# Assimilation of SAR winds in an intense mesoscale development case

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ACCORD
A Consortium for COnvection-scale modelling Research and Development

Meteorologisk institutt

CYMS with Sentinel-1

# SAR winds

- CYMS project: CYclone Monitoring Service based on Sentinel-1
  CYMS delivers high-resolution Tropical Cyclone observations from SAR systems
- SAR - Synthetic Aperture Radar
- MET Norway had a small part in this project:
  Assimilate SAR wind in AROME in a storm case
- CYMS provided SAR winds for several storm cases in the Norwegian Sea and Barents Sea areas
- SAR data in NETCDF and in 3km horizontal resolution

# HARMONIE-AROME system

- Copernicus Arctic Regional ReAnalysis (CARRA) system 1990-2021 on two domains
- Based on Cy40
- 3D-Var
- 3 hour cycling, analysis every third hour 00,03,06,09,12,15,18,21 UTC
- The SAR test was done on the NE domain (rightmost)

# SAR assimilation

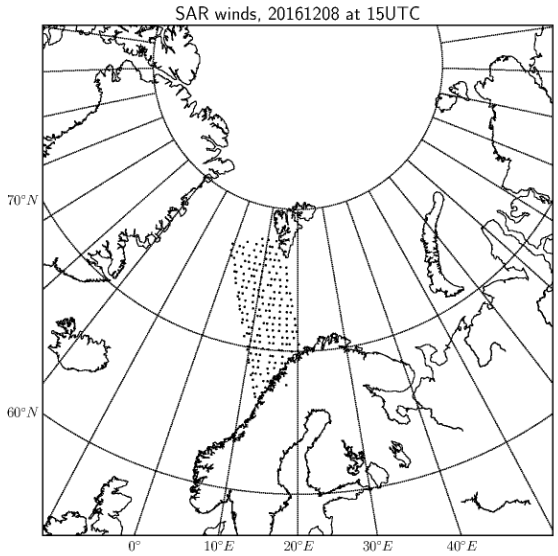
- Code updates for assmilation of SAR winds were provided by MF, via Roger Randriamampianina at MET

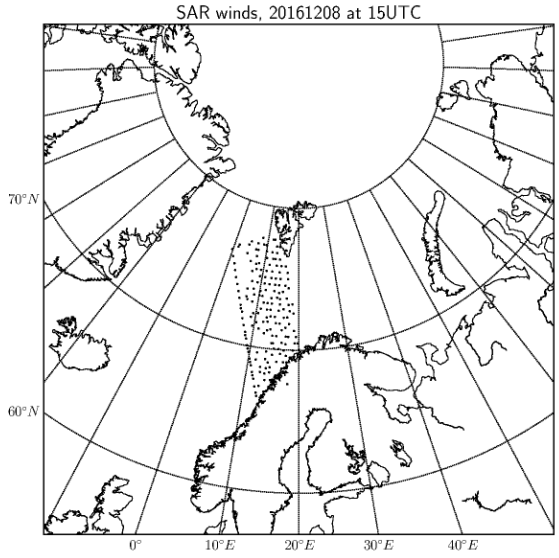
- The updates were phased into the CARRA system
  - NETCDF interface in BATOR
  - Updates from Cy41 while CARRA system based on Cy40
  - Limited time in project
    ==> not much time could be spent on tuning the system

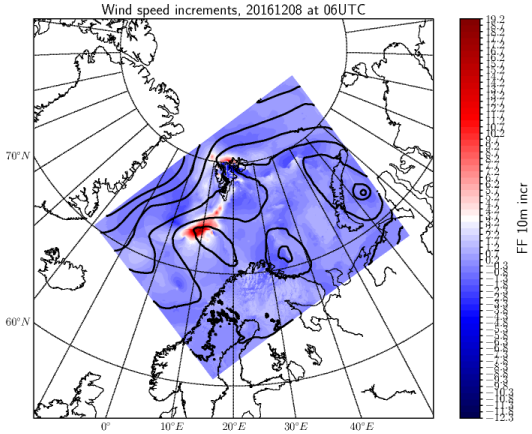
- SAR data were assimilated in a case study on 8 December 2016, an intense mesoscale development

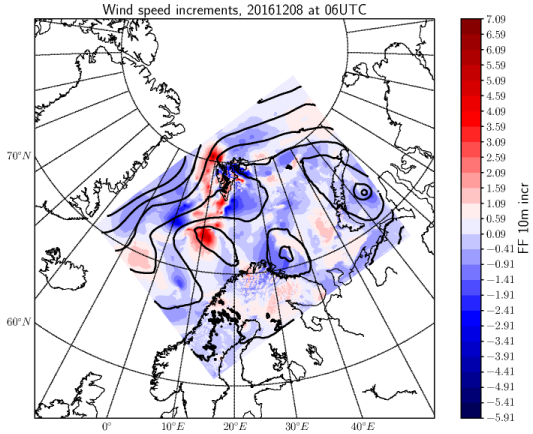
# SAR assimilation II

- Data thinned to 50km
- Reject data already in BATOR based on quality flagging by the processing
- Big difference in data usage
- First assimilation try showed FG check did not reject large innovations or was maybe not called at all
- Instead we used the blacklist file to reject data. Made a difference for the innovations in some cycles:



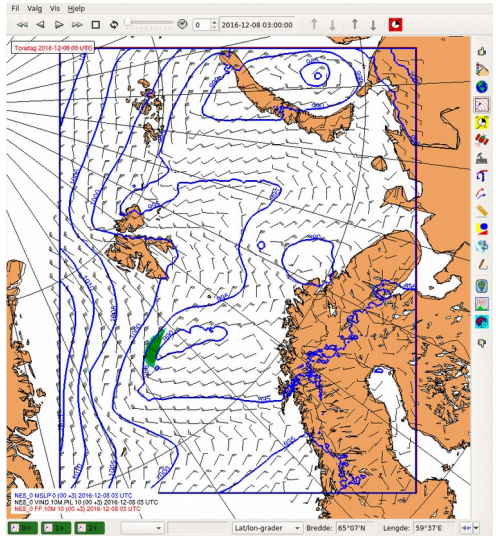



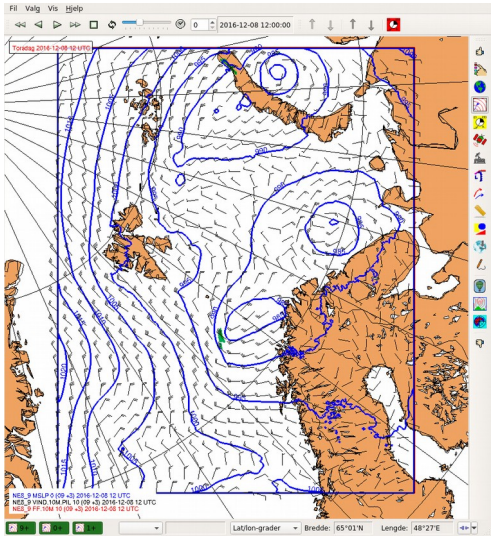



# Storm case 8 Dec 2016

03UTC



12UTC



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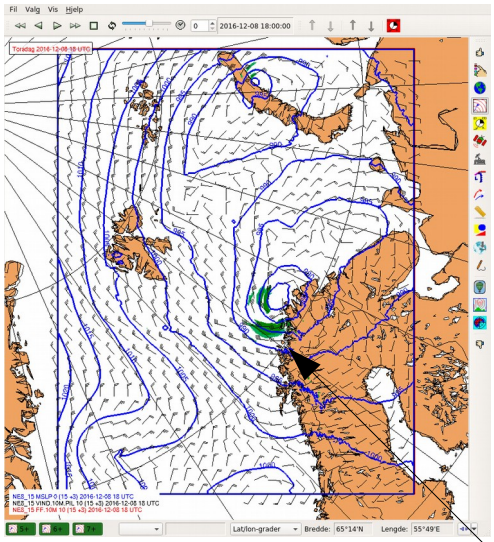
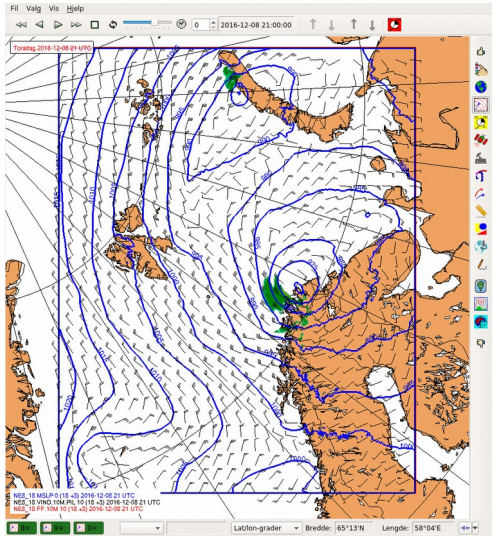
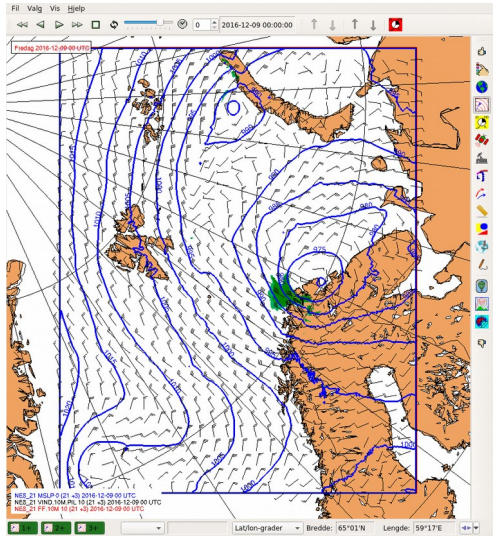


21UTC



00UTC (9 Dec)



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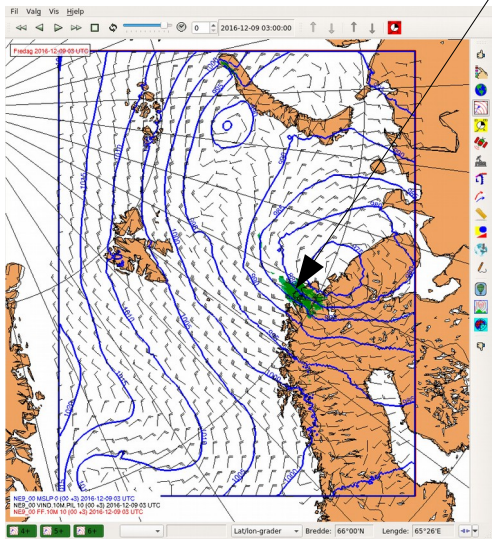
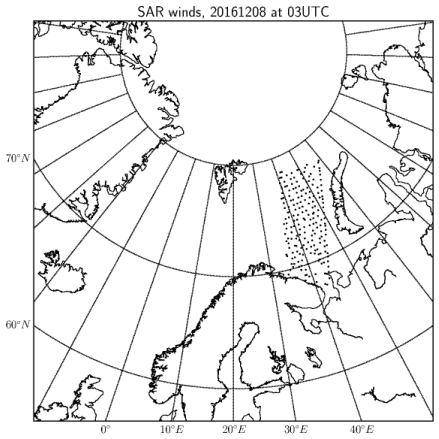
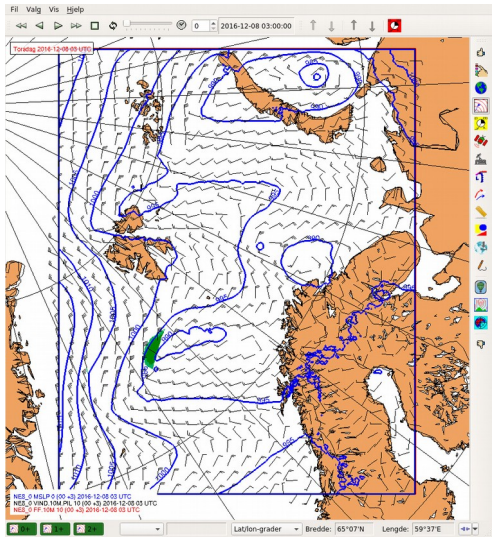


Green color shade indicate where wind speed is greater than 20 m/s

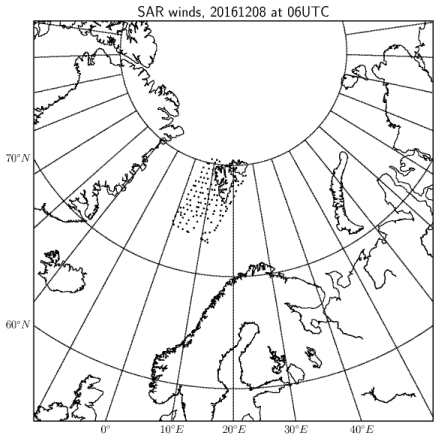
# Availability of SAR winds

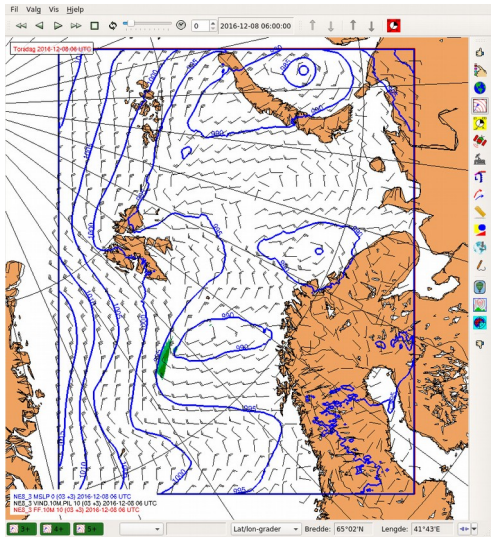
## 03UTC



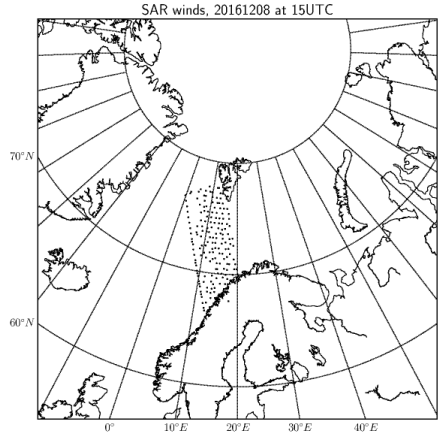



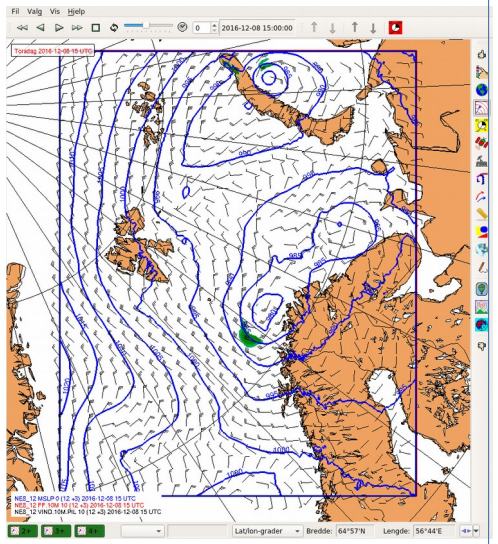
## 06UTC



## 15UTC



# Case study simulations

## Reference, or baseline, simulation

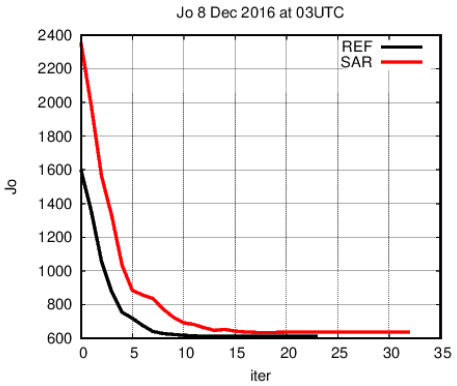
- Starts 00 UTC on 8 Dec 2016
- Warm start from the CARRA reanalysis
  (First guess from CARRA reanalysis, and bias corrections for ATOVS and IASI)
- Ends  00 UTC on 9 Dec 2016 (analysis every 3:rd hour)
- CONV, AMV, ATOVS, IASI, RO
  No scatterometer data

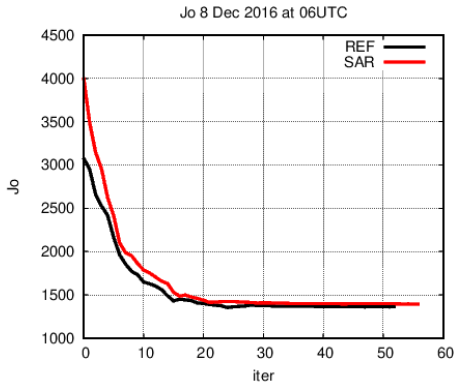
## Experiment simulation with SAR data

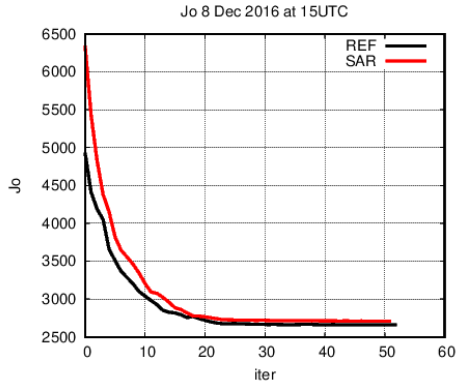
- Same as reference, but SAR data assimilated at 03, 06 and 15 UTC

# Case study simulations

## Jo costfunction minimization




Minimizes smoothly, but takes a few more iterations when SAR data is included

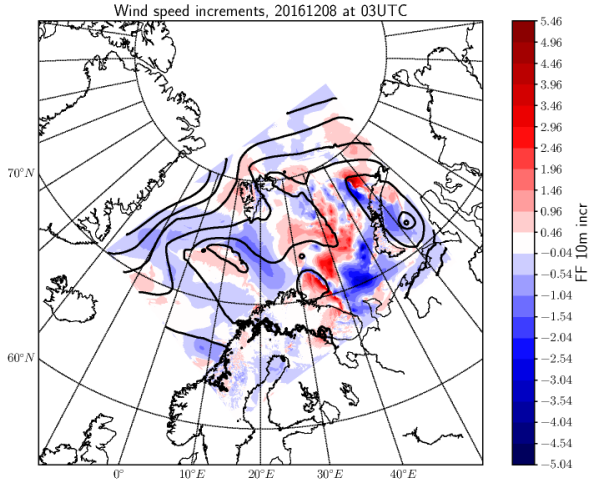
## 8 Dec 2016 at 15UTC

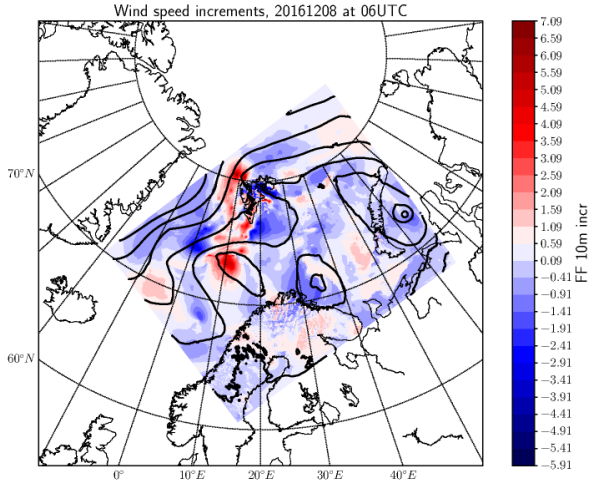
- CARRA reanalysis used similar amount of ASCAT data
- Jo for SAR (1430) much larger than for ASCAT (816)
- SAR obs errors might need tuning

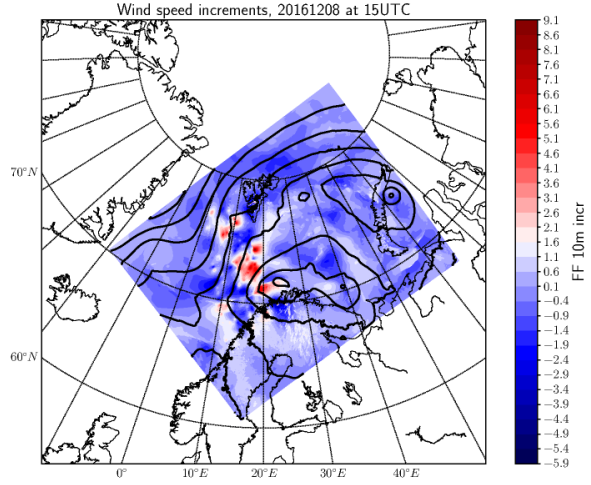
| CARRA ASCAT | Obs count | Jo | Jo/N |
|---|---|---|---|
| 1:st iter | 418 | 816 | 1.95 |
| Last iter | 418 | 35 | 0.09 |

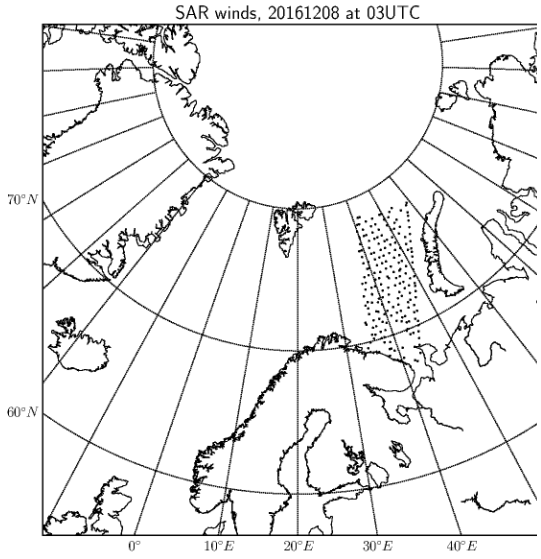
| SAR exp | Obs count | Jo | Jo/N |
|---|---|---|---|
| 1:st iter | 354 | 1430 | 4.04 |
| Last iter | 354 | 39 | 0.11 |

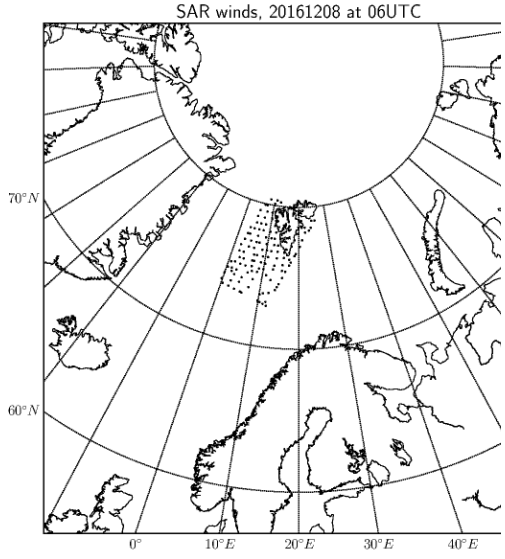
# 10m wind speed Increments

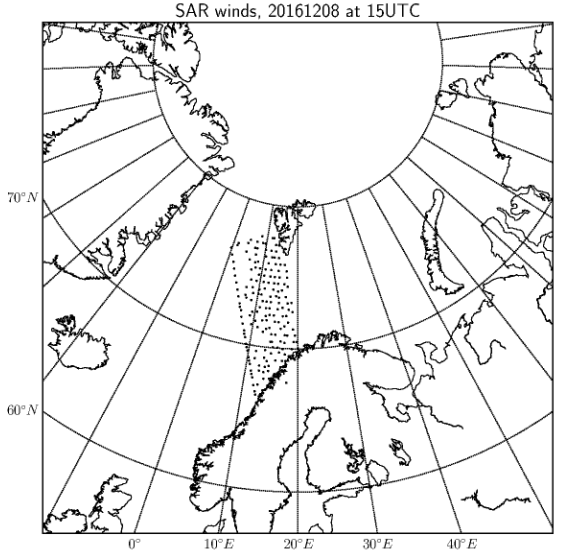


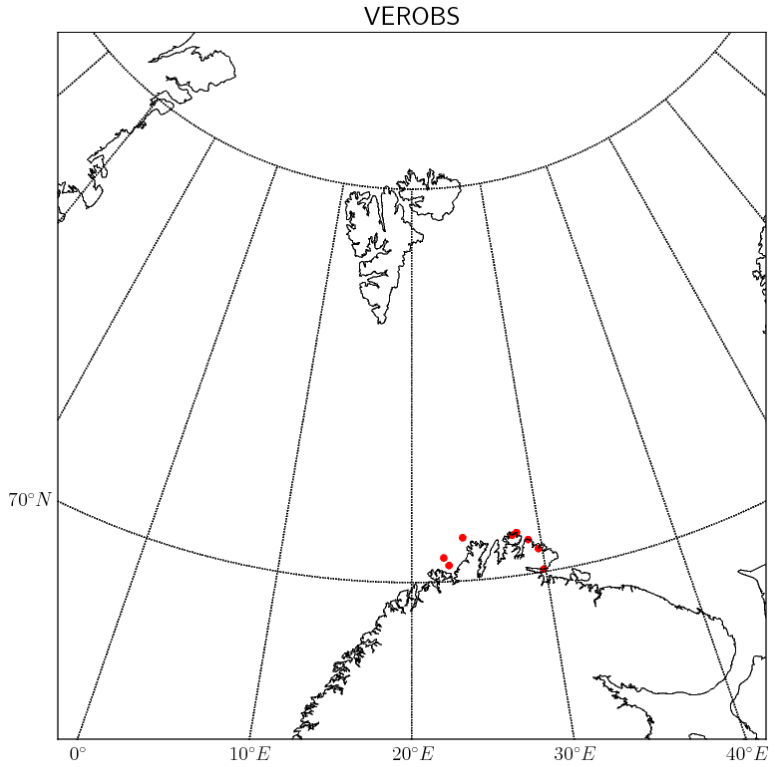
# Impact

We have done other observation denial studies for this period (with the CARRA system) and the performance is generally good when observations are taken out of the data assimilation

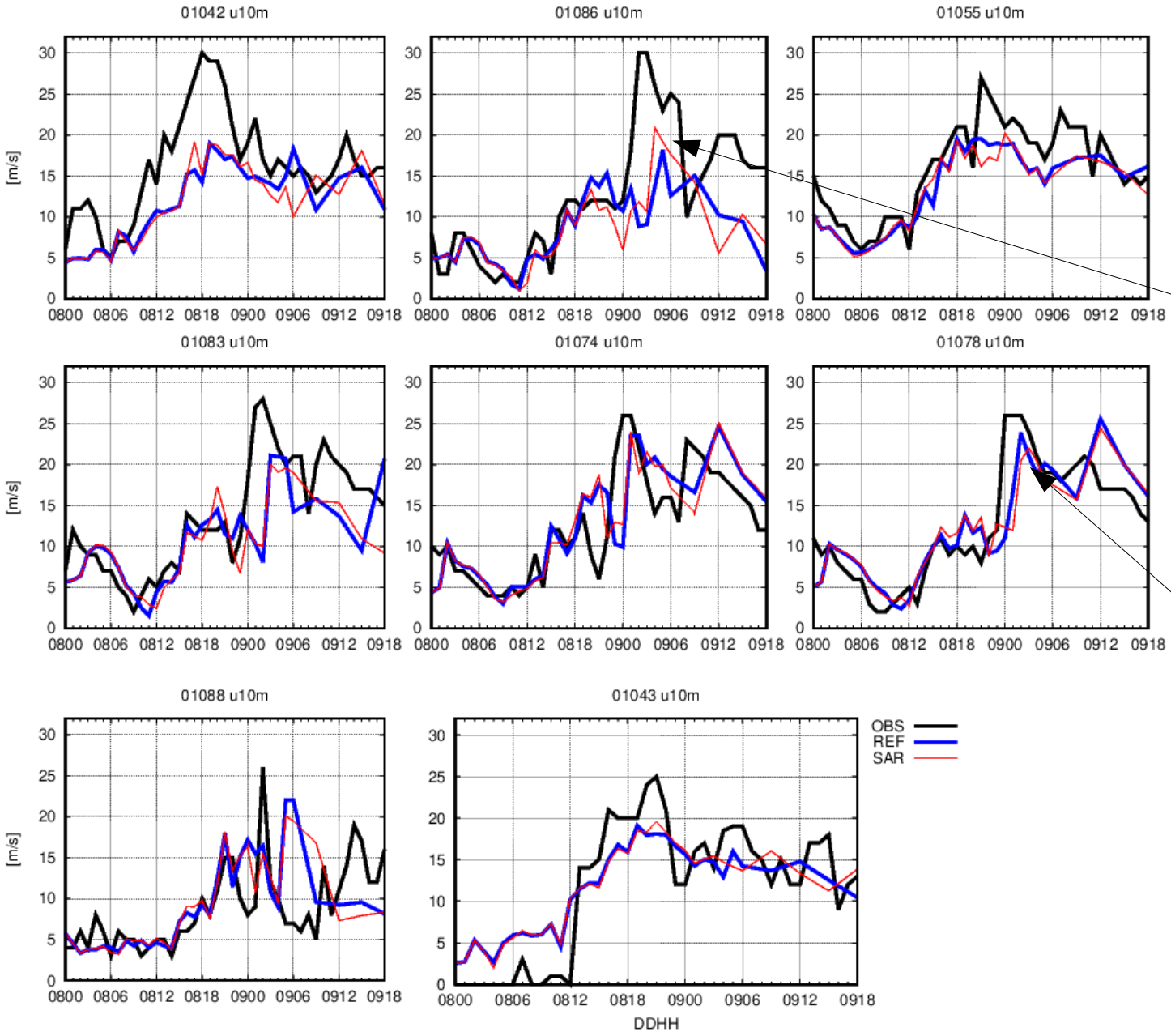
===> The CARRA system is quite robust in this case

We have selected 8 observing stations that reported >25m/s (storm)

2 stations reported 30 m/s



# Results




Overall small impact

SAR data improves, higher wind speeds

Exp with SAR data is worse than reference; lower wind speeds

# Summary

- CARRA, an AROME based reanalysis system, has been prepared to assimilate SAR winds

- Remarks:
  - Observation error tuning!
  - Quality control should be investigated
  - Methodology: thinning used now. Instead: superobbing …

  Methodology refinement needed to see better impact on NWP performance

- Impact on one intense storm case was small