Project: **688**

Project title: **Zirren in der Tropopausenregion**

Principal investigator: **Peter Spichtinger**

Report period: **2017-01-01 to 2017-12-31**

Progress report:

Delays in progress resulting into less use of CPU:

It was foreseen that a new PostDoc will carry out some simulations for the subproject CIRRUS-INH. However, the filling of the position was crucially delayed, therefore we could not carry out as much simulations as we planned to do.

(1) Gravity waves and cirrus clouds at the tropopause (CIRRUS-GW)

In this project (DFG research group MSGWaves, project GW-TP) we investigate the feedbacks between tropopause dynamics and gravity waves and their feedbacks on cirrus clouds. For this purpose we conducted 2D and 3D simulations of gravity waves propagating vertically from the troposphere through the tropopause into the stratosphere. We investigate different scenarios, changing background stratification, environmental wind conditions and wavelengths in the prescribed waves.

One important aspect in the recent work was to investigate the transmission of gravity waves through the tropopause with a prescribed stratification. In collaboration with C. Pütz and R. Klein (FU Berlin) we studied the transmission in a comparison of theoretical investigations (FU Berlin) and numerical simulations. For this purpose, time-dependent environmental conditions have been implemented into the EULAG model. This framework allows to prescribe monochromatic waves propagating vertically through the tropopause and to distinguish between the transmitted and the reflected part of the waves. An example for such a simulation is represented in figure 1. A wave prescribed in the bottom part is partly propagating through the tropopause, whereas a part of the wave is reflected, leading to the pattern of a standing wave.

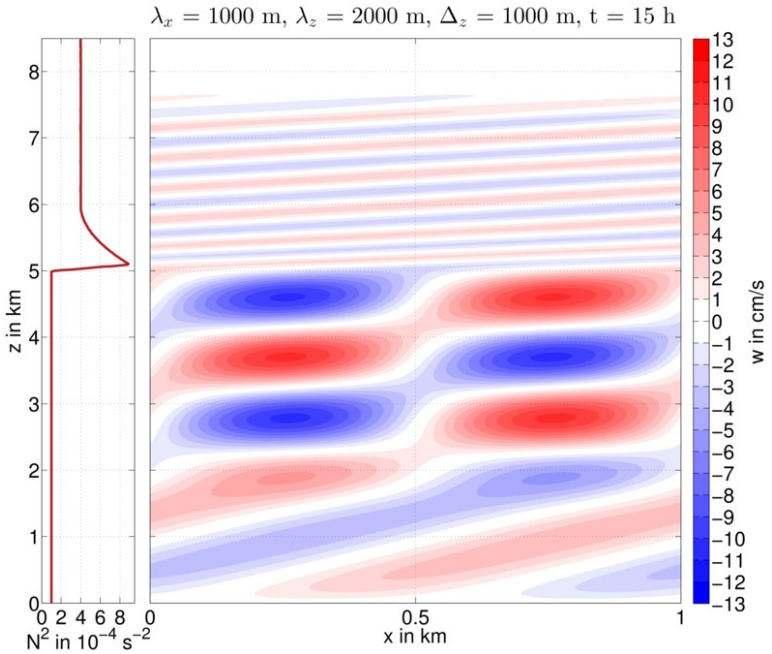

Figure 1: Example of a prescribed wave, propagating partly through a sharp tropopause (indicated by the stratification on the left panel)

The transmission coefficients as obtained from theory agree very well with the results as obtained from our numerical simulations, as indicated in figure 2.

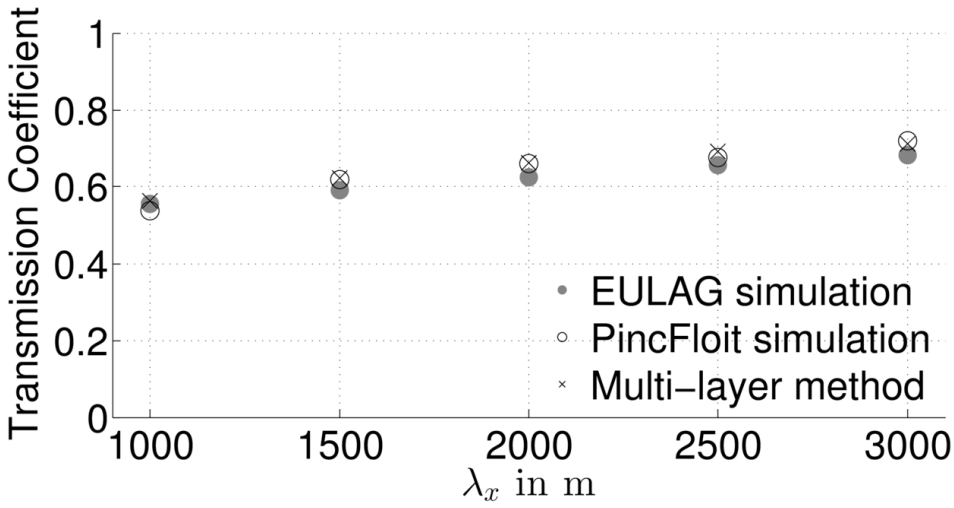

Figure 2: Transmission coefficient as calculated theoretically (multilayer method) and simulated using EULAG

The results were submitted to Theoretical and Computational Fluid Dynamics this summer, the revised version has been submitted on 25 October 2017.

For the investigation of the impact of gravity waves on the so-called tropopause inversion layer (TIL) (similarly to the profile as indicated in figure 1, left panel) we started systematic investigations for idealized profiles of the TIL and their impact on vertically propagating gravity waves. The results are promising, a manuscript is in preparation.

(2) Inhomogeneities and structures in cirrus clouds (CIRRUS-INH)

In this project the impact of instabilities in the tropopause region on the formation and evolution of cirrus clouds has been investigated. We identified several scenarios, in which instabilities (either convective or sheer instabilities) might occur in the tropopause region. In a second step, first simulations for representing shallow cirrus convection in idealized scenarios have been carried out.

In figure 3 a first example of shallow cirrus convection in an idealized setup is shown. Colours indicate relative humidity with respect to ice and ice water content is represented by black isolines.

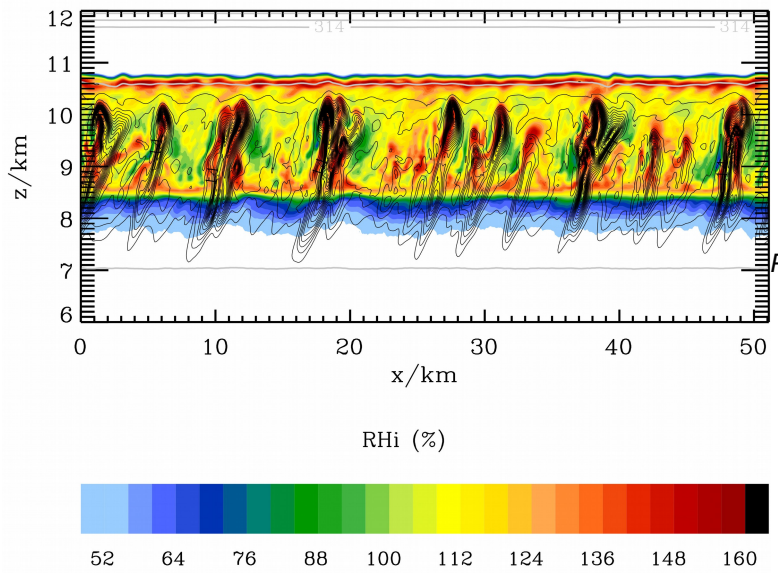

Figure 3: Shallow cirrus convection in an idealized setup representing a potentially unstable layer in the tropopause region

As indicated in the beginning, we did not make progress as we intended. Thus, these investigations will be continued in 2018.