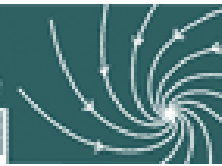




Bjerknes Centre
for Climate Research

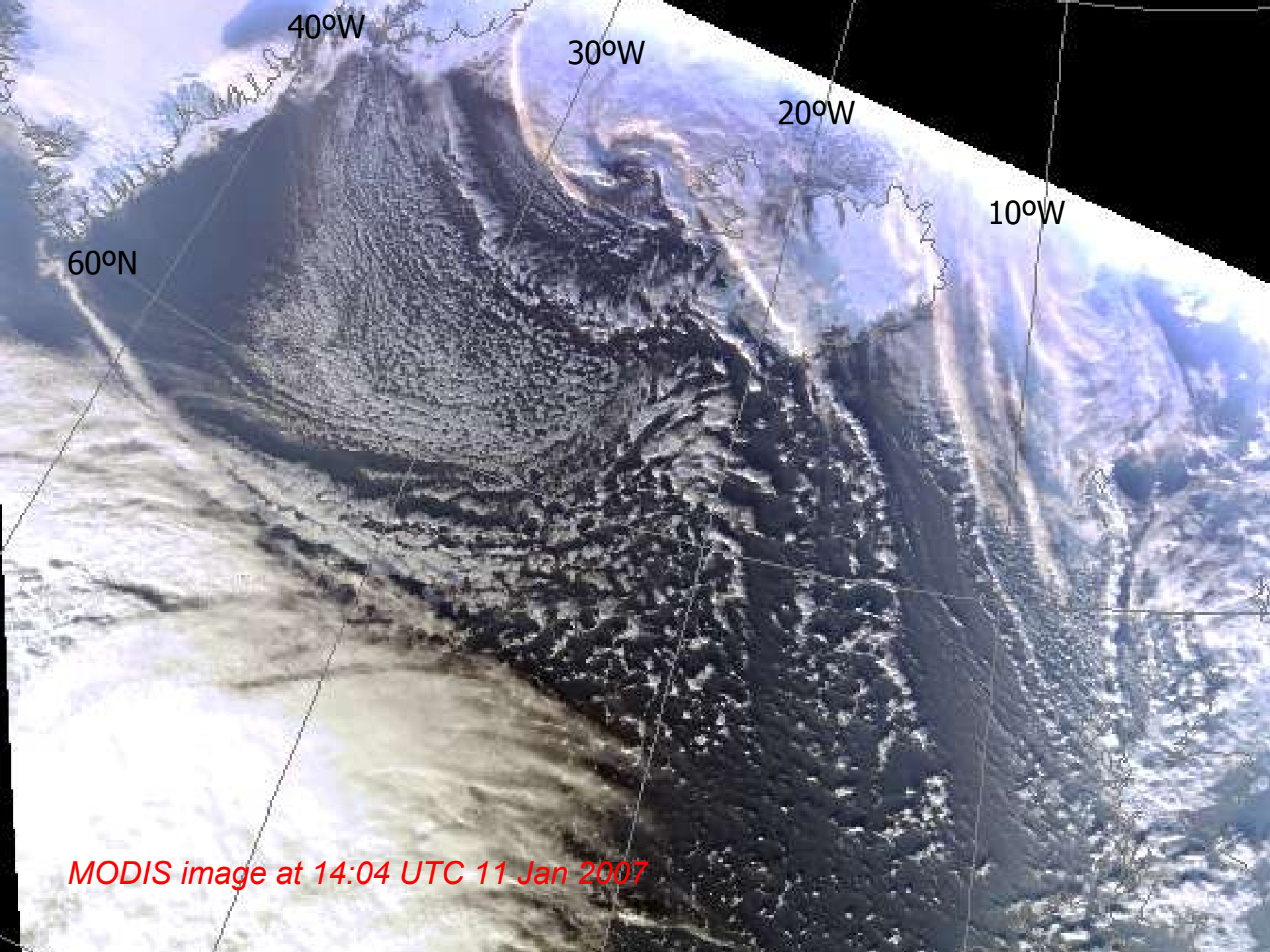


A case study of a Polar Low under the influence of Greenland's orography

Jón Egill Kristjánsson (University of Oslo)

Sigurður Thorsteinsson (Icelandic Met. Inst.)

Erik Kolstad (Bjerknes Centre for Climate Research)



40°W

30°W

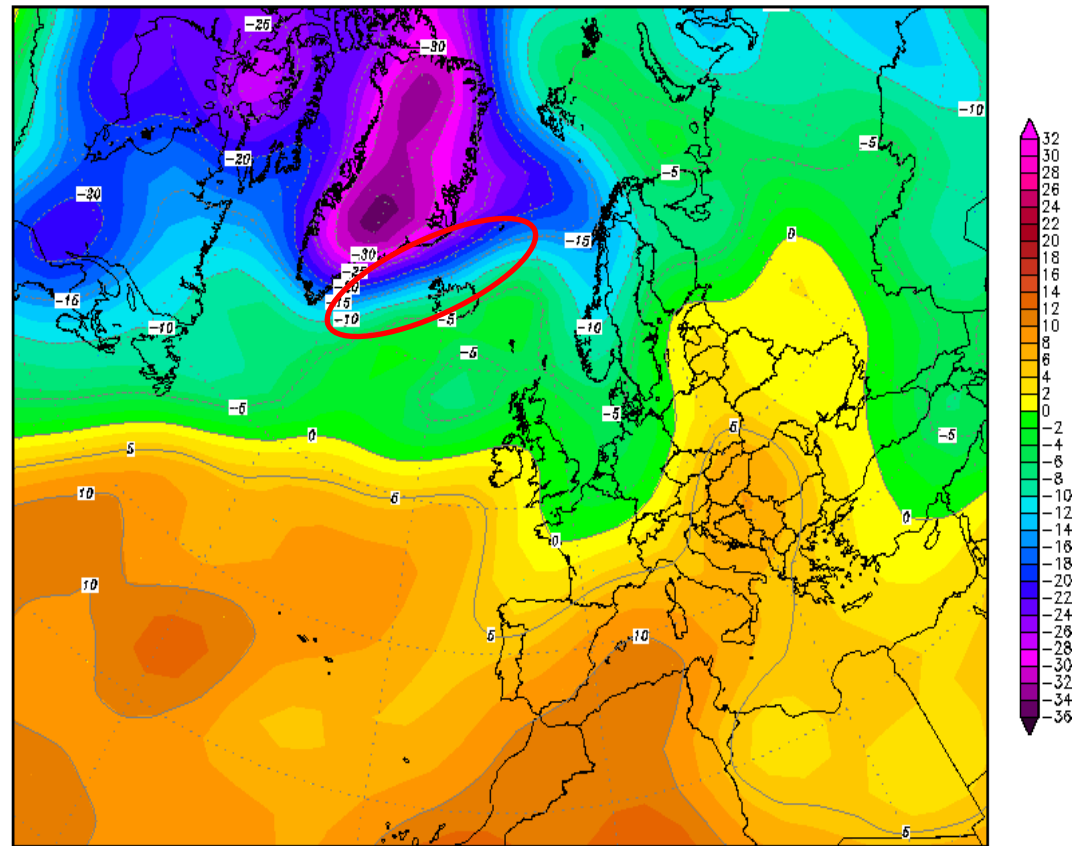
20°W

10°W

60°N

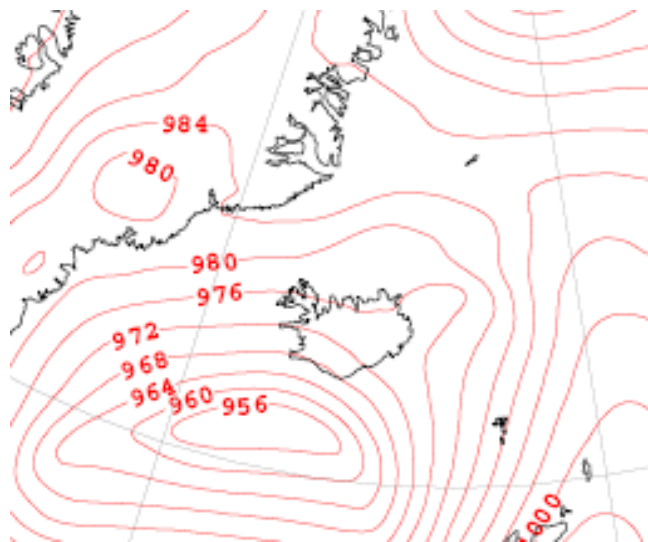
MODIS image at 14:04 UTC 11 Jan 2007

850 hPa Temperature analysis at 00Z 11 Jan 2007 (NCEP)

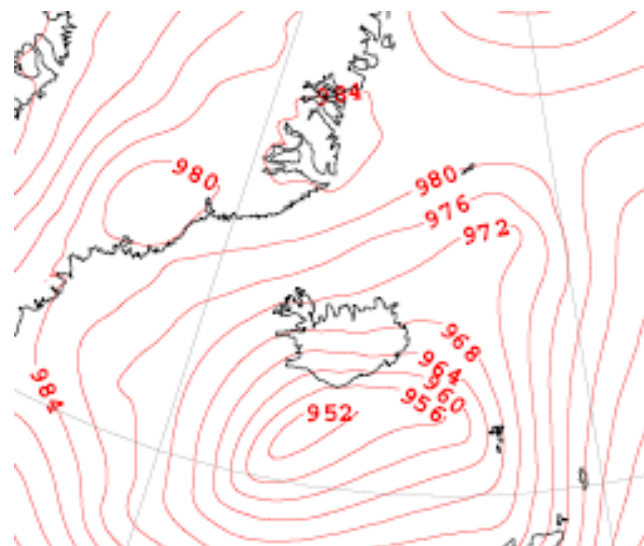


HIRLAM / ECMWF reanalyses

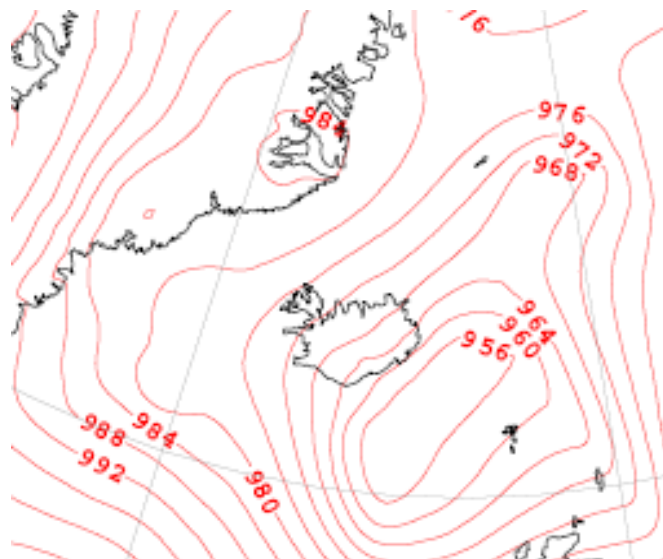
10
Jan
18Z



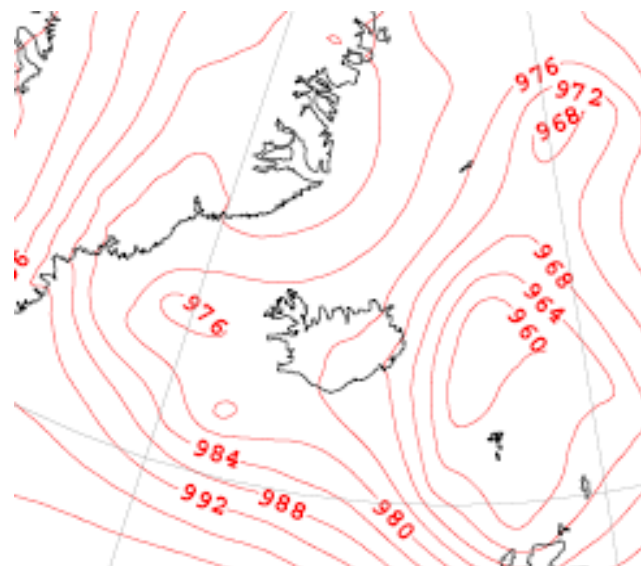
11
Jan
00Z



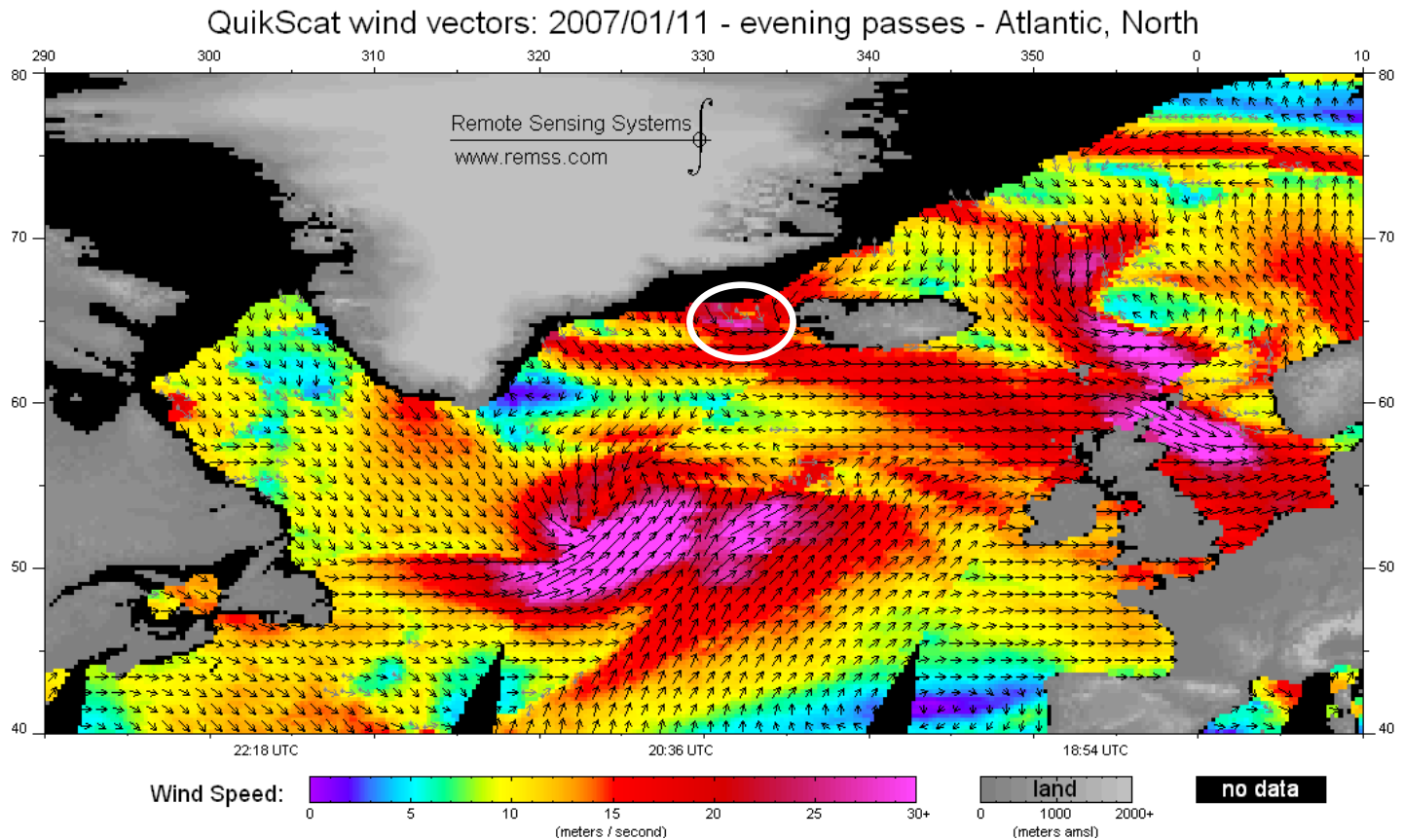
11
Jan
06Z



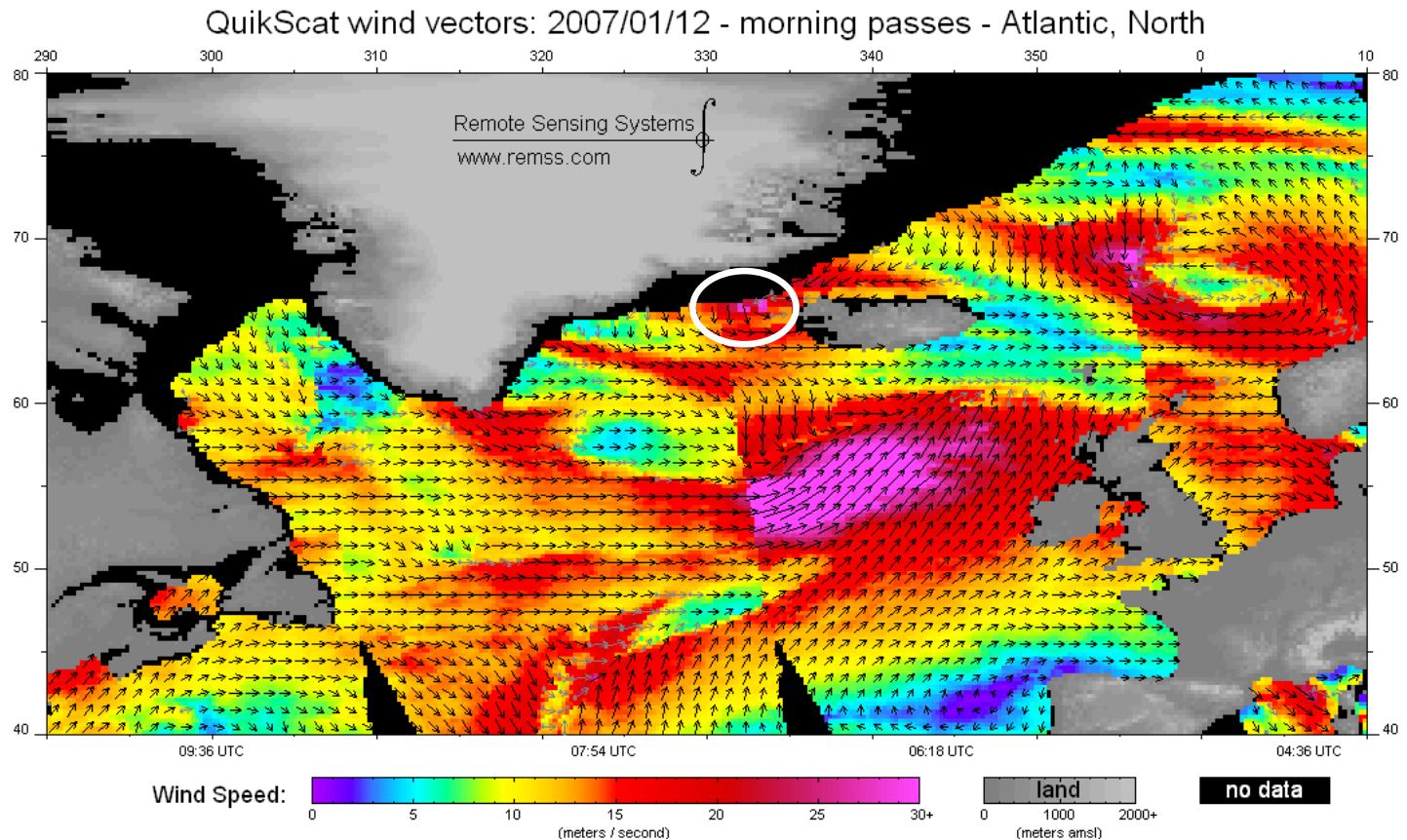
11
Jan
12Z



Surface winds on 11 Jan 2007

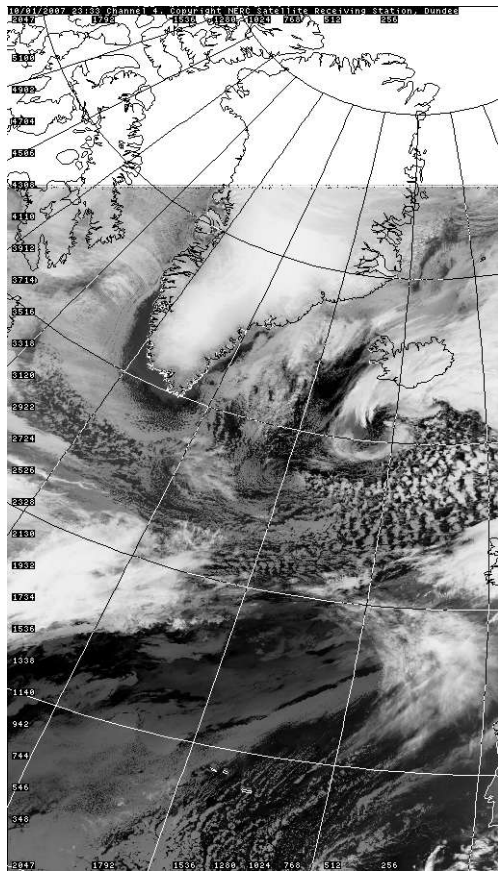


Surface winds on 12 Jan 2007

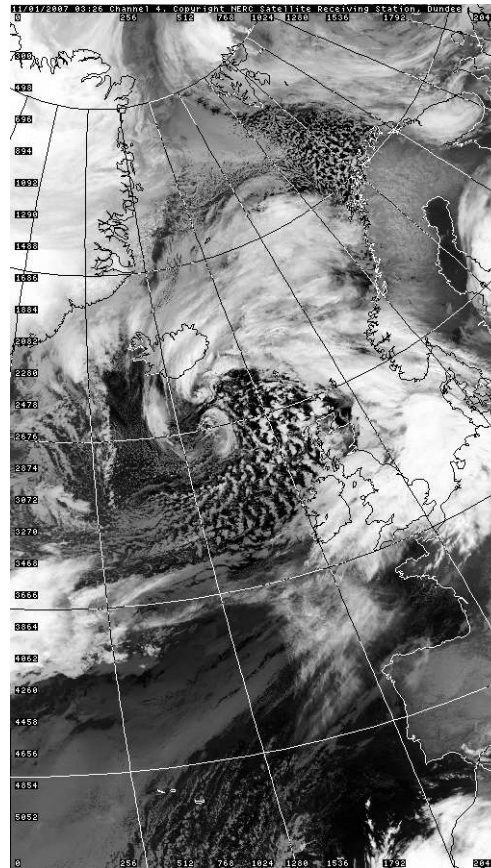


Initiation of polar low

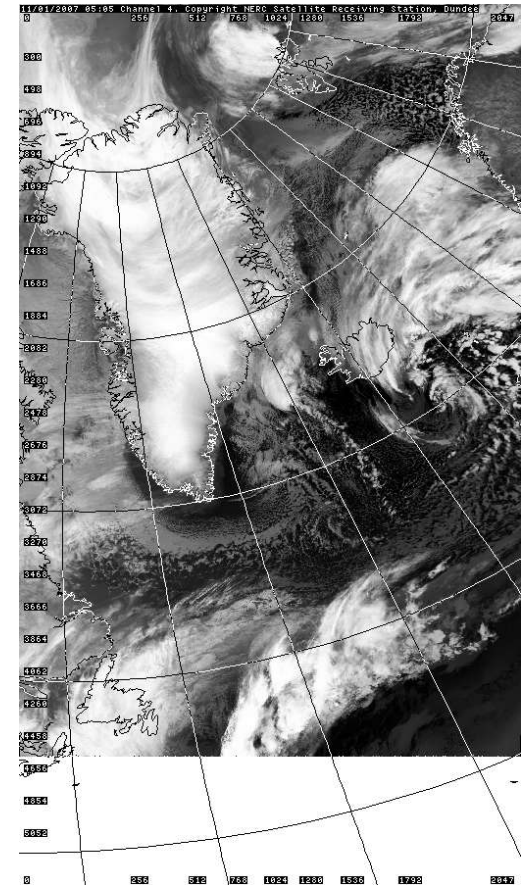
23:33 UTC 10 Jan 07



03:26 UTC 11 Jan 07



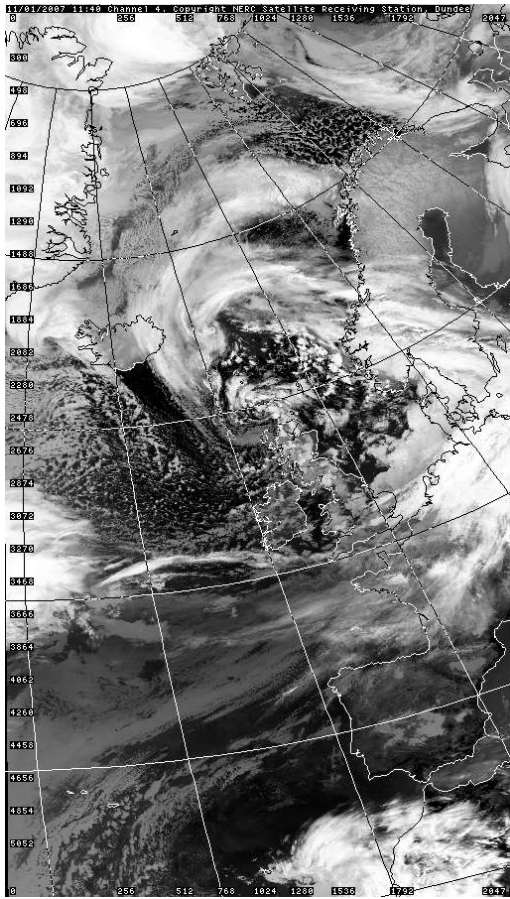
05:05 UTC 11 Jan 07



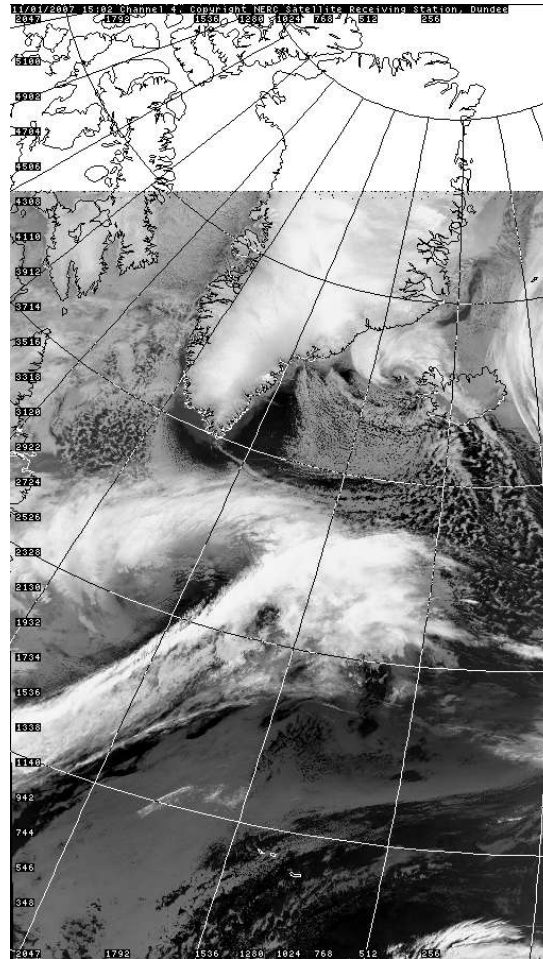
AVHRR IR images (Channel 4)

Intensification of polar low

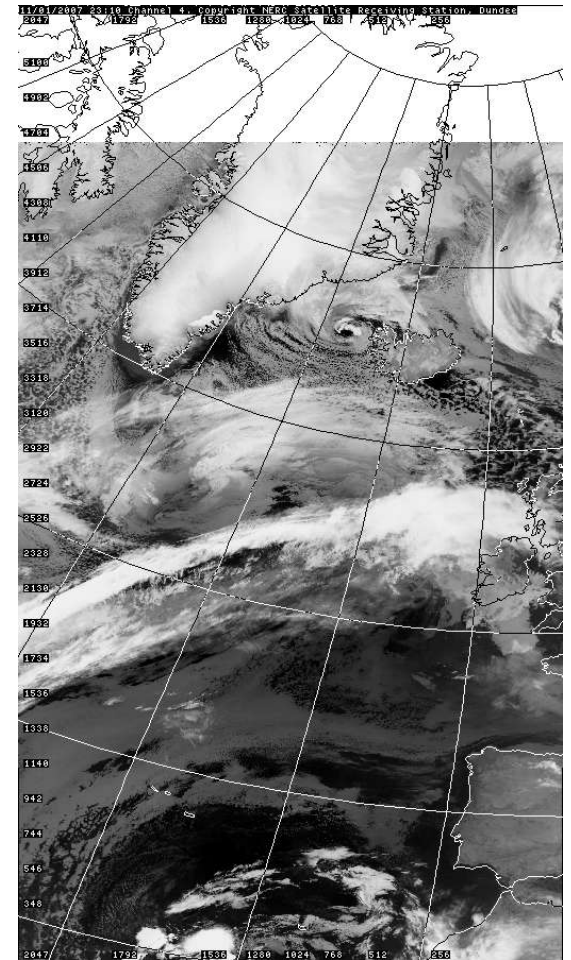
11:40 UTC 11 Jan 07



15:02 UTC 11 Jan 07



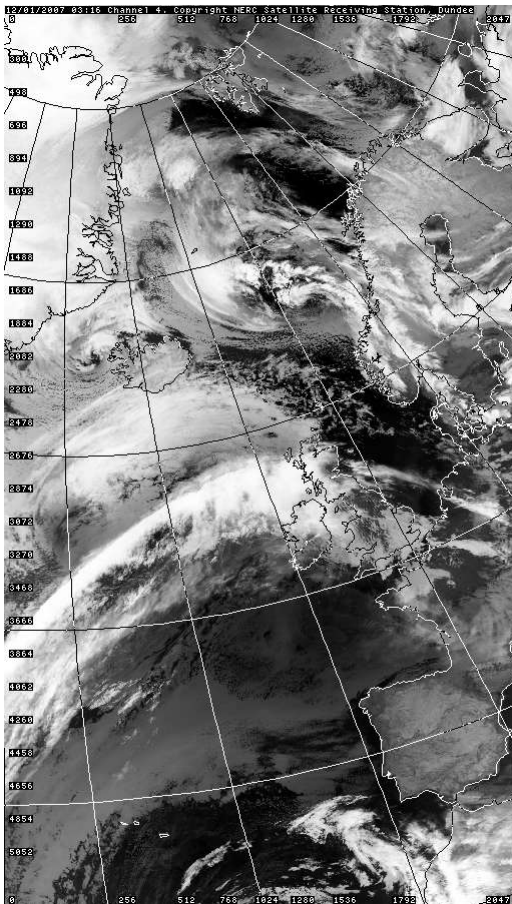
23:10 UTC 11 Jan 07



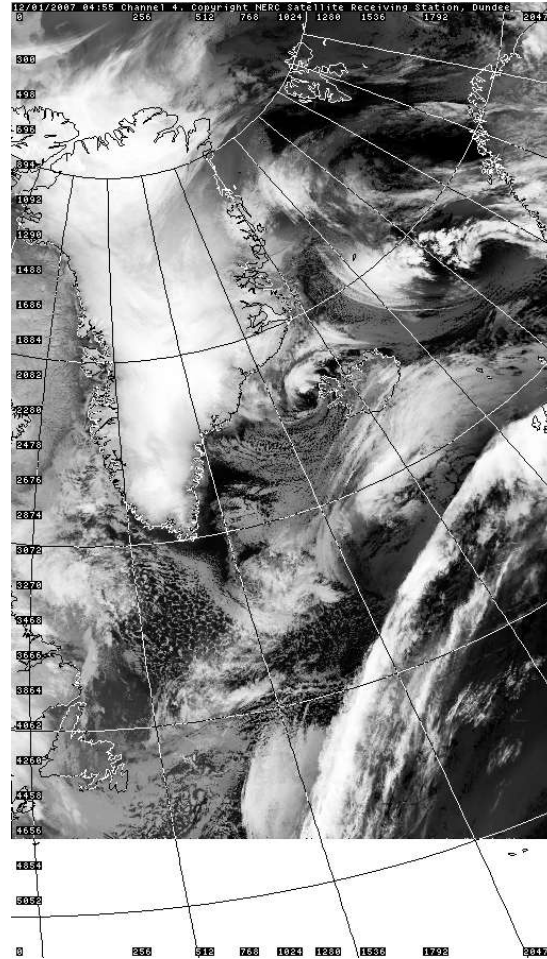
AVHRR IR images (Channel 4)

Mature polar low

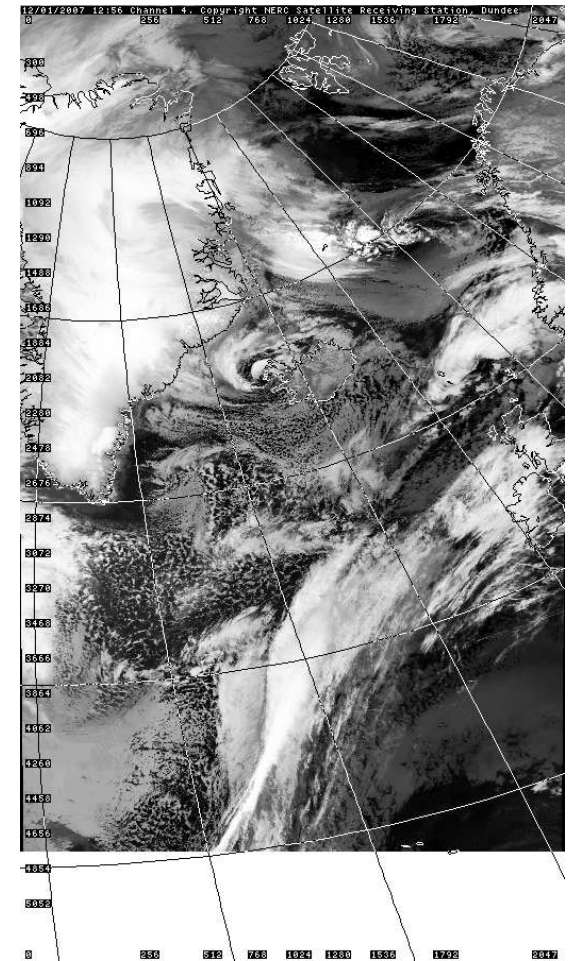
03:16 UTC 12 Jan 07



04:55 UTC 12 Jan 07



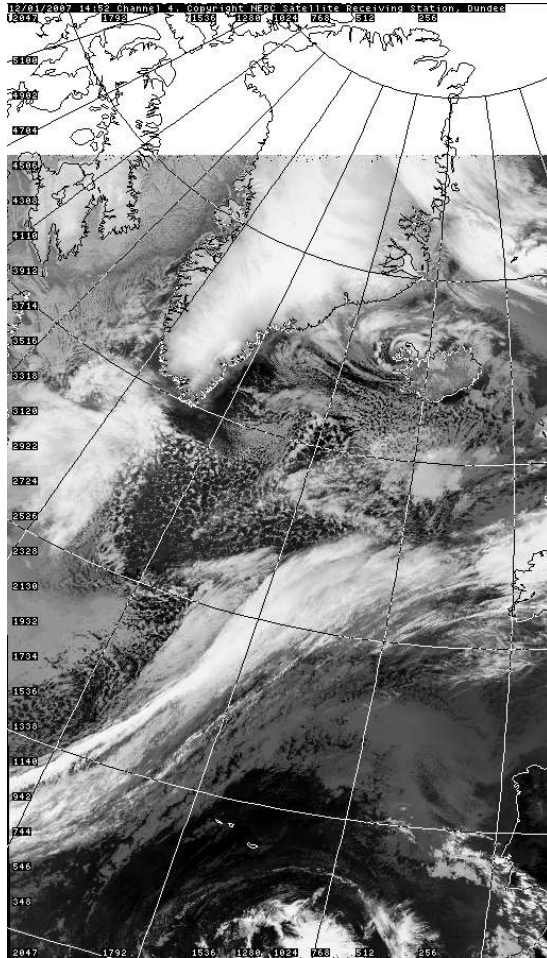
12:56 UTC 12 Jan 07



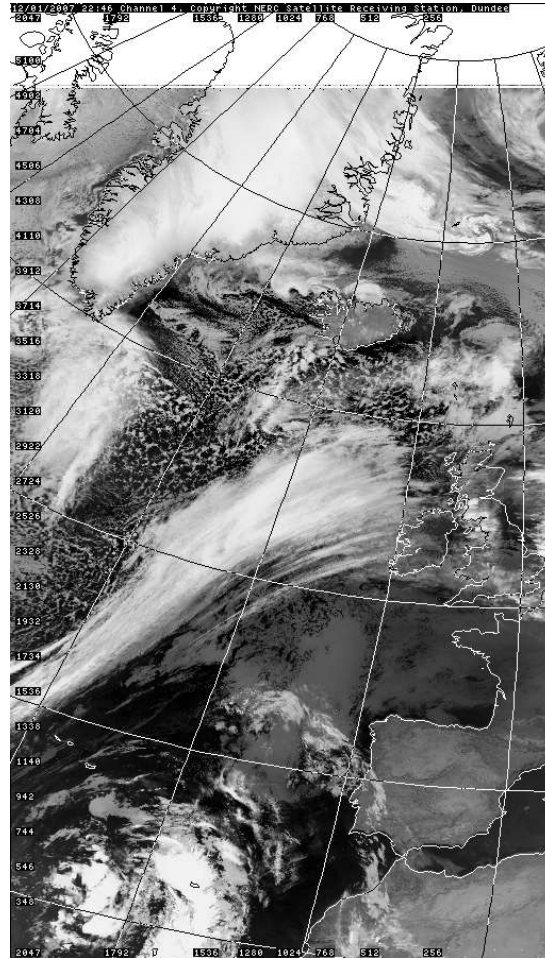
AVHRR IR images (Channel 4)

The polar low weakens

14:52 UTC 12 Jan 07



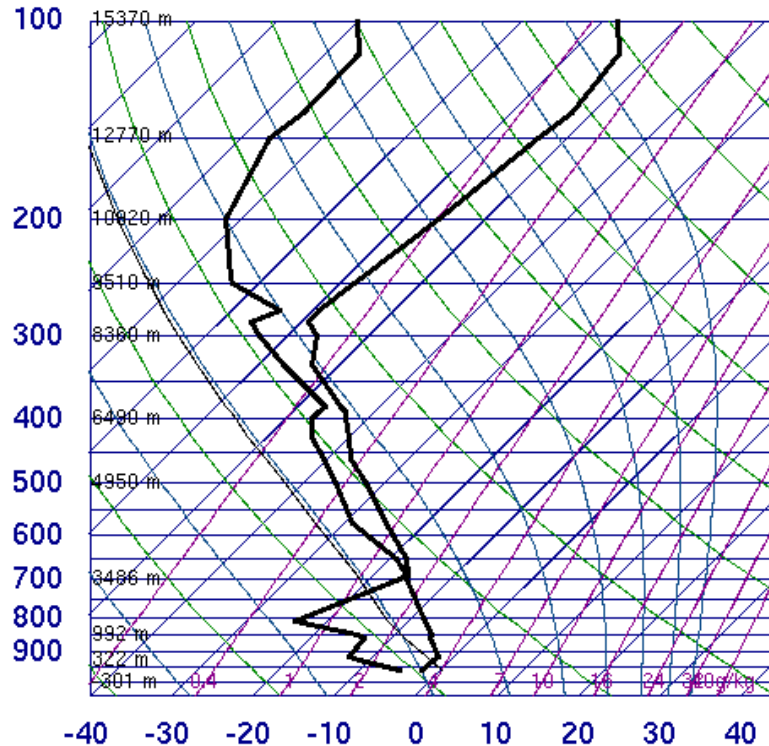
22:46 UTC 12 Jan 07



AVHRR IR images (Channel 4)

Soundings from Keflavík, SW Iceland (04018) – 11 Jan 00Z

04018 BIKF Keflavikurflugvollur



SLAT	63.97
SLON	-22.60
SELV	54.00
SHOW	7.88
LIFT	9.98
LFTV	10.00
SWET	58.99
KINX	11.50
CTOT	17.80
VTOT	26.80
TOTL	44.60
CAPE	0.00
CAPV	0.00
CINS	0.00
CINV	0.00
EQLV	-9999
EQTV	-9999
LFCT	-9999
LFCV	-9999
BRCH	0.00
BRCV	0.00
LCLT	261.3
LCLP	820.8
MLTH	276.5
MLMR	1.94
THCK	5251.
PWAT	5.77

00Z 11 Jan 2007

University of Wyoming

Soundings from Keflavík, SW Iceland (04018) – 11 Jan 12Z

04018 BIKF Keflavikurflugvollur

100

200

300

400

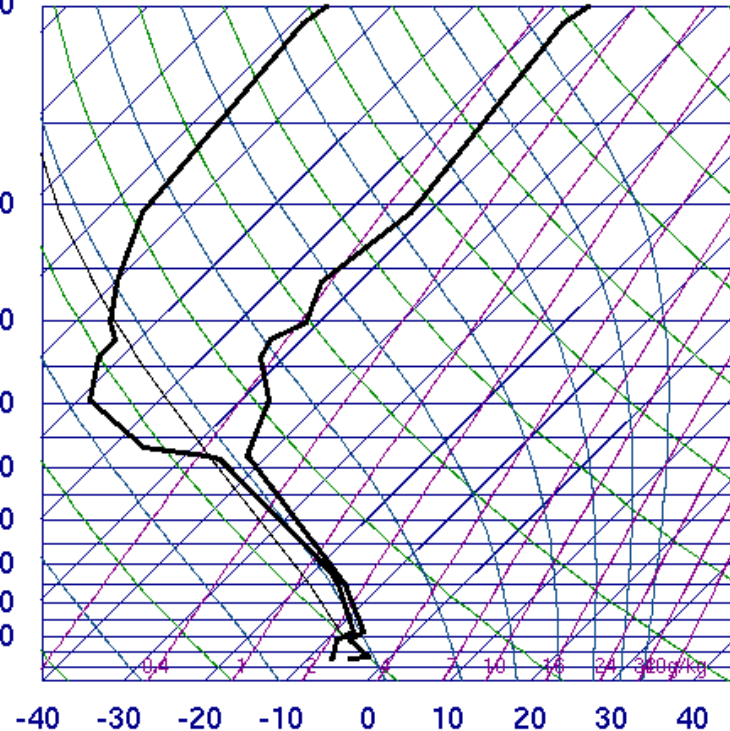
500

600

700

800

900



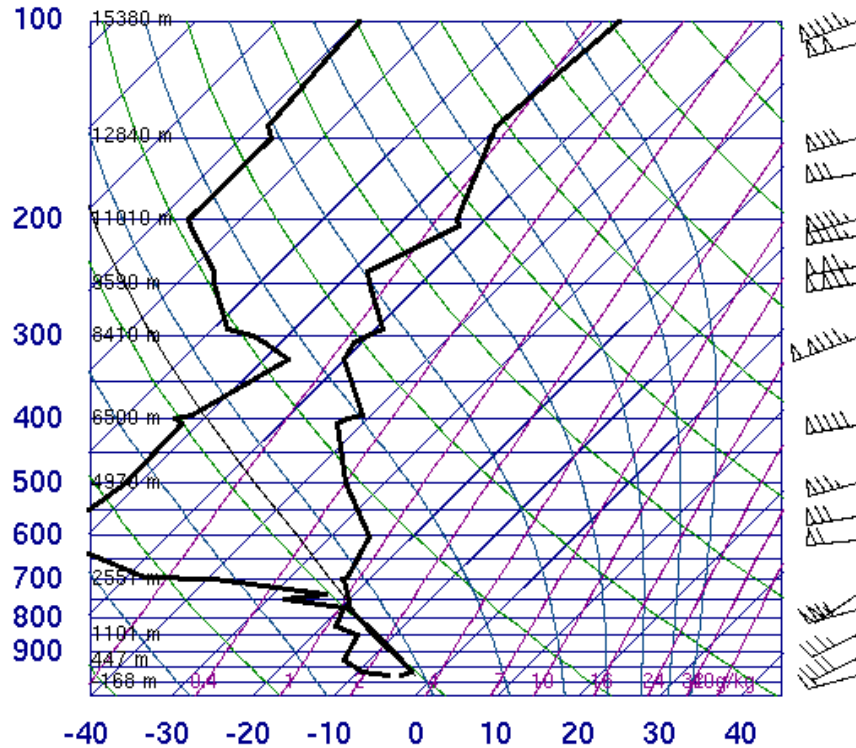
SLAT	63.97
SLOE	-22.60
SELV	54.00
SHOW	1.40
LIFT	4.64
LFTV	4.64
SWET	323.3
KINX	20.87
CTOT	30.20
VTOT	31.23
TOTL	61.44
CAPE	0.00
CAPV	0.00
CINS	0.00
CINV	0.00
EQLV	-9999
EQTV	-9999
LFCT	-9999
LFCV	-9999
BRCH	0.00
BRCV	0.00
LCLT	264.6
LCLP	897.7
MLTH	272.9
MLMR	2.25
THCK	-9999
PWAT	6.64

12Z 11 Jan 2007

University of Wyoming

Soundings from Keflavík, SW Iceland (04018) – 12 Jan 00Z

04018 BIKF Keflavikurflugvollur



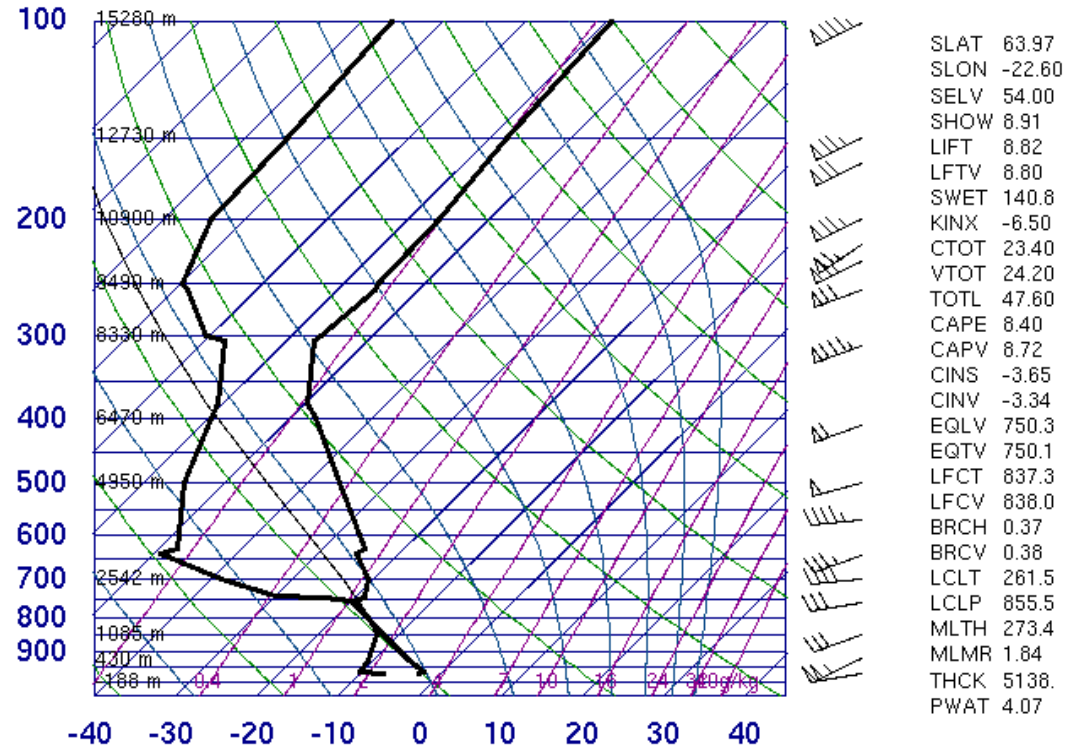
SLAT	63.97
SLON	-22.60
SELV	54.00
SHOW	11.18
LIFT	11.23
LFTV	11.21
SWET	194.7
KINX	-8.20
CTOT	20.10
VTOT	22.40
TOTL	42.50
CAPE	4.13
CAPV	4.67
CINS	-17.1
CINV	-15.6
EQLV	759.6
EQTV	758.5
LFCT	804.4
LFCV	806.7
BRCH	0.07
BRCV	0.08
LCLT	260.8
LCLP	855.8
MLTH	272.5
MLMR	1.74
THCK	5138.
PWAT	3.52

00Z 12 Jan 2007

University of Wyoming

Soundings from Keflavík, SW Iceland (04018) – 12 Jan 12Z

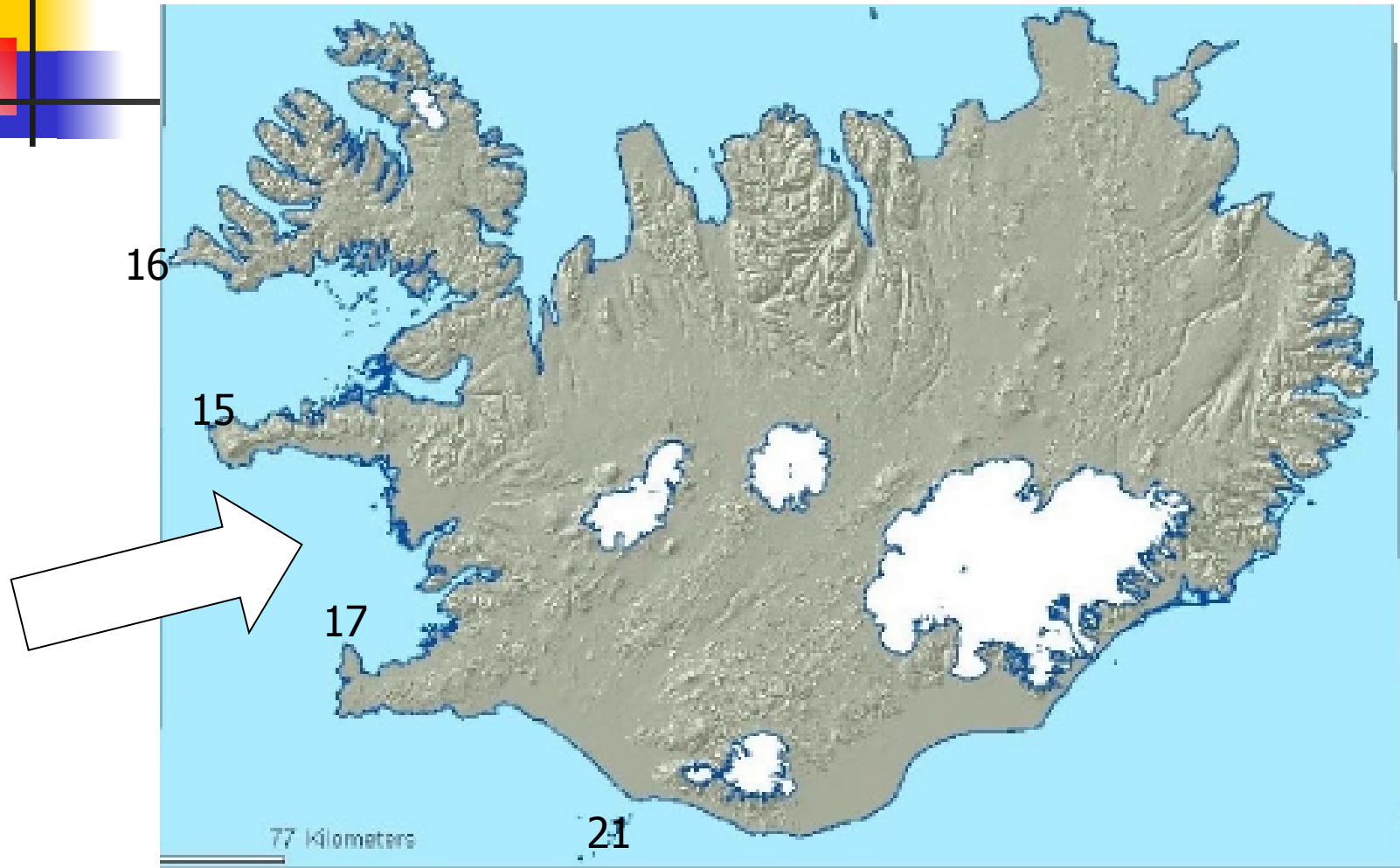
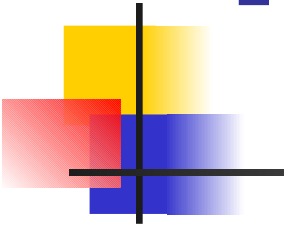
04018 BIKF Keflavikurflugvollur



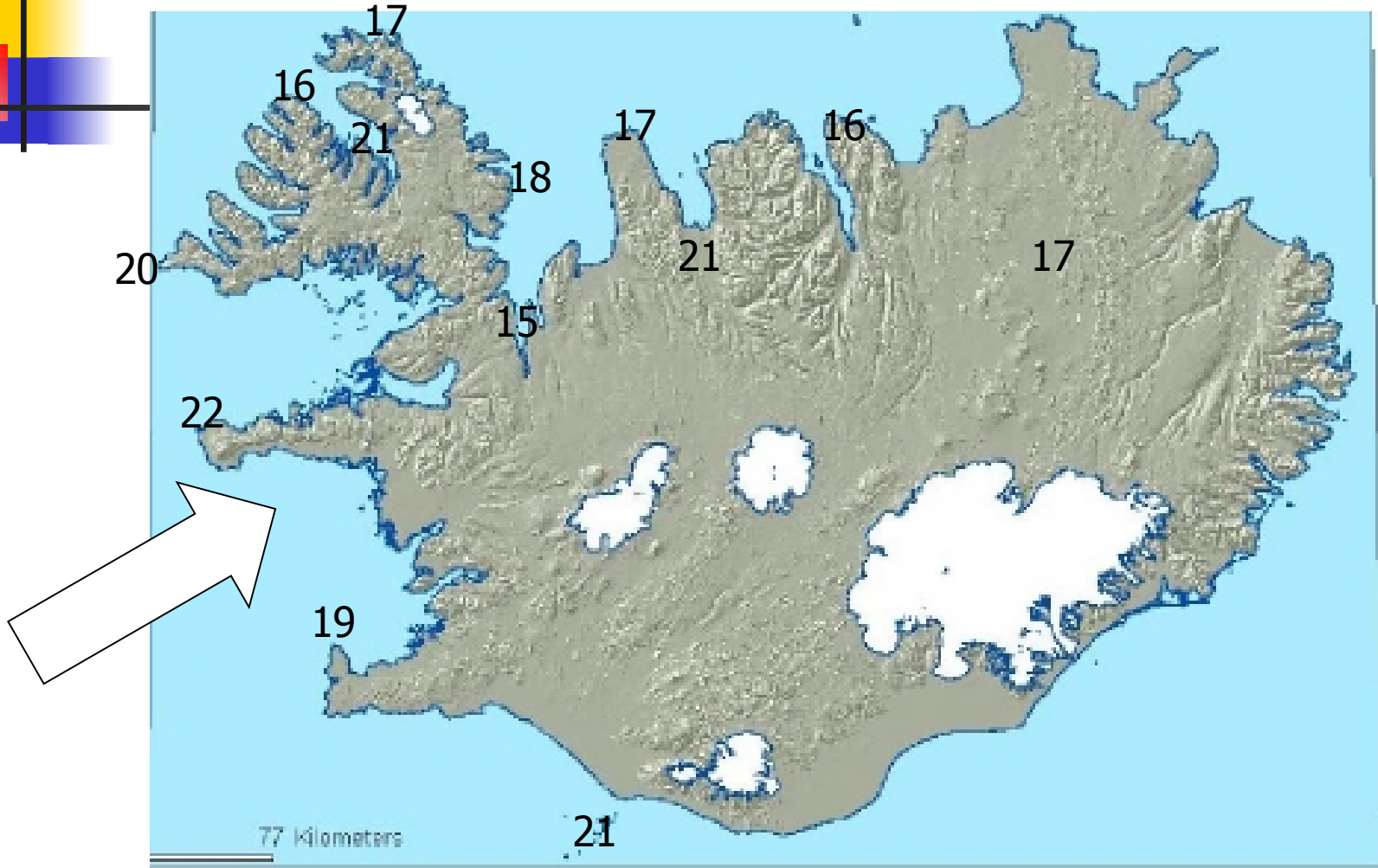
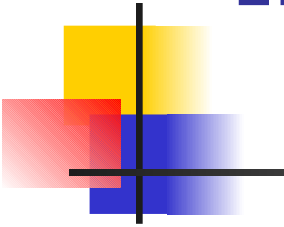
12Z 12 Jan 2007

University of Wyoming

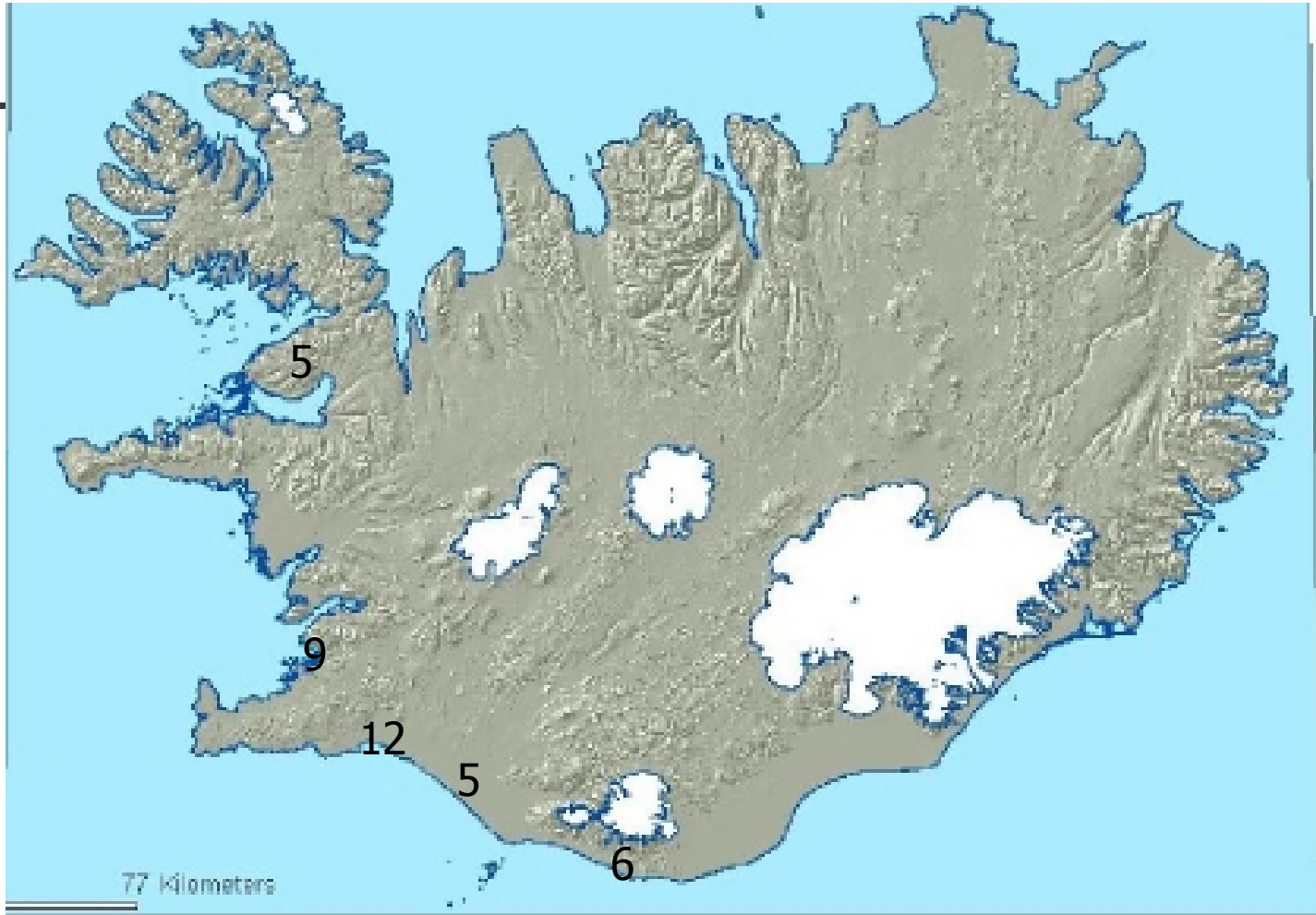
Observed maximum 10-min mean winds 11 Jan 2007 (m s^{-1})



Observed maximum 10-min mean winds 12 Jan 2007 (m s^{-1})



Observed 24 h Acc. Precip. 11-12 Jan (mm)

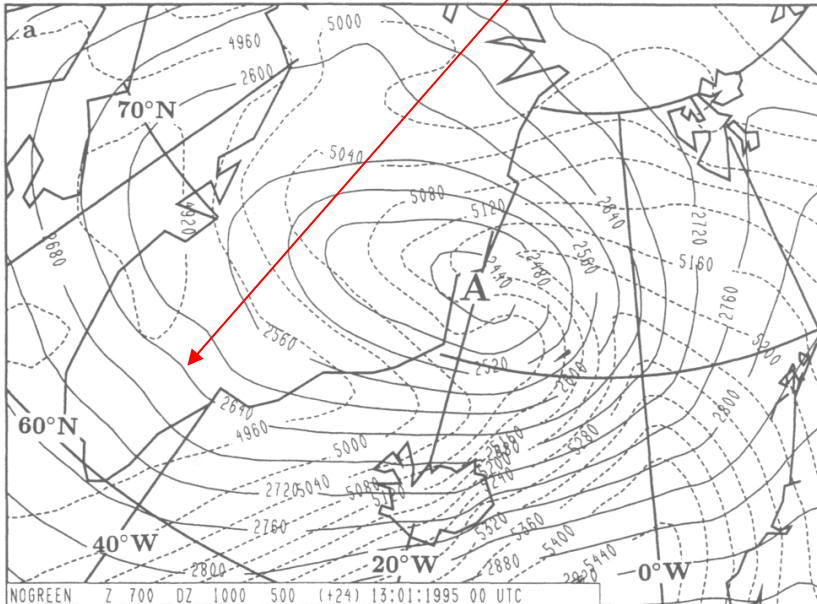




Previous studies on the influence of Greenland's orography

Case study January 1995: Diversion of cold air flow

NOGREEN



DOUBLE

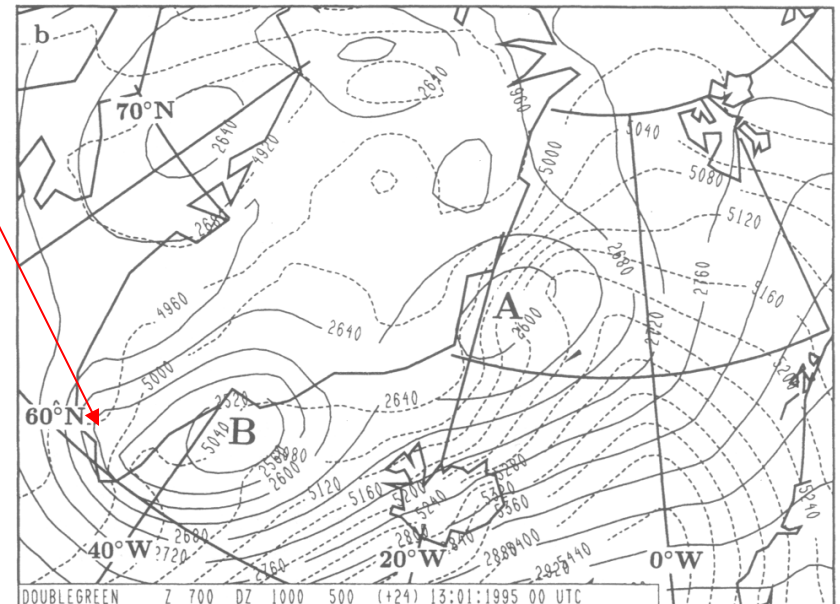


Figure 8. Simulated 700 hPa geopotential height (m) and 500–1000 hPa thickness (m) at 00 UTC 13 January 1995 (+24 h): (a) NOGREEN; (b) DOUBLEGREEN.

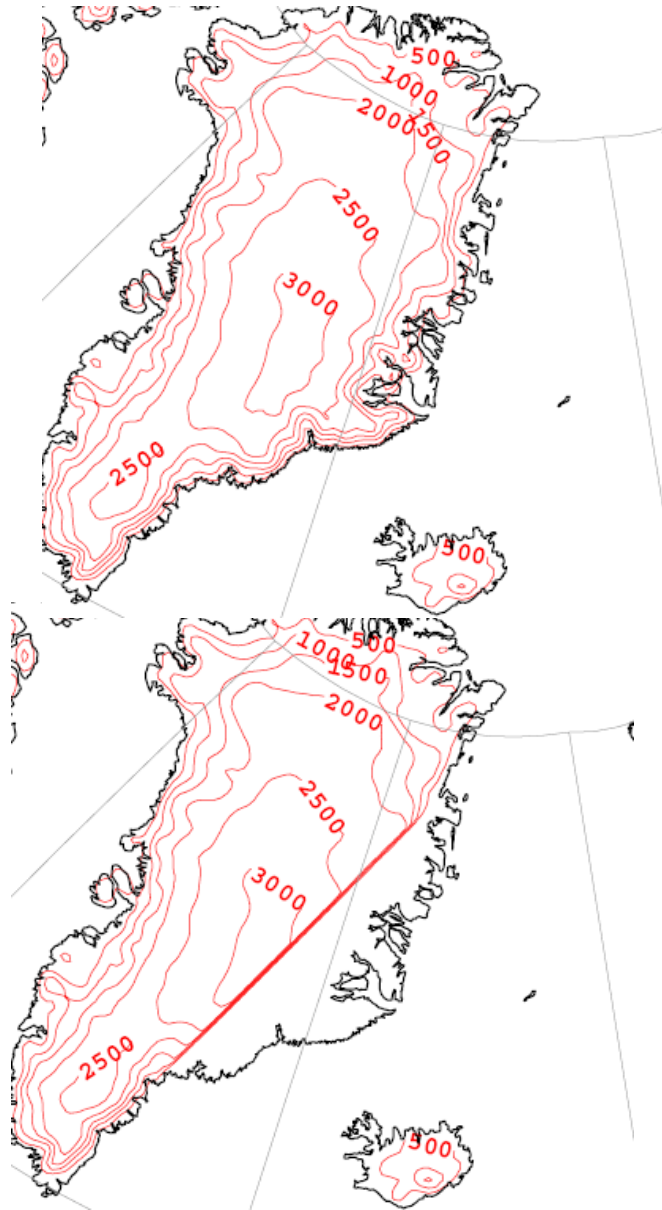


Model Simulations

Experimental Setup (HIRLAM)

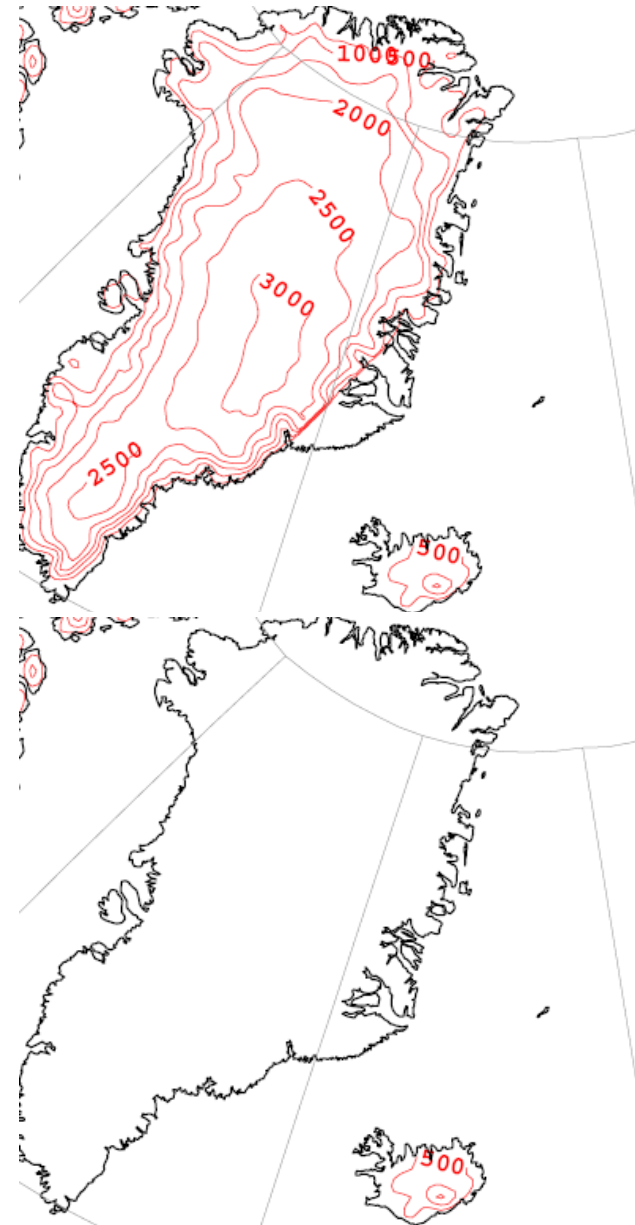
C
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Numerical Experiments

- **CONTROL**: Standard HIRLAM configuration
- **NOGUNN**: Mt. Gunnbjørn (3700 m) in E-Greenland removed
- **NOEAST**: All mountains in E-Greenland removed
- **NOGREEN**: Greenland's orography completely removed
- Length of simulations: 48 h, starting at 12 UTC 10 January 2007

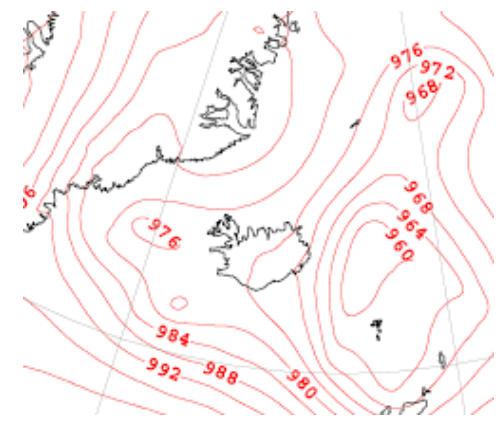


Model

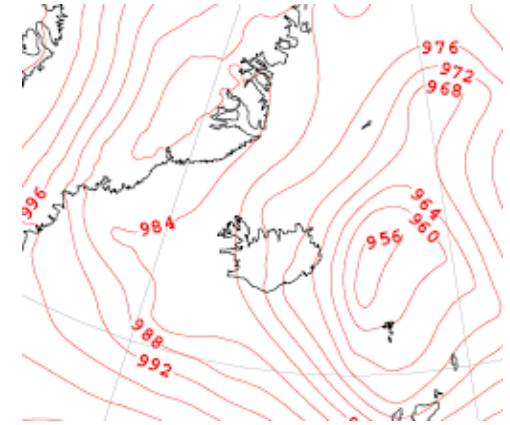
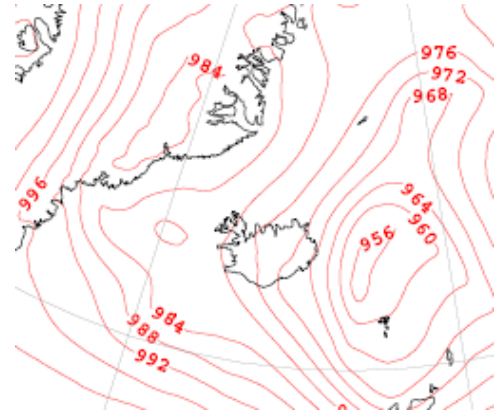
- The HIRLAM model is used
- Horizontal grid spacing: 22 km + additional runs at 11 km grid spacing
- Number of vertical levels: 40
- Physical parameterizations: CBR turbulence scheme; Kain-Fritsch convection scheme; Rasch-Kristjánsson cloud water scheme; ISBA surface scheme, no gravity-wave drag scheme

MSLP at 12 Z 11 Jan 07 (+24 h)

A
N
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Y
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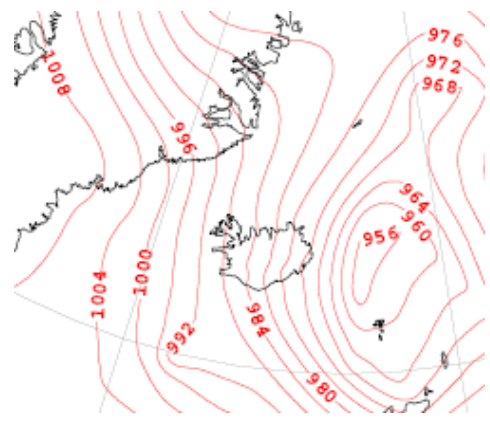
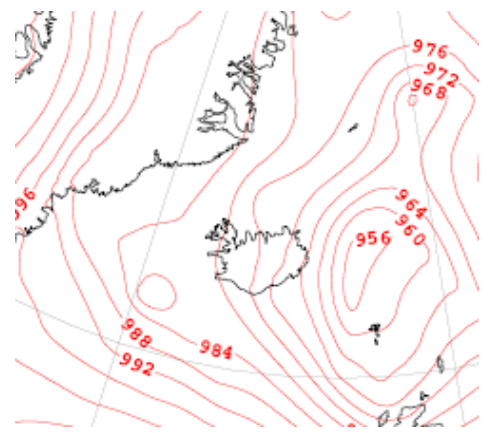


C
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C
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N

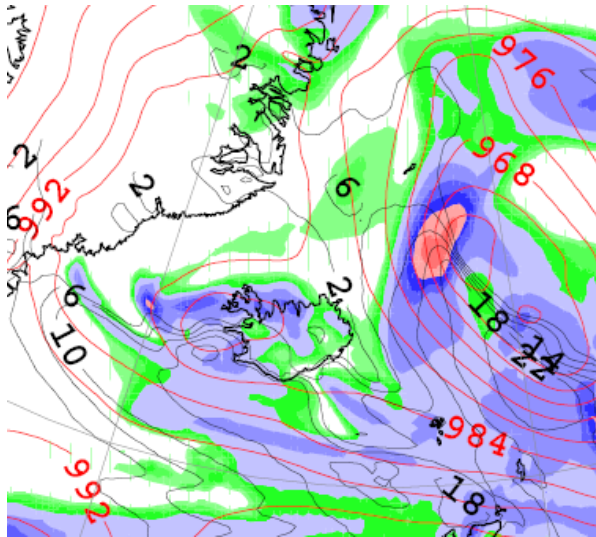
N
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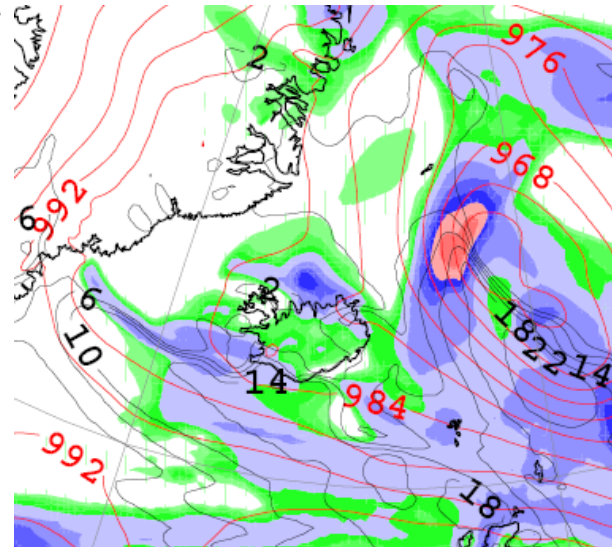
Z
E
P
G
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N

MSLP, wind, precip. at 00 UTC 12 Jan (+36 h)

C
O
N
T
R
O
L

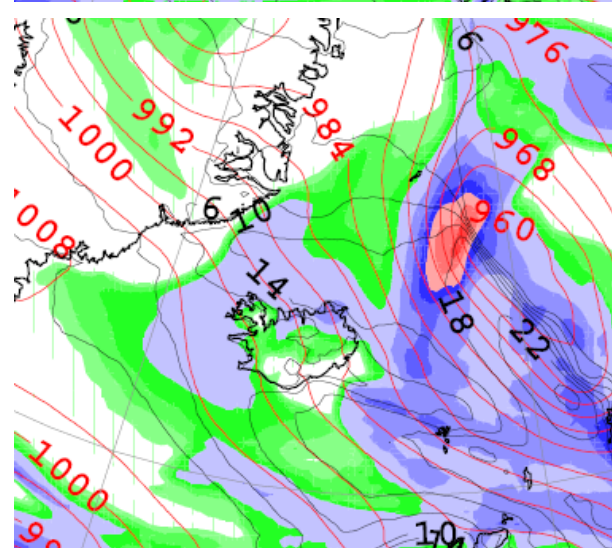
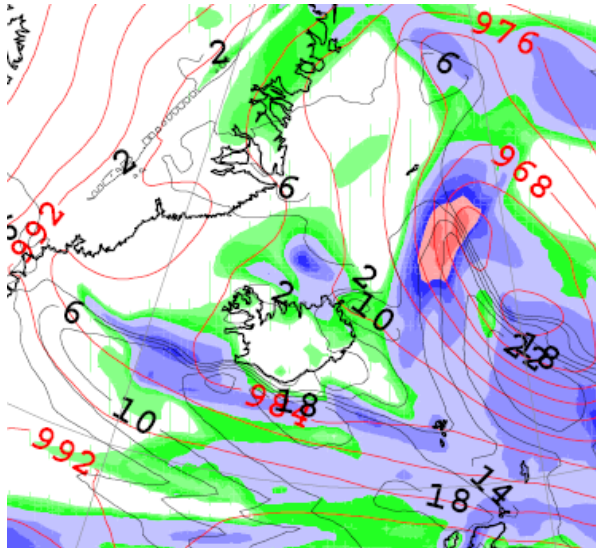


mm/12h



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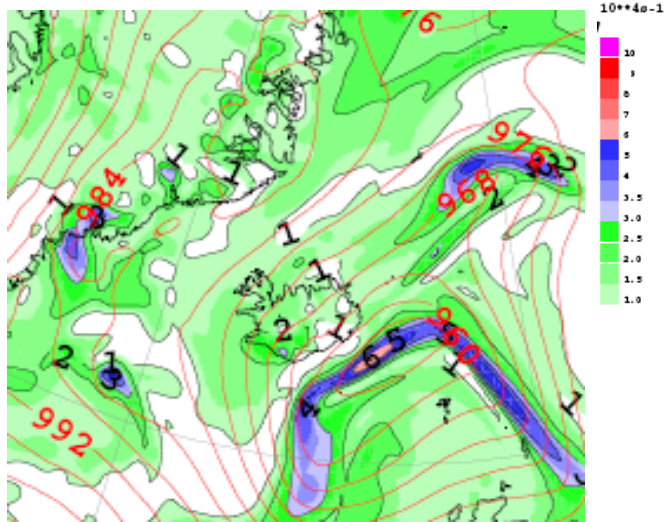
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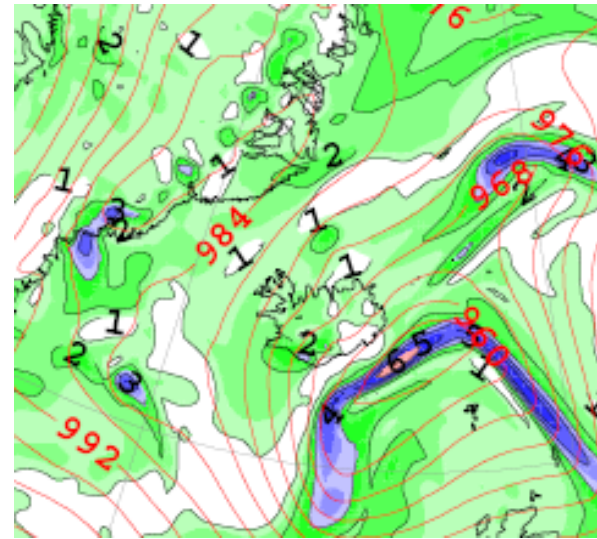
N
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Rel. Vorticity at 850 hPa at 06 UTC 11 Jan (+18 h)

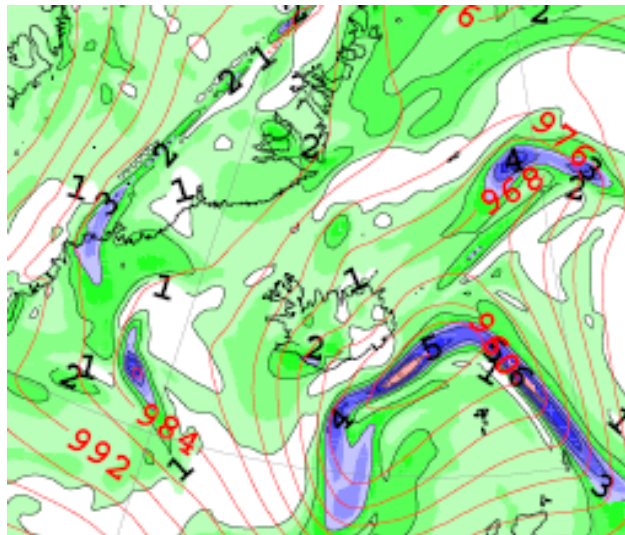
C
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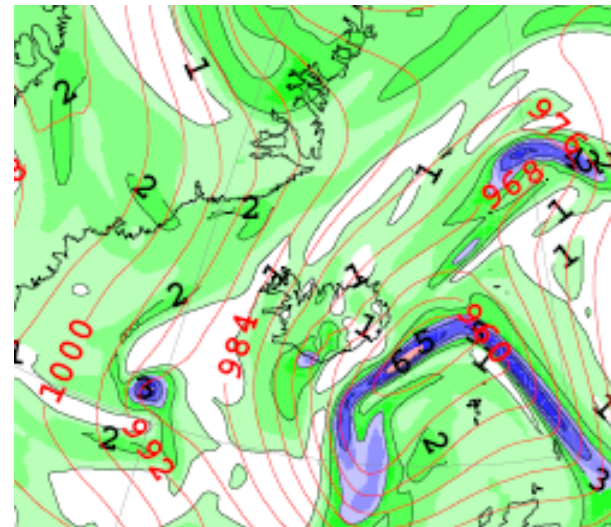
N
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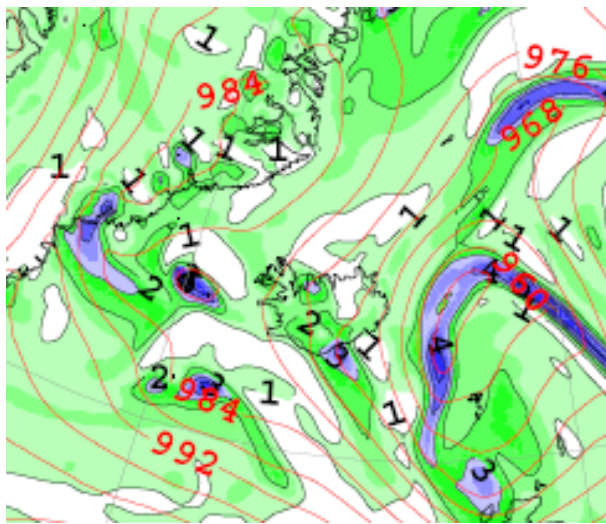


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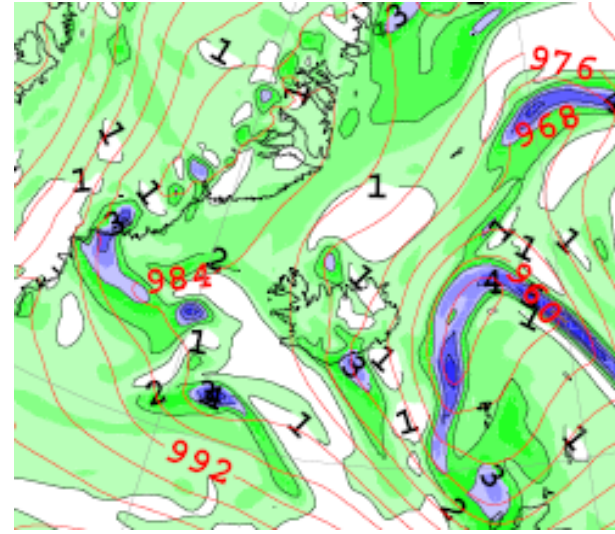


Rel. Vorticity at 850 hPa at 12 UTC 11 Jan (+24 h)

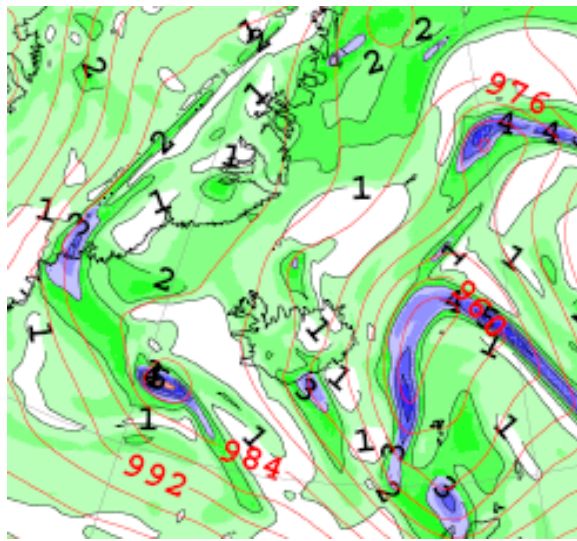
C
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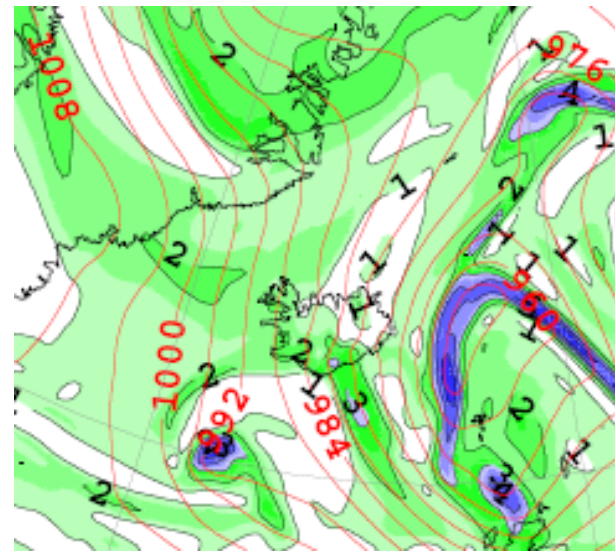
N
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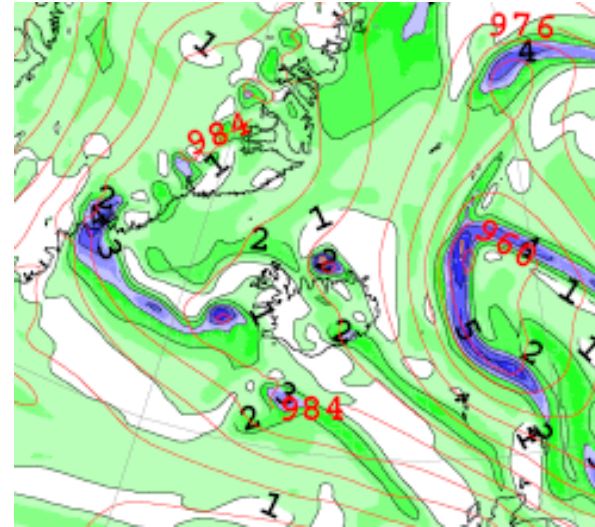
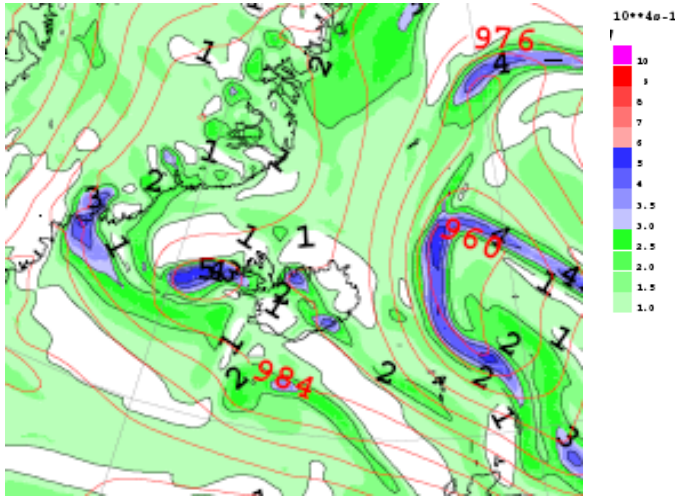


N
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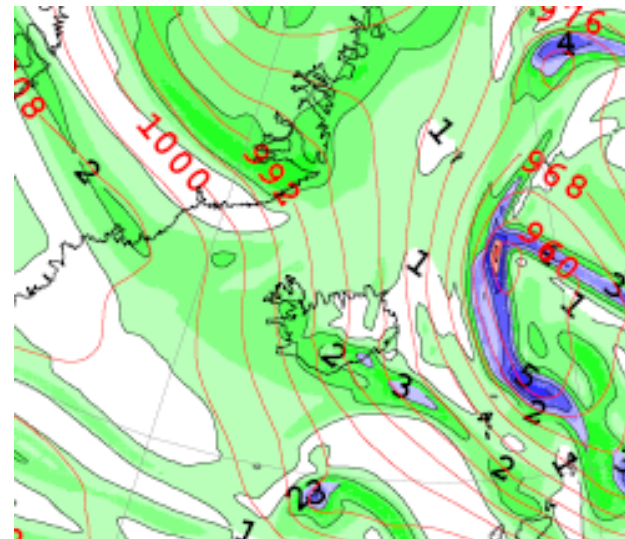
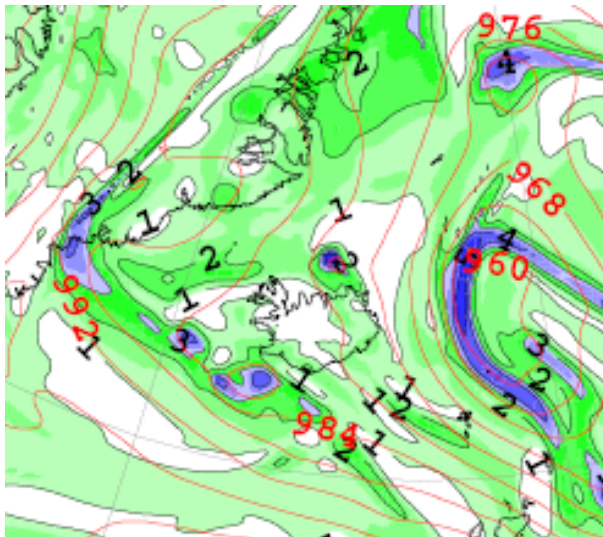
Rel. Vorticity at 850 hPa at 18 UTC 11 Jan (+30 h)

C
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N

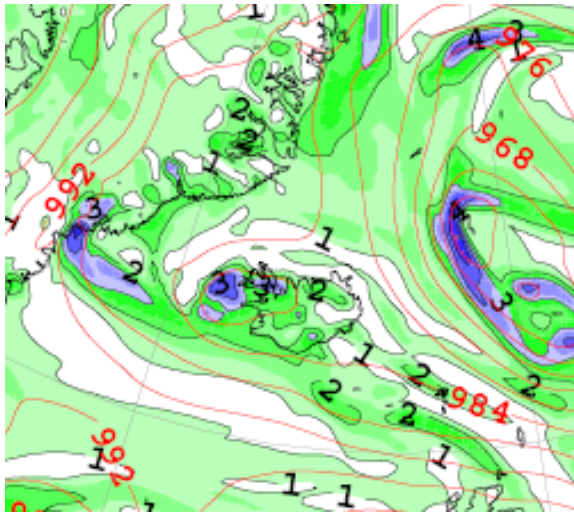
N
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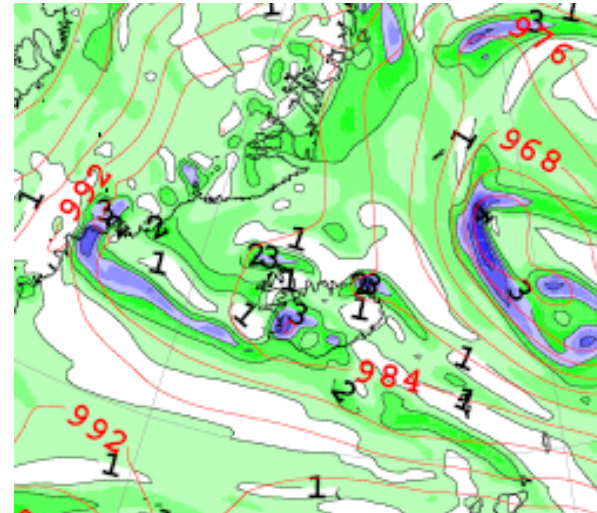
N
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F
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N

Rel. Vorticity at 850 hPa at 00 UTC 12 Jan (+36 h)

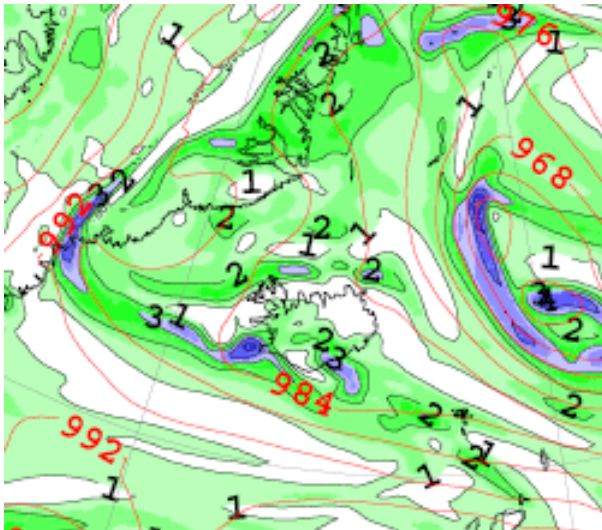
C
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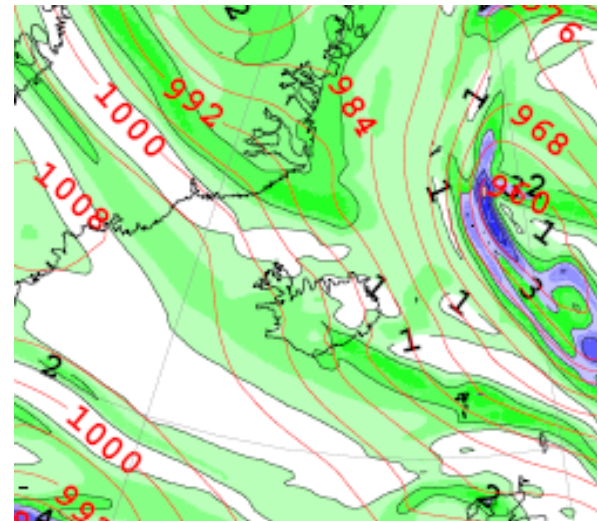
N
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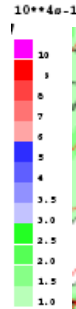
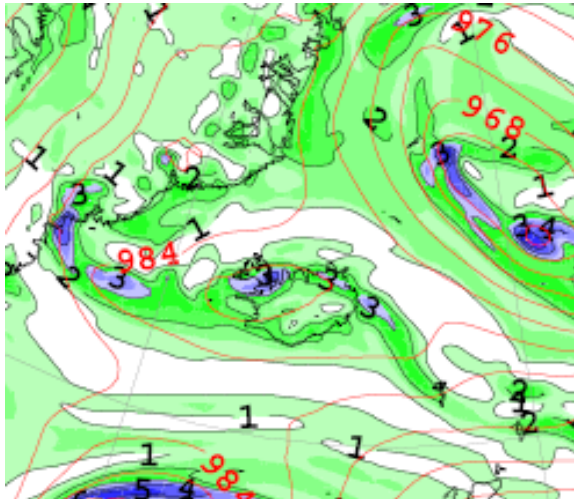


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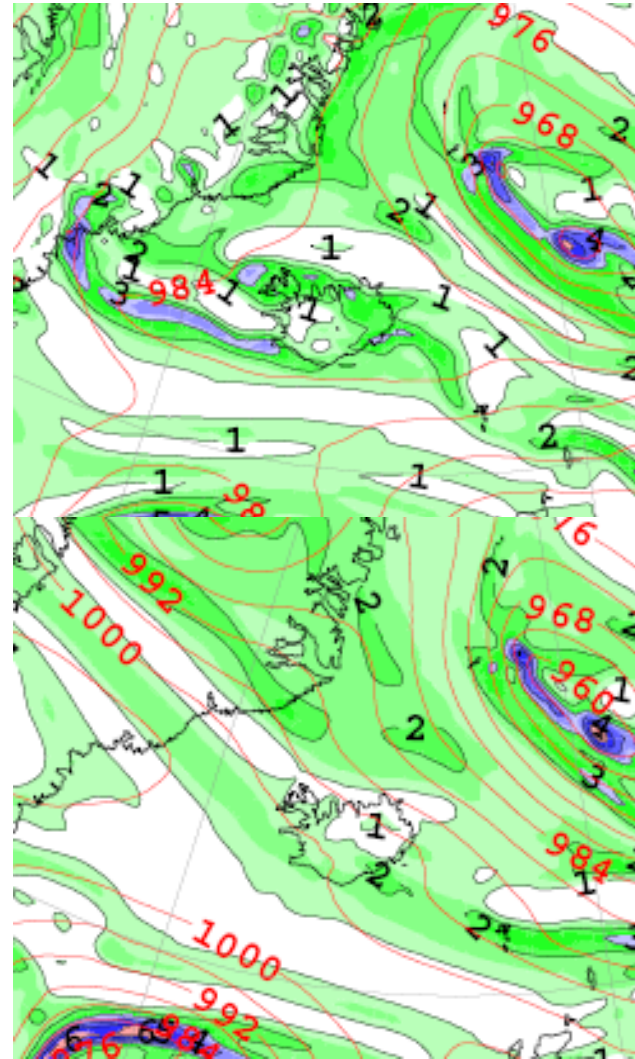
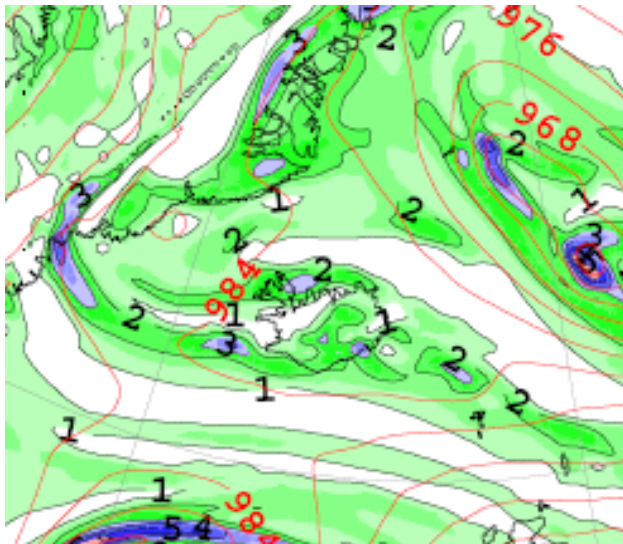
Rel. Vorticity at 850 hPa at 06 UTC 12 Jan (+42 h)

C
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O
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N

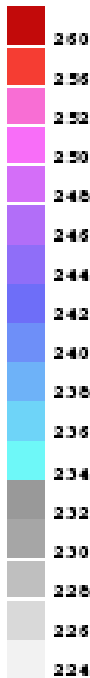
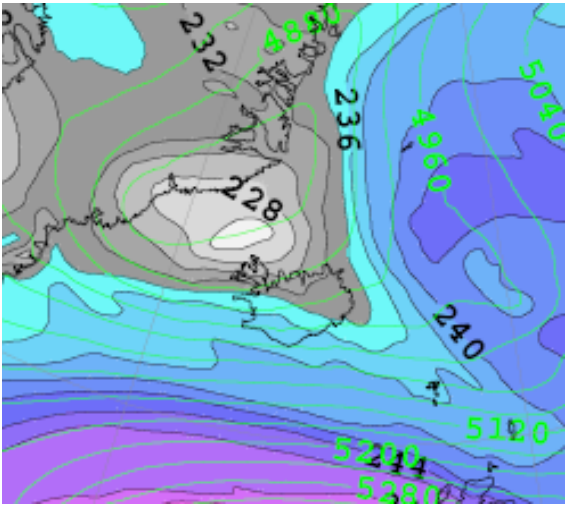
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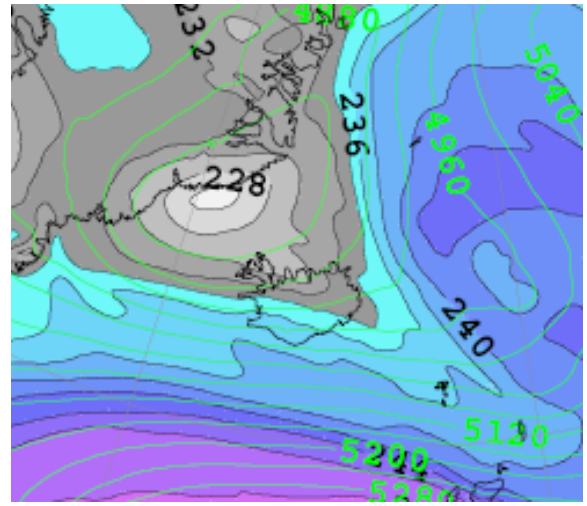
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Z, T at 500 hPa at 00 UTC 12 Jan (+36 h)

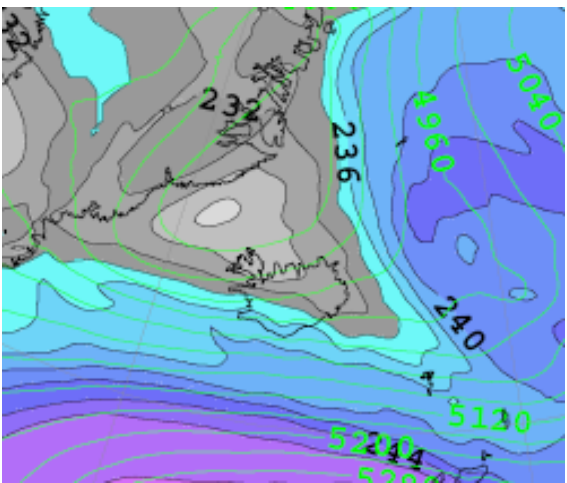
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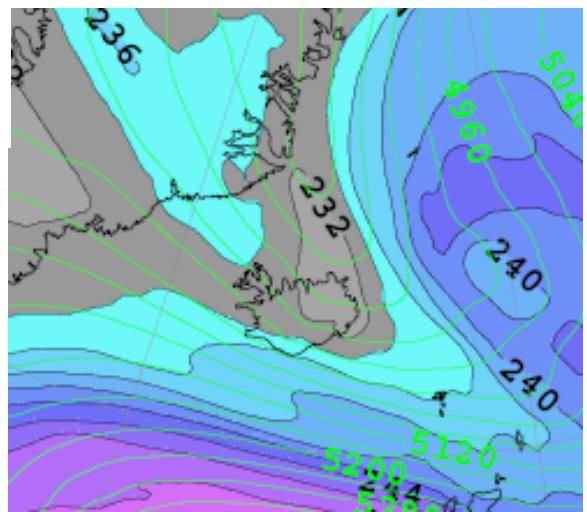
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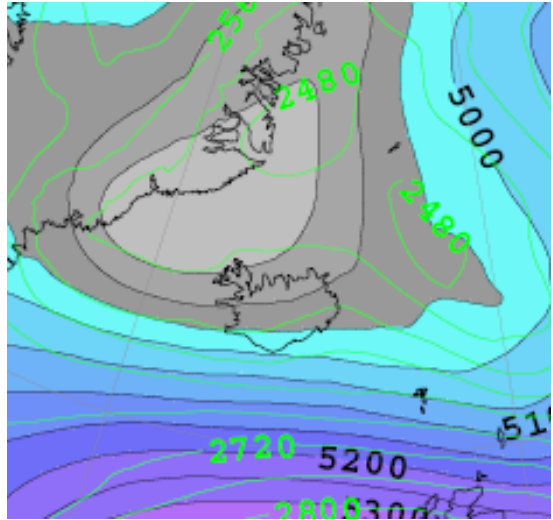
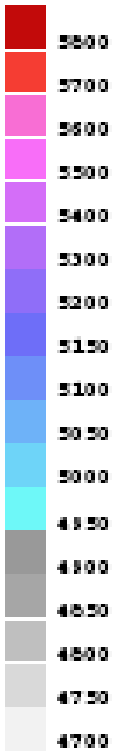
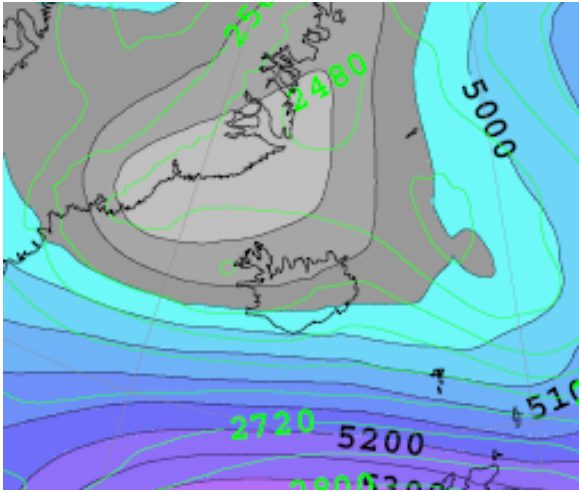


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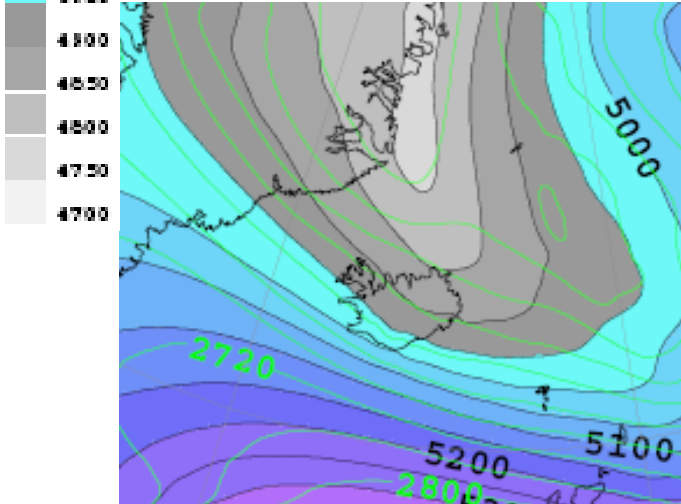
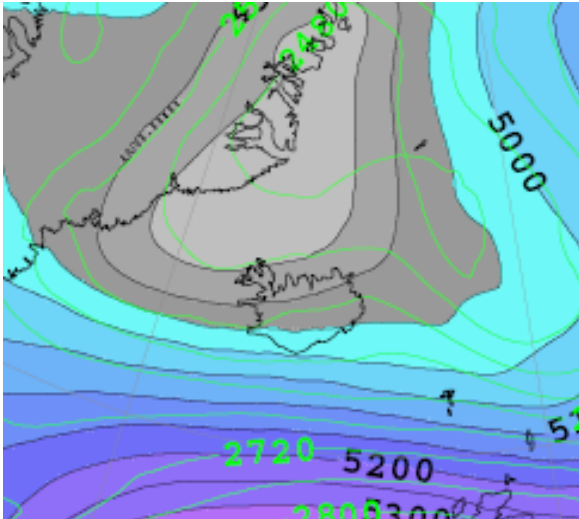
700 hPa Height and 500 hPa – 1000 hPa Thickness at 00 UTC 12 Jan (+36 h)

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Summary of case study - observations

- The Polar Low developed WNW of Iceland in the early hours of 11 Jan 2007 in an area of strong low-level baroclinicity and weak static stability
- Over ocean wind speeds of up to 25-30 m s⁻¹ indicated by QuikScat images
- Over northwestern parts of Iceland wind speeds exceeded 20 m s⁻¹ at several lowland locations as the low tracked east on 12 Jan 2007



Summary of case study – model simulations

- The Control Run gave an overall realistic picture of the PL development
- Even modest changes to E-Greenland's orography lead to significantly poorer forecasts
- In a simulation where Greenland's orography is removed altogether, the polar low does not form
- It is hypothesized that Greenland's orography provides the vorticity needed to organize the system