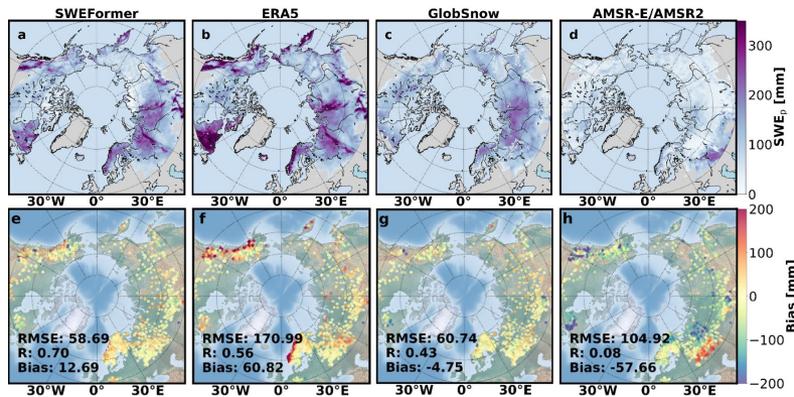# SWEFormer: A Deep Transformer for Estimating Peak Seasonal SWE using SMAP

Problem: Peak **snow water equivalent (SWE)** defines the maximum seasonal water storage in snowpack, controls spring runoff volume and timing, influences flood risk, and affects water-resource planning, hydropower, ecosystem processes, and thus water, food, and energy security.

Finding:

We found that when snow has more stored water, its more prolonged melting produces a unique pattern in the time series of SMAP observations, which a deep transformer neural network can learn for providing one of the most accurate near-global estimates of SWE using SMAP observations.
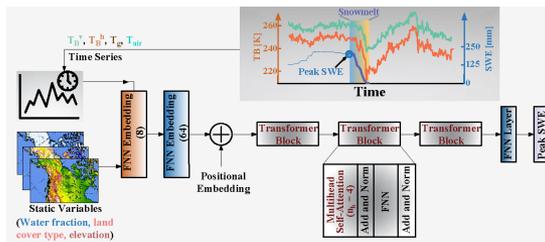
For the first time, it is shown that a deep transformer neural network can learn peak SWE from SMAP observations.

Impact: Satellite estimation of peak SWE revolutionizes water security by accurately quantifying maximum snowpack across inaccessible regions. This critical data enhances flood forecasting, optimizes reservoir operations for hydropower and agriculture, and strengthens drought resilience, ensuring reliable freshwater supplies for downstream communities.

Kumawat D., A. Ebtehaj, S. Kumar, A. Colliander (2025), Deep learning of seasonal Peak Snow Water Content of Global Boreal Forest and Arctic using Spaceborne L-band Radiometry, Remote Sensing of Environ., https://doi.org/10.1016/j.rse.2025.114963