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Ground-based magnetometer arrays in space research: A brief review

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Ground magnetometer studies have a long tradition in space research, starting with works by Gauss in the 19th century. From single station analysis of analogue instruments, via meridional chains, the use of magnetometers has proceeded to arrays of fully digital and automatic instruments with time resolutions of the order of seconds.

After a short historical introduction, this presentation gives a brief overview of the use of such modern magnetometer arrays in present-day space research. We present analysis examples from the IMAGE magnetometer network in Fennoscandia, the mesoscale network with the highest instrument density in the world, and from the Themis and associated magnetometer networks in Northern America, which together span up the worldwide largest region with a regular magnetometer coverage. State-of-art analysis techniques such as the Spherical Elementary Current System (SECS) technique for processing magnetometer data are introduced, with examples for the separation of internal and external magnetic field disturbances, and for the calculation of ionospheric equivalent currents. When these results are combined with data from ionospheric coherent scatter radars, such as STARE or SuperDARN, or with data of low-orbiting satellites, such as CHAMP, the full three-dimensional ionospheric current systems can be derived. A combination with magnetospheric satellite missions, such as Cluster or Themis, provides insight into the magnetosphere-ionosphere coupling. As result examples, we will present both statistical results of current systems, as well as event studies in conjunction with satellites, where the processed magnetometer data results provided knowledge of the geospace environment on a larger spatial domain and over a longer time period than satellite data can provide. Further, we will present some examples of the use of magnetometer arrays as long-term data sets monitoring changes of the Earth's geomagnetic field and the solar-terrestrial environment.