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Polar Lows – Arctic hurricane

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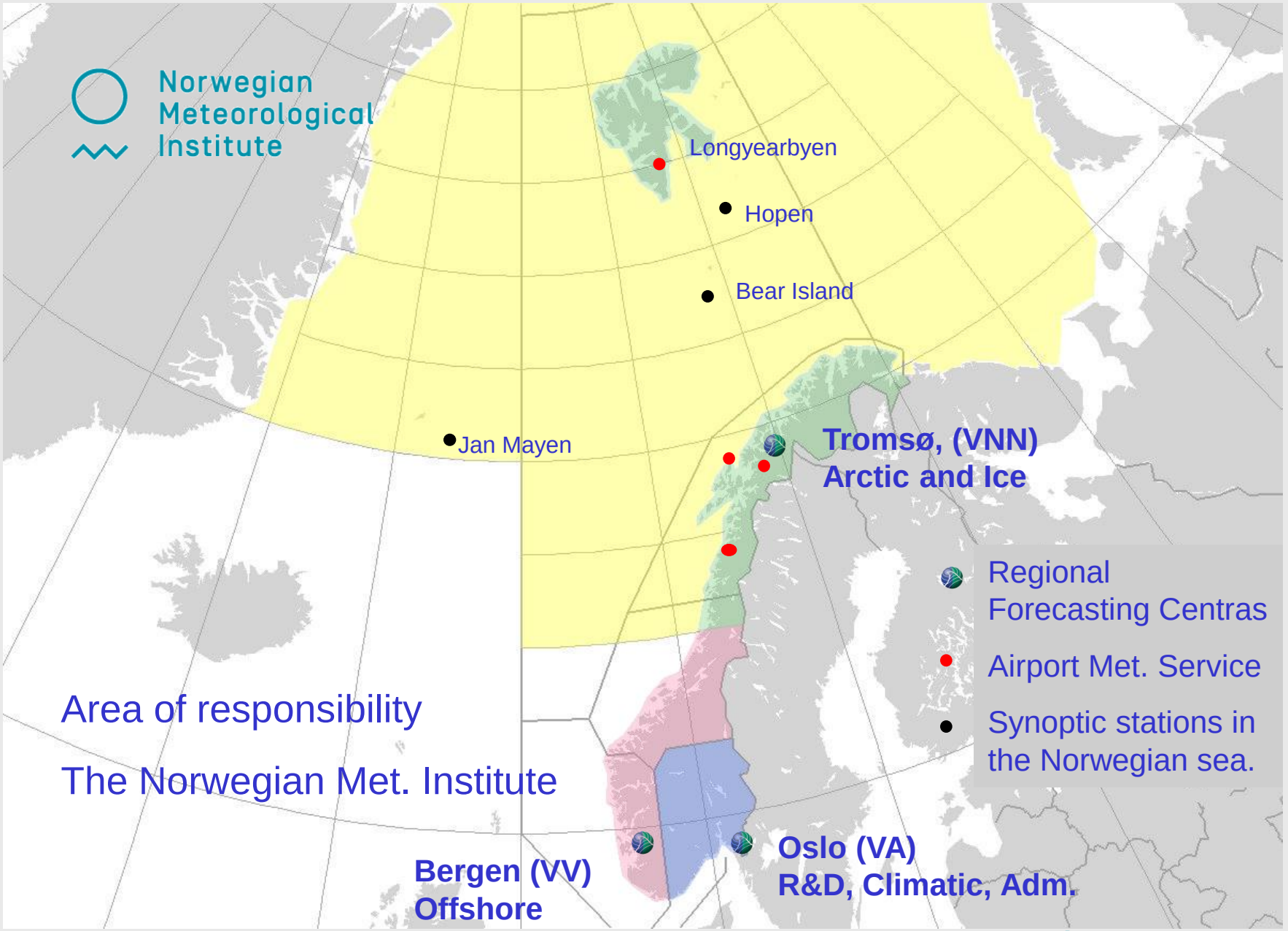
The Norwegian Meteorological Institute
Forecasting division of Northern Norway

19.01.2015



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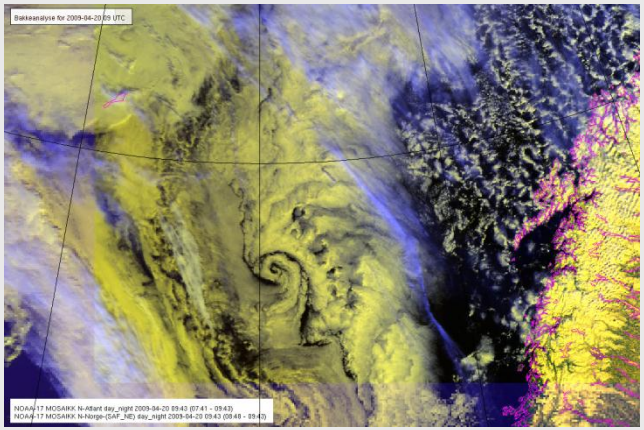
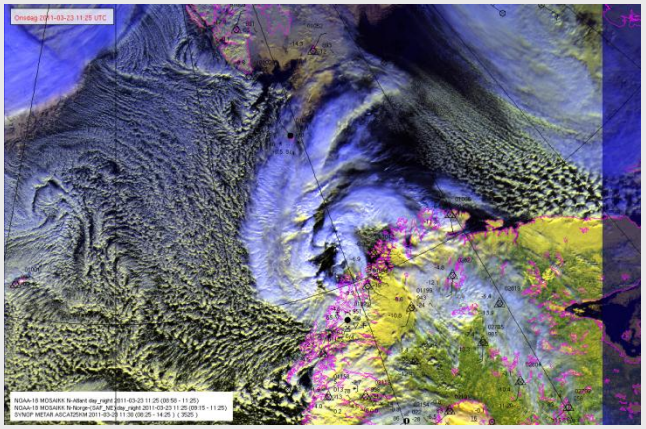
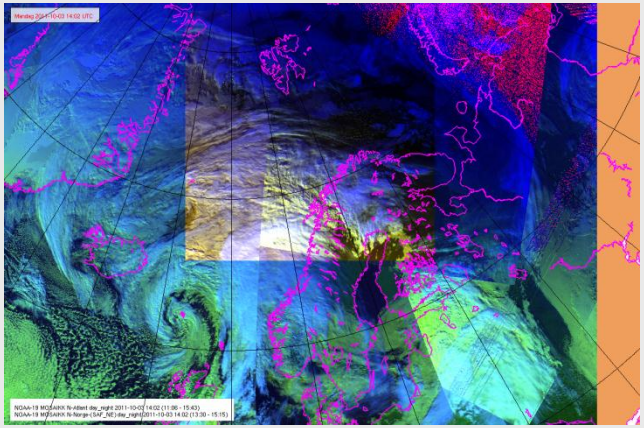
Find polar low







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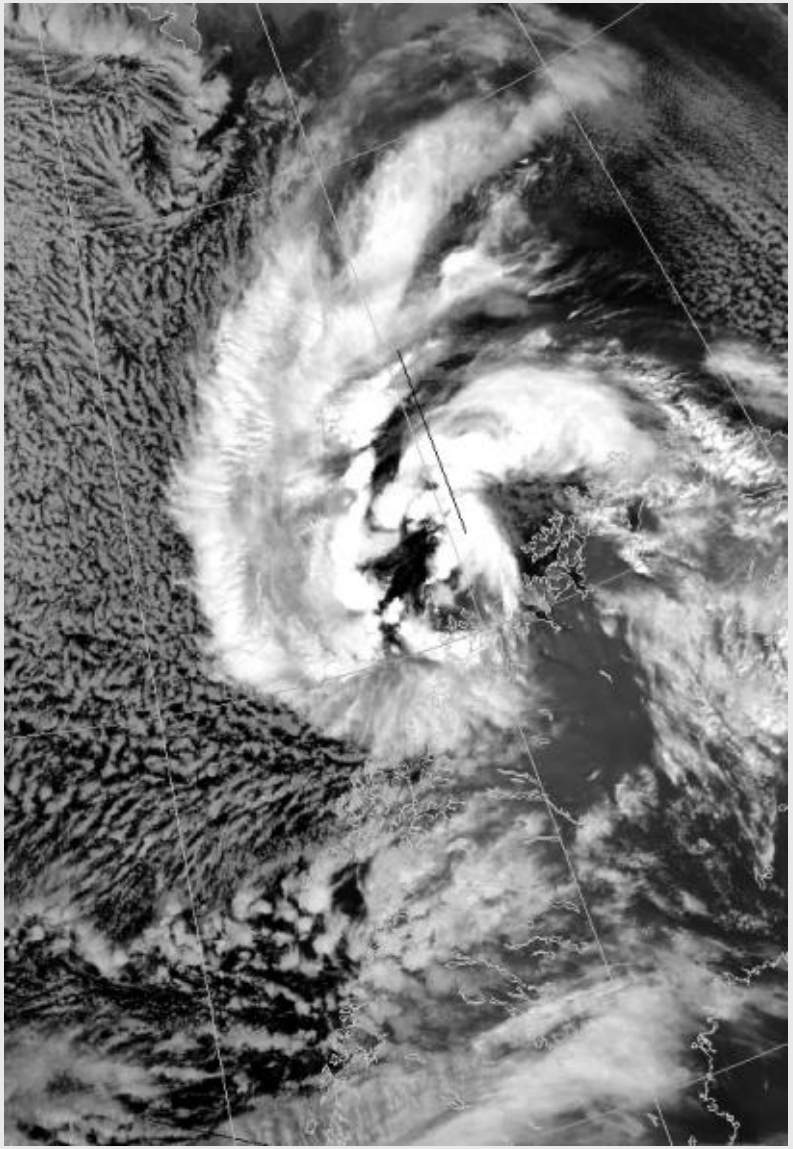

Definition:

- a small, but fairly intense low in maritime regions
- in cold air outbreaks, well north of the polar front
- Diameter 200 – 600 km
- surface winds near or above gale force
- cyclonic curvature

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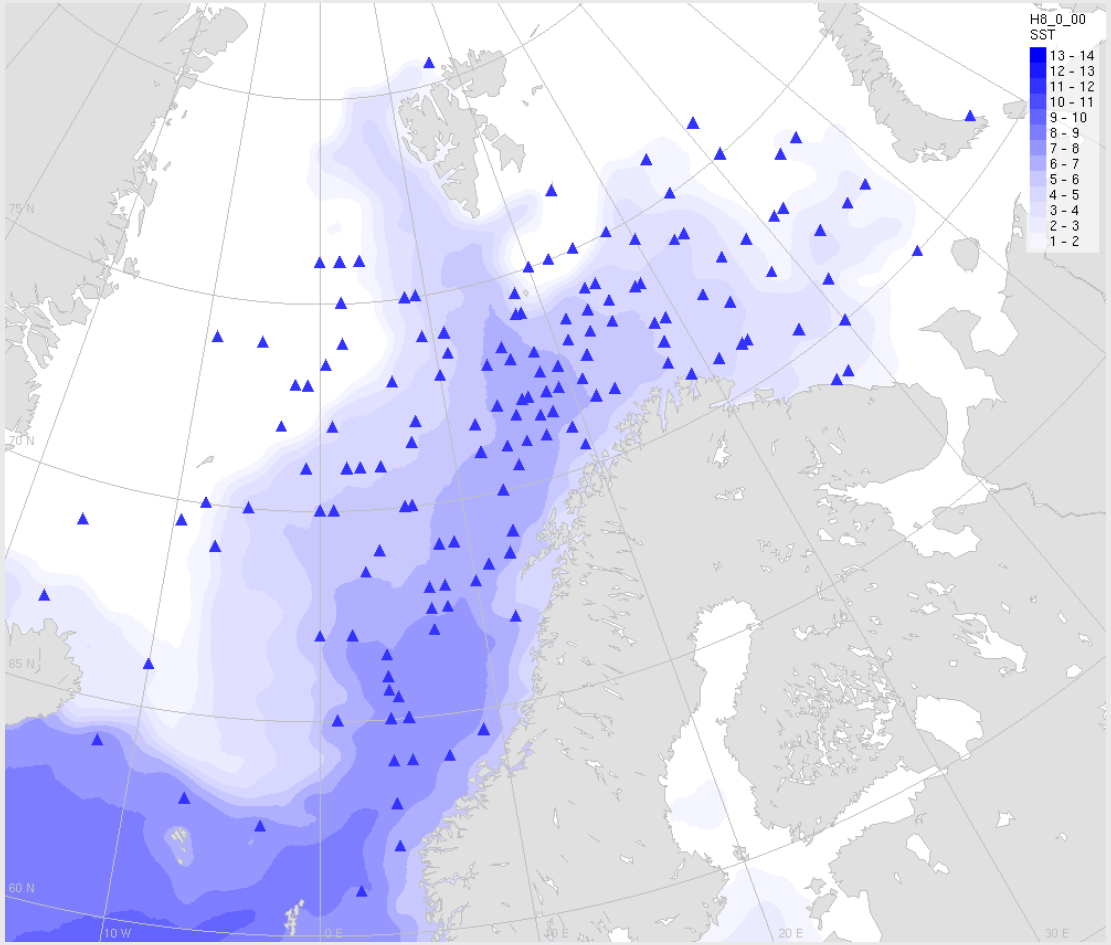
Polar low genesis areas



- 190 cases 2000 – 2013
- 50-70% recorded withing VNN AOR
- Most common east of E00, and south of N75
- Less cases in the eastern and southern part of area

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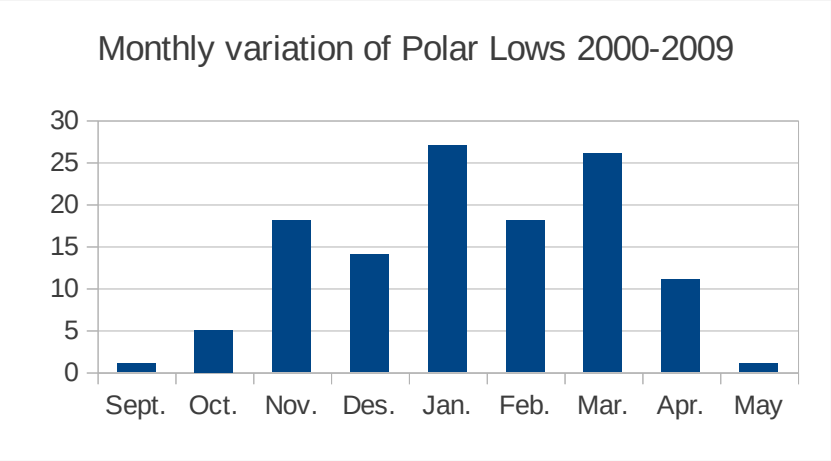
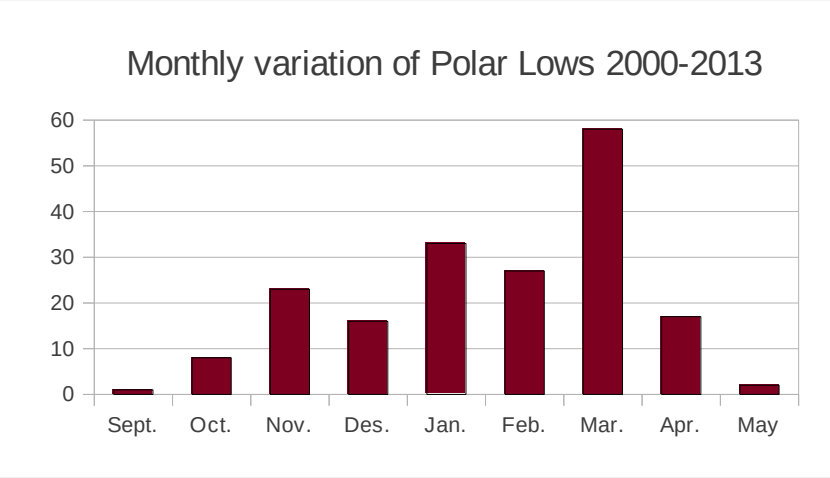
Sesonal variation:

- On average 13 events pr. year
- October til May
- Max in January and March, local min 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





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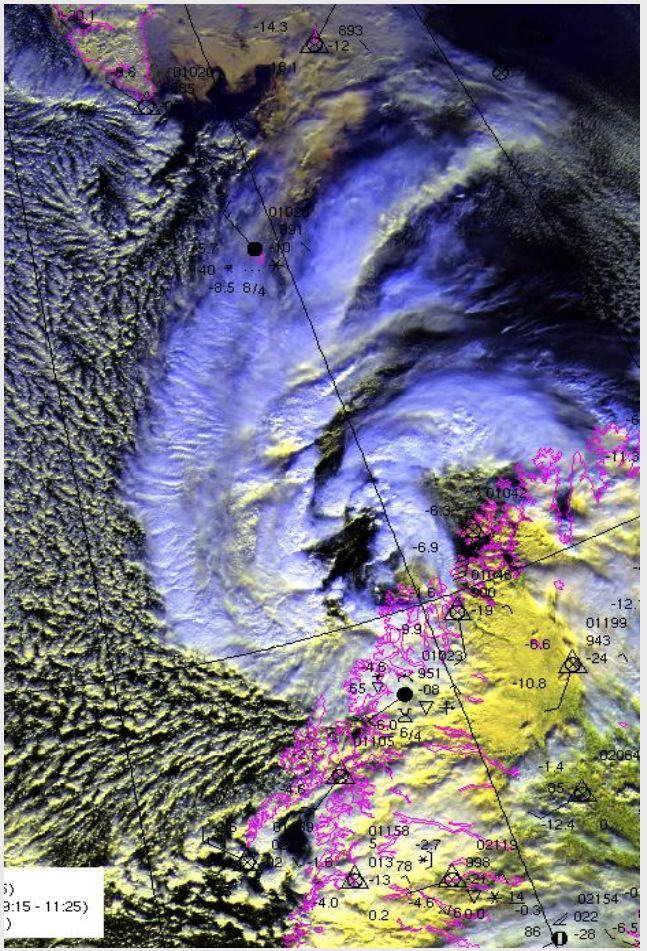
Characteristics of the polar lows

- Generally smaller than the ordinary synoptic lows (200-600 km)
- Average lifespan 18 hrs
- Speed of propagation 15-25KT, fastest recorded was 50KT
- Heavy showers of snow or hail, visibility less than 100m
- Waves and icing



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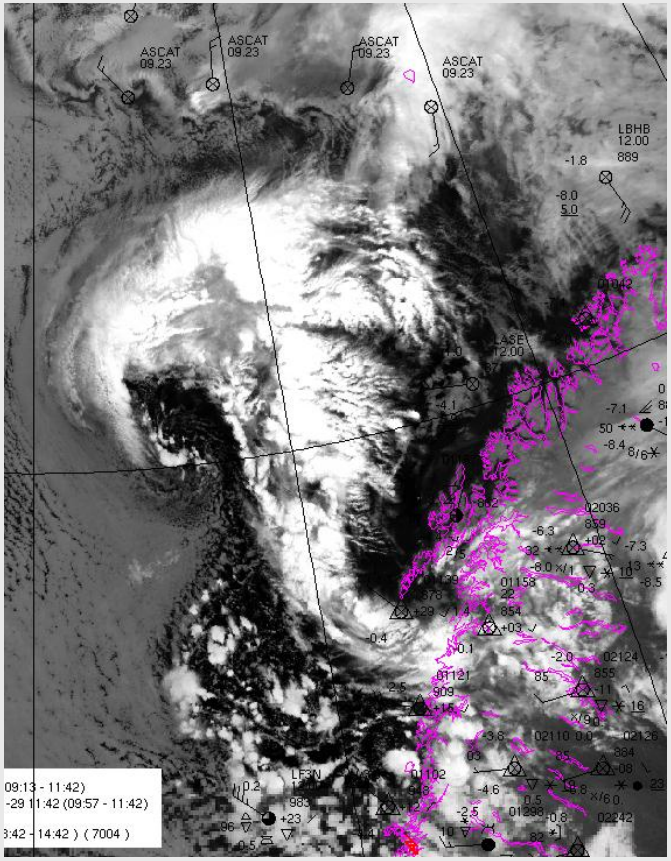
Wind characteristics of the polar low

- Rapid changes of wind, 15KT to 50KT in less than 15 minutes
- Average observed max wind 42KT (B9, strong gale)
- 25% have 50KT (Storm B10) or more
- Strongest recorded since 2000 had 70KT for more than 12 hrs
- Strong wind usually in the west side of the low, from NW to NE



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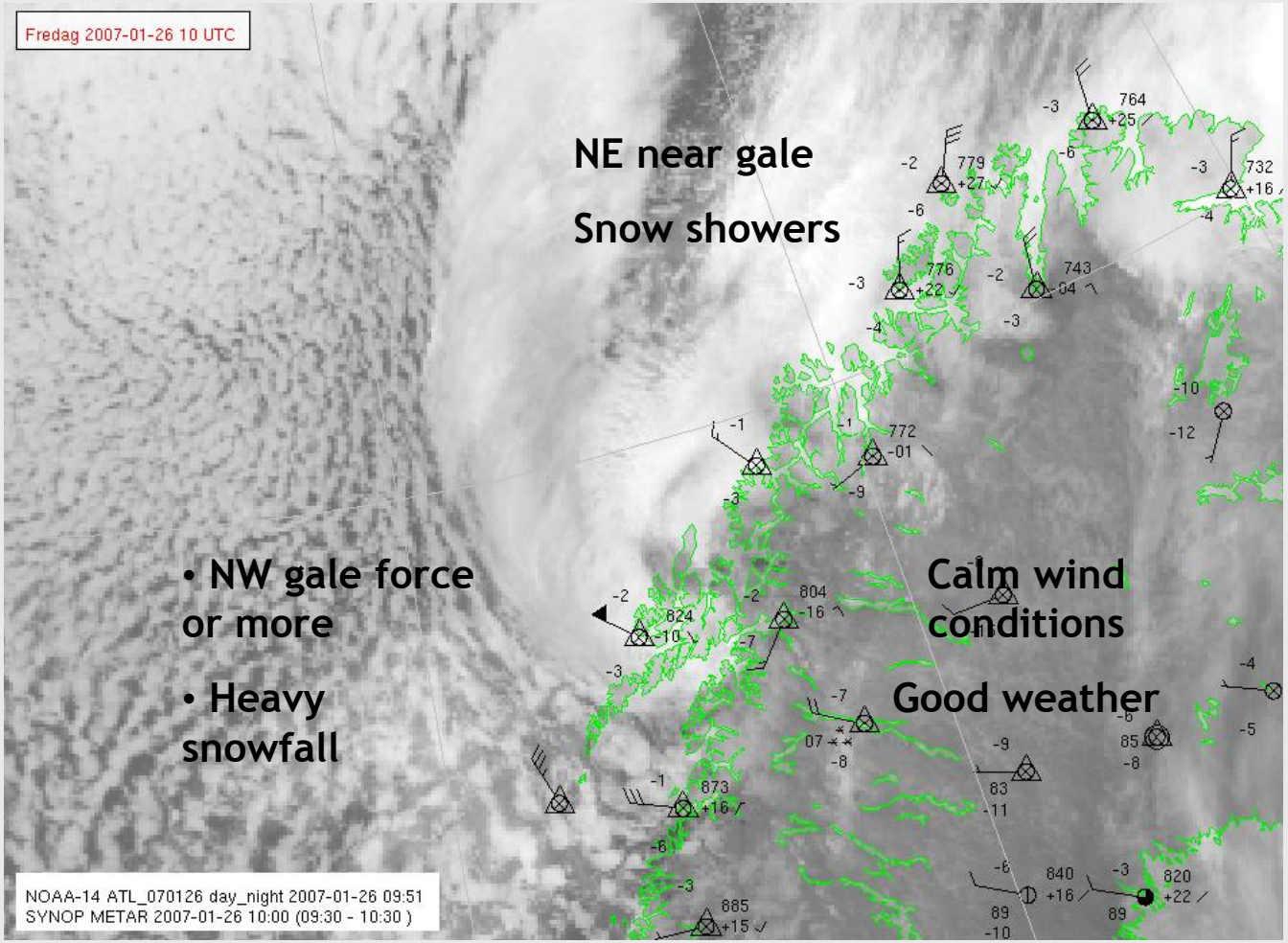
Typical wind pattern - observations



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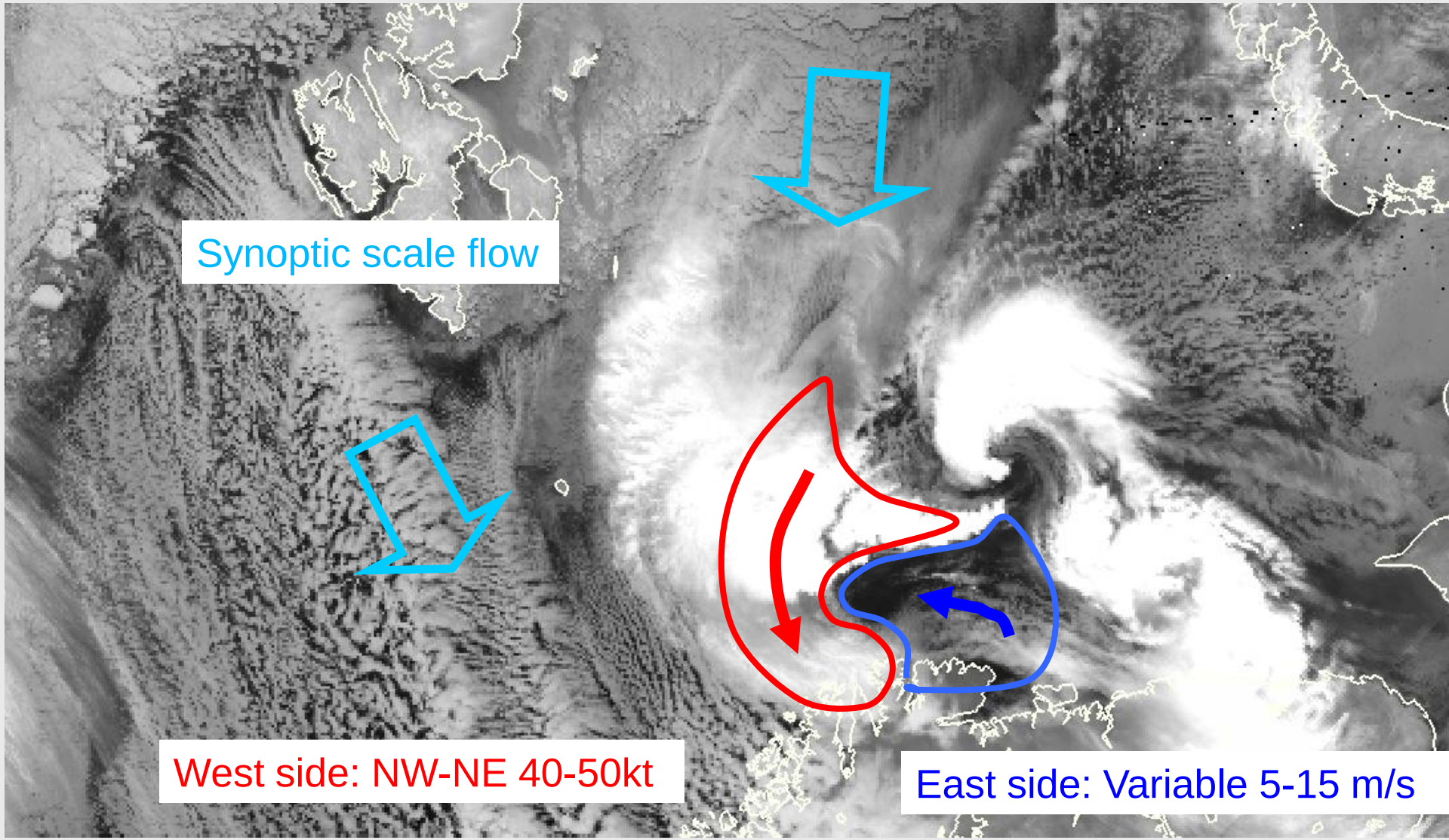
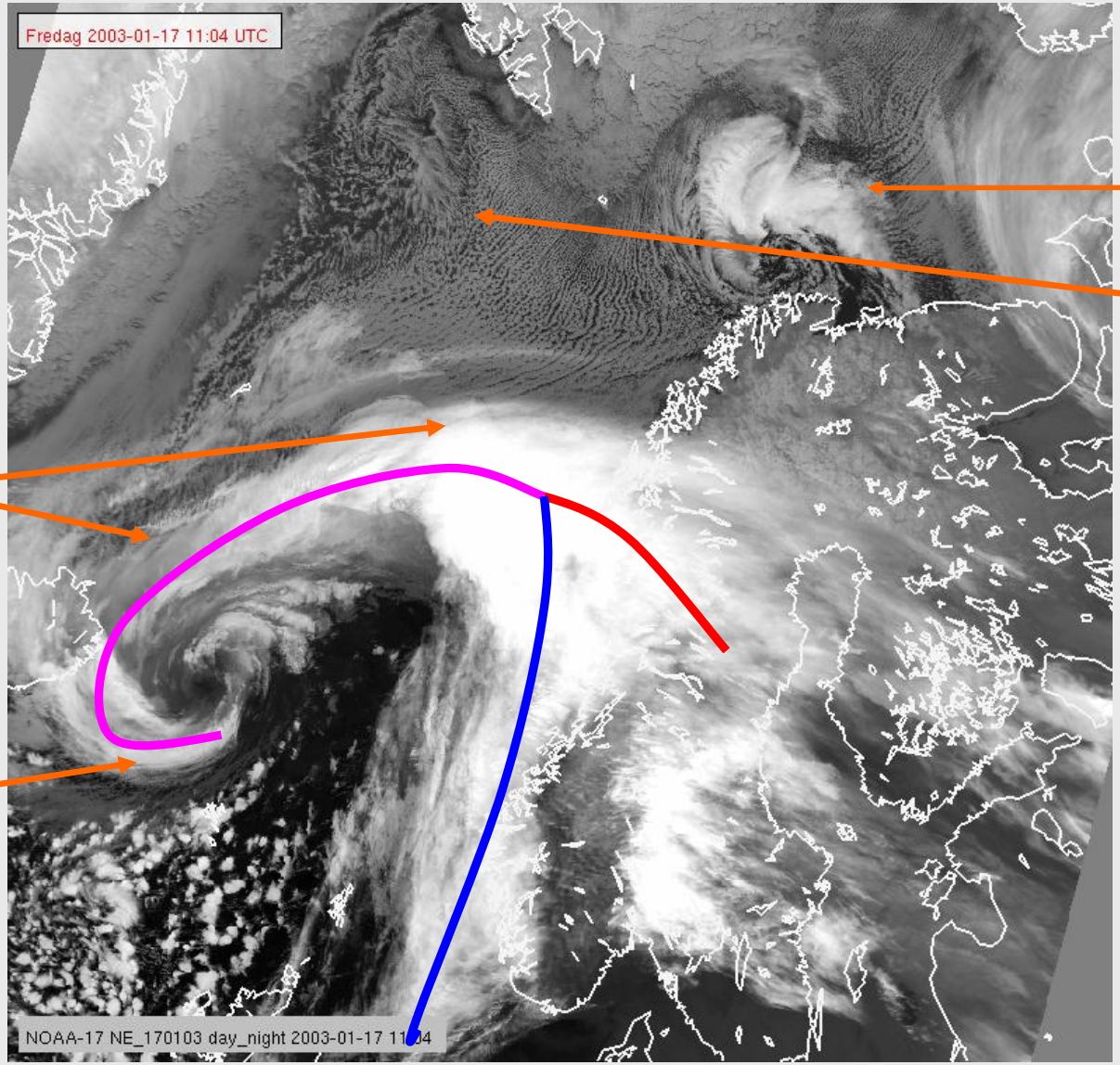
Typical wind pattern





Polar low

Cold air outbreak

The polar front

Synoptic low

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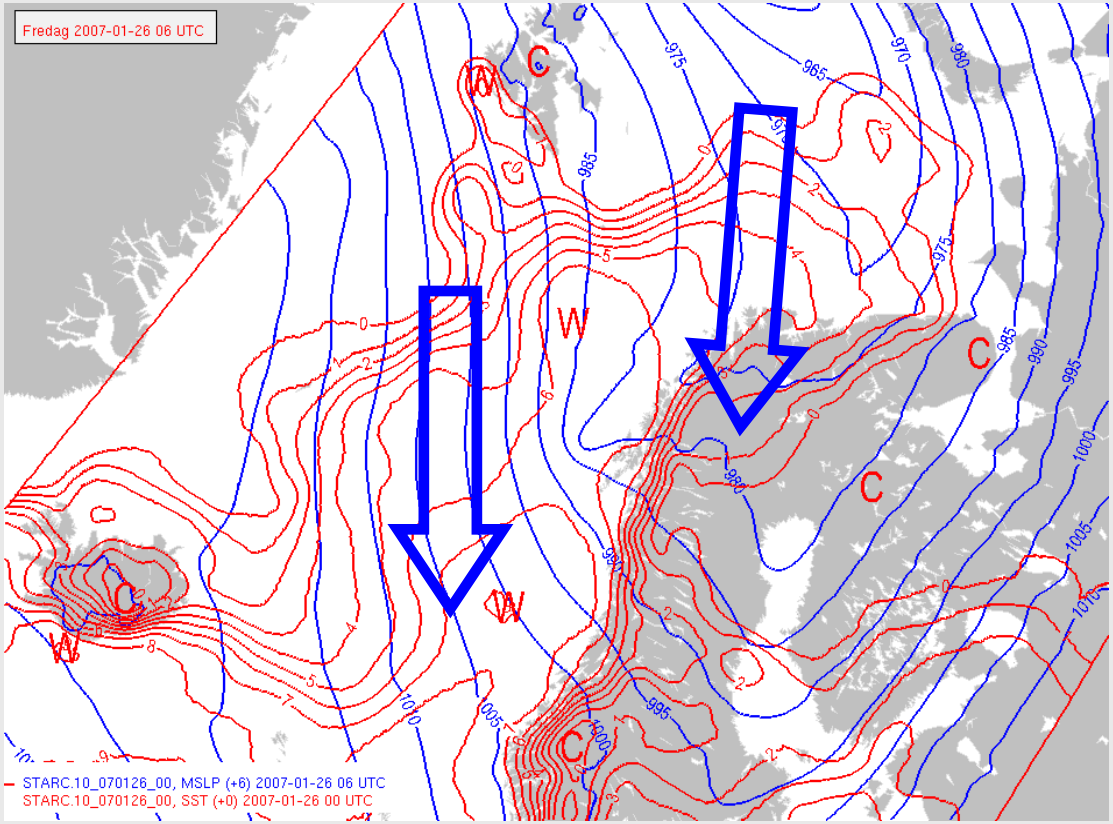
The Cold Air Outbreak

- Cold air flows south over gradually warmer waters.
- Supply of heat and moisture from the sea adds energy to the lower layers.
- The air is destabilized
- Showery weather downstream



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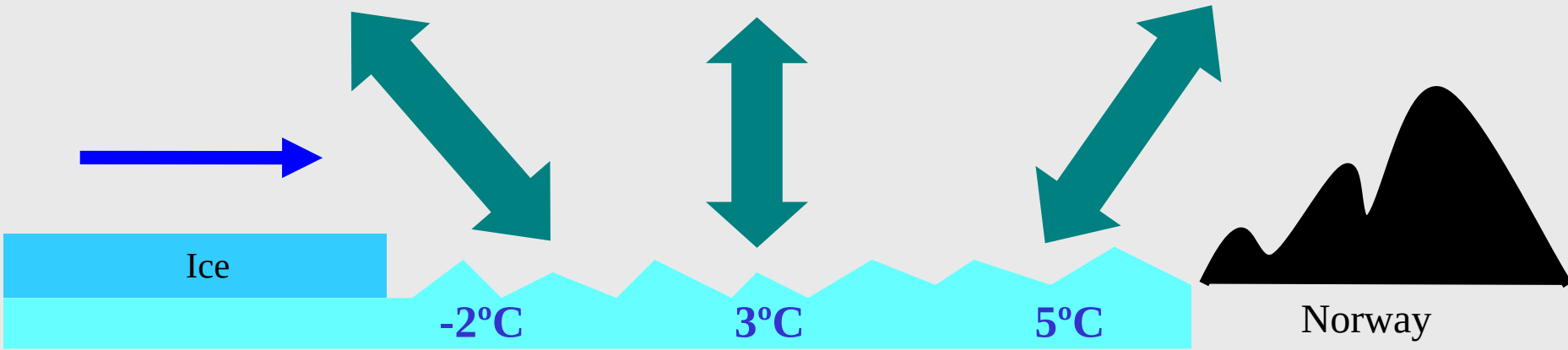
The Cold Air Outbreak

Shallow convection, Cu

Towering Cumulus, TCu

Cumulonimbus, Cb



Deepening convection from the ice across warmer waters

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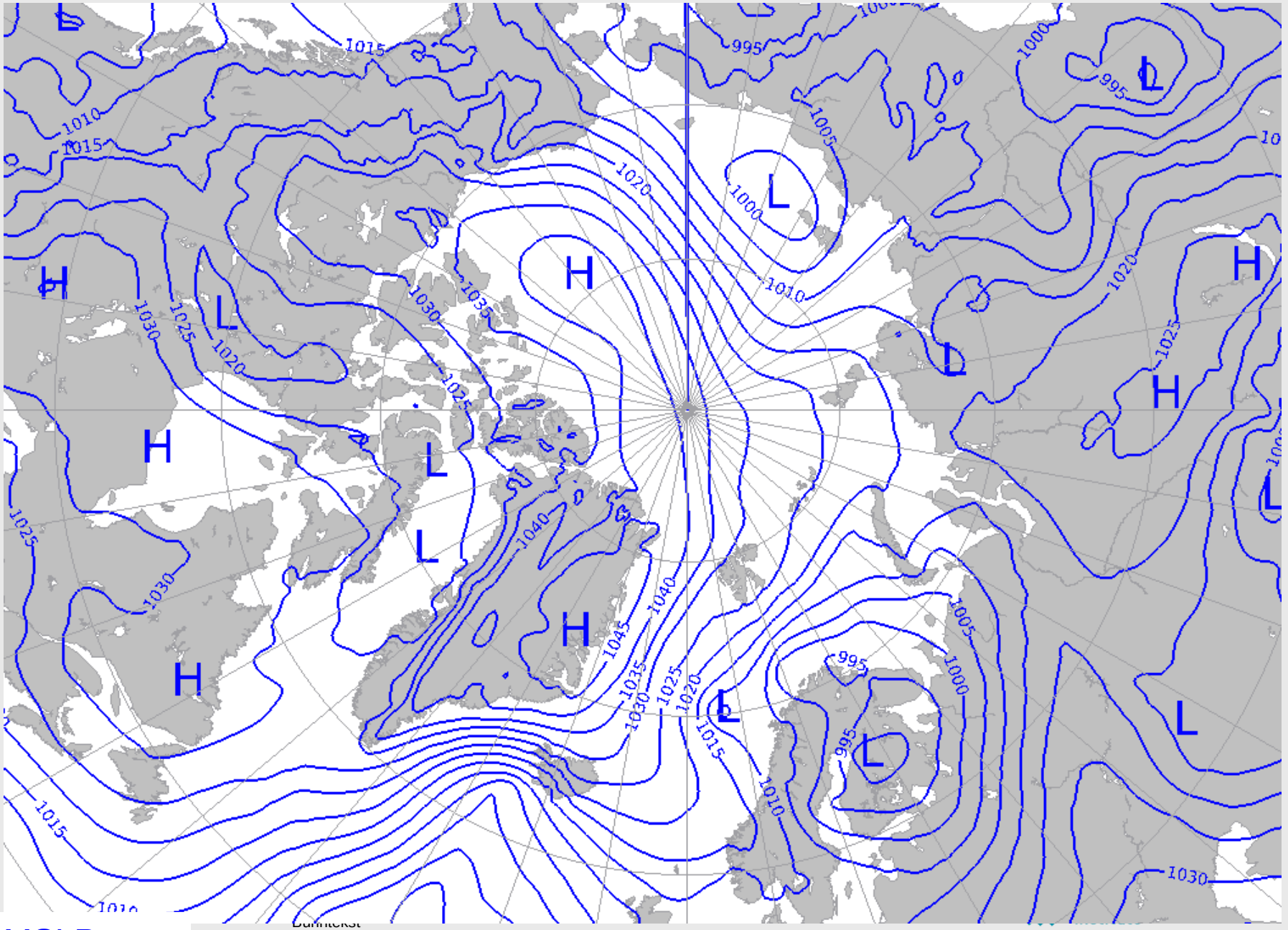
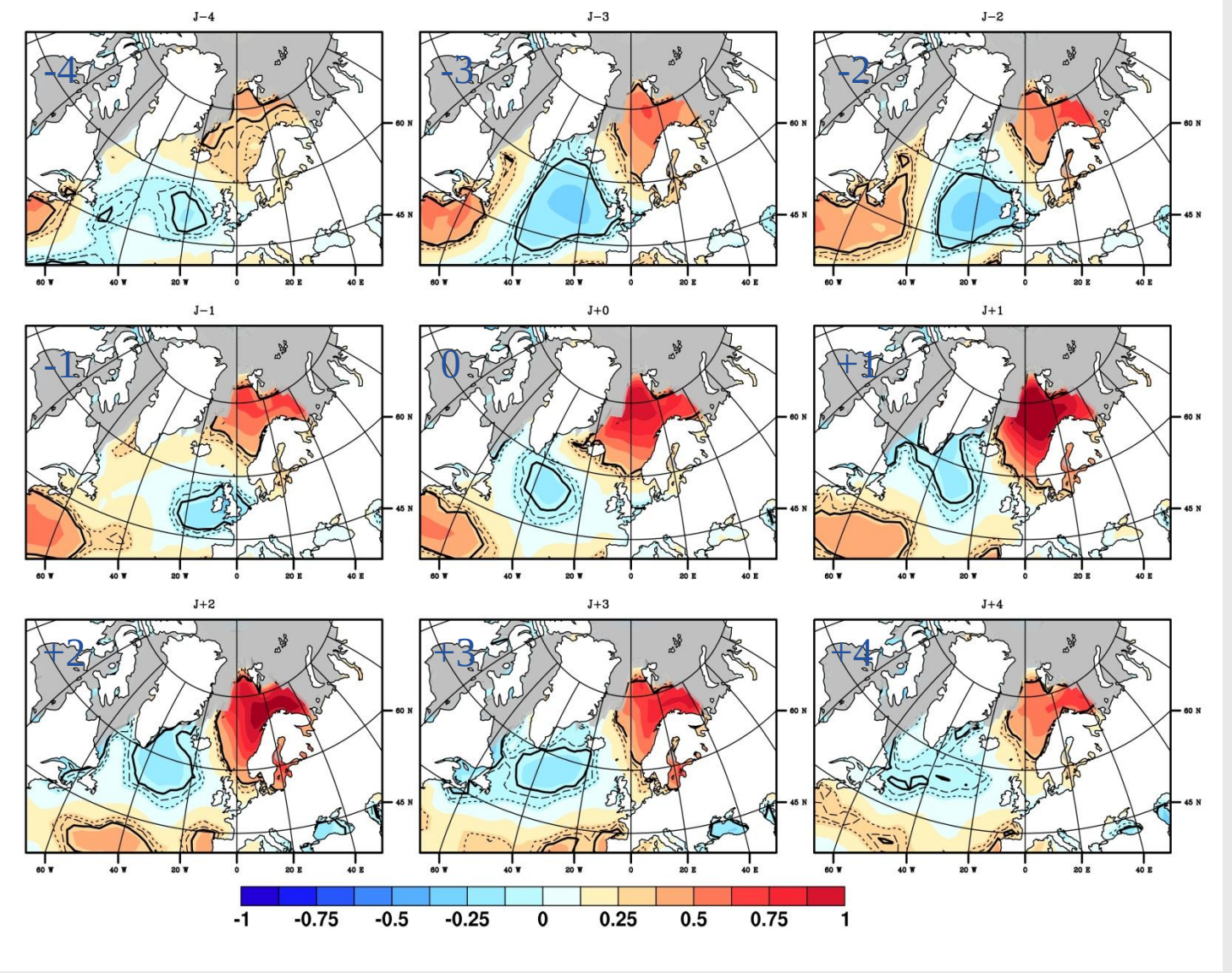

MSLP

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

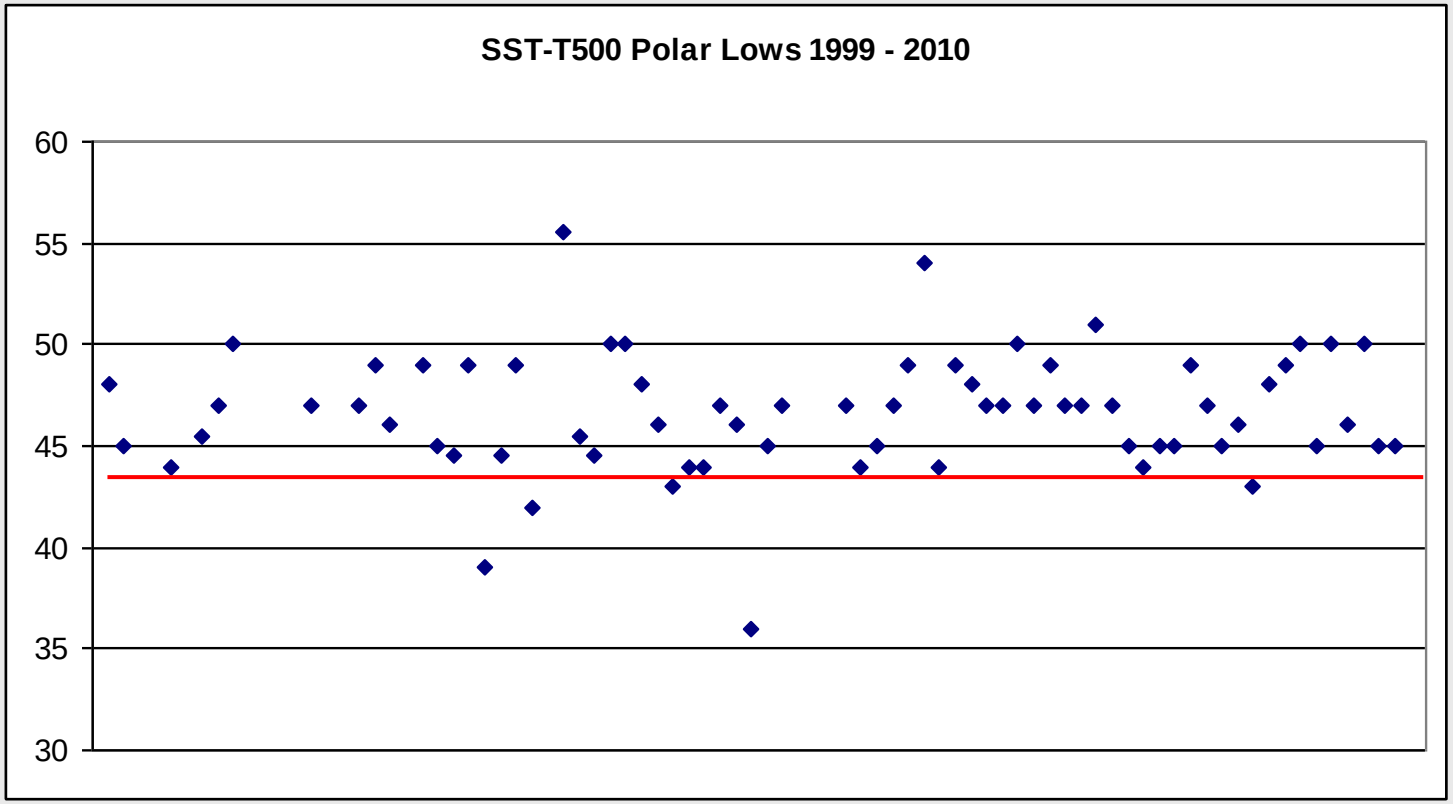
Physical background – triggering factors

- Neccesary:
  - Low level Cold Air Outbreak (CAO)
  - Upper level cold core and trough
  - Deep vertical instability, > 500hPa

- Additional
  - Low to mid level baroclinic zone
  - Reversed vertical shear
  - Vorticity maxima assosiated with jet shear or exit zone

The temperature difference

SST – T500 ≥ 44˚C !
– with exeptions!



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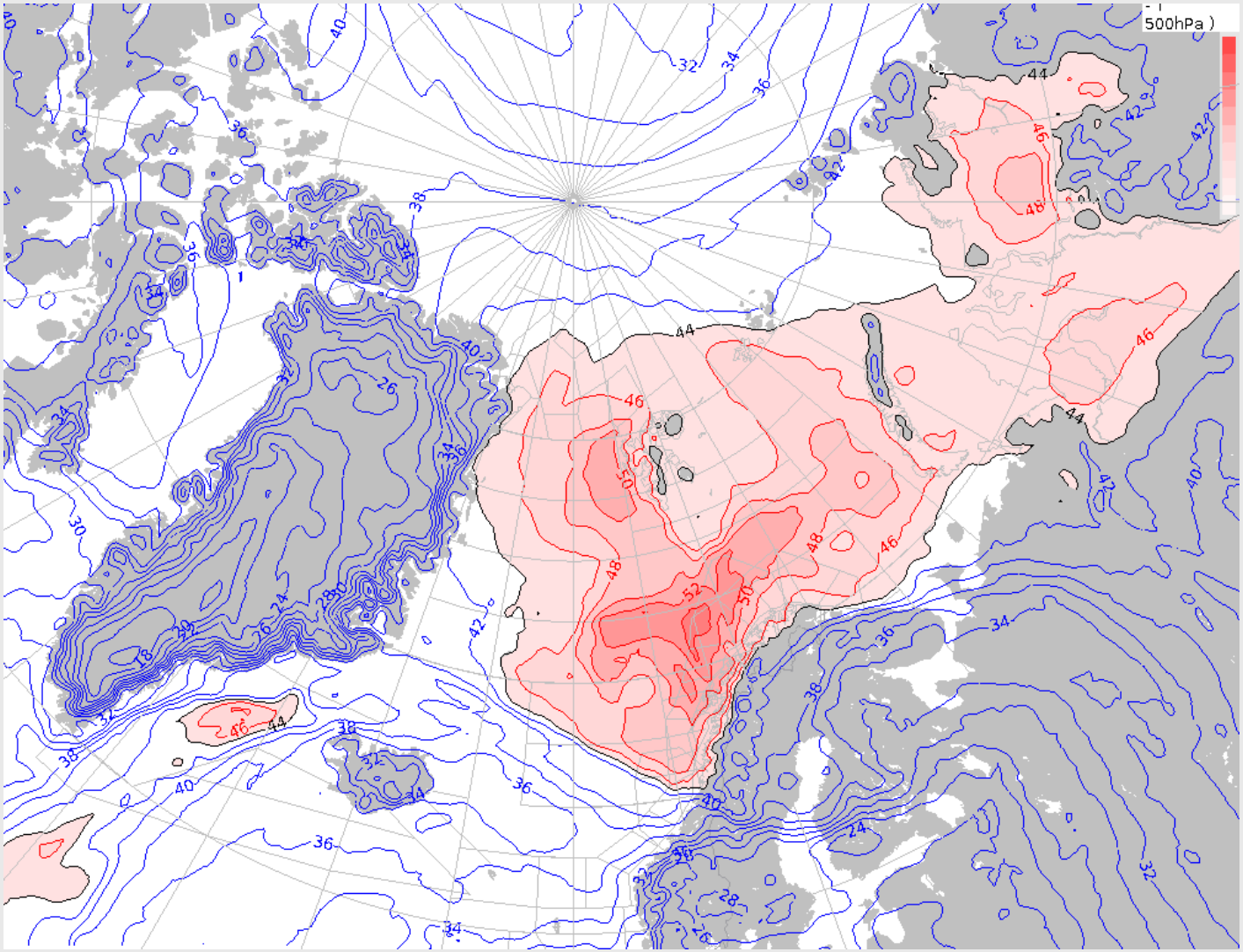
$T_{sea} - T_{500} \geq 44°C$



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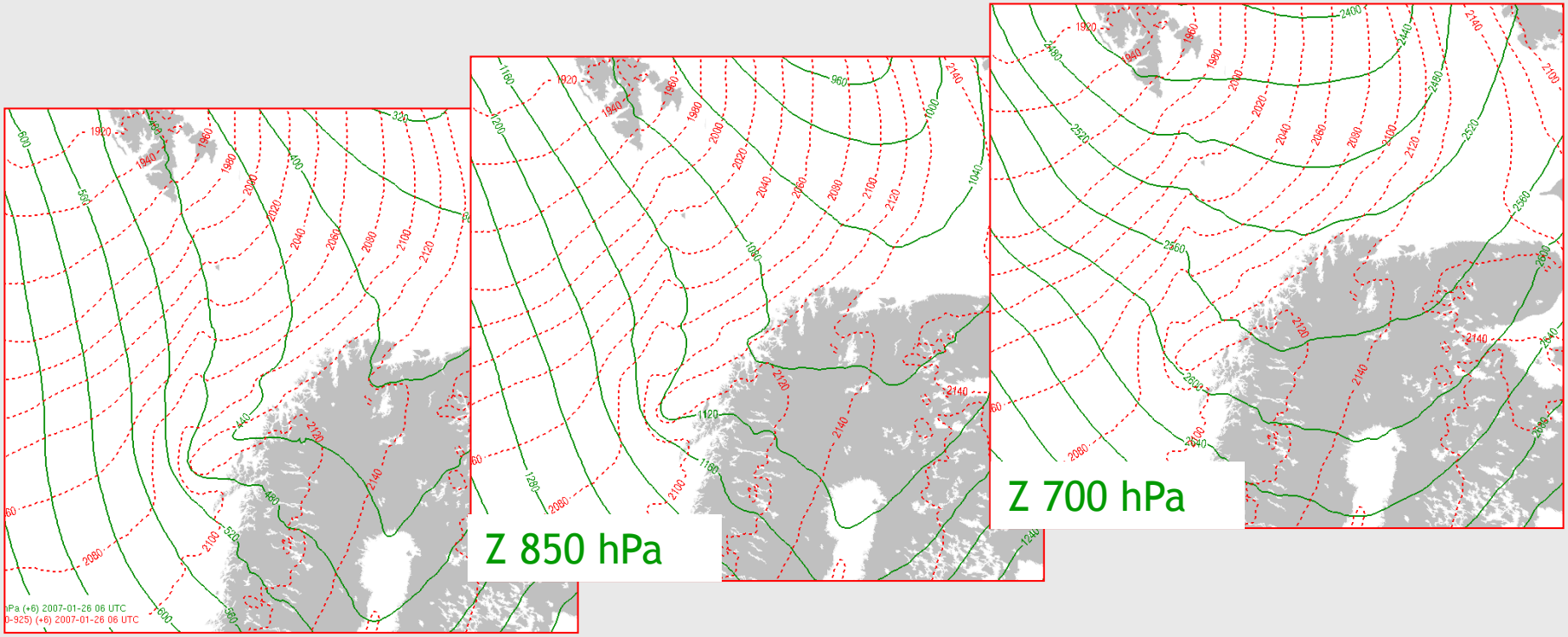
Reversed shear:



Reversed shear, seen in approximately 2/3 of the cases

Termal wind acting against the large scale wind field

Strongest horizontal pressure gradient and wind at low levels

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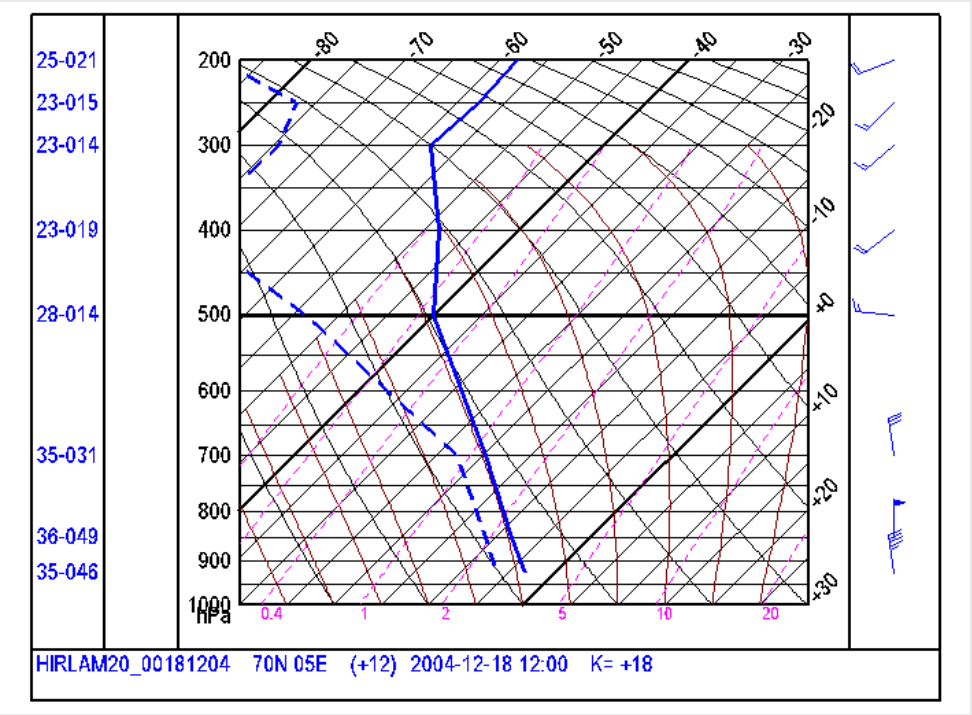
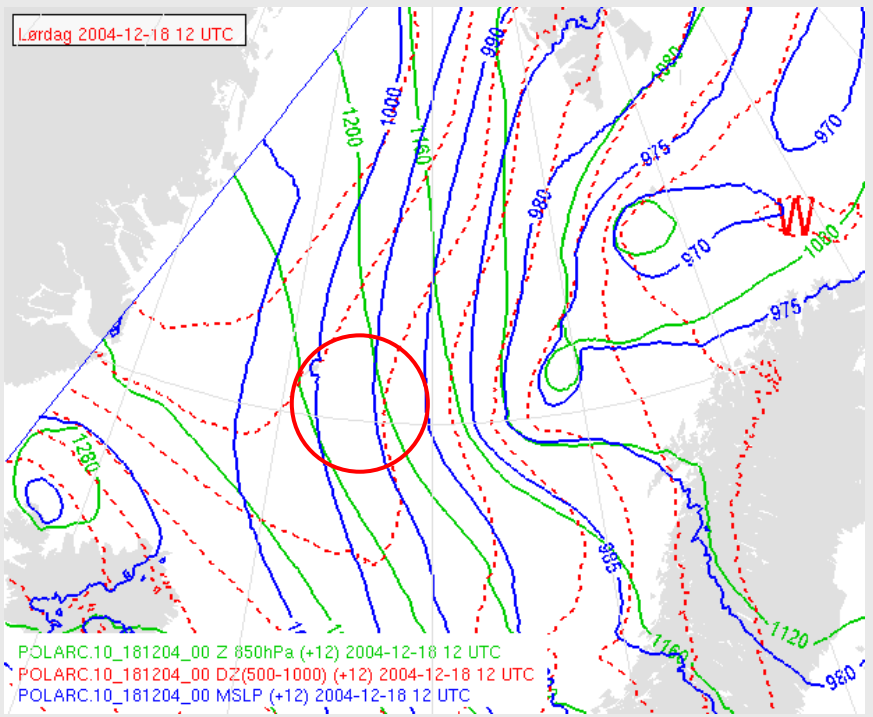
Reversed shear flow





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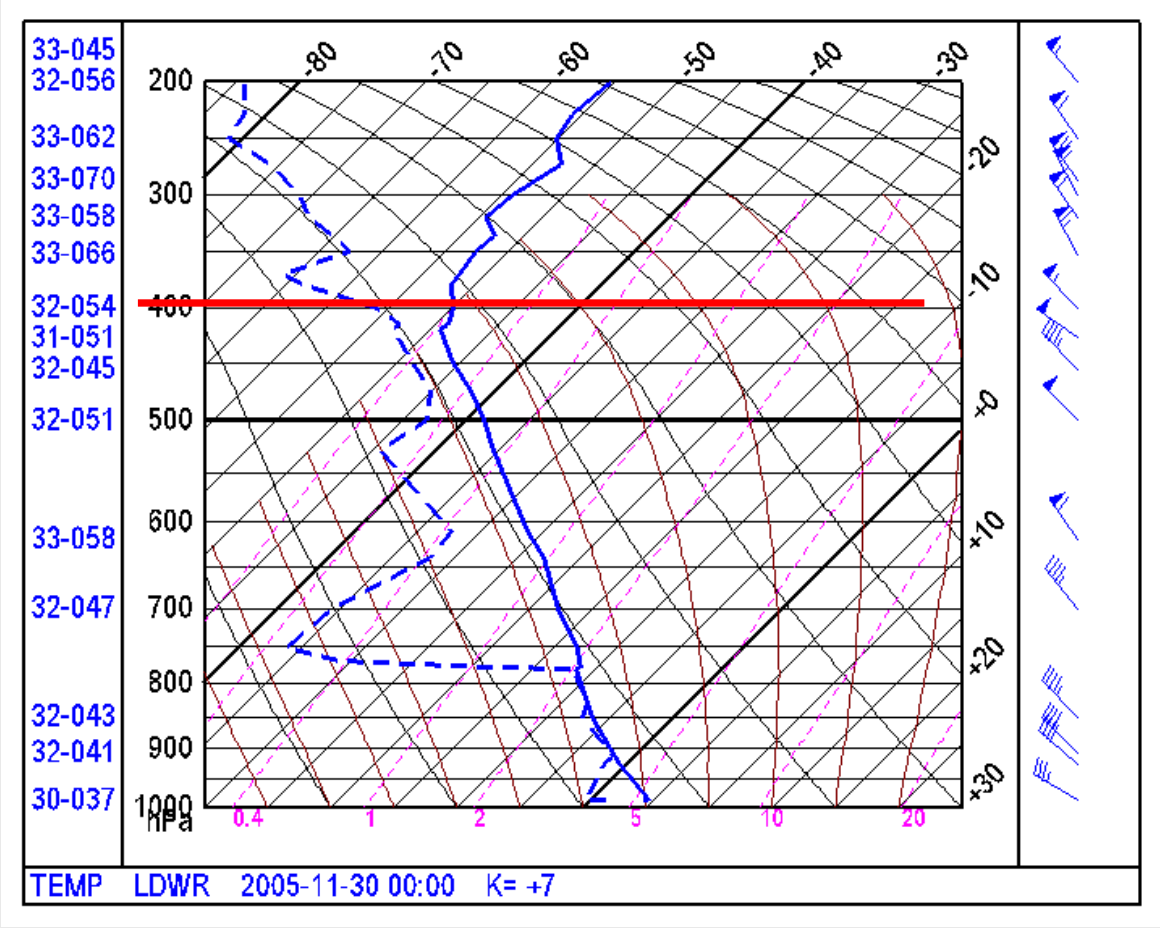
Instability up to 500 – 400 hPa



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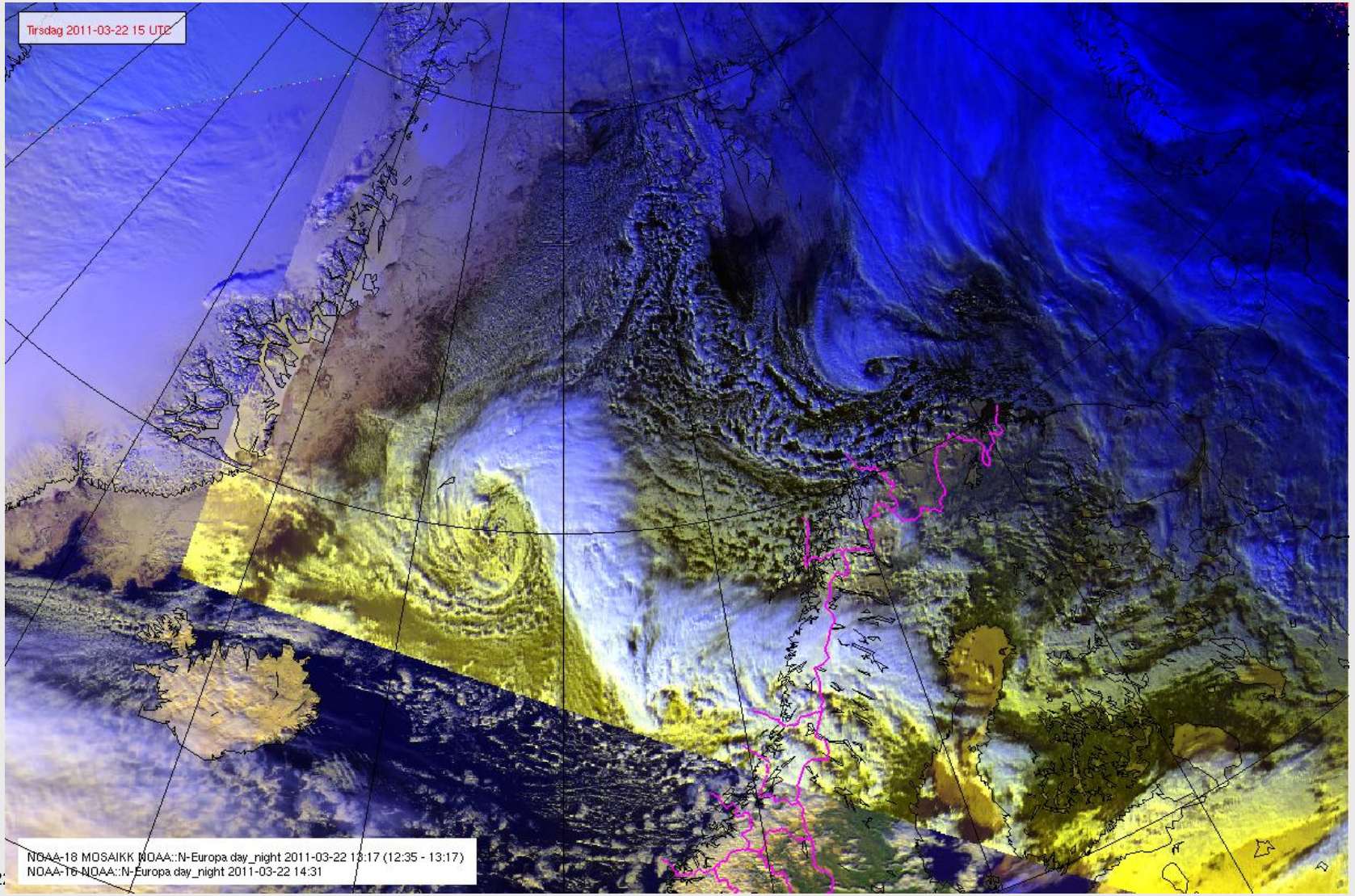
Polar Low forecasting
22 - 23.03.2011

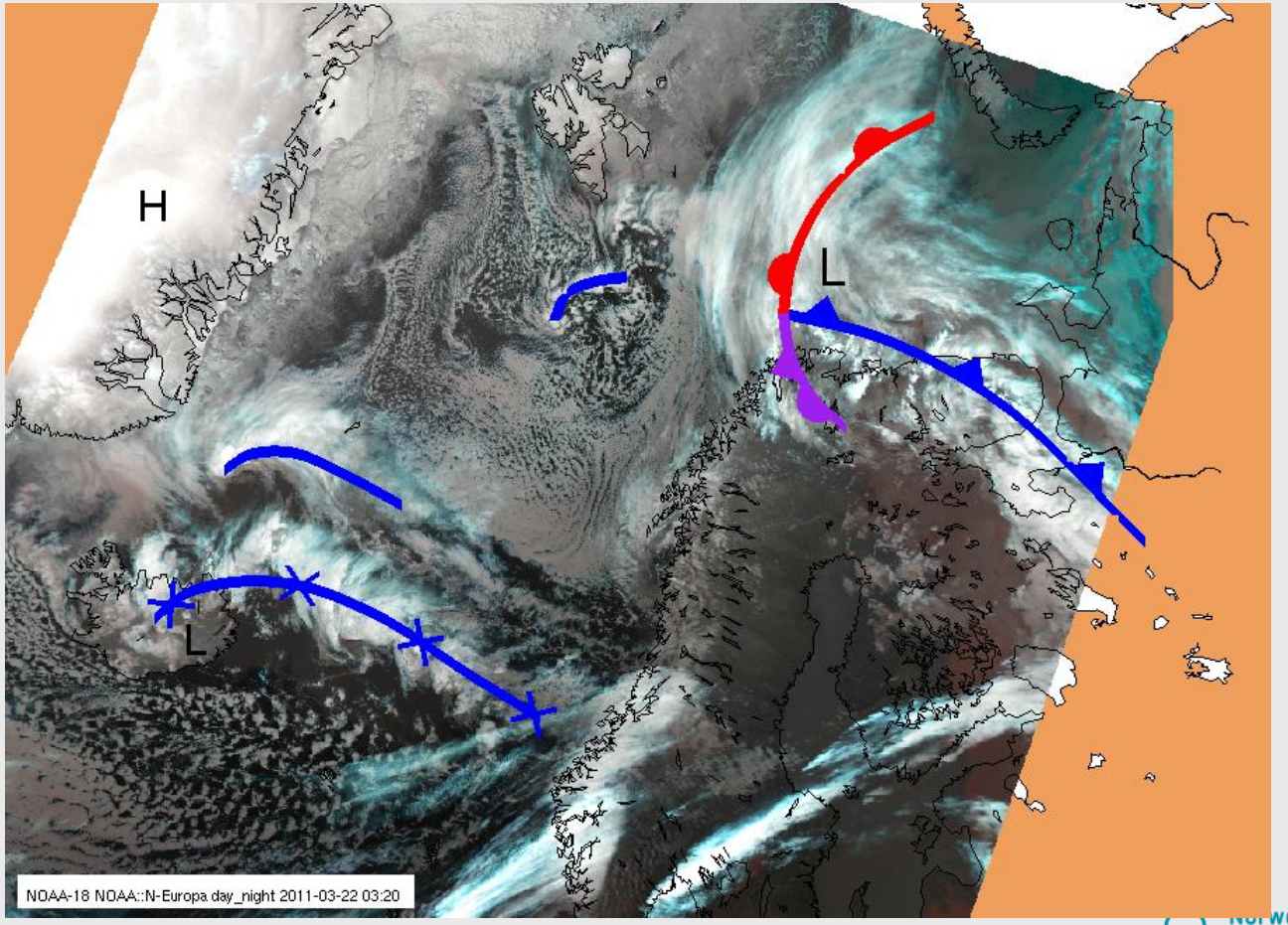


Polar Low some details

- max observed wind (KT)	60, gust of 87
- min pressure (hPa)	981 hPa
- min diameter (km)	200
- max diameter (km)	650
- lifespan (hrs)	36h
- SST – T500 (C)	44 – 48
- Cloud top temperatures (C)	-45 to -58
- pressure tendencies	-4 to +11

Classification: baroclinic, reversed shear at 900 – 850hPa

22.03.2011 03 utc satellite + synoptic analysis



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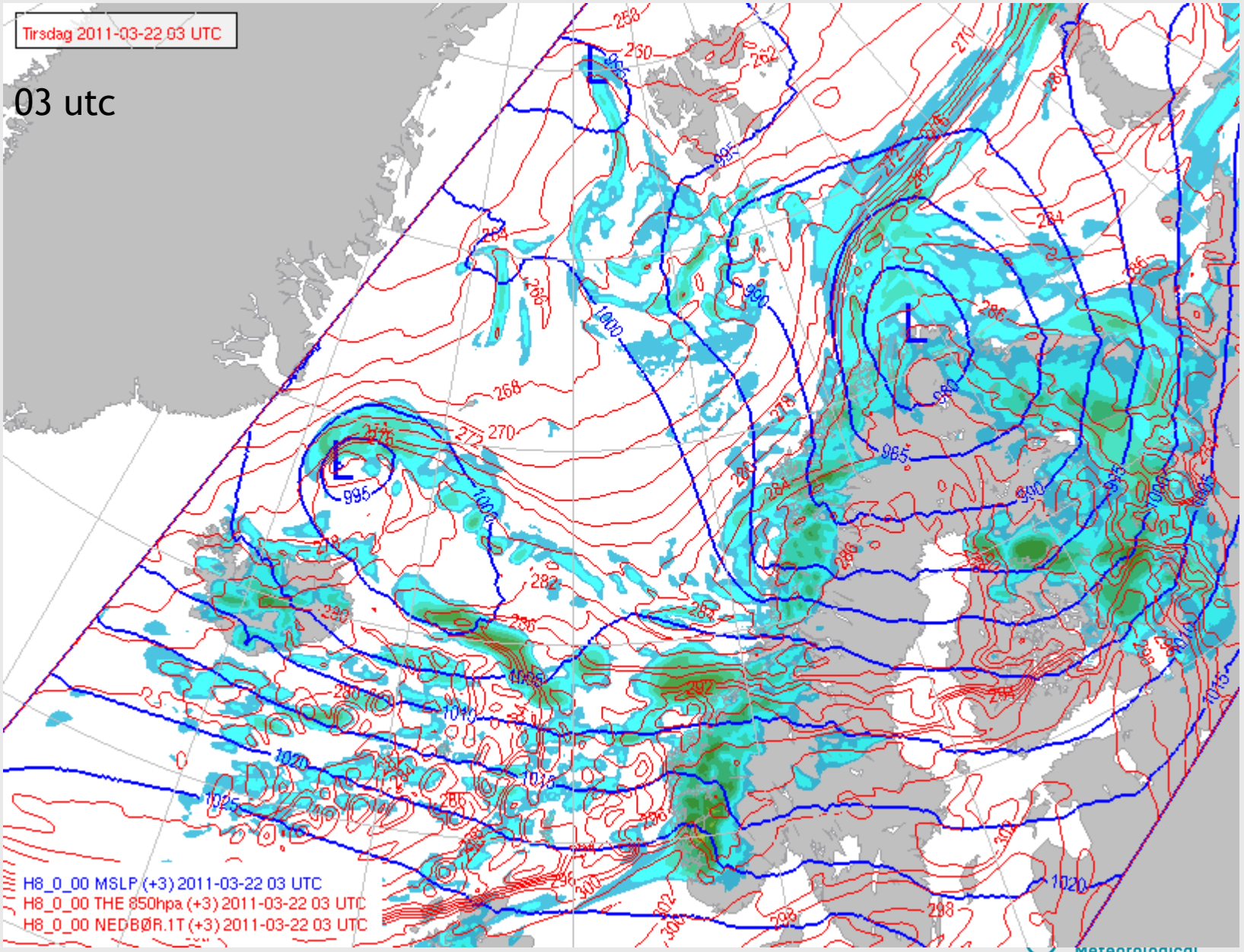

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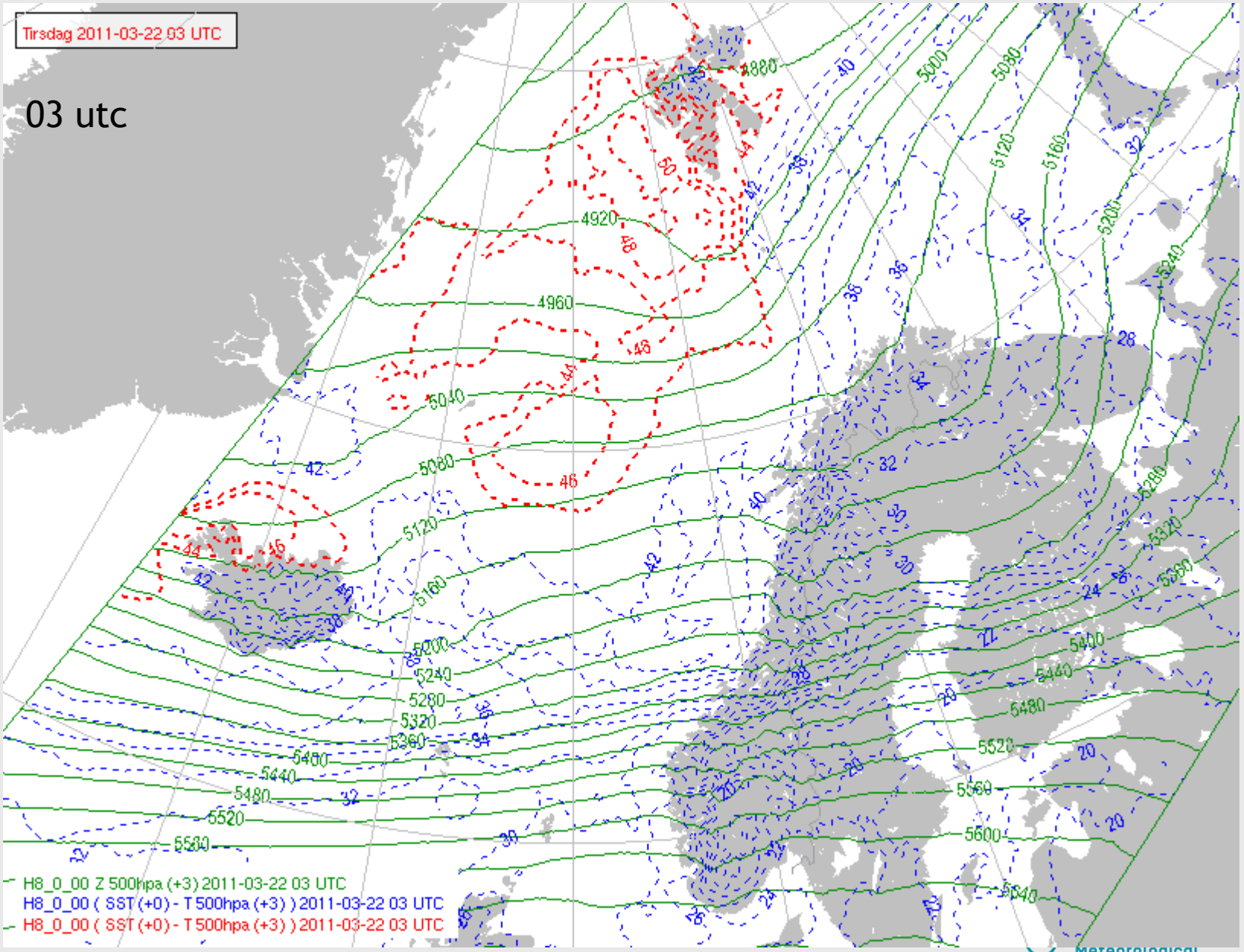

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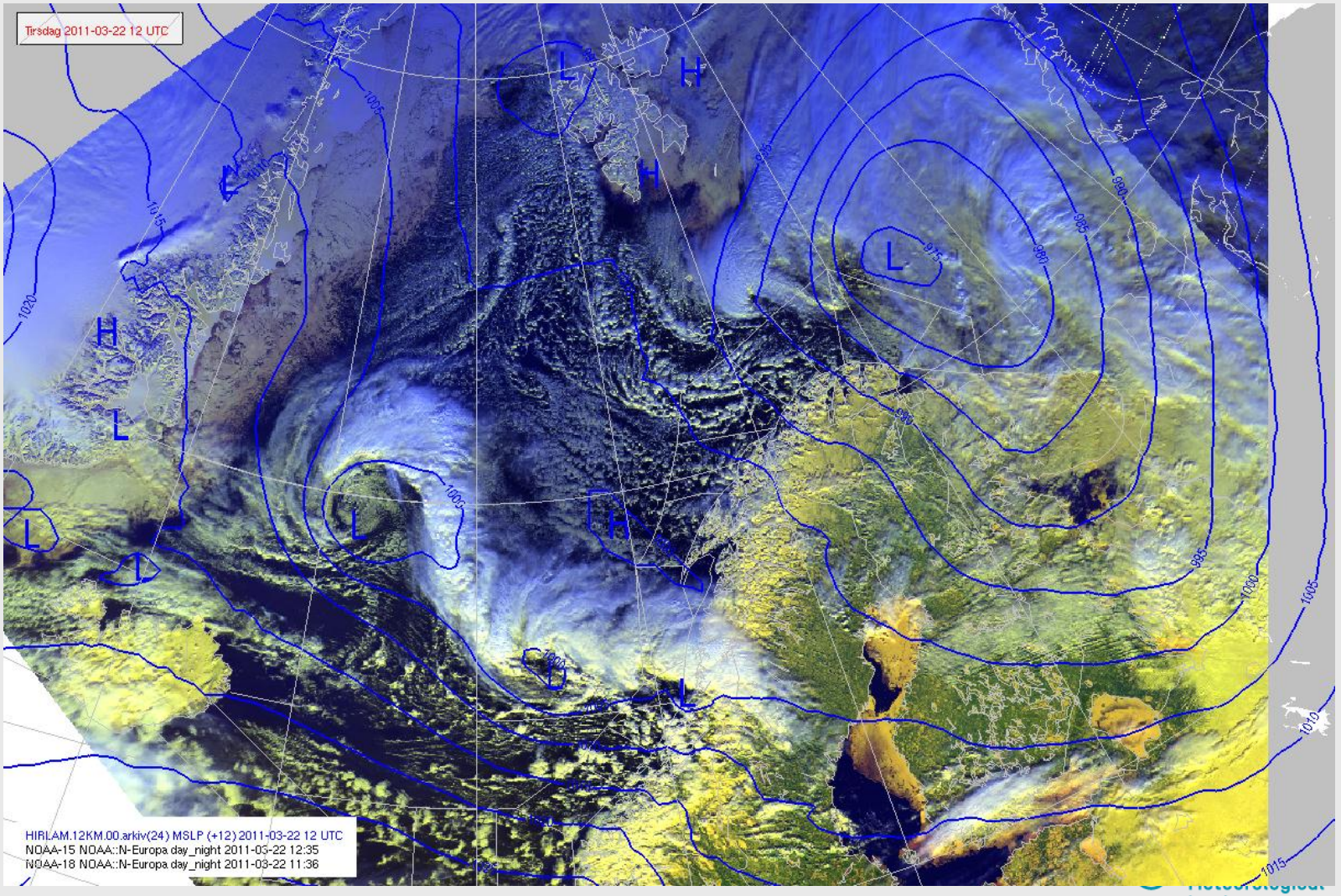
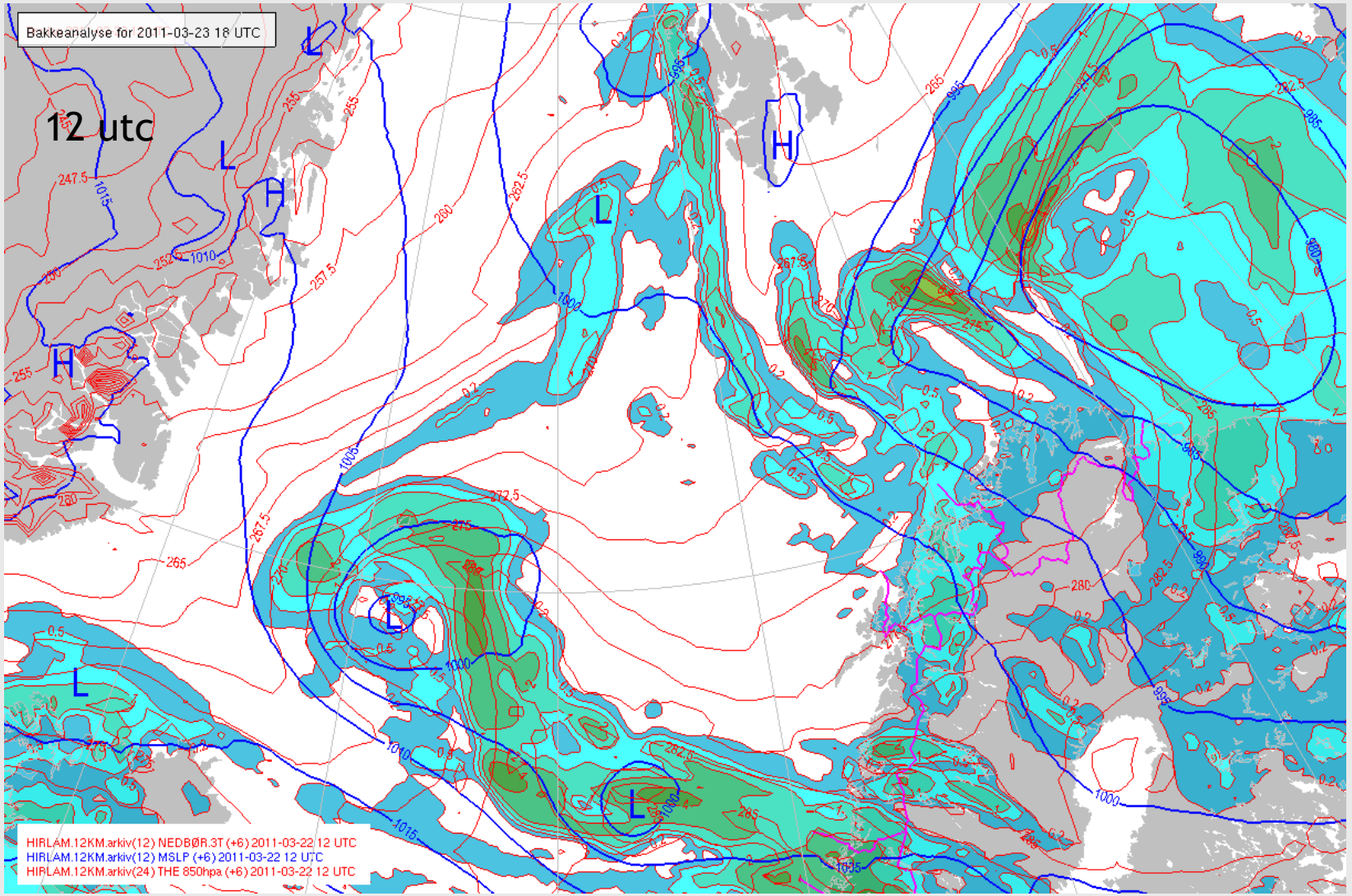
22.03.2011 12 utc





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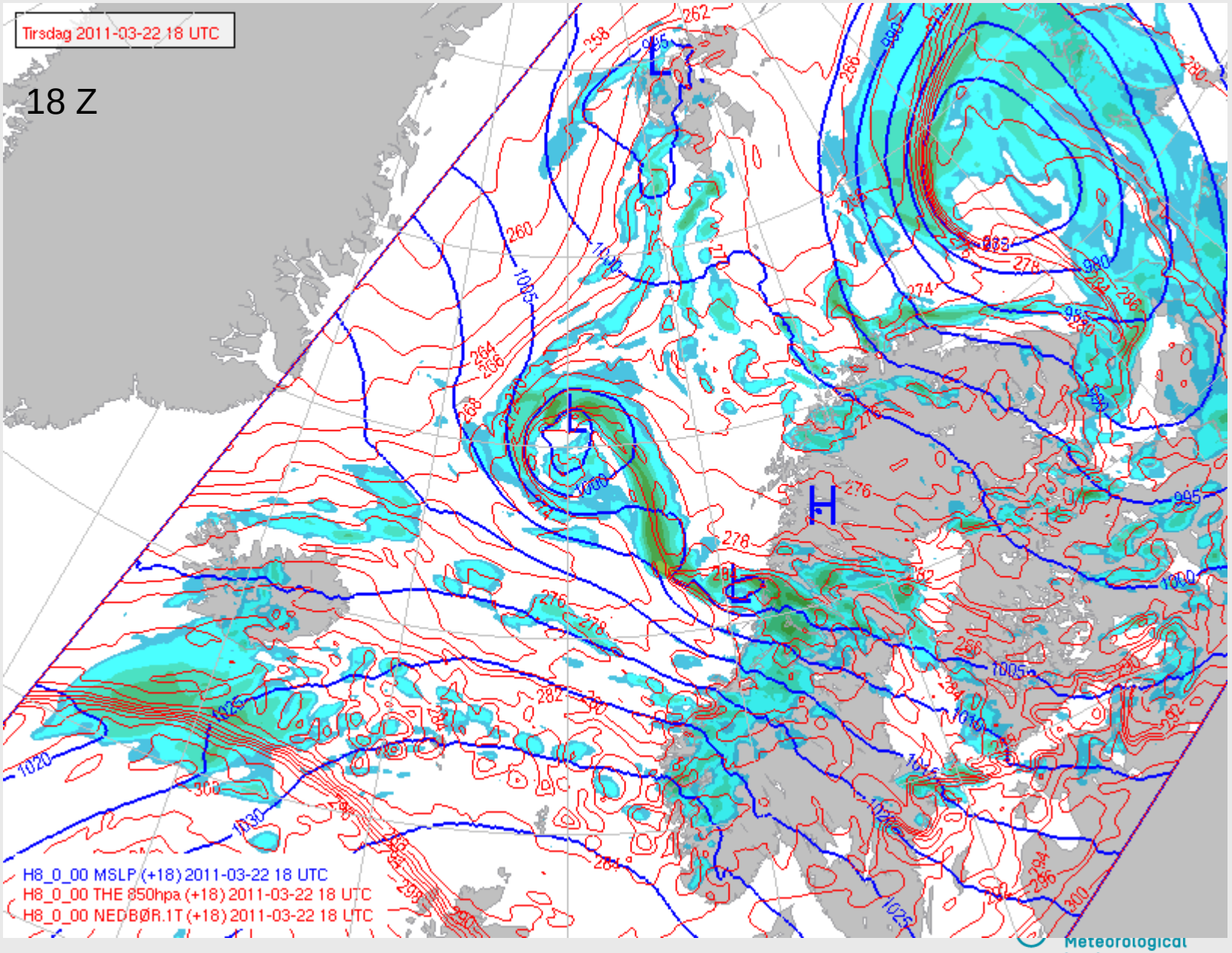

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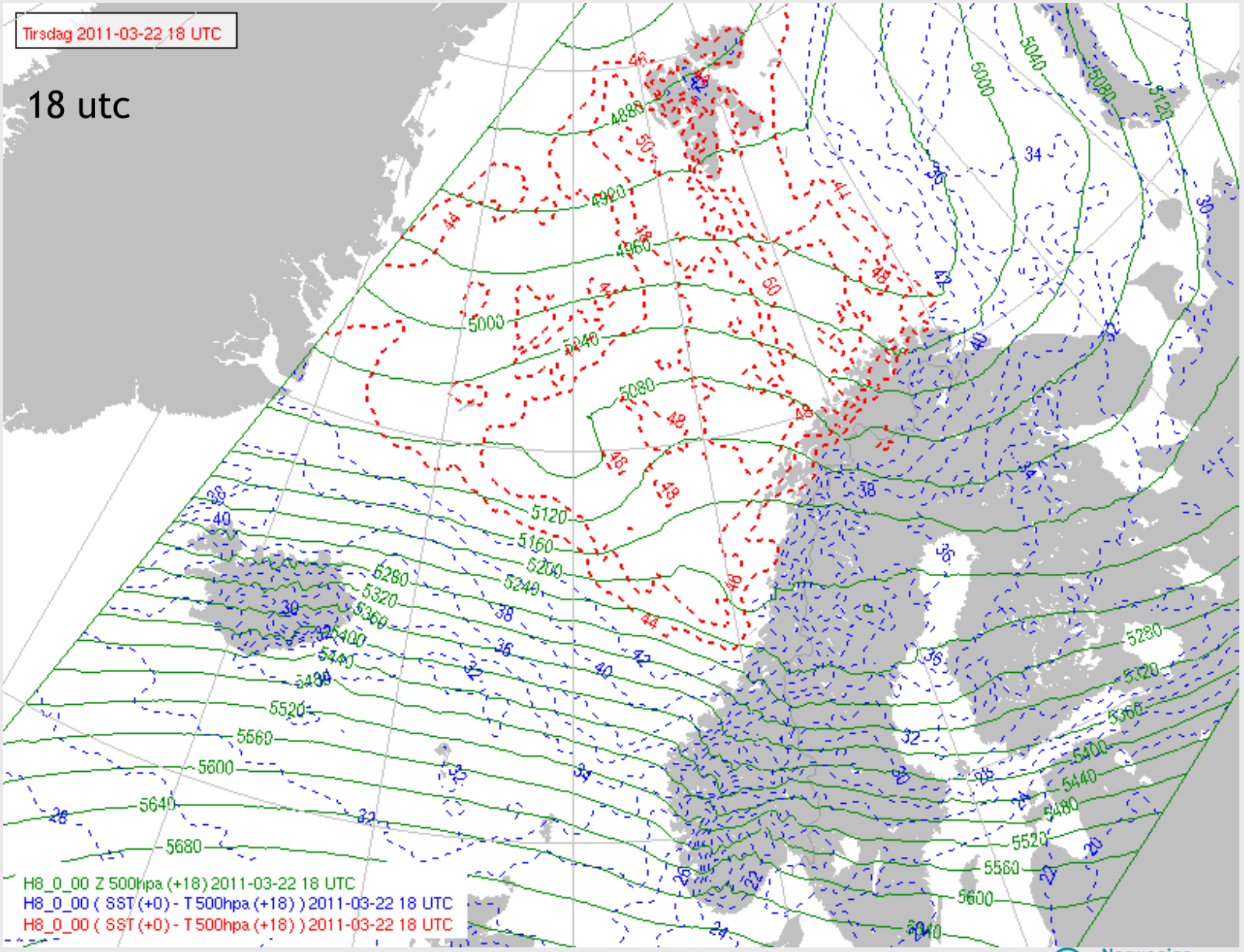

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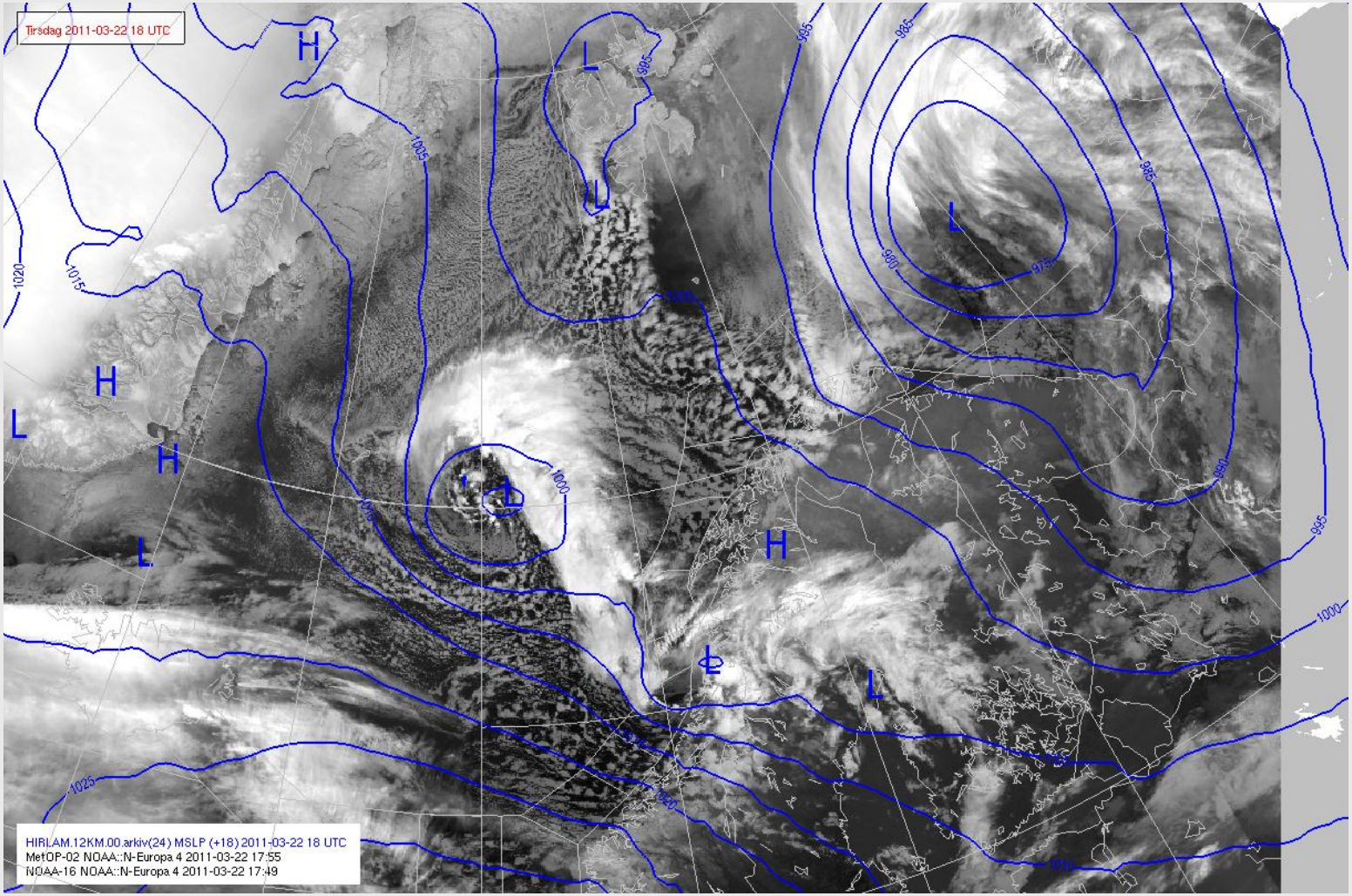
22.03.2011 18 UTC



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Meteosat RGB Airmasses 22.03.2011

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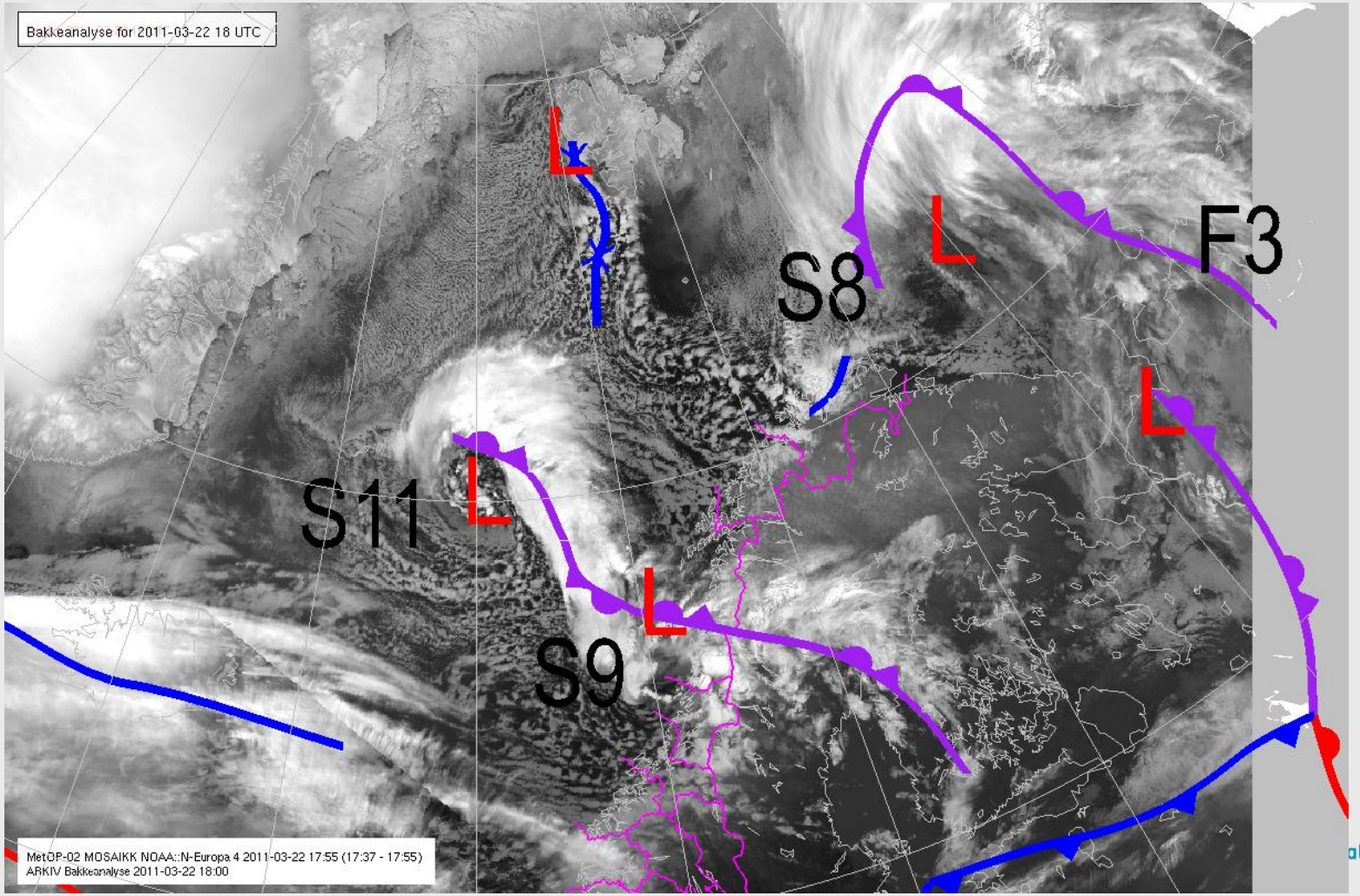
22.03.2011 18utc sat+ synoptic analyse



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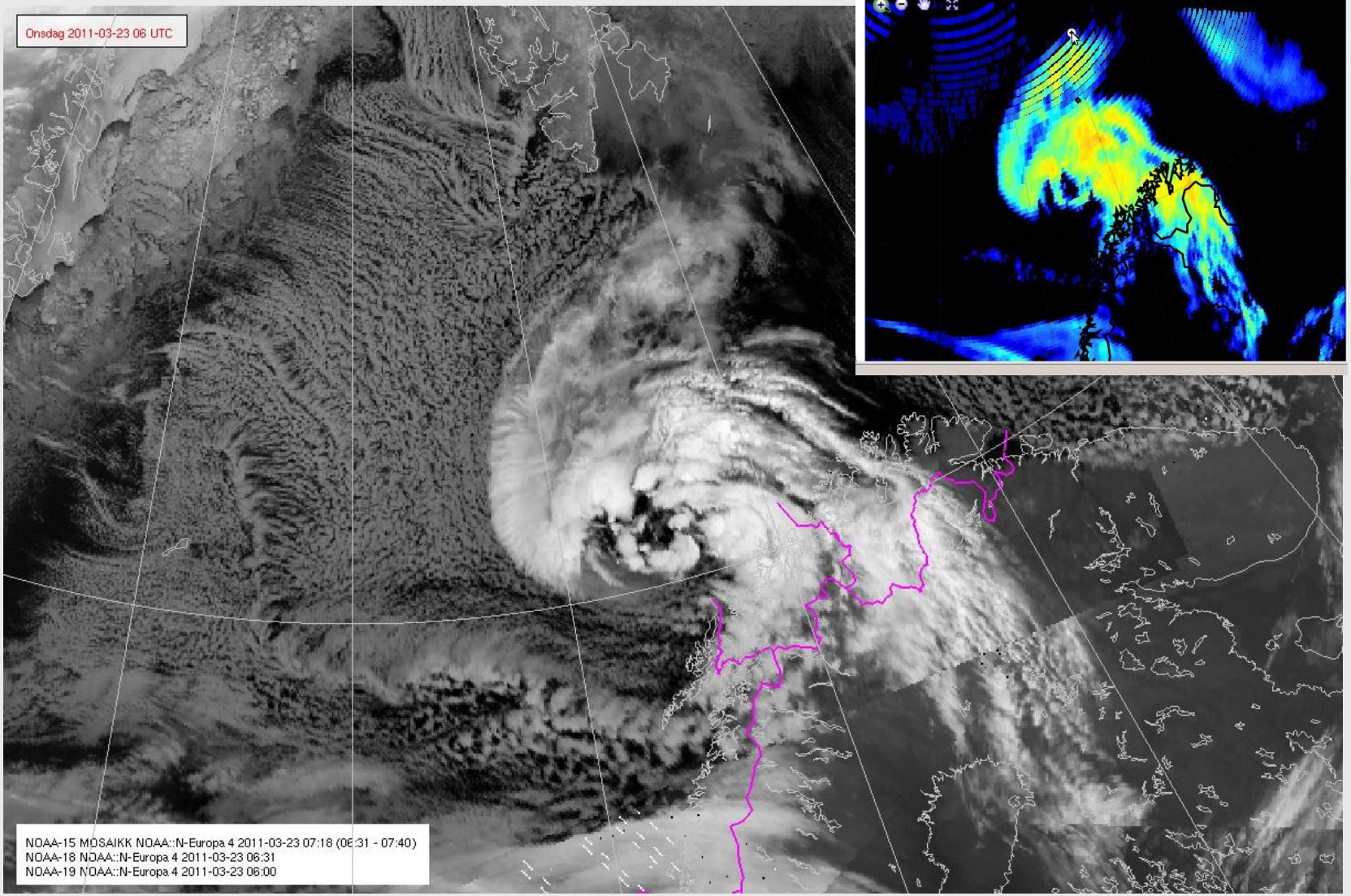

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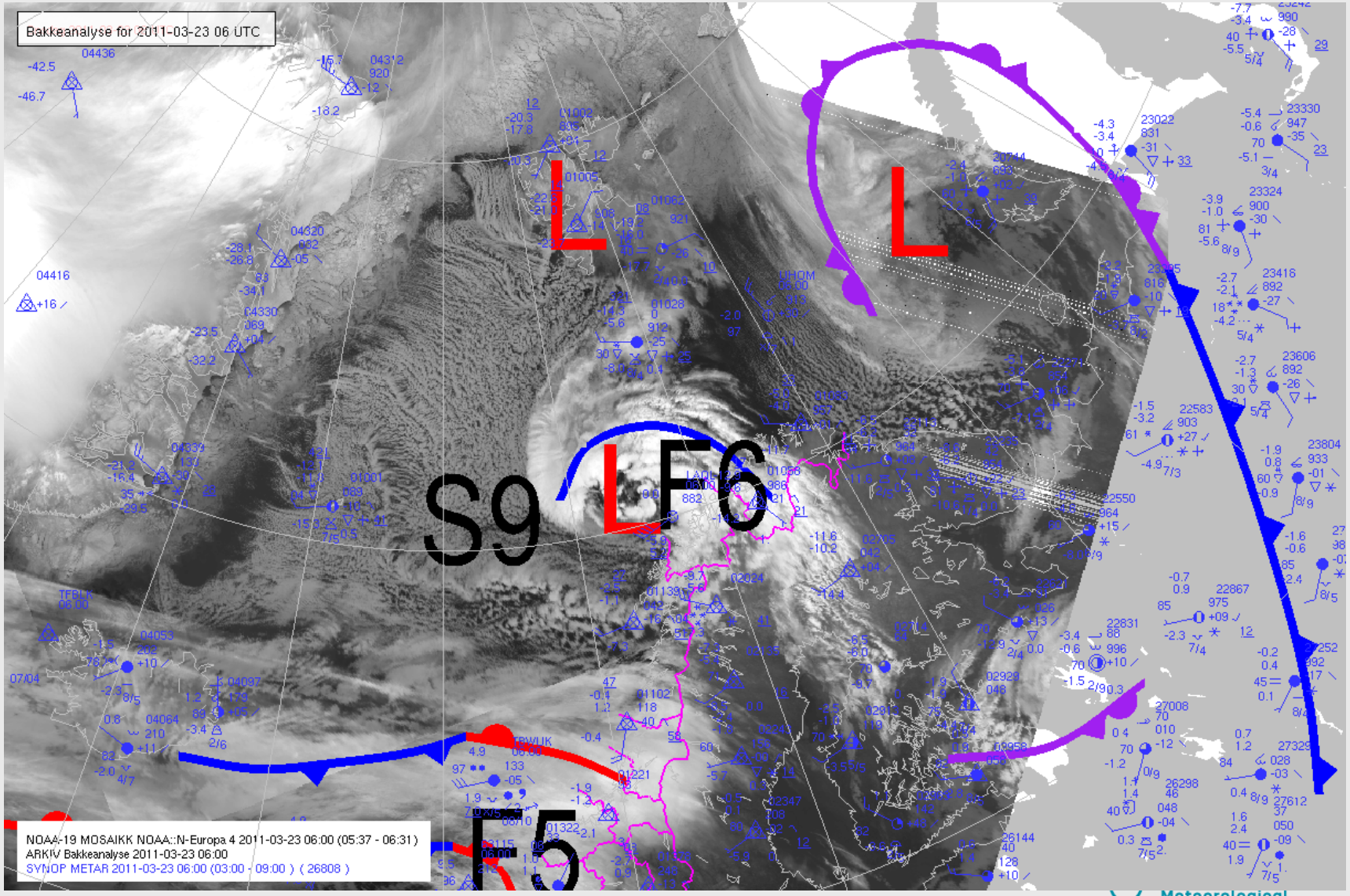

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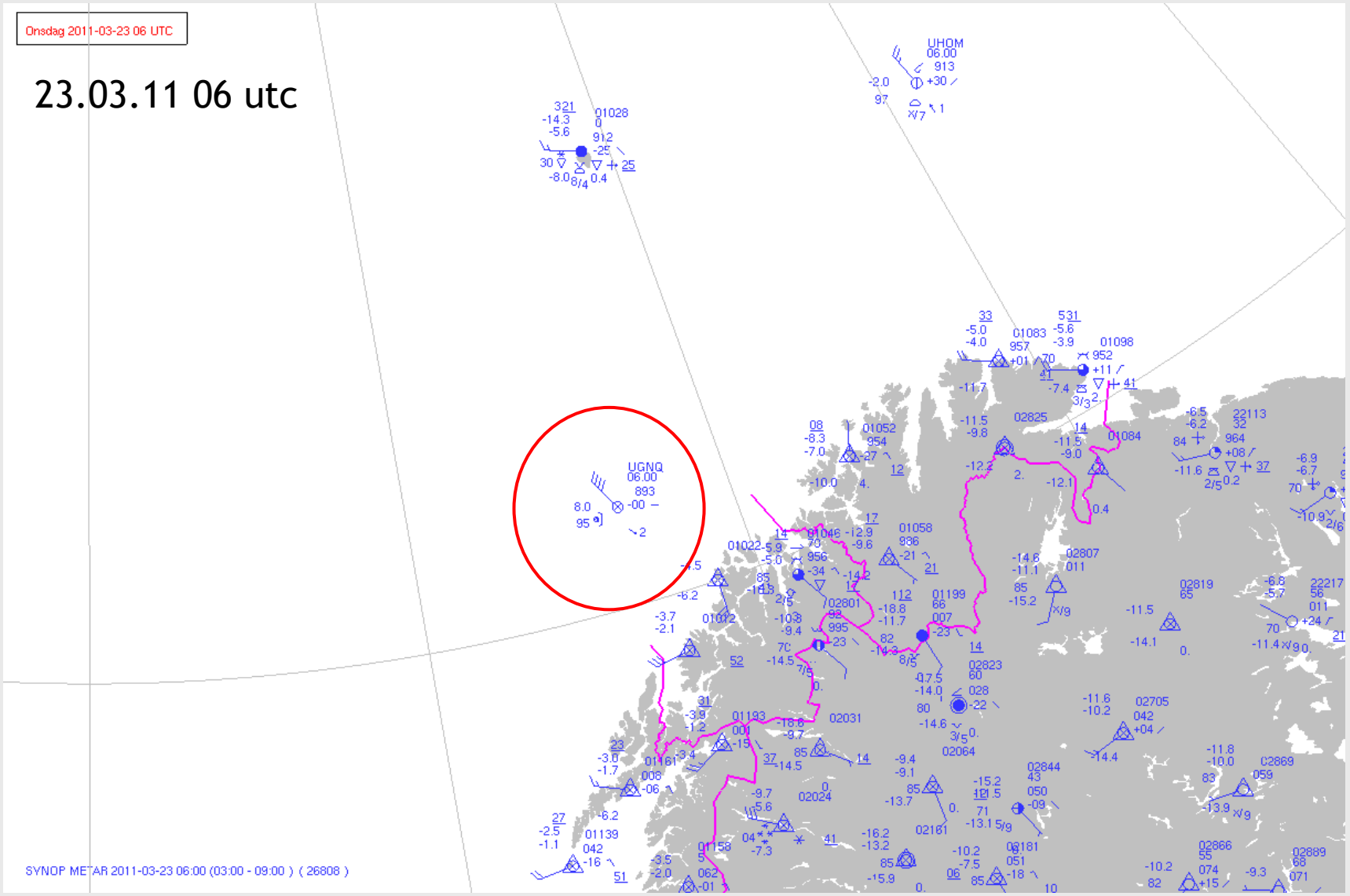

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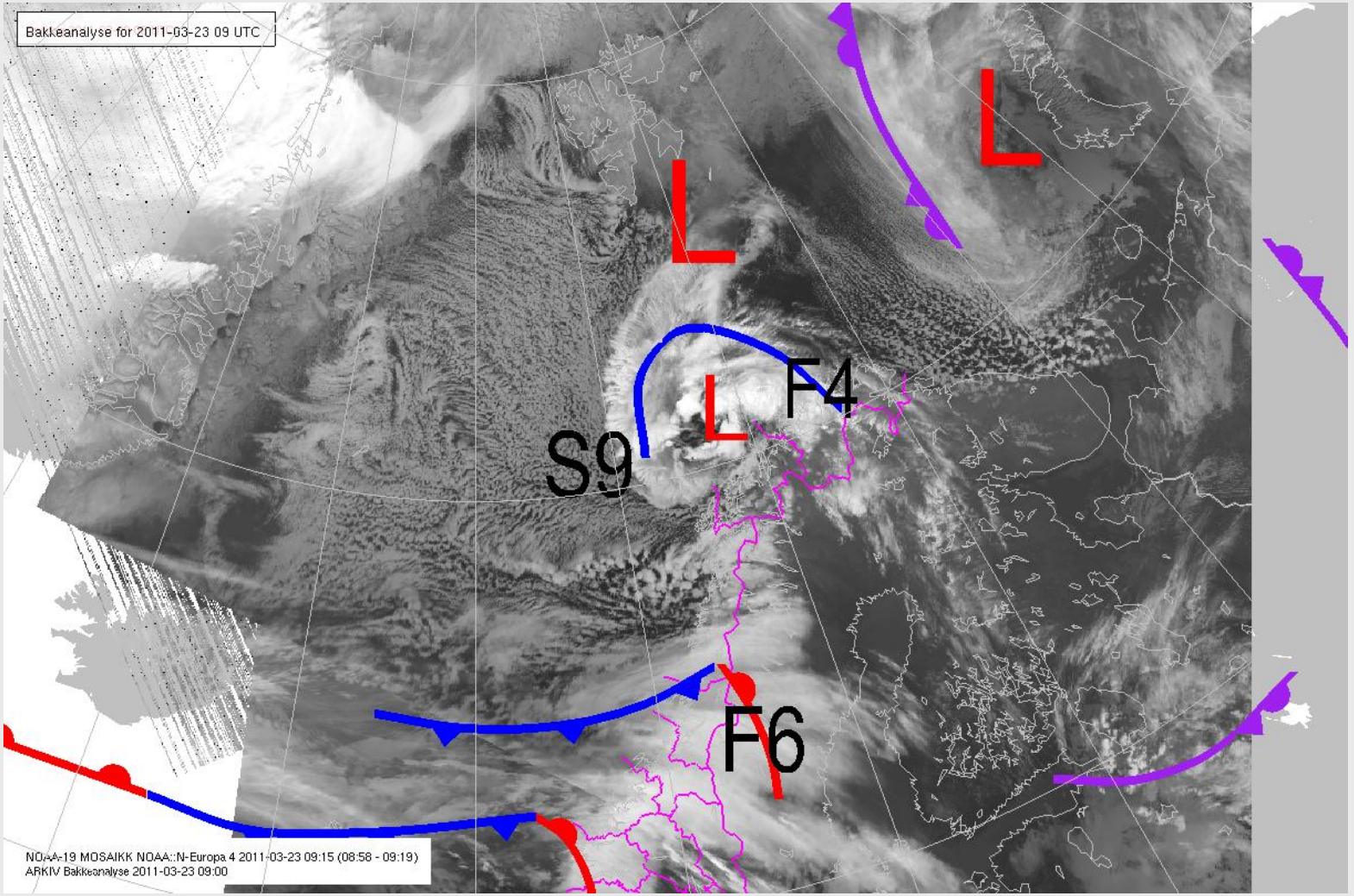

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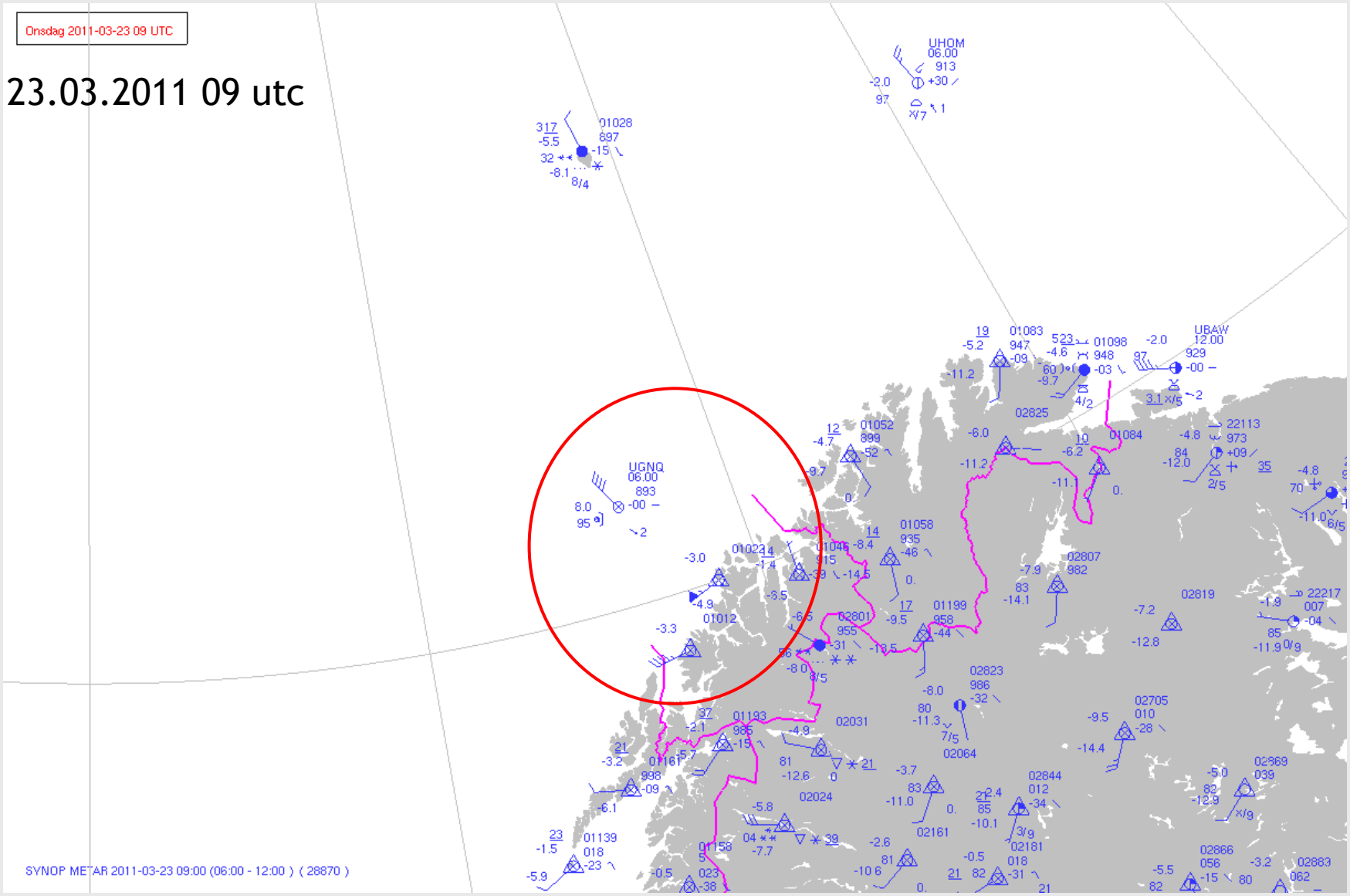

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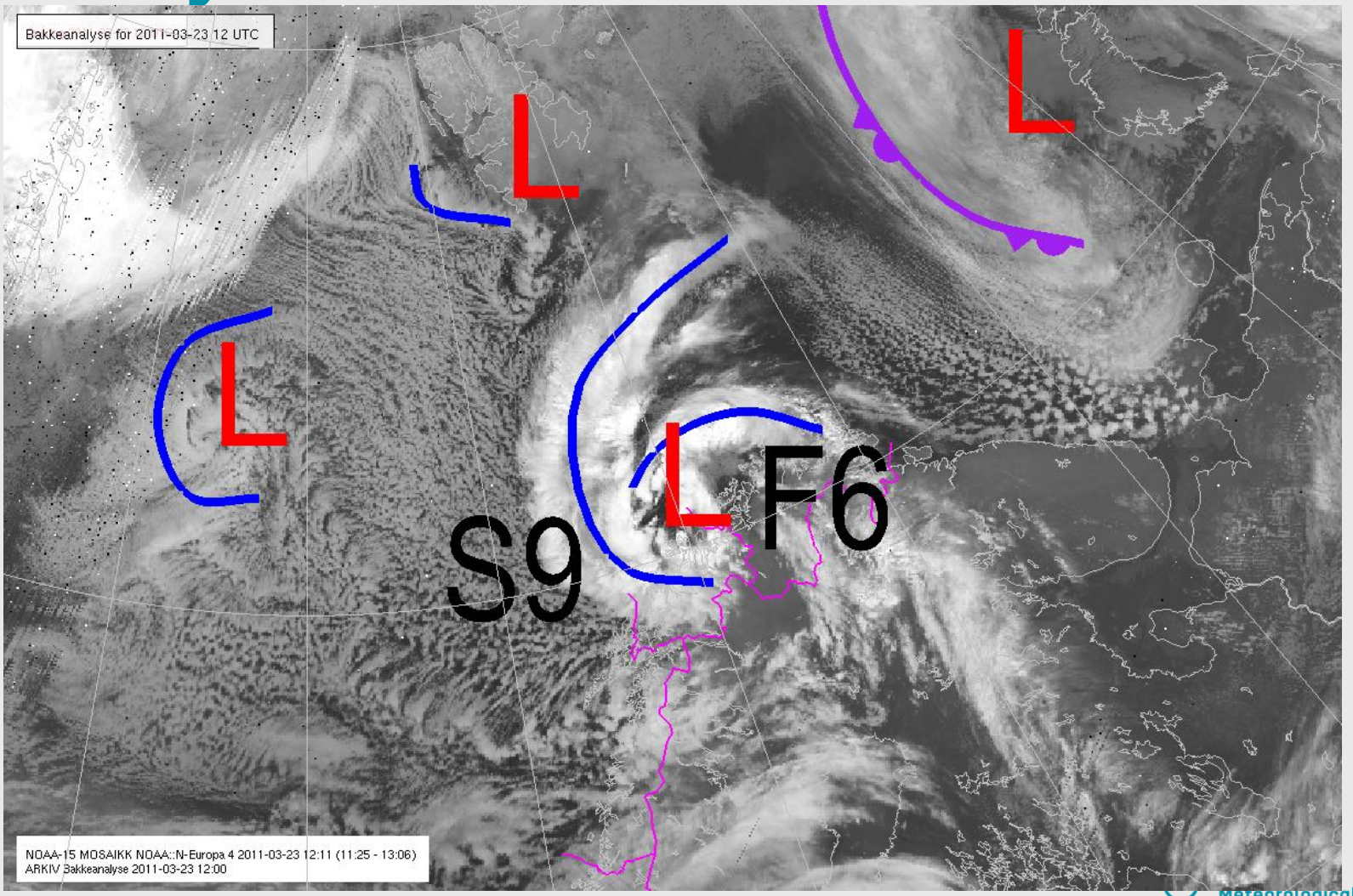
23.03.2011 12utc satellite + analysis



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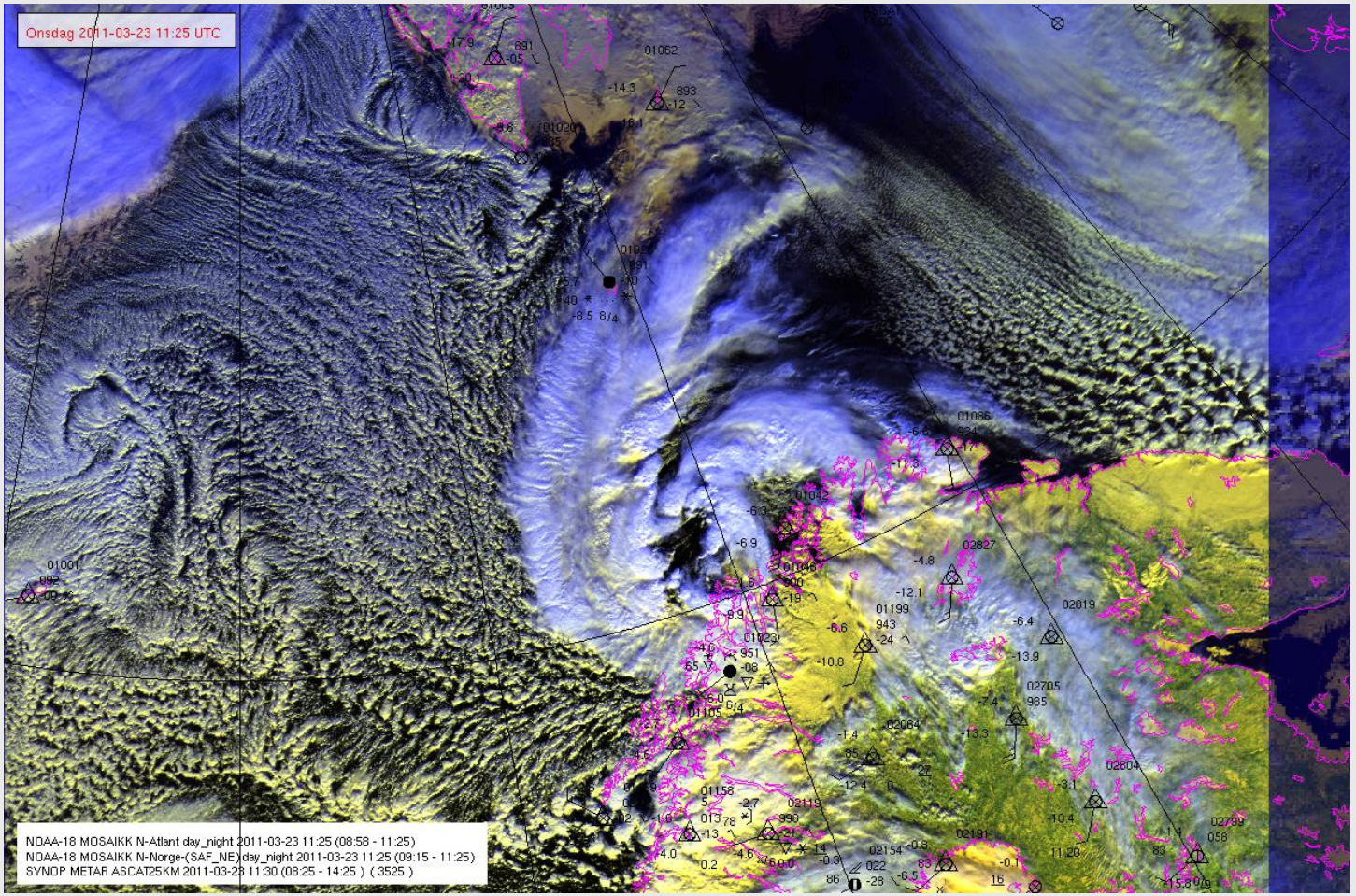

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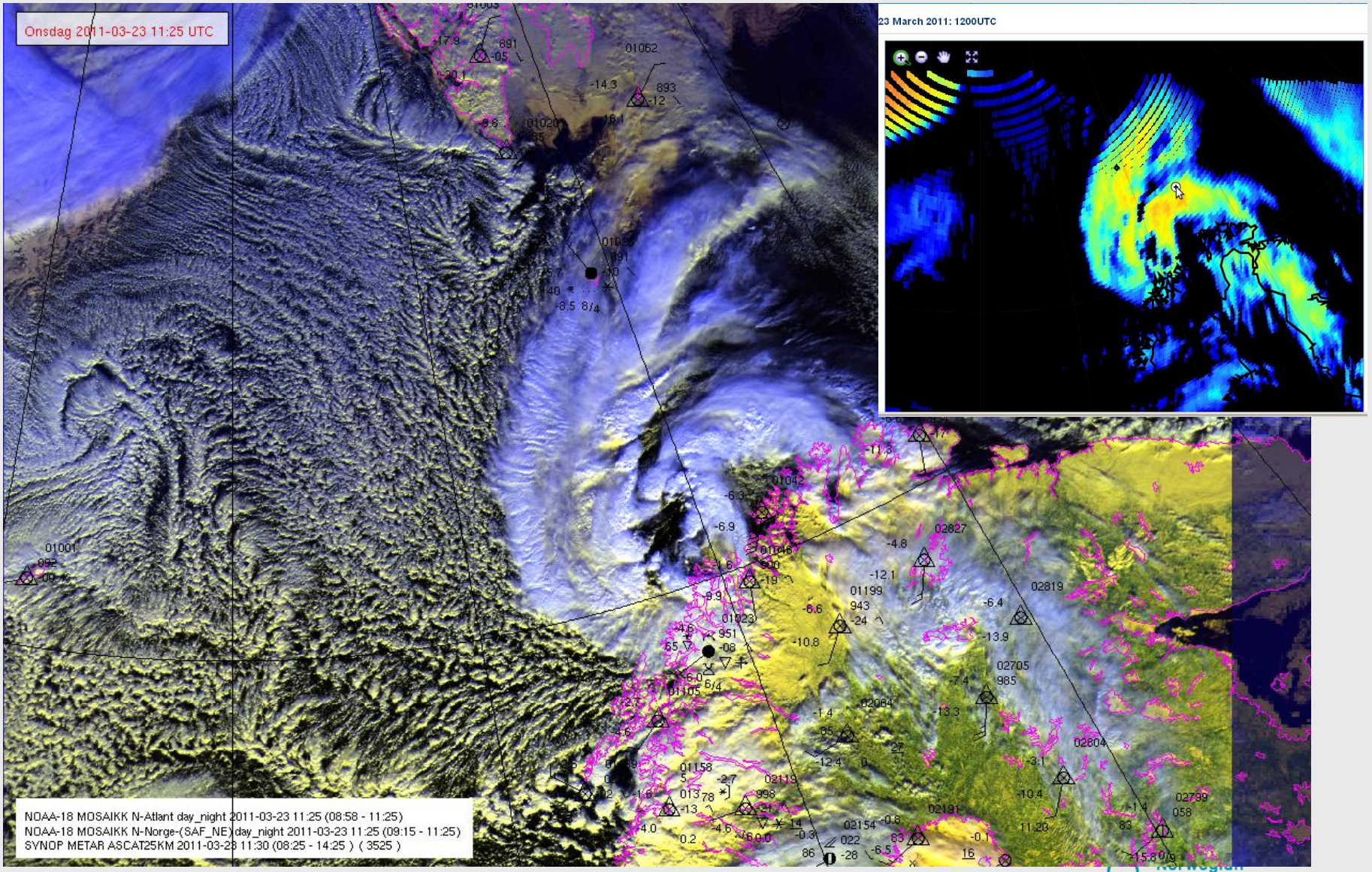

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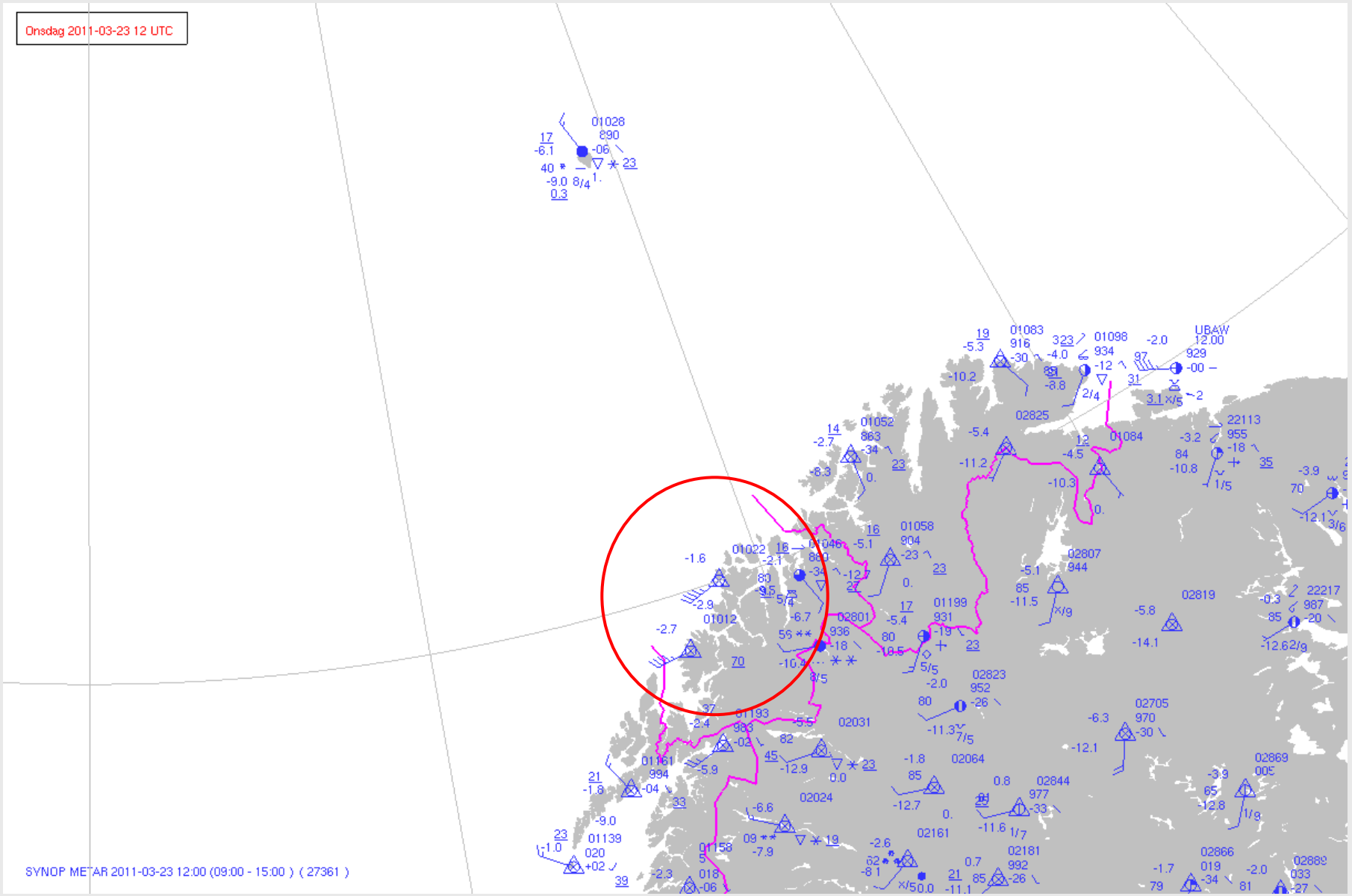

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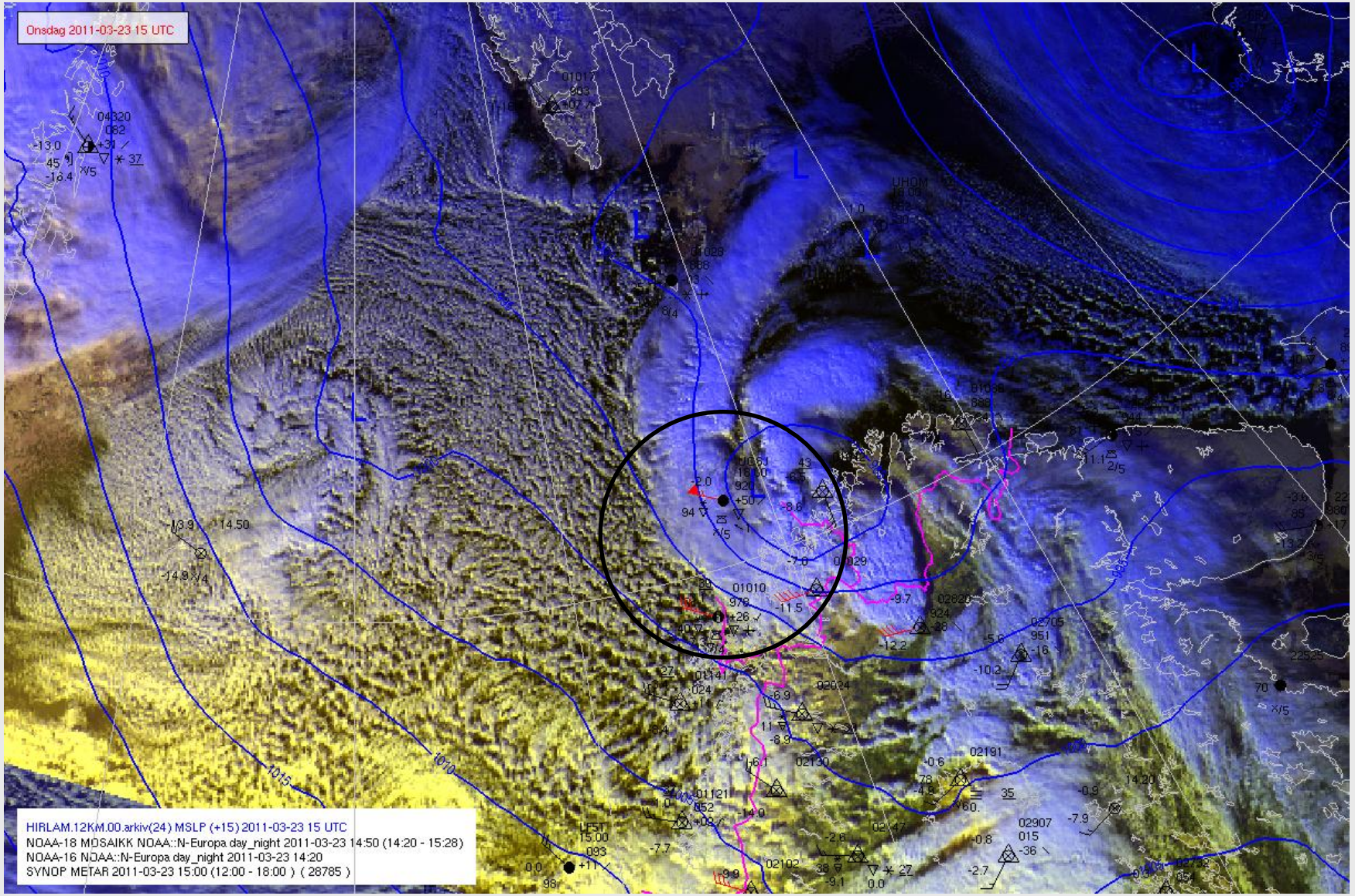
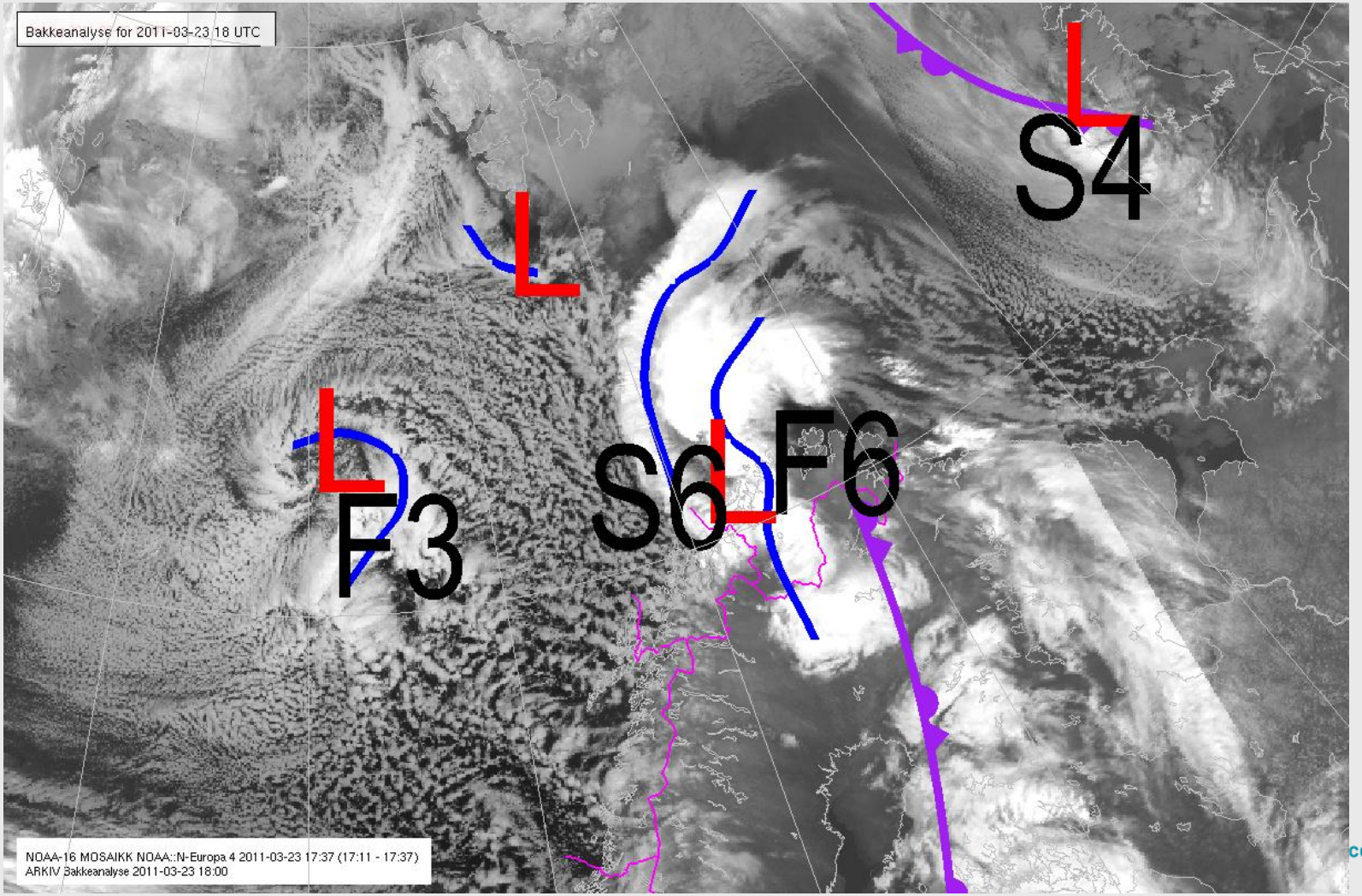
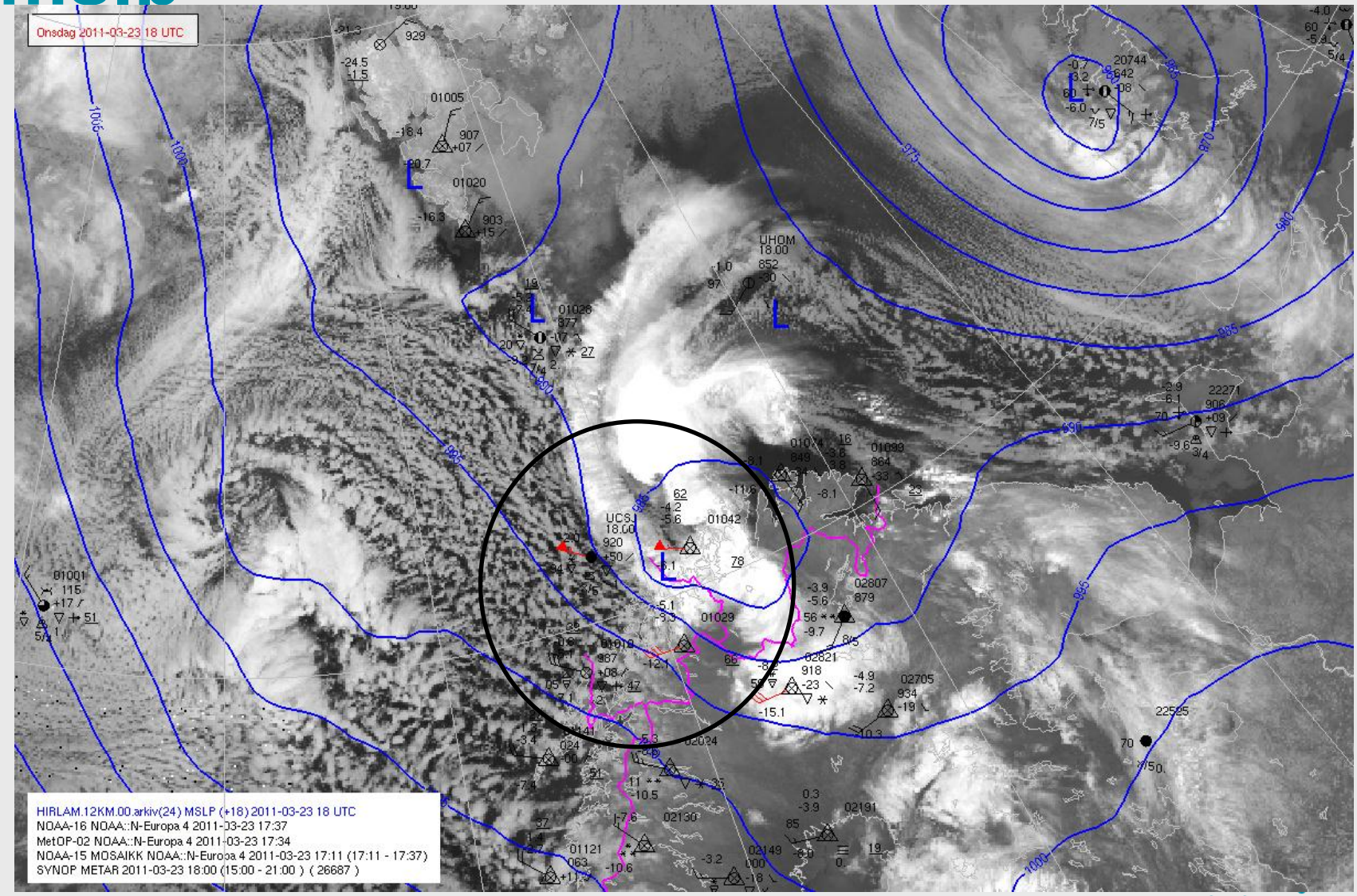
23.03.2011 15 UTC observations + mslp



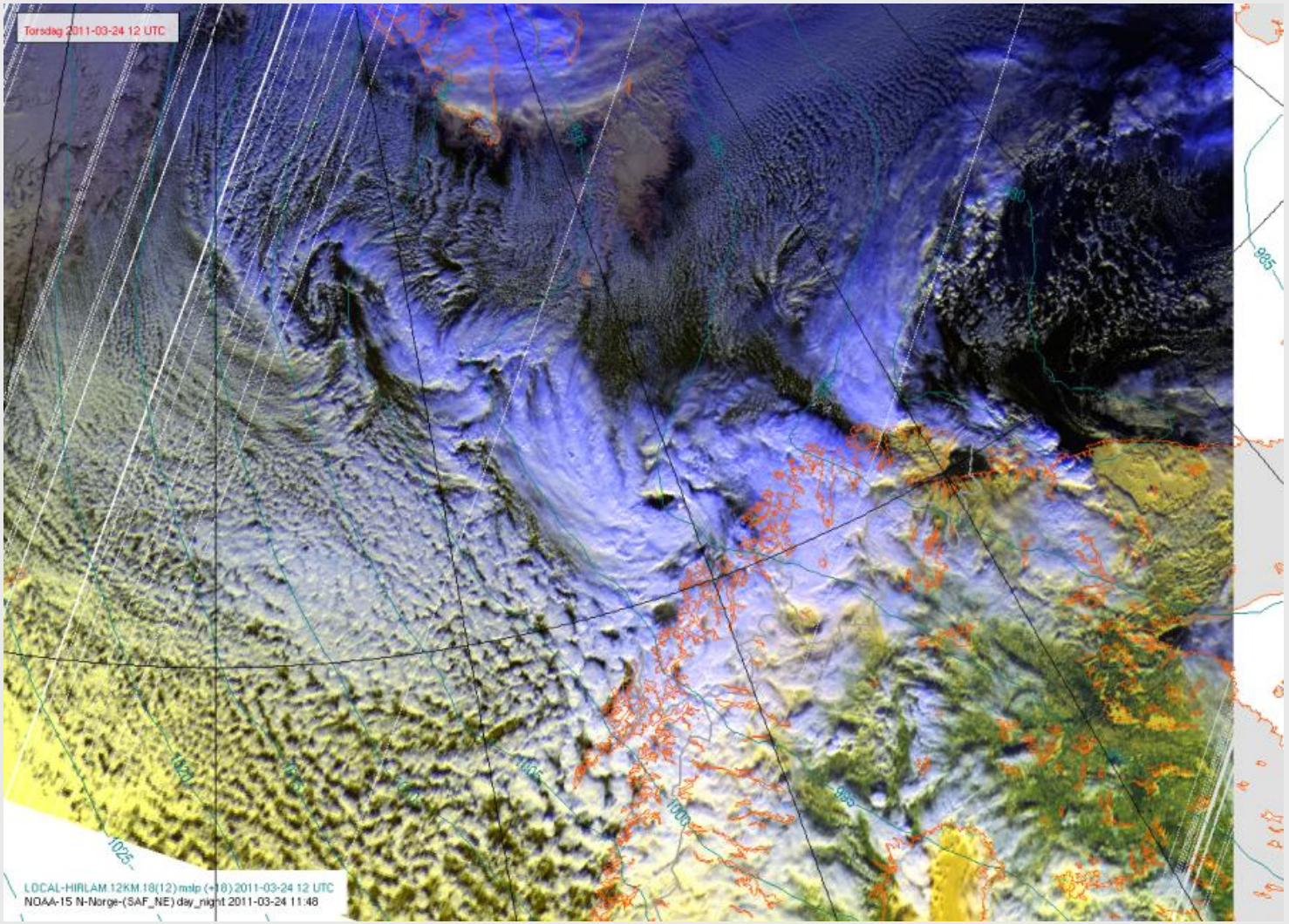
23.03.2011 18utc satellite + synoptic analysis



23.03.2011 18UTC observation + mslp



24.03.2011 new PL?



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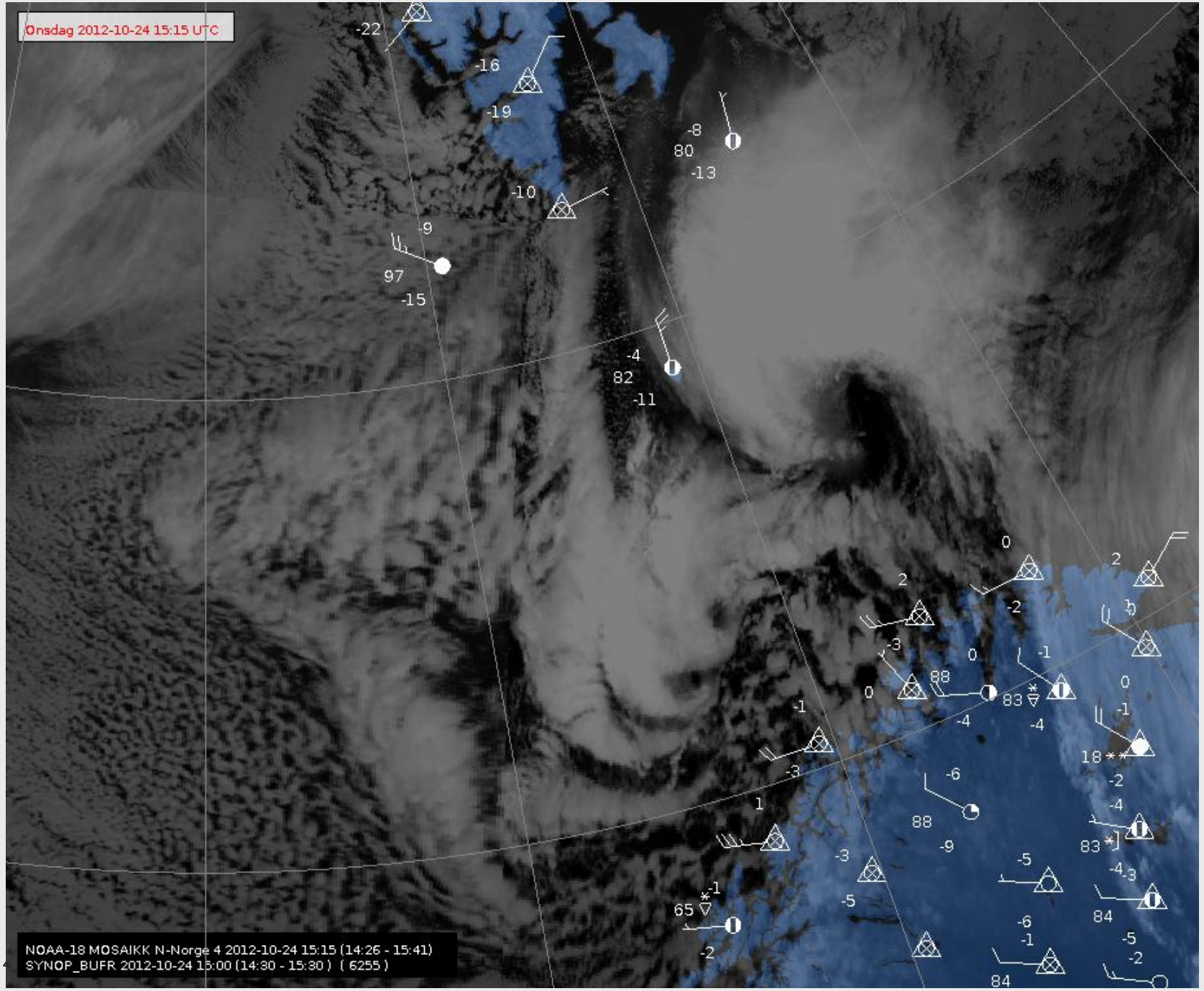
Forecasting of the polar low, - why was (is) it difficult?

- Few observations
  - Soundings
  - Radar
  - Satellite gap during night hours
- The numerical models
  - Poor data coverage, uncertain analysis
  - Insufficient describtion of convection
  - Polar lows too small to be fully resolved
- The forecaster
  - Forecast formats adapted to describe large areas over 24-42 hrs of weather
  - Polar lows: Small size, short duration.
  - The low was often ignored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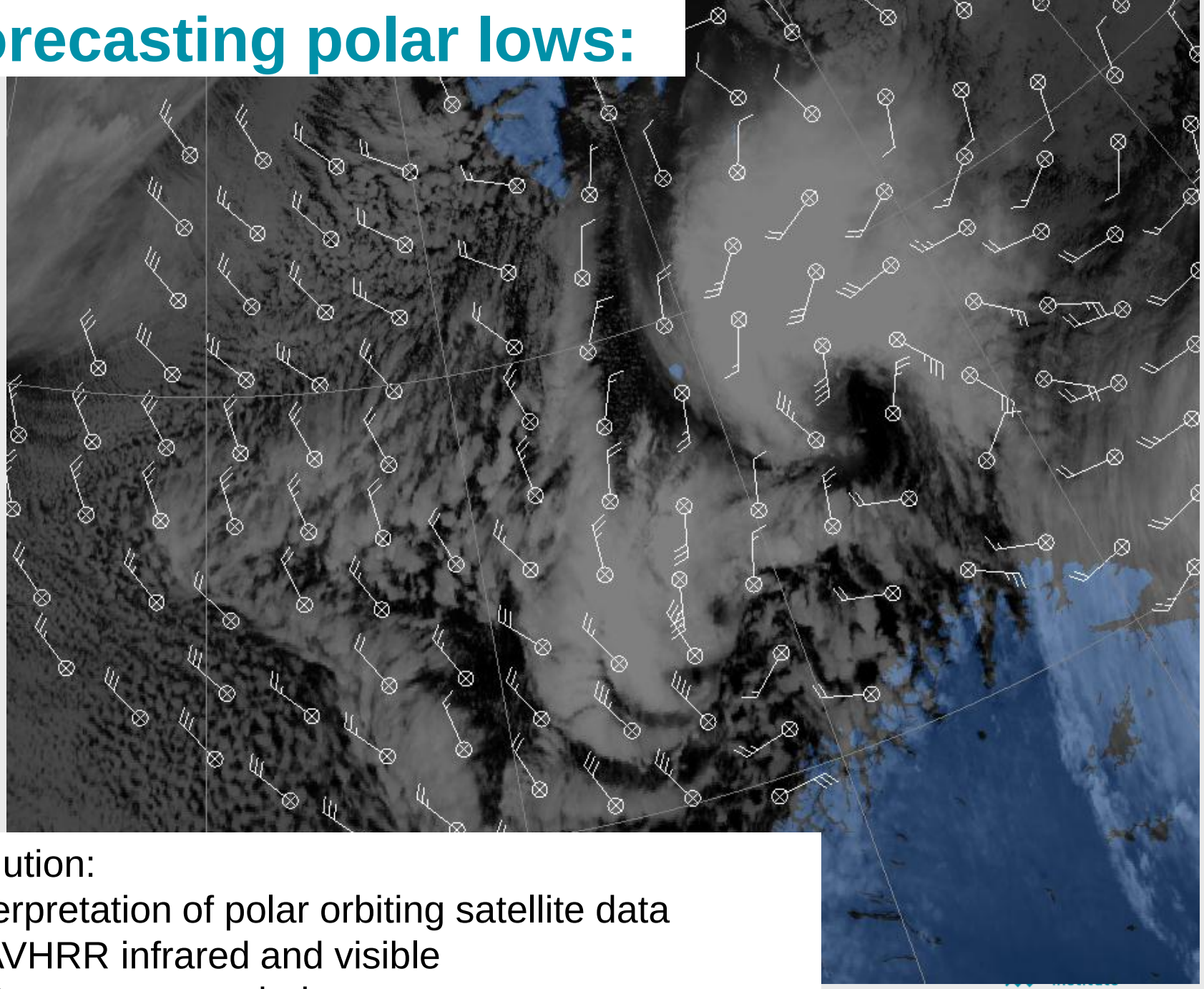
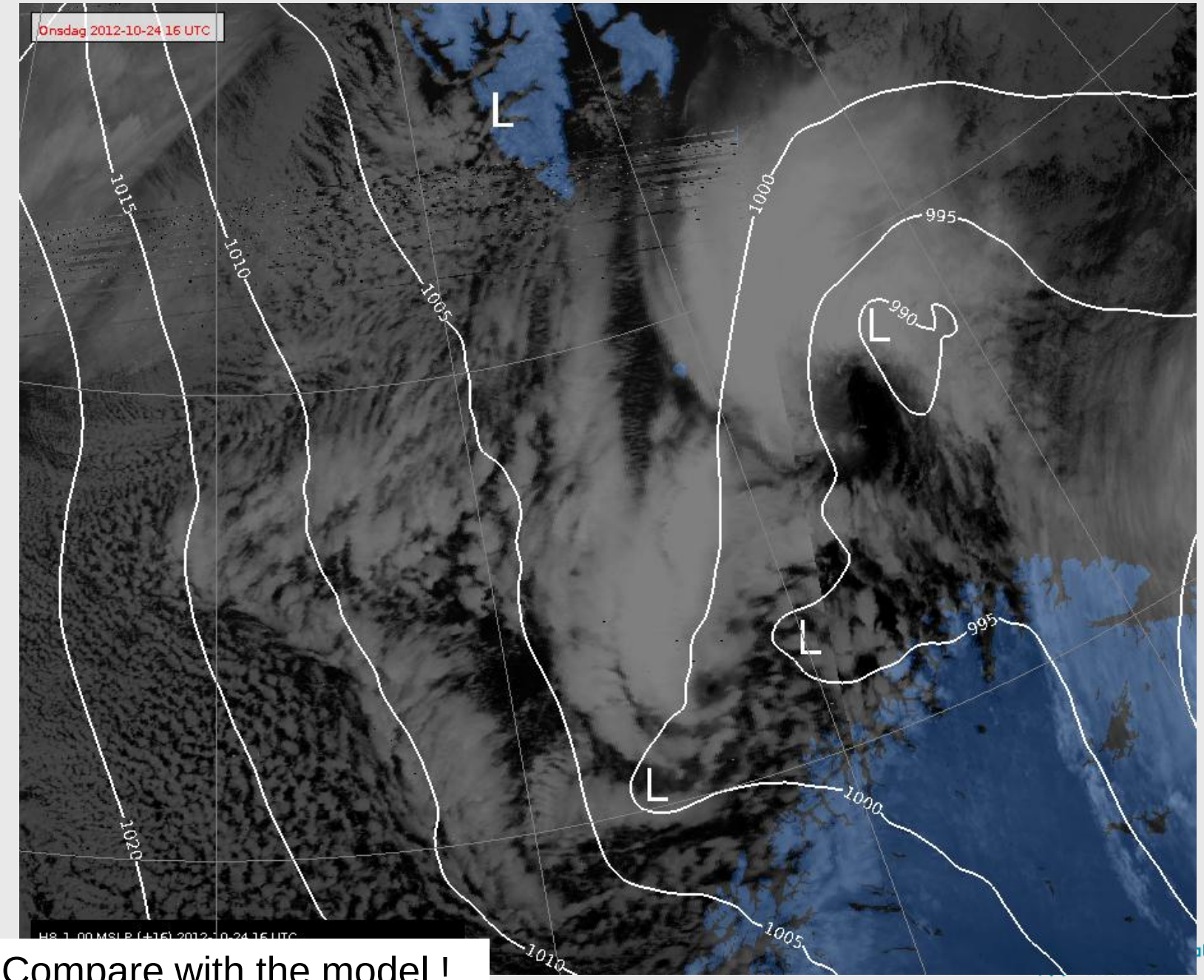
NOAA-18 MOSAIKK N-Norge 4 2012-10-24 15:15 (14:26 - 15:41)
SYNOP_BUFR 2012-10-24 15:00 (14:30 - 15:30) (6255)

Forecasting polar lows:



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



Compare with the model !

Forecasting of the polar low, - improvements since 2000

- Observations
  - Satellite data, e.g. Ascat
  - Slighly better radar coverage
  - Smaller gap in satellite during night hours, now 2-3 hrs

- The numerical models
  - Assimilation of satellite data, improved analysis
  - Better describtion of convection
  - Improved resolution, main models 8 – 12km, fine scale 4km and 2,5 km

- The forecaster
  - Improved knowledge and understanding
  - Standard methodology at the VNN (Met.no in Tromsø)

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Why worry ?

ENTC TROMSO/LANGNES -- NO

Raw surface observations for station ENTC

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ENTC 061950Z 05009KT CAVOK M05/M08 Q1000 NOSIG RMK WIND 2600FT 03012KT=
ENTC 061920Z 06008KT 9999 FEW010 SCT065 M05/M08 Q0999 NOSIG RMK WIND 2600FT 04020KT=
ENTC 061850Z 05015KT 9000 -SHSN FEW015 SCT045 M04/M07 Q0999 NOSIG RMK WIND 2600FT 03021KT=
ENTC 061820Z 36016G26KT 9999 VCSH SCT011 BKN045 M04/M06 Q0998 NOSIG RMK WIND 2600FT 02026KT=
ENTC 061750Z 36018KT 2000 SN VV012 M04/M05 Q0998 BECMG 9999 FEW010 SCT030 RMK WIND 2600FT 36039KT=
ENTC 061720Z 31018KT 2200 -SHSN VV017 M03/M06 Q0998 RESHSN TEMPO VRB08KT 0500 +SHSNGS VV004 RMK WIND 2600FT 31049KT=
ENTC 061650Z 33019KT 1500 R01/1200VP2000N R19/P2000N SHSN VV009 M04/M06 Q0999 TEMPO VRB08KT 0500 +SHSNGS VV004 RMK WIND 2600FT 33040KT=
ENTC 061620Z 31026KT 0800 R01/1000VP2000N R19/P2000D SHSN VV003 M04/M06 Q0999 TEMPO VRB08KT 0500 +SHSNGS RMK WIND 2600FT 33046KT=
ENTC 061520Z 30021G31KT 1000 R01/P2000D R19/1000VP2000D SHSN VV003 M04/M07 Q0999 TEMPO VRB08KT 0500 +SHSNGS RMK WIND 2600FT 32046G56KT=
ENTC 061450Z 31020KT 2500 -SHSN VV016 M04/M06 Q0999 TEMPO 0500 +SHSNGS VV004 RMK WIND 2600FT 32046KT=
ENTC 061420Z 33021KT 9999 -SHSNGR FEW014 SCT026 BKN037 M04/M07 Q0999 TEMPO 0500 +SHSNGS VV004 RMK WIND 2600FT 33051KT=
ENTC 061350Z 32021KT 2000 -SHSNGR VV010 M03/M07 Q0999 TEMPO 0500 SHSN VV004 RMK WIND 2600FT 34053G69KT=
ENTC 061320Z 29016KT 260V330 6000 -SHGRSN VV010 M04/M09 Q1000 TEMPO 0500 SHSN VV004 RMK WIND 2600FT 29003KT=
ENTC 061250Z 28012G24KT 9999 VCSH FEW006 SCT021 BKN041 M04/M10 Q1000 TEMPO 0500 SHSN VV004 RMK WIND 2600FT 28001KT=
ENTC 061220Z 27012KT 9000 -SHSN FEW008 SCT020 BKN040 M05/M10 Q1001 TEMPO 2000 SHSN VV010 RMK WIND 2600FT 32005KT=
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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)

Thank you for your attention!

Photo: Gunnar Mellem

Meteorological Institute

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