

ASCAT slope: a direct radar observable to constrain fast and slow processes in the terrestrial carbon cycle

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Contributions from: PETCHIAPPAN, ASHWINI; SHAN, XU; KAMINSKI, THOMAS; LEMMETYINEN, JUUHA; THUM, TEA; AURELA, MIKA; WILLIAMS, MATHEW; KNORR, WOLFGANG; SCHOLZE, MARKO; BUEECHI, EMANUEL; DORIGO, WOUTER

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Metop ASCAT specifications

Active microwave scatterometer

Frequency: C-band, 5.255 GHz

Polarisation: VV

Spatial Resolution: 25 km/ 50 km

Overpass: asc/desc 9:30 AM/PM

Multi-incidence: 25-65°

Daily global coverage: 82 %

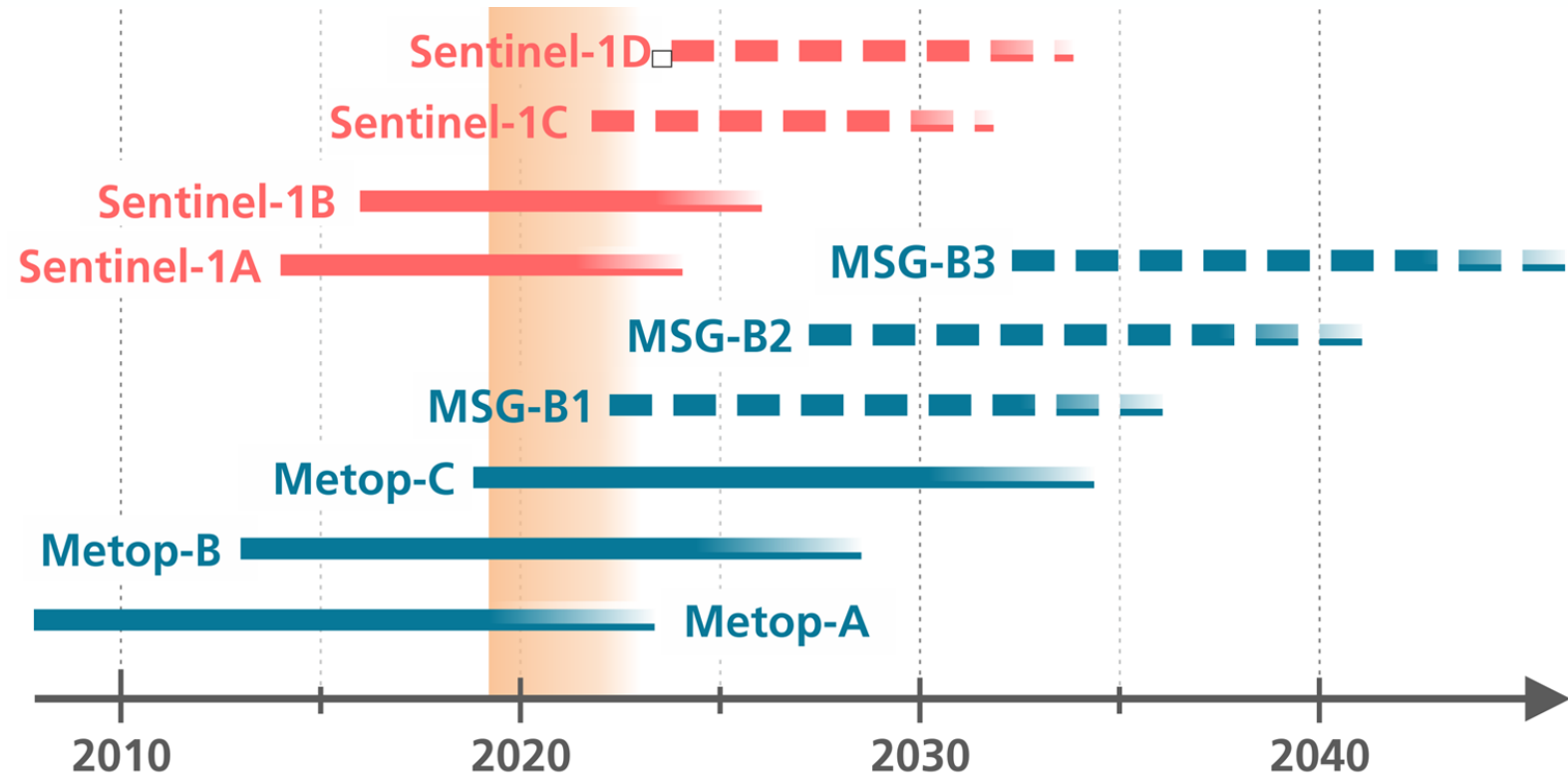
Metop-A (Oct. 2006 – 2021)

Metop-B (Sep. 2012 – ongoing)

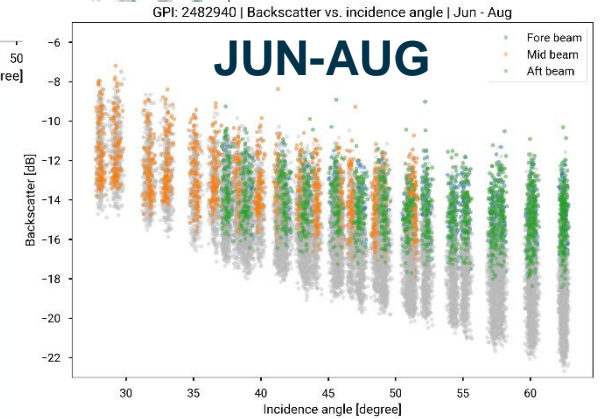
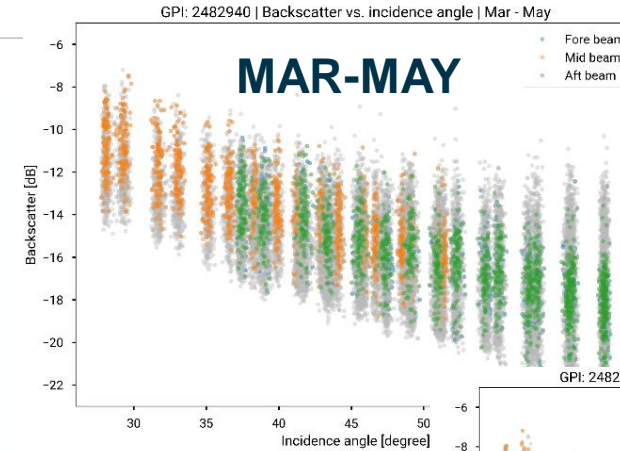
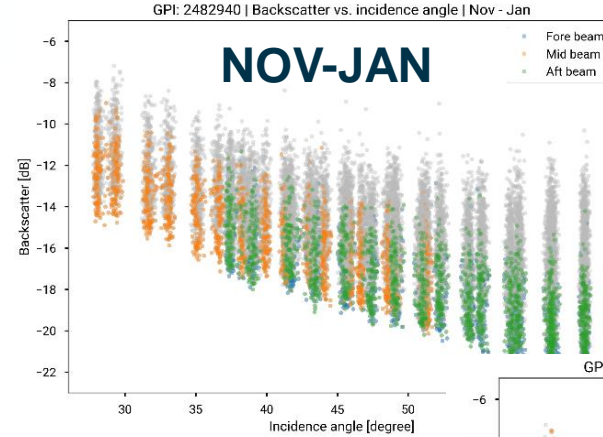
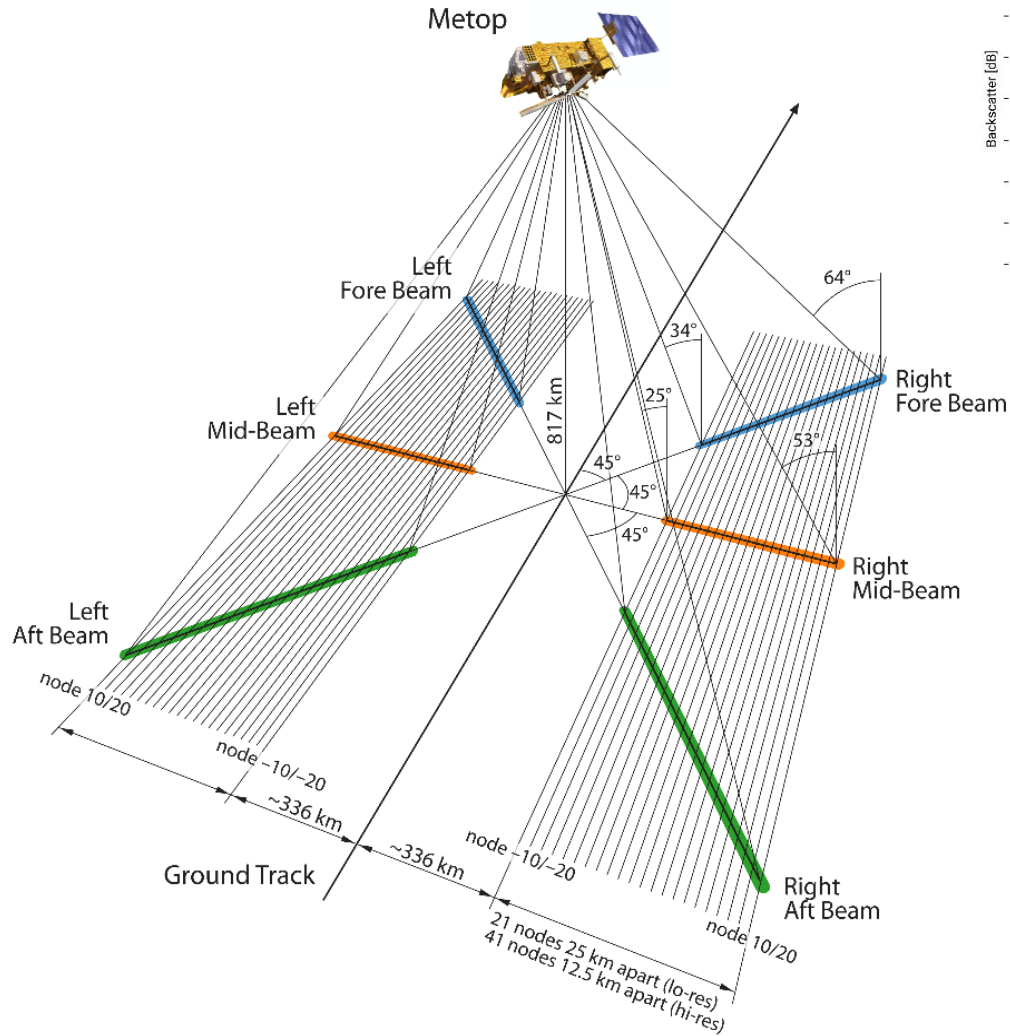
Metop-C (Nov. 2018 – ongoing)

Metop-SG (2023, planned until 2040)

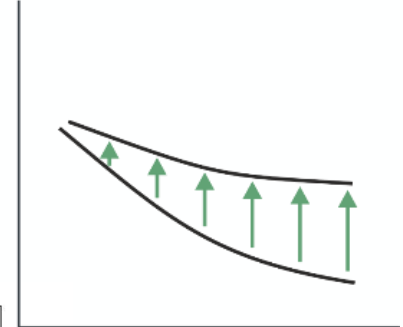
SAR
Scatterometer



ASCAT geometry, backscatter vs incidence angle



Vegetation change



Incidence angle θ



Relating slope to meteorological and phenology

Backscatter is sensitive to water content in soil and vegetation

Slope is sensitive to vegetation phenology, driven by moisture availability or radiation

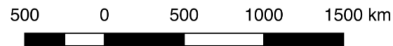


Study area:
land cover types and regions of interest

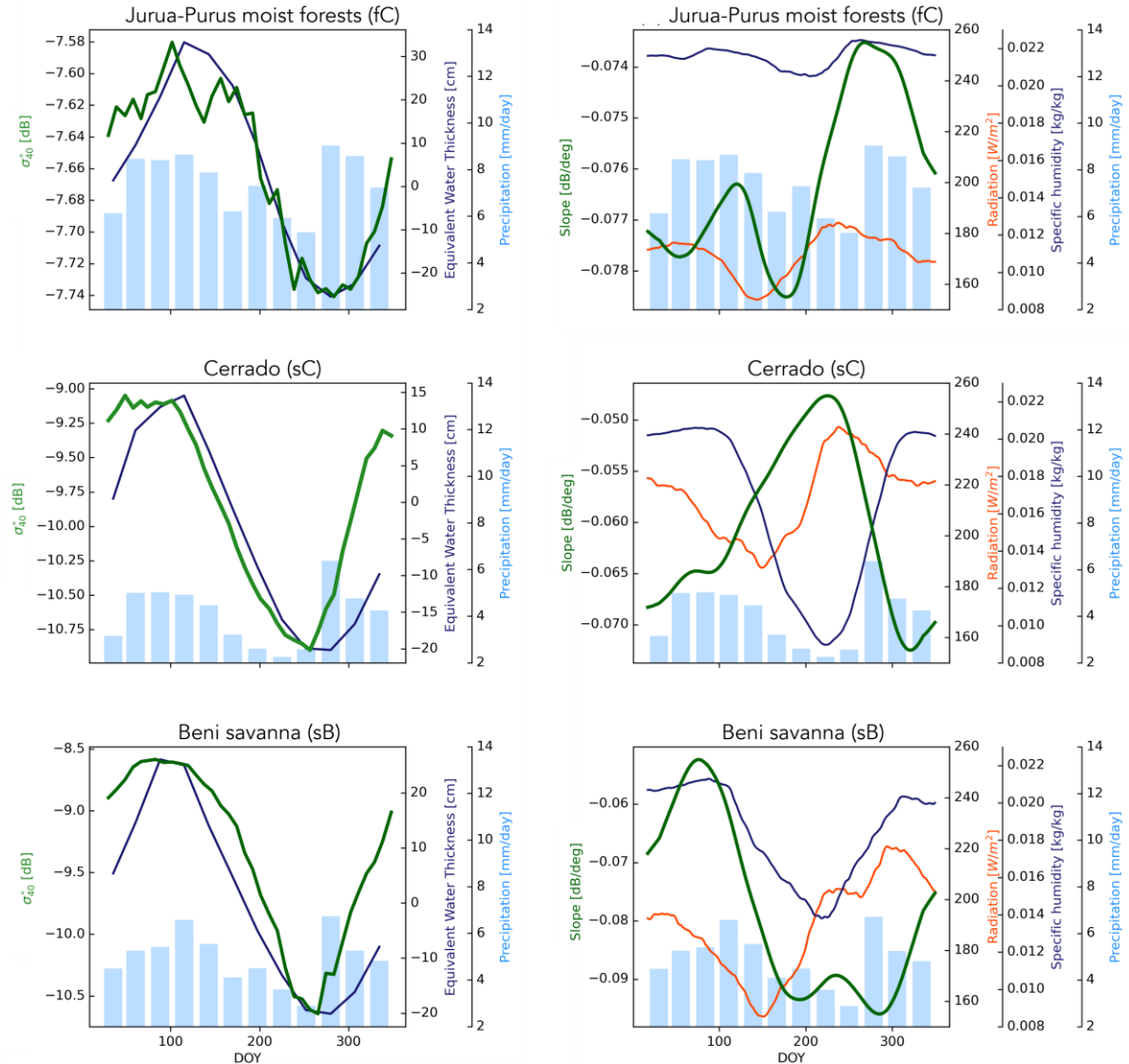
Source: *Terrestrial Ecoregions of the World (WWF)*

Legend

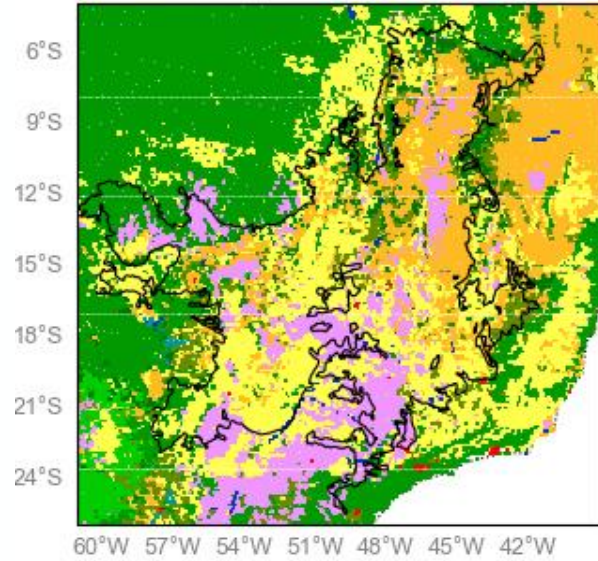
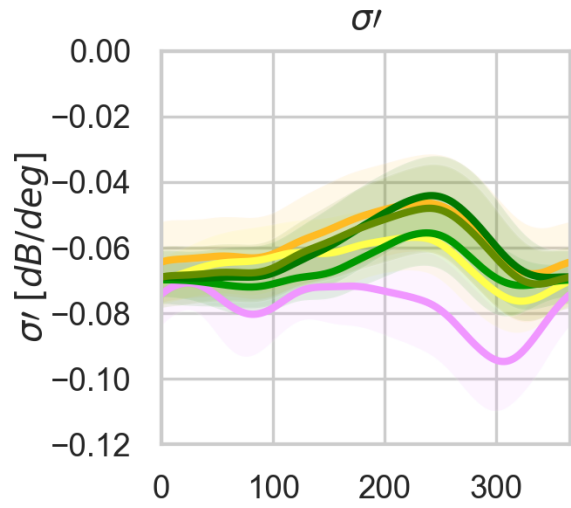
- Regions of interest
- Tropical & Subtropical Moist Broadleaf Forests
- Tropical & Subtropical Dry Broadleaf Forests
- Tropical & Subtropical Grasslands, Savannas & Shrublands
- Flooded Grasslands & Savannas
- Montane Grasslands & Shrublands
- Deserts & Xeric Shrublands
- Mangroves



Petchiappan, A., Steele-Dunne, S.C., Vreugdenhil, M., Hahn, S., Wagner, W., Oliveira, R., 2022. The influence of vegetation water dynamics on the ASCAT backscatter–incidence angle relationship in the Amazon. *Hydrology and Earth System Sciences* 26, 2997–3019. <https://doi.org/10.5194/hess-26-2997-2022>

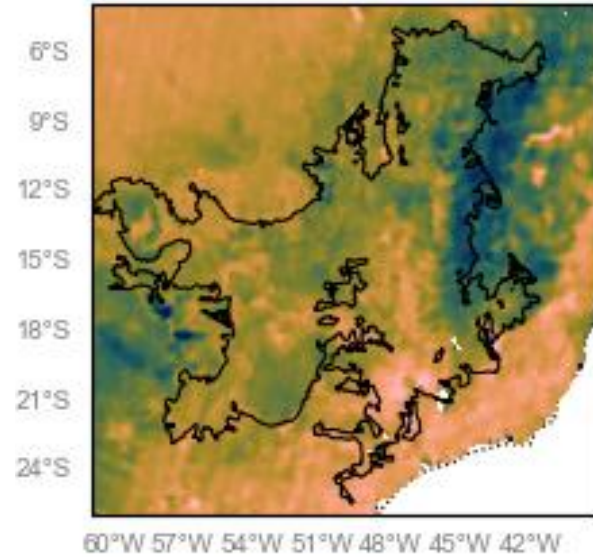


Slope per land cover type

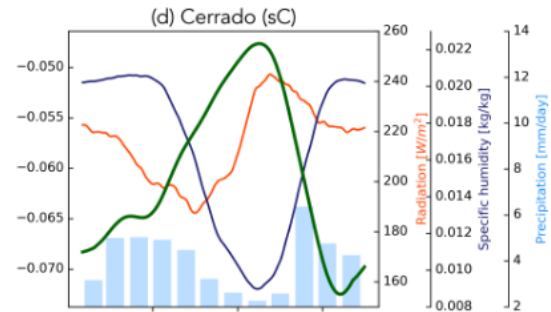
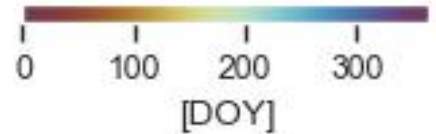
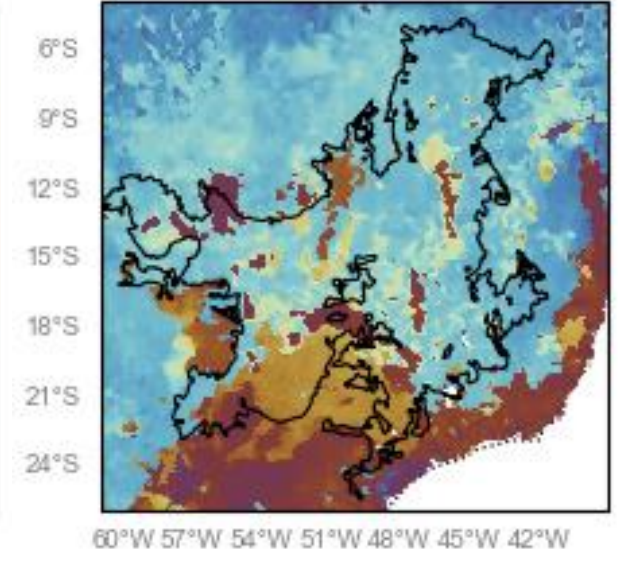


- Shrubs
- Herbaceous
- Cropland
- Urban
- Bare
- Water bodies
- Herb wetland
- Closed Evergreen
- Closed Deciduous
- Closed unknown
- Open Evergreen
- Open Deciduous
- Open unknown

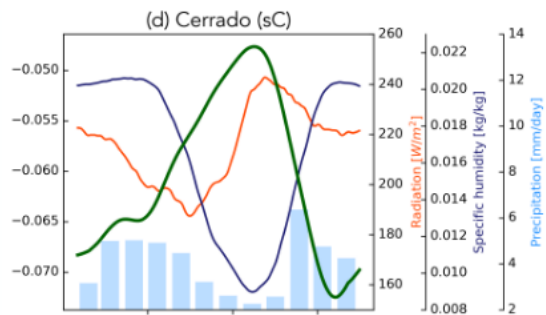
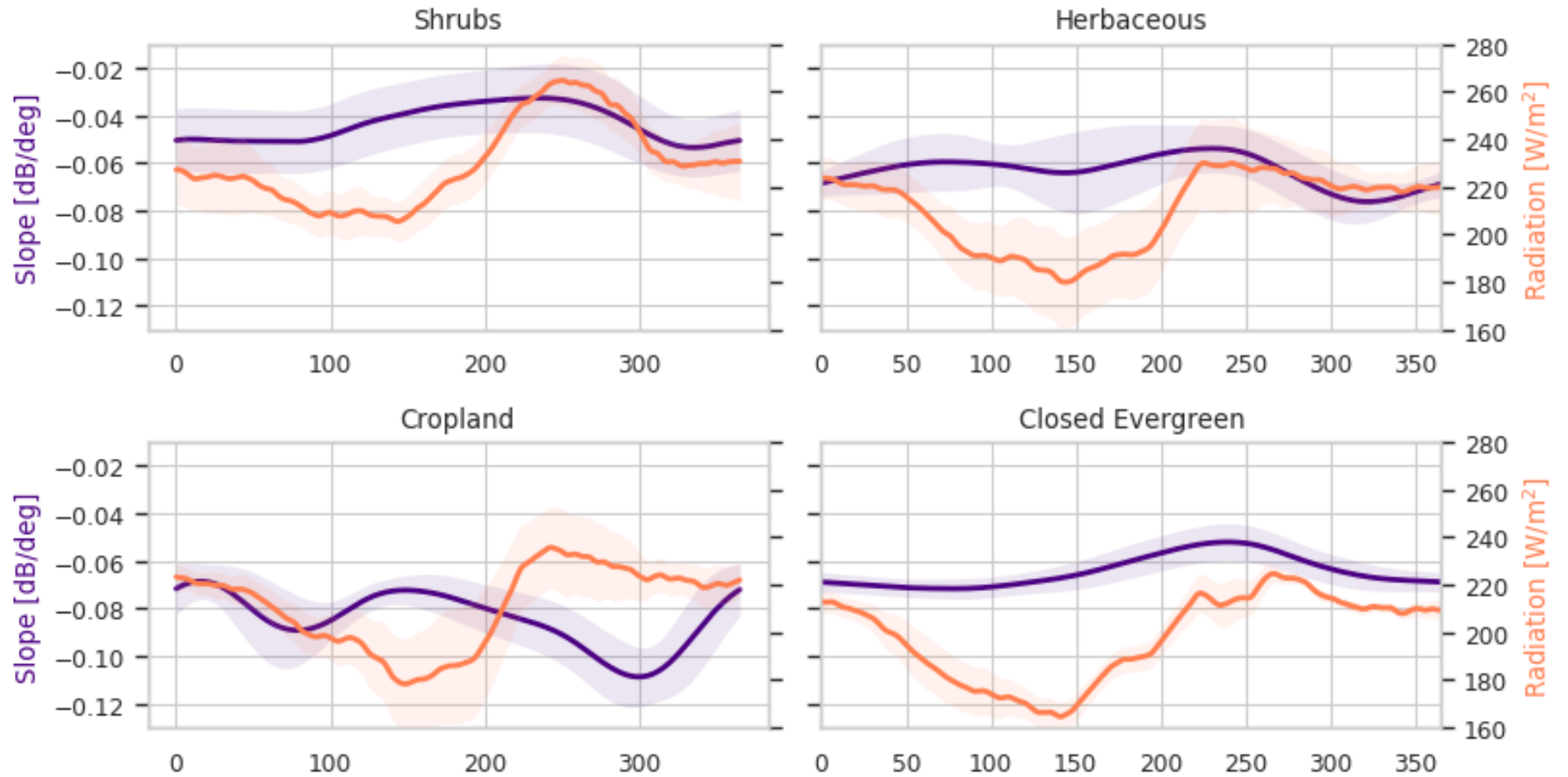
Maximum



DOY Maximum



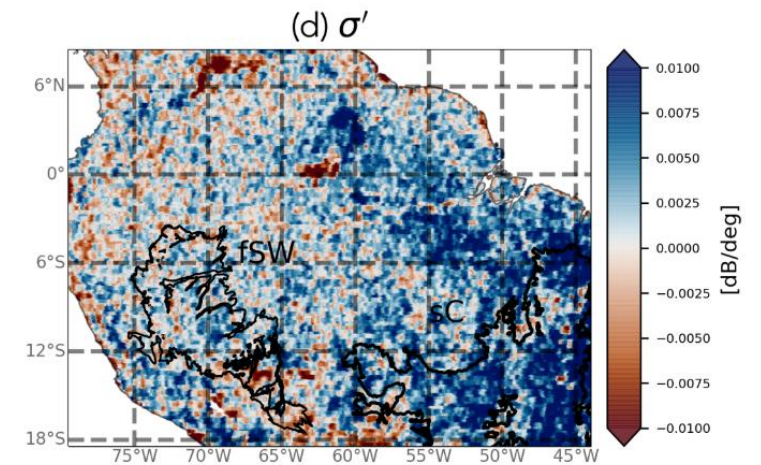
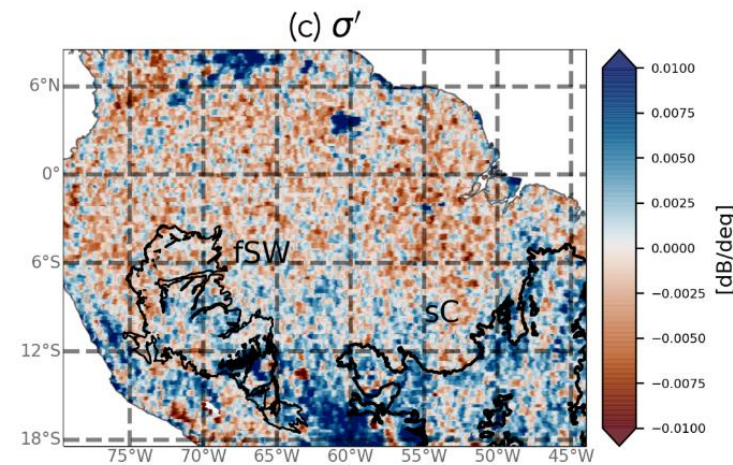
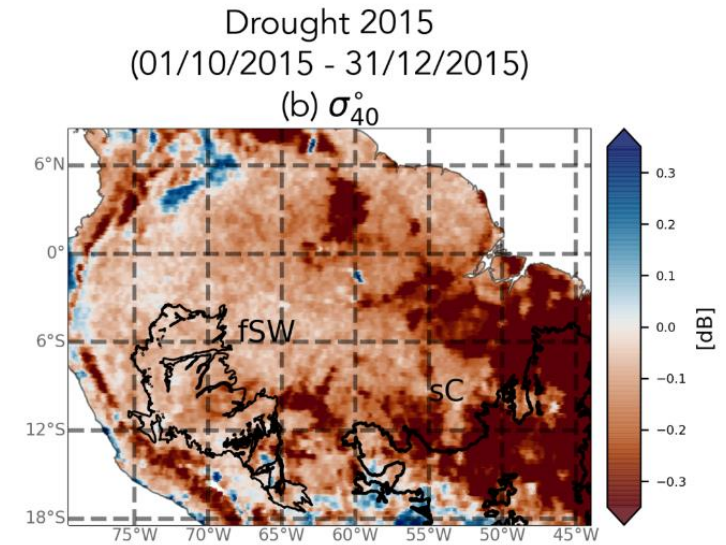
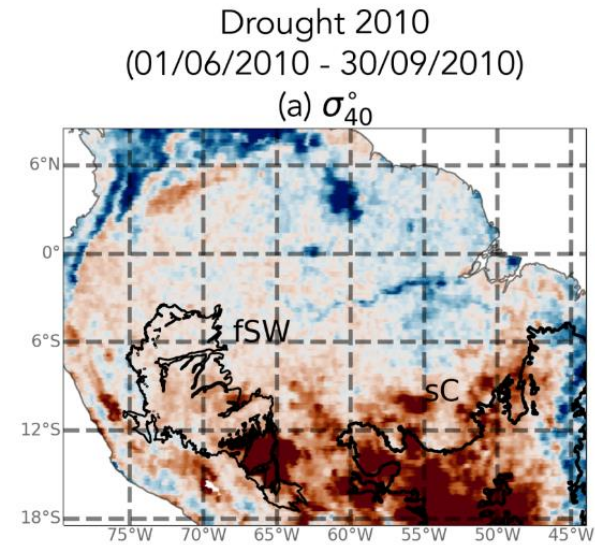
Can we explain slope?



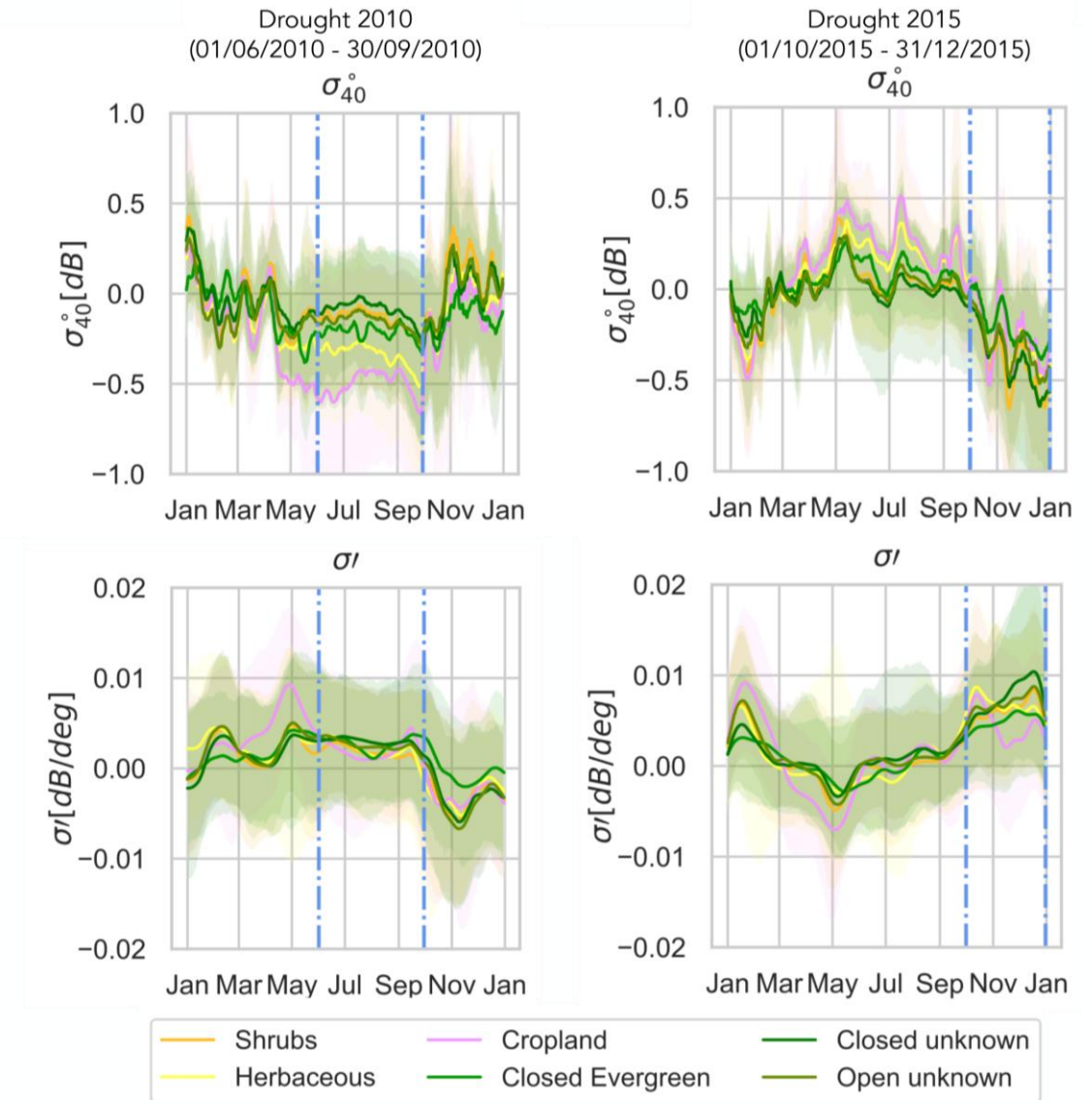
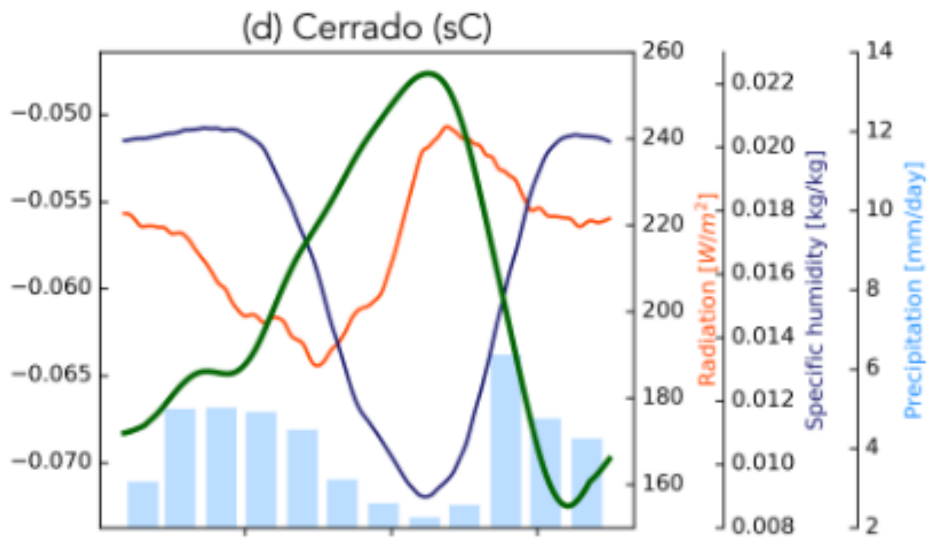
Drought impact in backscatter and slope

2010 drought:
most severe over
southern and western
Amazonia.

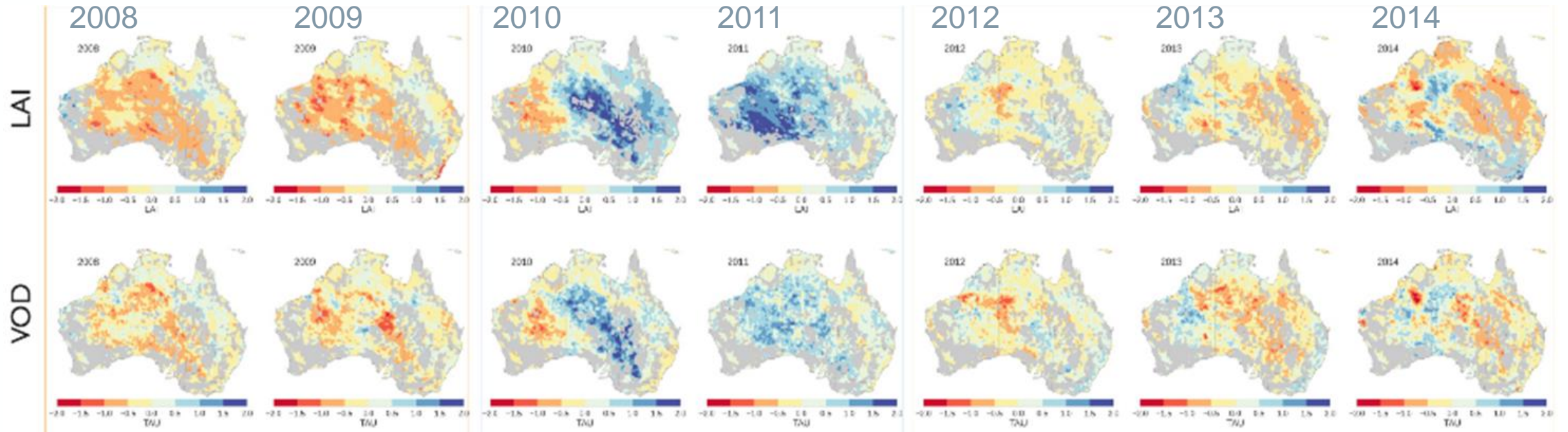
2015 drought:
more widespread and
strongest in eastern
Amazonia.



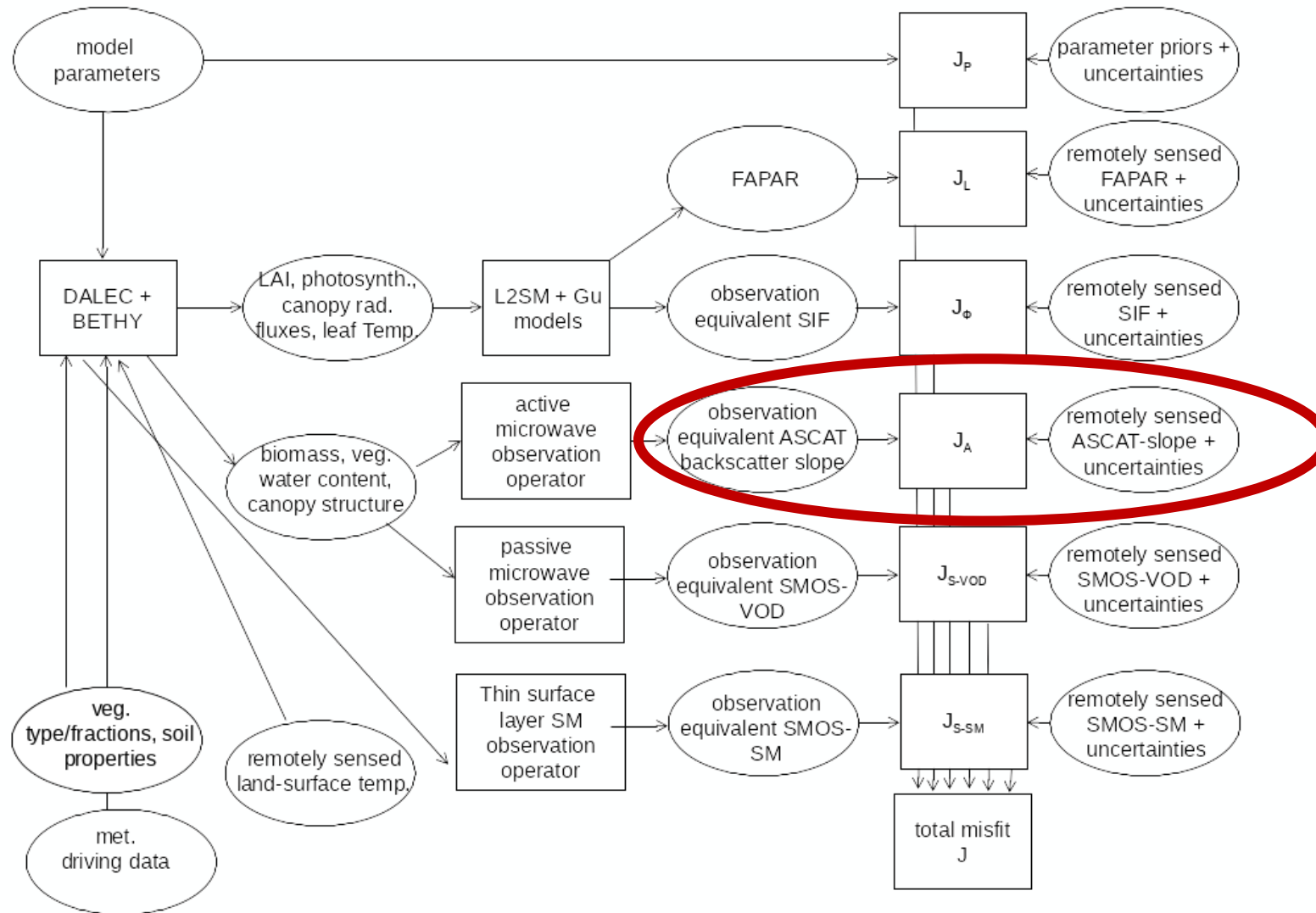
Drought impact in slope for different land cover types



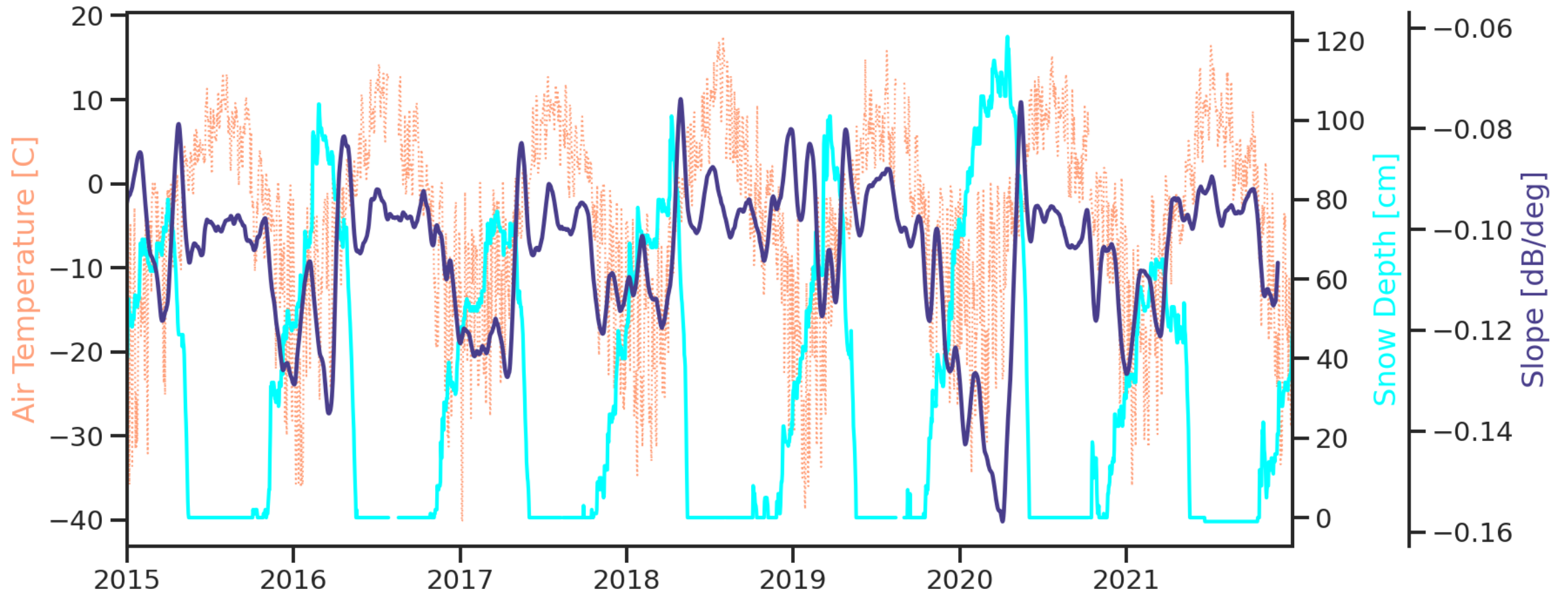
Temporal dynamics in VOD are from ASCAT slope



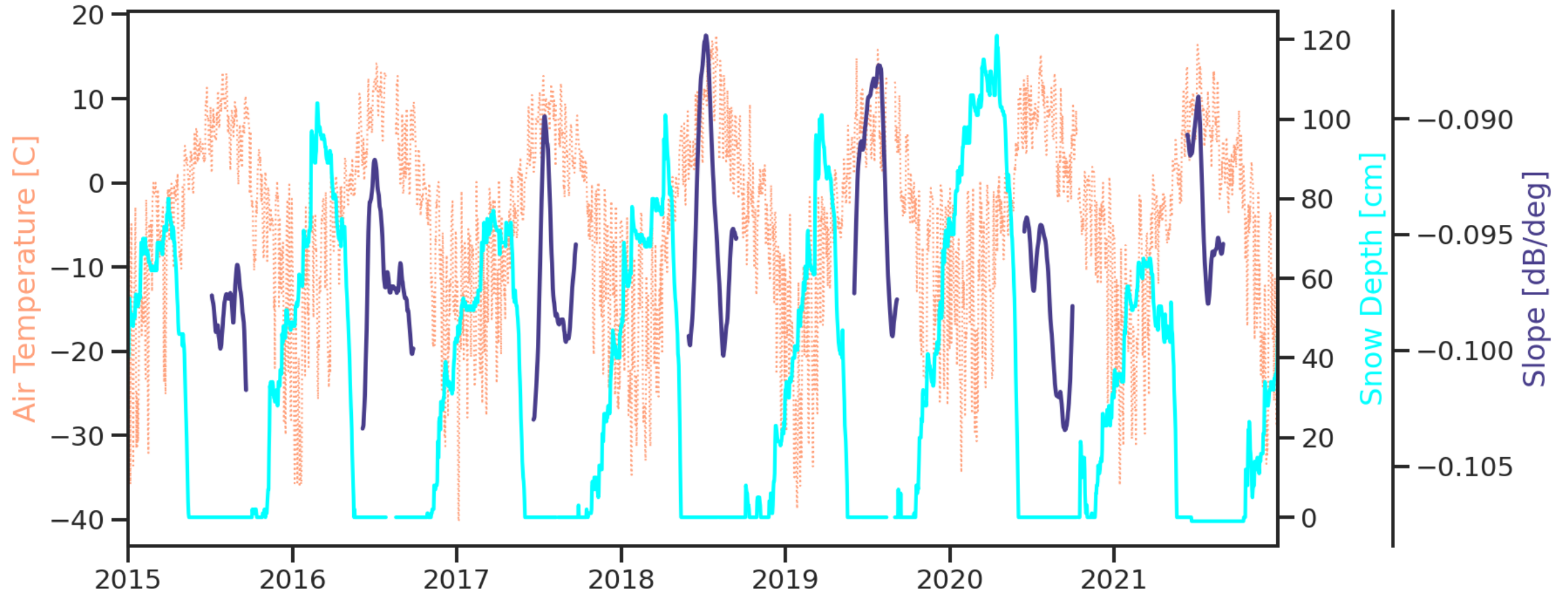
Vreugdenhil, M., Hahn, S., Melzer, T., Bauer-Marschallinger, B., Reimer, C., Dorigo, W.A., Wagner, W., 2017. Assessing Vegetation Dynamics Over Mainland Australia With Metop ASCAT. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing 10, 2240–2248. <https://doi.org/10.1109/JSTARS.2016.2618838>



Land Carbon Constellation: Sodankyla

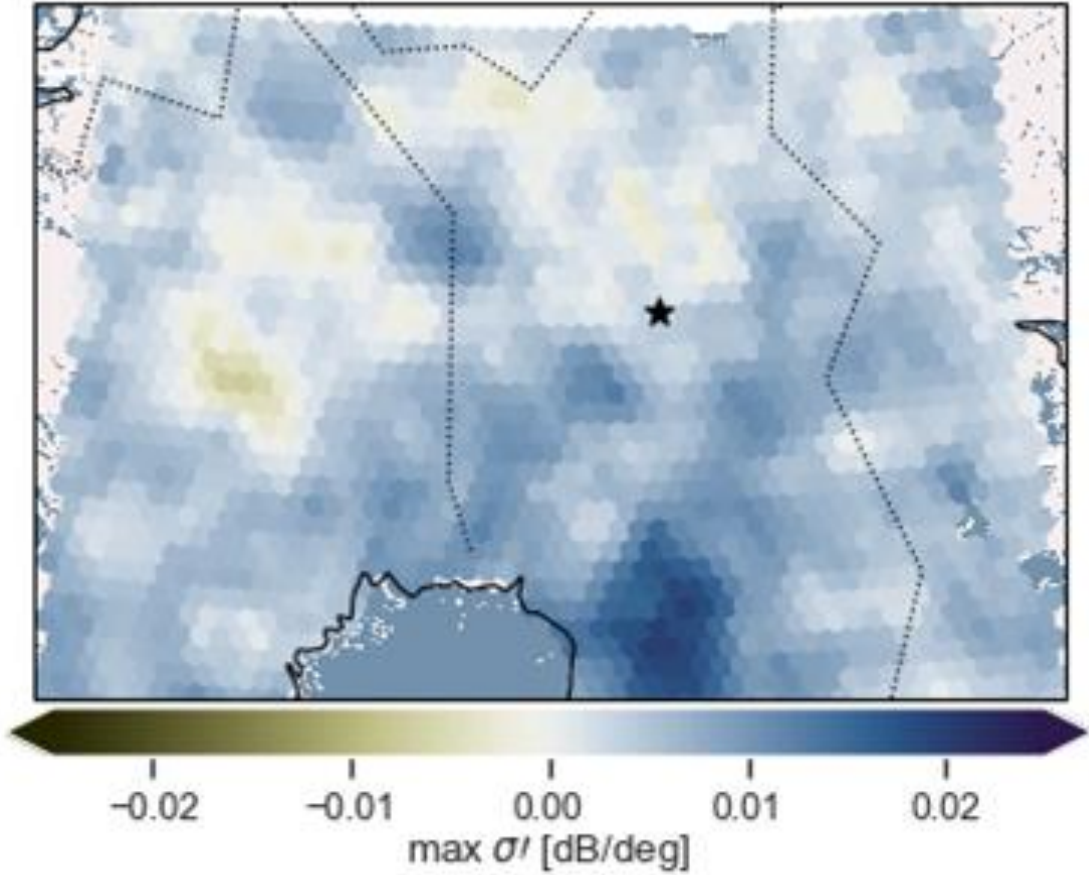
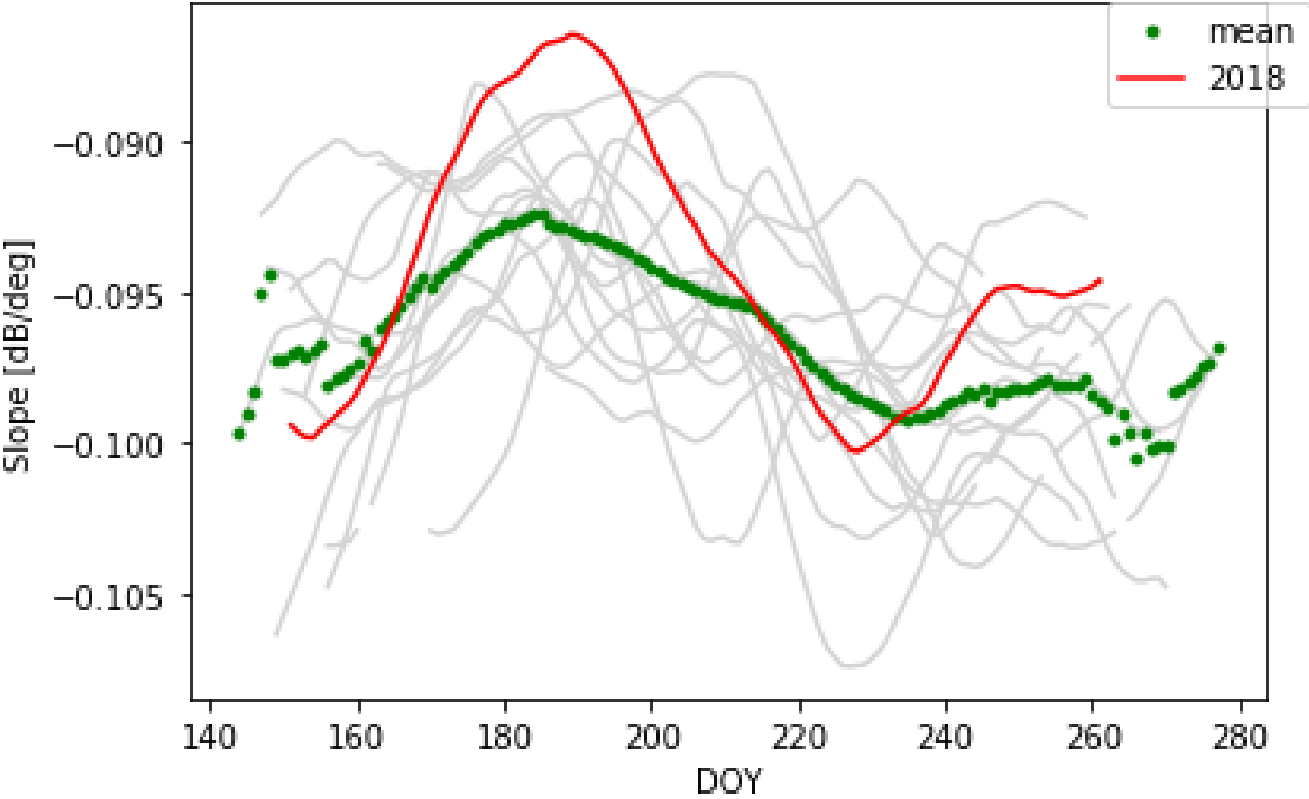


Land Carbon Constellation: Sodankyla

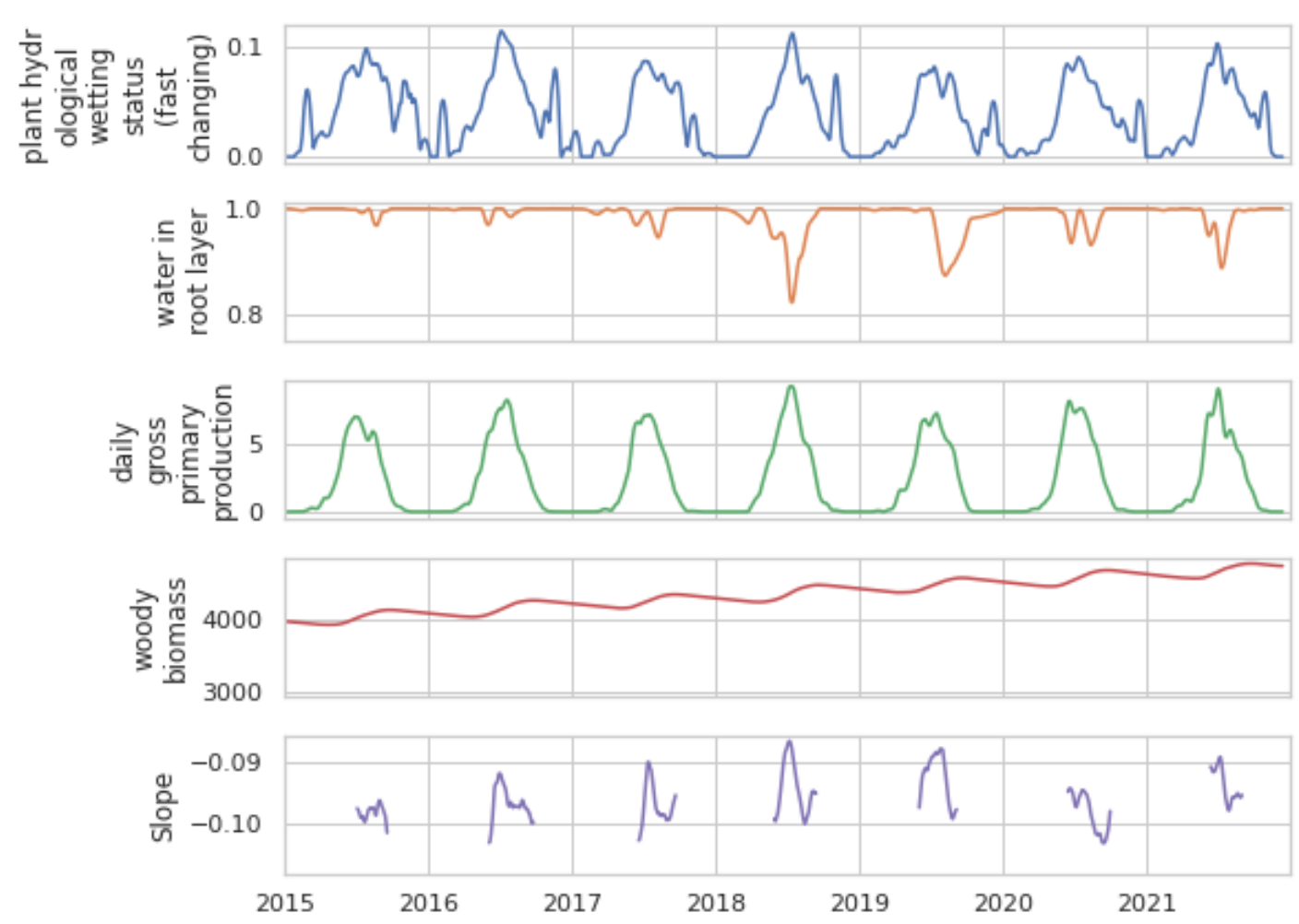
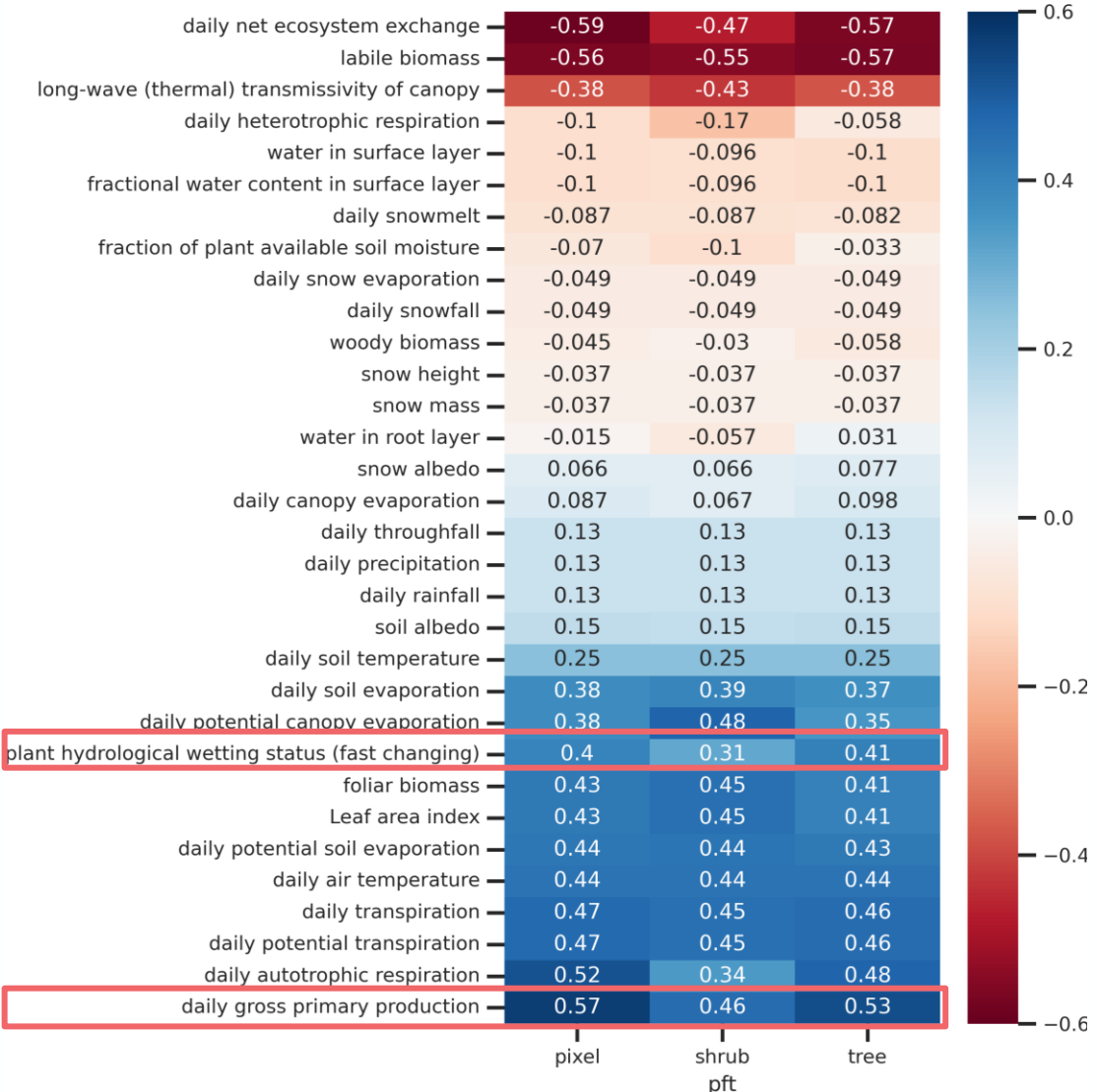


Sensitivity to extremes

Sodanklyya, Drought year



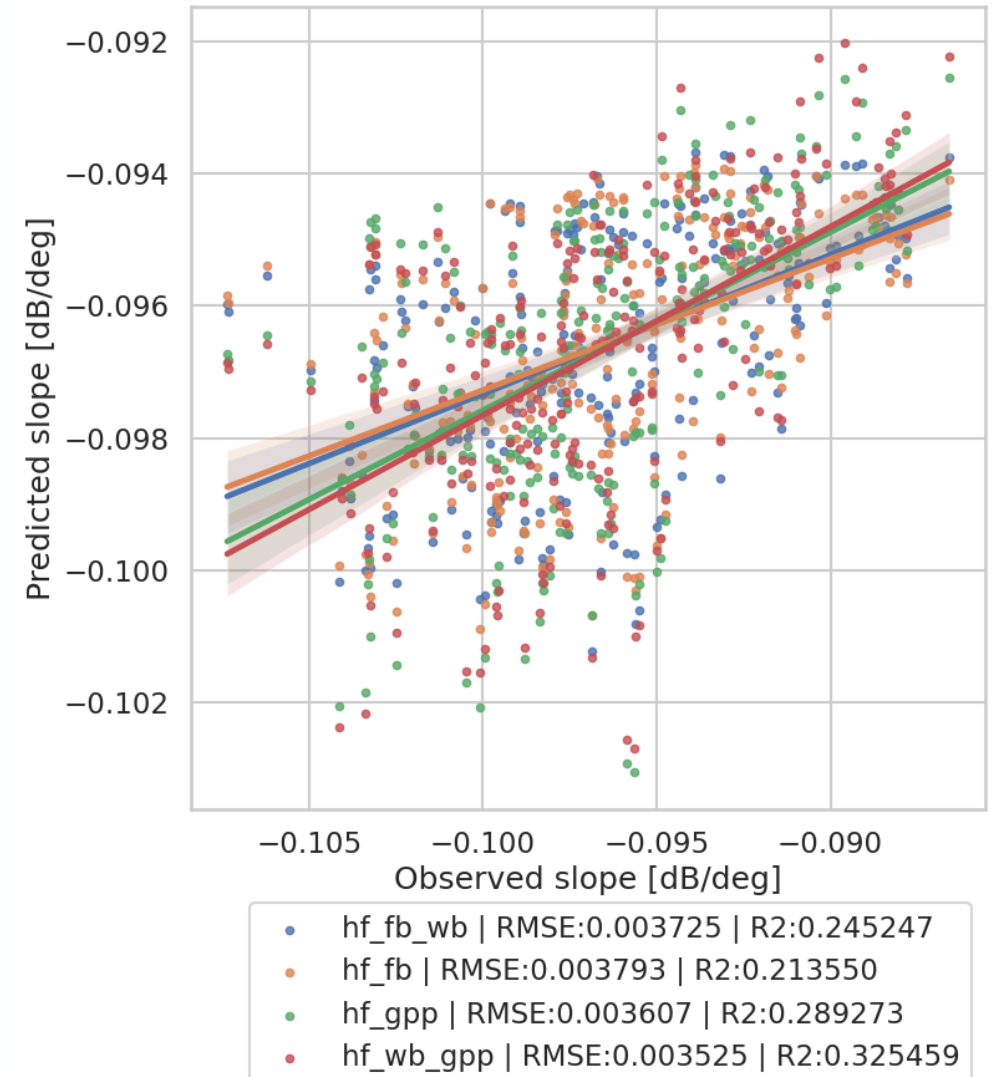
Measurement operator for slope



wb = Plant woody biomass (low correlation, but trend/IAV)
fb = Plant foliar biomass
hf= plant hydrological status (fast) = ETACT/ETPOT

Similar measurement operator as L-VOD

Continued analysis with ML to understand the feature importances



ASCAT Slope: Valuable long data record

Explained sensitivity to vegetation dynamics (outside of winter period)

- “similar” to VOD, but less processing and fewer necessary assumptions

Potential with 6.25km full resolution and extending to ERS

More in-depth research on microwave signal knowledge gaps:

What are we really measuring?

- structure affecting the radar signal
- scattering from dry soils