Advanced radiation and remote sensing

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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 the nadir brightness temperature (BT) at the top of the atmosphere; the other is the 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.