Project Name: Short-term deployment of Transportable Dynasonde System in the interests of Air Force Office of Scientific Research Project

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Description of Proposed Activity

Dynasonde is an advanced technique of ionospheric radio sounding based on comprehensive use of phase information in HF radio echoes. Autonomous data analysis software makes Dynasonde a truly universal instrument capable to provide quantitative real-time information about a broad range of ionospheric and thermospheric parameters. It is particularly useful for comprehensive characterization of the Traveling Ionospheric Disturbances and Atmospheric Gravity Waves (TIDs and AGWs). Dynasonde's capabilities with relation to wave measurements are comparable to those of scanning Incoherent Scatter Radars. Historically Dynasonde methodology has been developed in Boulder, Colorado, first at the NOAA's Space Environment Laboratory and then at the University of Colorado (https://www.ngdc.noaa.gov/stp/iono/Dynasonde/history.htm). The Transportable Dynasonde System is an important next step in this development and it is one of the currently supported by AFOSR/DURIP projects performed at the University of Colorado ECEE Department. The system allows applications of the Dynasonde technique at locations where permanent installations are not justified or simply absent. First three deployments of the system (at the Platteville Atmospheric Observatory in Colorado, in Socorro, New Mexico and in Palm Bay, FL) have been accomplished successfully in 2020-2021. The planned deployment in California is a part of a project sponsored by the Air Force Office of Scientific Research (AFOSR) program. The scientific goal of this deployment would be to study long-term correlation between the infragravity waves in the Pacific Ocean and the gravity waves in the thermosphere. North-East Pacific is considered a location of the strongest infragravity wave sources on the Earth and the data obtained in that region would provide a powerful argument for an important role the oceans play in generation of atmospheric gravity waves. As another benefit from this mission we would also obtain a dataset for studying connections between the ground-level infrasound (both ocean-produced microbaroms and man-made noise) and the ionospheric km-scale irregularities. There are no other Dynasonde-capable instruments on the west coast and possibility to deploy such system temporarily would allow to mitigate this deficiency.

A team of two University of Colorado employees will deliver the system in an enclosed trailer towed by a pickup truck, will deploy all components of the system within few days and will perform oversight of the system operation as necessary. After the observation period ends the same team will prepare the system for transportation and will drive it back to the home base in Colorado.

Customer Equipment

The Transportable Dynasonde System in transit state is shown in the following photo:

The trailer with attached telescopic tower is a product of the ALUMA Tower Company (Vero Beach, FL), model ECT-16/DD-100HD. The truck is Ford F250.

Photo below shows the system in operational state:

One can see the trailer (that also serves as a shelter for electronic equipment), the guyed 33-m high telescopic tower supporting the transmitting Delta antenna, which footprint is 90 m long. Also visible are seven of the total eight receiving dipole antennas supported by 5-m high telescopic poles, also guyed.

The photo on the right provides a view of the cables that for temporary installations are simply laying on the ground.

The main electronic component of the system is the VIPIR HF Radar Model 2, a product of the Scion Associates Inc. (Port Townsend, WA). Its main characteristics are the following: Interference immunity IP3 > +45 dBm; Dynamic Range 115 dB; Direct RF sampling 16 bits at 120 MHz; Fully digital FPGA conversion, receiver and exciter; USB3 Data & Control Interfaces; 8 coherent receive channels, 32 bit I/Q per channel; Frequency: 0.3 – 30 MHz; GPS Disciplined Rubidium oscillator for bistatic sounding; Tomco 4 kW class AB pulse

amplifier, 5% duty cycle; 3rd harmonic < -30 dBc; Low pass high power filter < -60 dBc. Below is the photo of the radar equipment:

The system is supplied with a portable infrasound monitor (0.05 Hz to 20.0 Hz bandwidth) Infiltec Instruments INFRA-20 (see photo below). This sensor can be installed at a distance up to 100 m from the trailer.

The system is supplied with a mobile Internet router and with three security cameras (one inside the trailer and two outside). The trailer is equipped with an AC unit (which is the main consumer of power).

The system normally operates unattended but may require maintenance visits.

Radio Frequency Emissions

The standard Dynasonde sounding session that will be used during the California deployment is characterized by a pulse repetition interval of 10 ms and by the number of base frequencies from 500 to 600 in the frequency band 1.9–15 MHz. Pulses are grouped into a carefully designed time-frequency pattern that facilitates echo detection and application of higher-level phase-based analysis routines. Base frequency is progressing steadily within each sounding session, so that only 8 pulses can occur at approximately the same frequencies (minimizing detectable effects for other users of the frequency band). A 2 min interval between sounding sessions guarantees sufficient temporal resolution for sampling wave and other dynamic processes in the ionosphere. Pulse bandwidth of 30 kHz and their raised cosine pulse envelope are among specifically chosen design solutions aimed at minimizing possible Radio Frequency Interference (RFI) to other users of the spectrum. The Effective Radiation Power of the system is only 30 W, and the duty factor 0.4-0.7%.

The tests of the VIPIR HF Radar hardware intended for the Transportable Dynasonde System have been conducted in downtown Boulder, Colorado for several months using earlier approved by FCC two Special Temporary Authorizations (File Number 1895-EX-ST-2019 and File Number 2220-EX-ST-2019). Operations proved to be completely non-disruptive for other users of the radio spectrum. Actually, nobody noticed them.

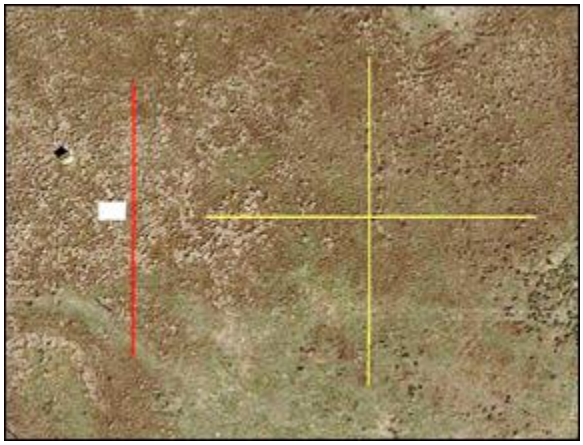
Dynasonde is a well-established low-RFI instrument. It has operated in many locations worldwide, without any RFI-related complaints. This includes the current multi-year Dynasonde operation at the NASA's Wallops Island Flight Facility, previous Dynasonde operation in Boulder, CO on NOAA campus, and the three deployments of the Transportable Dynasonde System.

Resources Requested from Hosting Organization

1) Access to the designated installation site for two team members and a pickup truck.
2) Electric power supply (240V 30A, 4.5 kW max).
3) Installation of a cable for the L14-30 power receptacle closer than 100 feet from the trailer. No other human contacts are necessary (this is emphasized because of the COVID-19 situation).

Facilities Required

1. *A 100 m X 150 m unobstructed level area (no trees or bushes). The ground should allow application of stakes. A typical configuration of our installation is illustrated in the figure below. The white rectangle is the trailer with attached 33-m high telescopic tower that supports a Delta transmit antenna (its footprint is shown by the red line). The yellow lines are two 100-m long lines of 5-m high dipole receive antennas (four of them in each line).*



2. *A power distribution box not further than 100 feet from the trailer, and a possibility to install there an L14-30 power receptacle (240V 30A).*
3. *Mobile Internet coverage.*
4. *Our cables will be laying on the ground. That is why the area should be (at least temporarily) restricted for any traffic (both vehicles and pedestrian). The perimeter will be marked by yellow tape.*
5. *Not desirable is a close proximity to aerial power lines.*

Here is the preferable location of the transmitting tower at the UC Santa Cruz Fort Ord Natural Reserve:

Proposed Need Dates

Start date: May 15, 2022; end date: December 31, 2022.

Recurring Operations/Duration

Operation is 24/7 for the entire observation period (7 months), except for few days in the beginning and in the end. No recurrence is planned at this time, but this is not excluded in the future.

Hazards: *N/A*