Commercial Space Weather Products for Real-Time and Forecast Applications

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USU Space Weather Center Partnerships

Utah State University Space Weather Center

- **Space Environment Technologies**
- **USU GAIM Team**
- **Space Environment Corporation**

Space Weather Center

Space Environment Technologies

Space Research *Space Operations* *Space Standards*

G A I M

"Bringing The Pieces Together"

Space Environment Corp

Partnership Members

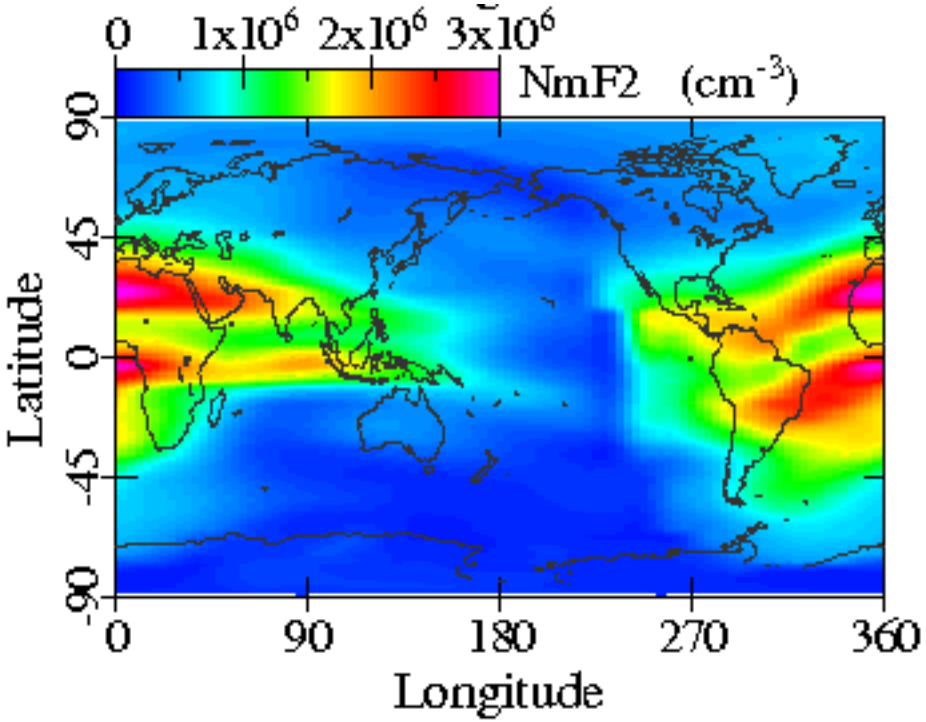
- **USU SWC**
  - **W. K. Tobiska, H. Carlson, E. Hunsaker, D. Hansen, J. Meehan, L. Pedersen, J. Fulgham, L. Heaton, S. Johnson**
- **GAIM**
  - **R. W. Schunk, L. Scherliess, A. R. Barakat, L. Gardner, J. J. Sojka and L. Zhu**
- **SET**
  - **D. Bouwer, R. Shelley, J. Bailey, J. Yoshii, B. Burke, P. Hagan, D. Knipp, T. Jackson, H. Richards**
- **SEC**
  - **V. Eccles, S. Sojka, and D. Rice**

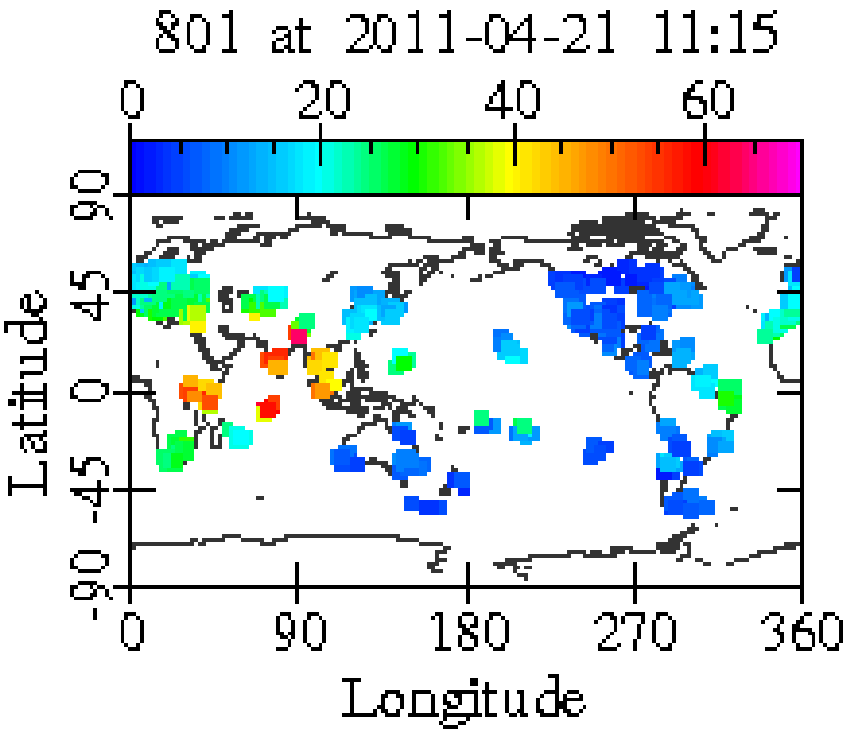
New 2011 Real-Time and Forecast Products

- real-time/forecast HF availability for Japanese emergency responders
- real-time point-to-point global HF propagation
- real-time airline dispatcher route planning HF availability
- real-time GPS correction maps for single- and dual-frequency users
- real-time radiation dose rates for aviation users
- real-time Dst ring current indices
- real-time/forecast solar and geomagnetic indices that drive the JB2008 thermospheric density model for LEO satellite operations
- real-time charging and discharging for GEO comm satellites

GAIM-GM global Run:

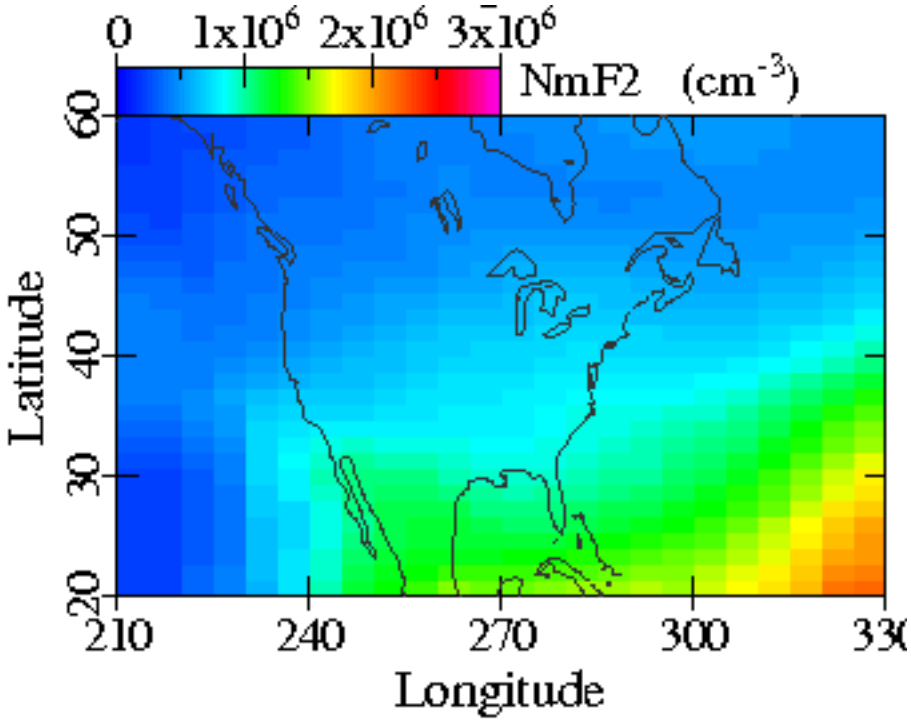
- 357 global TEC stations (IGS network) used in real-time at USU Space Weather Center
- Up to 10,000 measurements assimilated every 15- min

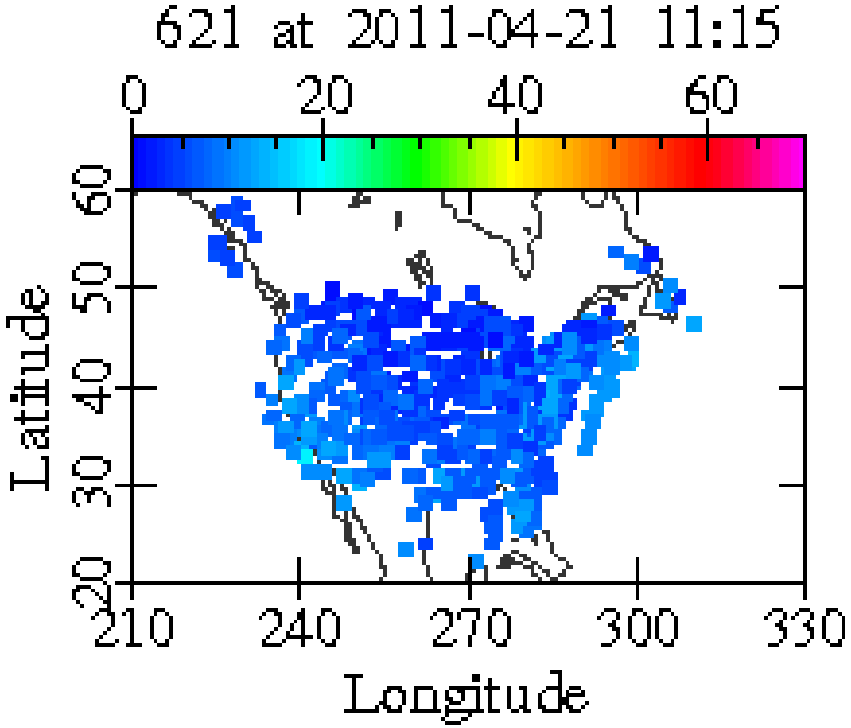




GAIM-GM regional (High Resolution) Run:

- **424 USTEC stations (CORS network) used in real-time at USU Space Weather Center**
- **Up to 10,000 measurements assimilated every 15-min**





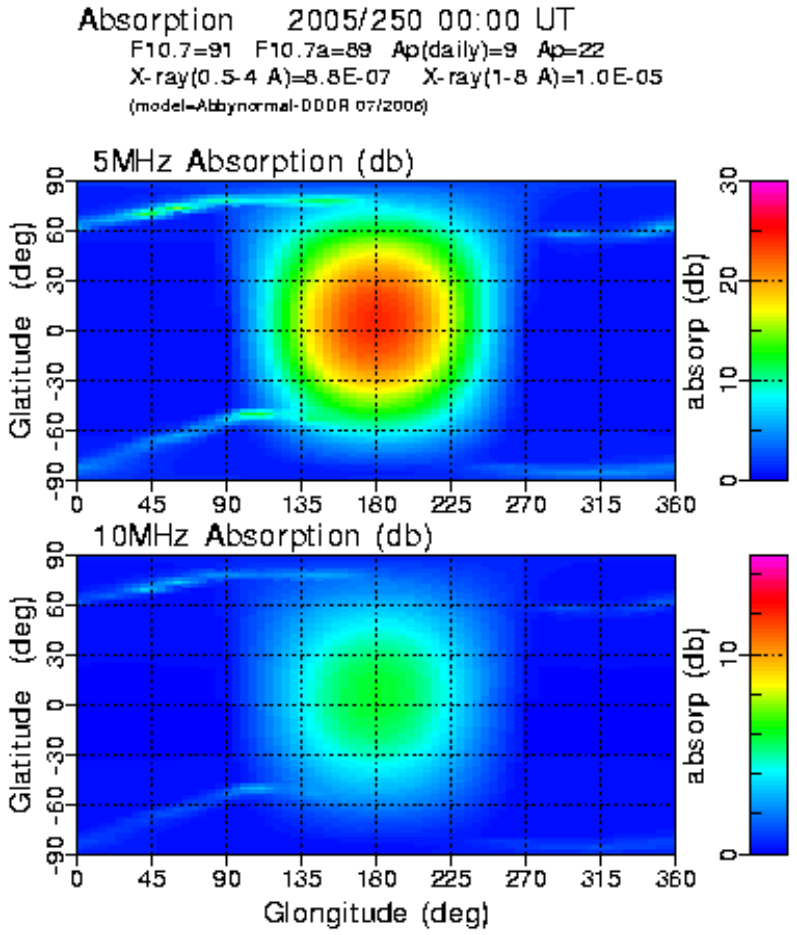
HF Communications Support

- **SWC combines models and utilities to provide HF propagation information**
  - **GAIM Ionosphere**
  - **ABBYNORMAL D-Region absorption maps**
  - **HASEL Ray-Tracing Model**
  - **Great Circle Signal Strength (GCSS)**
  - **Near Vertical Incidence Skywave (NVIS)**

ABBYNORMAL*

Data-Driven D-Region Model

Solar Flare Day



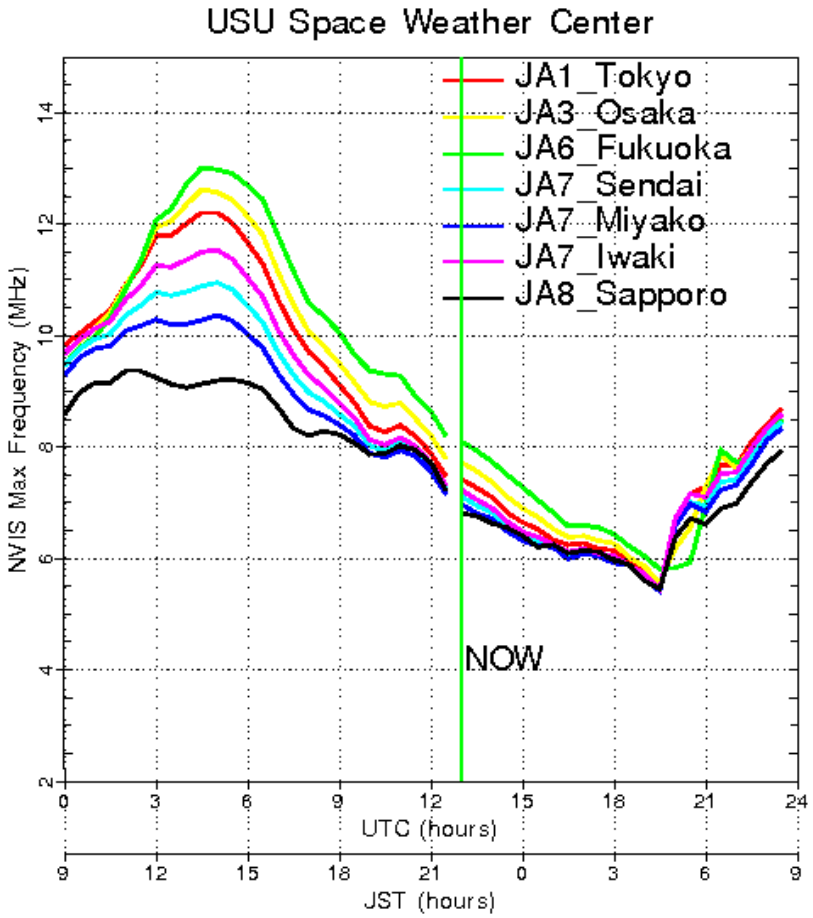
- **Global D-Region electron densities from 40 to 130 km combined with GAIM ionosphere**
- **Calculates signal absorption for HF propagation codes.**

***AB**sorption **BY** the D and E Region of HF Signals with **NORMAL** Incidence

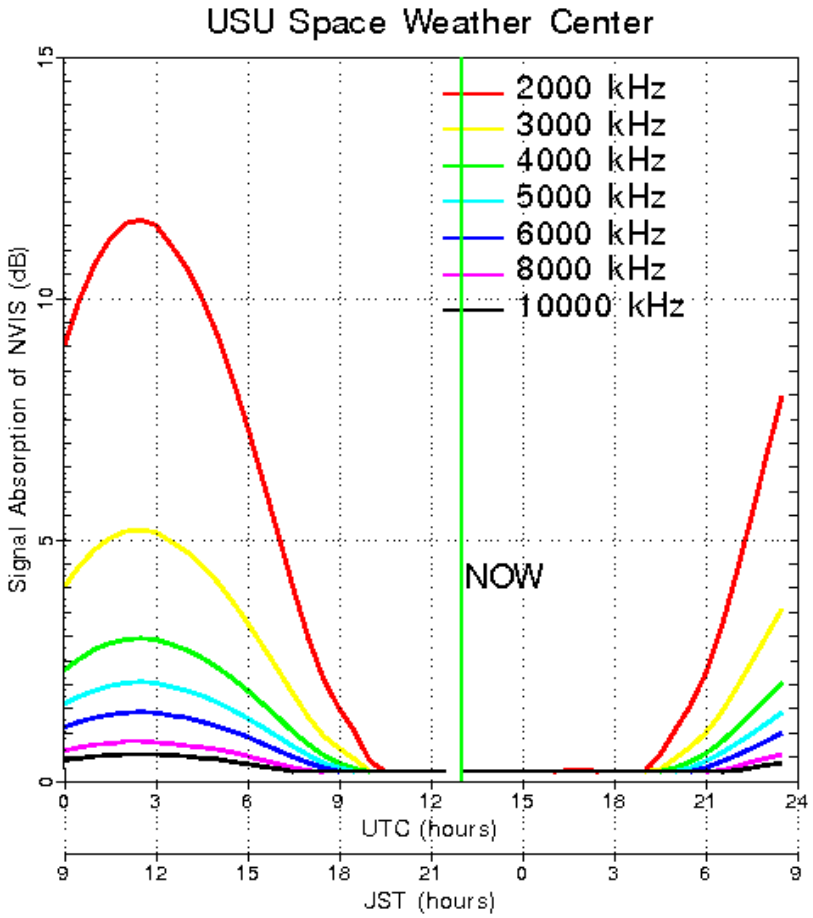
NVIS for Japan

- **SWC HF communications for Japan emergency conditions**

Maximum Frequency (MHz) for Near Vertical Incidence Skywave

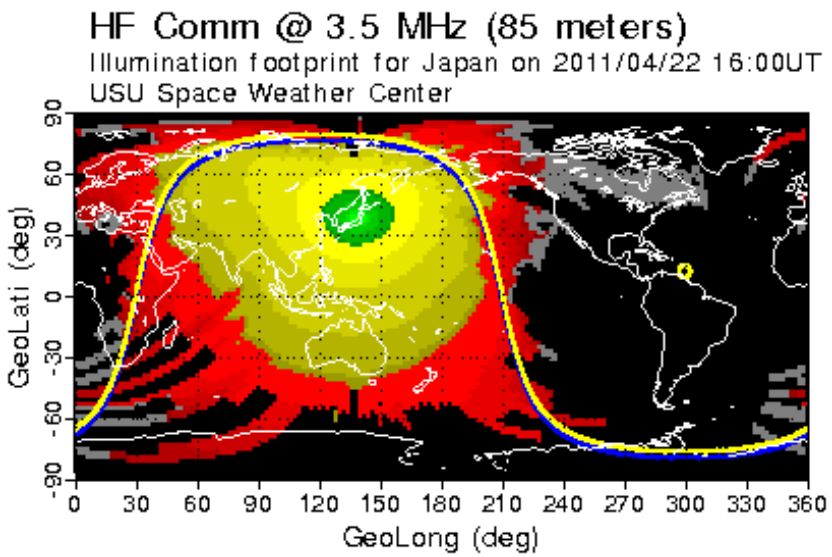


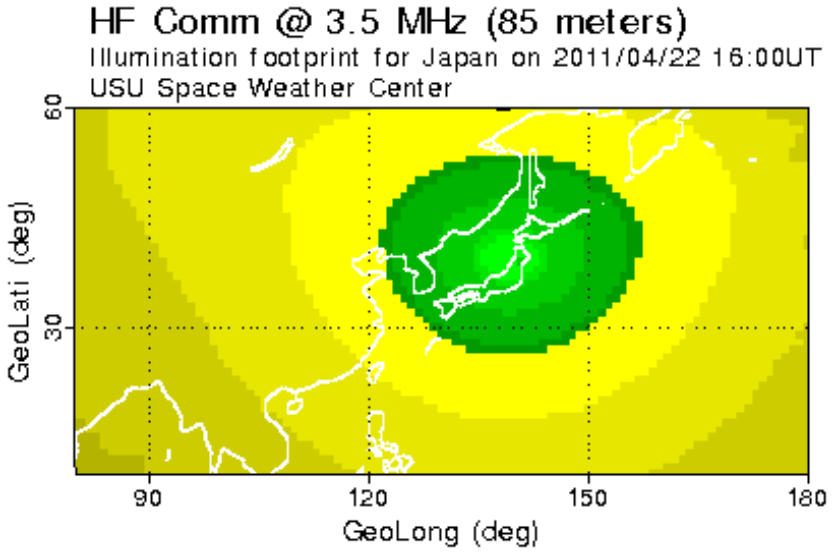
Signal Strength Absorption of NVIS HF Communication



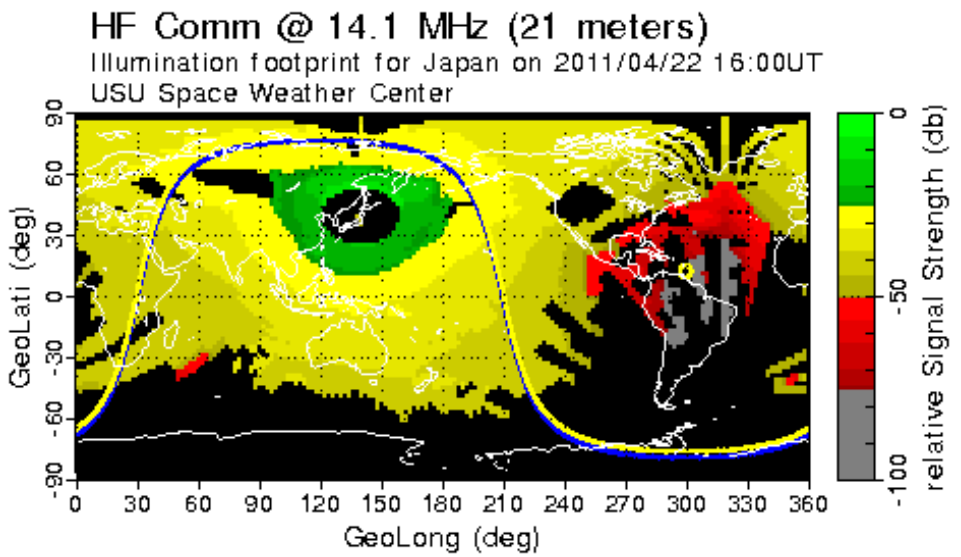
Global HF Comm for Japan

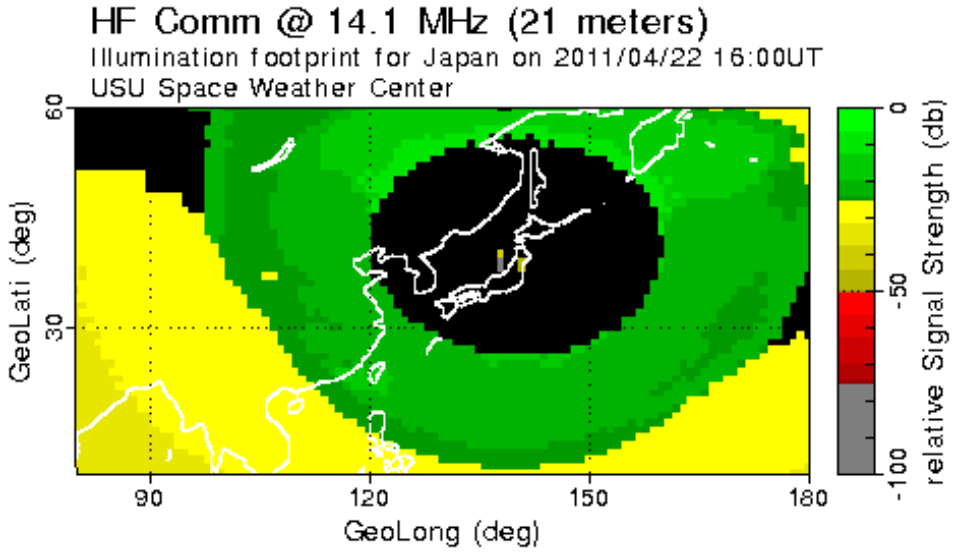
3.5 MHz Signal Strength





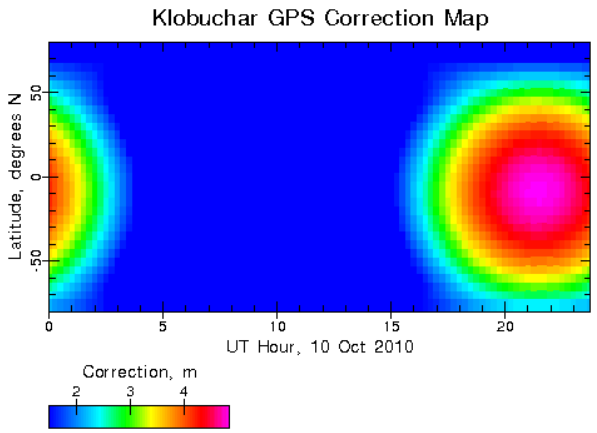
14.1 MHz Signal Strength

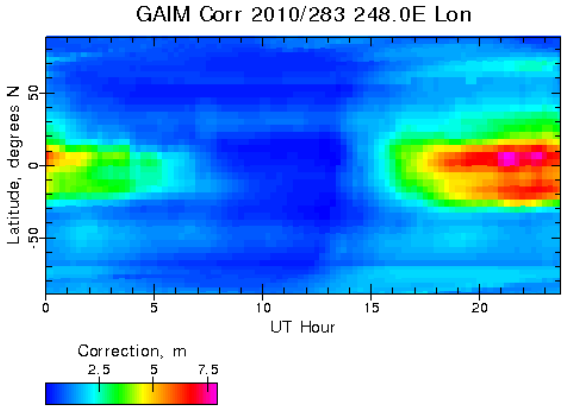


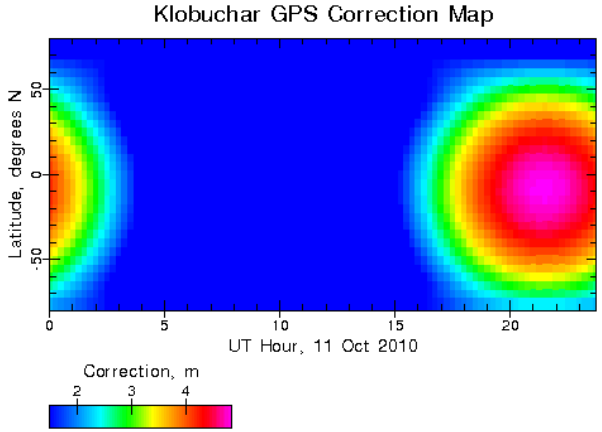


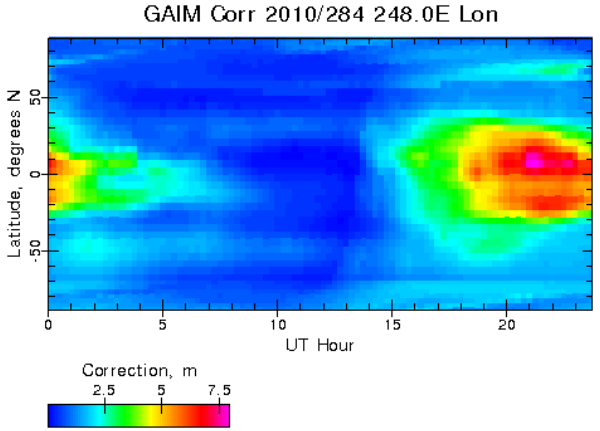
GPS Corrections

- **The conventional Klobuchar correction is updated about every 6 days and thus cannot track changing conditions**
- **GAIM tracks changing conditions and shows storm effects**



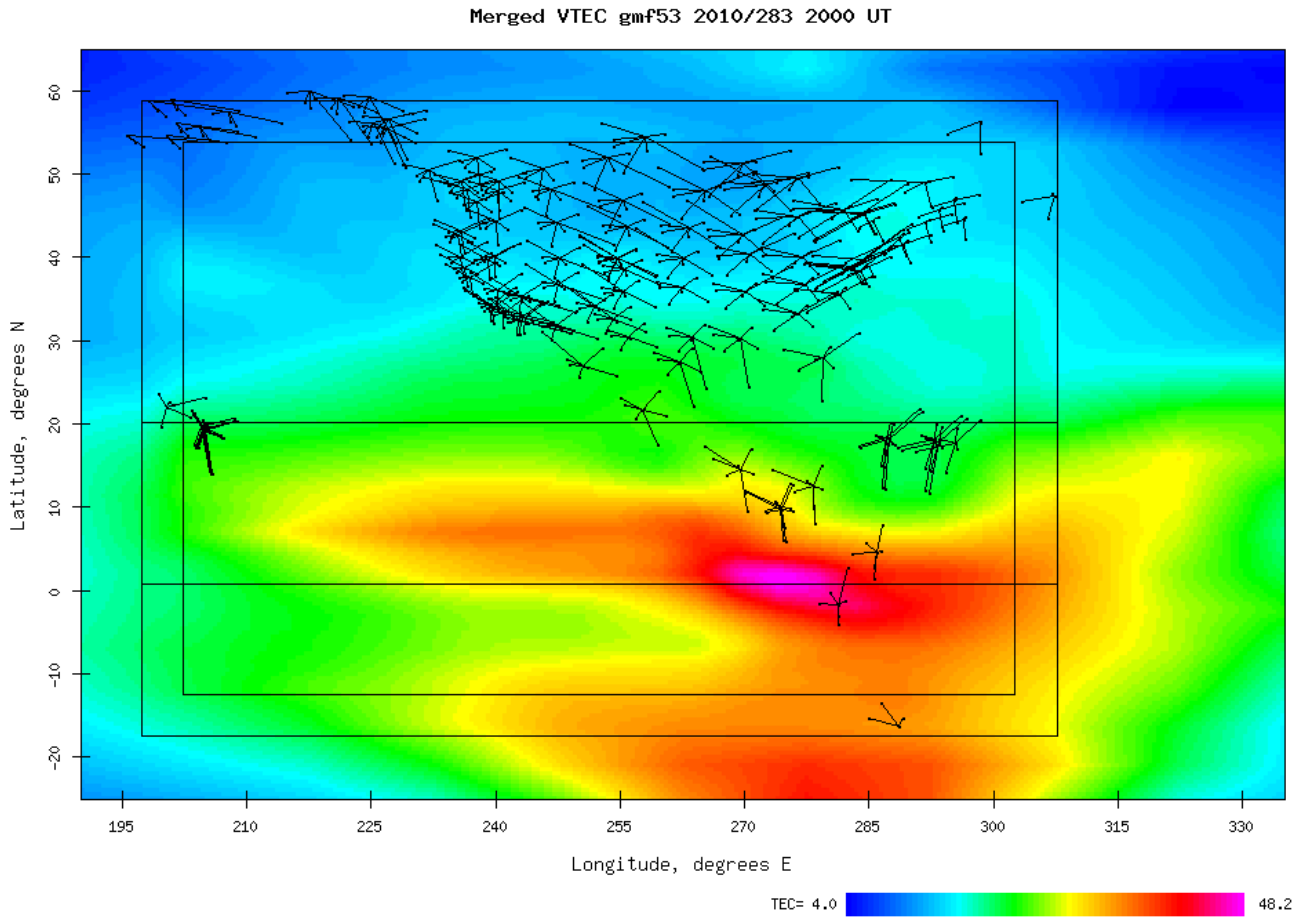






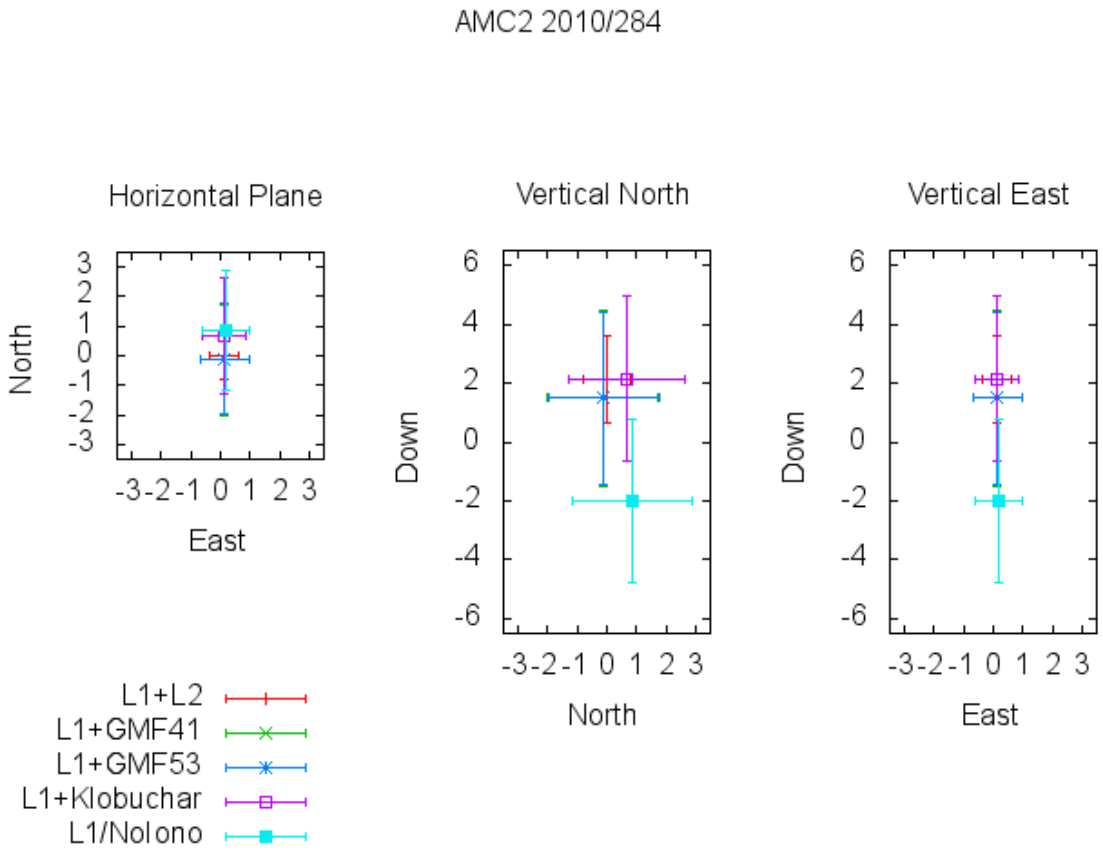
GAIM Requirements for Corrections

- **To calculate corrections for GPS in North America, two overlapping higher-resolution regional grids are included**
- **Grid coverage is shown below, with an example of the resultant GAIM ionosphere showing ingested data sites**



GAIM Correction Example

- **Fixes for moderately disturbed day were calculated with Colorado Springs GPS data, 30 second resolution**
- **Single frequency corrections and dual frequency estimates are compared; the nominal site position is at the origin**



GAIM Correction Analysis

- **In all cases, the GAIM corrections improved the average daily fix compared to the Klobuchar corrections**
- **In most cases, the GAIM corrections provided fixes comparable to the dual frequency fix**
- **Similar results were obtained for other test sites during the period considered**

Summary

- **Poster by Meehan et al. provides more details about our new products**
- **3 press releases will be available this week**
- **First space weather app (iPhone) and new iPad release**
  - **120 real-time data sets**
  - **Provided by 17 institutions /organizations**