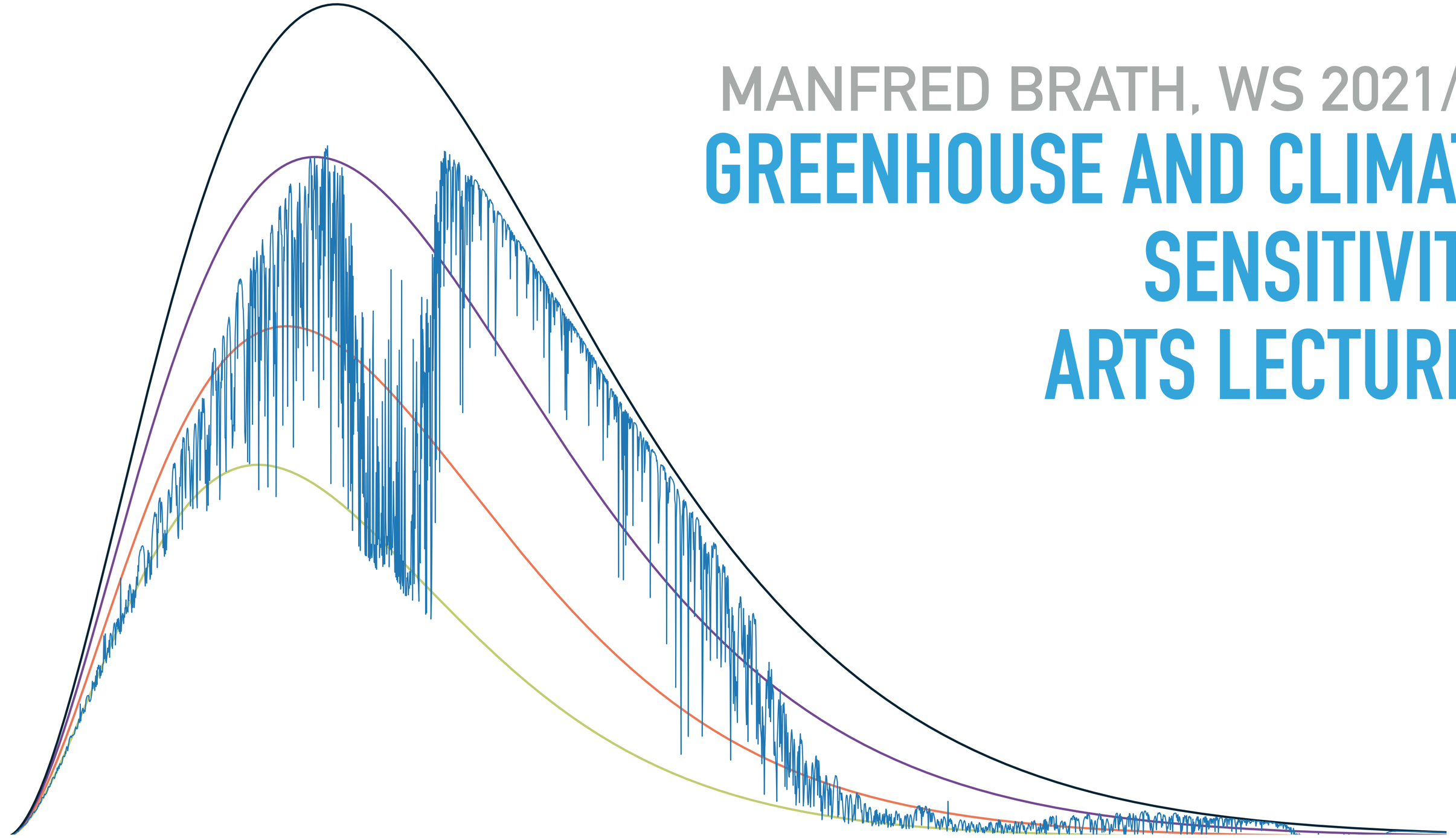

MANFRED BRATH, WS 2021/22

GREENHOUSE AND CLIMATE SENSITIVITY: ARTS LECTURES

GET THE SLIDES

- Go to

https://collaboration.cen.uni-hamburg.de/display/RaRe/ARTS+Lecture

and download the slides at the topic “Greenhouse and Climate Sensitivity - ARTS Lectures - Introduction”

WHAT IS ARTS?

ATMOSPHERIC RADIATIVE TRANSFER SIMULATOR (ARTS)

- Radiative transfer model for microwave to thermal IR (even fully polarised)
- Developed by the radiation and remote sensing group of the Meteorological Institute of Universität Hamburg and Chalmers University in Gothenburg

ARTS KEY FEATURES

- Radiative transfer model for microwave to thermal IR (even fully polarised)
- Spherical geometry (1D, 2D, or 3D)
- State of the art absorption models: **line-by-line** calculations based on HITRAN or other catalogs plus various continua
- All viewing geometries: up, limb, nadir, from inside or outside the atmosphere
- 4 different scattering solvers
- Dedicated methods for heating rate calculations and retrievals (1d-Var, OEM)
- Fully controllable from Python (PyARTS)
- Implemented in C++, modular design

ARTS DOCUMENTATION

- ARTS user guide

  https://atmtools.github.io/arts-docs-master/uguide/arts_user.pdf

- ARTS theory guide

  https://atmtools.github.io/arts-docs-master/uguide/arts_theory.pdf

- ARTS docserver

  https://atmtools.github.io/arts-docs-master/docserver/index.html

- PyARTS

  https://atmtools.github.io/arts-docs-master/pyarts/index.html

ARTS GENERAL INFORMATIONS

- For more information about ARTS see:

https://www.radiativetransfer.org

or

https://github.com/atmtools/arts

ARTS LECTURES

ARTS LECTURES

- Consists of 8 to 9 Jupyter notebooks with different aspects of ARTS.
- For this course, two exercises considering
    - absorption cross section,
    - absorption coefficient and
    - line shape

ARTS LECTURES

- For those, who wants to dig even more into ARTS and radiation, there is the

Advanced radiation and remote sensing course
Tue 14h30 and Thu 12h00 room 1536c

STINE:

63-836 Meteorologische Vertiefung: Strahlung und Fernerkundung – Vorlesung (Tue)

63-836a Meteorologische Vertiefung: Strahlung und Fernerkundung - Übung (Thu)

GETTING ARTS LECTURES

- Open terminal and login onto mistral via ssh and type:

```
1) curl -OL https://attachment.rrz.uni-hamburg.de/97c802f4/artscourse.zip

2) unzip artscourse.zip

3) cd artscourse

4) ./setup-mistral.sh
```

JUPYTERHUB

1) Log in to jupyterhub.dkrz.de
2) Start a preset profile
3) Navigate to
   `artscourse/arts-lectures/exercises/01-molecule_spectra` or
   `artscourse/arts-lectures/exercises/02-line_shape`
4) Open the file with the “`.ipynb`” ending
5) Set “`ARTS_DATA_PATH`" to “`~/artscourse/`”
6) Enjoy!

ABSORPTION COEFFICIENT

For the atmosphere considering only gases holds:

$$\alpha = \sum_{i}^{N_{gas}} \alpha_i = \sum_{i}^{N_{gas}} n_i \, \hat{\sigma}_{abs,i}$$

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depends on macroscopic state

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Number density of constituent i in $[\mathrm{m}^{-3}]$

depends on macroscopic state

Absorption cross section of constituent i in $[\mathrm{m}^{2}]$

depends on molecular spectral properties

NUMBER DENSITY AND OPTICAL THICKNESS

- Number density (from ideal gas law):

$$n = \frac{N}{V} = \frac{p}{k_b T}$$

- Optical thickness:

$$\tau = \int_{s_1}^{s_2} \kappa(s) \mathrm{d}s$$

s: path length

κ: extinction coefficient