To measure the estimation quantitatively, the estimation errors in terms of Monte Carlo averaged OSPA distance are shown in Figs. 6 and 7. For position estimation, the cut-off value \( c \) is five times the size of the range cell. For velocity estimation, the cut-off value \( c \) is two times the size of the velocity cell. It is shown that the shrinkage-PHDF estimates target position and velocity on all tracks with higher estimated precision than the MPF, because MPF requires a modeling setup to accommodate varying numbers of targets, which is very difficult to accomplish in reality. It also shows that the performance of shrinkage-PHDF is better than PHDF, which is discussed further below.

**Fig. 6** Comparison of the estimation errors of position given by the Monte Carlo-averaged OSPA miss distance with a measurement resolution \( R=50 \) m.

**Fig. 7** Comparison of the estimation errors of the velocity given by the Monte Carlo-averaged OSPA miss distance with a measurement resolution \( D=25 \) m/s.