

# Status of ICAO Space Weather Advisory Issuances, Including Large-Scale Space Weather Events in May 2024

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We have conducted an analysis of ICAO space weather advisory issued over the past approximately four and a half years. Space weather activity is increasing as we approach the maximum of the current solar activity cycle, resulting in a significant increase in advisory issuances. The number of advisories released in the past seven months nearly equaling the total issued during the entire four-year period from November 2019 to October 2023. This presentation will provide an overview of the recent status of ICAO advisory issuances, including a summary of the space weather events in May 2024.

**Key Words:** Space weather, ICAO, Advisory

## 1. Introduction

Space weather refers to changes in conditions around the Sun and Earth. These changes can potentially impact our activities and social infrastructure including aviation operation. Solar activity has an 11-year cycle. Solar activity is now increasing as it approaches its maximum period around 2025. The solar active region 13664 produced 13 significant solar flares, including an X8.7 class flare occurred on May 14, 2024 (UTC), which represents the largest solar flare event of the current solar cycle. The coronal mass ejections associated with these solar flares triggered the large geomagnetic disturbances, resulting in widespread low-latitude auroras.

The International Civil Aviation Organization (ICAO) initiated space weather service on November 8, 2019. Four global centers are responsible for monitoring and providing "advisories" related to high-frequency (HF) communications, Global Navigation Satellite Systems (GNSS), and human radiation exposure when severe risks are occurred/forecasted. The Australia-Canada-France-Japan Consortium, of which the National Institute of Information and Communications Technology is a constituent member, serves the information as one of the four global centers.

## 2. Advisory Issuance

There are two advisory levels: moderate and severe. The criteria for these levels are defined<sup>1)</sup> in Table 1.

Since the start of the space weather service in November 2019, all advisories issued by the four centers have been counted, as shown in Fig. 1 for GNSS and in Fig. 2 for HF. Radiation advisories have not been issued so far. The number of advisories issued in the past seven months nearly equals the total issued during the entire four-year period from November 2019 to October 2023. Particularly, the total of 111 HF advisories issued in May 2024, which is four times higher than any other month.

In this presentation, we will provide an overview of the recent status of ICAO advisory issuances including a summary of the space weather events in May 2024, and discuss how we approach to improve the advisories.

Table 1. Criteria for advisory issuance

impact	Index	Moderate	Severe
GNSS	Amplitude scintillation $S_4$	0.5	0.8
	Phase scintillation $\sigma_\phi$ [rad]	0.4	0.7
	Total electron content (TEC) [TEC unit]	125	175
RADIATION	Effective dose [ $\mu$ S/h]	30	80
HF	Kp index	8	9
	Riometer @30MHz [dB]	2	5
	Solar X-ray (0.1-0.8 nm) [ $W/m^2$ ]	$10^{-4}$ (X1)	$10^{-3}$ (X10)
	Depression of maximum usable frequency	30%	50%

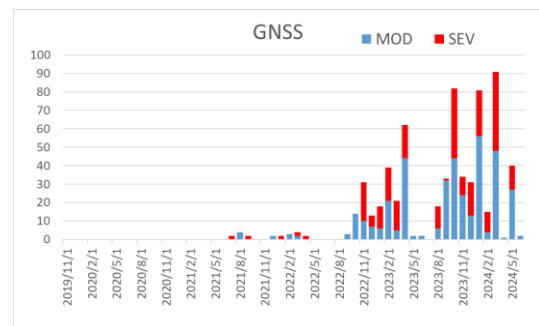


Fig. 1. Number of GNSS advisory issuance per month

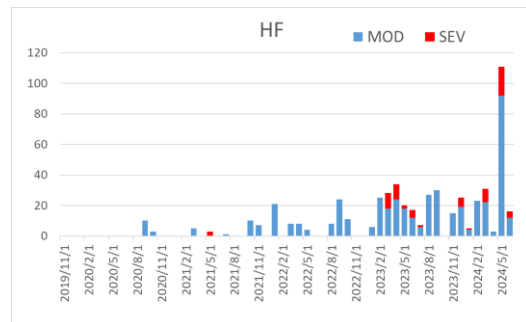


Fig. 2. Number of HF advisory issuance per month

## References

- 1) International Civil Aviation Organization. Manual on Space Weather Information in Support of International Air Navigation (Doc 10100), 1st ed.; ICAO: Montréal, Canada, 2019.