Modelling of Microwave Multi-Frequency Emission and Backscatter by a Community Land Active Passive Microwave Radiative Transfer Modelling Platform (CLAP)

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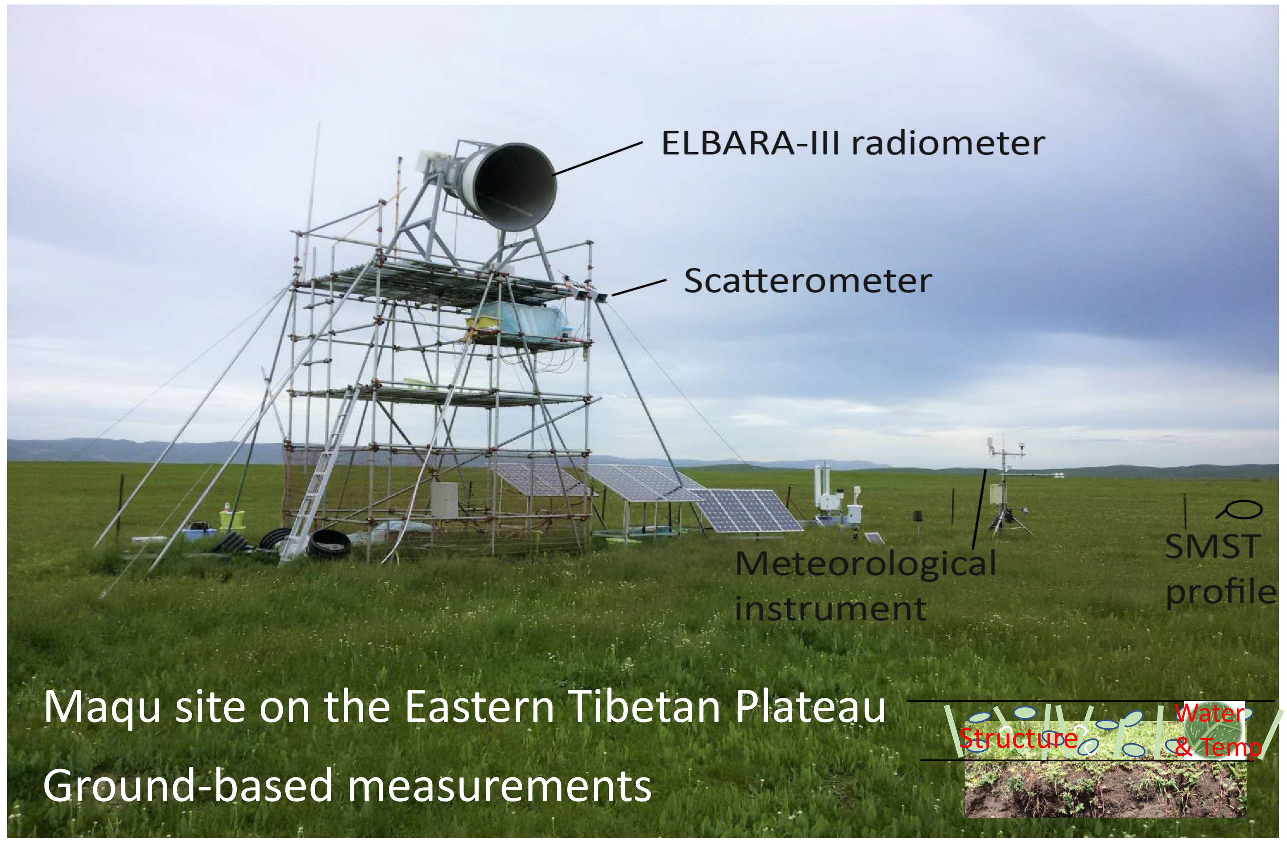
Question and objective

How satellite observations are rooted to the actual surface conditions, and further advance the understanding of land-atmosphere exchange processes?



(Su et al., 2020, Scientific data; Hofste et al., 2021, ESSD)

To explore the coupled roughness-vegetation scattering-emission mechanism and develop a multi-frequency simulator that can act as the measurement operator in the data assimilation system for land monitoring.

The prototype of CLAP

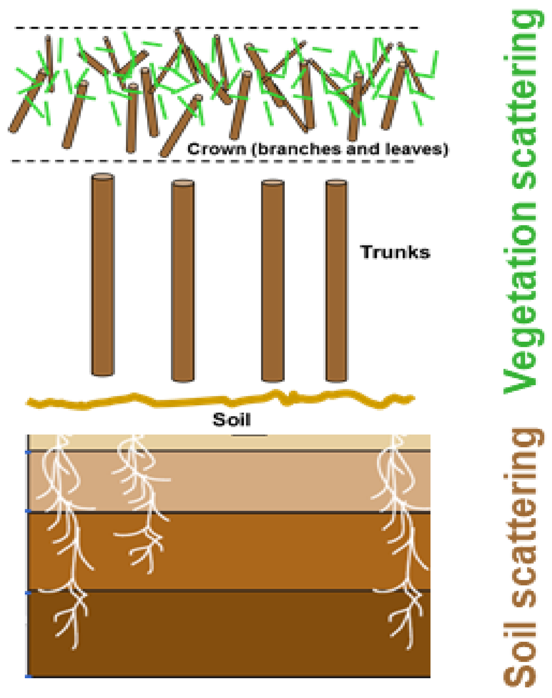
Inputs: soil water-temperature profile, roughness parameters, LAI, biomass, vegetation water-tem and geometrical parameters

$$\sigma^0 = \sigma_v^0 + \sigma_{vg}^0 + \sigma_g^0$$

The ATS+AIEM+TVG model

Core components

An air-to-soil transition model (**ATS**) (accounting for surface dielectric roughness), integrated with the Advanced Integral Equation Model (**AIEM**) for surface soil scattering modelling, and the TorVergata (**TVG**) discrete model for vegetation scattering and their interaction modelling.



Forward observation operator

Outputs: Backscattering σ_{pq}^0 and brightness temperature T_B^p

Zhao et al., 2021, JRS,
Zhao et al., 2022, submitted)

Outputs: Estimated tau and omega

$$\tau_p^* = -\ln(\gamma_p).cos\theta$$

$$\omega_p^* = 1 - \frac{e_p^{veg}}{1-\gamma_p}$$

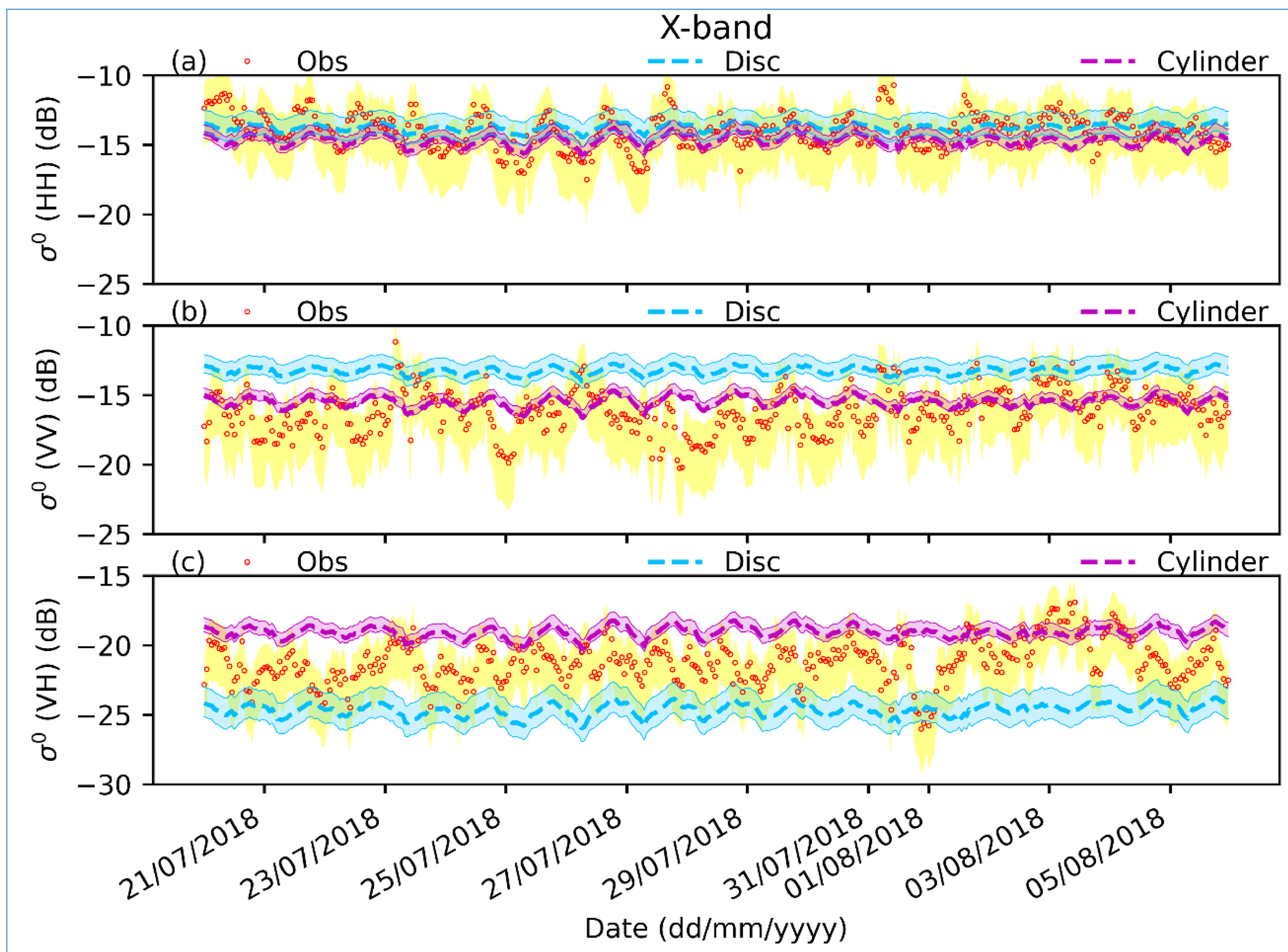
Ferrazzoli et al. (2002)

Simulation configurations

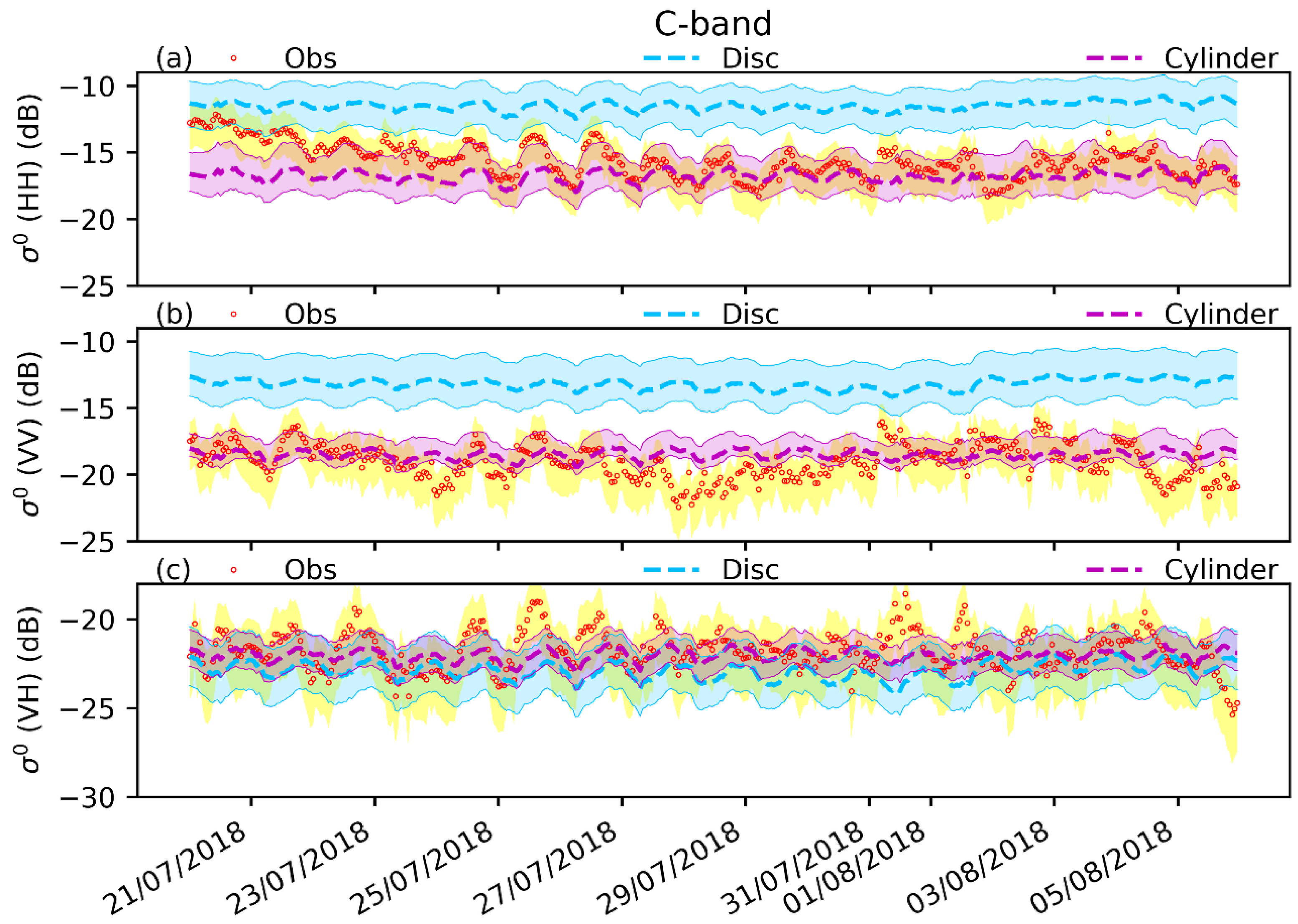
Name	Frequency	Effective incidence angle	Incidence angle range	Polarization
X-band	9.5 GHz	54°	21°-60°	VV, HH, VH
C-band	4.75 GHz	51°	39°-60°	same
S-band	2.75 GHz	44°	39°-60°	same
L-band	1.625 GHz	40°	48°-58°	same

Disc/cylinder: radius (cm)	1.4 .vs.0.05
Disc/cylinder: thickness (cm)	0.02 .vs.30
Number per unit of area (cm-2)	LAI/(pi * radius^2) .vs. 2
Vegetation temperature	Air temperature
Vegetation water	0.6 (kg/kg)
Soil water-temperature	in-situ observations
Vegetation dielectric model	Matzler model
Soil dielectric model	Mironov GRMDM
Surface roughness	s=0.9 cm, L=9 cm

Results and discussion



- Cylinder performs better than disc.
- Diurnal variation is more due to dynamic vegetation temperature



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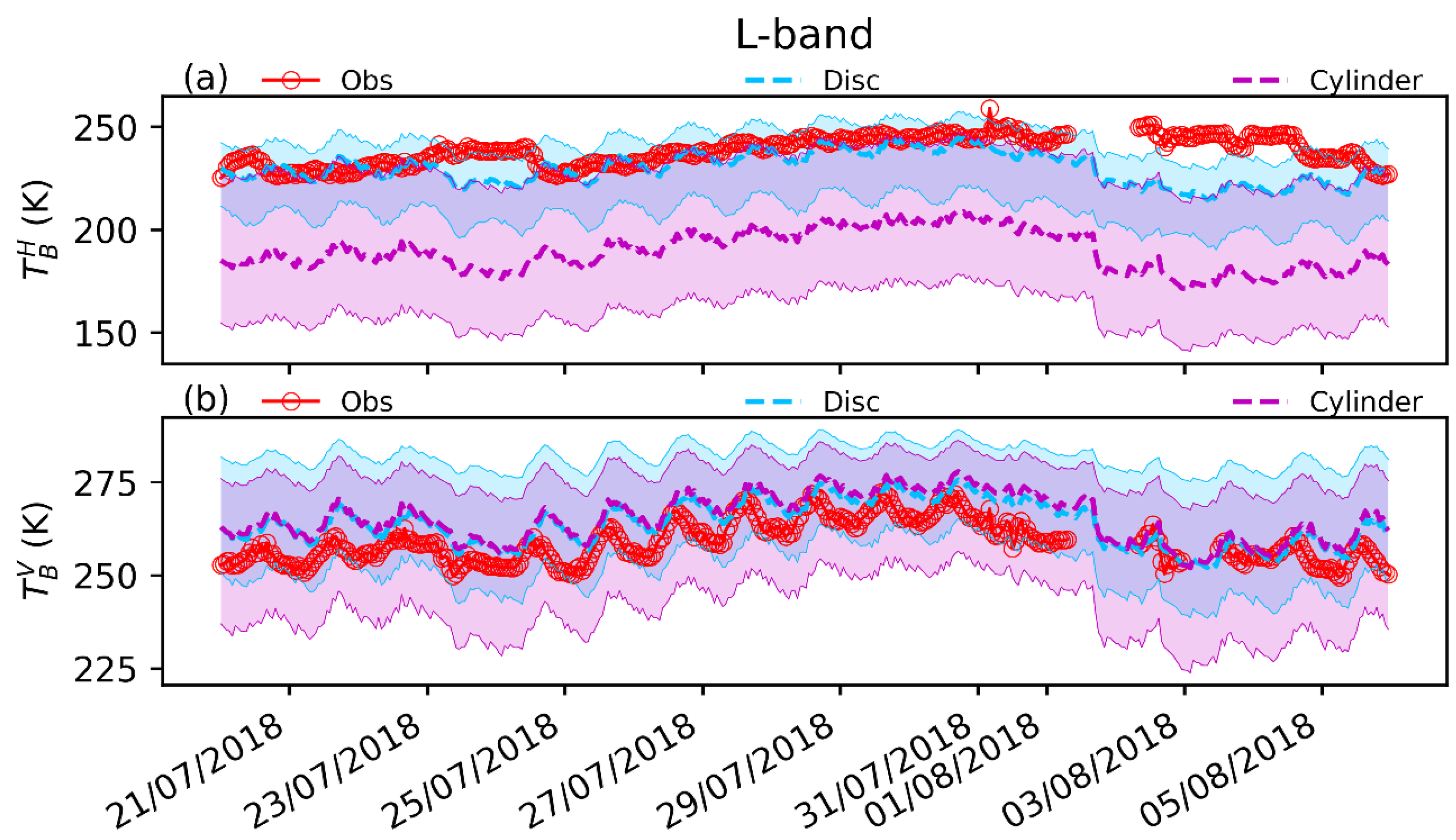
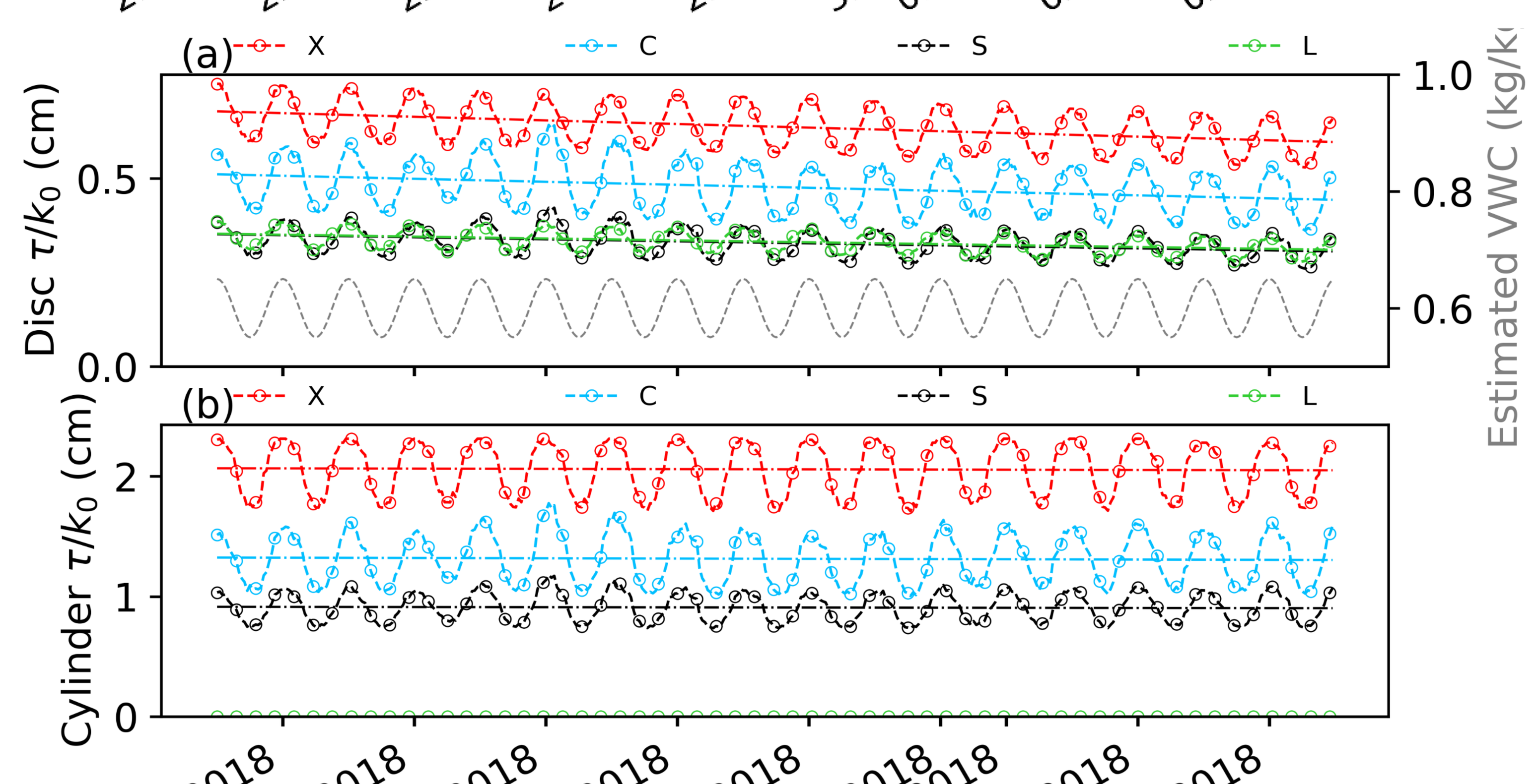


- Disc performs better than cylinder.
- Diurnal variation is more due to dynamic vegetation water



- τ is frequency-dependent
- τ for each frequency to be applied in the retrieval

CLAP has the capability for for integrated modelling, interpretation and application of multi-frequency emission and backscattering signals of land surface.

Major references

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