

Exercise No. 5 – Jacobian and Chapman's rule

1. Run arts on the controlfile “jacobian.arts”. (This time you have to do this only once.)
2. Start Matlab, run “plot_jacobian.m”. You get a figure with two sub-plots. One is the spectrum of nadir brightness temperature (BT) at the top of the atmosphere, the other is atmospheric zenith opacity. Both are for a spectral range near the 183.31 GHz water vapor line for a midlatitude-summer atmosphere.

- Are there window regions?

3. The atmospheric temperature profile for the calculation was:

| Pressure [hPa] | Temp. [K] | Altitude [km] |
|----------------|------------|---------------|
| 1013.000000 | 294.200000 | 0.000000 |
| 902.000000 | 289.700000 | 1.000000 |
| 802.000000 | 285.200000 | 2.000000 |
| 710.000000 | 279.200000 | 3.000000 |
| 628.000000 | 273.200000 | 4.000000 |
| 554.000000 | 267.200000 | 5.000000 |
| 487.000000 | 261.200000 | 6.000000 |
| 426.000000 | 254.700000 | 7.000000 |
| 372.000000 | 248.200000 | 8.000000 |
| 324.000000 | 241.700000 | 9.000000 |
| 281.000000 | 235.300000 | 10.000000 |
| 243.000000 | 228.800000 | 11.000000 |
| 209.000000 | 222.300000 | 12.000000 |
| 179.000000 | 215.800000 | 13.000000 |
| 153.000000 | 215.700000 | 14.000000 |
| 130.000000 | 215.700000 | 15.000000 |
| 111.000000 | 215.700000 | 16.000000 |
| 95.000000 | 215.700000 | 17.000000 |
| 81.200000 | 216.800000 | 18.000000 |
| 69.500000 | 217.900000 | 19.000000 |
| 59.500000 | 219.200000 | 20.000000 |

- Where does the radiation at the peak of the line (183 GHz) originate?
- Where does the radiation at the wing (150 GHz) originate?

4. Change the variable “freq_ind” at the beginning of the Matlab script from -1 to a number between 1 and 110. This will select a frequency and mark it with a circle in the BT plot. You get two more plots, the water vapor Jacobian and the opacity between the top of the atmosphere and altitude z , both for the selected frequency.
 - Write down the altitude of the Jacobian peak and the altitude where the opacity reaches 1 for some different frequencies.
 - Can you think of a reason why the two altitudes are not exactly the same?
 - Explain, why the Jacobians are sometimes positive, sometimes negative.