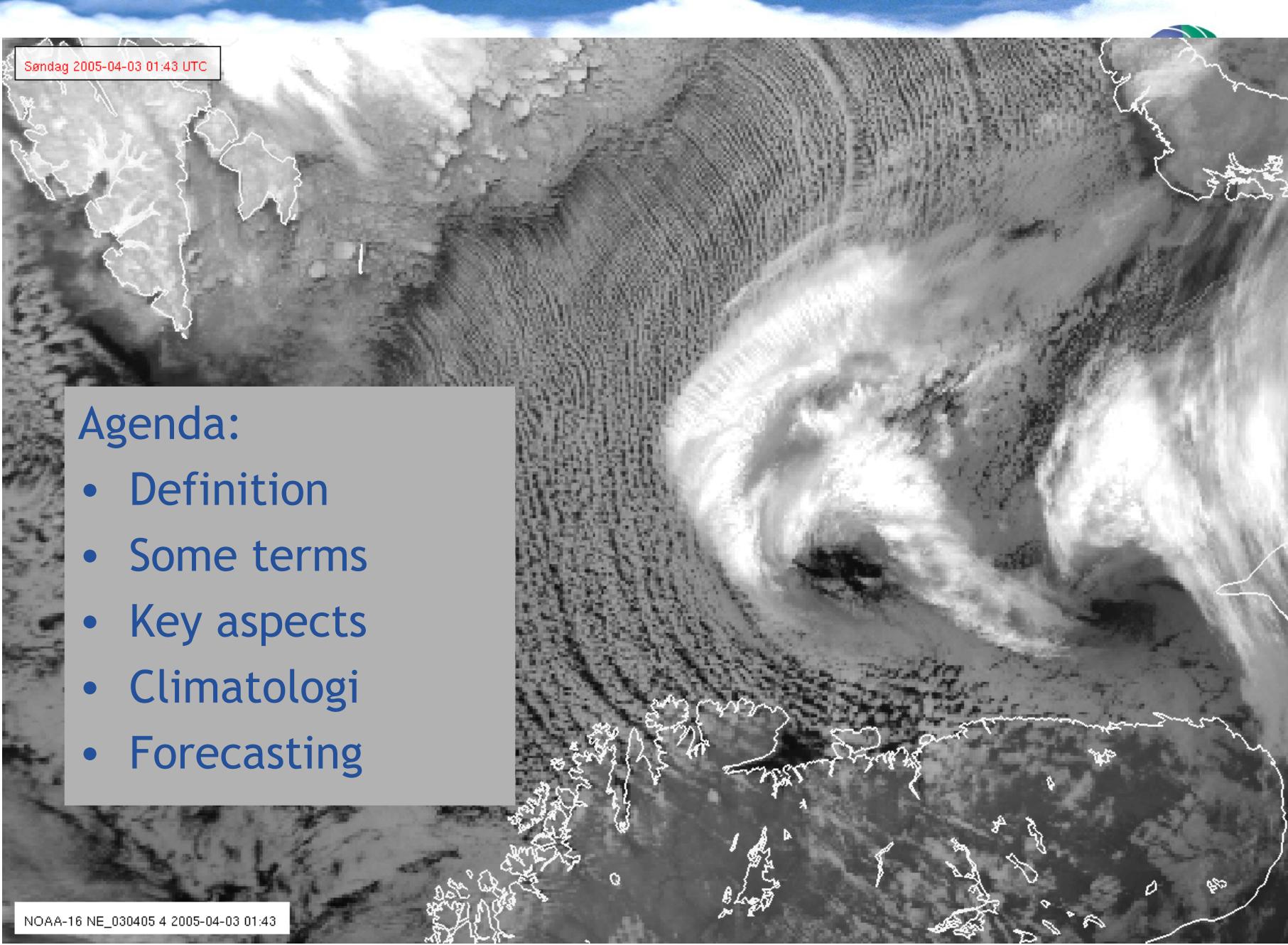




*Meteorologisk  
institutt  
met.no*

## Polar Lows in the Arctic

Gunnar Noer  
Vervarslinga for Nord-Norge



Søndag 2005-04-03 01:43 UTC

## Agenda:

- Definition
- Some terms
- Key aspects
- Climatology
- Forecasting

NOAA-16 NE\_030405 4 2005-04-03 01:43

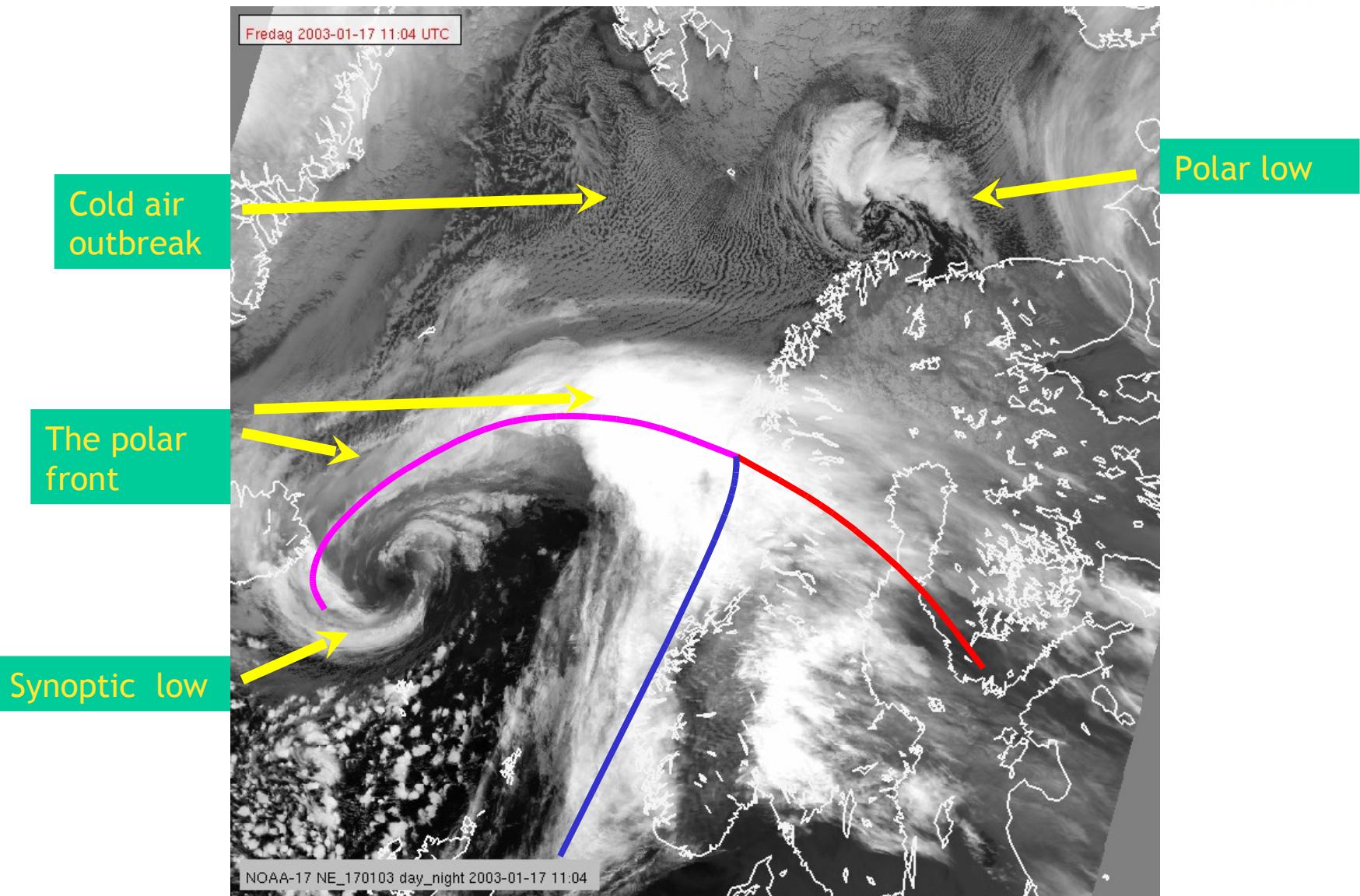


# Definition of the polar low at the met.no (from EPLWG)

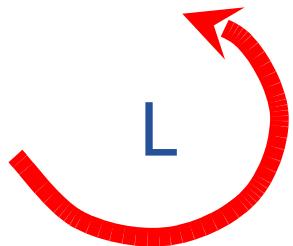
- 'A small, but fairly intense low in maritime regions'
- In cold air outbreaks, well north of the polar front.
- Diameter 100 - 500km
- Cyclonic curvature



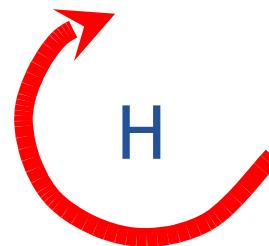
# Some terms:



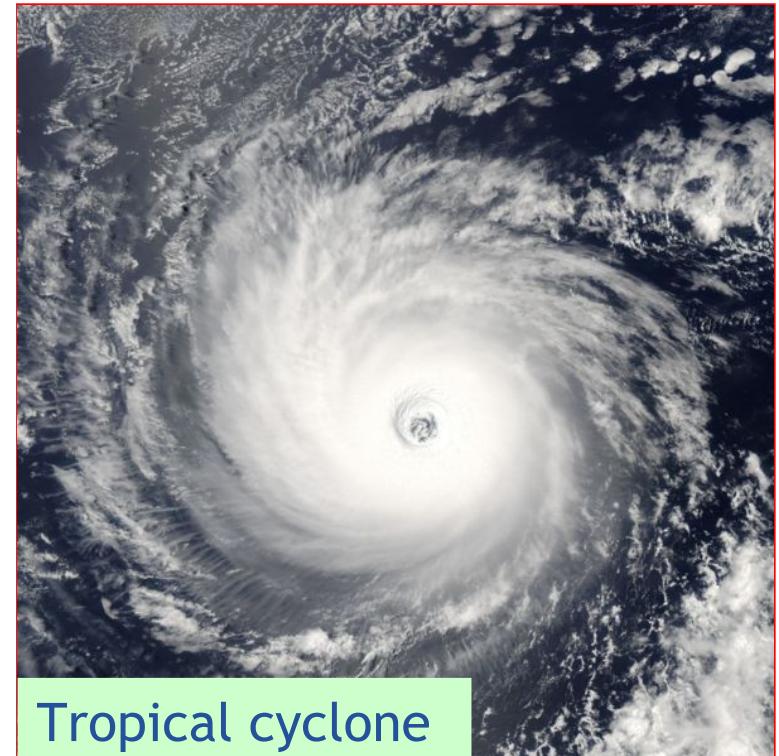
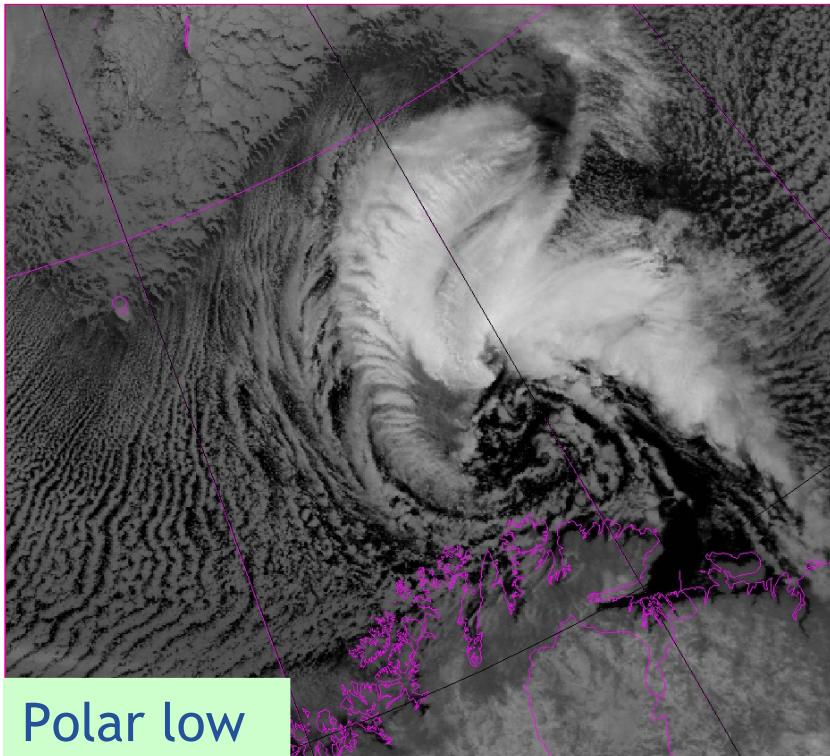
# Polar Low = Arctic Cyclone ?



Syklonic curvature



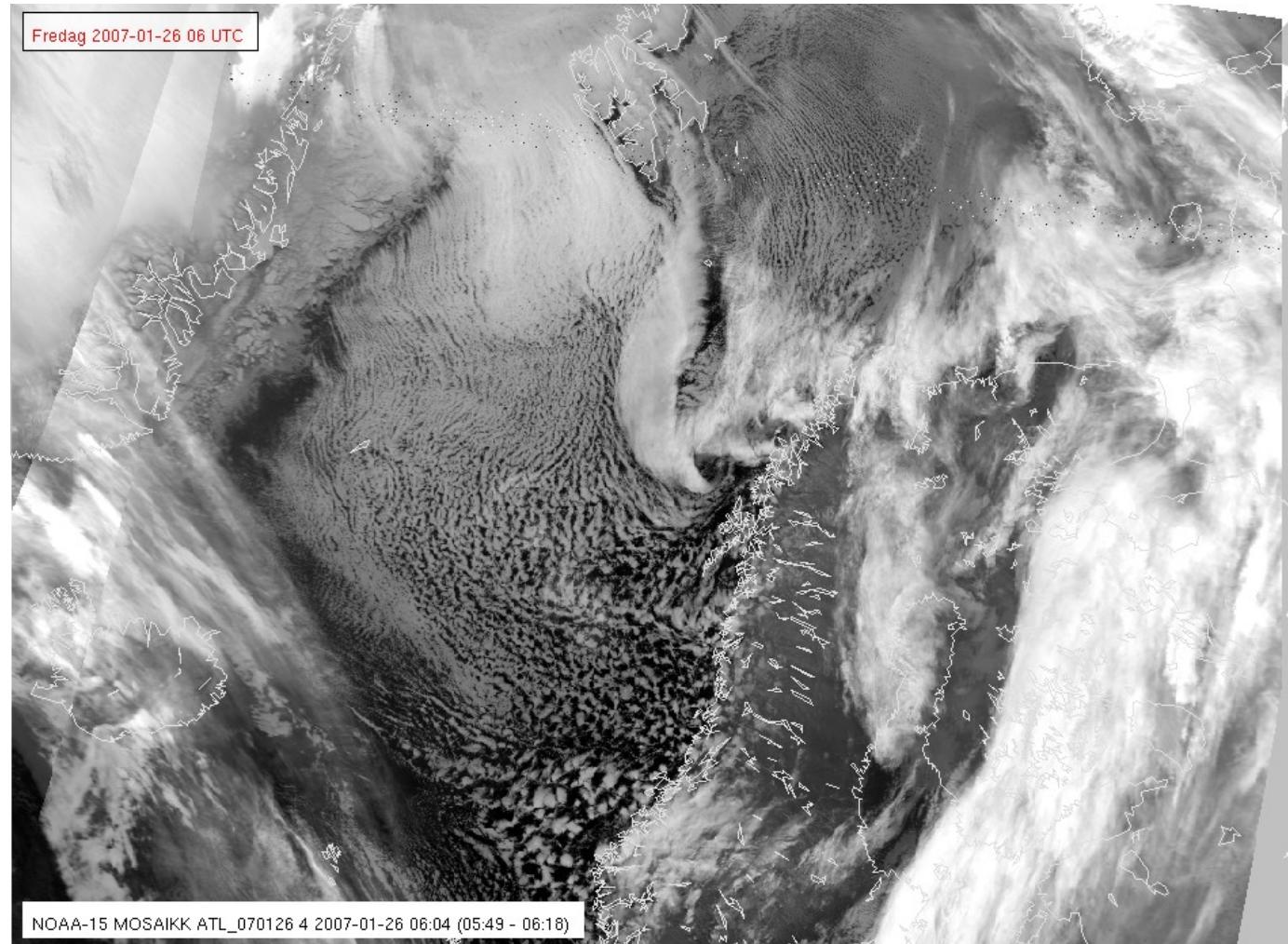
Anticyklonic curvature





# 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



# Cold air outbreak



Shallow convection, Cu

Towering Cumulus, TCu

Cumulonimbus, Cb

Northerly  
wind

Ice

-2°C

3°C

5°C

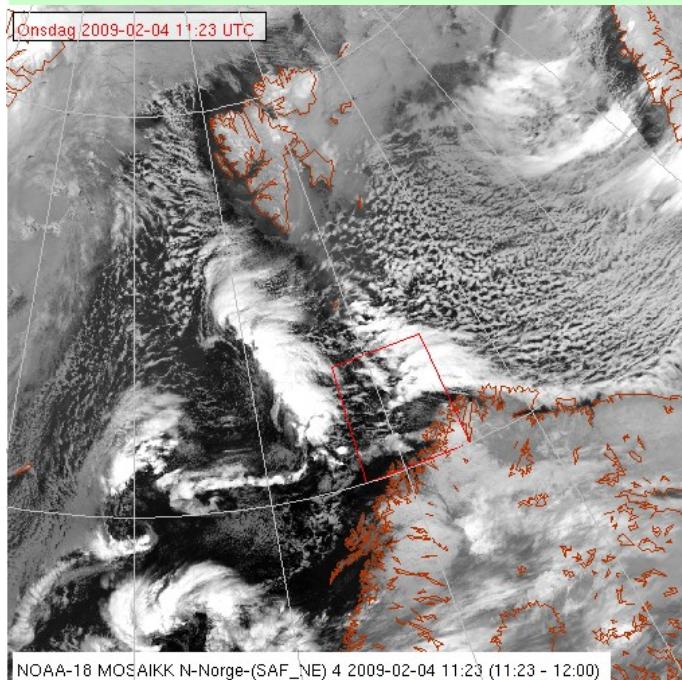
Norway

Deepening convection from the ice across warmer waters



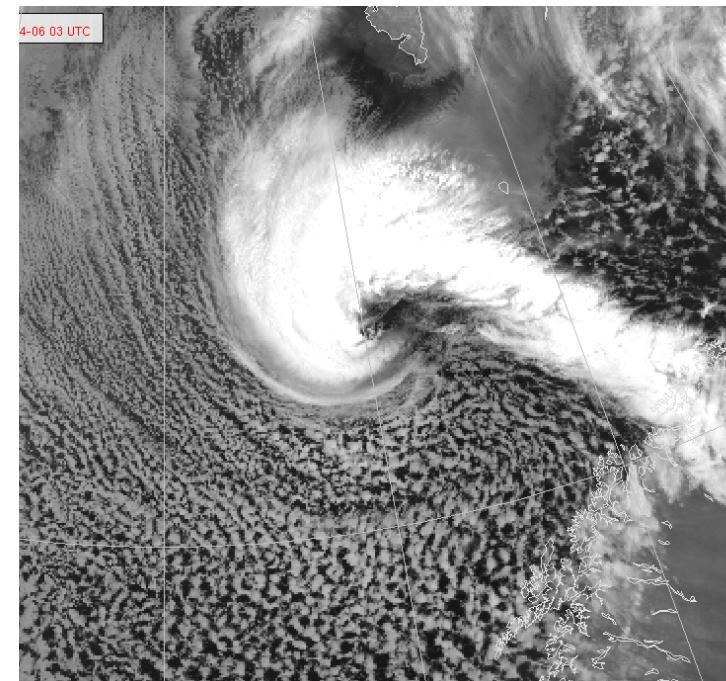
# The cold weather spectrum:

Showers, troughs, meso cyclones



Moderately unstable airmass,  
mixed and chaotic surface  
flow

Polar low

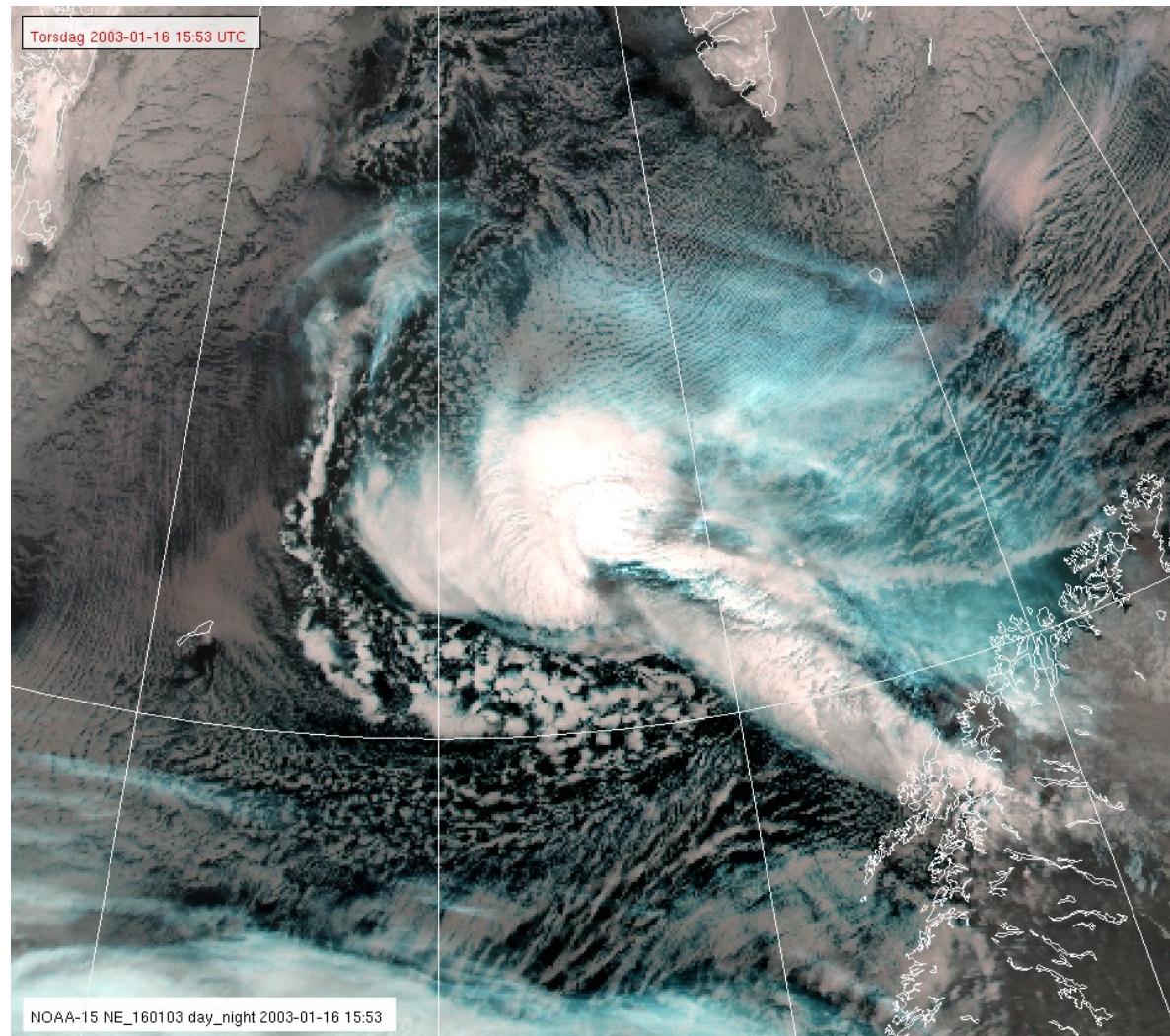


Deeply unstable airmass.  
Homogenic surface inflow.  
Strong supply of energy to the  
low

# Characteristics of the polar low



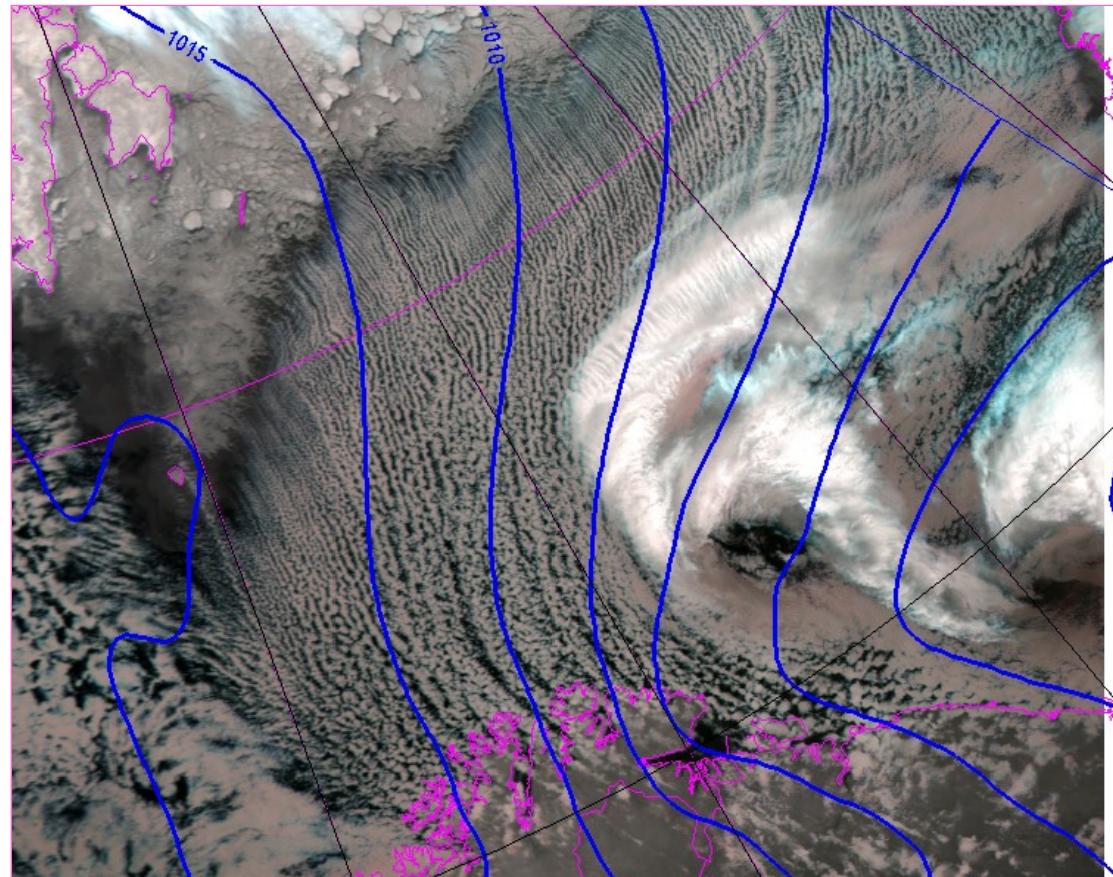
- Generally smaller (100-500 km) than the ordinary synoptic lows
- Average lifespan 18 hrs
- Speed of propagation 15-25kt, fastest recorded was 52kt
- Heavy showers of snow or hail, visibility less than 100m
- Waves and Icing



# Characteristics of the polar low



- Rapid changes of wind, 15kt to 45 kt in less than 15 minutes
- Average max wind 46kt (B9, strong gale)
- 35-50% have 50kt (Storm B10) or more
- Strongest recorded since 2000 had 70kt for 12 hrs
- Strong wind usually on the west side of the low, from NW to NE



Søndag 3. april 2005 00 UTC

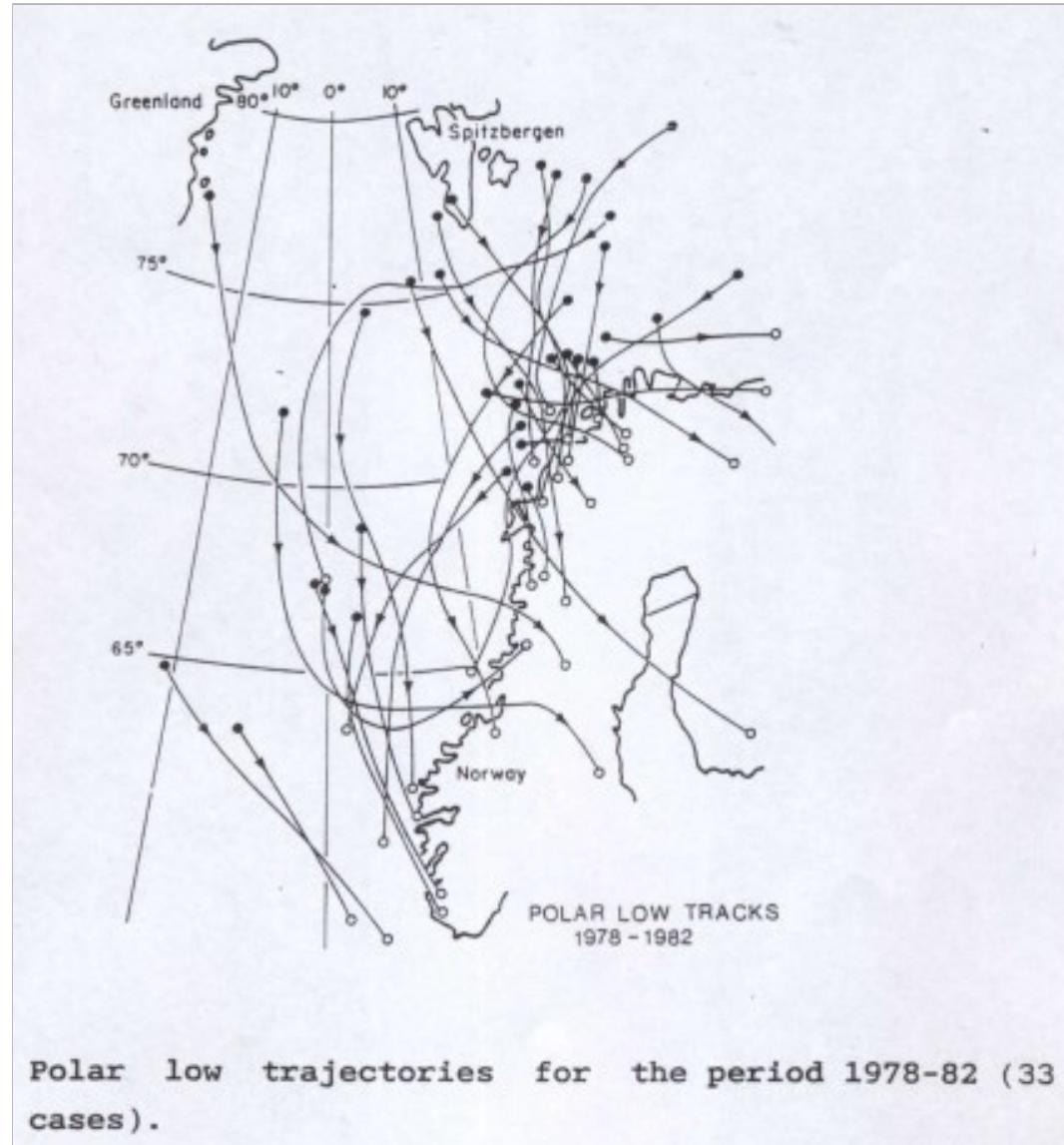
# Polar low trajectories



Uniquely associated with cold air outbreaks, to the west, or behind passing synoptic lows.

Never seen in flow from the SE, S or SV.

Difficult to forecast ?





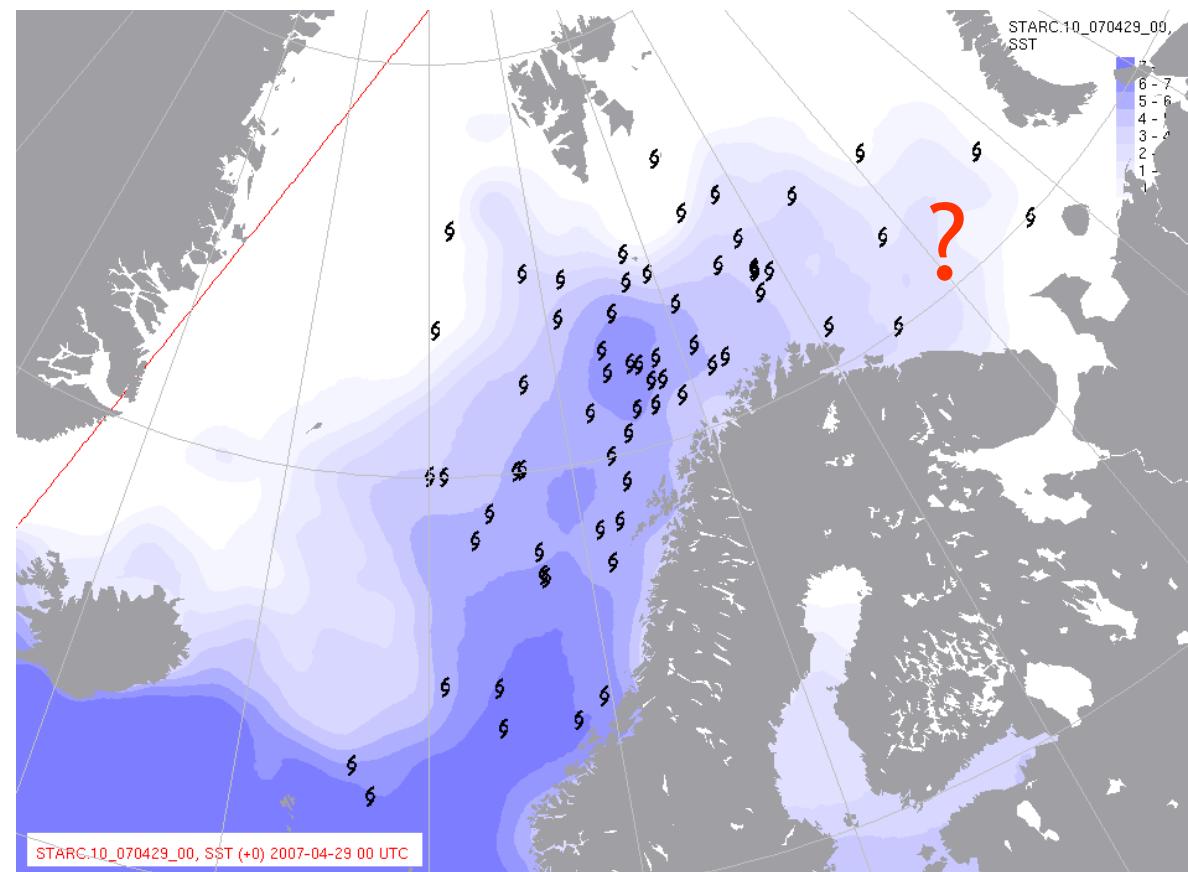
# Polar low genesis areas

80 cases 1999 - 2009

50-70% recorded  
within VNN AOR

The southeastern  
Barents sea ?

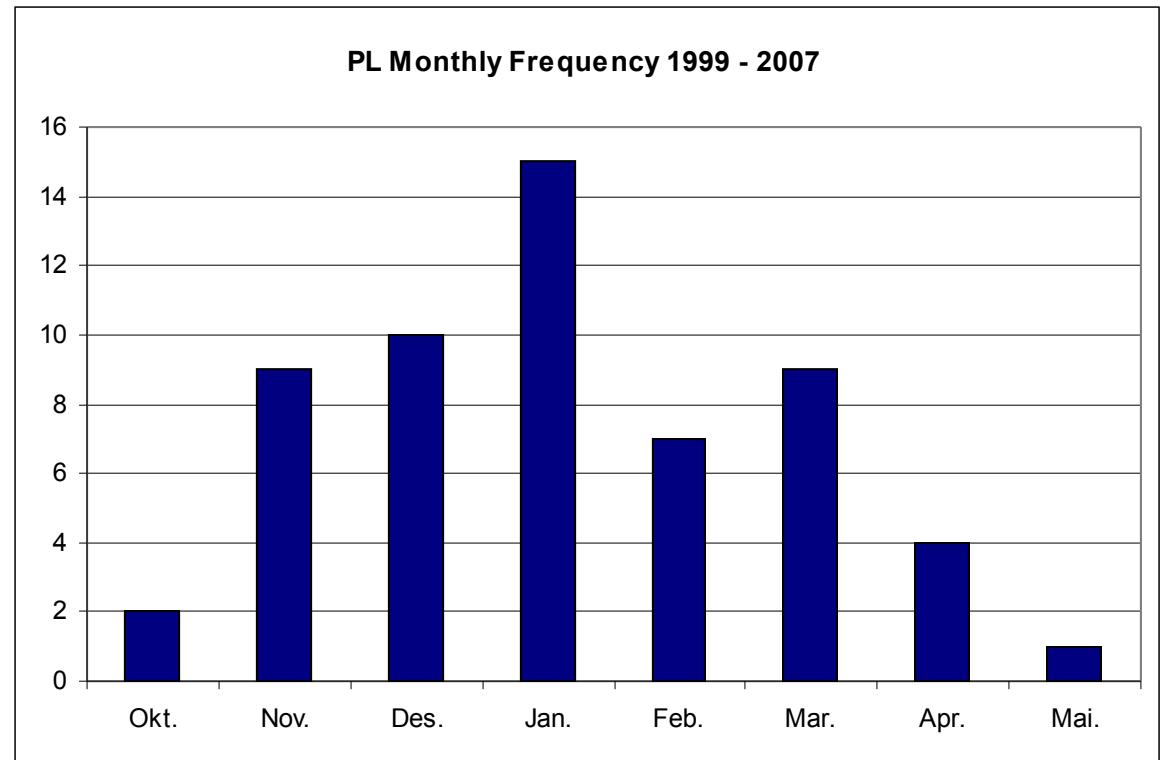
Most common east of  
E00, and south of N75





# Monthly variation 1999 - 2007

- Max in January
- Local min in February
- Local max in March



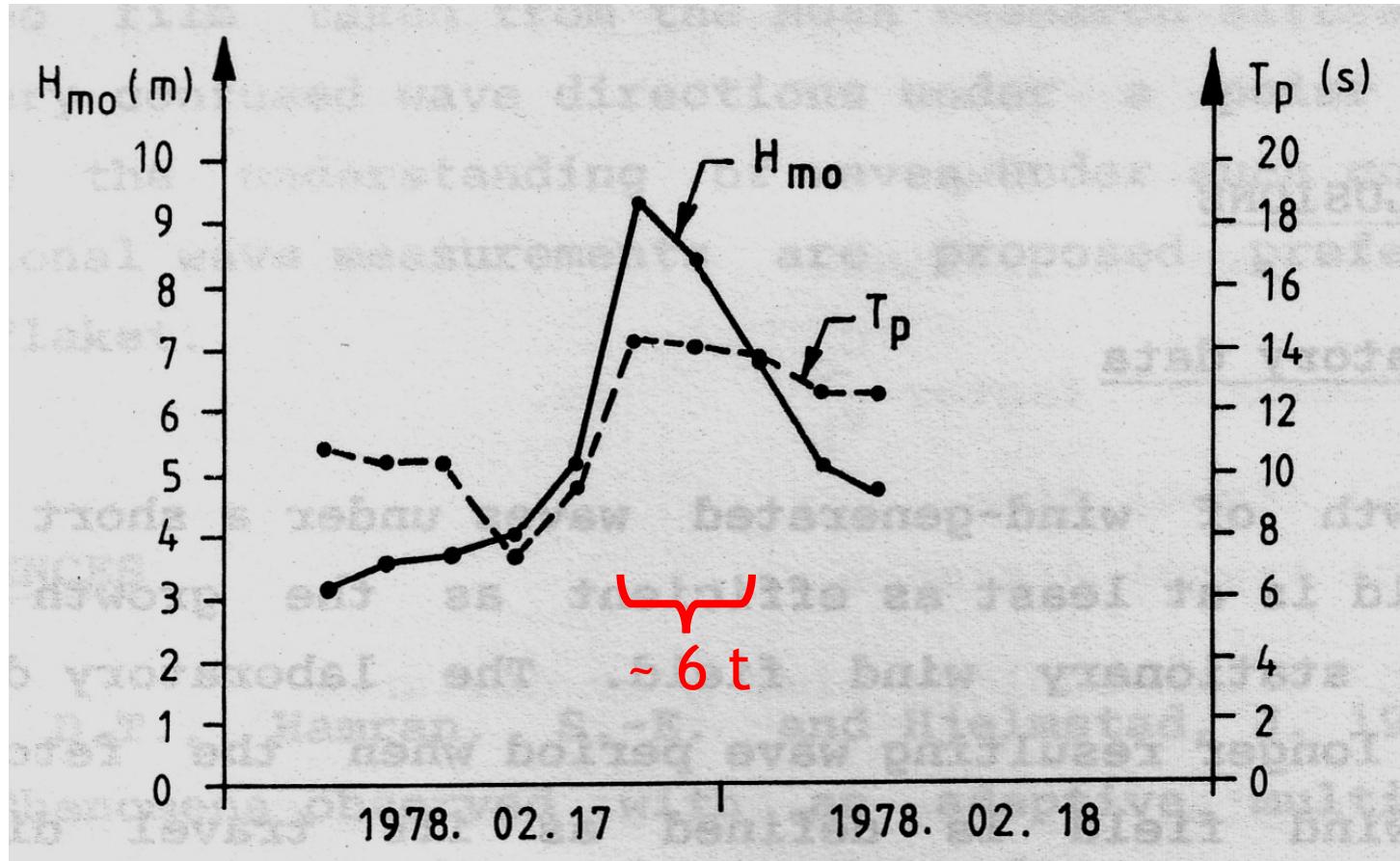


# Polar lows and waves

**Table 6.5 Extremes of significant wave height ( $H_{m0}$ ) for polar low situations compared to extremes when polar lows are excluded. Annual extremes for the period July - June for Utsira, Halten and Tromsøflaket, 1974/75 - 1983/84.**

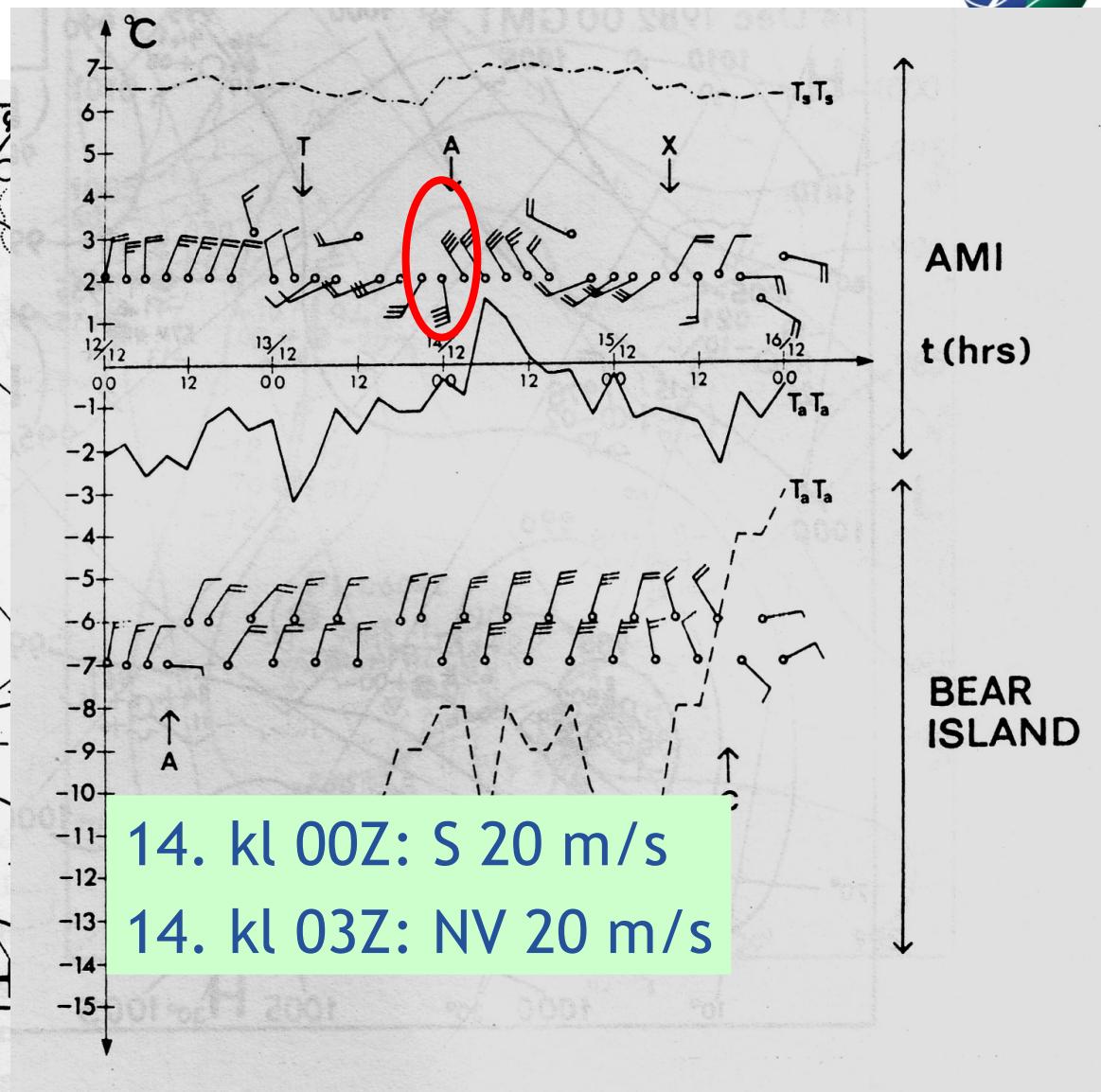
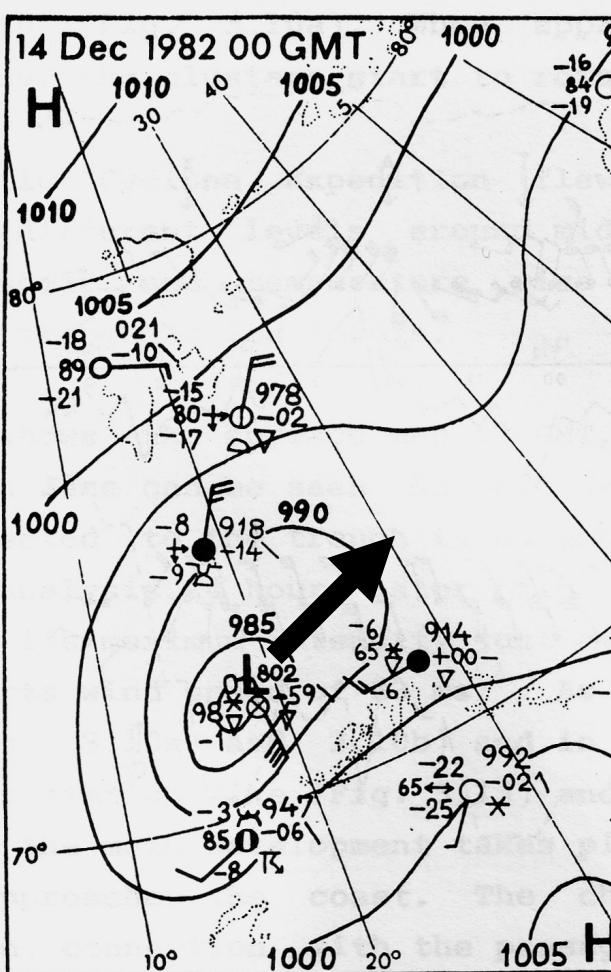
	Utsira		Halten		Tromsøflaket	
	Polar lows	Other storms	Polar lows	Other storms	Polar lows	Other storms
1974/75	-	7.6	8.0	8.2	-	-
1975/76	-	9.1	-	8.9	-	-
1976/77	-	8.4	3.0	6.8	4.9	6.5
1977/78	8.3	8.4	-	9.5	9.3	8.8
1978/79	-	8.7	-	11.8	7.0	12.1
1979/80	-	8.6	4.9	9.4	7.0	8.3
1980/81	10.2	11.7	10.5	10.2	6.4	9.0
1981/82	-	11.4	9.1	9.9	2.2	9.4
1982/83	6.5	9.1	7.2	9.4	7.8	12.1

# Polar lows and waves



Tromsøflaket: Increase in significant wave height from 4 m to 9,5 m in 6 hrs

# Rapid changes of wind speed and direction



Surface pressure analysis 00 GMT, 14 December 1982

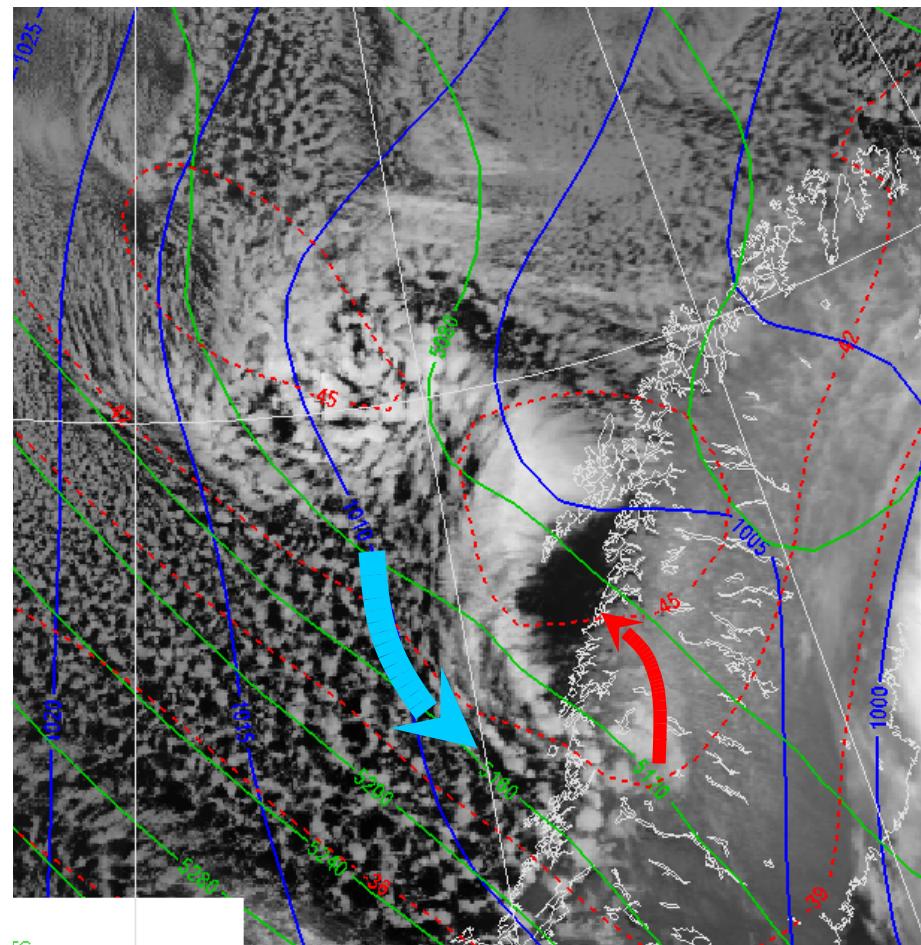
(Rasmussen, 1985).



# Effects of topography

Often light winds and fair weather on the northeast side of center.

Mesoscale circulation acts in addition to the large scale windfield





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

- Few observations
  - Soundings
  - Radar
  - Satellite gap during night hours, 7 -9 hrs (2000)
- The numerical models
  - Poor data coverage, uncertain analysis
  - Insufficient description 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



# Forecasting of the polar low, - improvements since 2000

- Observations
  - Satellite data, e.g. Quicksat and Ascot
  - Slightly better radar coverage
  - Smaller gap in satellite during night hours, now 2-3 hrs
- The numerical models
  - Assimilation of satellite data, improved analysis
  - Better description of convection
  - Improved resolution, main models 8 - 12km, fine scale 4km
- The forecaster
  - Improved knowledge and understanding
  - Standard methodology at the VNN (Met.no in Tromsø)



# Forecasting polar lows 2009

## 9-12 hrs prognosis:

- Some error in position
- Speed and direction of propagation fairly good
- Wind normally within 1-2 B
- Normally included in the text forecasts

- Beyond 12 hrs:

- Severe uncertainty in position and strength
- Large scale weather pattern predictable
- Often not included in the text forecasts

- Considerable input is still needed from the forecaster
  - Worst case scenario; The low is still not forecast.



# Forecasting formats:

- Ordinary text ([www.yr.no](http://www.yr.no))
  - Land
  - Coastal
  - High seas
- Gale warnings
- Aviation:
  - SIG/ICE message
  - IGA (International General Aviation)
  - SIG-maps (significant weather maps)
- Specialized forecasts,
  - Polar low probability forecast (Snøhvit)



# Polar Low Probability forecast

- **Very low**
  - PL never observed. No Surface CAO or cold core aloft
- **Low**
  - PL never observed, but either Surface CAO or cold core present
  - Tcu or Cb may be in the area
- **Moderate**
  - Surface CAO and cold core aloft
  - Troughs or Cb in the area (gusty winds)
- **High**
  - Polar Low observed in the area



Forecast valid until Monday December 13. 2004 at 24 utc: (12 h)

Risk of Polar Low (Very low, low, moderate, high):	Very low
--	----------

(At **high** risk a special weather chart (SWI) is issued and sent by fax)

Valid from Tuesday December 14. 00 utc until 12 utc (12 h):

Risk of Polar Low (Very low, low, moderate):	Very Low, becoming Low
--	------------------------

Valid Tuesday December 14. 12 utc until Wednesday 15. 12 utc (24h):

Risk of Polar Low (Very low, low, moderate):	Low becoming Very Low
--	-----------------------

Valid from Wednesday December 15. 12 utc until Friday December 17. 12 utc (48h):

Risk of Polar Low (Very low, low, moderate):	Low, Thursday and Friday moderate
--	-----------------------------------



# Predictability

- Favorable synoptic scale conditions (prob. moderate)
  - 7 days
- Model development in the MSLP (prob. high)
  - 24- 36 hrs
- Individual Polar Lows (prob. high)
  - 9-12 hrs
    - Intensification or dissipation ?

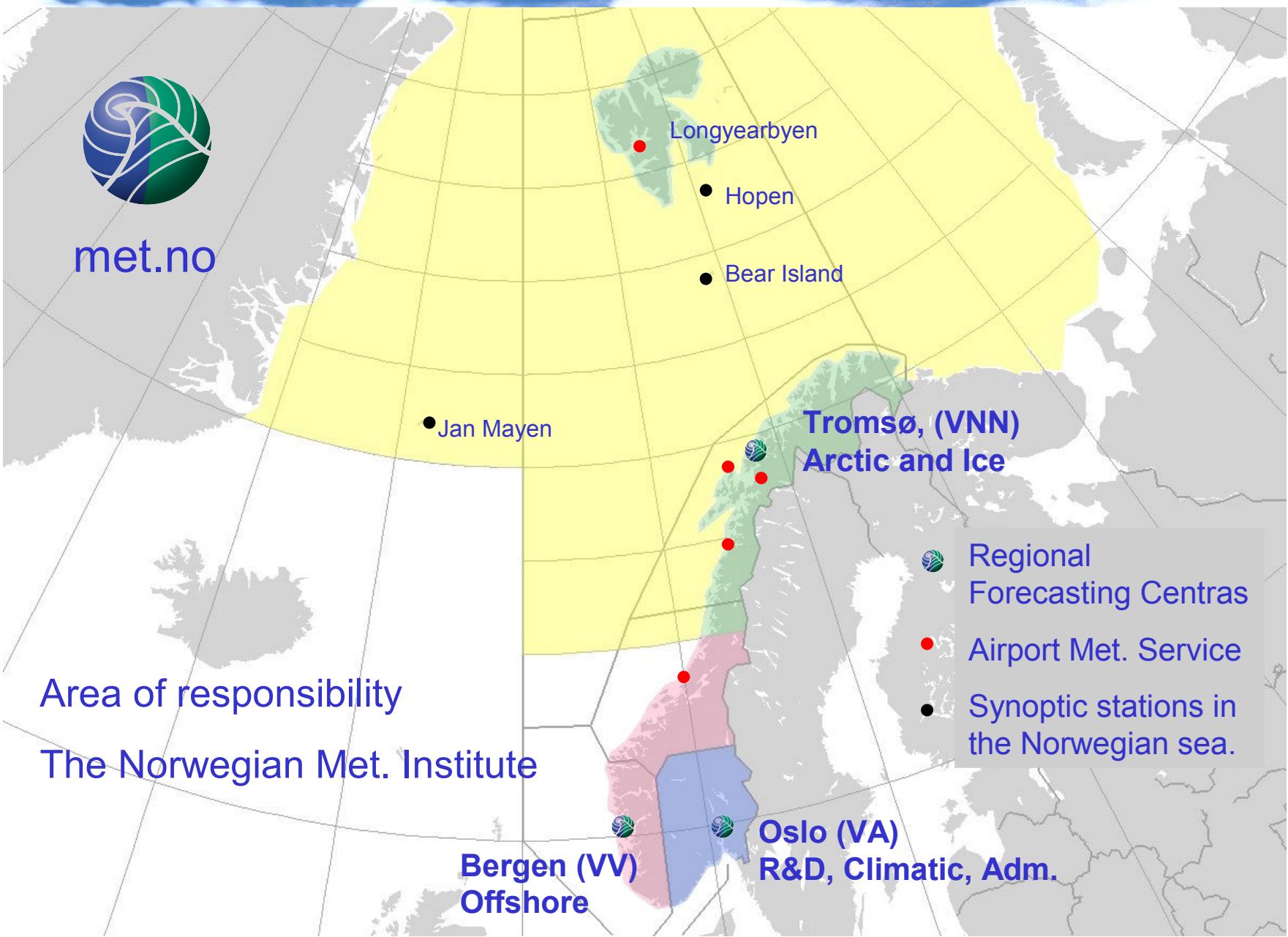


# Summary:

- Polar lows characteristics:
  - Same intensity as ordinary synoptic lows
  - The cold end of the weather spectrum
  - Rapidly changing wind and weather
- The forecasting of polar lows:
  - Usually good out to 9-12 hrs
  - Uncertain beyond 12 hrs, but large scale conditions predictable
  - Specialized forecasts are available

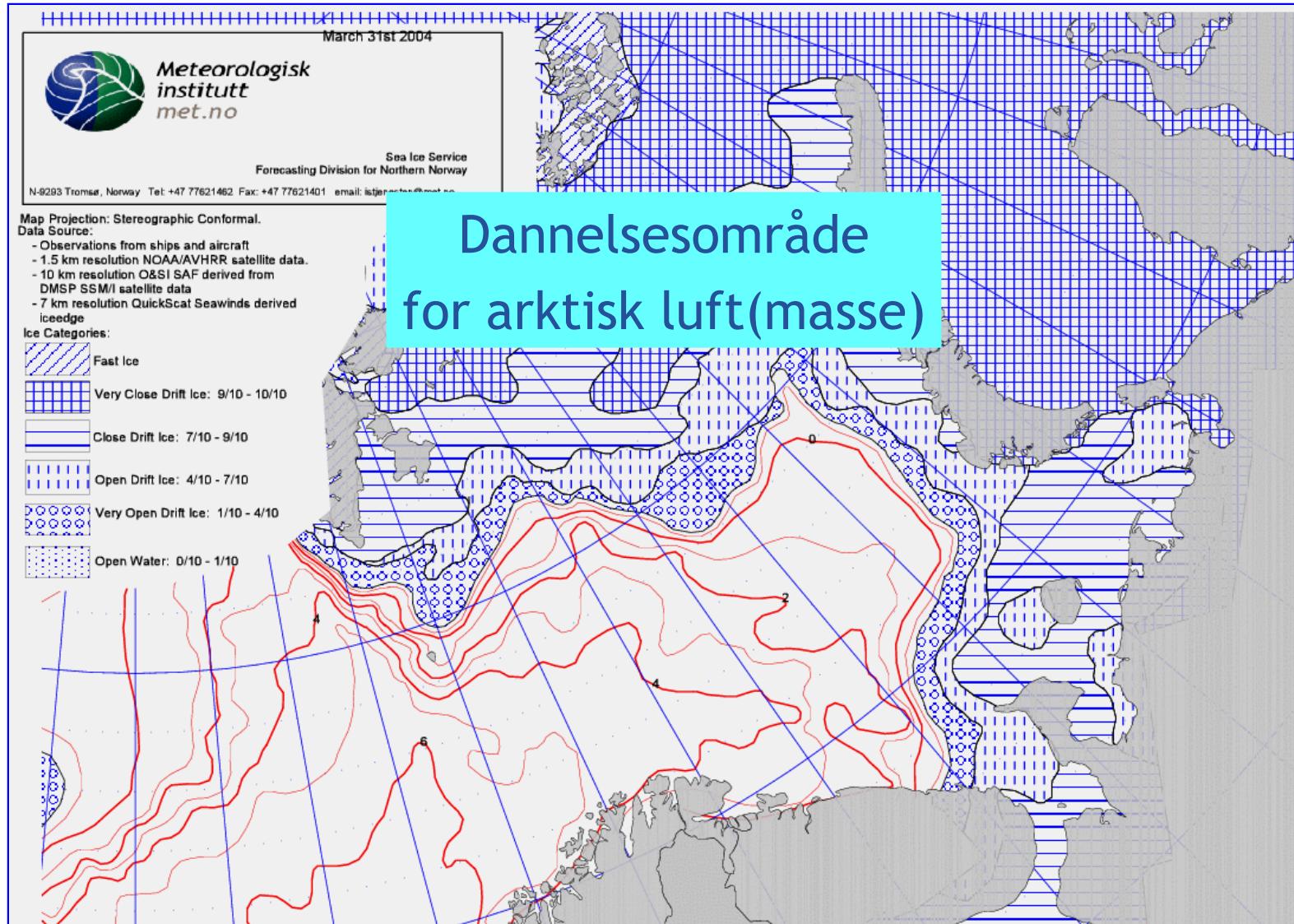


Thanks for your attention 😊!



# BARENTSHAVET

## IS-KART 31. MARS 2004

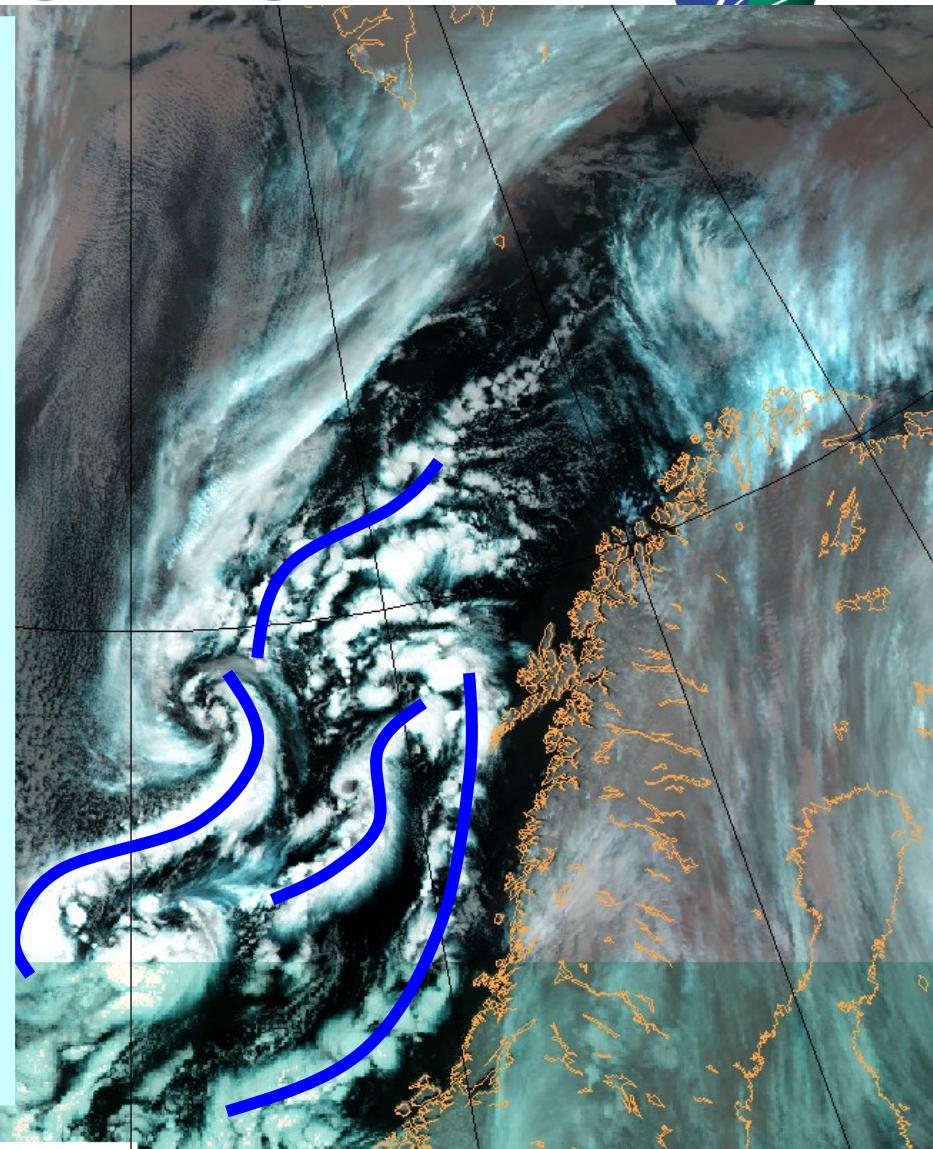


# KALDLUFTSUTBRUDD



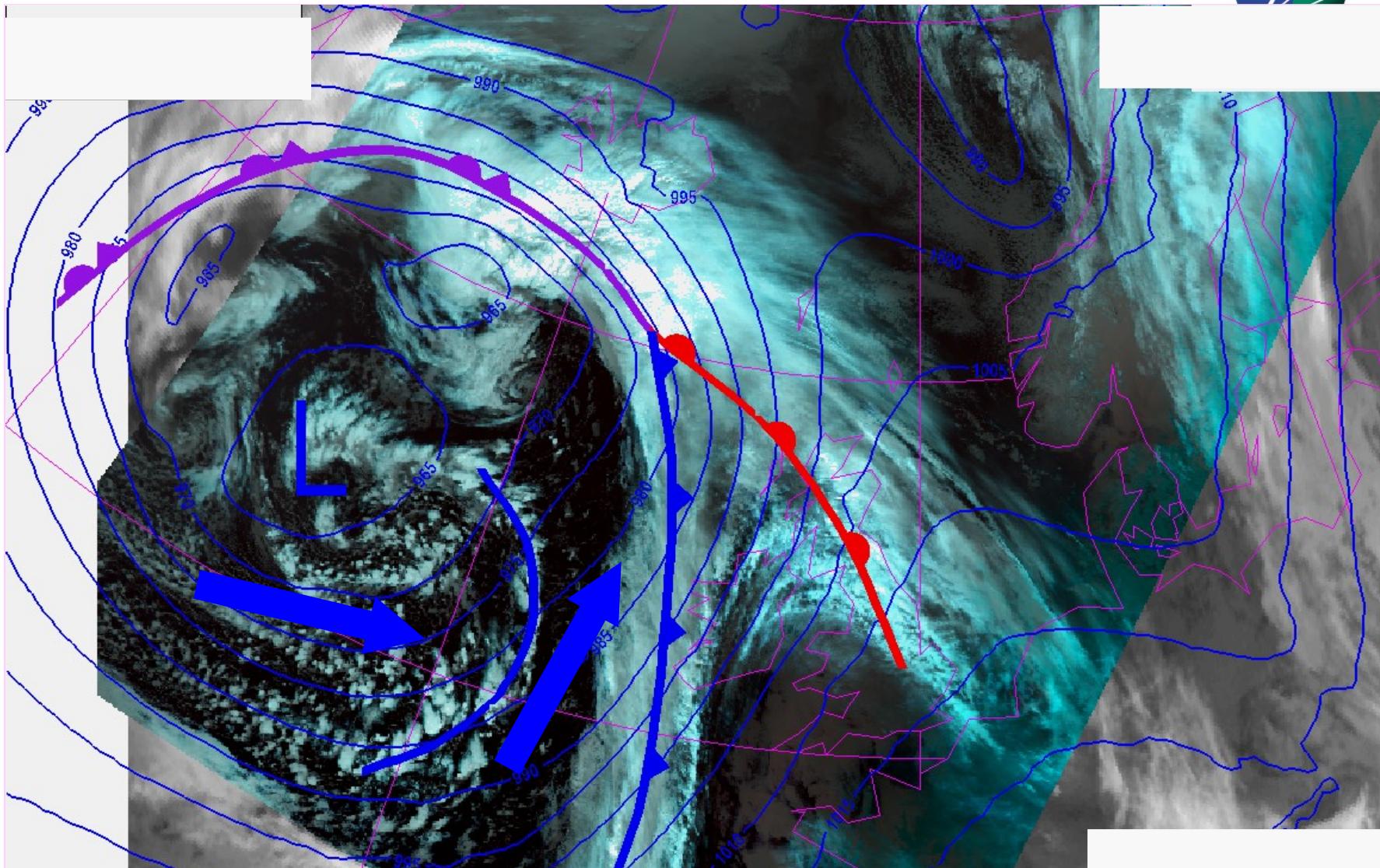
## TRÅG / BYGELINJE

- Dannes over havet i kaldlufta (bak kaldfronten)
- Kraftige bygeskyer på linje:
  - Blåser av gårde med vinden
  - Sterk vind (6B-9B)
  - Kan bevege seg fort (40 knop)
  - Rask vinddreining ved passasje
  - Sterke vindkast
  - Kraftige byger (~100 m sikt)
  - Kan hende med torden
  - Ising på skip
- Kan ligge og "stange" mot kaldlufta over land ved kysten



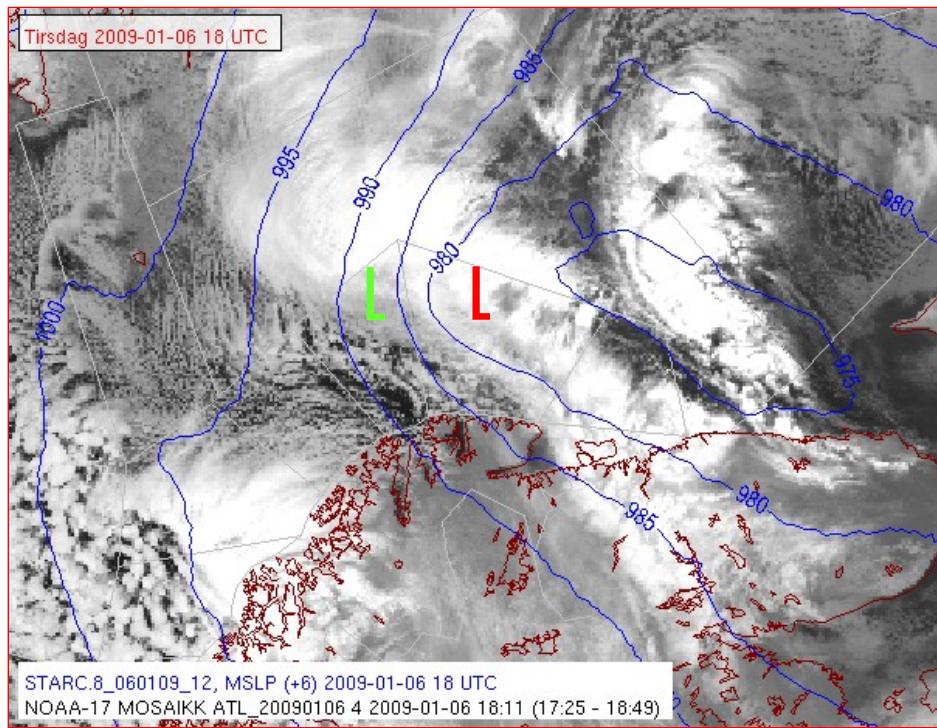
Greit å varsle værtypen, men ikke detaljene!!

# BYGELINJE / TRÅG

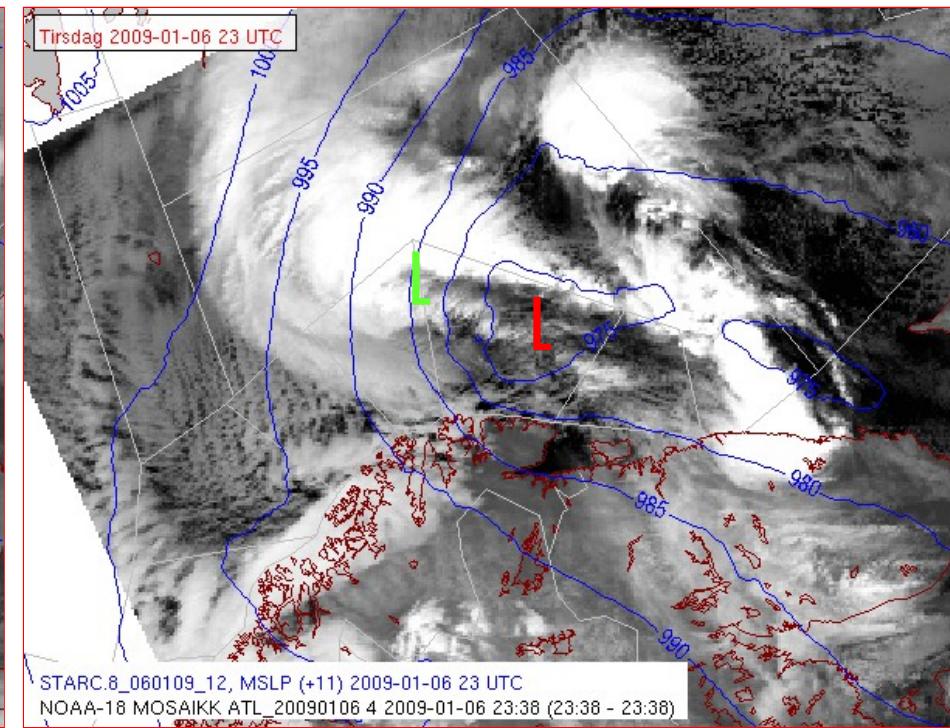


Dannes i kaldlufta bak kaldfronten/okklusjonen!

# A small case: PL 7.1.2009



Actual low



Model low

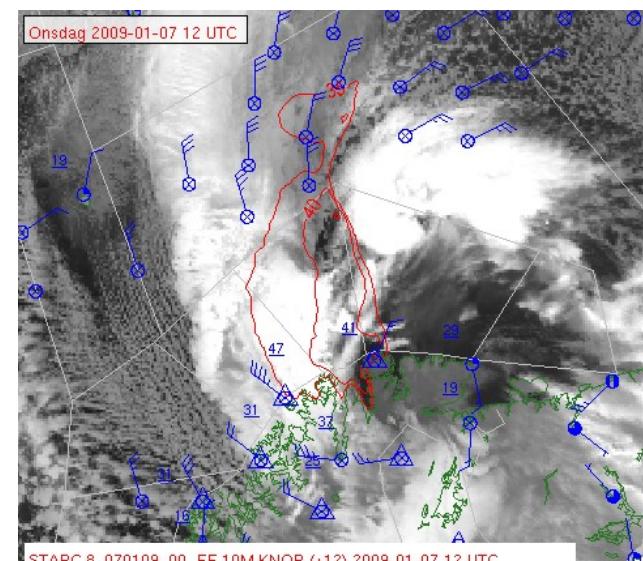
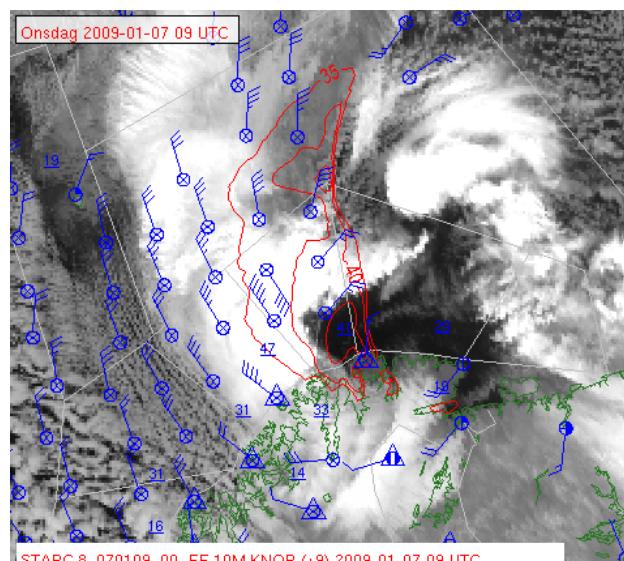
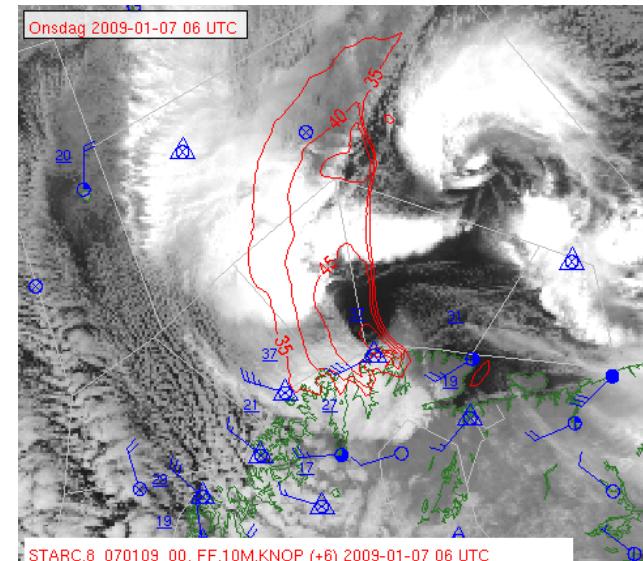
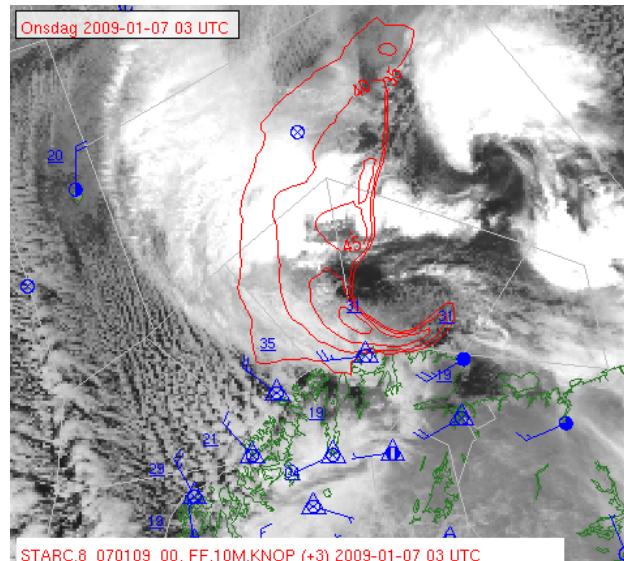
The model has the low slightly too far east. Storm 10B is forecast (on basis of the model) on the Varanger peninsula. Gale force 8 is forecast further west.

# A small case: PL 7.1.2009



The result:

W-N/15-30kt in the  
Varanger,  
N/49kt at Banak,  
further west





# PL 7.1.2009

## Varsel kl. 08 den 7.1.2009:

Kyst- og fjordstrøkene i Vest-Finnmark

Nordvestlig bris, periodevis stiv kuling 15 i kyststrøkene, **sterk kuling 20 nær Nordkapp**. Snøbyger, flest i kyststrøkene. I kveld minking...

Kyst- og fjordstrøkene i Øst-Finnmark

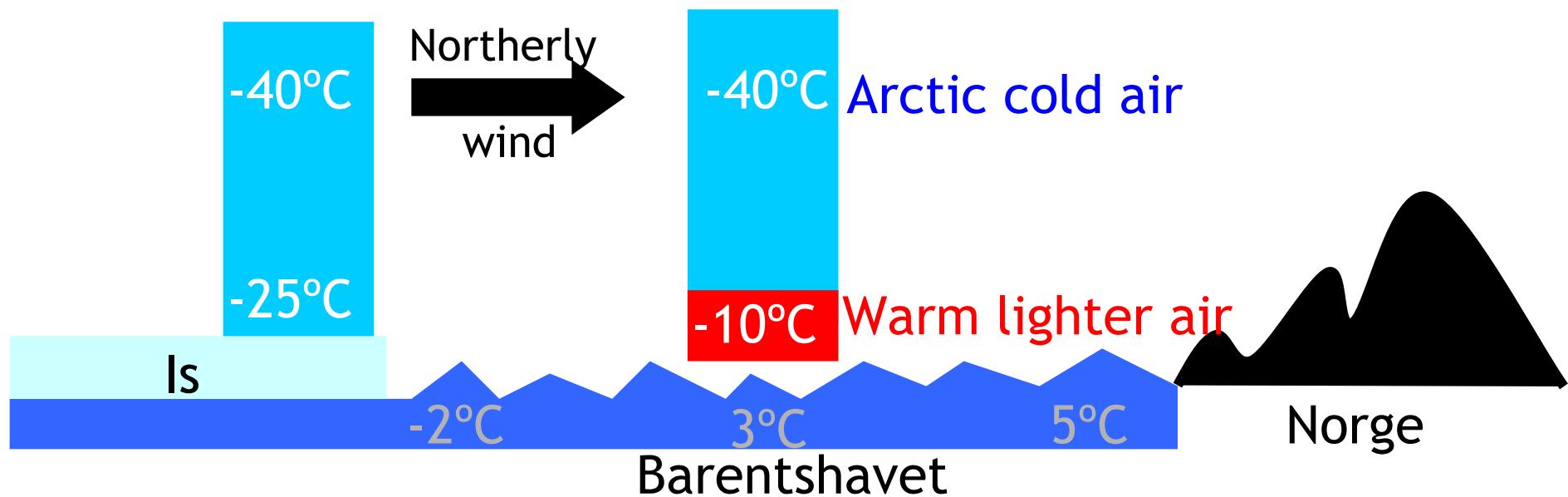
Nordvestlig sterk kuling 20 utsatte steder, til dels **full storm 25 på kysten vest for Berlevåg**. På strekningen Berlevåg - Vardø forbigående minking ...

# Cold air outbreak



~5km

Normal showery weather

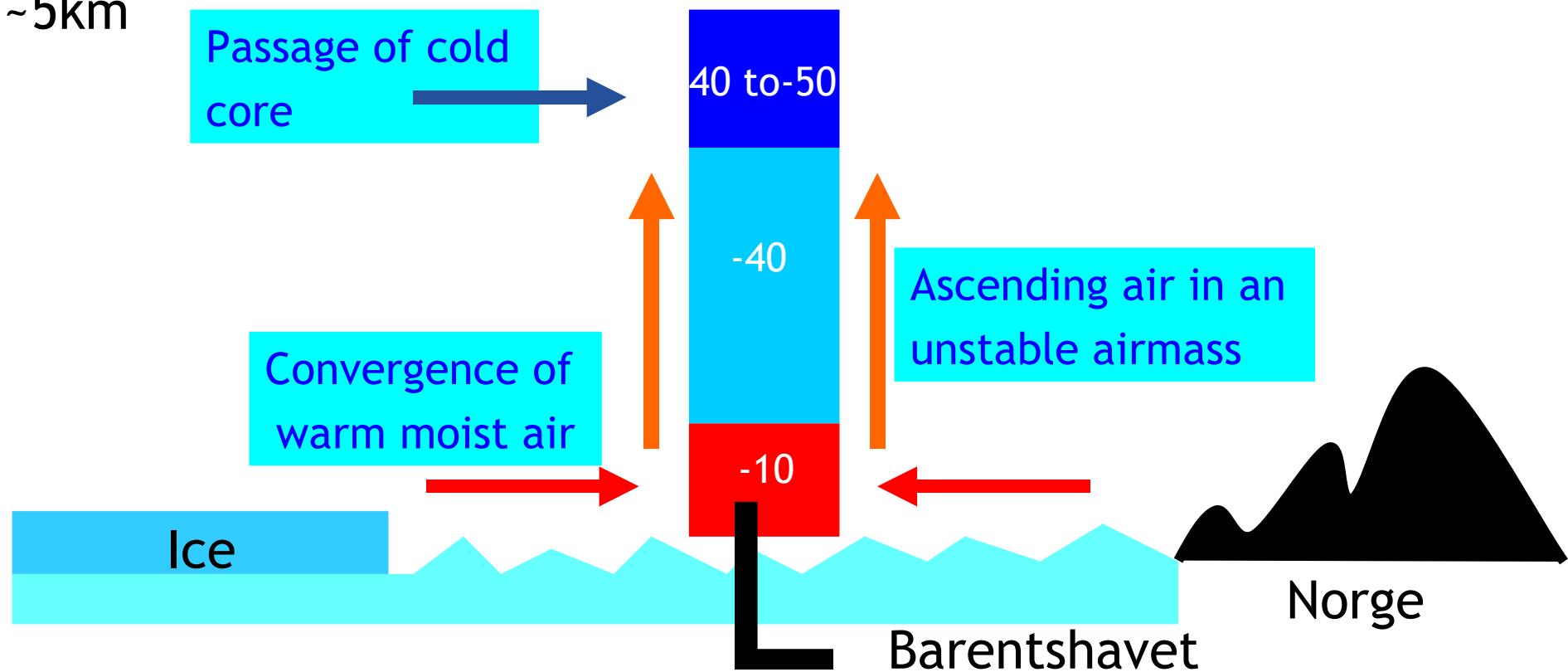


Arctic air blows south over warmer waters and is heated from below. The result is an unstable airmass, with showers, troughs and meso syklones.

# Development of the polar low



~5km



When the column is unstable enough,  
The ascending air is replaced by warm moist air at low levels.  
When the inflow is strong enough, a polar low is born.