Identification of the mechanisms producing different precipitation patterns over NEI: Insights from HyMeX-IOP18 and 19 and previous events

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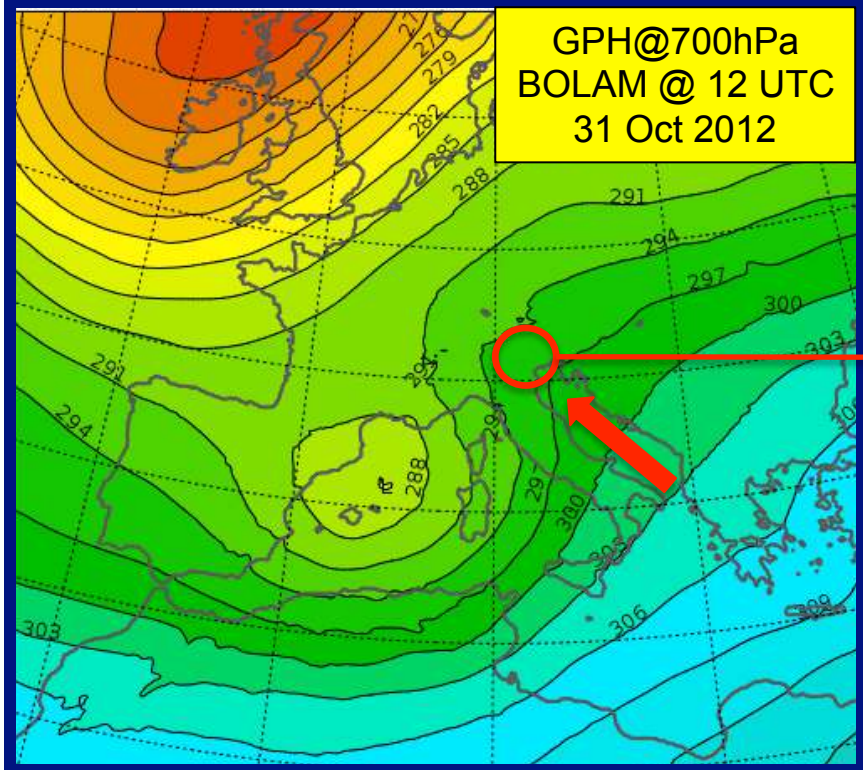
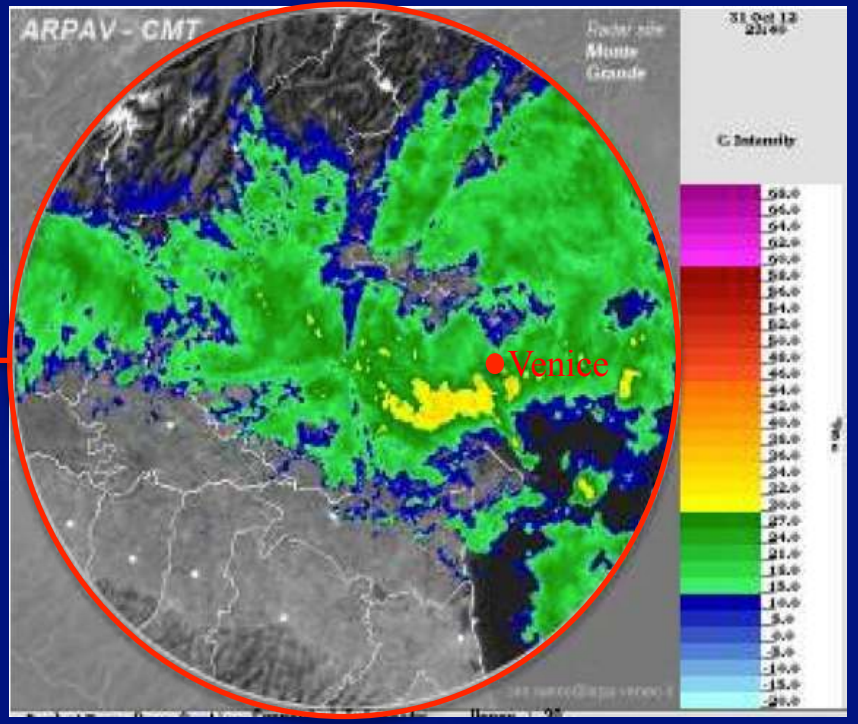
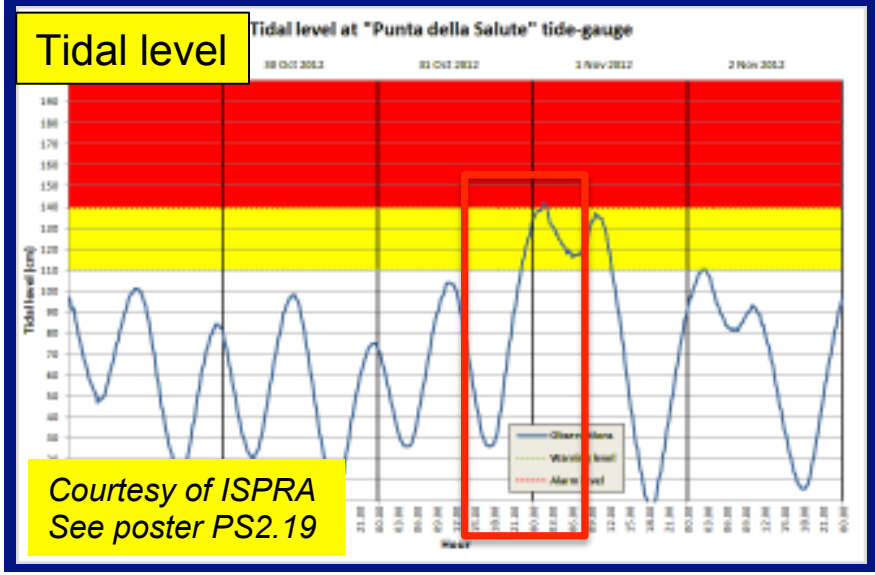
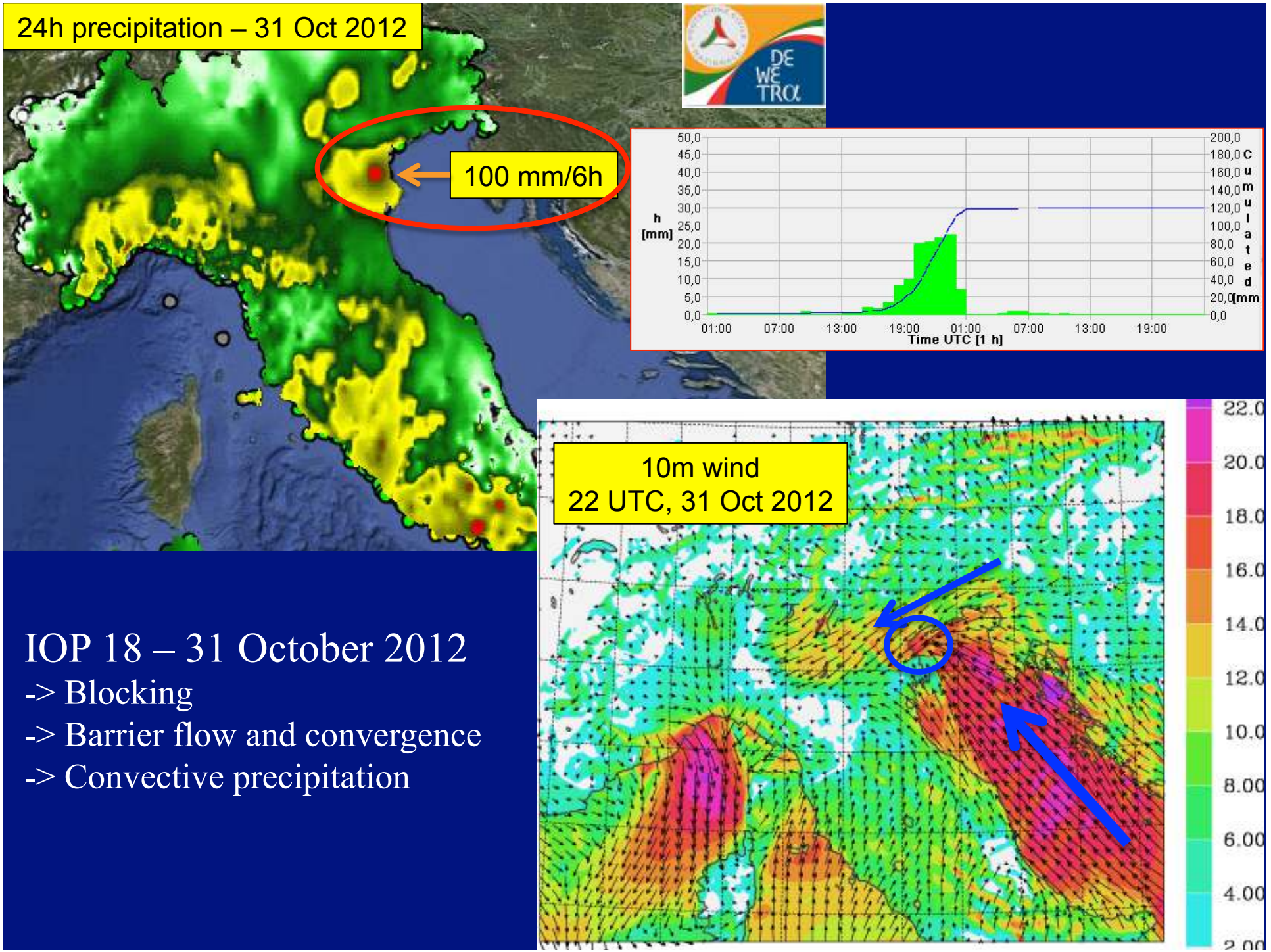
7 – 10 October 2013 7th HyMeX Workshop Cassis (France)

IOP 18 – 31 October 2012 - OVERVIEW









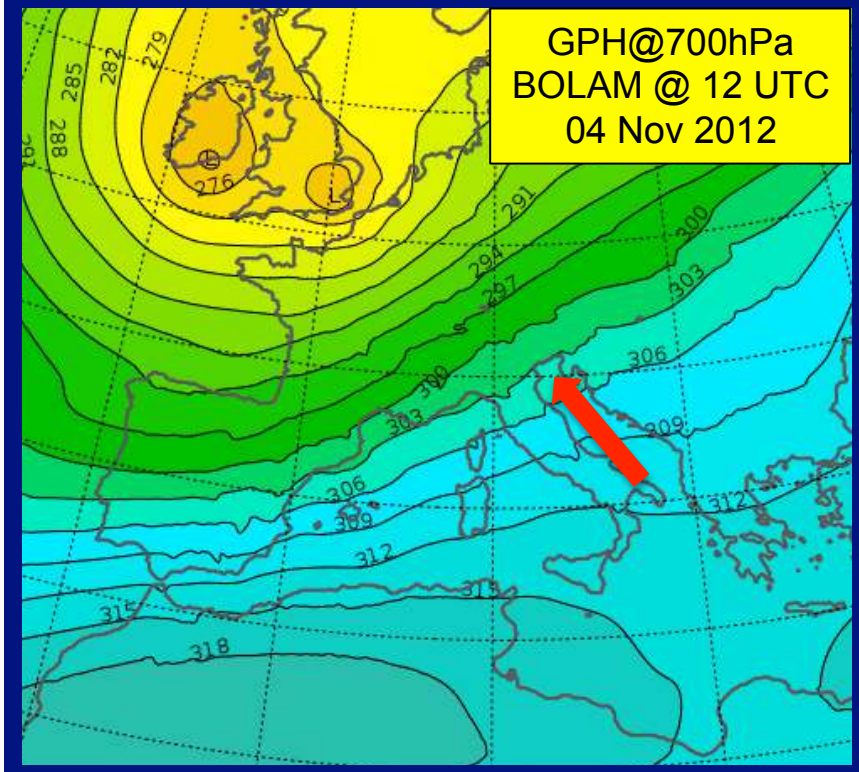
IOP 18 – 31 October 2012

-> Blocking

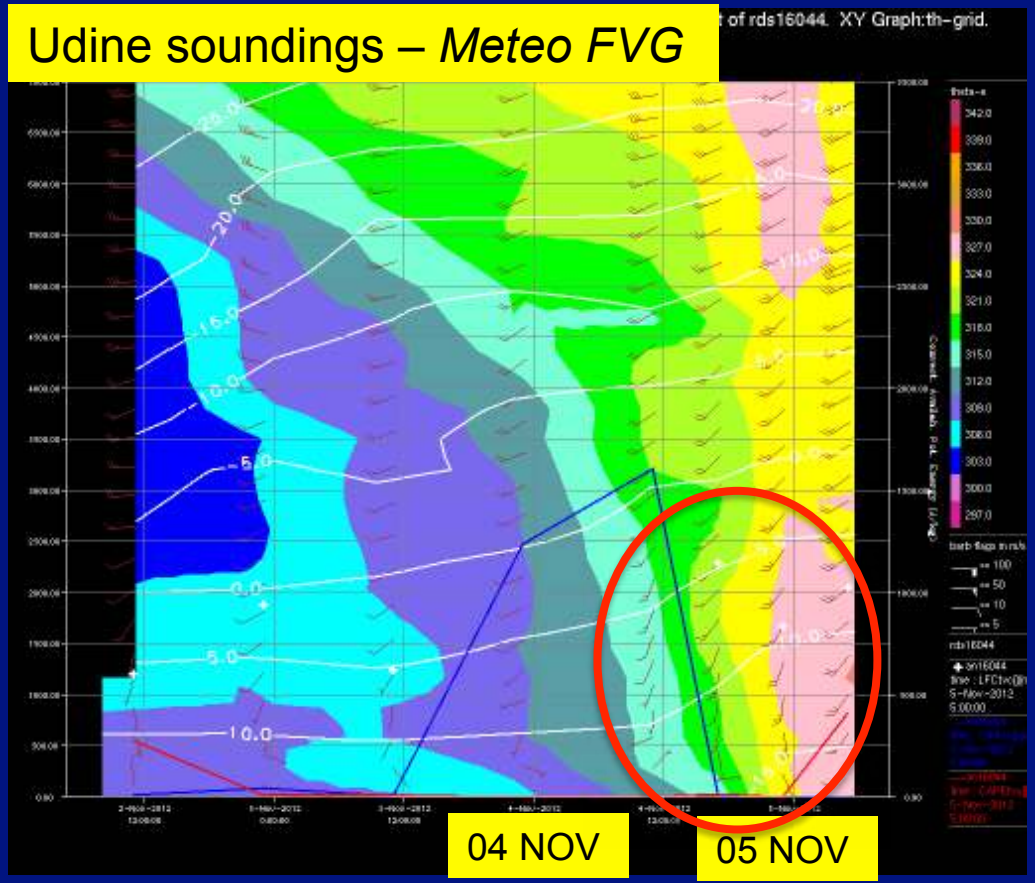
-> Barrier flow and convergence

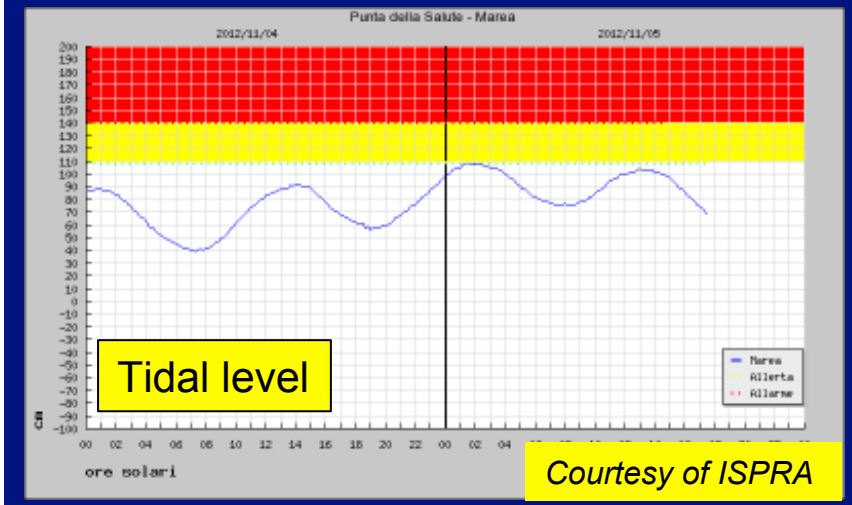
-> Convective precipitation

IOP 19 – 04-05 November 2012 - OVERVIEW

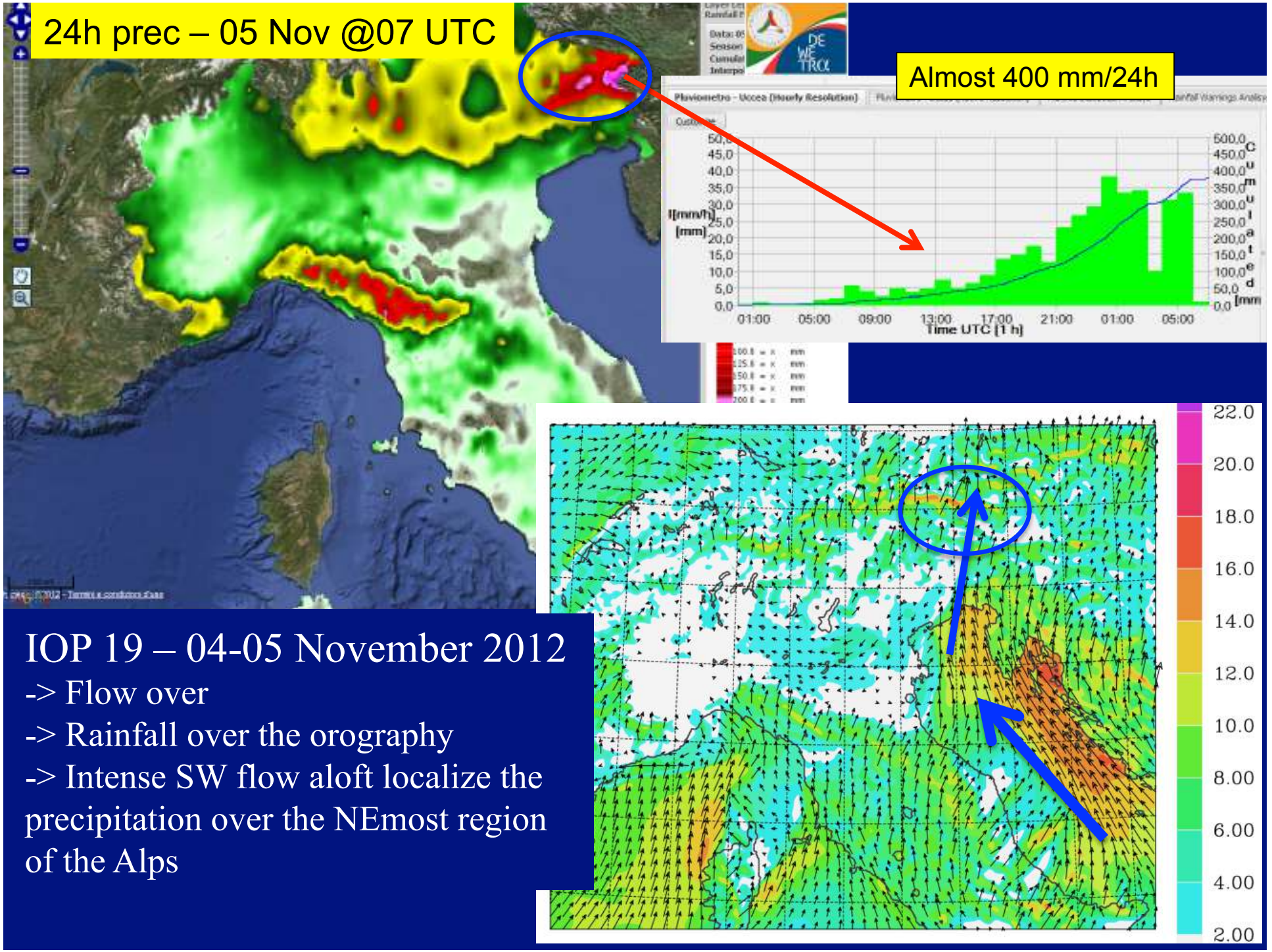


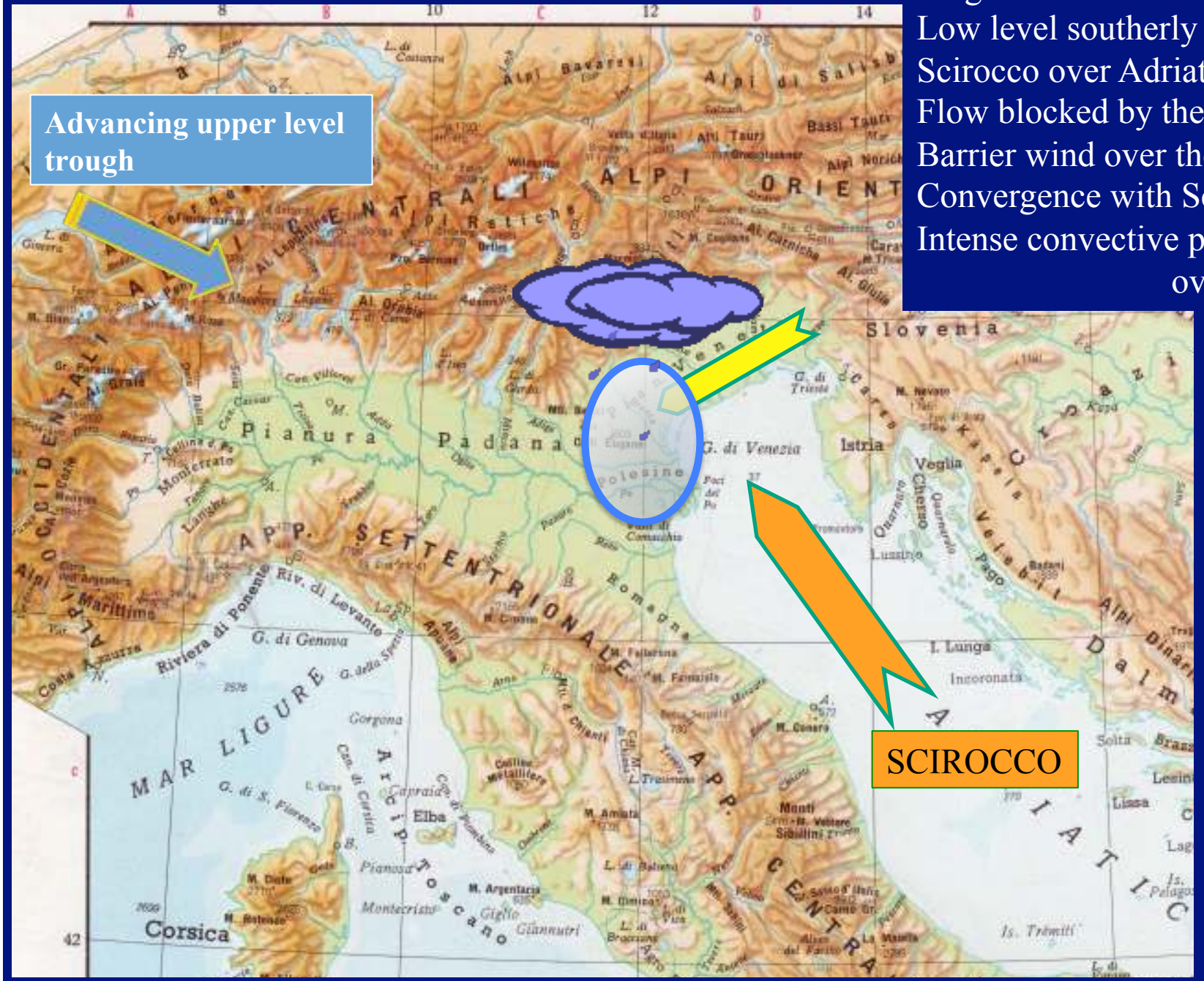
Udine soundings – *Meteo FVG*





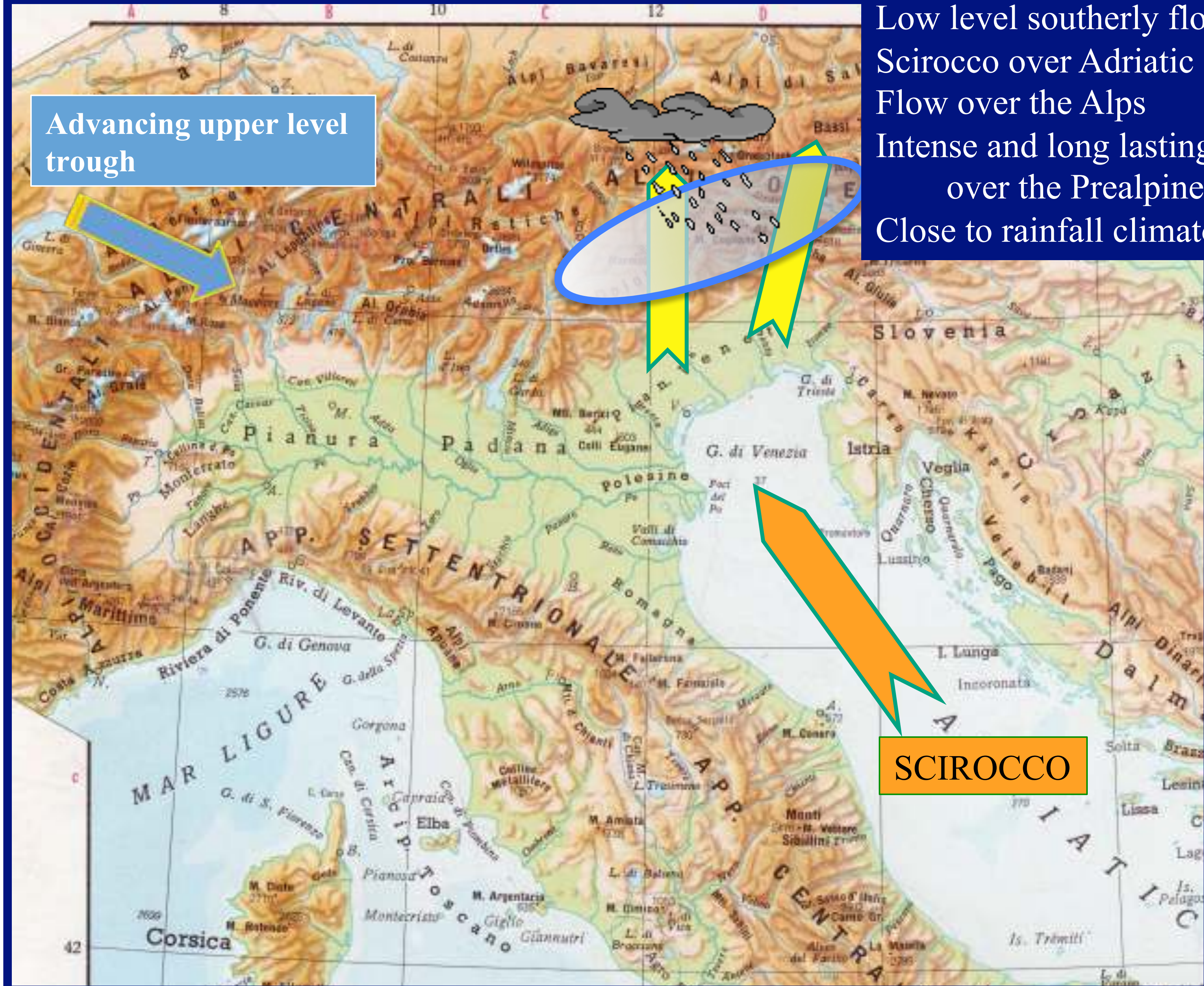
Warm and moist air progressively penetrates inland


24h prec – 05 Nov @07 UTC
Almost 400 mm/24h
Pluviometro - Ucea (Hourly Resolution)
I[mm/h]
[mm]
Time UTC [1 h]
IOP 19 – 04-05 November 2012
-> Flow over
-> Rainfall over the orography
-> Intense SW flow aloft localize the precipitation over the NEmost region of the Alps



Large scale disturbance
Low level southerly flow
Scirocco over Adriatic Sea
Flow blocked by the Alps
Barrier wind over the NEI plain
Convergence with Scirocco
Intense convective precipitation over the plain

Large scale disturbance
Low level southerly flow
Scirocco over Adriatic Sea
Flow over the Alps
Intense and long lasting precipitation
over the Prealpine/Alpine area
Close to rainfall climatology



Is this issue really new???

Nat. Hazards Earth Syst. Sci., 12, 2463–2477, 2012
www.nat-hazards-earth-syst-sci.net/12/2463/2012/
doi:10.5194/nhess-12-2463-2012

Natural Hazards and Earth System Sciences

Recurring features of extreme autumnall rainfall events on the Veneto coastal area

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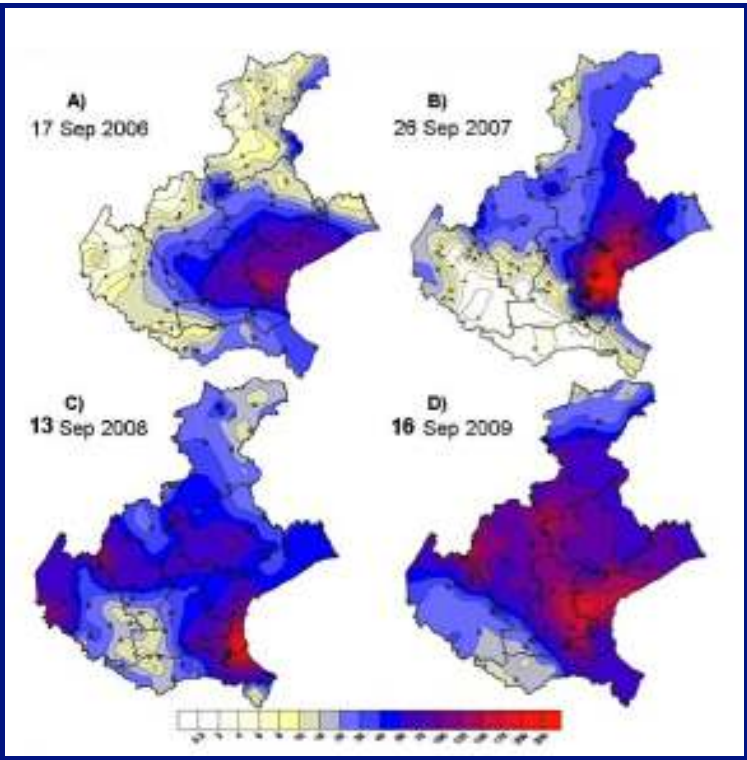
ARPAV, Regional Agency for Environmental Prevention and Protection of the Veneto, DRST, Land Safety Department, CMT, Meteorological Centre of Teolo, Italy

Correspondence to: A. Barbi (abarbi@arpa.veneto.it)

Received: 25 February 2011 – Revised: 29 August 2011 – Accepted: 1 October 2011 – Published: 7 August 2012



ELSEVIER

Atmospheric Research 83 (2007) 336–348

ATMOSPHERIC RESEARCH

www.elsevier.com/locate/atmos

The 6 h climatology of thunderstorms and rainfalls in the Friuli Venezia Giulia Plain

Agostino Manzato *

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Accepted 11 August 2005

Forecaster in FVG identify two categories:

a) Convective precipitation
b) Flux precipitation (stratiform rain, heavy rainfall)

MESOSCALE ALPINE PROGRAMME
MAP

Heavy orographic precipitation over the Alps

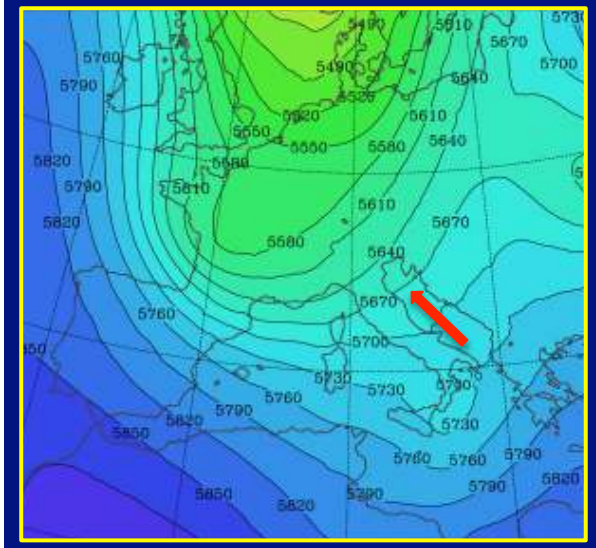
What's new, then?

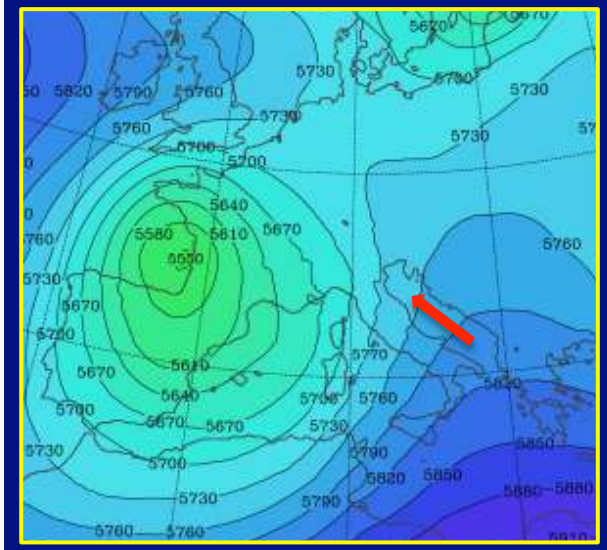
Only the meteorological effects are known and documented
AIMS
- Investigate the mechanisms associated with the two precipitation patterns, in terms of interaction between flow and orography.
- What are the factors that discriminate between the two observed patterns?

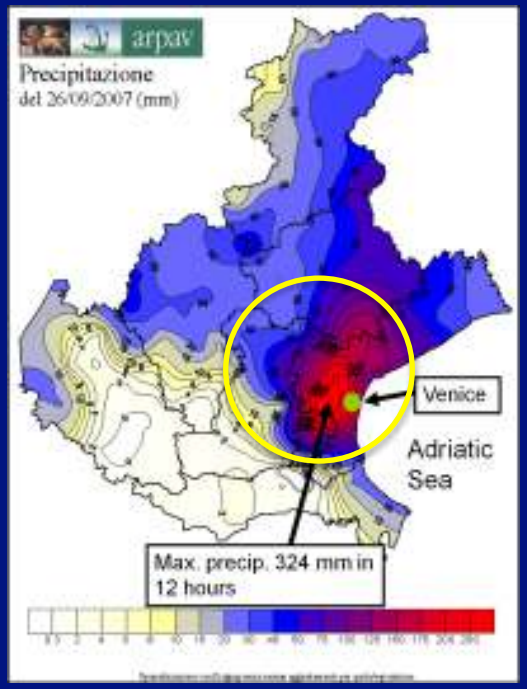
What we did:
- Selection of similar cases
Exclude cases with Bora from NE → blocked/non blocked flow
- Validation of the simulations (almost qualitative, but many data thanks to SOP and post-SOP collaborations)…not shown
- Analysis

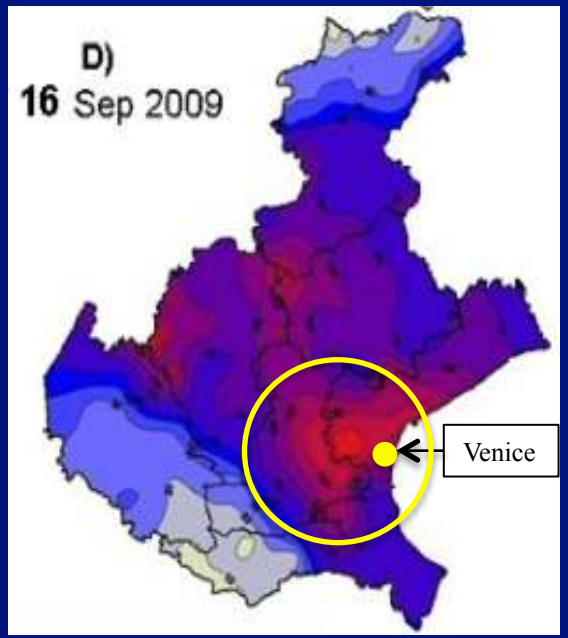
IOP18-like events

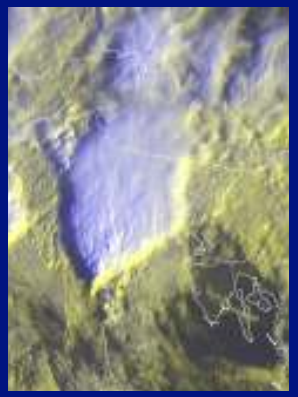
"Convective events"











Marghera – 26 Sep 2007

During MAP DPHASE

V-shape MCS, flood near Venice

Mira – 16 Sep 2009

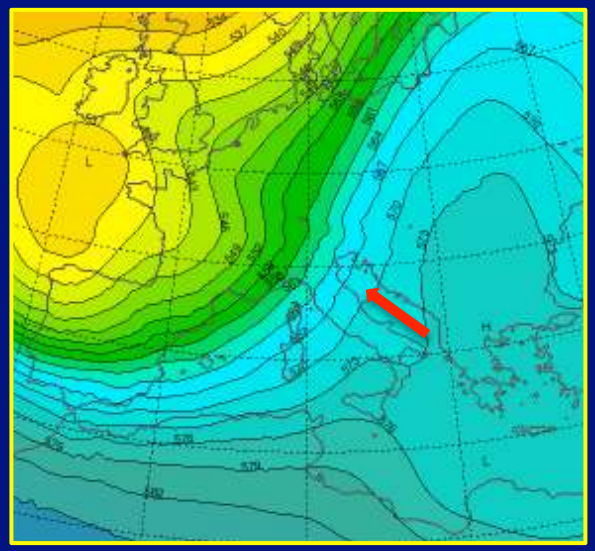
Stationary MCS

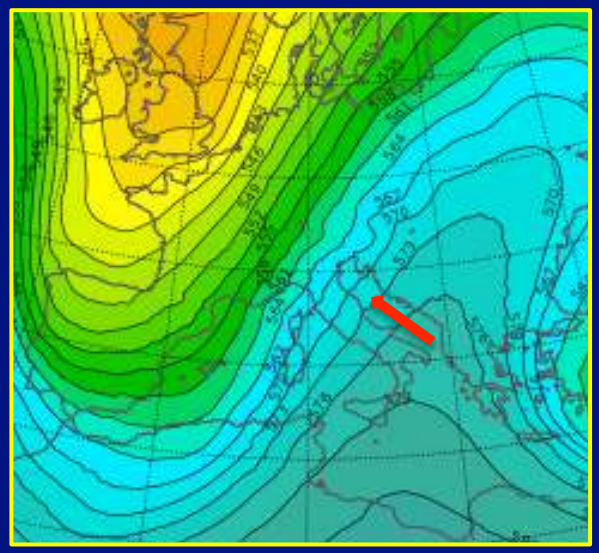
160 mm/12h

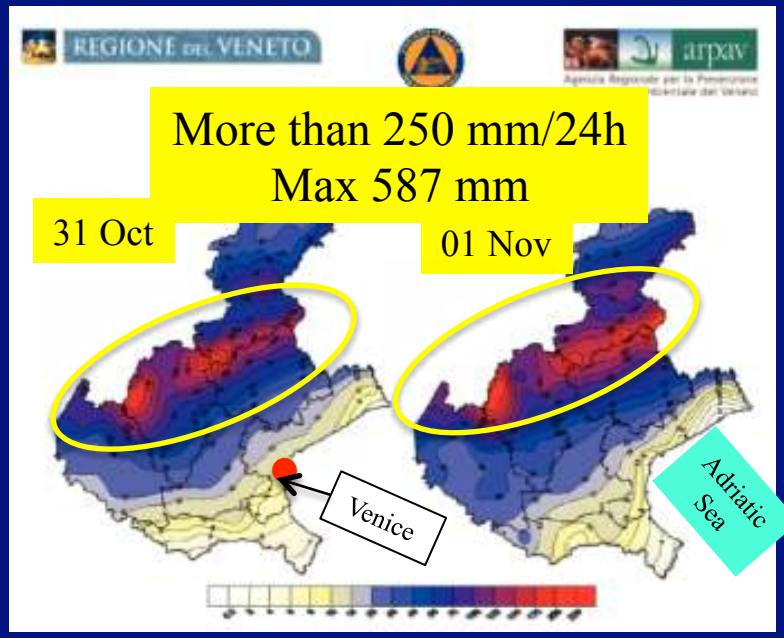
70 mm/1h

IOP19-like events

"Alpine events"





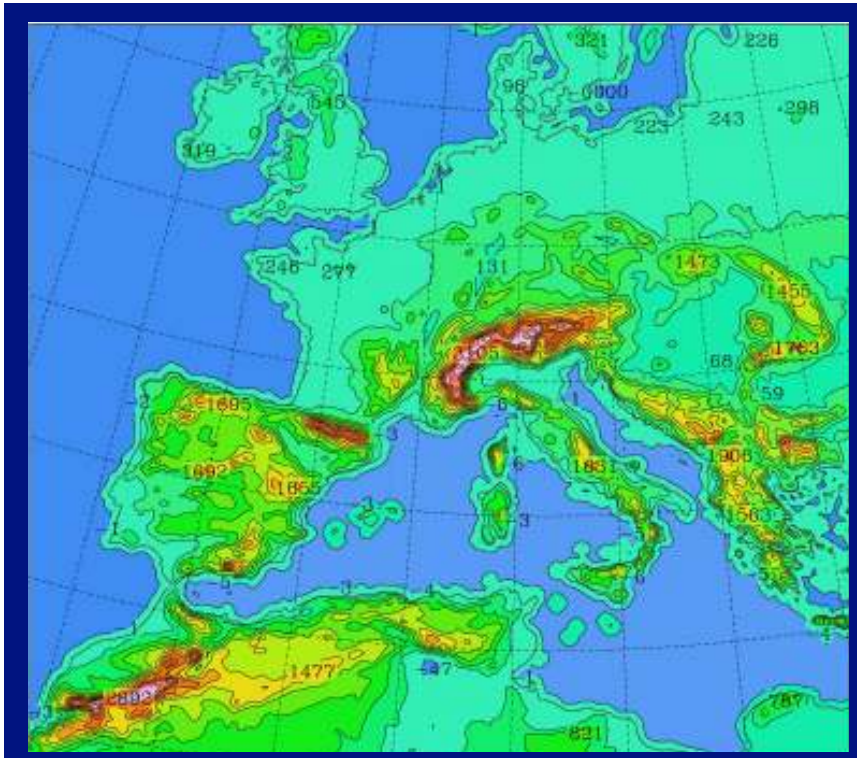


Vicenza 2010
31 Oct – 1 Nov

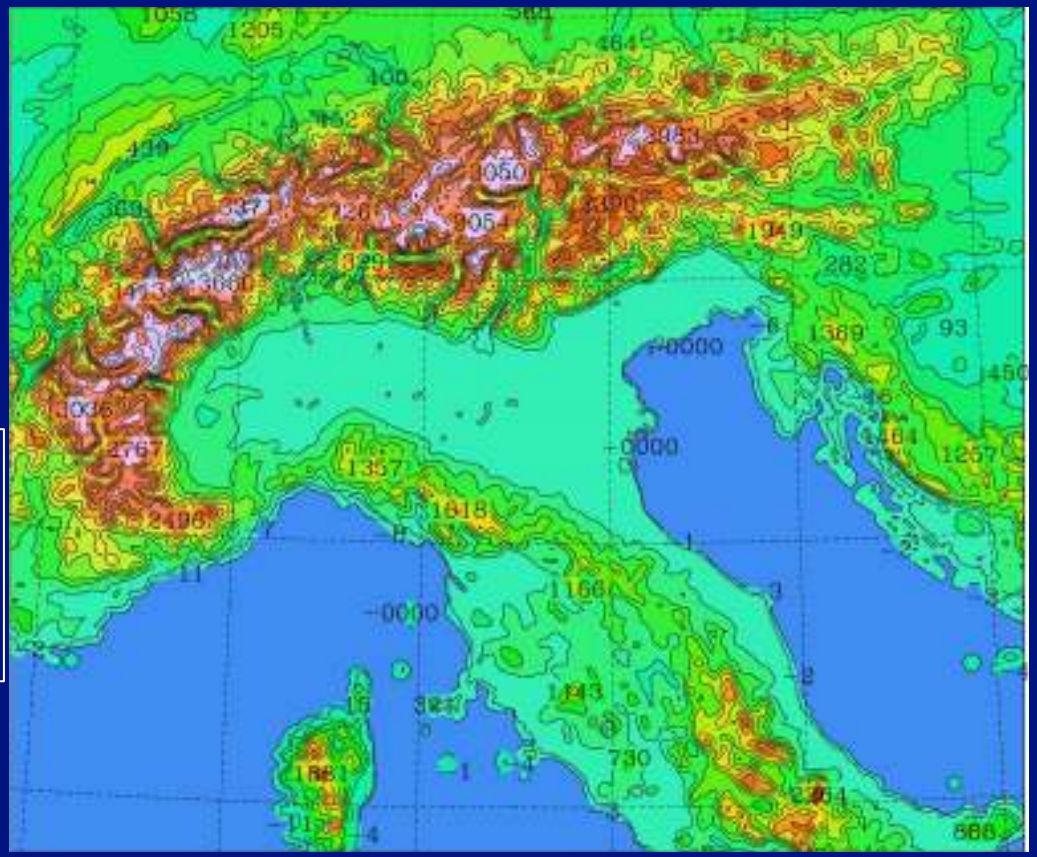
Long lasting HPE
Flood in Vicenza

Piancavallo
11 Nov 2012

Just after SOP1
Veneto and FVG affected



BOLAM
-hydrostatic
-horizontal resolution 11 km
-parameterized convection
-driven by ECMWF analyses

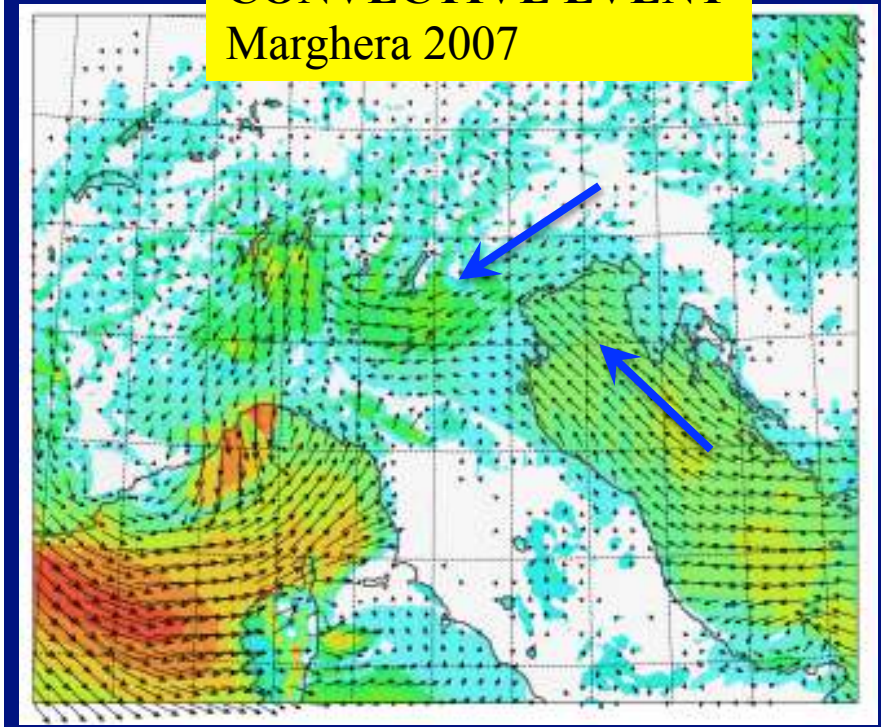


MOLOCH
-non hydrostatic, convection permitting
-horizontal resolution 2.3 km
-nested in BOLAM

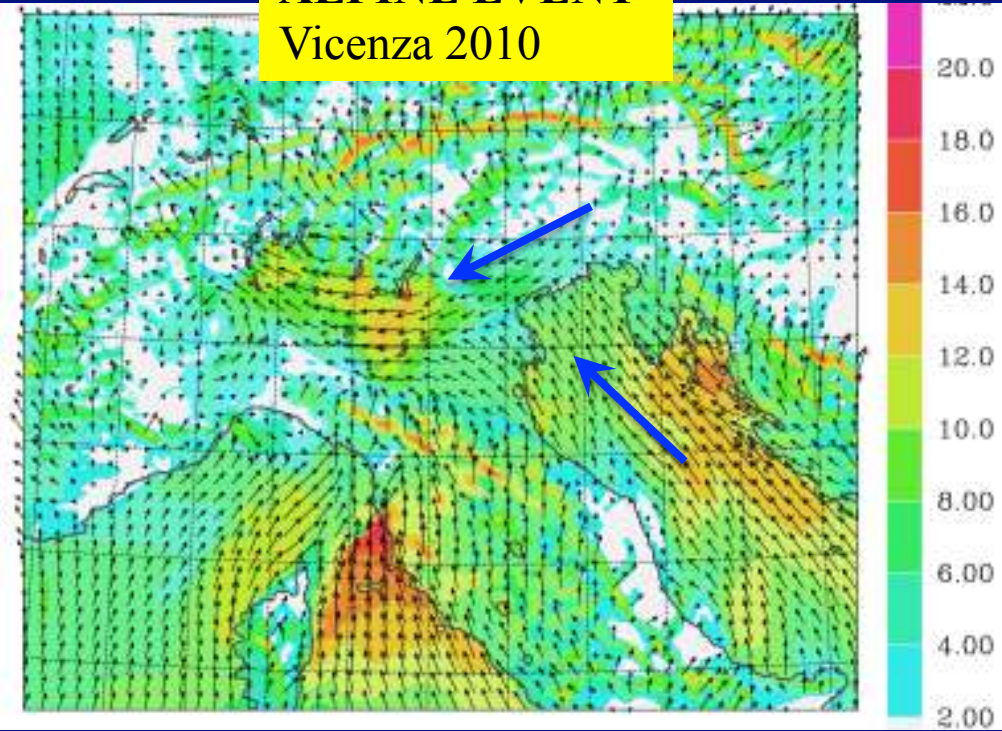
1) Comparison vs data to validate the simulations
2) Computation of parameters to identify the impinging flow characteristics

INITIAL PHASE: similar conditions of blocked low level flow before the event.
Scirocco is blocked by the orography and barrier wind flows over the NEI plain.

CONVECTIVE EVENT
Marghera 2007



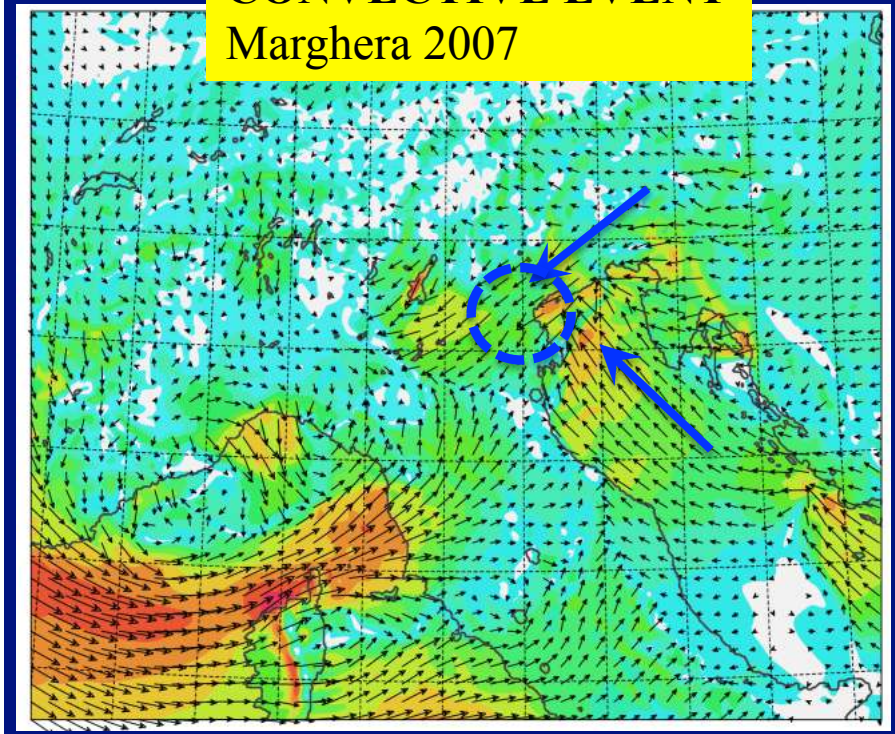
ALPINE EVENT
Vicenza 2010



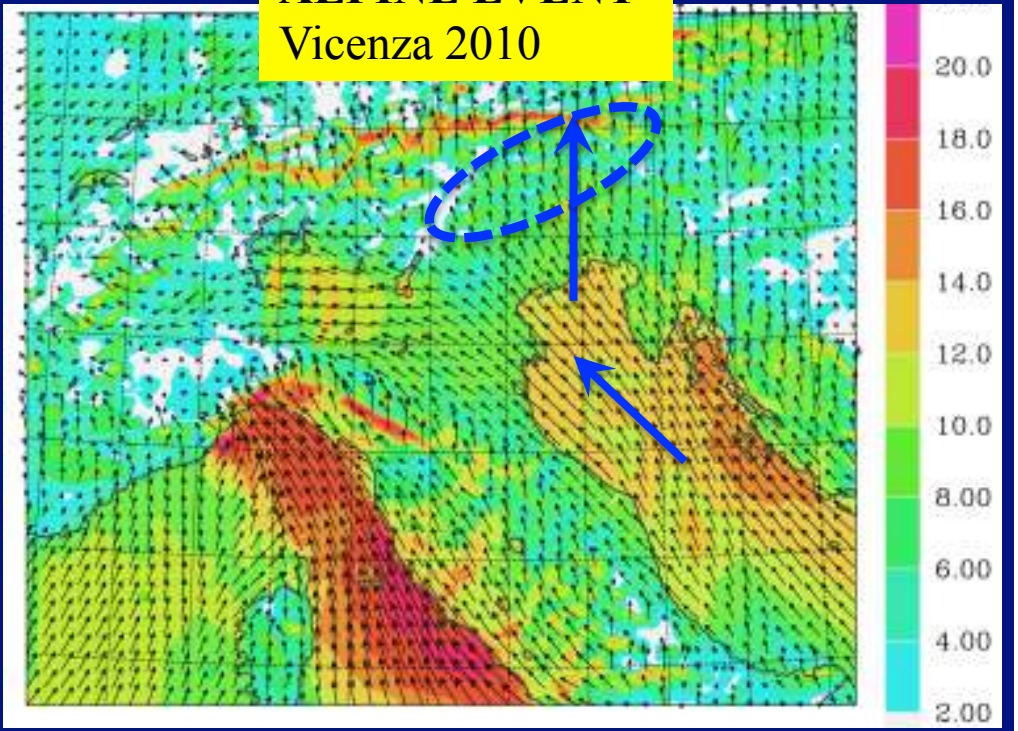
BUT …

INTENSE PRECIPITATION PHASE

CONVECTIVE EVENT
Marghera 2007



ALPINE EVENT
Vicenza 2010



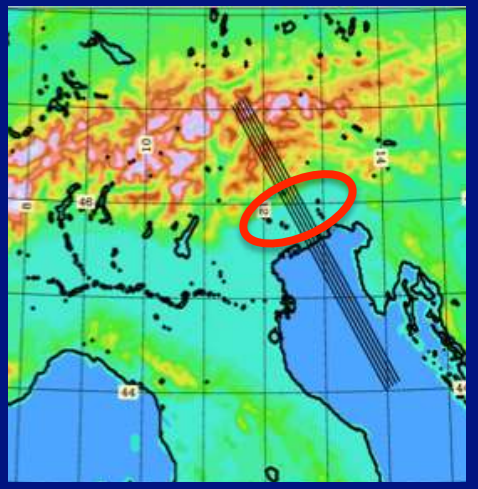
BUT as the flow intensifies the two cases differ

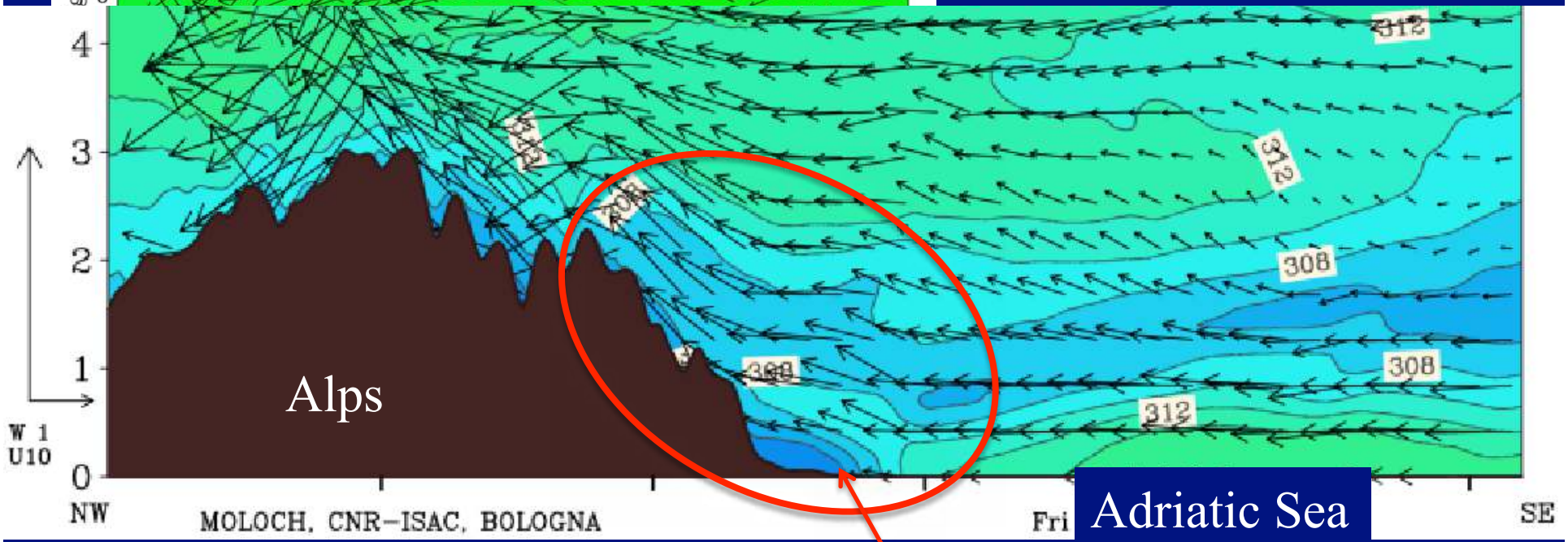
- Still blocked flow for the convective event
- Scirocco penetrates inland and flow over the Alps

THUS leading to different precipitation patterns

ALPINE EVENT
Vicenza 2010

INITIAL PHASE
Cross Section: wind & ThetaE



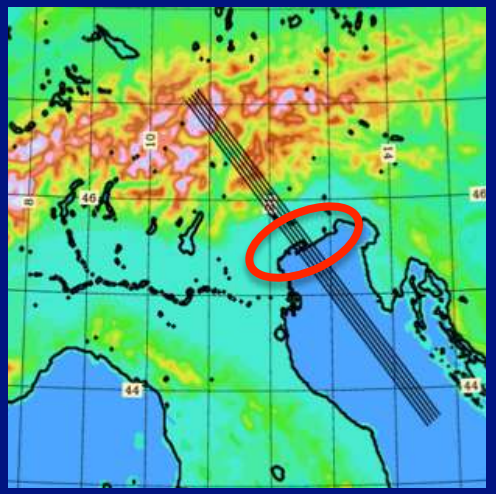


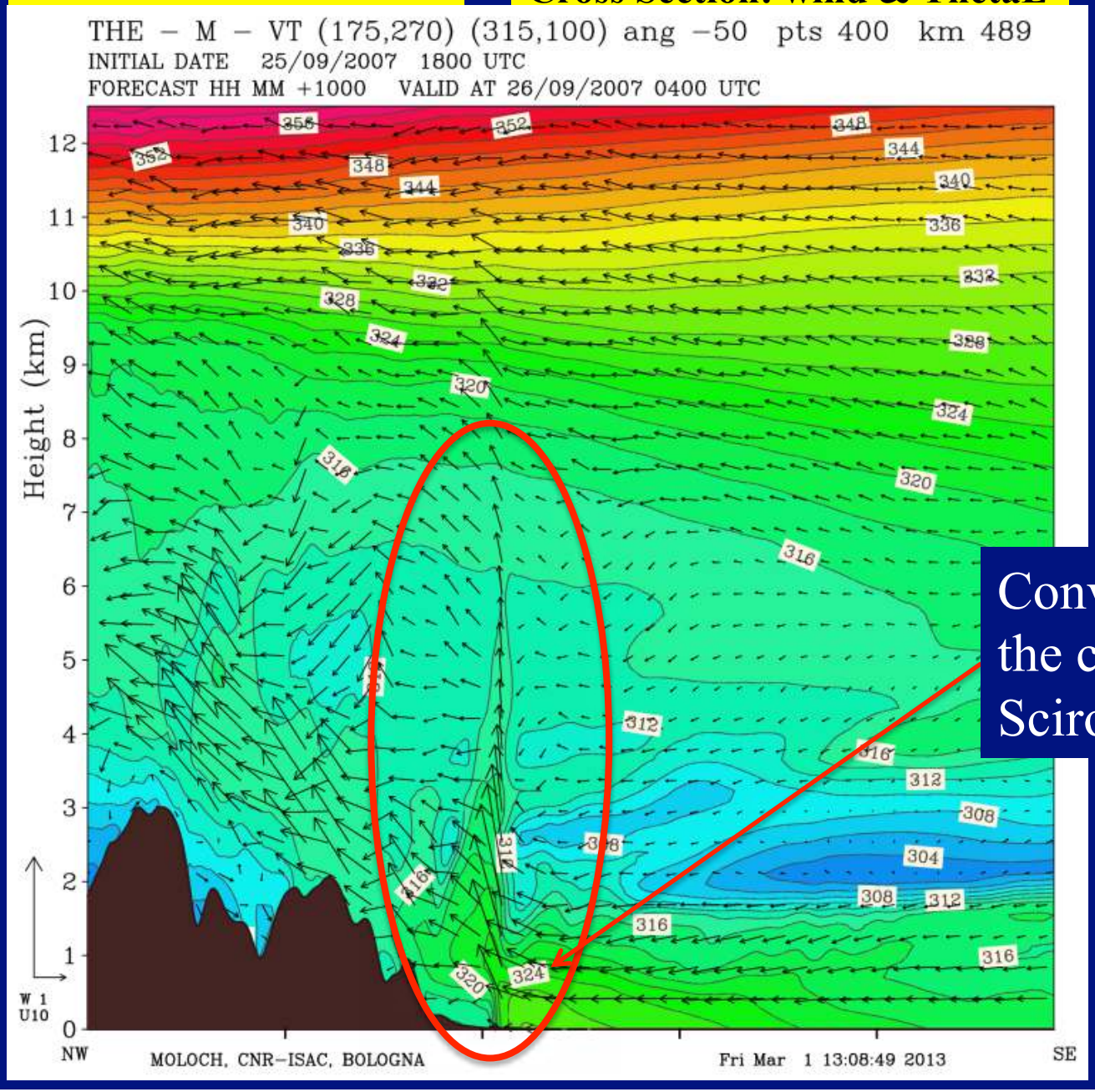
Gentle ascent over the cold pool/barrier flow

CONVECTIVE EVENT
Marghera 2007

INITIAL PHASE

Cross Section: wind & ThetaE



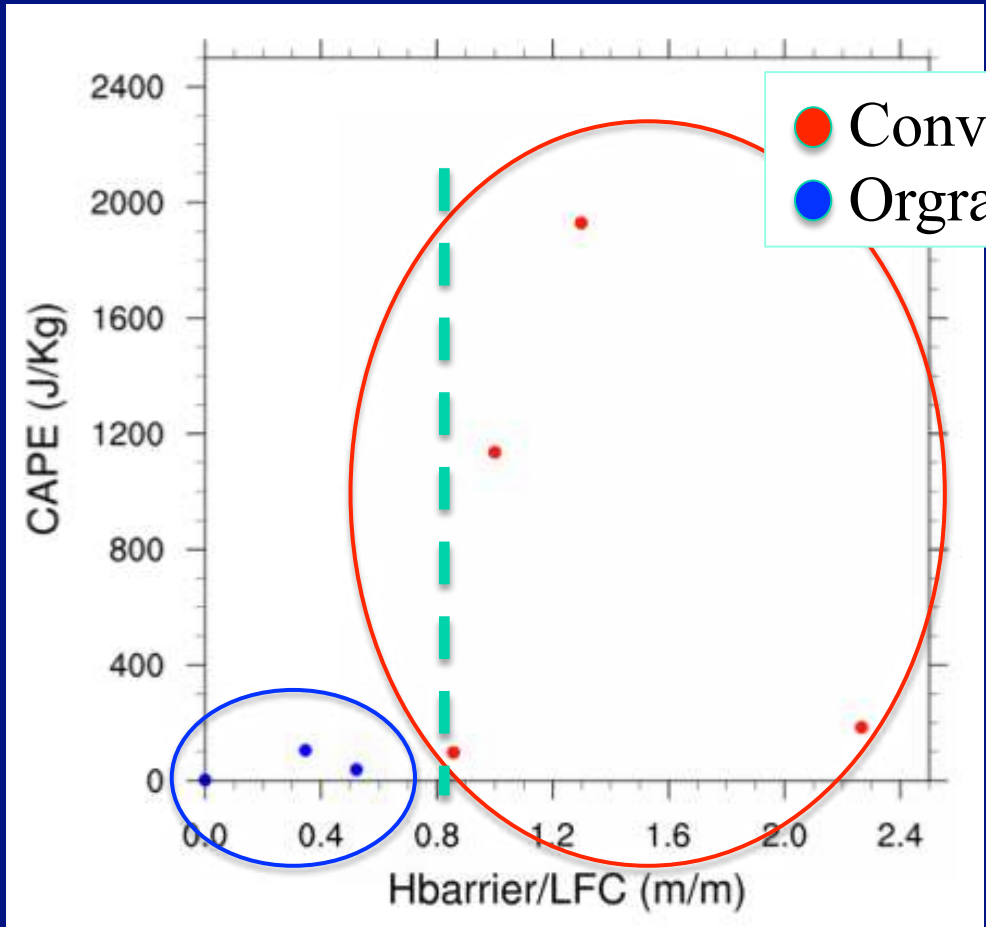


Convection is triggered at the convergence between Scirocco and barrier wind

Miglietta & Rotunno (2009) → identified several ambient parameters that modulate the precipitation distribution for a conditionally unstable flow over mountainous area

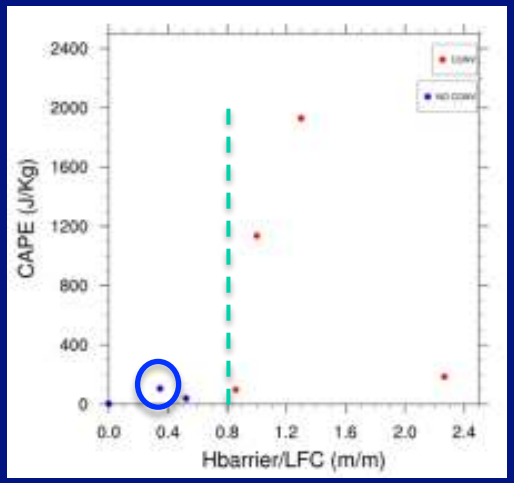
$$\frac{h_m}{LFC} \rightarrow \frac{h_b}{LFC}$$

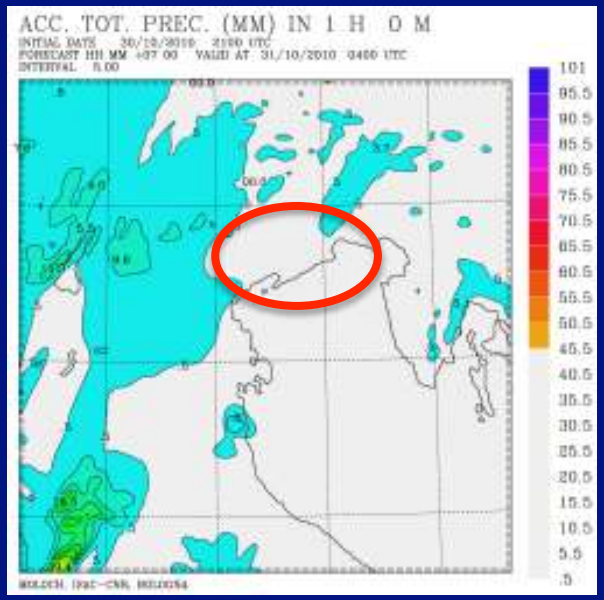
h_m=height of the mountain
h_b=height of the barrier wind layer
LFC=level of free convection

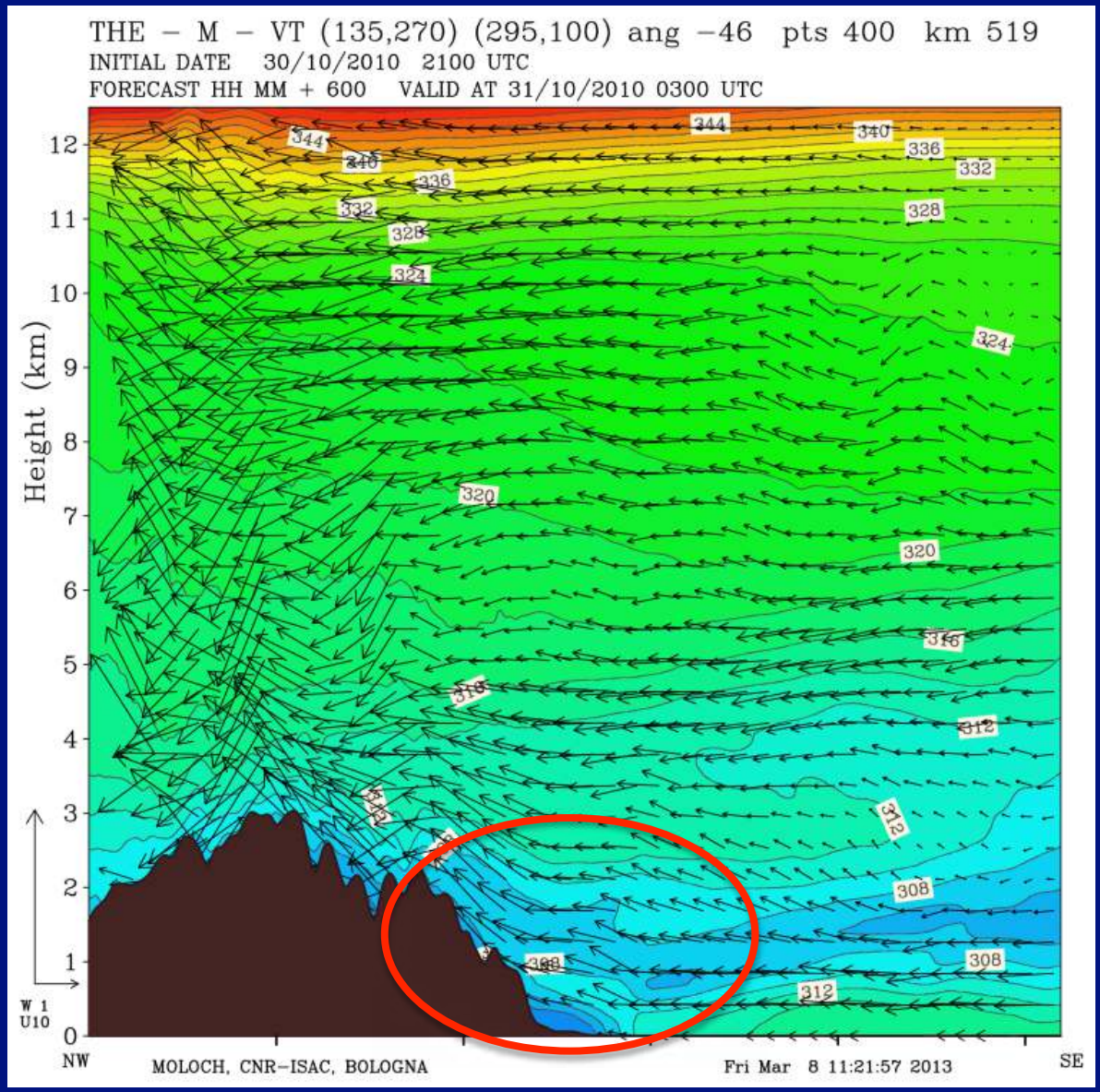


- Convection over the plain $h_b/LFC \geq 1$
- Orgraphic precipitation $h_b/LFC < 1$

The parameter h_b/LFC is evaluated
- before the precipitation event
- at some distance upstream of the orography
- area averaged

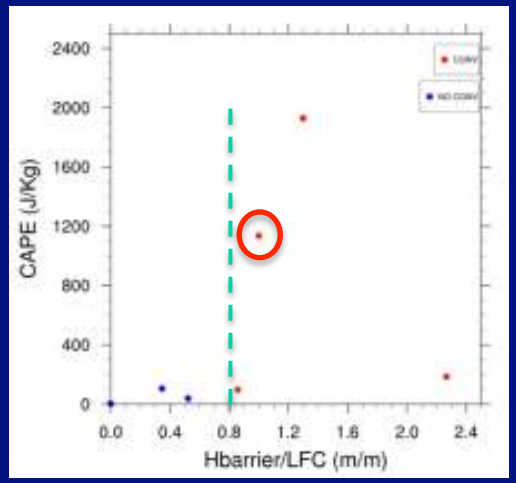


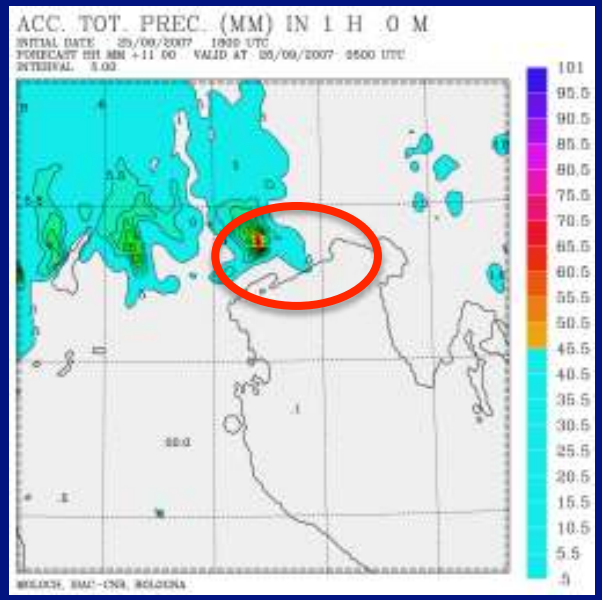


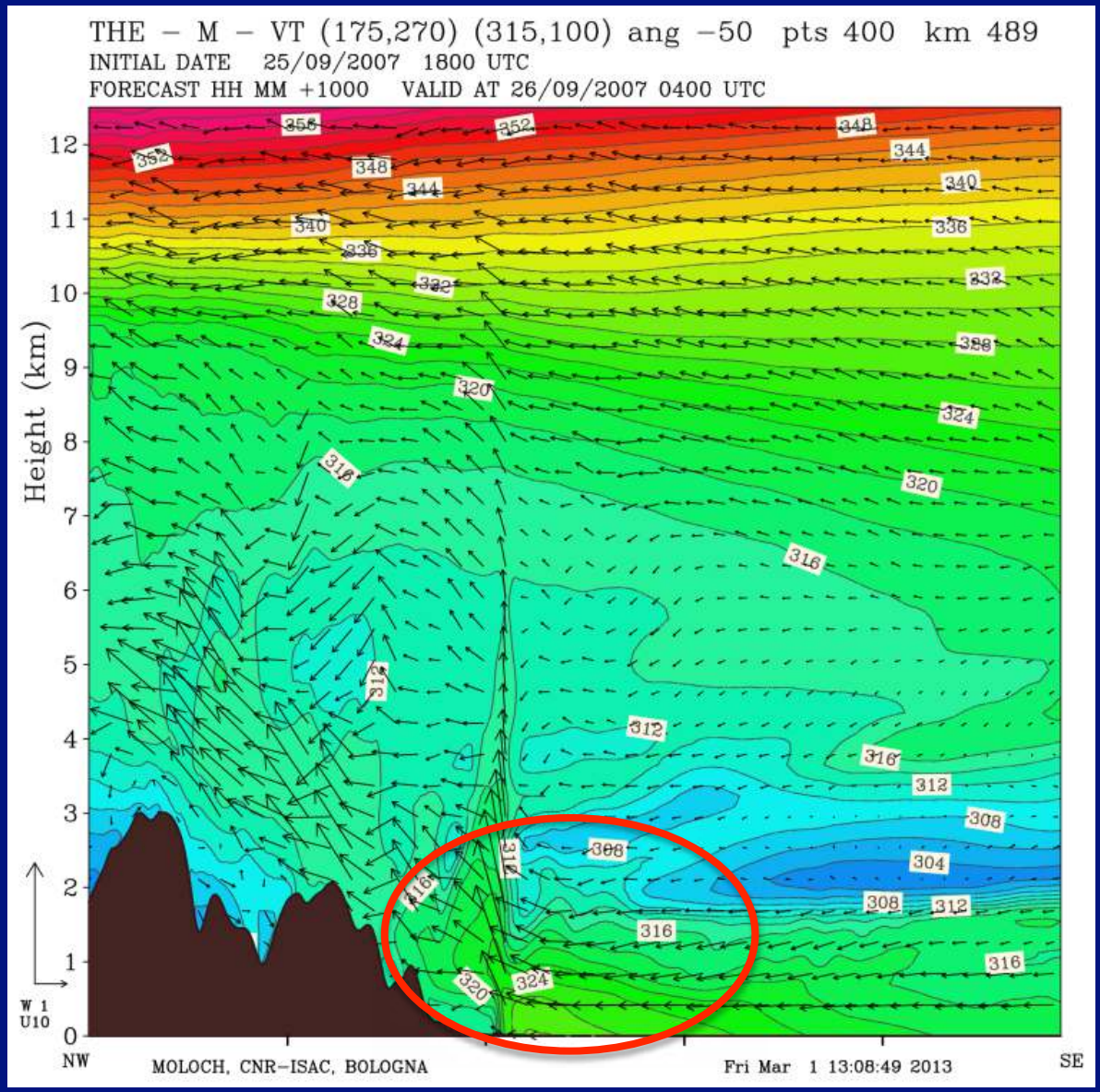


Vicenza 2010, "Alpine" event, $h_b/LFC << 1$

- Gentle ascent over the barrier wind layer.
- No precipitation associated

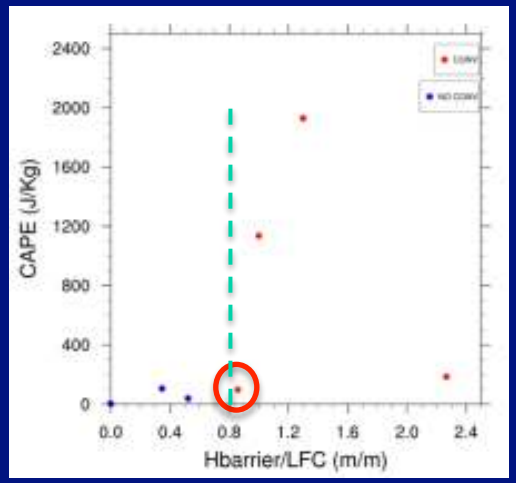


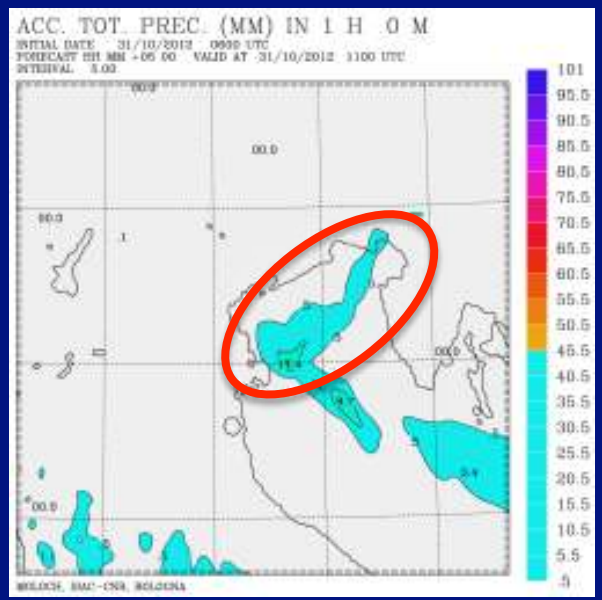


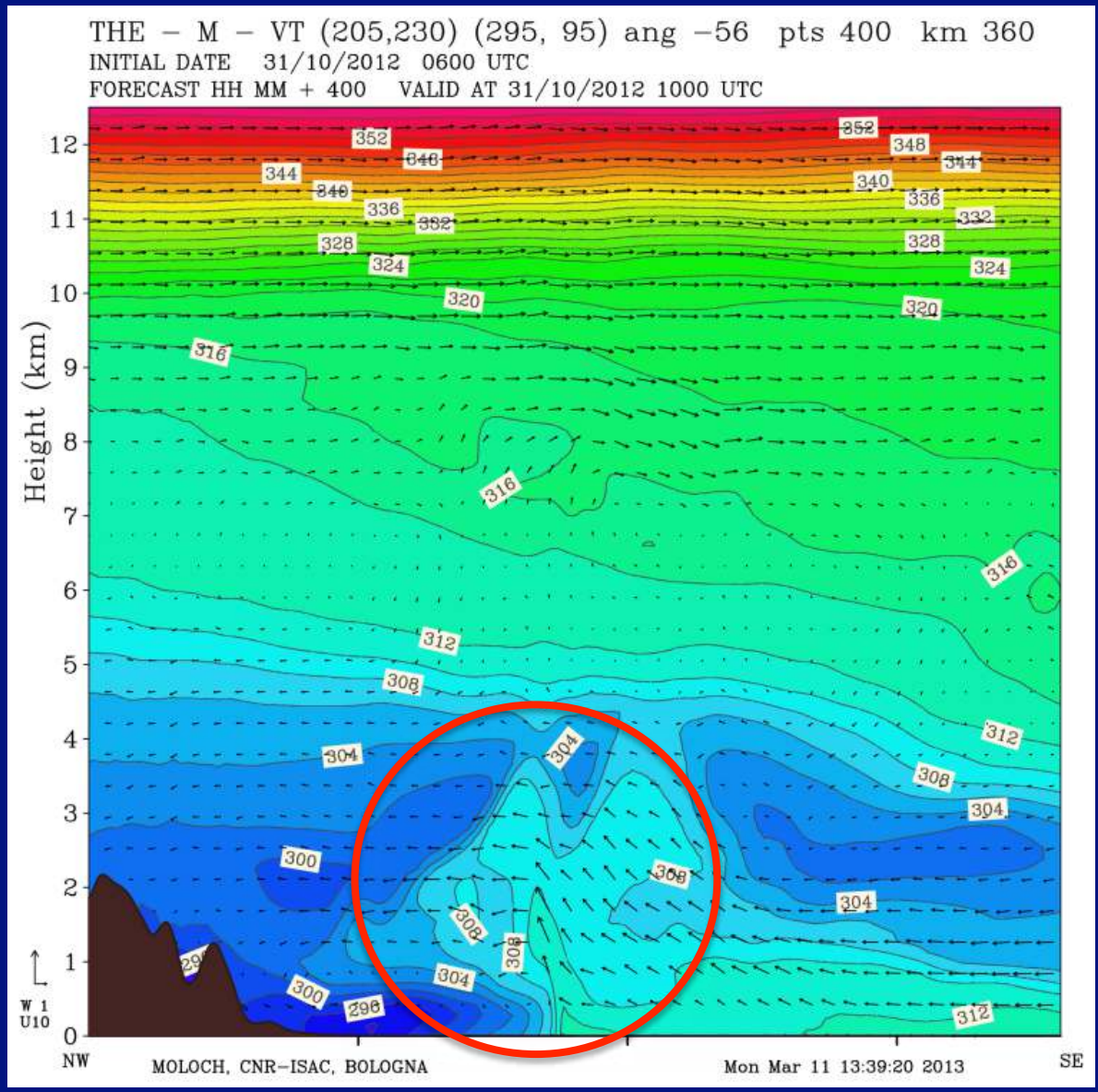


Marghera2007, “Convective” event, h_b/LFC > 1

- Deep convection triggered in correspondence with the ascent over the barrier wind layer.
- Intense precipitation associated







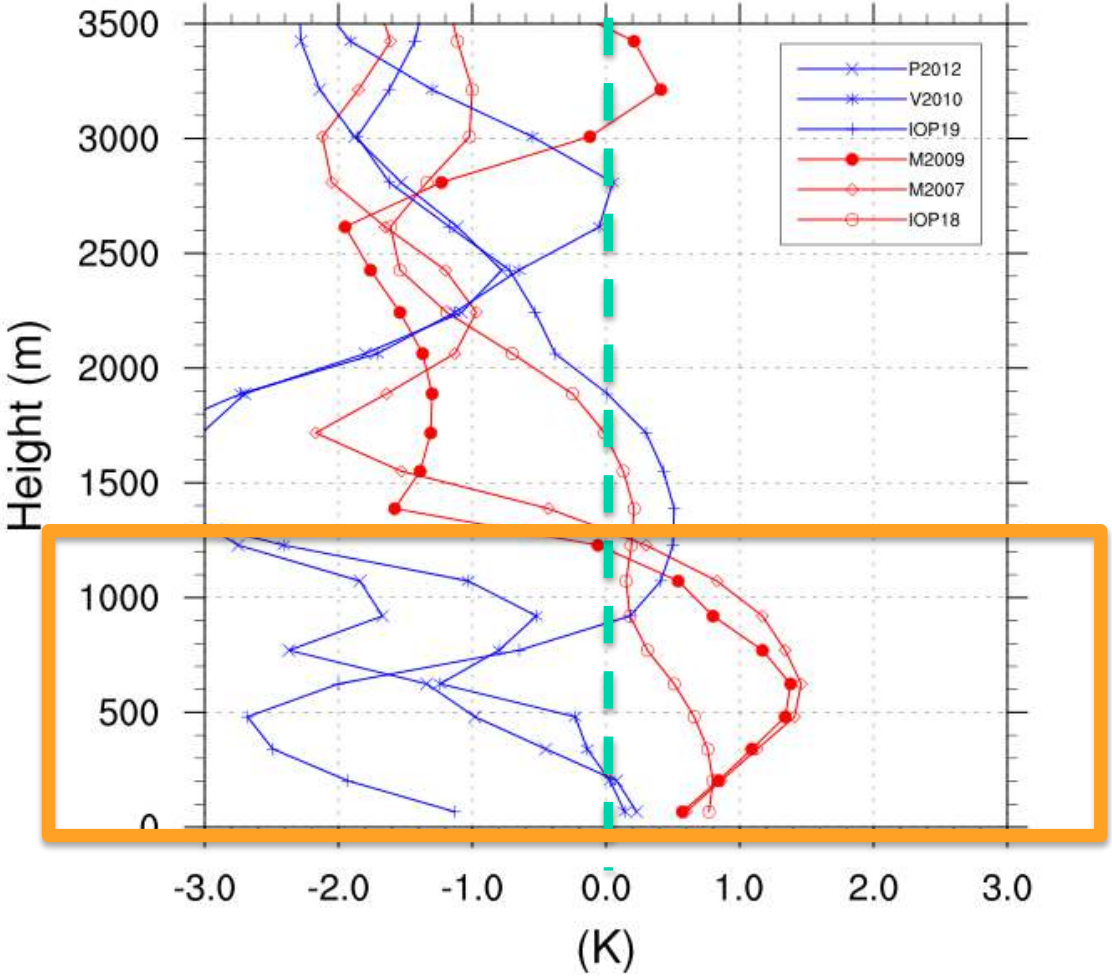
IOP18, "Convective" event, $h_b/LFC \geq 1$

-Shallow convection triggered in correspondence with the ascent over the barrier wind layer.

- Weak precipitation associated (consistent with low CAPE)

STABILITY OF AIR PARCEL TO SMALL VERTICAL DISPLACEMENTS

Virtual temperature of an air parcel adiabatically lifted by 500 m
minus
Virtual temperature of environment at the new altitude



Initial phase of the event
Before precipitation starts

RED: convective cases

$T_{vp} - T_{ve} > 0$ positive buoyancy
Unstable parcels in the lowest levels are lifted over the barrier wind layer

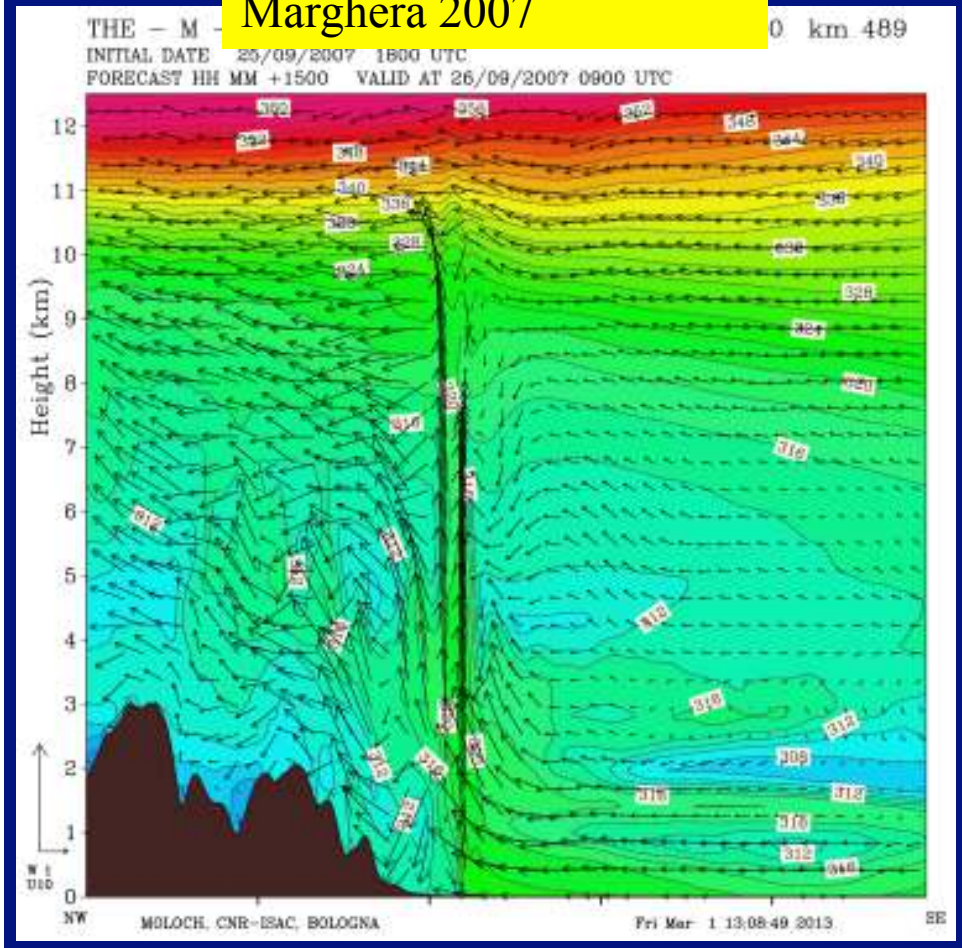
BLUE: alpine cases

$T_{vp} - T_{ve} > 0$ negative buoyancy
No convection

Cross Section: wind & ThetaE

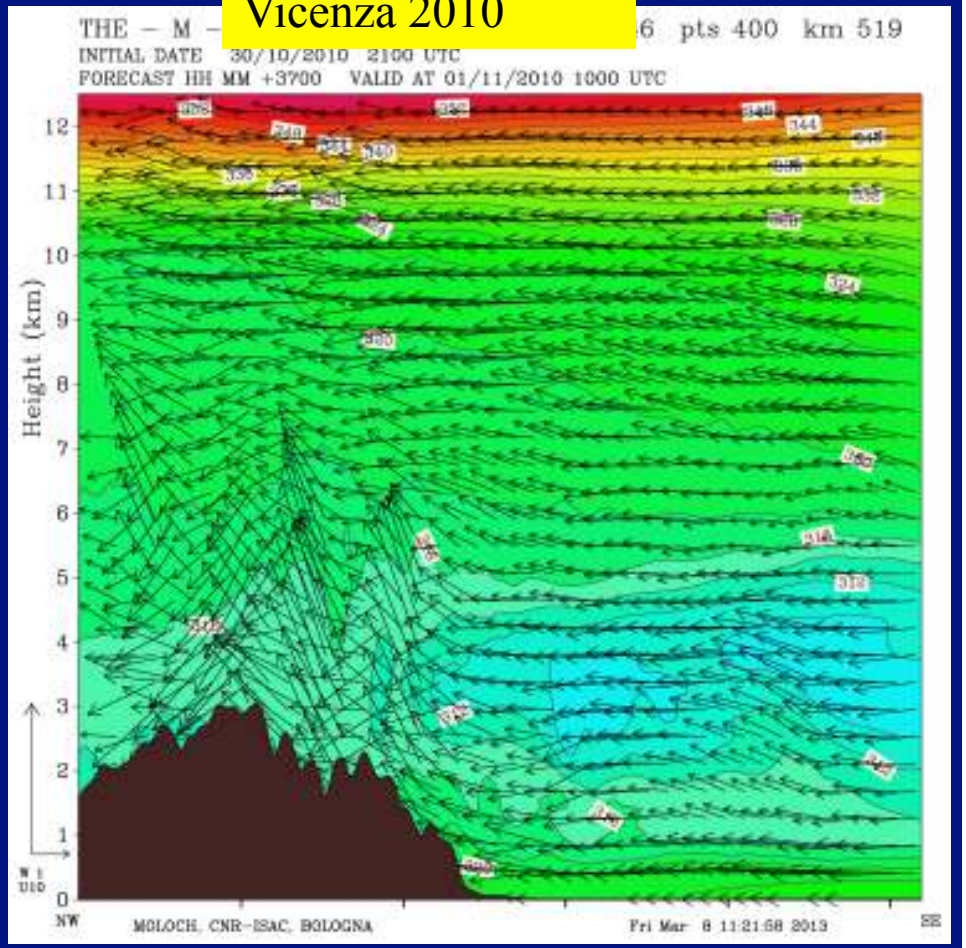
DURING PRECIPITATION EVENT

CONVECTIVE EVENT
Marghera 2007



Deep intense convection, reinforcing the cold pool associated with the barrier wind

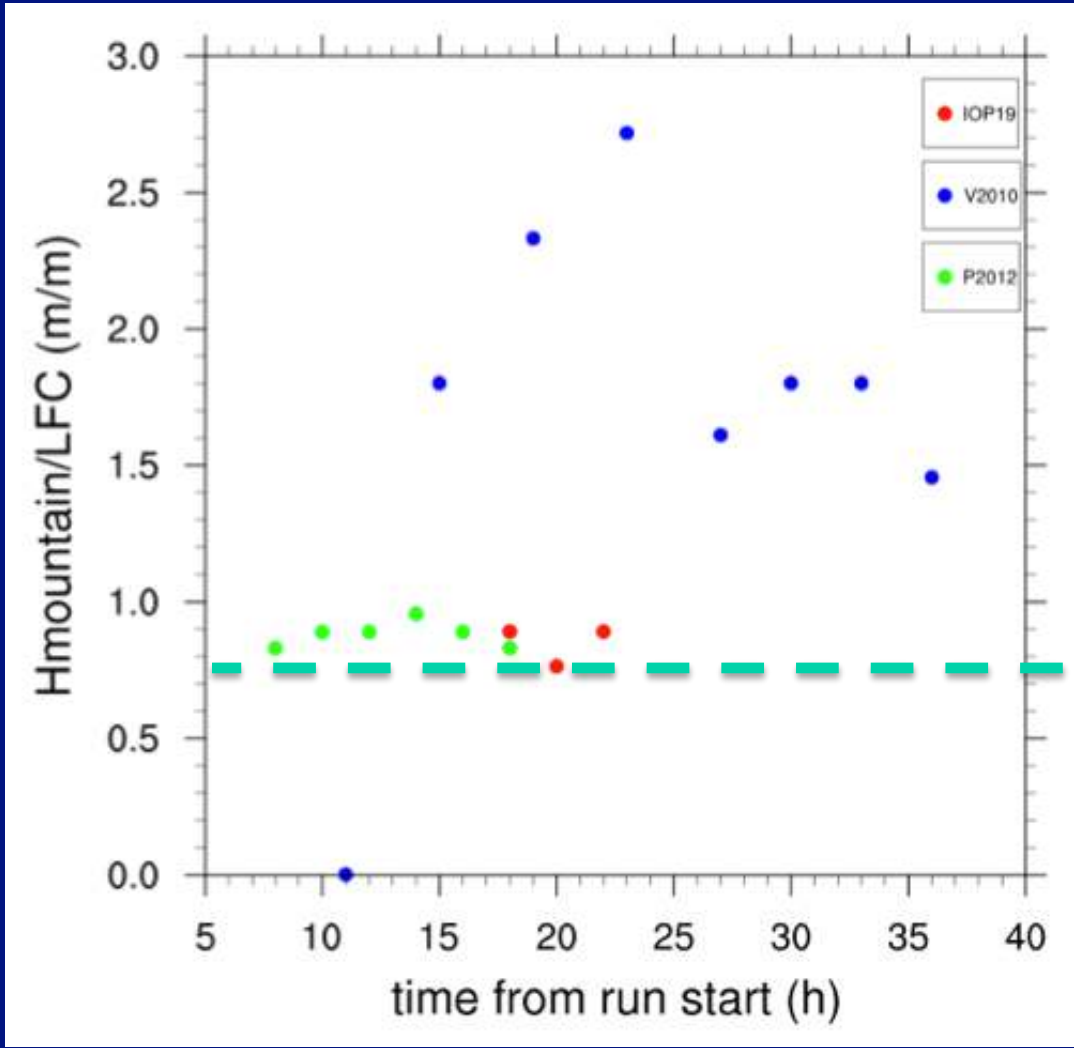
ALPINE EVENT
Vicenza 2010



Southerly Scirocco flow “eroded” barrier wind layer and flows over the Alps. Embedded convection

$\frac{h_m}{LFC}$

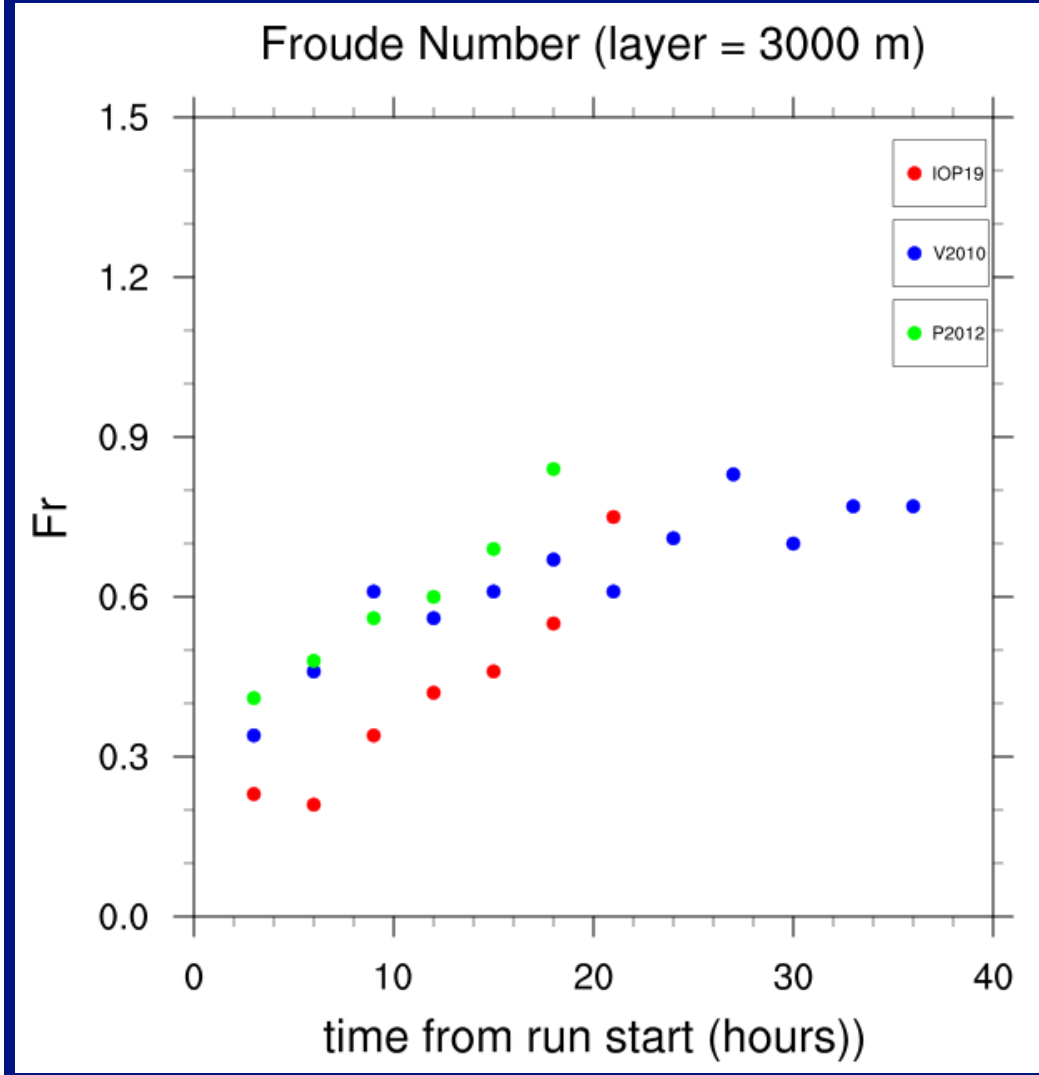
Computed for the "Alpine" cases to explain the possible presence of convection embedded in the large scale orographic precipitation



Values of $h_m/LFC \geq 1$

Orographically forced uplift is able to trigger convection since the LFC is overtaken.

Froude Number $F_r = \frac{U}{N * h}$

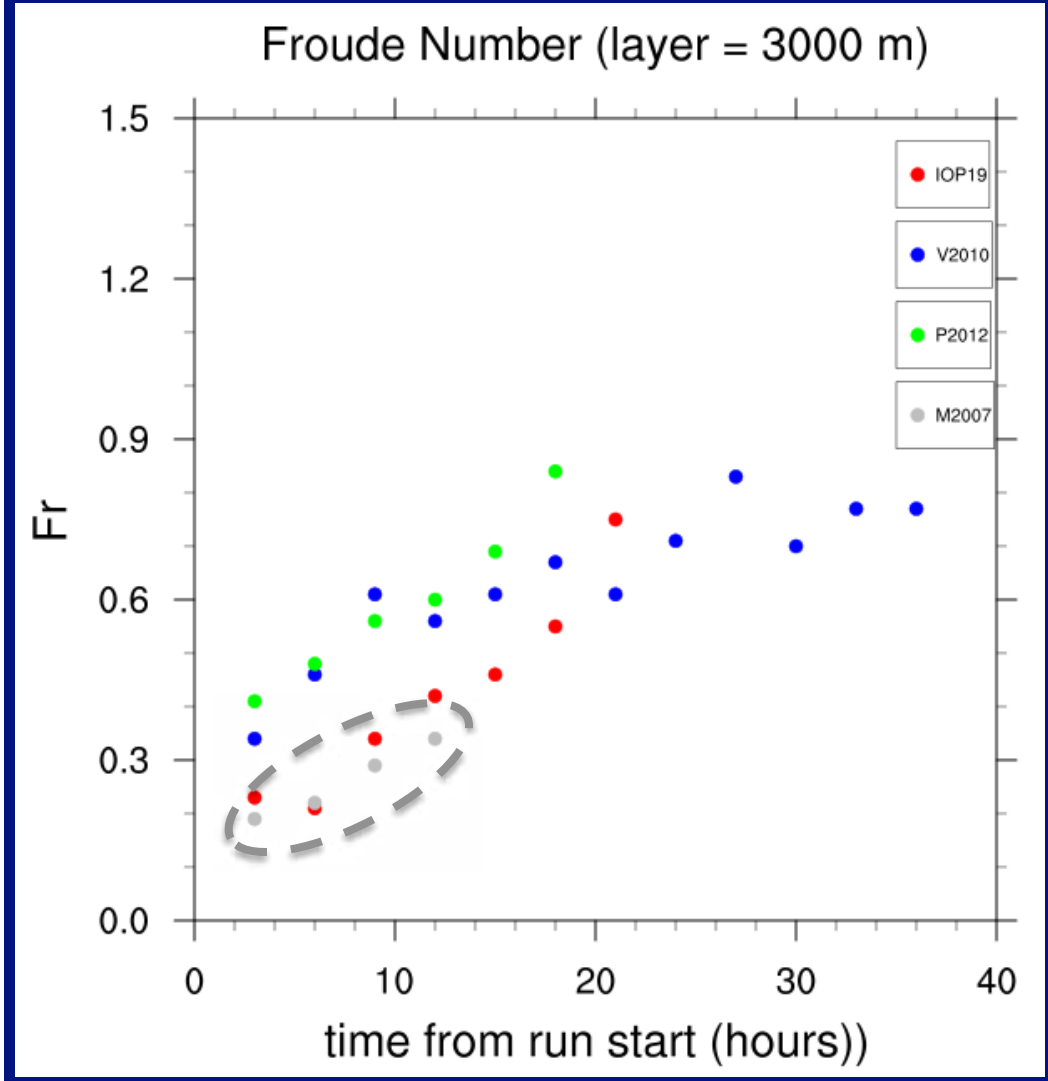


Not suitable for convective cases
Computed for the "alpine" cases

Fr increase during the event consistent with tendency to flow over the Alps

However, values are lower than expected (less than 1)

Froude Number $F_r = \frac{U}{N * h}$



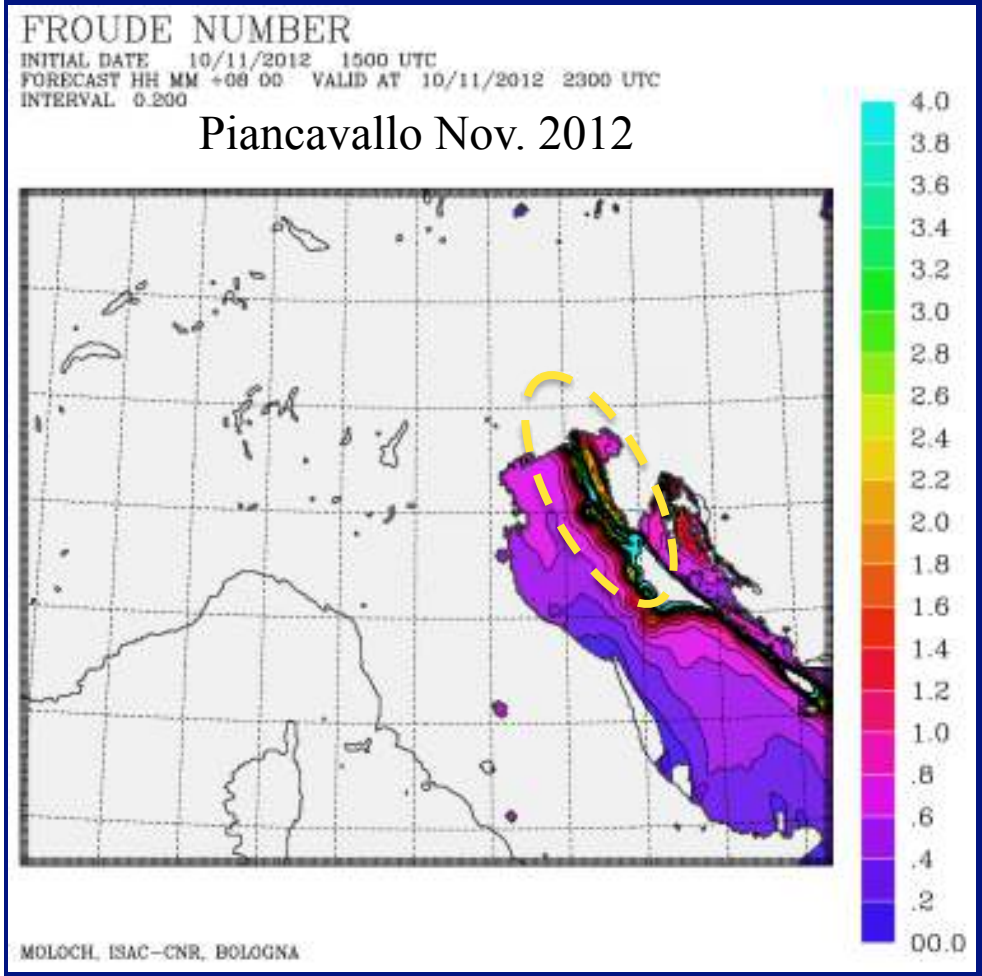
Not suitable for convective cases
Computed for the "alpine" cases

Fr increase during the event consistent with tendency to flow over the Alps

However, values are lower than expected (less than 1)
But larger than convective events

Possible explanation:
-not idealized experiment, complex 3D configuration, strong shear
-not really stable-stratified flow, nearly neutral or weakly unstable instead
-sensitivity to the considered area of average

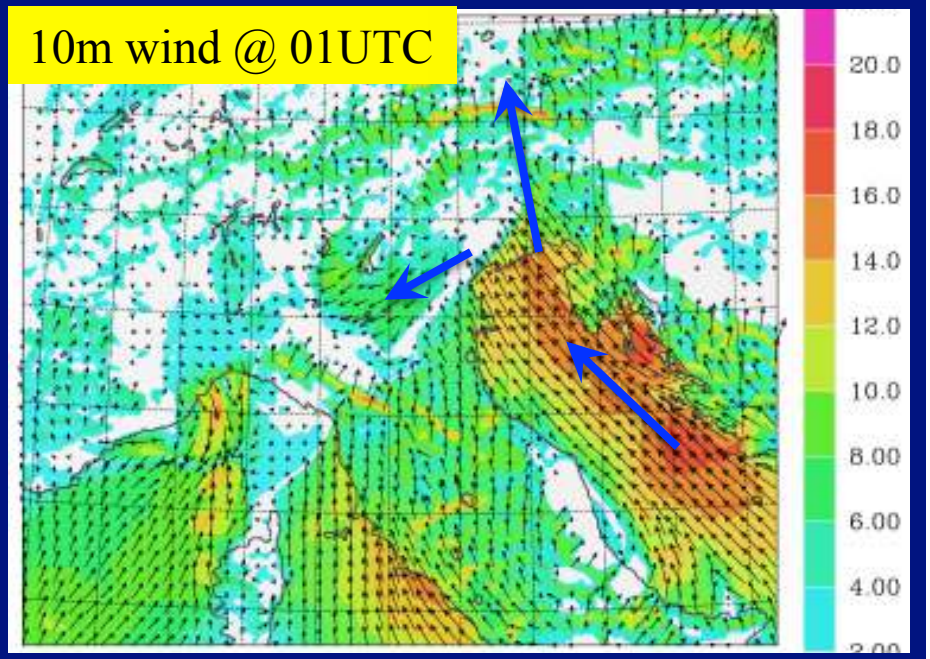
Froude Number

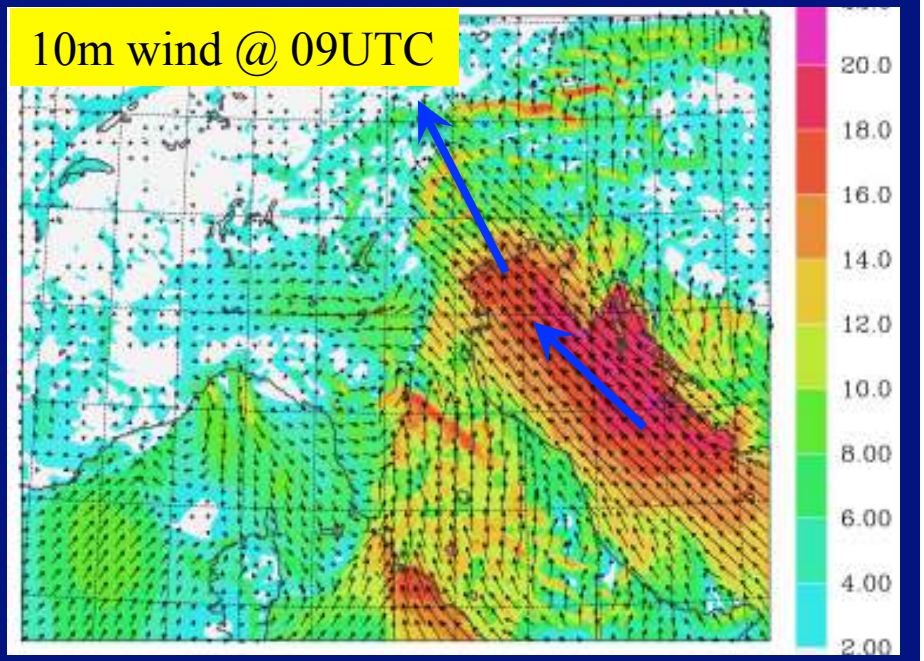


Piancavallo Nov. 2012

Strong variability of Fr over the Adriatic.

High values of Fr to the east consistent with "observed" flow over capability.





CONCLUSIONS

SOP1 allowed to identify two different flow/precipitation patterns (IOP18 vs IOP19), to verify simulations (not shown) against observations collected and to start fruitful collaboration among research institutions and operational centres.

Notwithstanding the peculiar features and the complexity of each analysed event, common mechanisms leading to two different precipitation patterns over NEI have been found in several HPE analysed.

Index such as h_b/LFC or TLIFT turned out to be useful in discriminating between the two classes of events. Low levels (1000-1500m) thermo-dynamics characteristics are critical since determine the trigger of convective activity due to uplift over the barrier wind layer.

h_m/LFC provided an explanation for embedded convection in the “Alpine” events

Fr: not robust results reached