National Aeronautics and Space Administration

FY24 Strategic University Research Partnership (SURP)

Detecting toxic metal contamination through imaging spectroscopy

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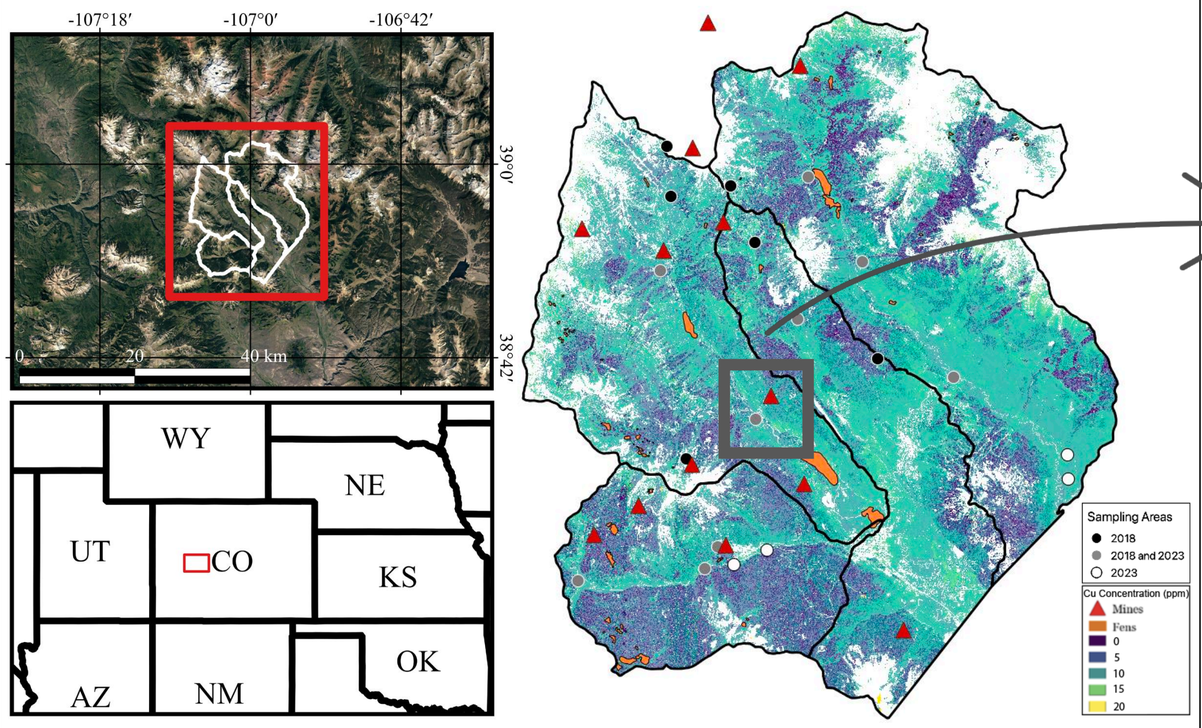
Objective

To identify areas of subsurface metal contamination through remotely sensed expressions of contamination in leaf chemistry by:

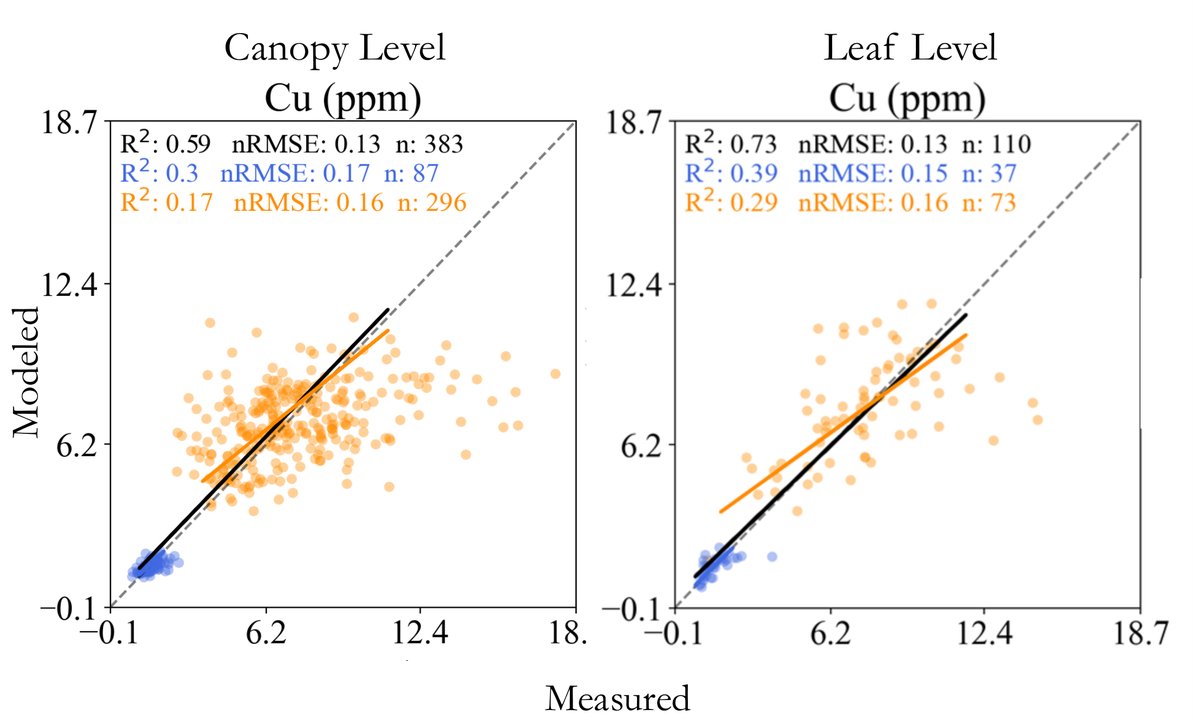
- **(a)** Utilizing an existing foliar metal concentration dataset from field samples and paired VSWIR spectra to calibrate, evaluate, and quantify error of algorithms for mapping foliar metal concentrations
- **(b)** Field validate metal mobilization occurrence through pre-existing samples and subsequent sampling [focus of Year 2].
- **(c)** Describe the relationship between foliar metal accumulation and the concentrations of these metals in various levels of chemical association with the soil matrix.

Background



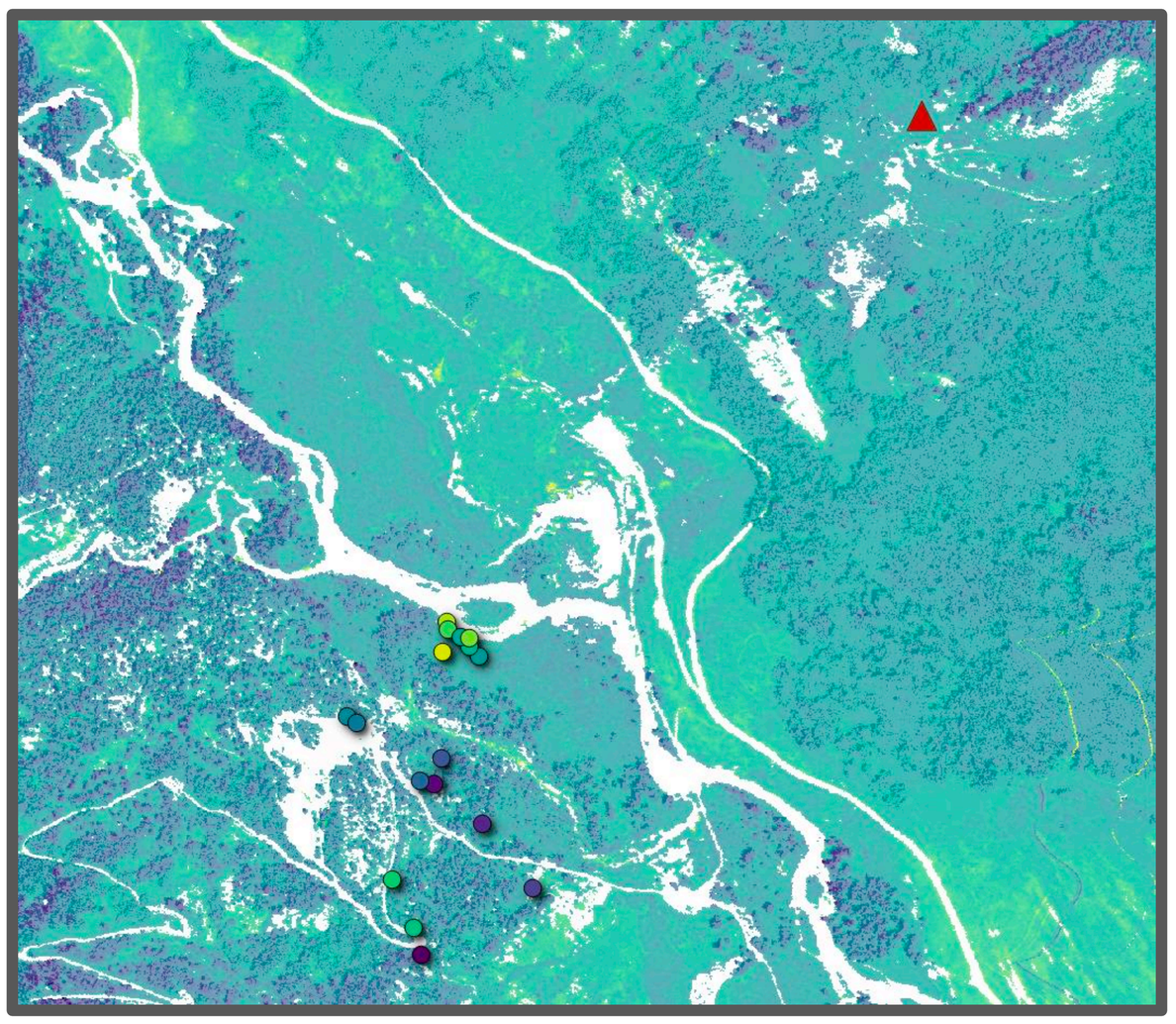
The Upper East River Basin of Colorado: a 330 km^2 area comprised of four watersheds. Vegetation ranges from conifer and aspen to meadow species. Coal and Slate River Watersheds (the left-most catchments) have ore-rich stocks and a century-long mining legacy.

Approach

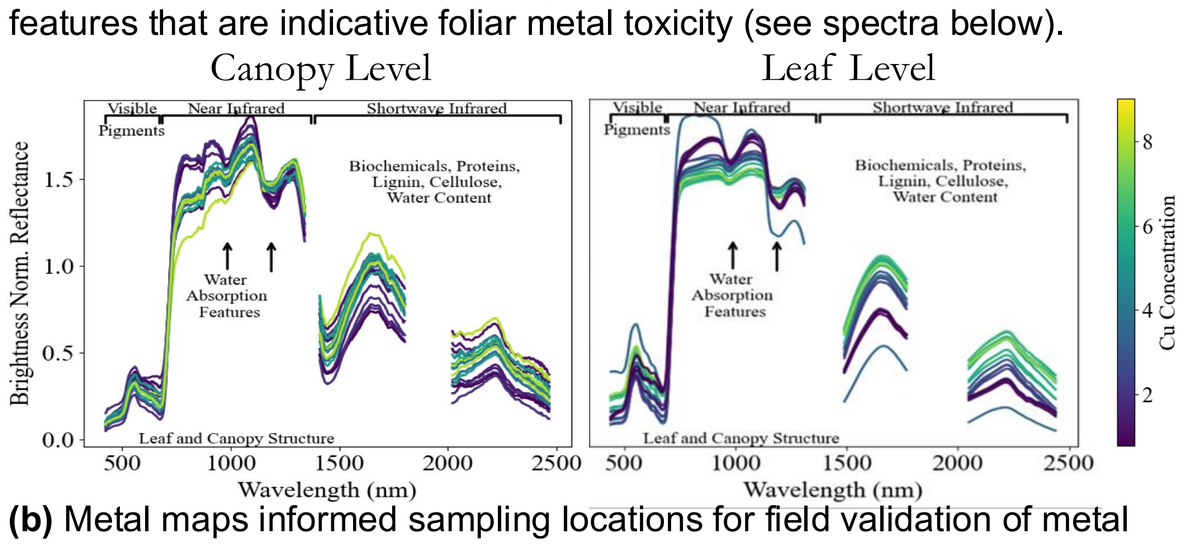


We used a partial least squares regression (PLSR) algorithm with included all spectral and elemental information to predicted foliar metal content

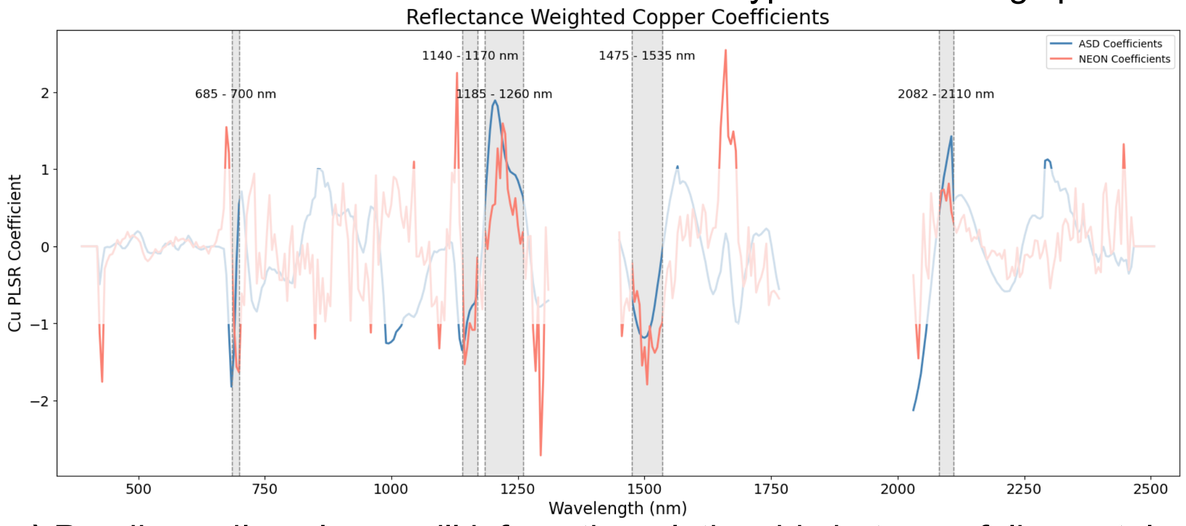
Results



(a) The extracted spectra paired with ground-truthed metal concentrations demonstrated our sensitivity to key broadband and narrowband spectral features that are indicative foliar metal toxicity (see spectra below).



(b) Metal maps informed sampling locations for field validation of metal hotspots (1,044 samples collected).Both our canopy and leaf-level models underpredict heightened foliar metal concentrations as compared to ground measurements. While our models do not capture the full magnitude of foliar metal content, they do predict heightened metal concentrations where there are increases in ground concentrations and where there is known metal contamination or hyperaccumulating species.



c) Pending soil analyses will inform the relationship between foliar metal accumulation and their association to various levels of the soil matrix.

Significance/Benefits to JPL and NASA:

Characterizing foliar traits and their relationship to active geologic processes is of key strategic interested to JPL, and a cornerstone component of the SBG mission. Expanding the capacity of VSWIR retrievals to capture bioaccumulation of metal contaminants could open up new avenues of research based on the data collected as part of SBG and the EMIT mission.

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Publications:

[A] Grant, Kathleen et al., “Remote detection of foliar metal toxicity: wavelength investigation”, submitted to *AGU Fall Meeting, Washington D.C. 2024.*
[B] Grant, Kathleen et al., “Wavelength identification for the remote detection of foliar metal toxicity”, *in prep*.

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