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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 regression-based method to explain latent information in the curve residuals, those observed departures from the long-term 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, accounting for 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 days to seasons. More accurate knowledge of the expected phenological state will improve assessments of forest health, stress, and disturbance events, including the severity and proximate causes of individual disturbances on the landscape. These methods are also aimed at improving the spatiotemporally-variable representation of forest phenology in weather and climate models, leading to more realistic effects of rapidly-changing vegetation state on energy, carbon, and moisture fluxes at the land–atmosphere interface.

Keywords: climatology, forest, Landsat, Minnesota, phenology