The impact of the ocean currents in the ASCAT observation operator in a coupled DA configuration

(study done in 2023/2024!!!)

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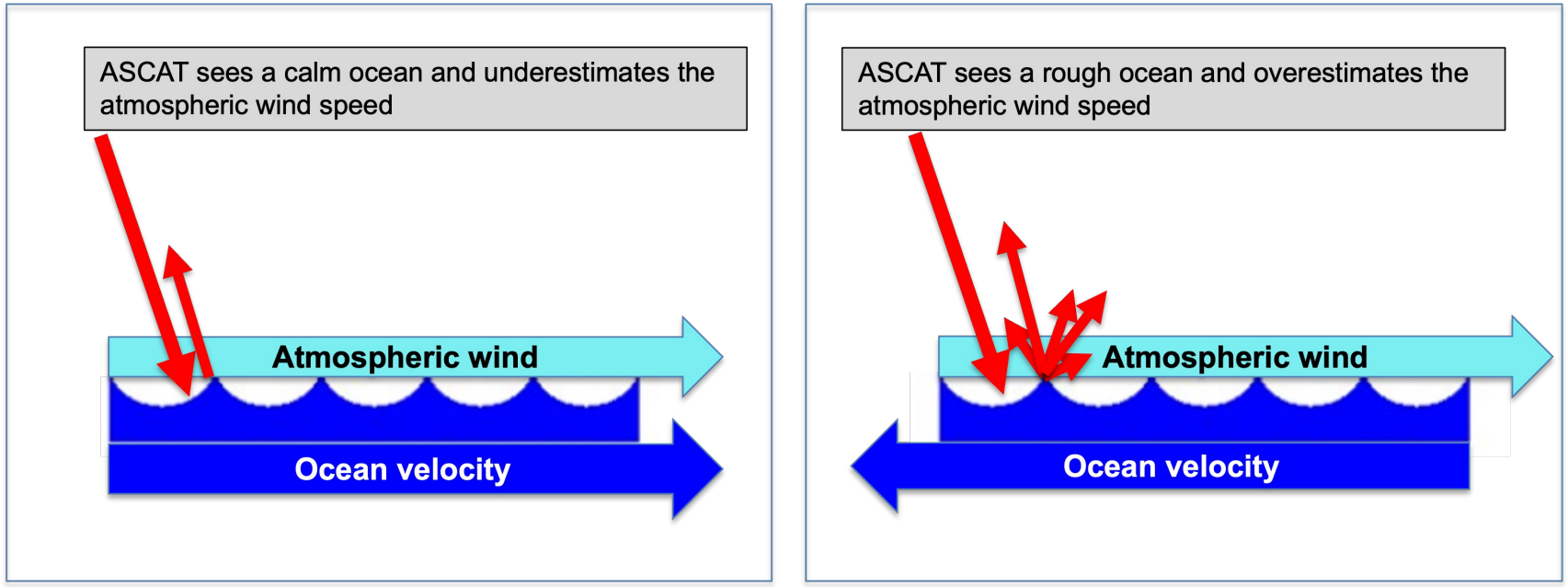
Scatterometer and Ocean Currents



- The scatterometer ”sees” the ocean currents
- In our system, the scatterometer observations operator *DOES NOT (*) account* for them but…
- This *will (*)* happen in ERA6

(*) back in 2023!

Scatterometer and Ocean Currents

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.

scatterometer : $\vec{\mathbf{u}}^{\text{mod}} = \vec{\mathbf{u}}_{\text{rel}}(z_{\text{obs}}) = R\,(\vec{\mathbf{u}}_{\mathbf{L}} -$ 

Model Space

Input NWP model variables

Observation Operator (H)

U10n/V10n_Mod **[abs]**

Innovation (O-B)

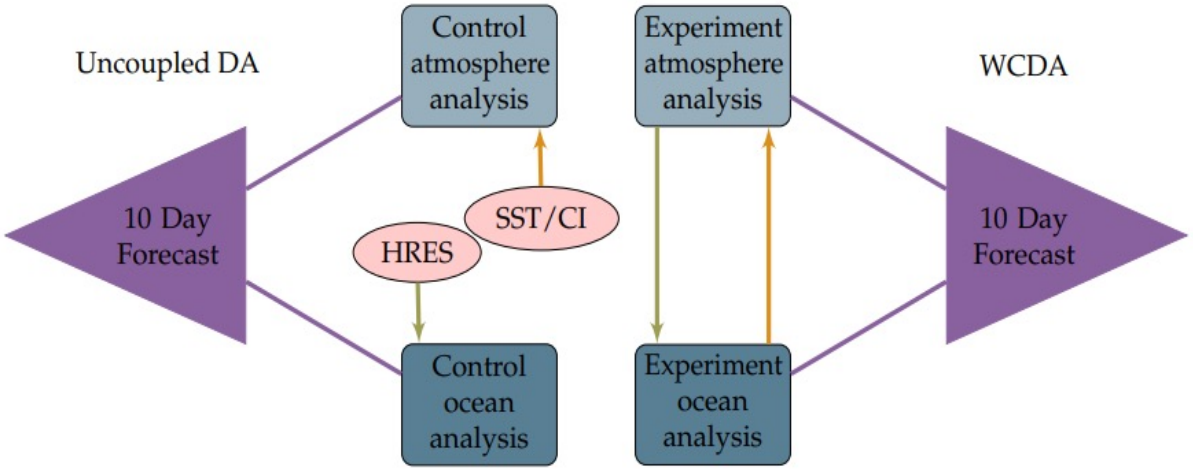
U10n/V10n_ASCAT [R] **– U10n/V10n_Mod**

Observation space

ASCAT U10n/V10n [Rel]

Weakly coupled data assimilation

Weakly Coupled Data Assimilation: allows components of the Earth system to be linked together.
The dynamical models of the ocean and sea ice can fill the gaps in observations and propagate fields to the appropriate time.
Thanks to the coupled forecast, the observational information gets propagated to the background used for subsequent analysis: there is a lag by which observations can influence different components

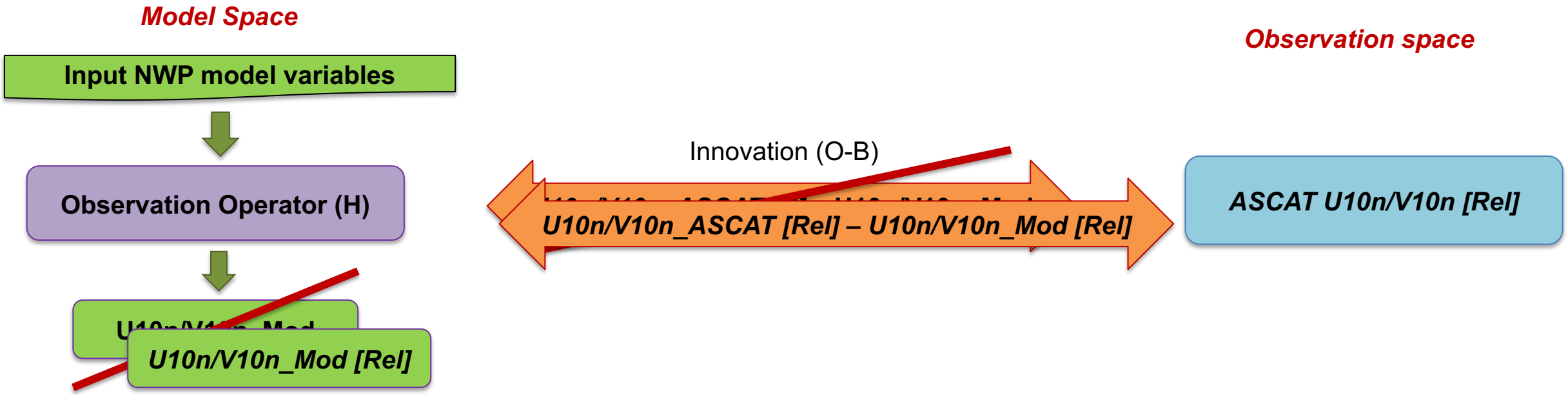


Ocean currents in couple DA:

The usage of the ocean currents in ~~the research mode version of~~ the WCDA system is activated through a switch. When the currents are available, they:

1) are used in the scatterometer observation operator to correct the wind components
2) change the surface boundary condition, so that the drag is different as winds flow over a moving surface rather than static
3) enter the wave model, causing waves to diffract/be guided by the surface currents

Scatterometer and Ocean Currents



To disentangle the impact of the ocean coupling on SCATT only ➔

Impact experiments (Dec ’21 – Feb ‘22) in ERA6-like (!!!) configuration (**using a prototype version of ERA6)**

- ***Partial OC coupling*** *(ocean currents used everywhere but not in the SCAT observation operator)*
- ***Full OC coupling*** *(ocean currents used everywhere)*

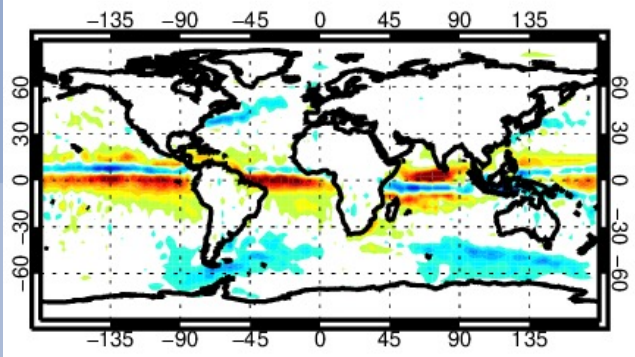
Impact of ocean currents in the scatterometer assimilation

Mean changes to U and V fields (An and 12 hour fc)

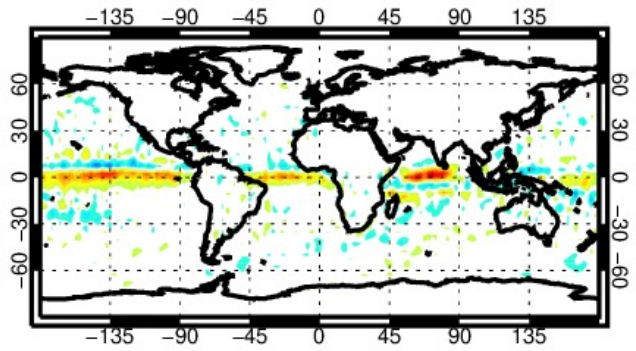
Partial OC coupling - Full OC Coupling

U

T+0; 1000hPa

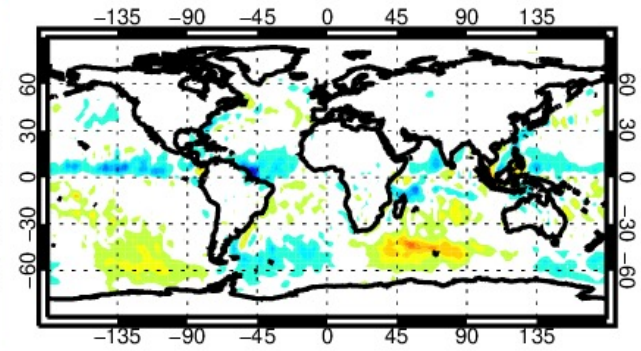


T+12; 1000hPa

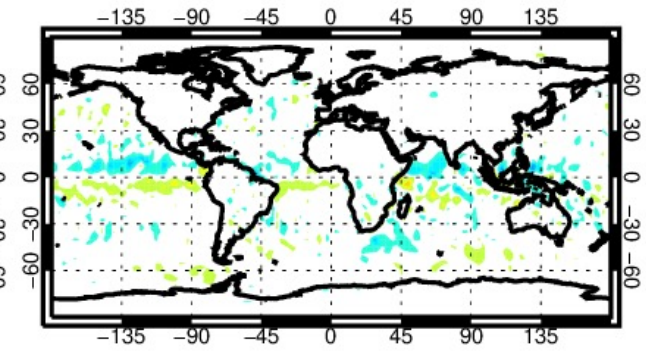


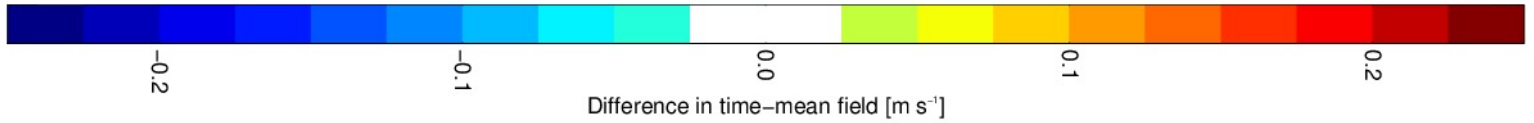
V

T+0; 1000hPa



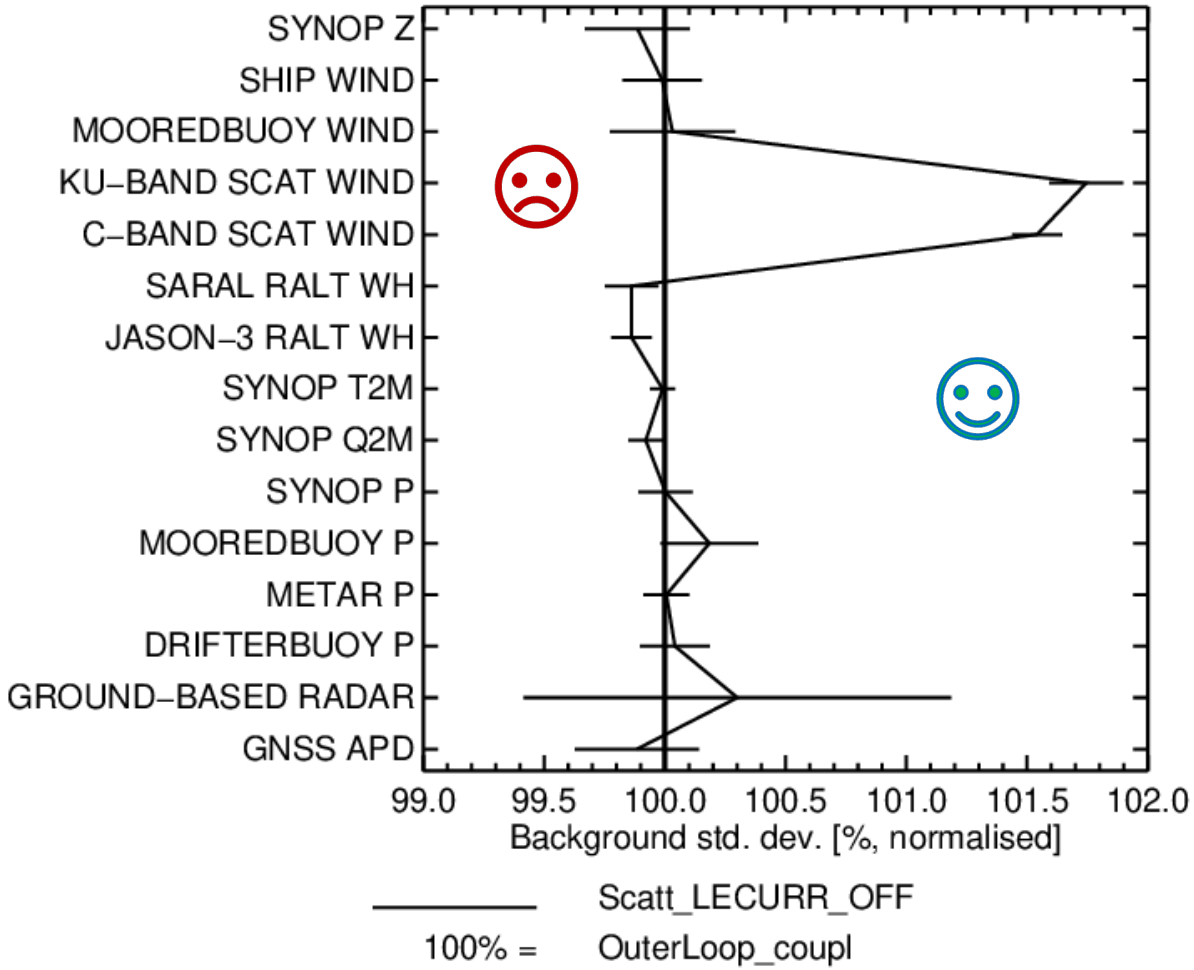
T+12; 1000hPa





Impact of ocean currents in the scatterometer assimilation

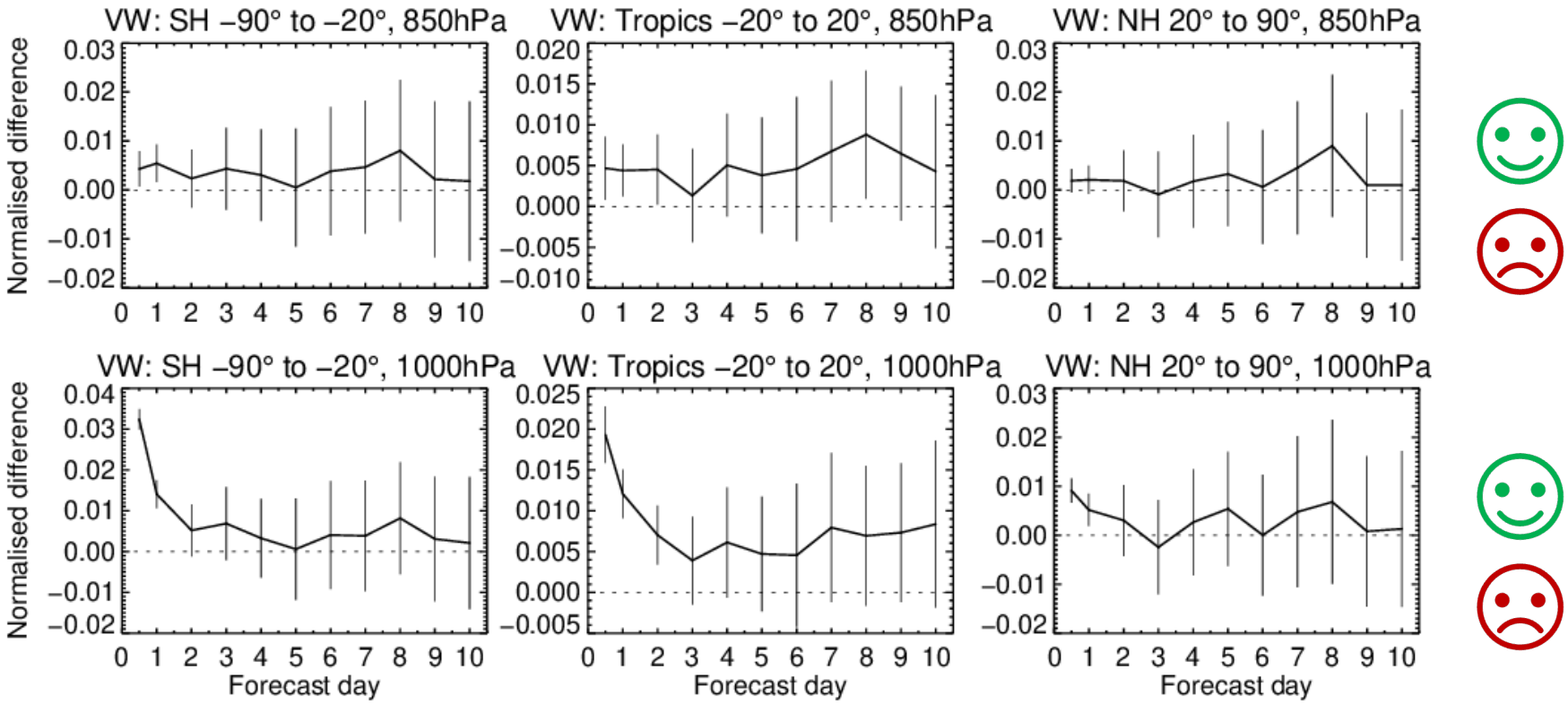
Changes in short-range fc departure stats
Surface observations
Normalized SD (%) to FULL Ocean currents COUPLING



Impact of ocean currents in the scatterometer assimilation

Changes in vector winds RMS forecast error (verified versus own analysis)

Partial OC Coupling - Full OC Coupling

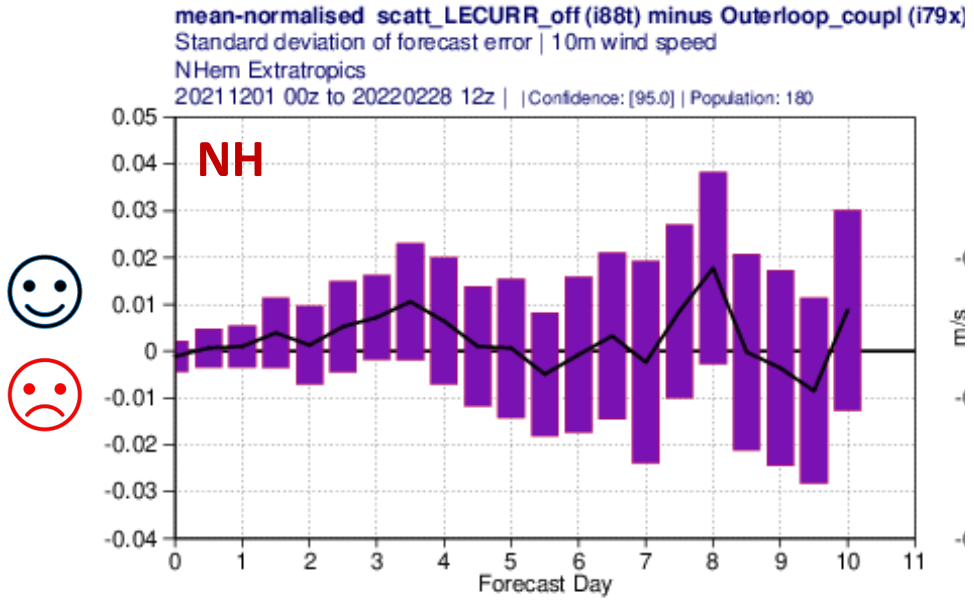


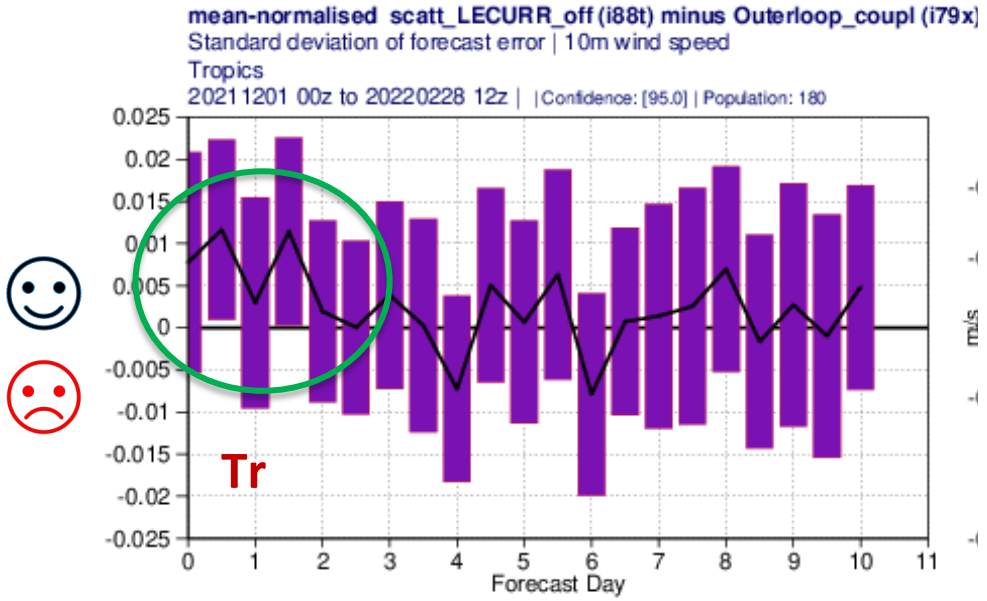
☺ = coupling beneficial

☹ = coupling not beneficial

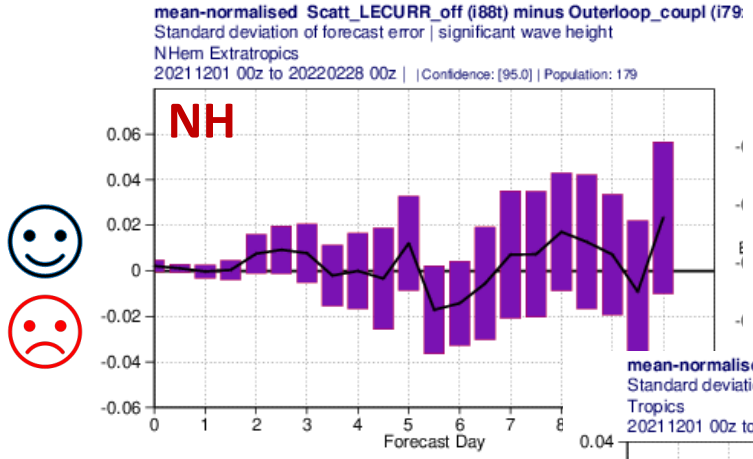
Partial OC coupling vs Full OC coupling: Verification vs buoy data

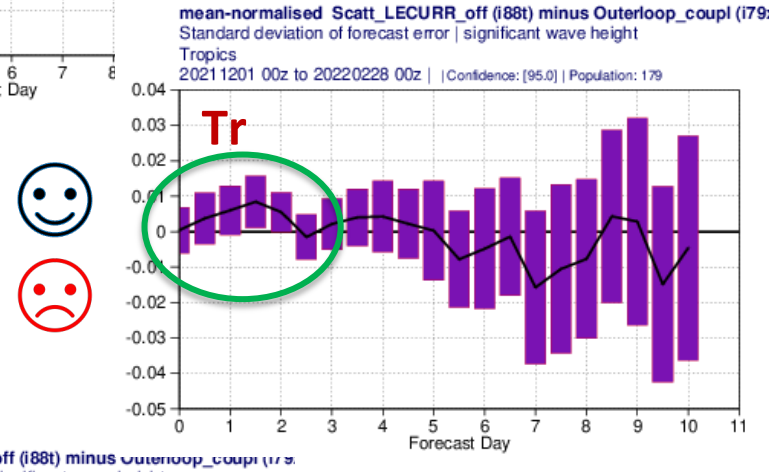
10m wind speed

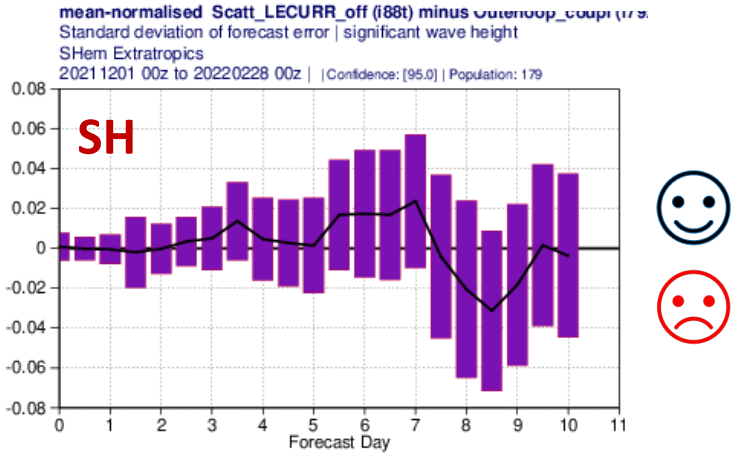




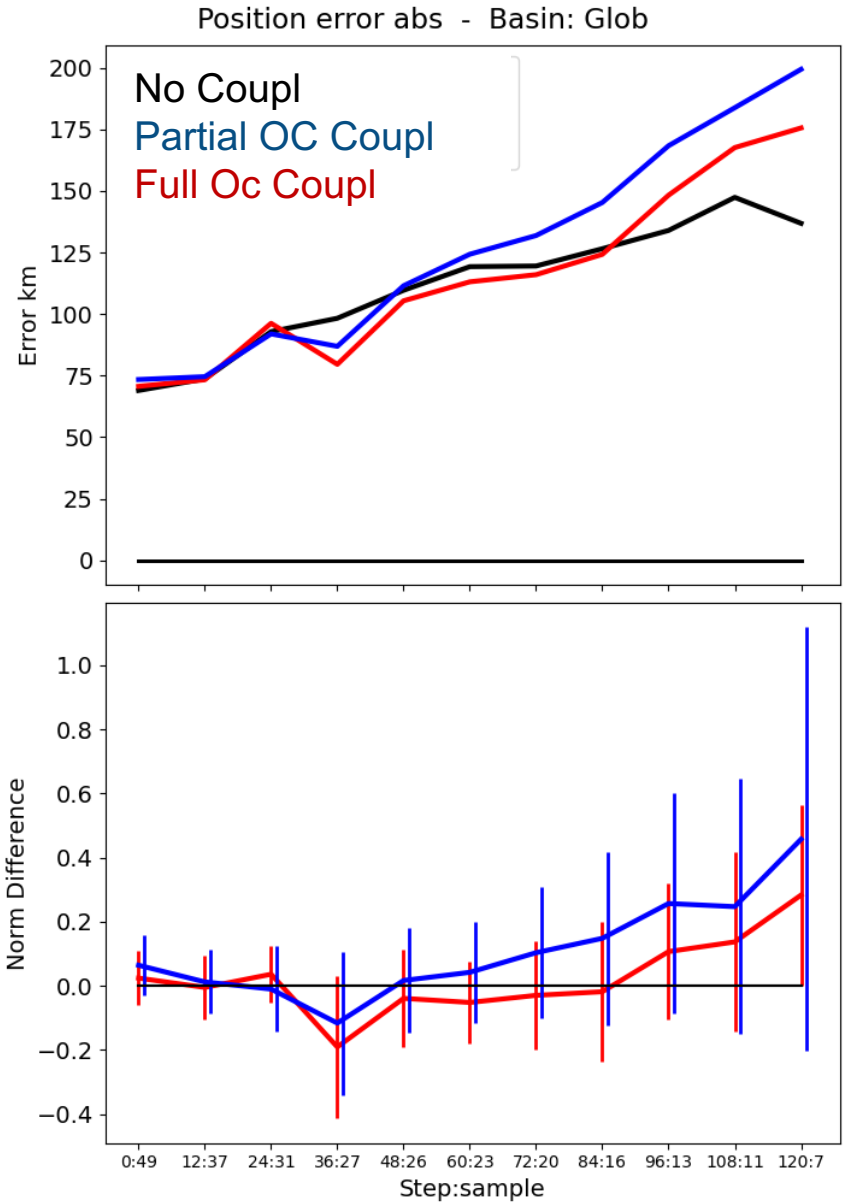
SWH

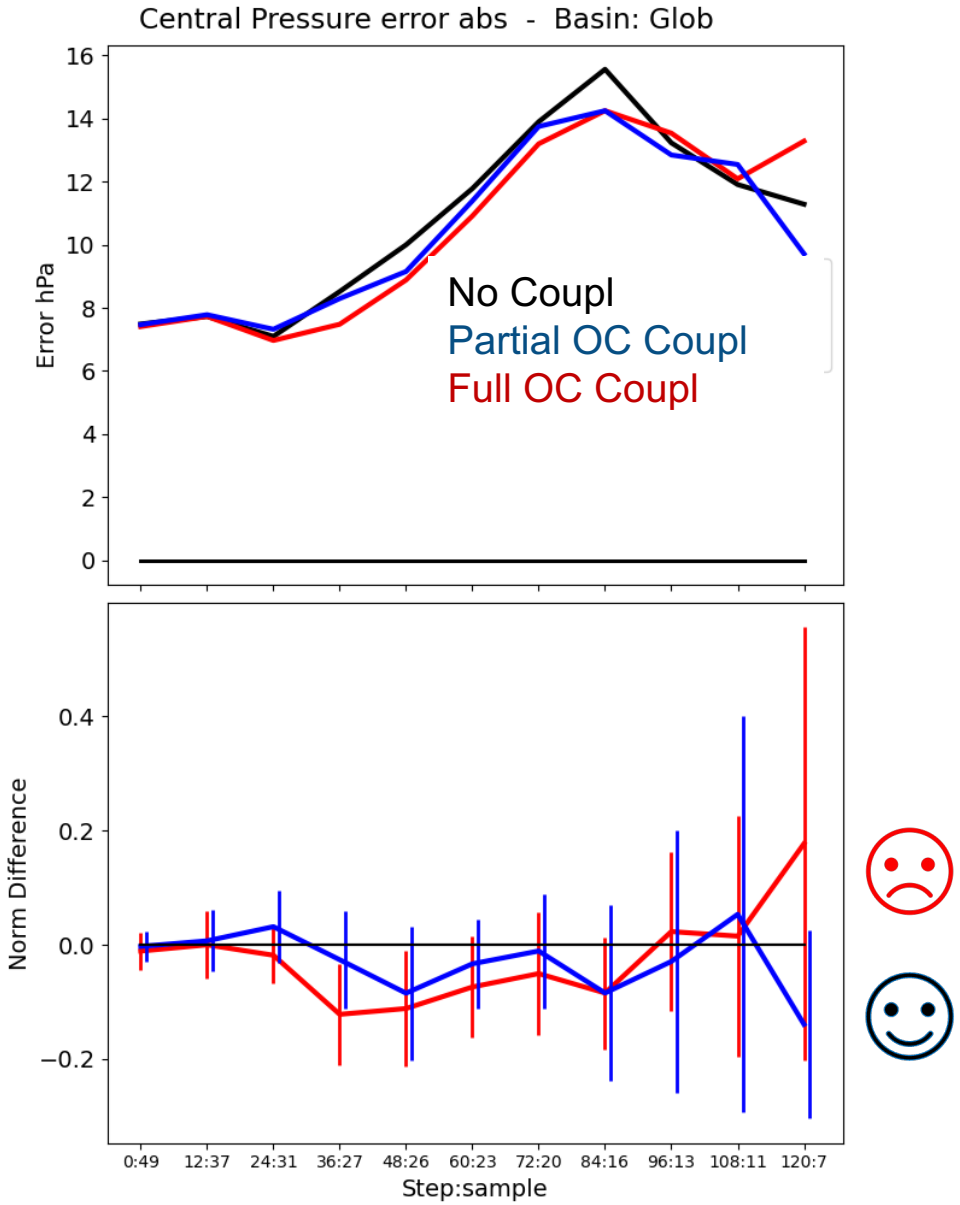




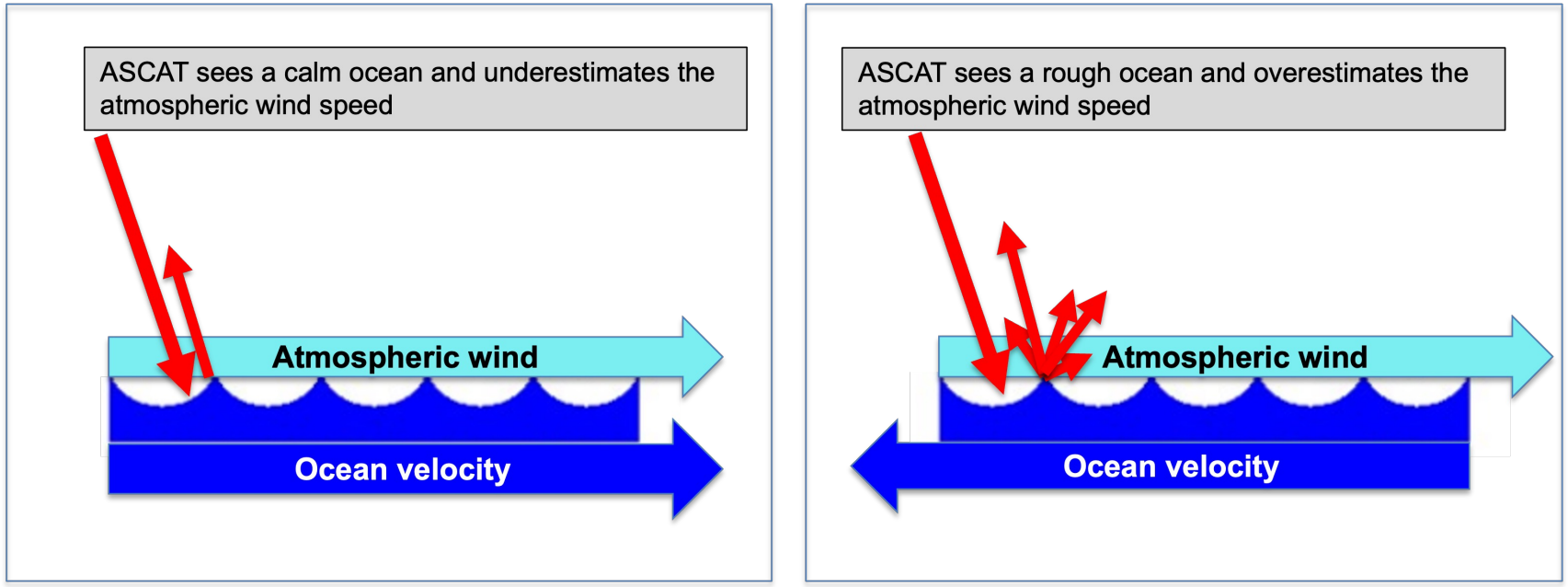


Partial OC coupling vs Full OC coupling: Impact on TC (on a different period!)





Scatterometer and Ocean Currents



- The scatterometer ”sees” the ocean currents
- In operations, the scatterometer observations operator *DOES (*) account* for them but…
- This *IS* happening now in ERA6 (first release potentially fall 2027)
- *I will repeat the test in the CURRENT operational model configuration*

(*) Since 12th May 2026!