ColoradoView 2023 - 2024

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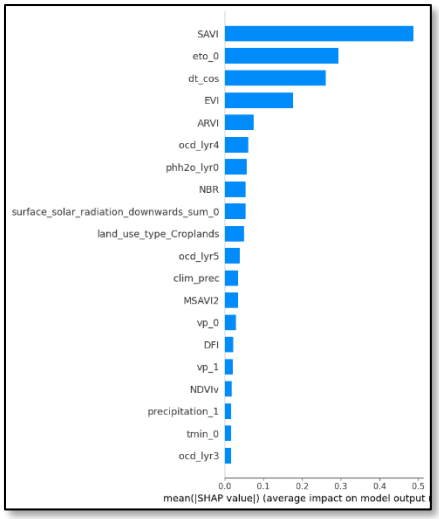
ColoradoView 2023 - 2024 Activities

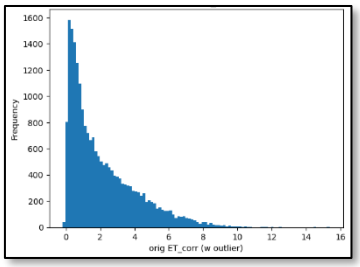
Accurate ET estimation is crucial for water resource management, irrigation scheduling, climate change impact prediction, and ecological studies. While existing surface-energy-balance methods are sensitive to various factors, this project leverages the power of machine learning with labeled in-situ ET data, Landsat satellite imagery, and meteorological observations to reduce uncertainties. This year's focus is on data preparation and baseline model development using supervised regression.

The project leverages in-situ ET measurements from 161 stations across the US (1995-2021), Landsat satellite imagery, and diverse meteorological datasets (Daymet, GridMet, ERA5, MSWEP). Additional features include soil properties, elevation, and land cover. Features are transformed using sine/linear scaling, Z-score normalization, log and Yeo-Johnson power transformation.

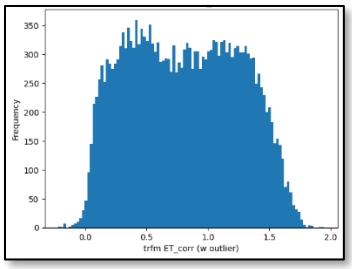
Two baseline models were developed: Linear (LN) and Random Forest (RF) models. The LN Model (test R^2: 0.76) primarily relies on soil properties and temperature, demonstrating a limited linear relationship with other features. The RF Model (test R^2: 0.86) achieved higher accuracy by leveraging non-linear relationships between spectral indices and environmental factors, demonstrating the importance of capturing complex interactions for improved ET prediction.



The top 20 important features of the Random Forest ET retrieval model using SHAP.



Histogram of original ET values.



Histogram of power transformed ET values.

Another project investigated the feasibility of predicting cloud fraction (CF) from ground-based shortwave solar irradiance using machine learning. The project uses data from three collocated stations measuring both CF and irradiance: SURFRAD/ARM for CF and UVMRP for irradiance. Approximately 885,000 matched data pairs at 3-minute intervals from IL, MT, and OK are processed for model development.

The team employed linear regression, random forest regression, and a deep neural network (DNN) composed of dense pre-activation residual blocks. The DNN outperformed other models, explaining over 95% of the variance in thick/total cloud fraction based on instantaneous irradiance measurements (R^2 = 0.959). However, model performance was notably lower for thin clouds (R^2 = 0.668), suggesting the need for improved input features.

The project's findings were published in *The Geographical Bulletin*, highlighting the potential of using ground irradiance data for accurate CF retrieval, particularly for thick clouds. The research provided valuable training opportunities for student interns. Intern Jamison Lerma received two awards from CSU recognizing his contributions: runner-up for Student Employee of the Year (Innovation & Technology) and the Undergraduate Research Award from the Warner College of Natural Resources.

ColoradoView is a member of the AmericaView Consortium, a nationally coordinated network of academic, agency, non-profit, and industry partners and cooperators that share the vision of promoting and supporting the use of remote sensing data and technology within each state. AmericaView is funded by USGS grant agreement G23AP00683.

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Benefits to Colorado

- Enhanced Colorado's water resource management by exploring evapotranspiration (ET) estimation using machine learning and satellite data The research has the potential to improve irrigation scheduling, climate change impact predictions, and ecological studies, ultimately promoting water conservation and informed decision-making.

- Provided Colorado student interns with valuable STEM education experience through real research projects. Interns developed skills in:
  - Processing satellite and ground-based Remote Sensing data using scripts;
  - Programming in a team environment;
  - Applying statistical techniques; and
  - Preparing summary reports/papers and present scientific findings.

- The project's educational impact is further demonstrated by resulting peer-reviewed publications and two university awards earned by student participants.

Jamison receiving the undergraduate research award.

Certificate of Recognition: Jamison's Student Employee of the Year Runner-Up.

ColoradoView Consortium Membership

Colorado State University

USDA

Google Earth Engine

Geospatial Centroid
gis.colostate.edu

NREL

USDA UV-B Monitoring and Research Program

Department of Ecosystem Science & Sustainability
Colorado State University
Warner College of Natural Resources

Google Cloud Platform

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