CYCLING OF WATER AND CARBON IN MOUNTAIN ECOSYSTEMS UNDER CHANGING CLIMATE AND LAND USE (CYCLAMEN)

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1 OBJECTIVES

- Collect and harmonize eddy covariance and remote sensing data for Alpine ecosystems to support modelling;
- Perform Two-Source-Energy-Balance (TSEB) and Soil-Vegetation-Atmosphere-Transfer (SVAT) modeling of water and carbon cycles;
- Enhance TSEB models [KUSTAS et al., 2011] based on remote sensing datasets for retrieving evapotranspiration in vegetated areas in the Alps.

2 METHOD

TSEB modeling (Eurac research, Earth Observation) exploits LST derived from thermal infrared remote sensing (TIR) as an indicator of water availability. TSEB allows to model evapotranspiration (ET) from the field to the global scale [ANDERSON et al., 2018], however, in regions characterized by complex orography and inhomogeneous land cover, the performances of TSEB are limited by the lack of high spatial and temporal resolution TIR data [CASTELLI et al., 2018].
In CYCLAMEN we solve part of these limitations by producing high-resolution (250 m) daily LST maps. Specifically, we downscale MODIS LST (MOD11A1) by using a digital elevation model and NDVI as predictors with a Random Forest algorithm (Fig.1).

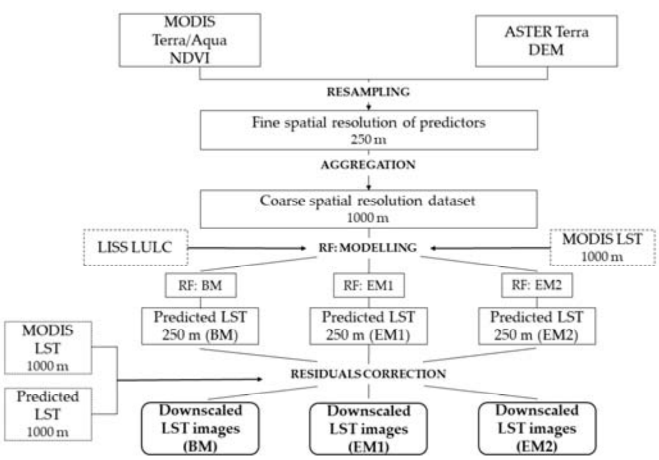

Fig.1: MODIS LST downscaling flowchart [BARTKOWIAK et al., 2019]

SVAT models (University of Innsbruck, Ecology) [WOHLFAHRT, 2004] calculate the CO_2, H_2O and energy fluxes between the soil-vegetation system and a reference height above the canopy.

The SVAT model SiB4 is exploited to simulate fluxes at selected eddy covariance sites in North and South Tyrol, also exploiting remote sensing inputs on vegetation status.

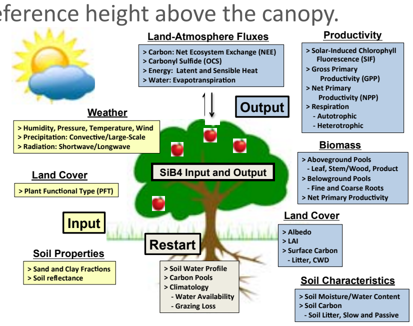

Fig.2: scheme of the SVAT model SiB4

3 RESULTS

We quantified the uncertainties of the downscaled LST maps by comparison with fine spatial resolution Landsat (Fig.3, Fig.4).
We built different schemes to model the non-linear relationships: 1) all pixels (BM), 2) only pixels with more than 90% of vegetation content (EM1) and 3) only pixels with 75% threshold of homogeneity for vegetated land-cover classes (EM2).

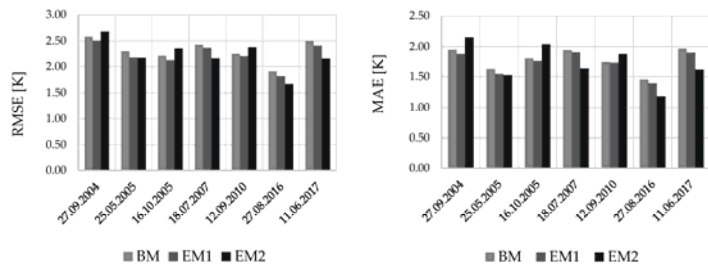

Fig.3: validation results based on average RMSE and MAE between disaggregated images and reference images for BM, EM1, and EM2 [BARTKOWIAK et al., 2019].

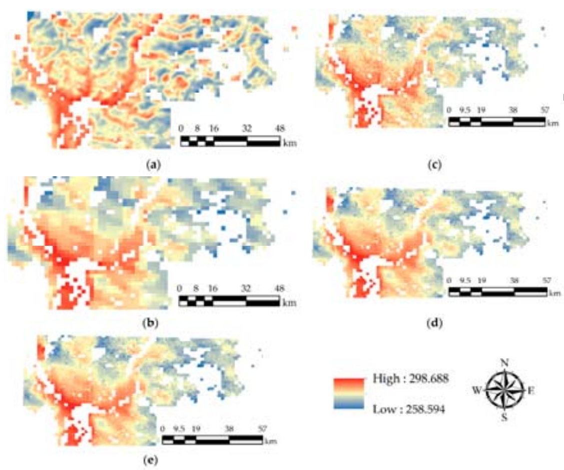

Fig.4: comparison between MODIS and Landsat LST degraded to 250 m spatial resolution. (a) degraded Landsat reference image, (b) original MODIS LST (1000 m), (c) BM, (d) EM1 , (e) EM2 on 27 September 2004 [BARTKOWIAK et al., 2019].

4 OUTLOOK

- Develop spatio-temporal gap-filling to overcome cloud contamination effects on remote sensing datasets;
- Exploit the enhanced remote sensing datasets for modelling ET by TSEB in the Alpine region;
- Compare TSEB and SVAT simulations of ET.

REFERENCES

Anderson, M., Gao, F., Knipper, K., Hain, C., Dulaney, W., Baldocchi, D., & Kustas, W. (2018). Field-scale assessment of land and water use change over the California Delta using remote sensing. *Remote Sensing*, 10(6), 889.
Bartkowiak, P.; Castelli, M.; Notarnicola, C. (2019). Downscaling Land Surface Temperature from MODIS Dataset with Random Forest Approach over Alpine Vegetated Areas. *Remote Sens.*, 11(11), 1319.
Castelli, M., Anderson, M. C., Yang, Y., Wohlfahrt, G., Bertoldi, G., Niedrist, G., Notarnicola, C. (2018). Two-source energy balance modeling of evapotranspiration in Alpine grasslands. *Remote Sensing of Environment*, 209, 327-342.
Kustas, W. P., Norman, J. M., Hain, C. R., Mecikalski, J. R., Schultz, L., Gonzalez-Dugo, M. P., & Gao, F. (2011). Mapping daily evapotranspiration at field to continental scales using geostationary and polar orbiting satellite imagery. *Hydrology and Earth System Sciences*, 15(1), 223.
Wohlfahrt, G., 2004. Modelling Fluxes and Concentrations of CO2, H2O and Sensible Heat Within and Above a Mountain Meadow Canopy: A Comparison of Three Lagrangian Models and Three Parameterisation Options for the Lagrangian Time Scale. *Boundary Layer Meteorol.*, 113(1): 43-80.

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