



Relationship between SSW and Lunalunar tidal Ionospheric Current Enhancement Obtained by MAGDAS Data

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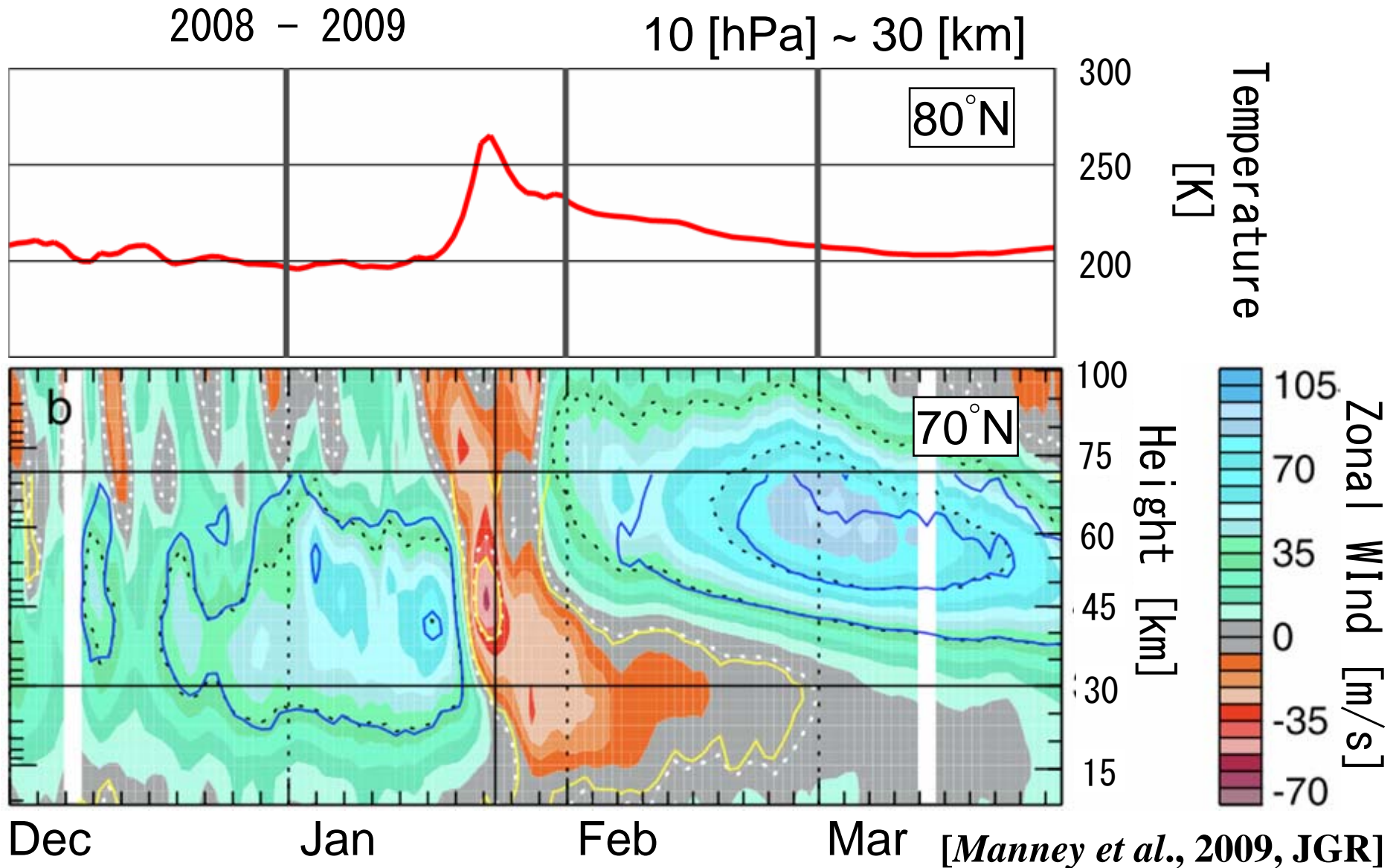
[1] Kyushu University

[2] Manila Observatory

[3] National Institute of Polar Research

1.1 Sudden Stratospheric Warming (SSW)

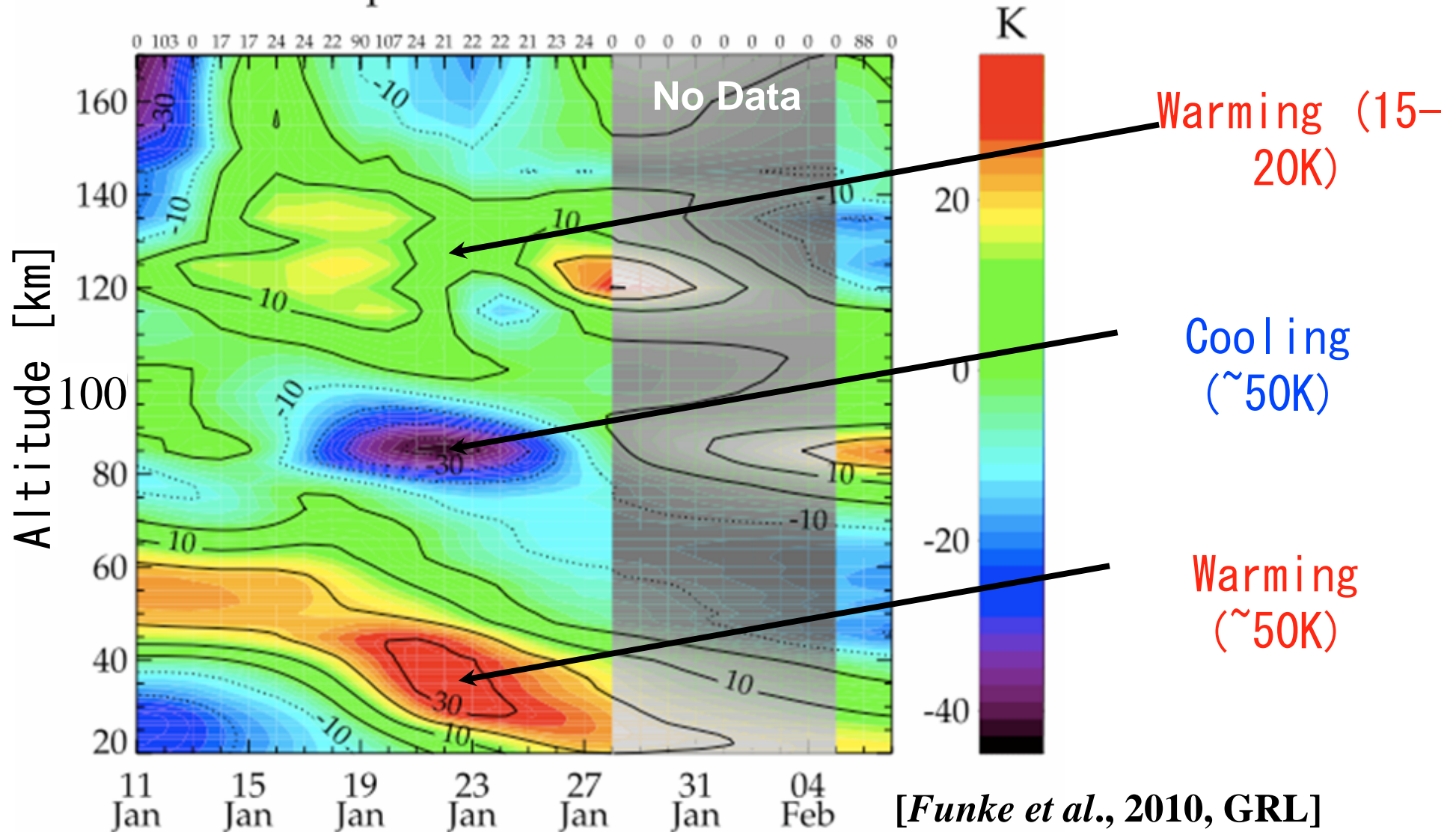
- Rapid increase of the polar stratospheric temperature
- Distribution of east-west zonal wind in the middle atmosphere global circulation.



1.2 Impact of SSW on the Middle/Upper Atmosphere

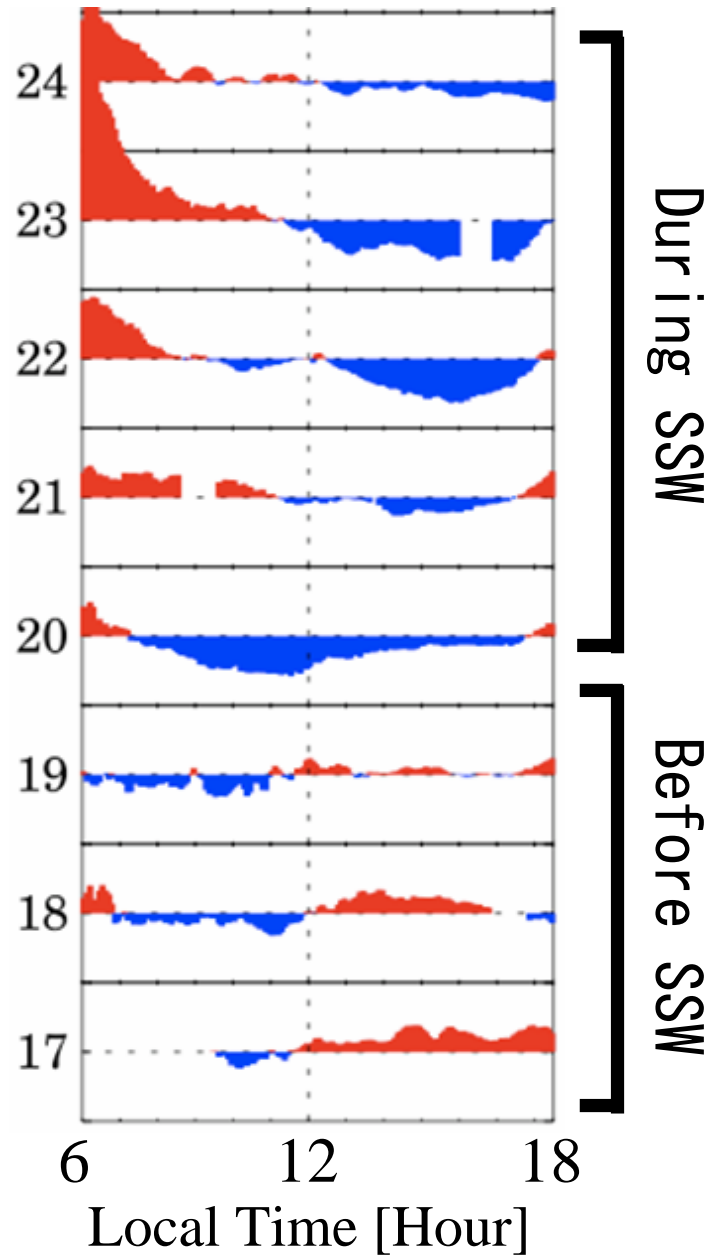
- Cooling in the mesosphere $\sim 80\text{--}90\text{km}$
- Warming in the thermosphere $\sim 120\text{--}140\text{km}$

MIPAS temperature anomalies 70-90N

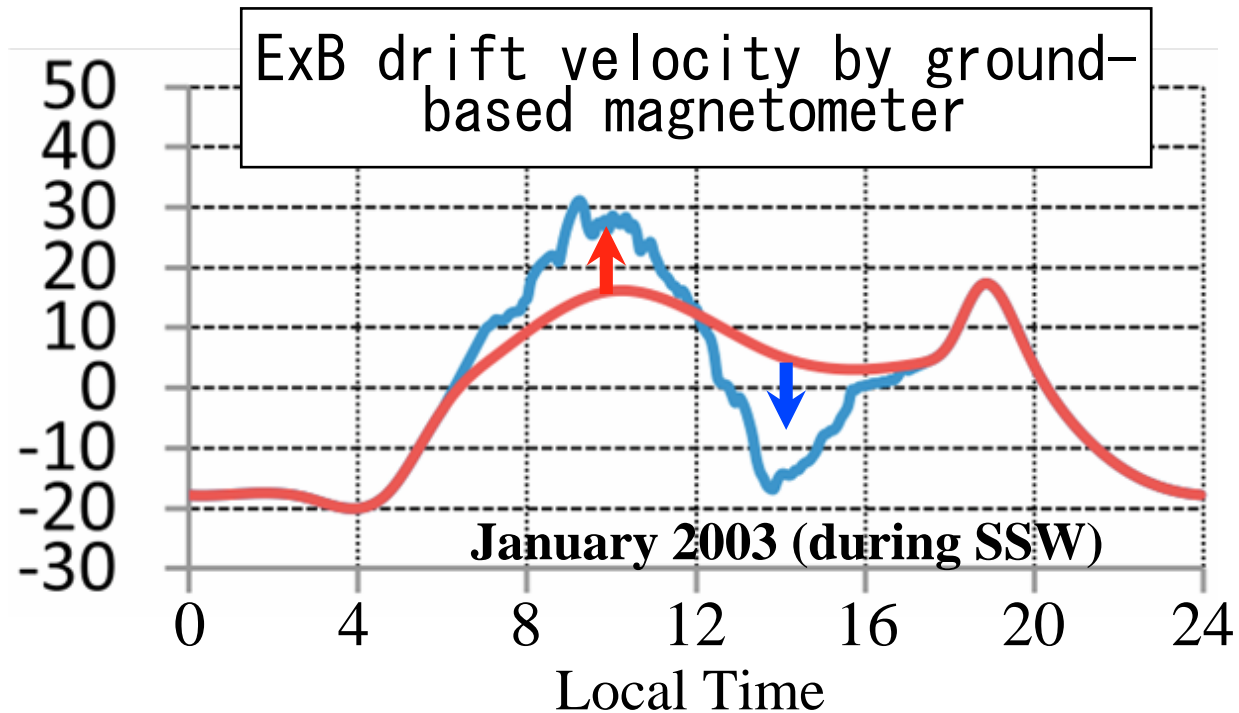


1.3 Impact of SSW on the Equatorial Ionosphere

Vertical ExB
drift velocity at [Chau et al., 2009, GRL]
Jicamarca



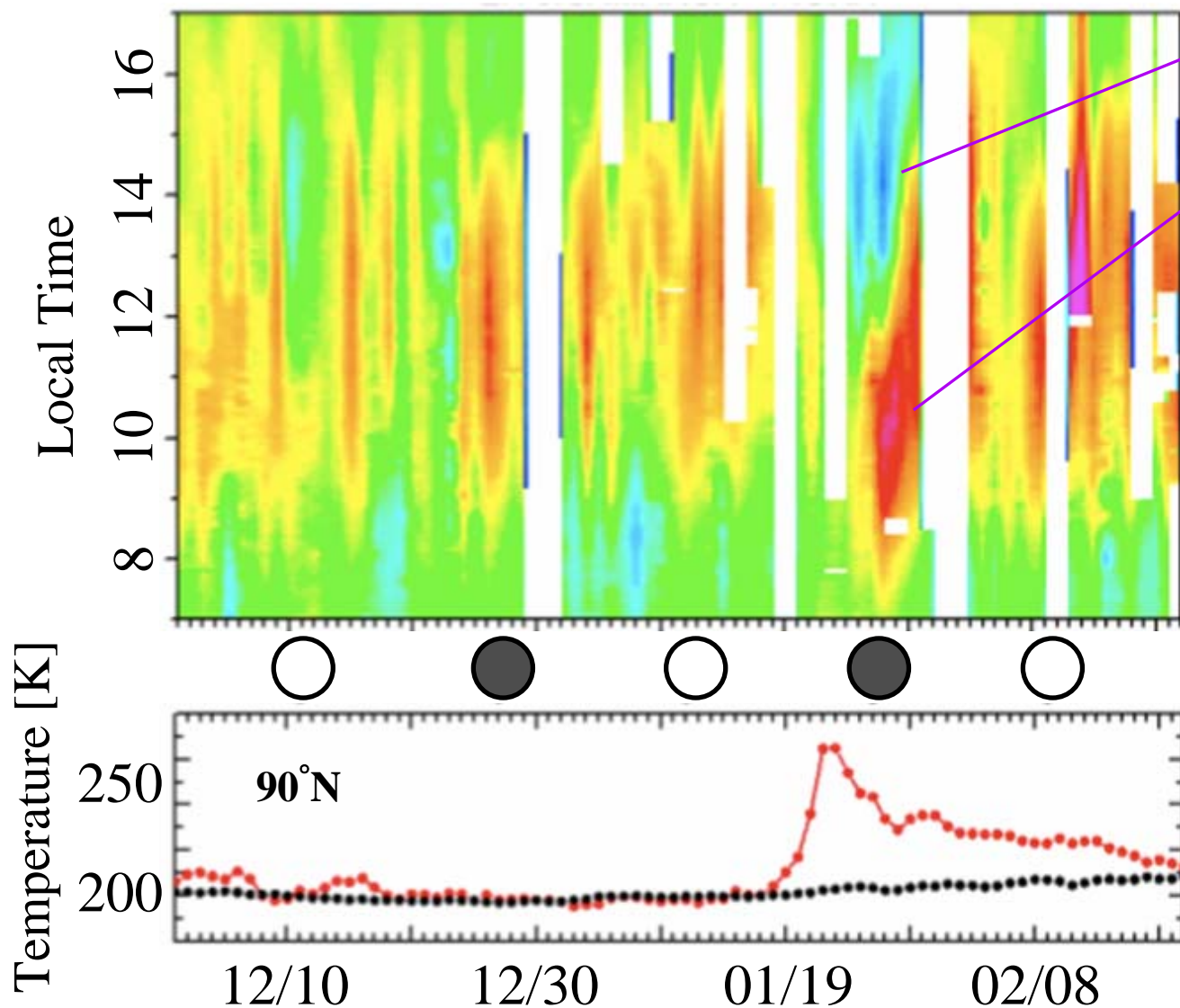
■ Increase in the morning
■ Decrease in the afternoon
→ Enhancement of the semidiurnal component



[Anderson and Araujo-Pradere, 2010, JGR]

1.4 Impact of SSW on the Equatorial Electrojet

Equatorial Electrojet (2008–2009)



■ CEJ in the afternoon

■ EEJ in the morning

With onset of the CEJs
near new moon or full
moon

Abnormally enhanced
lunartidal winds play
a key role?

[Fejer et al., 2010, JGR]

1.5 Enhancement of the Lunar Tidal Wind

Earlier simulation of the lunar tide during SSW:

1-D [Height]

Sawada [1954, Thesis]

Sawada [1956, Geophys. Mag.]

Increase in T by 9[K]
at stratopause



Increase in L amplitude by a
factor of 2.4 at E region

2-D [Height, Lat]

Stening et al. [1997, JGR]

Increase in T by 40[K] (40km)

Decrease in T by 20 [K] (80km)



L amplitude is 2-3 times
larger (90km)

can support *Fejer et al.*'s idea.

1.7 Remaining Issues

[1] Lack of case studies

Fejer et al. [2010, JGR]

Only 3 CEJ Events

- Statistical approach will be needed.
→ underway [Yamazaki et al.]

[2] Lack of global studies

- Although lunar tidal effects should be global, there is **no study on the global magnetic effects during SSWs.**
- A data set that can cover both the Northern Hemisphere and the Southern Hemisphere is needed.

2. Data Set

■ Event

Winter months during:

[1] 2001–2002

[2] 2002–2003

■ Data Source

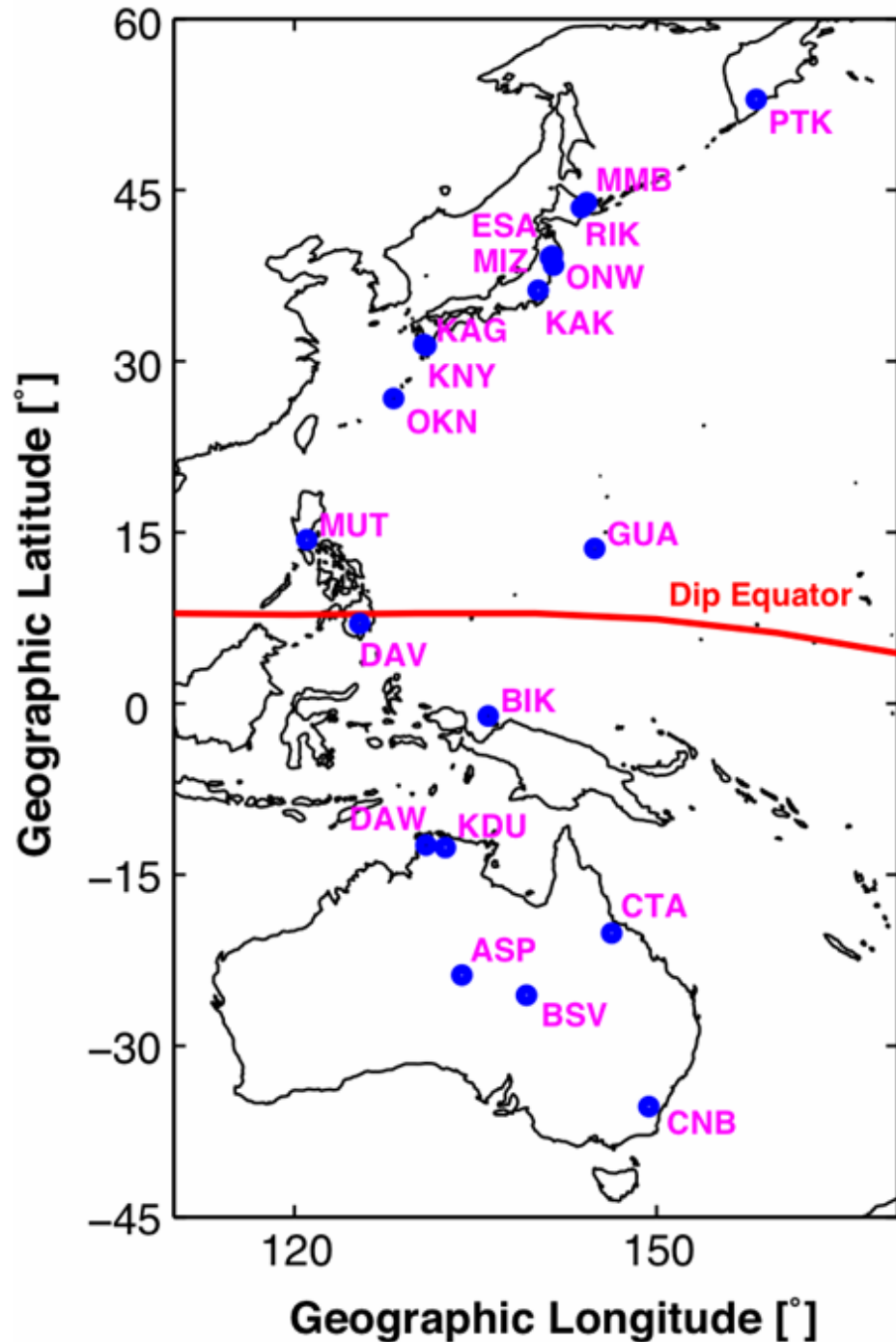
MAGDAS/210MM

Intermagnet

WDC, Kyoto

■ Disturbances Removed

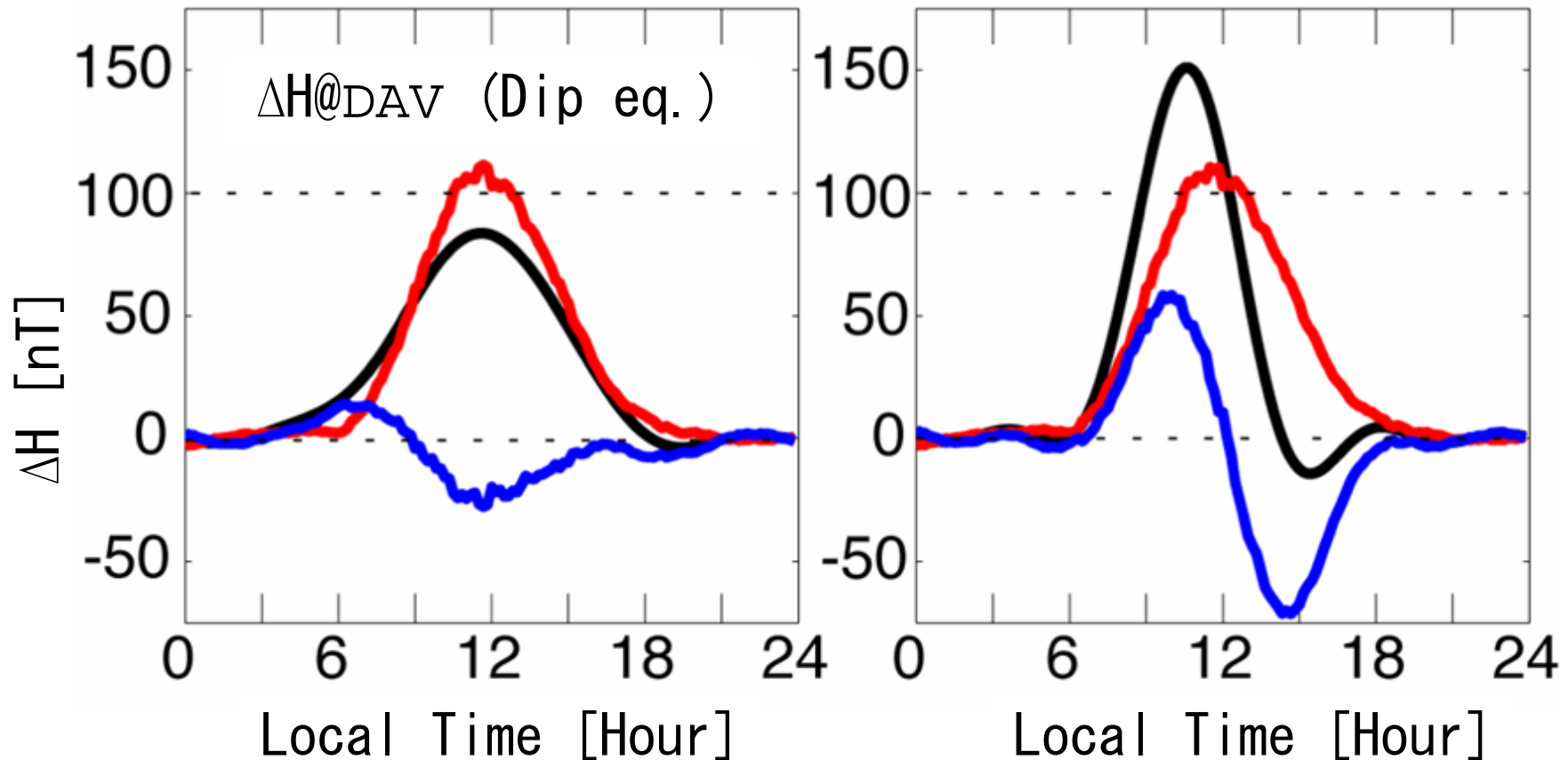
[H] – [SYM–H]



3. Analysis Method

Jan-02, 2003

Jan-05, 2003

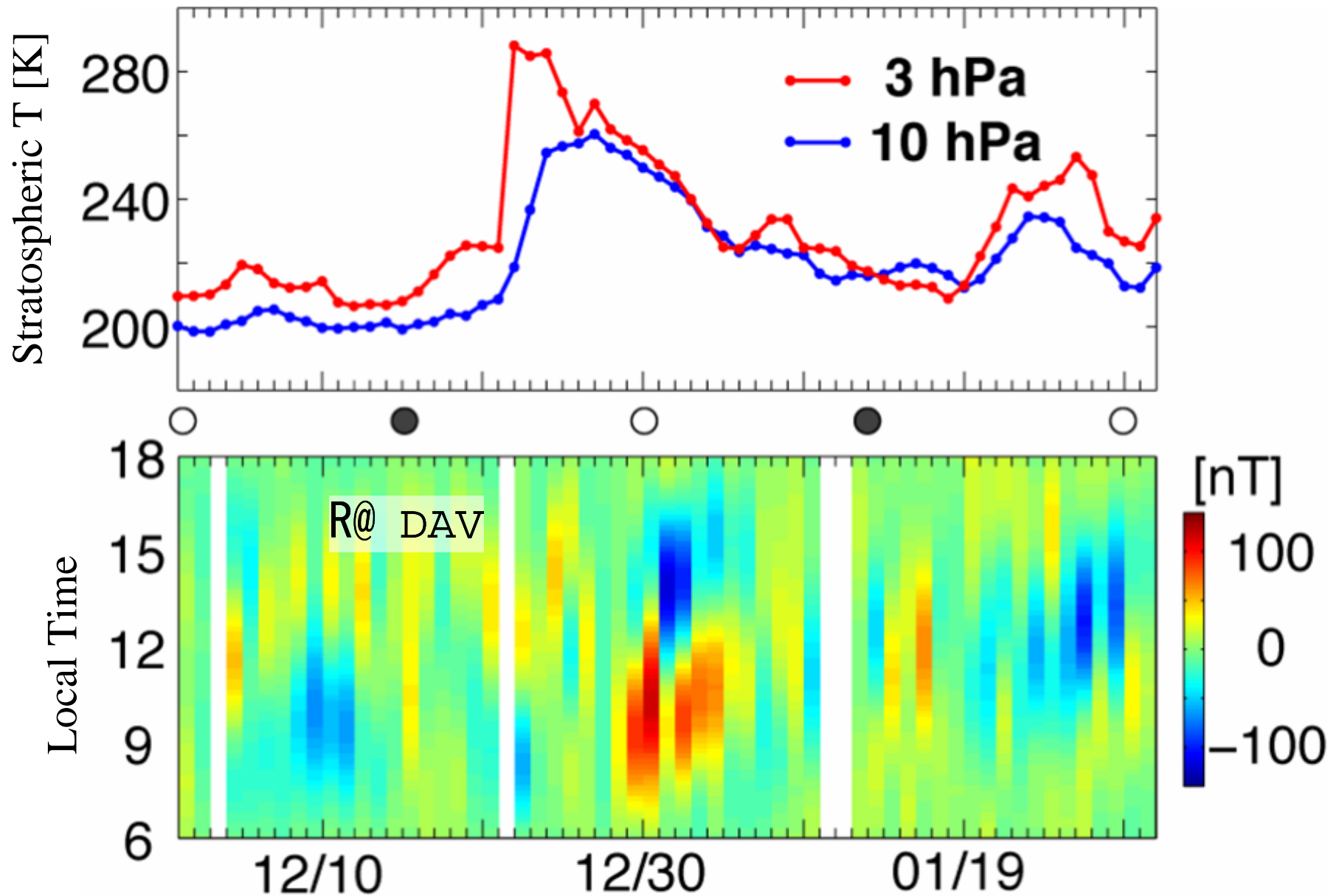


S_R ... Daily ΔH

S_q ... 90-day mean ΔH

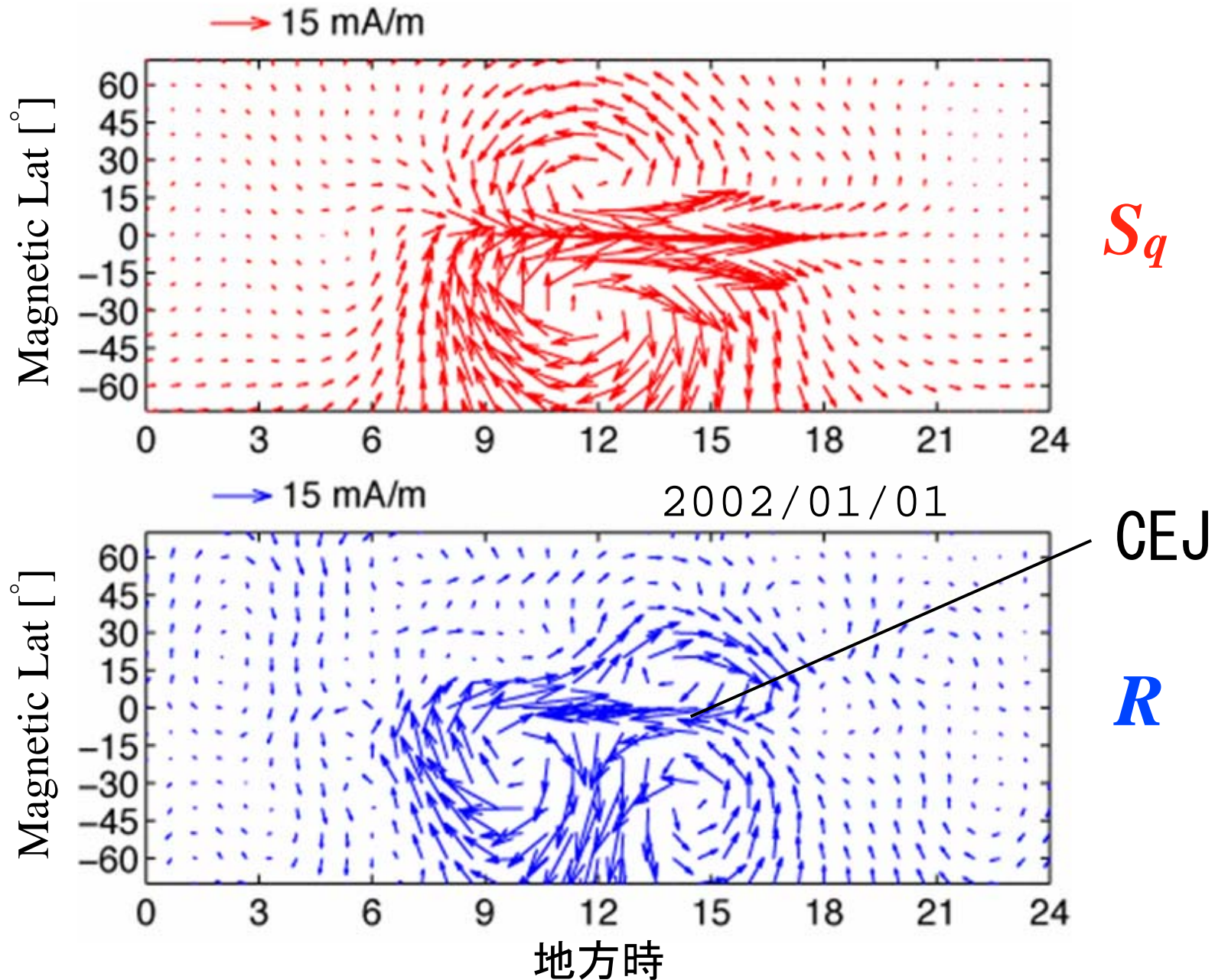
R ... $S_R - S_q$

4.1 SSW Effects at the Equator (2001-2002)



■ Enhanced semidiurnal variation in R during the SSW

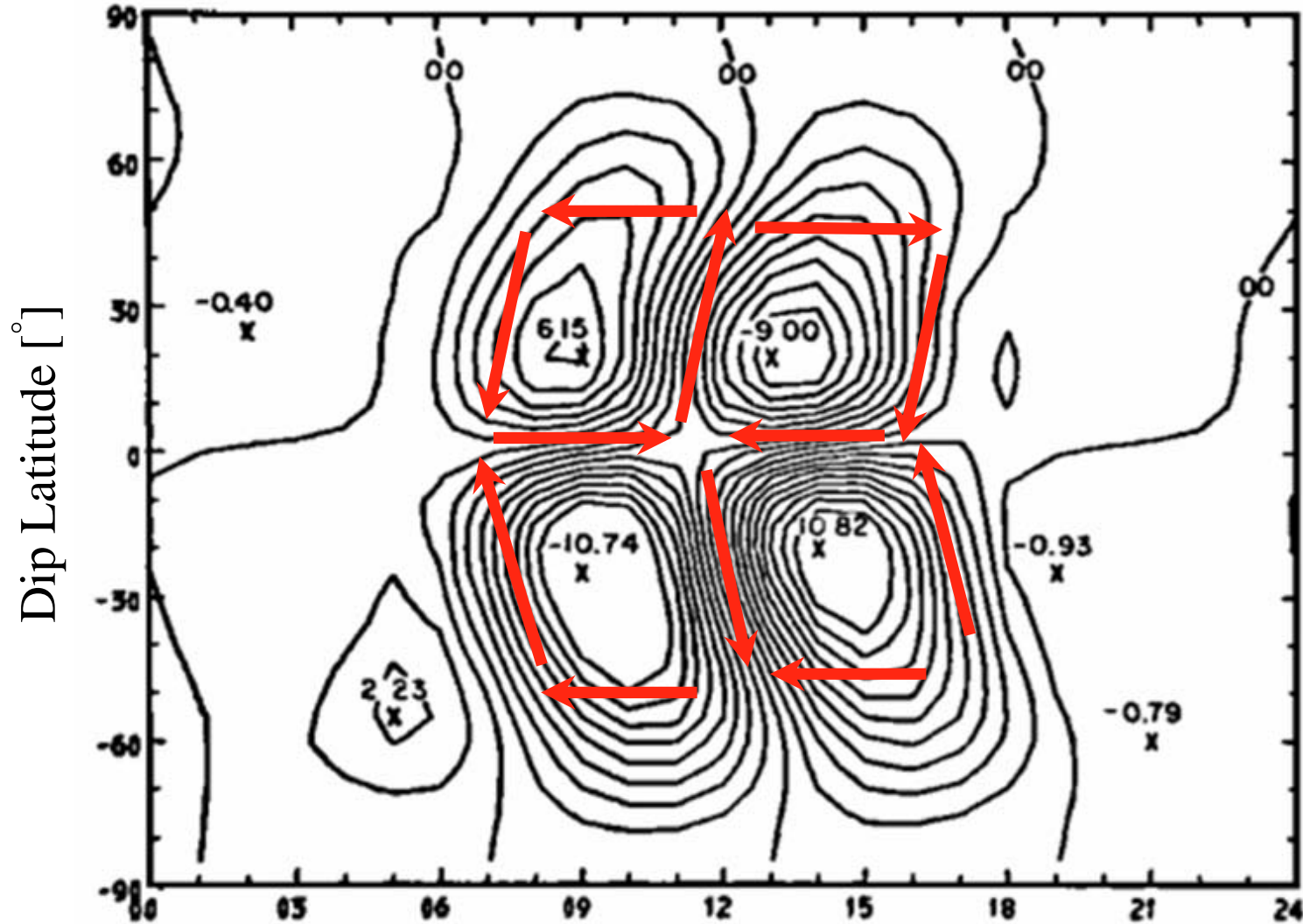
4.1.2 Ionospheric Current System (2001-2002)



■ The additional current system shows the semidurnal pattern

4.2 Ionospheric Lunar Current System

Northern Winter (New Moon)

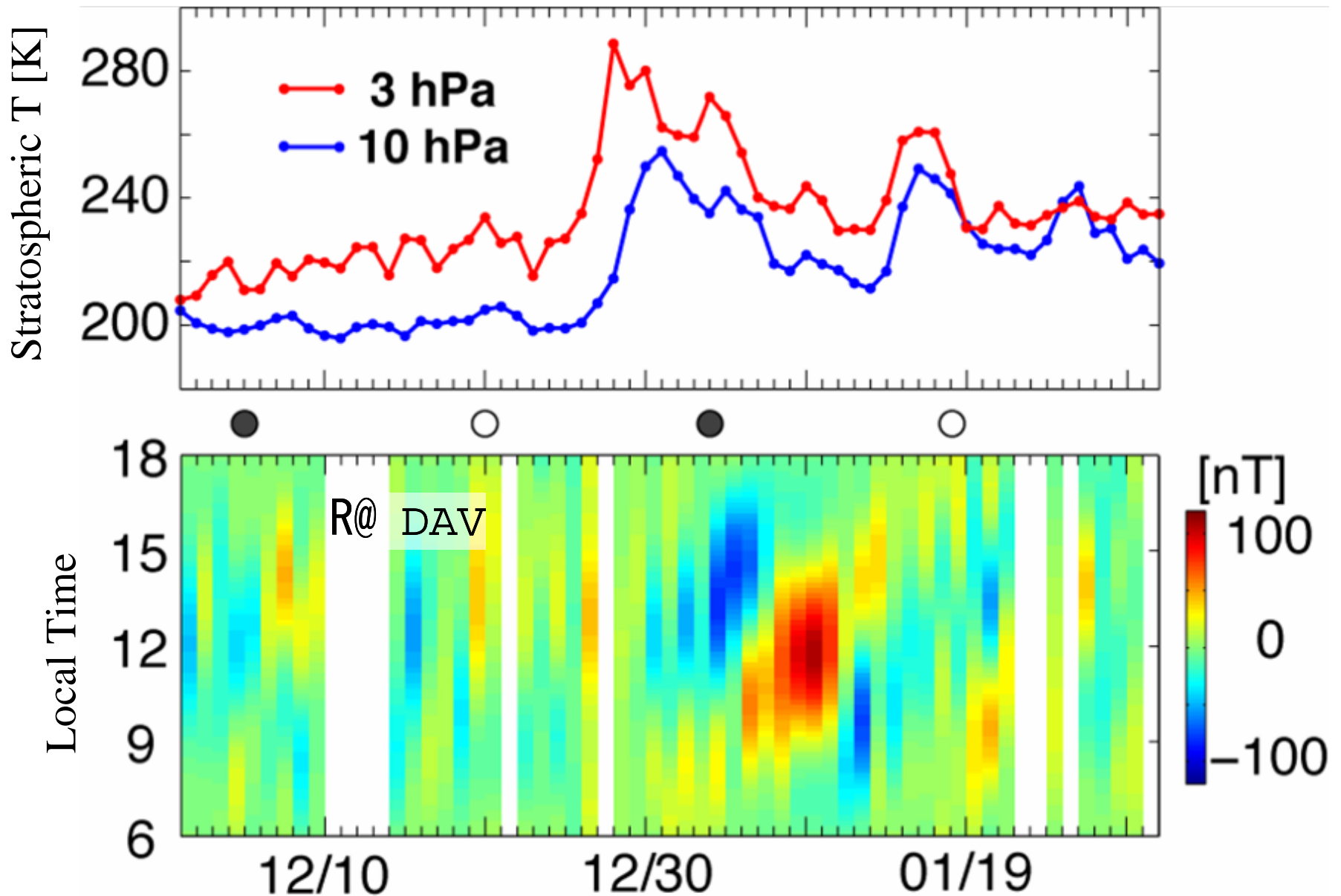


Local Time

Matsushita [1969]

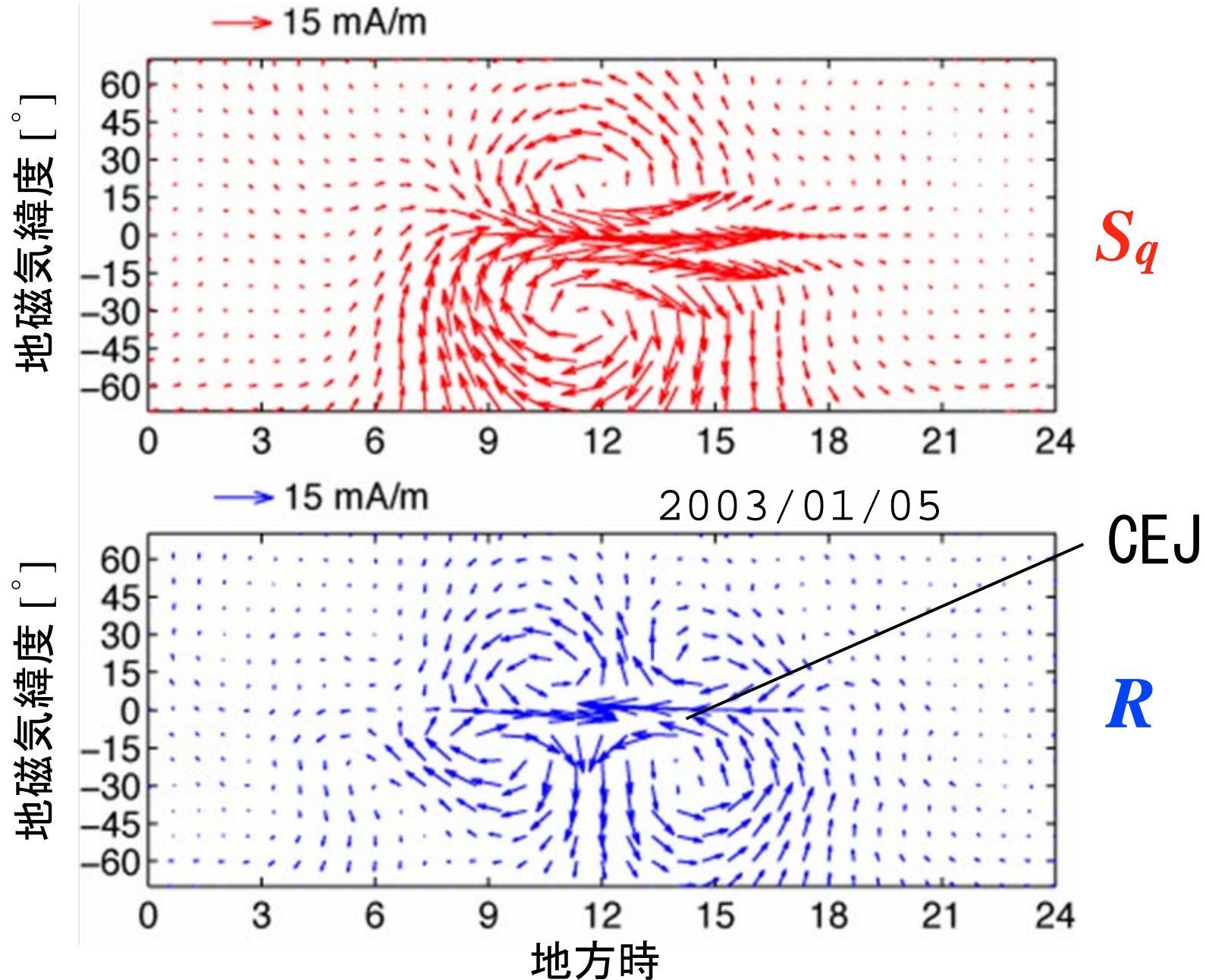
■ Semidiurnal current pattern

4.3 SSW Effects at the Equator (2002-2003)



■ Enhanced semidiurnal variation in R during the SSW

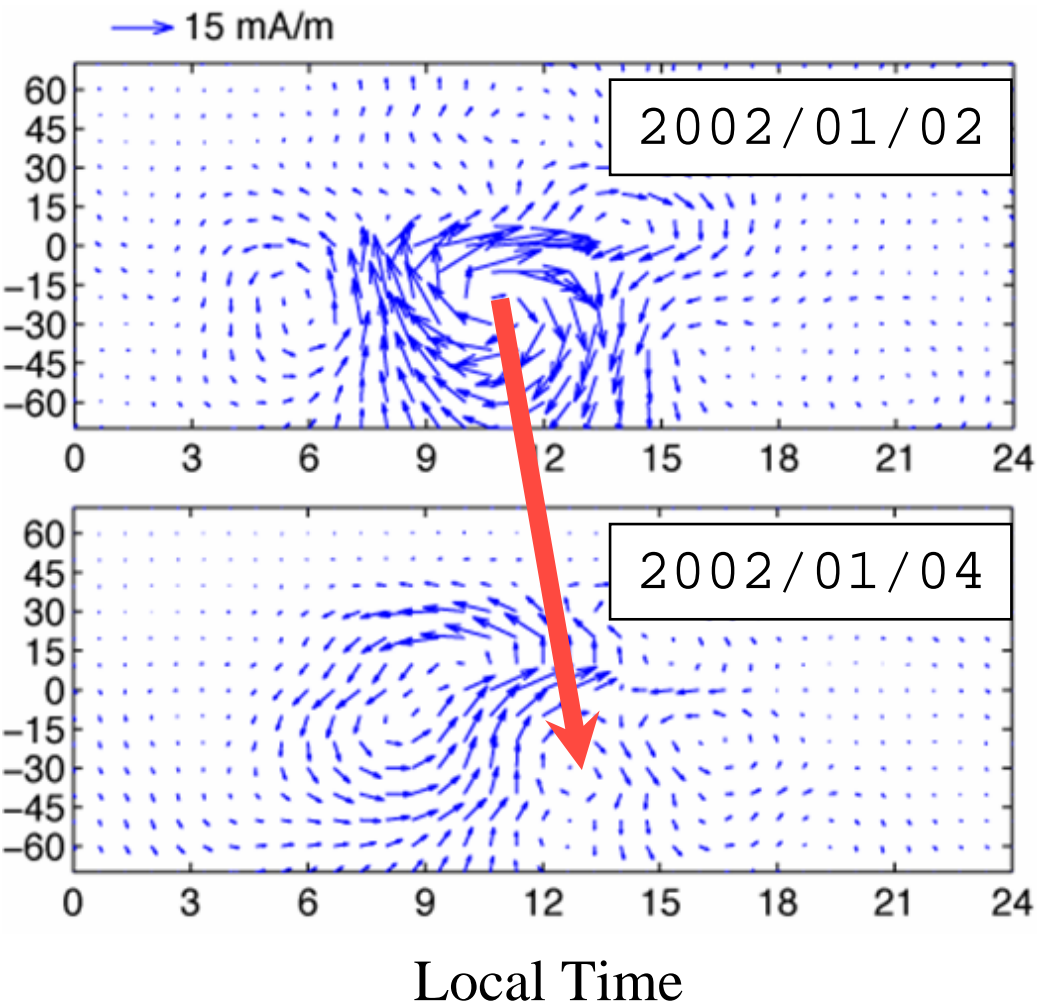
4.3.2 Ionospheric Current System (2002-2003)



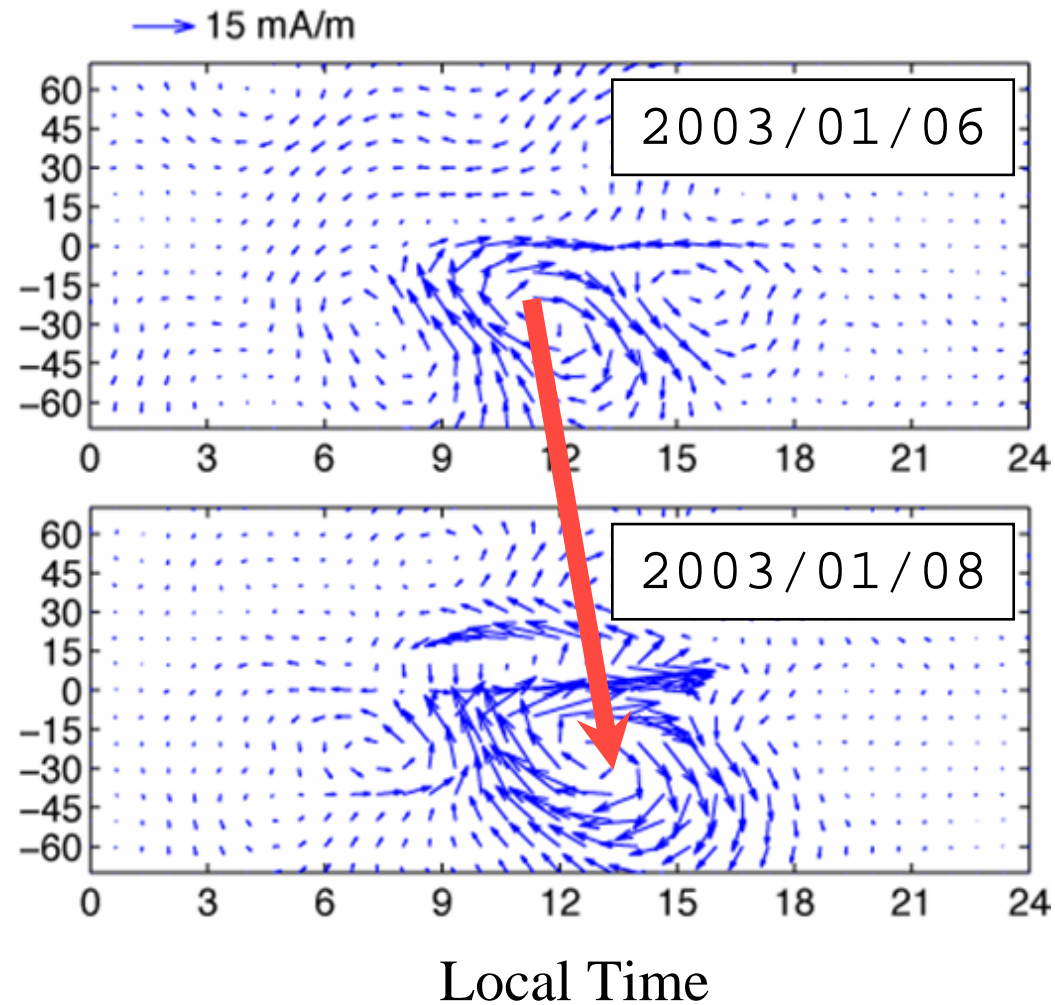
■ The additional current system shows the semidurnal pattern

4.4 Current System after the CEJ

2001–2002 Event



2002–2003 Event



■ A time shift of the vortex position by ~ 0.8 hour/day

5. Summary

■ Magnetic data during SSW events in the winter months of 2001–2002 and 2002–2003 are analyzed.

Common features :

- The **CEJ** is observed during the SSW events.
- Onsets are new moon and full moon for the 2001–2002 event and 2002–2003 event, respectively.
- The additional current system shows **semidiurnal current pattern** during the CEJ.
- A **time shift** of the vortex position **by 0.8 hour/day** is observed.

→ Characteristics of the additional current system during the SSW events are consistent with these of the **lunar current system**

Thank You for Your Attention!