Radiosonde and satellite observations of topographic flow off the Norwegian coast and in fjords

Birgitte Furevik¹,², Knut-Frode Dagestad¹, Haraldur Olafsson³

¹ Norwegian Meteorological Institute
² Geophysical Institute, University of Bergen
³ Icelandic Meteorological Institute

19.05.2015
Objective

Determine sea surface winds near complex terrain using high-resolution satellite-retrieved winds

Outline
- Observations
  - Satellite SAR
  - Radiosonde
- Coast and fjord winds
  - Bodø
  - Western Norway fjords
- Conclusions
Weather ship station M
radiosonde

Sognefjord
Hardanger

Bodo
radiosonde

Honningsvåg
Polar low

Mountains
1100 m

Sola
radiosonde
+Lidar

1500 m

1000 m
What is SAR?

- Synthetic Aperture Radar
SAR wind field with external wind direction

Furevik et al., 2015, ASAR and ASCAT in polar low situations, J. Atmos. Oc. Tech.

SAR wind field with ASCAT wind direction
SAR wind field with external wind direction

Furevik et al., 2015, ASAR and ASCAT in polar low situations, J. Atmos. Oc. Tech.
Radiosonde

2-second measurements
Comparison of radiosonde and LiDAR wind at Sola

Correlation coefficients
Scanning Lidar: >0.95 (165-2500m)
Profiling Lidar: 0.6-0.9 (60-200m)

Kumer et al., Energy Procedia, 2014
Mean wind speed maps from satellite
8500 satellite images over Norway
500m spatial resolution
Envisat ASAR 500m
Mean wind speed

Wind rose 20m asl
Wind direction 850 hPa
Radiosonde wind profiles
Winter 2013/2014

Bodo
4 m/s
11 m/s
Wind rose in Bodø given the wind direction at 850 hPa
Wind rose in Bodø given the wind direction at 850 hPa
Wind rose in Bodø given the wind direction at 850 hPa
Wind rose in Bodø given the wind direction at 850 hPa
Wind rose in Bodø given the wind direction at 850 hPa
Wind rose in Bodø given the wind direction at 850 hPa

Wind rose in 20m agl. for directions in 850hPa of 340deg. 15 entries (4pct.)
From the radiosonde: All winds interacting with land are directed through the fjord.
Mean wind speed

Satellite

AROME

Longterm hindcast

AROME 2.5km. 2013.12-2014.12
Mean wind speed

Satellite

AROME

Envisat ASAR

AROME 2.5km. 2013.12-2014.12

4 m/s

11 m/s

Longterm hindcast
Mean wind Satellites

- **Envisat ASAR**
  - Mean wind speed: 4 m/s
  - Max wind speed: 11 m/s

- **AROME 2.5km.**

---

**Kvamsøy**

- Mean FF: 4.3 m/s
- Max FF: 27.5 m/s

**Slatterøy**

- Mean FF: 6.1 m/s
- Max FF: 25.1 m/s

**Mean FF**

- Mean FF: 4.3 m/s
- Max FF: 27.5 m/s
Mean wind speed

**Satellite**

- **Sognefjord**
  - Mean wind speed: 3 m/s
  - Distance: 80 km

- **Hardanger**
  - Mean wind speed: 8 m/s
  - Distance: 80 km

**AROME**

- **Vangsnes**
- **Takle**
- **Utne**
- **Varaldsøy**
- **Odda**
Mean wind speed

Satellite

Sognefjord

Hardanger

Sognefjord

3 m/s

8 m/s

Varaldsøy

Kvamsøy

Utne

Odda

Vangsnes

Takle

4 km

2 km

80 km

http://baatplassen.no
Conclusions

- 8500 ASAR images from Envisat satellite are averaged to form mean wind speed (10m height) maps over the Norwegian coast and fjords
  - Useful details about wind enhancements in parts of the fjords and at fjord outlets where there are no ground observations
  - Absolute wind speed may be too strong
- 2-second measurements from radiosonde are useful for studying the wind profiles starting at 15-20m
- The AROME 2.5km operational model at MET represent the fjord winds quite well
  - Weak gradients in the model are attributed to the resolution and the representation of the complex terrain in the model