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The mesospheric sodium layer as a remotely, optically pumped magnetometer for investigation of Birkeland currents

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By means of optical pumping, it is possible to use the naturally occurring sodium layer in the mesosphere to measure Earth's scalar magnetic field at ∼90 km above ground. This is an altitude not accessible by other means than rockets, which only will provide point measurements of very short time scales. We are planning to modify the sodium lidar at ALOMAR in Northern Norway to be able, for the first time, to measure and monitor the magnetic field in situ in the high latitude mesosphere over longer time scales. The planned modifications to the lidar instrument will allow alternating between the new magnetometer mode and its present mode for atmospheric temperatures and winds. The technique, which has been proposed earlier for measurements at low or mid-latitudes for studies of Earth's internal magnetic field, will in our project be applied to high latitudes in the auroral zone. This opens for a completely new domain of measurements of externally generated geomagnetic variations related to currents in the magnetosphere-ionosphere system.
In particular, we aim to measure the magnetic field variations in close vicinity to Birkeland currents associated with particle precipitation events penetrating to altitudes below 90 km and small-scale, discrete auroral arcs. It is, furthermore, anticipated that it will be possible to detect horizontal current structures in the E-layer on much smaller length scales than it is presently possible from ground observations alone. During the project we plan take advantage of the rich space science infrastructure located in northern Norway, including ALOMAR, EISCAT and the Tromsø Geophysical Observatory magnetometer network. If possible, we also aim to make measurements in conjunction with overpasses of the SWARM satellites.