Update on Ocean Surface Wind Assimilation at the Met Office

James Cotton[1], Nicolas Reul[2], Pete Francis[1], Mary Forsythe[1]

1) Met Office, FitzRoy Road, Exeter UK

2) IFREMER, Centre Méditerranée - Zone Portuaire de Brégaillon, La Seyne-sur-Mer Cedex, France

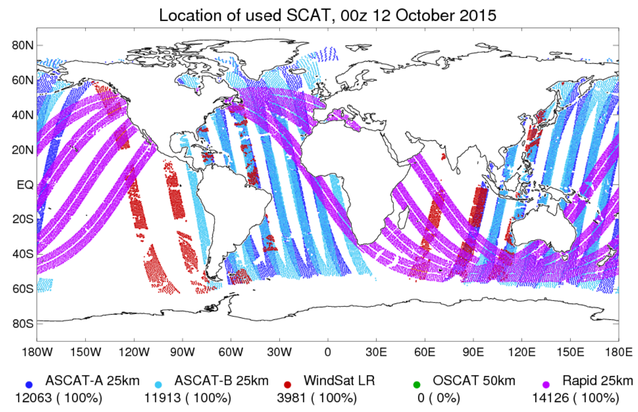
Overview

Ocean surface wind vectors from scatterometers and passive microwave radiometers are operationally assimilated in Met Office numerical weather prediction (NWP) models.

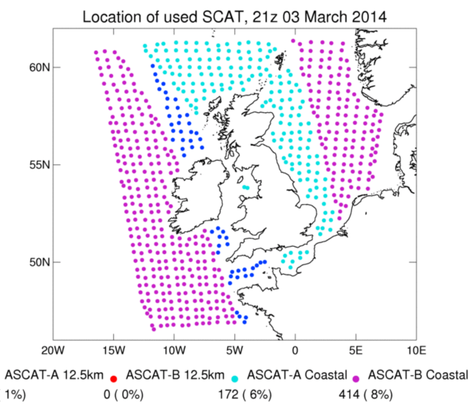
The Met Office global atmospheric NWP model has a horizontal resolution of N768 (17-km in mid latitudes), 70 vertical levels and runs a 4D-Var assimilation system four times per day (00,06,12,18Z) to produce an analysis of the current atmospheric state. Surface winds are operationally assimilated from ASCAT on Metop-A/B, WindSat and RapidScat on the International Space Station (ISS).

The Met Office also run a high resolution NWP model over the UK area at convection resolving resolution – the UKV 1.5-km model. Here we assimilate the Coastal ASCAT 12.5-km winds from Metop-A/B.

Following quality control procedures, scatterometer winds are assimilated as ambiguous U and V wind components, where up to 4 wind solutions are allowed to influence the analysis. In addition, a system has been developed to allow the assimilation of wind speed-only data sets, such as from SMOS.



Global Model



UKV Model

RapidScat Impact on Global NWP

- RapidScat data has been operational in the Global Model since 15 September 2015.
- Prior to its introduction, a set of assimilation experiments were performed to verify its impact. The period was from 21 January to 21 March 2015.
- The Assimilation method is similar to that used for OSCAT and QuikSCAT (see Cotton, 2013)

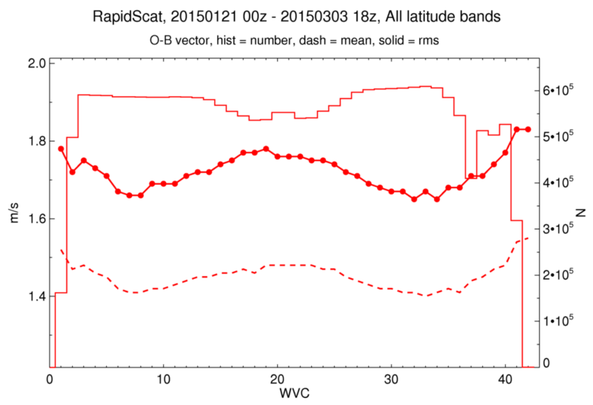


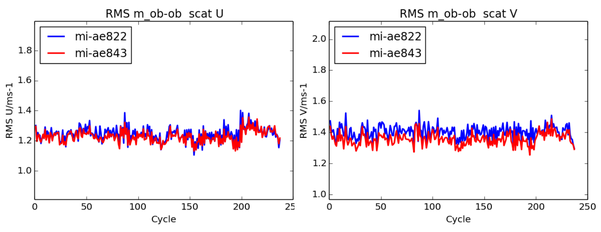
Fig: RapidScat O-B as function of WVC

Background Fit to Observations

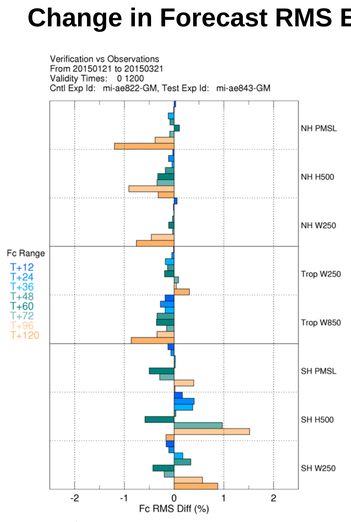
An important diagnostic is to examine the change in the fit of the background (T+6 forecast) to the observations.

Considering all Scatwind data assimilated:

- O-B U-component RMS reduced by 1.3%
- O-B V-component RMS reduced by 3.3%



Change in Forecast RMS Errors



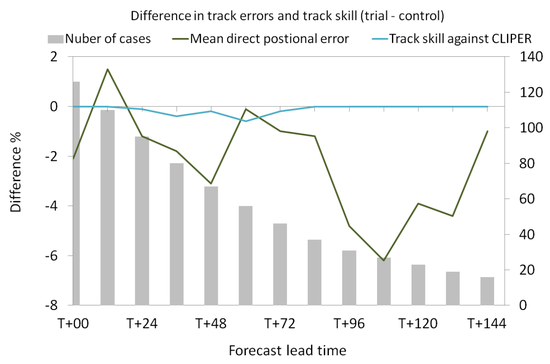
Benefit

Forecasts verified against observations for Global NWP Index parameters.

- Generally neutral or small positive impact on forecasts
- Some negative impact in SH

Tropical Cyclone Forecast Impact

The addition of RapidScat leads to a reduction in the mean positional error of tropical cyclones in both the analysis (T+0) and forecasts. The impact on track skill is neutral and there was no impact on storm intensity.



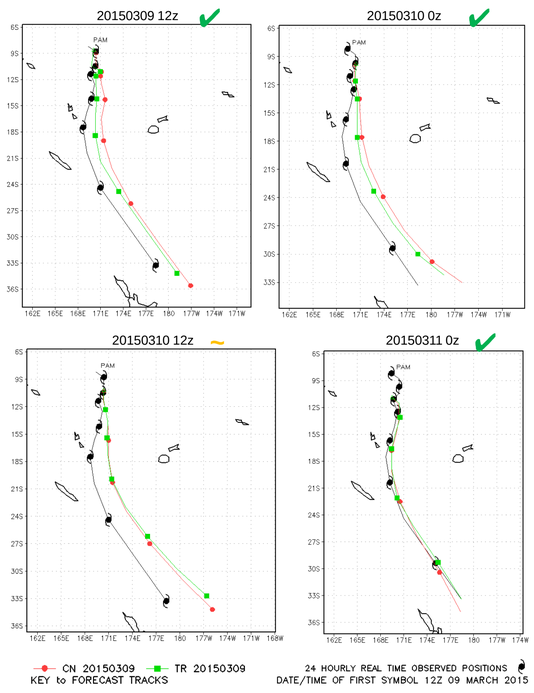
- Analysis errors 2.1% lower (126 analyses) ✔
- Forecast errors 1.5% lower (607 forecasts) ✔
- Track skill 0.2% lower ~

Tropical Cyclone Pam

The panels show forecasts made at 12hr intervals from 9-13 March 2015 for Cyclone Pam in the S. Pacific.

Black = observed positions (truth), Red = control, Green = experiment

- Forecasts on 09/12z and 10/0z clearly show an improved track at all lead times
- Some later forecasts (not shown) have slightly worse tracks, but overall track position errors are reduced with RapidScat



SMOS L-Band Wind Speeds

SMOS+Storm

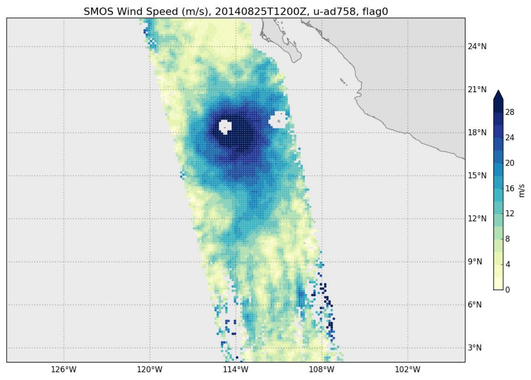
ESA-funded project (http://www.smosstorm.org/) aims to demonstrate the performance, utility and impact of SMOS L-band measurements

- Focus on high wind speeds during tropical and extra-tropical storm conditions.
- Met Office has been assessing the potential for SMOS high wind speeds (Reul et al., 2016) to improve NWP analyses.

Case Study: Hurricane Marie

Short assimilation experiments have been conducted to examine the impact of assimilating SMOS wind speeds on Hurricane Marie (2014) in the East Pacific basin.

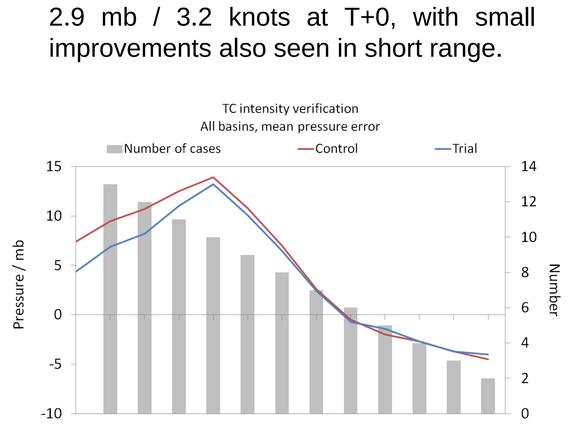
- Used when model and SMOS exceed 15 m/s.
- SMOS intercept shown below for all wind speeds at 12Z on 25 August.



The figure below shows analysed minimum central pressures for the control (green) and two experiments assimilating SMOS (red/blue).

- The SMOS experiments produce a more intense storm and central pressure errors are reduced by ~ 20 hPa at peak intensity.

A comparison of the surface wind analysis between the control (left), SMOS experiment (middle) and analysis difference (right):



Forecast and analysis intensity

- Control (red line) pressures are too high at T+0 and short range, but slightly too low at day 5/6. Winds are too weak, especially at analysis and short range.
- The SMOS experiment (blue line) shows increased intensity at T+0 and short range: lower min pressures, stronger max winds and higher vorticity.
- Abs. wind/pressure errors are reduced by 2.9 mb / 3.2 knots at T+0, with small improvements also seen in short range.

Summary

In this case study the use of SMOS results in better intensities at T+0 and short range. The impact on TC track is neutral or slightly negative. This is just for one storm case, but the initial results are encouraging. Longer assimilation experiments are now underway to cover the full hurricane season,

References

Cotton, J., (2013) Assimilating Scatterometer Winds from Oceansat-2: Impact on Met Office Analyses and Forecasts, Met Office Forecasting Research Technical Report 572.

Reul, N., Chapron, B., Zabolotskikh, E., Donlon, C., Quilfen, Y., Guimbard, S., and J.F. Piolle (2016) A revised L-band radio-brightness sensitivity to extreme winds under Tropical Cyclones: The 5 year SMOS-storm database, submitted RSE, 2016.

Met Office FitzRoy Road, Exeter, Devon, EX1 3PB United Kingdom
Tel: +44 1392 885680 Fax: +44 1392 885681
Email: james.cotton@metoffice.gov.uk