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SPRING PHENOLOGY AND THE NORTH ATLANTIC OSCILLATION

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There is a general consensus on the existence of perceivable variability in the timing of the spring season in Europe. Plant phenology is known for being a sensitive indicator of climate change impacts on the biosphere. In particular, fluctuations of winter surface temperature significantly affect the timing and length of the growing season at the mid and high latitudes, with consequent effects on the carbon budget of terrestrial ecosystems. Changes in spring phenology across the European continent are analyzed in detail searching for possible connections with the North Atlantic Oscillation (NAO), a large-scale displacement of air mass between the sub-arctic and the sub-tropical region of the North Atlantic.

The analysis of some of the longest available phenological records (1736-1947) from Central England shows how the significant principal components of these series are dominated by the same fluctuations as the winter (January-March) NAO. These and other leafing or blooming records are significantly correlated with winter NAO (e.g., Post and Stenseth, 1999). Similar results are found (Figure 1) for the onset and peak of the pollen season and for the seasonality of pollinosis and hay fever (D'Odorico et al., 2002). Moreover a regional analysis of cryo-phenological observations shows the presence in the dates of ice break-up of the same fluctuations existing in the winter NAO (Yoo and D'Odorico, in press).

The positive phase of NAO is associated with anomalous flow of moist and warm air across Europe and with consequently warmer winters. Spring phenology at the mid-high latitudes is determined by the regime of winter temperature. In fact, the end of dormancy is controlled by a decrease of substances inhibiting growth and by an increase of growth promoters (e.g., Larcher, 1995). In temperate trees this is preceded by a period of chilling, followed by a phase of heat accumulation necessary to resume growth. At the mid-high latitudes the chilling requirement is met between October and November, while the increase of temperature in the following months fulfills the heat requirement and controls the timing of bud burst, blooming and pollination.

Thus, due its impact on winter temperature, the NAO is able to explain the fluctuations existing in the timing of growing season start in Europe with a possible effect on the short-term variability of carbon sequestration by terrestrial ecosystems (Barford et al., 2001).

The positive trend of NAO over the last 30 years partly explains the early onset of the growing season in these decades. Whether this is a permanent trend in the European climate is still unclear, as it can be argued that the increase of NAO index over the last three decades is only a segment of a multidecadal fluctuation (e.g., Paeth et al., 1999; Wallace and Thompson, 2002).

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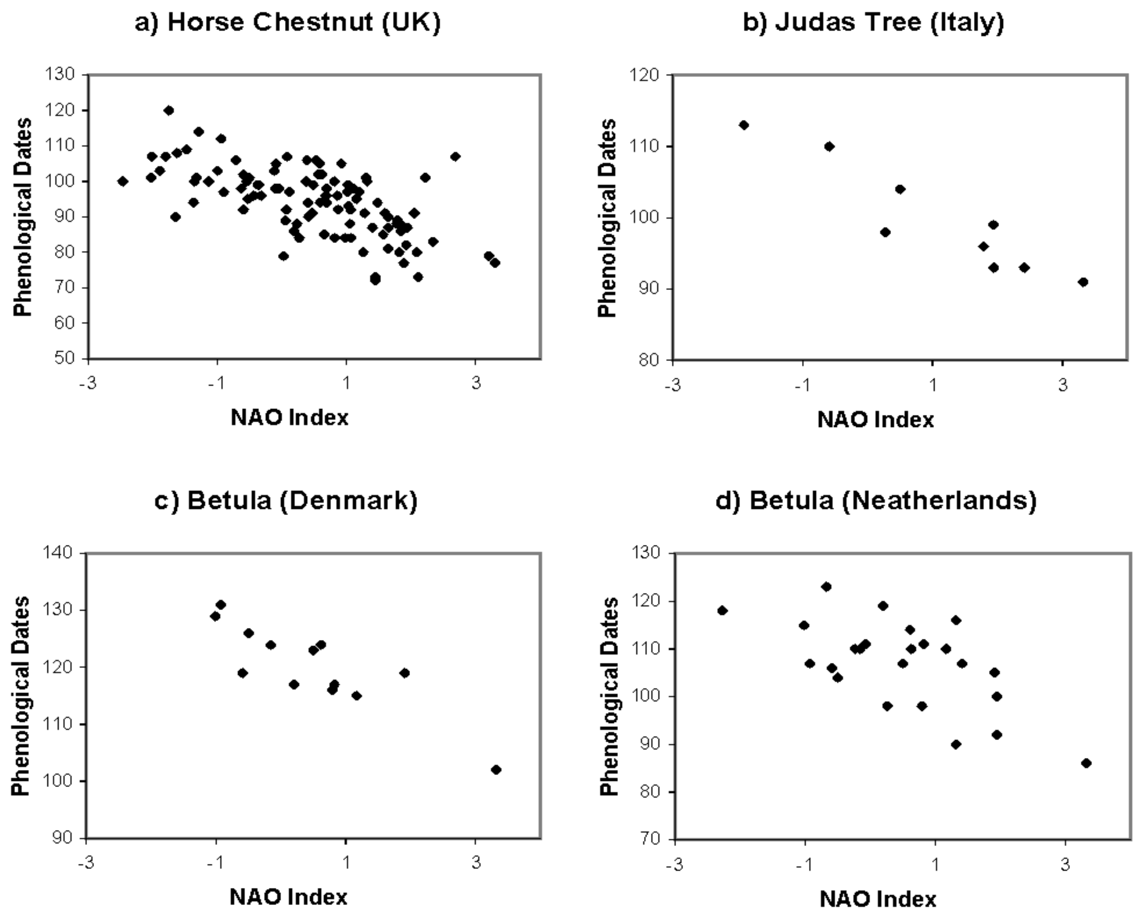

Figure 1: Dependence on the NAO Index (JFM) of some phenological dates (Julian day): a) leafing (Central UK; 1946-1947); b) bud break (Oristano, Italy; 1987-1996); c) Pollen season onset (Copenhagen, DK; 1977-1990); d) Pollen season onset (Leiden, NL; 1969-1994). Data are from Margary (1926); Sparks and Carey (1995); Spano et al., (1999); Anderson (1991); Jones et al, (1997).