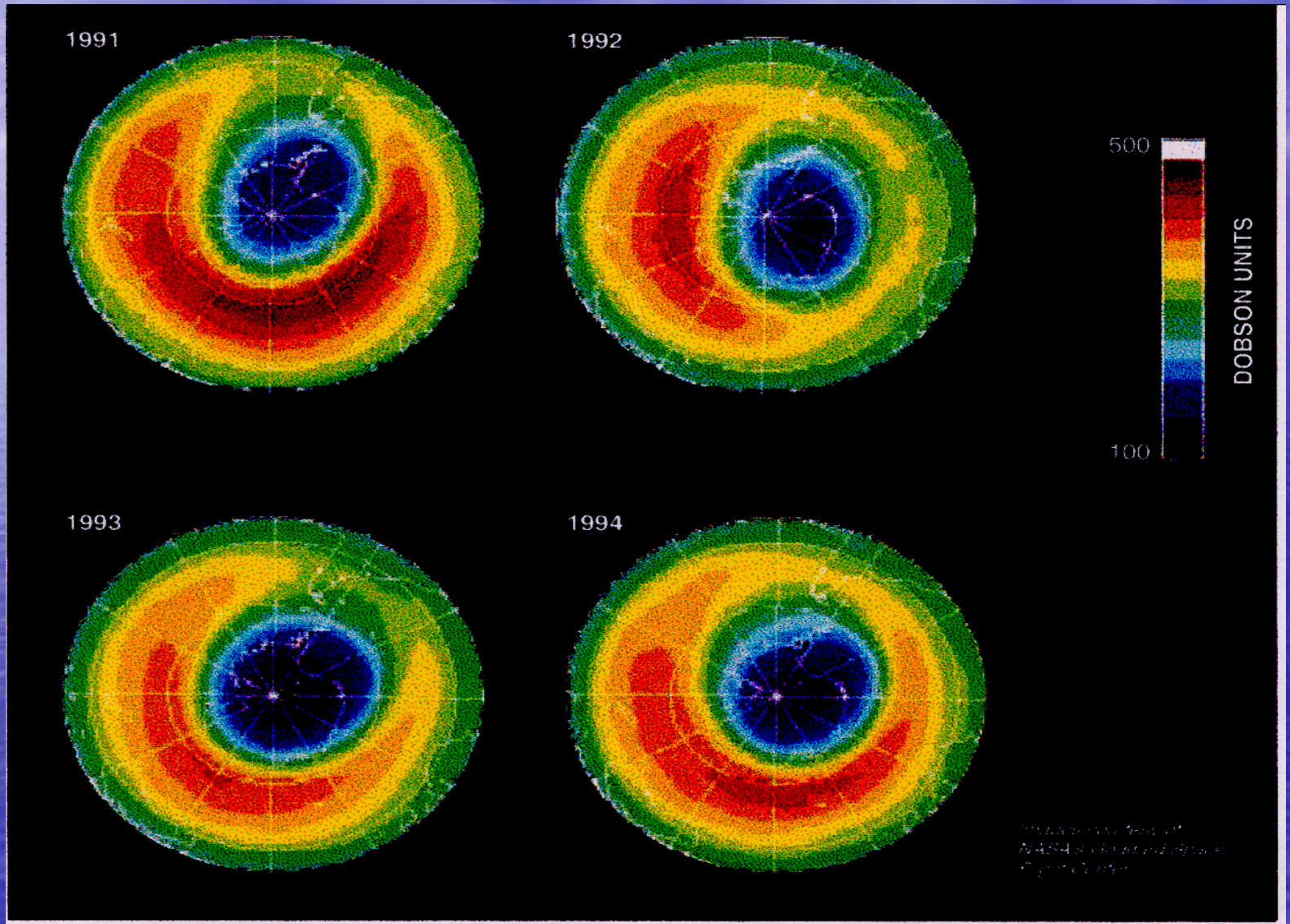


Stratospheric Ozon Destruction by Solar Relativistic Electrons.-

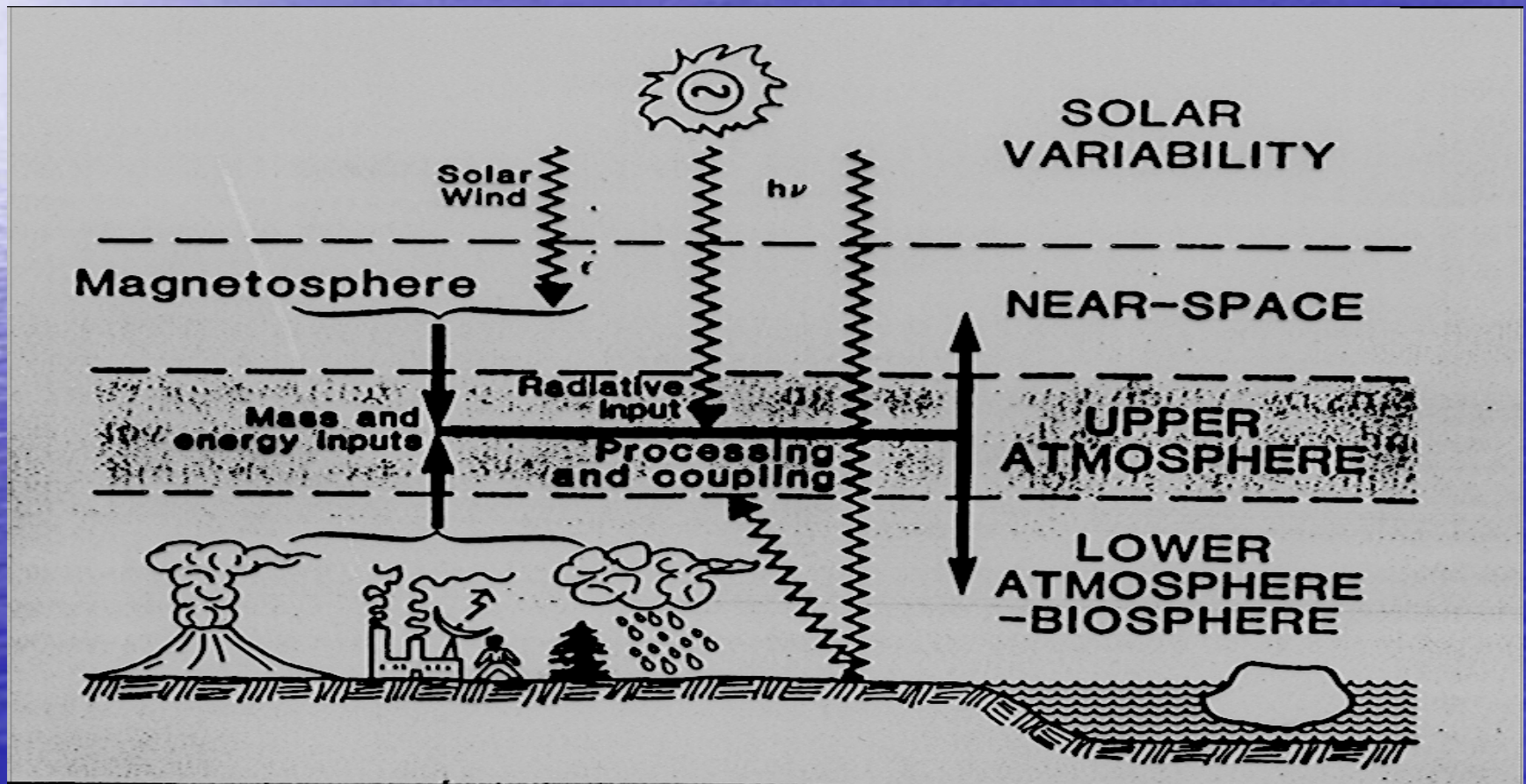
Vasilis Tritakis.

Research Center for Astronomy and Applied
Mathematics,
Academy of Athens.-

Ozon Hole.-



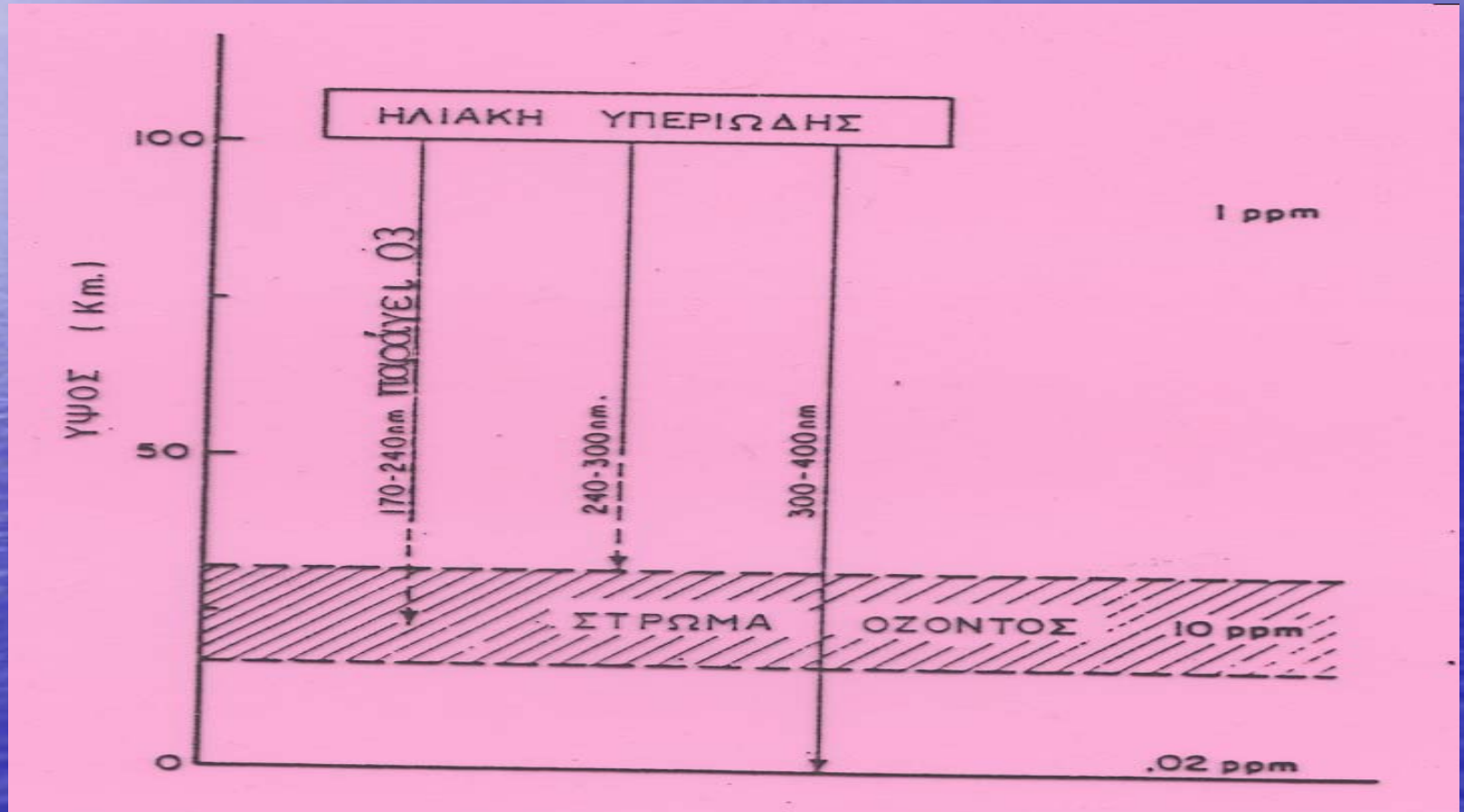
INTERNAL AND EXTERNAL IMPACTS IN THE MIDDLE ATMOSPHERE



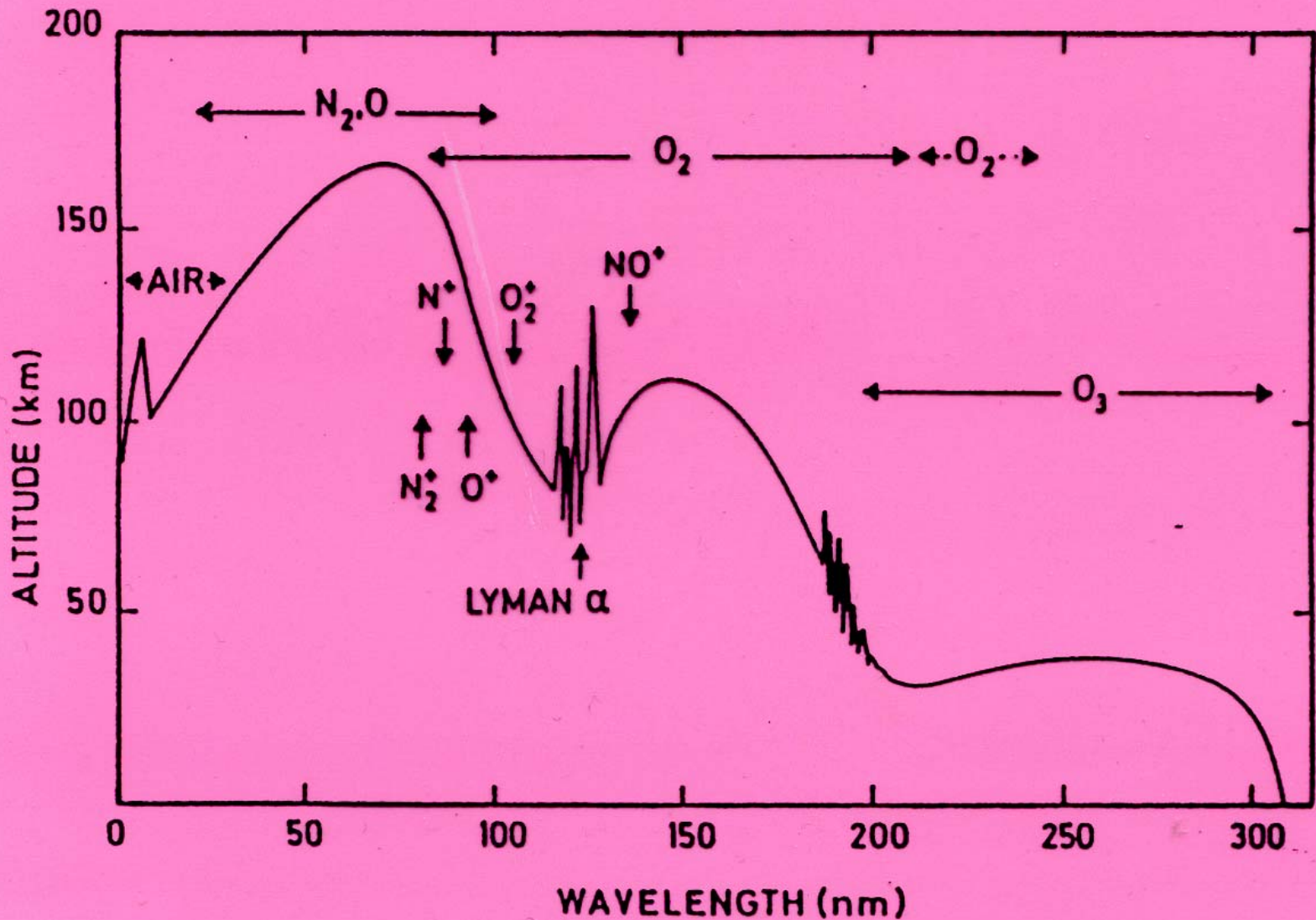
Some General Information about Stratospheric Ozon.-

- Height of the Ozon layer:.....**20-40 Km. .**
- Height of its Maximum Concentration :..... **25-30Km.**
- Rate of ozon to air:**10/10⁶ ή 10ppm .**
- Maximum Concentration:..... **~ 10¹⁰ μόρια/cm³**
- Band of Intense Absorption:..... **UV: 2000-3000 Å⁰**
- Best band for measurements:..... **3050-3100Å⁰**
- Way of Measure:.....**Spectrometer Dobson or Breuer.**
- Unit of Measure:..... **0,001cm=10⁻³ cmNTP= 1DU**
(On the average a vertical column contains $8 \cdot 10^{18}$ molecules/cm² or
0,3 cm NTP or 300 units 10⁻³ cmNTP ή 300DU

UV Absorption in the Ozone Layer.-

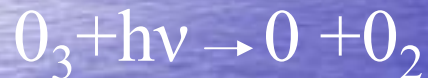
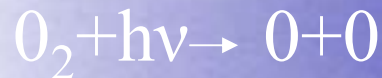


UV Depth of Absorption.-

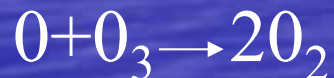


Ozon Production/Destruction Processing

1.-CHAPMAN'S production/Destruction Approach.



2.-Modern Theories.-

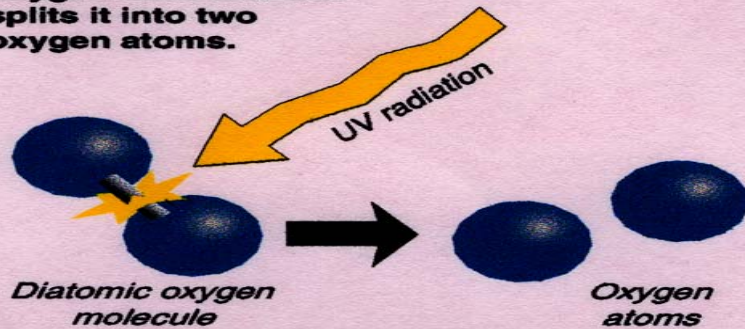


όπου: $X = H, OH, NO, Cl, Br$

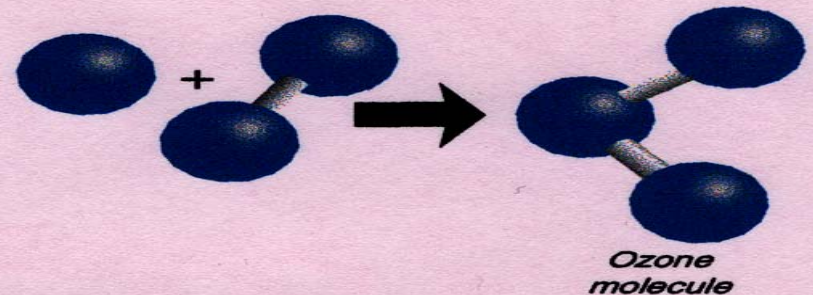
Schematic Ozon Production/Destruction.-

Natural Ozone Production in the Stratosphere

Ultraviolet radiation from the sun strikes a diatomic oxygen molecule and splits it into two oxygen atoms.

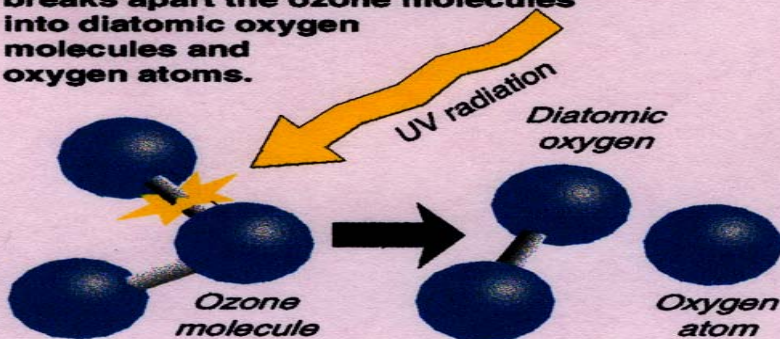


The free oxygen atoms react with diatomic oxygen molecules to form ozone.

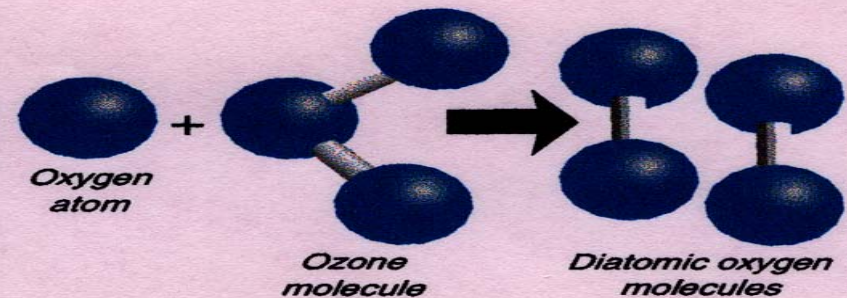


Natural Ozone Destruction in the Stratosphere

Ozone absorbs ultraviolet light in the range of 290-320 nanometers. This solar energy breaks apart the ozone molecules into diatomic oxygen molecules and oxygen atoms.



The free oxygen atom can react with an ozone molecule and form two molecules of diatomic oxygen.



Main Ozone Destroyers.-

Nitrogen Oxides. NO, NO₂.-

Destruction.-

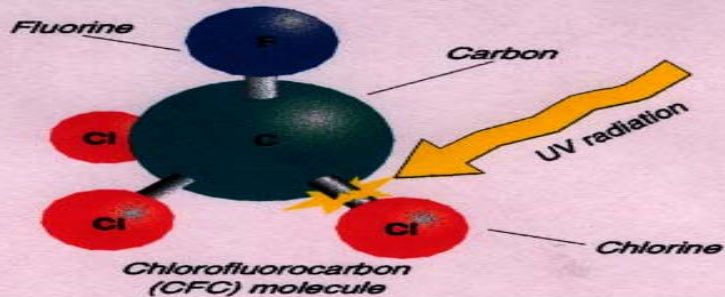


Cl₂ atoms created by photochemical reaction of,
CH₃Cl, CCl₄, {CF₂Cl₂, CFCl₃} Freons

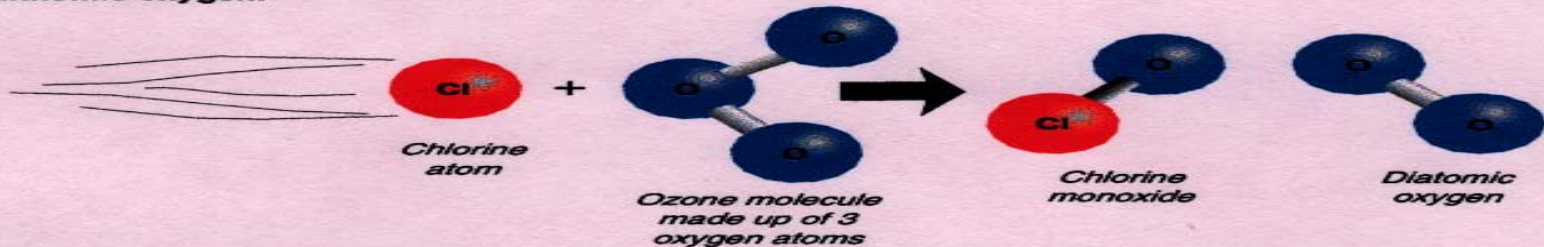
Anthropogenic Ozone Destruction.-

Ozone Destruction Caused by Manmade Compounds (e.g., CFCs)

Ultraviolet radiation from the sun strikes the CFC molecule and causes a chlorine atom to break away.



The chlorine atom reacts with an ozone molecule to form chlorine monoxide and diatomic oxygen.



When a free atom of oxygen reacts with a chlorine monoxide molecule, diatomic oxygen is formed and the chlorine atom is released to destroy more ozone.



Electrons in the Atmosphere.-

- Atmospheric atoms and molecules can be ionized either by short wavelength solar radiation (UV,X-rays) or precipitating electrons,

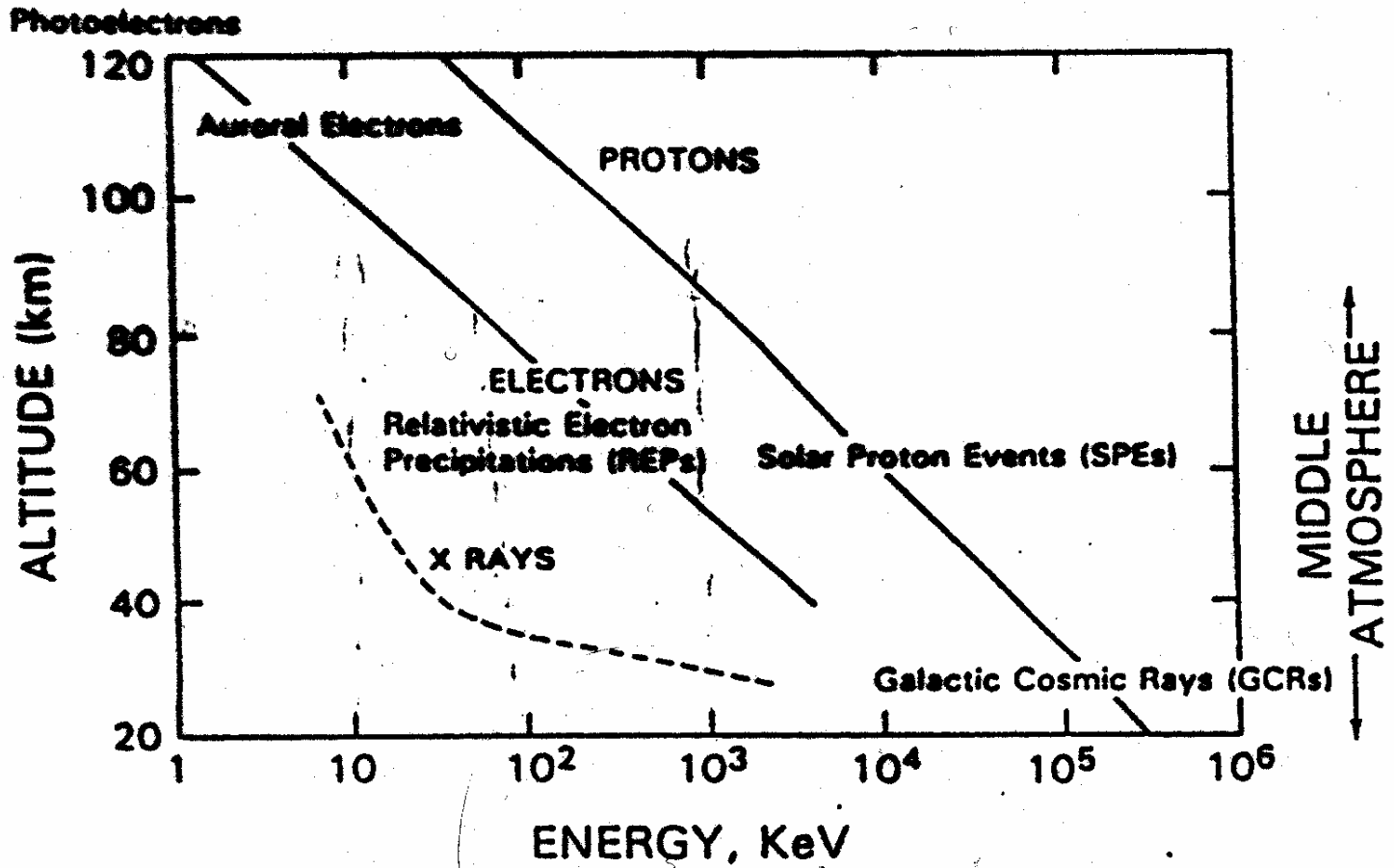


Corpuscular Radiation and Ozon.-

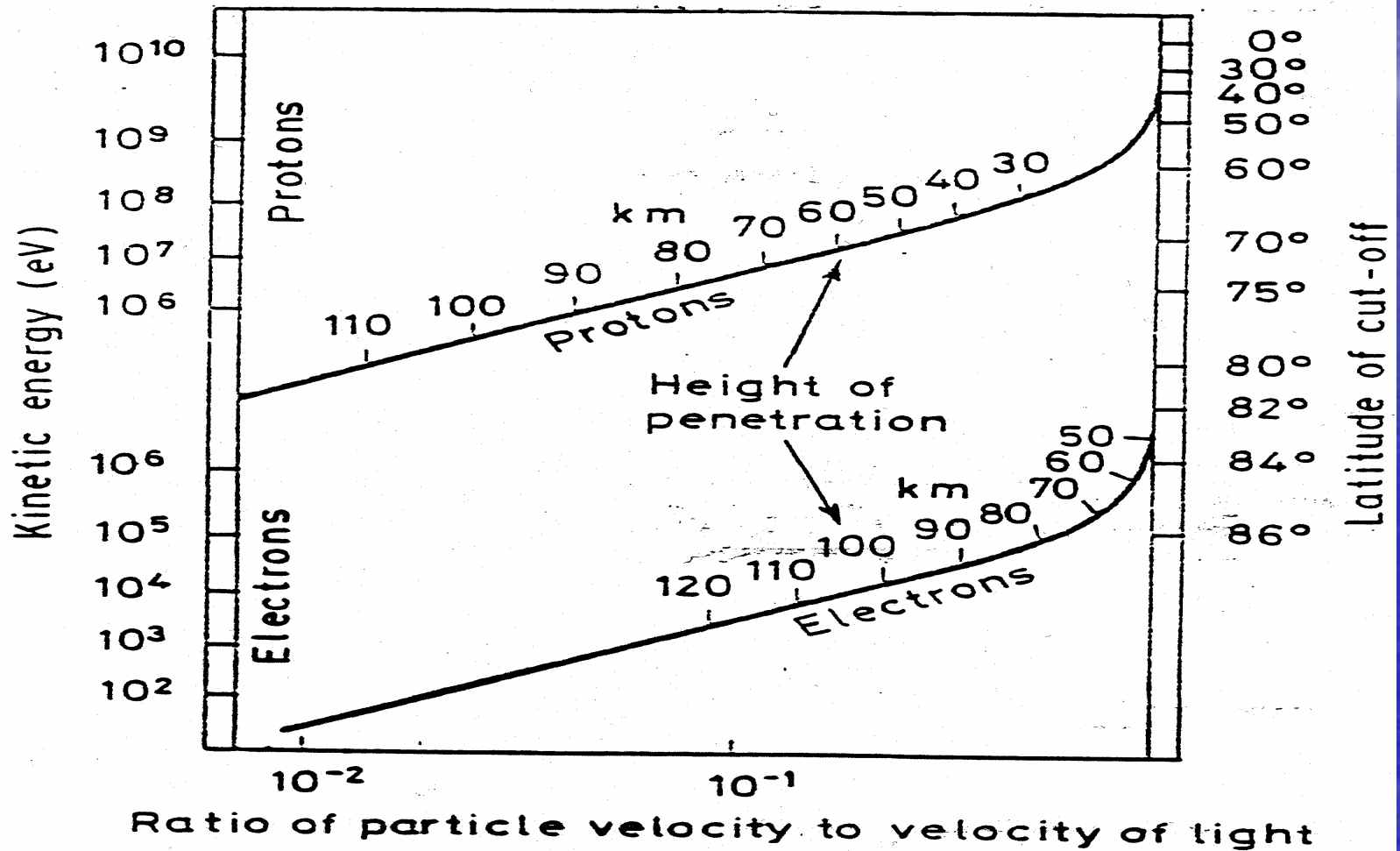
- Solar Protons create secondary electrons which carry energy of a few hundreds eV.
- Electrons break N_2 molecules creating N_2^+ , N , N^+ , ions.
- N , N^+ react with O_2 και O_3 producing NO.
- **Any increase in NO drives to decrease of O_3 according to the reaction:**



Particles Penetration in the Atmosphere.-



Latitudinal Cut off of Particles.-



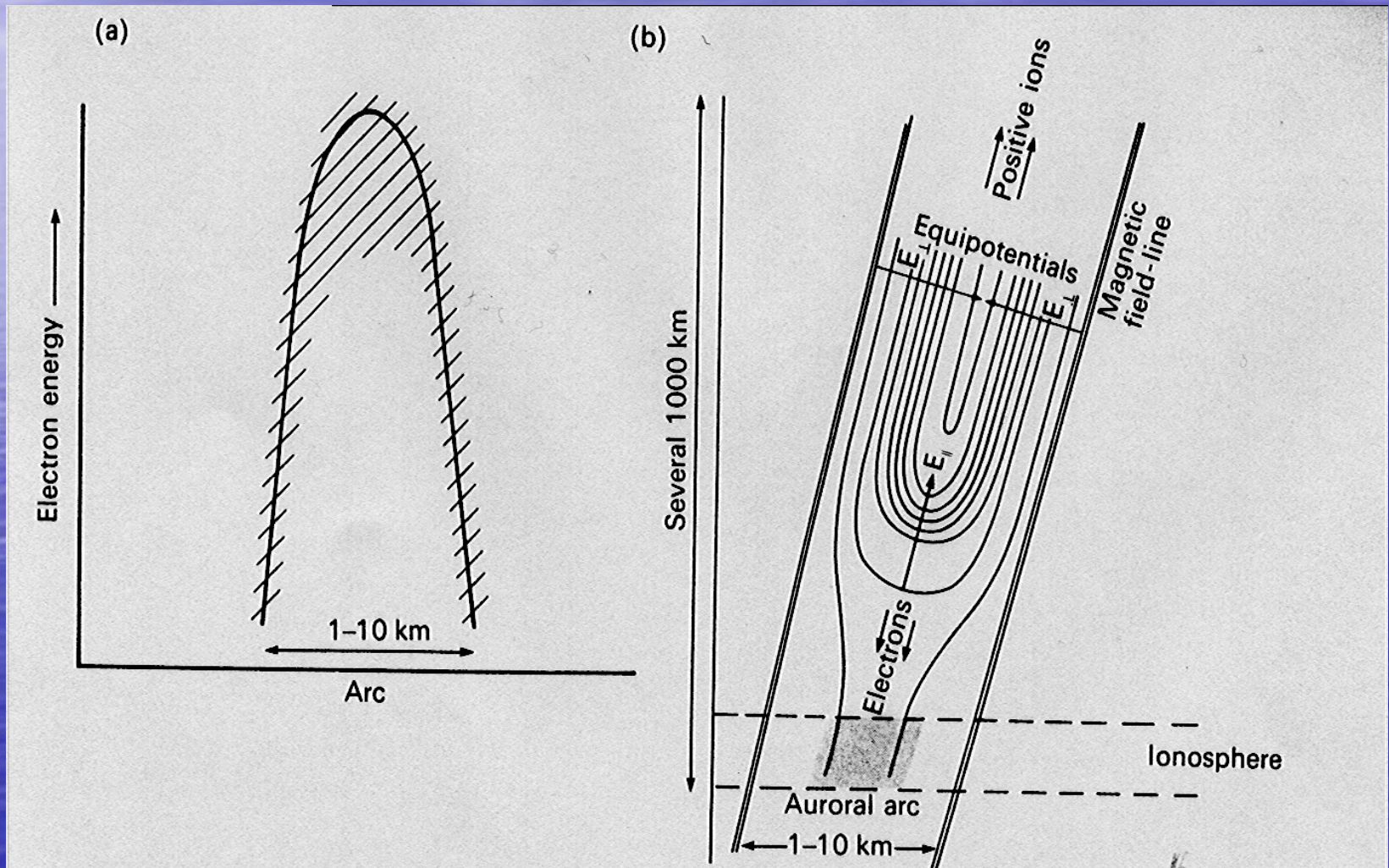
Possible Scenario.-

- HSSWS emanating from CH lead to enhanced populations of Ee and modulate EEPr into mesosphere.
- Precipitation initiates the formation of NOy which could move downward into the stratosphere.
- Confirmation of such a coupling requires:
 - 1.-Relationship SW and PrEI
 - 2.-NOy affected by EEP
 - 3.- NOy is moving downwards
 - 4.-NOy increases the stratospheric budget of NOy.

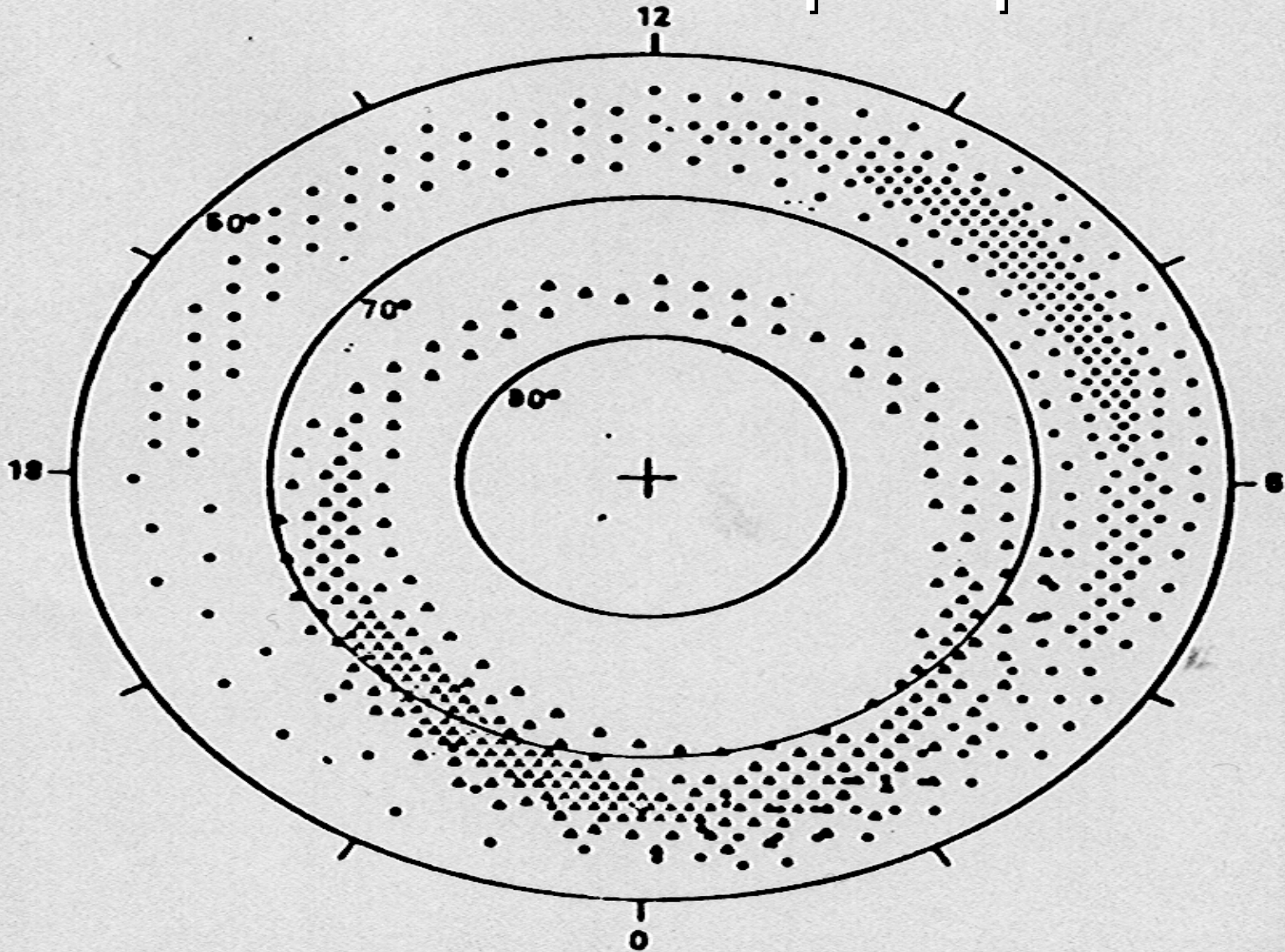
CONFIRMATIONS

- Magnetospheric EE are modulated by HSSWS.
- EEP events can lead to ionization and increase of NO_y.
- NO_y move downwards.
- ??????????????????(Not enough observations)

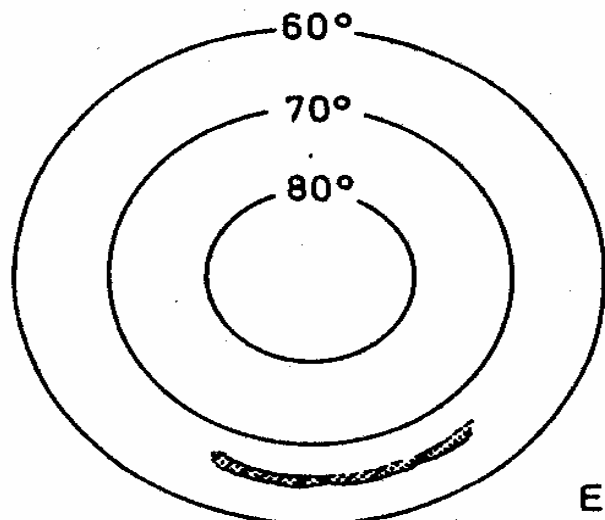
Precipitation of Auroral Electrons.-



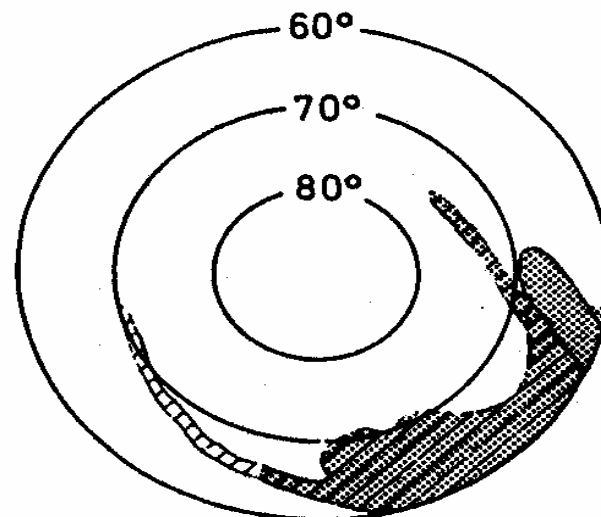
Areas of Particles precipitation



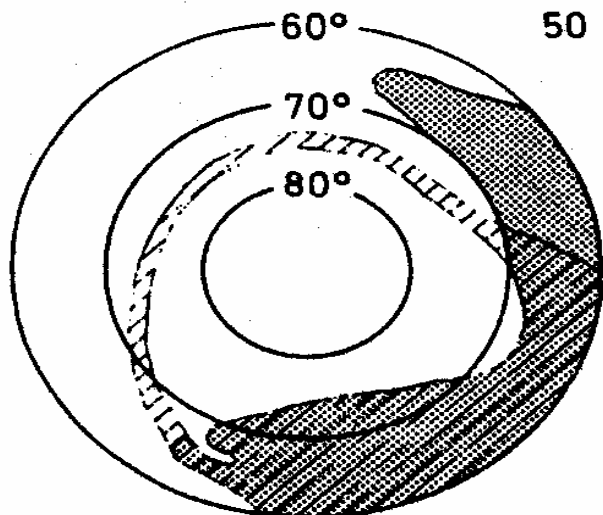
Geomagnetic Sub-storms and precipitation of Electrons





$T = 0-5$ min

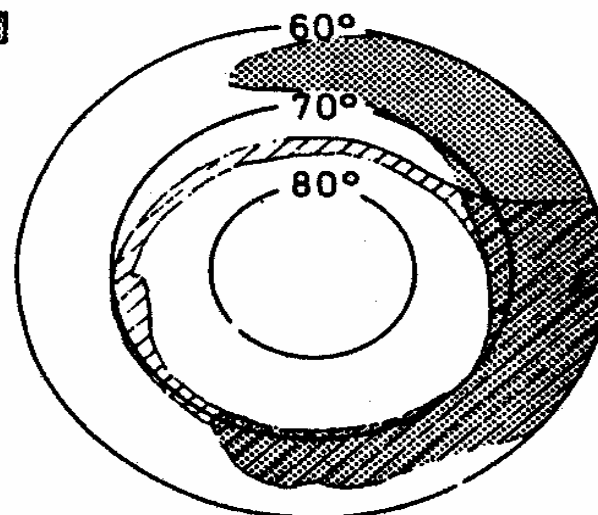


$T = 5-10$ min



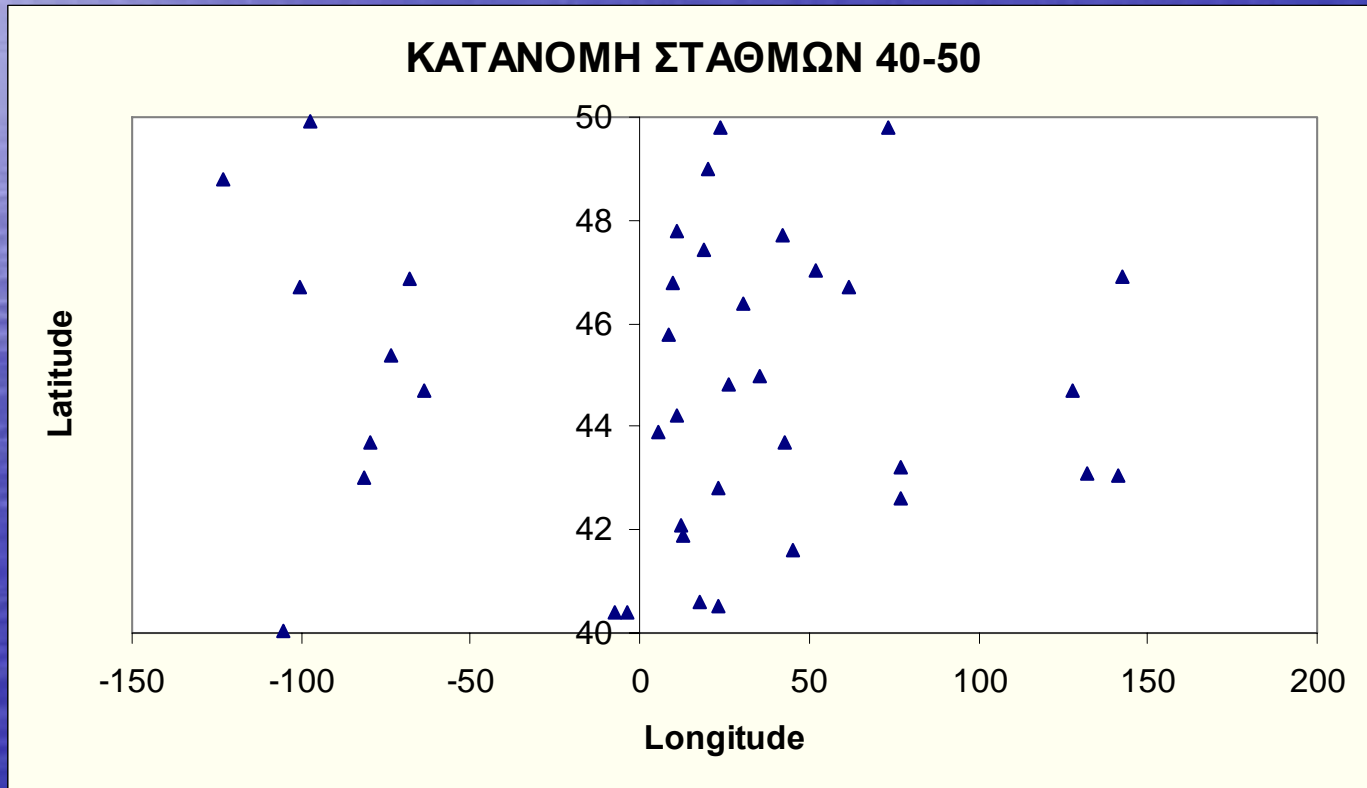
$T = 10-30$ min

Electrons
5 keV 
50 keV 

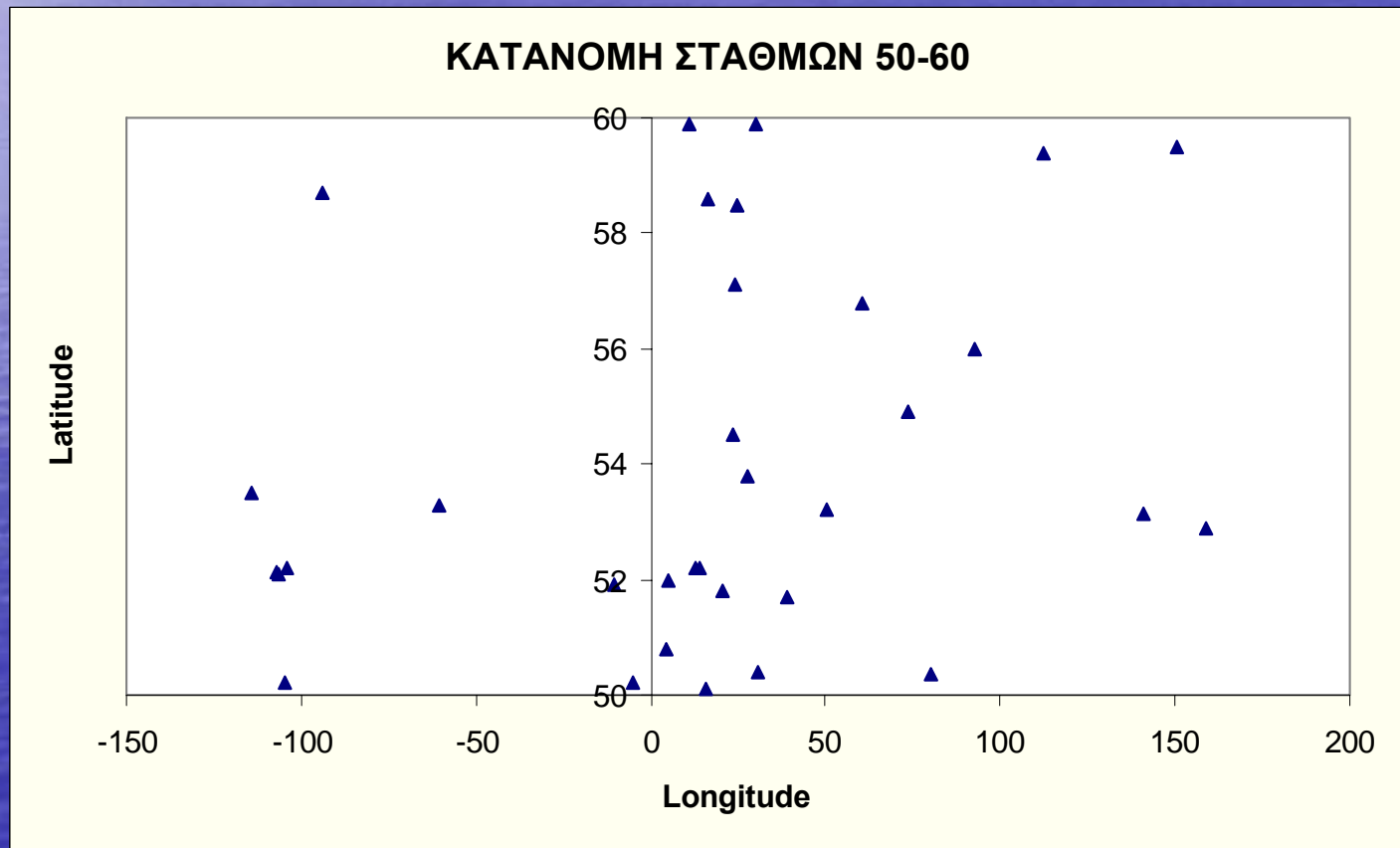


$T = 30-1$ hr

Distribution of Ground based Stations.- Lat. Zone 40-50deg, Stations:39

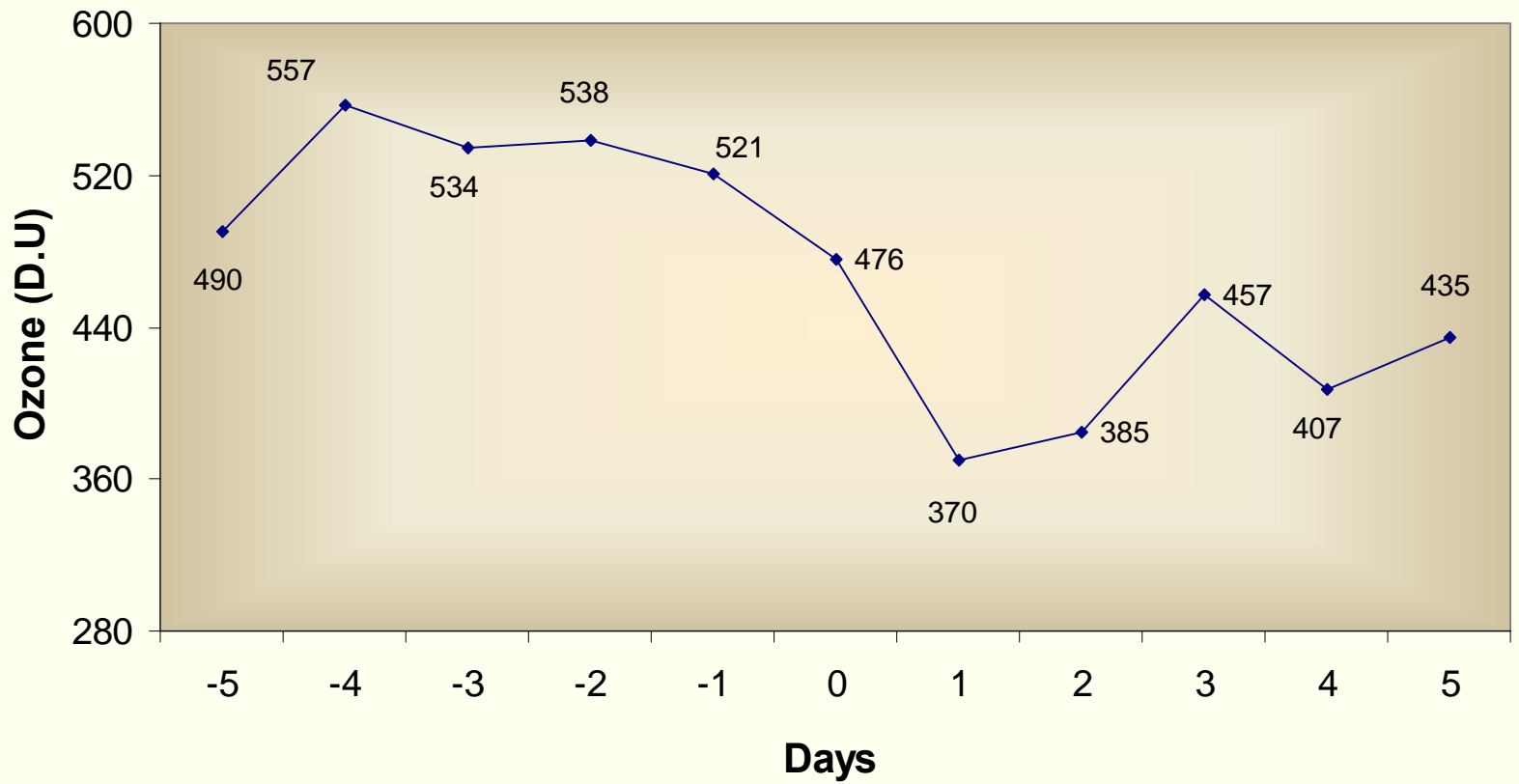


Lat. One: 50-60deg. Stations 35



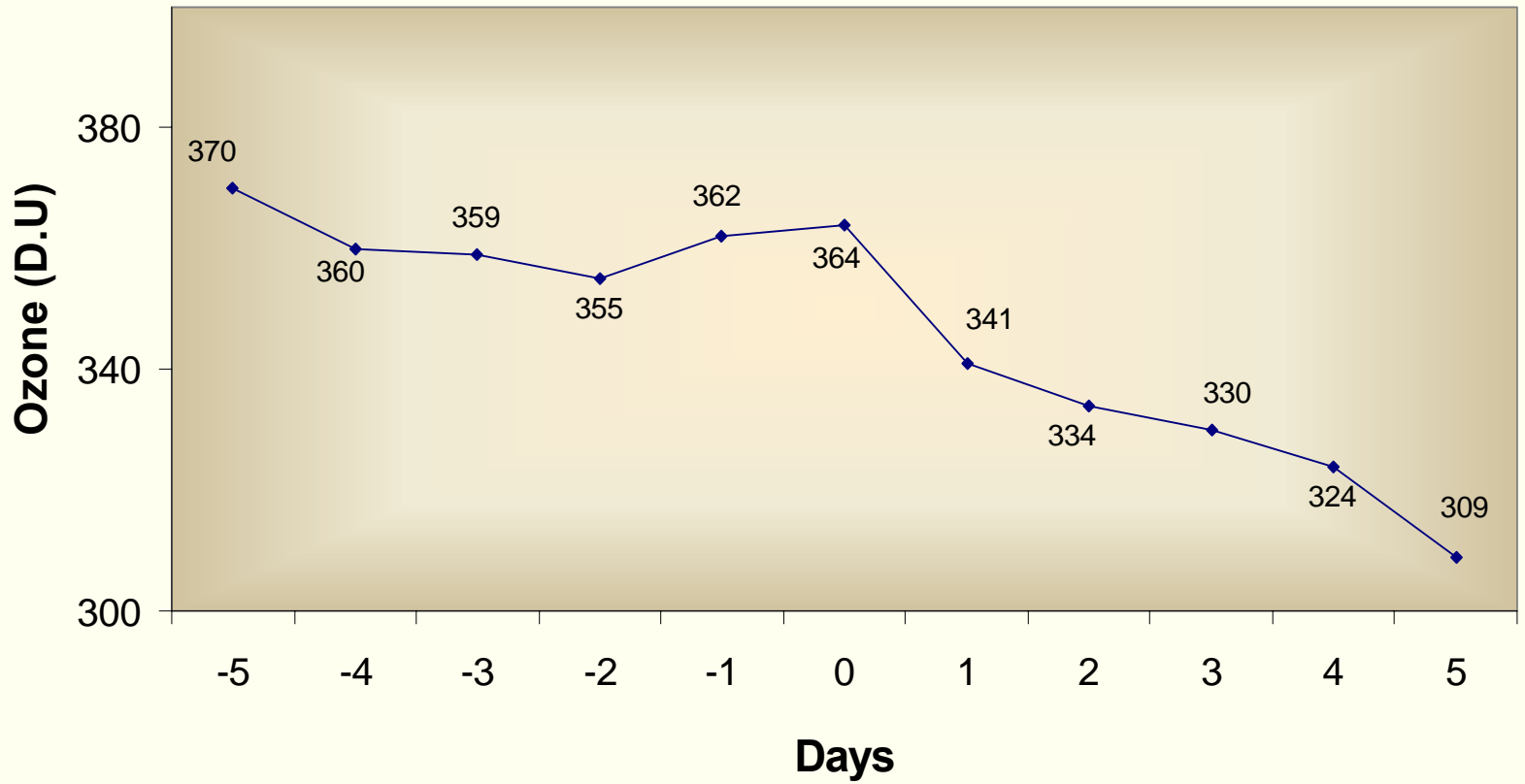
VLADIVOSTOK STATION 1991

Lat: 43,11 Long:131,9



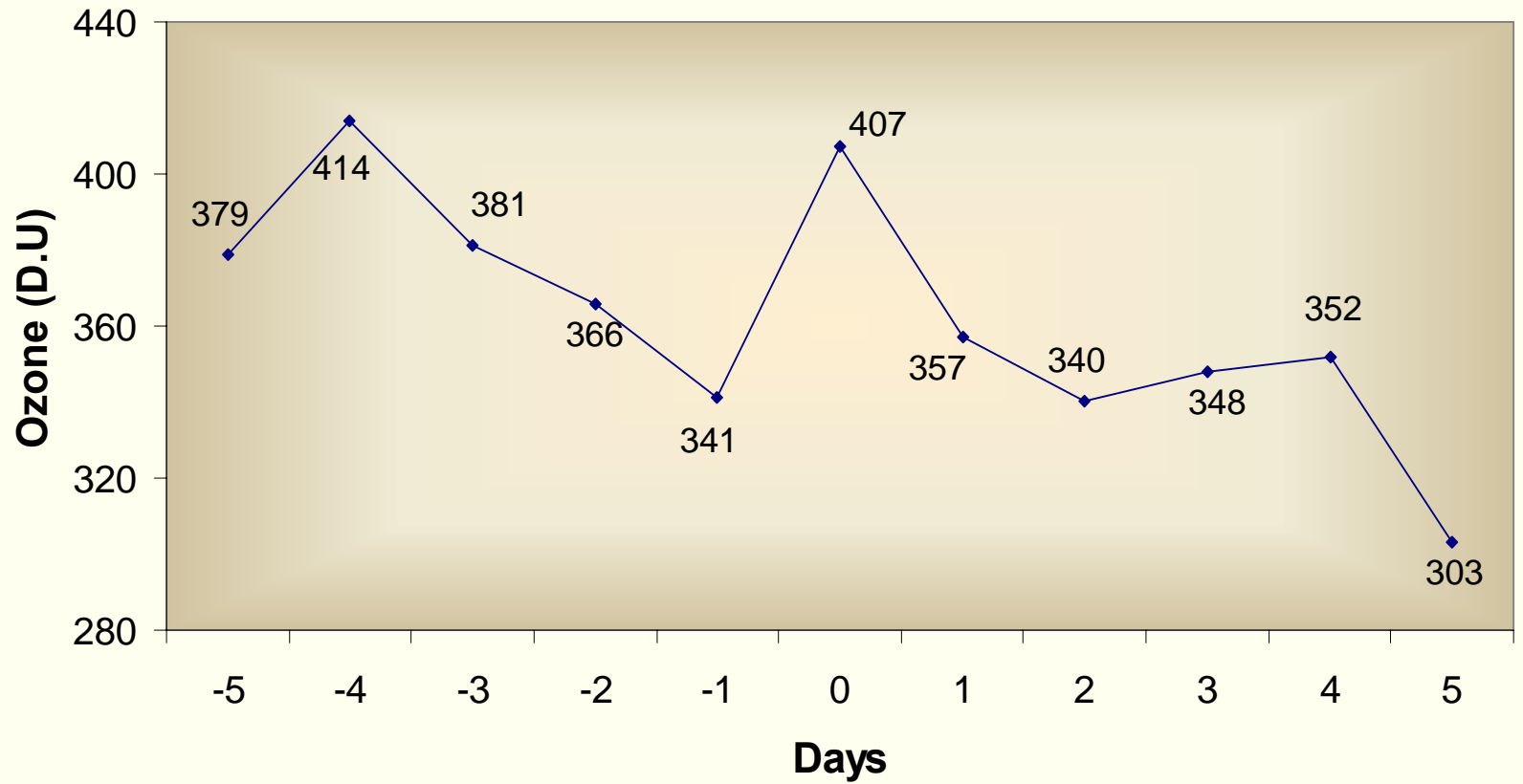
SASKATOON STATION 1992

Lat:52,11 Long:-106,7



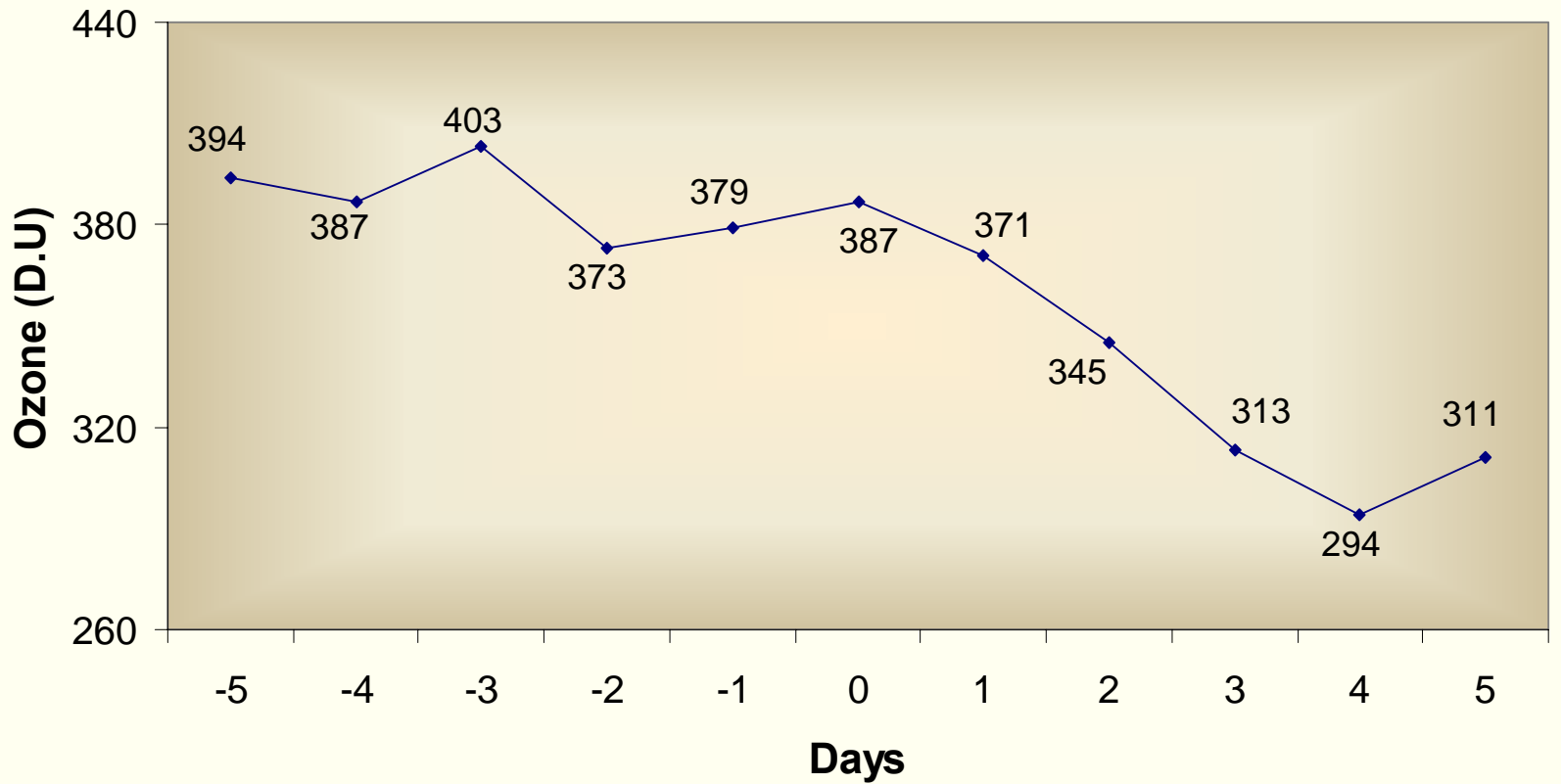
TORONTO STATION 1993

Lat: 43,7 Long:-79,47



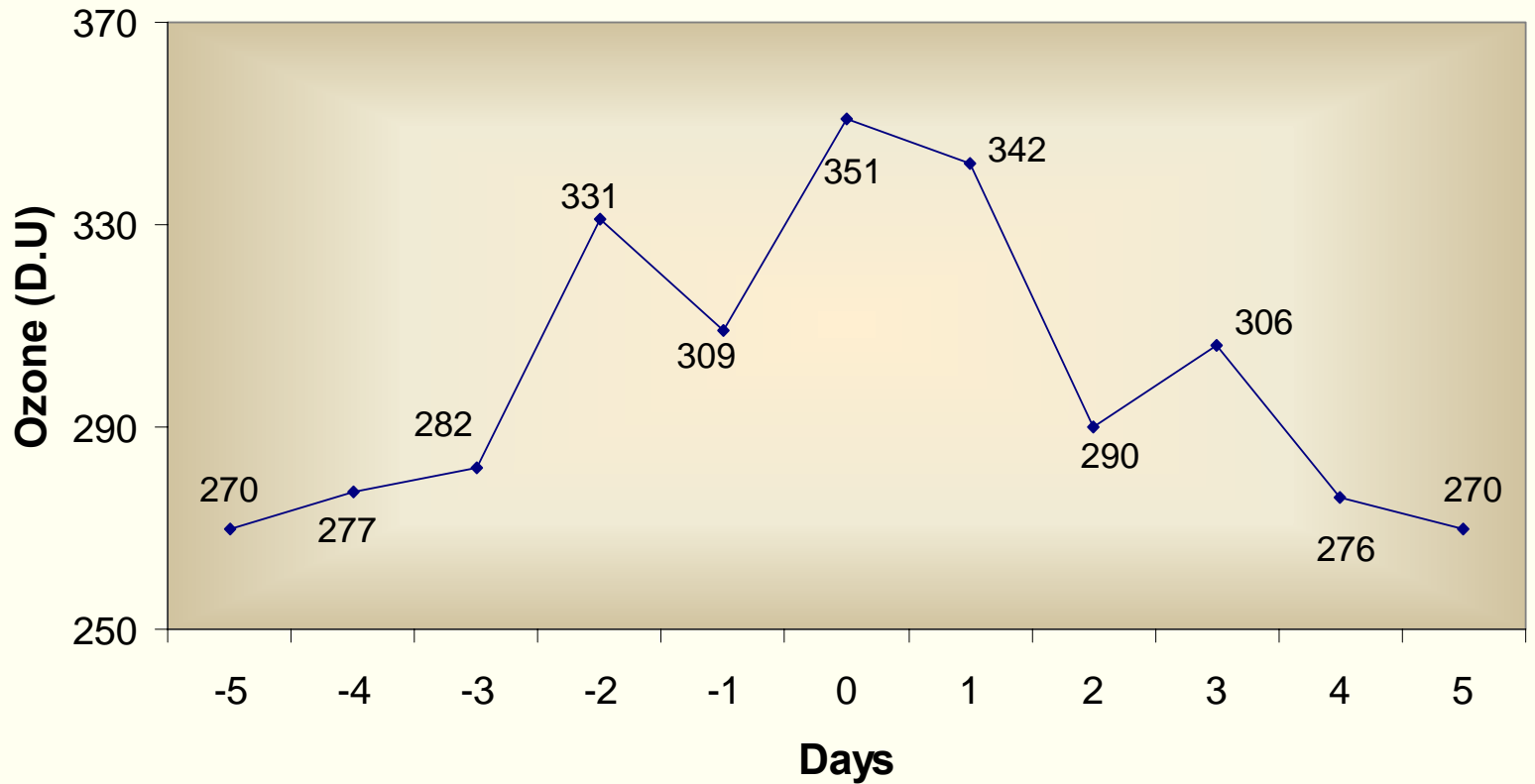
BELSK STATION 1994

Lat: 51,8 Long:20,7

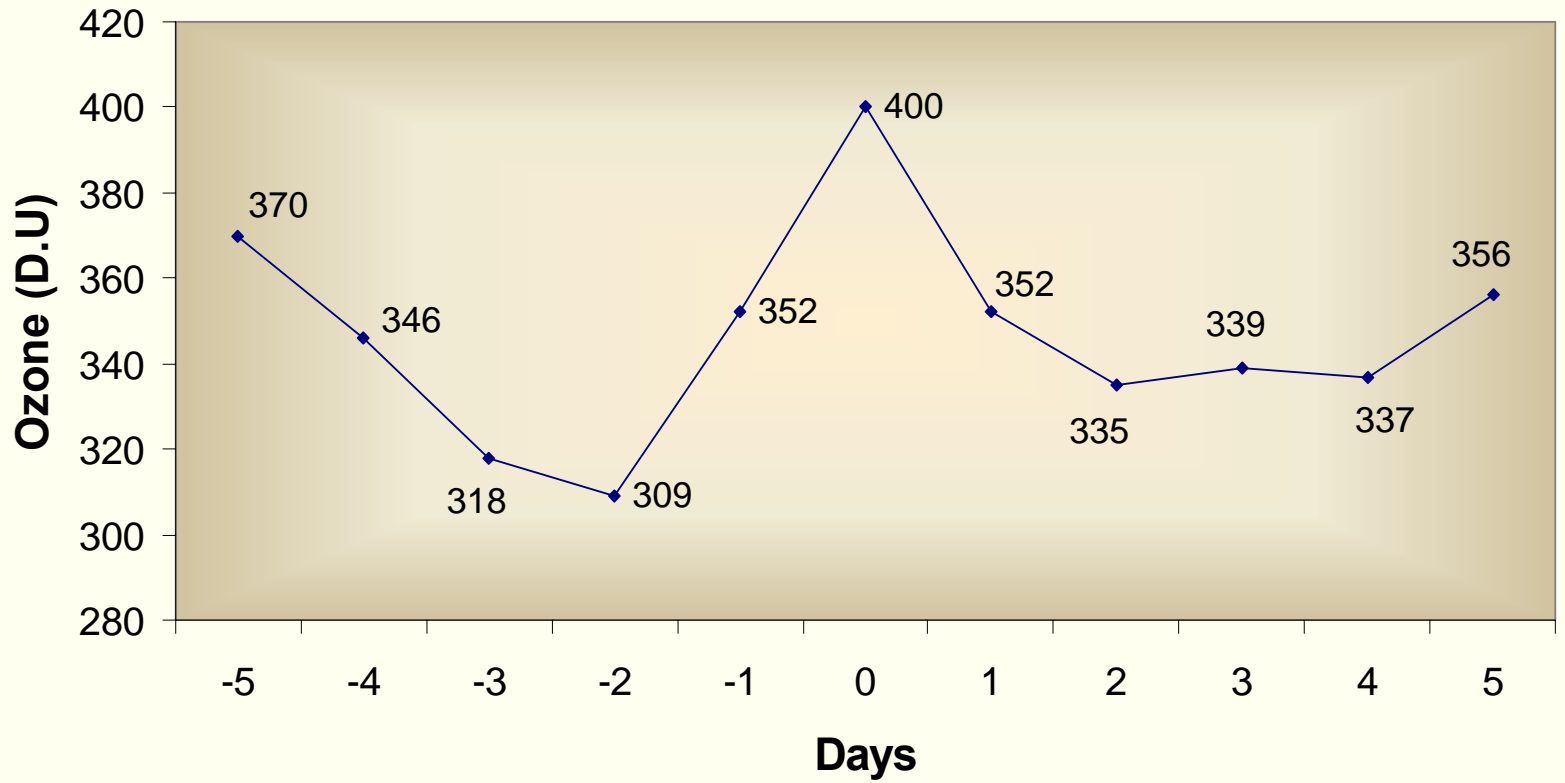


THESSALONIKI STATION 1995

Lat: 40,5 Long:23

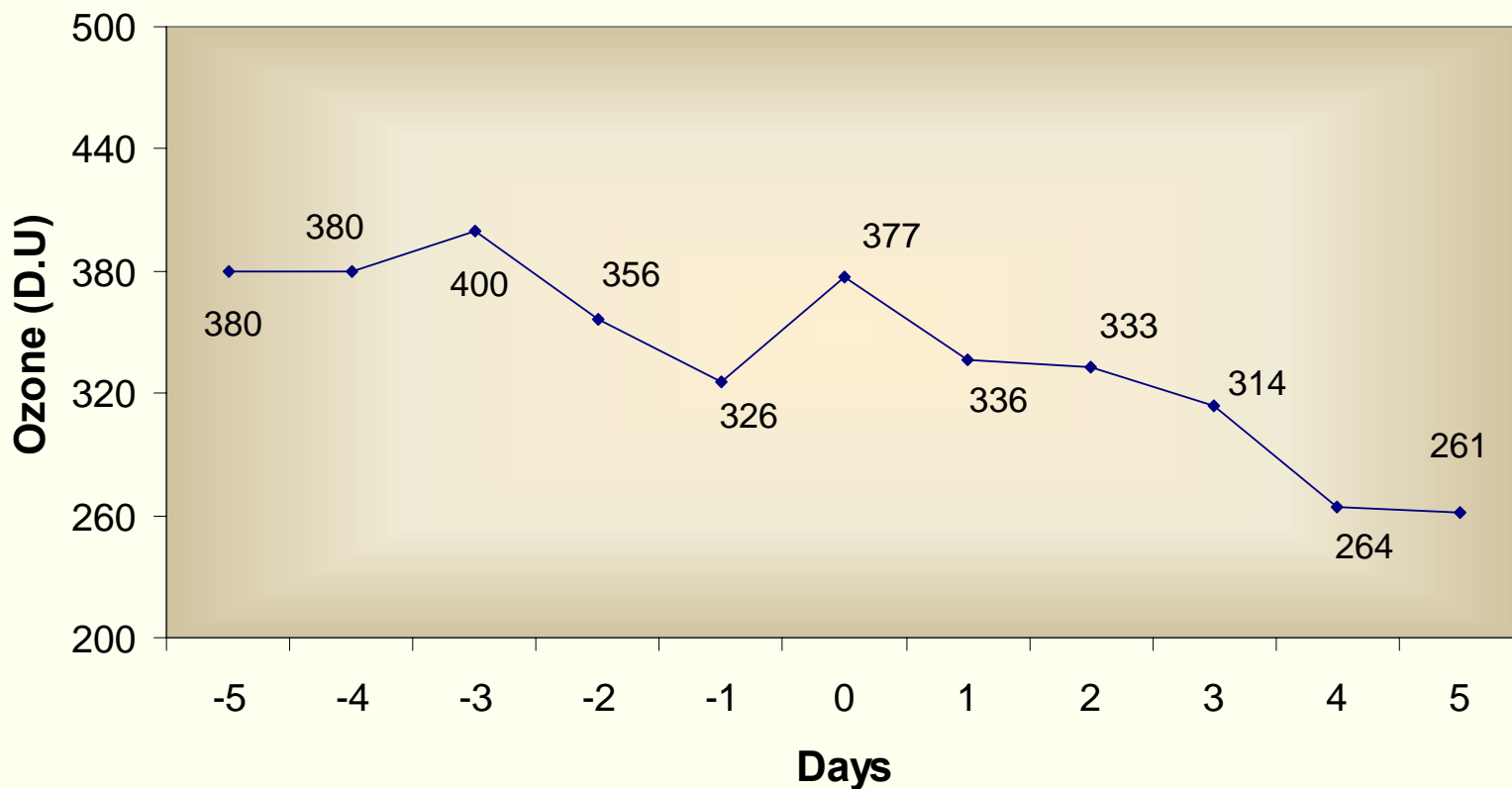


IRKUTSK STATION 1996
Lat: 52,2 Long:-104,3



POPRAD-GANOVCE STATION 1997

Lat:49 Long:20,3



Conclusions.-

- There is strong evidence that precipitating electrons are involved in stratospheric ozone destruction.
- However, there are many subjects open, like, propagation of electrons across the neutral atmosphere,
- Propagation of NO_x, NO_y to the ozone layer.
- Intermediate Mechanisms from the atmospheric top(1000 Km) to the Ozone layer (20-40 Km).
- In general, there is too much work left for young researchers who would like to deal with solar-terrestrial relations.



**THANK YOU FOR YOUR
ATTENTION!!**