Description of federally-supported project requiring this application

This license is being sought in pursuit of the research project AGS-1360718 being carried out by Cornell University, Clemson University, and the University of the Virgin Islands with support from the National Science Foundation of the U.S. The work uses a small research radar system on St. Croix to support experiments at the Arecibo Radio Observatory nearby in Puerto Rico. Research of this kind was performed for many years under the experimental license WE2XKG. The abstract for the NSF proposal behind this project is given below.

This is a proposal to investigate midlatitude sporadic *E* layers, medium-scale traveling ionospheric disturbances (MSTIDs), the associated plasma density irregularities, their mutual coupling, their geomagnetic conjugacy, and coupling to the thermospheric neutral motion, which is thought to be the ultimate driver during geomagnetically quiet times. The investigation will have experimental, theoretical, and modeling aspects as well as strong educational underpinnings. The broad goal of the research is to elucidate the processes involved in generating ionospheric structure by forcing from below, one of the two main themes highlighted by the 2013 Decadal Survey for Solar and Space Physics. Our emphasis on the connectivity between *E*- and *F*-region ionospheric irregularities and between neutral and charged species mirrors the systems theme of the CEDAR Strategic Plan.

Overview The experimental component of the research will be conducted in the Caribbean and will center on the Arecibo incoherent scatter radar. This radar will be supported by two coherent scatter radar imagers fielded by our team so as to have common *E*- and *F*-region scattering volumes with Arecibo. We will also utilize the Arecibo lidars and all-sky imagers as well as sounders that have recently been installed on Puerto Rico. For a synoptic view of the ionosphere, we will incorporate GPS TEC data from an expanding network of receivers operated with existing NSF support. Finally, our research will incorporate the RISR radar which is expected to be deployed in Argentina, near Arecibo's magnetic conjugate point, during the course of this project, if that radar becomes available at the new location.

Our theoretical investigation will focus on the turbulence properties of the neutral motions in the MLT region, which will be studied using a multi-scale analysis, and on the consquences for ionospheric structuring. Modeling work will incorporate a newly developed, fully three-dimensional plasma dynamics model, capable of simulating *E*- and *F*-region irregularity formation on common magnetic field lines formed under arbitrary background forcing. The model can be modified so as to simulate plasma dynamics on flux tubes extending across hemispheres.

Intellectual merit The intellectual merit of this proposal stems from the fundamental science questions being investigated, which are the keystones for understanding how the midlatitude ionosphere (under which North Americans live) behaves as a system. The midlatitude ionosphere is as prone to instability as the equatorial and auroral ionospheres despite the lack of obvious sources of free energy, and there is no comprehensive theory to explain this. There is a clear relationship between neutral winds, wind shear, and turbulence and E_s layer formation and structuring, but the causal links have yet to be clearly articulated. Equally clear is that *E* region irregularities and *F* region MSTIDs and irregularities are electrically coupled, but the roles of the regions (sources, loads, coupled resonators) remain unspecified. Our project has been designed to resolve these fundamental issues.

Broader impact The broader impact of this work is largely embodied in the instrumentational improvements we plan to bring to the Caribbean region. These include the coherent scatter radar imagers, which will function as a small network, expanding Arecibo's capabilities by adding regional context to Arecibo's point measurements. Similar remarks hold for the regional GPS network (COCONet), which will be utilized by our project for comprehensive GPS TEC mapping in the Caribbean for the first time. In addition, our effort is opening the Caribbean region, the U.S. Virgin Islands and the French West Indies, for access by ourselves and by other investigators in pursuit of the DASI (Distributed Arrays of Small Instruments) initiative. DASI is one of very few initiatives specifically endorsed by the 2013 Decadal Survey as a way forward for conducting discovery research in aeronomy. Research in this direction will be necessary to mitigate the hazardous aspects of ionospheric irregularities on a society dependent on space-based technology.