SPOT 4 –TAKE 5 Program

Snow cover monitoring in the French Alps
physical properties of surface snow,
snow cover dynamics impact on vegetation

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Partners and objectives *(sentinel-2 potential applications)*

- **Météo-France-CNRS** : CNRM-GAME/CEN. *Marie Dumont.*

    ⟹ Physical properties of surface snow (linked with *G. Picard* / LGGE-CNRS)

- **LTHE-CNRS** : Laboratoire d'étude des transferts en hydrologie et environnement. *Jean-Pierre Dedieu (*) & Sylvain Bigot* (**)

    ⟹ * Snow cover mapping at sub-pixel size (%): Spot-4, Landsat-8, VGT/Modis

   ** Snow cover variability and vegetation phenology.

- **LECA-CNRS** : Laboratoire d'Ecologie Alpine. *Philippe Choler, Brad Carlson.*

    ⟹ Snowmelt patterns and alpine plant distribution, ecosystem phenology.

- **IRSTEA** : Institut national de recherche en sciences et technologies pour l'environnement et l'agriculture. *Vincent Thierion* (Project leader), *Laurent Borgnier*.

    ⟹ Snow dynamics versus vegetation phenology, sentinel pastures.

Zone Atelier Alpes (ZAA)

Spot4- Take5 "Alps" footprints
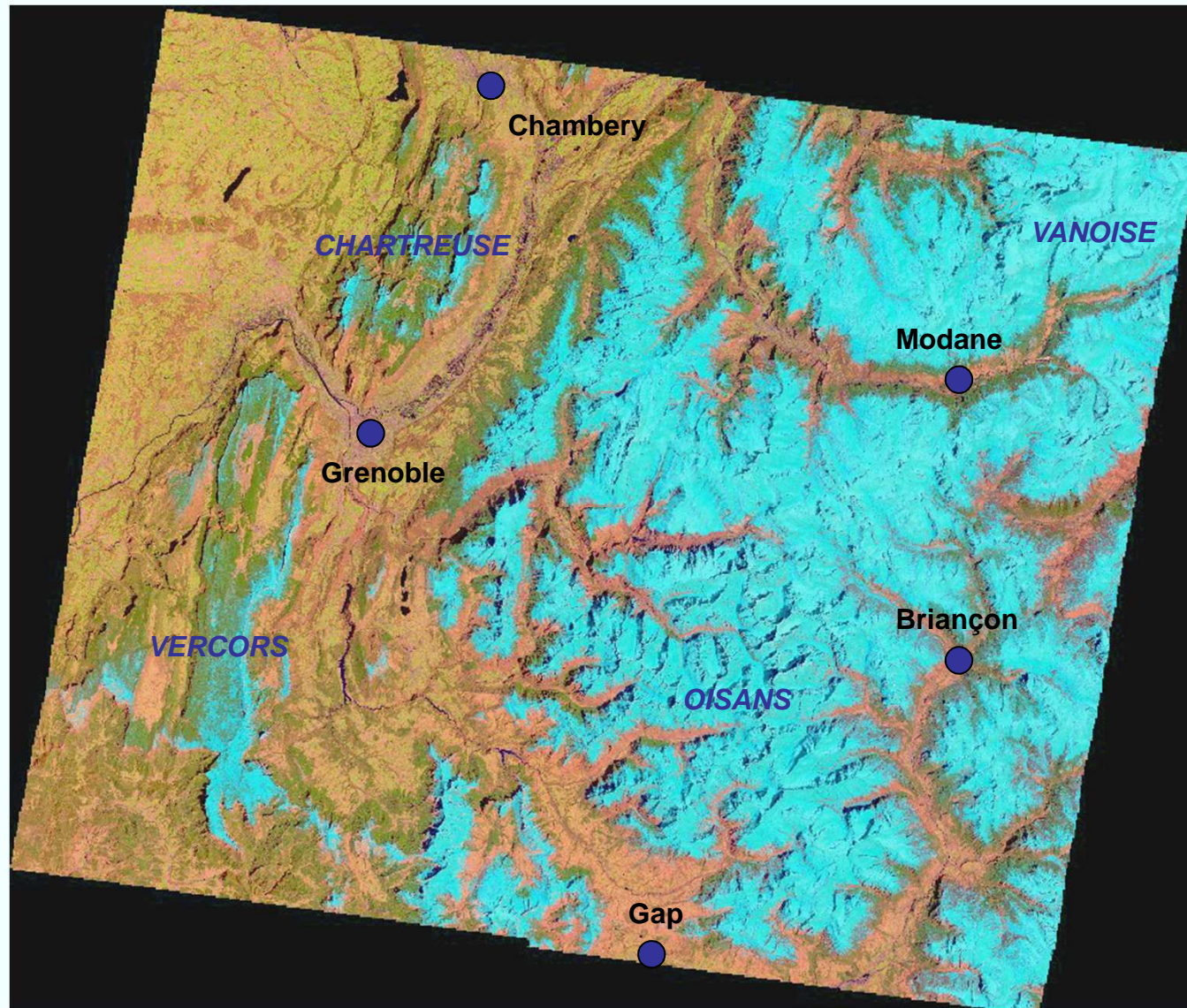
Spot-4 image, 14.04.2013

Main Application Areas

Legend:

- CarHAB project (IRSTEA, MEDDE) — yellow
- Vercors project (ZAA) — blue
- Oisans project (ZAA) — green
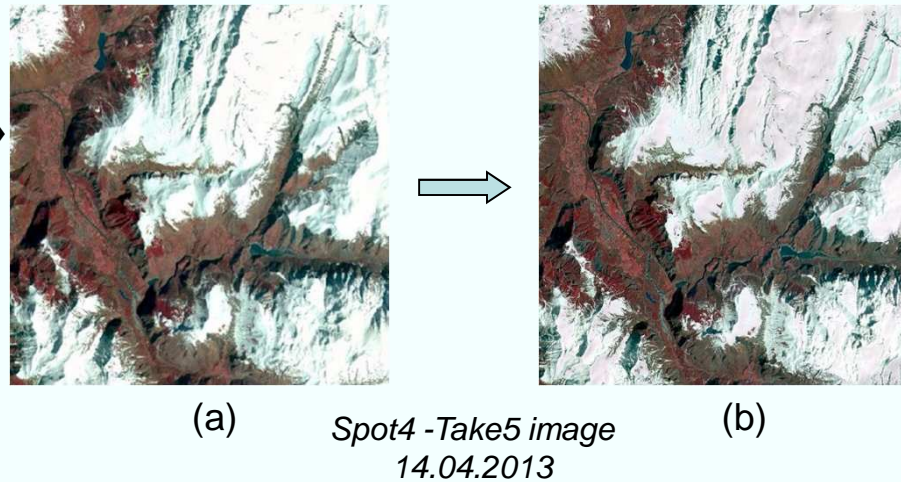- Sentinel Pastures project (ZAA, PNE) — red

GRENOBLE

GAP
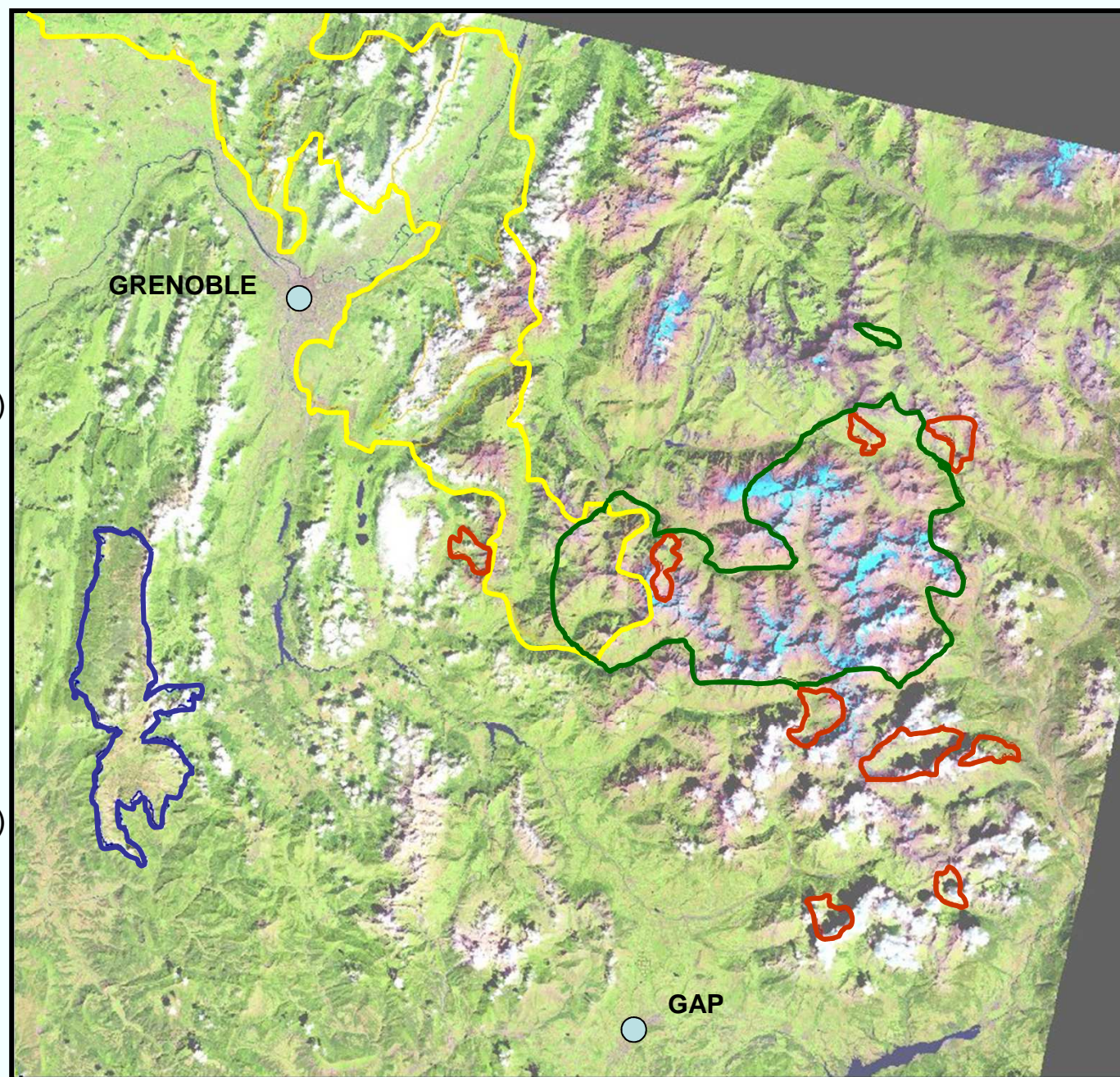
Landsat-8 image, 196-029 31.08.2013

0   20 km

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Data processing

1. SPOT 4 (Cesbio-CNES): 18 dates

2A level products,
« Cor-Env » to « Cor-Slope »
radiometric correction
(DEM SRTM 90-m)

(a)   (b)
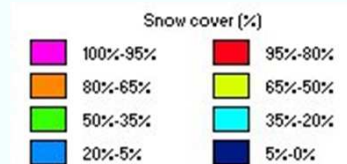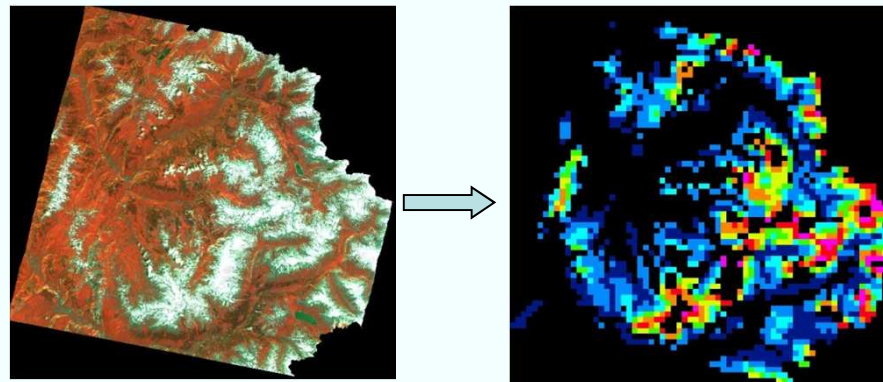
*Spot4 -Take5 image
14.04.2013*

2. Snow cover mapping (LTHE): 30 dates (Spot4, Spot6, Landsat8)

Sub-pixel cover (%):
NDSI, spectral unmixing
(ENVI, ERDAS).

*M2R 2014
(JPDedieu)*

Snow cover (%)

100%-95%	95%-80%
80%-65%	65%-50%
50%-35%	35%-20%
20%-5%	5%-0%

*Spot4 image
17.06.2000*

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APPLICATIONS

1. Physical properties of surface snow

- 9 daily field campaign have been performed simultaneously to SPOT4 overpasses

- Measurements : spectral irradiance and albedo, snow stratigraphy, optical grain size, impurity content

M2R : Evaluation of physical properties of surface snow retrieved from SPOT4 data using field measurements
(M. Dumont et G. Picard)

METEO FRANCE
Toujours un temps d'avance

L G G E
Laboratoire de Glaciologie et Géophysique de l'Environnement

2. Linking snowmelt patterns to alpine plant distribution

Snow cover dynamics

• patterns of seasonal snowmelt in alpine landscapes occur with surprising consistency from one year to the next

• snow has a direct effect on the abiotic constraints controlling plant growth → temperature, wind exposure, moisture

• climate change is anticipated to alter snowmelt regimes, which will affect the composition of alpine plant communities

SNOW → Key driver of alpine plant distribution

Spring snowmelt at the Col du Lautaret (2000m)

Alp Botany
DOI 10.1007/s00035-013-0117-4

REVIEW

Working toward integrated models of alpine plant distribution

Bradley Z. Carlson · Christophe F. Randin ·
Isabelle Boulangeat · Sébastien Lavergne ·
Wilfried Thuiller · Philippe Choler

Arctic, Antarctic, and Alpine Research, Vol. 41, No. 3, 2009, pp. 347-361

Introduction of Snow and Geomorphic Disturbance Variables into Predictive Models of Alpine Plant Distribution in the Western Swiss Alps

Christophe F. Randin*§

PhD 2014-2016: B.Carlson (Ph. Choler)

Currently, there is a concerted effort among ecologists and snow scientists to incorporate snow cover as an explanatory variable in **Species Distribution Models (SDMs)**

LECA
Laboratoire d'Ecologie Alpine

3. Improved monitoring of vegetation dynamics in relation to climate and snow cover in Vercors mountains

⊃ **Cartography and differentiation of vegetation types;**

⊃ **Identify main phenophases and vegetation seasons (bud, foliation, maturity, senescence, dormancy);**

⊃ **Determine climatic influences on vegetation seasonality, especially those of snow cover intraseasonal variability.**

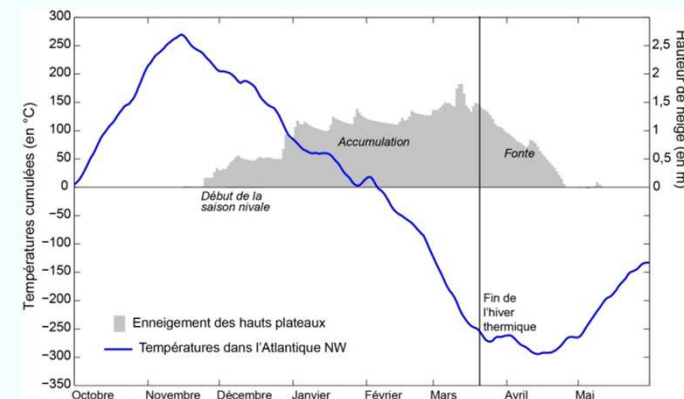*April to October monthly integrated NDVI in the Vercors.*
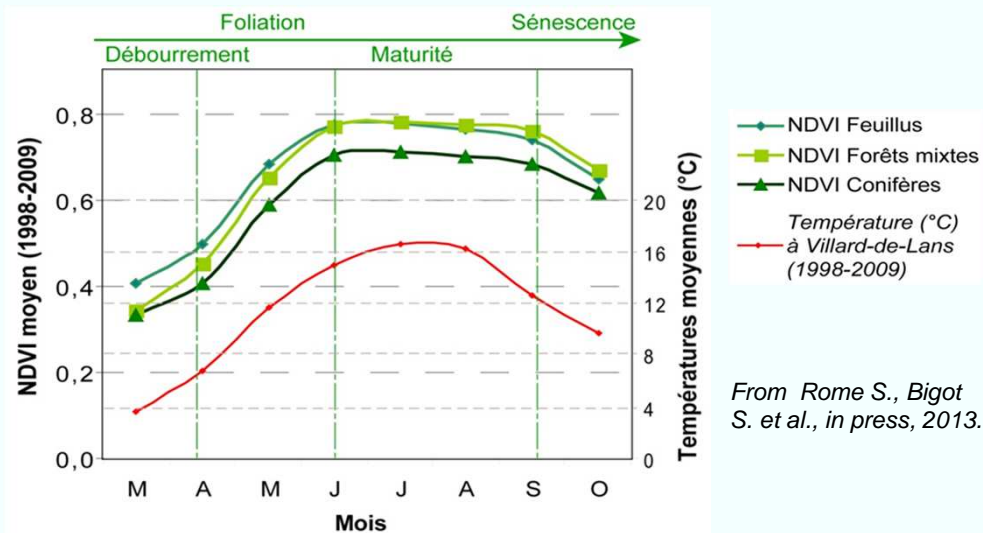
From Rome S., Bigot S. et al., in press, 2013.

Monthly average NDVI (SPOT-VGT 1998-2009) from March to October for the three main types of forest in the Vercors.
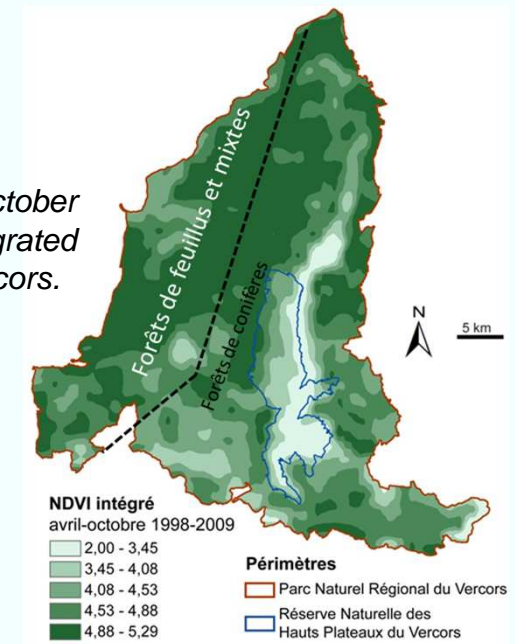
Snow cover on the high plateaus of the Vercors during winter 2005-06 and temperature variability in northwest Atlantic European area.

From Bigot S., Rome S. et Dedieu J.-P., 2009.

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4. CarHAB : Cartography of vegetation types

Project objective :

Semi-natural and natural vegetation mapping
of moutainous areas based on a phytosociological typology

Method :

1) A physiognomy classification of vegetation by HRS remote sensing
2) Species distribution models for ecological compartments delineation

Increasing needs :

-To determine snow cover dynamics (Task 2)
-To know main phenophases of the vegetation during summer season (Task 3)

GRENOBLE

**The combination of physiognomy and ecological compartments
should drastically improve the automatic recognition of agroecological types
in order to assist ecologists for accurate mapping**
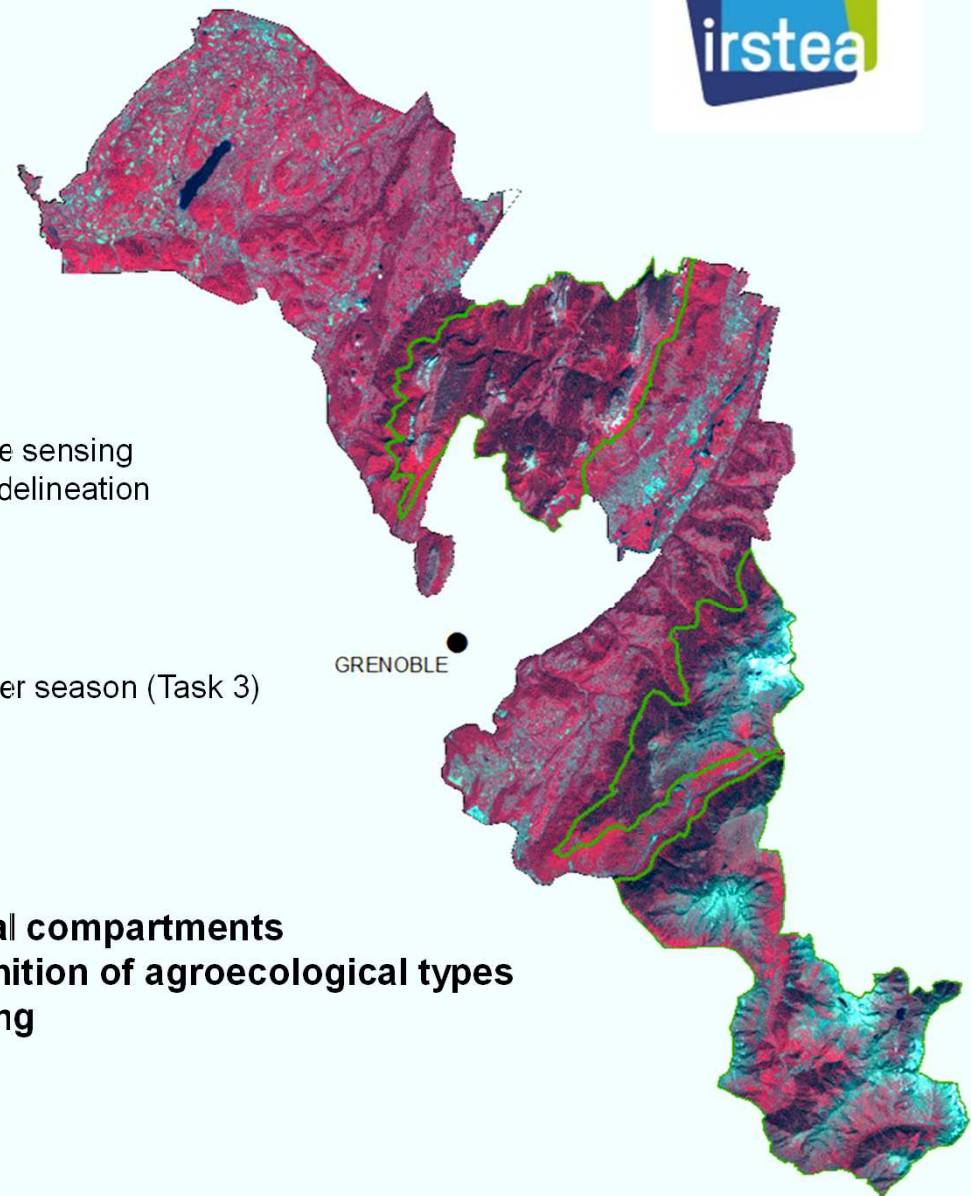
Key questions addressed

SNOW

1. Estimate temporal and spatial variability of the snow cover distribution (%) between sensors : Spot4 vs Landsat8 (local scale) and vs VGT/MODIS (regional).

2. Compare satellite data and ground measurements of snow surface physical properties.

VEGETATION

1. Estimate inter-annual variability in the Net Primary Productivity (NPP) of mountain vegetation (using NDVI-based approach).

2. Compare satellite and ground estimates of phenology and forage production.

3. Assess the relative importance of the time available for plant growth (length of the snow free period) & the climate of the growing season on NPP.