# rgssuperrmf

August 16, 2005

**Abstract**

****WARNING***** This task changes the SAS_CCF environment variable from a list of CCF files. DO NOT run another SAS task in the same terminal/session whilst this task is running.

Creates one response matrix from one or more pha spectra files, also combining a list of spectrum files (and background spectrum files) to create a combined spectrum file and combined background spectrum file, if required.

## 1 Instruments/Modes

| Instrument | Mode |
|---|---|

## 2 Use

| | |
|---|---|
| pipeline processing | no |
| interactive analysis | yes |

## 3 Description

The motivation for this task is to create one high resolution response matrix for a set of observations without the need for creating individual high resolution matrices. The task differs in this aspect from `rgscombine` and is designed to minimise the time and space required in producing the intermediary steps to combine a set of observations, espcially for high resolution matrices of, for example, 50000 rows. This task creates a single response matrix file using information from a list of spectrum from multiple observations, and can also combine spectra and background spectra of the same instrument and spectral order to produce final files that can be used for futher, quantitative analysis in a fitting package such as Xspec. This differs from `rgsfluxer`, in that this task is able to produce a single response matrix for the observation set for spectral analysis. The procedure makes use of the SAS task `rgsrmfgen`, so that individual responses relevant to each individual observation are considered appropriately. This task assumes the spectra have been produced by `rgsproc` using the `attsyle=user` parameter, to assure that all spectra are aligned in wavelength. The call to `rgsproc` for each of the required observations with the parameters `attstyle`, `attra`, `attdec` and `attapos` should be called prior to calling `rgssuperrmf`. For example:

```
rgsproc withsrc=yes srclabel=Capella  srcstyle=radec srcra=79.172330 srcdec=+45.997991  attstyle=user
attra=79.172330 attdec=+45.997991 attapos=259.81
```

The spectrum attributes and response values, bar counts, are weighted prior to addition, in terms of the exposure time or areascal of the individual observation. In this way the spectra (NET or TOTAL), and the background spectra, can be combined.

# 4 Parameters

This section documents the parameters recognized by this task (if any).

| Parameter | Mand | Type | Default | Constraints |
|---|---|---|---|---|
| **phalist** | yes | typelist of files | | |

A list of spectrum files from a set of observations, referring to one RGS instrument and one spectral order. These spectra files must be produced using the `attstyle=user` and associated parameters from a call to `rgsproc`.

| | | | | |
|---|---|---|---|---|
| **evlist** | yes | typelist of files | | |

A list of accompanying event list files, in the same order as the spectra files. Note, the file names are not derived from the spectra files.

| | | | | |
|---|---|---|---|---|
| **srclist** | yes | typelist of files | | |

A list of accompanying source list files, in the same order as the spectra files

| | | | | |
|---|---|---|---|---|
| **bkglist** | yes | list of files | | |

A list of background spectrum files from a set of observations observations

| | | | | |
|---|---|---|---|---|
| **withspeccombine** | no | boolean | | yes |

If this parameter is set to yes, the spectra files of the input lists will be combined to produced a combined spectrum file each for both spectra and background spectra files.

| | | | | |
|---|---|---|---|---|
| **filermf** | no | file | | resultantmatrix.ds |

Filename for final response matrix

| | | | | |
|---|---|---|---|---|
| **filepha** | no | file | | combinedspectra.ds |

Filename for final spectrum

| | | | | |
|---|---|---|---|---|
| **filebkg** | no | file | | combinedback.ds |

Filename for final background spectrum

The remaining parameters are exactly the same as those for the task rgsrmfgen, and are used when calling this task within rgssuperresponse, with the exception that spectra files are compulsory for this task and therefore the option that appears in rgsrmfgen, withspectrum, has been removed and is always true.

| | | | | |
|---|---|---|---|---|
| **emax** | no | real | 2.8 | non-negative |

When creating a new response matrix, this is the upper edge of the highest incident-energy bin to be included.

| | | | | |
|---|---|---|---|---|
| **emin** | no | real | 0.3 | non-negative |

When creating a new response matrix, this is the lower edge of the lowest incident-energy bin to be included. When overwriting part of an existing matrix (`newrmf`=no), this identifies the lower incident-energy bin in the interval to be recomputed. This value will be lowered automatically as necessary to maintain the contiguity of the bins, and can be used to extend the range of the existing matrix.

| | | | | |
|---|---|---|---|---|
| **rows** | no | integer | 4000 | positive |

The number of incident-energy bins to cover the range from `emin` to `emax`.

| | | | | |
|---|---|---|---|---|
| **phachannels** | no | integer | 3400 | positive |

The number of pha channels.

| | | | | |
|---|---|---|---|---|
| **withmirrorpsf** | no | boolean | yes | |

Whether to convolve the standard mirror PSF distribution into the LSF. *This option should be used with care and knowledge.* An appropriate circumstance for omitting the mirror PSF is when a custom angular distribution is provided (`withangdist`=yes) that empirically establishes the PSF contribution.

| | | | | |
|---|---|---|---|---|
| **withangdist** | no | boolean | no | |

Whether to convolve a custom angular distribution into the LSF. *This option should be used with care and knowledge.* Enables parameter `angdistset`. Note that this distribution is one-dimensional, an arbitrary function of dispersion off-axis angle. It is rebinned onto the dispersion channel space according to the order and central incident energy of each LSF. The problem of reducing a two-dimensional image to this one-dimensional distribution is left to the user.

| | | | | |
|---|---|---|---|---|
| **angdistset** | no | file | angdist.txt | |

An ASCII file containing a one-dimensional angular distribution along the axis of dispersion in arc minutes. Not modified. Each line of the file describes a distribution bin in terms of the start and stop angles, and the value assigned to that bin. The distribution may be normalized to any value, though unity is expected and recommended. See the input files descriptions for further details.

# 5 Errors

This section documents warnings and errors generated by this task (if any). Note that warnings and errors can also be generated in the SAS infrastructure libraries, in which case they would not be documented here. Refer to the index of all errors and warnings available in the HTML version of the SAS documentation.

**event pairing** *(error)*
The number of event list files does not match the number of spectrum files; there must be a one-to-one pairing.

**bkg pairing** *(error)*
The number of background spectra files does not match the number of spectrum files; there must be a one-to-one pairing.

**source pairing** *(error)*

The number of source list files does not match the number of spectrum files; there must be a one-to-one pairing.

**wrongOrder** *(error)*
Either: The `RFLORDER` attribute (reflection order) of the background spectra (if applicable) must match the `RFLORDER` of the corresponding spectrum.

**wrongInstrument** *(error)*
Either: The RGS instrument of the background spectrum file does not match that of the pha spectra file.

**Alignment of spectra** *(error)*
The pha files are not aligned in terms of wavelength. The task `rgsproc` will have to be called for each pha file with the appropriate attitude parameters (attastyle, attra, attdec, attapos).

**Environment variable warning,This tasks resets the SAS_CCF environment variable** *(warning)*
Making the user aware that this task uses multiple CCF files, and hence resets the SAS_CCF environment variable
*corrective action:*

No action required.

**Filename parameter** *(warning)*
No filename given for results files for either spectrum or response matrix
*corrective action:*

No action required. Defaults used.

# 6 Input Files

1. A list of spectrum files as produced by **rgsproc** with the option `attstyle=user` including the parameters `attra`, `attdec` and `attapos`.
2. A list of event files as produced by **rgsproc**.
3. A list of source list files as produced by **rgssources** or **rgsproc**.
4. A list of background spectrum files as produced by **rgsproc** with the option `attstyle=user` including the parameters `attra`, `attdec` and `attapos` (optional).

# 7 Output Files

1. A single response matrix file
2. A single combined spectrum file (optional but default)
3. A single combined background file (optional but default)

The output response matrix file is an OGIP-compliant Response Matrix File (RMF) as described in output files

# 8 Algorithm

```
ASSESS QUALITY: To apply information per channel

FOR EACH spectrum file:

  totalexposure = totalexposure + EXPOSURE

IF withspeccombine
  FOR EACH spectrum channel:
    IF ( acceptable QUALITY )
      channelexp =  EXPOSURE * AREASCAL
      OR IF SPECTRUM == NET
         staterrquad = squared(STAT_ERR)
      backscalexp = EXPOSURE * BACKSCAL
      totalcounts = totalcounts + COUNTS
      Then:
      Accumulate counts, backscalexp and channelexp or staterrquad
    ELSE
      do not add counts

  Call rgsrmfgen, creating temporary response onto which the channel quality criterion
  is applied

  FOR EACH response bin (rows):
    FOR EACH response channel (columns) AND IF ( acceptable QUALITY for channel):
      IF ( corresponding spectrum channel not discarded )
        newresponse = newresponse + MATRIX * EXPOSURE * AREASCAL


FOR EACH spectrum channel:
  IF (all quality flag 1 over all spectra files)
    Set final quality flag to 1
  IF (all quality flag 2 over all spectra files)
    Set final quality flag to 2
  ELSE
     Set final quality flag to 0

IF spectrum == TOTAL
Finalareascal = channelexp / totalexposure
ELSE
Finalstaterr = square-root(staterrquad)

Finalbackscal = backscalexp / totalexposure
Finalresponse = newresponse / Finalareascal

Write to file
Add attributes for DATE-OBS, DATE-END, applicable to observation list
```

# 9 Comments

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# References