Retrieval of Atmospheric Temperature from Airborne Microwave Radiometer Observations

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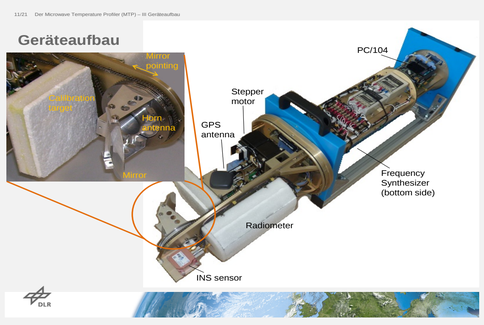
MTP Overview

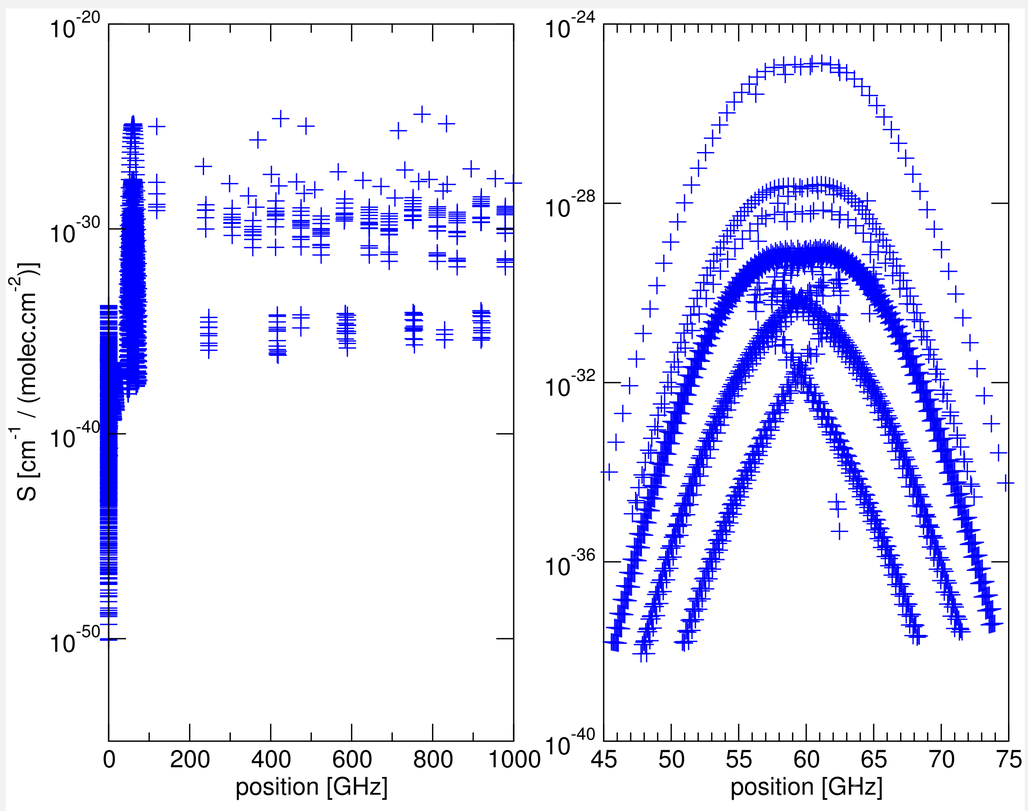
MTP (**M**icrowave **T**emperature **P**rofiler)

- Passively measure thermal emission from oxygen molecules
- Operational since many decades
- Focus on the upper troposphere and lower stratosphere
- Scan from near zenith to near nadir in the flight direction
- Recently on DLR's Falcon and HALO aircrafts



Oxygen Diagnostics

- O_2 emission around 55–60 GHz
- Covering MTP frequencies (56.363 GHz, 57.612 GHz, 58.363 GHz)



Dedicated Retrieval Code

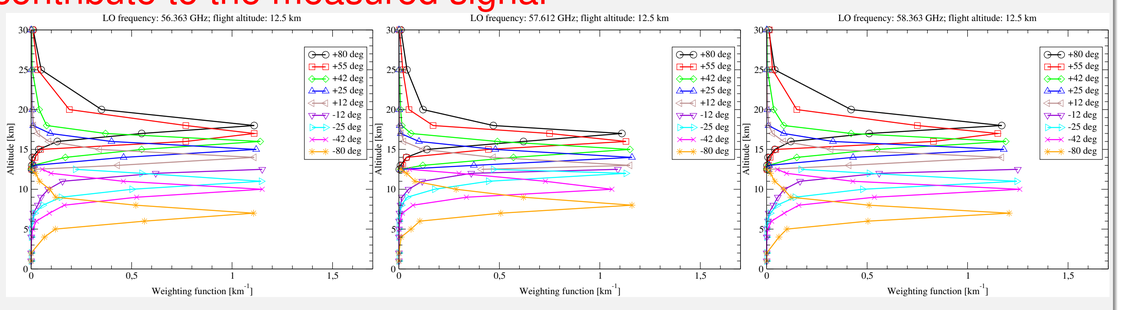
TIRAMISU (**T**emperature **I**nve**R**sion **A**lgorithm for **MI**crowave **S**o**U**nding)

- Line-by-line calculation based on GARLIC
- Regularized nonlinear least squares fitting
- Temperature derivatives by automatic differentiation
- Adaptive regularization methods

Regularization Method	λ	Constraint
Tikhonov regularization	constant	$\boldsymbol{x}_\mathrm{a}$ (a priori)
Iteratively regularized Gauss–Newton	variable	$\boldsymbol{x}_\mathrm{a}$ (a priori)
Regularizing Levenberg–Marquardt	variable	$\boldsymbol{x}_{\mathrm{i}-1}$ (previous iterate)

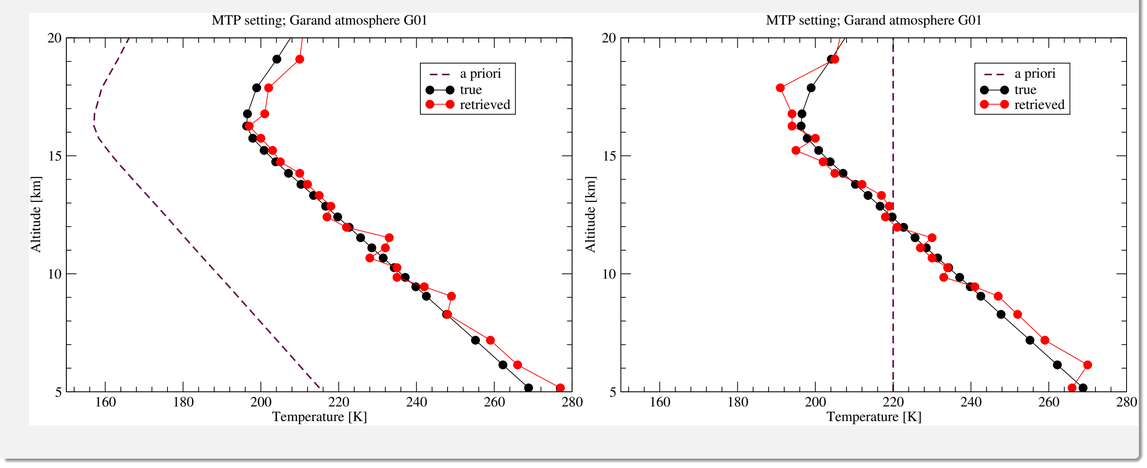
Weighting Function

Quantitative measure that describes how different altitude regimes contribute to the measured signal



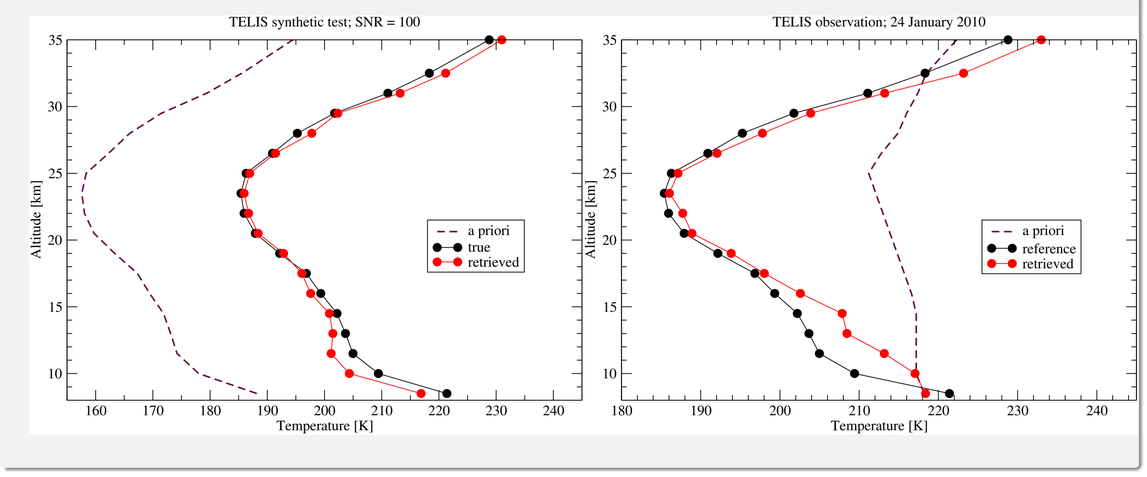
Retrieval Test: MTP Configuration

- Grande atmospheres
- Inequidistant altitude grid
  - denser when near aircraft
  - coarser
- Different a priori information



Retrieval Test: TELIS Configuration

- Based on TELIS data
  - synthetic DLR-THz data
  - real SRON-GHz data
- Equidistant altitude grid
- Different a priori information



Outlook

- Reliability test using MTP data with actual instrument input
- Sensitivity study with respect to instrument parameters
- Underdetermined inverse problem
- A priori information critical

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