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 1200 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 3 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*. All contributed data should be provided as raw (non-detrended) individual tree-ring width measurements in *.rwl* format. 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 1250 m from Central and Eastern Europe, which could be roughly defined as the area between 45 and 58 degrees latitude and between 5 and 28 degrees longitude. Please note that the described area of interest is approximate, and we accept also contributions form Baltic states and northern Balkan, which exhibit continental climate, but our initial analyses will not include Mediterranean or Scandinavian sites, which could be potentially considered in the later parts of our initiative. Thus, in case you would like to contribute data from Mediterranean or Scandinavian sites, you may get in touch with us to express your motivation for joining the network, which we then may consider at a later stage. The exact location of sampled trees is mandatory information to ensure comparison with overlapping pixels of satellite imagery. Accepted formats are WGS84 coordinates of one representative site coordinate. Alternatively, you can provide georeferenced polygon-shapefiles 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.

Regarding the relatively close sites, the central coordinates of the close forest stands should be at least 250 m apart, as we will create a polygon with a radius of 100 m around each point (this optimal radius has yet to be determined). So, if two stands are closer than 250 m apart, it would make sense to join (average) them, or simply provide one selected chronology. Optimally, each chronology should include one representative site coordinate located somewhere in the middle of a stand where trees were cored. I know this is sometimes difficult because we do not usually do circular sampling in forests, but still. So even if you have the coordinates of each tree, I would ask you to estimate the centre of each stand, ideally you would also check the coordinates on Google Earth (or similar).

2.4 Other valuable information

All measured trees should also have information on tree diameters at breast height (DBH), which will allow us to estimate basal area increments. If DBH is not available, you can still provide your data, which will only be used for analyses based on standardised chronologies.

Individual tree heights and crown base heights are not required, but we ask data contributors to let us know whether such information is available, which could be useful in alternative analyses applied only on a subset of the TREOS network.

We encourage data providers to share with us other important information that could facilitate the interpretation of the results. Such information could include measured tree diameters or 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. However, common contributions are possible if you provide higher number of chronologies, e.g. three common contributors should submit at least three chronologies. 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 with the data quality requirements or features unexplainable peculiarities. 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.

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