University of Zurich[UZH]

Department of Geography

Remote Sensing of Water Systems

8th Advance Training Course on Land Remote Sensing

TOWARDS ADVANCED ESTIMATES OF ECOSYSTEM TRANSPIRATION USING MULTI-MISSION SENTINEL SATELLITE DATA

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ABSTRACT

This study evaluates the capability of a mechanistic Earth Observation (EO) based approach to estimate ecosystem transpiration (T_r).

The approach involves multi-mission SENTINEL-2 and -3 satellite data.

Results indicate feasibility of observational approaches to estimate T_r and point to data requirements for advanced cross scale mapping of T_r.

INTRODUCTION

T_r is an unavoidable water loss while CO_2 is assimilated by plants to drive photosynthesis [1].

T_r is an important process substantially impacting the global water and energy balance [2], [3].

Uncertainities in global T_r estimates are still substantial since T_r is constrained by a complex biological control, i.e. stomatal conductance (g_s) and models lack an adequate representation of g_s [4] .

Data of novel satellite missions provide new avenues to advance global information of T_r

OBJECTIVES

Apply and evaluate an EO based top-down approach for estimating T_r.

Assess requirements for multi-mission satellite data in support of cross scale T_r estimates.

TEST SITE

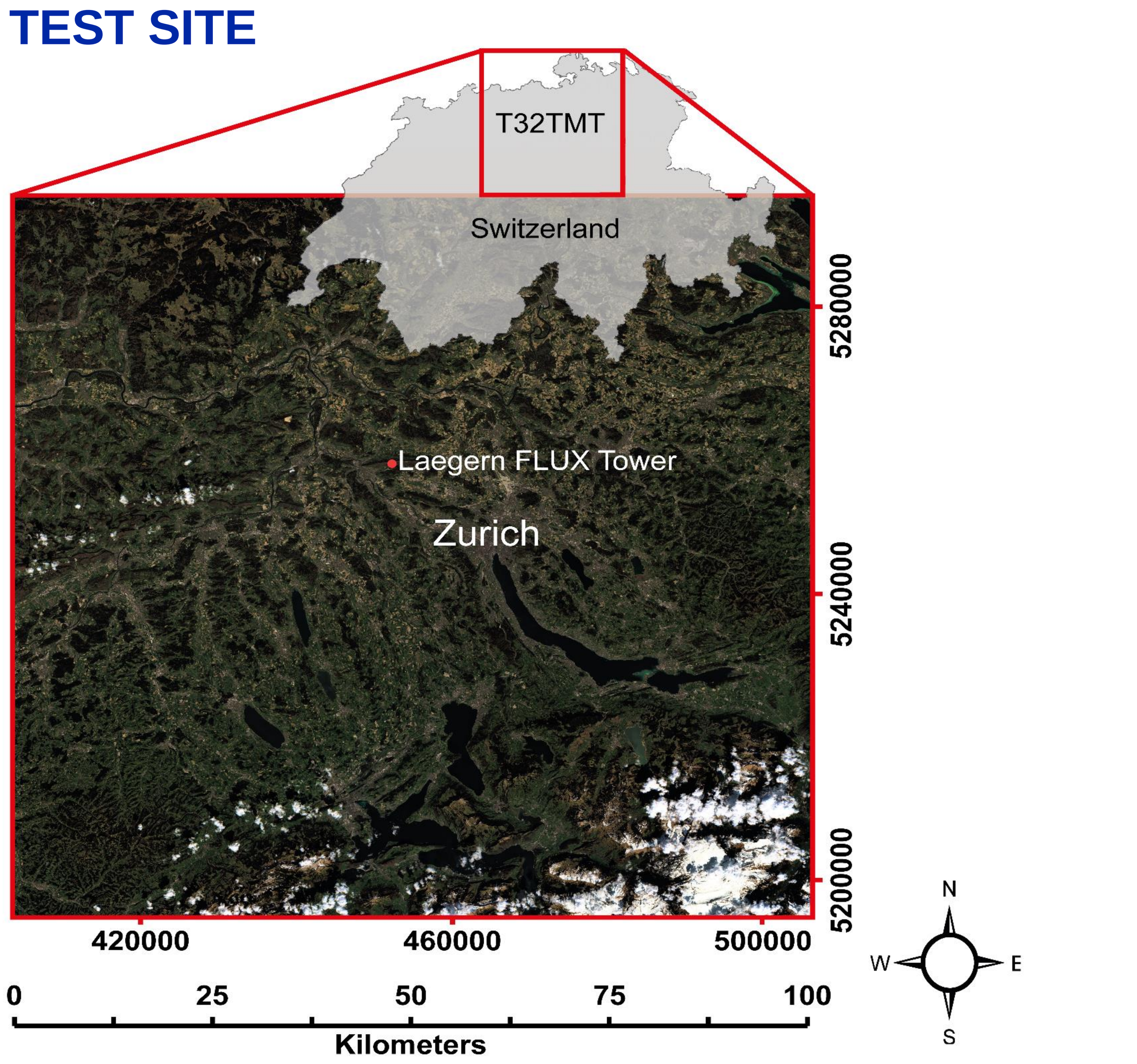

Figure 1: Test area define by a SENTINEL-2 tile (T32TMT). *Background: SENTINEL-2 RGB from 10th April 2017 (Copernicus Open Access Hub, ESA). Vector data: www.diva-gis.org. The flux tower is located in a mixed temperate forest.*

METHODS AND DATA

Multi-mission Satellite Data Processing & Transpiration Estimation

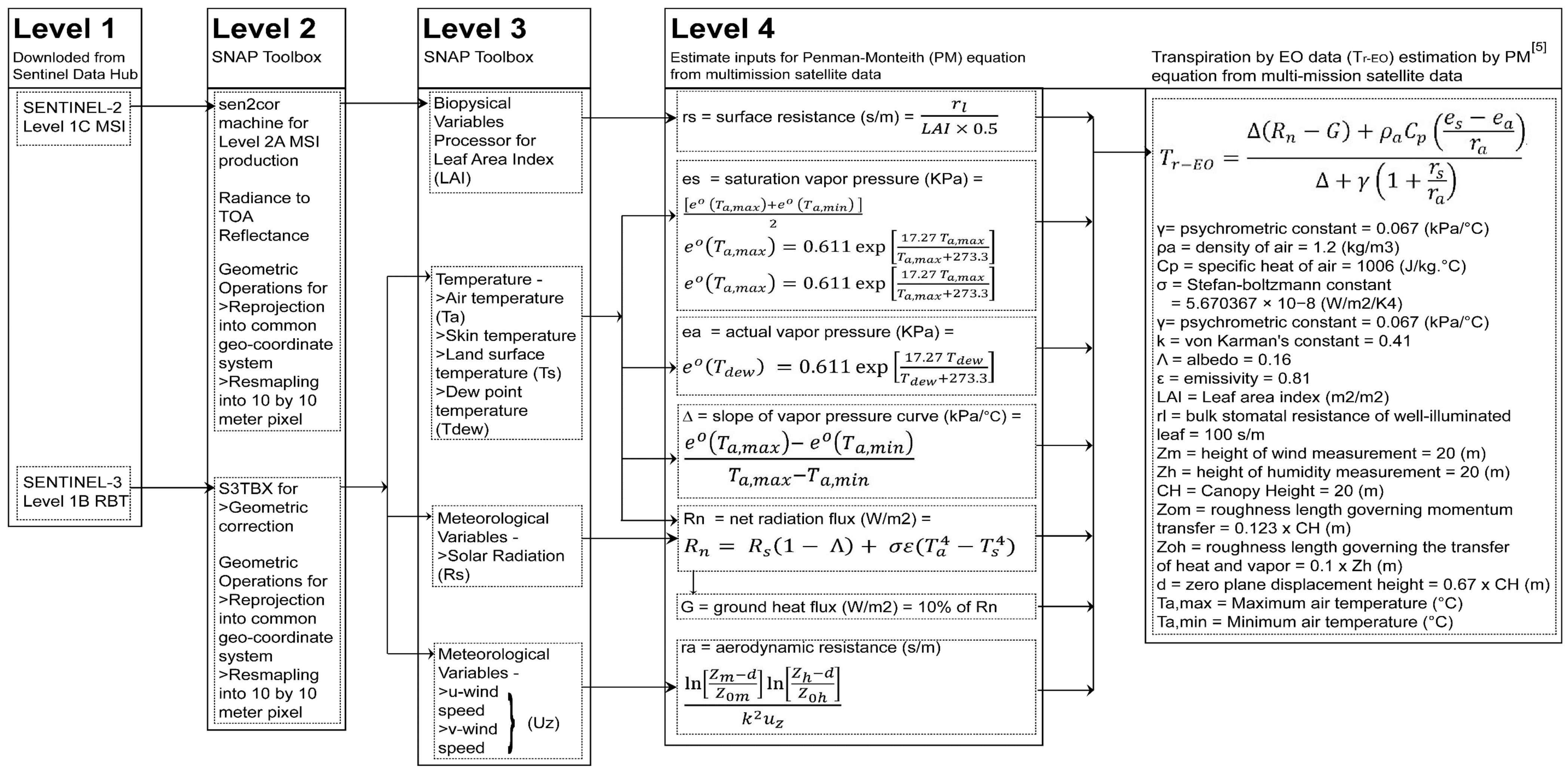

Figure 2: Overview of used satellite data, L1 – L4 processing tools and products to obtain T_r based on a Penman-Monteith modeling framework ($T_{r\text{-}EO}$). Additional data used for validation: Half hourly in situ measurements of evapotranspiration by an eddy flux tower.

RESULTS

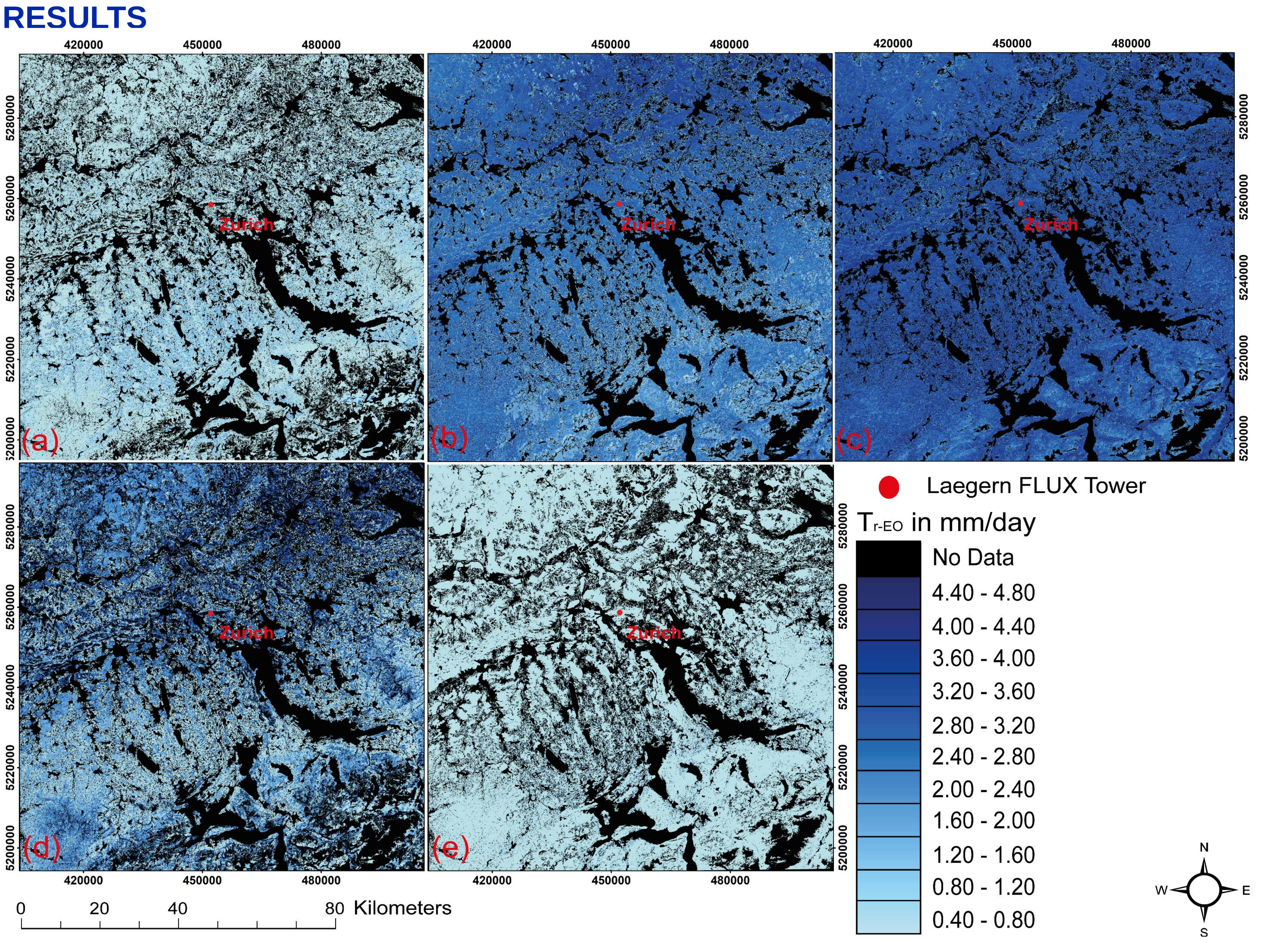

Figure 3: **(a-c)** Map of $T_{r\text{-}EO}$ for 4th April, 19th June, and 18th August 2017. **(d)** Difference between $T_{r\text{-}EO}$ from 19th June 2017 and 4th April 2017. **(e)** Difference between $T_{r\text{-}EO}$ from 18th August and 19th June 2017.

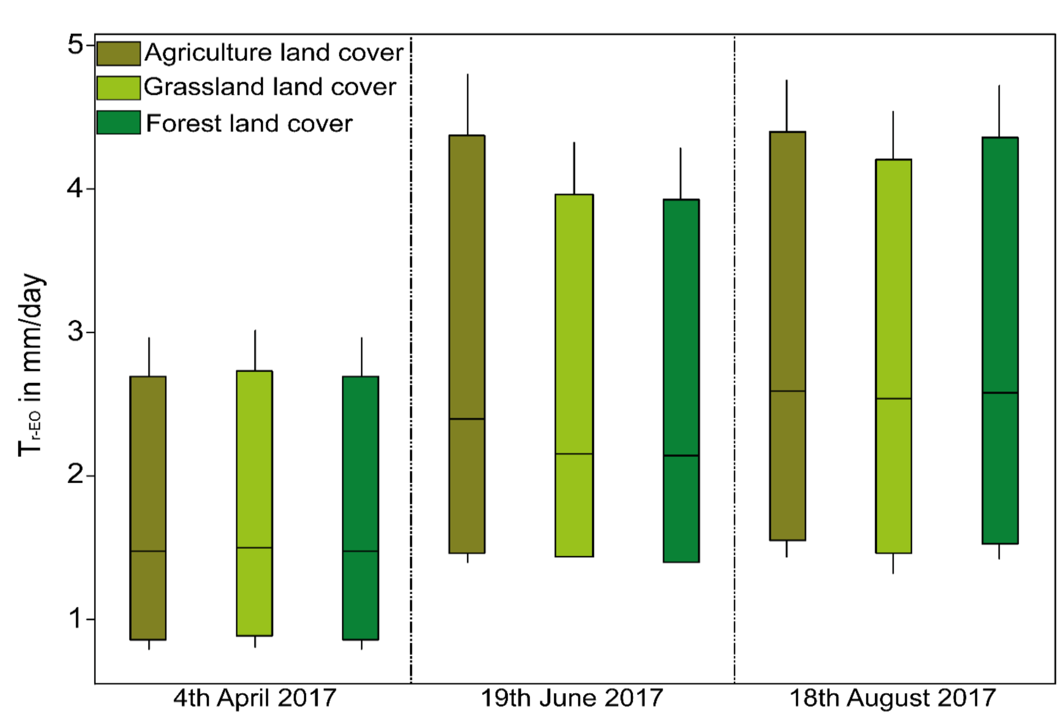

Figure 4: Variation of $T_{r\text{-}EO}$ for land cover classes agriculture, grassland, and forest.

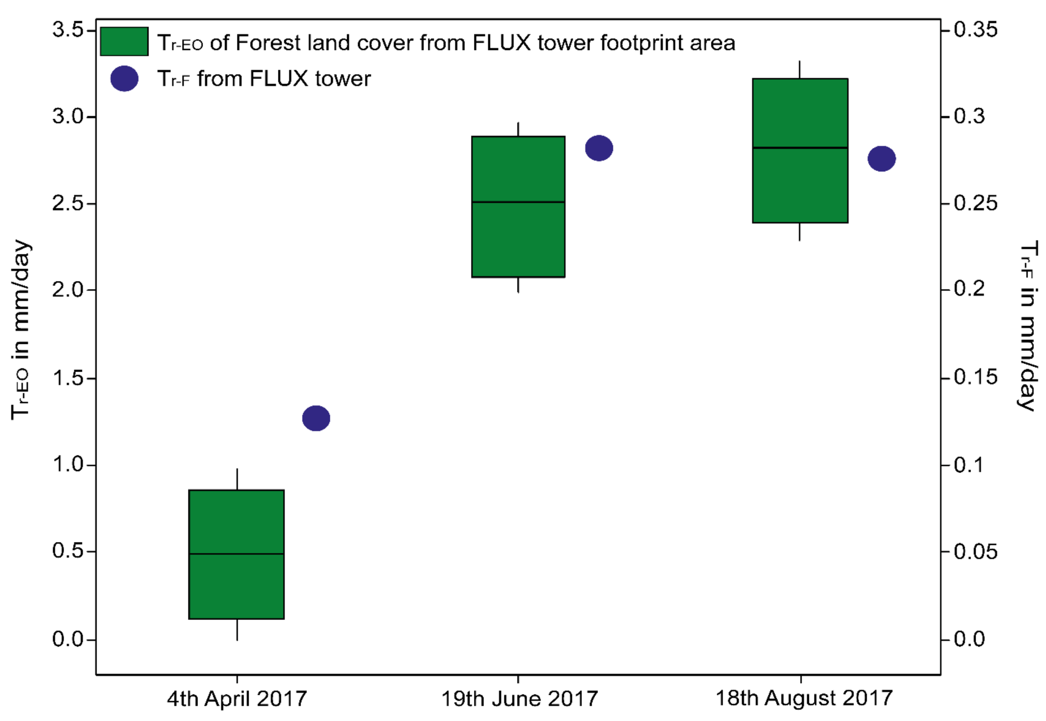

Figure 5: Comparison between T_r obtained in situ from an eddy flux tower ($T_{r\text{-}F}$) and $T_{r\text{-}EO}$ representing the tower footprint covering a mixed temperate forest.

DISCUSSION

$T_{r\text{-}EO}$ representing the Laegeren forest site well follows the annual dynamics as measured in situ but seems to overestimate T_r (**Figure 5**).

Possible explanations are that

(a) the spatial resolution of e.g. the used S3-SLSTR sensor is to coarse to map the small scale forests site. This causes a mix of land cover types in the sensors field of view.

(b) some PM input variables are not available yet and were thus assumed constant when calculating $T_{r\text{-}EO}$ (i.e. CH, Uz).

(c) used multi-sensor data diverge in their spatial resolution (**Figure 6**) and needed to be converted into a common pixel grid (10m x 10m)

(d) used multi-sensor data diverge in their temporal coverage (**Figure 6**), while ideally all input variables should be measured simultaneously.

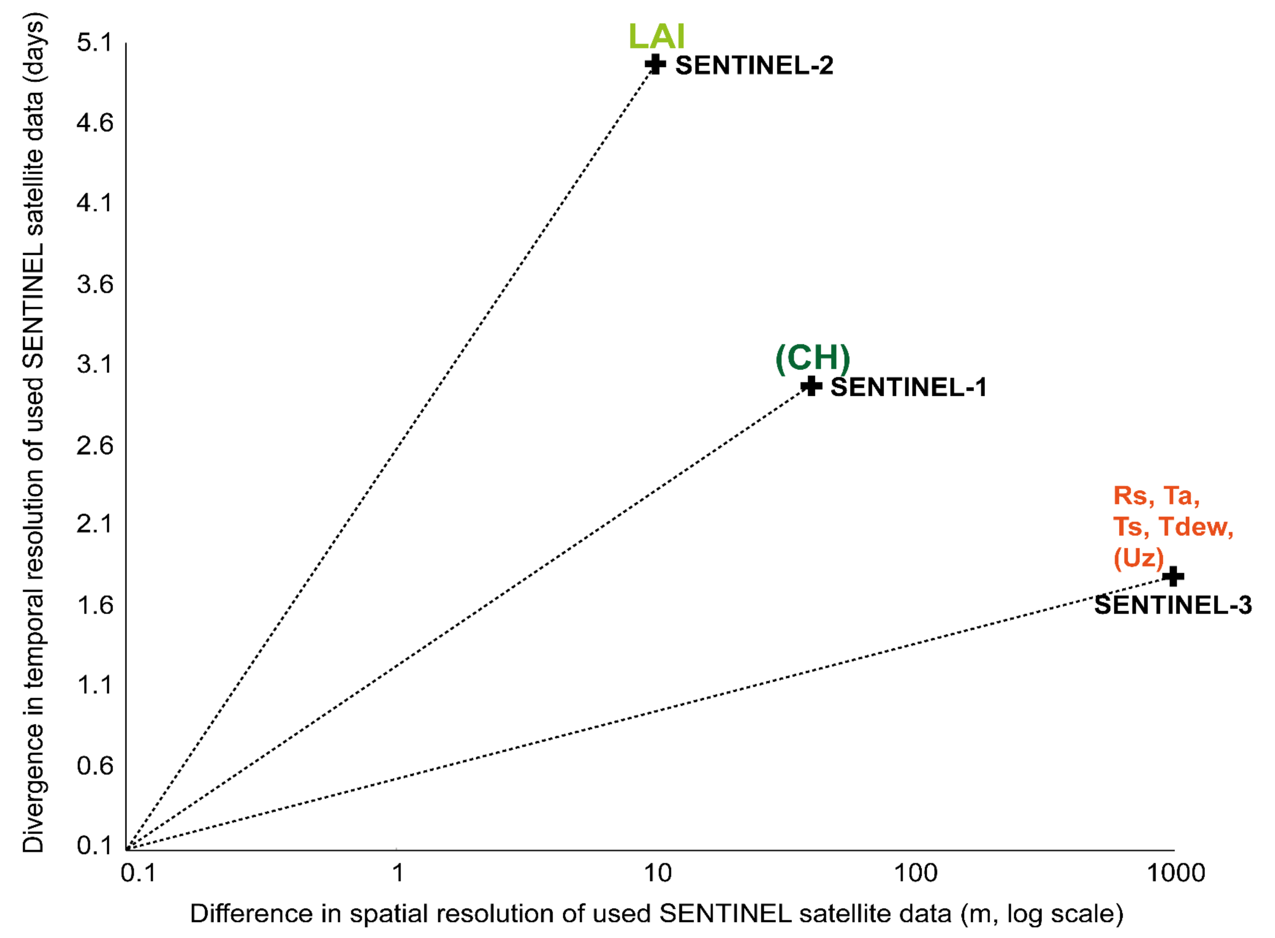

Figure 6: Mismatch of spatial and temporal resolution of used SENTINEL data and derived L3/L4 products relevant to facilitate a $T_{r\text{-}EO}$ mapping approach .

CONCLUSION

Multi-mission SENTINEL satellite data are important to facilitate a top-down T_r mapping from regional to global scale.

Not all input variables of the PM based modeling framework are available from SENTINEL missions yet (e.g. CH) or are of insufficient quality (e.g. U_z).

The divergence in spatial and temporal resolution complicates T_r assessments since error prone resampling steps for harmonizing data and missing observations compromise the accuracy of $T_{r\text{-}EO}$ estimates.

Combining operational SENTINEL missions with experimental ones (e.g. ESA's Earth Explorer FLEX, and Aeolus) is possibly a step forward.

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