Contribution ID: **77** Type: **Oral Presentation**

EISCAT_3D: Extreme computing and network in the Arctic

Wednesday, 26 August 2020 11:00 (30 minutes)

EISCAT, originally the European Incoherent Scatter Scientific Association, was established in 1975 as a collaboration between Norway, Sweden, Finland, UK, Germany and France. The purpose was to develop an incoherent scatter radar for the Northern auroral zone. EISCAT has been operational since 1981 and has grown to a globally used research infrastructure. The present members are Norway, Sweden, Finland, UK, China and Japan. The existing EISCAT radars are single beam systems with parabolic dish antennas.

EISCAT has now started to construct the next generation imaging incoherent scatter radar, EISCAT_3D. This will be a system of distributed antenna arrays with fully digital signal processing that will enable comprehensive three-dimensional vector observations of the atmosphere and ionosphere above Northern Fenno-Scandinavia. Through the use of new technology based on the latest advances within digital signal processing, it aims to achieve ten times higher temporal and spatial resolution compared to present radars.

The Nordic e-Infrastructure Collaboration (NeIC) facilitates development and operation of high-quality e-Infrastructure solutions in areas of joint Nordic interest. NeIC is a distributed organization consisting of technical experts from academic high-performance computing centres across the Nordic countries. The NeIC EISCAT_3D Data Solutions (E3DDS) project supports the EISCAT_3D project
This project cooperates with national e-infrastructure providers in the EISCAT_3D participating countries in order to simulate the data flows at the radar receive sites and from the sites to the central data storage and computing.

On each of the three EISCAT_3D radar receiver sites will be 109 sub-arrays of 91 antennas each, each with a first stage beamformer, based on FPGA technology, to form 10 wide-angle beams at two polarizations. Subsequently, the wide-angle beam data packets from each sub-array will be stored in a fast RAM memory
buffer and combined into 100 narrow-angle beams by a second stage beamformer on the site level. Data from each site will be sent to a storage buffer at a central site. At this central site, computing capacity connected to the storage buffer will combine the site data to form spatially resolved data products. The operational modes of the EISCAT_3D radars may be affected or controlled by results produced at the central site. Quality-checked final data products will be sent to long-term storage at data centres. This data is subsequently served to the EISCAT_3D users for further analysis.

The E3DDS project has facilitated a proposal for a novel extreme high-capacity wide-area network deployment in order to optimize the deployment of online and offline computing facilities. Concentration of the high-value computing resources will allow to solve the online and analysis problems. A re-arrangement of the computing resources, permitted by an improved WAN network, will allow a greater capacity, improve the use-ability and reduce the operational costs. The E3DDS project is cooperating in the acquisition, installation and operation of a first and second stage beamformer test cluster consisting of an EISCAT_3D first-stage receive unit and state of the art test server. This test programme is expected to expand to a national partner-hosted test cluster connected to the Nordic WAN.

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Session Classification: Joint DMCC & UND Workshop

Track Classification: Earth/Environmental Sciences & Biodiversity Applications