

SPACE WEATHER OPERATIONS AND RESEARCH INFRASTRUCTURE: A WORKSHOP IN TWO PARTS

PART 2—VIRTUAL: SEPTEMBER 9-11, 2020

Relevance of Space Weather Prediction to Applied Positioning Activities



Nicole Kinsman, Ph.D.

Alaska Regional Advisor
NOAA National Geodetic Survey

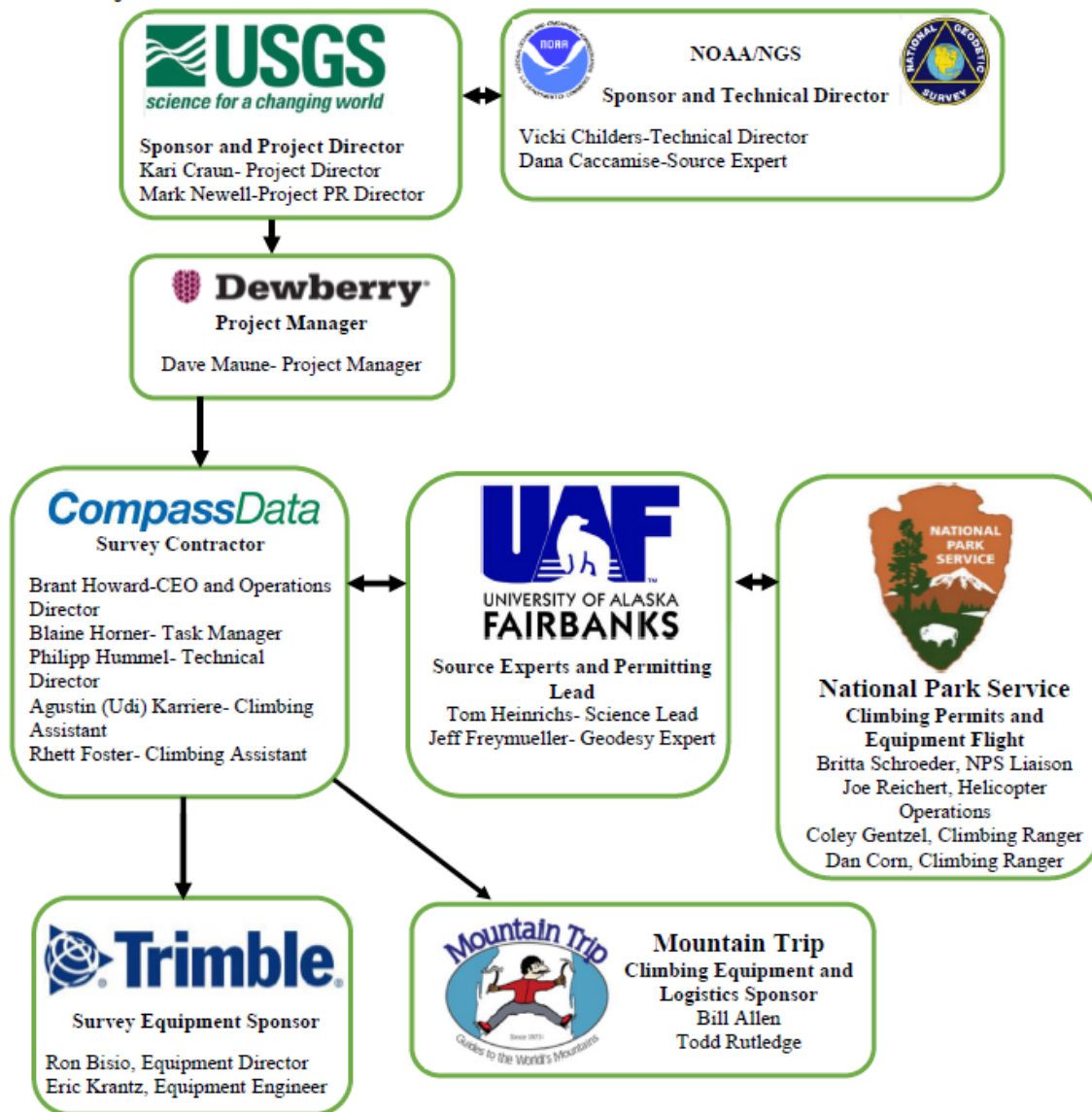
Currently on temporary assignment with:
IOOS and the Alaska Ocean Observing System

Special thanks to: Bill Murtagh & Rob Steenburgh



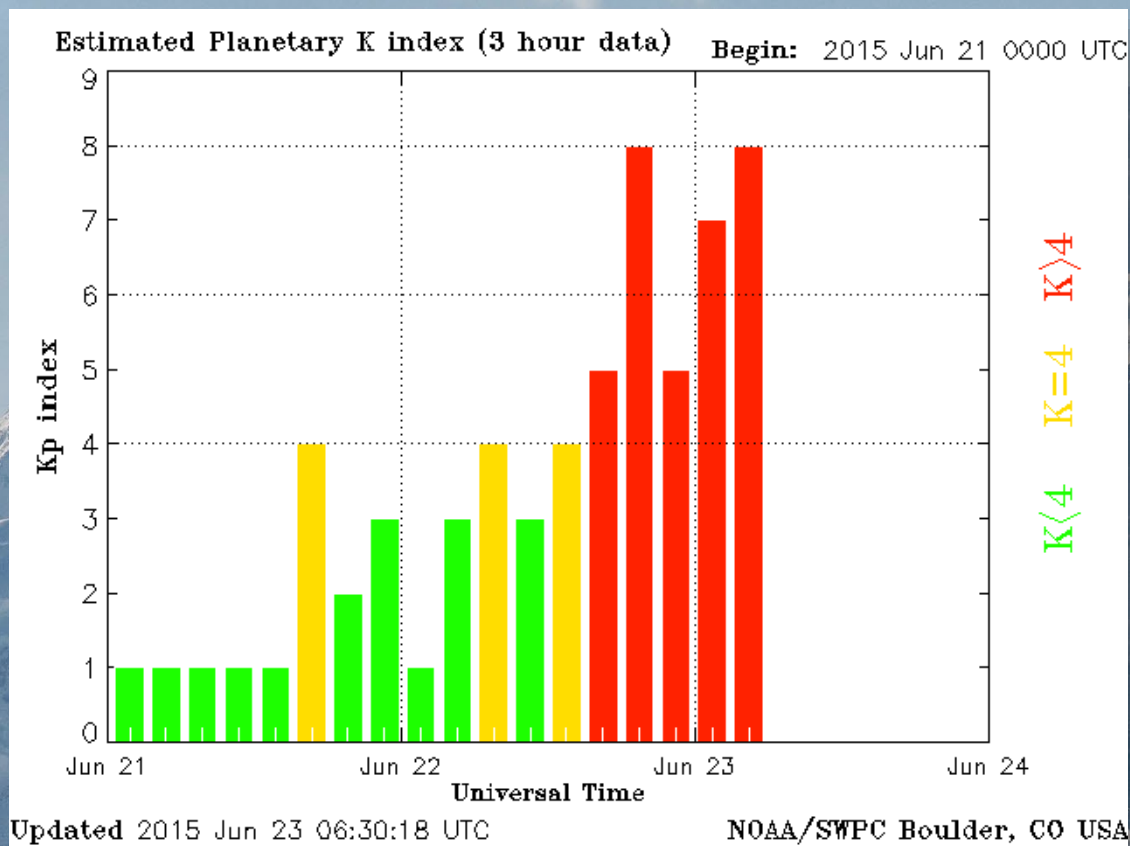
NATIONAL PRIORITIES SESSION

Project Team and Structure



Bluebird skies!
Oh, *but* the space weather!!!

June 24-25, 2015
summit window



SDO blended image in 131 and 171 angstroms of an M7.9 flare on June 25, 2015. Image Credit: NASA/SDO

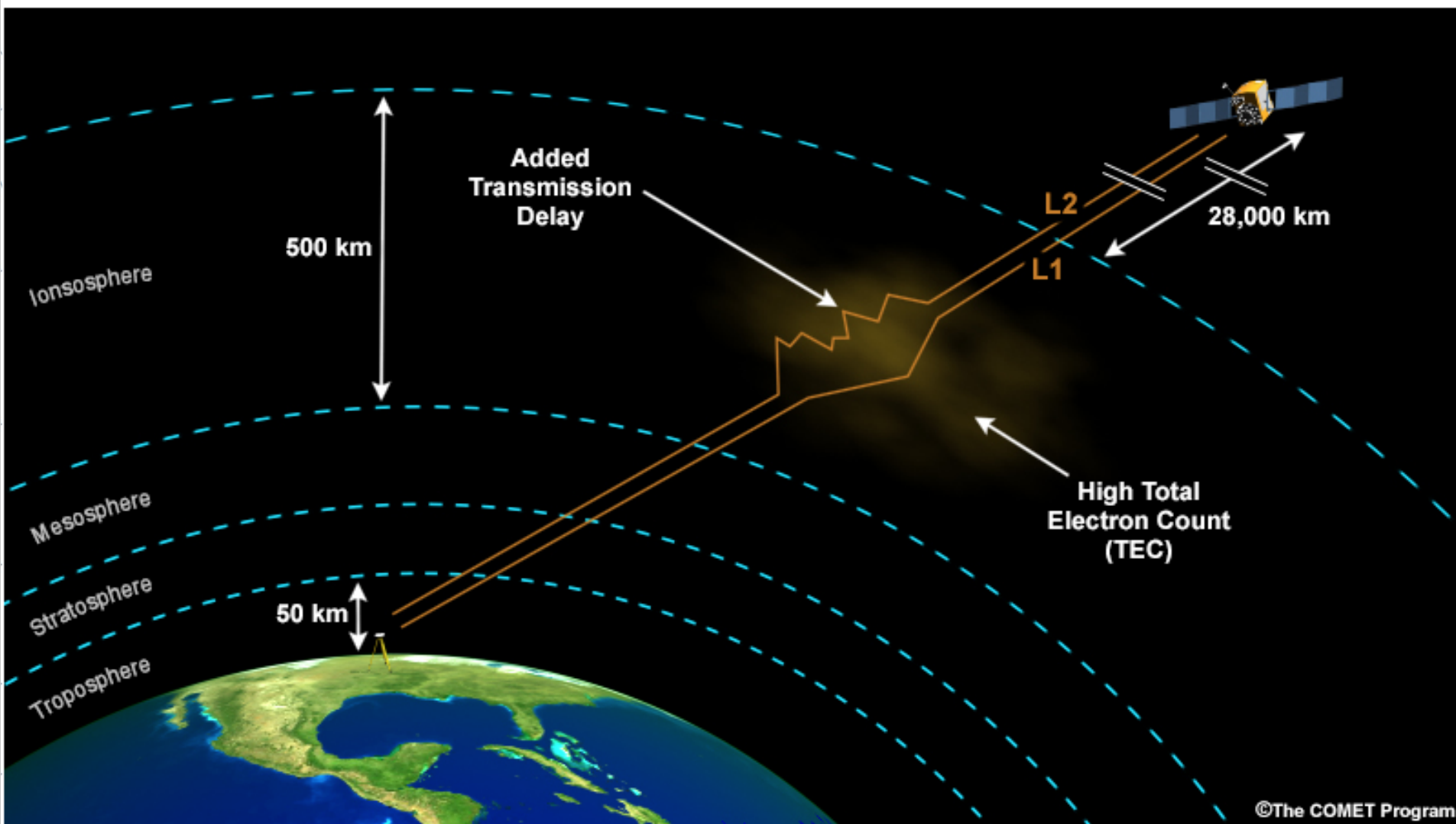


2015 Denali Survey Climbing Team



Image Credit: UNAVCO, 2015

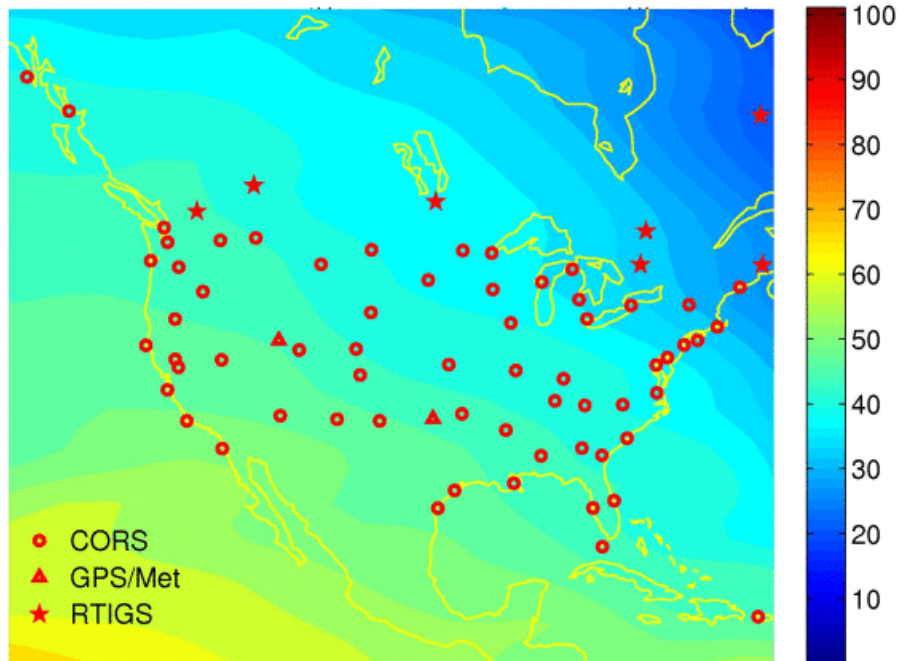
SPACE WEATHER AND GNSS SYSTEMS – RANGE ERRORS



TEC MAPS SUPPORT AUGMENTED GNSS

2/27/14 Ionospheric Storm:

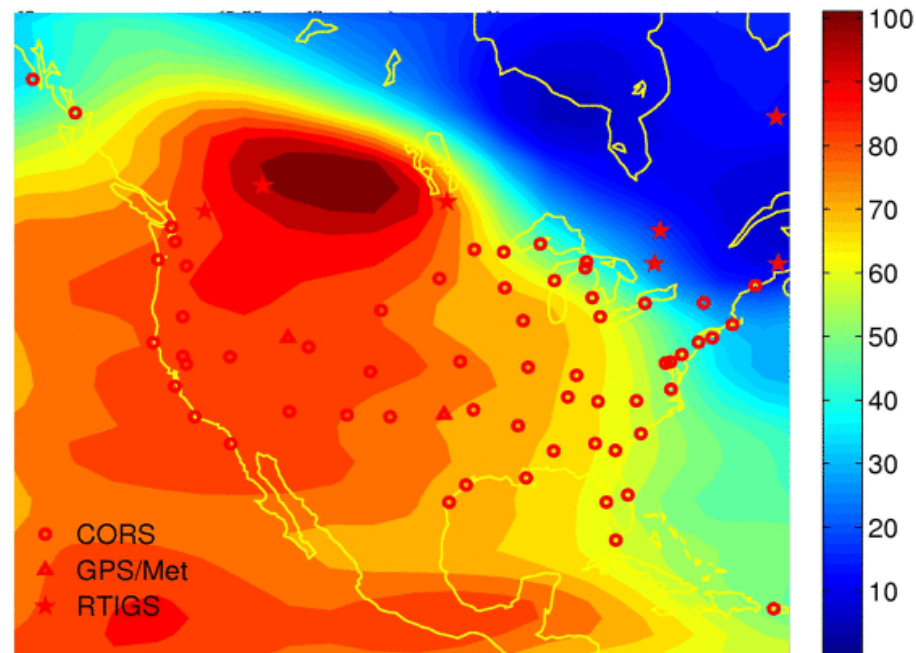
Total Electron Content Units $\times 10^{16} \text{ m}^{-2}$



26-Feb-2014 from 22:30 to 22:45 UT

NOAA/SWPC Boulder, CO USA (op.ver: 1.0)

Total Electron Content Units $\times 10^{16} \text{ m}^{-2}$



27-Feb-2014 from 22:30 to 22:45 UT

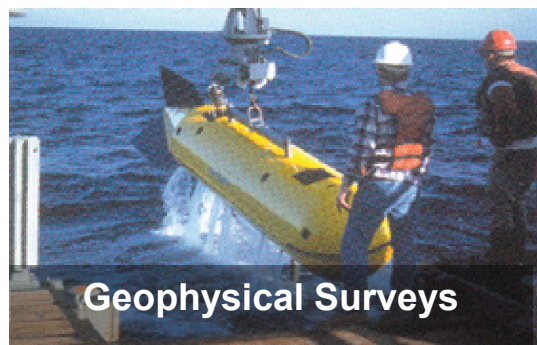
NOAA/SWPC Boulder, CO USA (op.ver: 1.0)

- Leverages the NOAA CORS Network as part of ground segment
- Used to estimate GNSS signal delay $\rightarrow$ GNSS positioning error
- Broadcast via FAA Wide Area Augmentation System

GNSS IS UBIQUITOUS



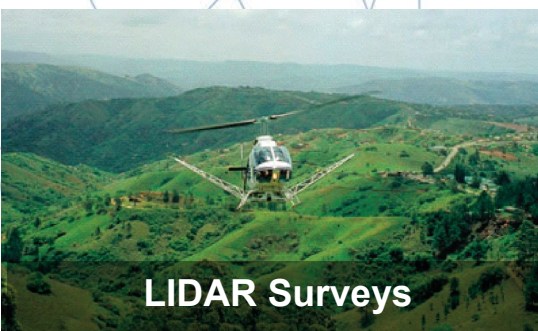
Positioning



Geophysical Surveys



**Marine
Construction Support**



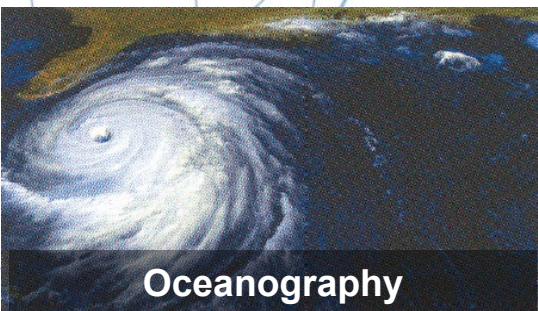
LIDAR Surveys



Seismic Data Collection



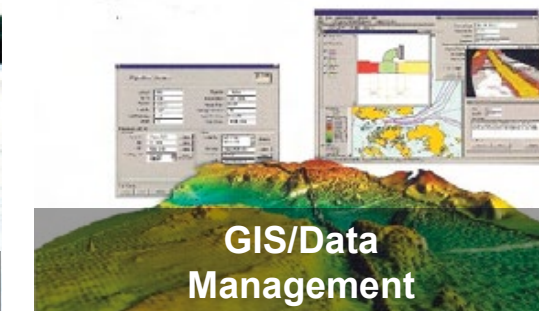
Submarine Cable Surveys



Oceanography



ROV / Diving



**GIS/Data
Management**

Diverse range of geo-location users are susceptible to space weather effects.

HIGH RESOLUTION LAND SURVEYING



Alaska project areas can be remote, unstable, and difficult to access.



DRILLING/SURVEY OPERATIONS

“We use GPS worldwide to position oilrigs and survey vessels, perform marine construction survey operations as well as a variety of airborne GPS survey operations...It is crucial to our organization to receive information on impending solar activity” - **FUGRO**

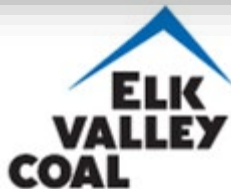
If airborne survey data, or marine seismic data, are useless or poor due to high solar activity levels...the financial and scheduling impact is significant, with costs in the **\$50,000 to \$1,000,000** range daily for large airborne and marine platforms.



MINING OPERATIONS

“I am a Mining Engineer employed in Canada for one of the world’s leading producers of metallurgical coal. Each mine is dependent on GPS system data for surveying, blast-hole drilling, automated mine dispatching, and geotechnical monitoring. Disruptions in GPS coverage as a result of solar activity can cause problems ranging from a minor nuisance to a severe production interruption...”

**- Mining Engineer
Elk Valley Coal Corporation
Calgary, Canada**



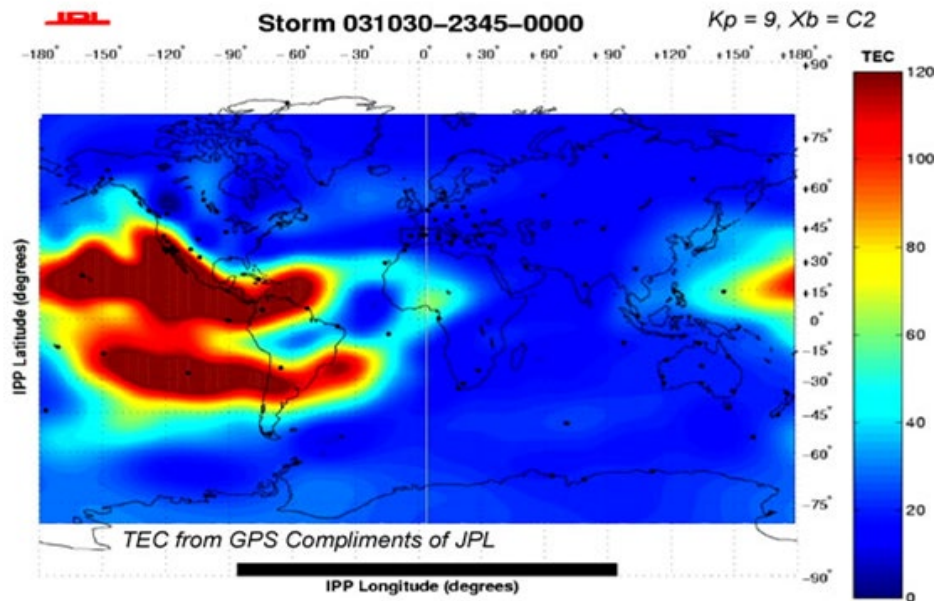
“The Solar warnings were very helpful. We encountered DGPS interruptions at the height of solar activity. These interruptions made the DGPS solutions un-reliable at the worst times. We ended up using primarily our acoustic array at the seabed as the primary solution for position when the DGPS solutions were affected. We now follow the Space Weather regularly. Thanks for your assistance.”

- Dynamic Positioning Operator on the C.R Luigs

MARINE DYNAMIC POSITIONING OPERATIONS



The C.R Luigs (an ultra-deep water drill ship) relies on GPS Dynamic Positioning System for precise drilling in 9,000 – 12,000 feet of water



NATIONAL PRIORITIES SESSION

SPACE WEATHER PREDICTION CENTER
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION



The National Academies of

SCIENCES
ENGINEERING
MEDICINE

CURRENT SPACE WEATHER CONDITIONS on NOAA Scales

Solar Wind Speed: 303 km/sec

Solar Wind Magnetic Fields: Bt 3 nT, Bz 3 nT

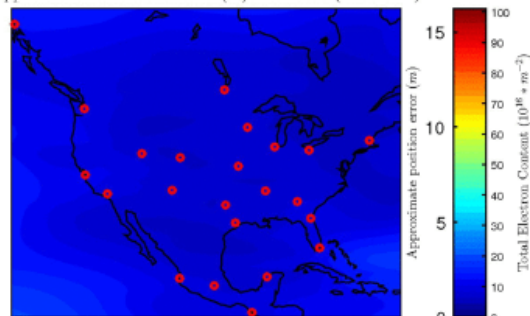
Noon 10.7cm Radio Flux: 70 sfu



GLOBAL POSITIONING SYSTEM (GPS) COMMUNITY DASHBOARD

U.S. TOTAL ELECTRON CONTENT

Approximate L1 Position Error (m) and TECu (10^{16} m^{-2})

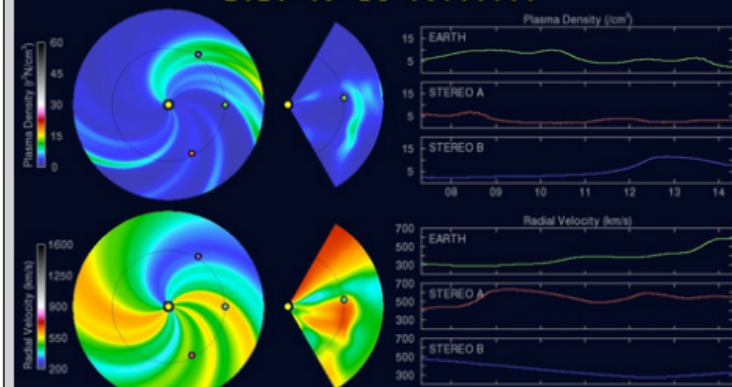


09-Sep-2020 from 09:15 to 09:30 UT NOAA/SWPC Boulder, CO USA (op.ver: 2.0)

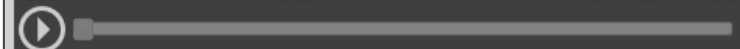


WSA-ENLIL SOLAR WIND PREDICTION

2020-09-14 08:00:00

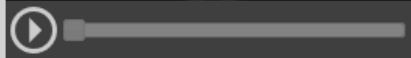
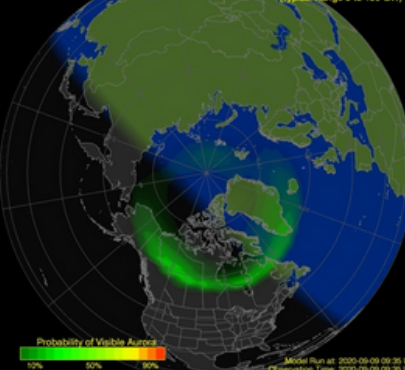


Space Weather Prediction Center Run Time: 2020-09-09 08:00 UT Mode: Ambient Image Created: 2020-09-09 08:28 UT

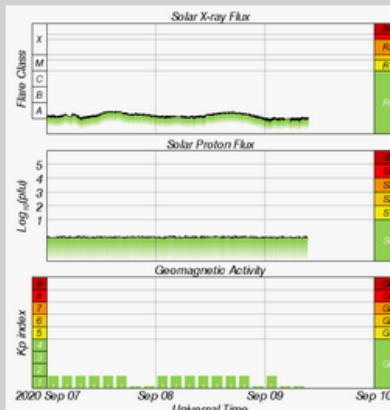


OVALION AURORAL FORECAST

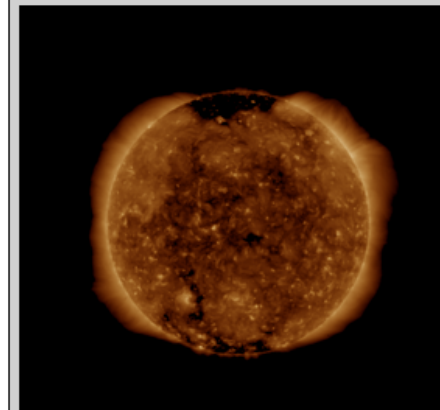
Aurora Forecast
OVALION-Prime Model
Forecast For: 2020-09-09 10:05 UT
Hemisp. Power: 10.14 GW
(Typical Range 5 to 150 GW)



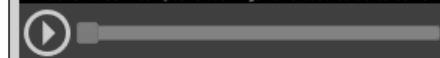
SPACE WEATHER OVERVIEW



GOES SOLAR ULTRAVIOLET IMAGER



GOES-16 SUVI Composite 195 Angstroms 2020-09-09 09:35:45



SUMMARY of NEED

- Space weather observations and predictions are of **great economic value** to the nation's positioning requirements
- Impacts on radio signals only **compound the effects in augmented GNSS systems**, including RTNs
- Space weather products are **in direct use** by precise-positioning professionals, particularly in high-latitude areas
- From precision navigation to unmanned systems, **GNSS operations are only expanding** in our daily lives
- **Desirable ionospheric model improvements** include more reliable TEC coverage, scintillation advisories, and advanced forecast windows

