Monitoring forests in remote areas by IoT based measuring systems: the RemoTrees project

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Objective

To design, **develop** and **test an innovative in-situ observation system** based on **Internet of Things (IoT) technology** and satellite communication, suited for **hard-to-reach forest areas.**

Background

Forests play a key role in the Earth climate system, contributing to **mitigate global warming** and **stocking** large reservoirs of **organic carbon**, while **climate change threatens their mitigation potential**. The extent and severity of this impact are unknown due to the **lack of a comprehensive monitoring site network**, from which hard-to-reach areas, characterized by strong logistic limitations and often associated challenging climatic conditions, are largely excluded.

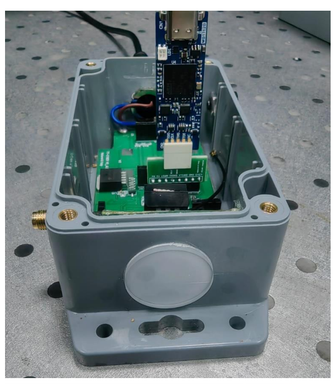
The RemoTrees project (Dec. 2023 - Nov. 2027) addresses the lack of in-situ data, **specifically from remote forests**, proposing novel technological solutions to complement Earth Observation efforts to monitor climate change effects on forest ecosystems globally.

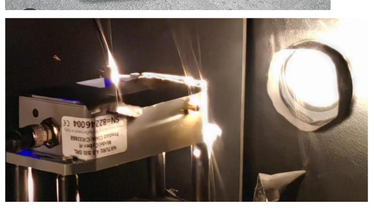
System Design and Development

The RemoTrees system design pillars are:

- **Comprehensive Forest Environment Monitoring**: IoT-based system measuring 4 Essential Climate Variables (fAPAR, LAI, soil moisture, above-ground biomass change) and other key eco-physiological and physical variables.
- **User-Friendliness and Low Maintenance**: easy installation, low maintenance with 6+ months of standalone operation and satellite communication for remote data collection on a web server.
- **Extreme Resistance**: waterproof (IP65+) and resistant to harsh environmental conditions.
- **Cost-Efficiency**: aiming at significantly lower market price compared to alternatives.

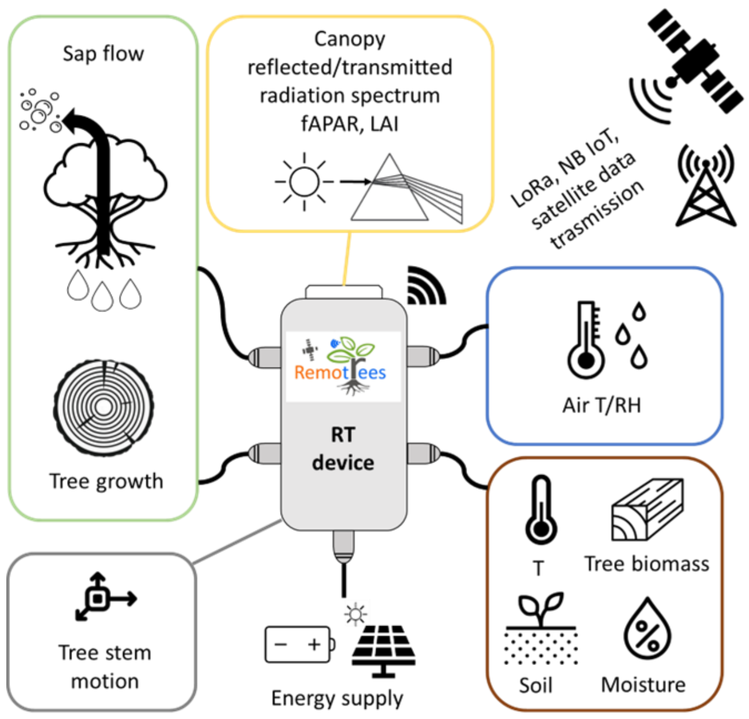
The RemoTrees sensor devices will be fully characterized and calibrated before the deployment in the field. Prototyping envisage an *alpha* (lab level), *beta* (L1 sites) and *gamma* (L2 sites) prototypes before the final system version.





Alpha prototype production and spectrometer lab characterization

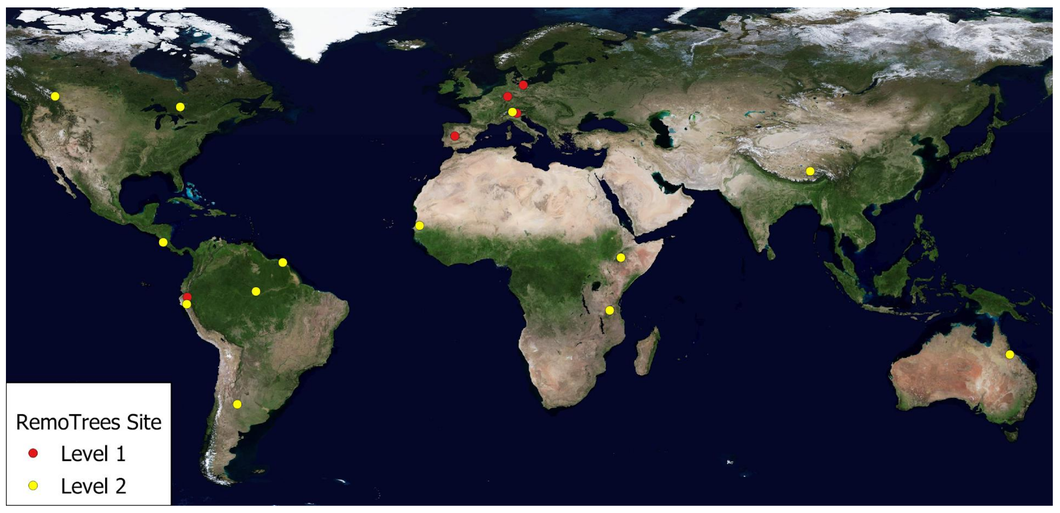
Diagram of RemoTrees device multi-sensor capabilities



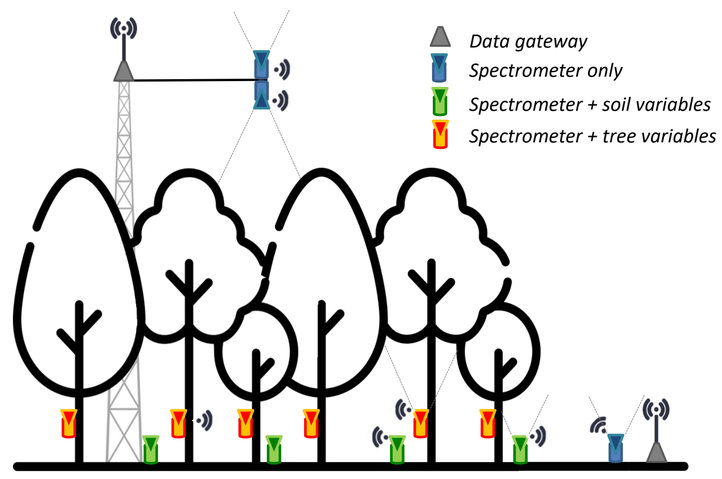
Forest sites network and field testing

RemoTrees device prototypes will be tested under field conditions at a number of preselected forest sites, categorized into:

- **Level 1**- easier to reach and with good **infrastructure**. At Level 1 sites, data collected from *beta* prototype devices will be **quality assessed** against a **benchmark** based on available **high-end instrumentation**.
- **Level 2**- **hard-to-reach**, located in boreal/high altitude, dry and wet tropical zones. Data from these sites will undergo a final scrutiny for system performance and calibration stability.



Geographic distribution of RemoTrees field test sites (above). A device installed on a tree stem and field set-up schematic showing devices deployment in a forest plot (below)



Data platform

A database resource, compliant to **FAIR principles**, will be designed and implemented to accomodate the data produced by the RemoTrees devices, considering also the **interoperability** and synchronization between in-situ and remote sensing systems according to **GEOSS requirements**. Data time series will be processed and **quality chec**ked and will be accessible through a specifically designed API.

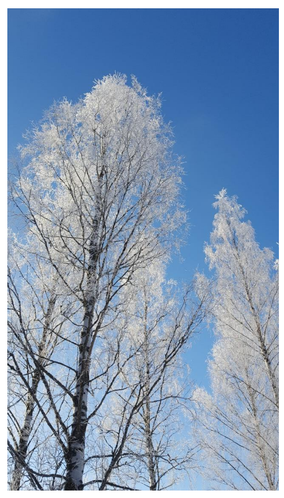
Integration with Copernicus

The **interoperability** within the whole Remotrees data platform will be pursued by **interfacing** it with **Copernicus Services** and **international validation programs**, in particular with the in-situ component and the Copernicus Land GBOV (Ground Based Observation for Validation).

Case studies

Case studies on **forest ecosystem services** and trees **eco-physiological responses to climate**, building on data produced by the RemoTrees systems and satellite products, will be developed to **assess climate change impacts on forests**.

We will investigate the pathways of **trees health parameters** which ultimately lead to their death under the pressure of **extreme climatic events**, as well as their recovery, to improve our understanding of **trees resilience**.



Project consortium

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https://remotrees.eu

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