Exploiting SWPC Products to Aid Positioning and Accuracy

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Outline

GNSS Customer Survey

Model Developments

The Last Mile (actionable products)

Using Today's Products

Acknowledgements:

- Tzu-Wei Fang
- Tim Fuller-Rowell
- Dominic Fuller-Rowell
- George Millward
- Michele Cash

2019 Space Weather Customer Survey - GNSS Community Input

Summary of User Data Product Requests
The four interviewees identified seven distinct data product requests for the GNSS sector. Requests:

1. **Develop warnings for scintillation, especially in the equatorial zone**.
2. **Improve timing and accuracy for geomagnetic storm forecasts**.

Forecasting Small-scale Plasma Structures

Award Abstract #2028032

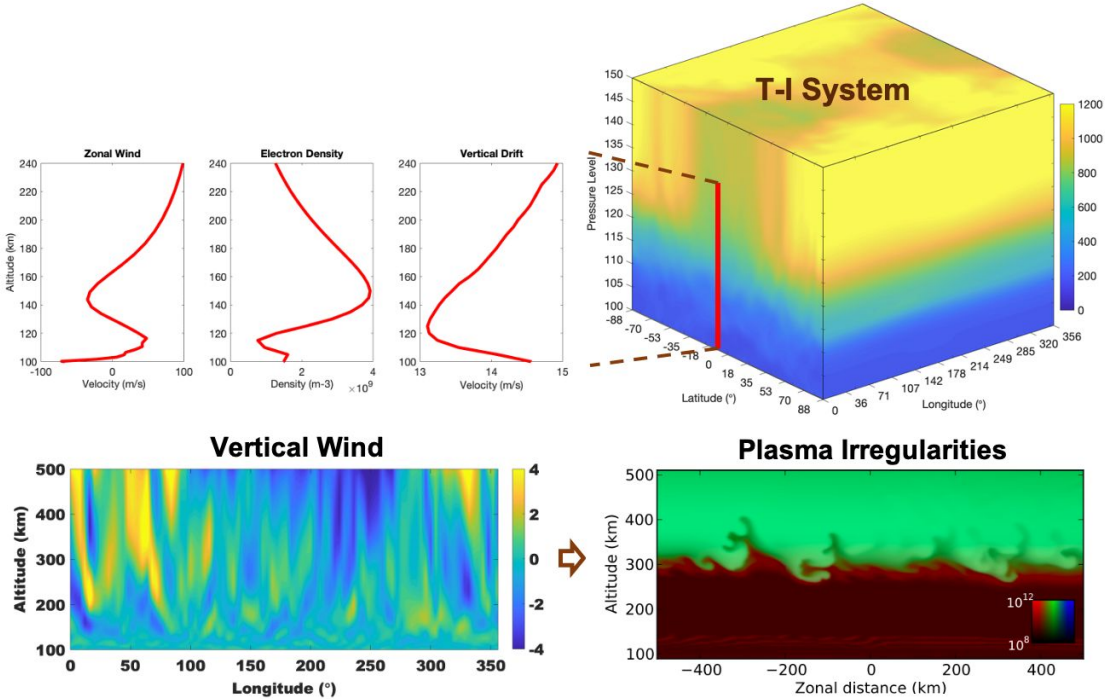
SWQU: Forecasting Small-Scale Plasma Structures in Earth's Ionosphere-Thermosphere System

NSF Org:	AGS Div Atmospheric & Geospace Sciences
Initial Amendment Date:	August 28, 2020
Latest Amendment Date:	August 28, 2020
Award Number:	2028032
Award Instrument:	Standard Grant
Program Manager:	Mangala Sharma AGS Div Atmospheric & Geospace Sciences GEO Directorate For Geosciences
Start Date:	September 1, 2020
End Date:	August 31, 2023 (Estimated)
Awarded Amount to Date:	$2,398,603.00
Investigator(s):	Tzu-Wei Fang tzu-wei.fang@noaa.gov (Principal Investigator) Timothy Fuller-Rowell (Co-Principal Investigator) David Hysell (Co-Principal Investigator) Alireza Doostan (Co-Principal Investigator) Eric Sutton (Co-Principal Investigator)
Sponsor:	University of Colorado at Boulder 3100 Marine Street, Room 481 Boulder, CO 80303-1058 (303)492-6221
NSF Program(s):	AERONOMY, AGS-ATM & Geospace Sciences, Space Weather Research
Program Reference Code(s):	026Z, 1521, 4444, 6897, 7569, 7699, 8092
Program Element Code(s):	1521, 6897, 8089

“Forecasting Small-scale Plasma Structures in the Earth’s Ionosphere-Thermosphere System,” awarded $2.4M by NSF.

[Tzu-Wei] Fang and her colleagues will model the conditions that lead to disturbances in the ionosphere and use ground- and satellite-based observations to validate the simulated ionosphere-thermosphere conditions. “Our goal is to advance fundamental research underpinning space weather forecasts. Our research will help us better forecast disturbances in the ionosphere and their impact on the satellite signals,” Fang said.

Plasma Irregularities and Scintillation



WAM-IPE Products and Customers

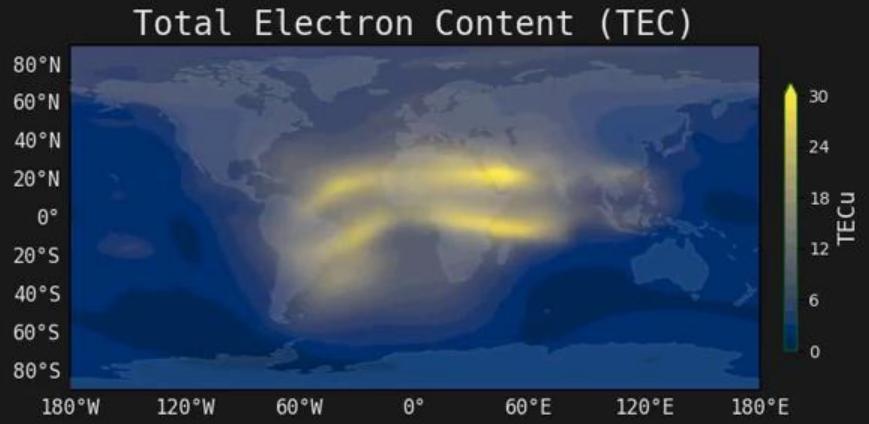
Satellite Navigation and positioning

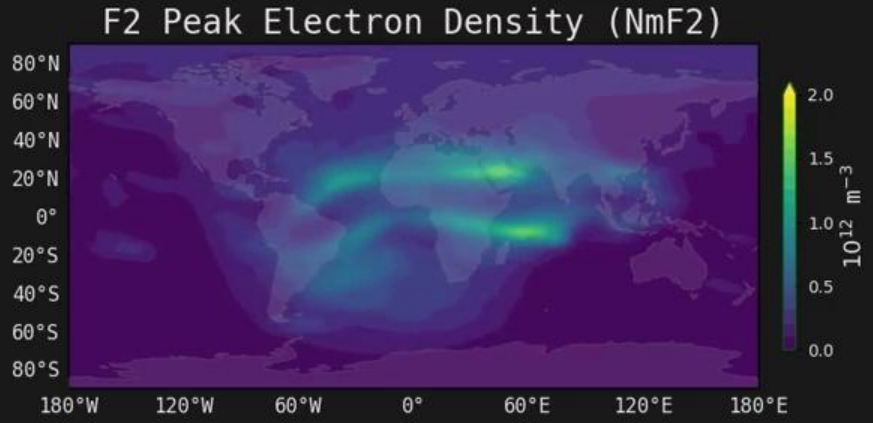
- Global Specification and Forecast of ***Total Electron Content (TEC)***
  - Proxy for GPS positioning error
  - Customers: Airlines, Maritime, Surveying and Exploration, Agriculture, Emergency Managers, DOD, FAA, DHS,
- **TEC *Gradient***
  - Single frequency GPS/GNSS customers
- TEC ***Rate of Change***
  - ***Scintillation*** (Parametrization of conditions and precursors to scintillation)
  - Dual frequency and precision GPS/GNSS customers

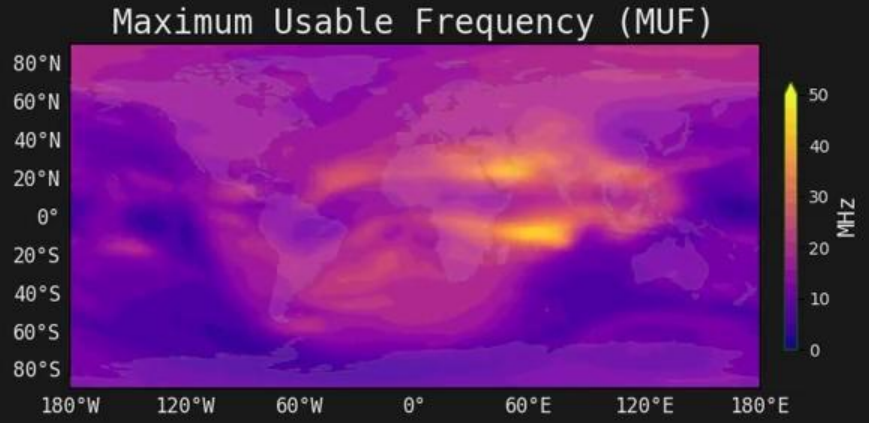
Valid at: Jul 8 2020 13:30 UTC

Global Ionosphere

Model: WAM-IPE (wfs) Init: Jul 7 2020 18 UTC







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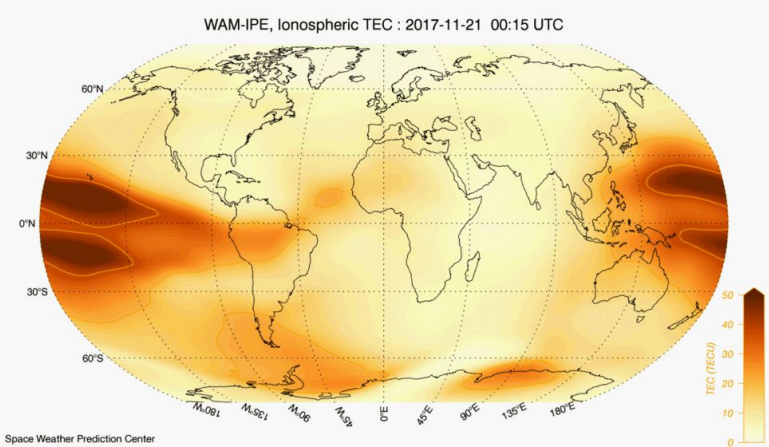
WAM-IPE Products and Forecast Validation

- Initial products: TEC, NmF2, hmF2, and anomalies (departure from 10-day mean)
- Example of animation of global IPE TEC for November 21 2017

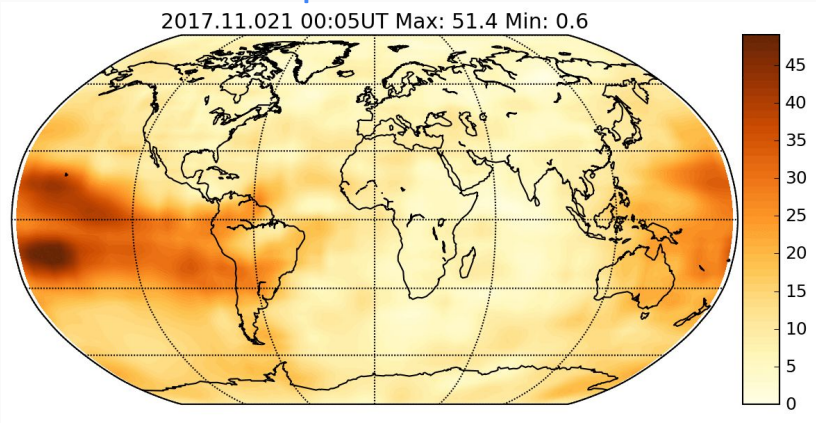
  (Animation courtesy George Millward)
- WAM-IPE forecasts will be validated against TEC maps from GloTEC, a data assimilation scheme combining ground (GNSS) and space-based (COSMIC RO) data

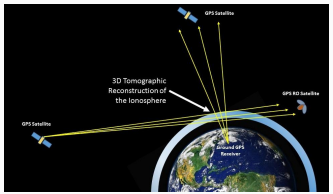
  (Courtesy Dominic Fuller-Rowell)

WAM-IPE Forecast of TEC

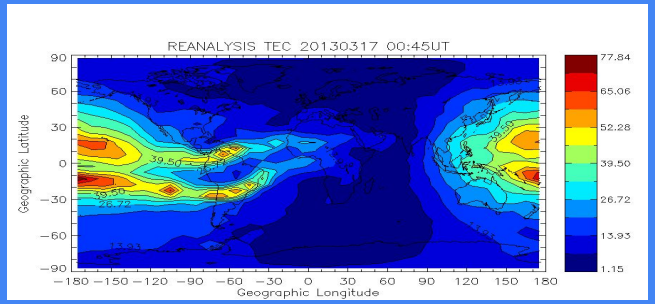


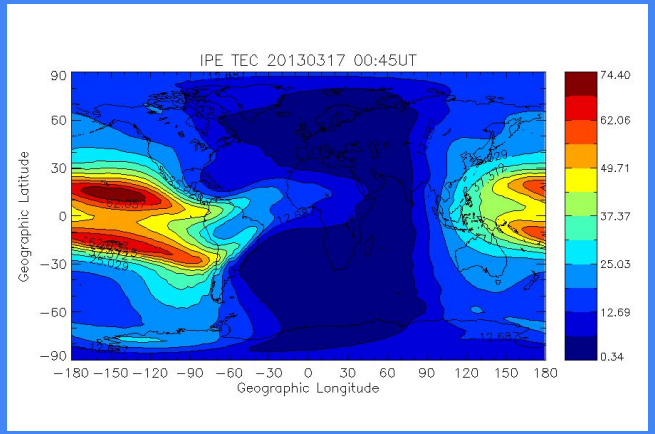
GloTEC Ionospheric Data Assimilation



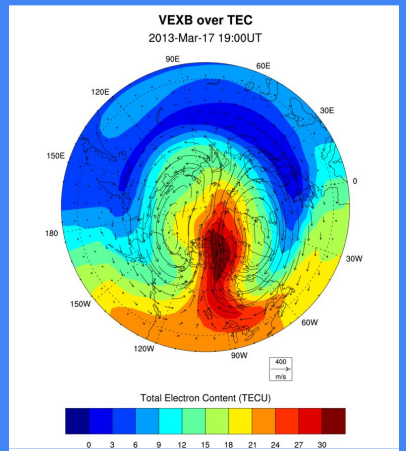


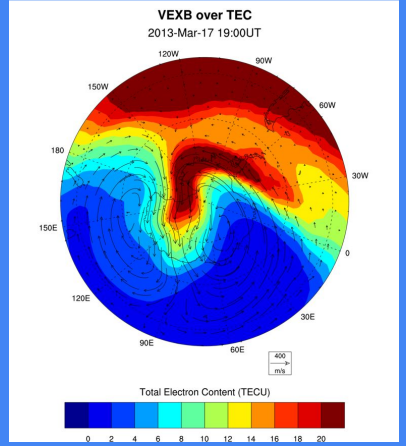
19UT March 17, 2013 North and South Hemisphere

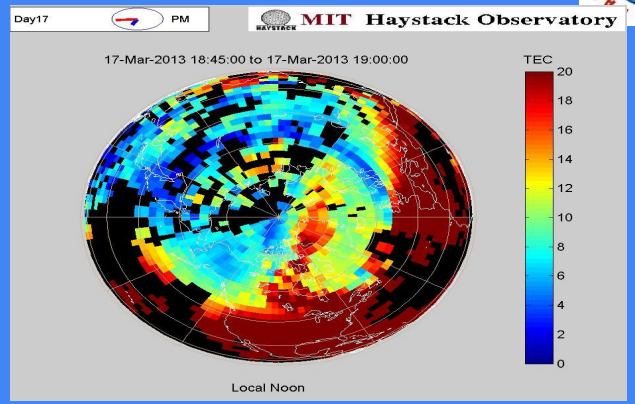


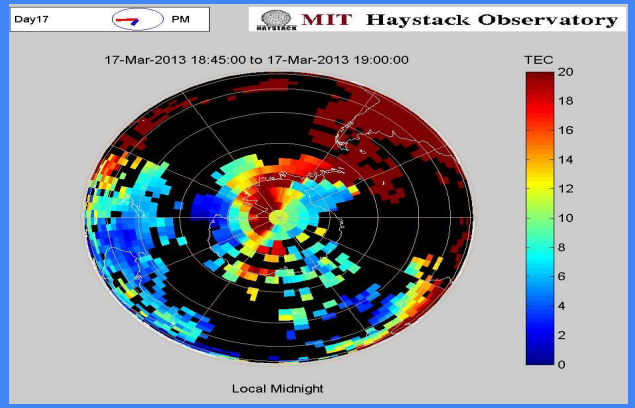


quiet initial conditions
Re-analysis vs IPE









Anthea Coster
TEC maps MIT

Jan 15-17, 2019

Customer Survey - GNSS Community Input: the last mile

3. **Develop a product that includes GNSS-specific warnings and nowcast observations**. ...Examples...include scintillation phase and amplitude, geomagnetic storms, and TEC disturbances and gradients.

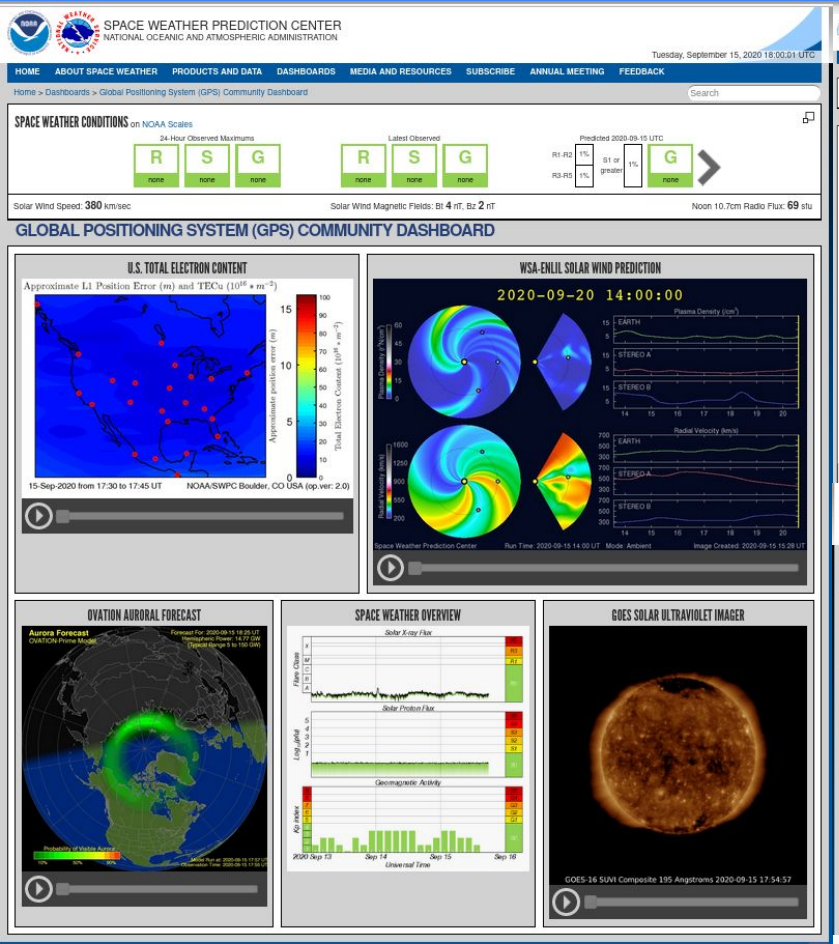
4. **Develop push alerts that are specific to users' *geographies*.**

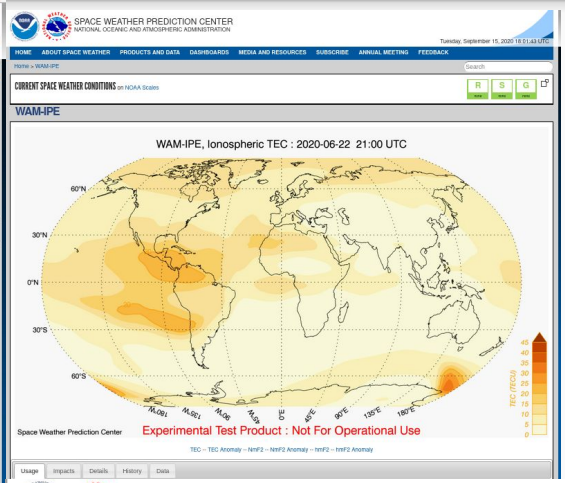
5. **Provide tools to translate space weather phenomena to impacts.**

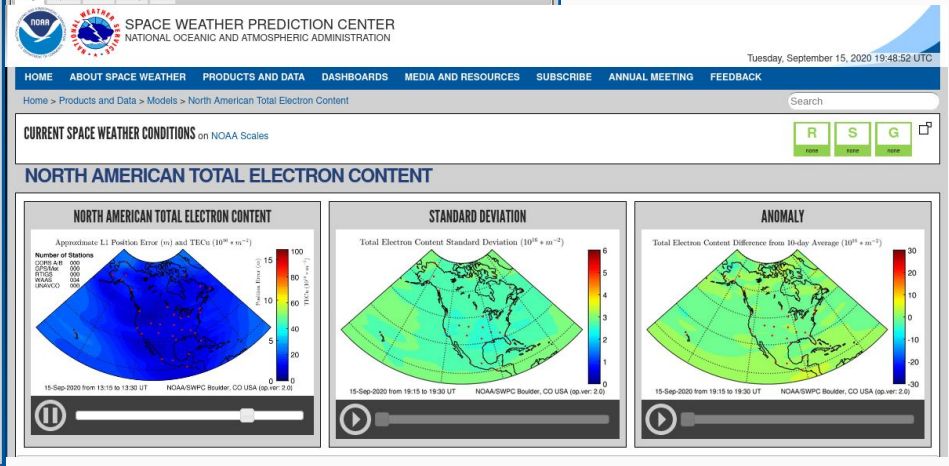
6. **Improve the SWPC website for use by non-experts [simplify]** ...interpretive tools that can relate or lead SWPC customers to the *nature, severity, and timing* of impacts they may experience.

7. **Create a mechanism for users to report GNSS issues**...through software that is already being used.

Using Today's Products







Questions?

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