



Spring phenology in boreal regions.

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Spring phenology, taken as the timing of leaf appearance, is both an indicator of climatic changes and a factor influencing the vegetation annual carbon uptake. It was previously shown that leaves tend to appear earlier in the Northern latitudes, in response to the warming recorded in these regions. However, the trends observed using remote sensing data has been suspected to be partially related to variations in the snowmelt timing rather than in phenology. We developed a remote sensing methodology, using NOAA/AVHRR and SPOT/VGT, able to measure the timing of the leaf appearance without being affected by snow, as shown by the comparison with in situ records (RMSE=8 days). We confirm that in boreal Eurasia and North America, the date of leaf appearance shifted earlier between 1982 and 1991. However, we show that this trend reversed after 1994. Overall, in 1982-2004, the average advance is 4 days in Eurasia and 2 days in North America. We re-positioned these remote sensing observations within a longer period using in situ data (80 year long records) and modeling. It is noteworthy that a large part of the trend toward earlier spring phenology observed in Central Siberia by remote sensing can be attributed to anomalously late phenology in the beginning of the 1980's. The results of the phenology model, using daily temperature from ECMWF-ERA40 and calibrated by the remote sensing observations, indicate a 3 and 4.9 days advance in Eurasia and North America from the 1950's to the 1990's.