Meteorological and hydrological analysis

The MeteoAlp R&D Project within the MONALISA framework

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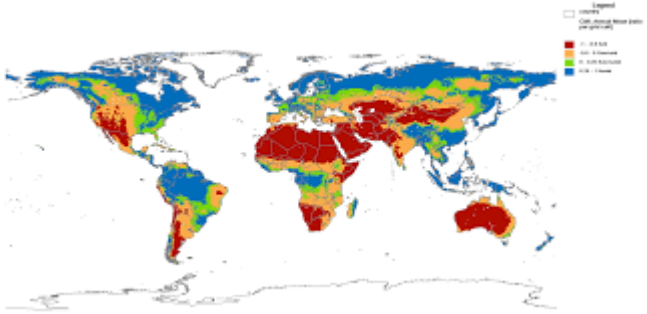
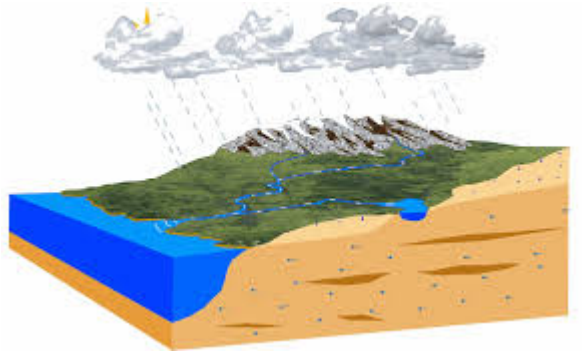
MeteoAlp overview (1)

Applied meteorology and hydrology in mountain regions





climate atlas

Reconstruction of past weather conditions over a long period with high spatial and temporal resolution.

CISMA Srl

hydrological forecast

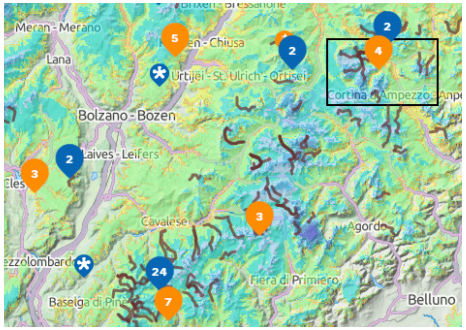
Dynamic maps of the impacts of meteorology on the ground (snow, soil moisture, evapotranspiration)

Mountain-eering Srl

Novelty in the Italian market => fill the gap with Northern European countries;

MeteoAlp overview (2)

Goal: environmental monitoring to improve the management of environmental activities (*"You can't manage what you can't measure*")



Results: high resolution meteo-hydrological maps

Applications:

- Industry (wind, solar and hydro-power energy)
- tourism (e.g. mountain sports, open air events)
- agriculture, ..

Part 1 – Metheorology (Cisma Srl)

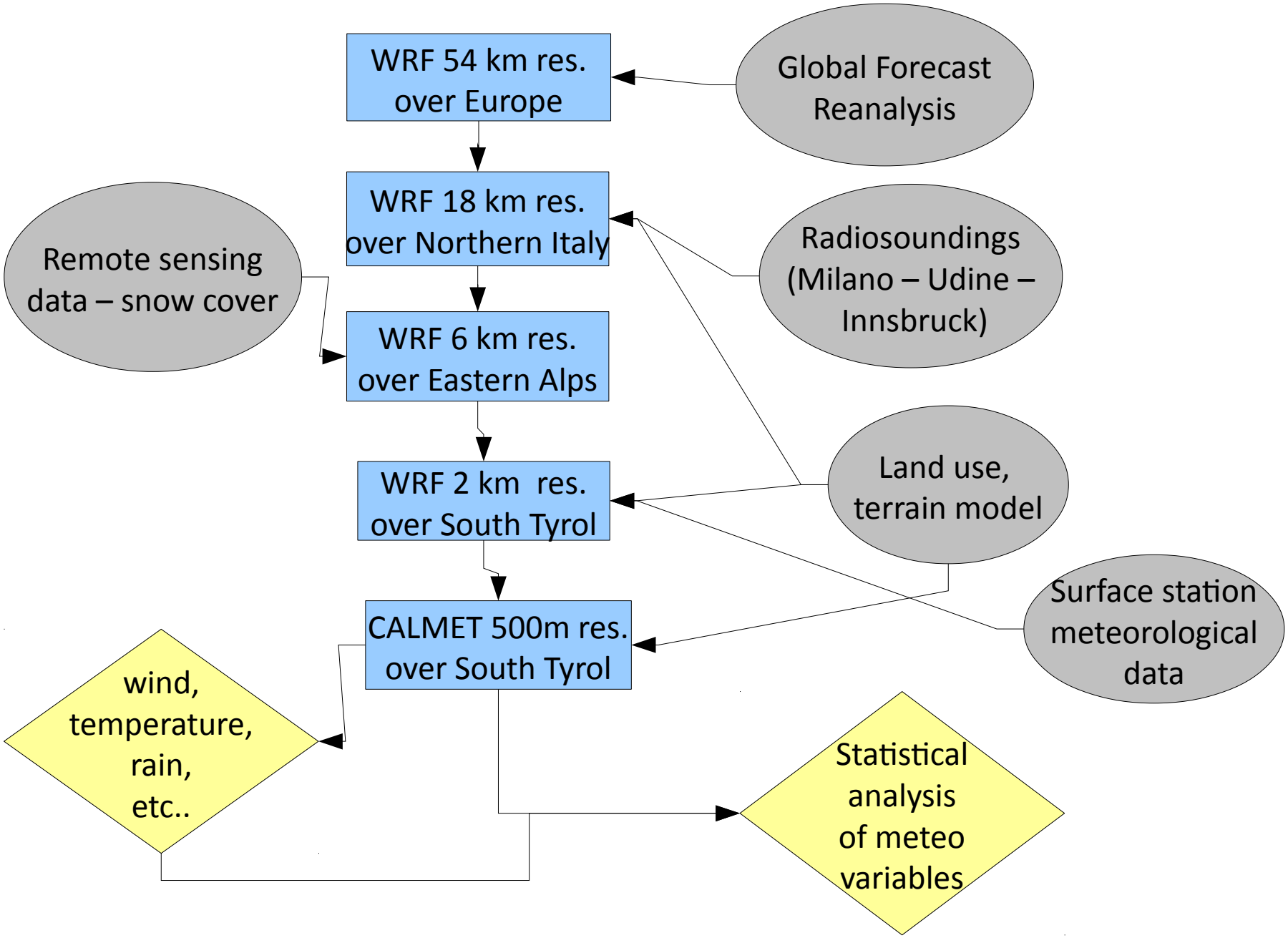
The meteorological part was carried out by CISMA Srl

Target: develop a gridded meteorological dataset over a decade (i.e. a complete "climate atlas" on the Province of Bolzano), through the reconstruction on the whole territory of the trend of past weather conditions, with high spatial and temporal resolution

.

Results: can be used to feed other calculus models in different fields:
- air quality mapping (currently adopted by the Provinces of Bolzano and Trento)
- hydrological models
- agricultural models
- renewable energy analysis (a wind atlas of whole Italian territory has been created on top of the current dataset on behalf of a private company)

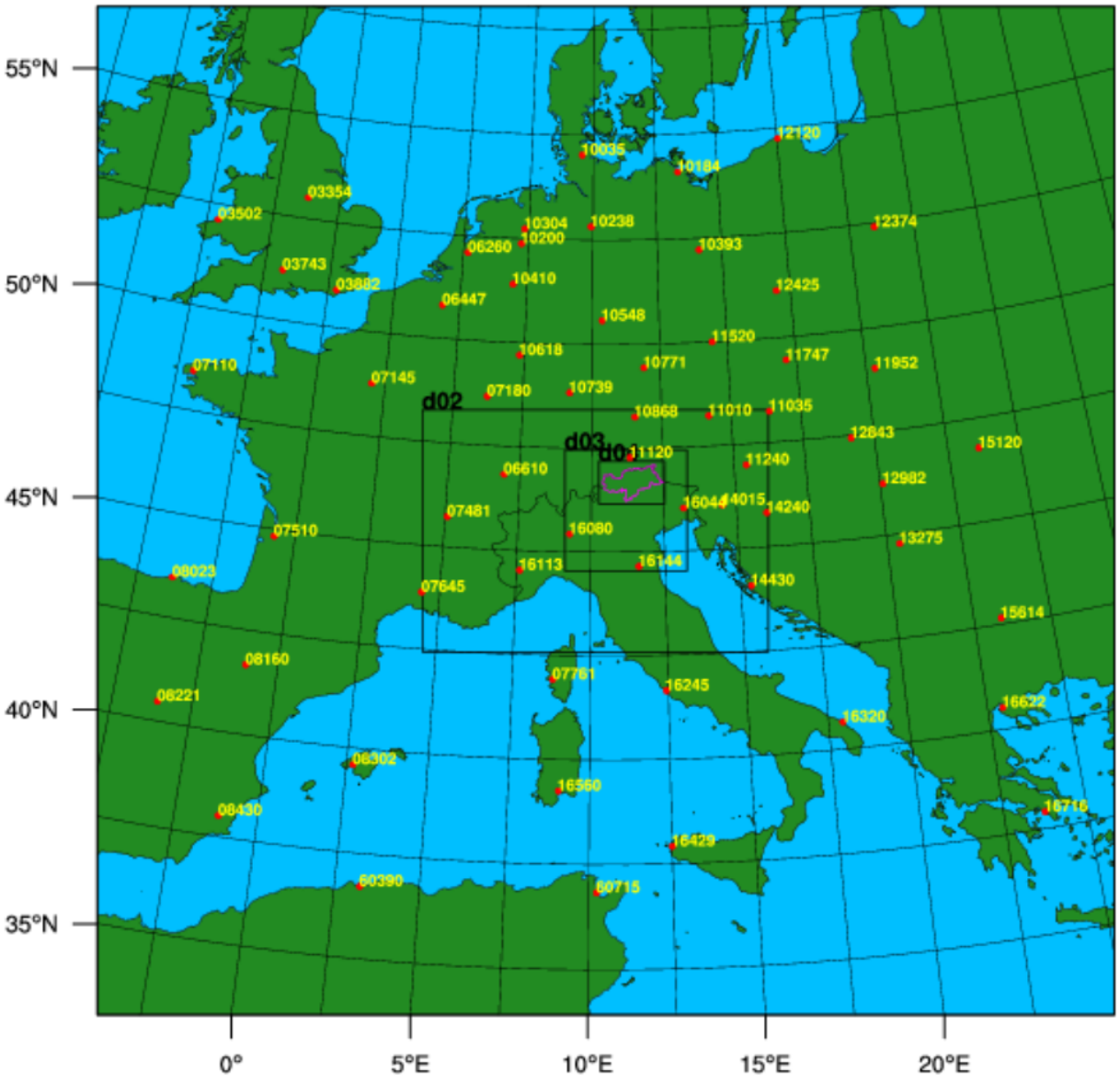
Modelling chain



Gridded meteorological reconstruction / reanalysis

1 – traformation of geographic data (digital model, land use) at different resolutions
2 – collection and quality check and homogenization of meteorological data
* NCEP global reanalysis at 0,5°/6h → jan 2004 – dec 2013
* European radiosoundings → aug 1999 – apr 2014
* Remote sensing (snow cover) → jan 2002 – dec 2014
* Surface meteo stations → jan 2003 - dec 2013 for South Tyrol, Trentino, Lombardia, Veneto
3 – Definition of a modelling chain on the range covered by all data (jan 2004 – dec 2013)
4 – Interface software coding
5 – Calculation runs
* Domain 0 (Europe) → complete meteo output / only needed for model initialization and nesting @54km res
* Domain 1 (Alps – enlarged domain) → complete meteo output @18km res
* Domain 2 (Eastern Alps) → complete meteo output @6km res
* Domain 3 (South Tyrol) → complete meteo output @2km res
* Domain 4 (South Tyrol) → limited meteo output (only temperature and wind speed) @0,5km res
6 – Data extraction → software accessing database for subsetting / slicing

Calculus domains

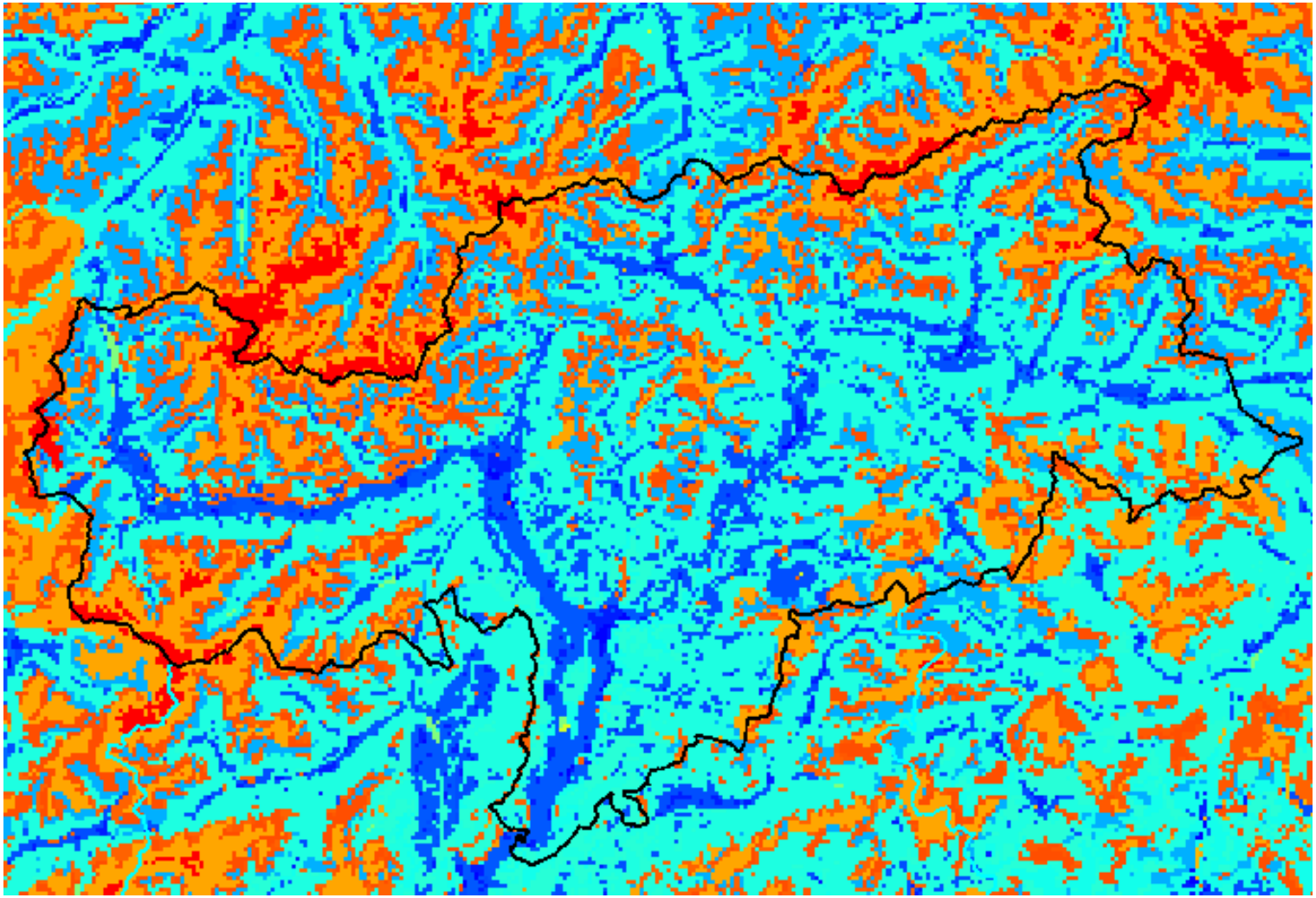


Grid 0 → 54km WRF
Grid 1 → 18km WRF
Grid 2 → 6 km WRF
Grid 3 → 2 km WRF
Griglia 4 → 0.5 km CALMET

Time step 1 hour
Range 10 years (2004-2013)

Output in netcdf format

Land use / land cover / snow cover

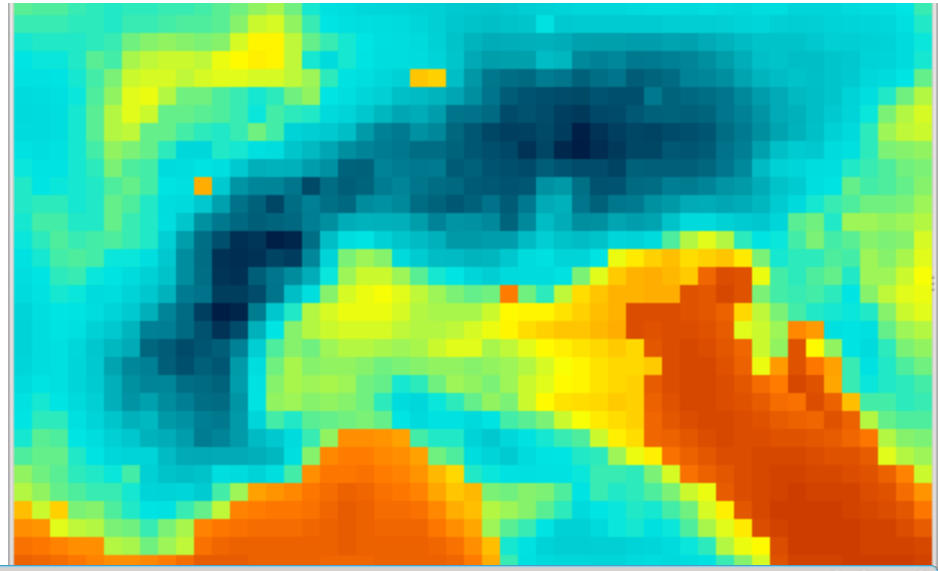


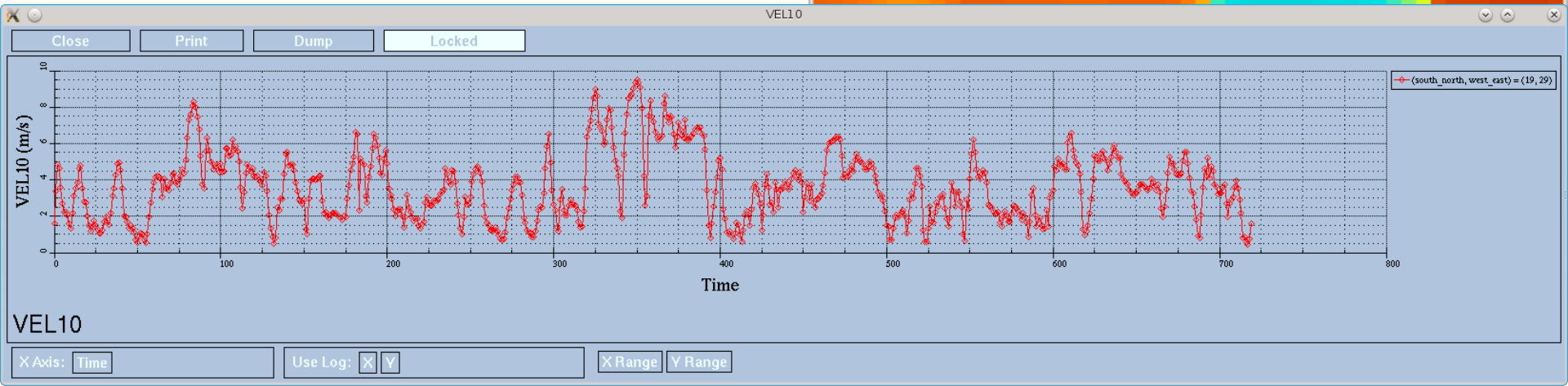
While increasing the model detail, local patterns (orography, land use, land cover) gain importance in reconstruction of atmospheric processes and air / ground energy exchange → detailed maps feeded in simulation models (example land use of South Tyrol)

Results (1)

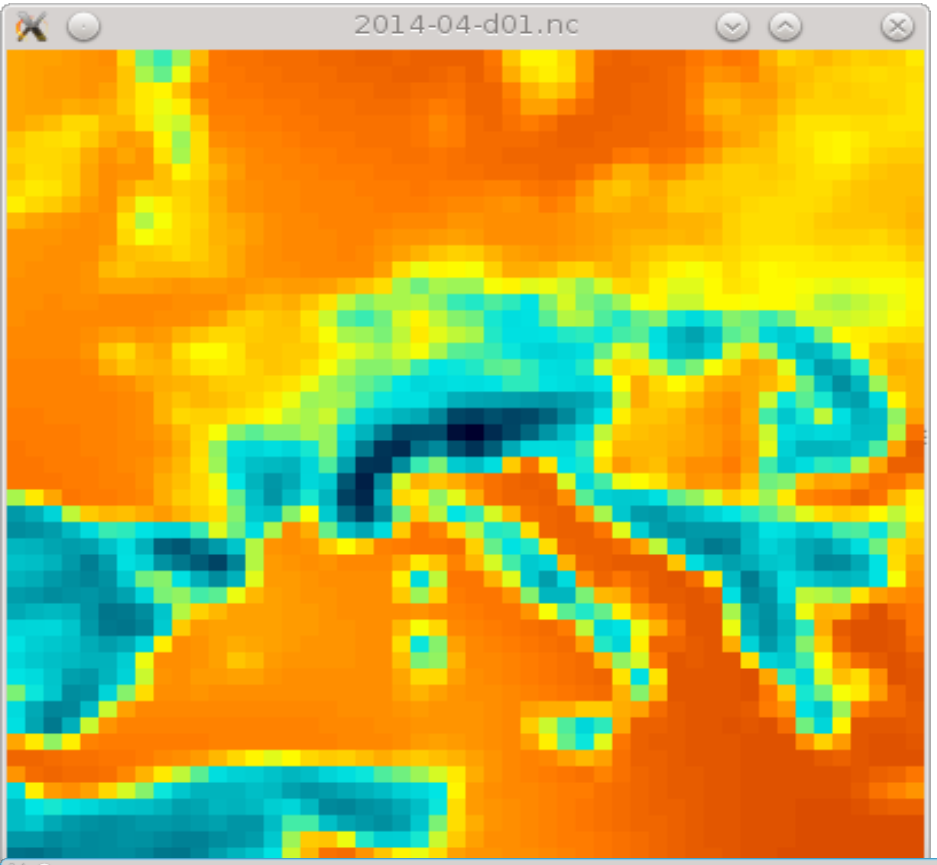
Weather maps reconstruction on different nested areas, with 1 hour resolution and up to 0.5 km resolution (at now different steps were already achieved: 54, 18, 6, 2 km resolution).

All the typical meteorological parameters have been reconstructed. Database prepared with standard NETCDF files, for easy access

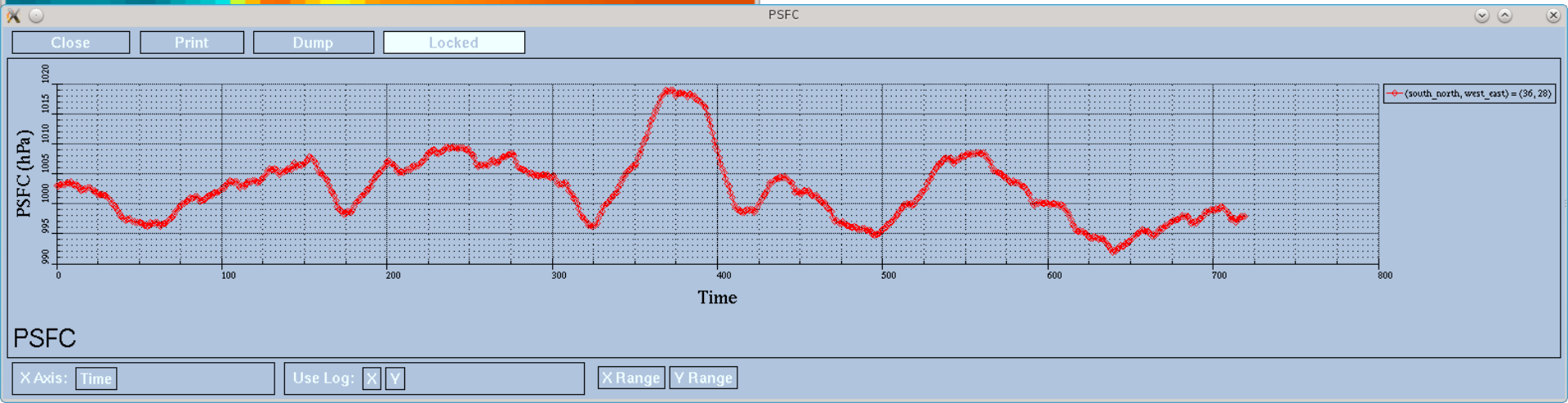




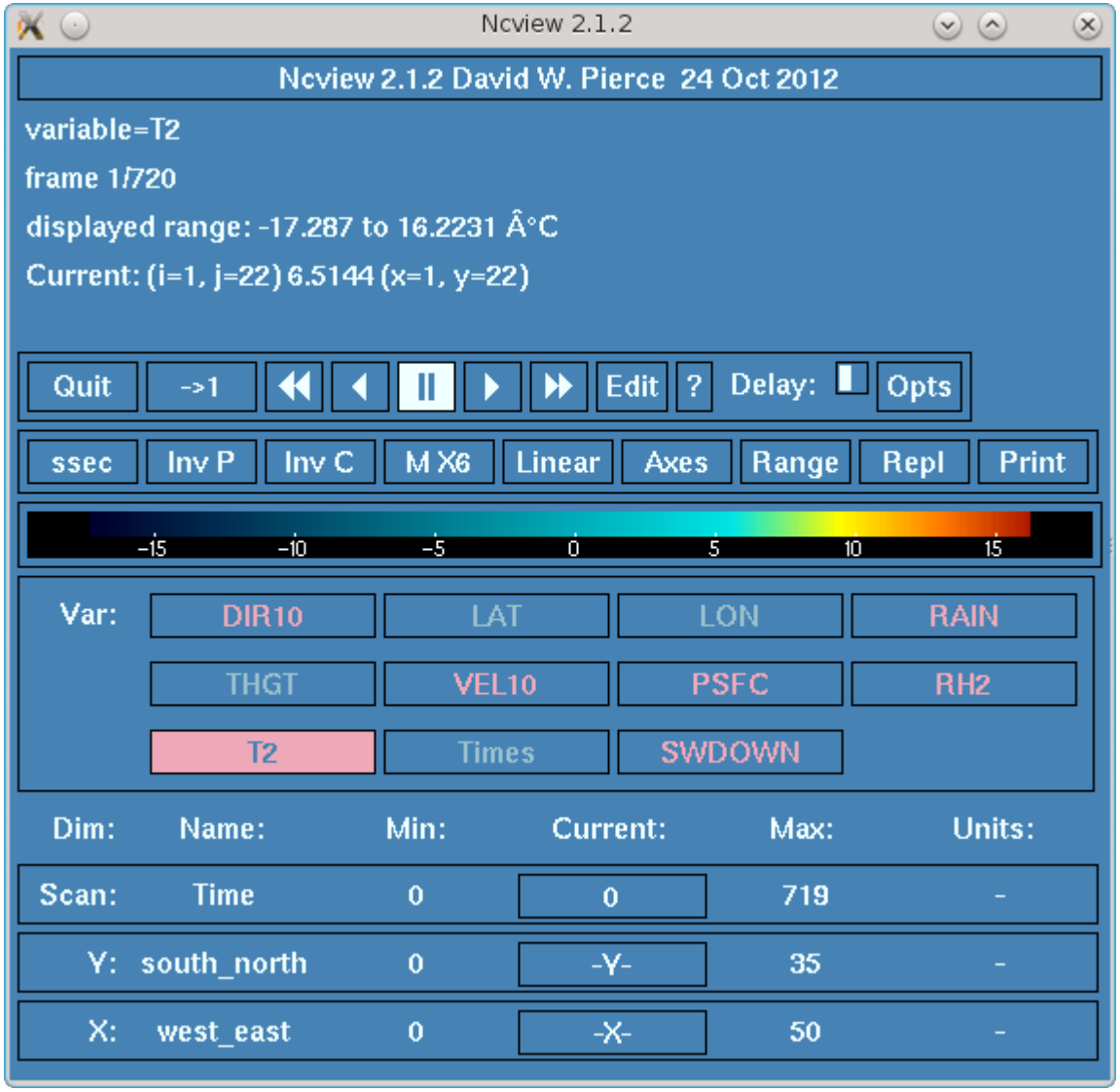
Results (2)



Example of calculation domain Europe maps + historicla maps automatically extracted from netcdf raw modelling data



Results (3)



Presently the following data are extracted from WRF simulations:

- DIR10 = wind direction at 10m above ground
- VEL10 = wind speed at 10m above ground
- T2 = air temperature at 2m above ground
- RH2 = relative humidity at 2m above ground
- PSFC = absolute pressure at ground level
- RAIN = precipitation
- SWDOWN = incoming short wave solar radiation
- THGT = terrain height
- LAT, LON = cell coordinates in EPSG:4326 system

Results (4)

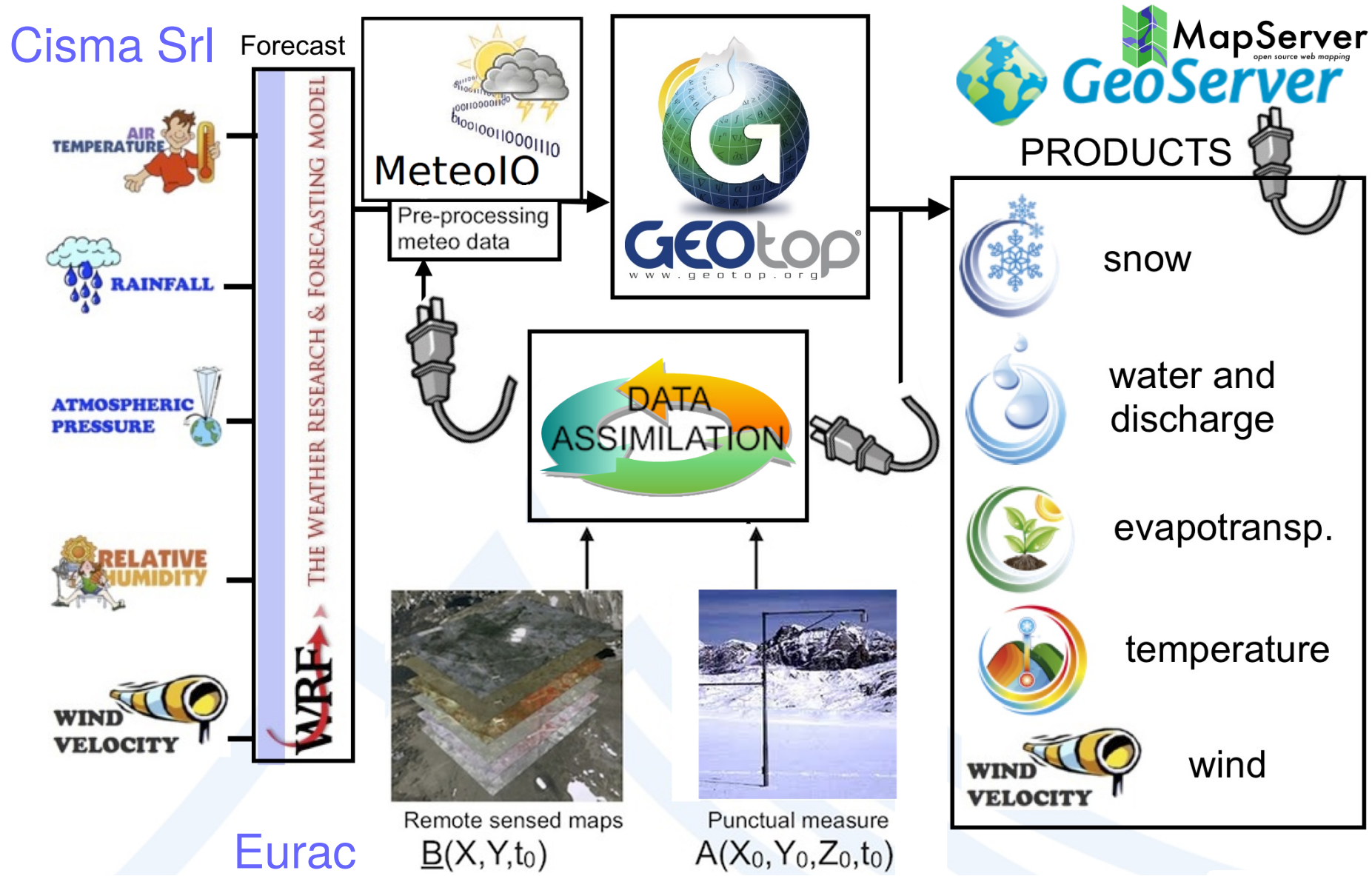
- Geographical Projection: Lambert Conical Conform projection with square cells, in order to minimize distortion on mass variables (wind speed and all derived variables)

- The data can be reprojected using standard library like GDAL or NCO

- Results are saved in netcdf CF-compliant files on a monthly basis. Each file contains 30*24 temporal frames for each of the computed variables

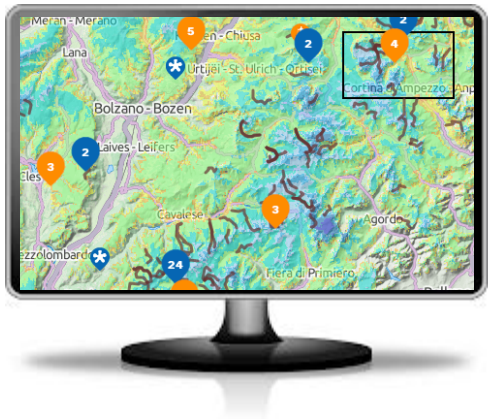
- Presently a subset of variables has been postprocessed to be easily accessed from other nested models (raw WRF data are really huge and not easy to manage)

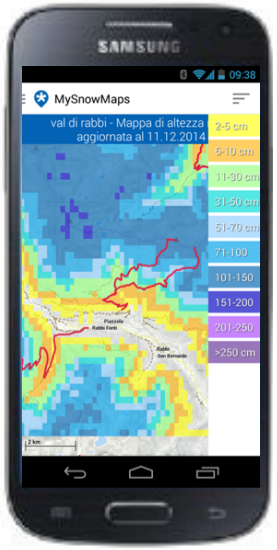
Part 2 – Hydrology (Mountain-eering Srl)



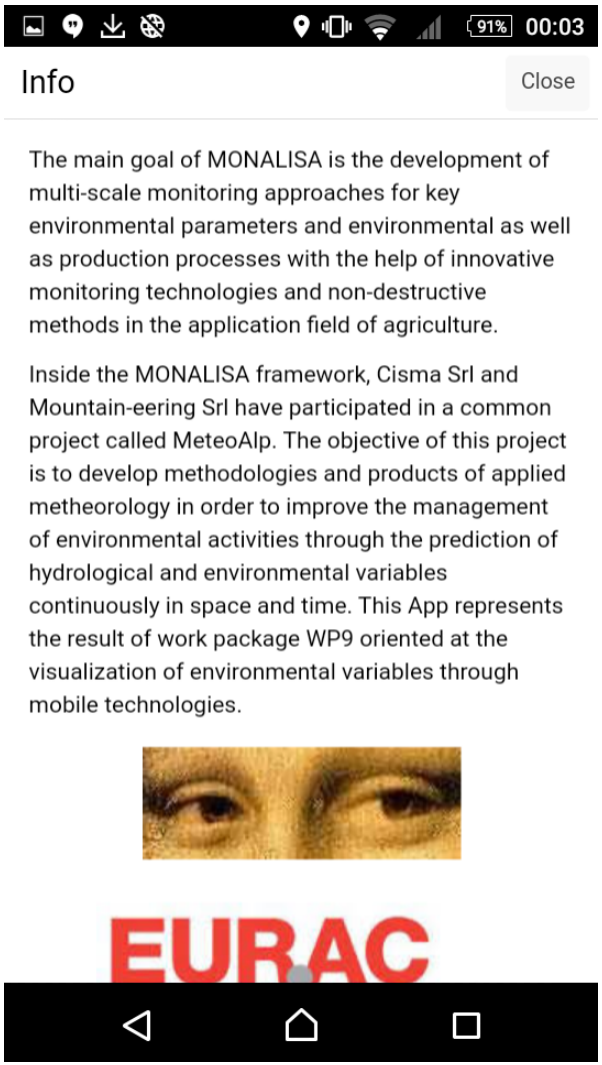
Monalisa APP

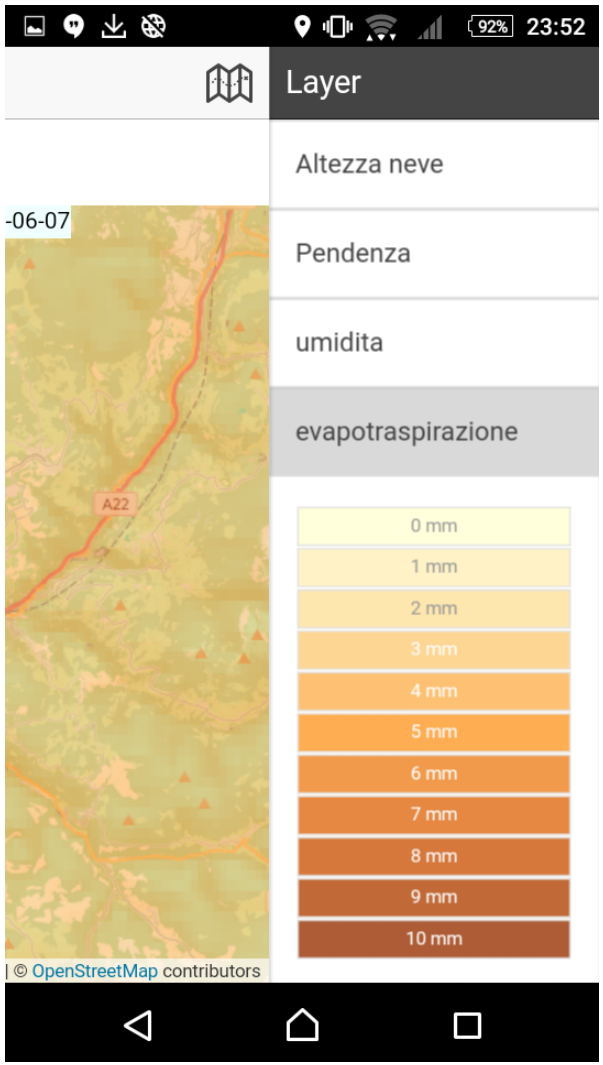
Hydrological maps

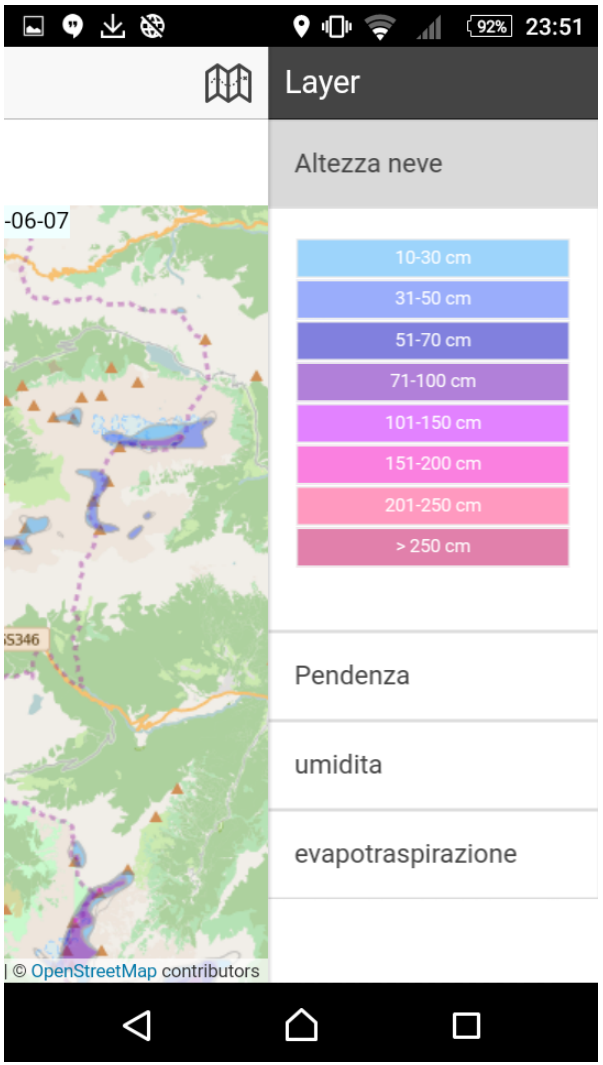




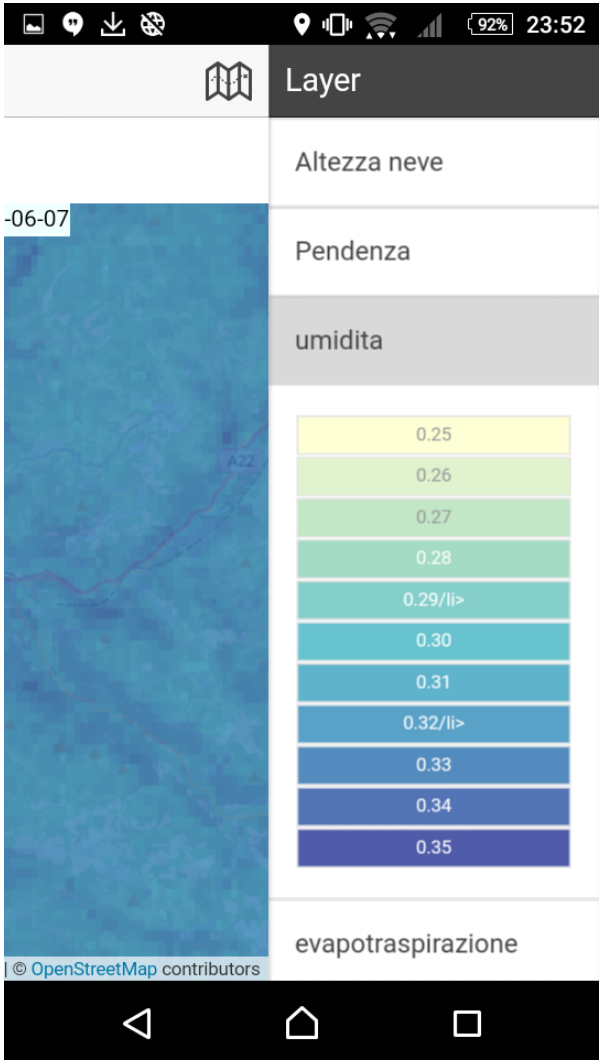
MeteoAlp App (1)

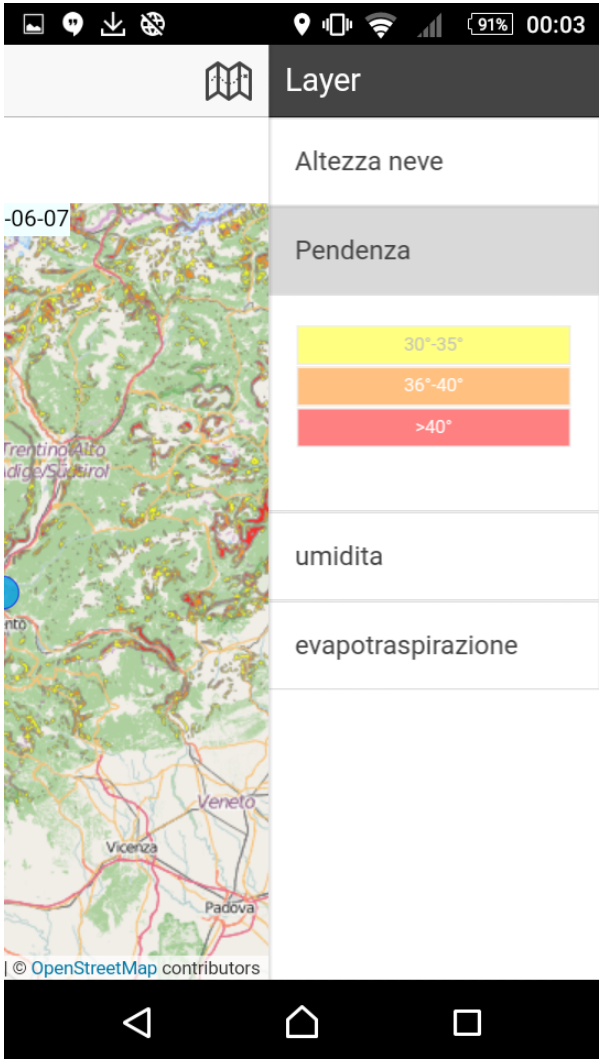






MeteoAlp App (2)





Conclusion

Key points

- interaction among public and private entities

- results will be useful both for applied research and for exploiting new market segments

- environmental data without appropriate analysis is useless: we need proper methodologies in order to practically exploit the large amount of data which is collected everyday

- the development in numerical simulation (hardware and software) nowadays allows rapid deployment of results which were impossible a few years ago at low cost

- necessity to deliver targeted results instead of general purpose climate/weather information, at least for professional users