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The excited electronic states of ionospheric molecular nitrogen.

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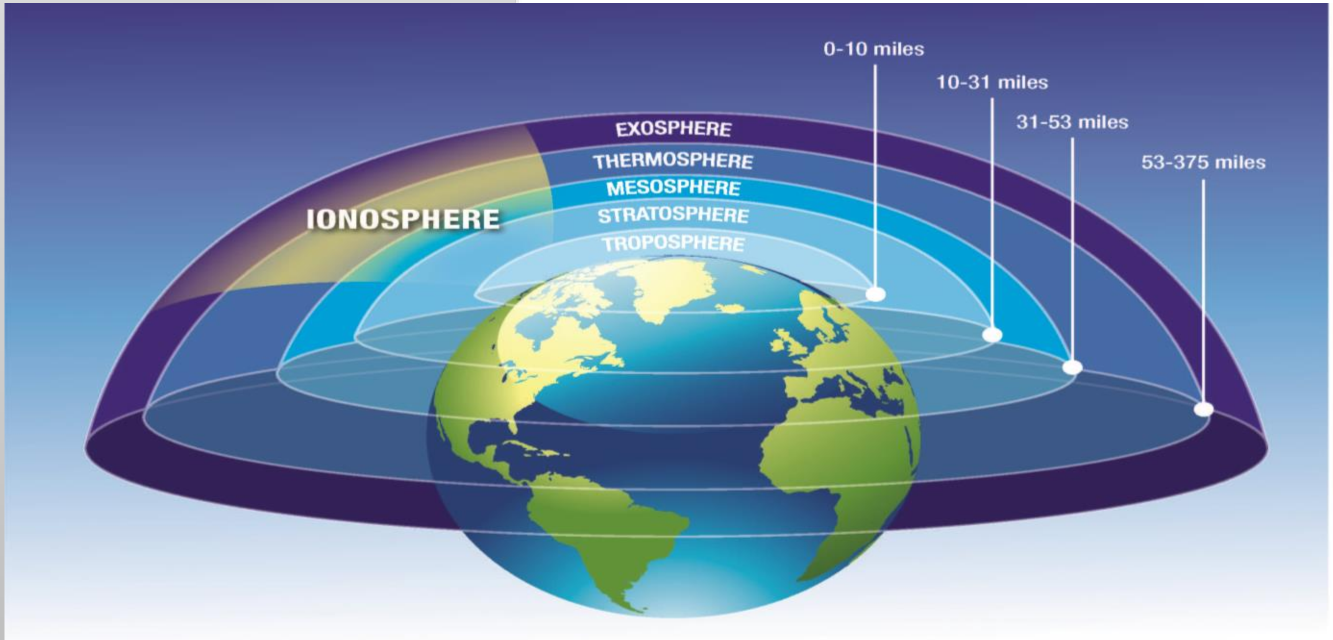
WORK PLAN

- Introduction
- Energetic inputs
- Boltzmann Equation
- Results
- Conclusion

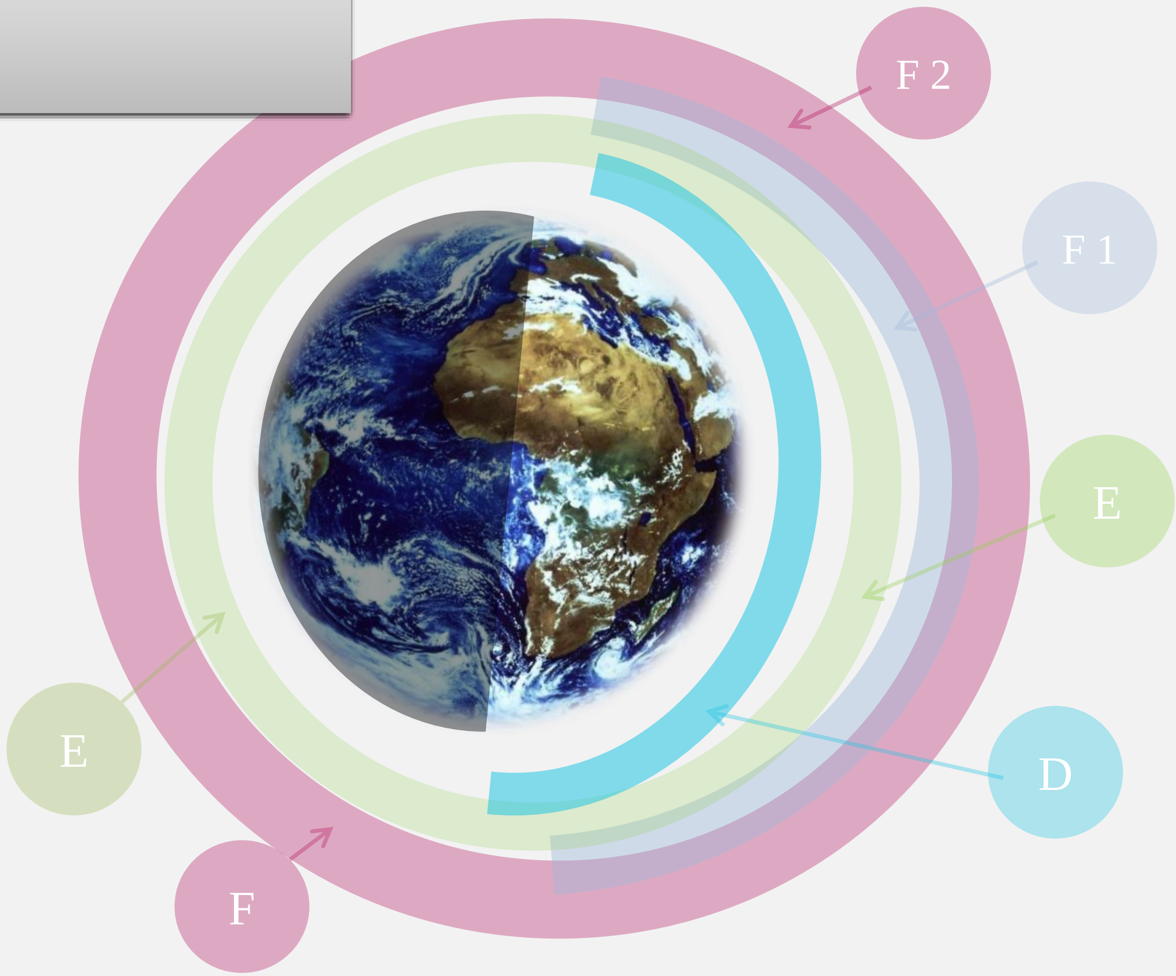
Earth Ionosphere

the ionosphere is a region of Earth's upper atmosphere, extending from about (50km to 1000 km) above the Earth's surface. It is primarily composed of ionized particles, and free electrons. The ionosphere plays a crucial role in various atmospheric and space phenomena.



The layers of the ionosphere

- Altitude: D(50-90),E(90-150),F(150-1000)km
- Electron density
- The components



Energetic inputs

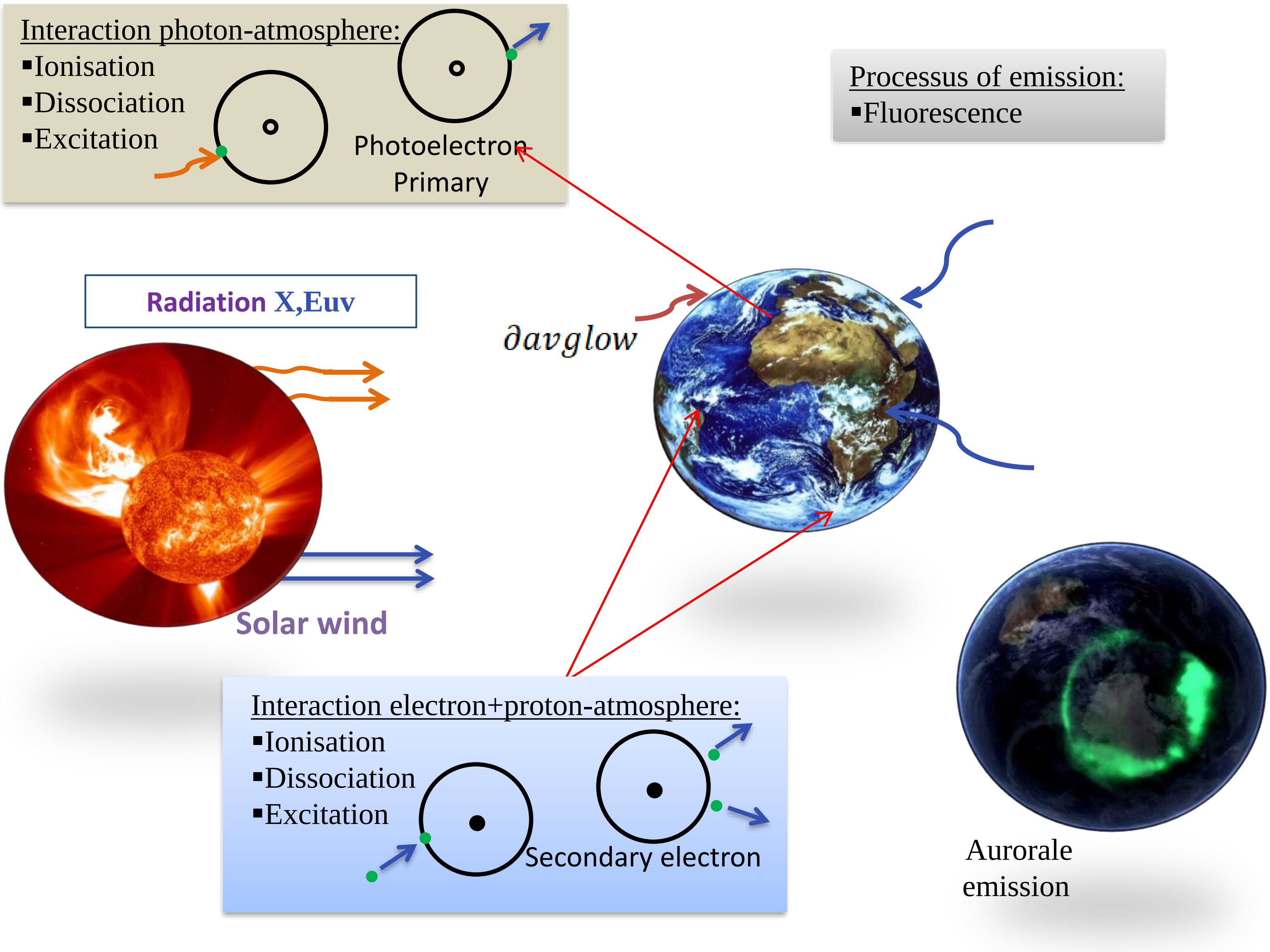
The Solar radiation EUV (photons)

- $2<\lambda<175nm$
- It measured by semi-empirical models like((tor &tor) and Tobiska) based on satellite measurements of solar flux, which expresses the flux through the solar activity index, which is high when the sun is active and low when it's not .

"**Electron precipitation**"

- Originate from the solar wind, initially low-energy(~ 0.5eV)
- Captured by Earth's magnetic field

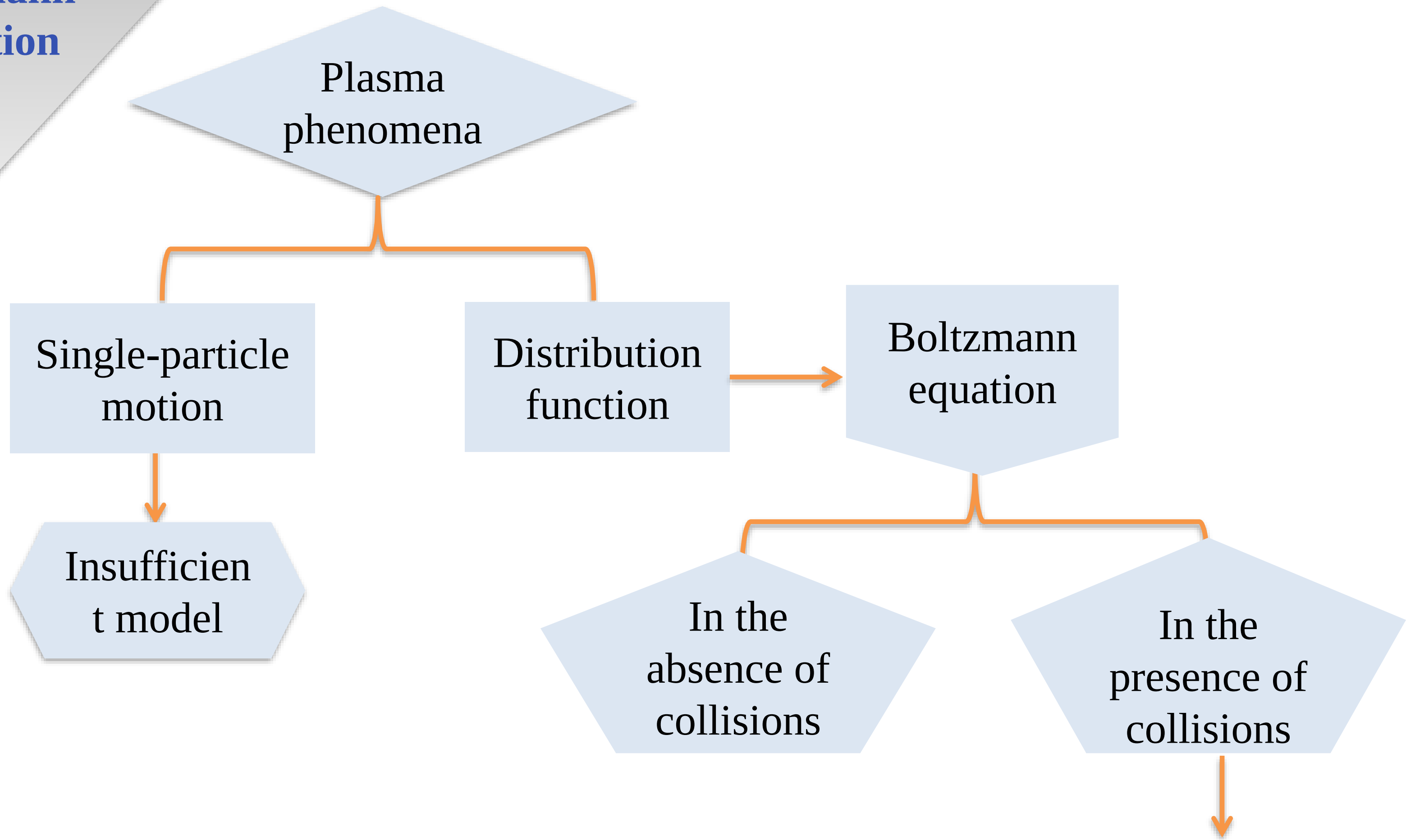
Sources of energie



In Earth's atmosphere... Electrons

The interaction of suprathermal electrons with neutral constituents gives rise to the luminous phenomena observed in the sky in auroral zones, where the colors observed depend on the excited neutral species.

Boltzmann Equation



$$\frac{\partial f(\vec{r},\vec{v},t)}{\partial t} + \vec{v}.\vec{\nabla}_r f(\vec{r},\vec{v},t) + \frac{\vec{F}}{m}\vec{\nabla}_v f(\vec{r},\vec{v},t) = \left[\frac{\delta f(\vec{r},\vec{v},t)}{\delta t}\right]_{coll}$$

Boltzmann equation for suprathermal electrons

Cosine of the angle of attack of the electron along the magnetic field line

Friction function between suprathermal and thermal electrons

Primary electrons of higher energy

$$\mu \frac{\partial \phi(z,E,\mu)}{\partial z} - n_e \frac{\partial}{\partial E}\Big(L(E)\phi(z,E,\mu)\Big) = sources - pertes$$

Electron concentration

Electron flux

Electron flux that degrades to lower energies through ionization, excitation, and dissociation.

Change of variable: $\phi_e(\vec{r}, E, \vec{v}, t) = \frac{v^2}{m_e} f(\vec{r}, \vec{v}, t)$

N_2-excitation

$$P_{sp}^{exc}(z) = n_{sp}(z) \int_0^{\infty} \varphi(\varepsilon, z)\sigma_{sp}^{exc}(\varepsilon)d\varepsilon$$

- P :Is the production rate of the excited state (cm^-3 s^-1)
- n : Is the density of neutral nitrogen molecules at the altitude z (cm^{-3}).
- $\sigma_{exc}(E)$: Is the electron-impact excitation cross-section of $N_2(A)$.
- φ:Is the steady-state suprathermale flux of electrons.

Parametres of modelisation

Winter day at 2 o'clock

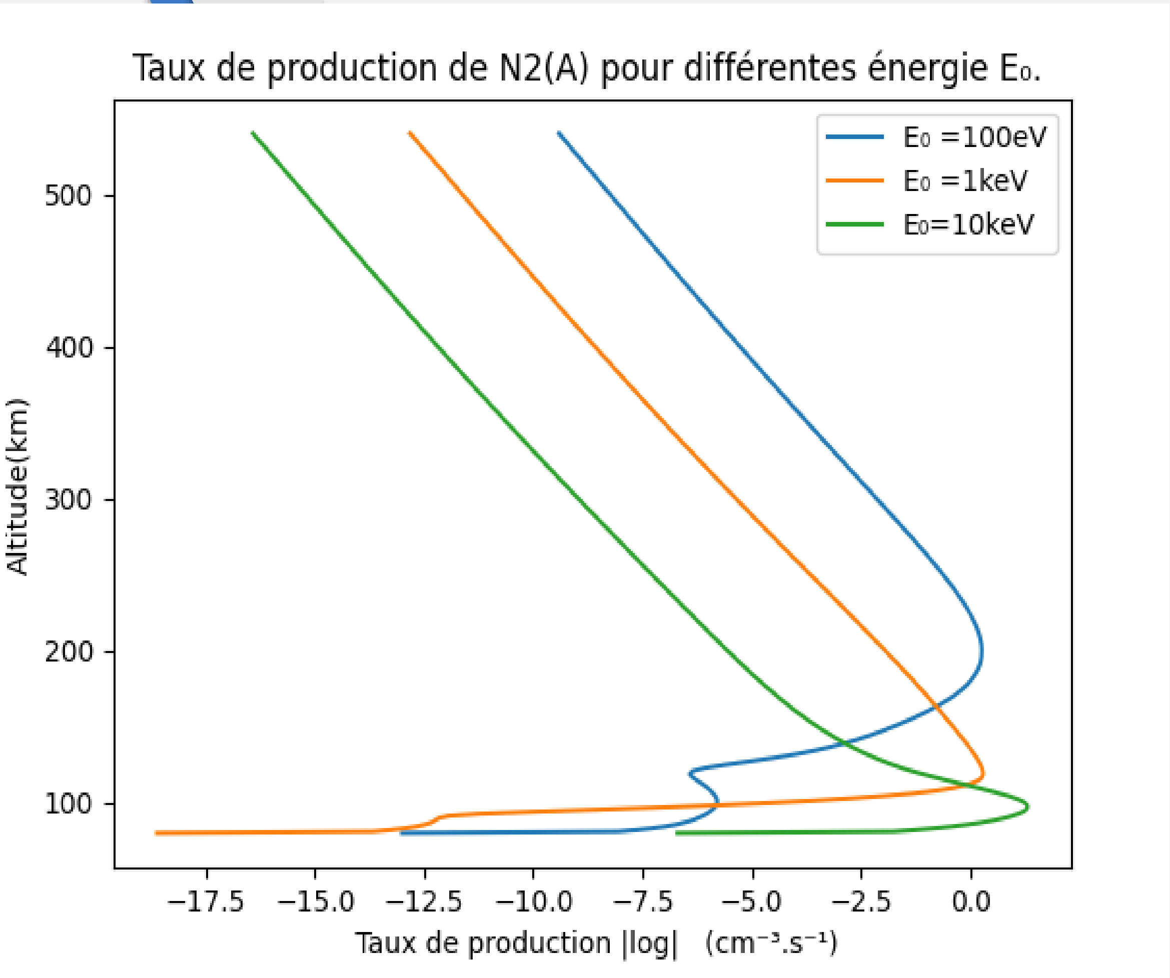
Parametres	Values
laltitude	76.42°
longitude	3.02°
Magnetic index Ap	9
Flux solar Index F10.7	150
Electron energy	500eV

The geophysical parameters for calculating the excitation productions of $N_2(A)$.

Results

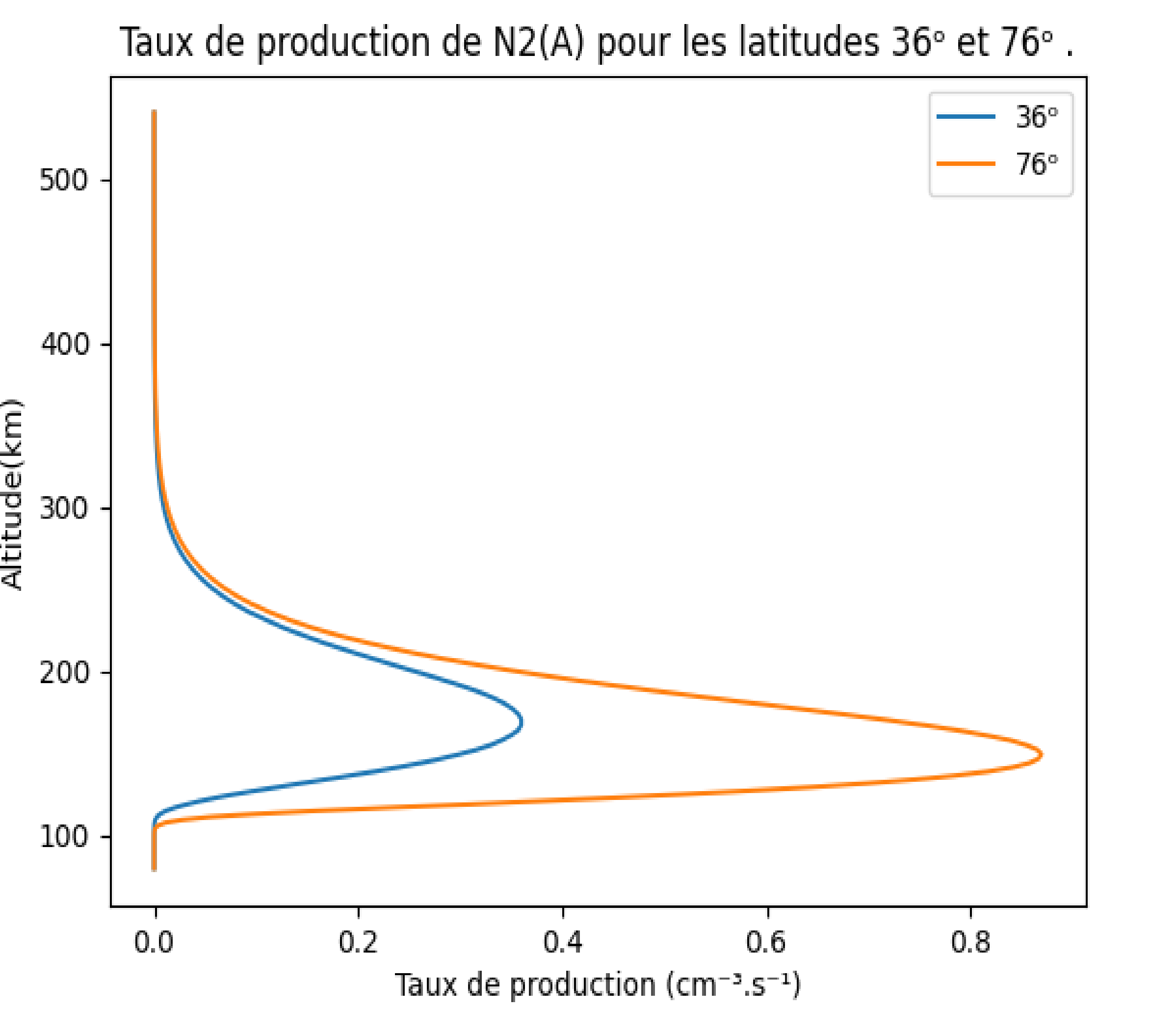
Sensitivity to precipitations

The effect of energy on the production rate variation of $N_2(A)$



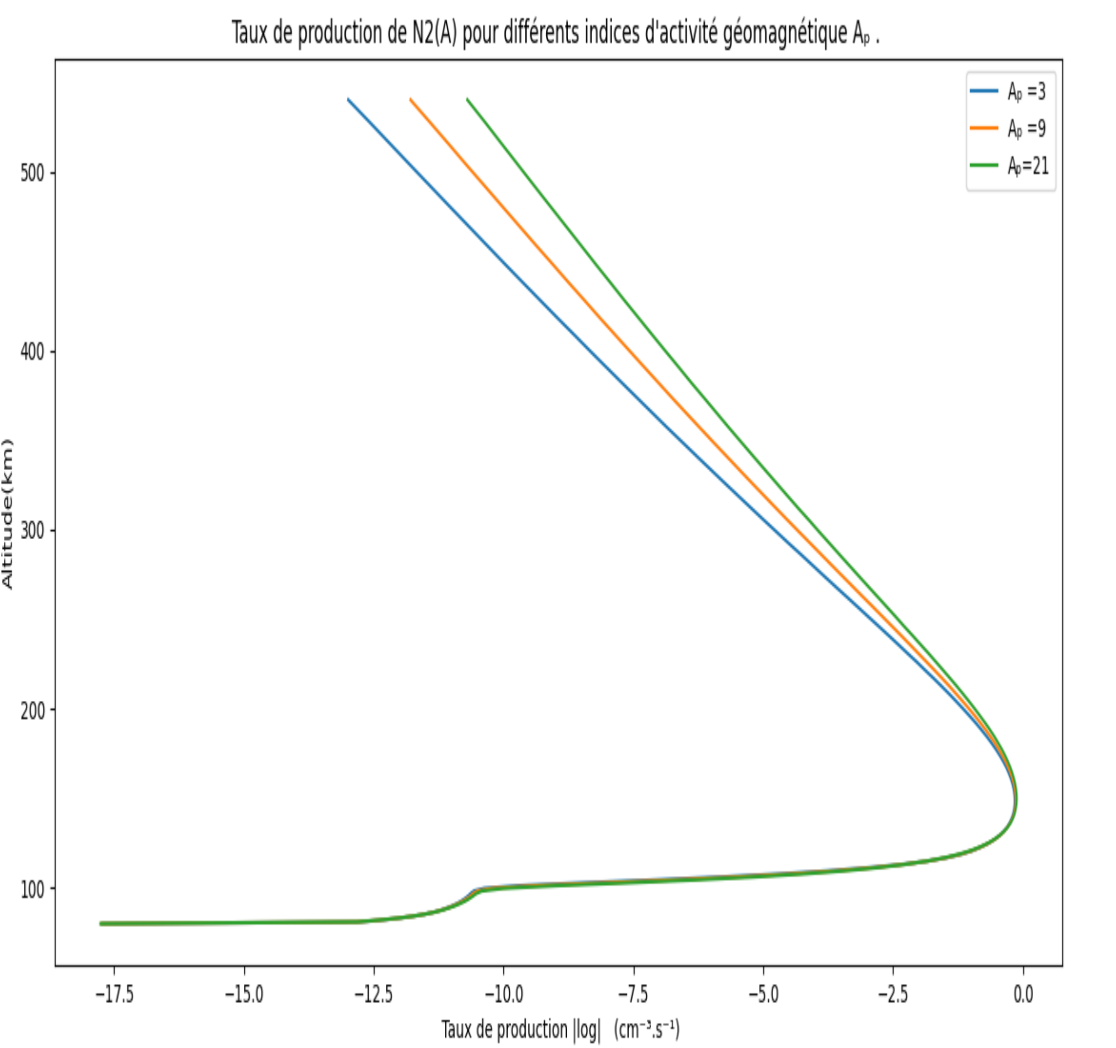
- ✓ The production rate of N2(A) for all three energy values increases with the rise in energy.
- ✓ It appears that modifying the average electron energy affects the altitude of the pic. This is because more energetic electrons penetrate deeper.

Sensitivity to geographical coordinates



- ✓ the production rate of the excited electronic state N2(A) at high latitudes is significant compared to average latitudes. Such a result is expected. The fact that precipitation influences the auroral zone.

Sensitivity to magnetic activity conditions



- ✓ The production rate is the same for all three AP values.
- ✓ the change in magnetic activity influences Earth's magnetic field, which captures different particles from the magnetosphere.
- ✓ These particles precipitate into the Earth's ionosphere in auroral regions.
- ✓ if the disturbance is strong enough, they reach the equator, where we observe auroras.

Conclusion

- ✓The production rate of N2(A) is high for high latitudes compared to averages.
- ✓The modeling parameters we used are interconnected.
- ✓Any change in the modeling parameters affects the entire atmospheric model.
- ✓The increase or decrease in N2(A) is linked to other particles such as oxygen.

Thanks