Physical Variables written by CTIPe simulations

The coordinate system (geographic) consists of:
- Geographic longitude \( \text{Lon} \) with positive vector components meaning eastward,
- Geographic latitude \( \text{Lat} \) from -90 at the south pole to 90 at the north pole with positive being northward,
- pressure level \( \text{IP} \) or height \( H \) in km.

Vector (arrow) plots of the velocities only make sense as:
- vertical cuts (meridional or at constant-latitude) if \( \text{UseHeight} \) is selected,
- synoptic maps of velocity vectors (over local time and latitude) if plotted at constant height (not constant pressure level \( \text{IP} \)).

The basic plasma and electrodynamic field variables in 3D are:
- Neutral mass density \( \rho \) in \([\text{kg/m}^3]\).
- \( H \) (height) in \([\text{km}]\) corresponding to pressure level number \( \text{IP} \)
The height of a pressure level varies spatially and with time. Heights covered start at about 80 km (\( \text{IP}=0 \)) and reach a few hundred km above ground (the maximum found for \( \text{IP}=14 \), the top layer, is typically between 450 km and 1000 km).
The height can be used as an alternative 3rd coordinate for plotting.
- Particle number density \( N \) in \([\text{m}^{-3}]\) 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 \([\text{K}]\).
- Mean molecular mass \( \text{Rmt} \) in \([\text{amu}]\).
- Hall and Pedersen conductivities \( \text{sigma}_H, \text{sigma}_P \) in \([\text{mho/m}]\).
- Neutral gas velocity \( V_n \) in \([\text{m/s}]\) with its three components \( V_{n\_Lat} \) (meridional; CTIP name "V_x"), \( V_{n\_Lon} \) (zonal, longitudinal; CTIP name "V_y") and \( V_{n\_IP} \) (vertical, radial; CTIP name "V_z").
- Plasma (ion) velocity \( V_i \) in \([\text{m/s}]\) with its components \( V_{i\_Lat} \) ("Vi_x"), \( V_{i\_Lon} \) ("Vi_y"). \( V_{i\_IP} \) ("Vi_z") is missing in the model output and assumed to be zero for vector arrow plots.
- Heating energy \( \text{Psolar} \): solar heating in \([\text{J/(kg\cdotsec)}]\)
**Pjoule**: joule heating in [J/(kg·sec)]

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

- **Electric field**
  - E\_140\_theta: latitudinal component of electric field at 140 km in [V/m]
  - E\_140\_lambda: longitudinal component of electric field at 140 km in [V/m]
  - E\_300\_theta: latitudinal component of electric field at 300 km in [V/m]
  - E\_300\_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 \([TECU=10^{16} \text{ electrons/m}^2]\) in the altitude range of 80 km - 2000 km.

**Height-integrated quantities**

- **Wjoule**: Joule heating \([\text{mW/m}^2]\),
- **Win**: Energy flux \([\text{mW/m}^2]\),
- **En\_avg**: Mean particle energy \([\text{keV}]\),

**Energy deposition rates (in GW)**

- **P\_tot**: auroral energy input over both the northern and southern hemispheres
- **P\_euv,N**: extreme ultraviolet solar radiation \((\lambda < 102.7 \text{ nm})\) integrated over northern hemisphere
- **P\_euv,S**: extreme ultraviolet solar radiation \((\lambda < 102.7 \text{ nm})\) integrated over southern hemisphere
- **P\_uv,N**: far ultraviolet solar radiation \((102.7 \text{ nm} < \lambda < 200 \text{ nm})\) integrated over northern hemisphere
- **P\_uv,S**: far ultraviolet solar radiation \((102.7 \text{ nm} < \lambda < 200 \text{ nm})\) 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 northern hemisphere
- **P\_Joule,N**: joule heating integrated over the northern hemisphere
- **P\_Joule,S**: joule heating integrated over the northern 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 \((Kp \sim 3)\): \( rd(output \ parameter) \)

\[(e.g: \ rd(T_n) = T_n \ (current \ condition) - T_n \ (geomagnetic \ quiet \ condition))\]