A Comprehensive Investigation of Machine Learning Models for Estimating Daily Snow Water Equivalent (SWE) over the Western U.S.

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HYPERFACETS
A Framework for Improving Analysis and Modeling of Earth System and Intersectoral Dynamics at Regional Scales

General Architecture

- **Dynamic inputs:** precipitation, temperature (min and max), solar radiation, specific humidity (min and max), relative humidity, vapor deficit and wind speed;
- **Static inputs:** latitude, longitude, elevation, diurnal anisotropic heat index (DAH) and solar radiation aspect index (TRASP);
- **Output variable:** SWE;
- **Input window size:** 180 days;
- **Models:** Long-Short Term Memory (LSTM), Temporal Convolution Neural Network (TCNN), and Self-Attention model (Attention).
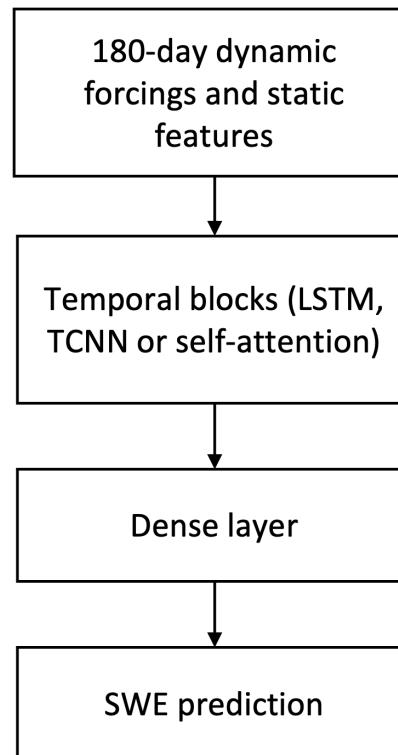
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┌─────────────────────┐
│  180-day dynamic    │
│  forcings and static│
│  features           │
└─────────────────────┘
           │
           ▼
┌─────────────────────┐
│ Temporal blocks     │
│ (LSTM, TCNN or      │
│  self-attention)    │
└─────────────────────┘
           │
           ▼
┌─────────────────────┐
│    Dense layer      │
└─────────────────────┘
           │
           ▼
┌─────────────────────┐
│   SWE prediction    │
└─────────────────────┘
```

Figure: flow chart of our models.

Experiment Settings	
Loss function	Mean squared error
Training	1980-10-01 to 1999-09-30
Validation	1999-10-01 to 2008-09-30
Testing	2008-10-01 to 2018-09-30

SNOTEL Prediction Results

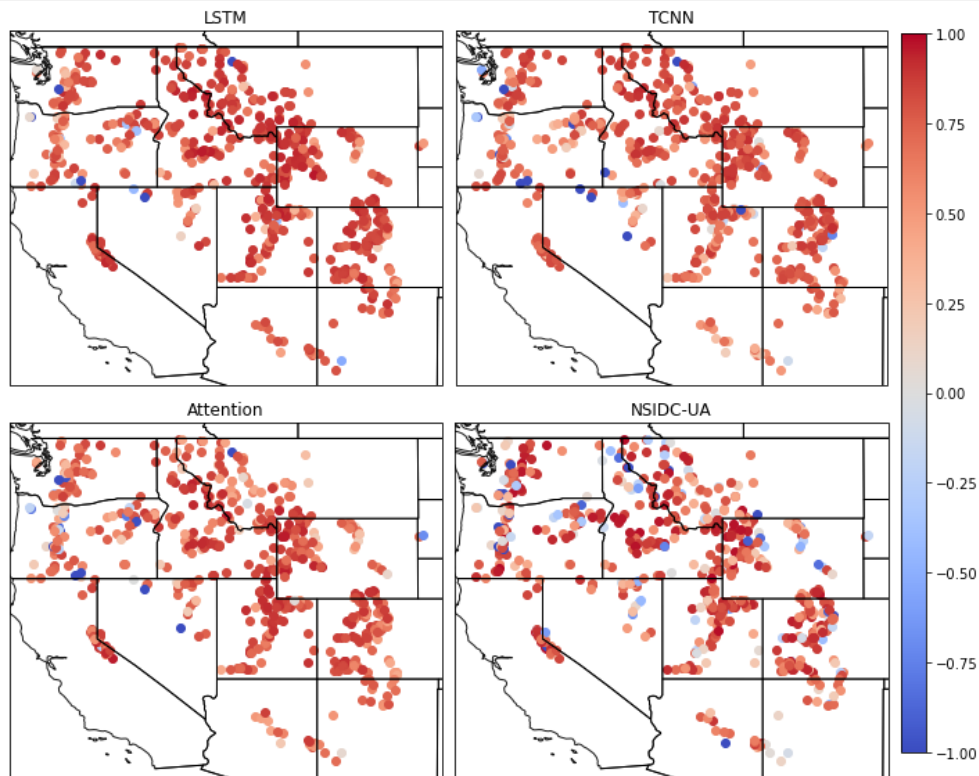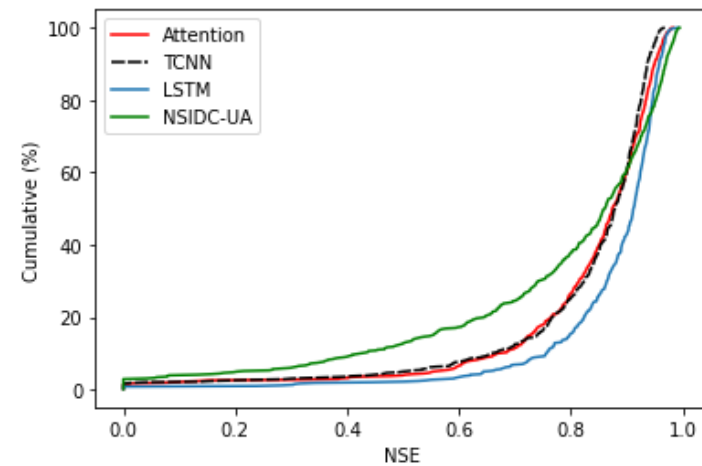| Model	Median NSE
LSTM	0.909
TCNN	0.878
Attention	0.874
NSIDC-UA	0.861

Figure: Prediction result from deep learning models and NSIDC UA dataset (left) and probability distribution of NSE values (right).
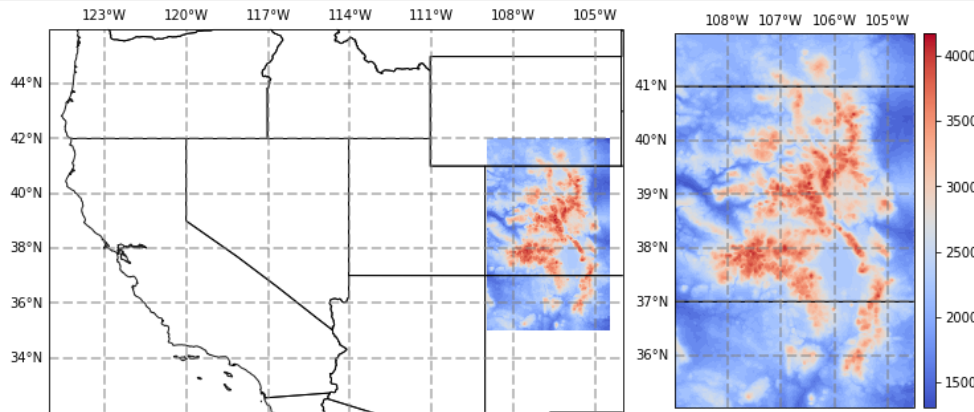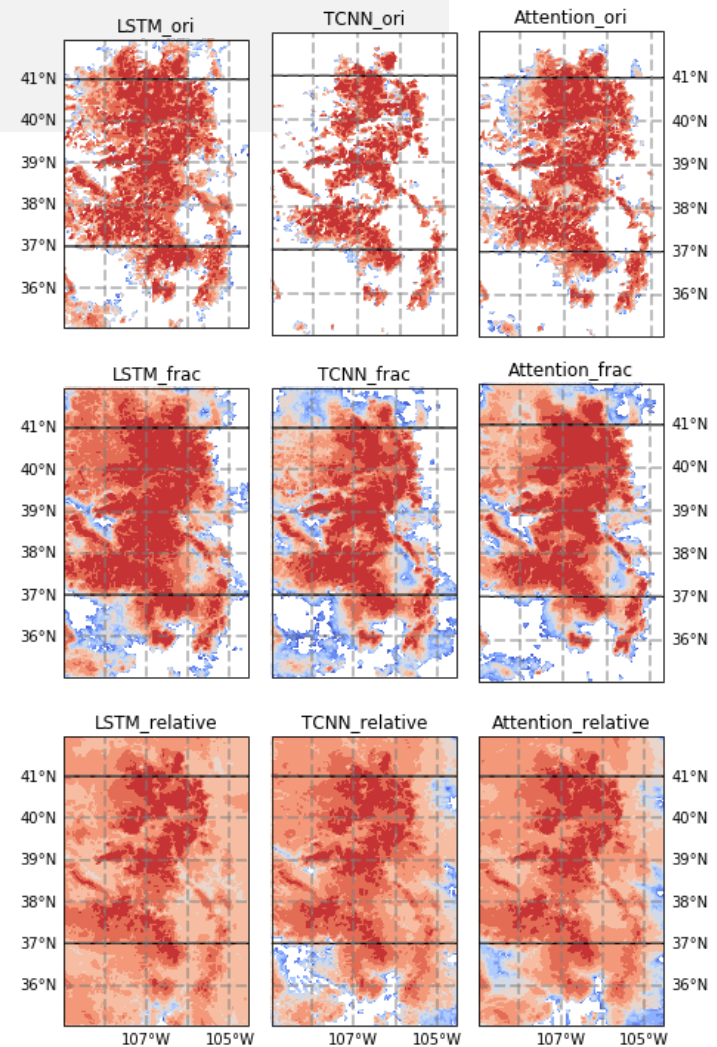
Extrapolation

Figure: Rocky Mountain Domain (left) and elevation (right).

- The seasonality itself will improve the generalization.
- By training another set of models, the generalization performance is much better.

Figure: Extrapolation NSE values against NSIDC dataset.
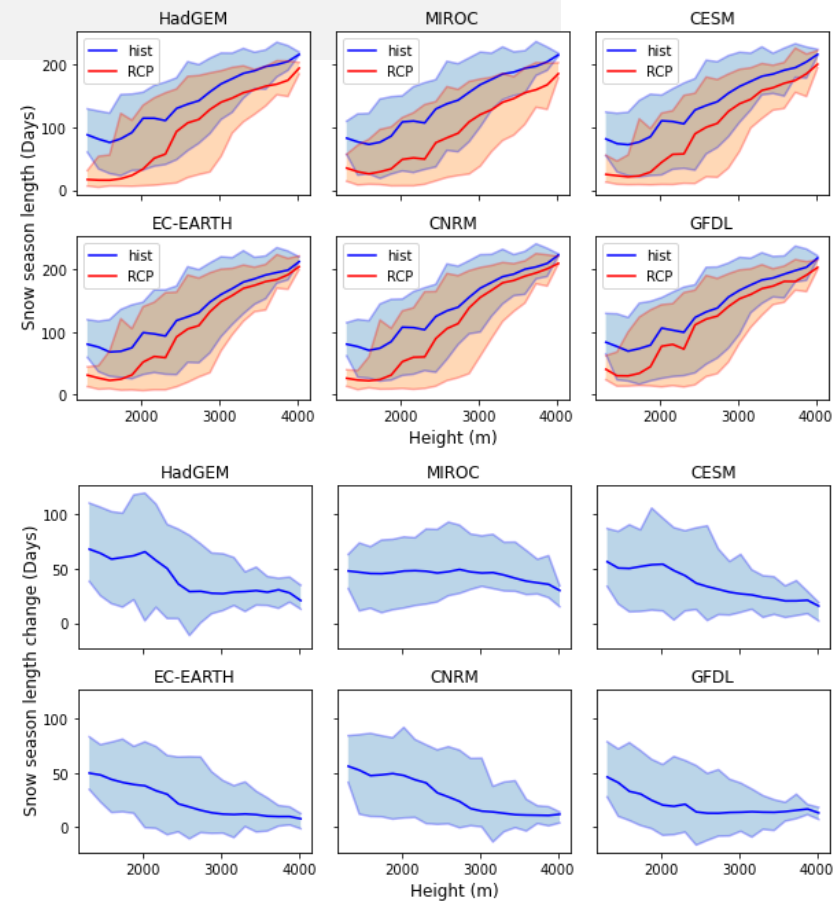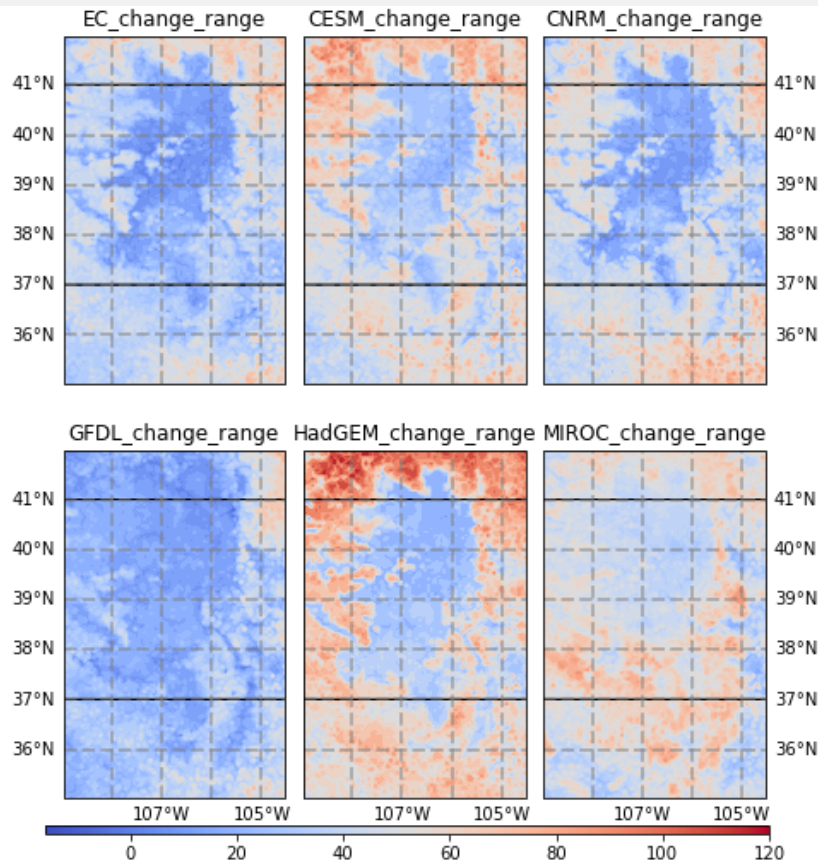
Projection Results

Figure: Snow season length changes in the future (left) and the height dependency (right).

Thanks

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- Any further questions or suggestions, please contact at shiduan@ucdavis.edu