

# Advanced radiation and remote sensing

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## Exercise No. 7 – Outgoing Longwave Radiation (OLR)

1. Run ARTS on the Jupyter notebook `olr.ipynb`. This will calculate the spectrum of outgoing longwave radiation for a midlatitude-summer atmosphere. Our calculation trades accuracy for computational efficiency. For example, we use only water vapor and carbon dioxide as absorbers. We use only 300 frequency grid points and approximately 54,000 spectral lines, whereas for accurate calculations one needs at least 10,000 frequency grid points and 500,000 spectral lines, taking into account absorbing species like ozone and methane. The script plots the spectral irradiance, in SI units, as a function of wavenumber. Planck curves for different temperatures are shown for comparison. We integrate the whole spectrum to quantify the power per square that is emitted by the atmosphere (value in title).
  - (a) How would the OLR spectrum look in units of brightness temperature?
  - (b) How would the Planck curves look in units of brightness temperature?
  - (c) Find the CO<sub>2</sub> absorption band and the regions of H<sub>2</sub>O absorption. From which height in the atmosphere does the radiation in the CO<sub>2</sub> band originate?
  - (d) Are there window regions?
  - (e) What will determine the OLR in the window regions?
  - (f) Use the plot to explain the atmospheric greenhouse effect.
2. Investigate how the OLR changes for different atmospheric conditions by modifying the input data. Use `atmfield.scale(...)`, `atmfield.set(...)` and `Change_T_with_RH_const(...)` to change the atmospheric data:
  - Add 1 K to the temperature.
  - Add 1 K to the temperature but hold relative humidity constant.
  - Increase the CO<sub>2</sub> concentration by a factor of 2.
  - Increase the H<sub>2</sub>O concentration by a factor of 1.2.
  - (a) Change it, and calculate and plot the spectrum for each change.
  - (b) Compare the spectra of the changed atmosphere with the unchanged OLR spectrum. Where do the changes occur? Explain the different effects of the changed atmospheres.
  - (c) Compare the OLR numbers, which is the more potent greenhouse gas, CO<sub>2</sub> or H<sub>2</sub>O?