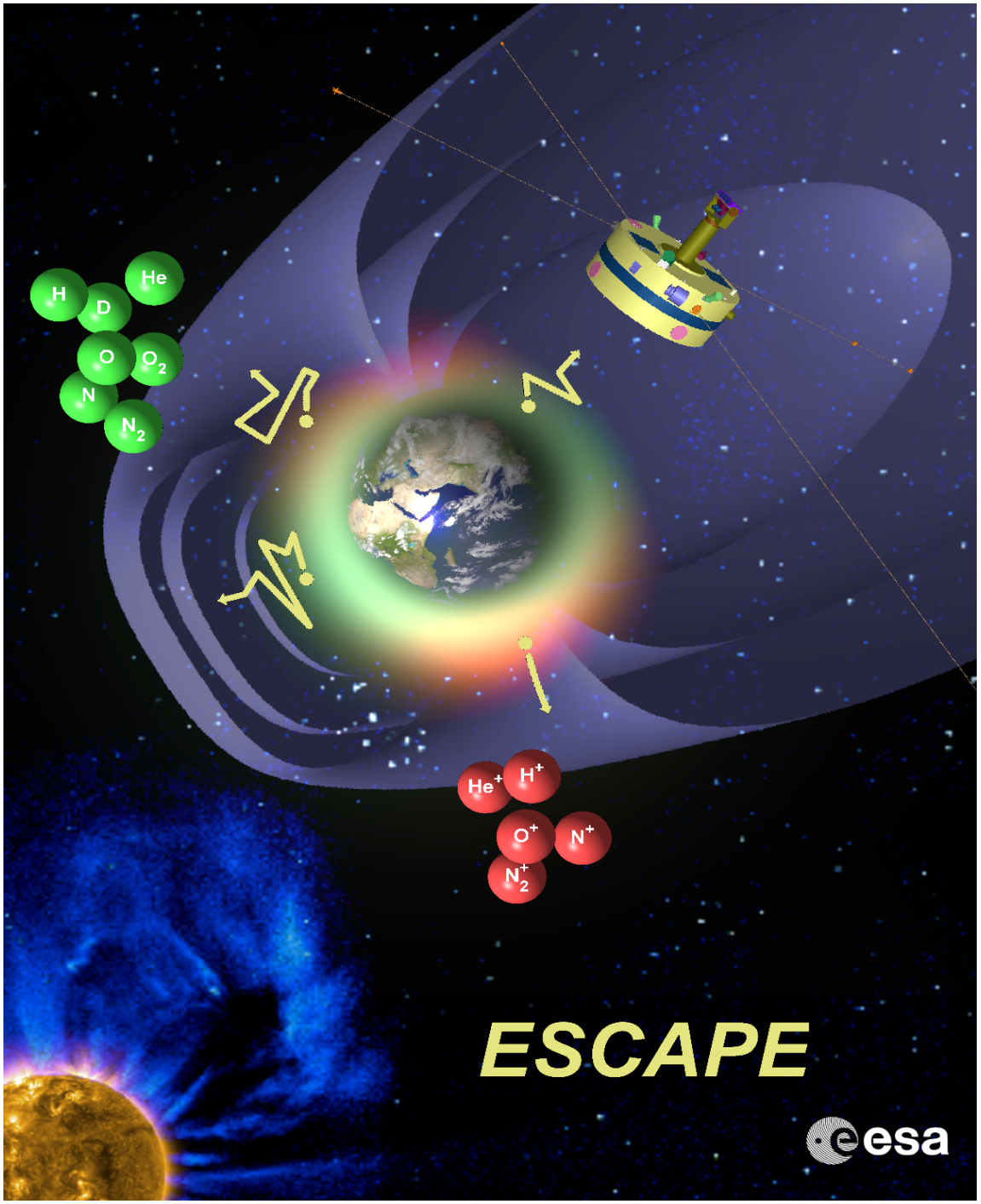
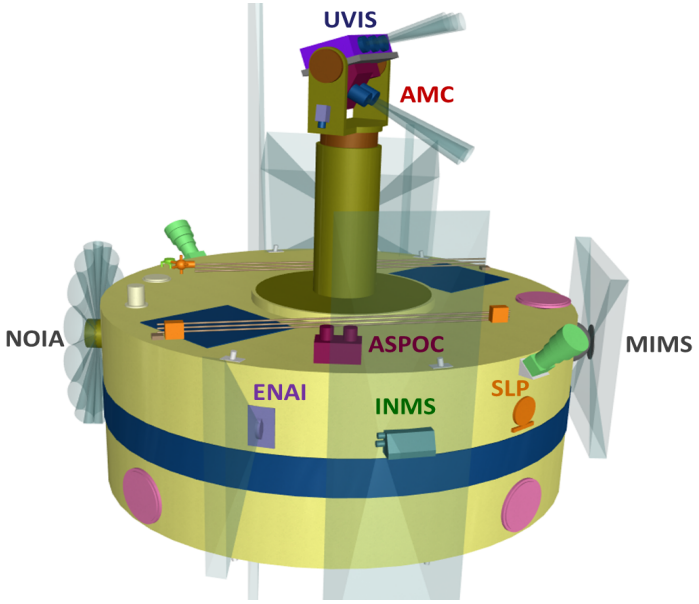


ESA M5 Proposal

ESCAPE

European SpaceCraft
for the study of
Atmospheric Particle Escape

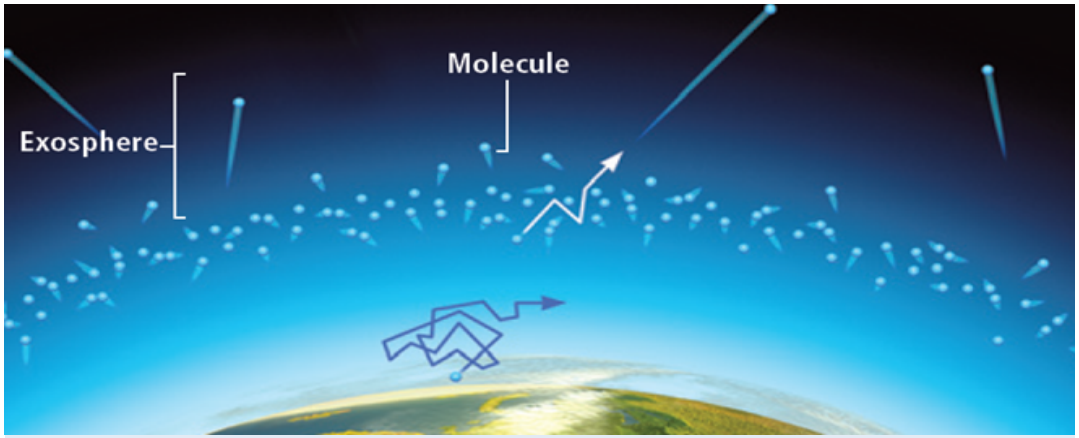
I. Dandouras (IRAP, Toulouse = Lead)
M. Yamauchi (IRF, Kiruna = co-Lead)
and **the ESCAPE Proposal Team**



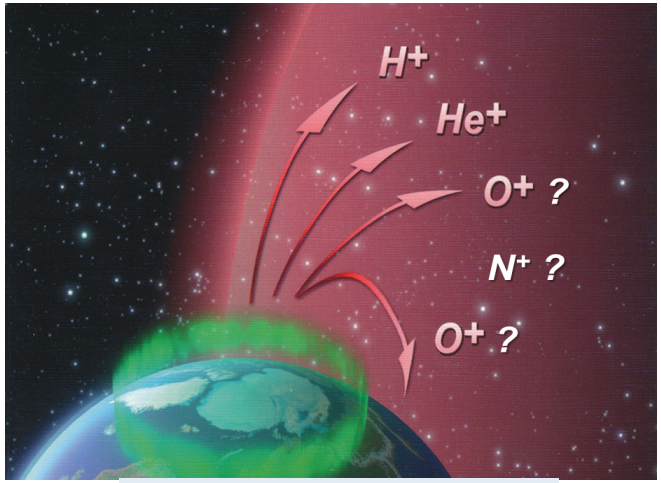
THEME: How and at what rate is Earth slowly losing its atmosphere to space?

What are the dominant escape mechanisms?

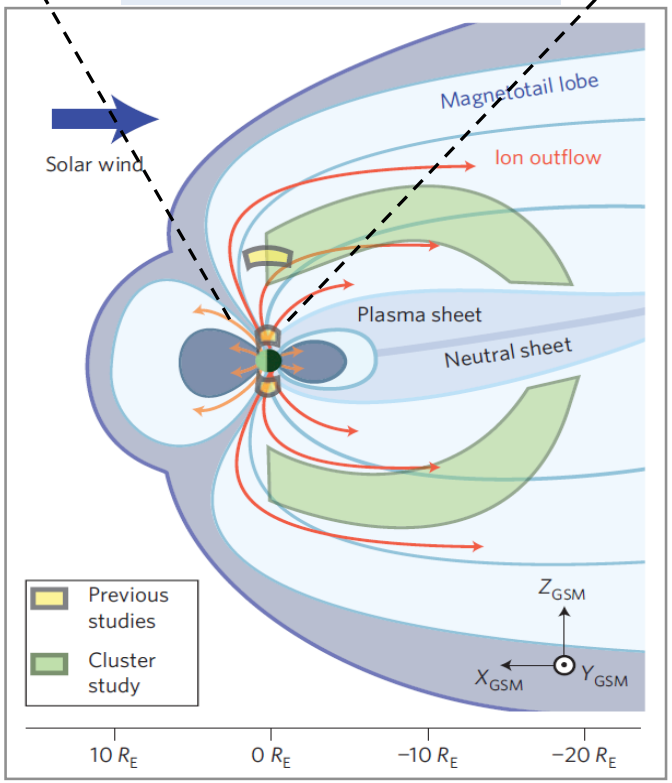
What is their dependence on the solar and geomagnetic activity conditions?



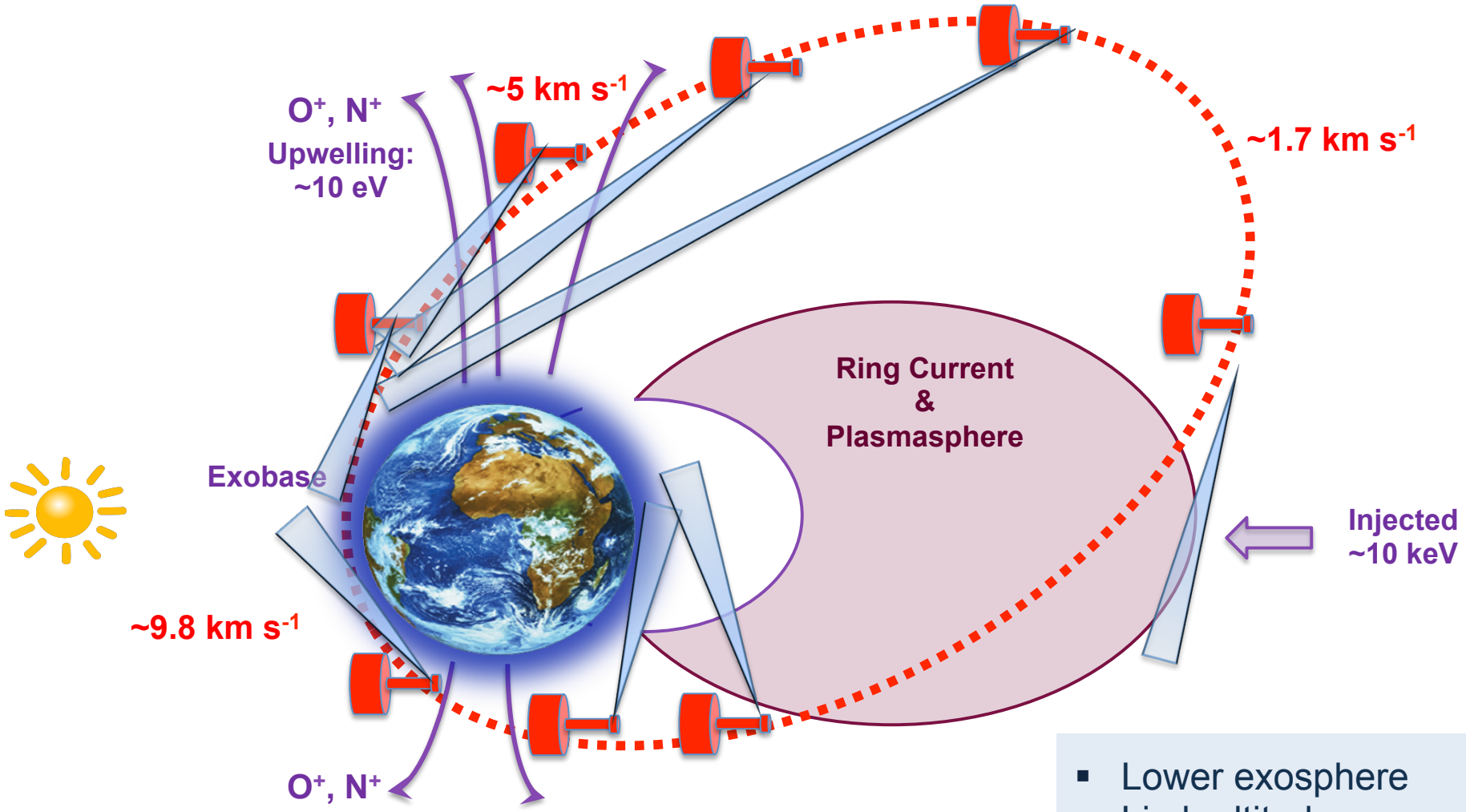
Neutral escape



Ion escape



Remote sensing of a selected exosphere region, while acquiring in-situ measurements in the upwelling region

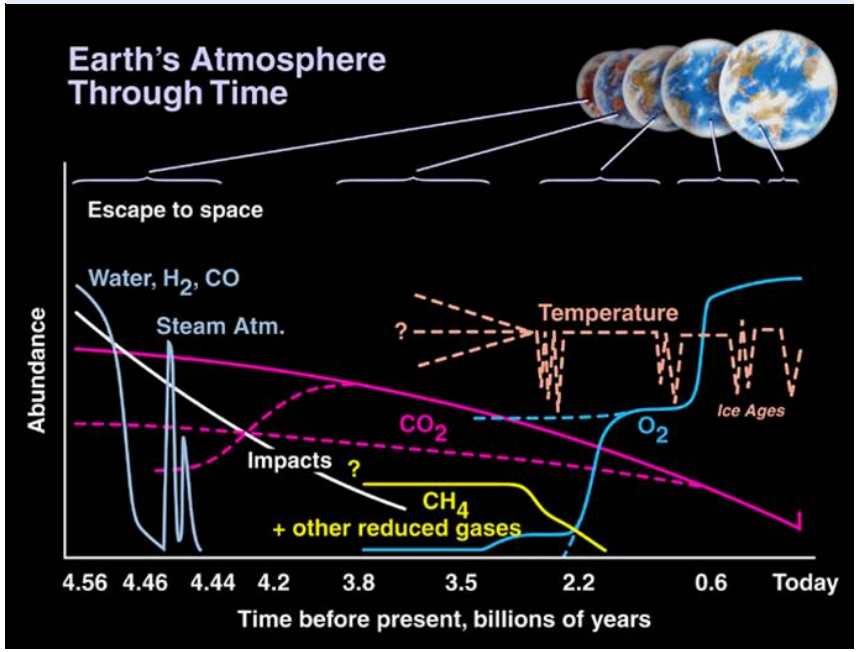


Imagers provide both: **remote sensing observations** of escaping populations and **visual support for outreach to the public**

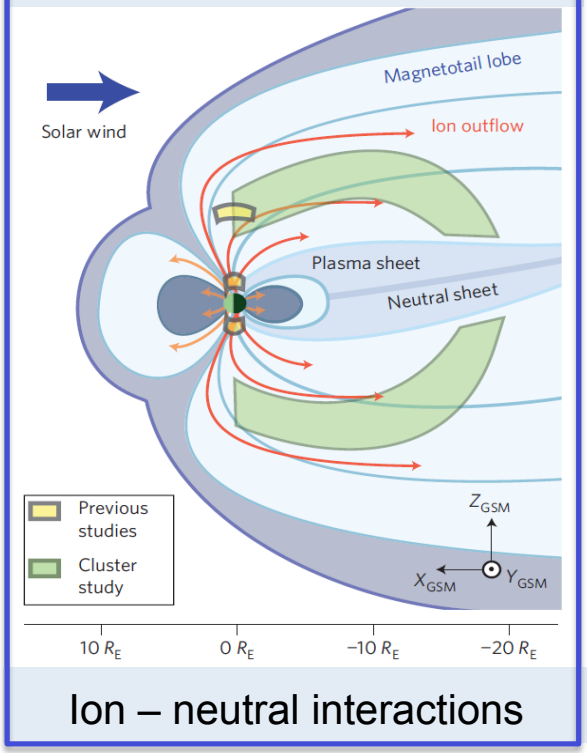
- Lower exosphere
- Limb altitude scans
- Ion upwelling regions
- Middle exosphere
- Plasmasphere

ESCAPE objectives are interdisciplinary

History of the Earth's atmospheric composition over a long (geological scale) time period

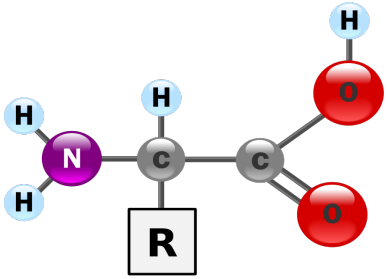


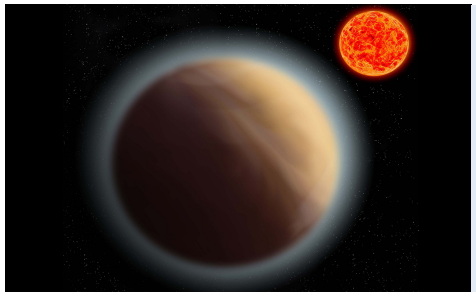
Ion and neutral escape



Ion – neutral interactions

Implications for habitability: nitrogen & oxygen are essential elements for life

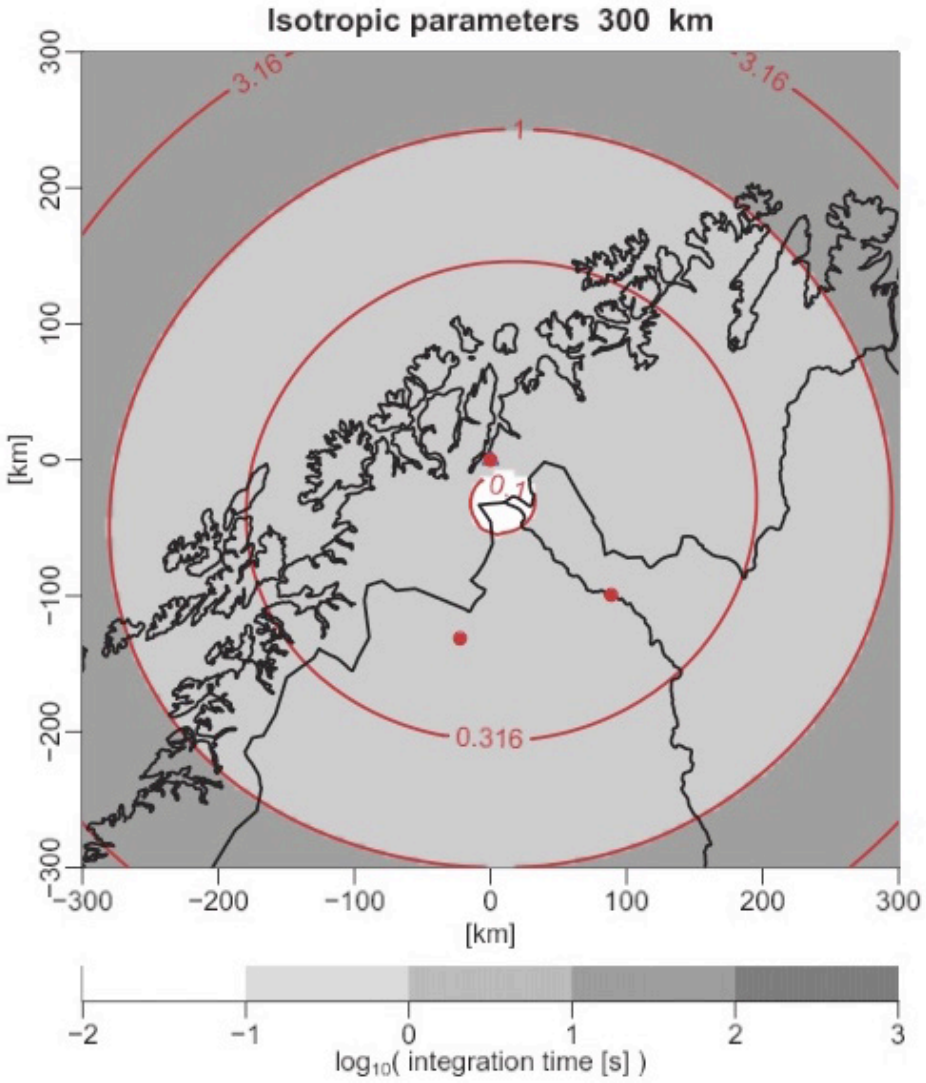




Atmospheric evolution of exoplanets

Comparative planetary atmospheres evolution

Covering area of EISCAT_3D



High sensitivity in more than 500 km diameter (grey area) ≈ 15° longitudinal range

⇓

5 % of polar orbits traverses this region in average

+

More conjugacies if we consider geomagnetic tracing

Some Unique Features of the ESCAPE Mission

 # 1: **A quantum leap in our knowledge** :

- First time comparison of **neutral/thermal escape** and **ion/non-thermal escape**
- First time thorough observation of the escape sources: **the exosphere > 500km** to give robust numbers (n, T)
- First time thorough observations of **isotope ratios** in the geospace environment

 # 2: **Unique observational strategy**:

- Unique **combination of in-situ and remote sensing** measurements
- Priority in high-mass resolution so that O-N separation becomes possible
- Low perigee with a wide altitude range: 500-33000 km

Some Unique Features of the ESCAPE Mission

 # 3: **Timely mission** :

- European **EISCAT_3D** , an revolution of ground-based observation that has just started, will be matured by launch
- We do not know as much on the exosphere of Earth as we now know on planetary exospheres
- Reference data for exo-planetary / planetary atmospheres and habitability, which now receives high public interest

 # 4: **Interdisciplinary objectives** :

- Basic ionization processes
- Neutral atmospheric science + space plasmas physics
- Comparative planetology
- Atmospheric evolution and habitability
- Satellite drag by atmospheric expansion during space weather events

ESCAPE Scientific Objectives

1. Build a quantitative and comprehensive picture for 500-2000 km altitudes

- Determine **exospheric** altitude density profiles and temperature profile **as a function of different drivers** such as **solar EUV, solar wind and geomagnetic conditions**.
- Establish **isotope ratios** for both **neutrals and ions** and compare them with those found at the Earth's surface and in other solar system objects.
- Determine **exospheric altitude profiles of ion/neutral ratios** and estimate ionisation / neutralisation efficiencies.
- Measure **temporal and spatial variations** of the density of **major exospheric species**.
- Correlate such **variability** with upper atmosphere parameters, and with different incident energies when **particle precipitation** is present.

2. Determine the dominant escape mechanisms, and their dependence on the drivers

- Estimate **thermal escape flux** for neutral and ion species **for different conditions**.
- Estimate the **prevailing escape mechanisms** and the relative importance of thermal or non-thermal escape **for different driver conditions**.
- Estimate the **response** of the ionisation / neutralisation efficiencies, isotope fractionation and the N/O ratio **to different drivers**.
- Estimate the **degree of recirculation of plasma** after it has left the ionosphere.