

Scatterometer Assimilation Experiments with HARMONIE-AROME Mesoscale Model over the Iberian Peninsula

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Thanks to:

Eoin Whelan

Daniel Santos

Jana Sánchez Arriola

Wenming Lin

- Objectives and motivation.
- Observing System Experiments (OSE) with mesoscale HARMONIE-AROME model.
- Results.
- Conclusions and future work.

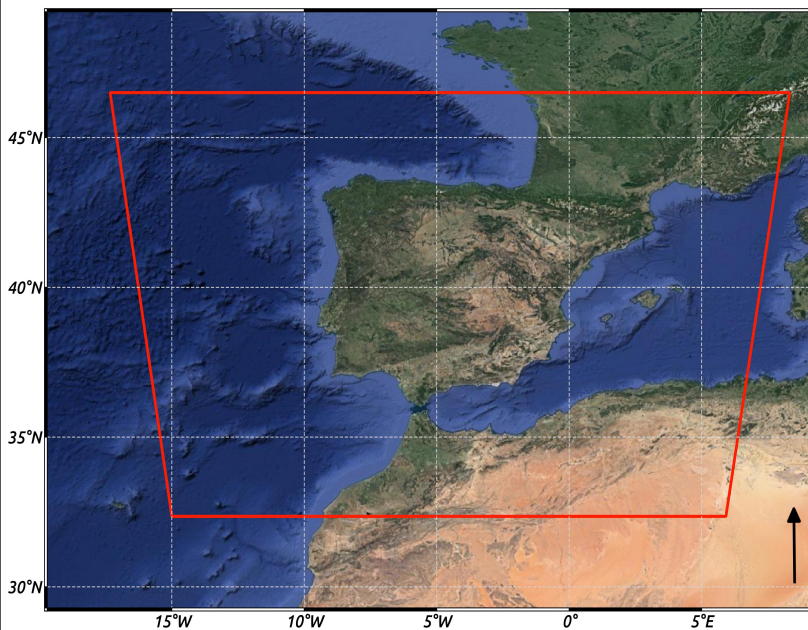
- **Mesoscale Models explicitly resolve** convective **processes which evolve quicker and in smaller scales** than processes resolved by **global models**.
- **Mesoscale Data Assimilation** is expected to provide **initial conditions for km-scale forecasts on the short range** (few hours to 1-day).
- To **initialize these phenomena deterministically** and correct positioning these rapidly evolving weather systems a **high density observation network is required**
- For a **domain over the Iberian Peninsula** a large number of observations are required over the Atlantic => **ocean winds from Scatterometers**

Can scatterometer winds be used for an improved estimate of the model initial state ?

Assess the impact of ASCAT DA

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Domain IBERIAxxm_2.5

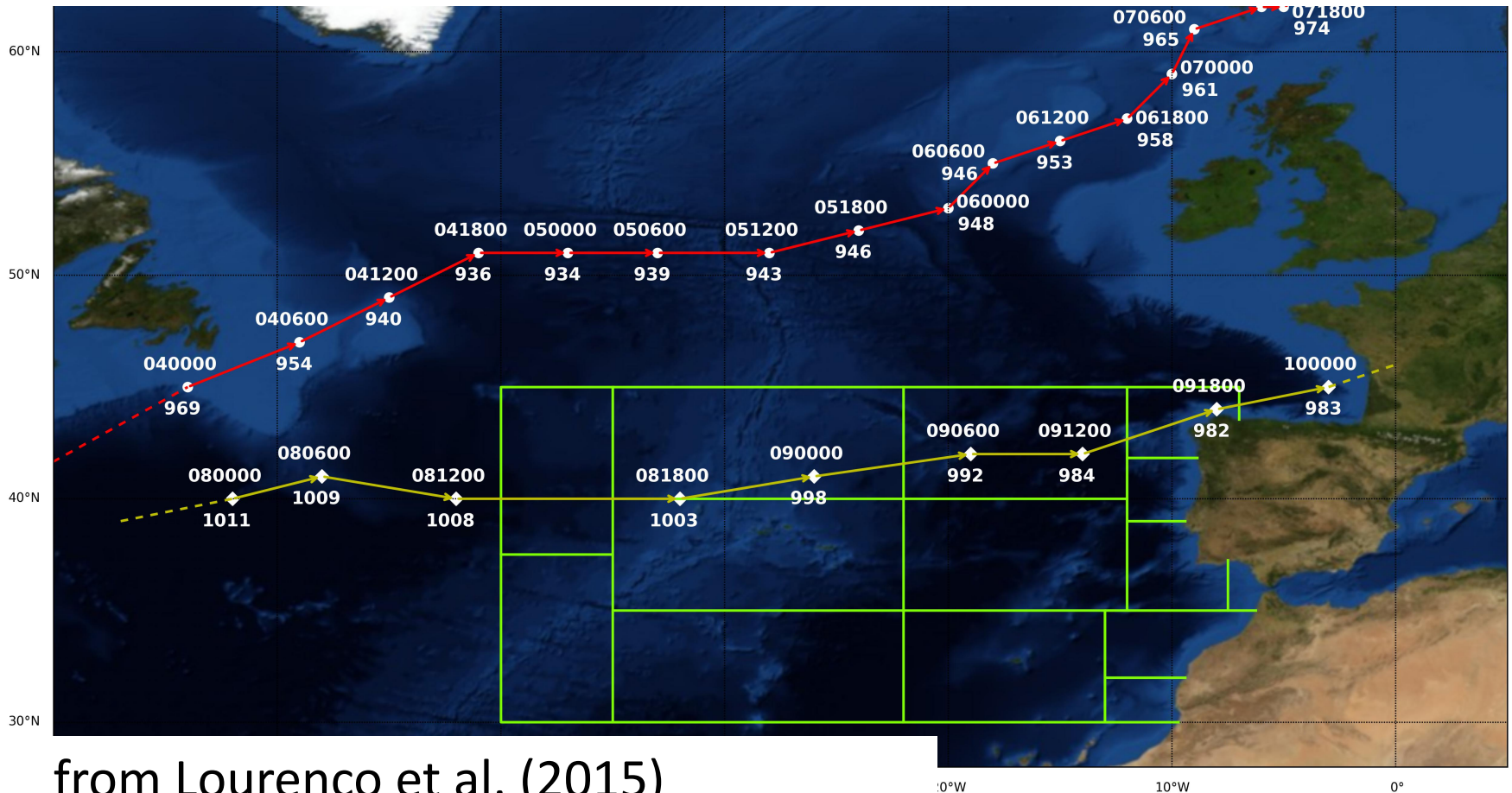


HARMONIE -AROME- Cy40h1.1

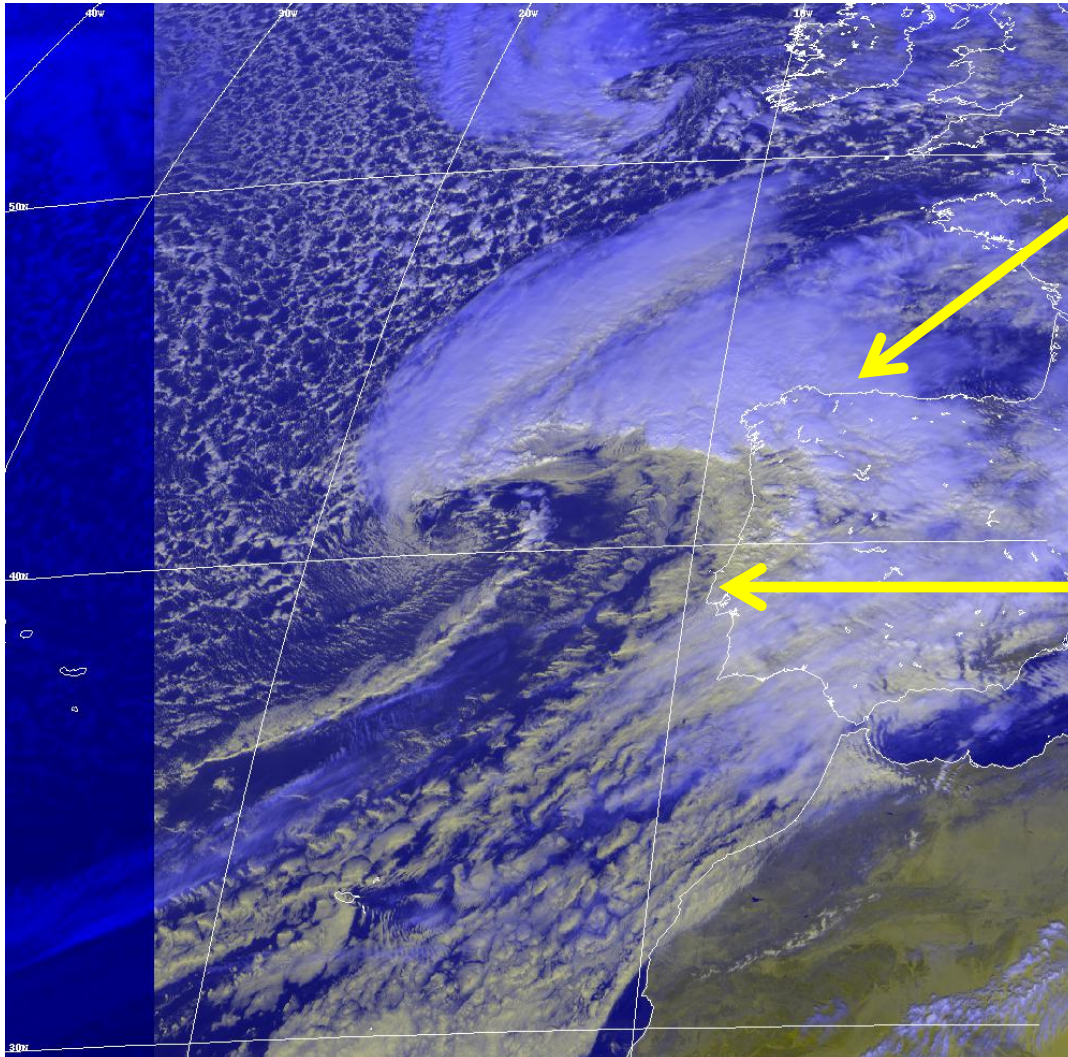
- Non-Hydrostatic.
- 800 (lon) X 648 (lat) grid
- 65 levels.
- 2.5 km grid spacing
- time step 60s
- 24-h fcst
- 3D-Var, Assimilation 8 times/day
- ECMWF boundaries



Experimentation period 6 to 11 Feb 2014 period during stormy 2013-2014 winter. Including “Stephanie storm” (9-10 Feb).



from Lourenço et al. (2015)



waves:

Estaca Bares

SWH: 12m ,

peak period: 14.3 s

Max wave height: 20 m

(8 Feb 1700 UTC)

wind:

Cape Roca

wind speed: 27 m/s

(09 Feb 1900 to 2000UTC)

wind gust 37 m/s

(09 Feb 2020 UTC)

HRV Cloud RGB 09-02-2014 at 1200UTC

Assess the impact of ASCAT DA

Verification over the ocean against independent observations:

- **HSCAT** Chinese Ku-band scatterometer on-board Haiyang-2A
sun-syn ~**0600/1800 UTC**
@25 km sampling and **50 km effective resolution**
 - **OSCAT** Indian Ku-band scatterometer on-board OceanSat-2
sun-syn ~**0000/1200 UTC**
@50 km sampling and **100 km effective resolution**
- Sampling ≠ Resolution**
- **ASCAT-coastal** @12.5 km sampling -> **28 km effective resolution**
 - **HARMONIE** @2.5 km grid -> **15-25 km effective resolution**
(7-10 times the grid resolution, Skamarock, 2004)

To assess the impact of ASCAT DA

1) Control - Conventional observations:

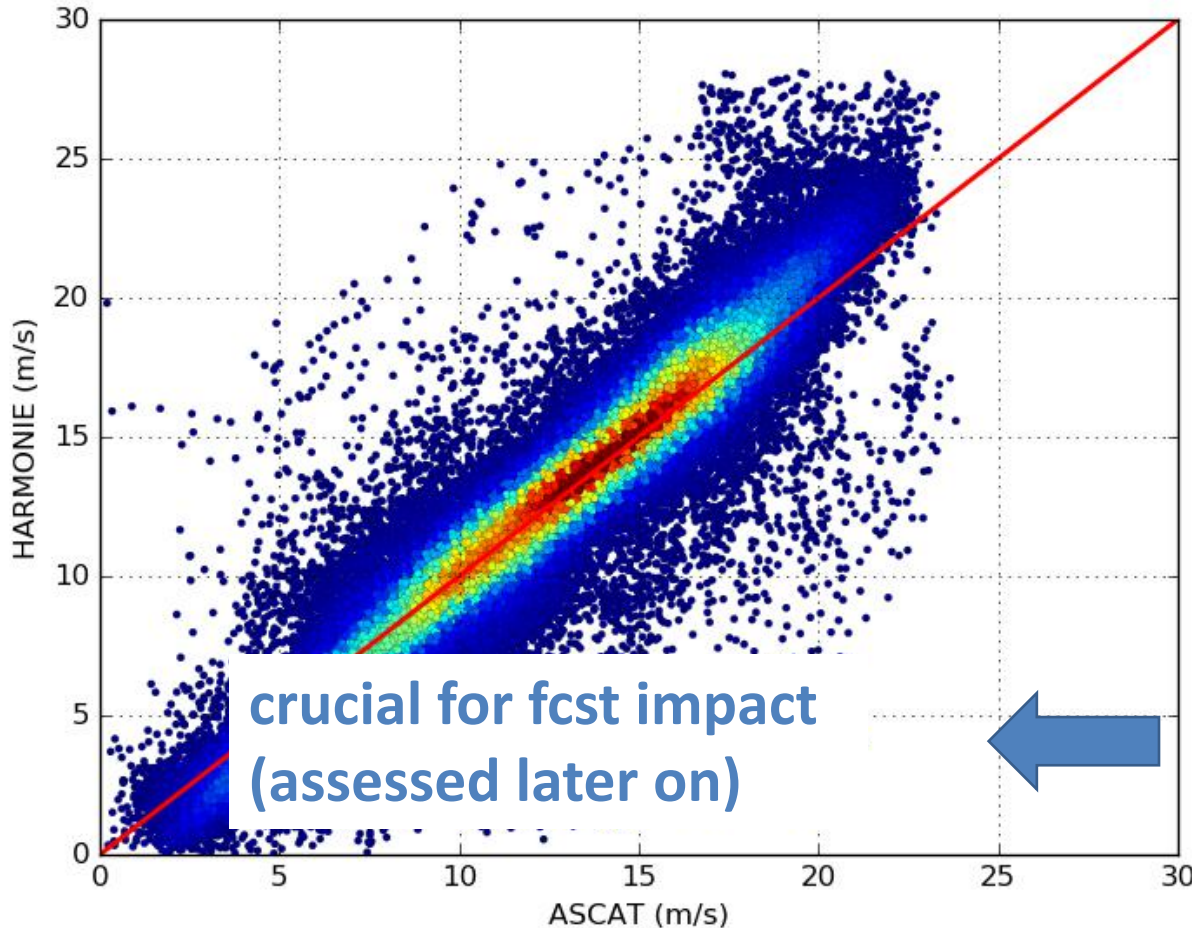
surface observations: synoptic stations, ships, and drifting buoys.

upper air observations: radiosondes and aircraft reports.

2) **Conventional + ASCAT-coastal** default Harmonie thinning inherit from Météo France and ECMWF settings (100 km).

3) **Conventional + ASCAT-coastal no thinning** ASCAT-coastal in the original grid spacing (12.5 km).

How confident are we in the model?



(CONTROL experiment)

Still **some bias for strong winds.**

Nevertheless, as already pointed out by other authors (Marseille and Stoffelen, 2017; De Rooy et al., 2017).

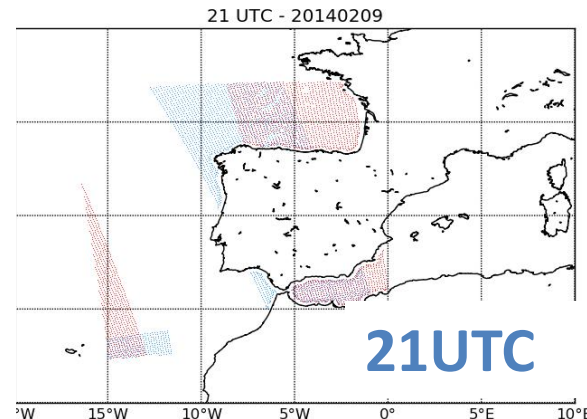
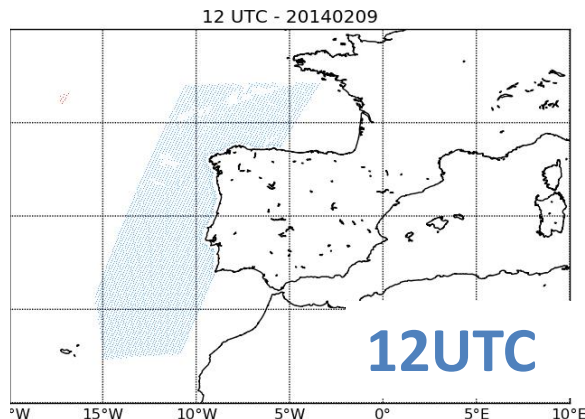
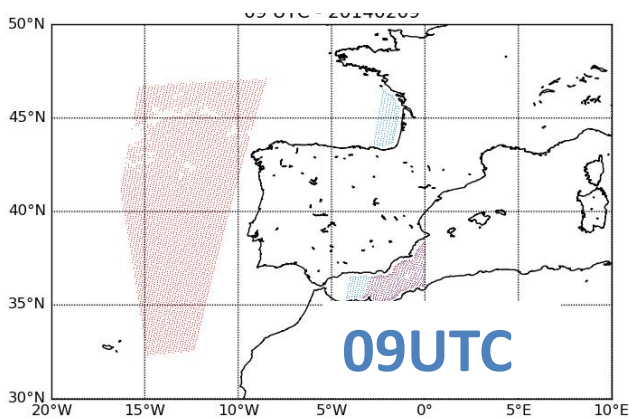
➤ **HARATUUP** (cy40) **reduces bias and spread** relative to previous model versions.



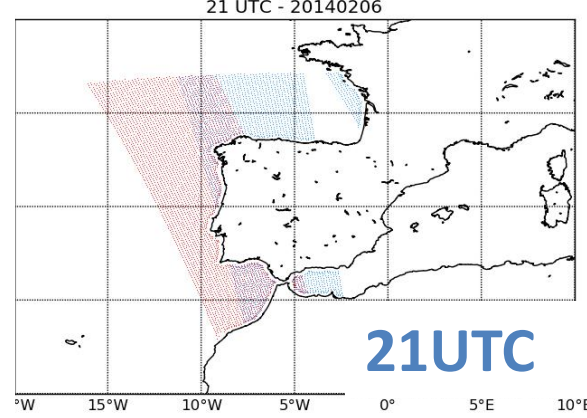
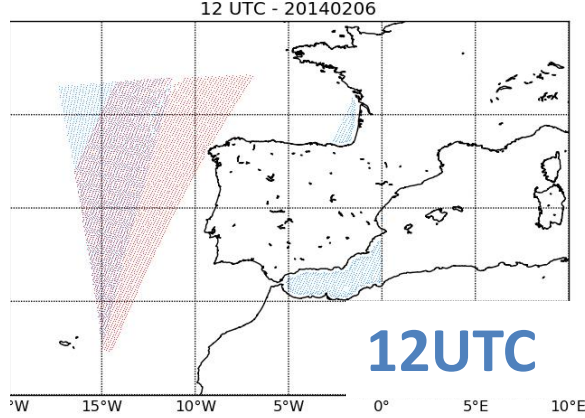
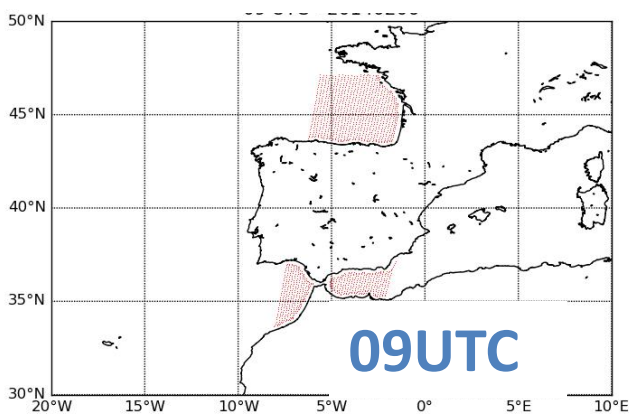
ASCAT-A/B coverage at analysis time

Netherlands
Meteorological Institute
Ministry of Infrastructure and the
Environment

09-02-2014



06-02-2014

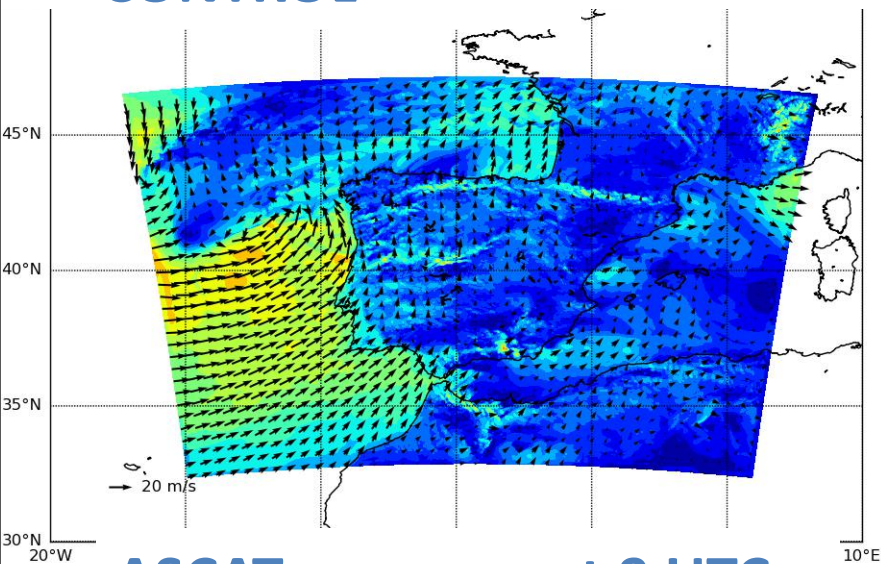


Blue - ASCAT-A

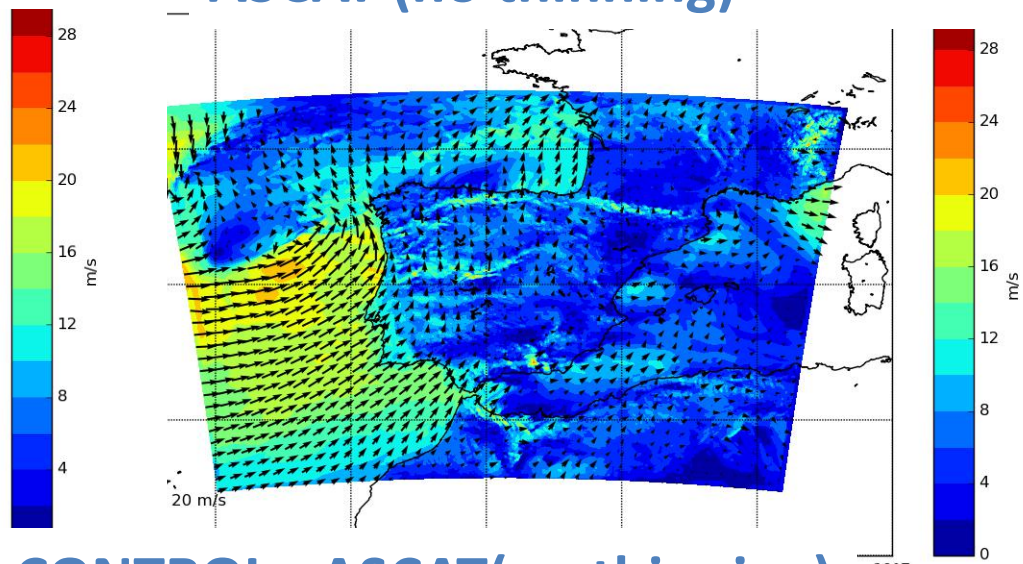
Red - ASCAT-B

20140209 H09+fc03

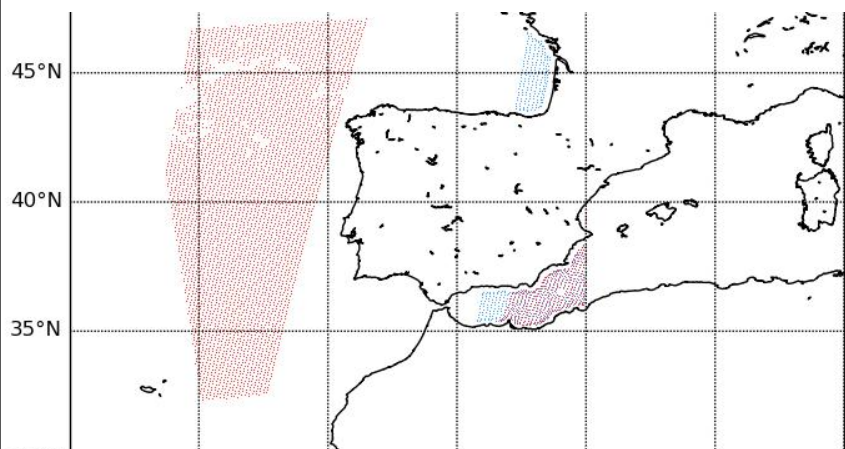
CONTROL



ASCAT (no thinning)



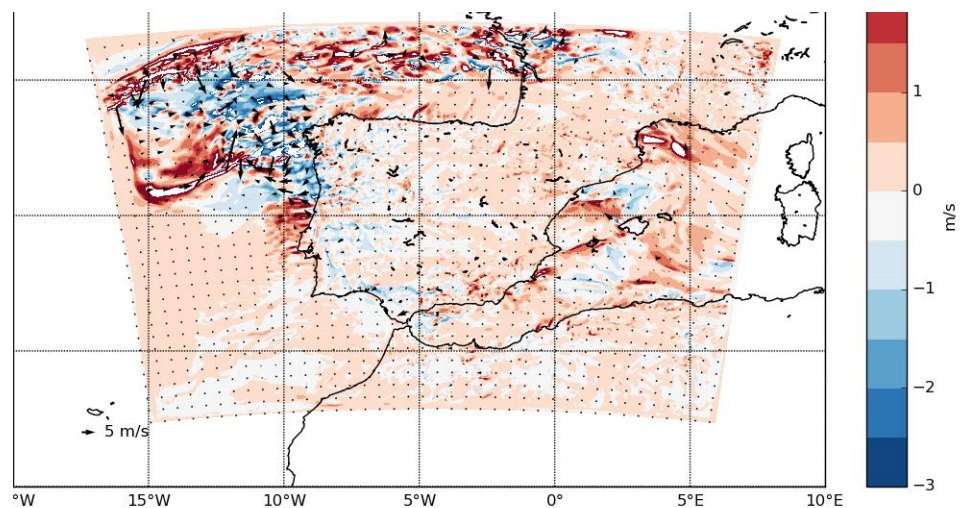
ASCAT coverage at 9 UTC



Blue - ASCAT-A

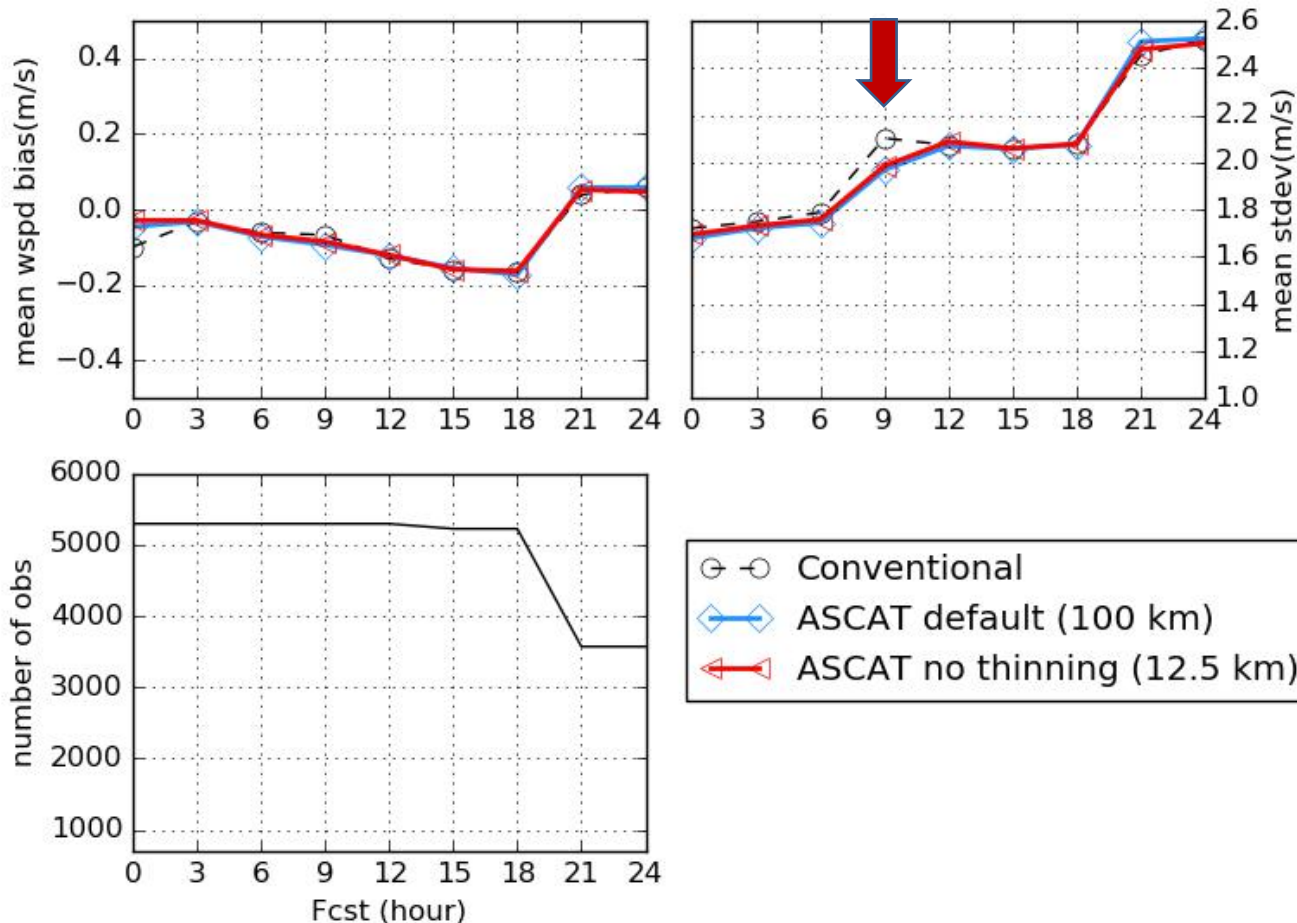
Red - ASCAT-B

CONTROL - ASCAT(no thinning)



Impact on forecasts over the ocean

10 m wind spd verified against HSCAT+OSCAT



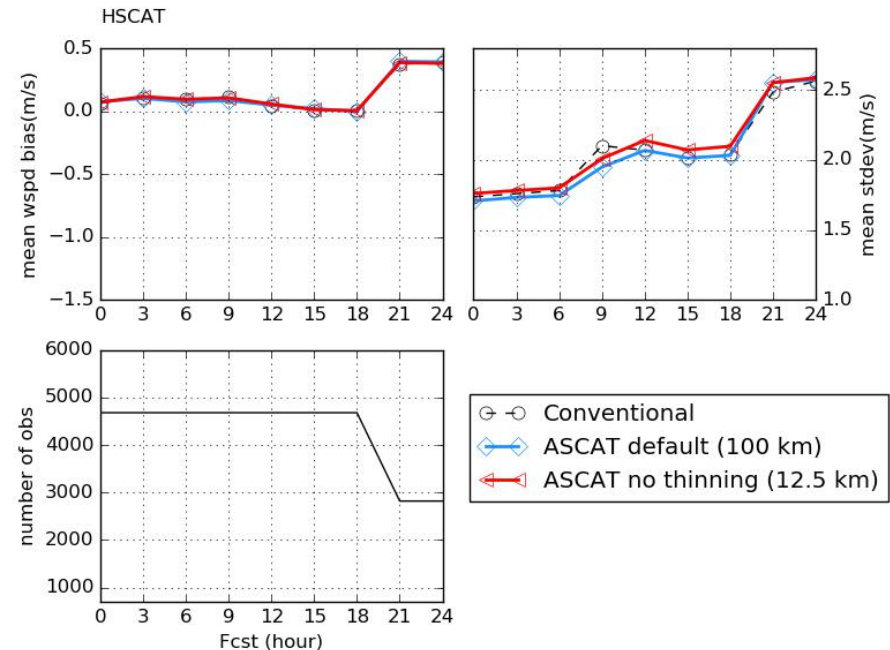
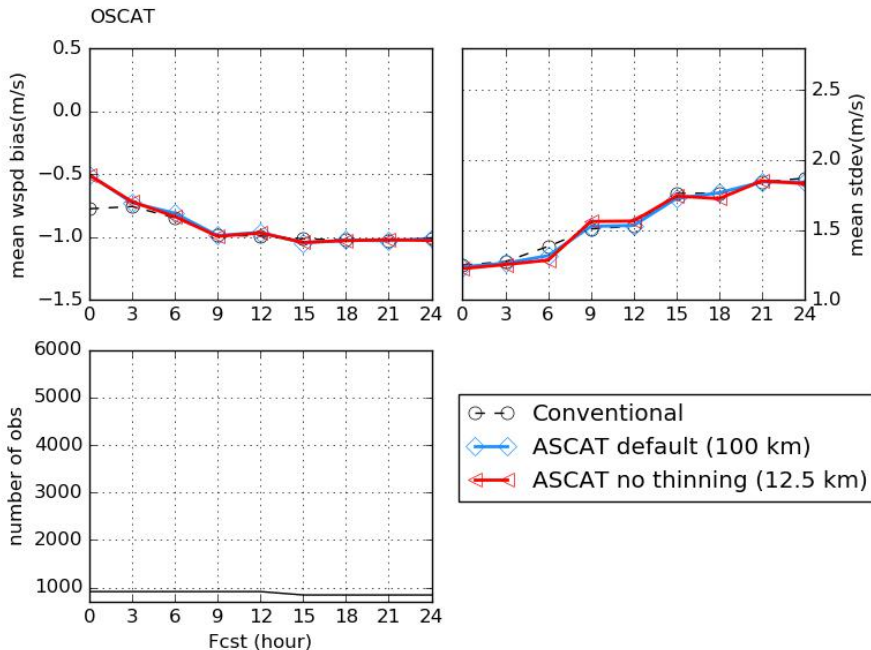
bias and stddev reduction are substantial
 (ASCAT 2 passes a day only)
Impact even to Fc+09

Impact on forecasts over the ocean

10 m wind spd verified against

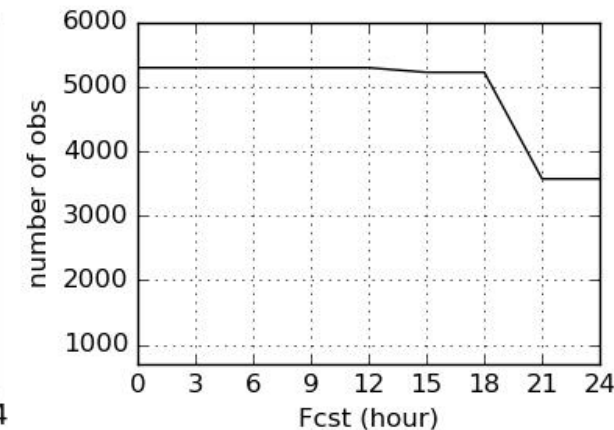
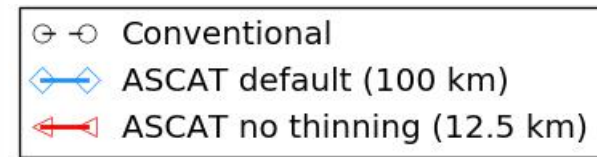
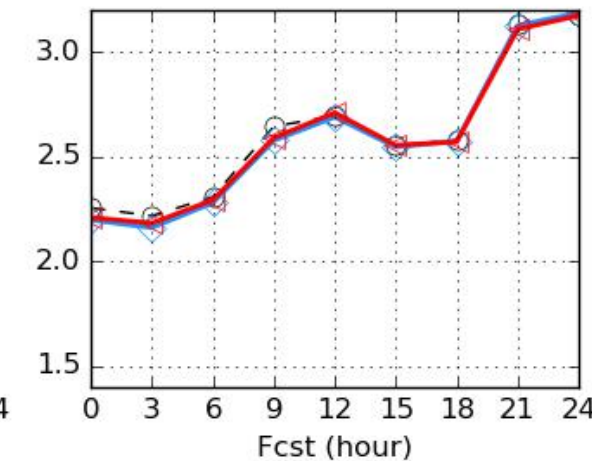
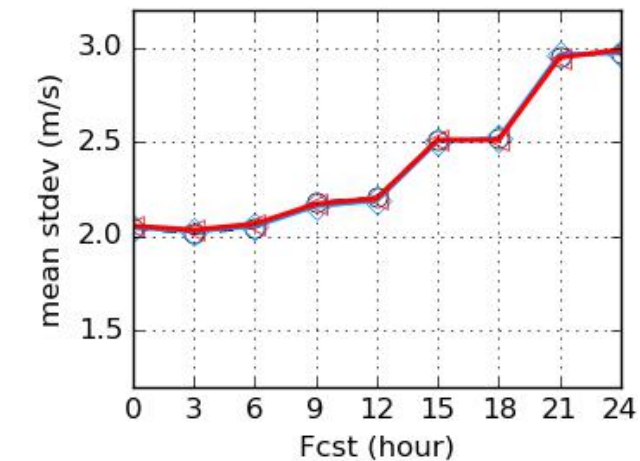
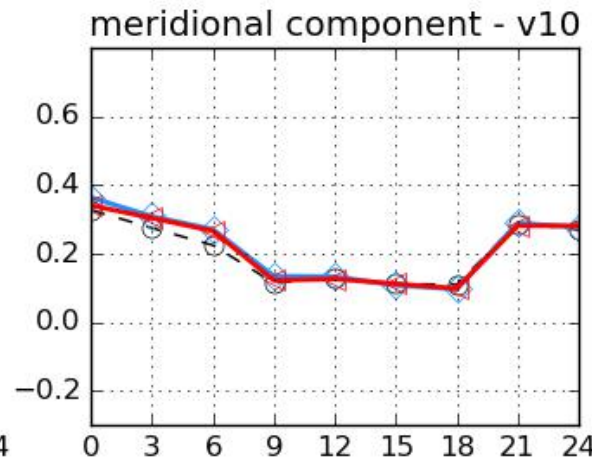
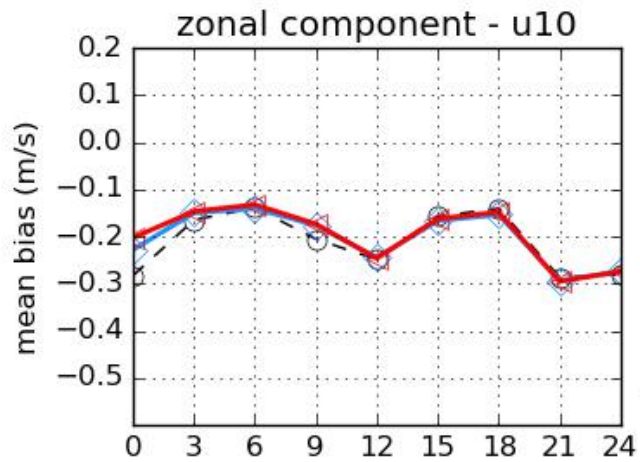
OSCAT \approx 100km eff. res.

HSCAT \approx 50 km eff. res.



Impact on forecasts over the ocean

10 m wind components verified against HSCAT+ OSCAT

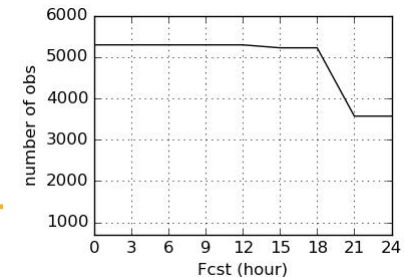
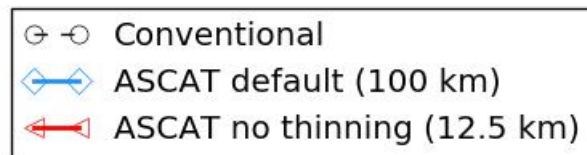
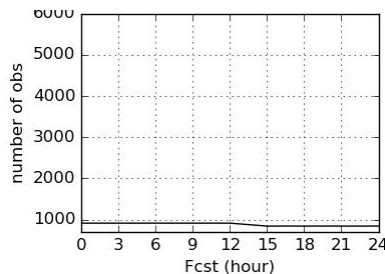
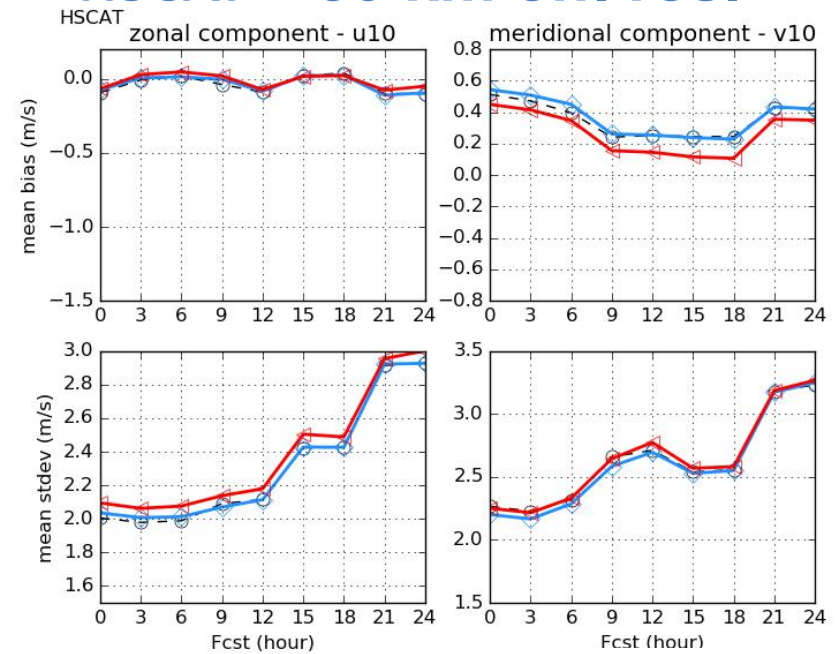
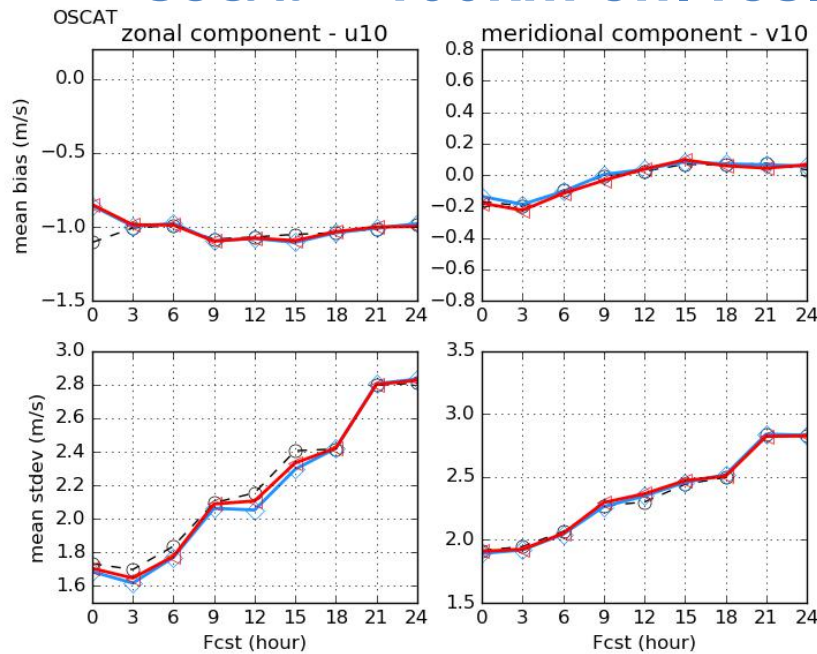


Impact on forecasts over the ocean

10 m wind spd verified against

OSCAT \approx 100km eff. res.

HSCAT \approx 50 km eff. res.



- Model simulations using **ASCAT DA** present **reduced (o-f) bias** and **stddev** when compared with **HSCAT** and **OSCAT** observations.
- The **ASCAT added value** is **mainly** found **up to fc+03**.
- **However, ASCAT experiments show impact up to fc+09**.
- **Better scores** than presented in Marseille and Stoffelen (2017) are likely the **combined effect of ASCAT DA** and the **improved cy40 relative to cy38**.

- Extend the experimental period to obtain more robust statistics.
- Extend the assessment of ASCAT DA impact on analysis and forecasts to other model variables (SLP, T, etc..) and over land.
- Assess impact of ASCAT DA in different weather regimes.
- Strategy for optimal use of ASCAT observations in mesoscale data assimilation (e.g. accounting for ASCAT footprint size in first-guess departure).



Thank you!



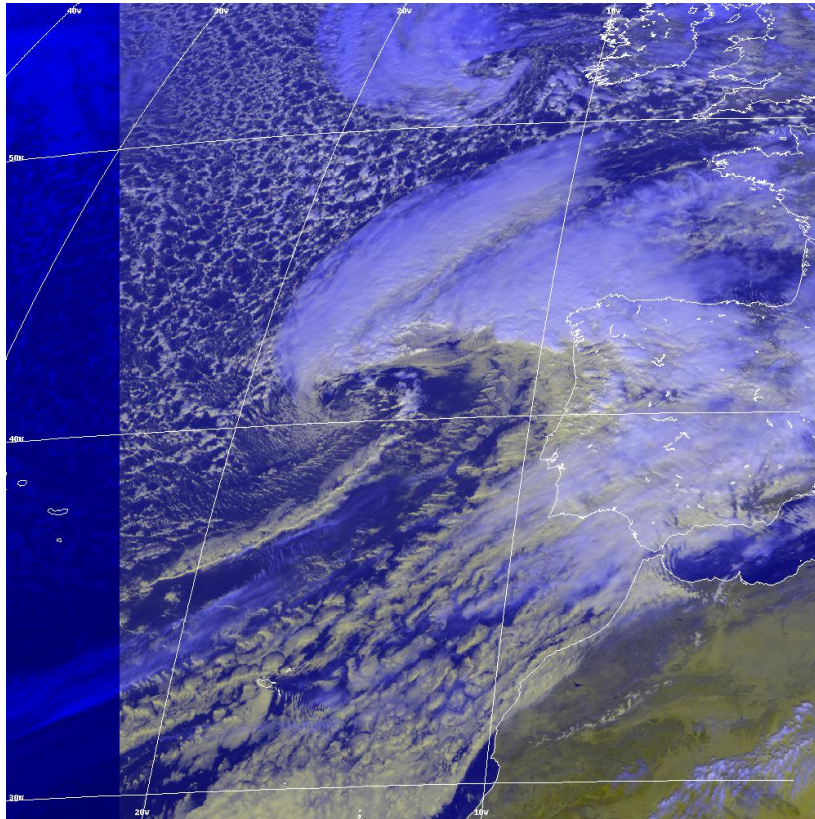
Winter 2013-2014, recap:

- Exceptional low temperatures across Canada and the US
- Exceptional storminess over western Europe
 - Although no individual storm was exceptional, the clustering and persistence of the storms was highly unusual
 - During **January into February 2014** the **tracks** of the storms fell at a **relatively low latitude** => Severe gales along the Iberia west and north coasts

These extreme weather events on both sides of the Atlantic were embedded **in a persistent pattern of perturbations to the tropospheric jet stream**

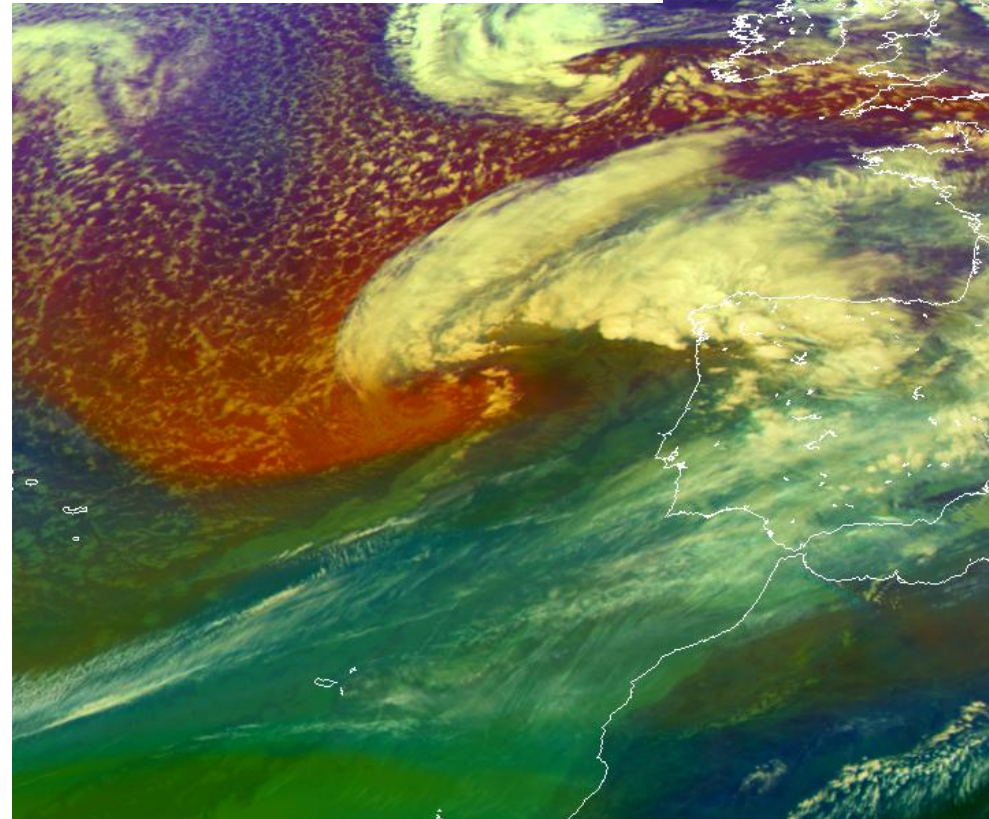


Stephanie 09 to 10 Feb 2014



HRV Cloud RGB

09-02-2014 at 1200UTC

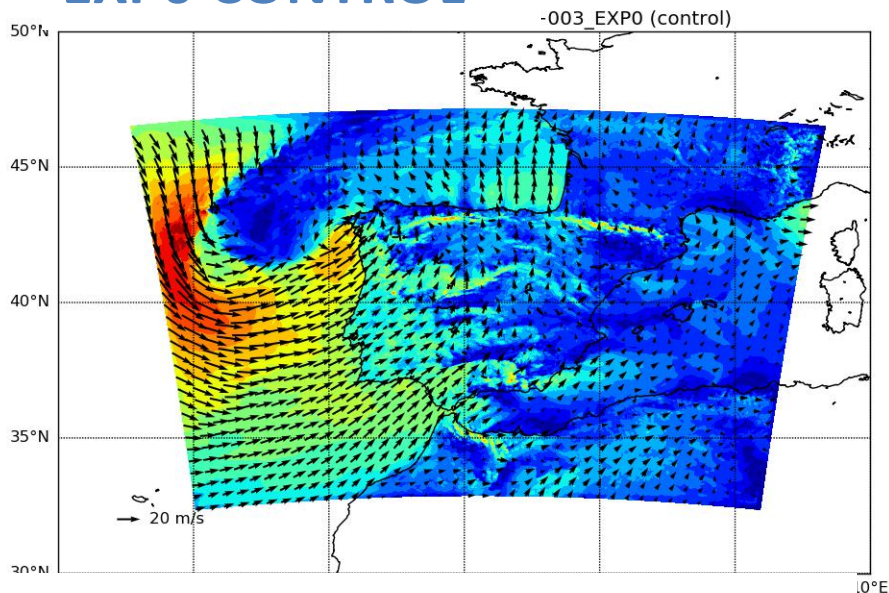


Air Mass RGB

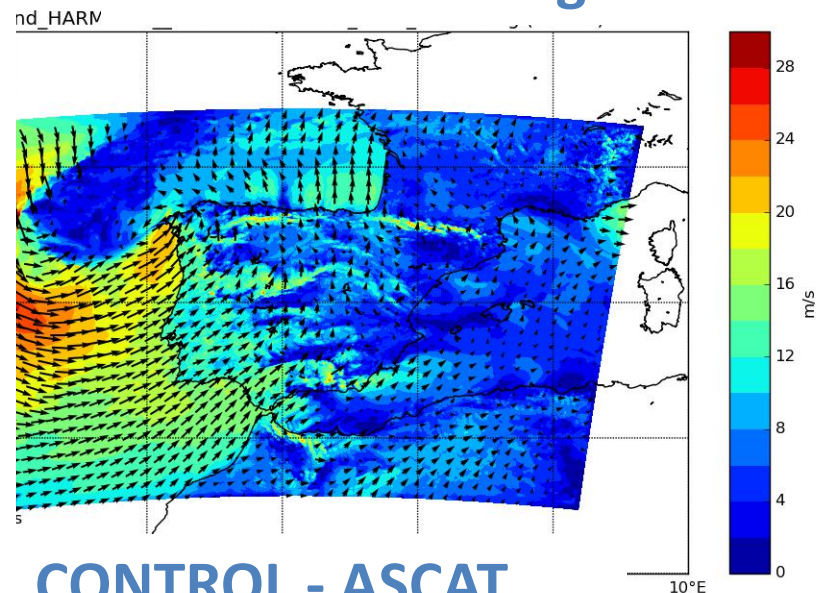
09-02-2014 at 1200UTC

20140209 H12+fc03

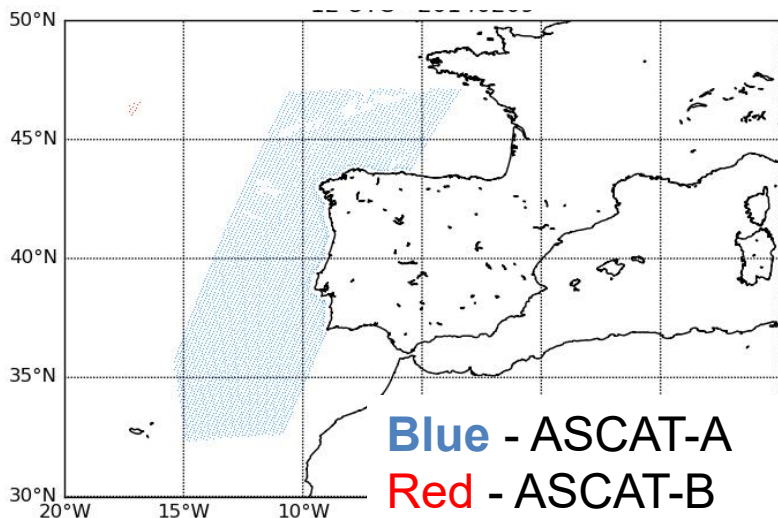
EXPO CONTROL



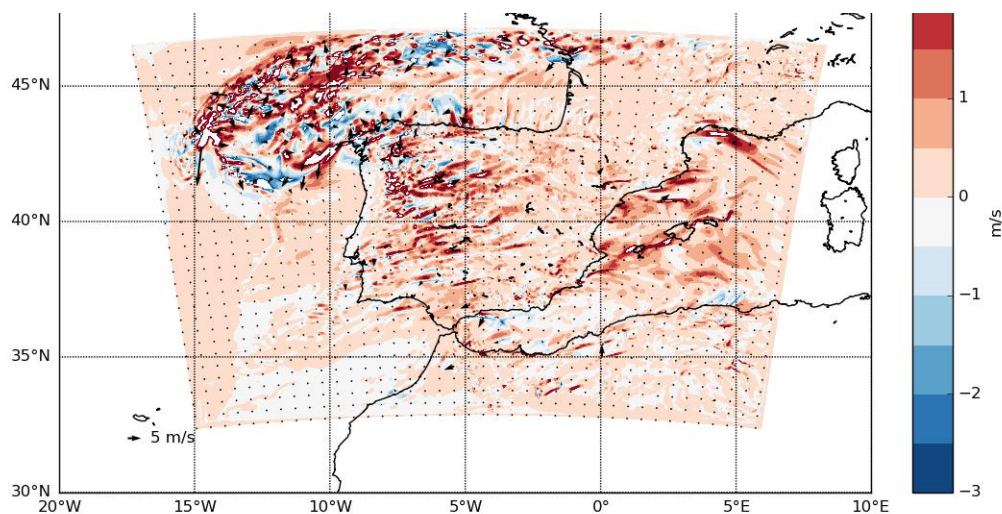
EXP2 no thinning- ASCAT



ASCAT coverage at 12UTC

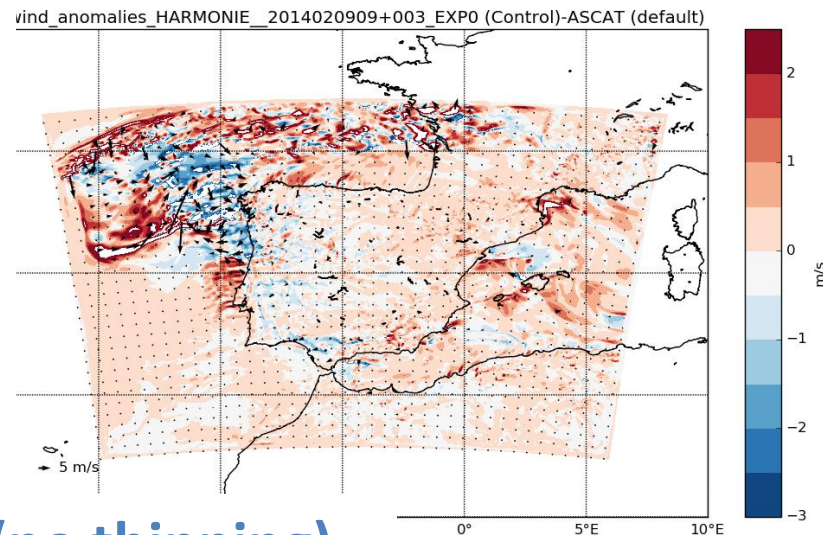
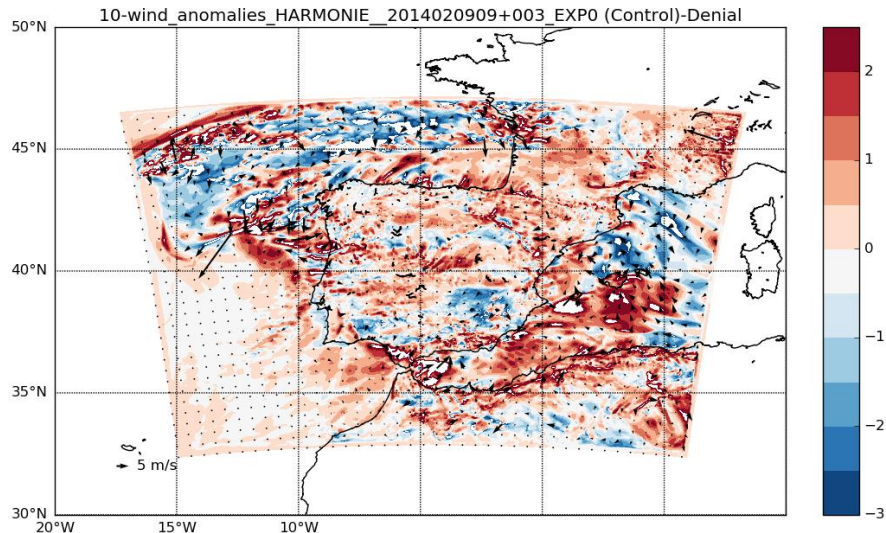


CONTROL - ASCAT



CONTROL-Denial

CONTROL-ASCAT(no thinning)



ASCAT(default)-ASCAT(no thinning)

