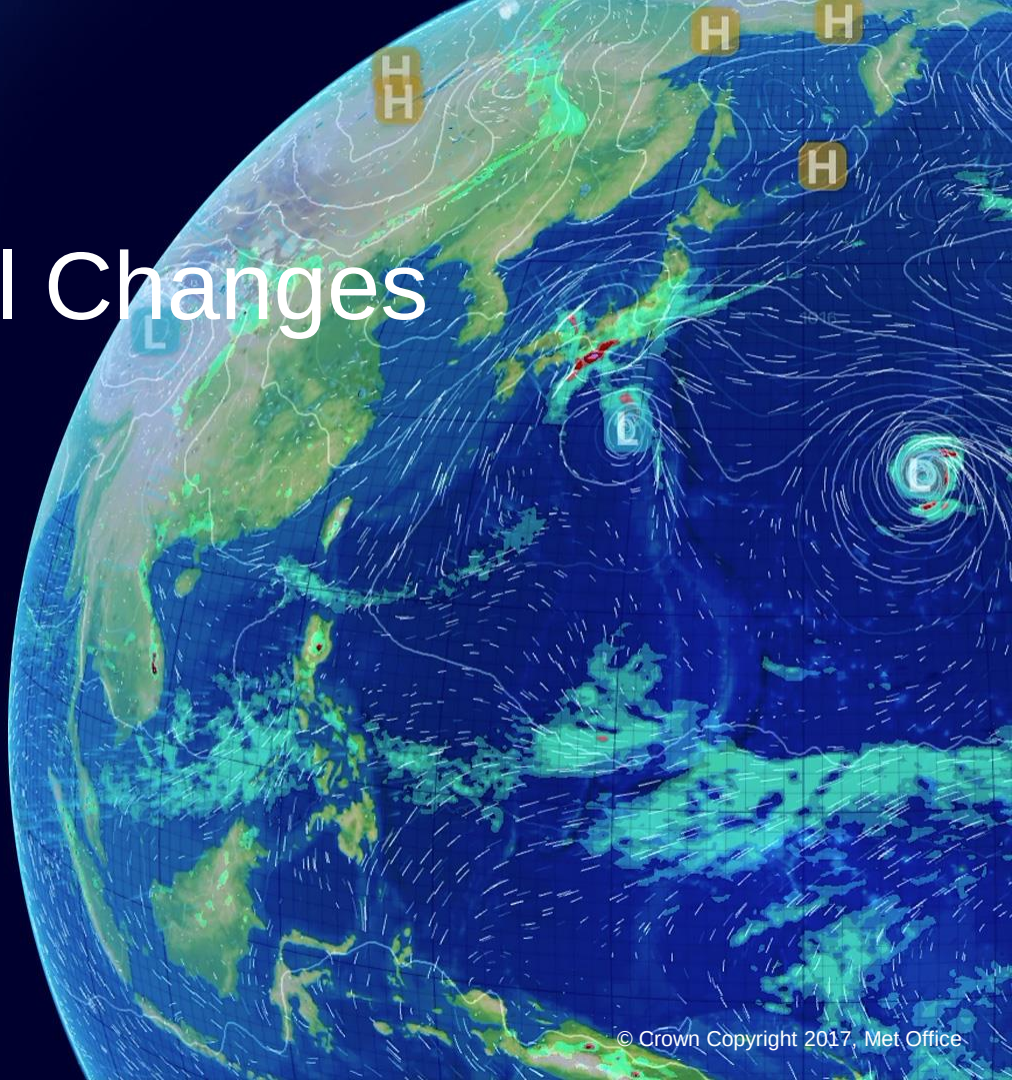
AMV Quality Control Changes

James Cotton

October 2017



Outline

- QI2 migration & updated thresholds
- Background check
- Minimum speed

Motivation

- Quality Indicator (QI) values supplied with AMVs
  - QI1 (*with* first-guess check against ECMWF, GFS, JMA)
  - QI2 (*without* first-guess check)
- Migrate from QI1 to QI2 to remove check against other centres NWP forecast
- Update thresholds

Met Office

Which QI get distributed?

Satellite	Provider	QI1	QI2	RFF	Min Value QI2	Min Value QI1
GOES-13/15	NESDIS	✓	✓	✓	50	50
Meteosat-8/10	EUMETSAT	✓	✓		30	24
Himawari-8	JMA	✓	✓	✓	70	75
Metop	EUMETSAT	✓	✓		0	0
NOAA/Metop	CIMSS	✓=	✓=	✓	50* (60)	
NOAA	DB	✓	✓	✓	50	
Aqua/Terra	NESDIS	✓	✓	✓	50	
LeoGeo	CIMSS	✓	✓	✓	50	60
VIIRS	NESDIS		✓		0	-
VIIRS	DB	✓	✓	✓	50	

Met Office Thresholds

Satellite	QI	Chan	Extra-tropics (HL/ML/LL)	Tropics
GOES-13/15	QI1	IR WV	85/80/80 80	90 90
Meteosat-8/10	QI1	IR VIS WV	85/80/80 65 80	90 90 90
Himawari-8	QI1		85	85
Metop (EUM)	QI1		80	-
VIIRS*	QI2		60	-
LeoGeo	QI1		70	-

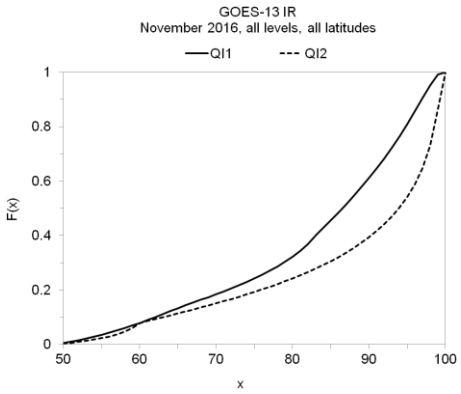
- Use QI1 for all data, except VIIRS
- Vary by channel and latitude band (tight in tropics..)
- QI2 is used to derive the vector error component for the individual observation error scheme

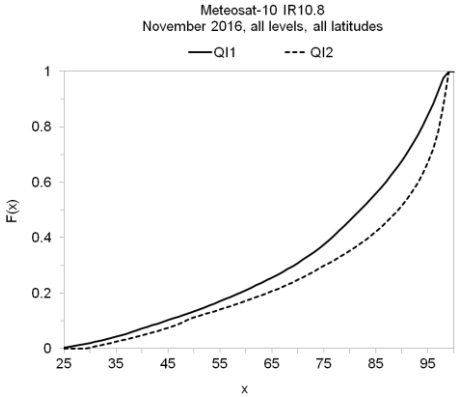
ECMWF Thresholds

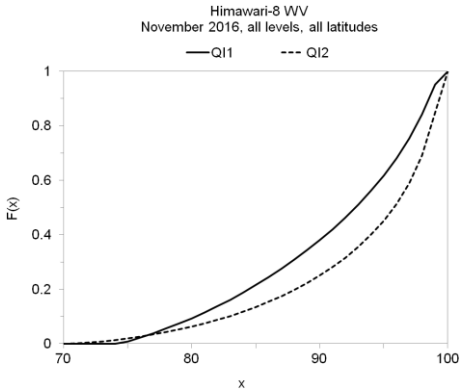
Satellite	QI	Threshold	Actively filtering?
GOES-13/15	QI2	50	N
Meteosat-8/10	QI2	85	Y
Himawari-8	QI2	70	N
Metop	QI2	60	Y
VIIRS*	QI2	60	Y
Other polar*	QI2	60	Y

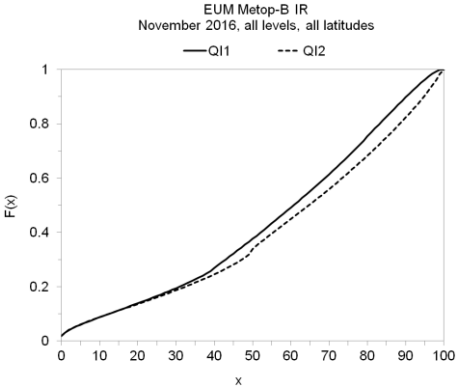
- Use QI2
- Essentially no filtering applied to GOES and Himawari-8 – just there to prevent unexpected data with lower QI appearing
- In spatial thinning winds are selected by highest QI2 value

Cumulative Distribution



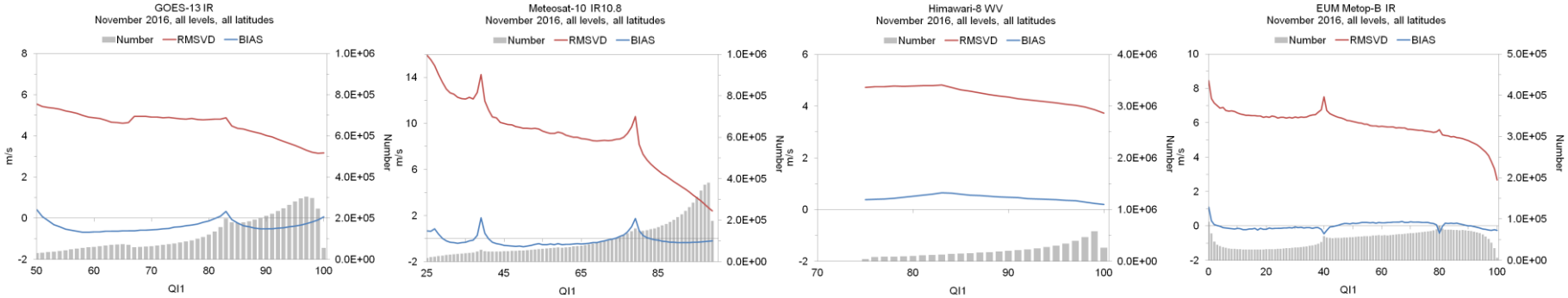






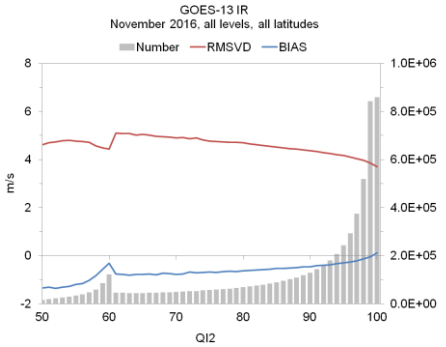
- QI2 has higher proportion of data that have high QI

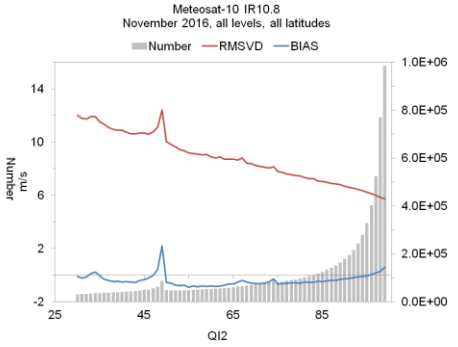
Bias and RMSVD by QI1

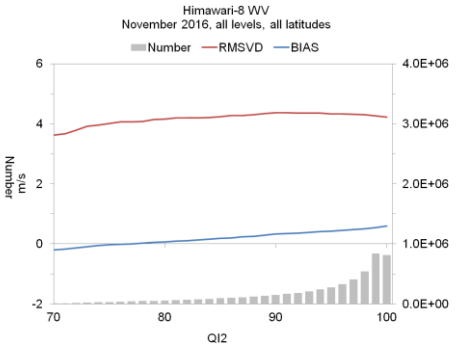


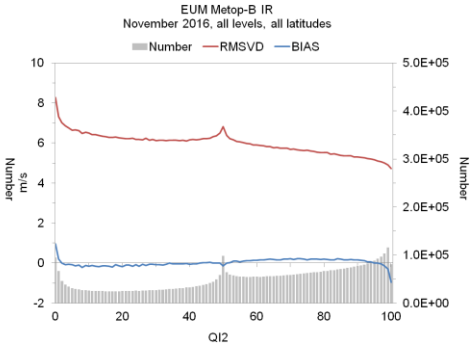
- GOES: downward trend in RMS for QI above 85, no trend in bias, ‘peak’ in stats at QI~83
- MSG: downward trend in RMS for QI>80, peak in stats for QI~39/79 (and ~26/53 for WV)
- Him-8: Slight downward trend in RMS
- Metop: trend in RMS

Bias and RMSVD by QI2









- GOES: slight trend in bias and RMSVD for QI > 60
- MSG: less ‘peaky’ and downward trend in RMSVD
- Him-8: flat
- Metop: less of a trend

QI Summary

- Distribution: QI2 has greater proportion with very high QI values
- QI2 less good at discriminating ‘good’ data – RMS trends flatter compared to QI1
- QI2 still useful for EUMETSAT data, esp. MSG
- QI2 less useful for GOES/LeoGeo/NPP, no use for Himawari-8

Impact Experiment – part I

N320 L70 UM, N108/N216 4D-VAR hybrid, PS38 baseline, VarBC

1 Nov – 31 Dec 2016

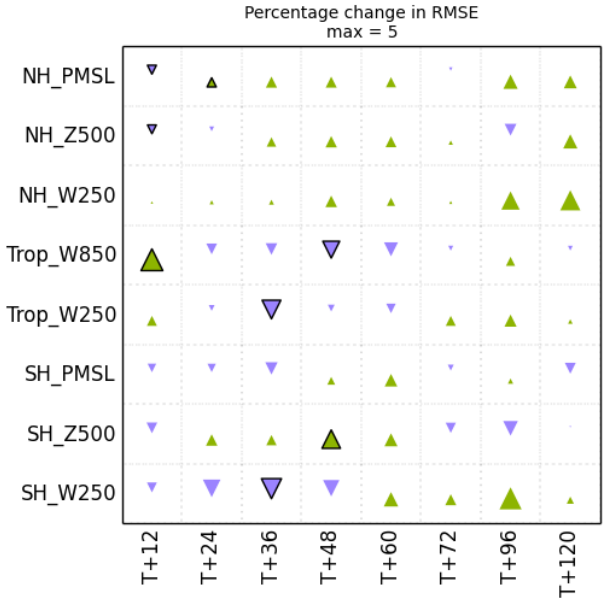
- Reference: QI1 operational thresholds (Met-8 IODC AMVs)
- Trial 1: QI2 operational thresholds
- Trial 2: QI2 ECMWF thresholds

Experiment	Reference	Days	Observations	Analysis	ECMWF
u-ak042 QI2 oper	u-ai607	60	-0.01 (0.01%)	-0.94 (0.69%)	+0.06 (0.04%)
u-ak043 QI2 ecmwf	u-ai607	60	-0.14 (0.13%)	-1.09 (0.80%)	+0.06 (0.05%)

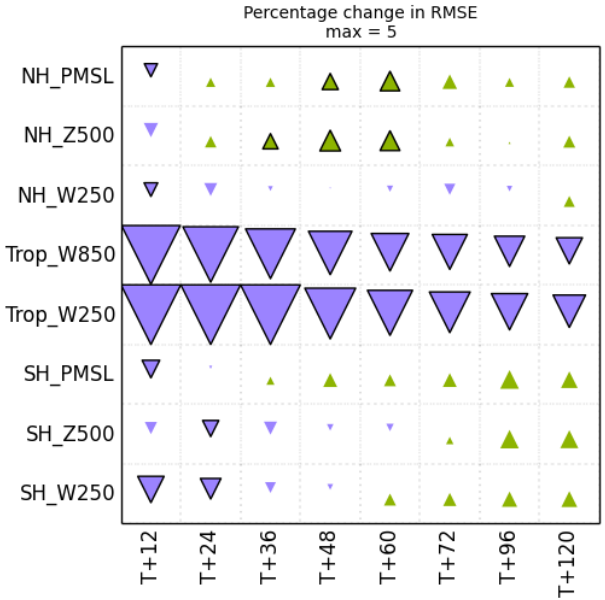
For 60-day trial, impact less than ~0.3% considered neutral at 95% level

QI2 Oper. vs Reference

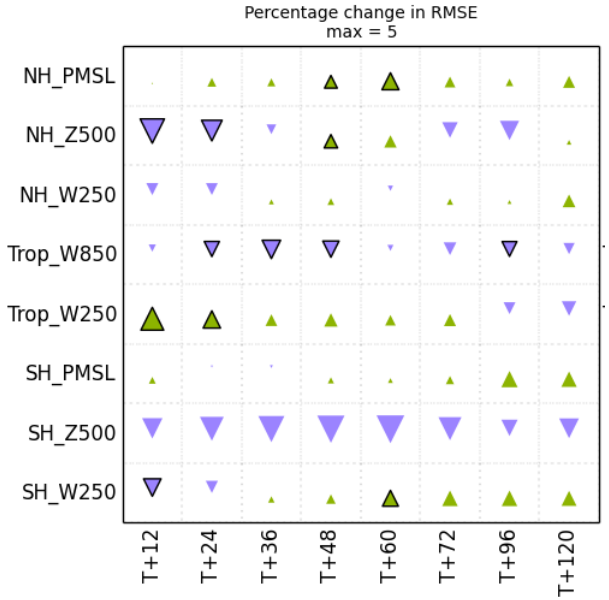
Incr. Error
Dec. Error
Significant



Observations

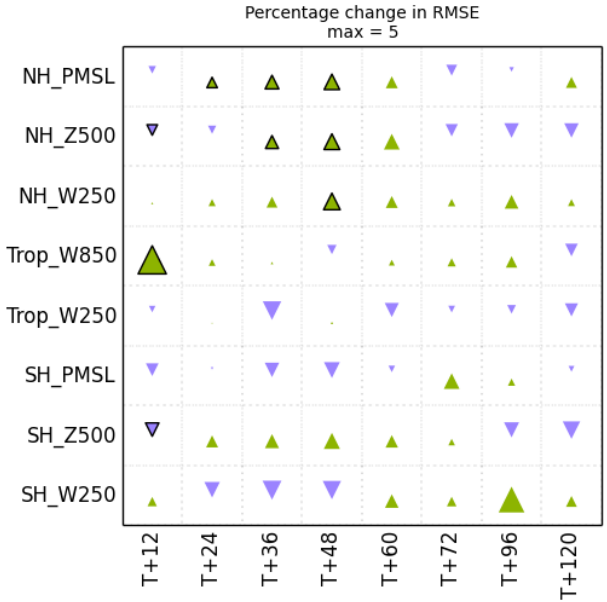


Own Analyses

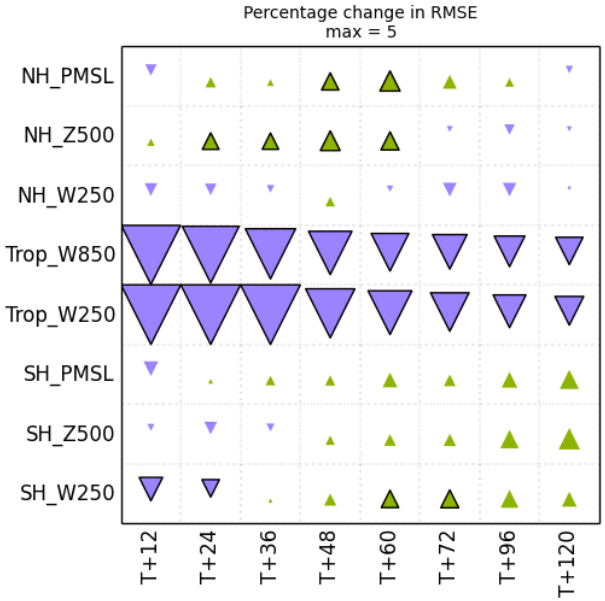


ECMWF

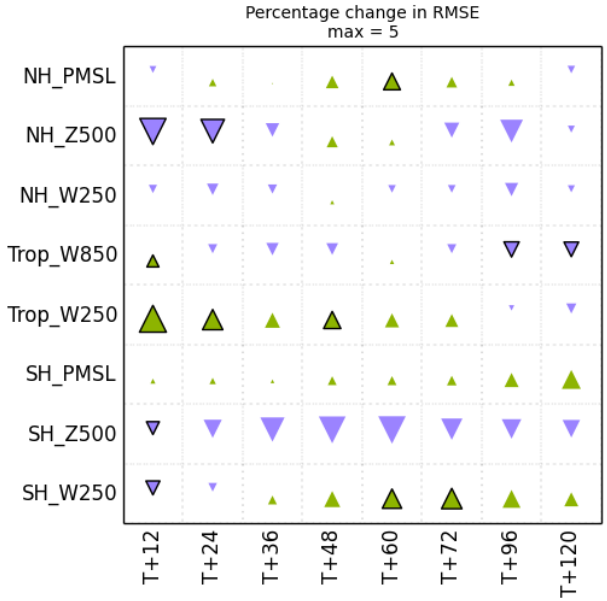
QI2 EC vs Reference



Observations

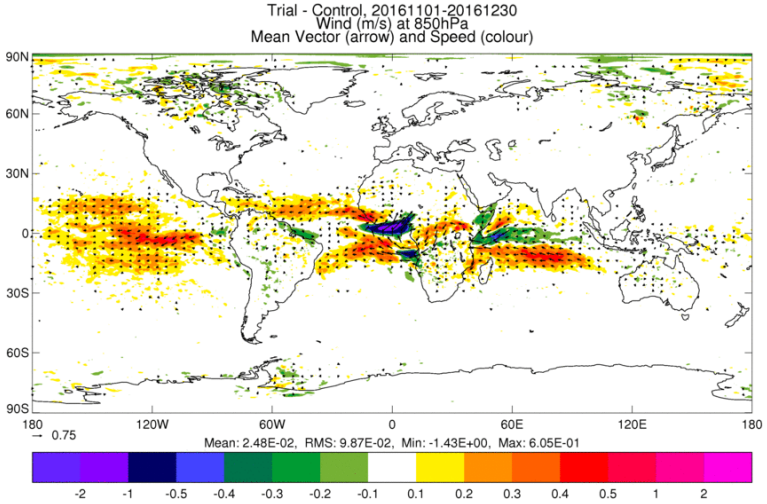


Own Analyses

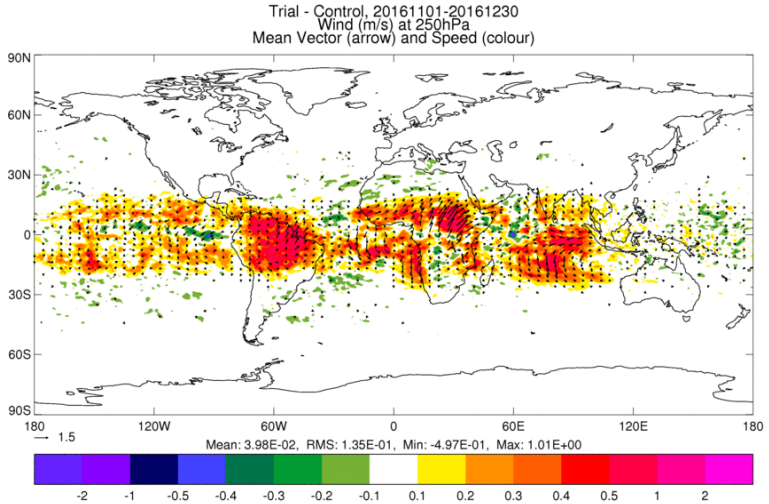


ECMWF

QI2 EC vs Reference



Wind 850 hPa



Wind 250 hPa

Impact Experiment I Summary

- Using operational/ECMWF thresholds with QI2 allows 11%/20% more data
  - MSG threshold not too different
- Background u/v wind fit to AMVs is degraded by ~8% in both cases
  - Tighter operational thresholds don't make much difference to O-B fit
  - Allowing some poorer quality data through
- Background fit to other obs is also slightly worse, including ~1% for SEVIRI radiances
- Forecast RMSE is ~neutral vs obs, large degradation in tropics vs own analyses (W,T,RH), and SH 500 hPa height worse vs ECMWF

Impact Experiment – part II

Try to improve quality of AMV assimilated

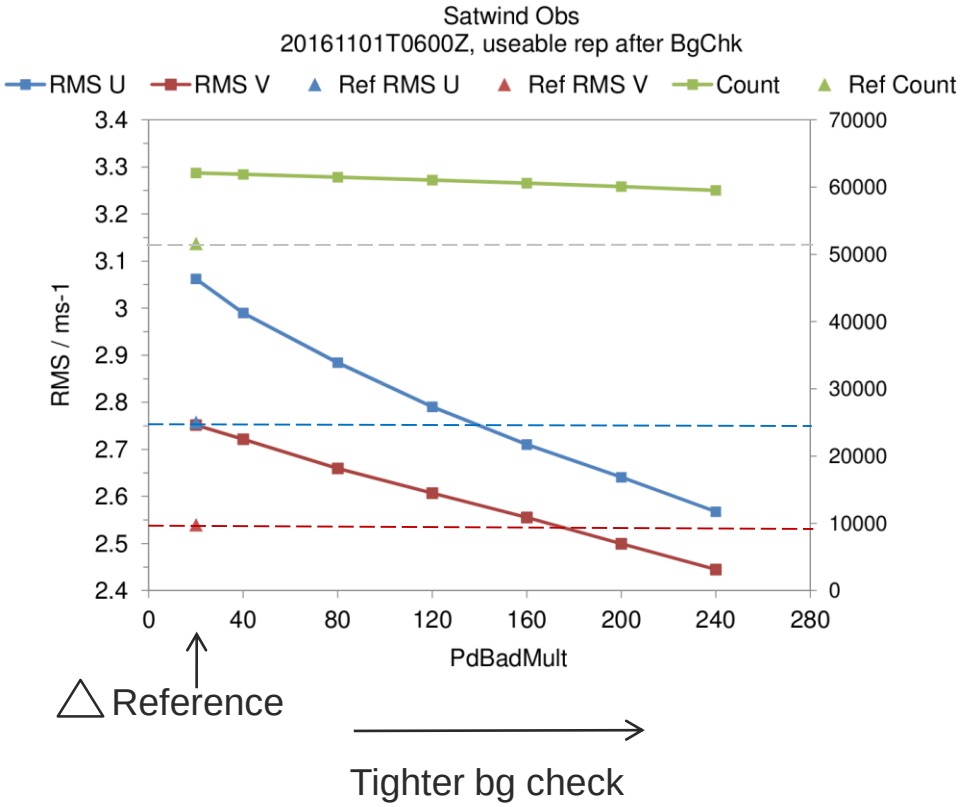
- Just use QI to filter ‘junk’ and tighten other QC, e.g.
- Background check – removing check against other models (via QI1) and tightening check against own model. But tuneable and currently setting is quite relaxed.

Aim

Tighten background check such that overall quality of AMVs remains *similar* in migration from QI1 to QI2

RMS Sensitivity

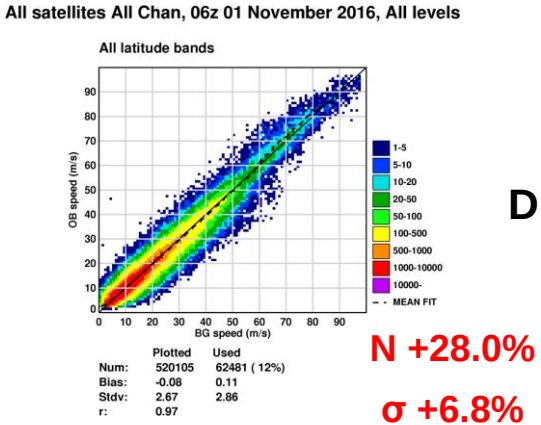
- Tightening background check more efficient way to improve quality (retains more data)



QI2, EC thresholds

After QC
+ BgChk

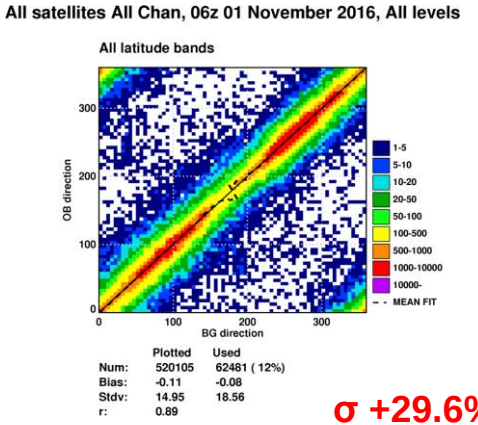
Spd



N +28.0%

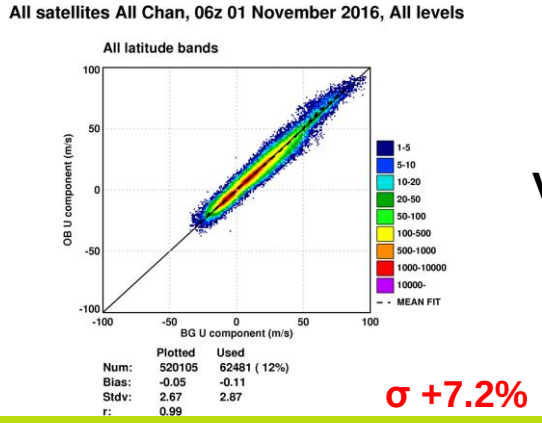
σ +6.8%

Dir



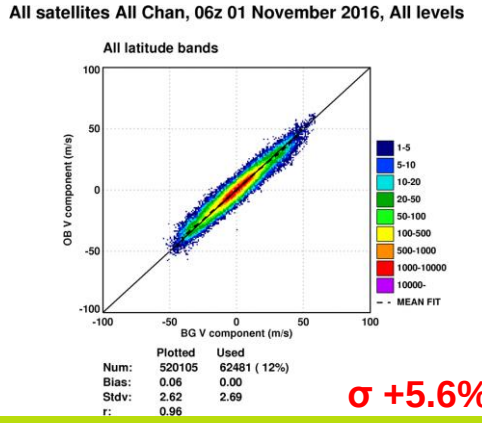
σ +29.6%

U



σ +7.2%

V



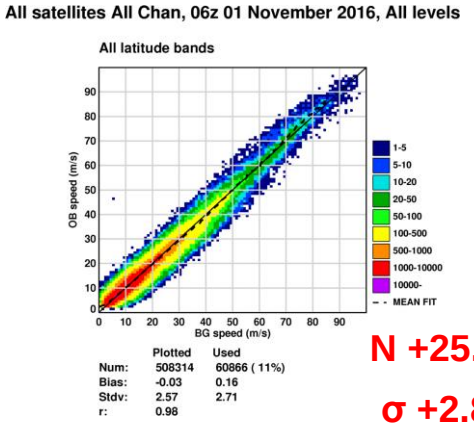
σ +5.6%

*Diff wrt Reference

QI2, EC thresholds, Tighter BgChk

After QC
+ BgChk

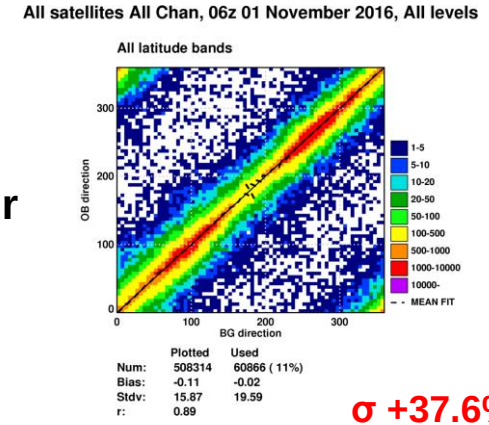
Spd



N +25.0%

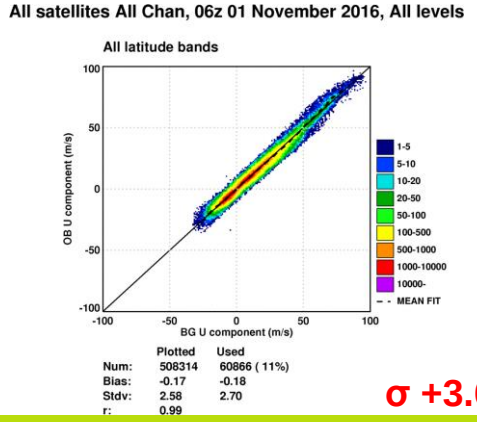
σ +2.8%

Dir



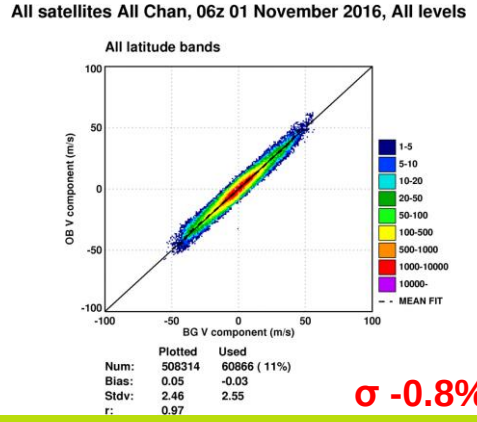
σ +37.6%

U



σ +3.6%

V



σ -0.8%

*Diff wrt Reference

Impact Experiment – part II

N320 L70 UM, N108/N216 4D-VAR hybrid, PS39 baseline, VarBC

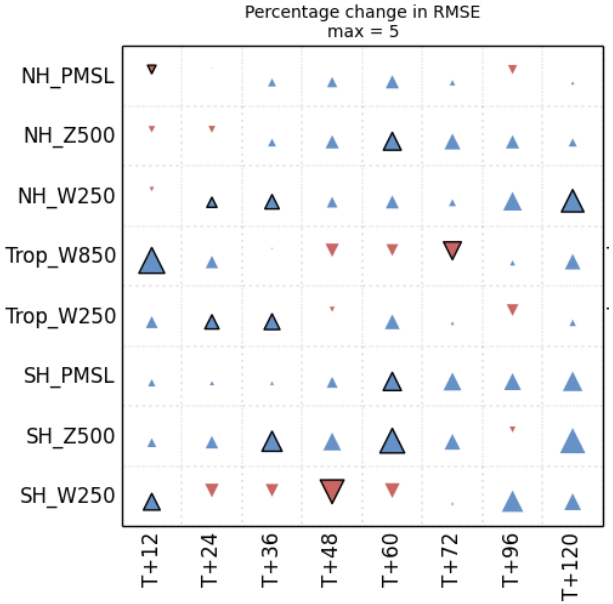
Winter: 15 Nov 2016 – 20 Feb 2017, Summer: 1 July 2016 – 30 Sept 2016

- Reference: QI1 operational thresholds (Met-8 IODC AMVs for Winter)
- Trial : QI2 ECMWF thresholds, tighter background check

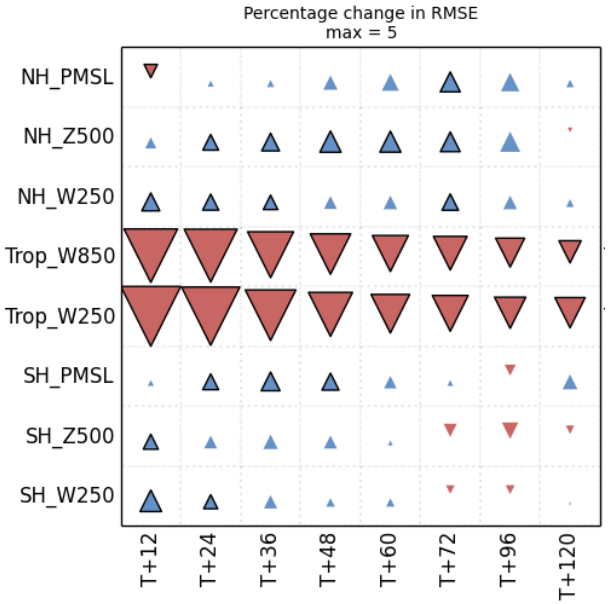
Experiment	Reference	Days	Observations	Analysis	ECMWF
u-am989 QI2 EC BgChk	u-am067 (Winter)	64	+0.03 (0.03%)	-0.83 (0.61%)	+0.09 (0.07%)
u-am990 QI2 EC BgChk	u-am250 (Summer)	60	+0.24 (0.24%)	-0.42 (0.34%)	+0.09 (0.10%)

For 60-day trial, impact less than ~0.3% considered neutral at 95% level

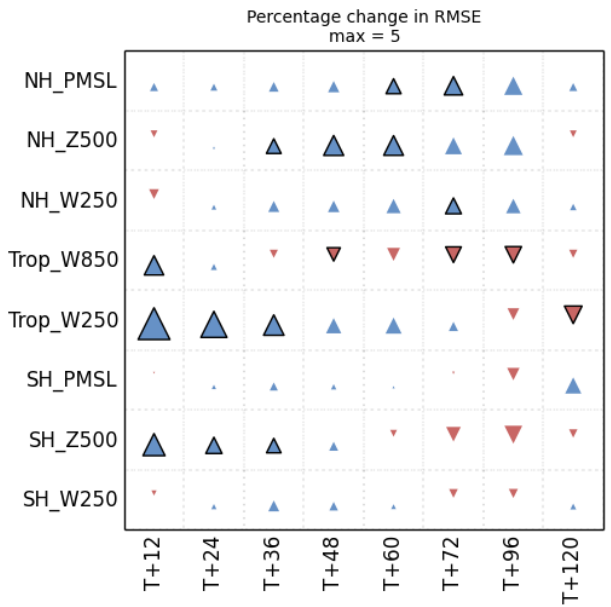
QI2 EC, BgChk vs Reference (Wint)



Observations

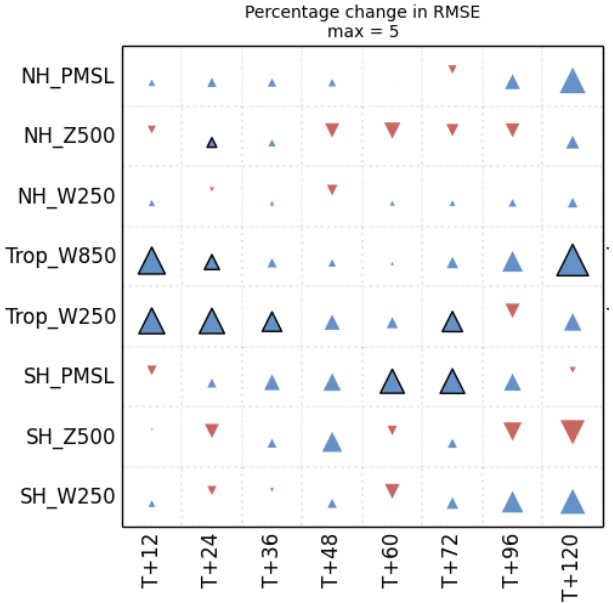


Own Analyses

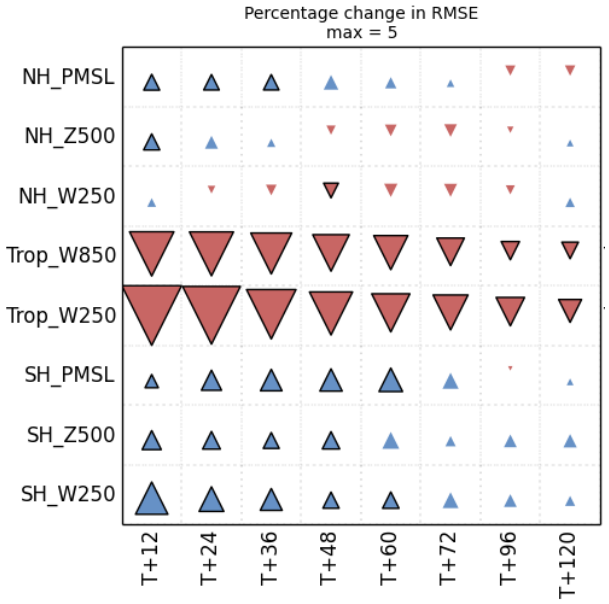


ECMWF

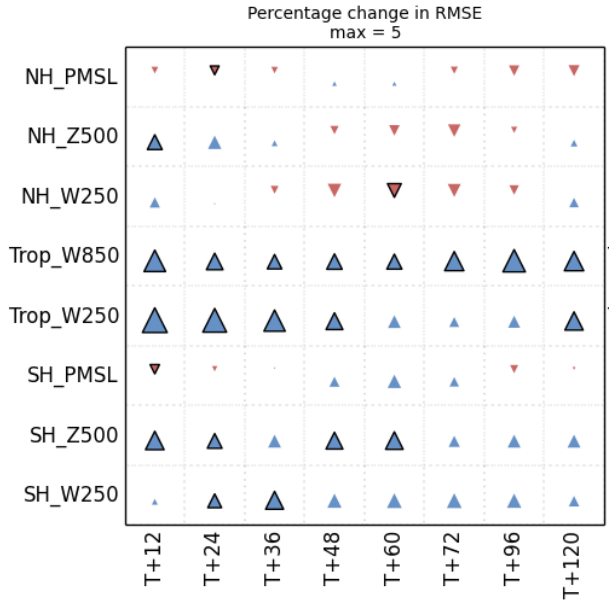
QI2 EC, BgChk vs Reference (Sum)



Observations



Own Analyses

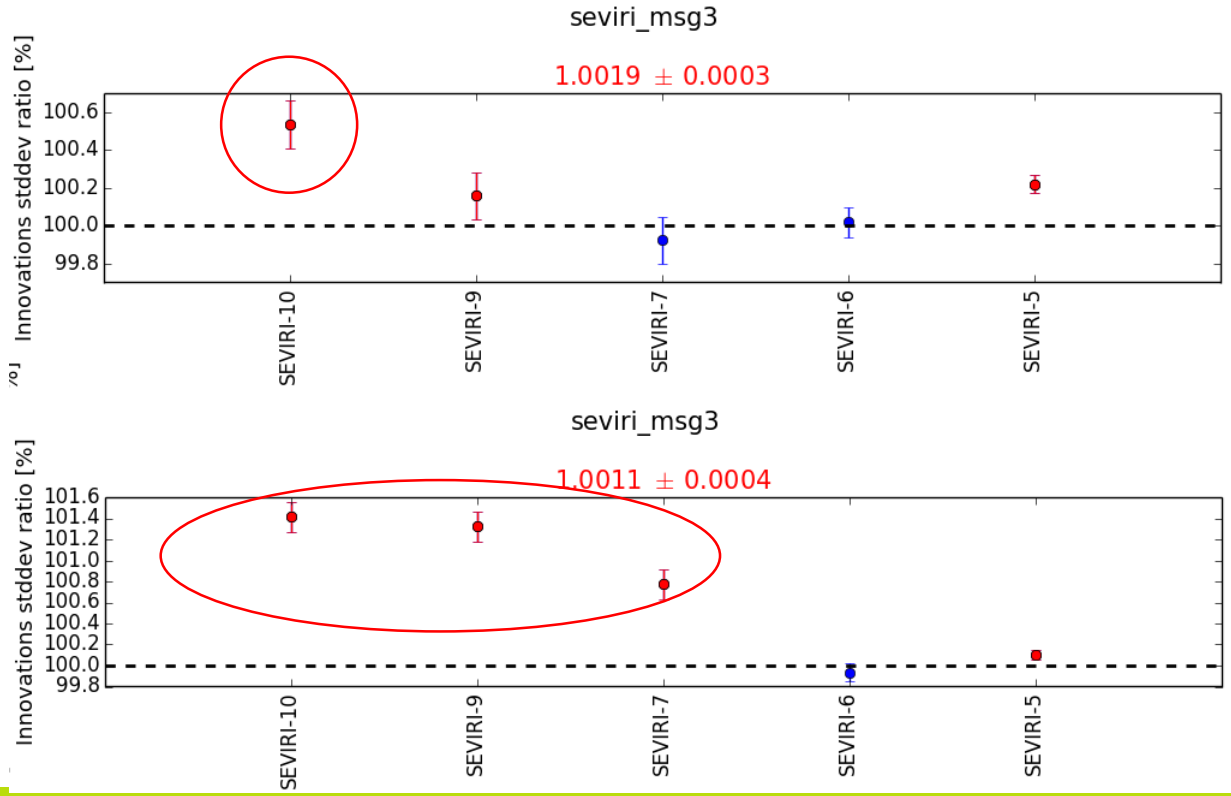


ECMWF

Impact Experiment II Summary

- Using ECMWF thresholds with QI2 and tighter bg check allows 18-19% more data
- Background wind fit to AMVs is more similar e.g. Winter trial
  - Improved by 2% for U wind
  - Degraded by 0.5% for V wind
- Change in background fit to other obs is small, apart from Geo radiances
  - Mainly SEVIRI channels-9 and -10 in winter which increase O-B stdev by up to 1.4%
  - Weighting function peak down at surface
  - SAPHIR WV, ATMS, SSMIS, CrIS neutral

SEVIRI O-B Standard Deviation

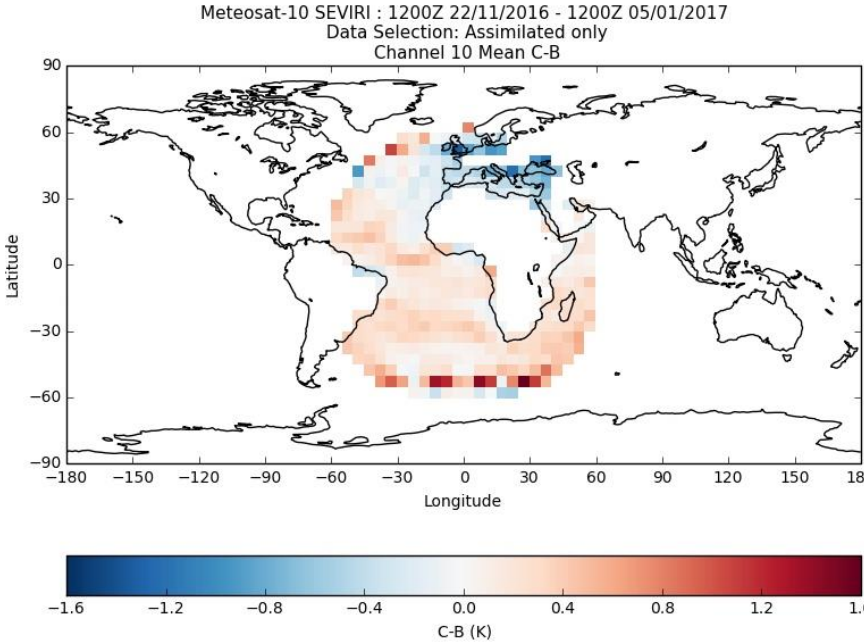


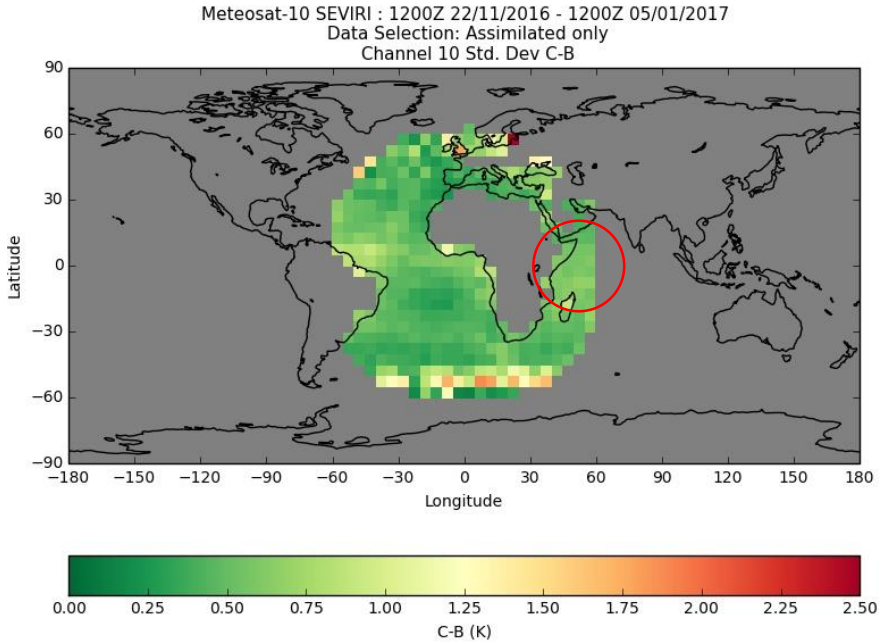
Summer 2016

Winter 2016/17

Channel 10 Mean/Stdv

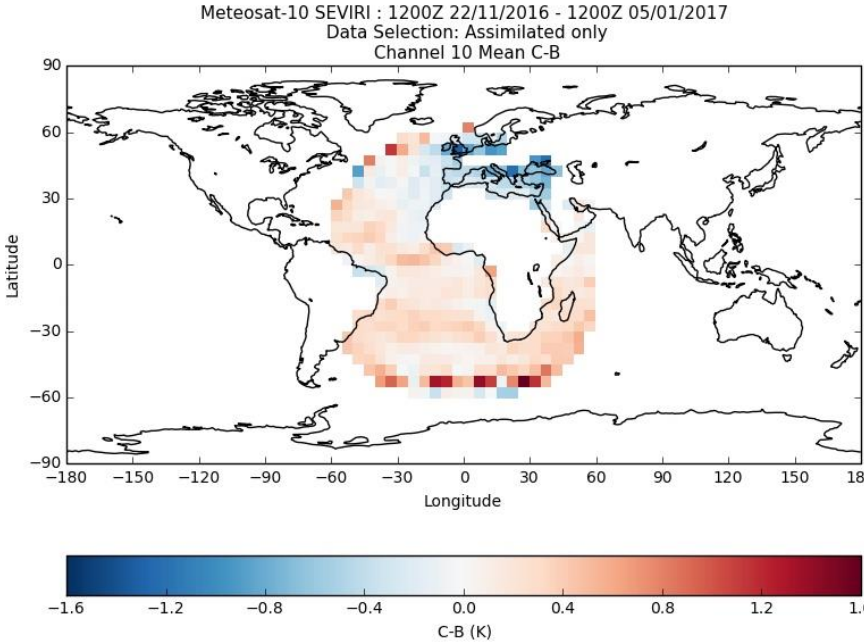
Control – u-am067

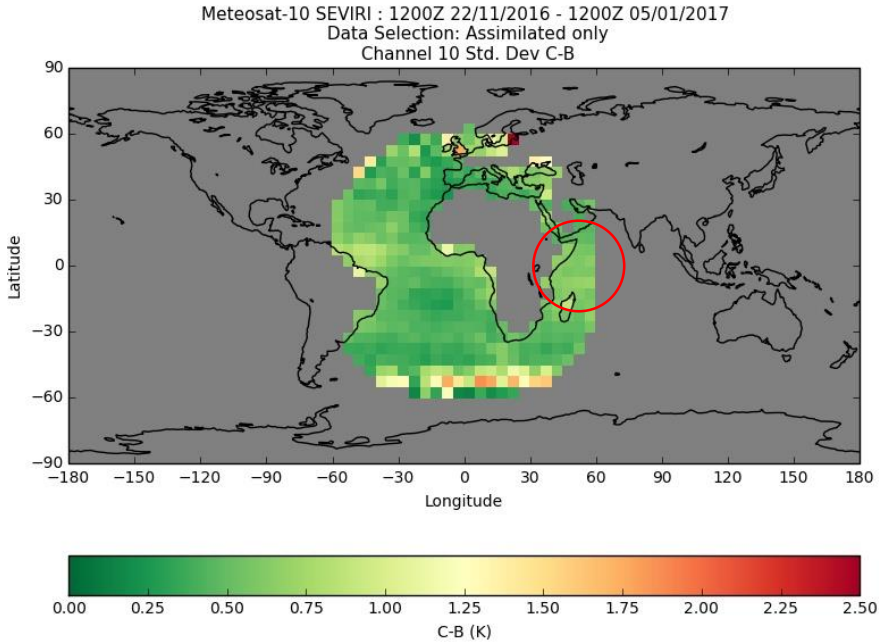




Channel 10 Mean/Stdv

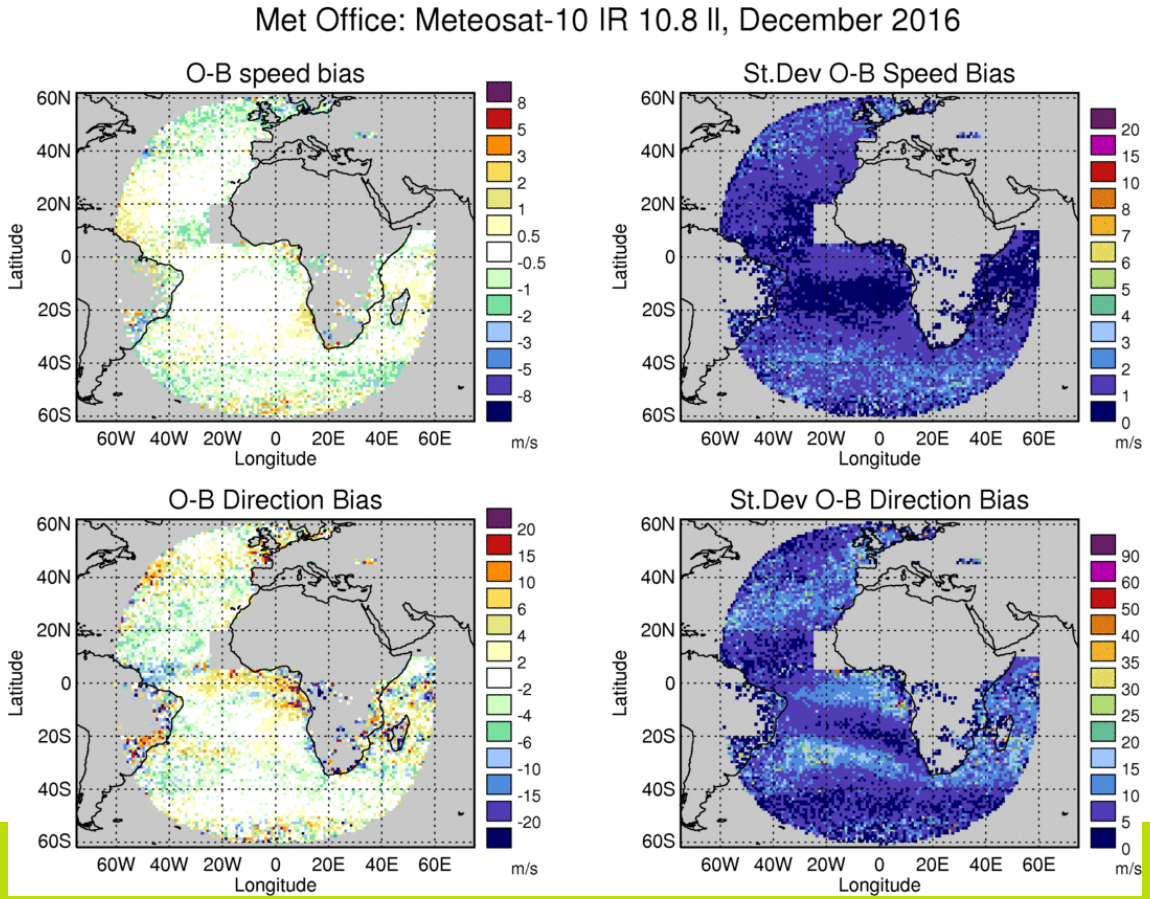
Trial – u-am989





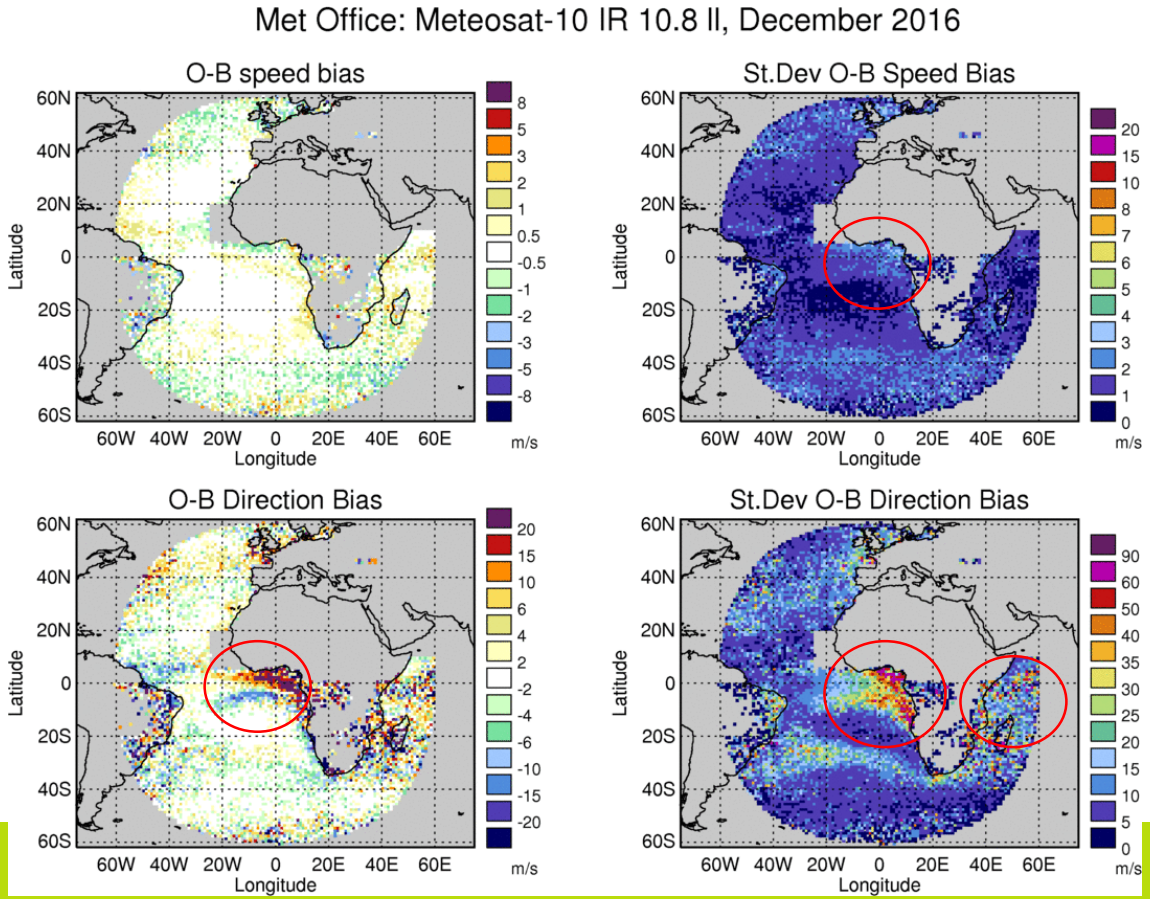
Some increase in stdev O-B in the tropical Indian Ocean – this area causing degradation in Var stats?

Operations: Met-10 IR LL AMVs



Control experiment AMV monitoring files not available so use operational statistics as proxy

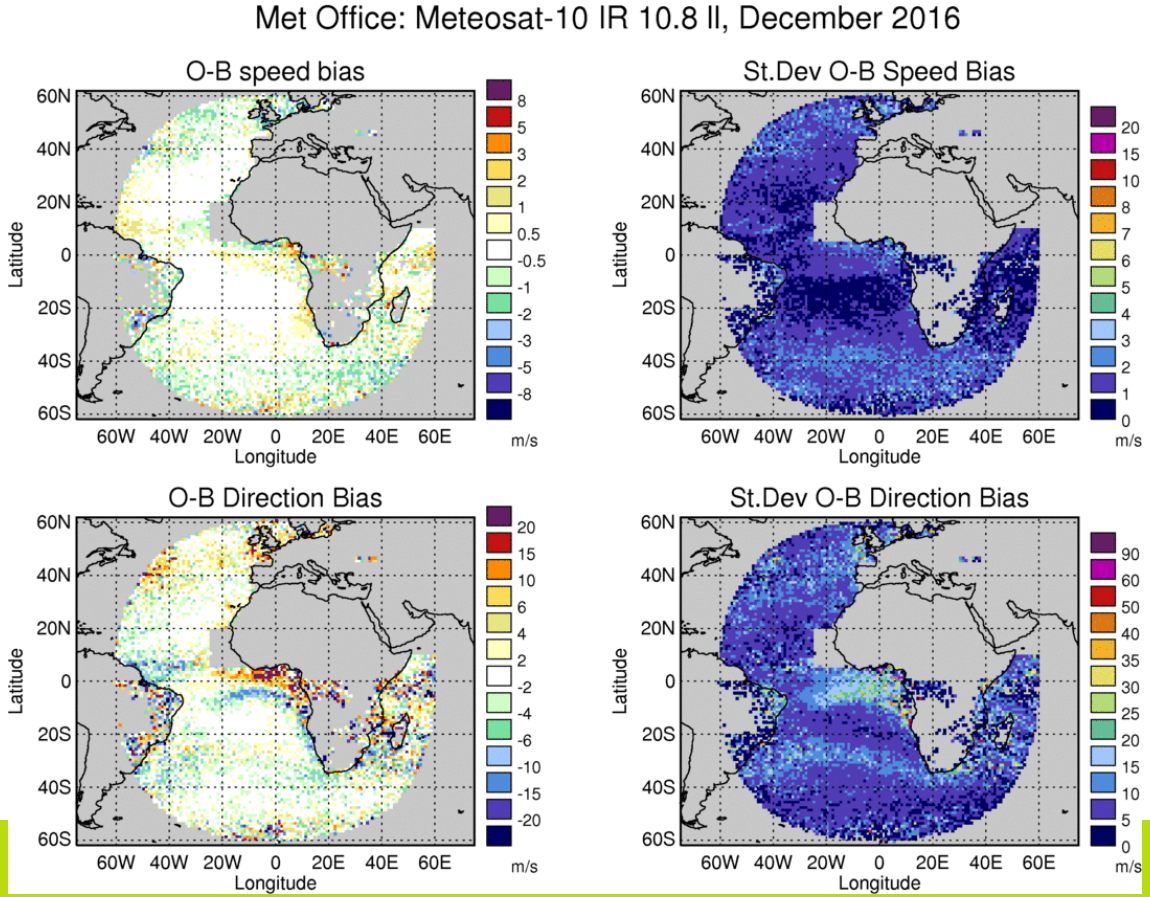
Trial u-am989: Met-10 IR LL AMVs



- Increase in speed standard deviation O-B nr equator in Atlantic

- Increase in direction standard deviation O-B in Indian Ocean and to the West of Africa in the tropics
- Direction bias increase nr equator in Atlantic

Trial u-am989: Met-10 IR LL AMVs



- Filter Obspeed and Bgspeed >4 m/s

Impact Experiment – part III

- Increase in AMV direction standard deviation O-B mainly in low wind speed regions (average speed < 5 m/s)
- Assimilating more slow AMVs with (potentially) greater directional variability
- Lower QI thresholds in tropics for Met-10 (was QI1>90, now QI2>85) means less strict spatial/temp. consistency checks?

Aim

- Remove slow winds < 4 m/s (applied to both model and AMV)

Impact Experiment – part III

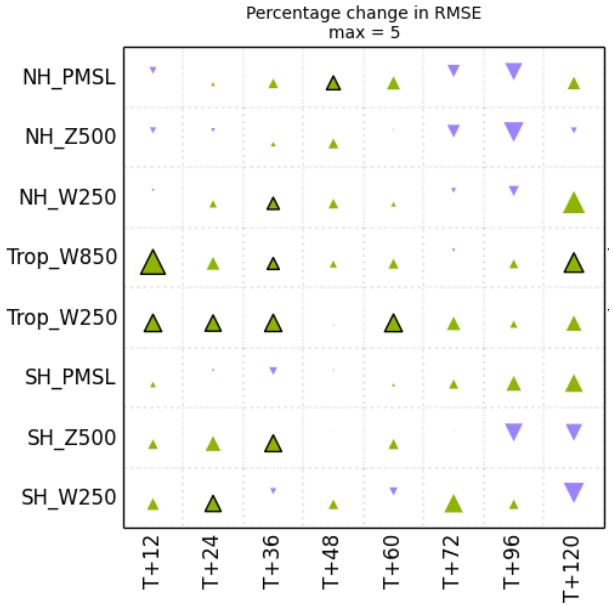
N320 L70 UM, N108/N216 4D-VAR hybrid, PS39 baseline, VarBC

Winter: 15 Nov 2016 – 20 Feb 2017, Summer: 1 July 2016 – 30 Sept 2016

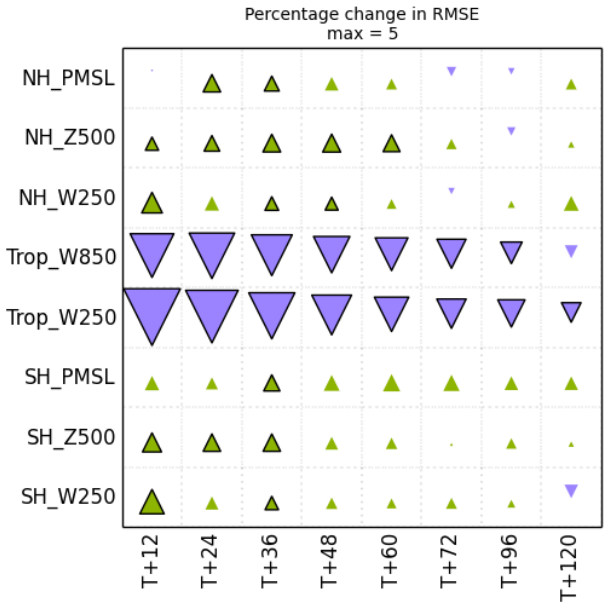
- Reference: QI1 operational thresholds (Met-8 IODC AMVs for Winter)
- Trial : QI2 ECMWF thresholds, tighter background check

Experiment	Reference	Days	Observations	Analysis	ECMWF
u-ao442 QI2 EC BgChk	u-ao568 (Winter)	62	+0.14 (0.13%)	-0.46 (0.33%)	+0.12 (0.10%)
u-ao473 QI2 EC BgChk	u-ao418 (Summer)	82	+0.13 (0.13%)	-0.42 (0.34%)	+0.05 (0.05%)

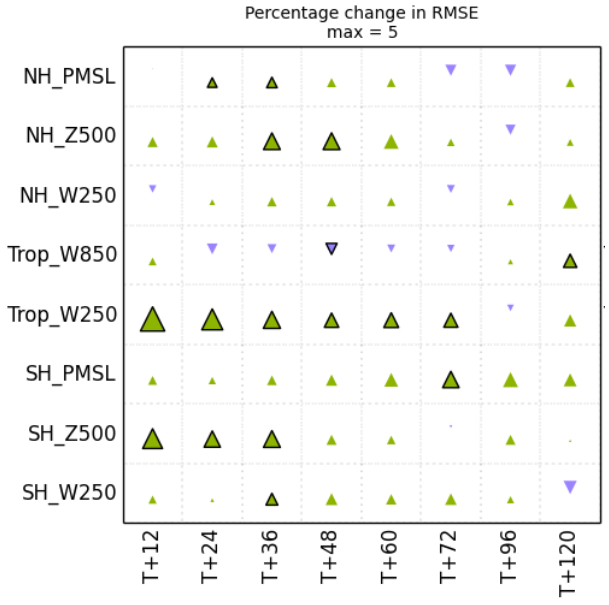
QI2 EC, BgChk, Slow vs Ref. (Wint)



Observations

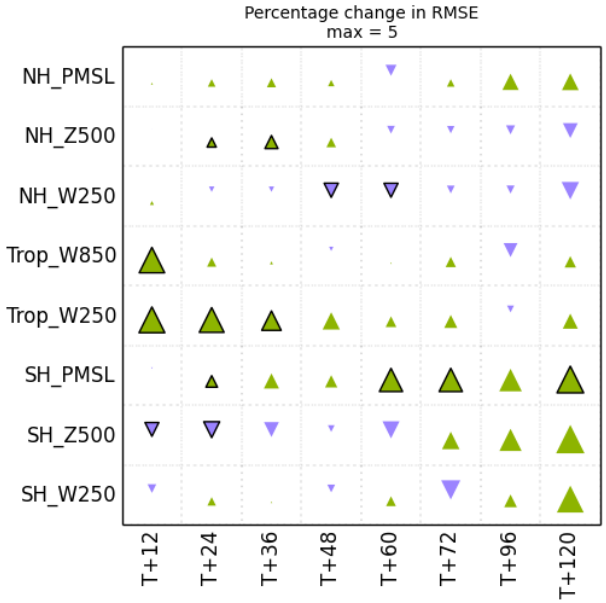


Own Analyses

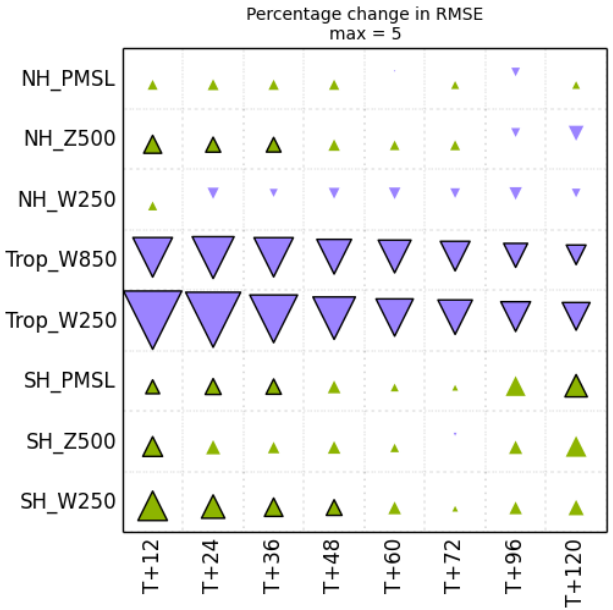


ECMWF

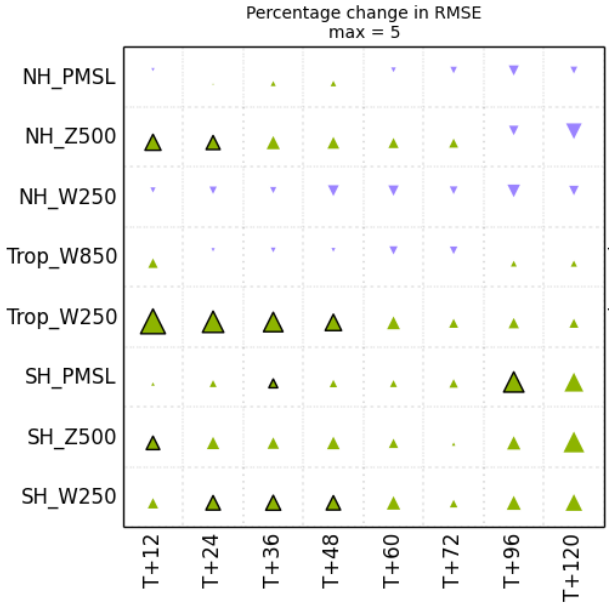
QI2 EC, BgChk, Slow vs Ref. (Sum)



Observations



Own Analyses



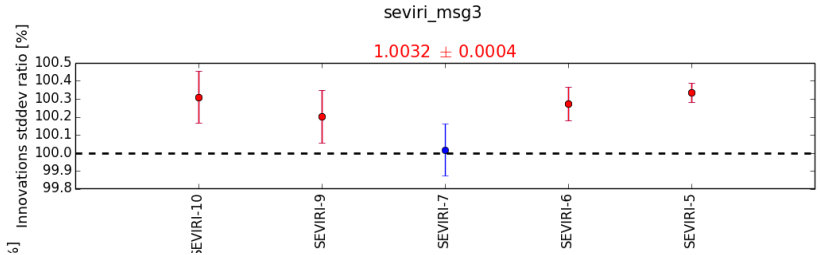
ECMWF

Impact Experiment III Summary

- Adding the slow speed check reduces the increase in AMVs to 11-13% and improves forecast scores slightly
- Background wind fit to AMVs is e.g. Summer
  - Improved by 2% for U wind
  - Degraded by 1% for V wind
- Change in background fit to Geo radiances generally neutral or slightly improved versus the trial without the AMV speed check (in Summer) for GOES and SEVIRI

SEVIRI Background Stdev - Summer

Without Speed Check



With Speed Check