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Forecasting Polar Lows

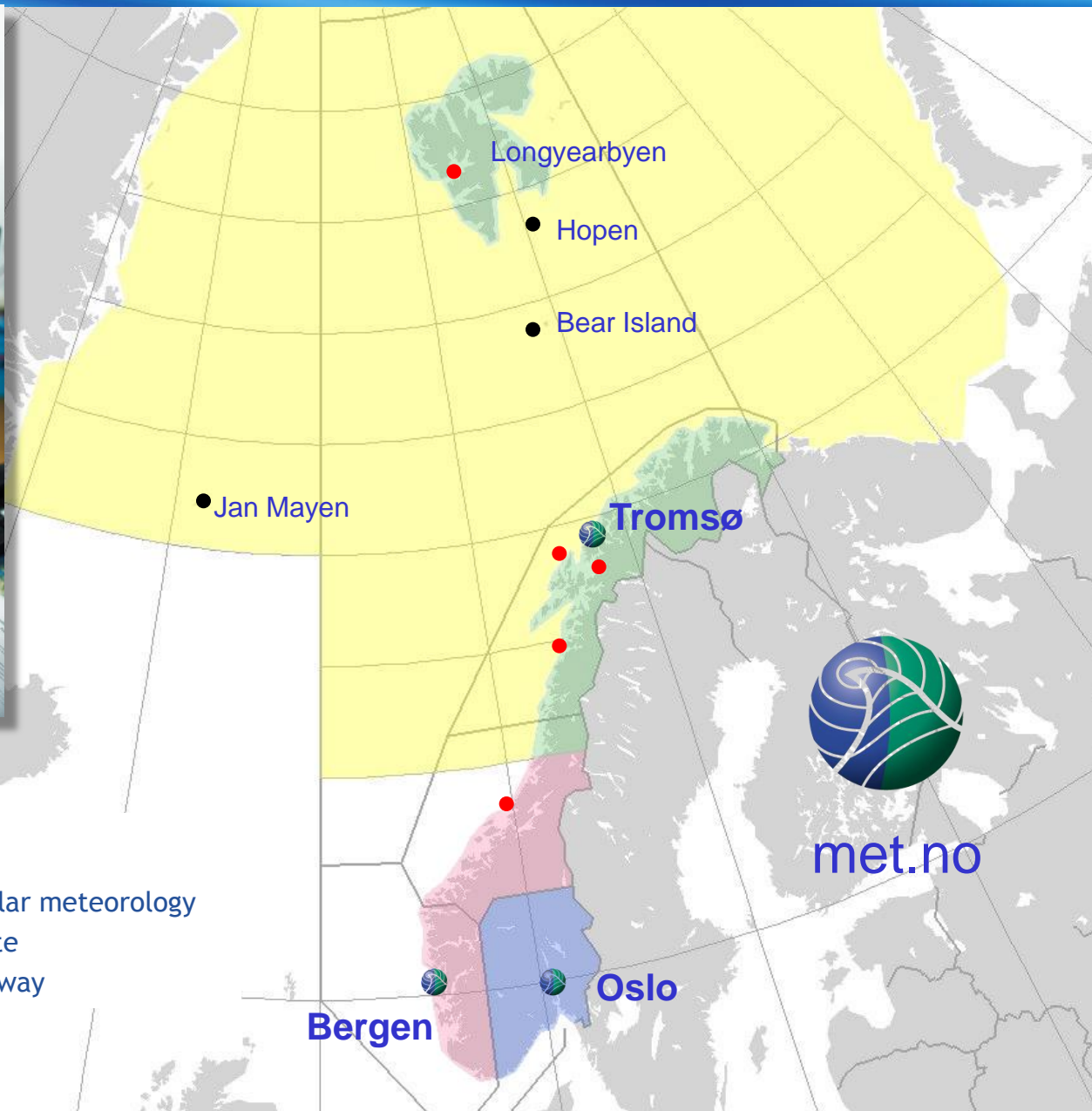
Gunnar Noer

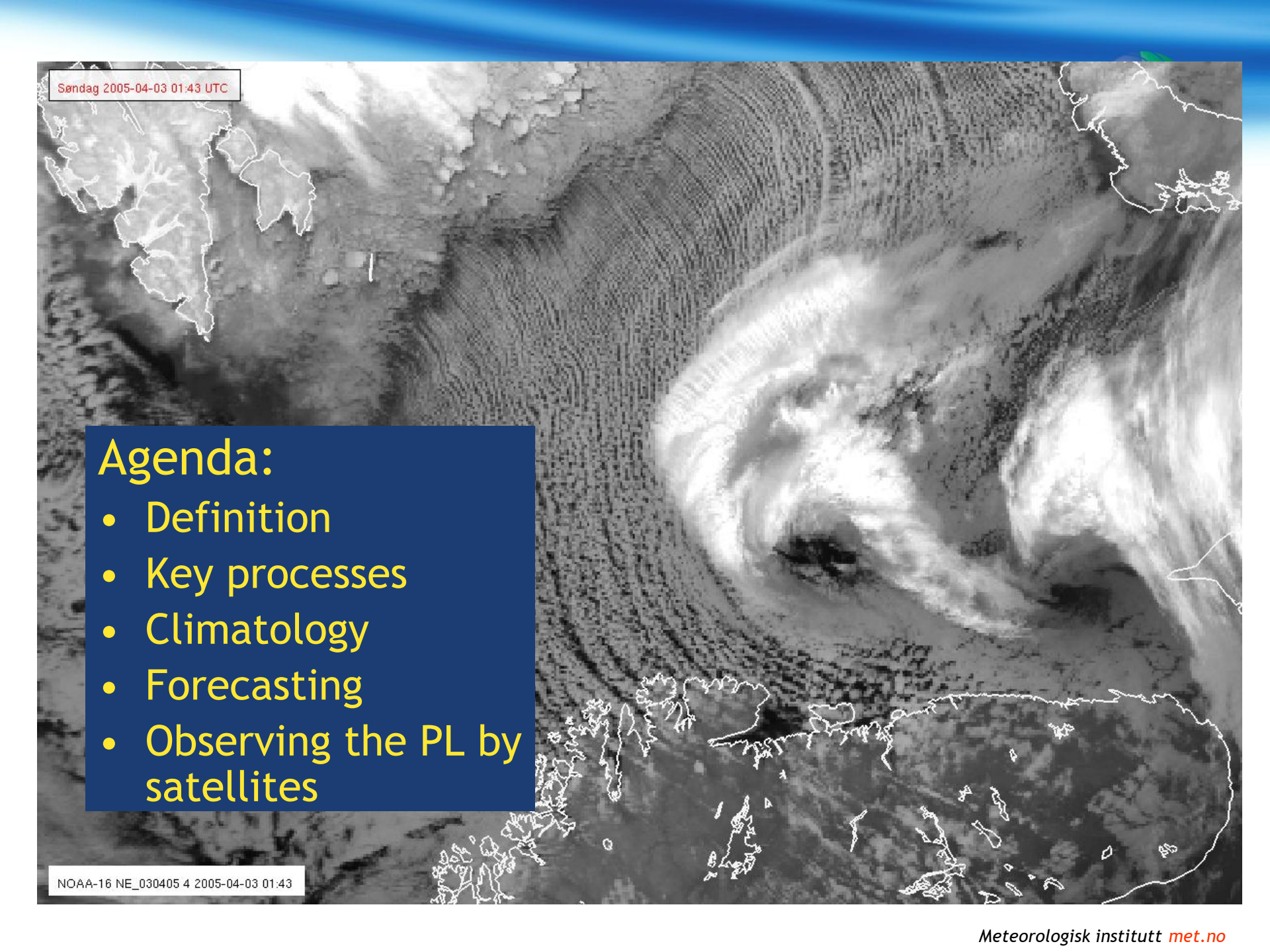
The Norwegian Meteorological Institute in Tromsø



Gunnar Noer

Senior forecaster / developer for polar meteorology
The Norwegian Meteorological Institute
Forecasting division of Northern Norway



A satellite image showing a large, swirling cloud system (a polar low) over the North Atlantic Ocean. The cloud system is characterized by a dense, bright core and a well-defined spiral structure. The surrounding ocean is visible in shades of gray, and the outlines of landmasses, including parts of North America and Europe, are visible in the background.

Søndag 2005-04-03 01:43 UTC

Agenda:

- Definition
- Key processes
- Climatology
- Forecasting
- Observing the PL by satellites

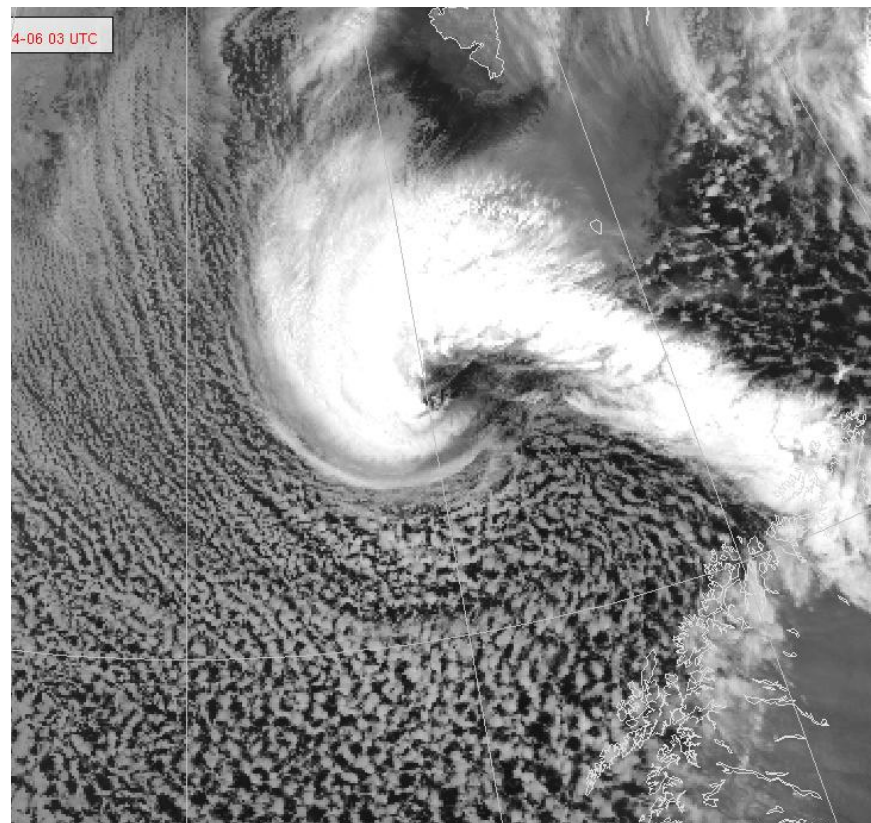
NOAA-16 NE_030405 4 2005-04-03 01:43



Definition of the polar low

(European Polar Low Work Group)

- 'A small, but fairly intense low in maritime areas'
- In cold air outbreaks (CAO) north of the polar front
- Diameter 100 - 600km
- Cyclonic curvature

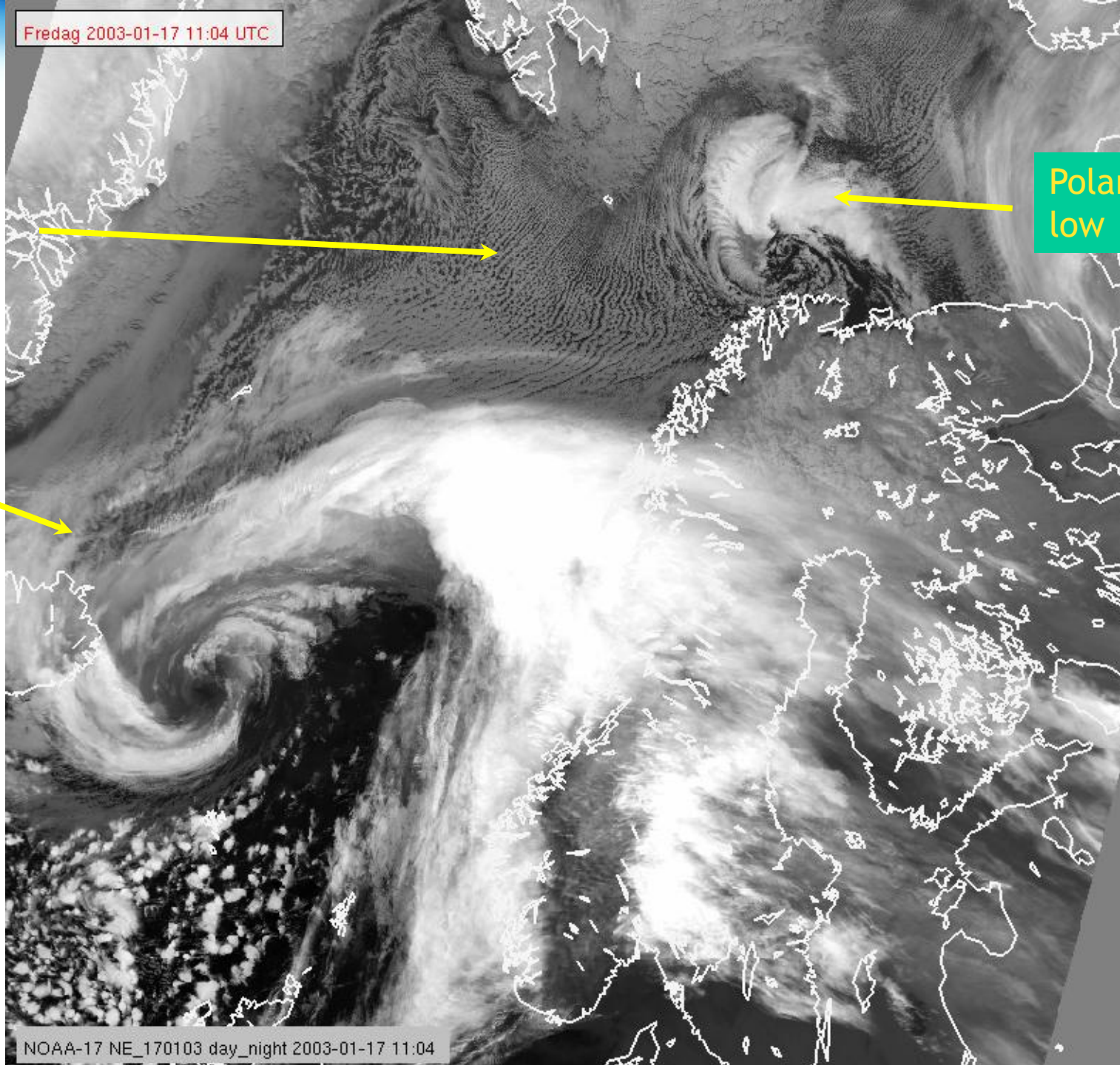


Fredag 2003-01-17 11:04 UTC

Cold air outbreak

Polar low

Synoptic low

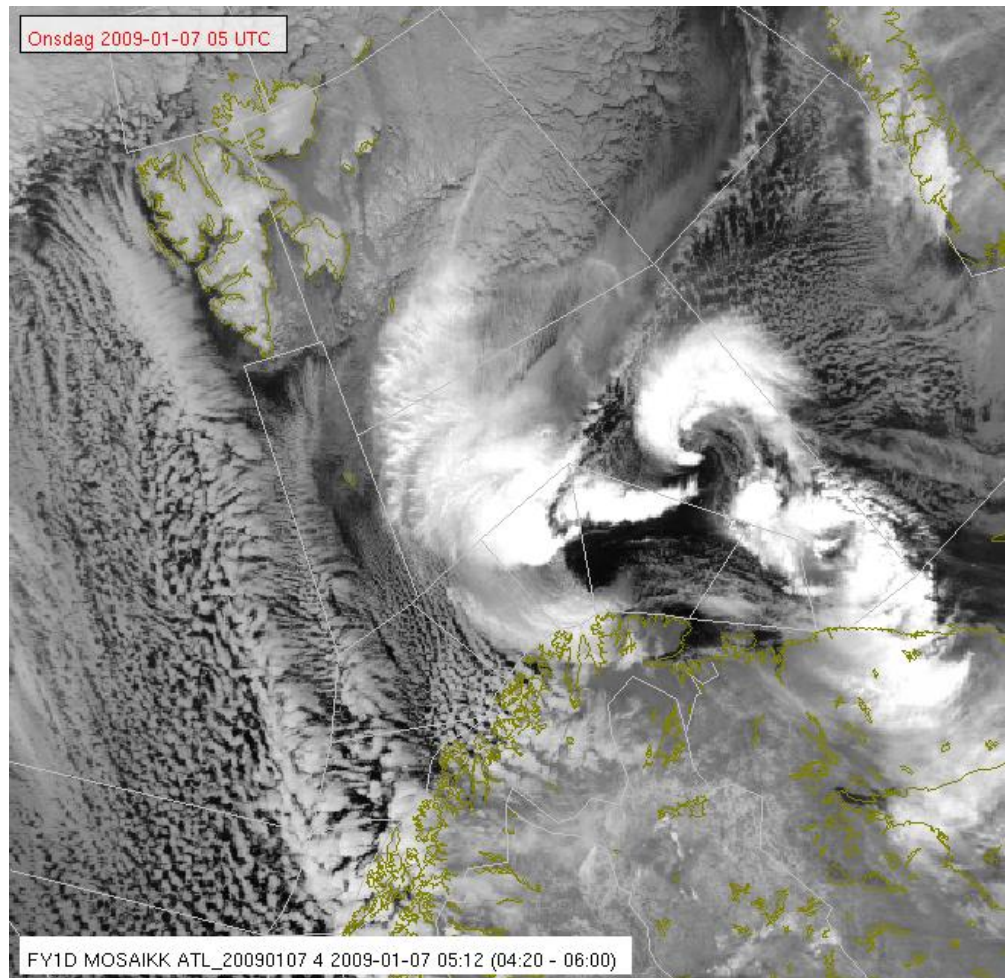


NOAA-17 NE_170103 day_night 2003-01-17 11:04



The weather in a polar low:

- Strong wind in western and northern parts
 - Average observed max wind 42kt
 - 25% have 50kt or more
 - Dense snow fall
 - Horizontal visibility < 100m
 - Vertical visibility < 100ft
 - Cb, icing and turbulence
- Eastern half usually less dramatic:
 - Clear eye
 - Off shore winds



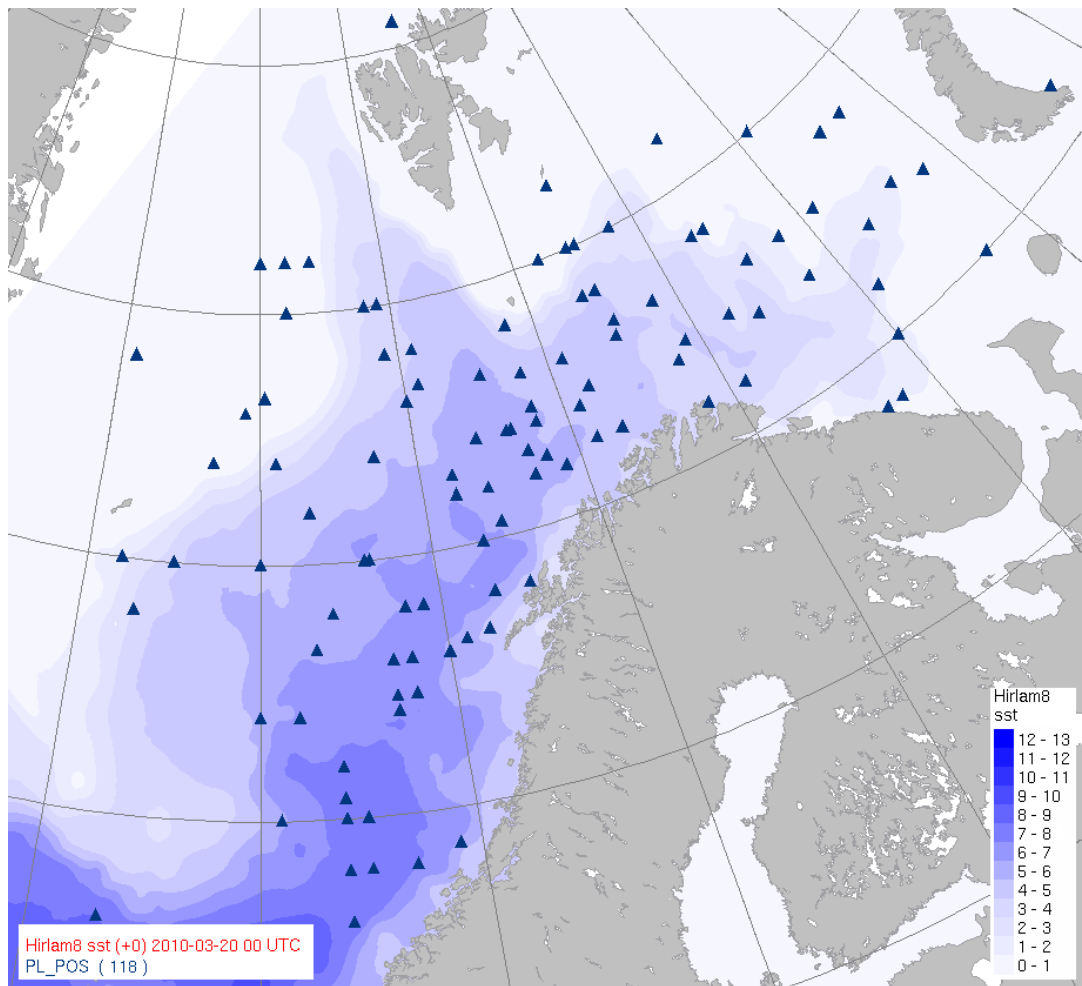
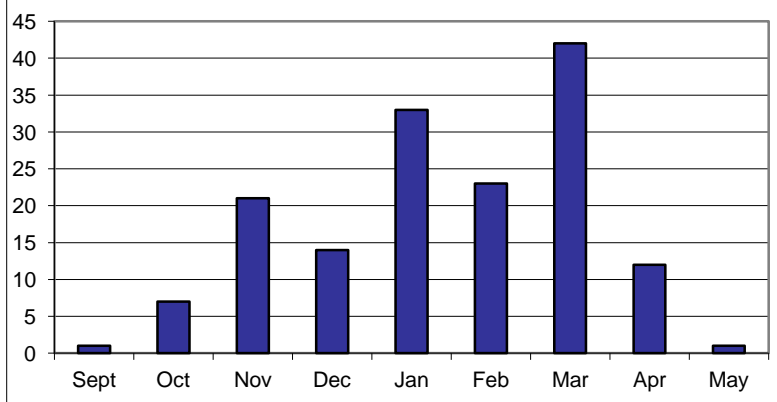


Climatology of the polar low:

Areas:

- Norwegian Sea/ Barents Sea
- Japan Sea, Bering Sea
- West of Greenland, Ungava bay
- Northeastern Pacific

Monthly distribution 2000-2011





Key processes:

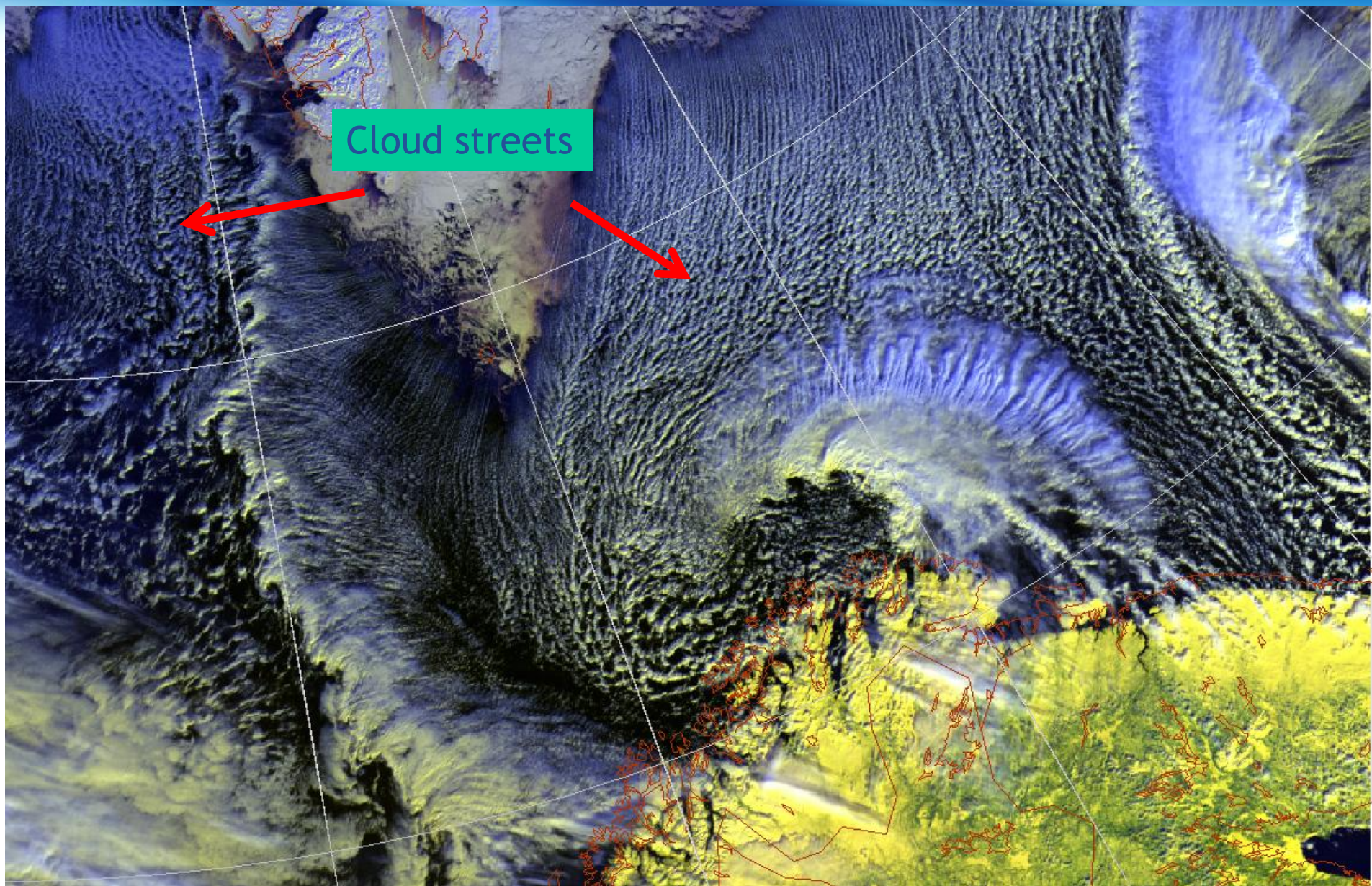
- Polar Lows develop from areas of instability:
 - Baroclinic, convective
 - Occlusions, troughs, convergence lines, etc.
- Destabilization of the lower layers, surface to 850 hPa:
 - Cold Arctic air is advected over warmer waters
 - Supply from the sea surface of latent and sensible heat
- Further destabilization of upper layers
 - Passage of cold air aloft
 - Unrestricted convection up to 400-500hPa
 - Upper trough in the Z500 hPa, with PVA and stretching of the column



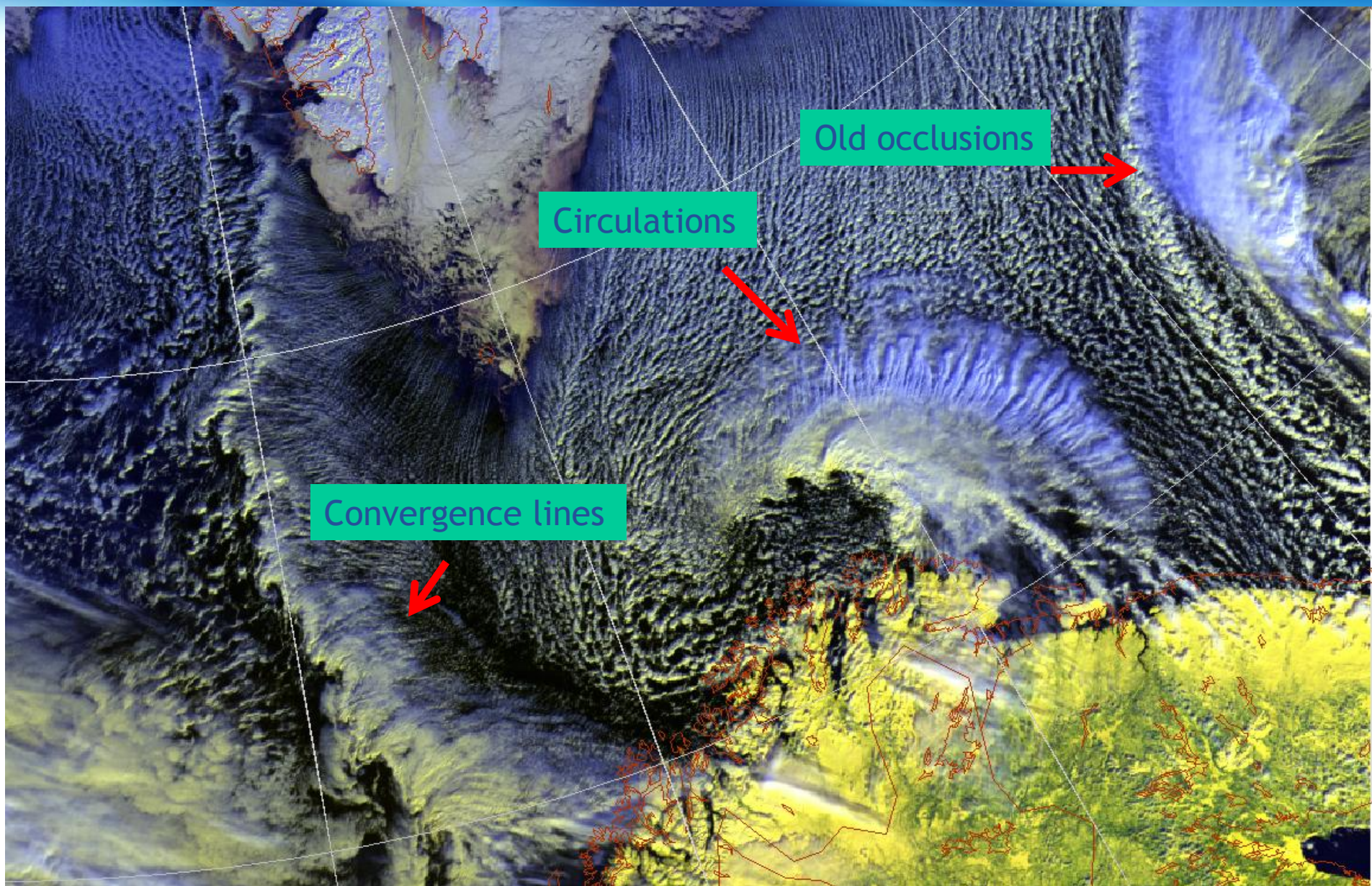
Forecasting methodology:

Look for:

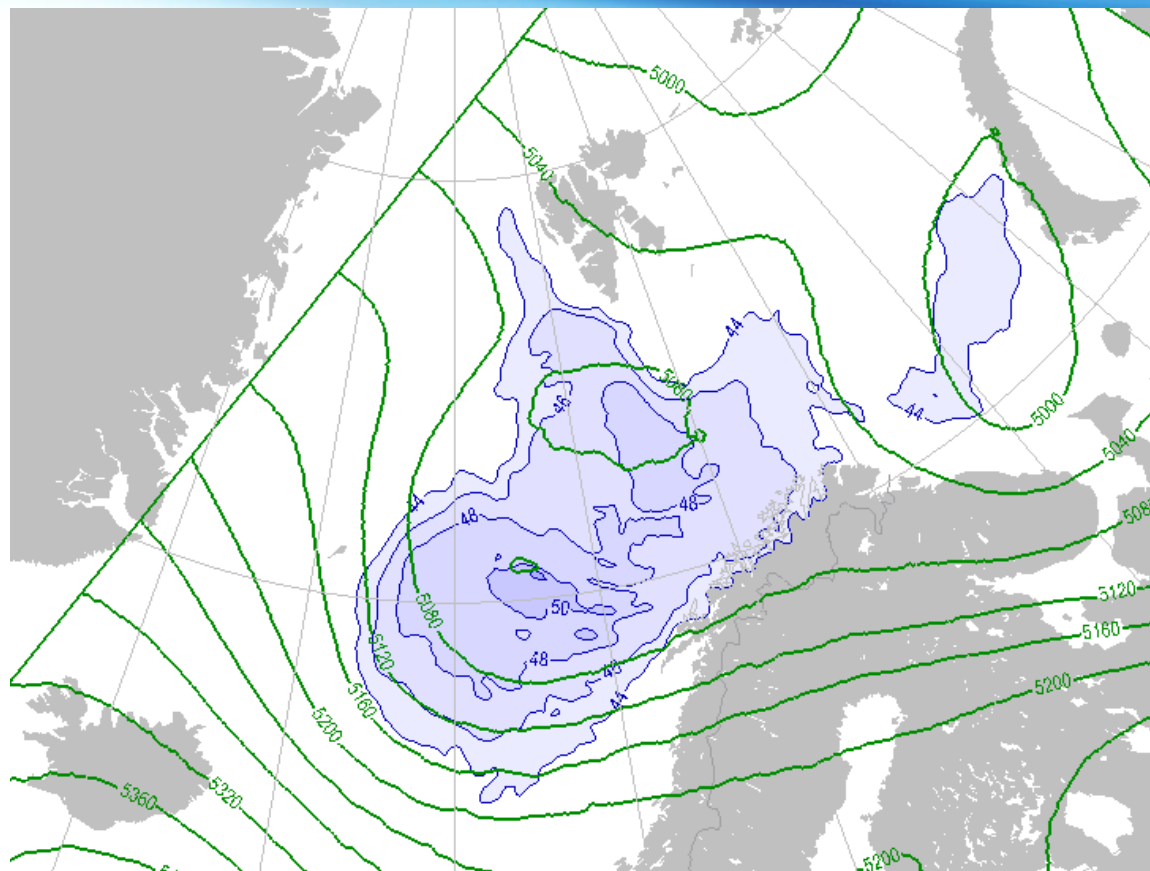
- Cold air outbreaks at low levels, -cloud streets, etc.
- Area of low level instability: Convergence zone, occlusion, Cb cluster, etc.
- Cold trough at 500hPa with PVA
- $SST - T_{500} \geq 44^{\circ}\text{C}$ (can be less)
- Polar lows usually situated at the fringes of the cold cores.



1. The cold air outbreak



2. Low level disturbances



The cold upper trough:

Trough @ Z500hPa with positive vorticity advection

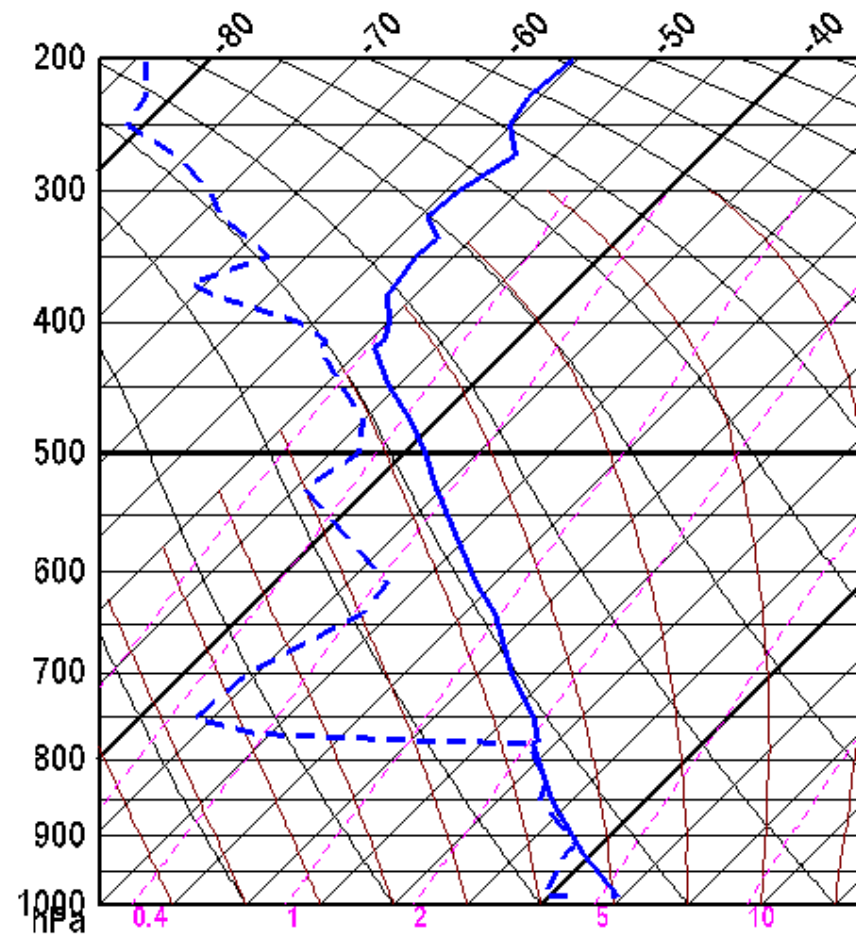
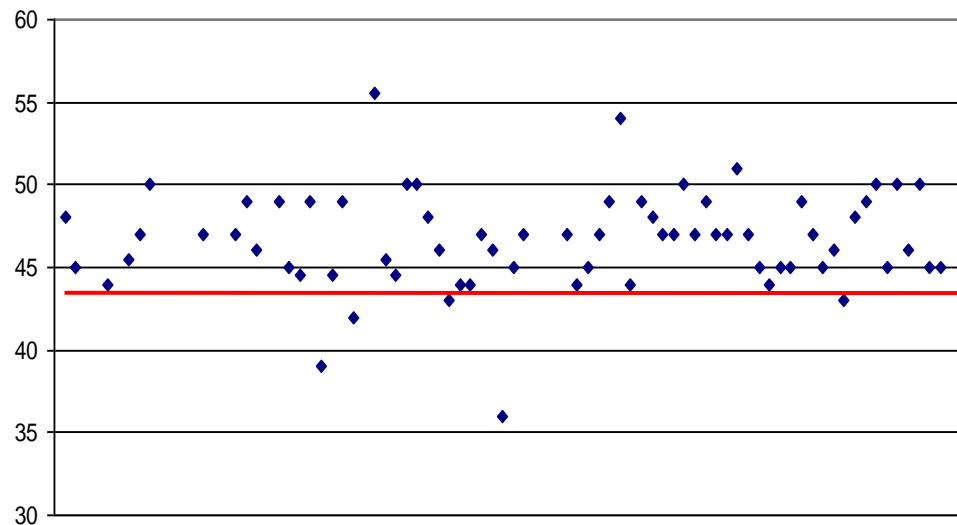
SST- T500hPa ~ 44 to 50°C

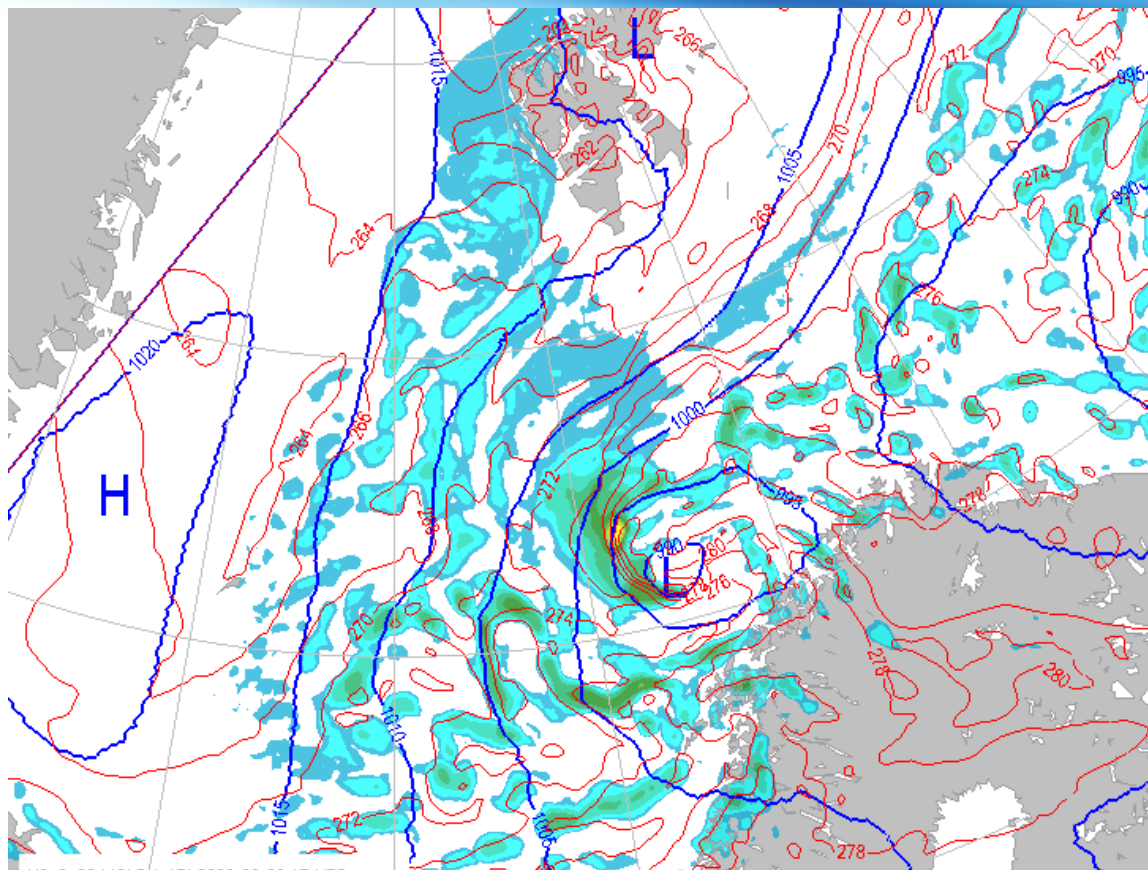


How cold ?

$SST - T_{500} \geq 44^{\circ}C$
- with exceptions !

SST-T500 Polar Lows 1999 - 2010



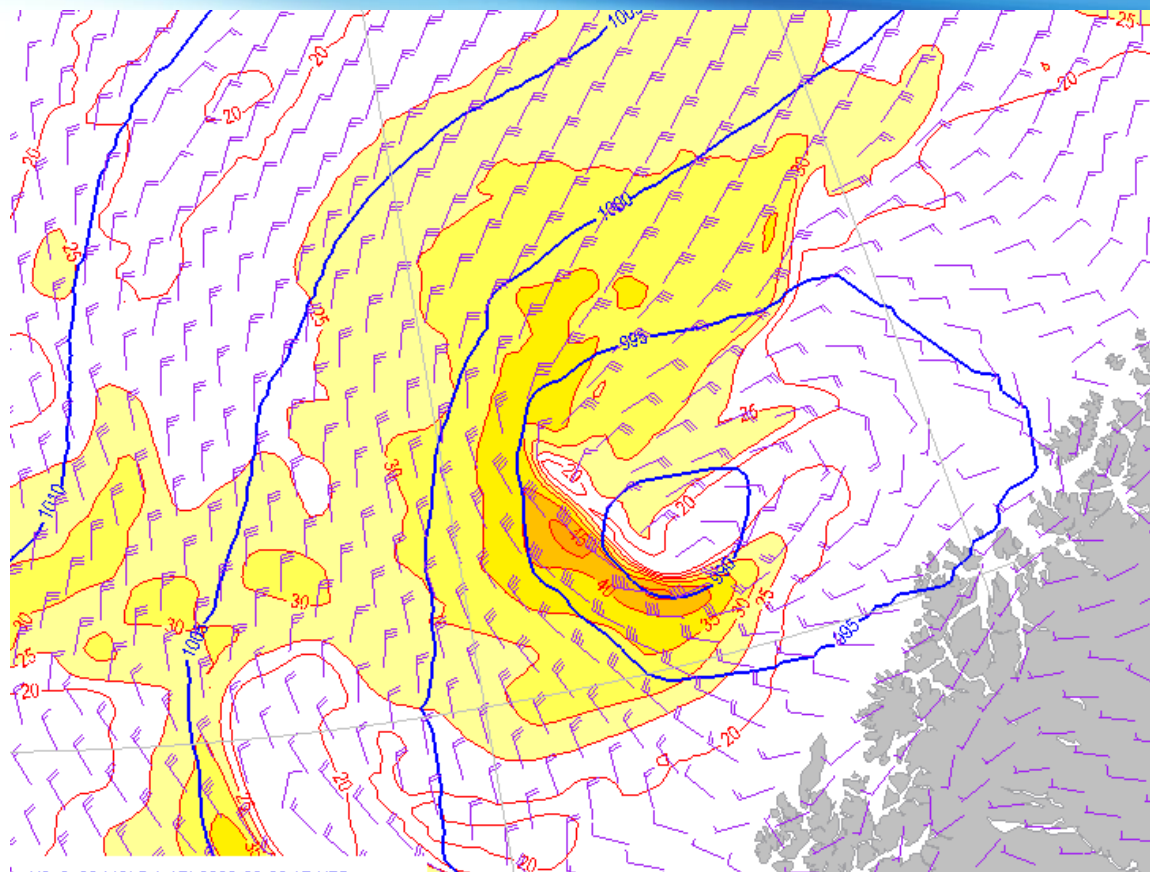


Development in the model:

MSLP signature

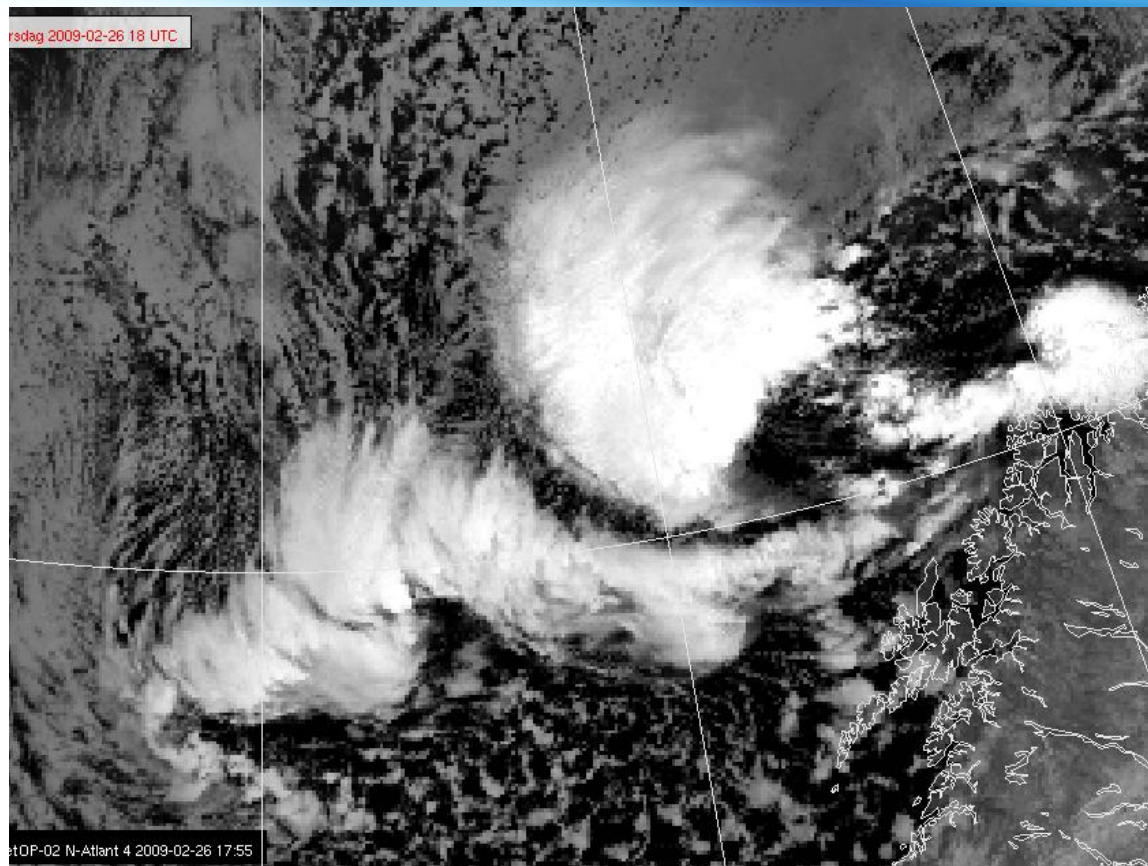
Precipitation and cloud bands

Baroclinic zones, as seen from thickness or in the equivalent potential temperature @ 850 hPa



Surface wind :

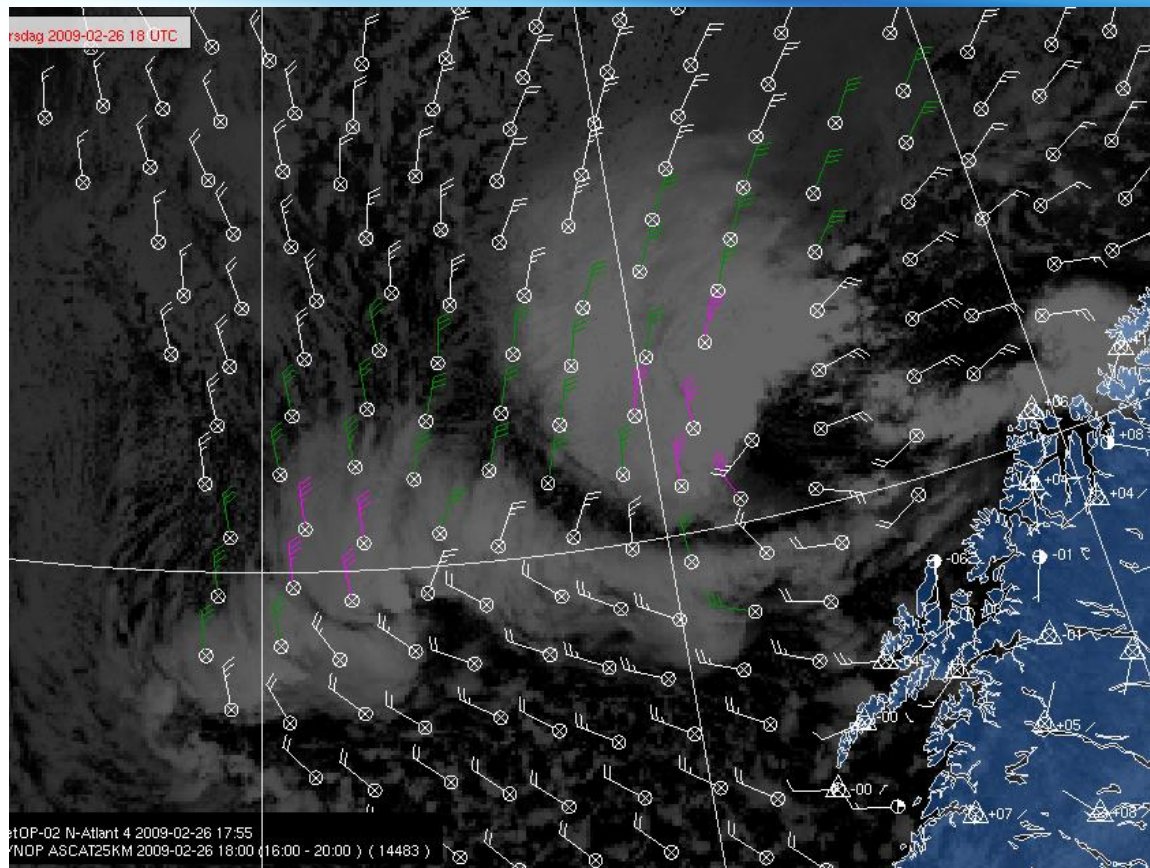
- ! Sharp shear zones
- ! Check position of the model



Observing polar lows from satellites

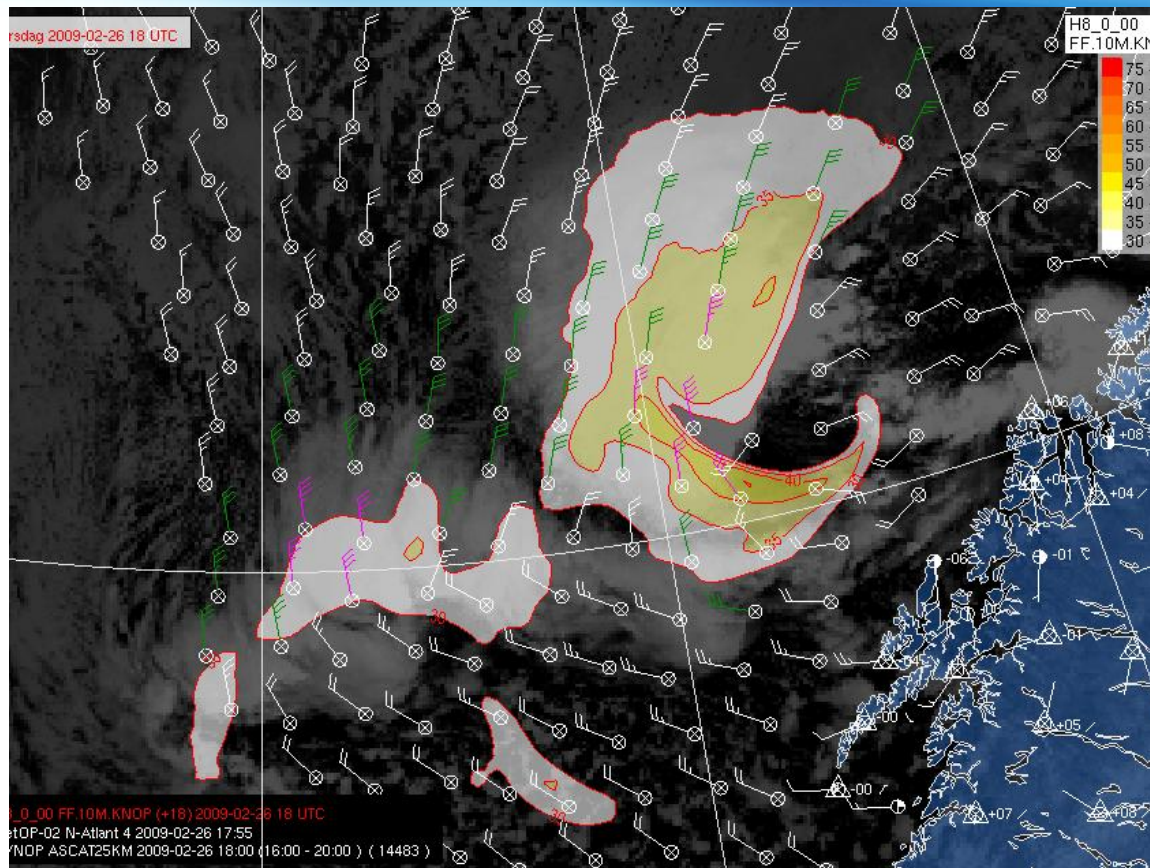
Polar orbiting (North of 70 degrees North)

AVHRR infrared or visible



Using the Ascet for wind

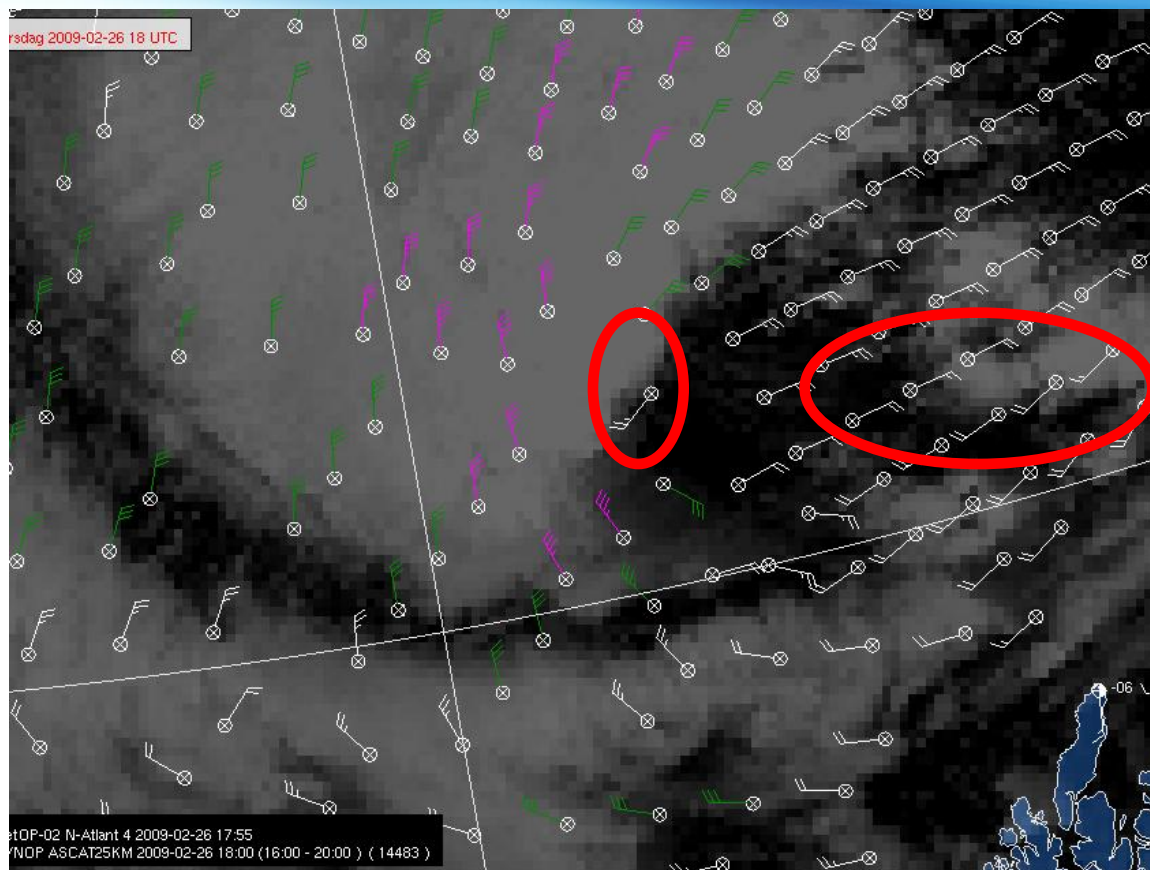
Scatterometer winds observations from Ascet or Oceansat



Using the Ascat for wind

Hirlam 8km model winds vs. Ascat

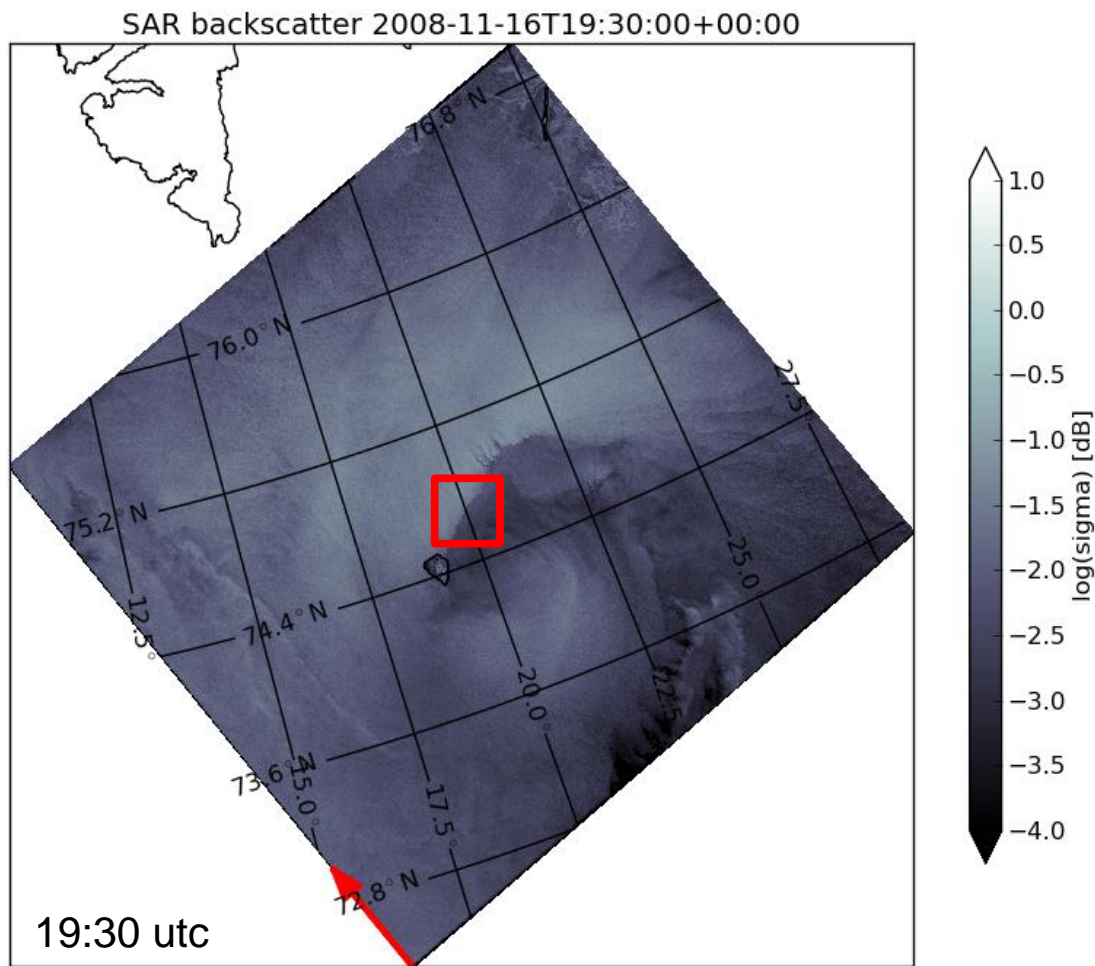
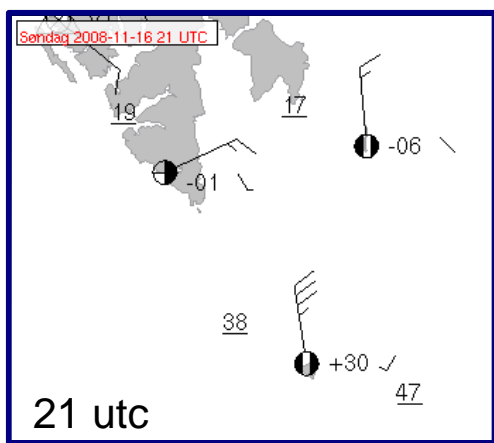
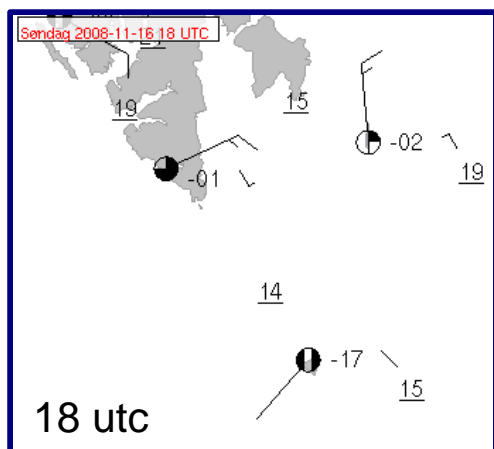
Are both lows captured ?



Scatterometer wind:

- Absolute wind speed OK
- Ambiguity in wind direction
- Contaminated by rain
- Insensitive to snow

Polar lows seen from SAR:

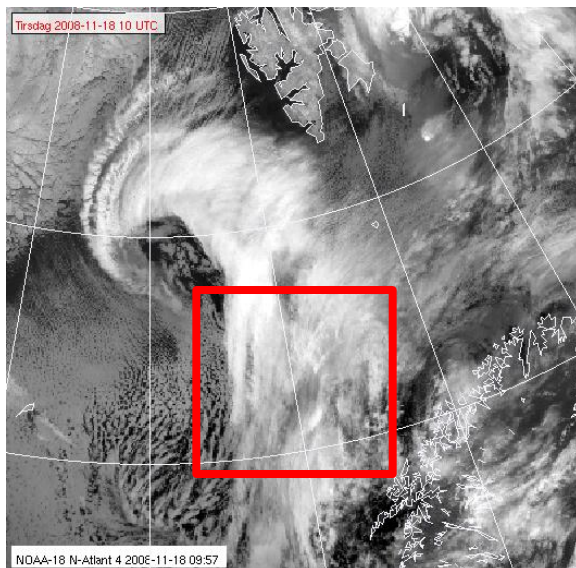


Shear zone ~ 1-3 km, time to increase ~ 1-10 minutes

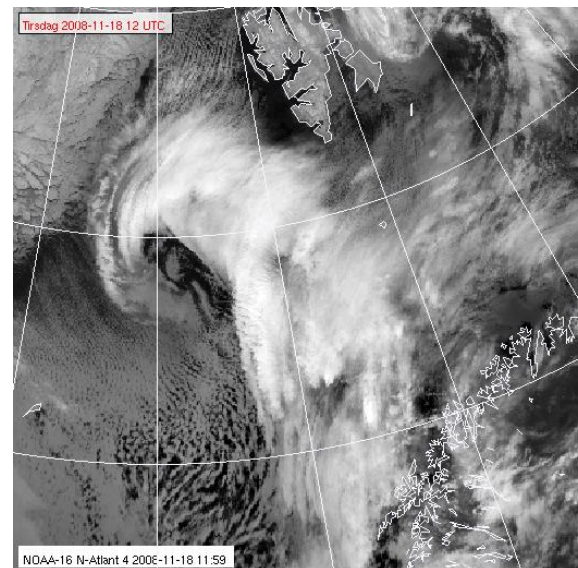
The 18.Nov. 2008 low: Early detection by SAR?



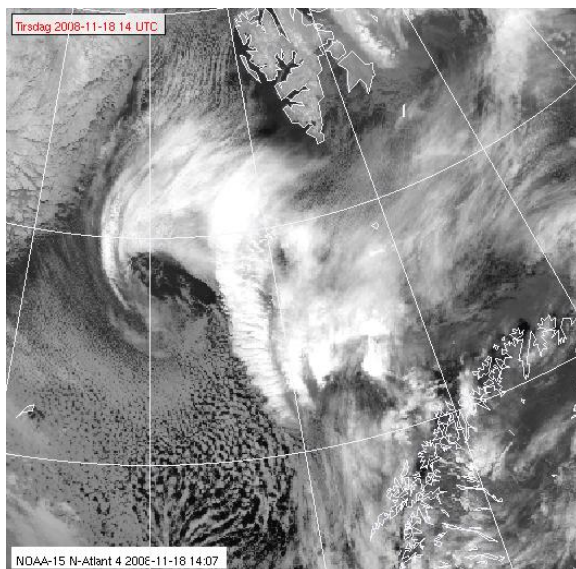
10 utc



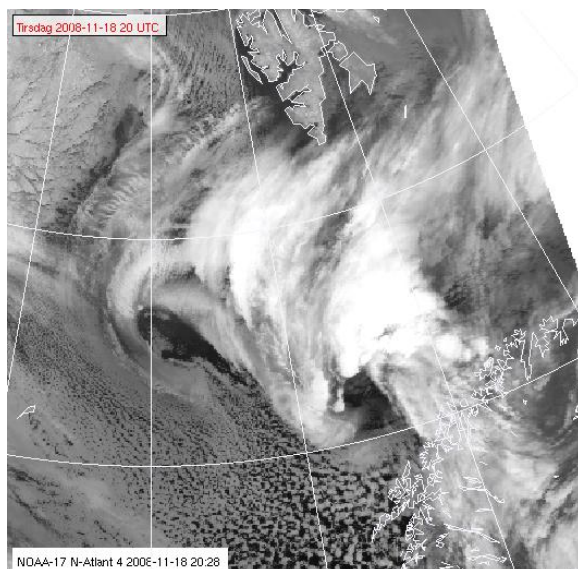
12 utc



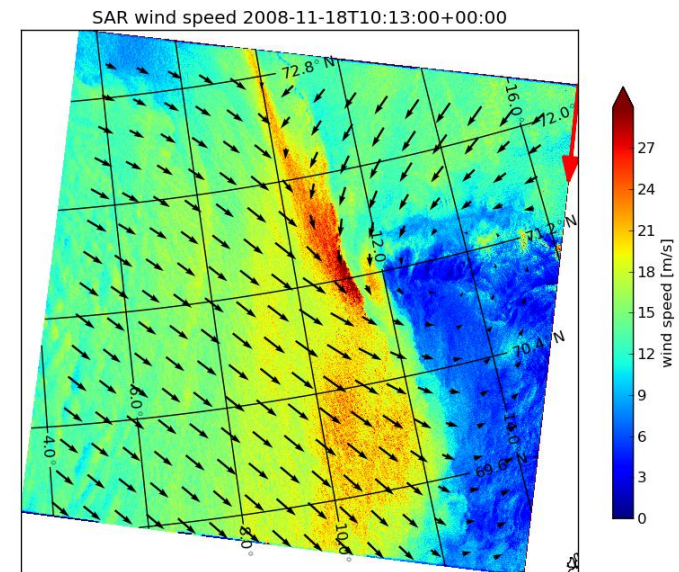
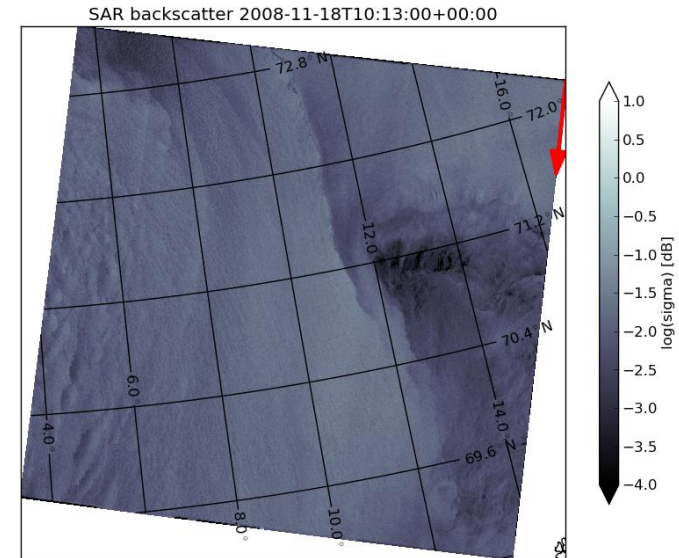
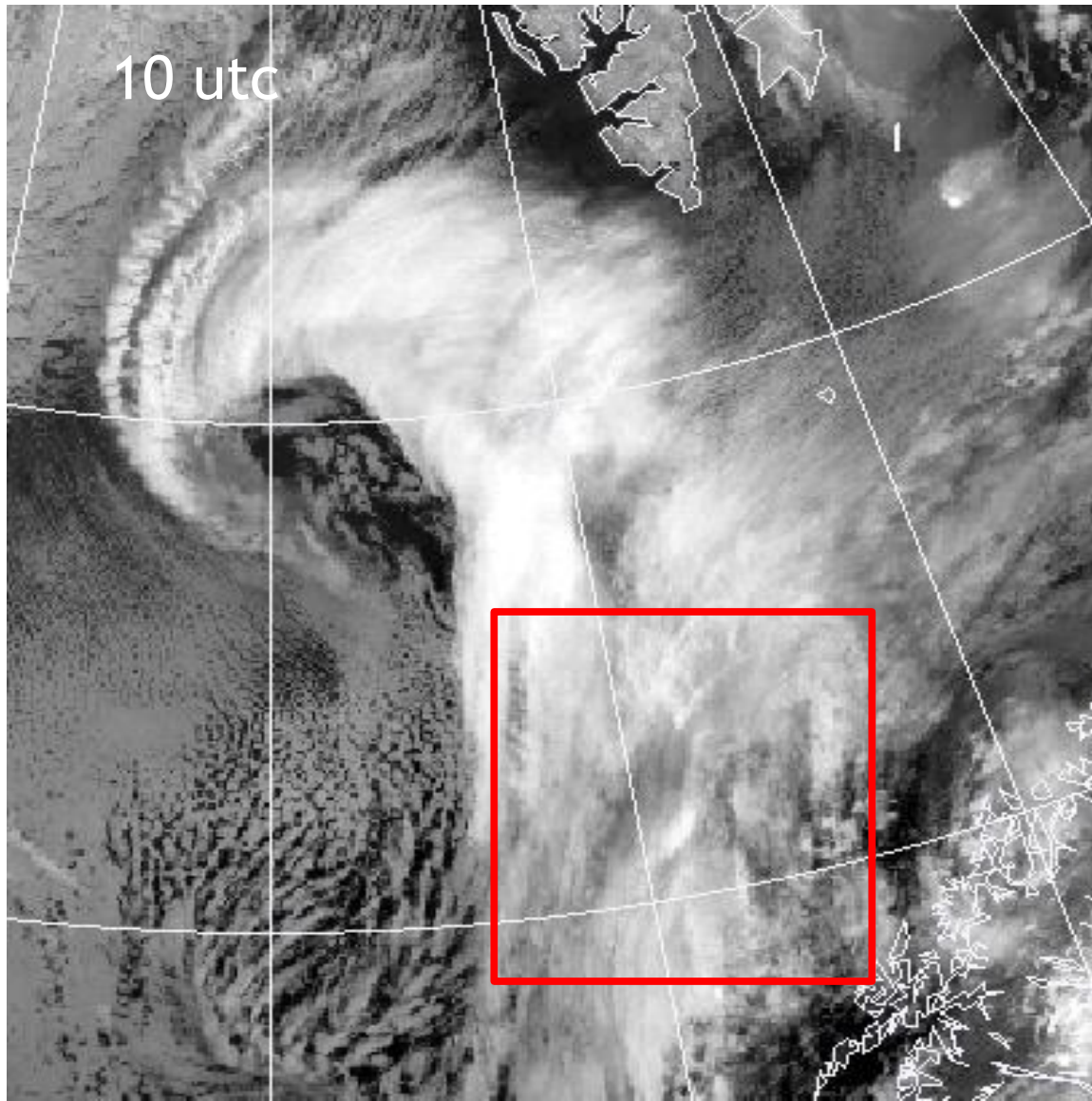
14 utc



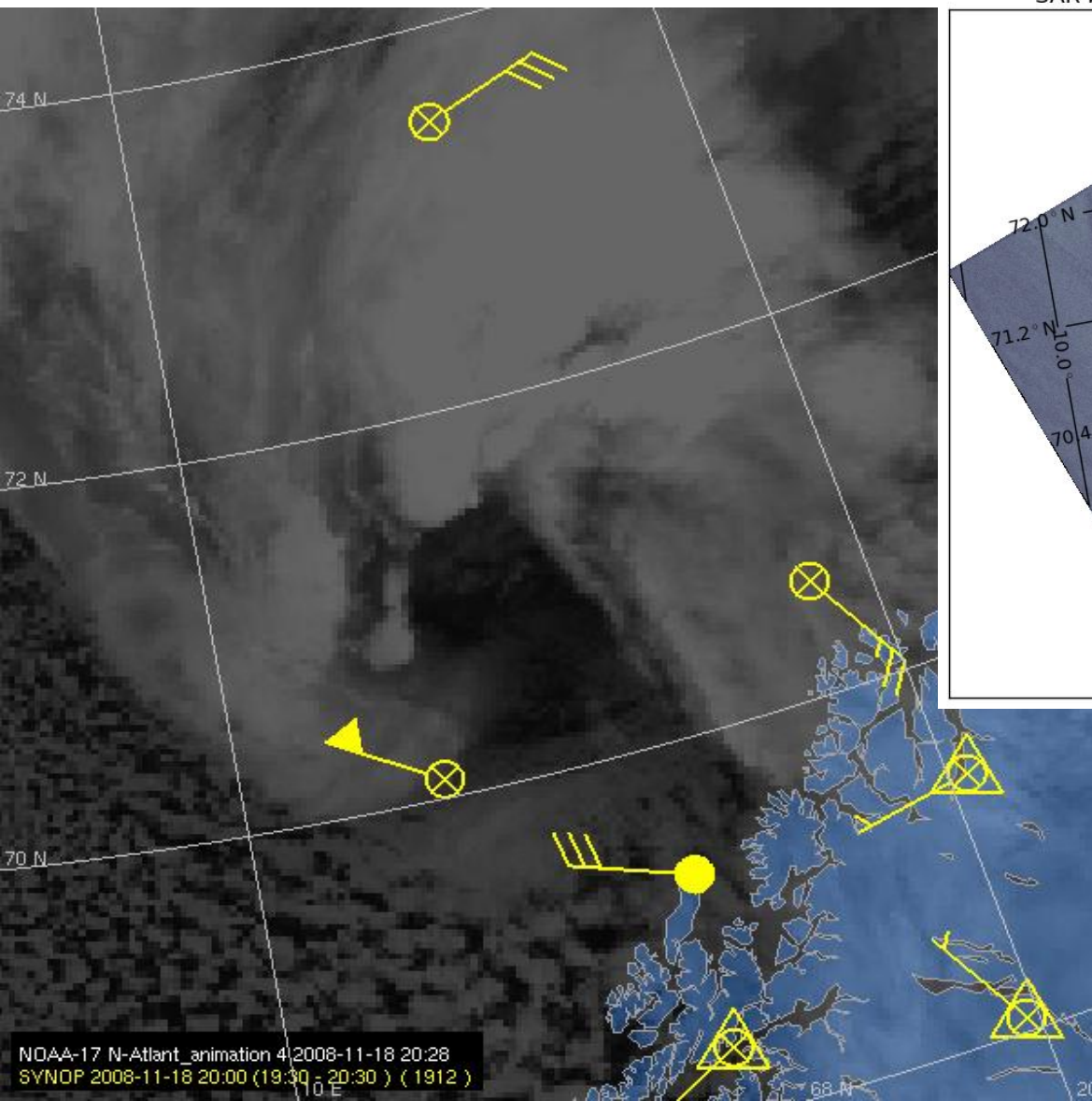
20 utc



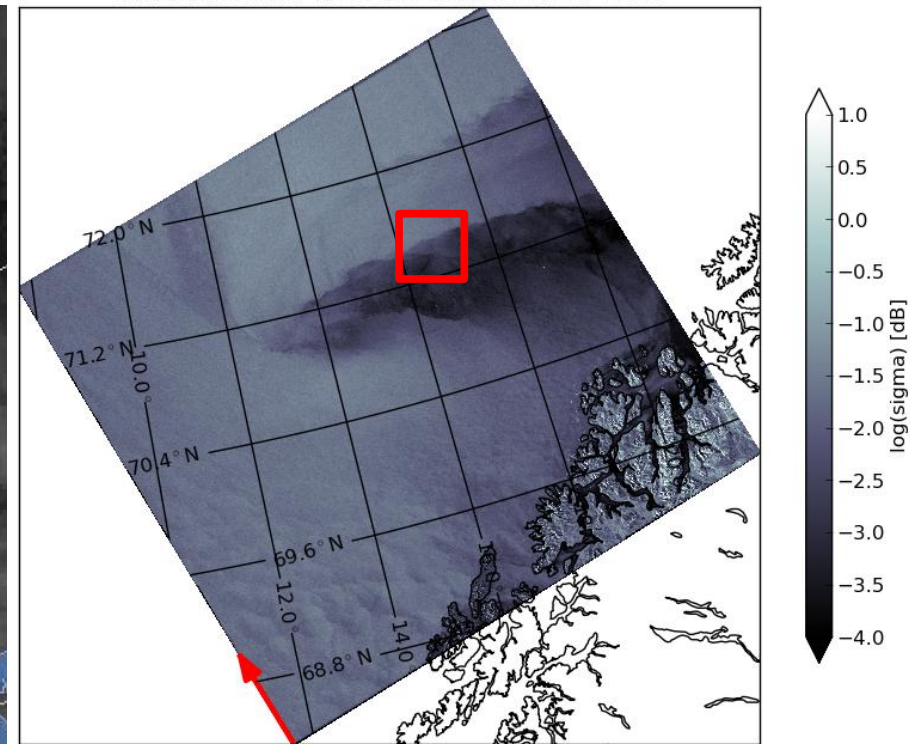
Surface signature in the SAR ?



AVHRR vs. SAR



SAR backscatter 2008-11-18T20:06:00+00:00



Signature of the polar low at surface vs. cloud top

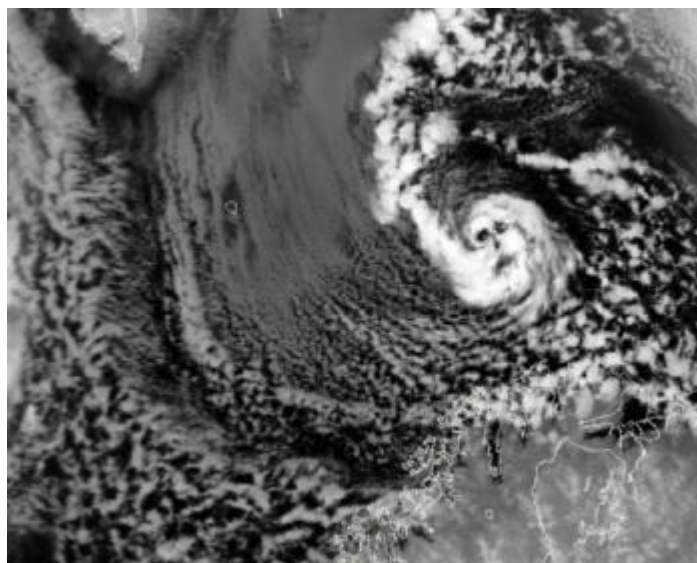


Summary on polar lows:

- Small, fairly intense lows in the marine Arctic in the winter
- Forecasting:
 - Cold air outbreaks
 - Areas of deep convective instability
- Observing the polar low from satellites:
 - AVHRR IR and visible for general cloud top
 - Ascatterometer for absolute wind speed
 - SAR for qualitative detailed studies



Questions ?



polarlow.met.no

www.yr.no