Participant information

Thank you for responding to this survey. After a small set of demographic questions, there will be 8 space weather questions, each of which includes an optional free-text followup where you can enter any comments. The survey should take 10-15 minutes to complete.

The survey will be open until May 12, 2023. Once complete, the mean response for each item will then be posted on www.apollosurveys.org, along with the individual responses of each participant. If you choose to not have your name shown, your responses will be listed as "Anonymous" on www.apollosurveys.org.

* 1. Participant Info [Required, although we will only display this if you choose not to be anonymous]

Full Name

Institution (typically a university name)

* 2. Would you like your responses to be anonymous?

- ◯ Anonymous
- ◯ Show my name

3. Which physical domain do you consider your primary area of expertise?

- ◯ Solar interior
- ◯ Photosphere
- ◯ Chromosphere
- ◯ Corona
- ◯ Near-Sun heliosphere (0.1 - 0.7 AU)
- ◯ Near-Earth heliosphere (0.7- 1 AU)
- ◯ Magnetosphere
- ◯ Ionosphere/Thermosphere
- ◯ Ground-based

4. How would you best describe your role?

- ◯ Primarily space weather research
- ◯ Primarily space weather forecast practitioner
- ◯ Mixture of both

5. If the Carrington event were to occur today without any warning, what do you think the impact would be? (Check all that apply):

- [ ] Regional power outages
- [ ] Continental power outages
- [ ] Widespread radio communication issues
- [ ] Widespread loss of internet
- [ ] Space hardware damage/failure
- [ ] Significant health risk to airline crew/passengers
- [ ] None of the above

6. Any comments? These will be shown with your responses. (Limit to 50 words.)

7. Cosmogenic isotope data – such as 14C and 10Be – suggest that significantly larger solar energetic particle events occurred in the last few thousand years than in the last few centuries, but it is not clear if this also translates to larger geomagnetic storms in the past. Does the nearly 200-year record of geomagnetic observations cover the likely range of impacts to the power distribution grid over the next 50 years?

- ◯ Yes, the geomagnetic record covers the likely range of power grid impacts
- ◯ No, but likely range is only slightly (10-50%) higher
- ◯ No, the likely range is moderately (50 -100%) higher
- ◯ No, the likely range is significantly (>100%) higher

8. Any comments? These will be shown with your responses. (Limit to 50 words.)

9. Which factors most limit our ability to make accurate space weather forecasts with 1-day lead time? (Rank from most limiting to least limiting)

- ≣ ☐ Observational limitations
- ≣ ☐ Incomplete physics knowledge
- ≣ ☐ Inherent unpredictability of the system
- ≣ ☐ Insufficient computational capability
- ≣ ☐ Lack of routine forecast verification and benchmarking

10. Any comments? These will be shown with your responses. (Limit to 50 words.)

11. What is the biggest challenge to delivering actionable forecasts of an extreme (Carrington-scale) space weather event?

- ◯ Detection/observation
- ◯ Distinguishing damaging events from those with negligible effect
- ◯ Effective dialogue with end users, such as power companies and satellite operators
- ◯ End users willing and able to act on forecast advice

12. Any comments? These will be shown with your responses. (Limit to 50 words.)

13. Assume that end users can take effective action for an extreme geomagnetic storm if given a sufficiently accurate forecast with 5 hours notice. Given current observation and modeling capability, what is the likelihood that forecasts will be sufficiently accurate by that time?

- ◯ Highly likely
- ◯ Somewhat likely
- ◯ Roughly even
- ◯ Somewhat unlikely
- ◯ Highly unlikely

14. Any comments? These will be shown with your responses. (Limit to 50 words.)

15. Given everything you are able to estimate about occurrence of extreme space weather and susceptibility of our technical infrastructure, what is the probability in the next 10 years that a space weather event will cause unplanned regional power outages? Please enter a percentage followed by the % symbol.

16. Any comments? These will be shown with your responses. (Limit to 50 words.)

17. Improved observations of which of these physical domains would have the highest return on investment for space weather forecasting?

- ◯ Solar interior
- ◯ Photosphere
- ◯ Chromosphere
- ◯ Corona
- ◯ Near-Sun heliosphere (0.1 - 0.7 AU)
- ◯ Near-Earth heliosphere (0.7- 1 AU)
- ◯ Magnetosphere
- ◯ Ionosphere/Thermosphere
- ◯ Ground-based

18. Any comments? These will be shown with your responses. (Limit to 50 words.)

19. How would you invest around $1B to best improve space weather forecasting, either through improved accuracy or improved lead time?

20. In the next decade, to what degree can machine learning and neural network approaches replace or complement physics-based models for forecasting extreme space weather with a 1-day lead time?

- ◯ Not at all
- ◯ A little
- ◯ A lot
- ◯ Completely

21. Any comments? These will be shown with your responses. (Limit to 50 words.)