NWP SAF scatterometer monitoring

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Background

The NWP SAF is a EUMETSAT-funded activity that exists to co-ordinate research and development efforts among the SAF partners to improve the interface between satellite data and NWP for the benefit of EUMETSAT member states. The NWP SAF is led by the Met Office, with partners ECMWF, KNMI and Météo-France

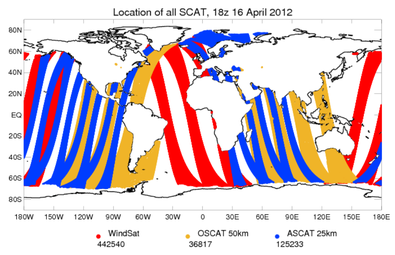
The main aim of the NWP SAF scatterometer monitoring site is to highlight differences between scatterometer and NWP model estimates of ocean surface wind vectors. This is primarily done by comparing observed wind vectors (O) with model background wind values (B) from a recent short-range forecast. Monitoring data is currently available for ASCAT on MetOp-A, WindSat on Coriolis and OSCAT on Oceansat-2. Archived data for AMI on ERS-2 is also available.

The site has undergone significant development over the last few years, with some major new additions.

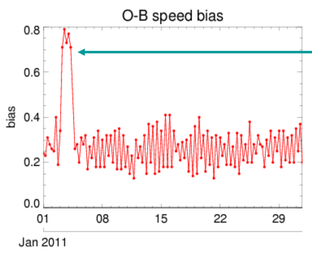
1. Near Real Time (NRT) monitoring

Scatterometer statistics are shown for the last four Met Office global model and North Atlantic and European (NAE) regional area model runs. Plots containing the latest data are updated every 6 hours, with time series plots updated once per day.

- Example data coverage



- ASCAT time series



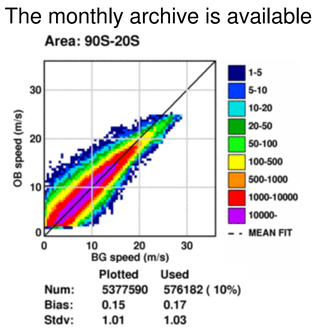
NRT plots are useful for identifying instrument problems/outages

e.g. ASCAT anomaly and subsequent outage on 3-4 January 2011. A problem with the ASCAT on-board power gain led to a temporary degradation in wind vector quality.

2. Monthly monitoring archive

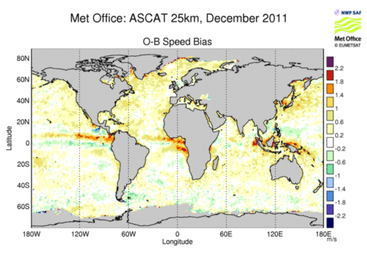
A major component of the NWP SAF monitoring is the routine production of monthly monitoring plots comparing scatterometer and WindSat winds against Met Office short-range forecasts (O-B monitoring). Note that both the scatterometers and the model contribute to the differences seen in the plots; neither can be assumed to be true.

The monthly archive is available from January 2010 onwards and five types of plot are routinely produced:

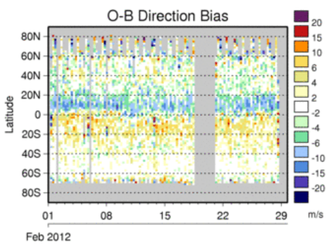


DENSITY
2D histograms of observed wind values against model estimates: speed, direction and U/V components. Separated by latitude band.

E.g. ASCAT 25-km, December 2011, SH

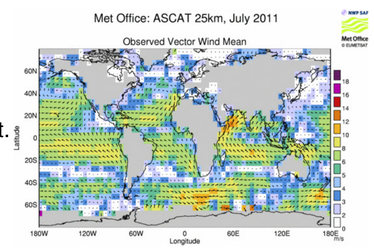


MAP
Plots of statistics as a function of latitude and longitude. Can highlight geographical areas where there is persistent disagreement between the observations and the model.

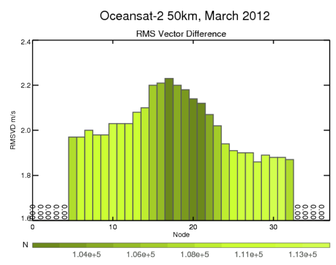


HOVMOELLER
Plots of statistics as a function of latitude and time for each instrument.

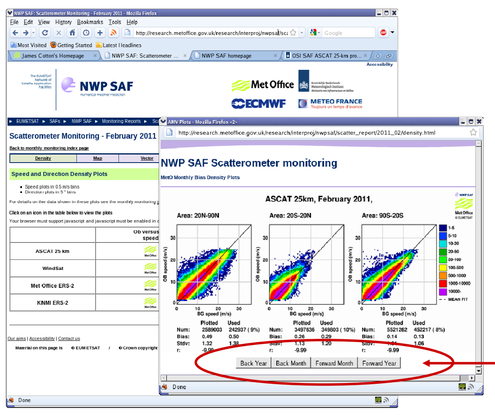
E.g. OSCAT 50-km, February 2012



VECTOR
Plots showing the mean observed vector, mean background vector and mean vector difference. Example for ASCAT in July 2011 shows low level Somali Jet and South Asia summer monsoon.



NODE
Statistics as a function of wind vector cell (WVC). Highlight how wind quality varies across the swath. For WindSat we instead look at statistics versus cloud liquid water (CLW).



Each plot appears in a pop-up window enabling side-by-side comparisons with other plots.

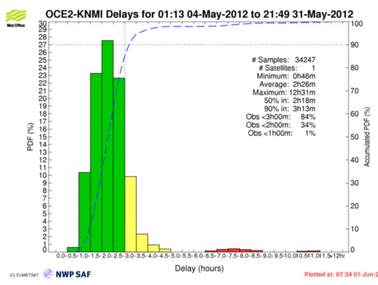
Interface gives users the ability to easily switch back and forwards between previous months and years.

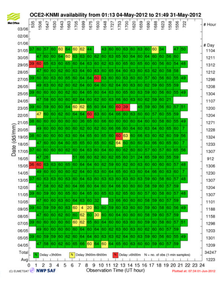
Plots are kept for at least 3 years to allow investigation of seasonal trends and longer-term changes in data quality.

3. Timeliness and availability

Information on the delivery of scatterometer data for each satellite-supplier combination. Here we define delays to be the difference between the observation time and receipt time in the Met Office's operational meteorological database (MetDB).

Delay histograms are available for the previous day/month as well as data availability plots for the last 28 days.





4. Use in Numerical Weather Prediction (NWP)

At the International Ocean Vector Winds Science Team (IOVWST) meeting in May 2010 it was suggested that the NWP SAF scatterometer monitoring pages could host information on how scatterometers are used at different NWP centres.

This is now available for

Met Office, JMA, Env. Canada, ECMWF

Summary of the main characteristics of the principle operational models in which scatterometer data are assimilated. E.g. horizontal and vertical resolutions, spectral or grid-point model

Assimilation method (e.g. 4D VAR) and time windows/constraints

Which instruments are assimilated? For each, specify which wind products are used (including at which resolution) or provide details of own retrieval if performed (e.g. GMF). Also state the models each scatterometer is assimilated in.

Are scatterometer monitoring web pages externally available? Do you need a password?

This section encompasses quality control procedures and assimilation methods that are common to all scatterometers.

- Blacklisting e.g. speed range, spatial
- How are the wind ambiguities handled?
- Bias correction method, e.g. sigma-nought, wind speed
- Is a model background check performed?

Quality control measures that are applied to specific instruments only.

Welcome contributions from more NWP centres!

Information relevant to the observation operator e.g. assimilated as real 10m winds or equivalent-neutral winds?

Useful to keep track of scatterometer changes or significant model upgrades. Plan to review and update the information at least every 12 months.

Physical characteristics

The atmospheric models used at the Met Office for operational NWP and climate modelling are all derived from the Unified Model (UM) System (Davies et al. 2005).

Global Model

- Grid-point model (1024 E-W x 769 N-S)
- Horizontal resolution: 0.35 x 0.23 degrees (25 km in mid-latitudes)
- Vertical resolution: 70 vertical levels, hybrid-eta configuration, lid ~80 km

UKV Model

- Grid-point model (744 E-W x 928 N-S) nested within NAE
- Horizontal resolution: variable.
  - The inner part of the domain (622 x 810 grid points) has a resolution of 0.0135 degrees (~1.5 km)
  - The outer parts of the domain vary up to 0.036 degrees (~4 km)
- Vertical resolution: 70 vertical levels, lid ~40 km (different levels from global and NAE)

Data assimilation method

Global Model

- 4D-Var, 6 hr time window
- Analysis times (T): 00, 06, 12, 18 Z
- Time window: T ± 3 hr
- Time constraints (model runtime):
  - Main forecast run: 15 min before time window ends
  - Update run: 3 hr 15 min after time window ends

UKV Model

- 3D-Var, 3 hr time window
- Analysis times (T): Full 36 hr forecasts at 03, 09, 15, 21 Z, whilst intermediate analyses are also produced at 00, 06, 12, 18 Z
- Time window: T ± 1.5 hr
- Time constraints (model runtime):
  - Full forecast run: T+75 mins at 03, 15 Z, T+30 mins at 09 Z, T+50 mins at 21 Z
  - Intermediate analysis: T+130 mins

Scatterometers assimilated

WindSat (if assimilated) should also be included here

Scat name	Product	Models assimilated
ASCAT	OSI-SAF Level 2 BUFR 25-km equivalent-neutral wind product produced by KNMI.	Global, NAE
	OSI-SAF Level 2 BUFR 12.5-km equivalent-neutral wind product produced by KNMI.	UKV
WindSat	Environmental Data Record (EDR) files received from NRL and processed in-house to produce a level 2 BUFR product. Version 2.2.3 low resolution EDRs at 50 km resolution.	Global, NAE

Monitoring

External monitoring web pages

- This site: no password required

Generic Quality Control

Blacklisting

- All wind speeds outside range 2-25 m/s
- All observations made over ice according to the Operational Sea Surface Temperature and Sea Ice Analysis (OSTIA)
- All winds in the Southern Ocean below 72S
- All observations with SST less than 273.15 K according to OSTIA

Ambiguity removal

- No prior ambiguity removal
- Scatterometer cost function contains a term for each ambiguous wind so no dealiasing is required prior to assimilation. Essentially the ambiguity removal is performed within the analysis and so uses other independent observations (e.g. ships) and the model background to choose the correct wind (Candy, 2001).

Bias correction

Speed dependent polynomial correction (Cotton, 2009)

- Correction is of the form: $Y = C_0 + C_1*X + C_2*X^2 + C_3*X^3$
  - X is the observed wind speed
  - Y is the bias corrected wind speed
  - C_i are the bias coefficients

Thinning

Prior to assimilation observations are thinned to 1 per analysis grid box

- Select only winds within box which have the highest assigned thinning score. In order of highest priority these are: ASCAT, WindSat.
- Chosen wind is that closest to centre of grid box
- Thinning distances are 80 km in global model and 46 km in NAE and UKV

Background check

- Background check: none
- Variational quality control applied to scatterometer cost function during assimilation. Initially the a-priori probability of gross error is set to zero then, after about half the iterations in the analysis, this is set non-zero which activates the quality control.

Specific Quality Control

Global model

Scat name	ASCAT	ERS-2	WindSat
Operational since	Nov 2007	1998-1999 and March 2006*-July 2011	Nov 2008
Observation error U/V	2.0 m/s	2.0 m/s	2.5 m/s
Wind speed range	2-25 m/s	2-25 m/s	6-20 m/s
Bias corrected?	Yes. 0.2 m/s is subtracted from retrieved wind speeds to account for average difference between equivalent-neutral and real wind speeds.	Speed increased by 5% in retrieval	Yes
Crosstrack cells used	All Nodes 1-21 and 22-42	All Nodes 1-19	n/a
QC thresholds	▪ Check supplied wind vector QC flag ▪ MLE-based QC method. Rank 1 MLE values are normalised by speed and observations are rejected if MLEnorm > 7 or MLEnorm < -20	▪ Check modified PCD product confidence flag during retrieval ▪ Rank 1 normalised distance to cone < 2.5 (expect unity)	▪ Check supplied EDR QC flag 1 ▪ Rank 1 chi-squared probability > 0.3 ▪ Check rain in field of view via retrieved rain rate ▪ Retrieved cloud liquid water < 0.2 mm

Observation Operator

Lowest model level

The UM uses a terrain following height coordinate with the wind (and density) levels vertically staggered from the potential temperature (theta) levels. Whilst the Global and NAE models share a common set of 70 levels, the UKV uses a different set designed to give most benefit to short-range forecasts, i.e. a lower model lid allowing greater resolution in the boundary layer and troposphere. The heights of the lowest horizontal wind levels over sea (zero orography) are

- Global and NAE: 10 m
- UKV: lowest wind level is 2.5m, second lowest is 13.33 m

Interpolation

The UM surface exchange scheme assumes that Monin-Obukhov similarity theory is valid for the surface layer, with surface variables interpolated to standard observation heights.

- 10m real wind components are calculated using the stability functions of Beljaars and Holtslag (1991) in stable conditions and Dyers and Hicks (Dyer, 1974) in unstable conditions.
- Model wind fields are horizontally interpolated to the observation location using standard linear interpolation of the surrounding 4 grid points. In the global and NAE models, if any of the 4 grid points are coast then the model value at the nearest grid point is used instead.

History of Changes

The list includes the main scatterometer or model changes implemented operationally in the Met Office global and NAE models.

Summary

- NWP SAF scatterometer monitoring is available at: http://research.metoffice.gov.uk/research/interproj/nwpsaf/scatter_report/index.html
- Aim is to highlight differences between scatterometer and NWP model estimates of ocean surface wind vectors.
- Key component is the provision of a rolling 3-year archive of monthly monitoring plots
- NWP section hosts information on how scatterometers are assimilated at the Met Office, Environment Canada, JMA and ECMWF
- It is hoped that the NWP SAF scatterometer monitoring can become a valuable resource to wind producers and users alike.

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The EUMETSAT Network of Satellite Application Facilities

NWP SAF Numerical Weather Prediction

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