kCARTA: An Atmospheric Radiative Transfer Algorithm using Compressed Lookup Tables

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v1.00 April 8, 2011

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1 Introduction

kCARTA stands for "kCompressed Atmospheric Radiative Transfer Algorithm." This is an infrared, "monochromatic" radiative transfer algorithm written for a one dimensional non-scattering Earth atmosphere. More documentation is found in "kcarta.pdf". This file shows the user how to set up the driver files found in the "Test" subdirectory.

2 Reminder about kCARTA database range

As given out, the code was optimized for the 605 - 2830 cm^{-1} spectral range which is the range covered by AIRS, IASA, CRiS, and HIRS and AERI instruments. However the code is flexible enough to allow optical depth and radiance calculations in other spectral bands. Since the FWHM of lines gets smaller (larger) as the wavenumbers get smaller (larger), the resolution of the database must change. Each file in each spectral range will contain 10000 points; so for example at the default 0.0025 cm^{-1} resolution of the main IR default band (605-2830 cm^{-1}), the files each span 25 cm^{-1}. We envisage the following :

```
kcartachunks = 00080 : 0002.5 : 00150;  prefix = '/j';
kcartachunks = 00140 : 0005.0 : 00310;  prefix = '/k';
kcartachunks = 00300 : 0010.0 : 00510;  prefix = '/p';
kcartachunks = 00500 : 0015.0 : 00605;  prefix = '/q';
kcartachunks = 00605 : 0025.0 : 02830;  prefix = '/r'; ** default **
kcartachunks = 02830 : 0025.0 : 03580;  prefix = '/s';
kcartachunks = 03550 : 0100.0 : 05650;  prefix = '/m';
kcartachunks = 05550 : 0150.0 : 08350;  prefix = '/n';
kcartachunks = 08250 : 0250.0 : 12250;  prefix = '/o';
kcartachunks = 12000 : 0500.0 : 25000;  prefix = '/v';
kcartachunks = 25000 : 1000.0 : 44000;  prefix = '/u';
```

3 Test directory

Examples of two driverfiles, one which computes optical depths (based on a list the user supplies), and the other which computes radiances (and jacobians if asked). The user should carefully examine these files, as they provide a working outline

of how to use this package. This subdir also includes two matlab files, containing radiances output using H2004 and H2008.

3.1 Setting the paths

The user needs to supply paths to where the solar files, continuum files, nlte files, klayers executables, optical depth database and reference profiles are; this is controlled via *user_set_dirs.m*

We will concentrate on the parameters that need to be set for kCARTA runs spanning 605-2830 cm^{-1}. The variables set in this file fall into three categories :

Category A : solar datafiles, water continuum files, 4um CO2 chifiles

soldir	path to solar files
nltedir	path and name of NLTE files
co2ChiFilePath	path to 4 um CO2 files
cdir	path to continuum files
cswt,cfwt	self and forn continuum weights

Category B : klayers executables and scratch space

klayers_code.junkdir	path to scratch space for klayers input/output
klayers_code.aeri	path to klayers executable for AERI (uplook, finer layers near ground)
klayers_code.airs	path to klayers executable for AIRS,IASI/CRiS (downlook, default klayers layers)

Category C : kCARTA database paths
Depending on whether the user is using f77 binary files or Matlab binary files (as set *via* iMatlab_vs_f77), the user is required to set the path to the reference profile (that was used to generate the database), as well as paths to where the database actually is. In addition, the user can set paths to different flavors of the database (eg H2000, H2004, H2008), depending on iHITRAN.

If iMatlab_vs_f77 == +1 then the Matlab files are

kpath	path to compressed files
refp	path to reference profile

while if iMatlab_vs_f77 == -1 then the f77 files are	
kdatadir	path to ieee-le f77 binary data
kpathh2o	subdir to h2o files
kpathhDo	subdir to hDo files
kpathco2	subdir to co2 files
kpathetc	subdir to all other gases
refp	path to reference profile

3.2 Setting the control variables

Depending what the user wants to do, the user sets the following parameters in a separate file : which HITRAN version to use, start/stop wavenumbers for the calculations, whether or not to do Jacobians, what output units for the Jacobians, what CKD version, and name of input rtp file. We will concentrate on text-colorblueuser_set_input_downlook.m, the file used to generate radiances and/or jacobians; the file used to generate optical depths is very similar.

As above, the parameters set in the file can be divided into a number of categories

Category A : HITRAN controllers

iHITRAN	sets the kCompressed directory choices are H2000,H2004,H2008
iMatlab_vs_f77	is the database is Matlab or ieee-le iMatlab_vs_f77 = +1 use Matlab version iMatlab_vs_f77 = -1 use f77 version

Category B : Jacobian controllers
Temperature jacobians are always done. Warning : the water jacobian includes the effects of the continuum.

iDoJac	controls the jacobians gasids	(-1 for none) no jacs
	[iGid1 iGid2 ... iGidN];	do jacobians for gases in list

iJacobOutput controls the output jacobians units

iJacobOutput = -1	dr/dT, dr/dq
iJacobOutput = 0	dr/dT, dr/dq*q
iJacobOutput = +1	dBT/dT, dBT/dq*q

Category C : General controllers

iAirs	drives klayers 0,-1,+1,2,3	raw, AIRS, IASI, CRiS
fA,fB	start, stop wavenumbers make sure they span only one spectral range	in cm^{-1}
CKD	water continuum version 1,2 are the MT CKD versions 3,4,5 are modified MT CKD versions	1,2,3,4,5

Category D : Profile information

dirin	the directory where the file is in
fin	is the actual file
iProfRun	which of the rtp profiles to run

3.3 Running the code!

Finally the user can commence the computation, calling one or the other of the routines named below (which call relevant files from above).

`dokcarta_downlook.m`	`compute RT`
`dokcarta_opticaldepths.m`	`compute optical depths`

All the user has to do is make sure the correct user_* files are called, at the top of these files.

4 VariablePressure Different pressure layers

This contains the main files a user should need for a pressure layering different than the AIRS 100 layers. This makes the code(s) slower. The structure and content of the directories is the same as before *viz*

```
drwxr-xr-x 2 sergio pi_strow    10 Mar 24 04:49 Test
drwxr-xr-x 6 sergio pi_strow     8 Mar 23 11:58 private
drwxr-xr-x 3 sergio pi_strow     4 Mar 23 10:36 JACUP_VarPress
drwxr-xr-x 3 sergio pi_strow     4 Mar 23 10:35 JACDOWN_VarPress
```

Test has dokcarta_downlook.m, dokcarta_uplook.m (very similar to the "downlook" case) and dokcarta_opticaldepths.m.

$JADOWN\_VarPress$ has jacobian routines for downlooking instruments

$JACUP\_VarPress$ has jacobian routines for uplooking instruments