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Global hybrid simulations: Foreshock morphology

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We perform global hybrid (kinetic ions, fluid electrons) simulations of the solar wind coupling with a magnetized planet and study foreshock morphology and its influence on the bow shock and magnetosheath. The advantage of the hybrid code over fluid codes is that it treats ionscale microphysics in the context of the global interaction. We study the characteristics of the ultralow frequency (ULF) waves generated by kinetic instabilities and find two types of waves, (1) noncompressive parallel propagating waves and (2) compressive obliquely propagating fluctuations. In contrast to suggestions made in the past we show that compressive waves do not evolve from the noncompressive wave population, but rather are generated by a different ion population. We find that the noncompressive waves are generated by field-aligned backtreaming ions, while the compressive waves are generated by gyrating ion beams closer to the shock. As compressive waves convect into the quasi-parallel region they evolve into large structures, steepen and form the shock transition. These waves play an active role in the shock dissipation processes and eventually form part of the wave spectra observed in the magnetosheath. We show that variations of IMF geometry have a deep influence on foreshock morphology, on magnetosheath structures and on the way that the plasma is heated and compressed. Finally, comparison of simulation results with observations is presented.