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Study of the Ionospheric Current System Using MAGDAS Data

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Acknowledgement

- Prof. K. Yumoto

  Supervisor, Director of SERC
  IP of MAGDAS/CPMN Project

- Space Environment Research Center (SERC)

  http://www.serc.kyushu-u.ac.jp/index_e.html

- All MAGDAS/CPMN Hosts

- Dr Mahrous, SWMC

0. Outline

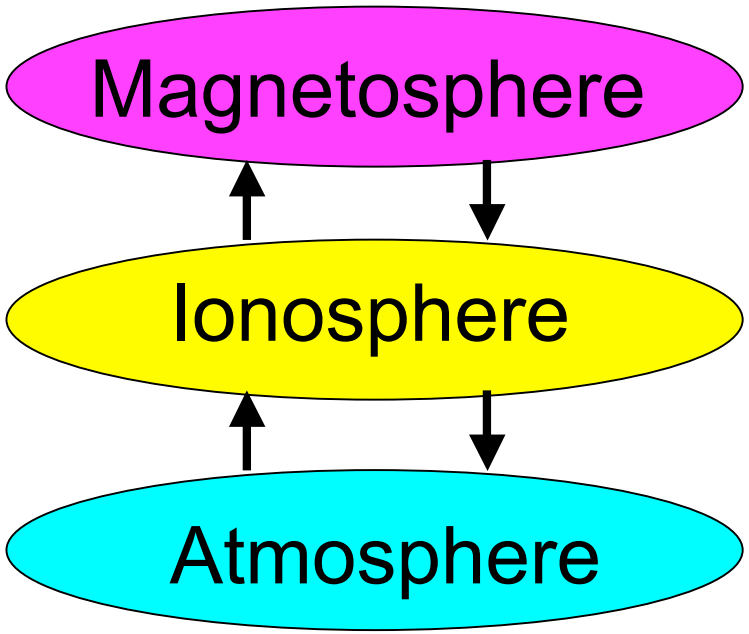
☆ The Earth's ionosphere and the current system therein

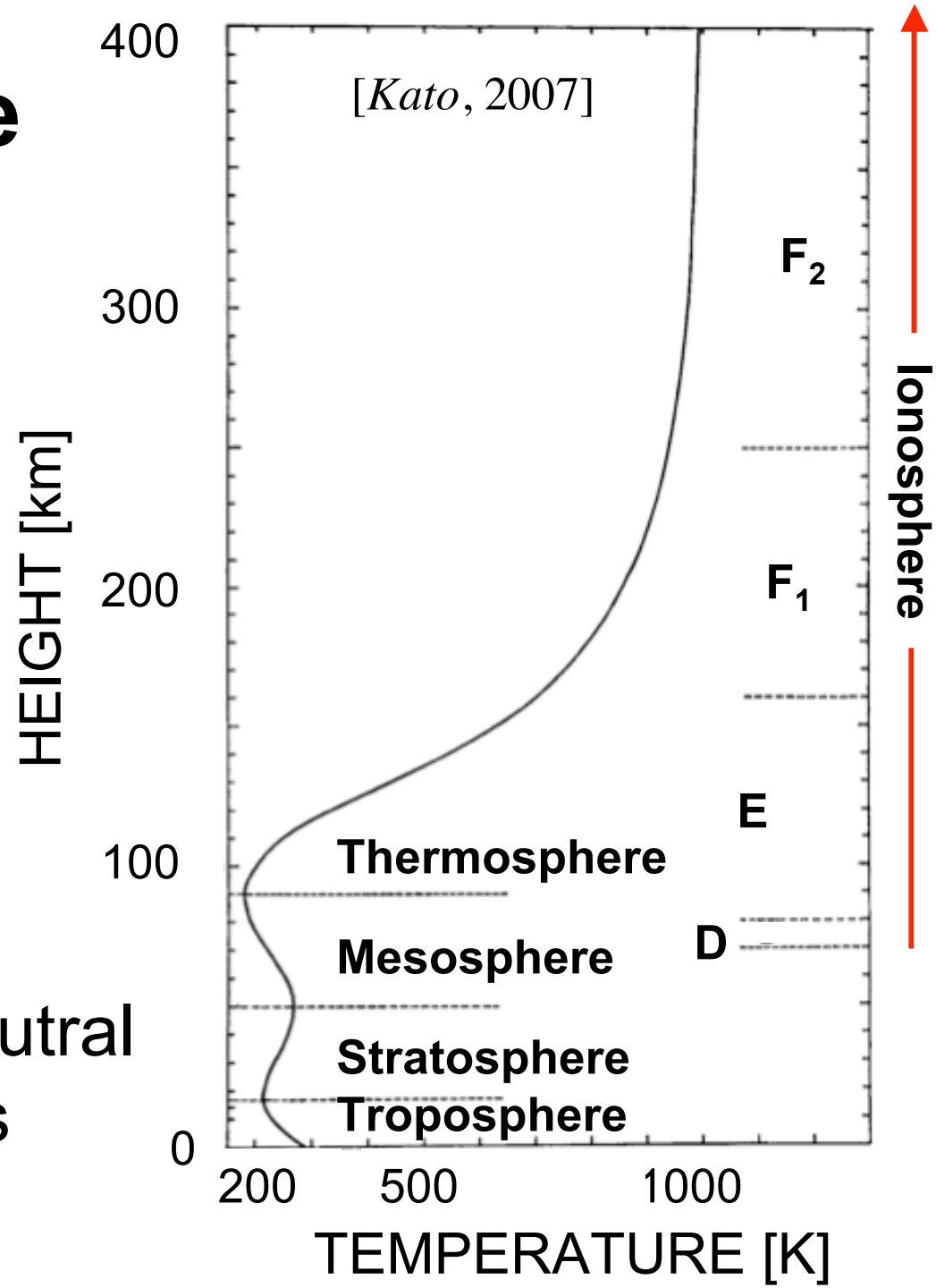
☆ The MAGDAS observation and methodology for estimation of the ionospheric current system

☆ Summary

1.1. Ionosphere

- 60<h<2000 km

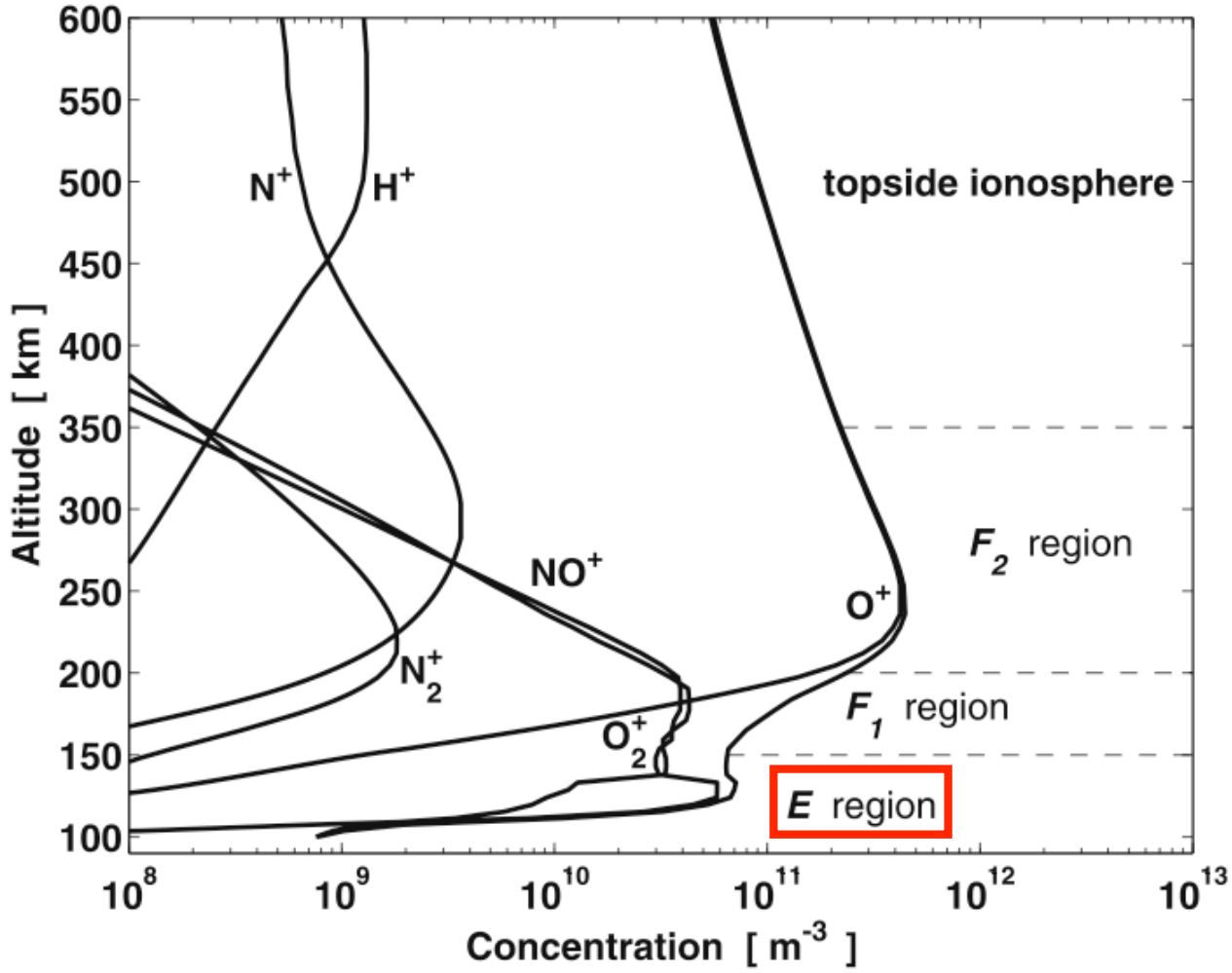




- Ionization of the neutral atoms and molecules

1.1. Ionosphere

- Ions and electrons created by EUV and X-ray
- $n_{i,e} \backsim 10^{-3} n_n$



[*Belelly and Alcayde*, 2007]

1.2. Ionospheric Currents

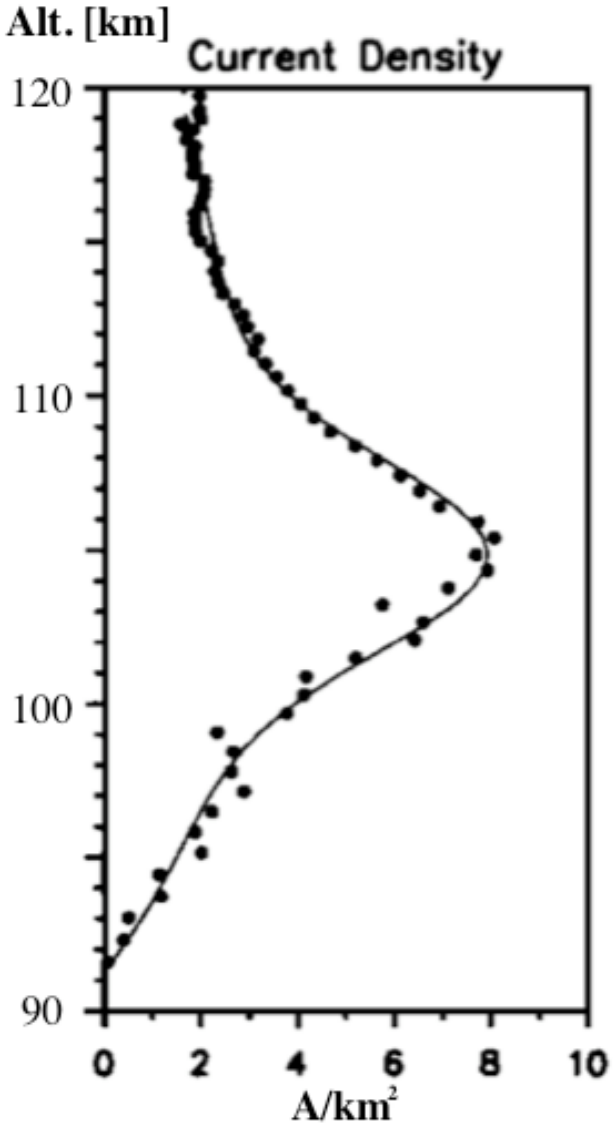
- Ionospheric Dynamo

$$\mathbf{J} = \sigma \mathbf{E}$$

$$\mathbf{E} = \mathbf{E}_s + \mathbf{u} \times \mathbf{B}$$

J: current density
σ: conductivity
E_s: electrostatic field
u: neutral wind velocity
B: geomagnetic field

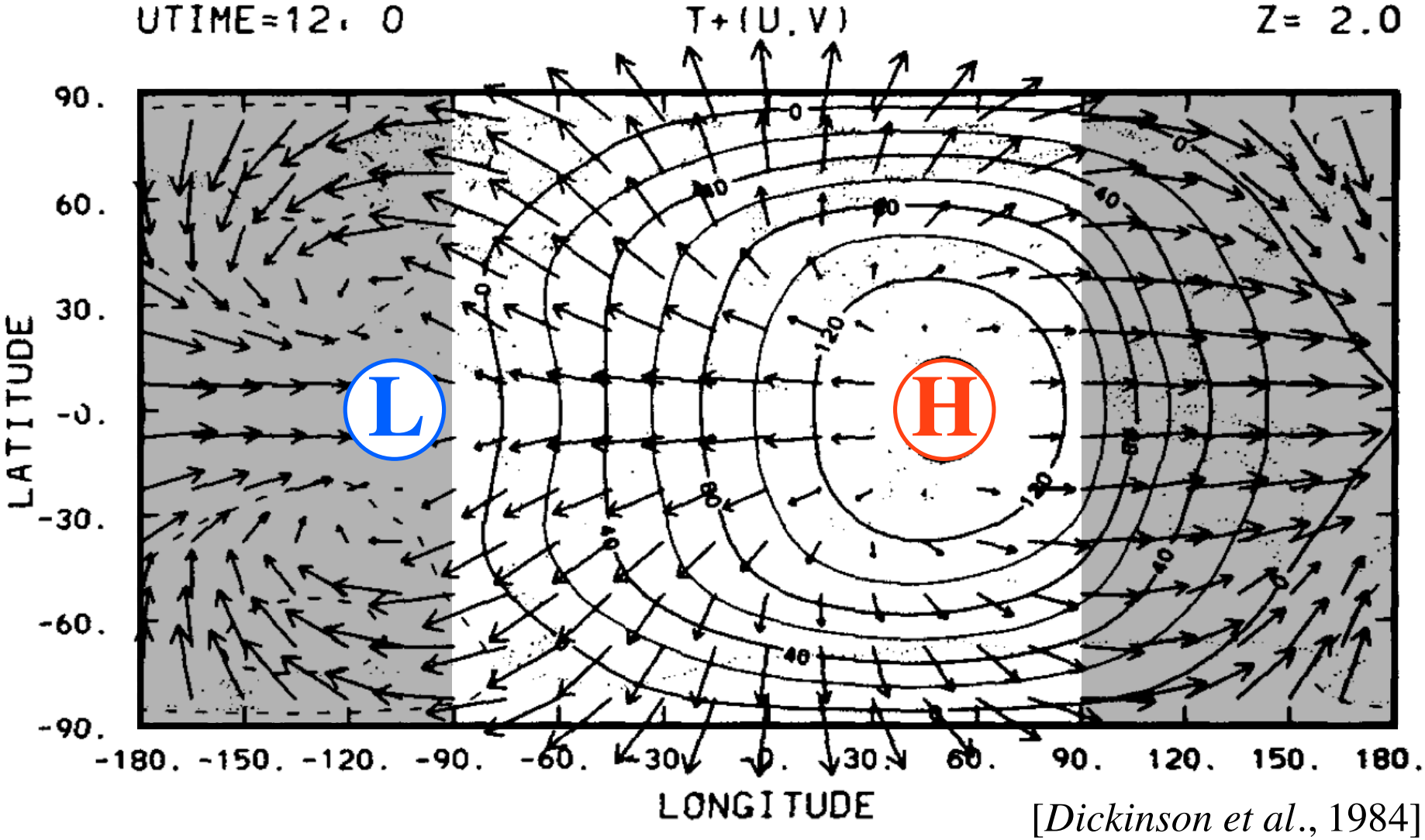
- E-region ionosphere
- Dayside ionosphere



[*Pfaff et al.*, 1997]

1.3. Ionospheric Dynamo

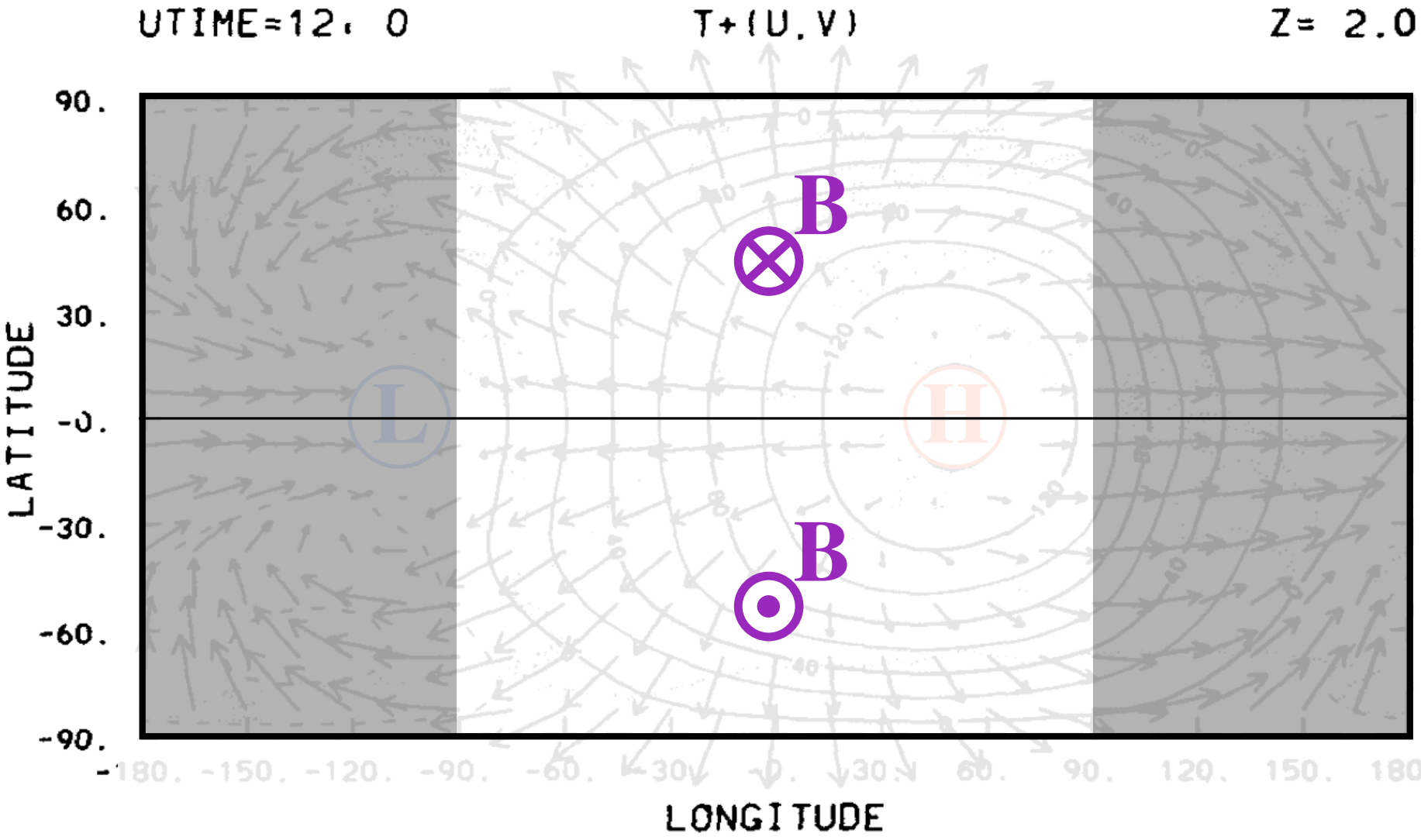
Alt.=300km



[*Dickinson et al.*, 1984]

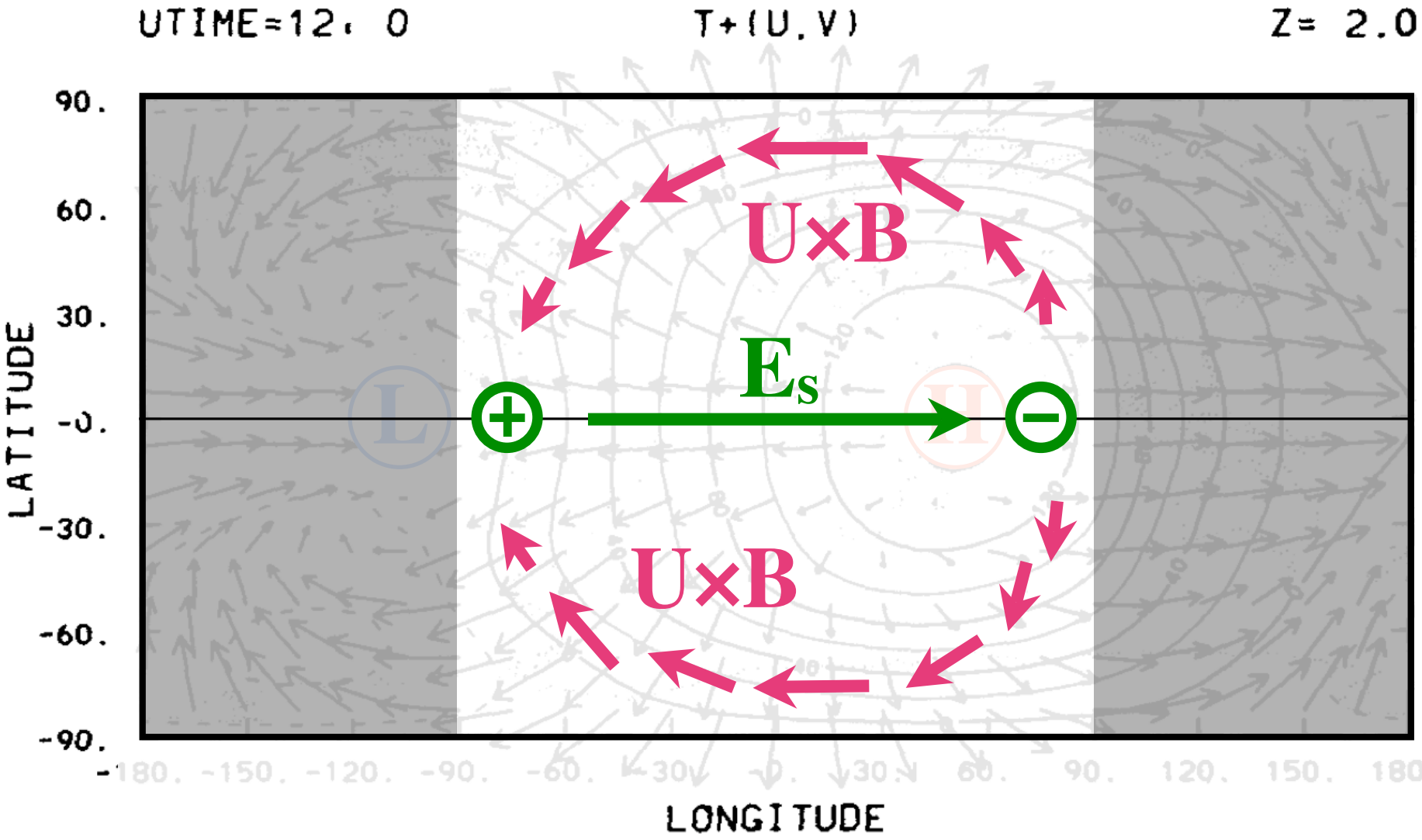
- Diurnal wind field **U** in the ionosphere

1.3. Ionospheric Dynamo



- Earth's main magnetic field **B**

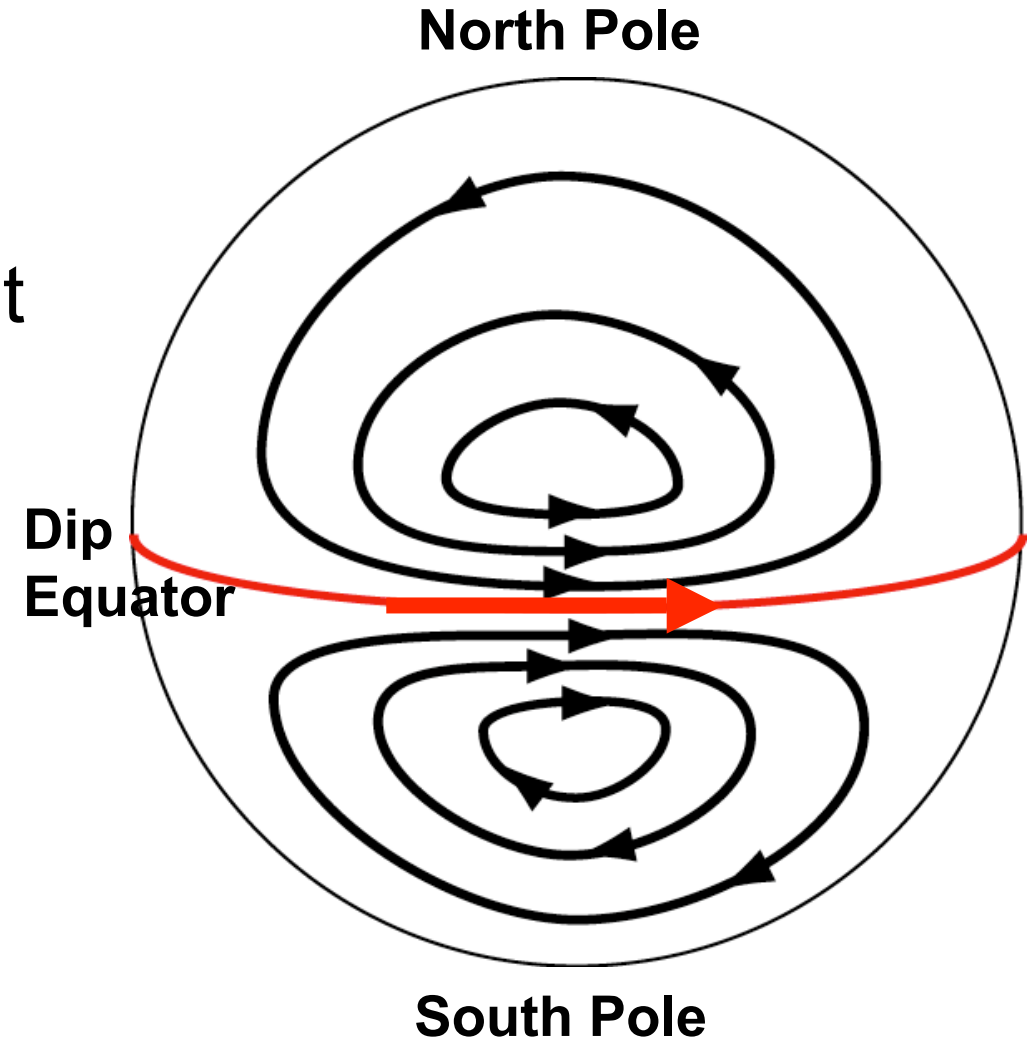
1.3. Ionospheric Dynamo



- Induced field **U×B** and electrostatic field $\mathbf{E_s}$

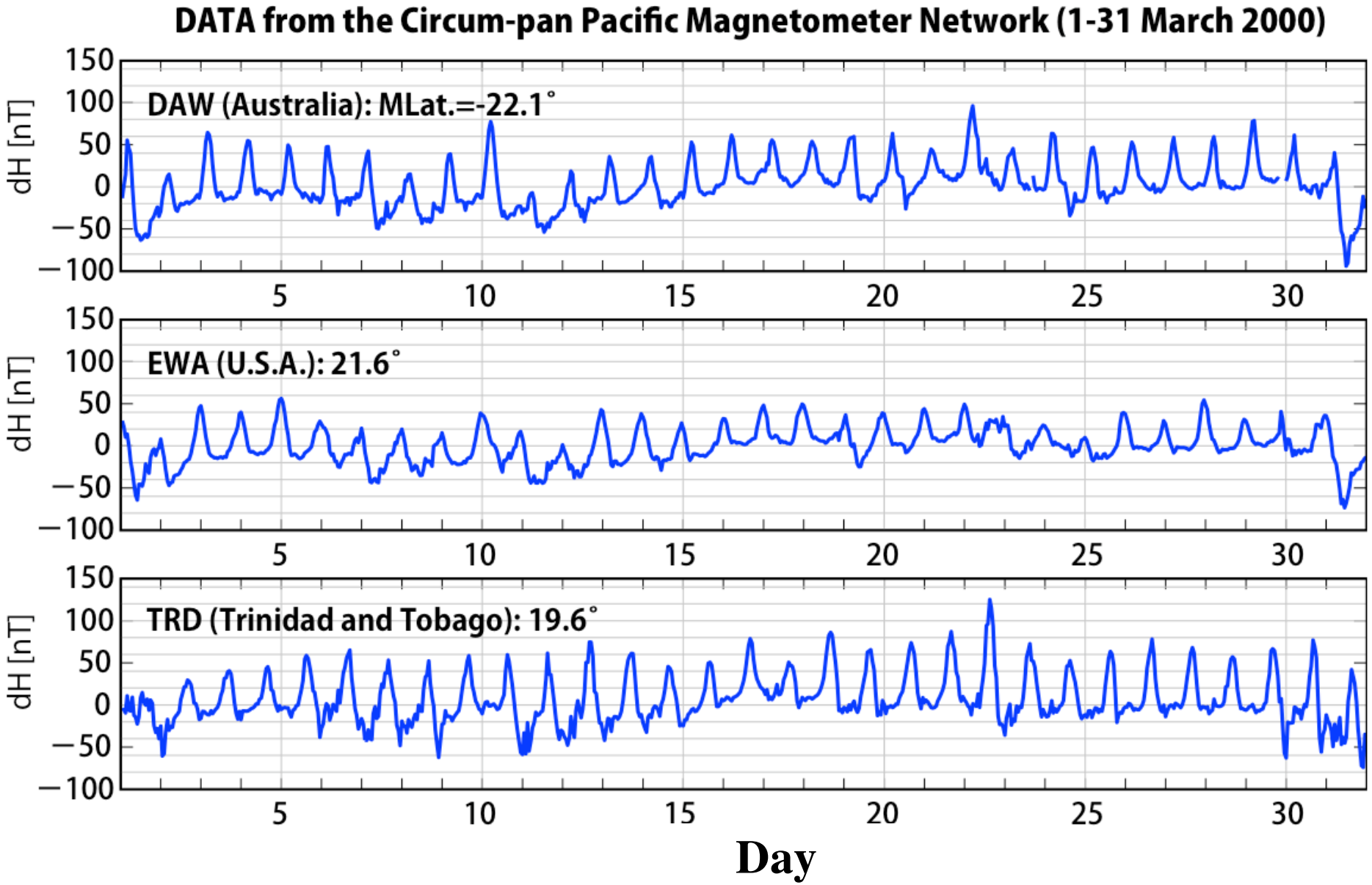
1.4. Current System

- Two global vortices
- Equatorial Electrojet



A view from the Sun

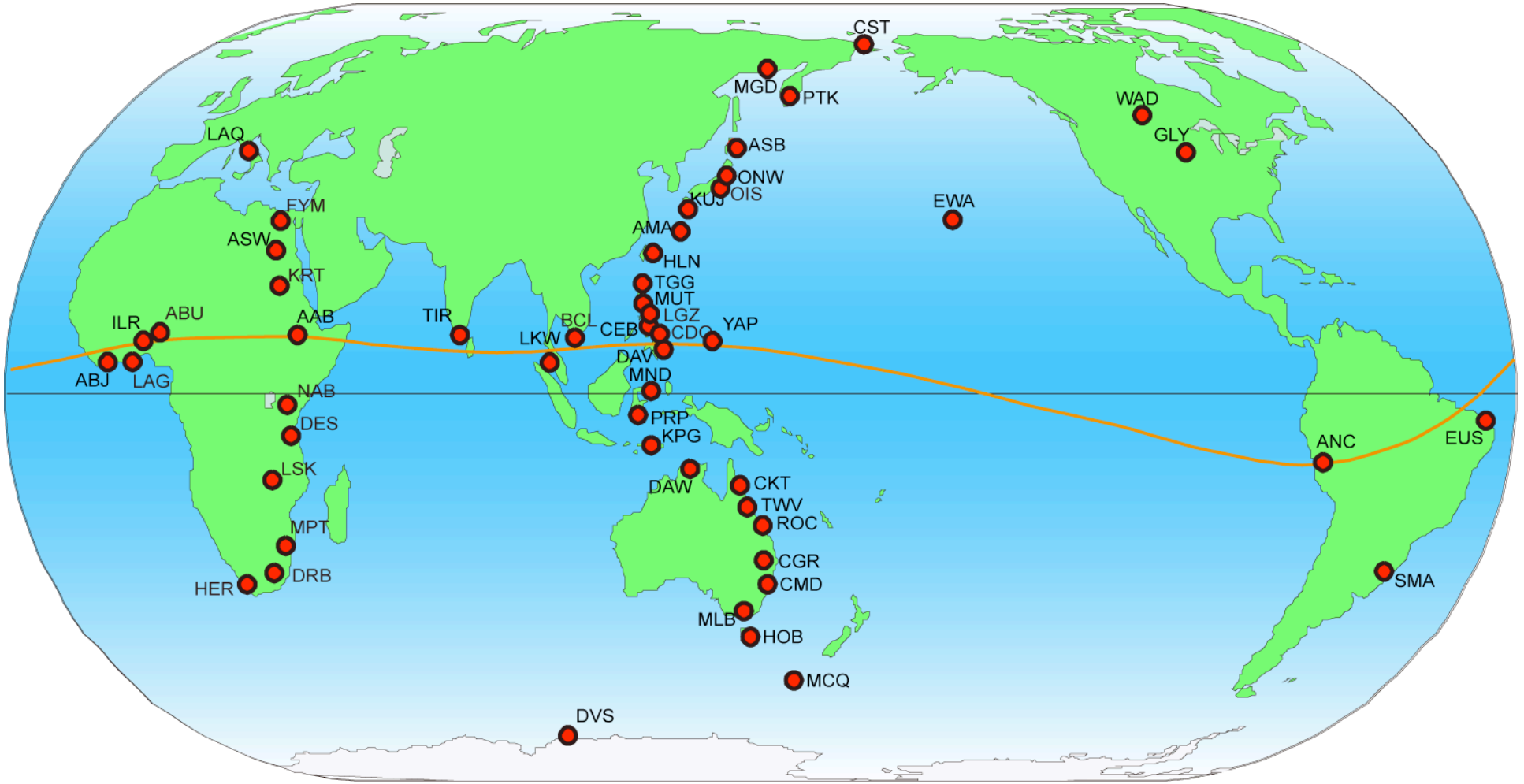
1.5. Geomagnetic Effects



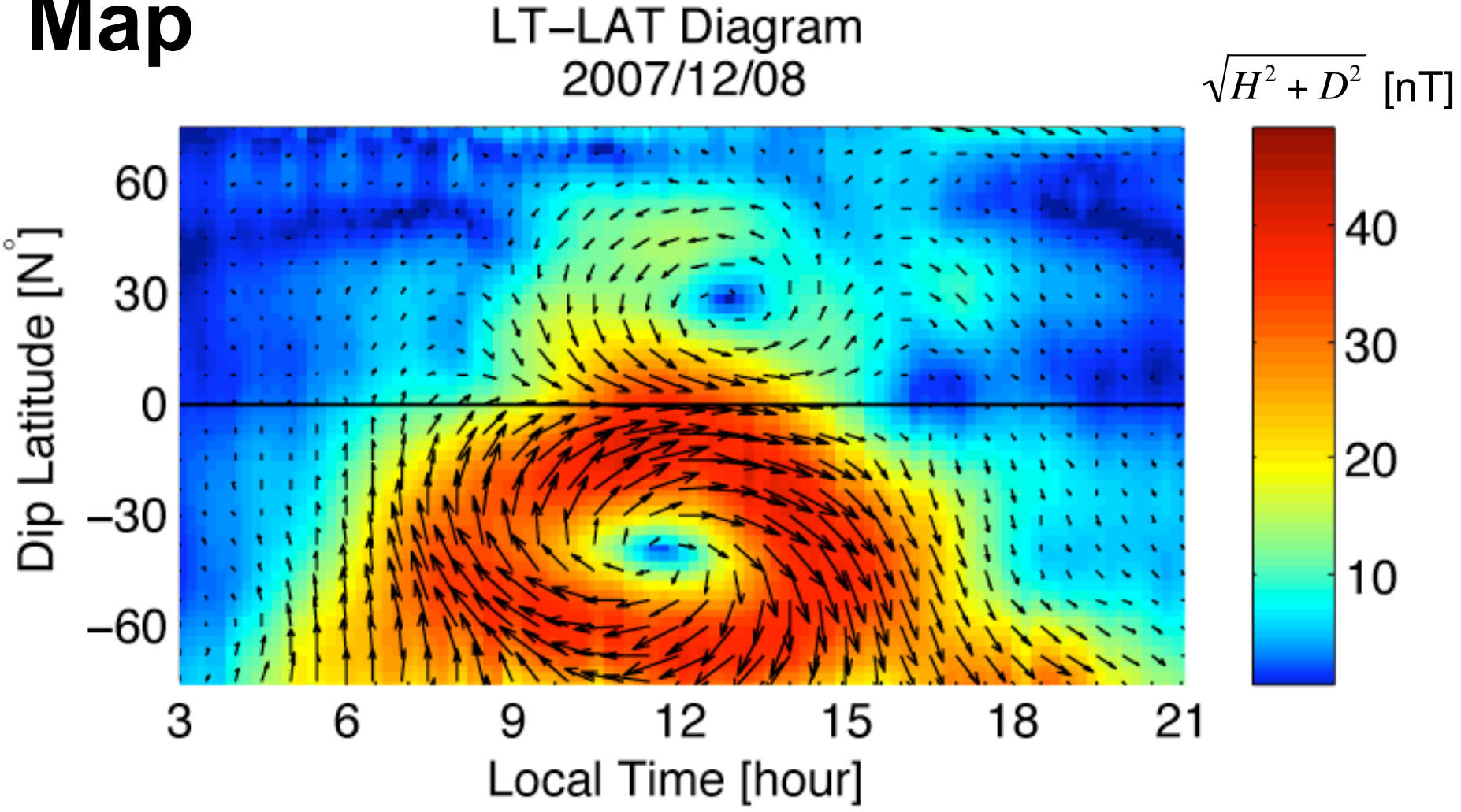
2.1. MAGDAS/CPMN Observation

MAGDAS/CPMN **PI: Prof. K. Yumoto**

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



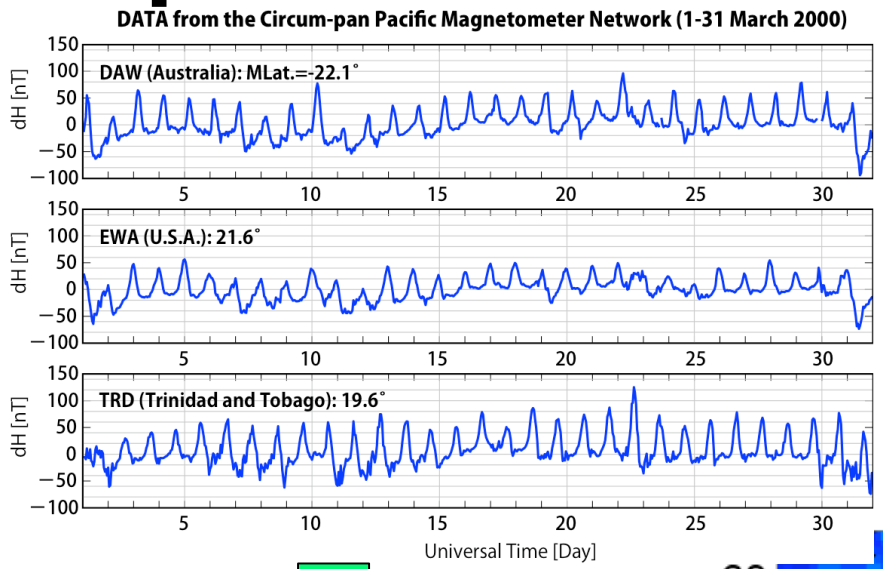
2.2. MAGDAS Equivalent Current Map



[*Yamazaki et al*., Space Environment Symposium, 2009]

- LT-LAT map describing current distributions

2.2. MAGDAS Equivalent Current Map



Estimation of the equivalent ionospheric current system from the ground magnetometer data

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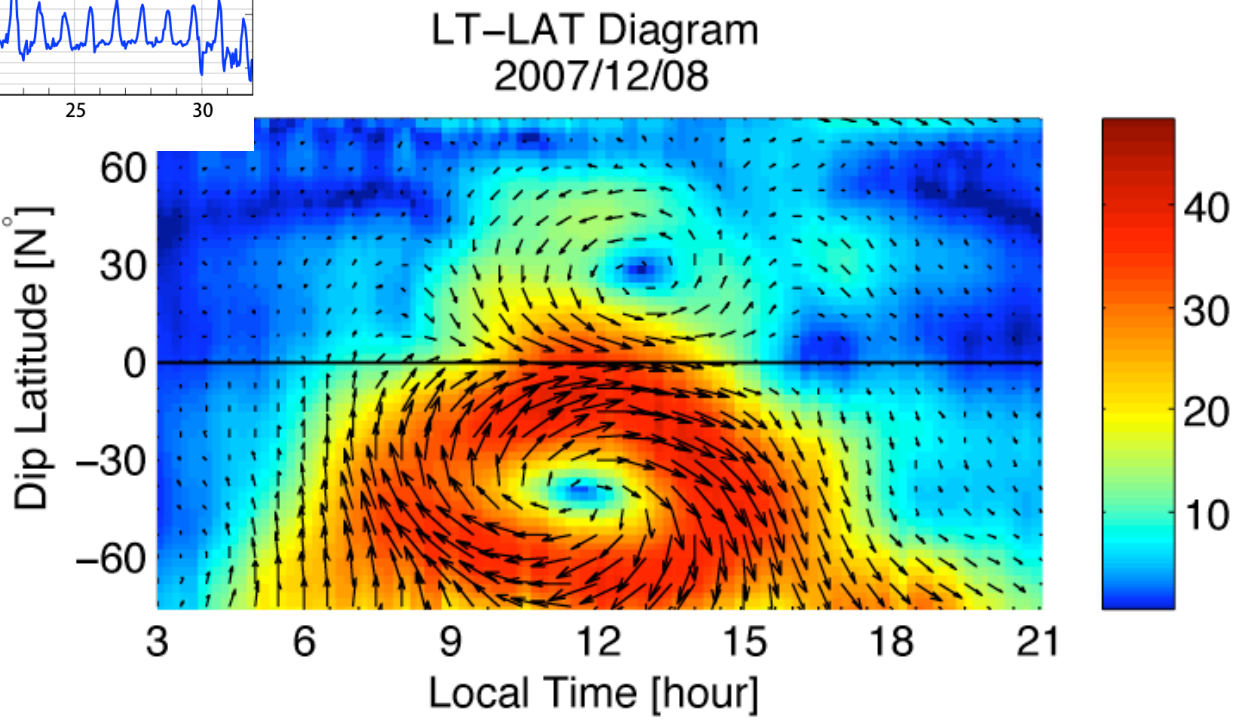


2.3. Extraction of Daily Variations

・Local time is calculated from geographic longitude of the station and universal time.

LT [Hour] = G.G.Long. [˚E]×15 + UT [Hour]

・Base level is calculated from night time values

Currents night side << Currents day side

Deviation of the geomagnetic field from night time values

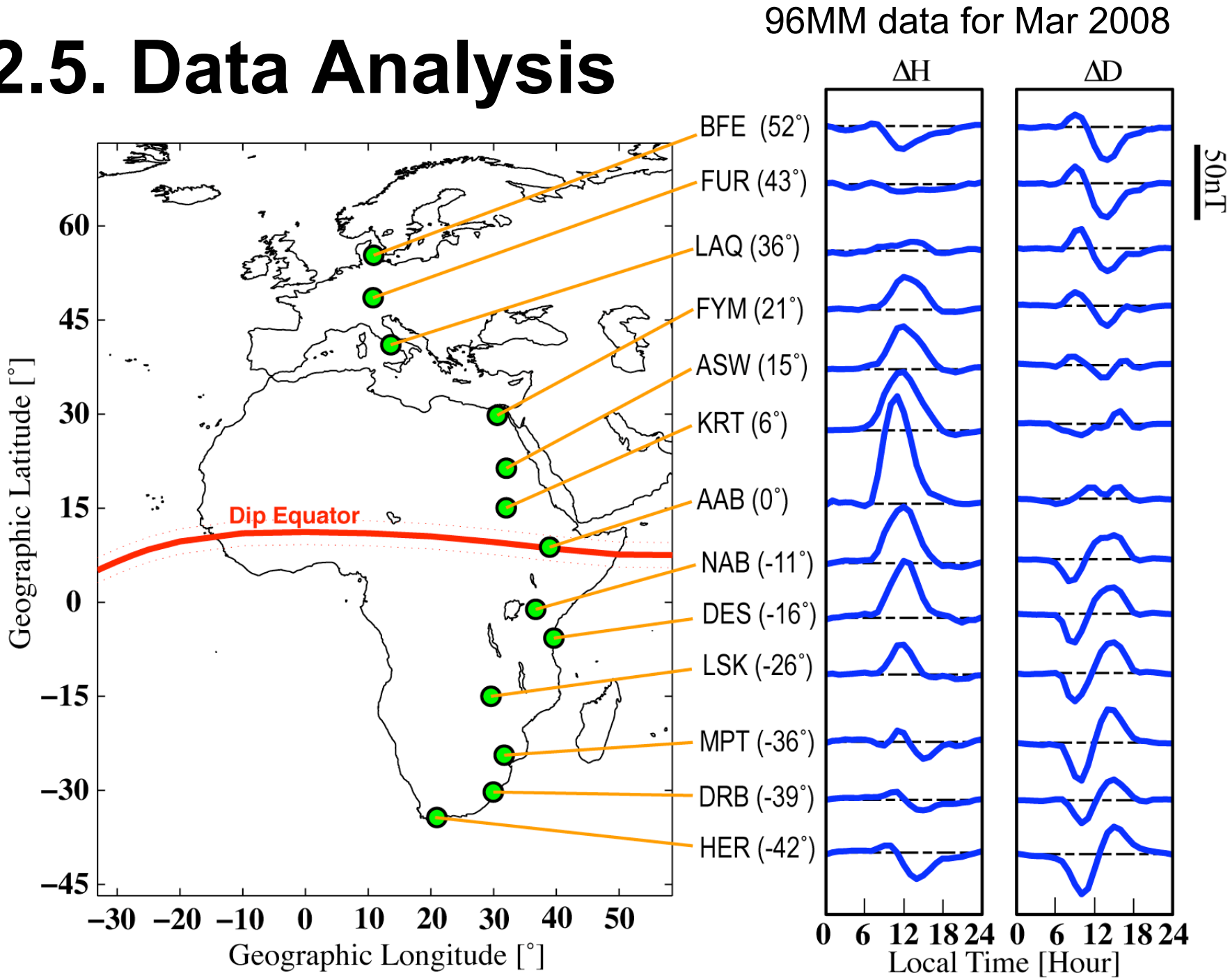
↓

Geomagnetic effects of the ionospheric current system

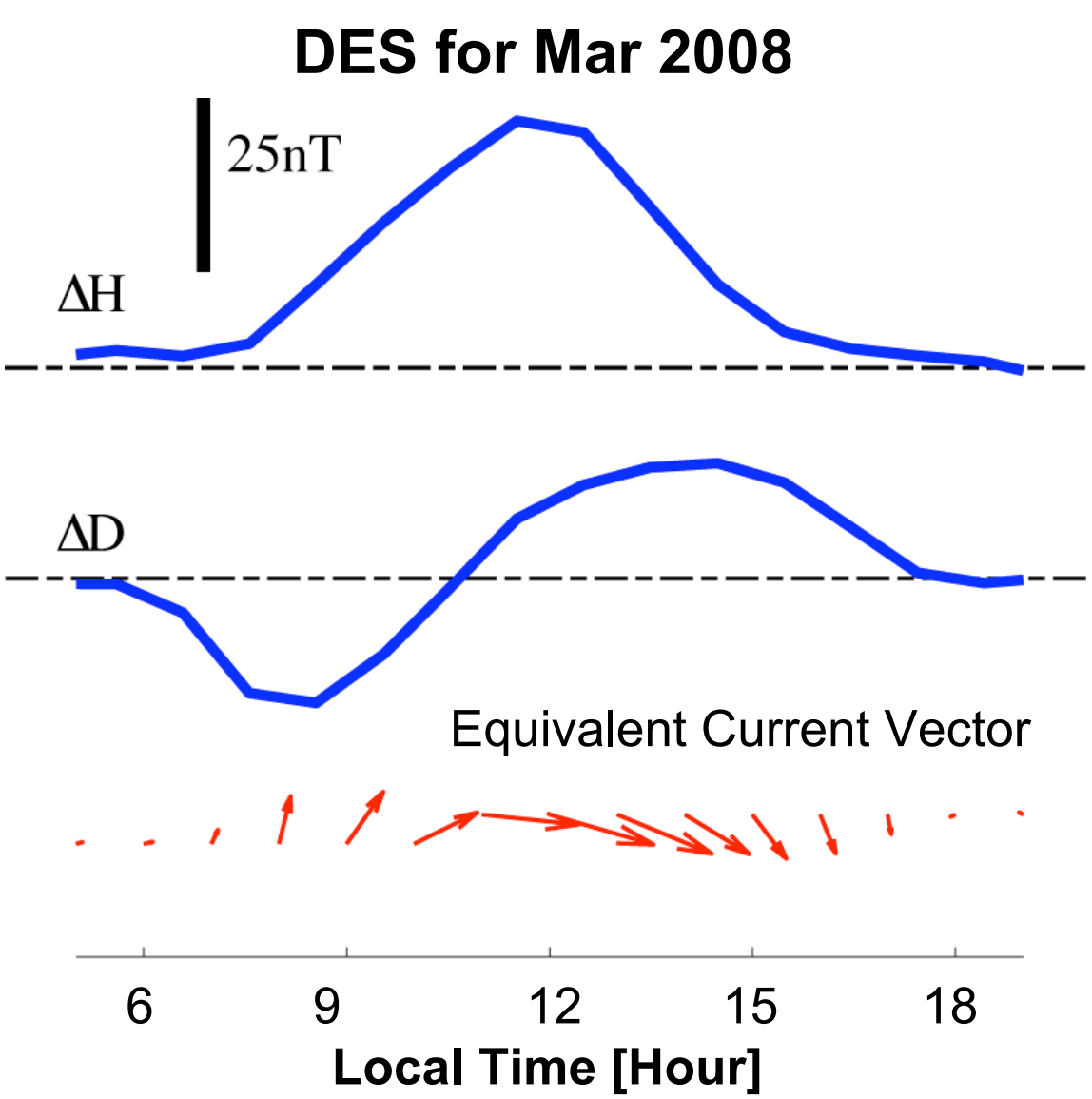
・Geomagnetically quiet days are used

ex) Kp ≤ 2+

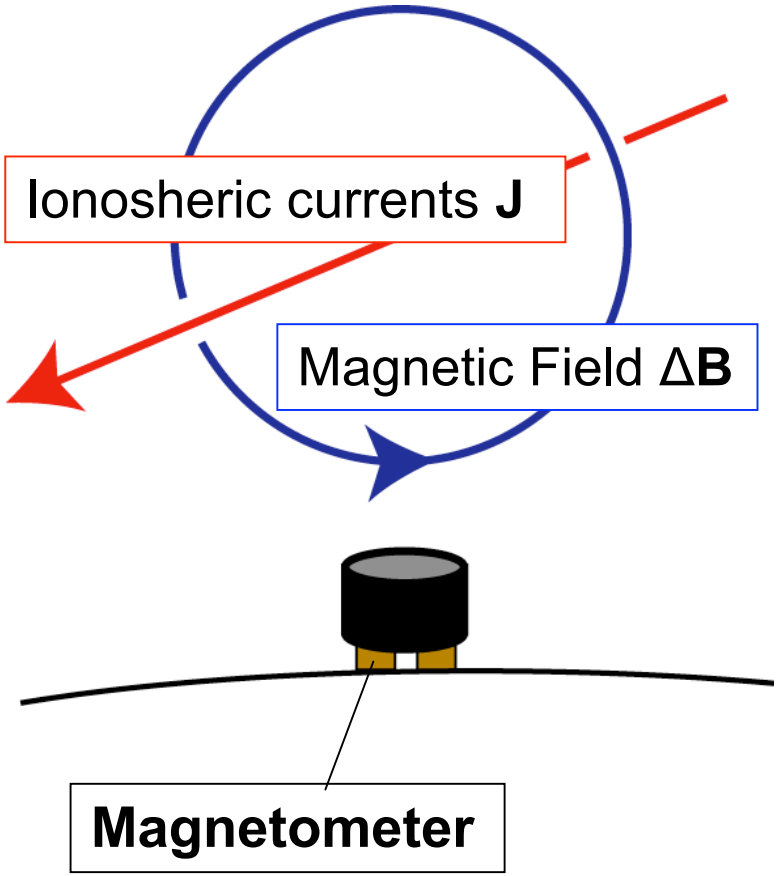
2.5. Data Analysis



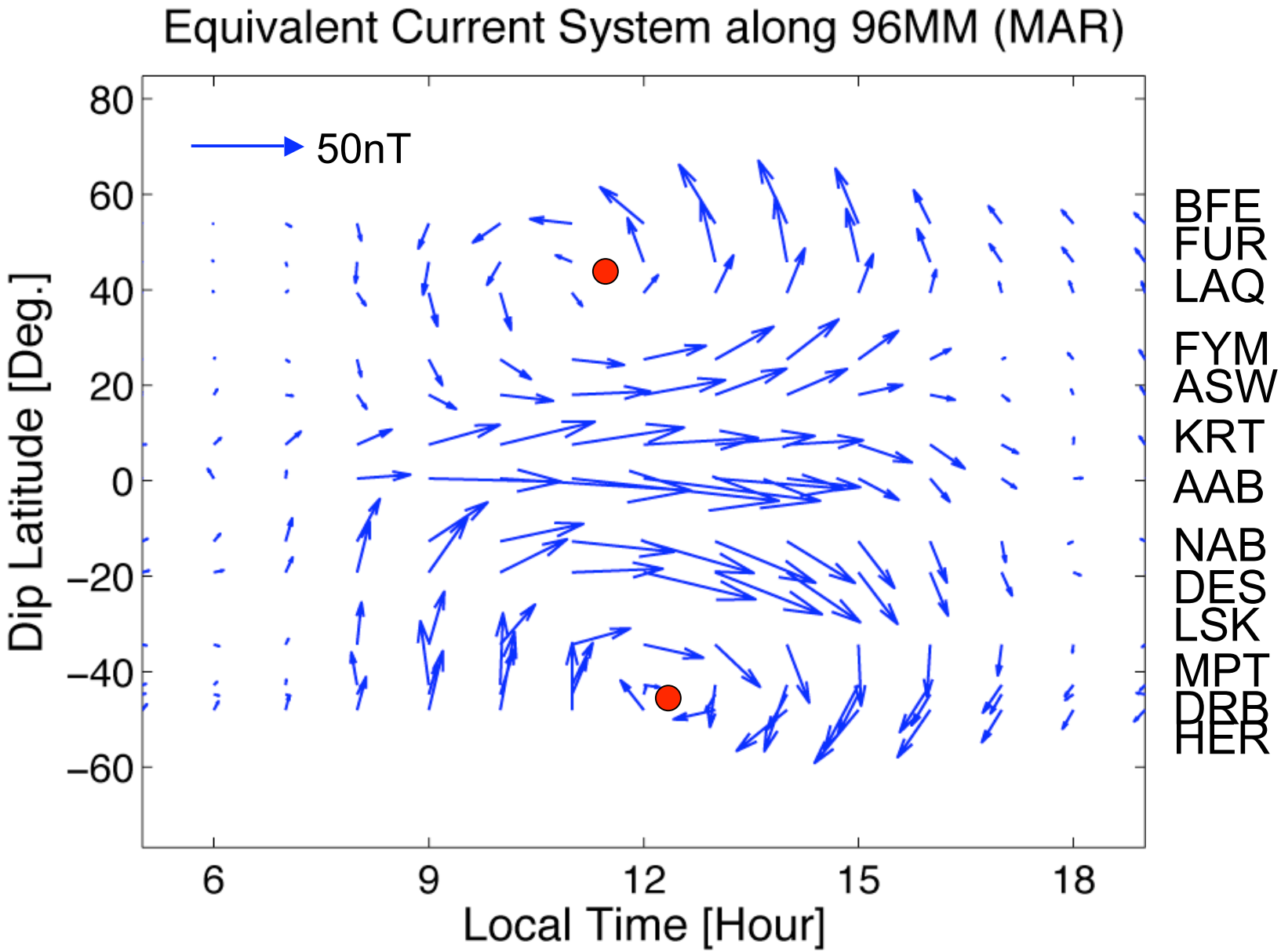
2.6. Equivalent Current Vector



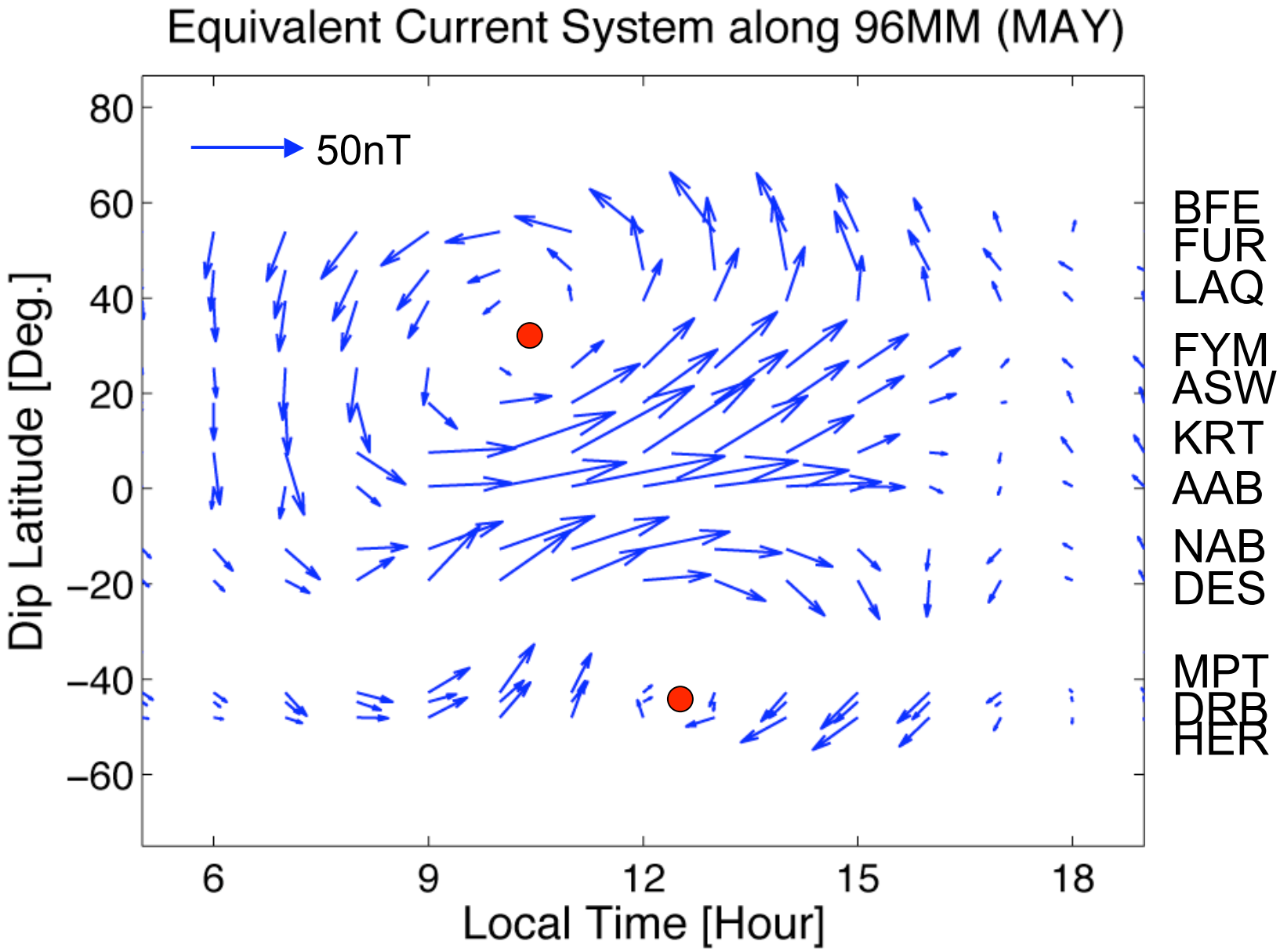
+ΔH → Eastward **J**
+ΔD → Southward **J**



2.7. Equivalent Current Vector



2.7. Equivalent Current Vector



3. Summary

・To study ionosphere is important for space weather and climatology.

・Quiet daily variations of the geomagnetic field is attributed to ionospheric currents.

・Global ionospheric current system can be estimated using MAGDAS data.

・It is not well understood what causes changes in the pattern and strength of the ionospheric currents.

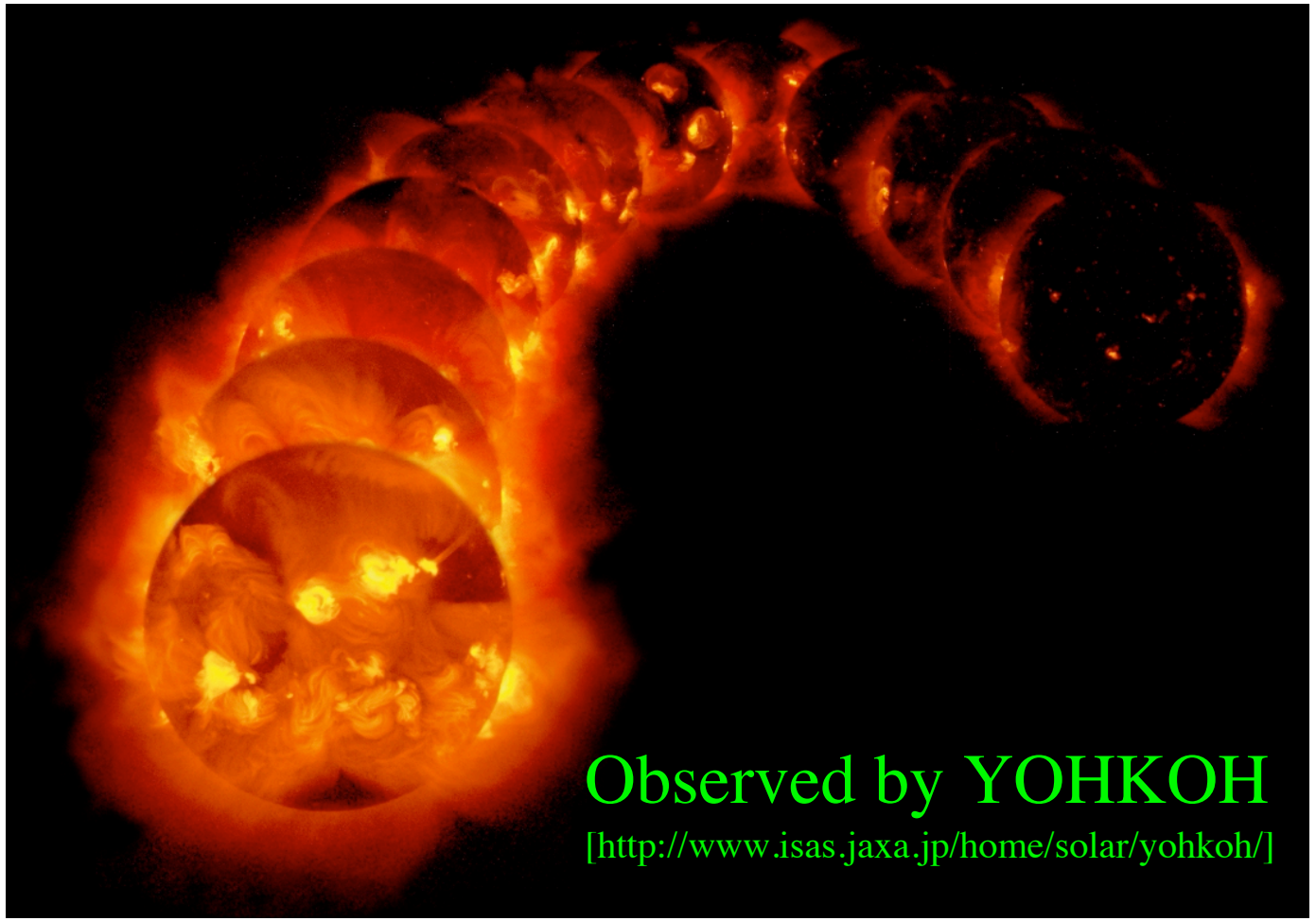
Thank you for your attention!

[http://www.serc.kyushu-u.ac.jp/index_e.html]

The ionospheric currents from MAGDAS/CPMN observations

- Response to changes of **solar activity**
- **Seasonal** variations
- **Day-to-day** variations
- **Longitudinal** dependence
- Relation to **equatorial electrojet**

2. Response to Changes of Solar Activity



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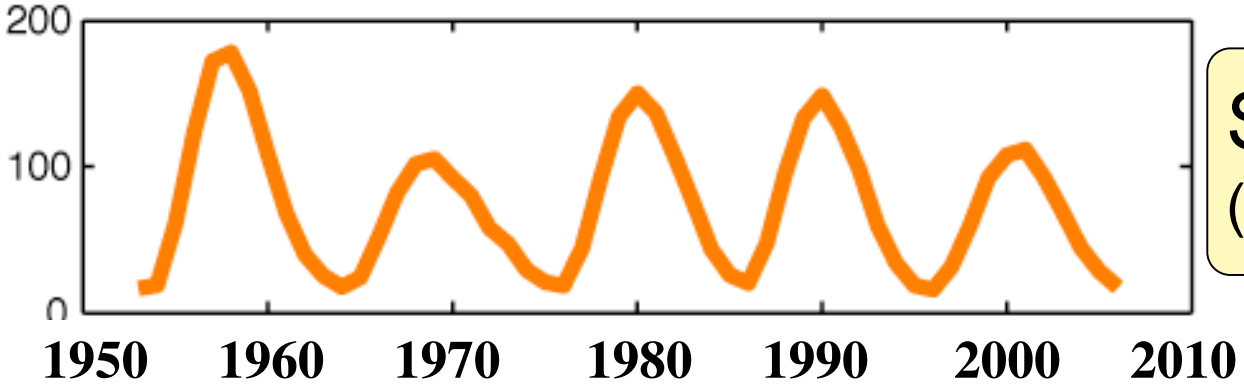
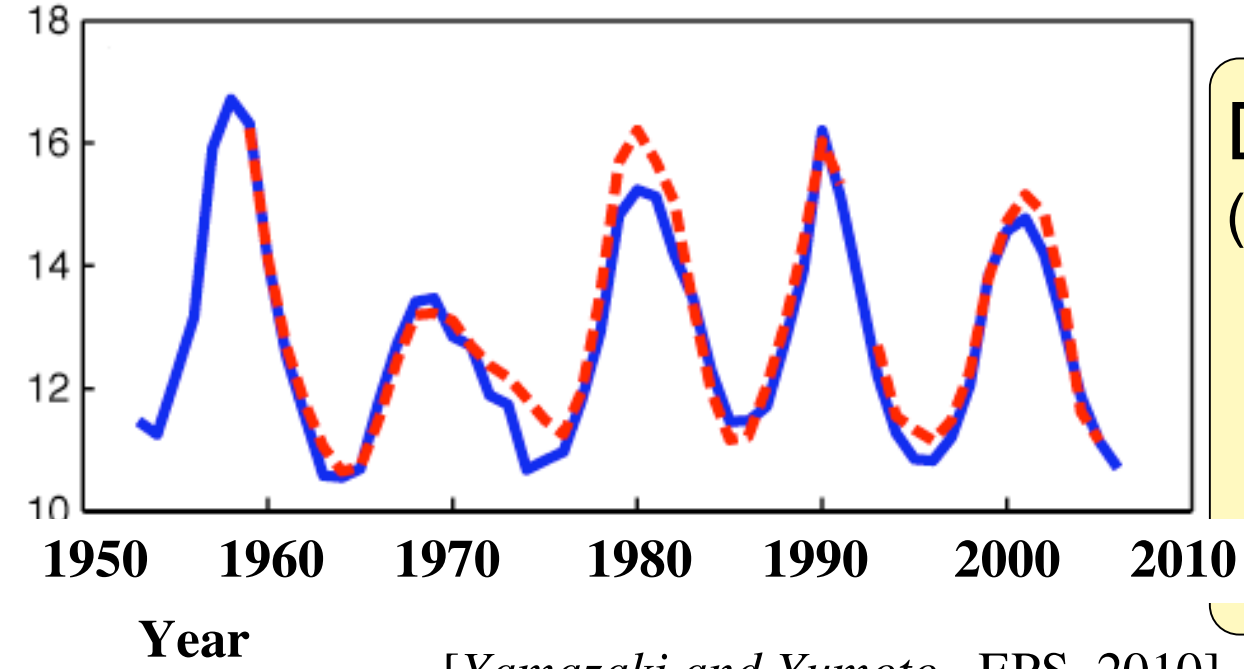


Sunspot Number
(3-year running average)



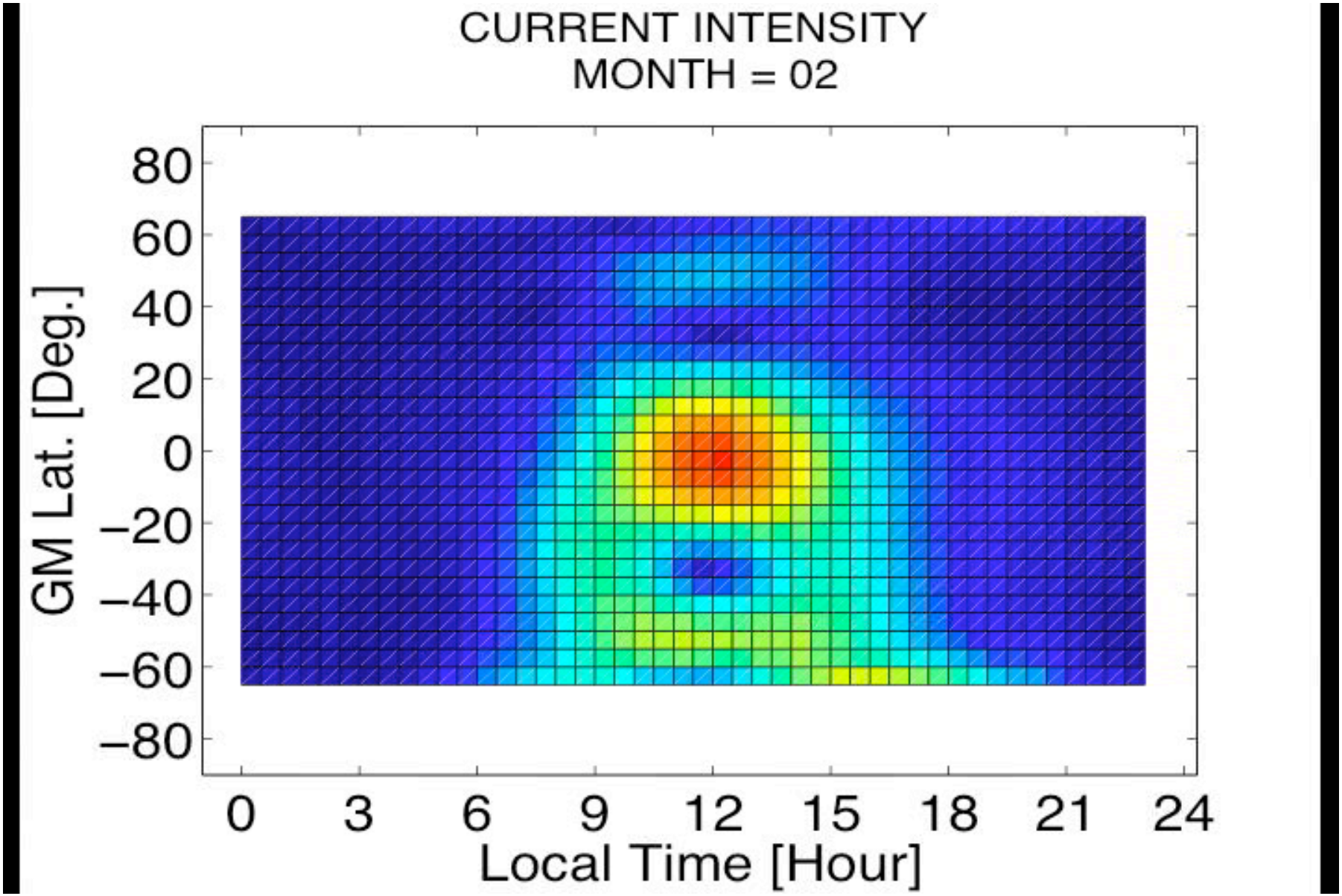
Daily Range
(3-year running average)

Blue: Kakioka (Japan)

Red: Gnangara (Australia)

[*Yamazaki and Yumoto*., EPS, 2010]

2. Seasonal Variations



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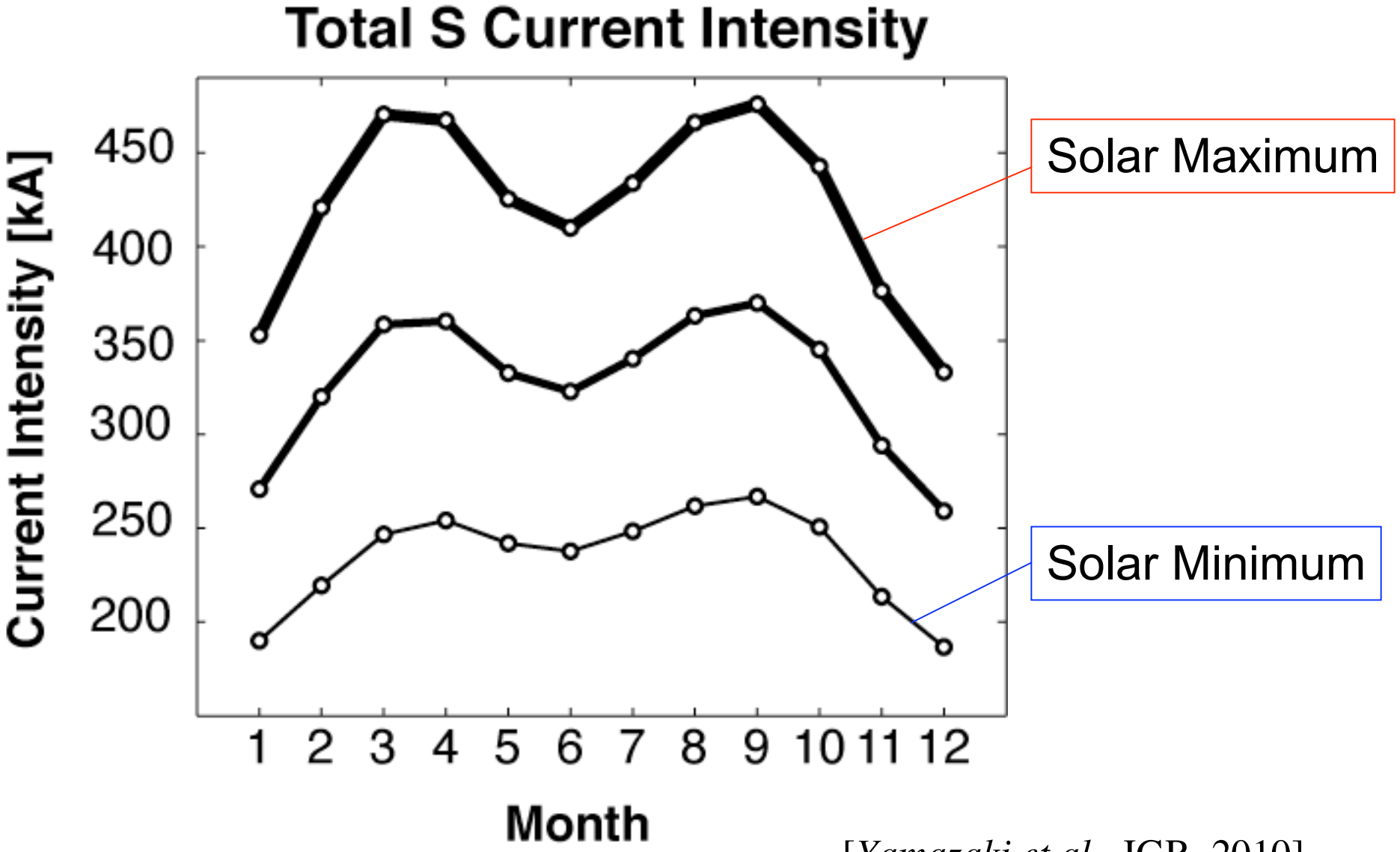


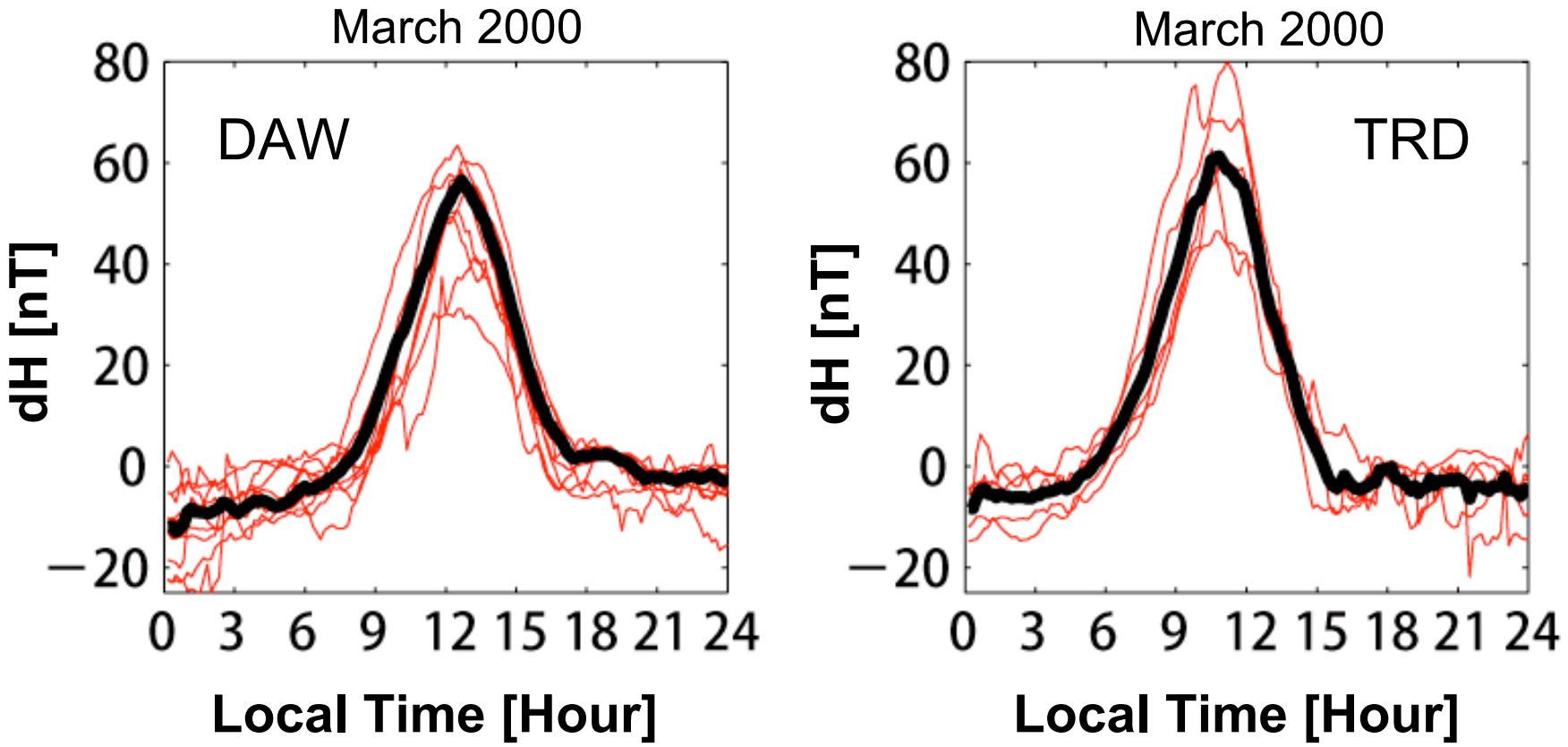
[*Yamazaki et al.*, JGR, 2010]

2. Day-to-day Variations

2. Longitudinal Dependence

2. Relation to Equatorial Electrojet

2.4. Sq and S_R



- S_R: daily regular variation of each day
- Sq: averaged S_R for geomagnetically quiet days