GNSS (and other) Observations from Autonomous Seagoing Platforms Larry Paxton[1], Mary R. Keller[2], [1]JHU/APL, Laurel Maryland. Larry.Paxton@jhuapl.edu ; Mary.Keller@jhuapl.edu

Introduction: Sailing 'drones' or buoys offer an option for the development of new insights into a wide range of problems including polar auroral processes, ionospheric electrodynamics, and possibly atmospheric gravity wave imaging.

The last decade has seen tremendous strides in the development of autonomous vehicles of all types. One of the newest is the development of ocean-going drones. These platforms have been extensively used to characterize the ocean surface and subsurface conditions. This idea was described by Paxton at the CEDAR talk "Creating a Future for Aeronomy" [1].

Heliophysics, particularly the study of the ionosphere, thermosphere and magnetosphere/ionosphere coupling processes, suffers from the lack of 'ground-based' global measurements. We have excellent coverage of many parts of the world but much of the world's oceans and polar regions are exceptionally poorly instrumented.

Approach: There are a number of technologies that have been demonstrated that could be readily used for Heliophysics:

1) Sailing drones (including very large vehicles) are commercially available [2] and used for scientific measurements [3]
2) Buoys that are solar powered and capable of long duration operation have been available but wave power expands the possibilities [4,5] extends the possibilities.

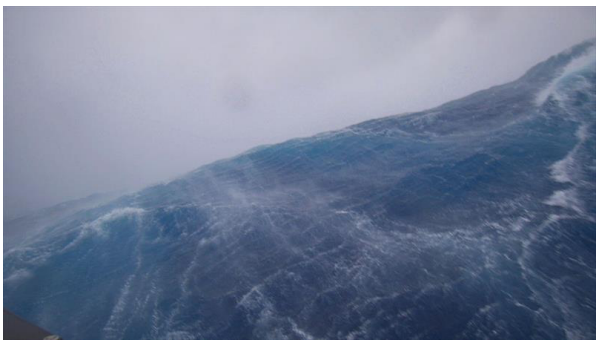
Applications: Global GNSS measurements and nightglow/aurora imagery are limited in availability for much of the world as that fraction is covered by oceans. International waters and their vastness enable freedom to operate in areas for which we have very little coverage even for simple GNSS TEC sensors. Data exfiltration via new opportunities such as, possibly, StarLink, may vastly improve our coverage. One might be concerned about the survivability of these platforms however SailDrones have operated inside hurricanes and provided imagery [6]. This capability would be particularly useful in the seas around Antarctica where we would like to obtain imagery of the aurora under all usual sea states.

Summary: New developments in autonomous vehicles and the expansion of the commercial market should enable the Heliophysics community to either upgrade existing capabilities (such as the use of GNSS navigation) to science product generation (in the example case, GNSS TEC). Stabilized platforms open up more exotic applications including nightglow and auroral imagery.

References:

[1] CEDAR Workshop Tutorial CEDAR Wiki 2012 – video available and slide upon request
[2] https://www.saildrone.com
[3] https://www.science.org/content/article/fleet-sailboat-drones-could-monitor-climate-change-s-effect-oceans
[4] https://www.boeing.com/defense/autonomous-systems/wave-glider/
[5] https://www.pmel.noaa.gov/co2/story/Autonomous+Surface+Vehicles
[6] https://www.saildrone.com/missions/atlantic-hurricane-monitoring

upload_5737b9606fd81ec09575147a90a3f501.jpeg (4032×3024) (noaa.gov)



SailDrones are robust. One SailDrone actually recorded information from within a Class 4 hurricane:
https://youtu.be/uQM_03zuSAI
https://youtu.be/6B-uwpZD454

Much of this material was presented at the Helio 2050 Workshop