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Global distribution of ion temperature and ULF wave activity in the magnetosheath from joint Cluster and THEMIS observations

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We present a multi-spacecraft statistical study of the terrestrial magnetosheath, focusing on large scale asymmetry in plasma parameters and properties of associated low frequency plasma waves. The study is based on conjunction events when Cluster and THEMIS spacecraft were simultaneously sampling opposite flanks of the magnetosheath. We show that ion temperature anisotropy $T_{\perp}/T_{||}$ is often strongly asymmetric with respect to the Sun-Earth line. Tracing the plasma flow from the spacecraft location back to the bow shock suggests that the ion temperature anisotropy depends strongly on the local shock parameters (shock strength and the angle Θ_{BN} between shock normal and upstream magnetic field) even relatively deep in the magnetosheath. The global distribution of the ion temperature itself is however more symmetric and shows less dependence on Θ_{BN}. We also investigated the asymmetry and spatial distribution of the occurrence of mirror and ion-cyclotron waves in different regions of the magnetosheath. The Alfvèn-ion-cyclotron (AIC) waves are found to be the dominant low frequency mode in the magnetosheath region close to to the bow shock. Mirror mode structures are more frequently observed deeper inside the magnetosheath, from intermediate radial distances to the magnetopause. The transition between regions dominated by AIC and mirror waves also depends strongly on Θ_{BN} parameter of the associated bow shock. The statistical results are compared to the predictions of Rankine-Hugoniot relations and thresholds of ion-cyclotron and mirror instabilities.