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A decision support tool to help prevent risks induced by permafrost degradation in high alpine environments

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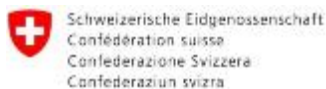
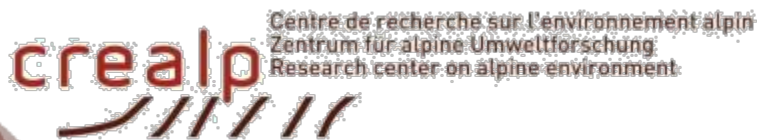
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Some of the authors of this publication are also working on these related projects:



Risk adaptation to degrading cryosphere [View project](#)

A decision support tool to help prevent risks induced by permafrost degradation in high alpine environments



Bundesamt für Umwelt BAFU
Office fédéral de l'environnement OFEV
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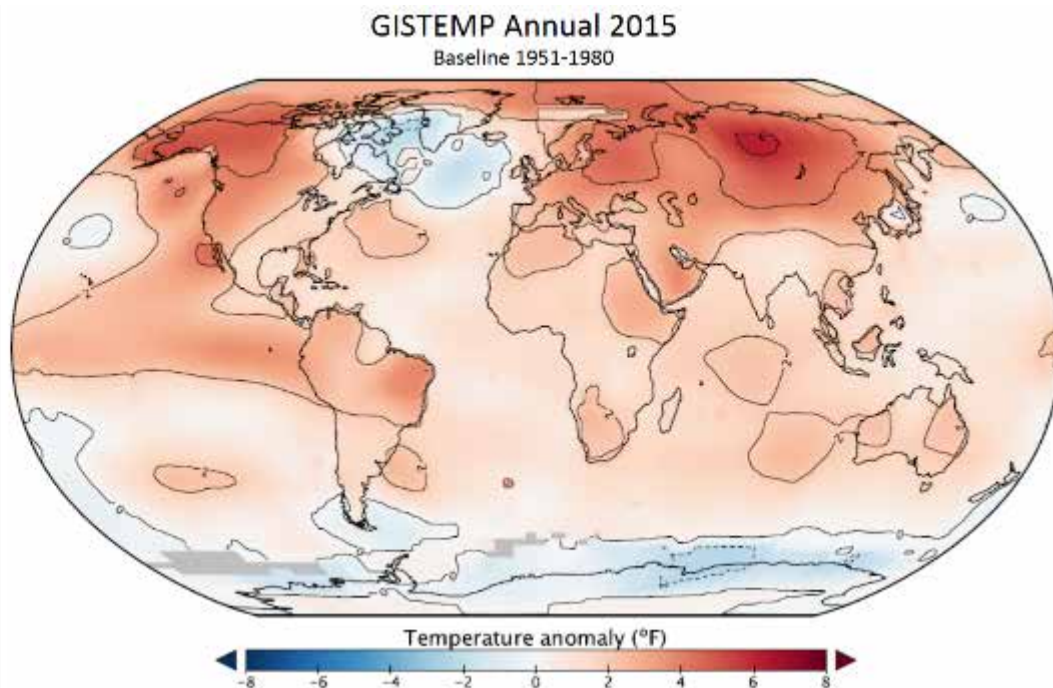


Bardou Eric
Favre-Bulle Guillaume
Ornstein Pascal
Pache Barnabé
Délèze Jean-Yves
Mayoraz Raphaël

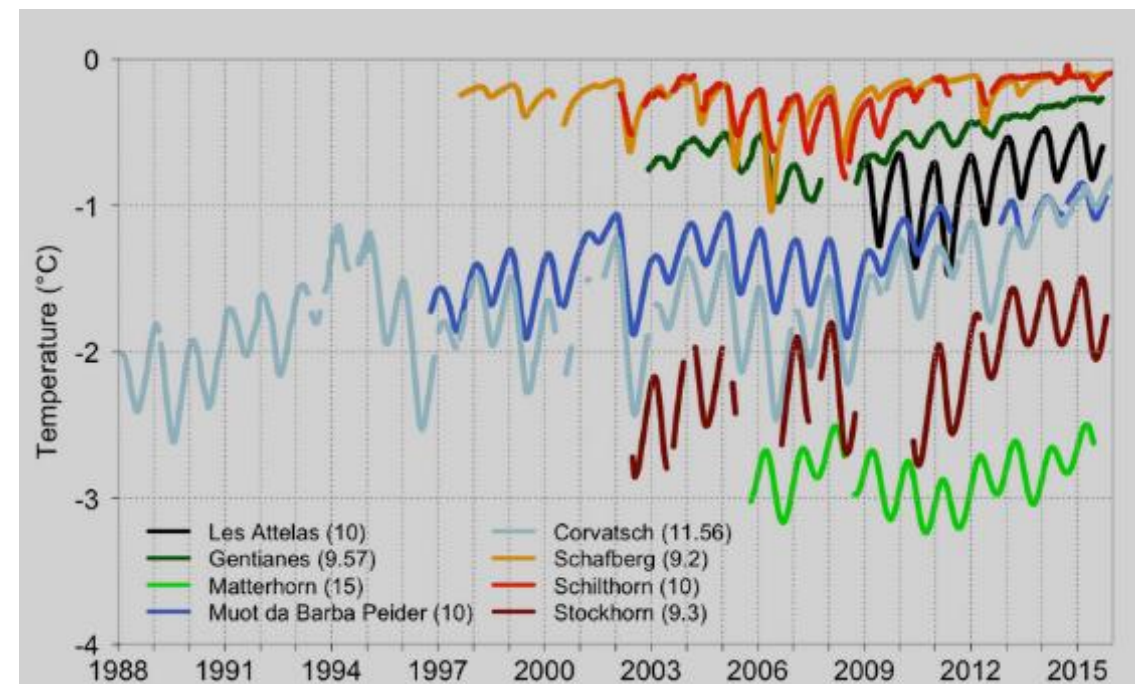
Federal Office for the Environment (FOEN) pilot program for climate change adaptation Risks associated with cryosphere degradation

2015:
0.87°C / 1.57°F
above 1951-80
average

Warmest year of
NASA GISTEMP
record



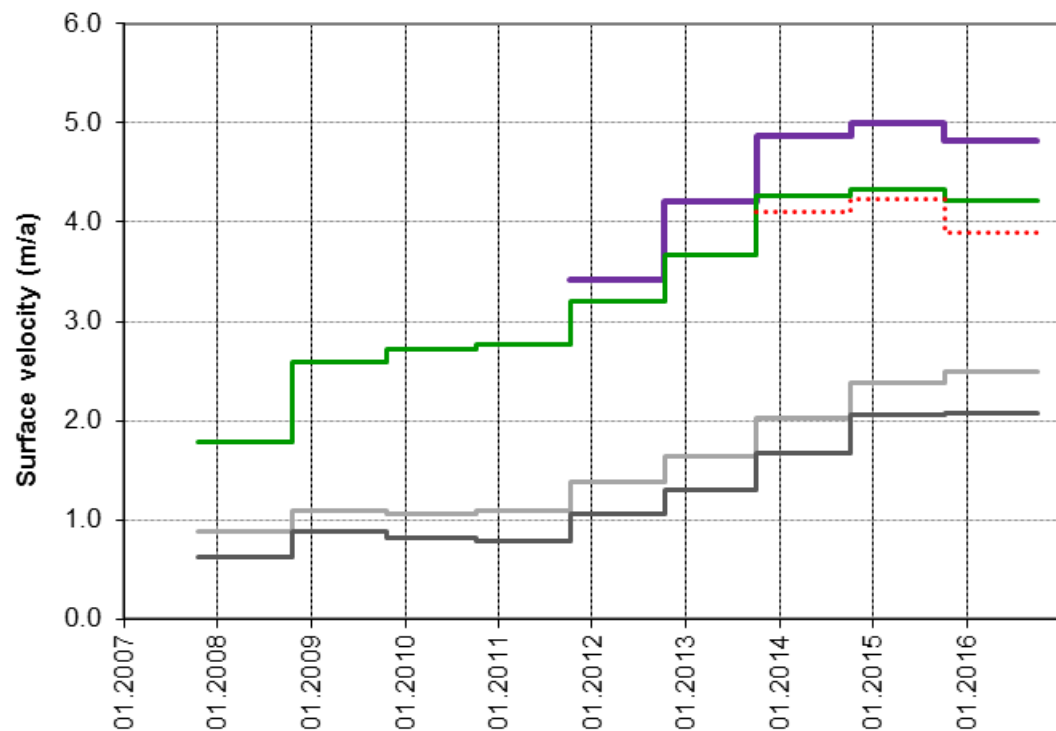
Credits: NOAA/NASA - Annual Global Analysis for 2015



Credits: PERMOS, Borehole temperature at PERMOS monitoring sites at ~10 m depth

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Project



Sektoren auf dem Blockgletscher, von der Stirn bis zur Wurzelzone :
Rock glacier sections, from the front to the rooting zone :

- Zone N 4b (3 pts)
- Zone N 3 (5 pts)
- Zone N 3b (5 pts)
- Zone 2 (5pts)
- Zone 1 (3pts)

(c) UniFR
Last update : 10.2016

Credits: UniFR, Delaloye R., 2016

Main natural hazard in our study : debris flows



Photo : Favre-Bulle G., 2013

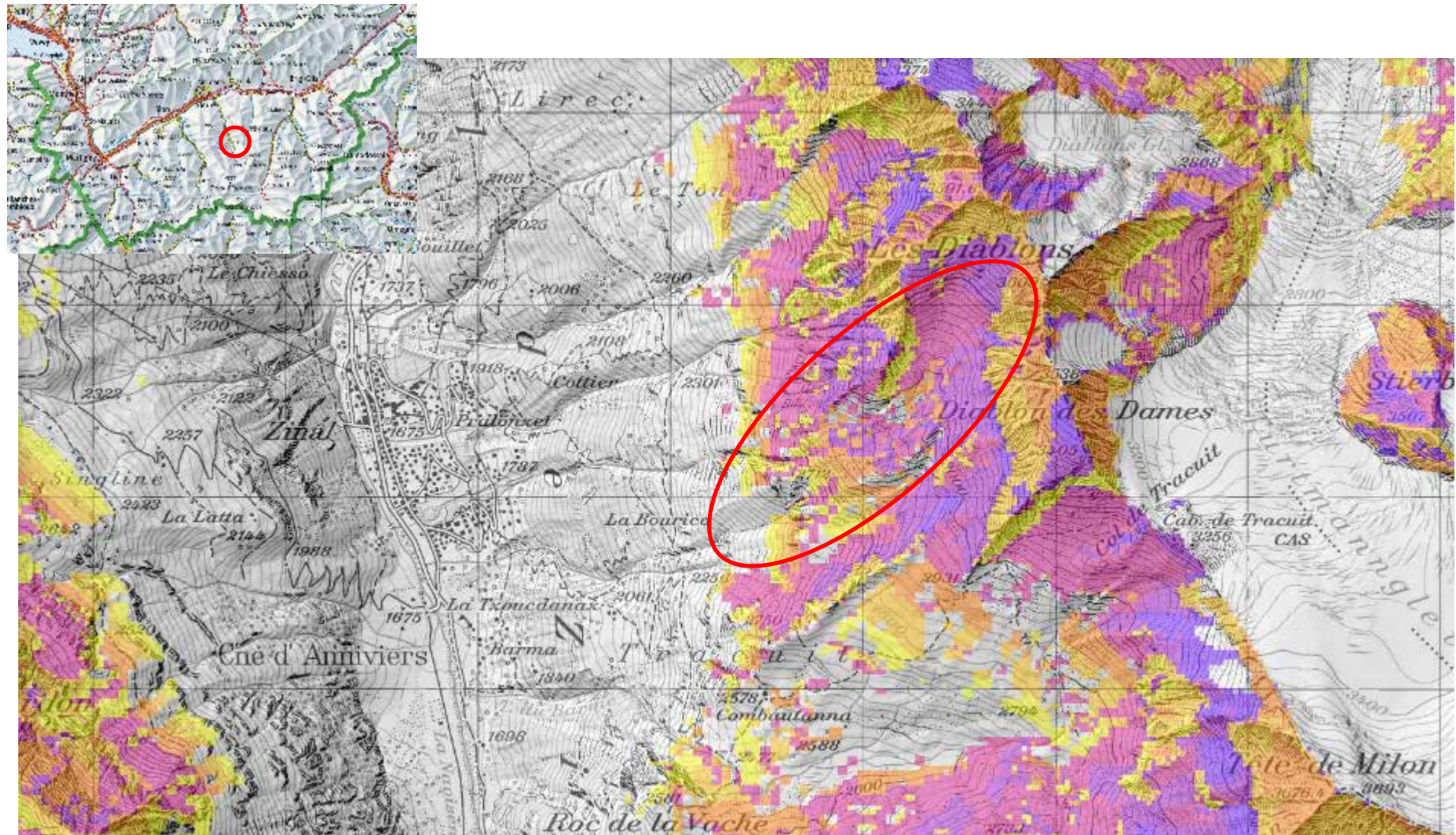


Photo : Rouiller J.-D., 2006

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Study sites

Glacier Bonnard
Val d'Anniviers



Credits : Swisstopo + OFEV (geo.admin.ch)

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Study sites

Glacier Bonnard
Val d'Anniviers

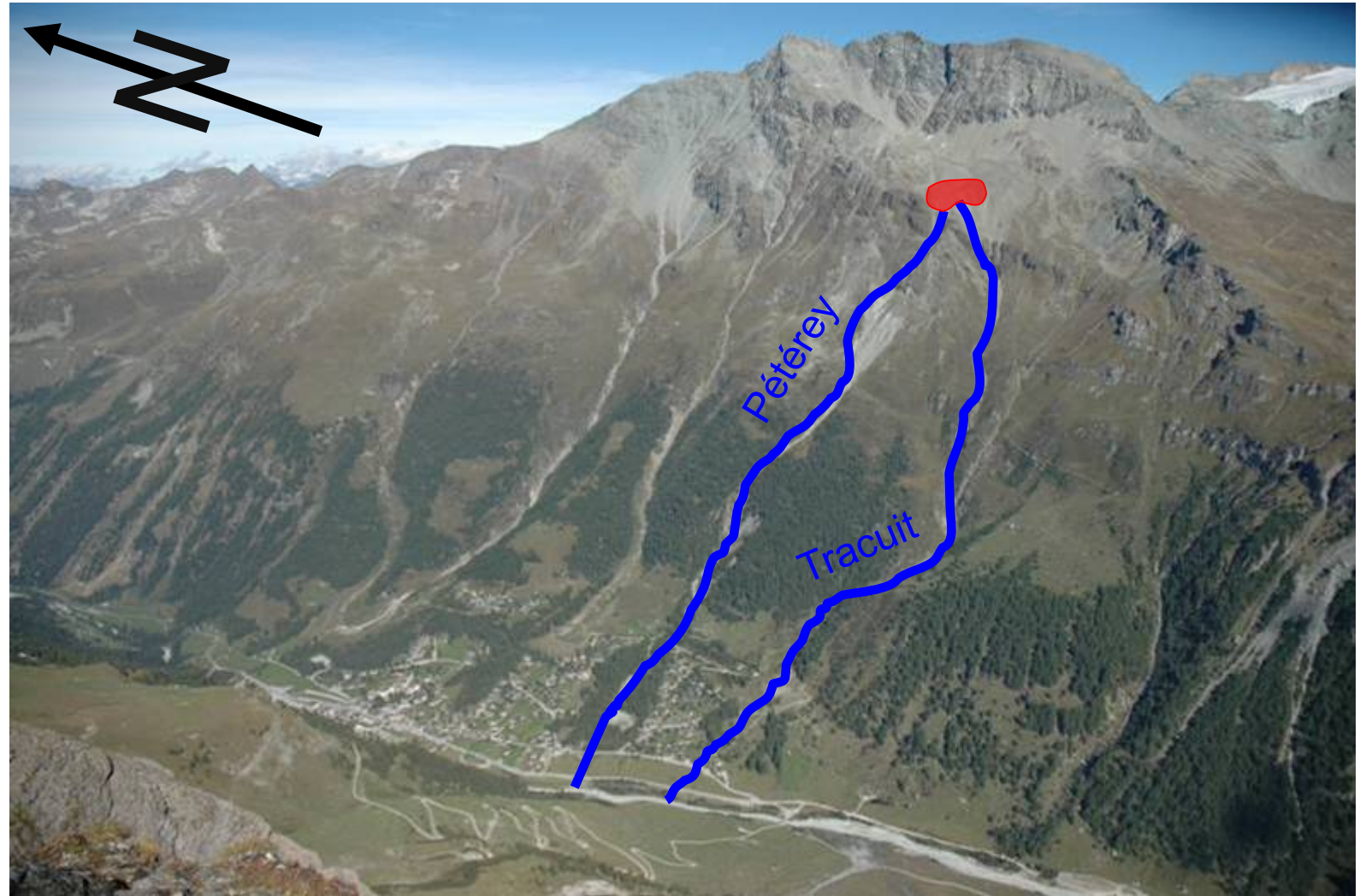


Photo : Bardou E.

Study sites

Glacier Bonnard
Val d'Anniviers

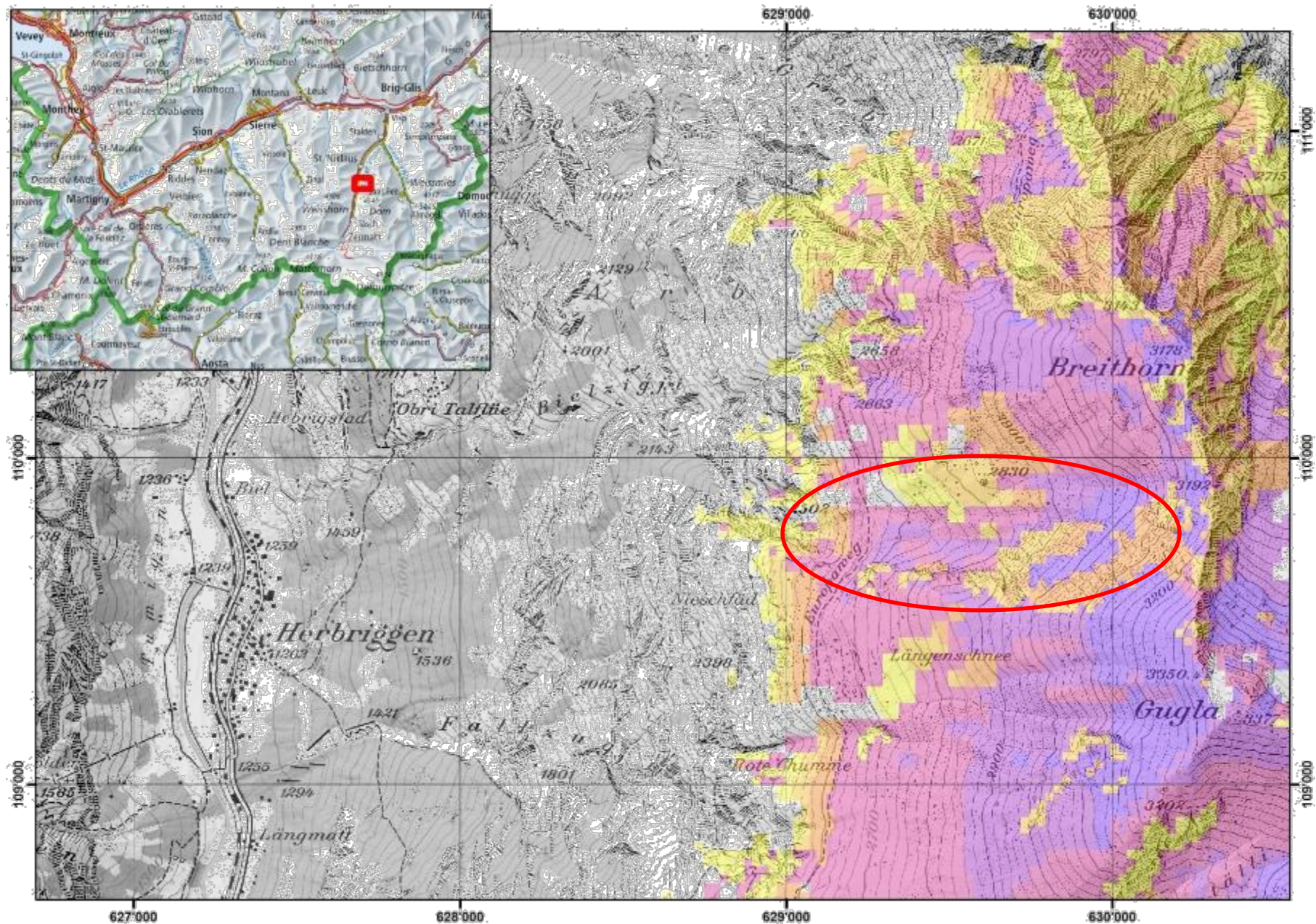


Credits : Google Earth

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Study sites

Gugla – Bielzug
Mattertal



Credits : Swisstopo + OFEV (geo.admin.ch)



14th Swiss Geoscience Meeting 2016, Geneva, 19.11.2016

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Study sites

Gugla - Bielzug



Credits : Google Earth

A decision support tool to help prevent risks induced by permafrost degradation in high alpine environments

Study sites

Gugla - Bielzug



Study sites

Both study sites produced debris flows events :

- During storms
- On sunny days

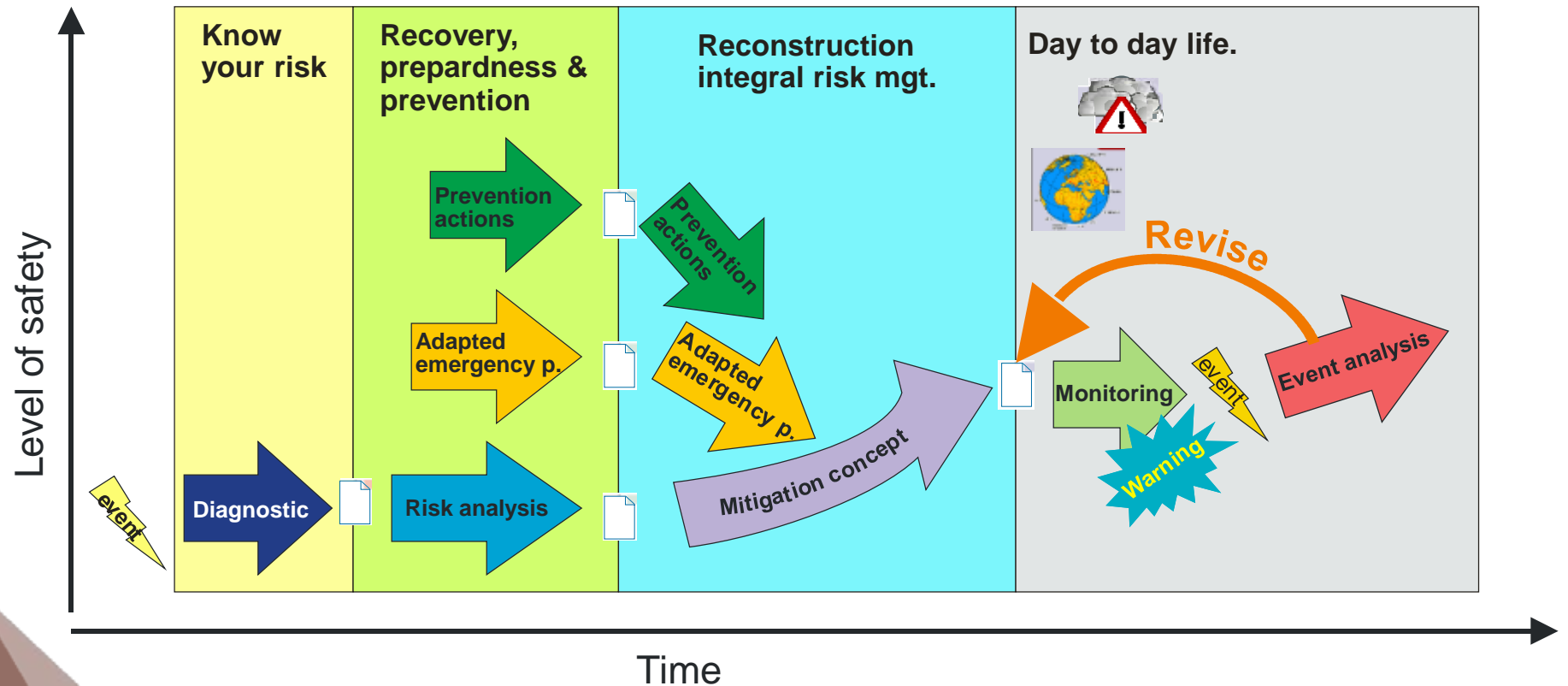


Credits: UniFR, Delaloye R., 2013

Decision support system

Main goal

- To help municipal hazards specialists detect and anticipate a potentially hazardous situation and if necessary, to enter a vigilance state
- Not an emergency tool



Decision support system

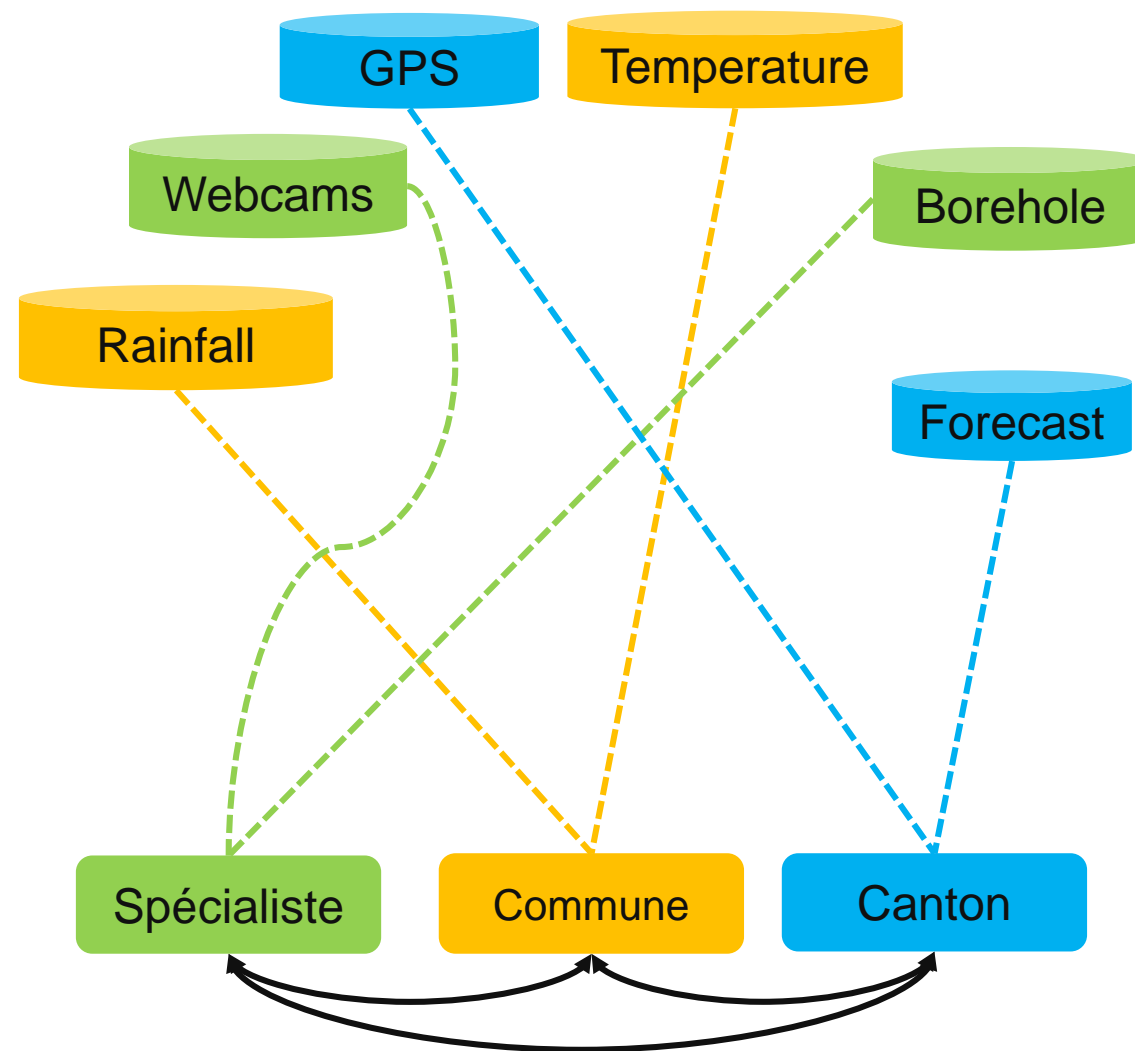
Monitoring based on main parameters that can trigger an debris flow :

- Direct indicators
 - Rainfall
 - Air/ground temperature
 - Snowmelt
 - ...
- Indirect indicators
 - Rock glacier movements
 - Photographic surveys
 - ...

Decision support system

Collected data are heterogeneous both in source and type :

- Many networks
- Many owners
- Many formats
- Many access
- ...



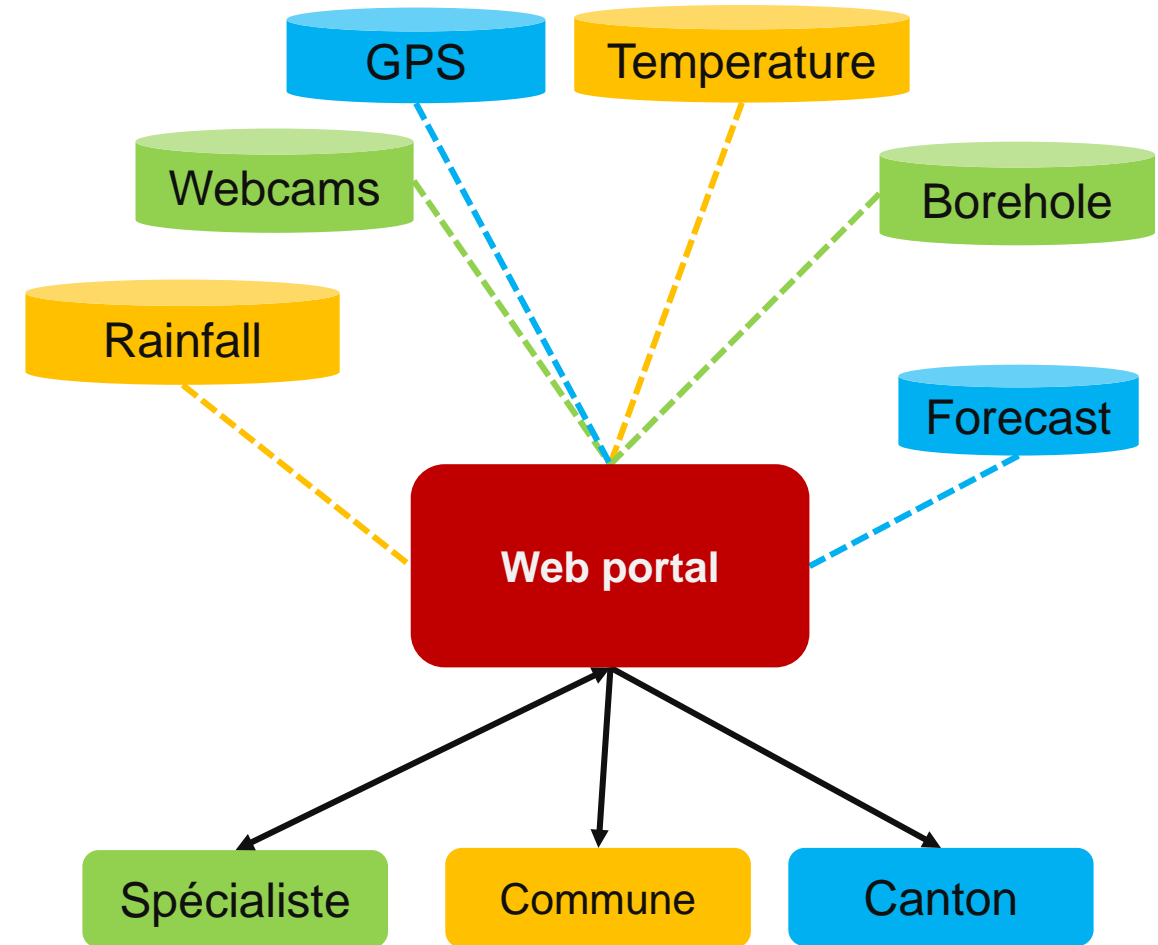
Decision support system

Observations :

- Land-based (federal, cantonal, local networks)
- Radar measurements (Meteoswiss data)
- Satellite (MODIS)

Forecasts :

- COSMO (Meteoswiss) : rainfall + temperature, more in the near future



Decision support system

Main target : municipal hazards specialists -> easy and simple to use -> dashboard

Accueil

OFEV Changements climatiques

Paramètres Déconnexion

Glacier Bonnard

Indicators

Glacier Bonnard

Precipitations

Température

Forte

Déplacement

Webcams

Hydrologie

Sensors

Données spatiales

Glacier Bonnard - Station virtuelle (VRTL)

Glacier Bonnard

Station météo de référence

Station météo

Précipitations prévues

Précipitations observées

Basé sur les prévisions COSMO-E du 16.11.2016 01:00

Basé sur les prévisions COSMO-7 du 16.11.2016 13:00

Glacier Bonnard - Station virtuelle (VRTL)

Altitude: N/A

Intensité de précipitations [mm/h]

Température [°C]

Seuil d'éveil

Montant

Observation (-12h)

Prévision COSMO-E (+120h)

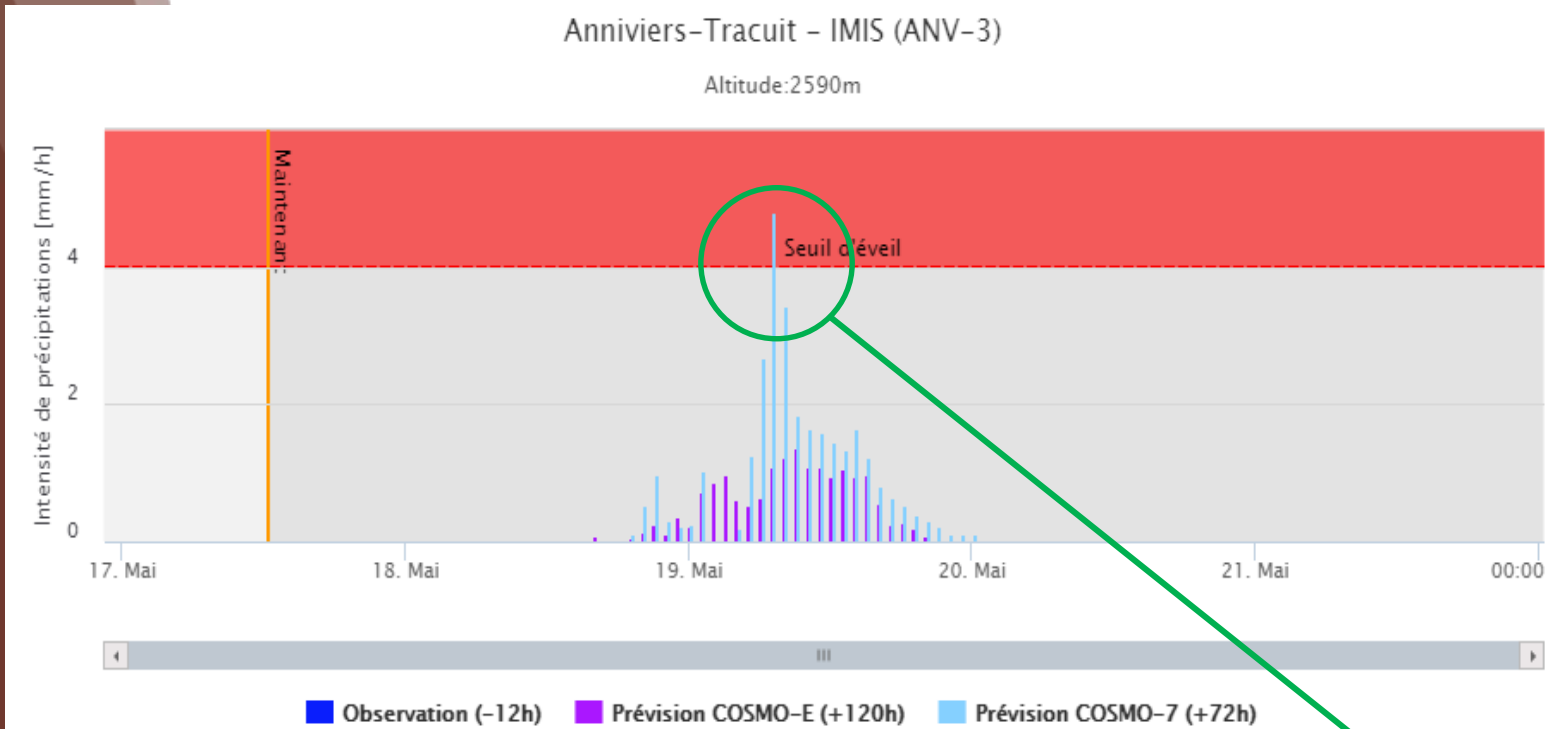
Prévision COSMO-7 (+72h)

Prévisions de température COSMO-7

Prévisions de température COSMO-E

risks induced by permafrost degradation in high alpine environments

Decision support system «Awakening threshold»

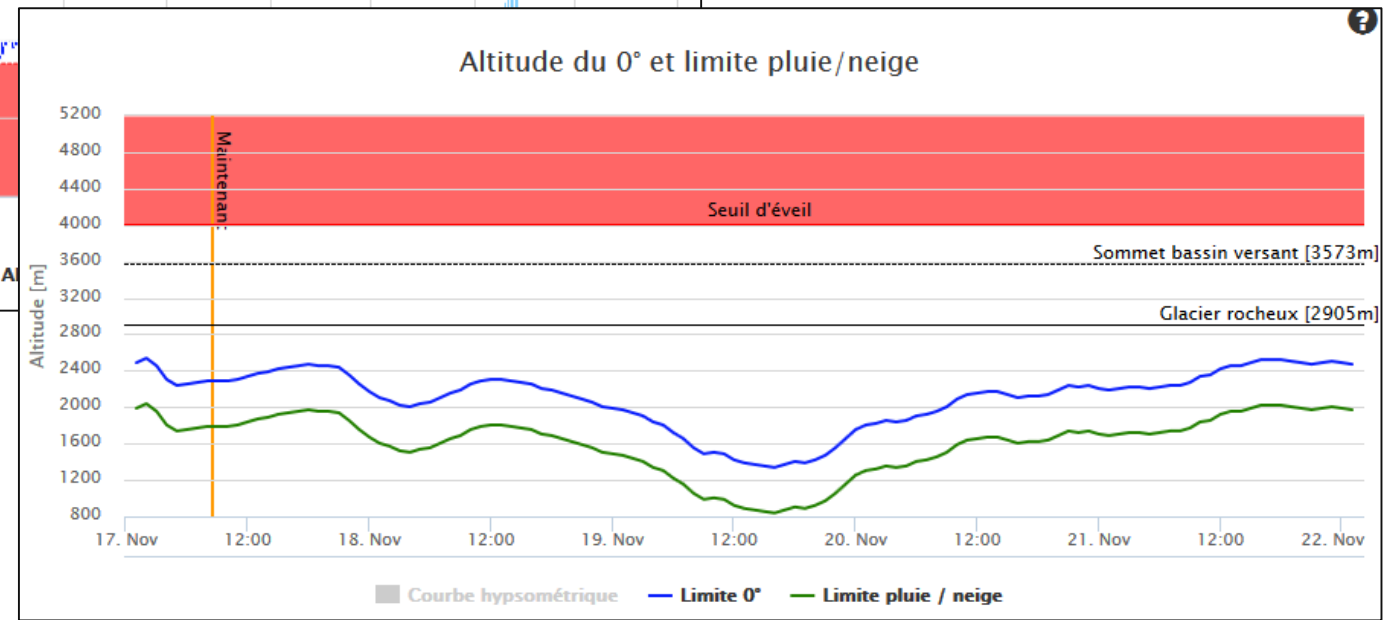
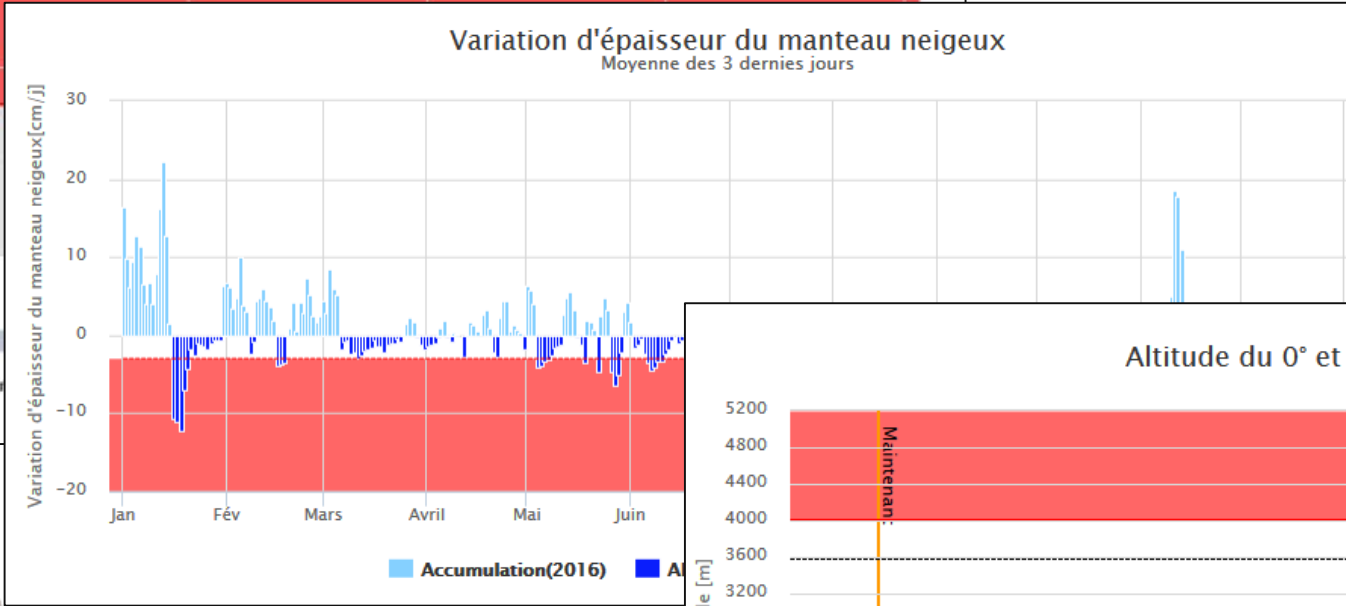
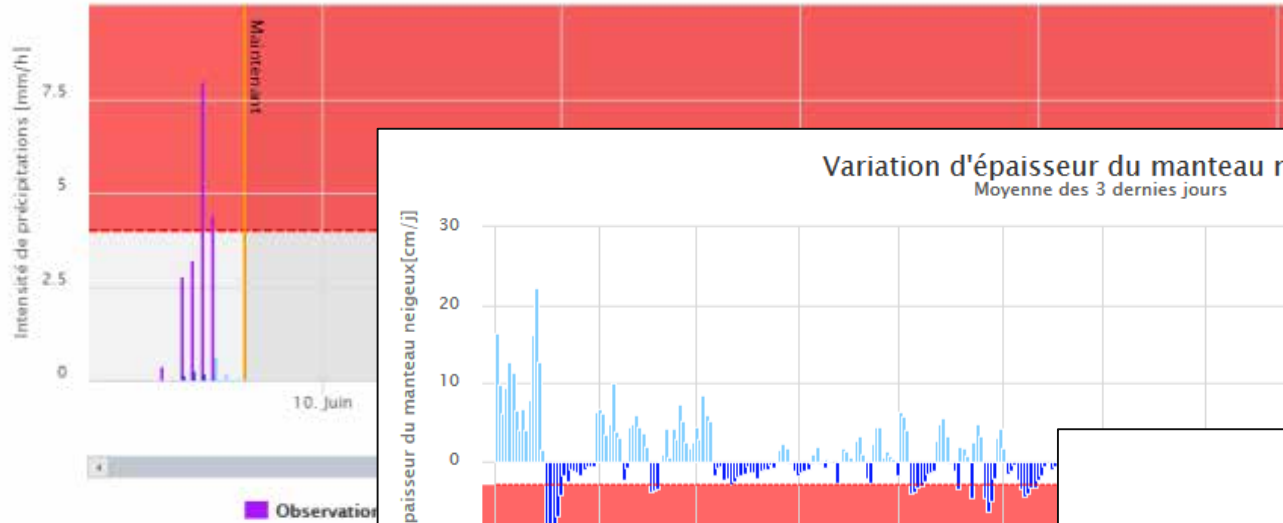


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Decision support system «Awakening threshold»

Anniviers-Tracuit - IMIS (ANV-3)

Altitude: 2590m



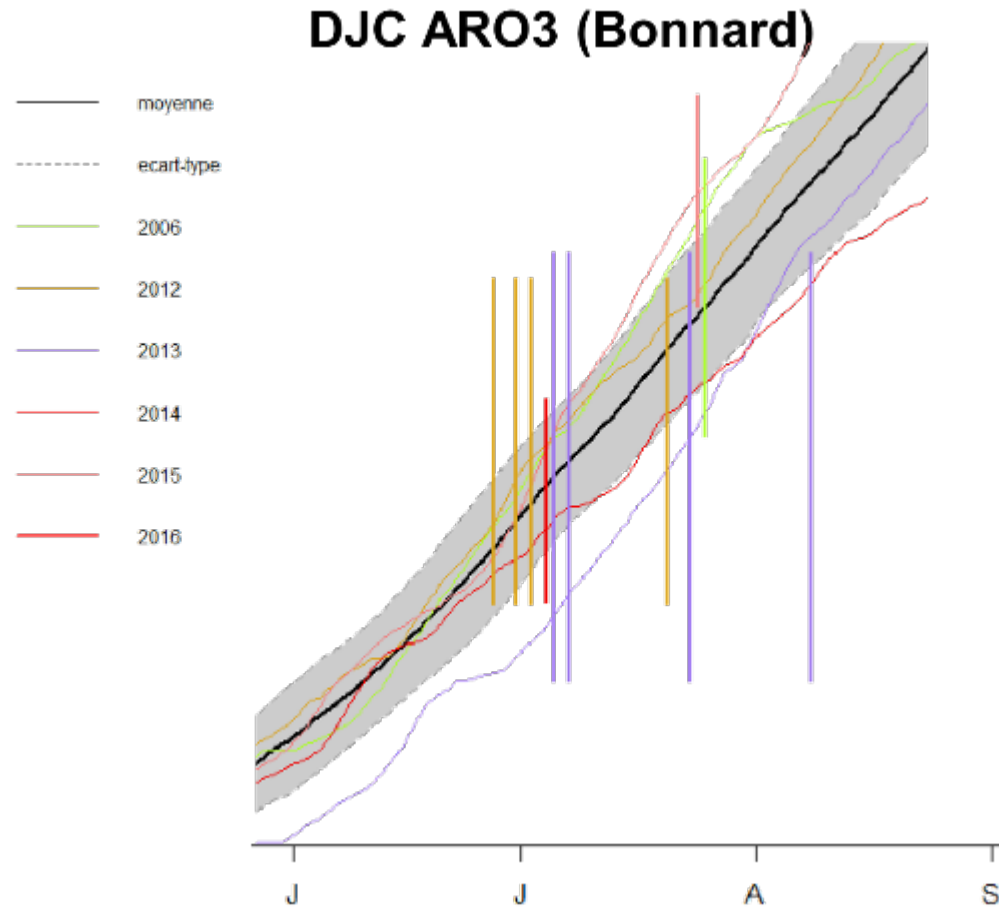
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Decision support system

«Awakening threshold»

- Calculated by the expert
- Easy to change depending on new events



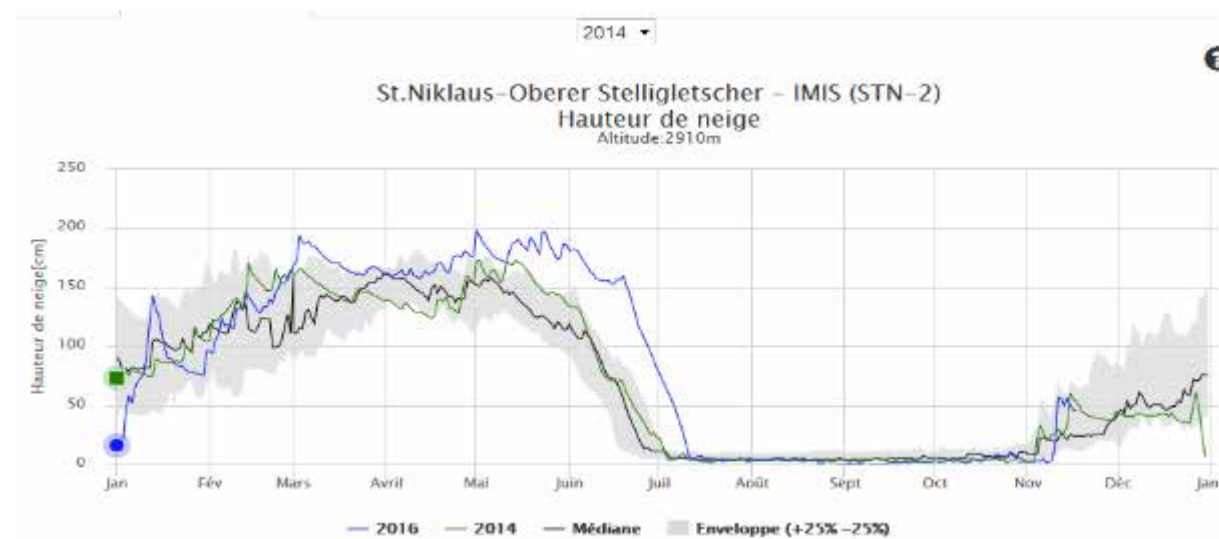
Decision support system

Data visualisation

Easy access to many parameters such as :

- Rainfall, intensity
- Air Temperature
- Altitude of 0°C + rain/snow limit
- Snow height and rate of change in snow height
- Melt Index (degree days over 0°C)
- MODIS data
- GPS speed
- Hydrology
- Webcams

Statistics + comparisons when possible



The two municipalities (St-Niklaus & Anniviers) are using the web portal.

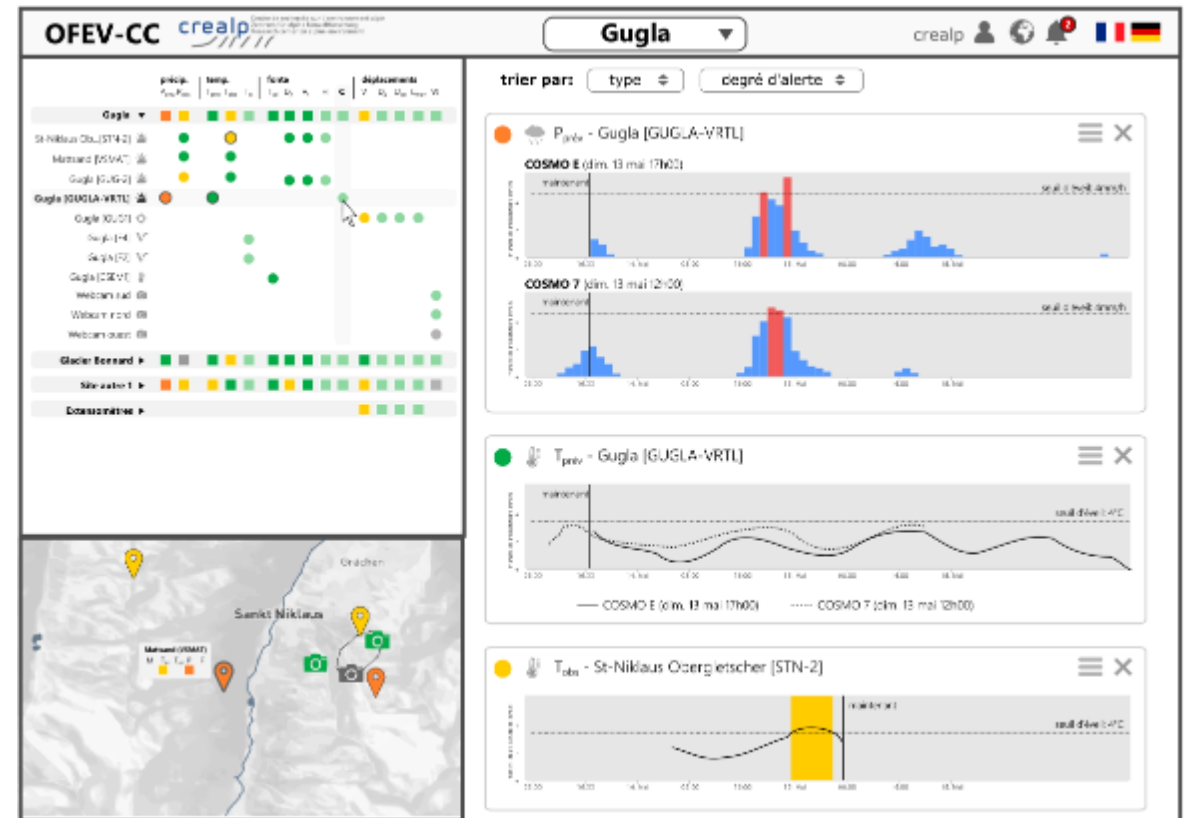
Main feedback :

- The web portal is used on a daily basis
- Very easy and friendly to use
- Some graphs provide situation awareness with the blink of an eye
- Some graphs where not understood, and therefore not used

Future developments

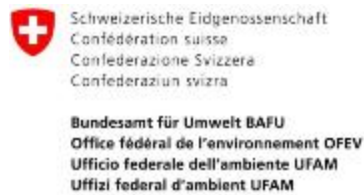
This is still a prototype !

- New indicators : ground temperature, GPS speed
- Better rainfall “awakening threshold”
- Better snowmelt indicators (SLF models ?)
- Interaction between indicators
- New graphic user interface



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Thank you for your attention



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