Local helioseismology consists of methods which study the propagation of the waves through the solar interior. The properties of the waves encode conditions in the plasma along their propagation trajectories. Local helioseismology allows us to learn about these conditions.

The principal method utilised in this thesis is the time-distance local helioseismology. The time-distance method is based on measurements of travel times of the waves, hence it is sensitive especially to plasma flows and sound-speed perturbations, to which we focus. We utilised the inverse modelling, mainly using subtractive optimally localised averaging method with a minimisation of the cross-talk. This method was modified to allow for a simultaneous inversion of vector flows and sound-speed perturbation. This combination makes use of both the difference and the mean point-to-annulus averaging geometries of wave travel times in both the ridge and the phase-speed filtering approaches. The combined inversion provides us with more information about the inverted quantities. Moreover, the user can control the cross-talk and other important mathematical properties of the objects involved.

The modified methodology was thoroughly tested. The main results may be summarised in five points. First, for successful inversions of the sound-speed perturbations it is necessary to minimise the cross-talk. Our results show that the separate inversions for sound-speed perturbations seen in literature are possibly highly affected by a cross-talk contribution, which artificially boosts the magnitude of the inverted sound-speed perturbations by a factor of about two. Second, the inference of the complete vertical flows is possible when both the mean and the difference geometries are taken into account. Before, only inversions for spatial variations of the vertical flows were possible. Third, for the successful inversion for vertical flows it is absolutely necessary to minimise the cross-talk, otherwise the cross-talk from horizontal flows spoils the inversion completely. Fourth, due to noise regularisation one cannot invert for vertical flows at depths larger than about 2 Mm with data averaged over 1 day. Fifth, we confirmed the state-of-the-art models of horizontal flows in supergranular regions. The models predict, and our inversions confirm the strong horizontal divergent flows in the supergranular centre, which get weaker at larger depths. Furthermore, we detected a trend in the longitudinal flows. This trend is consistent with the model of solar rotation.

At the end of the thesis, we briefly introduce new travel-time measurement geometries. These consist of one-sided arc geometries, which may be useful in active regions or anywhere, where the amplitude of the waves is affected by mode conversion.