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3D Thermomechanical models with surface processes: state of the art and current challenges

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Surface processes including erosion, transport and sedimentation have the potential to strongly influence crustal and lithospheric deformation whether passively, through isostatic response, or more actively by affecting the thermal structure, the potential energy field, and / or the local stress field. Thermo-mechanical models have proven to be valuable tools to understand the processes involved during deformation of the lithosphere. Coupling state of the art thermo-mechanical models to surface processes model is however not without challenges. We present a series of 3D thermomechanical models in extensional (Rifting), compressional (Orogenic) and transcurrent (Pull Apart) contexts. Effects of erosion and sedimentation is included by coupling Underworld models to the surface processes code Badlands. We explore the interactions and feedback between the tectonics, controlled by the rheology of the lithosphere, and the removal or deposition of material at the surface. We show that active surface processes may, at least locally, influence the deformation and alter the structural evolution of the system either by affecting the development, distribution and timing or faults or by influencing the flow of material in the viscous part of the lithosphere. We discuss the technical challenges that need to be addressed to satisfactory render the complex interactions occurring over ranges of spatial and temporal scales.