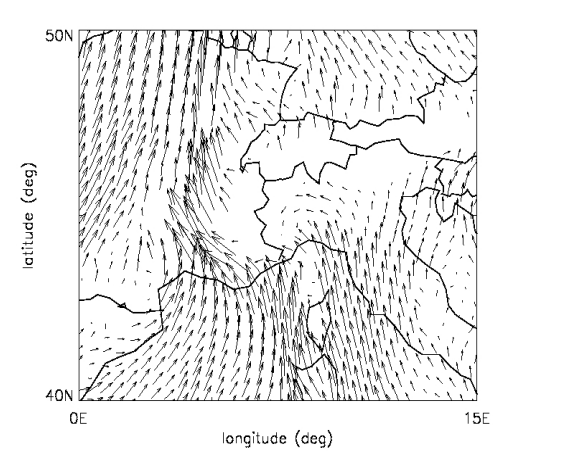
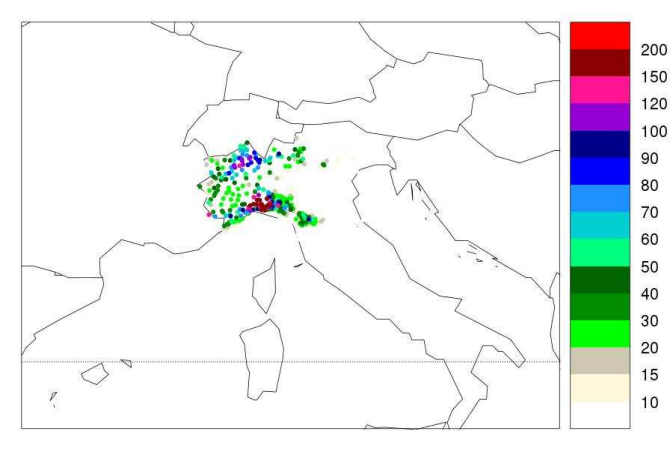
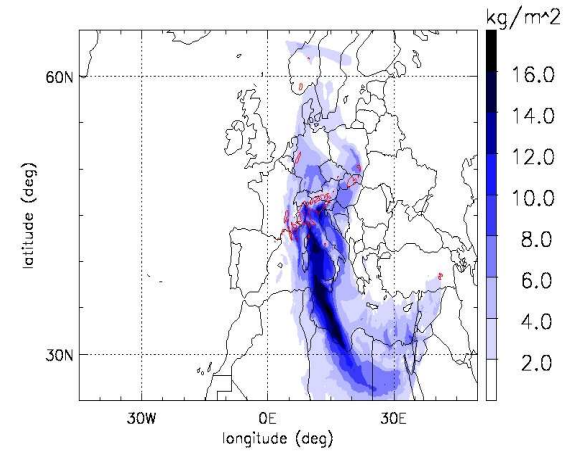
Moisture sources for the heavy precipitation event in northern Italy in November 2011

Andreas Winschall, Federico Grazzini, Stephan Pfahl,
Harald Sodemann, Heini Wernli





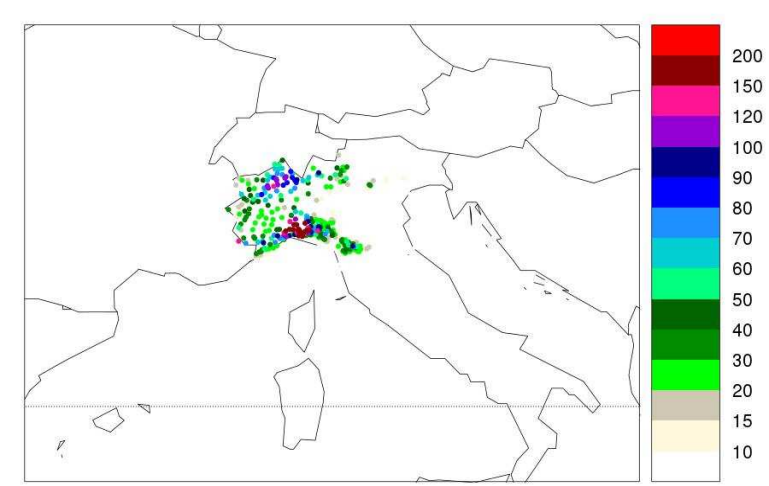


COSMO User Seminar 2013

Genoa heavy precipitation event Nov 2011

Heavy precipitation 04 and 05 November 2011

- convective event in Genoa
- intense orographic precipitation further north



Precipitation accumulated over 04 November 2011

Small-/Meso-scale perspective

- Role of convergence line
- V-shaped cloud

Large-scale perspective

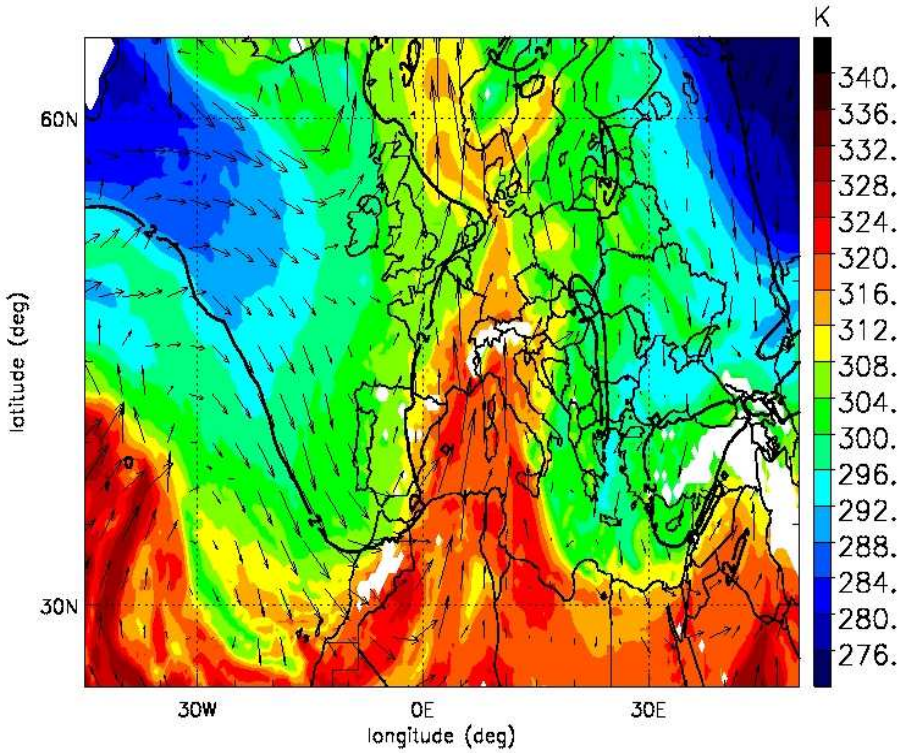
- Moisture sources for the event

→ simulation with COSMO with implemented moisture tagging

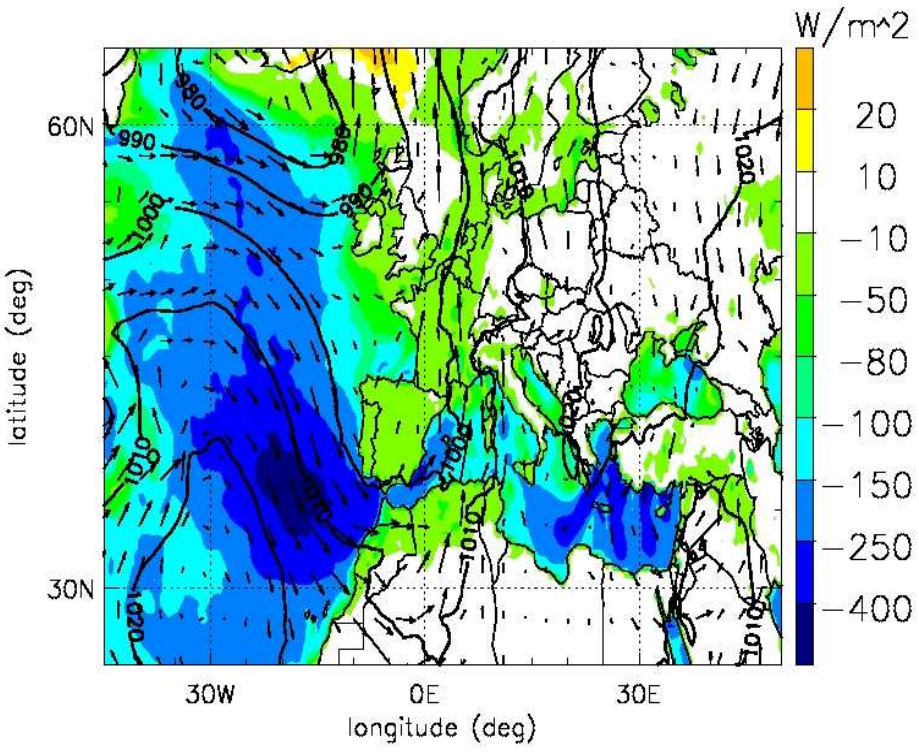
- Comparison of sources for convective Genoa event and large-scale precipitation further north

Synoptic situation

04 November 2011 12 UTC

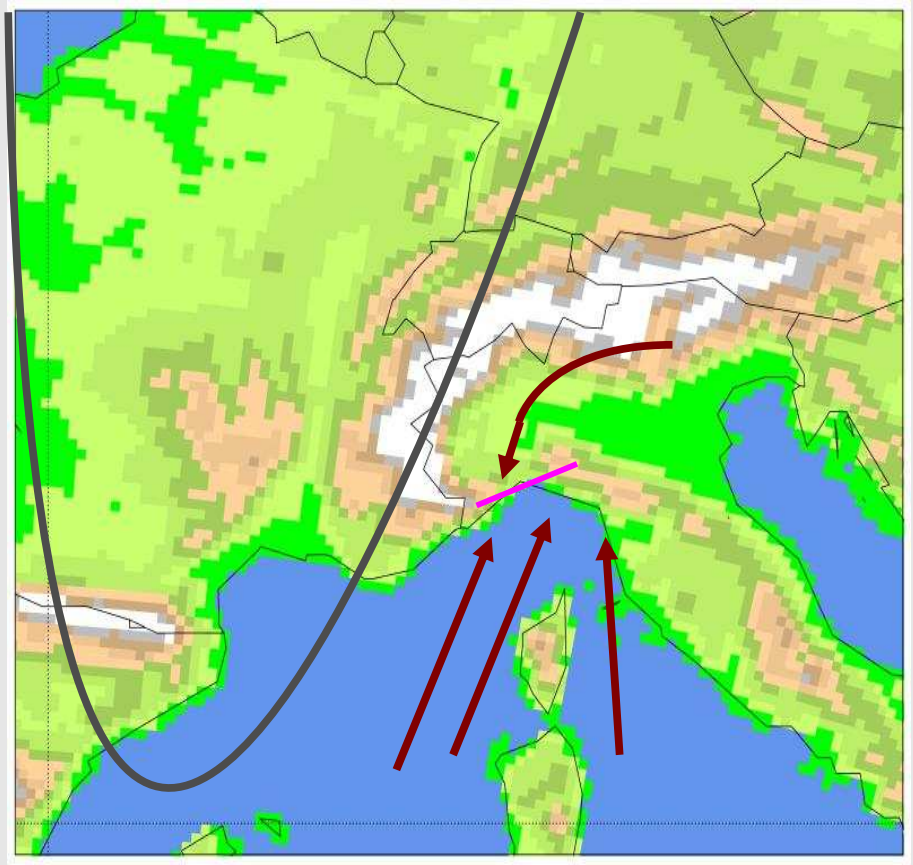


Equipotential temperature, wind @ 850hPa, PV (2pvu @330K)

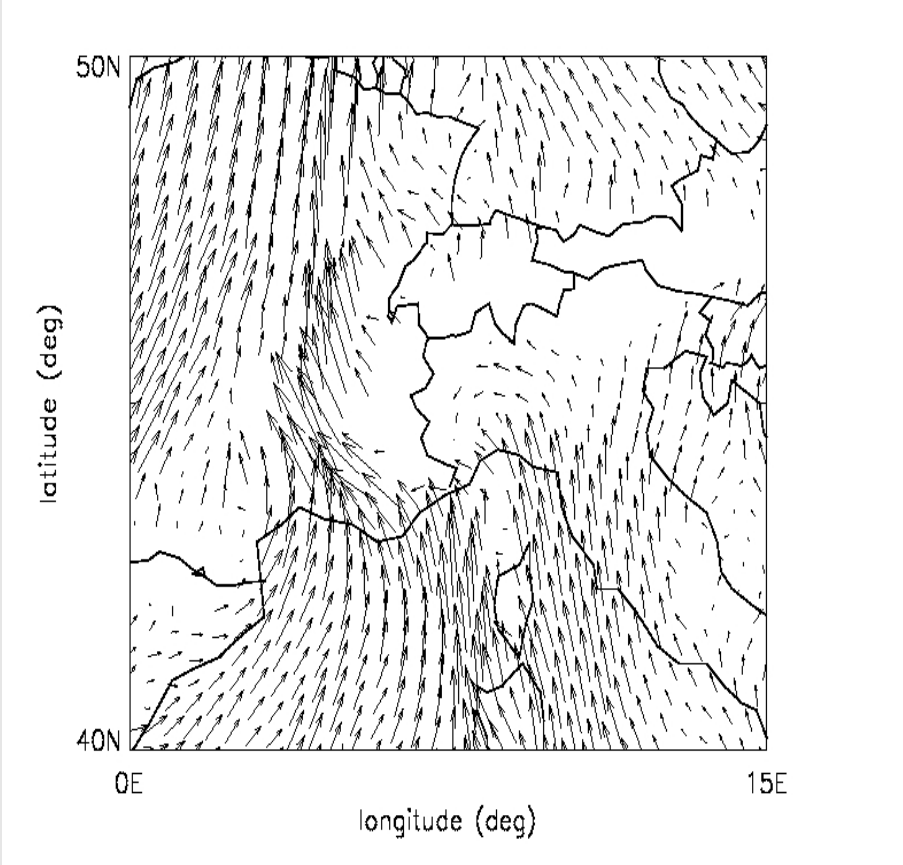


24 hourly averaged surface latent heat flux, sea level pressure, wind @ 850hPa

Dynamics – convergence line



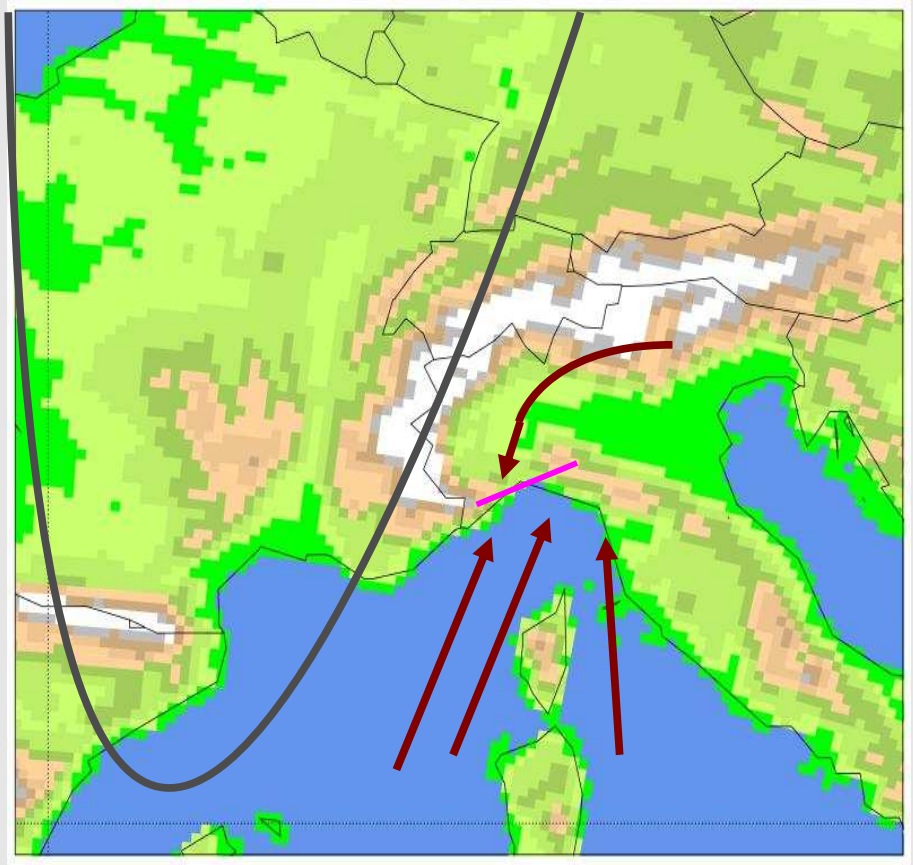
Schematic plot of upper level trough,
low level winds and resulting convergence line



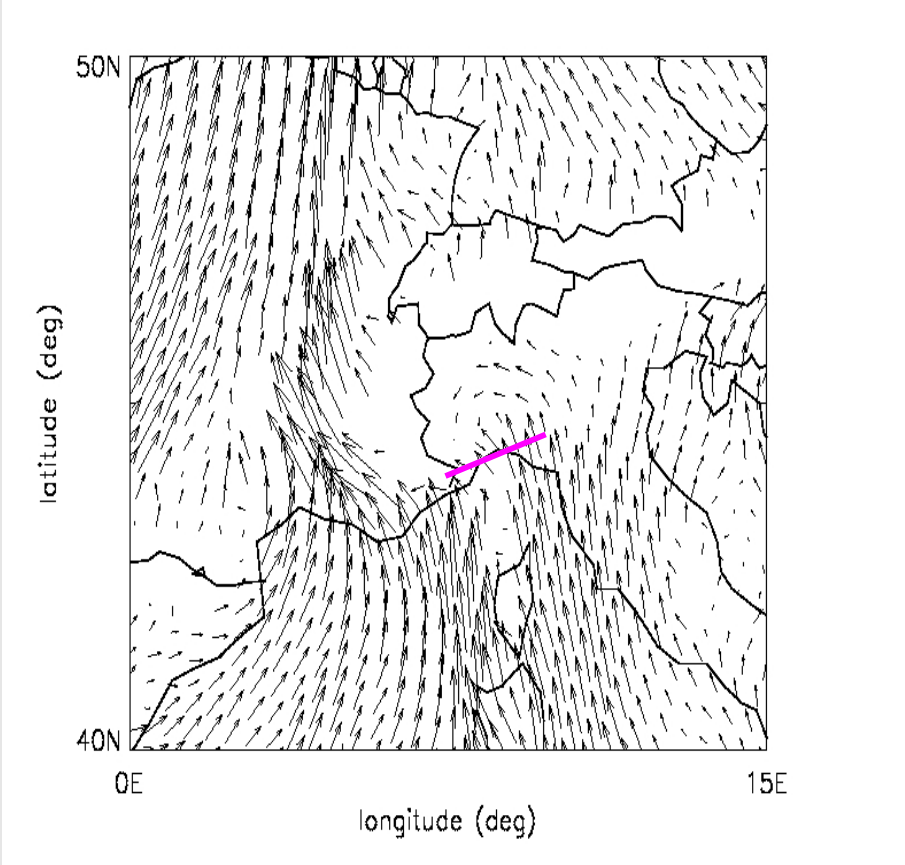
COSMO simulation of low level winds (900 hPa),
00 UTC 04 November 2011

based on work of Silvio Davolio

Dynamics – convergence line



Schematic plot of upper level trough,
low level winds and resulting convergence line



COSMO simulation of low level winds (900 hPa),
00 UTC 04 November 2011

based on work of Silvio Davolio

Dynamics – V-shaped cloud

Cloud structure frequently associated with high-impact weather

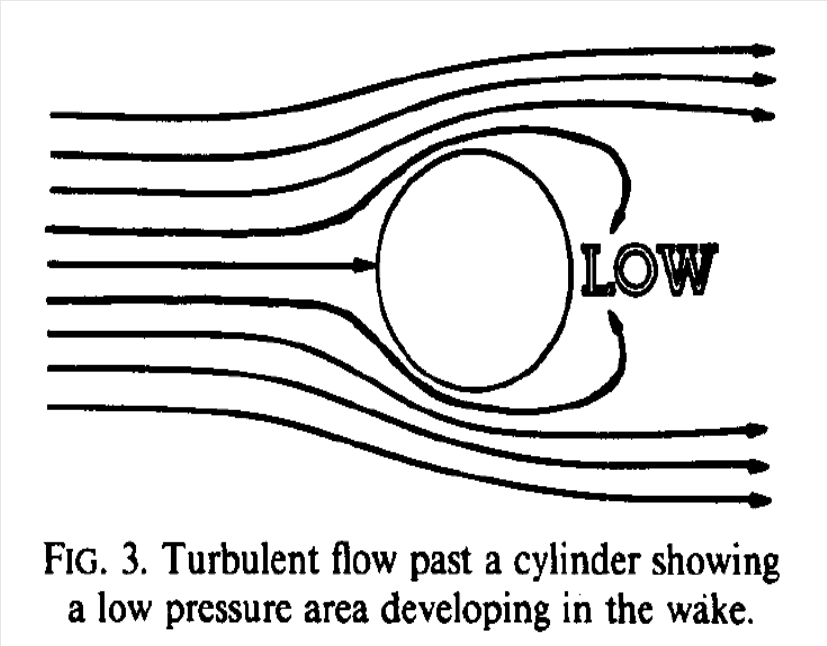
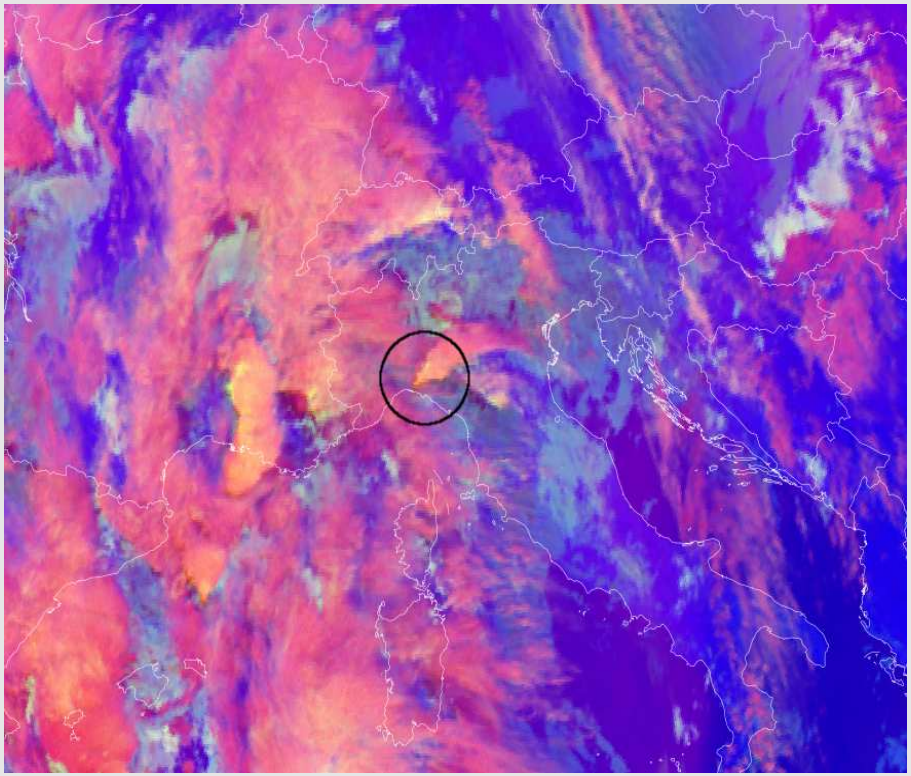


FIG. 3. Turbulent flow past a cylinder showing a low pressure area developing in the wake.

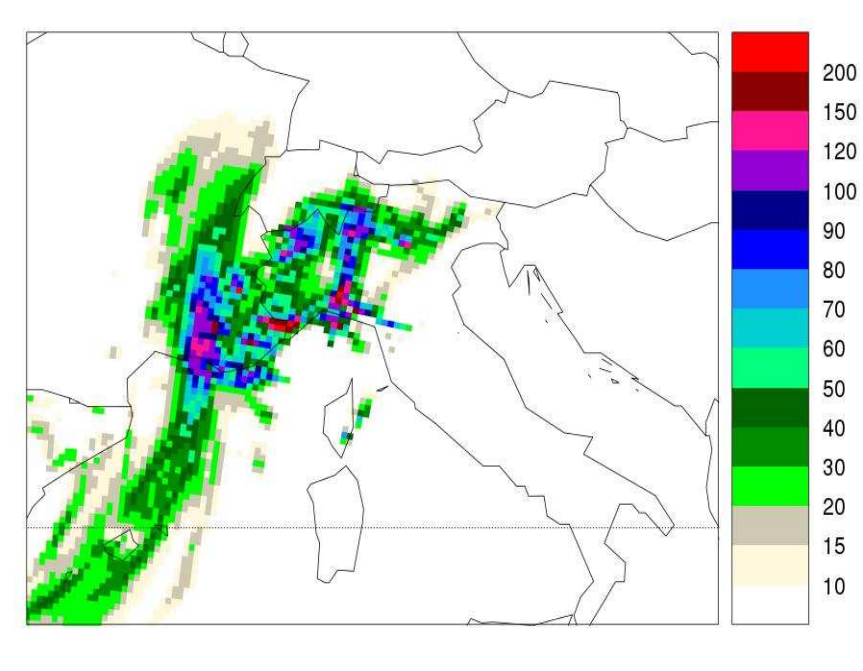
McCann, Mon. Weather Rev., 1983

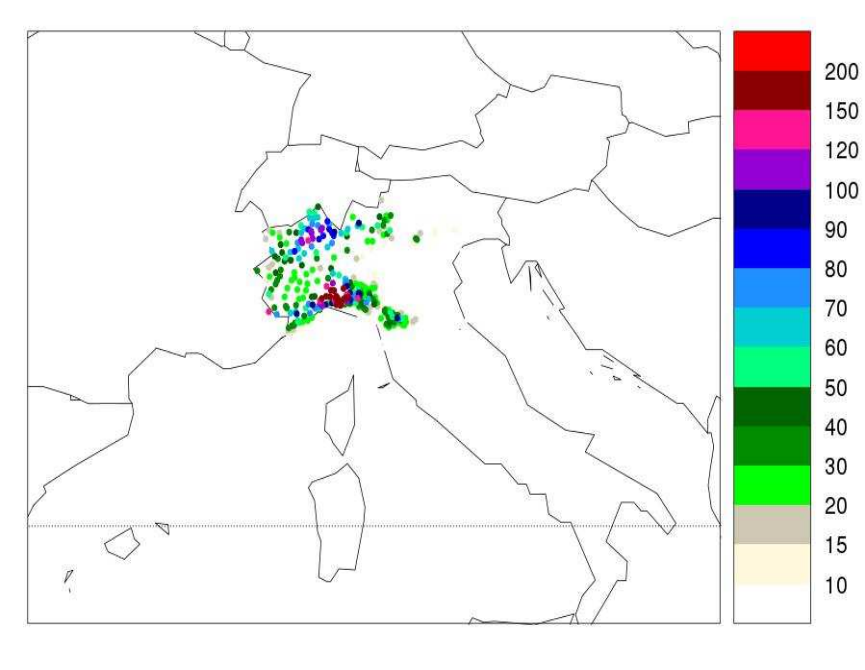


Satellite image for 12 UTC 04 November 2011, black circle marks the V-shaped storm over Genoa

COSMO simulation

COSMO tagging simulation: 03.11.2011 to 10.11.2011, resolution of 14 km





COSMO simulation of precipitation (mm/day) Precipitation measurements (mm/day)
04 November 2011

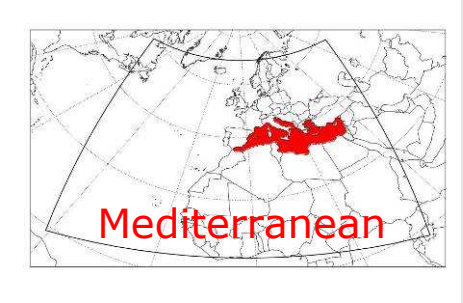
Moisture tagging

- use **moisture as a numerical tracer**
  in a secondary water cycle in the COSMO model

- most important **processes**:

  - **advection** and turbulent transport
  - cloud microphysics and moist convection
  - **evaporation of moisture**

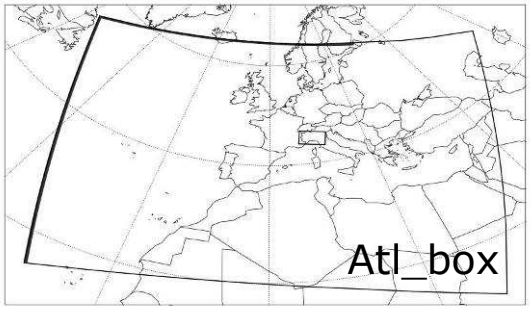
- **precipitation** in target region can be **decomposed into different source regions**

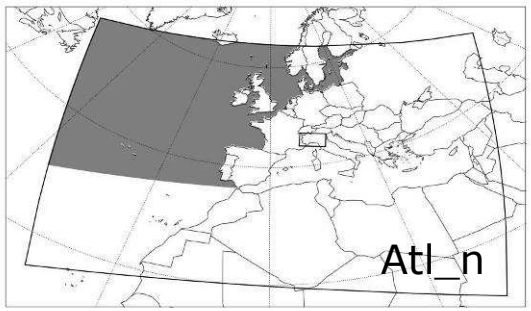


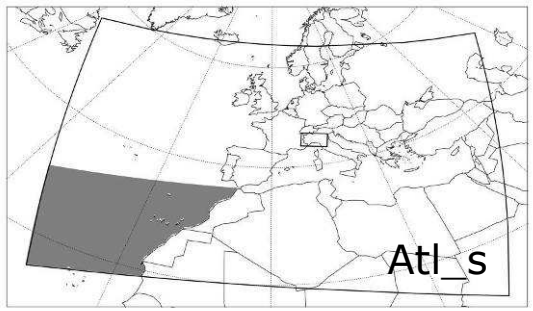
Model run of
COSMO_tag

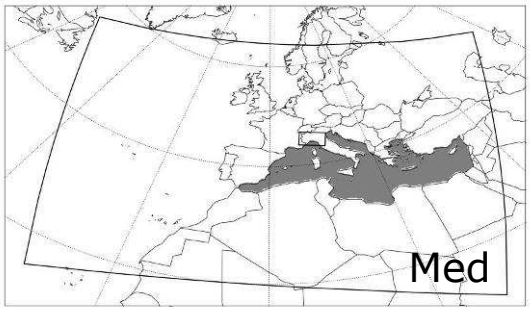
Precipitation in target region
at a certain day:
20% Mediterranean
10% Tropics
...70% others

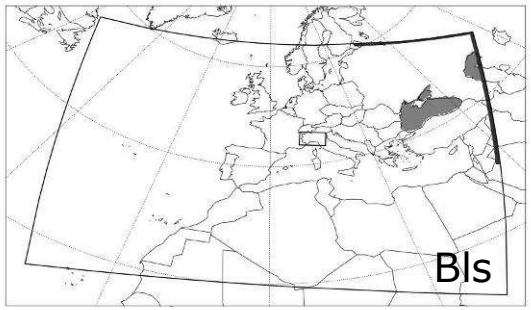
Tagging setup

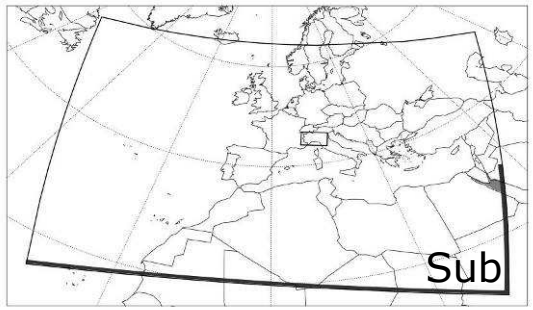


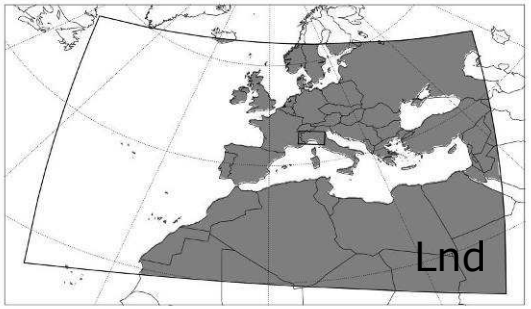


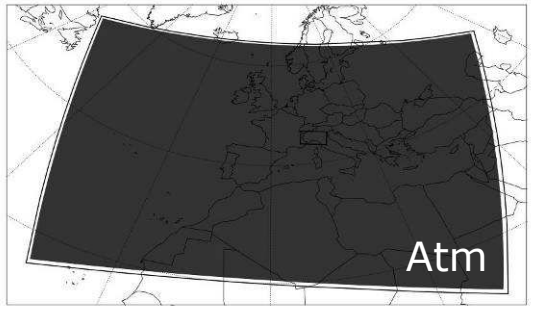




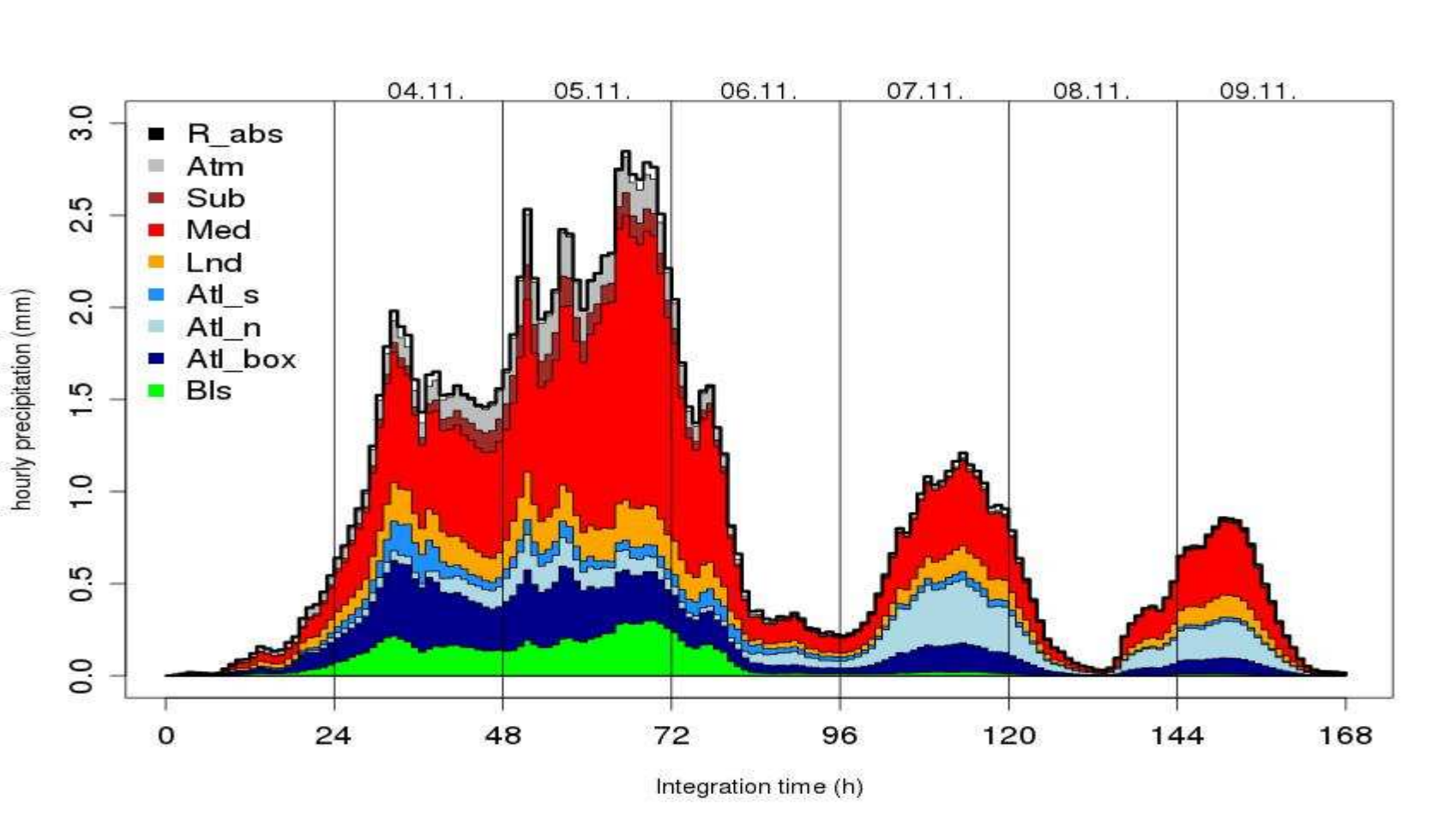






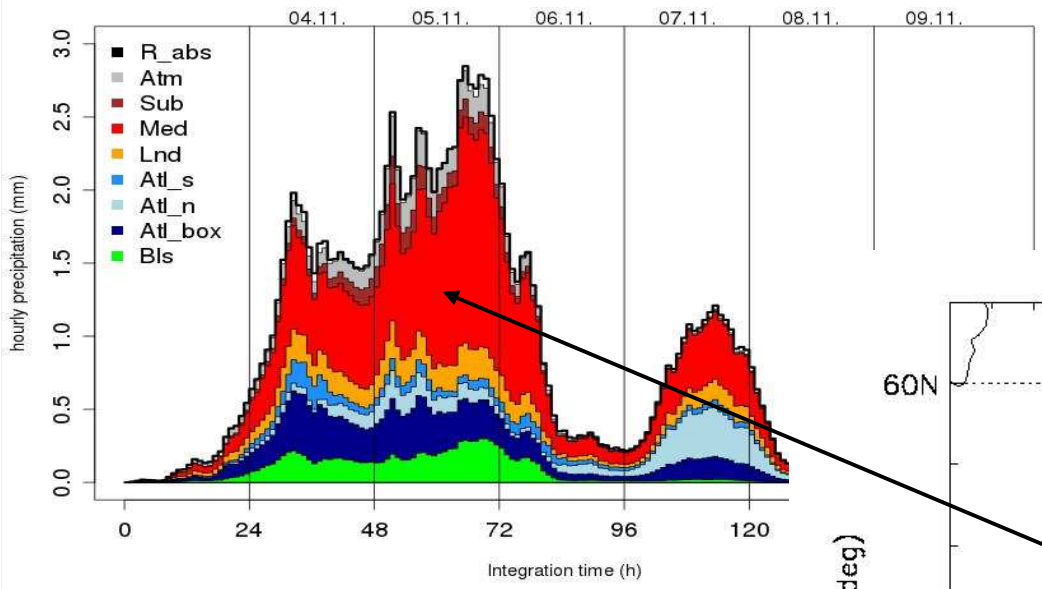


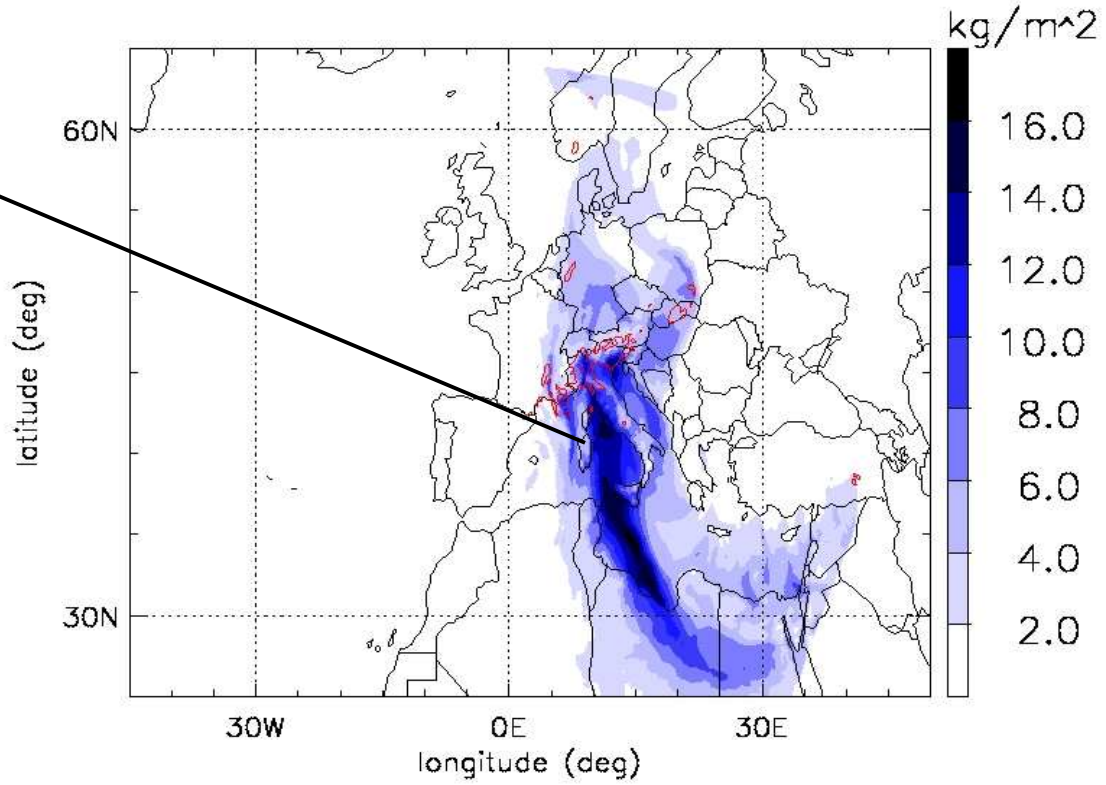
Tagging results



Hourly precipitation in target region Genoa decomposed into moisture sources

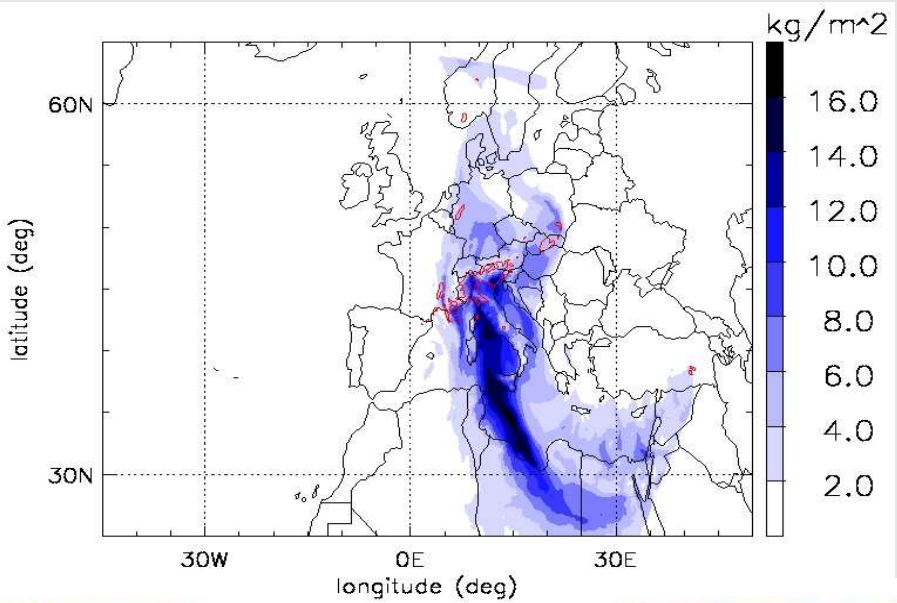
Tagging results

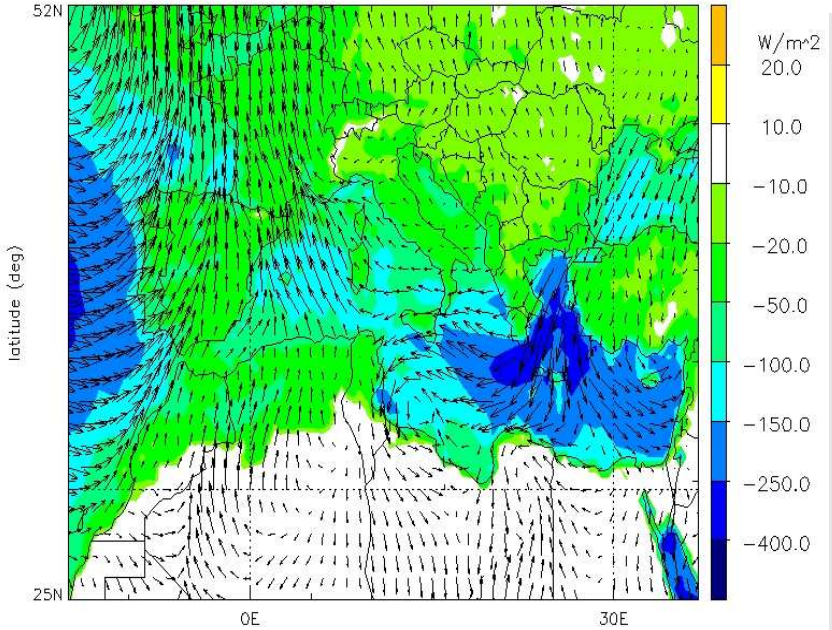




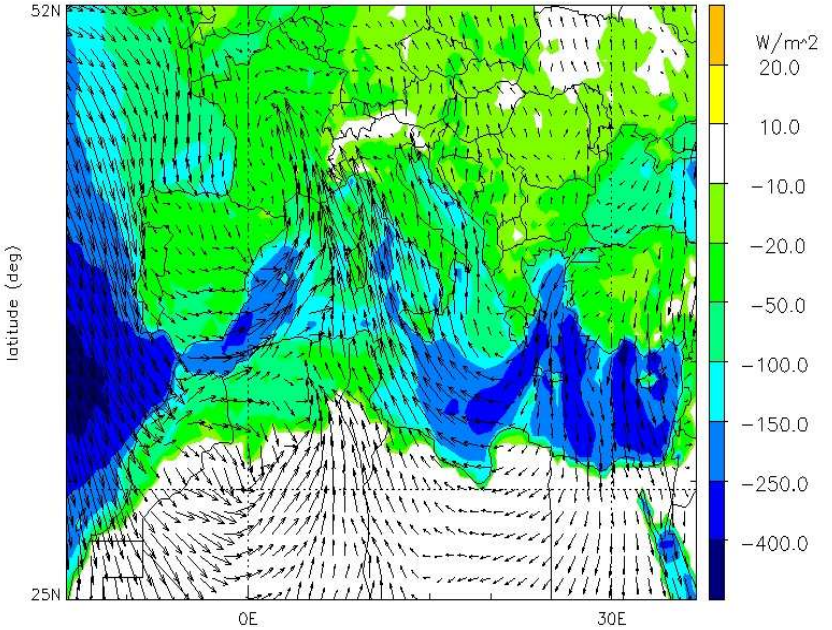
Vertically integrated tagged water vapour
of source Med, 05 November 2011 00 UTC

Tagging results





SLHF (avg. over 02 and 03 Nov),
10m wind on 03 Nov 11 00 UTC



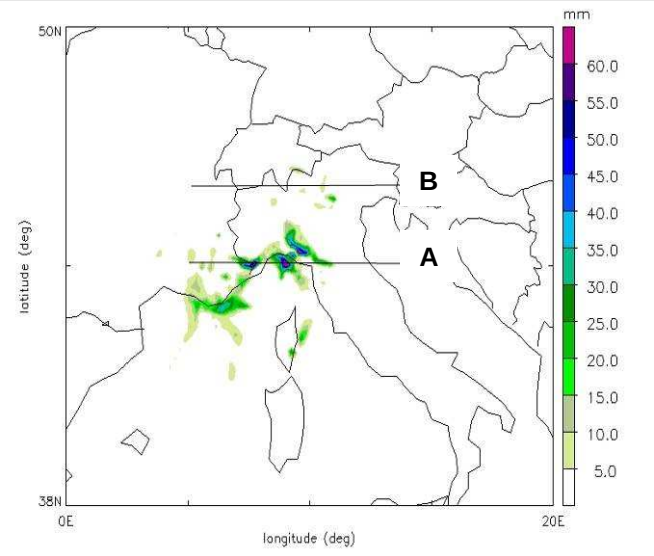
SLHF (avg. over 04 Nov),
10m wind on 04 Nov 11 00 UTC

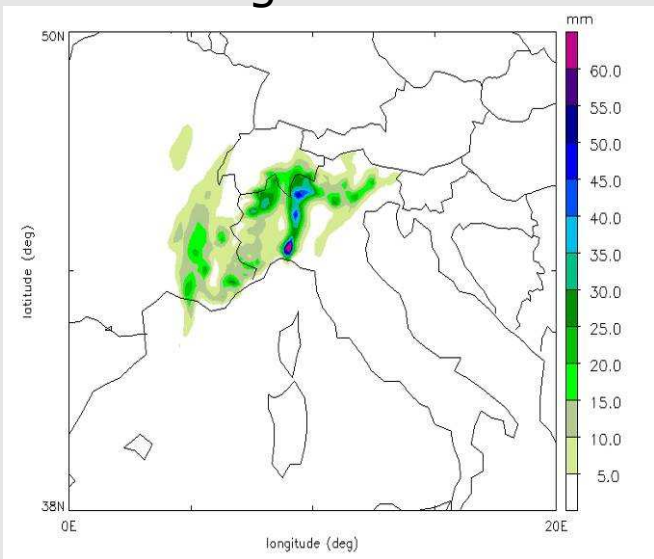
Tagging results – convective vs. large-scale precipitation

convective

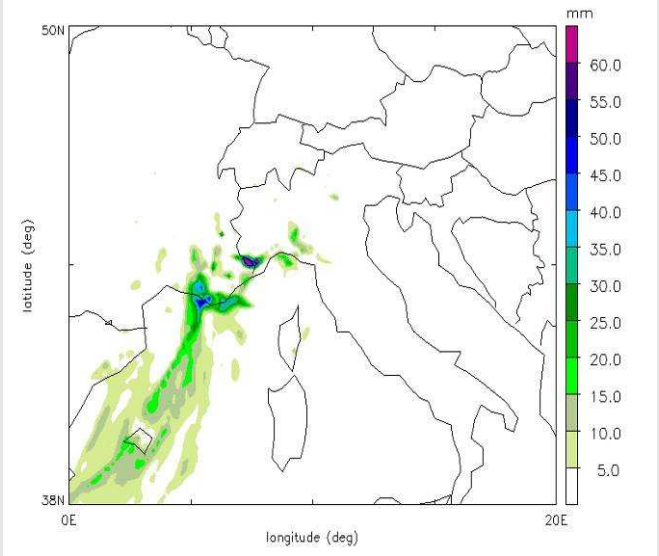
large-scale

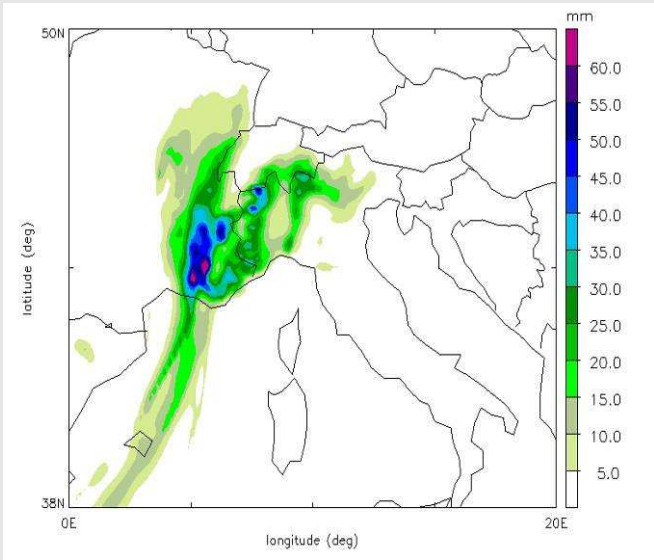
Med





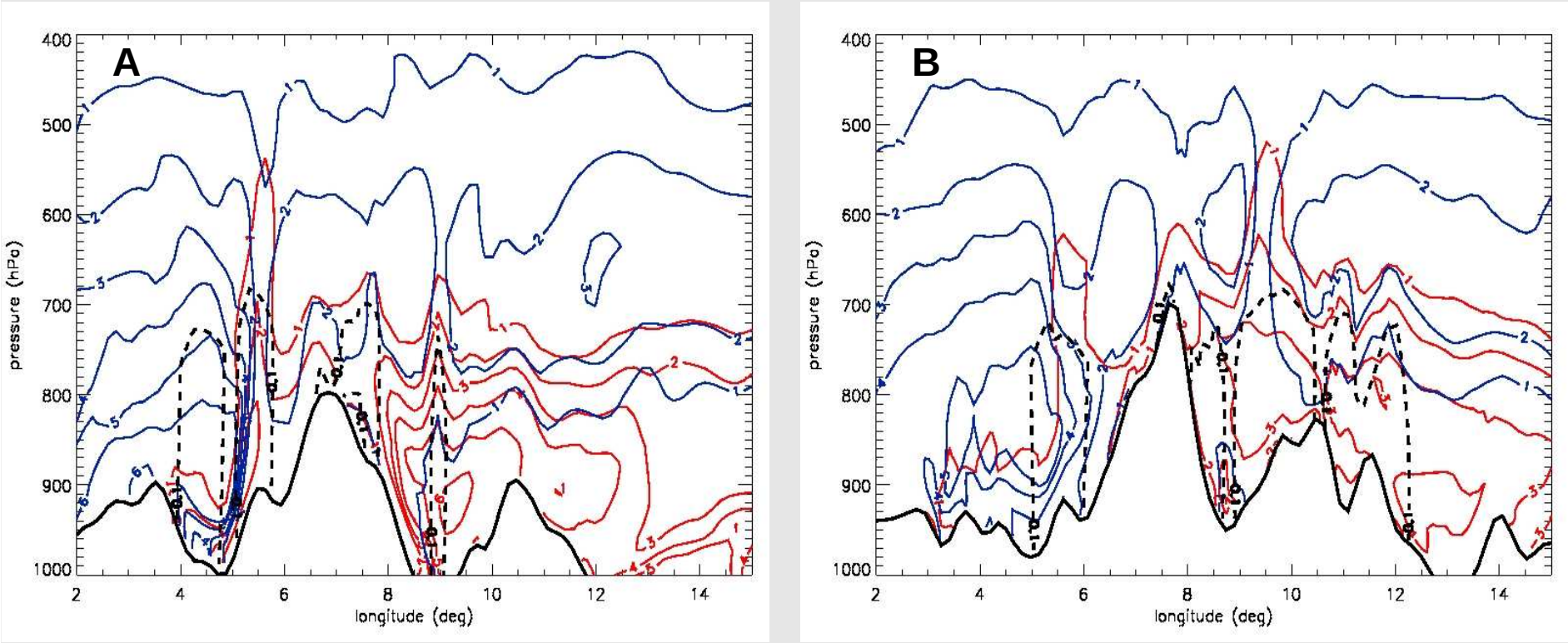
Atl





tagged precipitation 24 hourly accumulated for 04 November 2011

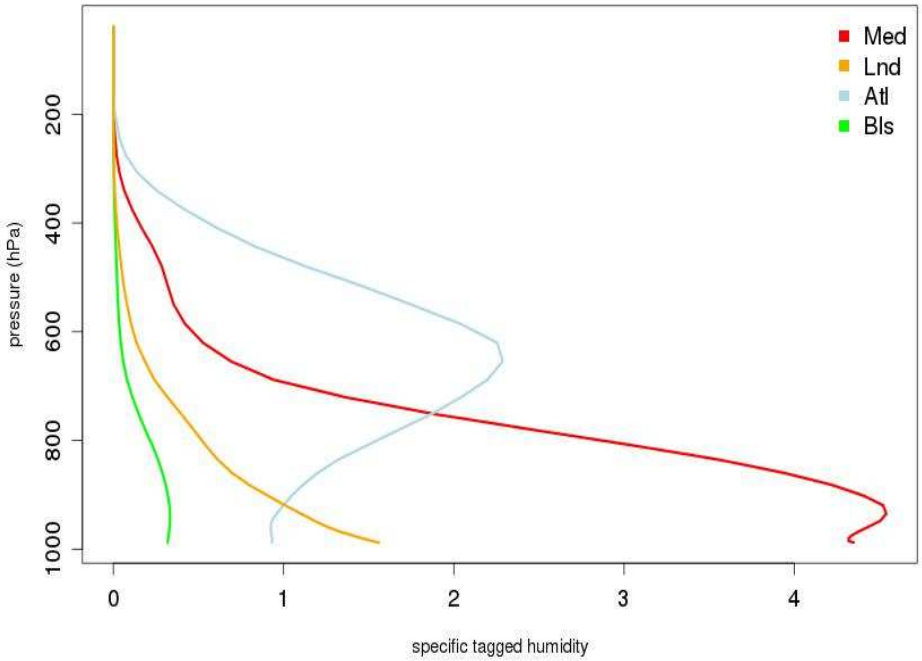
Tagging results – convective vs. large-scale event



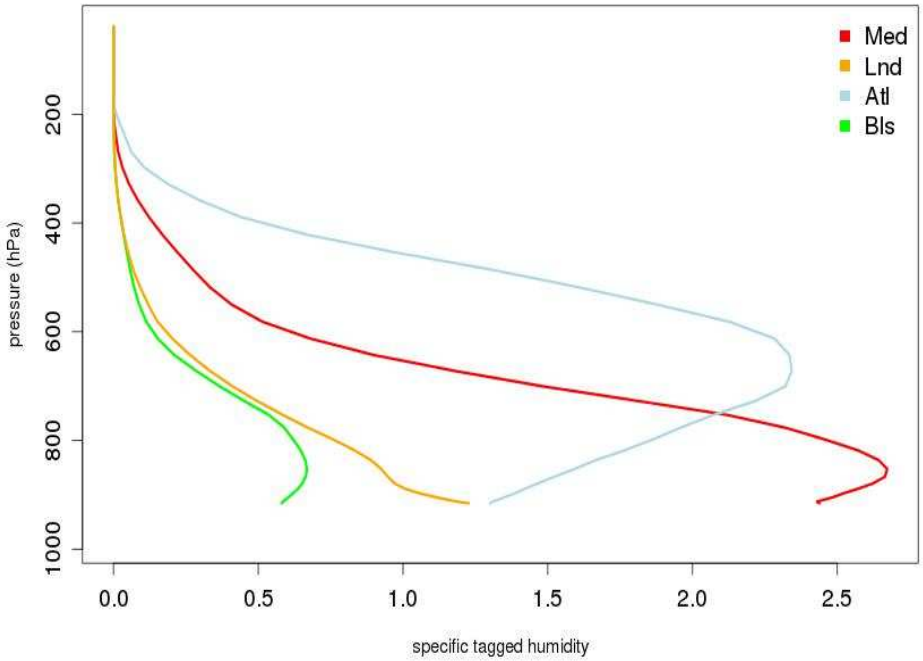
Vertical cross sections along 44.25° N (A) and 46° N (B) of
water vapor (in g/kg) from sources Med (red contours) and Atlantic (blue contours)
as well as the sum of total cloud water, cloud ice, rain water and snow
(in g/kg, black contours) for 1200 UTC 04 November 2011.

Tagging results – convective vs. large-scale event

south

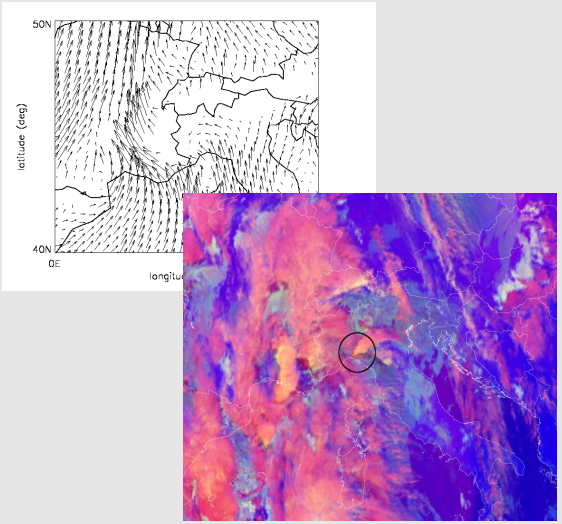


north

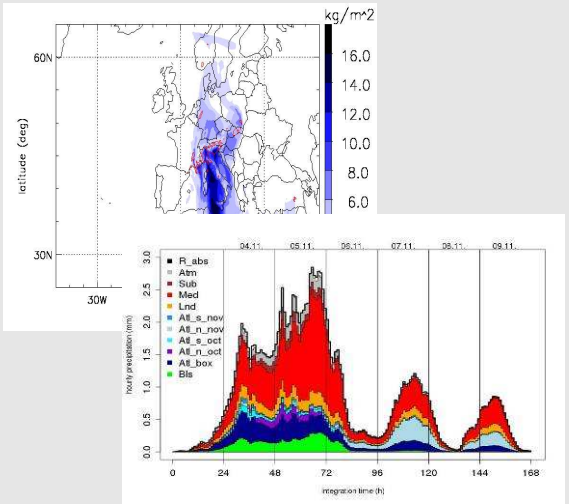


Vertical profiles of tagged water vapor (in g/kg) for tracers Med, Lnd, Atl and Bls, averaged over 04 and 05 November 2011 and over norther and southern half of the target region

Conclusions



Small/meso-scale features are important
for the generation of the event



Mediterranean dominates the moisture supply
for Genoa heavy precipitation event

Heterogeneous contribution
of different moisture sources
for large-scale vs. convective precipitation