Improving the spatial resolution of the Land Surface Temperature estimates derived from passive microwave observations

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Requested background: Strong background in physics. Good knowledge in statistics. Proficiency in at least one programming language.

The Land Surface Temperature (LST) is a key parameter of the terrestrial radiative budget and it determines the radiative flux from the surface towards the atmosphere, at local and global scales. It is also a very important variable for surface and weather forecasting models, with impacts on cloud cover, precipitation, and atmospheric chemistry. The importance of this variable in meteorology, climatology, hydrology, ecology and agriculture has led to the development of satellite estimations, primarily derived from infrared measurements (around 12 microns). However, these satellite observations are very affected by clouds, and with more than 60% of the globe covered by clouds at any time, other methods must be developed. Passive microwave satellite observations are much less contaminated by clouds and offer a very promising alternative to the infrared under cloudy conditions (Prigent et al., 2016). However, the spatial resolution provided by the microwave (~ 20 km) is significantly poorer than from the infrared (~1 km), thus limiting the use of microwave-derived LST for regional and local applications.

Under the European Space Agency (ESA) Climate Change Initiative (CCI) Lands Surface Temperature program (LST_cci, https://climate.esa.int/en/projects/land-surface-temperature/), long time records of LST are produced, both from infrared and from microwave observations, using a number of retrieval algorithms (Perry et al., 2020.). Given the coarser resolution of the microwave-derived LST, a downscaling technique has been developed to enhance the spatial resolution of the microwave LST estimates, using the high resolution spatial patterns obtained from the infrared, under cloud-clear conditions (Favrichon et al., 2021). The study proposed here will contribute to these developments, with the following steps:

- Comparisons of the microwave and infrared LST estimates under clear sky conditions. Only one microwave dataset exists, but there are several infrared ones. In situ measurements are also available for some locations.
- Analysis of the potential differences / biases between microwave and infrared estimates, as a function of environments, time of the day, season.
- Proposition of solutions to correct these differences under clear-sky conditions, and applications of these corrections.
- Application of the downscaling methodology to the corrected microwave estimates for selected scenes, and their evaluation.

This study will be conducted in direct relation with the ESA CCI Land Surface temperature team.

References:

- Favrichon, S., Prigent, C., and Jiménez, C., A method to downscale satellite microwave land surface temperature. Remote Sens., 2021, doi: 10.3390/ rs13071325.

- Perry, M., Ghent, D., Jimenez, C., Dodd, E. M. A., Ermida, S. L., Trigo, I. F., and Veal, K., Multi-Sensor thermal infrared and microwave land surface temperature algorithm intercomparison, Remote Sens., 2020, doi:10.3390/rs12244164.
- Prigent, C., Jimenez, C., and Aires, F., Towards 'all weather', long record, and real-time land surface temperature retrievals from microwave satellite observations, J. Geophys. Res., 2016, doi:10.1002/2015JD024402.