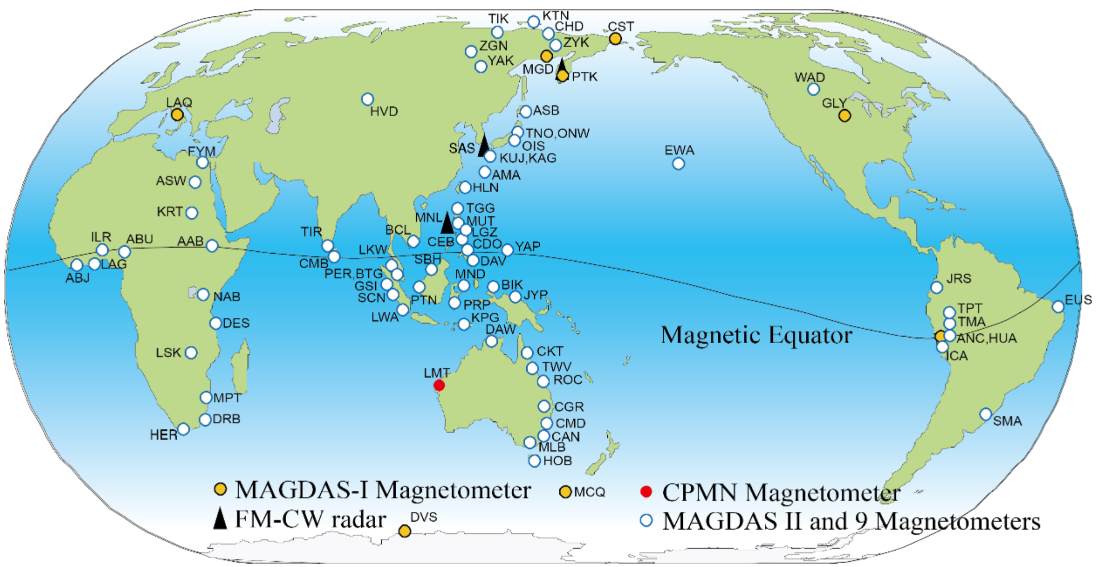
ICSWSE

# Latest scientific results of MAGDAS project - Seasonal dependence of semidiurnal equatorial magnetic variations -

MAGDAS/CPMN

(MAGnetic Data Acqusition System/Circum-pan Pacific Magnetometer Network)

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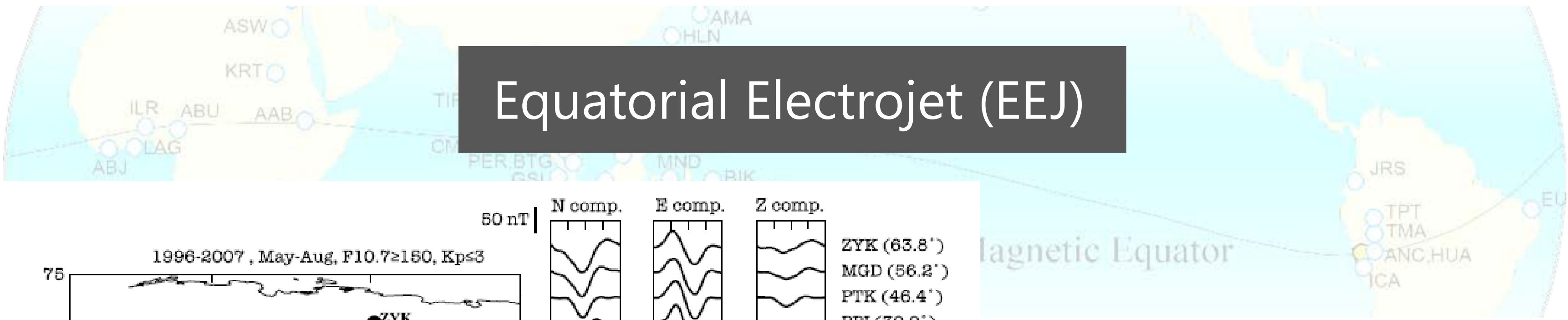
2. Earth and Planetary sciences, Kyushu University

# The importance of equatorial magnetic observation




## Equatorial Electrojet (EEJ)

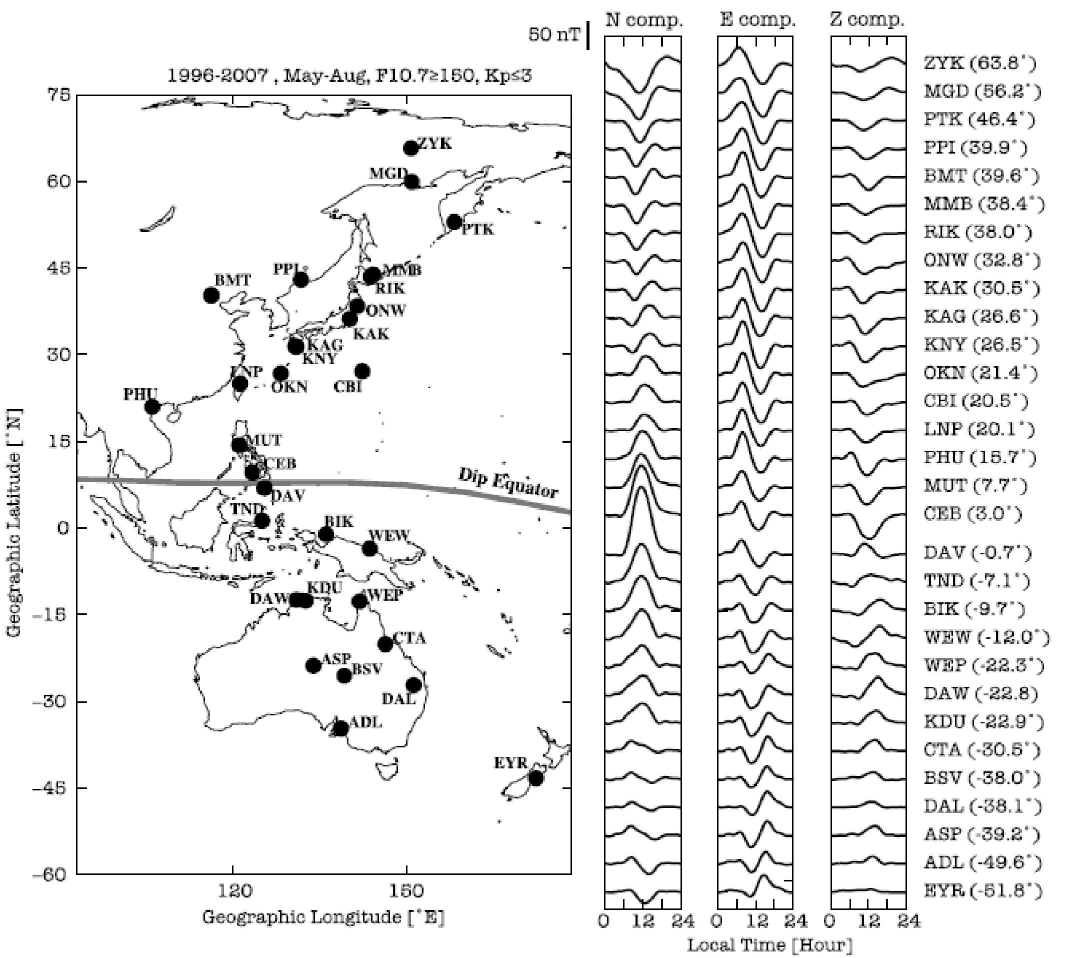
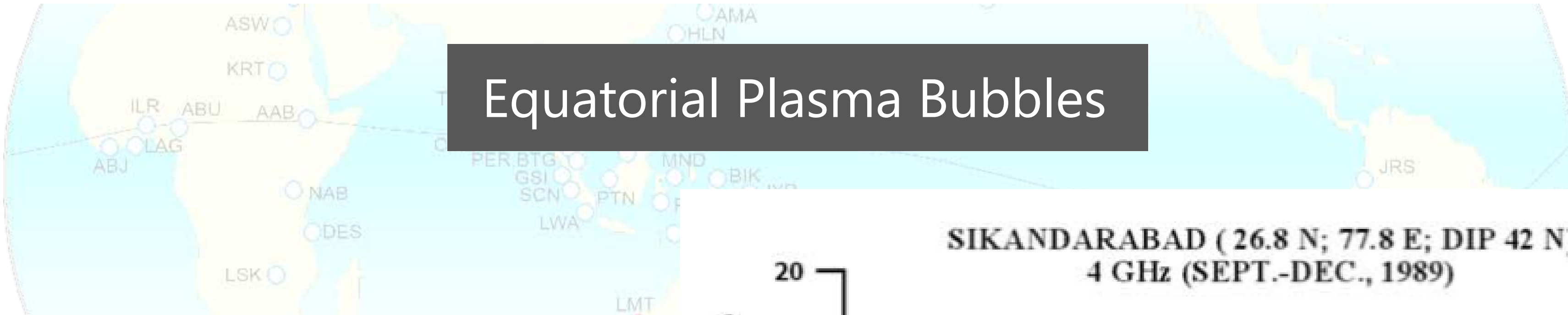


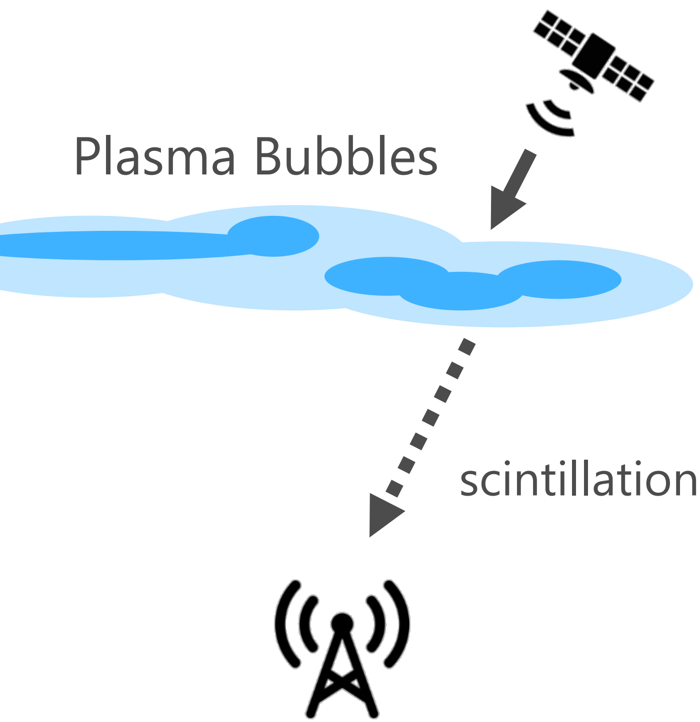

Fig. 2 Average geomagnetic daily variations in the magnetic-northward (*N*), magnetic-eastward (*E*), and vertically downward (*Z*) components during May–August of 1996–2007. From Yamazaki (2011)

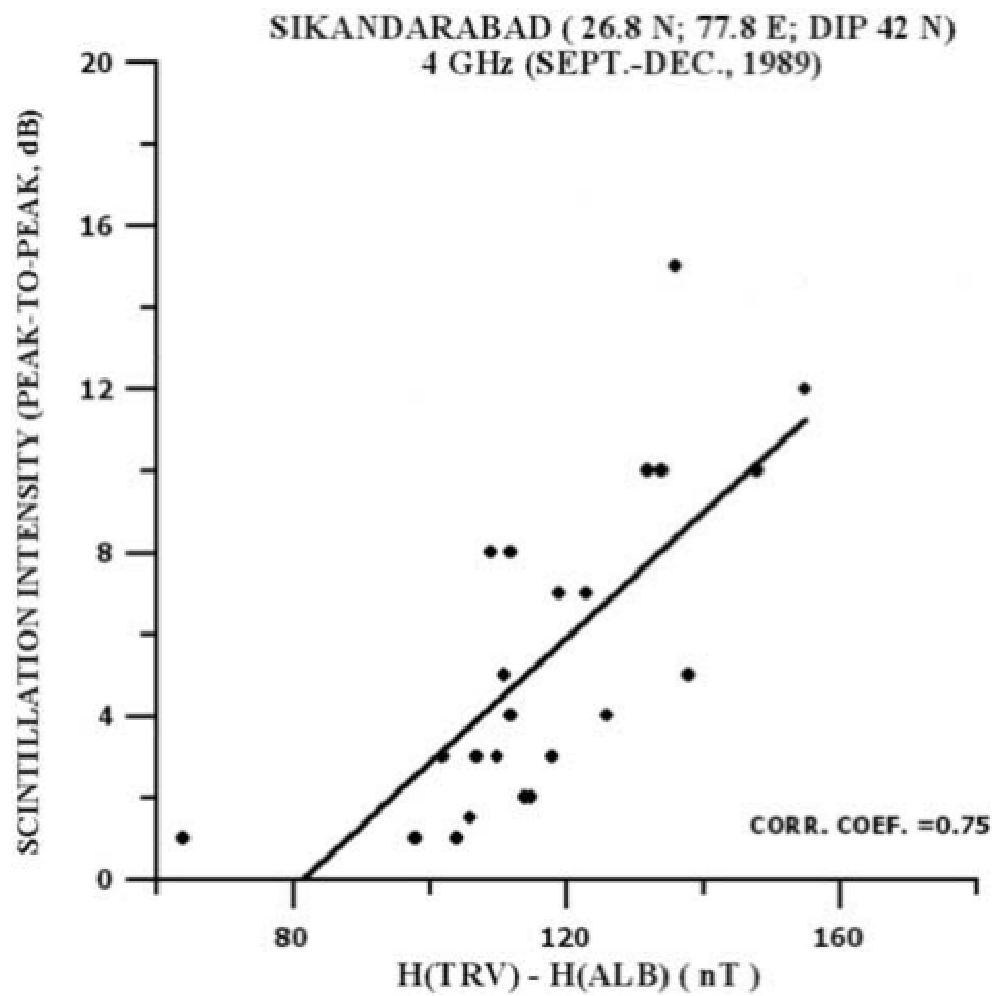
- The abnormally large range of northward component at the magnetic equator.
- First discovery, at Huancayo in Peru Bartels and Johnston (1940)
- “Equatorial Electrojet” named by Chapman (1951)

# The importance of equatorial magnetic observation

## Equatorial Plasma Bubbles

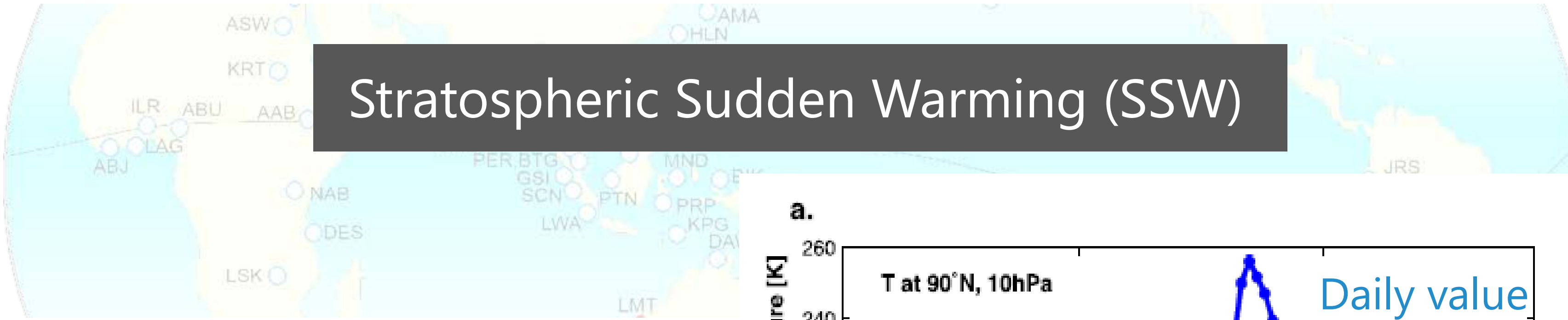


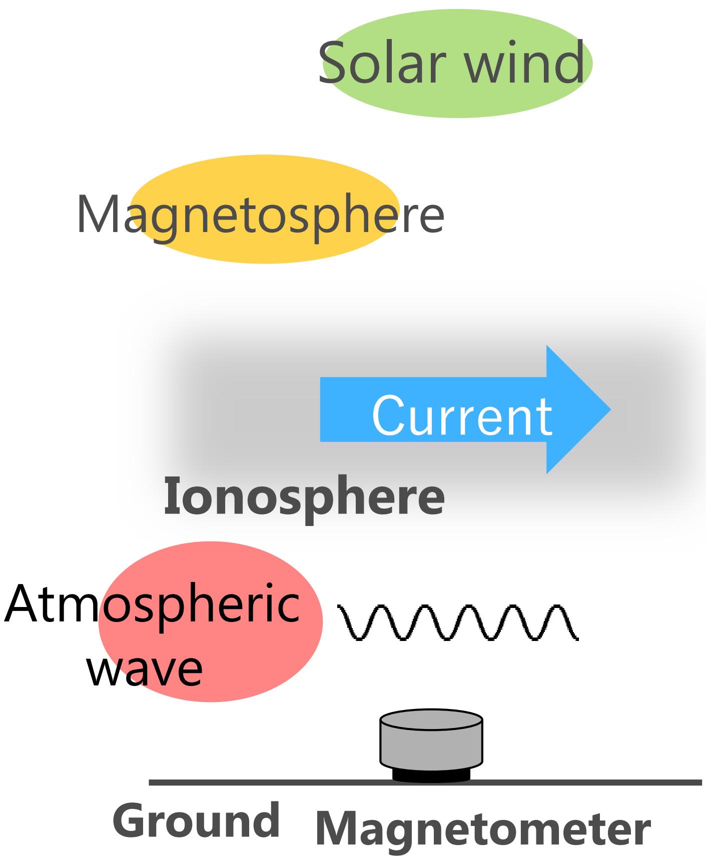



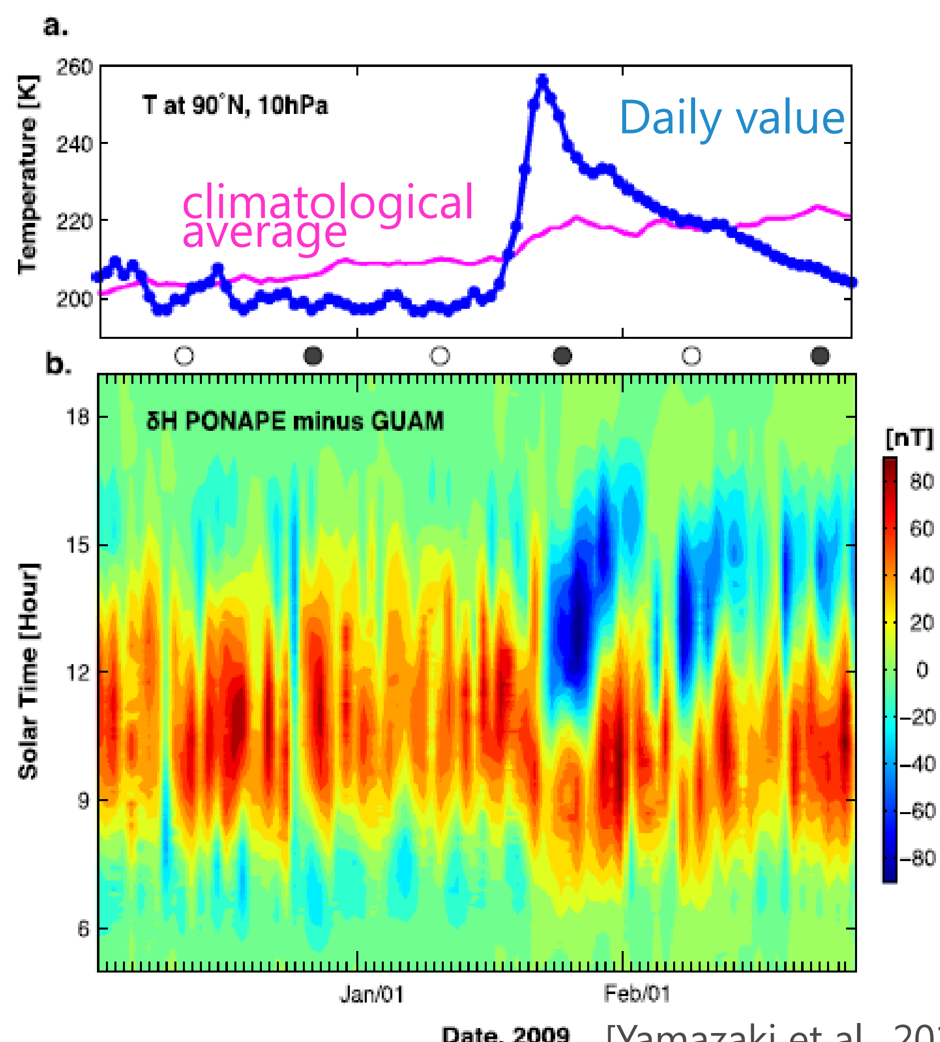

[Dabas et al., 2003]

# The importance of equatorial magnetic observation




## Stratospheric Sudden Warming (SSW)



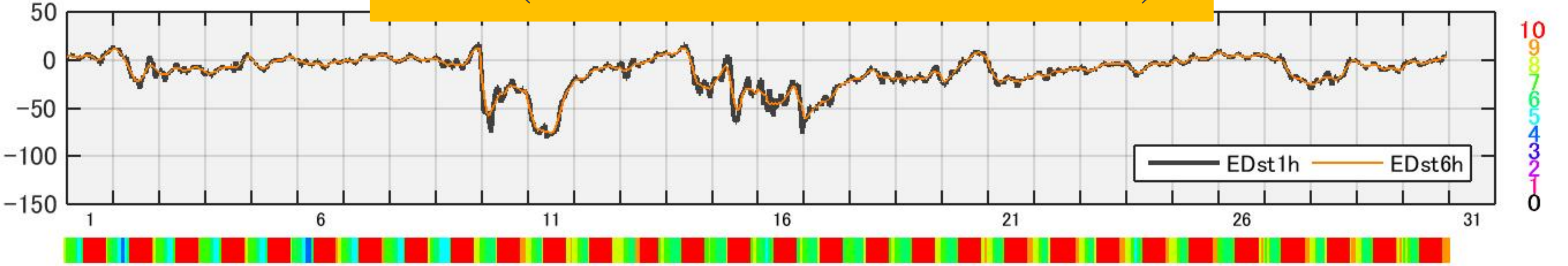

[Yamazaki et al., 2014]

# Morphology of EEJ during magnetically quiet periods

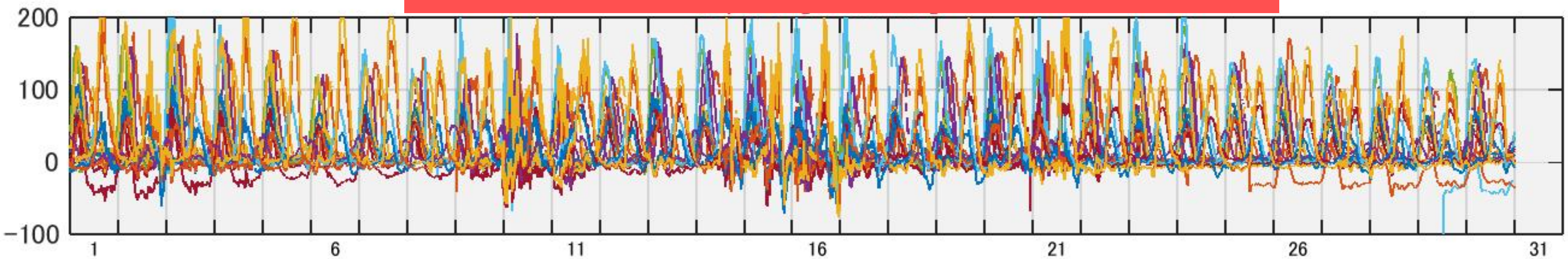
- Dependence of the EEJ intensity on the solar activity
  - 1976: Rastogi and Iyer
  - 1994: Rastogi et al.
- Semi-annual variations of the EEJ intensity
  - 1965: Chapman and Raja Rao
  - 1966: Yacob
  - 1980: Campbell
- Day-to-day variability in the EEJ intensity
  - 1976: Fambitakoya and Mayaud
  - 1980: Kane and Trivedi
  - 1998: Doumouya et al.
  - 2008: Kawano-sasaki and Miyahara
- Relationship of the EEJ to the Sq current system
  - 1992: Onwumechili
  - 1995: Stening

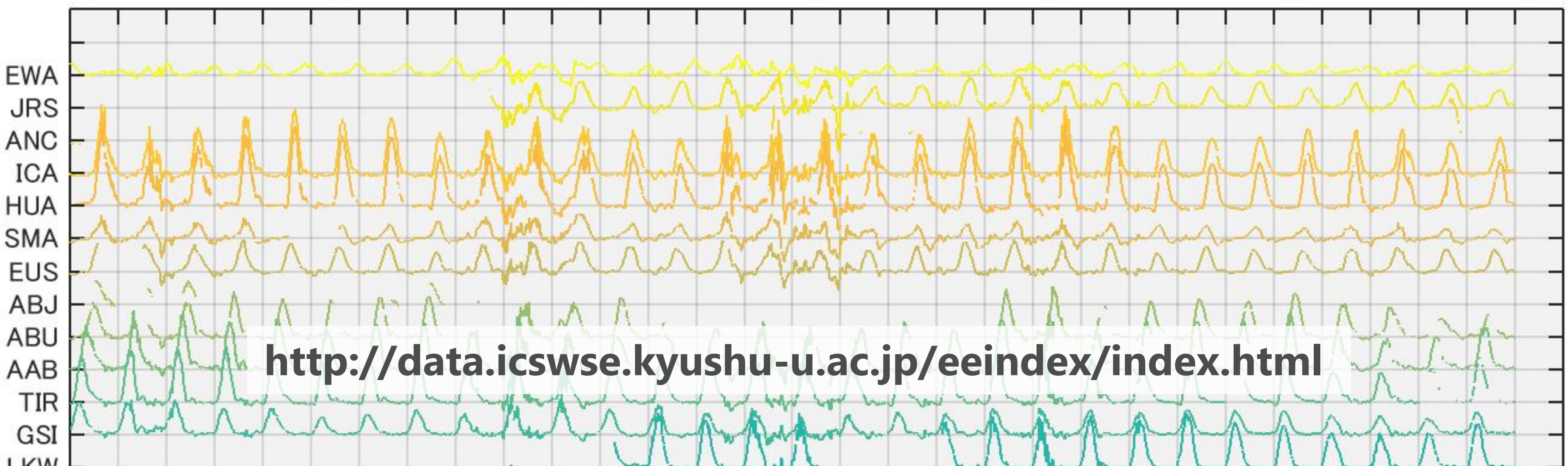
# Real-time EE-index

EDst（Global disturbance variation）



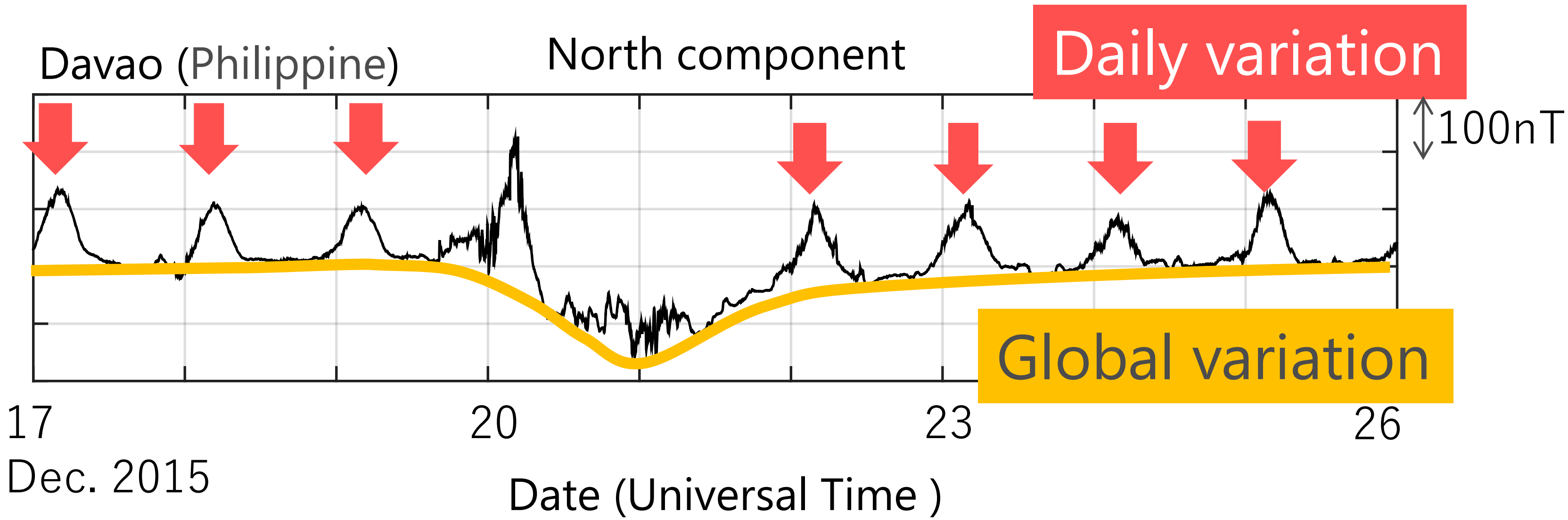

EUEL（Local disturbance variation ）

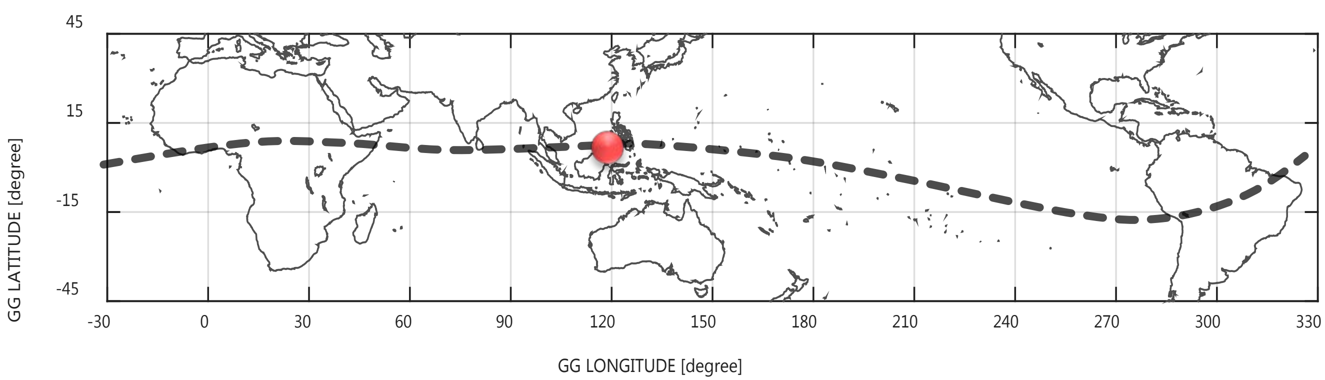


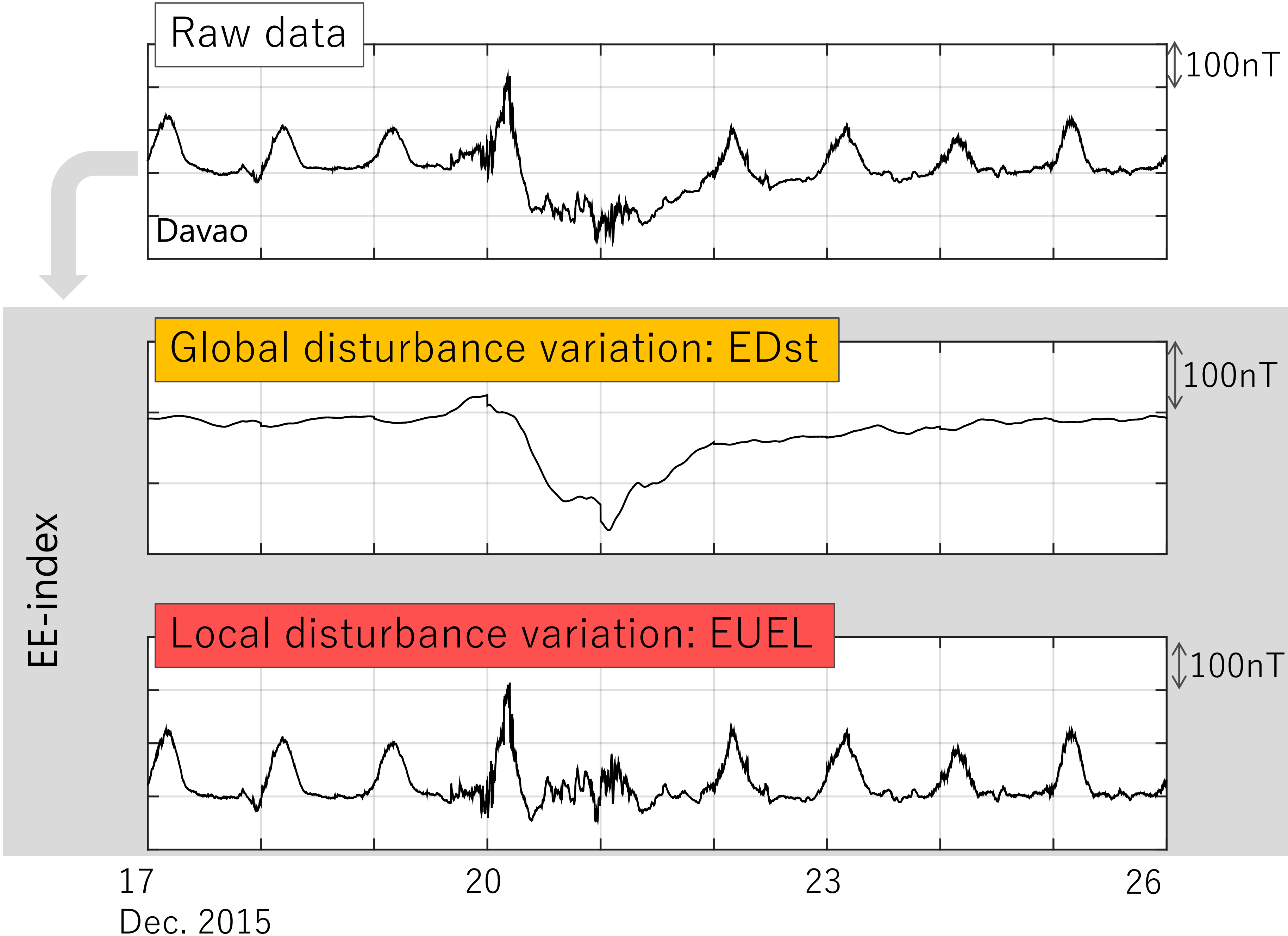




**http://data.icswse.kyushu-u.ac.jp/eeindex/index.html**

# Time series data of magnetic field along the equator

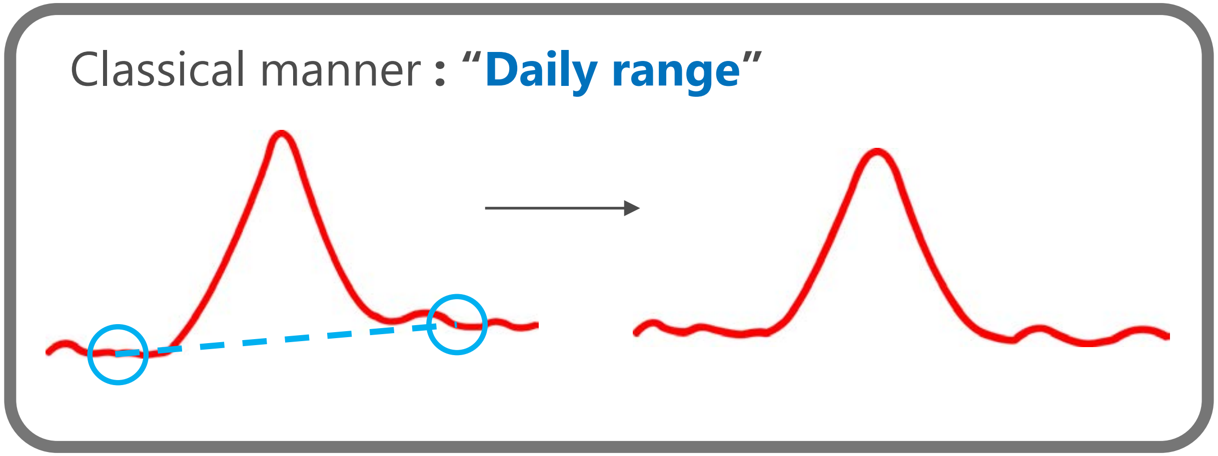




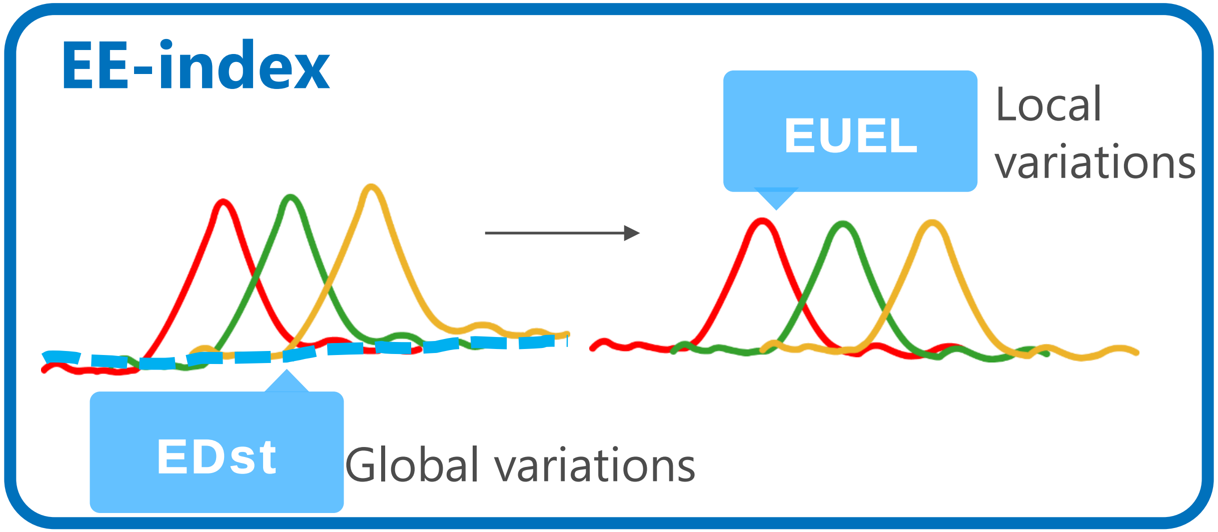
Raw data
100nT
Davao
EE-index
Global disturbance variation: EDst
100nT
Local disturbance variation: EUEL
100nT
17
Dec. 2015
20
23
26

# Classical manner vs. EE-index on the EEJ study




Static base line

Quiet time




Drastic base line

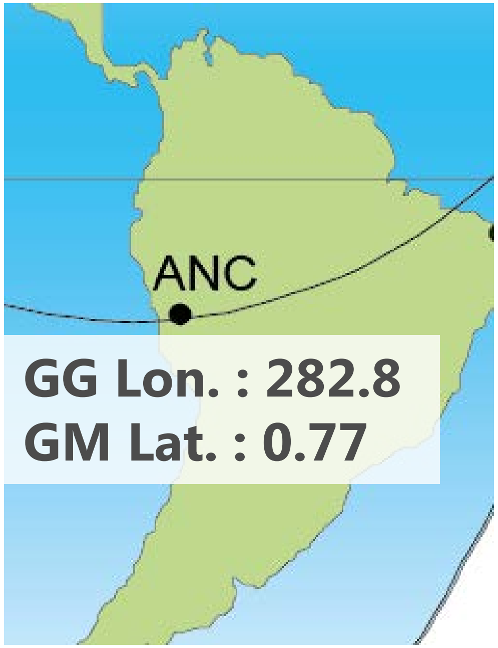
Quiet & Disturbance time

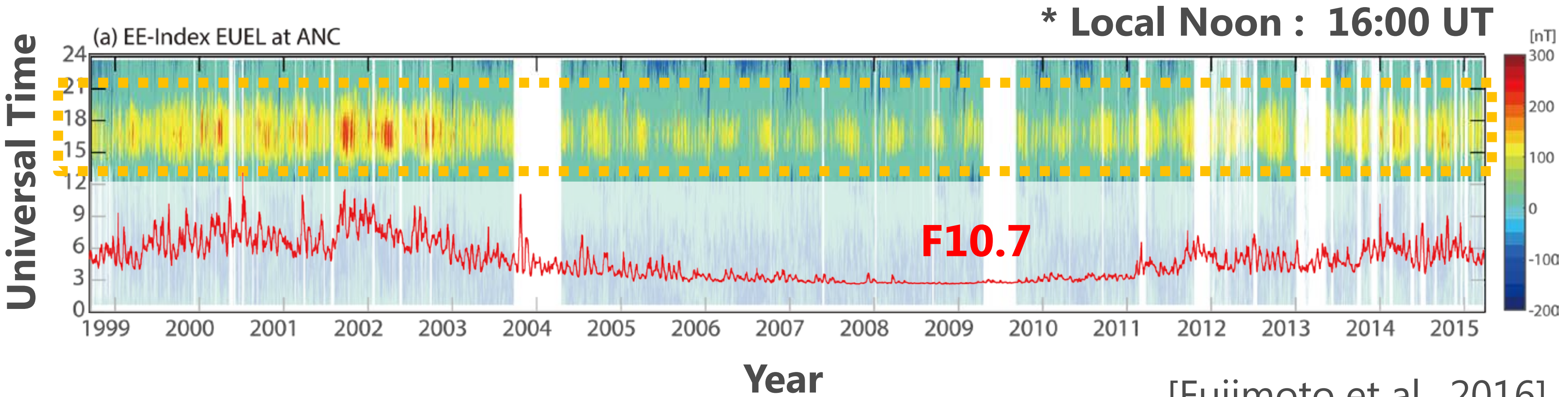
**Time series analysis**

# long-term variation of EUEL from 1998 to 2015

**EUEL** of EE-index @ Ancon (**ANC**) in Peru

- 1 min. sampling
- period：1998/09/18 – 2015/03/31
- Hourly averaged EUEL intensity




[Fujimoto et al., 2016]

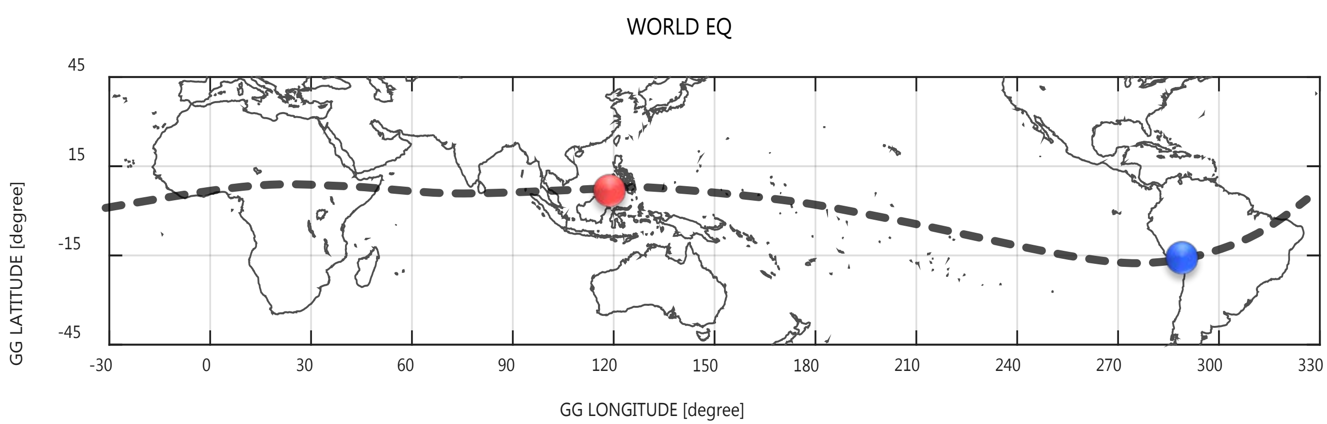
# Data & Analysis

Magnetometer Stations：Ancon（Peru）, Davao（Philippine）

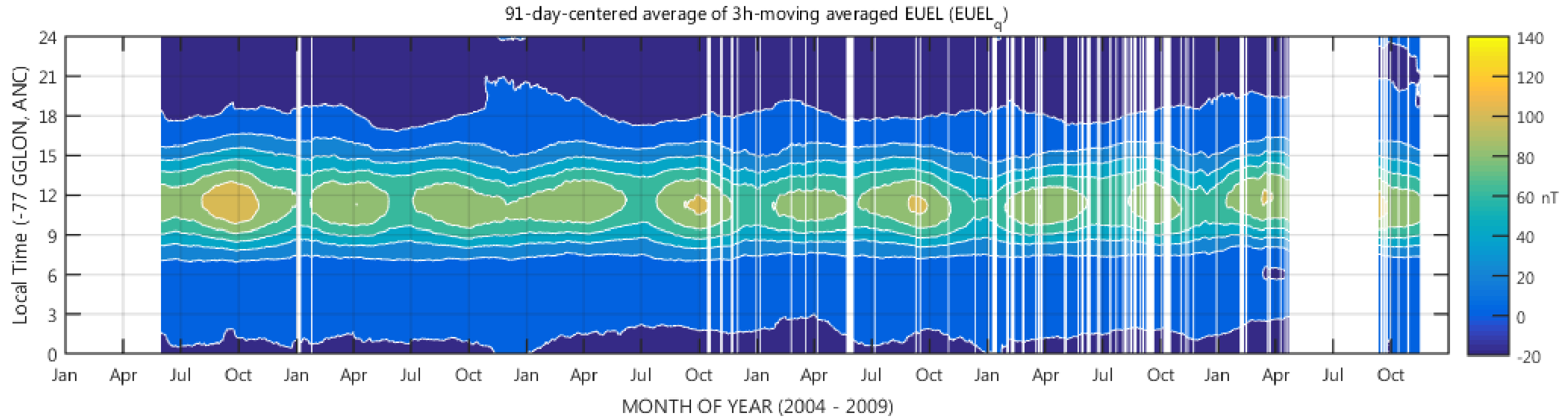
Period：2004 - 2009 (Ancon), 2005 – 2010 (Davao)
（solar cycle 23：1996, Jun. – 2008, Jan.　※Min： 2008, Mar.）

Data requirements ：no lack data in one day

Analysis: Semiannual and Semidiurnal of EUEL

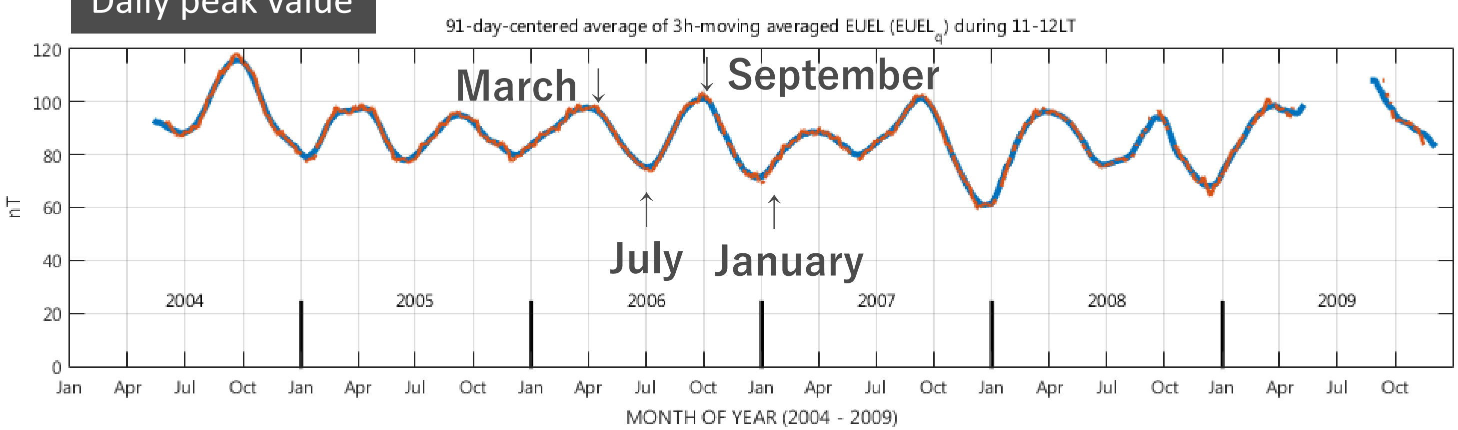


# Semiannual variation (Ancon)



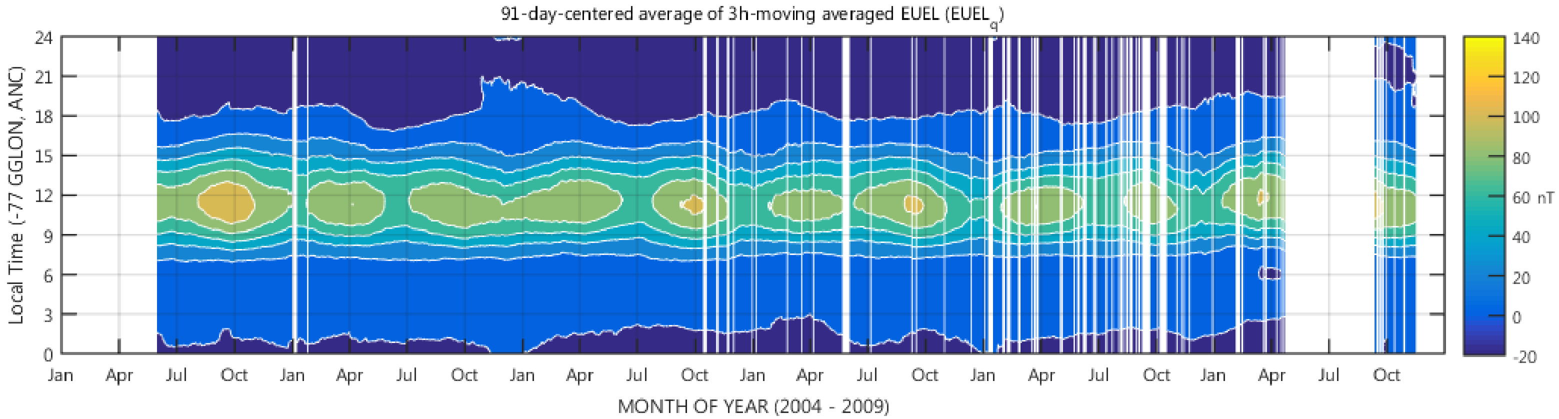

The contour shows the 91-day-centered average of 3-hour moving averaged EUEL. White color path indicates the lack data.

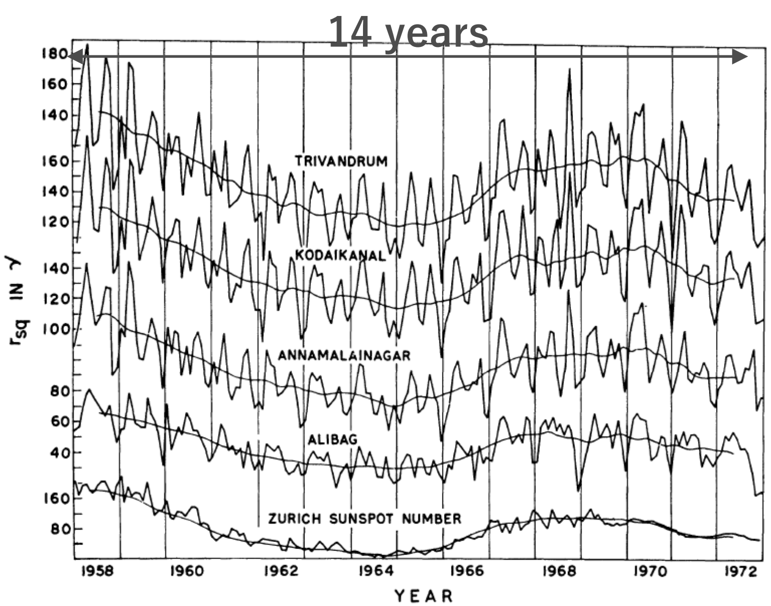
Daily peak value




The daily peak value is the maximum between 11:00 and 12:00 local time of the data on the upper panel.

# Semiannual variation (Ancon)



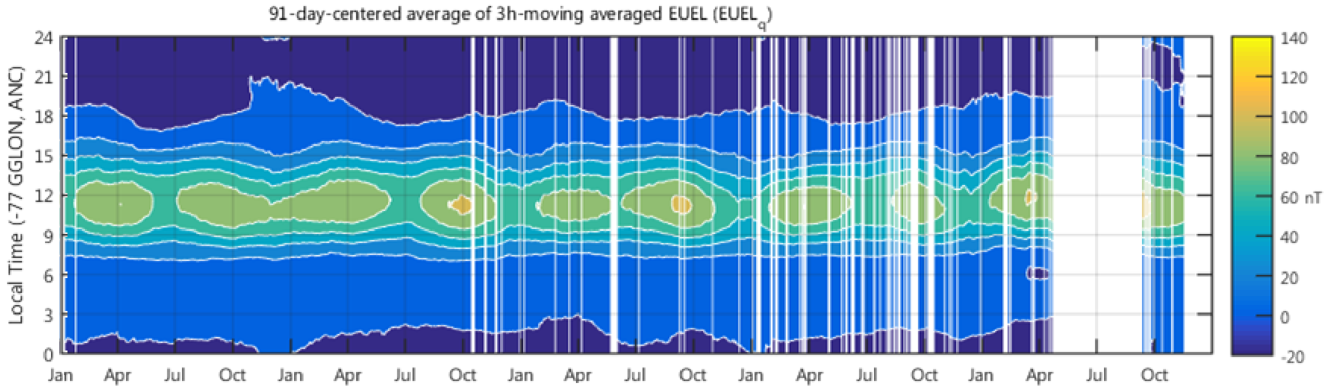

[Rastogi and Iyer, 1976 (JGG)]

The semiannual variation based on EE-index (including the quite/disturbed days), is consistent with the result of Rastogi and Iyer (1976).

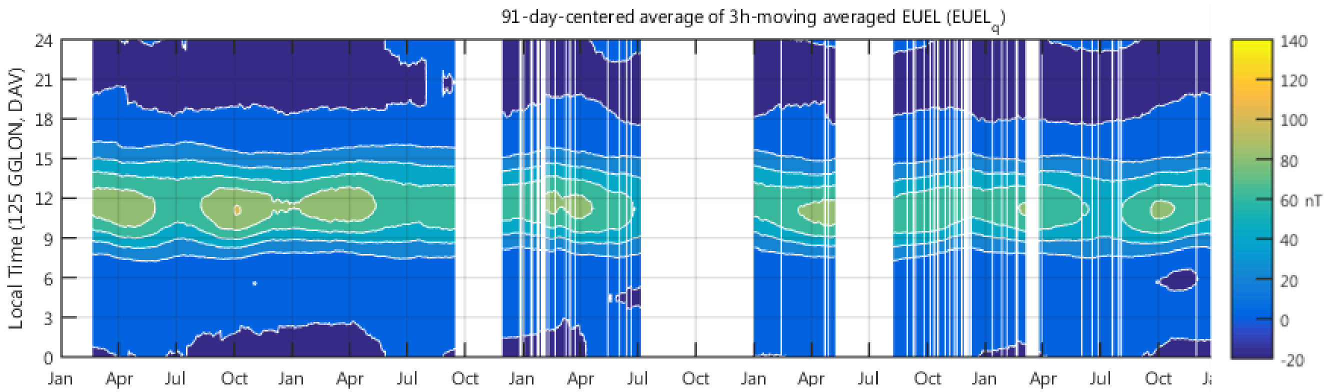
- There is a significant **semiannual variation** with maxima around March and September.
- The semiannual peak value follows the solar activity.

# Semiannual variation (2005-2010)

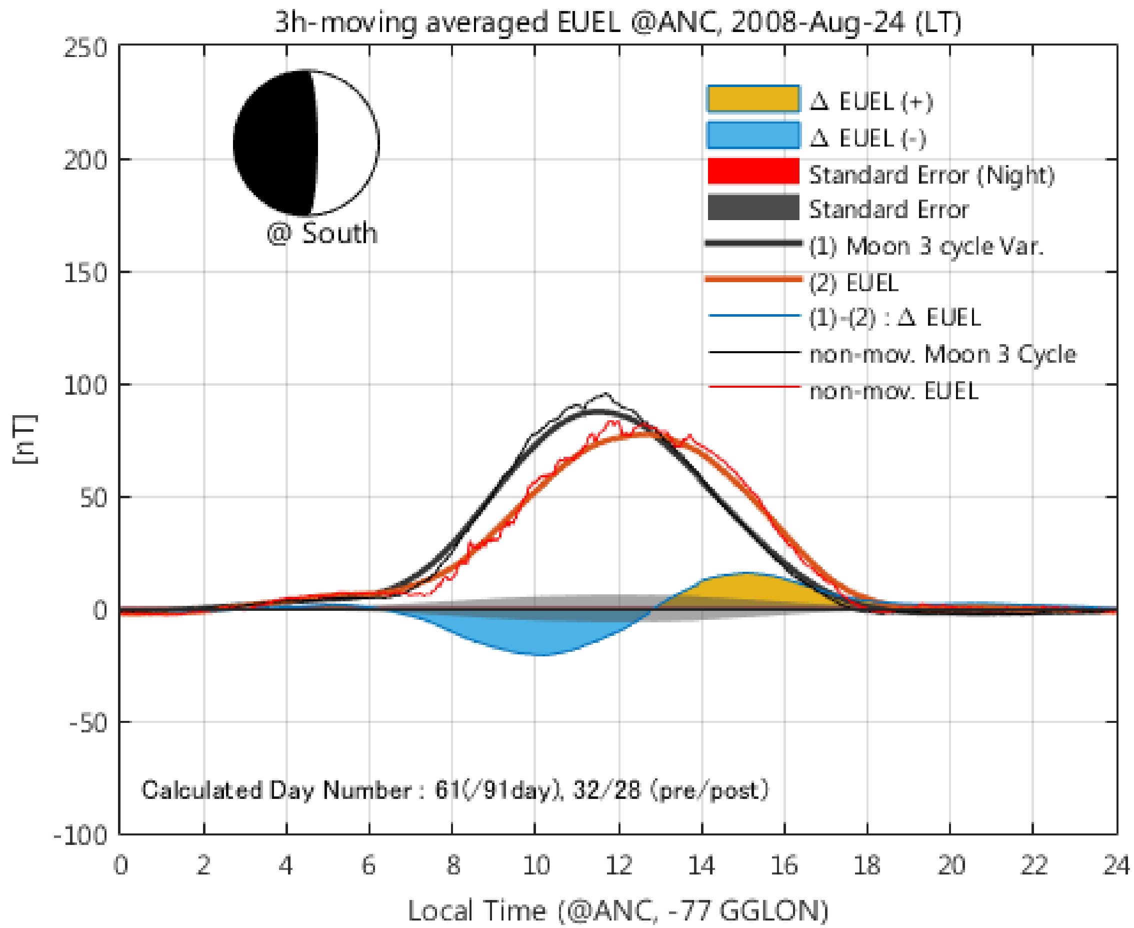
Ancon




Davao



# Semidiurnal variation ($\Delta EUEL$)



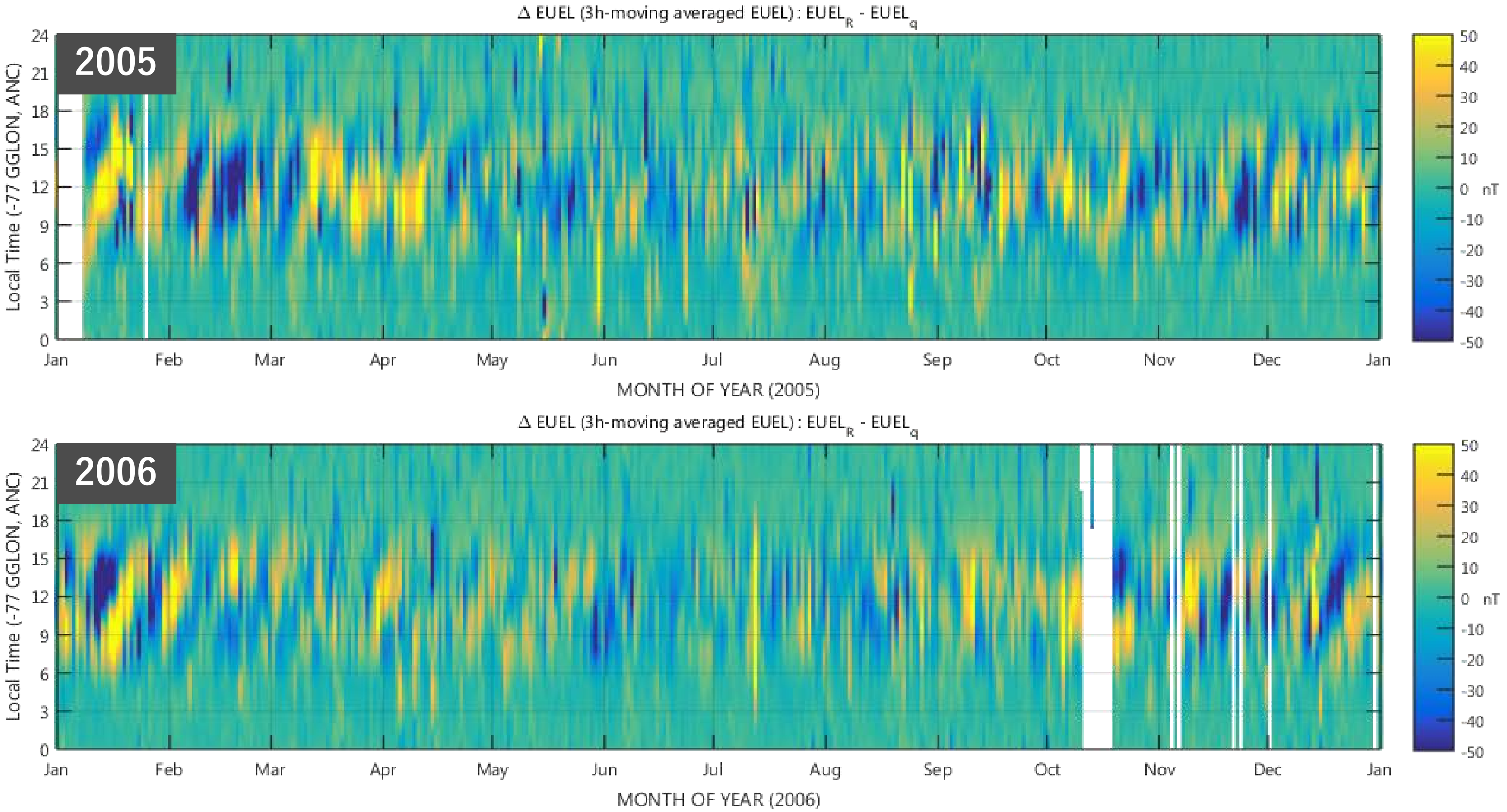

$EUEL_{3h}$ : 3 hour moving averaged $EUEL$

$\overline{EUEL}$ : 91 days entered average of $EUEL_{3h}$

$$\Delta EUEL = EUEL_{3h} - \overline{EUEL}$$

# Semidiurnal variation (Ancon)

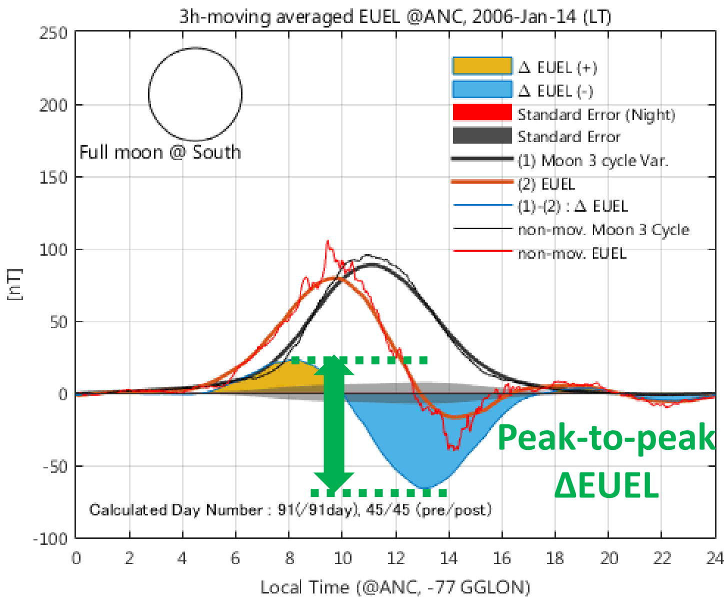
The amplitude of semidiurnal EUEL variations increased in January and decreased around July.



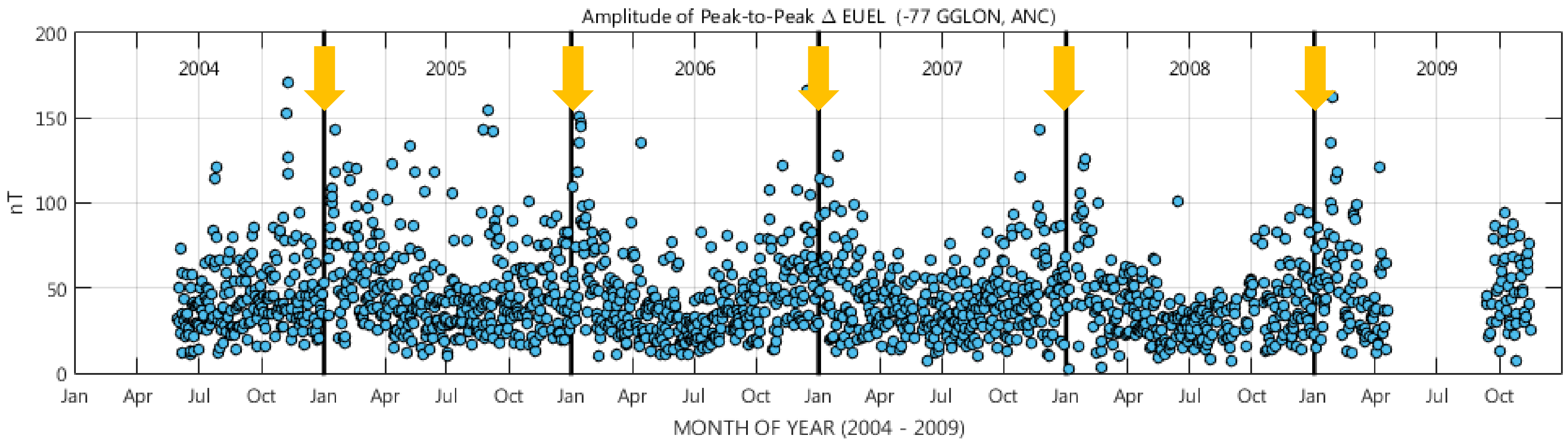

ΔEUEL is obtained by subtracting $\overline{EUEL}$ from $EUEL_{3h}$.

The yellow color and blue color indicate the positive and negative, respectively.

# Semidiurnal variation (Ancon)

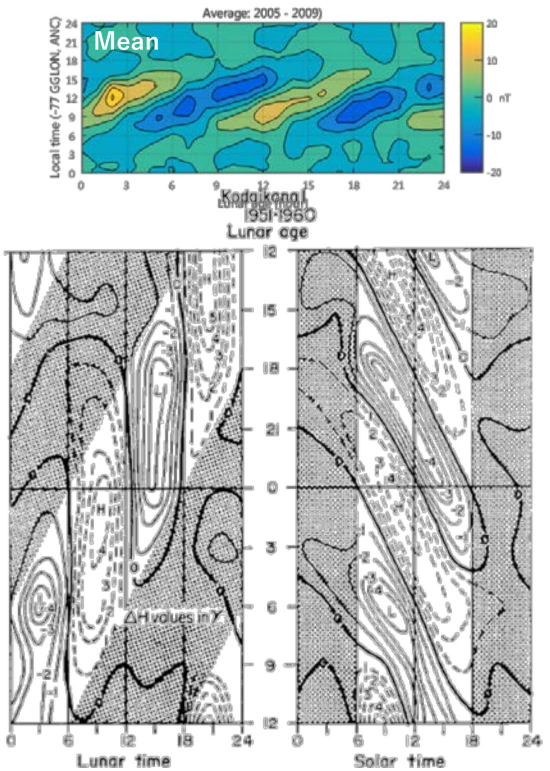



The peak-to-peak (indicated by the green arrows) is the difference between the maximum and minimum of ΔEUEL.

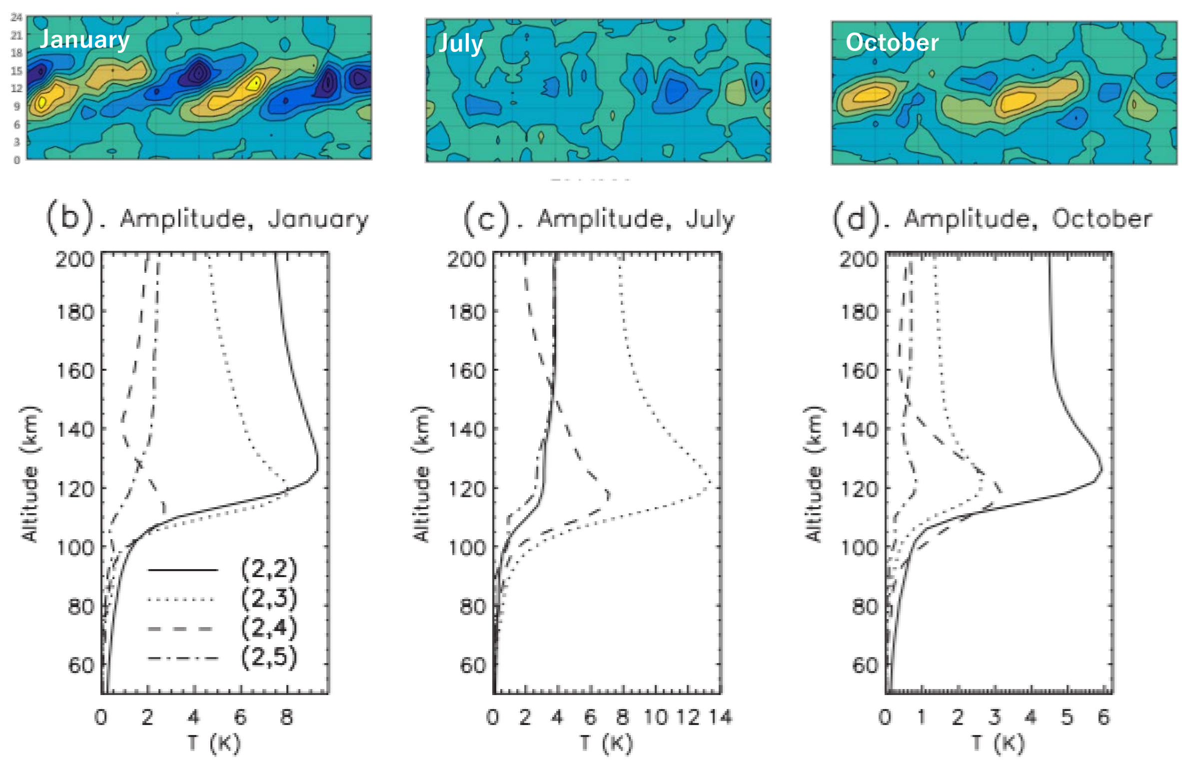


# Seasonal dependence of Semidiurnal Var.

- The mean behavior of ΔEUEL is consistent with the result of Rastogi (1973). We demonstrated the monthly average behavior of ΔEUEL, for the first time based on the time-series magnetometer data.
- The seasonal dependence of semidiurnal variation agrees with the seasonal profile of atmospheric neutral wind (2.2) mode corresponding to the lunar tide.




[Rastogi, 1973, PSS]

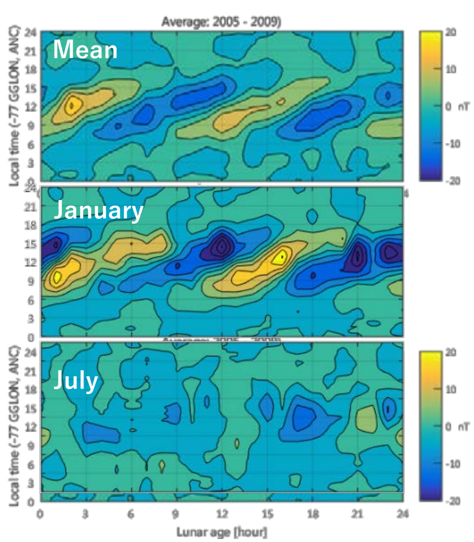


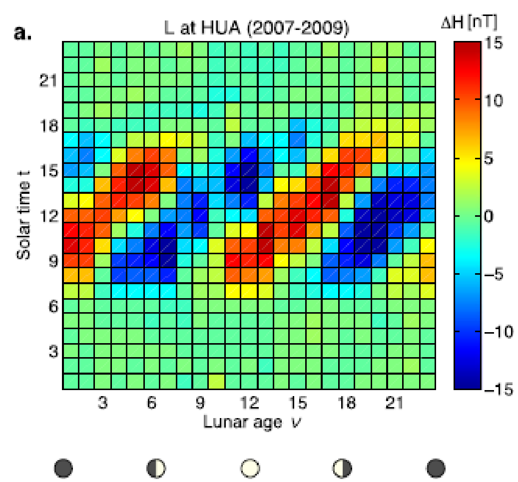

[Forbes et al., 2013]

# Summary

- The latest results on the long-term study of the EE-index:
  - solar cycle variation
  - semiannual variation
  - semidiurnal variation
- The remarkable seasonal dependence of semidiurnal variation : stronger in January and weaker around July

The seasonal dependence of semidiurnal variation agrees with the seasonal profile of atmospheric neutral wind (2.2) mode corresponding to the lunar tide.




[Yamazaki and Maute, 2016]

# EE-index : **Monitoring index for equatorial electrojet (EEJ)**

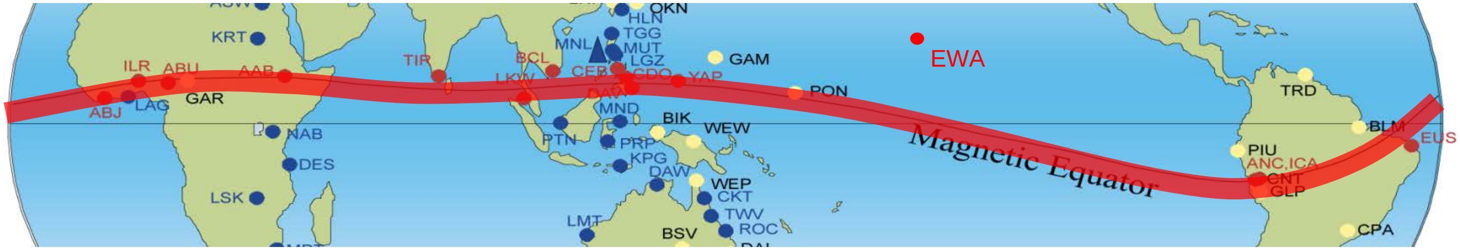
❶ Proposed by ICSWSE in 2008 [Uozumi et al., 2008]

First Version：4 stations along the magnetic equator

Latest version：**multiple equatorial magnetometer data**

[Fujimoto et al., 2016]

❷ Produced by using MAGDAS/CPMN magnetometer network




❸ Be useful for the study on the long-term time series analysis of the magnetic filed along the magnetic equator

We can evaluate the equatorial magnetic field variation with the same ruler during the unquiet time as well as quiet time

**http://data.icswse.kyushu-u.ac.jp/eeindex/index.html**