# ALARO0 experiences
# in Croatian Meteorological and Hydrological Service

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# Outline

Introduction

- the operational suite

   - 8 km and 2 km runs

Case by case evolution and analysis

- initial NH experiments

- initial NH experimetns in 2 km resolution

- pre operational tests

- overview of the operational 2 km run

Summary and plans

# The operational suite

- 8 km run uses AL32T3 (no 3MT) starting from 00 and 12 UTC, up to 72 hours, uses data assimilation for initialization (OI and 3Dvar), quadratic truncation, 37 levels in the vertical
- 2 km dynamical adaptation for hourly output files, up to 72 hours, only turbulence
- 2 km NH run AL36T1 (and a number of bugfixes) with 3MT up to 24 hours, starting from 00 UTC 8 km 6 hour forecast, initialized using SSDFI
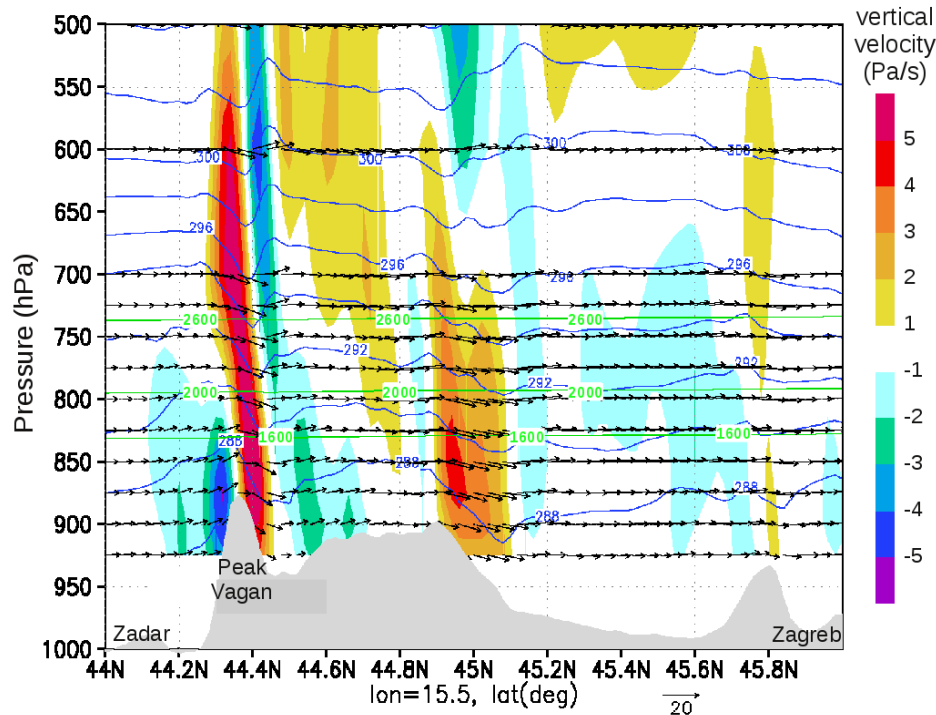
# NH run – how it all begun

- 5<sup>th</sup> Feb 2009 – air crash into Velebit mountain
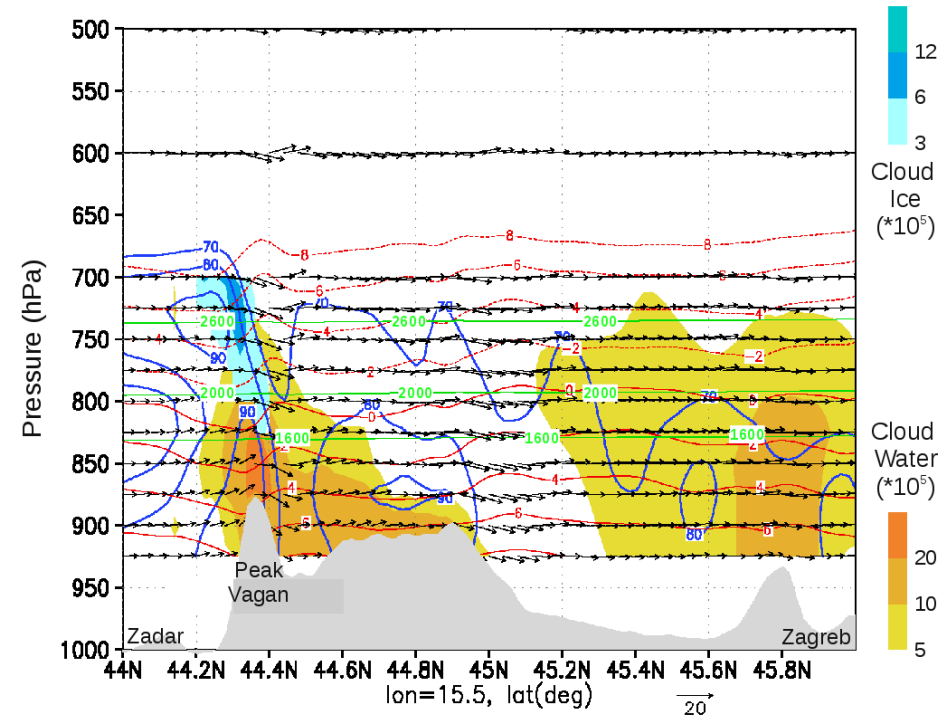- lee waves and clouds, scarce measured data

ALARO workshop, Ljubljana, Slovenia
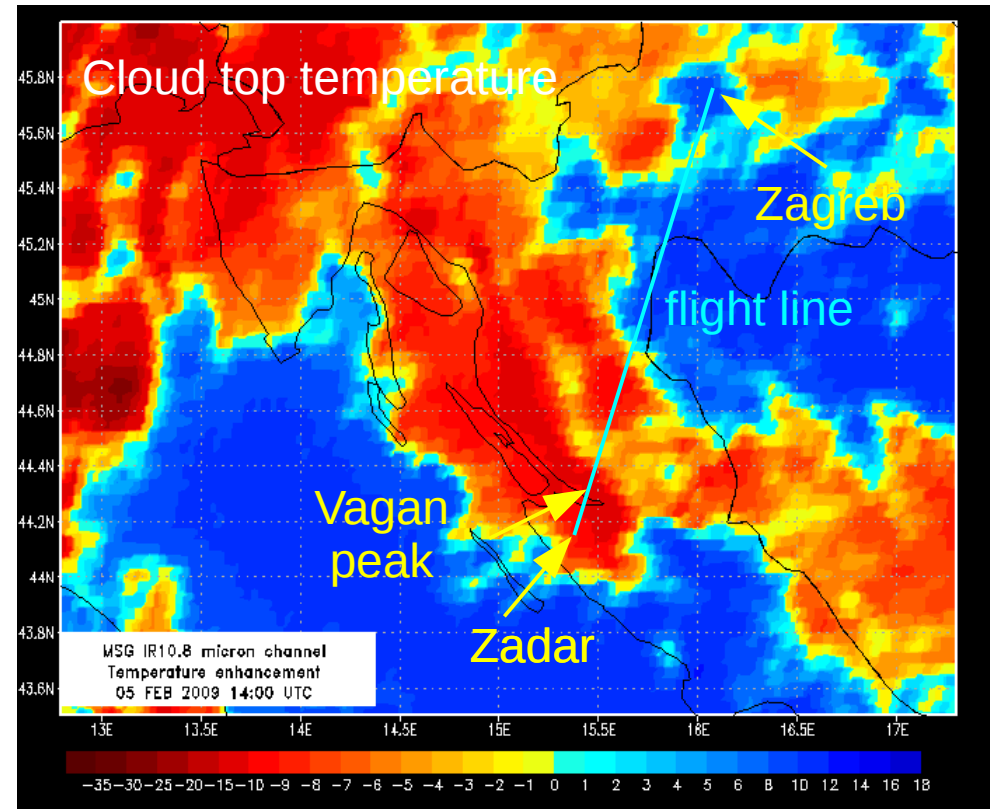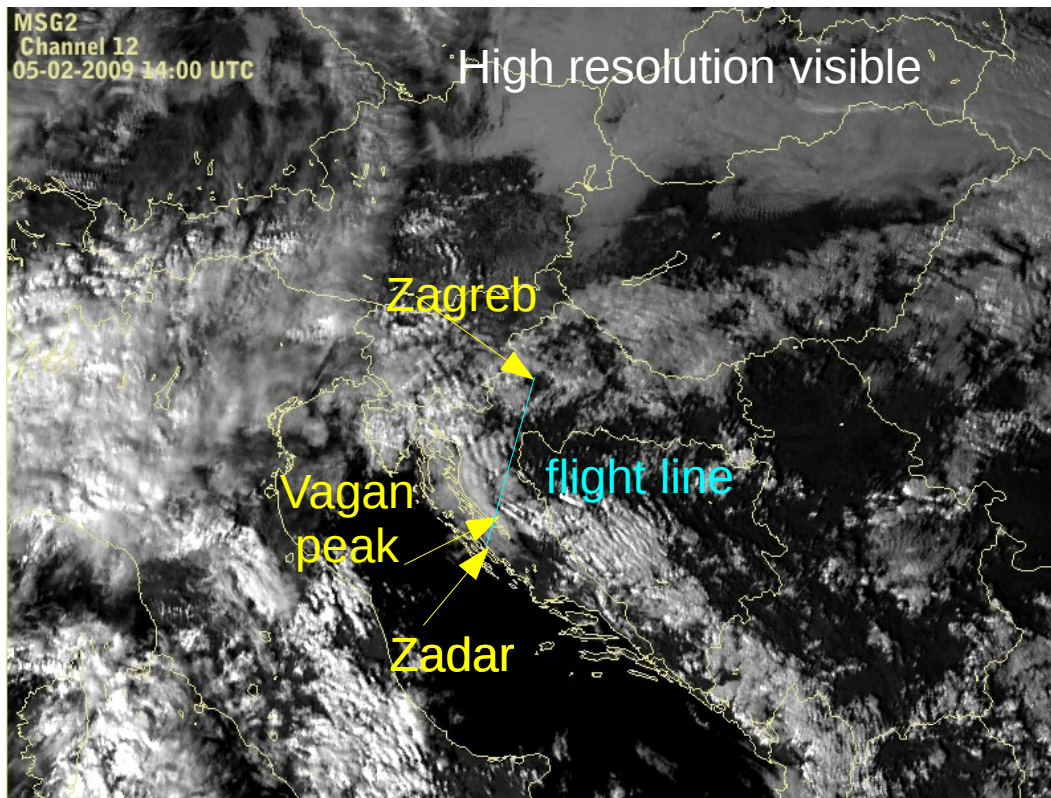
# 5th Feb 2009 00 UTC 8 km NH run

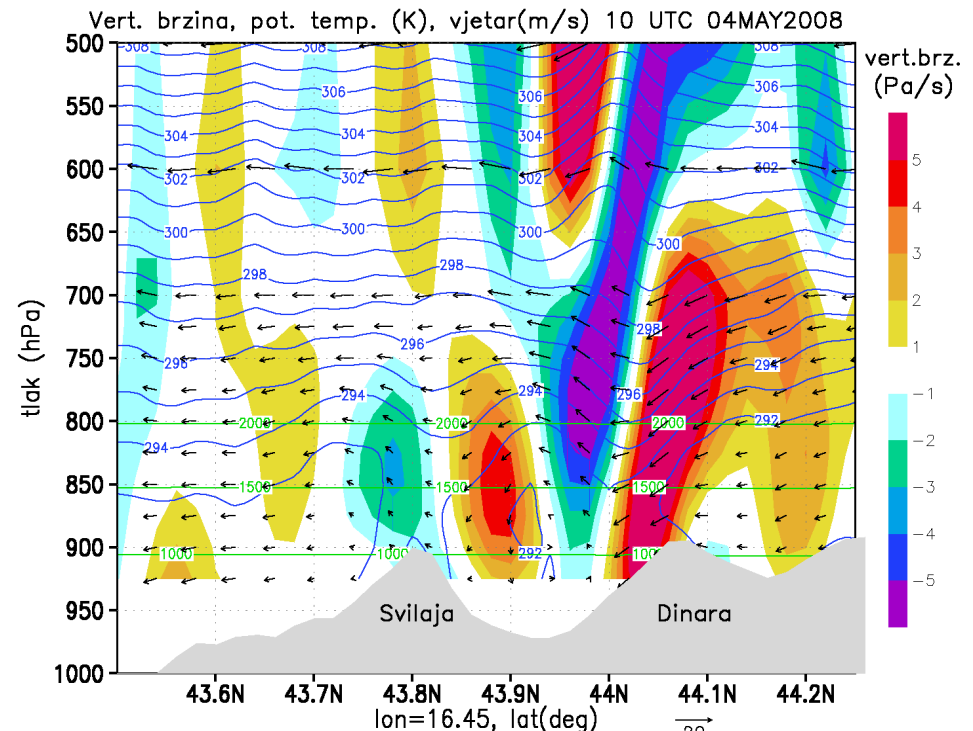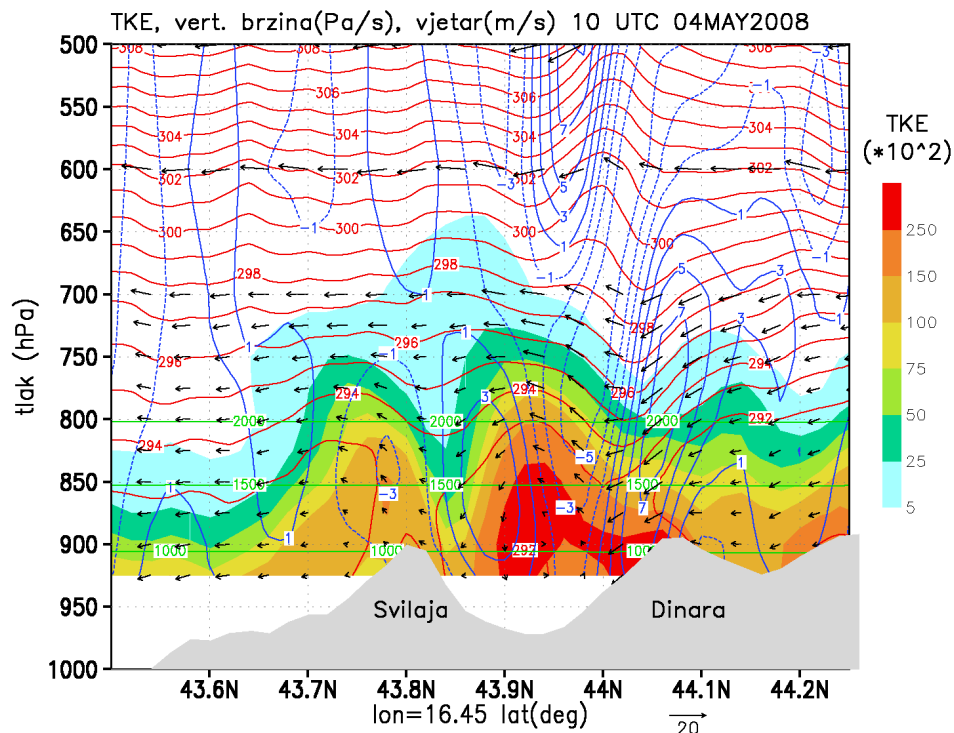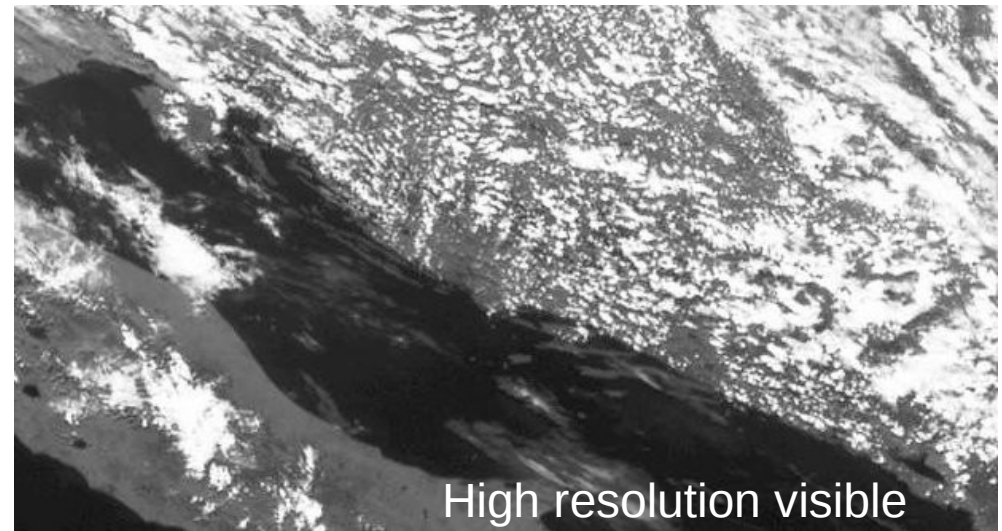- lee waves, stong downward motion



3D wind parallel to the vertical cross-section (arrows), omega (shaded), potential temp (blue) and flight levels (green).

3D wind parallel to the vertical cross-section (arrows), cloud water and ice (shaded), relative humidity (blue), temperature (red) and flight levels (green).

# Svilaja mountain, 4ᵗʰ May 2008
## - lee waves and rotor
## - no measured data



High resolution visible



TKE, vert. brzina(Pa/s), vjetar(m/s) 10 UTC 04MAY2008

3D wind parallel to the vertical cross-section (arrows), TKE (shaded), potential temp (red), omega (blue), elevations (green).



Vert. brzina, pot. temp. (K), vjetar(m/s) 10 UTC 04MAY2008

3D wind vectors, omega (shaded), potential temp (blue), elevations (green).

# Bura cases of 1$^{st}$ and 3$^{rd}$ Feb 2007

- bura triggered localy, not forecast by 2km DA



Strong bura events not forecast operationally
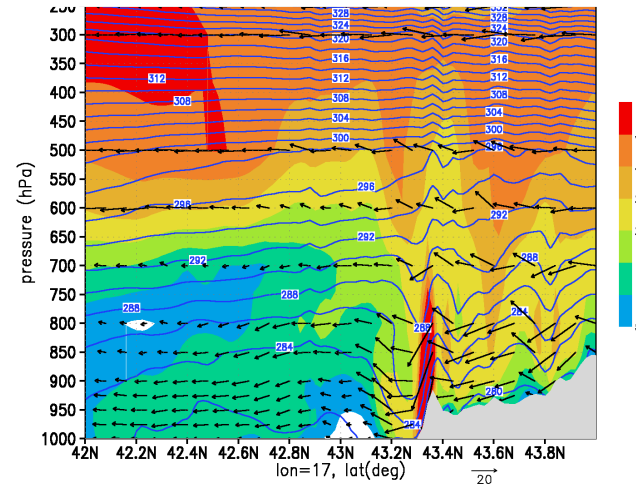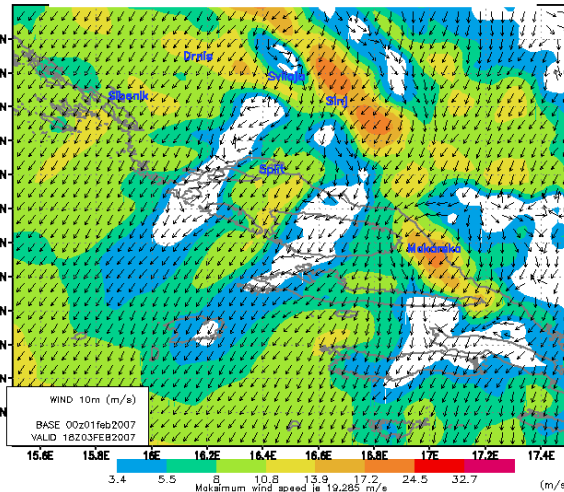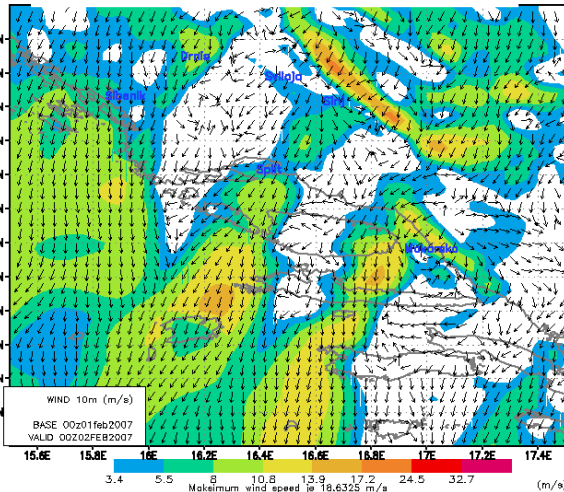
?

Local storm
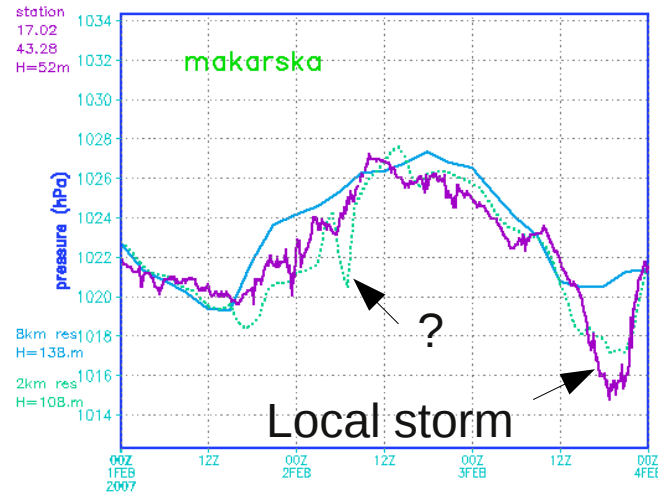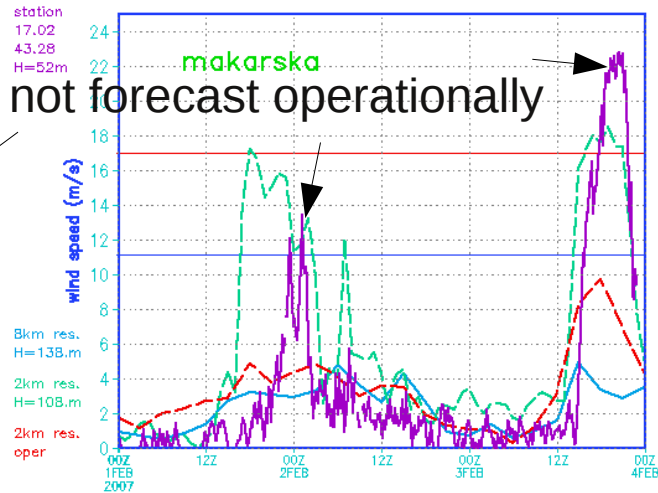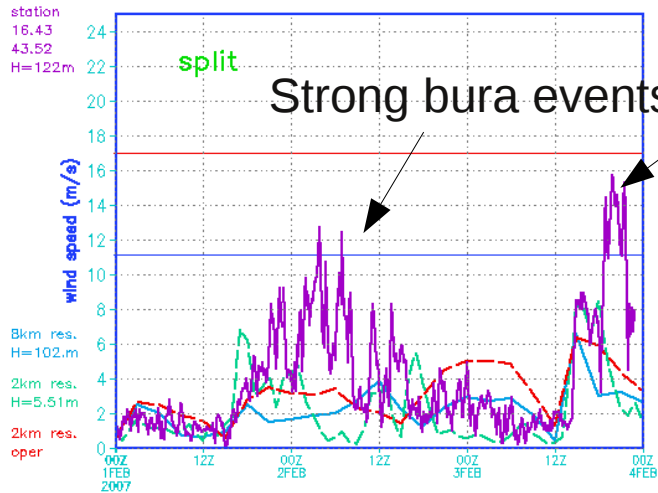
Meas. 10m wind and mslp (purple), 8km fcst (blue), 2km DynAd (red) and 2km NH run (blue-green dashed).
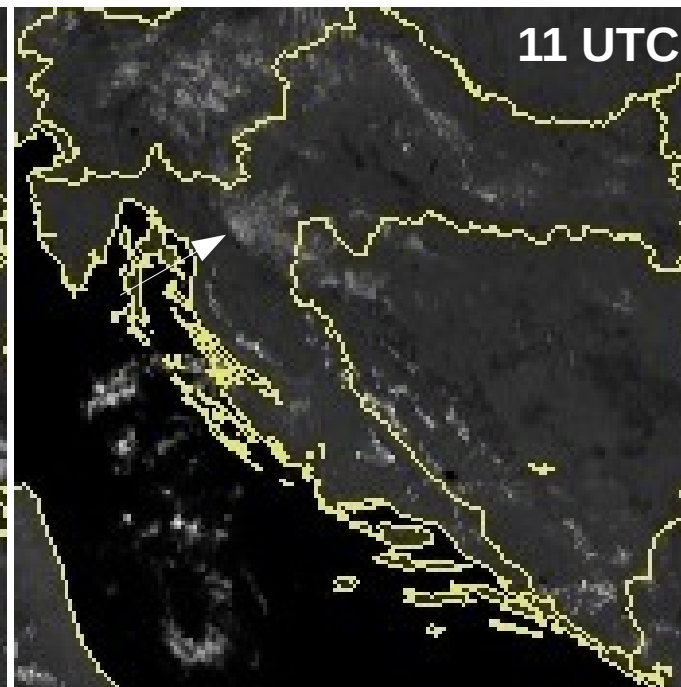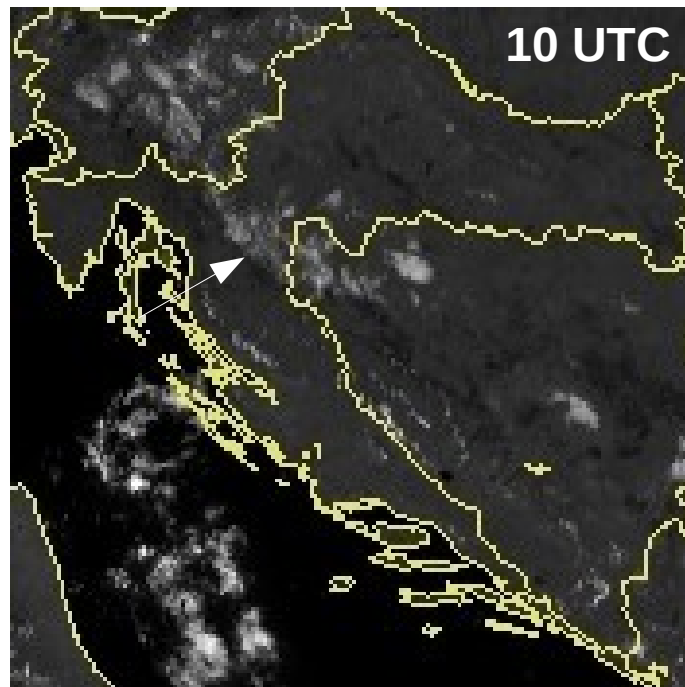
**10 m wind (m/s)  00 UTC 2 Feb 2007**    **10 m wind (m/s)  18 UTC 3 Feb 2007**    **Wind (m/s) and pot.temp 18 UTC 3 Feb 2007**
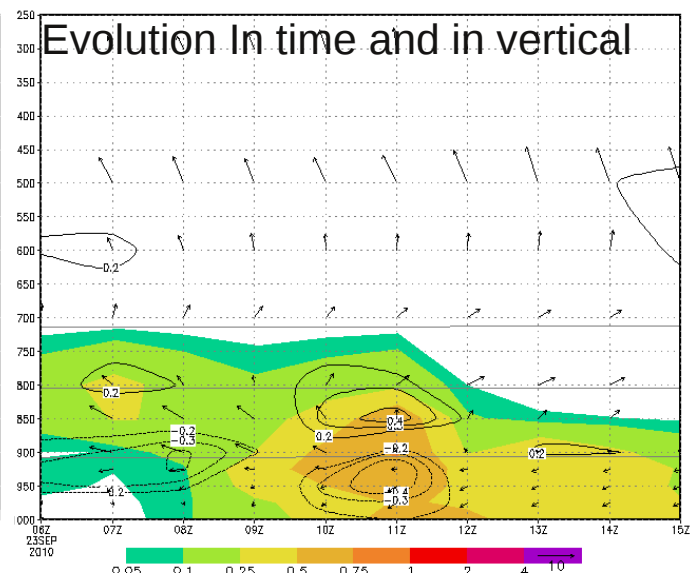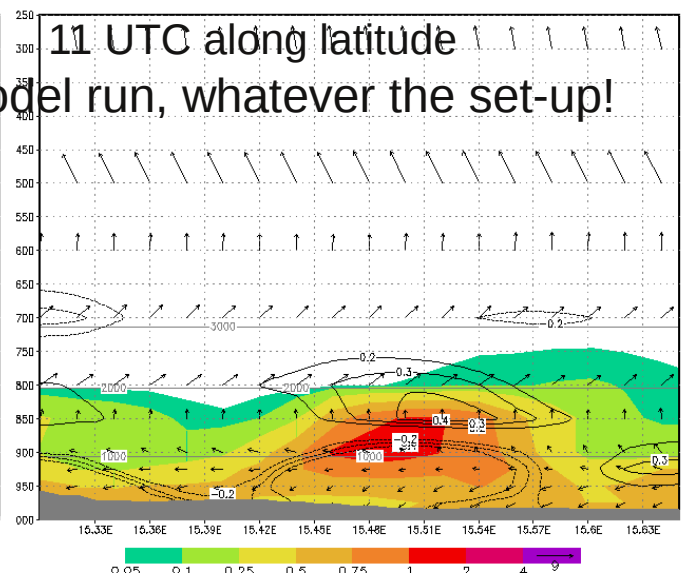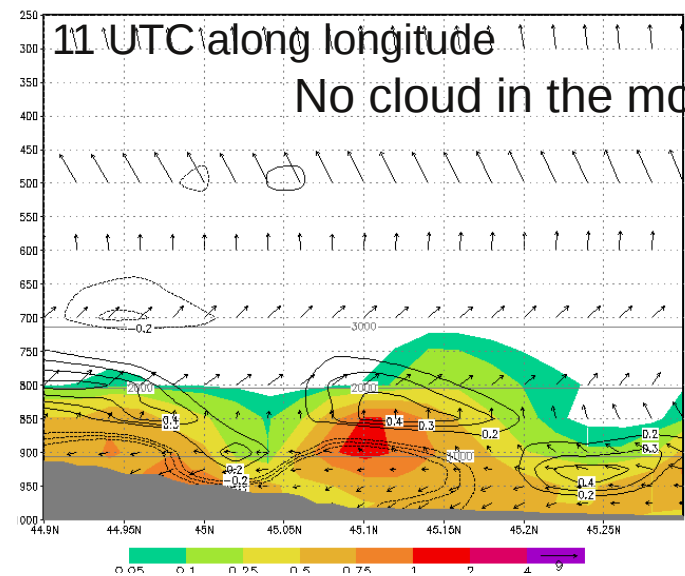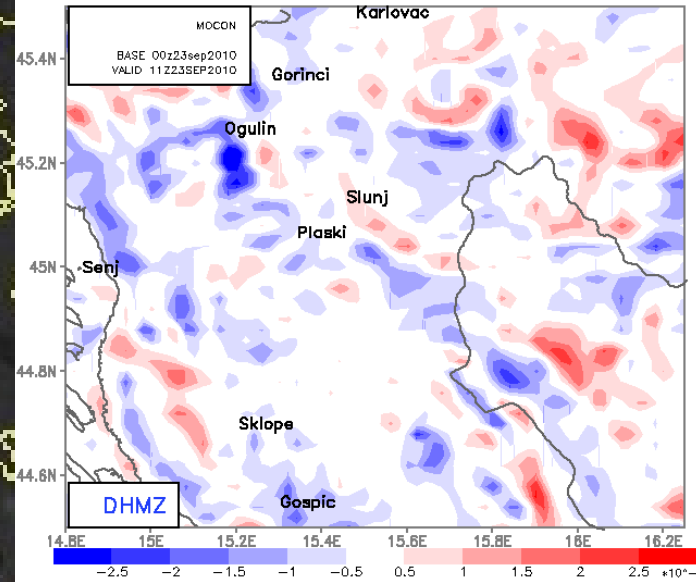


2km NH 00 UTC 1$^{st}$ Feb 2007 run, 10m wind 24 and 66 hour fcst and vertical cross-section of wind and PT.

# Slunj, 23. Sep 2010 - a cloud develops



10 UTC



11 UTC

Moisture convergece 11 UTC



11 UTC along longitude

11 UTC along latitude

Evolution in time and in vertical

No cloud in the model run, whatever the set-up!

Vertical cross-sections of TKE (shaded), horizontal wind (vectors) and omega (isolines)

# Operational 2 km NH run

- since 1$^{st}$ July 2011, once a day, from 00 UTC 8km 6 hr fcst using AL36T1+bfX
- initialized using SSDFI (RDFIS=30, NEDFI=7, NSTDFI=21, NTPDFI=4)
- 450x450 points, 11 extension, 8 coupling zones, 37 levels, quadratic grid

It was requested by the forecast office that the NH run must be finished before 7 UTC. The operational suite is severely constrained by hardvare. It is running on 50 out of 56 processors on the SGI Altix.
Consequently, the operational set-up is a compromise between optimal model performance and speed.
Model execution is stable, in the sense that it does not blow-up during the model forecast.
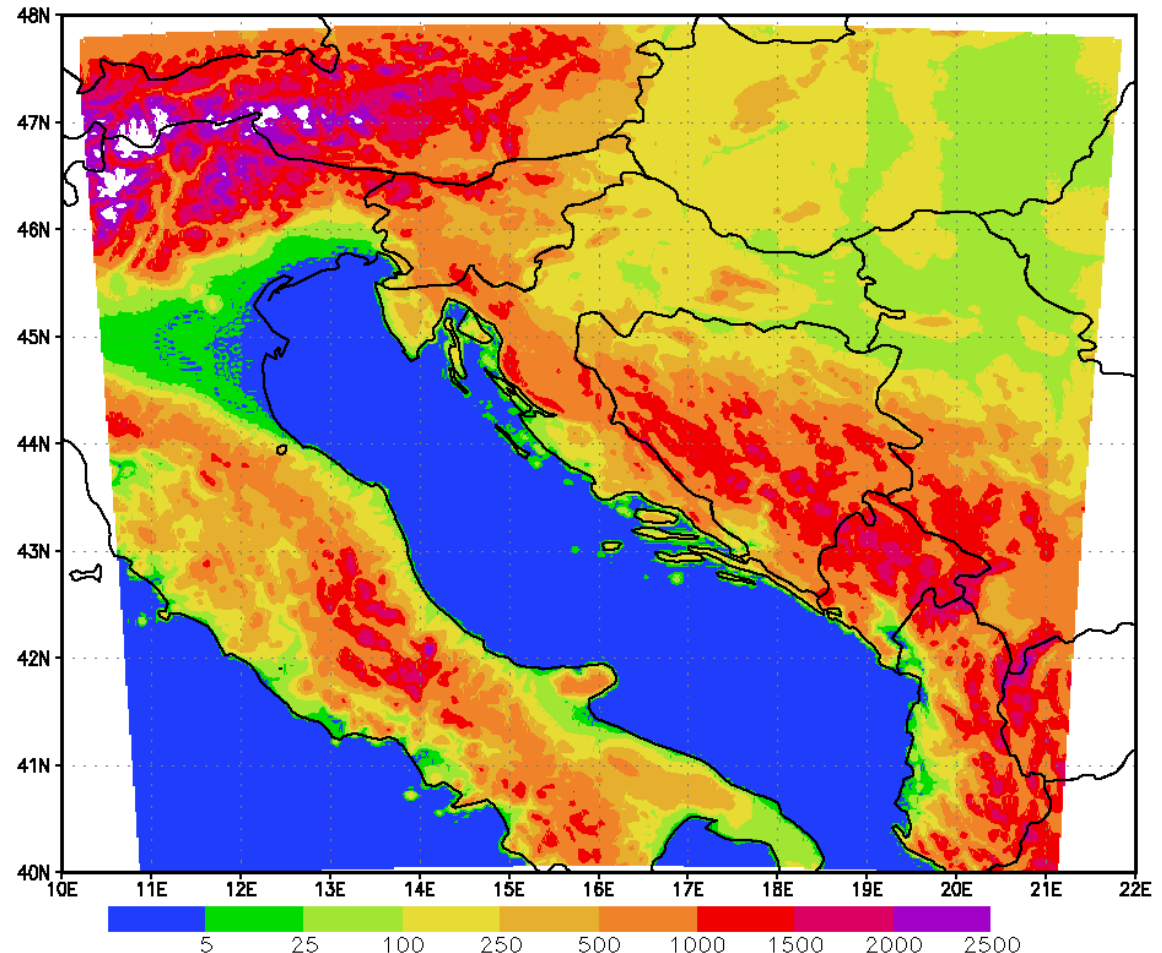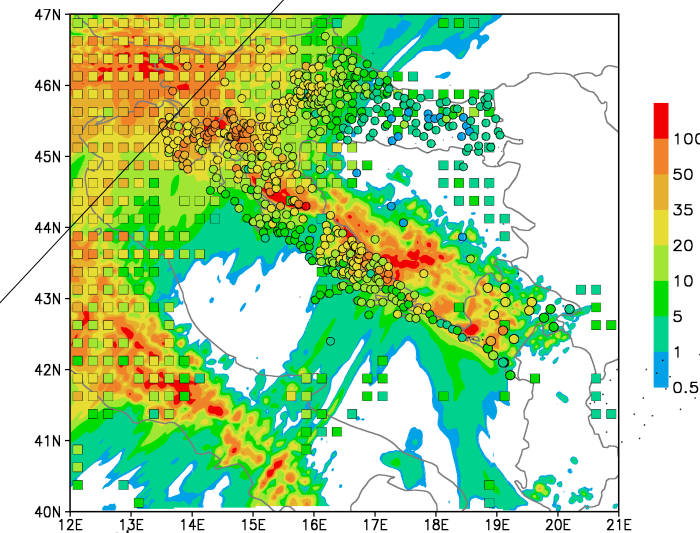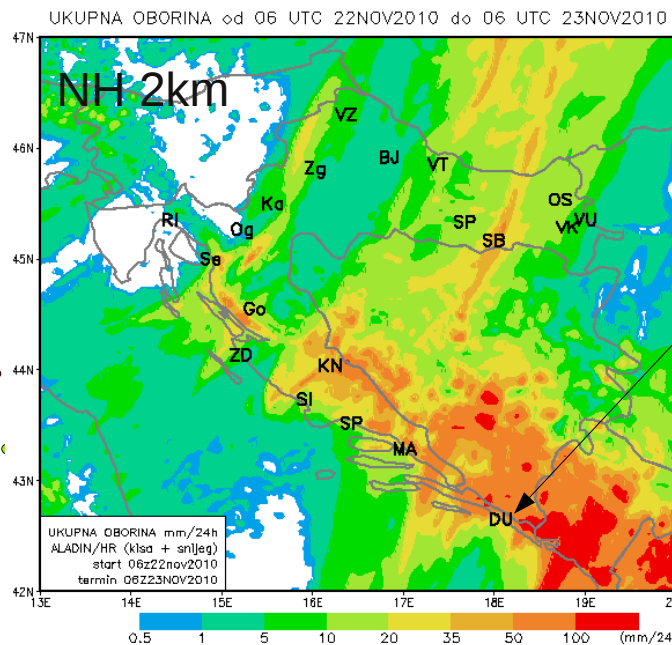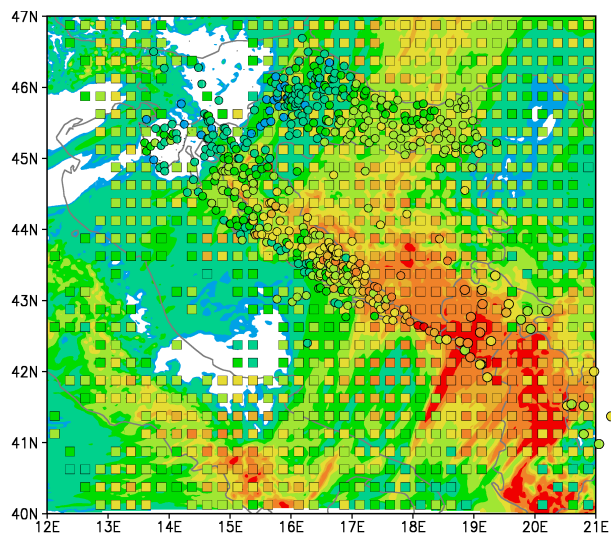
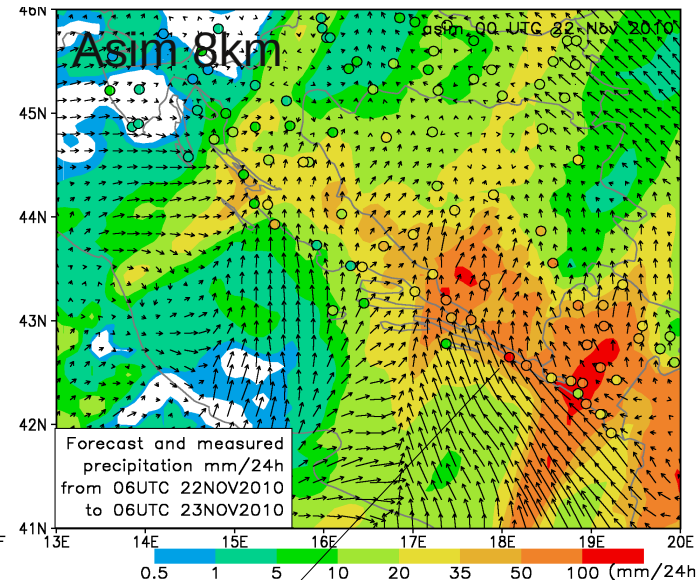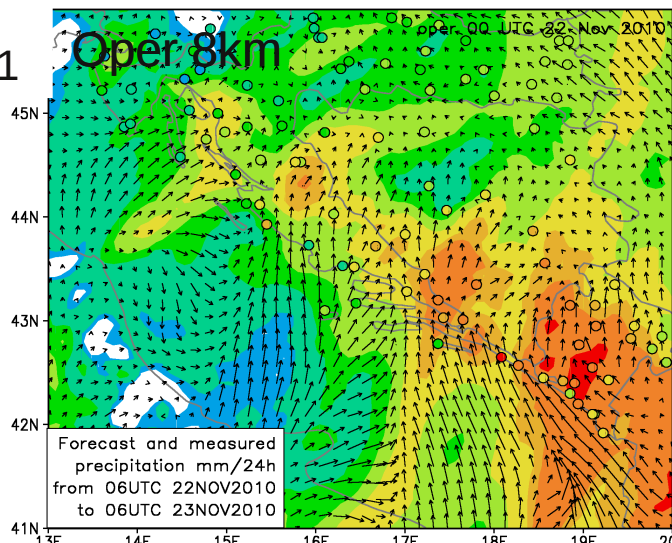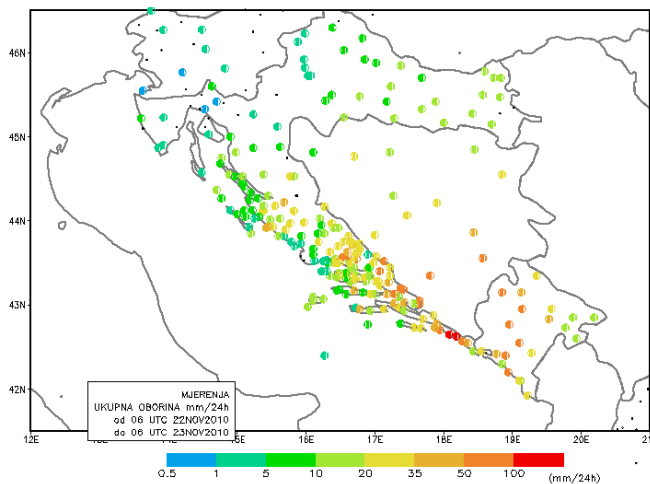# Pre-operational testing cases:
# Pula flash flood 25ᵗʰ Sep 2010

## - most rainfall 00 to 03 UTC on 25ᵗʰ, accumulated 24 and 18 hourly precipitation
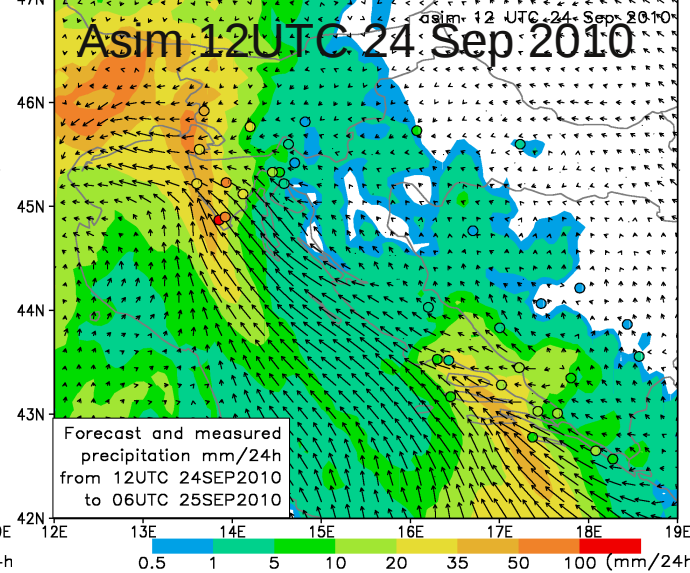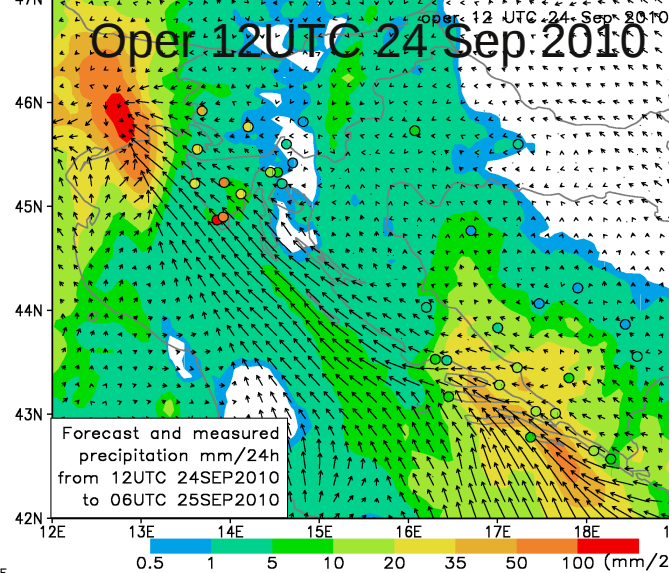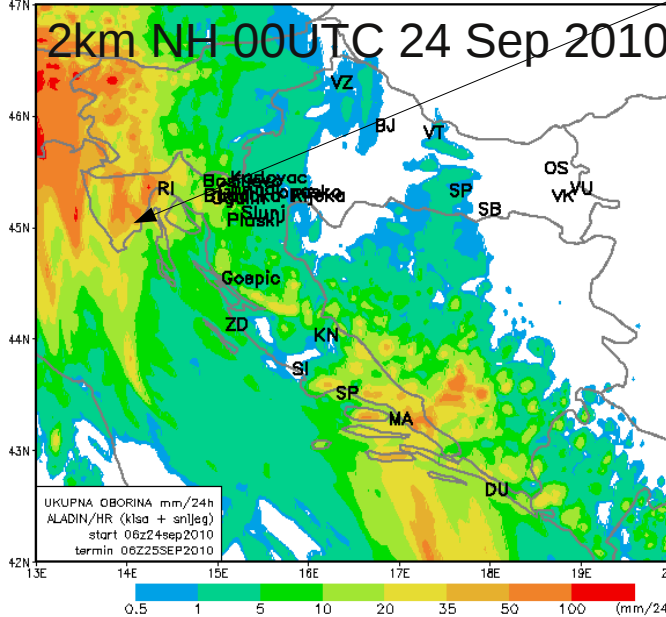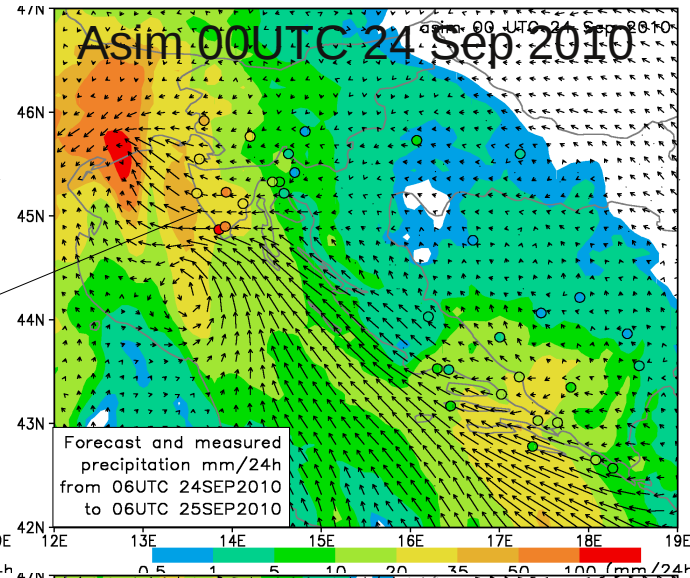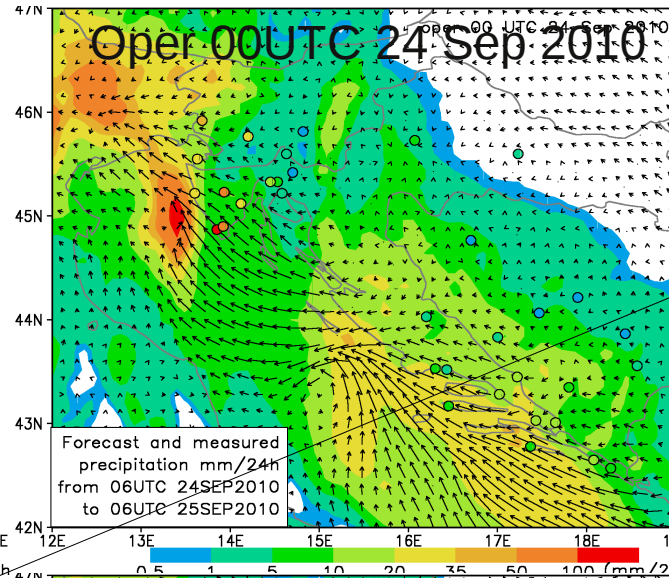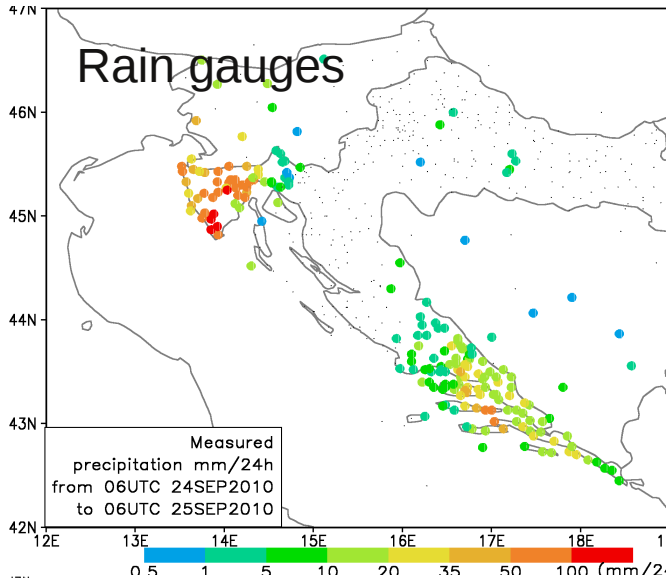
# Pre-operational testing cases:
# Dubrovnik flash flood 22$^{nd}$ Nov 2010



Rain-gauge measured 24 hr prec 06 UTC 22$^{nd}$ to 06 UTC 23$^{rd}$ Nov 2011

Oper 8km

Asim 8km

NH 2km

NH 2km with measurements

21$^{st}$ Nov 2010 NH2km +meas

# Pre-operational testing cases:
## Flash flood in Albania – waste on Pelješac 21$^{st}$ Nov 2010



ROMS and ocean drifters (c) Ivica Janeković, IRB

9 Nov 2010

10 Nov 2010

24 hr rainfall
8km forecast
TRMM
rain-gauges

16 Nov 2010

17 Nov 2010

10m wind
2km NH
SYNOP
Auto
MetOp ASCAT

Numerical drifters
6 hours after init

Drifter positions
At the time waste
accumulated on the shore
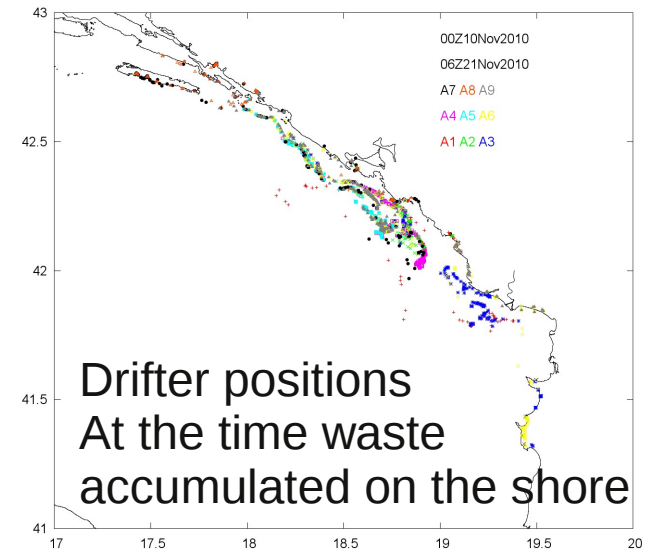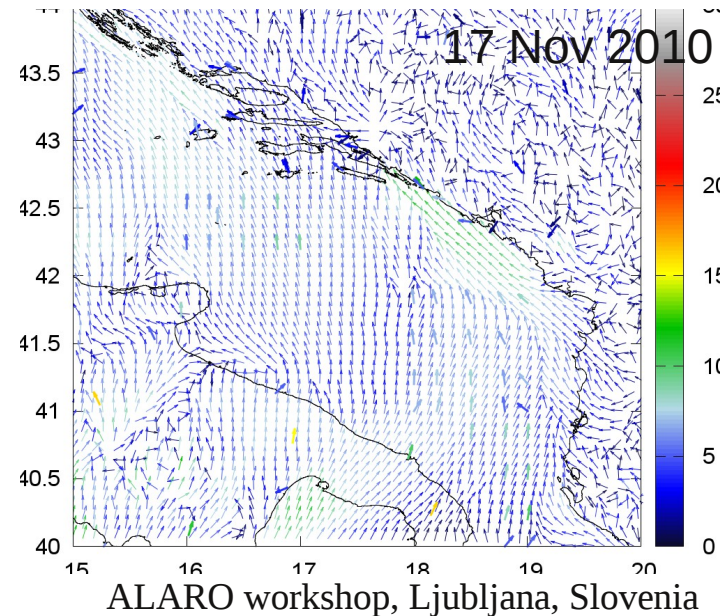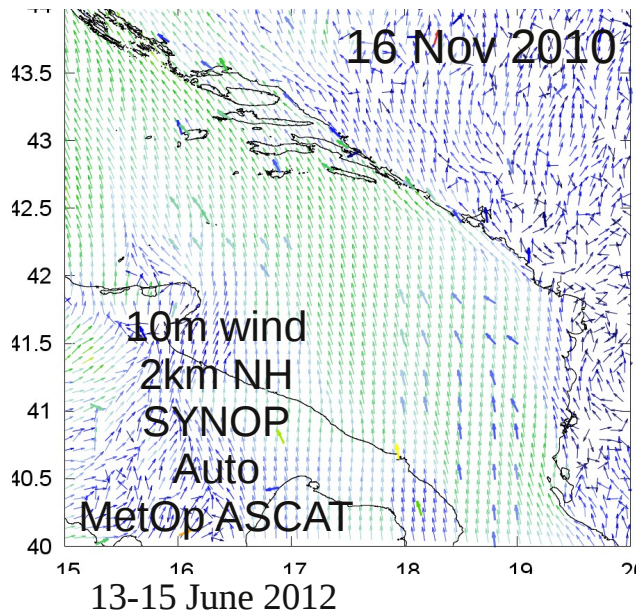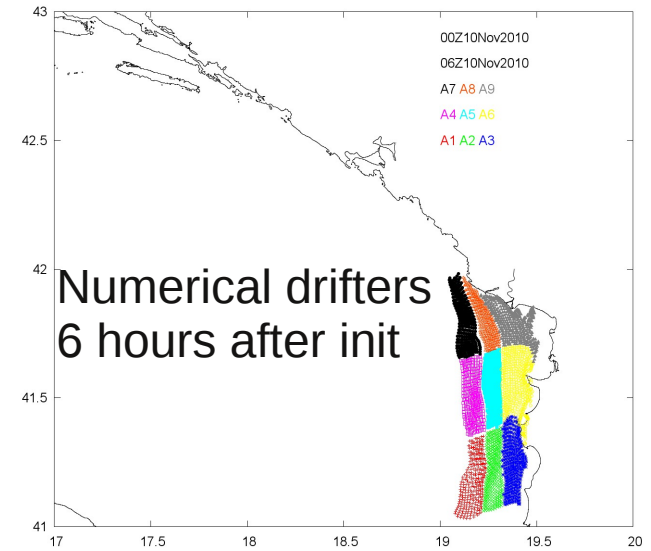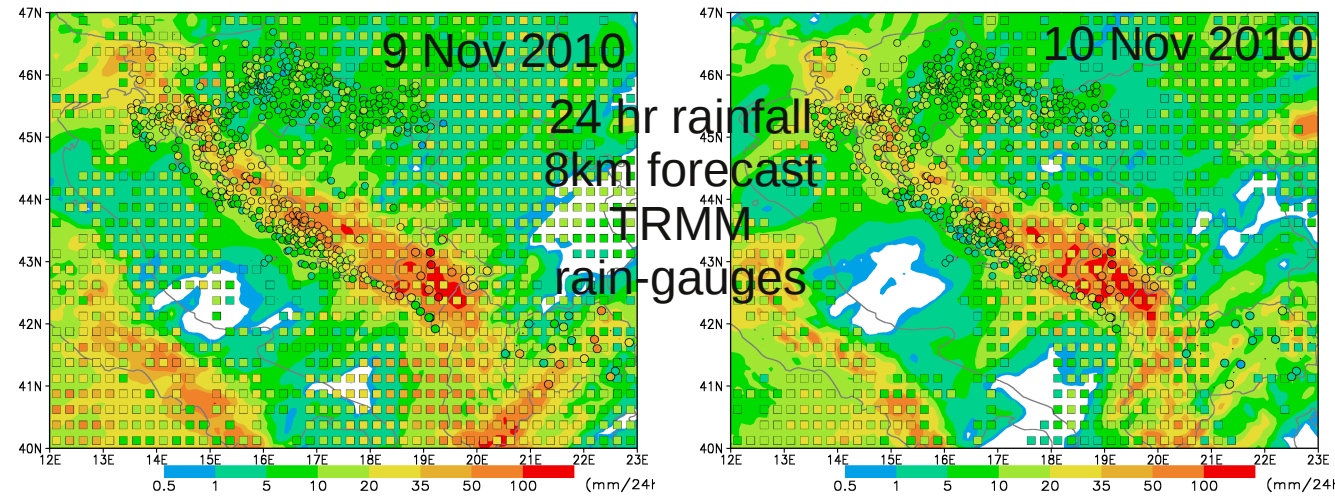
# Operational cases: Adriatic mesocyclone

Measured (purple) and forecast from 2km NH run (red), 8km runs (other colors)
and 2km wind DynAd (dashed) mslp, wind speed and direction, temperature.



mesocyclone

windstorm

bura

Correct pressure disturbance

Improved 2m temp. fcst

Storm too deep - retune SLHD?
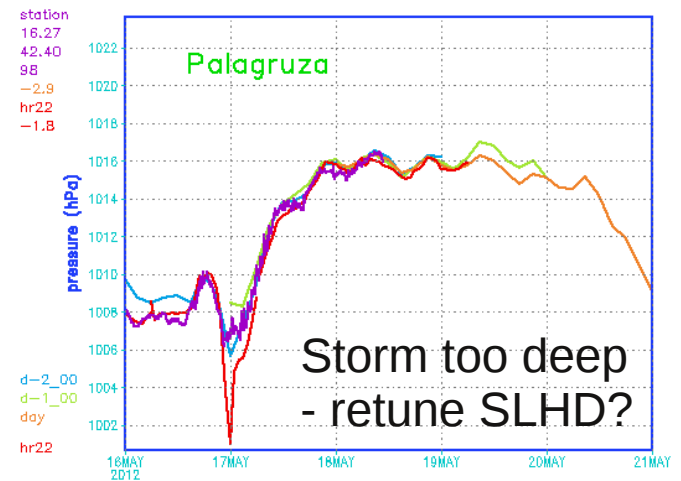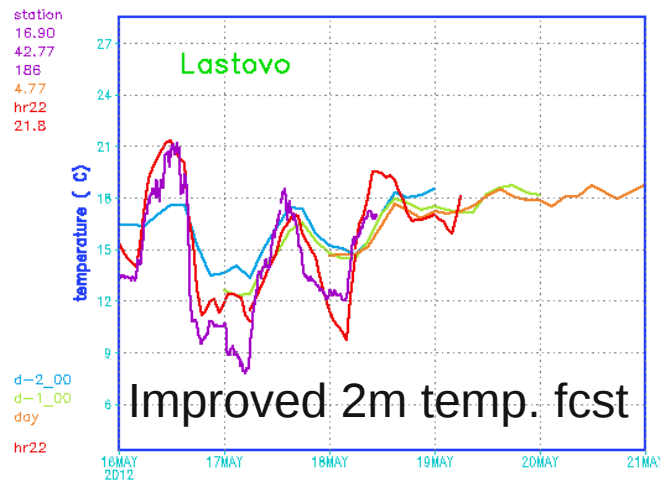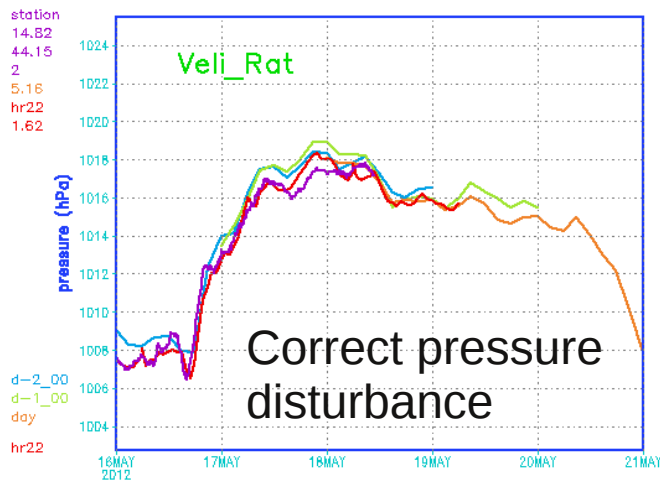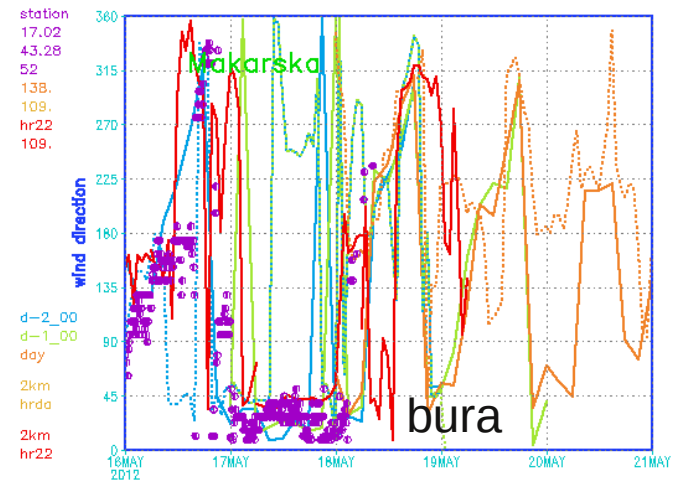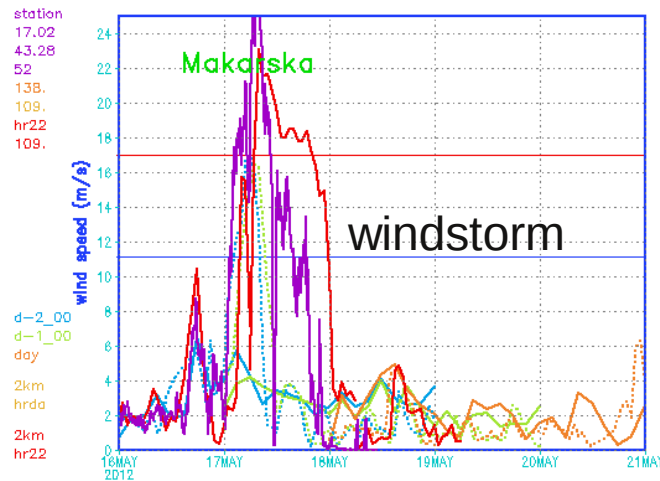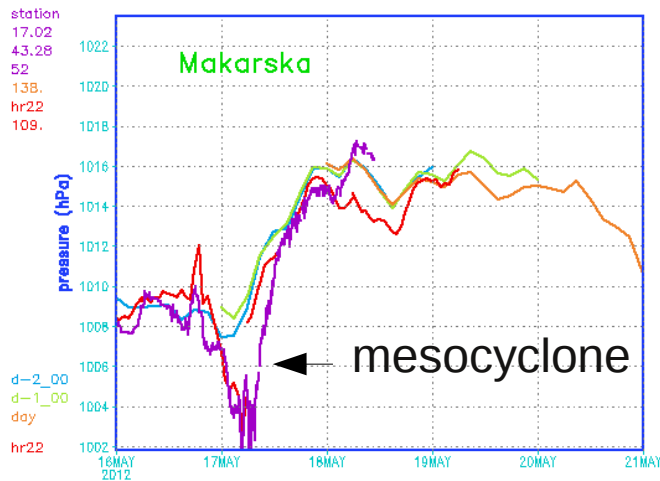
# Operational cases: 5<sup>th</sup> July 2011
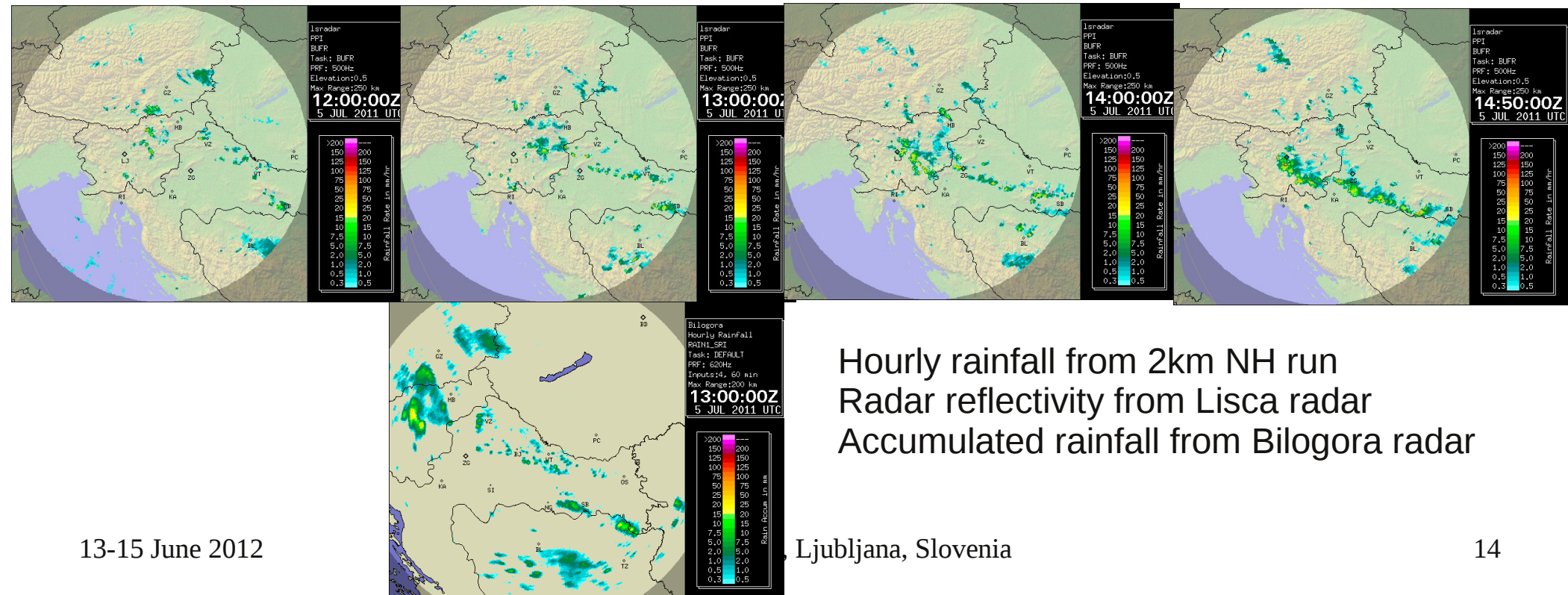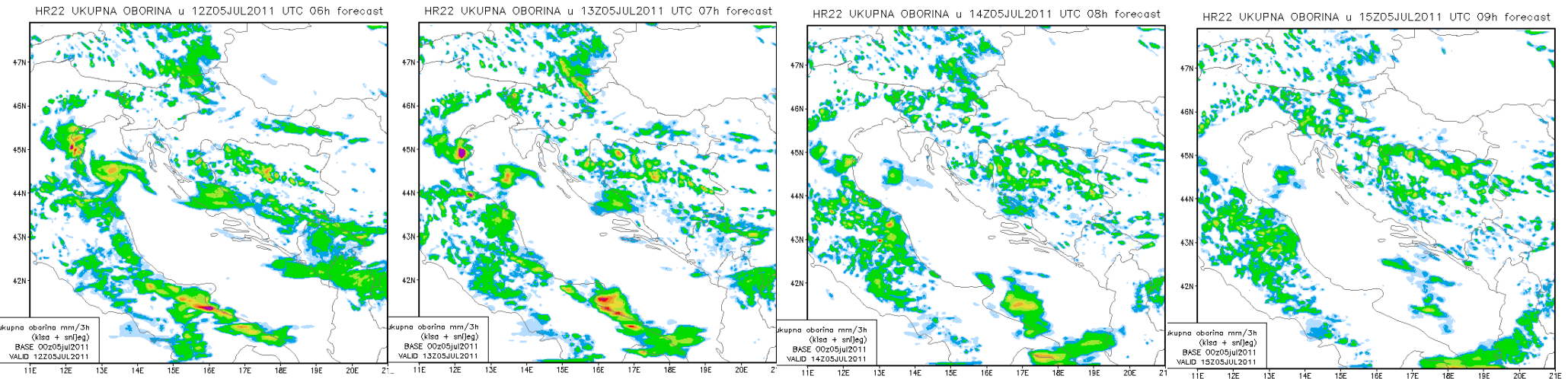


Hourly rainfall from 2km NH run
Radar reflectivity from Lisca radar
Accumulated rainfall from Bilogora radar

# Operational cases - Winter 2012 – 1$^{st}$ Feb

- accumulated 24 hourly precipitation fields from 2km res forecast (shaded), TRMM (squares), rain gauges (triangles for snow, circles for rain)
- 10m wind from model, SYNOP and automatic stations and MetOp ASCAT



HR22 Precipitation 06Z01FEB2012 to 06Z02FEB2012

0.5  1  5  10  20  35  50  100  (mm

12 UTC 2km model, SYNOP, auto and ASCAT wind - 01 Feb 2012
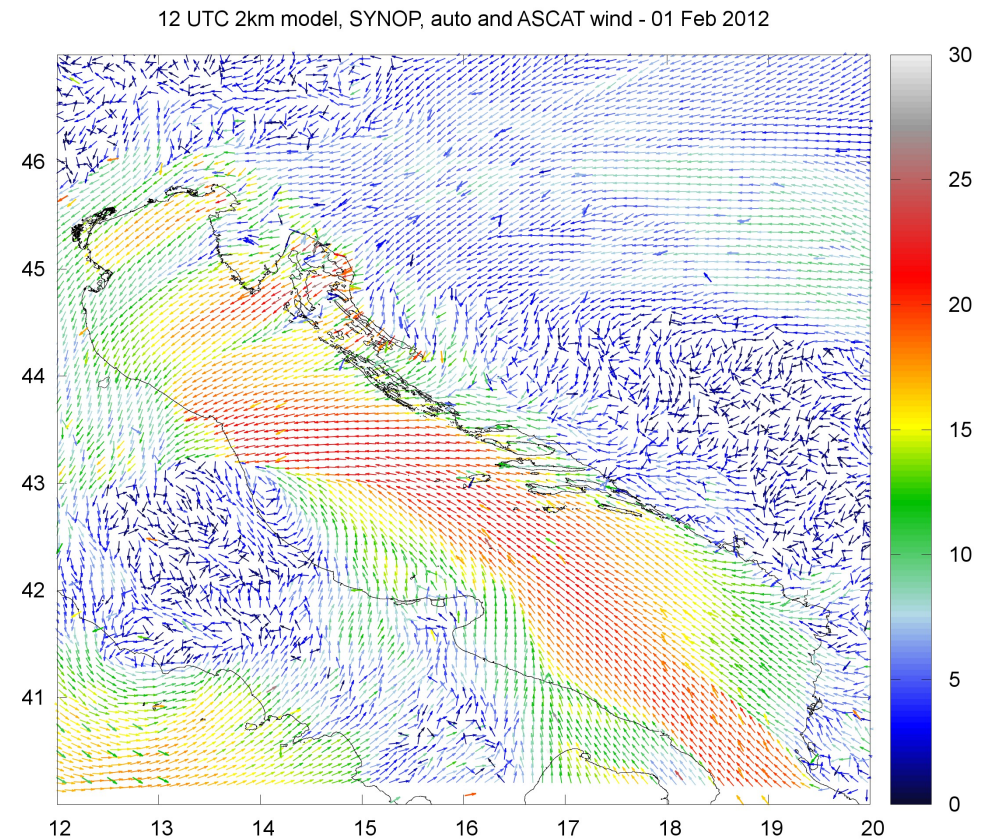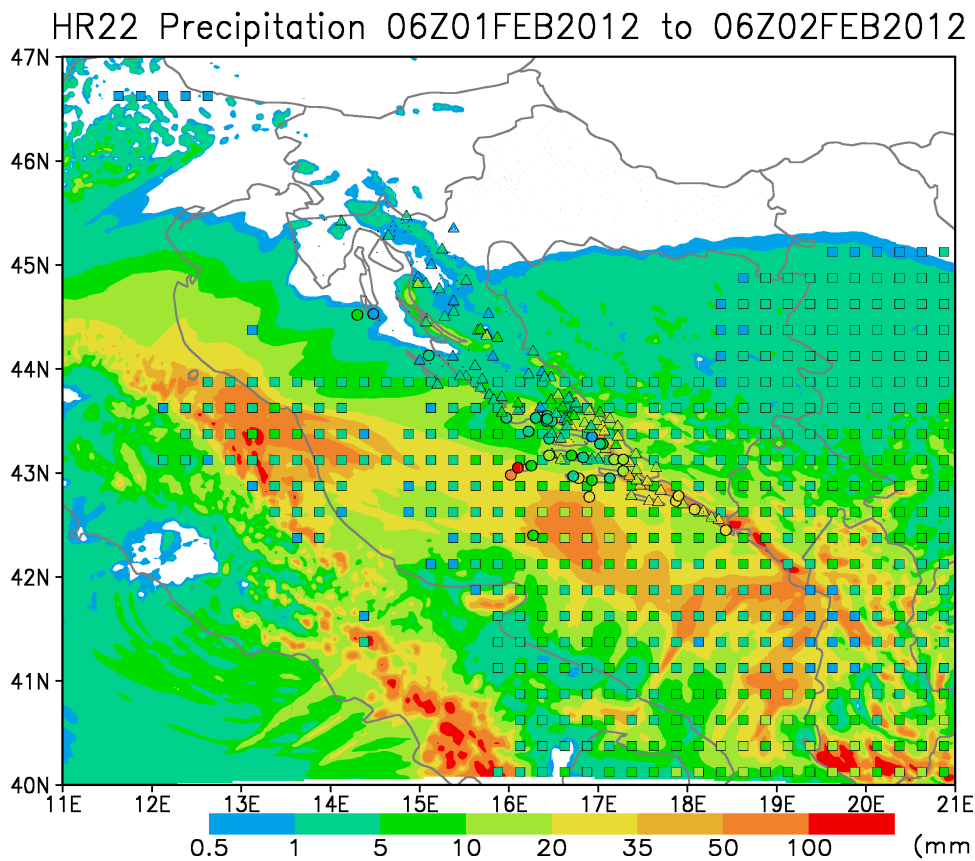
# Operational cases - Winter 2012 – 2$^{nd}$ Feb

- accumulated 24 hourly precipitation fields from 2km res forecast (shaded), TRMM (squares), rain gauges (triangles for snow, circles for rain)
- 10m wind from model, SYNOP and automatic stations and MetOp ASCAT



HR22 Precipitation 06Z02FEB2012 to 06Z03FEB2012

12 UTC 2km model, SYNOP, auto and ASCAT wind - 02 Feb 2012

# Operational cases - Winter 2012 – 3rd Feb

- accumulated 24 hourly precipitation fields from 2km res forecast (shaded), TRMM (squares), rain gauges (triangles for snow, circles for rain)
- 10m wind from model, SYNOP and automatic stations and MetOp ASCAT



HR22 Precipitation 06Z03FEB2012 to 06Z04FEB2012



12 UTC 2km model, SYNOP, auto and ASCAT wind - 03 Feb 2012

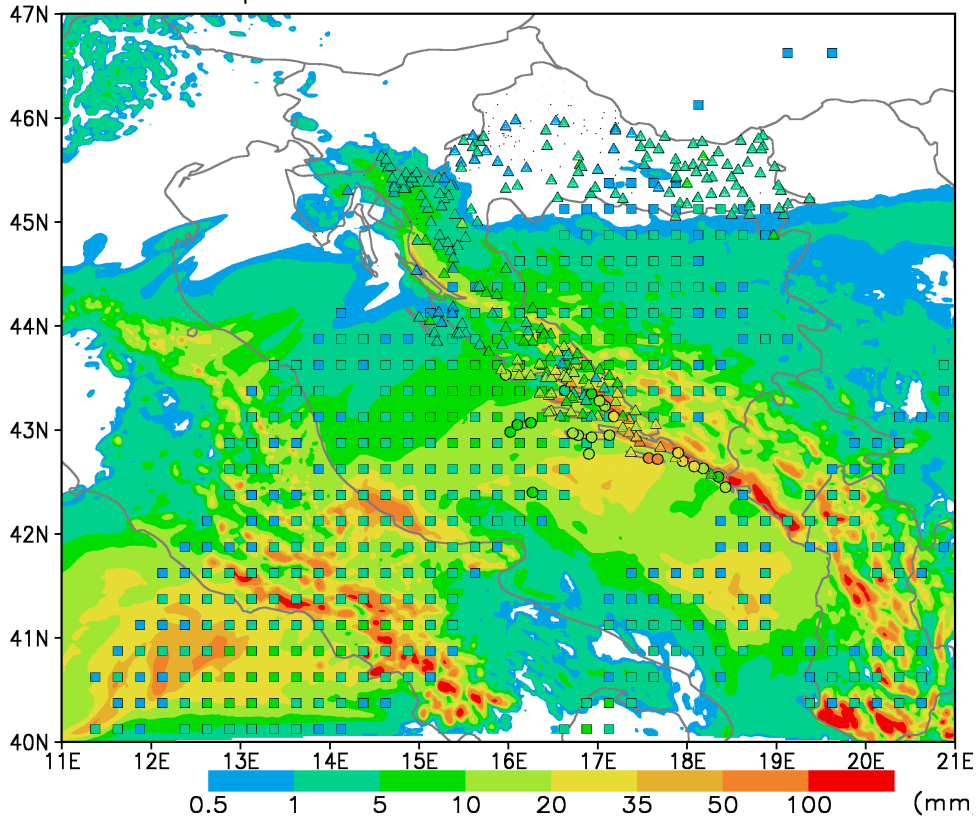# Operational cases - Winter 2012 – 4<sup>th</sup> Feb

- accumulated 24 hourly precipitation fields from 2km res forecast (shaded), TRMM (squares), rain gauges (triangles for snow, circles for rain)
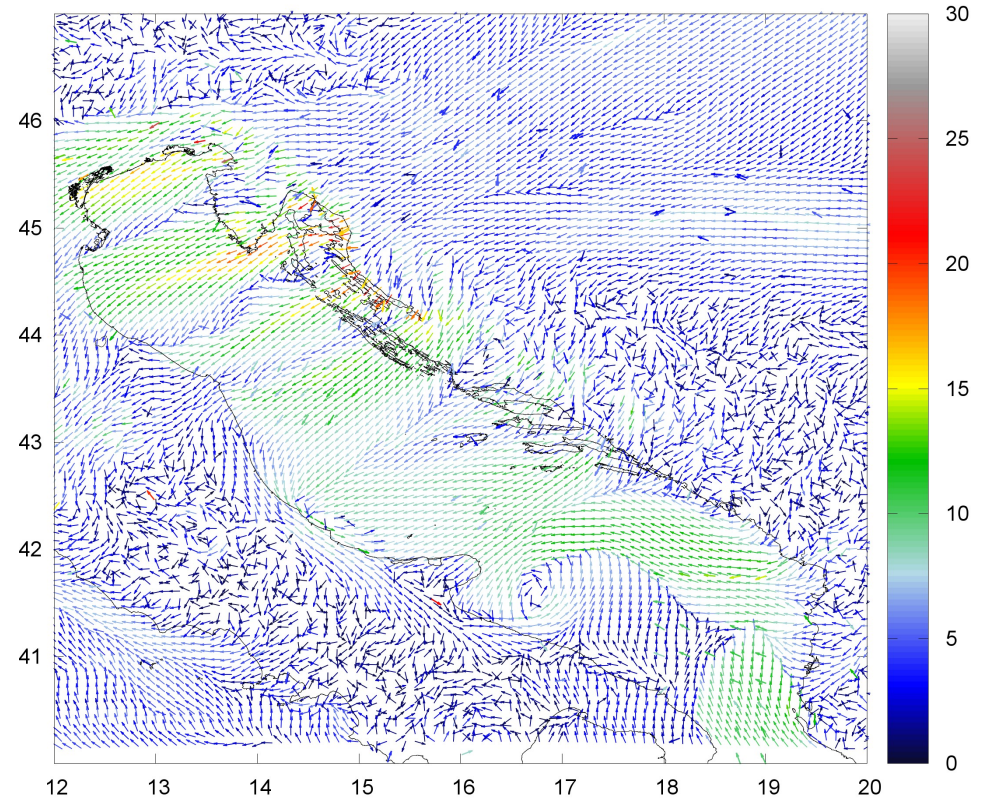- 10m wind from model, SYNOP and automatic stations and MetOp ASCAT



HR22 Precipitation 06Z04FEB2012 to 06Z05FEB2012

12 UTC 2km model, SYNOP, auto and ASCAT wind - 04 Feb 2012

# Operational cases - Winter 2012 – 5th Feb

- accumulated 24 hourly precipitation fields from 2km res forecast (shaded), TRMM (squares), rain gauges (triangles for snow, circles for rain)
- 10m wind from model, SYNOP and automatic stations and MetOp ASCAT


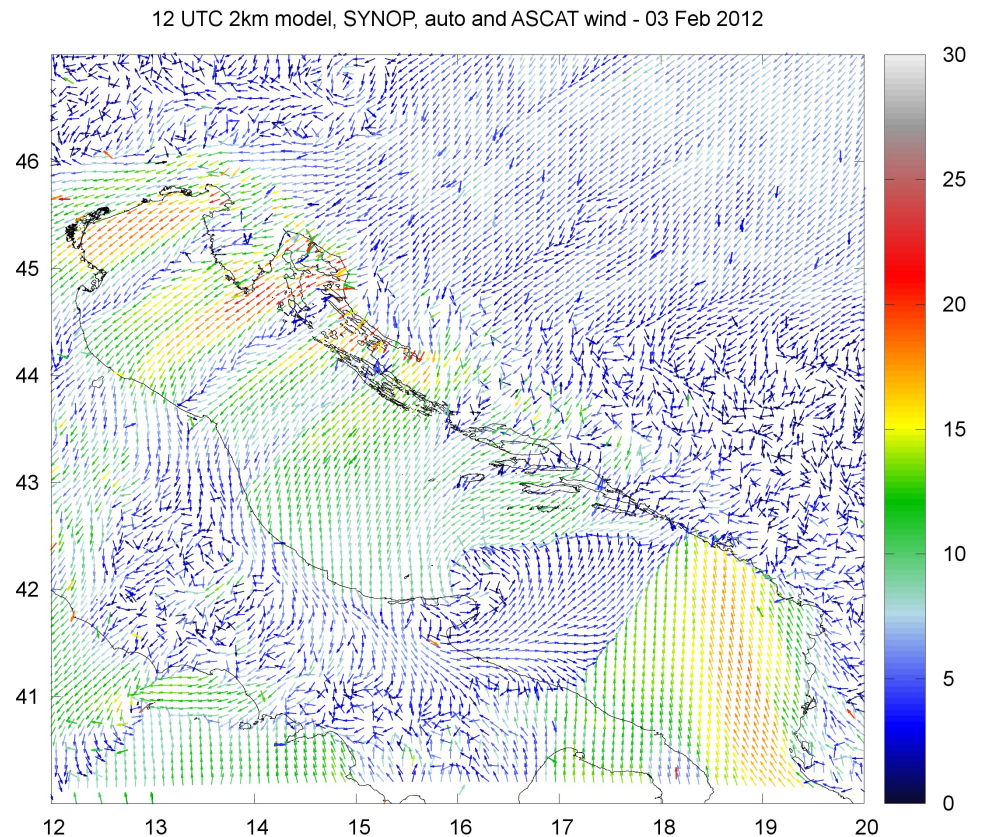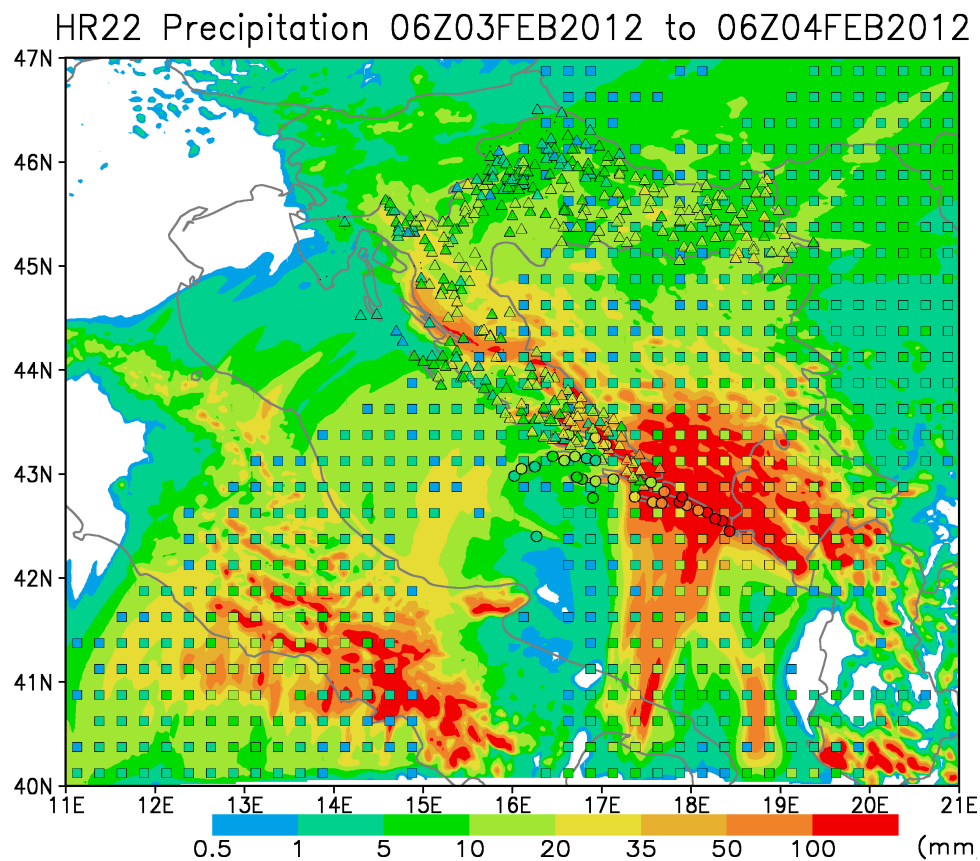
HR22 Precipitation 06Z05FEB2012 to 06Z06FEB2012

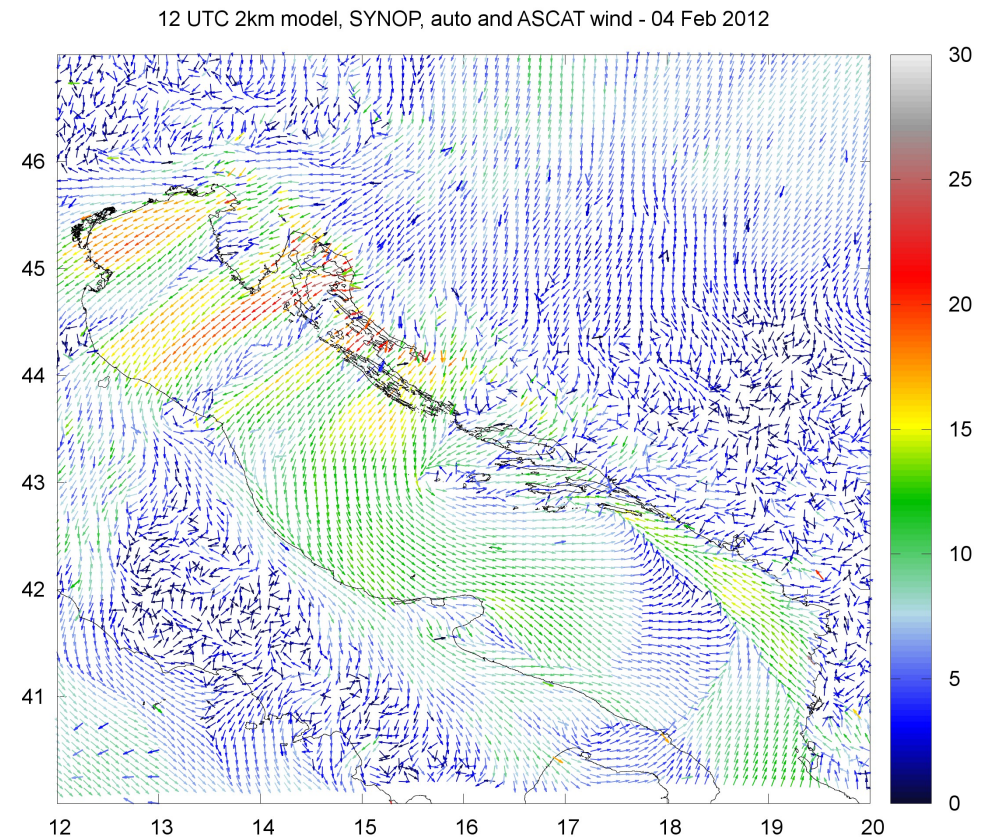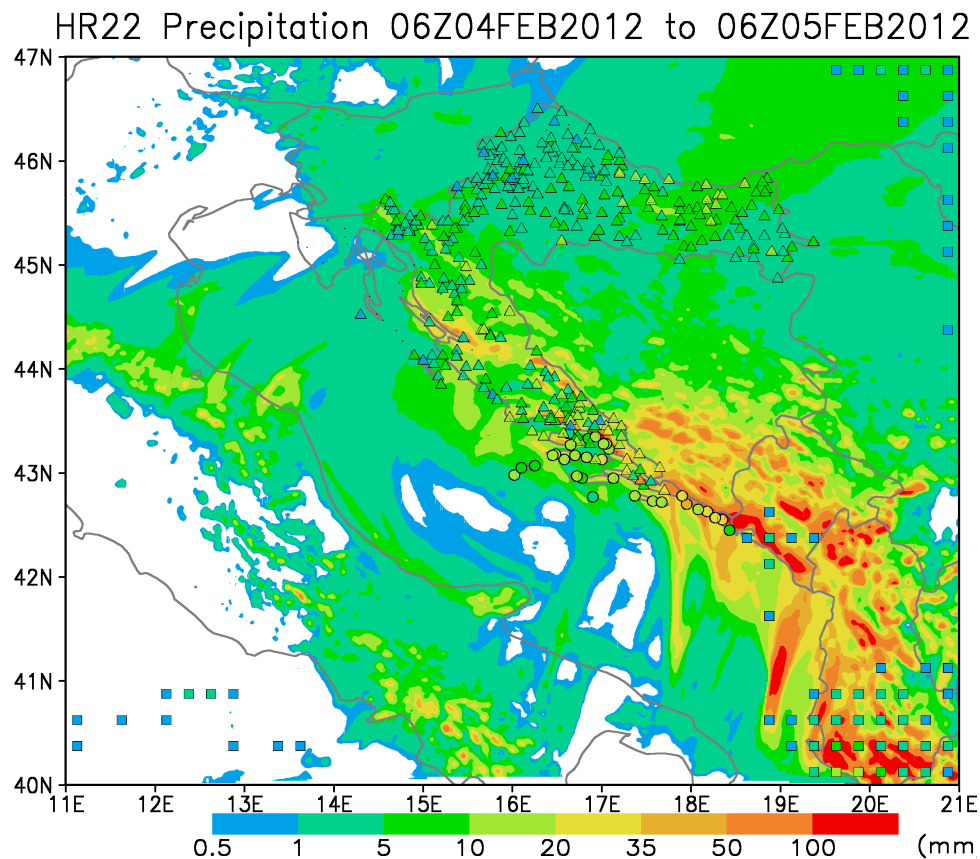12 UTC 2km model, SYNOP, auto and ASCAT wind - 05 Feb 2012
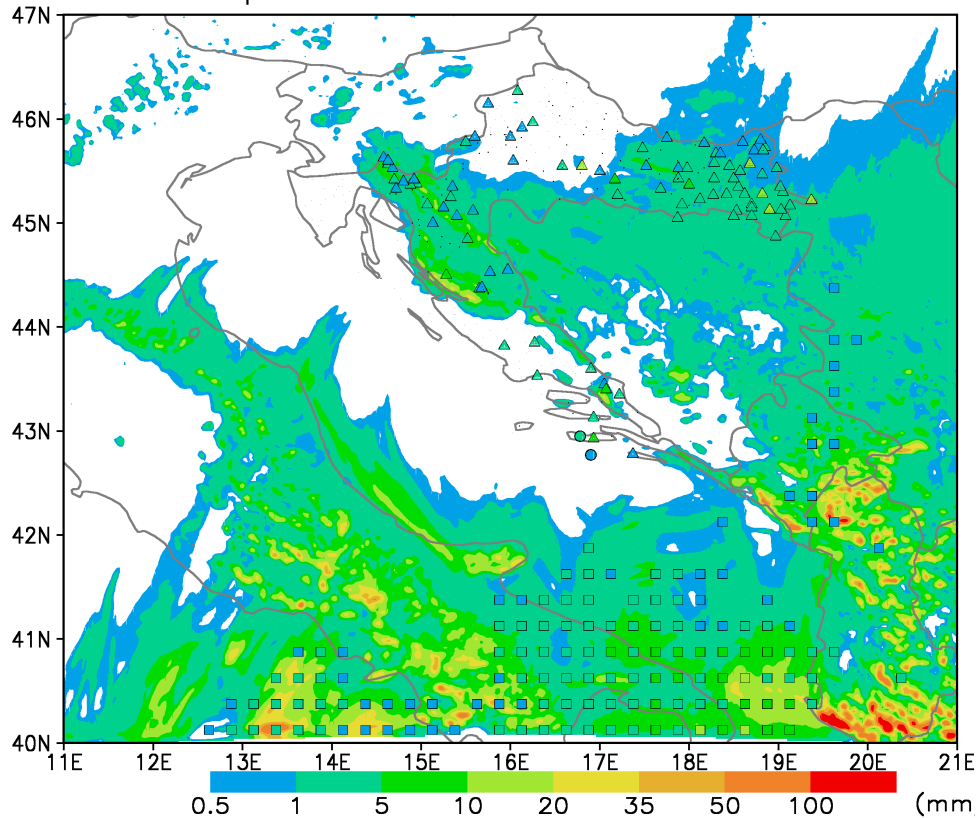
# Operational cases - Winter 2012 – 6th Feb

- accumulated 24 hourly precipitation fields from 2km res forecast (shaded), TRMM (squares), rain gauges (triangles for snow, circles for rain)
- 10m wind from model, SYNOP and automatic stations and MetOp ASCAT



HR22 Precipitation 06Z06FEB2012 to 06Z07FEB2012



12 UTC 2km model, SYNOP, auto and ASCAT wind - 06 Feb 2012

# Operational cases - Winter 2012 – 7th Feb

- accumulated 24 hourly precipitation fields from 2km res forecast (shaded), TRMM (squares), rain gauges (triangles for snow, circles for rain)
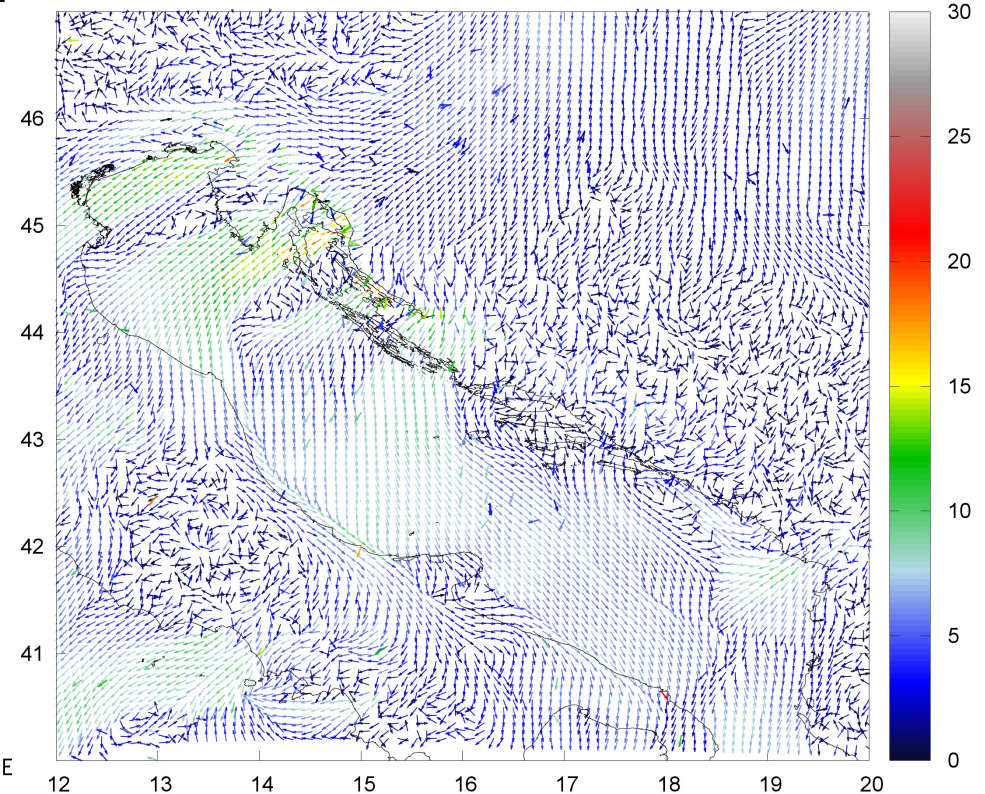- 10m wind from model, SYNOP and automatic stations and MetOp ASCAT


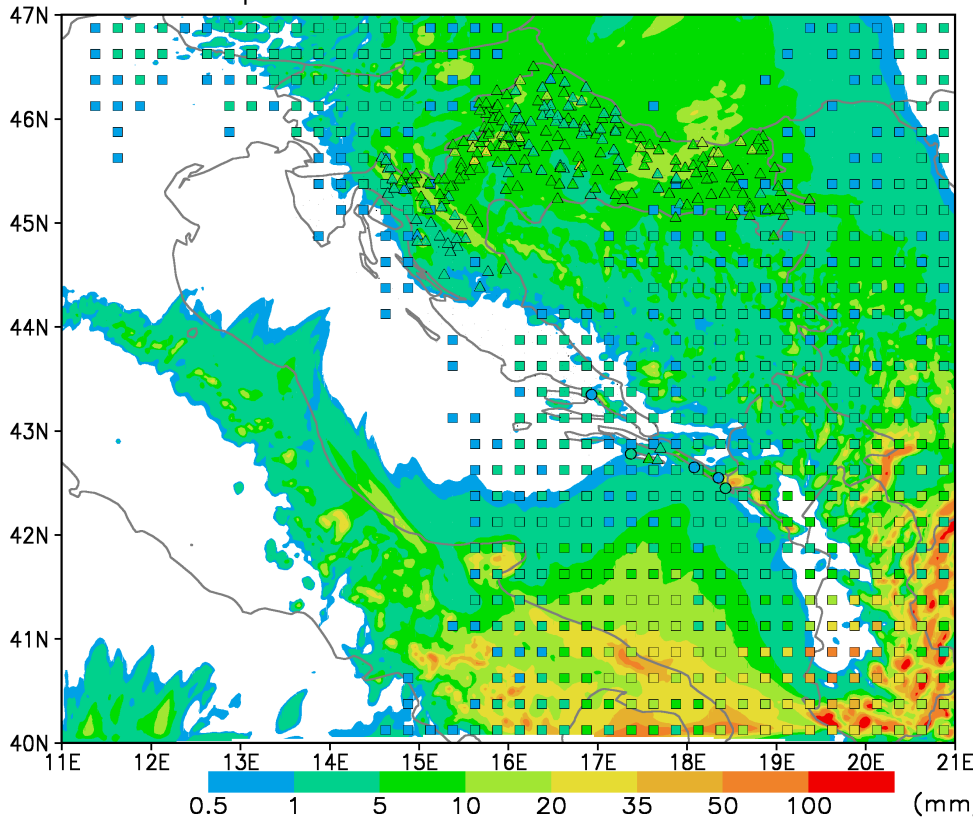
HR22 Precipitation 06Z07FEB2012 to 06Z08FEB2012



12 UTC 2km model, SYNOP, auto and ASCAT wind - 07 Feb 2012
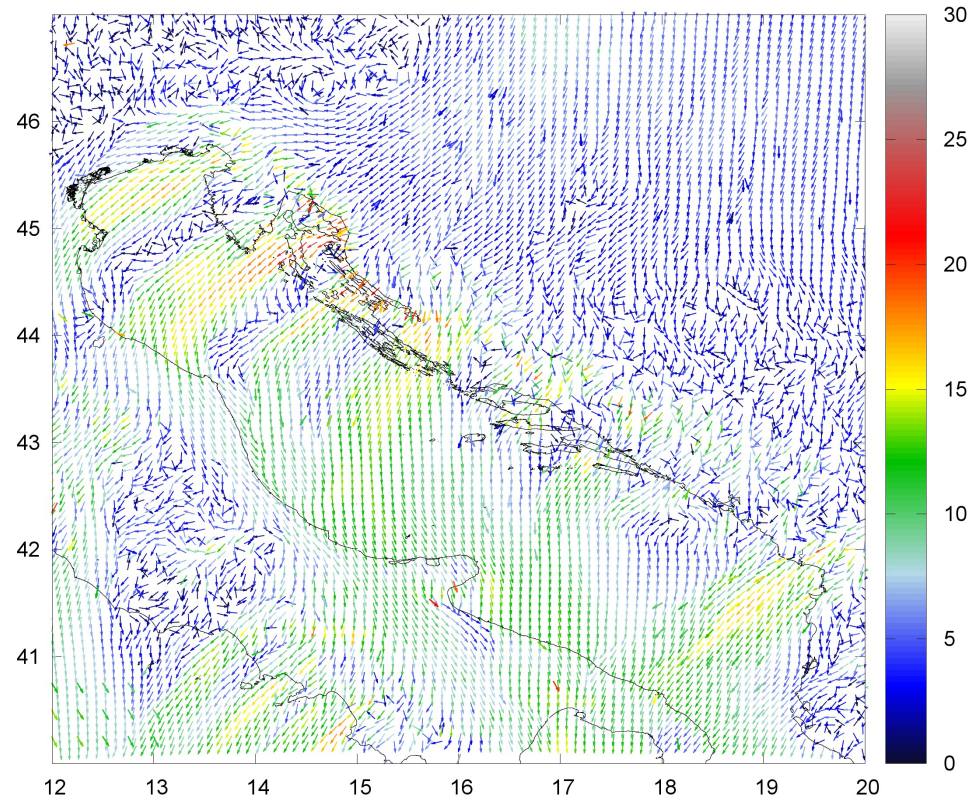
# Operational cases - Winter 2012 – 8<sup>th</sup> Feb

- accumulated 24 hourly precipitation fields from 2km res forecast (shaded), TRMM (squares), rain gauges (triangles for snow, circles for rain)
- 10m wind from model, SYNOP and automatic stations and MetOp ASCAT
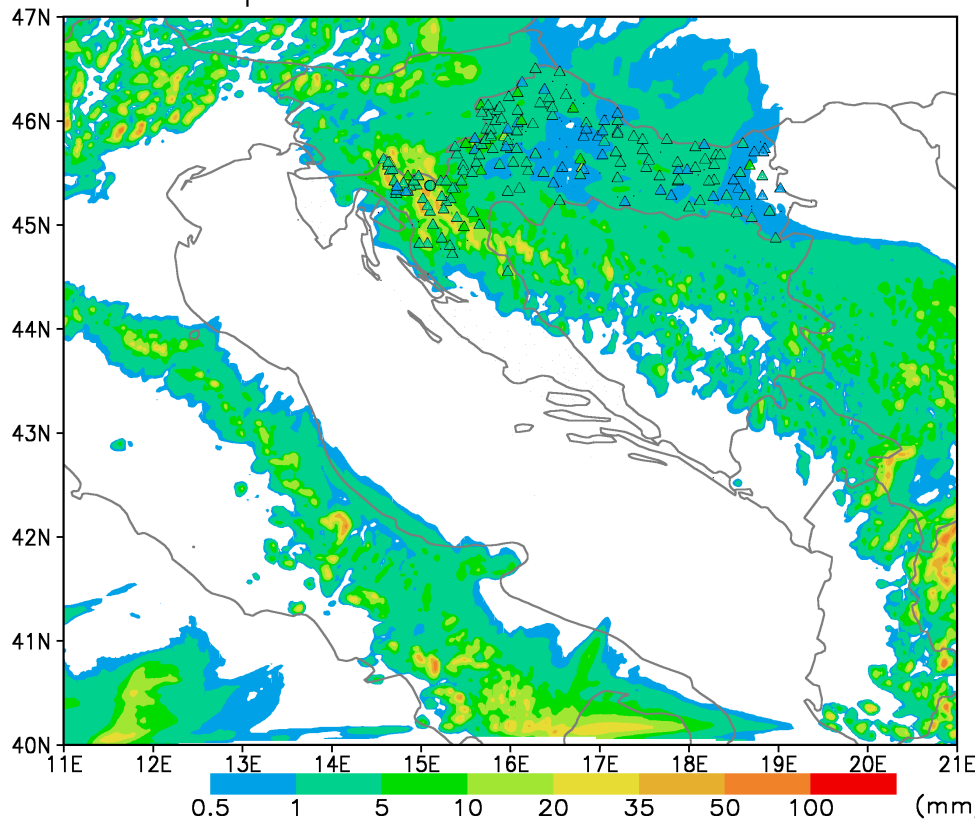


HR22 Precipitation 06Z08FEB2012 to 06Z09FEB2012



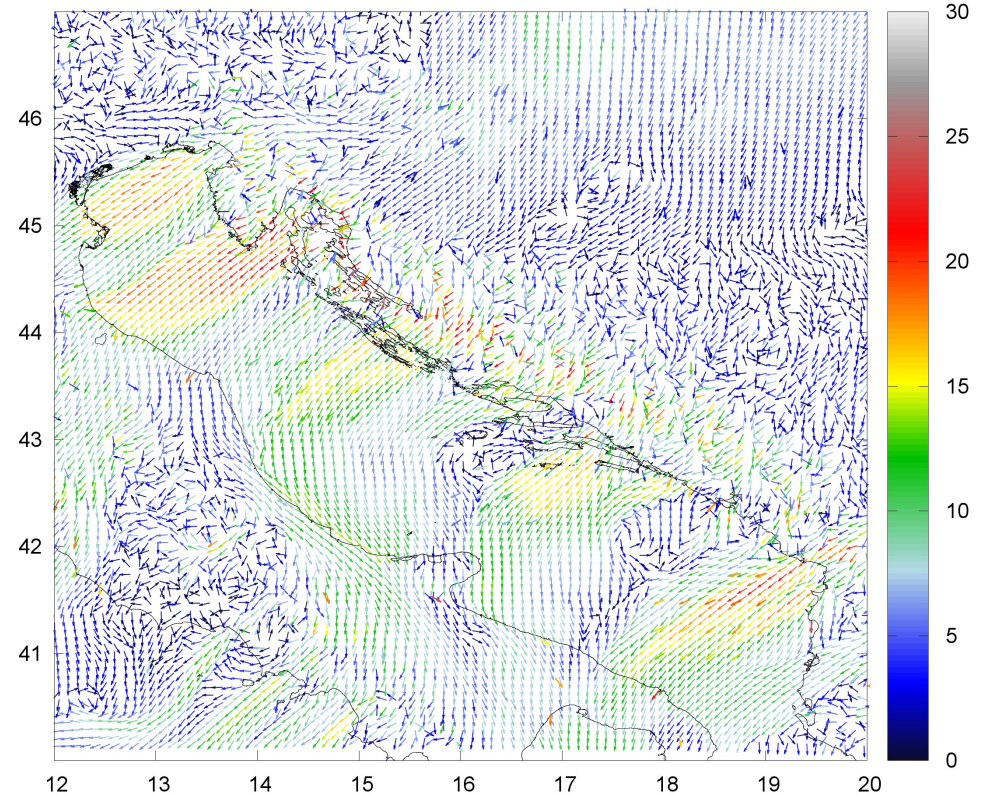12 UTC 2km model, SYNOP, auto and ASCAT wind - 08 Feb 2012

# Operational cases - Winter 2012 – 9th Feb

- accumulated 24 hourly precipitation fields from 2km res forecast (shaded), TRMM (squares), rain gauges (triangles for snow, circles for rain)
- 10m wind from model, SYNOP and automatic stations and MetOp ASCAT


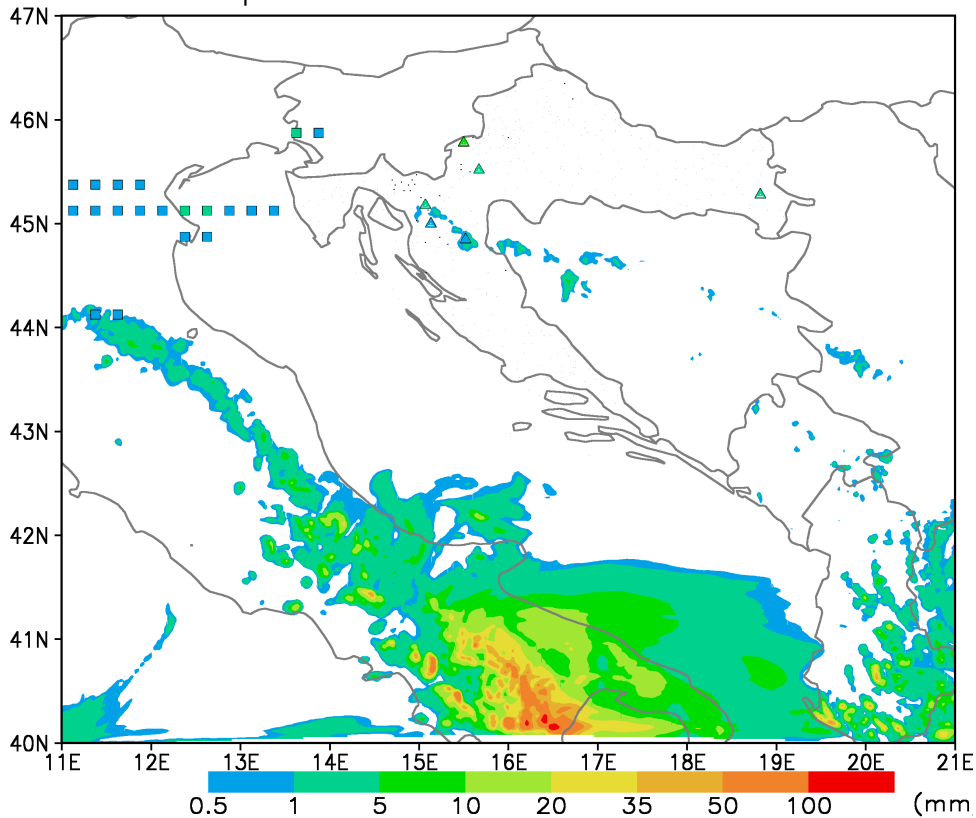
HR22 Precipitation 06Z09FEB2012 to 06Z10FEB2012

12 UTC 2km model, SYNOP, auto and ASCAT wind - 09 Feb 2012
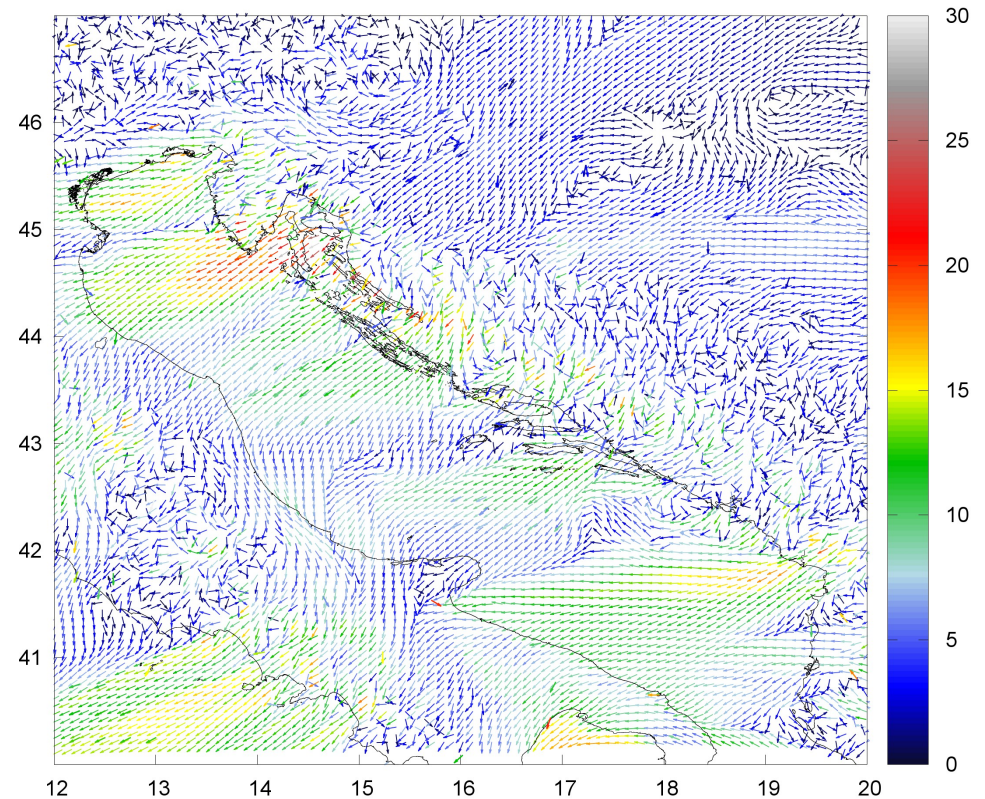
# Operational cases - Winter 2012 – 10<sup>th</sup> Feb

- accumulated 24 hourly precipitation fields from 2km res forecast (shaded), TRMM (squares), rain gauges (triangles for snow, circles for rain)
- 10m wind from model, SYNOP and automatic stations and MetOp ASCAT
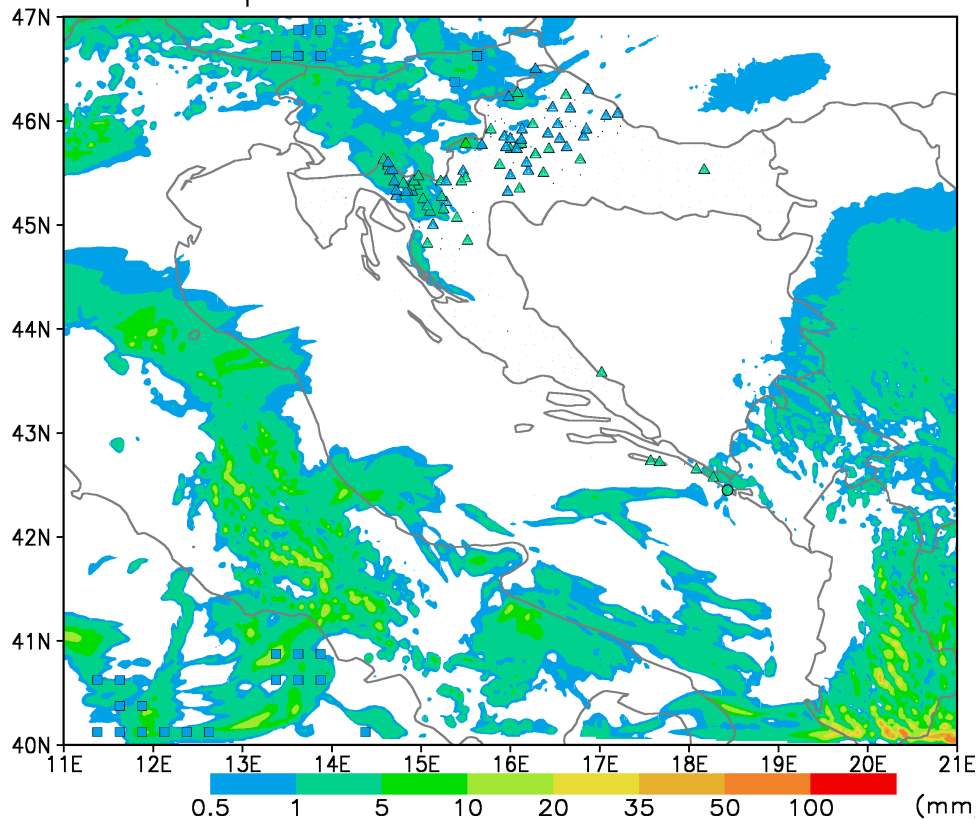


HR22 Precipitation 06Z10FEB2012 to 06Z11FEB2012

12 UTC 2km model, SYNOP, auto and ASCAT wind - 10 Feb 2012
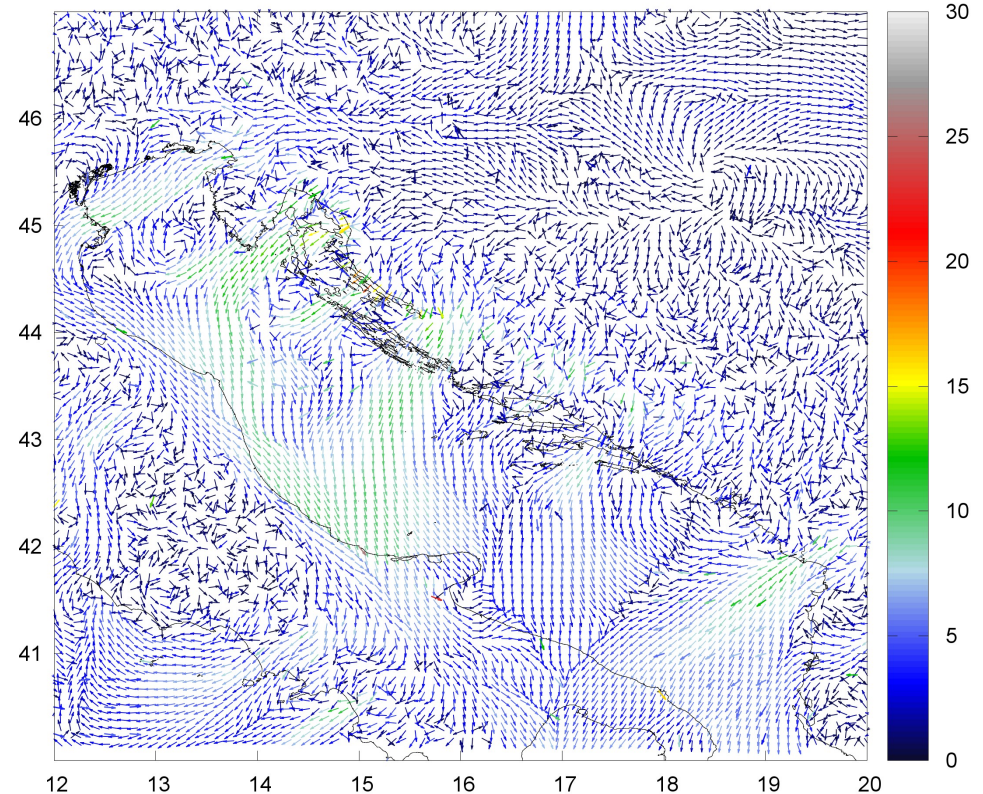
# Operational cases - Winter 2012 – 11th Feb

- accumulated 24 hourly precipitation fields from 2km res forecast (shaded), TRMM (squares), rain gauges (triangles for snow, circles for rain)
- 10m wind from model, SYNOP and automatic stations and MetOp ASCAT

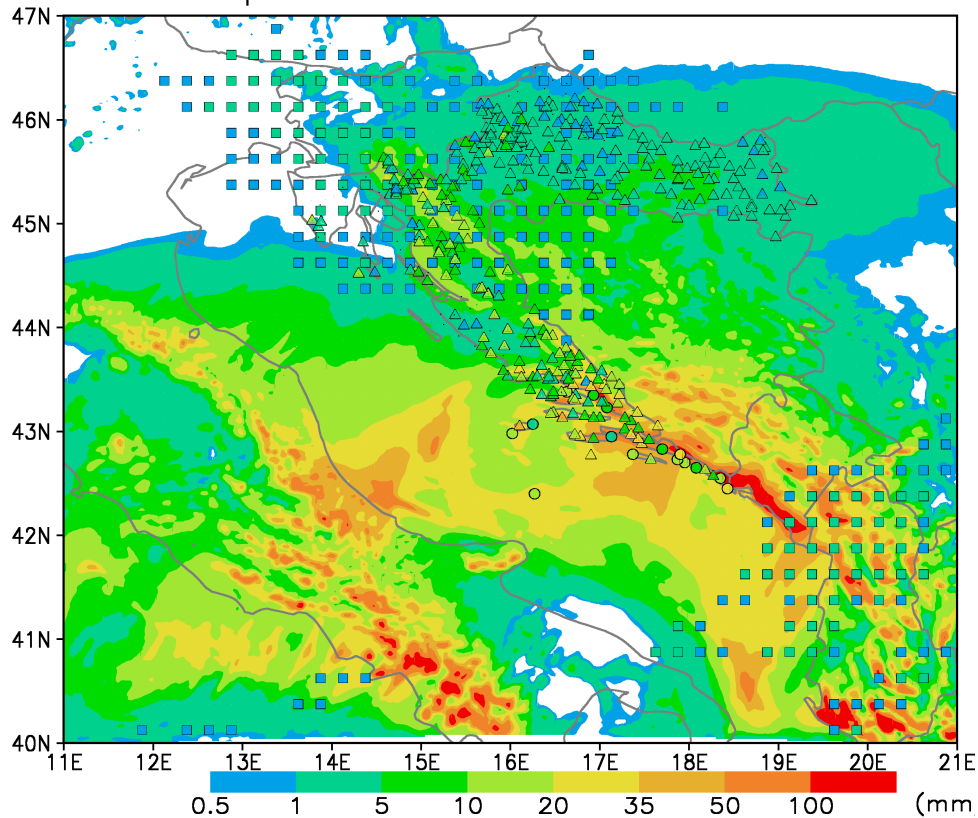

HR22 Precipitation 06Z11FEB2012 to 06Z12FEB2012



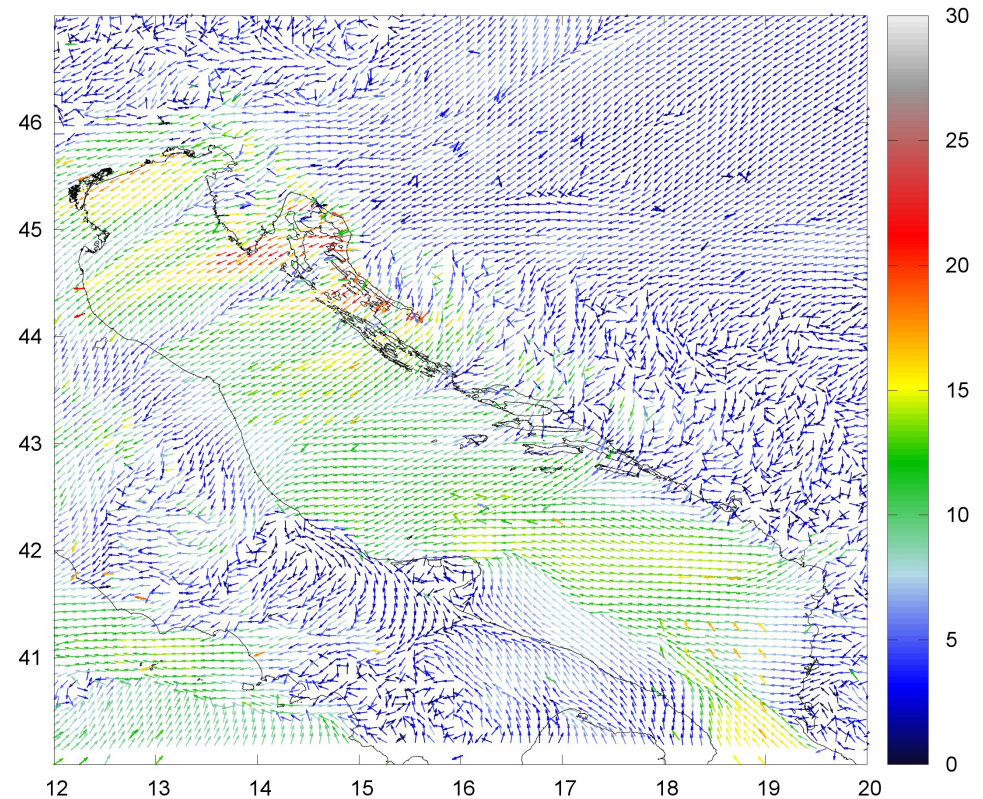12 UTC 2km model, SYNOP, auto and ASCAT wind - 11 Feb 2012

# Operational cases - Winter 2012 – 12th Feb

- accumulated 24 hourly precipitation fields from 2km res forecast (shaded),
TRMM (squares), rain gauges (triangles for snow, circles for rain)
- 10m wind from model, SYNOP and automatic stations and MetOp ASCAT

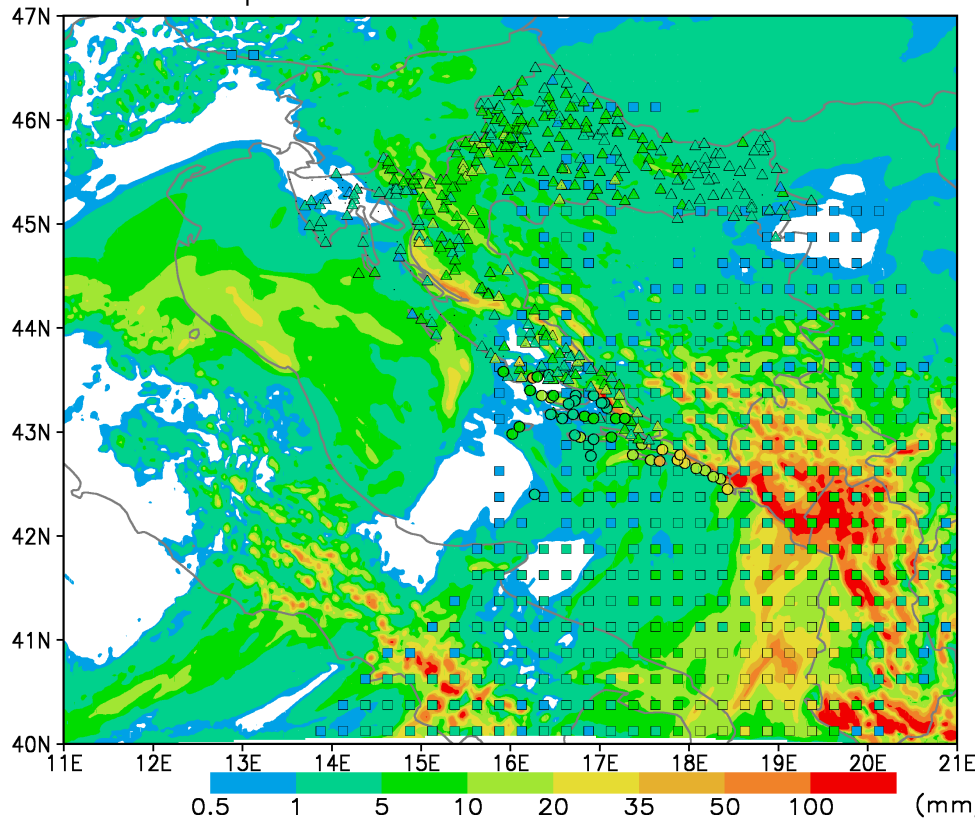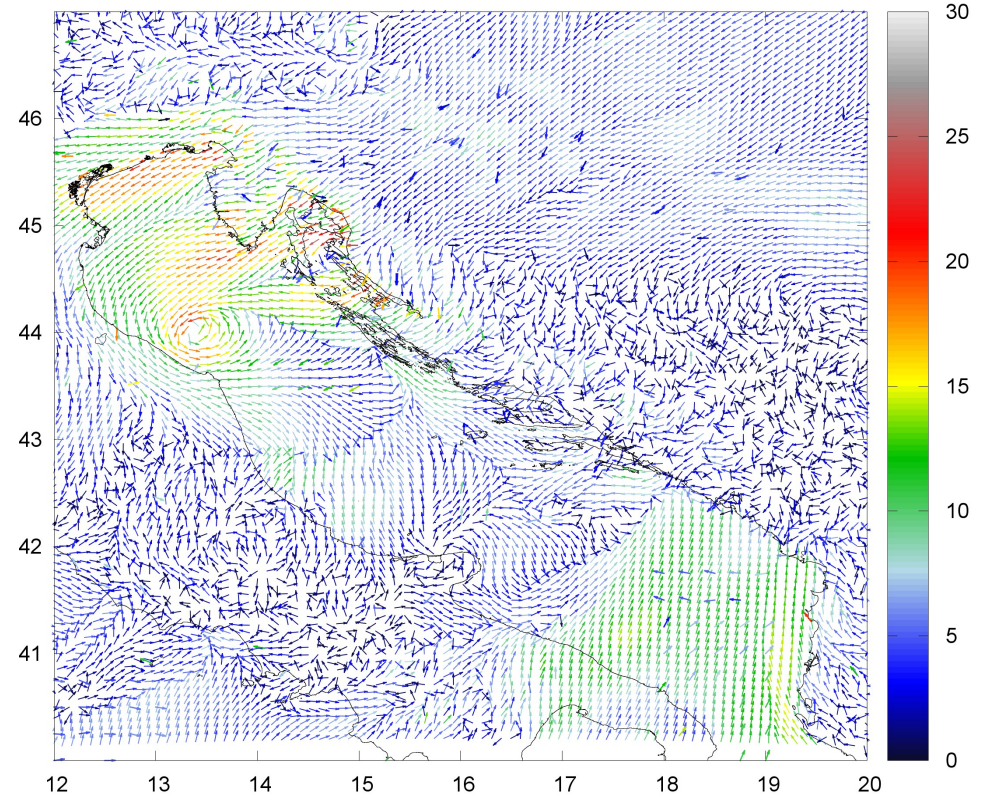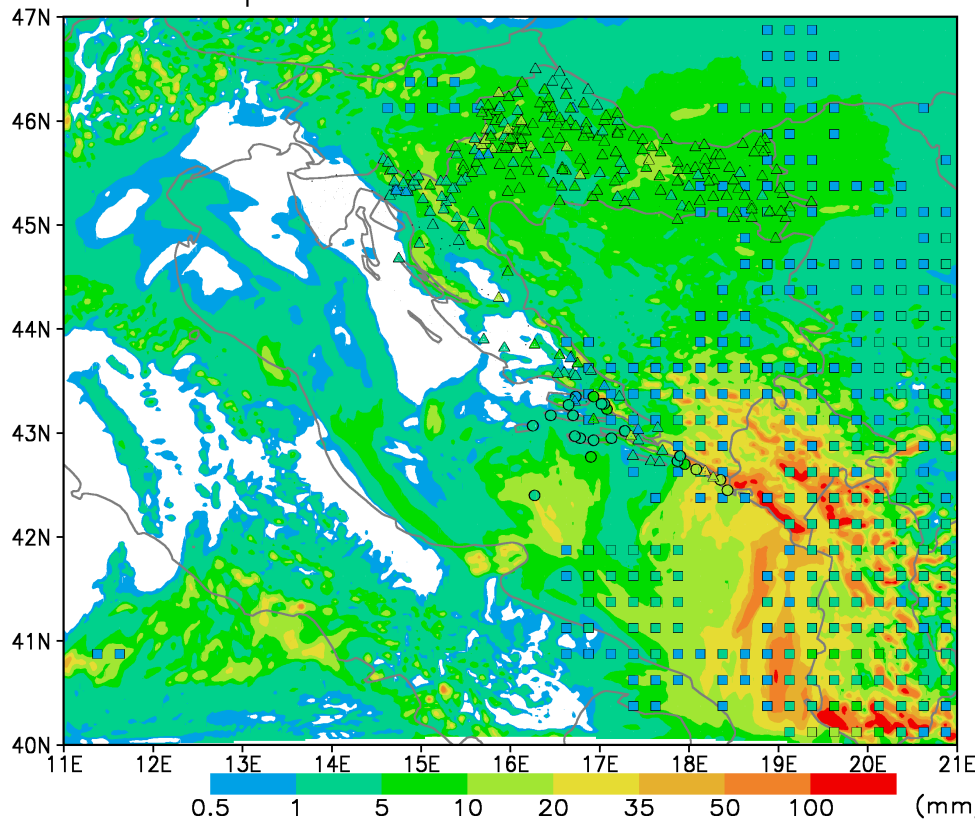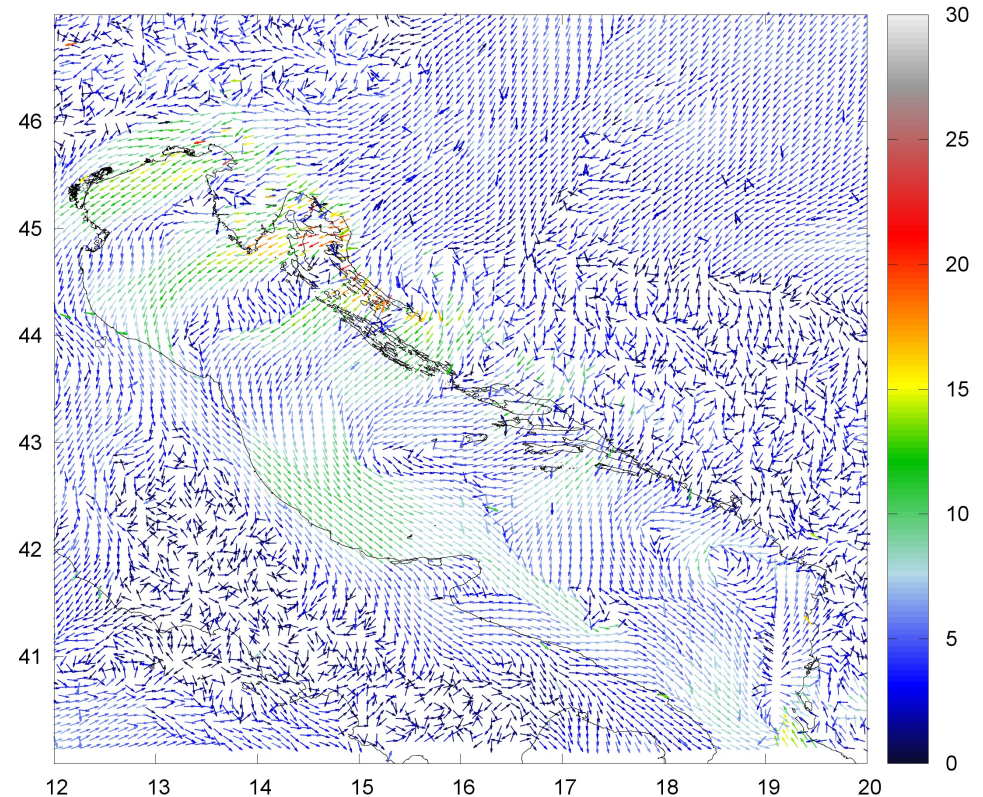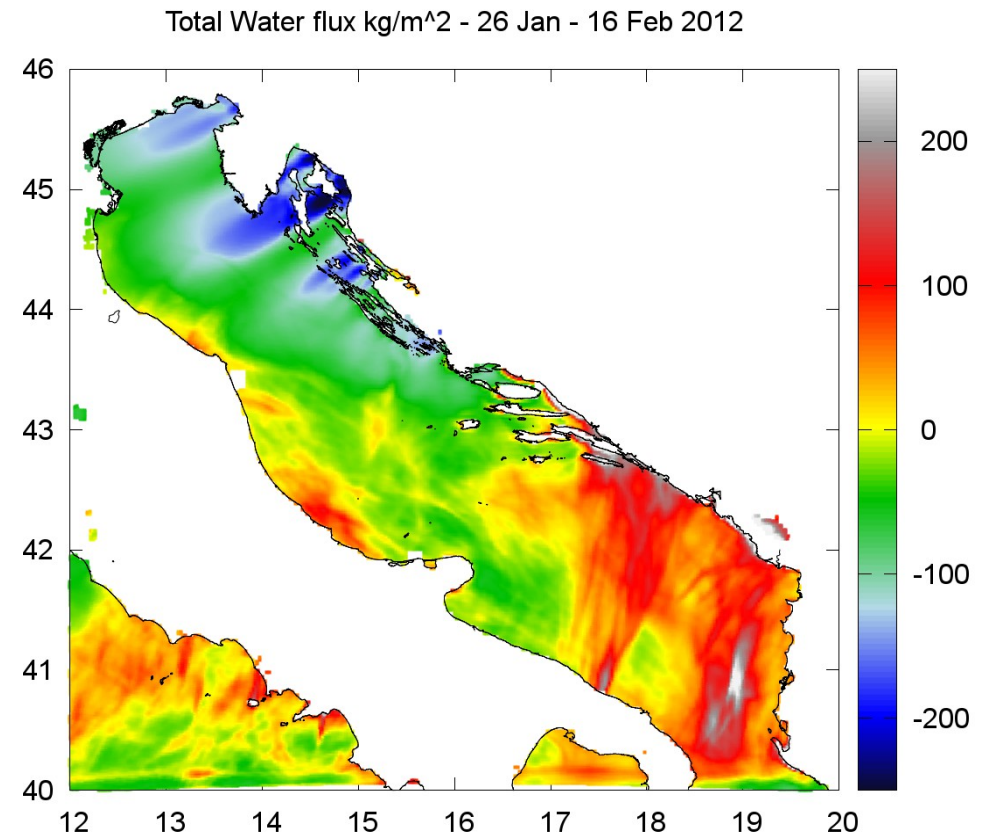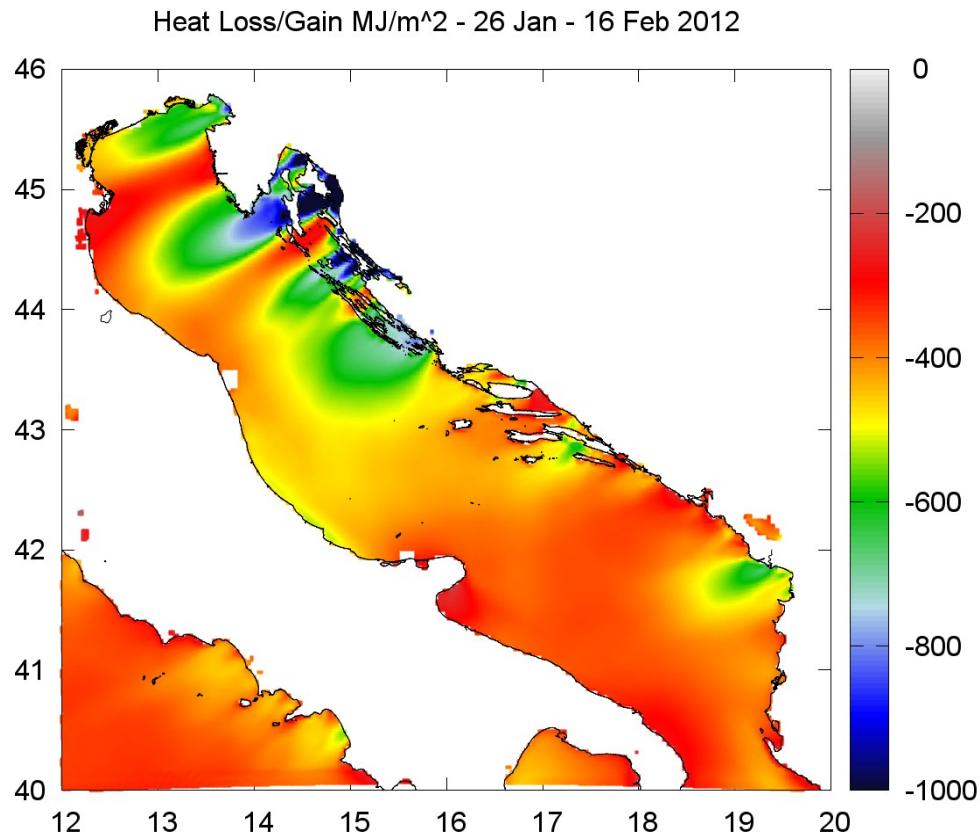

HR22 Precipitation 06Z12FEB2012 to 06Z13FEB2012



12 UTC 2km model, SYNOP, auto and ASCAT wind - 12 Feb 2012

# Operational cases - Winter 2012

- air sea interaction study
- record levels of water density recorded
- deep water generation



Heat Loss/Gain MJ/m^2 - 26 Jan - 16 Feb 2012

Total Water flux kg/m^2 - 26 Jan - 16 Feb 2012

# Summary and plans

The high-resolution ALARO0 contributions to the operations:
- the improved forecast of severe weather cases,
- additional forecast products (TKE, microphy, updrafts),
- resolving explicitly specific local phenomena,
- providing forcing to ocean and wave models ...

The consequences of some "optimizing" (eg. No PC) chioces are active only in certain weather situations:
- exaggerated rainfall over sharp isolated mountains (eg. Velebit)
- too much 10m wind and gustiness in mountains

Things to do and things to dream of:
- AL36T1+3MT in 8km resolution run (new B matrix?)
- investigate the role of particular processes in different weather
- improvements in the air-sea interaction ...