

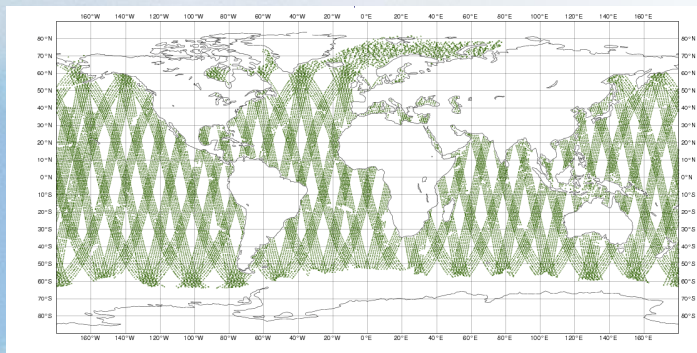
# Status of Scatterometer Winds assimilation at ECMWF

**Giovanna De Chiara, Peter Janssen, Stephen English**

## **Outline**

- ❖ OSCAT winds assimilation
- ❖ ASCAT-B winds calibration & assimilation
- ❖ Impact study results

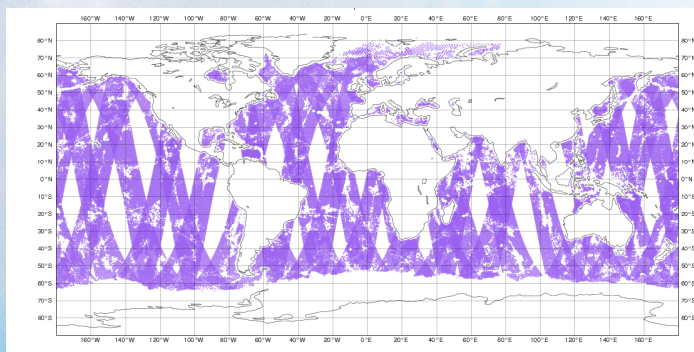
# Scatterometer winds at ECMWF



**ASCAT METOP-A**

➤ Since 12-06-2007

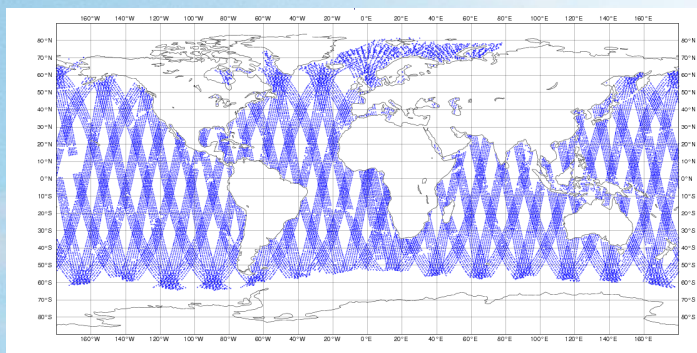
**Operational**



**OCEANSAT-2**

➤ Since 17/12/2012

**Operational**



**ASCAT METOP-B**

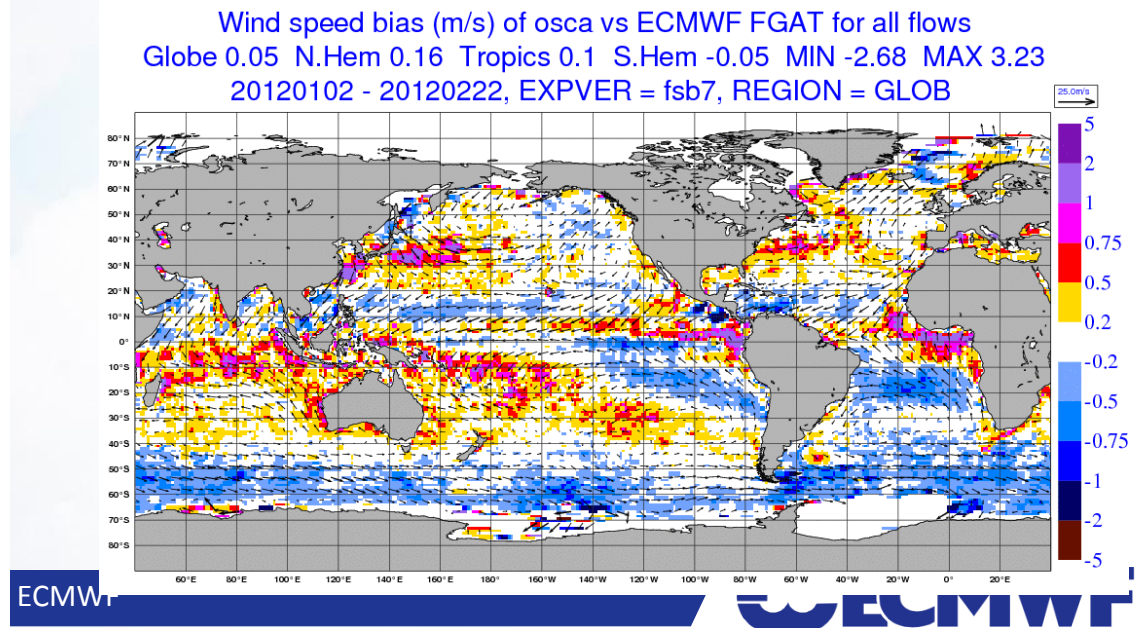
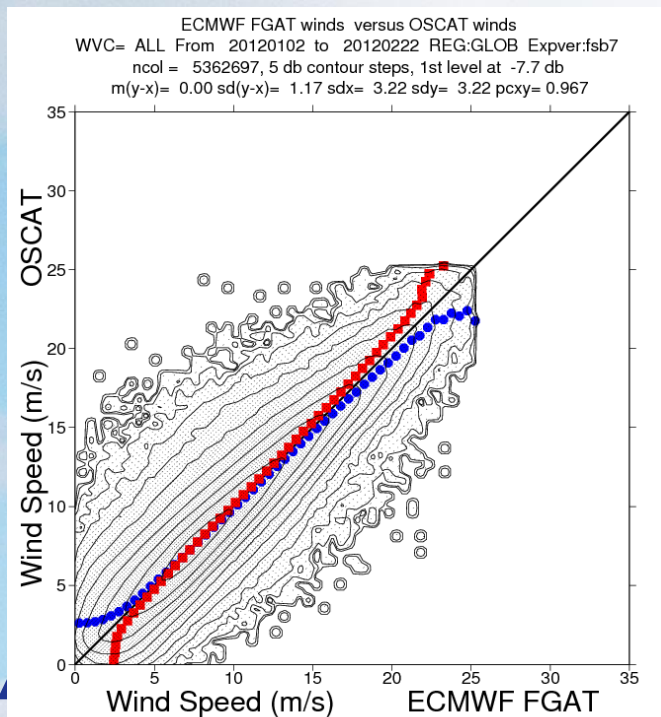
**Cal/Val**

**Example 1 day coverage**

# OCEANSAT-2 Scatterometer data

## OCEANSAT-2 (50km):

- ✓ Use of L2 wind products from OSI-SAF (KNMI)
- ✓ Quality control:
  - Screening: Sea Ice check on SST and Sea Ice model
  - No thinning
  - Weight in the assimilation 0.25
- ✓ Wind speed bias correction
- ✓ Assimilated up to 25 m/s
- ✓ **Actively assimilated** in IFS since 17 December 2012



# OCEANSAT-2 Scatterometer data

## Impact on 500 hPa Vector Wind forecast scores

### mean-normalised Inc. 4DVar OSCAT NF BC minus CTRL

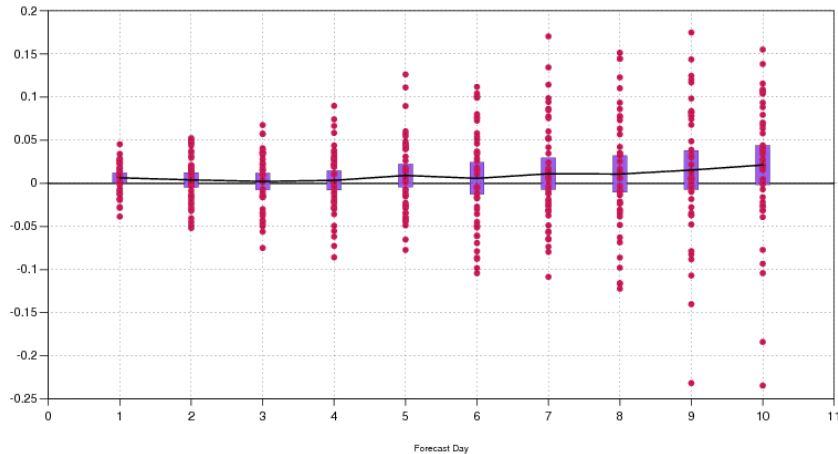
500hPa vector wind

Anomaly correlation

NHem Extratropics (lat: 20.0 to 90.0, lon: -180.0 to 180.0)

Date: 20120102 00UTC to 20120217 00UTC

Confidence: [95.0] | Population: 46



### mean-normalised Inc. 4DVar OSCAT NF minus CTRL

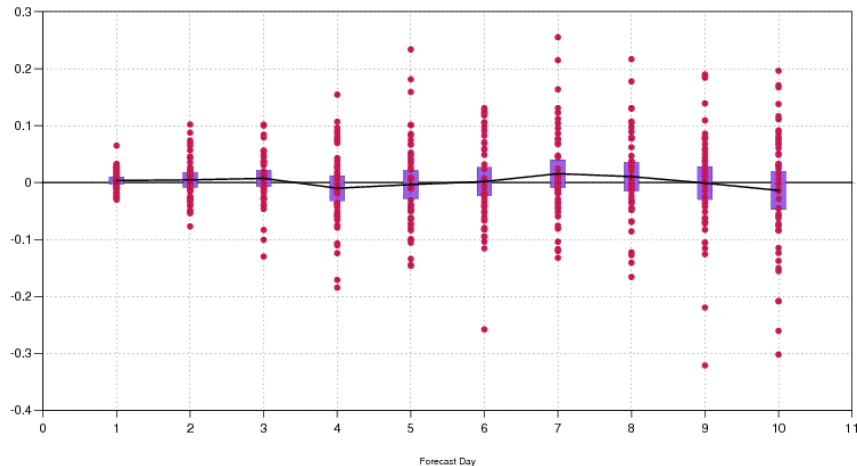
500hPa vector wind

Anomaly correlation

SHem Extratropics (lat: -90.0 to -20.0, lon: -180.0 to 180.0)

Date: 20120102 00UTC to 20120217 00UTC

Confidence: [95.0] | Population: 46



### mean-normalised Inc. 4DVar OSCAT NF minus CTRL

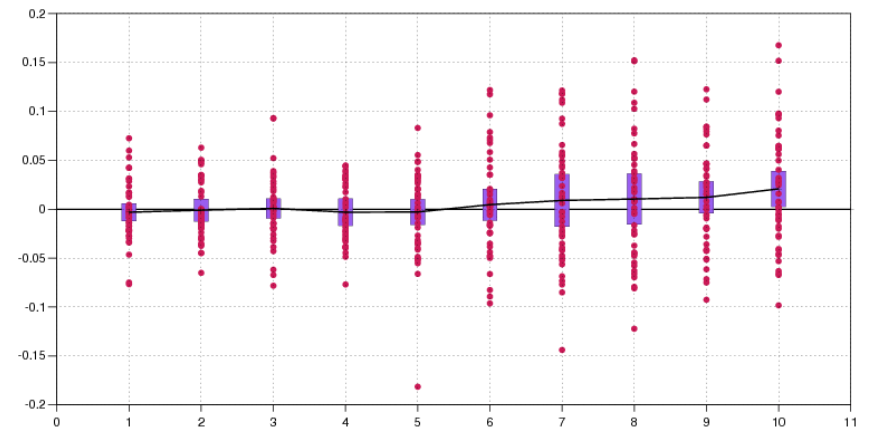
500hPa vector wind

Anomaly correlation

Tropics (lat: -20.0 to 20.0, lon: -180.0 to 180.0)

Date: 20120102 00UTC to 20120217 00UTC

Confidence: [95.0] | Population: 46



# OCEANSAT-2 Scatterometer data

## Impact on SWH forecast scores

### mean-normalised Inc. 4DVar OSCAT NF BC minus CTRL

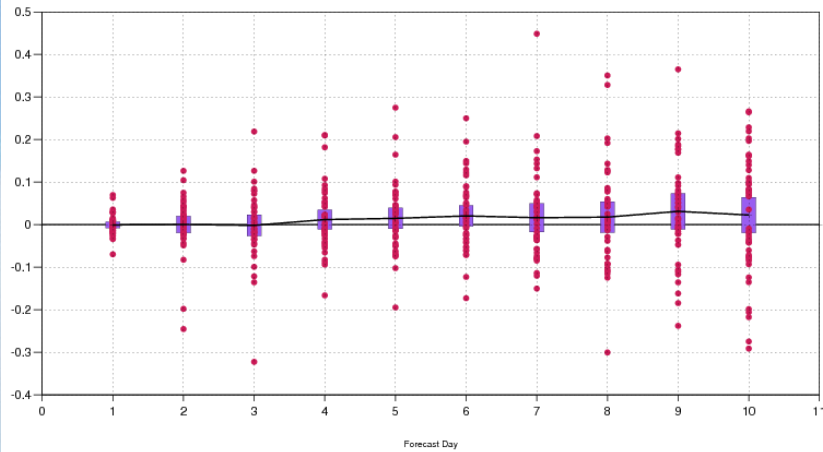
significant wave height

Anomaly correlation

NHem Extratropics (lat 20.0 to 90.0, lon -180.0 to 180.0)

Date: 20120102 00UTC to 20120217 00UTC

00UTC | Confidence: [95.0] | Population: 46



### mean-normalised Inc. 4DVar OSCAT NF BC minus CTRL

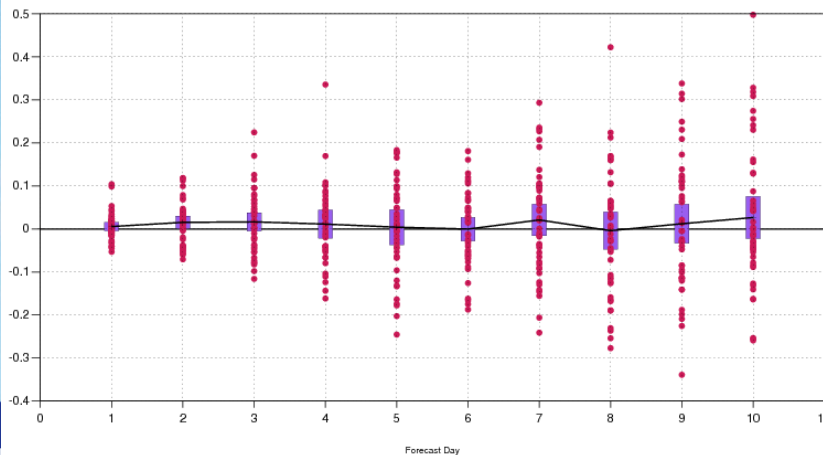
significant wave height

Anomaly correlation

SHem Extratropics (lat -90.0 to -20.0, lon -180.0 to 180.0)

Date: 20120102 00UTC to 20120217 00UTC

00UTC | Confidence: [95.0] | Population: 46



### mean-normalised Inc. 4DVar OSCAT NF BC minus CTRL

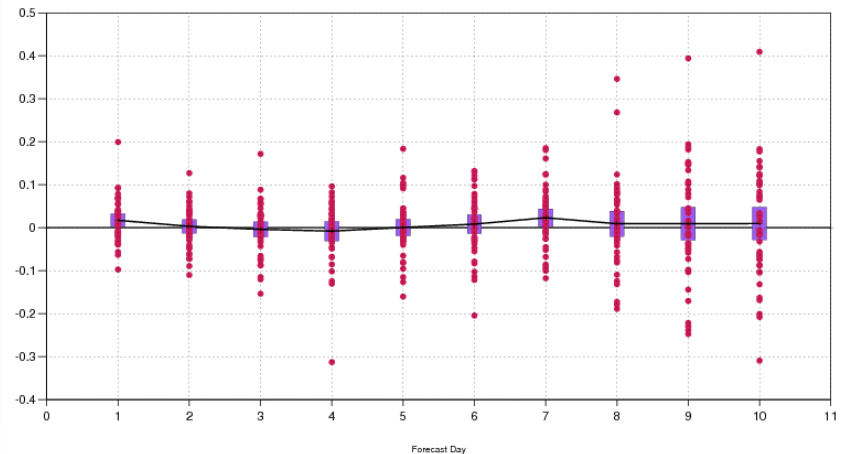
significant wave height

Anomaly correlation

Tropics (lat -20.0 to 20.0, lon -180.0 to 180.0)

Date: 20120102 00UTC to 20120217 00UTC

00UTC | Confidence: [95.0] | Population: 46



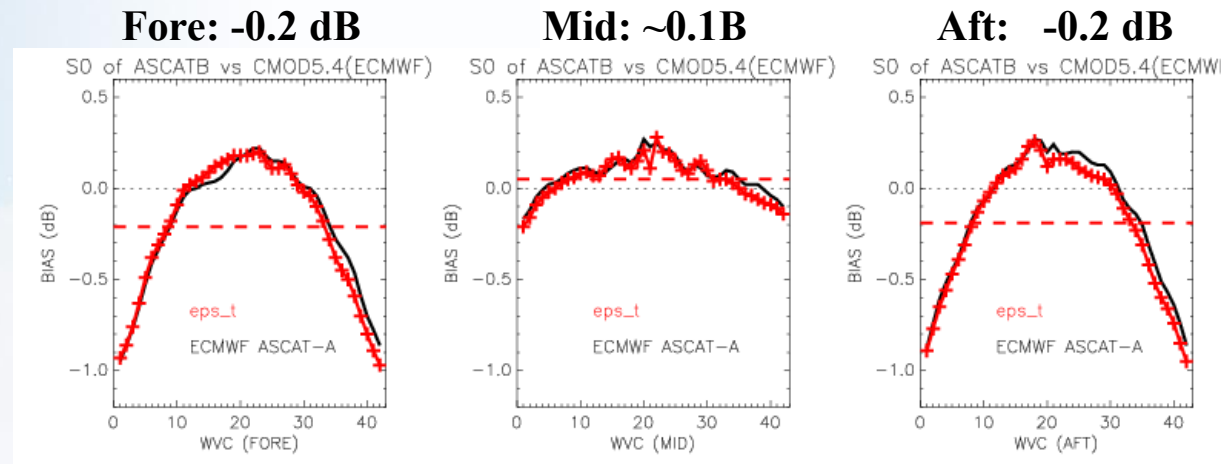


# ASCAT-B wind data cal/val

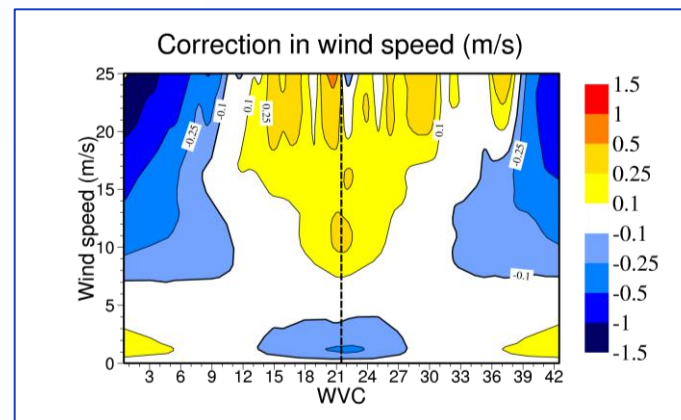
Test dataset: L1b from EUMETSAT (eps\_t)  
Orbits 551-1198 (26<sup>th</sup> Oct – 10<sup>th</sup> Dec 2012)

Calibration in sigma nought space

Ocean Calibration



Calibration in wind speed space



# ASCAT-B wind data

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## Assimilation strategy (same as ASCAT-A)

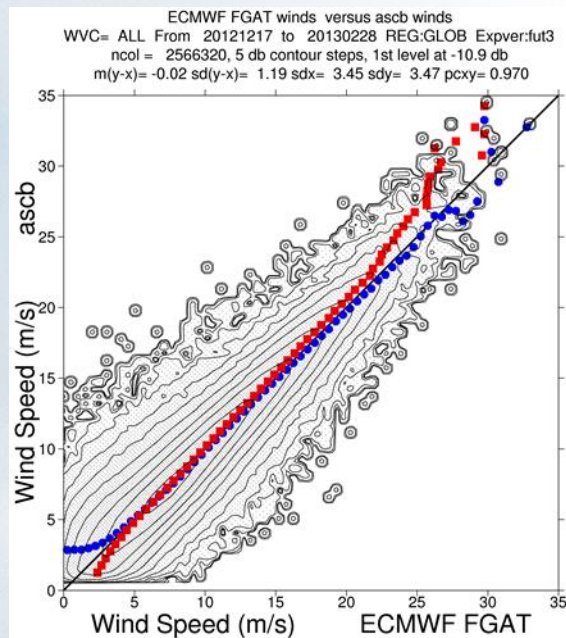
- ✓ **Sigma nought bias corrected**
- ✓ **Inversion → CMOD5.N**
- ✓ **Wind speed bias correction**
- ✓ **Thinning ~ 100 km**
- ✓ **Observation error: 1.5 m/s**

## Numerical Experiments:

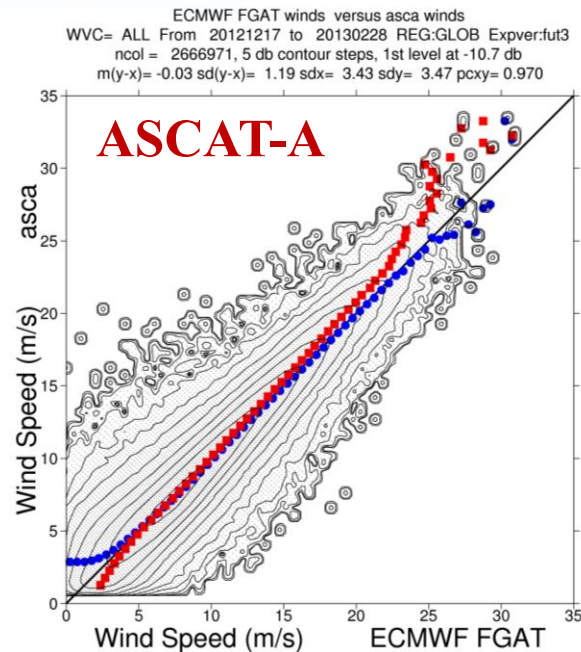
- ✓ **Res. T511 (~40km);**
- ✓ **17 December 2012 – 28 February 2013**
- ✓ **Sigma nought and Wind speed bias correction**

**ASCAT-B in (*fut3*): Operational configuration + ASCAT-B**  
**CTRL (*fut4*): Operational Configuration**

# ASCAT-B wind data

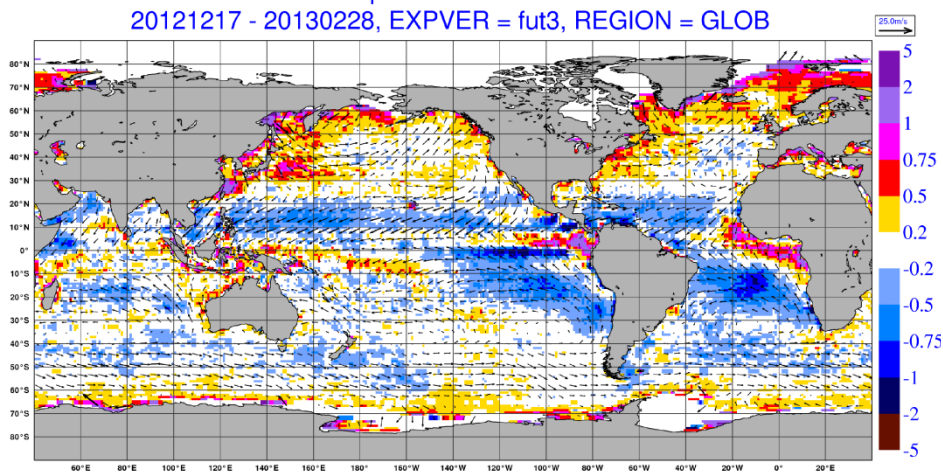


**ASCAT-B**

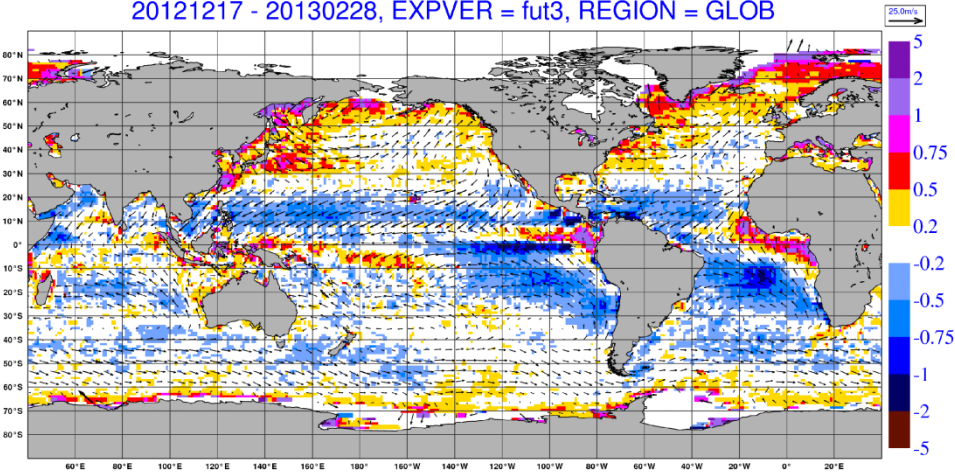


**ASCAT-A**

Wind speed bias (m/s) of ascb vs ECMWF FGAT for all flows  
Globe -0.01 N.Hem 0.19 Tropics -0.1 S.Hem -0.03 MIN -2.32 MAX 4.24  
20121217 - 20130228, EXPVER = fut3, REGION = GLOB



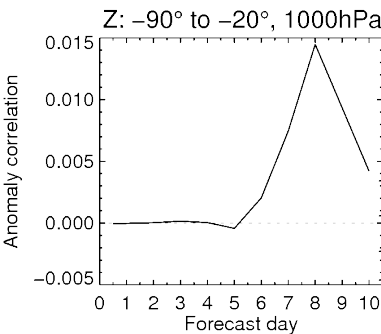
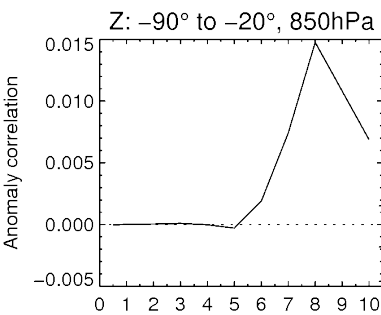
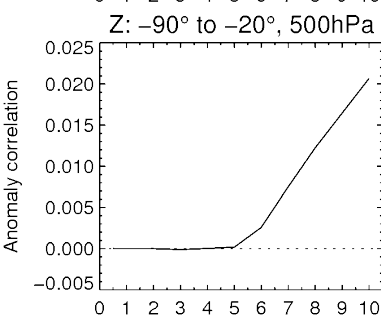
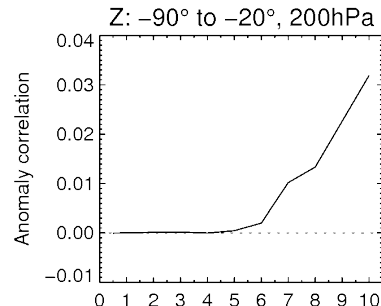
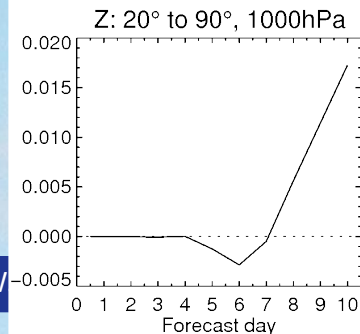
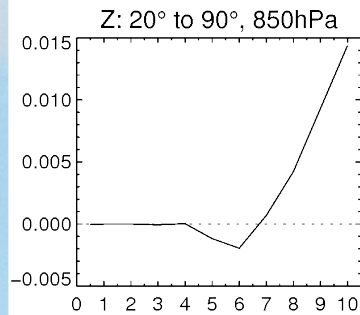
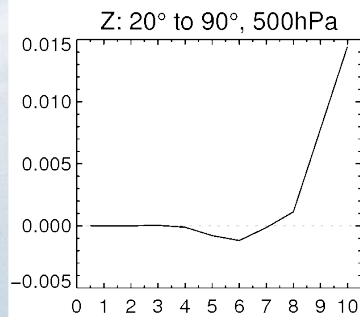
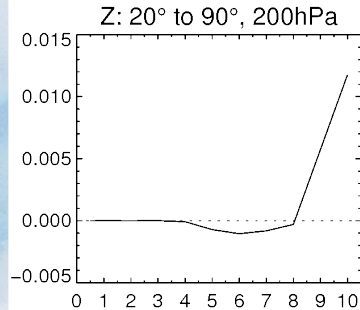
Wind speed bias (m/s) of asca vs ECMWF FGAT for all flows  
Globe -0.02 N.Hem 0.19 Tropics -0.11 S.Hem -0.04 MIN -4.01 MAX 4.23  
20121217 - 20130228, EXPVER = fut3, REGION = GLOB





# ASCAT-B: geopotential forecast verification

NH



SH

**Anomaly correlation difference**  
*ASCAT-B in - CTRL*

**Against own analysis**

# ASCAT-B forecast verification

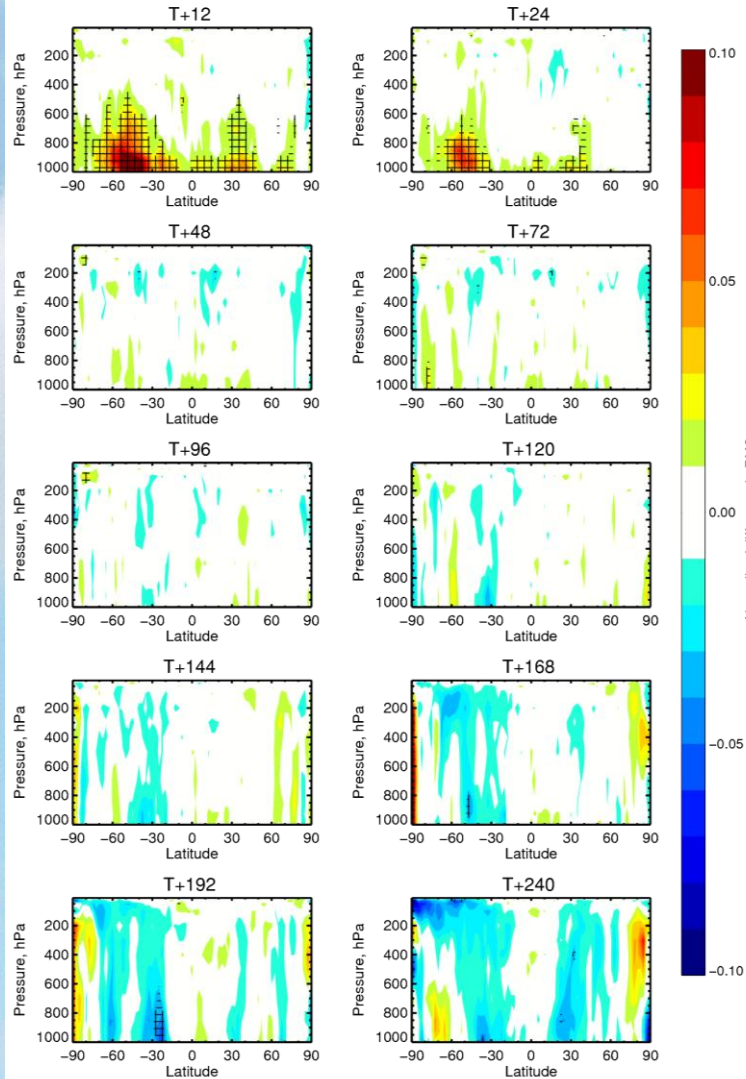
## Against own analysis - VW

## ASCAT-B in - CTRL

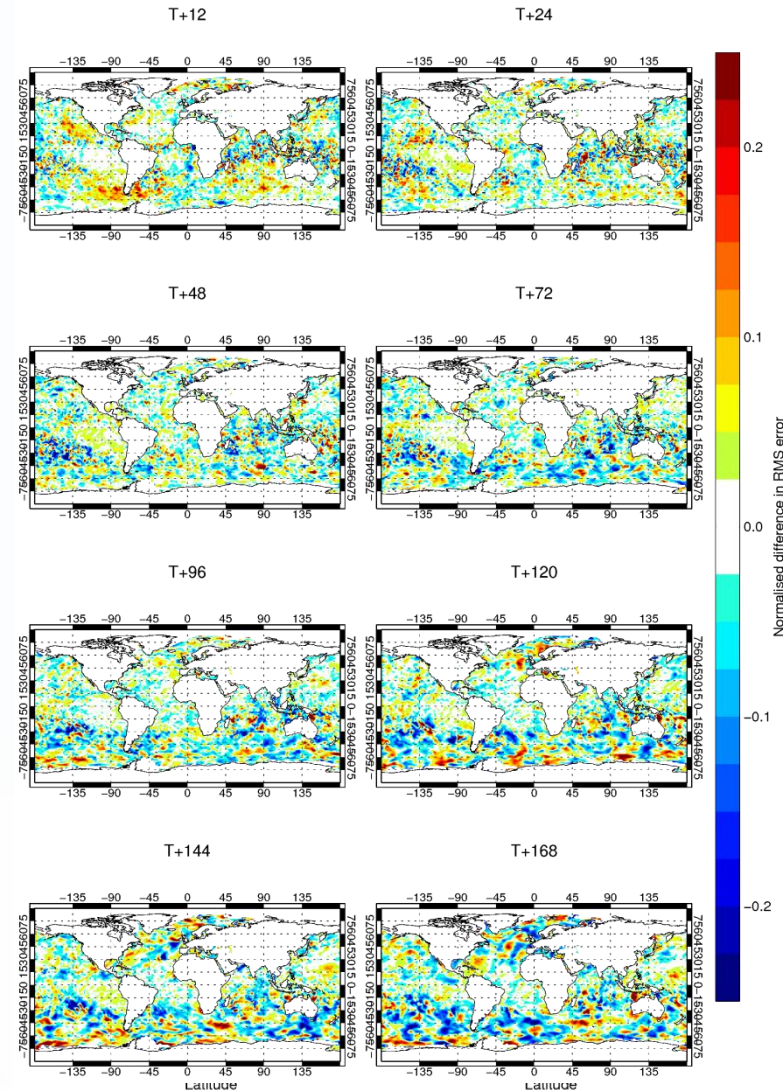
## SWH

## Against own analysis

RMS forecast errors in VW(fut3-fut4), 17-Dec-2012 to 28-Feb-2013, from 64 to 74 samples  
Point confidence 99.8% to give multiple-comparison adjusted confidence 95%. Verified against own-analysis.

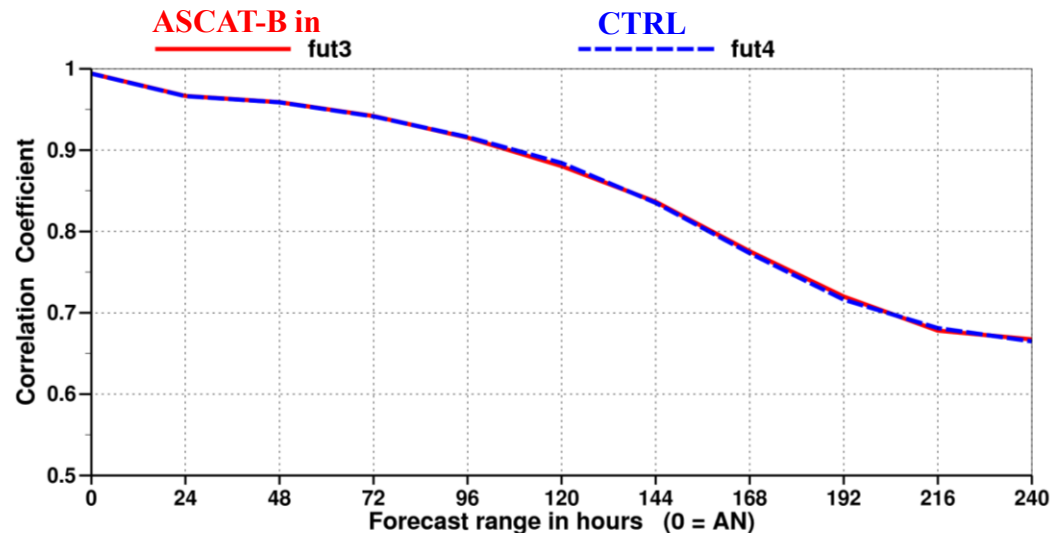
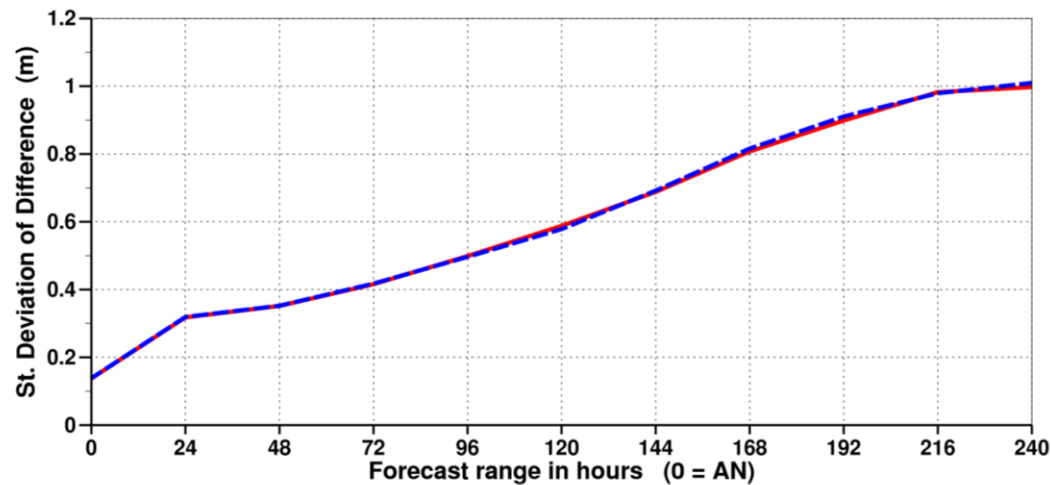


RMS forecast errors in SWH (fut3 - fut4); 17-Dec-2012 to 28-Feb-2013 from 64 to 74 samples.  
Verified against own-analysis.



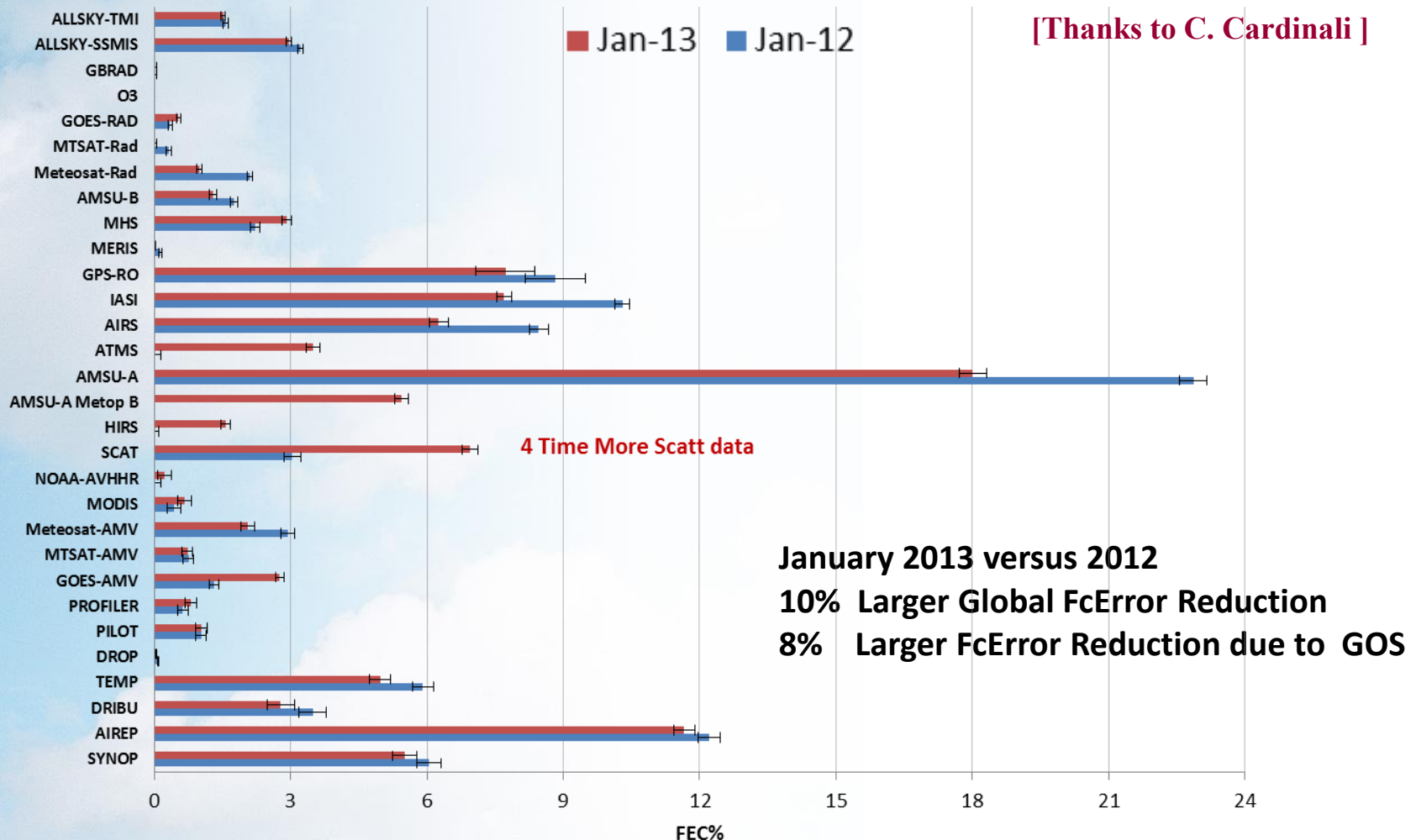
# Verification of SWH vs Altimeter (JASON-1)

Global, 20121217 - 20130228, ASCAT-B in (fut3)-CTRL (A-O) (fut4) (62854 collocations)



# Impact of Assimilated observations on Forecast Error Reduction

The *forecast sensitivity to observations* measures the impact of the observations on the short-range forecast (24 hours). The forecast sensitivity tool developed at ECMWF computes the Forecast Error Contribution (FEC) that is a measure (%) of the variation of the forecast error (as defined through the dry energy norm) due to the assimilated observations.



Langland RH, Baker NL, 2004. *Estimation of observation impact using the NRL atmospheric variational data assimilation adjoint system*, Tellus 56A.

Zhu Y, Gelaro R, 2008. *Observation Sensitivity Calculation using the adjoint of the GSI analysis system*, Mon. Weather Rev 136.

Cardinali C, 2009. *Monitoring the observation impact on the short-range forecast*, Q.J.R. Meteorol. Soc. 135.



# Forecast Sensitivity to Observations

## Assimilation experiments

**Model Resolution:** T511 (~40km); 91 levels up to 0.01hPa

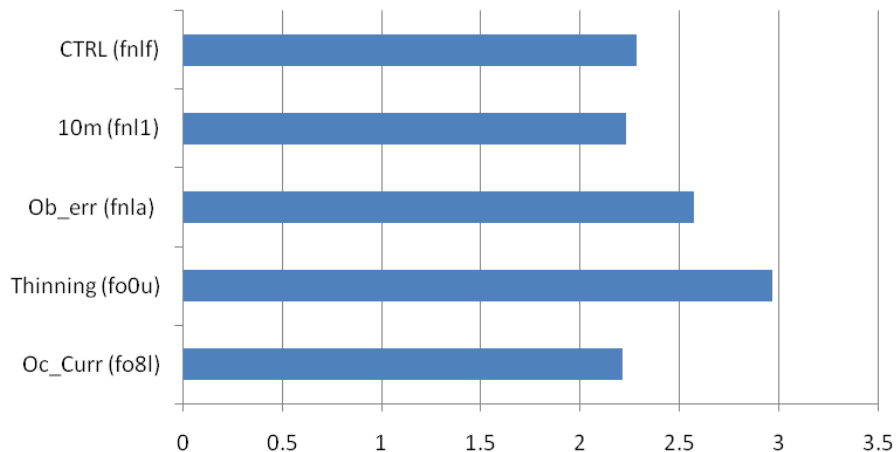
**DA system:** Incremental 4D-VAR with a 12 h window and an analysis resolution of T255 (~80km)

**Period:** 1 Jun – 31 July 2011 (ERS-2 SCAT + ASCAT-A)

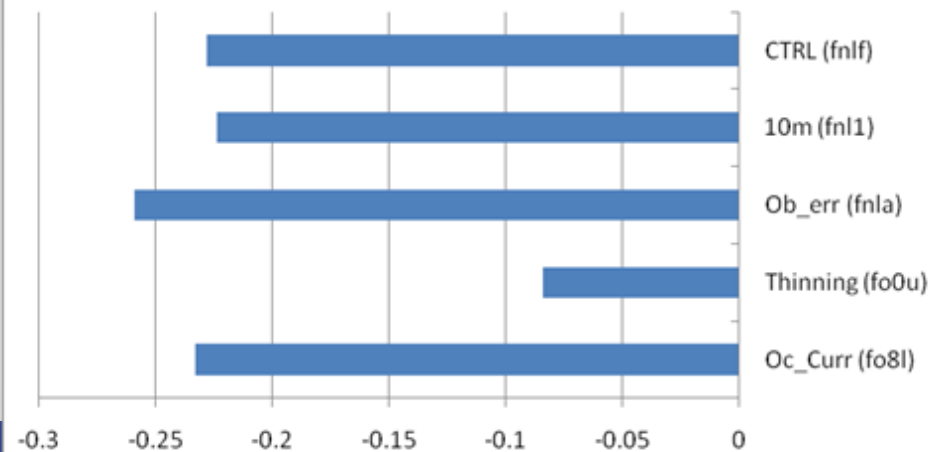
Exp T511	Period	Perturbation
CTRL	2011	CTRL (Neutral Winds, Thinning=4; Obs. Error 1.5m/s; Oc.Currents OFF)
10m	2011	CTRL + 10 m winds;
Obs. Error	2011	CTRL + observation error=1.0 m/s
Thinning	2011	CTRL + thinning=2 (every 50km)
Oc. Currents	2011	CTRL + Ocean Currents ON (Mercator)

For each observation

SCATT FEC % Jun-Jul 2011



Mean FEC (J/Kg) Jun-Jul 2011



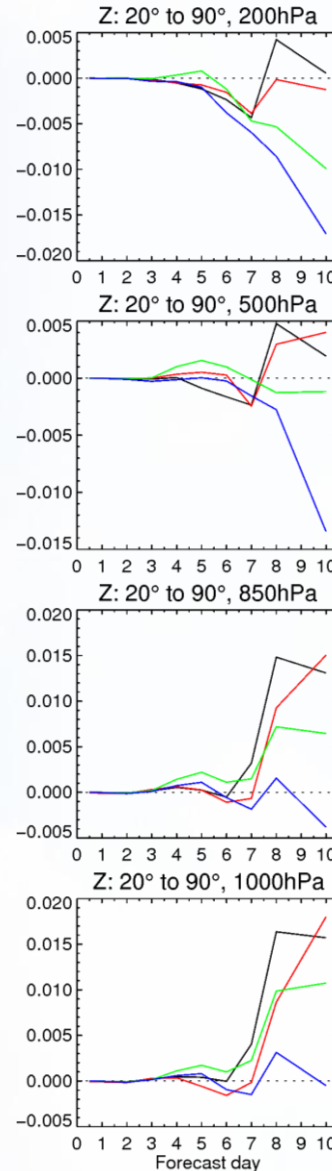
# Forecast Sensitivity to Observations

## Anomaly correlation

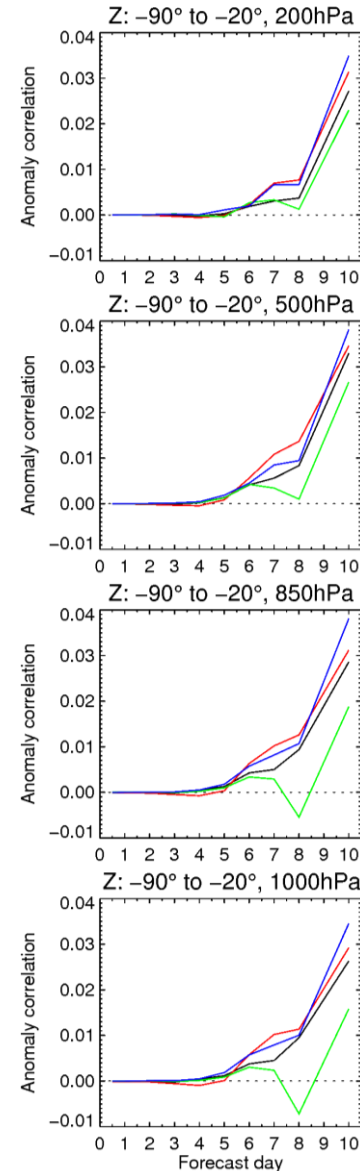
Verification against own-analysis  
1-Jun-2011 to 31-Jul-2011

Obs.Error – CTRL  
Thinning – CTRL  
10m winds – CTRL  
Oc.Currents – CTRL

NH



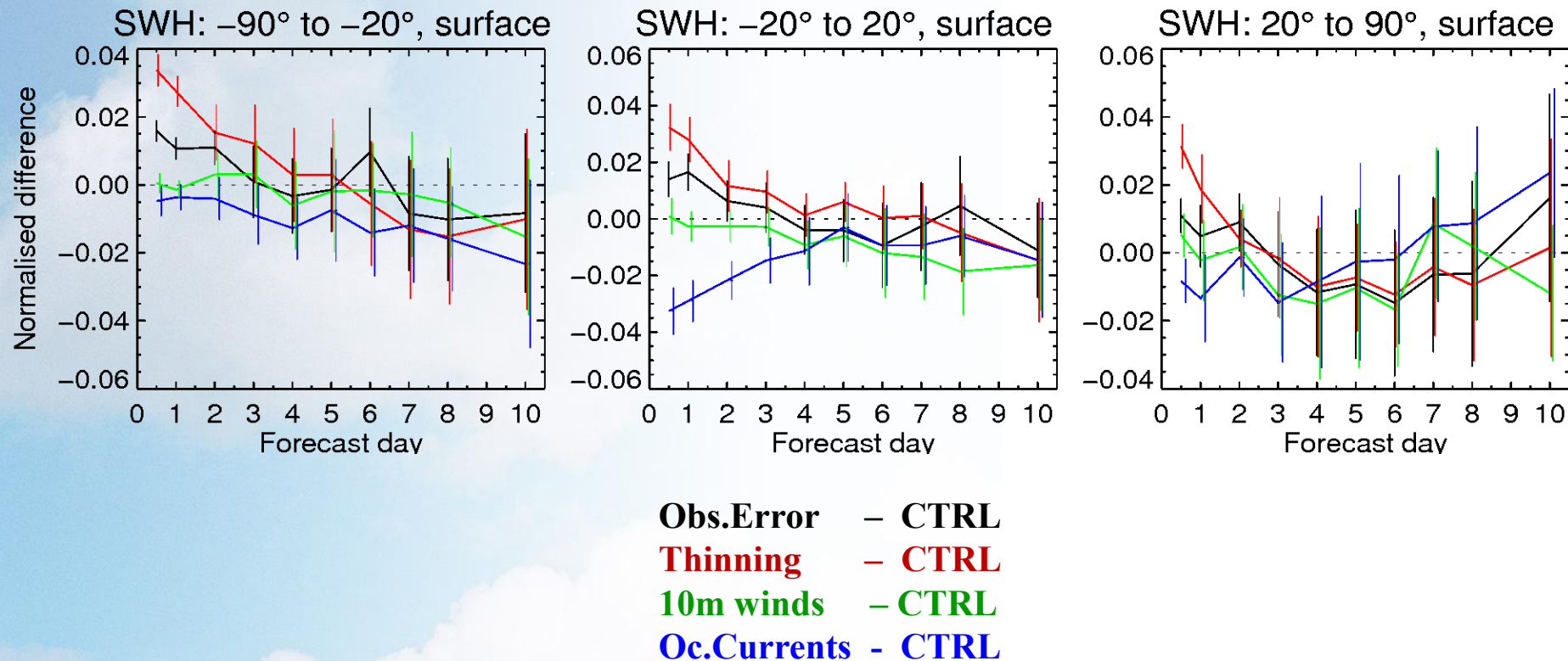
SH



# Forecast Sensitivity to Observations

## RMSE

1-Jun-2011 to 31-Jul-2011 from 51 to 61 samples. Confidence range 95%. Verified against own-analysis.

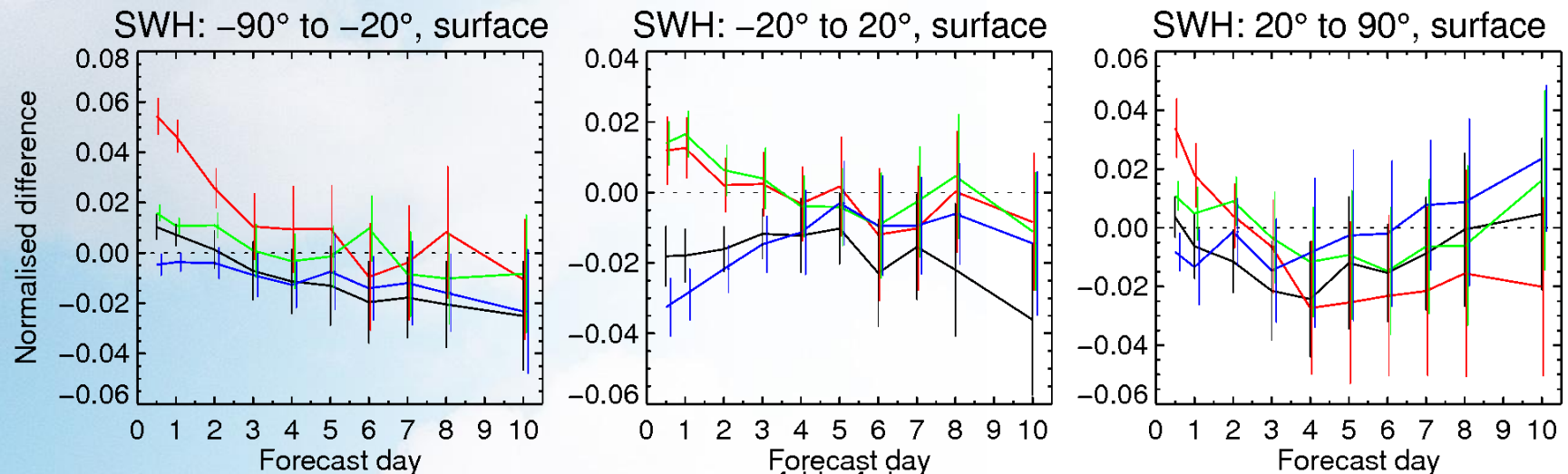


# Forecast Sensitivity to Observations

Exp T511	Period	Perturbation
Oc.Curr+Obs.Err.	2011	CTRL + Oc.Currents ON; Obs. Error 1.0m/s
Oc.Curr+Obs.Err.+Thin	2011	CTRL + Oc.Currents ON; Obs. Error 1.0m/s; Thinning=2

## RMSE

1-Jun-2011 to 31-Jul-2011 from 51 to 61 samples. Confidence range 95%. Verified against own-analysis.



**Oc.Curr+Obs.Err.** – CTRL  
**Oc.Curr+Obs.Err.+Thin** – CTRL  
**Obs.Error** – CTRL  
**Oc.Currents** – CTRL



# Summary

## OSCAT:

- ✓ Active assimilation in IFS since December 2012
- ✓ Wind speed bias correction applied and wind assimilated up to 25m/s
- ✓ Neutral/positive impact in terms of SWH and Vector winds, mostly NH

## ASCAT

**ASCAT-A** winds are stable;

**ASCAT-B** cal/val completed:

- wind quality as good as ASCAT-A
- positive impact on most of the parameters mostly SH
- Active assimilation possibly in June

## IMPACT STUDY

- ✓ FEC (%) higher in case of lower observation error
- ✓ Verification scores: improvements for observation error and use of ocean currents
  - ❖ The use of ocean currents will be probably activated in IFS by the end of the year
- ✓ Computation of FEC including also OSCAT and ASCAT-B will be performed
  - ❖ Operational analysis results show higher FEC (%) since OSCAT is assimilated
- ✓ Impact studies will be extended to a complete GOS including all the Scatterometer datasets now available (project on going with EUMETSAT)

## **ERS-2 SCATT ASPS Reprocessed products (1997-2003)**

**<https://earth.esa.int/web/guest/data-access/browse-data-products>**

## **ECMWF ERA-Interim 3h forecast**

**[http://apps.ecmwf.int/datasets/data/interim\\_full\\_daily](http://apps.ecmwf.int/datasets/data/interim_full_daily)**