Improving nowcast capability through **automatic processing** of combined ground-based measurements

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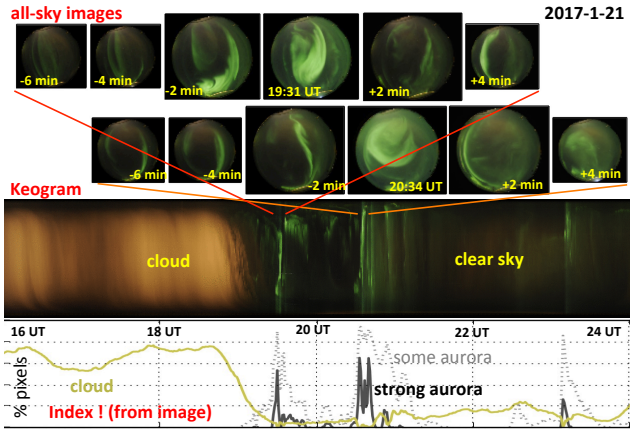


Current status, and Problems to solve

GIC proxy: Both dB/dt and sd(B) are **useful**
AI-1: Find out relation between dB/dt and actual induction current
AI-2: Improve GIC proxy by using pulsation magnetometer data
AI-3: Can sd(B) be used as precursor for large dB/dt or large GIC?
AI-4: Find out best window time for prediction

All-sky indices: **Useful** and consistent with GIC proxy!
AI-5: Find out best HLS definition of "aurora pixel" for different cameras
AI-6: Find out best definition of "cloud" without city light reflection
AI-7: Find out best integration scheme of auroral strength to obtain "indices" for different aurora (discrete, diffuse, surge, pulsation, omega band)
AI-8: Find out relation between these indices and GIC proxy and GIC
AI-9: Improve these indices by using riometer data and ionosonde data

Combined nowcast: adding many line plots is not good for **"quick overview"**
AI-10: need to **make "nowcast" indices** for different purposes, e.g., GIC, auroral observation, EISCAT_3D observation, and satellite conjugate.

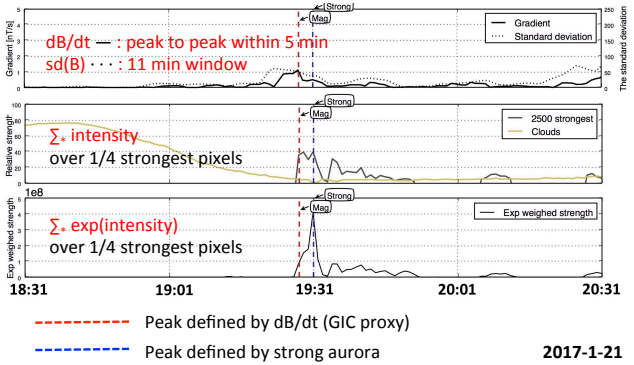
Motivation

While recent effort of the space weather forecast is mainly focused on Sun and interplanetary monitoring for early warning, importance of **nowcast at the ground/ionospheric level** is also increasing **for short-term but high accuracy pinpoint-warning**, such as 5-minutes prediction of the ground induced current (GIC). This is why many geomagnetic stations started to calculate dB/dt to estimate the GIC.

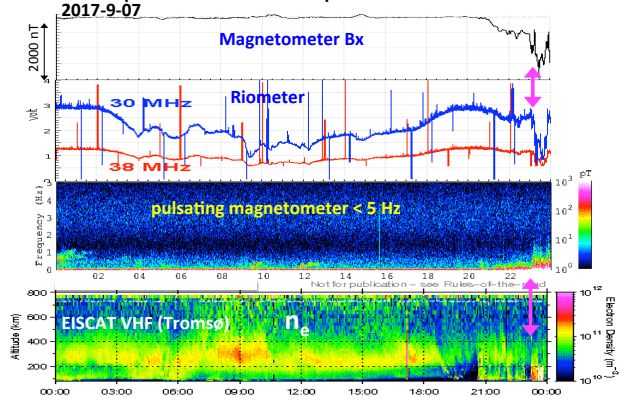
Such nowcast (or last-minute prediction) will be improved by combining different types of data: DC and pulsation magnetometers, all-sky camera and riometer, because such a combination has been used to predict substorm onsets for many years by experienced auroral scientists.

However, such a combination is not yet established in automatic method, partly because **characterizing auroral image as a simple index (number)** and particularly quantifying auroral strength are difficult. We challenge this problem using our all-sky camera data at Kiruna (Swedish Institute of Space Physics), and compared with our GIC proxy from magnetometer.

Real-time display of GIC proxy & all-sky indices



cf. September 2017 space weather event



Today: all-sky index and GIC proxy

Work in progress: (1) Real-time automatic identification/prediction of "strong aurora" with "large ground induction current (GIC)" from all-sky camera data and magnetic field data. (2) Non-specialist can easily understand

GIC proxy: compare peak-to-peak dB/dt & standard deviation sd(B).

Strong aurora ⇒ To judge "strong", need **overview-type auroral monitor**
⇒ **Keogram** ⇒ still difficult for non-specialist and do not cover all sky.
⇒ Assign each image as **"indices"**
⇒ Classify by colors, size, and intensity.
(a) for each pixel: change RGB to HSL color code ⇒ virtual photometers
(b) discrete aurora: ∑_. exp(intensity) or ∑_. intensity
diffuse aurora: ∑_all [1 or 0] (depending on the judge of color)
⇒ **Line plot** (time-series) of **"All-Sky indices"** ⇒ everybody understands
note: ∑_. integration is only for strongest pixels
note: criterion is different between different camera and location

At moment we use criterions of (1) aurora: h=18-46%, s=8-15%, l=10-80%
(2) **strong: h=20-46%, s=8-20%, l=20-80%**
(3) cloud: h=0-16%, s=10-80%, l=15-80%
cf. moon: l>80%, sky: h=60-80%

But this might not yet optimum.