A Remote Sensing-Based Daily Stream Water Temperature Model for Gridded, High-Resolution Predictions at Subcontinental Scales [EGU25-4506: A.44]

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BACKGROUND

- **Motivation: stream water temperature (SWT) is fundamental to understanding ecological needs (Fig. 1) and water quality issues**
- SWT models provide ≤10-km/daily resolution estimates for ungaged streams at regional to global scale, but not high-resolution (1-km/daily) datasets for subcontinental scales, e.g., the contiguous United States (CONUS)
- Current high-resolution, subcontinental-scale models are not optimized for large-scale gridded processing, emphasizing point predictions instead
- **OBJECTIVES:**
  - **Optimize an existing high-resolution, ungaged, remote-sensing SWT model (TempEst 2) for large-scale, gridded application** (TempEst 2-FAST: "stream temperature estimation, version 2: fast analysis in space and time")
  - **Develop a gridded, 1-km/daily estimated SWT dataset for the CONUS**

- TempEst 2: across gages, median validation RMSE 2.0 °C (Fig. 3), R^2 0.94, NSE 0.91, bias 0.1%
- TempEst 2 uses globally-available inputs (tested with varying climate, geography, and training gage network density), supporting global application with replacement training gage and humidity datasets

Fig. 1: Trout fish, Sagehen Exp. Forest, Sierra Nevada, California, USA

METHODS FOR GRIDDED SWT MODELING W/TEMPEST 2-FAST

- Export model components from trained model (∼1,300 USGS gages)
- Retrieve CONUS-wide inputs & convert to 0.01-degree (∼1-km) grid
- Mask inputs to MERIT Hydro hydrography for ease of use, computational efficiency, and smaller output dataset
- Apply geostatistical model to estimate SWT coefficients (seasonality & weather sensitivity; Fig. 2) for each pixel
- Compute full estimated SWT timeseries for each pixel
- Final version will be available as open-source Python package

Sharing is encouraged

← EGU25 poster QR code | TempEst models and research →

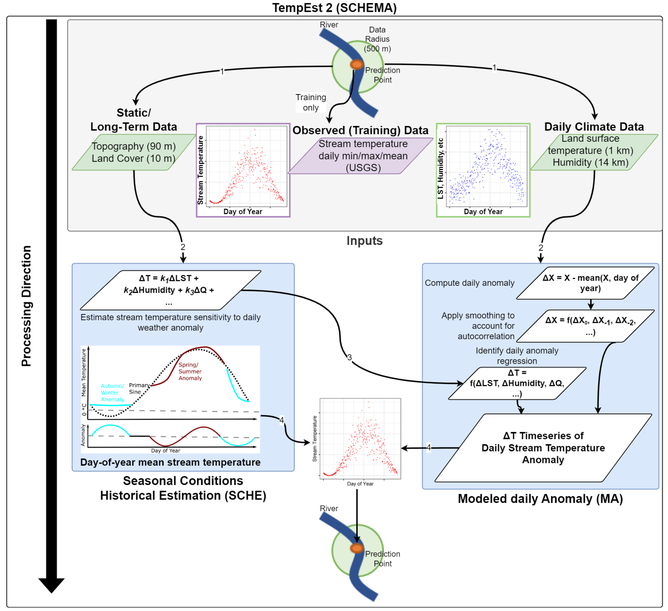

Fig. 2: Conceptual diagram of historical daily SWT estimation model TempEst 2

Model estimates stream temperature across CONUS

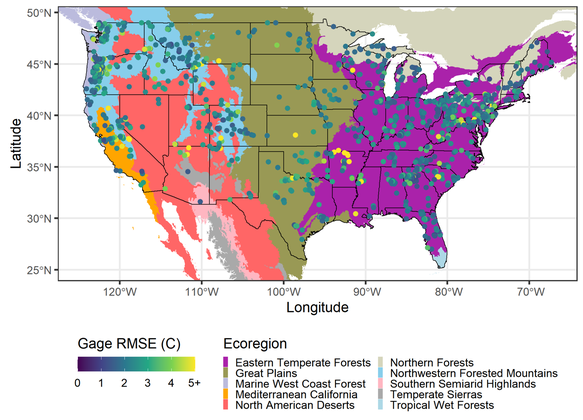

Fig. 3: Testing RMSE for gages (limited to 5 °C) w/EPA Level I Ecoregions

IMPLEMENTATION PROGRESS AND NEXT STEPS

- All input data (Fig. 4; ∼1.5 TB) downloaded and regridded
- Coefficient estimation and prediction logic implemented
- Next steps: predict coefficients and full timeseries

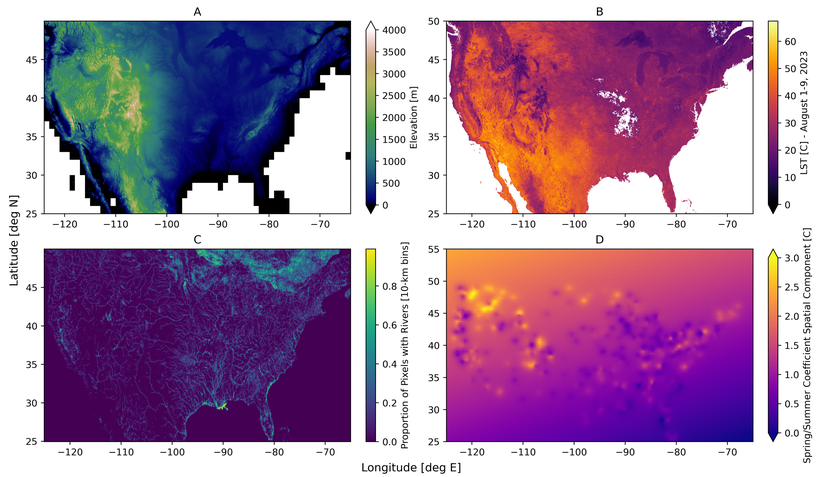

Fig. 4: Examples of TempEst 2-FAST input datasets - elevation (A), land surface temperature (B; blank areas were blocked by clouds), river mask (C), and the spatial model component for the spring/summer seasonality coefficient (D)

CONCLUSIONS

- First high-resolution, grid-optimized, subcontinental-scale ungaged SWT model and gridded SWT dataset for full CONUS
- Thermal regime coefficients (seasonality and sensitivity) can be analyzed directly and more efficiently to study river characteristics (e.g., mean SWT, annual variability)
- Potential to explore large-scale spatiotemporal trends without dependence on local observation networks

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