CSQ-13 Summary

Question	Knowledge Advancement Objectives	Geophysical Observables	Measurement Requirements	Tools & Models	Policies / Benefits
Would it be of value to develop a system of systems while combining different types of satellites under different orbit constellations to advance monitoring capacities (e.g., diurnal cycle, higher resolution)?	Diurnal cycle of essential climate variables	Essential climate variables (ECVs) presenting a strong diurnal cycle	Measurements at different local time at ascending node (LTAN)	Instruments on board satellites with precessing orbits or on board several sun-synchronous orbits with different LTAN	• Better survey of diurnal and seasonal cycle of ECVs • Observations with higher spatial and temporal resolutions in key areas
	Increase the horizontal resolution and the revisit time	ECVs that need to be followed frequently and at high resolution to follow the seasonal evolution and/or to observe fast changes: e.g. energy cycle, water cycle.	Measurements at higher spatial and temporal resolution	• Constellation of satellites with different LTAN • Combination of one large satellites for the accuracy and small satellites for the spatial and local time coverage • Combination of geostationary for the continuous observations and LEO satellites for the resolution	

CSQ-13 Narrative

Many geophysical variables present a diurnal cycle, for instance the cloud cover is very dependent on local time. The deep convection develops during the day. Low-level clouds are affected by the diurnal warming and cooling of the surface temperature. Most Earth observation LEO satellites have sun-synchronous orbits (SSO), observing only at two local times, one during the day and one during the night. Orbits of LEO satellites are characterised by the local time of their ascending node (LTAN). Geostationary satellites provide the information on the diurnal cycle but, due to their distance to the Earth, with a lower resolution than LEO satellites. Some LEO satellites are able to observe the diurnal cycle due to the drifting LTAN of their orbit, which is depending on the orbit inclination. For instance, the ISS orbit with a 51.6° inclination precesses 360° in roughly 60 days, allowing observation at all local times in 30 days. But it may be difficult to separate the diurnal cycle to the evolution during the month and the geographical coverage is limited to latitudes smaller than the inclination, excluding the polar regions.

Different strategies can be defined to monitor the diurnal cycle, for instance:

- Combination of GEO and LEO orbits
- Constellation of satellites with different LTAN.

The observation of the diurnal cycle is not required for all geophysical variables and, due to the cost of these strategies, it is important to determine what are the observations for which the diurnal cycle needs to be observed.

The constellation of satellites, by multiplying the number of observations, would also increase spatial resolution and reduce the revisit time of observations at the same location. This would be beneficial for several scientific subjects, e.g. the energy cycle at high resolution.

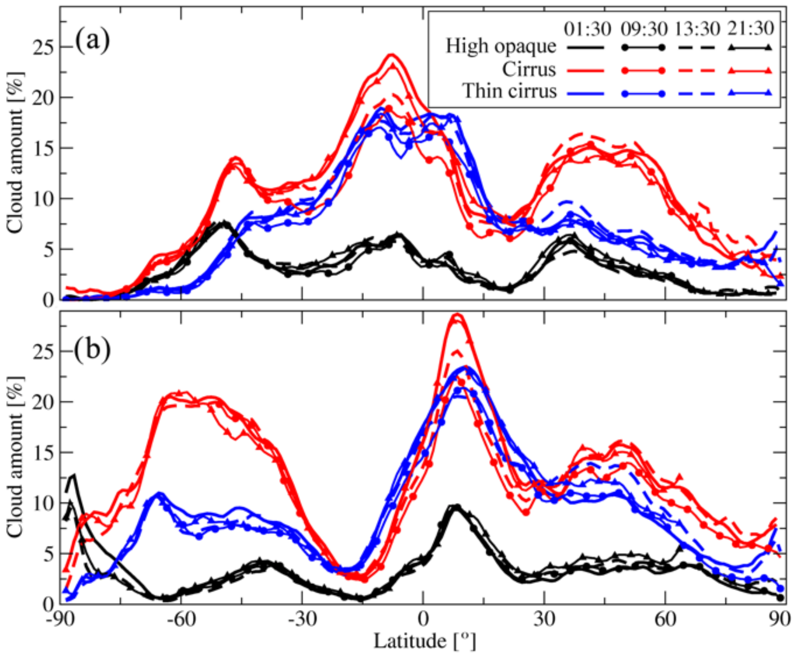

Figure 1: top, cloud cover as a function of local time and latitude, Feofilov and Stubenrauch, diurnal cycle cloud coverage, ACP 2019.

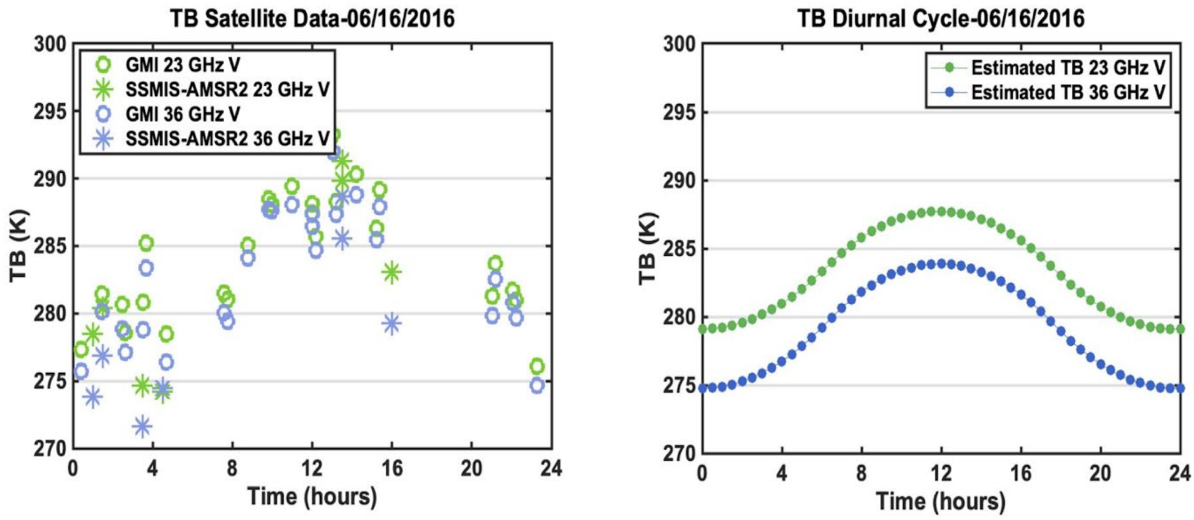

Figure 2: diurnal cycle microwave brightness temperature over land. From Sharifnezhad et al., Remote Sensing, 2021.

References

Feofilov A.G. and Stubenrauch C.J., Diurnal variation of high-level clouds from the synergy of AIRS and IASI space-borne infrared sounders, Atmospheric Chemistry and Physics 19:13957-13972, doi: 10.5194/acp-19-13957-2019.

Sharifnezhad, Z.; Norouzi, H.; Prakash, S.; Blake, R.; Khanbilvardi, R. Diurnal Cycle of Passive Microwave Brightness Temperatures over Land at a Global Scale. *Remote Sens.* 2021, *13*, 817. https://doi.org/10.3390/rs13040817