

Physical Variables written by CTIPe simulations

The **coordinate system** consists of

- Longitude **Lon** with **positive** vector components meaning **eastward**,
- Latitude **Lat** from -90 at the south pole to 90 at the north pole with **positive** being **northward**,
- Pressure level **IP** or altitude (height) **H** in km (3rd coordinate for plotting).
The altitude of a pressure level varies spatially and with time. Heights covered start at about 80 km (**IP=0**) and reach a few hundred km above ground.
Approximate altitudes: pressure level 1 (80km, lower boundary), level 3 (90km), level 5 (103km), level 6 (110km), level 7 (120 km, E-region ionosphere), level 8 (135km), level 9 (160km), level 12 (300 km, F-region ionosphere)

The **basic plasma and electrodynamic field variables in 3D** are:

- Neutral mass density **rho** in [kg/m^3].
- Particle number density **N** in [m^{-3}] with species identifier (after the "_"):
 - **e**: electrons,
 - **O**: atomic oxygen,
 - **N2**: nitrogen molecules,
 - **O2**: oxygen molecules,
 - **NO**: nitric oxide,
 - **NO+**: nitric oxide ion,
 - **N2+**: molecular nitrogen ion,
 - **O2+**: molecular oxygen ion,
 - **N+**: atomic nitrogen ion,
 - **O+**: atomic oxygen ion,
 - **H+**: atomic hydrogen ion.
- Neutral gas temperature **T_n** in [K].
- Mean molecular mass **Rmt** in [amu].
- Hall and Pedersen conductivities **sigma_H**, **sigma_P** in [mho/m].
- Neutral gas velocity **Vn** in [m/s] with its three components
Vn_Lat (meridional; positive north),
Vn_Lon (zonal, longitudinal; positive east),
Vn_IP (vertical, radial; positive south).
- Plasma (ion) velocity **Vi** in [m/s] with its components **Vi_Lat**, **Vi_Lon**
- Heating energy
Psolar: solar heating in [J/(kg·sec)]
Pjoule: joule heating in [J/(kg·sec)]

Prad: radiation heating/cooling in [J/(kg·sec)]

- Electric field

E140_theta: latitudinal component of electric field at 140 km in [V/m]

E140_lambda: longitudinal component of electric field at 140 km in [V/m]

E300_theta: latitudinal component of electric field at 300 km in [V/m]

E300_lambda: longitudinal component of electric field at 300 km in [V/m]

Height-integrated quantities in 3D data

available at each position in local time and latitude (obtained from 3D CTIP variables above)

- **NmF2**: maximum electron density N_e in [m^{-3}] in the vertical profile,
- **HmF2**: height in [km] of the maximum of N_e (see **NmF2**),
- **TEC**: integrated total electron content in [TECU= 10^{16} electrons/ m^2] in the altitude range of 80 km - 2000 km.

Height-integrated quantities

- **Wjoule**: Joule heating [mW/m^2],
- **Win**: Energy flux [mW/m^2],
- **En_avg**: Mean particle energy [keV],

Energy deposition rates (in GW)

- **P_tot** : auroral energy input over both the northern and southern hemispheres
- **P_euv,N** : extreme ultraviolet solar radiation ($\lambda < 102.7$ nm) integrated over northern hemisphere
- **P_euv,S** : extreme ultraviolet solar radiation ($\lambda < 102.7$ nm) integrated over southern hemisphere
- **P_uv,N** : far ultraviolet solar radiation (102.7 nm $< \lambda < 200$ nm) integrated over northern hemisphere
- **P_uv,S** : far ultraviolet solar radiation (102.7 nm $< \lambda < 200$ nm) integrated over southern hemisphere
- **P_J,E,N** : sum of Joule heating and kinetic energy dissipation in northern hemisphere
- **P_J,E,S** : sum of Joule heating and kinetic energy dissipation in southern hemisphere
- **P_Joule,N** : joule heating integrated over the northern hemisphere
- **P_Joule,S** : joule heating integrated over the southern hemisphere
- **P_kin,N** : kinetic energy in the northern hemisphere
- **P_kin,S** : kinetic energy in the southern hemisphere
- **P_kin** : kinetic energy in both the southern and northern hemispheres

Changes in output parameters from geomagnetic quiet condition ($K_p \sim 3$) :
rd(output parameter) (e.g: $rd(T_n) = T_n$ (current condition) – T_n (geomagnetic quiet condition))

Ratio of NmF2 **rr**(NmF2): $NmF2(\text{current condition})/NmF2(\text{geomagnetic quiet condition})$