High resolution weather forecasting

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– GalileoCast -

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Overview

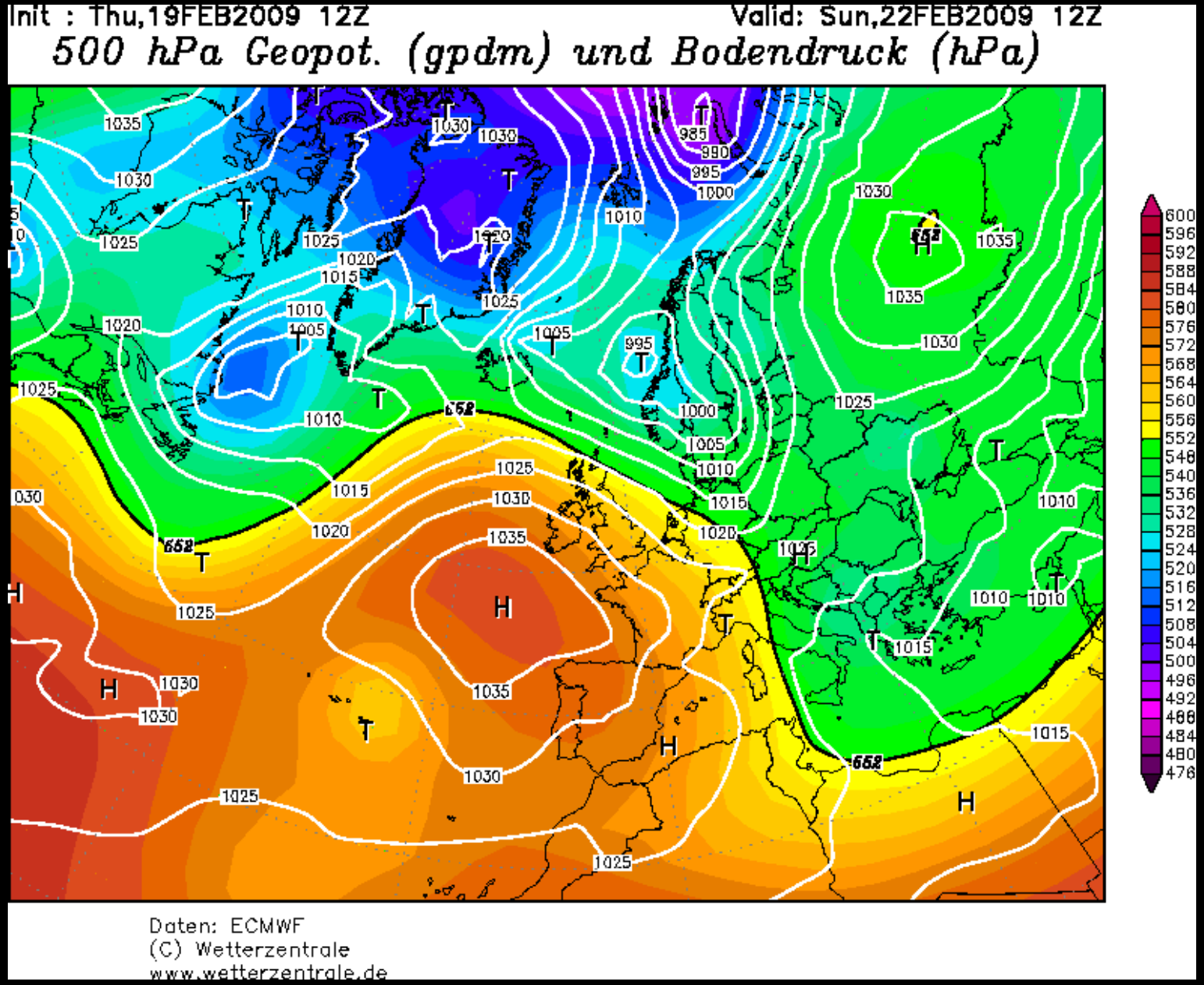
I. What is numerical weather forecasting and how is a high resolution weather forecast produced?

II. How can we benefit from high resolution weather forecasts?

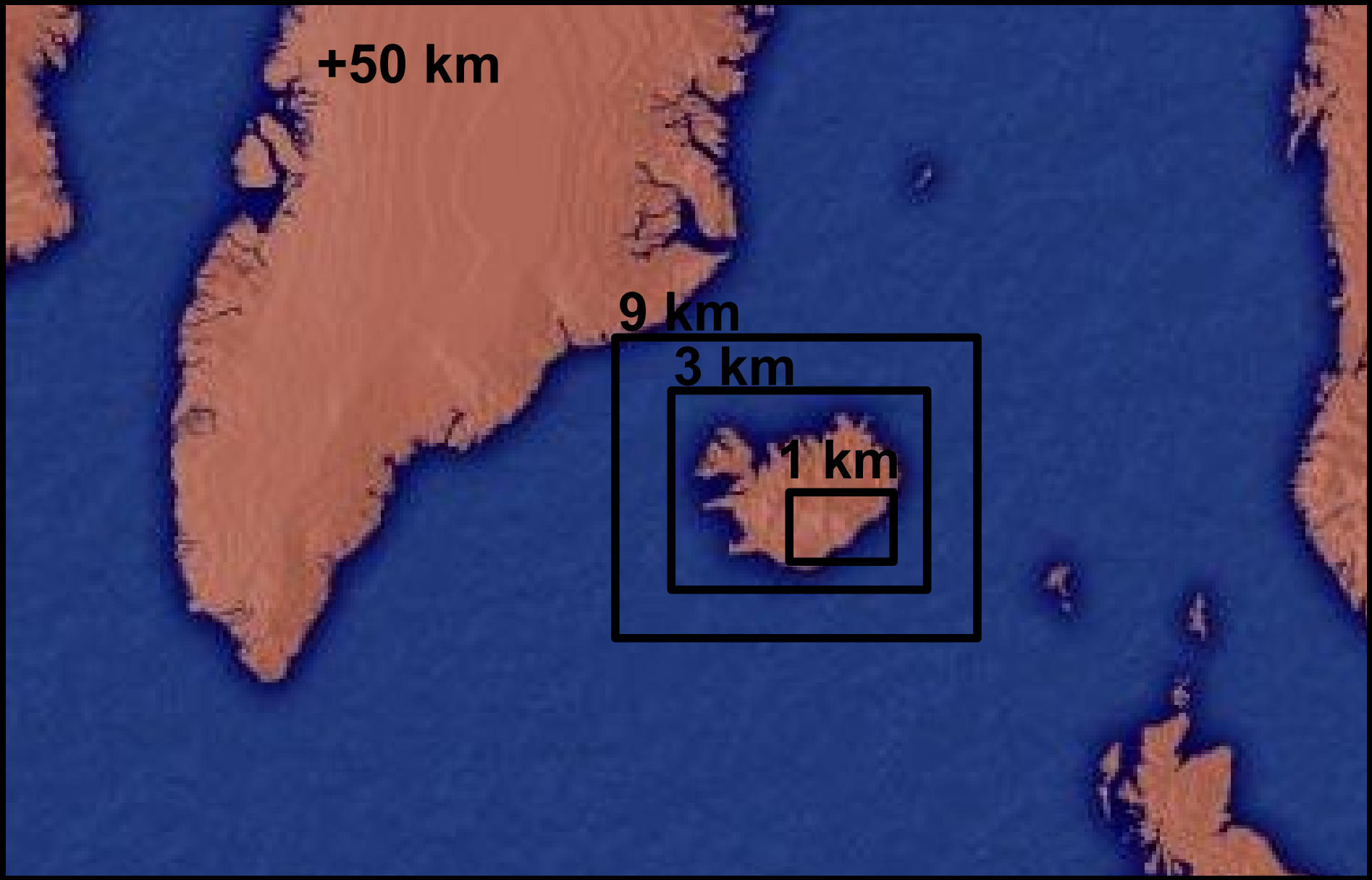
Numerical weather forecasting?

- We use a state of the art mesoscale numerical weather model, e.g. the AR-WRF.
- We solve a set of non-linear equations describing the state of the atmosphere.
- And then we have a set of extra equations describing radiation, moisture, clouds etc.
- These are solved in difference form on a vertical and horizontal grid.

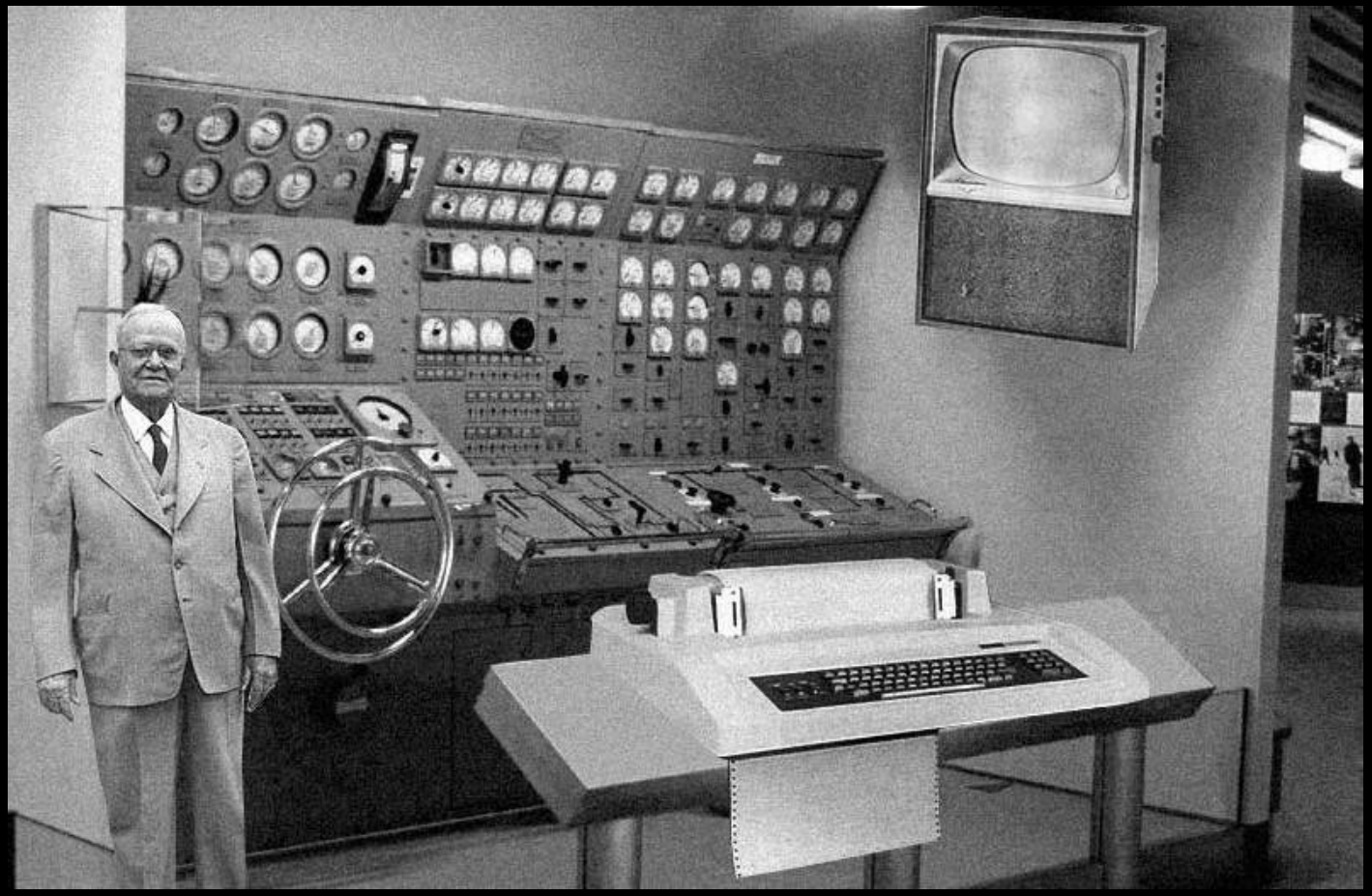
Global forecast at a coarse resolution



Downscale with increased resolution

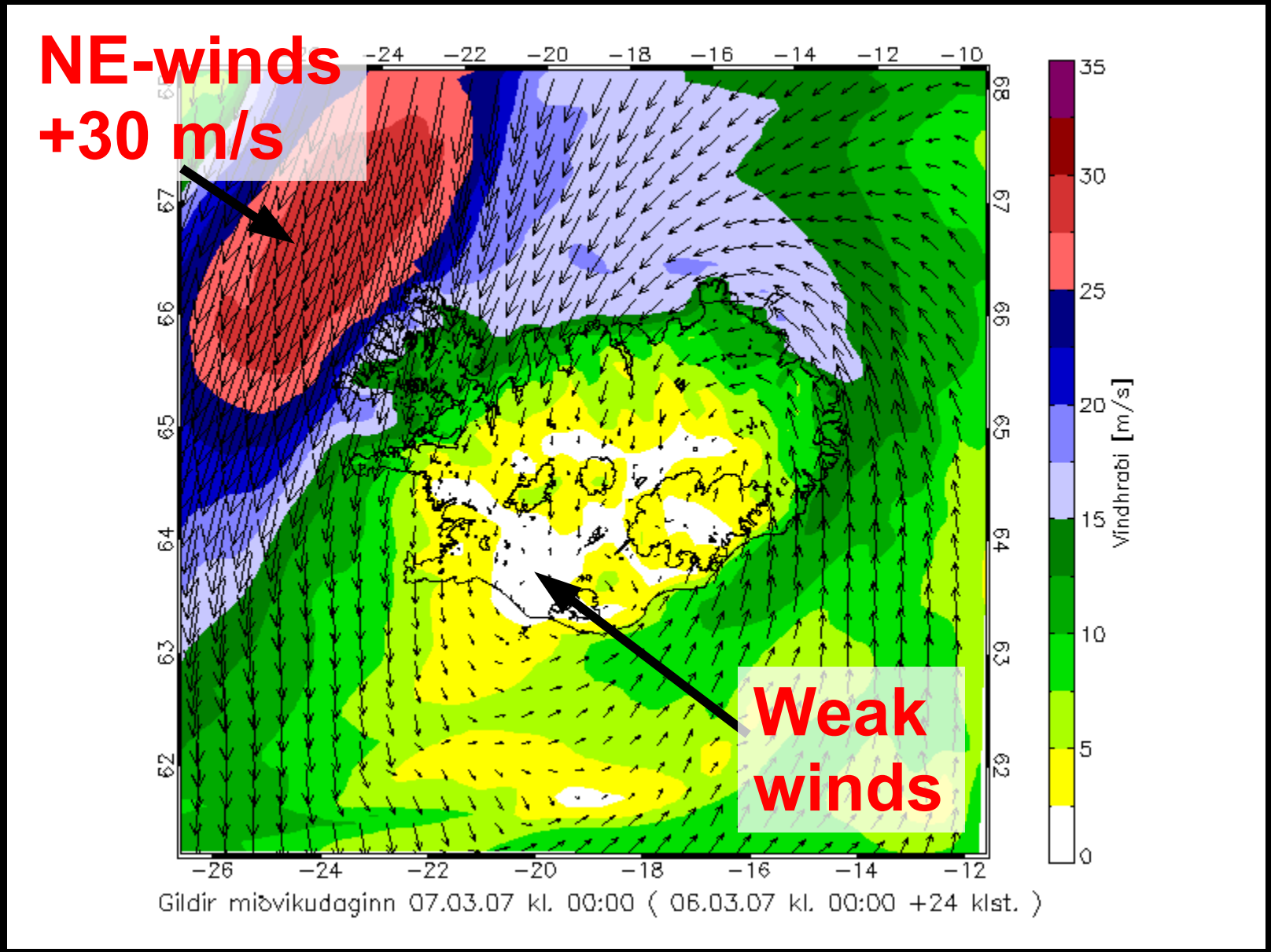


We need a big and fast computer

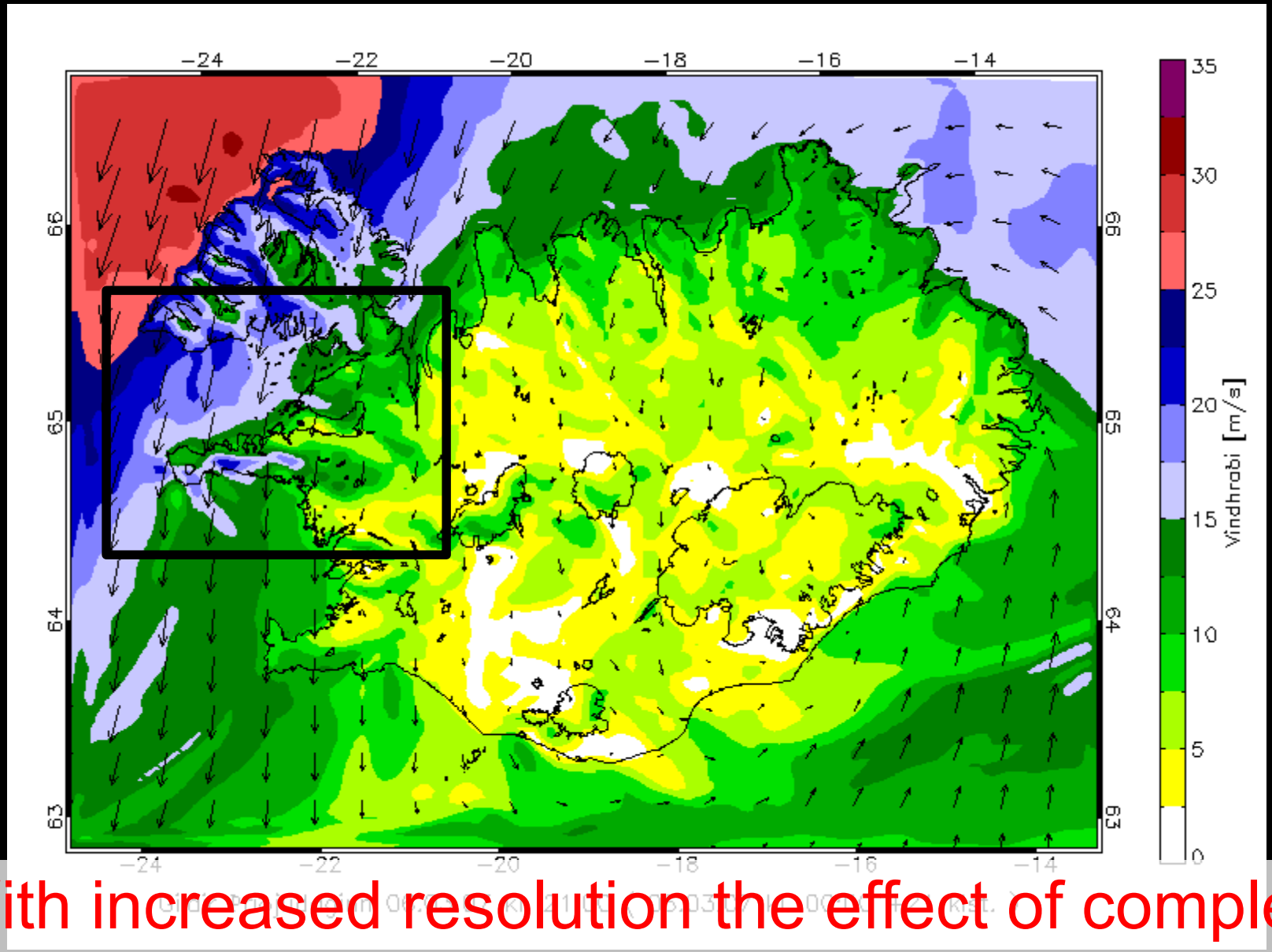


- Increase the resolution by a factor of 3
  - → Increase the computational cost by a factor of 3 x 3 x 3 = 27 and then some

Winds at a resolution of 9 km

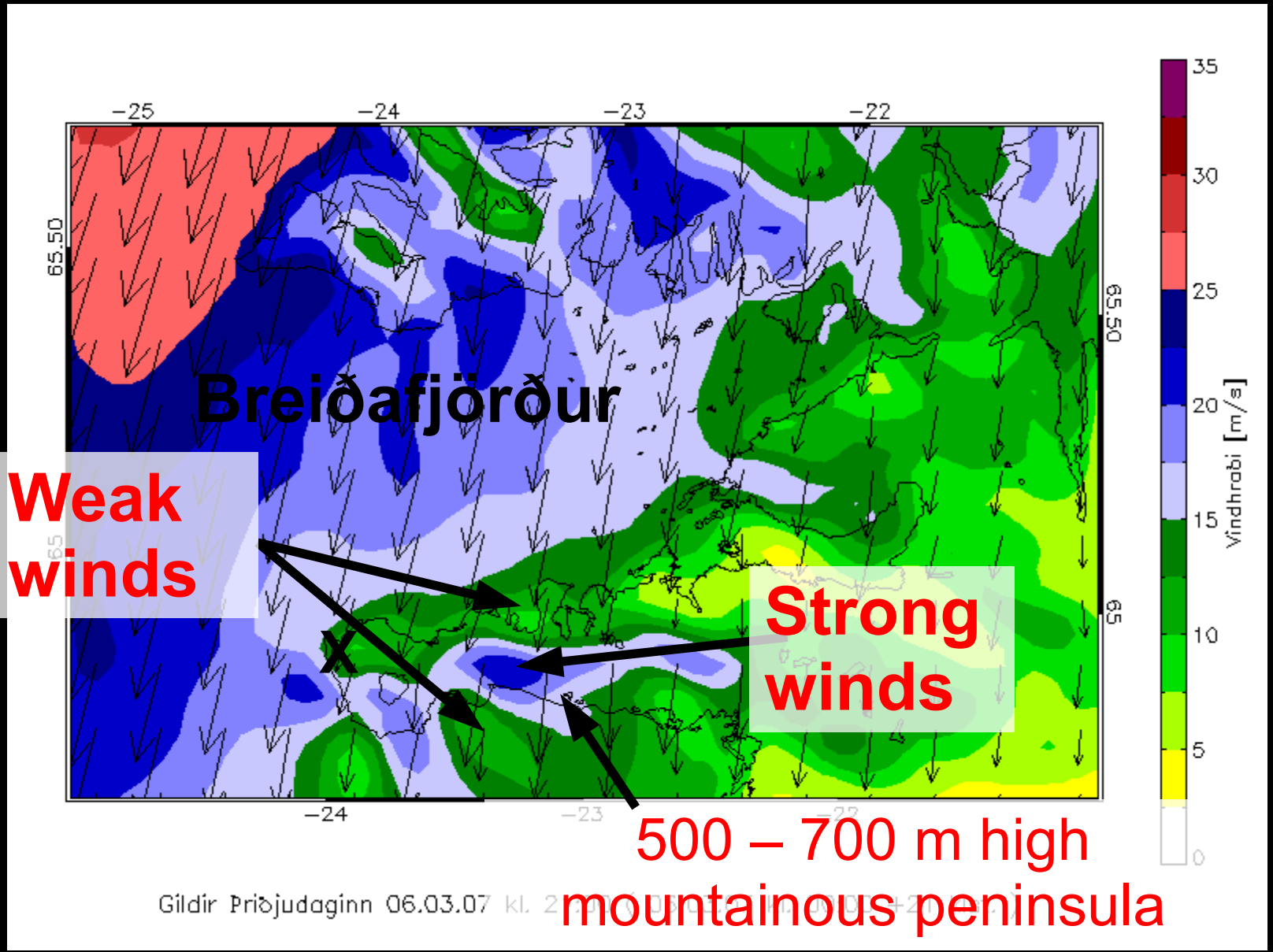


Winds at a resolution of 3 km



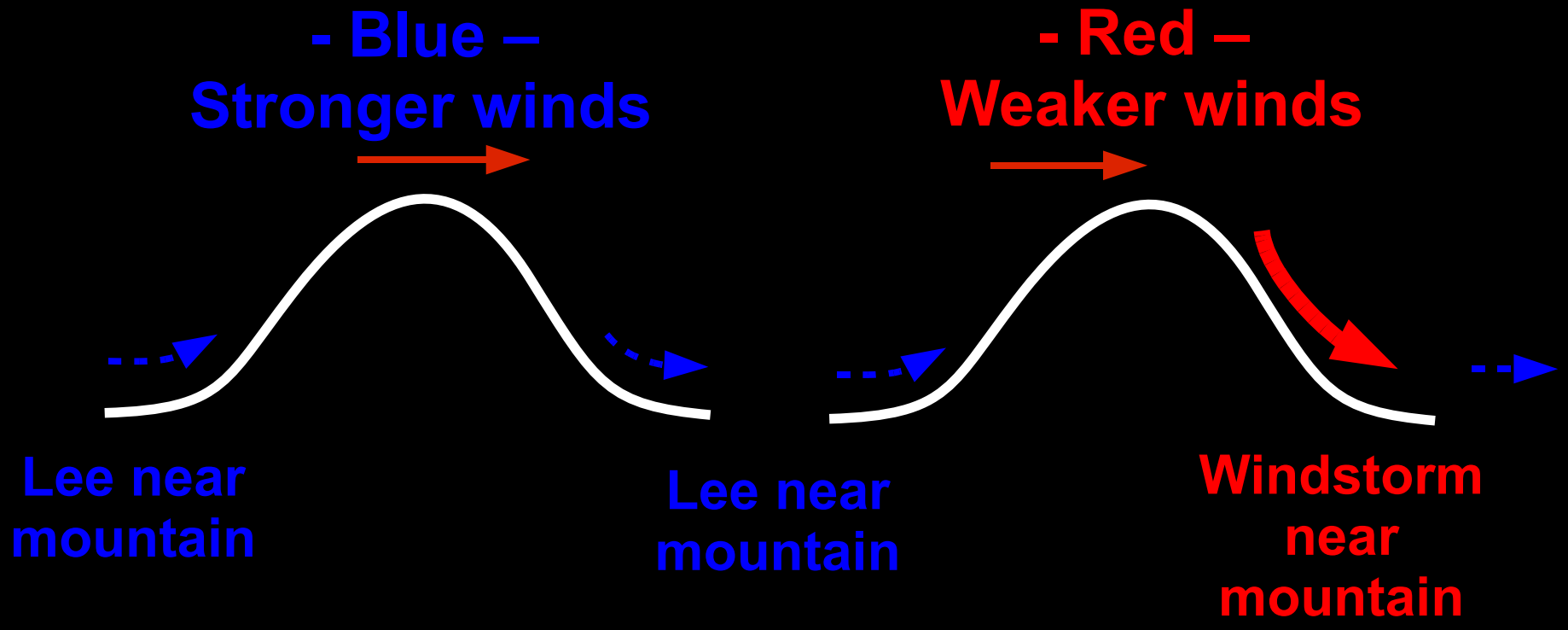
With increased resolution the effect of complex topography on weather is better represented

Winds at a resolution of 3 km

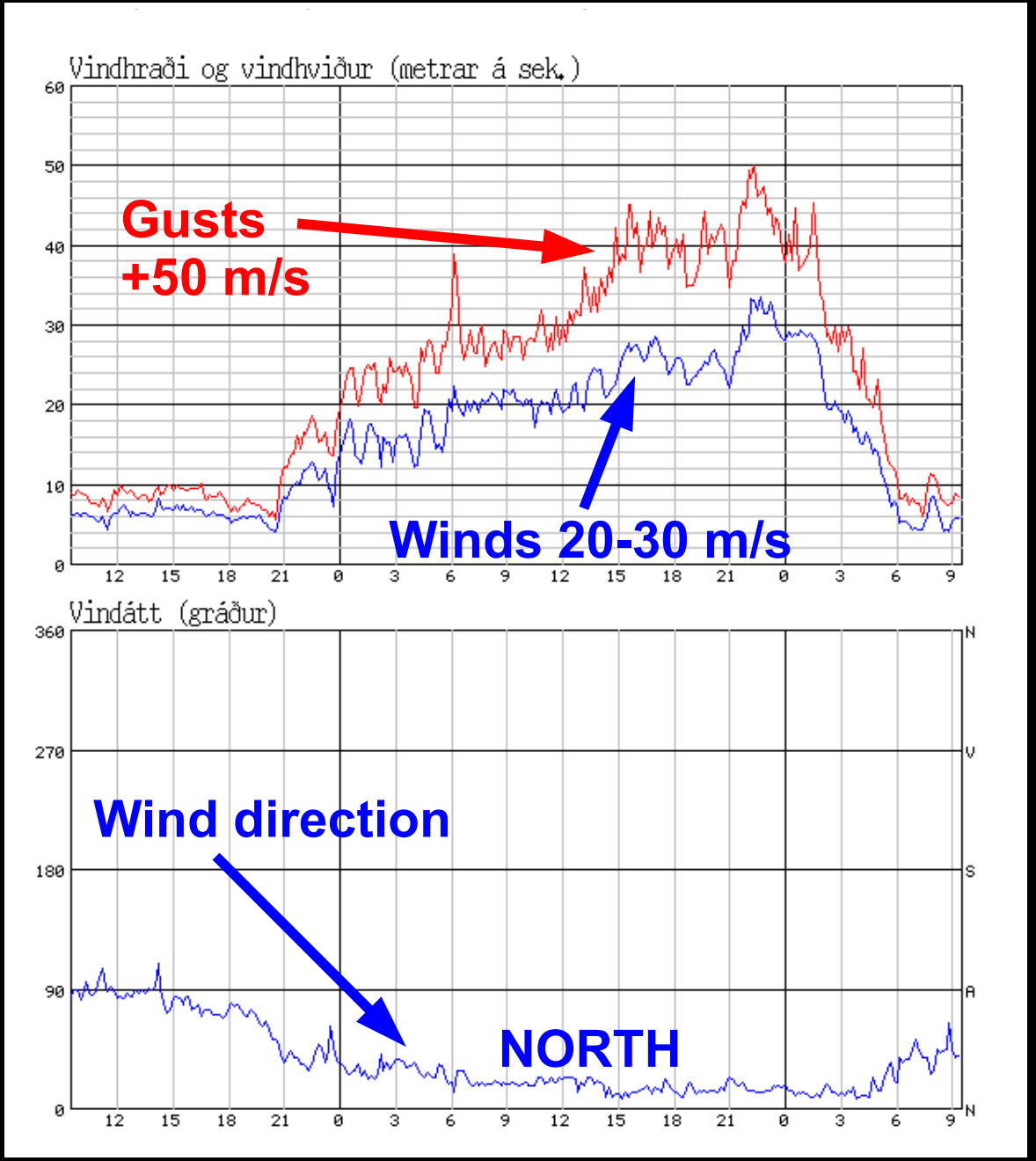


What is happening here?

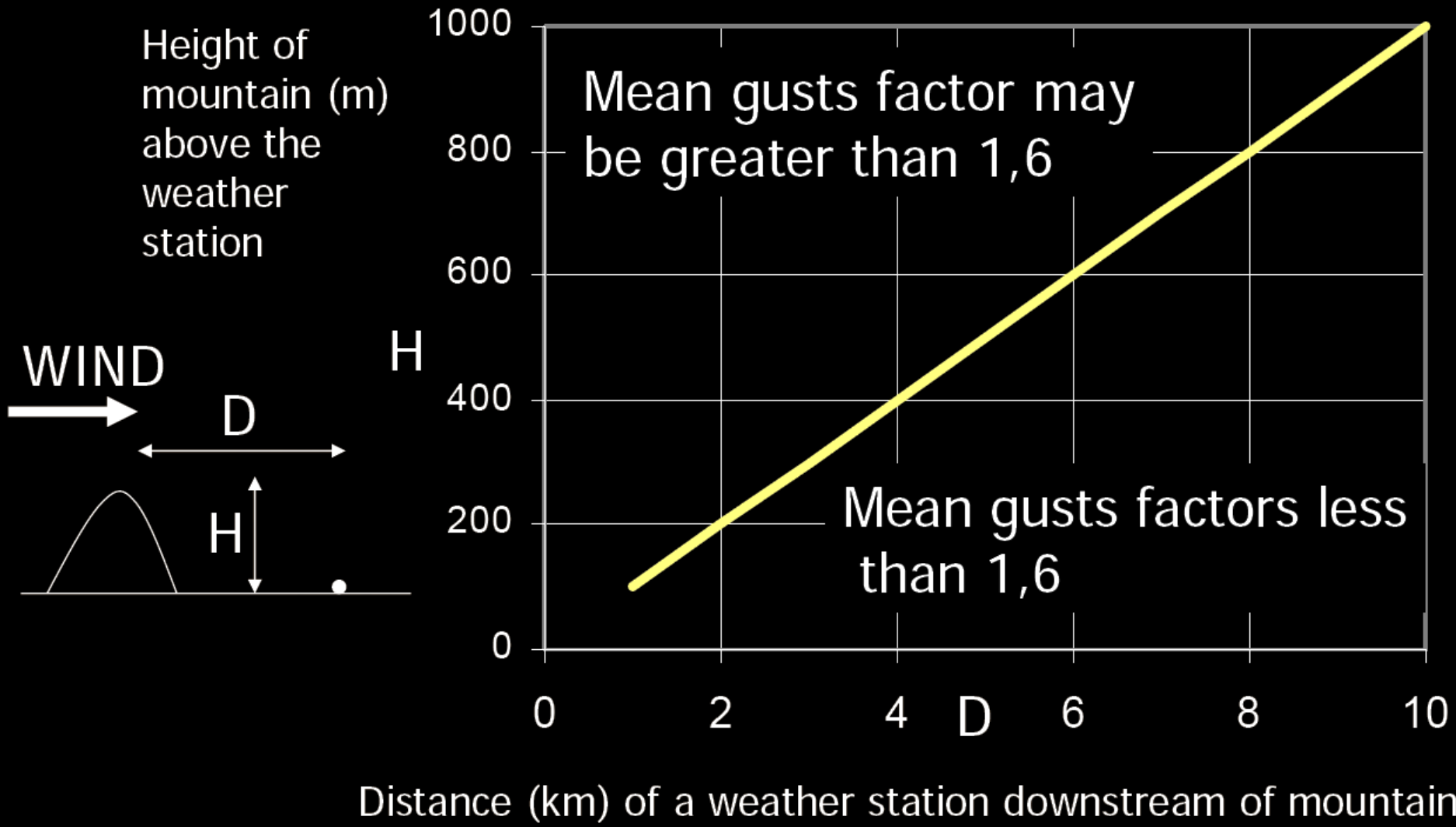
- 2 different possibilities -



Observed wind at Hraunsmúli on the southern edge of the Snæfellsnes peninsula



The gust factor diagramme

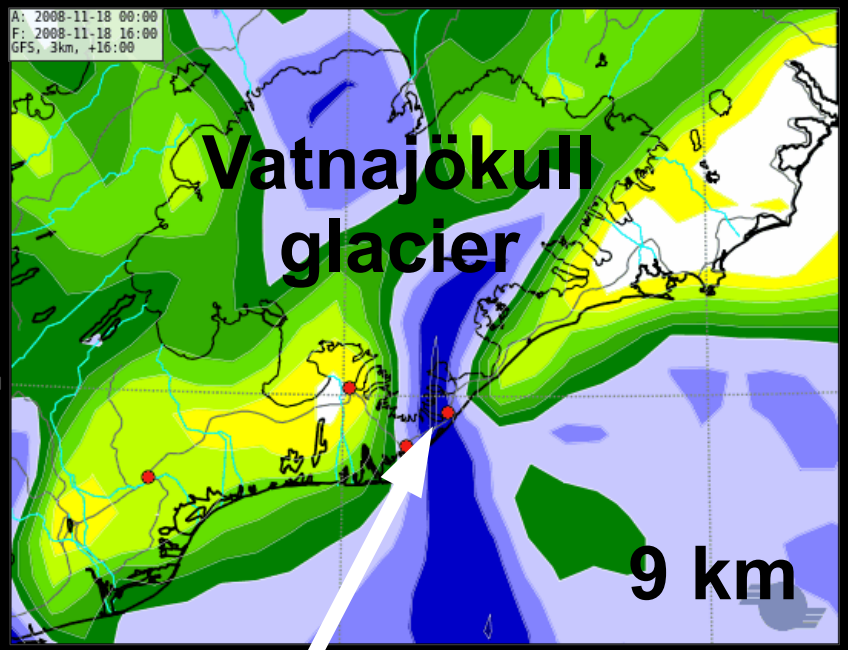


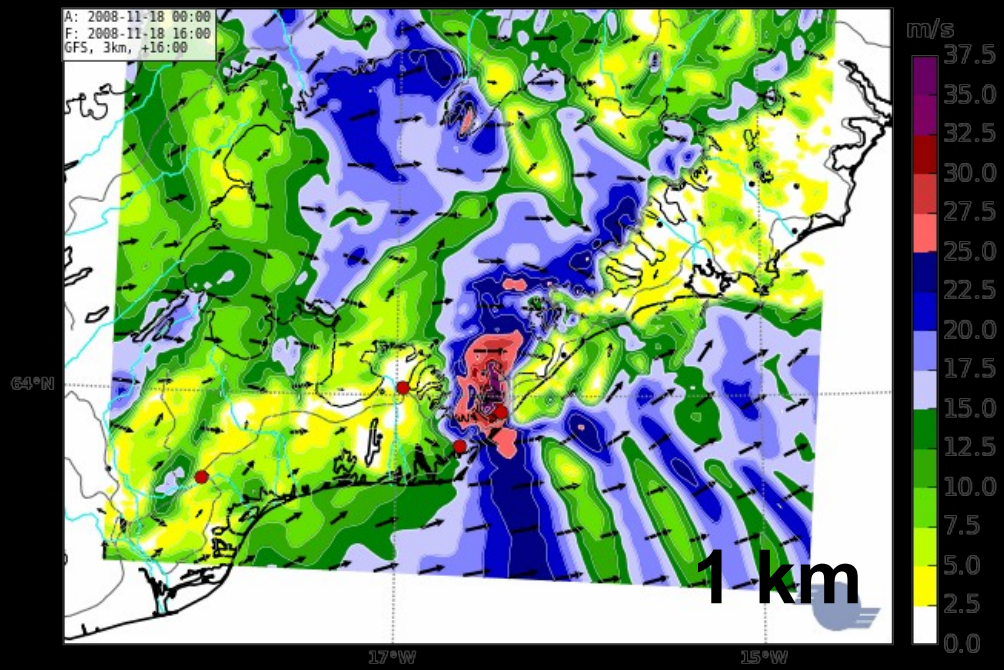
Hálfdán Ágústsson og Haraldur ólafsson

At Kvísker after a typical windstorm

Frequent localized damage and/or disruption of traffic

Simulated winds in Southeast-Iceland





Weak downslope winds

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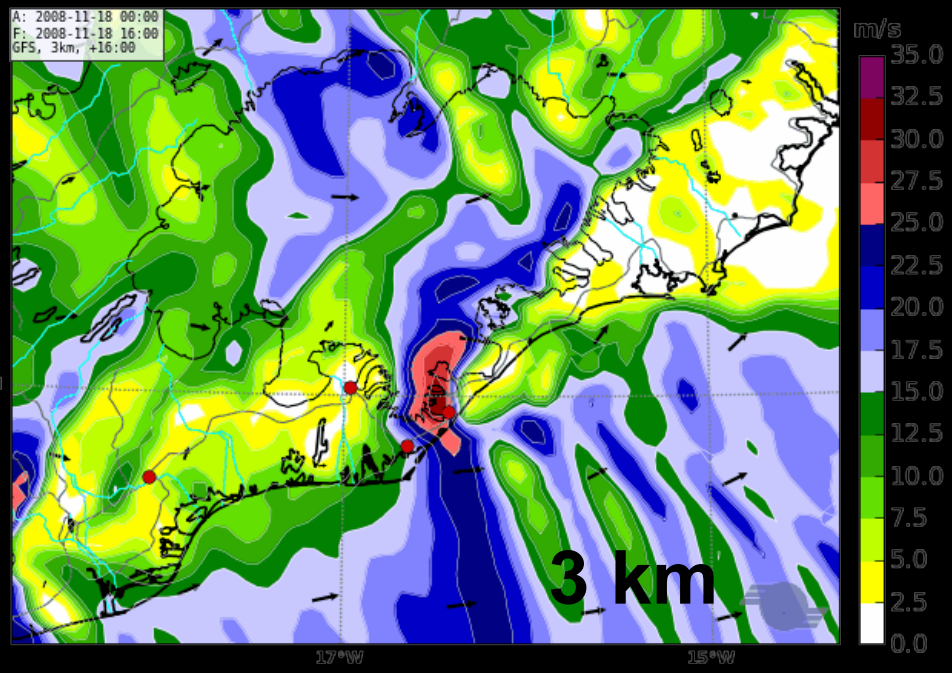
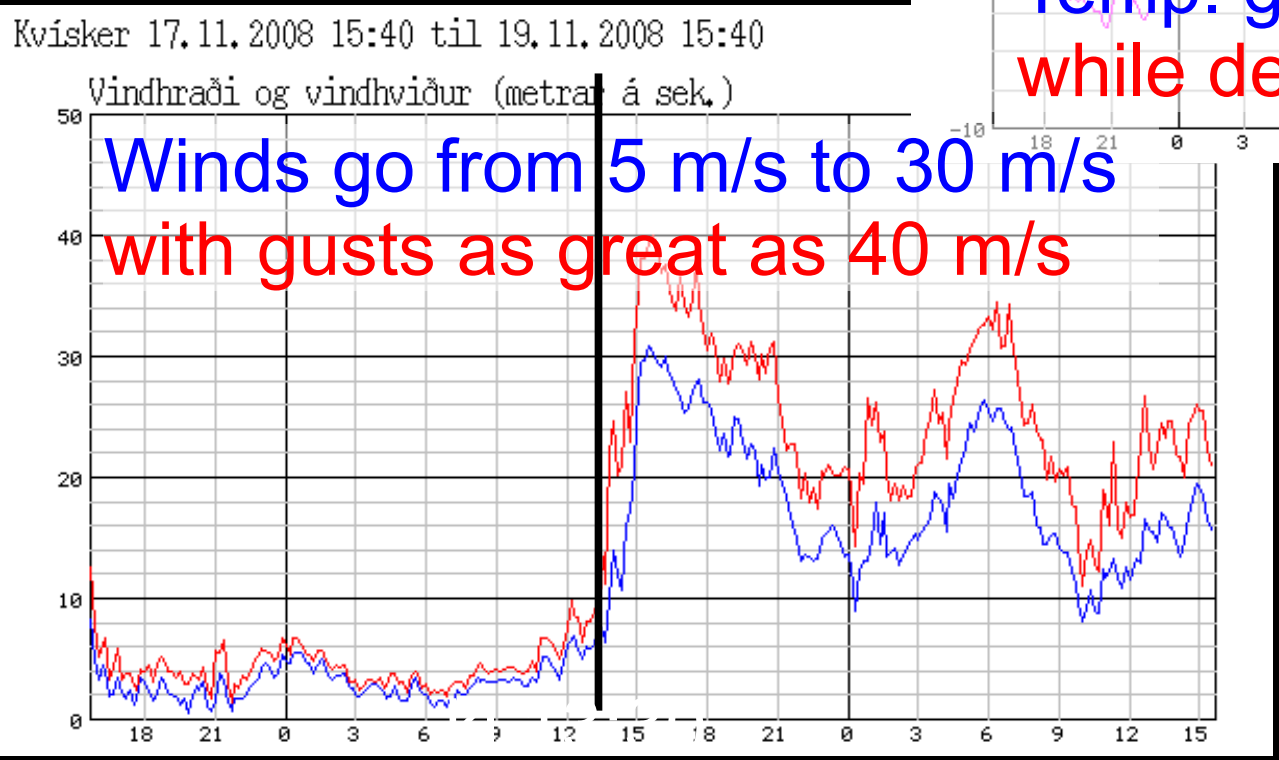
No downstream wave pattern

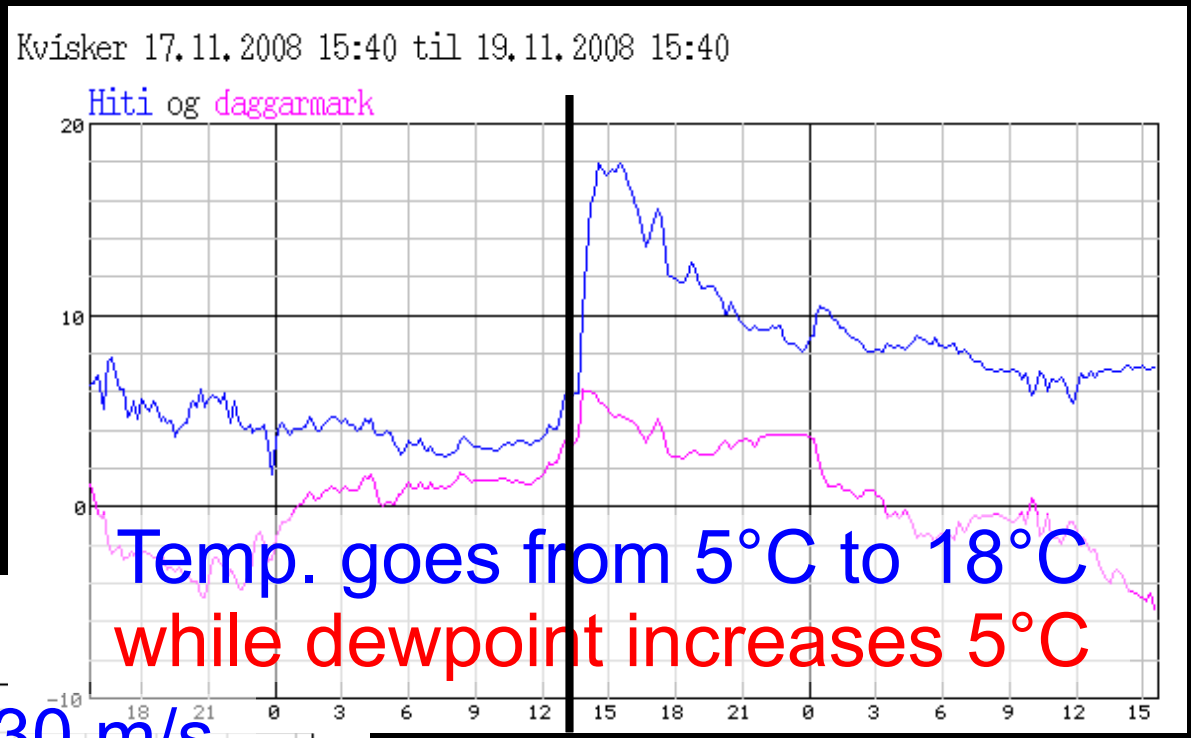


Observations at Kvísker on main road



13 UTC

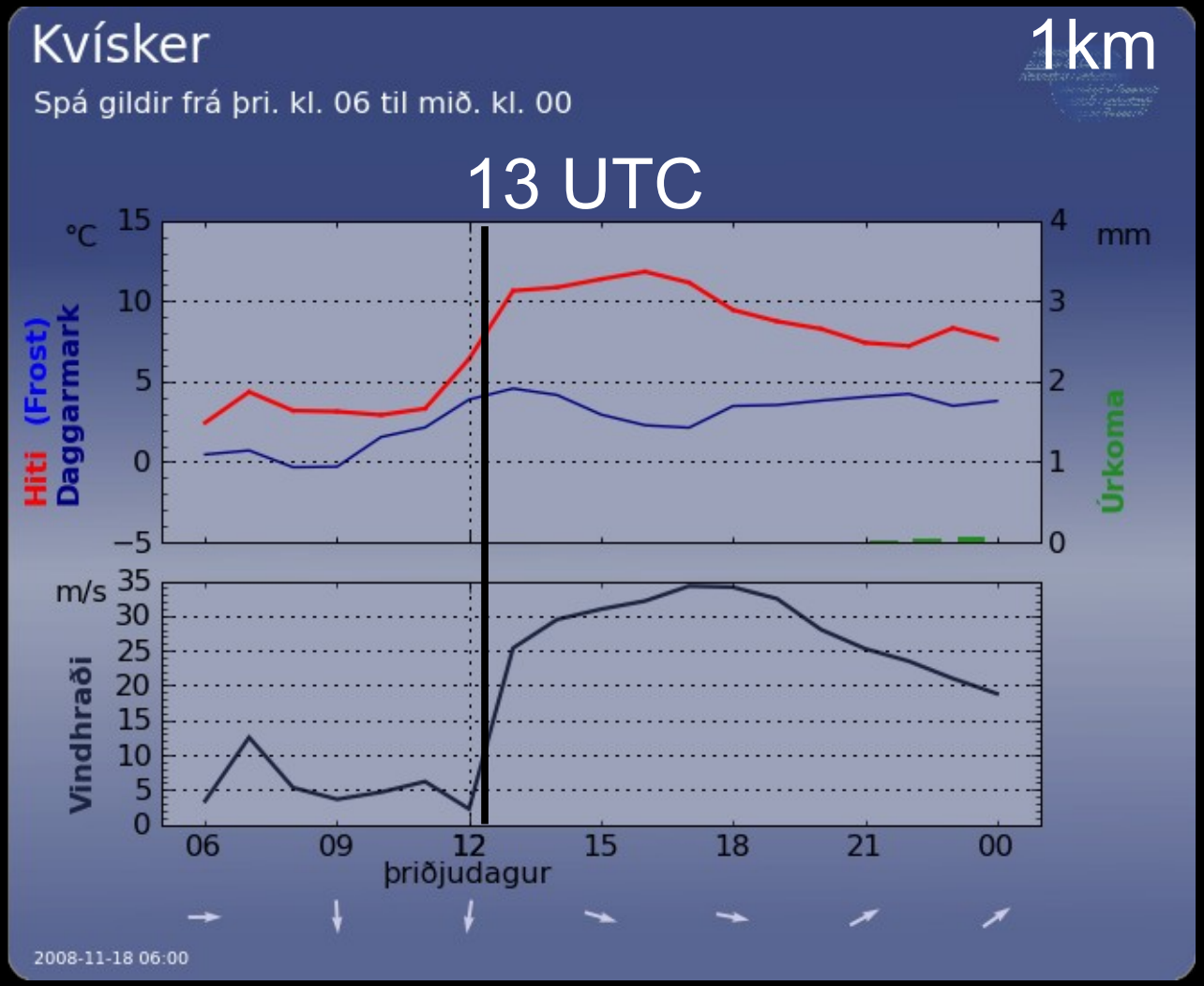
Winds go from 5 m/s to 30 m/s
with gusts as great as 40 m/s



Temp. goes from 5°C to 18°C
while dewpoint increases 5°C

13 UTC

Simulated weather at Kvísker

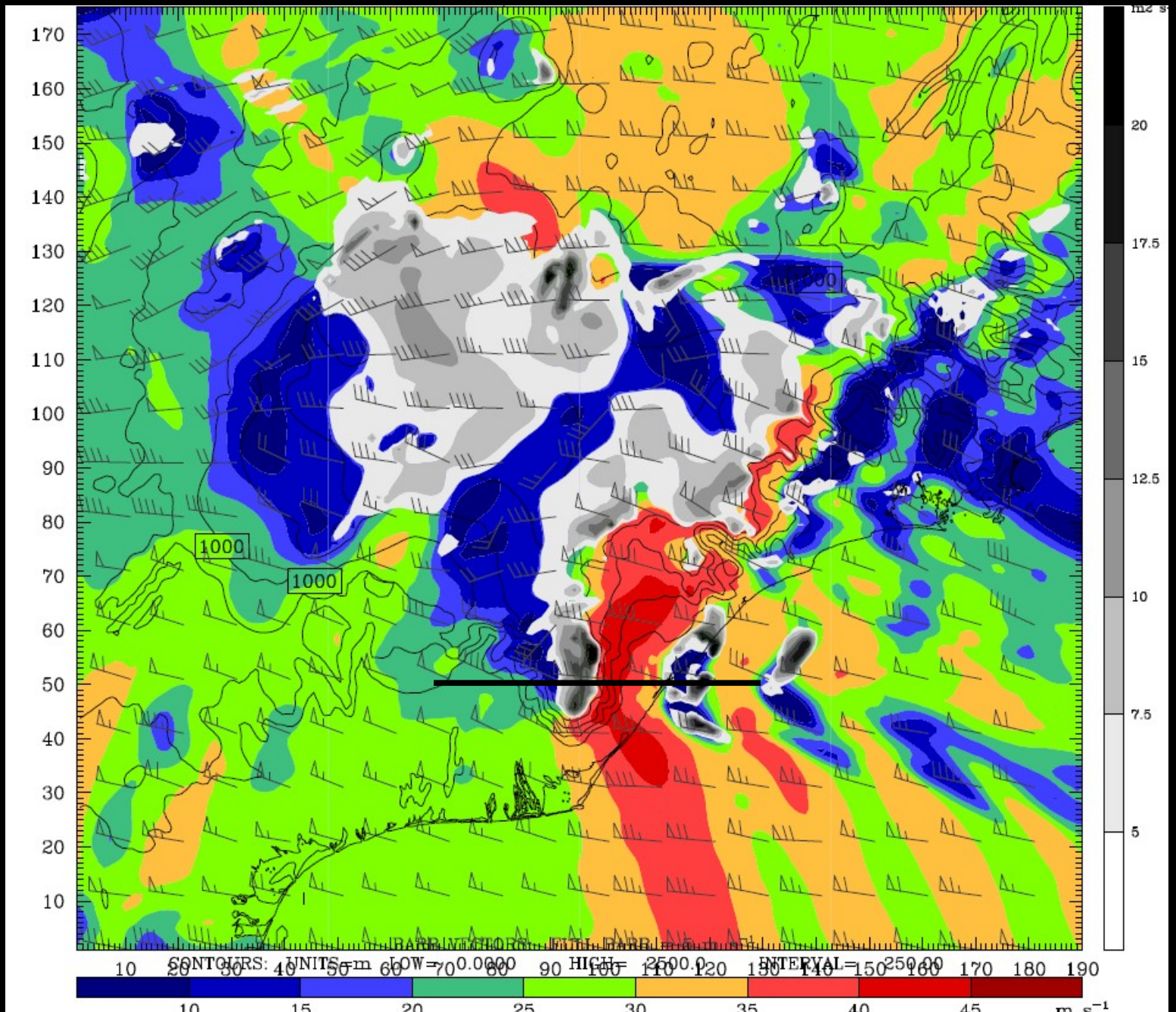


Temperature increases by 10°C but dew point by a few degrees

Winds go from 5 m/s to 30 m/s.

Wind and turbulent kinetic energy

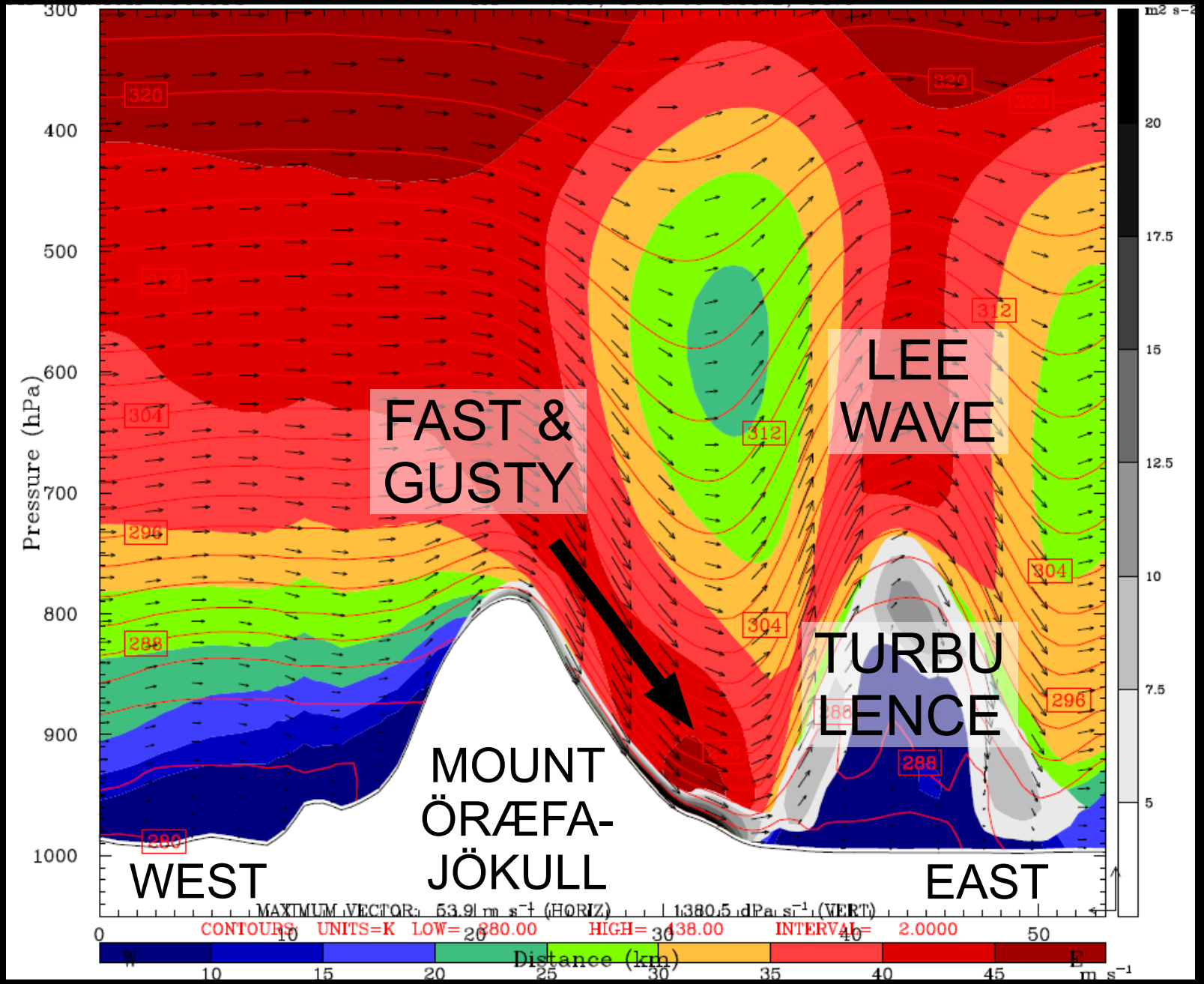
925 hPA



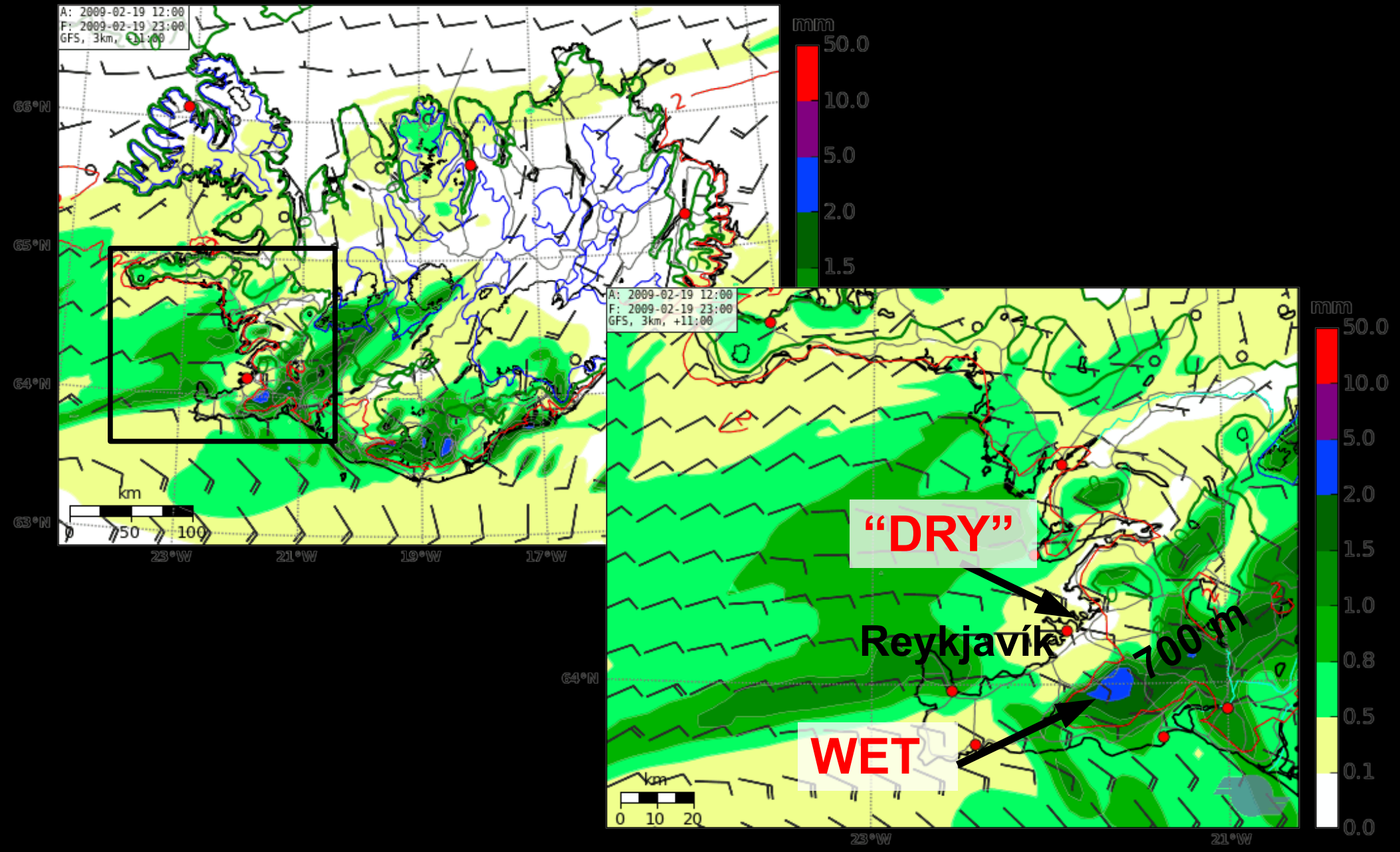
TKE [j/kg]

Windspeed [m/s]

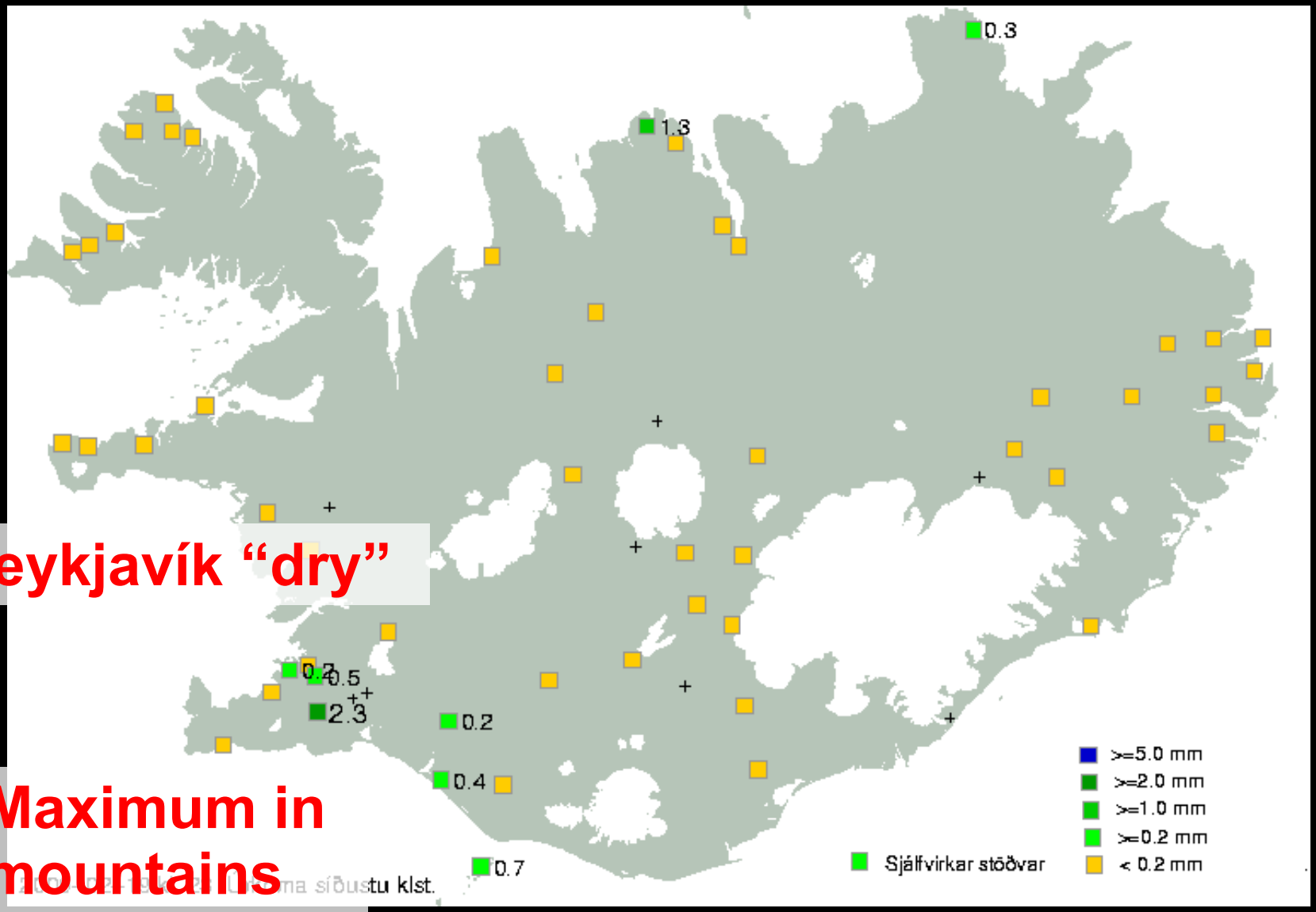
Simulated wind, pot. Temperature and turbulent kinetic energy in section



Simulated precipitation last midnight



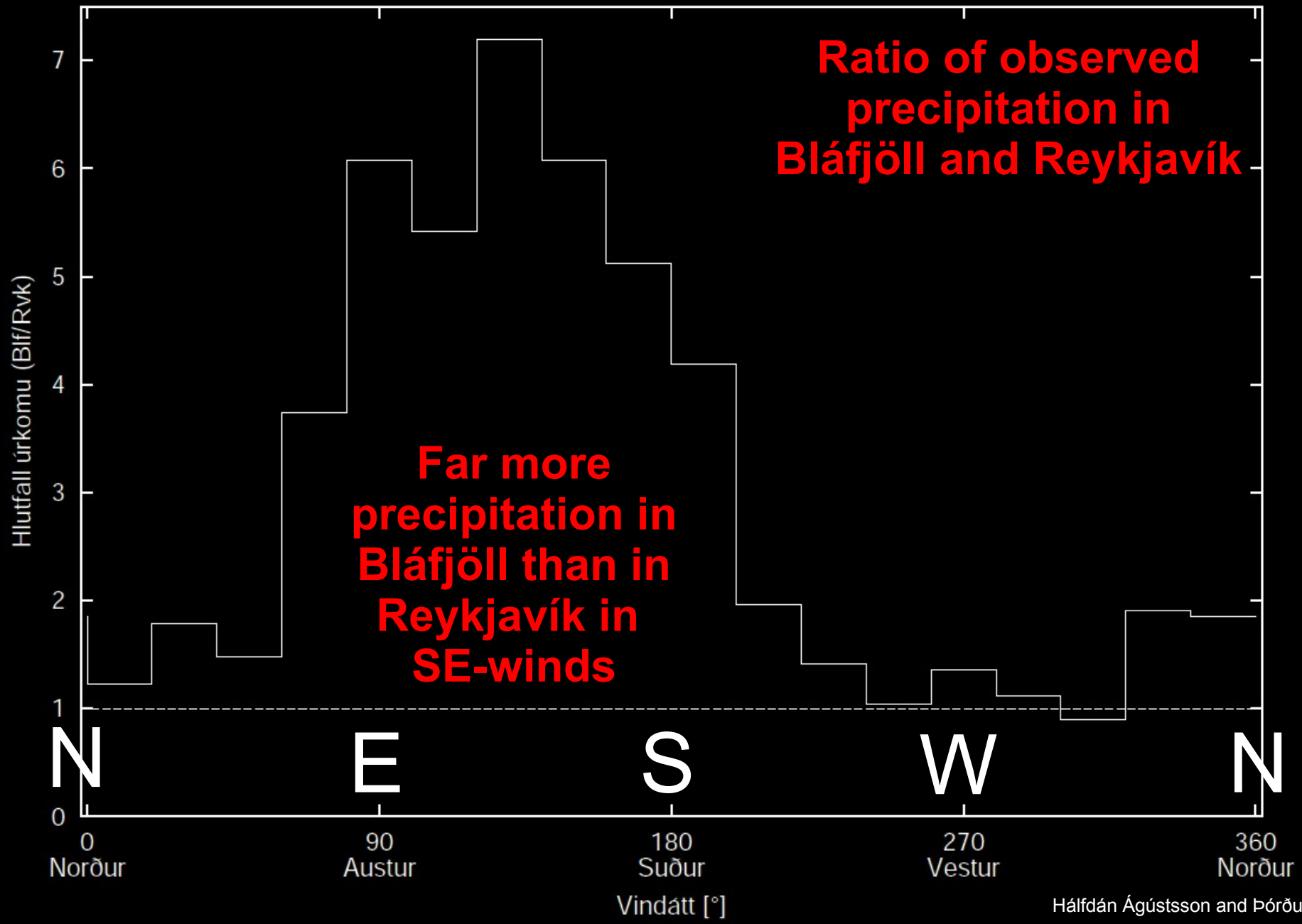
Observed precipitation last midnight



Reykjavík “dry”

Maximum in mountains

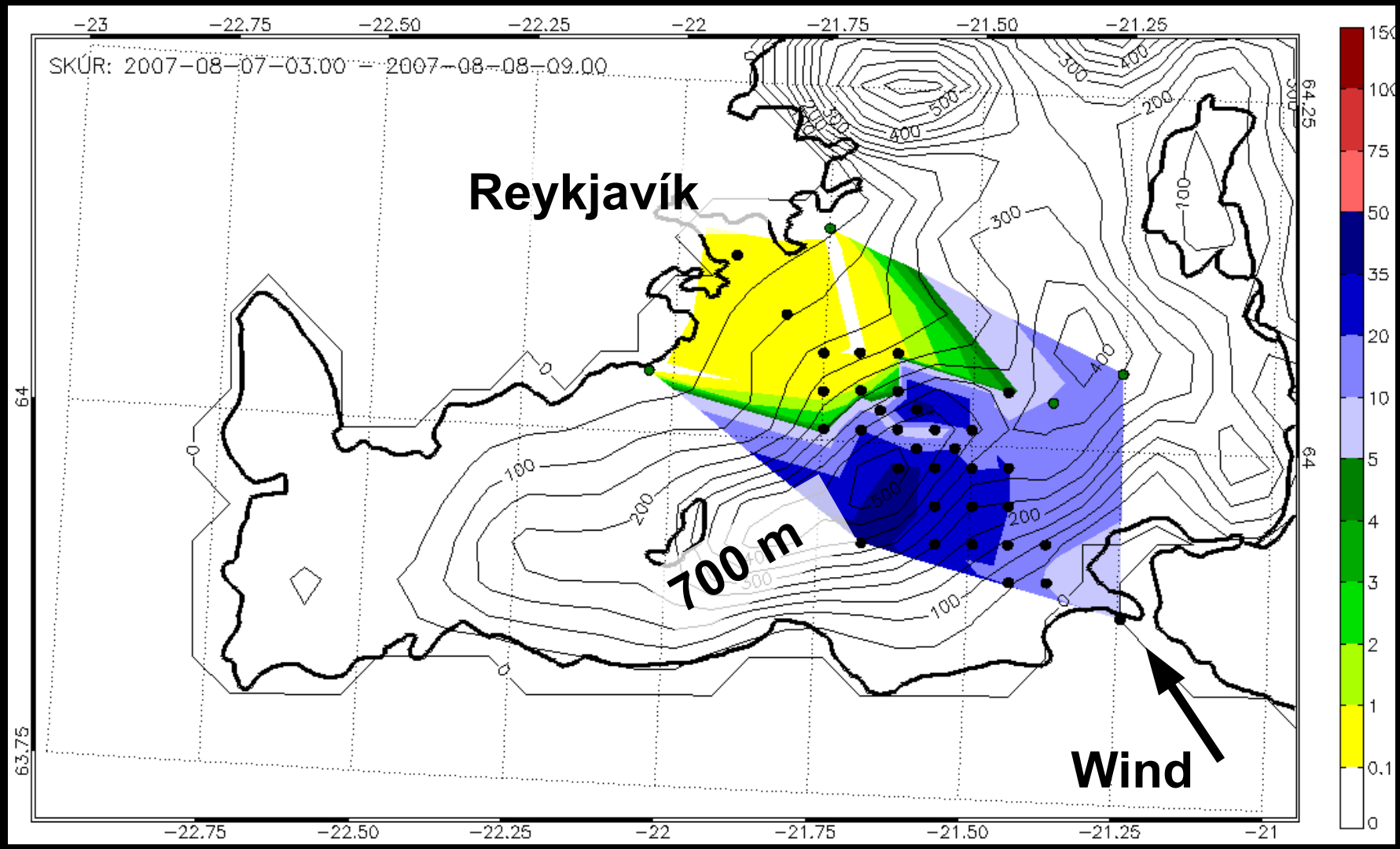
Precipitation in Reykjavík and Bláfjöll



Hálfdán Ágústsson and Þórður Arason

Observed precipitation in SKÚR

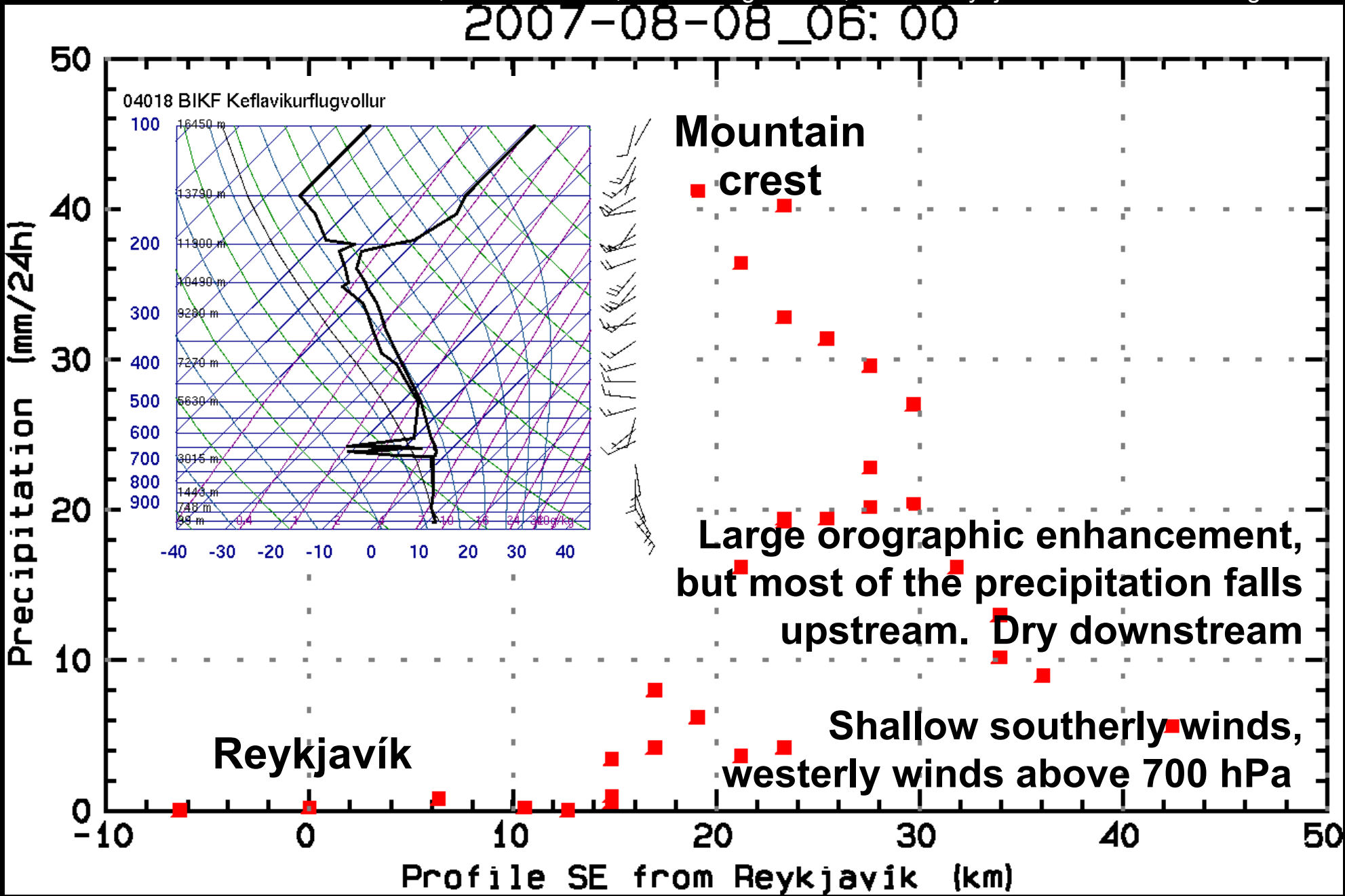
Precipitation experiment using 38 rain gauges
(Staðbundin kortlagning úrkomu á Reykjanesskaga)



Haraldur Ólafsson, Þórður Arason, Hálfdán Ágústsson, Sveinn Brynjólfsson and Ólafur Rögnvaldsson

Observed precipitation in SKÚR

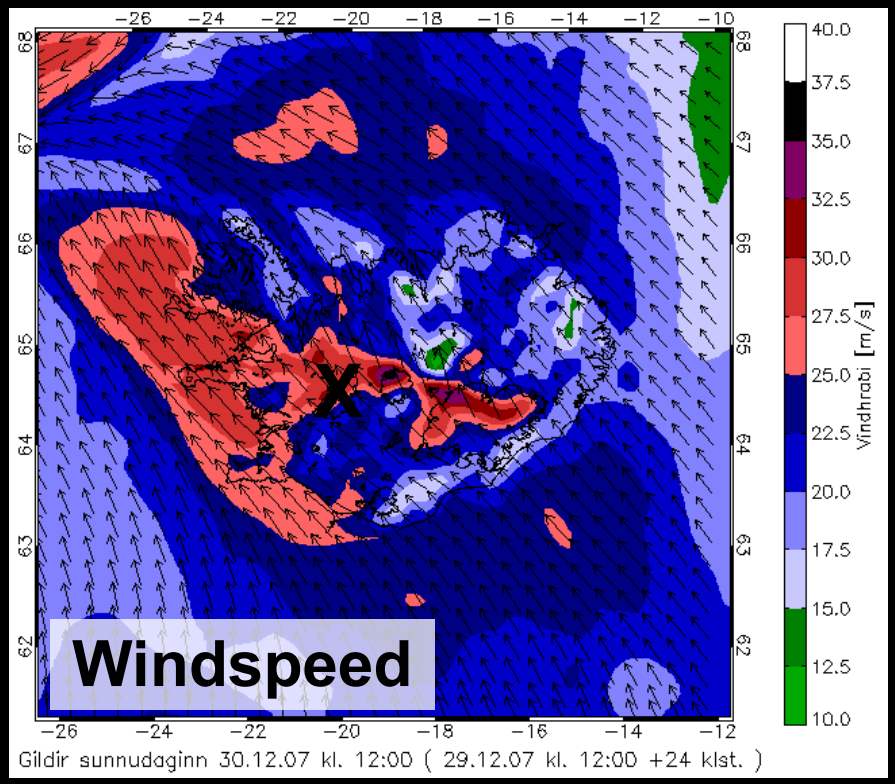
Haraldur Ólafsson, Þórður Arason, Hálfdán Ágústsson, Sveinn Brynjólfsson and Ólafur Rögnvaldsson

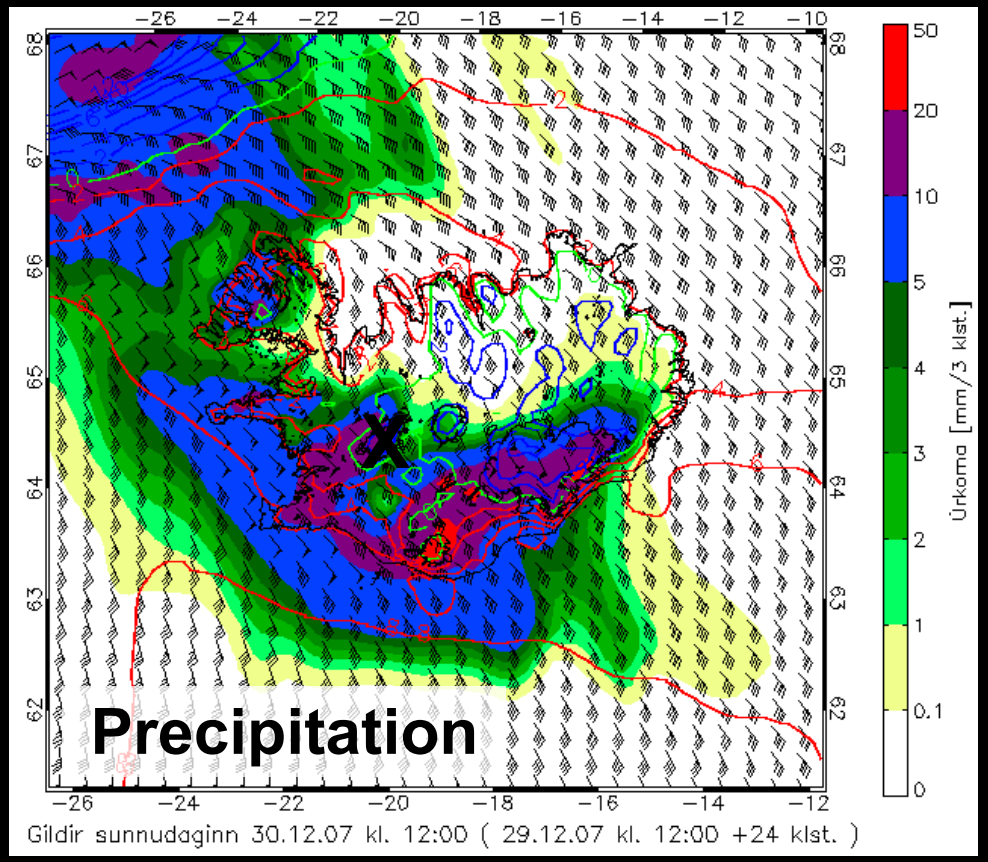


S&R operations in a SE-windstorm

Windstorm on 30 Dec 2008

Strong winds and flooding in e.g. Reykjavík. Rescue operations on Langjökull glacier in +50 m/s and snowfall.



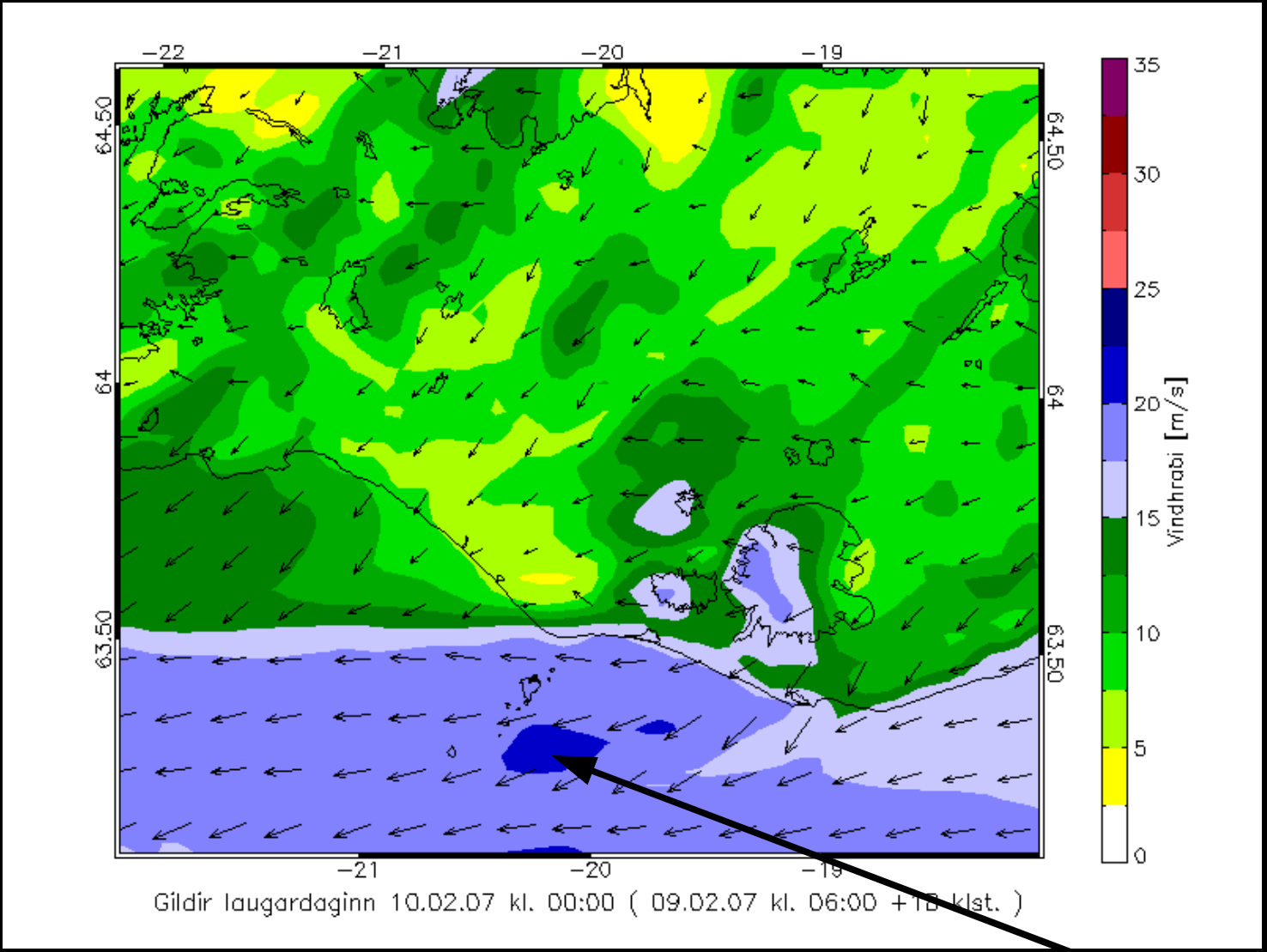


Summary

- We have looked at what is a high resolution weather forecast.
- With increased resolution the effect of topography on weather is better reproduced.
- We benefit with a more accurate prediction of orographic precipitation, locally enhanced winds, gravity waves, turbulence, boundary-layer etc. Simulations at coarser resolution may not capture important phenomena.

Gravity waves aloft in a faraway place

Tip jet or barrier wind



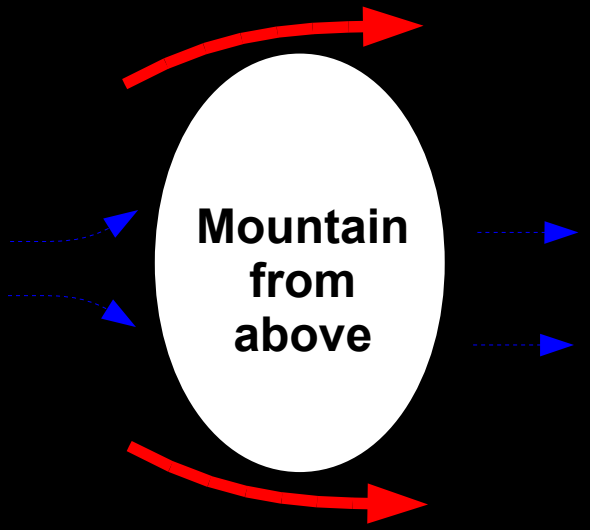
Enhanced winds

Tip jet or barrier wind

– Blue –
Weaker winds

Lee near mountain

– Red –
Stronger winds



Strong winds at mountain tip