Changes in land surface phenology and gas exchange of deciduous and coniferous forests in response to heat and drought stress

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Heat and drought stress events have a significant impact on plant phenology. Changes in phenology can alter the length of the growing season and affect carbon, water, and energy fluxes. Some of these changes can persist for several years, especially in response to successive stress events. In this work, we combine remote sensing data and process-based modeling to investigate the effect of different heat and drought stress events on land surface phenology (LSP) and water and carbon fluxes in a deciduous and coniferous forest in southwest Germany. We used climate data to characterize different stress events for selected forest sites and as input for the process-based model LandscapeDNDC (LDNDC). For the determination of different LSP metrics we used time series of the Enhanced Vegetation Index (EVI) covering the last two decades. The evaluation of the model simulations was done using remote sensing data. The results indicated that different EVI and LSP trajectories exist for deciduous and coniferous sites. The model simulations also demonstrated that significant variations in water and carbon fluxes exist for the period during and after the stress events, and that leaf area recovery was linked to gas exchange. Since the overall forest development strongly depends on stress response strategy as well as stress frequency and intensity, combining climate projections and process-based models is needed to explore the suitability of forest response types under expected climate changes.