FUTURE CONTRIBUTIONS OF THE AMISR FACILITIES. R. H. Varney[1], A. N. Bhatt[1], M. J. Greffen[1], and P. R. Reyes[1] [1]SRI International, 333 Ravenswood Ave, Menlo Park CA, 94025, roger.varney@sri.com.

Introduction: The Advanced Modular Incoherent Scatter Radar (AMISR) facilities support a wide array of research areas including magnetosphere-ionosphere coupling, auroral plasma physics, radio propagation and scintillation, polar cap density structures, atmospheric waves, energetic particle precipitation, and meteor science. They were the first incoherent scatter radars specifically designed for NSF-supported basic research in atmospheric and geospace science, and the first large-scale electronically steerable phased arrays commissioned by the NSF. Three full-scale AMISR systems were built and deployed early this century: the Poker Flat Incoherent Scatter Radar (PFISR) in 2007, the Resolute Bay Incoherent Scatter Radar North (RISR-N) in 2009, and the Resolute Bay Incoherent Scatter Radar Canada (RISR-C) in 2015, with RISR-C being supported by the Canadian Foundation for Innovation. The facilities frequently coordinate observations with national and international satellite missions and sounding rocket missions launched from the Poker Flat Research Range.

Research and Educational Priorities: Continuation of the operation of the AMISR facilities will have many benefits to the geospace community.

Coordination with Future Misions. Geospace research benefits from careful coordination between ground-based and space-based assets, and the continued development of the Heliophysics System Observatory should emphasize opportunities for coordination. In the next decade NASA is scheduled to launch several significant missions in high-latitude LEO orbits that will make frequent conjunctions with the AMISRs. These include the Tandem Reconnection and Cusp Electrodynamics Reconnaissance Satellites (TRACERS), the Electrojet Zeeman Imaging Explorer (EZIE), and the Geospace Dynamics Constellation (GDC). Ground-based incoherent scatter radars can complement space-based measurements with observational capabilities that are impractical from LEO orbit, including altitude-resolved profiles of parameters, continuous observations of a fixed geographic region, and volumetric imaging of a fixed geographic region. These capabilities provide researchers with incisive tools for resolving the space-time ambiguities inherent in the interpretation of data from LEO platforms.

Long-Term Datasets: The AMISR systems are capable of unattended long-term operations. PFISR has run nearly continuously since 2007 using a low-duty-cycle background mode between user-requested experiments. Furthermore, low-duty-cycle operations have become more feasible with RISR as a result of power generation infrastructure investments starting in 2018. Nearly continuous operation of the facilities enables serendipitous observations of rare or unforeseen events and generates large databases suitable for large-scale statistical studies. The geospace community is increasing embracing machine learning techniques alongside conventional statistical analysis methods. Extension of the existing AMISR datasets to cover another solar cycle along with attention to the curation of analysis-ready data will expand the impact of these facilities beyond what has historically been possible.

Education and Workforce Development. The sustained intellectual and broader impacts of geospace research requires the continued development of highly qualified personnel, including personnel with expertise in phased array radar. The next generation of geospace facilities will almost certainly employ phased array technology, and the weather radar community is also moving towards phased arrays. Additionally, phased arrays are increasingly important in the defense and commercial sectors, especially as space traffic management concerns escalate in the age of proliferated LEO constellations. As currently operational electronically steerable phased array radars dedicated to basic research, the AMISRs are an ideal platform for the continued education of highly qualified personnel. Continuation of the AMISRs in the near to medium term can serve as a bridge towards future facilities in the long term.

Need for Reinvestment: The modular design of the AMISR radars gives them very few risks of single-point failures and makes them degrade gracefully. Nonetheless, the AMISRs were originally designed for a nominal 20-year lifetime, and the existing facilities are approaching that threshold. Of particular concern has been the steady loss of solid-state power amplifiers (SSPAs) over time. The continued scientific productivity of the facilities over the next decade will necessitate the manufacture and replacement of large numbers of components. We estimate that this effort will be on the order of an NSF Mid-scale level-1 facility effort, which will be worthwhile considering that the construction of entirely new facilities with comparable capabilities to the AMISRs would be at least a Mid-scale level-2 scale of investment and much higher risk.

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