kCARTA: An Atmospheric Radiative Transfer Algorithm using Compressed Lookup Tables

Sergio De Souza-Machado, L. Larrabee Strow,
Howard Motteler and Scott Hannon

Physics Department
University of Maryland Baltimore County
Baltimore, MD 21250 USA

Copyright 2011
University of Maryland Baltimore County
All Rights Reserved
v1.00 April 12, 2011

Sergio De Souza-Machado: sergio@umbc.edu
L. Larrabee Strow: strow@umbc.edu

Contents

1 Introduction **3**

2 Reminder about kCARTA output **3**

3 AIRS convolution **4**

4 Interferometer convolution **4**

5 Generic gaussian convolver **5**

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 convolve the output from the Matlab kCARTA runs.

2 Reminder about kCARTA output

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. The spectral convolutions we describe in this section are designed for this range. In general, the output is of the form

```
radsOut or jacsOut or odOut
```

where for example the fields of the structure are

```
   freqAllChunks                  1x90000          freq      cm-1
    radAllChunks                  90000x1          radiances mW/cm2/sr/cm-1
iaa_kcomprstats_AllChunks          2x73             Singular Vectors stats
```

"jacOut" and "odOut" will have fields that are for example

```
   ejacAllChunks: [90000x1]       surface emissivity jacobians
   qjacAllChunks: [2x90000x96]    gas amount jacs, for each gas in iDoJac
   sjacAllChunks: [90000x1]       surface temp jacobians
   tjacAllChunks: [90000x96]      temperature jacobians
    wgtAllChunks: [90000x96]      weighting functions
```

We have provided some general purpose convolvers in the CONVOLVE subdirectory. The user is free to modify the routines, at his/her own risk. Some of the routines are contained within this package; if the user does wish to use them, he/she will need to get more routines from us.

```
aeri_convolution_results.m          AERI convolver (needs fixing)
airs_convolution_results.m          AIRS convolver
cris_convolution_results.m          CRIS convolver
```

```
iasi_convolution_results.m          IASI convolver

kcarta_fconvkc.m                    sets up the FFT convolver

generic_convolution_results.m       gaussian convolver
quickconvolve.m                     called by generic_convolve

convolveNplot.m                     Calls one of the convolvers

rad2bt.m
```

In everything described below, we assume we are doing either a radiance convolution; other convolutions can be done similarly, by pulling out the appropriate fields of eg a jac "temperature" convolution

3 AIRS convolution

[rconv, fconv] = sconv2(rads,freqs,clist,sfile);
Here
sfile = path to AIRS SRFs
clist = list of AIRS channels that you want results for
freqs = input freqs from, radsOut structure
rads = input radiances from radsOut structure

4 Interferometer convolution

rconv, fconv = kcarta_fconvkc(rads,freqs,ifp,atype,aparg);
rconv, fconv = s1fconvkc(rads, ifp, atype, aparg);
rconv, fconv = s2fconvkc(rads, ifp, atype, aparg);
rconv, fconv = s3fconvkc(rads, ifp, atype, aparg);

Here
freqs = input freqs from, radsOut structure
rads = input radiances from radsOut structure
ifp = interferometer type

atype = apodization
aparg = argument (strength) of apodization

In general the matlab file "ifp" contains the start and stop wavenumbers, (fA,fB) that are expected for the convolutions. If freqs corresponds exactly to these parameters, then you can directly call sXfconvkc. The different flavors X=1,2,3 stand for
X = 1 : fast, not very accurate
X = 2 : compromise between 1 and 3 (the goldilocks optimal)
X = 3 : slow, very accurate

However if freqs only partially spans (fA,fB), or overspans (fA,fB), then kcarta_fconvkc tries to zero fill required data, or cut out unnecessary monochromatic data, before calling s2fconkc.

The parameters (ifp, atype, aparg) for various instruments are :
IASI : iasi12992','gauss',6
CRIS B1 : 'crisB1','hamming',6
CRIS B2 : 'crisB2','hamming',6
CRIS B3 : 'crisB3','hamming',6
Note : you don't really need to supply "aparg" ie you can just use
rconv, fconv = s3fconvkc(rads, ifp, atype);

Note that the fconvkc routines need to be separately called N times, if the interferometer parameters are specified separately for different bands.

5 Generic gaussian convolver

[fconv,rconv] = quickconvolve(freqs,rads,rFWHM,rSp);

Here the user can input a FWHM and a channel spacing, and a generic gaussian SRF is applied for convolution :
freqs = input freqs from, radsOut structure
rads = input radiances from radsOut structure
rFWHM = FWHM of SRF model
rSP = channel spacing