Norwegian Meteorological Institute

An introduction to polar lows

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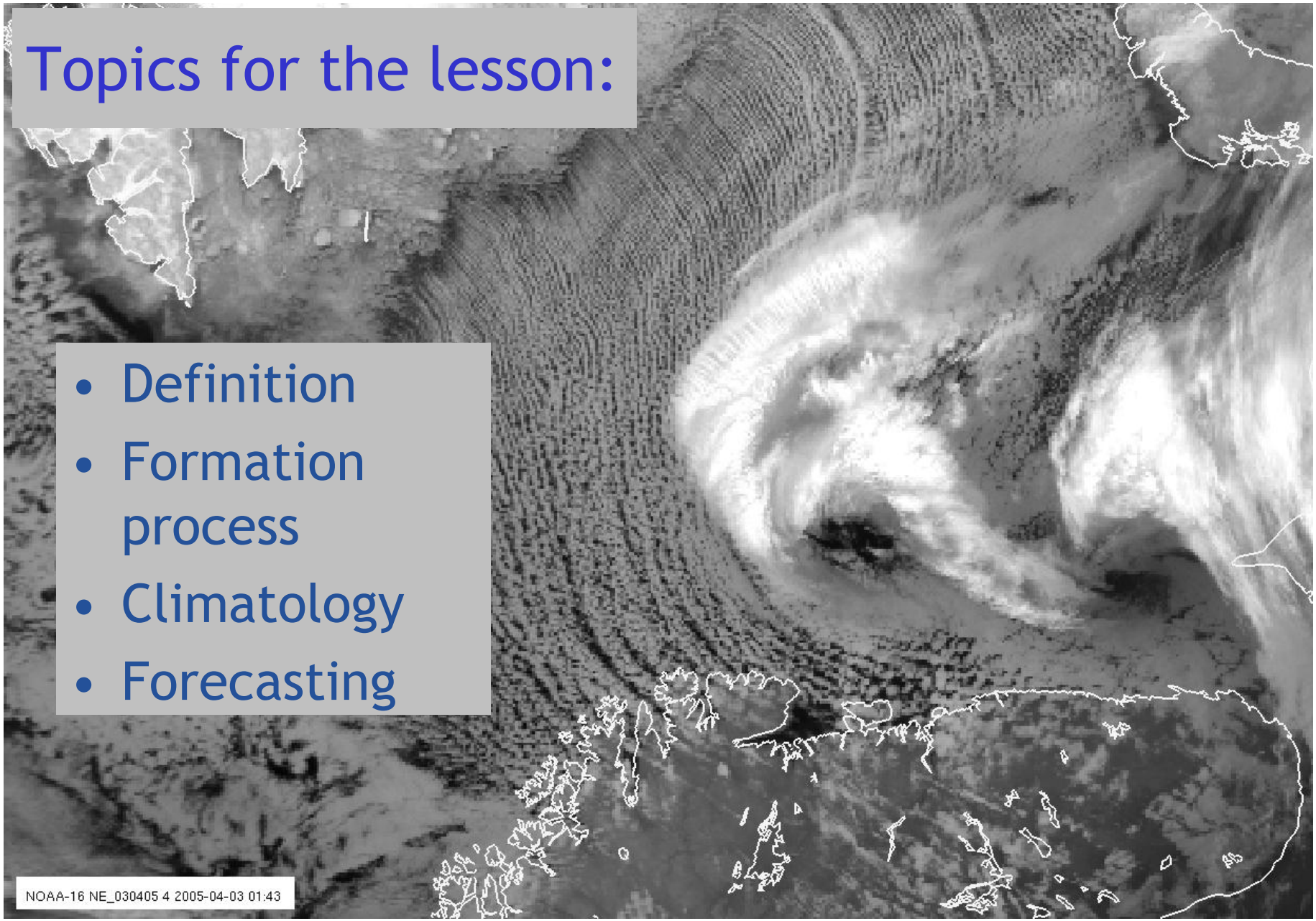
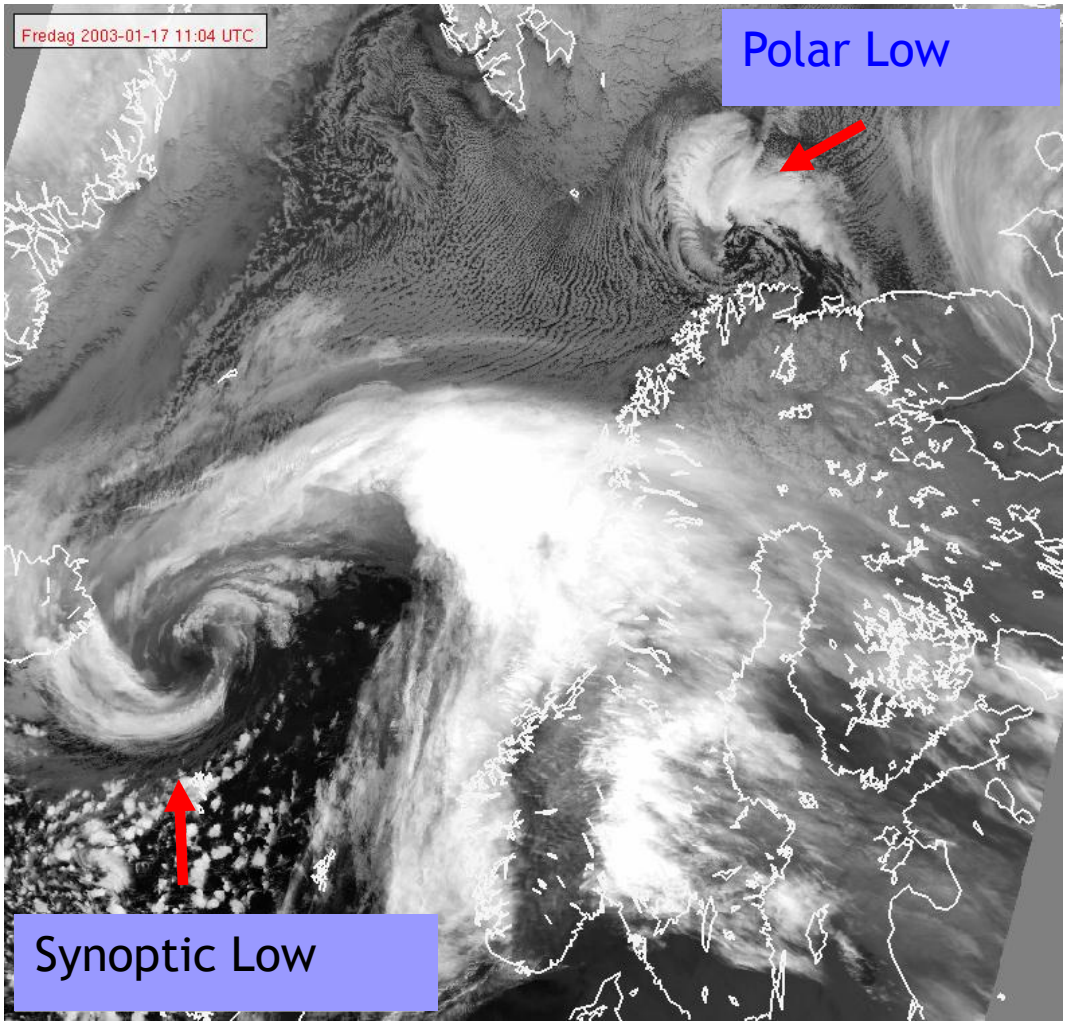
Topics for the lesson:

- Definition
- Formation process
- Climatology
- Forecasting



The definition of polar lows by the European polar low working group:

- ’A small, but fairly intense low in maritime regions’
- In cold air outbreaks, well north of the polar front.
- Diameter 200 – 600km
- Cyclonic curvature

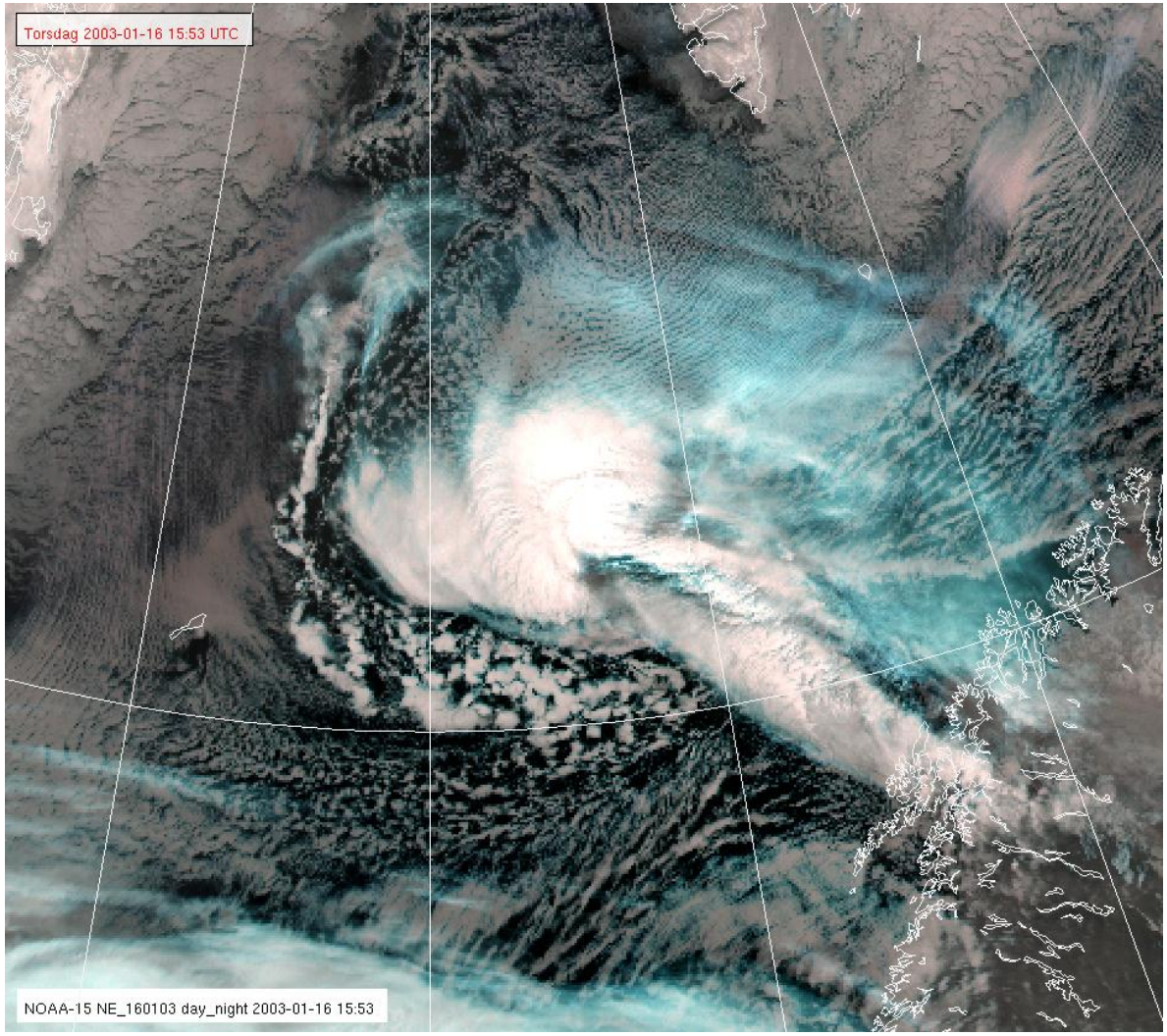


Key processes:

- Polar Lows develop from areas of baroclinic or convective instability:
  - Occlusions, troughs, convergence lines, etc.
- Destabilisation at low levels:
  - Cold arctic air is advected out over warmer sea surface
  - Transfer of sensible and latent heat from the sea surface
- Further destabilisation of the layers above:
  - Passing cold core, unobstructed static instability up til 500-400hPa
  - Trough at mid troposphere, e.g. as seen from Z500 hPa

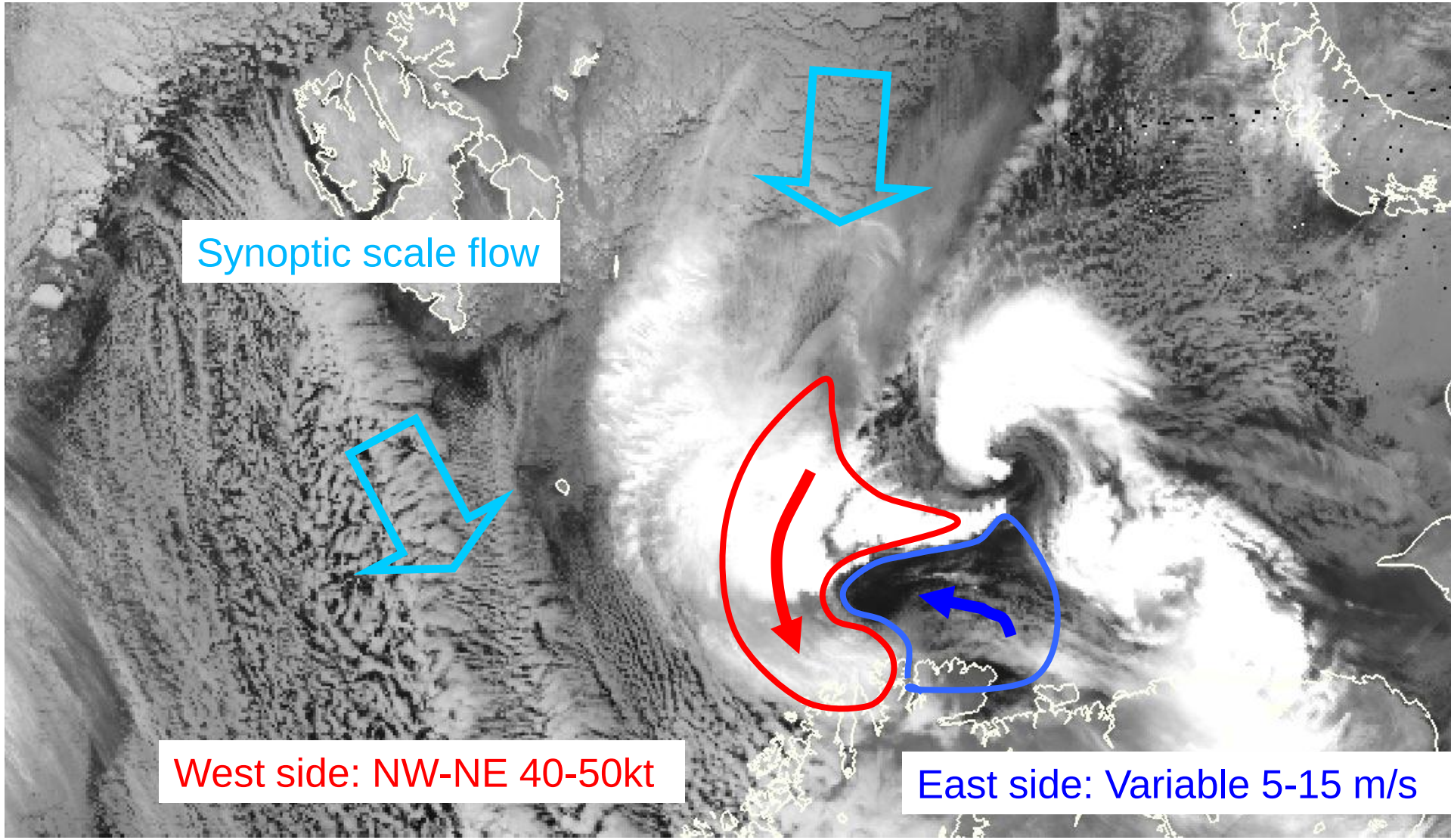
Characteristics of the polar low

- Average max obs. windspeed 42kt
- About 30% have more than 50kt
- Rapid changes in wind speed and direction
- Showers of snow or hail, visibility less than 100m
- Avalanche danger
- Waves

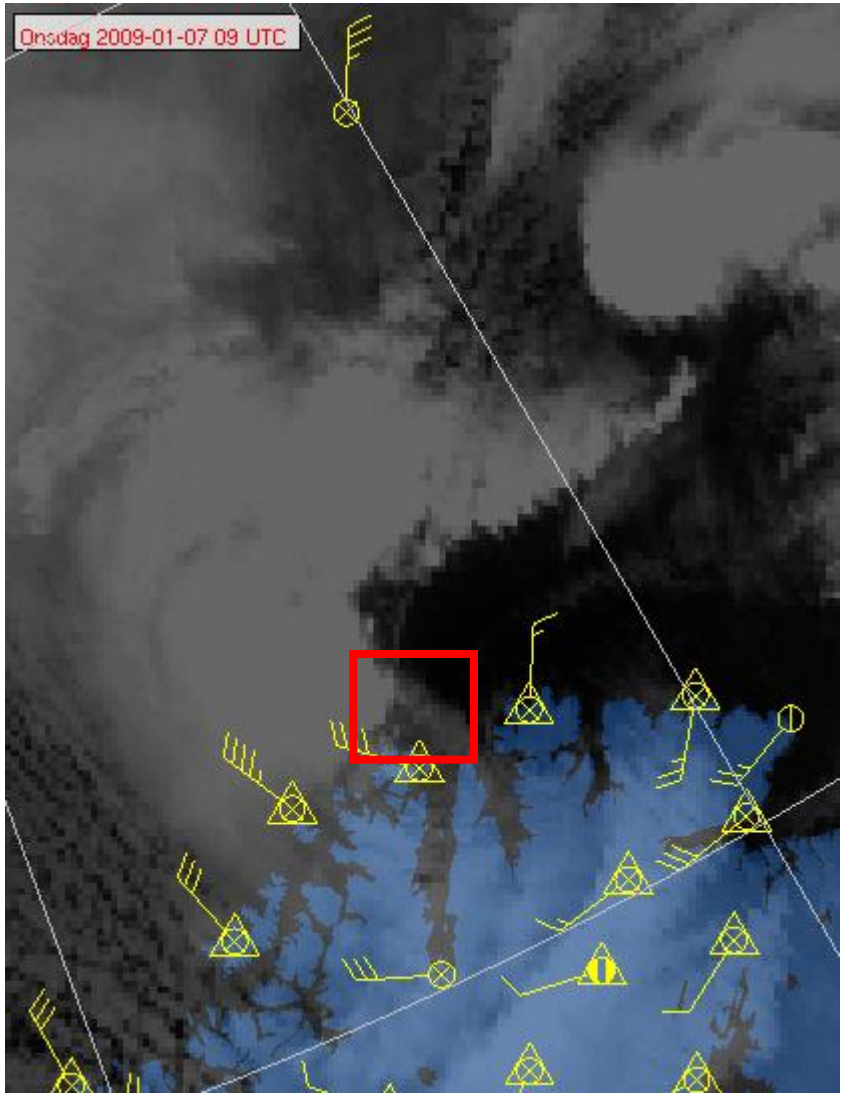


Senior Forecaster/Developer Gunnar Noer, Norwegian Meteorological Institute, Tromsø

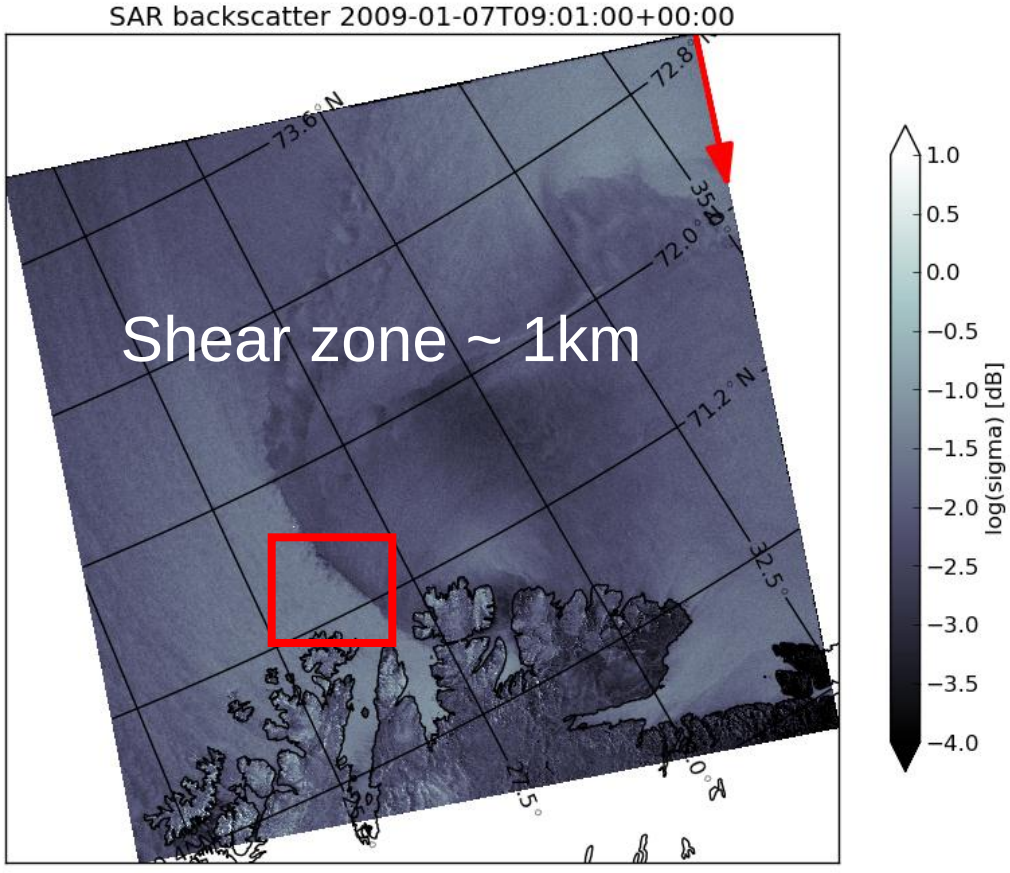
Typical wind pattern:



The wind from SAR-images:



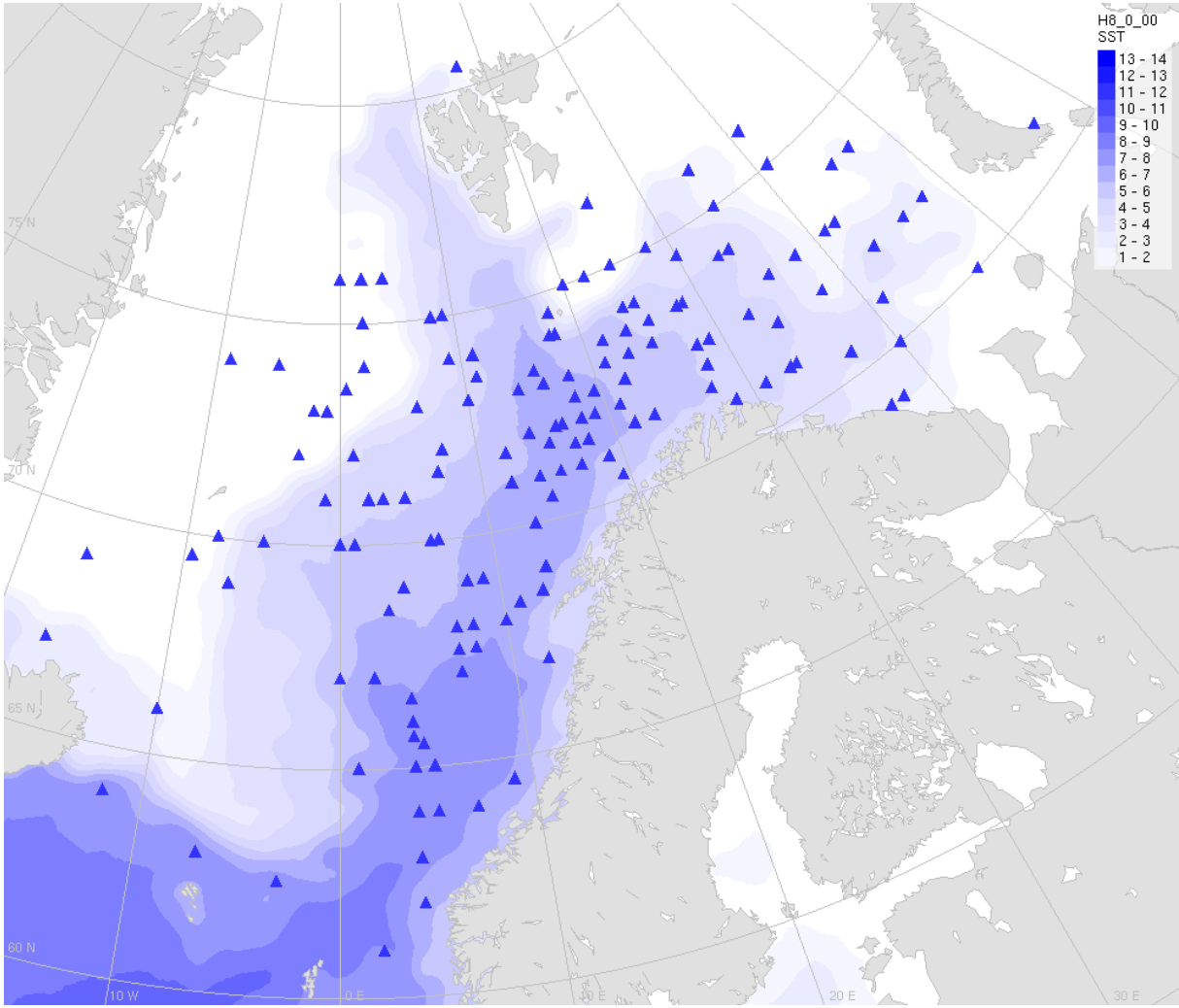
Honningsvåg 7th January, 2009



Kilde: Furevik et. al. 2012

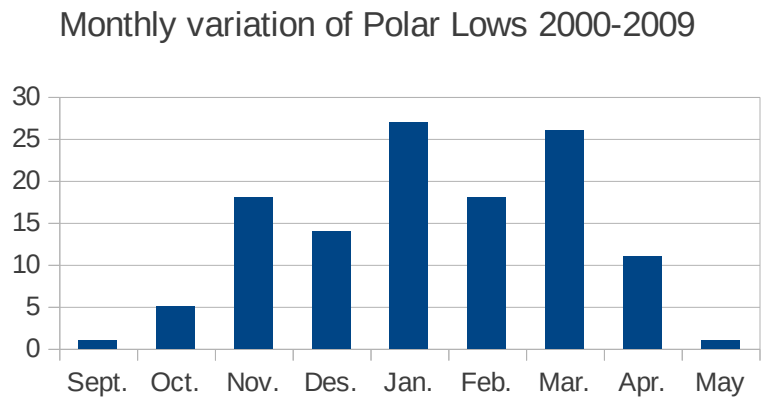
Geographical extent

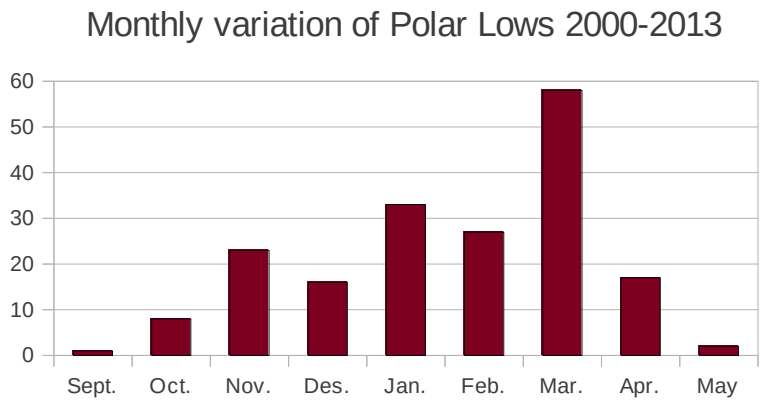
- Points of development
- Temperature gradients in the Golf current
- Areas of convergence, Spitsbergen
- Less cases in the eastern and southern part of area
- 190 events 2000-2013



Seasonal variation:

- On average 13 events pr. Year
- October til May
- Max in January and March, Local nadir in February
- Interannual variation in November and March
  - 2000-2009: On average 2,8 pr month in March
  - In 2010, 2011 and 2013: 8 to 12 PL's in March

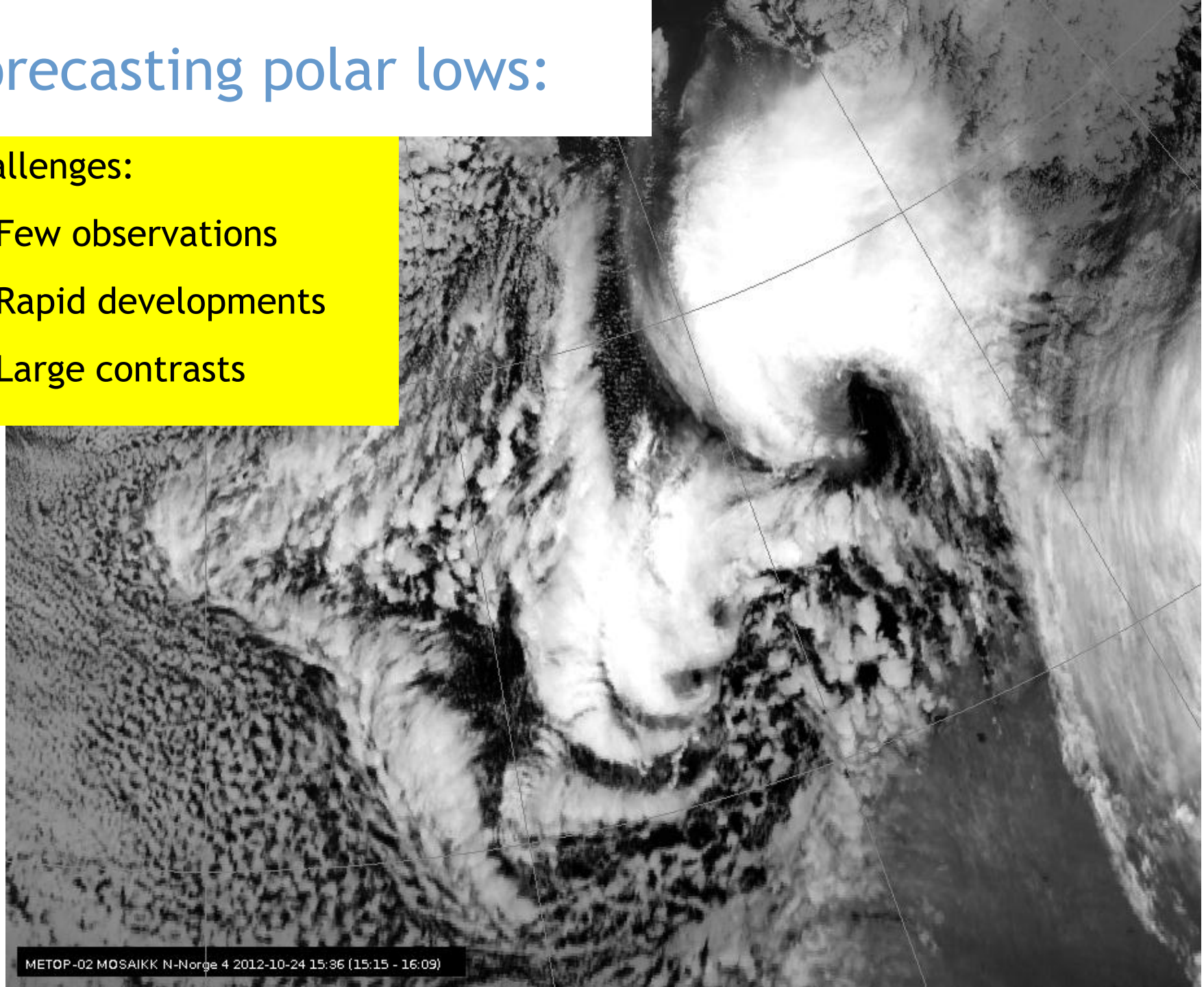




Forecasting polar lows:

Challenges:

- Few observations
- Rapid developments
- Large contrasts



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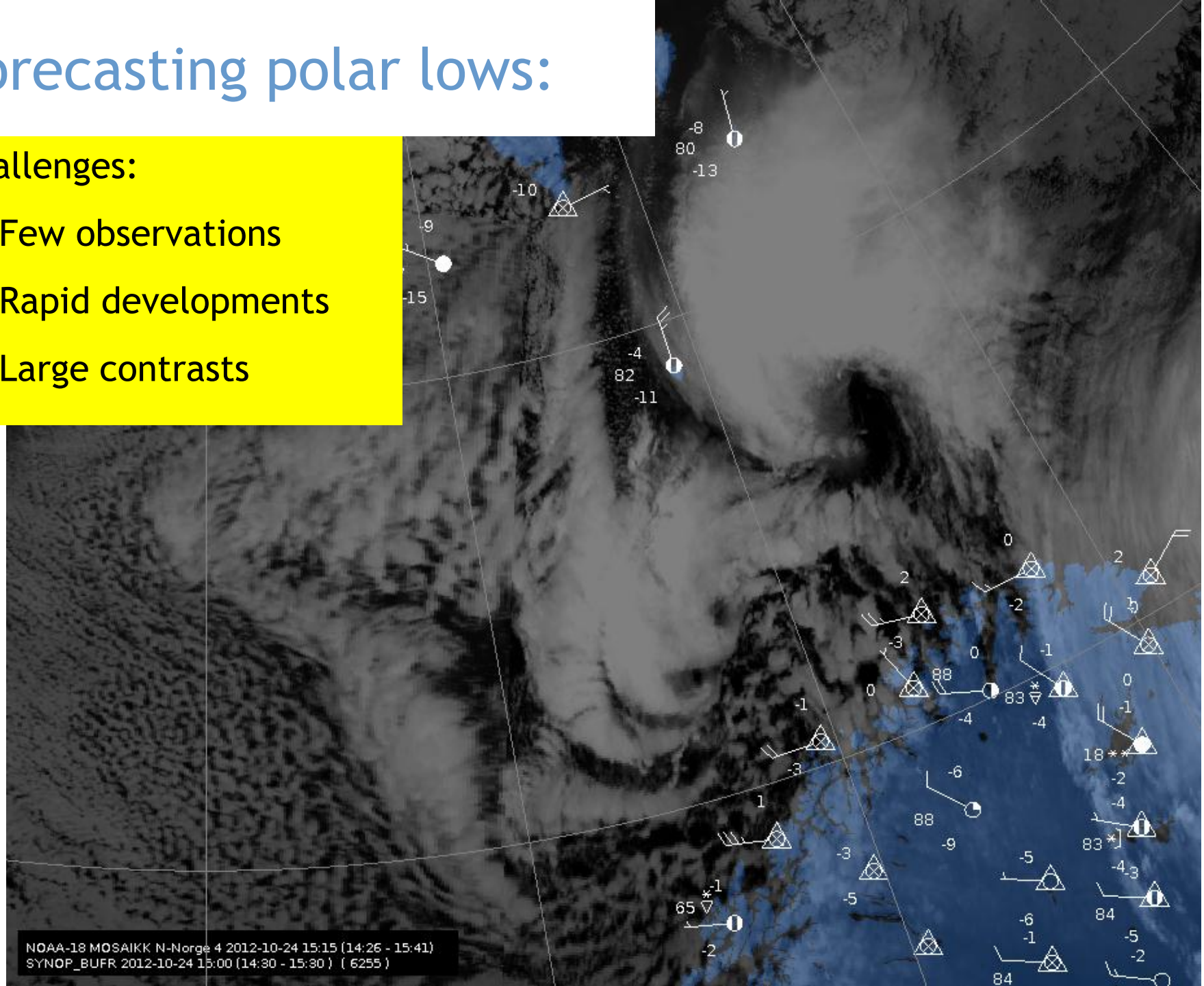

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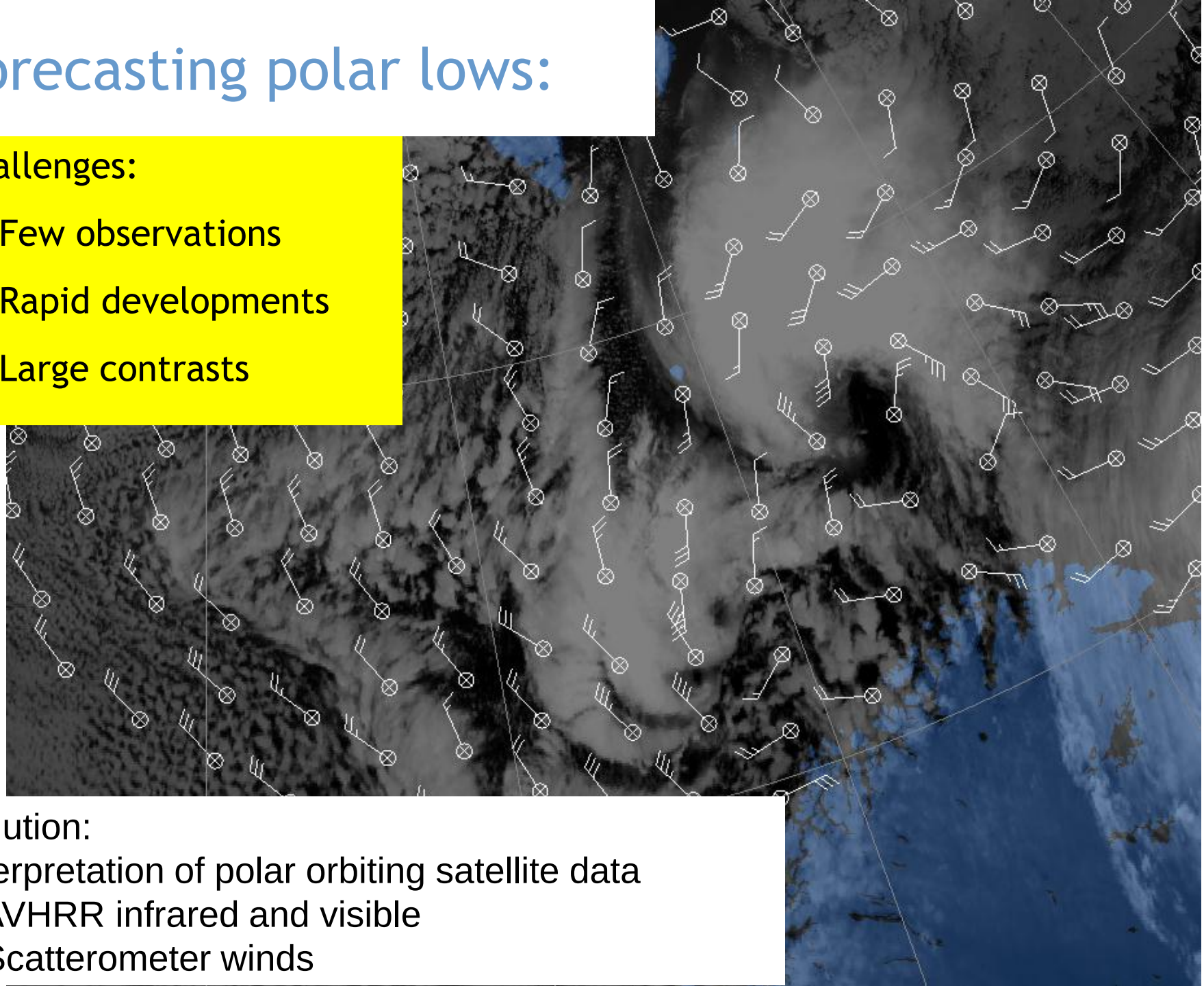

Solution:
Interpretation of polar orbiting satellite data
- AVHRR infrared and visible
- Scatterometer winds

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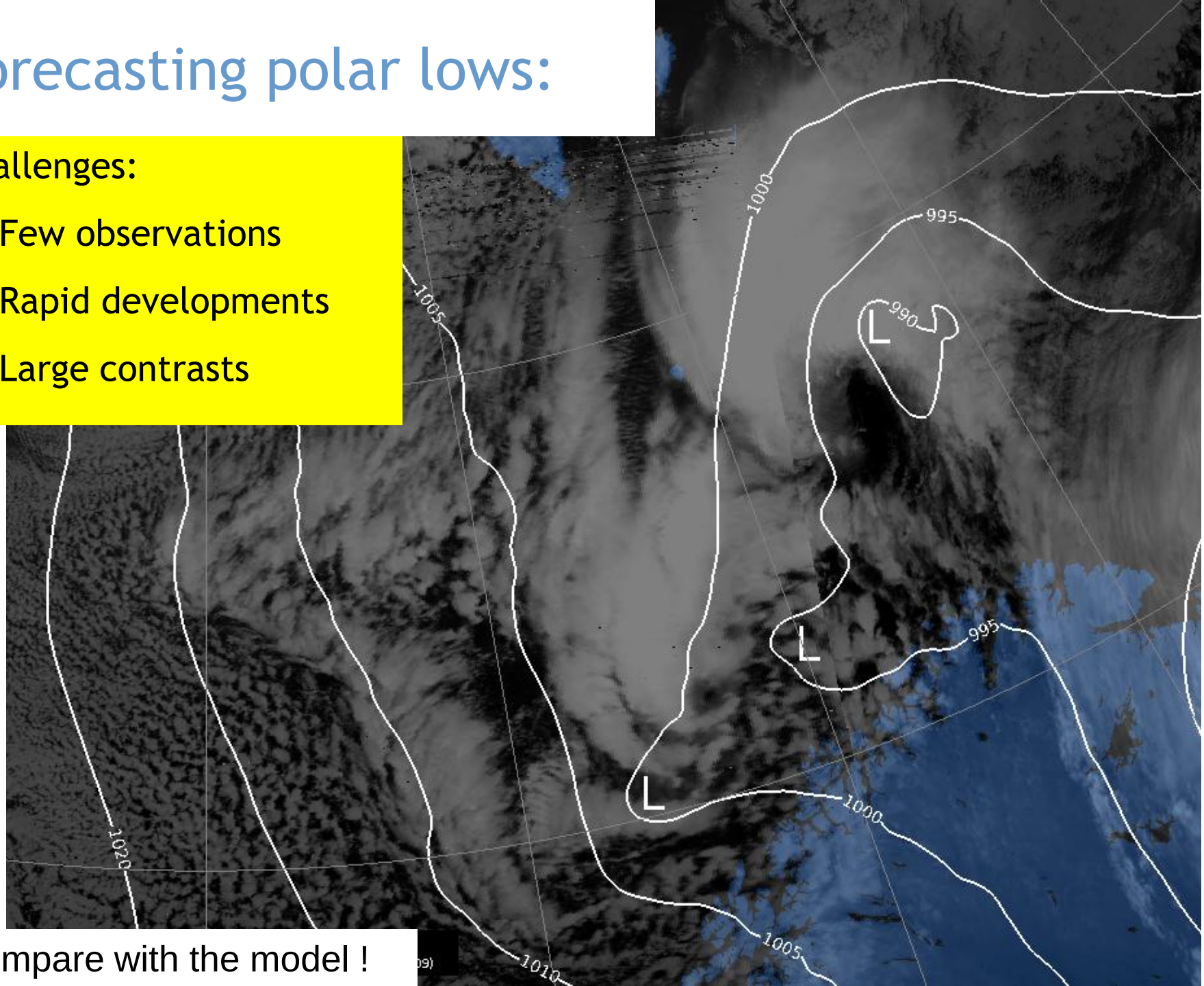
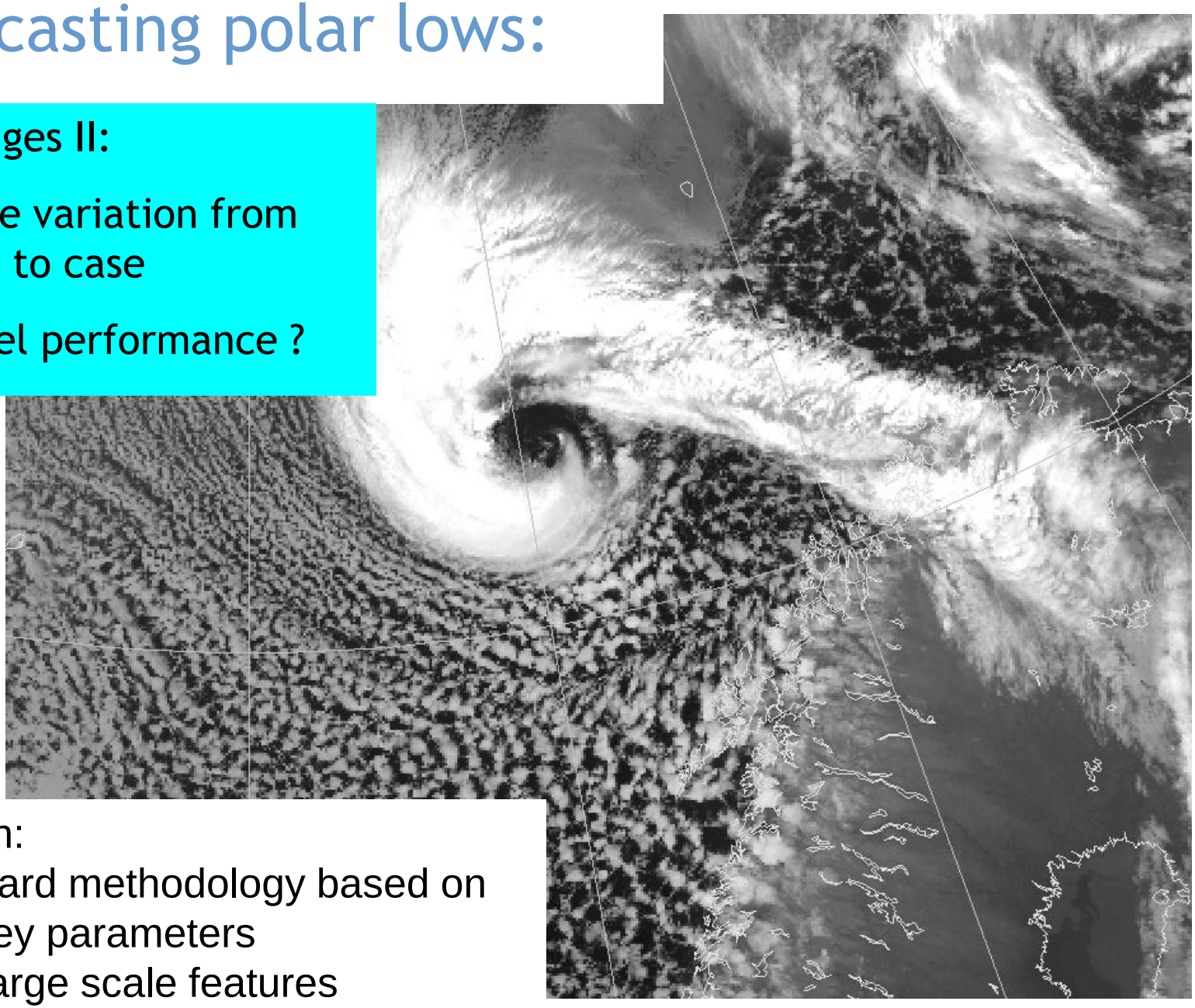


Compare with the model !

Forecasting polar lows:

Challenges II:

- Large variation from case to case
- Model performance ?



Solution:

- Standard methodology based on
  - Key parameters
  - Large scale features
  - EPS

Standard methodology:

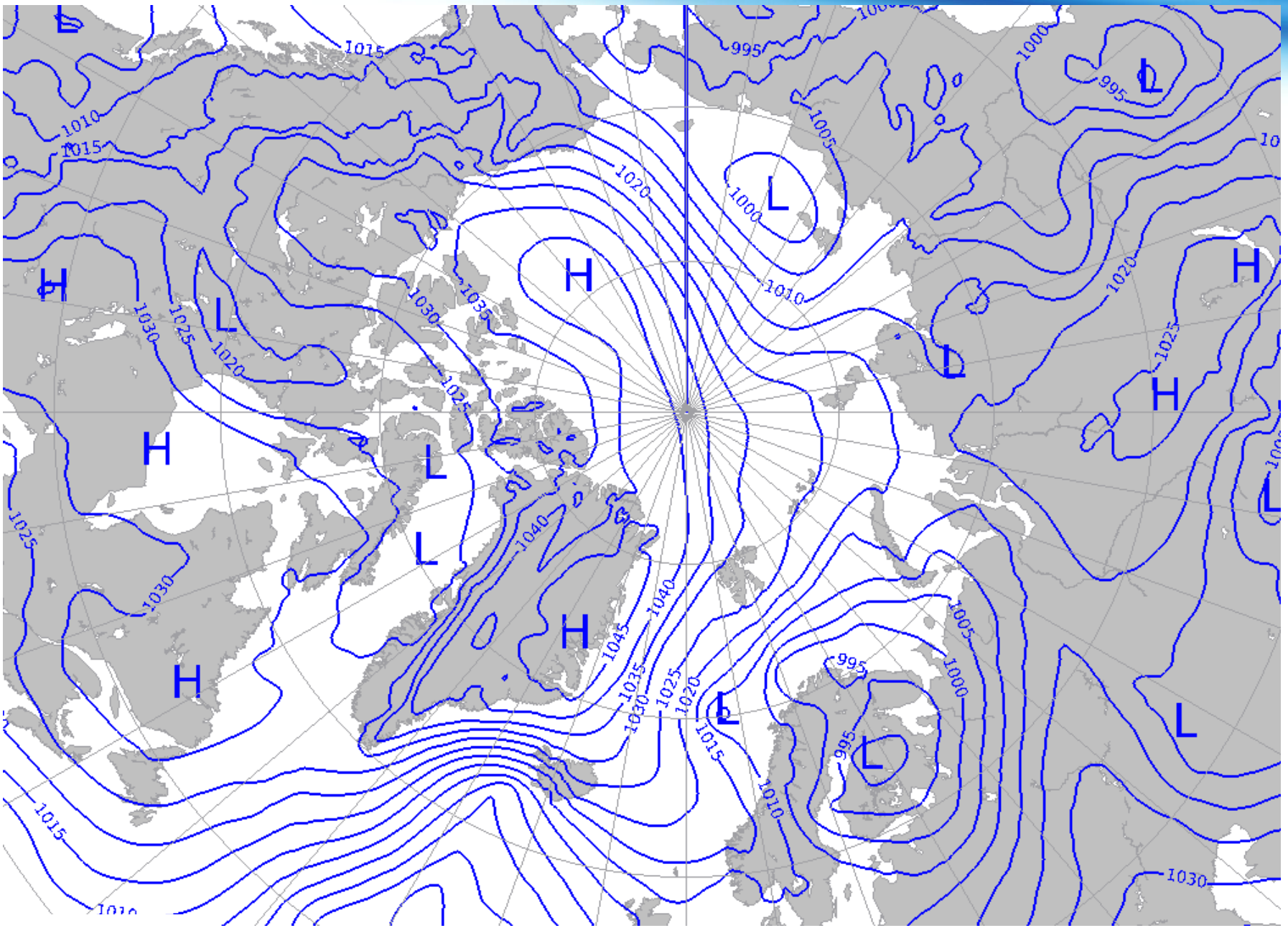
- Synoptic scale:

- Cold air outbreak at low levels
- Trough in the mid. Trophosphere, e.g. Z@500hPa
- The temperature potential; SST-T500

- Meso scale:

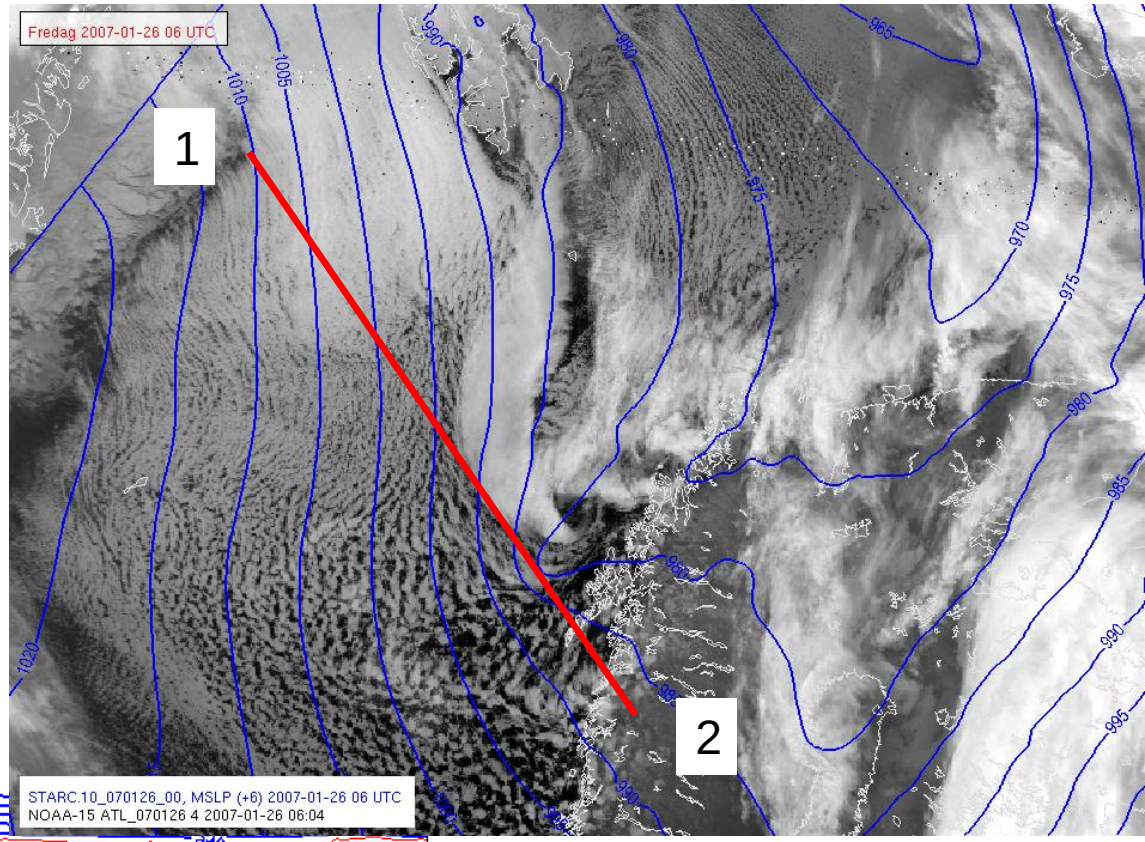
- Low level source of instability:
- Troughs, convergence lines, fronts, etc..

The cold air outbreak

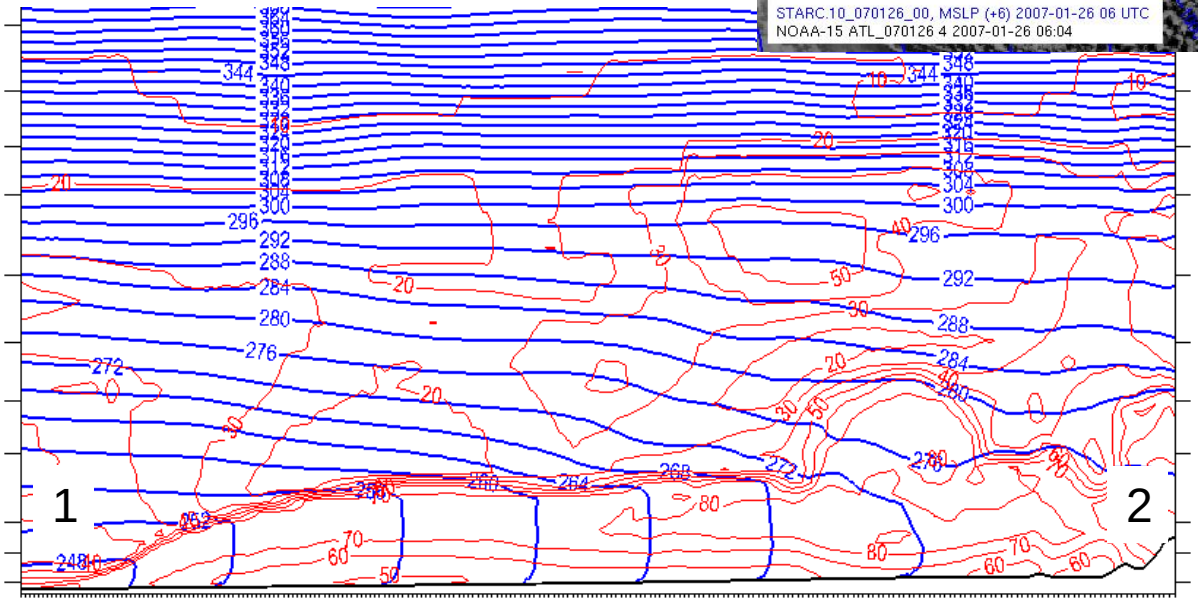


MSLP

The cold air outbreak



MSLP

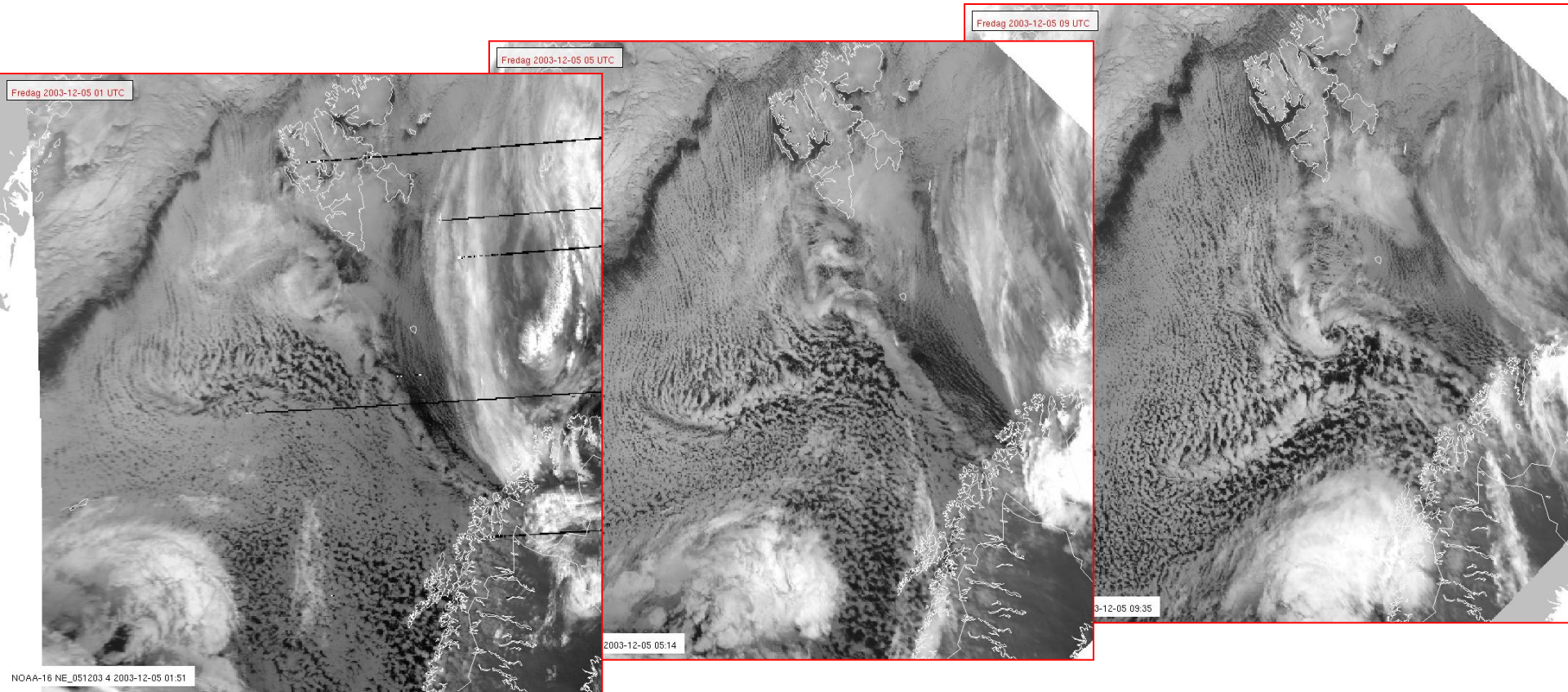


Potential temperature

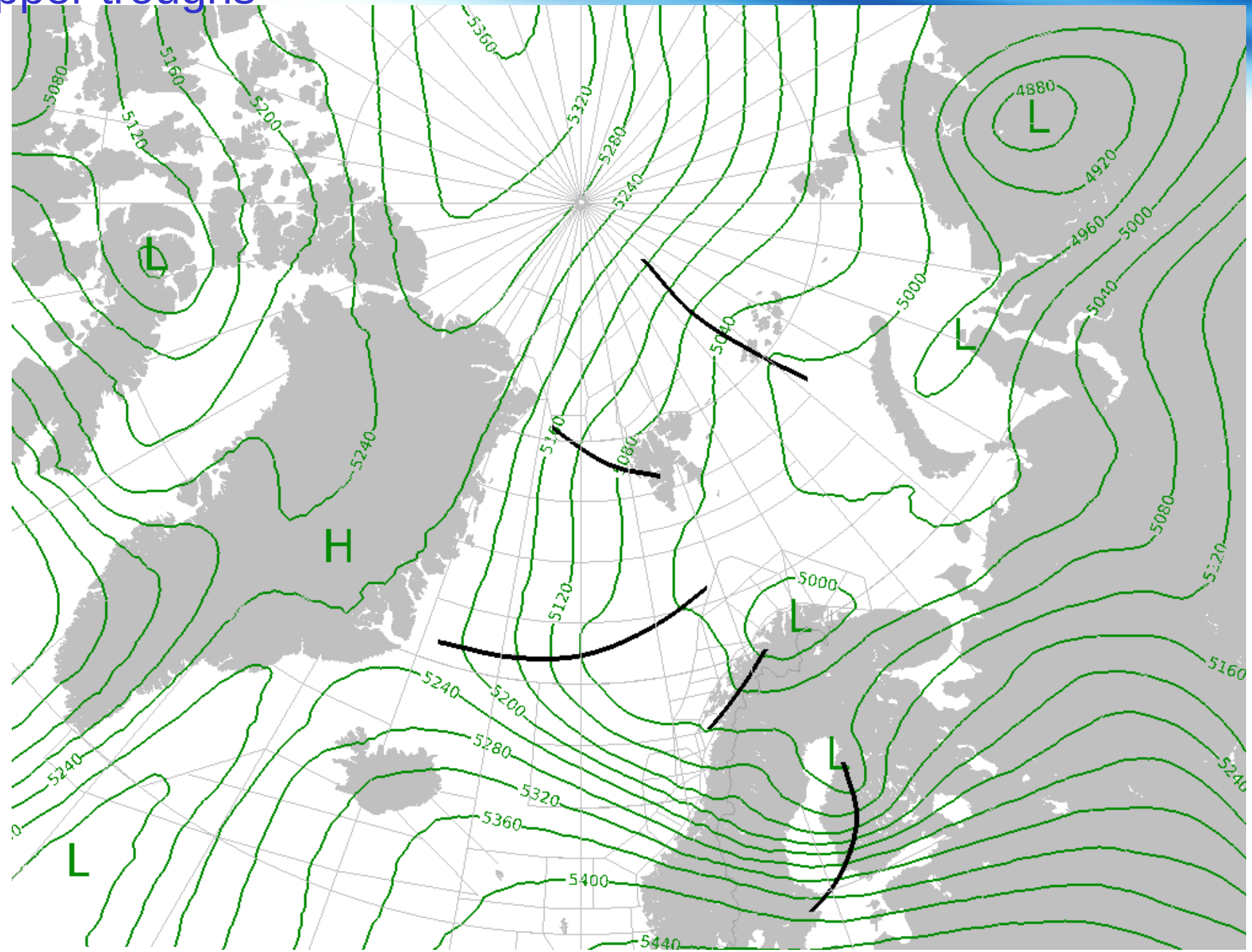
Relative humidity

Low level areas of instability

Convergence lines, arctic fronts, troughs, CB-clusters, old fronts, etc.

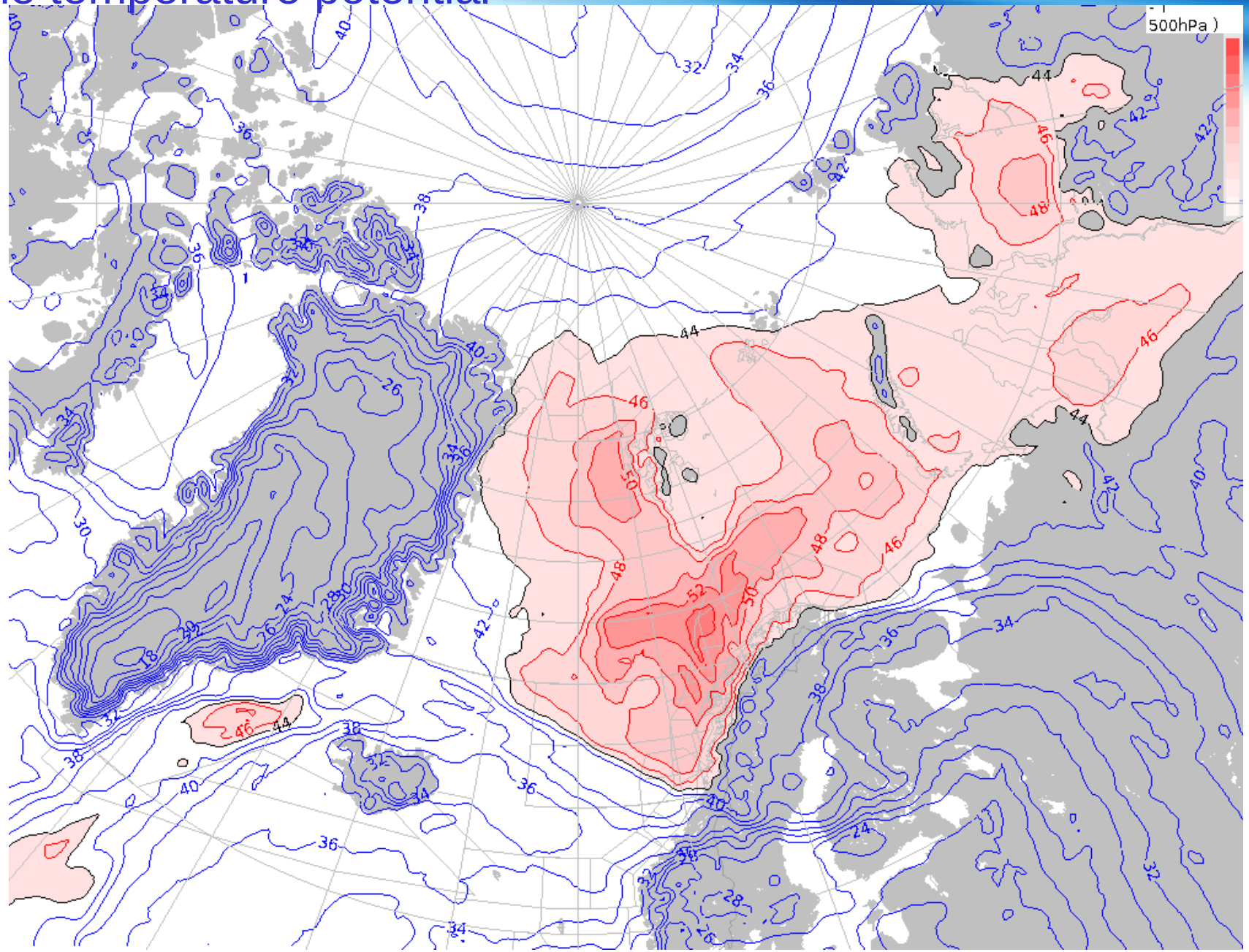


Upper troughs



Z 500 hPa

The temperature potential

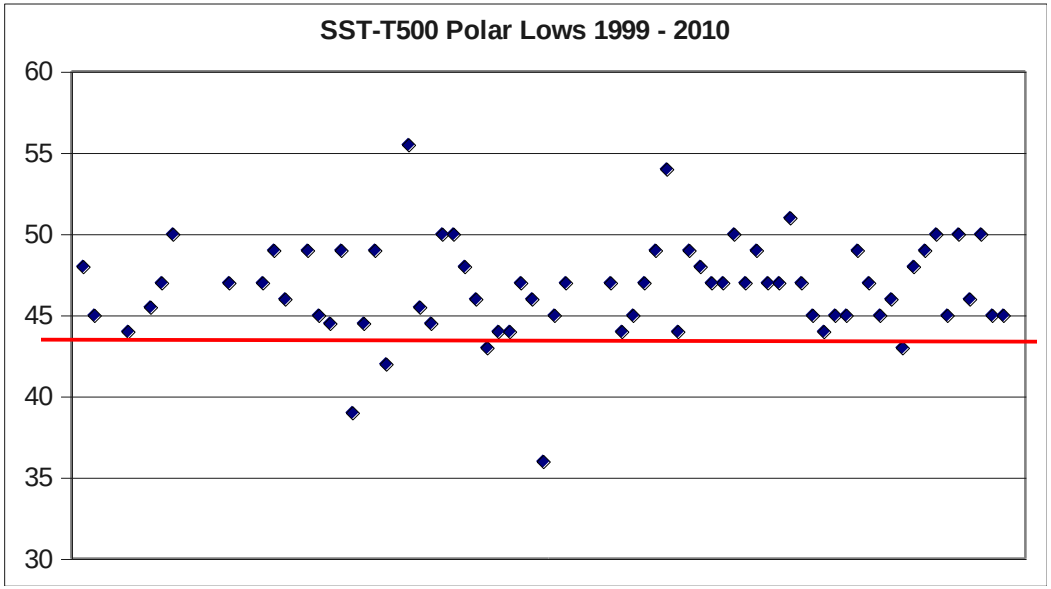


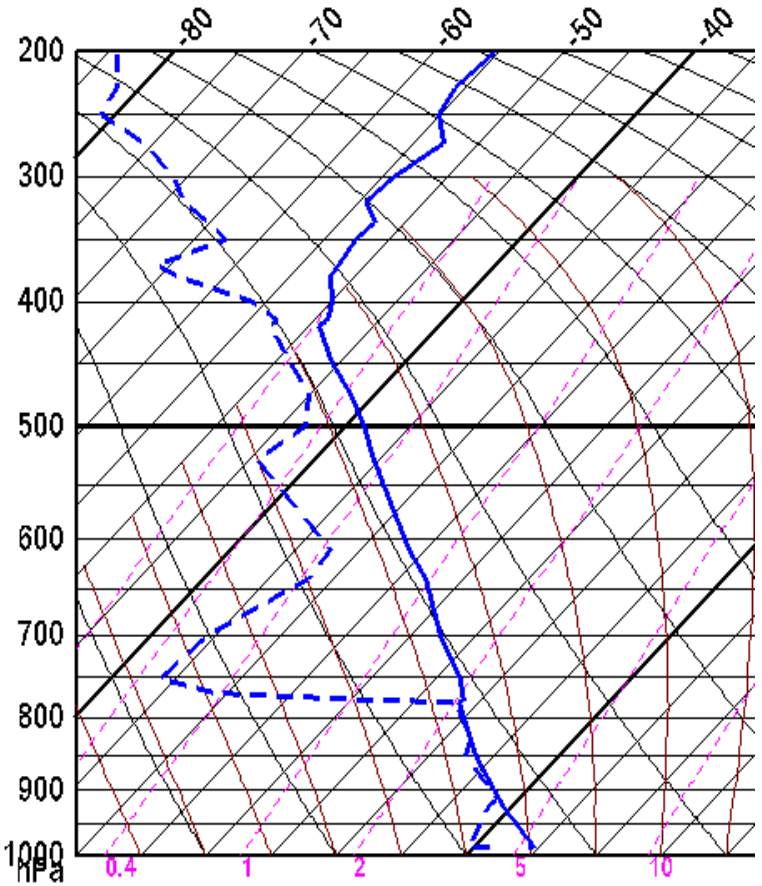
The temperature potential

How big a difference?

SST – T_{500} ≥ 44˚C

- with exeptions !

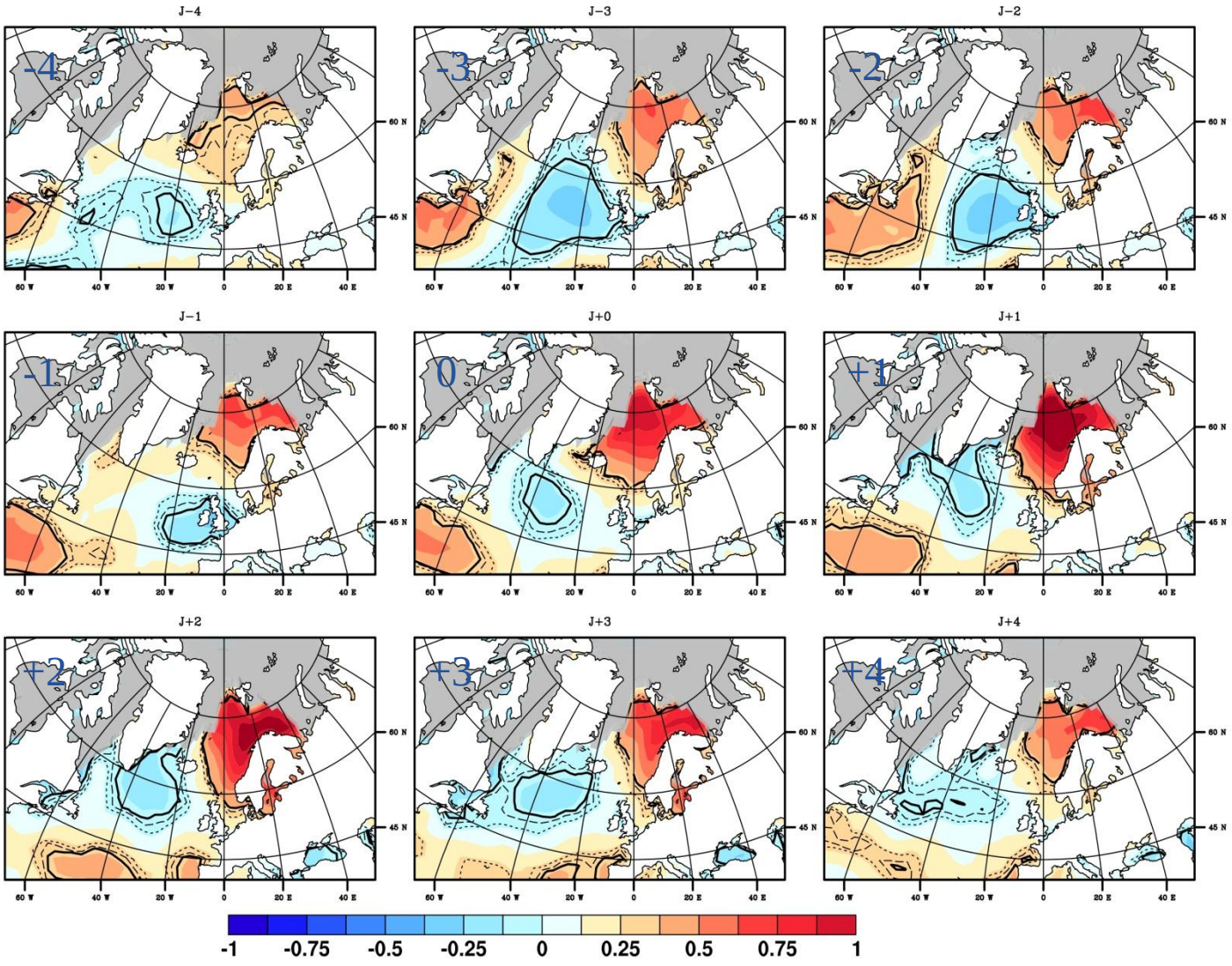




Time dependency of the temperature potential:

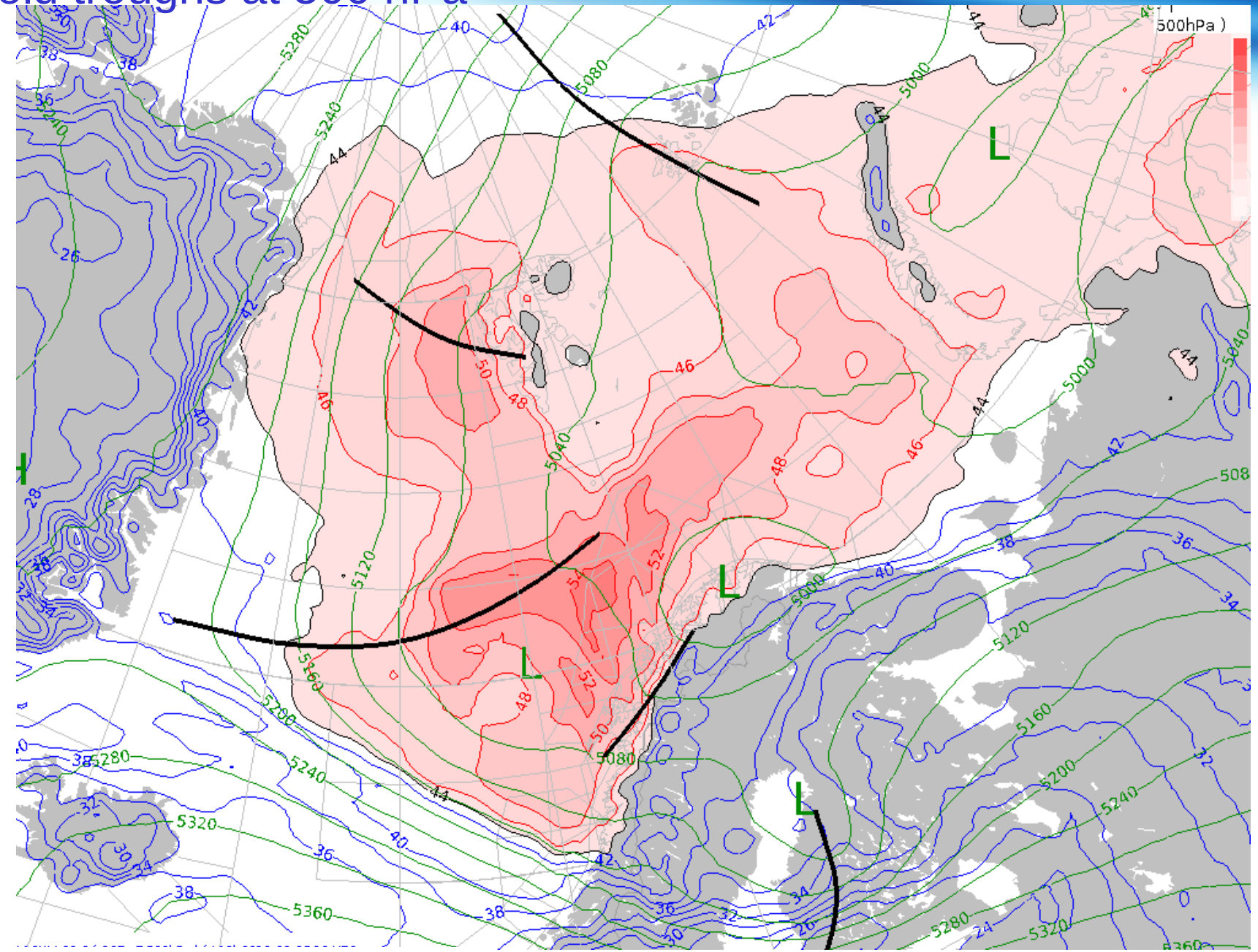
Standard deviation of the temperature potential

J+0 is day of development



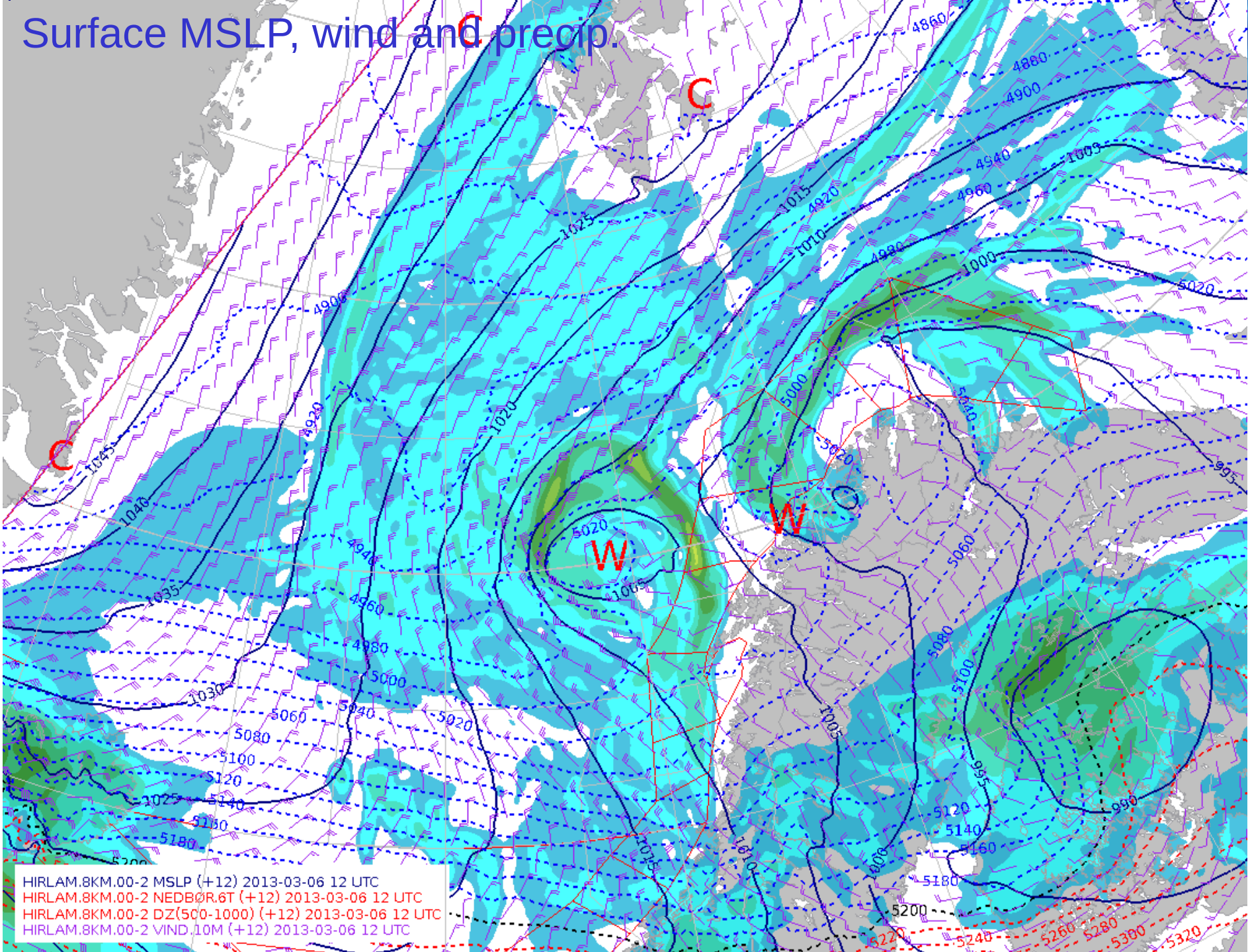
Polar lows over the Nordic and Labrador Seas: Synoptic circulation patterns and associations with North Atlantic-Europe wintertime weather regimes.
Mallet, Claud, Cassou, Noer, and Kodera, 2012

Cold troughs at 500 hPa

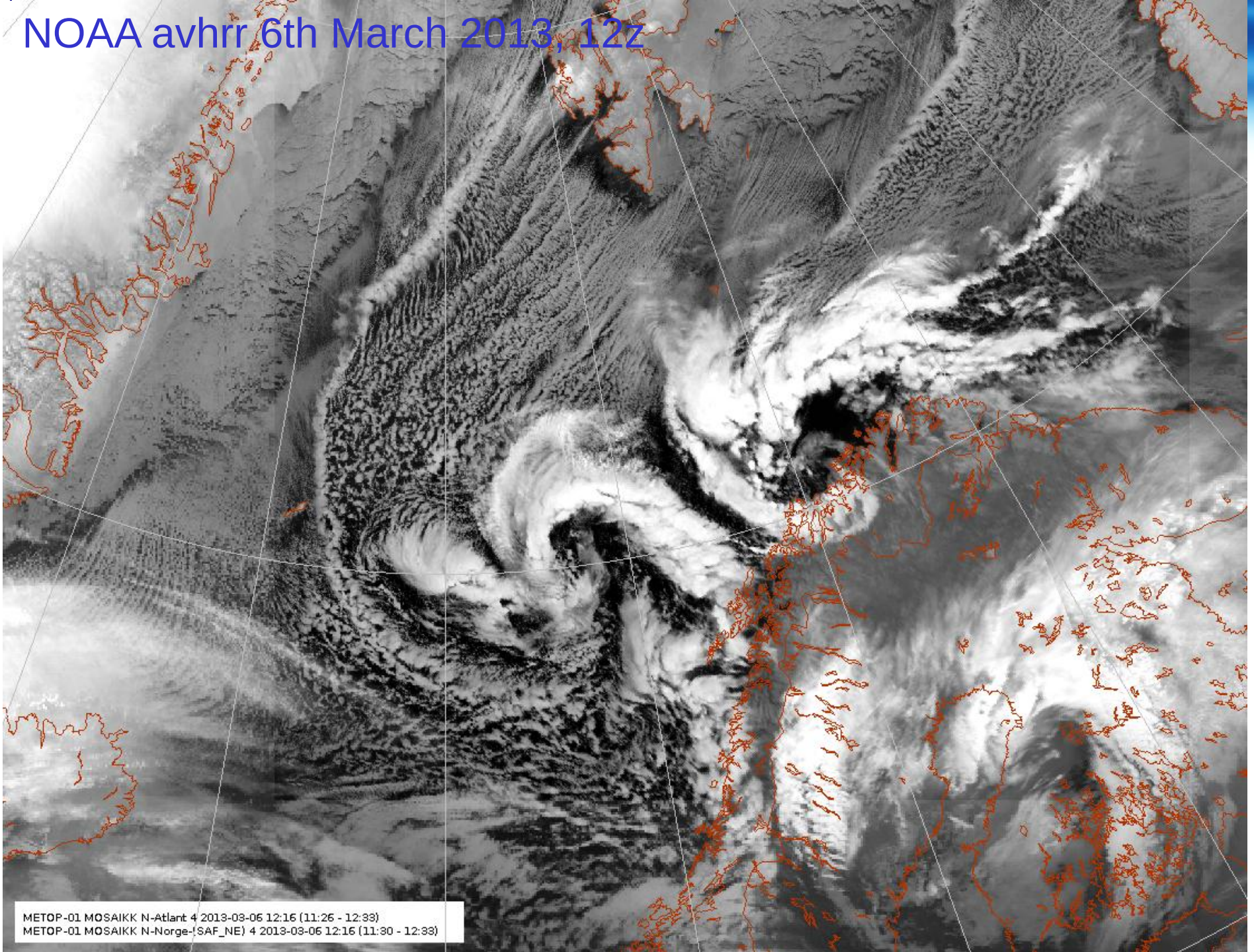


SST- T 500 hPa > 44 ºC

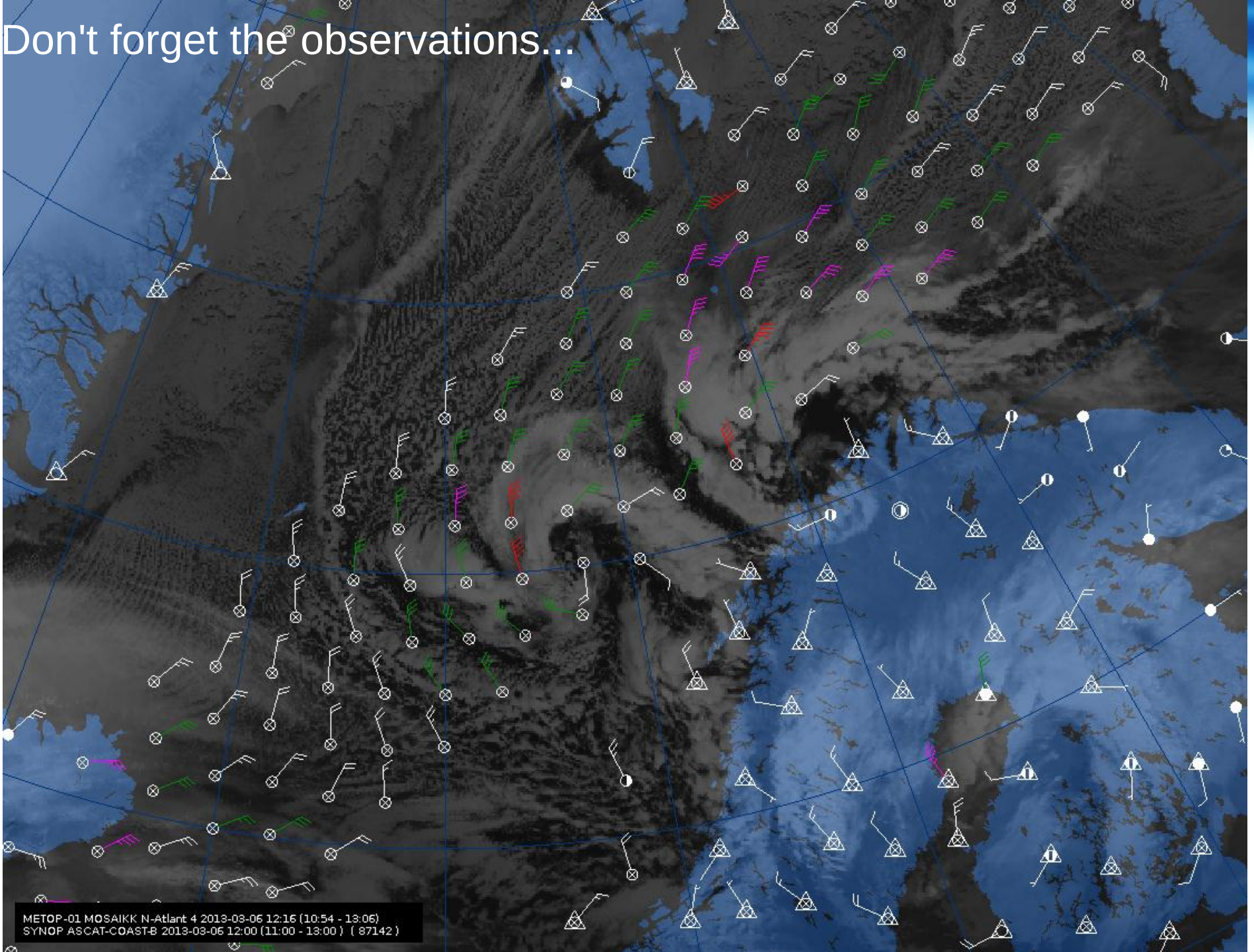
Surface MSLP, wind and precip.



NOAA avhrr 6th March 2013, 12z



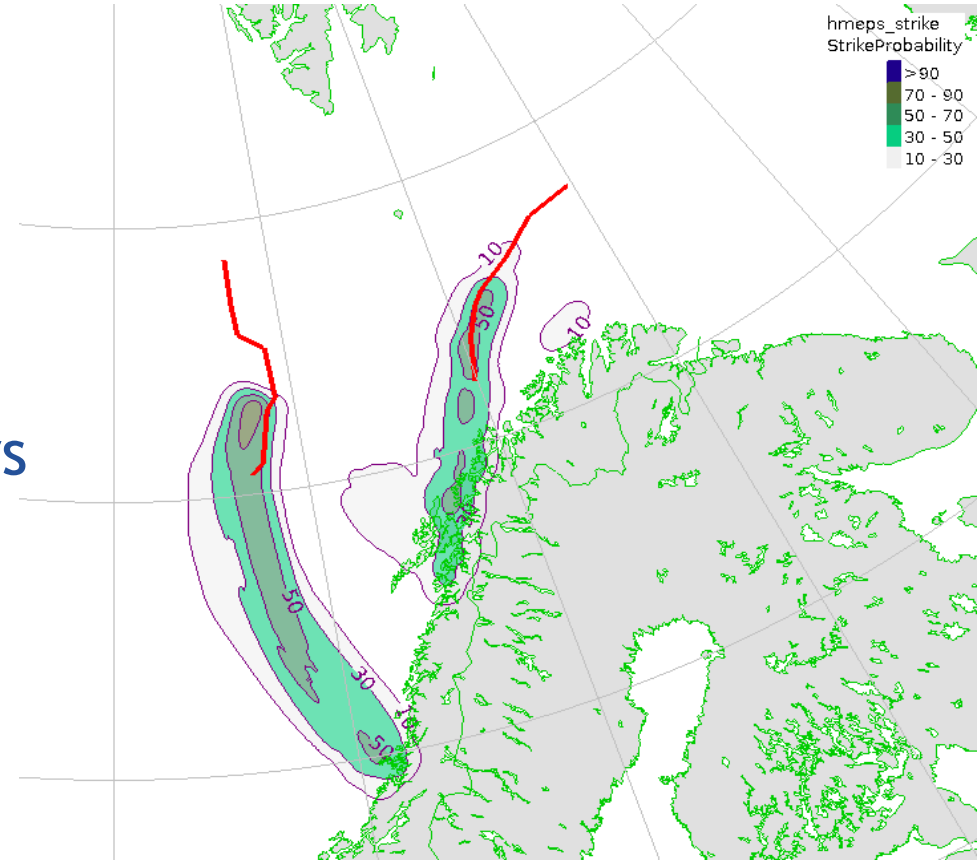
Don't forget the observations...



Practical use of the temperature potential:

Polar low tracking:

- EPS, downscaling EC-EPS by Arome 2,5km
- Tracking of low centers
- Filtering by
  - Temperature potential
  - Diameter
  - Duration



Why worry ?

ENTC TROMSO/LANGNES -- NO

Raw surface observations for station ENTC

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ENTC 061920Z 06008KT 9999 FEW010 SCT065 M05/M08 Q0999 NOSIG RMK WIND 2600FT 04020KT=
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Tromsø airport mountain observation at 2600ft:

13:20z: 290 03kt (Westerly force 1)

13:50z: 340 53kt gusting 69kt (Northwesterly storm force 10)


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Questions ?

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