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iTREE: Long-term variability of tree growth in a changing environment - identifying physiological mechanisms using stable C and O isotopes in tree rings.

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Trees play are a critical role in the carbon cycle – their photosynthetic assimilation is one of the largest terrestrial carbon fluxes and their standing biomass represents the largest carbon pool of the terrestrial biosphere. Understanding how tree physiology and growth respond to long-term environmental change is pivotal to predict the magnitude and direction of the terrestrial carbon sink.

iTREE is an interdisciplinary research framework to capitalize on synergies among leading dendroclimatologists, plant physiologists, isotope specialists, and global carbon cycle modelers with the objectives of reducing uncertainties related to tree/forest growth in the context of changing natural environments. Cross-cutting themes in our project are tree rings, stable isotopes, and mechanistic modelling. We will (i) establish a European network of tree-ring based isotope time-series to retrodict interannual to long-term tree physiological changes, (ii) conduct laboratory and field experiments to adapt a mechanistic isotope model to derive plant physiological variables from tree-ring isotopes, (iii) implement this model into a dynamic global vegetation model, and perform subsequent model-data validation exercises to refine model representation of plant physiological processes and (iv) attribute long-term variation in tree growth to plant physiological and environmental drivers, and identify how our refined knowledge revises predictions of the coupled carbon-cycle climate system.

We will contribute to i) advanced quantifications of long-term variation in tree growth across Central Europe, ii) novel long-term information on key physiological processes that underlie variations in tree growth, and iii) improved carbon cycle models that can be employed to revise predictions of the coupled carbon-cycle climate system. Hence iTREE will significantly contribute towards a seamless understanding of the responses of terrestrial ecosystems to long-term environmental change, and ultimately help reduce uncertainties of the magnitude and direction of the past and future terrestrial carbon sink.