Biospheric Sciences Laboratory

Blooming Dynamics: Deciphering the Spectra of Flowers

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Motivation

The coloration of flowers is driven by inherent optical properties (pigments, scattering structure, and thickness). However, establishing the relative contribution of these factors to canopy spectral signal is usually limited to in-situ observations at a flower scale. Modeling flowering dynamics (e.g., blooming, span, spatial distribution) at the landscape scale may reveal hints on:

- Ecological processes.
- Diversity of plants and pollinators.
- Phenological adaptations to environmental changes.

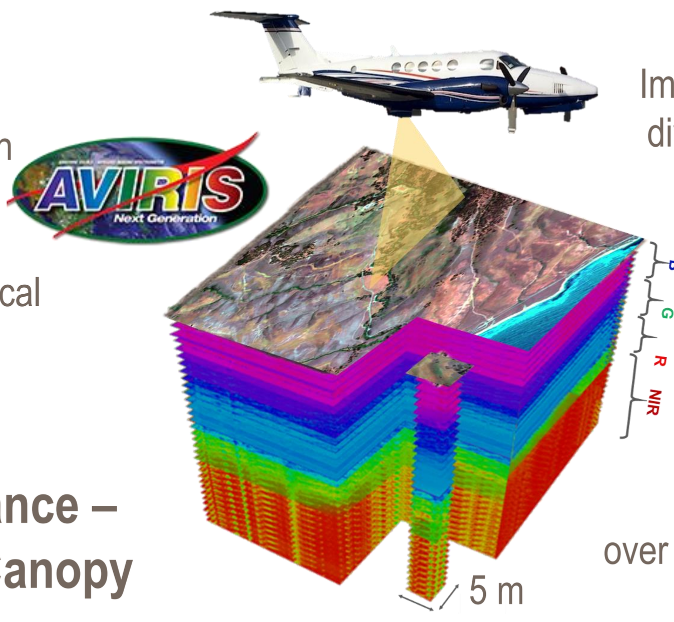
Challenge

Multitemporal hyperspectral aerial and satellite-based observations can be sensitive to major flower pigments, flowering phenology traces, and biophysical differences between flowers and other plant parts. We explore how flowers contribute to canopy spectral signal by using airborne remote sensing for monitoring and detecting blooming dynamics at high spatial, spectral and temporal resolution. The retrieved flowering distribution maps would serve as products to evaluate phenology from individual species.

1. **Data collection**: Weekly time series of imagery from the airborne imaging spectrometer AVIRIS-NG and field spectra collected as part of the SBG High-Frequency Time Series (SHIFT) campaign.

2. **Processing**: Raw radiance swaths are atmospherically corrected and translated into reflectance. Ground spectra from flowering and non-flowering sampled plots are post-processed.

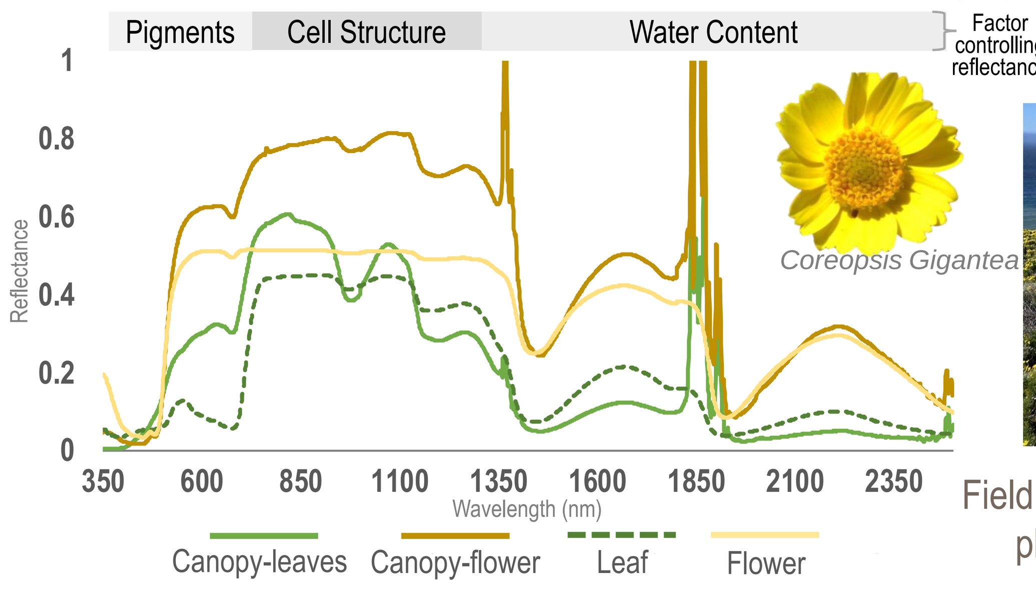
Each Photosynthetic Vegetation (PV) pixel represents a reflectance spectrum, which is correlated with plant physiological characteristics.



Imaging spectroscopy involves dividing light into thousands of narrow bands to gain detailed information.

SHIFT campaign was carried out between February and May 2022 over two natural reserve areas in Santa Barbara, California.

Field reflectance – Flower/Leaf/Canopy



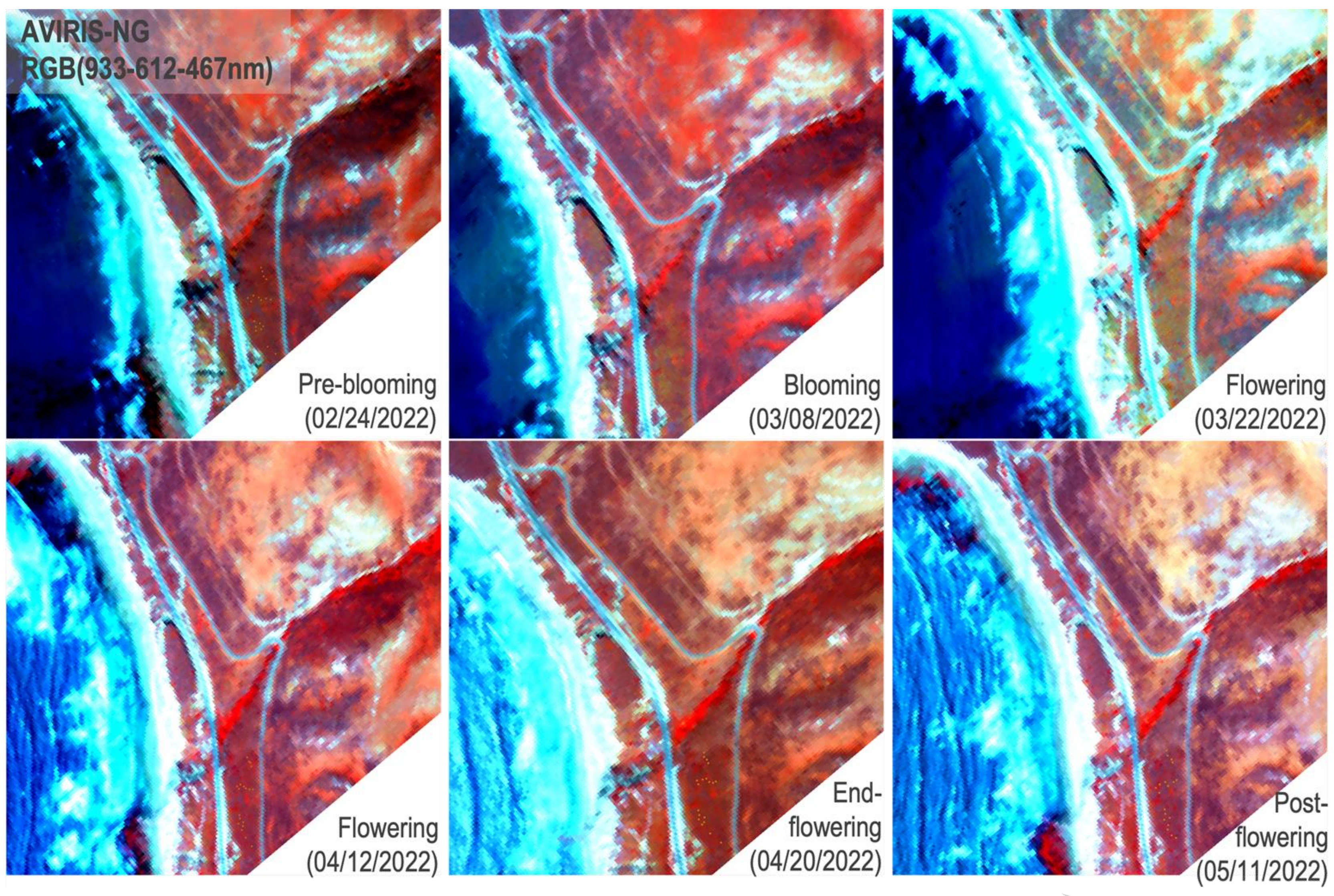
Field spectra were gathered from blooming plots at leaf, flower, and canopy levels.

3. **Modeling**: Field spectra and processed images are used to investigate the spectro-temporal variation and spatial distribution of flowering species against non-flowering ones using radiative transfer models (RTM).

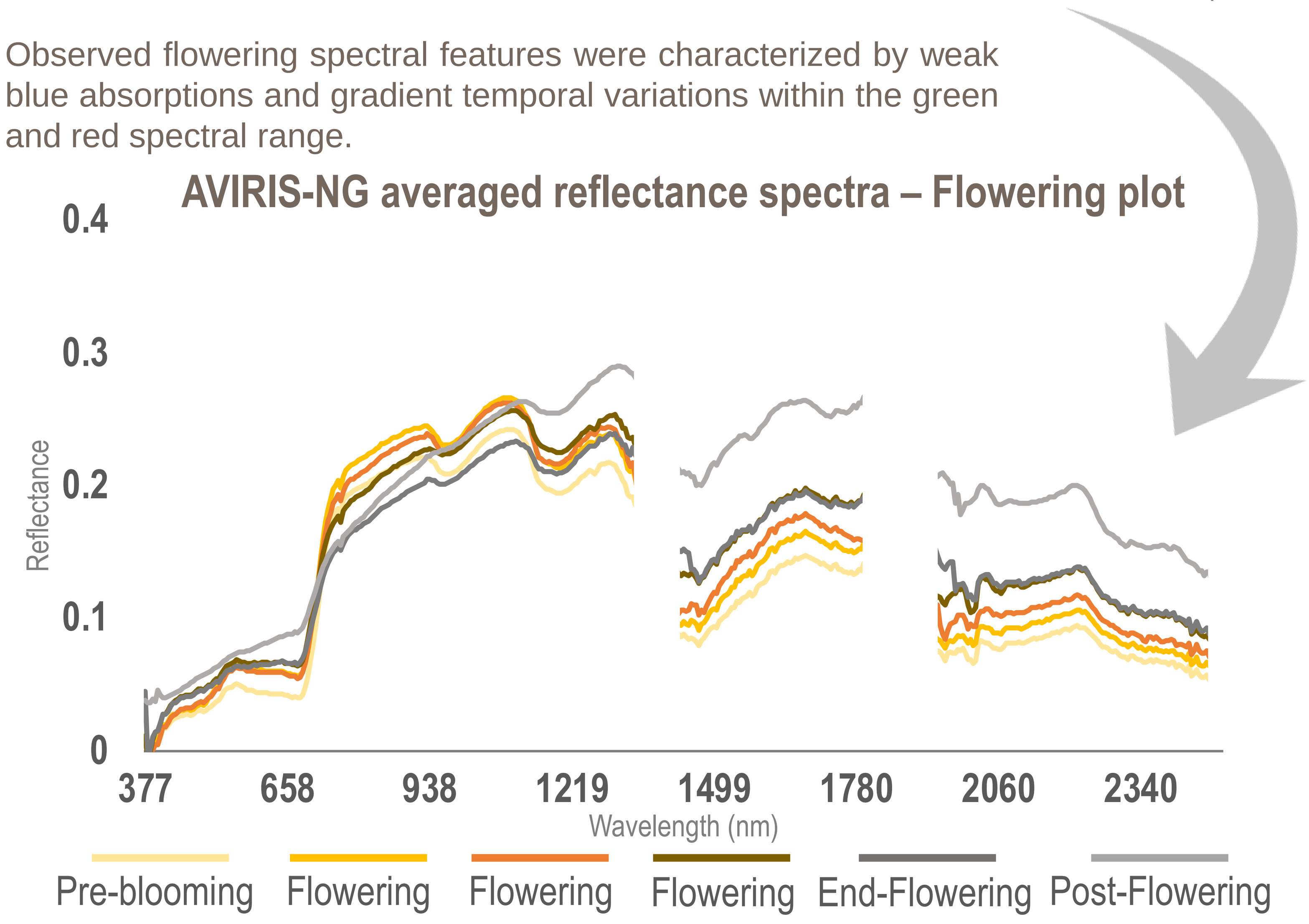
4. **Analysis**: Mapping flowering events from modeling spectro-temporal dynamics over the course of the season, from pre-blooming to post-flowering stages. Comparing results with Blooming Vegetation Indices (BVIs).

Research goals

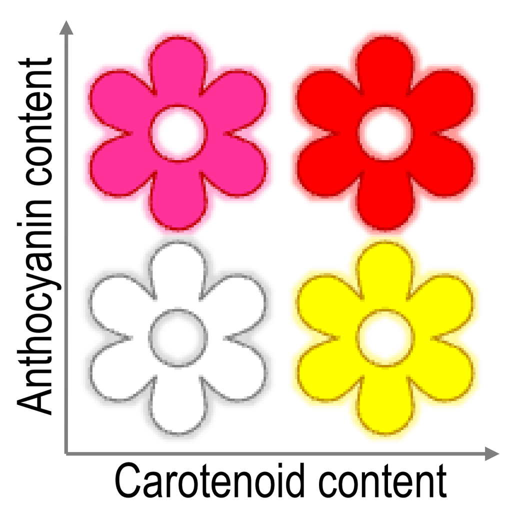
- Mapping flowering events from modeling spectro-temporal dynamics opens opportunities for future satellite monitoring of floral cycles at broader scales.



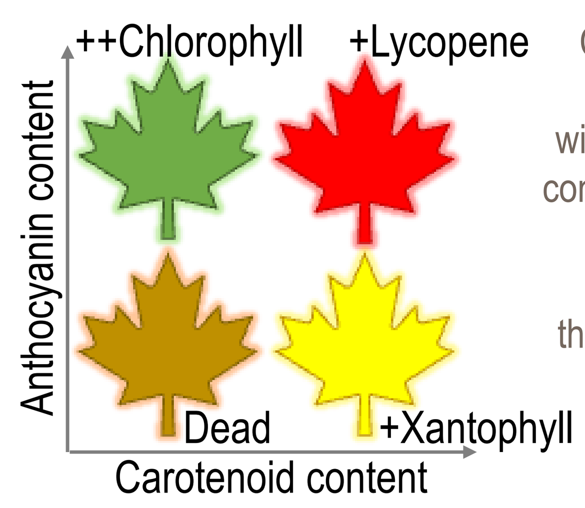
Observed flowering spectral features were characterized by weak blue absorptions and gradient temporal variations within the green and red spectral range.



- Inverse fitting of RTM parameters of pigment contents (e.g., carotenoids, anthocyanins) and plant structural traits (e.g., LAI) could led to the advance of a model able to account for flower pigments absorptions.



Major flower pigments determine different colour signal to pollinators .



Canopy and leaf spectra change with leaf pigments content variations.

As plants go through flowering:

Ccar →
Cbrown ↑
Canth ↑

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