Tools for Earth Observation/Remote Sensing for Disaster Menagement and Emergency Response

A Case Study
Earthquake Prediction

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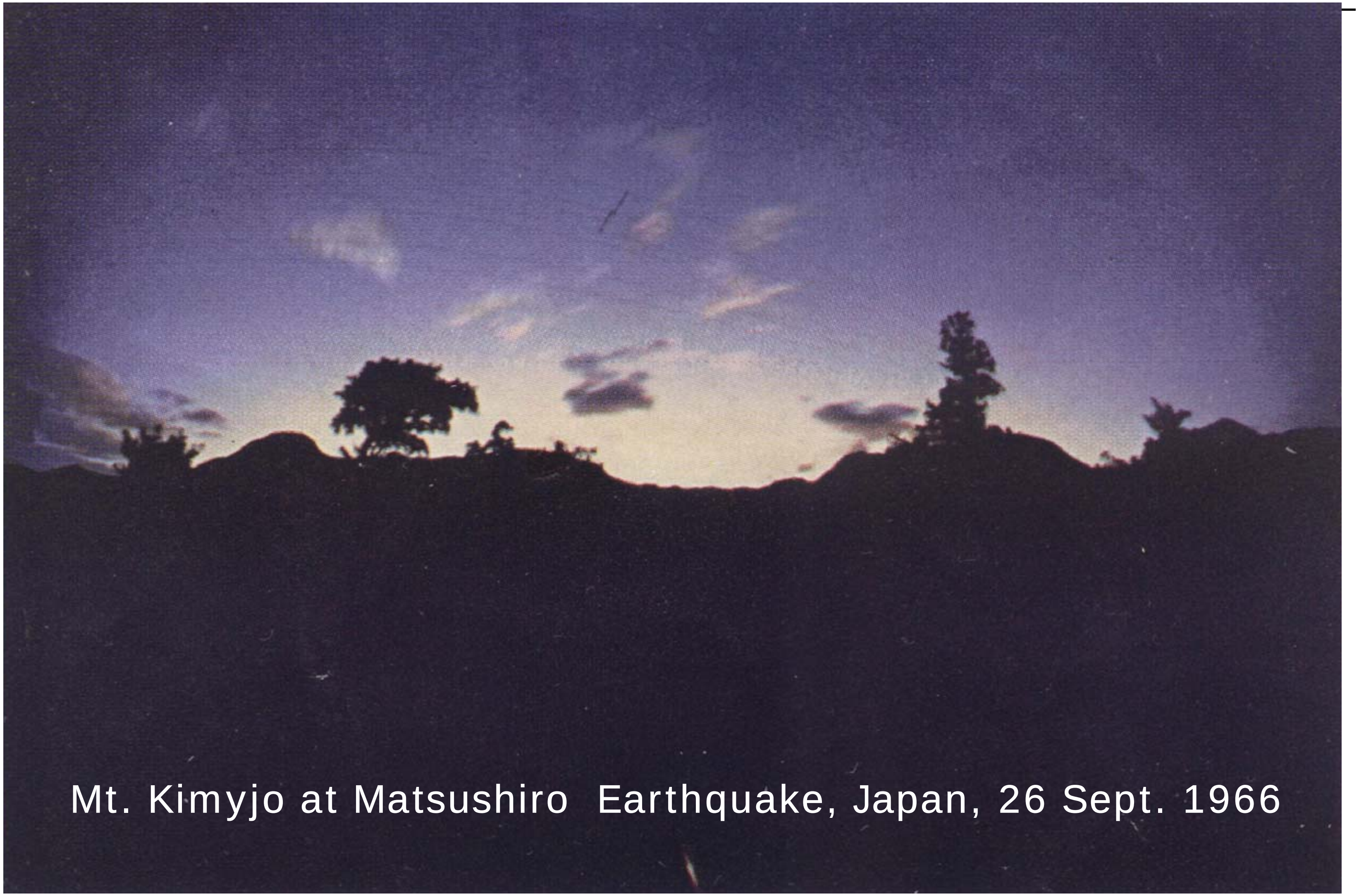
Are there earthquake indicators?

- Aqoustic waves cause radio emission in ionosphere near epicenter region ???
- Water and surface heating ?
- Atmospheric lightening ?
- Radon gas emission contributes electron content of the atmosphere?
- The Earth Electrical Field anomalies (Ez) in Z directions?

Atmospheric Lightening

- **Yashui (1968, 1973) reported that total eight earthquake occurred in Japan between 1965 and 1967. During these earthquakes, the earth atmosphere had been illuminated (like a lightening) by the earthquake at least for 10 seconds.**
- **These illuminations appeared to very close to the epicenter of earthquake.**
- **Corliss (1982) collected this kind of activities in a catalogue.**
- **Recently, a lot of paper published about the eathquake lightening by different researchers.**
- **It is proposed that during the earthquake the broken rocks under the earth crust produce piezoelectric shocks in the atmosphere resulting atomic excitation and electrical de-charge and then the earth quake lightening occurs.**

Lightening During An Earthquake



Mt. Saijo at Matsushiro depremi, Japan, 12 Feb. 1966 (Yashui Y., 1968)

Jizotoge, Matsushiro Earth quake, Japan, 4 Dec.1965 (Yashui Y., 1968)

(1) 4 second after beginning

(2) 6 sec. after

(3) 8 sec. after

(4) 10 sec. after

(5) 11.5 sec. after

(6) 13 sec. after

(7) 14.5 sec. after

(8) 16 sec. after

Acoustic Waves at Ionosphere and the Earth Surface Heating

- Gorbatikov et al. (2002) claim that they measured acoustic waves as an indicator for pre-seismic activities.
- Pre-seismic activities heat water up to 6 c depending the magnitude of earthquake (Sigusaki et al., 1996).
- Before the 7.8 magnitude earthquake in Tangshan and Haiheng (China), Wang and Zhu (1984) surface temperature increased 5 c.

Reason :

- IR energy absorbed by CO2, CH4 and water molecules during pre-seismic activities than increase temperature of the surface and other under surface liquids.

NOAA/AVHRR IR Satellite Observation

- NOAA/AVHRR IR Satellite detects surface temperature with 0.1 C sensivity (Gorny et al., 1997, Qiang et al., 1999, Tronin et al. 2002).
- It is claimed thad surface temperature increased atleast 3 C within 100km circle 7 days before than an earthqueke if magnitude is greather than 5 magnitude.

Radio Emission from ionosphere

- **Parrot (1995), Karasev et al.(1953), Parkhomenko and Martyshev, (1975), Mizutani et al. (1976), Nitsan (1977), Ishido and Mizutani (1981), Gokhberg et al. (1982) claimed that radio emission from Hz to MHz (ULF, VLF and HF) received from ionosphere near the epicenter region of earthquekes (Cosmos – 1809 sat. observation).**

Radio Emission from ionosphere

- **Gokhberg et al.** (1982) claimed that he measured radio emission at 27 kHz, 1.63 MHz ve 385 KHz frecancy around the epicenter of the Iran earthquake in 16 th Sep. 1978 just before 45 min the earthquake occurs.

GOKHBERG ET AL.: ELECTROMAGNETIC EMISSION AS EARTHQUAKE PRESAGE

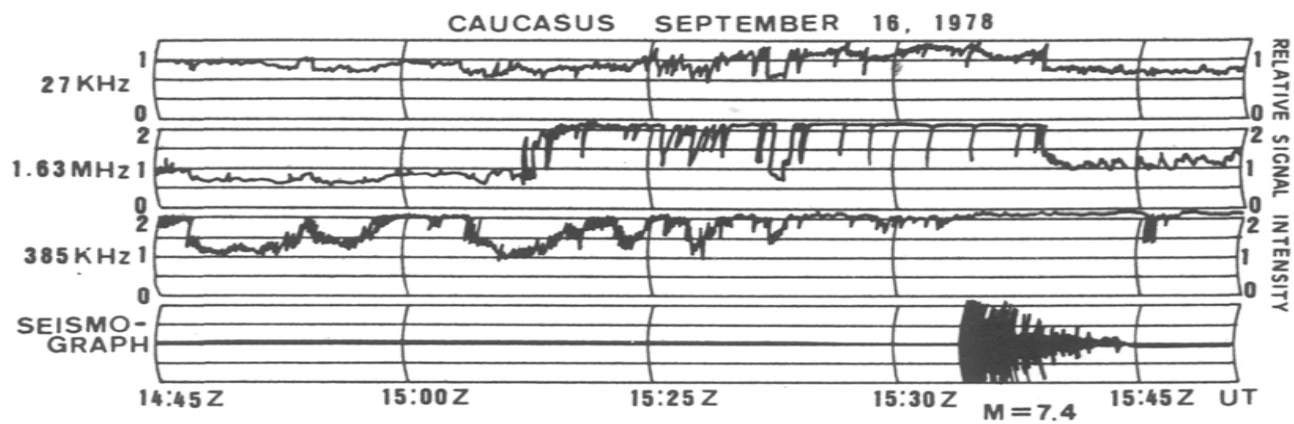


Fig. 1. Electromagnetic noise levels at frequencies of 27 and 385 kHz and 1.63 MHz and the record of seismograph observed between 1445 and 1550 UT on September 16, 1978, at Caucasus, USSR [*Gokhberg et al.*, 1979].

Radio Emission from ionosphere

- **Gokhberg et al. (1982), claimed that he received radio signals at 81 Khz from** Kyoto, Japan (Mart 31, 1980) 1.5 hours than the earthquake.

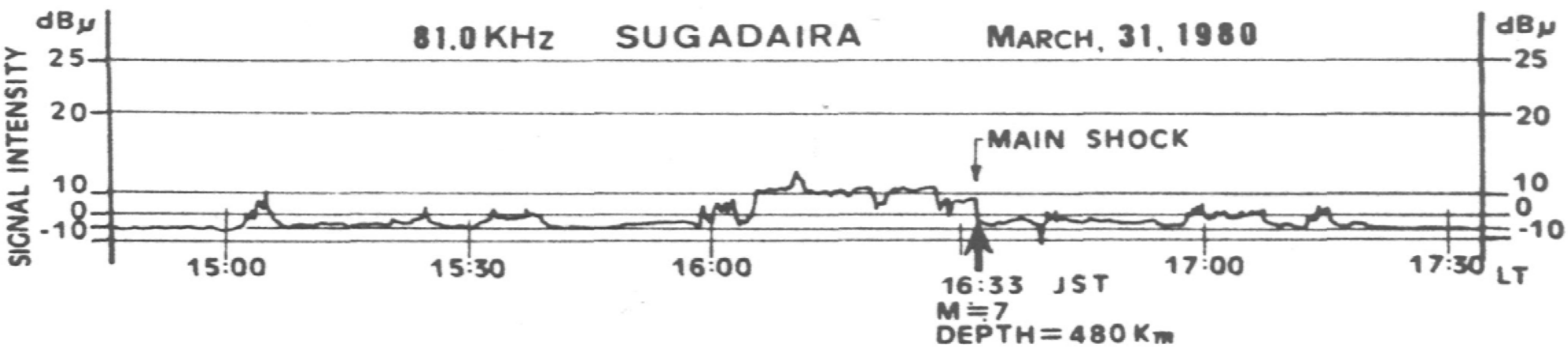
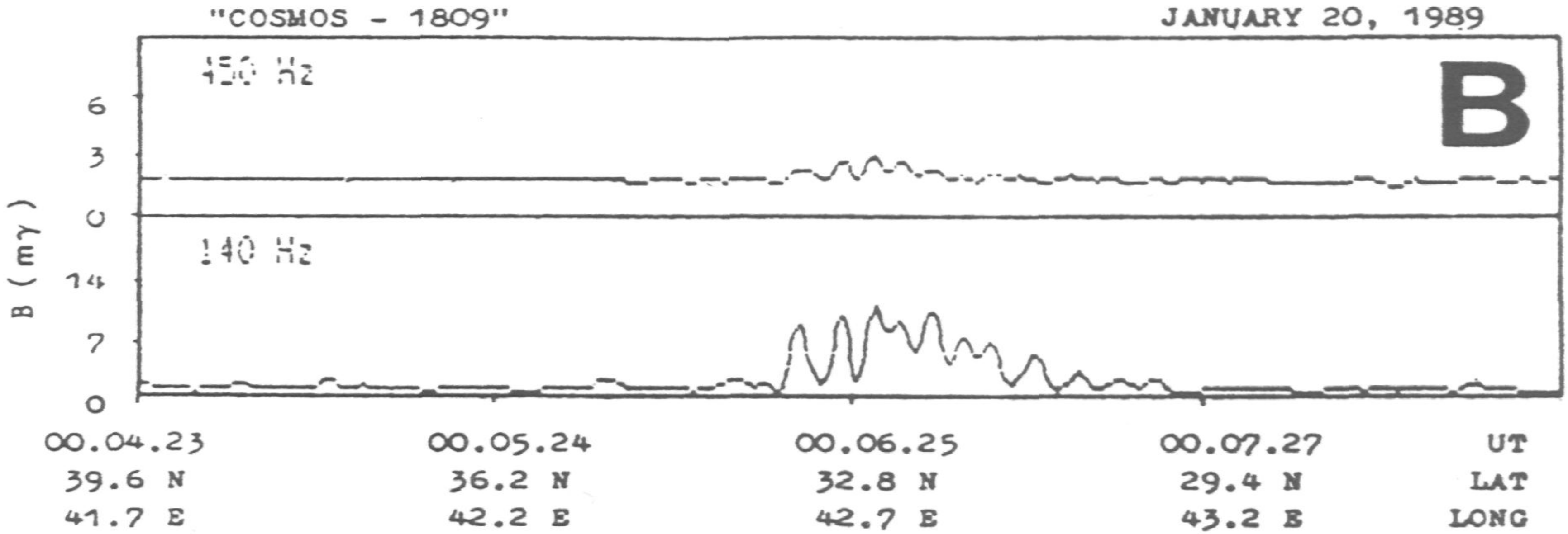


Fig. 3. Electromagnetic radiation level at frequency 81 kHz at 1633 JST (0733 UT) on March 31, 1980, observed at Sugadaira Space Radiowave Observatory.

Cosmos 1809 Satellite Observations

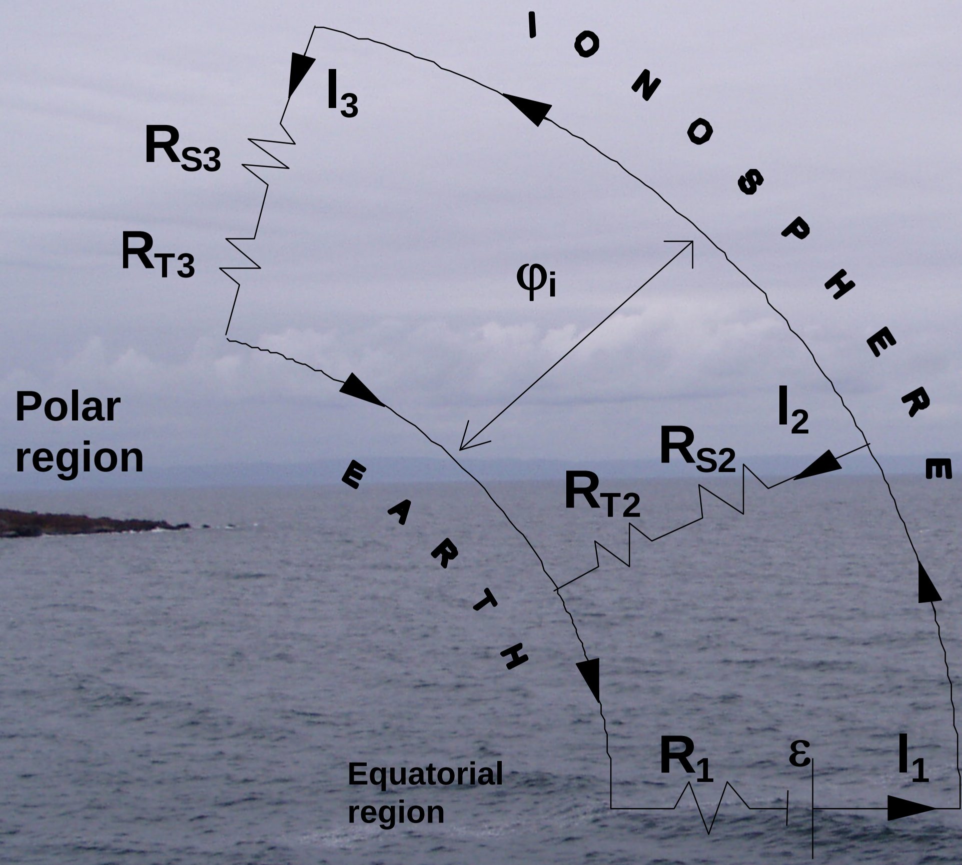
Chmyrev et al. (1997) measured ionospheric activity using Cosmos 1809 satellite at 140-150 Hz for 3 months before than Ermanian Earthquake in 1989 .

Cosmos-1809 satellite measured radio activity near the epicenter of the earthquake near spinak region of Armenia in 1989 (Serebryakova et al., 1992).



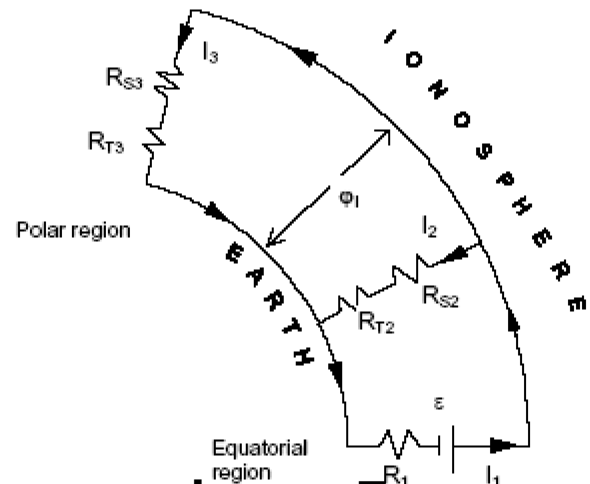
Atmospheric Electrical Circuit

(Tinsley, 2000)



Atmospheric Electrical Circuit Variation(Ez)

- Milne (1985, 1990) at all.recognised electrical activity in the atmoshphere near the surface and epicenter of the earthquakes before then seismic activity.
- But, they could not recognize the reason of electrical changes if it is sismic activity or volcanic activity, or thunderstorms etc.



$$jz = \sigma Ez,$$

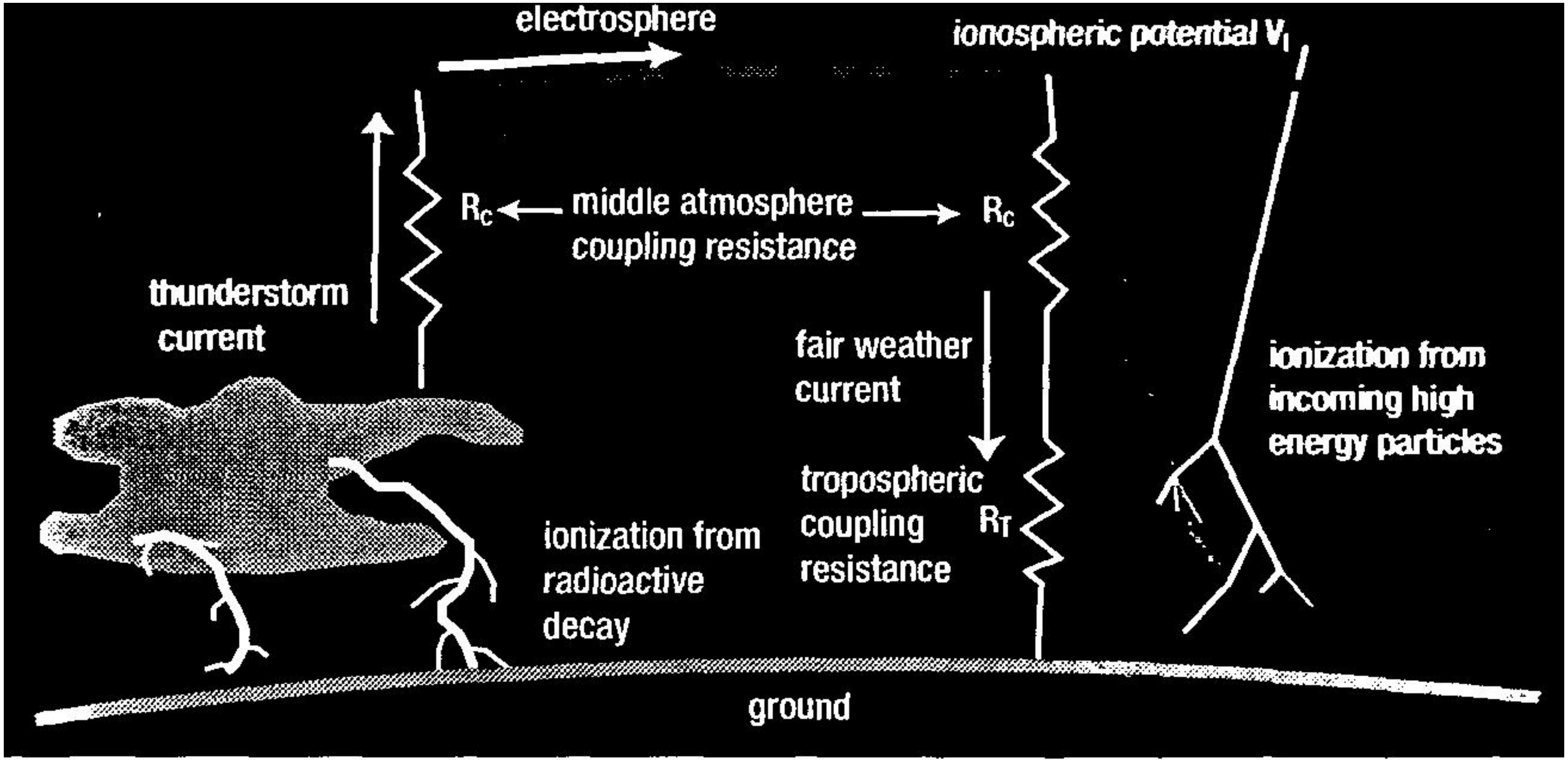
$$R_{T,S} = \int_L^H \sigma(z)^{-1} dz$$

$$jz = \varphi i / (RT + RS).$$

$$Jz = 1\text{-}4\ mA/m^2$$

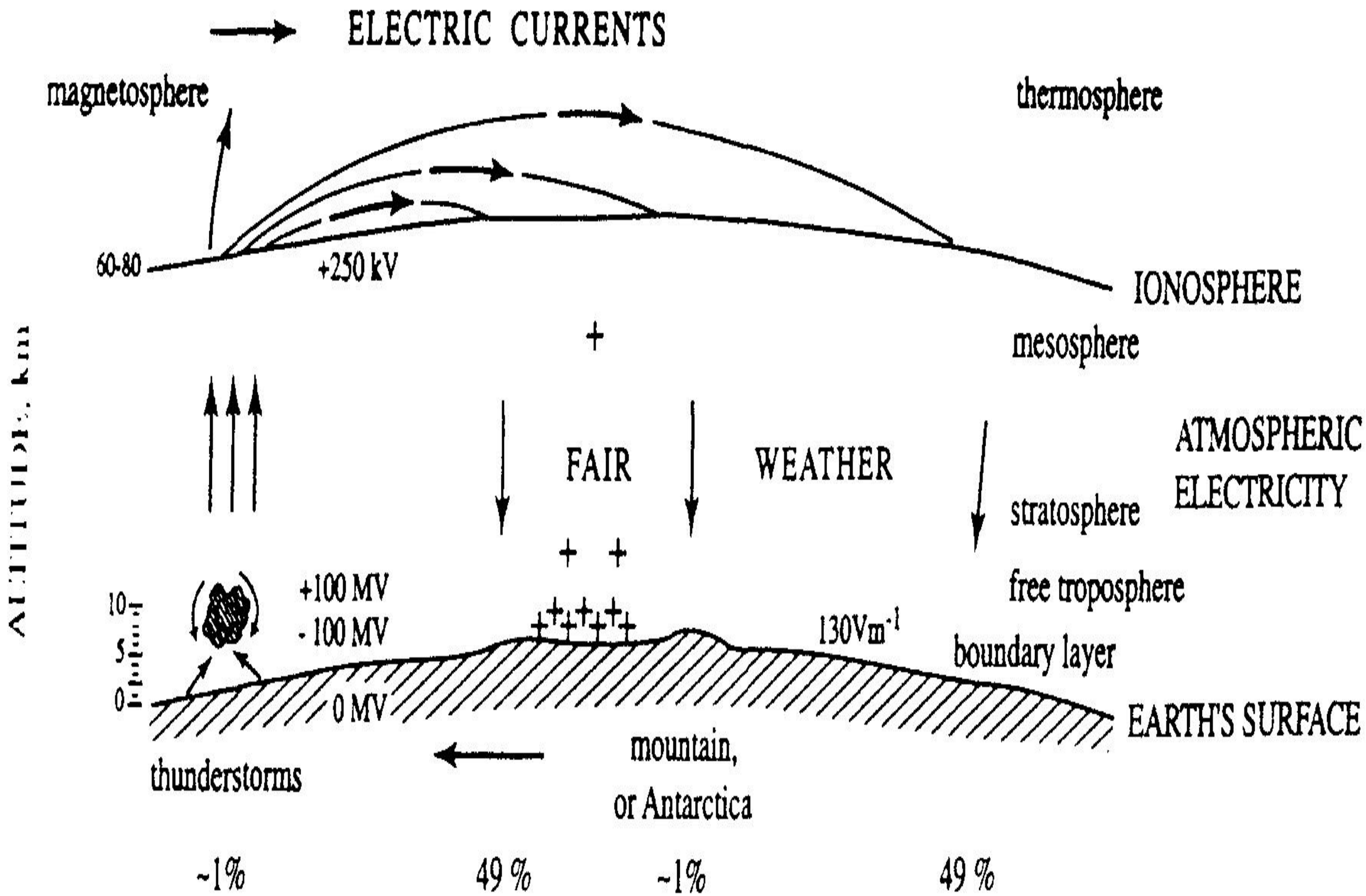
Jz : Vertical electrical current density

Global Electrical Circuit



. The main global electrical circuit. Thunderstorms drive the currents to the highly conducting electrosphere while the fair-weather current balances the circuit. Ionization from radioactive rocks and incoming energetic particles greatly enhance the conductivity of the air. (Adapted from MacGorman and Rust 1997.)

Global Electrical Circuit



Rycroft et al., 2000

Ionosphere and Space Interaction

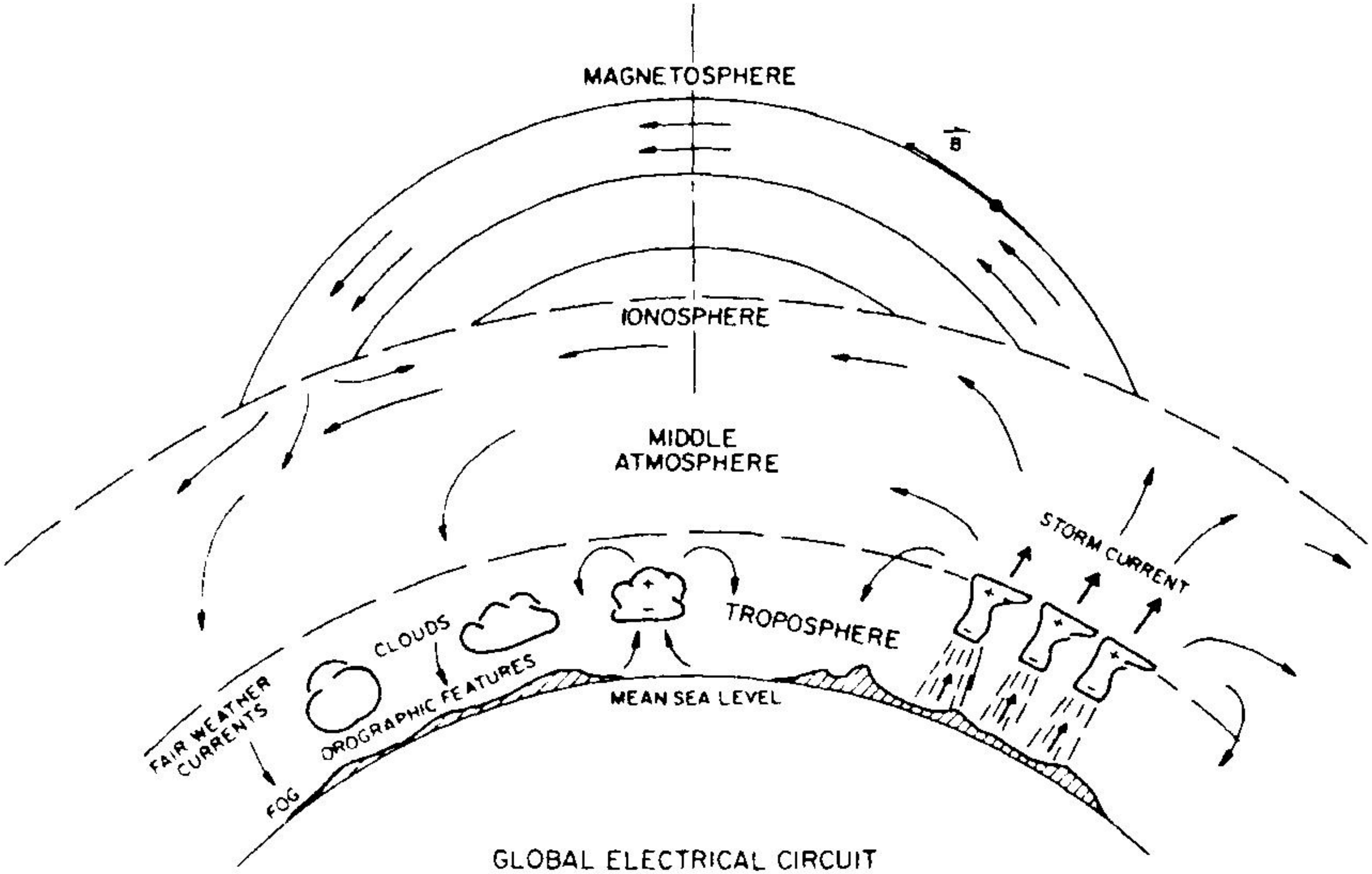


Fig. 1.22 Schematic presentation of the global electric circuit (After Roble and Tzur 1986)

Atmospheric Conductivity

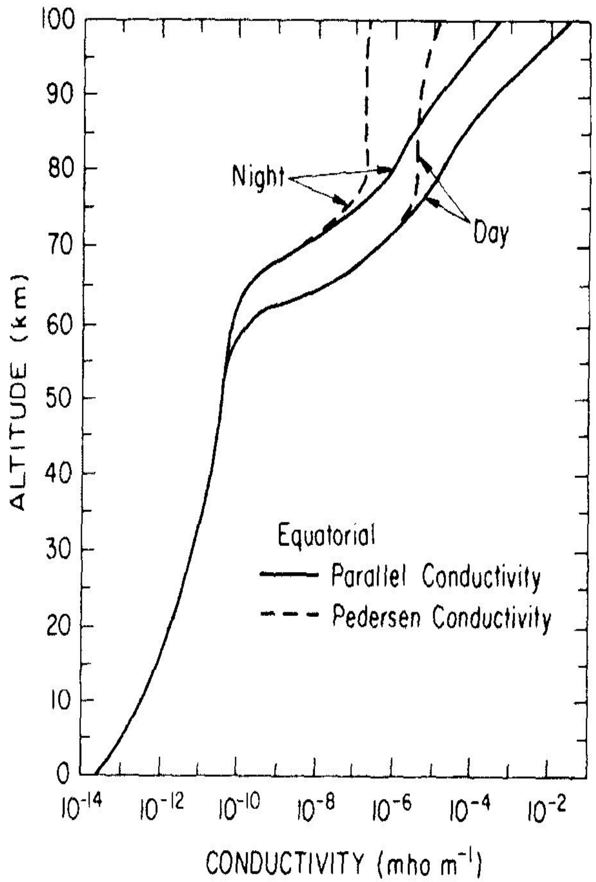


Fig. 1.23 The day and night atmosphere conductivity height profiles in equatorial phere (after Tzur and Roble 1985)

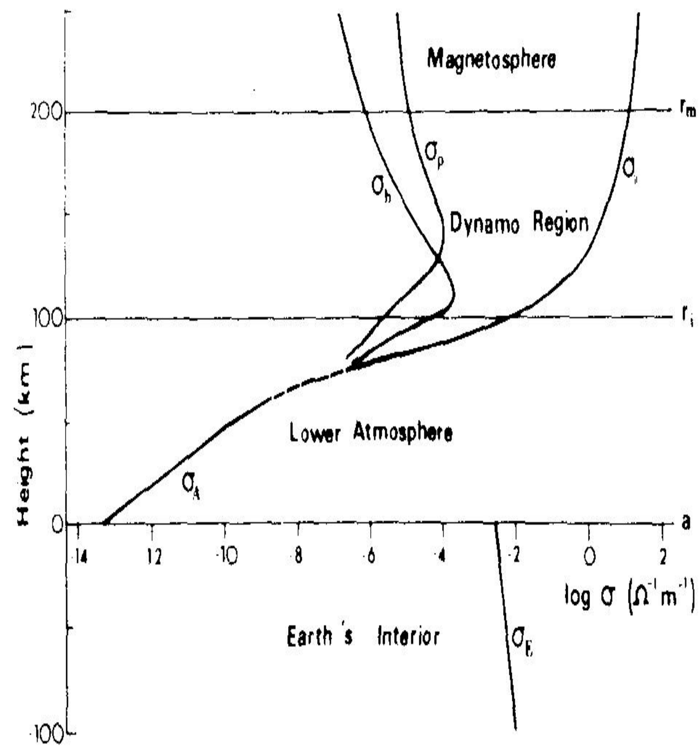


FIGURE 3. Mean altitude profile of electric conductivity.

Atmospheric Conductivity

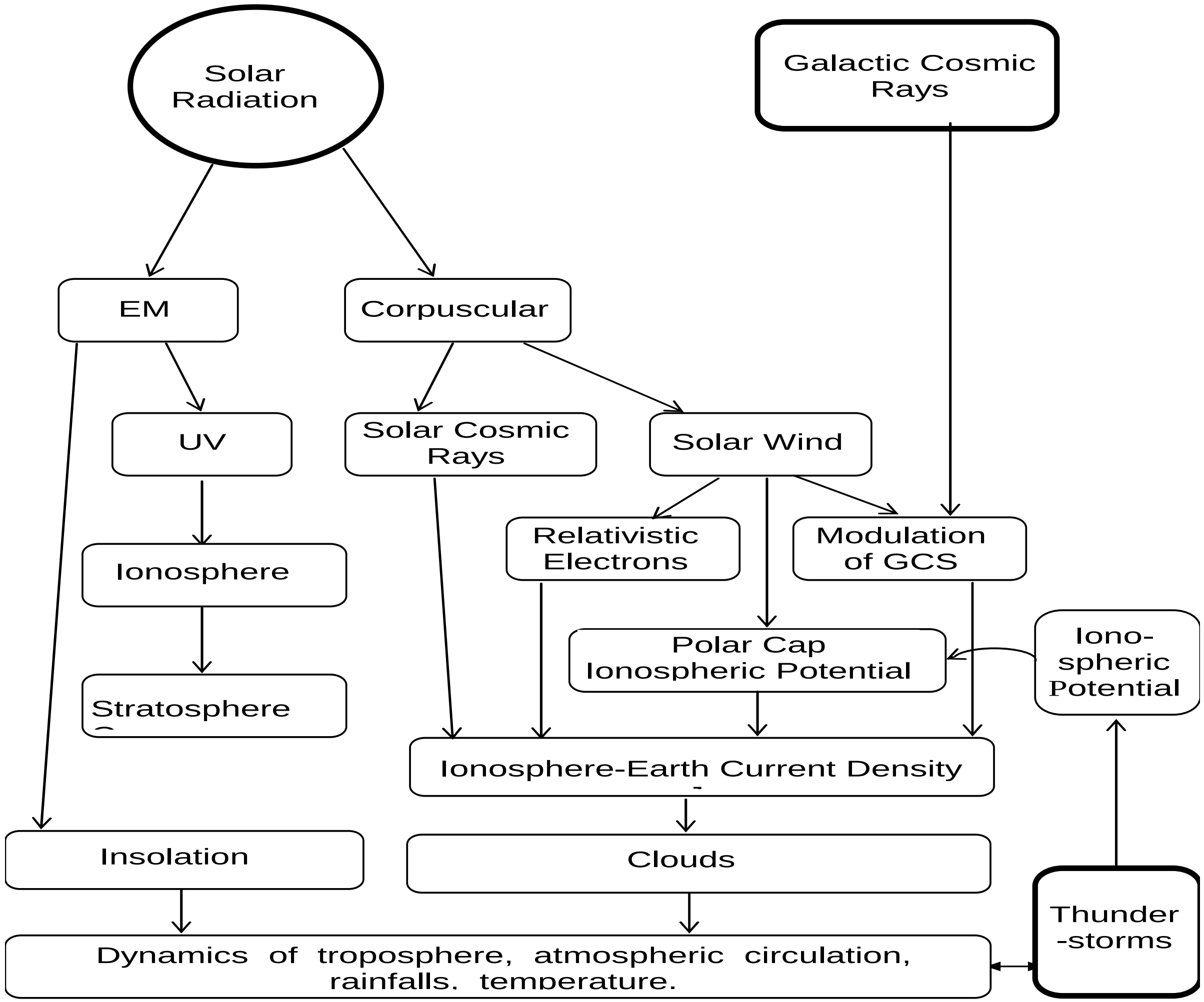


Figure 1. Scheme of simplified system of processes connecting the solar activity with the global electric circuit and possible dynamic effects in the troposphere.

- Does atmospheric electricity change ?
- What are the major contributors ??

Vulcanion Eruptions

Vulcanian eruption that occurred at Sakurajima at 22:53 JST on February 6, 1990. Incandescent arcs define the trajectory paths of ejected bl
Photo taken at the Sakurajima Volcano Observatory by Tetsuro Takayama with an exposure time of 30 sec.

- **Vulcanian eruptions trigger the seismic activity of the Earth crust.**
- **Heavy mass ejection changes electrical and magnetic field characteristics of the Earth atmosphere.**

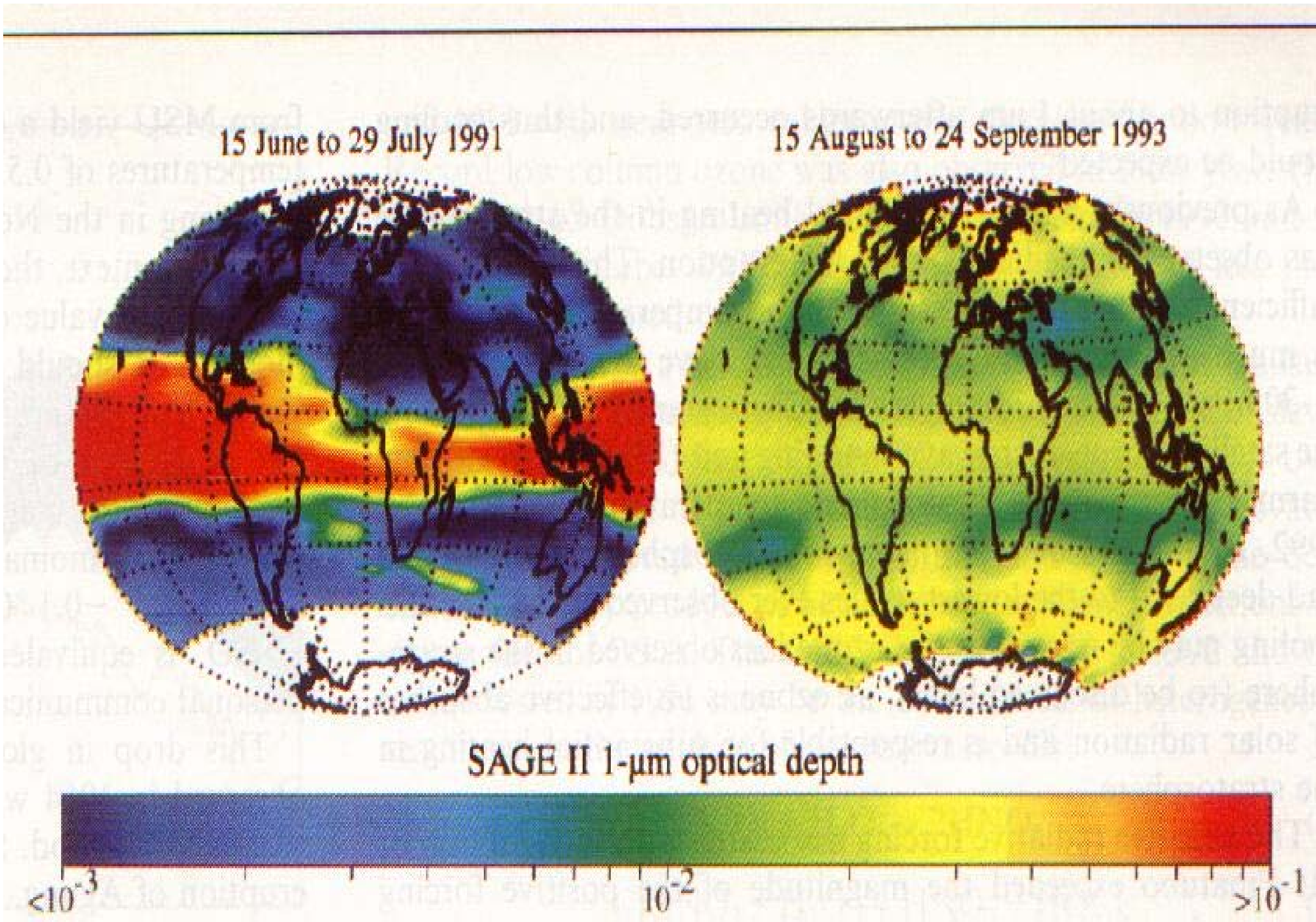
Photograph from the Space Shuttle mission STS-068 showing the elongated spreading of the October 1, 1994, plume of Klyuchevskoi near tropopause. Note that the plume border becomes smoother with height and distance because of the weakening of the internal turbulence.

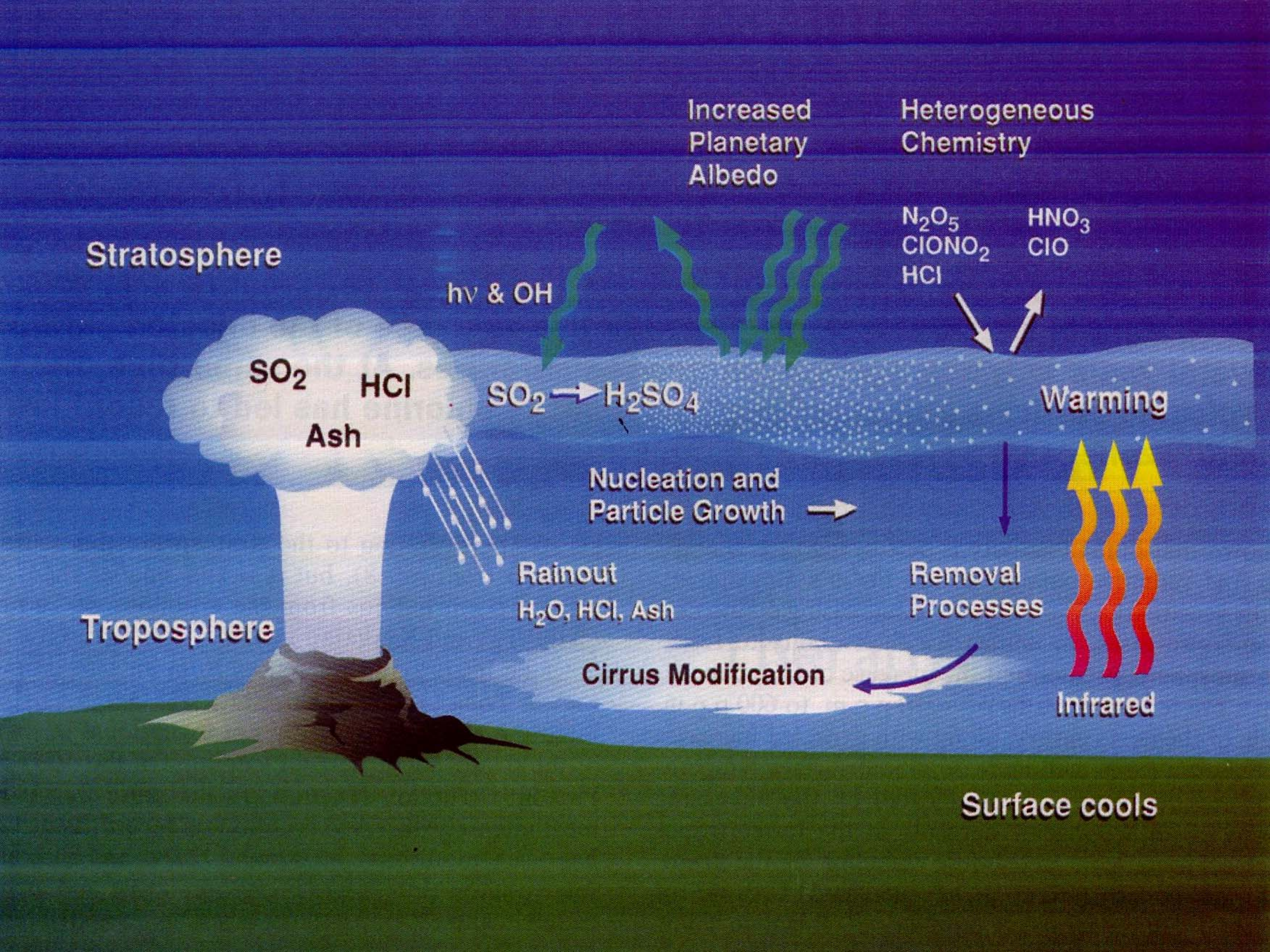
Mass Ejection by Volcanos

- Pinatubo volcano (Philippines) ejected 20 M ton gas and ash in 1991.

- Increased amount of H_2O, N_2 and CO_2, SO_2, H_2S ratio in the atmosphere (Pollack et al., 1976), Ahn (1997), Bluth (1992)

Eruption	Total magnitude (kg)	Thermal energy release (J)	Total seismic energy release (J)	Peak eruption plume height (km)
Toba, ca. 75 ka B.P.	7×10^{15}	7×10^{21}	—	—
Tambora, Indonesia, A.D. 1815	2×10^{14}	2×10^{20}	—	43
Taupo, New Zealand, ca. A.D. 180	8×10^{13}	8×10^{19}	—	51
Novarupta, Alaska, 1912	3×10^{13}	3×10^{19}	1.6×10^{16}	25
Krakatau, Indonesia, 1883	3×10^{13}	3×10^{19}	—	25
Santa Maria, Guatemala, 1902	2×10^{13}	2×10^{19}	—	34
Pinatubo, Philippines, 1991	1.1×10^{13}	10^{19}	6.3×10^{13}	35
Vesuvius, Italy, A.D. 79	6×10^{12}	6×10^{18}	—	32
Bezymianny, Russia, 1956	10^{12}	10^{18}	—	36
Mount St. Helens, USA, 1980	1.3×10^{12}	10^{18}	2×10^{13}	19
Augustine, Alaska, 31 March 1986	6×10^{10}	8×10^{16}	—	12
Augustine, 27 March 1986	1×10^{10}	1.5×10^{16}	—	8
Augustine, 30 March 1986	4×10^{8}	5×10^{14}	—	4


15 June to 29 July 1991
15 August to 24 September 1993
SAGE II 1-µm optical depth
<10^-3
10^-2
>10^-1



Increased
Planetary
Albedo
Heterogeneous
Chemistry
N_2O_5
$ClONO_2$
HCl
HNO_3
ClO
Stratosphere
hν & OH
SO_2
HCl
Ash
$SO_2 \rightarrow H_2SO_4$
Warming
Nucleation and
Particle Growth
Rainout
H_2O, HCl, Ash
Removal
Processes
Troposphere
Cirrus Modification
Infrared
Surface cools

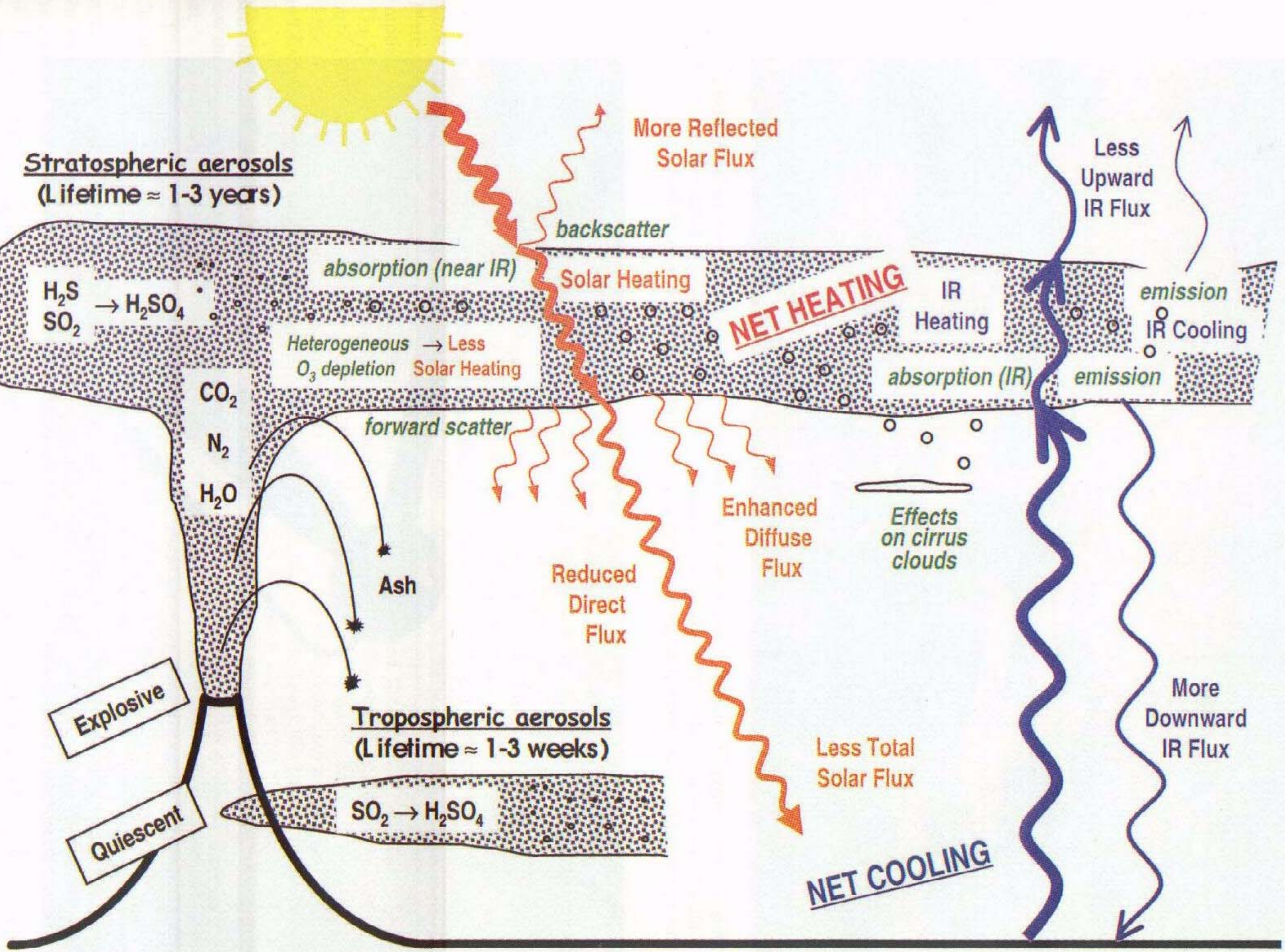
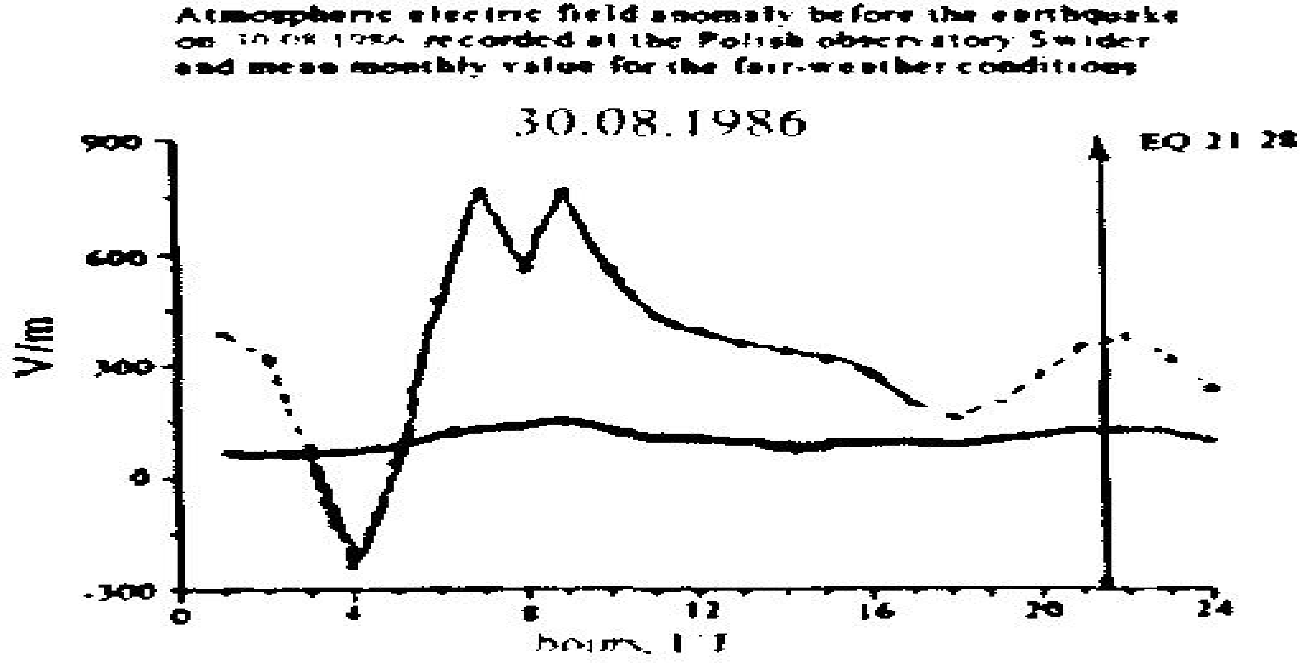


Plate 1. Schematic diagram of volcanic inputs to the atmosphere and their effects. This is an extended version of Figures 1 and 2 of *Simarski* [1992], drawn by L. Walter and R. Turco.

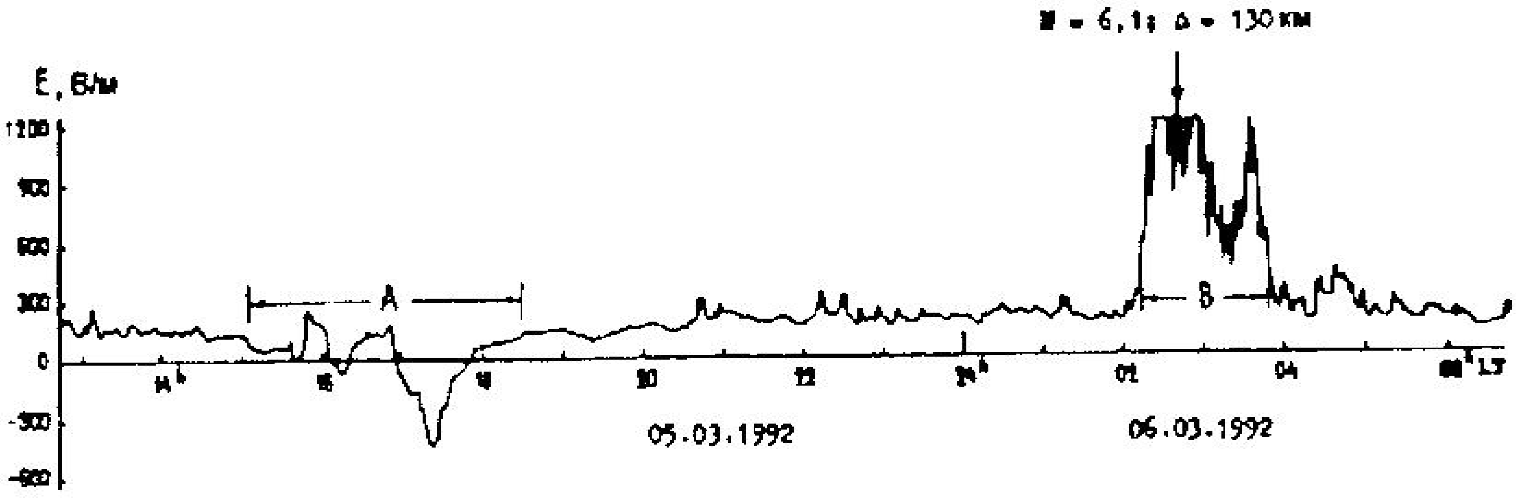
Surface electrical activities variation before than an earthquake

- **Nikiforova and Michnowski (1995) recognized that the electrical field vector (Ez) of the atmosphere changes its direction. They claimed that Ez vector direction which is (+) through to the earth surface changed 2.5 hours before than Carpatian Earthquake in 1986 with 7 order of magnitude.**

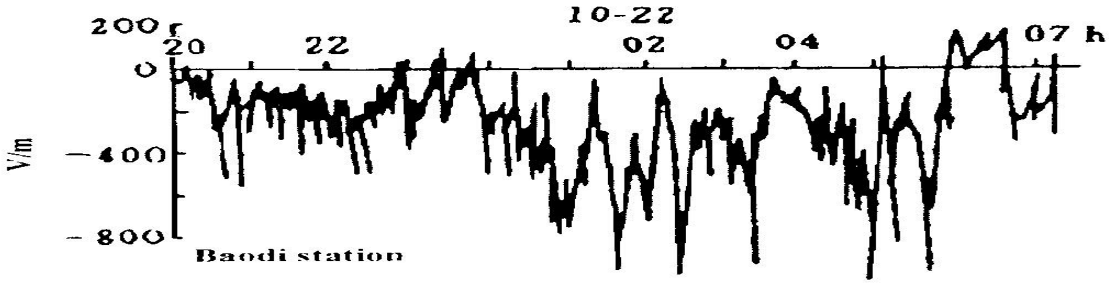


Surface electrical activities variation before than an earthquake

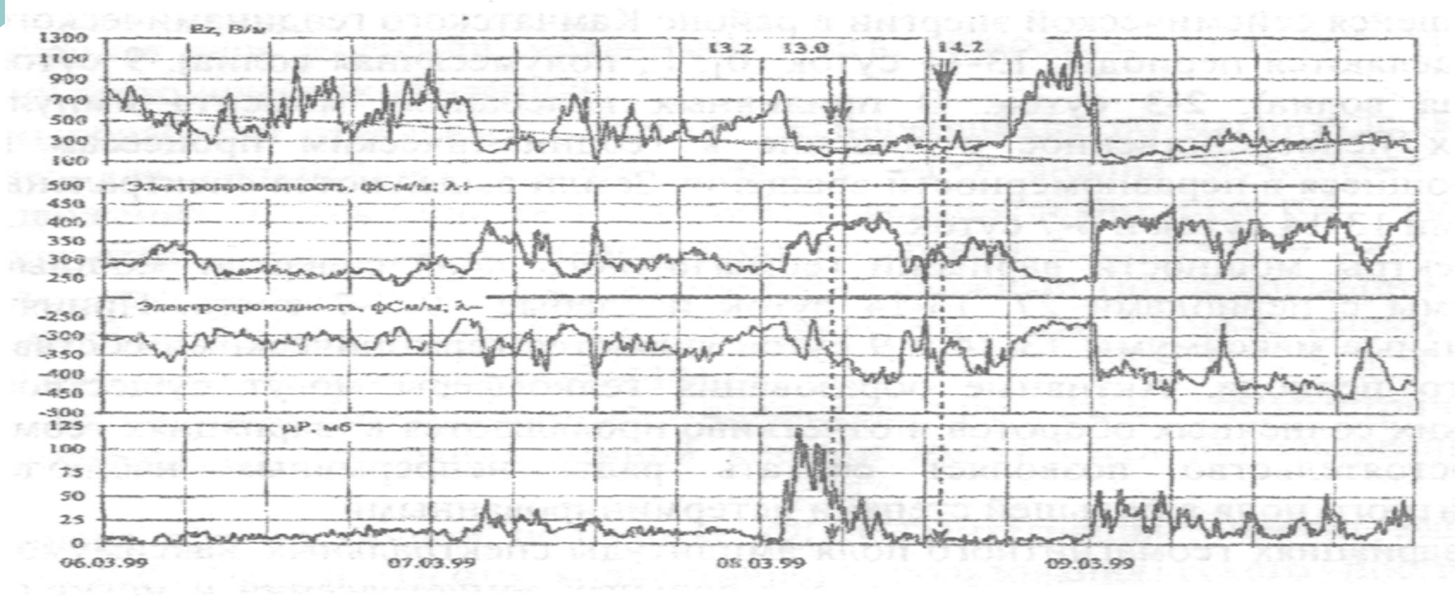
Vershinin et al. (1999) also measured Ez vector changed its direction (-) before than Kamchatka earthquake occurs (mag. : 6.1) before 1.5 days ago .



Surface electrical activities variation before than an earthquake

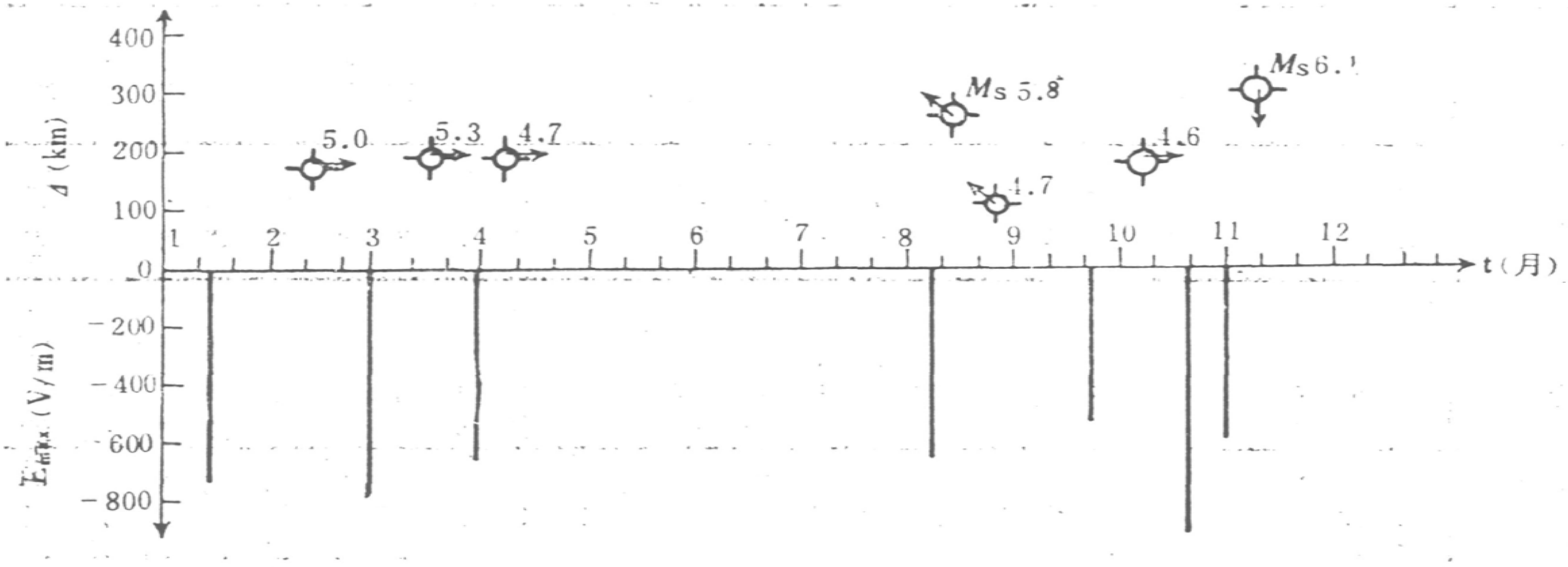


Hao et al., 2000

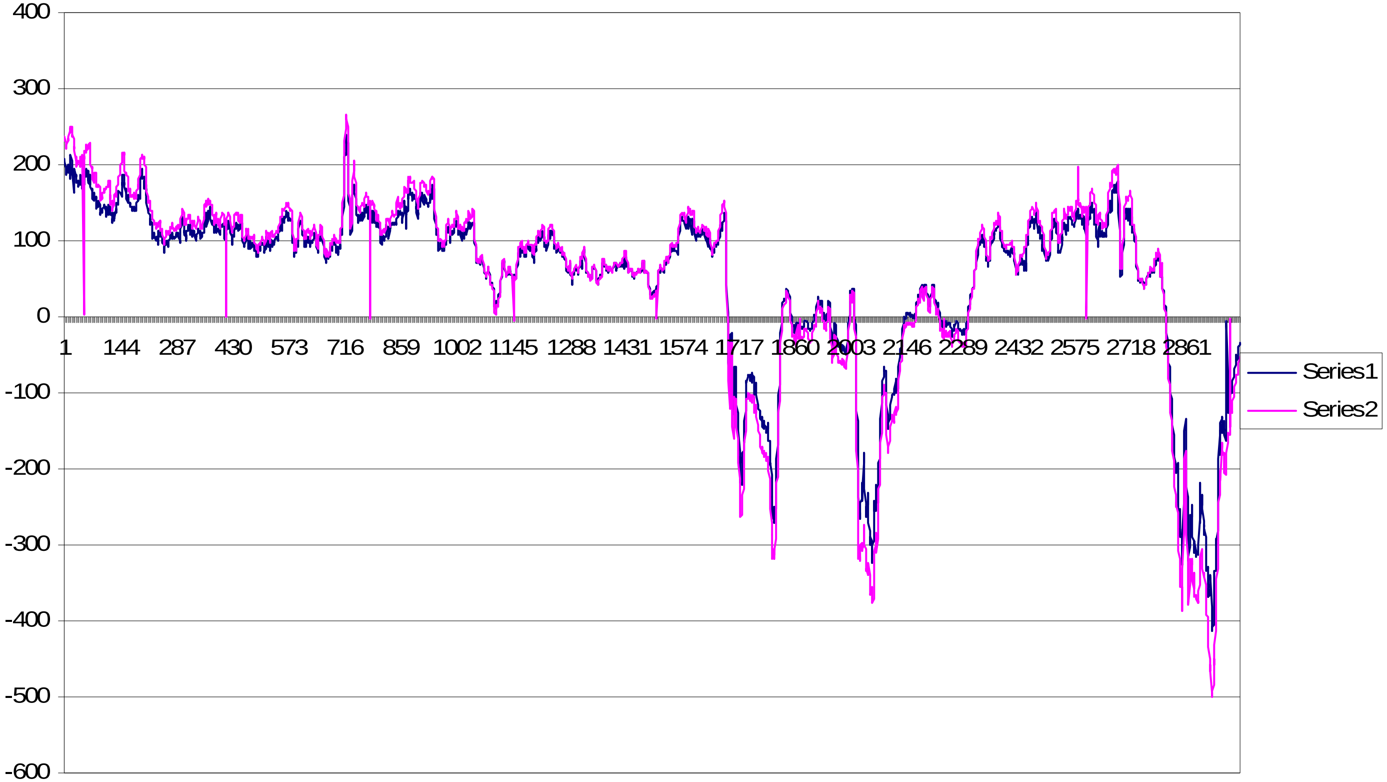


Buzevic et al. (2003).

Surface electrical activities variation before than an earthquake



Surface electrical activities variation before than an earthquake



Z. Kobylinski, 2006

Radon Emission

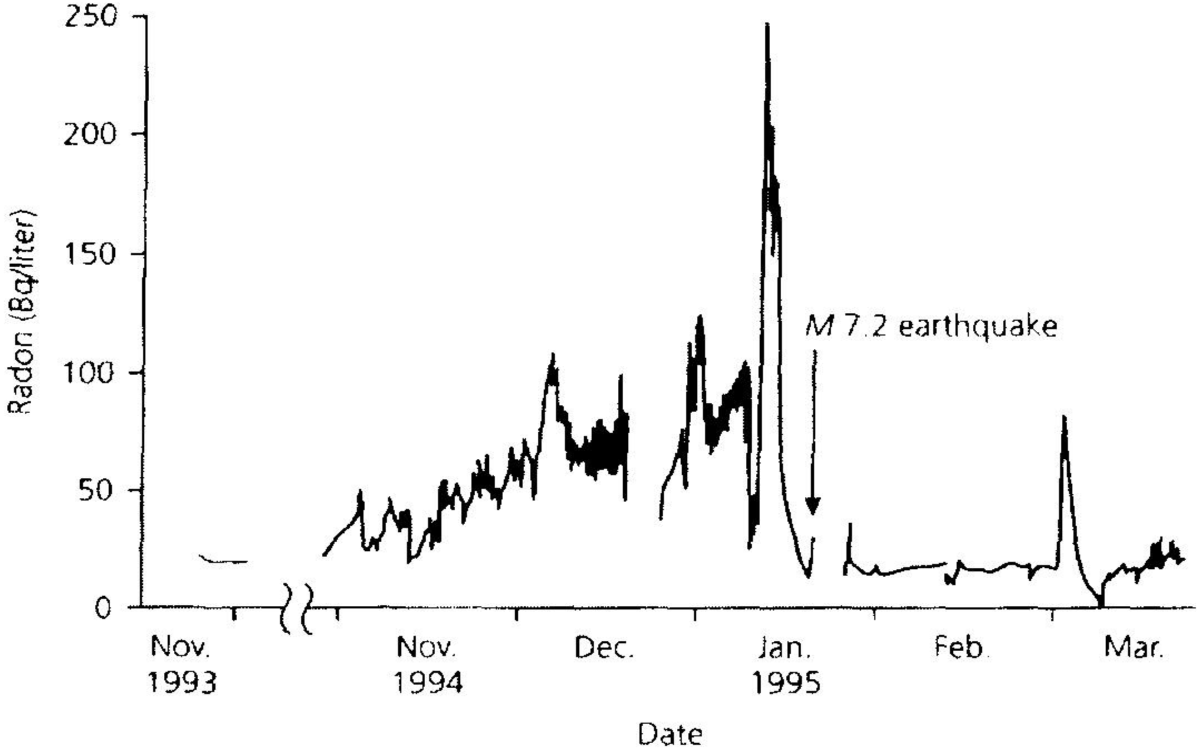


Fig. 1.8 Radon in groundwater before and after the 16 January 1995, Kobe earthquake in Japan (Igarashi et al. 1995)

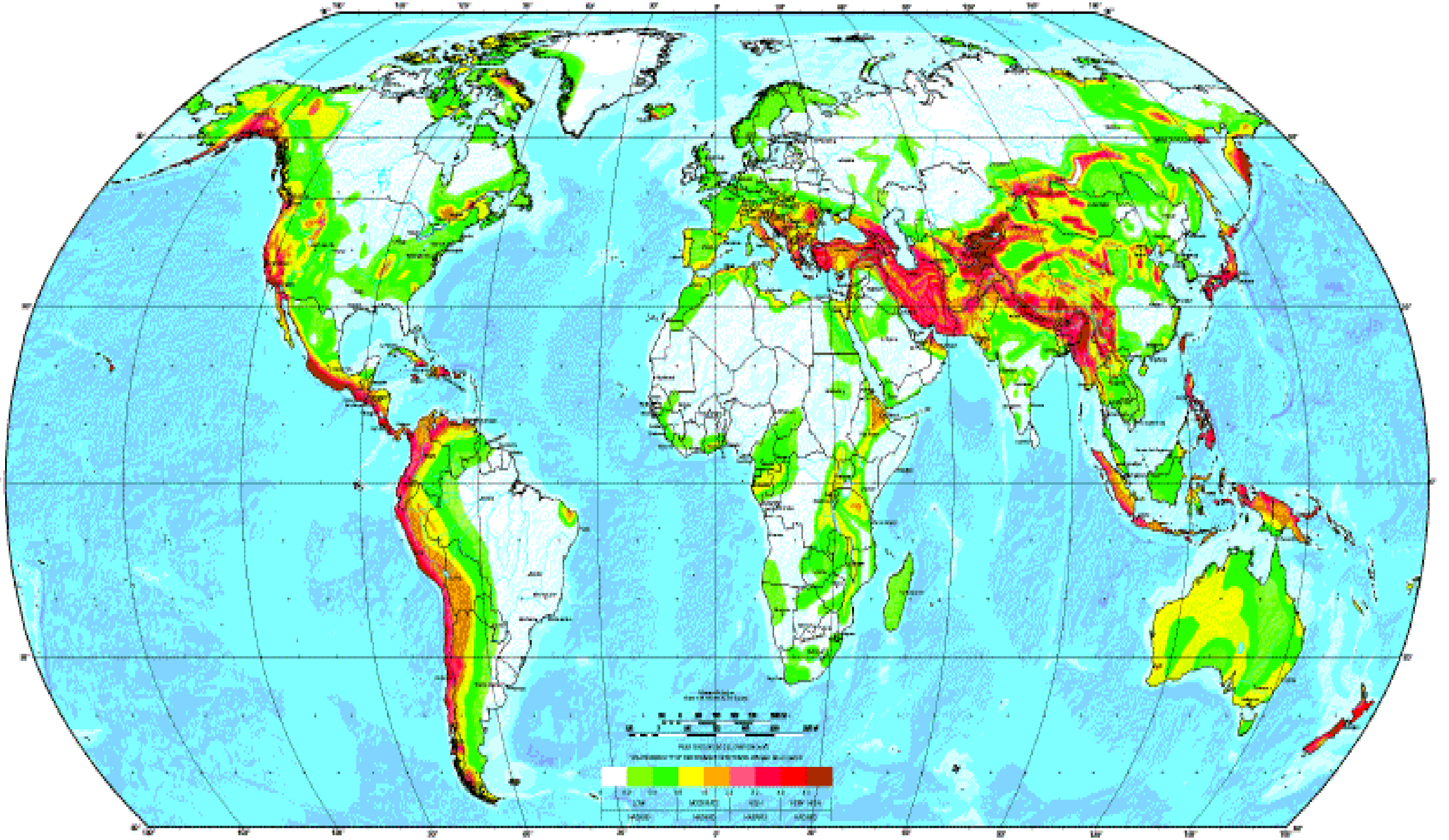
Radon gas release and Ez relation

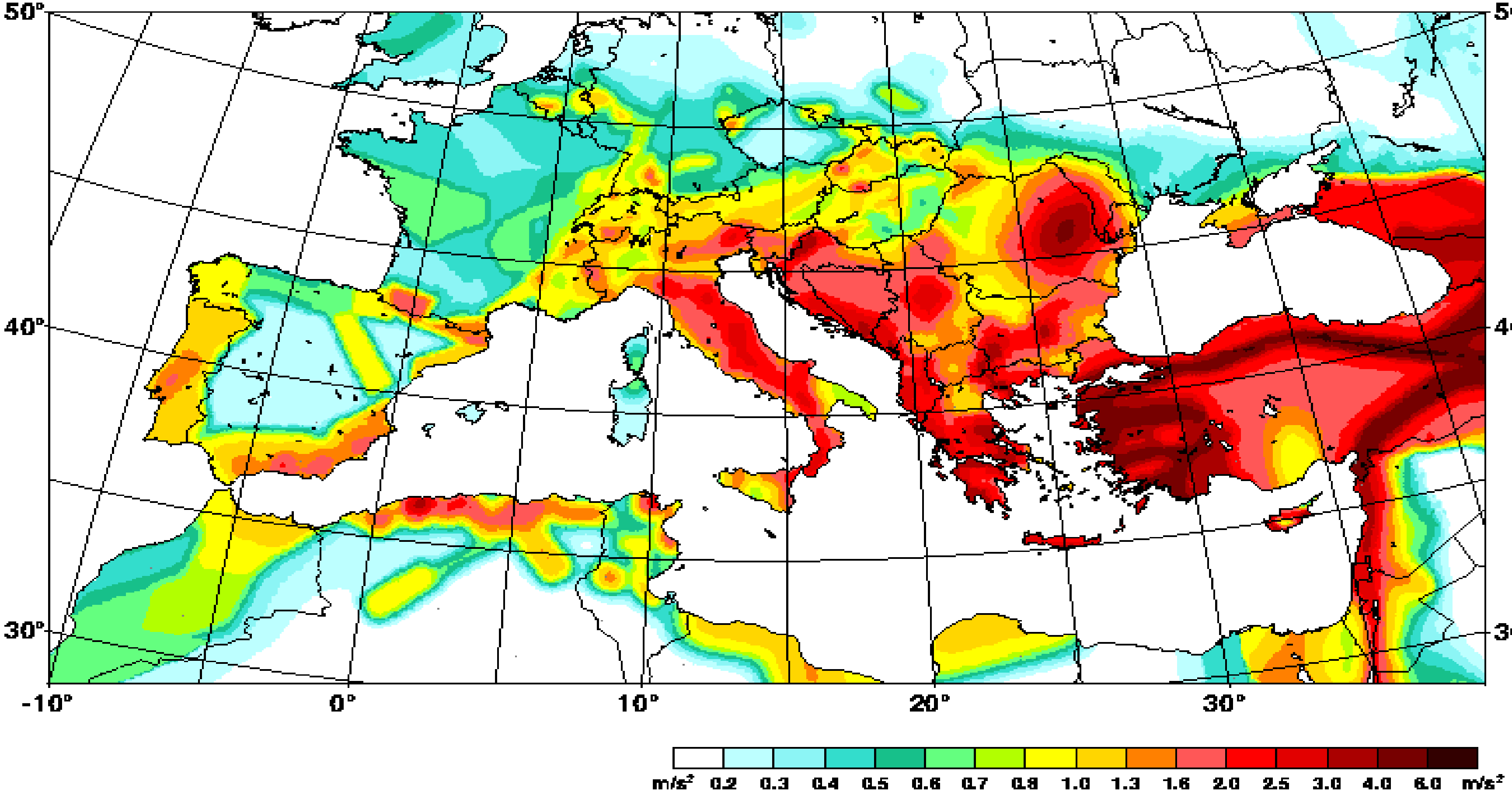
- **Why is Ez (+,-) changes its directios ?**
- $Radon_{222}$ loses its electrons during pre-seismic activities into the earth atmosphere and liquids
- Changes electron content of the atmosphere and earth surface
- E(z) vector becomes (-)

GSHAP: The Global Seismic Hazard Assessment Program

In 1992, International Council of Scientific Unions (ICSU) supported to start the International Lithosphere Program (ILP), launch GSHAP satellite (Mission ended in 1999) to measure seismic activities.

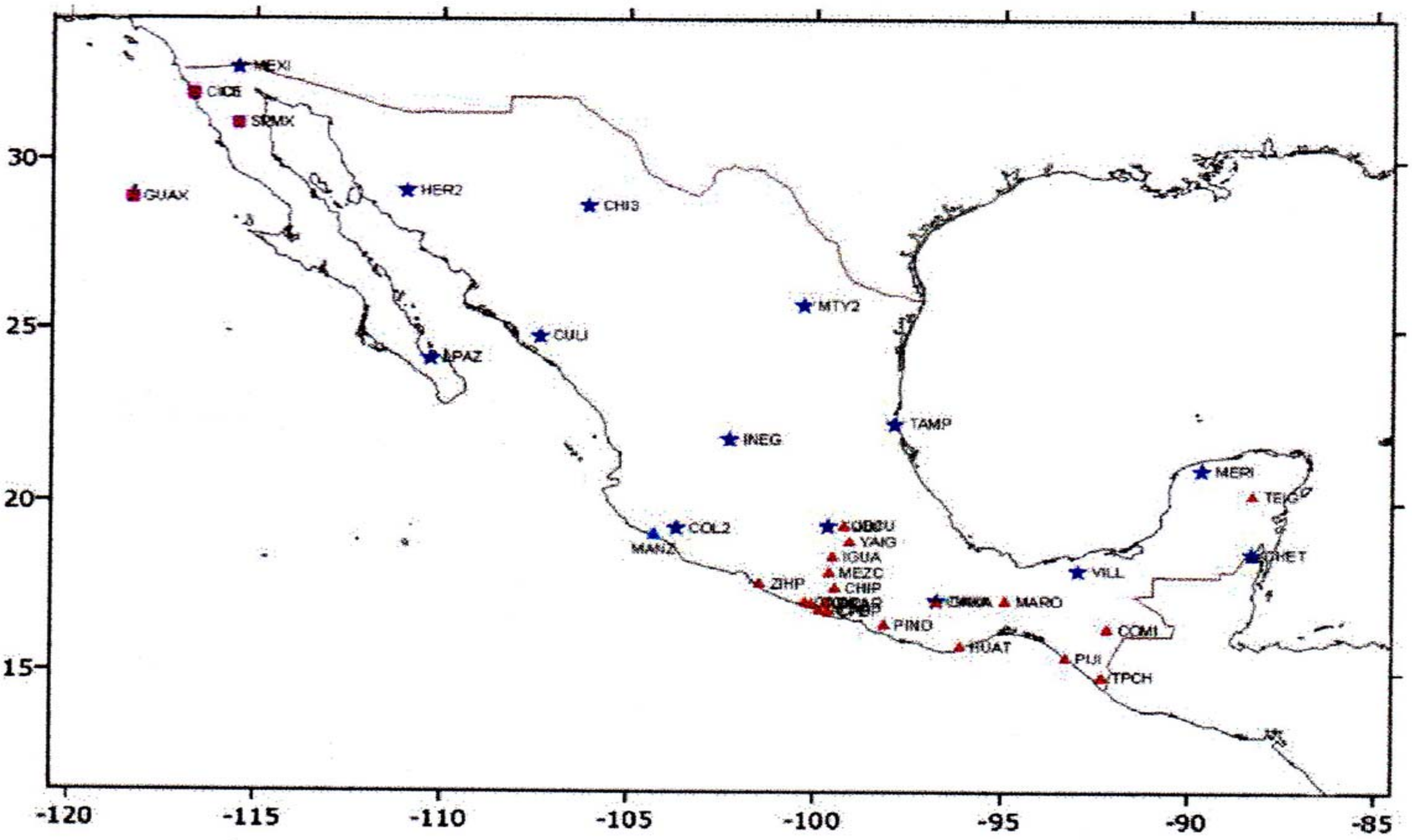
GLOBAL SEISMIC HAZARD MAP



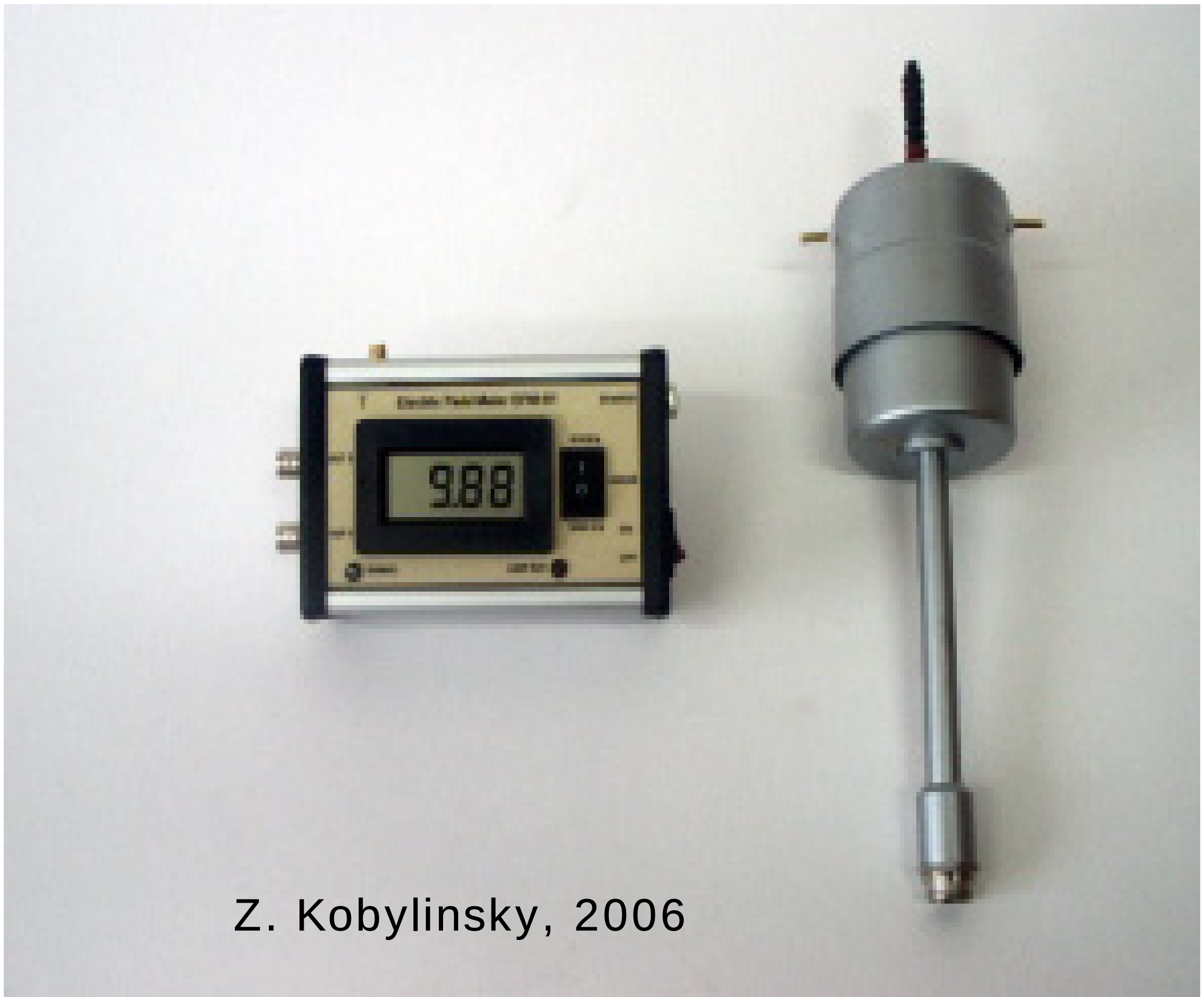


Horizontal Peak Ground Acceleration seismic hazard map representing stiff site conditions for an exceedance or occurrence rate of 10% within 50 years for the Mediterranean region (after: www.seismo.ethz.ch/GSHP).

Ez Measurement Network



Ez measurement tools



Z. Kobylinsky, 2006

Results

- Need more observation
- Need more collaboration to measure Ez and other indicators.
- **Akdeniz University launched a program to establish a newwork to measure Ez variations co-operating with Kandilli Observatory in Istanbul.**

Special thanks goes to Mr. Z. Kobylinski of Poland. His valuable studies helped me to prepare this presentation.

THANK YOU VERY MUCH

FOR YOUR ATTENTION

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