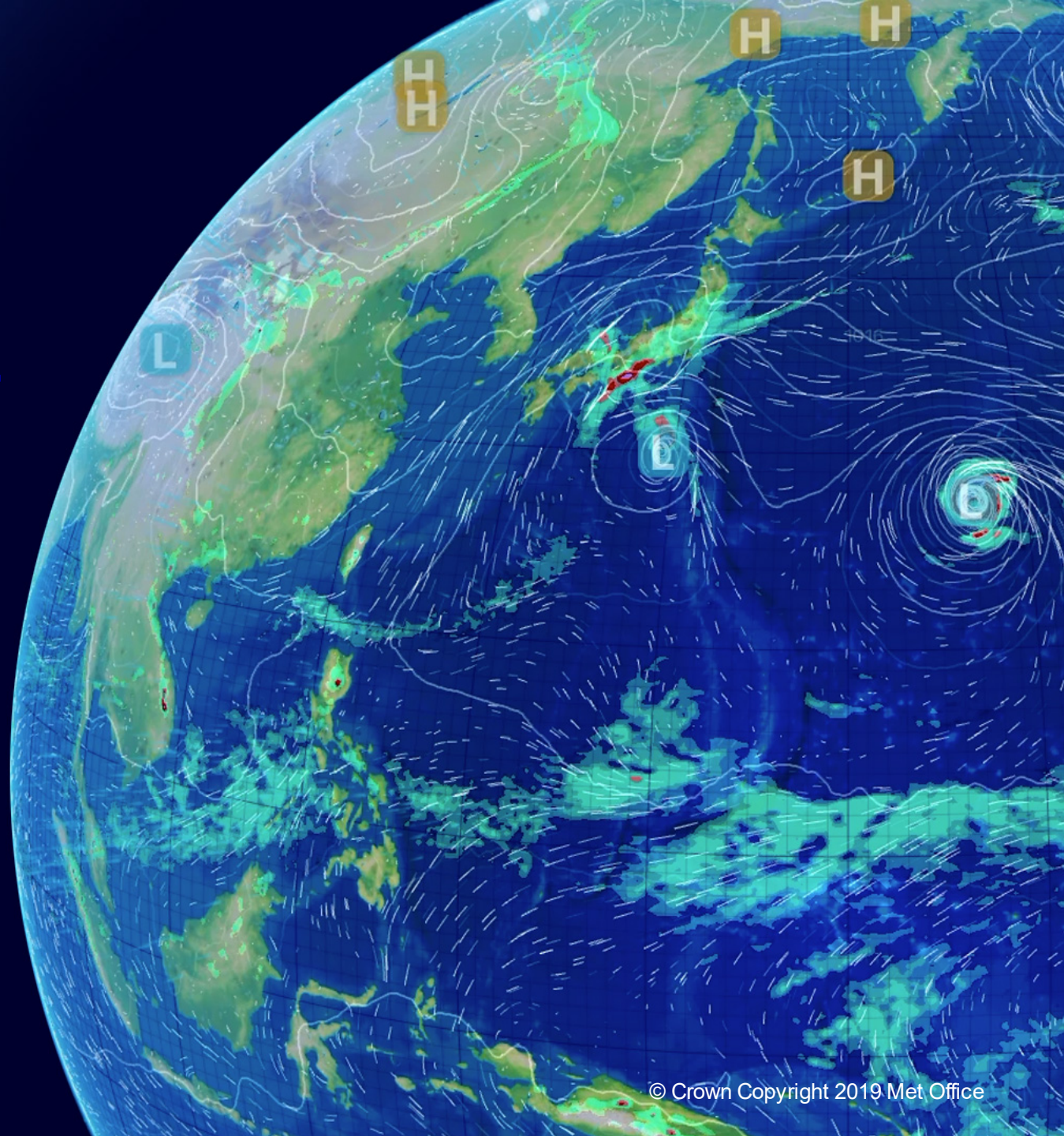
AMV Cross Correlation Matrices



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IWW15 12 April 2021
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The structure of AMV correlation surface matrices and their relation to AMV accuracy.

This study explores the structure of the cross correlation matrices that are used to compute the initial trajectories at the beginning of the AMV process. A simple test, based on the identification and separation of the first two maxima in the correlation surface, is found to give an estimate of the AMV quality.

This study uses the AMV processing code from the NWCSAF package together with a large sample of AMV innervations from the MetOffice mesoscale model.

Reasons for study

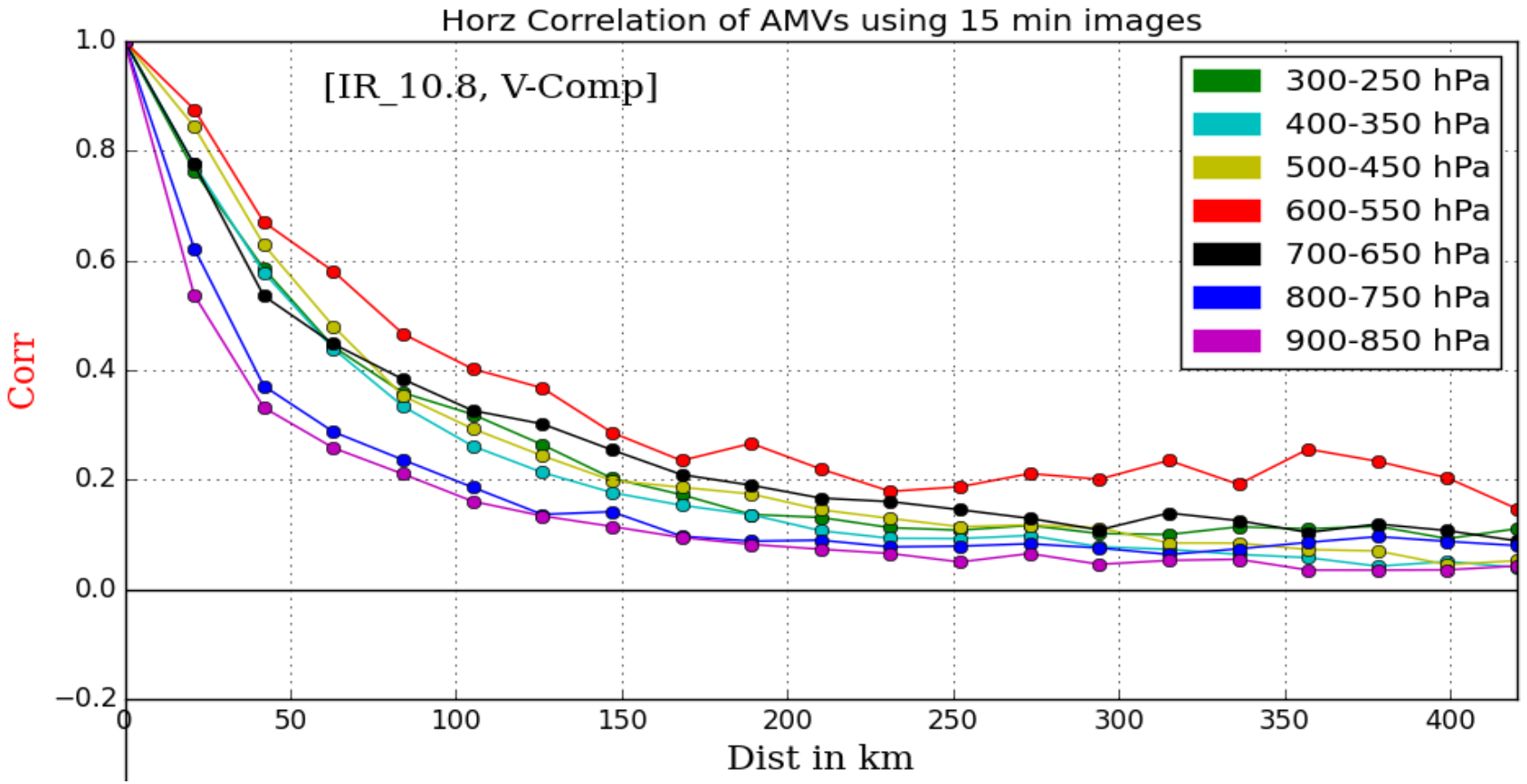
AMV providers have concentrated on producing improved height assignment and increasing coverage.

The latest AMVs still have large correlated errors.

Because of the large correlation errors NWP centres generally have to thin AMVs.

Is there any additional quality control information, besides the maxima correlation, that is contained in the correlation surface?

Horizontal error correlation estimate (20km bin size) for SEVIRI channel IR108. using the Desroziers et al. (2005) method.



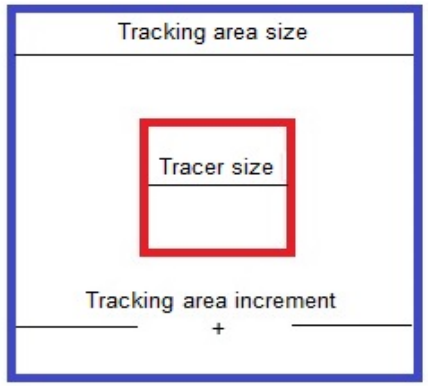
AMVs at the MetOffice are produced with the NWCSAF AMV package.

The MetOffice UKV mesoscale forecasts of temperate and humidity are used by the NWCSAF package.

The forecast is not used in the QI calculation.

The nearest neighbour check in the NWPSAF AMV processing is switched turned off.

Correlation matrix



Tracking area size (in pix) = Tracer size (in pix) + Tracking area increment (in pix)

where

Tracking area increment (in pix) = 2 * Speed component wished at least to be detected (in pix/h) * Temporal gap between images (in h)

(defined at subsatellite point)

and

Correlation matrix size (in pix) = 1 + Tracking area increment (in pix)

Considering for example HRW v2018 values for MSG satellite, with:

Tracer size = 24 pix (24 km at subsatellite point for HRVIS channel)
(72 km at subsatellite point for low res channels)

Speed component wished at least to be detected = 288 km/h (288 pix/h at subsatellite point for HRVIS channel)
(96 pix/h at subsatellite point for low res channels)

We have:

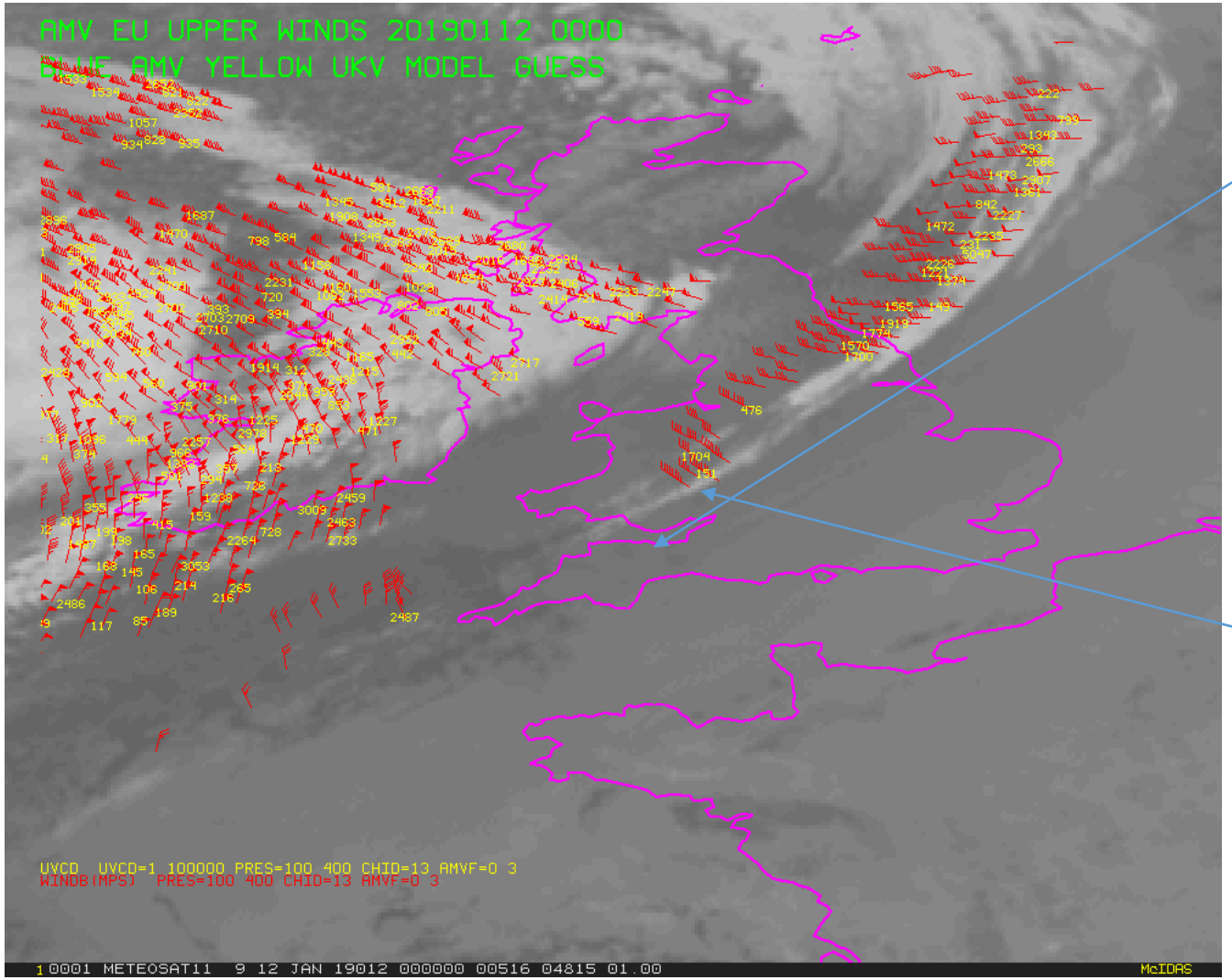
Tracking area increment = 2 * 288 pix/h * 0.25 h = 144 pix for HRVIS channel
2 * 96 pix/h * 0.25 h = 48 pix for low res channels

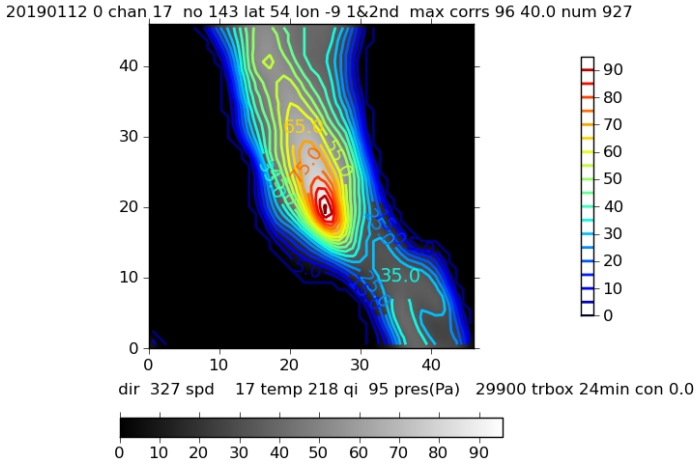
and

Correlation matrix size = 1 + 144 = 145 pix for HRVIS channel
1 + 48 = 49 pix for low res channels

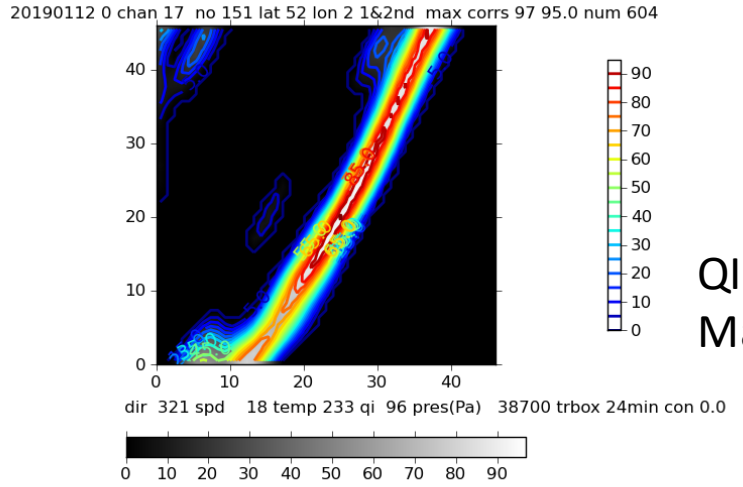
As the tracking area increment is always an even number,
the correlation matrix size will always be an odd number

Two upper level examples of correlation surfaces.



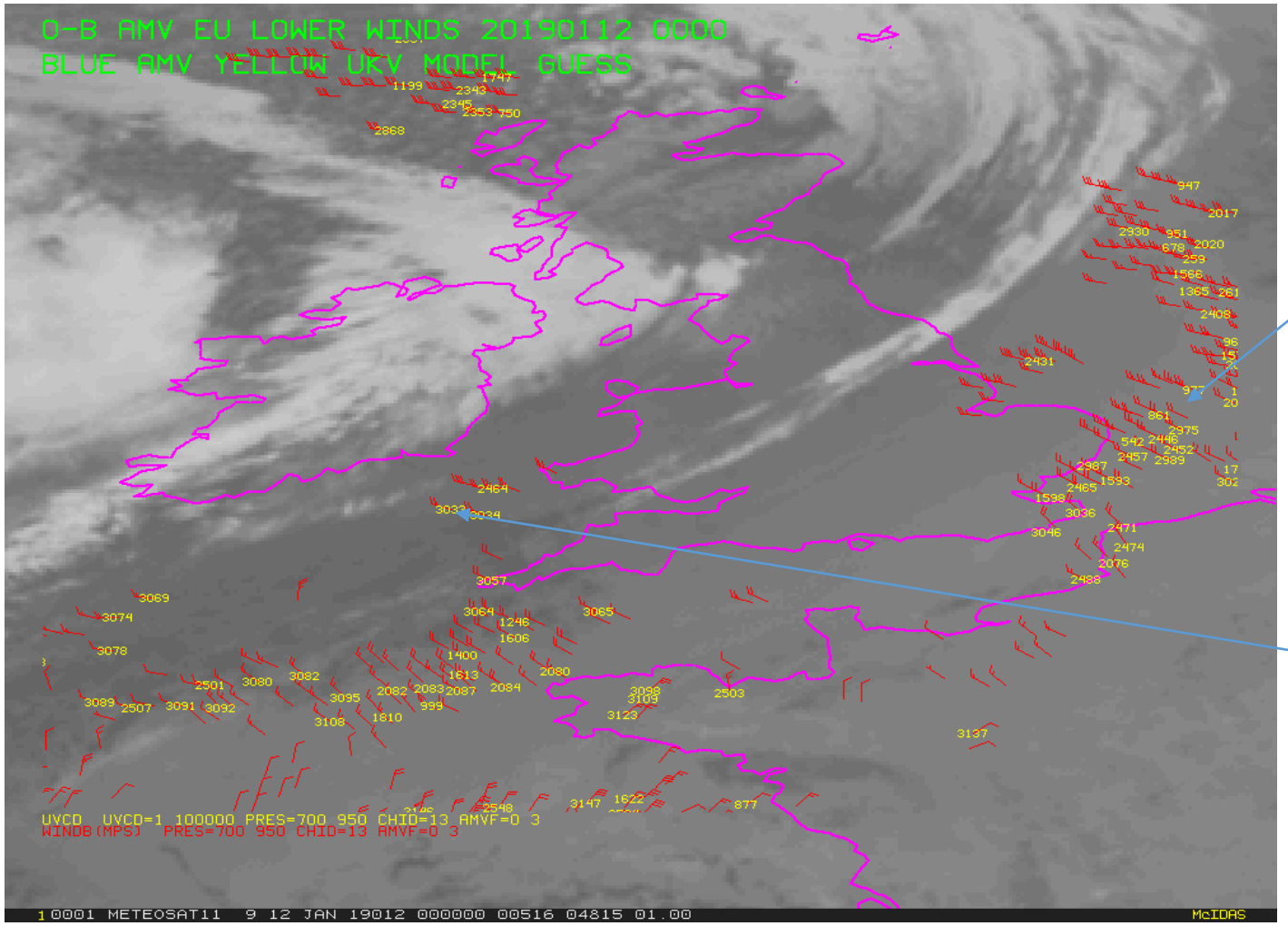


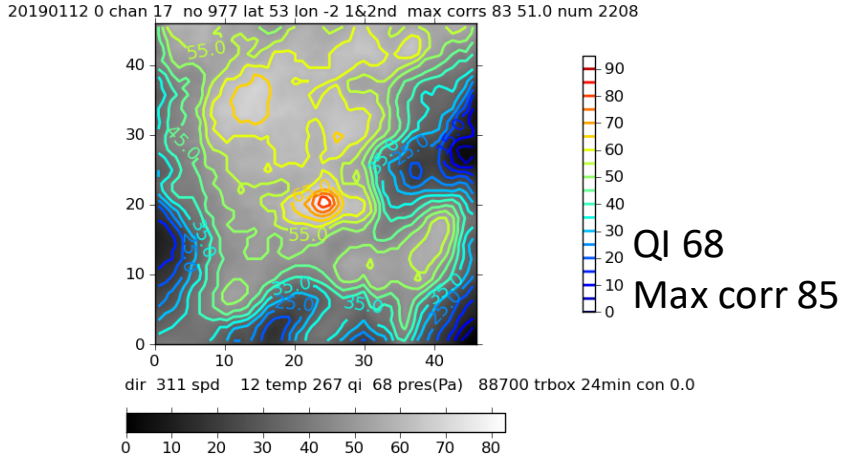
QI 95
Max corr 96



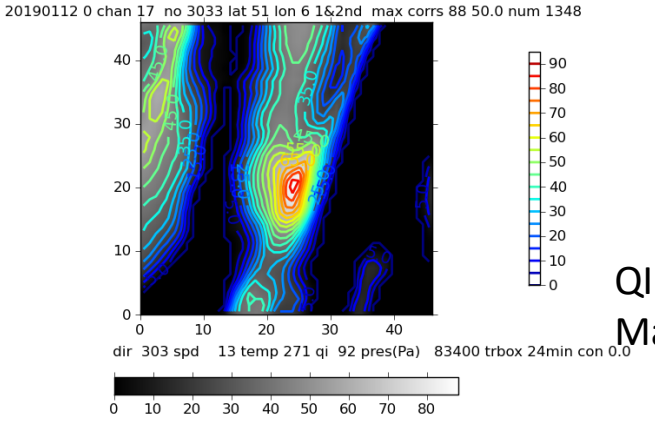
QI 96
Max corr 97

Two lower level examples of AMV correlation surfaces.





QI 68
Max corr 85



QI 92
Max corr 88

Correlation surface classification (CSC).

The method tests the hypnotises that AMVs derived from a correlation surface with a clearly defined maxima gives an estimate of AMV quality.

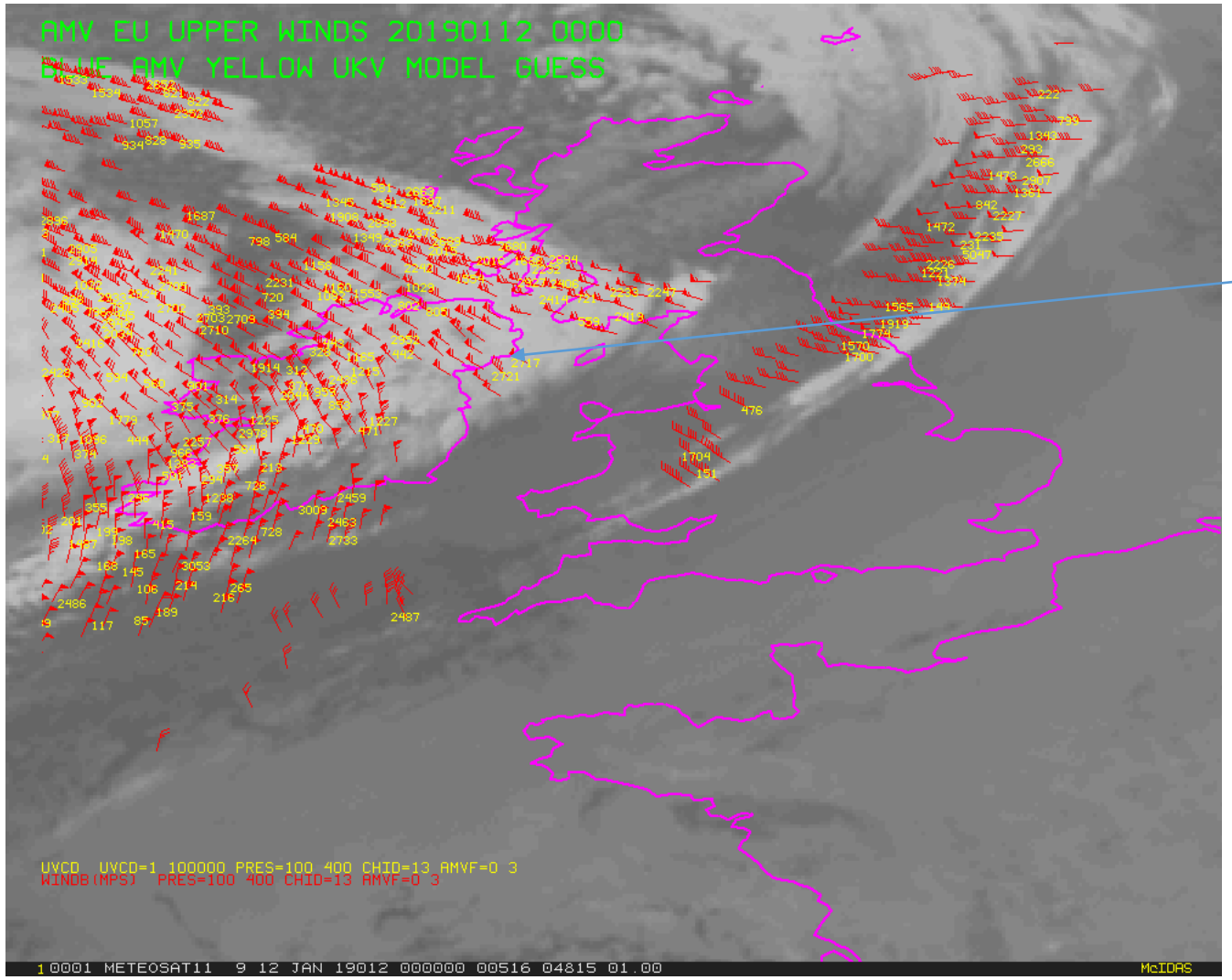
- First find the position and strength of the strongest maximum.
- Remove a 8x8 pixel square centred on this first maximum.
- Find the next maximum (the second).
- Compare the data assimilation innervations with the normalised difference between the first and second correlation maximum.

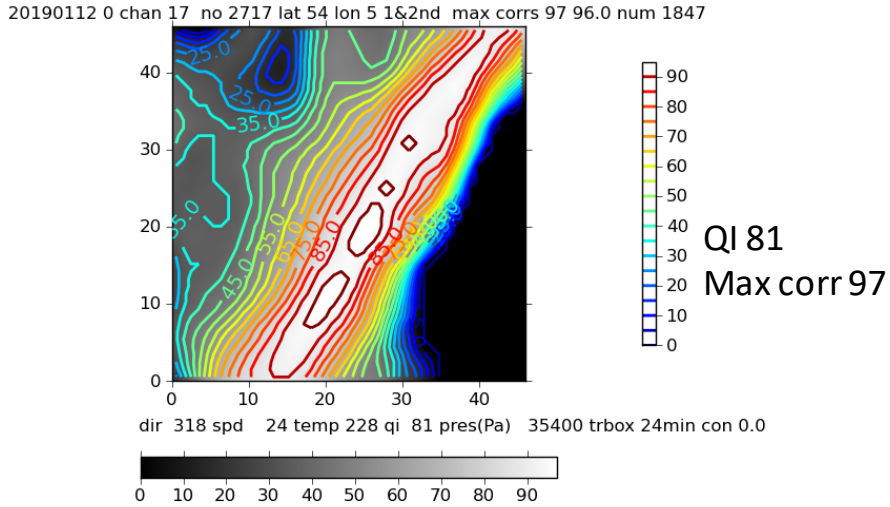
TEST AMV suite setup.

- A modified version of NWCSAF 2017 package produced increased diagnostics including the correlation surfaces.

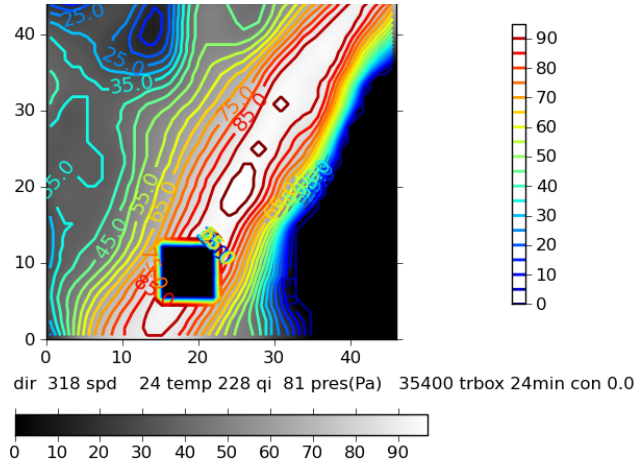
- Switch off use of forecast winds in the search and their use in the QI calculations.
- Run UKV mesoscale Model preprocessing and combine the innervation files and the NWCSAF diagnostics.

Example of AMV correlation matrix surface and the first maxima removed.

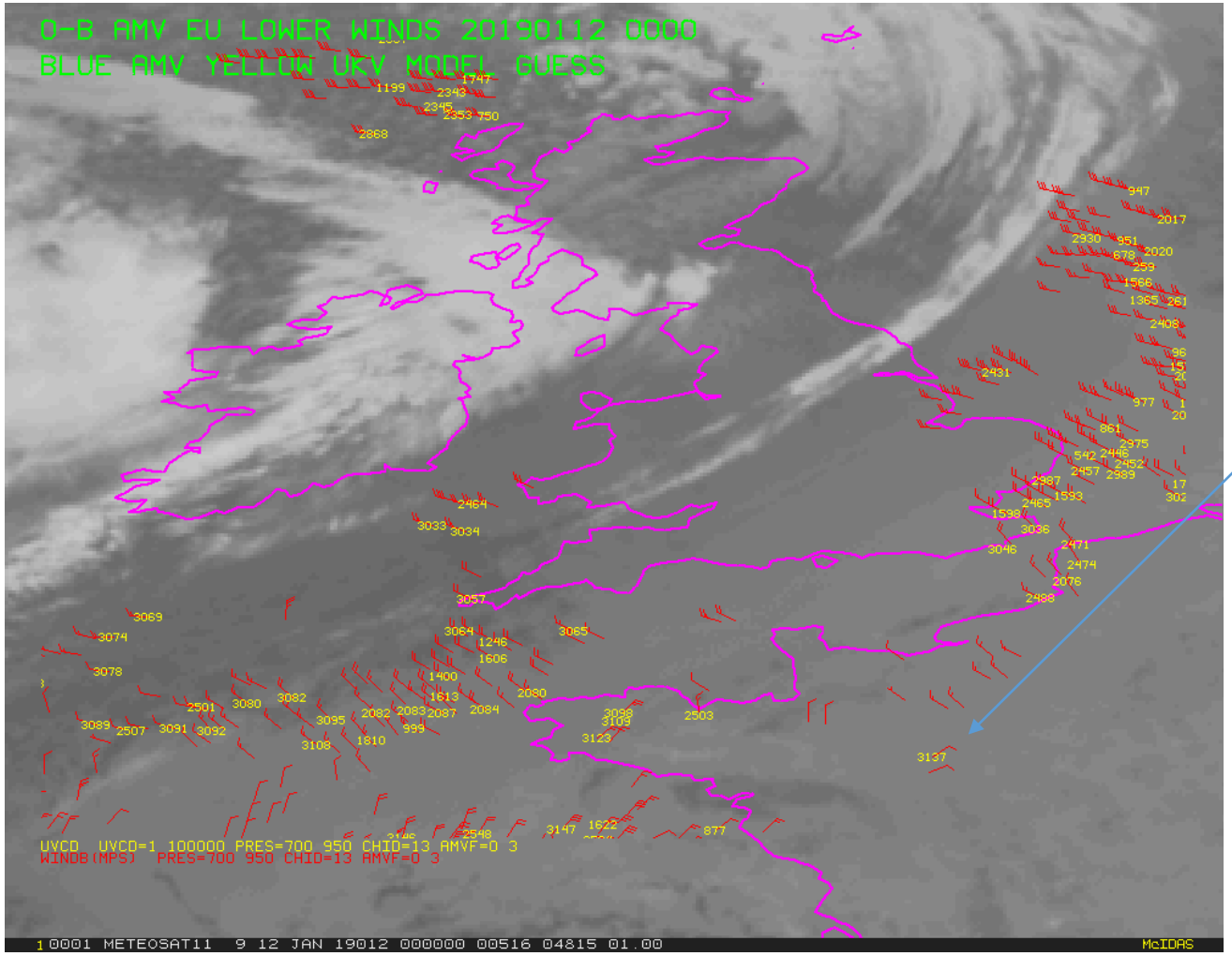


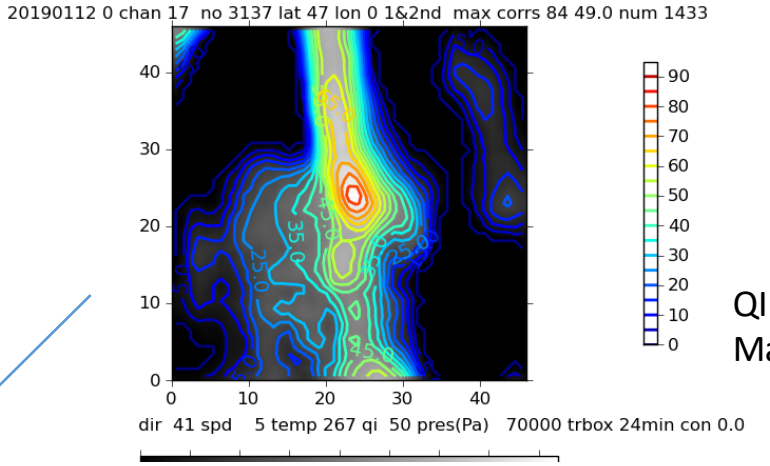


QI 81
Max corr 97

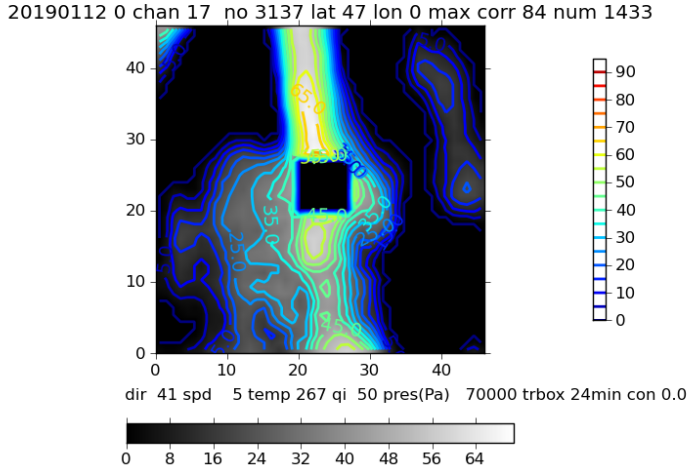


Example of AMV correlation matrix surface and the first maxima removed.





QI 50
Max corr 84



Correlation surface matrices innervation statistics.

The statistics have collected during December 2018 and January 2019 using hourly UKV AMV innervations.

Statistics have been stratified by AMV channel tracked, speed layer and QI range.

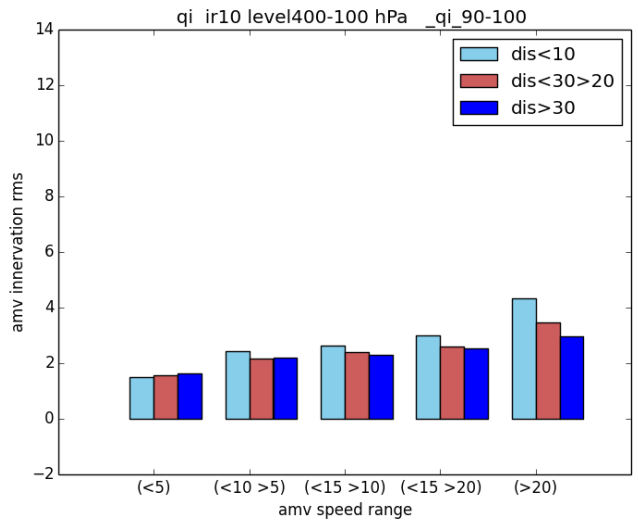
There are three sets of plots:

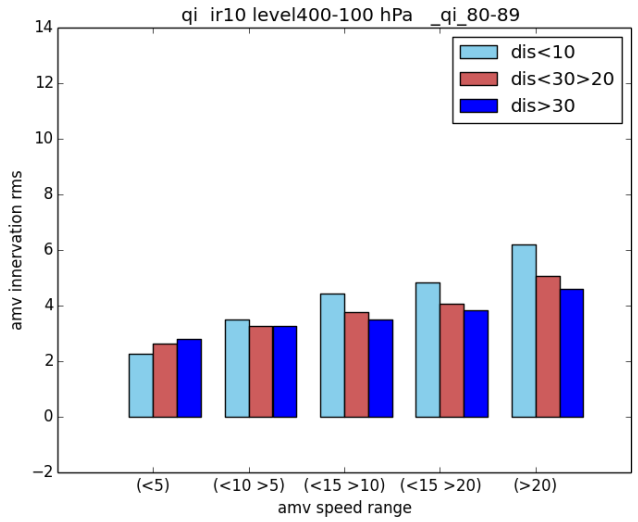
Innervation rms,

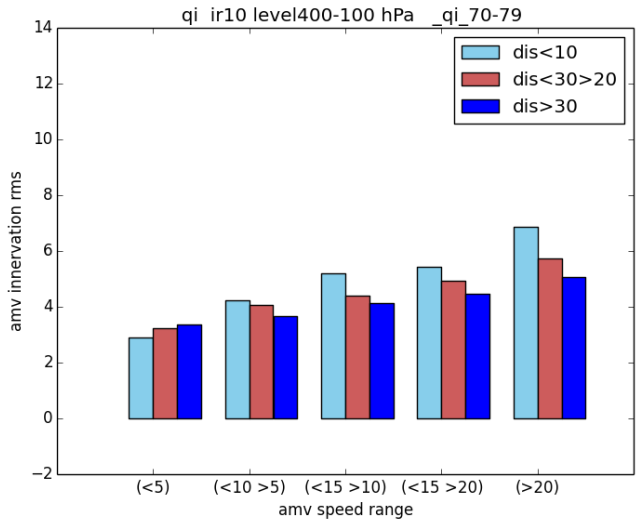
Innervation bias,

and number of innervations co-located with CFC.

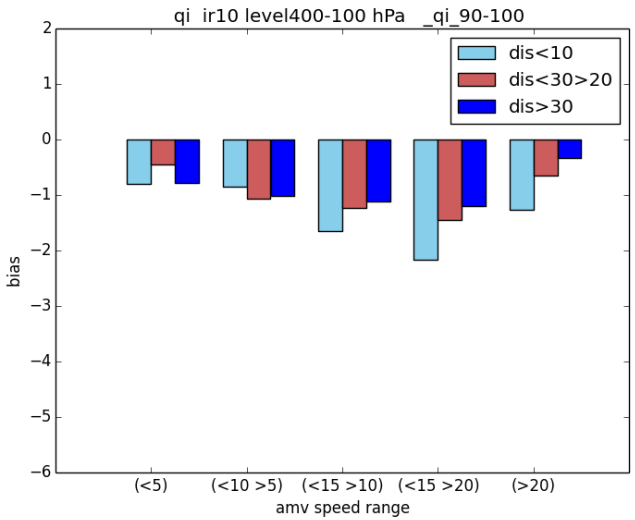
RMS CHANNEL IR10 SEPARATION DISTANCE (CSC) BETWEEN FIRST AND SECOND MAXIMA

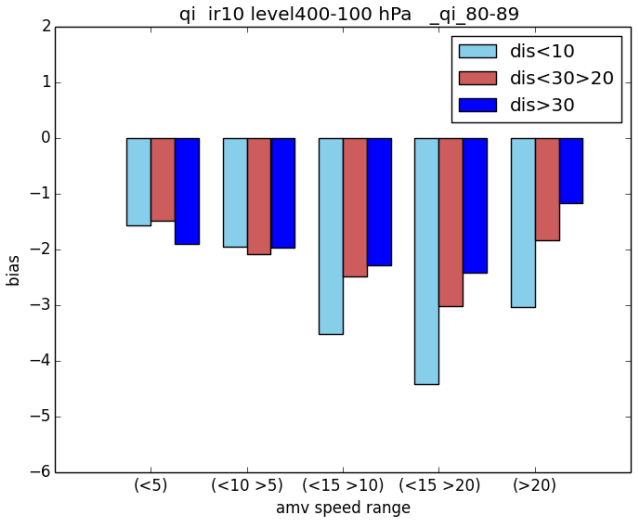


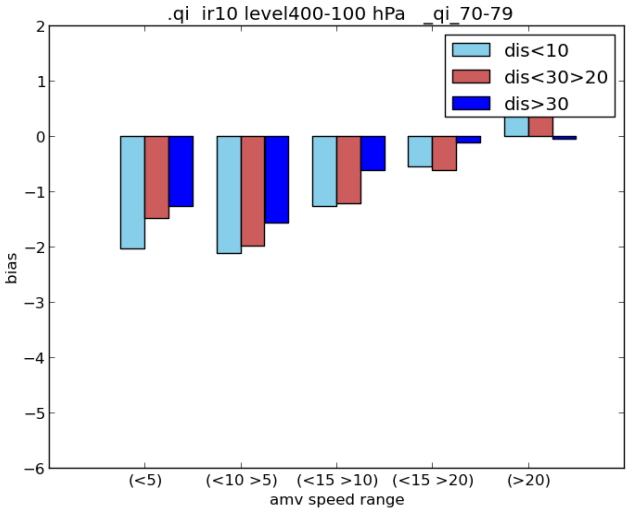




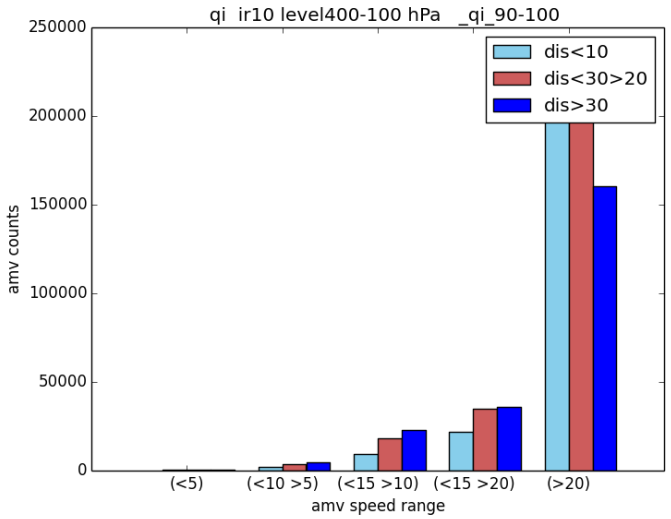
BIAS CHANNEL IR10 SEPARATION DISTANCE (CSC) BETWEEN FIRST AND SECOND MAXIMA

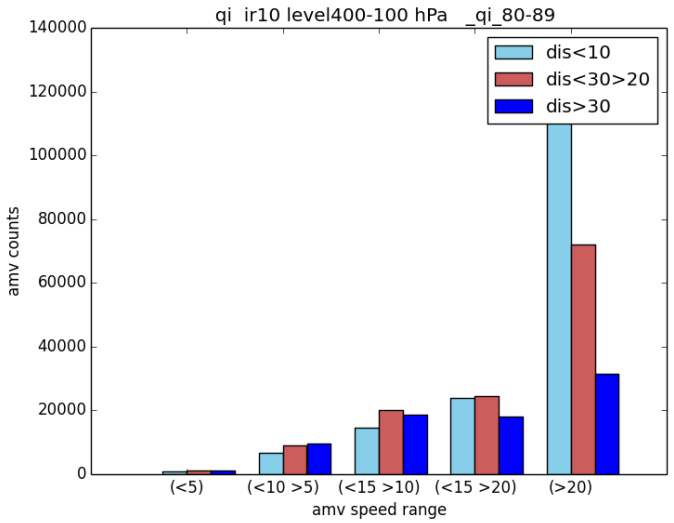


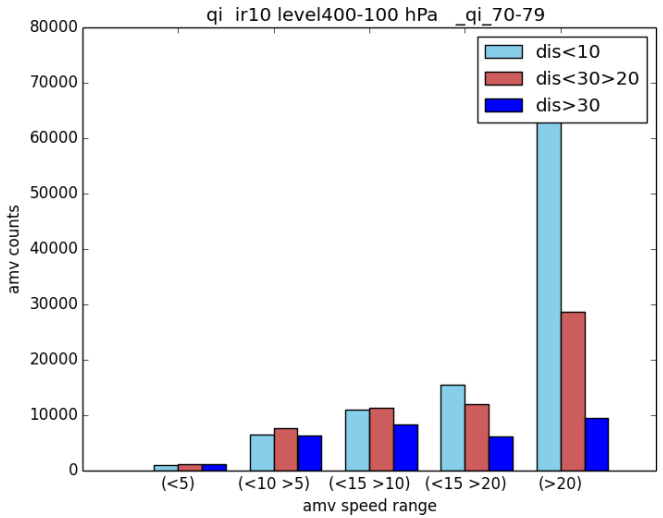




COUNTS CHANNEL IR10 SEPARATION DISTANCE (CSC) BETWEEN FIRST AND SECOND MAXIMA







Findings :

- AMVs produced from correlation surfaces with large values of CSC are the most accurate.
- The study suggests the results are not dependent on the channel used in the tracking, AMV's speed range or QI.
- The CSC could be included in the QI calculation.
- NWP data assimilation systems could use the CSC in their AMVs selection.

UKV experiments using cross correlation QI

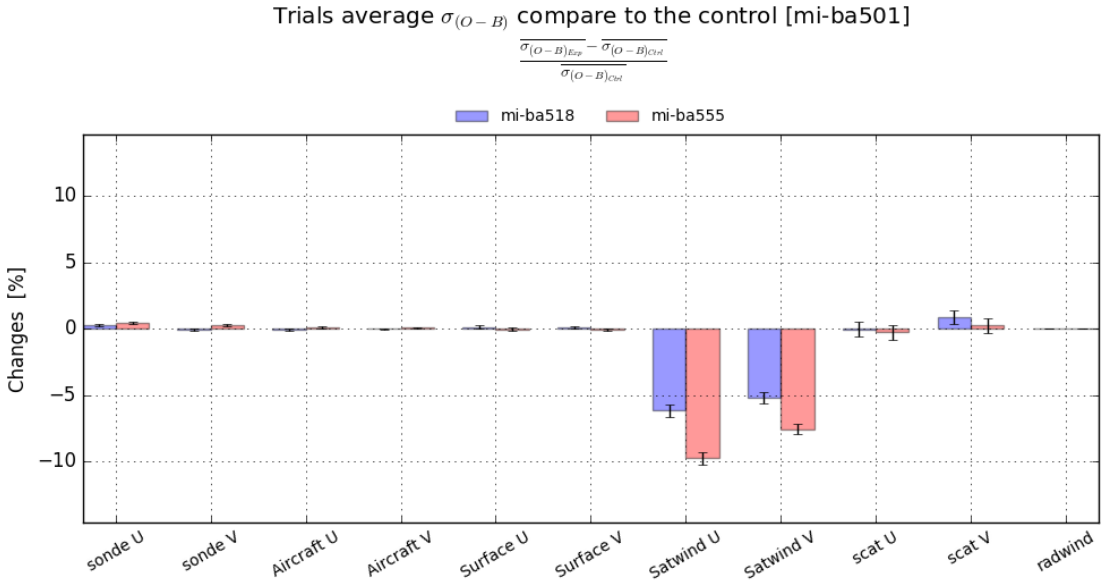
- Suite name: u-at789_PS44_amv1

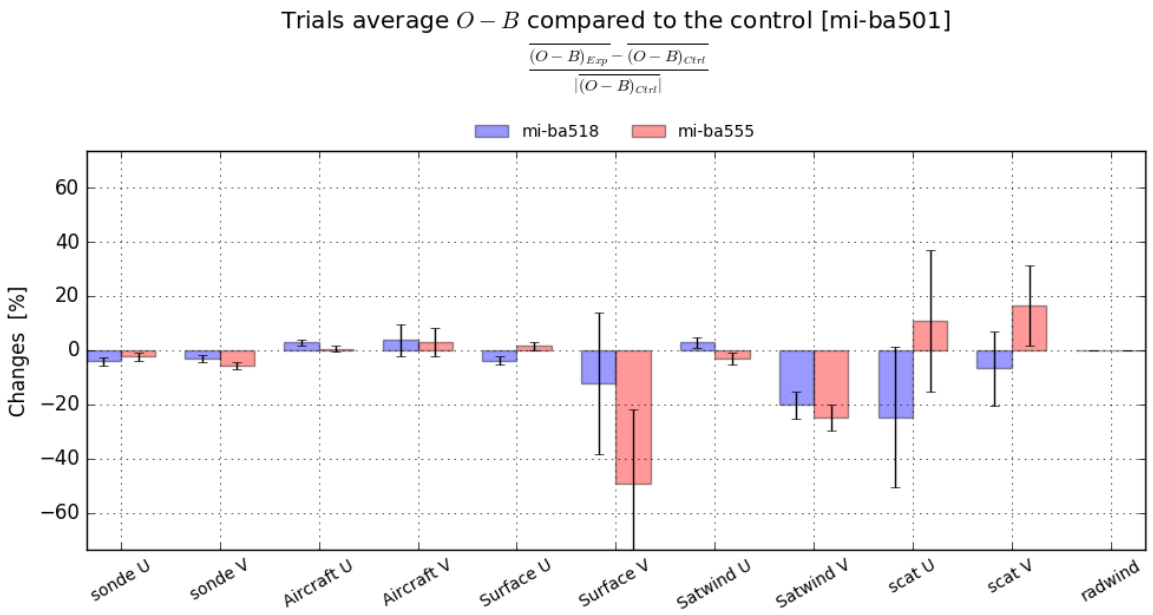
- Run at 20200328T130702:

- Trial start cycle(s)*: '20200214T1500Z'
- Trial end cycle(s)*: '20200309T1500Z’

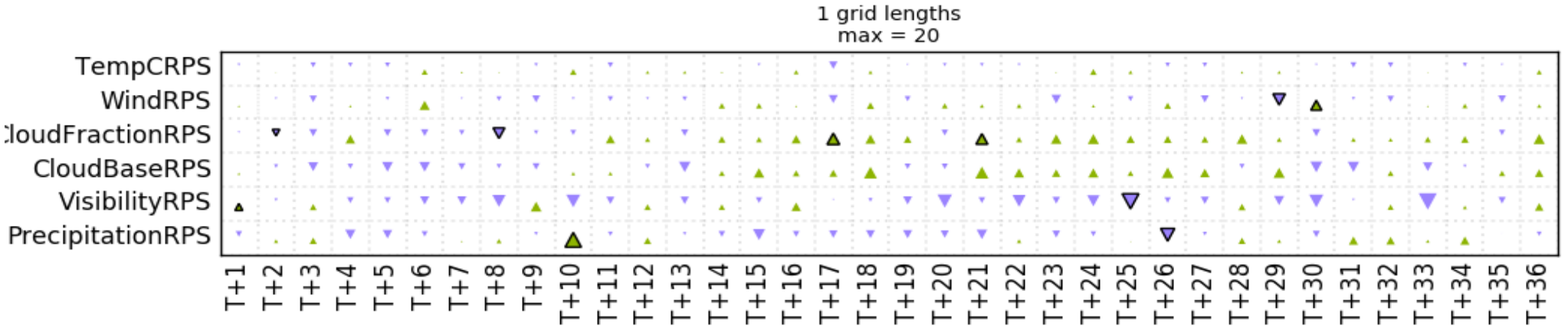
- Control operational UKAMVs every 60 minutes mi-ba501
- AMVs every 60 minutes mi-ba518
- AMVs QI every 15 minutes mi-ba555

Control operational UKAMVs every 60 minutes mi-ba501
AMVs QI every 60 minutes mi-ba518
AMVs QI every 15 minutes mi-ba555

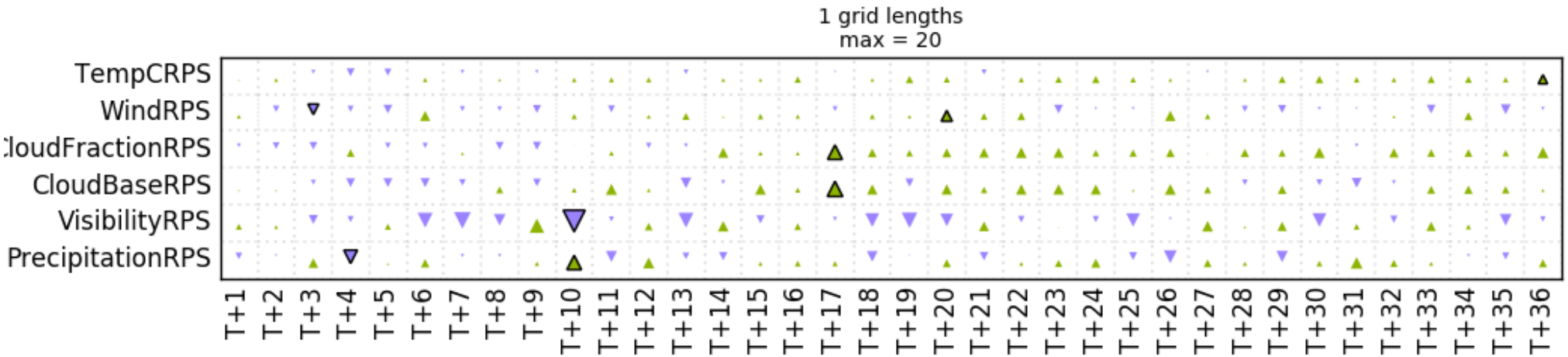




AMVs QI every 60 minutes Exp ba518



AMVs QI every 15 minutesExp ba555



Remarks

- The NWCSAF output products are very useful for mesoscale NWP Nowcasting and model validation.

- At present the impact for the new QI method looks good for short range model wind forecasts but have little effect on other model variables.

- More tuning of the Data Assimilation is under way in improve the use of the CSC index.