TREOS (Tree Ring-Earth Observation by Satellites) – a network initiative to link ring-width measurements with satellite-borne earth observations

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1. Background

The TREOS initiative aims to establish a new tree ring research network to explore the possibilities of interpolating tree growth at mesic sites in Central Europe using the latest high-resolution satellite data. In recent decades, satellite imagery has developed rapidly and now provides open access to time series with high temporal and spatial resolution. Earth observations by satellites (EOS) can be related to radial growth of trees if field calibration is performed, which could then support upscaling of tree growth from individual trees to site and landscape levels. Statistical relationships between EOS and tree rings are commonly studied in alpine and boreal forests, where individual growth factors often determine growth. However, at mesic sites in temperate climates, tree growth is limited by multiple factors, and the relationship between EOS and tree growth remains challenging. We hypothesize that at mesic sites, additional site descriptors such as elevation, slope, and forest characteristics play an important role in explaining tree growth. In addition, the application of machine learning algorithms and the use of higher resolution satellite data could increase the predictive accuracy of already established models. However, to train appropriate algorithms, regional to continental tree ring networks covering recent years are needed to allow for a sufficiently large sample size over the entire observation period of the main satellite missions, such as Landsat 8 (since 2013) and Sentinel 2 (since 2015). We therefore invite researchers to participate in our TREOS initiative by sampling and/or providing tree ring data from Central Europe and altitudes below 1000 m that have been collected in October 2018 or a more recent period. Based on the network, we aim to improve our understanding of the robustness and uncertainty of the link between EOS and secondary tree growth of conifers and broadleaves, and to generate appropriate transfer functions.

2 TREOS network

2.1 Date of sampling, ring-width measurements and quality assessment

The tree ring chronologies provided should have been sampled in recent years, but not earlier than in October 2018.This condition is necessary to have an overlap of at least 2 years with high resolution satellite imagery such as Sentinel 2. The sampled tree species should be dominant in a stand, representative in the canopy layer, include at least 10 individual trees, and belong to one of the genera *Fagus, Picea, Pinus, Quercus, Abies,* and *Pseudotsuga*. Tree cores should be processed using standard

dendrochronological methods beginning with air drying, mounting into wooden holders, and sanding to obtain clearly visible ring boundaries. Ring widths should be measured using standard dendrochronological equipment such as LinTab or image analysis software such as CooRecorder and WinDendro and cross-dated using software such as CDendro, COFECHA, PAST -5 or similar software.The submitted tree-ring chronologies should meet the following minimum quality requirements, i.e., rbar > 0.25 and *GLK > 0.60*. Although we appreciate each tree-ring chronology contribution, we encourage all researchers to provide a couple of chronologies to support the TREOS network on a larger scale.

2.2 Site coordinates

TREOS will initially focus on mesic forests at elevations below 1000 m from Central Europe, which we here define as the area between 45 and 55 degrees latitude and between 5 and 25 degrees longitude. The exact location of sampled trees is mandatory information to ensure comparison with overlapping pixels of satellite imagery. Accepted formats are WGS84 coordinates of individual trees or a site coordinate representative of all trees. Alternatively, you can provide polygons representing the area where the trees were sampled. We strongly recommend that you verify that the coordinates provided are valid and within a forested area (https://earth.google.com/web/) with at least 50 m distance to the nearest forest edge to avoid artefacts from non-forest areas.

2.3 Forest type

A necessary piece of information for any tree ring chronology is the classification of forest type: 1) coniferous forests, 2) broadleaves, or 3) mixed forests. In broadleaved stands, the proportion of broadleaved species is > 75%, while for conifer stands have the share of coniferous species > 75%, and all other stands should be classified as mixed forest.

2.4 Other valuable information

We encourage data providers to share with us other important information that could facilitate the interpretation of the results. Such information could include tree heights, soil type, stand descriptors such as total growing stock or stand basal area, recent management history since 2018, and the like.

3. Data policy agreement

This data policy agreement is designed to ensure that each data provider is listed as a co-author on all publications containing their data and that ideas developed within the network are kept confidential. In addition, the agreement clarifies rights regarding

ownership of the data and how the order of co-authorship will be handled in the resulting publications.

To clarify, a data contributor (i.e., a TREOS network member) is someone who contributes at least one tree-ring dataset representative of a site and species to the TREOS network. Therefore, one tree-ring chronology can be contributed only by one contributor. Each data contributor retains the rights to their own data and ideas and must give permission for the data to be used. However, we retain the right to exclude any chronology that is not in accordance with the rules presented in this description. In case you're uncertain whether your data-set fulfils the requirements, please clarify prior to data submission with Jernej Jevšenak.

In case data contributors want to pursue own research questions based on the network, all data providers have to be introduced to the idea so that they can decide for themselves whether they want to contribute their specific data and collaborate on the topic. Once approval is granted for a particular dataset and study, it cannot be withdrawn, thus avoiding the need to reorganise manuscripts due to removal of data at an advanced stage of the writing process. Ideas should ideally be presented early on to avoid parallel investigations on similar topics.

The greater the contribution to a particular study (be it data, analysis, ideas, contributions to the paper, etc.), the stronger the position of a coauthor in the resulting publication. For equal contributions (e.g., if you contribute one chronology and proofread the final version of the manuscript), authors are listed in alphabetical order. Equal first authorship is also possible if two authors contribute equally to the main body of the paper, but then these two authors must agree on a specific order. A statement of author contribution must be provided for each publication and must be agreed upon along with the data use permissions. Similar to the data use permissions, the author contribution statement is initiated by the principal investigator, who is usually the first author of the publication in question. Author contribution statements are not for internal use only, but must be published with the research paper.

4. The first step

We invite all potential data contributors to express their interest by sending an email to jernej.jevsenak@gozdis.si. At this stage, TREOS consists of more than 80 tree-ring width chronologies from Poland, Slovenia and Germany.