



# *NOAA Non-standard and Test Products for Space Weather*



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# Non-standard SWx Products

Available from SWPC / NGDC

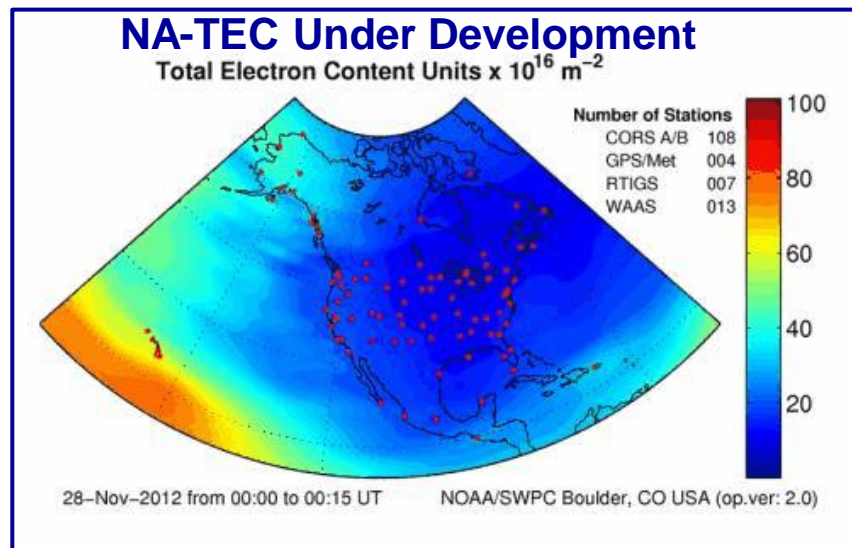
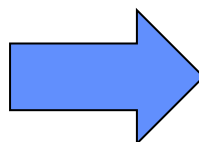
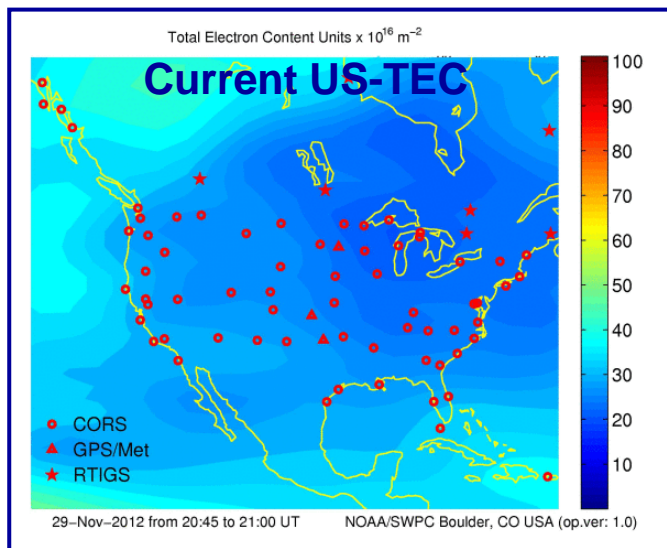
**Non-standard test products include space weather models and applications that are under development as beta-version or test products.**

- **NA-TEC (North America Total Electron Content)** – Ionospheric model of vertical TEC within North America and surrounding areas.
- **FIRST (Forecasting Ionospheric Real-time Scintillation Tool)** – Forecast the probability of evening equatorial scintillation by monitoring the height rise of the ionospheric F layer (after Redmon & Anderson [2010]).
- **SEAESRT (Space Space Environmental Anomalies Expert System Real Time)** – Risk assessment tool for geosynchronous satellite operations (after O'Brian et al [2009]).
- **OPRT (OVATION Prime Real-Time)** – Real-time forecast and nowcast model of auroral power using ACE solar-wind data and Kp (after Newell et al [2009]).
- **PeEPs (People Empowered Products)** – Combines Twitter reports of auroral sightings with auroral model projected onto Google Earth.
- **ART (Auroral Resources Toolkit)** – A rich internet application for the visualization and collaboration of auroral phenomenology.



# NA-TEC: North America Total Electron Content

## A Product for GPS Users



### SWPC/NGDC are expanding the coverage of the operational US TEC model to cover North America

- Errors in GPS position information are directly related to the Total Electron Content above the receiver.
- Both US-TEC and NA-TEC are Kalman-filter based data assimilation ionospheric models of Total Electron Content. (TEC) which can be an indicator of GPS error.
- The solution is well constrained over the CONUS due to the availability of GPS receivers but not so at the high and low latitudes.
- More real-time data is needed. Efforts are underway to add new receivers in Alaska and Canada. Many data sets are not “real time” (Latency <15 minutes)
- Customers: Airlines, Agriculture, Surveying, Snow Removal, Oil Exploration

**Status: Validation prior to release as a test product**

**US-TEC: <http://www.swpc.noaa.gov/ustec/index.html>**



# FIRST: Forecasting Ionospheric Rt Scintillation Tool

## A Product for Dual Frequency GPS Users Near the Equator

### Kwajalein Scintillation Forecast (FIRST)

h'F time history (LT):

Date	11/5	11/4	11/3	11/2	11/1	10/31	10/30
Day of Year	309	308	307	306	305	304	303
19:45LT	240	245	N/A	380	N/A	320	245
19:30LT	275	340	N/A	340	405	N/A	385
19:15LT	290	290	N/A	N/A	290	N/A	365
19:00LT	300	325	N/A	N/A	295	N/A	355
18:45LT	305	295	N/A	280	N/A	N/A	N/A
18:30LT	280	265	622	300	340	235	170
THMS4							

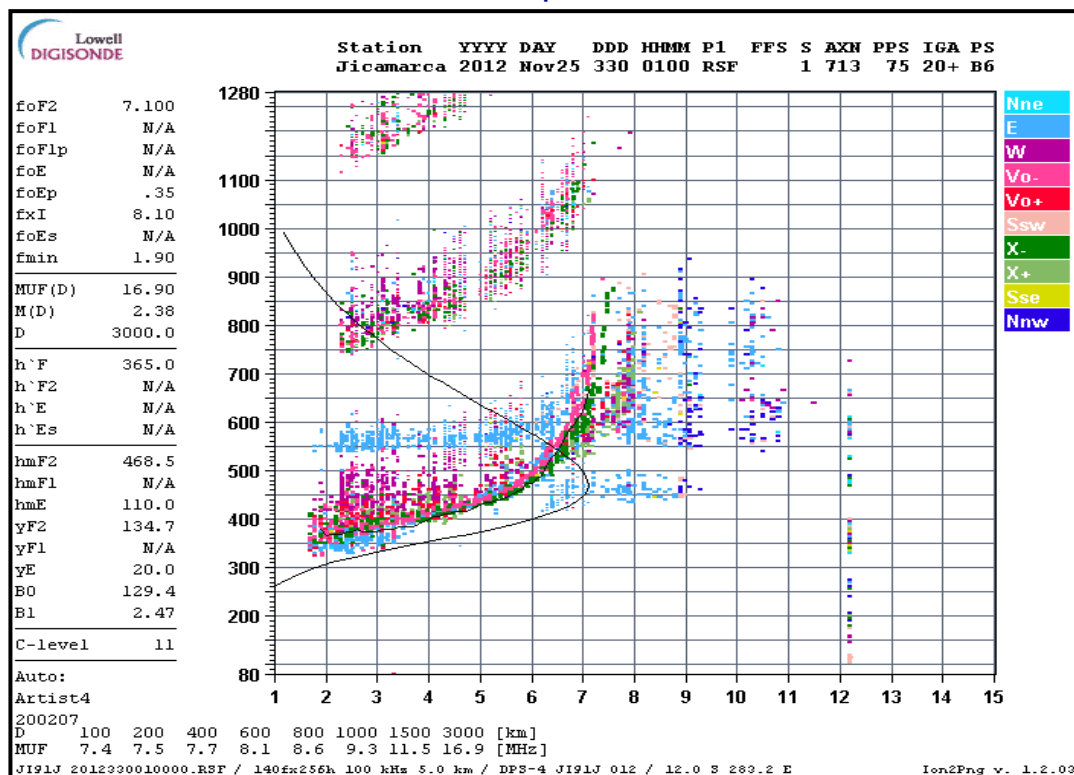
### Jicamarca Scintillation Forecast (FIRST)

h'F time history (LT):

Date	11/5	11/4	11/3	11/2	11/1	10/31	10/30
Day of Year	309	308	307	306	305	304	303
19:30LT	356	311	296	276	291	275	307
19:15LT	353	272	292	270	283	273	307
19:00LT	332	285	278	260	270	268	N/A
18:45LT	286	270	265	255	257	262	285
18:30LT	260	260	255	247	246	251	262
THMS4							

Predict the occurrence of local ionospheric scintillation:

- Evening-side phenomena at low magnetic latitudes.
- Uses ionosonde measurements of the ionosphere height h'F, (values in boxes) as a proxy for ExB drift and to assess likelihood of scintillation.
- **Red – Likely** / **Yellow – Possible** / **Green – Unlikely**
- Customers: Aviation, Oil Exploration, DOD







# SEAESRT: Space Env. Anomalies Expert System RT Supporting Satellite Operators in Geostationary Orbit

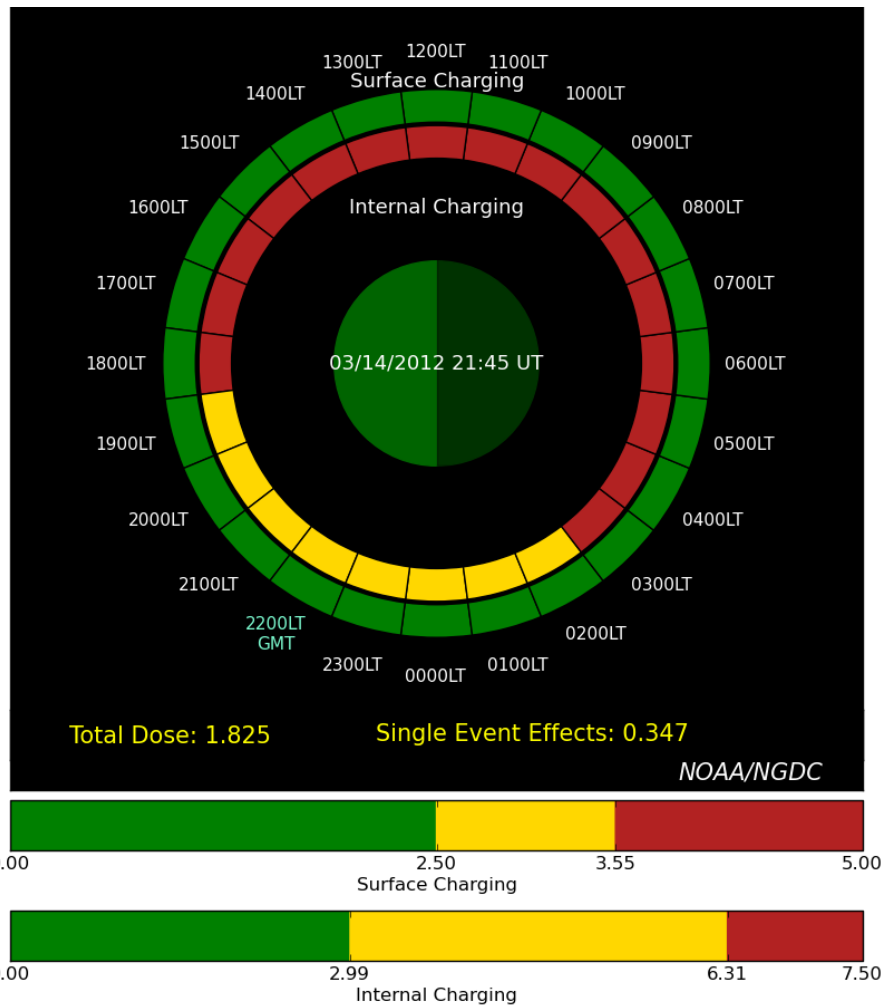
Near real-time utility to calculate spacecraft charging hazard quotients for geostationary satellites.

Inputs: GOES particle data and the  $K_p$  geomagnetic index.

## Satellite charging hazards:

- **Surface charging** – Surface discharging – induced currents; low energy particles.
- **Internal charging** – Electro-static discharge within sensitive electronics; medium energy particles.
- **Single Event Upsets** – Particle energy deposition in microelectronics; very energetic particles.

Customers: Geosynchronous Satellite Operators



Status: Being Transitioned to Operations

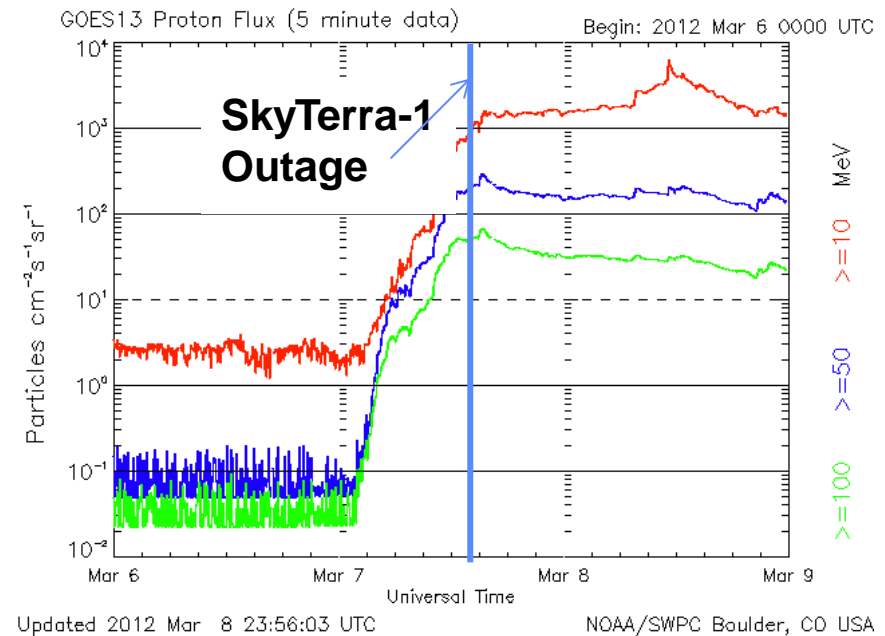


# Skyterra Failure: Single Event Upsets

## SEAESRT Confirms Probable Cause

The SkyTerra outage was likely caused by a solar proton induced Single Event Upset (based on SEAESRT hazard estimates).

- **GOES 13 data: SkyTerra-1 outage began on March 07 14:43 UT just after the flux of energetic protons increased dramatically.**
- **SEAESRT: Hazard estimate due to energetic protons indicates that a single event upset was 106 times more likely at the time of the outage.**
  - The SEAESRT hazard quotient is based on the flux of >30 MeV protons measured by GOES at the time of the anomaly
  - Hazard Quotient  
 $Z=(495 \text{ protons/cm}^2\text{-s-str})/4.67$

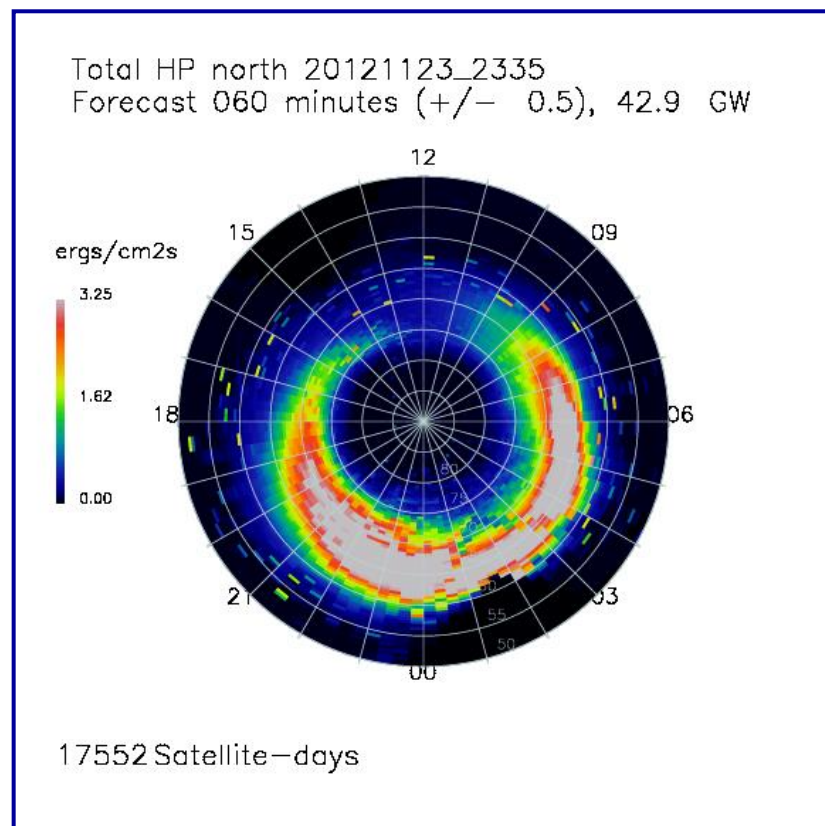




# Ovation Prime:

## Short Term Forecasts of Aurora

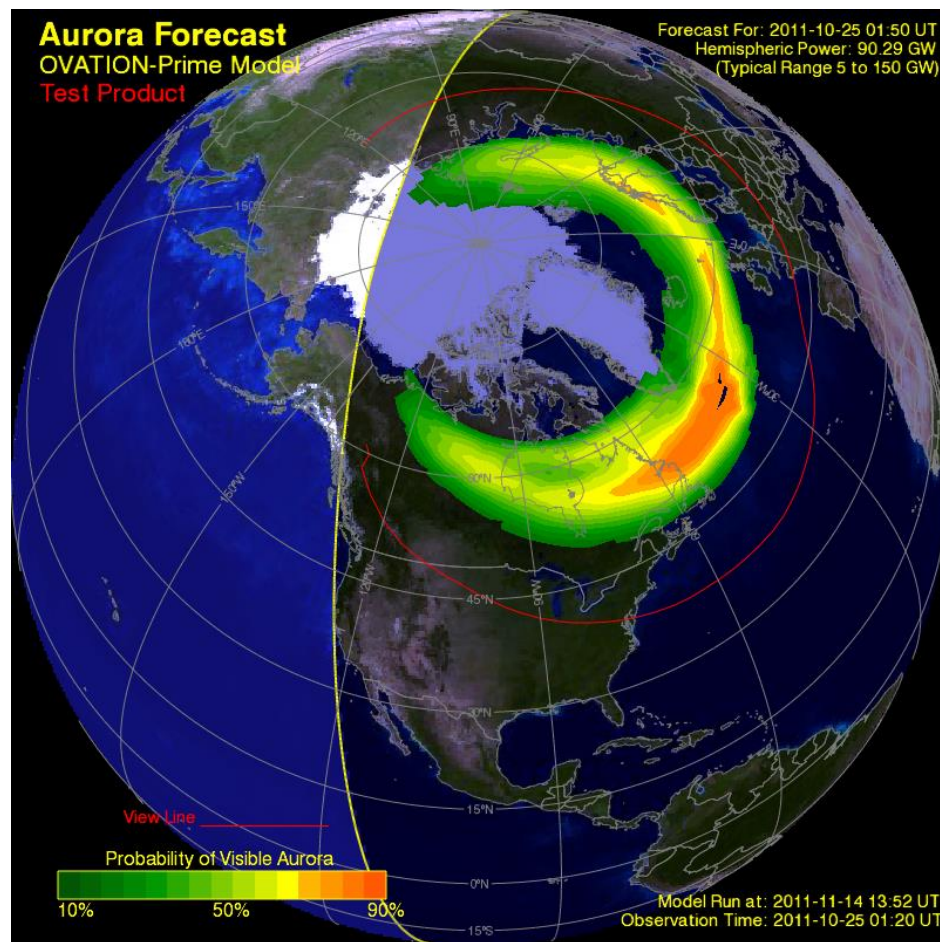
- Provides 30-50 min forecast auroral energy deposition in geomagnetic coordinates and hemispheric power (gigawatts).
- Runs on a 5 minute cadence.
- Empirical model based on DMSP particle data and driven by real-time ACE measurements at L1
- Improvements underway
  - Robustness
  - Expand to larger storms
  - Multi-day forecast
- Customers: Space Weather Models/products, GPS users, HF Com , DoD





# Ovation: Aurora Probability

- An additional OVATION product is a map of the aurora in geographic coordinates
- Designed as a forecast product for the public
  - Probability of aurora
  - Location of aurora
  - Intensity of aurora
- Customers: Aviation, Oil Exploration, Tourism industry, general public interested in viewing the aurora
- Status: In transition to operations



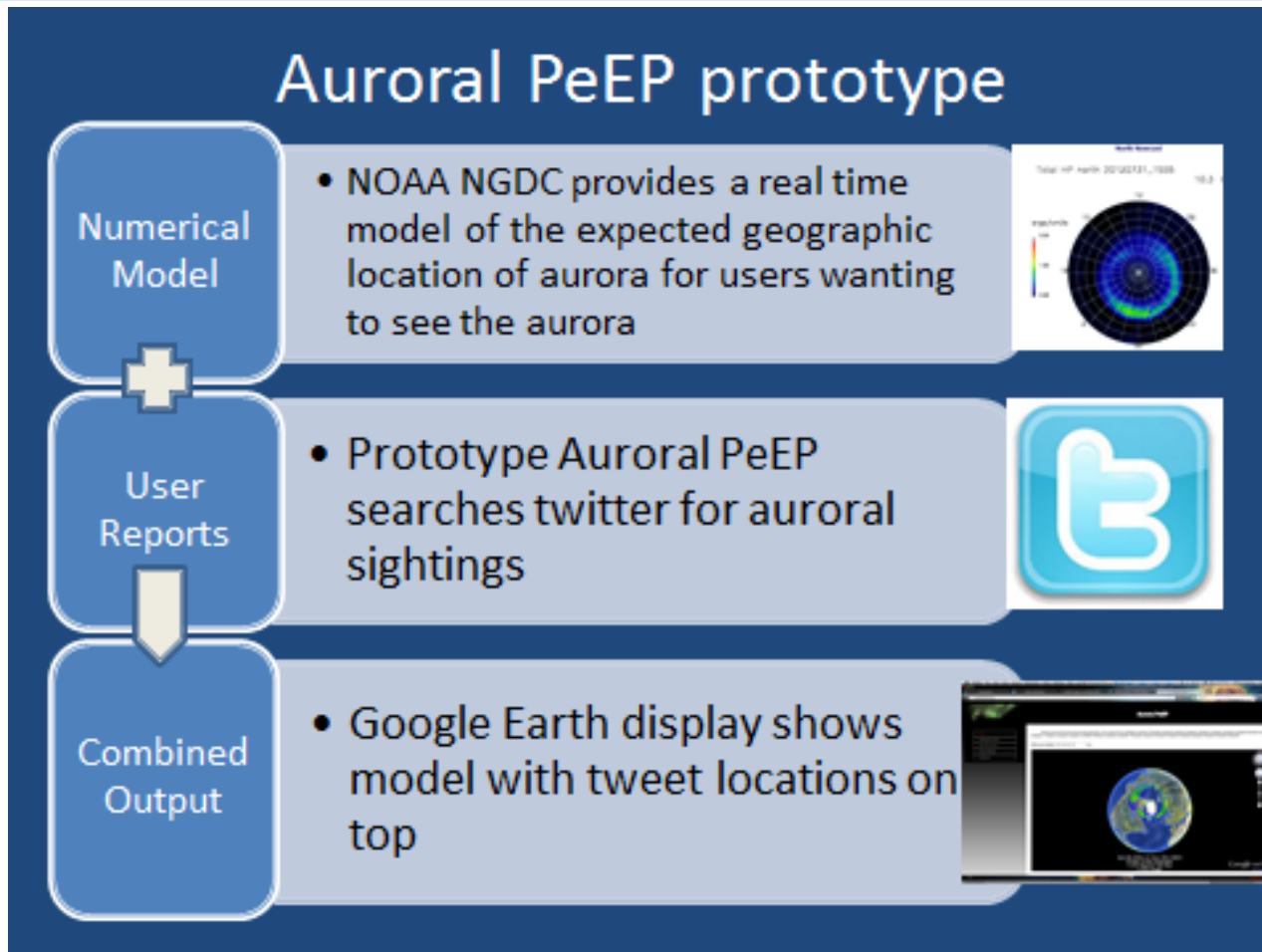




# PeEPs

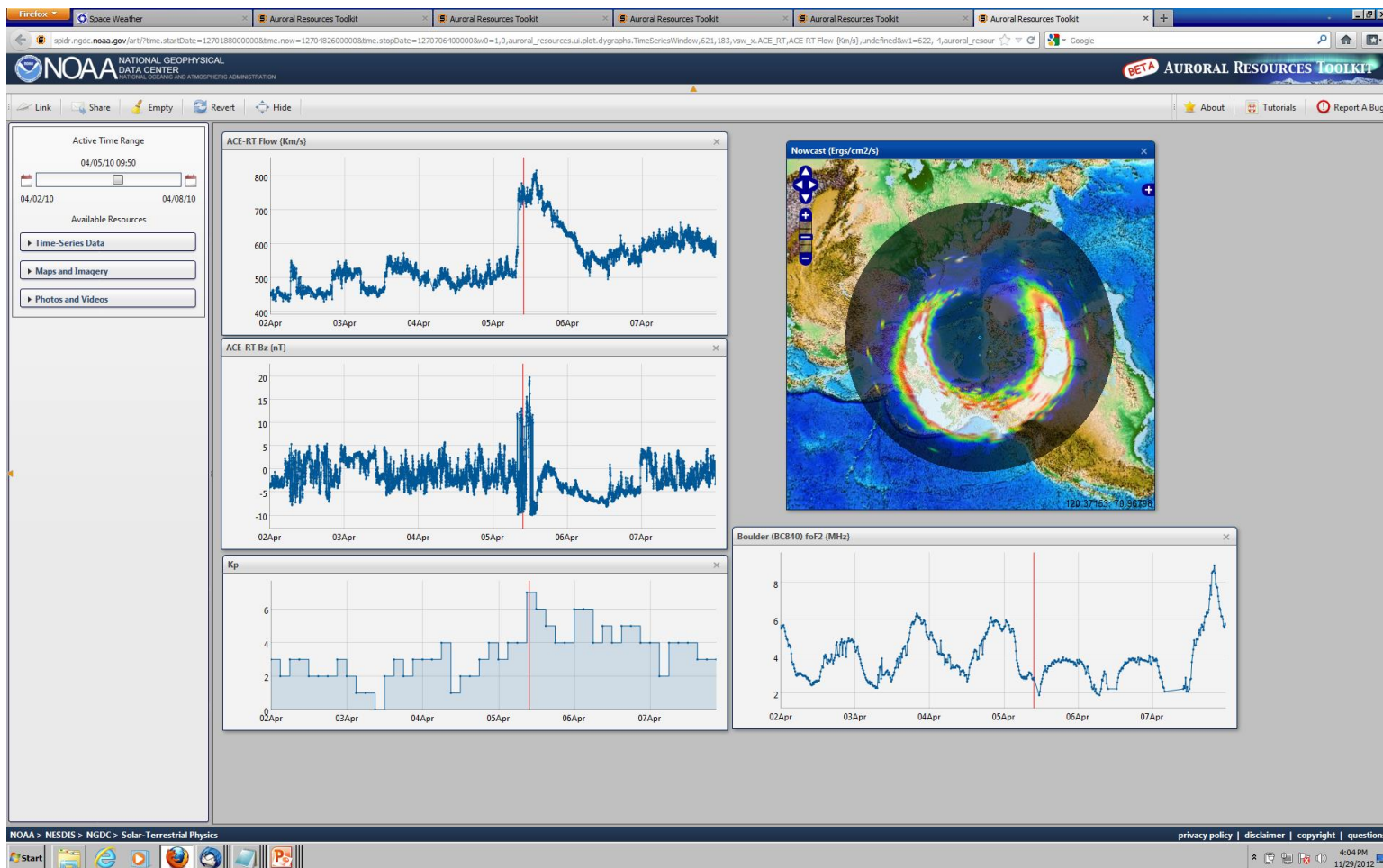
## People Empowered Products

Goal: To create a generic framework that incorporates user reports into NOAA real time and retrospective weather products





# ART Auroral Resources Toolkit



**A rich internet, open source application for visualization and collaboration of auroral phenomenology utilizing VxO best practices.**

Web access: <http://1.usa.gov/le0Q2V>



# Summary

## Concluding Remarks

- SWPC and NGDC have a number of “non-standard” products that are available or under development for the space weather community.
  - These products are driven by user and customer requirements.
  - Each product will go through a test and evaluation period where customer feedback will be solicited
- 
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  - ART          [Rob.Redmon@noaa.gov](mailto:Rob.Redmon@noaa.gov) 303 497-4331



# Thank You

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## Questions?





# References

## Additional Reading

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