Energetic upflowing ionospheric O$^+$ ions are believed to play an important role in the dynamics in the different regions of the magnetosphere, including the ring current. In this study, we use single-particle trajectory simulations in conjunction with Akebono ion measurements and related IMF and ionospheric convection data to investigate the role of thermal O$^+$ ions at quiet times preceding magnetic storms, as a source of heavy ions in the “pipeline” from the ionosphere to the ring current via the plasma sheet. Our study shows that the up-flow of the observed ions and their centrifugal acceleration at higher altitudes results in a low but non-negligible flux of low-energy O$^+$ ions in the pipeline. The flow is enhanced and confined to lower L-shells at times of strongly southward IMF, compared with that at times of northward IMF. Its flow rate to the plasma sheet is found to correlate strongly with the ion temperature. As a result and despite its relatively low flux, it constitutes a significant “in-transit” population of oxygen ions between the ionosphere and the inner magnetosphere in the quiet-time period preceding a magnetic storm, which is poised to potentially influence the dynamics of the plasma sheet and the ring current at the onset of a storm.