

Heavy rainfall and flash flood in Dubrovnik on 22nd November 2010

**M. Tudor, K. Horvath, D. Mazzocco Drvar,
A. Stanesic, S. Ivatek-Sahdan and D. Placko-Vrsnak**

Meteorological and Hydrological service of Croatia

Outline

1. The heavy rainfall event and flash flood
2. Synoptic forcing
3. ALADIN operational and parallel suite forecast and experiments in 8km resolution
4. ALADIN experiments in 2km resolution
5. WRF simulation
6. Summary



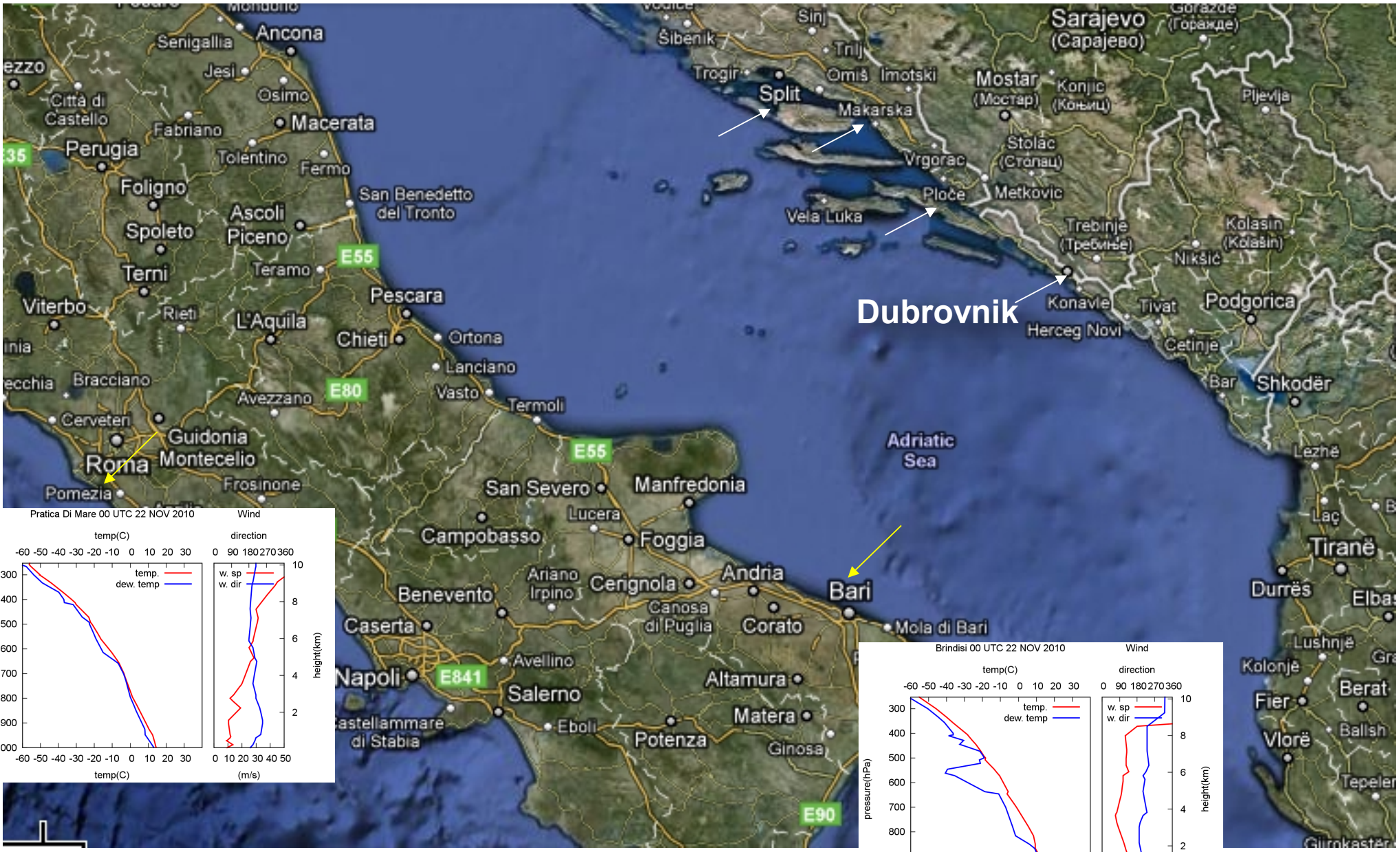
Dnevnik



Dnevnik Dubrovnik pod vodom

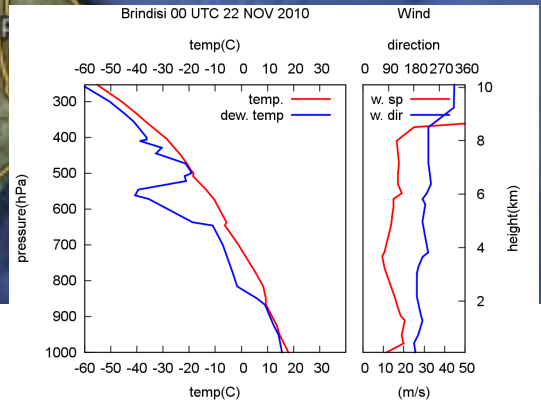


Damage: 6.5 M EUR



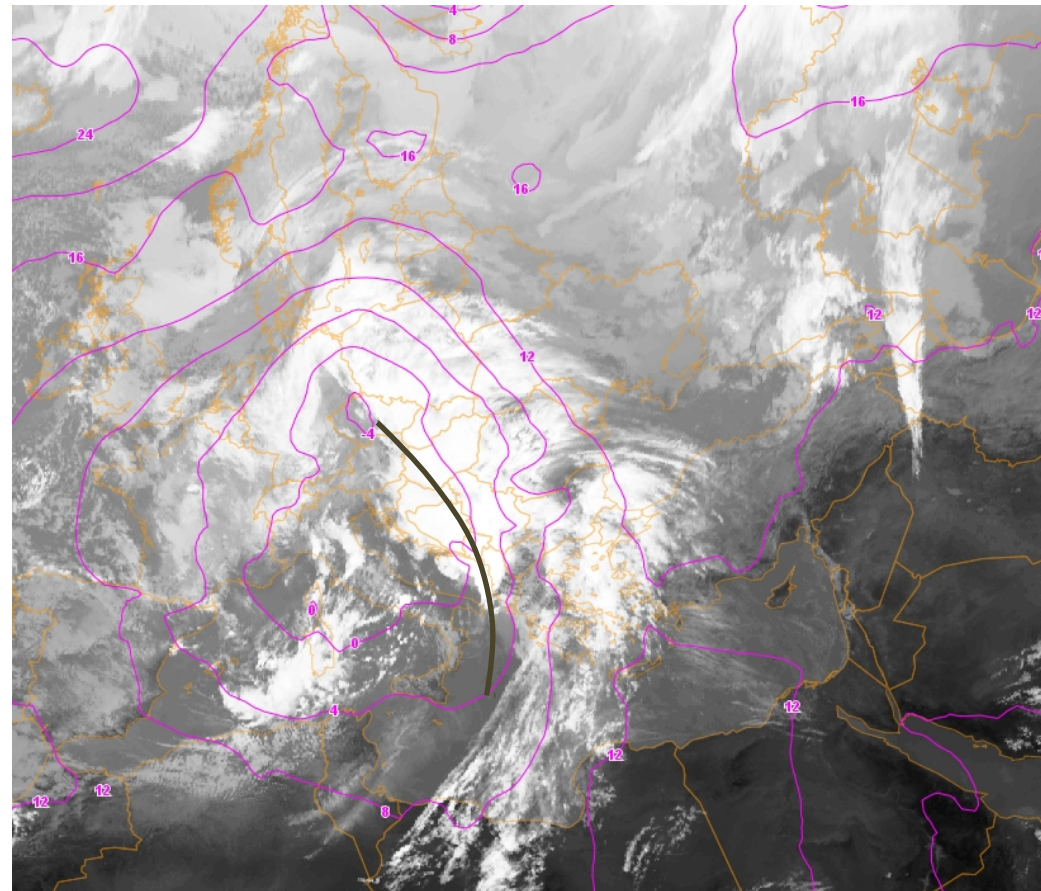
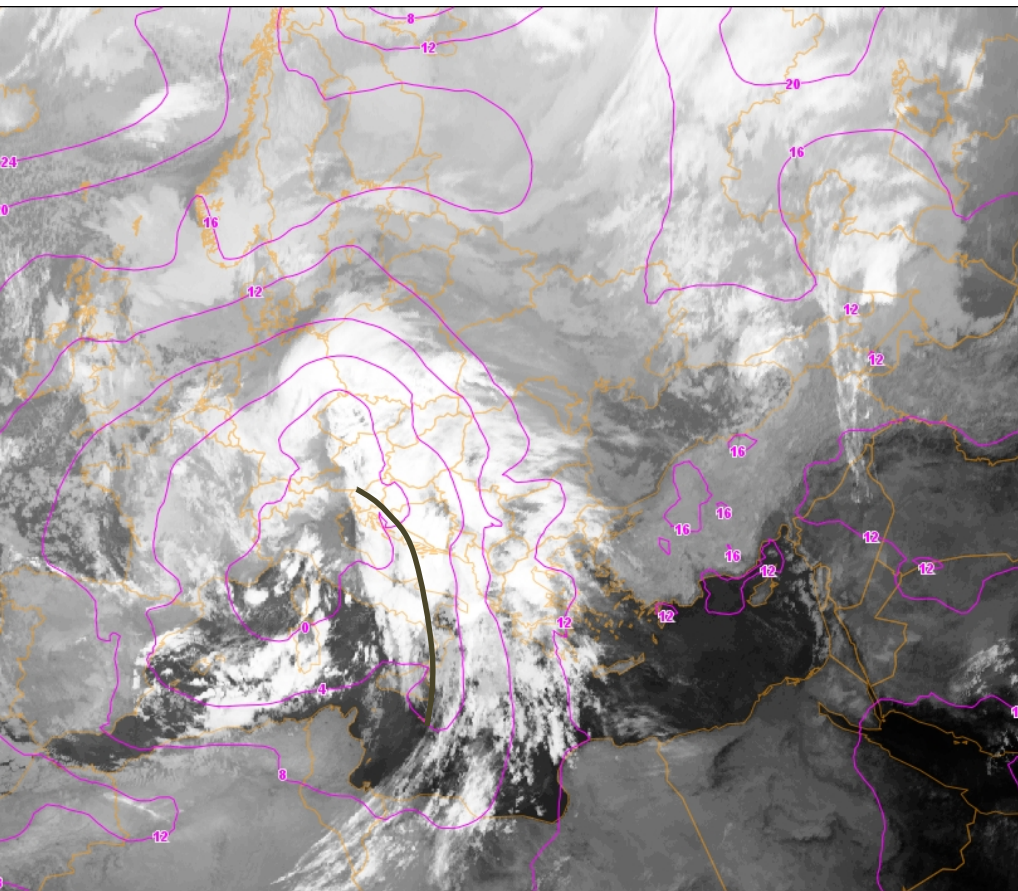
17 May 2011

5th HyMEX workshop



Synoptic situation (Initial phase of a Cyclogenesis driven by an upper air process)

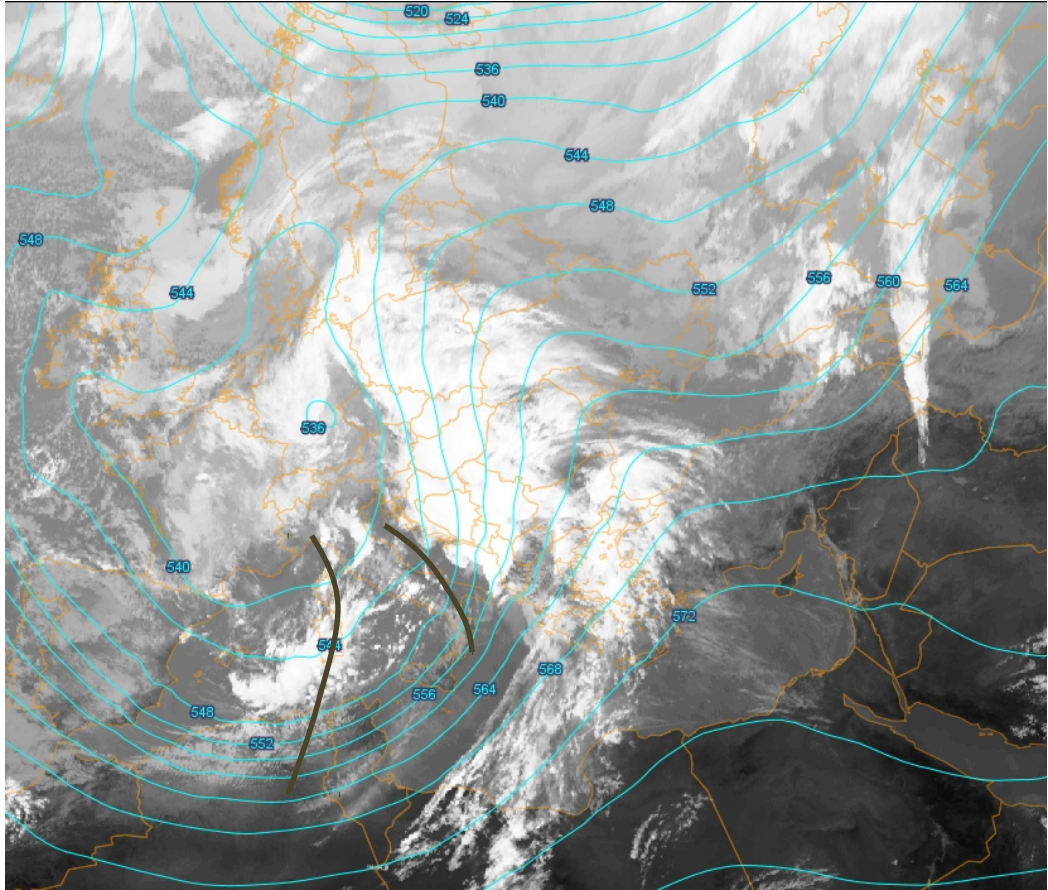
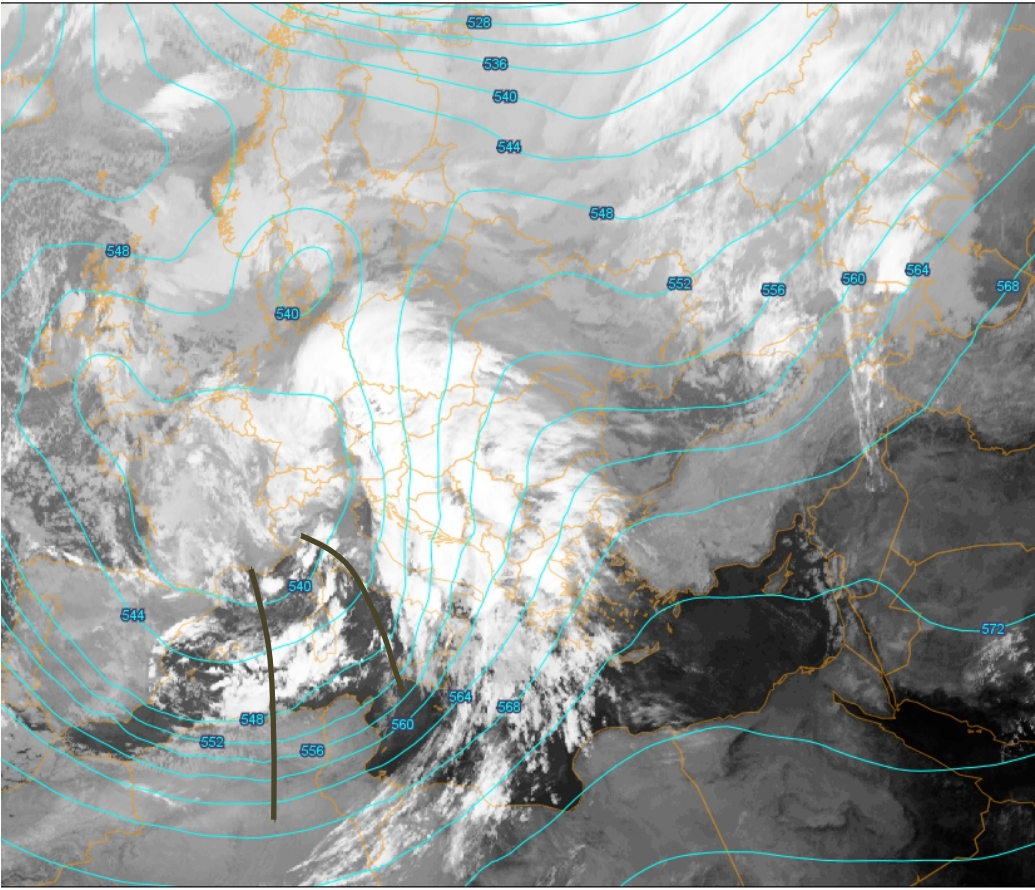
A huge low moving over the Alps with the frontal system covering most of Central Europe and Mid-Mediterranean
Moving of the low level trough over the South Adriatic



METEOSAT9 IR 10.8 micron image with ECMWF 1000hPa height at 06 and 12 UTC 22 Nov 2010

Synoptic situation, cont.

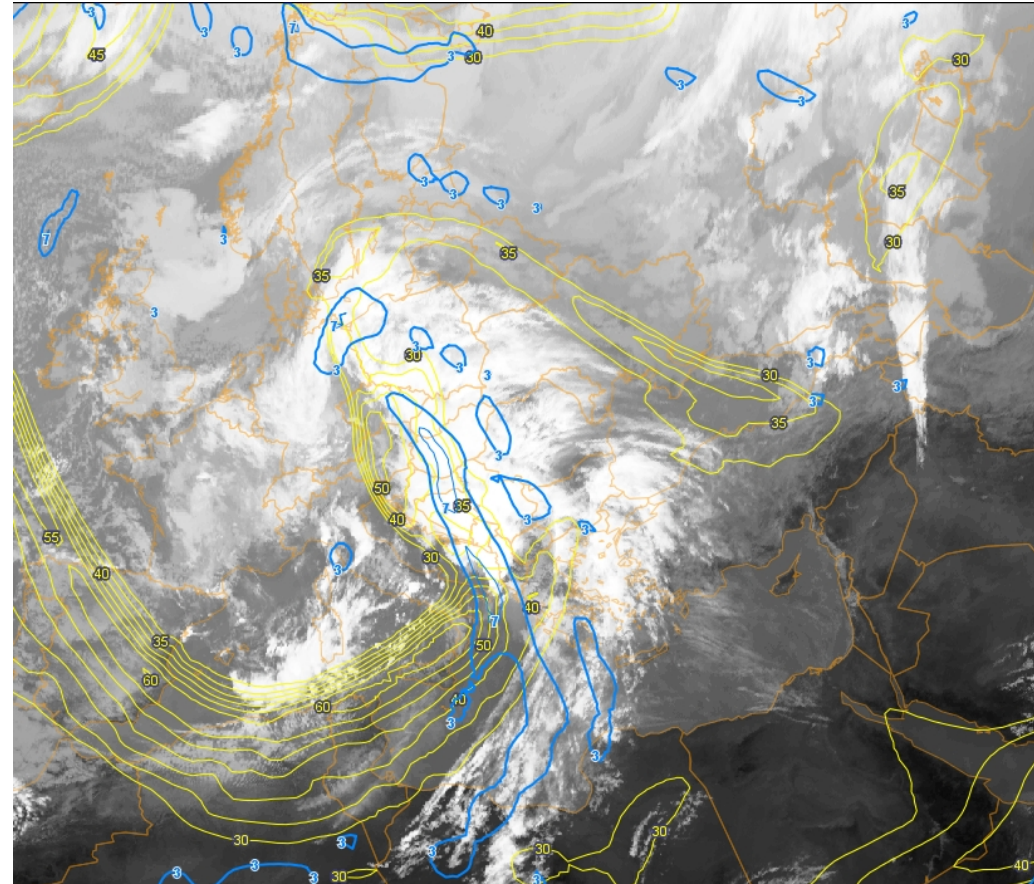
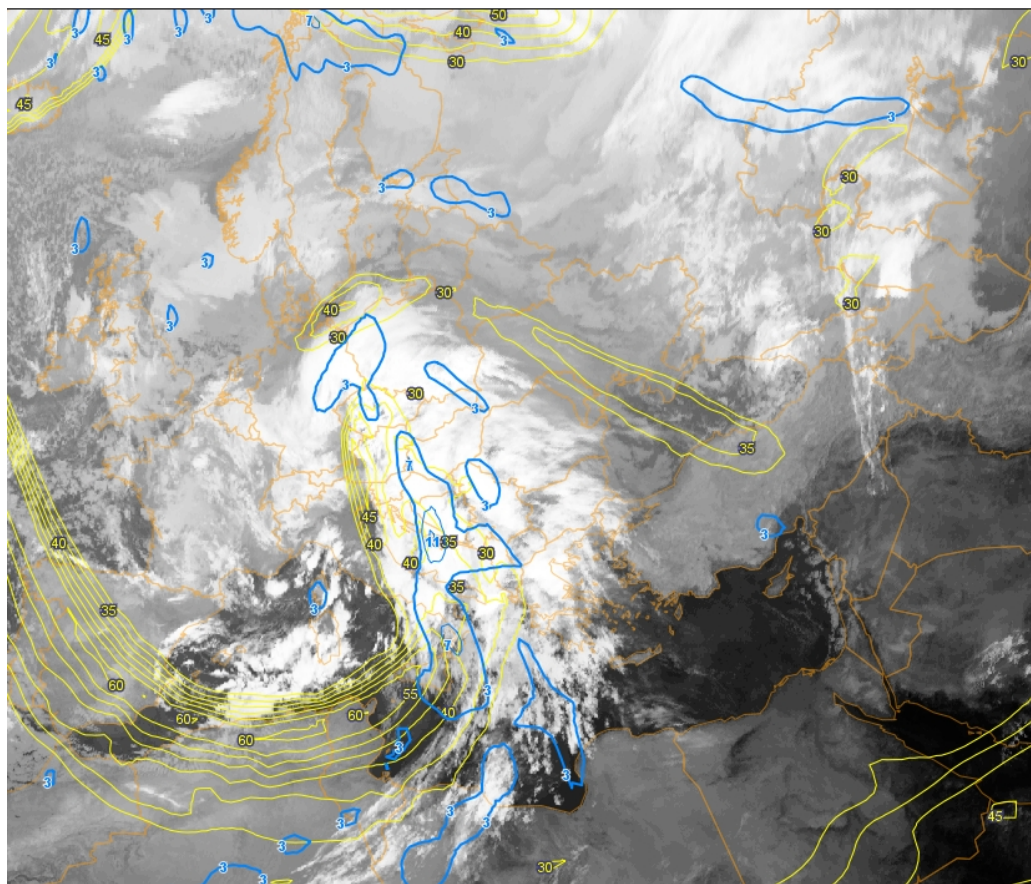
A deep Upper level low with a development of a secondary trough



METEOSAT9 IR 10.8 micron image with ECMWF 500hPa height at 06 and 12 UTC 22 Nov 2010

Synoptic situation, cont.

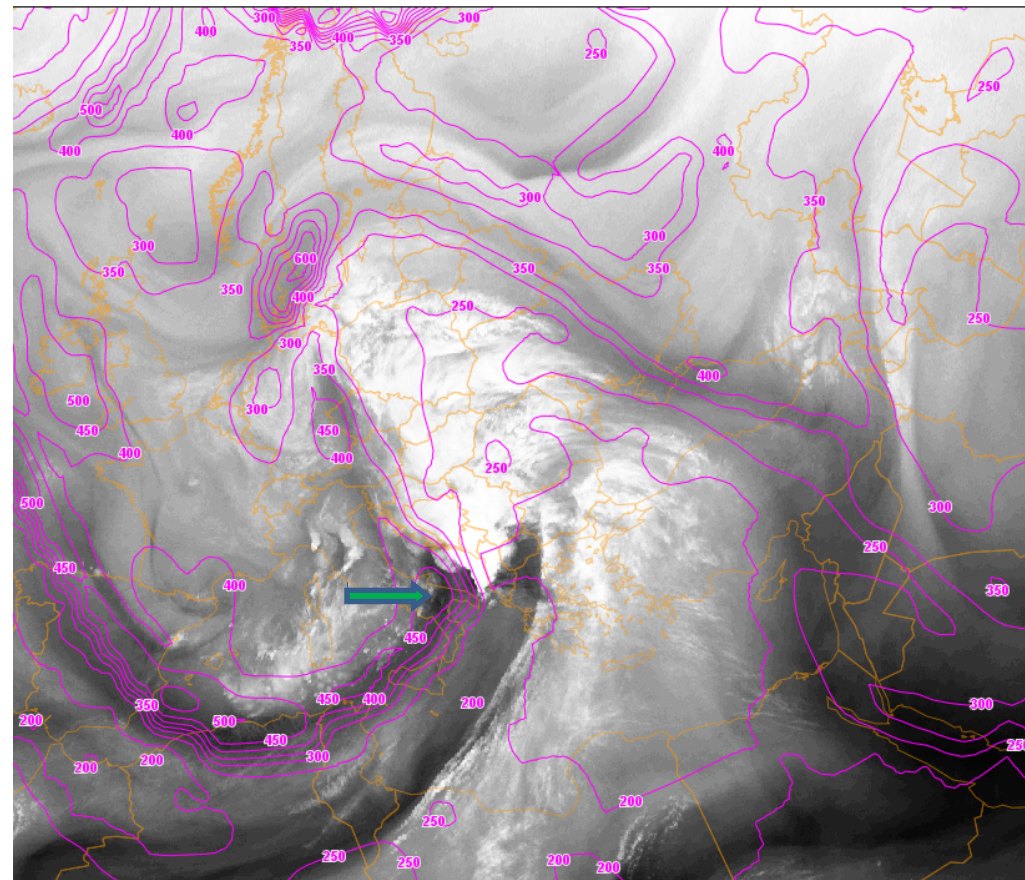
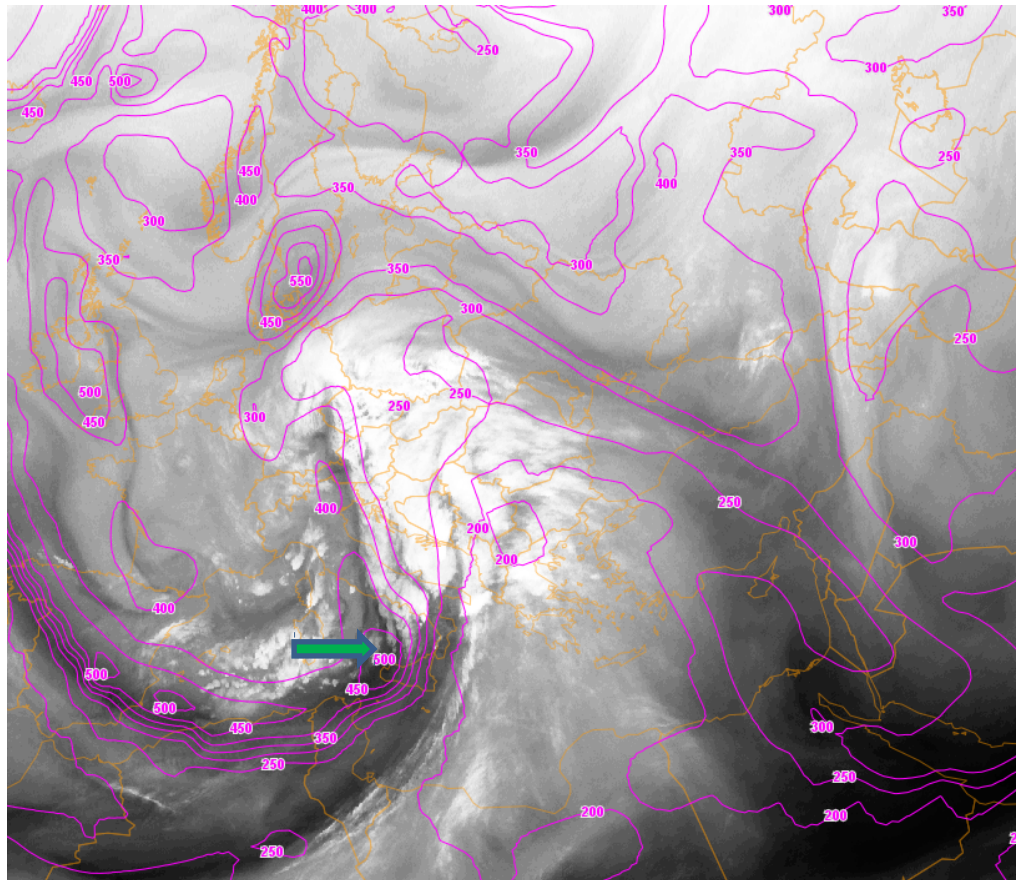
Jet streak at the rear side of the cold front crosses the frontal cloud band causing the intensification of the process in the left exit region over the South Italy and Adriatic



METEOSAT9 IR 10.8 micron image with ECMWF 300hPa isotachs and TFP at 06 and 12 UTC 22 Nov 2010

Synoptic situation, cont.

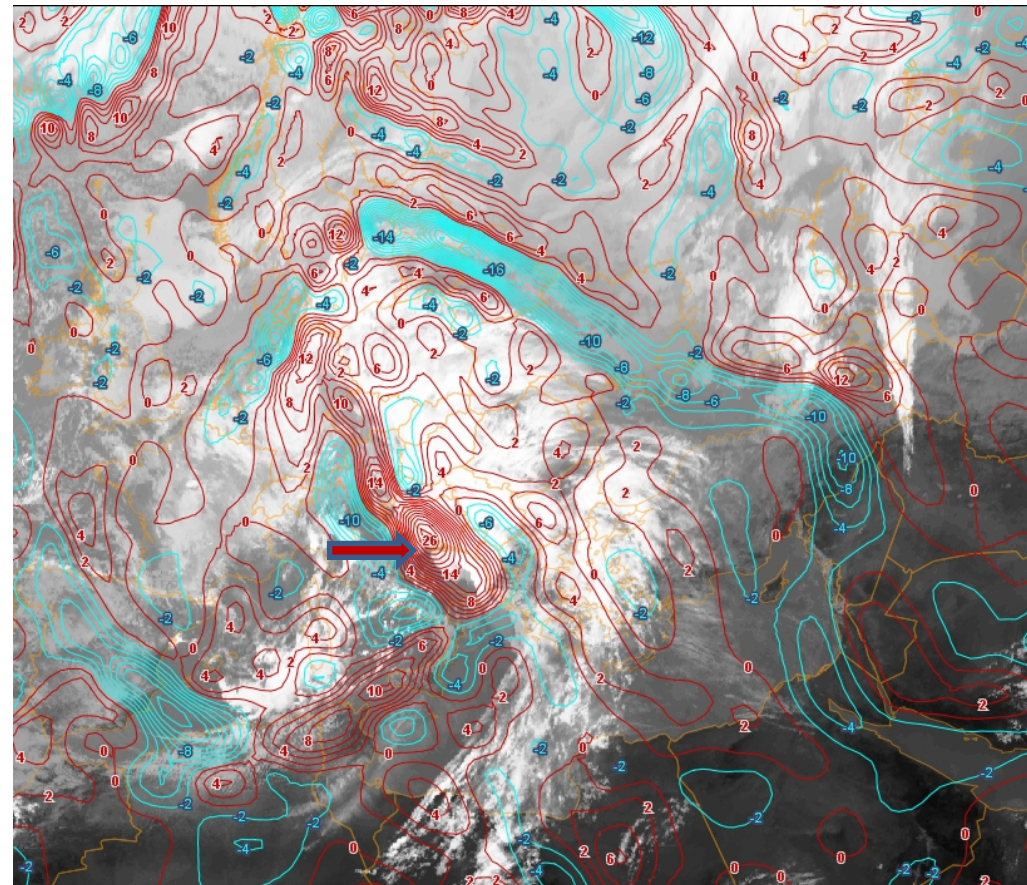
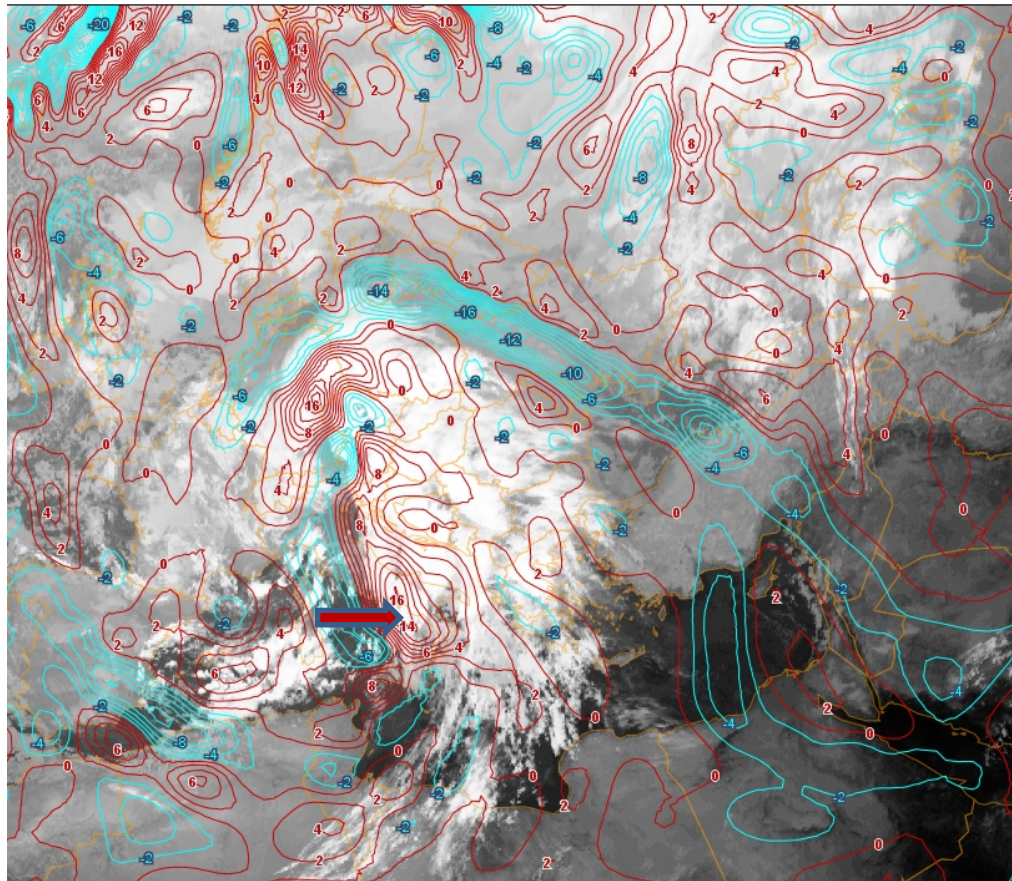
PV anomaly; the intrusion of the dry stratospheric air reaching below 450hPa



METEOSAT9 WV 6.2 micron image with ECMWF height (hPa) of PV=2units at 06 and 12 UTC

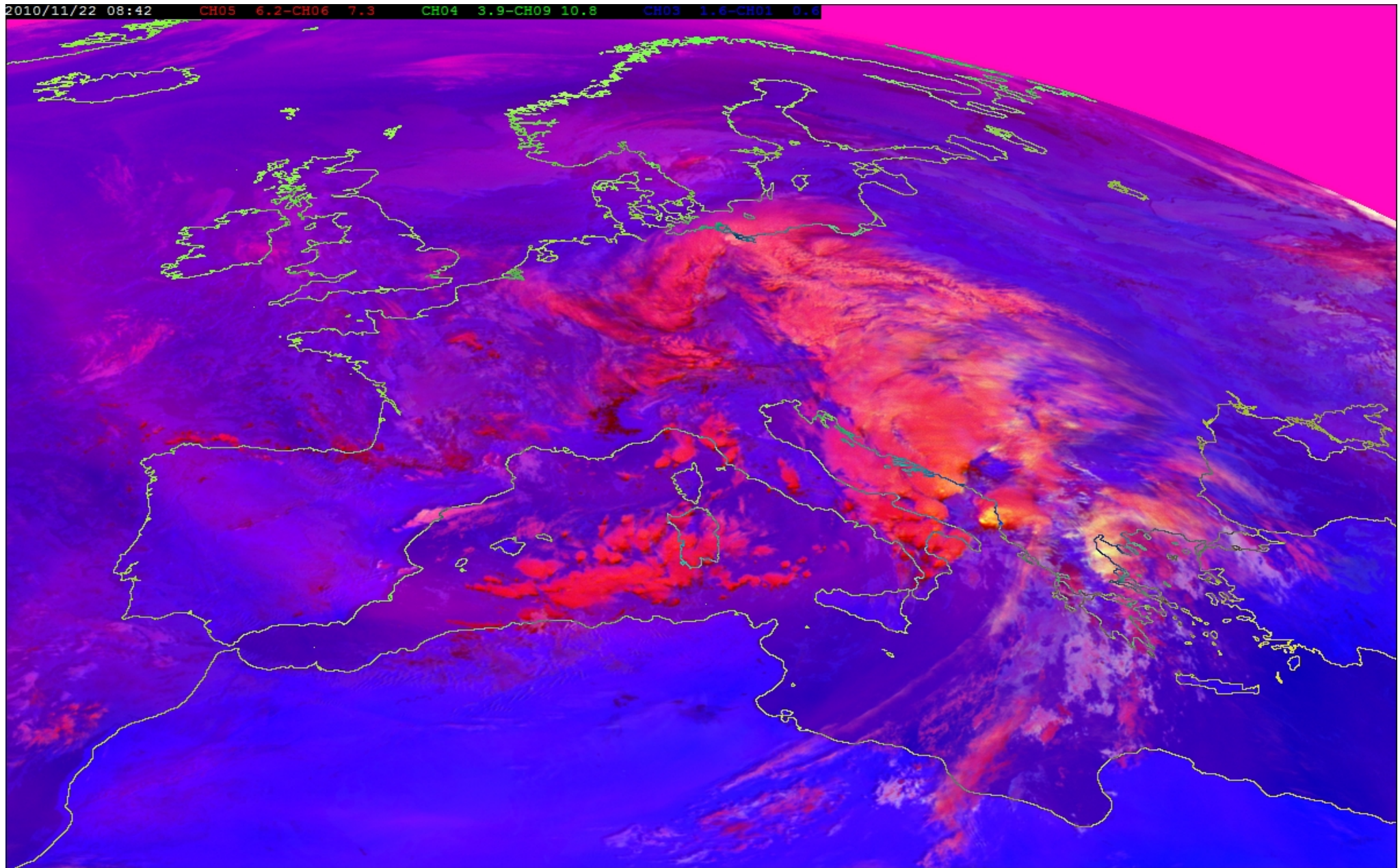
Synoptic situation, cont.

Intensive Positive Vorticity Advection (PVA) as a consequence of the deepening trough in the neighbourhood of the left exit region of a jet streak gives strong upward motion in the area of South Italy and Adriatic

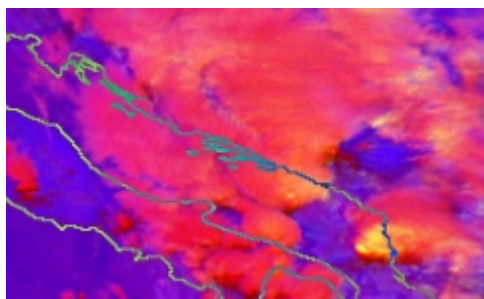
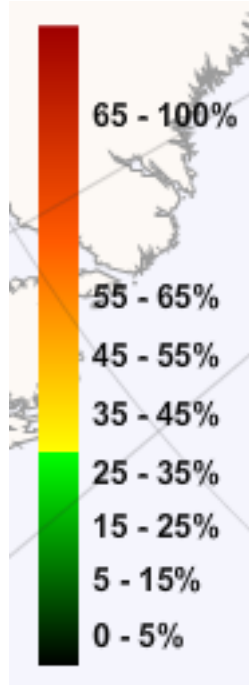


METEOSAT9 IR image with ECMWF VA at 300 hPa (positive in red, negative in blue) at 06 and 12 UTC

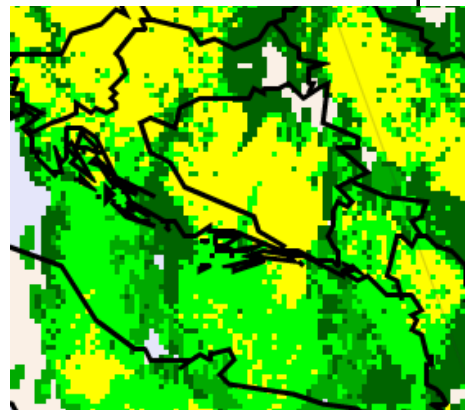
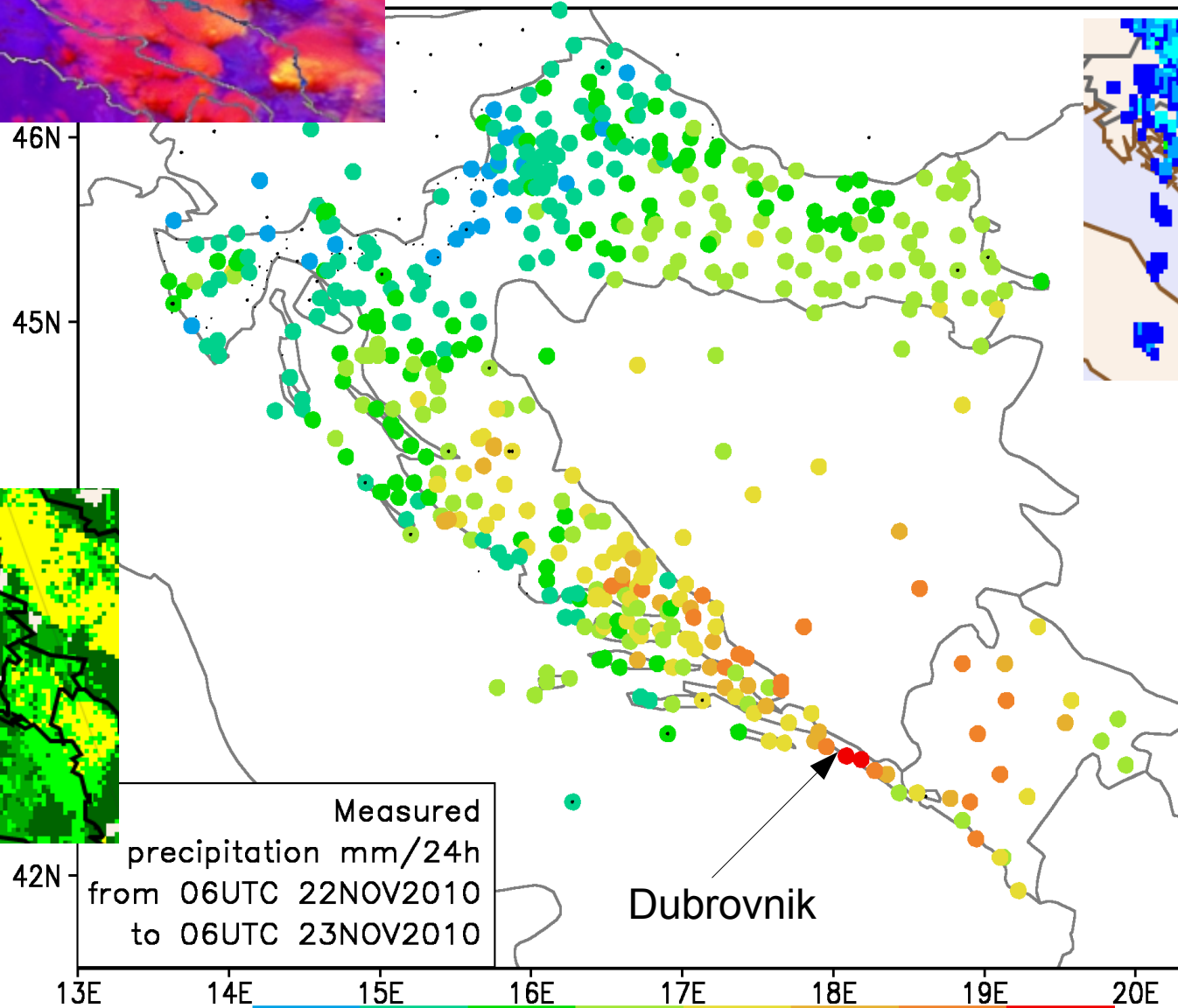
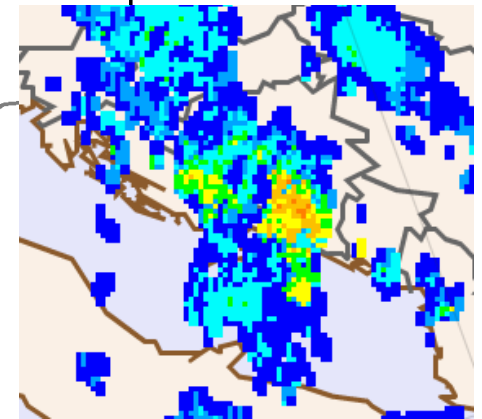
Synoptic situation, cont.



METEOSAT9 Severe storms RGB at 8:42 UTC, 22 September 2010

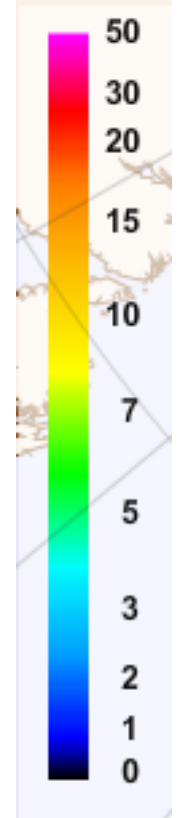
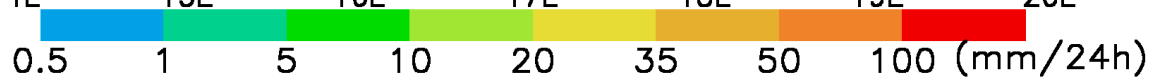


06 UTC
22 Nov 2010
Convective
rainfall rate

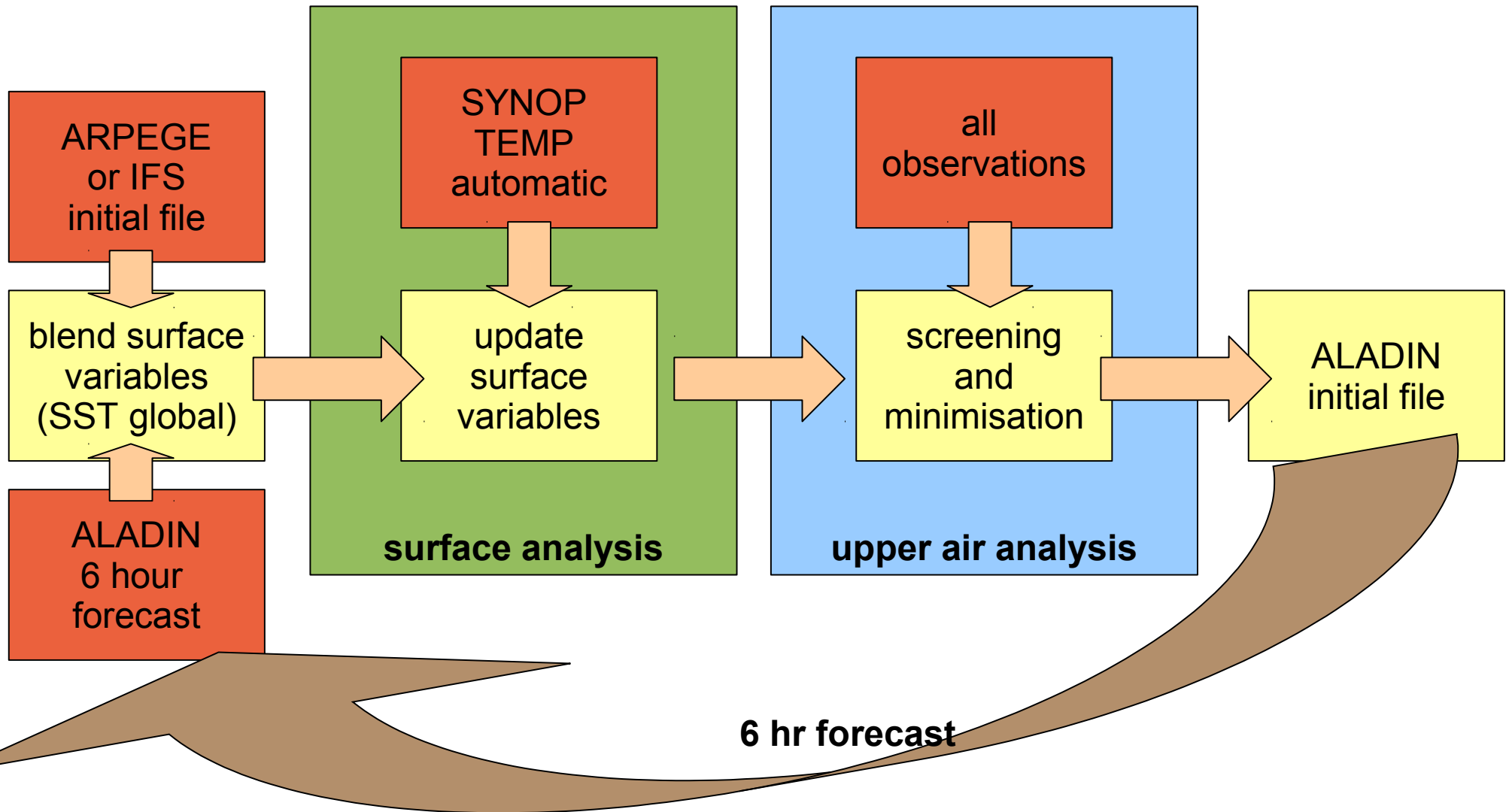


Measured
precipitation mm/24h
from 06UTC 22NOV2010
to 06UTC 23NOV2010

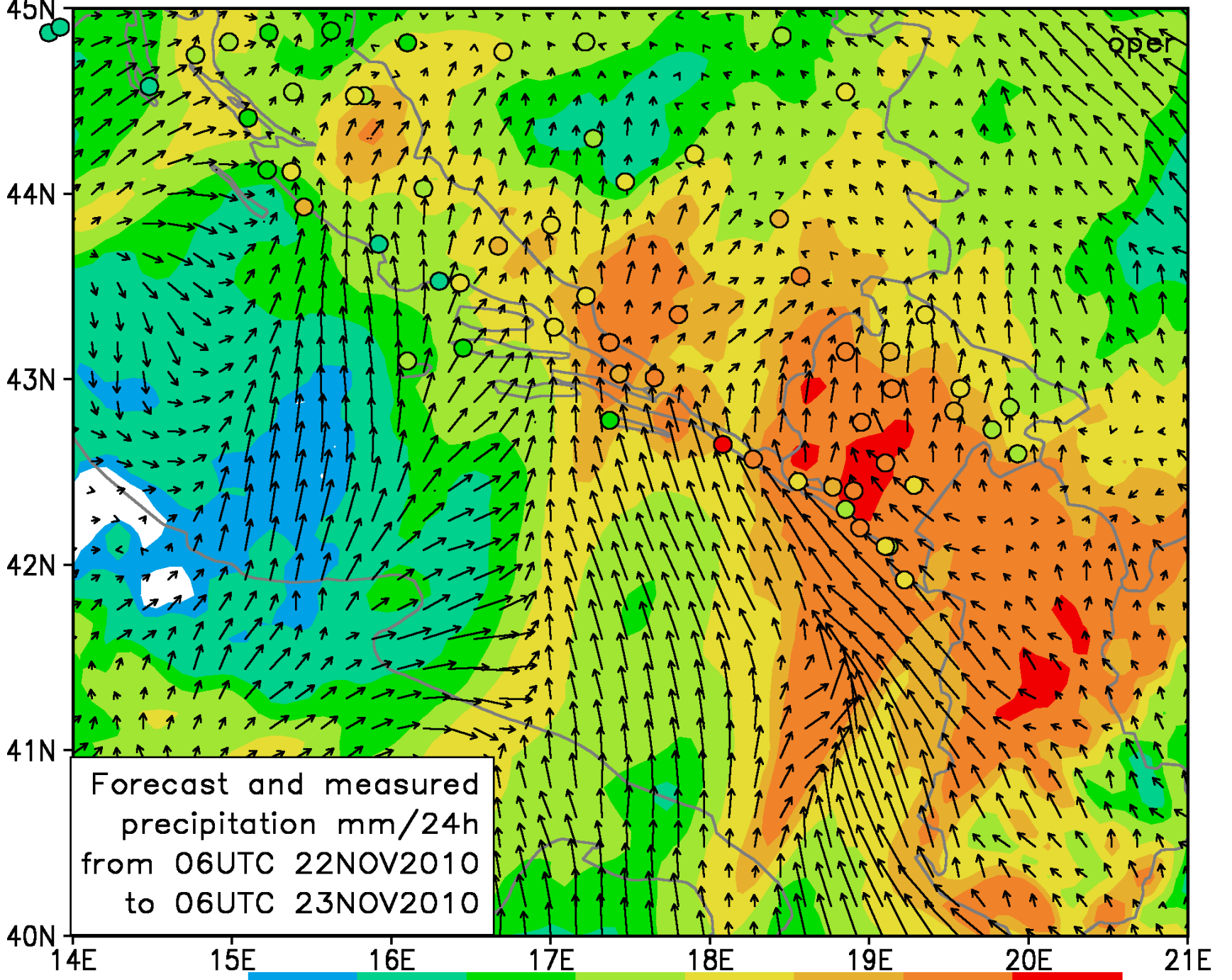
Dubrovnik



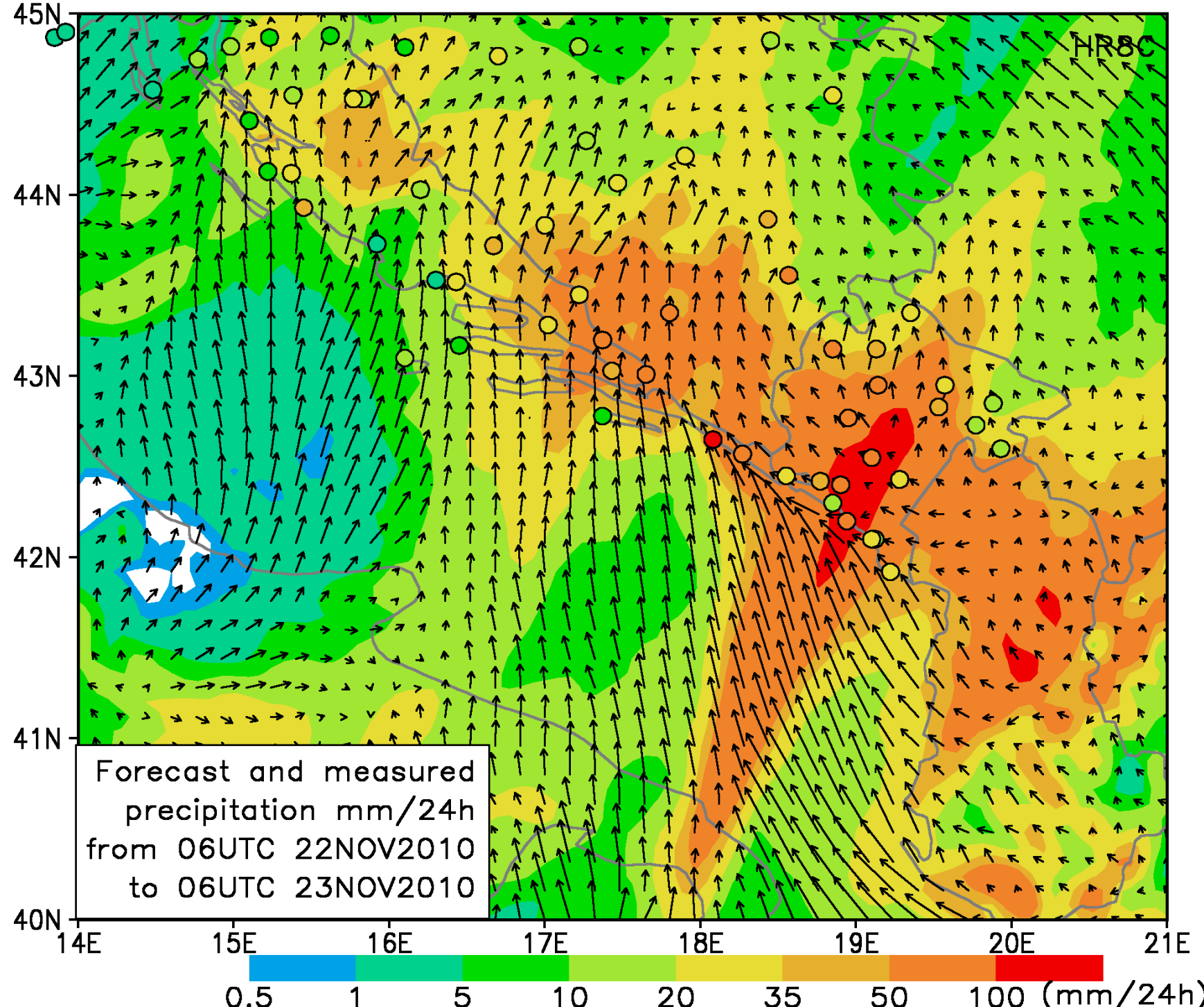
The data assimilation cycle at CMHS



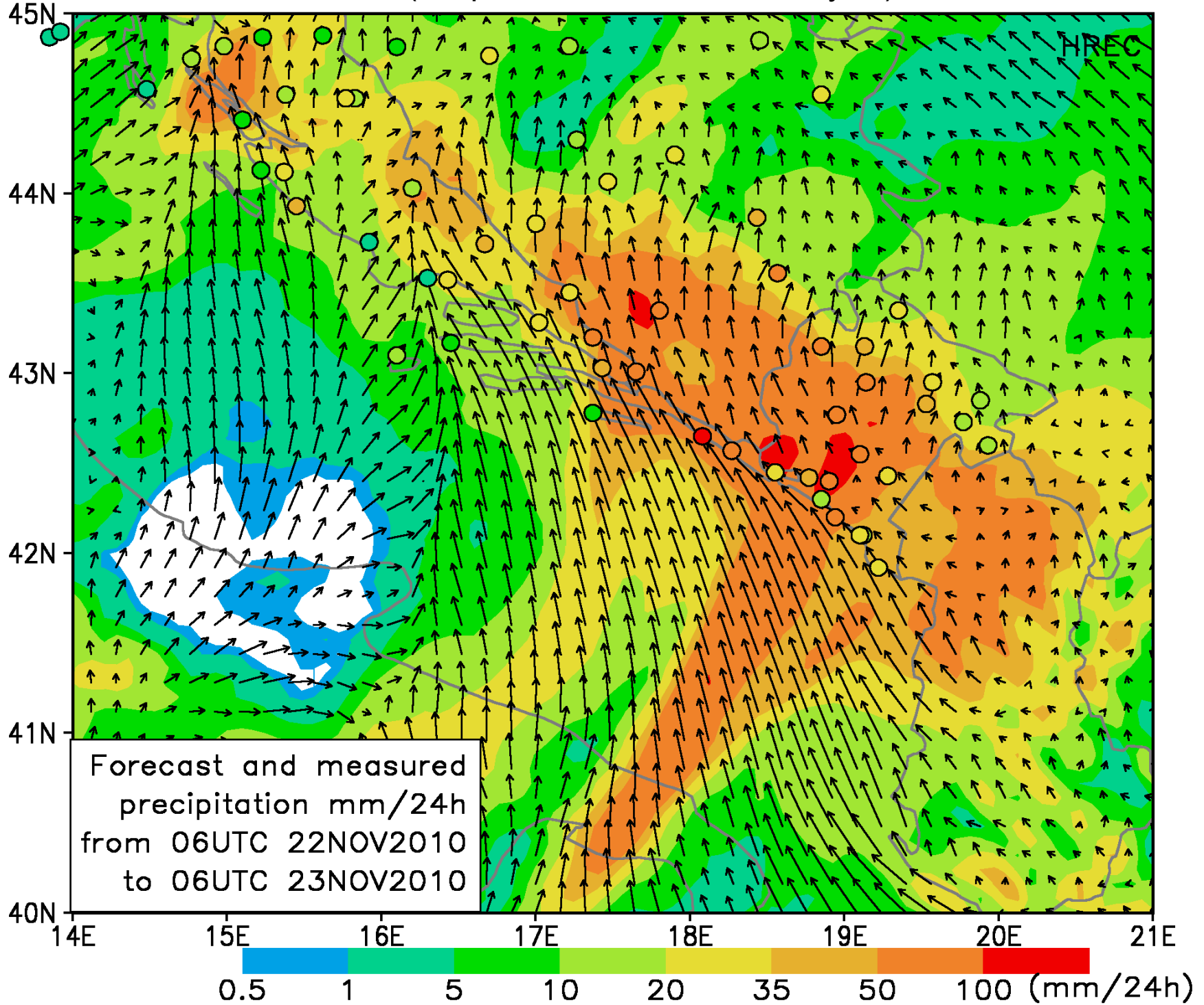
The operational 24 hour precipitation forecast (shaded), measurements on rain gauges (circles) and wind for 09 UTC 22 Nov 2010 (coupled to ARPEGE, DFI)



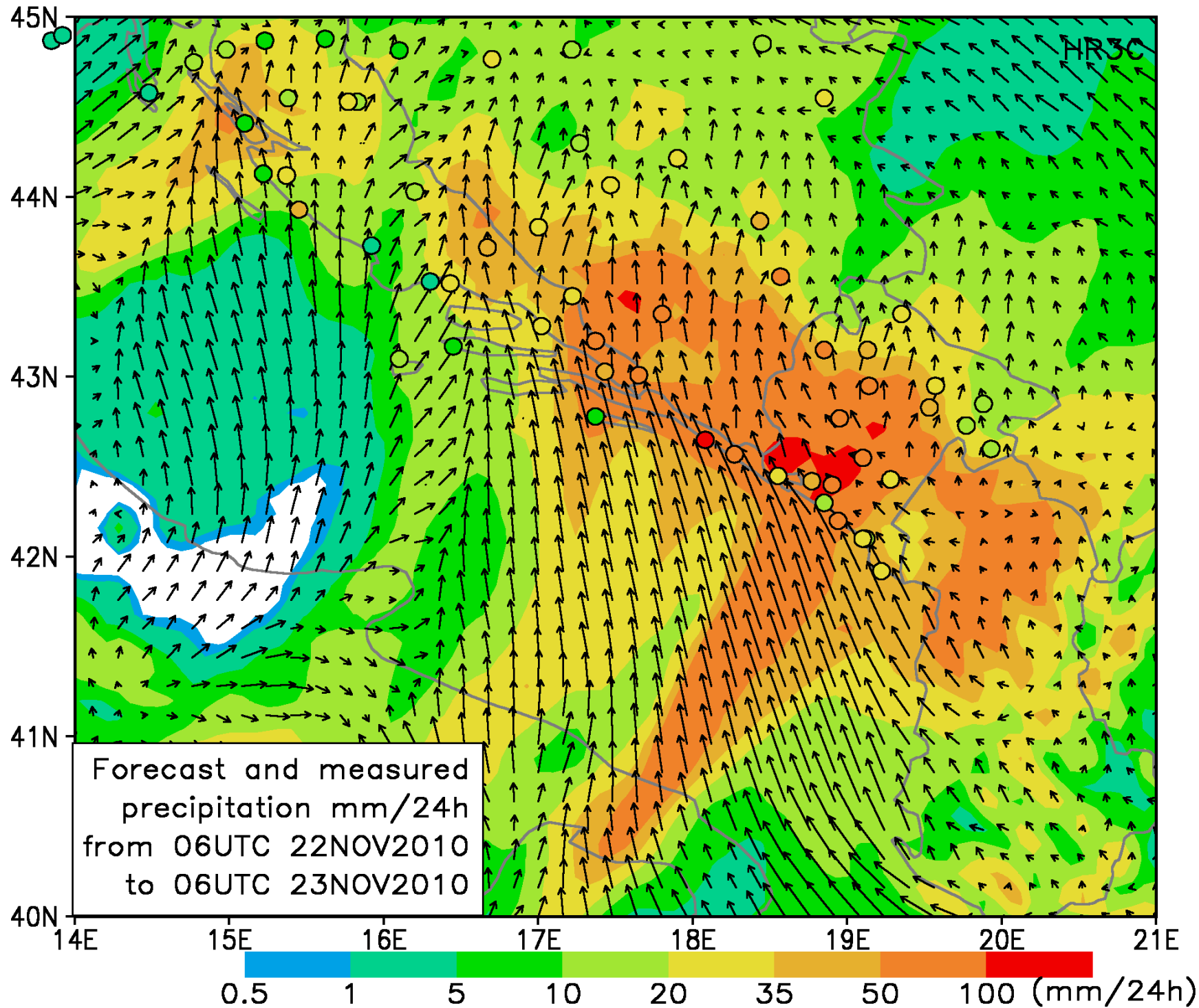
The parallel suite 24 hour precipitation forecast (shaded), measurements on rain gauges (circles) and wind for 09 UTC 22 Nov 2010 (coupled to ARPEGE, 3Dvar)

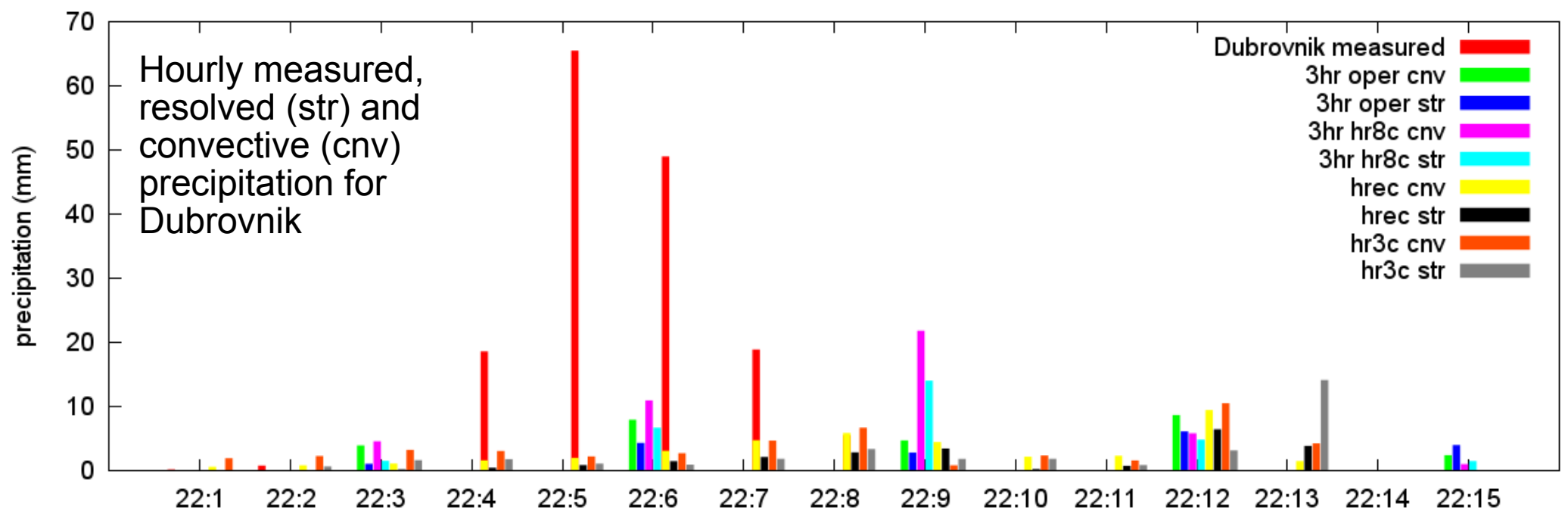
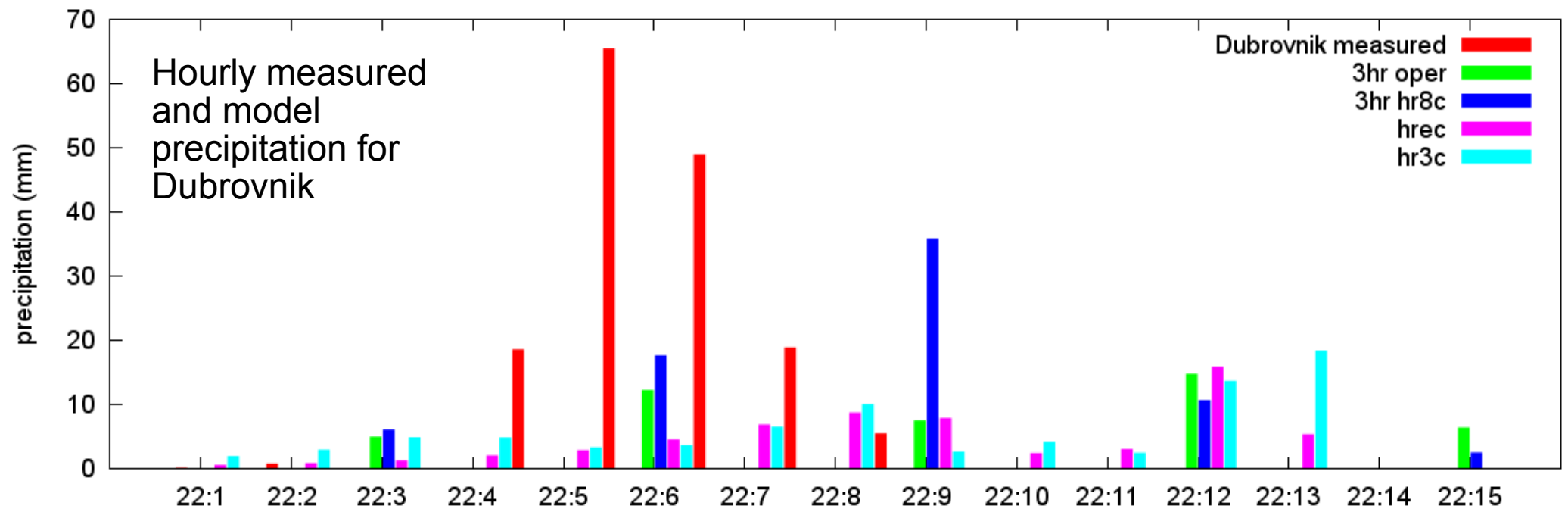


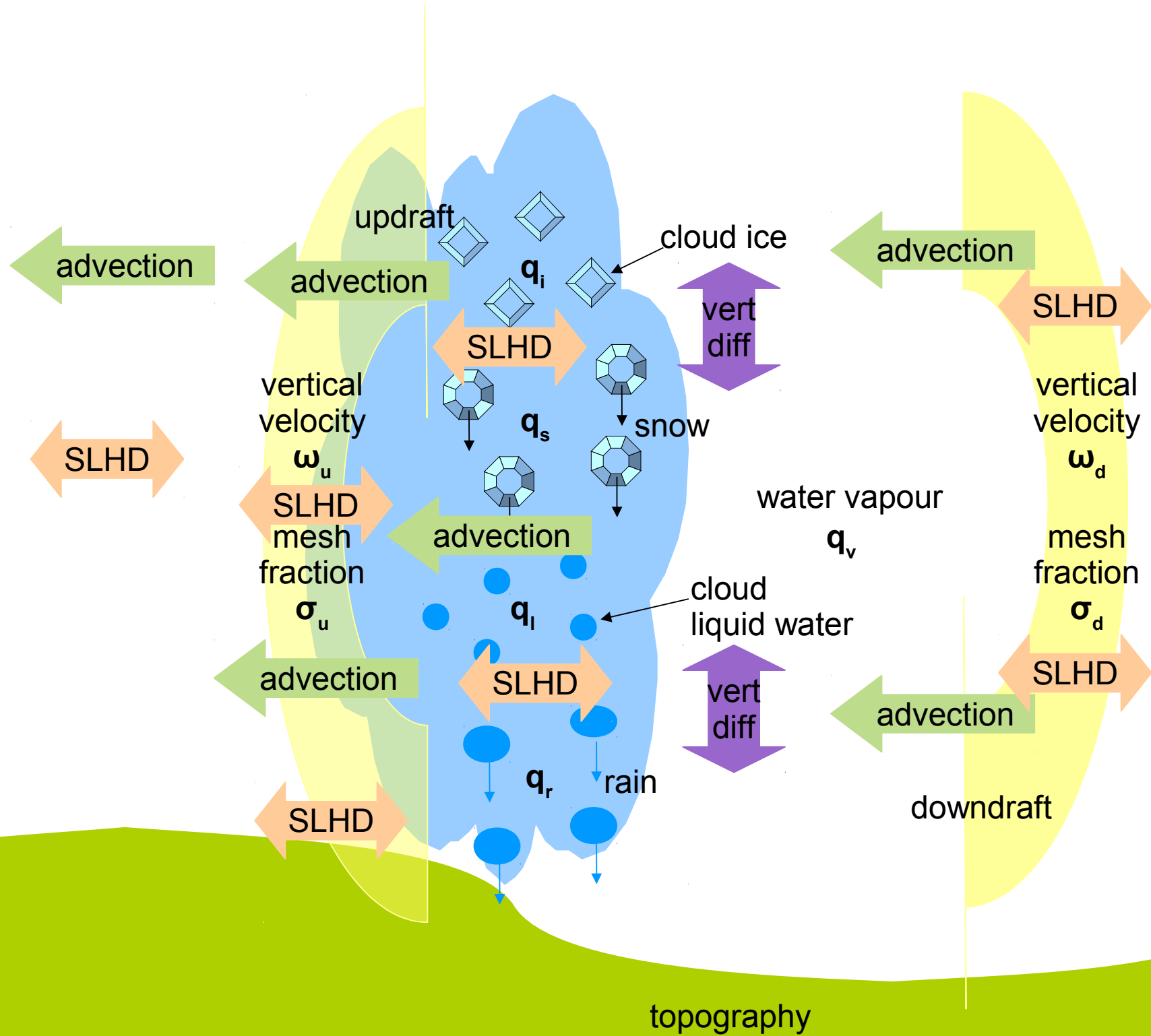
The 24 hour precipitation forecast (shaded), measurements on rain gauges (circles) and wind for 09 UTC 22 Nov 2010 (coupled to IFS, surface analysis)



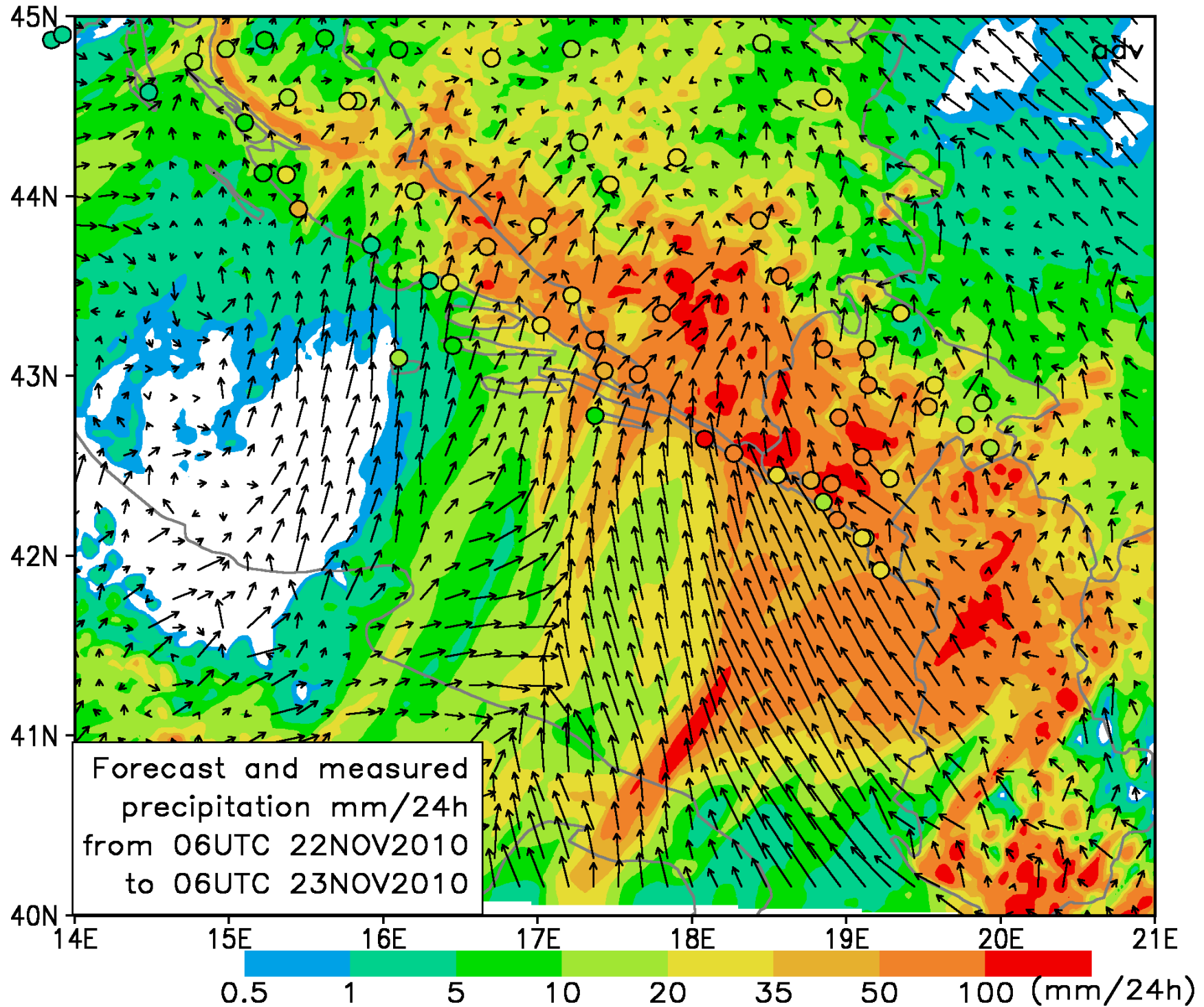
The 24 hour precipitation forecast (shaded), measurements on rain gauges (circles) and wind for 09 UTC 22 Nov 2010 (coupled to IFS, 3Dvar)



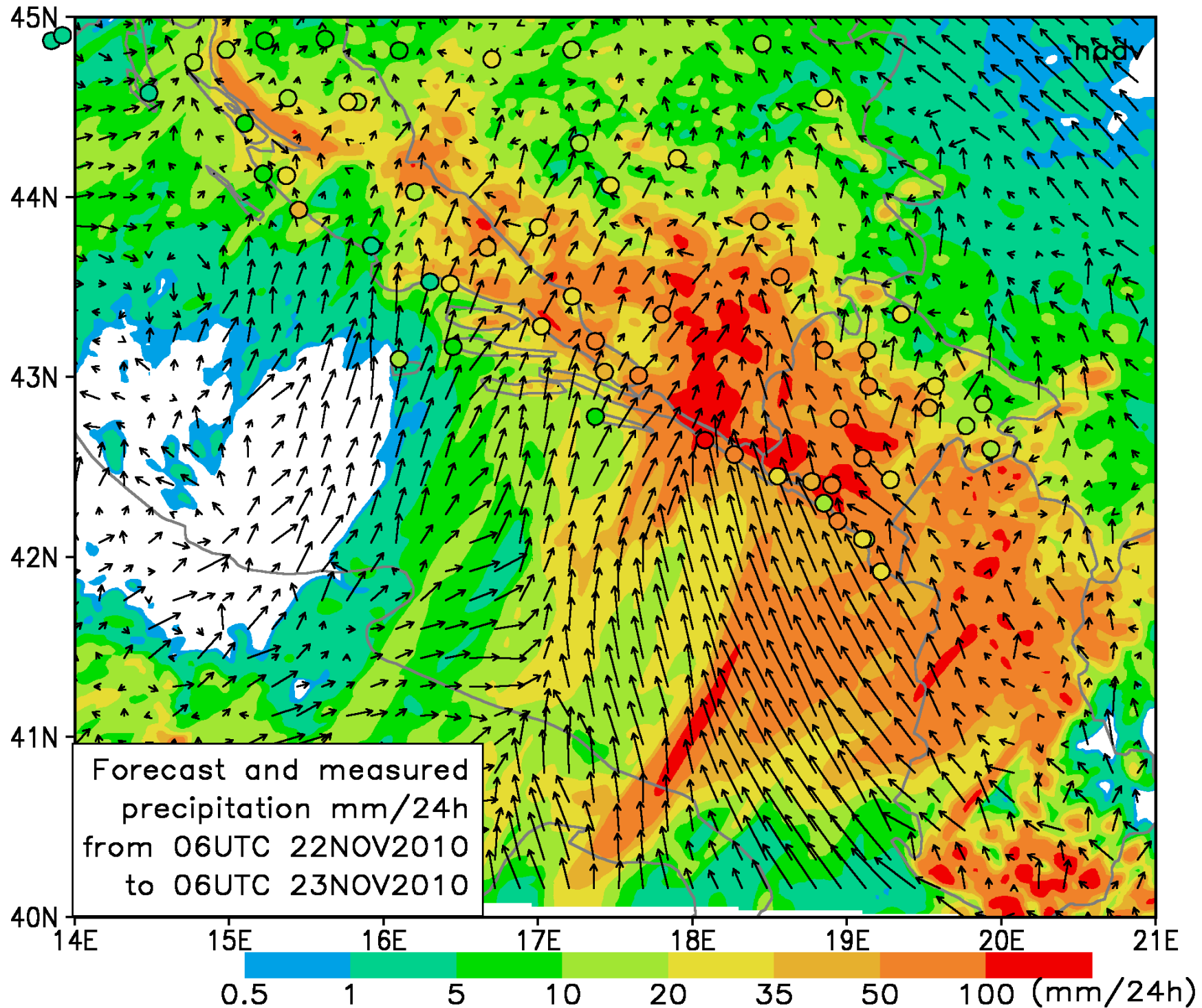




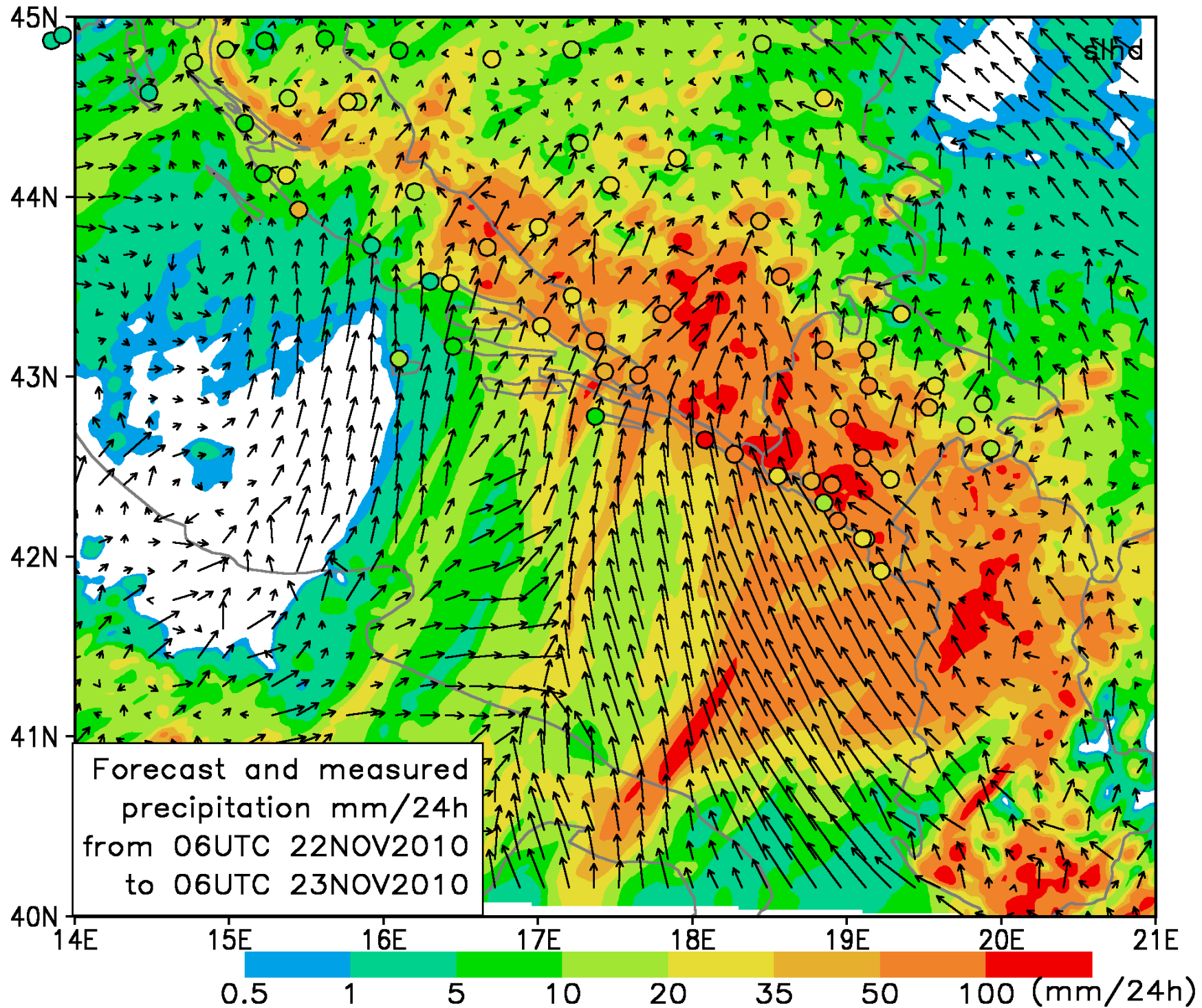
2km resolution 24 hour precipitation forecast (shaded), measurements on rain gauges (circles) and wind for 09 UTC 22 Nov 2010 (advected hydrometeors and convection)



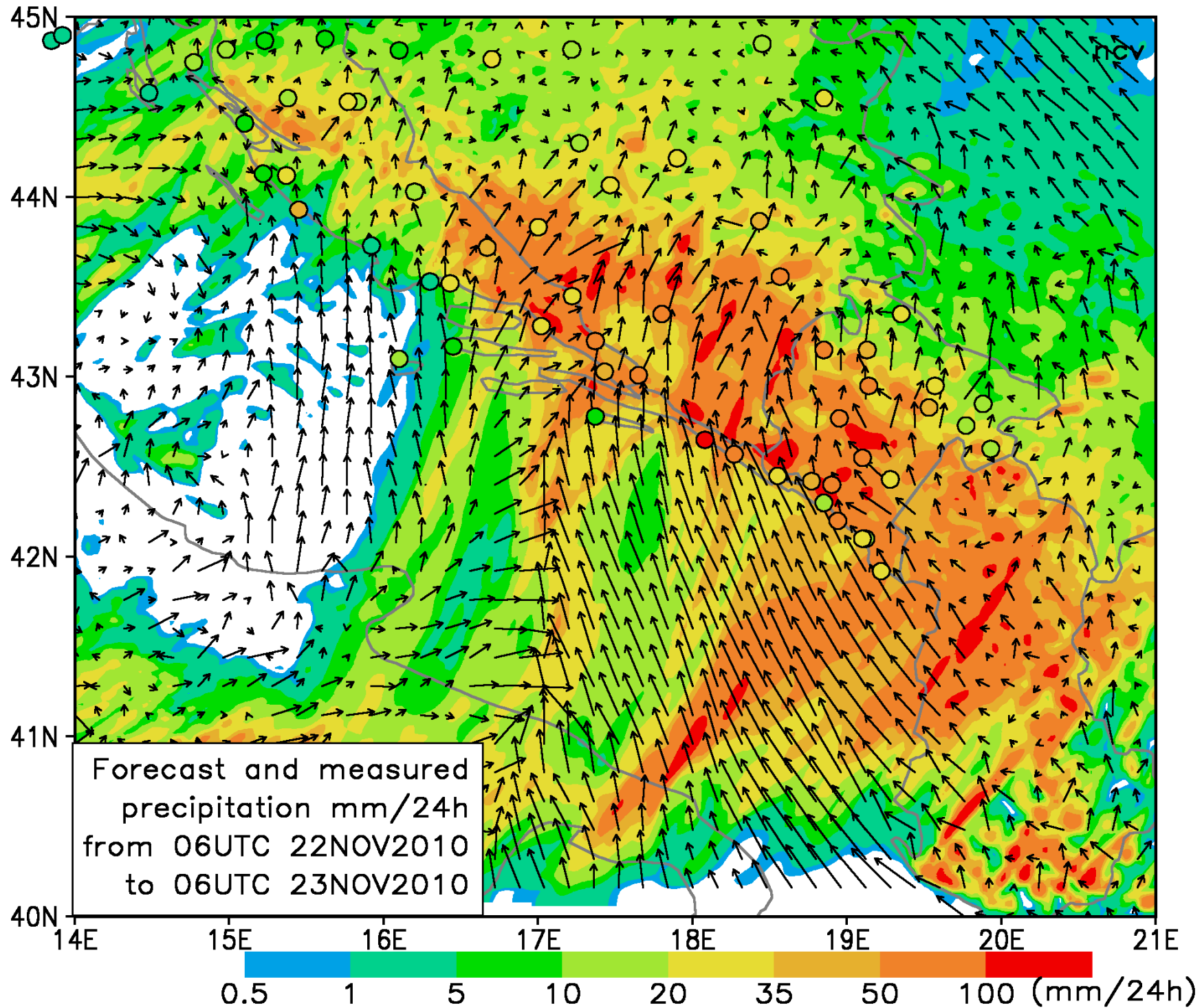
2km resolution 24 hour precipitation forecast (shaded), measurements on rain gauges (circles) and wind for 09 UTC 22 Nov 2010 (hydrometeors and convection not advected)



2km resolution 24 hour precipitation forecast (shaded), measurements on rain gauges (circles) and wind for 09 UTC 22 Nov 2010 (hydrometeors and convection advected and diffused horiz.)



2km resolution 24 hour precipitation forecast (shaded), measurements on rain gauges (circles) and wind for 09 UTC 22 Nov 2010 (without convection)



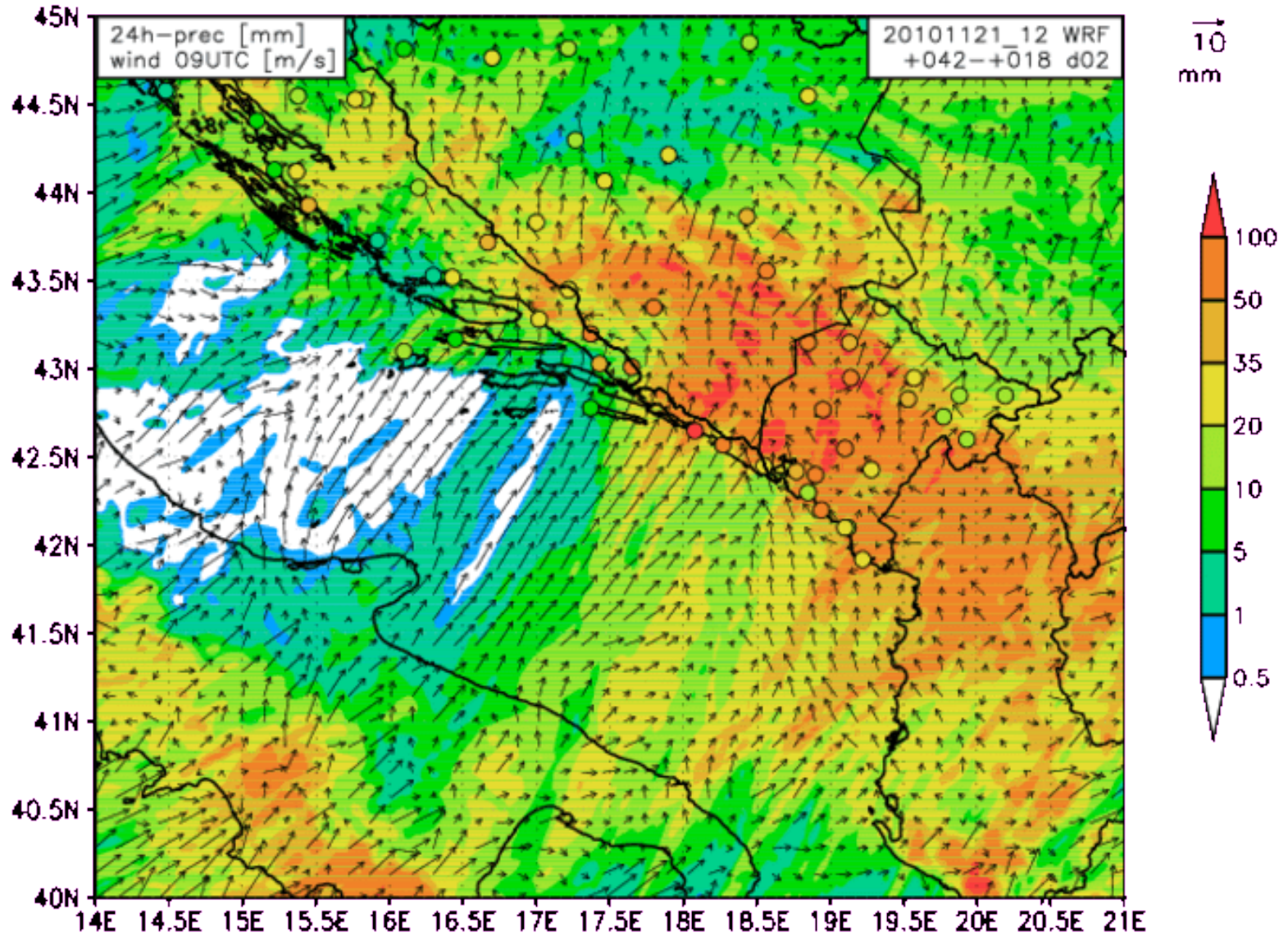
WRF simulations

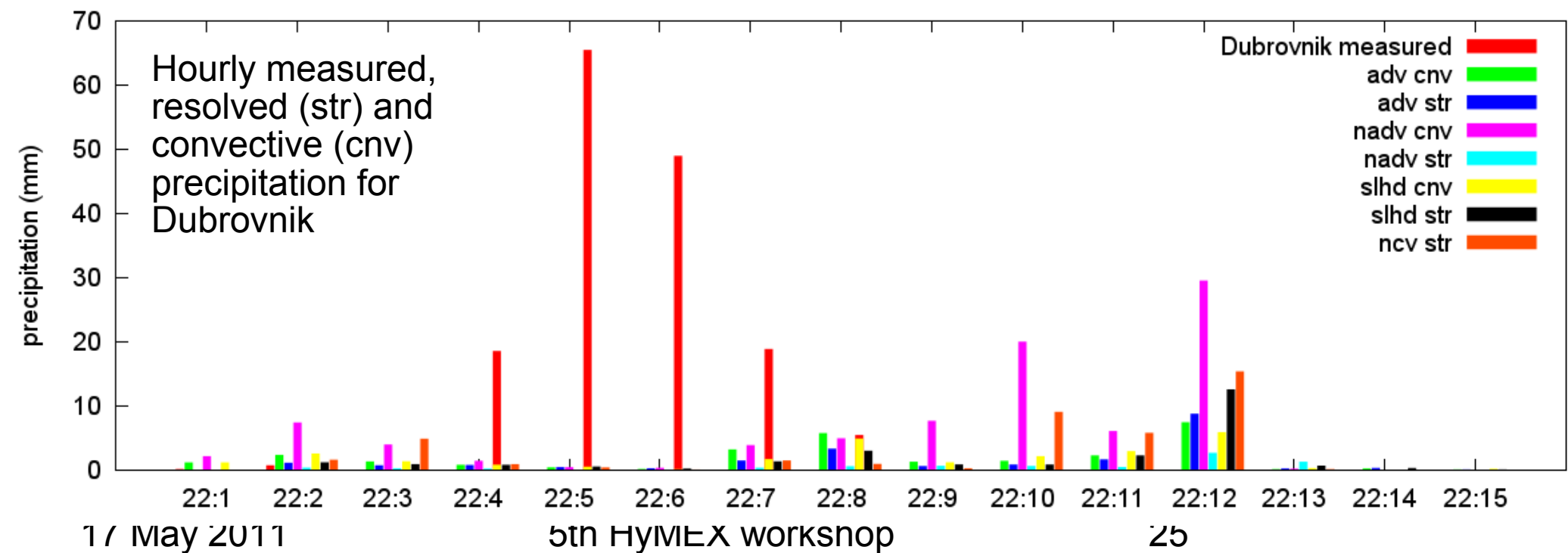
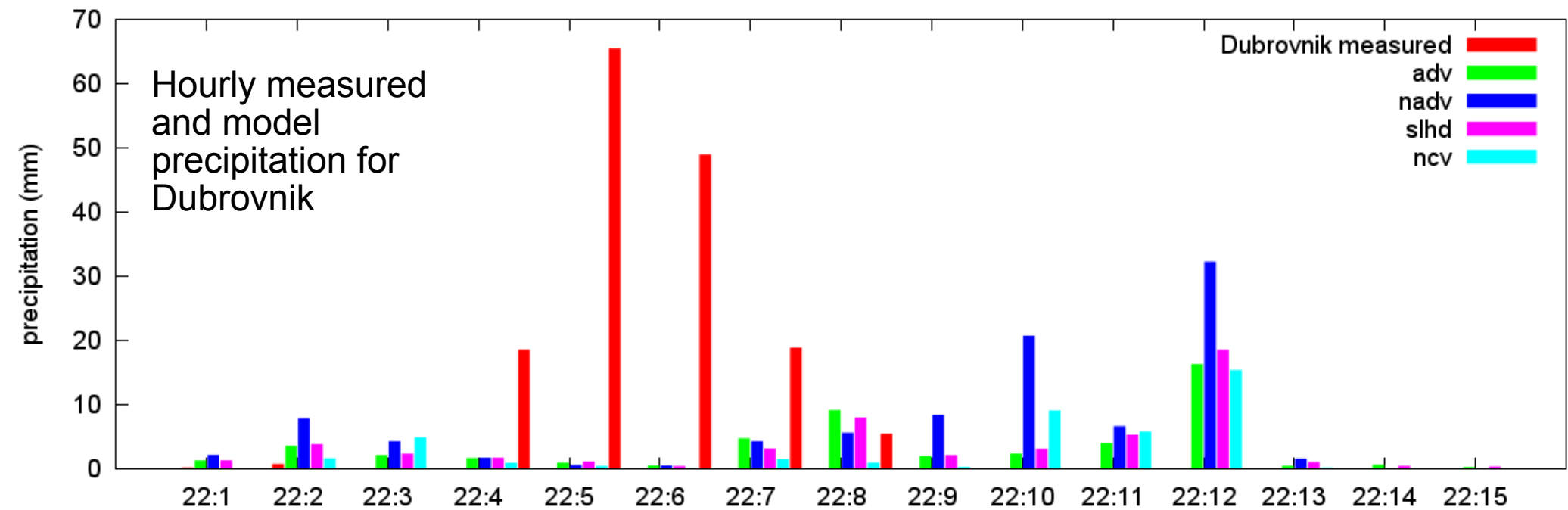
Simulations were initialized on 12 UTC 21 Nov 2010 for 42 hr forecast range with ECMWF LBC

Parameters:

1. 41 sigma levels
2. 2 domains, outer at 8 km (d01), inner at 2 km (d02)
3. Betts-Miller_Janjic cumulus (only in domain 1)
4. Morrison 2-moment microphysics
5. Noah land-surface model
6. Monin-Obhikov-Janjic (eta) surface scheme
7. Mellor-Yamada-Janjic TKE scheme for PBL parametrization with 1.5 order TKE closure
8. 2nd order diffusion on coordinate surfaces
9. 3rd order Runge-Kutta time-integration scheme
10. 5th order momentum advection
11. no assimilation

WRF simulations + 24-h precipitation measurements in circles on precipitation plots





Summary

- Flash flood event in Dubrovnik is a consequence of the synoptic setting
 - As well as local conditions (mountains)
 - Intensive rainfall in few hours
 - The model runs underestimate the rainfall intensity and the peak is too late
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- Thanks to the Met service of Montenegro