# Response of forest phenology to elevation from SPOT/VEGETATION

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## Réponse phénologique des forêts à l'altitude avec Spot/Vegetation

Cette étude montre le potentiel de Spot/Vegetation pour suivre l'impact du changement climatique sur la variabilité altitudinale de la phénologie des forêts feuillues. Elle est fondée sur l'analyse statistique des variations saisonnières de l'indice de végétation PVI de 2002 à 2006 dans les Pyrénées françaises. Le raccourcissement du cycle de végétation avec l'altitude est clairement retrouvé. La date de débourrement a été cartographiée. La précision attendue (~ 4 jours) est satisfaisante en comparaison de l'étendue des variations (34 jours pour un dénivelé de 1000 m).

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The consequences of the climate present change are already obvious on the spatial distribution of species and the carbon balance of terrestrial ecosystems. Species can either adapt via their phenotype plasticity or/and their genetic diversity or migrate to milder latitudes and altitudes. The response of phenology to the temperature increase is the most conspicuous. Earlier spring phenophases and longer growing seasons appear among the most significant changes of seasonal cycle of the vegetation. Satellite observations revealed these shifts of phenology at global scale (Cleland et al. 2007). Mountain ecosystems, where temperature varies strongly with elevation along a short distance, are assumed to be the most sensitive to the climate warming. Thus they are well suitable for understanding and modelling the adaptation processes. The purpose of this study was to investigate the potential of remote sensing for the long-term monitoring of altitudinal dynamics of phenology of deciduous forest species in combination with ground-based observations inevitably limited in space. The studied area covers almost 10,000km² (Long.: 1.21°E – 0.24°W, Lat.: 42.6°N – 43.3°N) in the French Pyrenean region. Oak (Quercus sp) and beech (Fagus sylvatica) are the main deciduous species. Their maximal elevation reaches 1,800m.

The seasonal dynamics of leaf area of these species was characterized from analysing the variations of the vegetation index PVI (Perpendicular Vegetation Index) between successive 10-day periods from 2002 to 2006. The 10-day time series of PVI was produced from the daily reflectance data acquired with Vegetation/Spot sensors by using algorithms of Hagolle and al. (2004), which filter the cloudy and snowy pixels and normalise directional effects. The 5-year dataset was reduced to an average year. In fact the high contamination of altitude pixels with clouds and snow in spring induced a lot of missing PVI data during the period of leaf unfolding, which did not allow monitoring the onset of the green-up year by year. The seasonal response of PVI peculiar to deciduous trees included in each 1-km² pixel was retrieved using the nonparametric statistical method of spatial disaggregating of Cardot et al. (2004).

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