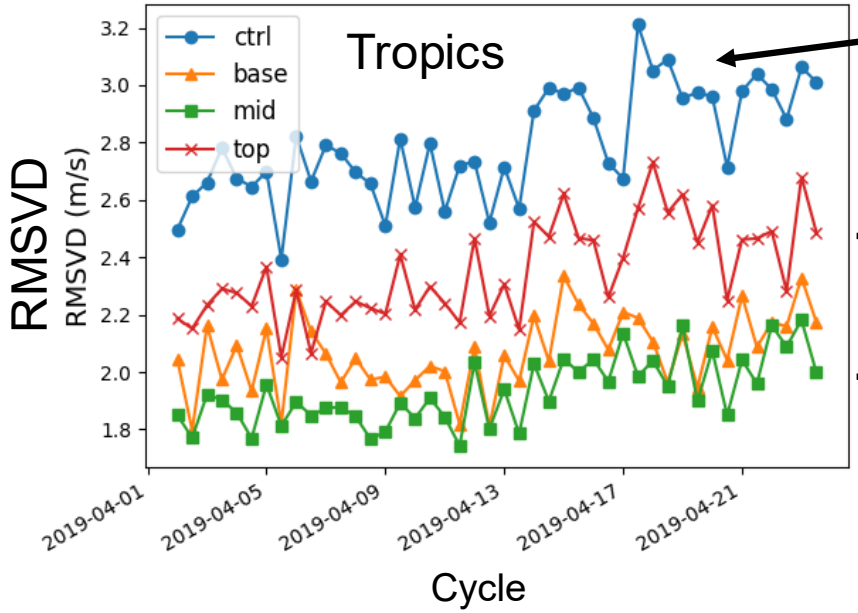


Reassigning AMVs using model cloud may be more beneficial

AMVs above model cloud only

- Reassign AMV height to collocated cloud top/base or average pressure

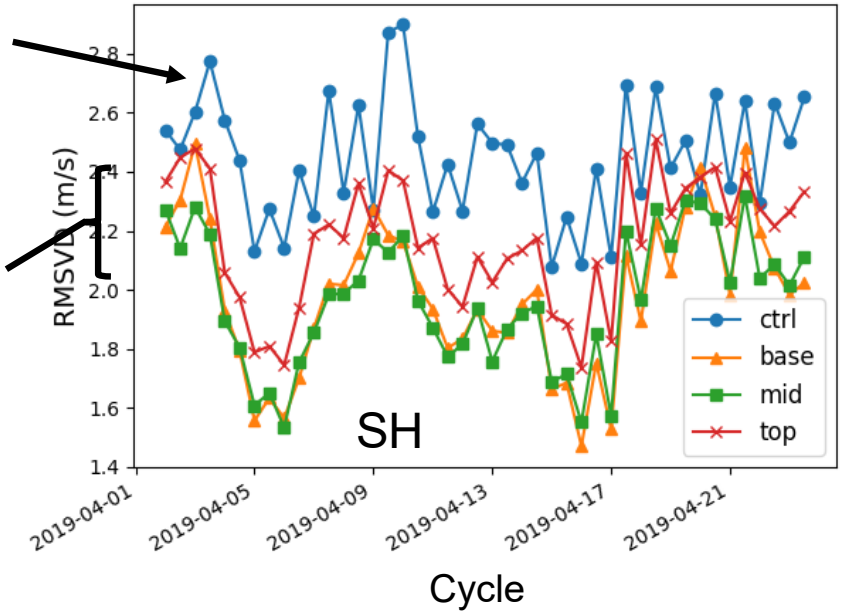
Met-8 Vis (with 1st guess screening)



Original assignment has higher RMSVD

Values lower when height reassigned to model cloud

GOES-16 Vis (with 1st guess screening)



Departure statistics encouraging for height reassignment

Assimilation experiments to test different reassignment options and apply to all geo satellites

Compare to control with original heights

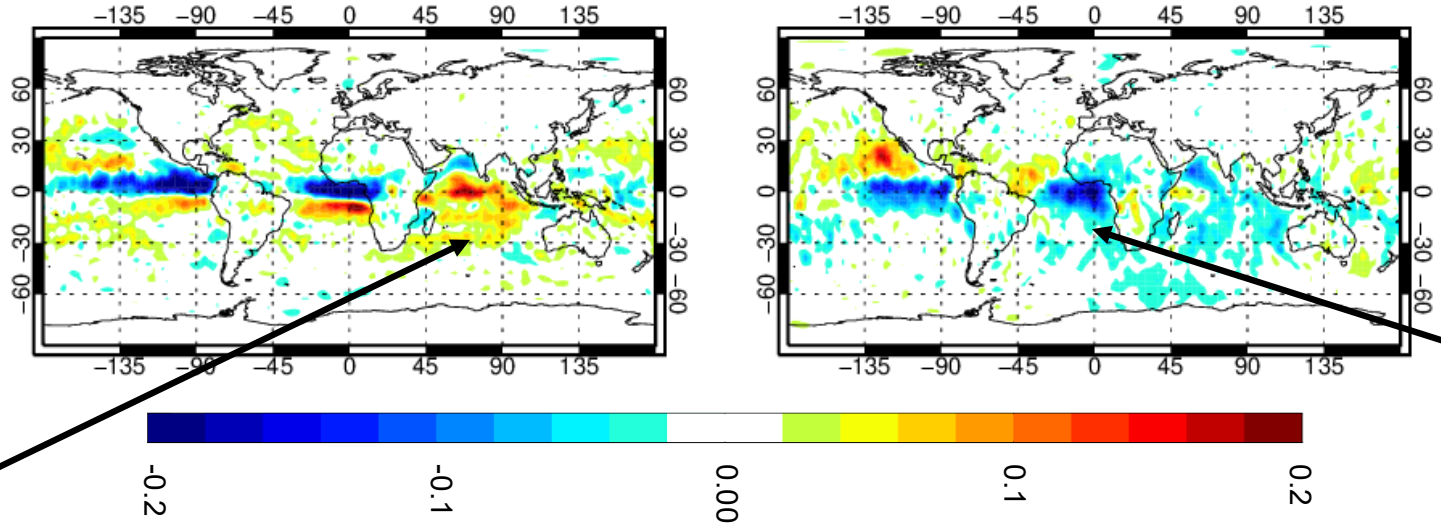
Changes in mean analysis wind fields

1st Dec 19 – 31st Mar 20 + 20th Jun – 30th Sept 19 (~7.5 months)

Reassigned to average cloud pressure vs. ctrl

Mean U diff 850hPa

Mean V diff 850hPa



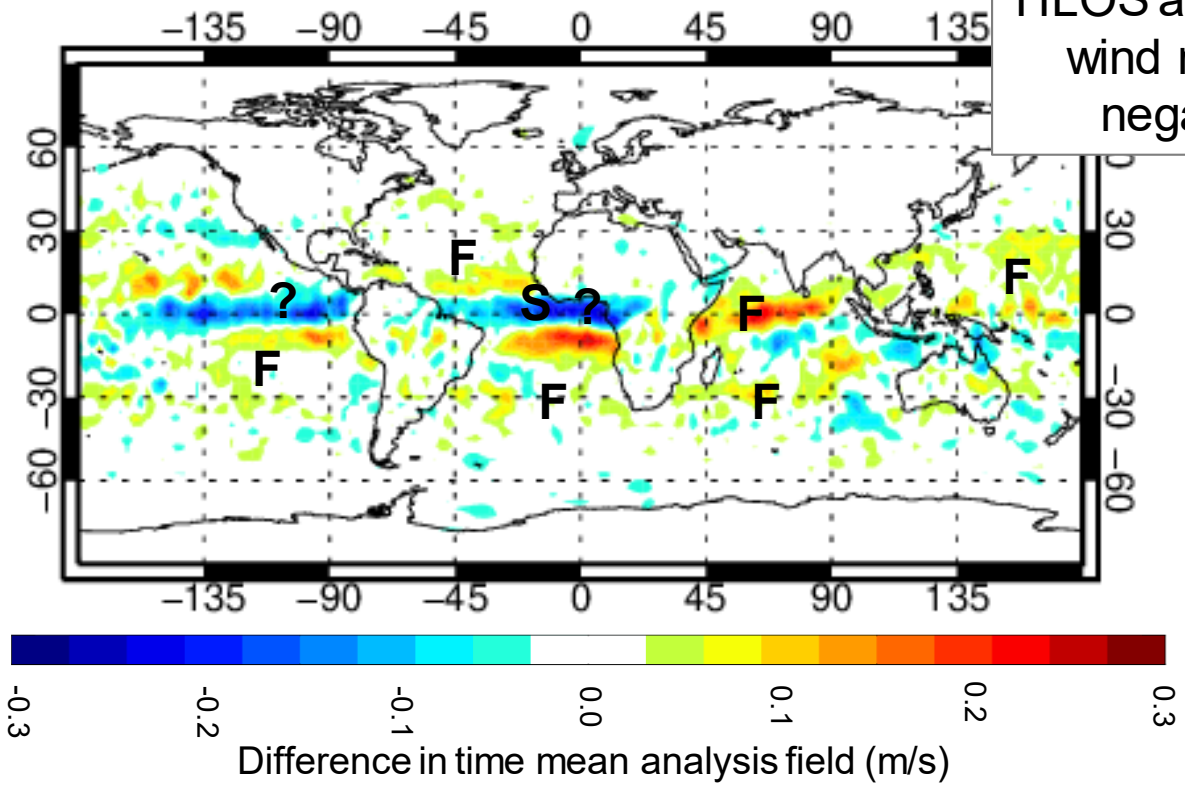
Zonal flow slowed in Indian Ocean

Weakens low level convergence in tropical Atlantic and East Pacific – effects on humidity and cloud formation?

Aeolus also indicates similar areas where control "too fast"

19th Jan – 31st Mar 2020

Mean U diff 850hPa

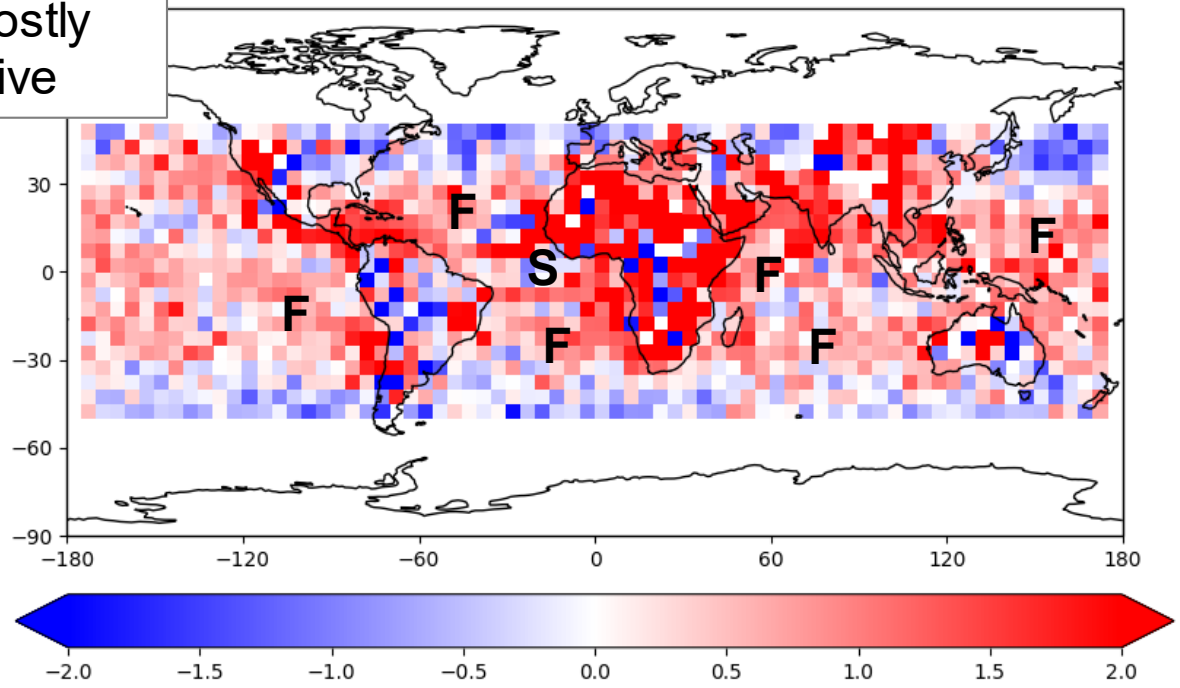


Difference in time mean analysis field (m/s)

In tropics asc. HLOS and zonal wind mostly negative

Aeolus **Ascending** orbit
Mean HLOS analysis departure for control

9th Jan – 31st Mar 2020, Mie only, 800-900hPa



Mean HLOS observation - analysis (m/s)

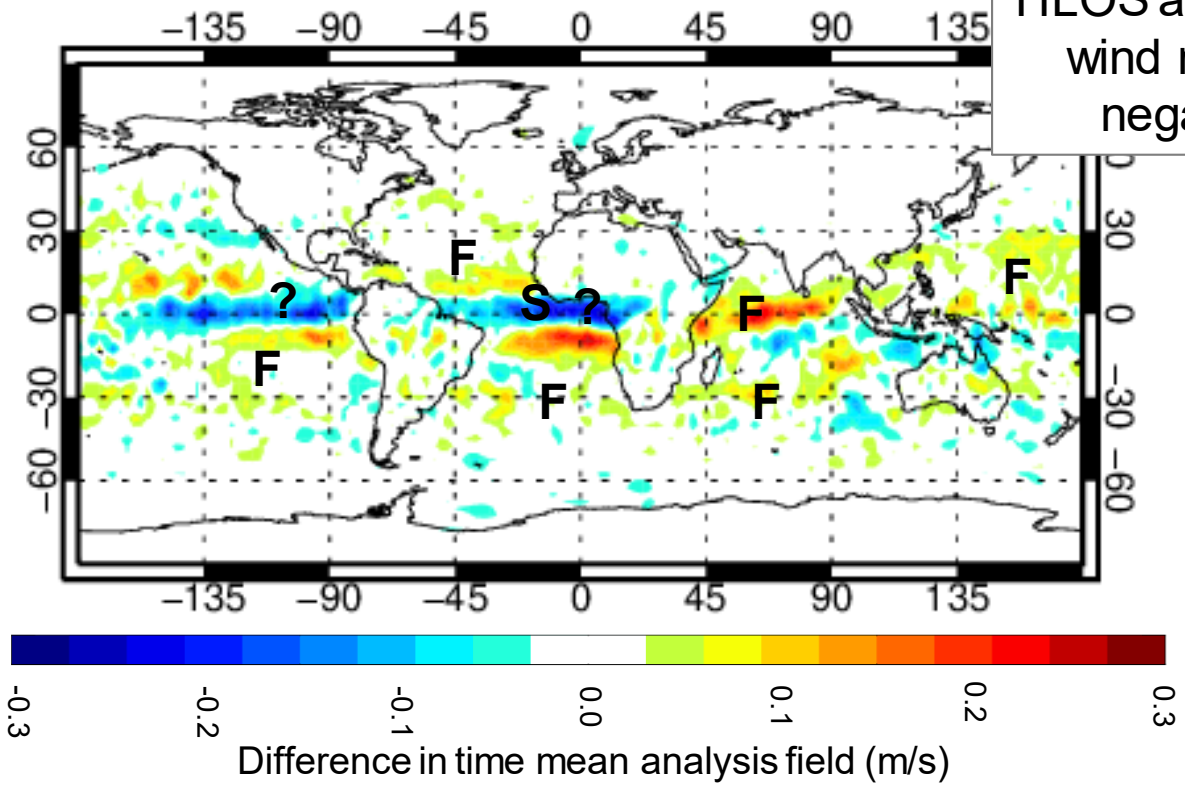
Red = ctrl faster than expt/asc Aeolus -> ctrl too fast? (F)
Blue = ctrl slower than expt/asc Aeolus -> ctrl too slow? (S)

HLOS = Horizontal Line Of Sight

Aeolus also indicates similar areas where control "too fast"

19th Jan – 31st Mar 2020

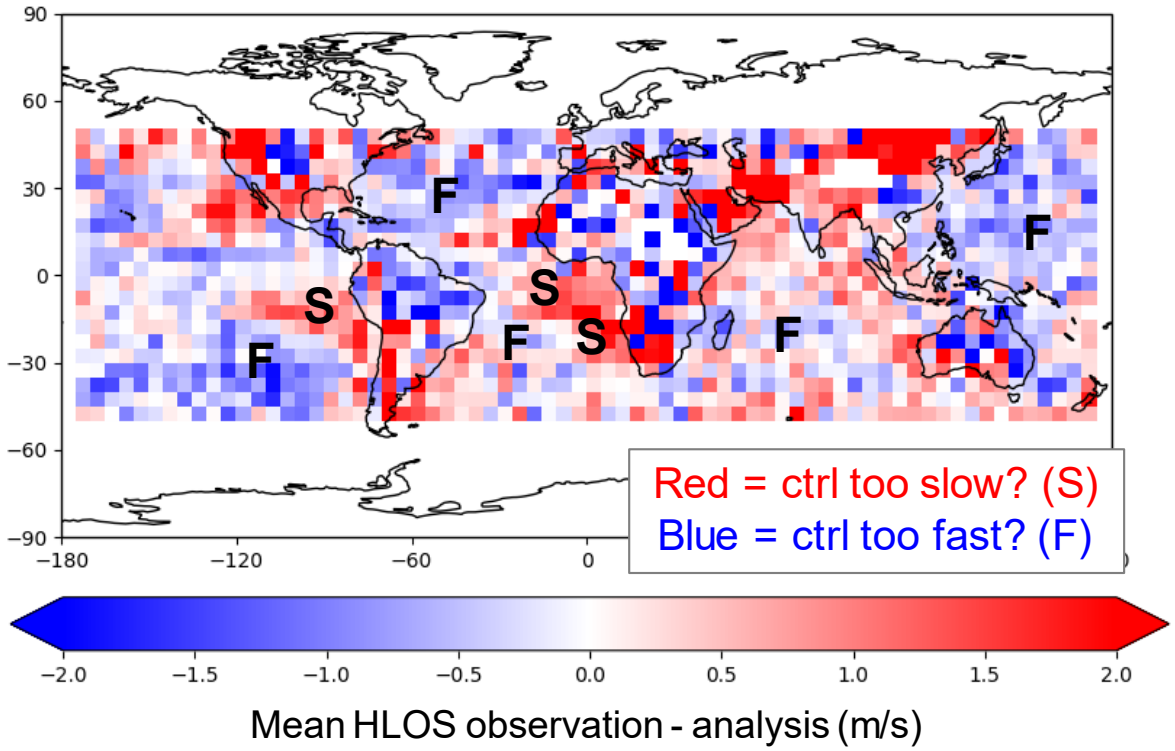
Mean U diff 850hPa



In tropics asc. HLOS and zonal wind m nega

Aeolus **Descending** orbit Mean HLOS analysis departure for control

9th Jan – 31st Mar 2020, Mie only, 800-900hPa



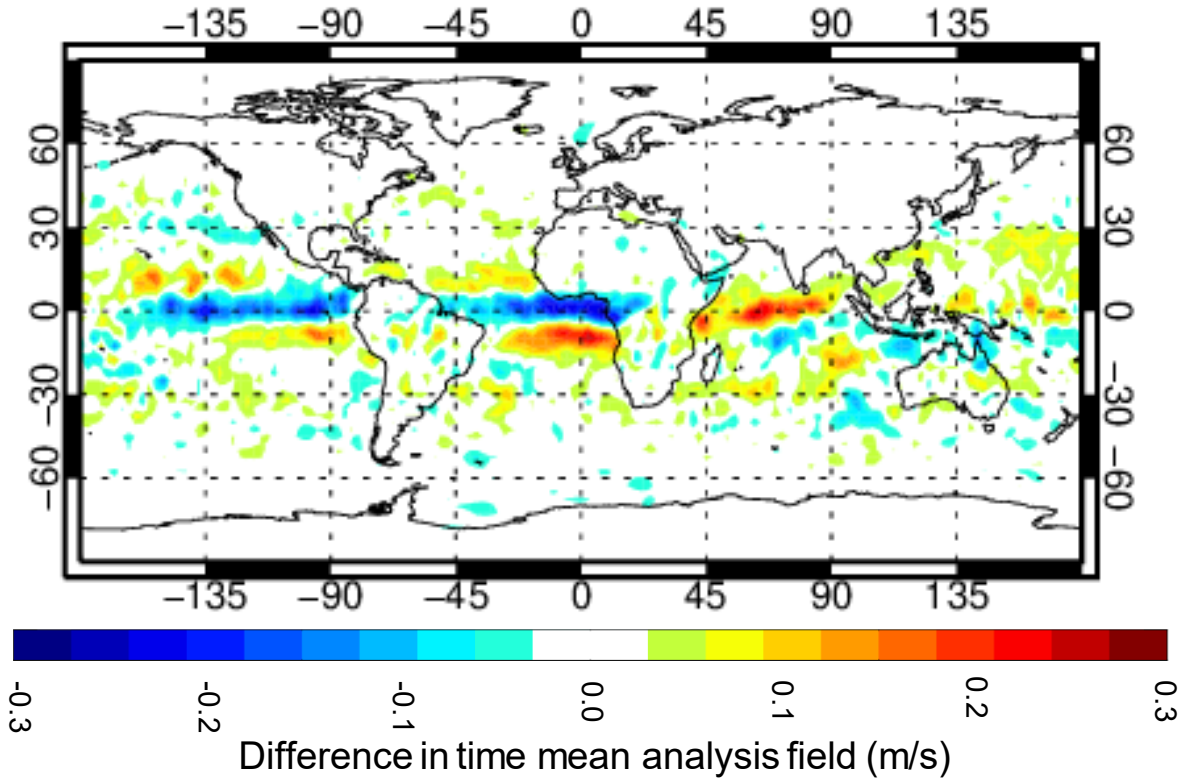
Red = ctrl faster than expt/asc Aeolus -> ctrl too fast? (F)
Blue = ctrl slower than expt/asc Aeolus -> ctrl too slow? (S)

Differences in Aeolus ascending/descending O-A (orbital bias)
Both asc./desc. O-A support AMV change slowing areas of analysis
But less consistent for areas where AMV increases analysis speed

Aeolus provides support for analysis changes

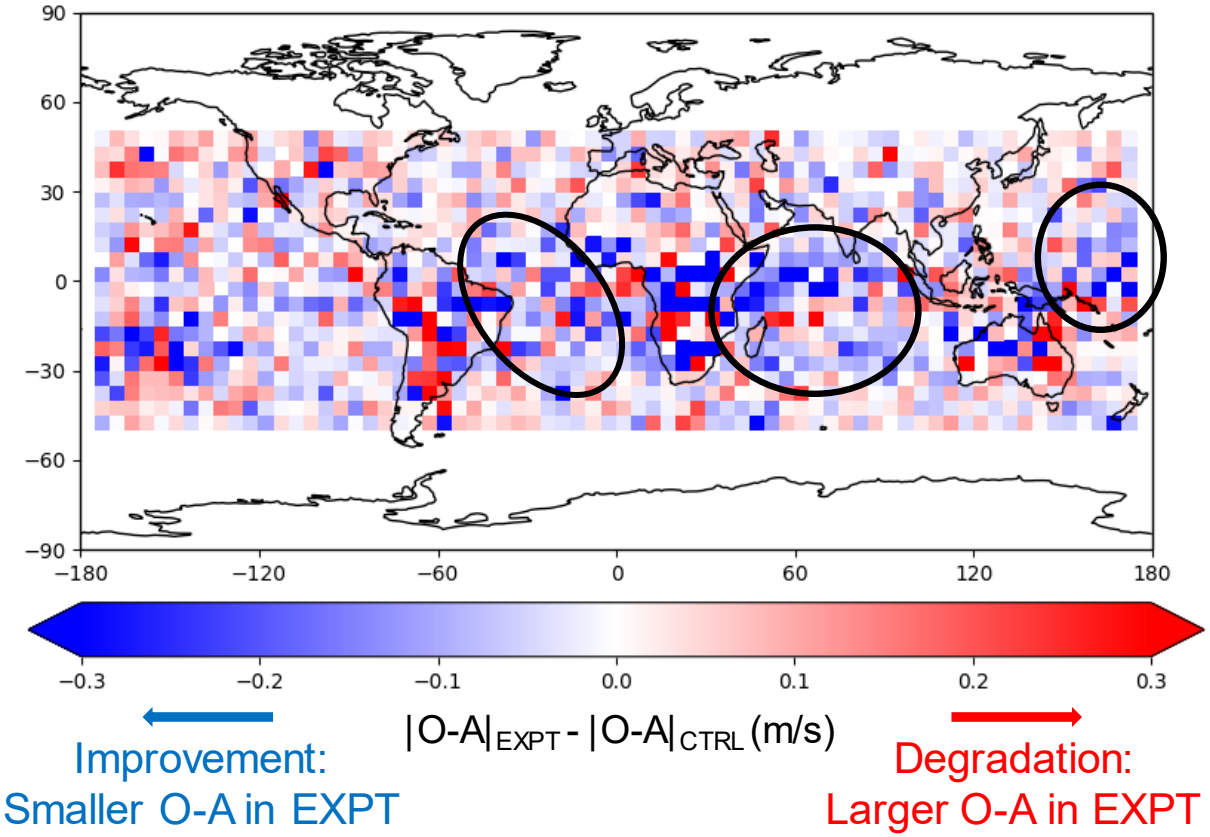
19th Jan – 31st Mar 2020

Mean U diff
850hPa



Aeolus **Ascending** orbit
Mean diff HLOS analysis departure
$abs(O\text{-}A)_{EXPT} - abs(O\text{-}A)_{CTRL}$

9th Jan – 31st Mar 2020, Mie only, 800-900hPa



Improvement:
Smaller O-A in EXPT

Degradation:
Larger O-A in EXPT

Reduction in O-A to support changes due to AMV processing
Changes in descending O-A more neutral - differences due to orbital bias?

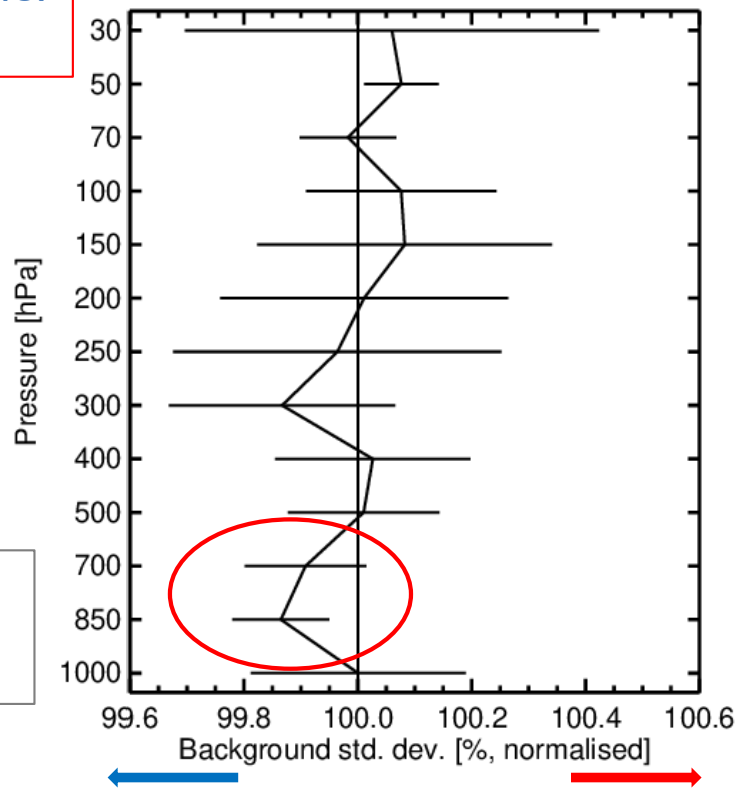
Small positive changes for wind and humidity observations

- Aeolus and scatterometer winds show improvements in tropics
- Little impact on conventional obs…but main changes are ocean based

1st Dec 19 – 31st Mar 20 + 20th Jun – 30th Sept 19 (~7.5 months)

Reassigned to average cloud pressure vs. ctrl

Aeolus (Mie Cloudy + Rayleigh Clear) Tropics



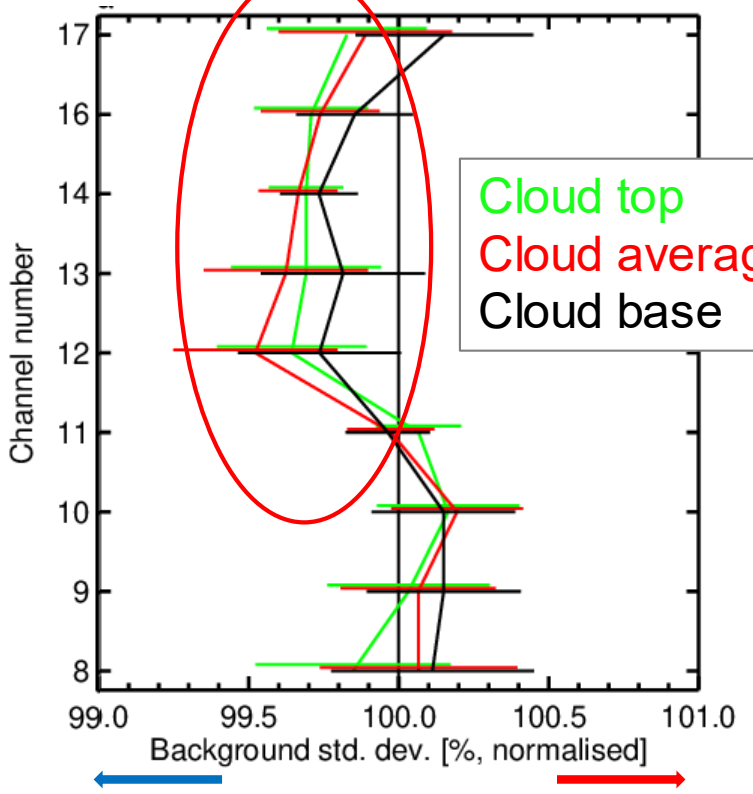
9th Jan – 31st Mar 2020

Improvement

Degradation

SSMIS used in all sky -> cloud improvements likely dominate change

SSMIS tropics MW Imager/Sounder



Improvement

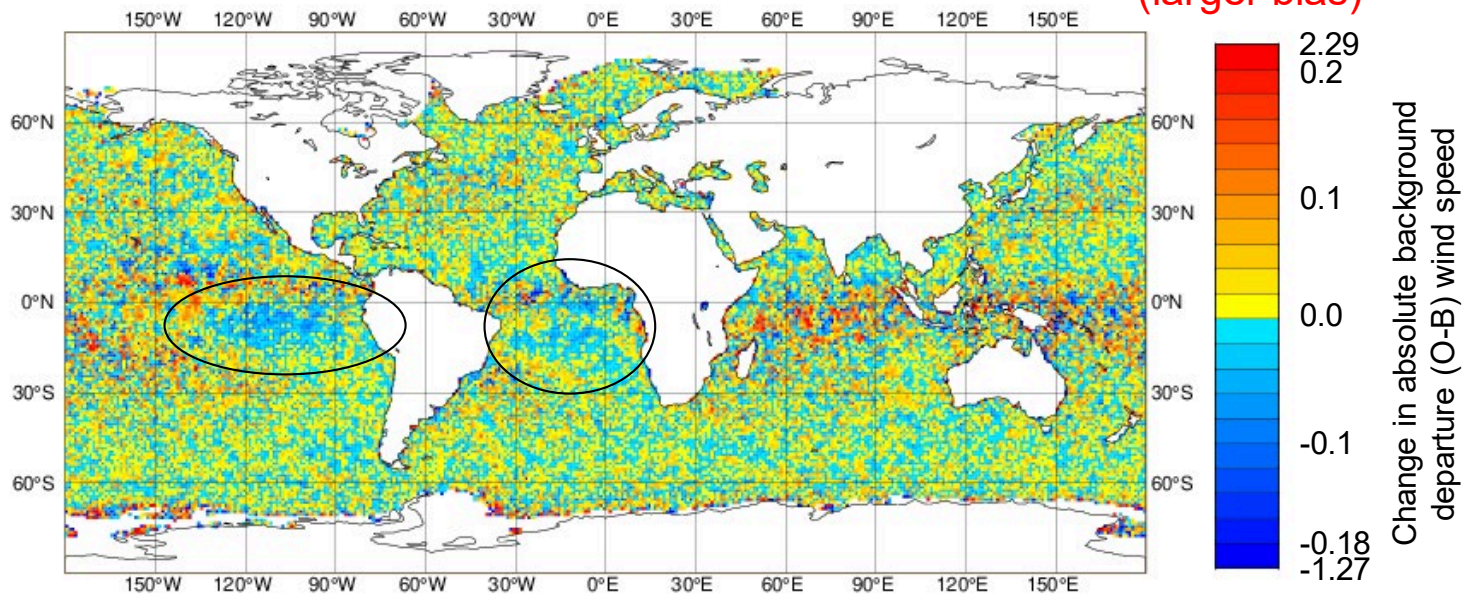
Degradation

Small reductions in tropical scatterometer speed bias

- Reduction in speed bias magnitude in Atlantic/East Pacific tropical areas
- Impact of changes to AMVs propagating to surface

Reassigned to average cloud pressure vs. ctrl

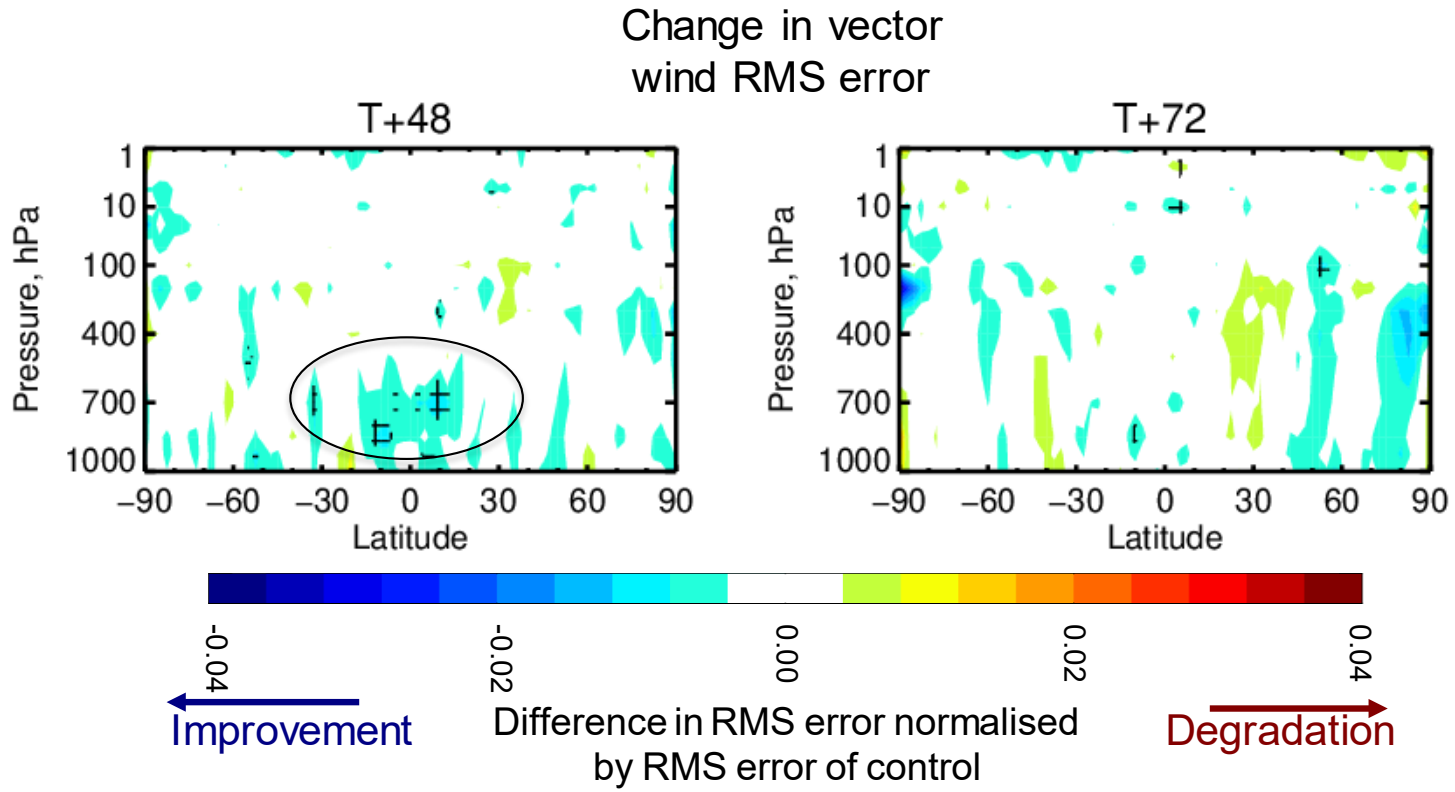
Metop-B ASCAT
Change in speed bias (O-B)
(1st Dec 19 – 31st Mar 20)



Positive impacts in tropics from reassignment

1st Dec 19 – 31st Mar 20 + 20th Jun – 30th Sept 19 (~7.5 months)

Reassigned to average cloud pressure vs. ctrl



Reduction in RMS error (mainly over tropical ocean)

Impact smaller for reassigning to top of cloud

Overall results using cloud average pressure/base performing generally better

Summary and next steps

- Comparison with model cloud suggests AMVs placed too high could be more detrimental
- Reassigning height using model cloud improves statistics
- Assimilation experiments show promising results
- Combining results from initial departure analysis and assimilation expts, cloud average pressure performs best
- Submitted for operational implementation in future model cycle: **Reassigning low level AMVs diagnosed above model cloud to average pressure of cloud layer**

Thank you for listening!