Dear Dr. Romano,

I finished my review of the manuscript egusphere-2026-2481 ("Linking hydrological responses in forest ecosystems to atmospheric forcing" by Martinetti et al.).

I posted the detailed comments on the EGUsphere discussion page. The structure is the usual one: General comments and Specific comments (Introduction, Methods, Results & Discussion, Summary & Outlook).

Please note that my comments mainly come from a hydrological perspective, focusing on the water fluxes, the interpretation of the impulse-response functions, and how the atmospheric forcing is transferred through the soil–plant system. I did not go deep into plant physiological details beyond what is needed for understanding the hydrological responses.

Overall the study is solid and relevant for HESS. Applying ERRA to high-frequency soil and tree water data gives some interesting insights into species differences and canopy–soil interactions. Still, a few points need clarification, especially the interpretation of some impulse responses, the geometric scaling, the use of Eaero measured outside the forest, and one missing reference.

Recommendation: **Moderate revisions**

Please let me know if any further information is required.

Kind regards,

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General comments

This manuscript presents a novel and timely application of the Ensemble Rainfall-Runoff Analysis (ERRA) framework to high-resolution measurements of soil and tree water fluxes and states in a mixed beech–spruce forest. The core idea — de-mixing and deconvolving the responses of multiple ecosystem variables to three correlated atmospheric forcings (precipitation, solar radiation, and aerodynamic evaporative demand E_{aero} — is scientifically sound and addresses a genuine challenge in ecohydrology.

The study is based on an impressive multi-year (2021–2025) observational dataset from a well-instrumented site. The figures are generally clear, the discussion is thoughtful, and the authors are appropriately cautious in interpreting weaker signals (e.g., sapflow response to precipitation). The paper is well written and fits the scope of HESS.

Nevertheless, Two aspects nevertheless require more careful treatment. First, E_{aero} is derived from a weather station located outside the stand. Below-canopy aerodynamic conditions differ

substantially from those in the open, and this mismatch may affect the magnitude and interpretation of the responses attributed to E_{aero}. Second, the conversion of dendrometer and sapflow signals into equivalent water fluxes rests on several geometric assumptions whose uncertainty is not quantified. While the timing of the responses is robust, the absolute magnitudes should be interpreted with greater caution.

Specific comments

Introduction

- The introduction correctly highlights the difficulty of isolating the effects of precipitation, radiation and E_{aero} because of their strong correlations and feedbacks. However, the text would benefit from a clearer statement of *why* sub-hourly resolution is essential here. Most of the cited pulse studies operate at daily scales, yet stomatal responses and the initial recharge of tree capacitance occur within minutes to a few hours. Making this temporal mismatch more explicit would strengthen the motivation for the high-frequency analysis that follows.
- The contrast between beech and spruce is central to the later results, yet the introduction only briefly mentions "species-specific plant physiology." A short paragraph that anticipates the known differences in hydraulic capacitance and stomatal regulation between these two species (isohydric vs. more anisohydric behaviour) would prepare the reader better for the species-specific impulse-response functions presented later.
- The sentence beginning "During times of high VPD or high solar radiation…" is long and could be split for clarity.
- The phrase "complicating efforts to predict transpiration and its effects on the water cycle" is slightly vague; specifying *which* effects (e.g., streamflow generation, groundwater recharge) would make the broader relevance sharper.

2. Materials and Methods

- The instrumentation is comprehensive, yet the number of trees equipped with sapflow sensors (3 beech, 4 spruce) and dendrometers (3 + 3) remains modest. While the stacking approach used for ERRA is statistically elegant, it would be helpful to discuss briefly whether the selected trees can be considered representative of the stand, especially given known intra-specific variability in sapwood depth and crown architecture.
- The calculation of E_{aero} from the weather station located ~150 m outside the forest is pragmatic, but the aerodynamic and humidity conditions below the canopy differ substantially from those in the open. A short note on the expected magnitude of this bias (or a reference to typical below-canopy reductions in wind speed and VPD) would help the reader judge how much the impulse responses to E_{aero} might be affected.

- Several response variables are converted into equivalent water fluxes (mm h^{-1}) using estimated xylem area, crown projected area and active-xylem circumference. These geometric factors are treated as constant scaling constants. Even if the temporal dynamics remain robust, the absolute magnitudes of the impulse responses inherit the uncertainty of these estimates. A brief sensitivity check or explicit statement that only relative comparisons are intended would strengthen the methods section.
- The joint Granier calibration for beech and spruce is justified by the similarity of the parameter values, yet a short comparison of species-specific calibrations (even if ultimately not used) would be reassuring.

Results and Discussion

- The contrast between beech and spruce in the timing and duration of the tree-water-content and sapflow responses is one of the strongest results of the paper. The longer recovery of spruce water storage after precipitation and the more prolonged sapflow response to radiation are consistent with higher hydraulic capacitance. However, the claim that these patterns directly reflect differences in passive versus active stomatal control remains somewhat speculative. A more cautious phrasing (or a clearer link to independent evidence of stomatal behaviour at the site) would strengthen this interpretation.
- The weak or near-zero short-term sapflow response to precipitation, while tree water content rises rapidly, is intriguing. The authors suggest that canopy wetting may temporarily reduce transpiration. An equally plausible alternative is that the first water taken up after a pulse preferentially refills capacitance below the sapflow sensor (roots and lower stem). Both mechanisms are possible; presenting them as competing hypotheses rather than favouring one would make the discussion more balanced.
- The damped oscillatory behaviour observed in the spruce responses to E_{aero} (especially under wet conditions) is potentially important. Linking it to lagged hydraulic equilibration of guard cells under passive stomatal control is interesting, yet the evidence remains indirect. It would help if the authors indicated whether similar oscillations appear in the raw time series or only after deconvolution.
- Soil responses to radiation and E_{aero} are essentially absent at the half-hourly scale and only become visible in the daily aggregates for radiation. This is a clean demonstration of canopy shielding. The interpretation would be even more convincing if the authors could provide a rough estimate of how much radiation and aerodynamic demand are typically attenuated below the canopy at this site (or cite typical values for similar stands).
- The daily-scale impulse responses of soil water content to precipitation show a peak on the day after the rain under dry conditions. The authors correctly attribute this to the combination of late-day rainfall and the use of daily averages of a derivative. Figure C15 illustrates the artefact well. It would be useful to state explicitly in the main text that this lag is largely an aggregation artefact rather than a physical delay in infiltration.

- Figures 4 and 5 are central to the paper but are visually dense. The empty versus filled markers for dry versus wet conditions are sometimes difficult to distinguish, especially in the lower panels. Adding a consistent legend to each multi-panel figure (or using colour in addition to symbol type) would improve readability. Captions are also quite long; some methodological detail could be moved to the Methods or Supplementary Material.

4. Summary and outlook

- The canopy-shielding argument in Section 4.2 is one of the most compelling parts of the paper. The physical reasoning (radiation interception, reduced wind speed, elevated humidity and lower temperature beneath the canopy) is sound and clearly explained. The observation that short-term soil responses to radiation and E_{aero} are essentially absent, while daily-scale responses to radiation become detectable, is a clean and valuable result. I would only suggest that the authors state more explicitly that the daily-scale soil drying signal is the integrated consequence of root water uptake rather than a direct atmospheric effect on the soil surface.
- The interpretation that soils “buffer” sapflow from precipitation forcing, while tree water content responds rapidly, is interesting but can be read in two ways. The present text slightly favours the canopy-wetting explanation. Presenting the alternative (preferential refill of below-sensor capacitance) with equal weight would make the discussion more complete and would better reflect the limits of the current sensor placement.