

ARTS: overview and status

Patrick Eriksson^a and Stefan Buehler^b

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

^b Meteorological Institute, University of Hamburg, Germany



Kristineberg, June 9, 2014

Outline

1 ARTS

2 Related tools

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

Fetaures of v2.0

Limitations apply, e.g. MC demands 3D

- ▶ Full polarisation (1-4 Stokes elements)
- ▶ 1D, 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

Outline

1 ARTS

2 Related tools

PyARTS

A set of Python functions

- ▶ 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
 - ▶ `y = arts_y(Q);`
- ▶ Qpack2: retrieval environment
 - ▶ `L2 = qpack2(Q, O, Y);`

Atmlab versions

- ▶ 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