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Spatiotemporally Explicit Forest Phenoclimatology in Northeastern Minnesota, USA

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Abstract

We present analyses and hindcasts of forest phenology in northeastern Minnesota, USA, as observed using 35 years of Landsat images over the region and more than a decade of phenocamera observations in the Boundary Waters Canoe Area Wilderness. Various studies of forest phenology from both of these perspectives have employed logistic, harmonic, or other curves fitted to long-term observations but then used only that mean curve in subsequent analyses. We have developed a method to explain latent information in the curve residuals, those observed departures from the mean phenology, using seasonal and interannual deviations from the long-term climatology at the same location. While the long-term mean phenology is useful in a diagnostic sense, these phenoclimatological relationships permit prediction of expected forest phenology, allowing interannual variability, using meteorological quantities measured at the land surface on a daily basis prior to and throughout the growing season. At the spatial scale and resolution of Landsat observations, these phenoclimatological relationships advance our understanding of vegetation responses to atmospheric conditions on temporal scales from weeks to seasons. These methods can help improve the representation of forest phenology in weather and climate models, especially its spatiotemporal variability, leading to more realistic effects of vegetation state on energy, carbon, and moisture fluxes at the land–atmosphere interface.

Keywords: climatology, forest, phenology, Landsat, Minnesota