SuperDARN plan for Phase X JARE project and beyond

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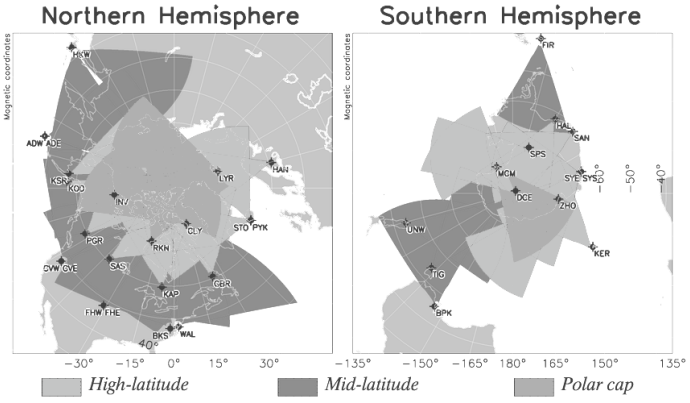
SuperDARN (Super Dual Auroral Radar Network) is an international high-frequency coherent radar network established in 1995. More than 35 radars are currently distributed from middle to polar latitudes in both hemispheres and running and operated by more than 15 research institutions in about 10 countries. One of the original main scientific goals was to obtain real-time global plasma convection and electric field potential maps not in a statistical manner, which had never been done before, to contribute primarily to space weather research. It can also address many aspects of scientific questions on global upper atmosphere including neutral atmosphere and its coupling with ionised atmosphere, influence of geospace on lower atmosphere and possible global climate change, plasma physics, and practical applied physics including space weather nowcast/forecast. NIPR has joined the SuperDARN project since its establishment in 1995 and run 2 SENSU SuperDARN radars, that is, Syowa South and Syowa East radars in Antarctic Syowa station (69.00 S, 39.58 E) in polar auroral zone. Both radars have substantially contributed to the international project and scientific researches, e.g., studies on auroral phenomena and storms/substorms, geomagnetic pulsations, precise neutral wind around mesopause region using meteor echoes, studies on polar mesospheric summer echoes (PMSEs), magnetosphere-ionosphere-neutral atmosphere vertical coupling, studies on influence of low solar activity or grand minimum on geospace space weather.

Long-term plan-making of next Phase X 6-year JARE project (JARE 64-69, 2022-2028) started practically last year especially on Prioritized Research Projects and long-term monitoring observation. Many proposals were presented at the last NIPR Symposium on Polar Science in Dec., 2019, where we proposed SuperDARN observation plan as one of the key components contributing mainly to the new space weather / space climate research project proposed by Kataoka et al., which tries to reveal geospace high energy particle impact on earth's atmosphere with cosmic ray observation and new spectral riometer etc, and also to understand geospace environment quantitatively under lower solar activity where polar cap region observation, such as optical imager network in Antarctica, is essential and important for understanding and predicting geospace under recently started lower solar activity condition after about a half-century long high solar activity period in collaboration with theoretical and simulation studies. In the proposal, SuperDARN is characterised as one of the important tools to provide global ionospheric condition to contribute to the research.

We have devoted much time to new space weather and upper atmosphere research with SuperDARN, and our international community has published several tens of cutting-edge scientific papers every year continuously since 1990s. Moreover, "Space weather maps" - global ionospheric convection and electrical potential maps - with high temporal resolution (of about 1 to 2 mins typically) obtained from the international network data (in quasi-real time) have been widely utilised for a variety of space weather researches and prediction works and the number of papers citing SuperDARN has also almost monotonically increased and have exceeded more than 1000 papers per year recently (meaning h-index of SuperDARN as a community is more than 40). The number of research groups, HF radars joining SuperDARN and its total fields-of-view covering upper atmosphere has also grown. Hence this basic data obtained with SuperDARN has been more important nowadays, which means it is of a great importance to keep this observation stably in a long term basis and to provide the basic valuable data to the community. We have taken into account these two aspects of this observational research, and reached a conclusion that we should position SuperDARN observation as an essential long-term scientific monitoring observation since the coming phase X JARE project for long-term stable contribution to a wider coverage of researches and applications, which can also contribute to the prioritised research project on space weather and space climate researches. We plan to complete upgrade of the current conventional log-period antenna array which required laborious maintenance with human and financial resources to mostly maintenance-free wire-type log-periodic antenna array as well as upgrade of old transmitters to new stable transmitters also for long-term stable operation in close engineering and technical collaboration with NICT and Nagoya Univ./ISEE groups.



Fields of view of SuperDARN radars in both hemispheres as of 2019 (Courtesy of Virginia Tech SuperDARN group at vt.superdarn.org).