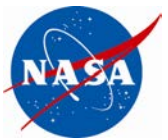




Complementary satellite data improve understanding of the Arctic-boreal spring transition



Kim, Kimball, Parazoo, Xu, Colliander, Reichle, Xiao, and Li, 2024. *JGR Biogeosci.*, 129, 8, DOI:10.1029/2023JG007977.

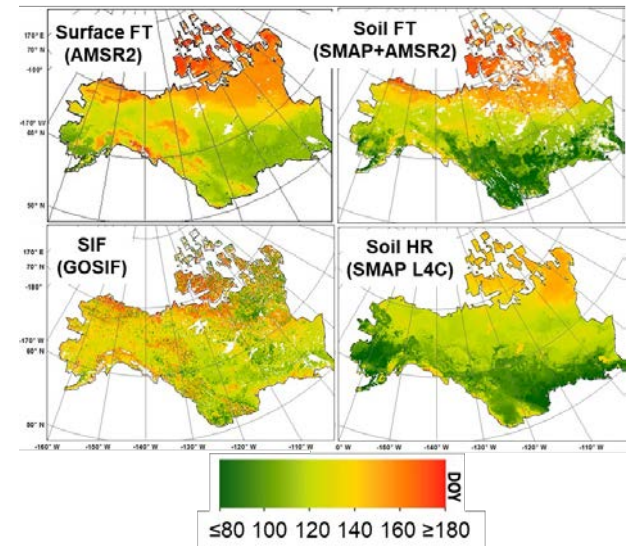
Problem: Arctic-boreal spring coincides with seasonal thawing, increased soil moisture and growing season activation from winter dormancy, including plant photosynthesis (SIF) and primary production (GPP), soil respiration (HR), and evapotranspiration (ET). The timing and order of these events impacts the boreal carbon (CO₂) sink and carbon-climate feedback, but the onset pattern is uncertain in vast, remote northern ecosystems ($\geq 45^\circ\text{N}$).

Method: Complementary environmental data records (EDRs) from microwave and optical satellites were used to map critical spring onset events across Alaska and NW Canada from 2016 to 2020. Classified events included surface and soil thaw (FT) timing from AMSR2 (36.5 GHz) and SMAP (1.4 GHz) brightness temperatures; SIF onset from OCO-2 and MODIS (GOSIF); SMAP L4 model-derived onset in GPP, HR and root zone soil moisture (RZSM), and evapotranspiration (ET).

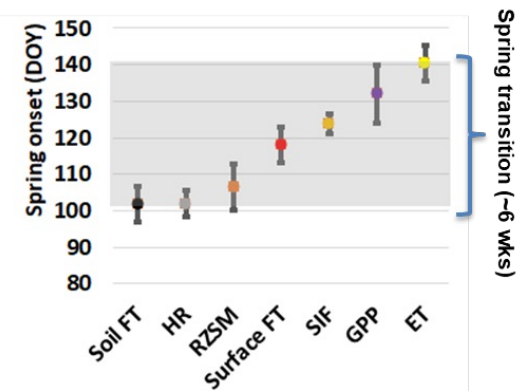
Findings: The spring transition spans $\sim 6 \pm 1.5$ (SD) weeks between initial thaw and final growing season onset events. Differences in the timing of soil and surface thaw impose seasonal lags in GPP and HR, affecting ecosystem C-sink strength. Elevated HR from early soil thaw prior to surface thaw and GPP onset can degrade C-sink capacity. FT retrievals from short and long wavelength microwave sensors can better distinguish surface and soil FT timing, and their distinctive influence on permafrost active layer development, vegetation activity, and carbon-water-energy fluxes.

Impact: The combined EDRs provide a more complete view of the spring transition than individual satellite or single sensor observations.

Timing of spring onset events (DOY)



Order of boreal onset events



Top: Spring onset pattern in 2018 for surface and soil thaw (FT), photosynthesis (SIF) and soil respiration (HR). **Lower:** Mean annual order of EDR onset events in the boreal biome; vertical bars denote ± 1 temporal standard deviation (SD).