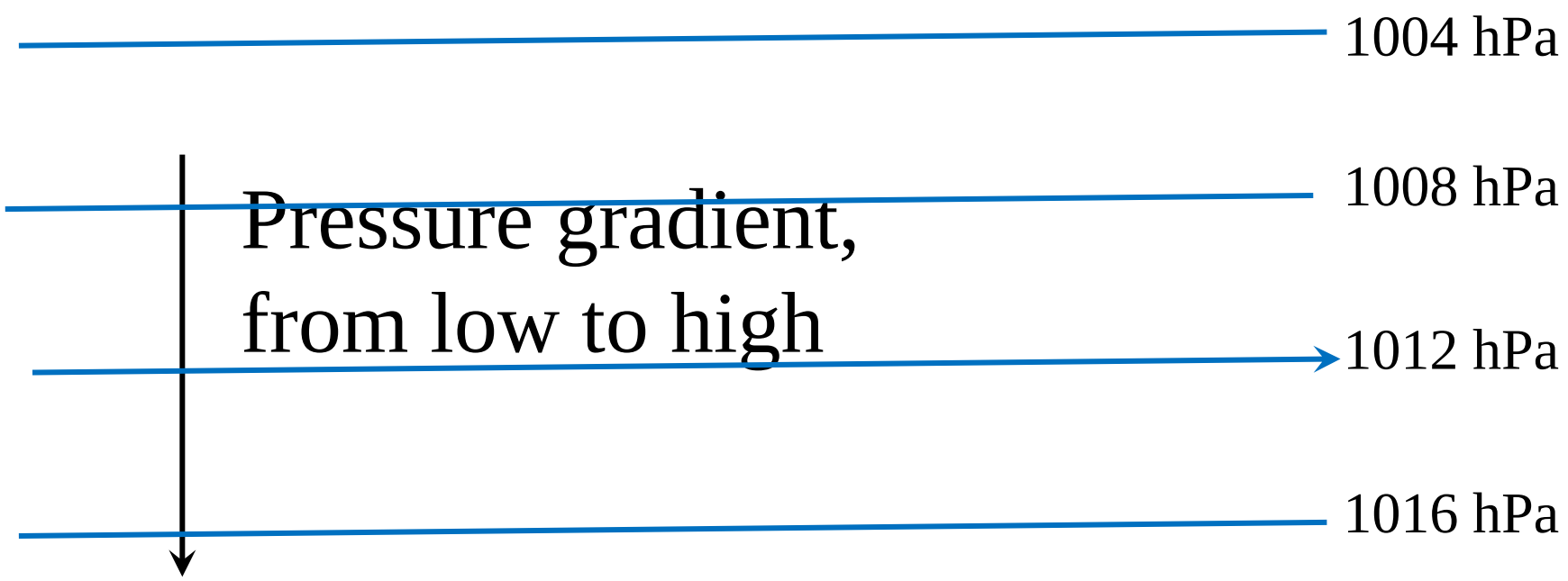
Dynamic meteorology without tears

Part 1 a:

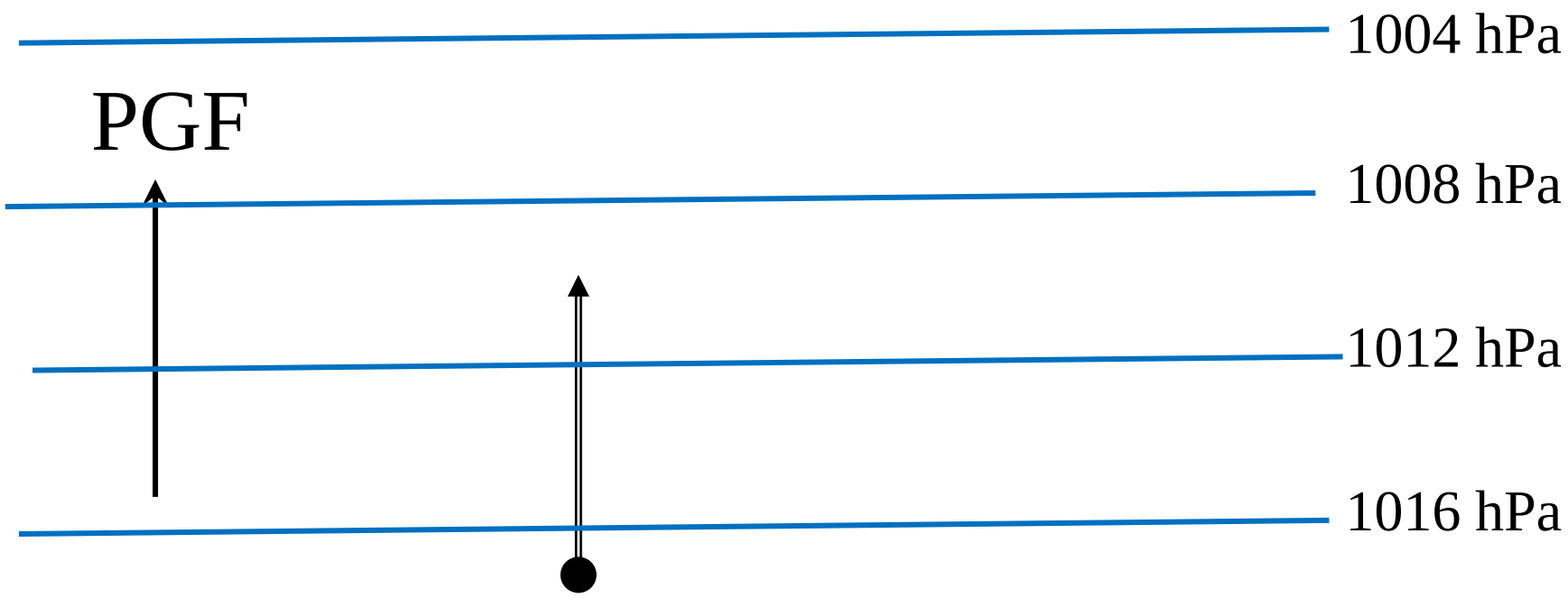
The geostrophic wind

1. What is the “geostrophic” wind?

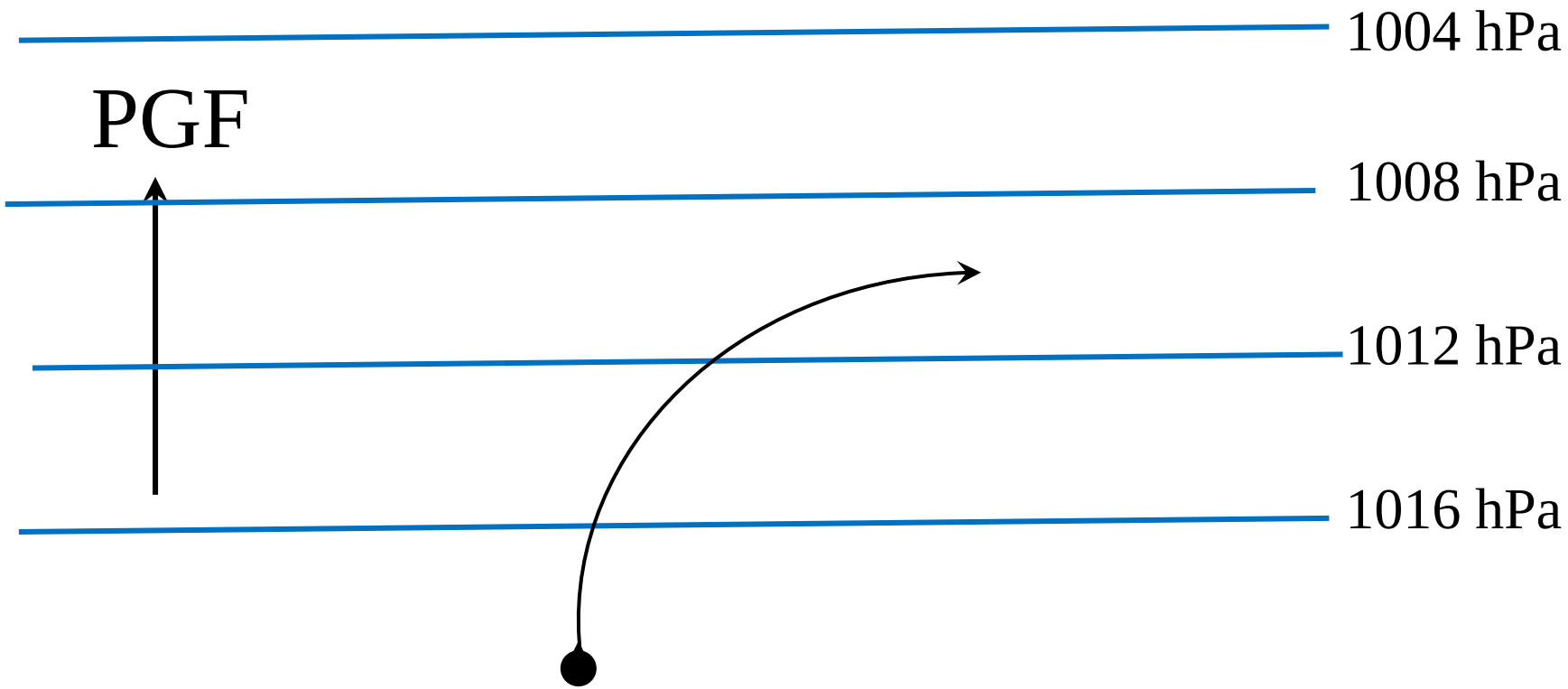
The weight of all air above defines the pressure at a certain location. It is not evenly distributed in the horisontal and we have graidents in the pressure



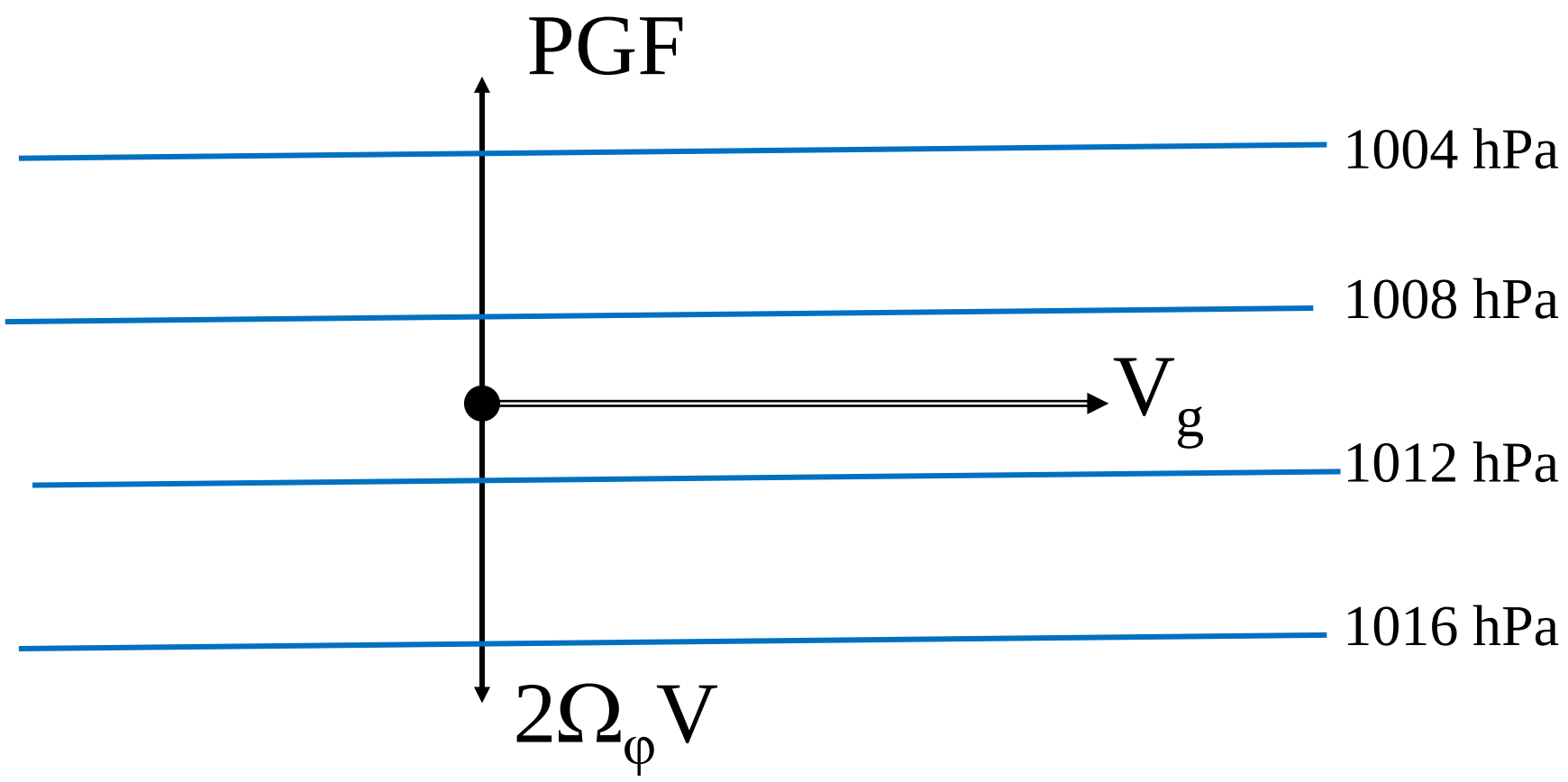
The wind is acclerated by these pressure differences, from high to low, just like a ball rolling down a hill. This pressure graident force (PGF) is opposite the gradient.



But the earth's rotation, the Coriolis force ($2\Omega_{\varphi}V$) deflects the acclerated wind to the right (at latitude φ on the Northern Hemísphere)

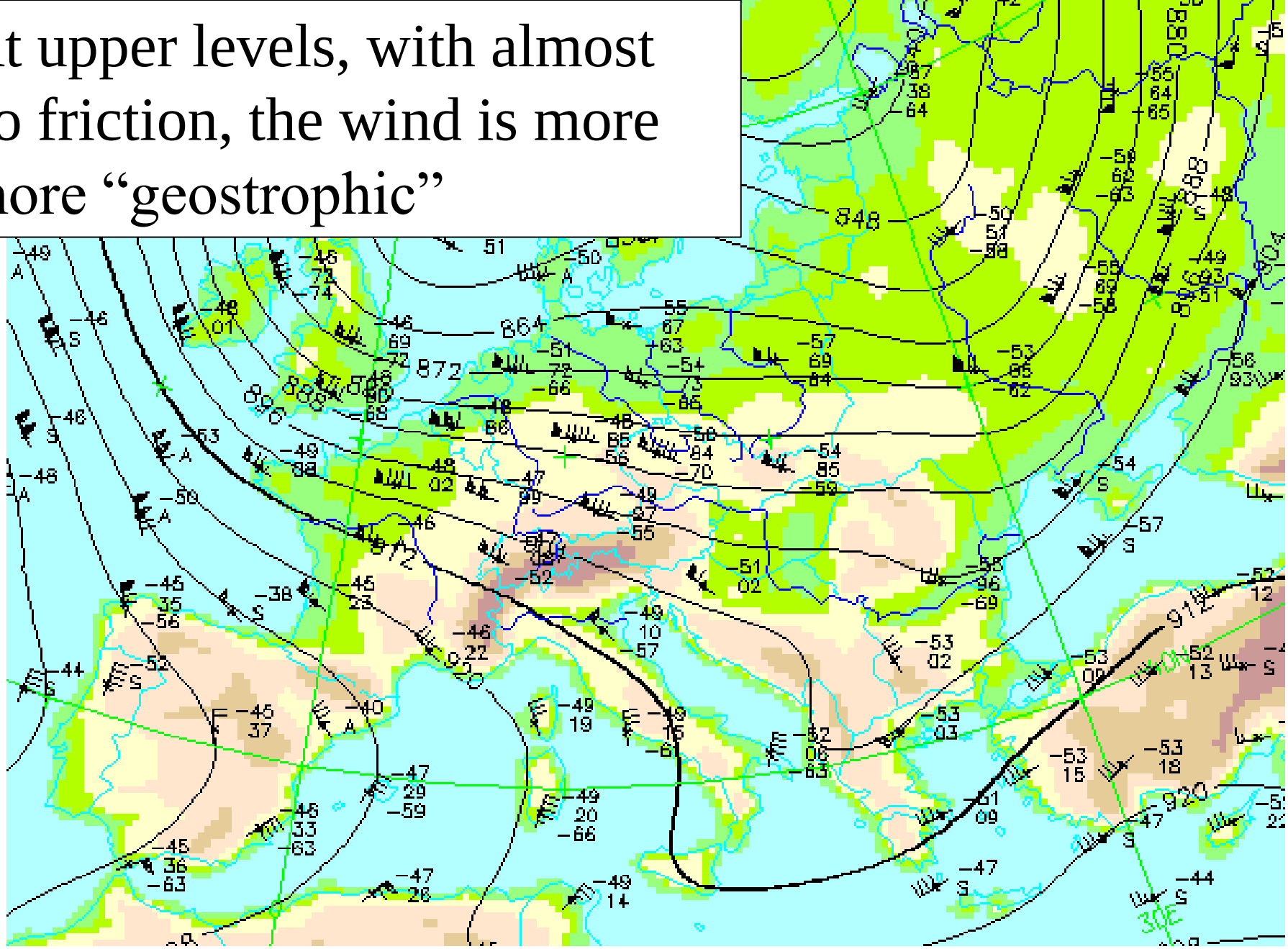


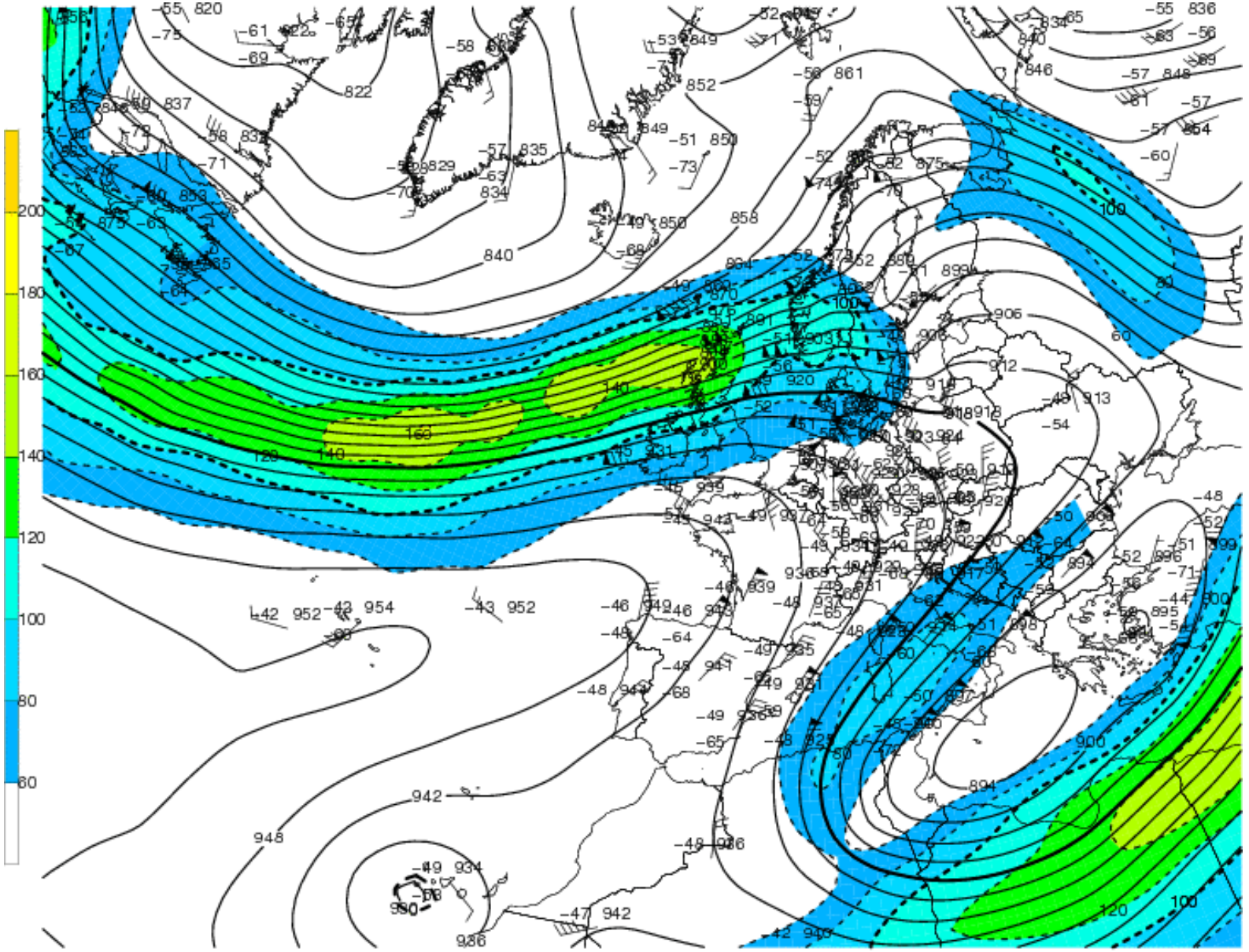
When the pressure gradient force (PGF) and the Coriolis force ($2\Omega_\varphi V$) are equal and opposite the wind moves along the isobars and is said to be “geostrophic”.



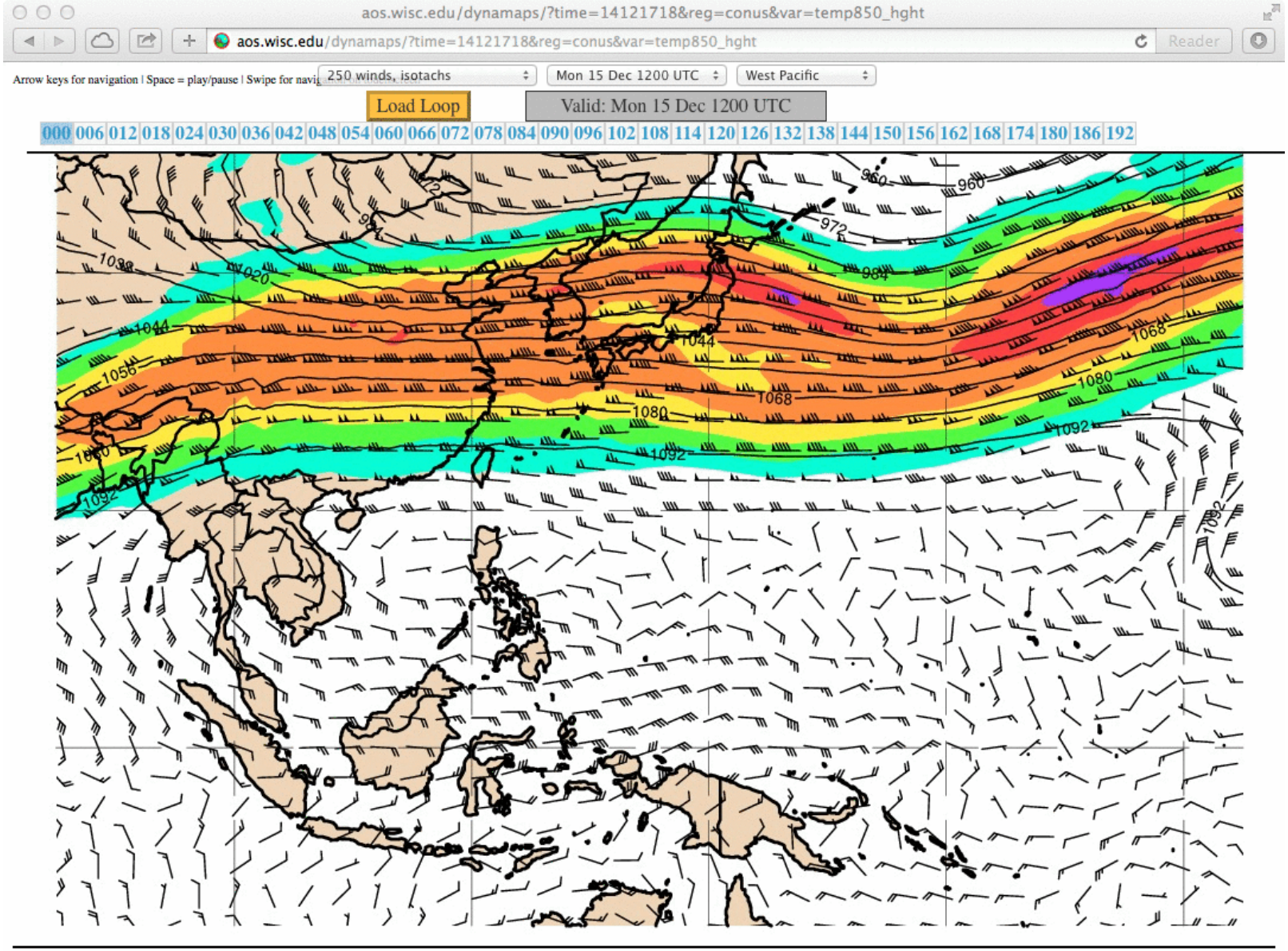
2. How does it look like?

At upper levels, with almost no friction, the wind is more more “geostrophic”





300 hPa wind/geop.h plot/150101/1200 http://meteocentre.com/toulouse/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aos.wisc.edu/dynamaps/?time=14121718&reg=conus&var=temp850_hght
Reader
Arrow keys for navigation | Space = play/pause | Swipe for navi
250 winds, isotachs
Mon 15 Dec 1200 UTC
West Pacific
Load Loop
Valid: Mon 15 Dec 1200 UTC
000 006 012 018 024 030 036 042 048 054 060 066 072 078 084 090 096 102 108 114 120 126 132 138 144 150 156 162 168 174 180 186 192
960
960
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984
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1044
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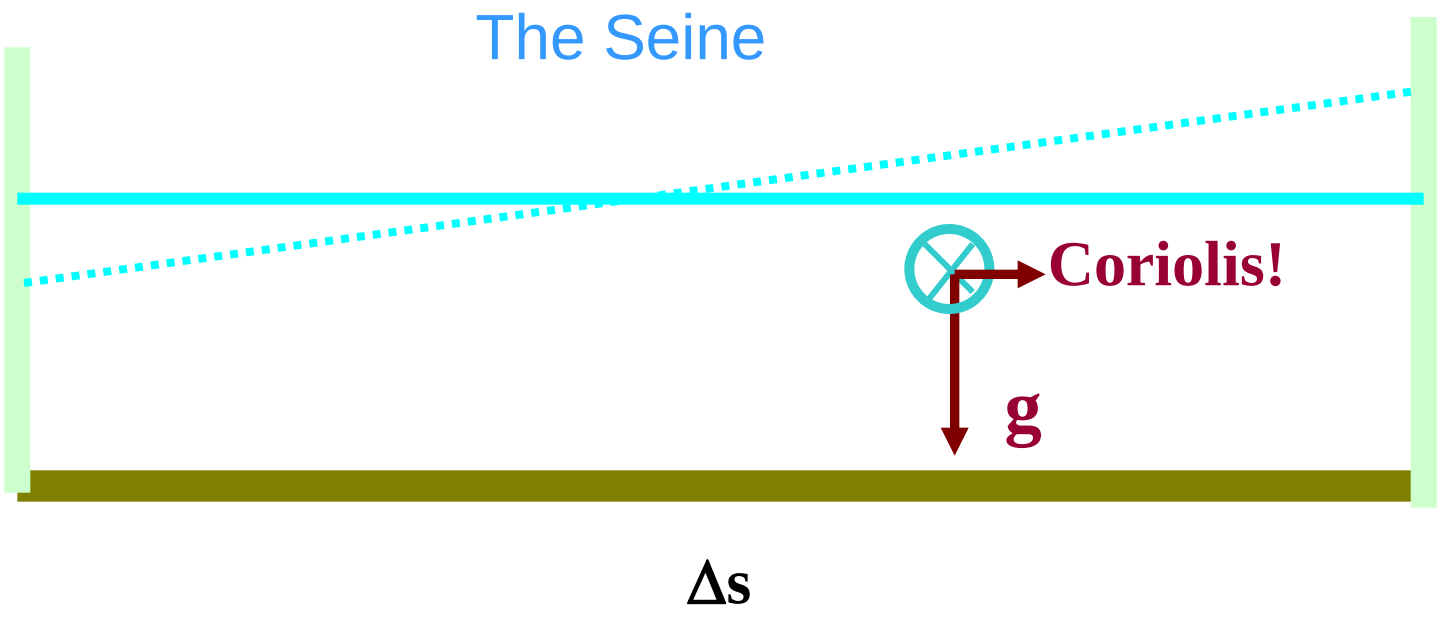
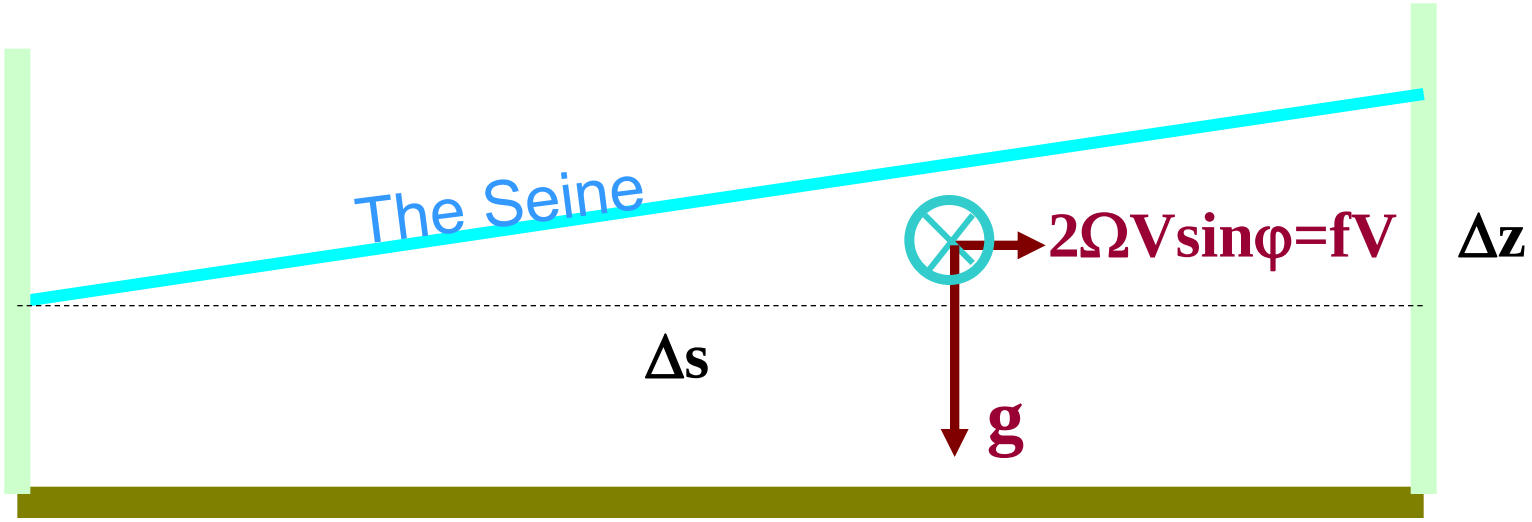
1092

3. How can we calculate it?

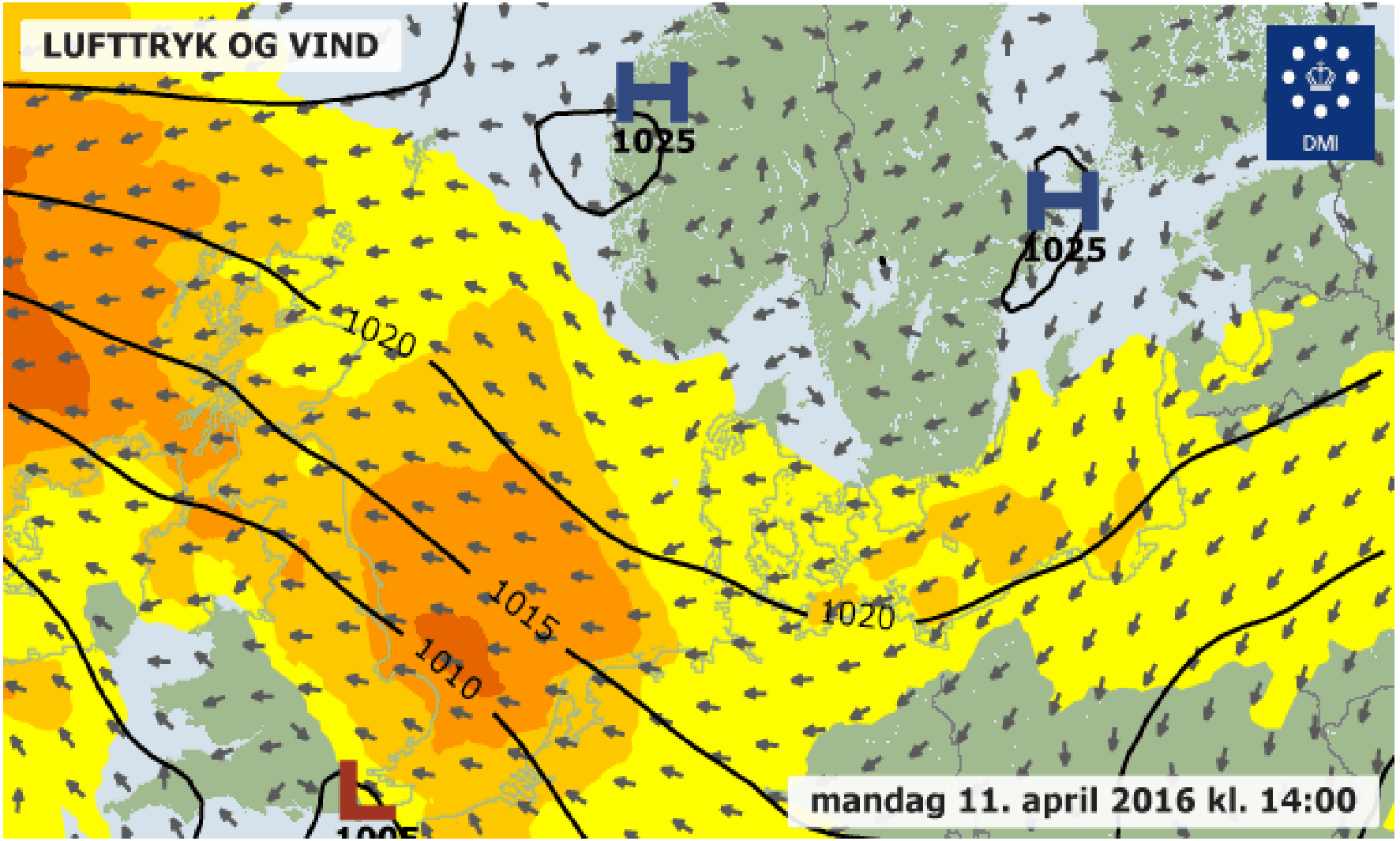
How the French Academy derived the geostrophic equation without knowing it!



$$\frac{\Delta z}{\Delta s} = \frac{fV}{g} \Rightarrow V = \frac{g}{f}\frac{\Delta z}{\Delta s}$$

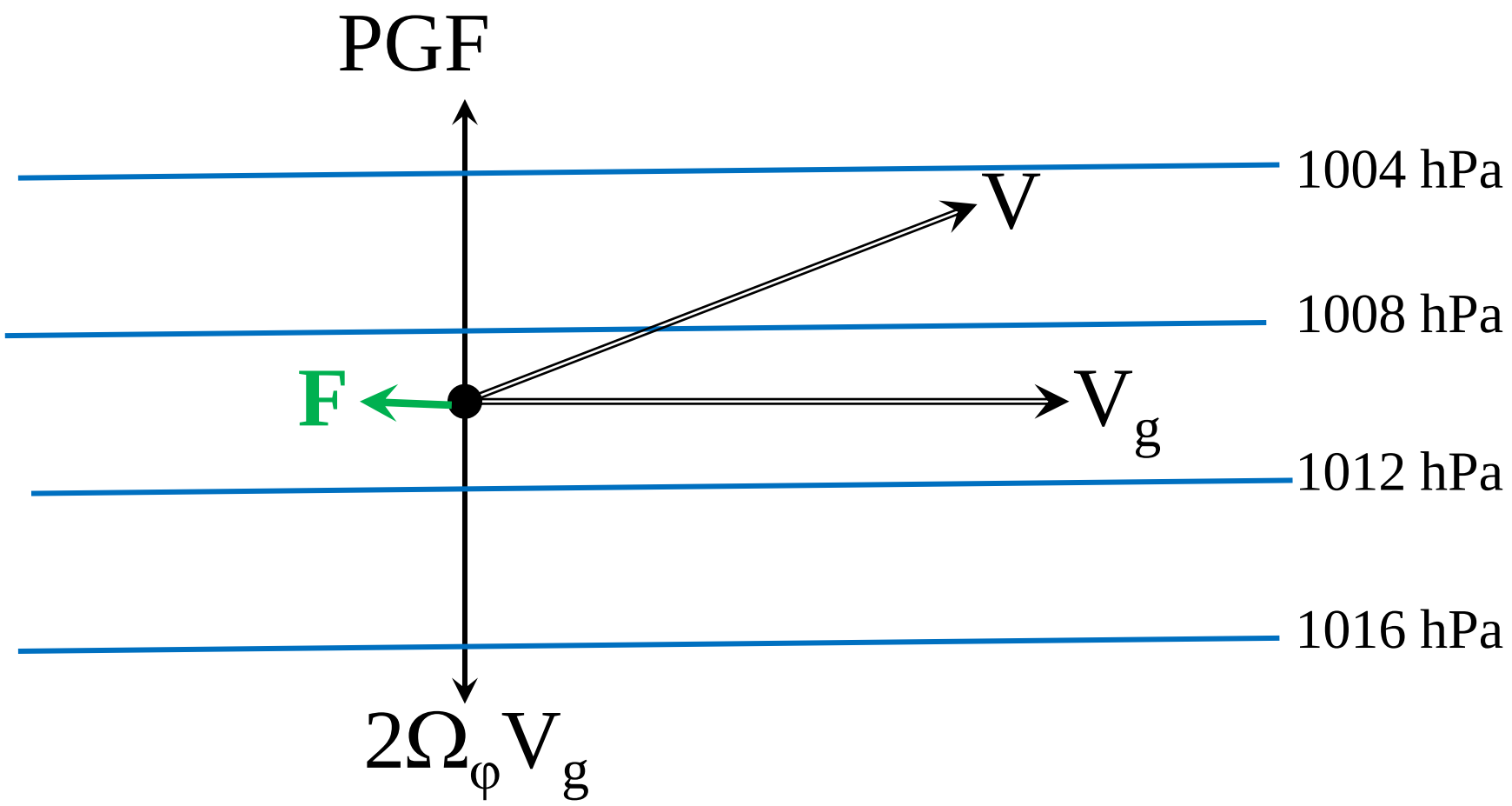


4. The role of friction



Because of friction the wind is pointing slightly towards lower pressure

If there is friction (F) against the motion, there will be balance only if the wind (V) turns towards low pressure and will no longer be “geostrophic” (V_g)



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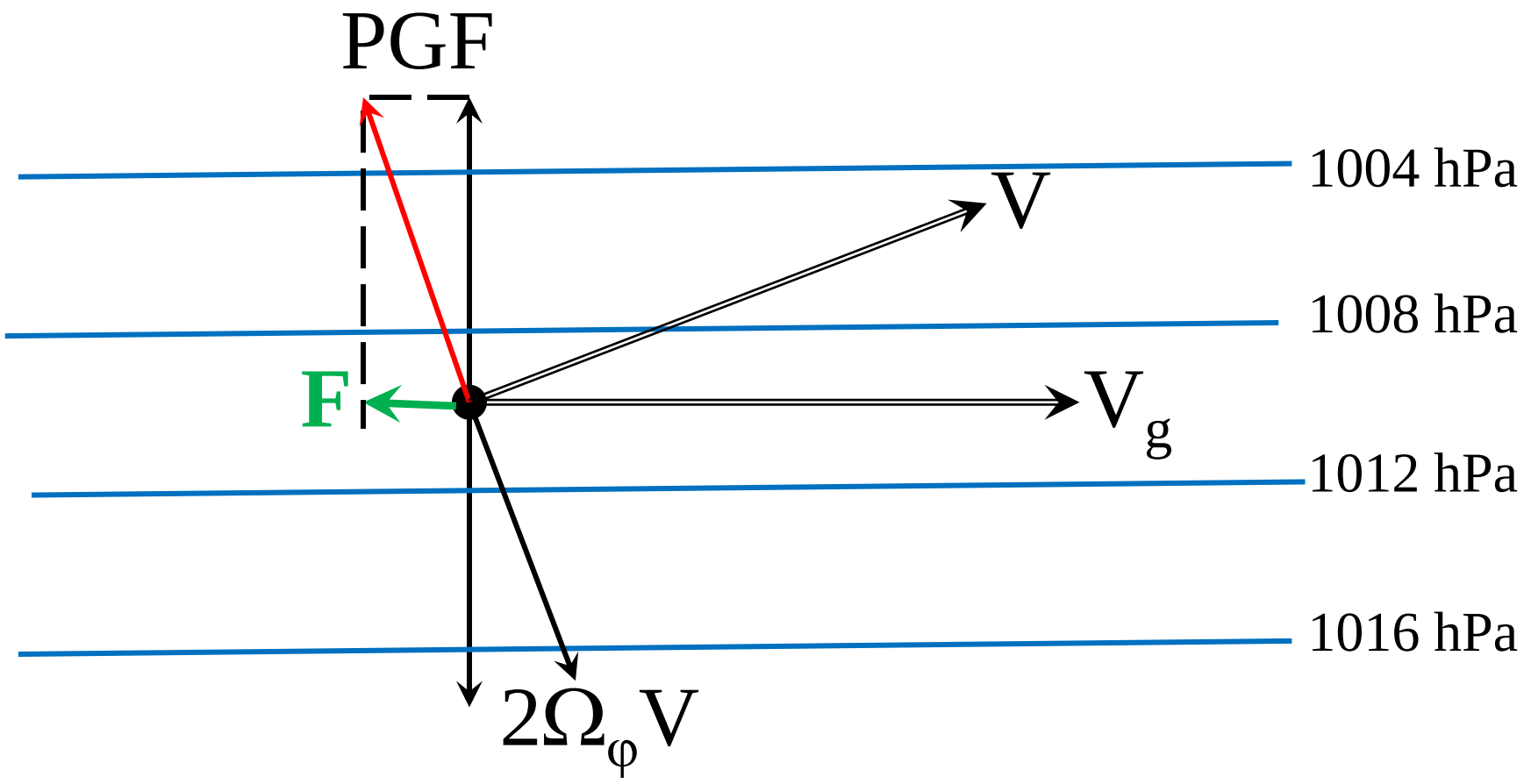

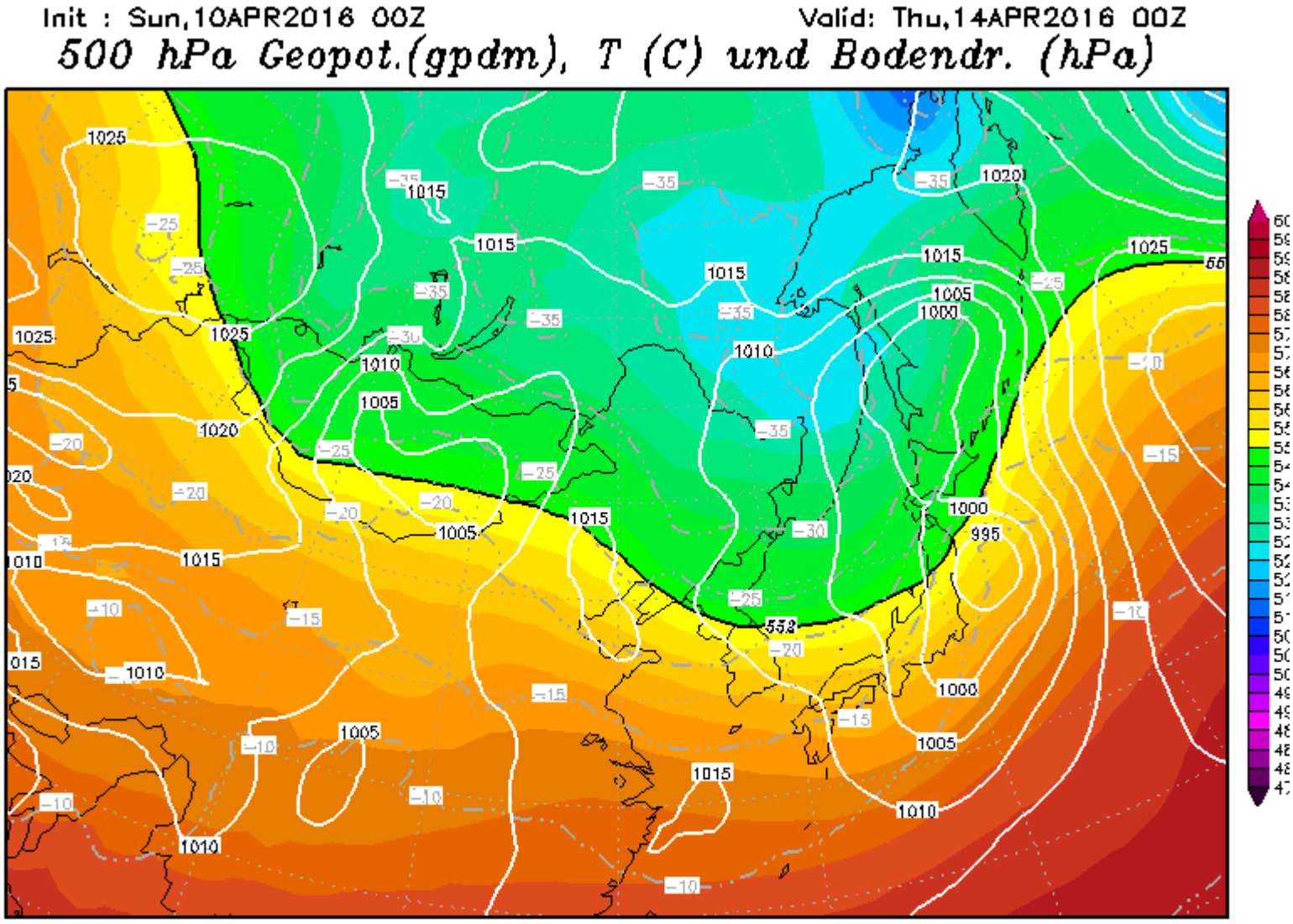
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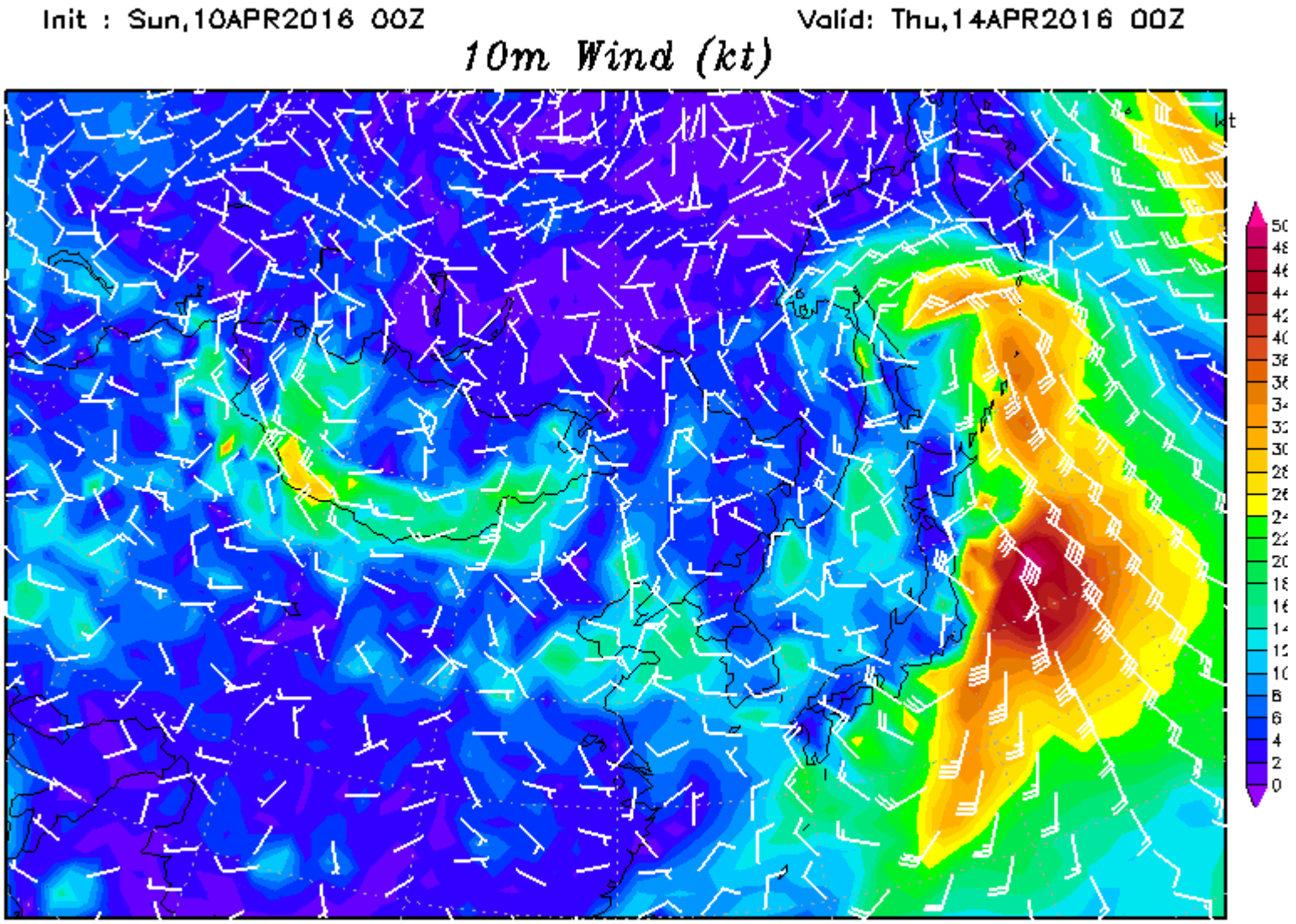
Valid: Thu,14APR2016 00Z
500 hPa Geopot.(gpdm), T (C) und Bodendr. (hPa)
Daten: GFS-Modell des amerikanischen Wetterdienstes
www.wetterzentrale.de


Init : Sun,10APR2016 00Z
Valid: Thu,14APR2016 00Z
10m Wind (kt)
kt
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46
44
42
40
38
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32
30
28
26
24
22
20
18
16
14
12
10
8
6
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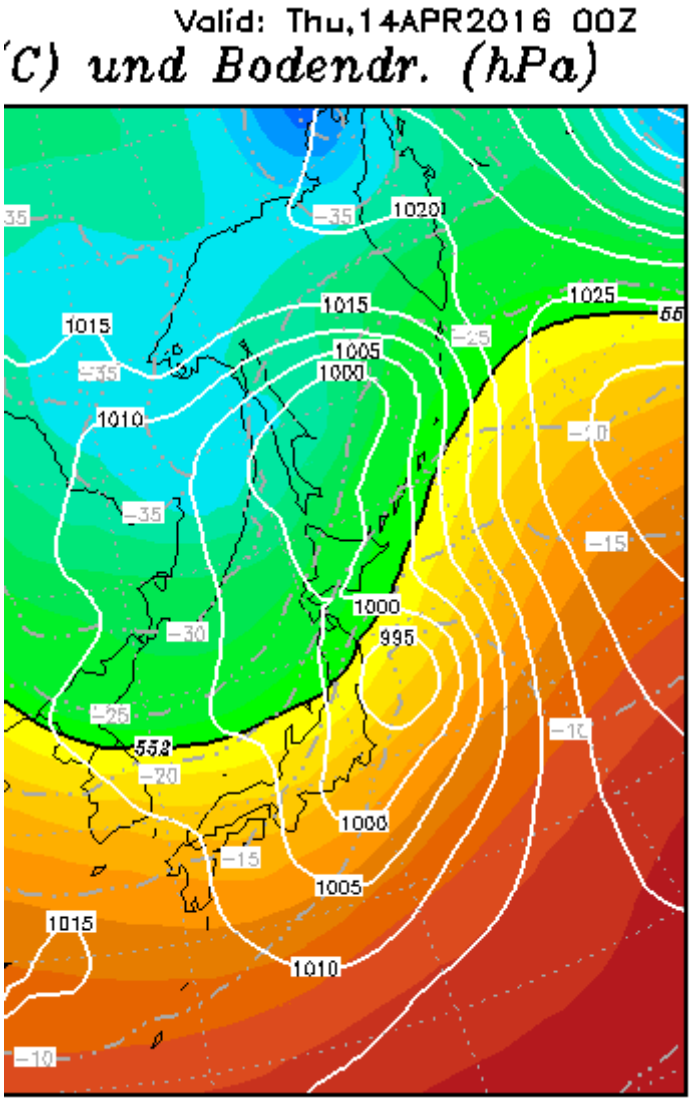
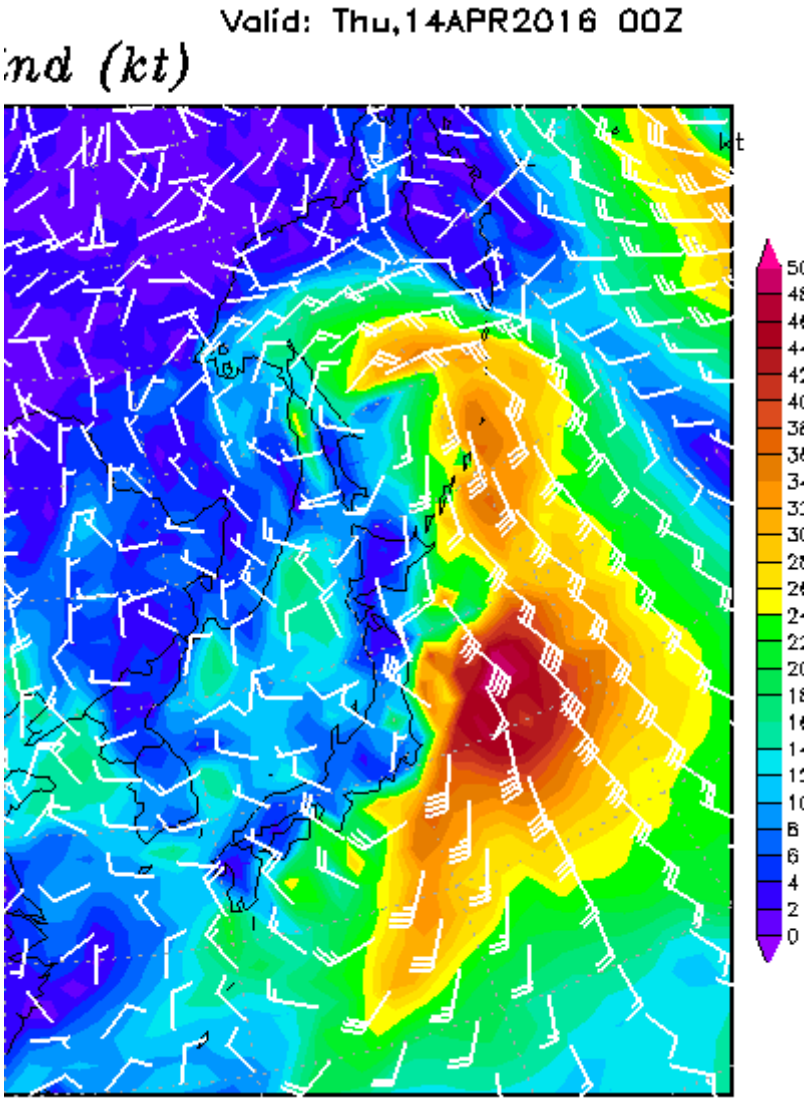
2
0
Daten: GFS-Modell des amerikanischen Wetterdienstes
www.wetterzentrale.de


Valid: Thu,14APR2016 00Z
C) und Bodendr. (hPa)
1020
1025
1015
1005
1000
1010
995
552
1015
1010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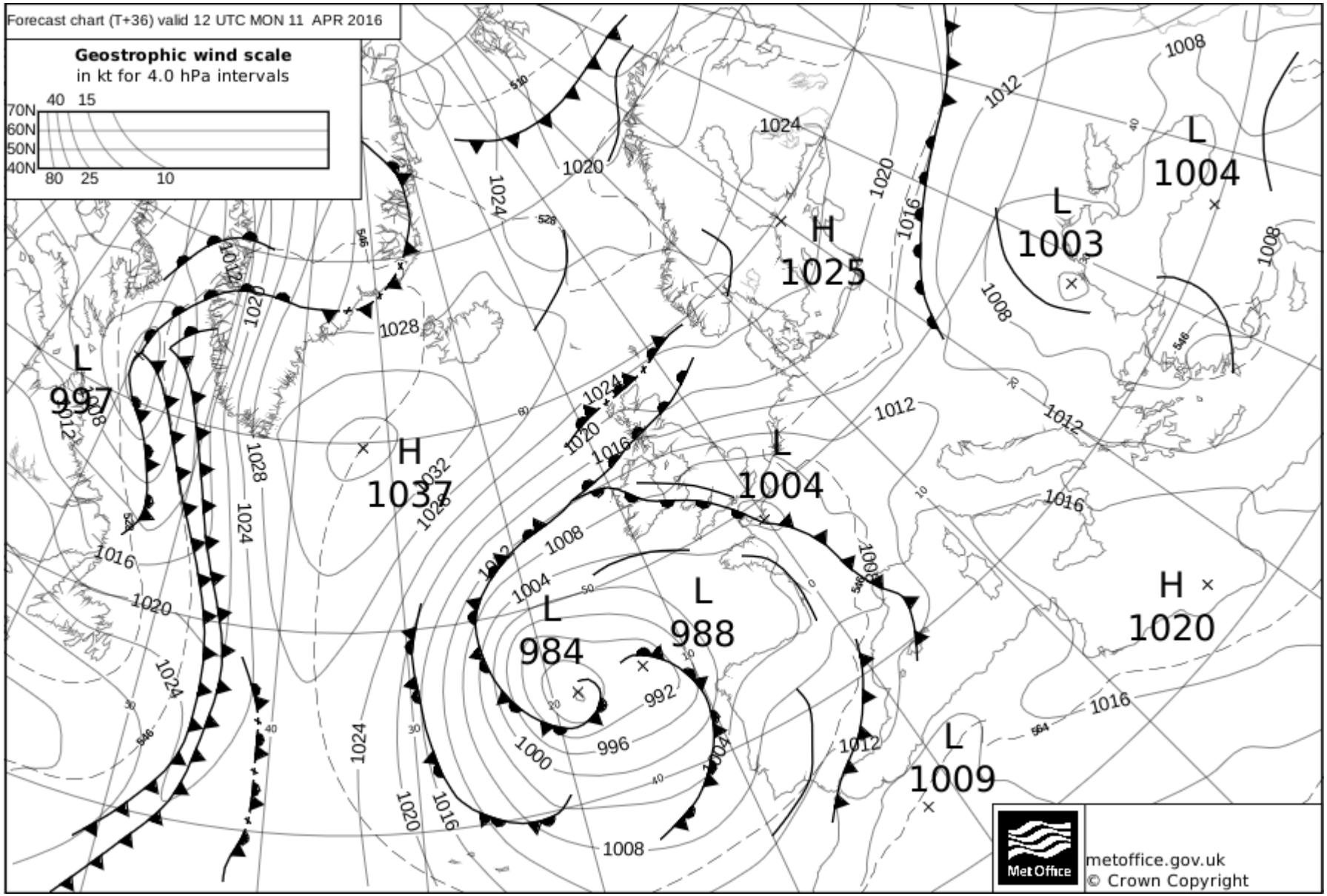
nd (kt)
kt

5. How to use it to read weather maps


Forecast chart (T+36) valid 12 UTC MON 11 APR 2016
Geostrophic wind scale
in kt for 4.0 hPa intervals
40 15
70N
60N
50N
40N
80 25 10
L 997
H 1037
L 984
L 988
L 1004
H 1025
L 1003
L 1004
H 1020
L 1009
1028
1024
1020
1016
1012
1008
1004
1000
996
992
metoffice.gov.uk
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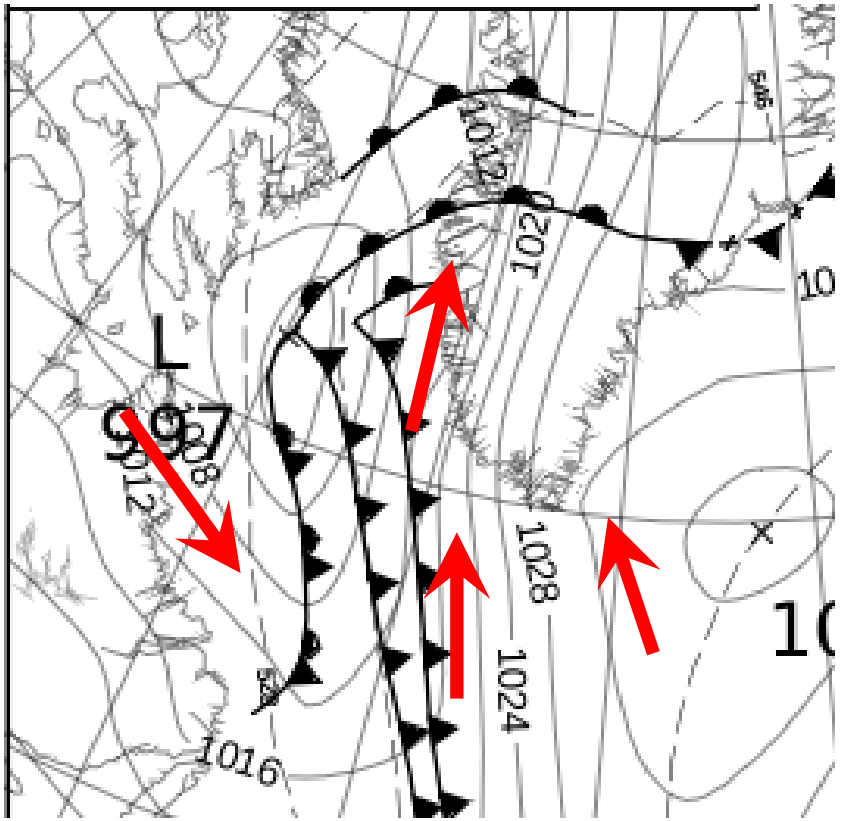
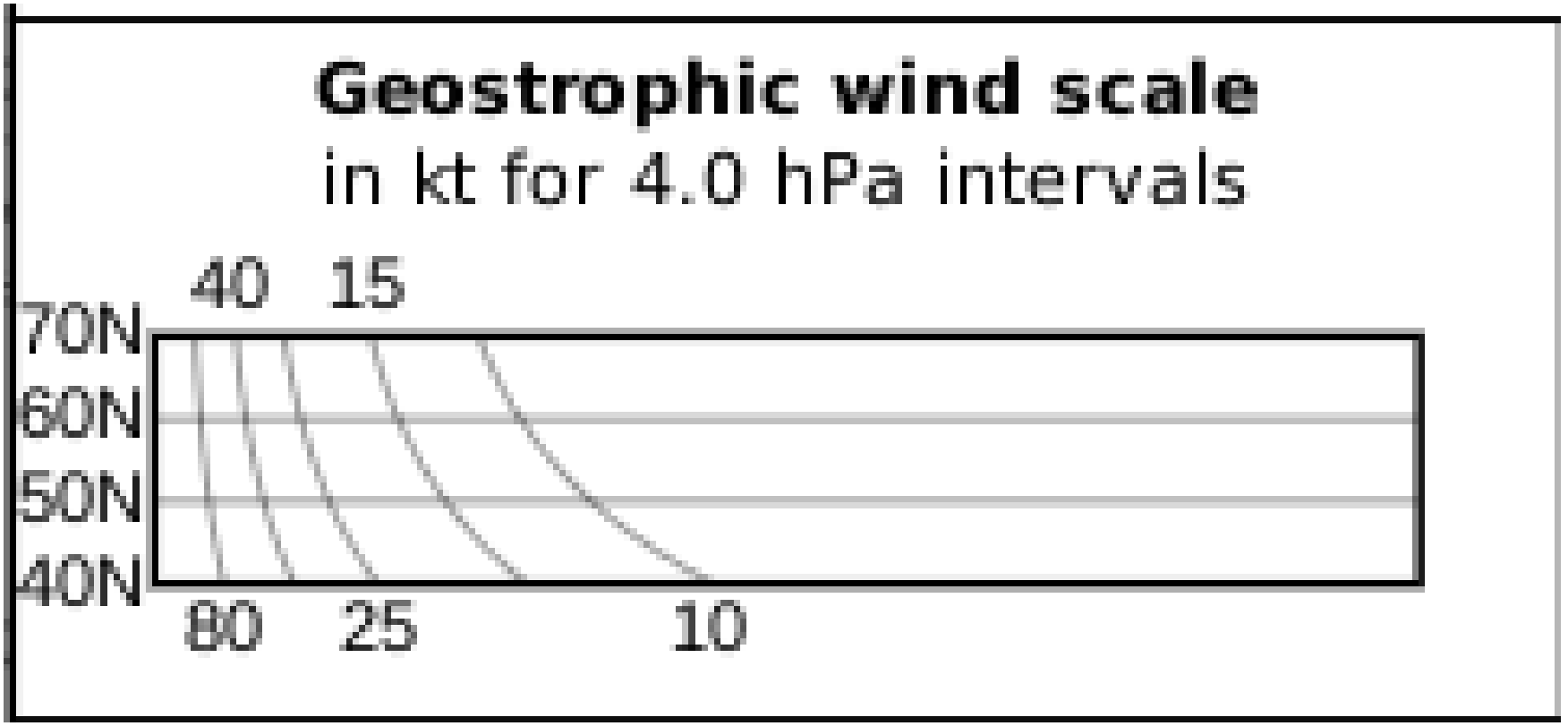
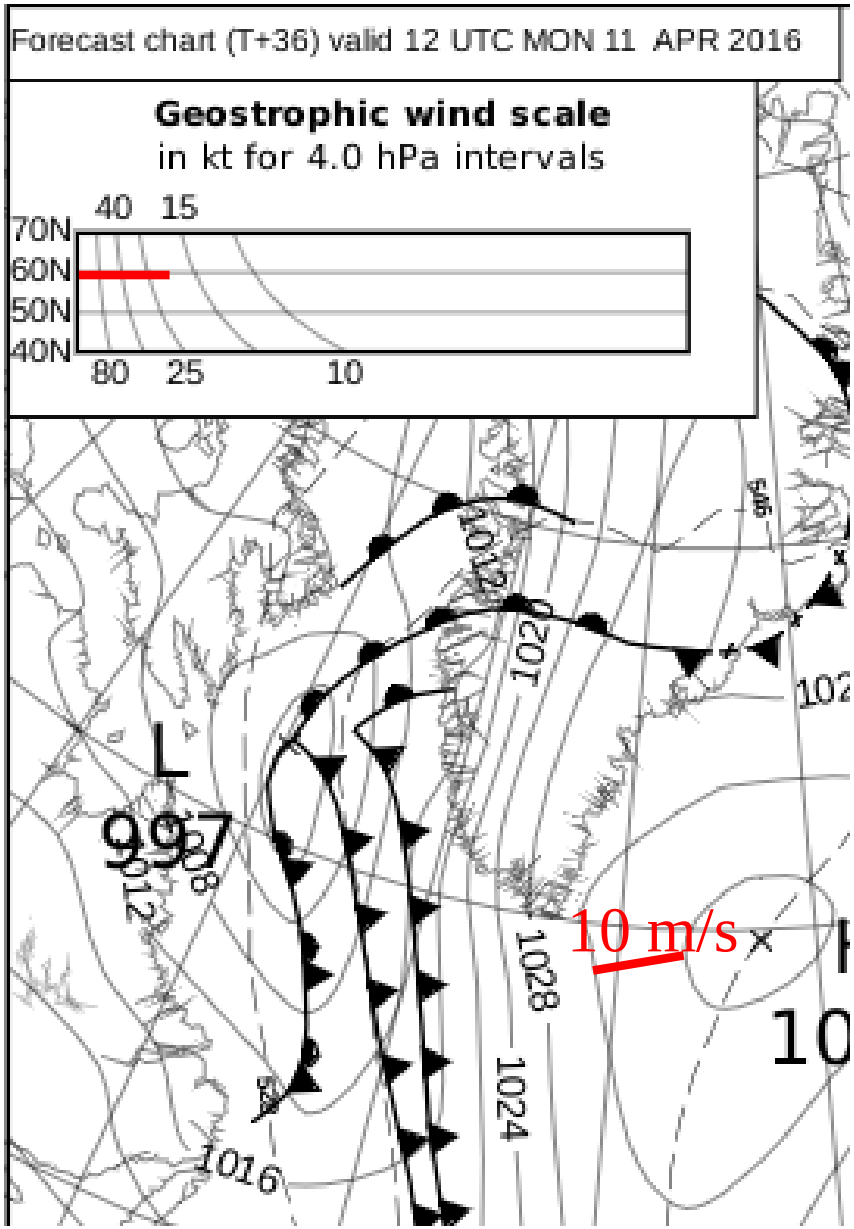
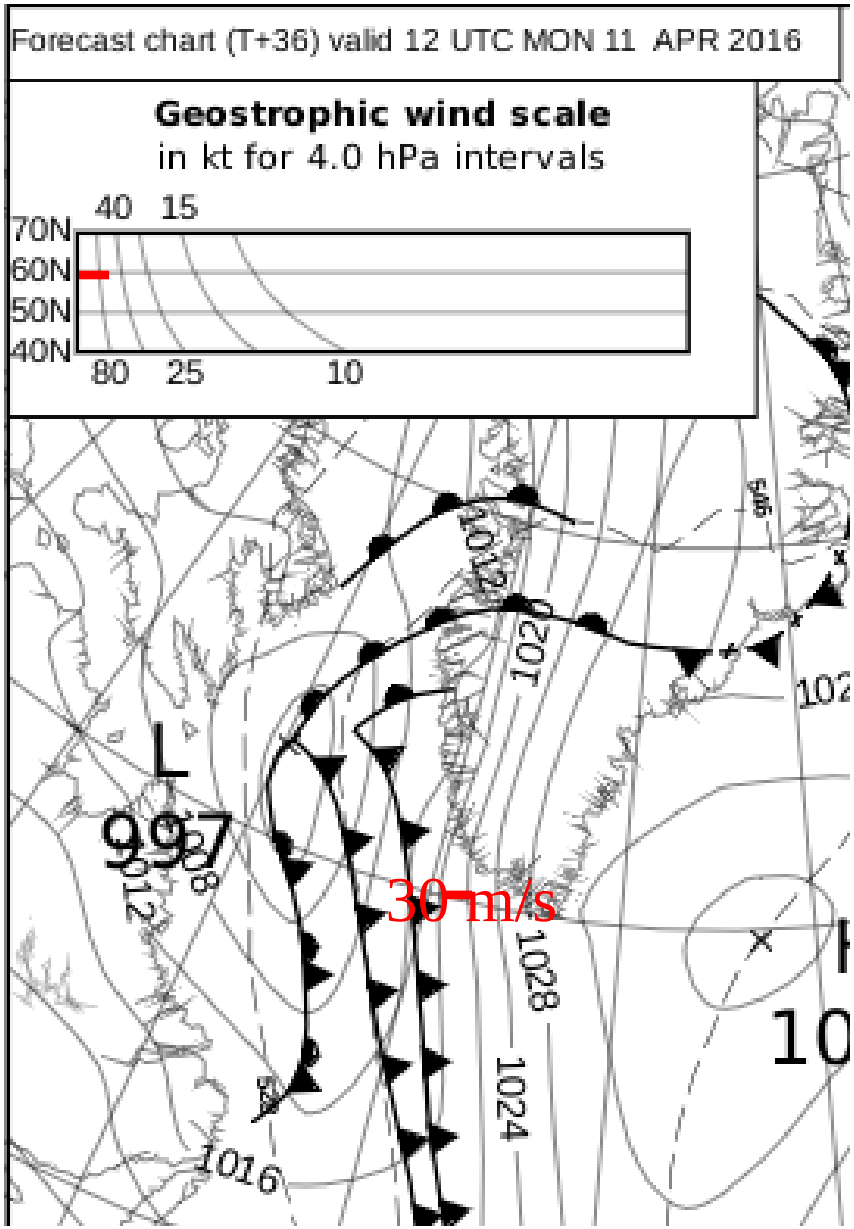
The sea surface pressure and wind just now, Monday 11 April 2016 at midday



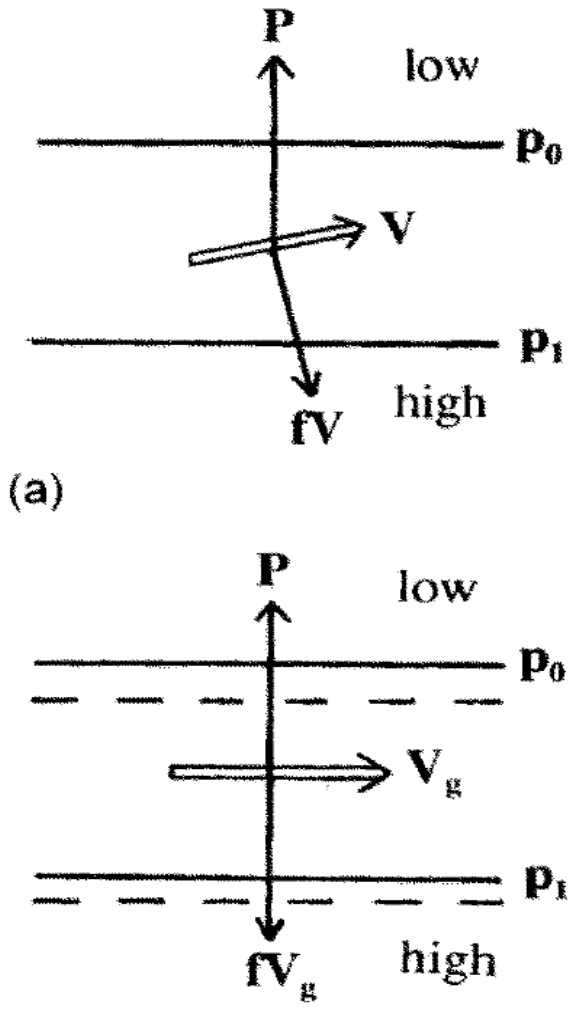

Geostrophic wind scale
in kt for 4.0 hPa intervals
40
15
70N
60N
50N
40N
80
25
10


Forecast chart (T+36) valid 12 UTC MON 11 APR 2016
Geostrophic wind scale
in kt for 4.0 hPa intervals
40 15
70N
60N
50N
40N
80 25 10
L
997
1012
1008
1012
1020
1028
1024
1016
10 m/s


Forecast chart (T+36) valid 12 UTC MON 11 APR 2016
Geostrophic wind scale
in kt for 4.0 hPa intervals
40 15
70N
60N
50N
40N
80 25 10
L
997
30 m/s
1012
1020
1028
1024
1016

6. But if the wind is not “geostrophic”????

Then the wind and the pressure field adjust towards each other

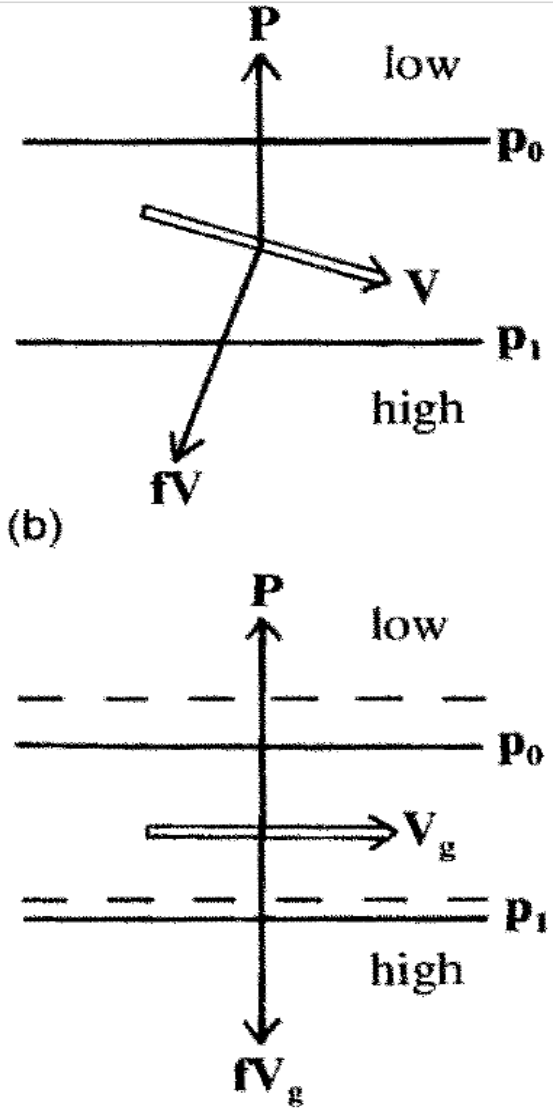


If the wind is weaker than the "geostrophic", the PGF will accelerate it "downhill" towards lower pressure and make the wind stronger.

At the same time this will also transport air and weaken the pressure gradient.

Wind and pressure will adjust towards each other

Then the wind and the pressure field adjust towards each other



If the wind is stronger than the "geostrophic", the PGF will accelerate it "uphill" towards higher pressure and make the wind weaker.

At the same time this will also transport air and strengthen the pressure gradient.

Wind and pressure will adjust towards each other

END