UNIVERSITÀ DEGLI STUDI DI TRENTO

MOUNTAIN-EERING

Società di Ingegneria

Engineering for the Mountain

Modelli road-weather: un caso di studio utilizzando il modello GEOtop

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Mountain-eering Srl

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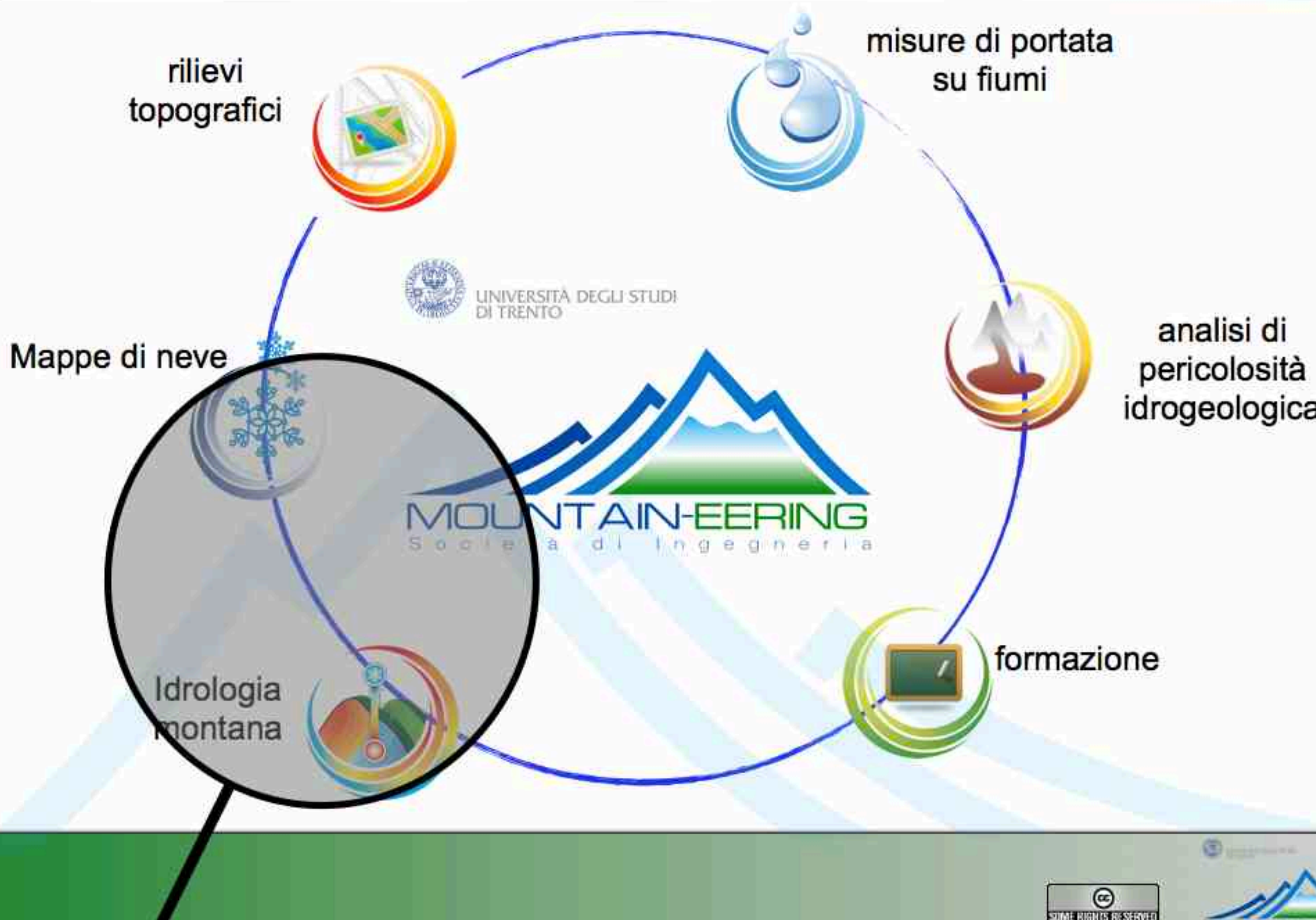
Portafoglio prodotti

Portafoglio prodotti



Neve e protezione civile

valanghe

protezione strade

scioglimenti rapidi

Protezione civile: previsione neve su strade

È possibile **prevedere** la temperatura del manto stradale da **remoto senza strumentazione** in loco?

Catena modellistica

modello GEOtop

GEOtop
www.geotop.org

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Geoscientific Model Development
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doi:10.5194/gmdd-6-6279-2013

GEOtop 2.0: simulating the combined energy and water balance at and below the land surface accounting for soil freezing, snow cover and terrain effects

Review Status
This discussion paper is under review for the journal Geoscientific Model Development (GMD).

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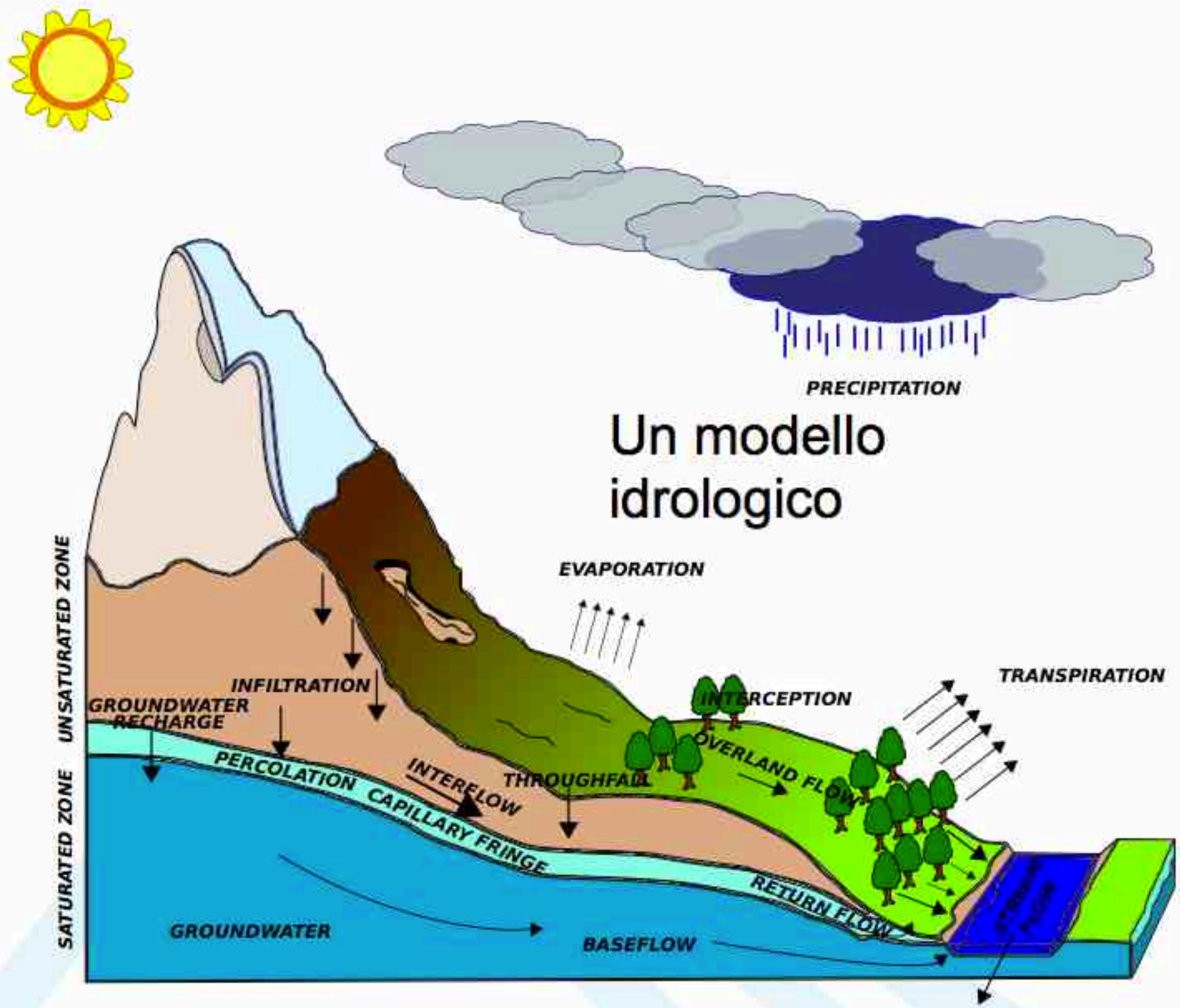
Abstract. GEOtop is a small-scale grid-based simulator that represents the heat and water budgets at and below the soil surface. It represents the energy exchange with the atmosphere, considering the radiative and turbulent fluxes, and describes the three-dimensional subsurface water flow. Furthermore, it reproduces the highly non-linear interaction of the water and energy balance during soil freezing and thawing, and describes the temporal evolution of water and energy budgets in the snow cover and their effect on soil temperature.

Here, we describe the core components of GEOtop 2.0 and demonstrate its functioning. Based on a synthetic simulation, we show that the interaction of processes represented in GEOtop 2.0 can result in phenomena that are significant and relevant for applications involving permafrost and seasonally-frozen soils, both in high altitude and latitude regions.

Citation: Endrizzi, S., Gruber, S., Dall'Amico, M., and Rigon, R.: GEOtop 2.0: simulating the combined energy and water balance at and below the land surface accounting for soil freezing, snow cover and terrain effects, Geosci. Model Dev. Discuss., 6, 6279-6341, doi:10.5194/gmdd-6-6279-2013, 2013.

GEOtop: un modello idrologico



GEOtop: cosa fa

1. Bilancio dell'acqua

- pioggia efficace
- deflusso superficiale (versanti e canali)
- flusso sub-superficiale (eq. Richards 3D)

2. Bilancio di energia superficiale

- radiazione
- interazioni con lo strato limite

3. Neve-ghiacciaio

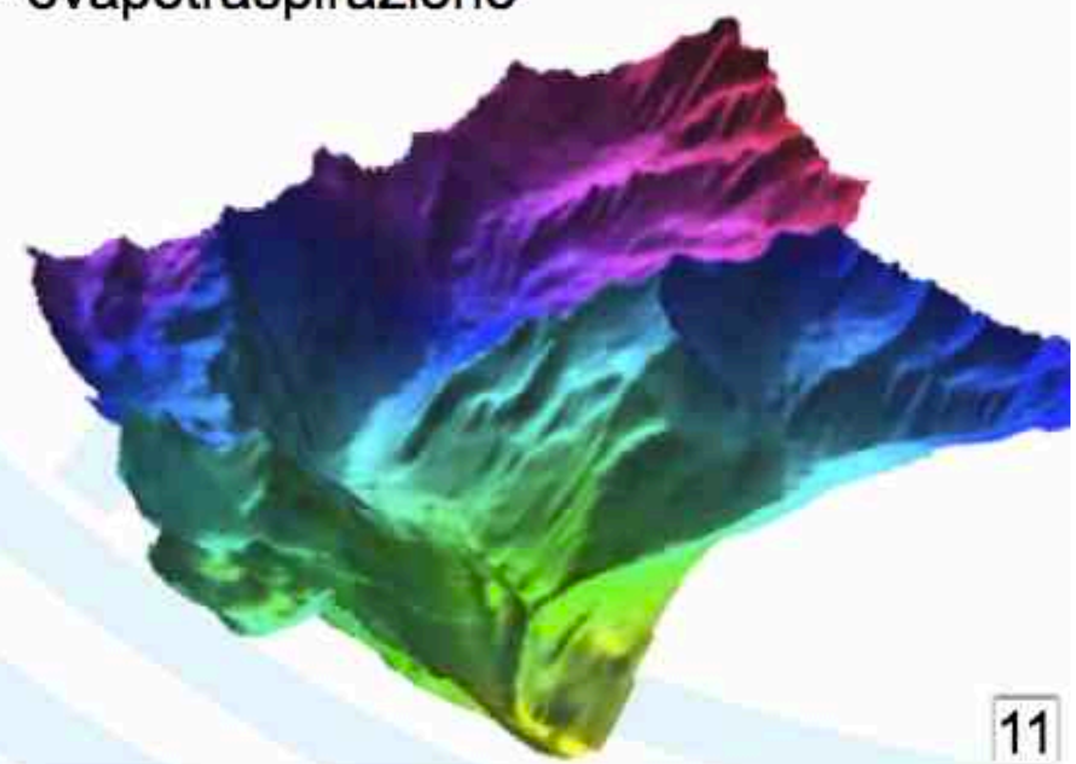
- schema neve multi-strato
- bilancio di massa del ghiacciaio

4. Bilancio energia nel suolo

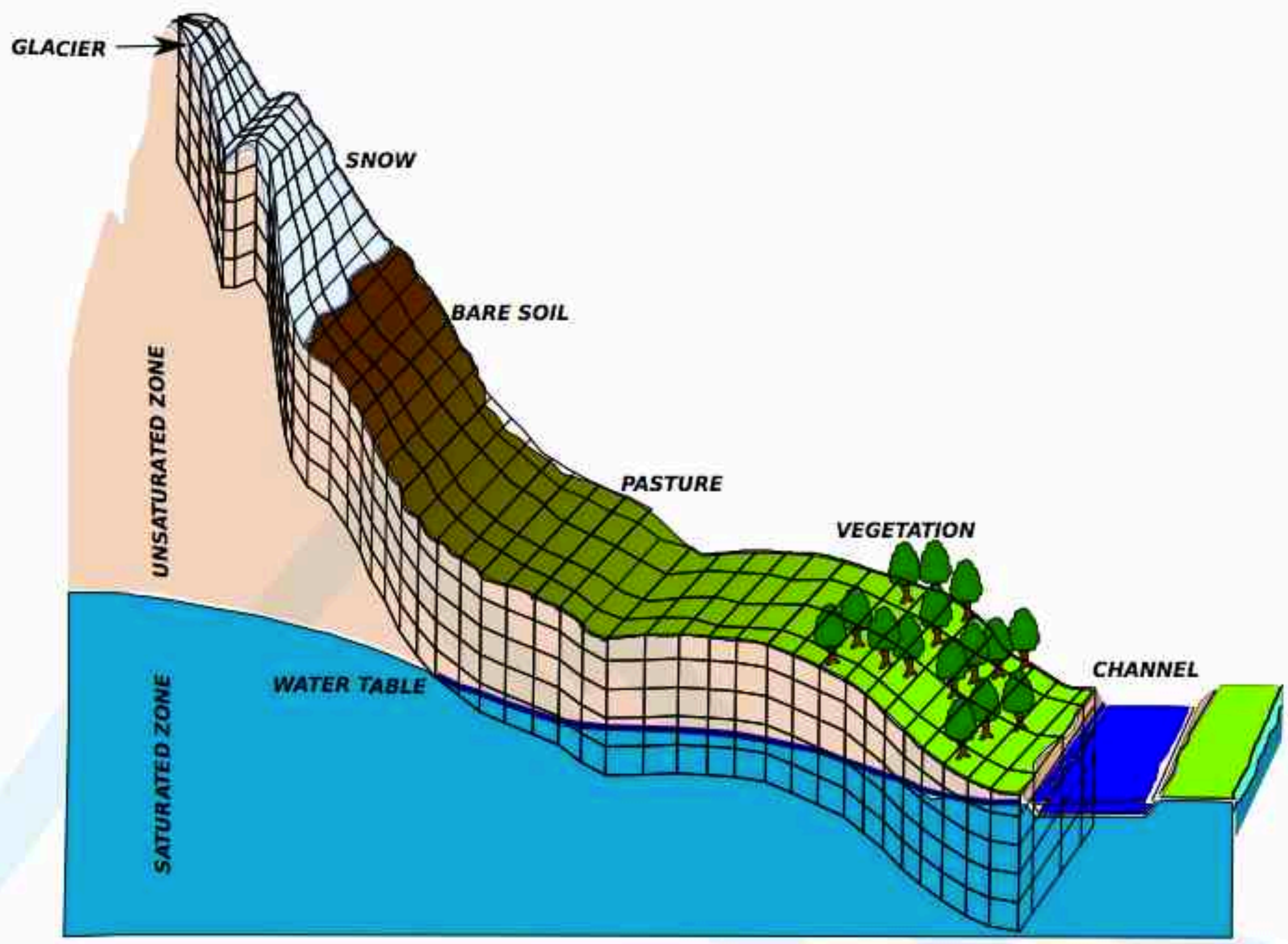
- temperatura del suolo
- suoli ghiacciati

5. Interazione con vegetazione

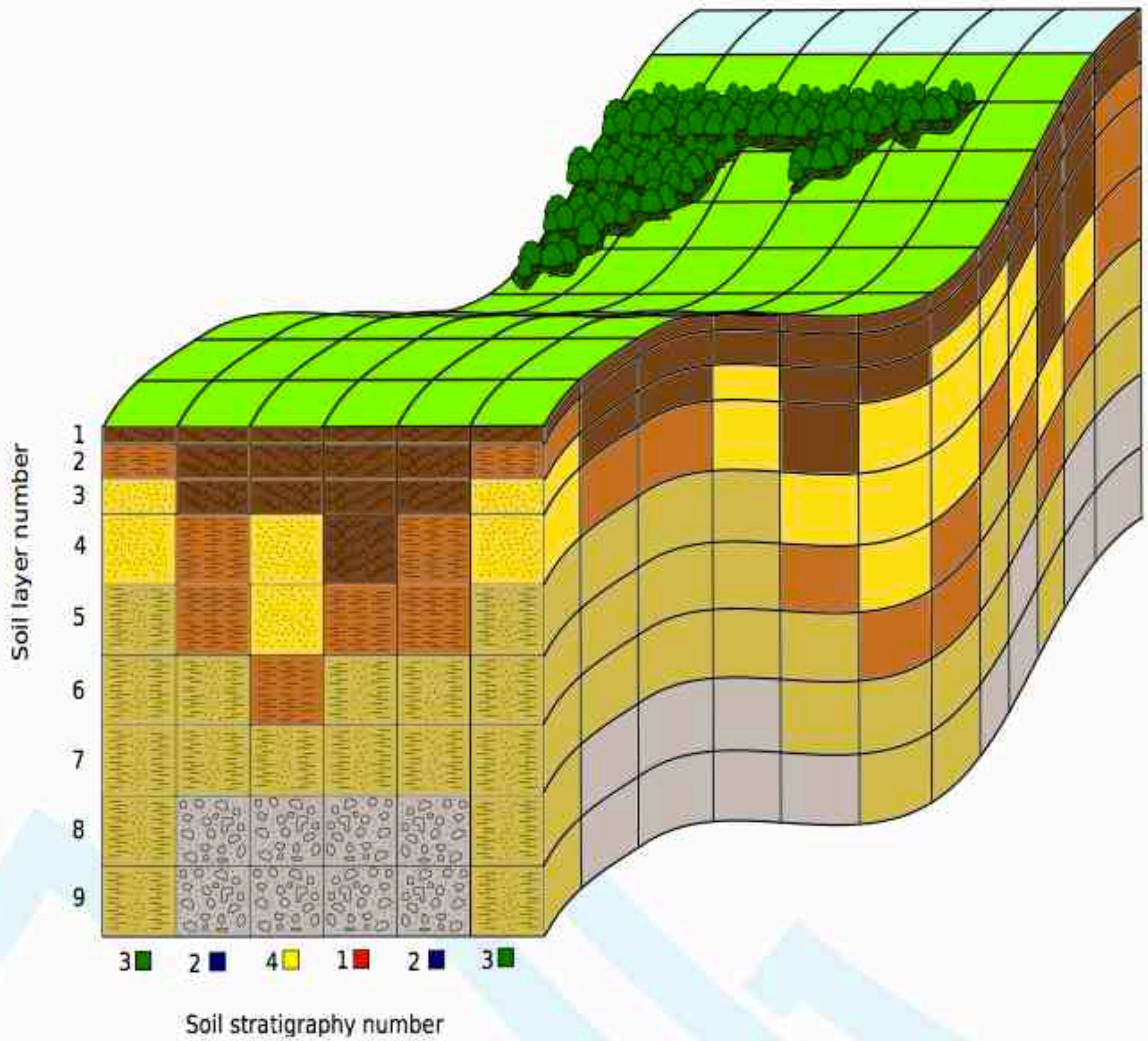
- schema vegetazione multi-strato
- evapotraspirazione



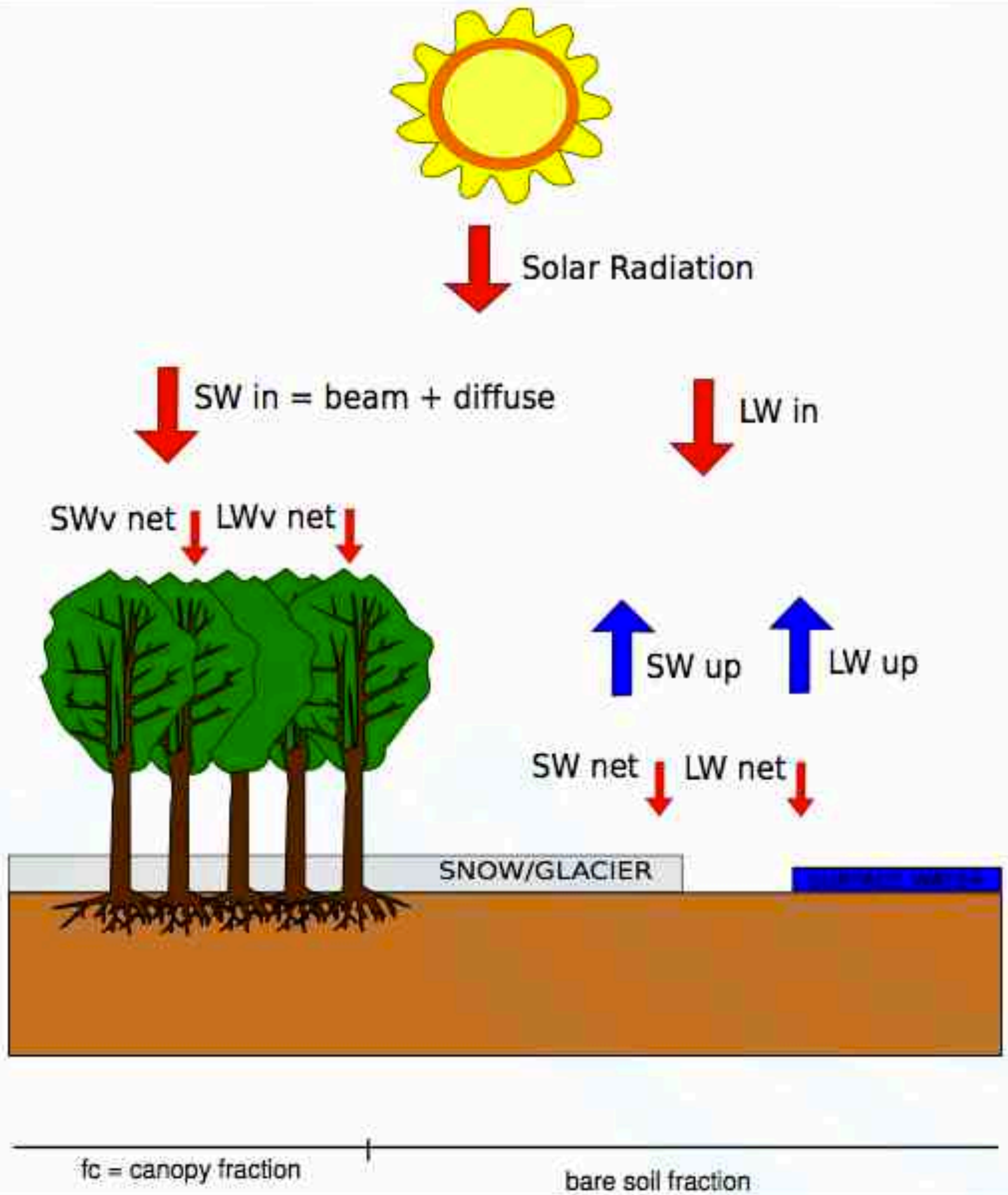
Discretizzazione del territorio



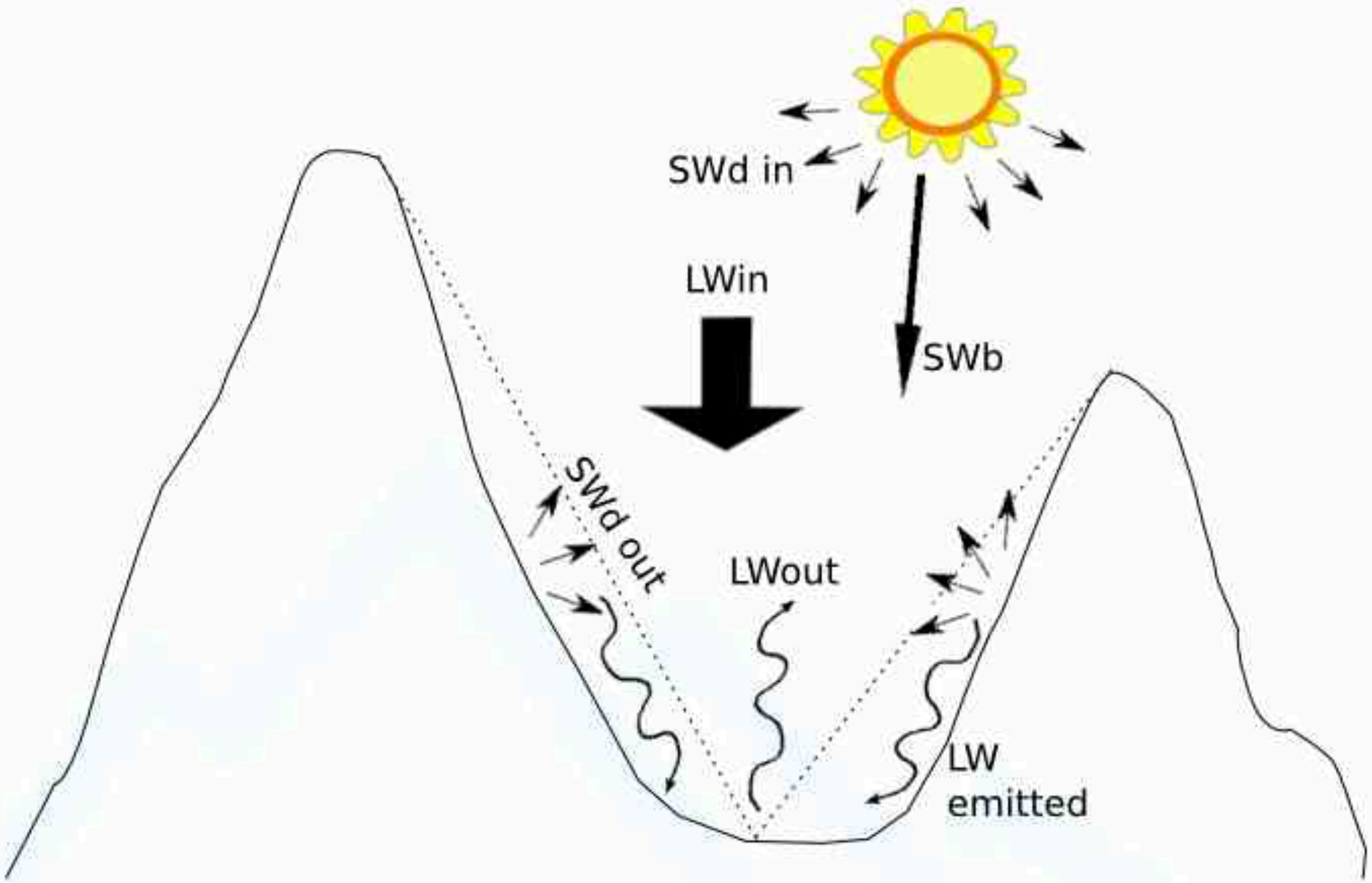
Discretizzazione del territorio



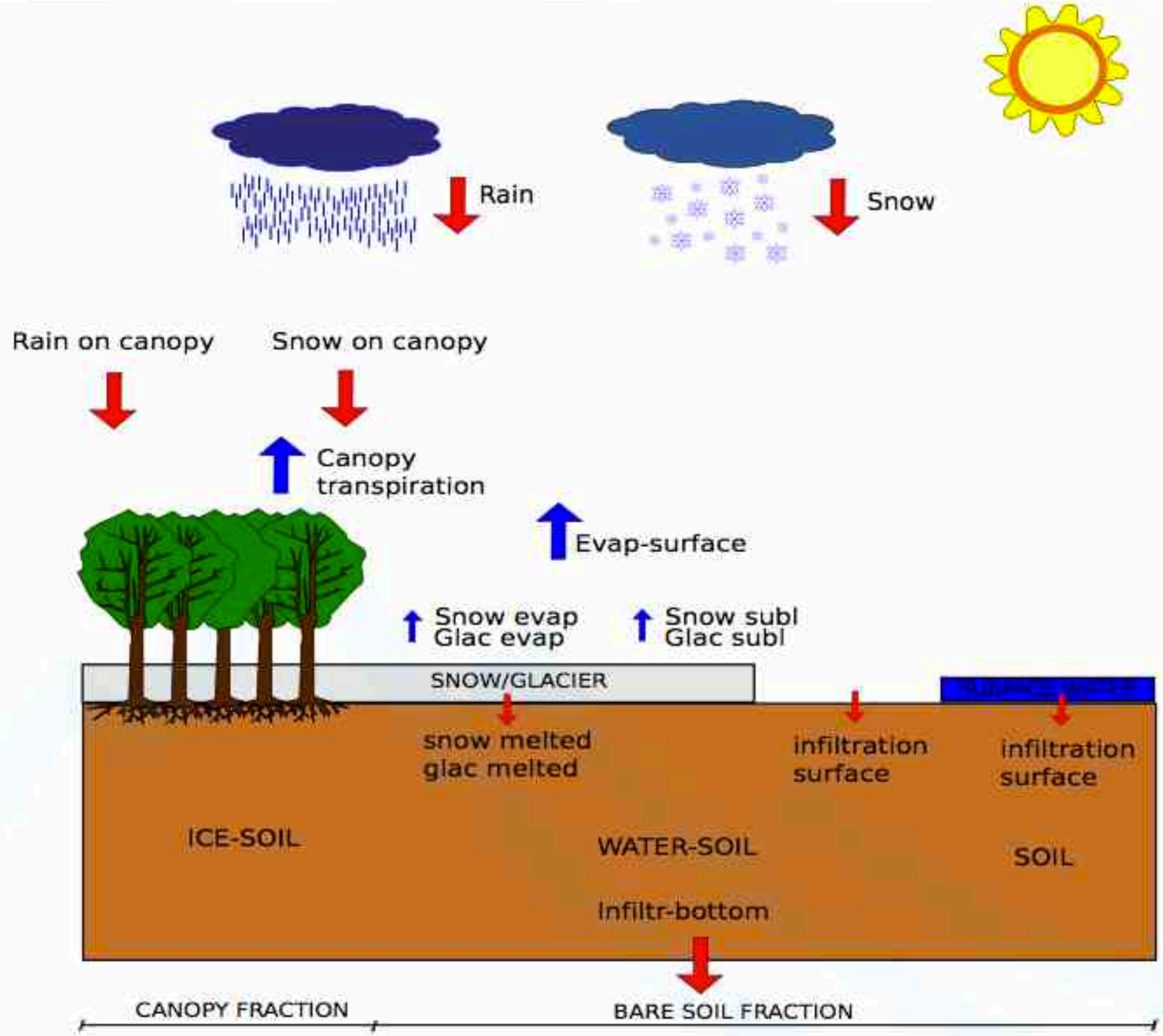
Flussi di energia



Topografia complessa



Flussi di massa



Equazioni di conservazione

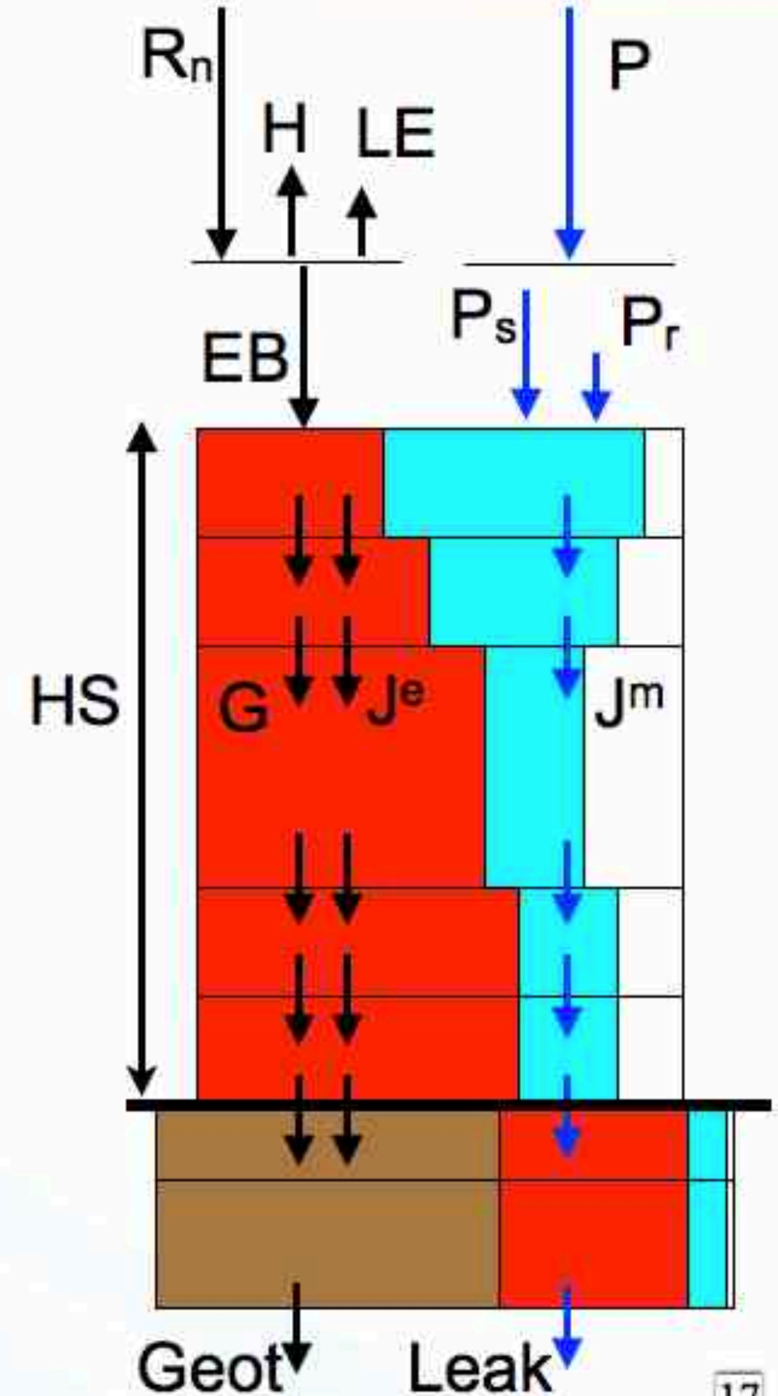
I flussi superficiali calcolati vengono trasmessi al suolo (neve) tramite “*semplici*” equazioni di conservazione

1. Massa

$$\frac{\partial}{\partial t}\int_V \left[\rho_i\theta_i + \rho_w\theta_w\right] dV + \int_V \nabla \bullet (\rho_w J^m)\ dV = 0$$

2. Energia

$$\frac{\partial}{\partial t}\int_V U\ dV + \int_V \nabla \bullet (G + J^e)\ dV = 0$$



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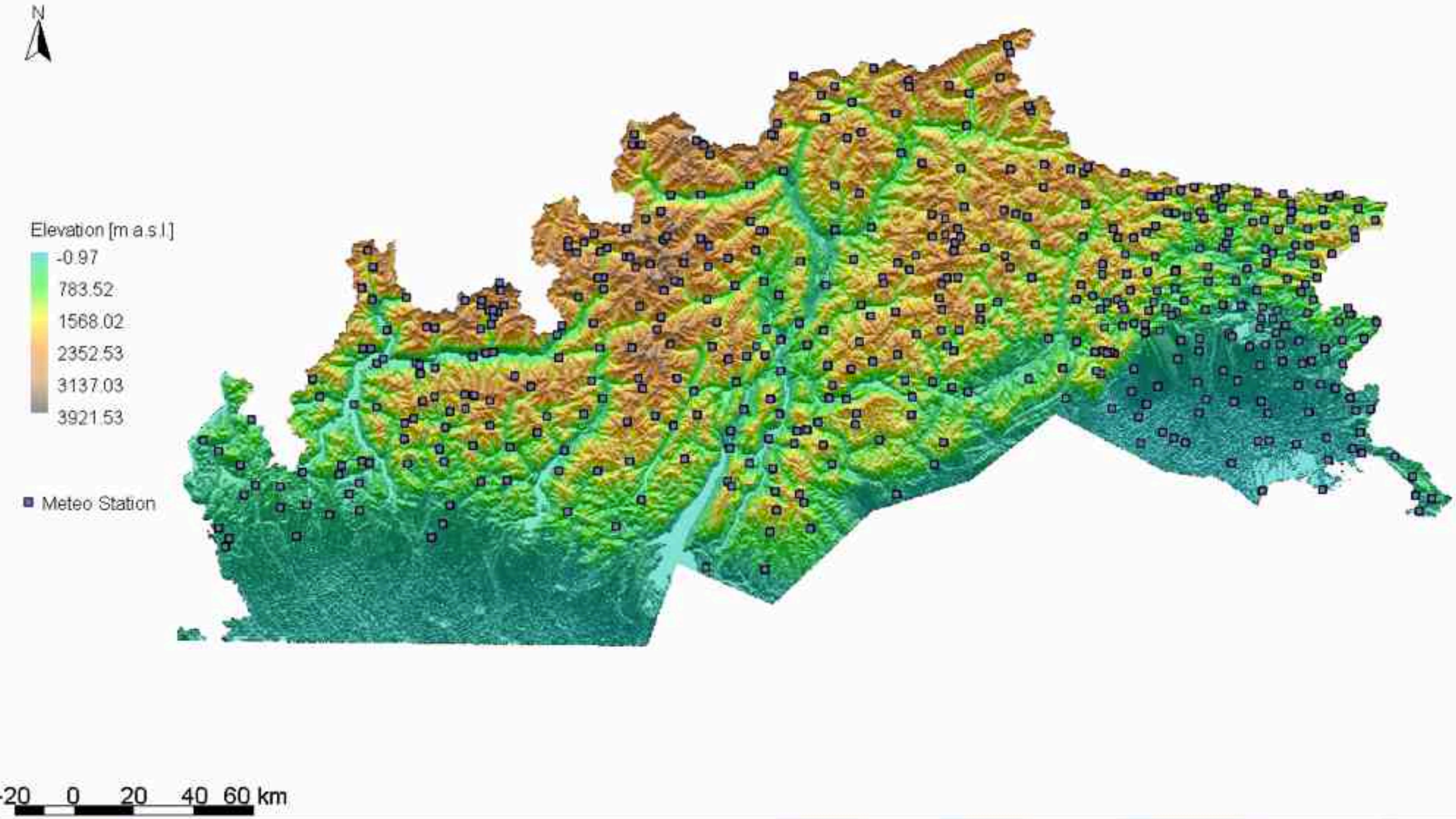
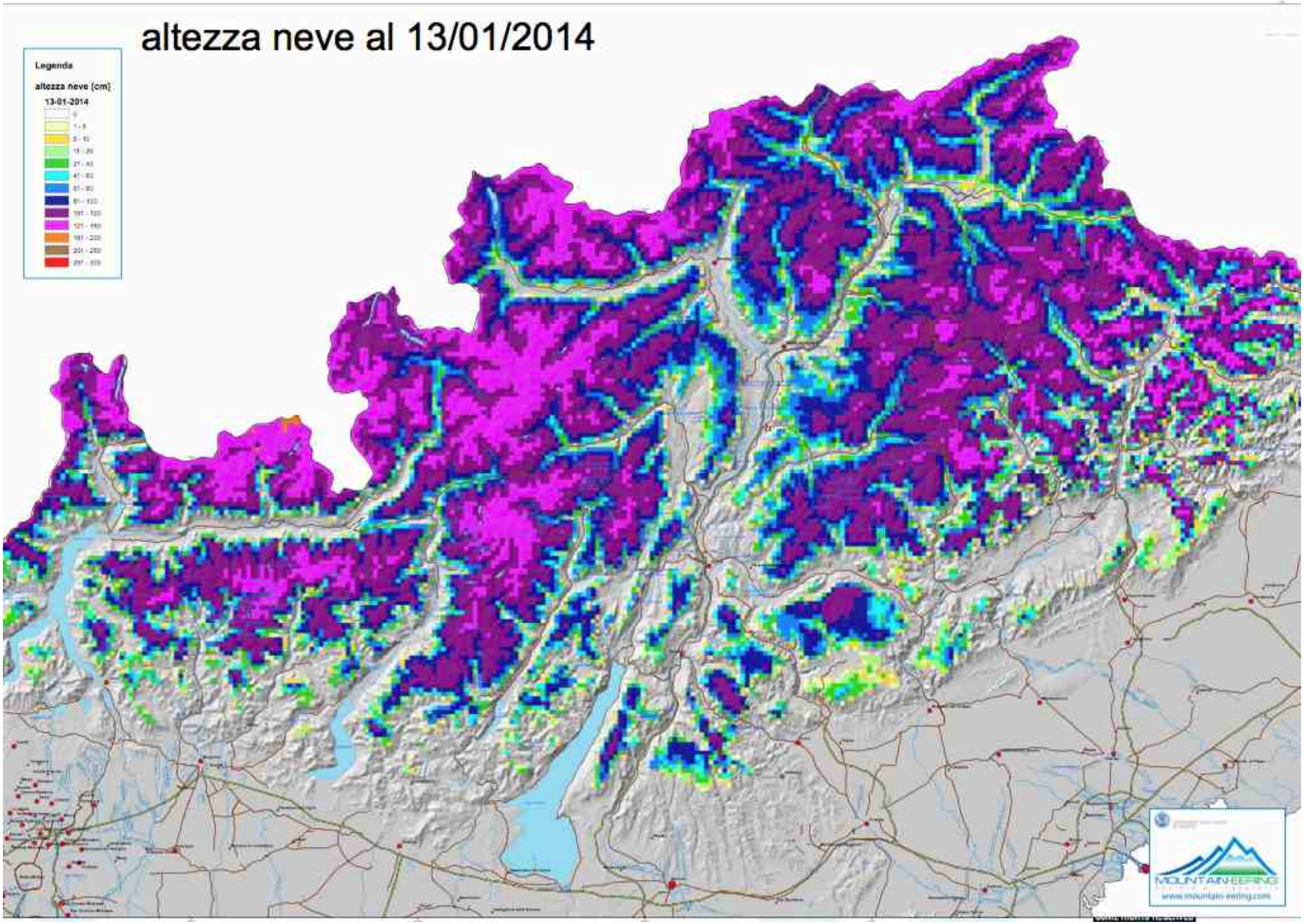
Applicazioni:
Mappe di neve

Mappe di neve

Trentino, Alto-Adige, Lombardia,
Veneto, Friuli Venezia-Giulia

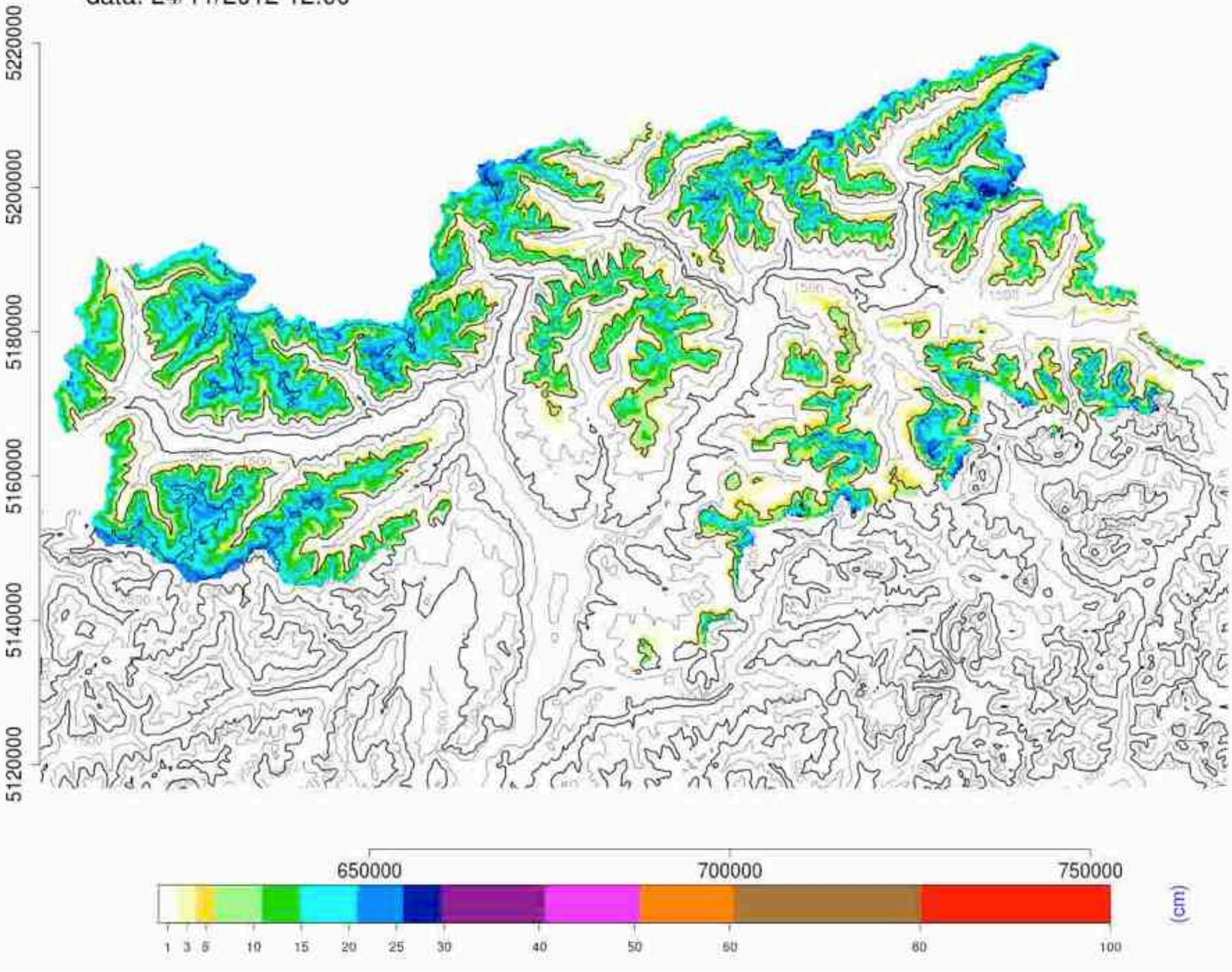


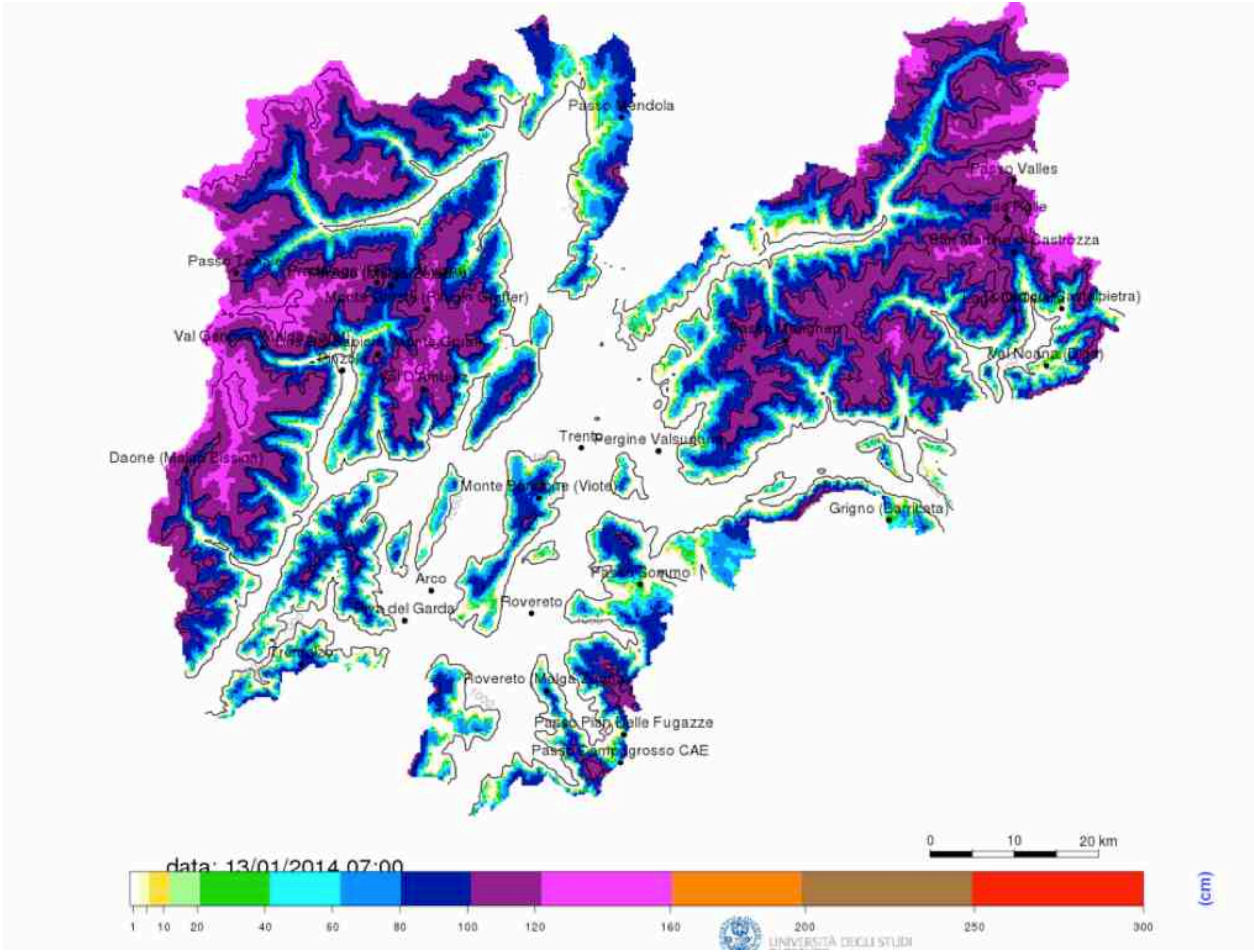
altezza neve al 13/01/2014



Equivalente in acqua (cm). Zona: SudTirolo

data: 24/11/2012 12:00




Passo Valles
Trento
Pergine Valsugana
Monte Bondone (Viote)
Grigno
Arco
Rovereto
Riva del Garda
Passo Pian delle Fugazze
Passo Campogrosso CAE
Daone
0 10 20 km
data: 13/01/2014 07:00
1 10 20 40 60 80 100 120 160 200 250 300
(cm)
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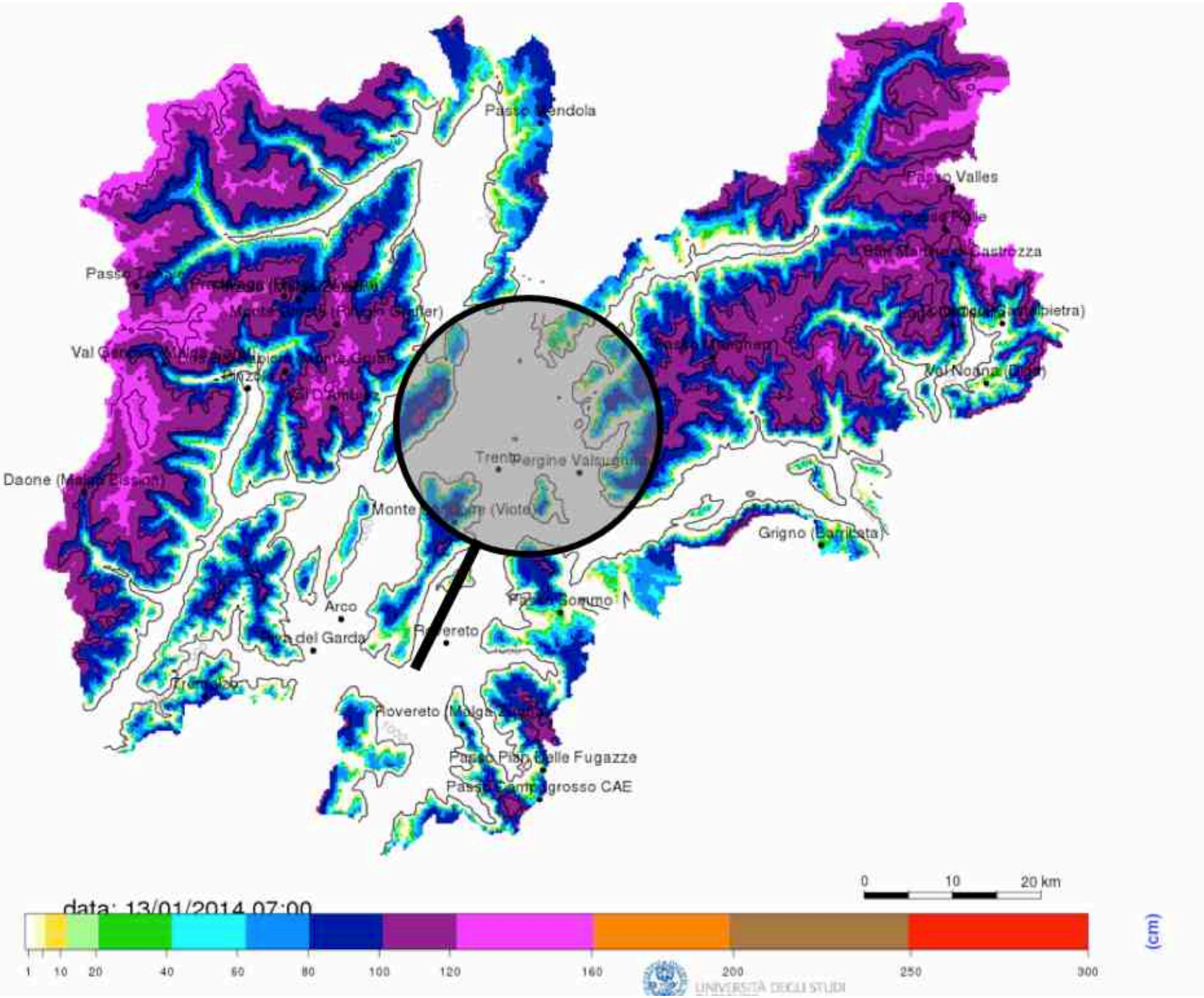

Passo Valles
Grigno
Trento
Pergine Valsugana
Arco
del Garda
Rovereto
Passo Pian
Fugazze
grosso CAE
Daone
Monte
(Viote)
data: 13/01/2014 07:00
0
10
20 km
1
10
20
40
60
80
100
120
160
200
250
300
(cm)
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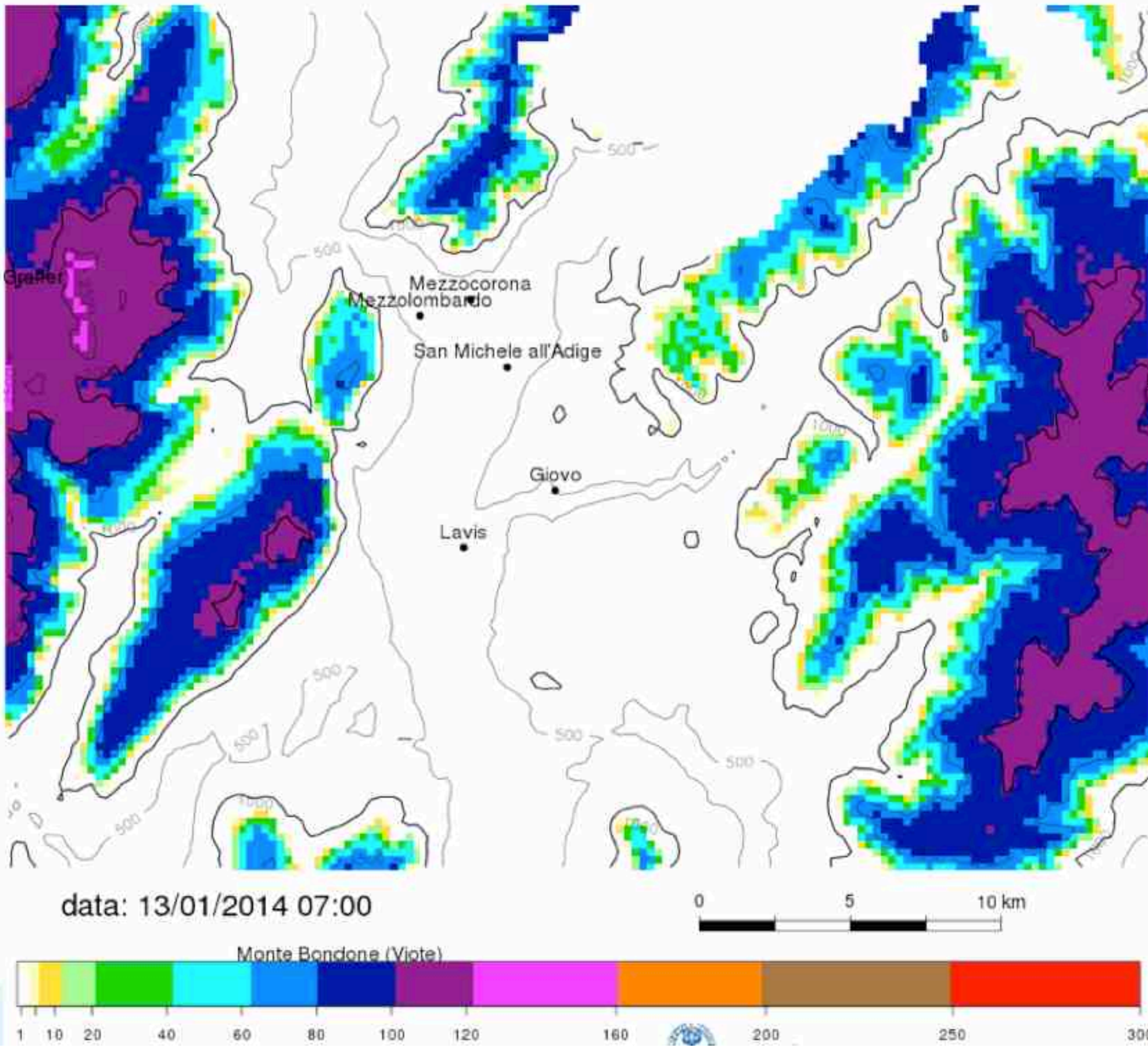

Mezzocorona
Mezzolombardo
San Michele all'Adige
Giovo
Lavis
500
1000
data: 13/01/2014 07:00
0
5
10 km
Monte Bondone (Viote)
1
10
20
40
60
80
100
120
160
200
250
300

Applicazioni: CleanRoads

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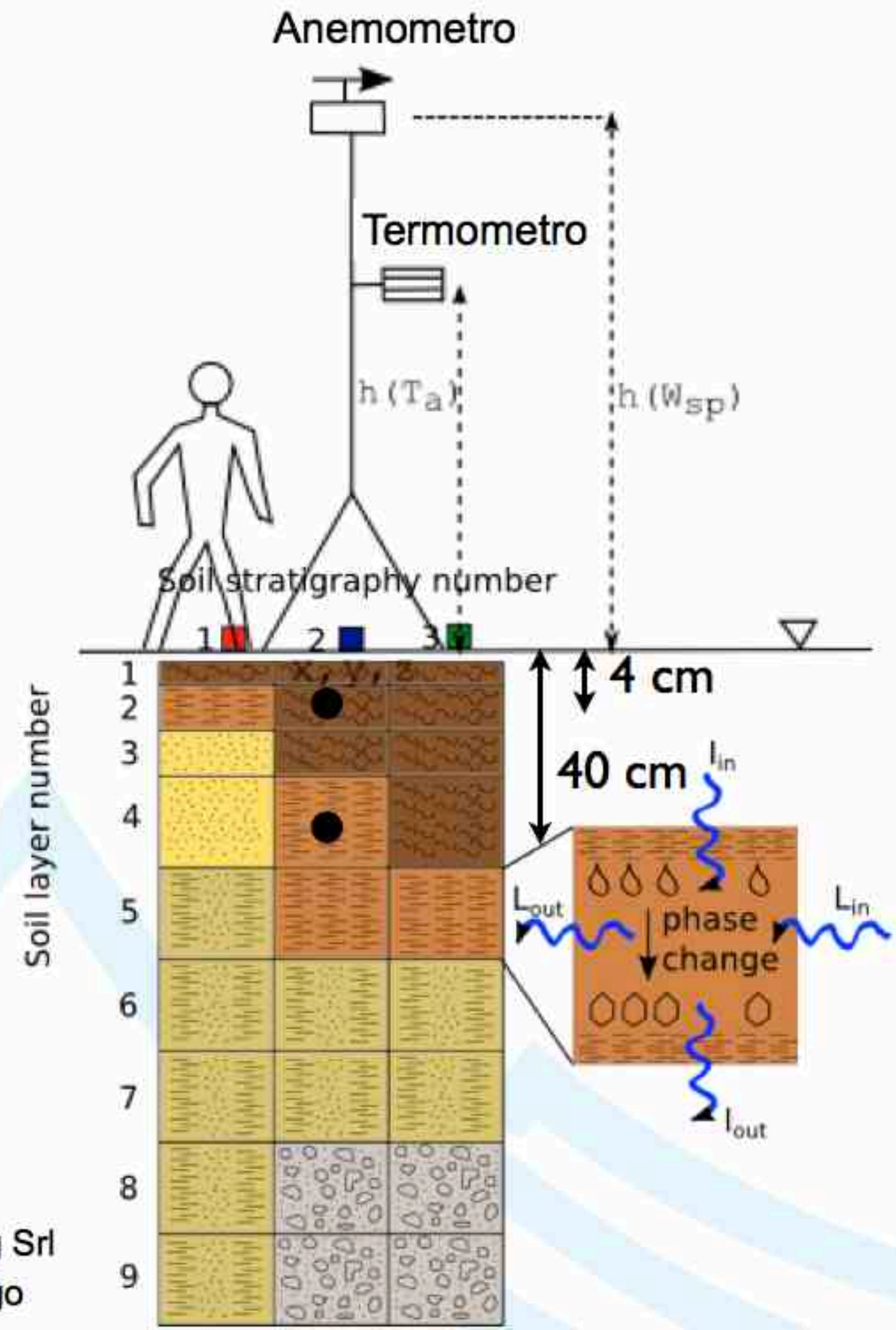
Stefano Endrizzi, Università di Zurigo



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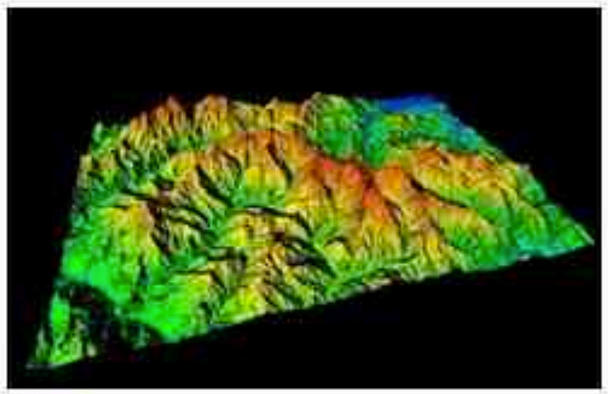
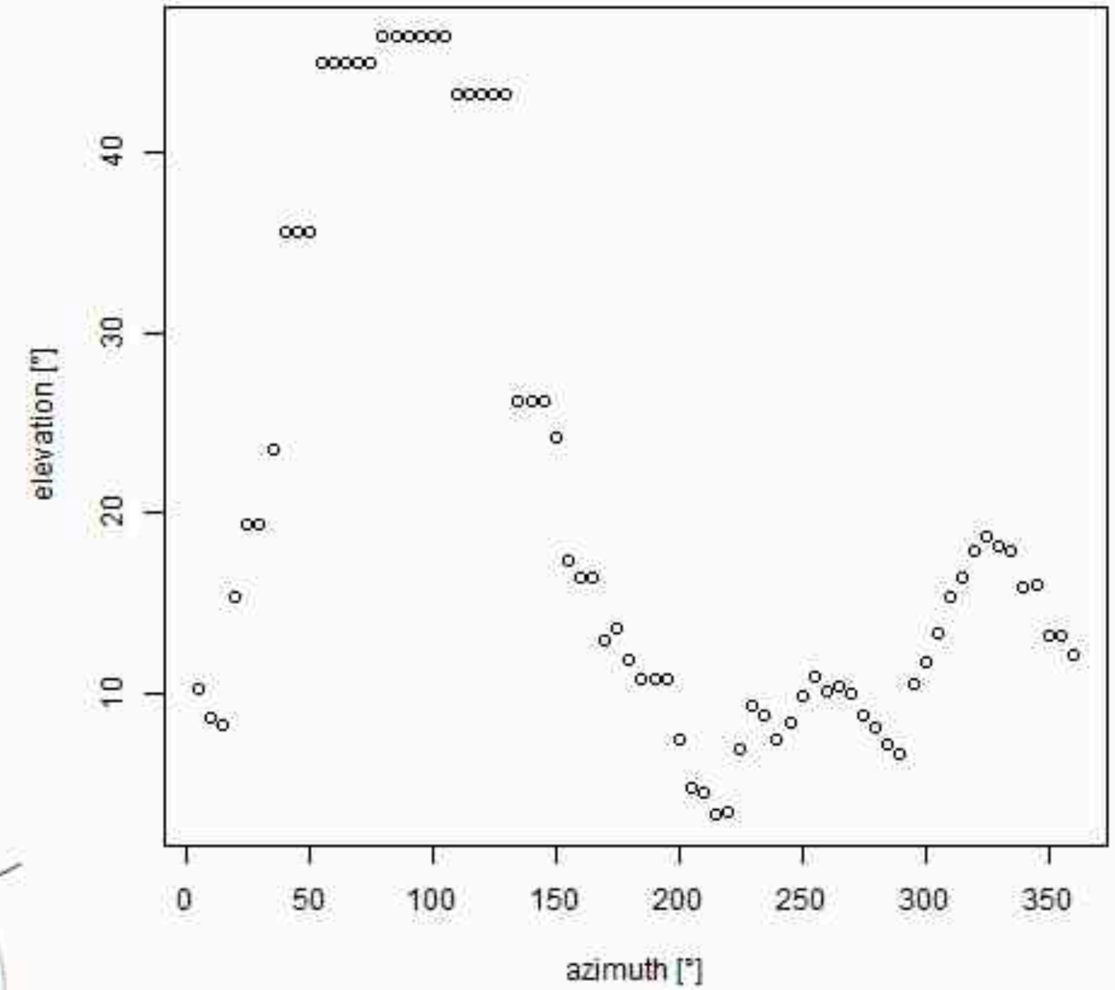
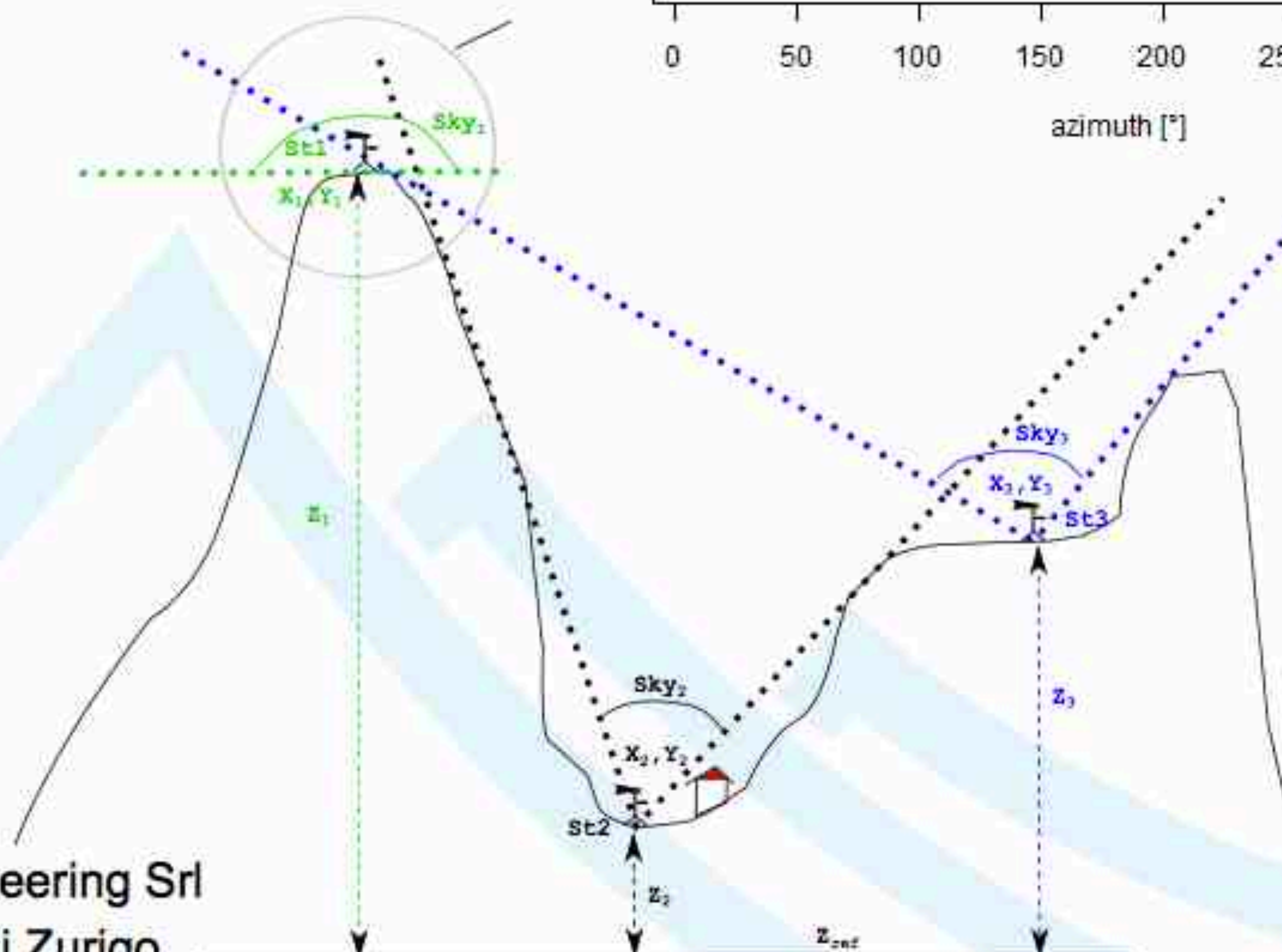
Stefano Endrizzi, Università di Zurigo

Topografia complessa in simulazioni 1D







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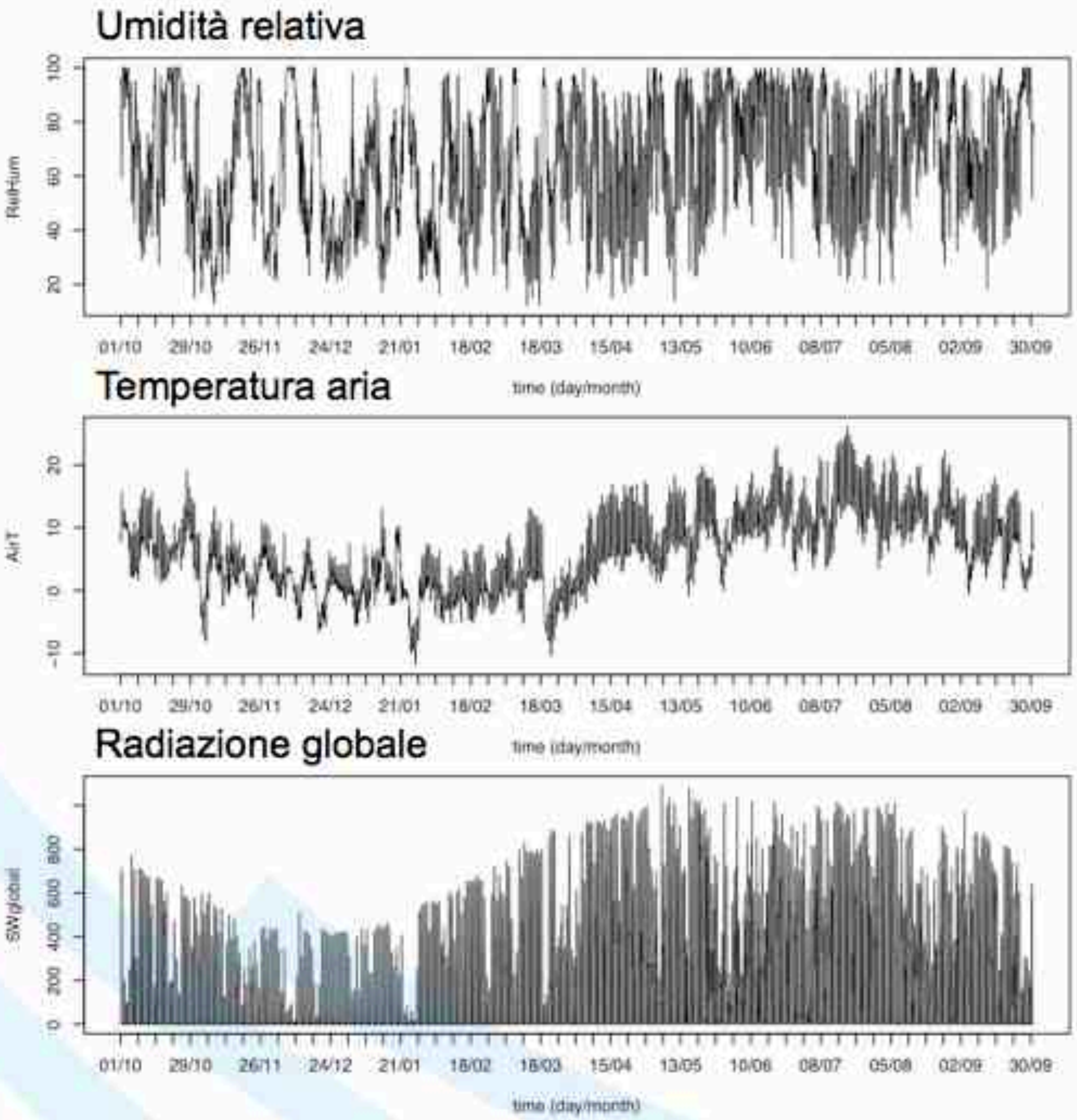
GEOtop: dati di ingresso

- caratteristiche **topografiche e vegetazionali** del territorio
- **forzanti meteorologiche**
- **parametri specifici del suolo**



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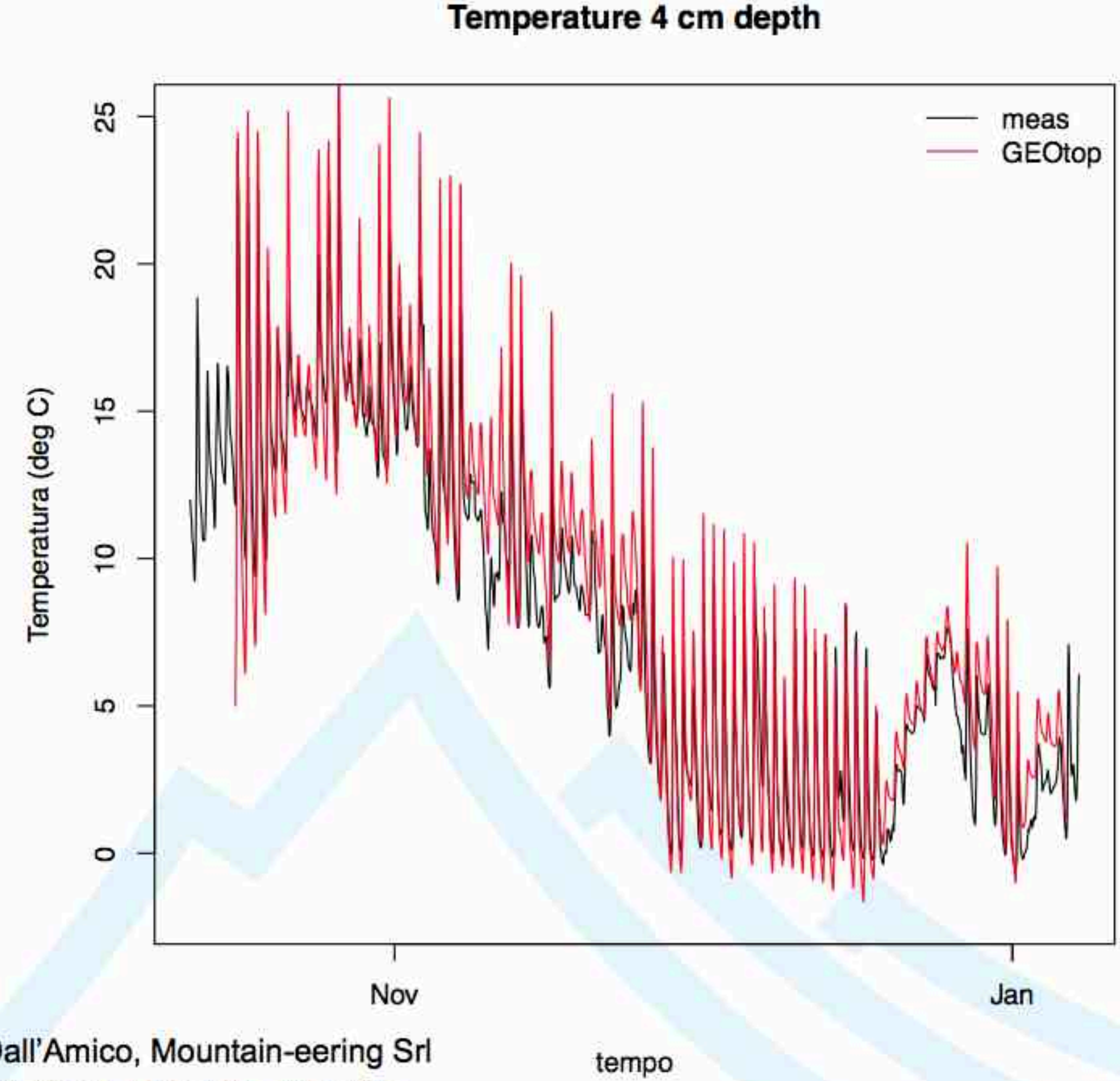
Parametri

```
!**********************************
!******* CONFIGURATION *********
!**********************************
TimeStepEnergyAndWater = 3600
InitDateDDMMYYYYhhmm = 16/10/2013 07:00
EndDateDDMMYYYYhhmm =  06/01/2014 07:00
EnergyBalance = 1
PointSim=1

!****** METEO STATIONS *********
NumberOfMeteoStations=2
!Name: Condino, S.Michele
MeteoStationElevation=209,209
MeteoStationStandardTime=1
MeteoStationWindVelocitySensorHeight=5
MeteoStationTemperatureSensorHeight =2

!***** PARAMETERIZATIONS *******
MoninObukhov=1
LWinParameterization=7

!******* LAPSE RATES **********
LapseRateTemp= 6.5

!******* INIT. CONDIT **********
InitWaterTableDepth = 3000
InitSoilTemp = 5
```

```
Z,Dz,Kh,Kv,res,sat,a,n,SS
5,10,1.00E-007,1.00E-007,0,0.05,0.004,1.1,1.00E-006
15,10,1.00E-007,1.00E-007,0,0.05,0.004,1.1,1.00E-006
25,10,1.00E-007,1.00E-007,0,0.05,0.004,1.1,1.00E-006
40,20,1.00E-007,1.00E-007,0,0.05,0.004,1.1,1.00E-006
60,20,1.00E-007,1.00E-007,0,0.05,0.004,1.1,1.00E-006
85,30,1.00E-007,1.00E-007,0,0.05,0.004,1.1,1.00E-006
120,40,1.00E-007,1.00E-007,0,0.05,0.004,1.1,1.00E-006
160,40,1.00E-007,1.00E-007,0,0.05,0.004,1.1,1.00E-006
205,50,1.00E-007,1.00E-007,0,0.1,0.004,1.1,1.00E-006
255,50,1.00E-007,1.00E-007,0,0.1,0.004,1.1,1.00E-006
310,60,1.00E-007,1.00E-007,0,0.1,0.004,1.1,1.00E-006
370,60,1.00E-007,1.00E-007,0,0.1,0.004,1.1,1.00E-006
440,80,1.00E-007,1.00E-007,0,0.1,0.004,1.1,1.00E-006
530,100,1.00E-007,1.00E-007,0,0.1,0.004,1.1,1.00E-006
630,100,1.00E-007,1.00E-007,0,0.1,0.004,1.1,1.00E-006
730,100,1.00E-007,1.00E-007,0,0.1,0.004,1.1,1.00E-006
880,200,1.00E-007,1.00E-007,0,0.1,0.004,1.1,1.00E-006
1120,280,1.00E-007,1.00E-007,0,0.1,0.004,1.1,1.00E-006
1430,340,1.00E-007,1.00E-007,0,0.1,0.004,1.1,1.00E-006
1800,400,1.00E-007,1.00E-007,0,0.1,0.004,1.1,1.00E-006
2250,500,1.00E-007,1.00E-007,0,0.1,0.004,1.1,1.00E-006
2750,500,1.00E-007,1.00E-007,0,0.1,0.004,1.1,1.00E-006
```

Confronto temperature simulate-misurate



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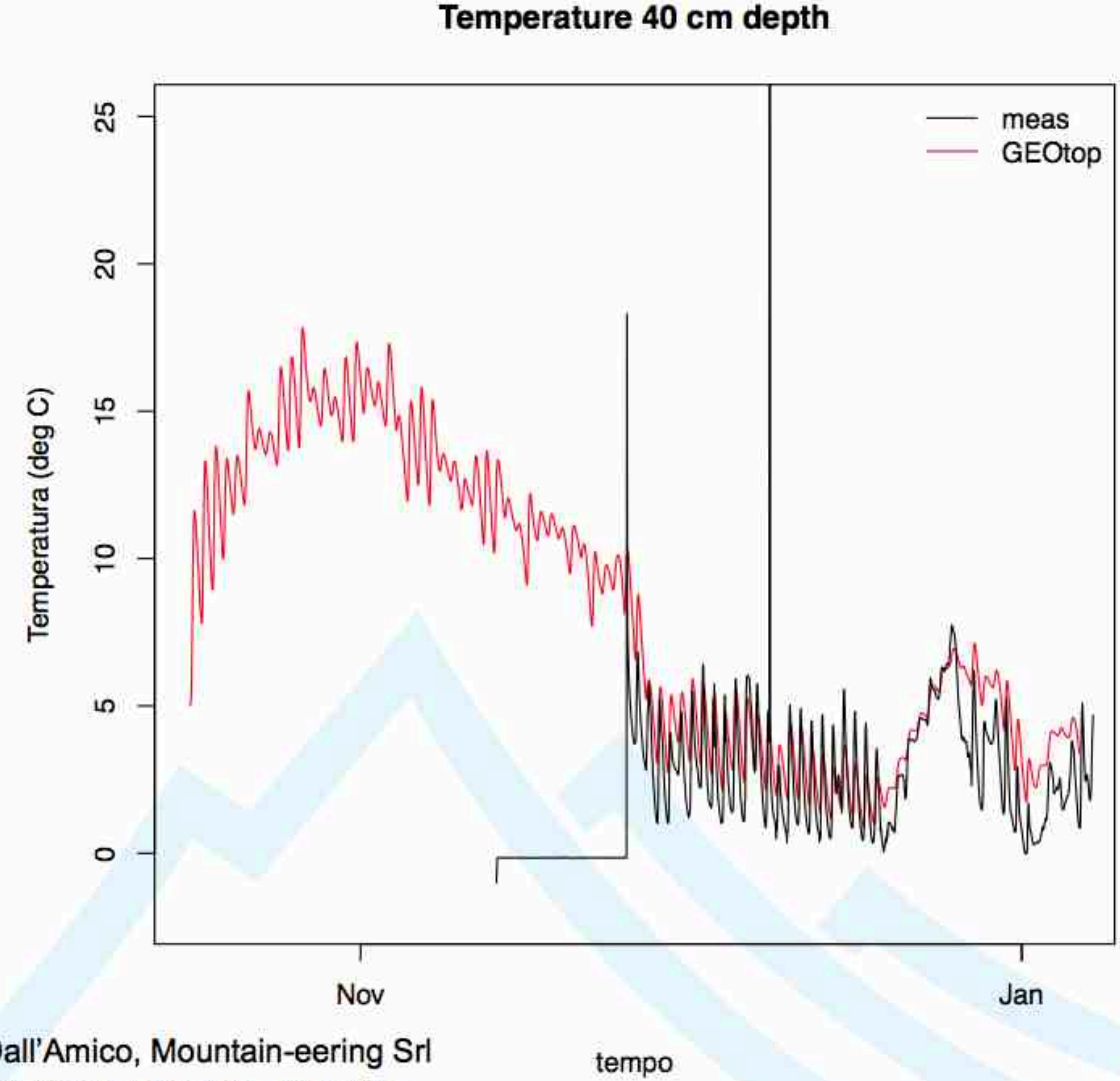
Confronto temperature simulate-misurate



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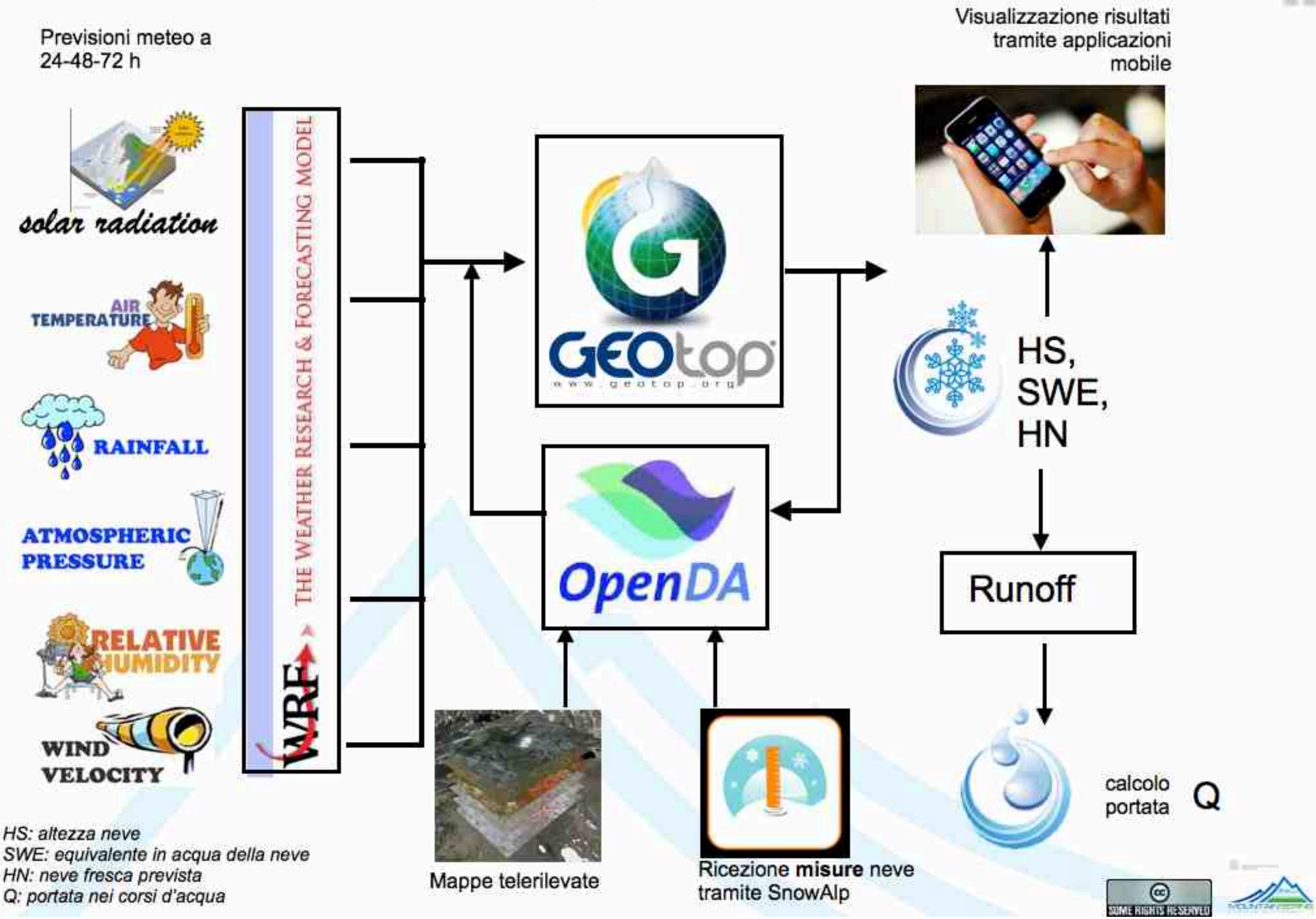
Come monitorare una grandezza ambientale?

La capacità del modello di simulare le temperature del manto stradale sulla base delle forzanti meteorologiche permette di stimare le temperature del manto stradale in punti di interesse dove NON esistono misure in loco

Catena modellistica

GEOtop + WRF



Previsioni meteo a
24-48-72 h
solar radiation
AIR
TEMPERATURE
RAINFALL
ATMOSPHERIC
PRESSURE
RELATIVE
HUMIDITY
WIND
VELOCITY
WRF
THE WEATHER RESEARCH & FORECASTING MODEL
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OpenDA
Mappe telerilevate
Ricezione misure neve
tramite SnowAlp
Visualizzazione risultati
tramite applicazioni
mobile
HS,
SWE,
HN
Runoff
calcolo
portata
Q
HS: altezza neve
SWE: equivalente in acqua della neve
HN: neve fresca prevista
Q: portata nei corsi d'acqua
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Grazie dell'attenzione

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