Oyama's trail

2010 Venus Orbitor launched failed to Orbit injection

2012 Effect of Sudden stratosphere warming

2007 Effect of large earthquake

2006 Retired from ISAS

Education

Nozomi,Mars Orbitor (Radio Science,Te)

1998 Started Venus orbitor Mission

Development of NTV and chaff ejection

Initiation of Space School, 7 days Space high school

Editorial committee for text book

Asia-pacific Space Education WG,Water rocket event,space education forum

Member of Advisory committee,CSSTEA P affiliated to UN

Chairman Satellite Desin Evaluation Committee

1989 Akebprojrctono(f(eV))

1989Voyager 2 Radio Occultation

1986 Sakigake(Solar wind)

Scientillation of solor corona

1988-89 DYANA（International Middle Atmosphere Dynamics Campaign)）

1985 Ohzora(Te probe)

1981 Hinotori (Te probe)

International collaboration
Brazil, West Germany

Jan/Us Tether collaboration

Canada ,USA Rocket experiement

1978 Kyokko

1975 Taiyo（Te probe）

L-3H-6, S-210-4,K-9M-28,29,32,34,36,38,40,42,45,47,55,62,68,69,72,81,S-310-5,S-310-14,18,24,25,26,28,29 Antactic

Wise man learns from history, fool form experience
Bismark(1815-1898)

Laboratory experiment

1972-1974 India – Japan rocket

Contamination,Te probe, Glass sealed Langmuir probe

1966

International collaboration

ISWI and Magdas School,17-26,2012, Bandung,Indonesia 23 10:00-10:50

Precursor effects of large earthquakes on the ionosphere

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The work is jointly conducted with Y. Kakinami,M.A. Abdu, J,Y, Liu, T. Kodama, M. Kamogawa, and others

Great Hanshin-Awaji Earthquake M.7.3 Jan 17, 1995: Death 6437 Unknown 3, Injured 43792, 10 chouen (Annual budget 80 chouen)

Contents about the effects of large earthquake

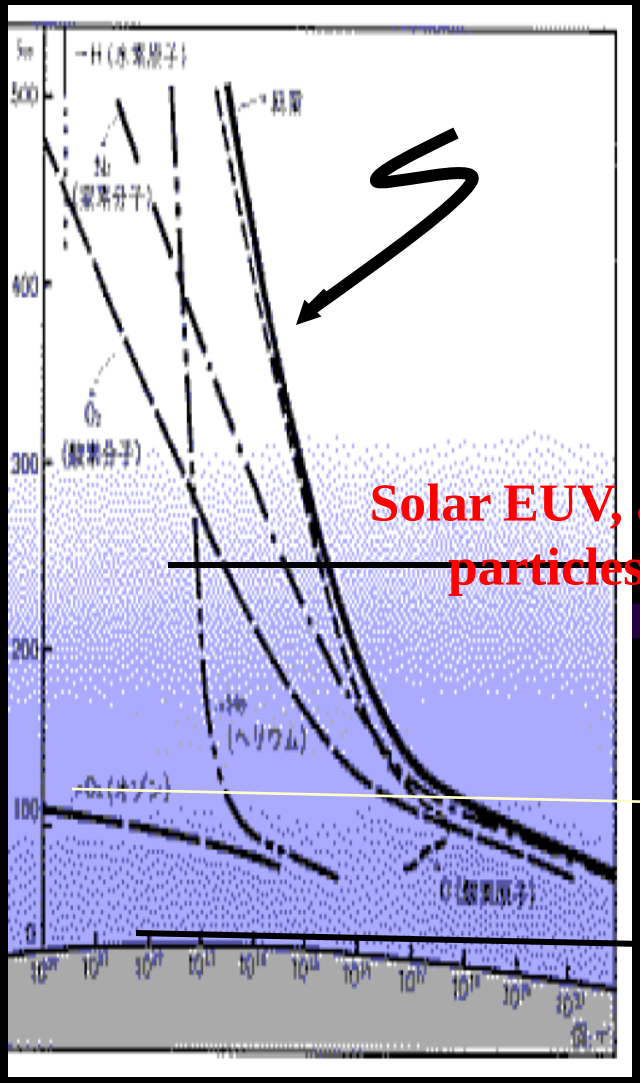
1. What is Ionosphere ?

2. Observation by satellite ; VLF, Plasma density, Infrared , particle precipitation

3. Observation by HINOTORI (Japan) and DE-2 (US) satellites

4. What modifies the ionosphere ? Electric field

5. Future works; Earthquake study satellites



Height profile of neutral particles

Density of neutrals (N_2,O_2)

Earth surface; 1 atom. 、 10^{19} /cm^3

Altitude 30 km; 10^{17} particles /cm^3

Altitude about 105 km; 10^{12} particles /cm^3

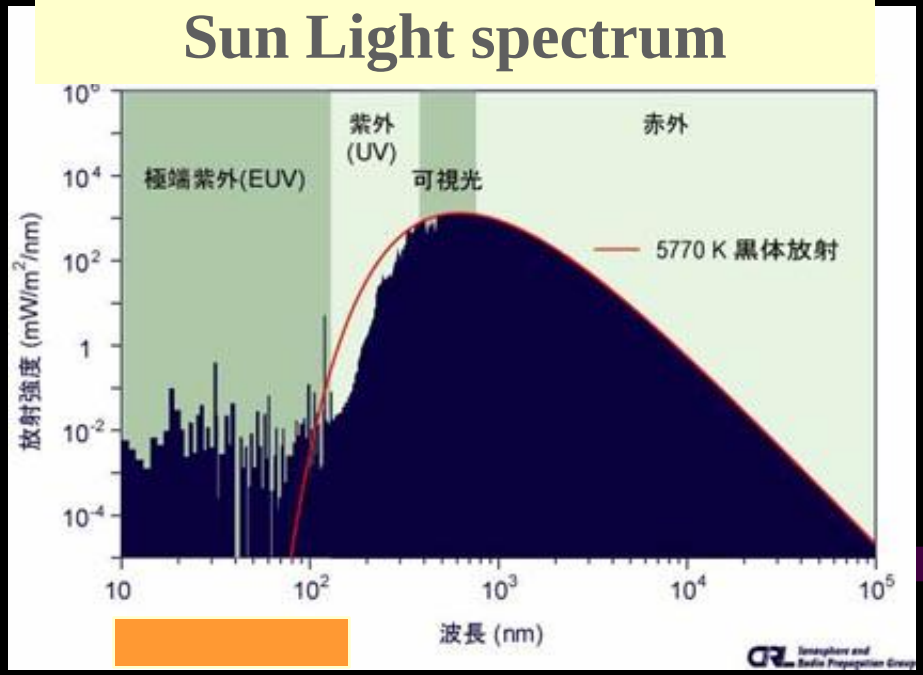
(1 order reduction/15 km)

Solar EUV, and particles

Composition

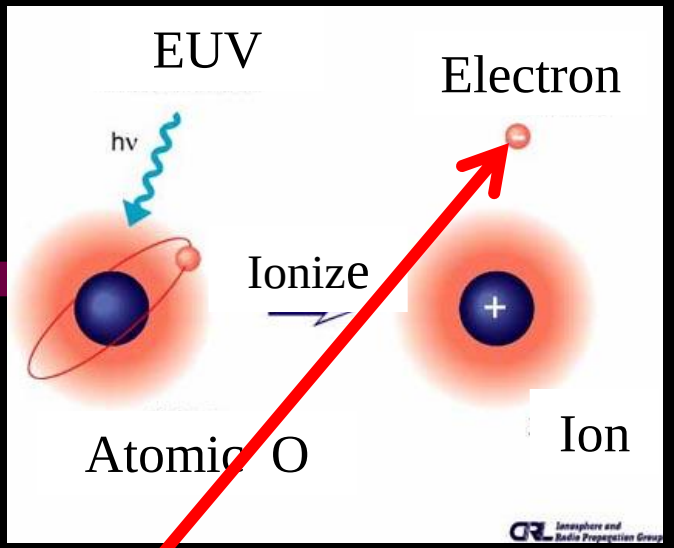
Up to the height of - 100km (turbopause), the composition ratio is the same, while above 100km, heavier particles sink in lower altitude.

Sun Light spectrum



Ionization of neutral particle

(by EUV or Energetic charged particle)



$O_2 \longrightarrow O + O$ (5.1eV, 242nm)

$O + EUV \longrightarrow O^+ + e$ (13.6eV, 91.04 nm)

$N_2 \longrightarrow N + N$ (9.8 eV, 127nm)

$N_2 + EUV \longrightarrow N_2^+ + e$ (15. 6 eV, 79.6 nm)

Equal number of electrons and ions : Plasma

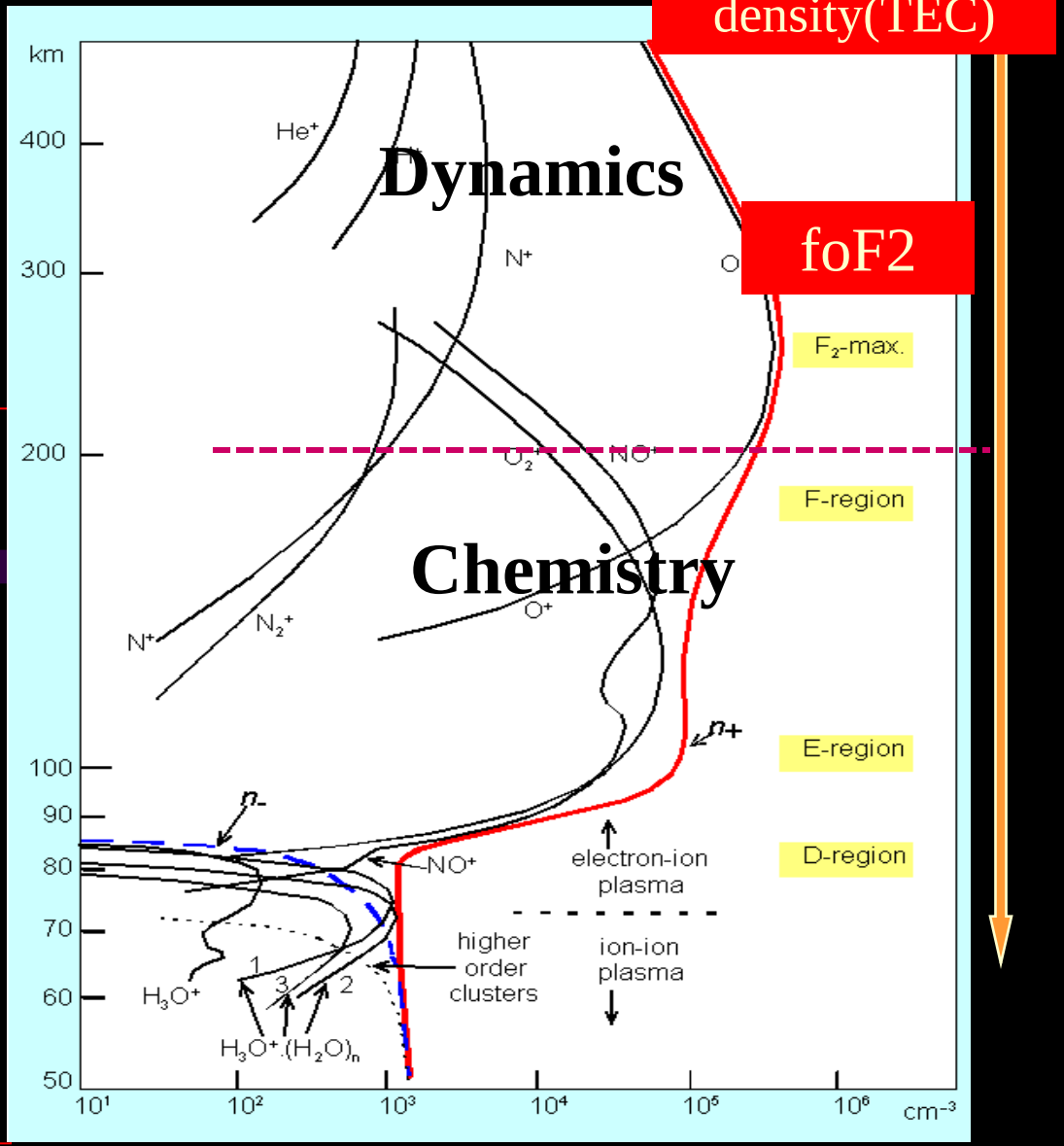
Electrons collides with neutral particles, and finally thermalized …. Electron temperature, Te

What is Ionosphere ?

Basic parameter;

Ne (Electron density), Ni (ion density), Te(electron temperature, Ti (ion temperature), Ion composition (O^+, NO^+, O_2^+), Vd (plasma drift

Electron/ion temperature is defined totally in the same way as atmospheric temperature (Tn= < ½ mv^2>)

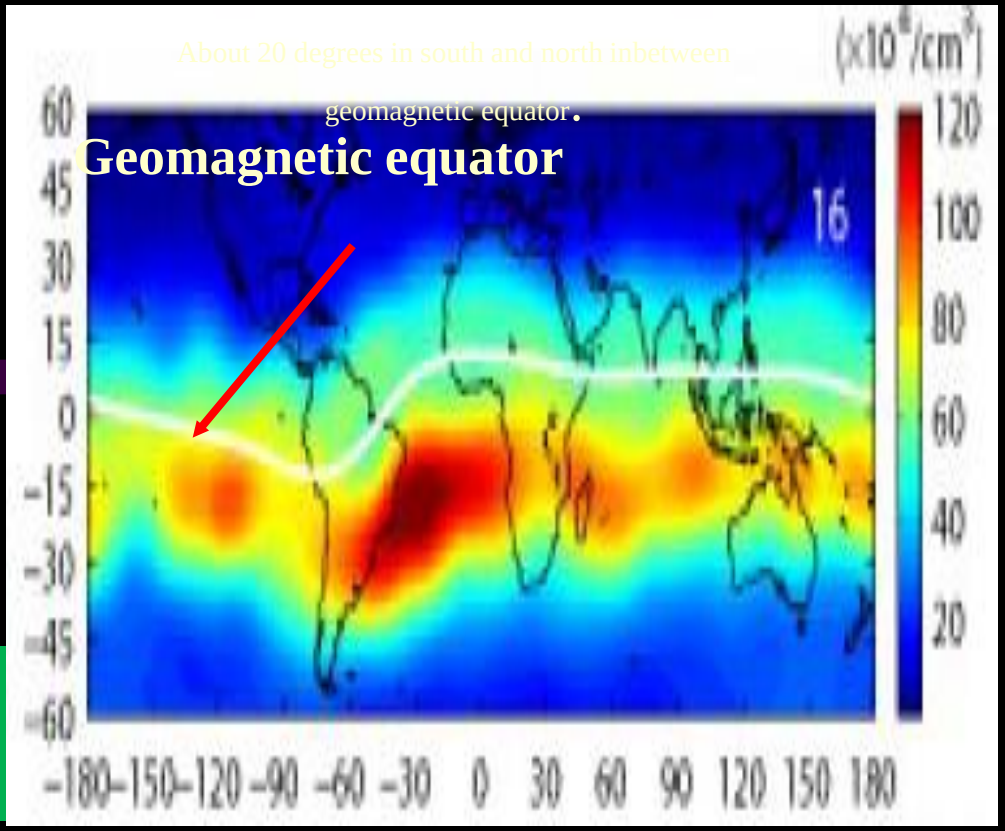


Exploration of another planets .If atmosphere exist, ionosphere exist !!! (Detect ion of ionosphere is easier than neutral atmopshere)

Ionospere is modified by Electric field / neutral wind under the existence of Earth magnetic field

1. Equatorial Ionization Anomaly (EIA)

2. Sporadic E layer, Four cell feature

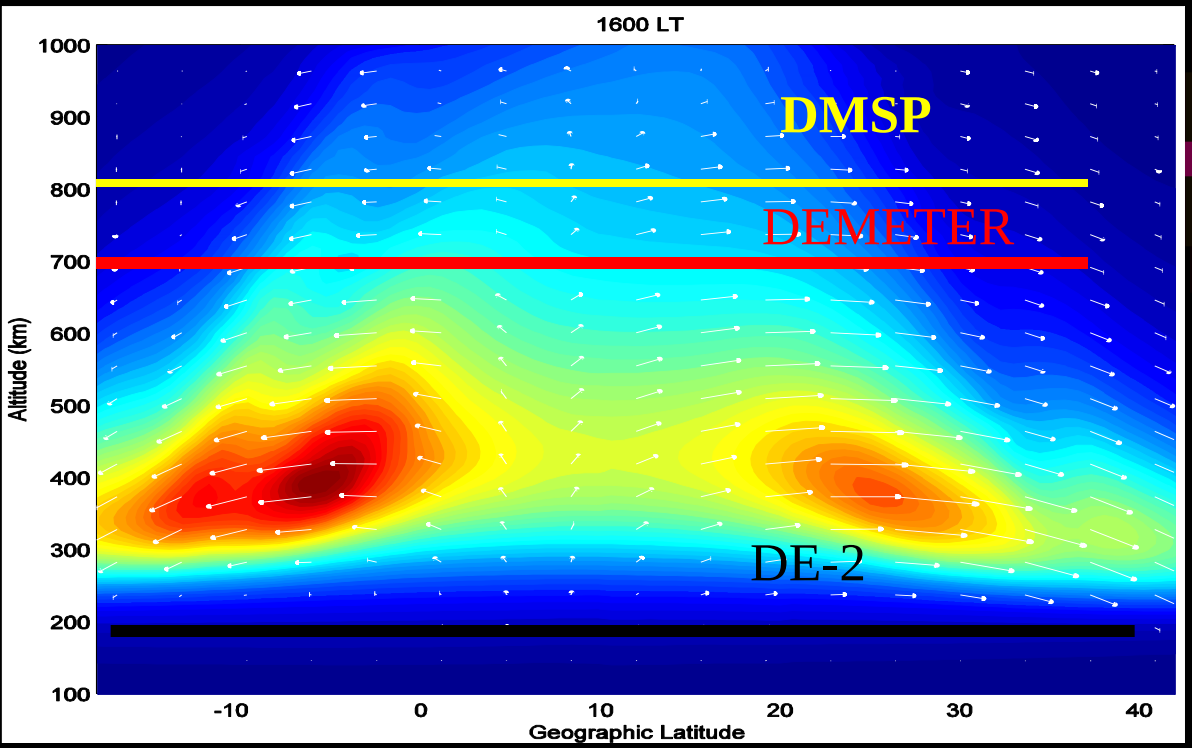


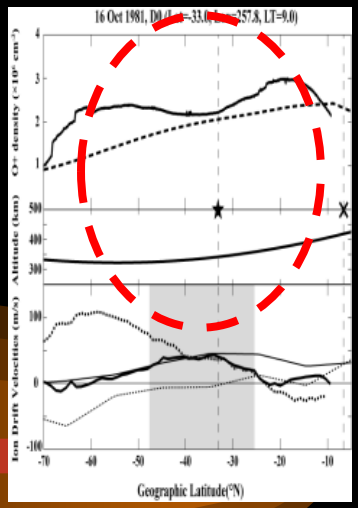
Maximum Ne, Jan , 2009 calculated by Chou , NCKU

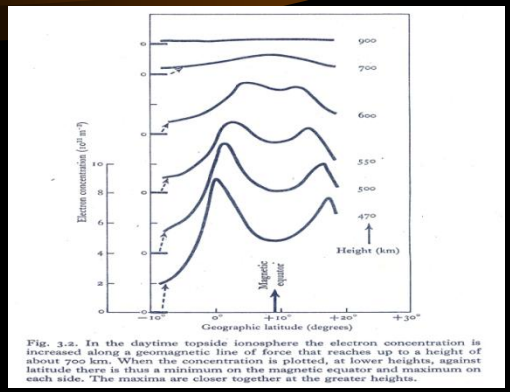
磁気赤道　地磁気の伏角がゼロの地点を連ねた線。地球の赤道の付近にある

Modification of the ionosphere by E field (EIA)

Fountain Effect







EIA is further modified by Neutral wind

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Past observations of the precursor feature

Ground Observations (example)

Night Glow, Mikhalev et al., 2001 Periodic variation of

foF2 :Liu et al., 2006, Maekawa et al., 2006; Hobara and Parrot , 2005;Zhao et al., 2008, Liu et al., 2009, Sharma et al, 2008

VLF: Hayakawa et al., 2006, Rozhnoi et al., 2007

TEC: Zakharenkova et al., 2007

……

Recent Reports on Precursor Phenomena of ionosphere/atmosphere of Large earthquakes -continued

Satellite observations

VLF wave; DEMETER (French satellite, Parrot)
Electron temperature；Oyama et al., J.G.R., 2008 (Philipine 1981 Nov, Dec)

Electron density/ GPSTEC； Akhoondzadeh et al., 2010 Samoa Island (29.Sep, 2009 and 3 others)
Atomic Oxygen ion（O^+）； Oyama et al., J.G.R., 2011, Chillie 1981 Oct

Infrared (11-12 μm) : Ouzounov et al, 2006

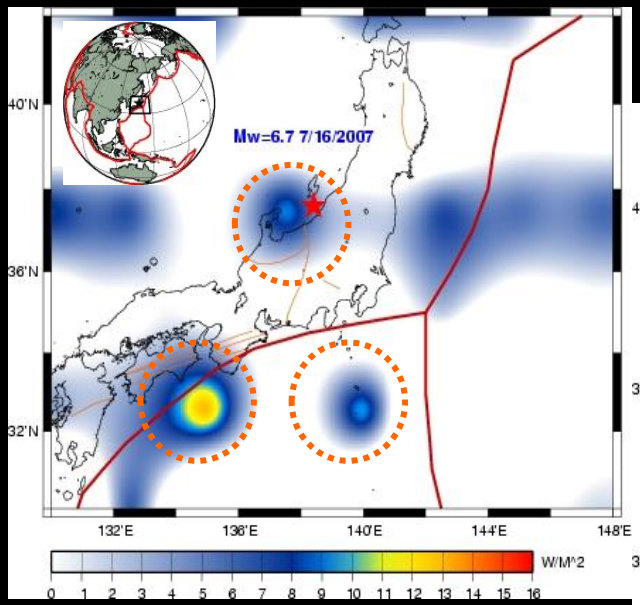
O^+, He^+ ion composition；Bankov et al., 2009, Smatra

Particle precipitation； Rothkaehl et al., 2006

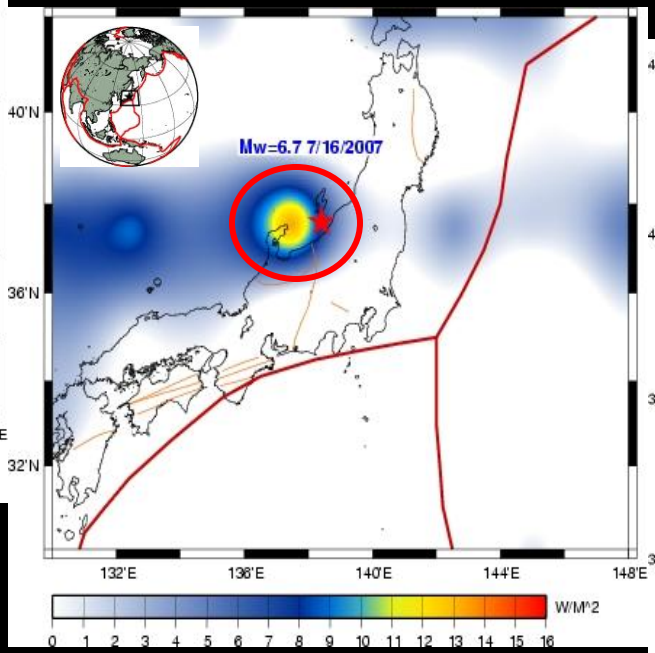
Evolution of daily satellite thermal anomalies.

Earthquake has occurred 2007-07-16 01:13 (Mw 6.7) (Niigata-ken Chuetsu-oki

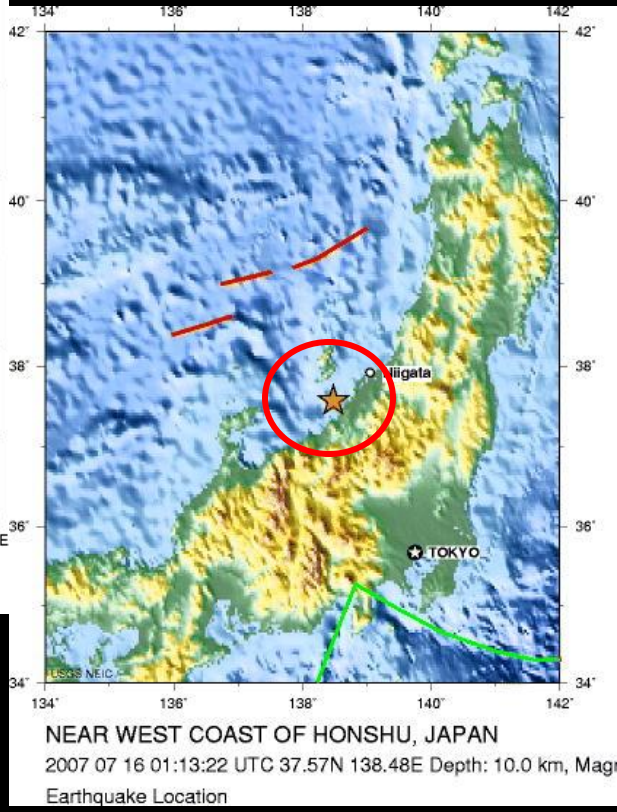
Infrared ob. before earthquake



July 4, 2007



July 14, 2007



July 16, 2007, USGS

Time evolution:
July 4 – EQ Alert
July 14- EQ Warning
July 16- EQ Event

Courtesy Dimitar.P.Ouzounov@nasa.gov

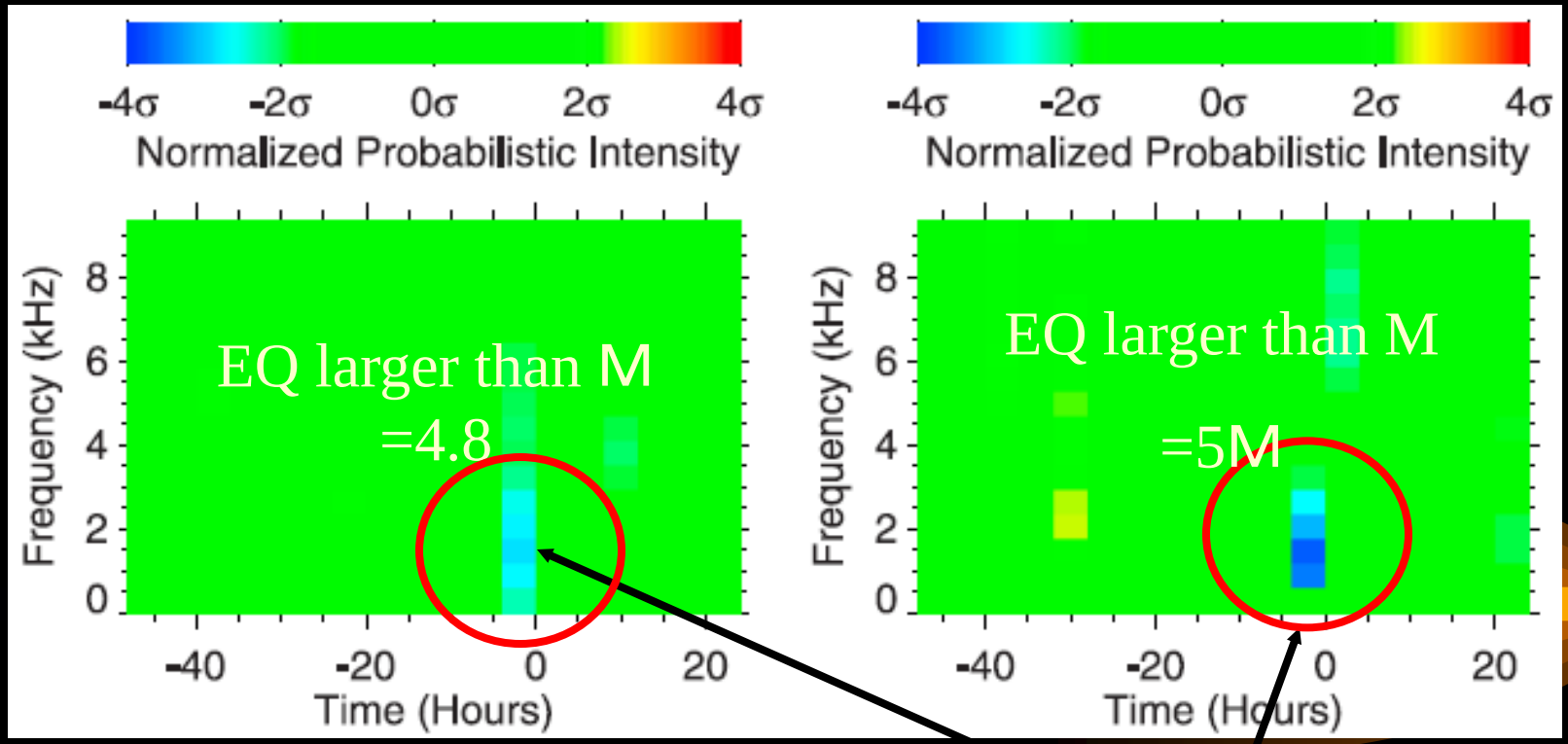


Figure 2. (left) Frequency-time spectrogram of the normalized probabilistic intensity (see text) obtained from the night-time electric field data measured within 330 km of the earthquakes with magnitudes larger than or equal to 4.8 and less than or equal to 40 km. Data measured for all Kp values and seasons have been included. (right) Same as left but for earthquakes with magnitudes larger than or equal to 5.0.

VLF wave detected before EQ

VLF observation by DEMETER satellite (Detection of Elec tro Magnetic Emissions Transmitted from *Earthquake* Re- gions)

Nemec et al., J.G. R., 2008

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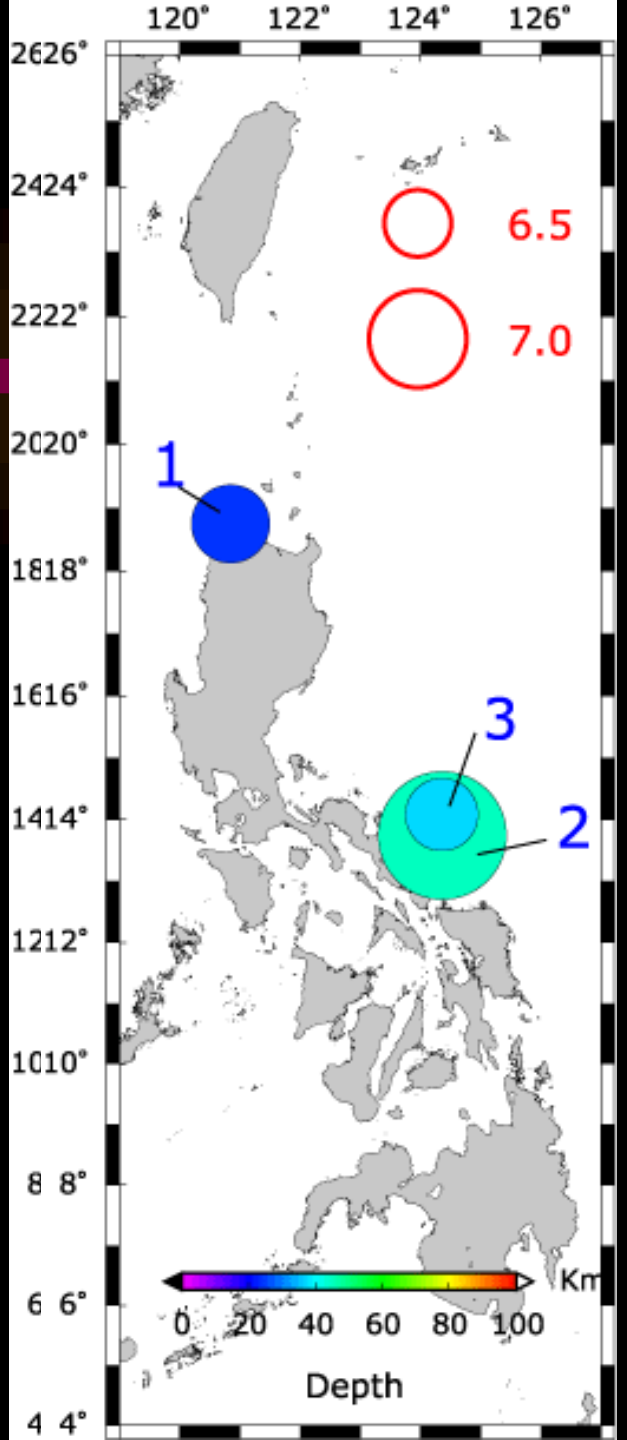
1. HINOTORI, 1981-1982

(Oyama et al., JGR, 2008)

- (EQ1) 1981/11/22 15:05 N18.75 E120.84 24km Ms6.7
- (EQ2) 1982/1/11 6:10 N13.75 E124.36 45km Ms7.4
- (EQ3) 1982/1/24 6:08 N14.09 E124.35 37km Ms6.6

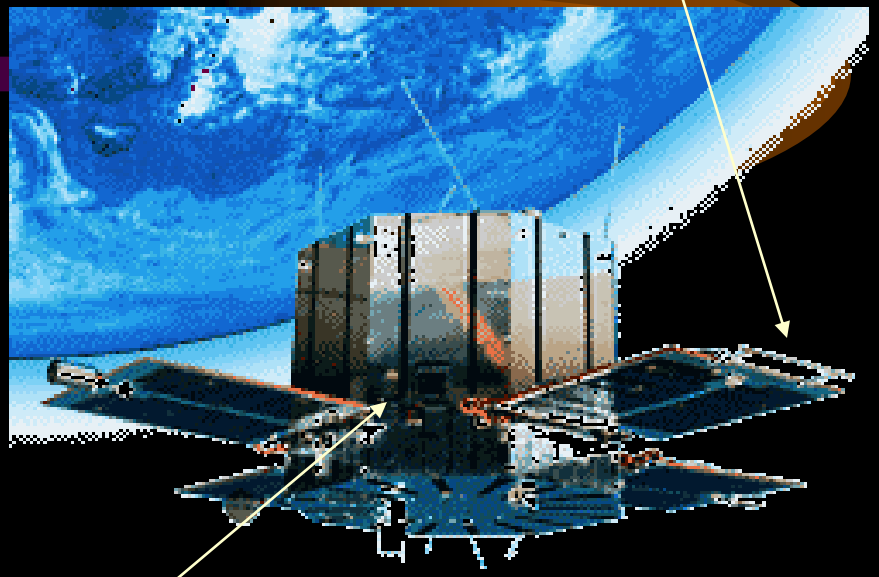


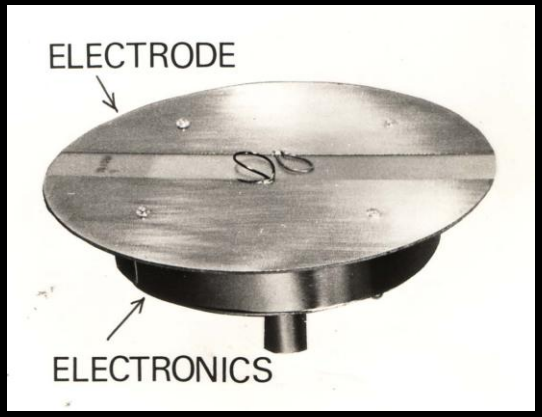
Japan, 1981 Feb

Impedance Probe (Ne)

Oya,H.,T.Takahashi,and S.Watanabe,, J.Geomag.Geoelectr.,38,111-124,1986., weight ;less than 500g + sensor rod

- Inclination; 31 degrees
- Heigth576-644 km
- Electron temperature and density
- 1981/2/1-1982/6/30/





Electron Temperature Probe(Te)

300g (including sensor)、1W Hirao, K. and K.- I.Oyama, J.Geomag Geoelectr . ,**22**,239-402,1970. less than 300 g including sensor Electrode

Usually , when Ne is high (low), Te reduces (Increases)

How can you find anormaly？

Te case

1. The instrument should be reliable enough

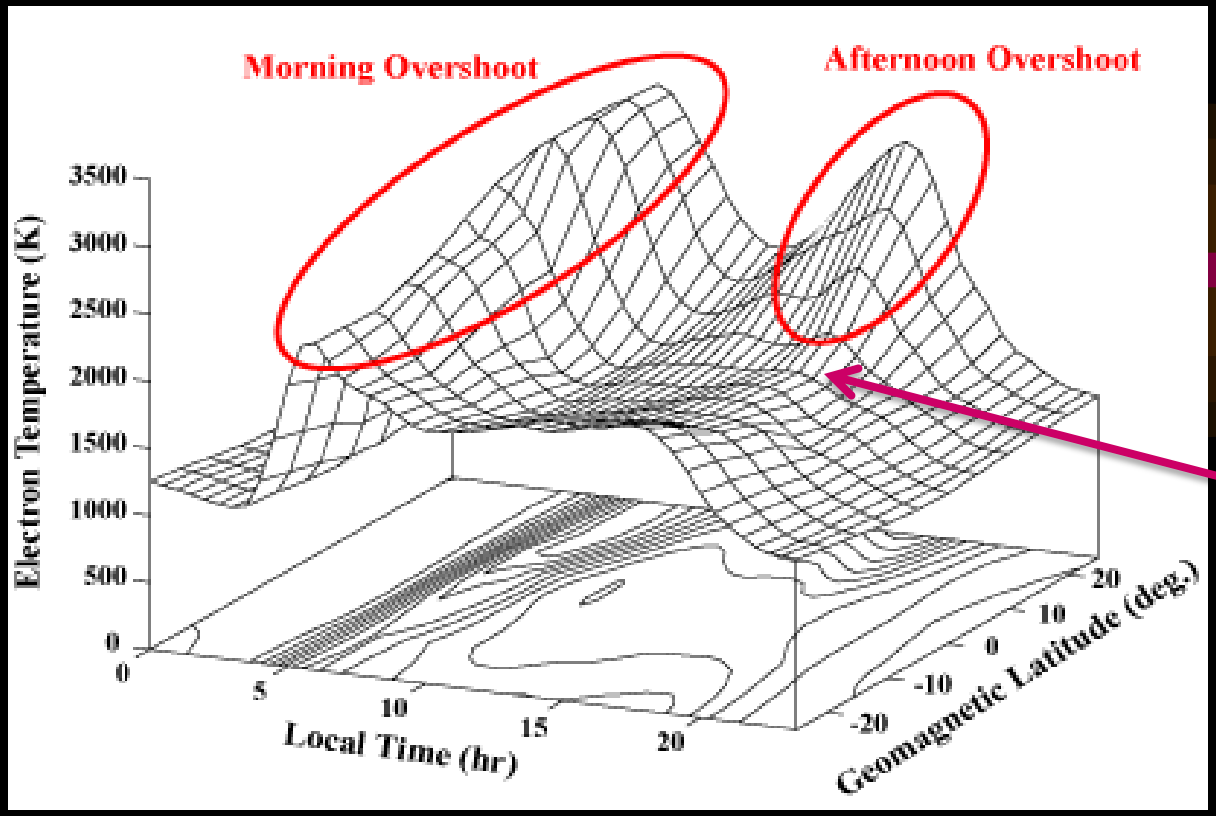
2. Scientist should know the ionosphere well (senior scientist , or if young scientist ,he(she) needs advise from senior scientists)

3. Construct a model（ normal days）

4. Try to find the deviation from the model.

This is a process which Oyama took.

Te behavior at the height of 600km

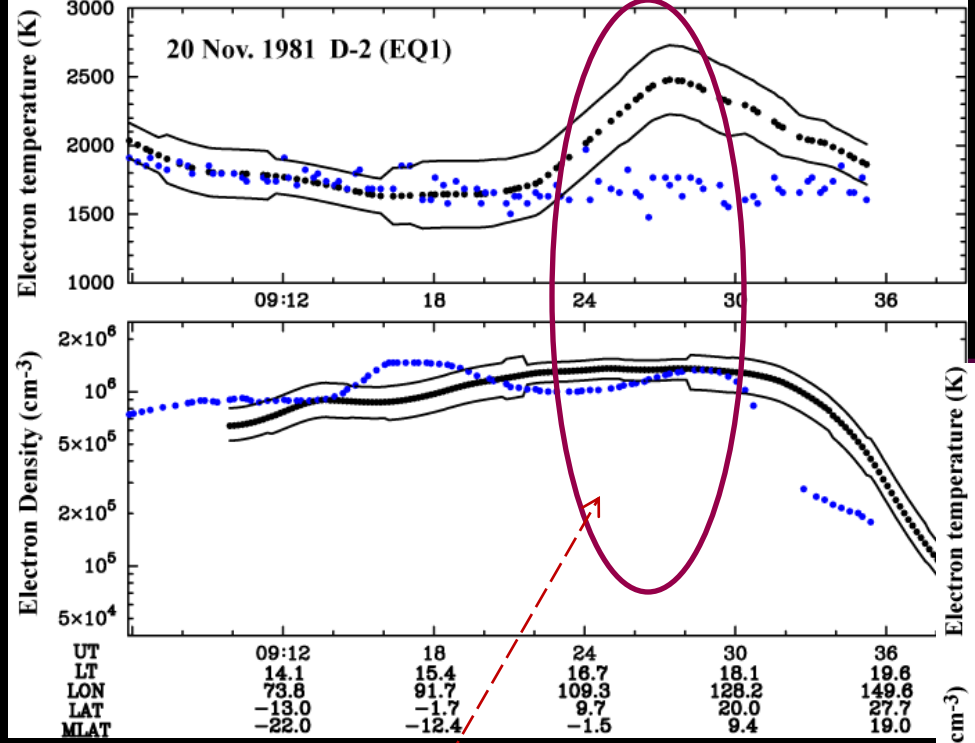


Variation of Te is the smallest in the magnetic equator

Te changes depending on local time,sun activity, location , and season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.

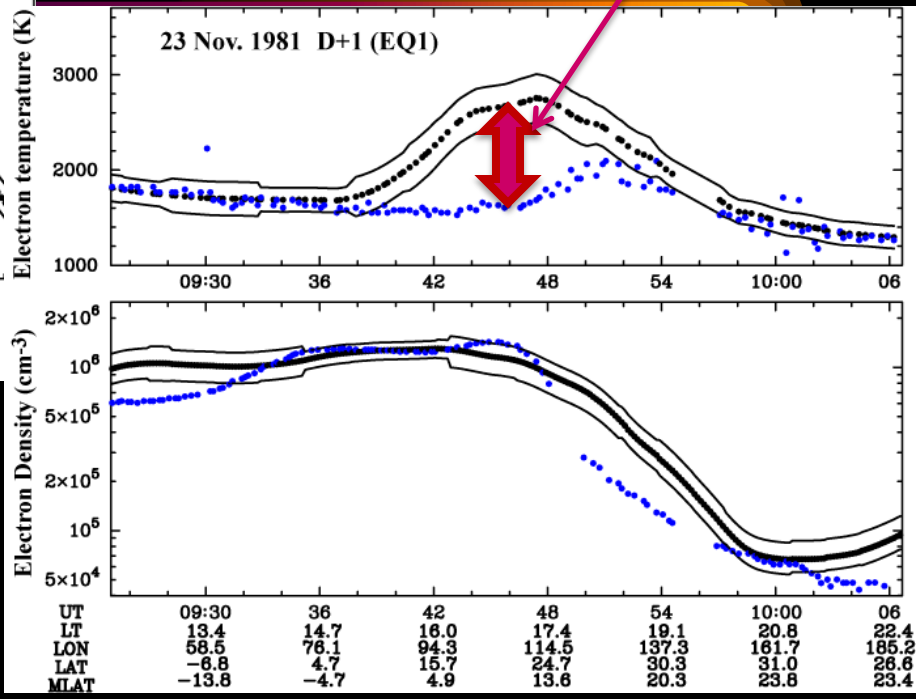


(a)

Oyama et al, JGR 2008

(b)

Te



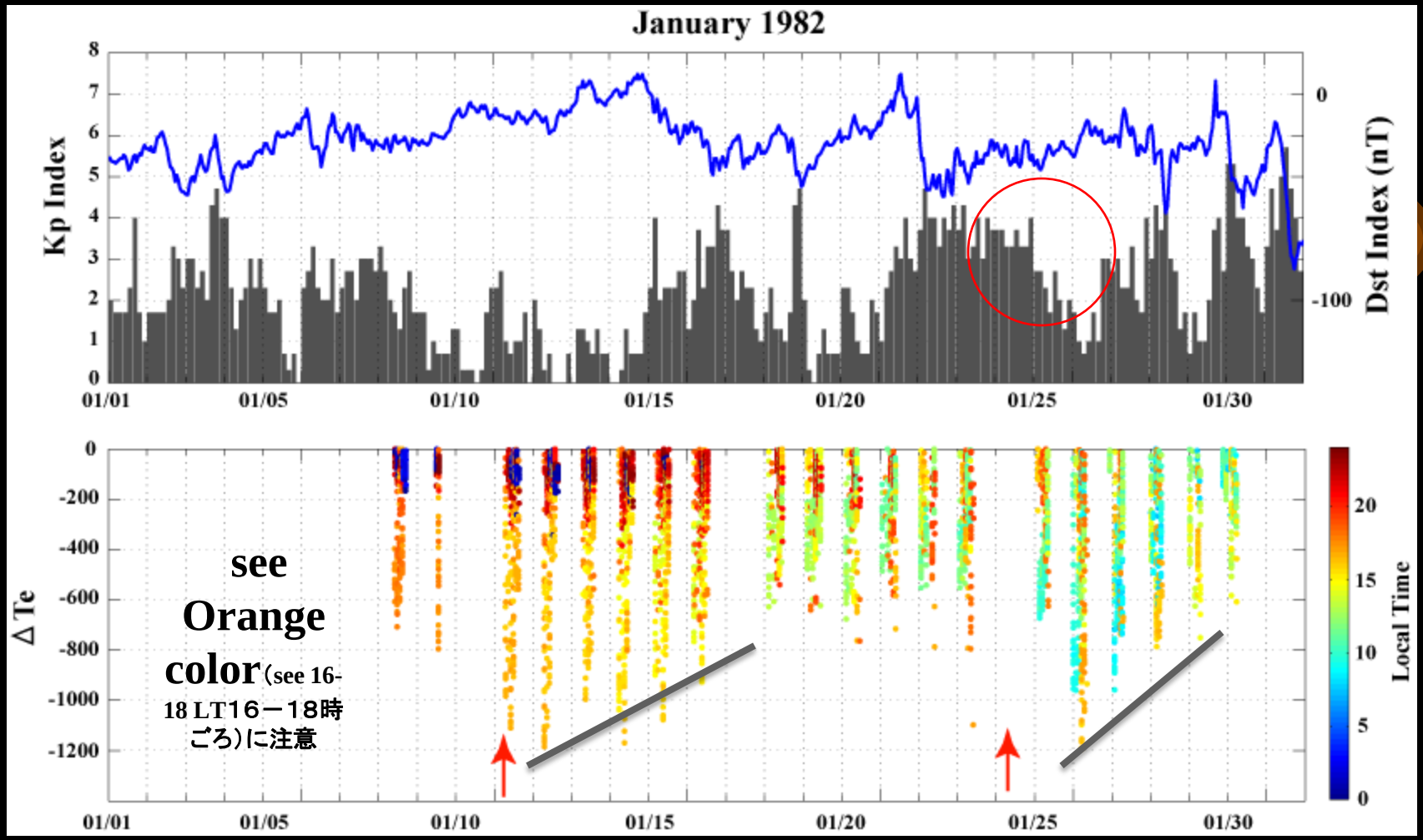
Why does this funny feature ? なぜこんな事が起きる？

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

Example of the deviation of Te from the model ; Black ;model, and blue; observation. Thin black lines are standard deviation.

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



M=7.4　　M=6.6

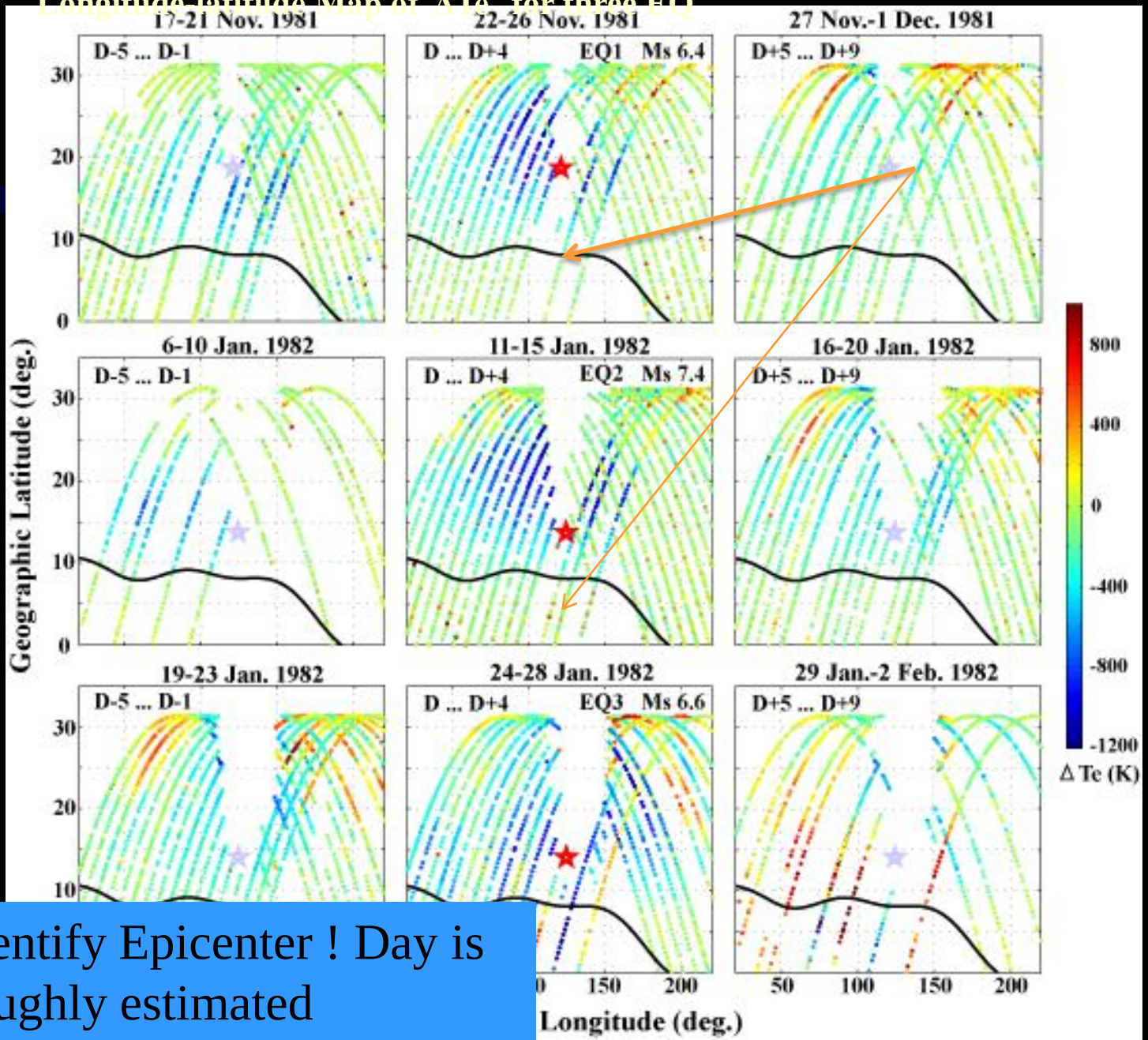
Deviation of Te from the model (Averaged) versus days. For larger earth quake precursor and recovery become longer.

3つの地震にたいする平均からの電子温度のずれの経度ー緯度分布

22 Nov 1981

11 Jan 1982

24 Jan 1982



Can not identify Epicenter ! Day is roughly estimated

New findings by HINOTORI satellite

Afternoon overshoot which appears in mid latitude at 15-16 LT disappears totally or partially about 5 days*before large earthquakes, and recovers about 5 days after the earthquake. There is a tendency that larger earthquake has longer leading/lasting time. * 1-2 days ambiguity because of the insufficient amount of data

中低緯度で電子温度に午後現れるオーバシュート大きな地震約５日前に一部なくなるか、或いは全部消えてしまう。研究した地震では旧に回復するのに約５日かかっている。地震が大きければ大きいほど、前兆の現れる時間、回復時間は長くなりそう。この研究では地震発生日は１－２日の曖昧さあり（データが少ないため）

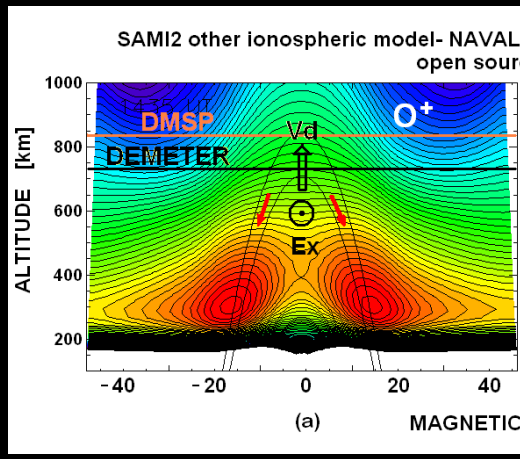
2. Analysis of the data by US satellite Dynamic Explorer 2

Analysis of Dynamic Explorer 2 data 1981-1982 （Oyama et al., J.G.R. 2011）

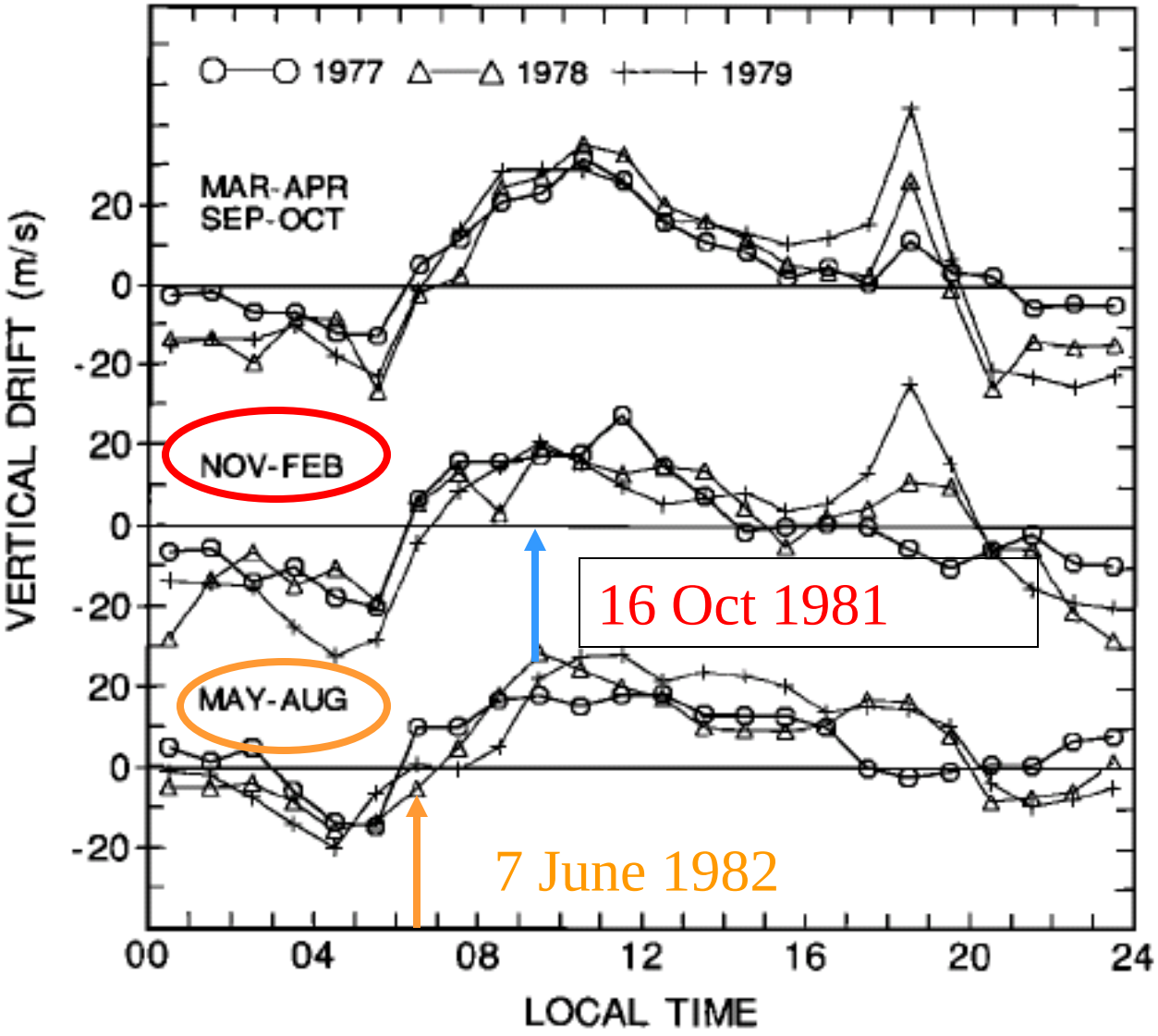
Minimum of plasma density which is similar to Equatorial Ionization Anomaly (EIA) appears over the epicenter . If we are not informed in advance the geomagnetic equator ,we surely misunderstand that this is equatorial ionization anomaly. We named this “ Precursor ionization Anomaly” (PIA).

大きな地震の前に地磁気赤道（Equator Ionization Anomaly. E.I.A) にあらわれる赤道異常によく似た現象が震源上空に現れる。もし私達が事前に地磁気赤道の場所を知らされていなければ、これを間違いなく普通の赤道異常と勘違いする。私達はこの現象を （地震）予兆赤道異常（ “ PIA, Precursor Ionization Anomaly”, P.I.A）と名付けた。

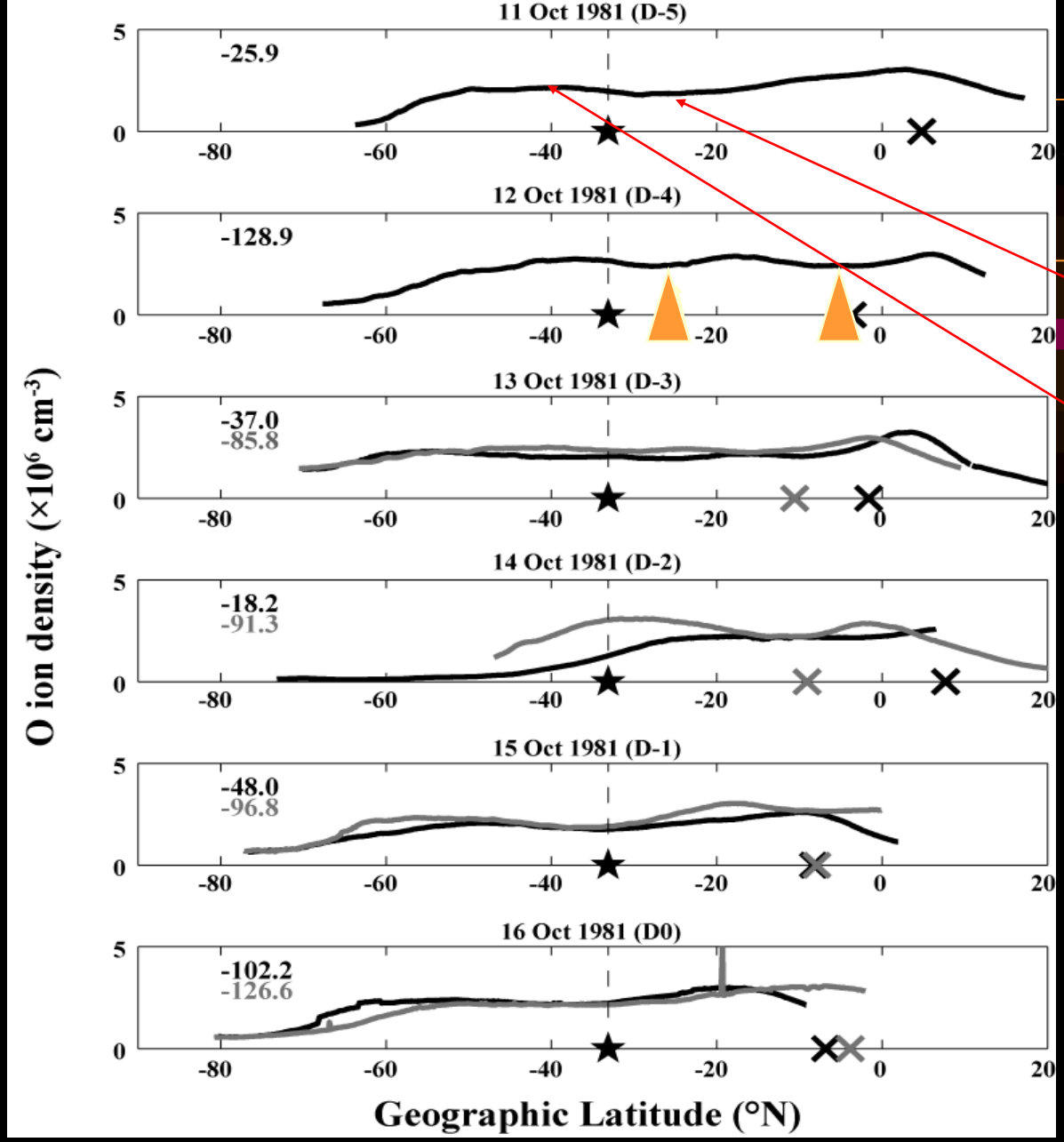
Upward(down) plasma drift caused by eastward(westward) E field



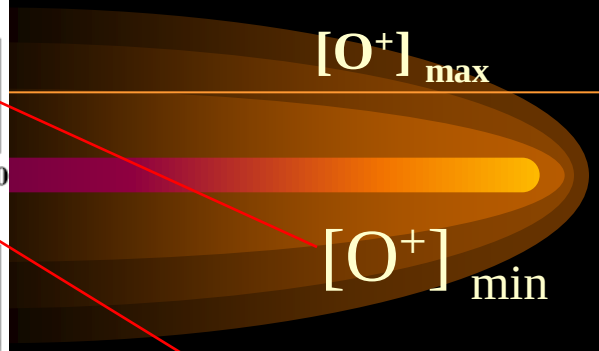
Two EQs to be discussed here



Fejer et al, JGR., 1995



$\Delta N = \{ [O^+]_{min} - [O^+]_{max} \} / [O^+]_{max}$

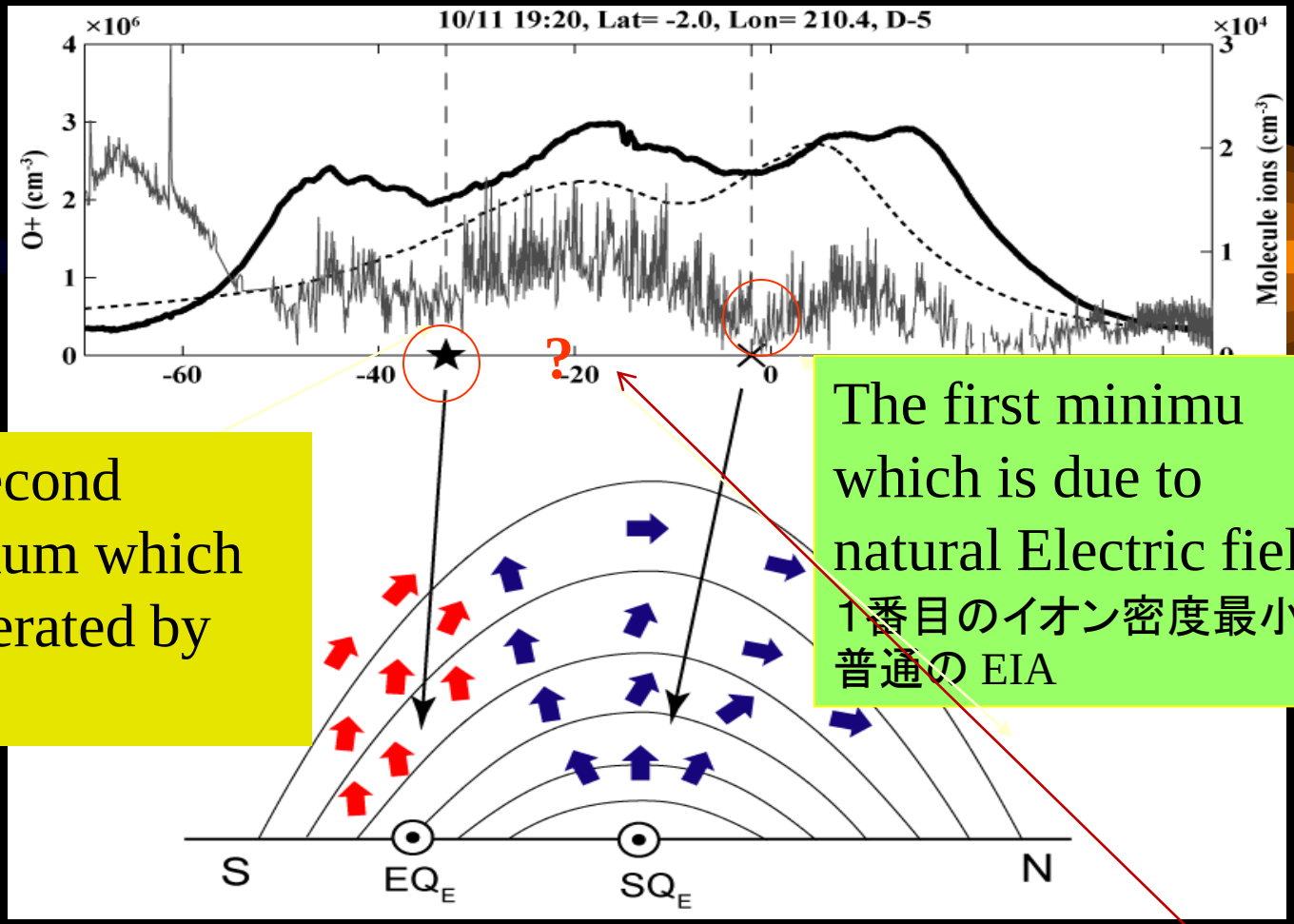


$[O^+]_{min}$

$[O^+]_{max}$

3. Chile EQ :16 Oct.1981, -33.1/-73.1, M=7.5, D=33km

Example one : Natural electric field for EIA exists

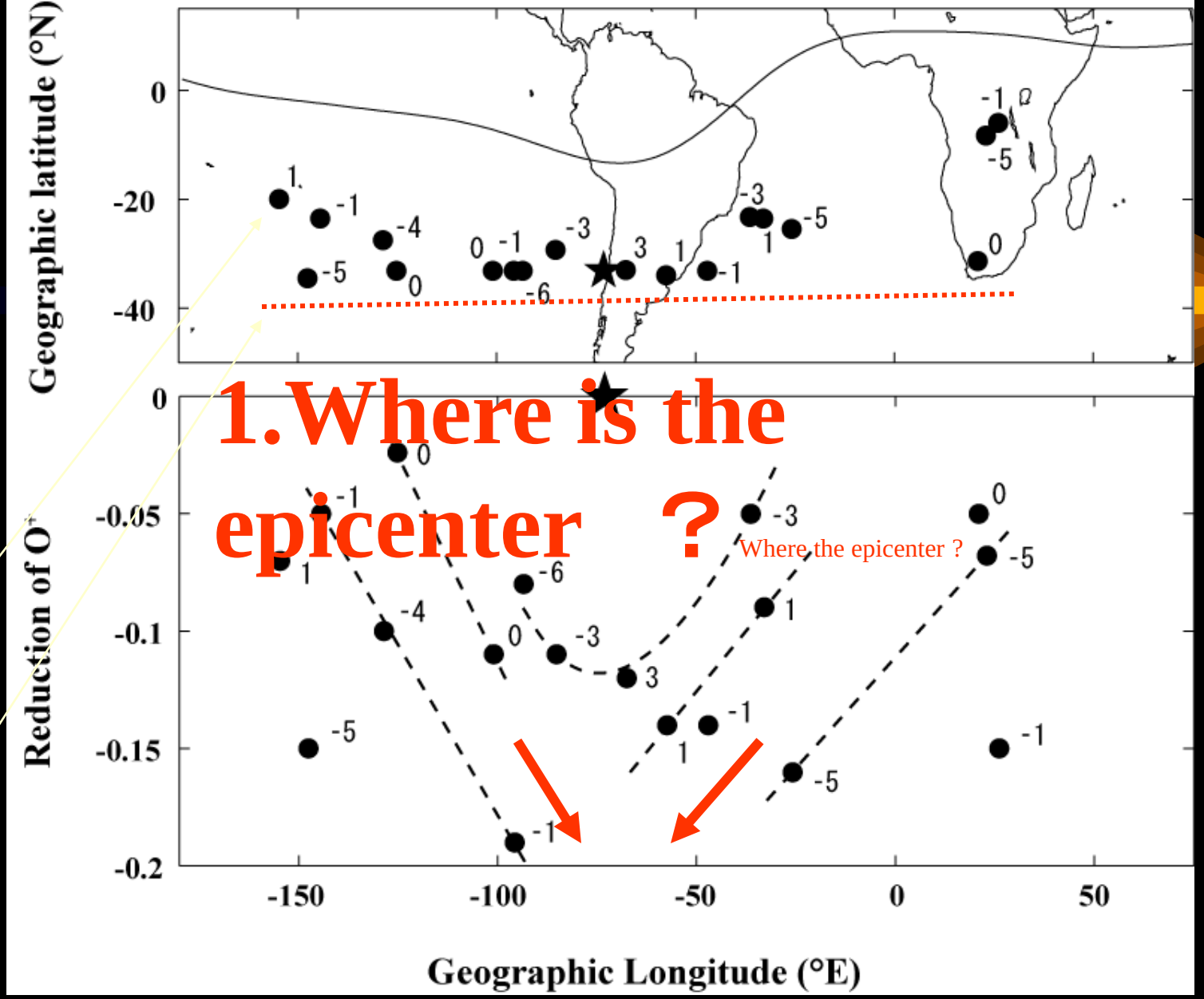


The second minimum which is generated by EQ.

The first minimu which is due to natural Electric field
1番目のイオン密度最小
普通の EIA

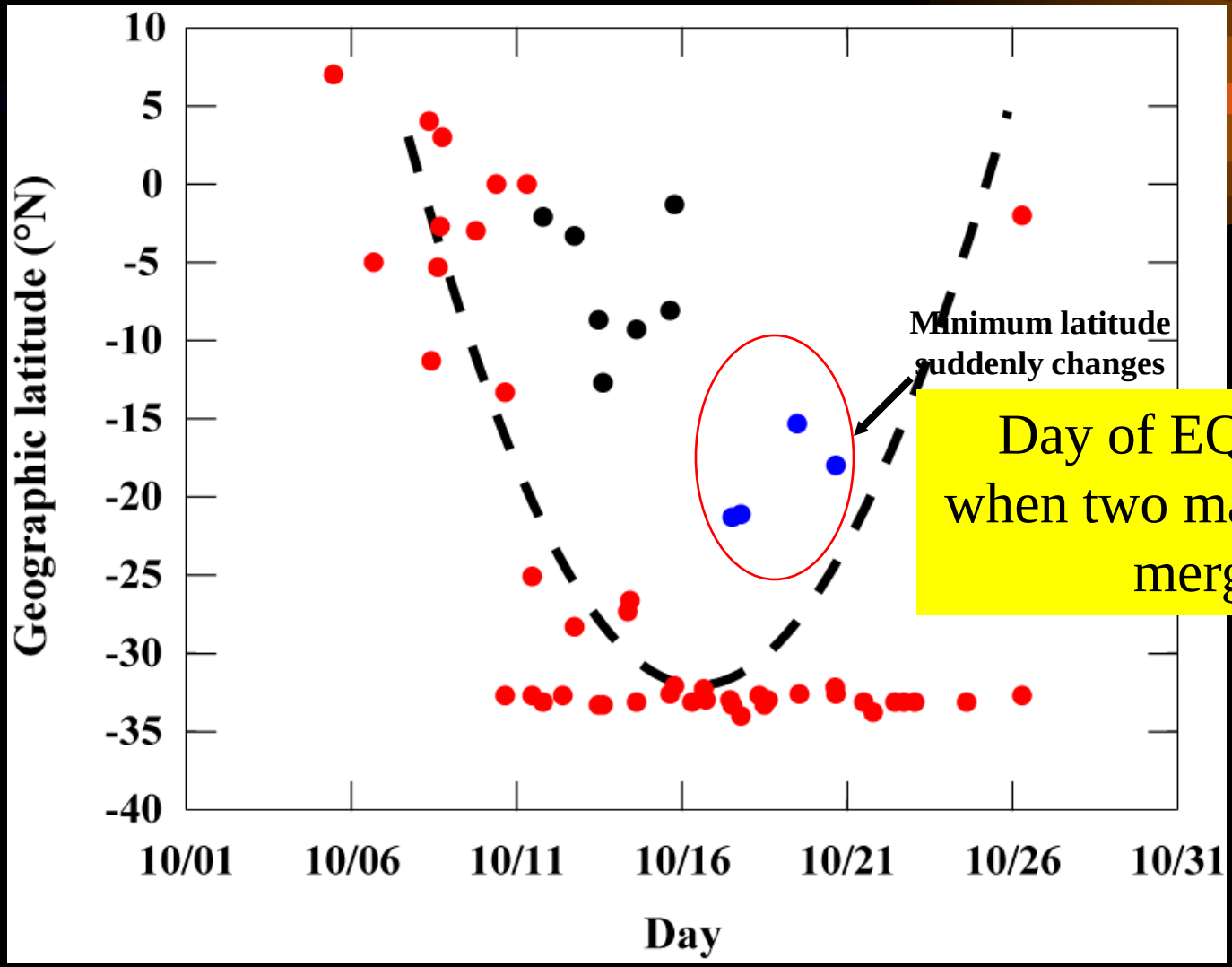
Sometimes the third minimum appears。

Fountain effect due to Earthquake associated E field地震による噴水効果の図



Location of atomic oxygen minimum Location of the minimum of $[O^+]$ (upper panel),and reduction of $[O^+]$

2. When EQ occurs ?



Day of EQ is the day when two main minimum merges !.

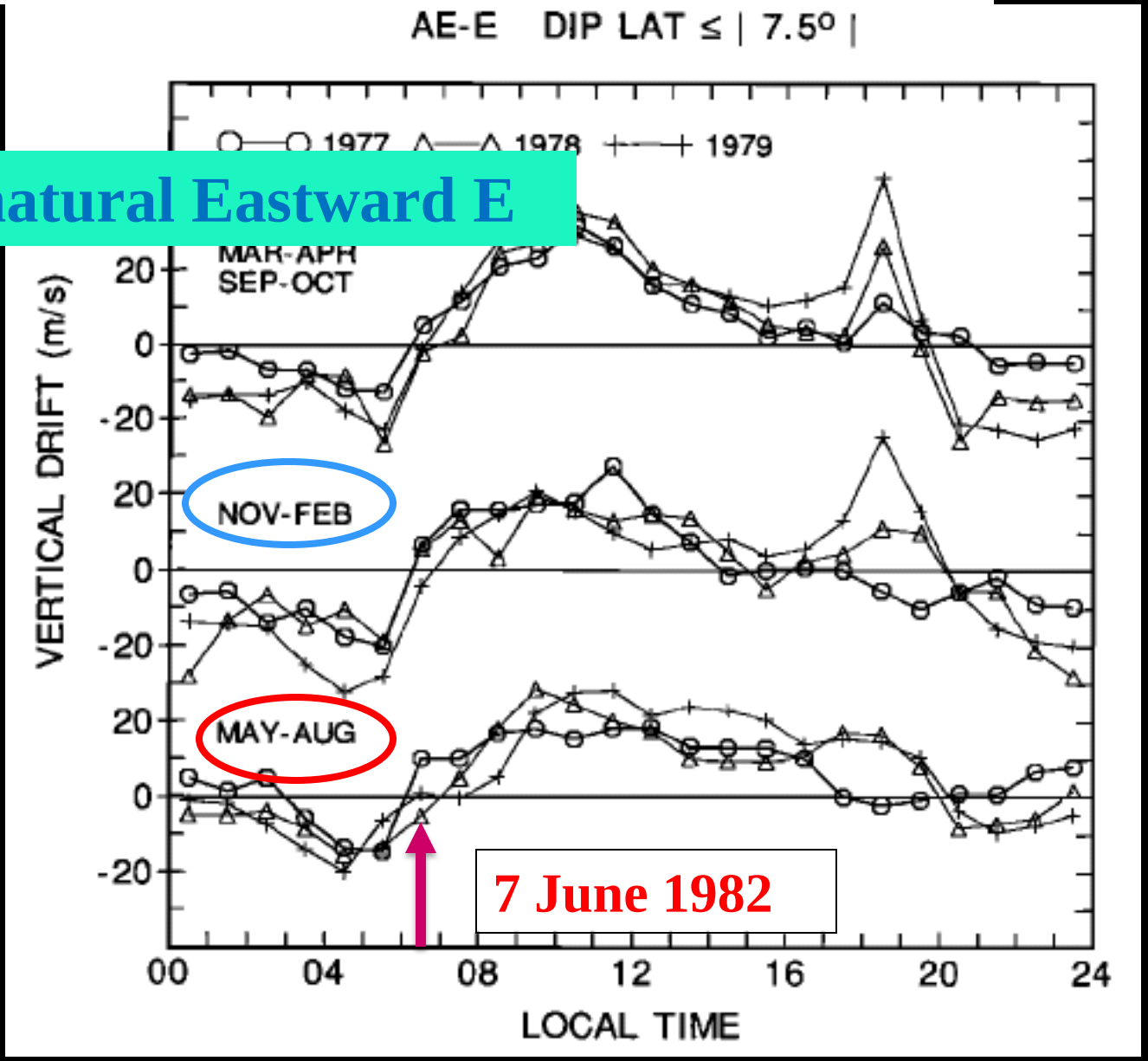
JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 100, NO. A4, PAGES 5769–5776, APRIL 1, 1995

Global equatorial ionospheric vertical plasma drifts measured by the AE-E satellite

B. G. Fejer and E. R. de Paula[1]
Center for Atmospheric and Space Sciences, Utah State University, Logan

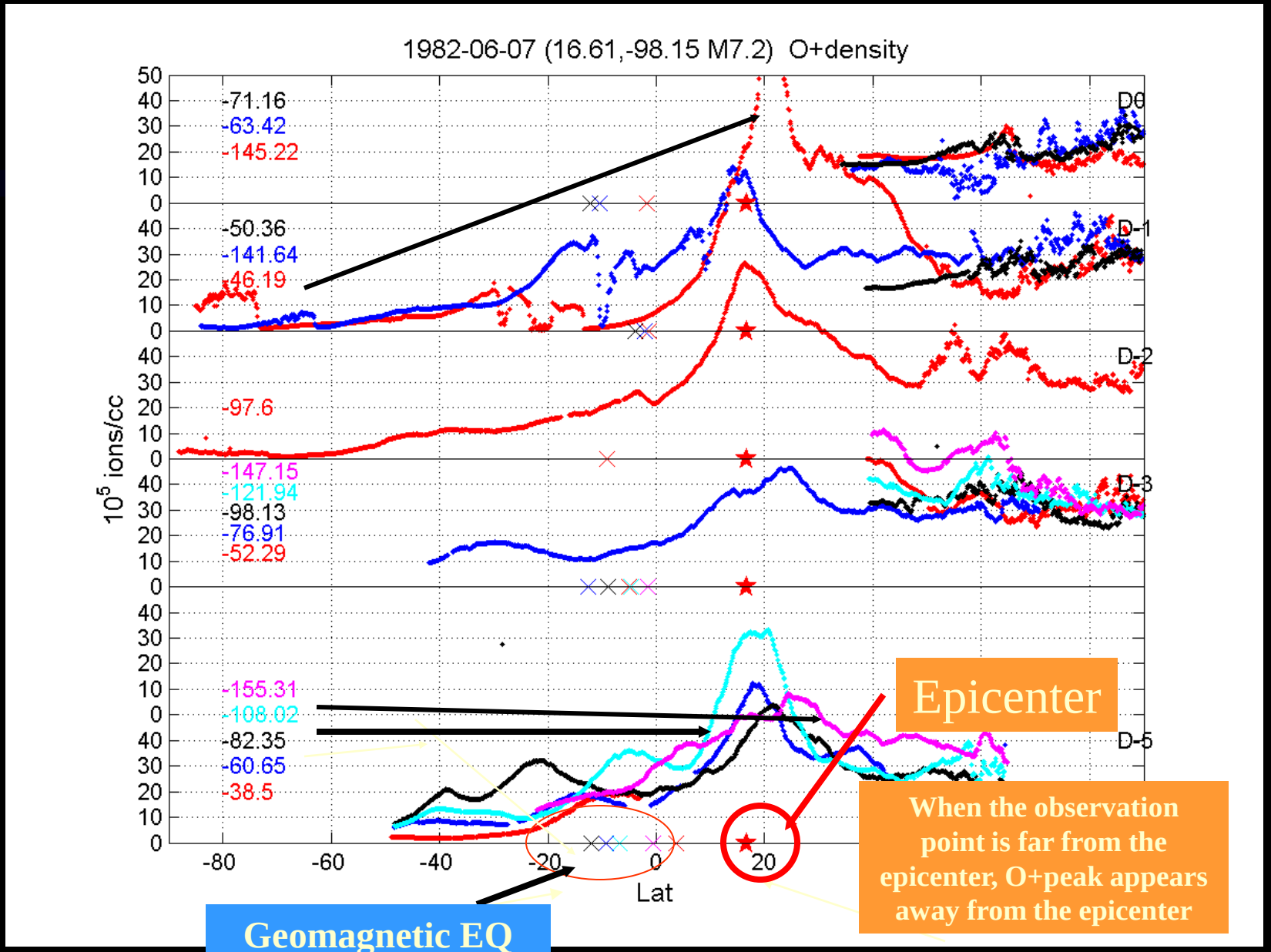
R. A. Heelis and W. B. Hanson[2]
Center for Space Sciences, University of Texas at Dallas, Richardson

Case of no natural Eastward E

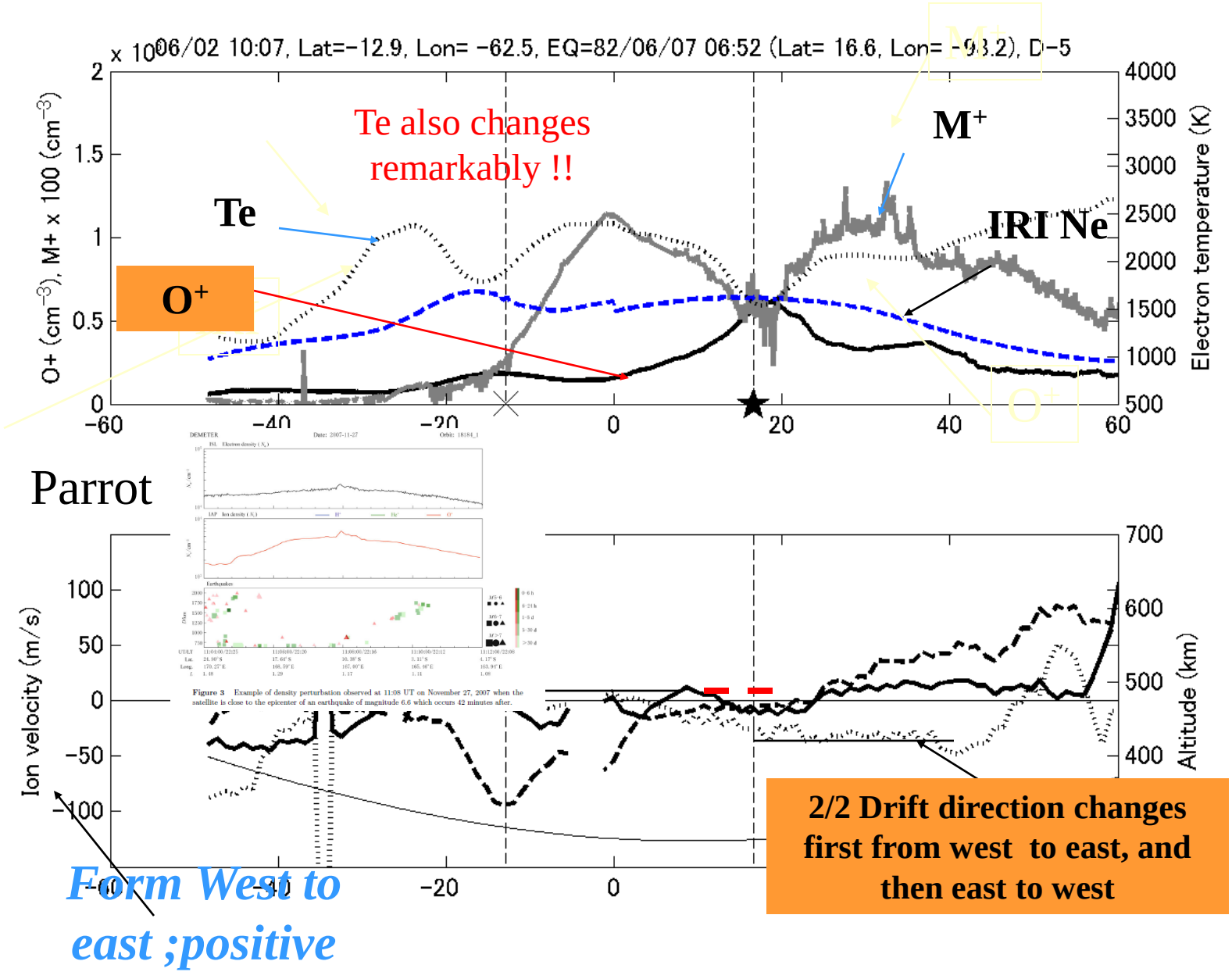


Fejer et al, JGR., 1995

Example of PIA 2, without Eastward EF, 16.6, -98.15, M-7.2



Difference of Te behavior, depending on local time



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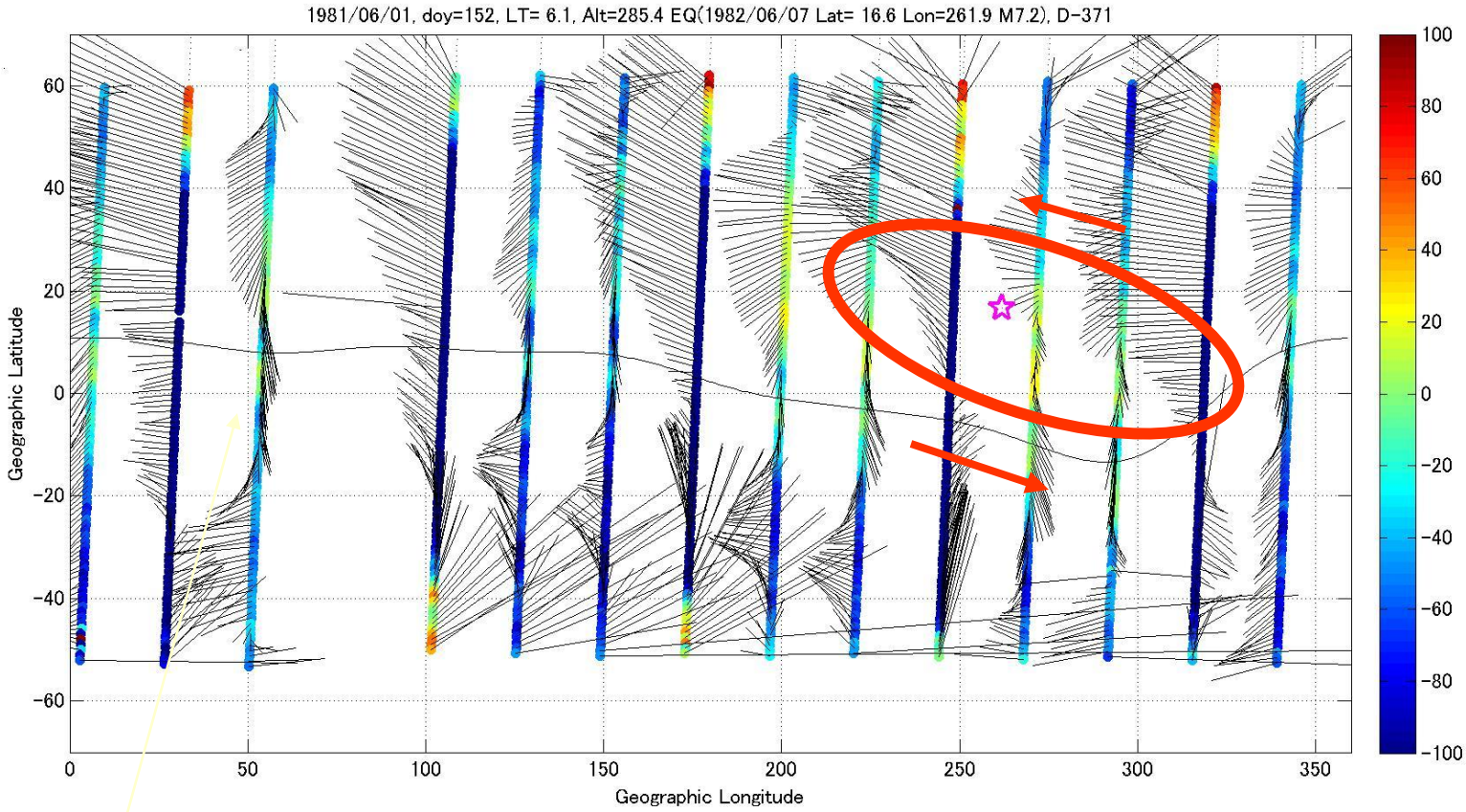
Element which modifies ionosphere - most probably Electric field

Next task to be pursued !

Where and how is the electric field produced ? We are in the complete darkness know

Invention needs a lot of imaginations and large amount of garbage- T. Edison 発明するには豊な想像力とごみの山が必要だートーマスエヂソン

Direction of plasma drift

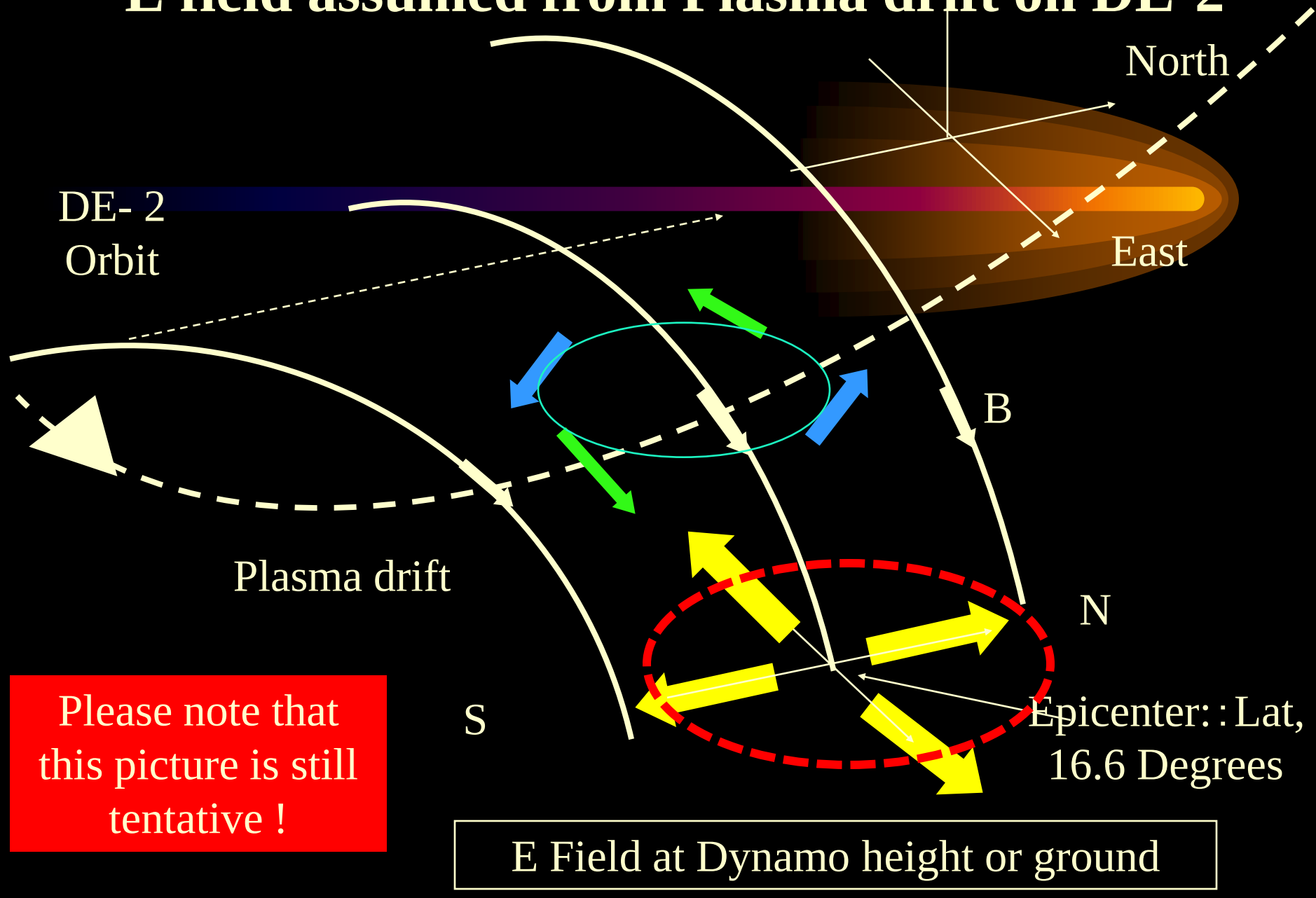


Please check

Plasma Drift

EQ 1981.06.07 M=7.2, 6 days before

E field assumed from Plasma drift on DE-2



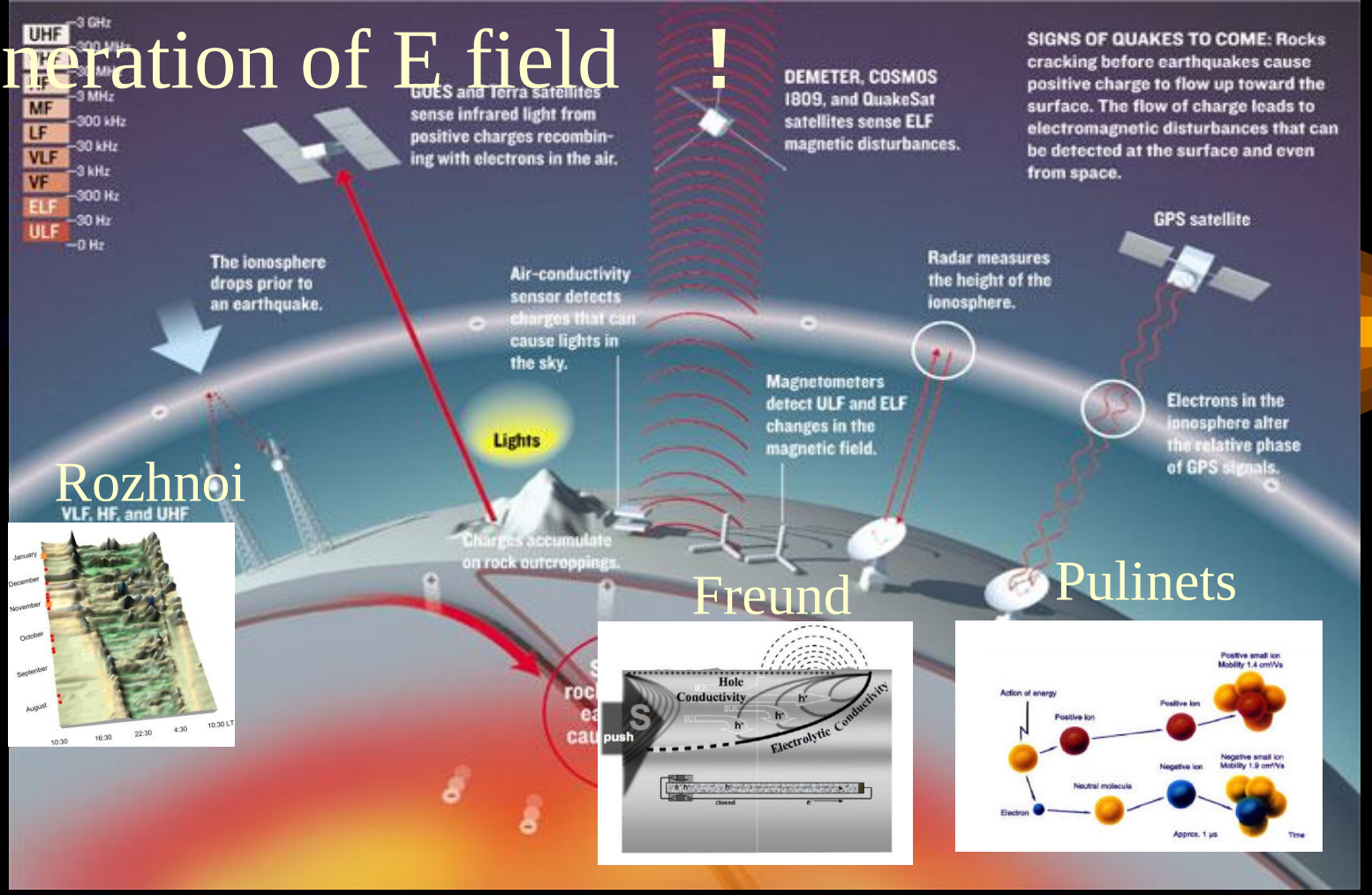
Concluding remarks

We studied two events which are possibly the precursor effect of the large earthquakes, by using by DE-2 satellite data.

When natural eastward electric field exists; two minima of ion (atomic and molecular) density(EIA, and PIA) appear at around geomagnetic altitude and epicenter. The minima of both ions start continuously appear 5 days before a large EQ. The reduction of [O^+] reached about 19 %. The disturbance region extends to roughly 70° both east and west in longitude , and about 20° to north and west from the epicenter for the earthquakes of M > 7. Natural E field is –2-4 mV/m for both EW and SN direction.

When natural electric field is weak; only one peak can be seen only near the epicenter. E field related to EQ is 0.1- 0.3 mV/m for both EW, and NS direction.

Generation of E field !



Rozhnoi

Freund

Pulinets

1. **Interior of the Earth, Positive Hole** 地球内部　岩石の圧縮によるホールの形成 **Freund et al., 2009**

2. **Radon Emanation**ラドン放射　クラスタ、雲による潜熱　**Pulinets et al, 2010**

3. **Atmospheris wave**大気波動による ダイナモ電場の変調　**Rozhnoi et al., 2008**　10-30 min の波長約2倍

1.Electric field (ac/d c) by Dr. Freund

Important thing is that you abandon your common knowledge which you have in your mind. Clue to solve the problem can not be found if you do not abandon common sense – T.Edisont大事なことは君の中に巣食っている常識という理性を綺麗さっぱり捨てることだ。もっともらしい考えの中に新しい問題の解決の糸口はないーエヂソン

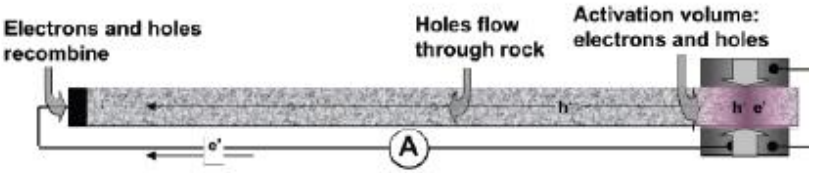


Figure 8b. schematic circuit of the battery current circuit.

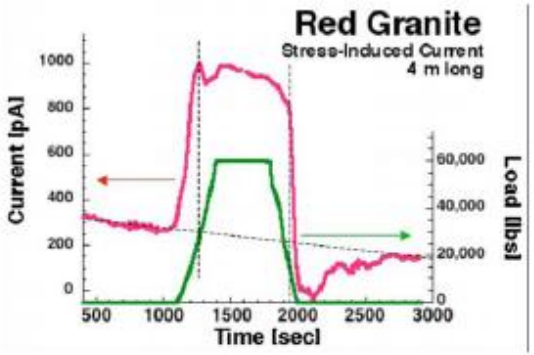
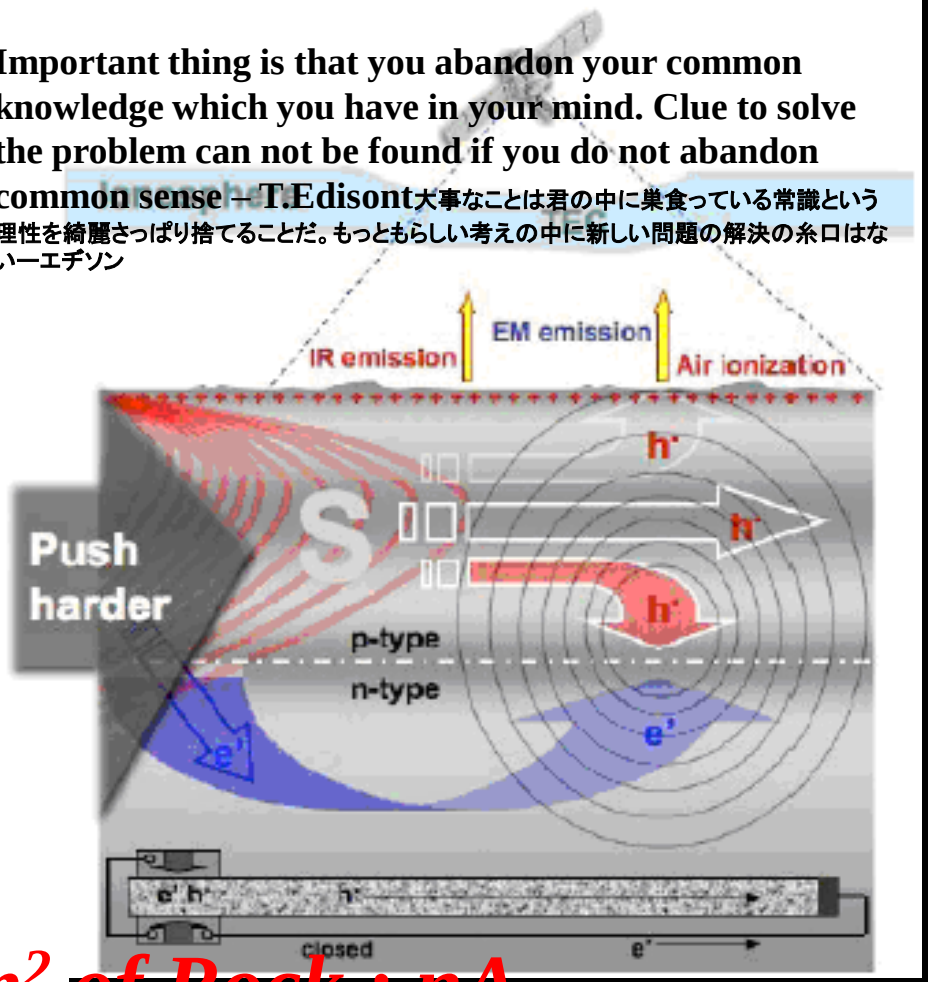


Figure 9. Current flowing through the 4 m long granite slab upon slowly loading to 60,000 lbs. (Dotted lines for aiding the eye.)



$1m^2$ of Rock : nA ,

$1Km^2$ produces 10^4-10^5 A A10cm立方の岩石が圧縮されるとnAの電流

→1km立方なら10,000～100,000A発生！

2. Modification of E field by Atmospheric wave 波動による

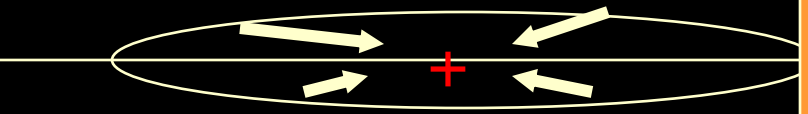
電場の変形of wind system in E region dynamo

Higher than 300 km

E field produce at 100km is conducted to higher altitude as well as conjugate point through magnetic line of force
磁力線を通じてより高い高度，
および
磁気共役点へ

Invention needs a lot of imagination and extreme amount of garbage – T Edison 発明するには豊な想像力とごみの山が必要だー トーマスエヂソン

Dynamo Region region －100km ダイナモ領域



Modification Waves modifies the wind system around Dynamo region

or

Wind pattern changes- and finally change electric field at 100km height 高度100km付近；波動による風系が変形する。その結果 電場が変形する

Morning (From W to East

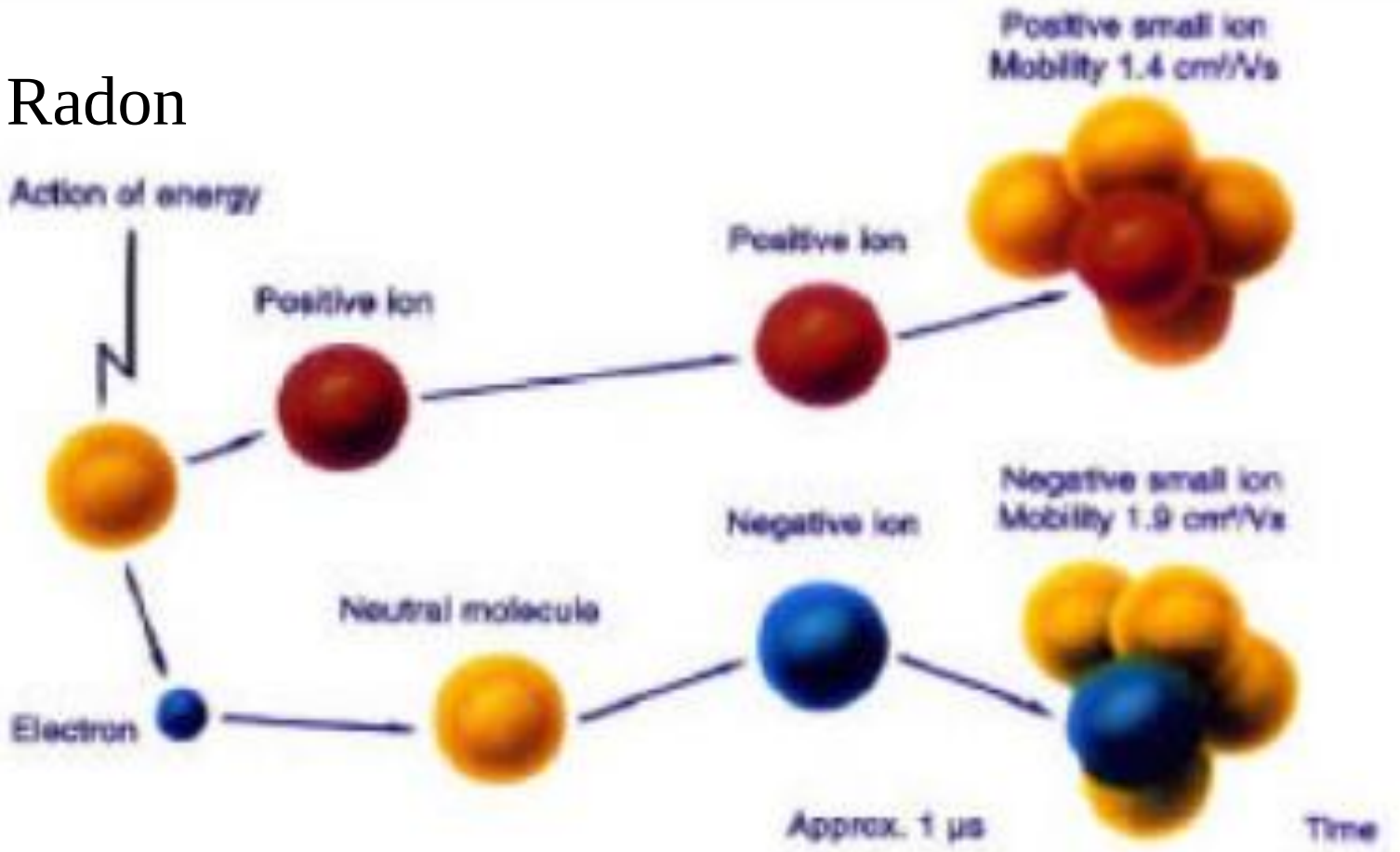
Evening(From West to E)

1.Wave produce d by Heating of atmosphere by such as latent heat, heated earth surface, **or**
2.Wave by mechanical vibration

3.Latent Heat Flux

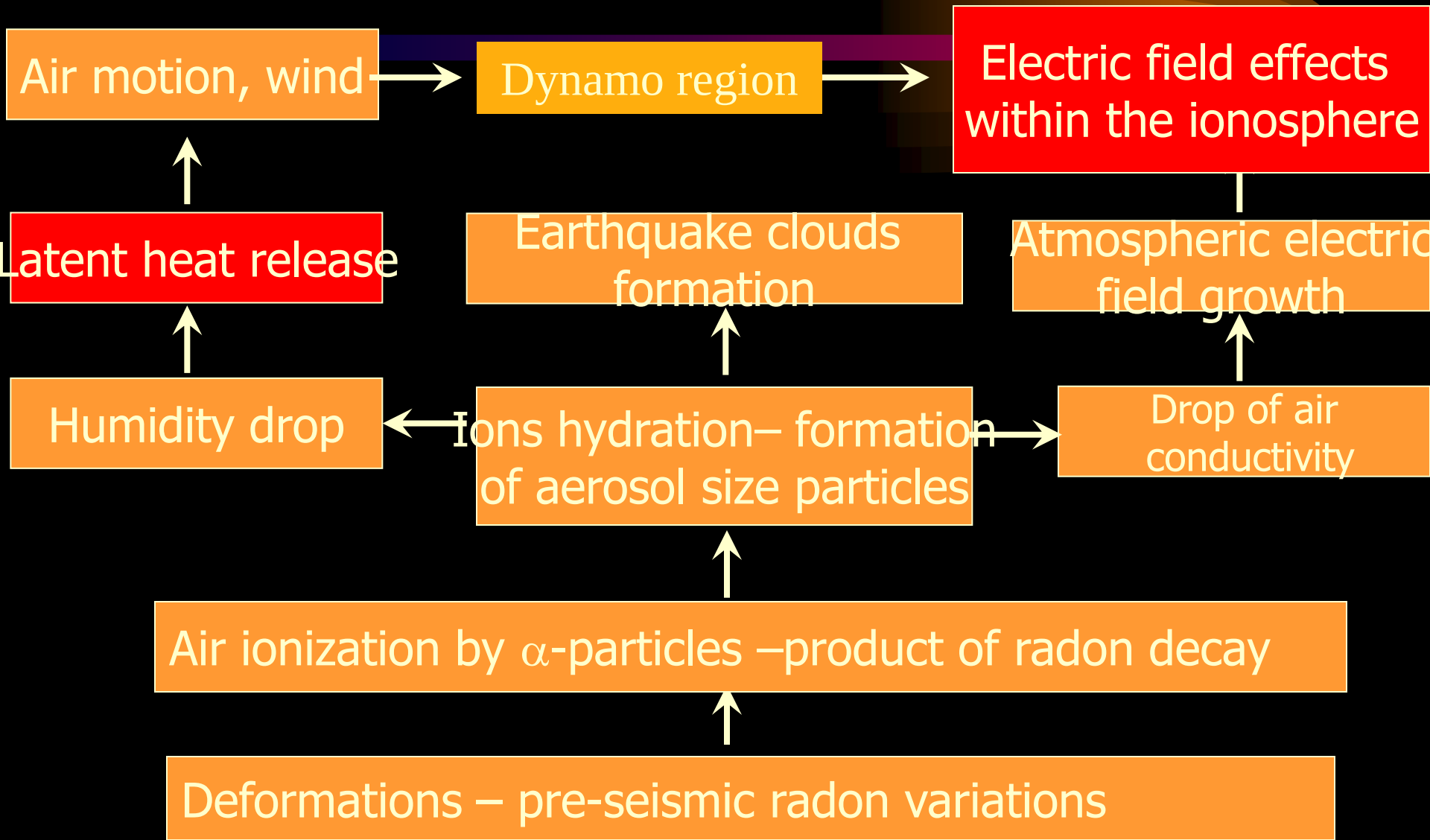
Hydrated cluster ions

Radon



How the heat is generated from Radon emanation ?
Courtesy Pulinets

Generation of heat and electric filed proposed by Pulinets



Contents about the effects of large earthquake

1. What is Ionosphere ?

2. Observation by satellite ; VLF, Plasma density, Infrared , particle precipitation

3. Observation by HINOTORI (Japan) and DE-2 (US) satellites

4. What modifies the ionosphere ? Electric field

5. Future works; Earthquake study satellites

Why do we need satellites which are purely dedicated to Earthquake study ?なぜ地震研究に特化した衛星が必要か？

1. Instrument should provide accurate and relaible information

測定器は安定でかつ精密なデータを提供できること .

1. **Ground based Instrument at many places is difficult to maintain the accuracy, and continuous measurement.** 2.**Reliable data is extremely few ; for Te, HINOTORI and DE-2**

2. Circular Orbit; If not, Global survey is impossible, and model construction is difficult. Most of the Current satellite, Not circular orbit /not low inclination/does not cover all LT全地球を楕円軌道でサーベイするのはモデル構築に時間がかかる

3. Wide area survey is needed*広範囲なサーベイ必要；大きな地震が及ぼす領域はきわめて大きい、

4. Events increased by satellite広範囲をサーベイすることによる件数の増加；

EQ of M=6-9 120/year, M=7-9M,18/year. M=6.0-6.9 の地震は毎年120個 、M=7.0-7.9 の地震 は 毎年18

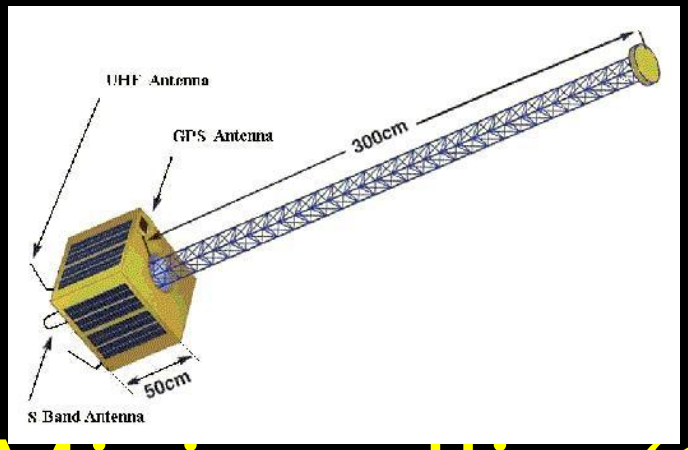
＊The instrument should be stable, and same performance. This task is almost impossible because fro maintenance you need a lot of enegy to travel, and time for the maintenance.動作が安定し、かつすべて同じ性能が同じである測定器を全世界に設置するのは現実には不可能である。もし出来たとしても維持に多大の費用と人力が必要。 衛星が時間、費用的にも安くなる

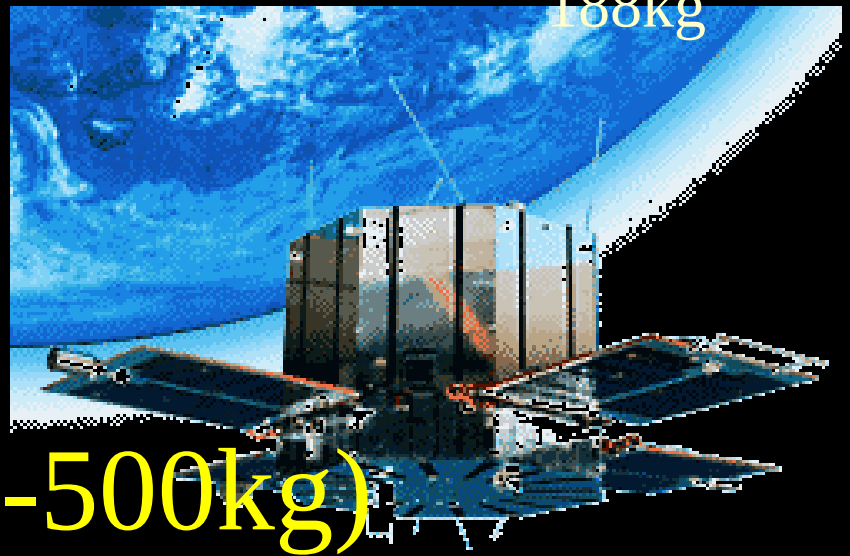
Proposal for Satellite mission for Earthquake studies (Low Inc, 5-600km)

Oyama et al., 2010)

One or two satellites/country 各国が1個の衛星を担当すること

Pico/ Nano/Micro satellites (10-200kg) should use commercially available part 民生部品を使うこと

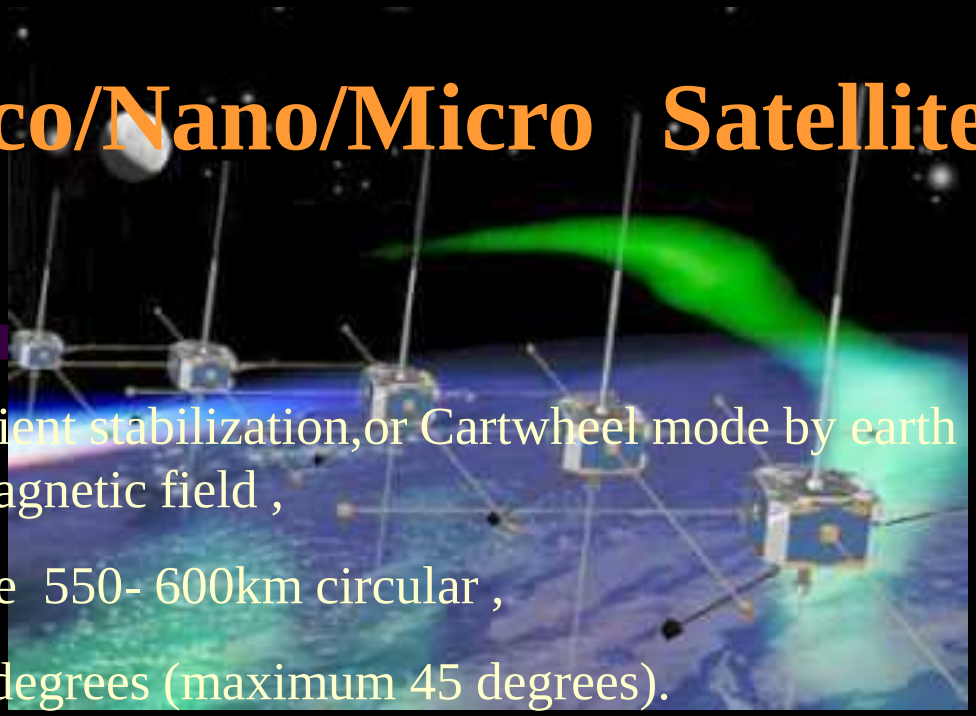




Mini satellite (100-500kg)

Constellation of Pico/Nano/Micro Satellites

Pico satellite



Weight; 3kg～50kg, Gravity gradient stabilization,or Cartwheel mode by earth magnetic field ,

Orbit altitude 550- 600km circular ,

Inclination: 30-40 degrees (maximum 45 degrees).

Science payloads(priority order): 1. Resonance Rec.Probe (Te), Impedance probe (Ne)*, 2. 2D Photometer (5577, 630nm) , 3. Solid state Energetic detector, 4. Search coil :

*Te /Ne probe should be the same .

Battery,solar cell,Telemeter transmitter,Command receiver, DPU, Magnetometer, Sun sensor , HK, Magnetic torquer, **RCS**

Mini satellite *1

1.Plasma probes*2,
2.2Dhotometer(ionosphere), 3.Lightning detector 4. 2D imager(Visible cloud observation) 4.VLF direction finding receiver, 5.Charged particle analyzer(from eV-keV)

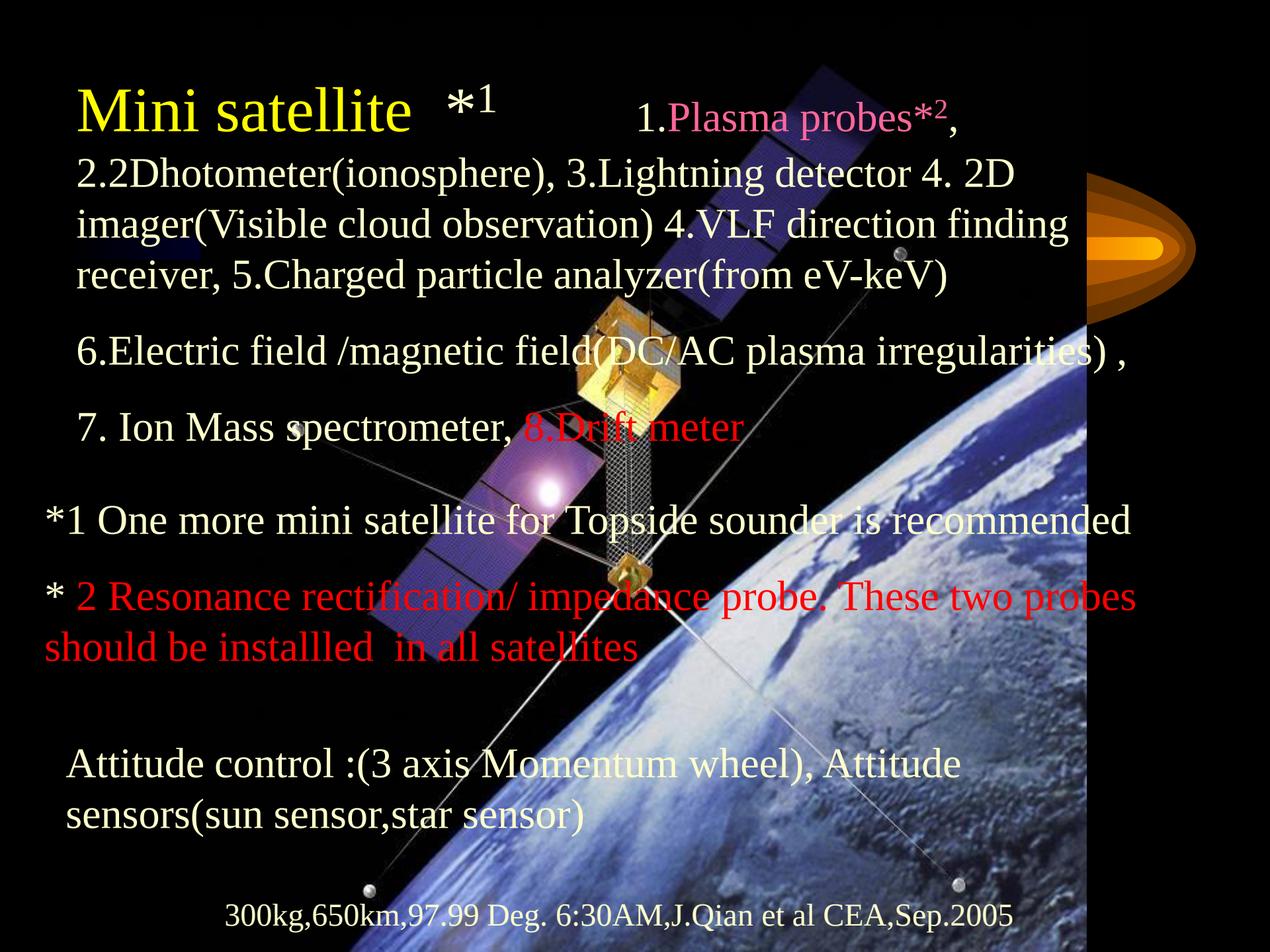
6.Electric field /magnetic field(DC/AC plasma irregularities) ,

7. Ion Mass spectrometer, 8.Drift meter

*1 One more mini satellite for Topside sounder is recommended

* 2 Resonance rectification/ impedance probe. These two probes should be installled in all satellites

Attitude control :(3 axis Momentum wheel), Attitude sensors(sun sensor,star sensor)



300kg,650km,97.99 Deg. 6:30AM,J.Qian et al CEA,Sep.2005

Concluding Remarks on Earthquake Research

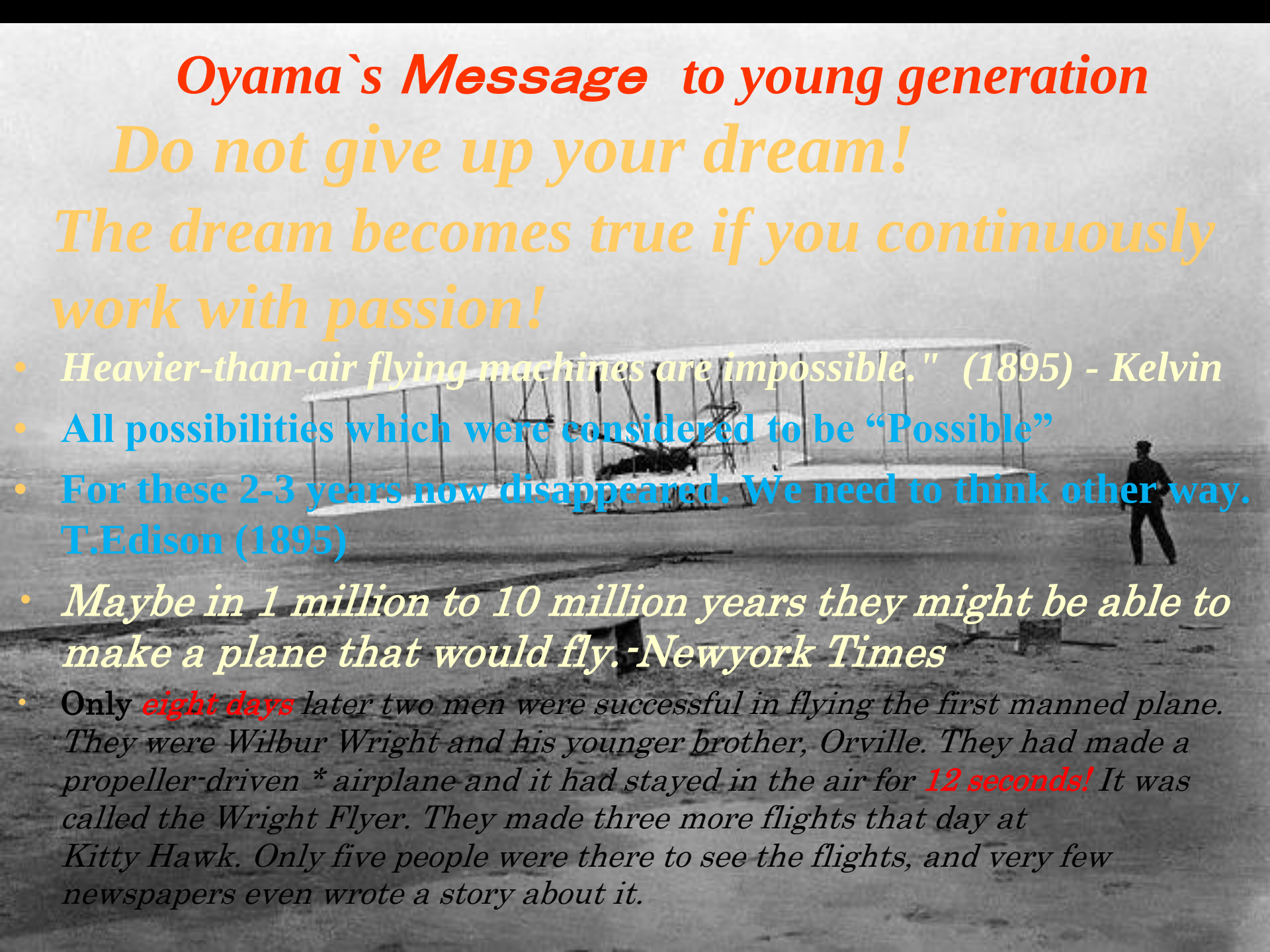
Ground and satellite data suggest that prior to some large earthquakes, ionosphere is modified. However the road to establish means of finding precursor features of large earthquake is still far, because of the data which we can use is extremely limited. Although we should make our maximum effort by using existing data, there is a limit of our efforts which can not be overcome. Collaboration to launch constellation of micro, mini, and small satellites among the countries suffering from earthquake disasters is essentially needed.

While effort is being made for satellite mission, collaboration with other fields (solid earth, meteorology, upper atmosphere) are strongly needed.

Oyama`s Message to young generation

Do not give up your dream!

The dream becomes true if you continuously work with passion!



- ***Heavier-than-air flying machines are impossible." (1895) - Kelvin***
- **All possibilities which were considered to be "Possible"**
- **For these 2-3 years now disappeared. We need to think other way. T.Edison (1895)**
- ***Maybe in 1 million to 10 million years they might be able to make a plane that would fly.-Newyork Times***
- **Only** ***eight days*** *later two men were successful in flying the first manned plane. They were Wilbur Wright and his younger brother, Orville. They had made a propeller-driven * airplane and it had stayed in the air for* ***12 seconds!*** *It was called the Wright Flyer. They made three more flights that day at Kitty Hawk. Only five people were there to see the flights, and very few newspapers even wrote a story about it.*

Ask not what America (your country) can do for you, ask what you can do for America (your country) ……..

Torch has been passed to a new generation.

J.F.Kennedy（1917－1963） Inaugural Address
Washington ,DC,January,1961

It is time for me to pass my torch to the new generation to launch the satellites in order to predict earthquakes

Thank you for your attending !!!!

End of the presentation

Left slides are appendix

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Friedman Freund

Freund et al, 2009 JASTP

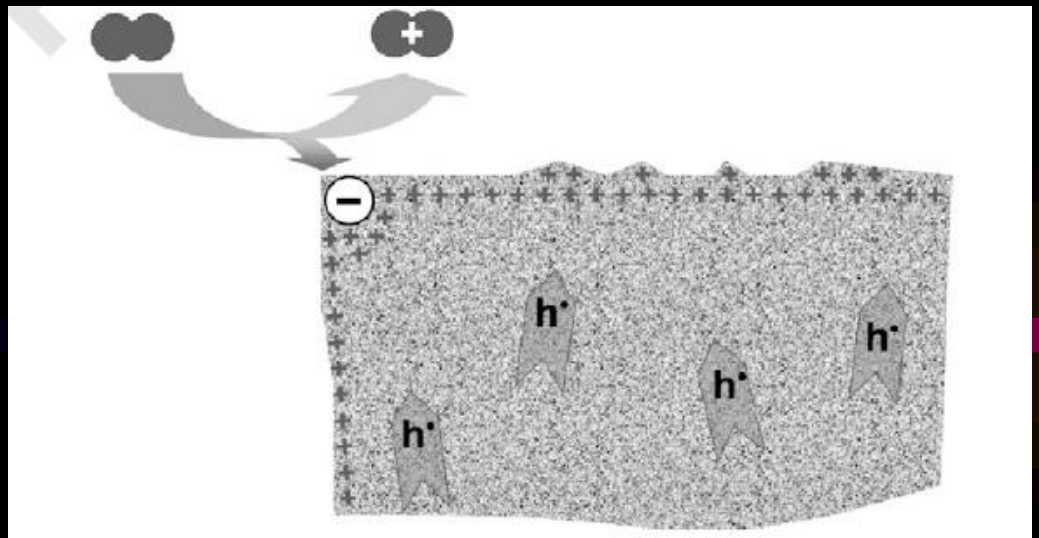
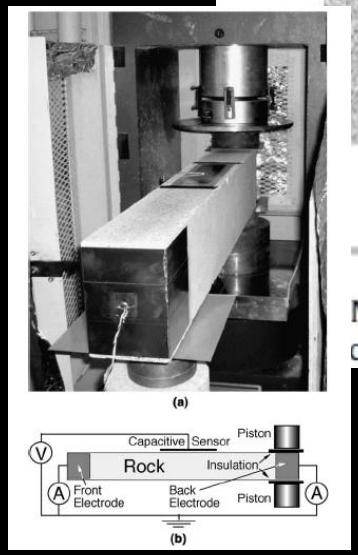
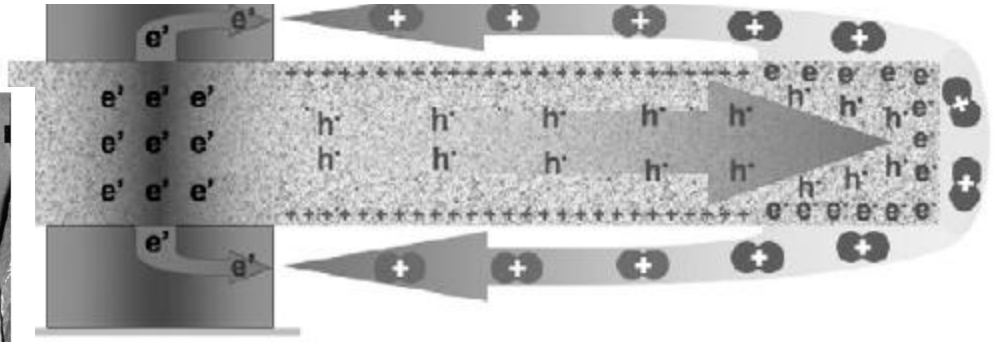


Fig. 9. Conceptual representation of field-ionization of air molecules at the rock surface, in particular at edges and corners, where the h• densities are highest and where the electric field will be high enough to extract an electron from a gas molecule.





Massive air ionization on the unstressed part of the rock will produce an current running through the air and closing the battery circuit.

Freund et al Physics and Chemistry of Earth 3,389-396,2006

Mission Strategy

1.Strong data analysis group should be organized from the beginning of the mission ;more money should be prepared for data analysis . Common program for data analysis

2.Coordination with ground based observations

Ionosphere:ionosonde,GPS,VLF ,HF Doppler,Magnetometer Meteorology: lightning ,cloud analysis

..continued

3. Data should be opened to world communities from the beginning of the data acquisition

4. Space Education , small transmitter ,and/or data distribution by internet to high schools

Thermal anomaly

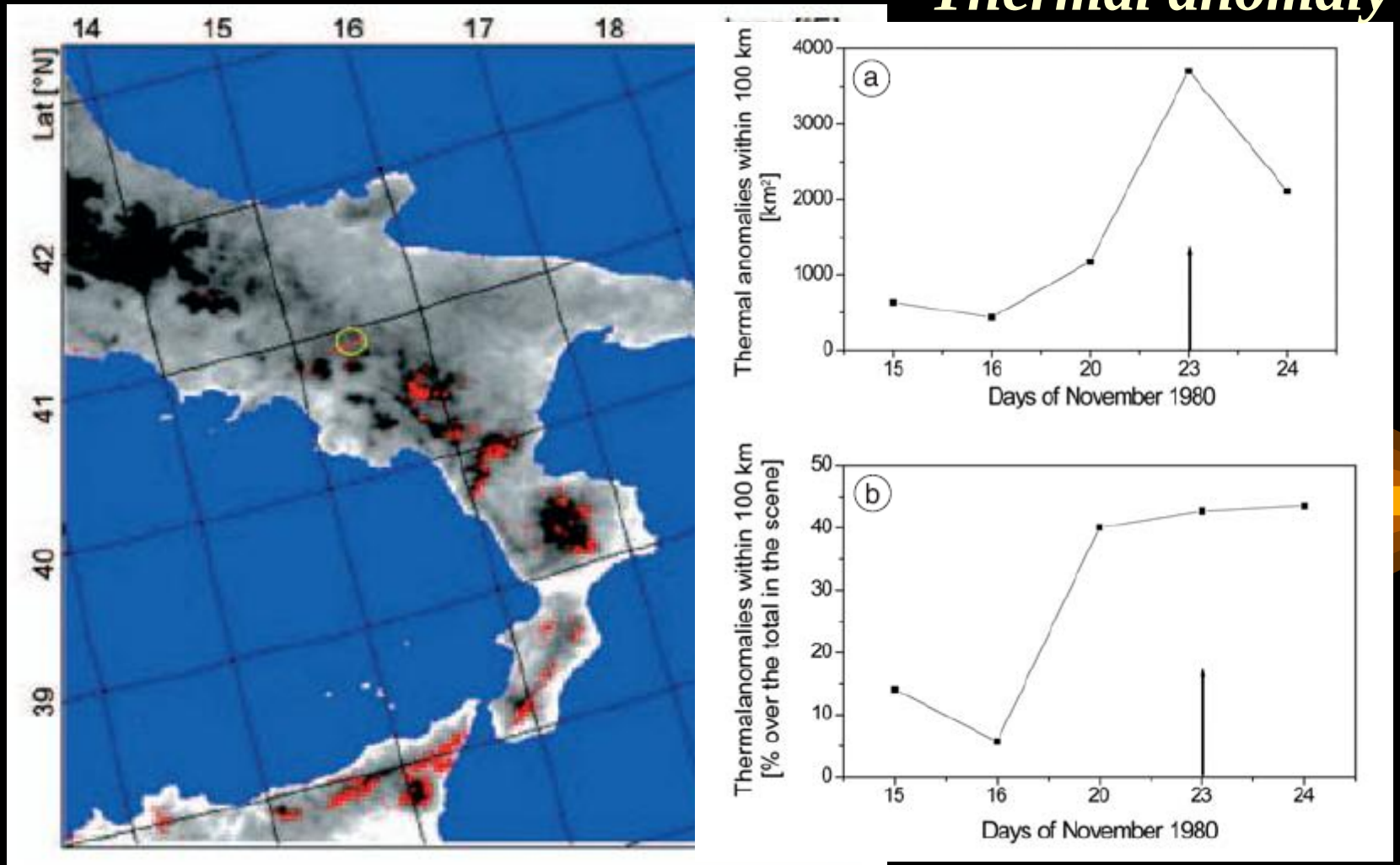


Fig. 3. Irpinia-Basilicata earthquake (M_S=6.9, November, 23, 1980, 7.32 p.m.): analysis in the temporal domain over the extended study area for November 1980. Thermally anomalous area is depicted with dots. The circle represents the epicentral zone (from Tramutoli *et al.*, 2001).

Irpinia-Basilicata EQ(Ms=6.9)

Pulinets et al.,Ann Geophys,50,2007

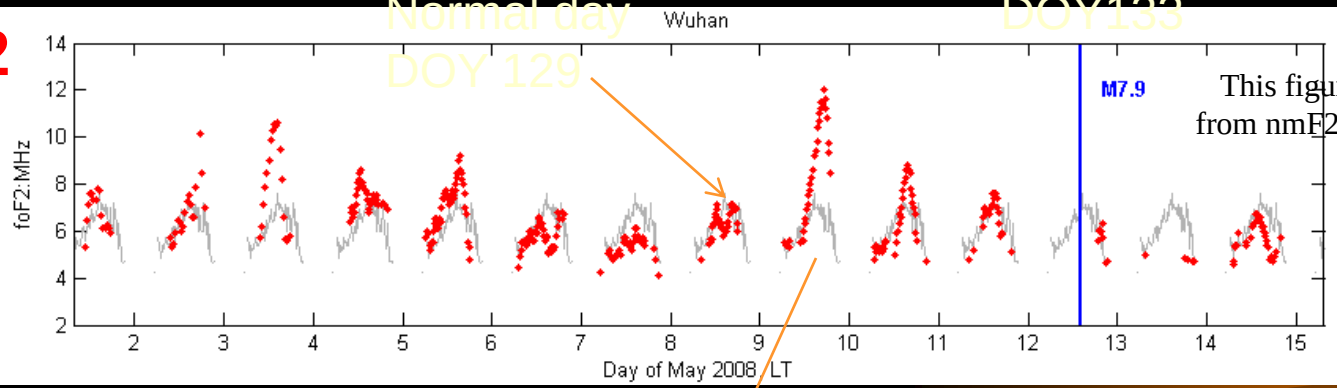
DOY130

Normal day

DOY133

DOY 129

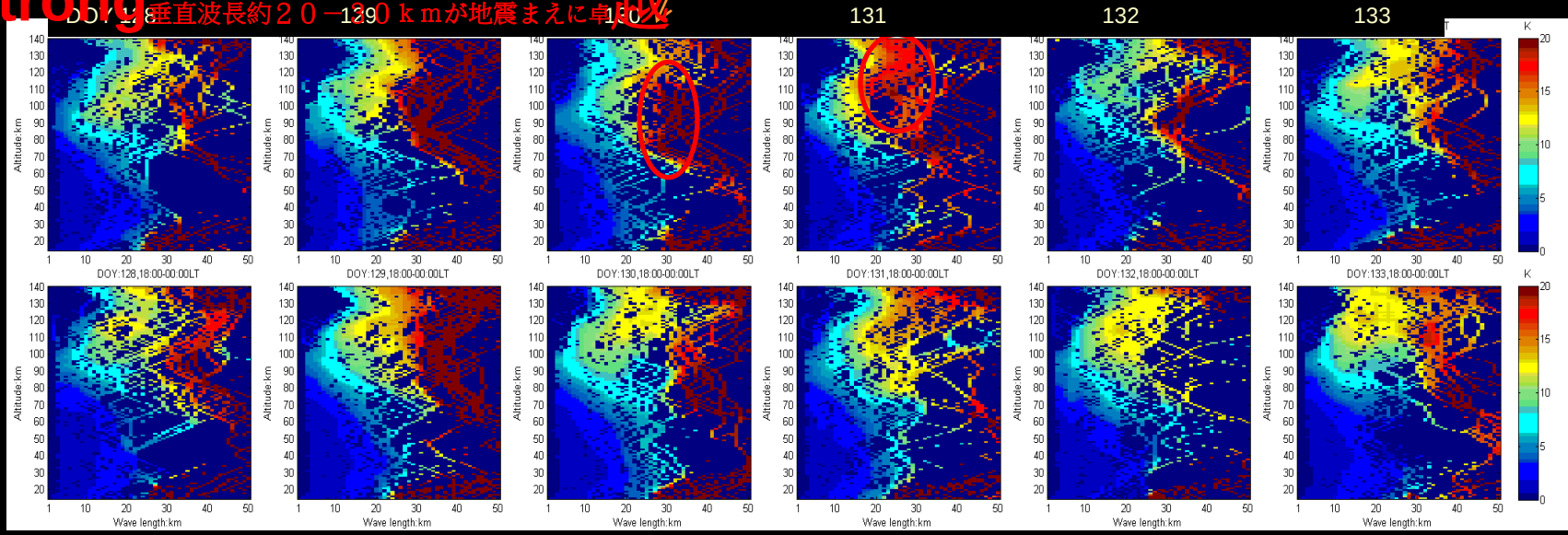
foF2



This figure is taken from nmF2,Zhao et al

Vertical wave signatures, wavelength: 20-30 km become dominant at – 100 Km. Sun et al, 2011, wind seem to become strong

垂直波長約２０－３０ｋｍが地震まえに卓越



TIMED/SABER temperature profiles.

The figures are the dynamic spectra of amplitude in wavelength-altitude domain.

Sun et al.,2011・，

Pico/Micro Satellite Constellation

Weight; about 5kg-50kg, Gravity gradient stabilization, or spin stabilization with magnetic torquer(20rpm/sec) ,

Orbit altitude 600km circular ,

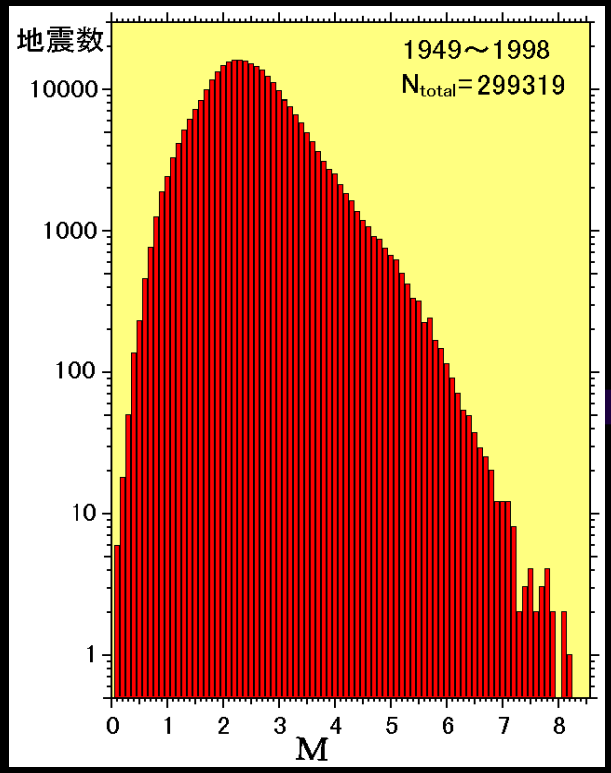
Inclination: 30 degrees (maximum 35 degrees).

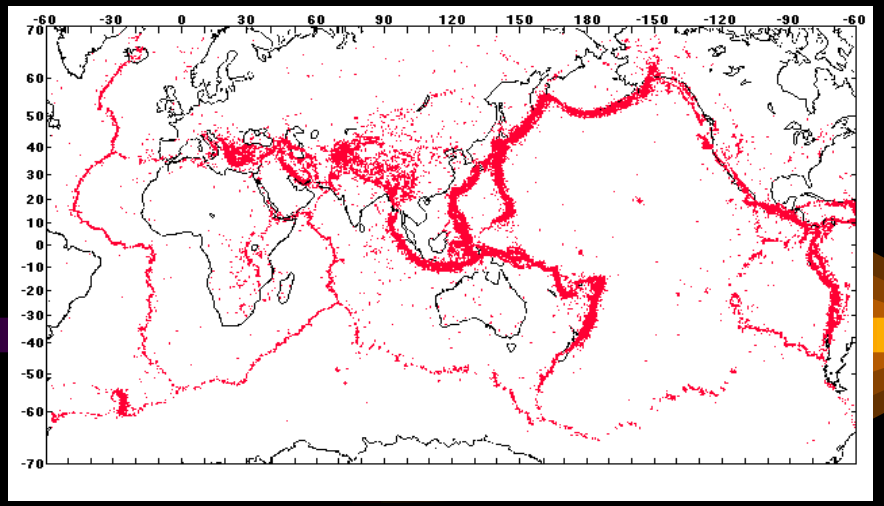
Science payload(priority order): 1. Resonance Rec.Probe(Te),Impedance probe(Ne)*, 2. 2D Photometer (630nm) 3. Search coil 4. Solid state Energetic detector, :

*Te /Ne probe should be the same .

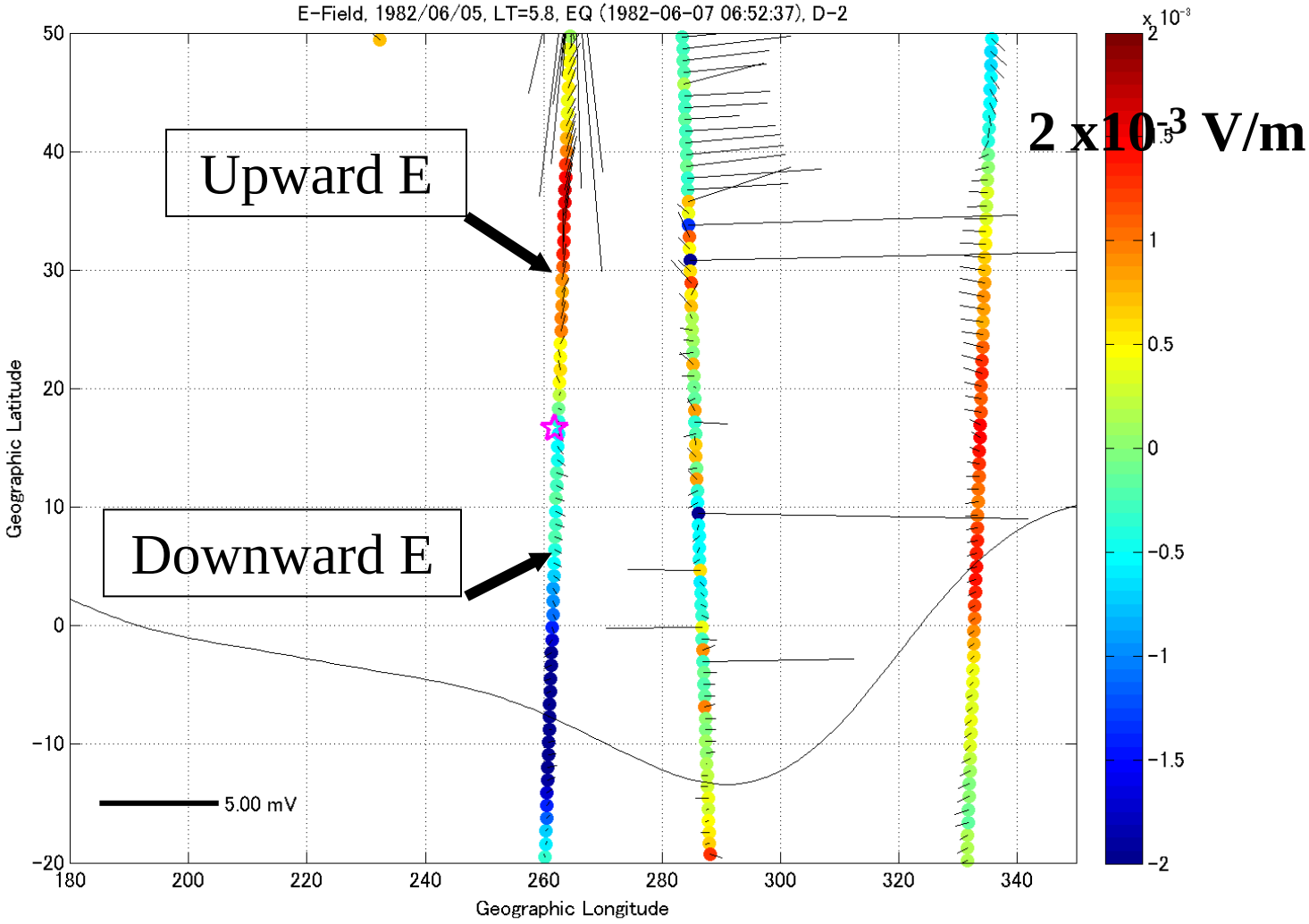
Battery, solar cell,Telemeter transmitter, command receiver, DPU, Magnetometer,sun sensor , HK, magnetic torquer

Gutenberg-Richter law





EQ of M=6-9, 120/year,
M=7-9, 18/year



June 7 EQ: E field 1982 06/05 D-2 along satellite paths, calculated from plasma drift velocity

Lord Kelvin (1895)

All possibilities which were considered to be “Possible” now disappeared. We need to think other way.

T.Edison (1895)

Human beings can not fly for these 50 years

From Wilver Wright(Elder) to Oliver Wright (1901)

Airplane flew in 1903 !

To launch the satellites and prediction of earthquakes will surely become possible in the near future if we continue the effort with passion.

People reaches the stage that It is no longer possible to think the idea, and give up., although the game starts from that point. Our fault is to give up. Clear means for the success is to challenge one more time. YT.Edisonもうこれ以上、アイデアを考えるのは不可能だというところまで行き着き、そこでやる気をなくしてしまう。勝負はそこからだというのに。我々の最も大きな弱点はあきらめることである。成功する一番の近道は常にあともう一度だけ挑戦してみることである。トーマス・エジソン

Thank you for your attention

Energetic Particle Precipitation before Earthquakes

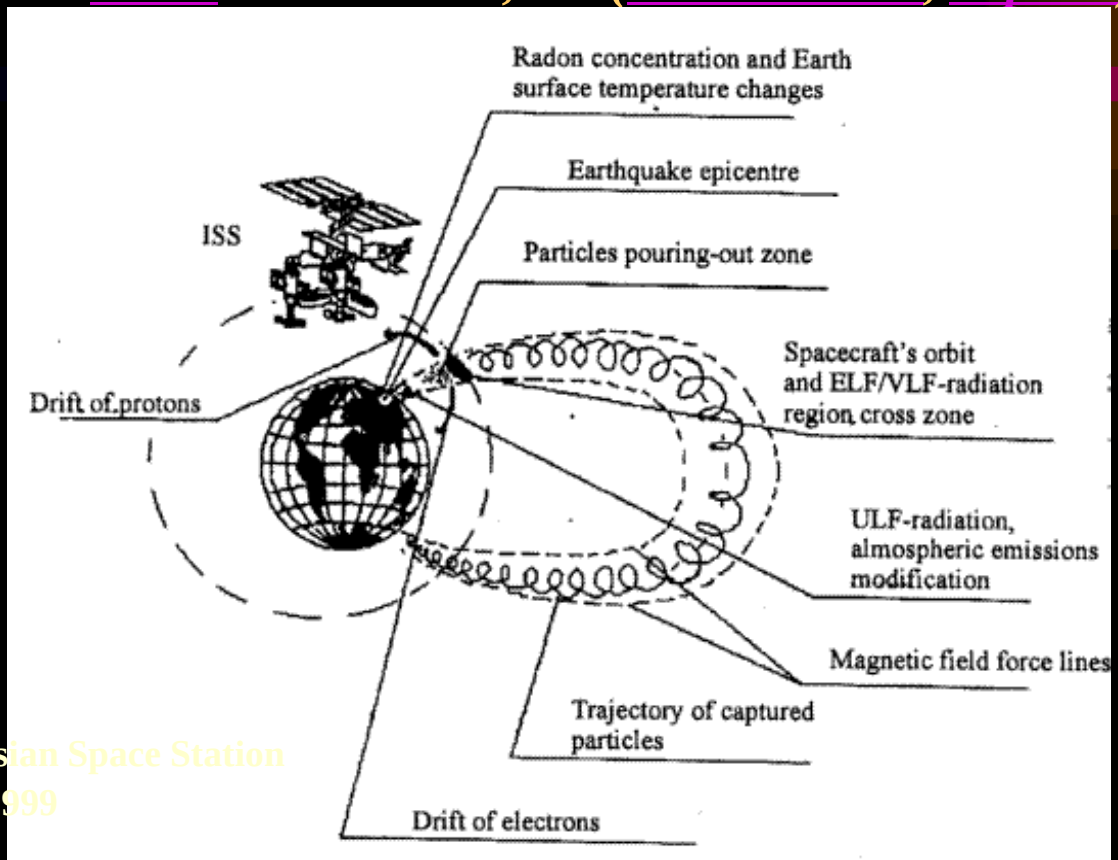
Aleksandrin et al., 2003

Ann. Geophys., 21, 597-602, 2003

www.ann-geophys.net/21/597/2003/

**** Ongoing monitoring:***

Arina/Resurs-DK1, ISS(LAZIO-Sirad, Vsplesk)



Utkin, Russian Space Station Program, 1999

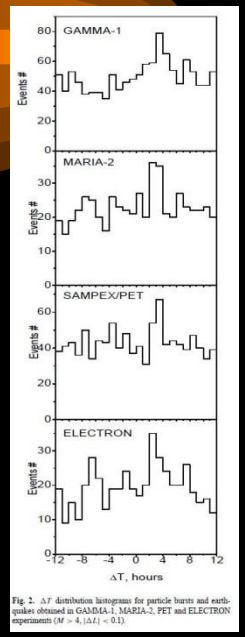


Fig. 2. ΔT distribution histograms for particle bursts and earthquakes obtained in GAMMA-1, MARIA-2, PET and ELECTRON experiments ($M > 4$, $|\Delta L| < 0.1$).