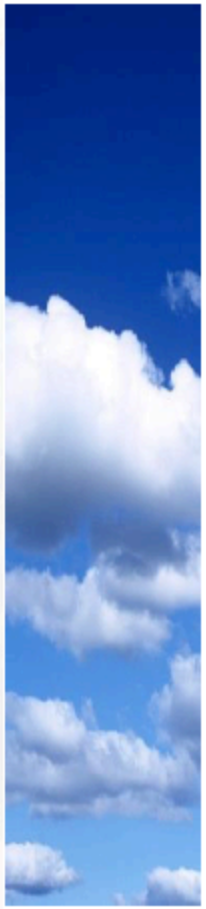
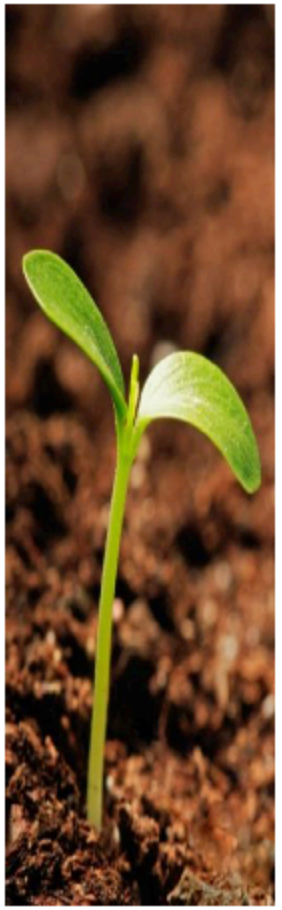
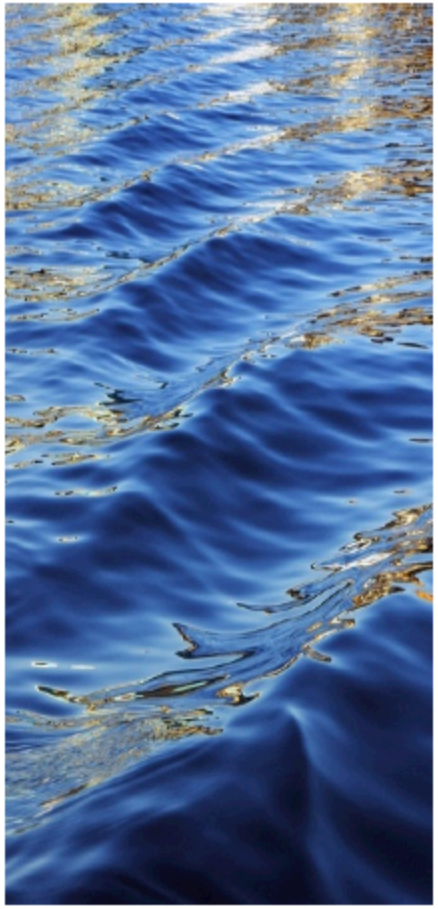


Impacts of climate variability on vegetation dynamics as observed from microwave observations

Mariette Vreugdenhil, Sebastian Hahn, Irene Teubner , Wouter Dorigo and Wolfgang Wagner





Research Area Remote Sensing | **Department of Geodesy and Geoinformation**
TU Wien | rs.geo.tuwien.ac.at

Motivation

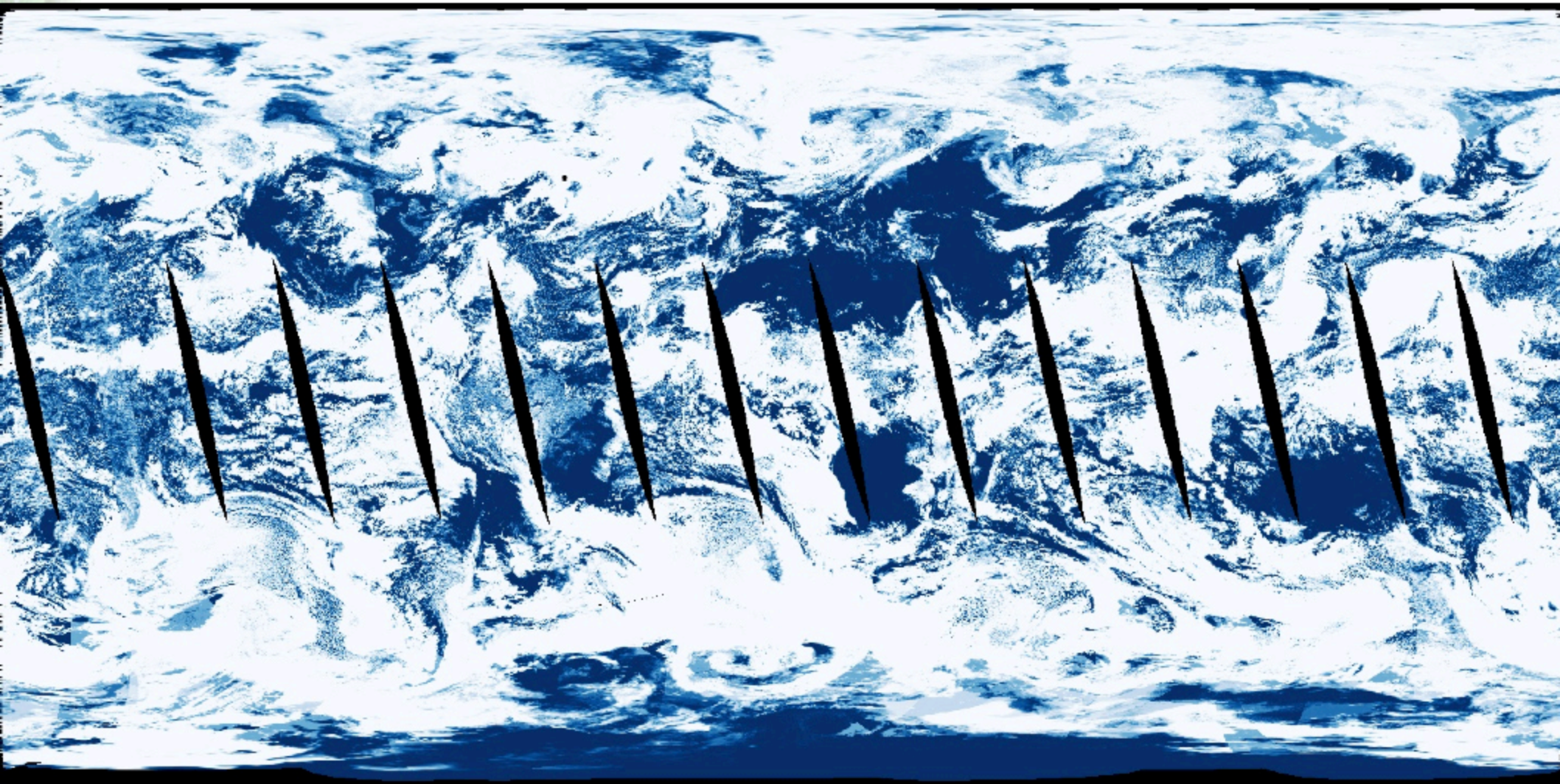
- **Vegetation** plays an important role in regional and global **hydrological**-, **energy**- and **carbon cycles**
  - **e.g. lengthening of growing season increases carbon uptake**
- **Controlled by climate drivers;** water availability, temperature, radiation
- **Highly dynamic** in time and space

Do soil water deficits affect vegetation dynamics and can we observe this with EO data?

Vegetation Monitoring using VNIR

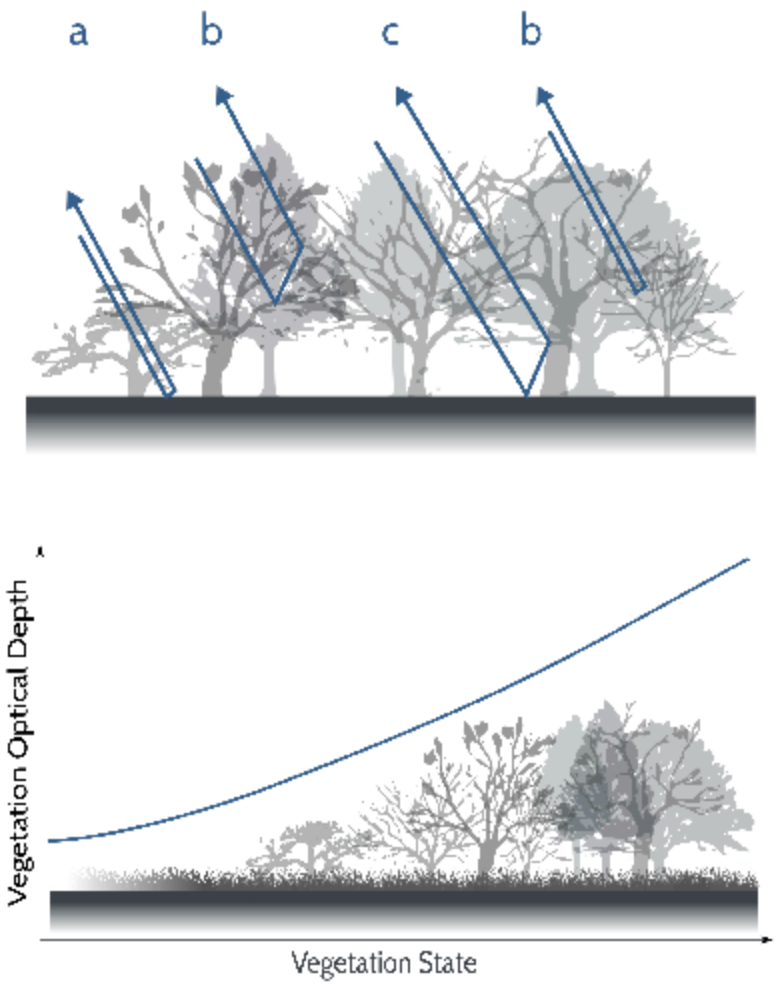
MODIS Cloud Fraction

30 August 2011



Microwave Remote Sensing for Vegetation Monitoring

- Microwaves are sensitive to the water content in soil and vegetation.
- Vegetation Optical Depth (VOD) is sensitive to **water content in the above ground biomass**
  - a measure of attenuation of the microwave signal by the vegetation
- Advantage over VNIR since it is not hindered by clouds and is not dependent on solar-illumination

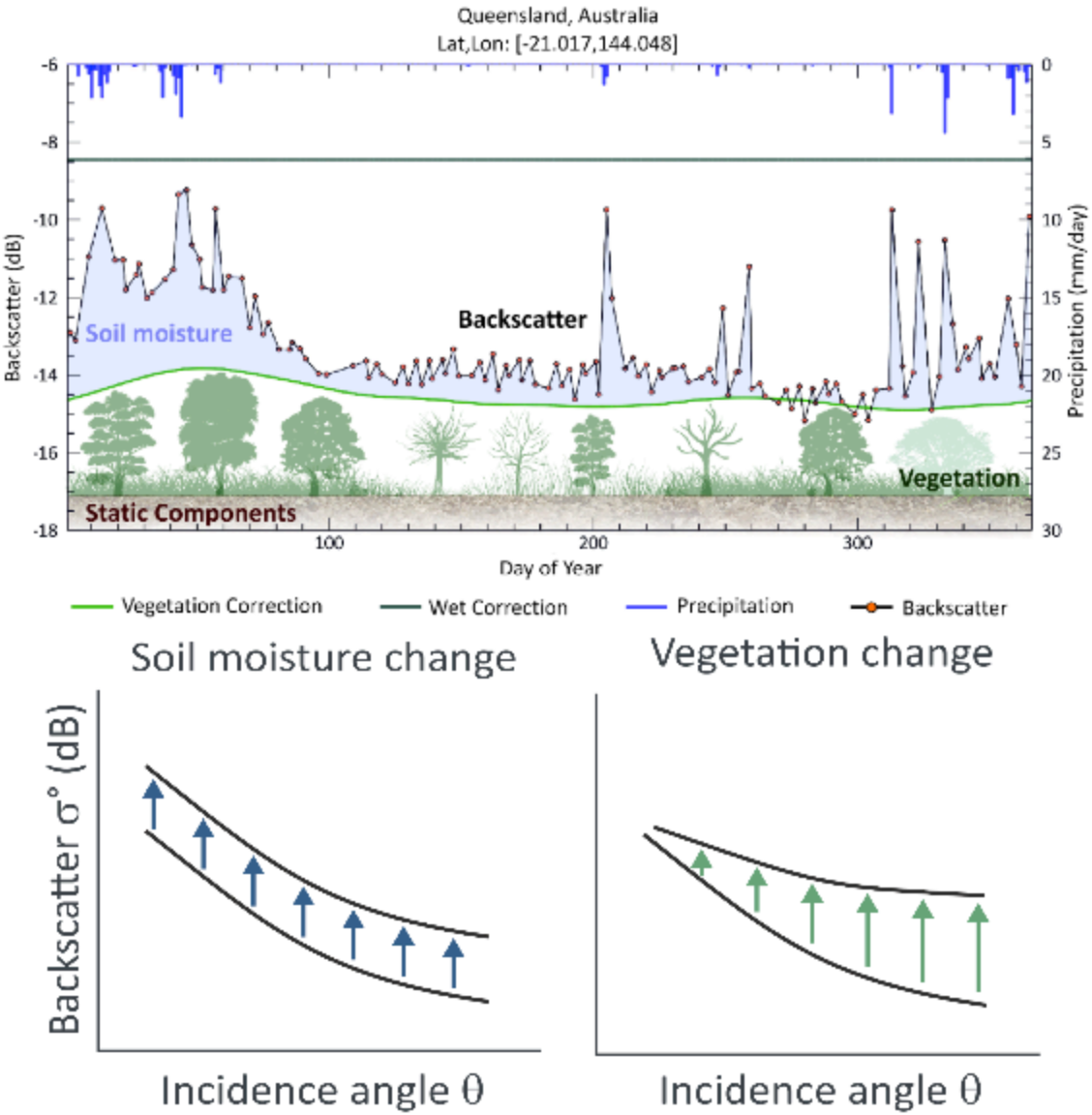


TU Wien Vegetation Optical Depth

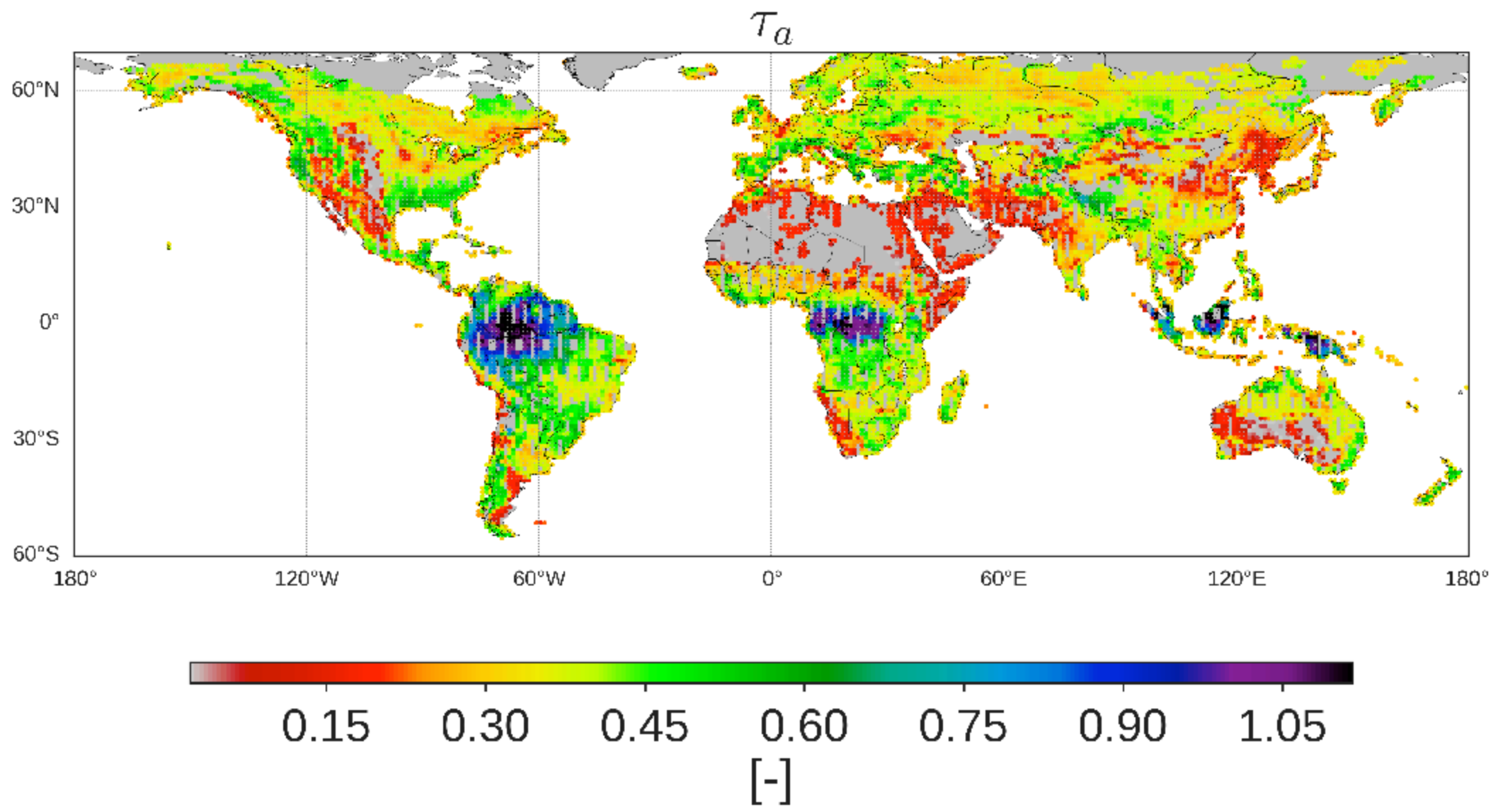
Change detection model scaling backscatter between driest and wettest recorded measurements to obtain soil moisture.

Vegetation correction is incorporated in the dry reference:

- the **temporal dynamics** originate from the **backscatter** and **incidence angle** relationship.



TU Wien Vegetation Optical Depth



Data and Methods

Two case studies

I. Yearly anomalies in VOD, LAI and SSM over **Australia** during Millenium Drought and La Nina

II. Anomalies in peak of vegetation from VOD and LAI and SSM for the 2011 **USA** drought

	ASCAT VOD	MODIS LAI	CCI SM	ASCAT SSM	GLDAS-Noah
Variable	VOD	LAI	Soil Moisture	Soil Moisture	Temp., SWE, Soil Temp.
Spat. Sam.	12.5 km	0.01°	0.25°	12.5 km	0.25°
Temp.Res.	Daily	8 days	Monthly	Daily	3-hr
Period	2007-2017	2007-2016	2007-2017	2007-2017	2007-2017
Source	TU Wien	NASA	ESA	TU Wien	NASA

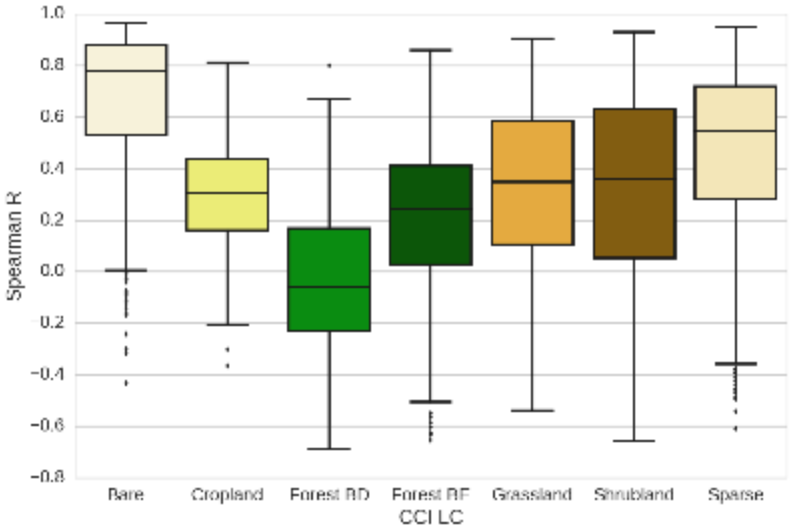
All datasets are:
- Spatially and temporally matched
- Masked for frozen soils and snow cover using GLDAS-Noah

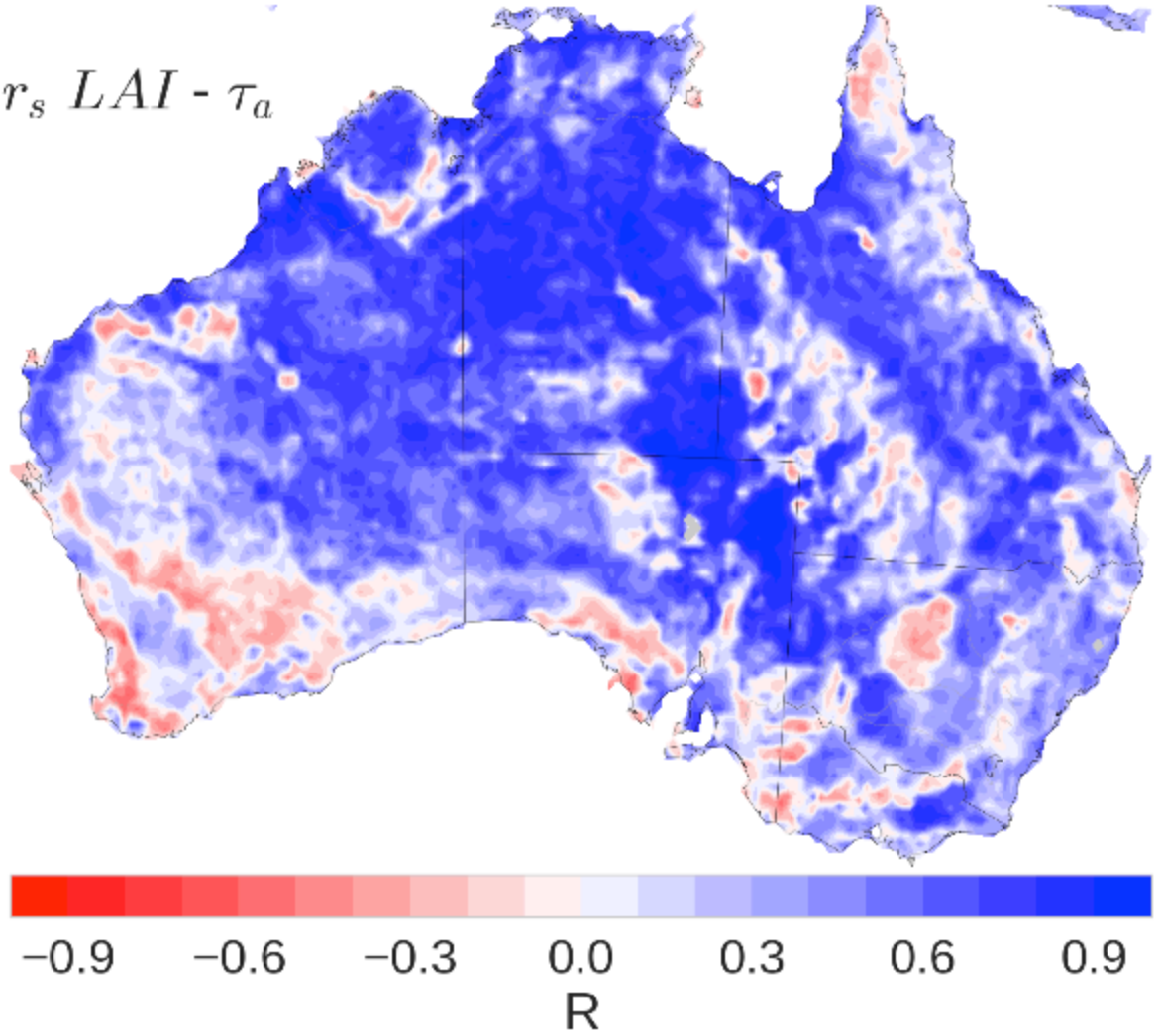
MODIS LAI: smoothed with a 45-day moving average window.

Case Study I: Australia

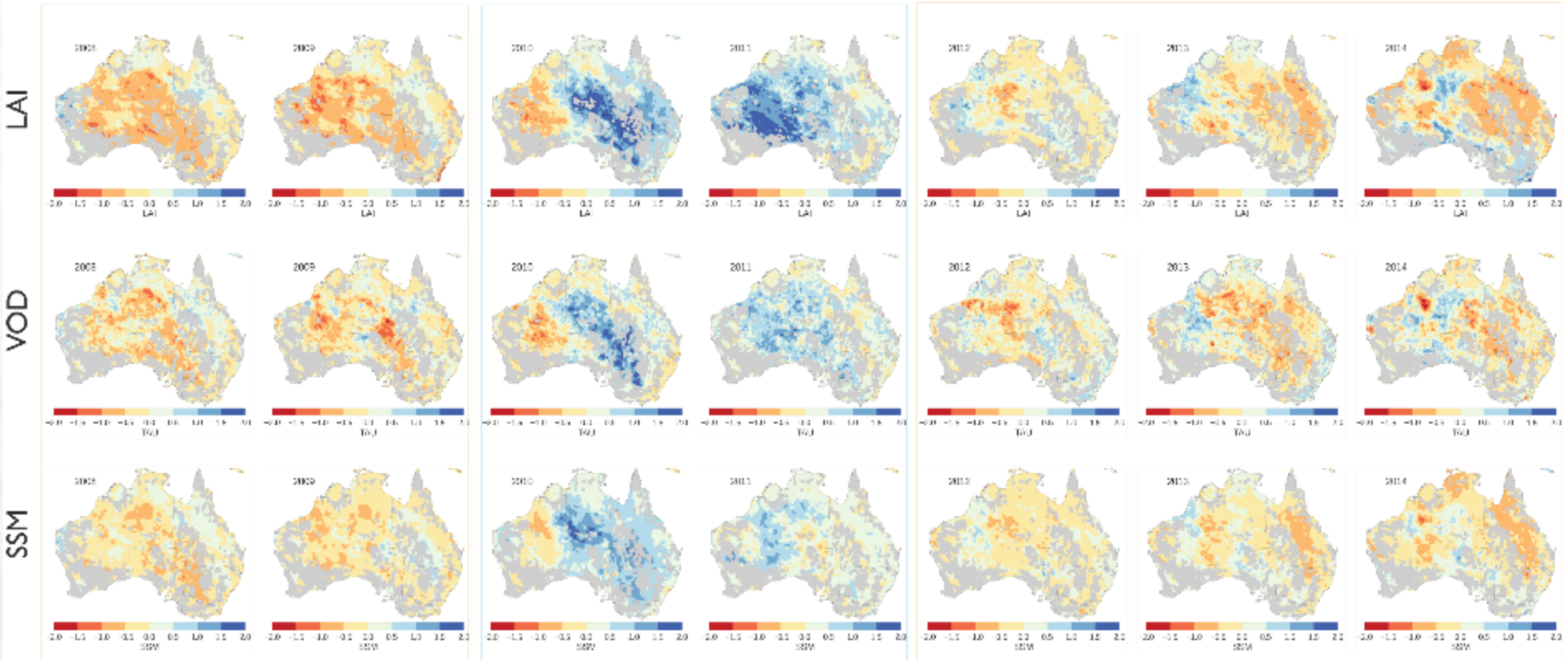
High correlation in bare soils, sparse, shrubs and grasslands

Low correlations in deciduous forests in arid regions and ephemeral flooded areas





Case Study I: Australia

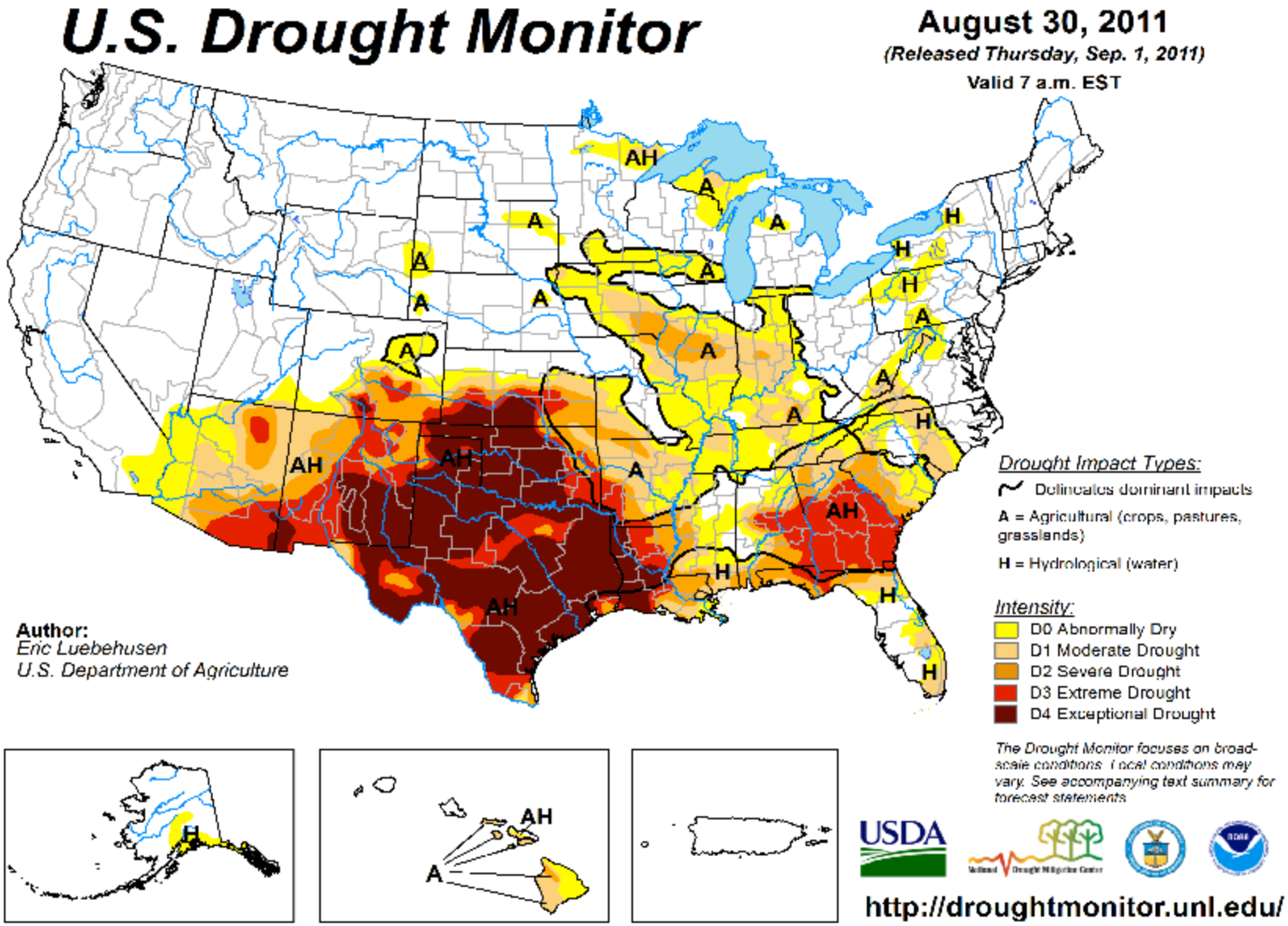


Millenium Drought (2007–2009)
- Strong negative anomalies in VOD, LAI and SSM
- Spatial patterns between VOD, LAI and SSM correspond with lowest values in northwest to southeast region

La Nina (2010-2011)
- Positive anomalies in VOD, LAI and SSM
- 2010 only in southeast Australia, drought in western Australia
- 2011 positive anomalies in Western Australia

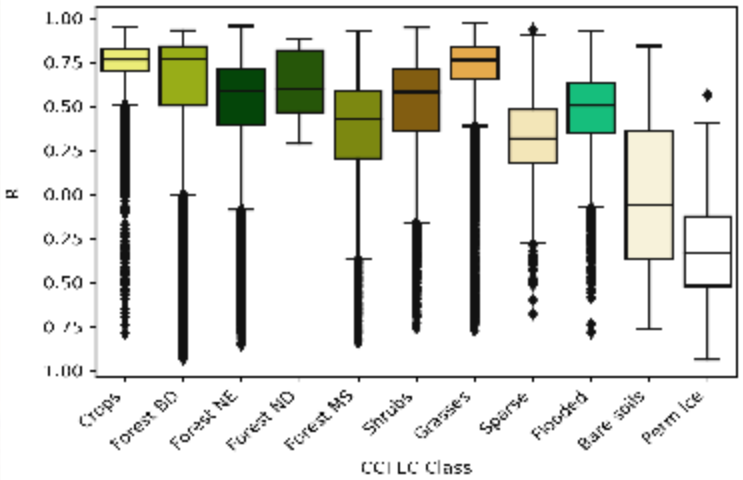
Normal conditions (2012–2014)
- Negative anomalies increase from year to year in VOD, LAI and SSM
- Negative anomalies increase over a large area in southern Australia
- Strong negative anomalies in VOD, LAI and SSM in small area in northwestern Australia in 2014

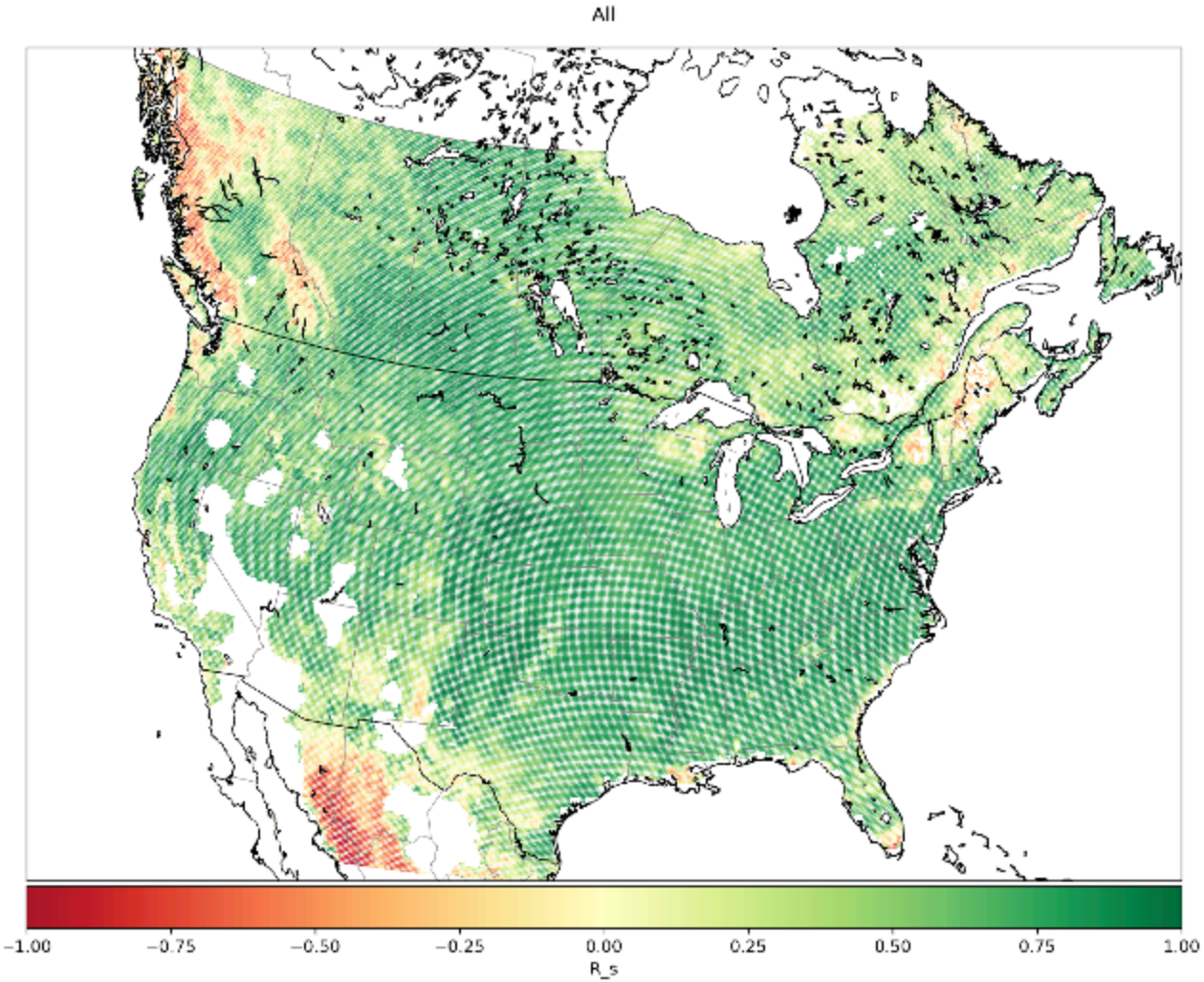
Case Study II: North-America



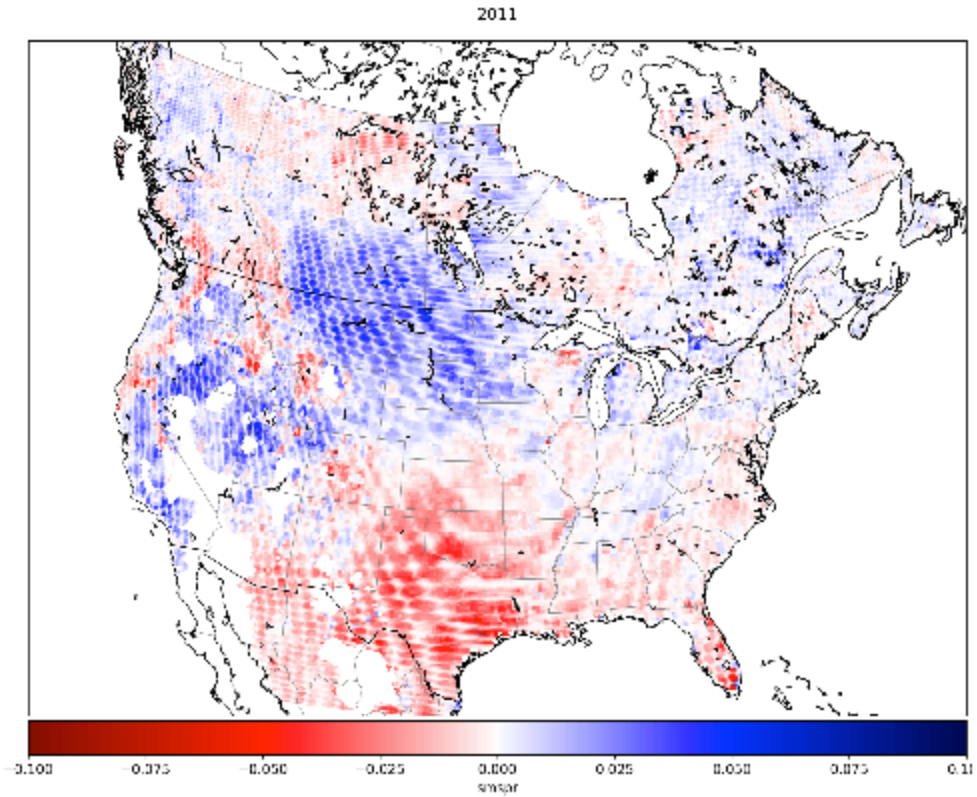
Case Study II: North-America

High correlation over forests, croplands and grasslands. Low correlations in mountainous regions, forests in arid regions bare soils and sparse vegetation.



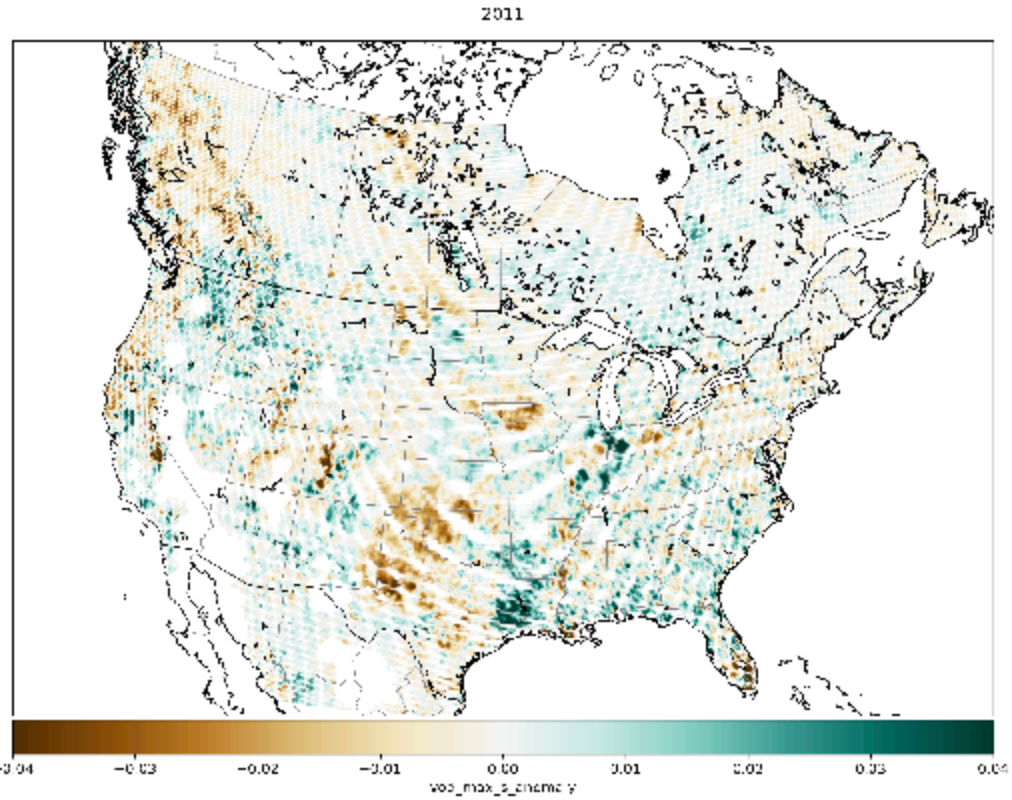


Case Study II: North-America



Average soil moisture anomaly in months before peak of season, based on climatology 2007-2017.

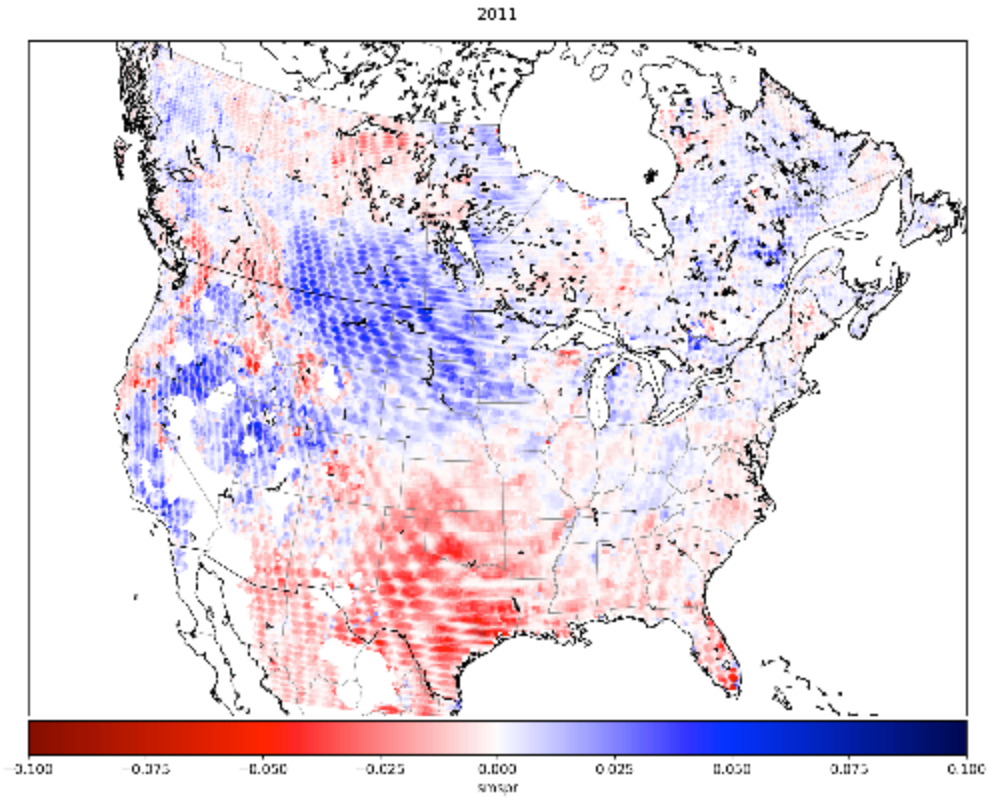
Strong negative anomaly in soil moisture observed over Lower Plains and southeastern USA.



Anomaly in VOD maximum compared to average of maxima 2007-2017.

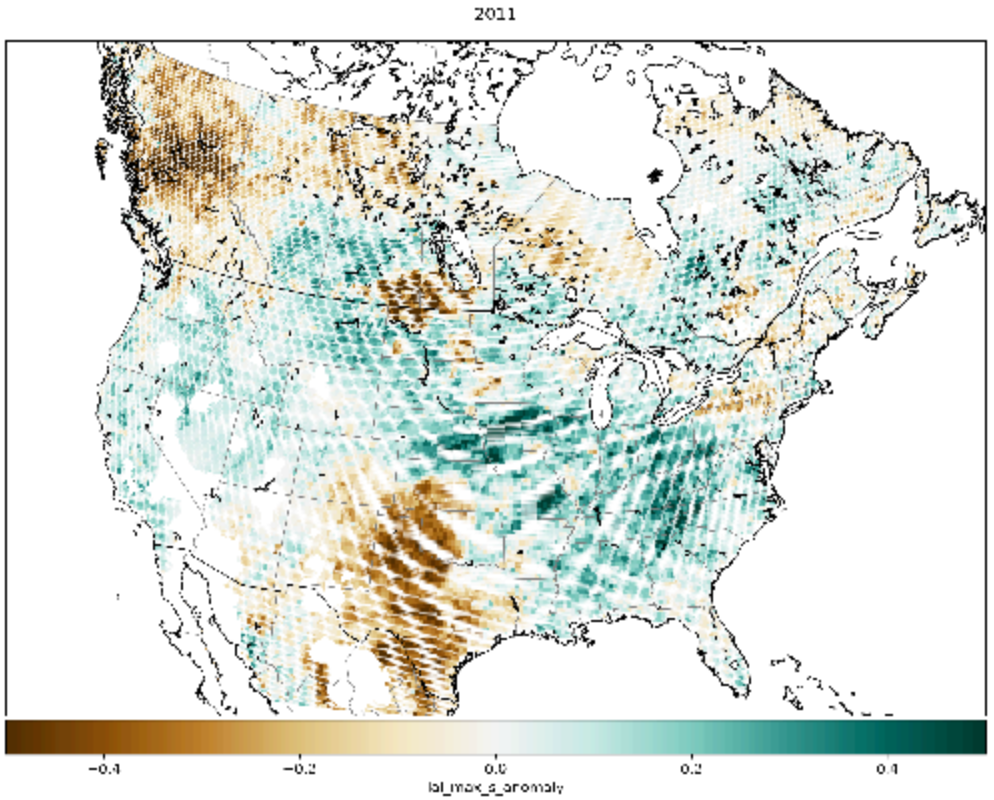
Negative anomalies in Lower Plains, positive anomalies in southeastern USA.

Case Study II: North-America



Average soil moisture anomaly in months before peak of season, based on climatology 2007-2017.

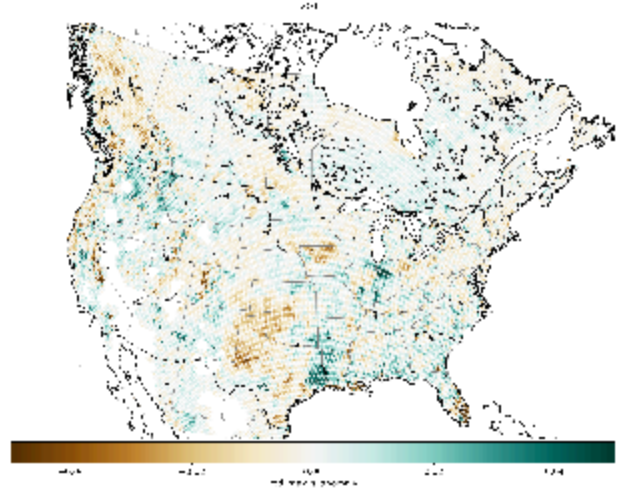
Strong negative anomaly in soil moisture observed over Lower Plains and southeastern USA.

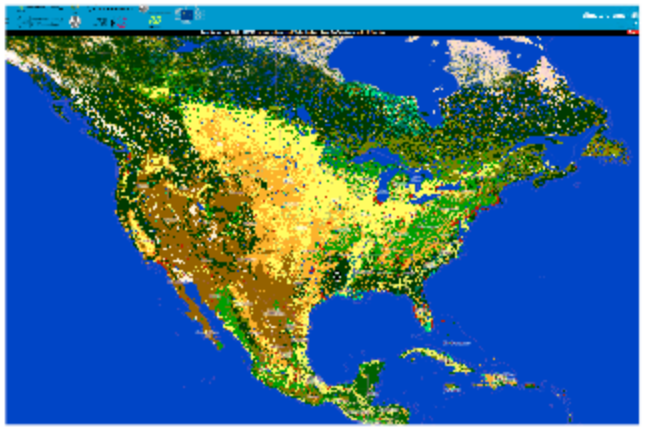


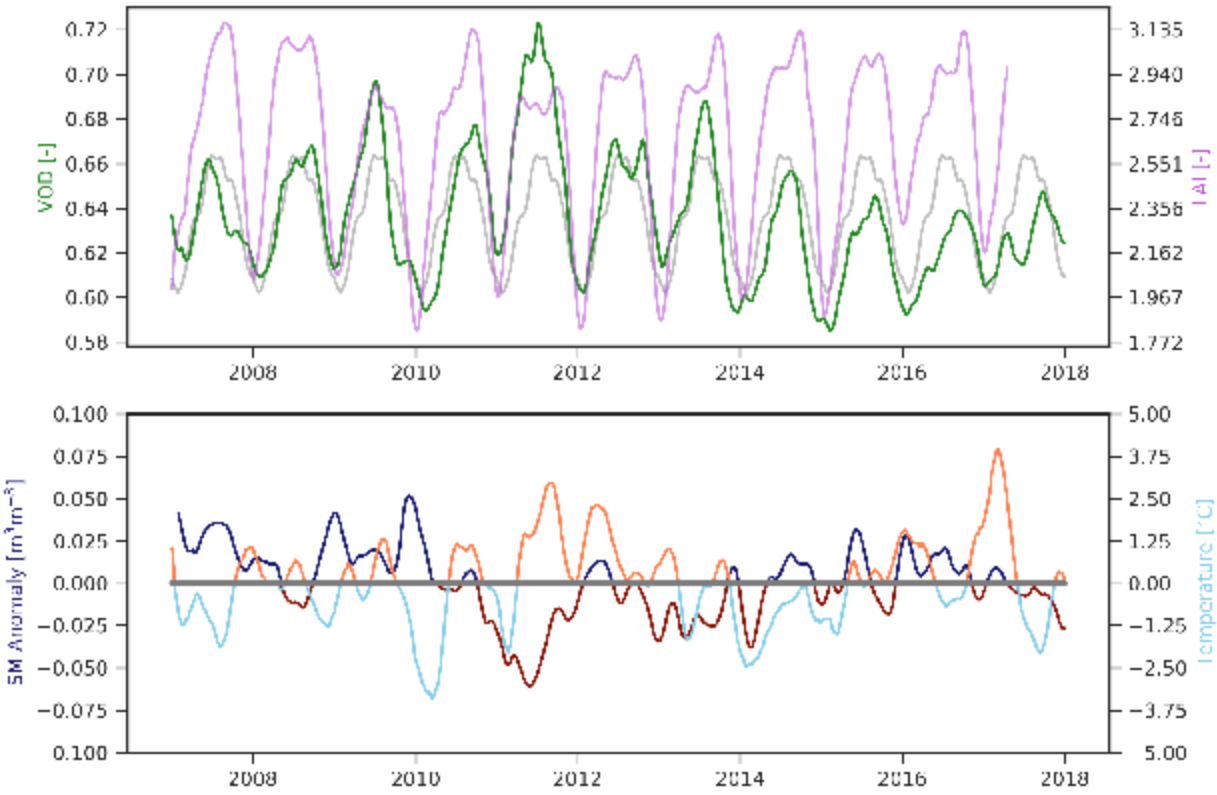
Anomaly in LAI maximum compared to average of maxima 2007-2017.

Negative anomalies in Lower Plains, positive anomalies in southeastern USA.

Case Study II: North-America

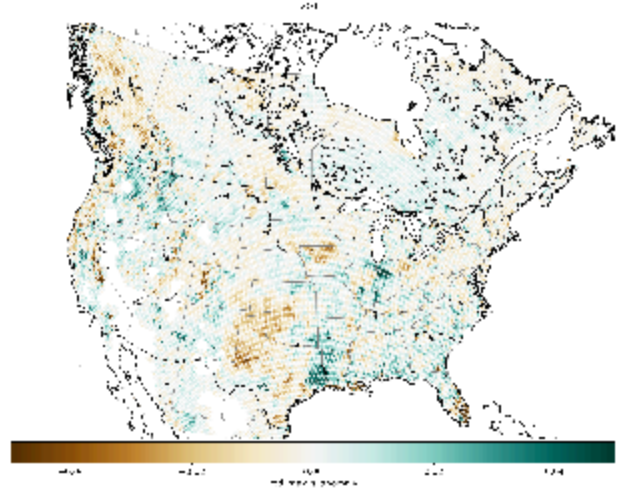


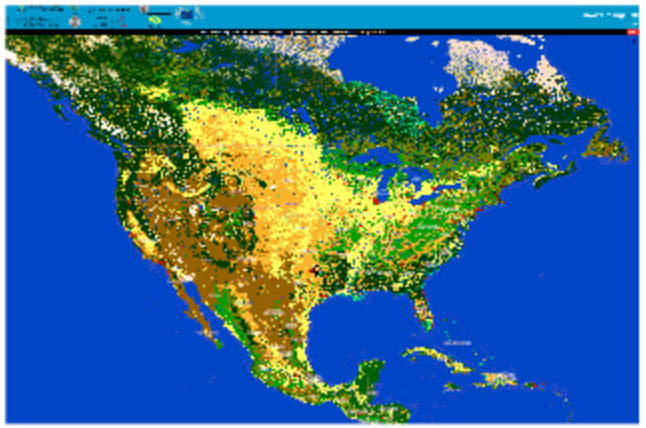


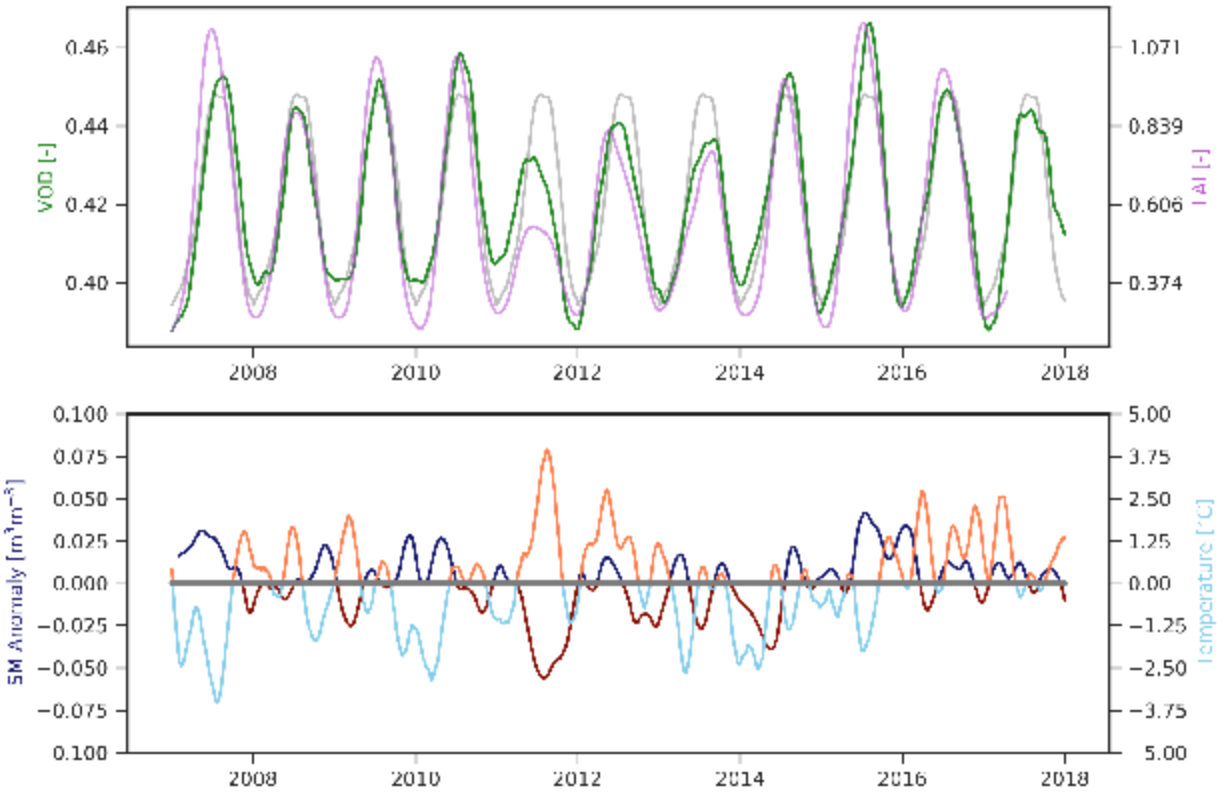


Over forest areas VOD shows highest maximum, whereas LAI is around average.

Case Study II: North-America







Over grassland and shrubland both VOD and LAI show lowest maxima in 11 years.

Summary

- Active microwave based VOD shows potential for monitoring vegetation dynamics.
- Provides a complementary dataset next to VNIR datasets with observations not hindered by cloud cover.
- Inter-annual variability observed in VOD over Australia in relation to drought and climate modes.
- Anomalies in maxima during the 2011 drought in Southern Plains
  - Difference between VOD and LAI over evergreen forests.