Scatterometer Wind Assimilation at the Met Office

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International Ocean Vector Winds Science Team (IOVWST) meeting, Brest, June 2014

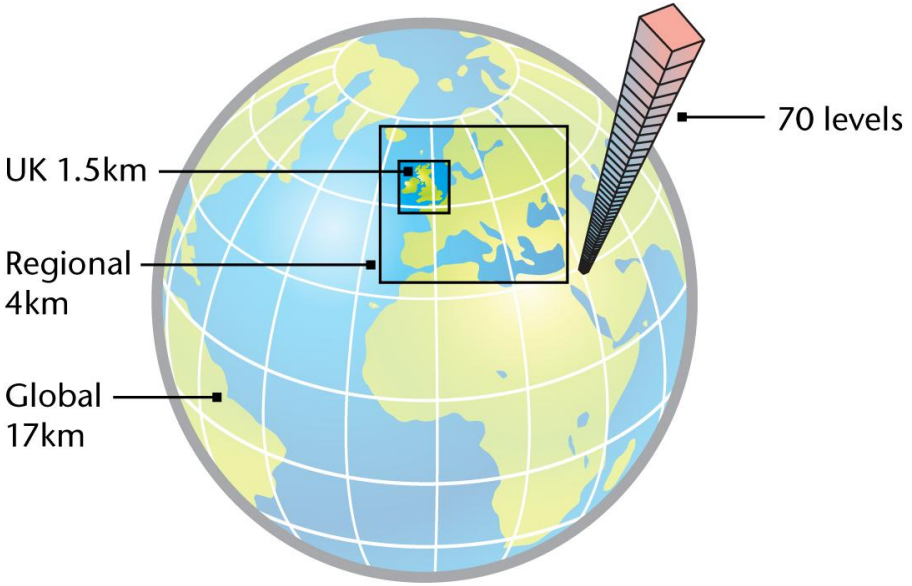
Outline

- Assimilation status
- Global updates: Metop-B and spatial thinning
- UKV updates: Coastal ASCAT winds

Met Office NWP model suites

Global and MOGREPS-G

- 25-km in mid latitudes (17-km from July 2014)
- 70 levels (80-km model top)
- Hybrid 4D-Var (60-km)
- Analysis times: 0,6,12,18 Z
- T+67 forecast twice/day
- T+168 (7 day) forecast twice/day
- 12-member EPS - 32 km 4x/day T+168



Euro4

- 4.4 km, 70 levels (40-km model top)
- Global downscaler
- T+60 forecast twice/day
- T+120 (5 day) forecast twice/day

UKV and MOGREPS-UK

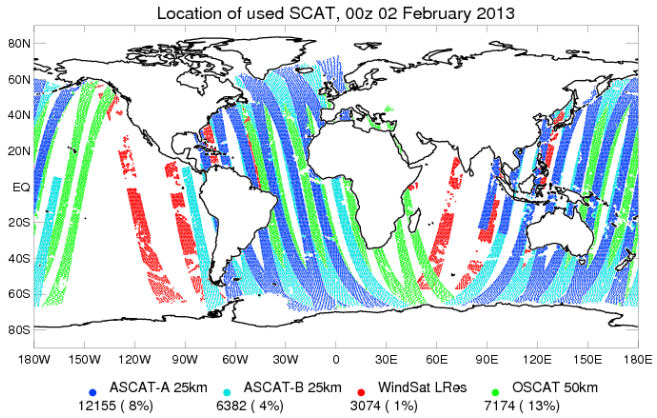
- 1.5-km, 70 levels (40-km model top)
- 3D-Var (3 hourly)
- T+36 hr forecast 8/day
- 12-member EPS - 2.2 km 4x/day 36h

MOGREPS = Met Office Global Regional Ensemble Prediction System

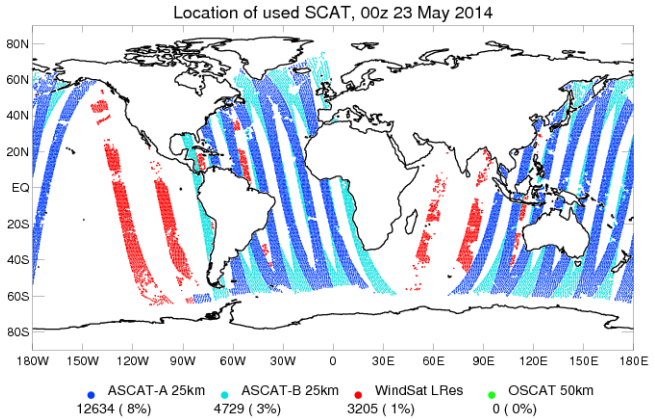
Scatterometer use in Met Office Global NWP

Instrument	Assimilated from	Product	Status
ASCAT-A/B	Nov 2007 (Metop-A) April 2013 (Metop-B)	OSI-SAF Level 2 BUFR 25-km wind product produced by KNMI	Operational
WindSat	Nov 2008	Native EDR files received from NRL and processed in-house to produce a level 2 BUFR product at approx 50 km resolution.	Operational
OSCAT	Jan 2013 to Feb 2014	OSI-SAF Level 2 BUFR 50-km wind product produced by KNMI	Failed

Pre loss of OSCAT



Data coverage now



Assimilation Method

Scatterometer and WindSat winds are assimilated as ambiguous 10m (real) wind components i.e. no prior ambiguity removal

Quality Control

- Allowed wind speed range: 2-25 m/s
- Screen for ice using OSTIA SST (273.15 K) and sea ice model
- Check supplied wind vector QC flag
- WindSat: chi-squared probability and cloud liquid water checks

Bias correction: Wind speed bias correction

Background check: None - instead use VarQC where observations with high probability of gross error are considered rejected.

Spatial Thinning

- Distances: 80-km in global, 46-km in UKV
- All scat thinned together – in overlap regions select by rank.
- In order of highest priority: ASCAT-A > ASCAT-B >WindSat.

Metop-B and thinning experiments

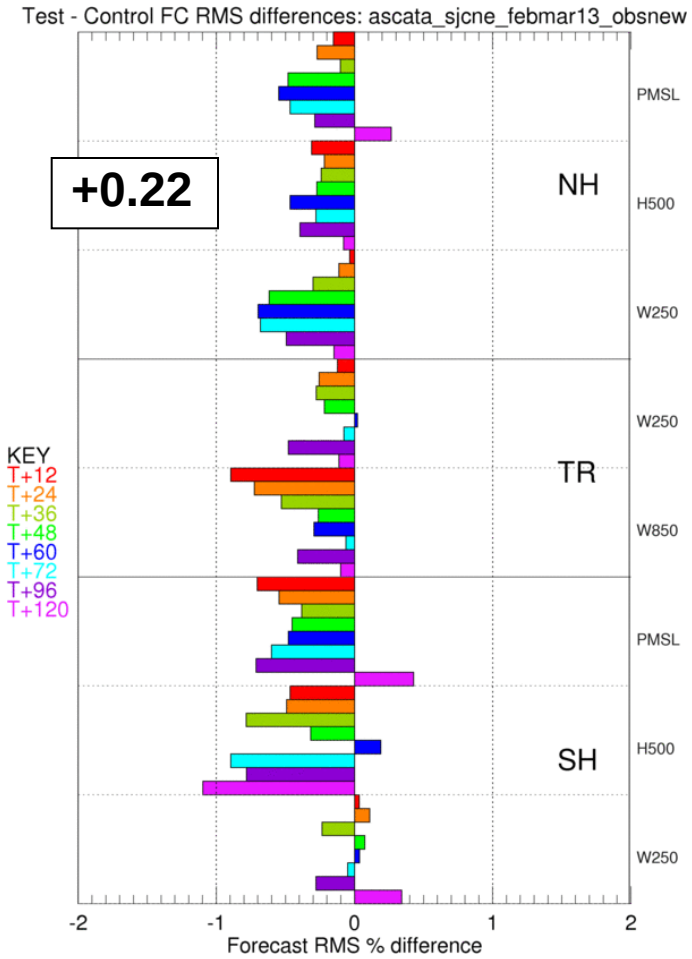
Verifying impact ASCAT-A

Global NWP index

- Weighted skill score combining improvements in forecast skill for a subset of atmospheric parameters
- Verified against observations

Plot shows change in forecast RMS for the NWP index parameters

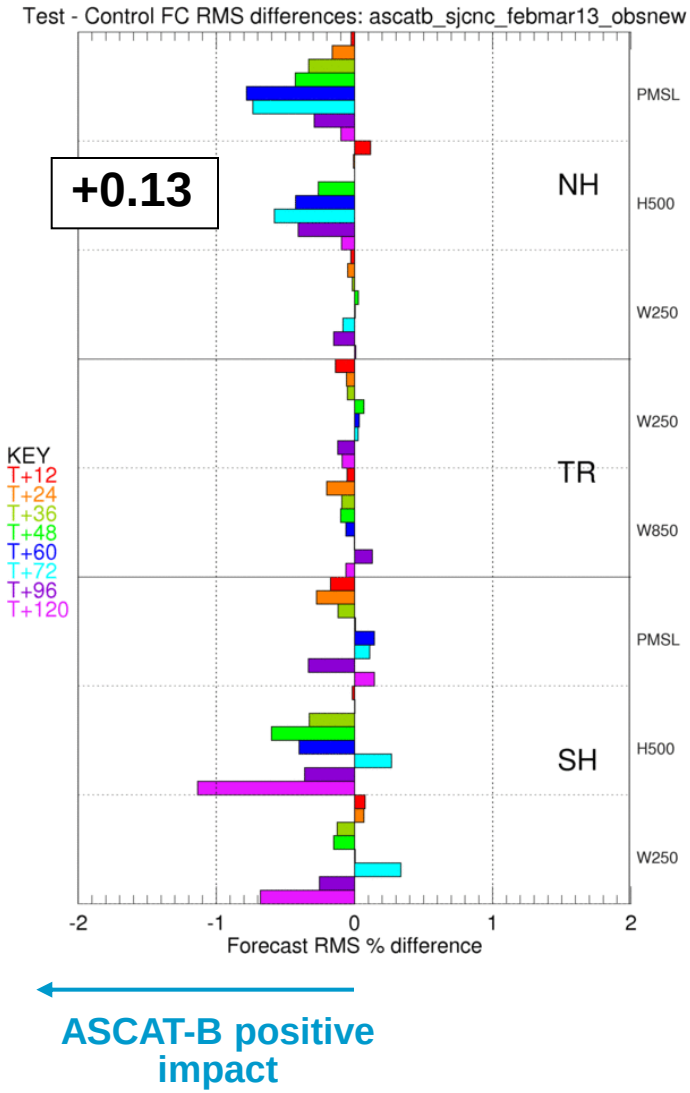
- Index score **+0.22** (0.2%)
- Consistent positive impact



Impact of adding ASCAT-B

Add ASCAT-B to current system

- Index score **+0.13** (0.1%)
- Index gain ~1/2 ASCAT-A
- Consistent with number of obs used

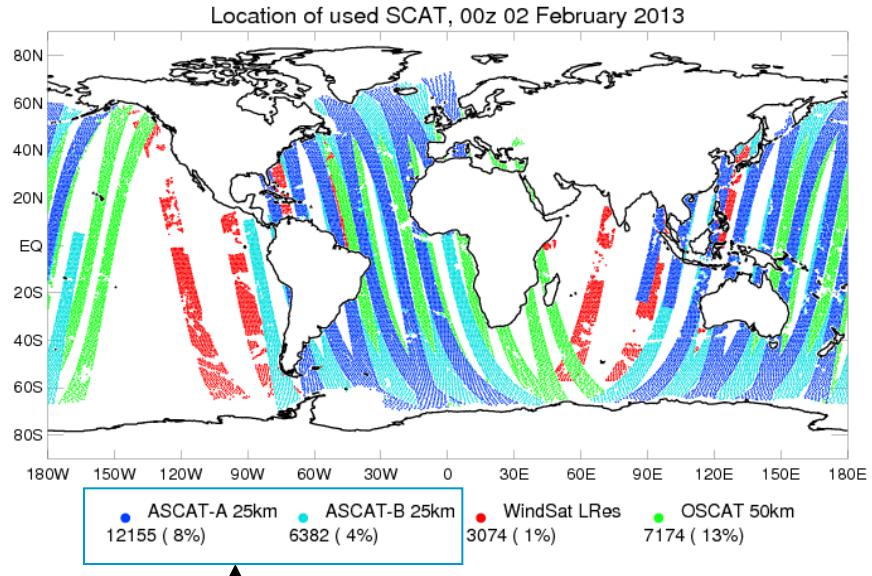


Individual thinning scheme

Attempt to better exploit data from parallel Metop-A/B operations

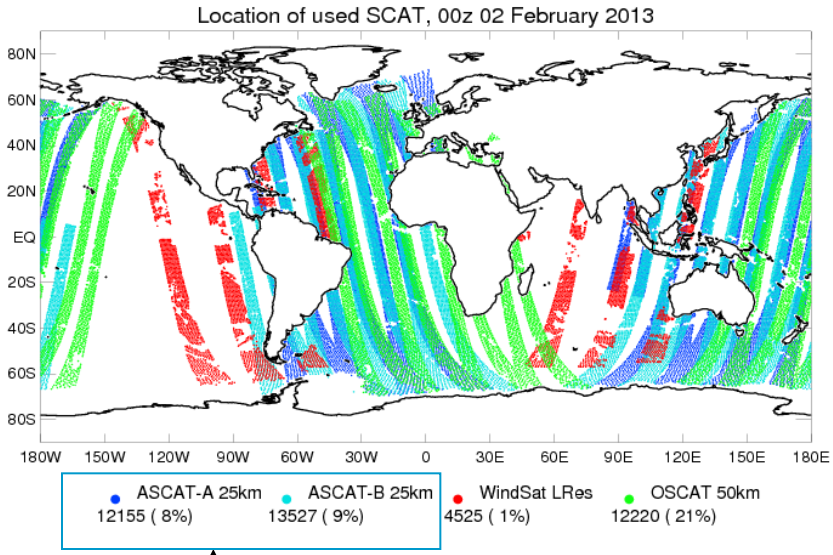
- Consider separate spatial thinning round for each instrument
- Allow 1 wind per instrument / 80-km box / 6 hour window

Operational



ASCAT-B ~ 50% of ASCAT-A

Individual

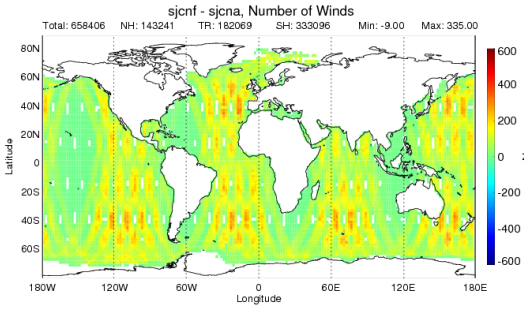


ASCAT-A/B used equally

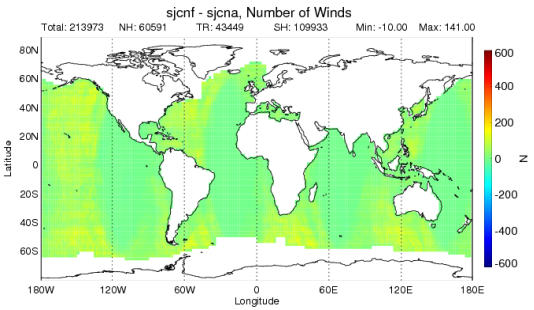
Impact individual thinning (no Metop-B)

- Index score **+0.12** (0.1%)
- Impact in SH – where most data added

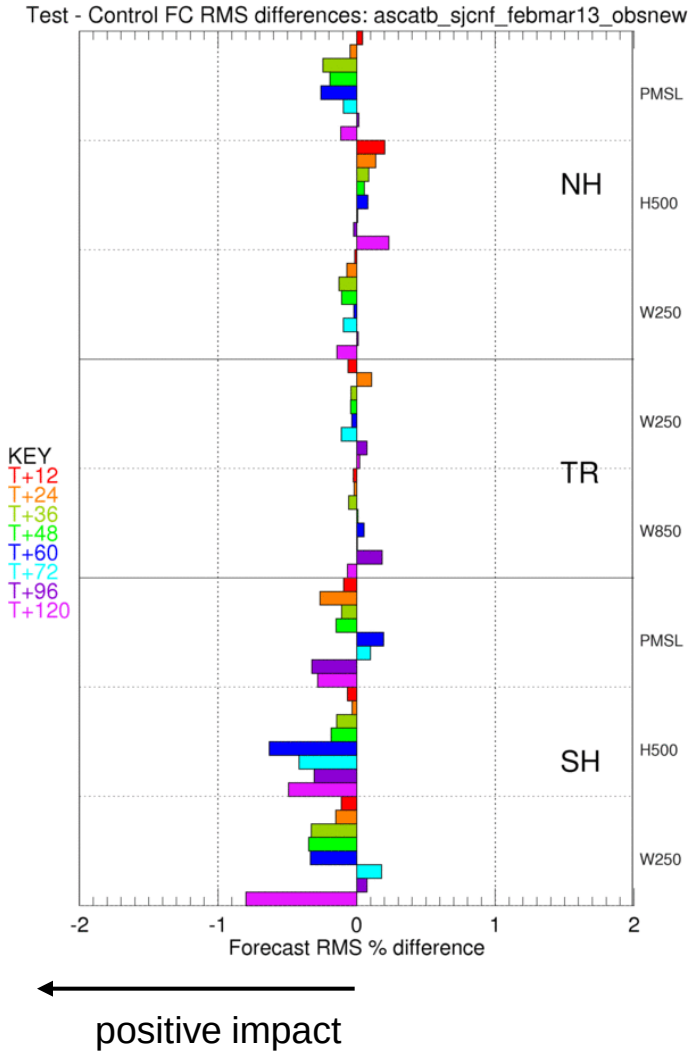
OSCAT



WindSat



Can derive small benefit from assimilating OSCAT and WindSat in areas already observed by ASCAT-A

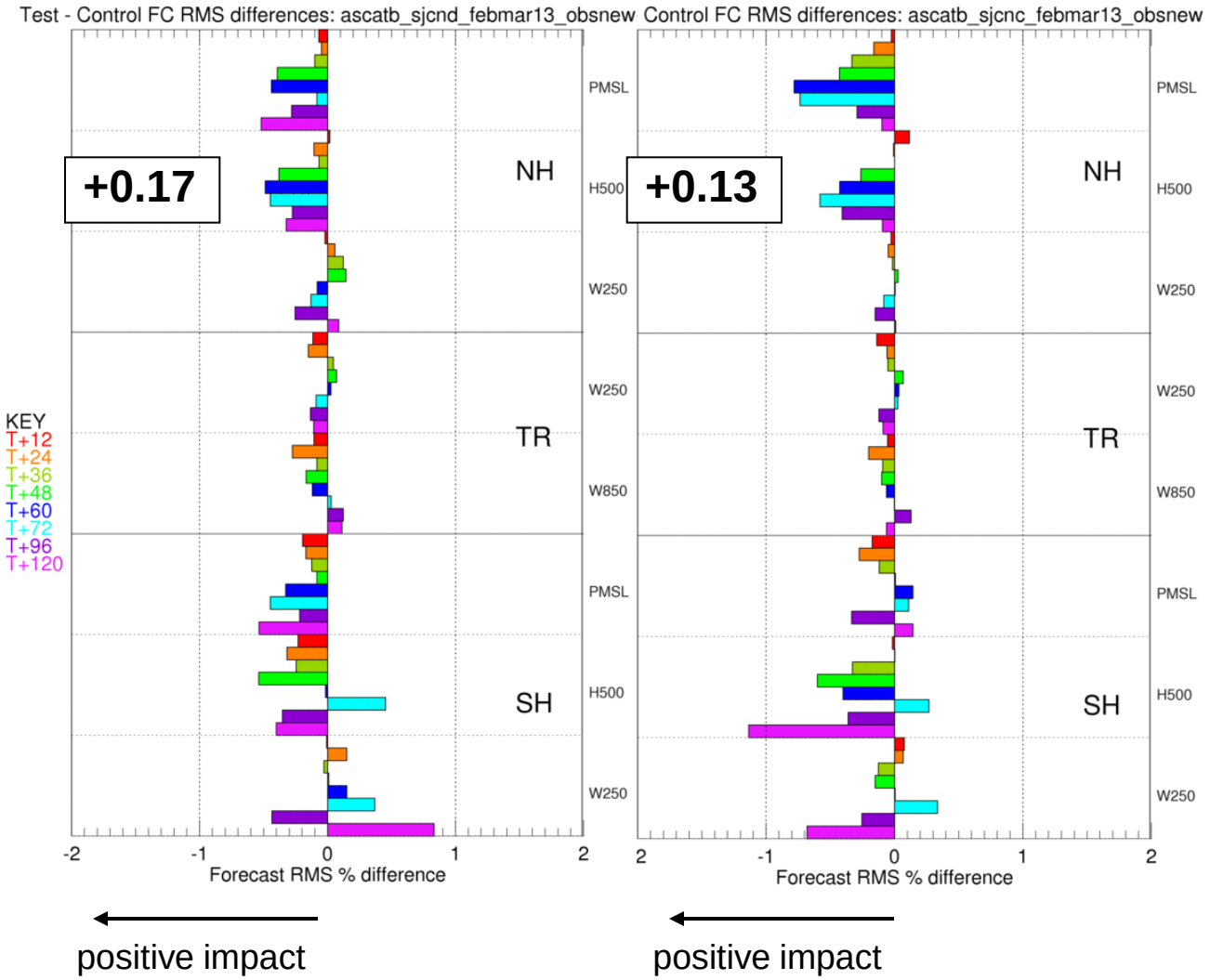


positive impact

ASCAT-B impact compared

Similar impact on NWP index scores

- improvement in PMSL and Z500 in NH
- Neutral in tropics



Summary

Impact of ASCAT-B similar in both schemes, despite a large difference in the number of observations used

Op. thinning → ASCAT-B = ½ ASCAT-A

Only in areas not already observed by ASCAT-A

Indiv. thinning → ASCAT-B = ASCAT-A

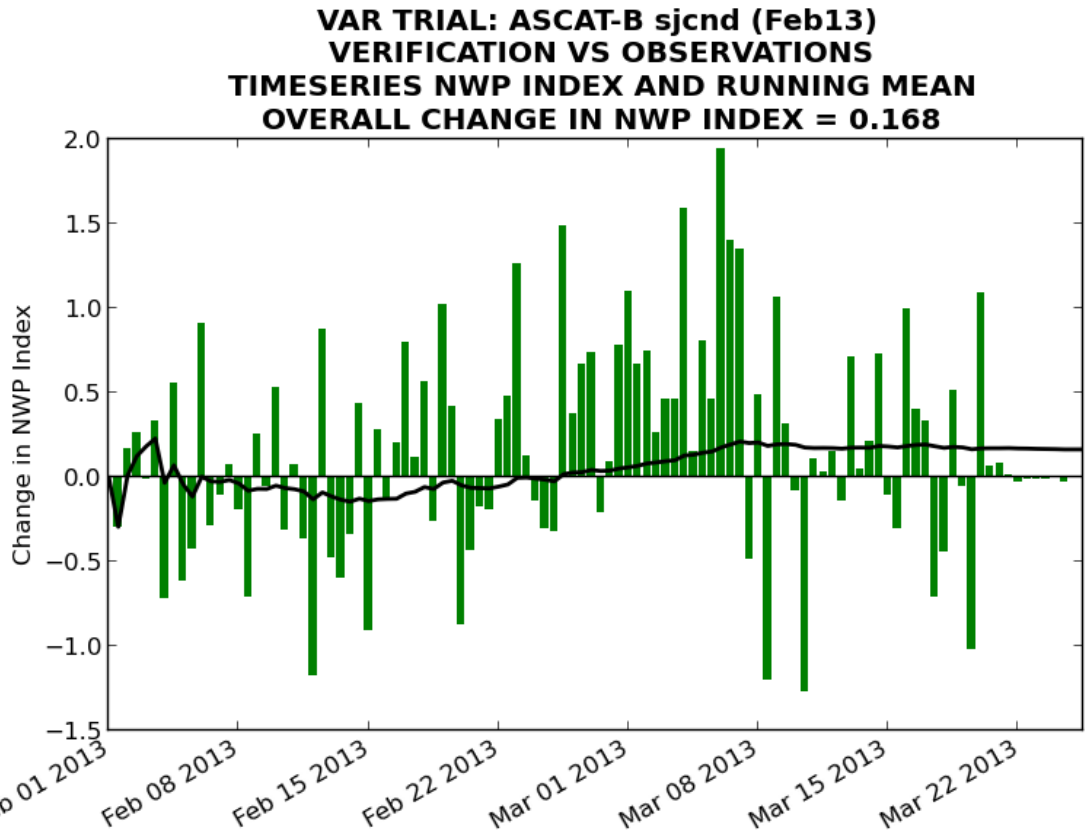
Both used in overlap regions

Results suggests only see benefit from ASCAT-B where adding observations into areas not already observed by ASCAT-A

- Temporal separation of ASCAT-A/B too small? (50 mins)
- Small benefit from overlap of OSCAT/ASCAT-A (100-150 mins)

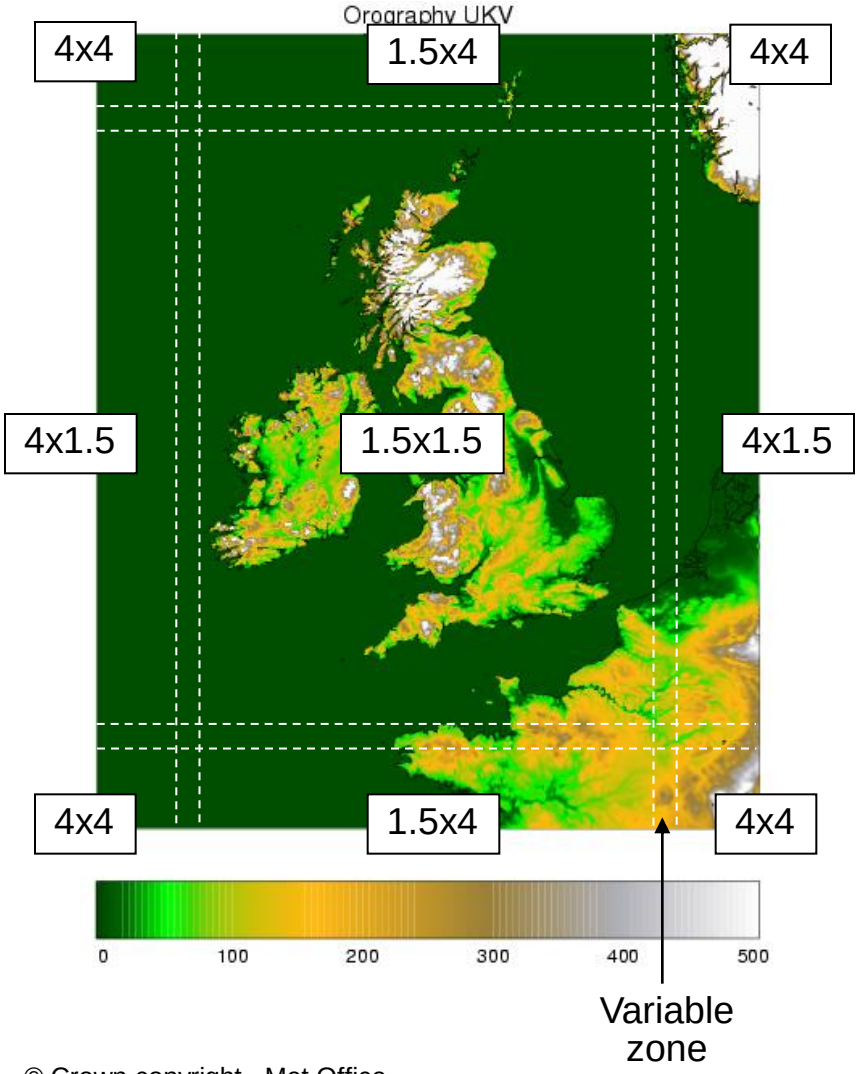
Impact ASCAT-B (indiv. thinning)

Benefit of ASCAT-B greatest during an OSCAT outage from 2-6 March 2013.



Coastal ASCAT winds in UKV

UKV 1.5km Model



- Variable resolution from 1.5 km – 4 km
- Lateral boundaries from Global model
- 3D-Var (3-km)
- 8 x 3-hour assimilation cycles per day
- Forecasts to T+36 every 3 hours
- Observation cut-off T+75 mins

Satellite data

- SEVIRI clear-sky radiances
- SEVIRI cloud products
- AMSU-B/MHS
- AMVs
- Scatterometer winds
- Ground-based GPS

ASCAT in the UKV

Currently make use of the 12.5-km ASCAT winds from Metop-A

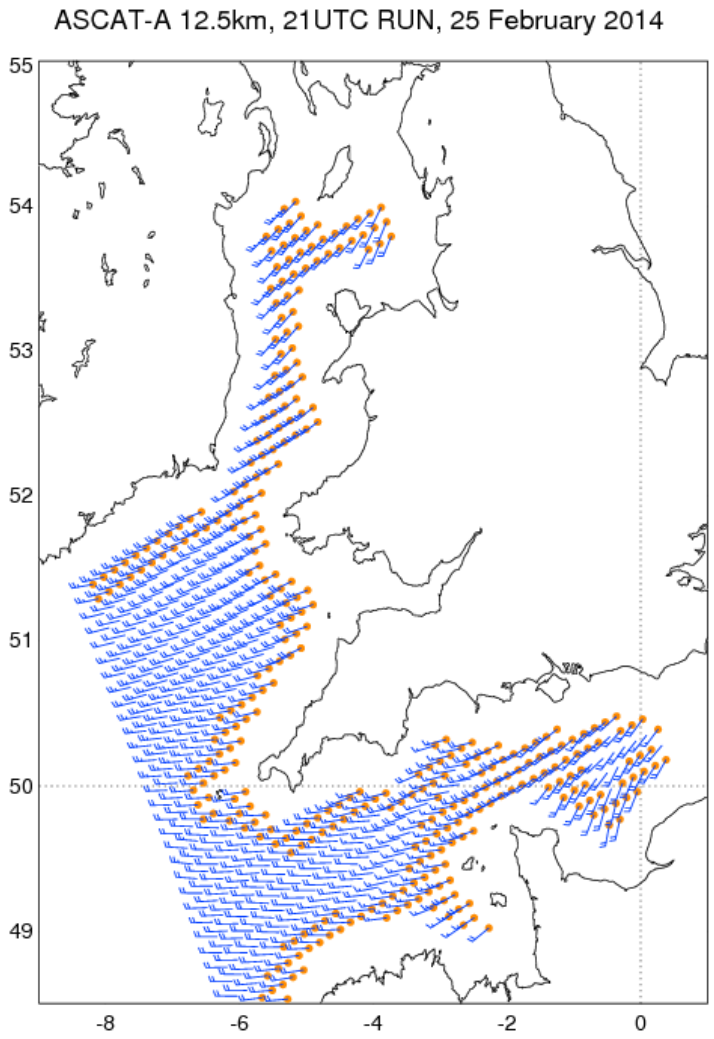
- Global data & EARS (Svalbard dumps only)
- 46-km spatial thinning

No equivalent product for Metop-B so have been investigating use of the coastal wind products from Metop-A and Metop-B

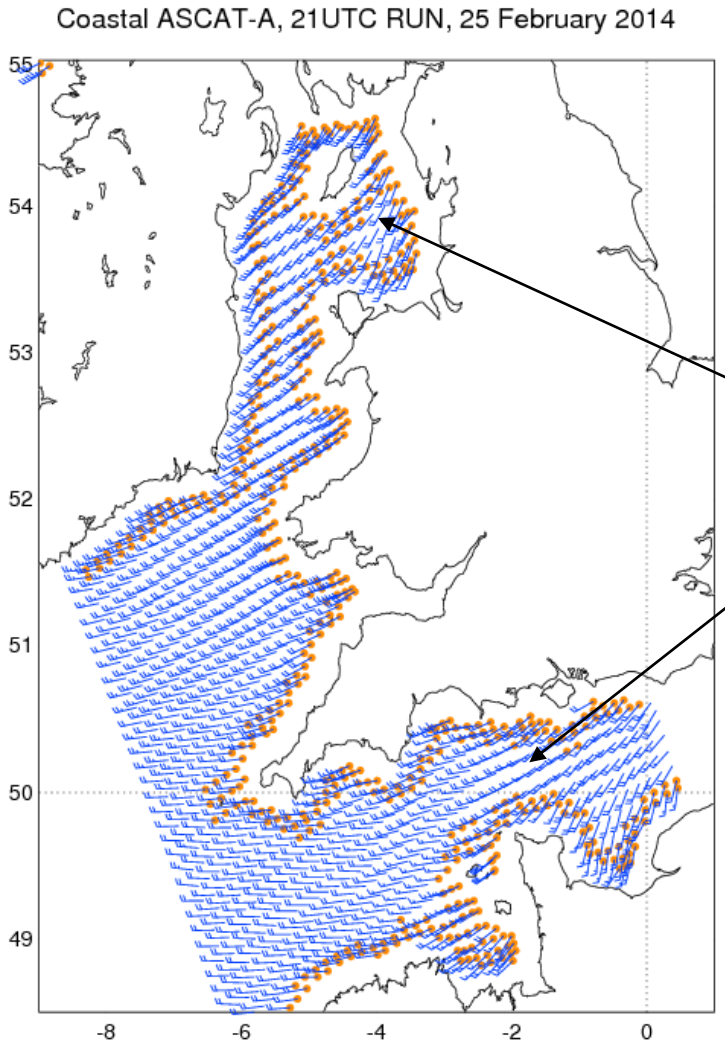
- Box filter so winds closer to coast (15-km rather than 35-km)
- Addition of Metop-B will improve coverage

Coastal ASCAT

12.5-km Hamming window



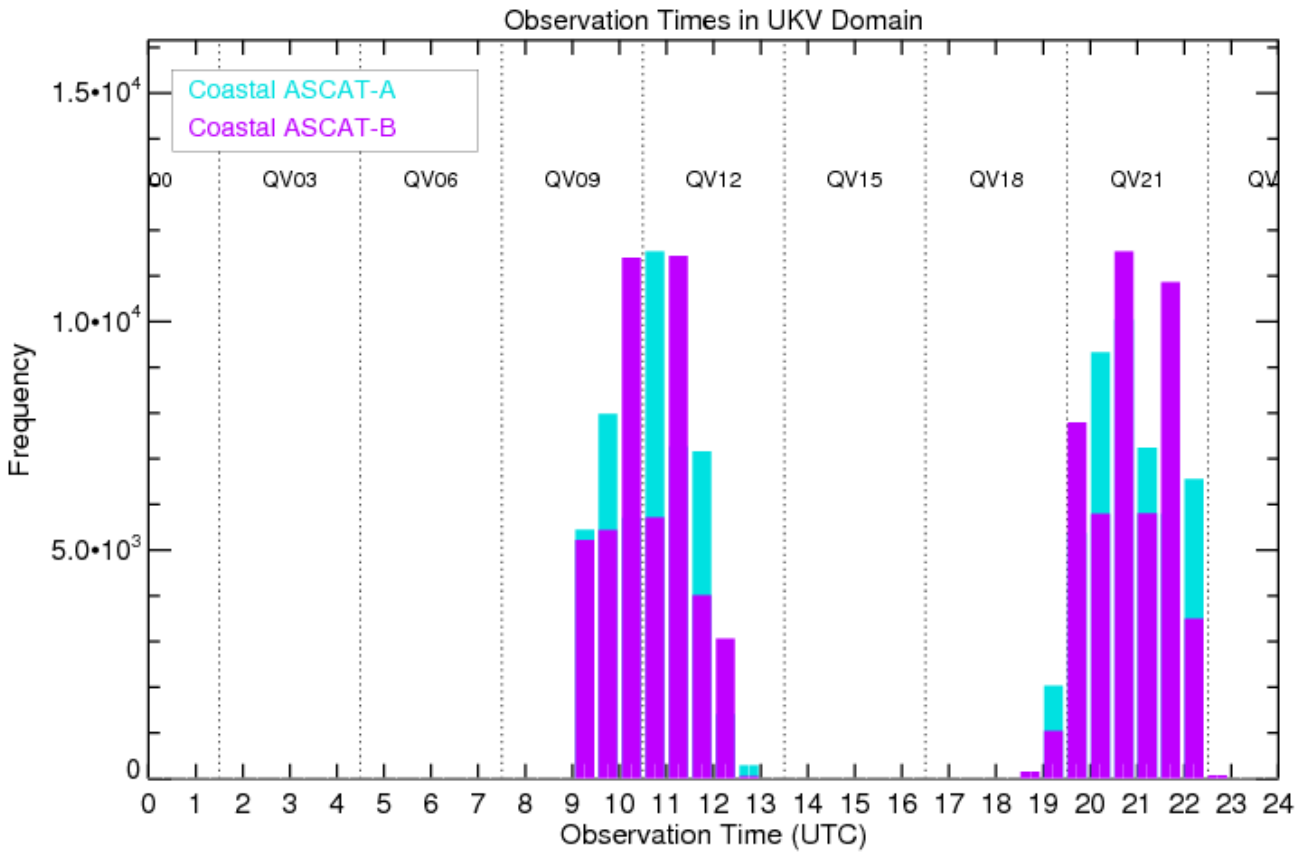
Coastal



Improved coverage in Irish Sea and English Channel

- Land flag set

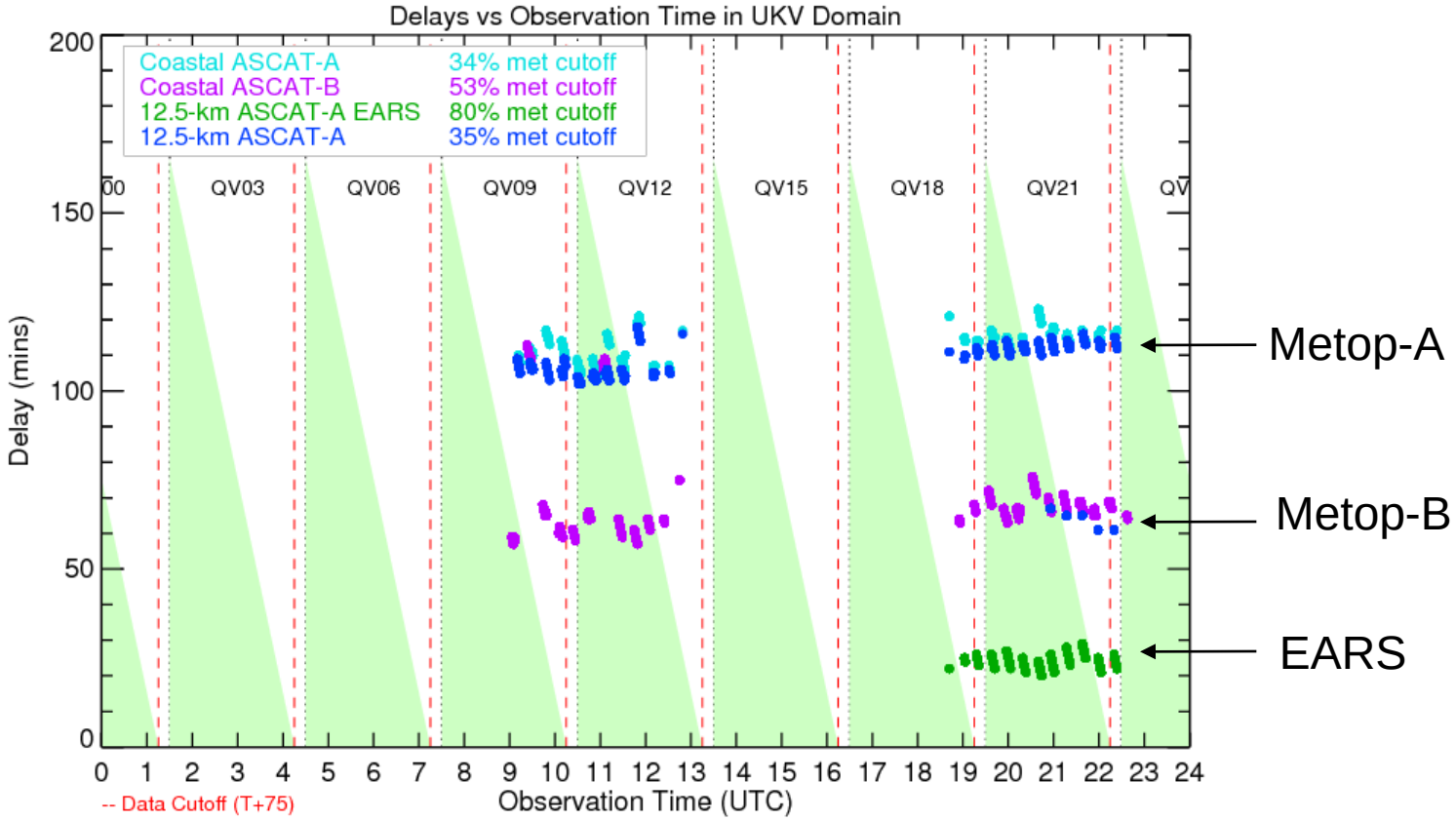
Temporal Coverage in UKV



Metop-A/B overpasses in UKV domain at ~09:30 and 21:30 UTC

Coverage mostly in 09z, 12z and 21z cycles

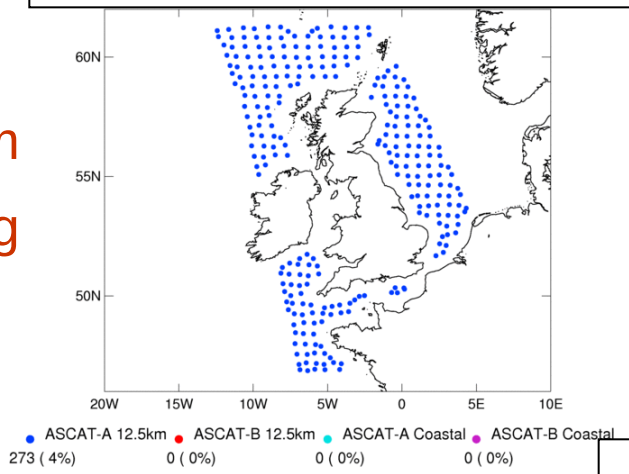
What data can we actually use?



- Cut-off at T+75 mins (i.e. before end of assimilation window)
- Both observation time and timeliness are important
- Coverage only really in 12z and 21z

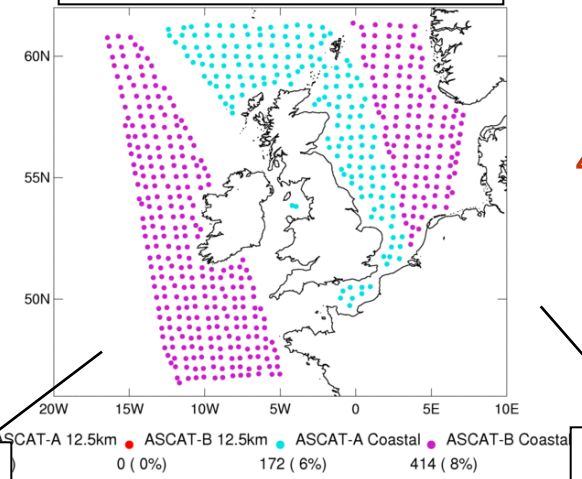
Assimilation Experiments

12.5-km ASCAT-A (gl+ears)



46-km thinning

Coastal A/B

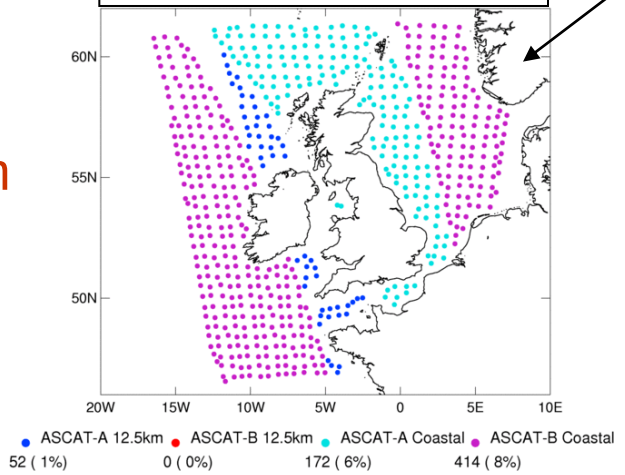


46-km

Impact EARS

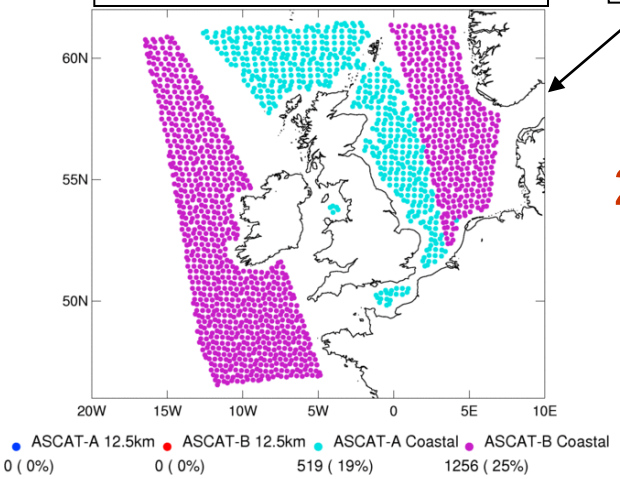
Impact higher density

Coastal A/B + ears



46-km

Coastal A/B



25-km

UK Index Metric

Element	ETS Threshold / RMS
1.5m Visibility (yes/no)	<= 200 / 1000 / 4000 m
6 hr precip accum	>= 0.5 / 1.0 / 4.0 mm
Cloud Amount	>= 0.3, 0.6, 0.8
Cloud Base Height	<= 100 / 500 / 1000 m
1.5m Temperature	$1-\frac{rms^2(\mathrm{fc})}{rms^2(\mathrm{pst})}$
10m wind	$1-\frac{rms^2(\mathrm{fc})}{rms^2(\mathrm{pst})}$

Weighted Basket of indices

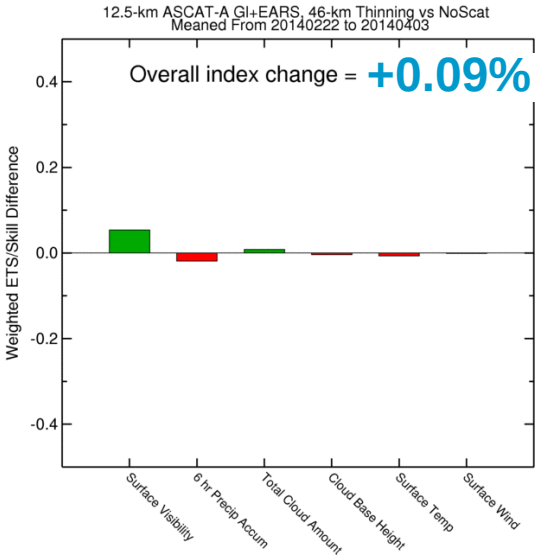
- 6 elements
- Combination of equitable threat scores **(ETS)** & **RMS** scores

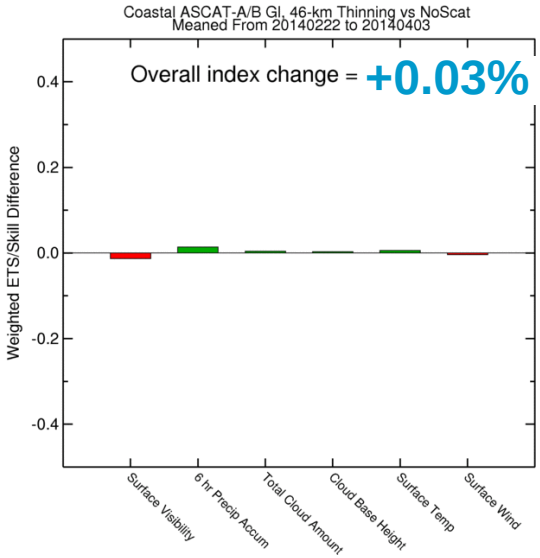
- Trials often have very few events for e.g. 200m vis and 4.0mm precipitation thresholds.

Depends on weather, season..

UKV Index Scores

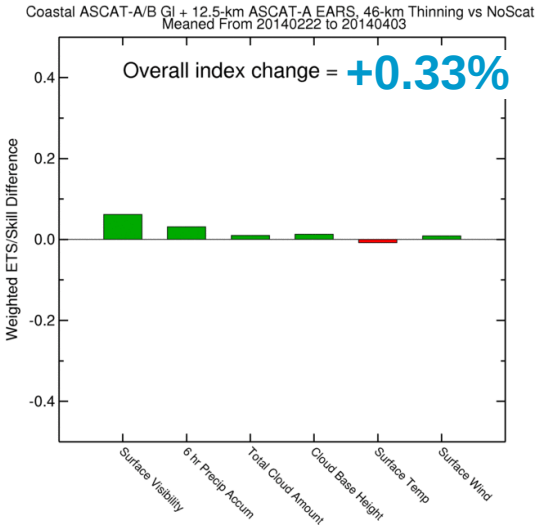
12.5-km ASCAT-A (gl+ears)

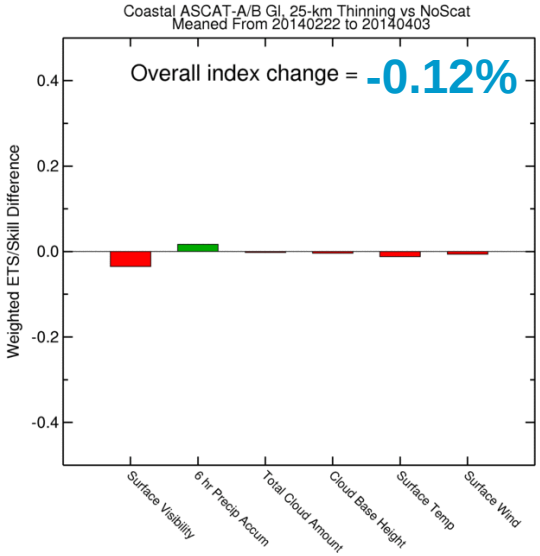




Coastal A/B

Coastal A/B + ears





Coastal A/B

Assimilation Experiments

Results from period 20140222 to 20140403 (41 days)

Experiment	Data	Thinning	UKV Index
Reference	No Scat		
Control	12.5-km ASCAT-A (global + EARS)	46-km	+0.09%
Coast46	Coastal ASCAT-A/B (global)	46-km	+0.03%
Coast+ears46	Coastal ASCAT-A/B (global) + 12.5-km ASCAT-A (EARS)	46-km	+0.33%
Coast25	Coastal ASCAT-A/B (global)	25-km	-0.12 %

- UKV Index scores are rather neutral, however..
- EARS data appears to show some benefit
- Reduced thinning distance to 25-km does not look to be beneficial
- Main impact is on surface visibility scores

Assimilation Experiments

Potential reasons for small impact of ASCAT in UKV

- Poor temporal coverage
- Already a dense observing network being assimilated into the UKV (with additional obs not in global)
- The majority of the information important for the initialisation of UKV model forecasts coming from the LBCs and not the data assimilation
- 3D-Var assimilation does not account for times of observations from different orbits
- UK Index stations over land only

Summary

- Oceansat-2 assimilated from Jan 2013 to Feb 2014
- Metop-B ASCAT provides around half the impact of Metop-A
- Individual thinning scheme will be implemented from PS34 – July 2014
- Assessing coastal ASCAT winds to replace 12.5-km product
- Neutral impact on UK Index scores but further verification required (against buoy data?)
- EARS data is important for shorter DA cycles
- Coastal winds planned for operations end 2014

Thank You
Questions?

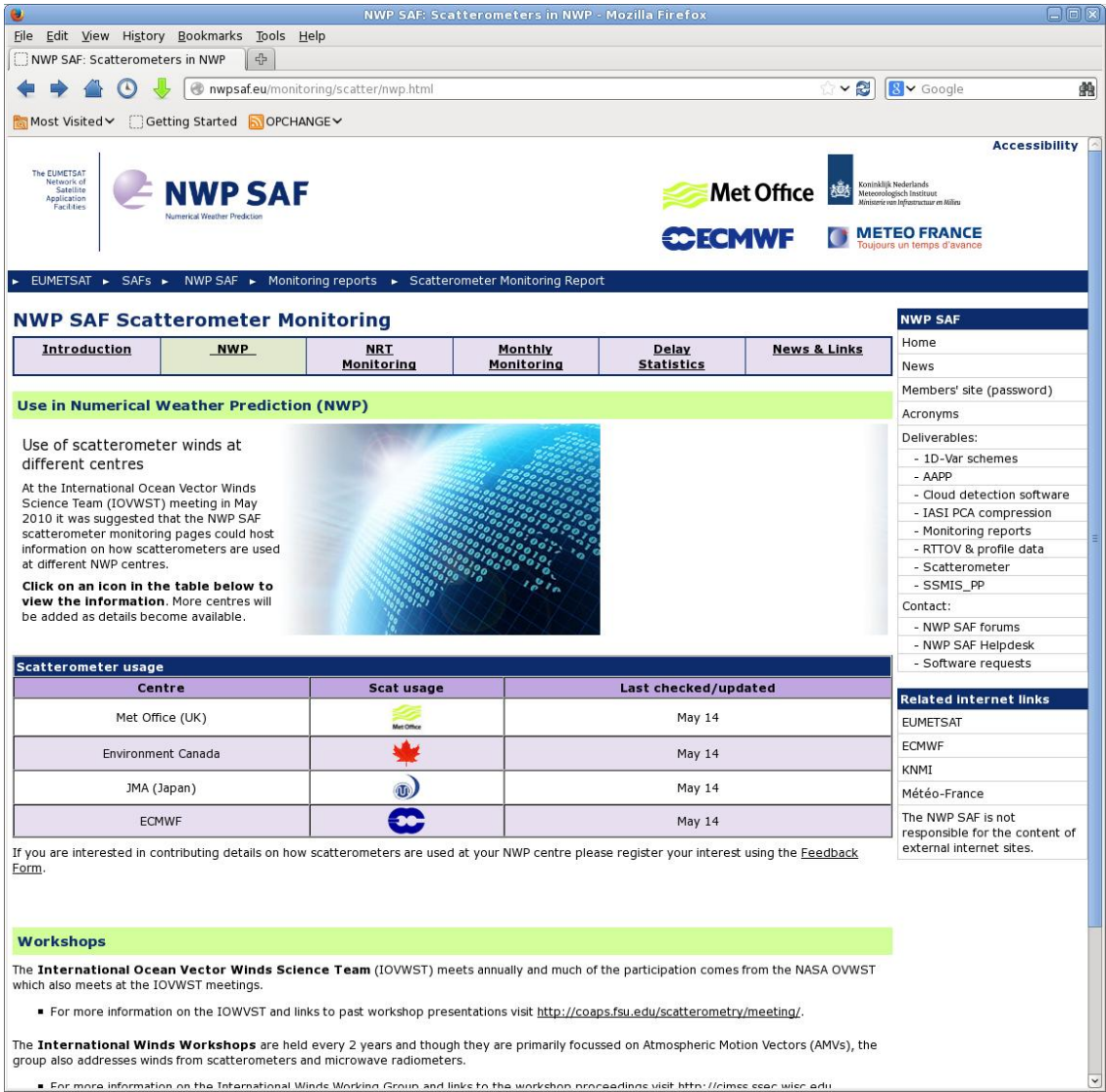
Scatterometer use in NWP

http://nwpsaf.eu/monitoring/scatter/nwp.html

NWP SAF scatterometer monitoring website

- Met Office
- Environment Canada
- JMA
- ECMWF

Further contributions welcome!



ASCAT-B impact compared

Explanation may lie in temporal separation between instruments

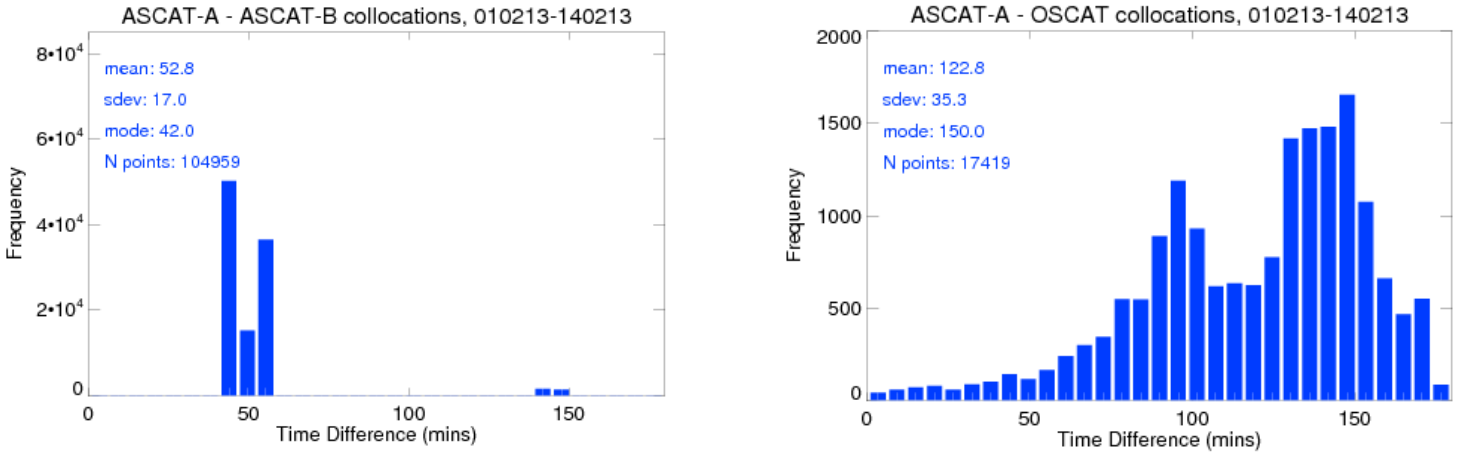


Figure: Histograms of the time difference between collocated observations. Collocations were within 10km and within the same assimilation cycle.

- OSCAT and ASCAT-A show much wider range of time differences, frequently around 100 mins and 150 mins.
- Temporal separation of ASCAT-A/B too small to provide substantial extra information to the analysis where they overlap? Still expect benefit from the noise reduction properties of assimilating two ASCAT obs.

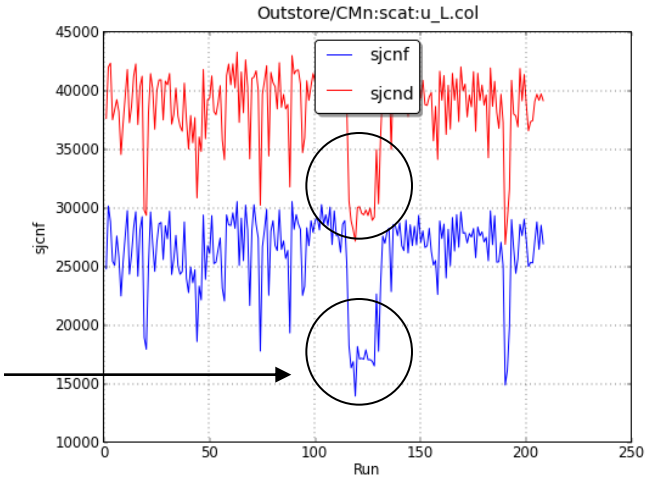
Impact ASCAT-B (indiv. thinning)

Control

ASCAT-B experiment

Number of surface wind obs

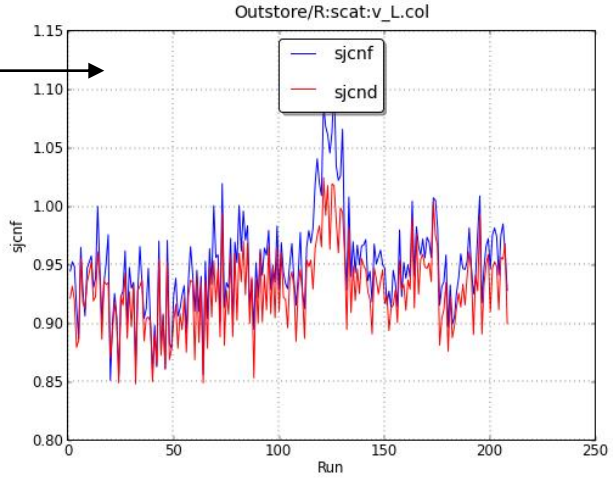
• Oceansat-2 problem from 2 March



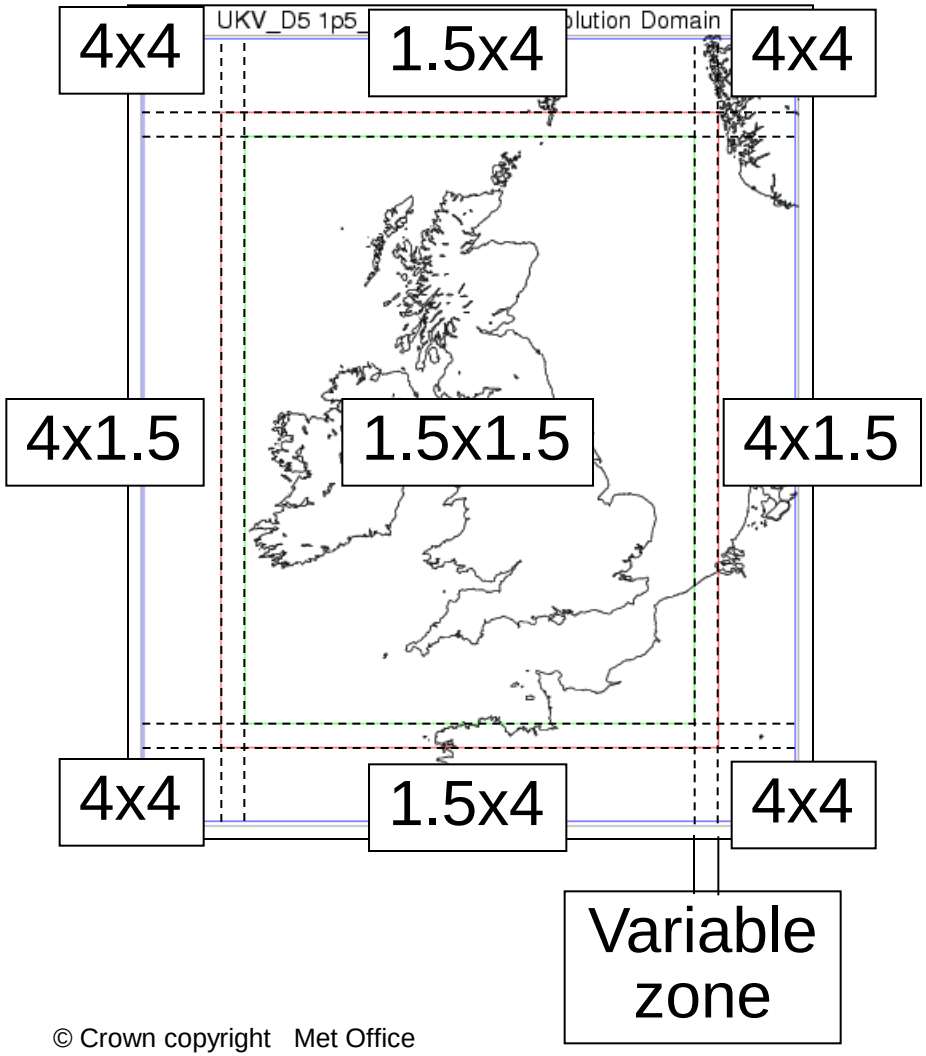
RMS O-A fit of zonal wind comp.

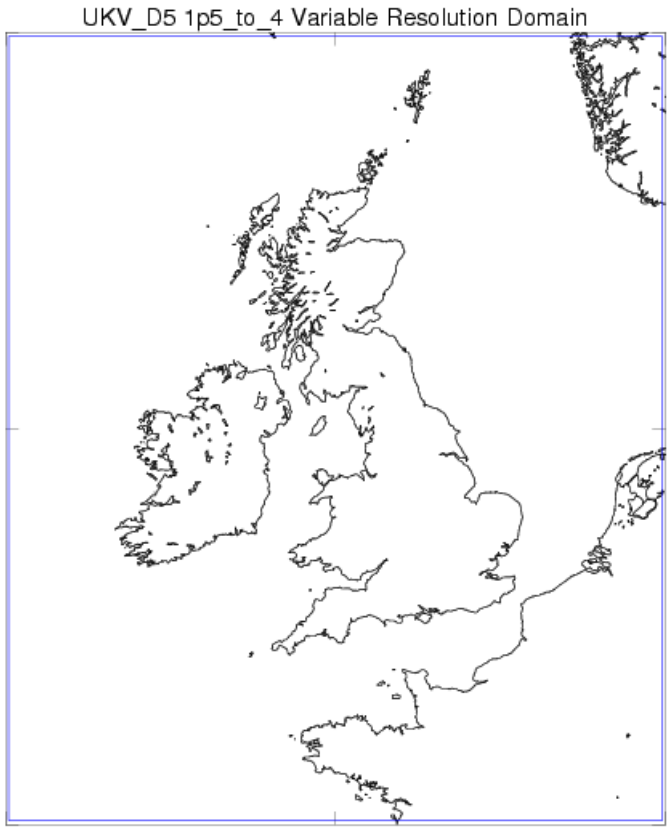
• During OSCAT outage, RMS increased by 0.1 m/s for control, but much less for ASCAT-B experiment

• Difference in RMS grew from around 2% to 7%



UK1.5km Domain



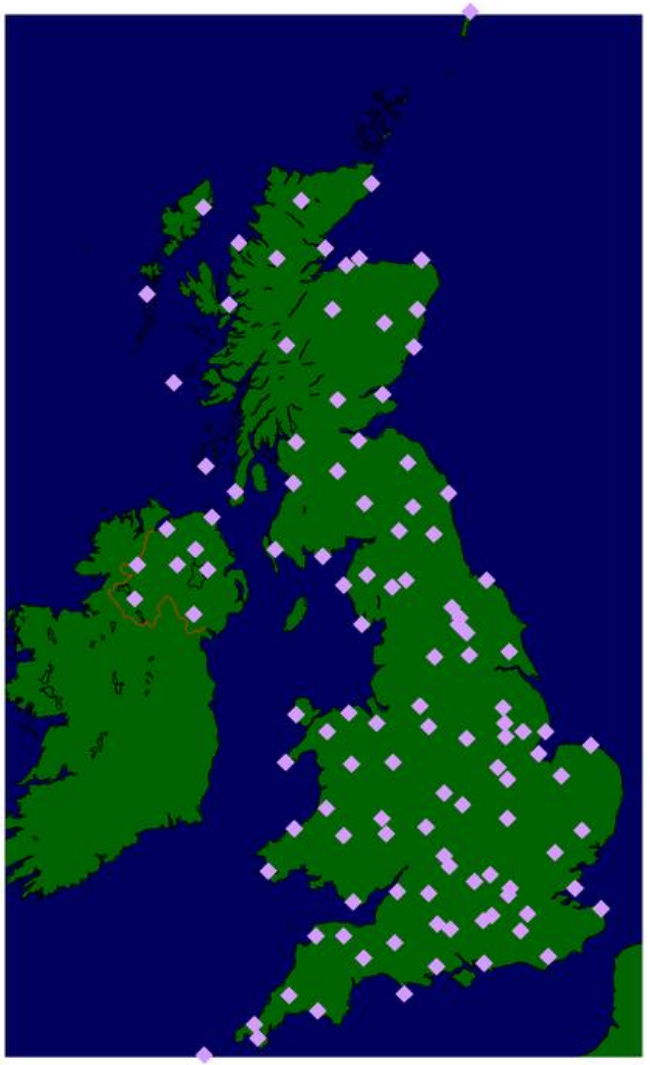


744(622) x 928(810) points

UK Index Stations

Parameters verified at quality-controlled observing stations across the UK

WMO block 03 stations, excluding the Republic of Ireland



UKV – extra observations not assimilated in global model

- GeoCLOUD cloud fraction profiles (3-hourly, 5km resolution)
- cloud fraction profiles from SYNOPs (3-hourly)
- radar-derived surface rain rate (hourly, 5km resolution)
- visibility from SYNOPs and METARs (hourly)
- T2m & RH2m from ~600 roadside sensors (hourly)
- Doppler radial winds from ~12 UK radars (3-hourly)
- AMVs from NWP SAF