Solar Influences
Data analysis Centre

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Solar Influences Data Analysis Center (SIDC)

Validation of space weather advisories for aviation

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Reliable High Frequency communication (HF COM) is critical especially for trans-Atlantic and polar flights. The HF COM can be strongly affected by space weather disturbances, such as strong geomagnetic storms, solar flaring and solar energetic particles events. In this study we perform a first validation of the HF COM advisories issued by the ICAO space weather advisory service for aviation, using in situ verification of HF COM quality in Reykjavik Control Area.

600

200

266

PCA only



Impact Area	Parameter (Unit)	Moderate	Severe
HF	Auroral absorption (Kp)	8	9
	PCA (dB from 30 MHz riometer data)	2	5
	SWF/Solar X-ray (W/m ²) (0.1–0.8 nm)	10^{-4}	10^{-3}
	MUF (%)	30	50

(1) We visualised all ICAO HF COM advisories of 2024 on a timeline, as well as the HF COM quality experienced by Radio Iceland for the *Reykjavik Control Area* (reports every 4 hours, ranging from "Fairly good" to "Blackout").

We observe a clear correlation between degraded HF conditions and PCA advisories/Proton events. In 12 out of 16 PCA events degraded HF communication was detected.

When there was no PCA but only AA or PSD no degradation in HF COM was detected, hinting that PCA is the main space weather driver for HF COM degradation experienced in the Reykjavik Control Area.

Isolated cases of HF COM degradation, independent of any space weather events can be identified.

intervals

HF COM was

Check if any Iceland

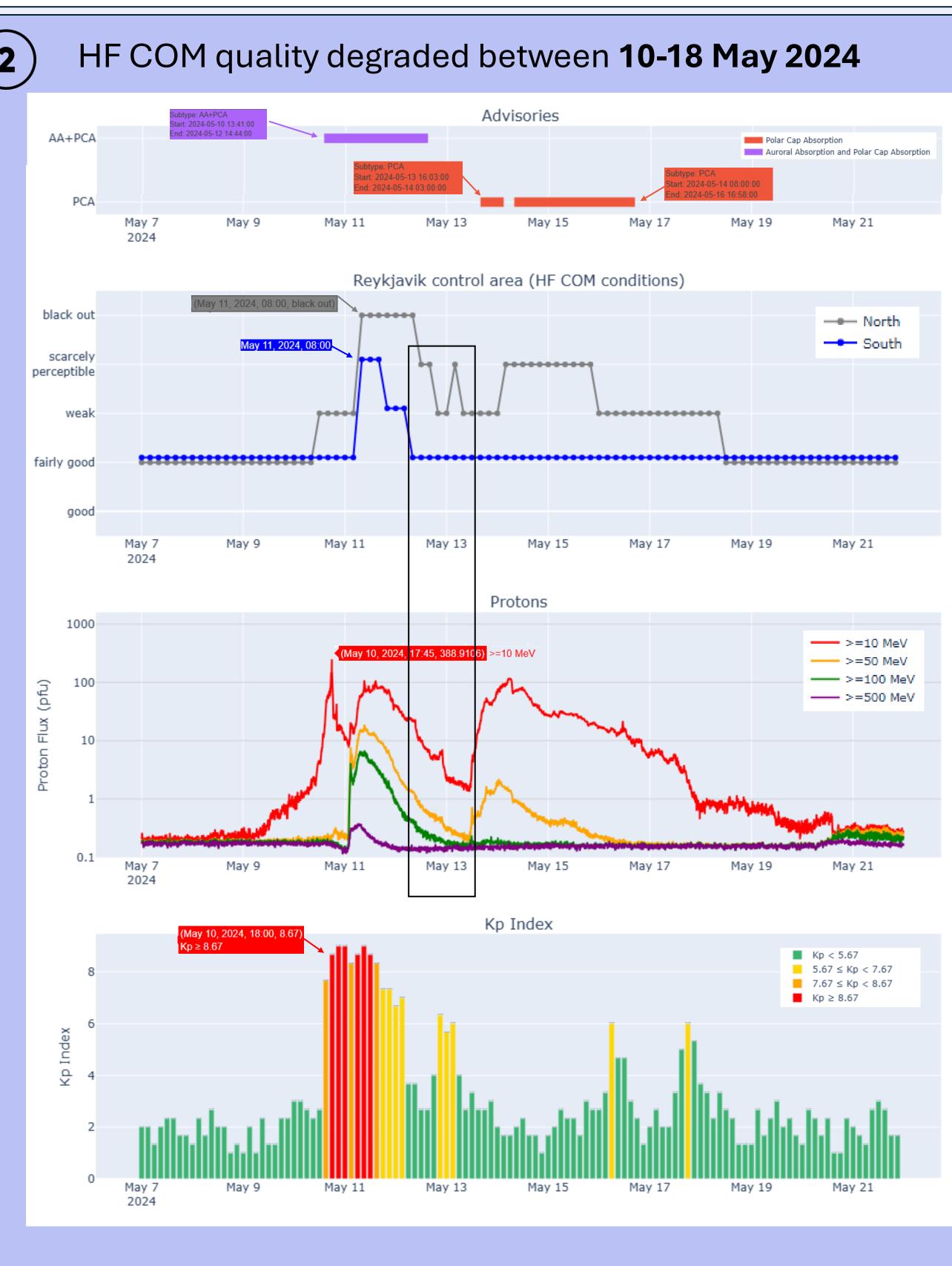
degraded (≥Weak)

Check if a PECASUS

advisory was issued

Classification of

events (TP/FP/FN)

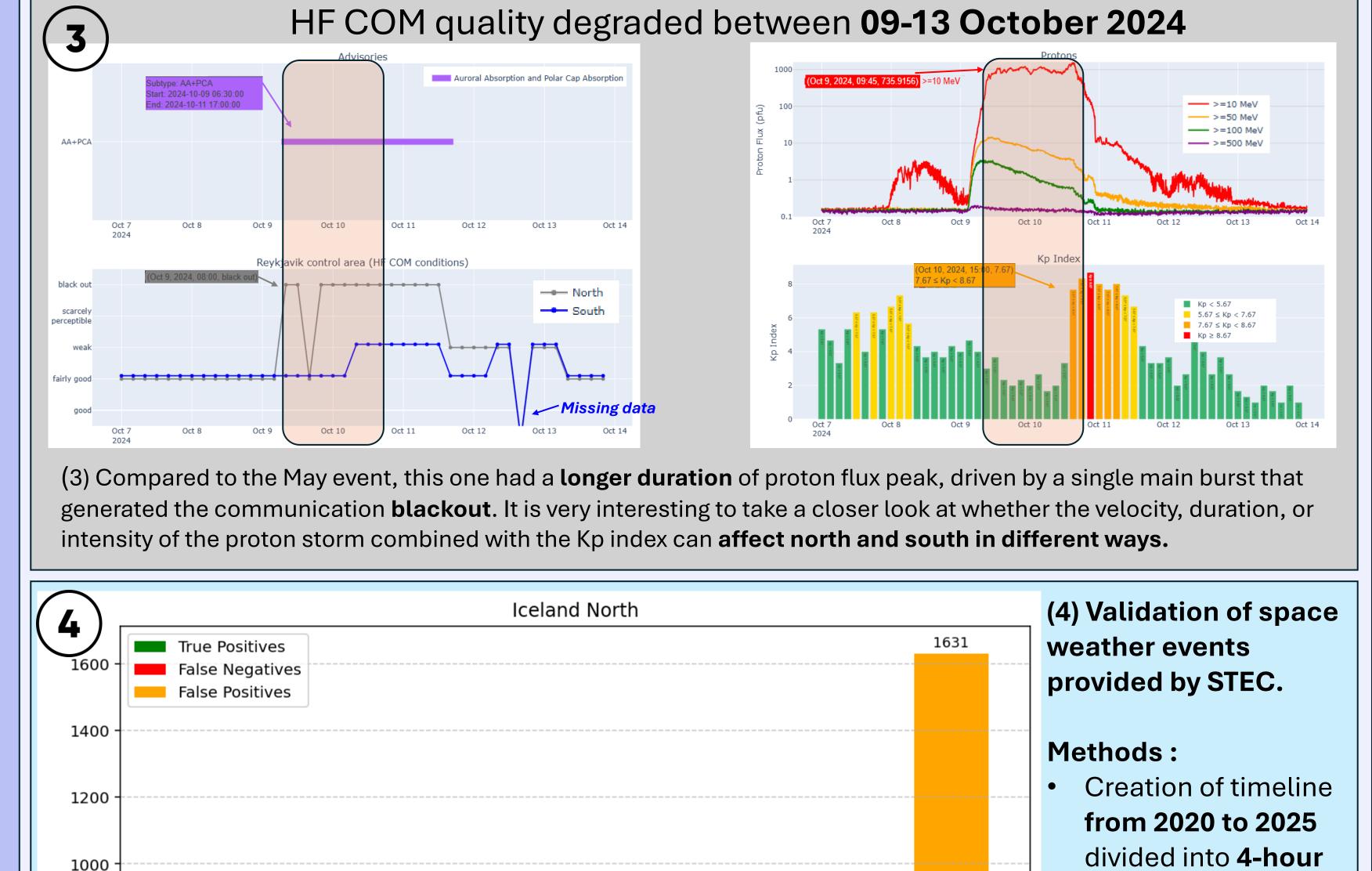


(2) Between **10 and 18 May 2024**, Radio Iceland faced degraded HF communication conditions:

From 10 to 12 May, the simultaneous occurrence of high Kp (\geq 8.67) and proton storm (\geq 10 MeV flux exceeding 100pfu) led to a combined **Auroral Absorption (AA)** and **Polar Cap Absorption (PCA)** event. During this period, the degradation extended **south of 70°N**, which is rather rare and suggests that the geomagnetic contribution was particularly strong.

The two main degradation peaks match the peaks in proton flux, further illustrating the strong correlation between high-energy proton events and HF blackout conditions. The second peak in proton storm affected strongly **the northern sector only.**

Interestingly, the degraded conditions lasted slightly longer than indicated by **ICAO advisories**, hinting at a longer ionospheric recovery time than considered in the models for the advisories/ the set thresholds.



Conclusion: A strong correlation has been observed between deterioration of HF COM conditions as registered by Iceland radio, and AA and PCA events driven by geomagnetic or proton storms. The deterioration of the HF COM quality for certain events tends to last longer than the duration of the open advisories, suggesting that ionospheric recovery may be slower than currently assumed in advisory models.

270

True Positive (TP): Number of advisories issued for which an HF communication event was recorded from Reykjavik Control Area,

False Negative (FN): Cases where an HF communication event from Reykjavik Control Area, was recorded, but no advisory was issued.

False Positive (FP): Number of advisories issued without any corresponding event observed from Reykjavik Control Area,

214

PCA + AA + SWF

332

152

PCA + AA + SWF + PSD

In addition, the high number of false positives in the statistics over the past 5 years highlights the need for a more detailed investigation into the reported impacted area within the different advisories, particularly in the case of PSD and SWF. Another possible reason for the increased number of both false positive and false negative events is the fact that advisories are being updated on a different timescales as compared to the HF COM data quality estimates.

The results confirm the expectation that Iceland north area is more impacted than the southern part of the Reikjavik control area. Additional case studies will be required to dermine whether impacts, particularly in the southern sector are observed predominantly when proton storms and geomagnetic disturbances occur simultaneously. The duration of the space weather events can also have an effect on the impacts.