Theoretical results on the latitude dependence of the Kelvin-Helmholtz instability at the dayside magnetopause for northward interplanetary magnetic fields
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We study the Kelvin-Helmholtz (KH) instability at the dayside magnetopause, modeling the flow, the magnetic field, and the density profiles in the transition from magnetosheath to magnetosphere with hyperbolic tangent functions. The strength and the direction of the fields on the sunward sides of the magnetopause are obtained from a MHD simulation code of the magnetosheath, which includes the magnetic tension forces on the plasma in the plasma depletion layer. The theory is applied to strongly northward interplanetary magnetic fields. We work at slightly off-noon local times and compute at three different latitudes. We find that as the latitude increases the instability growth rate becomes negligible due to the increasing local magnetic shear, which reaches ~21° at the highest latitude examined. The KH growth rates for the most unstable modes are given as functions of $\lambda/\Delta$, the ratio of the wavelength to the width of the transitions. The KH perturbation tends to be localized on the magnetospheric side when the configuration is most unstable, whereas it shifts increasingly toward the magnetosheath side of the velocity gradient region as the latitude increases and the growth rate diminishes substantially. Growth rates for a tangential discontinuity model are within a 10% of those corresponding to continuous profiles when $\lambda>15\Delta$. The influence of temporary (sunward or earthward) accelerations of the magnetopause on the KH modes is examined. The effect of a difference between the scale length of the density profile and the width of the current sheath on the KH instability, as in pristine magnetopause, is also studied.