

# SMAP Improves Detection and Monitoring of Soil Freeze-Thaw Dynamics



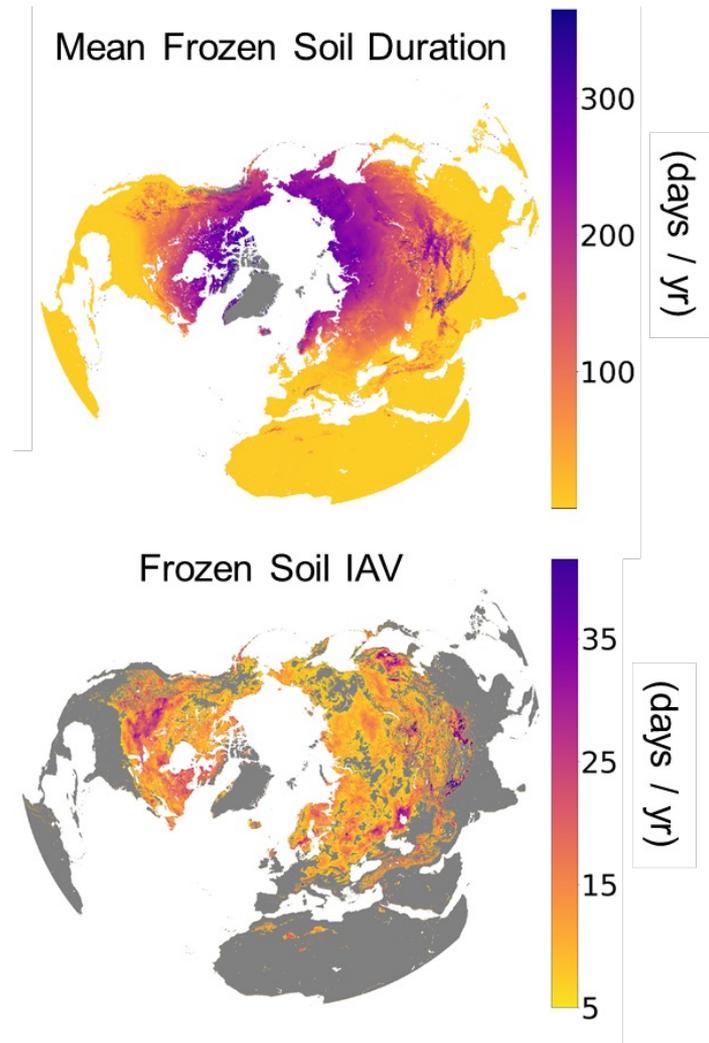
**Problem:** Satellite microwave radiometers can detect freeze/thaw (FT) related controls on soil respiration and greenhouse gas (GHG) emissions. Low frequency (L-band) sensors have enhanced soil sensitivity, but prevailing FT products don't distinguish soil from other landscape features, leading to uncertainty about how climate change is affecting the frozen soil season and GHG emissions.

**Method:** AI Deep Learning (DL) models were trained on topsoil ( $\leq 5\text{cm}$  depth) FT observations using SMAP and AMSR2 multi-frequency TBs as key drivers. 9-km daily soil FT estimates were derived over the Northern Hemisphere from 2016-2020 and validated using soil FT observations from regional weather stations and reanalysis (ERA5).

**Finding:** Resulting mean annual soil FT accuracy (MAE $\geq 91\%$ ) is superior to other FT records. SMAP L-band provides enhanced soil FT sensitivity and performance gain over alternative DL results derived using only AMSR2 data. Large spatial and inter-annual variability in the frozen soil season revealed.

**Impact:** Better understanding of the soil FT cycle and related controls on ecosystem carbon and climate feedbacks.

Donahue, Kimball, Du, Bunt, Colliander, Moghaddam, et al., 2023. *Front. Big Data* 6: 1243559.



Climatological mean frozen soil season and inter-annual variation (IAV) derived from the new soil FT daily record (2016-2020).