UNIVERSITA' DEGLI STUDI DI TORINO
POLITECNICO DI TORINO

Dipartimento Interateneo di Scienze, Progetto e Politiche del Territorio

SNOWMELT MASS AND ENERGY BALANCE ON A STEEP SLOPE

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NEXTSNOW Project

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1) THE ALPS HAVE COMPLEX
MORPHOLOGIES

2) THE ALTITUDE RANGE WHERE THE SNOWLINE WONDER IS WIDER AND WIDER, DUE TO GLOBAL WARMING

In other words, in between these two extremes (2500 m high and the plain)

there is a range in altitude of several hundred meters where snow falls and melts away several times per year.

Introduction

→ **SOIL SURFACE SPATIAL VARIABILITY : ITS EFFECTS**

→ **FAST DYNAMICS (SURFACE TEMPERATURE RISE OF 20 DEGREES IN A FEW MINUTES, ALBEDO VARIES IN A FEW HOURS)**

GLOBAL WARMING ENHANCES THESE DYNAMICS

FEEDBACK ON THE ATMOSPHERE

INFLUENCE ON RIVER DISCHARGE AND GROUNDWATER RECHARGE

Objective

Monitoring a south-east aspect slope at 1730 m asl during fast snowmelt events (1-3 days) and quantifying:

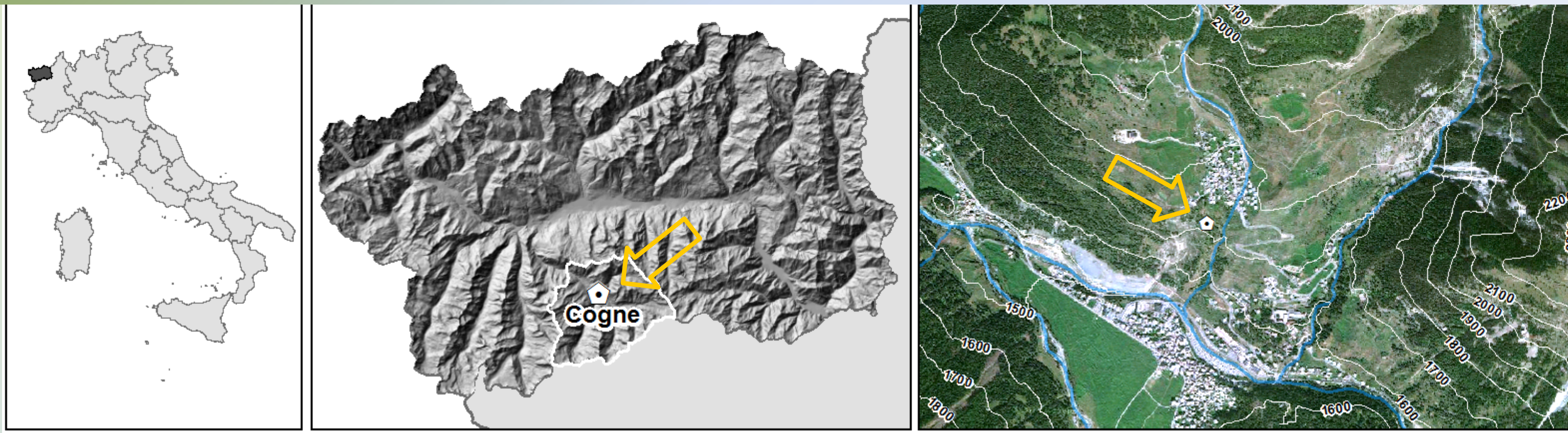
- **Mass balance**
- **Energy closure (is often a problem)**

$$\mathbf{R_n - G - S - H - LE = M}$$

M = **energy** needed to melt the **snowpack**

R_n = Net Radiation
G = Soil heat flux
S = Soil heat stock variation
H = Sensible heat
LE = Latent heat

Location of the monitoring site



Altitude: 1730 m asl;

Aspect: South-east;

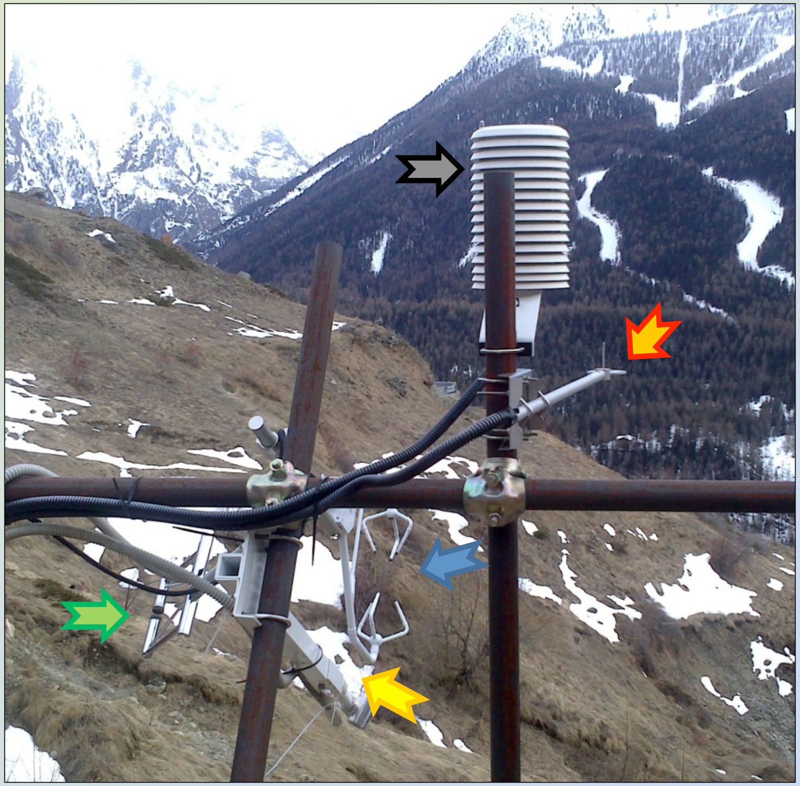
Slope: 26°;

Average yearly T : +4°C;

Average yearly precipitation: 650 mm;

Landcover: herbaceous/ shrubs

Monitoring site



- Tridimensional sonic anemometer
- Infrared gas analyser (Licor)
- Kripton hygrometer
- Thermo-hygrometer
- Net radiometer

Soil heat plates (x2) – 6 cm (thermocouples)
TDR soilmoisture probes (x2) – 8, 20, 40 cm
Soil thermometers (x4) – 2 e 8 cm
Surface infrared thermometer
CR3000datalogger
Photovoltaic electrical supply
Nearby ARPA meteorological station

Monitoring start→ September 2010 (all year long)
Snowfall events→ automn (October/November)
spring (March/April)

Snow Water Equivalent range : 7.8 - 28 mm

Monitoring results

ENERGY FLUXES [W/m²]

- Net Radiation on the slope (Rn)
- Latent heat flux (LE)
- Sensible heat flux (H)
- Soil heat flux (G)
- Ground storage (S)

TEMPERATURES [T°C]

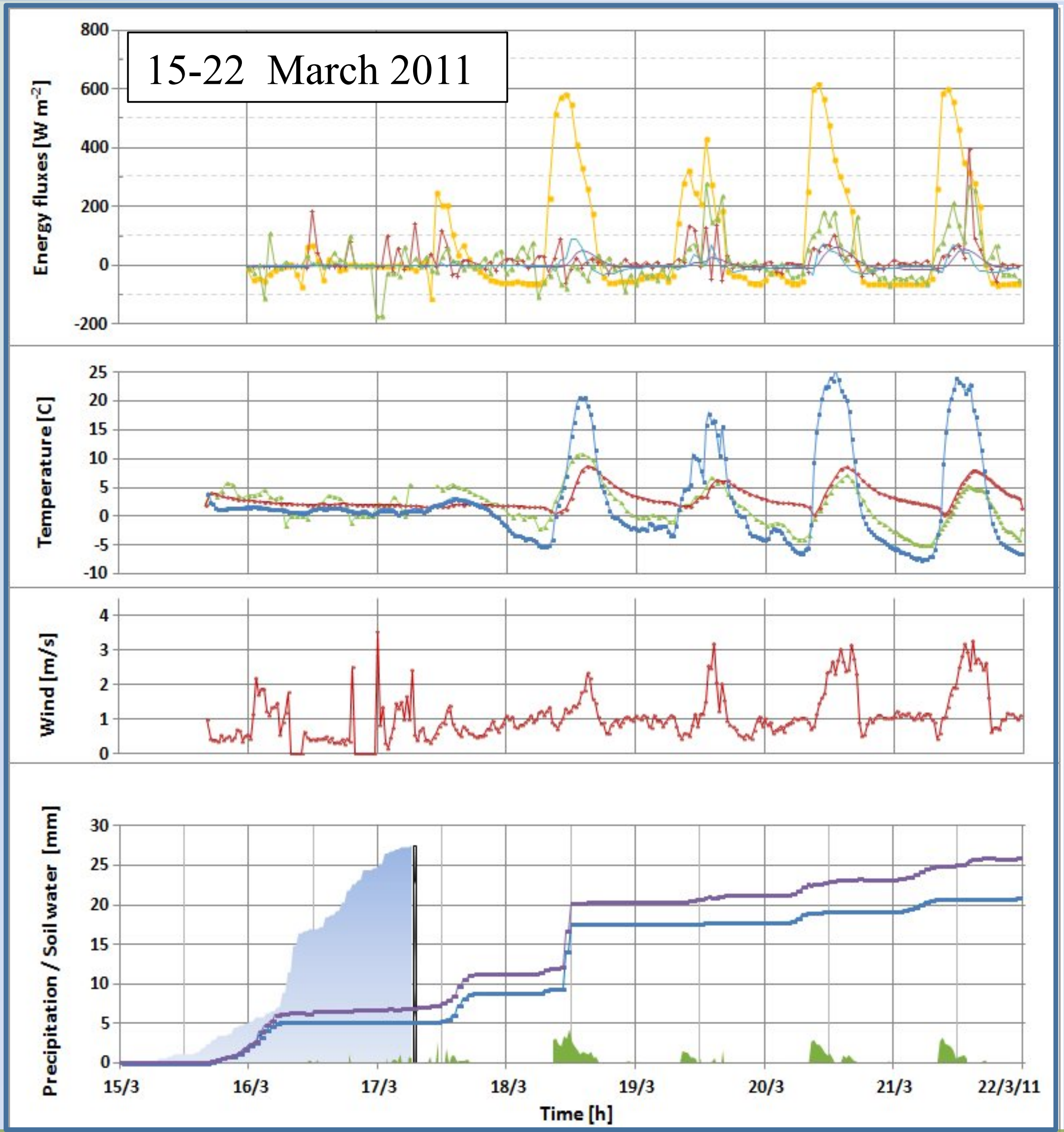
- Air temperature
- Soil temperature
- Surface temperature

WIND (m/s)

- Wind speed

MASS BALANCE (mm)

- Cumulative snowfall (SWE)
- Measured SWE
- Soil moisture increase
- Soil moisture + Evapo-sublimation
- Residuals of Energy Balance



Energy and mass balance at the surface of a mountain slope, during repeated snowpack fusion events

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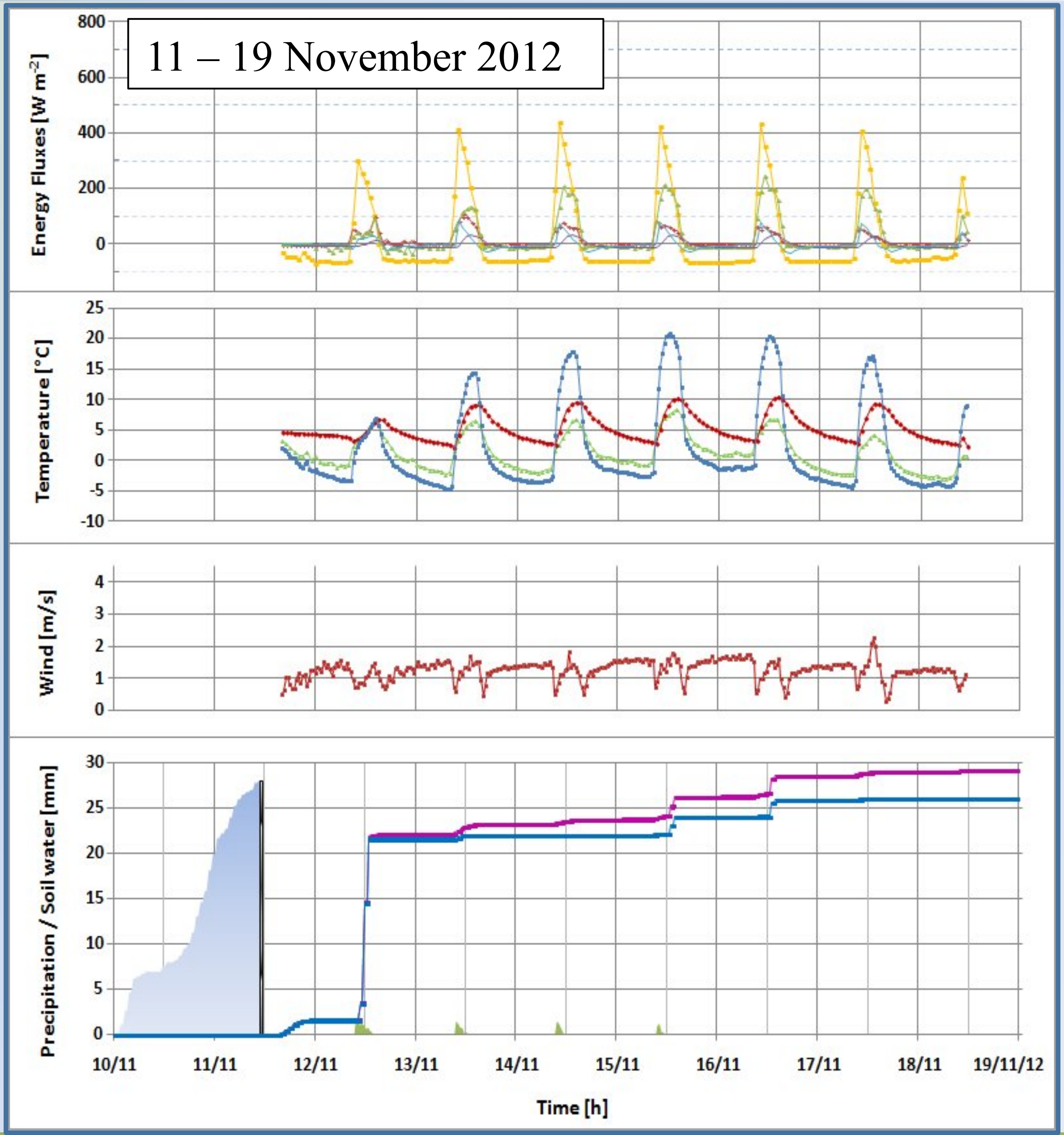

Energy and mass balance at the surface of a mountain slope, during repeated snowpack fusion events

Conclusions

First analyses of data show the following:

1) Mass balance is OK.

2) Solar radiation perpendicular to the slope provides enough energy to melt the whole snowpack in a few hours/days (depends on variable SWE, automn vs.springtime).

3) The melting energy helps to close the balance, but it is not enough.

4) Evapo- sublimation is not disregardable (both mass and energy).

5) Wind and soil heat contribution seems to be disregardable in this site, while the vegetation and litter between snow and soil needs to be better studied.

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Thanks for your attention !!

What news?
4-component radiometer since 13th August 2014