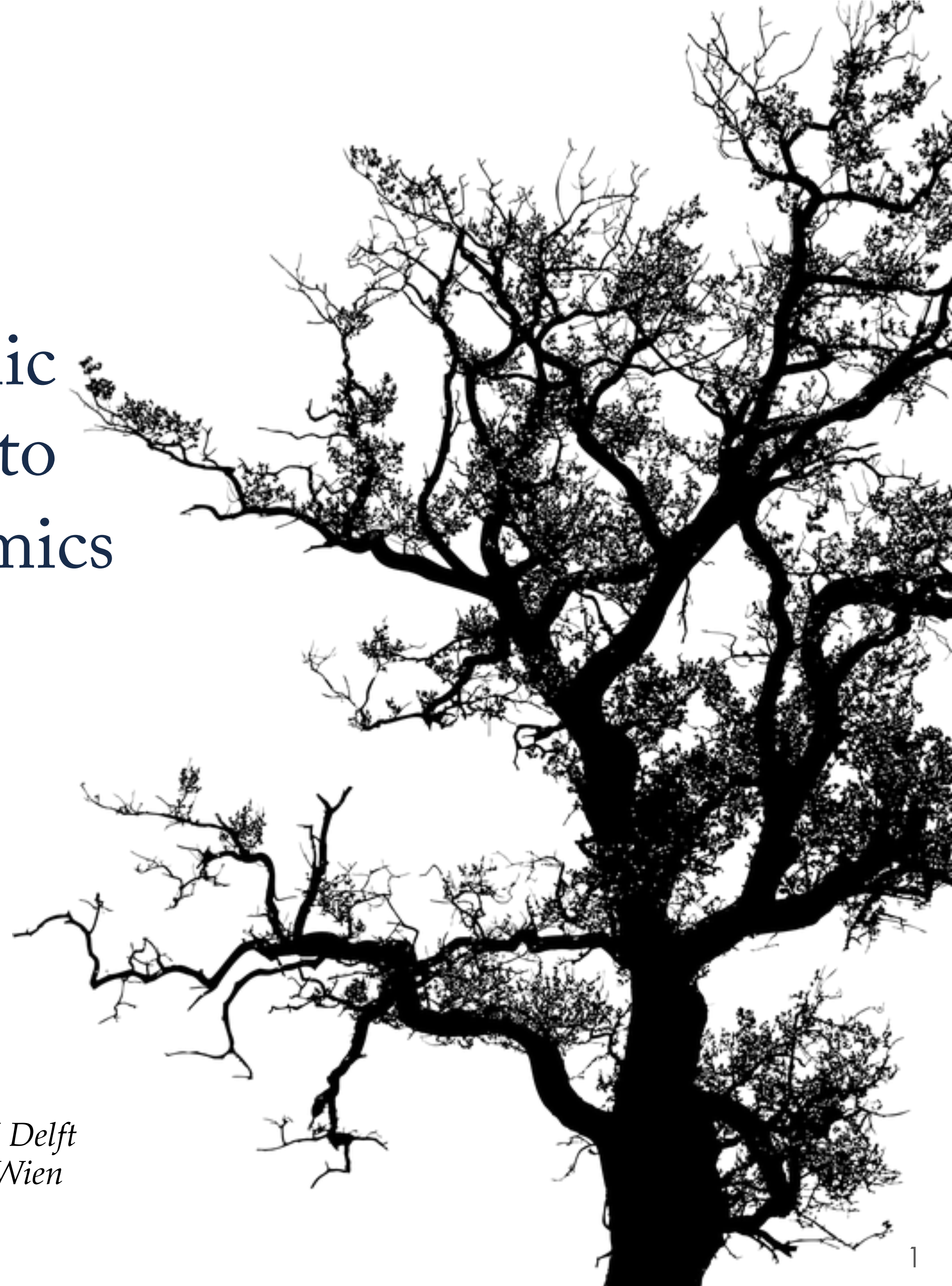
EGU 2020

Relating ASCAT backscatter and dynamic vegetation parameters to vegetation water dynamics in the Amazon



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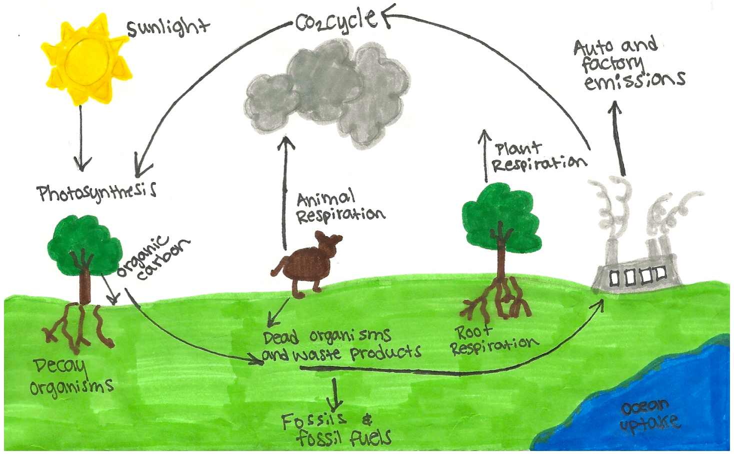
Why the Amazon?

Half of global rainforest cover

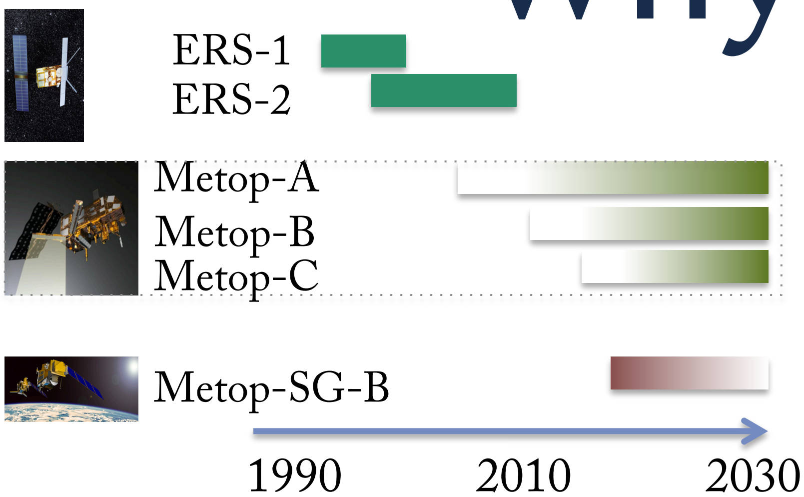
1 in 10 known species in the world

Increasing frequency of droughts



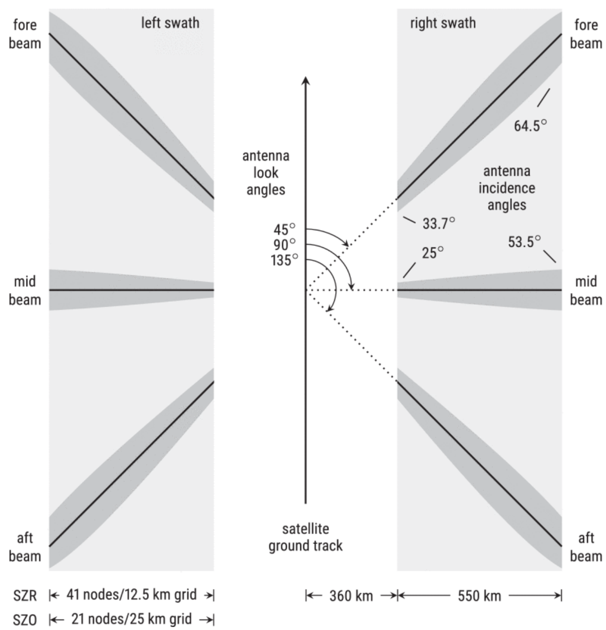
25% of terrestrial carbon sink

Why ASCAT?

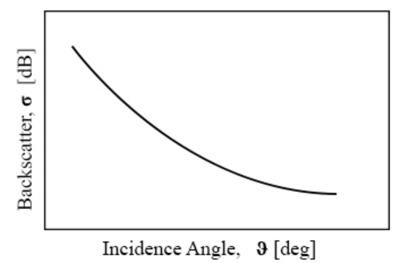


- Data record for at least 40 years
- Climatology possible
- Incidence angle dependence can be studied

ASCAT instrument (MetOp A/B satellites)

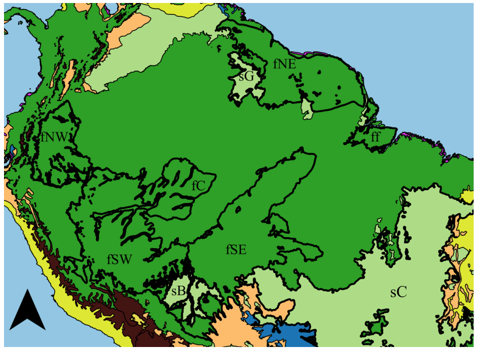


Source: *Hahn et al. (2017)*



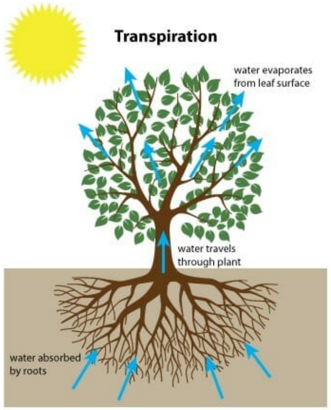
- C-band (5.255 GHz)
- Full global coverage in 1.5 days
- Satellite overpass timings:
  - Descending : ~10am
  - Ascending : ~10pm

Study objectives



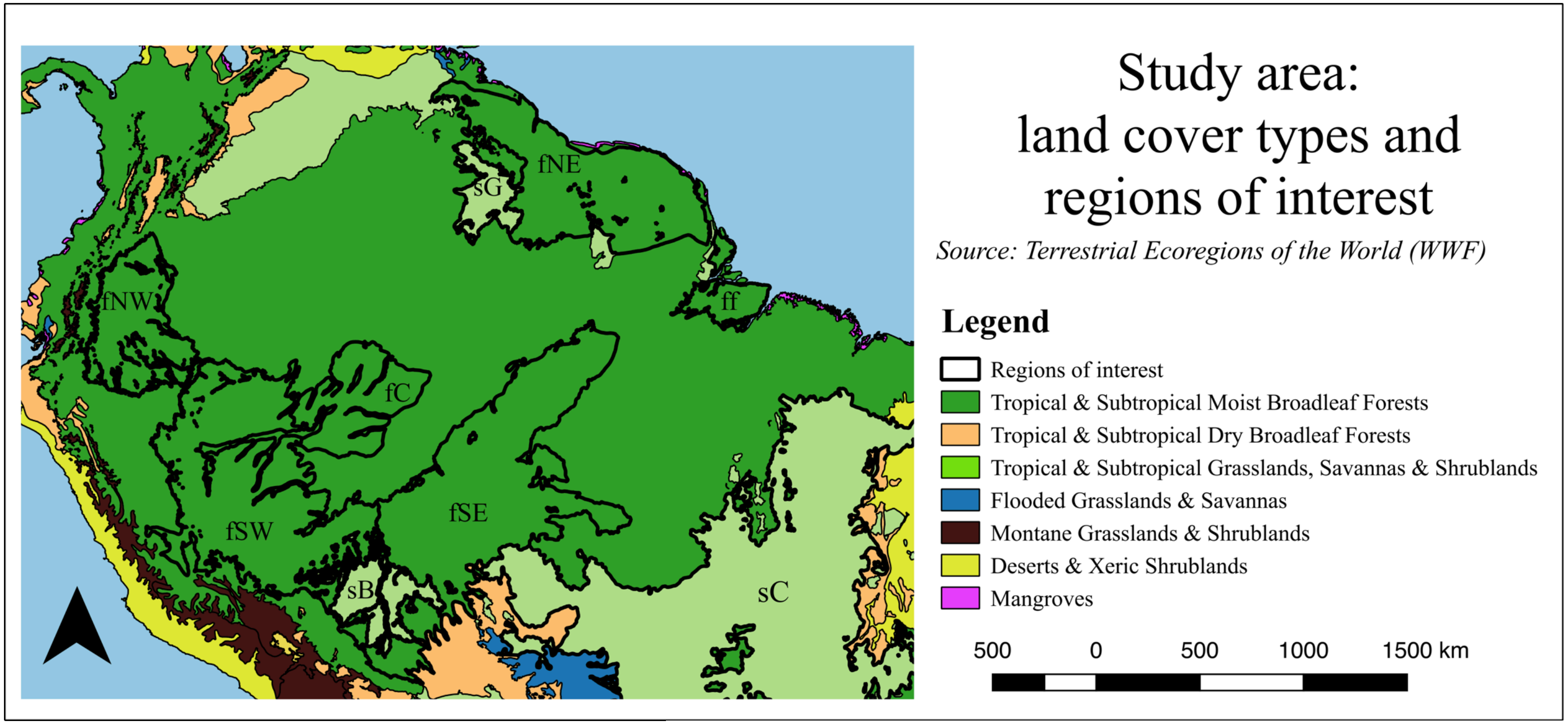
1. To find spatial and temporal patterns in ASCAT data of Amazon region.

2. To determine whether Amazon droughts can be detected through ASCAT data.



3. To relate ASCAT parameters to canopy water dynamics.

Study area



Study period:

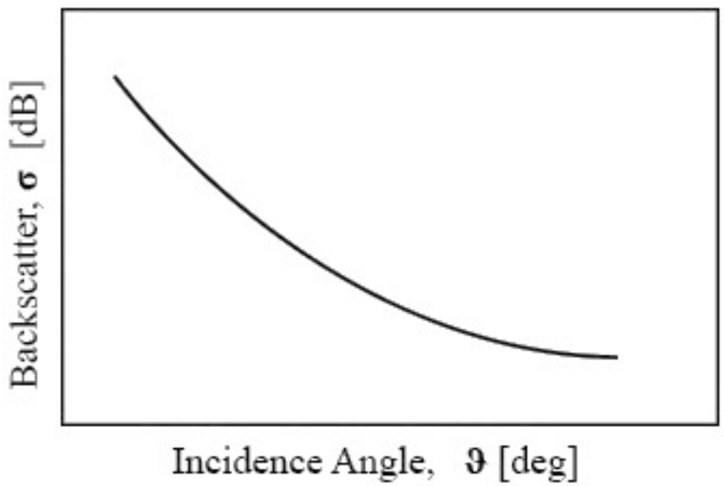
2007-16
(Including two droughts in 2010 and 2015)

Table 1: Regions of interest for the study

Symbol	Name	Cover Type	Grid Points
fNW	Napo moist forests	Evergreen forest	1595
fNE	Guianan moist forests	Evergreen forest	3032
fSW	Southwest Amazon moist forests	Evergreen forest	4758
fSE	Madeira-Tapajós moist forests	Evergreen forest	4569
fC	Juruá-Perez moist forests	Evergreen forest	1299
ff	Marajó várzea *	Evergreen forest	478
sC	Cerrado	Savanna	8492
sG	Guianan savanna	Savanna	509
sB	Beni savanna	Savanna	692

* This region is a seasonally flooded forest.

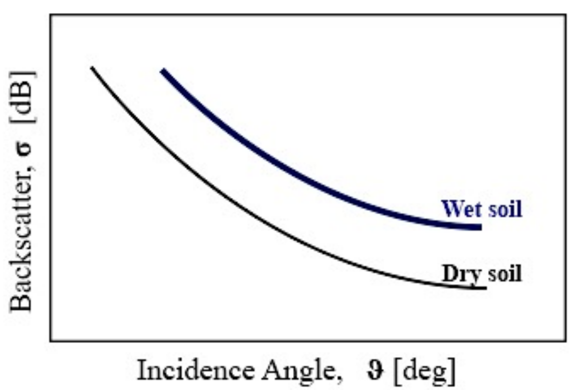
Dynamic vegetation parameters

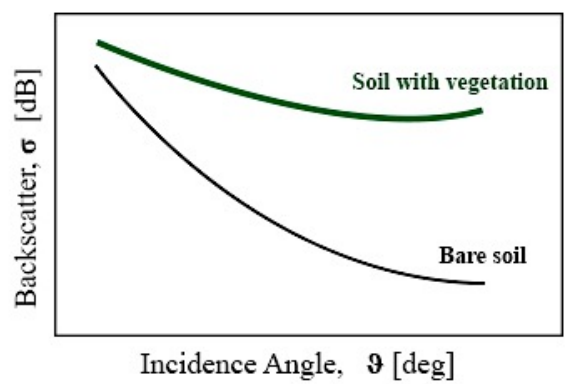


Slope (σ') is the first differential of a second-order Taylor polynomial describing the incidence angle dependence of backscatter data.

Curvature (σ") is the second differential.

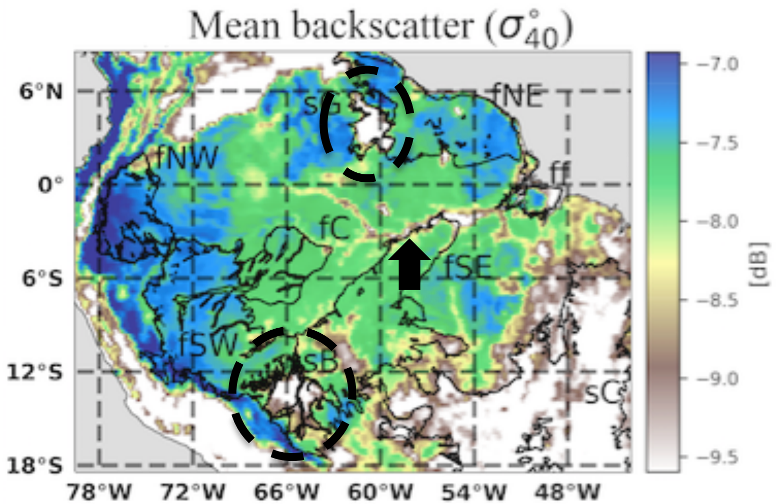
They are calculated at a reference angle of 40°.

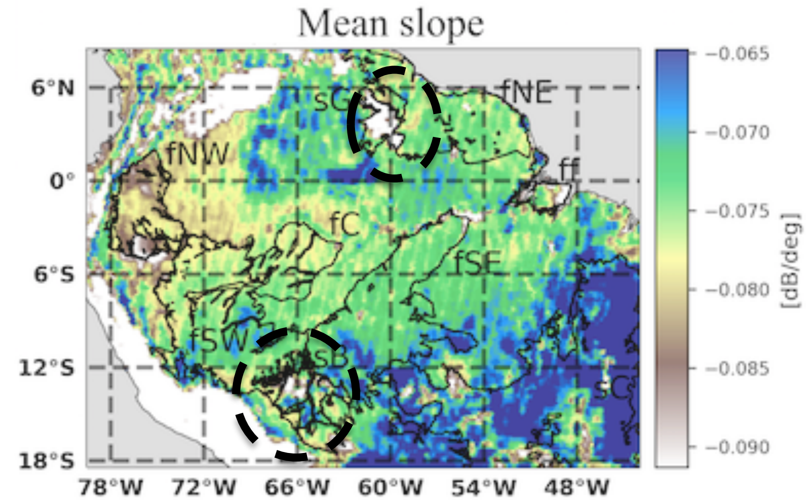


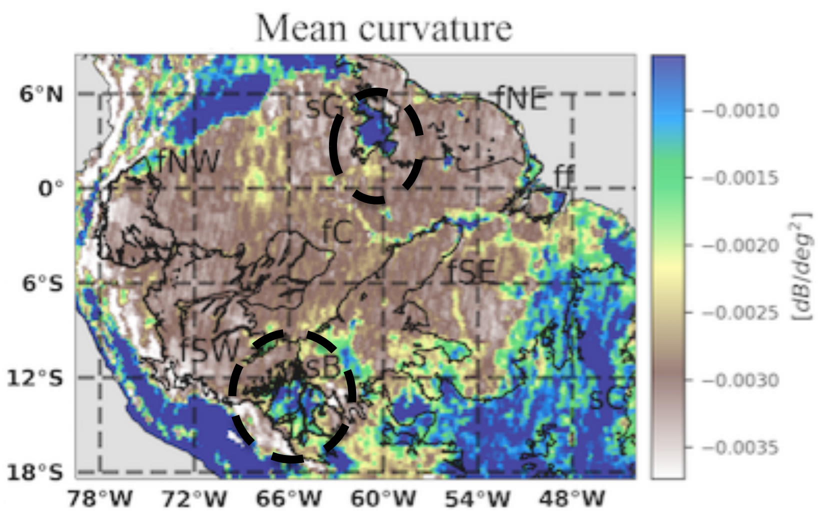


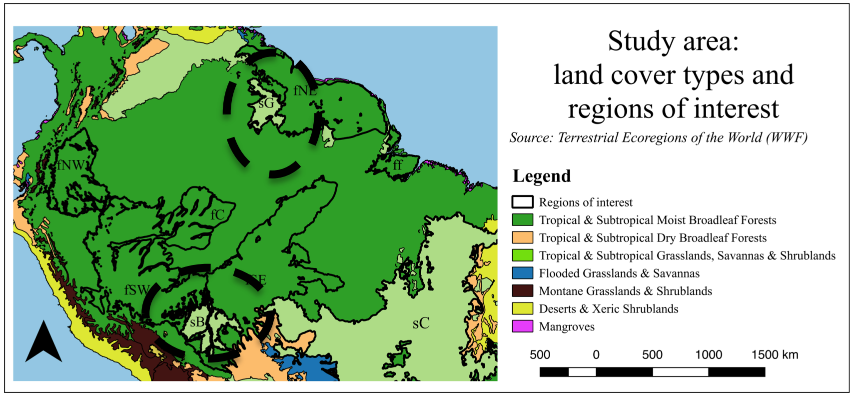
Slope and curvature are useful for separating out effects of soil moisture. They are sensitive to changes in vegetation.

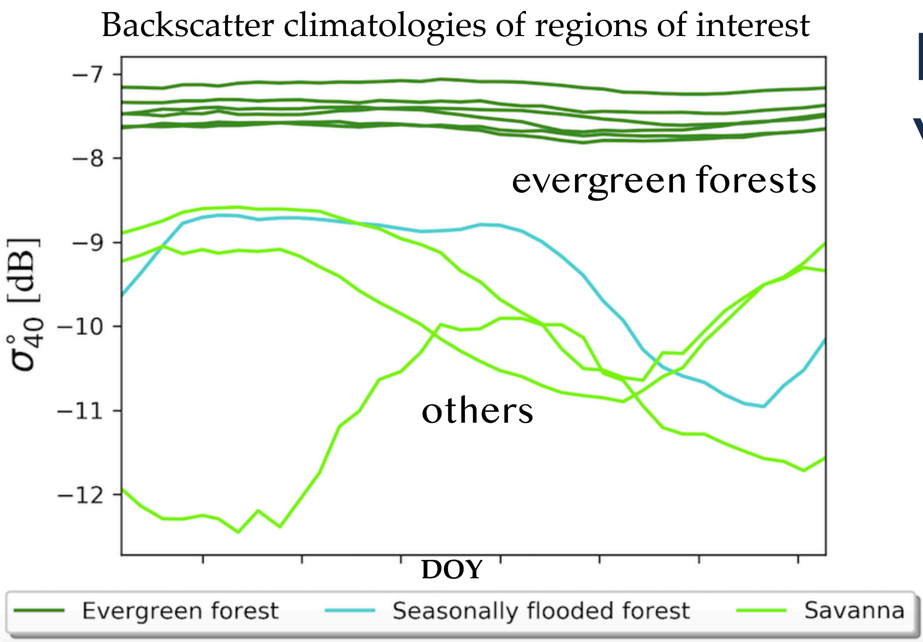
Spatial distribution of backscatter matches land cover types. Slope and curvature are less clear.









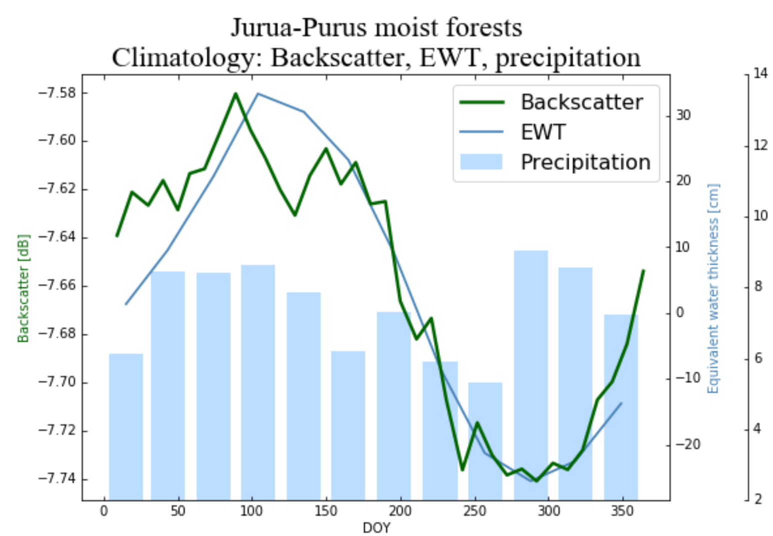


Backscatter seasonality varies between cover types

- Evergreen forests show weaker seasonality compared to savannas and seasonally flooded forest.
- Forests show higher mean.

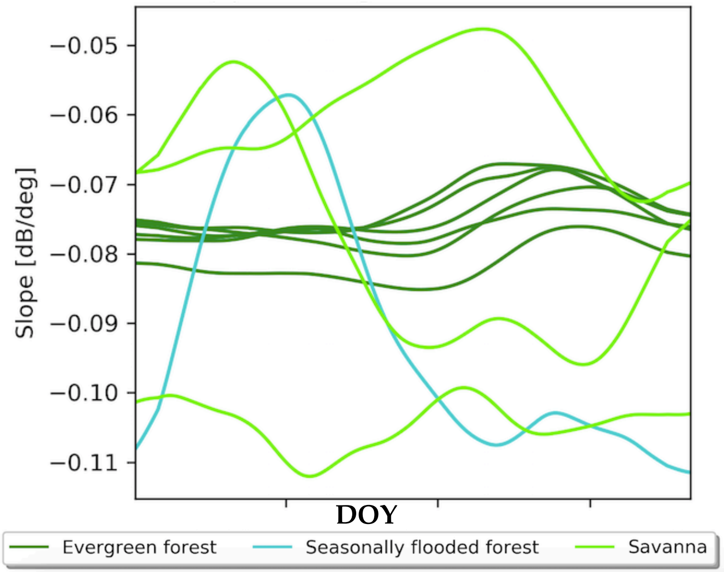
Backscatter is related to moisture availability

- EWT is Equivalent Water Thickness, a measure of terrestrial water storage (TWS)



EWT data source:
GRACE Tellus dataset available at 1°x1° monthly resolution from NASA JPL PO.DAAC.

Slope climatologies of regions of interest



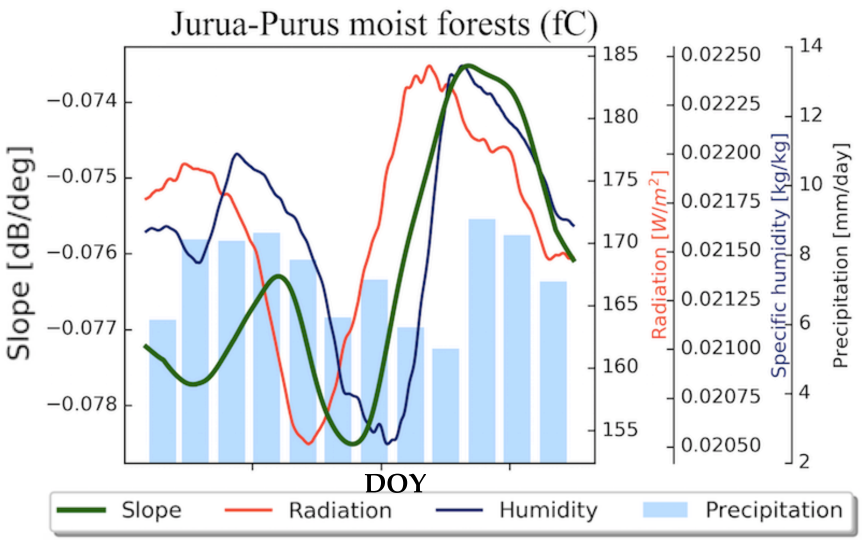
Slope seasonality shows less clear differences between land cover types

- Evergreen forests show weaker seasonality in general.
- Seasonally flooded forest shows high range.

Slope climatology follows moisture demand

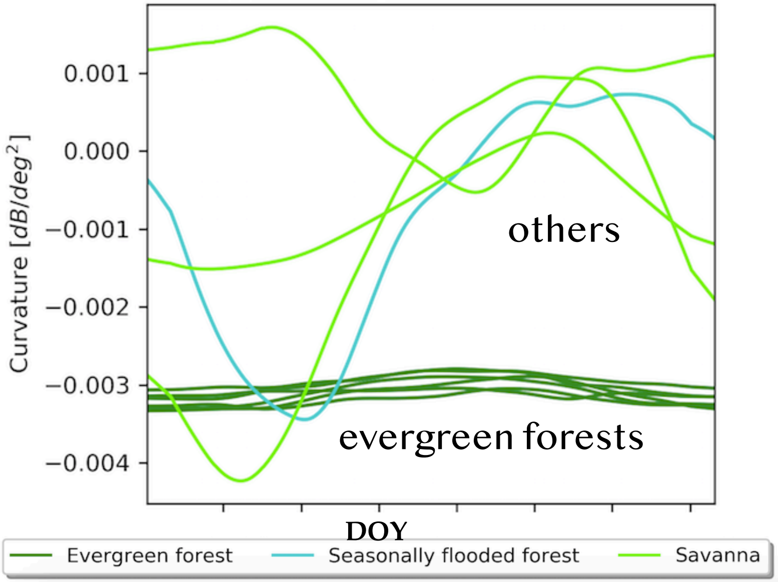
- High radiation would increase moisture demand, and hence, transpiration.
- Increased water flow in canopy changes slope.

Climatologies of slope, radiation, EWT, and precipitation (2007-16)



Radiation and humidity data source:
Princeton meteorological dataset at 0.5°x0.5° daily resolution.

Curvature climatologies of regions of interest



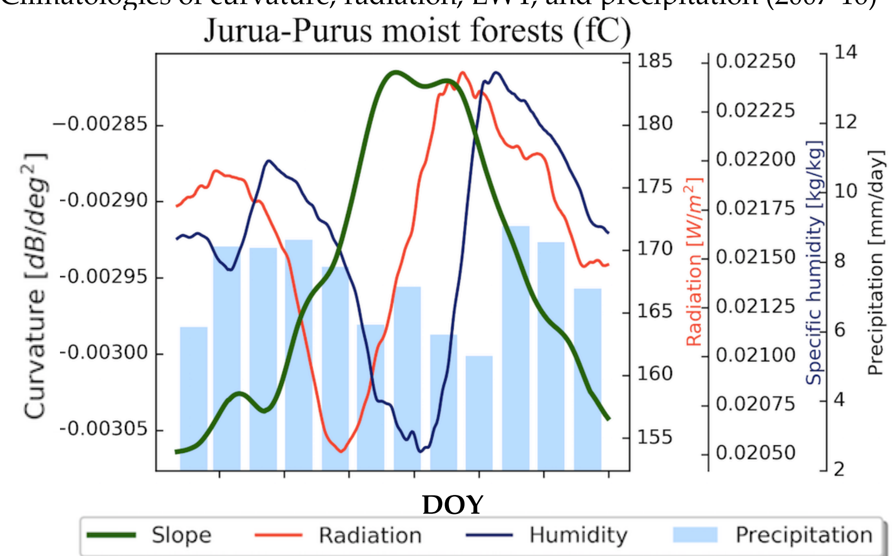
Curvature seasonality varies between land cover types

- Evergreen forests show weaker seasonality compared to savannas and seasonally flooded forest.
- Forests show lower mean.

Curvature is related to vegetation phenology
(through leaf flushing, etc.)

- Amazon phenology is driven by radiation.
- Leaf flushing is a period of production of new leaves which precedes radiation peak.

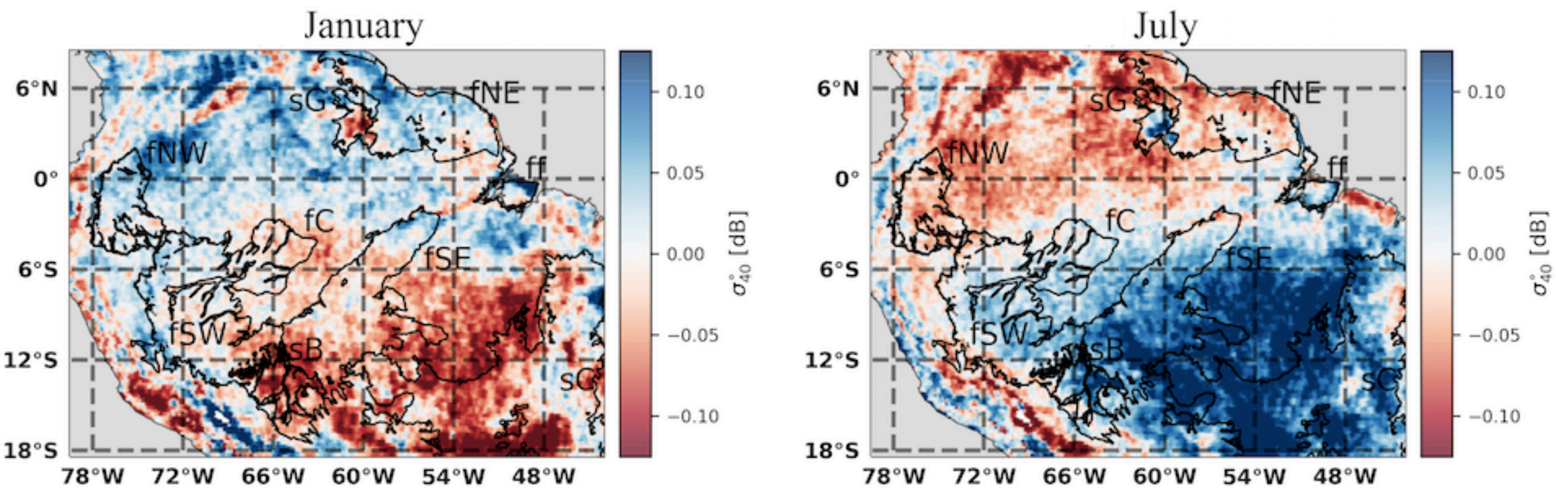
Climatologies of curvature, radiation, EWT, and precipitation (2007-16)



Radiation and humidity data source:
Princeton meteorological dataset at 0.5°x0.5° daily resolution.

Diurnal difference in backscatter is influenced by moisture demand and availability

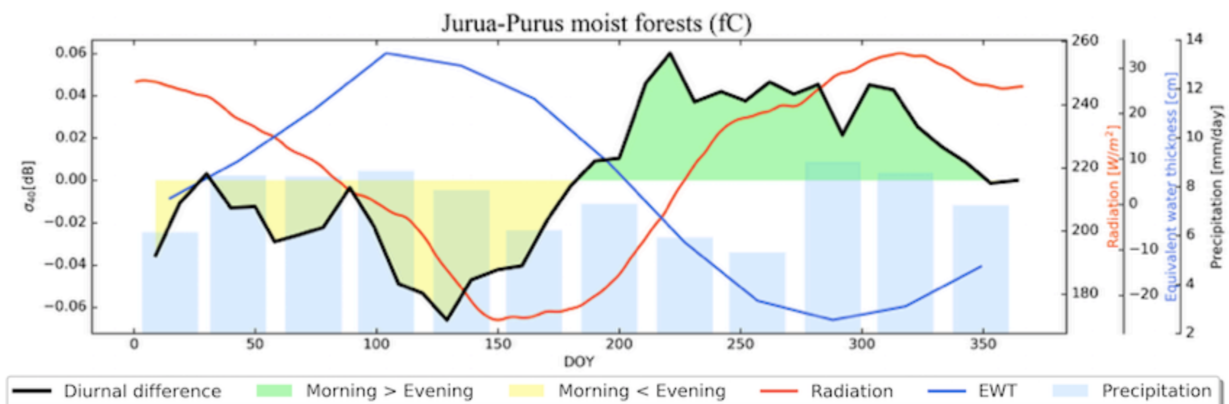
Mean diurnal difference in backscatter (2007-16)



Positive: Morning value higher

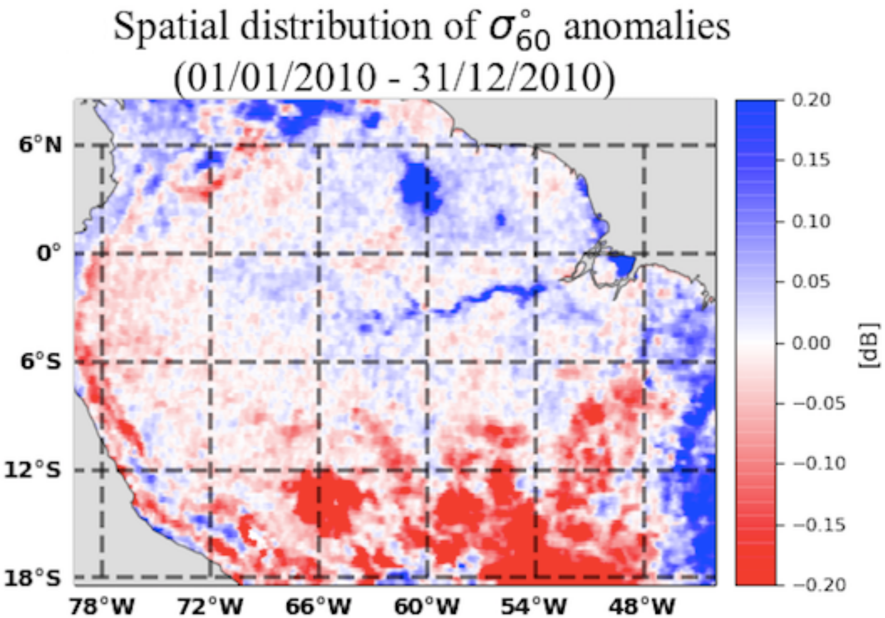
Negative: Evening value higher

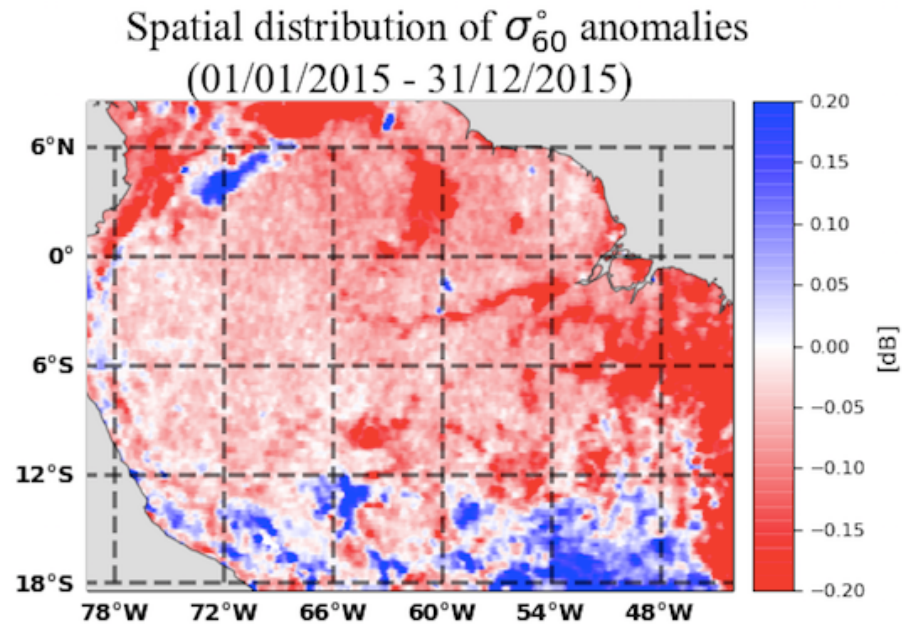
Climatology of diurnal difference in backscatter (2007-16)



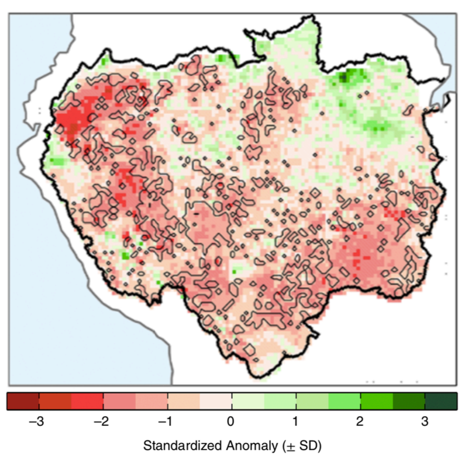
Morning backscatter higher when transpiration high.
Evening backscatter higher in when moisture availability is high, water stress low.

Backscatter anomalies match distribution of precipitation anomalies during drought years

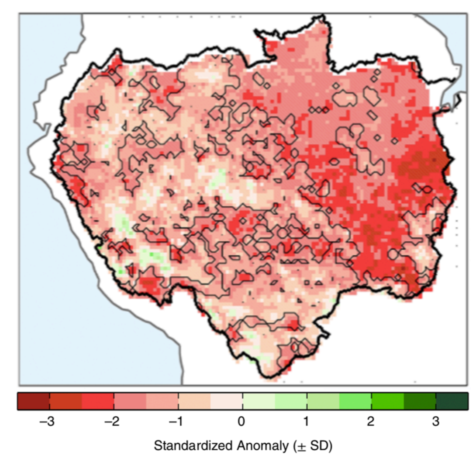




2010



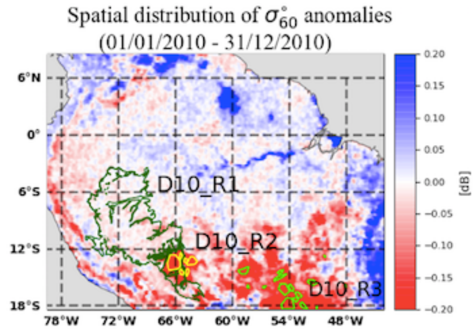
Source: *Panisset et al. (2018)*

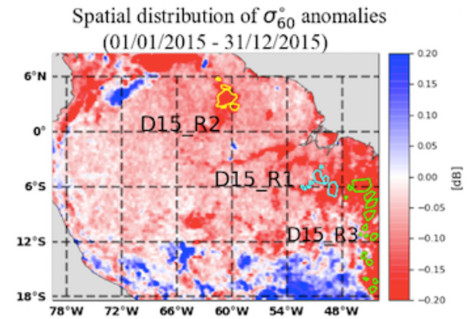


2015

Source: *Panisset et al. (2018)*

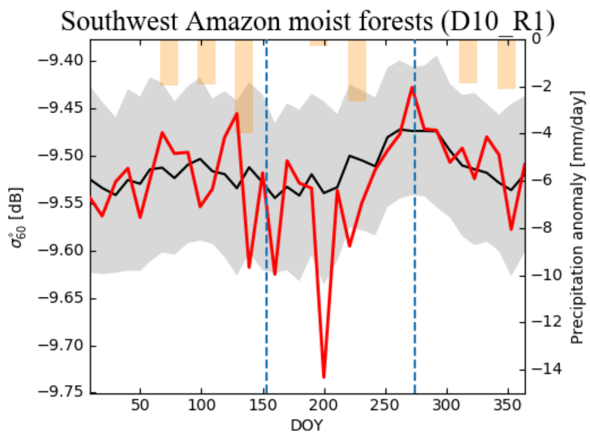
Backscatter anomalies are strongest during peak drought period

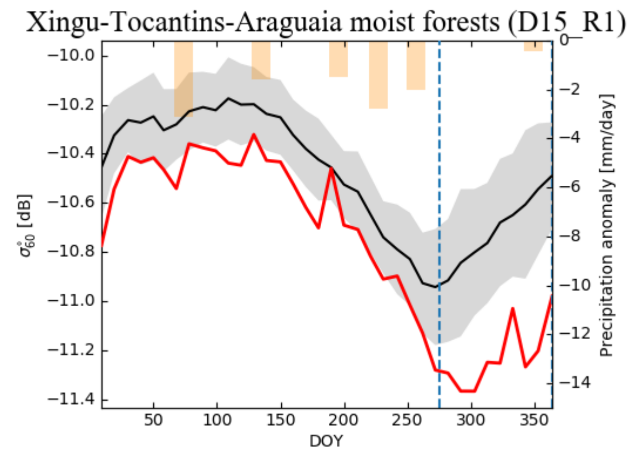


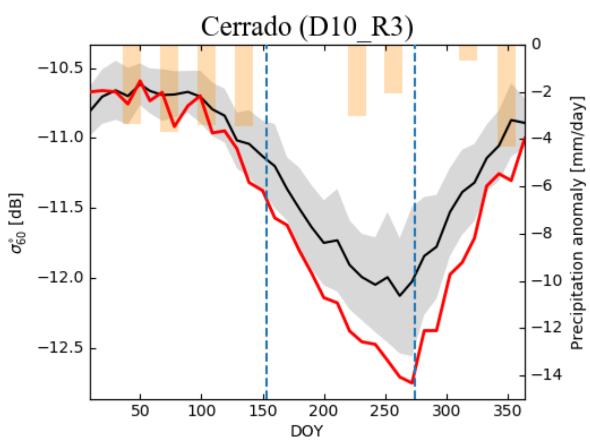


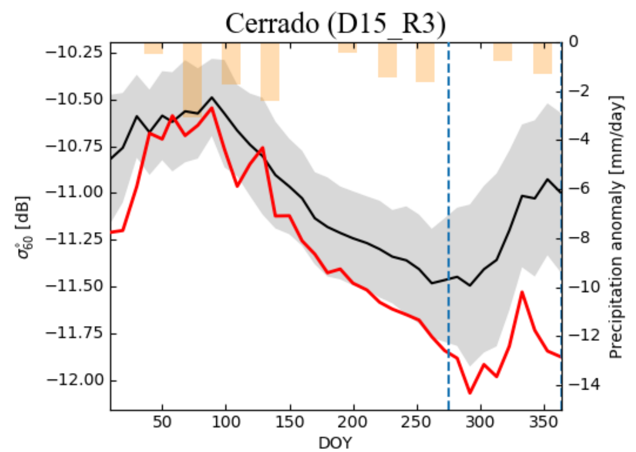
2010

Peak months: June-September







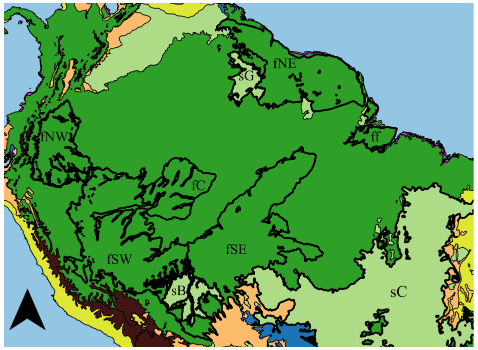


2015

Peak months: October-December

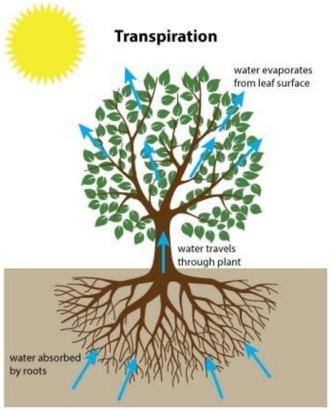
Drought year | Peak drought period | Climatology | +/- 1 SD | Precipitation anomaly

Conclusions



1. ASCAT parameters can differentiate between major vegetation types (such as forests and grasslands) in the Amazon region.

2. ASCAT backscatter can detect Amazon droughts.



3. ASCAT parameters are related to canopy water dynamics.

Questions?

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