Subsurface flows of solar active regions

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Mass flows below the solar surface are likely to play significant role in evolution of solar active regions, their magnetic topology and dynamics. Recently, new methods of local helioseismology have provided three-dimensional maps of subsurface flows in active regions. These maps have revealed a great variety of complicated flow patterns of various scales. In particular, local helioseismology discovered around active regions large-scale circulation flows, converging in the upper convective layer and diverging at greater depths. These persistent flows affect the global meridional circulation on the Sun and magnetic flux transport during the solar cycle. These flows may also influence the convective energy transport and large-scale zonal flows - 'torsional oscillations'. Another class of subsurface flows, associated with horizontal vortices, is probably important for twisting magnetic field of active regions and generating magnetic helicity. In addition, local helioseismology has found initial evidence for strong shearing flows below flaring active regions, which may be significant for initiation of solar flares and CMEs.