

Advanced radiation and remote sensing

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Exercise No. 8 – Scattering

1. Run the Python script `scattering.py`. This will simulate the radiation field at a frequency of 229 GHz for an atmosphere with an ice cloud as well for clear-sky. Since this is a one-dimensional simulation (vertical dimension only), the calculated radiation fields have two dimensions: altitude (pressure) and zenith angle. The python script will plot the two radiation fields in the atmosphere at a zenith angle of 180° . Here, the zenith angle describes the viewing direction. This means that you are looking at the upward directed radiation. The unit is brightness temperature.
 - (a) Describe the difference between cloudy and clear-sky radiation.
 - (b) Guess where the ice cloud is located in the atmosphere based on the two radiation fields?
 - (c) Explain the difference between cloudy and clear-sky radiation.
2. Change the zenith angle (`zenith_angle`) from 180° to 0° and rerun the Python script.
 - (a) Describe and explain the difference.
 - (b) Why is the brightness temperature at the top of the atmosphere so low?
3. Now you will look at the radiation fields as a function of zenith angle (viewing direction) at a fixed pressure level. In the Python script, change the variable `pressure_level` from `None` to a pressure level in [Pa], which is within the ice cloud and rerun the script.
 - (a) Explain the shape of the radiation field without the cloud.
 - (b) How does the radiation field with the cloud differ?
4. Make the same calculation as in task 3 but with a less or a more dense ice cloud. To do that, you have to call the function `scattering()` within your script with the argument `ice_water_path` set to your desired value in $[\text{kg m}^{-2}]$. The ice water path is the vertically integrated mass content of ice. In task 3, the function `scattering()` used a default value of 2 kg m^{-2} .