3D Coronal Magnetic Field Inversion: from UCoMP toward DKIST

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Due to the low optical density of the coronal atmosphere, the inference of the physical properties of the corona are constrained by the entanglement of coronal signals due to the integration over line of sight (LOS), except for localized emission sources (bright loops in active regions). To disentangle the LOS integrated signals, the tomographic inversion is needed. Tomography is the determination of the structure of a 3D object using measurements of line-of-sight integrated signals obtained from many different viewing directions. The reliability of the vector field tomographic inversion has been investigated by numerical experiments that showed that the vector tomography can recover the orientation and, with less accuracy, amplitude of the field vector with only linear polarization (LP) data and photospheric magnetic field boundary conditions, and with higher accuracy than the PFSS model. We applied the vector tomography inversion to the Upgraded Coronal Multi-channel Polarimeter (UCoMP) which observes linear polarization (LP) of the Fe XIII 10747 A coronal emission line (CEL) with a wide field of view (FOV) covering almost the whole lower solar corona. The additionally required 3D coronal electron density and temperature were obtained by scalar field tomographic inversion of STEREO/EUVI observations. Therefore, we have obtained 3D vector magnetic field, electron density, and temperature which will allow us to plot 3D maps of free magnetic energy, plasma beta, and current (curl B). Particularly, the preliminary inversion result shows a larger value the magnetic field strength than for MHD model used as the starting conditions for the inversion. As supplementary to LP data, the circular polarization (CP, Stokes-V) provide information about the LOS projected field strength. We demonstrate that the CP observations by the DKIST Cryo-NIRSP and DL-NIRSP will further constrain the solution and provide a more realistic coronal magnetic field than PFSS models.