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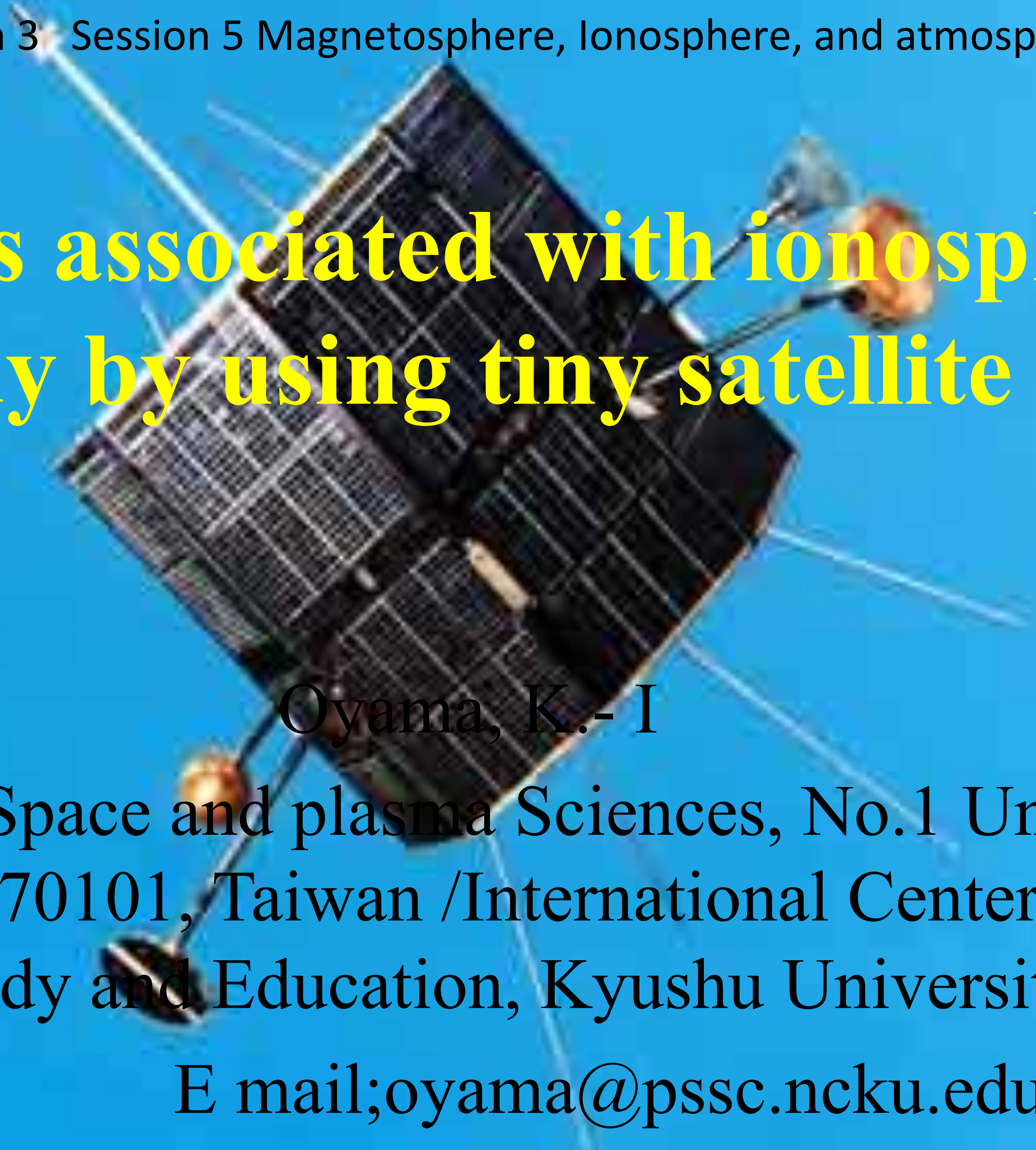
14:45-15:00 March 3 Session 5 Magnetosphere, Ionosphere, and atmosphere



# Problems associated with ionosphere study by using tiny satellite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# Aim of the paper , and summary

Tiny satellites（ ~10-20 kg) might be able to provide excellent platforms in many science fields in the near future when it is used for the constellation. However the tiny satellite has its own problems, which should be overcome now to prepare for the near future mission. For ionosphere satellite, two serious problems appear when we try to use conventional DC Langmuir probe to measure Te and Ne.

. These are , (1) insufficient conductive surface area of satellite, (2) Contaminants attached on both electrode and satellite wall. We discuss these two problems and suggests possible countermoves: an instrument which is not influenced by contamination as well as that of surface area.

We divide our discussion into two parts.

1. Problems which come out from tiny satellite , conductive surface area as counter electrode, and contamination of the electrode and satellite surface

2. One solution to the above

# Principle of Electron Temperature probe

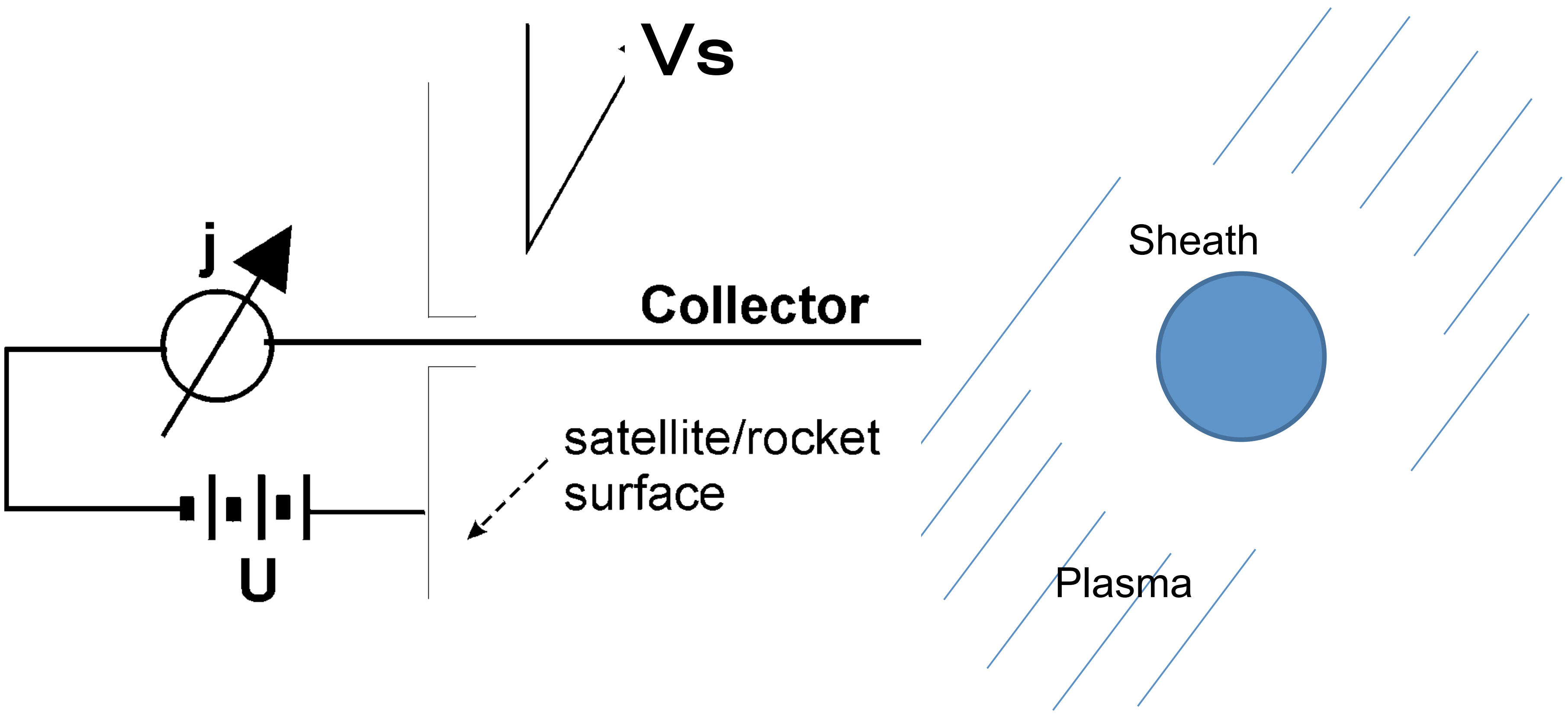



Fig.1 DC Langmuir probe on board satellite /rocket

# Problems of counter electrode

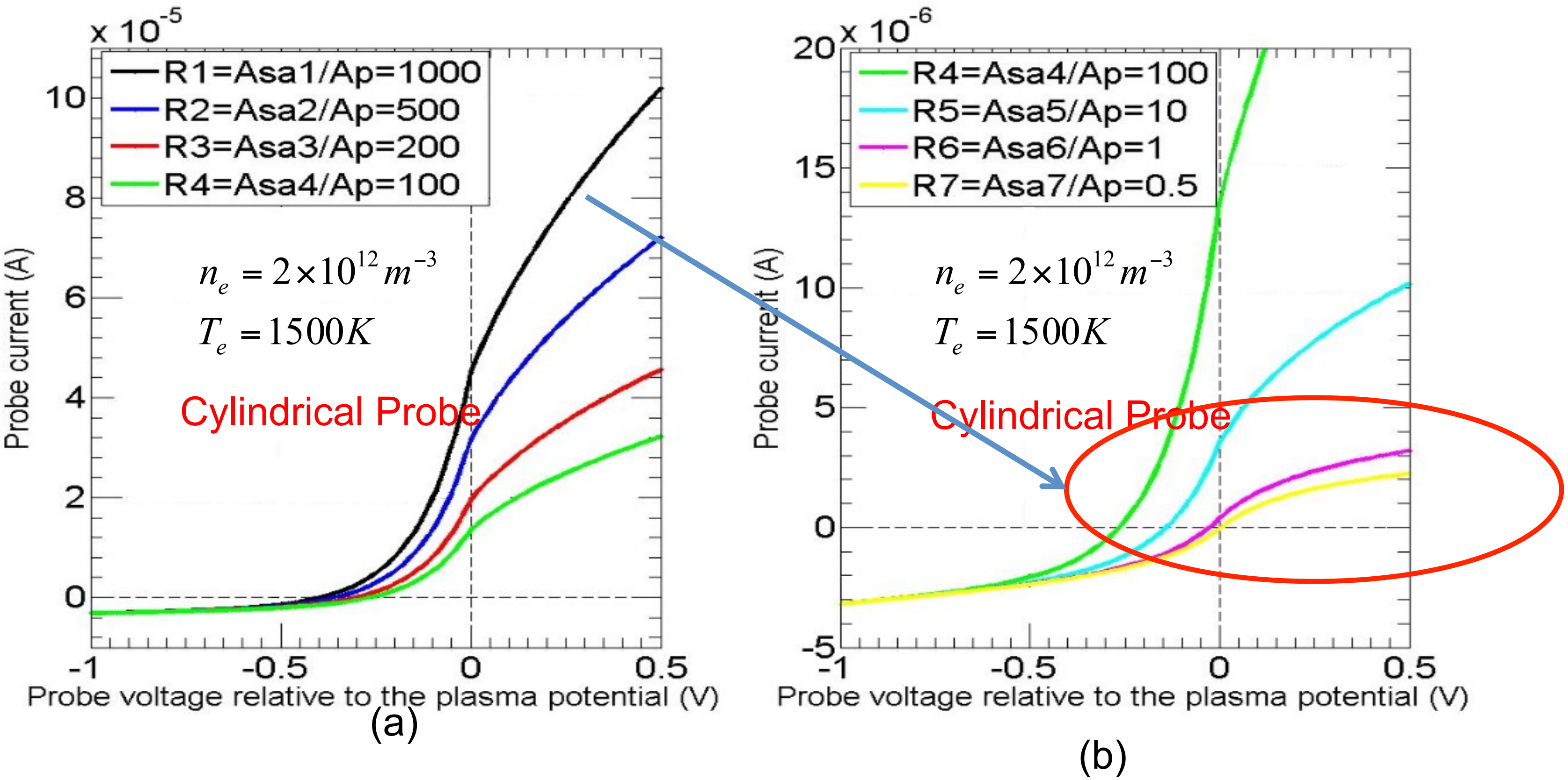



Fig. 2 The I-V curves for different satellite areas

as surface area ratio of electrode and satellite surface becomes 1, ion and electron current is equal

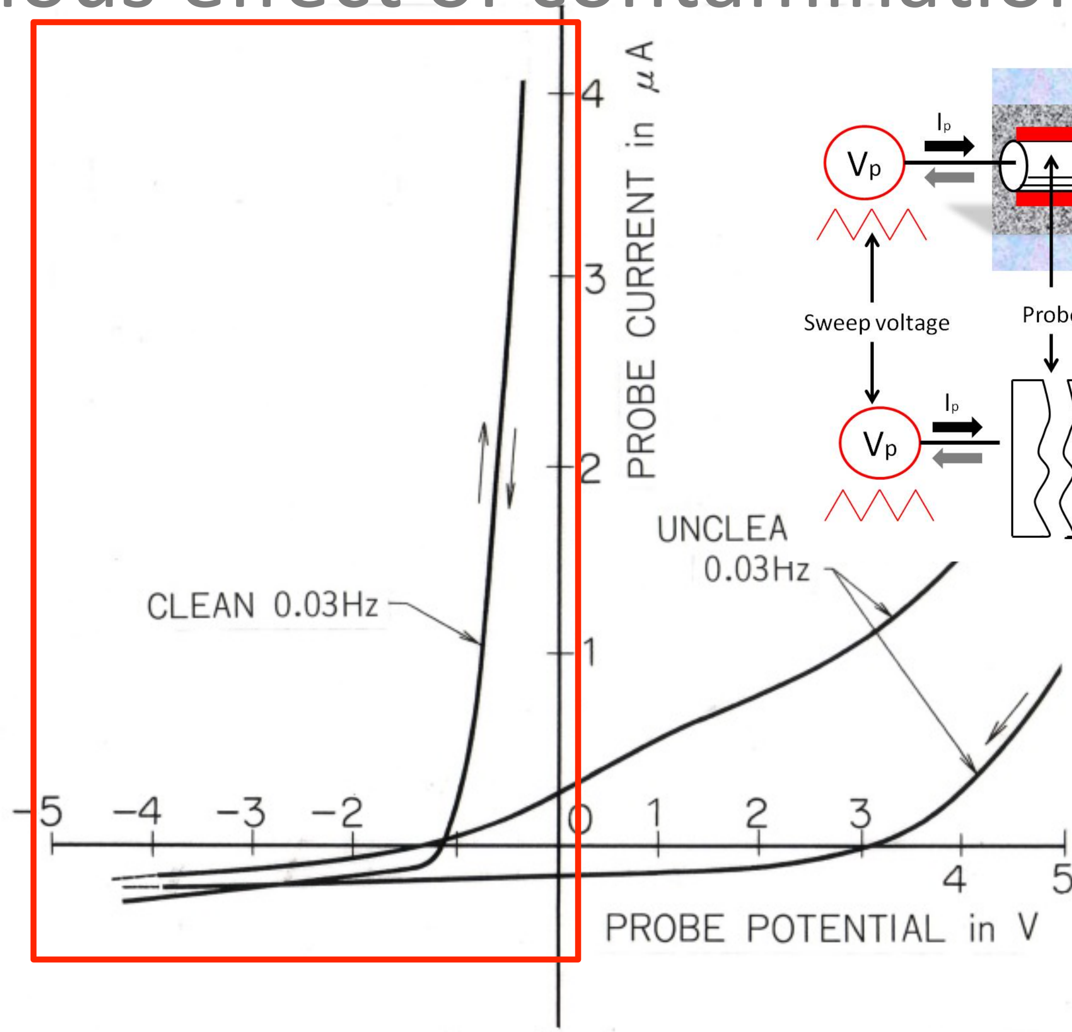
# In addition to surface area ,effect of contamination layer of satellite frame needs to be considered

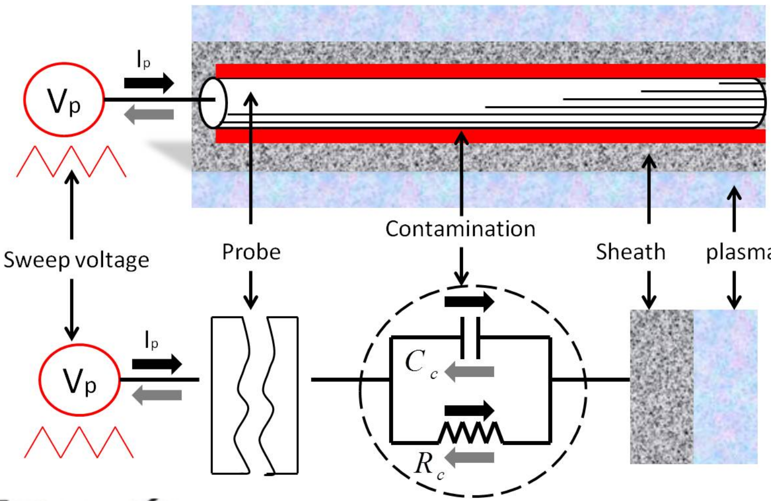
1. When conductive surface area of the satellite(Asa) is much larger than the electrode surface area (Ap) (1000 times), I-V curve is simply controlled by electrode sheath. .....

2. When Asa is the same order of Apr, I-V curve becomes complicated . Capacitance effect of contamination of satellite wall can not be neglected. ...

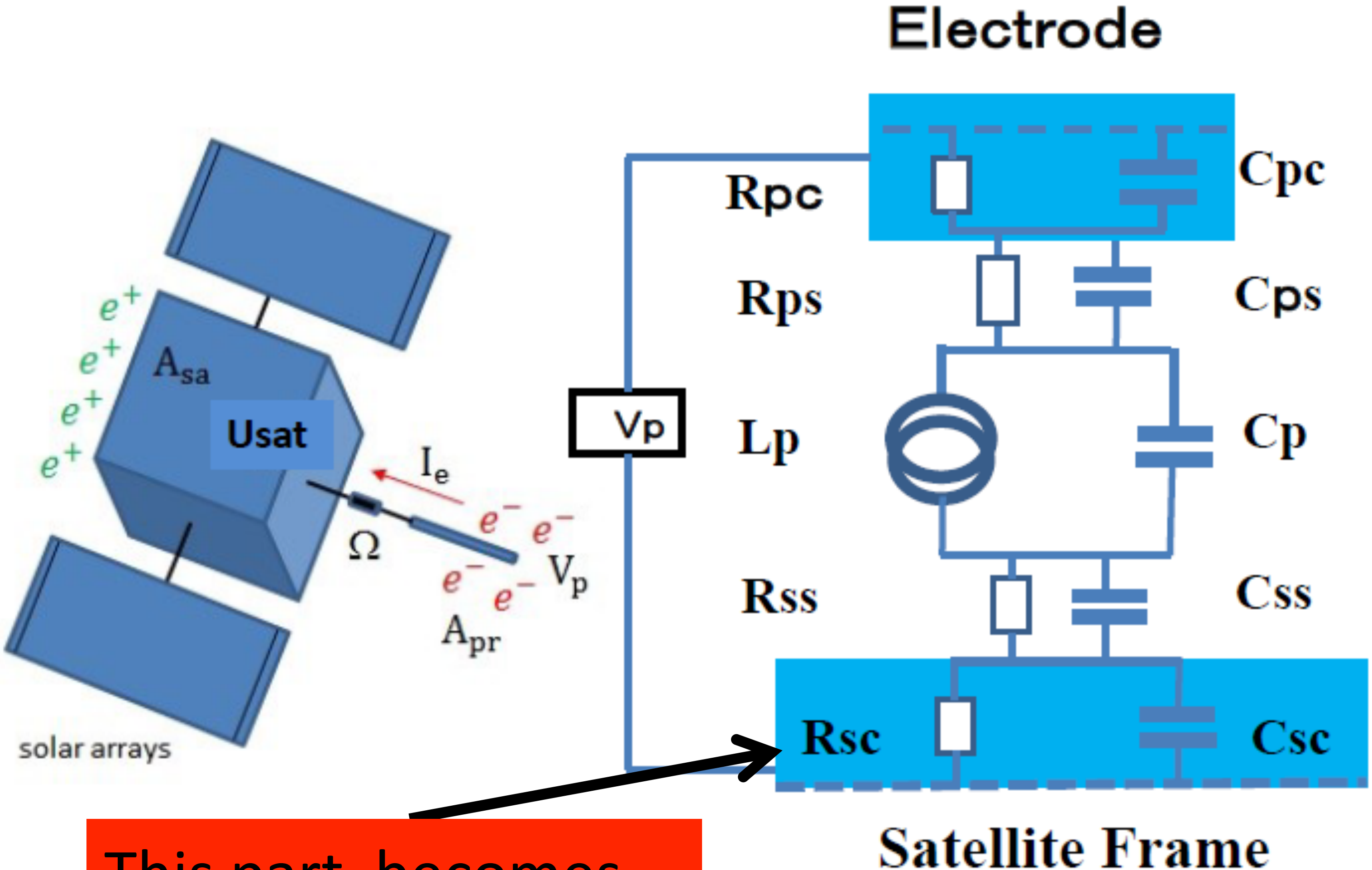
For large probe current, fast sweep of probe bias reduces contamination effects. While, for small satellite, the probe current is an order of ion current , which reduces frequency response of the pre amplifier.

# Serious effect of contamination !




Current –voltage characteristic of a conventional DC Langmuir probe (assuming infinite surface area of counter electrode)

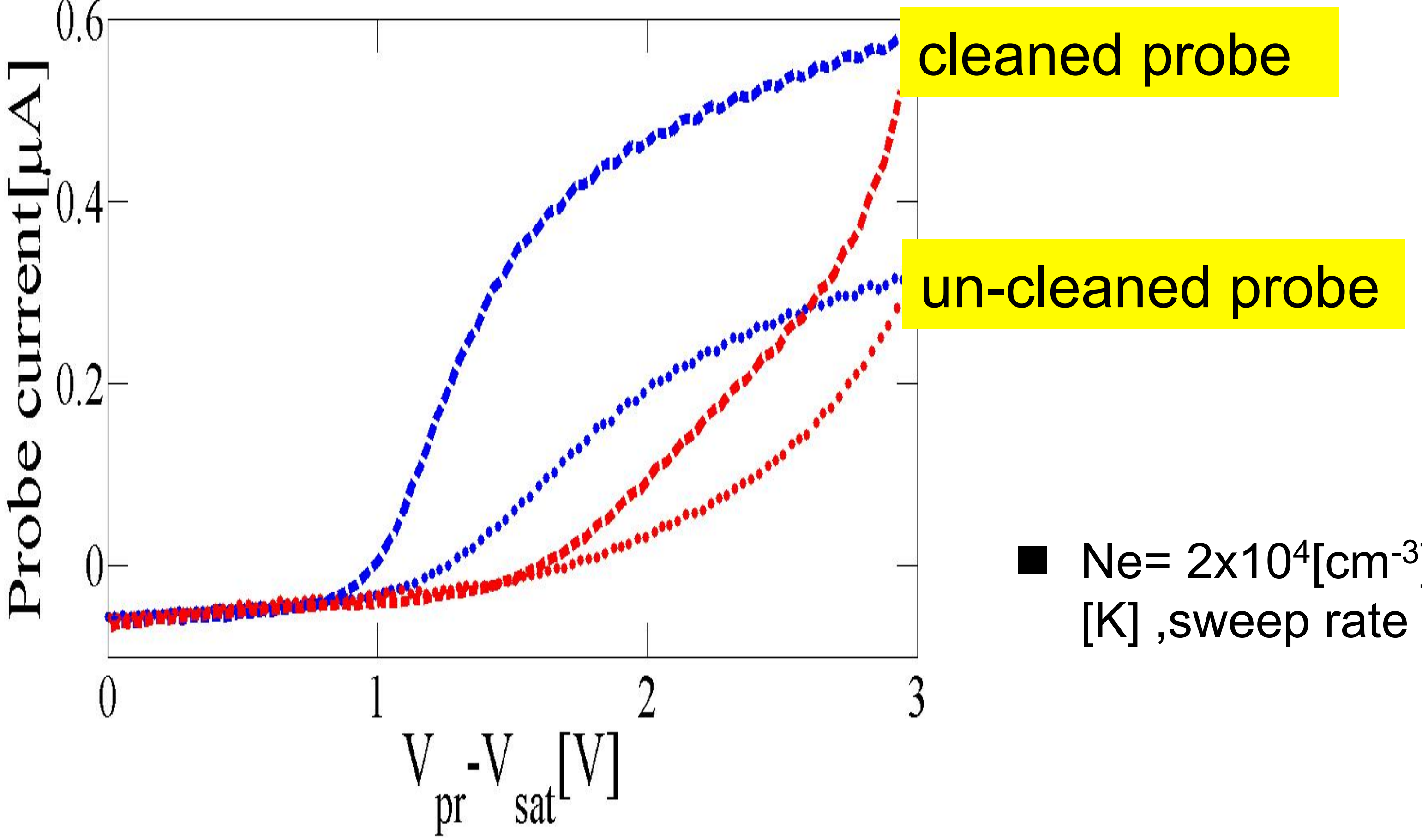



This part becomes effective

Large satellite; Csc is large enough to work as a battery

Fig.3 Electric current system of probe- plasma –satellite system :Small satellite surface area

# What will happen for small surface area ($A_{sa}/A_p$=19.48) ?




■ Ne= $2x10^4$[$cm^{-3}$], Te= 1240 [K] ,sweep rate :1 Hz

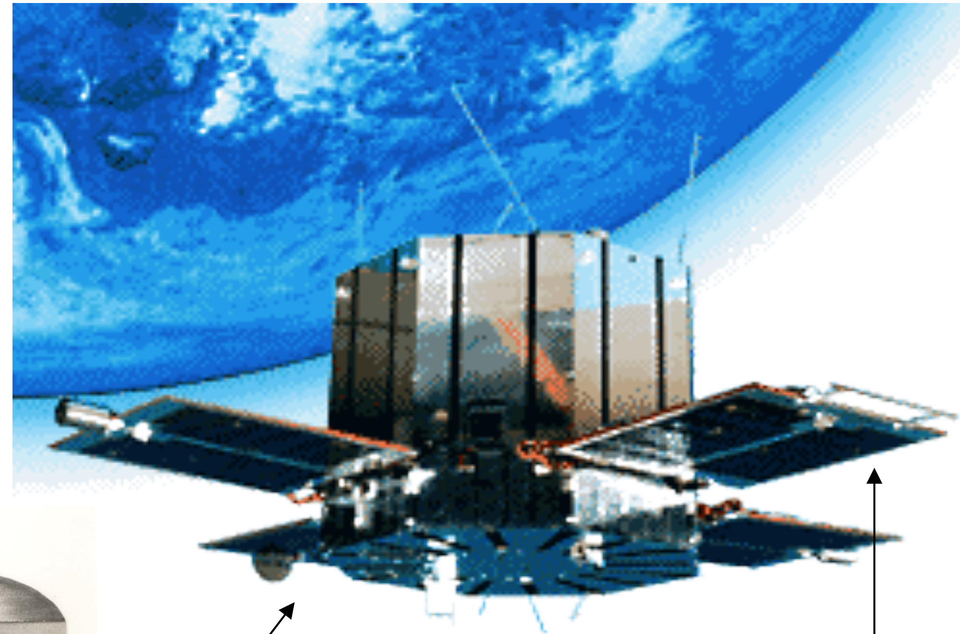
Fig.4 Hysteresis of I-V curve for small counter electrode

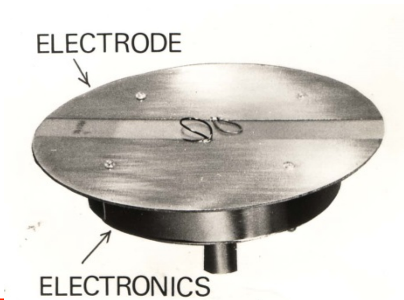
Can we have a solution to get accurate Te and Ne by small satellite ?- yes

How ?

TeNeP :modification of ETP (Electron temperature probe is not influenced by electrode contamination, and can work for tiny satellite.

HINOTORI Sun Observer
(Launched ;1981 Feb
Mission Termination ;June
1982



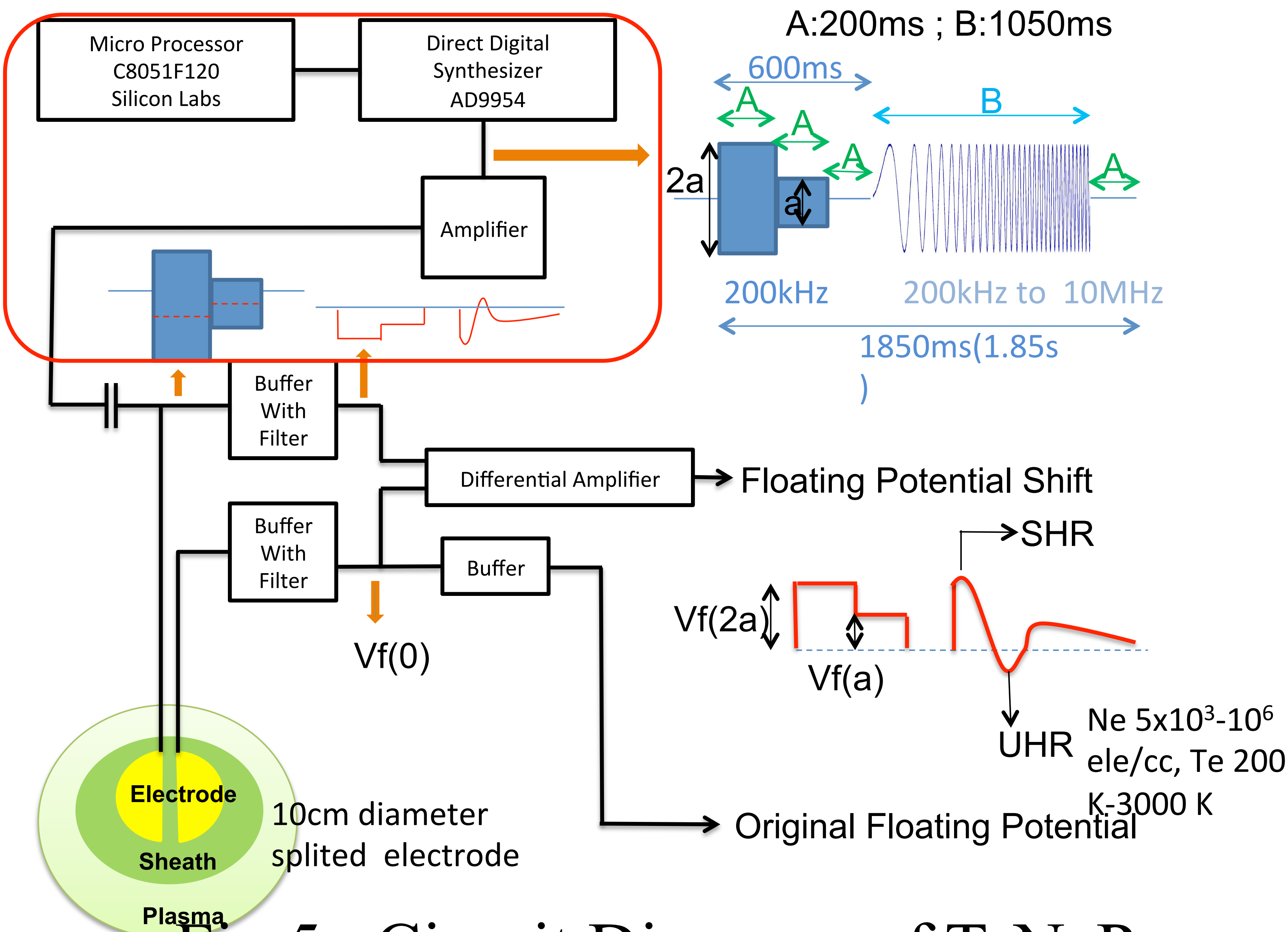



Electron Temperature Probe (Hirao, K. and K.- I.Oyama, J.Geomag Geoelectr . ,**22**,239-402,1970.

5 Earth orbiting Japanese satellites, Korean, Russia, Brazil satellites, and more than 60 sounding rockets including India, US ,Brazil, West Germany, Canada

**300g, 25mmH,100mm Dia. With 120 mm circular electrode with 10mm gap**

Impedance Probe (Ne)
Oya,H.,T.Takahashi,and S.Watanabe,, J.Geomag.Geoelectr.,38,111-124,1986.




# Fig.5 Circuit Diagram of TeNeP

**AOGS Small Satellite Payload Task Group: S3PTG**

**http://space.geocities.jp/s3ptg/members.html**

Under AOGS ( Asia Oceania ,Geoscience Society) we have established a group named above in 2013. The purpose of this group is to prepare for the future small satellite constellation for ionosphere study. The data which come out from this mission will be used for space weather Study. We would like to use this data to study the coupling among lithosphere, atmosphere-and ionosphere, such as effects of large earthquake on the ionosphere. In order to increase drastically the output from satellite mission, a constellation of small satellite is essential. In order to materialize the satellite constellation, we propose to work together among the countries who are interested in. Specifically one tiny satellite might be provided from individual member country.

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## Concluding Remarks

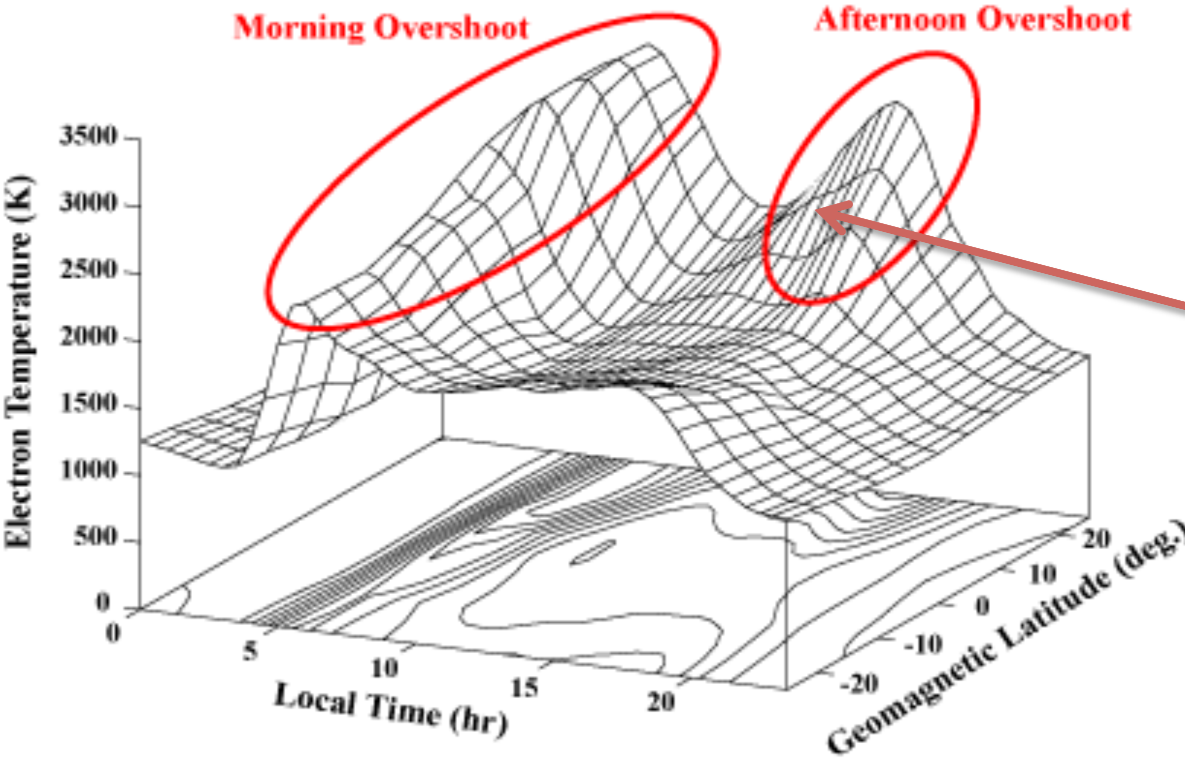
Two serious problems should be taken into account for tiny satellite mission to measure Te and Ne of ionosphere plasma: Insufficient conductive surface area of satellite, and contaminants attached on both electrode and satellite wall. To remove these problems we have proposed one instrument.

We introduced Small Satellite Payload Task group which tries to prepare for near future mission.

Enjoy your stay at Fukuoka !!!

Slides following are appendix

# Local time and geomagnetic latitude variation of Electron temperature at 600 km 600kmにおける電子温度地方時変化



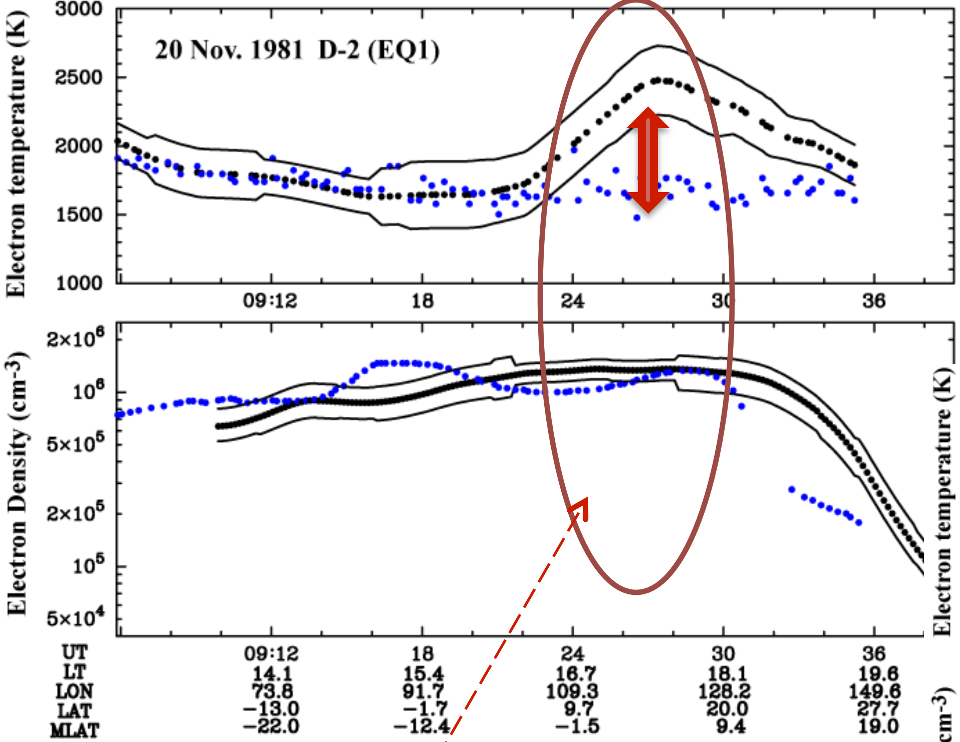

磁気赤道付近では電子温度の増加少ない

電子温度は地方時、太陽活動度、緯度、経度、季節により変化する。

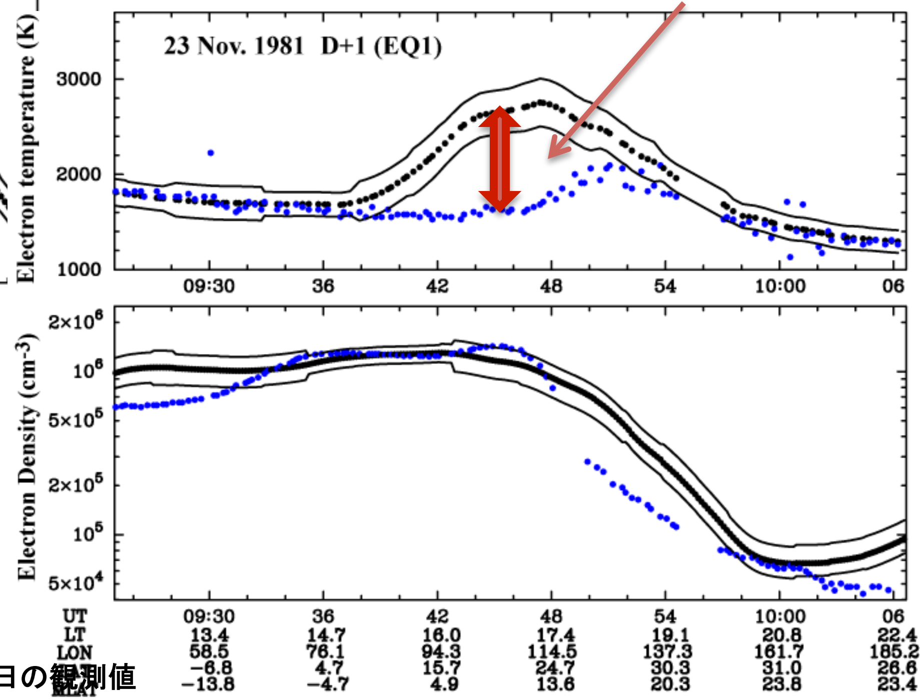

Su, Y. Z., K.-I. Oyama, G. J. Bailey, T. Takahashi and S. Watanabe, J. Geophys. Res., 100, 14591, 1995.

.Oyama, K.-I., M. A. Abdu, N. Balan, G. J. Bailey, S. Watanabe, T. Takahashi, E. R. de Paula, I. S. Batista, H. Oya and F. Isoda, J. Geophys.Res.,102,417, 1997.

Oyama et al,　JGR 2008




(a)



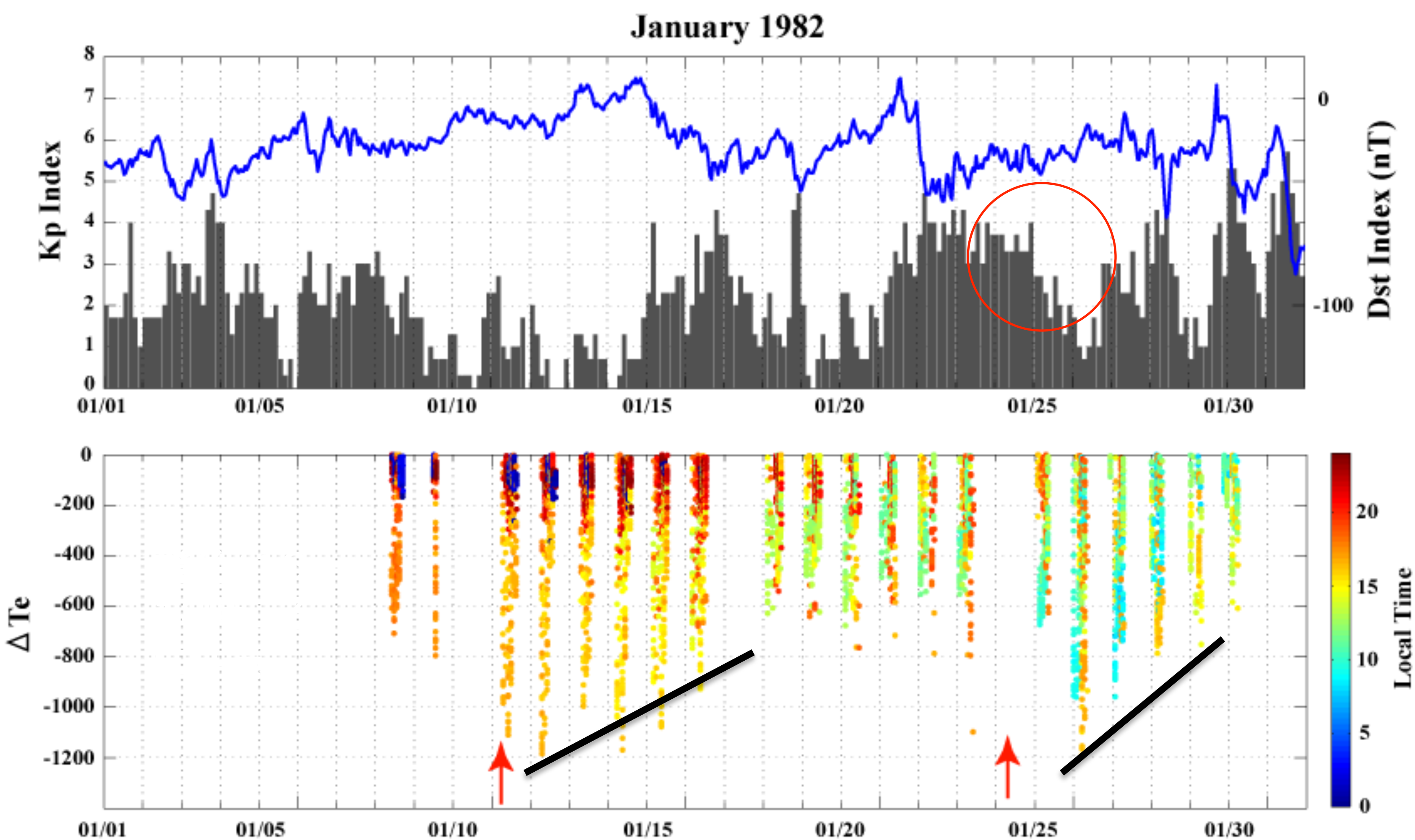

(b)

Te

私が心の努力に疲れ果てて問題を考えることをやめるとその時こそ問題の真の解答がやってくる　ートーマスエヂソン

電子密度温度のモデルからのずれの例；　黒い点線はモデル、青色はその日の観測値

Examples of the deviation of $T_e$ and $N_e$ from the model for EQ1 in the afternoon overshoot for EQ1. 2 days before EQ1 (a)(satellite pass, 4065), and 1 day after (b)(satellite pass 4110). $N_e$ is shown for each panel at the lower panels. Black and blue dots show the model and observation respectively



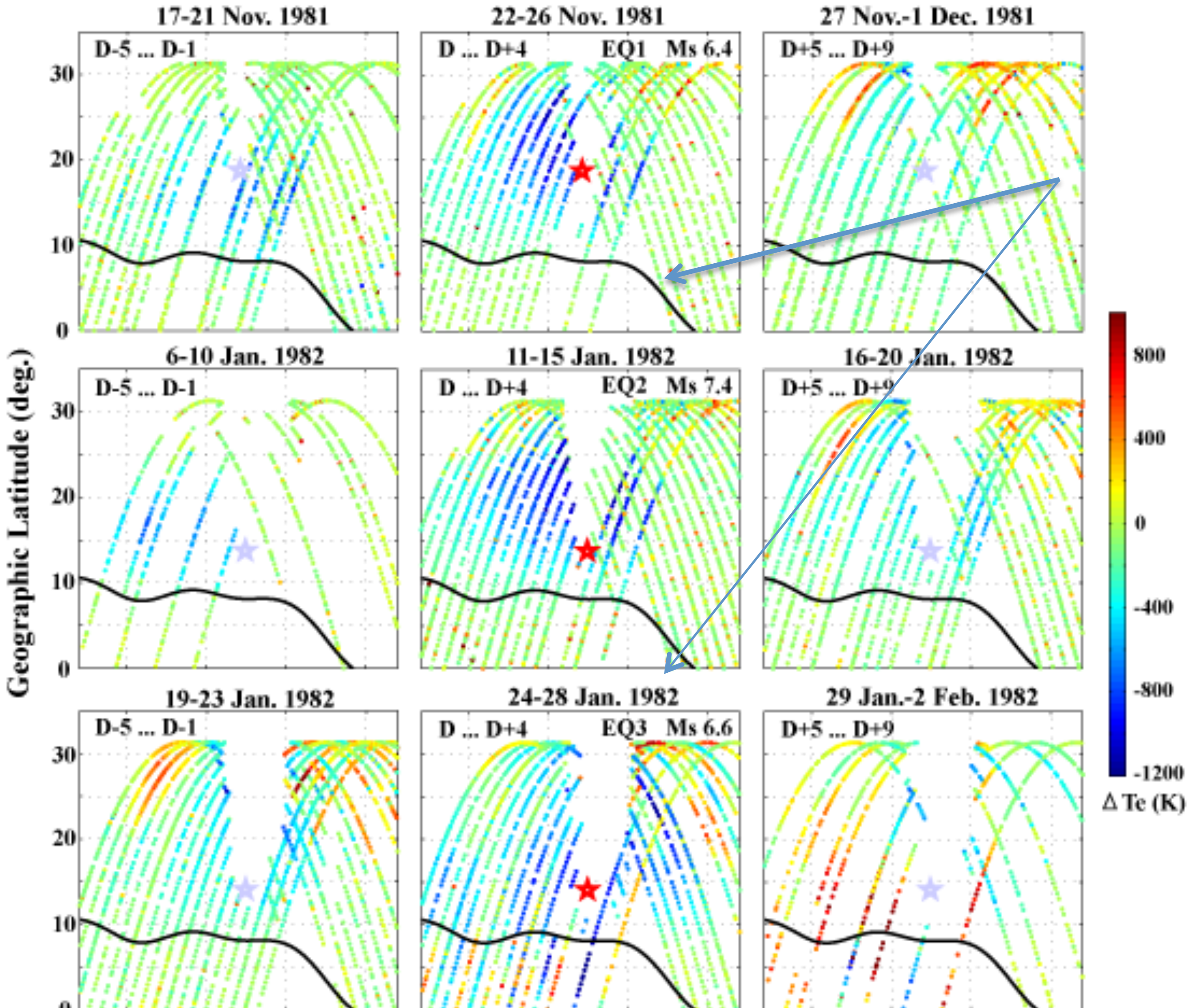

電子温度のモデルからのずれ **Deviation of Te from the model (Averaged) versus days. For larger earth quake precursor and recovery become longer**

# Longitude-latitude Map of ΔTe for three EQs

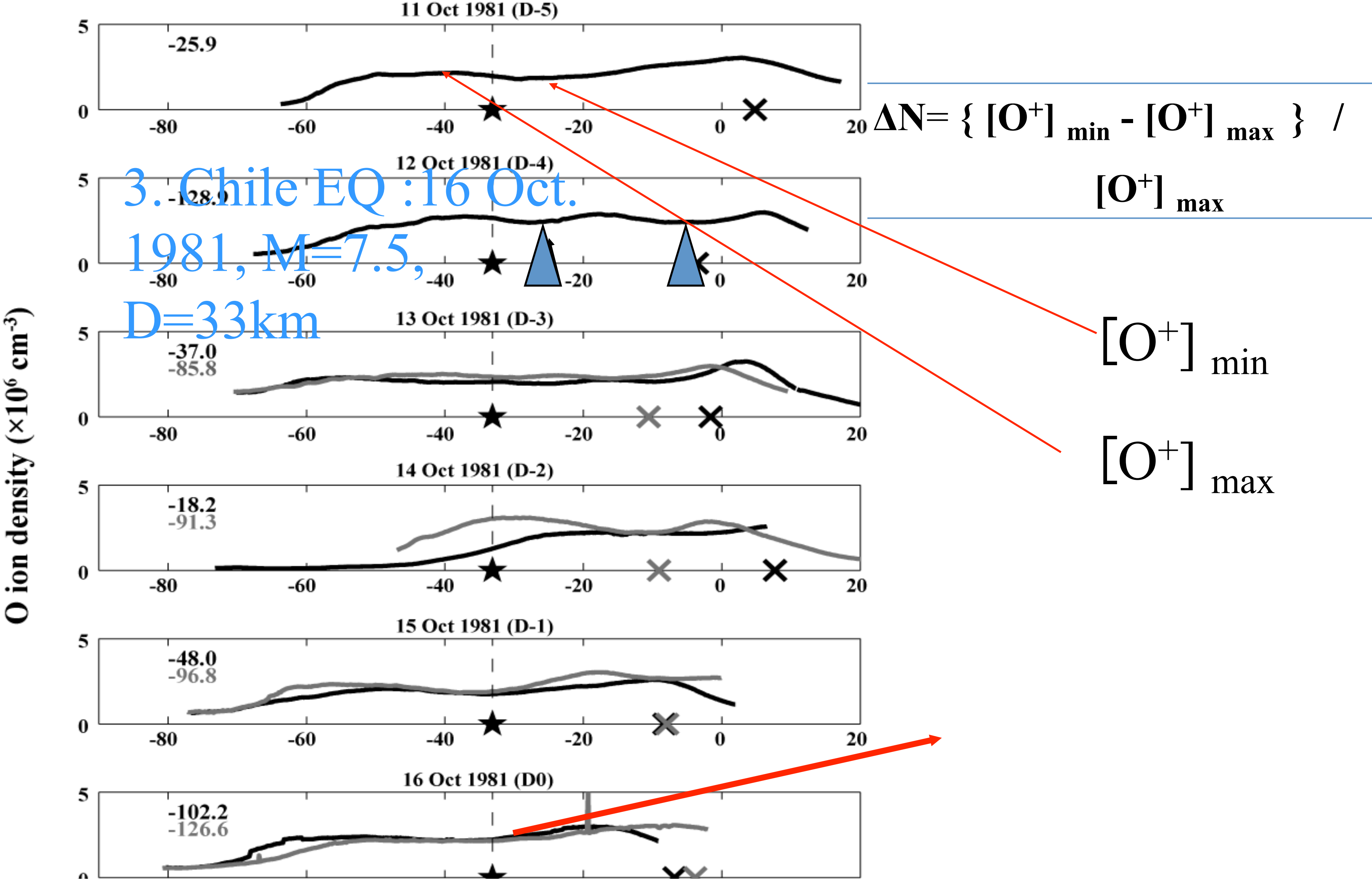
22 Nov 1981

11 Jan 1982

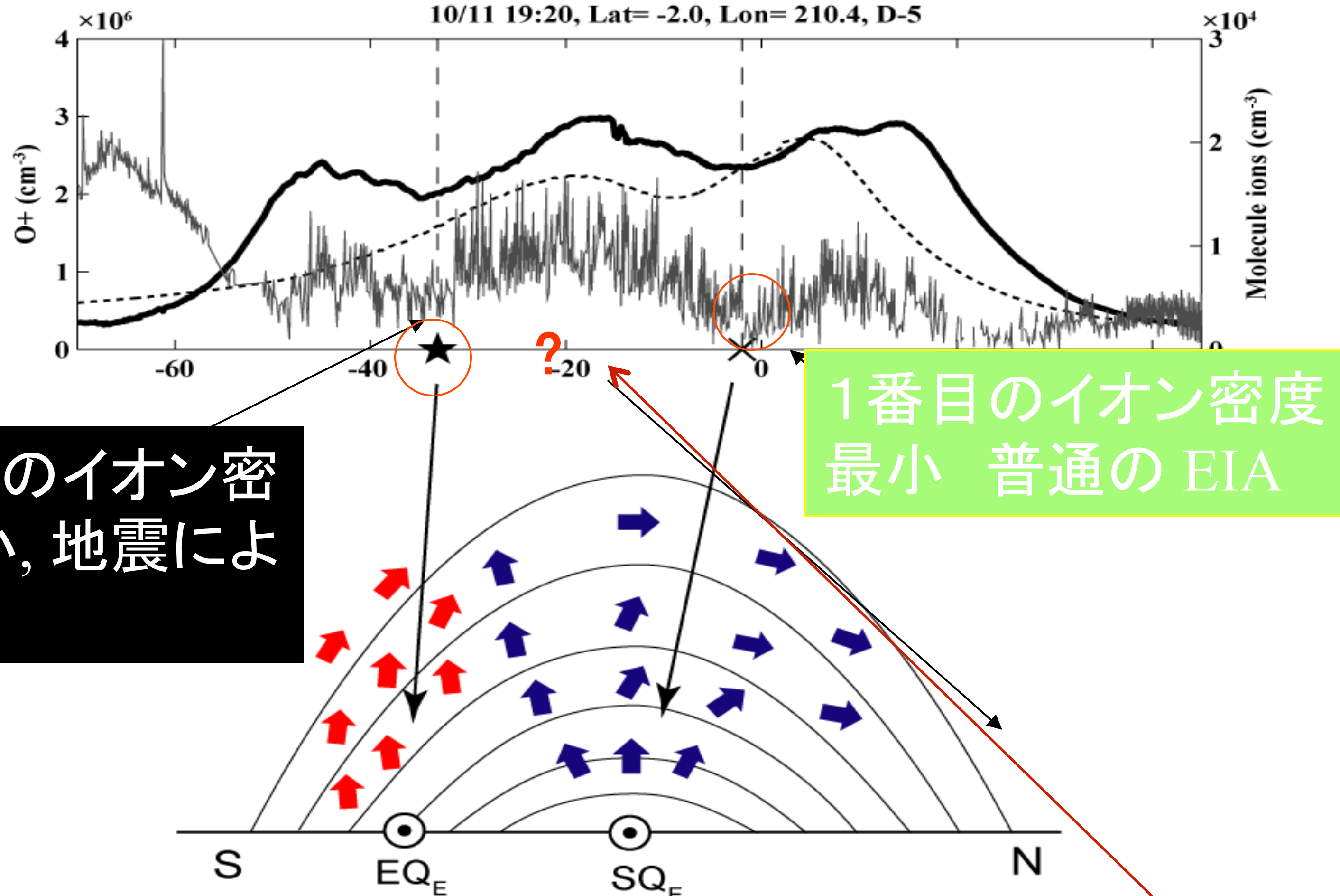
24 Jan 1982




この時点では震源は特定できなかった　！Can not identify Epicenter ! Day is roughly estimated



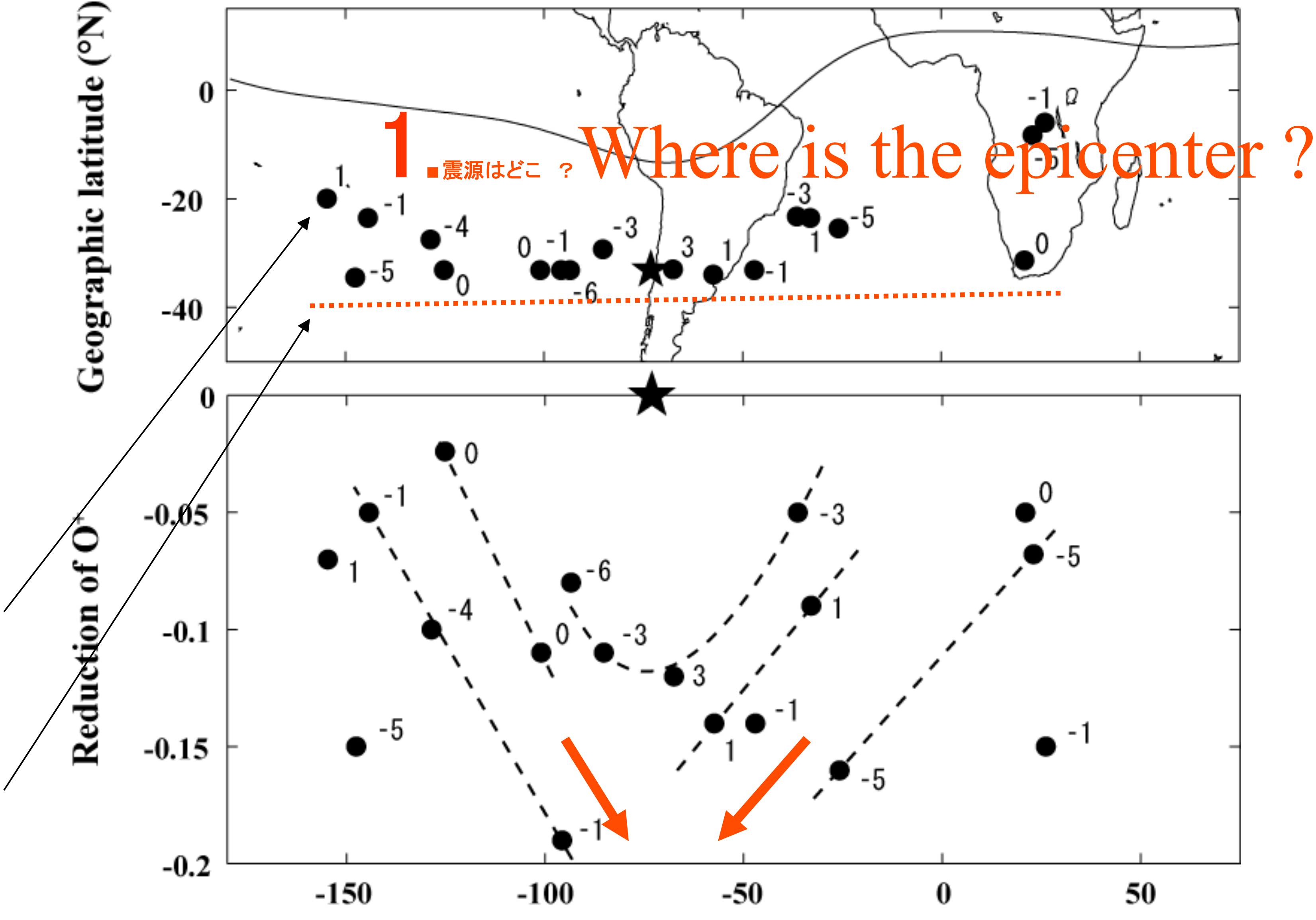

Atomic ion density along satellite pass from 5 days prior to EQ 地震5日前からの衛星軌道に沿う酸素原子イオン密度




３番目の最小値が現れる時あがる。

# Fountain Effect due to EQ related Electric

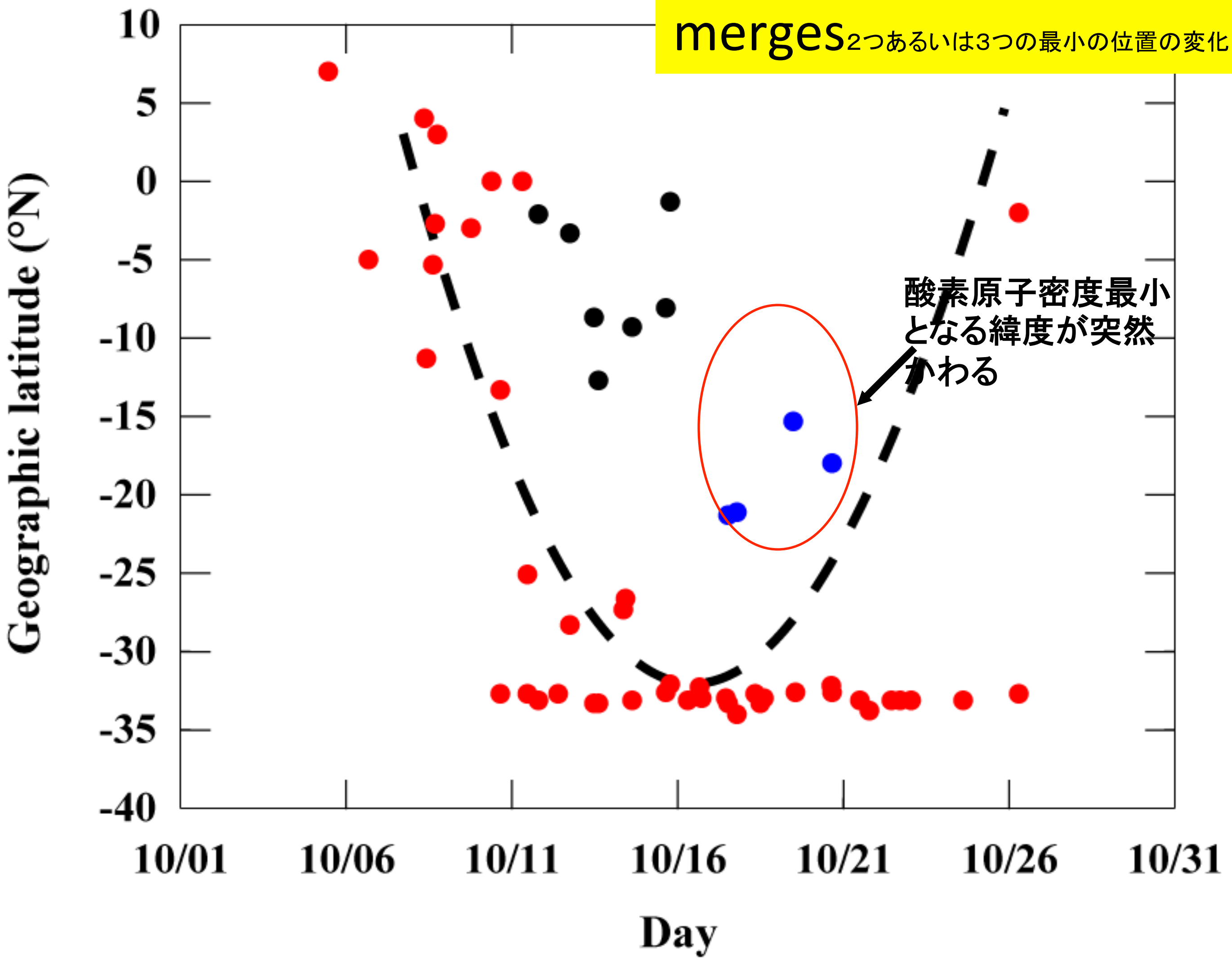
field地震による噴水効果の図

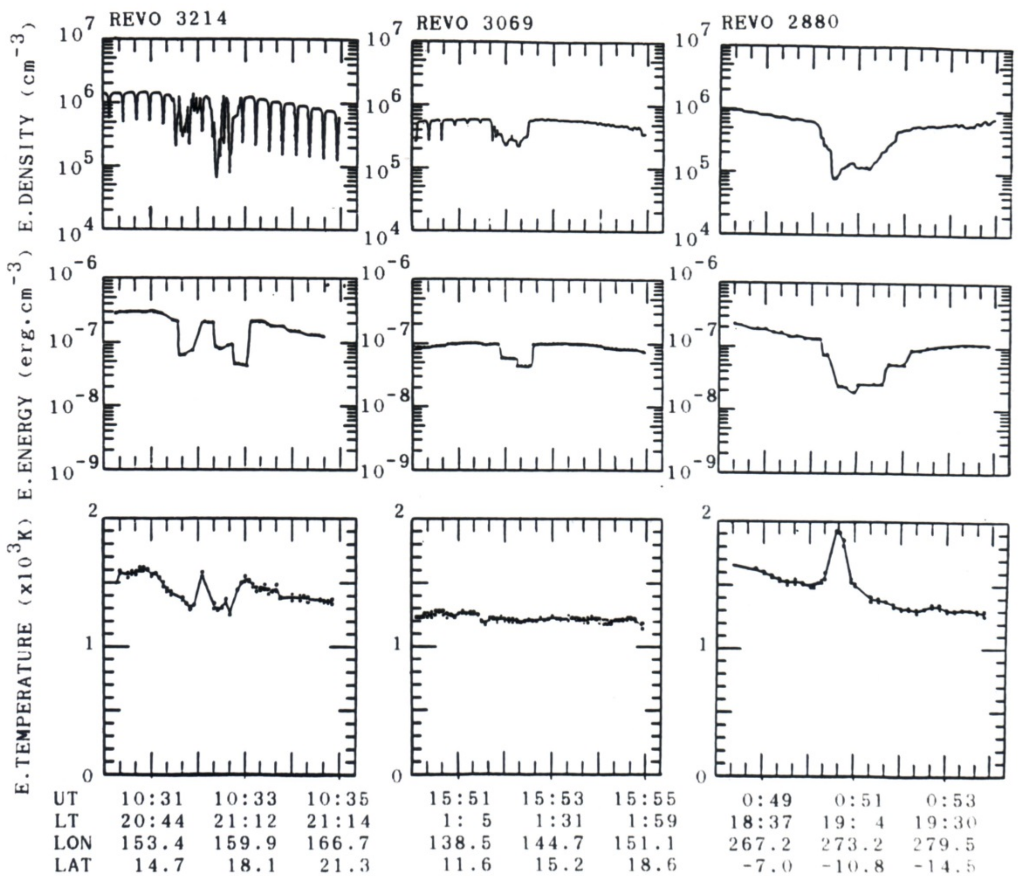



Location of the minimum of [O+] (upper panel),and reduction of [O+] 酸素原子イオンが最小をとる位置

# 2. When is D day地震発生の日は？

D day is a day when two minima merges2つあるいは3つの最小の位置の変化






# Diversity of Te in the plasma bubble.

**Oyama, K.-I.,** K. Schlegel, and S. Watanabe, Temperature structure of plasma bubbles in the low latitude ionosphere around 600 km altitude, Planet. Space Sci., 36, No.6, 553-567, 1988.