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A composite smeared finite element for mass transport in capillary systems and biological tissue

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One of the key processes in living organisms is mass transport occurring from blood vessels to tissues for supplying tissues with oxygen, nutrients, drugs, immune cells, and - in the reverse direction - transport of waste products of cell metabolism to blood vessels. The mass exchange from blood vessels to tissue and vice versa occurs through blood vessel walls. This vital process has been investigated experimentally over centuries, and also in the last decades by the use of computational methods. Due to geometrical and functional complexity and heterogeneity of capillary systems, it is however not feasible to model *in silico* individual capillaries (including transport through the walls and coupling to tissue) within whole organ models. Hence, there is a need for simplified and robust computational models that address mass transport in capillary-tissue systems. We here introduce a smeared modeling concept for gradient-driven mass transport and formulate a new composite smeared finite element (CSFE). The transport from capillary system is first smeared to continuous mass sources within tissue, under the assumption