



Conference Abstract

Carbon and Water Fluxes in a Temperate Scots Pine Chronosequence Study in Poland: An EC Measurement Story from an ICOS-Aspiring Country

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Abstract

Long-term measurements of greenhouse gases, and consequently the carbon, water, and nitrogen cycles, have been the focus of numerous studies for decades. Currently, the most accurate and widely used method for real-time, spatially-averaged estimates of these fluxes is the eddy covariance technique (EC). Over time, individual sites across Europe have been integrated into the Integrated Carbon Observation System (ICOS), creating a network with standardized measurement and data processing protocols, thereby producing high-quality, directly comparable results. Since forests play a major role in the land CO₂ sink both globally and in Europe, there is naturally a substantial number of forest EC sites within ICOS. However, there are still well-equipped research sites that, for various reasons, are not yet included in this network. A notable example is Poland, the ninth largest country in Europe by area (and seventh by population), which also marks the eastern border of the European Union.

In this presentation, we aim to highlight the most interesting results from a network of Scots pine forest sites in Poland, which have been measuring EC CO₂ and H₂O fluxes for periods ranging from a few to over 10 years. The primary goal is not only to share the

results of our analysis but also to explore new collaboration opportunities with the eLTER network to fully utilize the potential of our sites beyond greenhouse gas fluxes.

To provide context for why Scots pine (*Pinus sylvestris*) was chosen for the Polish network, it is the most widespread pine species globally and the second most distributed conifer after the common juniper (*Juniperus communis*). Its natural Euro-Asian range spans vast areas, and in Poland, Scots pine dominates 58.6% of the total forest area. Additionally, the mean age of Scots pine trees in Poland is 62 years, meaning that most of them are mature stands. After several years of continuous EC and basic meteorological measurements, complemented by carbon stock inventories in soil and biomass, we addressed the following research questions:

1. What is the nature of the relationship between the age of temperate, managed Scots pine stands, and their sequestration abilities (chronosequence approach)? At what age do these stands reach their maximum sequestration potential?
2. Does the classic forest inventory-based carbon accumulation in woody biomass align with the EC-derived Net Ecosystem Exchange estimates at both annual (based on dendrometers) and multiannual (forest inventory) scales?

Additional questions related specifically to the impact of different forest management practices on the carbon budget of temperate Scots pine forests were also explored and will be discussed here.

In conclusion, although the presented Scots pine EC sites are not yet part of ICOS, the results may be of significant interest to other forest site Principal Investigators (PIs) in this network. This comprehensive, long-term dataset on carbon and water flux exchange between the atmosphere and one of Europe's most common forest tree species holds relevance not only for climate-related impacts but also for socio-economic factors, as Scots pine is a crucial wood source species.

Keywords

eddy covariance (EC), carbon fluxes, Scots pine, chronosequence, greenhouse gases measurement

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Conflicts of interest

The authors have declared that no competing interests exist.