



# Topical Discussion Meeting report

**Name of the meeting:** ICAO Space Weather: Early experience and ways forward

**Conveners:** Marcin Latocha (Seibersdorf Laboratories), Klaus Sievers (European Cockpit Association, ECA), Issaad Kacem (ESSP)

**Secretary:** Issaad Kacem (ESSP)

**Data – Time – Room:** Friday 24<sup>th</sup> November, 2023 at 11:45-12:45 – Room Guillaumet

**Number of participants:** ~70

**Form of TMD:** Service/Project Feedback - Discussion on Space Weather Service for ICAO inspired by three pre-defined questions.

## TDM Abstract

Space weather events have caused disruptions to aviation communications, navigation and surveillance systems, and increased radiation exposure at aircraft cruising levels in a non-acute fashion. The aviation industry is becoming increasingly aware of these impacts. On 7<sup>th</sup> November 2019, the International Civil Aviation Organization (ICAO) launched a real-time worldwide space weather service for aviation. After four years, it is time to discuss the experience of Airlines, Air Navigation Service Providers, Authorities, Pilots and other stakeholders in Aviation with the service. What direction should developments take, which improvements or new services are desired?

## Objective of the TDM

The objective of this TDM was to discuss the experience of Airlines, Air Navigation Service Providers, Authorities, Pilots and other stakeholders in aviation with the ICAO space weather service for aviation in order to identify the direction in which developments, improvements or possible new services to be developed should go.

## Discussion highlights

The discussion highlighted the need to establish communication between the service providers and the end users on a regular basis in order to get the feedback needed to improve the service. The creation of a working group to find out what information airlines (or airline organizations) could share with service providers/developers has been also discussed. Some improvement in advisories have been also identified. It was also concluded that the four global centres should communicate, coordinate closely, consider data sharing and to think about initiating a global collection of incidents dedicated for aviation. A concern was raised on how to finance the investments required for improvement of the service.

## Main conclusions of the meeting

Communication seems to be the key point for further improvement. That needs improvement at several layers: communication between airlines and service providers (especially involvement of airlines), between airline organisations and service providers, among various service providers and as well among model developers. Some successful examples exist like space weather forums, on request trainings for pilots, space weather exercises organized by airline organisations, and model comparisons organized by service providers. This needs to be continued and developed further.

For pilots, advisories should be impact-based. This may help in verification of advisories and also help in defining actions that pilots need to take during a flight. On the other hand, the EACCC (European Aviation Crisis Coordination Cell at EUROCONTROL) seems to be interested in a prediction of huge space weather events causing various critical conditions, rather than in receiving impact-based advisories that don't lead to critical situations.

Verification and validation of the advisories are important to avoid issuing false alarms that in turn would trigger unnecessary actions. Here the following aspects were identified: careful instrument calibrations; cross-correlation with registered issues on board aircraft (for impact based advisories); further model developments aiming at better performance and reduced uncertainty; model comparison; data sharing. Almost all identified aspects require appropriate communication and possibly more open data sharing.

## Annexes

### Minutes of meeting:

#### Question 1: How to make aviation aware of space weather and the need to prepare?

- It is important to reach out to aviation.
- The South African National Space Agency (SANSA) representatives informed that the SANSA' SWX centre organizes regularly SWX forums to communicate with the aviation community. During these meetings, they present the SWX impacts on aviation. They also organize some training for the users on request. SANSA is already certified as an aviation training school by the South African Civil Aviation Authority (SACAA).
- The SWX community needs to understand how aviation people think. In fact, the only criterion that is important for pilots is to know whether they have to do something or not. If they have to react, it will be easier to reach them since they need to act. For them, the situation as it is right

now is too exoteric. Demonstrating impacts that could happen may help. At the moment, it is not clear for pilots if the observed effects are caused by space weather or not.

- The scientific community can show what may happen but cannot tell aviation how to react. It is therefore important that the scientific community shows the impacts of space weather on aviation and to start discussions between both scientists and aviation on this topic.
- One important point is also to avoid overloading the aviation with too much information. There are already such kinds of discussions in several countries such as the United Kingdom. The exercise that has been made recently by EUROCONTROL and which addressed an extreme space weather event is also valuable to engage discussions with the aviation community.
- The scientific community has already shown proofs of space weather related impacts on aviation that happened in the past. But it is important also to better understand the daily operations. In Europe, there is a clear problem with databases because every country has a different database for the ionospheric data for example.
- There is a clear need to have discussions between the service providers and the end users. We need to have discussions about creating a platform for sharing impact data and to consider sharing data among the four global centres providing the service (PECASUS, ACFJ, SWPC and CRC). There is currently no global collection of incidents dedicated for aviation.
- It is important to highlight one contradiction: the ICAO SWX service exists because the airlines asked for it; however they seem to be no longer interested in it. For instance, regarding the recent exercise made by EUROCONTROL, the big companies did not provide any feedback. Only some airlines responded.
- There is a need to exchange through creation of a working group able to work on data that airlines can (or are willing) to share to outside. Currently, we do not get any feedbacks from airlines to improve our service. We noted that no one during the TDM identified himself as working for an airline or air traffic control organisation (other than the invited Eurocontrol speaker from the plenary meeting).
- It is time to have EASA & EUROCONTROL workshop again. EASA and EUROCONTROL collect reports and data. It is important to get EASA, EUROCONTROL and users together to have more meetings on a regular basis. EASA is now involved. They participated in a workshop with an SWX expert group. There is actually a lot of talking, but what we need is actions. Also the question is who will provide the resources needed and pay for that?

From an aviation point of view, these actions are not urgent since nothing happened until now so far. Even if nothing happened recently, there are some historical events with some impacts. We have to keep in mind that we may have similar events again soon. We therefore need to do something now because it is clear that such events will happen again. "We cannot wait for a tragedy to act; things need to be done before." We have to keep pushing the organizations to spend more time on studying the impact of space weather on aviation.

- EUROCONTROL exercise on severe space weather. EUROCONTROL considered 16 scenarios. ICAO co-organized the exercise of this year but discussion is ongoing on European level with ICAO to look in a more structured way because participation was not enough. These exercises

could help to provide reports about the possible impacts and should be organized more regularly.

- When we try to contact people to discuss the impacts related to radiation and to ask them about the tools and procedures they are using, we conclude that there is a “parallel world”. We need to communicate because the service could be not aligned with what they need.
- We need to get people to reach each other and to communicate.

### Question 2: How to introduce verification into SWx for aviation?

- The first comment was that this question is more addressed to scientists. Users want as precise information as possible. When the comparison of radiation codes among the four global centres has been done, it was noticed that the centres may issue different advisories at different times; we have to decide what to do about that. This is a common problem for GNSS and HFCOM advisories also. The four centres need to communicate to harmonize advisories. Model developers need to communicate to improve models’ quality and reduce uncertainty.
- The scientists established during the last solar cycle most of the tools available now. These are trustful tools but not all of them have been validated. Validation of models is a serious task to be done continuously. It is a difficult task. For example, for radiation, due to anisotropy effects NH vs SH, latitude cut-off...
- Another comment disagreed with the comment stating that the verification is a matter for scientists only because the service is an “impact base” service.  
Within the increasing phase of solar cycle SC25, more advisories are being issued for equatorial area according to the threshold defined by ICAO. But we need to know how do pilots “see” these scintillations. We are sure to see scintillation with our scientific instruments but we need to know what the impact of this scintillation is and to collect the information about that. Radiation advisories are based on a “direct impact”, but for GNSS advisories it is not the same. This is why we need information from airlines end operators about the area, region and time of the impact and whether they were able to use another system while the impact was lasting. We need the users to get involved because their input can help validating our models.
- It is important not to forget that pilots already have a significant workload. They do not want to take on additional tasks by doing reports about the impacts. If reports are really needed, we have to automate this task.  
Airbus keeps a track of GNSS issues, but it is not clear whether this is done globally or locally. For those who are interested in having this data, they should consider contacting Airbus. However, it may be difficult to have access to this data since Airbus and BOEING did not even answer solicitations regarding EACCC exercise.  
EUROCONTROL has also some data about the impacts because they monitor the performances of GNSS. It is a common interest to have access to this data.
- Regarding the advisories, we know which area is impacted but we do not know which flight is impacted. We have to provide this information automatically to airlines. The question on if this

can be really done automatically was raised. The scientific community thinks that this is possible and they have plenty of ideas to do it but they need specific resources for that.

- There are currently more than 500 GNSS advisories issued but no feedback from airlines to consider reviewing the thresholds that may be low – or high - for example. It is also important to keep in mind that we may miss advisories. We should also think what to do when we missed an advisory. Suggestion was: The best way to assess that on a large scale is to reach airlines.
- Considering radiation measurements, it is possible to install instruments on board aircrafts, even though it may be complicated to keep them flying for a long time. In the past, these instruments helped providing measurements from the Halloween storm. This example shows the direction to follow. If we do not want to add high workload on pilots to get their feedback, we may consider having innovative instruments along with automated procedures to validate our models without putting additional workload on pilots. But is that feasible for GNSS too?
- Regarding radiation dose measurements, if the big companies do not want to put detectors on board their aircrafts, it is possible to put the simple instruments on some individual flights. But it is important to have very well understood and calibrated instruments otherwise the measurements would have only limited value to scientific community.
- There are currently more than 30 ground level neutron monitor stations worldwide that can be used for modelling of GLEs. The MET office will launch a radiosonde to detect GLEs and monitor radiation.
- Beyond verification and validation, there is a need for further model improvements.

### Question 3: What key improvements to ICAO SWx are needed?

- Many points have been touched during the presentations of the plenary session P03 dedicated to space weather services for aviation: thresholds, response times, phraseology...
- Advisories are not accurate and not specific. The remark field (RMK) is very general and not so clear. There is no way to check if we really have a problem based on the RMK field and the effects of the impact are not really specified. The chain to issue an advisory is very long and includes many manual steps; therefore the time for the advisories to be disseminated is too long. The distribution chain needs also to be reviewed because end users are not always reached. When inquiries are made regarding the reasoning behind set thresholds, specific and clear responses are often lacking. EACCC is not interested in impact based advisories but rather in a prediction of huge solar events that may lead to critical situations.
- Regarding radiation, the time until an ICAO advisory is sent out is too long because by the time the advisory is received, the radiation dose would have already changed. Perhaps it would be better to use gradients rather than threshold-values alone.
- It is interesting to share data among the four global centres and to agree whether to strictly follow the “cookbook” or to permit additional verifications. For instance, the equatorial plasma bubbles (EPBs) may not be considered as a potential source of impact even though the thresholds could be reached there.

- Regarding the comparison of the different models used by the four global centres, this work has been done to compare six radiation models to compare results on GLE events. For HF COM models, NICT has a data server that aims to build a harmonized database and to compare models. Comparison of GNSS models has not started yet but a new sub-team may be created for that purpose.
- The period from 2015-2018 marked the beginning of the discussions, involving many experts and institutes. It was essential to start somewhere, now we need to focus on continuously improving the service.

**Material presented:**



The banner features a stylized satellite in the foreground, a large red sun in the background, and a city skyline. Text on the banner includes '20-24 NOVEMBER', 'EUROPEAN SPACE WEATHER WEEK 2023', and the tagline 'BRINGING SPACE WEATHER SPACE CLIMATE AND ENGINEERING TOGETHER'.

**Topical Discussion Meeting:**  
*ICAO Space Weather Advisories for Aviation*

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**Thank you to everyone who contributed to our session preparation:**

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## QUESTION 1

How to make aviation aware of space weather and the need to prepare ?



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## QUESTION 2

How to introduce verification into space weather for aviation ?



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## QUESTION 3

What key improvements to ICAO SWx are needed ?



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