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Transport
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Long-term cosmic-ray modulation a comparison of the 1D full transport equation and the force-field approximation

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The local interstellar spectrum (LIS) has not been directly measured and has to be estimated from cosmic ray intensity measured in the solar system. Cosmic rays have been analyzed with instruments onboard spacecraft, balloons, and at ground since the 1930s. This period, however, is characterized by high solar activity and hence strong cosmic ray modulation. Therefore estimating the unmodulated spectrum, i.e. LIS, is difficult. Several LIS exist in literature and the true LIS is not known yet. Going back to periods of low solar activity and weak cosmic ray modulation may help. This can be done with cosmogenic radionuclide records, which cover the past about 10,000 years including several periods of low solar activity. Here we analyze a longterm reconstruction of the force-field parameter (solar modulation potential) mainly based on ^{10}Be from the GRIP ice core based on the LIS by Garcia-Munoz et al.(1975). This reconstruction shows several periods of negative and very low modulation, which would mean that particles are accelerated to the Sun. As discussed in Herbst et al.(2010) the modulation parameter depends on the LIS. They show that using the LIS by Webber and Higbie(2003) and (2009) would lead to more negative values and using the LIS by Langner et al.(2003) and Usoskin et al.(2005) would give larger, i.e. more positive, values. Besides the LIS other reasons for negative values exists such as uncertainty in geomagnetic dipole field strength reconstruction, in ^{10}Be measurement, in ^{10}Be production calculations, in ^{10}Be transport and source regions, and in force-field approximation. We test the sensitivity of modulation parameter due to LIS and these points and find that uncertainty in geomagnetic field and LIS are most important. A second modulation parameter reconstruction based on ^{14}C and the LIS by Usoskin et al.(2005) shows a slightly other long-term trend as the ^{10}Be based reconstruction. However, also this reconstruction rejects the LIS by Webber and Higbie(2003) and (2009). From both reconstructions we conclude that the LIS by Usoskin et al.(2005) and Langner et al.(2003) are most likely.