StormGeo

Control in a changing environment

Utfordringer i den operative værvarslingen i nordområdene

Dr. Olav Krogsæter

Senior scientist and meteorologist

Decision Support for Weather Sensitive Operations

StormGeo Group – Where we are

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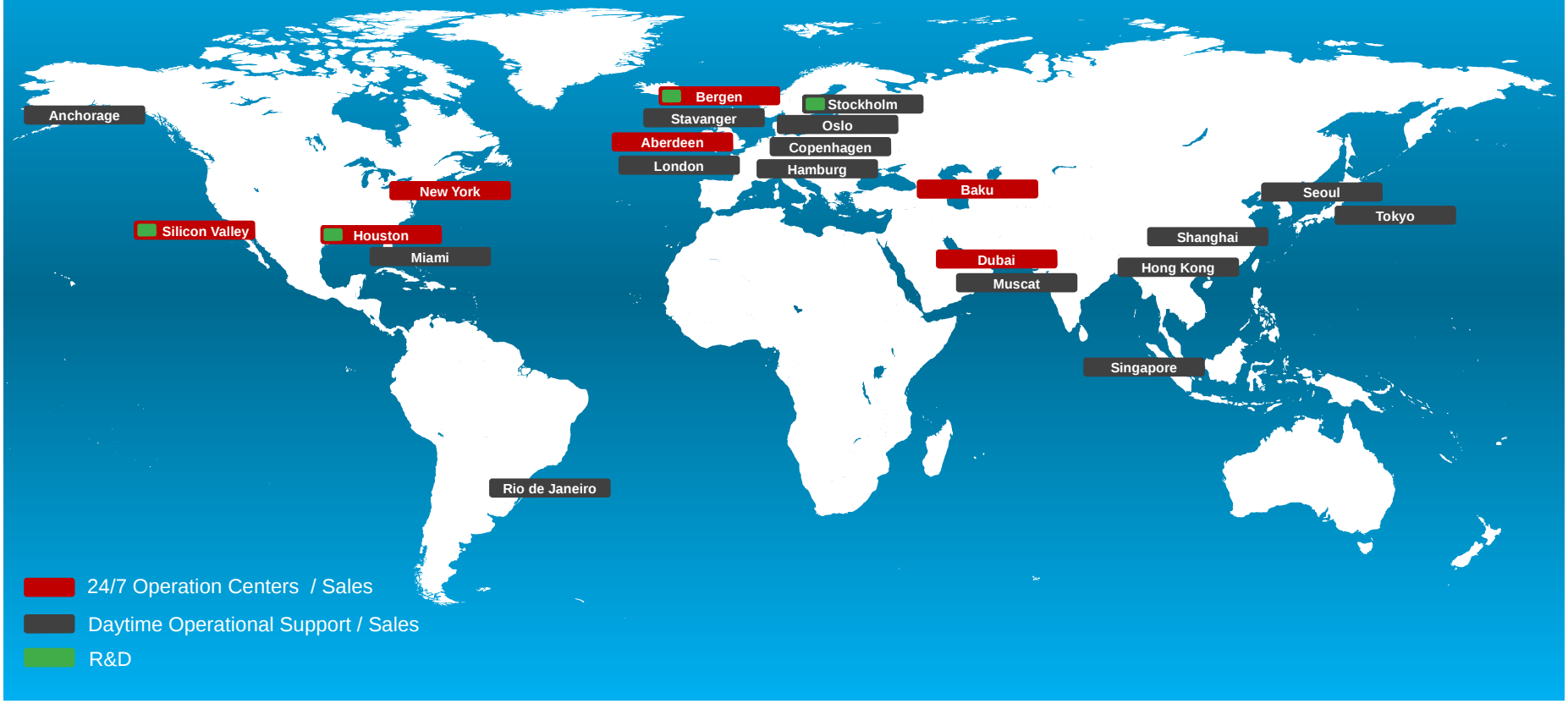
22 Offices, 7 Forecast Centers



COMPETENCE - INSPIRATION - INNOVATION

Outlook - Arctic challenges

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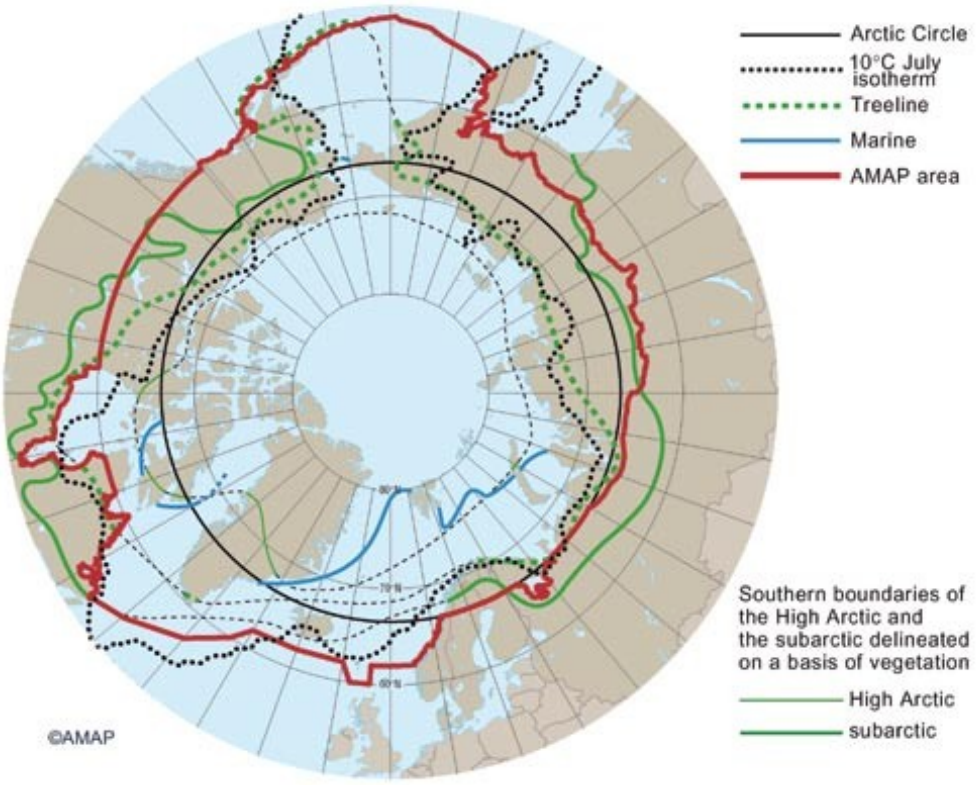
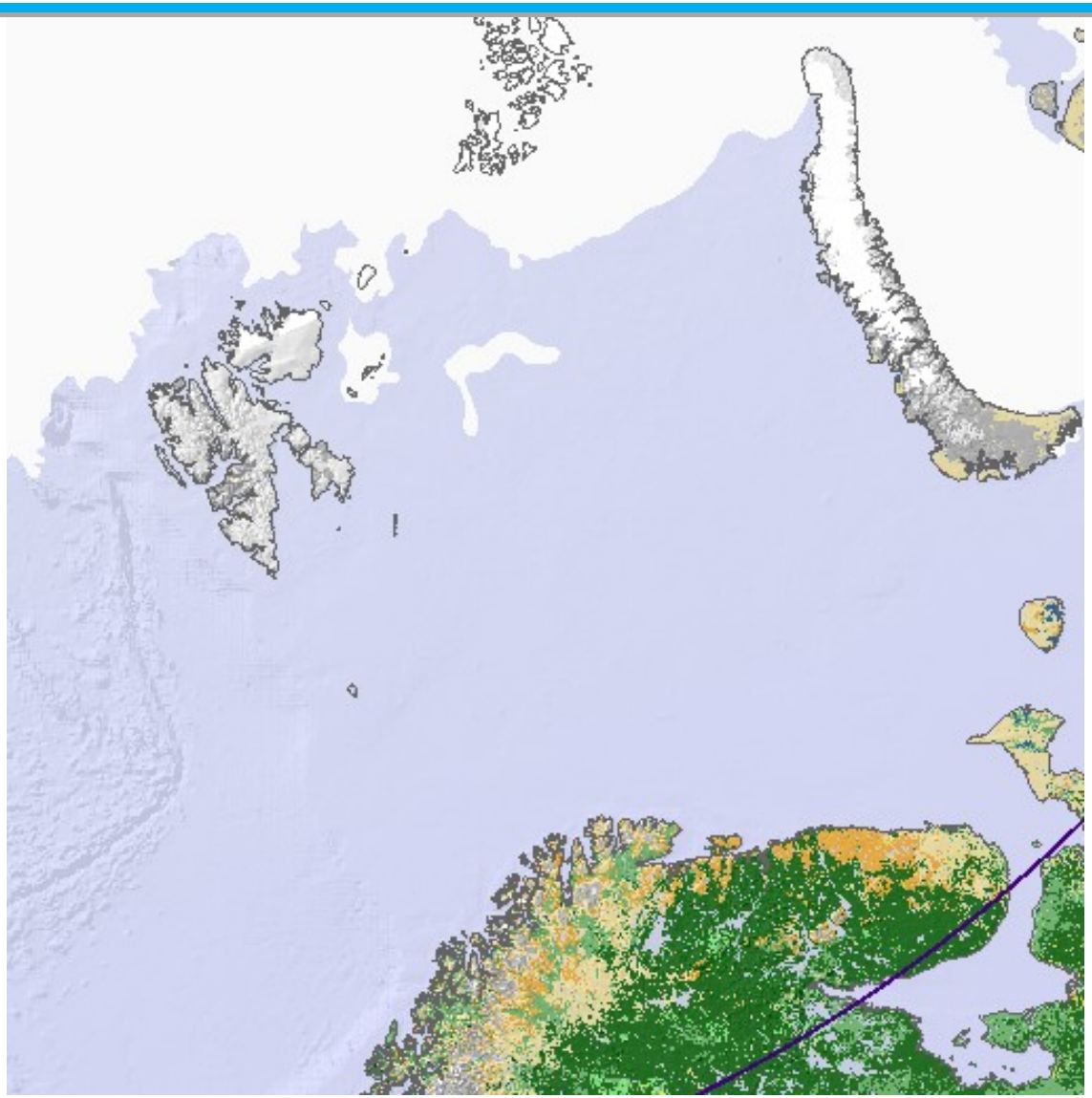
- Climatic background
- Observations -> Forecasts
  - Ground based observations
  - Satellite observations
- Sea Spray Icing forecasts
- Visibility forecasts
- Weather RADAR
- Sea ice forecasts
- Polar lows, arctic fronts
- High resolution weather models
- Other forecasting products
  - Response forecasts
  - SAR forecasts

So what are the new challenges?





BACKGROUND

Barents Sea

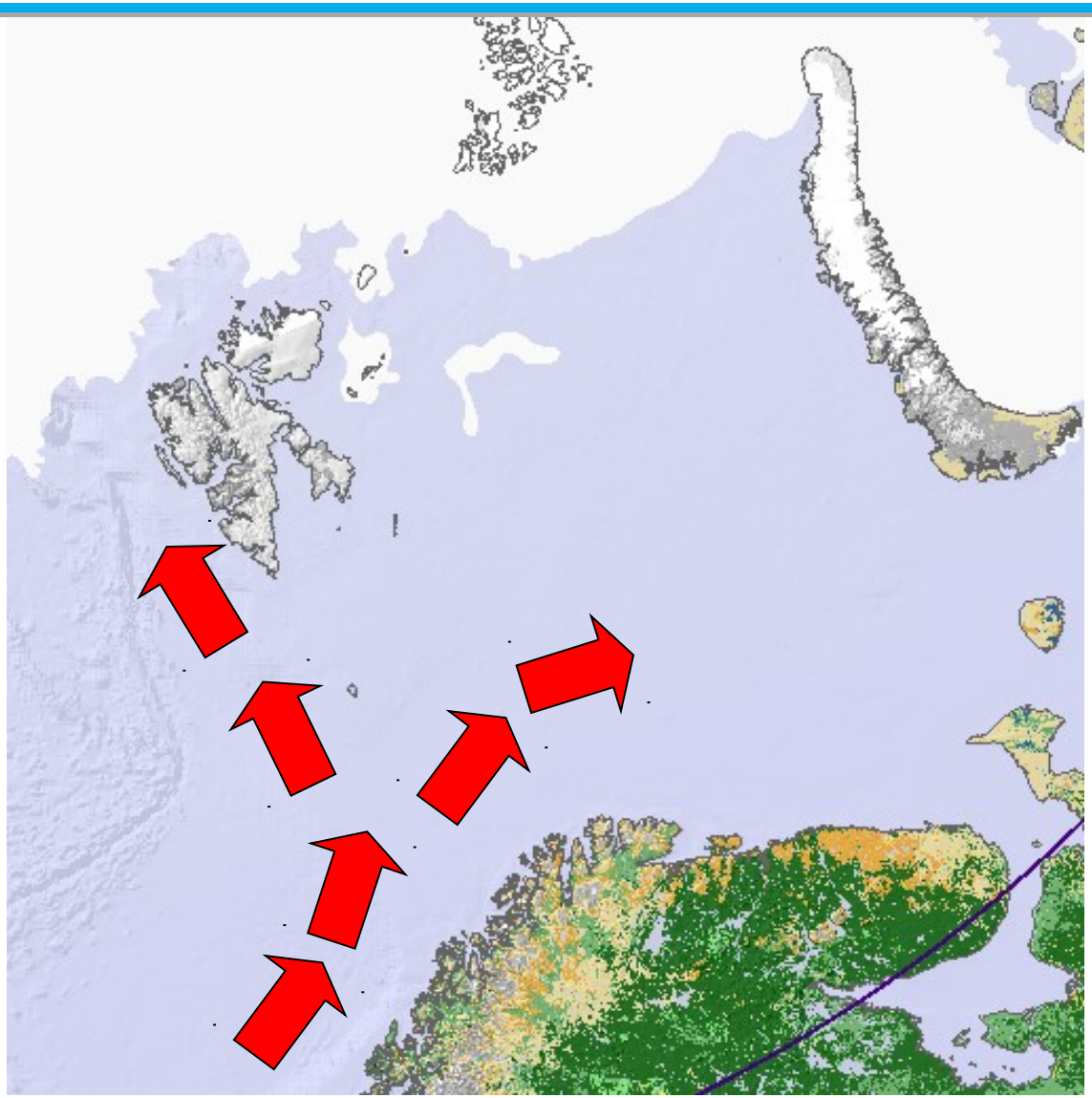
-relative shallow water

-Very warm relative to latitude

-Large seasonal variability in ice extent and temperature

-In the border zone between the ”cold” and the warm

-Especially valid for wintertime conditions



Ice covered sea temperatures
–15 to –30 C

+

Open sea, Sea temperature 4-6 C

+

Northern Russia

temperatures

– 30 to –50

=

A CHALLENGE FOR WEATHER FORECASTING

Significant wave height, Hs

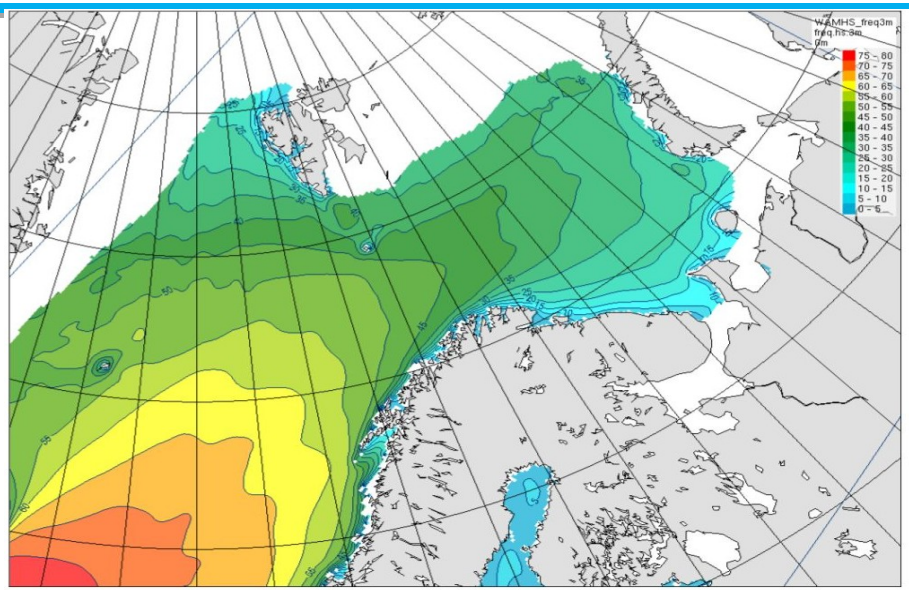


Fig. 3.2.12 Prosentvis forekomst av Hs > 3 m i januar

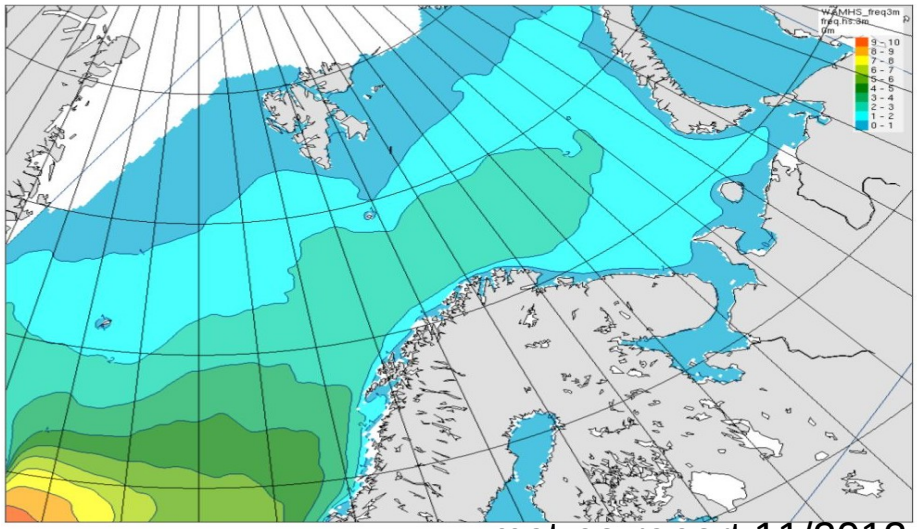


Fig. 3.2.15 Prosentvis forekomst av Hs > 3 m i juli

Much higher waves in the Norwegian Sea than in the Barents Sea.

To be discussed:

Average winds and waves are «better» in the Arctic than further south, but strong small scale weather phenomena are much more unpredictable, together with lower temperatures, icing etc.: What are the consequences?

met.no report 11/2012

From observations to weather forecasts

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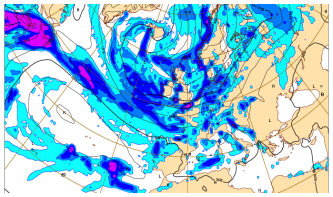
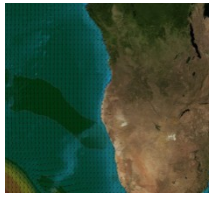
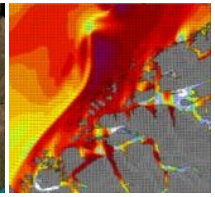
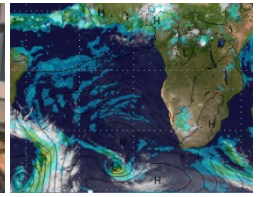
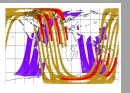
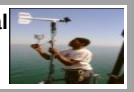
Observations	Global scale models	Regional and local scale models	Forecasting	Visualization	Products/ Deliveries




Global and local

- Satellite 
- Conventional 
- Buoy 
- Aircraft 
- Soundings 
- Other

Modelling and statistical postprocessing

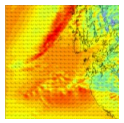
Level 1 models

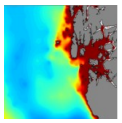
16-100 km resolution

ECMWF

National/Other

1-9 km resolution

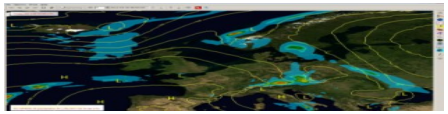
WRF 

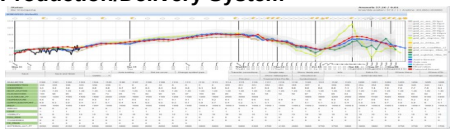
SWAN 

Level 2 models (StormGeo impact modelling):
Oil spill, statistical post processing, response modelling.
Ship optimal routing.

Forecast production systems

24/7 forecasting 

Digital analysis 

Production/Delivery System 

PRODUCT PLATFORM

- Offshore
- Renewables
- Media
- Aviation
- Shipping
- Onshore

Ground based observations

few observations in the north

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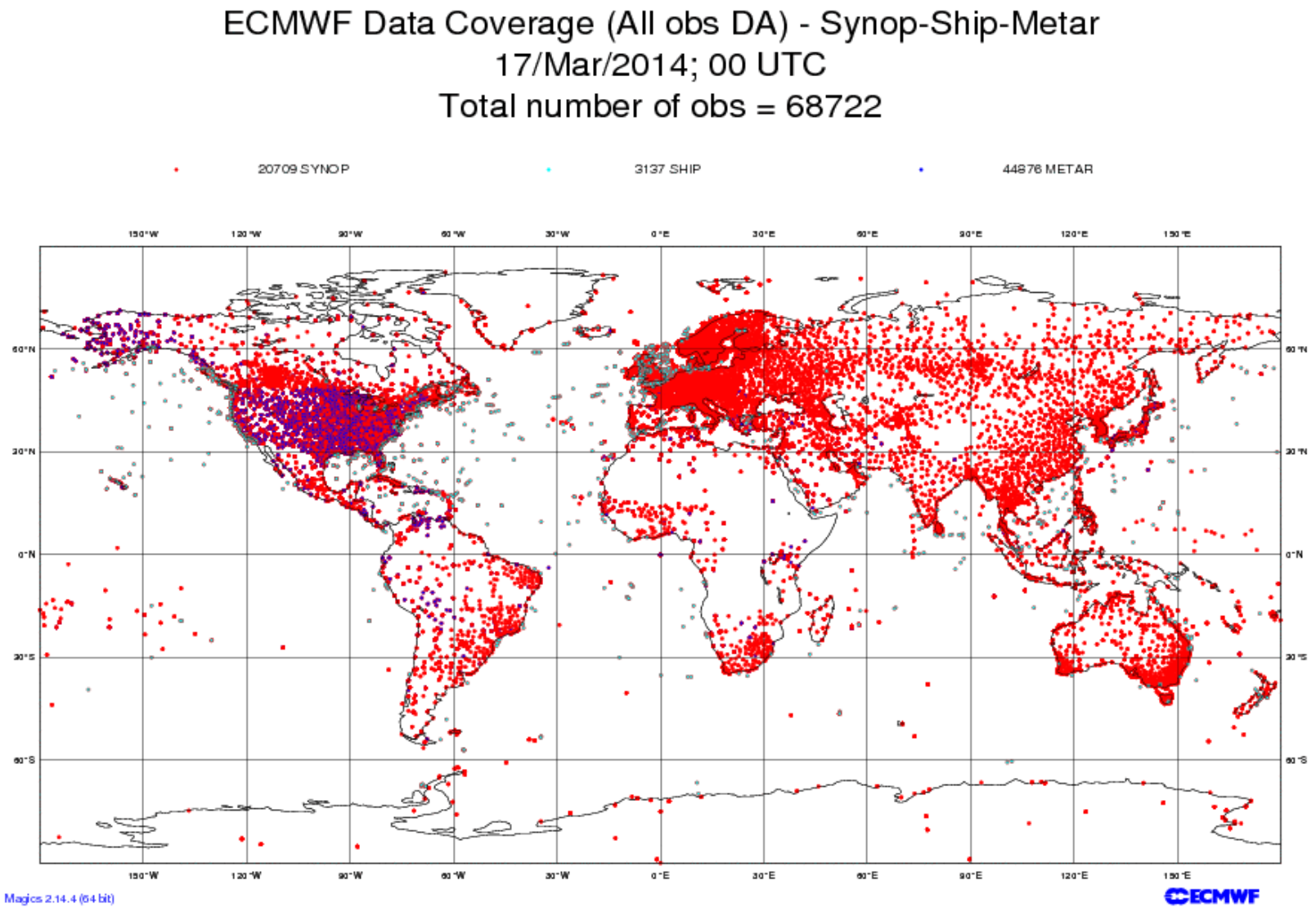

Buoy observations – drifters

few observations in the north

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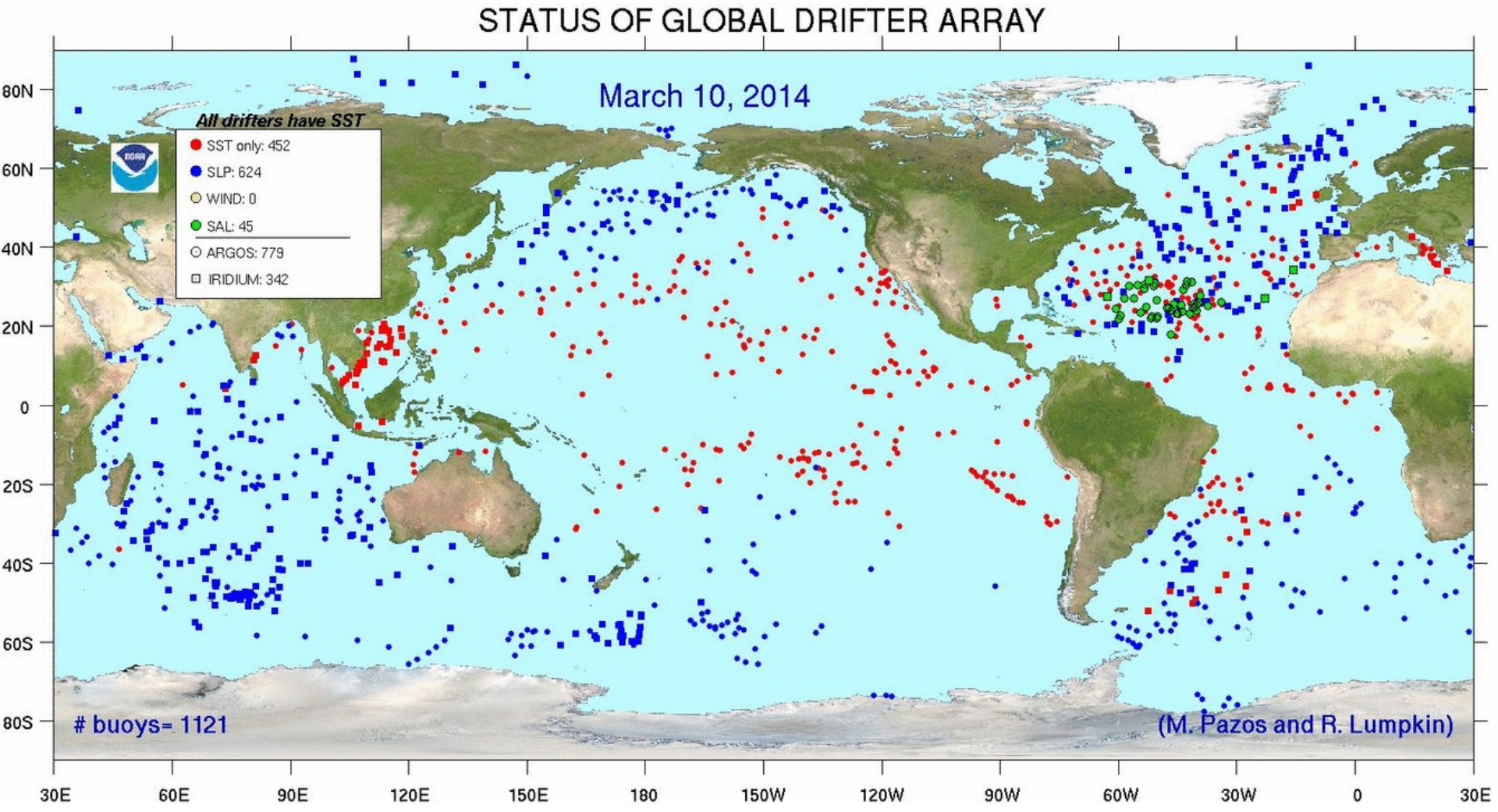
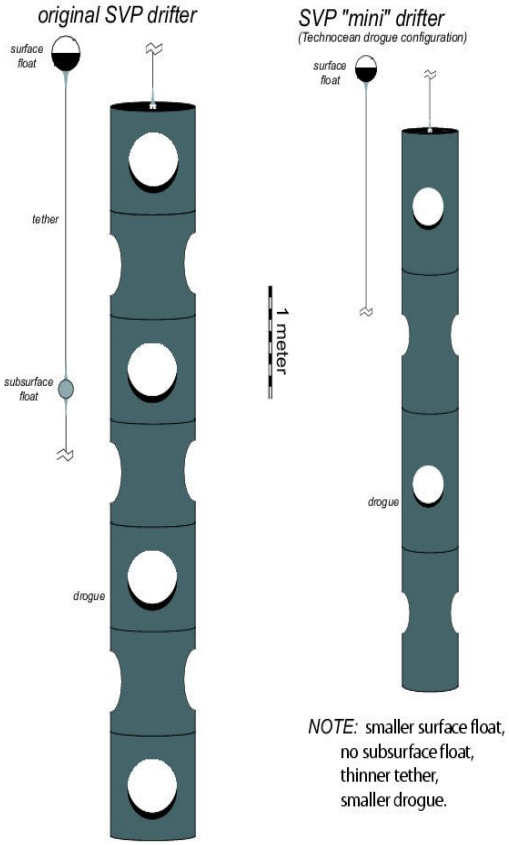
Control in a changing environment



Buoy observations - drifters



To be discussed: To invest in weather buoys is a rather cheap way of getting more observations from the northerly offshore regions together with observations from vessels and rigs.

Data quality is an issue!

Aircraft observations

almost non observations in the north

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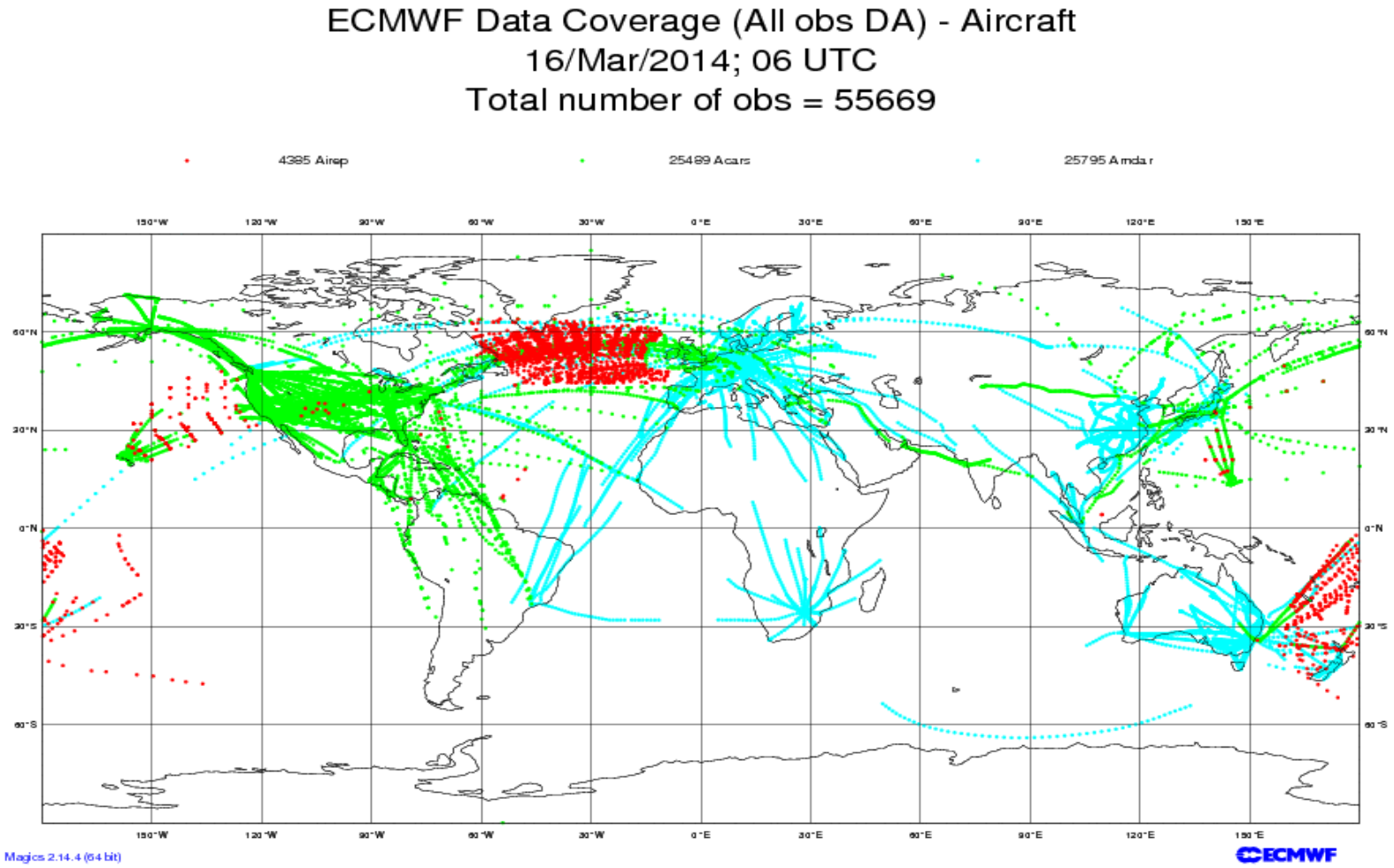

Satellite observations

geostationary satellites do not «see» higher latitudes

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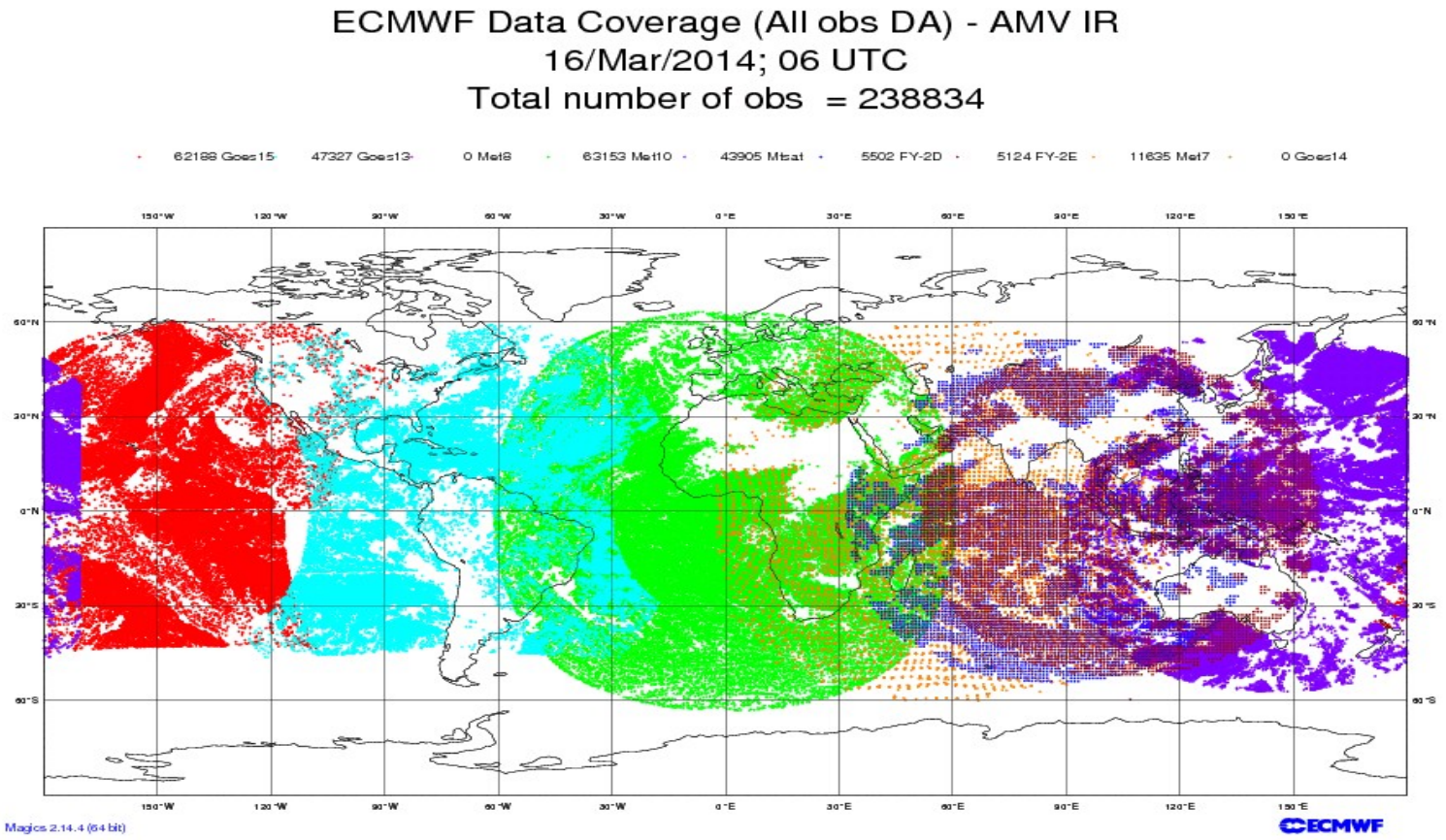

Satellite observations

polar orbiting satellites «see» higher latitudes only at certain times

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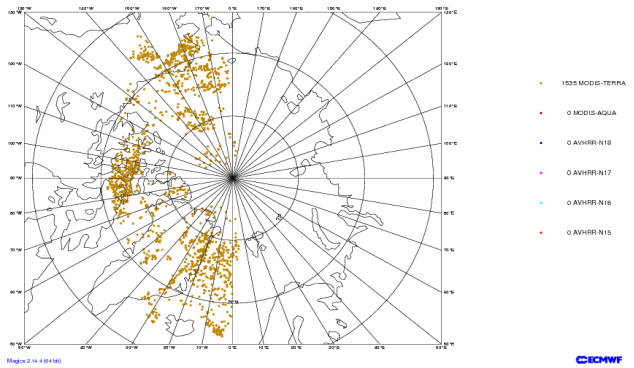
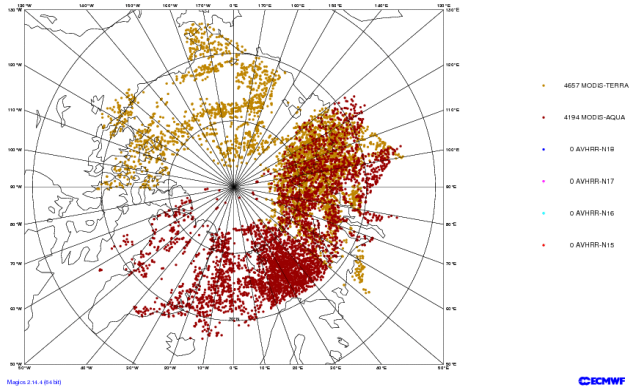
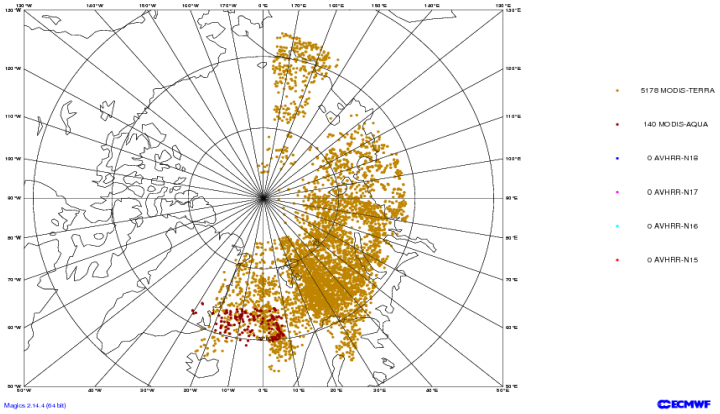
ECMWF Data Coverage (All obs DA) - AMV POLAR IR
17/Mar/2014; 00 UTC
Total number of obs = 1535



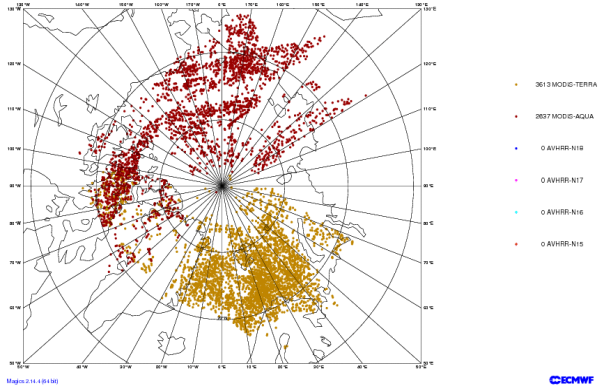
ECMWF Data Coverage (All obs DA) - AMV POLAR IR
16/Mar/2014; 06 UTC
Total number of obs = 8851



ECMWF Data Coverage (All obs DA) - AMV POLAR IR
16/Mar/2014; 12 UTC
Total number of obs = 5318



ECMWF Data Coverage (All obs DA) - AMV POLAR IR
16/Mar/2014; 18 UTC
Total number of obs = 6250



Prediction of Sea Spray Icing

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Ice accreation

Wind
+
Waves
+
Low air temperature
=
Icing

74.00N, 32.88E,
Dec.-April.:
Light: 29-33 %
Moderate: 12-15 %
Severe: 1-6 %
Extreme: 0-2 %

(Source: met.no report 11/2012)

Prediction of Sea Spray Icing

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Prediction of Sea Spray Icing

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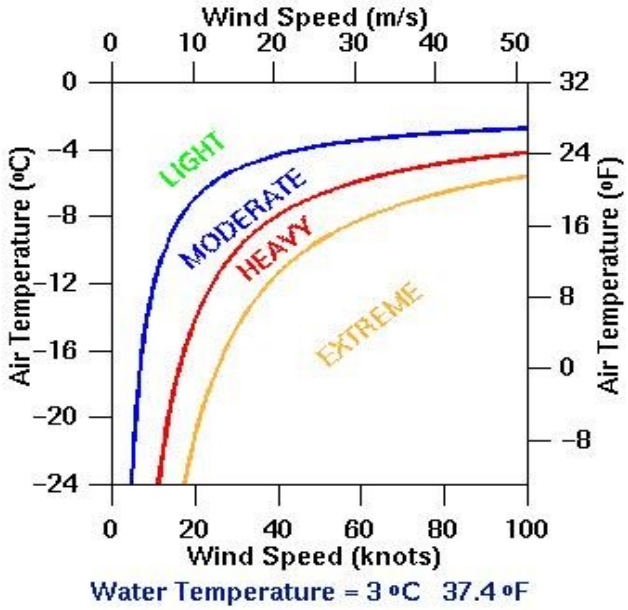
Need of accurate predictions of:

- Wind speed
- Air temperature
- Sea Surface Temperature (SST)
- (Freezing point of sea water (appr. -1.7C, dependent on the salinity)



Calculated by the algorithm presented by Overland (1990).

Fog prediction

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- Very difficult to predict!
- Can only give some sort of probability of occurence in time and space.
- Typical summer phenomenon – up to 20-30 % of the time in June-August in the Barents Sea.
- Solution: Better representation of the physical and dynamical procesess in the Marine Atmospheric Boundary Layer (MABL) in the weather models – and more and better observations. This is a slowly progress and needs a lot of research – to be discussed.

RADAR coverage

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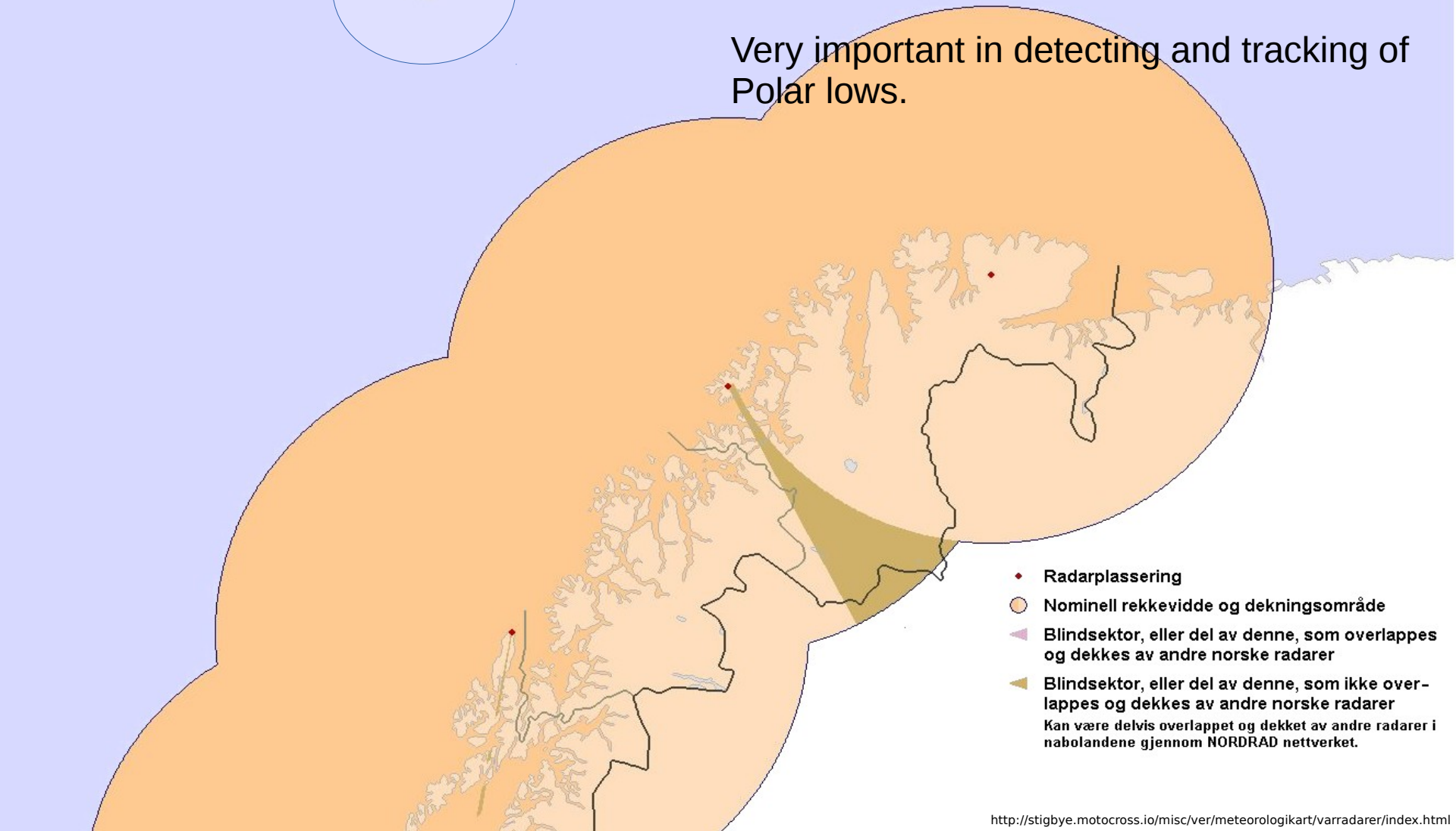
Bjørnøya

To be discussed:
We need a weather RADAR at Bjørnøya!

Very important in detecting and tracking of Polar lows.



http://stigbye.motocross.io/misc/ver/meteorologikart/varradarer/index.html

Sea ice – a major factor in Arctic weather

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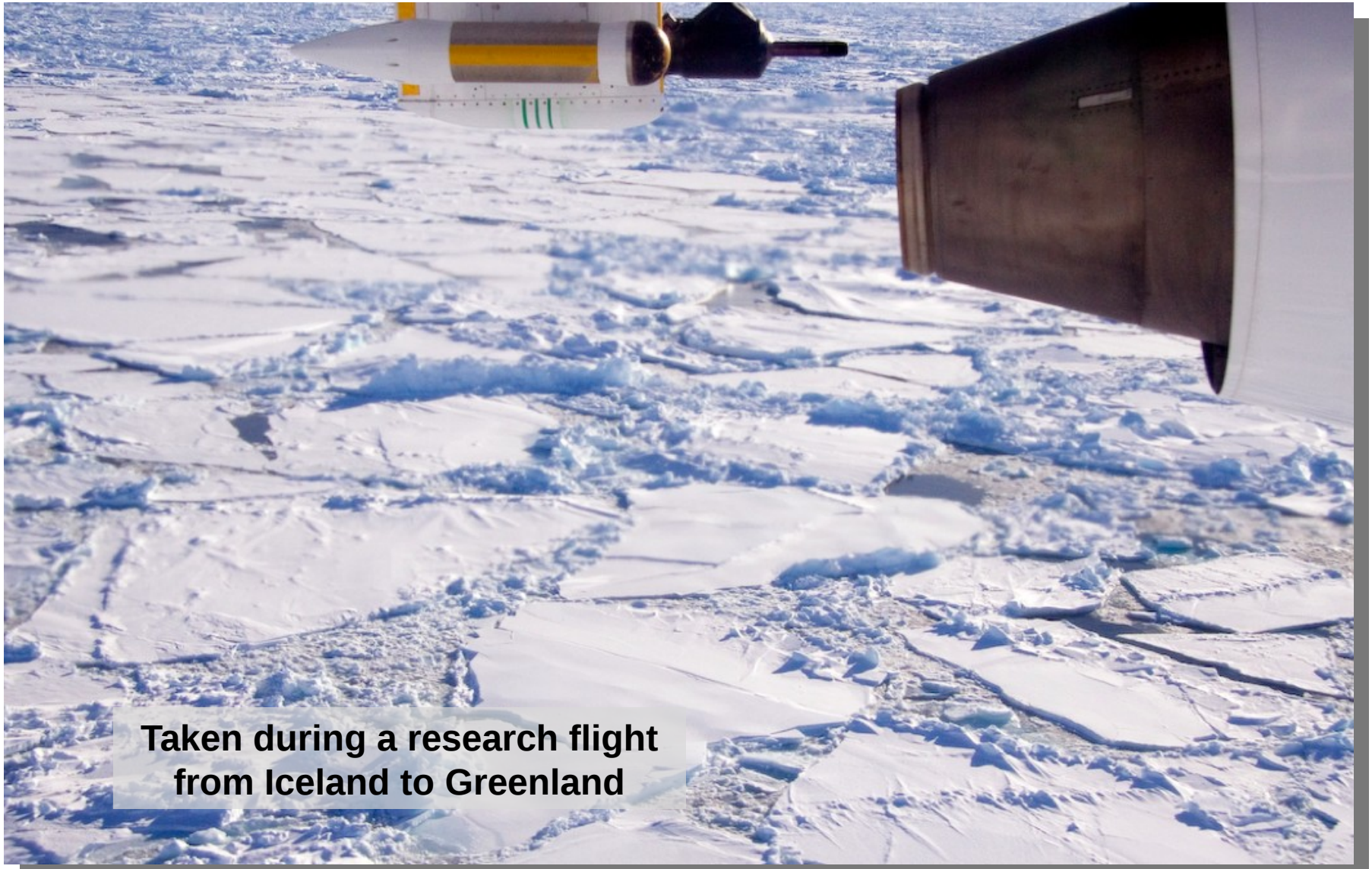

Radar satellite ice concentration
- cloud cover is no limitation -

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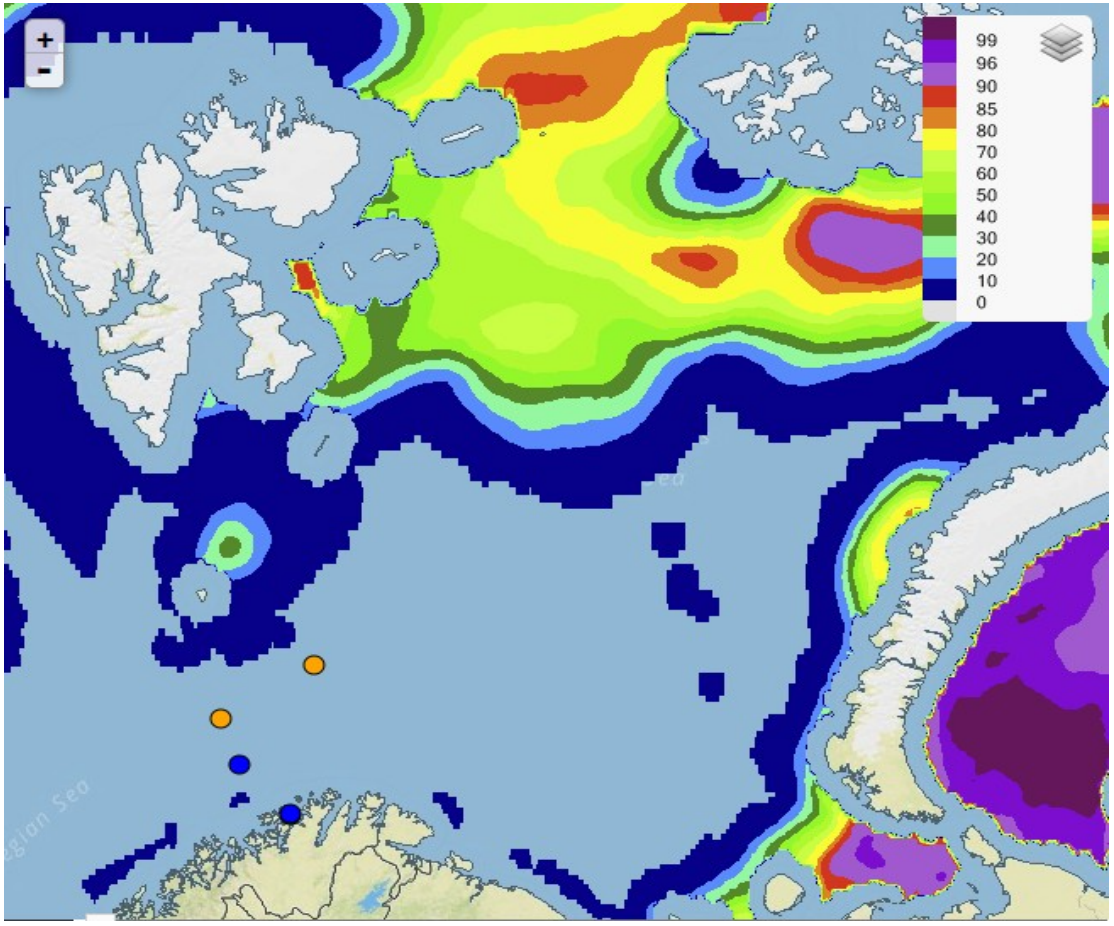
OSI SAF: Ocean and Sea Ice Satellite Application Facility
10 km pixels - 25 km buffer from coastline
(March 18th 2014)



EUMETSAT

METEO FRANCE

DMI

Koninklijk Nederlands Meteorologisch Instituut
Ministerie van Infrastructuur en Milieu

Norwegian Meteorological Institute

Ifremer

Radar satellite ice concentration
- cloud cover is no limitation -

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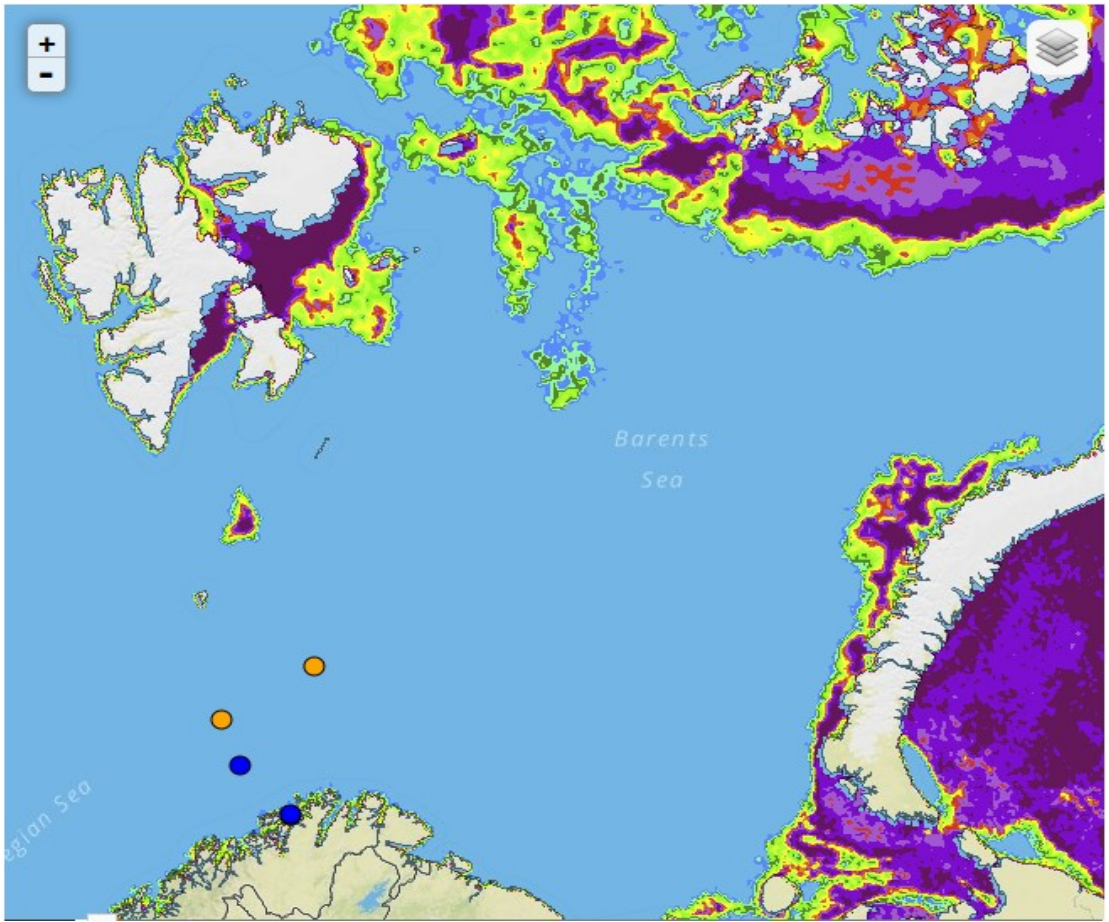
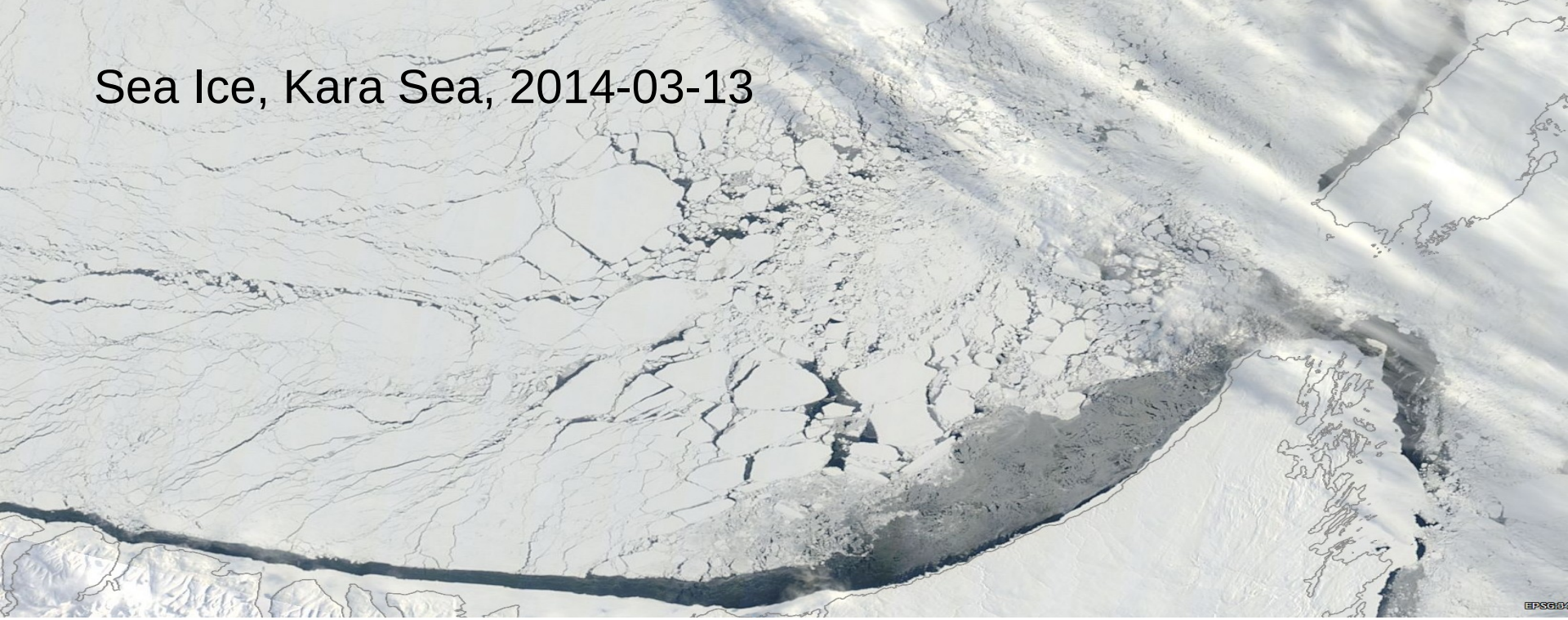
AMSR2: Advanced Microwave Scanning Radiometer 2
Down to 3.25 km pixels – no buffer from coastline
(March 18th 2014)




Sea Ice, Kara Sea, 2014-03-13


Sea Ice, Kara Sea, 2013-03-15

Sea ice forecasts?

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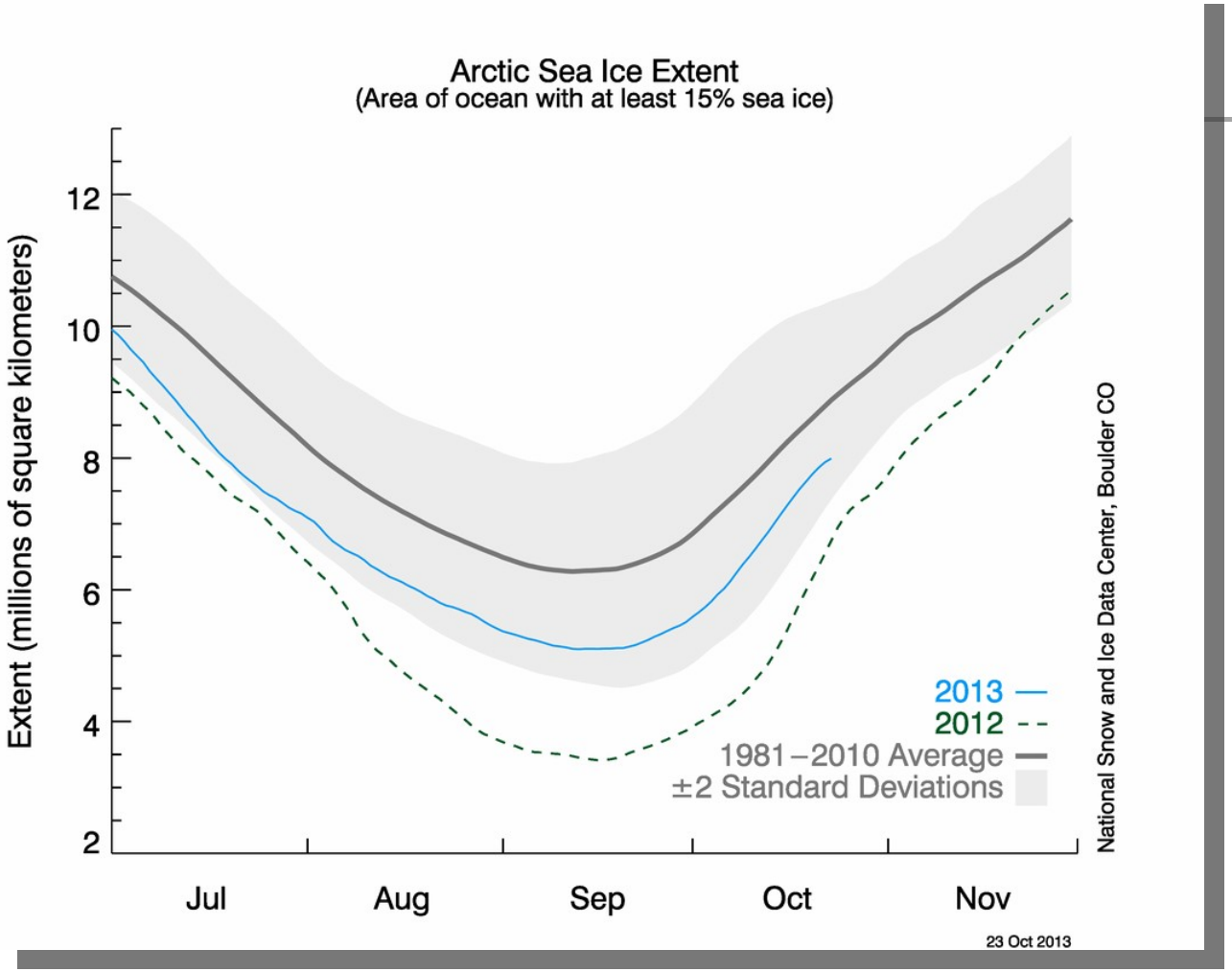
- Today: Daily updated sea ice charts

- Day-to-day sea ice *forecasts* are almost non existent

To be discussed:

- Are sea ice *forecasts* really necessary?
  - A complex system of interaction between the atmosphere, waves, and sea currents (very poorly represented in today's numerical models) – need a lot of research resources.



Sea ice retreat in the Arctic will lead to new opportunities, but also massive changes to weather and ocean conditions.

Arctic conditions not uniform

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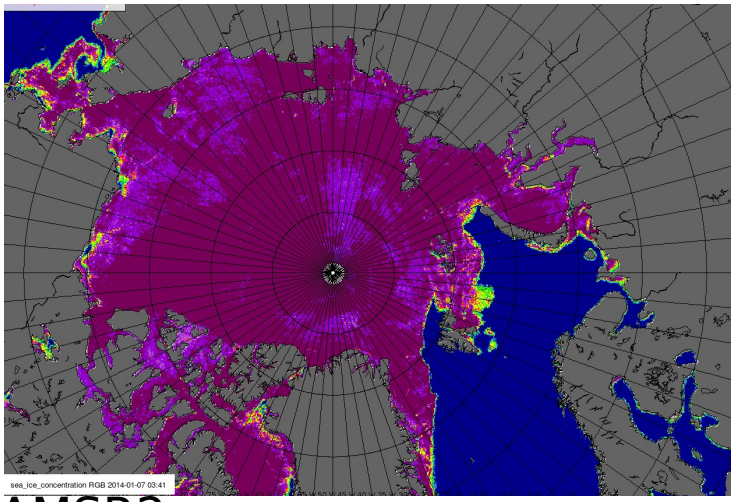
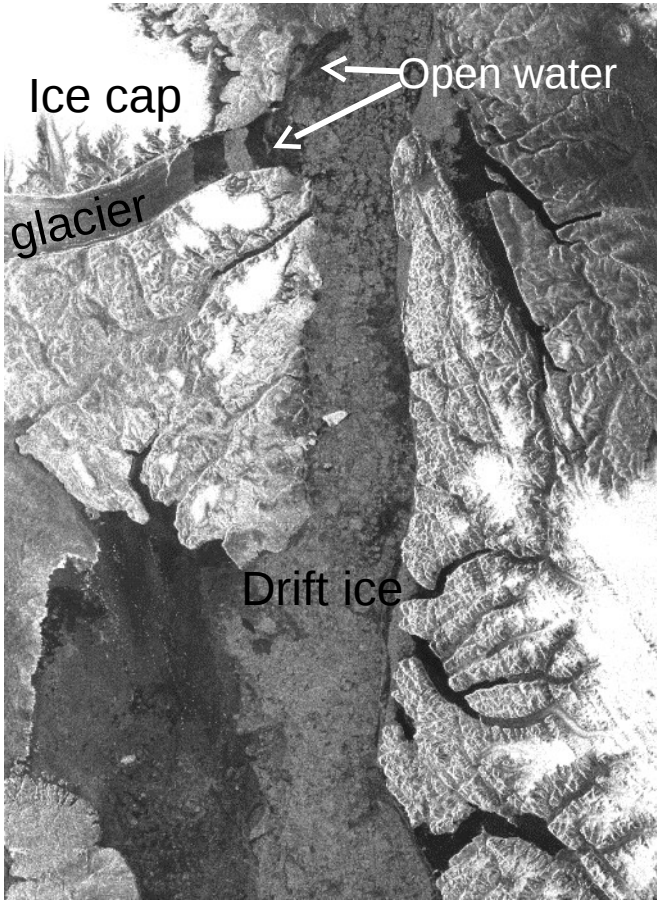
- Drilling operations in partly ice covered waters
  - Short operating windows
- Transport of modules through the Barents Sea
  - Risk of icing and stability challenges
- LNG-transport in ice covered waters
  - Ice breaker capabilities



AMSR2



Arctic weather

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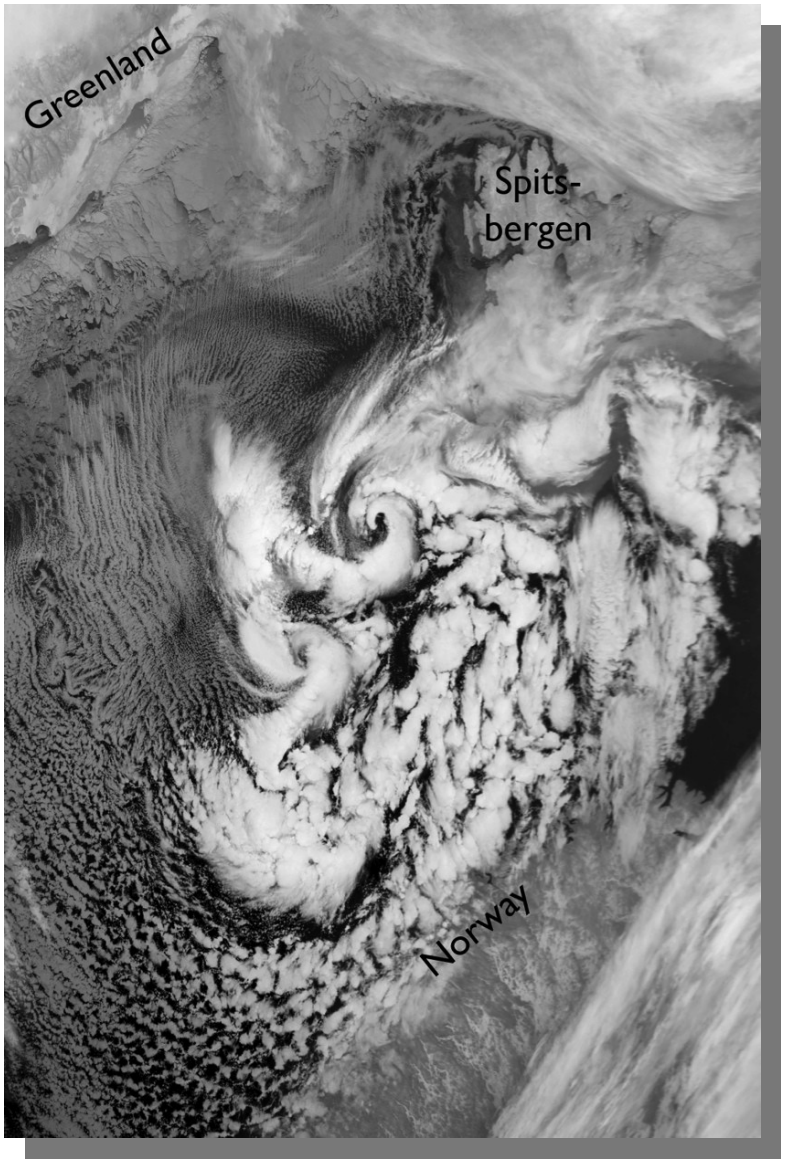
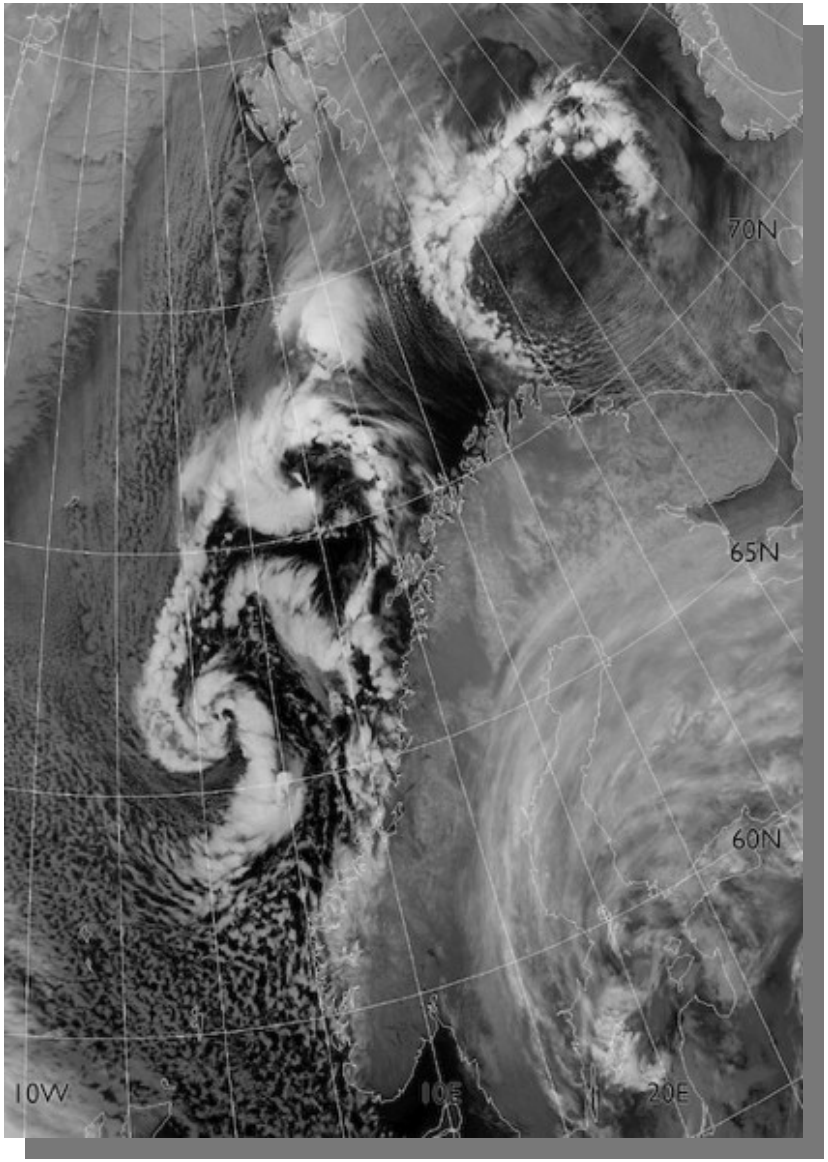
In addition to problems with icing, fog, and sea ice, some Arctic weather phenomena are very difficult to forecast properly.

These include:

- Polar lows
- Arctic fronts
- Jets near the sea ice edge and mountains



Cold air outbreaks

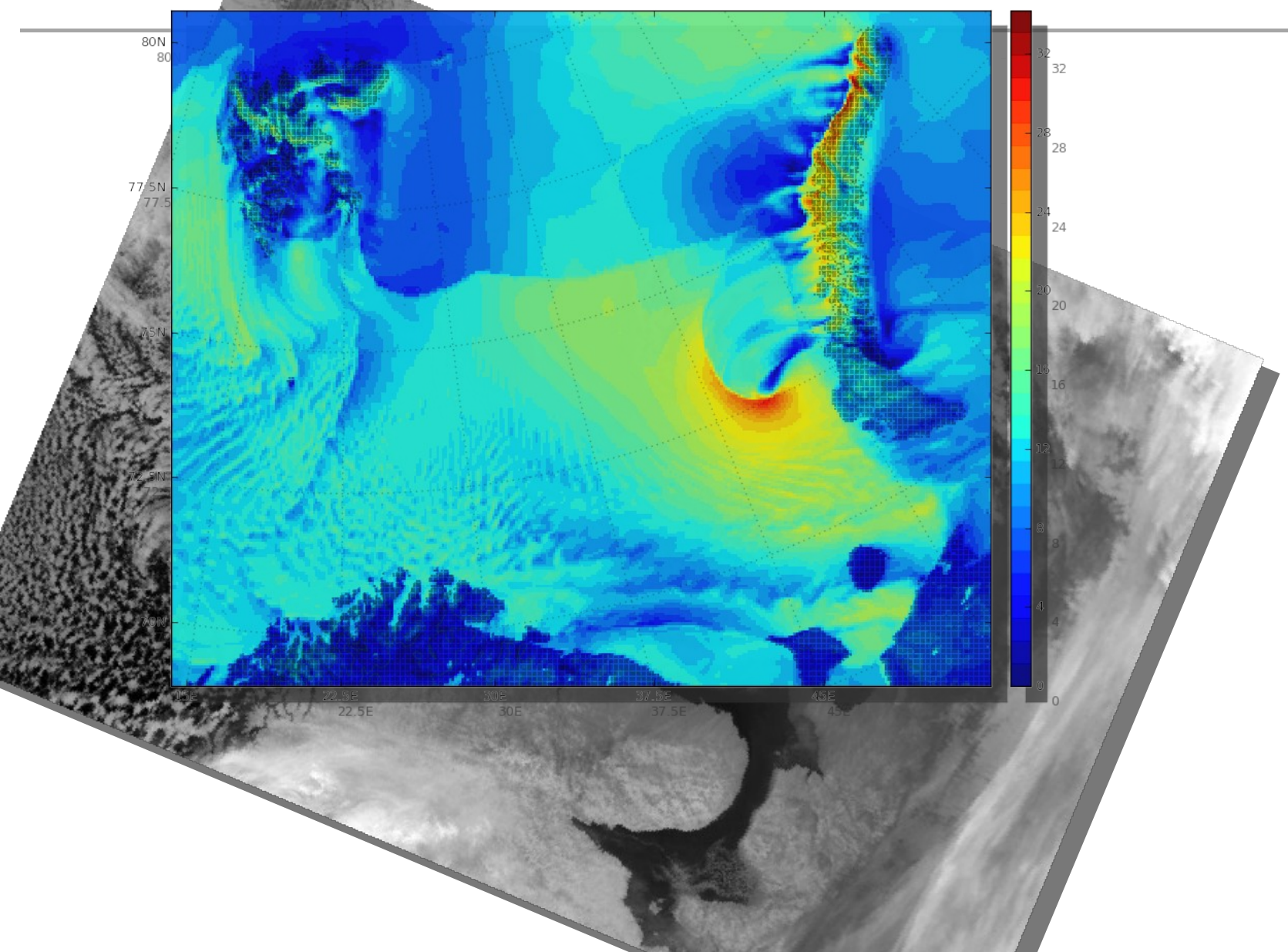


Polar lows and Arctic fronts always occur in cold air outbreaks.

Cold air outbreaks are common in the Nordic Seas region, near Japan and in the Labrador Sea.

Probably not as common in the Chukchi and Beaufort Seas, but this is likely to change.

Polar low off the coast of Novaja Zemlja



Fewer polar lows?

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The air warms up faster than the ocean

⇒ the air becomes more stable

⇒ fewer low pressure systems

BUT! The retreating sea ice opens up new regions for polar low development.

Climate change

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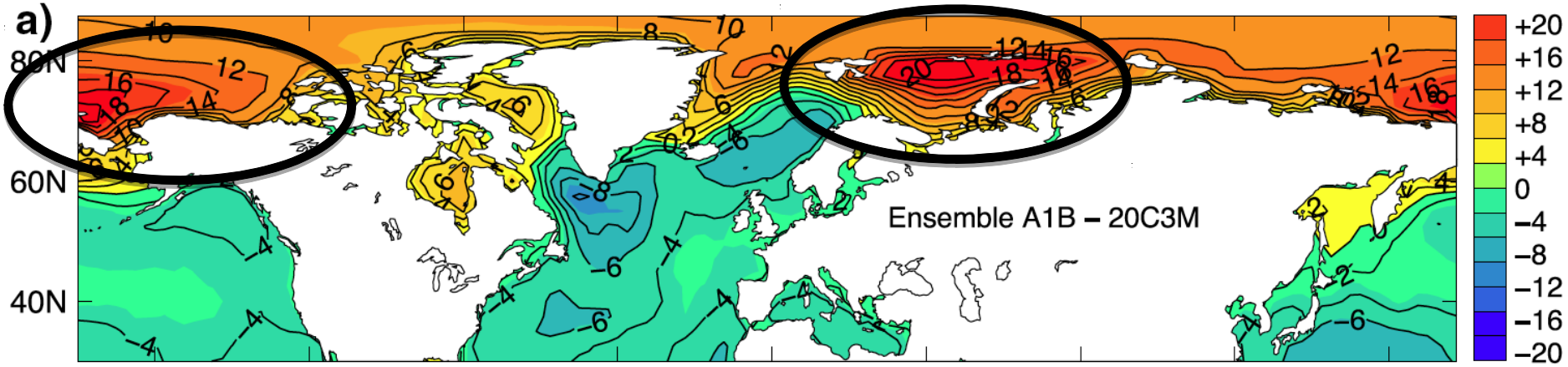
Projected changes in polar low activity according to the IPCC climate model simulations.



Kolstad and Bracegirdle, *Climate Dynamics*, 20

Arctic fronts

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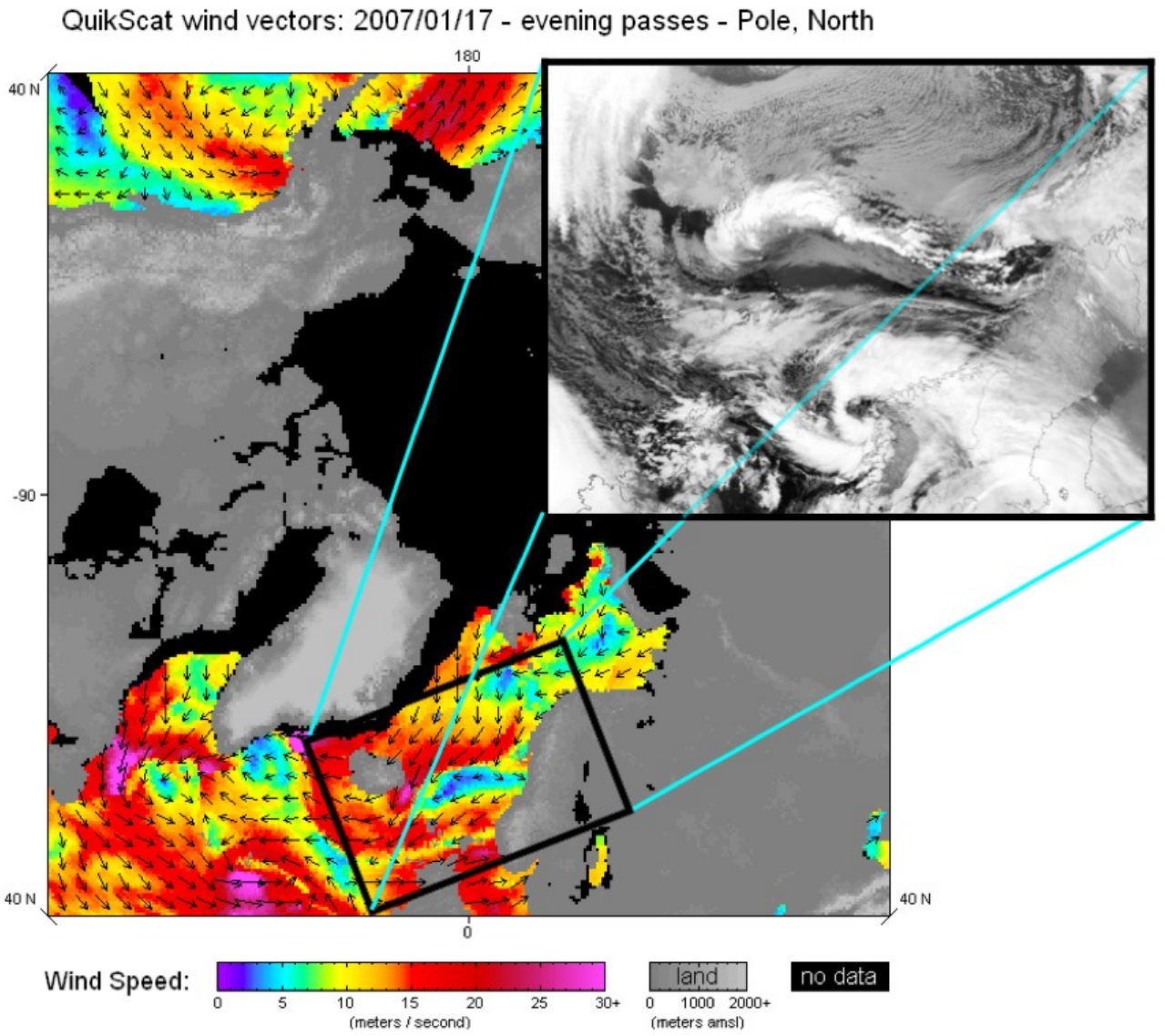
A less known marine hazard is what we call Arctic fronts or boundary-layer fronts.

Very large gradients in wind speed.

Typically form near the sea ice edge.



Arctic fronts

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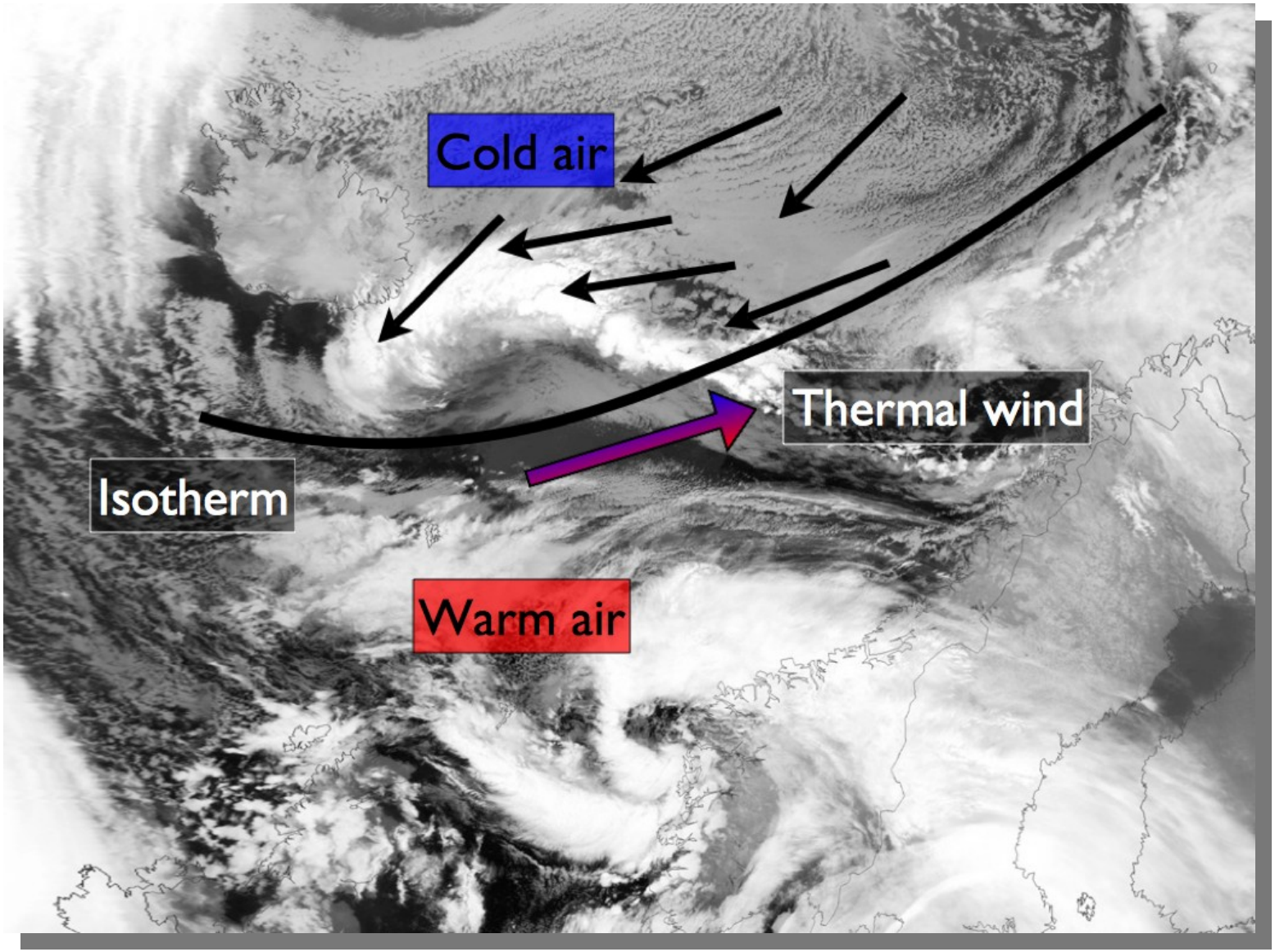

WRF High resolution models - Sakhalin

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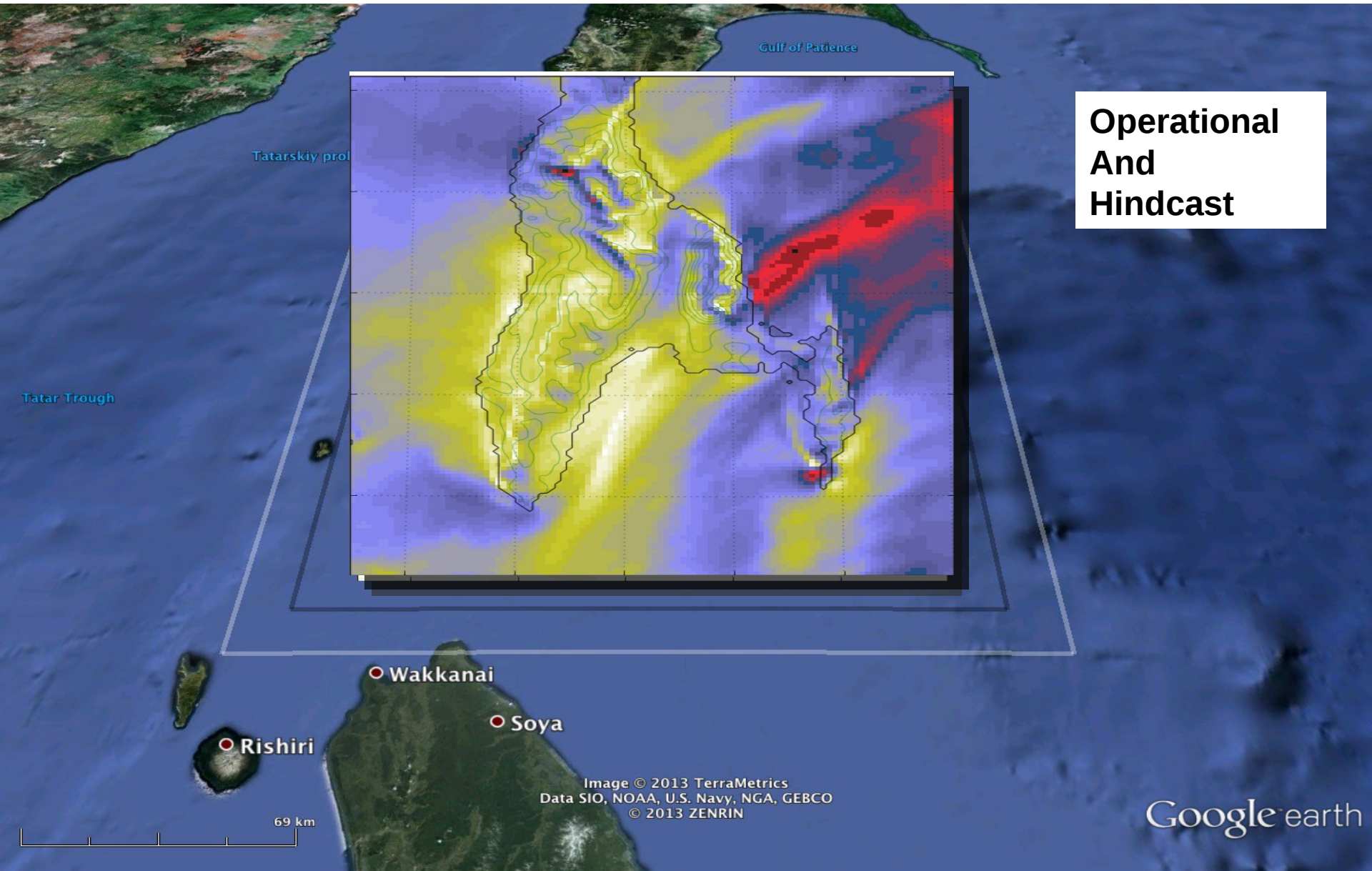

Operational And Hindcast

WRF high resolution Kara Sea

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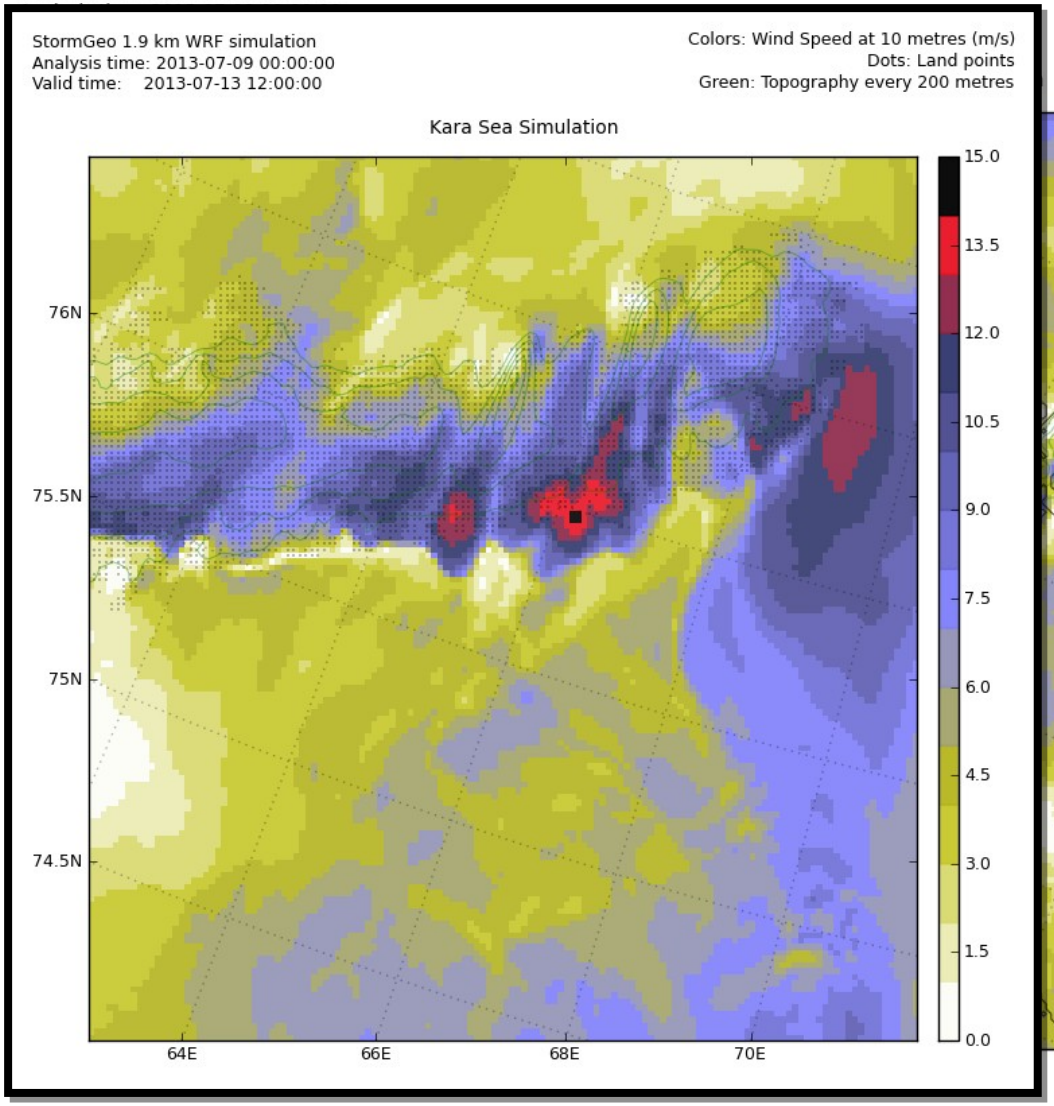
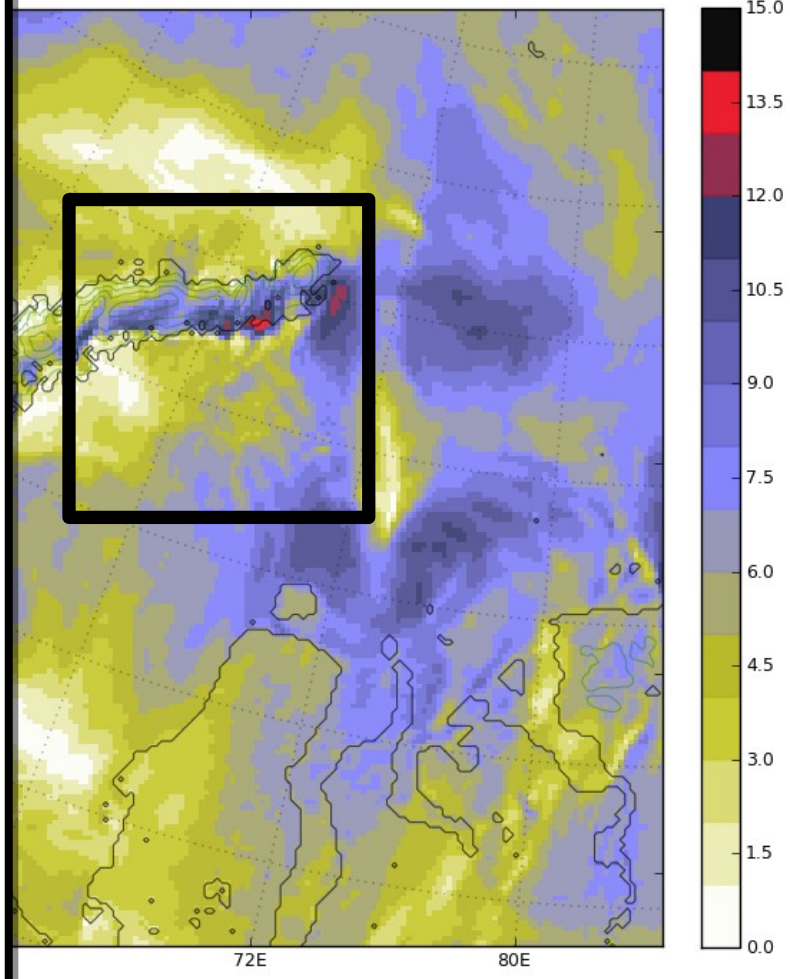
StormGeo 5.7 km WRF simulation

Colors: Wind Speed at 10 metres (m/s)
Black: Land mask
Green: Topography every 200 metres





SWAN – high resolution wave model

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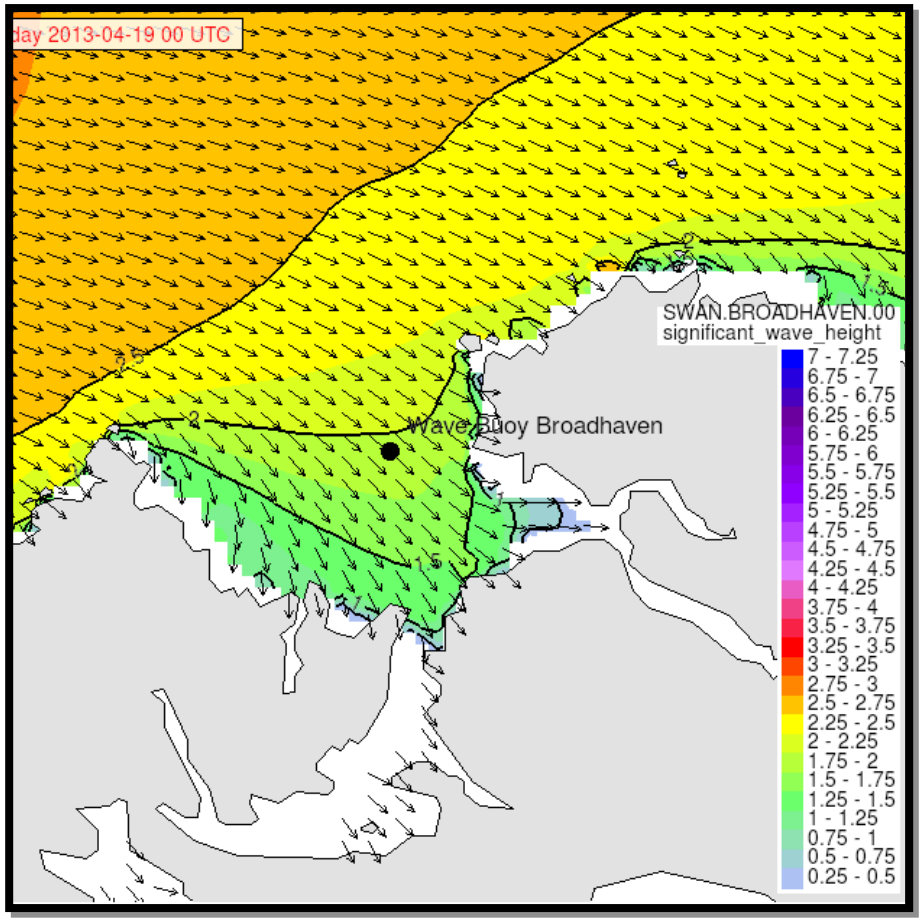

Broadhaven Bay, Ireland

Response forecast

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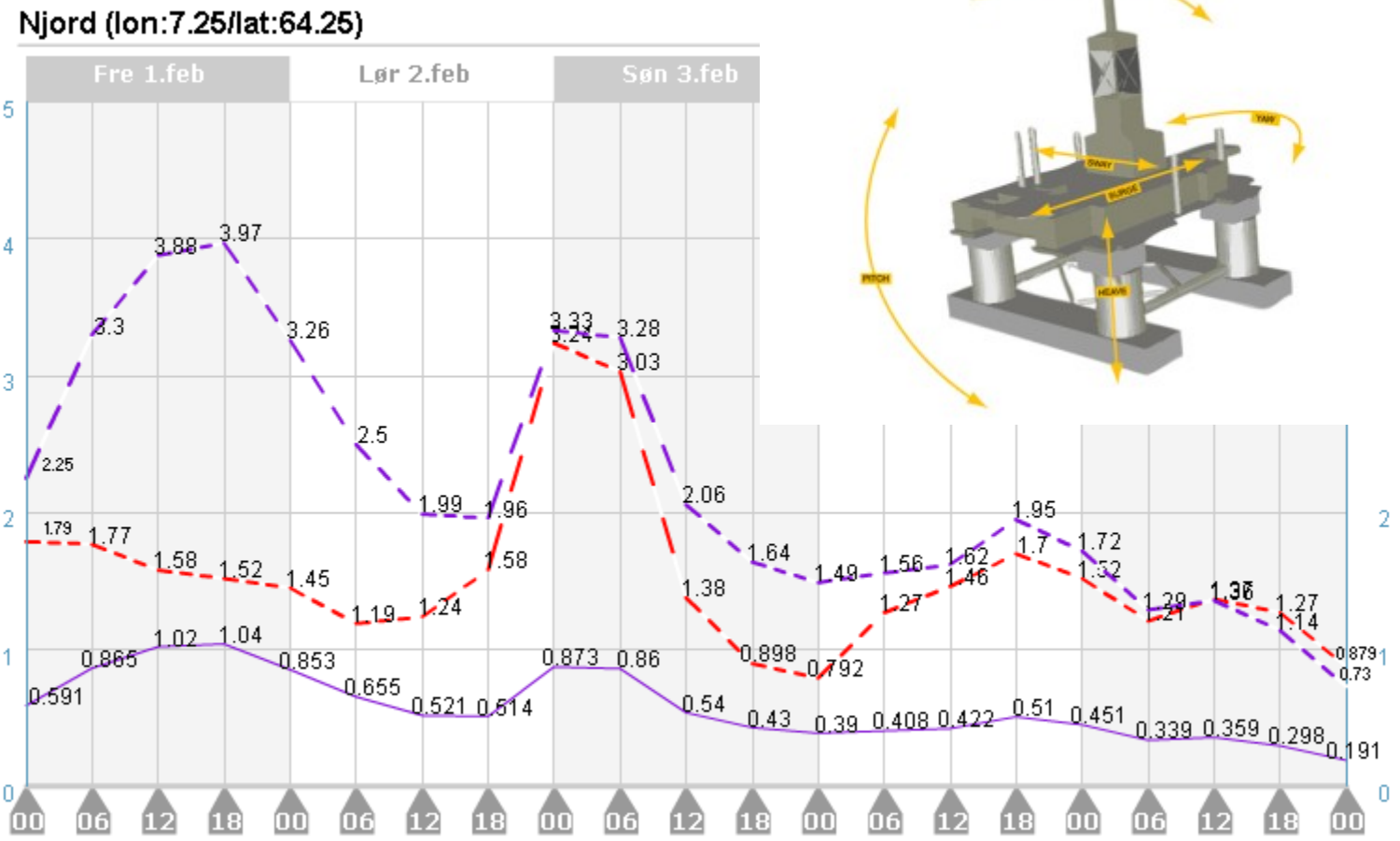
- [ ] SURGE max
- [ ] SURGE std
- [ ] SWAY max
- [ ] SWAY std
- [x] HEAVE max
- [x] HEAVE std
- [ ] ROLL max
- [ ] ROLL std
- [x] PITCH max
- [ ] PITCH std
- [ ] YAW max
- [ ] YAW std

(M)

velg

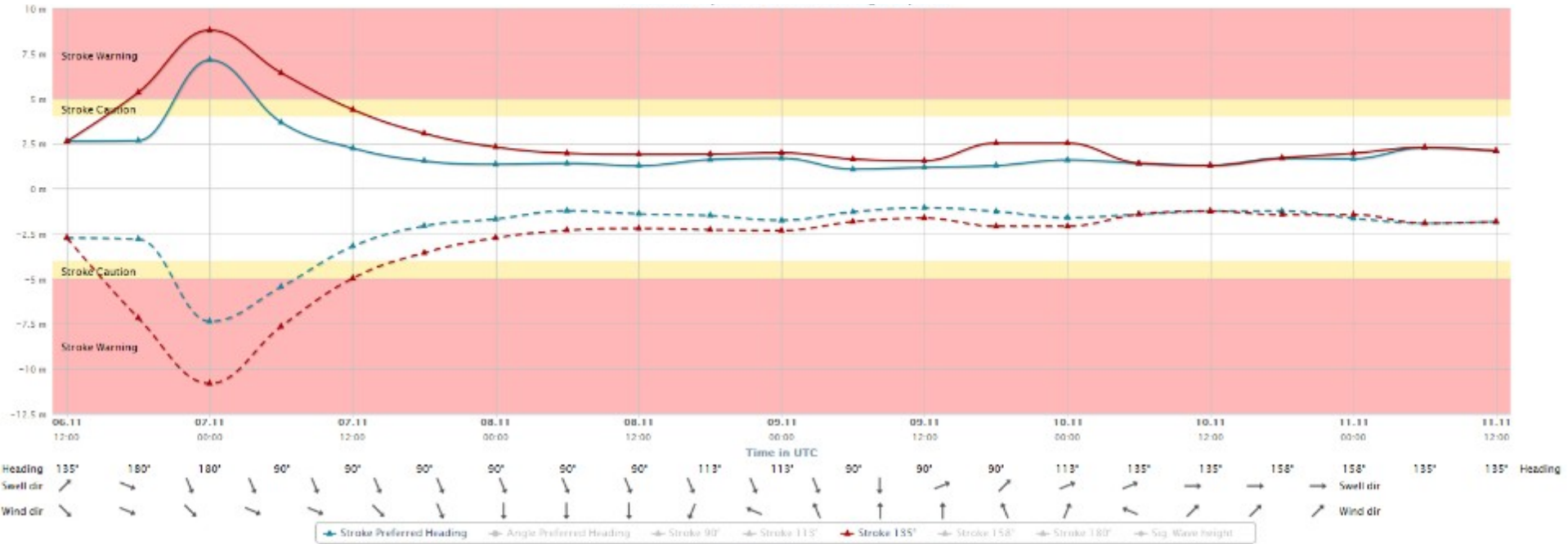


Response Forecast Gangway

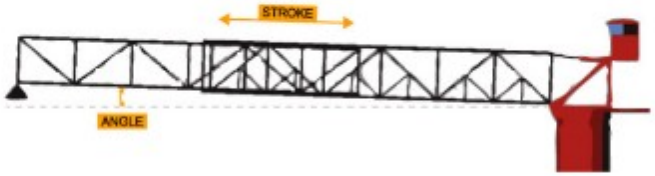
StormGeo
Control in a changing environment

Response Forecast Gangway

StormGeo
Control in a changing environment



Hide Stroke Criteria



Questions or comments? Send an email.

Response Forecast Helideck

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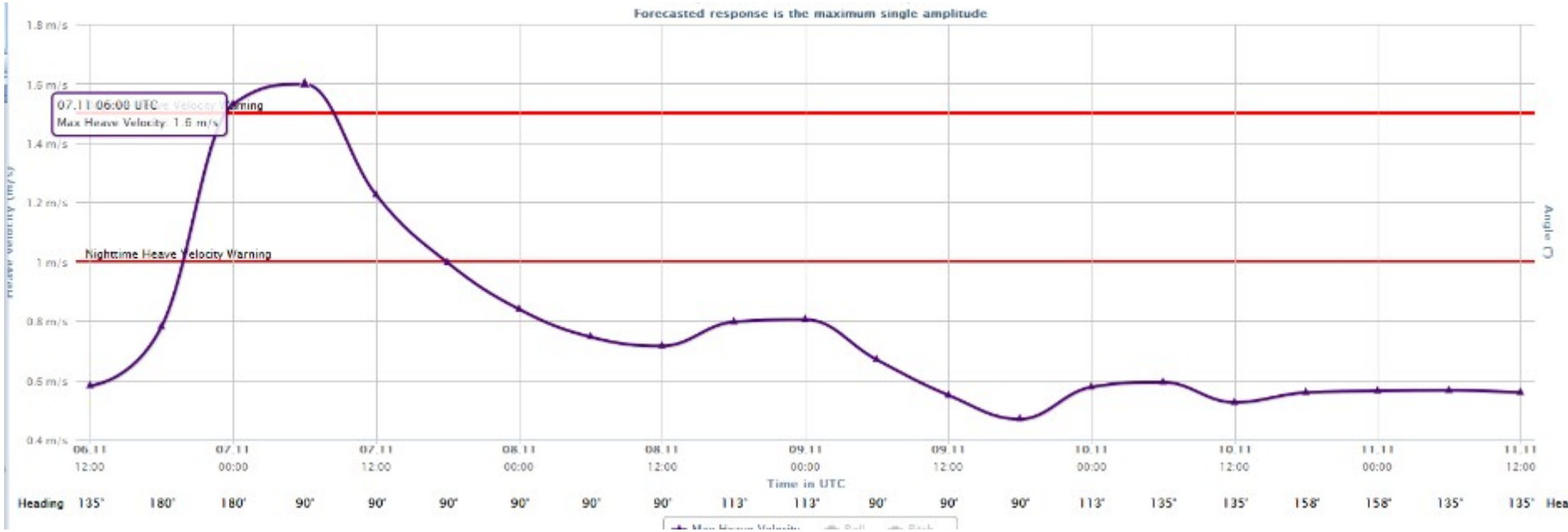

Helicopter rescue

DFU (Definert Fare og Ulykkessituasjon)

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HOME | ADMIN | LOGOUT

DFU 2 (beta)

RESCUEUNITS

Oseberg
- Oseberg A
- Bergen
- N/A

Tampen
- Statfjord C
- Bergen
- N/A

Halten
- Heidrun
- Kristiansund
- N/A

All dates and times are in UTC

WEATHER AND TIME

	Wdirection	Wspeed (925hpa)	Feast date
Oseberg A	170°	44.7 kts	15:00:00 2014-01-03
Bergen	136°	42.6 kts	15:00:00 2014-01-03
Statfjord C	164°	44.7 kts	15:00:00 2014-01-03
Heidrun	111°	17.5 kts	15:00:00 2014-01-03
Kristiansund	135°	23.3 kts	15:00:00 2014-01-03

<- Previous | Next ->

VARIABLES

Total avail. time	120 min.
Pax	21
Pickup time per pax	3 min.
Response time day	15 min.
Response time night	20 min.

OSEBERG

	Oseberg Location: Oseberg A	Tampen Location: Bergen
Oseberg A	-	21 pax / 102 min.
Oseberg C	21 pax / 83 min.	21 pax / 100 min.
Oseberg East	21 pax / 83 min.	21 pax / 100 min.
Oseberg Sør	21 pax / 78 min.	21 pax / 102 min.
Veslefrikk	21 pax / 85 min.	21 pax / 100 min.
Huldra	21 pax / 88 min.	21 pax / 102 min.
Troll A	21 pax / 90 min.	21 pax / 92 min.
Troll B	21 pax / 90 min.	21 pax / 92 min.

TAMPEN

	Tampen Location: Bergen	Oseberg Location: Oseberg A
Visund	21 pax / 106 min.	21 pax / 95 min.
Statfjord C	21 pax / 112 min.	
Snorre A	21 pax / 110 min.	
Snorre B	21 pax / 110 min.	
Gullfaks	21 pax / 107 min.	21 pax / 92 min.
Kvitebjørn	21 pax / 105 min.	21 pax / 89 min.

2014-01-03 00:00:00: alert
2014-01-03 03:00:00: warn
2014-01-03 06:00:00: warn
2014-01-03 18:00:00: warn
2014-01-03 21:00:00: warn

HALTEN

	Halten Location: Kristiansund
Heidrun	19 pax / 128 min.
Norne	12 pax / 146 min.
Åsgard A	20 pax / 123 min.
Åsgard B	20 pax / 123 min.
Kristin	21 pax / 120 min.
Njord	21 pax / 103 min.


So what are the
new challenges?

New challenges

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- Lack of weather and sea observations
  - Ground based, buoys, weather RADAR (satellite coverage is rather good)
- The environment is much colder than in e.g. the North Sea region
  - -> icing, sea ice, wind chill increasing,
- The weather is more difficult to model than at lower latitudes.

New challenges

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- The worst kinds of weather – polar lows and arctic fronts – arrive much more suddenly than is typical in the North Sea and Norwegian Sea (but in average the winds and waves are «better» in the polar regions than e.g. in the Norwegian Sea)

- New regions for polar low developments due to declining sea ice coverage

New challenges

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- **Continued research and development of weather/waves/current/ice models with more focus on polar regions**.
- Remoteness ?
- Darkness ?
- Communication ?

The «selfie» of the day ;-)