Interleaved Quantification of Ionospheric Vertical Electron Content Using International Space Station Observations, Ham Radio Networks and Stochastic-Search Galileo-Based NeQuickG Model

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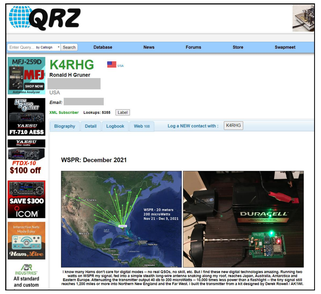
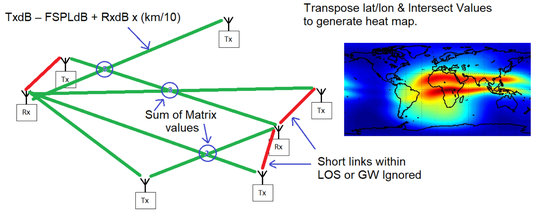
ABSTRACT

Ionospheric electron density plays a significant role in long-distance communications and sky-wave propagation. Prediction of the accurate state of the ionosphere is necessary to understand the accurate signal perturbations thereby estimating the critical parameters for better signal transmission. The space weather impacts on such trans-ionospheric technological systems are evident. In this work, a web application is developed to represent the global day-to-day electron density variations from the NeQuickG model. Also, the ground-based HAM radio broadcast network hop data with different wavelengths (eg. 10 m and 20 m) and simultaneous top-side electron density with space-based International Space Station (ISS) probe data from floating point measurement units are examined. The electron density variations for the year 2017 are clearly represented. Optimization techniques are necessary to frame a denser spatial grid-based ionospheric electron density map from all the observations. It is essential to estimate the optimal weight function that can distribute the observation influence over empty grid bins with minimum error variance through a probabilistic approach. User-understandable metrics development exclusively for Amateur radio operators and civil aviation sectors is focused. In the near future, the developed web-based application could serve as a better visualization platform for space weather forecasting. Our work is being extended for future work for predicting the Vertical Total Electron Content (vTEC) via a Convolutional Neural Network that contains Convolutional, Maxpool Averaging and Softmax Hidden layers with the goal of having global spatial ionospheric images.

This project, **Fellowship of the Ionosphere**, is a Global Finalist in the **2022 NASA Space Apps Challenge**. NASA Space Apps 2022 had 31,400+ registered participants from 162 counties and territories, with over 3000 submissions from 5327 teams. Global Finalists are ranked as one of the top 35 projects from all submissions.



Assigned a Matrix value with...



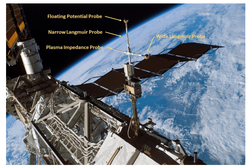
Transpose lat/lon & Intersect Values to generate heat map.

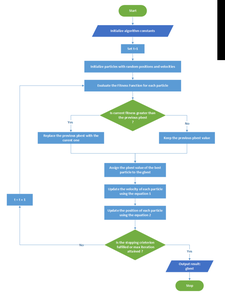
OBJECTIVES

- Web application to allow more exposure (broader audience)
  - no technical knowledge needed to use it
  - public website can promote ionospheric research
  - splitting frontend and backend allows for independent development
- Be flexible / future proof
  - We might want to eventually combine multiple sources of data
- Be able to see / compare multiple sources of data
  - HAM
  - ISS
  - Model
  - (possibly others)

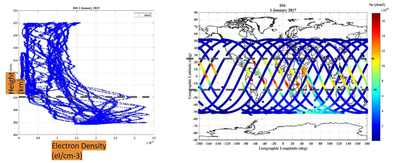
METHODS

WSPR Networks
ISS
Galileo Model



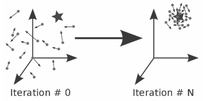


Diurnal variation of electron density



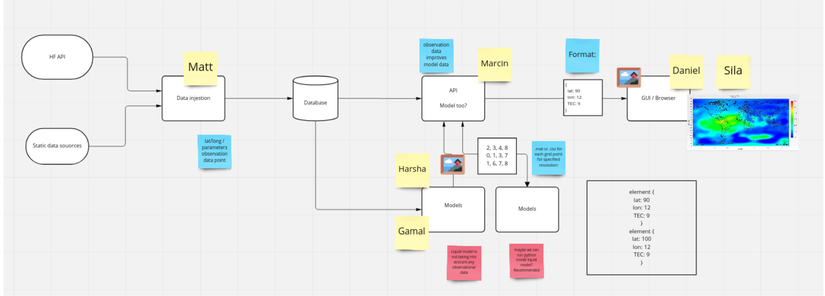
ISS data could be useful for better prediction of space weather impacts.

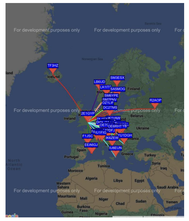
ISS daily orbital trajectory for the 1 January 2017

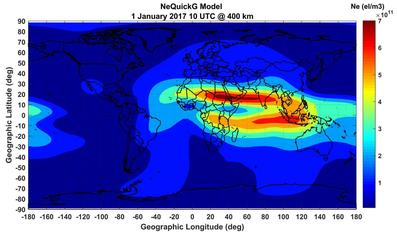


TEAM

WORK SYSTEM CHART

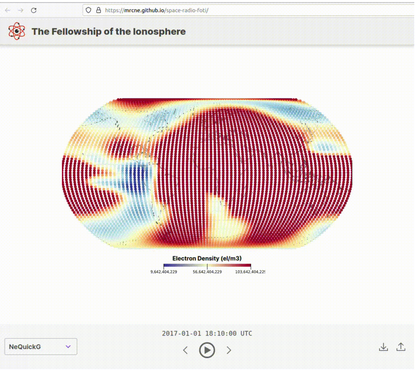


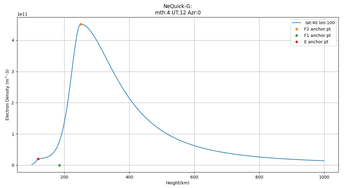




RESULTS / APP

https://mrcne.github.io/space-radio-foti/





REFERENCES/ SOURCES

- Feel free to explore the web app: https://mrcne.github.io/space-radio-foti/
- Source code: https://github.com/mrcne/space-radio-foti
- Space Apps Challenge: https://2022.spaceappschallenge.org/challenges/2022-challenges/radio-enthusiasts/details
- Challenge project: https://2022.spaceappschallenge.org/challenges/2022-challenges/radio-enthusiasts/teams/fellowship-of-the-ionosphere/project
- Weather balloon data: https://www.ncei.noaa.gov/products/weather-balloon/integrated-global-radiosonde-archive
- A survey of the techniques for measuring the radio refractive index (nist.gov)

CONTACT

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www.PosterPresentations.com