Application of the NWCSAF MSG SEVIRI Package to derived AMVs and their impact on the Metoffice system

Graeme Kelly, James Cotton and Peter Lean , eumetsat fellow with Stefano Migliorini (NCEO)

and Javier Garcia Pereda(AEMET)

Contents

This presentation covers the following areas

- Project
- Nowcasting / DA systems
- High Resolution UK AMVs
- Plans for future work

Project aims.

PART 1. (this talk)

Make use of AMVs from 5-15min SEVIRI imagery in the NOWCASTING and UKV suites with less than15 minutes delay.

Provide with real time and monthly monitoring of UK AMV's

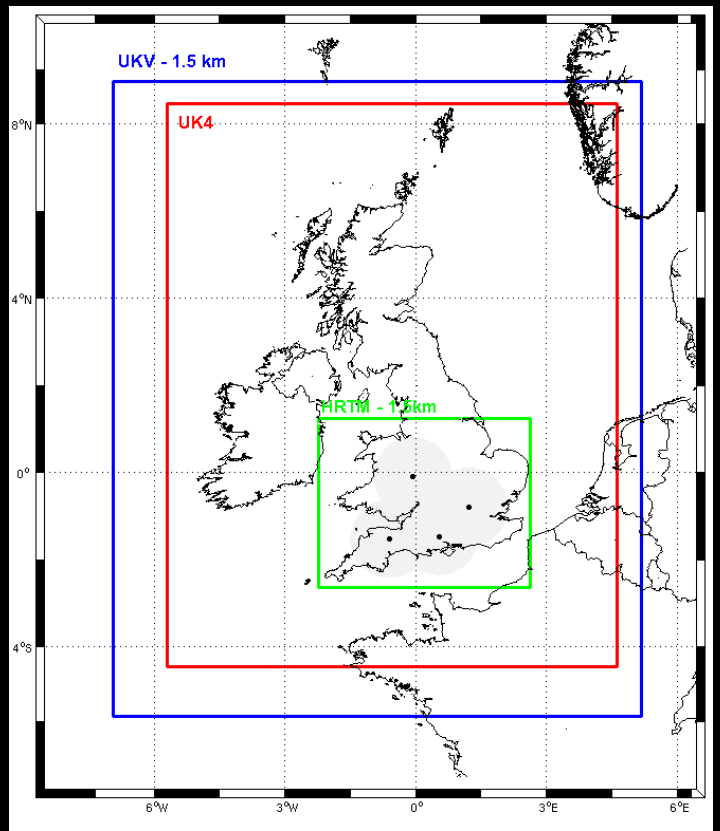
Carry out data impacts experiments

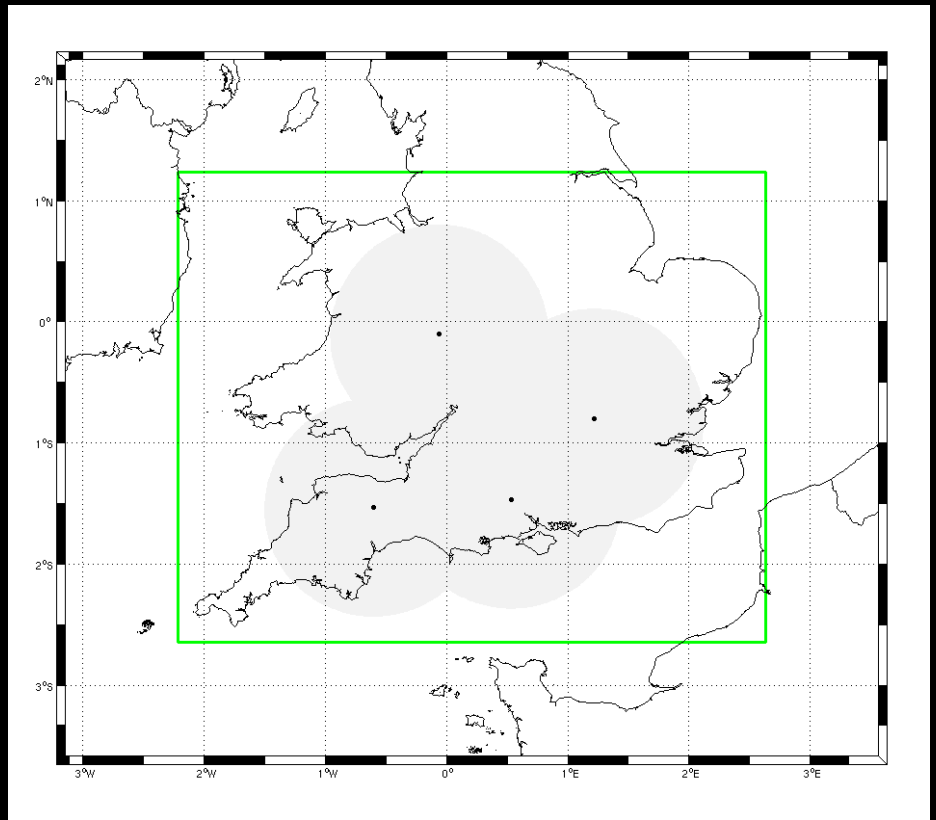
PART 2. (Peter Lean's talk)

Use of simulated imagery from UKV to help understand how the AMV processing works and produce new observation operators.

Nowcasting Model Domain

Model	Resolution	VAR	Time Window	Cycling	Forecast Length
UK4 / UKV	4 km / 1.5km	3D-Var 4/3km	3 hr	3 hr	T+36
South UK Fixed	1.5 km	3D/4D-Var 1.5/3km	1 hr	1 hr	T+6 or T+12





UK 1.5km DA cycling

- 8 three-hour cycles per day, as in UK4km model
- Data times for long (t+36) forecasts 03, 09, 15, 21 UTC
  - Observation cut-off hh+ 30min
  - Lateral boundaries from hh-3hr run of 12km Global model
- Intermediate cycles at 00, 06, 12, 18 UTC
  - Observation cut-off hh+ 2hr 40min
  - Lateral boundaries from hh Global run

UK 1.5km DA

- 3DVAR for all observations including MOPS cloud fraction Latent Heat Nudging for hourly radar-derived surface rain rate
- VAR grid is uniform 3km resolution over whole domain (including area of variable UM resolution)
  - Variable→ fixed grid interpolation for VAR linearisation states and Cx columns
  - Fixed → variable grid interpolation for VAR increments

Nowcasting System

- NWP-based nowcasting system is non-hydrostatic model that resolves convection explicitly.
- Nonlinear UM is 1.5 km resolution (360 x 288 x 70 levels), has model top at 40 km, and uses 50 s timestep.
  - Supercomputer: 4 nodes in 8 x16 decomposition. After upgrade (Power 7) 6 nodes used, equivalent to 8-9 nodes on old machine.
- Linear (PF) model and its adjoint are 3 km resolution (180 x 144 x 70 levels) and use 100 s timestep.
- 4D-Var uses hourly assimilation windows with linearization states updated every 10 minutes.
- Observations are extracted in the observation time window T-30 to T +30 minutes. Might change to T-60 to T+0.
- 4D-Var increments are added to UM at initial forecast time T-30 mins (first UM time step). Might change to T-60.

Observations currently available

- Observation availability versus usage
  - Wind profiler (u, v) [15 min] 1 hr NDP, UKV, UK4, NAE
  - Doppler radar radial winds [5 min] 1 hr NDP*, 3 hr UKV, UK4
  - GPS (integrated humidity path) [15 min] 1 hr NDP, UKV, UK4, NAE
  - Scatterometer winds [~5 min] 1 hr NDP, UKV, UK4, NAE
  - Seviri radiances. [~5-15 min] 1 hr NDP, UKV, UK4, NAE
  - Seviri AMVs [~5-15 min] . 1 hr NDP, UKV, UK4, NAE
  - Mops Cloud [~5-15 min] . 1 hr NDP, UKV, UK4, NAE
  - Mops Rain [~5-15 min] . 1 hr NDP, UKV, UK4, NAE

- Work is ongoing to use more observation to maximize the impact without increasing the cost.

SAFNWC MSG products

PGE01 CLOUD MASK (CMA)

PGE02 CLOUD TYPE (CT)

PGE03 CLOUD TOP TEMPERATURE & HEIGHT (CTTH)

PGE04 PRECIPITATING CLOUDS (PC)

PGE05 CONVECTIVE RAINFALL RATE (CRR).

PGE06 TOTAL PRECIPITABLE WATER (TPW)

PGE07 LAYER PRECIPITABLE WATER (LPW)

PGE08 STABILITY ANALYSIS IMAGERY (SAI)

PGE09 HIGH RESOLUTION WINDS (HRW)

PGE10 AUTOMATIC SATELLITE IMAGE INTERPRETATION(ASII) .

PGE11 RAPID DEVELOPING THUNDERSTORMS (RDT)

PGE12 AIR MASS ANALYSIS (AMA)

PGE13 SEVIRI PHYSICAL RETRIEVAL (SPHR)

NWCLIB

TASK MANAGER .

NWCSAF High Resolution Winds product

Input data

- Full Resolution SEVIRI/HRVIS & IR10.8
- NWP data for the working region (not mandatory but fairly recommended):
  Temperature, Wind, Geopotential, Surface temperature forecast
- NWCSAF/Cloud Type output file for the working slot (not mandatory

Output data

- Two BUFR bulletins, with AMVs related to up to two different scales of tracers
  Basic scale Tracer size 24 pixels
  Detailed scale Tracer size 12 pixels
- Detailed winds can be calculated in areas where:
  - No basic tracers found
  - Basic tracers are large with the possibility of a more meticulous search.

Current version of NWCSAF/HRW product

- HRW v3.1 available since spring 2011

NWCSAF High Resolution Winds product

Main steps of HRW algorithm:

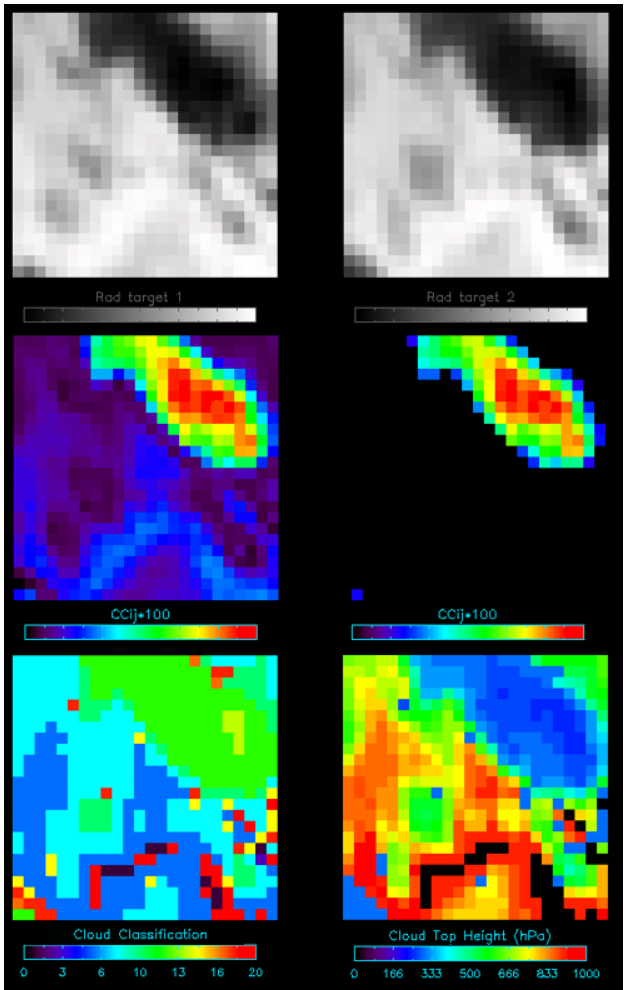
- Preprocessing Initialization of SEVIRI & NWP data through NWCLIB library included
- Tracer calculation with two different methods
  Gradient Tracer characteristics
- Height assignment one of two different height levels is defined for each tracer,
  depending on the NWCSAF/Cloud type output value related to the tracer
  Cloud top Cloud base
- Tracer tracking / Wind calculation Selection of up to three correlation centres with Euclidean differences or Cross correlation methods.
- Quality control with Eumetsat Quality Indicator method (also used at MPEF).
- Orographic flag test tracers affected by land influence are rejected

CCC method for Height assignment

- Collaboration with Régis Borde,

  EUMETSAT

  (Dertermining height only using pixels contributing most to the image correlation).



NWCSAF/HRW algorithm: Quality Control

Currently for assimilation trials UKIR .92 UKVIS .97

- **Quality Indicator method,** developed at Eumetsat for the AMV calculation at MPEF (K.Holmlund 1998), is adapted for HRW product.

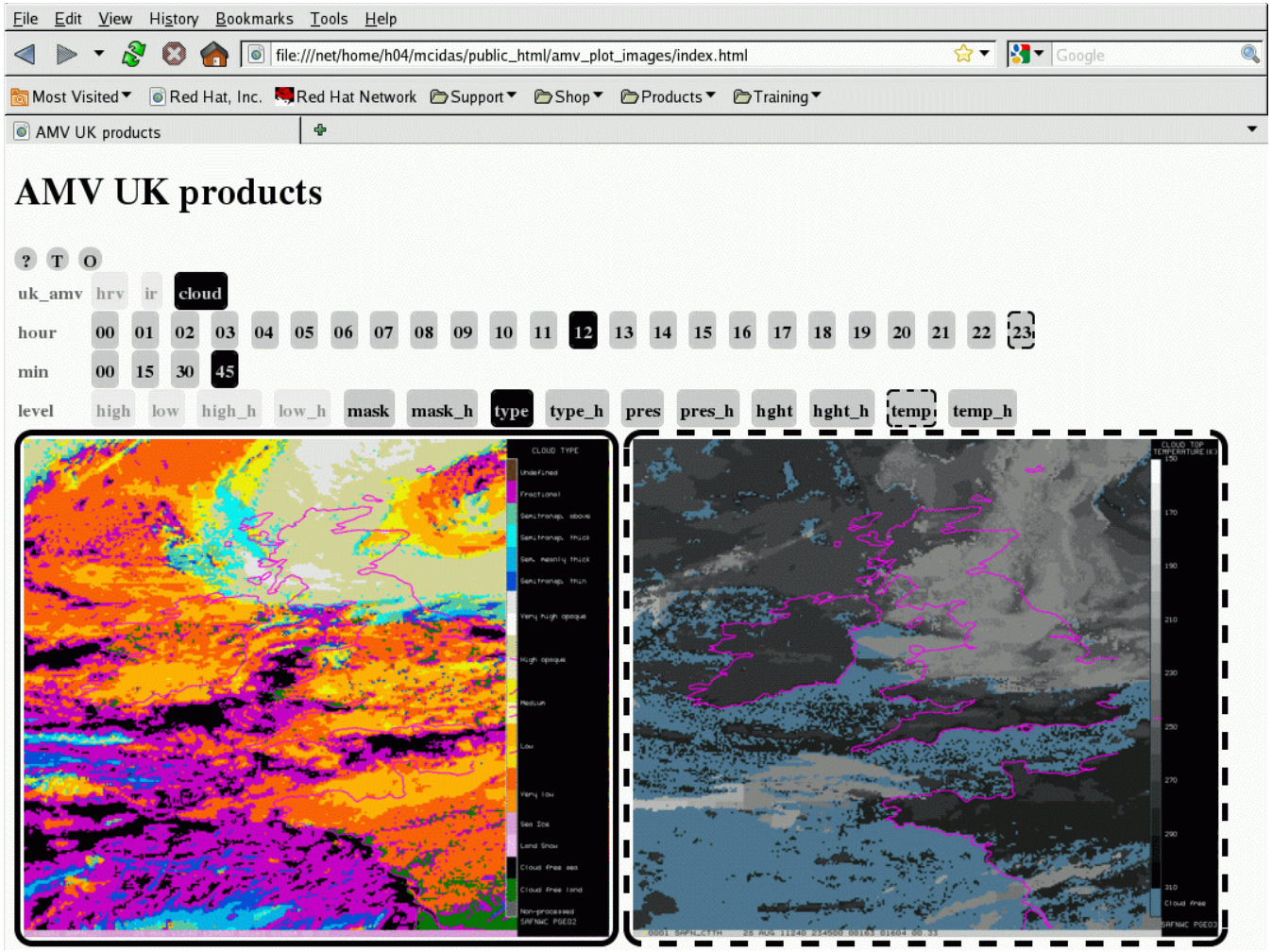
- Several tests on consistency (partial QIs)
  - Temporal test vector/direction/speed consistency with AMVs in previous slot).
  - Spatial test consistency between neighbour AMVs).
  - Forecast test vector consistency with NWP forecast winds

  Detailed winds also
  - Two scale test consistency with simultaneous Basic winds

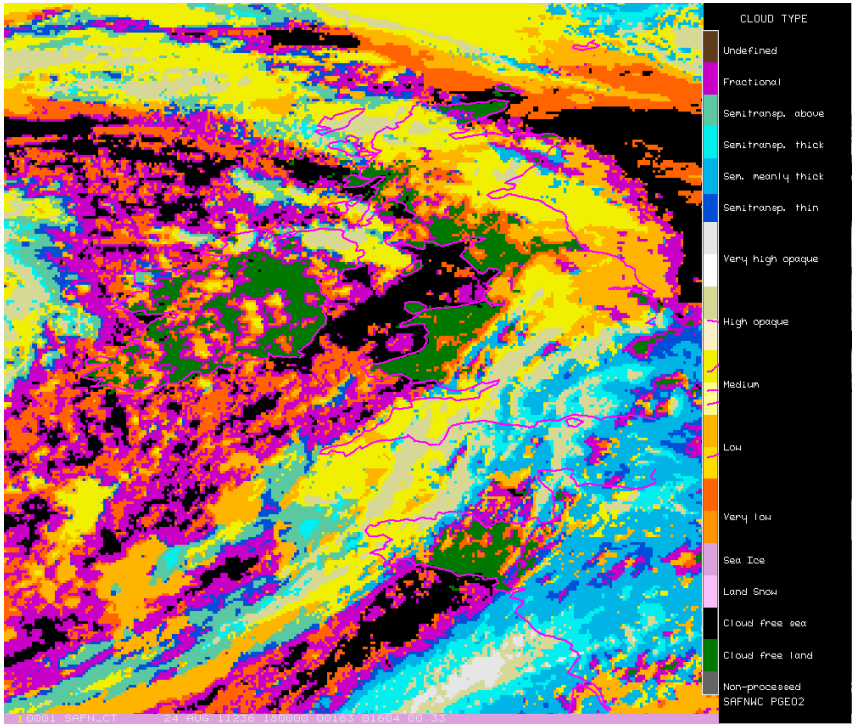
Partial QIs statistical fitting functions given by the method.

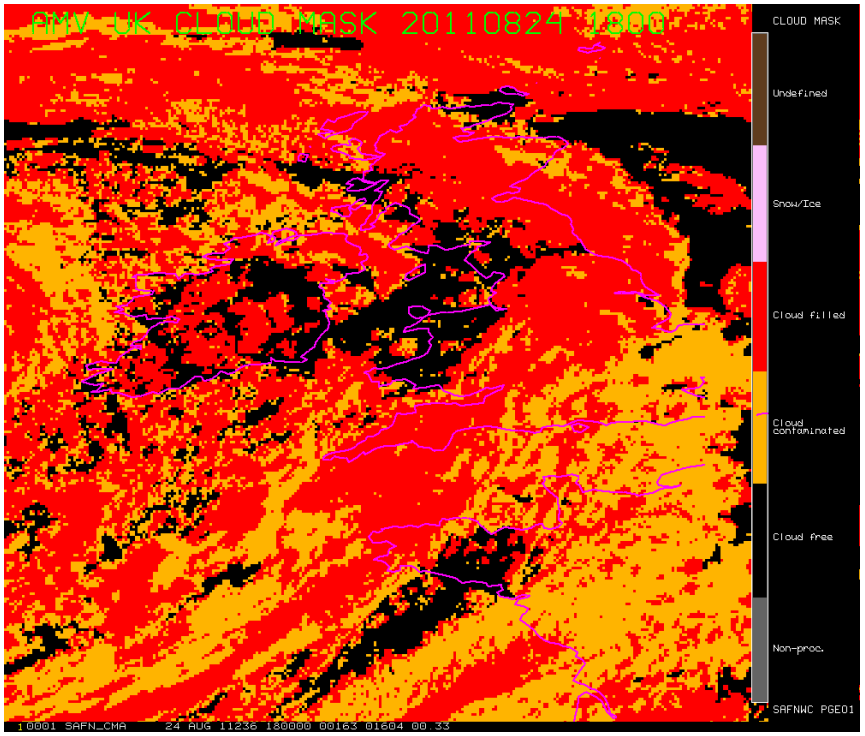
- The overall QI is the average sum of partial QI, with a double contribution of the spatial

UK AMVs 15min daily schedule of products

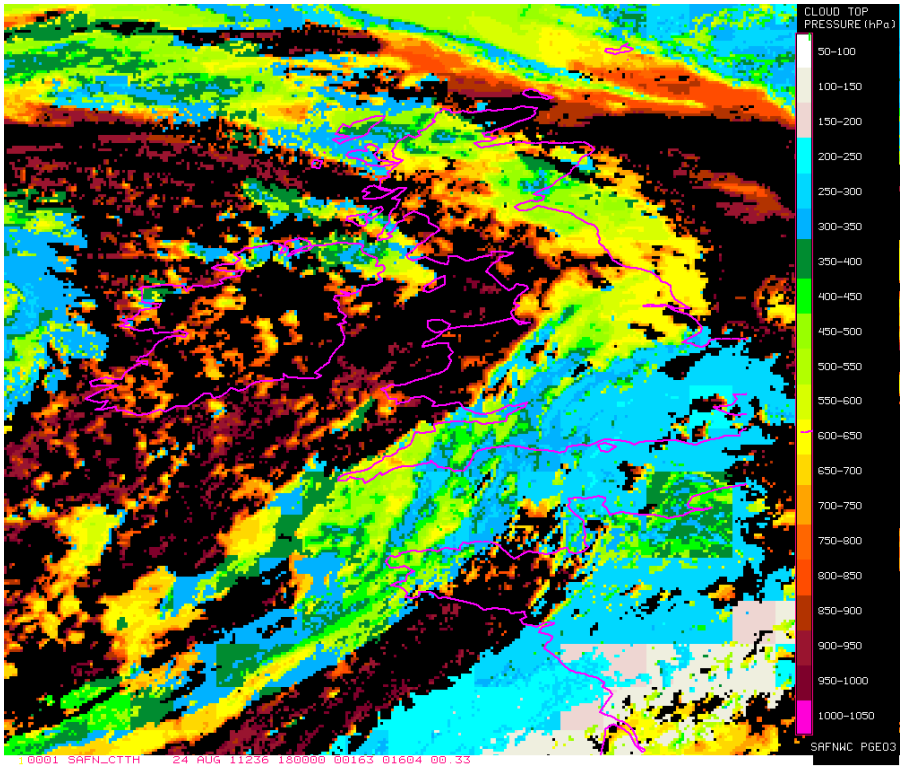


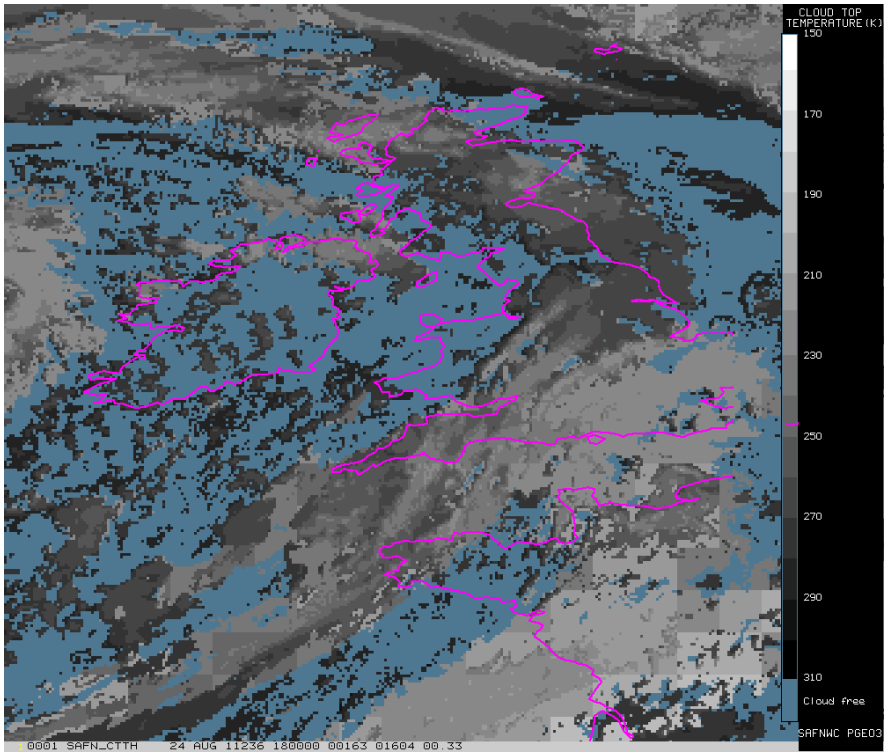
Cloud mask (left)and Cloud type (right)



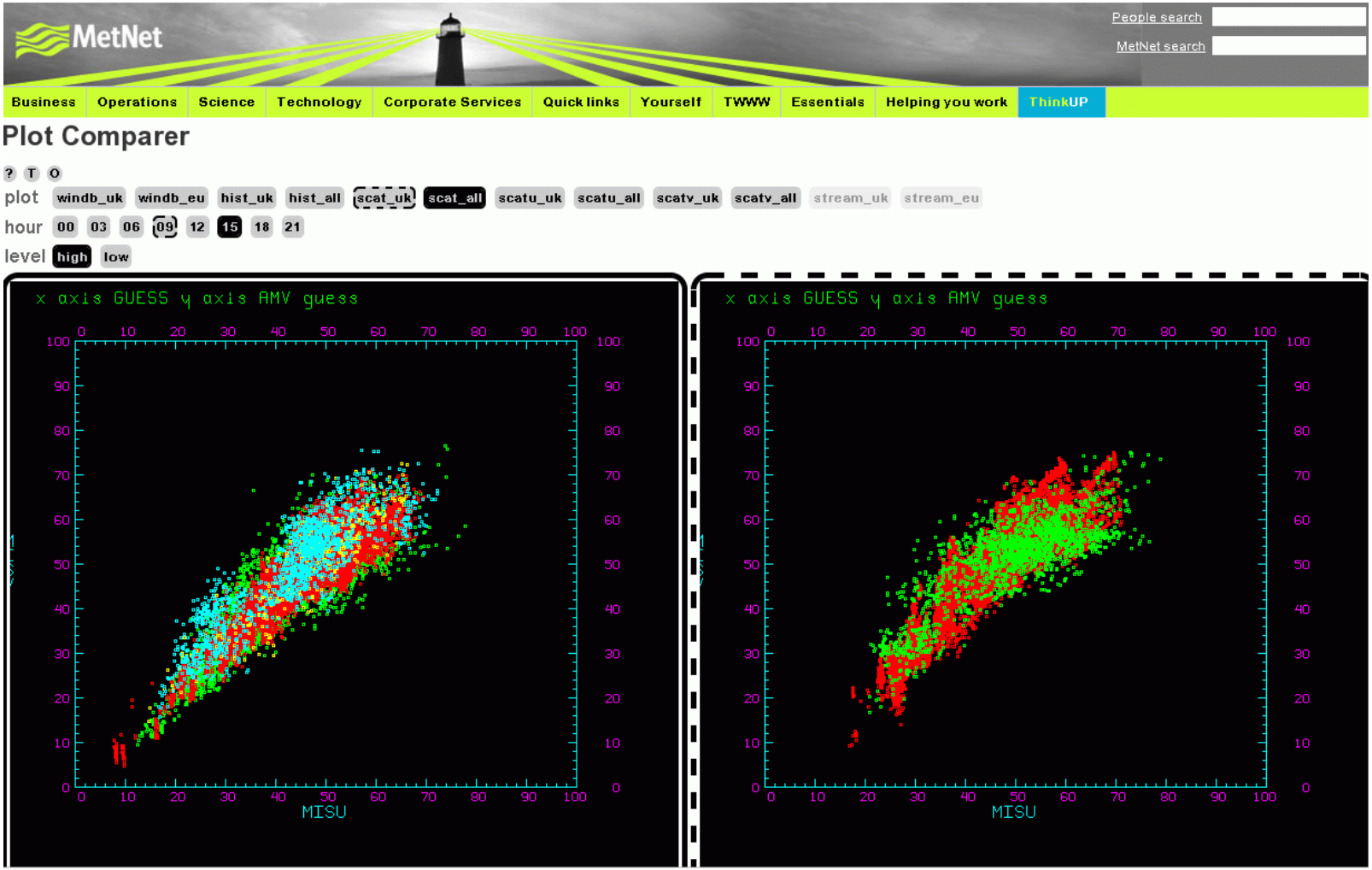


Cloud pressure (left) and height (right)

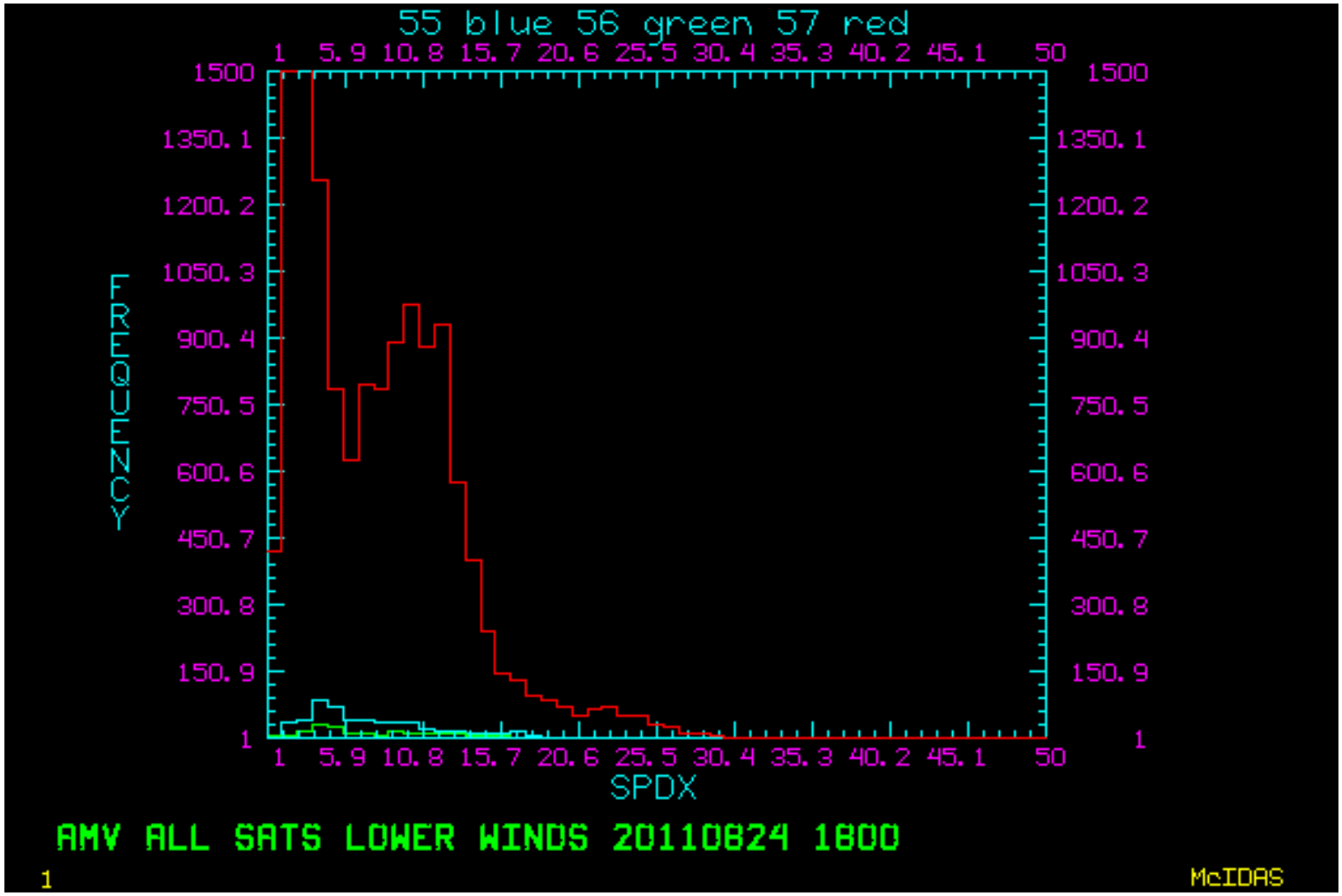




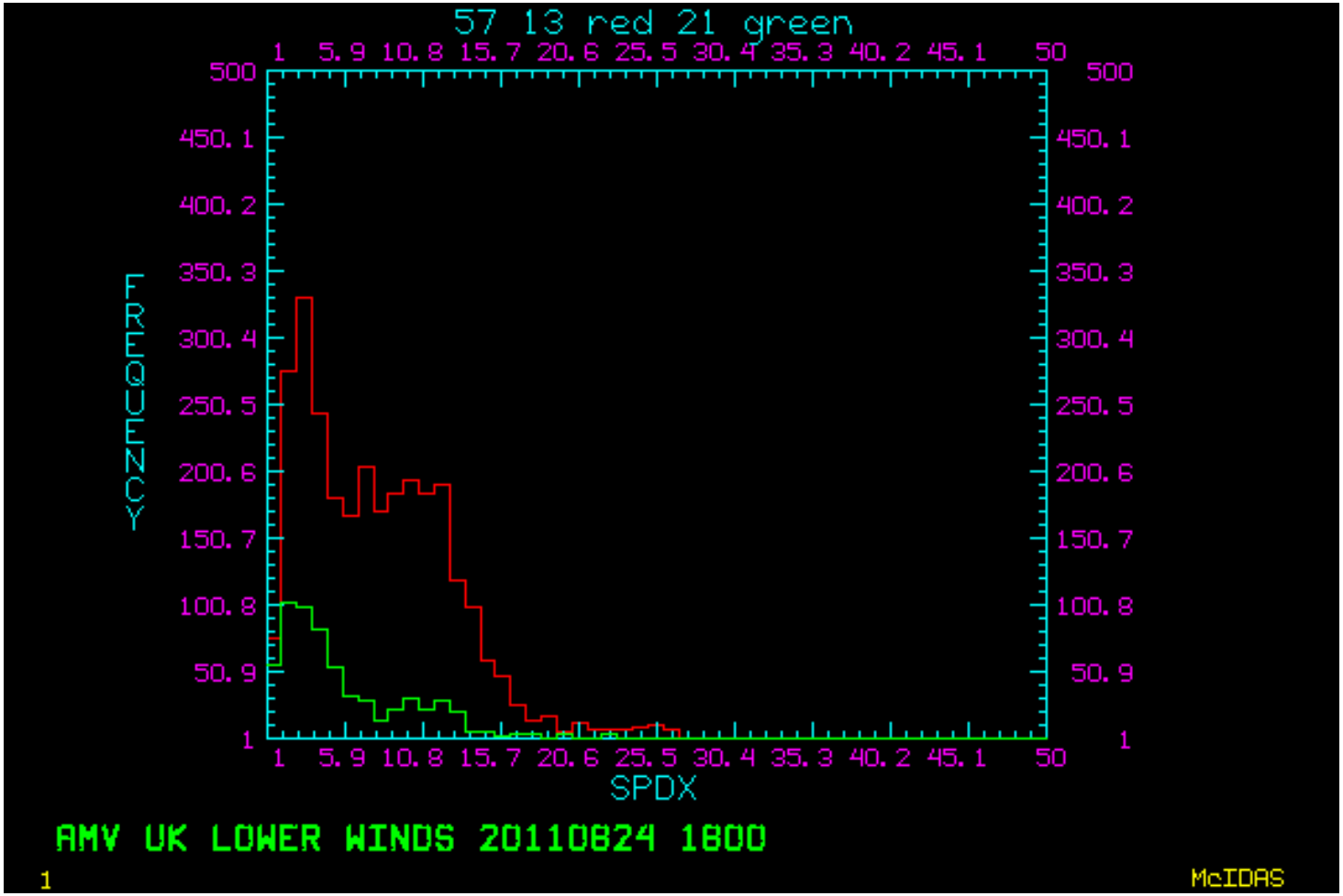
Daily UK4 OPS monitoring of UK AMVs and EUM AMVs (run every 3hr on els044)



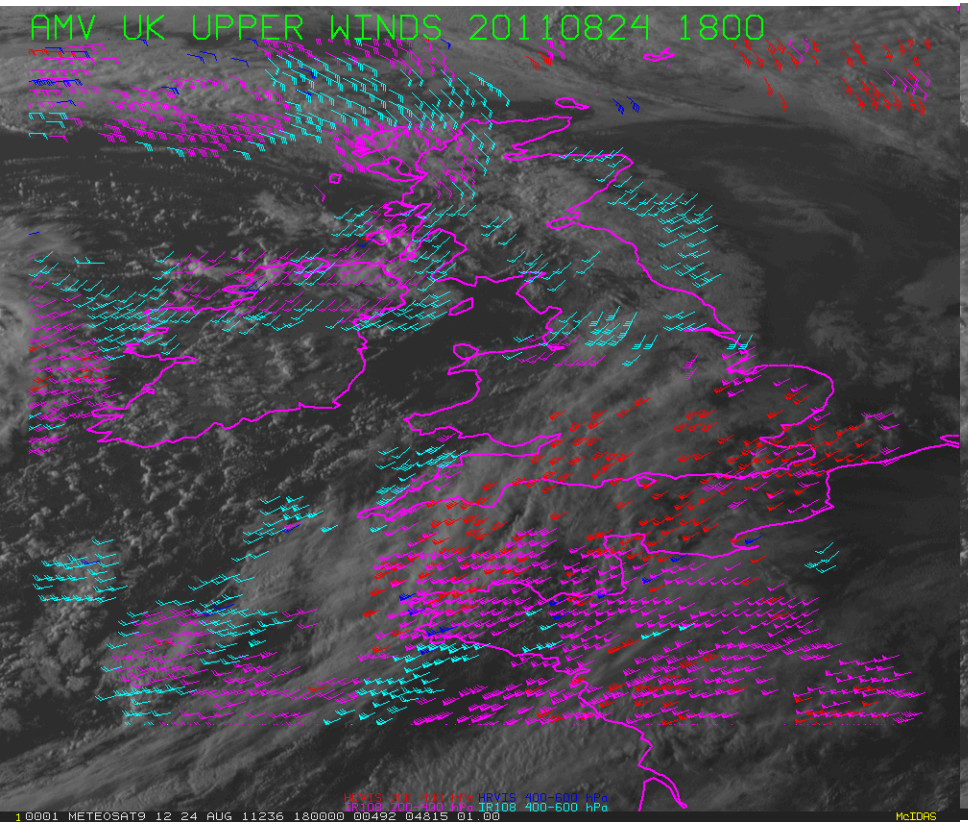
UK4 3hr monitoring
red UKAMV blue/green EUMAMV

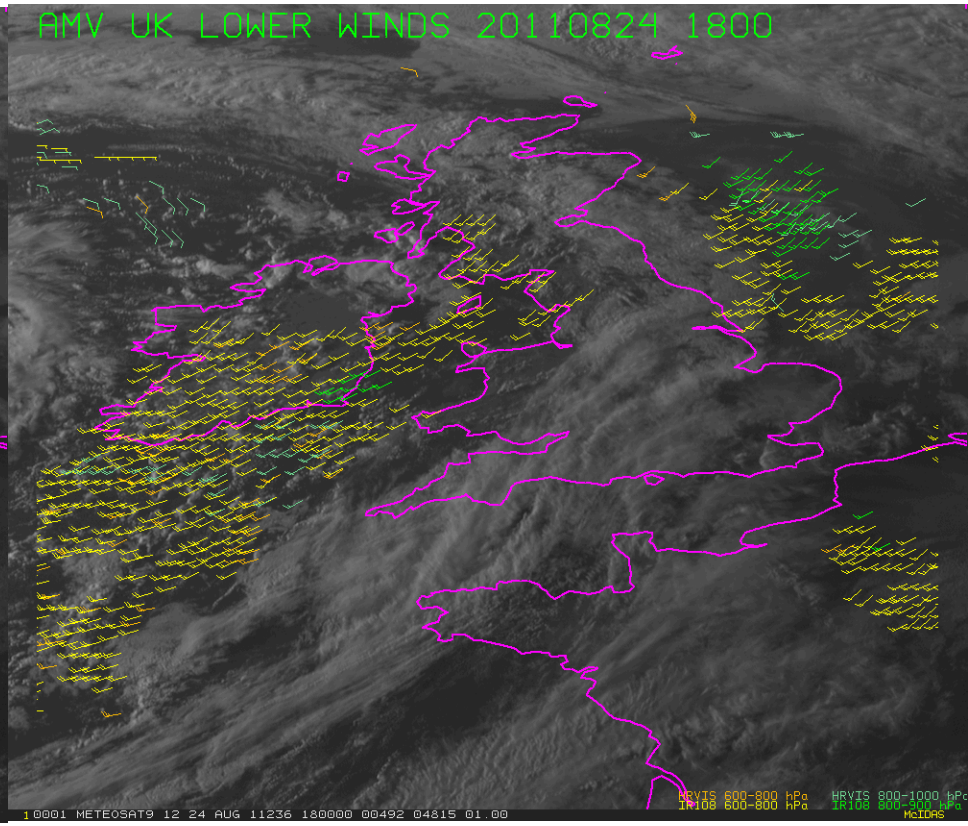


UK4 3hr monitoring
red UK AMV's IR green HRV AMV's

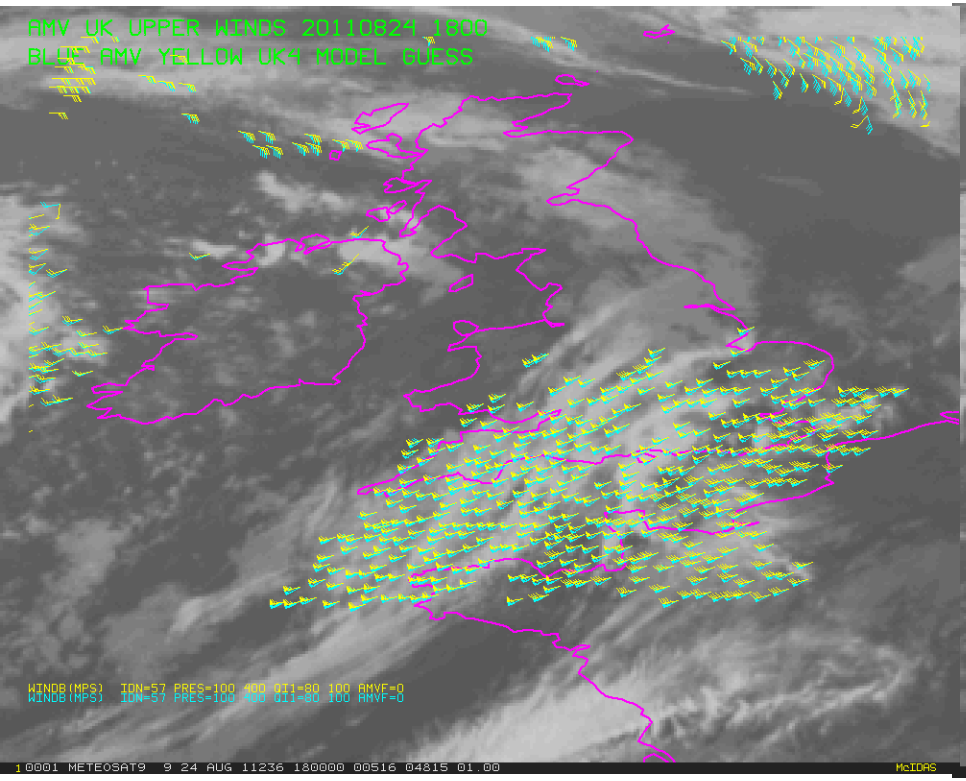


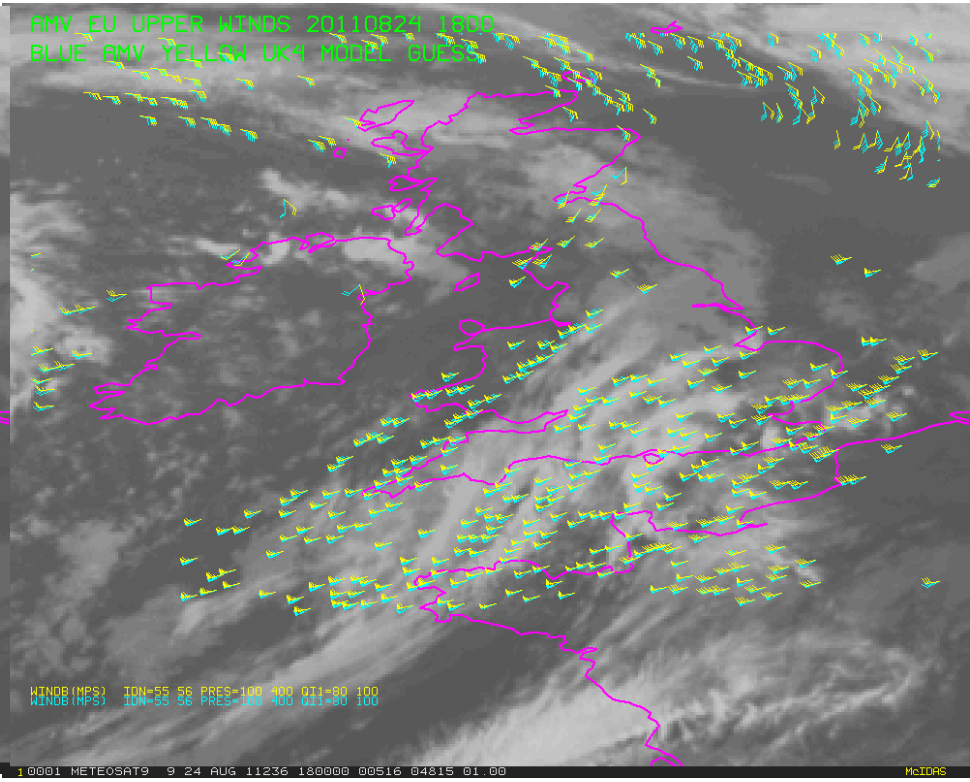
Upper level (left) and low level winds(right)



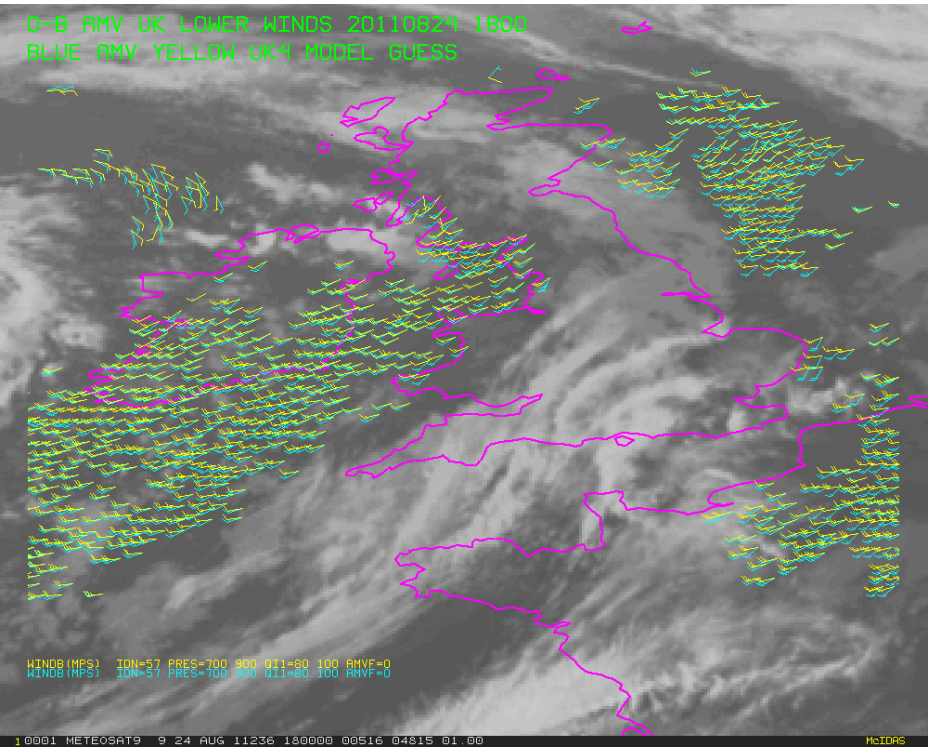


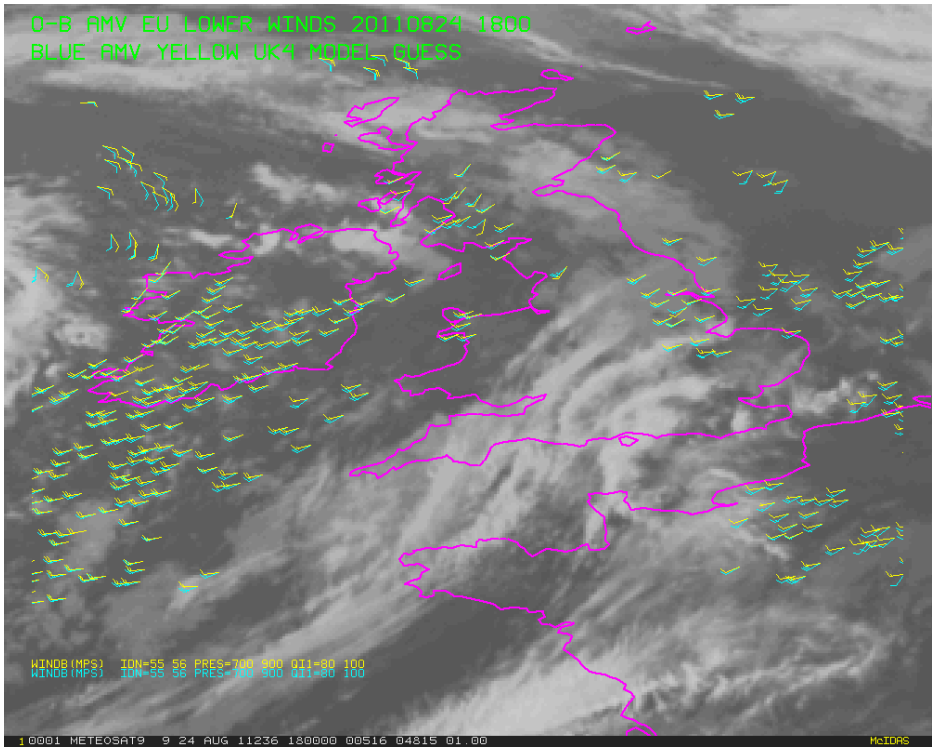
UK4 3hr monitoring
left UK AMV right EUM AMV





UK4 3hr monitoring
left UK AMV right EUM AMV





AMV Monitoring Output (monthly and some examples)

AMV Monitoring Output

Mary Forsythe > *AMV Home Page* > *AMV Monitoring: New Data* > *UK NWC SAF*

Last updated 01 Sep 2011

UK NWC SAF winds

- Monitoring performed in the UK4 model for August 2011
- QI with FG check: QI1 > 80
- High level is above 400 hPa, mid level is 400-700 hPa and low level is below 700 hPa

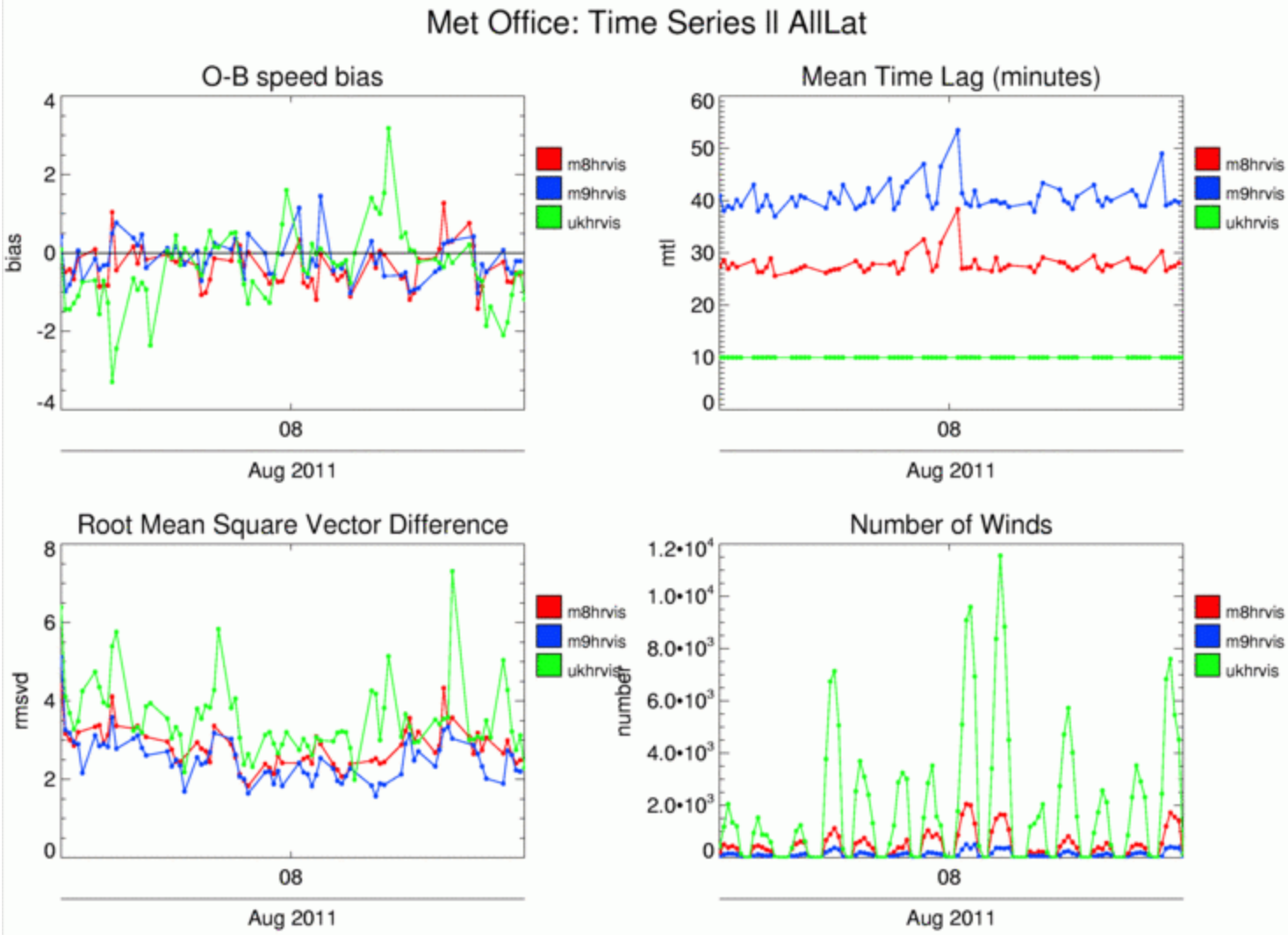
1. Timeliness
2. Data volume
3. Data coverage
4. NWP SAF statistics
5. Time series statistics
6. Collocation statistics
7. Statistics versus QIs
8. Comparisons to model bestfit pressure

Thanks to james cotton

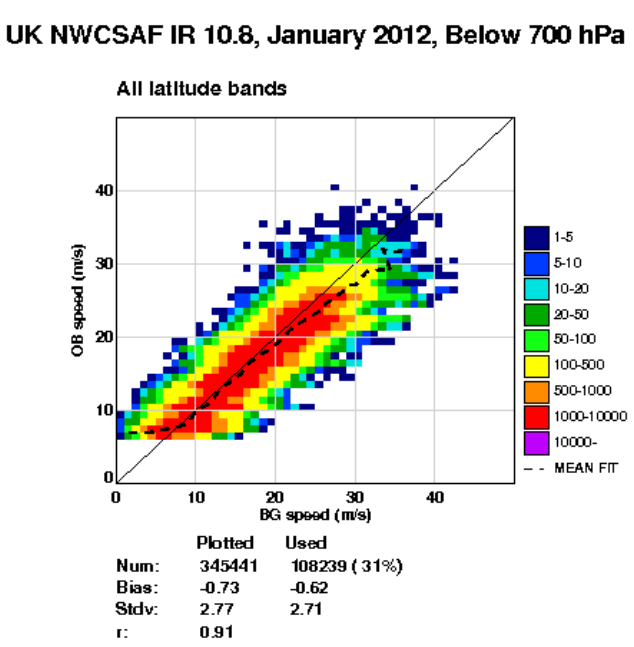
Time series

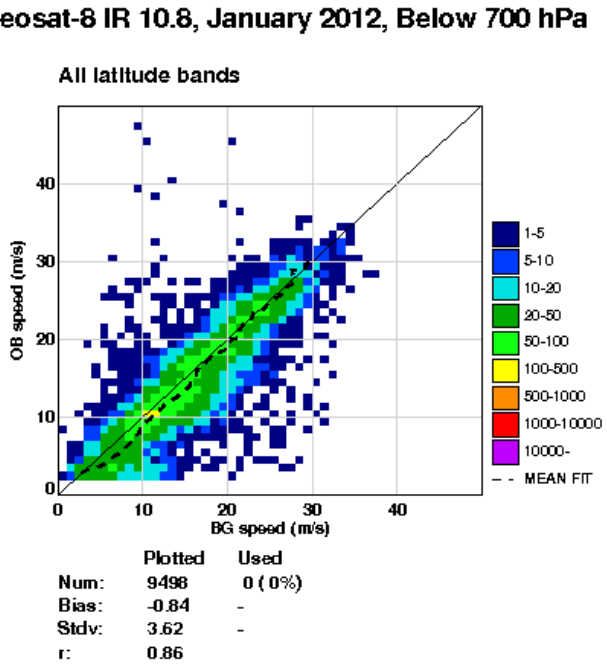
AMV monitoring

MetO Monthly Time Series Statistics Plots



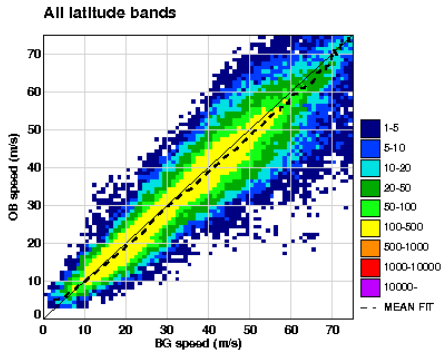
Low level IR10.8 Scatter OB Speed v BG Speed Below 700 hPa





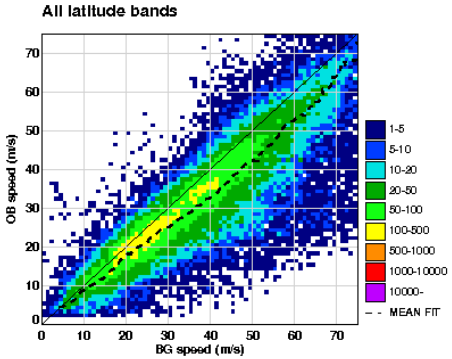
Scatter OB speed v BG Speed
High level UK VIS & IR 10.8

UK NWCSAF HRVIS, January 2012, Above 400 hPa



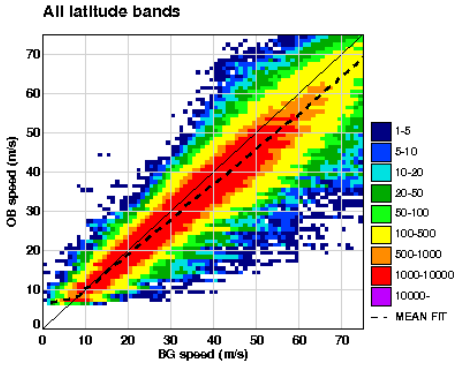
	Plotted	Used
Num:	121048	13152 (10%)
Bias:	-1.06	-0.33
Stdv:	5.17	5.81
r:	0.95	

Meteosat-8 WV 7.3, January 2012, Above 400 hPa



	Plotted	Used
Num:	61543	0 (0%)
Bias:	-5.46	-
Stdv:	8.26	-
r:	0.87	

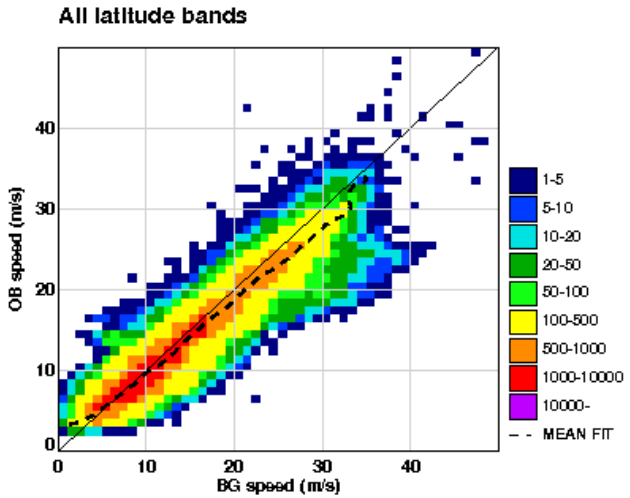
UK NWCSAF IR 10.8, January 2012, Above 400 hPa



	Plotted	Used
Num:	1449199	384874 (26%)
Bias:	-2.81	-2.24
Stdv:	4.98	4.81
r:	0.95	

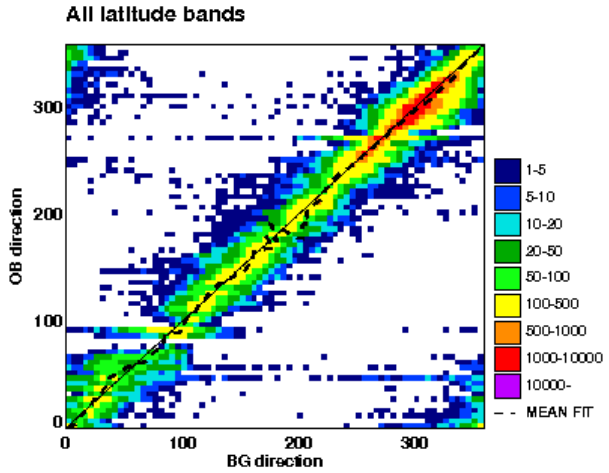
Low level O-B Scatter for HRVIS Direction & Speed

UK NWCSAF HRVIS, January 2012, Below 700 hPa



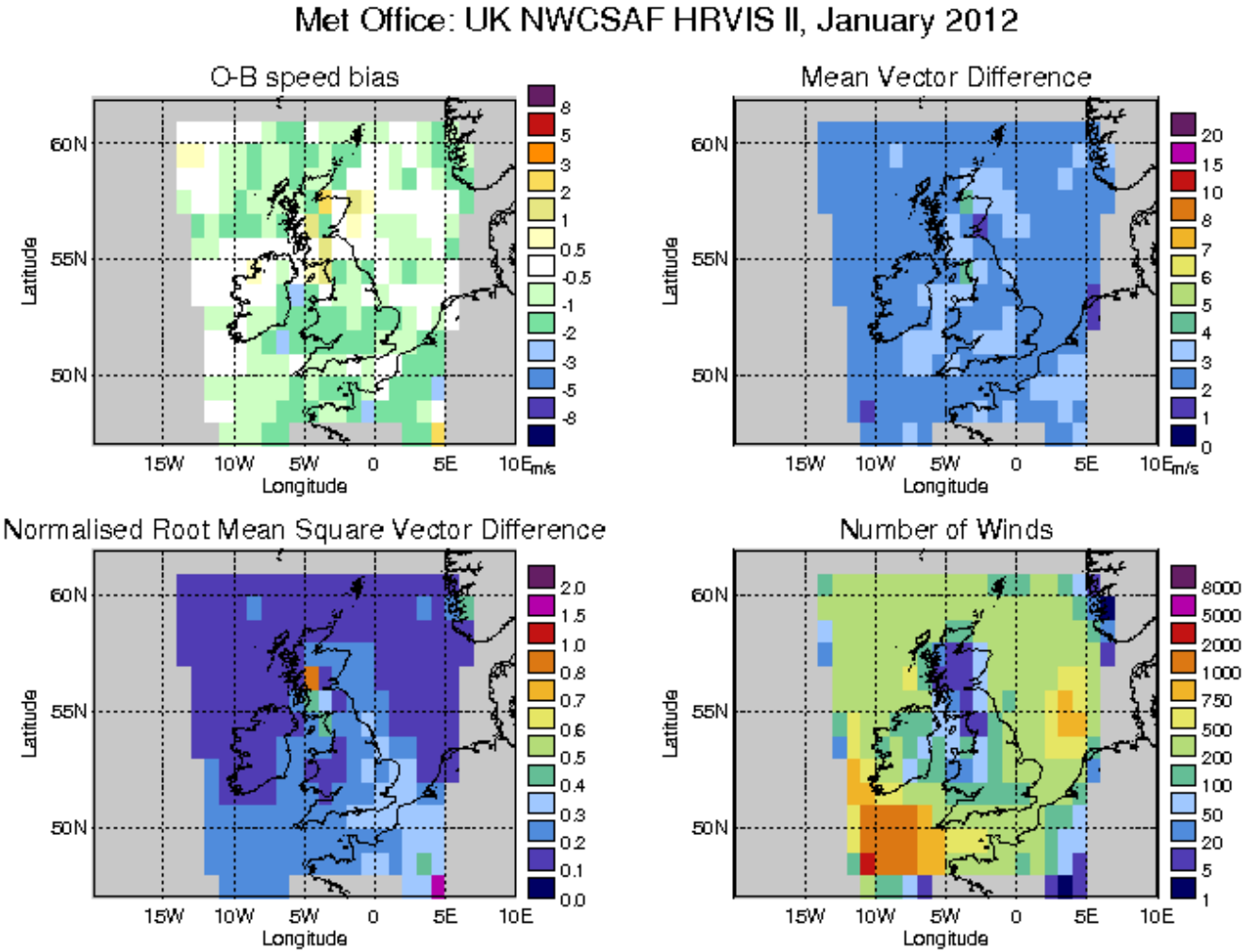
	Plotted	Used
Num:	148707	68393 (45%)
Bias:	-0.87	-0.75
Stdv:	2.61	2.43
r:	0.94	

UK NWCSAF HRVIS, January 2012, Below 700 hPa

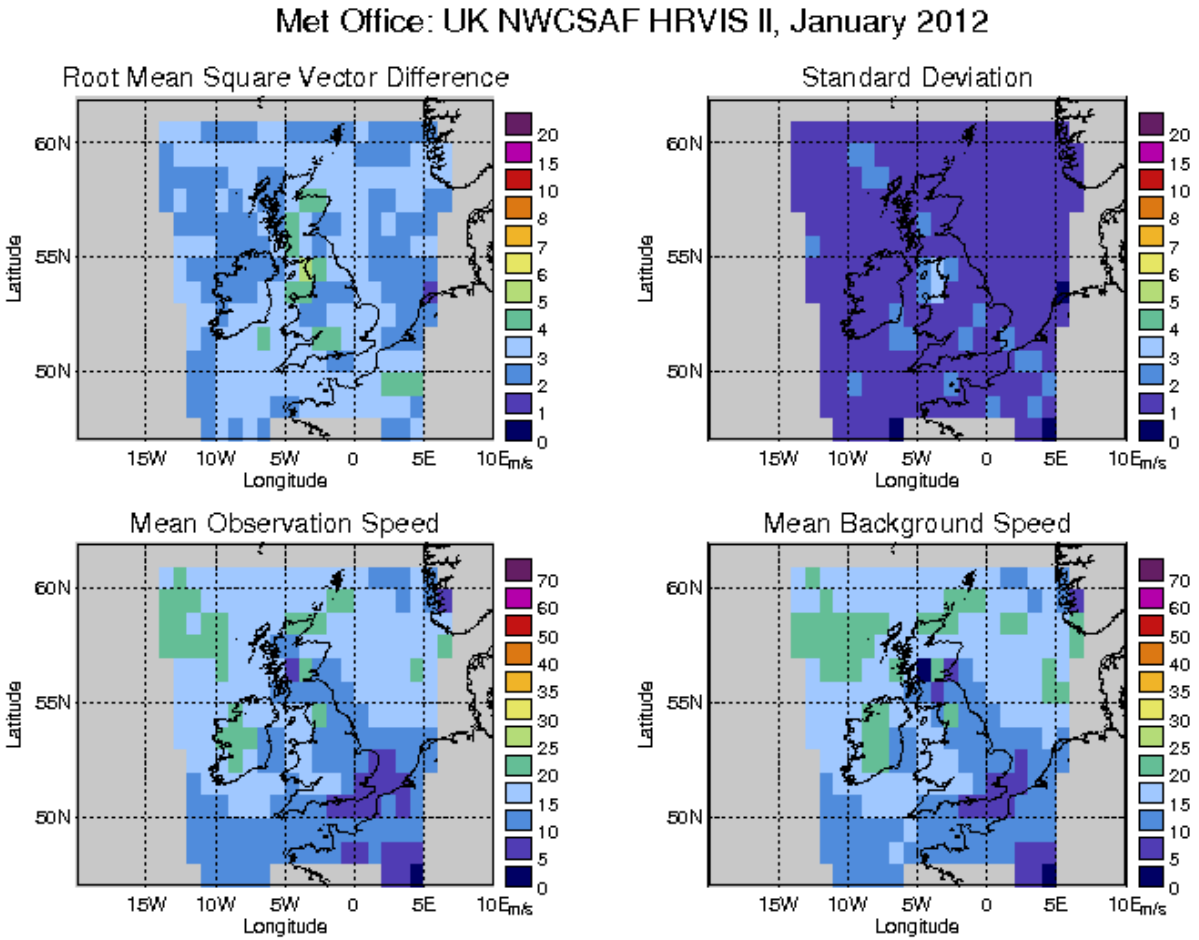


	Plotted	Used
Num:	160986	72647 (45%)
Bias:	-2.06	-1.38
Stdv:	14.50	13.52
r:	0.90	

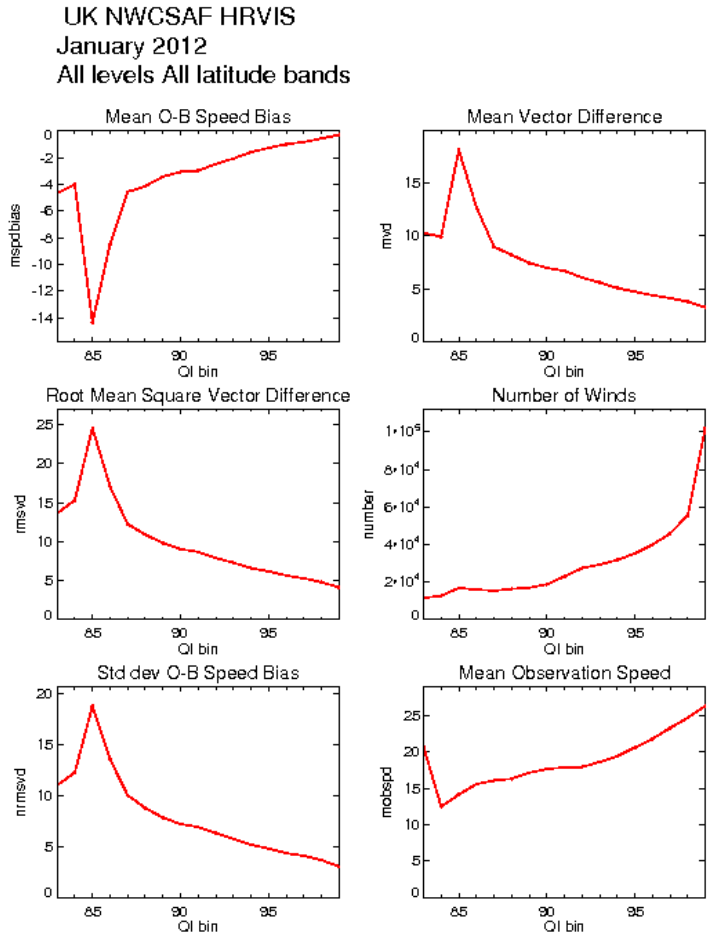
Below 700 hPa HRVIS O-B stats

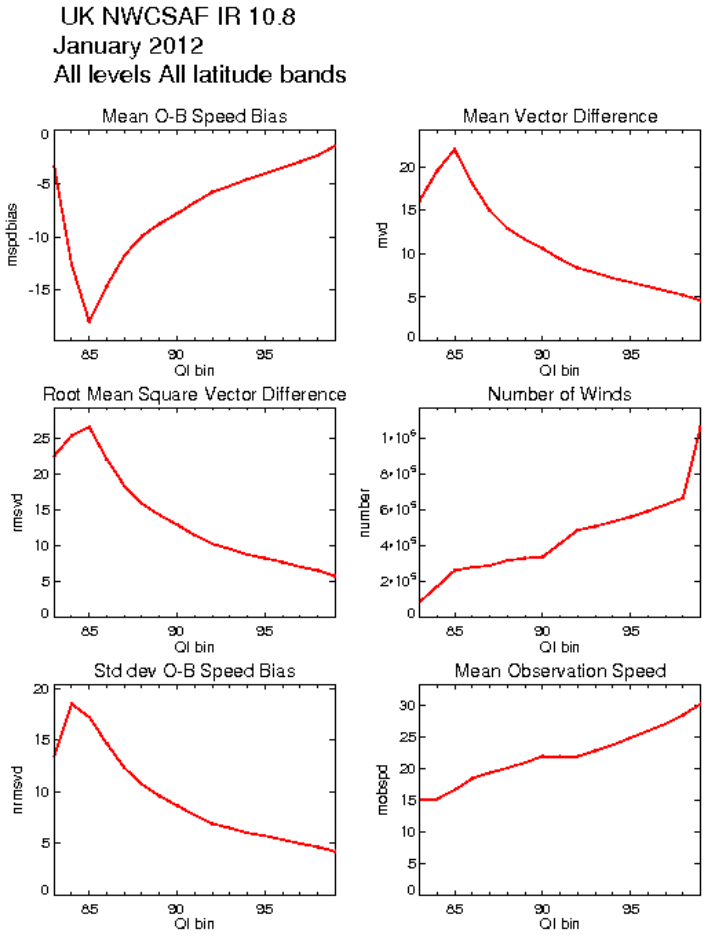


Below 700 hPa HRVIS O-B stats

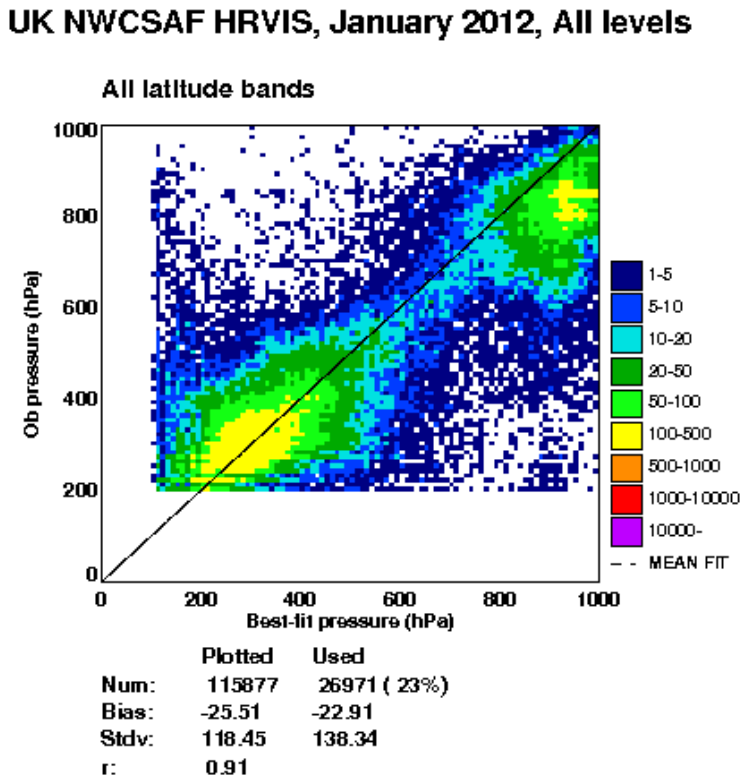


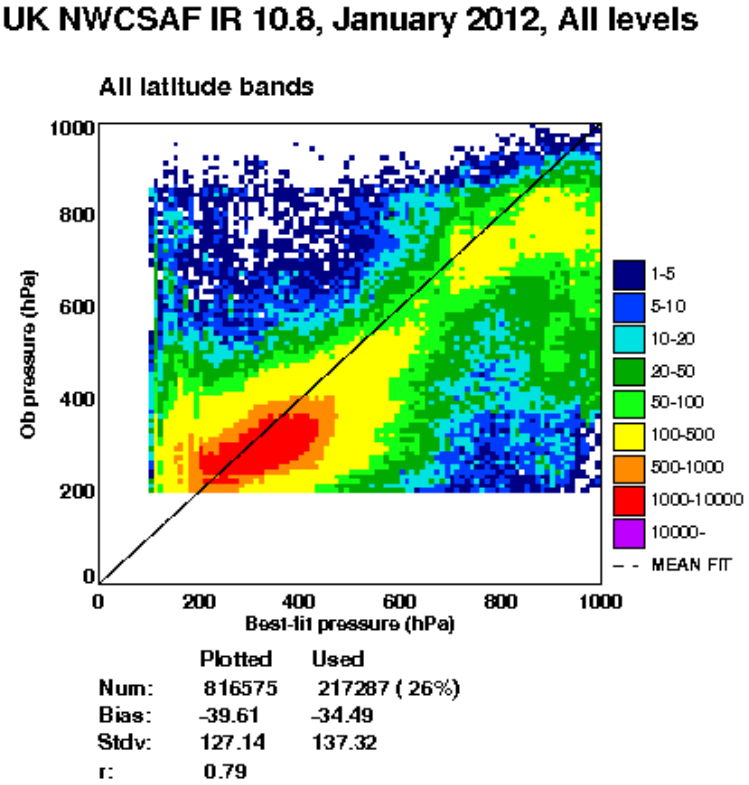
QI values for HRVIS & IR 10.8 chosen values for data assimilation HRVIS .92 IR .97



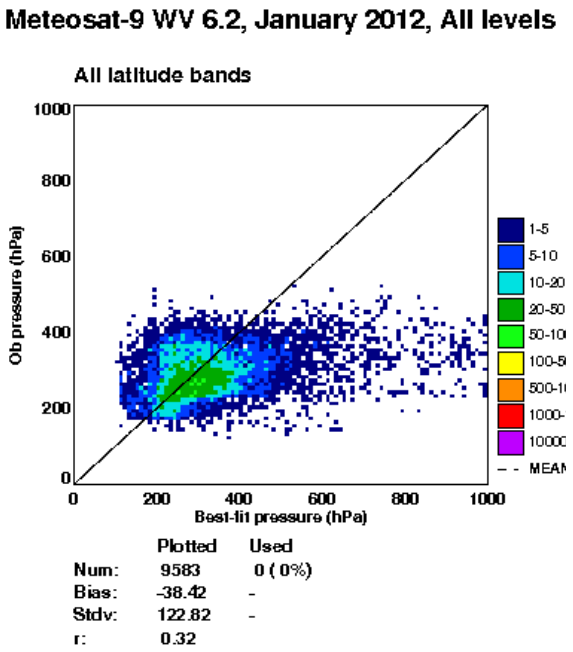


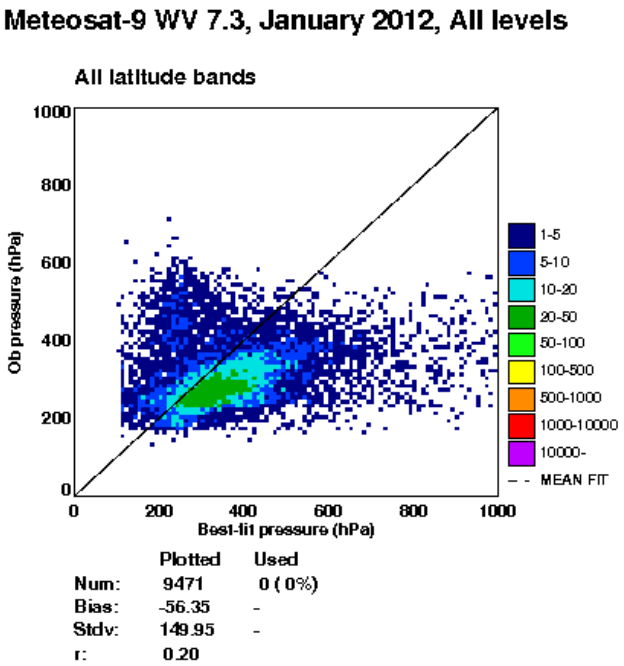
Scatter plots for HRVIS and IR10.8 Observed pressure v Best fit pressure





Scatter plots for WV 7.3 and WV 6.2 Observed pressure v Best fit pressure





Forecast Trials of PS27 UK4 suite

Low Total number of days = 16
From 20111221 to 20120105
Validity Times: 0 600 1200 1800
Area Code: 2014 (over the UK)

Parameter	Control Data	Test Data	Test - Control
	Mean ETS	Mean ETS	Wted ETS Diff
Surface Visibility	0.025	0.025	0.001
6 hr Precip Accum	0.299	0.303	0.088
Total Cloud Amount	0.287	0.297	0.091
Cloud Based Height (3/8 Cover)	0.204	0.212	0.085
	Mean Skill	Mean Skill	Wted Skill Diff
Surface Temp	0.696	0.696	-0.007
Surface Wind	0.620	0.619	-0.030

```
Total Weighted Score (%)
  Control Case   =   37.719
  Test Case      =   37.947
  Test - Control =    0.229 (   0.6% change)
```

Plans:

- Remove the forecast dependence from the QI calculation
- Add extra channels to the AMV calculations
- Investigate to use of clear sky AMVs from the water vapour channels
- Begin trials with the Nowcasting suite including 4DVAR.
- Trial some variations of observation usage
- Observation operators based on the simulated studies

Questions?