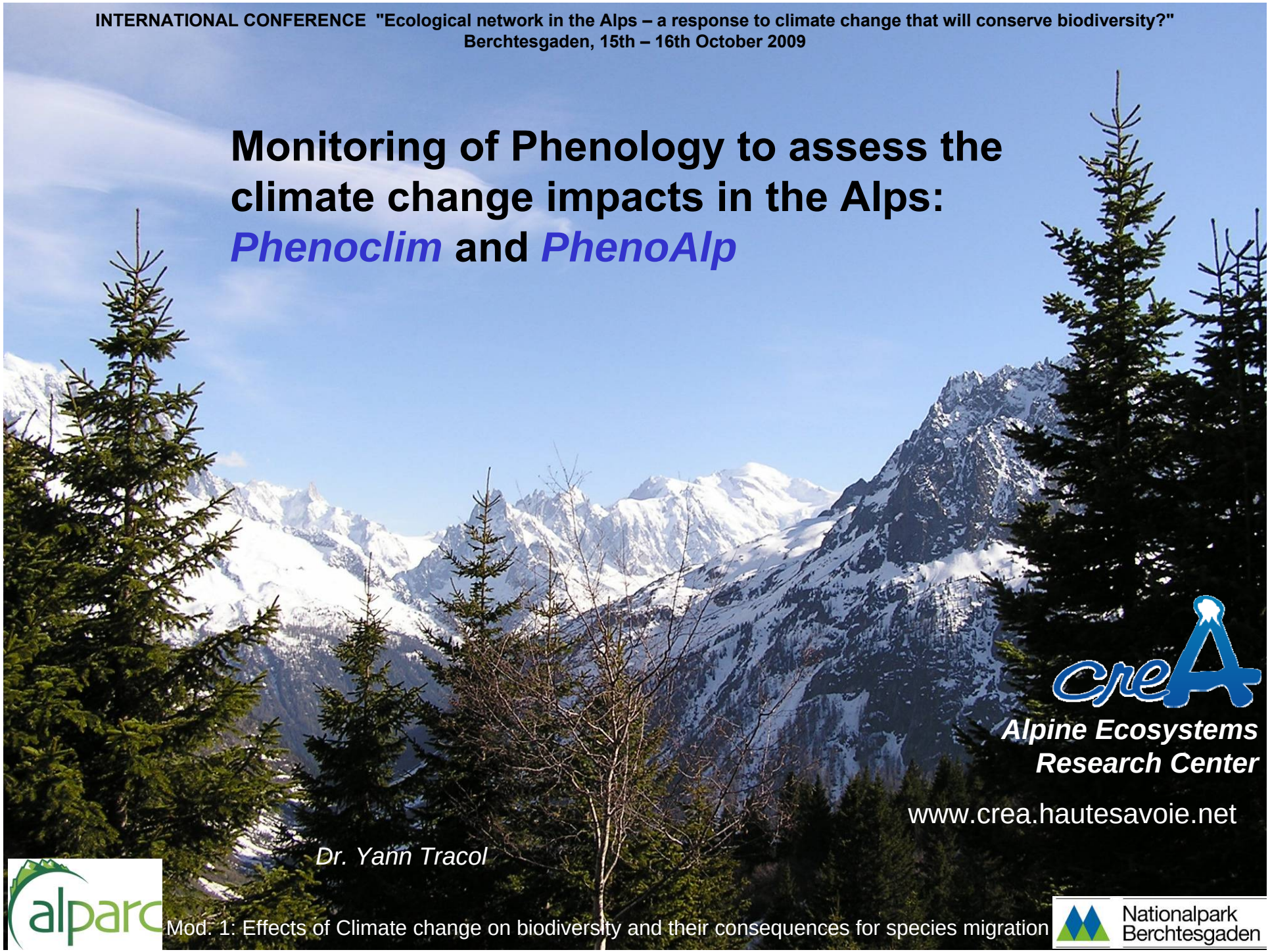
INTERNATIONAL CONFERENCE "Ecological network in the Alps – a response to climate change that will conserve biodiversity?"
Berchtesgaden, 15th – 16th October 2009



Monitoring of Phenology to assess the climate change impacts in the Alps: *Phenoclim* and *PhenoAlp*

Dr. Yann Tracol

Alpine Ecosystems Research Center

www.crea.hautesavoie.net

Alpine **E**cosystems **R**esearch **C**enter

Centre de **R**echerches sur les **E**cosystèmes d'**A**ltitude

« **Response of mountainous species to climate forcing** »

Scientific Research

Educational activities

National Scientific Research Center University…

Non profit organizations Schools …

Citizen science

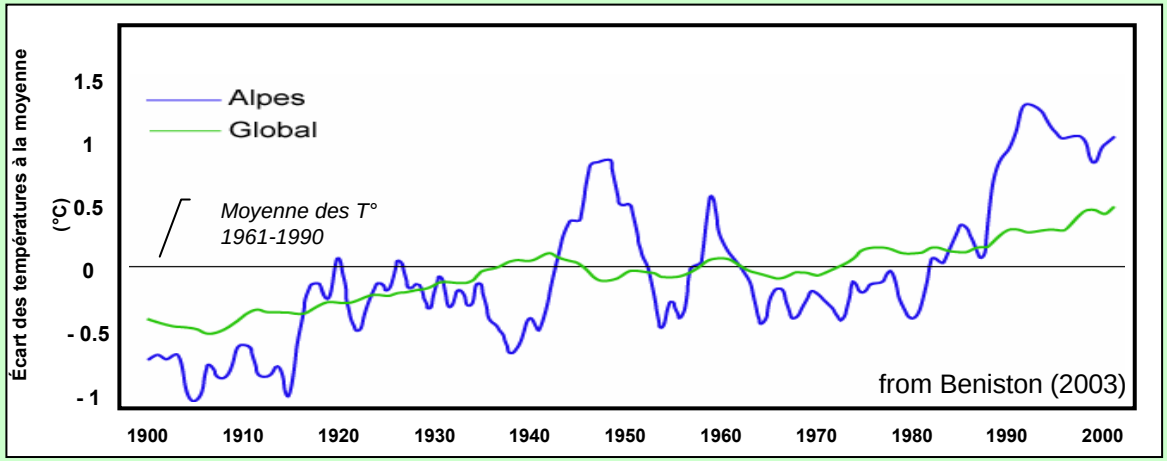




6 employees

Members nb : 72

Background

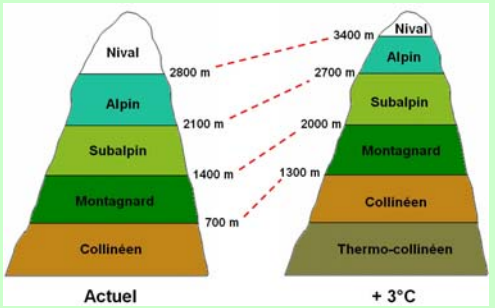


Increase of Air T°, especially during summer and at high elevation zones

↓ rainfall (summer)

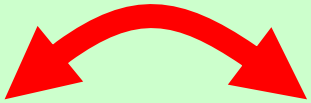
↑ rainfall (winter)

- Precocity of the growth season
- Increase in duration of the growth season (9d)
- Migration of species to high elevation and latitude
- Shift of the vegetation belts (Lenoir et al., 2008)
- mismatching of biological cycles: prey-predator
- Loss of biodiversity and increase of invasive species



from Theurillat & Guisan (2001) Climatic Change

Phenology – *the study of the timing of periodic biological events driven by environmental factor*
First biotic indicator of climatic changes / A major component of species adaptation to climate variations



PHENOALP

A scientific and educational program which invites the public to measure the impact of climate change on phenology of mountain vegetation. This ongoing program was launched in 2004.

Phenopiaf invites you to monitor the arrival (in the Alps) of five species of migratory birds.

EU co-funded Interreg project under the operational program for cross border cooperation France –Italy (Alps-Alcotra).

Aims

1. To create a standardized methodology for the monitoring and the study of climatic changes effects on alpine vegetation and animals using a phenological approach
2. To increase public awareness on the effects of global changes using a participatory science approach

10 species studied :

Type of plants	Species	Scientific name
Trees	Spruce	*Picea abies*
	European Larch	*Larix decidua*
	Silver Birch	*Betula pendula*
	Downy Birch	*Betula pubescens*
	Ash	*Fraxinus exelsior*
	Rowan	*Sorbus aucuparia*
Shrubs	Hazel	*Corylus avellana*
	Common Lilac	*Syringa vulgaris*
Herbaceous	Primrose	*Primula veris*
	Colt's foot	*Tussilago farfara*

➔ Common in the Alps and easily recognizable by non-specialists

➔ Present on a large range of altitude

➔ Studied as climate change indicators in Europe

3 species monitored per study sites with **3 labelled individuals**

Phenological observations : 5 phenophases from the beginning to the end of the vegetation period

➔ **Spring :**

Budburst

Flowering

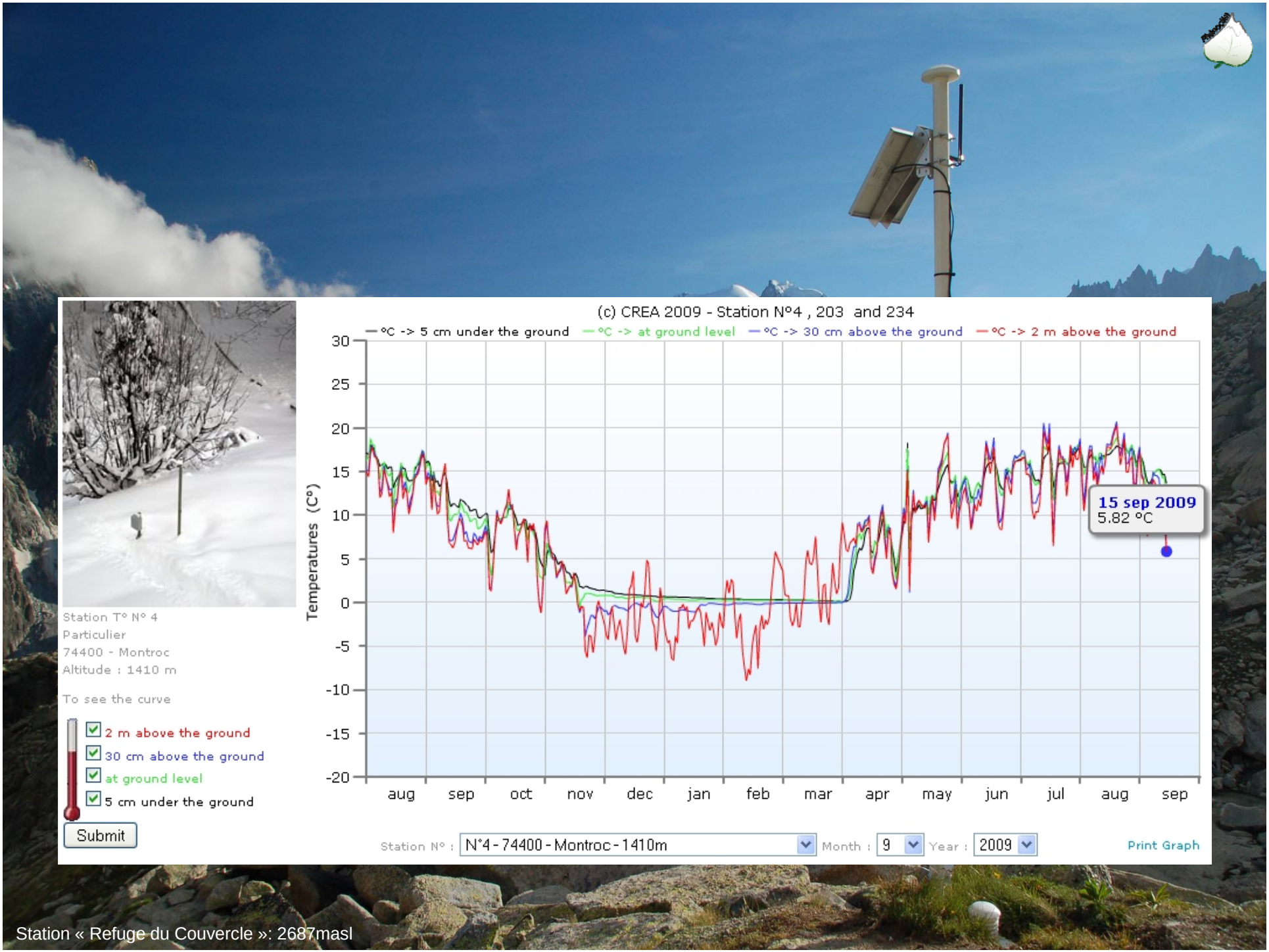
Leaf unfolding

➔ **Autumn :**

Leaf coloring

Leaf fall

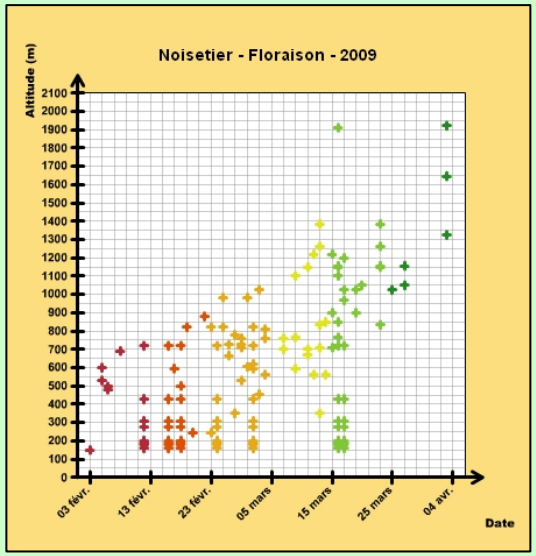
Observations carried out **every 8 days**



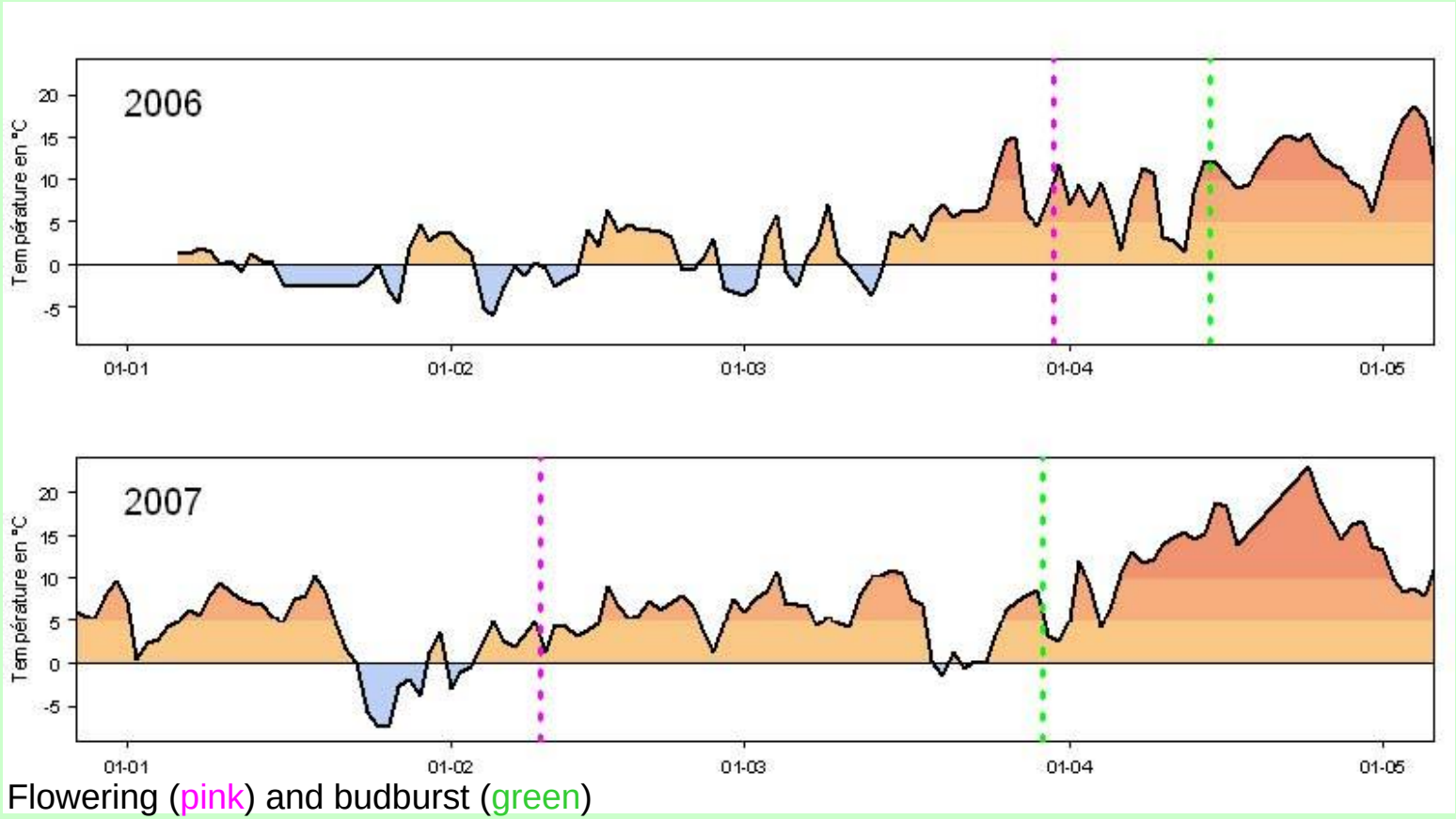
Station « Refuge du Couvercle »: 2687masl

Feedback to the participants (professionals from protected areas, individuals…):

- http://www.crea.hautesavoie.net/phenoclim
- Seminars, training courses, newsletters…



Hazel, an early species !!

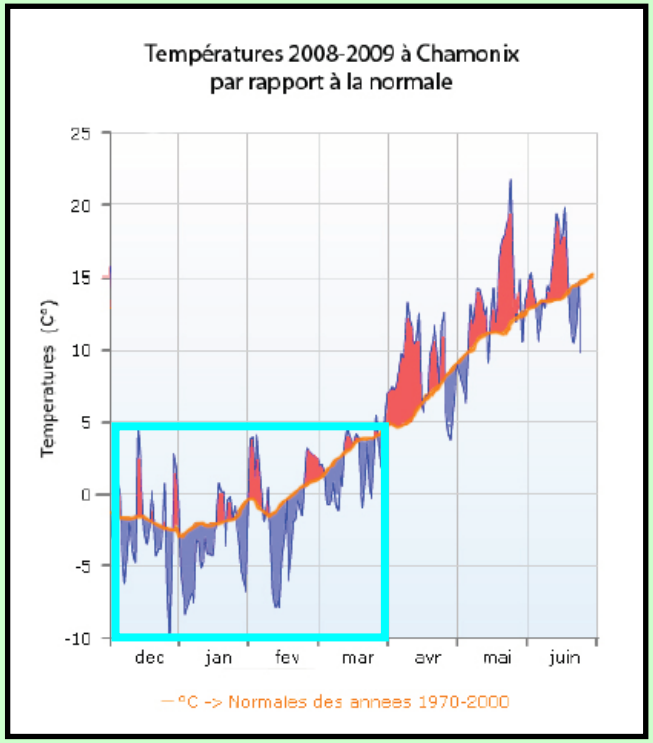


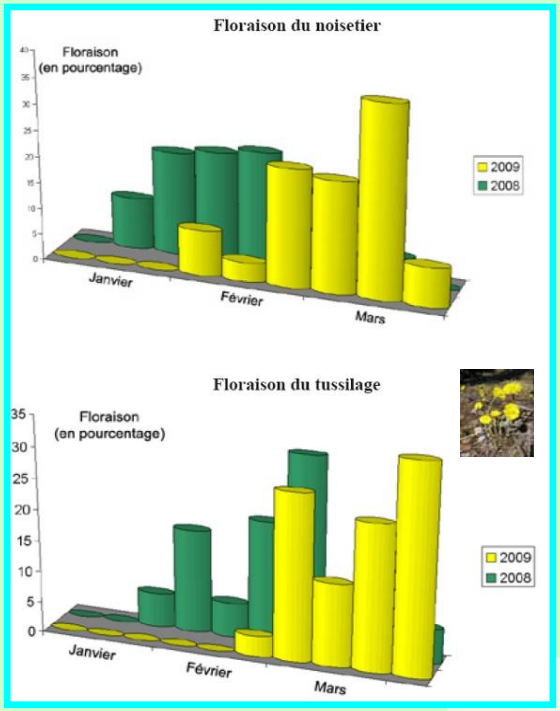
Flowering (pink) and budburst (green)

$T°_{\text{Winter-spring 2006}} < T°_{\text{Winter-spring 2007}}$ (2007 warmer)

$\text{Date}_{\text{flowering 2006}} >> \text{Date}_{\text{flowering 2007}}$ (2007 earlier)

Small differences in budburst dates in 2006 and 2007

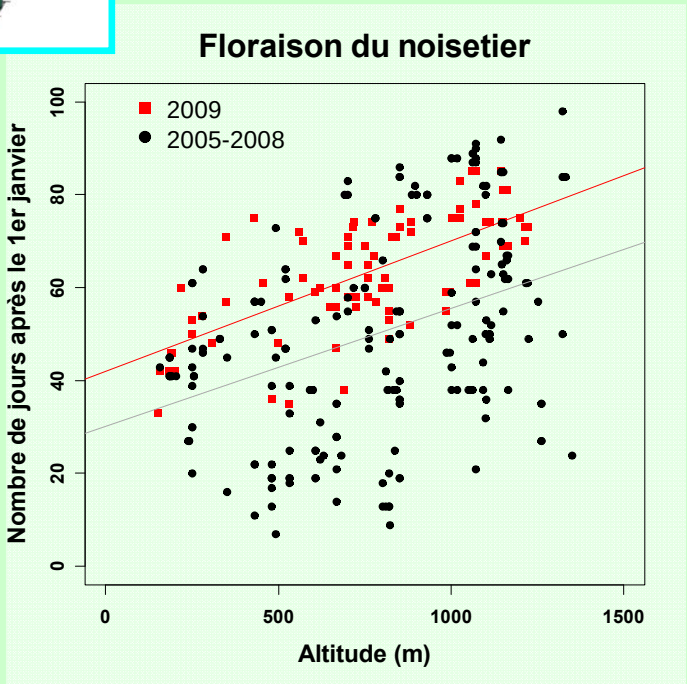


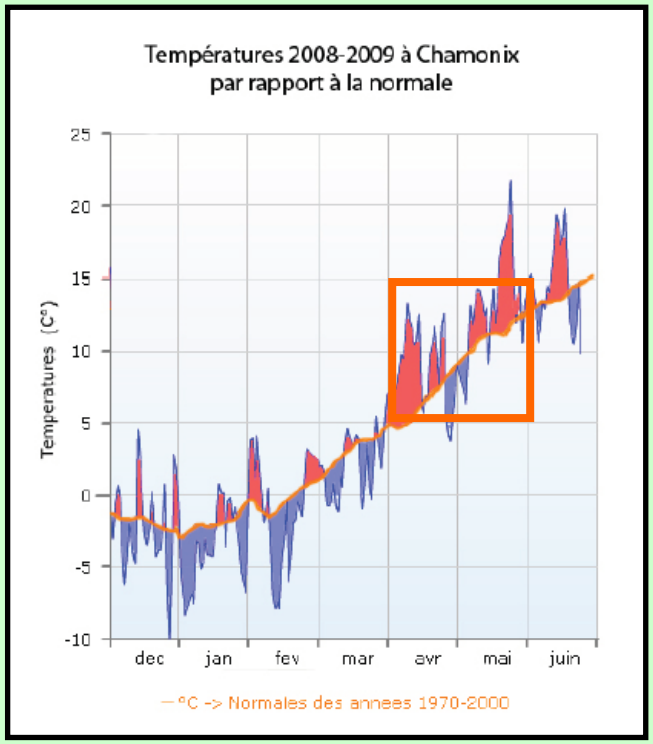


Cold winter

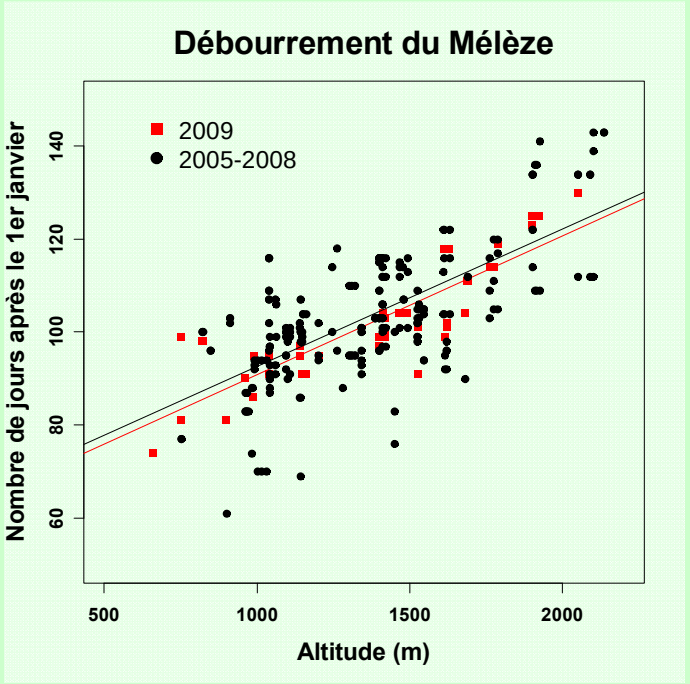
- **A specific response along the altitude gradient (Hazel)…**

Early species « delayed »



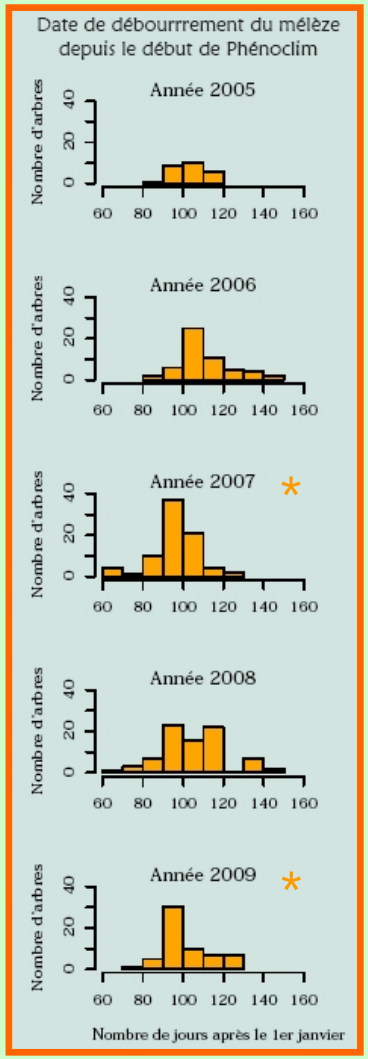


Cold winter
and
Warm spring



Late species
« adapted »

- **A specific response along the altitude gradient…(Larch)**



Deciduous species

Spring tree phenology in the Alps: effects of air temperature, altitude and local topography
submitted to *International Journal of Biometeorology*
Maryline Pellerin et al., 2009

Model	Parameter	Birch	Ash	Hazel	Spruce	Larch
	n_{obs}	47	60	52	43	37
Altitude	k	3	3	3	3	3
	AIC_c	374.2	468.4	437.7	367.9	334.3
	r^2 (adjusted)	41.9	58.0	34.2	25.9	51.0
Temperature sum	k	3	3	3	3	3
	AIC_c	366.0	482.9	459.7	358.4	330.3
	r^2 (adjusted)	50.4	47.6	1.75	39.5	55.1
Altitude + Temperature sum	k	4	4	4	4	4
	AIC_c	337.8	435.8	436.6	332.4	303.1
	r^2 (adjusted)	72.2	75.1	36.9	66.2	76.2

Budburst

Model	Parameter	Birch	Ash	Hazel	Spruce	Larch
	n_{obs}	46	57	46	37	36
Altitude	k	3	3	3	3	3
	AIC_c	352.7	467.7	360.0	300.9	315.9
	r^2 (adjusted)	48.6	56.5	55.8	53.1	37.7
Temperature sum	k	3	3	3	3	3
	AIC_c	348.6	470.5	342.4	315.1	324.8
	r^2 (adjusted)	52.7	54.5	69.1	33.3	23.2
Altitude + Temperature sum	k	4	4	4	4	4
	AIC_c	326.4	428.1	325.5	280.2	297.2
	r^2 (adjusted)	71.1	77.5	78.7	73.0	60.9

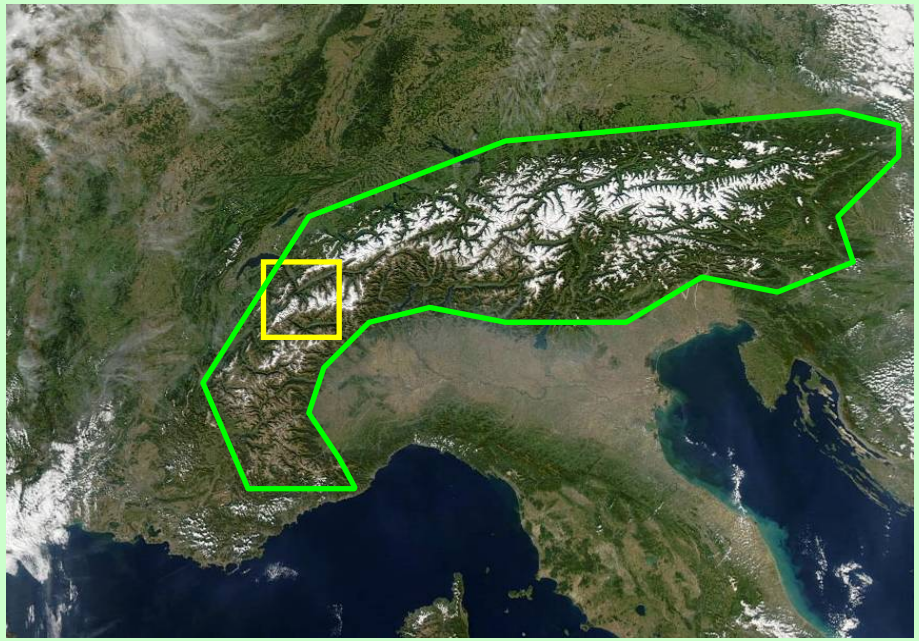
Unfolding

Akaike information criterion (AIC): low AIC, better model

The phenology is not only controlled by the T°sum. Topographic parameters like elevation, lat/long°, concavity and exposure control budburst and unfolding.

➔ Physiological effects of elevation, phenotypic plasticity or adaptation to local conditions are hypothesis (1) probably because the T°soil and the snow cover limit the onset, (2) to « reduce » frost probabilities

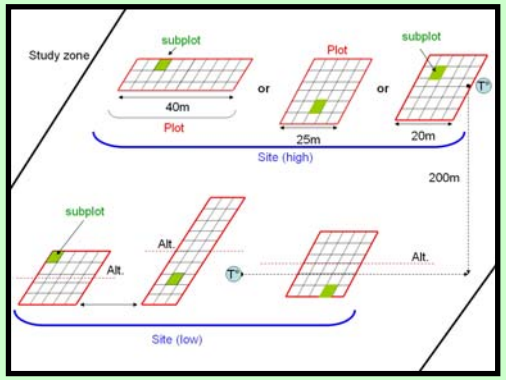
This effect could be observed for others plants or animals ?



PHENOALP

The major goals are:

1- the implementation of an observatory network

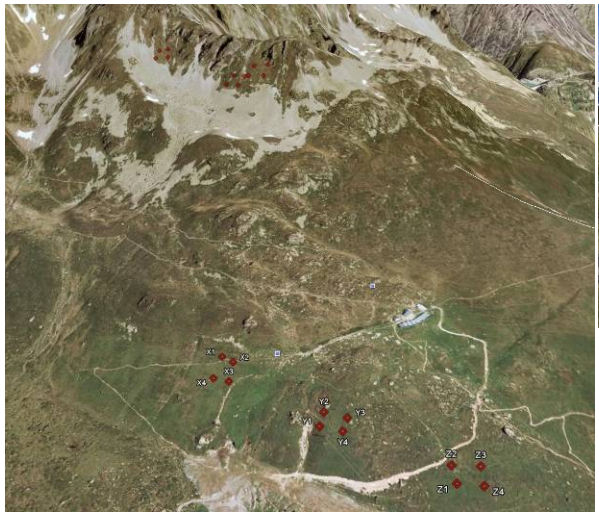


2- the definition of a common observation strategy and commons protocols

3- the involvement of local community in the observation to increase public awareness on the effects of global changes

PhenoPlantes: ***developing climate changes indicators from plant phenology***

- based on Phénoclim protocol regarding forest species
- based on 7 growth life forms regarding alpine grasslands (evergreen, deciduous shrubs, grazed and non grazed poacea, leguminous…)



PhenoZoo: ***developing climate changes indicators from animal phenology***

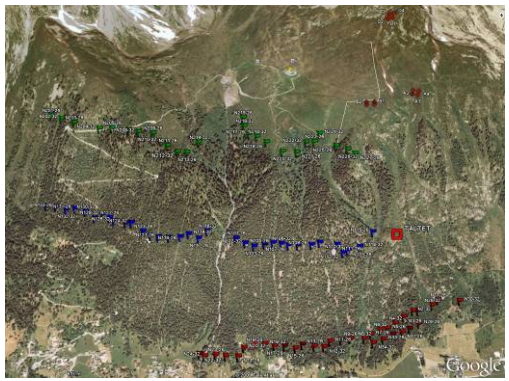
- monitoring of passerines and amphibian phenology (*Rana temporaria*) along an elevation gradient (dates of laying, brood and hatching)

⇨ ponds and nestboxes















InterPheno: ***to analyse relationships between plants and animals phenology***

PhenoFlux: ***to analyse relationships between inter-annual variability of plant phenology and productivity, measuring CO_2 fluxes by Eddy-Covariance technique***

MeteoReseau: ***to create a network of temperature measurements stations in order to link phenological shift with T° trends***

Vallorcine 1910m (Fr)

Mont Avic Park 1150m (It)

PhenoDetect: ***monitoring of the larch forests and alpine grasslands phenology***

- MODIS NDVI time series to retrieve phenological events linked with field measurements

- Continuous phenological observation by webcams

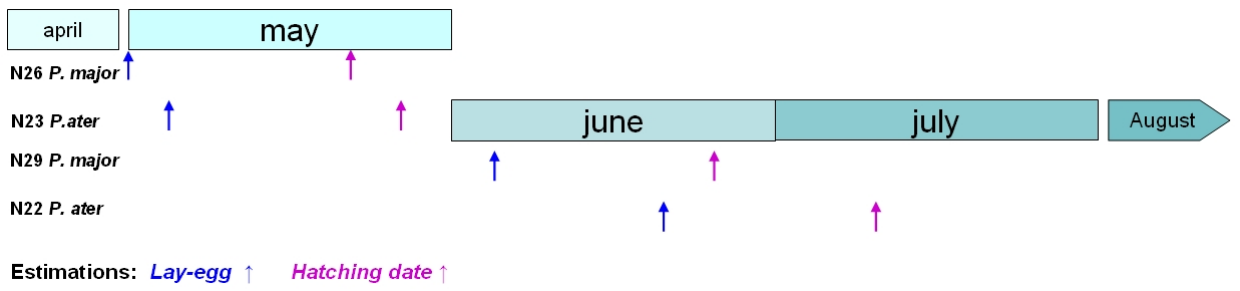
Field training day: PhenoPlantes 18-05-09
« Massif des Bauges » Natural Regional Park

PhenoForm: ***to create a network of partners in education promoting phenological observations to increase public awareness of CC in the Alps***

Field scolar visit (25-06-09), School of Yvoire (74)

PhenoZoo: *first results*

Monitoring of passerines:



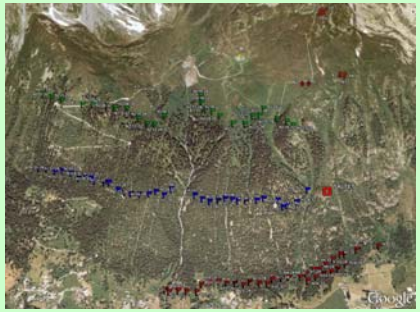
- *Breeding are observed only along the lower transect*
- *4 nest boxes: 2 at the beginning of may and 2 during June*
- *Incubation period range: 11 and 15 days*

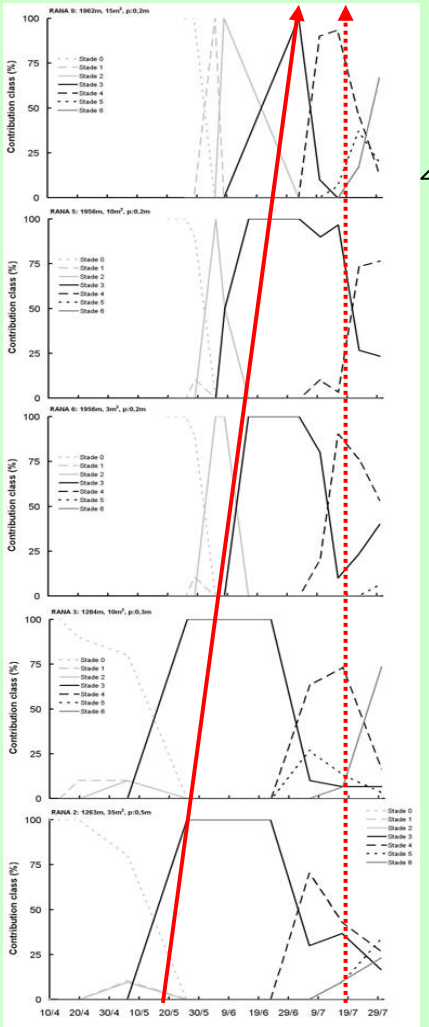
Monitoring amphibian phenology (Rana temporaria) along an elevation gradient

- *First spawns: one month delay between low and high ponds*
- *Stage 3 : 11 days delay, Stage 4: 5 days delay*
- *Total duration: 60 days at high elevation conditions and 90 at low conditions*

→ *as expected, we observe a shorter cycle of development at 1900m than at 1300m.*

→ *to go on the monitoring and extend the study sites distribution*





ELEVATION

Main conclusions

- Huge efficiency of a network approach to collect data and educate the public : citizens or professionals of protected areas (Phenoclim or PhenoAlp programs)

- Interest to standardize protocols and common models (growth life forms, passerines, amphibians…): a common observation strategy

- Promising start of the PhenoAlp field campaign in France and Italy: adjustment of the protocol and first results

Outlooks

- To develop easier protocols from the PhenoAlp program to involve more and better local communities

- To create more educational tools

- To share experiences with similar projects about animal and vegetal phenology

- To find motivated partners to set-up Phenoclim sites at the Alpine regional scale: Alpine Phenology Observatory Network (APON !!!?!!!?)

- To find financial supports: international, national, regional or local organizations

Centre de **R**echerches sur les **E**cosystèmes d'**A**ltitude

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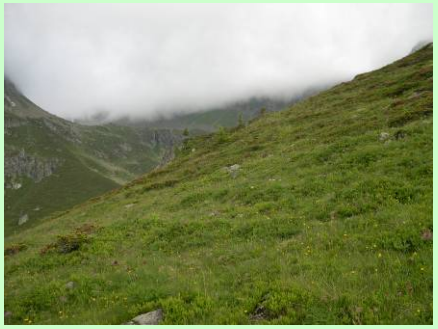


Thanks




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