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Seasonal thermal structure variations of Lake Geneva using 3D finite element modeling

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A three-dimensional finite element model with the capacity to simulate water movements and temperature structure was applied to Lake Geneva (Switzerland and France). The finite element grid, joined with bathymetric data, has a resolution of 8149 triangular elements and 4553 nodes covering the two sections of the lake: “Petit Lac” (70m maximum water depth) and “Grand Lac” (309m maximum water depth). The aim of this work was the investigation of processes of water exchange between two basins and hydrodynamical - thermal structures that occur during a year in the Lake Geneva using a numerical tool. Model code solves conservation equations for mass, momentum and temperature transport, which provide water temperature, current velocities and current directions. The model was run for a one-year period (year 2005) with continued meteorological data: wind speed and direction, air temperature, incident solar radiation, relative humidity, precipitation and cloud cover factor; and hydrological data: tributary discharge and temperature. This paper mainly investigates temperature structure of the lake during a one-year cycle; however, it also shows the relationship between current regimes and thermal structure. Temperature vertical profiles and horizontal distribution derived from the model were analysed and compared with field data. The application of the 3D numerical model allows investigating the seasonal evolution of the thermal regime, the thermal stratification, accumulation and release of heat and the winter mixing within and between the two lake basins. The model results integrated with the historical knowledge about the hydrodynamical processes in the Lake Geneva allowed to better investigate the variability of these phenomena during the year and the differences between the responses of the two sub-basins water masses.