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SMARTSAT COOPERATIVE RESEARCH CENTRE

Improving the Measurement and Understanding of Australian Vegetation Phenology

Introduction

Vegetation Phenology is the periodic events in a plant's life cycle controlled by their biological processes and climate. Capabilities to accurately map and monitor vegetation phenology are fundamental input variables for Earth System Models, and for assessing local to global scale carbon dynamics and ecosystem responses to climate change.

Land Surface Phenology (LSP), is a satellite pixel-based measurement widely used in tracking vegetation phenology. However, LSP metrics derived from satellite data using Vegetation Indices (VIs) can be decoupled with the ground-based measurement of Gross Primary Productivity (GPP), i.e. the amount of carbon fixed during photosynthesis [1].

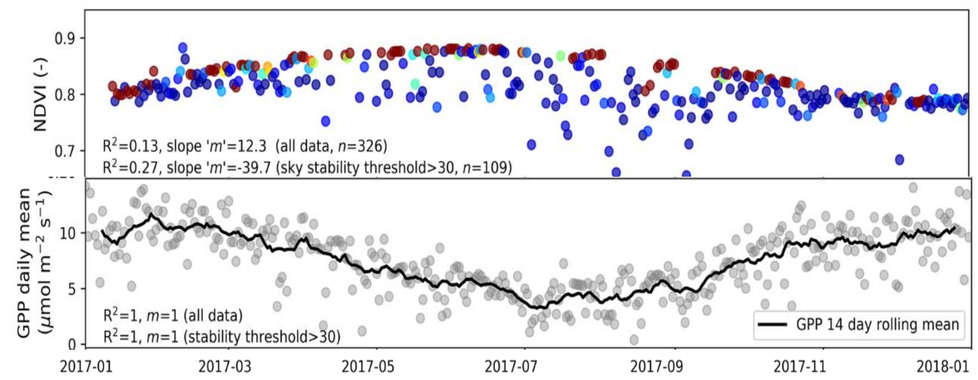
Canopy structure, sun-illumination and sensor-view geometries, and understorey dynamics, are factors responsible for decoupling. The underlying reason behind this decoupling in Australian vegetation types remains to be determined.

Radiative Transfer Models (RTMs) can be used to understand the impacts of factors in the decoupling process using measurements of vegetation 3D structure and their spectral properties (reflectance/absorption).

Aims

1) To evaluate and improve the Land Surface Phenology of Australian vegetation using Vegetation Indices and Sun-Induced Fluorescence derived from high-spatial resolution satellite imagery,

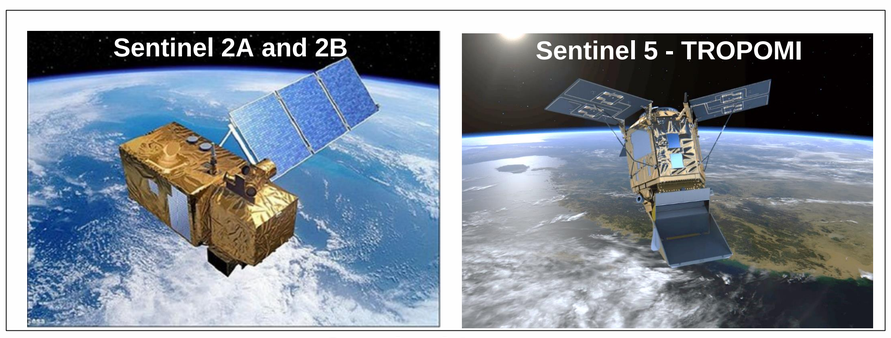
2) Investigate the impact of sun-illumination and sensor-view geometries, and understorey vegetation dynamics on the decoupling of phenology and GPP using a 3D Discrete Radiative Transfer Model.



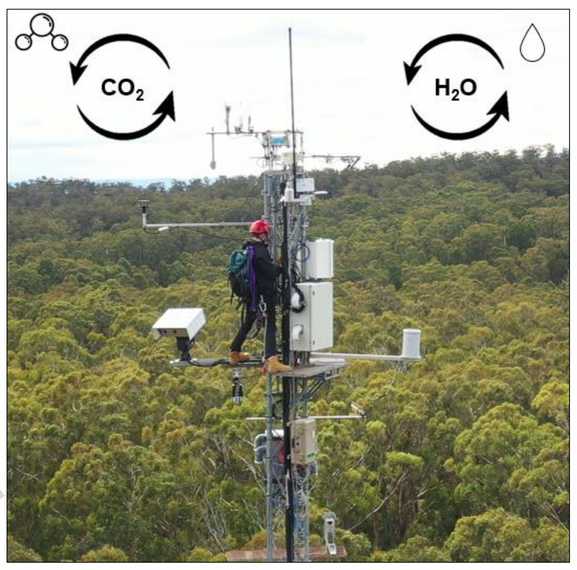
Inter-annual decoupling of GPP and NDVI phenological metrics [2]

Methods

Study Sites



Sentinel Imagery



Flux Tower GPP Measurement

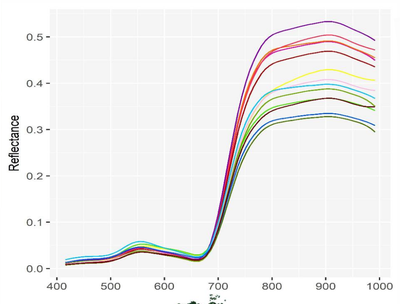
Satellite Metrics (NDVI, EVI, NIRv & SIF)

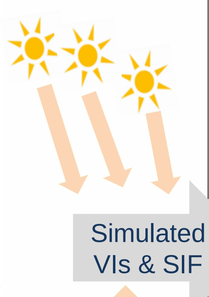
GPP data

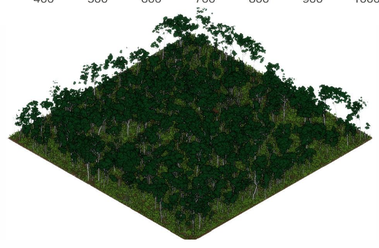
Spectral Property Measurement

Input for DART model

Sun-Sensor View Geometry



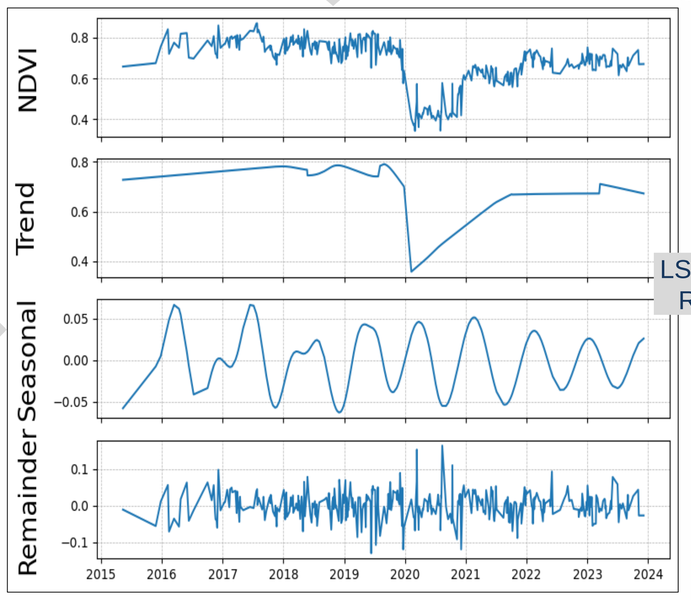




Simulated VIs & SIF

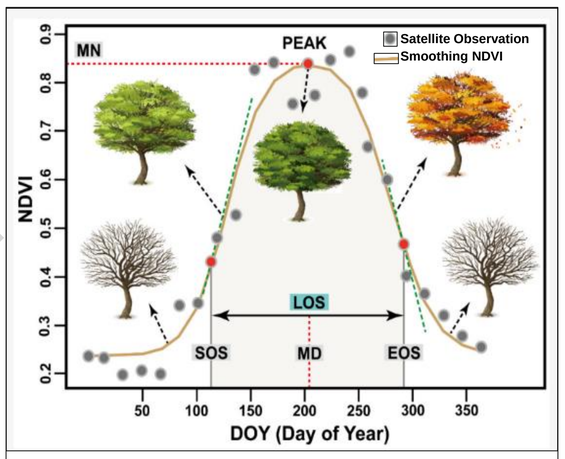
With & Without Understorey

3D Discrete Anisotropic Radiative Transfer (DART) Model



Time Series Decomposition

LSP Metrics Retrieval



SoS: Start of Season
EoS: End of Season
LoS: Length of season

Land Surface Phenology Metrics

Expected Results

- **More accurate input variables for Earth System Models:** Comparing satellite-based LSP metrics aids in selecting the right LSP tracking approach for Australian vegetation types and best fitted to Earth System Model.
- **Understanding of Decoupling Phenomenon:** Quantifying the impact of sun-illumination and sensor-view geometries, and understorey vegetation dynamics on tracking vegetation productivity.
- **Key Message:** Multiple LSP metric retrieval approaches are required to accurately cover all Australian vegetation communities.

References

[1] Leng, S., Huete, A., Cleverly, J., Yu, Q., Zhang, R., Wang, Q., 2022. Spatiotemporal Variations of Dryland Vegetation Phenology Revealed by Satellite-Observed Fluorescence and Greenness across the North Australian Tropical Transect. Remote Sens. 14, 2985.

[2] Woodgate, W., van Gorsel, E., Hughes, D. et al. THEMS: an automated thermal and hyperspectral proximal sensing system for canopy reflectance, radiance and temperature. Plant Methods 16, 105 (2020).

Raja Ram Aryal
r.aryal@uq.edu.au
School of the Environment
The University of Queensland
Advisory Team: William Woodgate, Stuart Phinn

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