## ARTS: overview and status

#### Patrick Eriksson<sup>a</sup> and Stefan Buehler<sup>b</sup>

 $^{a}$  Earth and Space Sciences, Chalmers University of Technology, Sweden

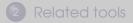
<sup>b</sup> Meteorological Institute, University of Hamburg, Germany



#### Kristineberg, June 9, 2014







## **ARTS versions**

### Version 1

- started 2000
- "traditional" 1D model
- development until  $\approx 2005$
- used for Odin-SMR operational processing

#### Version 1.1/2.0

- version 1.1 started 2002
- 1D/2D/3D, full Stokes, scattering ...
- version 2.0 released 2011

#### Version 2.2

- released now
- new: T-matrix, other planets, radio link, Zeeman ...
- supported version from now

# Main applications

- Microwave emission observations
  - including scattering and tomographic retrievals
- Applicable in the IR range
  - including broadband flux calculations
- Basic treatment of radio link budgets
- Applicable for other planets
- Operational inversions:
  - Odin-SMR (standard + off-line tropospheric)
  - UTH from AMSU-B type instruments
  - SMILES (upper troposphere)
  - several ground-based strato/mesospheric radiometers
- Scientific and design studies:
  - ▶ in total about 90 journal articles and 10 ESA studies

## This is ARTS!

#### Flexible

important for users

#### Modular

important for developers

#### Documented

important for all

Maintained

important for users

- Full polarisation (1-4 Stokes elements)
- ID, 2D or 3D atmosphere
- Free geoid + surface topography (no "flat Earth" approx.)
- All observation geometries covered
- Broad coverage of sensor responses
- Many weighting functions provided (very slow if scattering)
- Two modules for handling scattering (DOIT and MC)
   also "FOS", implemented but not yet official module

# How is flexibility and modularity achieved?

ARTS works somewhat as a scripting language
 in contrast to keyword based programs

ARTS operates with variables, methods and agendas

"Hello world" in ARTS:

```
Arts{
  StringCreate( s )
  StringSet( s, "Hello World" )
  Print( s )
}
```

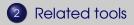
Example on agenda: propmat\_clearsky\_agenda

# Documentation and user support

- Articles
- ARTS user guide (AUG)
- ARTS development guide (ADG)
- ARTS theory document (ATD)
- Built-in documentation
  - ▶ arts -d iyRadioLink
  - arts -s + http://localhost:9000/
  - http://www.sat.ltu.se/arts/docserver
- Control file examples = "demos"
- Mailing lists
- Wiki page (not active)
- Workshops







### Reading and writing of ARTS output and input files

# Interface to T-matrix code this feature part of ARTS-2.2

#### No active maintenance or development

Various general functions

such as vec2col and optargs

#### Set of functions

▶ time formats, interface to GMT, Mie, H2O ...

- Some small "systems"
  - ▶ qinfo, OEM, gformat, collocations ...
- Qarts: interface to ARTS

 $\blacktriangleright$  y = arts\_y(Q);

Qpack2: retrieval environment

L2 = qpack2(Q, 0, Y);

- The version numbering follows ARTS
- That is, for ARTS A-B-c use Atmlab A-B-d



## OEM inversions using ARTS2

a Matlab tool

#### Scope:

- Atmosphere 1D
- Free observation geometry
- Batch calculations
- A number of retrieval quantities

(2D and 3D handled by Qarts + oem.m)

## New in Qpack2(.2)

- Multiple spectra handled
- Observations can have an azimuth angle
  - retrieval still only 1D
- Min and max value during iterations can be set
  - e.g. to avoid negative VMR
- New retrieval quantities
  - winds, pointing and "sinefit"
- Combine instruments using yCalcAppend
  - complicated and restrictions apply!
- For example:
  - microwave/emission + FTIR/solar occultation
  - combining radiometers operating at different angles