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Increasing complexity in Aerodynamic Gradient flux calculations inside the roughness sublayer applied on a two-year dataset

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Over tall canopies such as forests the atmospheric surface layer is subdivided into an inertial sublayer (ISL) and a roughness sublayer (RSL). Inside the RSL the classic aerodynamic gradient method using Monin-Obukhov similarity theory (MOST) by itself does not represent the gradient well and is insufficient to calculate fluxes. Over the past decades multiple studies have proposed methods to extend MOST to account for the different turbulent conditions, containing a wide range of approaches and complexity. In this study we investigate how much complexity is necessary to calculate the flux more accurate and what we can learn from the respective complexity. A large dataset is required to assess the statistical robustness of the respective complexity during different environmental conditions. To this end, we study and apply the effect of forest roughness and directional heterogeneity in our flux calculations on a two-year dataset (2009-2010) of the sensible heat flux measured over a Douglas fir forest in the Netherlands. We apply standard MOST, an observational based method (the α-factor) and a physically based method (Harman and Finnigan, 2007, 2008) (hereafter HF07/08) together with a range of methods for the displacement height (d). Our results show that both a simple method (the α-factor) and a complex method (HF07/08) are able to more accurately represent the flux but that, as expected, standard MOST (regardless of the method estimating d) alone is insufficient. Both the α-factor and (HF07/08) allow to analyze large scale patterns in canopy turbulence. Differences between the methods lie in the level of detail and practical usability.