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Can we use soil thermal inertia to map soil moisture from drones?

DTU

In hydrology particularly, estimation of soil moisture conditions is critical for the partition between surface runoff and infiltration. At global scales, having spatial measurements of soil moisture from field sensors is not feasible yet remote sensing thermal data can cover this gap. Measurements of soil thermal inertia can be used to estimate near surface soil water content. However, finding a general dynamic model between thermal inertia and soil moisture is necessary. The approach is based on a one dimensional thermal diffusion equation.

This research has two steps: a) Model setup and calibration using laboratory or field measurements of radiometric temperature and soil moisture. b) Application of the model with thermal images acquired from a drone (UAV) over field monitored sites where soil moisture is measured (Risø site).

Project type

Topic is suitable for MSc project

Pre-requisite

Modelling experience

Group size

1-2 students

Department of supervisors

Main supervisor: DTU Environment

Co-supervisor: DTU Space

Contact person

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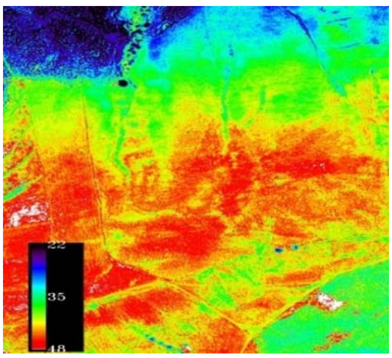

One-dimensional thermal differential diffusion equation

$$D\frac{\delta^2 T(z,t)}{\delta z^2}=\frac{\delta T(z,t)}{\delta t}$$

Boundary conditions

$$\begin{cases} -k\dfrac{\delta T(z,t)}{\delta z}\Big\|_{z=0} \\ T(z,t)\Big\|_{z\to\infty} \end{cases}$$

Temperature fluctuation

$$T(z,t)=-\frac{A_c}{B}+(1-\alpha_{SW})E_{Sun}\tau_{SW}\sum_{n=1}^{\infty}A_n\frac{\exp(-k_0\sqrt{nz})\cdot\cos(n\omega t-k_0\sqrt{nz}-\delta_n)}{\sqrt{\omega P^2+\sqrt{2\omega}PB+B^2}}$$

Xue and Cracknell (1995) 1° order approximation at $z=0$

$$P=P_{RS}=\frac{(1-\alpha_{SW})E_{Sun}\tau_{SW}}{\Delta T(0,t_1-t_2)}\cdot A_1\frac{\cos(\omega t_1-\delta_1)-\cos(\omega t_2-\delta_1)}{\sqrt{\omega}\sqrt{1+\frac{1}{b}+\frac{1}{2b^2}}}$$

with $\delta_1=\omega t_{max}$

From Minacappilli et al., (2013)

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