

FYS 3003: Programming task 3

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Photo-ionization

- a Make functions that calculate the production rate of photo-electrons as a function of altitude and energy.
- b Make functions that calculate the photo-ionization profiles as a function of altitude.

Here you should use the functions for calculating the optical depth and EUV photon-flux in the thermosphere to calculate the altitude-profile of total photo-ionization-rates, and the photo-electron production rate. The presentation of this task should contain plots for solar zenith angles between 0 and 50 degrees (in steps of 10 degrees), and for full credits 75 degrees. Comparisons of the total ionization-profiles with the simplified relations for the solar-zenith-angle variation of the peak photo-ionization-rate and its altitude (equations 4.18 and 4.15 in the Brekke-book respectively).

See Chapter 2 of Physics and Chemistry (M H Rees):

<https://www.cambridge.org/core/books/physics-and-chemistry-of-the-upper-atmosphere/interactionof-energetic-solar-photons-with-the-upper-atmosphere/C85B0C162B7F347214CCC8129F257739> for the background physics and geometry for the necessary equations to implement. The functions you write should be general enough to work for a given atmospheric density-profiles, possibly with completely different composition than the upper atmosphere of Earth. However, the example and test-atmospheres we will use are the Earth's atmosphere, as are the photo-absorption and photo-ionization cross-sections and the solar EUV irradiances.