Status on the use of scatterometer winds in the HARMONIE model system at MET Norway

Teresa Valkonen
Introduction

Why this research is important?

- Successfull numerical weather forecasting of storms is dependent on an accurate description of atmospheric initial state.
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What we know and don't know

- Several weather centres improve the model initial state and forecasts with scatterometer data assimilation in global models
- Impact of scatterometer winds in the high-resolution limited area model HARMONIE hasn't been shown
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Fellowship Project
- HARMONIE model experiments applying ASCAT-A and ASCAT-B data in the data assimilation with different settings
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Hypothesis

- ASCAT winds help to achieve more accurate initial state of the NWP model which would improve forecasting of mid-latitude cyclones and polar lows
Experimentation with ASCAT data

ASCAT on board MetOp-A and MetOp-B satellites

ASCAT winds

Model system

Experiments

Analysis

09 March 2015

EUMETSAT Fellow Day

Picture: EUMETSAT
Experimentation with ASCAT data

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Scatterometer wind retrieval leads to 2-4 wind solutions

12.5 km spacing
Experimentation with ASCAT data

- ASCAT on board MetOp-A and MetOp-B satellites
- Scatterometer wind retrieval leads to 2-4 different wind solutions
- The accuracy of ASCAT products is known to be characterised by a wind component RMSE < 2 m/s and bias < 0.5 m/s
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Model system

- HARMONIE model system 38h1.2, which is operational at MET Norway/SMHI at the moment
- 3D-Var assimilation of ambiguous ASCAT wind components, observation error 1.5 m/s

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HARMONIE model system 38h1.2 – operational at MET Norway/SMHI at the moment
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- 1-week thinning experiments: 50 km and 12.5 km thinning
- ~1-month Arctic domain experiment

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1-week thinning experiment: 50 km thinning

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MetCoOp & Arctic domains
Experimentation with ASCAT data

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**Analysis**
- Wind departures from model background and analysis
- Average impact on forecasts over land at surface: default, thinning and Arctic experiments
- Individual case: storm positioning and wind strength
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- **Individual case: storm positioning and wind strength**
Wind component departures from model background

- **Zonal wind component u: O-B (m/s)**
  - Std: 1.97 m/s
  - Mean: -0.02 m/s

- **Meridional wind component v: O-B (m/s)**
  - Std: 2.02 m/s
  - Mean: -0.21 m/s
Wind component departures from model analysis

- **Zonal wind component u: O-A (m/s)**
  - Std: 1.16 m/s
  - Mean: -0.02 m/s

- **Meridional wind component v: O-A (m/s)**
  - Std: 1.29 m/s
  - Mean: -0.11 m/s
Wind component departures from model background and analysis
Average impact on forecasts over land at surface

Variables
- Mean sea level pressure (MSLP)
- 10-m wind speed

Measures
- Mean error (ME)
- Root-mean-square-error (RMSE)
Average impact on forecasts over land at surface

Mean sea level pressure – errors by forecast length
Average impact on forecasts over land at surface

Mean sea level pressure – errors by forecast length

![Graphs showing mean and RMS errors for different forecast lengths and combinations of CONV, AMSU, and ASCAT.]
Average impact on forecasts over land at surface

Mean sea level pressure – errors of 12-h forecast as timeseries
Average impact on forecasts over land at surface

10-m wind speed – errors by forecast length

MEAN ERROR

2013/03/01

35 stations

Forecast length (h)

10-m wind speed (m/s)

CONV+AMSU+ASCAT

CONV+AMSU
Average impact on forecasts over land at surface

10-m wind speed – errors by forecast length

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<th>Forecast length (h)</th>
<th>MEAN ERROR</th>
<th>RMS ERROR</th>
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</table>
Average impact on forecasts over land at surface

10-m wind speed – errors of 12-h forecast as timeseries
Average impact on forecasts in thinning experiments

1-week thinning experiments

CONV+AMSU+ ASCAT 100 km thinning

CONV+AMSU+ ASCAT 50 km thinning

CONV+AMSU+ ASCAT 12.5 km thinning
Average impact on forecasts in thinning experiments

1-week thinning experiments – errors by forecast length

![Mean error chart](chart.png)

**MEAN ERROR**

- **2013/03/01**
- **35 stations**

- **CONV+AMSU+ASCAT 100km**
- **CONV+AMSU**
- **CONV+AMSU+ASCAT 50km**
- **CONV+AMSU+ASCAT 12.5km**

**Forecast length (h)**

**MSLP (hPa)**

- Range: -0.5 to 1.0
Average impact on forecasts in thinning experiments

1-week thinning experiments – errors by forecast length

![Graphs showing mean error in MSLP (hPa) and 10-m wind speed (m/s) for different forecast lengths.](image)
Average impact on forecasts over land in the Arctic experiments
Average impact on forecasts over land in the Arctic experiments

![Graph showing mean error over forecast length (h)]
Average impact on forecasts over land in the Arctic experiments

Mean error over land in the Arctic experiments with different forecast lengths (h) for MSLP (hPa) and 10-m wind speed (m/s). The graphs show the mean error for various periods and stations, with lines representing different forecast scenarios.
Individual cases: storm positioning and wind strength

Satellite image and surface observations

Torsvåg station

City of Tromsø
Individual cases: storm positioning and wind strength

MetCoOp REF – CONV+AMSU +12h
Individual cases: storm positioning and wind strength

MetCoOp SCAT – CONV+AMSU+ASCAT +12h
Individual cases: storm positioning and wind strength

Arctic REF – CONV+AMSU +12h
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Timeseries of 12-h forecast at Torsvåg station
Conclusions

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- Impact of ASCAT is small but neutral-positive
- Reduced thinning distance seems to improve results
- We don't know yet how the assimilation works in operational setting (data streams, robustness etc.)
- Impact of shorter assimilation window and revisited background errors is not known

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Why this research is important?

- When implemented into operations, improved forecasts can help to protect life and property
Next steps

Operational implementation

- Planing of implementing ASCAT data assimilation into operations has started in the framework of MetCoOp (MET Norway/SMHI)
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**Further experimentation**
- More detailed analysis of the model results available
- Impact of shorter assimilation window
- Impact of background error covariances
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Publication(s)
- Start writing a peer-review journal article about «scatterometer data impact in a high-resolution limited area model»
Thank you!

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