

The Usage of Scatterometer Data at ECMWF

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Overview

- **Assessment of the EARS ASCAT service**
- **Re-calibration of ERS-1 and ERS-2**
- **Usage/inter-comparison of scatterometer data
in the ECMWF interim reanalysis**
- **Concluding remarks**

Assessment of EARS ASCAT data

➤ EUMETSAT Global ASCAT data service (GDS)

- Since February 2007,
- timeliness of about 2 hours,
- used at ECMWF since 12 June 2007.

➤ EUMETSAT Advanced Retransmission Service (EARS)

- Available in pilot phase since September 2008,
- Timeliness of 15 to 45 minutes.

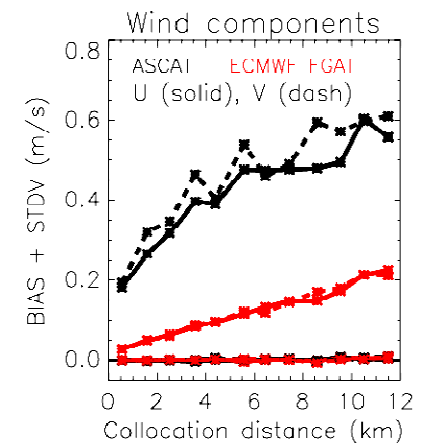
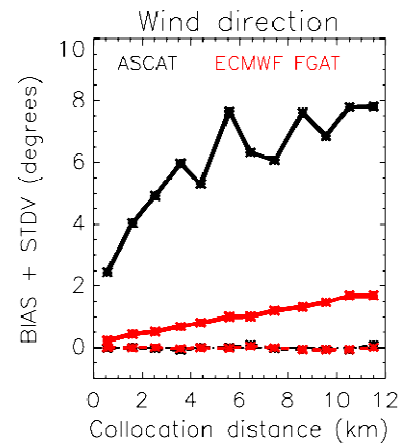
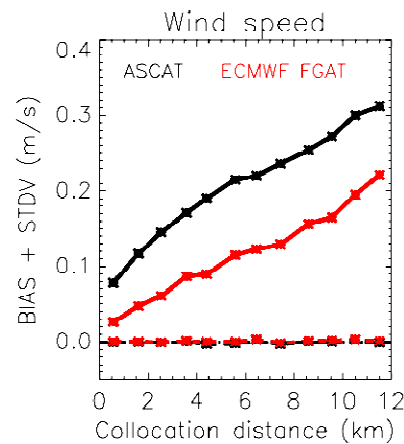
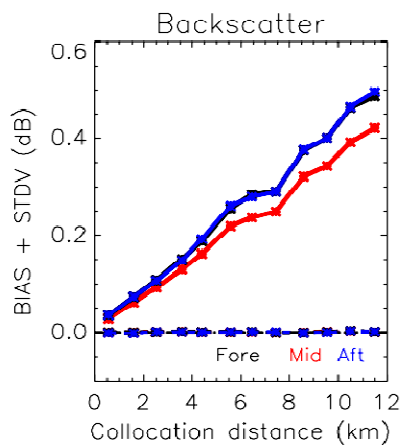
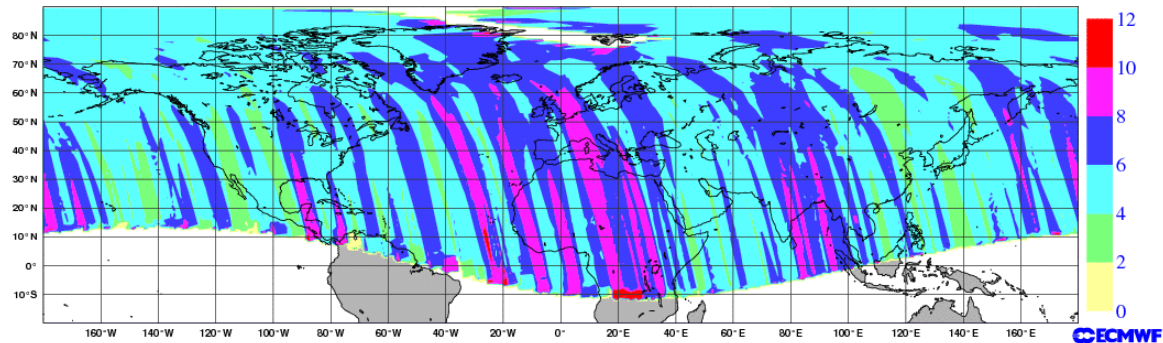
➤ Collocation study

➤ Impact study

- Duplicate data to be automatically removed by generic thinning algorithm

Collocation between EARS and GDS ASCAT

Average (km) EARS (Collocation distance up to 12 km)
Globe 5.8 N.Hem 5.7 Tropics 5.9 MIN 0 MAX 11.9
2008091500 - 2008093018, EXPVER = T1X12

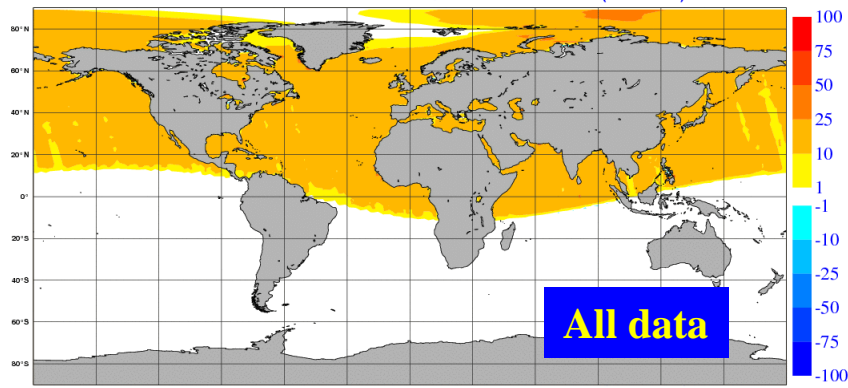


EARS + GDS ASCAT Impact study

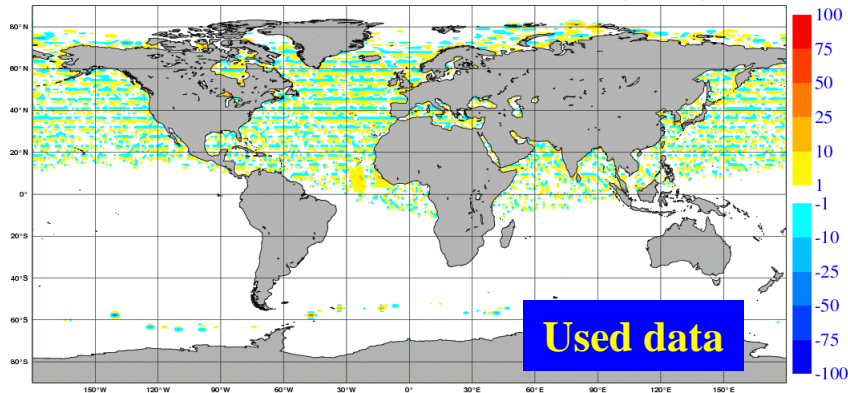
Data count

Delayed cut off (12-hour window + 4h45m cut off)

$(N_EARS - N_CONTROL)/(N_EARS + N_CONTROL)$ in Percent
2008091500 - 2008093018, All wind data (DCDA)

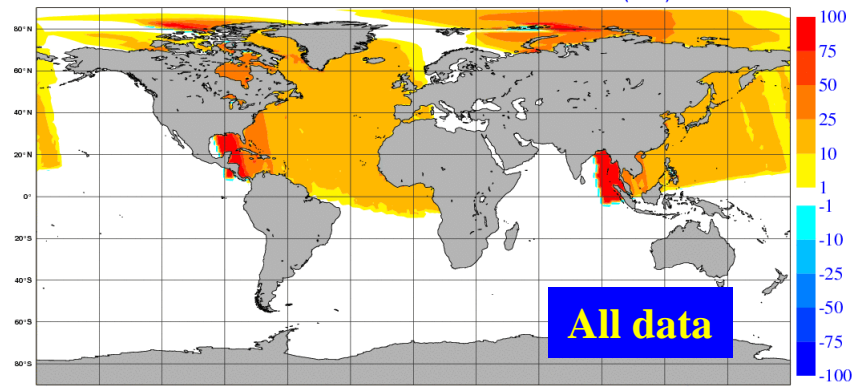


$(N_EARS - N_CONTROL)/(N_EARS + N_CONTROL)$ in Percent
2008091500 - 2008093018, Active wind data (DCDA)

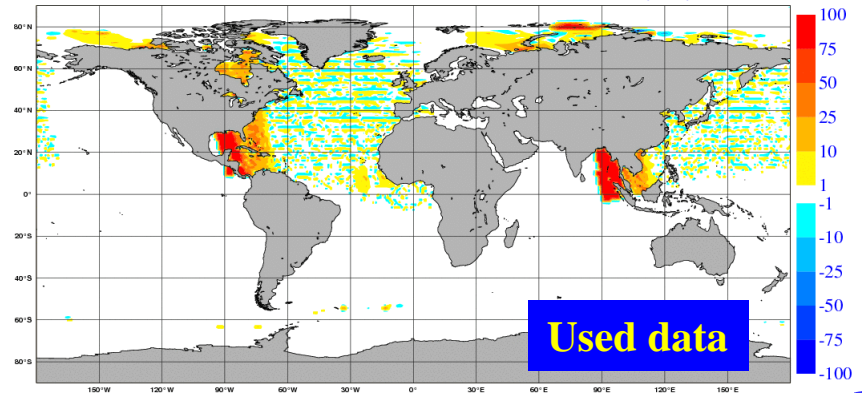


Early delivery (6-hour window + 1h cut off)

$(N_EARS - N_CONTROL)/(N_EARS + N_CONTROL)$ in Percent
2008091500 - 2008093018, All wind data (DA)



$(N_EARS - N_CONTROL)/(N_EARS + N_CONTROL)$ in Percent
2008091500 - 2008093018, Active wind data (DA)



Re-calibration of the ERS archive

ESA report, Abdalla and Hersbach 2007, www.ecmwf.int/publications

- ERS-1&2 have known periods of σ_0 calibration.
- Triple collocation:
 - ✓ ERS, buoy, ERA-40 (all as non-neutral 10m wind)
 - ✓ 18 Buoys: far enough from coast, stable, available for long period
 - ✓ ERS based on CMOD5
 - ✓ Stable periods: ERS1: 1993-1995 ERS2: 1998-2000

U.S. National Data Buoy Center (NDBC)							
41001	41002	41010	42001	42002	42003	44011	46002
46004	46005	46006	46035	51001	51003	51004	46059
Canadian Marine Environmental Data Service (CMEDS)							
46036	46184						

Table 1: Five-digit WMO identifiers of buoys that were taken in consideration for the collocation with ERS winds, grouped into originating data provider.

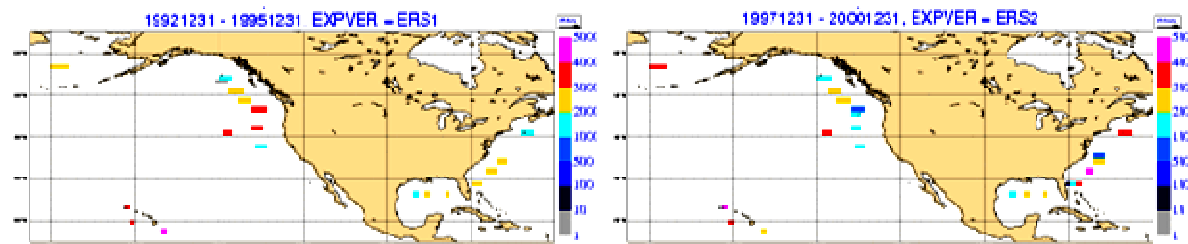
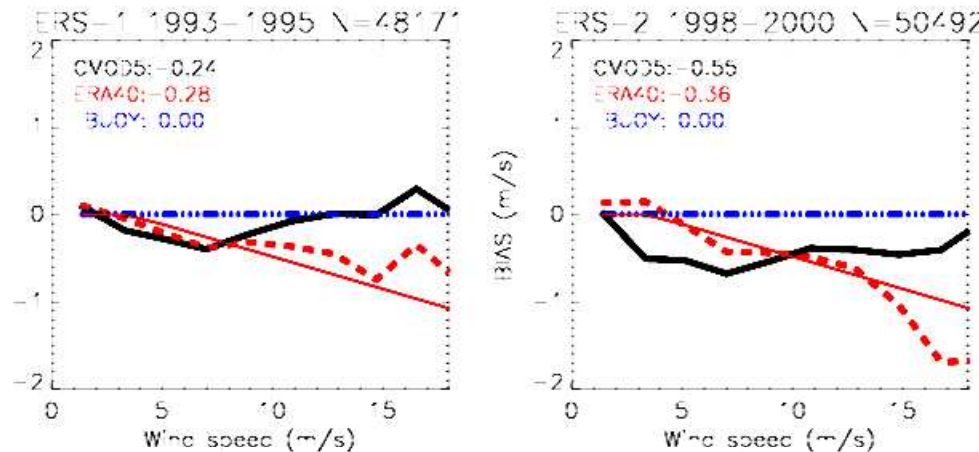


Figure 36: Number of collocations accumulated over the indicated period (and mapped on a N80 reduced Gaussian grid) for which buoy and ERS-1 (left) respectively ERS-2 (right) are positioned within 30 minutes and 50 km. Adjacent non-empty grid boxes expose buoy displacements.

Re-calibration of the ERS archive



- For ERS-2, CMOD5 ~ 0.5 m/s biased low → CMOD5.4
- Relative bias between ERS-1 and ERS-2
- @ buoy location, ERA-40 is biased low as:

$$s_{\text{unbiased}} = \begin{cases} s & s \leq 3.5 \text{ m s}^{-1} \\ 1.08s - 0.28 \text{ m s}^{-1} & s > 3.5 \text{ m s}^{-1} \end{cases}$$

Re-calibration of the ERS archive

- Extend ERA-40 bias correction @buoy location for:

- ✓ entire globe
- ✓ from ~1991-2000

- Perform ocean calibration:

$$\text{ERS bias} = \sigma_0 - \text{CMOD5.4}(\text{ERA-40}_{\text{corrected}})$$

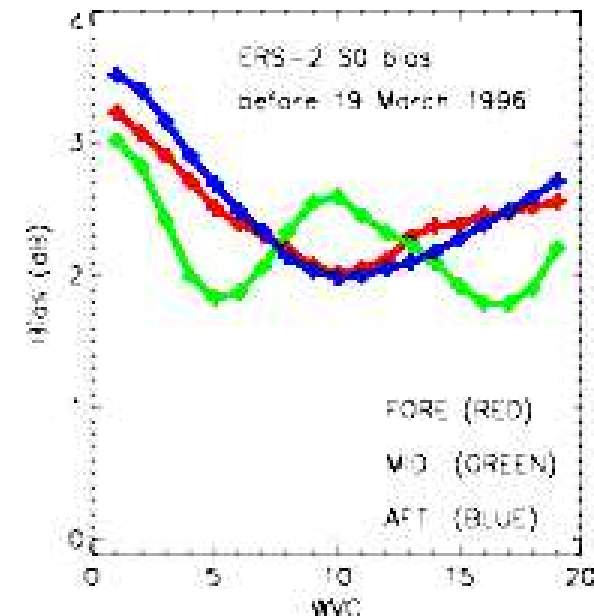
- Correct for this bias

- Automatically identify specific periods

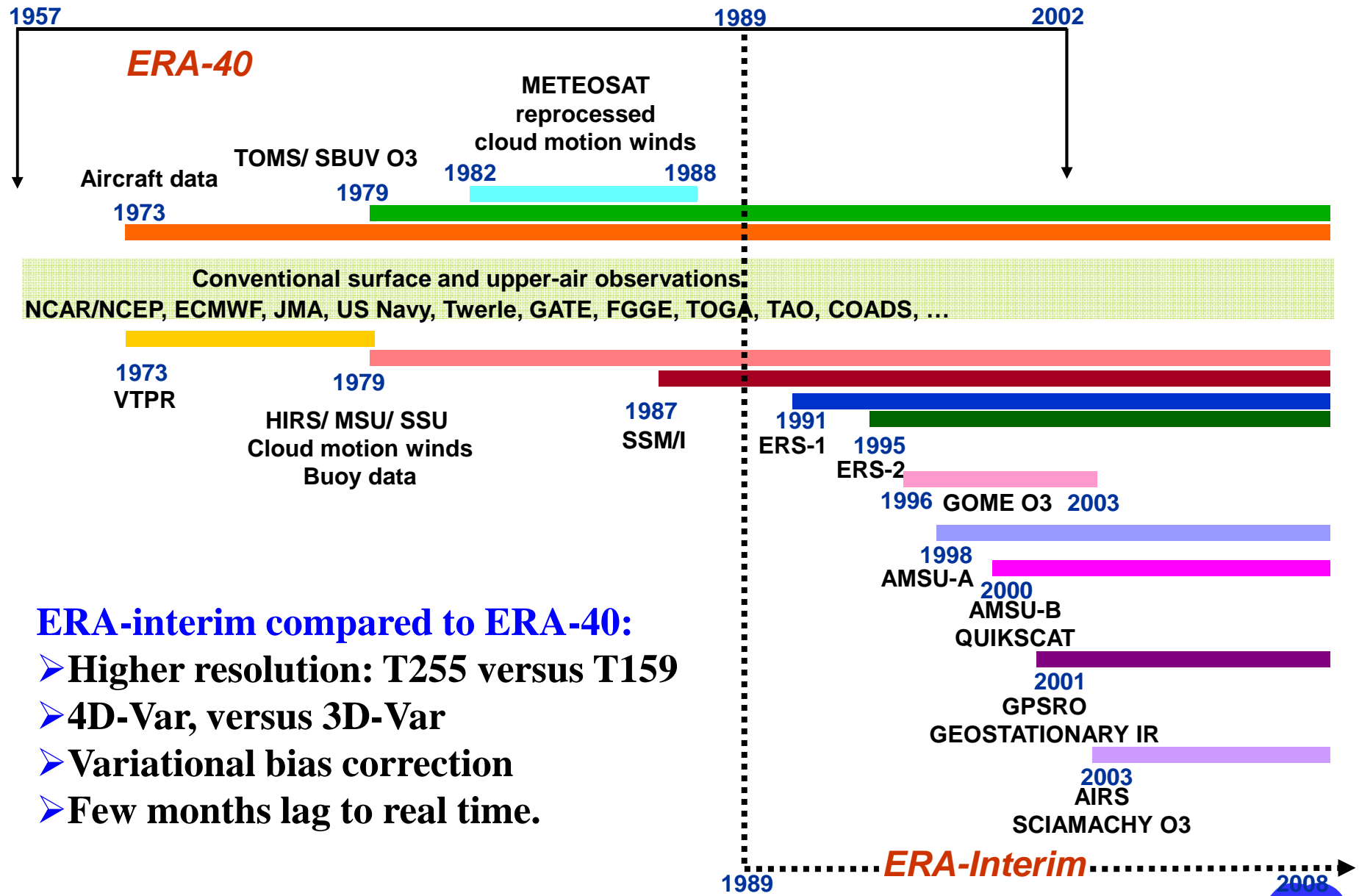
- Correct for bias in σ_0 , then apply CMOD5.4

- Re-make scatter plots

- Residual small wind-speed and WVC dependent speed correction



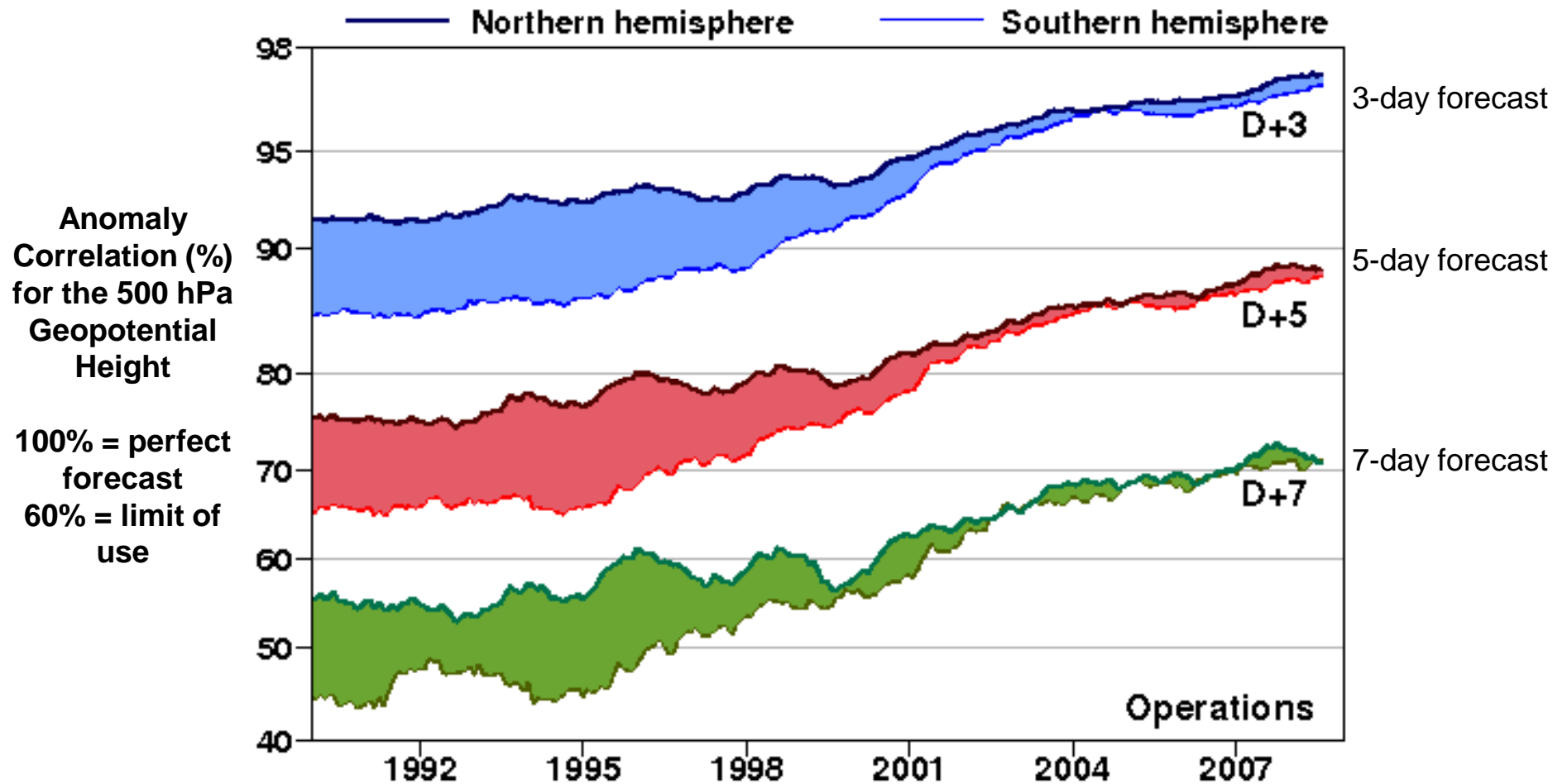
ERA-Interim reanalysis at ECMWF



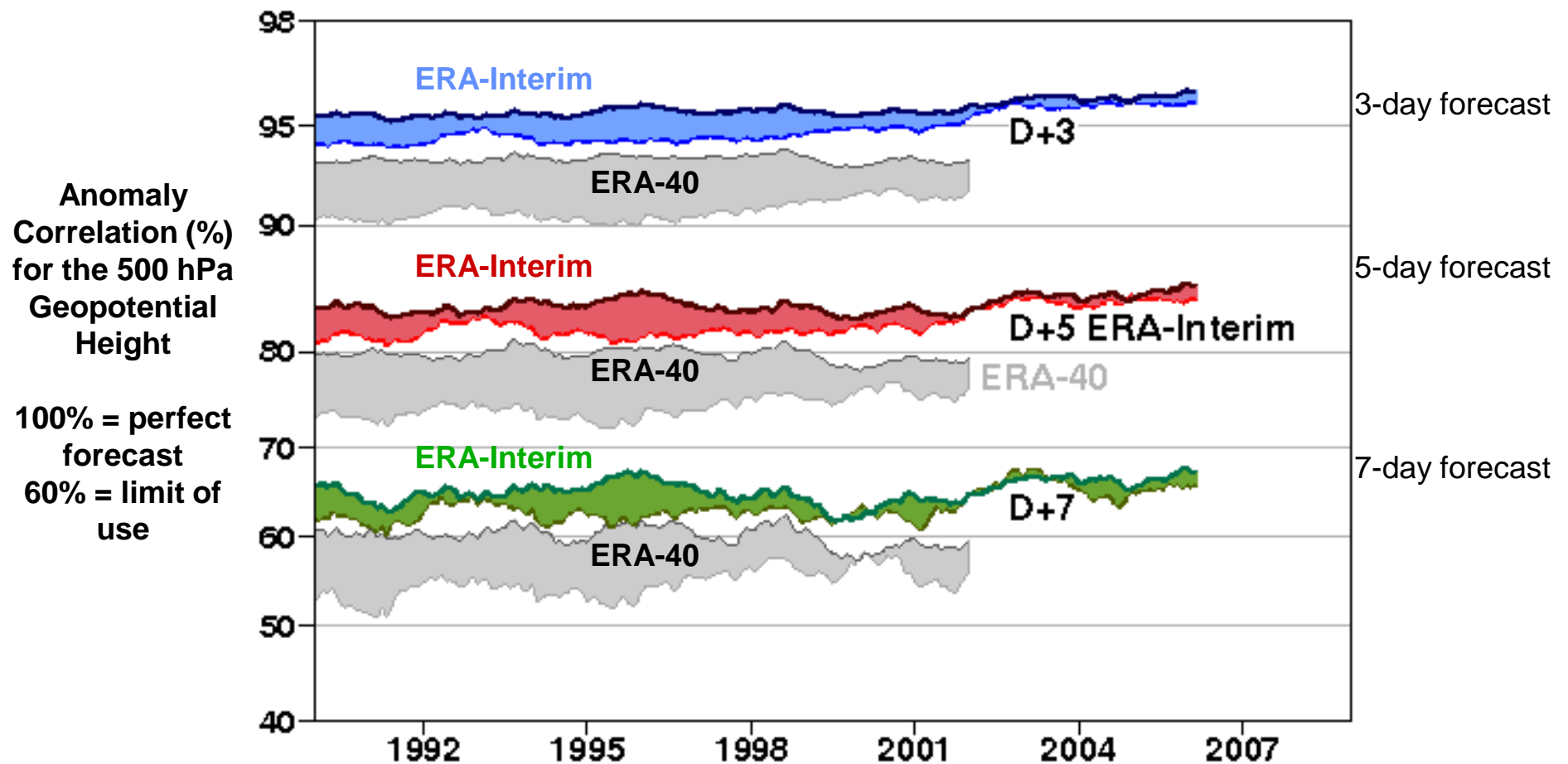
ERA-interim compared to ERA-40:

- Higher resolution: T255 versus T159
- 4D-Var, versus 3D-Var
- Variational bias correction
- Few months lag to real time.

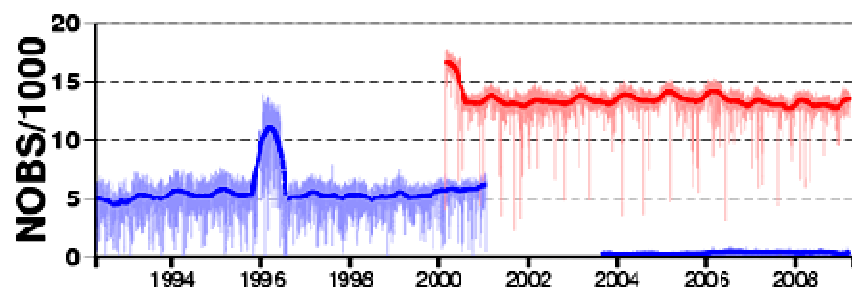
Operational Model Forecast Performance



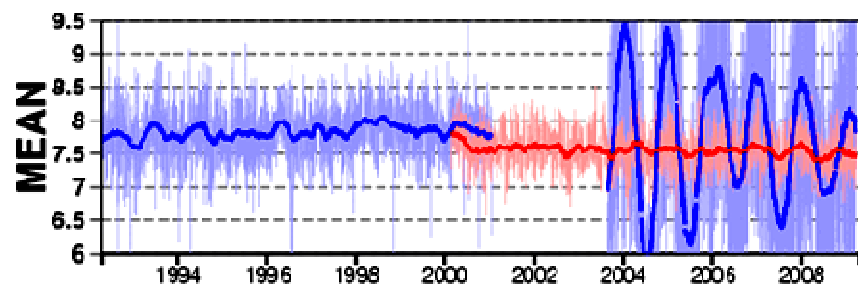
Reanalyses Forecast Performance



The usage of Scatterometer data in the ECMWF interim reanalysis

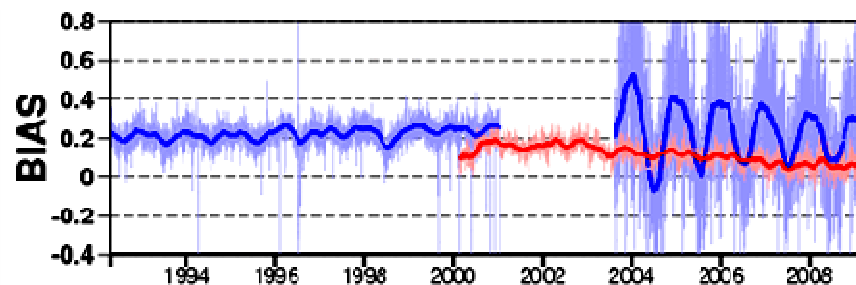


- **ERS1:** 15 Apr 1992, recalibrated
- **ERS2:** 22 Nov 1995, recalibrated
- **QSCAT:** 23 Feb 2000, non-neutral (-4%), $v > 17$ m/s
- **ASCAT:** None

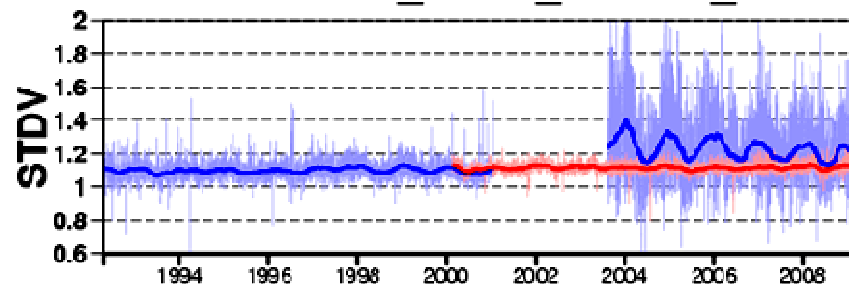


Differences ERS/QSCAT: Sampling, QC, tuning
Slightly increasing wind speed 1998?

ERA-interim biased low ~ 0.2 m/s
Gradually improves since 2003

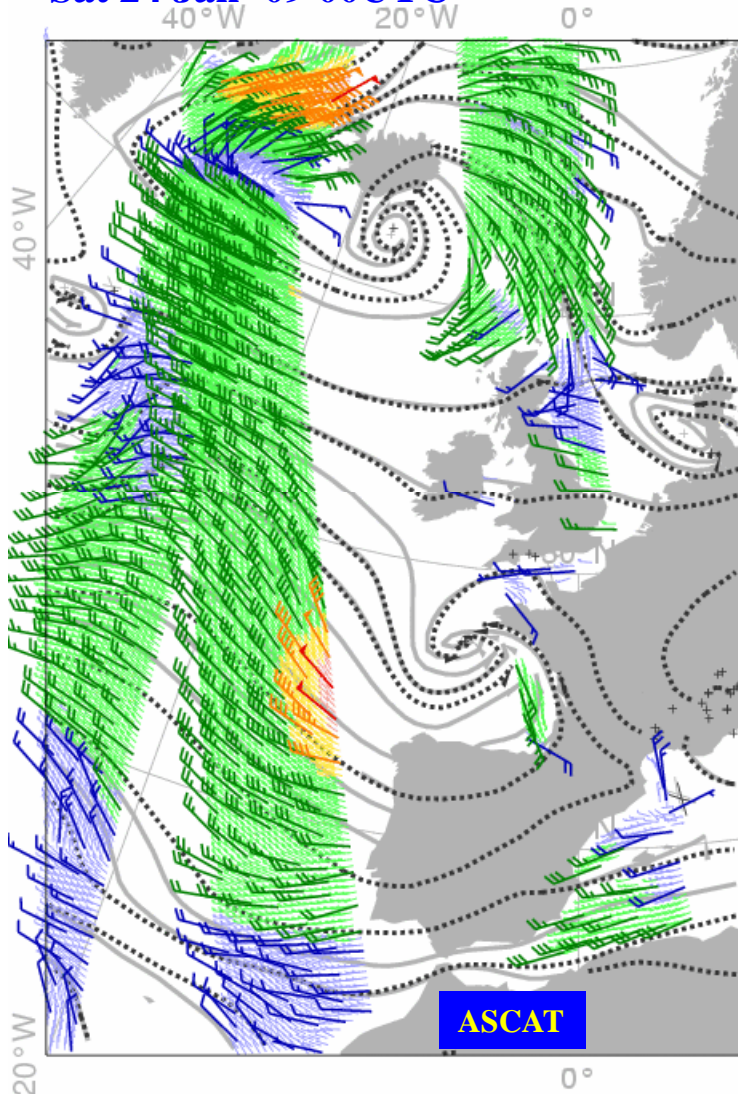


SCAT-U10m_V10m_GLOBE_o-a



Concluding remarks

Sat 24 Jan '09 00UTC



Scatterometer data from ERS-2, QuikSCAT and ASCAT are routinely assimilated:

- ✓ Operational model
- ✓ Interim reanalysis (ERS, QuikSCAT)
- ✓ ERS/ASCAT well inter-calibrated
- ✓ ESA ERS reprocessing underway
- ✓ ERS/QuikSCAT inter-calibration to be revisited

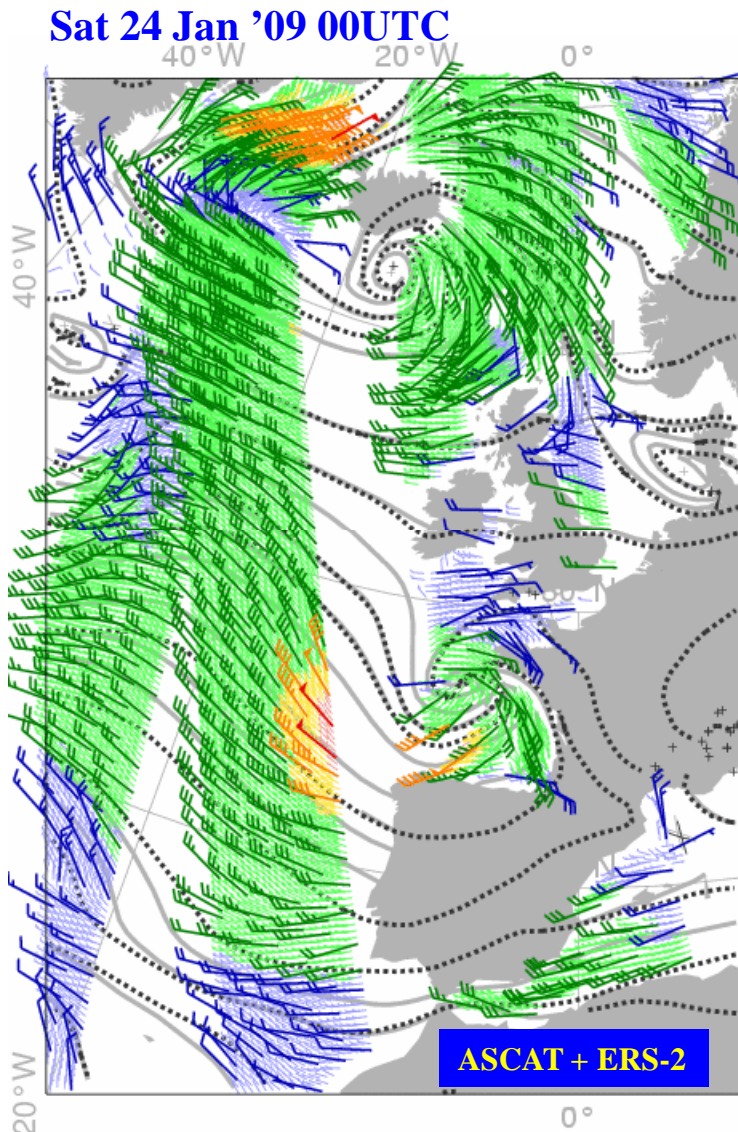
Pending operational changes

- ✓ ASCAT EARS has been assessed

Ongoing research

- ✓ Include option for ocean currents and neutral winds in **SCAT** observation operator (switch in current model cycle)

Summary/final remarks



Scatterometer data from ERS-2, QuikSCAT and ASCAT are routinely assimilated:

- ✓ Operational model
- ✓ Interim reanalysis (ERS, QuikSCAT)
- ✓ ERS/ASCAT well inter-calibrated
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- ✓ Include option for ocean currents and neutral winds in **SCAT** observation operator (switch in current model cycle)

ERS and ASCAT together fill in data gaps

BACK UP SLIDES

Re-calibration of the ERS archive

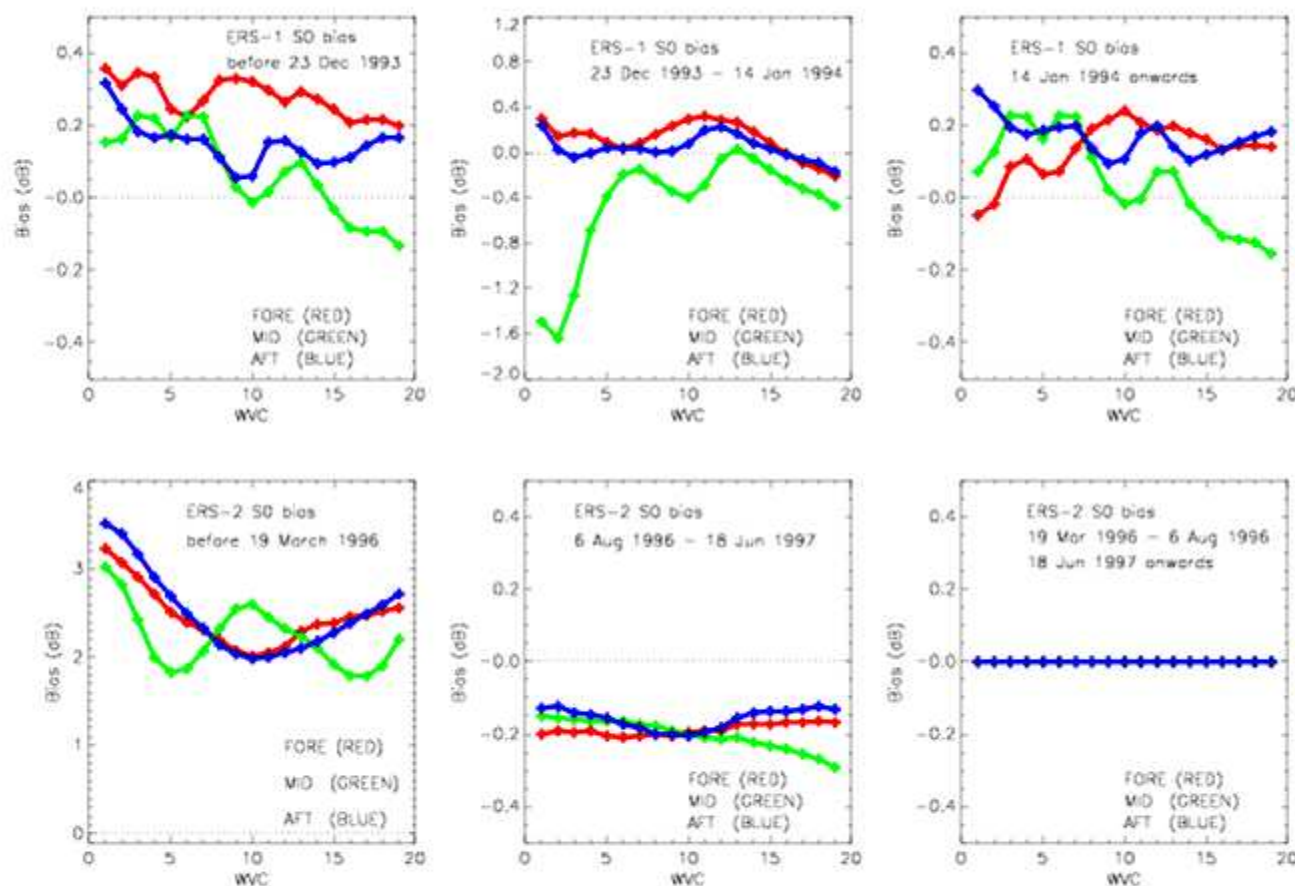


Figure 39: Biases observed in backscatter levels, based on ocean calibration for ERS-1 (top panels), respectively ERS-2 (lower panels) for the indicated periods, and relative to the nominal period for ERS-2 (lower right-hand panel). The vertical scale varies between the plots.

Usage of ocean current/neutral wind in the ECMWF assimilation system

Adaptation of the scatterometer cost function:

$$J_o^{\text{scatt}}(\vec{\mathbf{u}}^{\text{mod}}, \text{scatt}) = \frac{||\vec{\mathbf{u}}^{\text{mod}} - \vec{\mathbf{u}}^{\text{scatt}}||^2}{\sigma_0^2}$$

Here, $\vec{\mathbf{u}}^{\text{mod}}$ is the scatterometer observation operator.

It is determined from the wind $\vec{\mathbf{u}}_L$ at lowest model level z_L (Geleyn 1988):

$$\vec{\mathbf{u}}_{\text{rel}}(z_{\text{obs}}) = R\vec{\mathbf{u}}_{\text{rel}}(z_L),$$

where

$$R = R(z_{\text{obs}}/z_L, z_0, \text{stability}), \quad R = 1, \text{ for } z_{\text{obs}} = z_L.$$

Since now $\vec{\mathbf{u}}_L = \vec{\mathbf{u}}_{\text{abs}}(z_L)$, rather than $\vec{\mathbf{u}}_{\text{rel}}(z_L)$

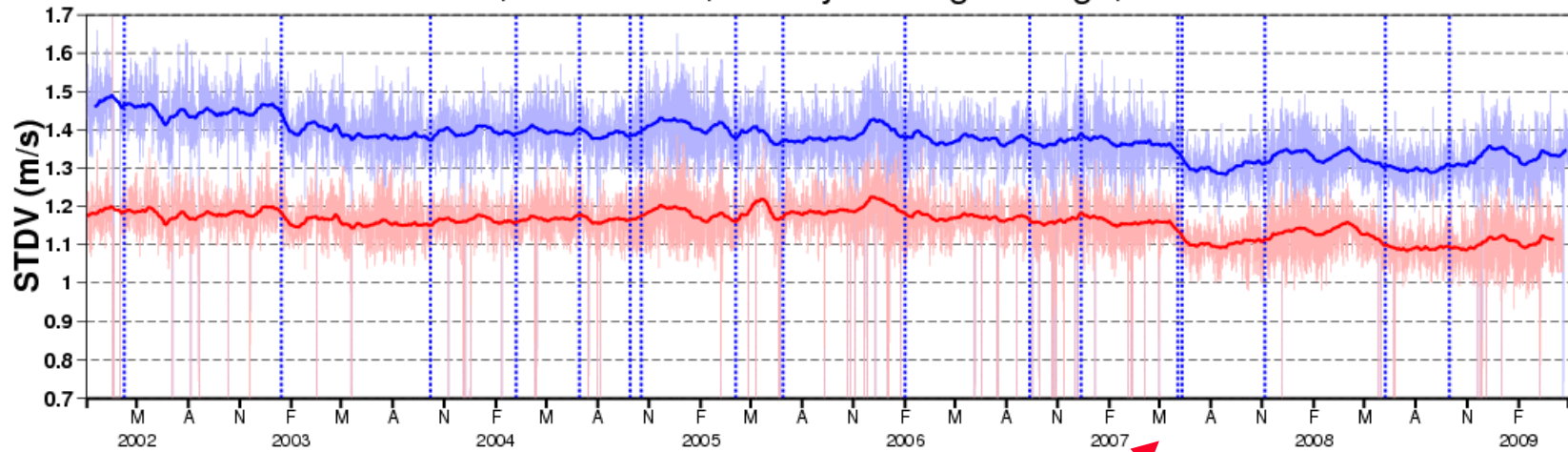
$$\begin{aligned} \text{scatterometer :} \quad \vec{\mathbf{u}}^{\text{mod}} &= \vec{\mathbf{u}}_{\text{rel}}(z_{\text{obs}}) = R (\vec{\mathbf{u}}_L - \vec{\mathbf{u}}_{\text{oc}}) \\ \text{buoy/ship :} \quad \vec{\mathbf{u}}^{\text{mod}} &= \vec{\mathbf{u}}_{\text{abs}}(z_{\text{obs}}) = R \vec{\mathbf{u}}_L + (1 - R) \vec{\mathbf{u}}_{\text{oc}} \end{aligned}$$

The usage of ASCAT data at ECMWF

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Impact of ASCAT and IASI on the ECMWF analysis system

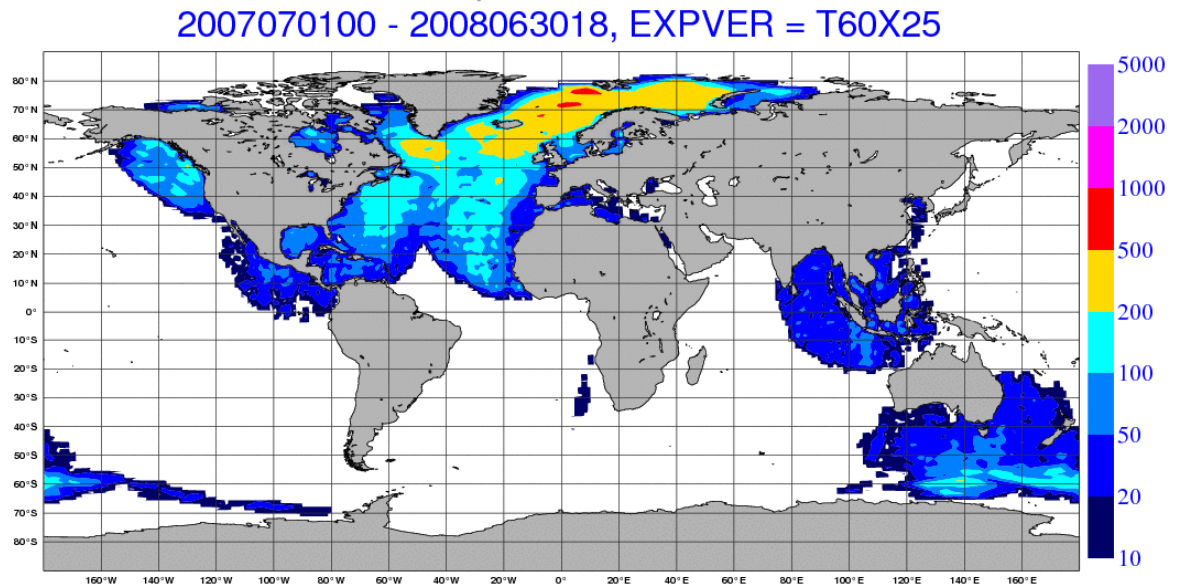
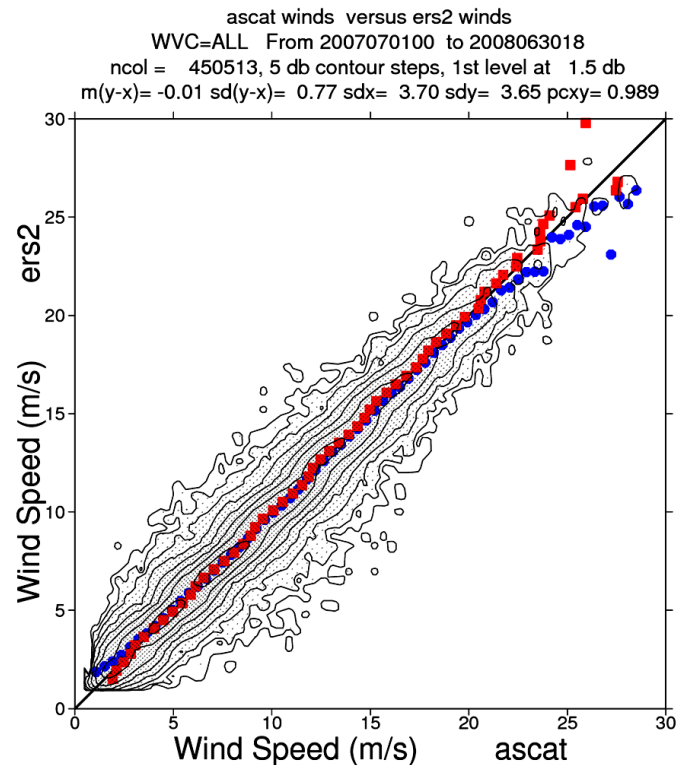
QuikSCAT (50km) versus ECMWF FGAT (BLUE) and Analysis (RED)
WIND SPEED, nodes 5-34, 30-day moving average, AREA= GLOB



- Vector wind from ASCAT and radiances from IASI were introduced on 12 June 2007.
- A positive effect on the quality of ECMWF winds emerged from a comparison with (already active) QuikSCAT data

Collocation of ERS-2 and ASCAT

(for one year, $\Delta t < 60$ min, $\Delta x < 25$ km)



- Both ASCAT and ERS-2 data are bias-corrected at ECMWF
- Both inter-compare very well: no bias, very low scatter