Impact studies of ASCAT winds in rapidly developing storms

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19/06/2014
Outline

· Introduction
· ASCAT data usage in the HARMONIE NWP model in Norway
· Background and analysis departures
· Impact of ASCAT data assimilation on the forecast over land
· Conclusions
Polar low

Midlatitude cyclone
Experimental setup

- HARMONIE 37h1.2
- METCOOP25B domain
- Grid size 2.5 km
- ECMWF forecast used at boundaries
- 3DVar with 3-h assimilation cycle
- Two cases:
  - **Hilde storm**: Midlatitude cyclone in November 2013
  - **Polar low week**: March 2013
Questions

Data usage:

- What is the spatial and temporal ASCAT data coverage in the domain used operational domain?
- Which data are used in the data assimilation? Does the wind ambiguity selection work properly, specially close to the fronts and storm cores?

Observation departures:

- How are the ASCAT winds compared to the model forecasts (background) and the analysis (initial state)?

Forecast impact:

- Do ASCAT winds have an impact on the forecast?
ASCAT data usage in the weather prediction model

- ASCAT Global OSI-SAF Coastal product, 12.5km grid size
- Default thinning is set by the thinning factor of 4 → thinning distance of ~100 km
- Two ambiguous wind solutions are used in the data assimilation
- Observation error for ASCAT is 2.0 m/s as default
ASCAT data usage in the weather prediction model

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Data usage

- Data thinning by factor of 4 → thinning distance of ~100 km
- Data rejection close to the storm core
- Individual ambiguity selection problems related to the moving fronts

Hilde Storm
Default thinning
ASCAT winds read into the model but rejected

ASCAT winds used in the data assimilation

Black wind arrows
Harmonie winds in full resolution

Warm front in first guess
Analysis Time 12 UTC

Warm front of ASCAT winds
Measurement time 11:16 UTC
Observation departures

- **u wind component**
  - Std: 2.22871 m/s
  - Mean: -0.510425 m/s

- **v wind component**
  - Std: 2.48256 m/s
  - Mean: -0.094231 m/s

**Hilde Storm**
Default thinning
Observation departures

- The standard deviation of the analysis departure appr. 30 % smaller than the background departure
- The standard deviation of background (2.2 m/s, 2.5 m/s) is higher than the observation error set in the system (2.0 m/s)

Hilde Storm
Default thinning
Observation departures

- Background departure: Observation – background O-B
- Analysis departure: Observation – analysis O-A
- Day-to-day variations in the std
- The analysis has been changed closer to the ASCAT wind retrieval

Hilde Storm
Default thinning
Data usage

- Data thinning by factor of 1 → thinning distance of ~50 km
- Data rejection close to the storm core
- Ambiguity selection problems related to the moving fronts

ASCAT data points read into the model but thinned or rejected

ASCAT winds used in the data assimilation

Hilde Storm
Reduced thinning
Observation departures

- Larger O-B std when reduced thinning

Hilde Storm
Reduced thinning

- Mean: -0.385456 m/s
- Std: 2.25009 m/s

- Mean: -0.104766 m/s
- Std: 2.48081 m/s
Observation departures

- Smaller O-A std when reduced thinning
- More weight on the observations

Hilde Storm
Reduced thinning
Data usage

- Data thinning by factor of 1 → thinning distance of ~50 km

- Data rejection close to the polar low but also along the coast and close to the domain boundaries

Polar low week
Reduced thinning

ASCAT data points read into the model but thinned or rejected

ASCAT winds used in the data assimilation

6 Mar 18UTC
Observation departures

- Stds are larger than for the Hilde case

Polar low week
Reduced thinning
Observation departures

- Stds are larger than for the Hilde case

Polar low week
Redused thinning
Forecast impact: SYNOP

Variables to evaluate:
- Mean sea level pressure (mslp)
- 10 m wind speed (U10)

Scores:
- Bias and RMSE as forecast length

26 stations used for the evaluation
Forecast impact: SYNOP mslp

With ASCAT winds – 100 km thinning
Without ASCAT winds
Forecast impact: SYNOP mslp

RMSE and bias of mslp

Difference (90 % confidence)

With ASCAT winds – 50 km thinning
With ASCAT winds – 100 km thinning

Hilde Storm
Default & reduced thinning

Norwegian Meteorological Institute
Forecast impact: SYNOP mslp

RMSE and bias of mslp

Difference (90 % confidence)

With ASCAT winds – 50 km thinning
Without ASCAT winds

Polar low week
Redused thinning
Forecast impact: SYNOP mslp

RMSE and bias of mslp as timeseries

With ASCAT winds – 50 km thinning
Without ASCAT winds

Polar low week
Redused thinning
Forecast impact: SYNOP U10m

RMSE and bias of U10m

Difference (90 % confidence)

Hilde Storm

Polar low week
Summary

ASCAT data usage:
- Spatial coverage within the domain is good during daytime though data are strongly thinned
- Individual ambiguity selection problems close to fronts
- Data rejection issues

Observation departures:
- Wind speeds are drawn from background closer to the observations. DA works reasonably.

Forecast impact:
- Positive impact of scatterometer winds on SYNOP mslp
- Reduced thinning gives slightly improved forecasts
- No significant impact on other surface variables (yet)
Plans

- Closer look on Polar lows and other high impact events
- Evaluation of storm core tracks for Polar lows
Observed polar low tracks 2013-2014

Figure: H. Luijting, MET Norway, Tromsø
Plans

- Closer look on Polar lows and other high impact events
- Evaluation of storm core tracks for Polar lows
- Evaluation against radar reflectivity
- Work on optimal thinning distance, data rejection procedures and observation weighting
- Longer simulation periods for robust verification result
- Experiments on a newer HARMONIE version
- Operational implementation of scatterometer wind assimilation when actual
- Follow the shorter and longer term developments within the Hirlam NWP consortium, and apply and test new methods when available
Thank you!

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