Project title

Phenological variations in response to climate change (Pheno)

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1. Aim (for the LTER)

a. Identify critical phenological signals at LTER sites.
b. Compare changes in these signals across sites and ecosystems.
c. Collect new parameter for spatialize ground truth information.
d. Obtain useful data for the implementation of the GMES initiative.

2. Research questions and Hypothesis (500 words)

Recurrent seasonal variations in critical biological variables, i.e. phenological patterns, are of extreme importance as they can synchronize the trophic web and determine the ecological performance of species and communities, thereby affecting the productivity of biological systems and the outcome of environmental selection.
Phenological signatures are the results of the interplay between environmental parameters and the biological and life history characteristics of individual species and whole communities. The genetic and biological constraints can be more or less important in determining the phenological patterns of organisms. Therefore, the expected response to environmental changes may vary among species and among sites. Climatic and anthropogenic variations are commonly observed in all marine and terrestrial ecosystems and they are followed by changes in the species phenology (Menzel 2000) or not. The resilience shown by some biota demonstrates the strength of the genetic and endogenous biological control versus the environmental forcing.

We propose to identify a number of phenological elements across lacustrine, marine and terrestrial time series and compare their variations at different spatial scales. The comparison among sites can shed light on the mechanisms underlying the observed seasonality of biological communities and the expected impact that climate change can have on their performances and evolution over time.

In the water case chlorophyll concentration is one of these phenological elements and remote sensing is an essential tool to understand the spatial distribution of the factors involved in the ecology of aquatic systems; but underwater light climate is affected by the absorption and scattering processes that take place within the water column. The measurement in the of Inherent optical properties (IOPs), defined as the light absorption, scattering and backscattering, has been used to retrieve water quality parameters, such as the concentrations of chlorophyll a and other pigments, to model and monitor dynamic environmental processes. This will allow spatialize information obtained in the single stations, giving more reliable phenological signal.

In the case of forest ecosystems, the phenology has been monitored in-situ thorough observation campaigns. Satellite are being used (e.g. MODIS Moderate Resolution Imaging Spectrometer) but the ground truth validation of phenology signals in terrestrial ecosystems is still a debated theme (Fisher et al. 2007).

3. Spatial and temporal coverage

All habitats across Europe

At least 10-15 years of past data of chlorophyll concentration; species data; measure of absorption of Inherent Optical Properties (IOPs) just collected or that will be collected in the next fields work.

At least 6 years of past data in Italian forest ecosystems belonged to the LTER network can be provide from 7 different sites and 4 different tree species (*Picea abies*, *Fagus sylvatica*, *Quercus cerris* and *Quercus robur*).

4. Parameters used/needed*

Parameter group (theme)	Selected parameter	Details about the parameter	Should be taken from existing data (yes/no)	Feasibility/constraints regarding existing data	Should be recorded in field (A5 work) (yes/no)	feasibility/ constraints regarding field sampling
1) Climate and physical variability						
2) Biogeochemistry data	Inherent Optical Properties	Absorption of Non Algal Particle (NAP), coloured dissolved organic matter (CDOM), phytoplankton and Total Suspended Matter (TSM)	No	none	No	none
3) Structure and function of the ecosystems, communities and populations	Primary producers, abundance and composition	Chlorophyll content & vegetation biomass. Species composition (biodiversity). Phenological phases	Yes	None	No	none
4) Human population and economy						

5. METHODS USED

Forest ecosystems. The protocol adopted by the Italian Natianal Forest Service deal with the observation of phenological phases in different period of the year within 50x50 m plots. The phonological phases are: Budding, Secondary budding, Flowering, Leaf colouring, Leaf fall. The values for each phenological phases are reported according to 5 different class of coverage.

6. EXPECTED RESULTS

The comparision of phenological data across lacustrine, marine and terrestrial ecosystems will allow to describe and quantify the variation of responses to similar climatic forcing.

We expect that these findings may be useful for regionalisation of bio-optical models and hence in remote sensing applications on lake water quality, costal zone of the sea and forests.

Moreover, this process will make possible to indicate sites in the LTER network as ground-truth validation stations for satellite image under the GMES initiative.

7. REFERENCES

Menzel A., 2000. Trends in phenological phases in Europe between 1951 and 1996. Int J Biometeorol 44: 76–81.

Fisher J.I., Richardson A.D., Mustard J.F., 2007. Phenology model from surface meteorology does not capture satellite-based greenup estimations. Global Change Biology 13, 707–721.