Passive and Active Microwave Transfer (PAMTRA)

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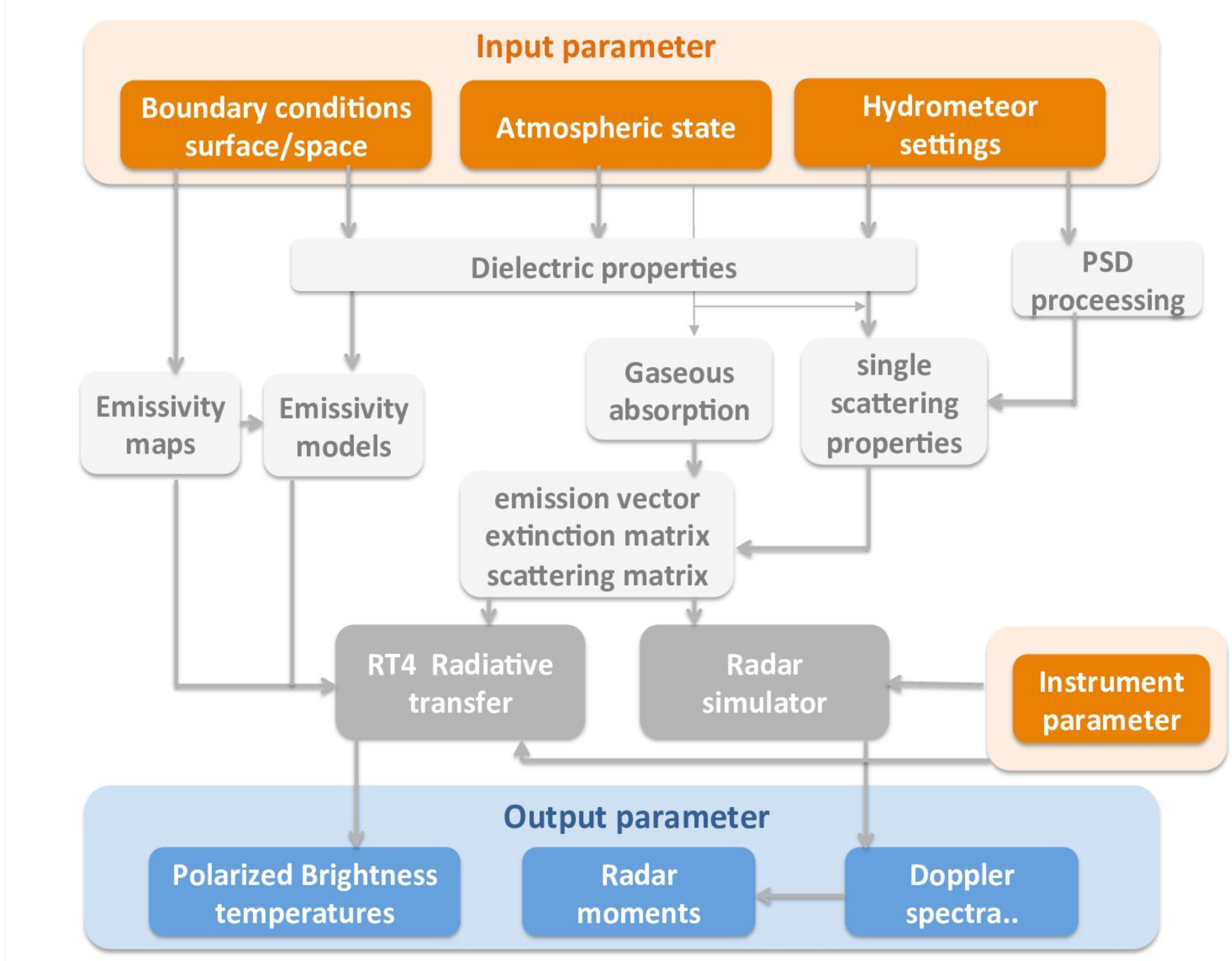
Introduction

Well established models/forward operators for the active or passive radiative transfer in the microwave frequency region exist (RTTOV, ARTS, CRTM, QuickBeam,..). Why another one like **PAMTRA**?

•Consistency between active and passive RT
•Unique choice of scattering models
•Unique treatment of Doppler spectra
•Possibility of integrating new scientific results and features
•Full control of code design and future development

PAMTRA



- Simulation of polarized T_B (Evans et al., 1995) and radar moments (Kollias et al., 2010) up to 800 GHz
- Ground- and satellite-/airborne based geometries
- Jacobians calculation
- Interfaces to various input data types and formats
- Set of possibilities for interaction parameter generation:
  - Surface: FASTEM6, TELSEM2, TESSEM2, simple assumption
  - Fas absorption: Liebe, Rosenkranz with recent modifications
  - Hydrometeors scattering: Mie, soft-spheres, T-Matrix, DDA-DBs, Self-similar Rayleigh-Gans

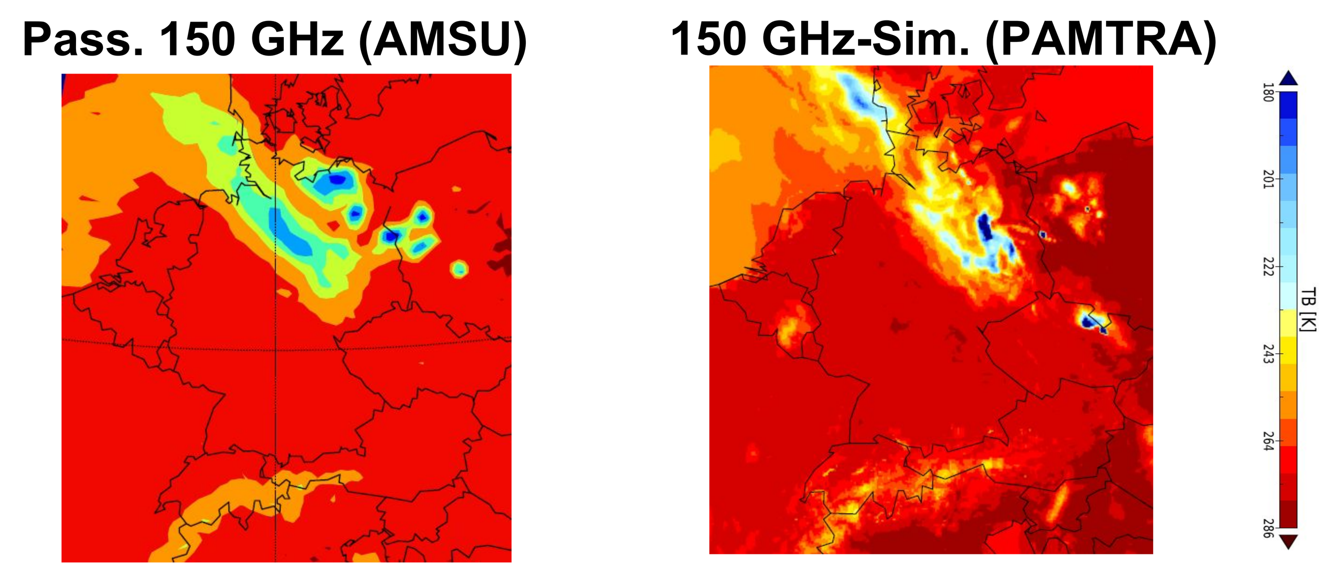
PAMTRA Toolbox

Collection of python scripts and fortran programs:

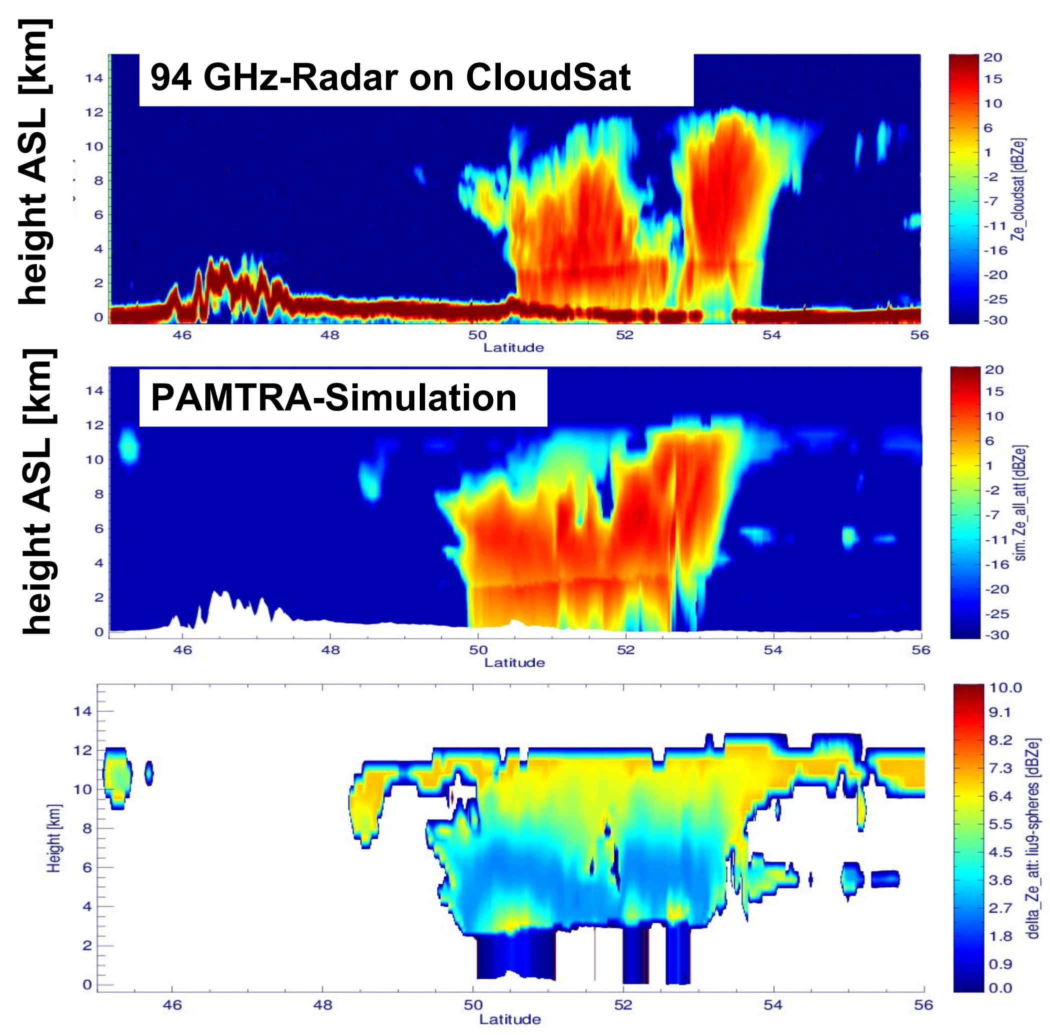
- **PyPamtra**: library to create input, run the model (even in parallel), process the output, inclusion into other programs (i.e., optimal estimation), easy extendable to other input sources (CRMs)
- Convolution with antenna function for various satellites
- Creation of RT/SRS input from CRM output
- Build up of T-Matrix DBs for faster calculation

Available on github: https://github.com/igmk/pamtra

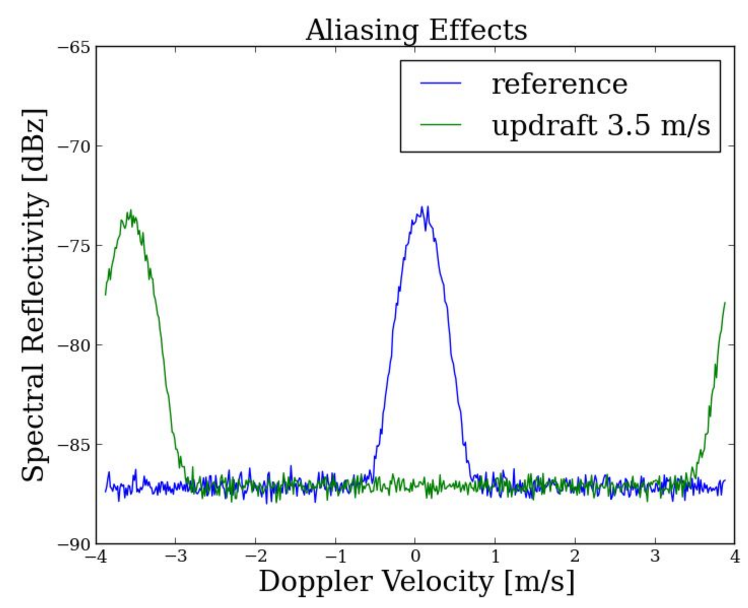
Applications

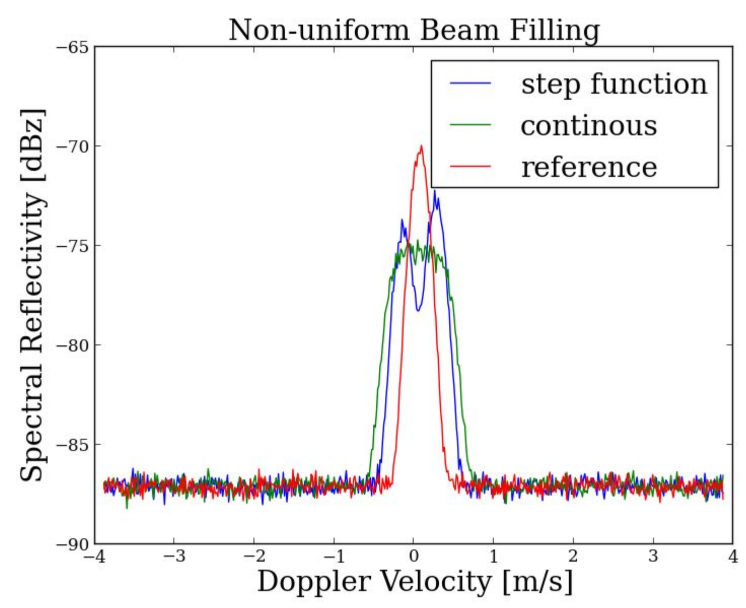


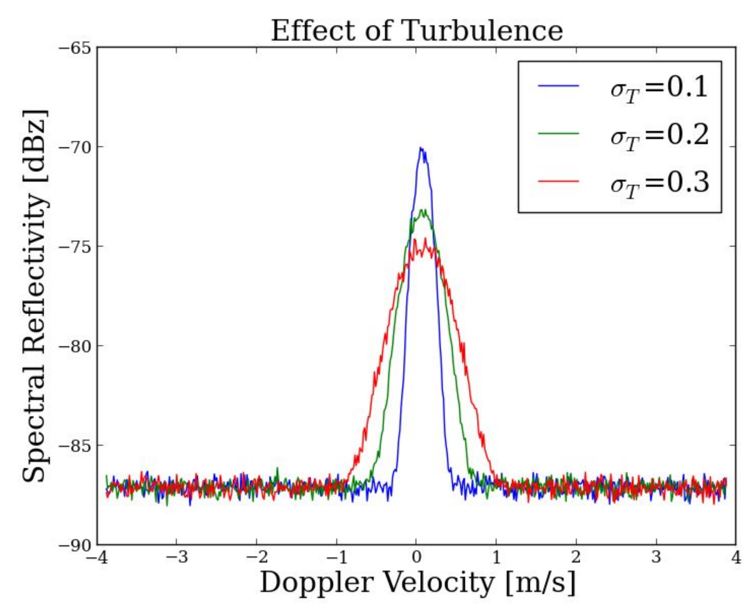
Passive high frequency MW observations (left) reveal the spatial distribution and amount of frozen hydrometeors (high amount of snow/graupel = low TB values) that can be compared to forward simulated reanalysis fields (right).



Space-borne radar observations (CloudSat) provide vertical structure along the flight track. PAMTRA simulations reveal realistic radar signatures (e.g. attenuation in rain shafts) and allow to compare vertical cloud structure of the reanalysis with real observations.
Maximum Ze difference due to snow particle habit (spherical vs. realistic habit) estimated to be up to 7 dB for this particular case.







The spectral radar simulator can simulate:

- *instrument effects like aliasing*
- *Measurement issues like non-uniform beam filling*
- *Effect of turbulence on the spectrum*

(Maahn et al. 2015, Maahn and Löhnert, 2017)

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