Toward last-minute warnings of local aurora activity & large dB/dt

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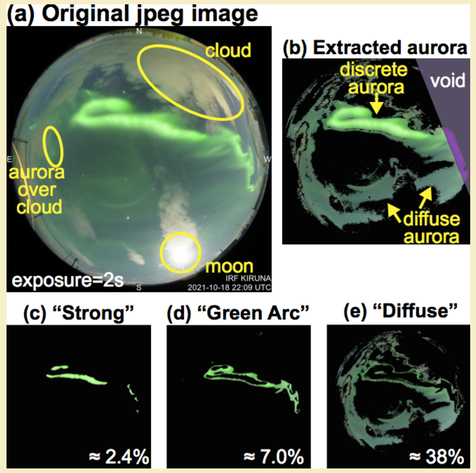
1. Numerization of aurora activity

We developed an expert-system algorithm to quantify the auroral activity seen in the all-sky camera (ASC). doi: 10.5194/gi-12-71-2023
➜ Can identify sudden and significant intensification of auroral arc with expanding motion "Local-Arc Breaking" on a real-time basis.

Level 6: Local-Arc Breaking
Level 4: possible precursor

other Level are reserved for lower activity

Local-Arc Breaking is normally accompanied by large deviation of geomagnetic field (|dB/dt| > 2nT/s over more than 1 min), but exact relation between the auroral activity (Level) and geomagnetic activities (dB/dt) is unknown.

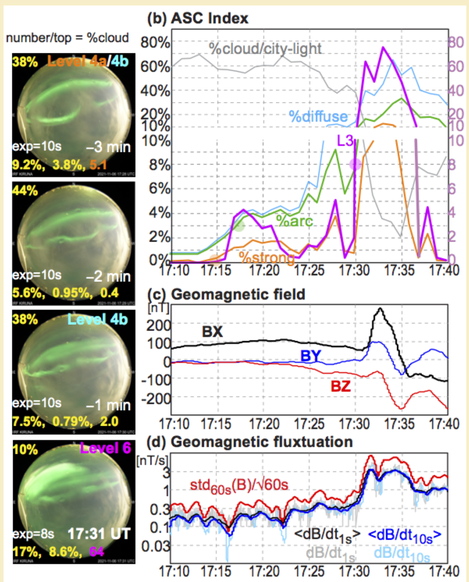


Appendix: how to obtain Level

(1a) Classify each pixel into "strong", "green arc", "diffuse", cloud, artificial light, and moon, according to RGB values

(1b) Obtain coverage (%) of each category & "strong" aurora's average intensity = L_3 = aver(L^3) (L = lightness in HSL) in real-time.
➜ This set of numbers is "ASC auroral index".

(2) Obtain "Level" from the ASC auroral index only.
Level 6: arc ≥ 3%, strong ≥ 0.2%, L_3 ≥ 8
Level 4a: arc ≥ 2%, strong ≥ 0.2%, L_3 ≥ 5
Level 4b: arc ≥ 1%, strong ≥ 0.1%, strong*L_3 ≥ 1.5 (%)

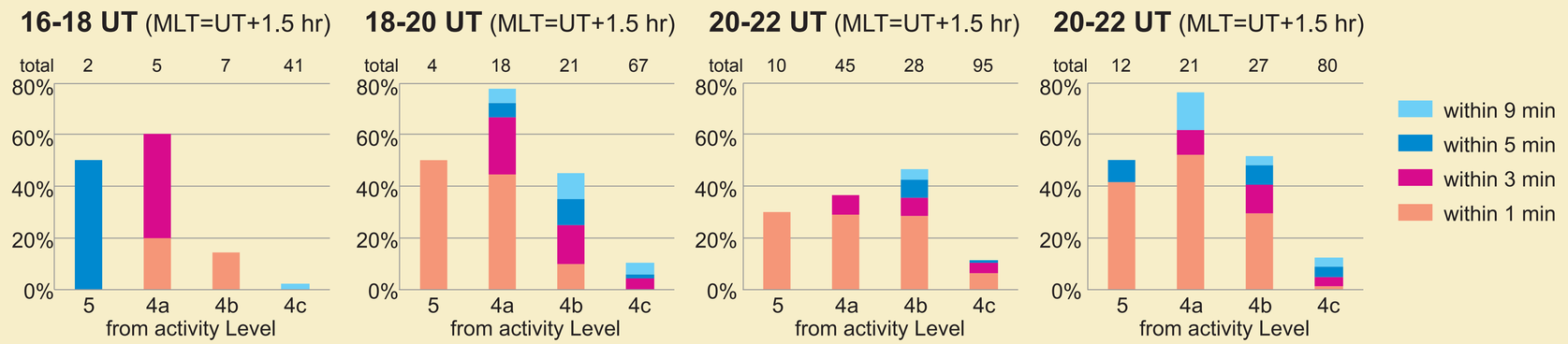


2. Examine relation between "Level" and "dB/dt"

In the present work, we obtain the probability of reaching |B/dt| > 5 nT/s (Level 8) and Level 6 from lower levels (Level 5, Level 4a, Level 4b, Level 4c) withn 15 min.
(Level 8 ≈ potential risk of geomagnetic induced current (GIC) hazard)

Level 8: |dB/dt| ≥ 5 nT/s
Level 7: Level 6 & |dB/dt| > 2 nT/s
Level 5: two of {arc ≥ 2.5% , str ≥ 0.15%, aver(L3) ≥ 5}, void < 30%, dB/dt > 0.8 nT
Level 4c: {arc ≥ 2% OR strong ≥ 0.2% OR aver(L3) ≥ 5}, void < 30%, dB/dt > 0.5 nT

Probability of reaching Level 6 (first time of reaching low level in entire night)



probability of reaching |dB/dt| > 5 nT/s (Level 8)

Too little statistics (only 6 cases of Level 8), and only 3 cases had precursor (Level 5, Level 6, and Level 7)

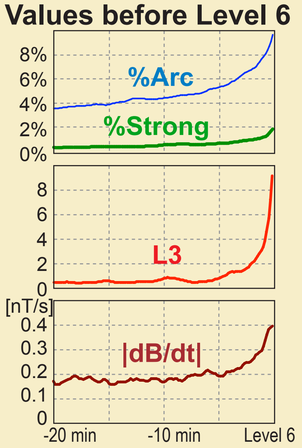
correlatiobe between dB/dt and ASC auroral index

|dB/dt| vs. %Arc: **0.54** (20-22 UT) / **0.41** (22-24 UT)
|dB/dt| vs. %Strong: **0.26** (20-22 UT) / **0.36** (22-24 UT)
|dB/dt| vs. L_3: **0.26** (20-22 UT) / **0.36** (22-24 UT)

NOTE

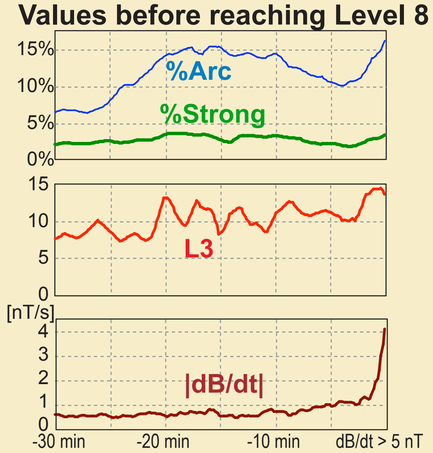
Data is limited: we used only winter 2021/2022 season (from November 2021 to April 2022).

Values before Level 6



sharpest increase of L3

Values before reaching Level 8



Level 6 already -30 min before

very preliminary SUMMERY with limited data

1. For both Level 6 (Local-Arc Breaking), rise time is very short, within one minute from Level 4 for nearly half the case, and 10 minute is sufficient.

2. Out of four possible precursors, three precursors (Level 4a, 4b, 4c, 5) give 40-70% probability of the Local-Arc Breaking (Level 6) within 10 minutes. Level 4a is so far the best precursor.

3. Correlation between the aurora activity (ASC auroral index) not very high, but still exists.

4. Prediction of dB/dt > 5 nT/s (Level 8) is yet difficult, but Level 7 (Level 6 + |dB/dt| >2 nT/s) can be a possible candidate. Considering the risk of GIC hazard, 20% is still worth warning. We will examine more data in this direction (add 2022/2023 data and add 2023/2024 data).

ST4.2/X4.291 (Thurday, 2023-4-27)