Reply to comment by Dr. Vesala regarding HESS Manuscript
https://egusphere.copernicus.org/preprints/2025/egusphere-2025-2814

A. S. Kowalski

At Dr. Vesala's request, I have reread Sections 17.7 – 17.9 of *Transport Phenomena* by Bird, Steward and Lightfoot (2002). If I am not mistaken, these authors motivate the use of a mole-based framework to facilitate the quantification of chemical reactions, but note that a mass-based framework is "preferable" when the diffusion equations are solved together with the equation of motion. In my view, the mass-based framework is not merely preferable but actually essential to respect the key role played by inertia in Newton's laws. My reply to the comment by Dr. Roderick shows that the differences between the two frameworks are not negligible over a range of water temperatures that is relevant to the Earth's hydrological system.

Vilà-Guerau de Arellano et al. (2025) define the mole-average velocity of the mixture (u) in their Eq. (5), and then in their Appendix C refer to "the governing equations for u (Navier-Stokes equation)". However, I do not believe that the Navier-Stokes equations govern mole-average velocities. To my mind, defining a mechanical velocity as the mole-average velocity seems incorrect in general. In this sense—for my example involving no net argon transport—it seems to me that both the "diffusive transport" due to a mole-fraction gradient and the "Stefan flow (ternary effect)" required to counterbalance it are artefacts of an invalid basis for quantifying motion.

Maybe it is overly optimistic on my part, but I hope that "shooting off" might mean: defending the centuries-old principles of classical mechanics established by Sir Isaac Newton.

References

Bird, R. B., Stewart, W. E., and Lightfoot, E. N.: Transport Phenomena, John Wiley & Sons, Cambridge, 2002.

Vilà-Guerau de Arellano, J., Dewar, D., Faassen, K. A.P., Hölttä, T, de Kok, R., Luijkx, I.T. and Vesala, T., Technical note: New insights into stomatal oxygen transport viewed as a multicomponent diffusion process, Biogeosciences, 22, 6327–6341, https://doi.org/10.5194/bg-22-6327-2025, 2025.