On the use of satellite ocean surface winds at ECMWF

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ECMWF - Earth System Assimilation Section

Acknowledgements:
Massimo Bonavita, Patrick Laloyaux, Jean Bidlot, Mohamed Dahoui, Wenming Lin (ICM)

EUMETSAT contract EUM/CO/12/4600001149/JF
ESA contract 4000101703/10/NL/FF/fk CCN5

ECMWF

Outline

Scatterometer Winds

- ✓ Use of Scatterometer winds at ECMWF & Impact on TC
- ✓ Assimilation strategy & QC
- ✓ Issues & research activities

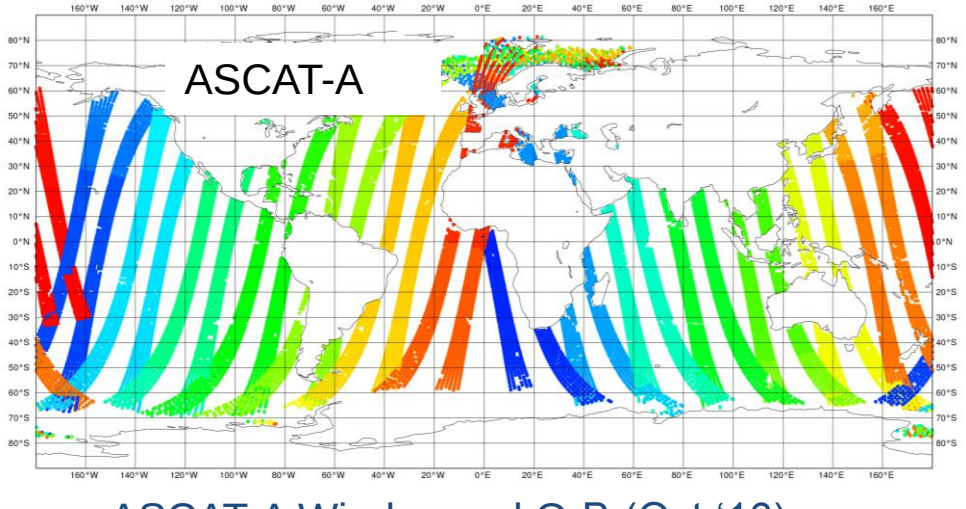
SMOS Winds

- ✓ Wind speed analysis preliminary results
- ✓ TC analysis departure: some examples

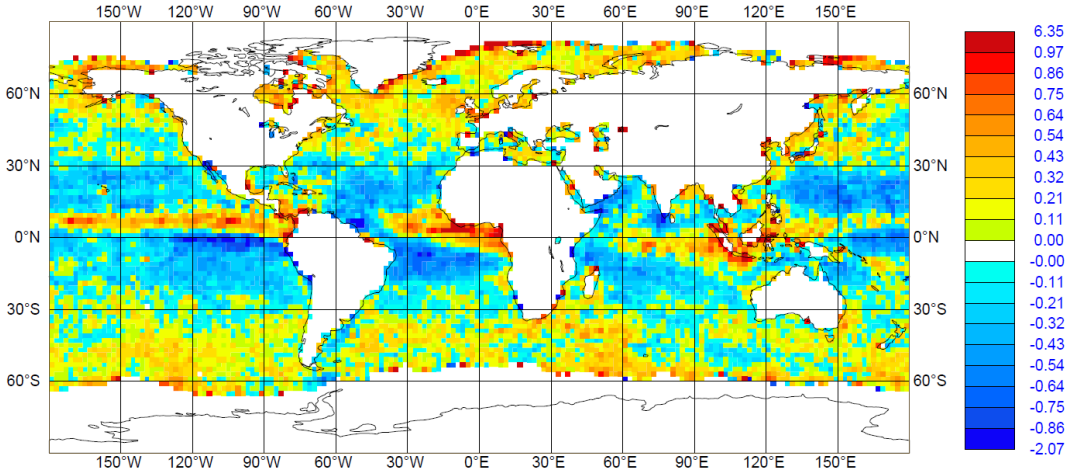
ASCAT wind data

ASCAT-A and ASCAT-B operationally assimilated into IFS

Assimilation Window: 09 – 21 UTC

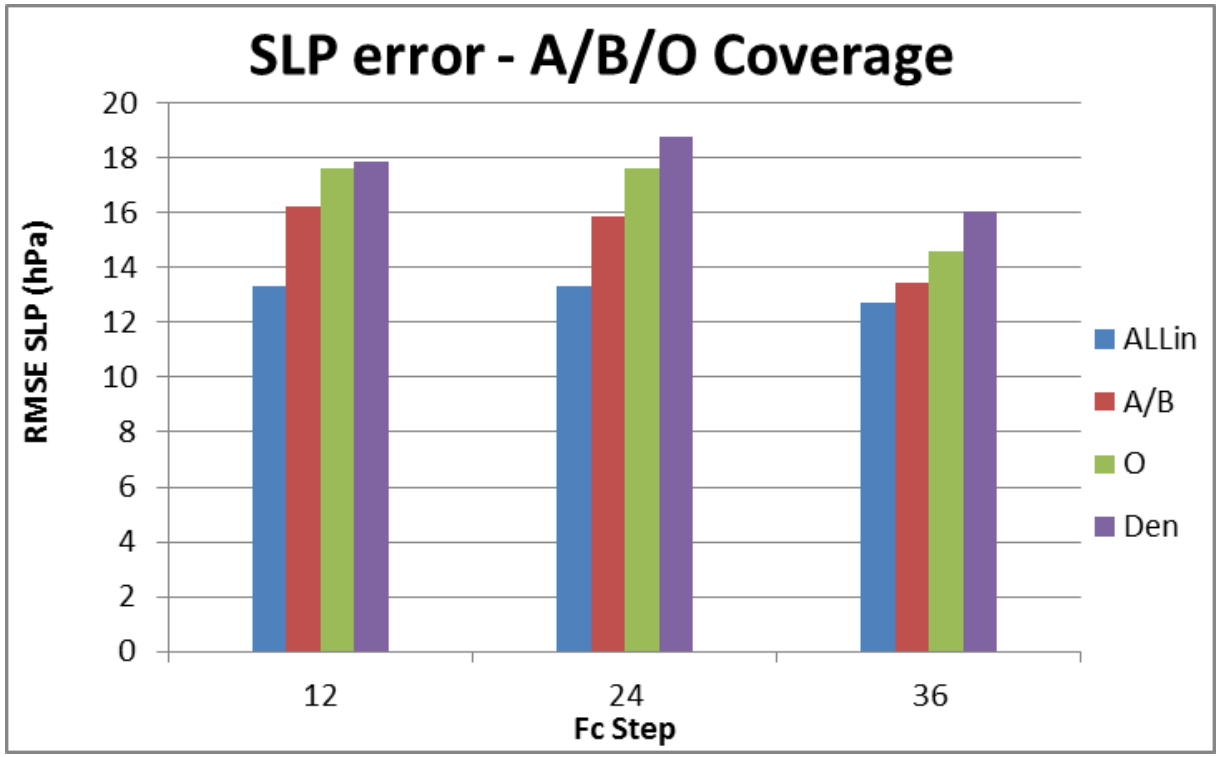


ASCAT-A Wind speed O-B (Oct ‘16)



Impact on Tropical Cyclone FC

- ✓ For each storm the min SLP have been detected from the ECMWF model fields
- ✓ SLP have been compared to observation values (from NHC and JMA)

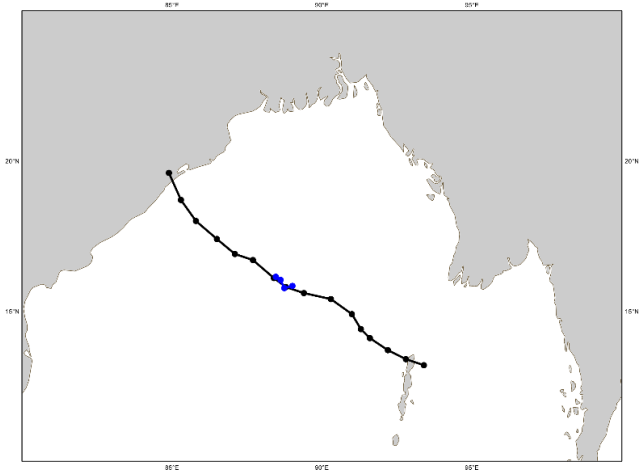


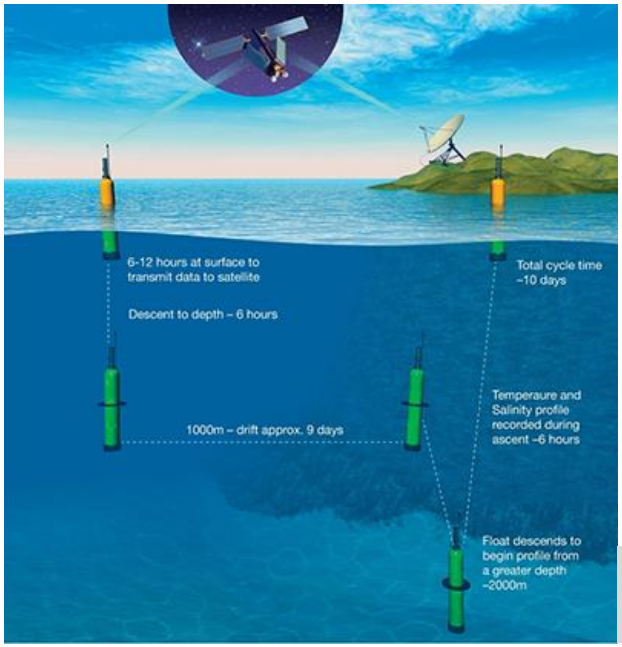
Statistics based only on cases where ASCAT-A, ASCAT-B and OSCAT passes were available Dec 2012/ Feb 2013

G. De Chiara, S. English, P. Janssen and J.-R. Bidlot, “ASCAT ocean surface wind assessment” ECMWF Technical Memorandum 776, 2016.

Impact on the coupled system

Impact of scatterometer data in the CERA and UNCPL systems

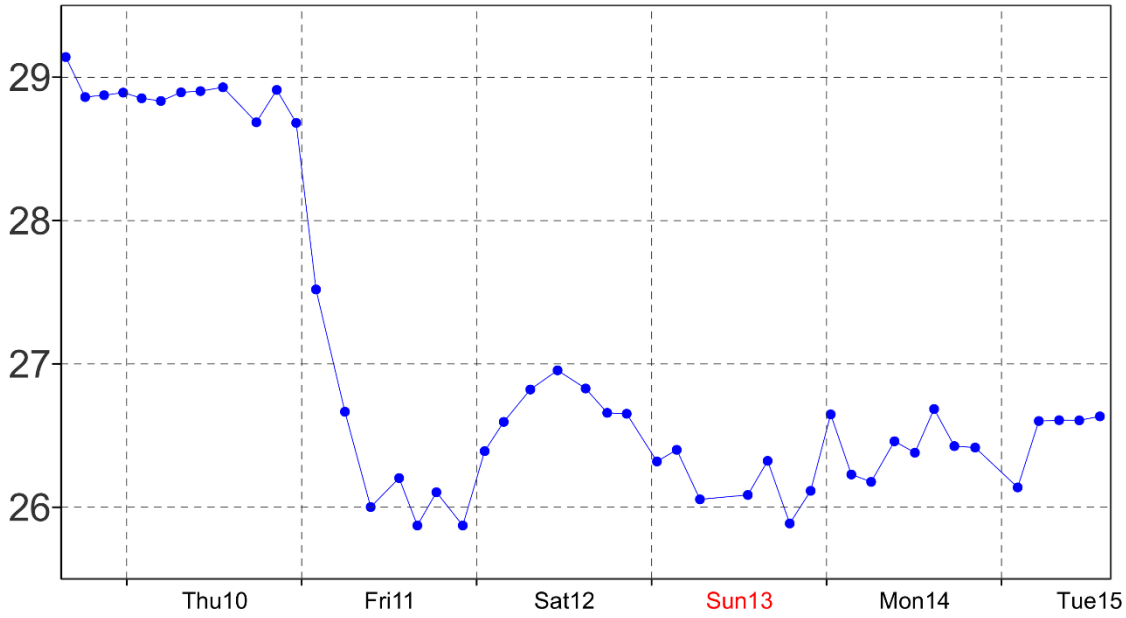




Focus on a specific weather event:

- TC Phailin
- Bay of Bengal
- formed on the 4th October 2013
- Argo probe with high-frequency measurements

Temperature measurements at 40-meter depth

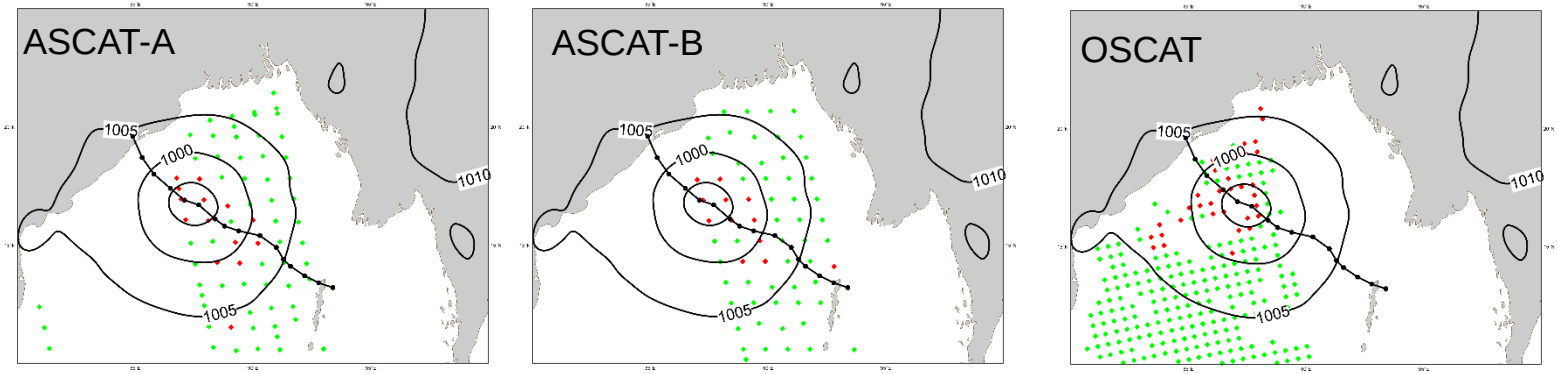


Impact of scatterometer surface wind data in the ECMWF coupled assimilation system
P. Laloyaux, J-N Thépaut and D. Dee. MWR, 2016

Impact on the coupled system

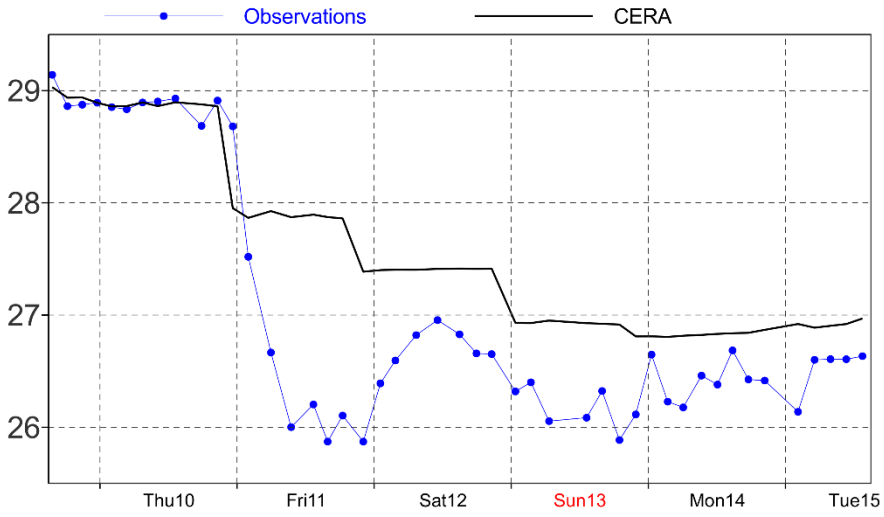
TC Phailin

Wind measurements from scatterometers (ascending pass, 11 October 2013)

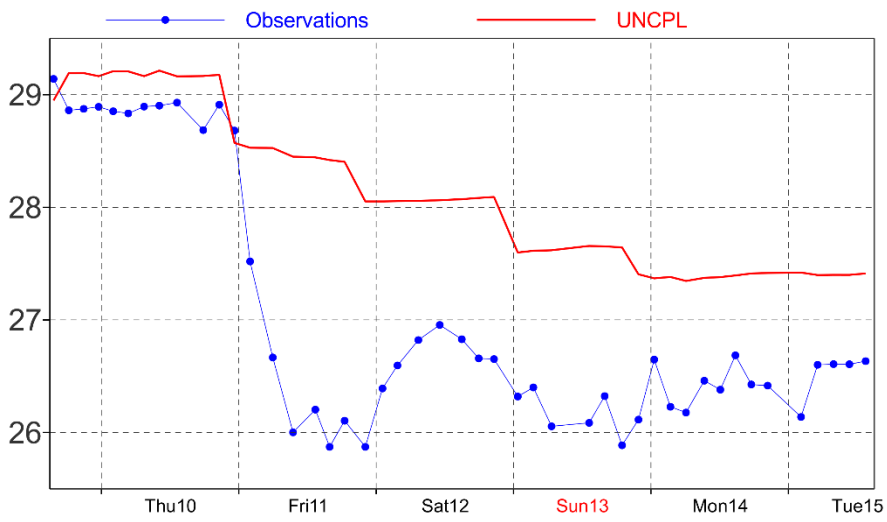


Ocean temperature analysis at 40-meter depth (scatterometer data are assimilated)

CERA



UNCPL

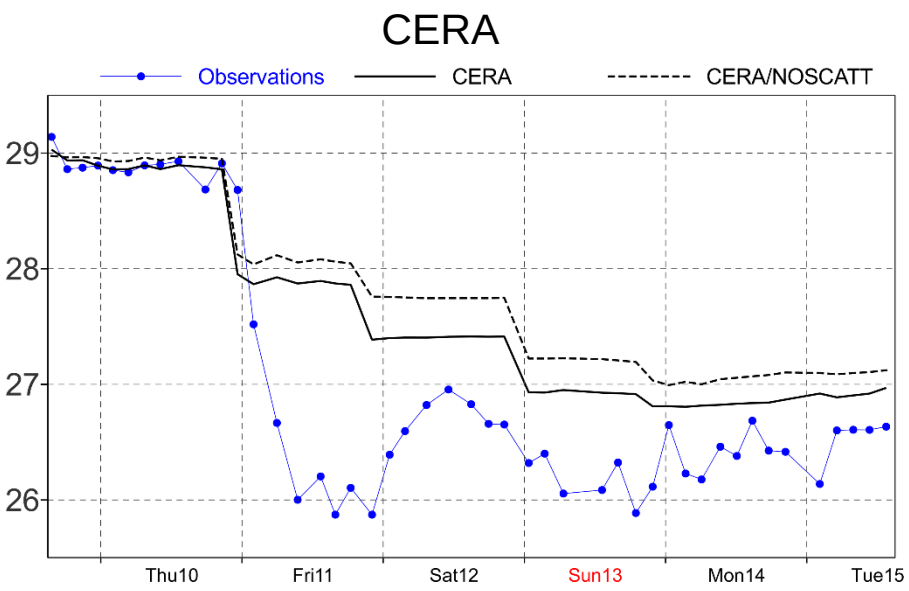


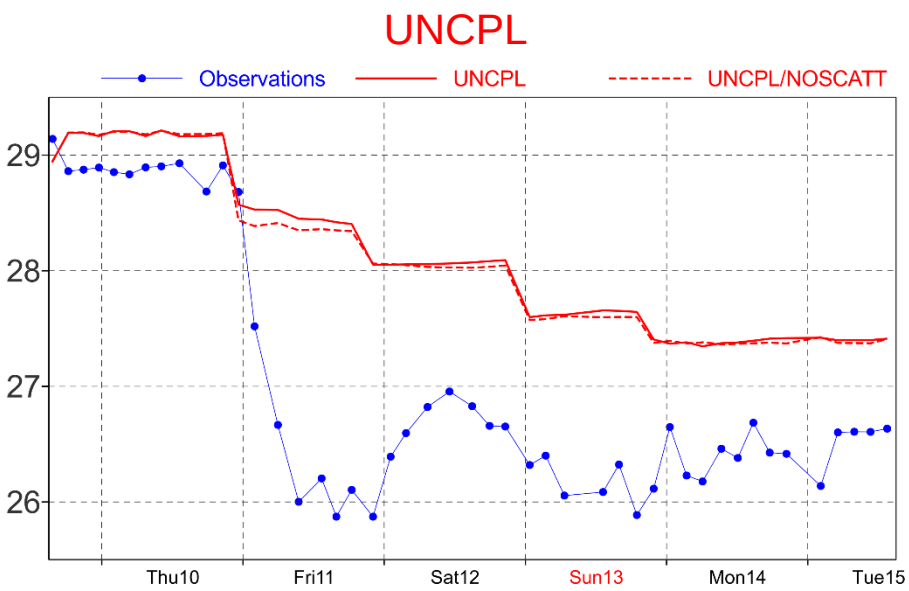
Coupled analysis is closer to the observations with a stronger cold wake

Impact on the coupled system

TC Phailin

Ocean temperature analysis at 40-meter depth (no scatterometer data in dashed)

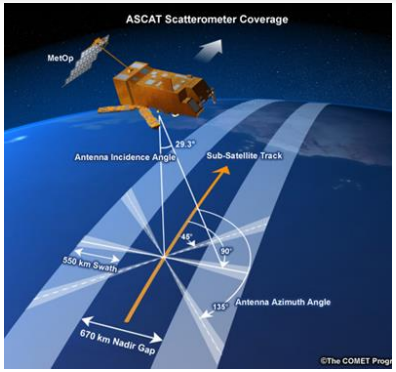




Crucial role of scatterometer data to estimate the ocean state in coupled assimilation
Atmospheric observations have the potential to improve ocean analysis
Fit to observations is not perfect (vertical resolution, nudge to a daily SST product)

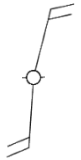
ASCAT-A & ASCAT-B assimilation strategy

ASCAT (25km) from EUMETSAT



- ✓ Wind inversion is performed in-house using the CMOD5.N (10m equivalent neutral winds)

- ✓ 2 wind solutions are provided
- ✓ The best solution is dynamically chosen during the minimization

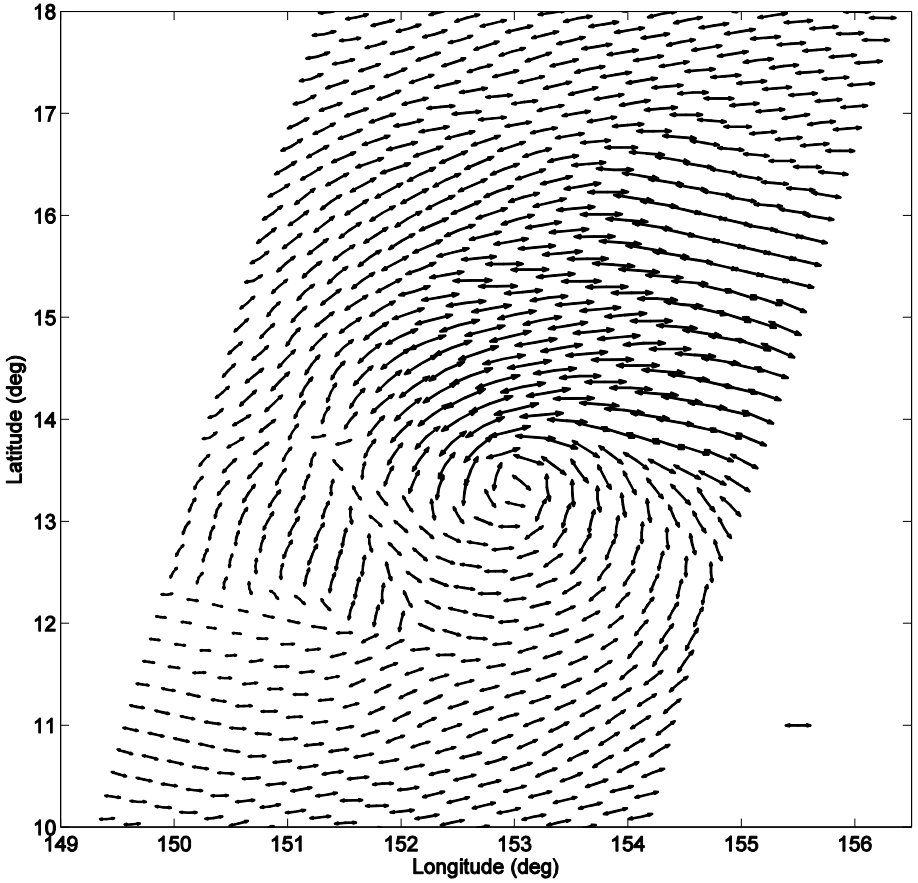


- ✓ Quality control, thinning:
  - Screening: sea ice check based on SST and sea ice data
  - Capping: 35 m/s
  - Thinning: 1 out of 4 along & across track→ 100 km
  - Background check / VarQC

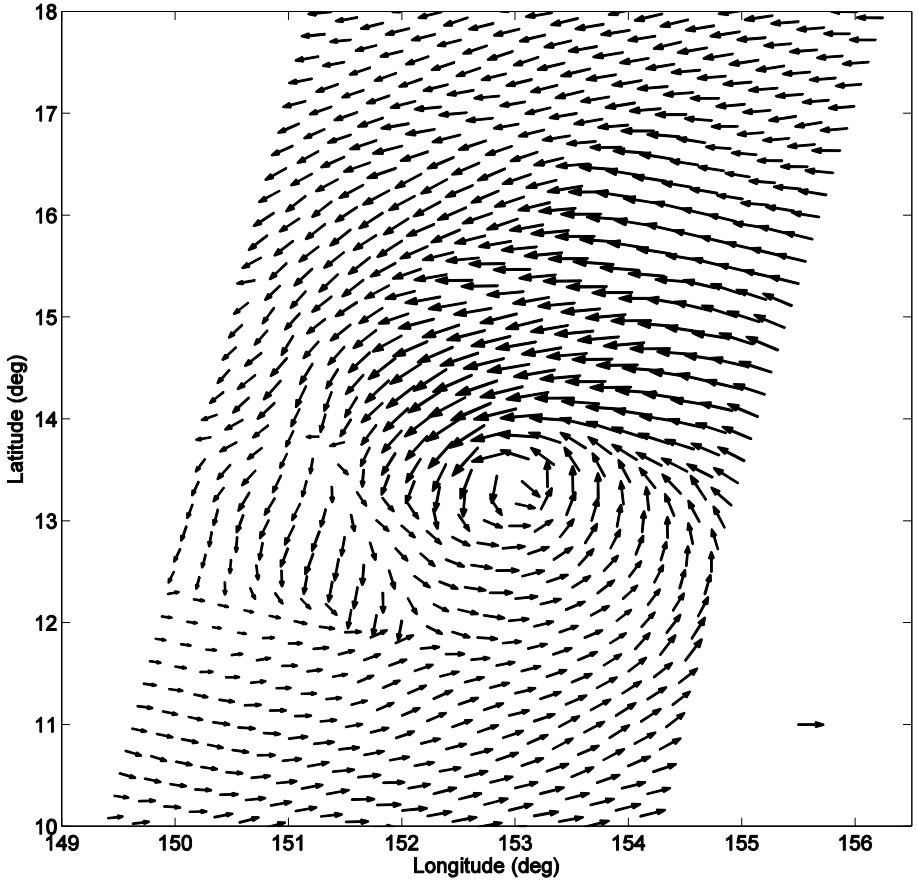
Ambiguity removal

Wind Direction Ambiguity removal:

- ✓ We provide 2 solutions (almost same wind speed, opposite directions)
- ✓ At each minimization the solutions are compared to the background



Ambiguities provided

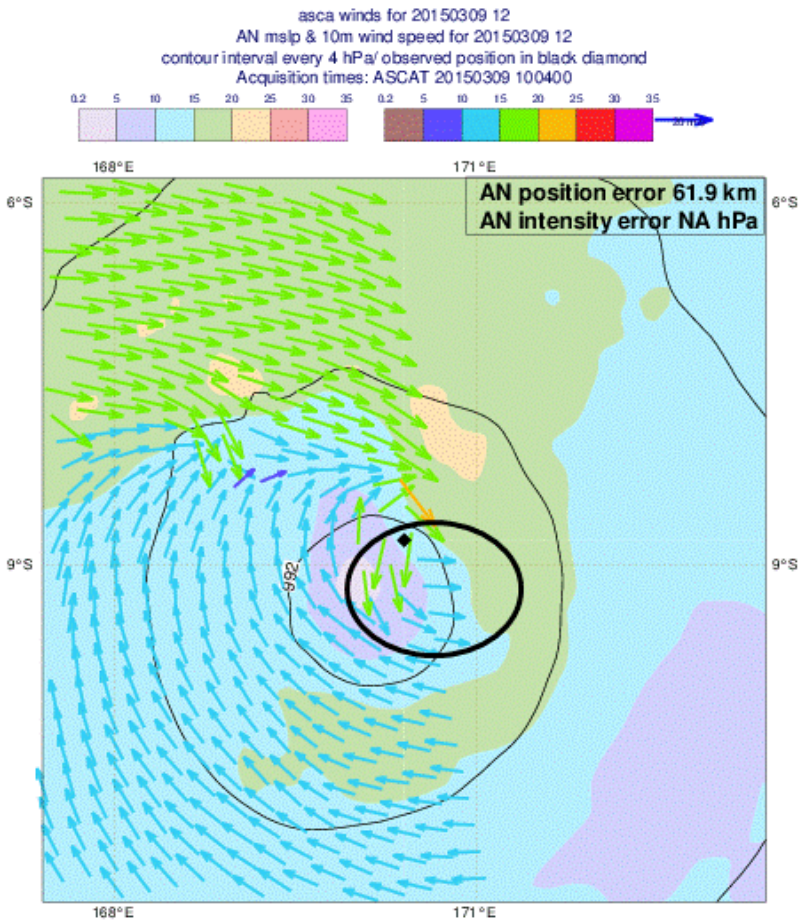


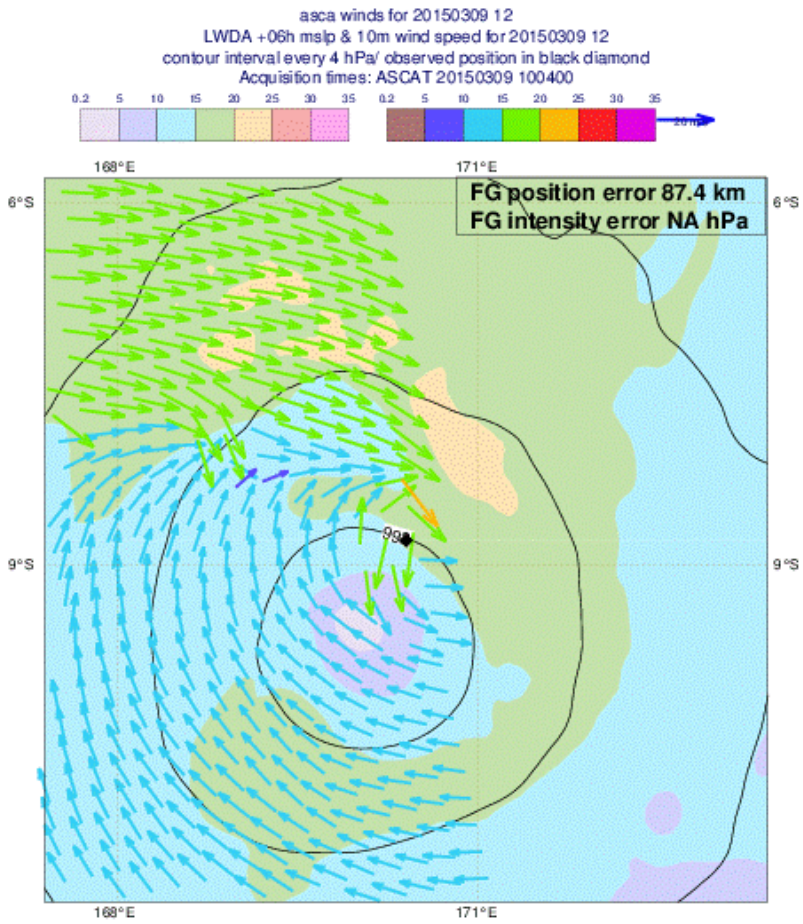
Ambiguities selected

[by Wenming Lin]

Ambiguity removal

TC Pam – 9 March 2015 12 UTC





ASCAT-A & ASCAT-B assimilation strategy

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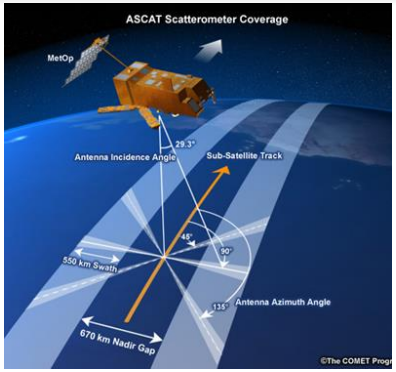

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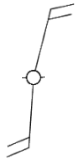

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  - Screening: sea ice check based on SST and sea ice data
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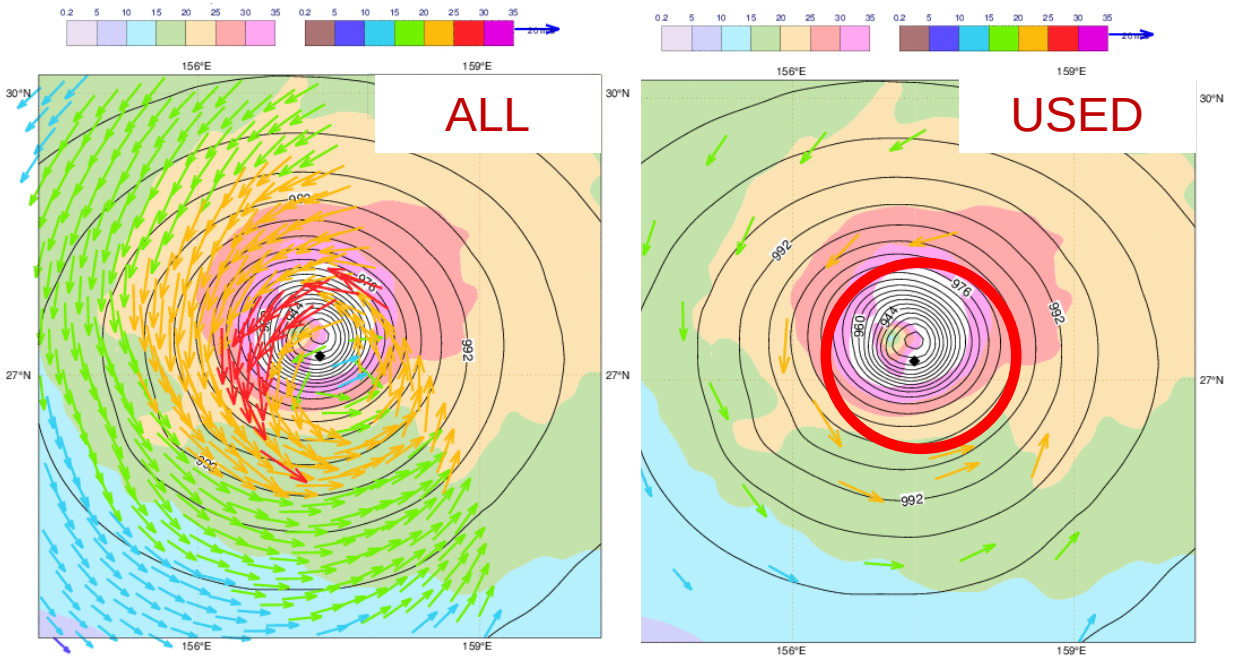
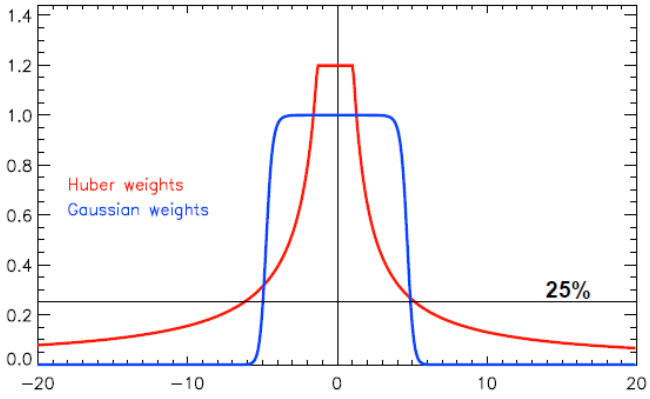
Thinning and QC issues



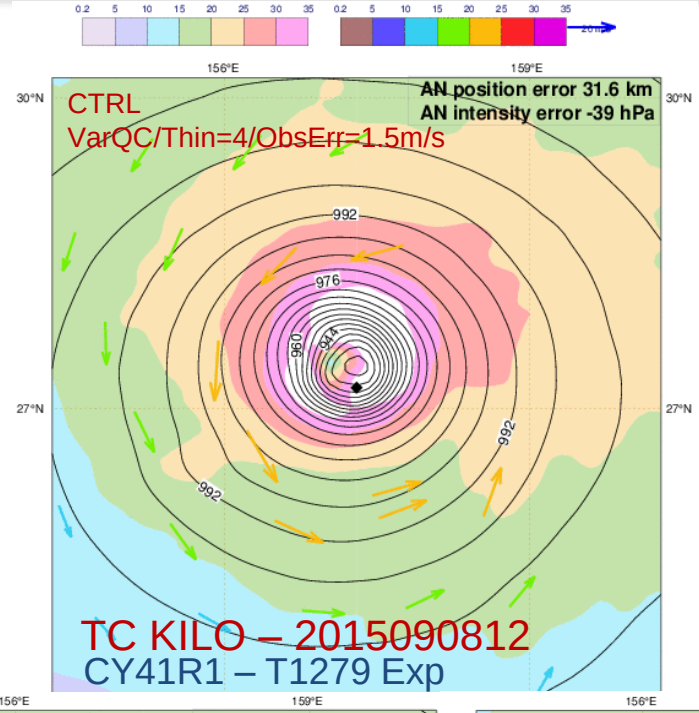
Comparing Observation weights:

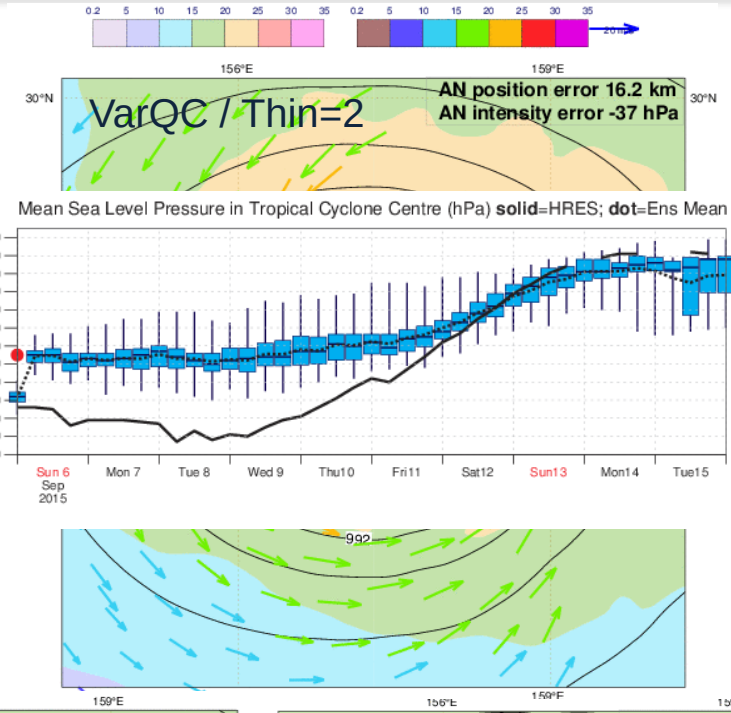
Gaussian + flat (VarQC): more weight in the middle of the distribution

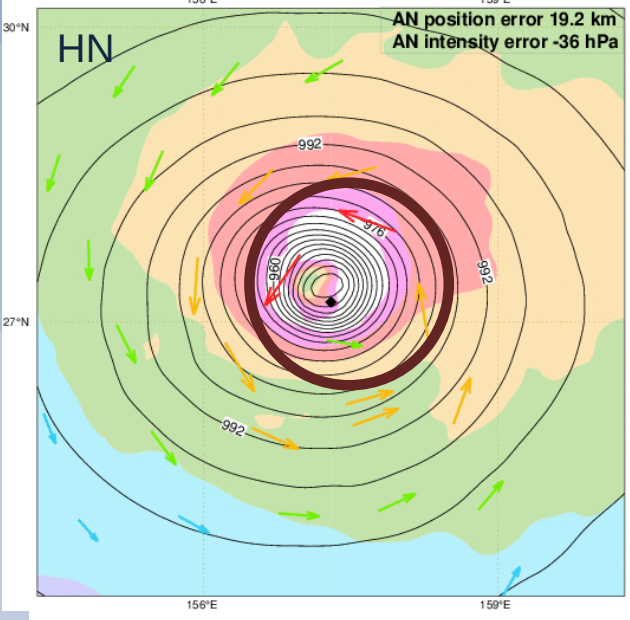
Huber Norm: more weight on the edges (to data with large departure)

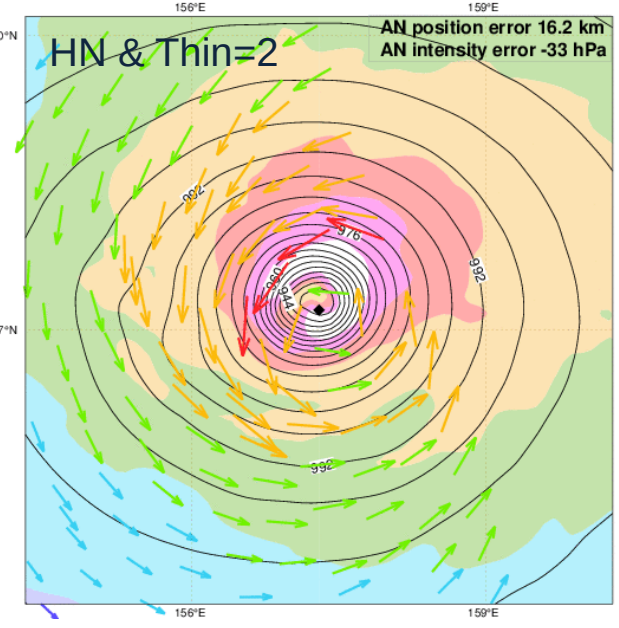


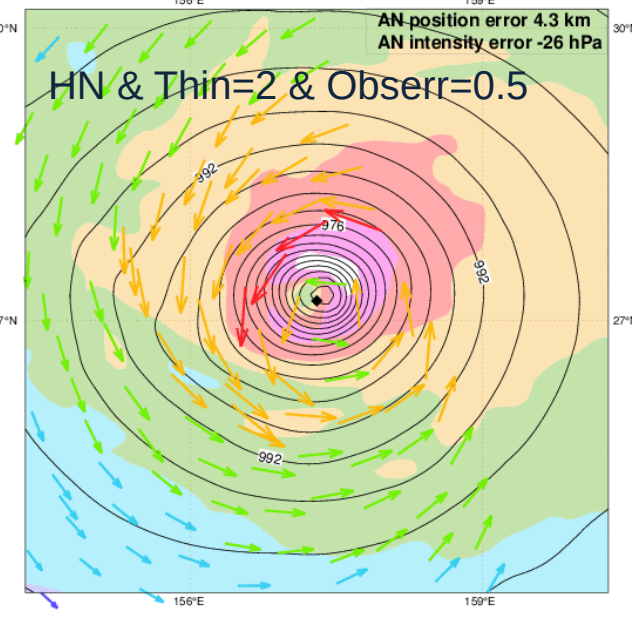
TC QC issues


CTRL
VarQC/Thin=4/ObsErr=1.5m/s
AN position error 31.6 km
AN intensity error -39 hPa
TC KILO – 2015090812
CY41R1 – T1279 Exp


VarQC / Thin=2
AN position error 16.2 km
AN intensity error -37 hPa
Mean Sea Level Pressure in Tropical Cyclone Centre (hPa) solid=HRES; dot=Ens Mean
Sun 6 Sep 2015
Mon 7
Tue 8
Wed 9
Thu10
Fri11
Sat12
Sun13
Mon14
Tue15


HN
AN position error 19.2 km
AN intensity error -36 hPa

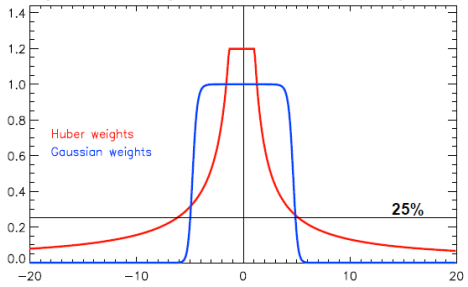

HN & Thin=2
AN position error 16.2 km
AN intensity error -33 hPa


HN & Thin=2 & Obserr=0.5
AN position error 4.3 km
AN intensity error -26 hPa

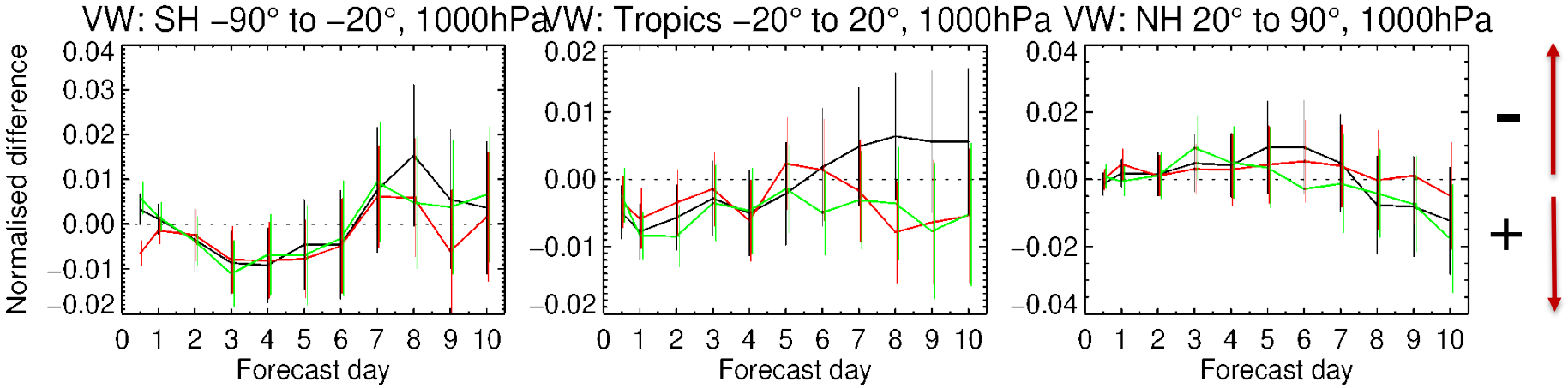
Huber Norm

Cy41R1 TL639 Sep-Nov 2013

- CTRL: VarQC
- HN Left/Right = 1
- HN Left/Right = 1 & No Upper Wind Speed threshold
- HN Left/Right = 3



VW RMS Forecast Error Differences



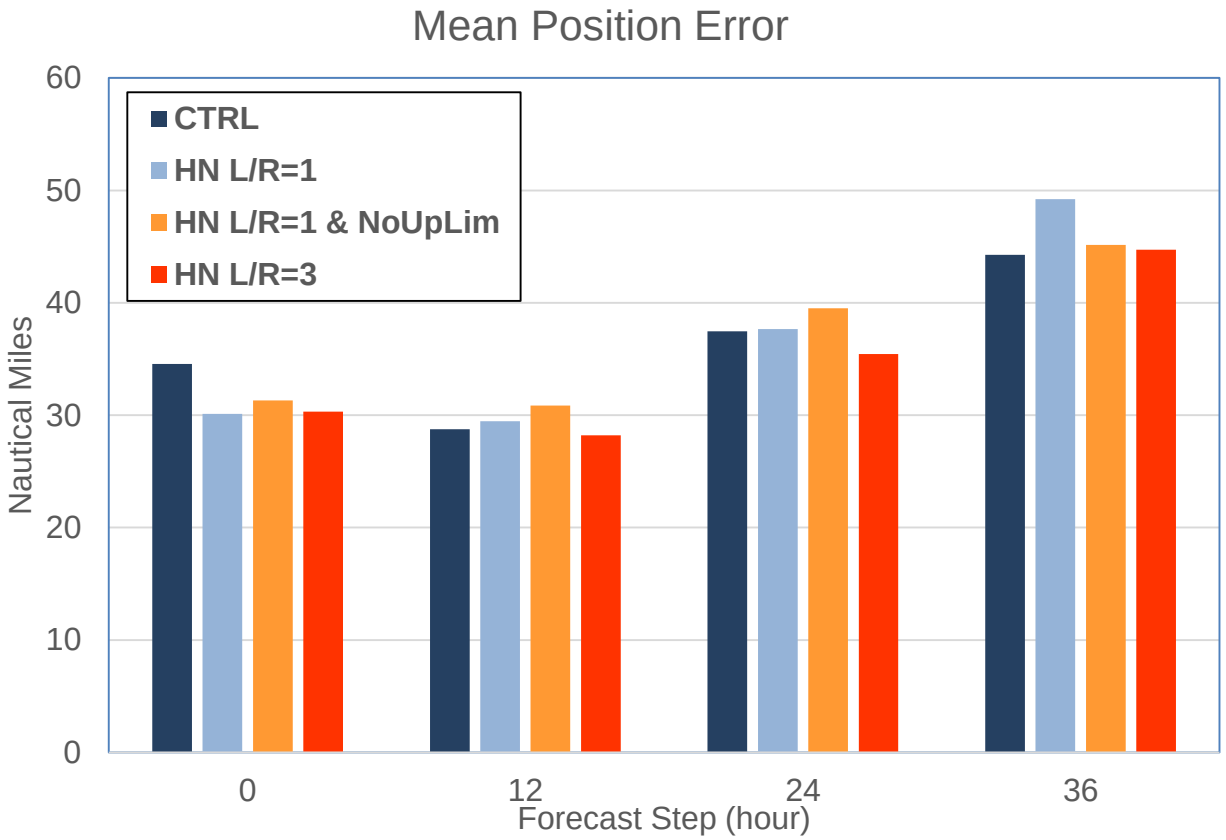
HN L/R=1 - CTRL

HN L/R=3 - CTRL

HN NoUpLim - CTRL

Huber Norm

Impact on TC Analysis and Forecast



N.Obs: ~	*150*	*130*	*110*	*90*

Outline

Scatterometer Winds

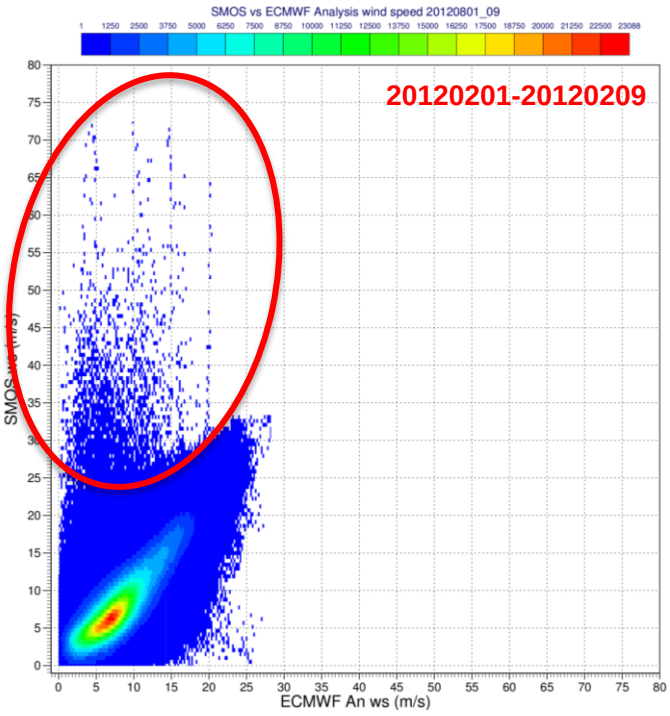
- ✓ Use of Scatterometer winds at ECMWF & Impact in the Tropics
- ✓ Assimilation strategy & QC
- ✓ Research activities

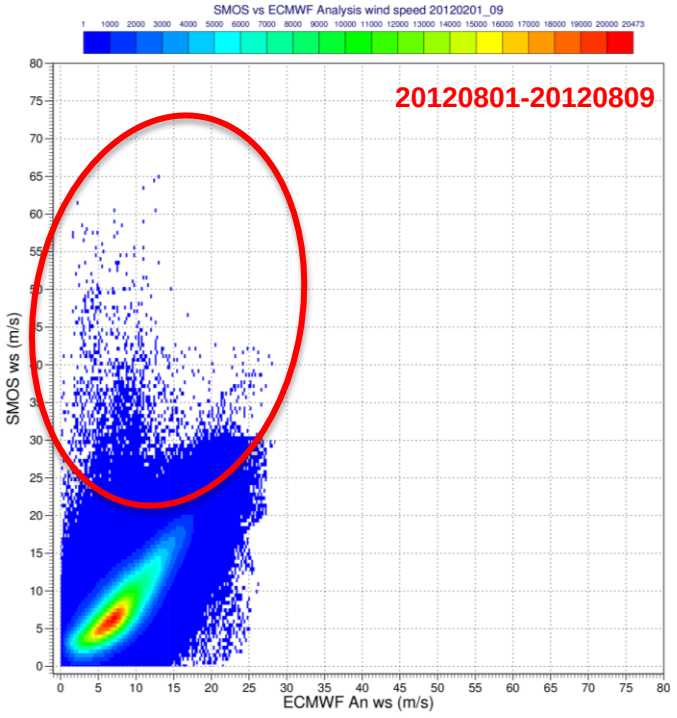
SMOS Winds

- ✓ Wind speed analysis preliminary results
- ✓ TC analysis departure: some examples

SMOS wind speed analysis

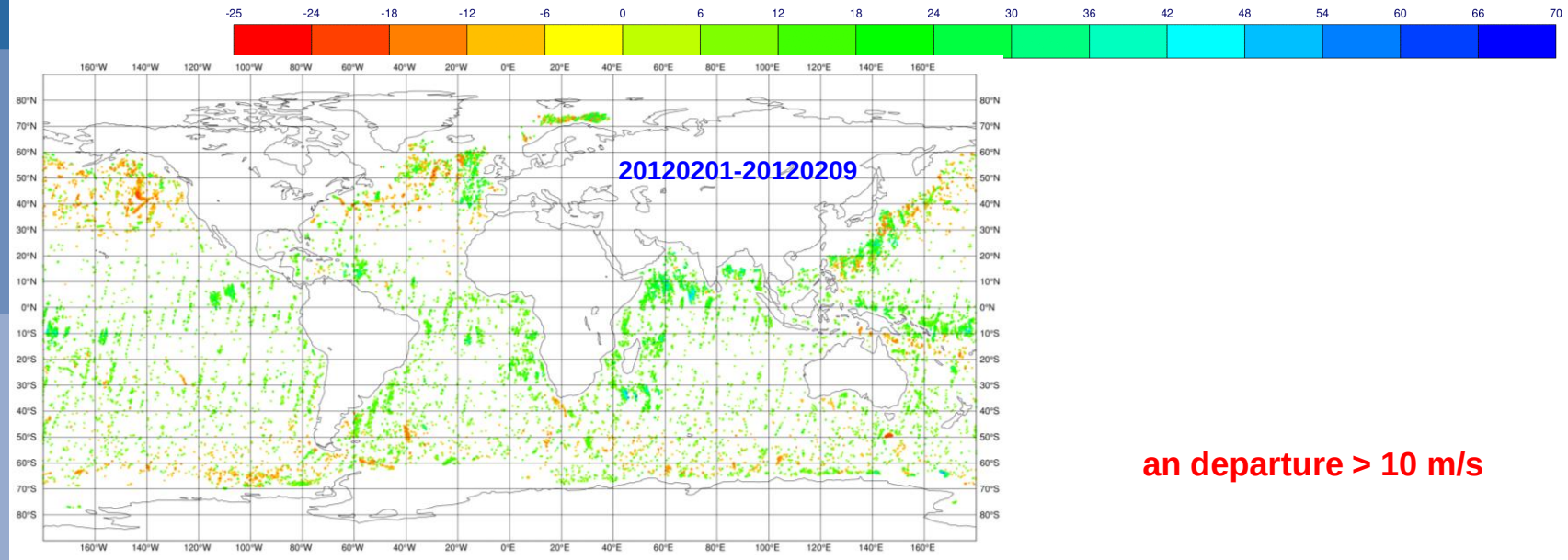
- ✓ The project is aimed at performing a preliminary assessment of the quality of SMOS wind data
- ✓ Two sets of nine days were filtered (QC) and processed: 1-9 February 2012 & 1-9 August 2012
- ✓ SMOS winds are compared to ECMWF analysis wind fields



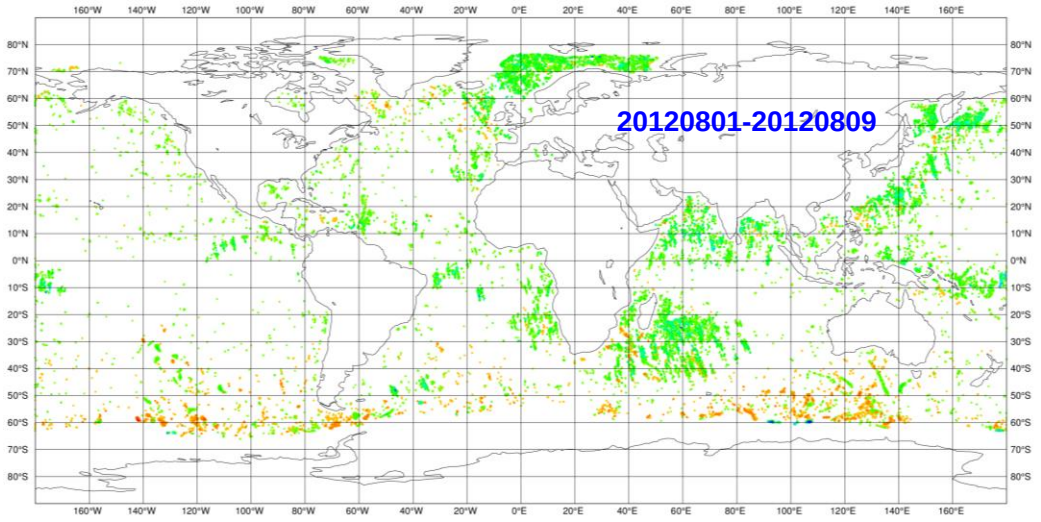


SMOS wind speed analysis

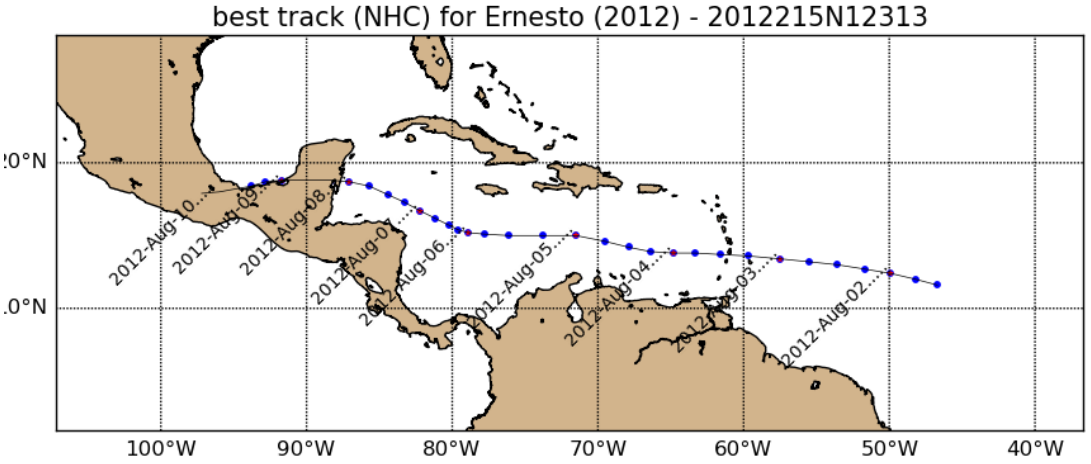
SMOS vs ECMWF AN wind speed

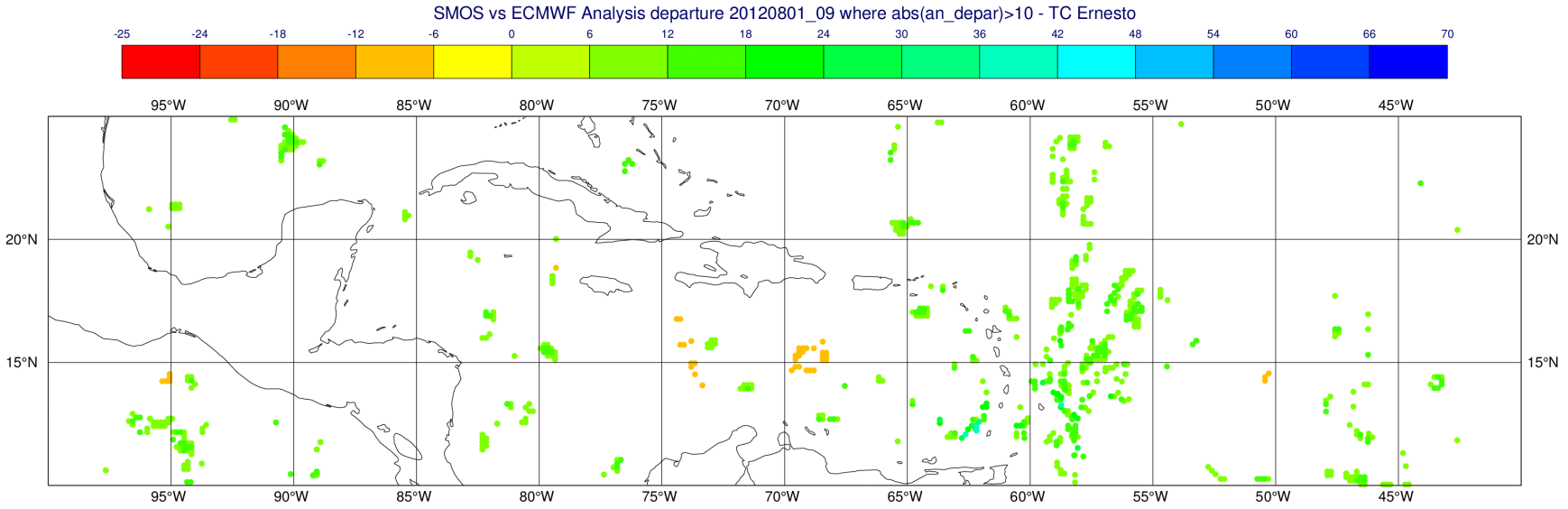


an departure > 10 m/s



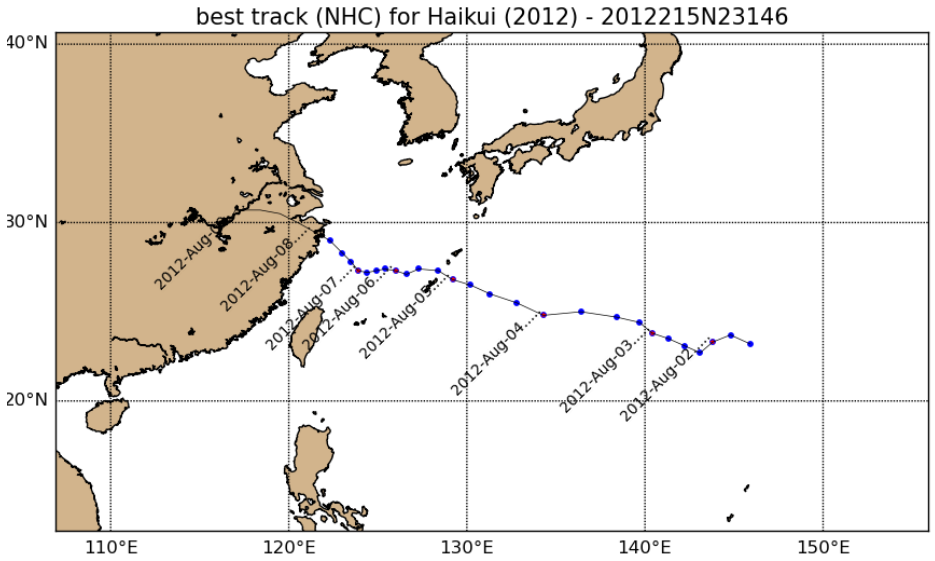
SMOS wind speed analysis

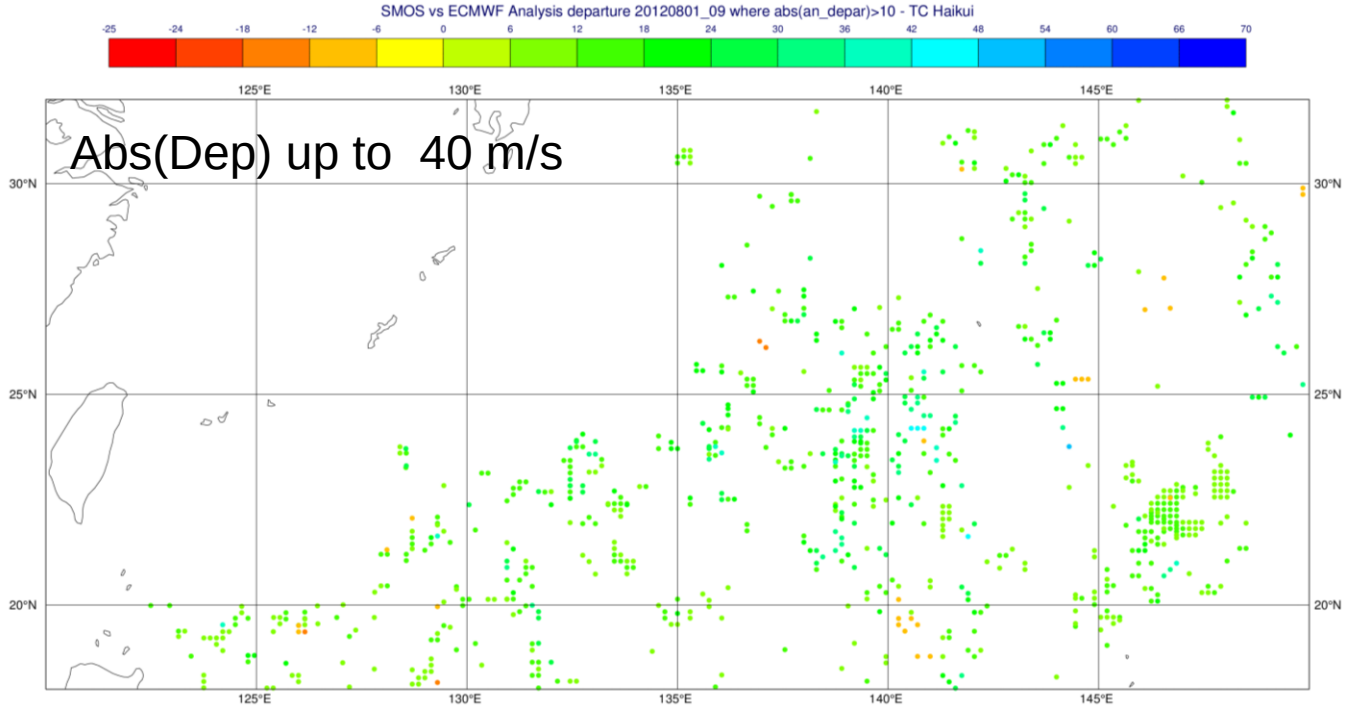




Abs(Dep) < 38m/s

SMOS wind speed analysis





Summary

- ✓ Scatterometer winds are widely used in NWP and have shown to have positive impact on analysis and the forecast:
  - Beneficial impact on atmospheric, wave and ocean models
  - On global scale and extreme events
  - Important for TC and extra-TC analysis and forecast
- ✓ Work to improve the QC and wind sampling, in particular for TC, is ongoing
- ✓ Plans to improve the ambiguity removal scheme
- ✓ It is important to better investigate the sensitivity of the system to different resolutions & scales
- ✓ Assimilation of as many good datasets as possible

- ✓ Overall SMOS winds look promising
- ✓ More investigations needed to better characterize the data
- ✓ A comparison of the analysis increments with other available wind in-situ and satellite dataset will performed (i.e. ASCAT, AMVs, microwave imagers)
- ✓ Preparation for the SMOS multi-angular BT monitoring over the ocean
- ✓ Based on these analysis the potential positive impact of SMOS assimilation will be evaluated