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Contribution of thermal infrared images on the understanding of the subsurface/atmosphere exchanges on Earth.

Teodolina Lopez (1), Raphaël Antoine (2), David Baratoux (3,4), and Michel Rabinowicz (3)

(1) ISSI, Bern, Switzerland (teodolina.lopez@issibern.ch), (2) LRPC, CETE Normadie Centre, Le Grand Quevilly, France (raphael.antoine@cerema.fr), (3) GET, Observatoire Midi-Pyrénées, Toulouse, France (david.baratoux@gmail.com; michel.rabinowicz@yahoo.fr), (4) IFAN, Dakar, Senegal

High temporal resolution of space-based thermal infrared images (METEOSAT, MODIS) and the development of field thermal cameras have permitted the development of thermal remote sensing in Earth Sciences. Thermal images are influenced by many factors such as atmosphere, solar radiation, topography and physico-chemical properties of the surface. However, considering these limitations, we have discovered that thermal images can be used in order to better understand subsurface hydrology. In order to reduce as much as possible the impact of these perturbing factors, our approach combine 1) field observations and 2) numerical modelling of surface/subsurface thermal processes.
Thermal images of the Piton de la Fournaise volcano (Réunion Island), acquired by hand, show that the Formica Leo inactive scoria cone and some fractures close to the Bory-Dolomieu caldera are always warmer, inducing a thermal difference with the surrounding of at least $\sim$5°C and a Self-Potential anomaly [1, 2]. Topography cannot explain this thermal behaviour, but Piton de la Fournaise is known as highly permeable. This fact allows the development of an air convection within the whole permeable structure volcanic edifice [2]. Cold air enters the base of the volcano, and exits warmer upslope, as the air is warmed by the geothermal flow [1,2]. Then, we have decided to understand the interaction between subsurface hydrogeological flows and the humidity in the atmosphere. In the Lake Chad basin, regions on both sides of Lake Chad present a different thermal behaviour during the diurnal cycle and between seasons [3]. We propose that this thermal behaviour can only be explained by lateral variations of the surface permeability that directly impact the process of evaporation/condensation cycle. These studies bring new highlights on the understanding of the exchanges between subsurface and the atmosphere, as the presence of a very permeable media and/or variations of the surface permeability may enhance or not the evaporation/condensation cycle.

[1] Antoine et al. (2009). J. Volcanol. Geotherm. Res., 183(3-4), 228-1140. [2] Antoine et al. (2017). Geothermics, 65, 81-98. [3] Lopez et al. (2016). Surv. Geophys., 37 (2), 471-502.