Reproduction of solar near-surface shear layer, poleward meridional flow, and fast equator with super-high-resolution simulation

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We carry out an unprecedentedly high-resolution simulation for the solar convection zone to understand flow structures, especially around the solar surface.
Hotta & Kusano (2021) for the first time reproduce the solar-like differential rotation, i.e., the fast equator with a high-resolution simulation without using any manipulation. In the calculation, the top boundary is at 0.96Rsun from the solar center (Rsun is the solar radius). The final 4% in the radius is a numerically difficult layer where the convection spatial and time scale is small. At the same time, this layer is observationally important since there is a prominent shear layer of the differential rotation, and poleward meridional flow is confirmed with many observations while the flow structure in the deeper layer is still controversial.
In this study, we raise our top boundary to 0.99Rsun and increase the resolution. We, for the first time, succeed in reproducing all the flow structures, i.e., the near-surface shear layer, poleward meridional flow, and the fast equator. We revealed that complicated interactions between turbulence and magnetic field nicely reproduce these features.
The fast equator and the near-surface layer are mainly maintained by the magnetic field, while the poleward meridional flow is caused by turbulence. In our presentation, details of the mechanism are explained.

Keywords: Sun, Magnetic field, Thermal convection

