Space Weather Impacts on GNSS Applications

Space weather describes changes in the near Earth environment from approximately 4 miles (6 km) to the surface of the sun. These changes can impact radio frequency signals including GNSS signals (e.g., GPS). The impacts to GNSS signals can range from a partial blockage resulting in errors in position/navigation/timing (PNT) to complete loss of signal resulting in a lack of position/navigation/timing information. The following survey asks general questions regarding the technology's and end user application's reliance on GNSS PNT information. It then seeks to understand the level of knowledge related to identifying potential impacts due to space weather events vs. other sources.

Public Burden Statement

A Federal agency may not conduct or sponsor, and a person is not required to respond to, nor shall a person be subject to a penalty for failure to comply with an information collection subject to the requirements of the Paperwork Reduction Act of 1995 unless the information collection has a currently valid OMB Control Number. The approved OMB Control Number for this information collection is 0648-O814. Without this approval, we could not conduct this Space Weather User Survey. Public reporting for this information collection is estimated to be approximately 15 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the information collection. All responses to this information collection are voluntary. Send comments regarding this burden estimate or any other aspect of this information collection, including suggestions for reducing this burden to the Dr. Jennifer Meehan, National Weather Service, NOAA, 1325 East West Highway, Silver Spring, Maryland, 20910; 301-427-9798, jennifer.meehan@noaa.gov.

* Required

Current Technological Systems or Components Affected by Space Weather

1. Which GNSS constellations or other Radio Navigation systems are currently used and/or are expected to be used in the future? (select all that apply) *

Check all that apply.

- [ ] GPS
- [ ] GLONASS
- [ ] Galileo
- [ ] BeiDou
- [ ] India
- [ ] QZZ
- [ ] SBAS
- [ ] Other: _____

2. How many types and sources of signals does the GNSS receiver use to track? (select all that apply) *

Check all that apply.

- [ ] Single Frequency
- [ ] Dual Freqency
- [ ] Triple Frequency
- [ ] Single constellation tracking
- [ ] Multi-constellation tracking
- [ ] Don't know
- [ ] None
- [ ] Other:

3. Which component and/or system depends on GNSS? *

Mark only one oval.

- ◯ User Interface
- ◯ Embedded receiver
- ◯ Don't know
- ◯ Other:

4. What is the order of magnitude of the ***accuracies/precision for timing required*** by the technological system and/or application? *

Mark only one oval.

- ◯ > 1 second
- ◯ 1milisecond to 1 second
- ◯ 100 microsecond to 1 milisecond
- ◯ 10 to 100 microsecond
- ◯ 1-10 microsecond
- ◯ 100 nanosecond to 1 microsecond
- ◯ 10 to 100 nanosecond
- ◯ 1 to 10 nanosecond
- ◯ <1 nanosecond
- ◯ Don't know
- ◯ Other:

5. Does the technological systems and/or application meet the ***accuracies/precision for timing required?*** *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Maybe
- ◯ Don't know

6. What is the ***sampling rate required*** by the technological system and/or application for either *time*? *

Mark only one oval.

- ◯ < 1 Hz
- ◯ 1 Hz
- ◯ 1-50 Hz
- ◯ > 50 Hz
- ◯ Don't know
- ◯ Other:

7. Does the technological systems and/or application meet the requirements specified ***sampling rate required?*** *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Maybe
- ◯ Don't know

8. What is the order of magnitude of the ***accuracies/precision for position/navigation required*** by the technological system and/or application? *

Mark only one oval.

- ◯ >200 meters
- ◯ 20 - 200 meters
- ◯ 2-20 meters
- ◯ 2 cm - 2 meter
- ◯ < 2 cm
- ◯ Don't know
- ◯ Other:

9. Does the technological systems and/or application meet the ***accuracies/precision for position/navigation required?*** *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Maybe
- ◯ Don't know

10. What is the ***sampling rate required*** by the technological system and/or application for either *position/navigation*? *

Mark only one oval.

- ◯ < 1 Hz
- ◯ 1 Hz
- ◯ 1-50 Hz
- ◯ > 50 Hz
- ◯ Don't know
- ◯ Other:

11. Does the technological systems and/or application meet the ***sampling rate required?*** *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Maybe
- ◯ Don't know

Current Risk Reduction and Resilience Activities

12. Does the technological system or application specifically note degradation in GNSS ***timing*** values? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Don't Know

13. Does the technological system or application note degradation in GNSS ***position/navigation*** values? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Don't Know

14. Does the system/technology depend on or use as a backup any other source of timing or position information? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Maybe
- ◯ Don't know

Current space weather impacts, and utilized observations, information, and forecasts.

15. Does space weather impact your operations and/or technological system? *

Mark only one oval.

- ◯ Yes
- ◯ No *Skip to question 23*
- ◯ Maybe

16. Which space weather events and/or parameters are important for your operations and/or technological system? *

Check all that apply.

- [ ] Aurora
- [ ] Geomagnetic Storms
- [ ] Ionosphere Density
- [ ] Indices (e.g, Kp, Ap, Dst, S4, F10.7)
- [ ] Scintillation
- [ ] Sunspot Number
- [ ] Solar Flares
- [ ] All of the above
- [ ] None of the above
- [ ] Other:

17. How often are ***operations and/or end users*** adversely impacted by space weather events? *

Mark only one oval.

- ◯ Daily
- ◯ Weekly
- ◯ Monthly
- ◯ Few Times a Year
- ◯ Unknown
- ◯ Other:

18. How often are the ***technological systems*** adversely impacted by space weather events? *

Mark only one oval.

- ◯ Daily
- ◯ Weekly
- ◯ Monthly
- ◯ Few Times a Year
- ◯ Unknown
- ◯ Other:

19. Does your application/system/component consider space weather conditions for planning or operations? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Don't know

20. What lead-times for space weather forecasts and products ***are used t***o implement ***current*** operational planning and mitigation activities? *

Mark only one oval.

- ◯ < 12 hours
- ◯ 12 - 24 hours
- ◯ 1 - 3 days
- ◯ 3 - 7 days
- ◯ Don't Know
- ◯ Don't Use
- ◯ Other:

21. Where do you get the Space Weather information currently used? (select all that apply) *

Check all that apply.

- [ ] National Guard
- [ ] NASA
- [ ] NOAA
- [ ] DoD
- [ ] Social Media
- [ ] Other:

22. What lead-times for space weather forecasts and products ***are needed*** to implement ***current and future system*** operational planning and mitigation activities? *

Mark only one oval.

- ◯ < 12 hours
- ◯ 12 - 24 hours
- ◯ 1 - 3 days
- ◯ 3 - 7 days
- ◯ Don't Know
- ◯ Don't Use
- ◯ Other:

New or Non-traditional Sources of Space Weather Data

23. Does your application/system/component monitor ***anomaly and/or environmental*** conditions? *

Mark only one oval.

- ◯ Yes
- ◯ No *Skip to question 26*
- ◯ Maybe
- ◯ Don't Know

24. For how long is the information and/or data stored? *

Mark only one oval.

- ◯ < 30 min
- ◯ 30-60 min
- ◯ 1 - 24 hours
- ◯ 1 - 7 days
- ◯ > 1 week
- ◯ Don't know
- ◯ Other:

25. Can this information/data be shared outside of the application, company, or community? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Maybe
- ◯ Don't know

Follow-up Interview Participation

26. Are you willing to be part of an in-depth virtual/phone interview lasting no more than 60 min? *

Mark only one oval.

- ◯ Yes
- ◯ No *Skip to question 28*
- ◯ Maybe

27. If Yes, please provide your preferred contact information (e.g., email, phone)

Others Recommended and General Comments

28. Please provide name/contact information of others you recommend being contacted for the survey and/or interview.

29. Do you have any other comments related to space weather impacts on your technology/applications?