Predictability of high-impact weather - a three case study

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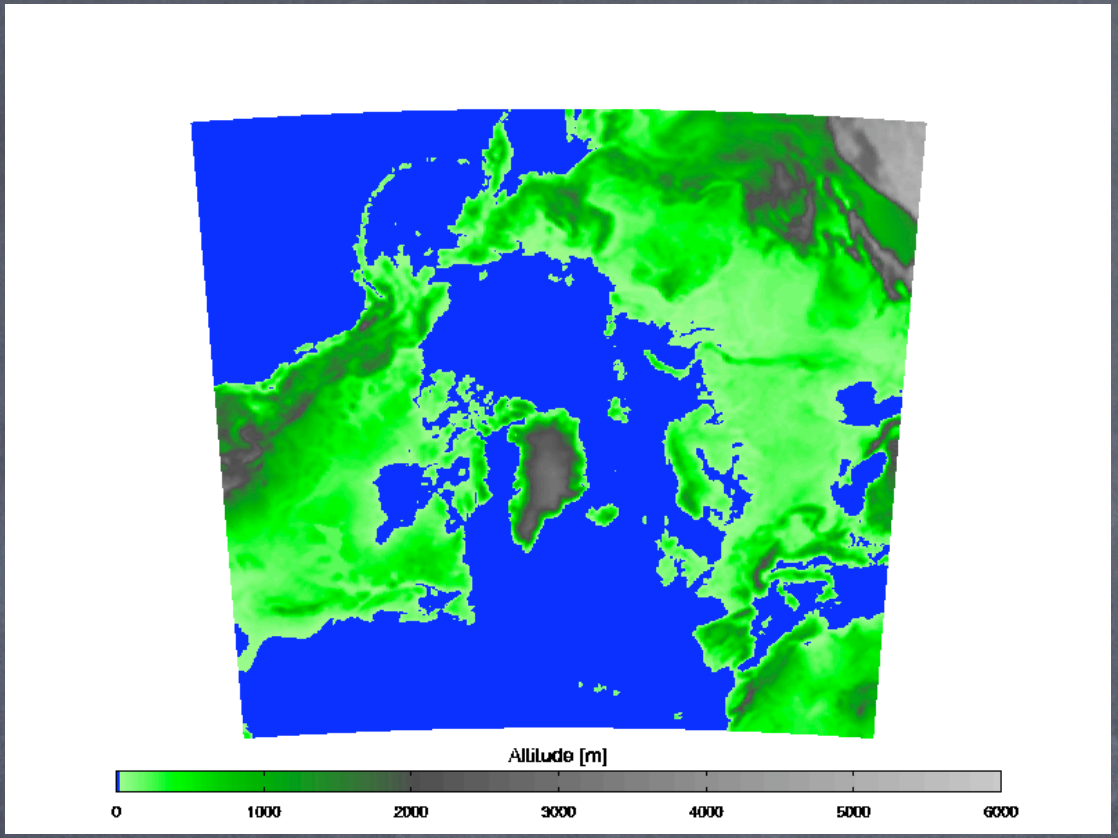
What? / Why?

- Three extreme weather events that were not very well predicted in medium and/or long term forecast
- We want to know what went wrong in each case

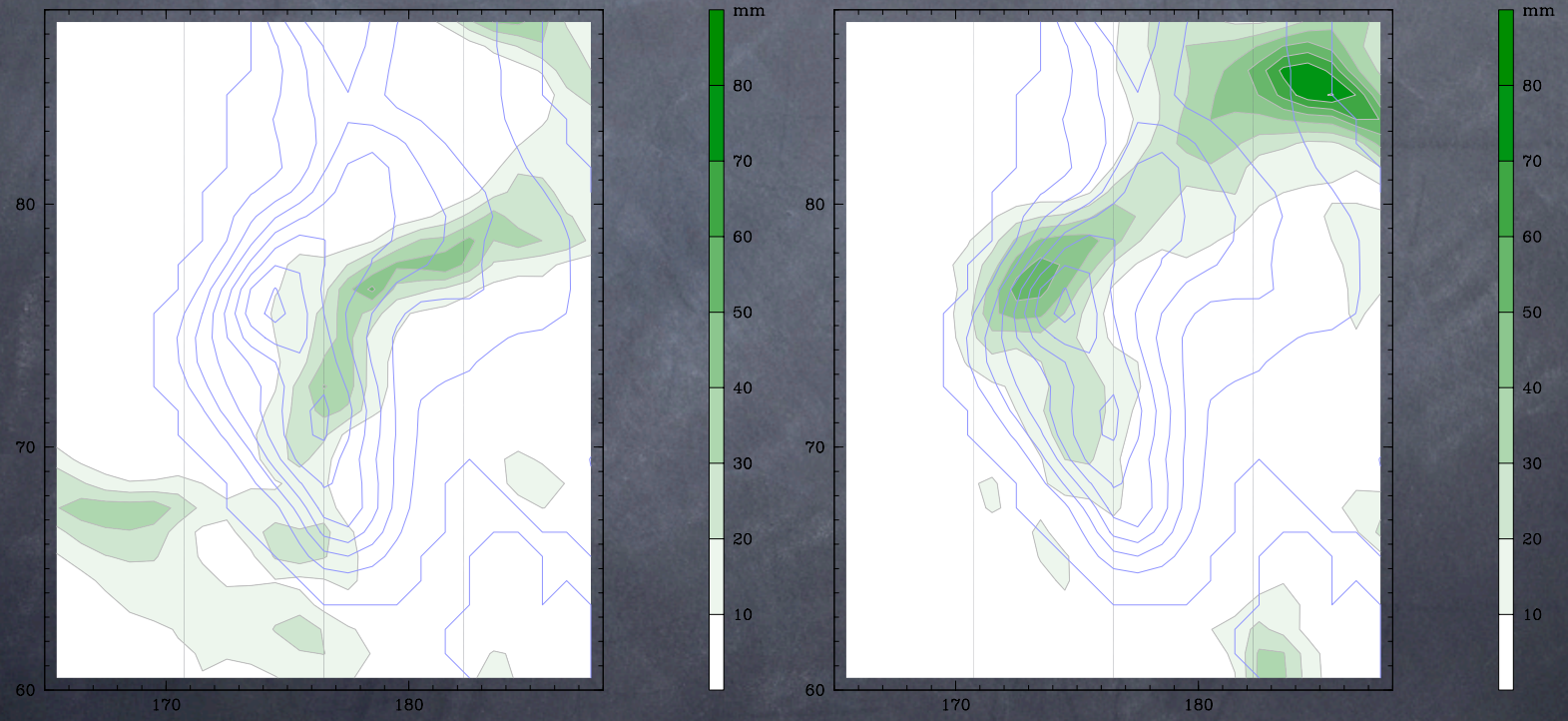
Introduction

- The study contains 3 different cases.
- We ran the MM5 model with 36 km horizontal resolution and 40 vertical (sigma) levels. The size of the grid was 300*300. The Eta Planetary boundary layer scheme was used
- The model was ran from several different analysis (initial conditions) 24 hours apart. Every piece of data comes from the ECMWF.
- Every piece of input-data comes from the ECMWF.



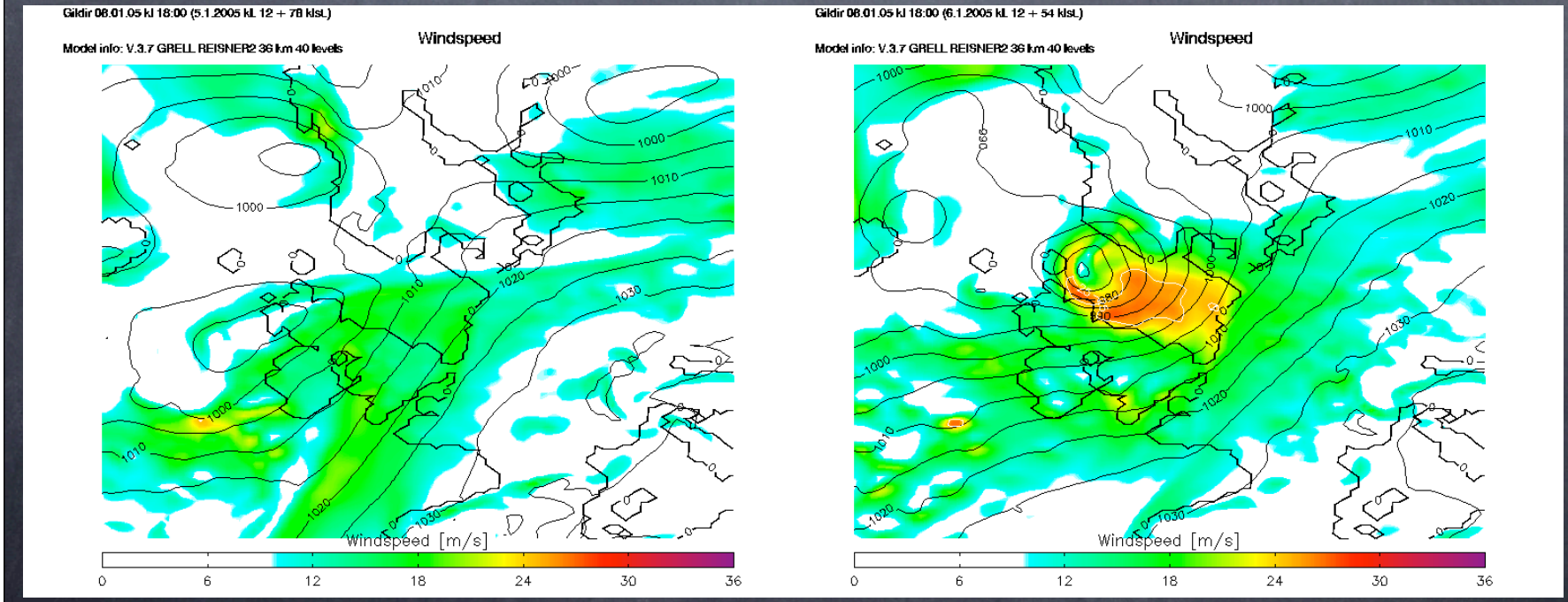
The domain

1. Extreme precipitation in Norway



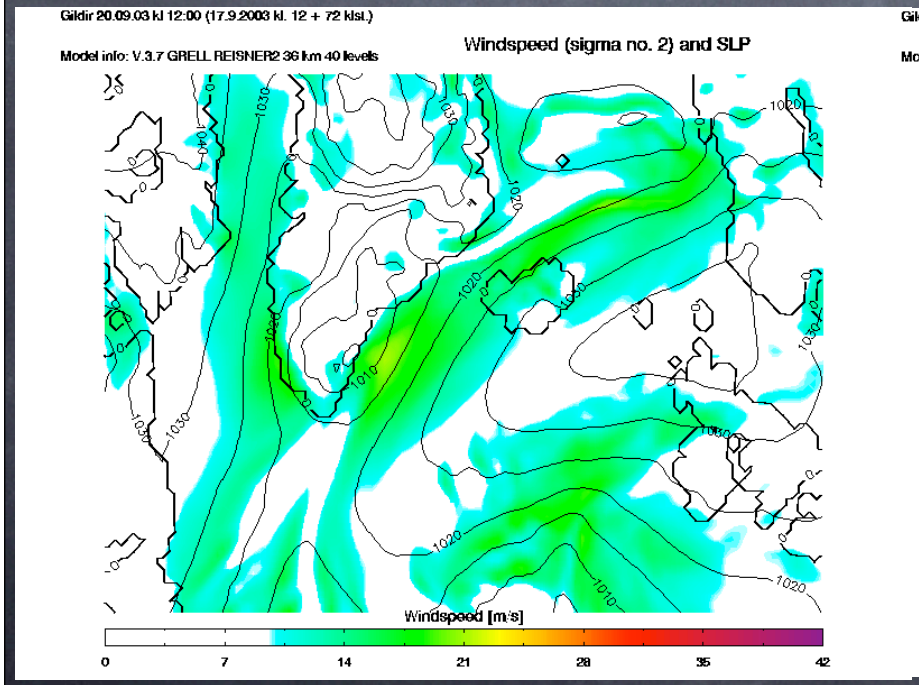
2. Windstorm in Denmark

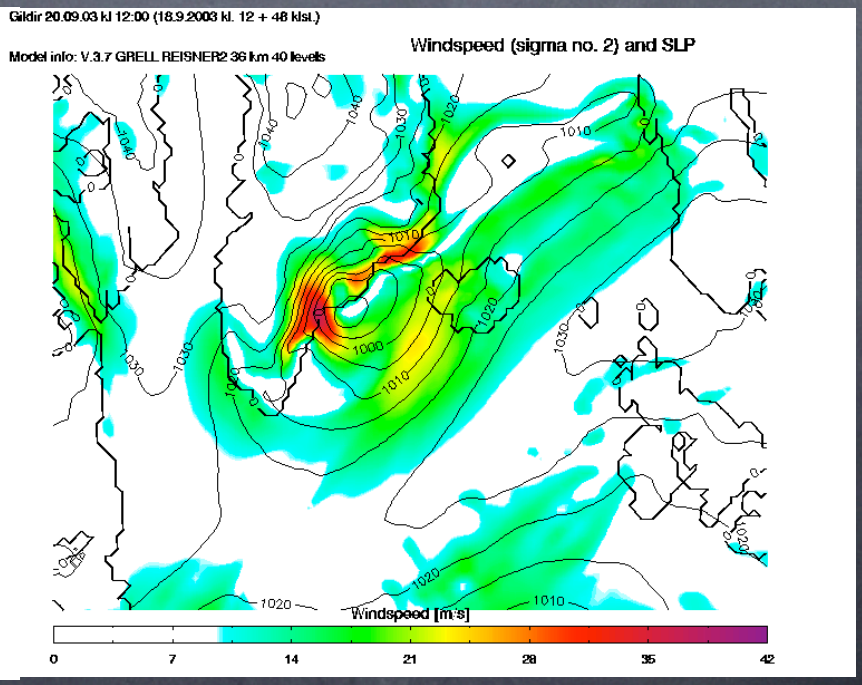
in collaboration with Jon E. Kristjánsson and
Guðrún Nína Petersen



3. Low west of Iceland

Which will be the topic of this talk

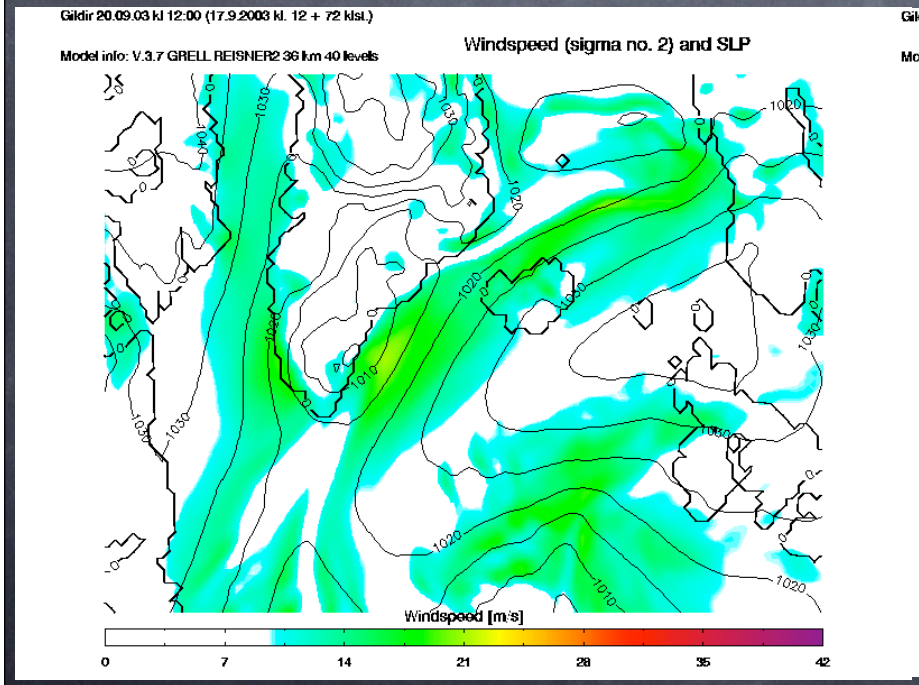


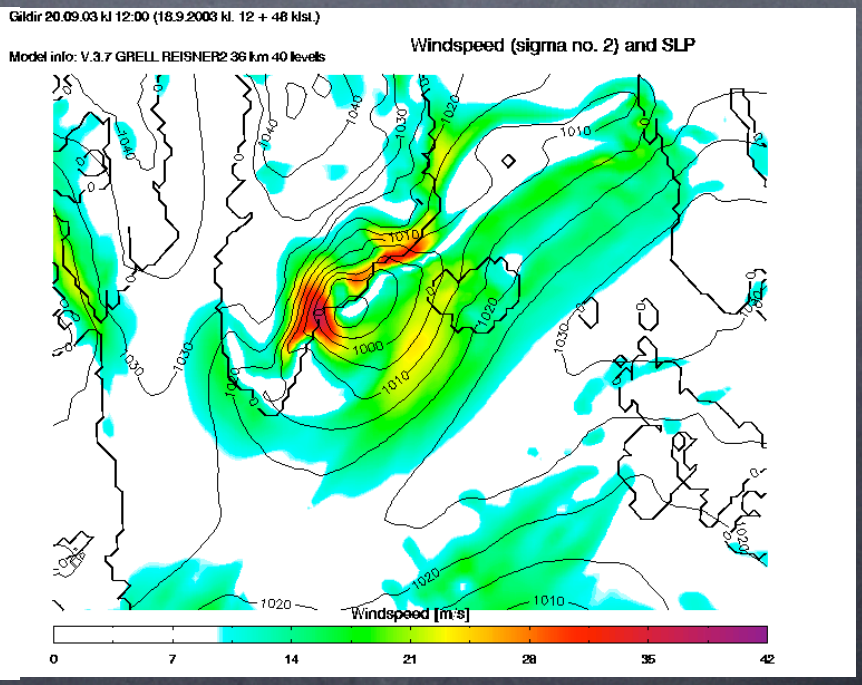


The method:

- We compare these two runs to see where the forecast derails.
- We try to find a traceable link between the wrongly predicted event to a difference in the analysis of the "good" run from the same time step in the "bad" longer run.
- In this case we got a "bad" 72h run which we then compare to a "good" 48h run.

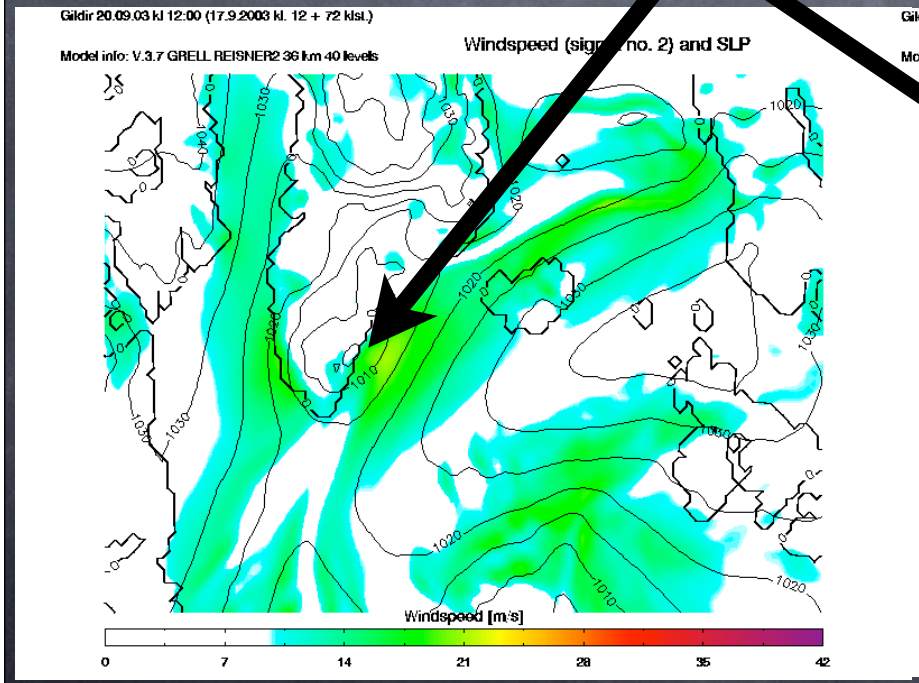
Back to Iceland

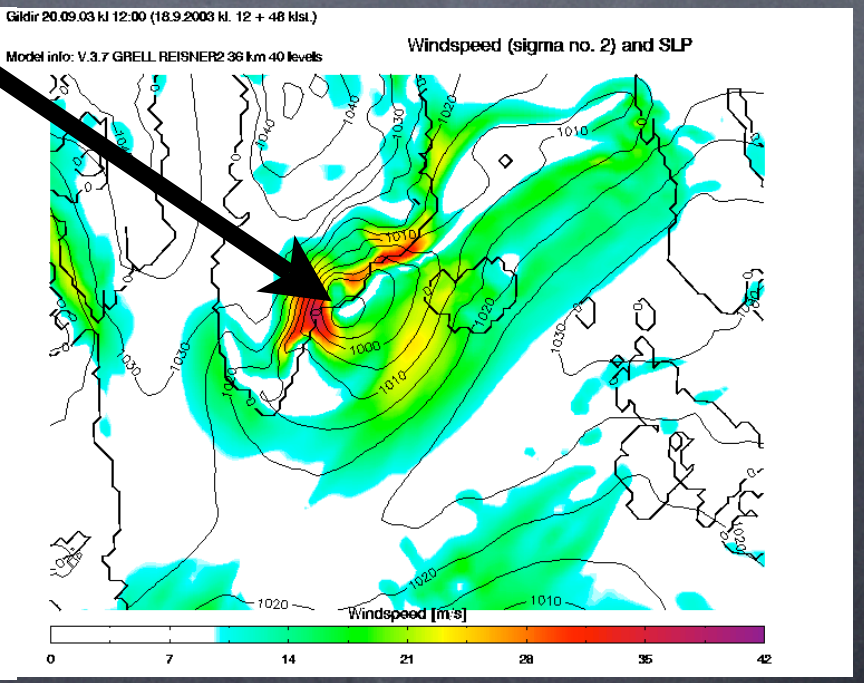




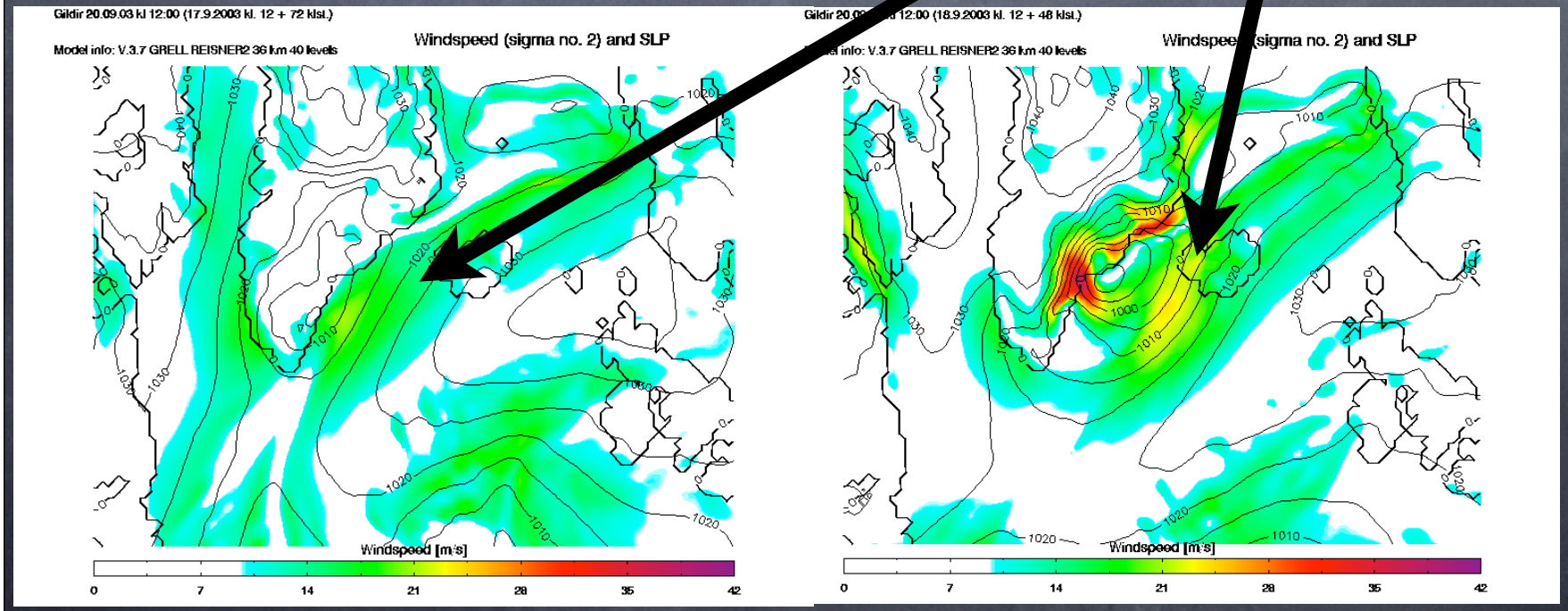
valid: 20th of september 2003

The center of the low is misplaced and 15hPa lower than predicted





The steeper pressure gradient
doubles the wind speed,
from 10 to over 20 m/s in west Iceland



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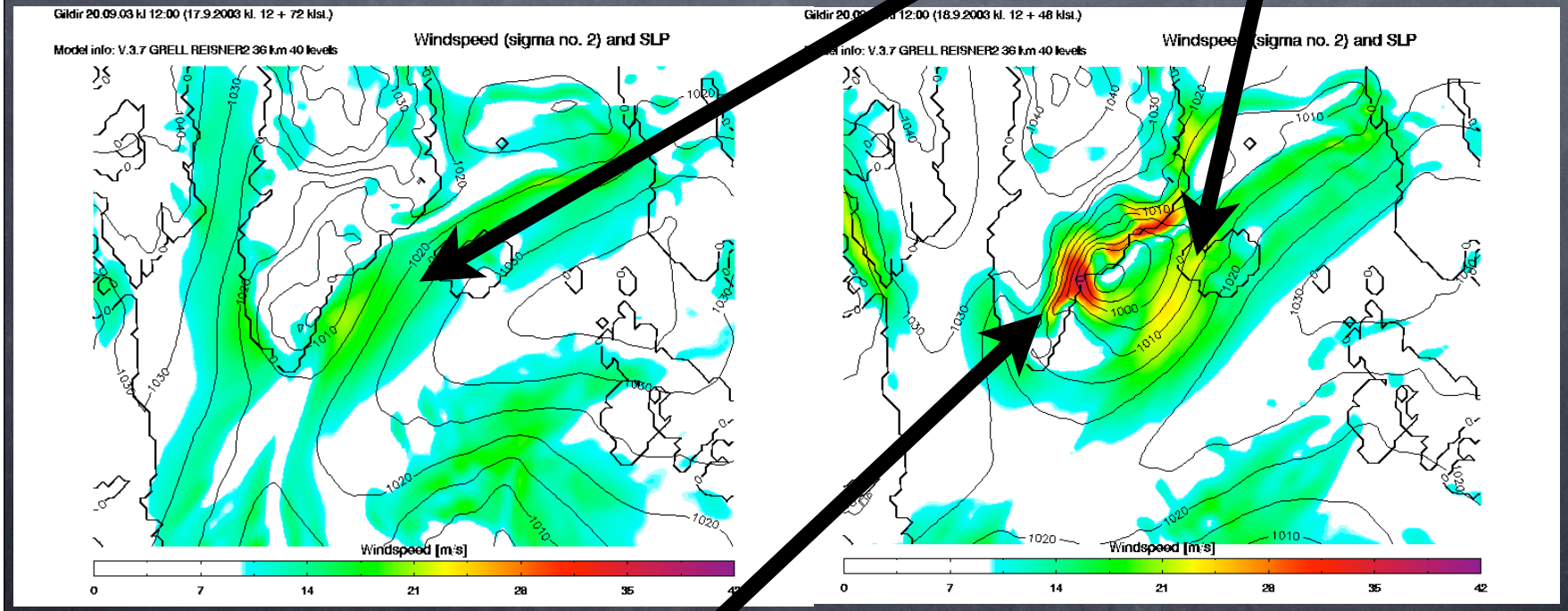
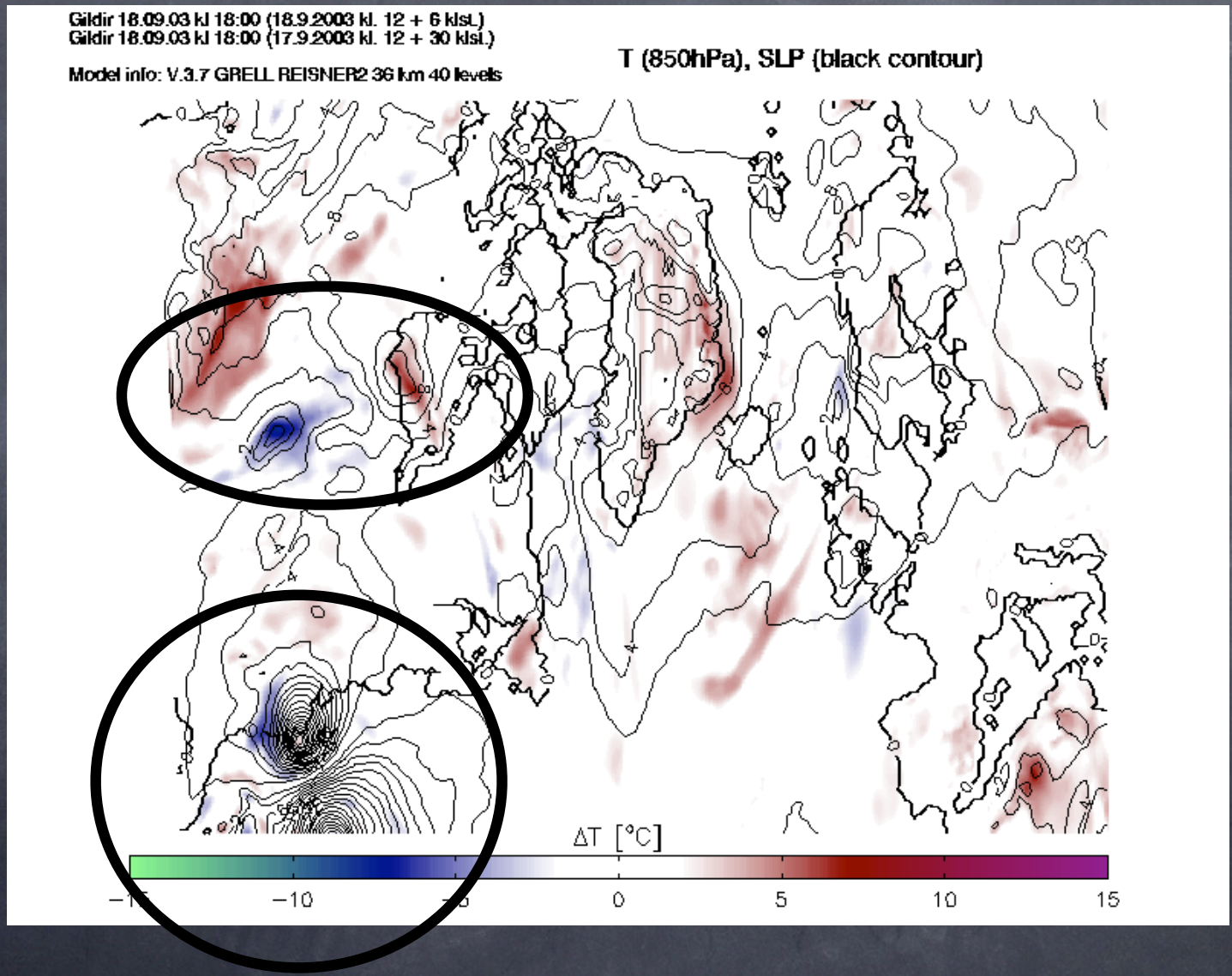
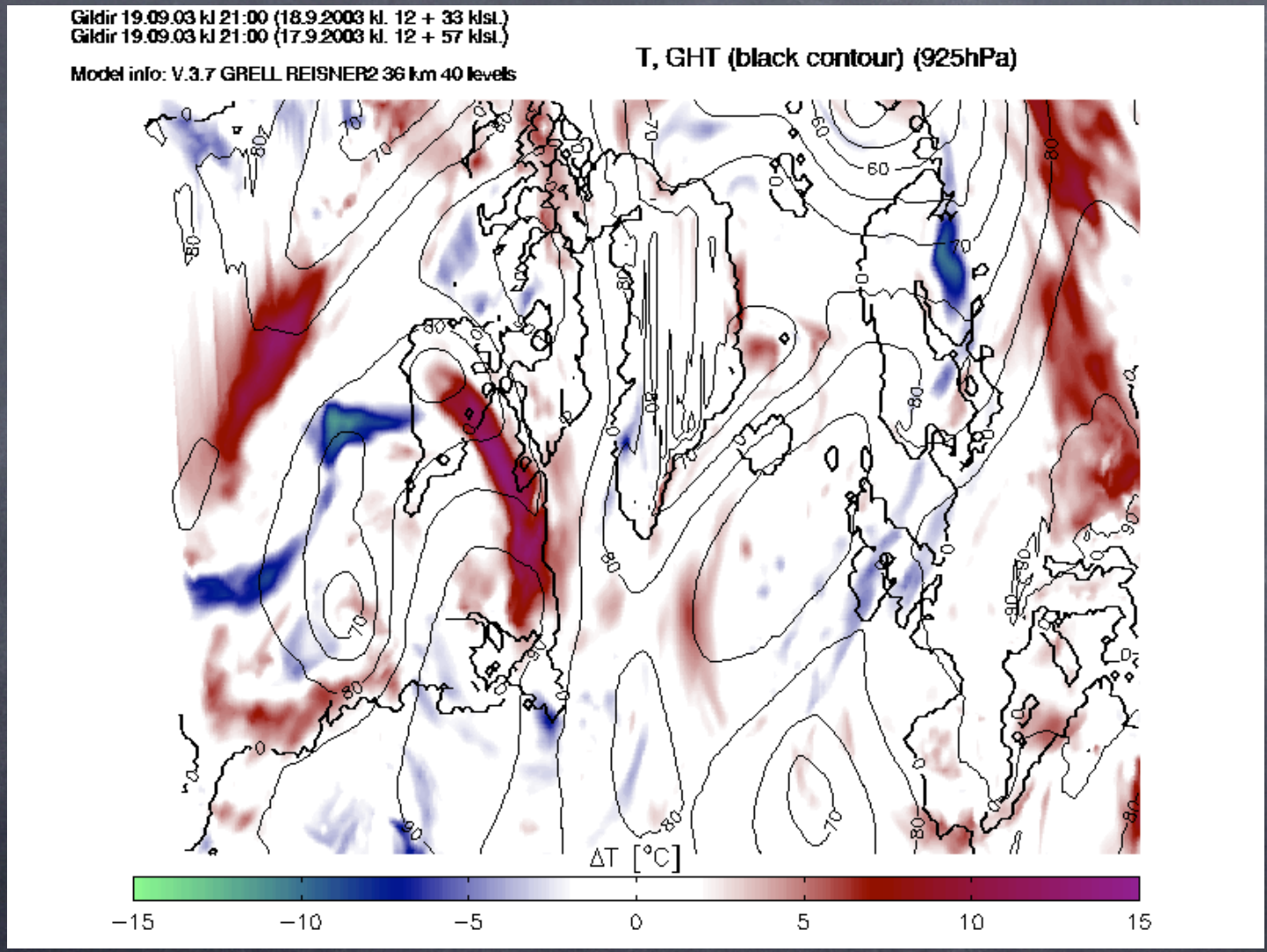


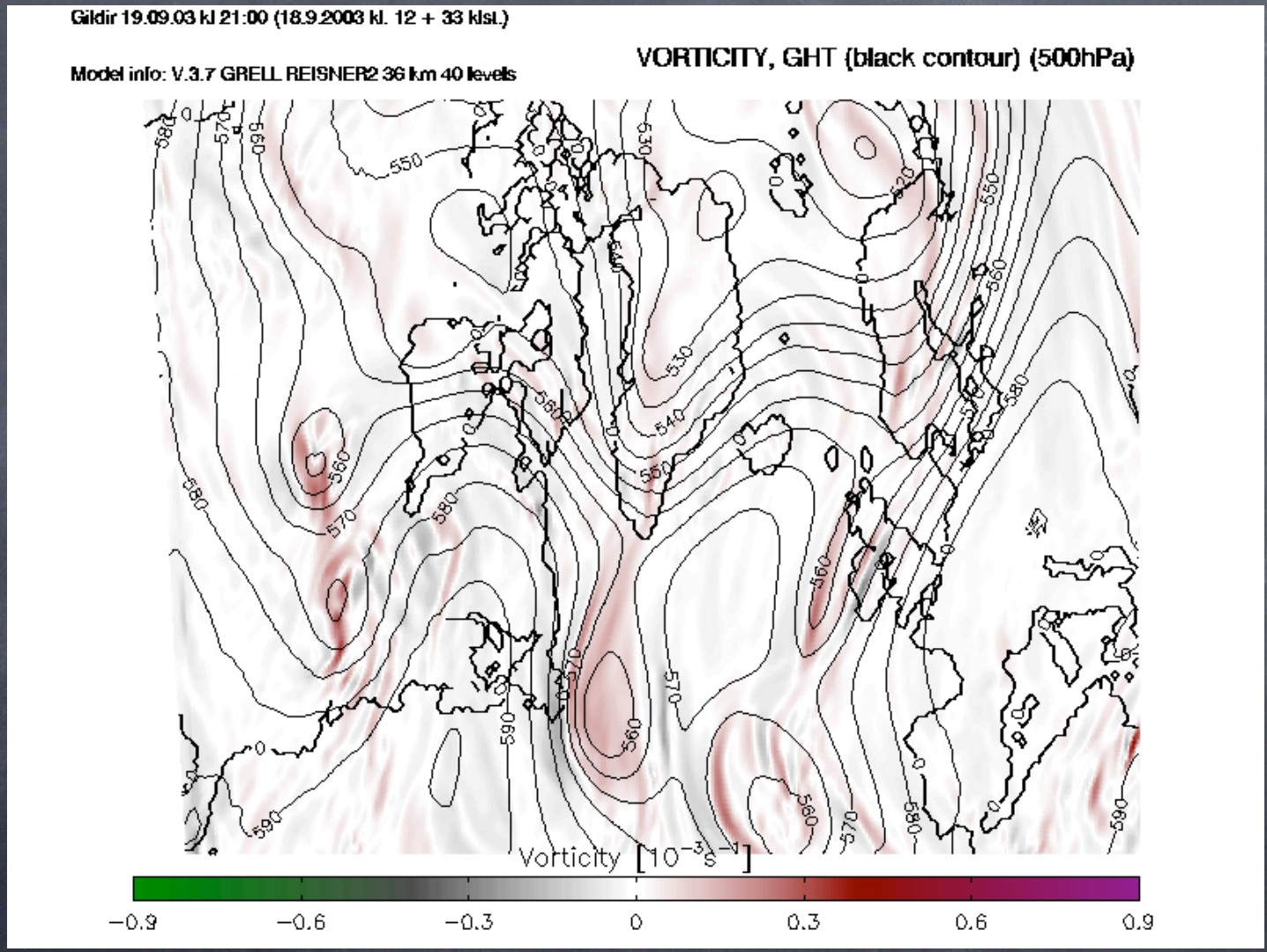
slight increase there as well...

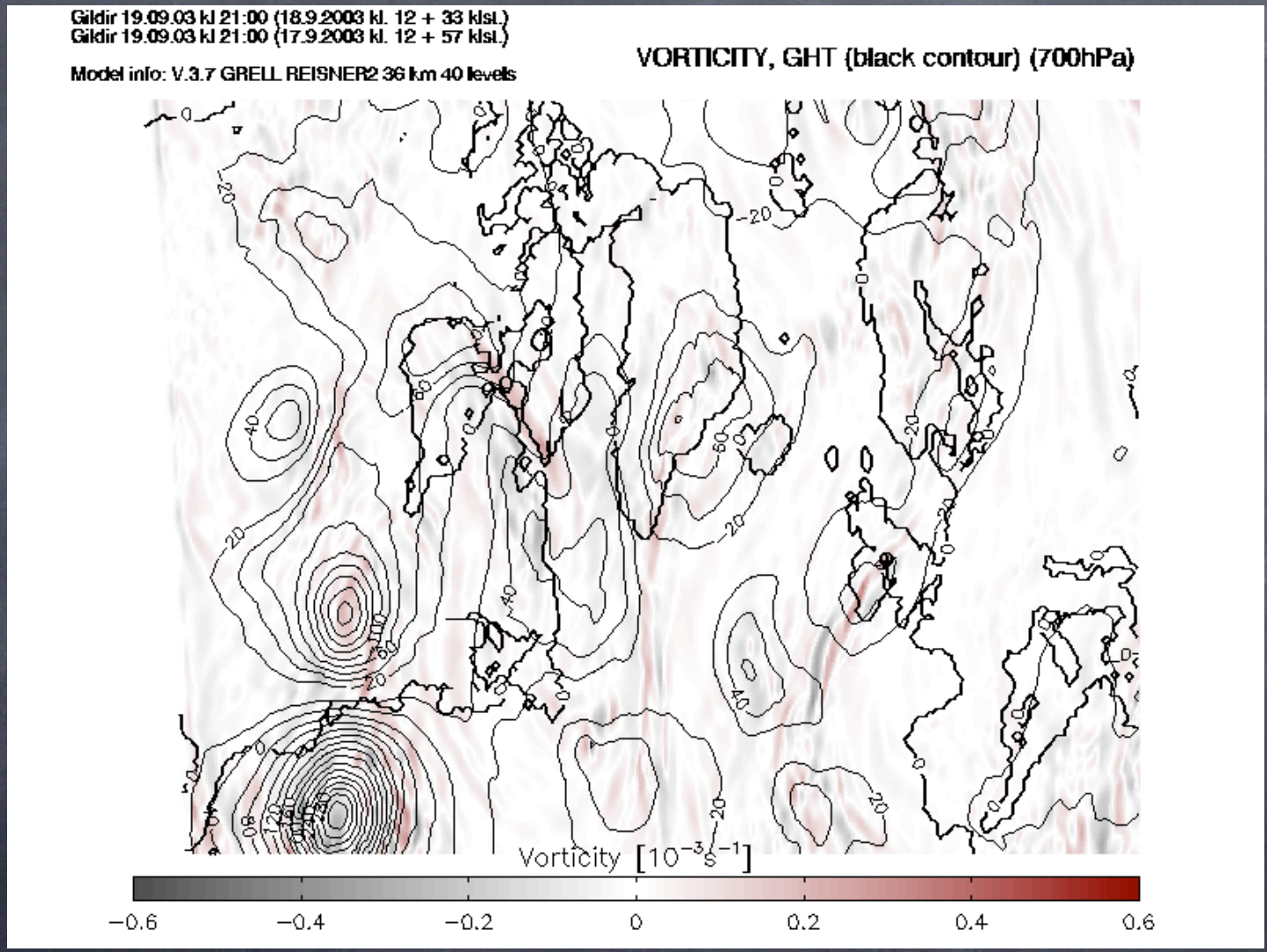
- So what happened....
- 6 hours into the run (for a clearer picture) we get this:


Gildir 18.09.03 kl 18:00 (18.9.2003 kl. 12 + 6 klst.)
Gildir 18.09.03 kl 18:00 (17.9.2003 kl. 12 + 30 klst.)
Model info: V.3.7 GRELL REISNER2 36 km 40 levels
T (850hPa), SLP (black contour)
ΔT [°C]
−10
0
5
10
15

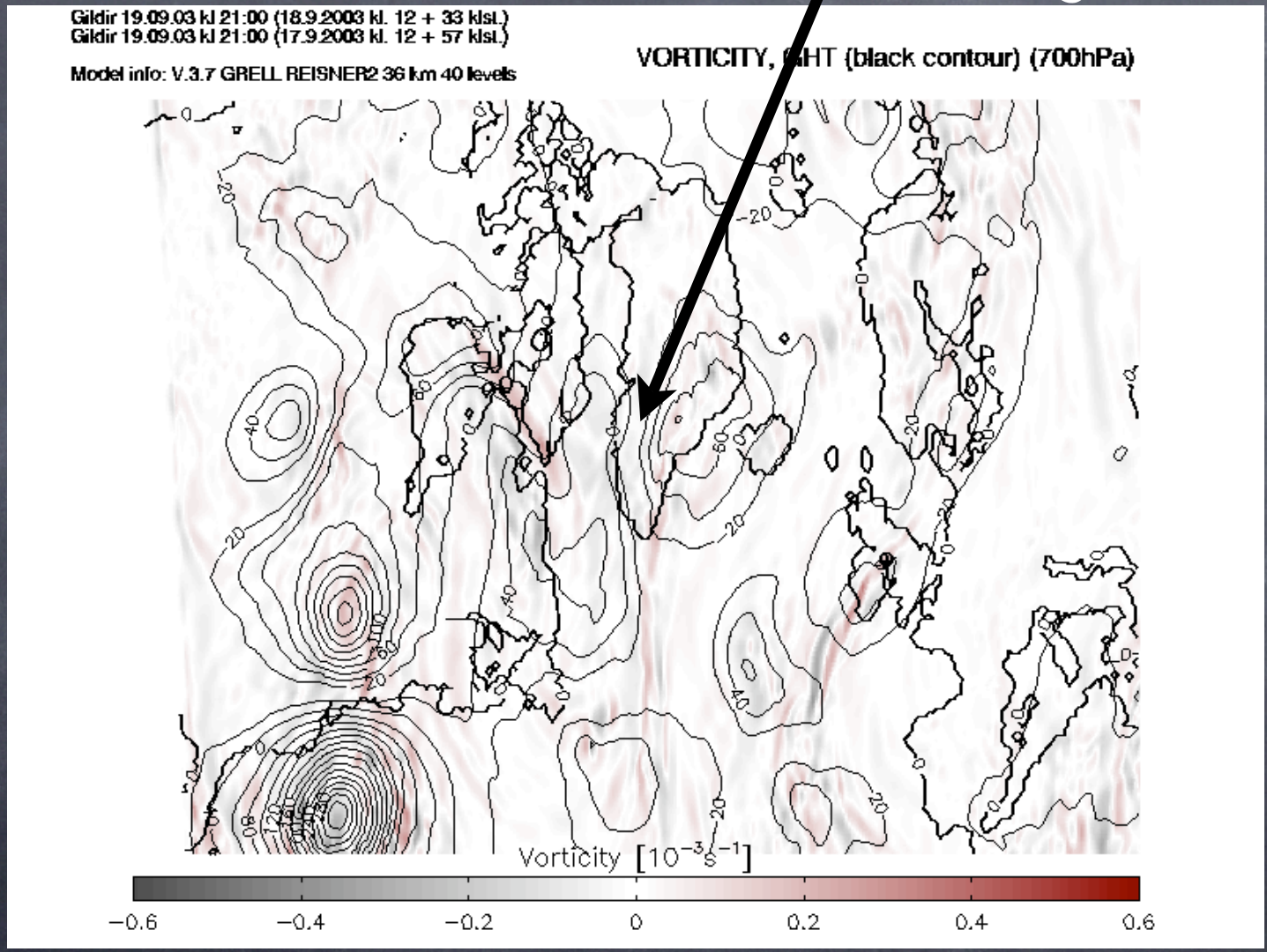
- Warmer air in propagates north over the north american continent


Gildir 19.09.03 kl 21:00 (18.9.2003 kl. 12 + 33 klst.)
Gildir 19.09.03 kl 21:00 (17.9.2003 kl. 12 + 57 klst.)
Model info: V.3.7 GRELL REISNER2 36 km 40 levels
T, GHT (black contour) (925hPa)
ΔT [°C]
−15
−10
−5
0
5
10
15


Gildir 19.09.03 kl 21:00 (18.9.2003 kl. 12 + 33 klst.)
Model info: V.3.7 GRELL REISNER2 36 km 40 levels
VORTICITY, GHT (black contour) (500hPa)
Vorticity [10^-3 s^-1]
−0.9
−0.6
−0.3
0
0.3
0.6
0.9


Gildir 19.09.03 kl 21:00 (18.9.2003 kl. 12 + 33 klst.)
Gildir 19.09.03 kl 21:00 (17.9.2003 kl. 12 + 57 klst.)
Model info: V.3.7 GRELL REISNER2 36 km 40 levels
VORTICITY, GHT (black contour) (700hPa)
Vorticity [10⁻³s⁻¹]
−0.6
−0.4
−0.2
0
0.2
0.4
0.6

Increased gradient

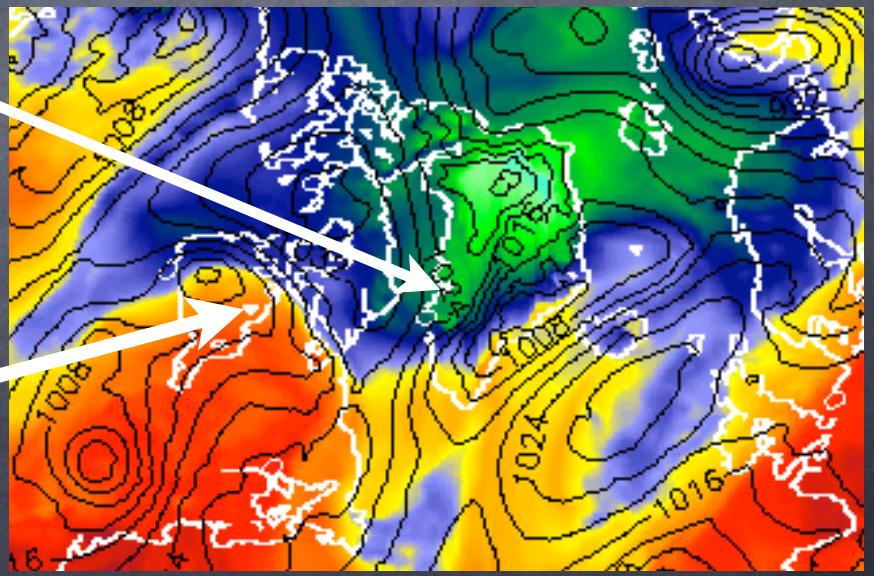


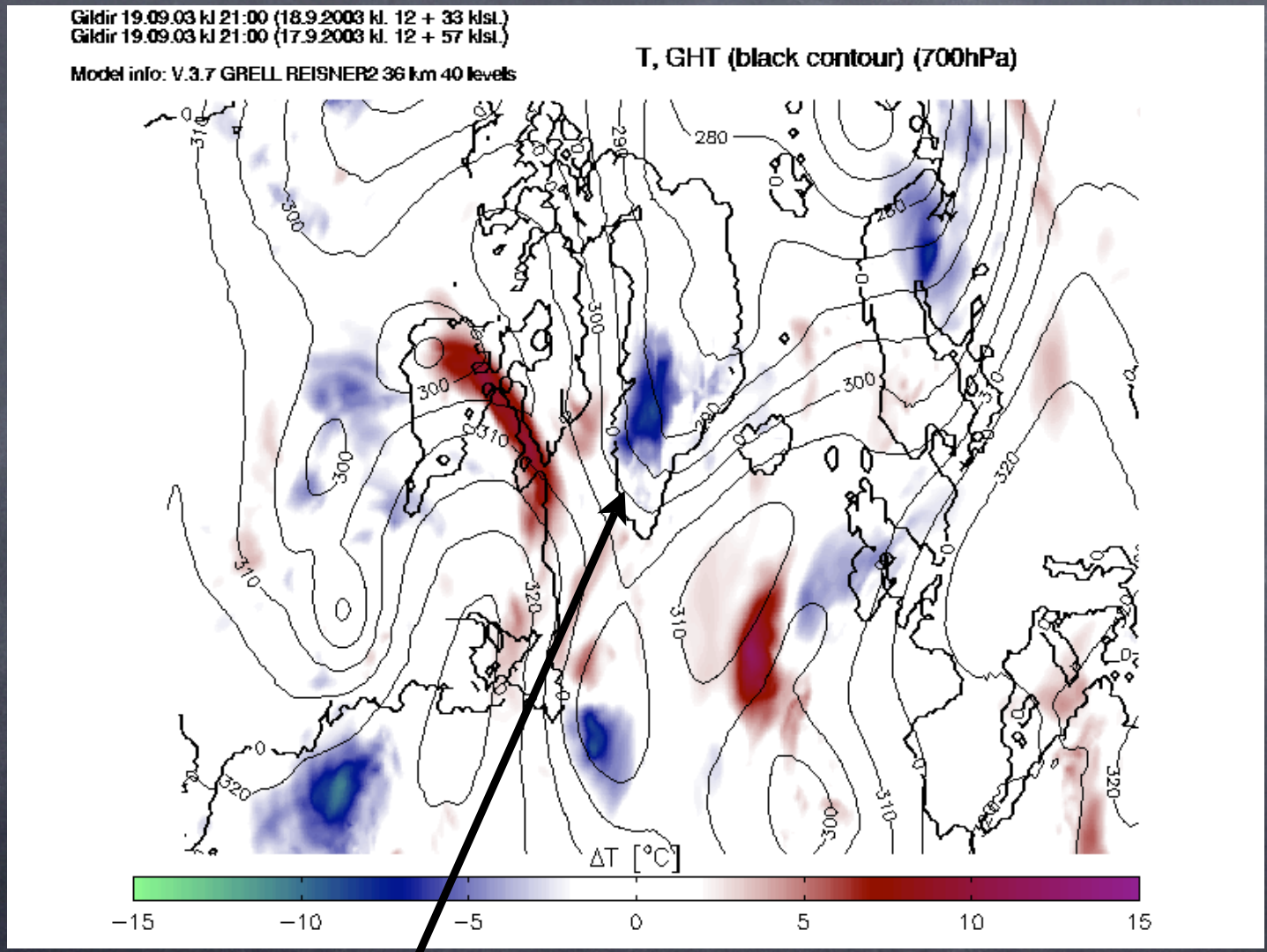
- We get a higher 500 hPa/700hPa surfaces in the ridge west of Greenland

- --> higher gradient and "more" cold air coming from the north

Cold advection

Warm advection:

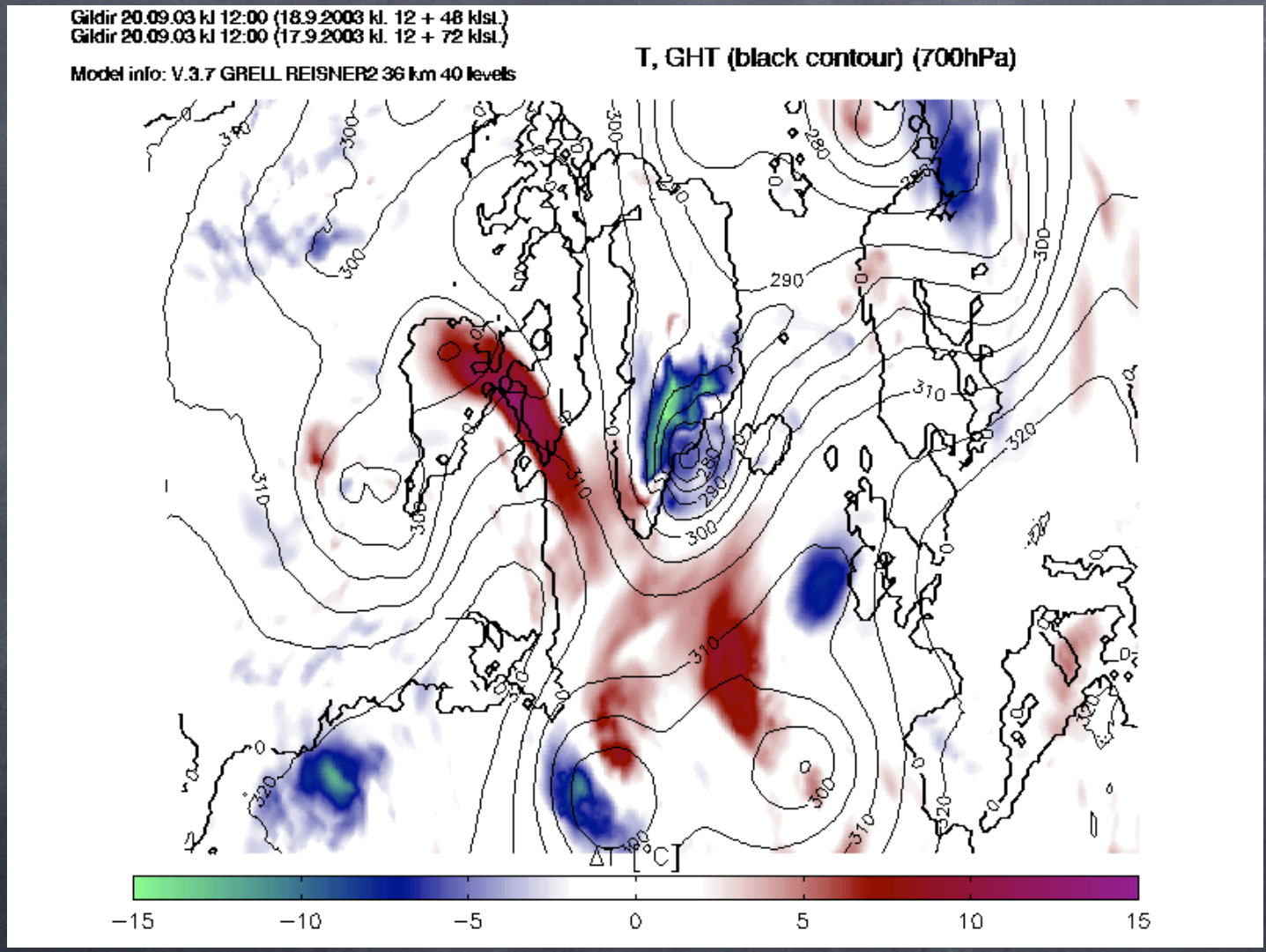


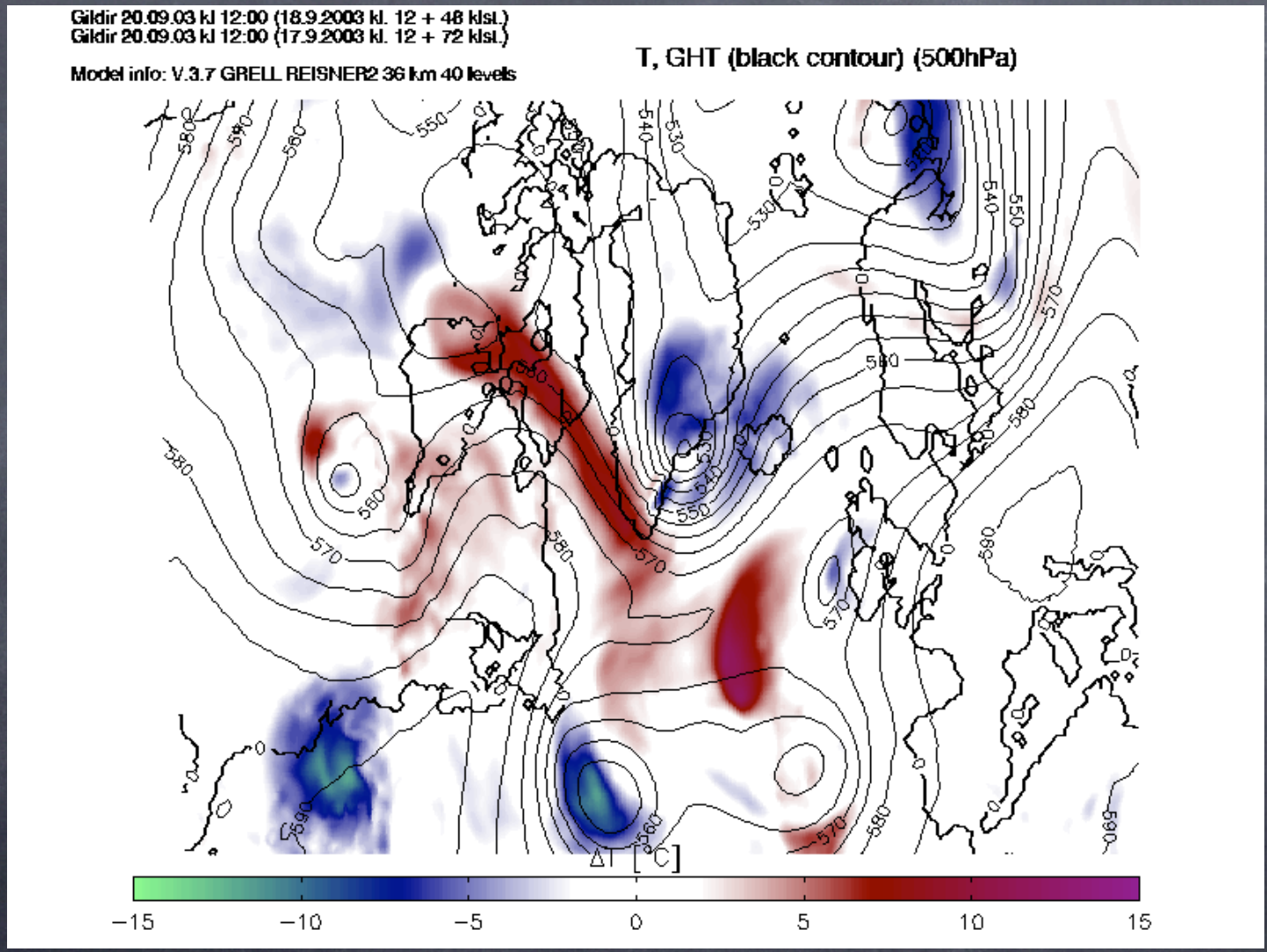


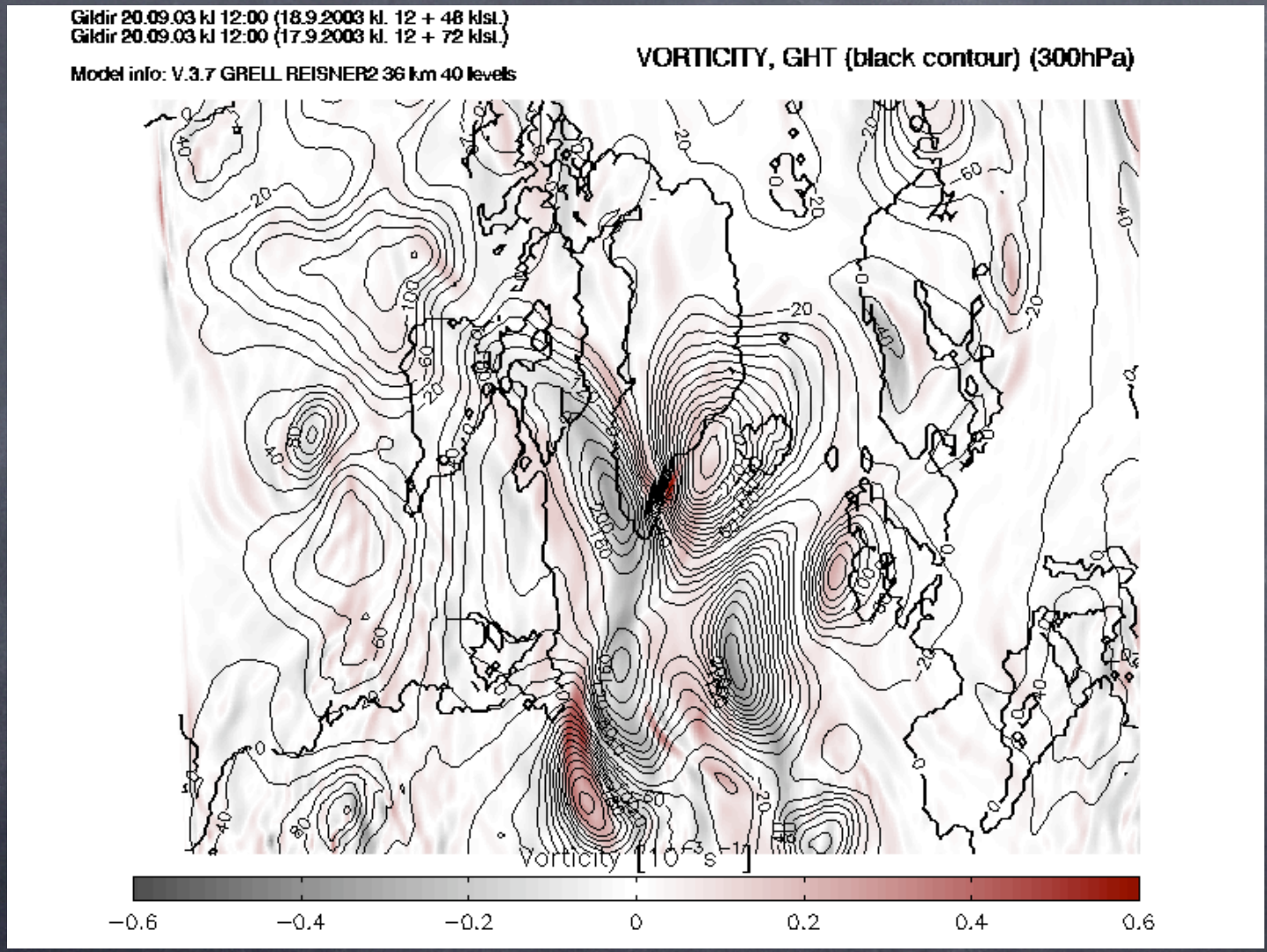
Cold advection from the north

- Resulting in a higher 500 hPa surface in the ridge west of Greenland
- --> higher gradient and "more" cold air coming from the north

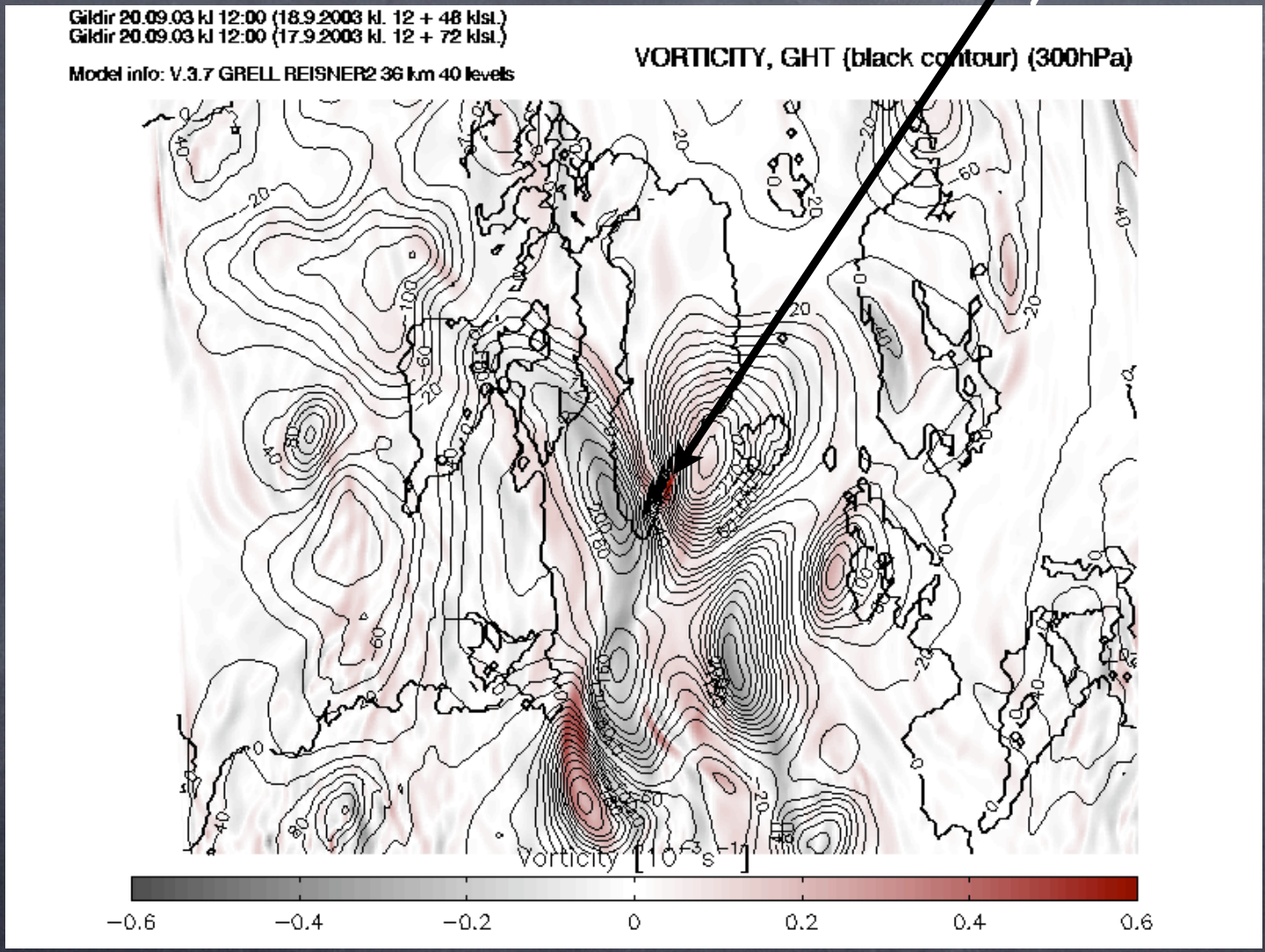
- Cold air in the lower layers --> causes the 300hPa surface to drop
- --> the wind-shear increases
  - Increase in vorticity aloft
  - --> deeper and more intense Low between Iceland and Greenland

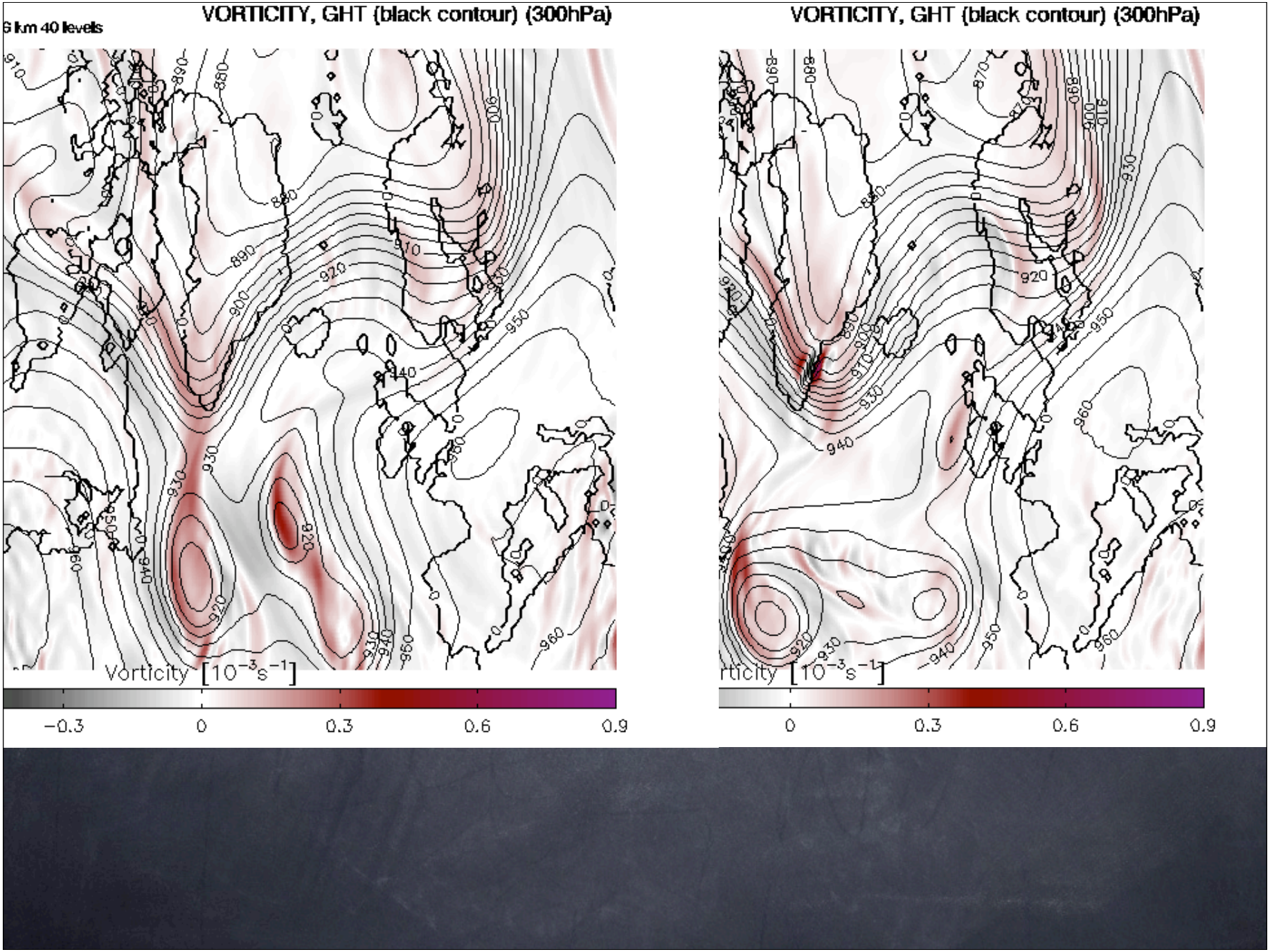

Gildir 20.09.03 kl 12:00 (18.9.2003 kl. 12 + 48 klst.)
Gildir 20.09.03 kl 12:00 (17.9.2003 kl. 12 + 72 klst.)
Model info: V.3.7 GRELL REISNER2 36 km 40 levels
T, GHT (black contour) (700hPa)
ΔT [°C]
−15
−10
−5
0
5
10
15

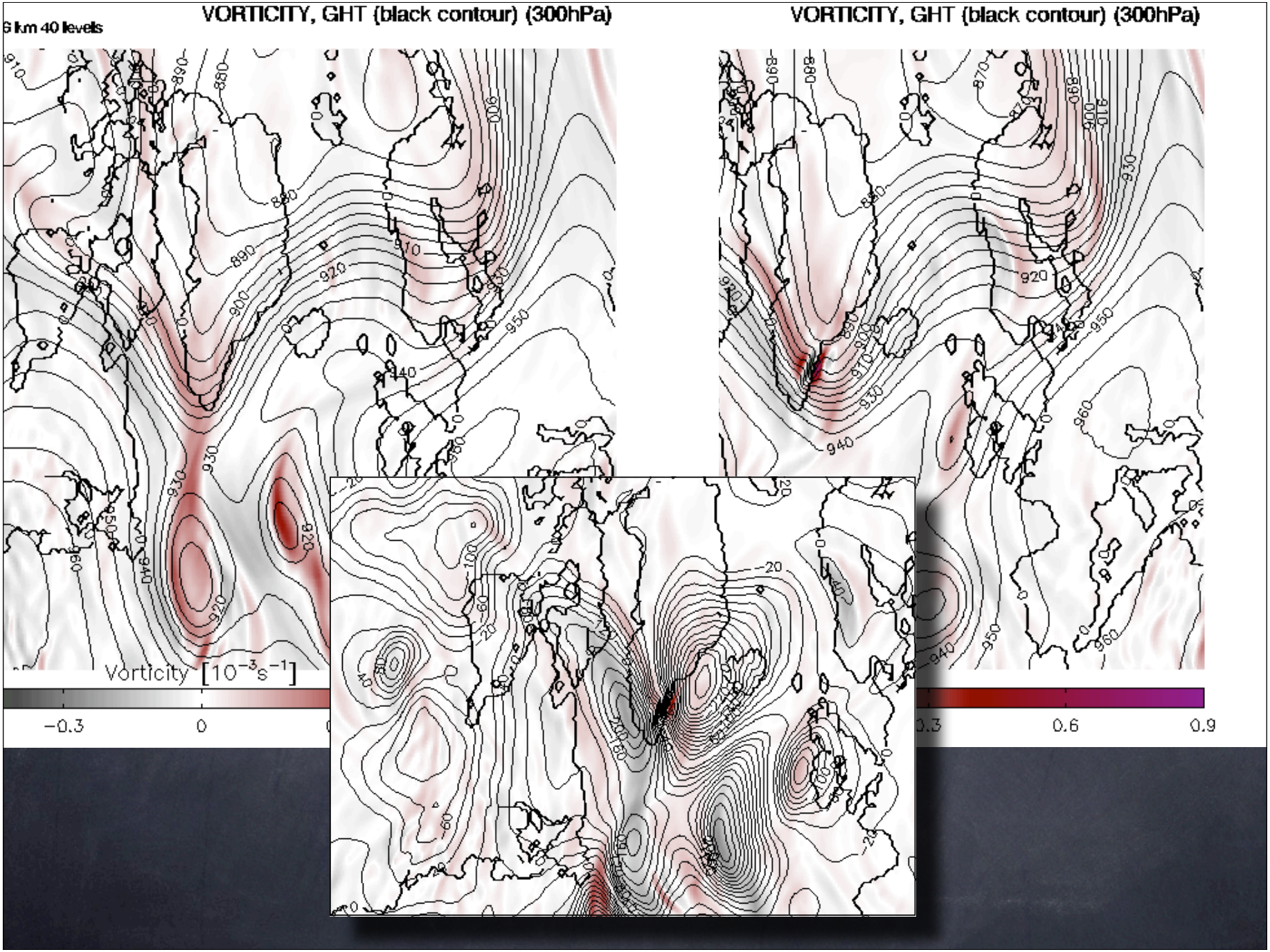

Gildir 20.09.03 kl 12:00 (18.9.2003 kl. 12 + 48 klst.)
Gildir 20.09.03 kl 12:00 (17.9.2003 kl. 12 + 72 klst.)
Model info: V.3.7 GRELL REISNER2 36 km 40 levels
T, GHT (black contour) (500hPa)
ΔT [°C]
−15
−10
−5
0
5
10
15


Gildir 20.09.03 kl 12:00 (18.9.2003 kl. 12 + 48 klst.)
Gildir 20.09.03 kl 12:00 (17.9.2003 kl. 12 + 72 klst.)
Model info: V.3.7 GRELL REISNER2 36 km 40 levels
VORTICITY, GHT (black contour) (300hPa)
Vorticity [10^-5 s^-1]
−0.6
−0.4
−0.2
0
0.2
0.4
0.6

Increased shear vorticity

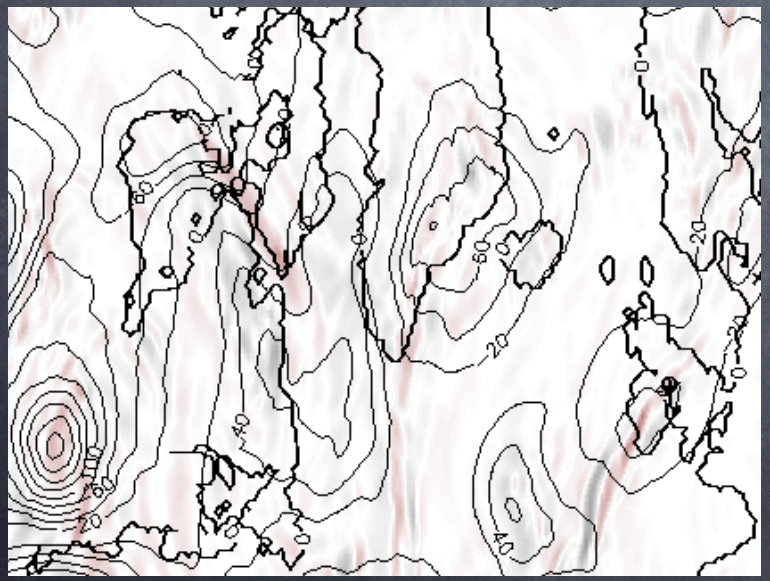


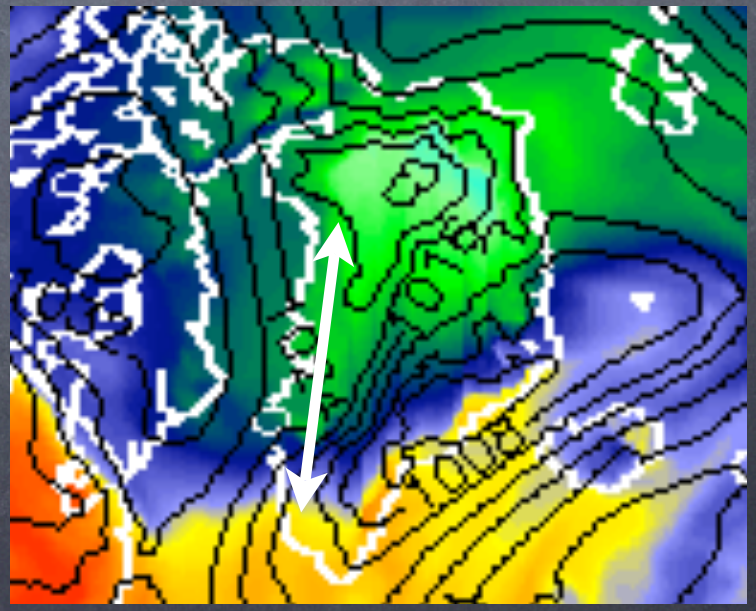

6 km 40 levels
VORTICITY, GHT (black contour) (300hPa)
VORTICITY, GHT (black contour) (300hPa)
Vorticity [10⁻³s⁻¹]
−0.3
0
0.3
0.6
0.9
0
0.3
0.6
0.9


6 km 40 levels
VORTICITY, GHT (black contour) (300hPa)
VORTICITY, GHT (black contour) (300hPa)
Vorticity [$10^{-3}s^{-1}$]
−0.3
0
0.6
0.9

And again:

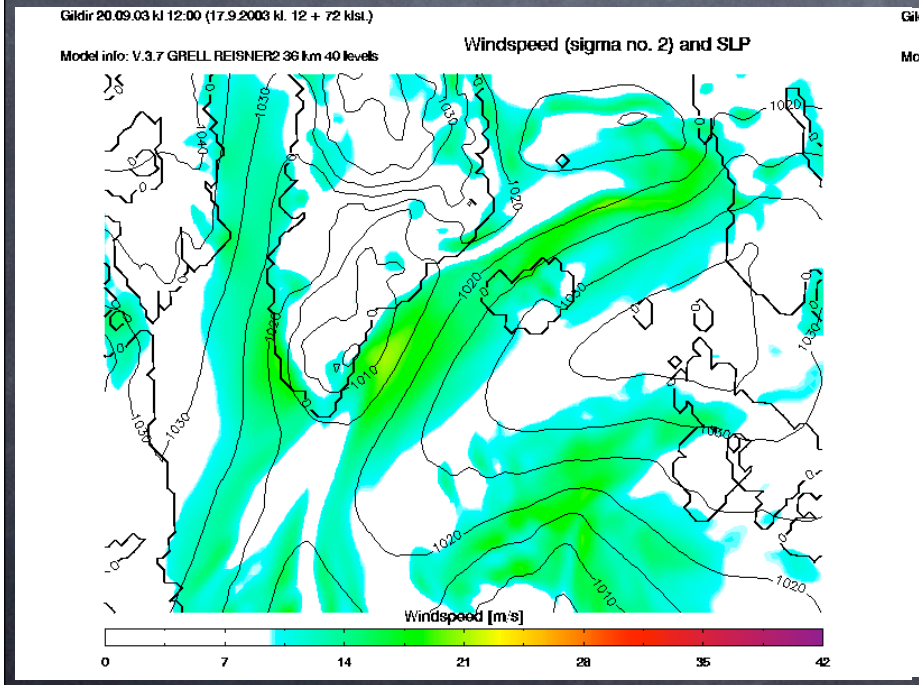
- The northerly wind was NOT so much greater
- It was the N-S temperature gradient that did the trick.

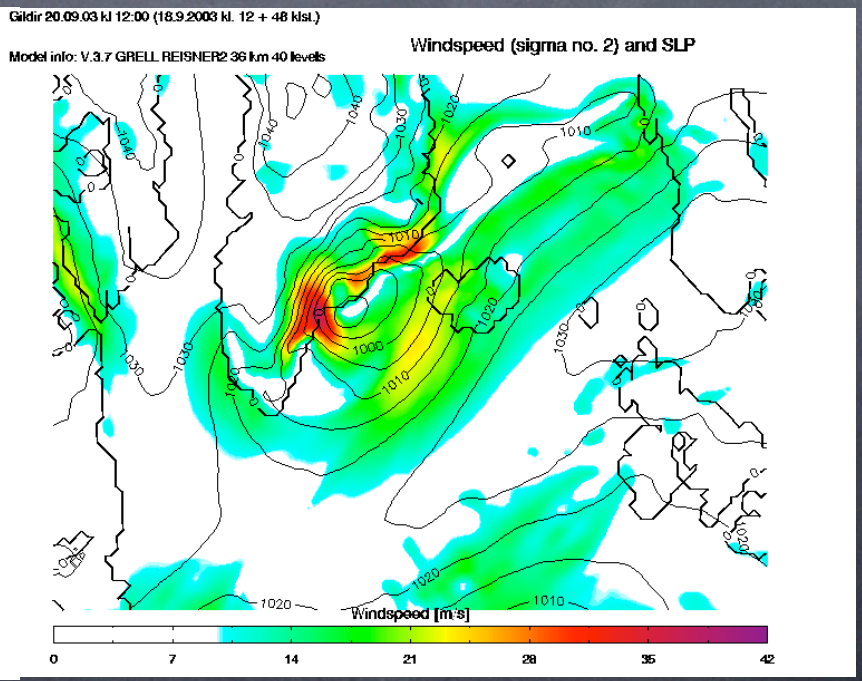




dT = 25°c

The final low:





Hafið Þökk fyrir áheyrnina

(thanks)