

## GammaLib - Action #2973

### Improve COMPTEL classes

07/22/2019 02:17 PM - Knödseder Jürgen

<b>Status:</b>	Closed	<b>Start date:</b>	07/22/2019
<b>Priority:</b>	Normal	<b>Due date:</b>	
<b>Assigned To:</b>	Knödseder Jürgen	<b>% Done:</b>	100%
<b>Category:</b>		<b>Estimated time:</b>	0.00 hour
<b>Target version:</b>	2.0.0		
<b>Description</b>			
Several minor issues arose when analysing the full COMPTEL database that are tracked under this issue.			

#### History

##### #1 - 07/22/2019 02:25 PM - Knödseder Jürgen

- Assigned To set to Knödseder Jürgen
- Target version set to 1.7.0

The ontime in GCOMObservation::load(GFilename&, GFilename&, std::vector<GFilename>&) is now extracted from the ontime of the associated TIM datasets. Before it was computed from the start and stop time, yet this neglects the cut-out of time intervals in the TIM due to the SAA passage.

##### #2 - 07/22/2019 02:26 PM - Knödseder Jürgen

- % Done changed from 0 to 10

The default usage when loading TIM files is now set to YES and the default mode to NORMAL. Before, both strings were blank by default.

##### #3 - 07/22/2019 02:30 PM - Knödseder Jürgen

- % Done changed from 10 to 20

In GCOMEventList::read(GFits&) the Good Time Intervals are now set on the basis of the times of the first and last events. The reason is that the VISDAY, VISTIM, VIEDAY and VIETIM keywords that were used before do not seem to related to the GTI of the events but rather relate to the full time period of the observation.

##### #4 - 07/22/2019 02:39 PM - Knödseder Jürgen

- % Done changed from 20 to 30

In GCOMOads::print(GChatter&) only print the number of superpackets for higher than default chatter levels.

##### #5 - 07/22/2019 03:17 PM - Knödseder Jürgen

Disable geocentre warning in GCOMOads::read() since this quite pollutes the console.

##### #6 - 07/22/2019 04:25 PM - Knödseder Jürgen

- % Done changed from 30 to 40

Put COMPTEL support functions in gammalib namespace.

##### #7 - 07/22/2019 10:53 PM - Knödseder Jürgen

- Status changed from New to In Progress

- % Done changed from 40 to 50

I added remove\_response\_cache methods to the classes GObservations, GObservation, GCOMObservation, GCTAObservation and GCTAResponse to allow the controlled removal of one or all models from an observation container. For this purpose, the GCOMResponseCache::remove() method was also implemented.

The verification of parameter changes was removed in the COMPTEL response caching, and a call to GObservations::remove\_response\_cache was added in ctsmap so that cached values for the test source are removed before computation of the TS for the test source.

#### #8 - 07/24/2019 09:41 PM - Knödlseider Jürgen

- % Done changed from 50 to 60

I added a GCOMObservation::drm(GModels&) method that computes a model DRM cube for all applicable models in a model container.

I also added a GCOMDri::cone\_content() method to compute the DRI content within an event cube.

#### #9 - 07/09/2020 03:21 PM - Knödlseider Jürgen

- Target version changed from 1.7.0 to 2.0.0

Moved issue to next release.

#### #10 - 03/03/2021 11:09 AM - Knödlseider Jürgen

- % Done changed from 60 to 70

The response caching is now dealt with at the level of the GResponse base class, I therefore removed the COMPTEL specific response caching. Specifically the GCOMObservation::drm(GModelSky&) and GCOMResponse::irf\_spatial() methods were removed.

#### #11 - 10/14/2021 02:48 PM - Knödlseider Jürgen

- % Done changed from 70 to 80

In finally implemented support for extended model in the COMPTEL response, completing response handling.

Here is a test case of a SRCLIX analysis of the Crab v1.0 in the 4 standard energy bands. The run gives the following result for a point source

```
2021-10-13T14:07:00: +=====+
2021-10-13T14:07:00: | Iterative maximum likelihood model fitting |
2021-10-13T14:07:00: +=====+
2021-10-13T14:07:05: logL after iteration 1 .....: -67027.48666
2021-10-13T14:07:10: logL after iteration 2 .....: -67041.94875 (14.46210)
2021-10-13T14:07:15: logL after iteration 3 .....: -67044.96521 (3.01646)
2021-10-13T14:07:19: logL after iteration 4 .....: -67045.57367 (0.60846)
2021-10-13T14:07:25: logL after iteration 5 .....: -67045.63165 (0.05797)
2021-10-13T14:07:29: logL after iteration 6 .....: -67045.59895 (-0.03270)
2021-10-13T14:07:37: logL after final iteration : -67045.59894 (-0.00001)
2021-10-13T14:07:37: === GModelSky ===
2021-10-13T14:07:37: Name .....: Crab
2021-10-13T14:07:37: Instruments .....: all
2021-10-13T14:07:37: Test Statistic .....: 1004.16178071871
2021-10-13T14:07:37: Observation identifiers ...: all
2021-10-13T14:07:37: Model type .....: PointSource
2021-10-13T14:07:37: Model components .....: "PointSource" * "PowerLaw" * "Constant"
2021-10-13T14:07:37: Number of parameters .....: 6
2021-10-13T14:07:37: Number of spatial par's ...: 2
2021-10-13T14:07:37: RA .....: 83.7860667134836 +/- 0.111312108719039 deg (free,scale=1)
2021-10-13T14:07:37: DEC .....: 21.6291010912198 +/- 0.101021895111379 deg (free,scale=1)
```

2021-10-13T14:07:37: Number of spectral par's ...: 3  
 2021-10-13T14:07:37: Prefactor .....: 0.0016763606983258 +/- 8.56368715168633e-05 [1e-25,infty[ ph/cm2/s/MeV (free,scale=0.002,gradient)  
 2021-10-13T14:07:37: Index .....: -2.14913178754043 +/- 0.0382371945279881 [-10,10] (free,scale=-2,gradient)  
 2021-10-13T14:07:37: PivotEnergy .....: 1 MeV (fixed,scale=1,gradient)  
 2021-10-13T14:07:37: Number of temporal par's ...: 1  
 2021-10-13T14:07:37: Normalization .....: 1 (relative value) (fixed,scale=1,gradient)  
 2021-10-13T14:07:37: Number of scale par's .....: 0

and the following result for a disk source

2021-10-14T12:50:58: +=====+  
 2021-10-14T12:50:58: | Iterative maximum likelihood model fitting |  
 2021-10-14T12:50:58: +=====+  
 2021-10-14T12:53:01: logL after iteration 1 .....: -67037.18725  
 2021-10-14T12:54:10: logL after iteration 2 .....: -67043.74861 (6.56136)  
 2021-10-14T12:55:46: logL after iteration 3 .....: -67046.41870 (2.67009)  
 2021-10-14T12:56:50: logL after iteration 4 .....: -67047.15837 (0.73967)  
 2021-10-14T12:57:38: logL after iteration 5 .....: -67047.24089 (0.08252)  
 2021-10-14T12:59:12: logL after iteration 6 .....: -67047.11076 (-0.13013)  
 2021-10-14T13:00:00: logL after final iteration : -67047.11374 (0.00298)  
 2021-10-14T13:00:00: === GModelSky ===  
 2021-10-14T13:00:00: Name .....: Crab  
 2021-10-14T13:00:00: Instruments .....: all  
 2021-10-14T13:00:00: Test Statistic .....: 1101.97154647962  
 2021-10-14T13:00:00: Observation identifiers ...: all  
 2021-10-14T13:00:00: Model type .....: ExtendedSource  
 2021-10-14T13:00:00: Model components .....: "RadialDisk" \* "PowerLaw" \* "Constant"  
 2021-10-14T13:00:00: Number of parameters .....: 7  
 2021-10-14T13:00:00: Number of spatial par's ....: 3  
 2021-10-14T13:00:00: RA .....: 83.7858226805196 +/- 0.116796678591813 deg (free,scale=1)  
 2021-10-14T13:00:00: DEC .....: 21.6527349414119 +/- 0.105916502256037 deg (free,scale=1)  
 2021-10-14T13:00:00: Radius .....: 1.31224708888018 +/- 0.415734840183593 [0.05,10] deg (free,scale=1)  
 2021-10-14T13:00:00: Number of spectral par's ...: 3  
 2021-10-14T13:00:00: Prefactor .....: 0.00170719506442216 +/- 8.76326119024385e-05 [1e-25,infty[ ph/cm2/s/MeV (free,scale=0.002,gradient)  
 2021-10-14T13:00:00: Index .....: -2.15088249332866 +/- 0.0366685007302425 [-10,10] (free,scale=-2,gradient)  
 2021-10-14T13:00:00: PivotEnergy .....: 1 MeV (fixed,scale=1,gradient)  
 2021-10-14T13:00:00: Number of temporal par's ...: 1  
 2021-10-14T13:00:00: Normalization .....: 1 (relative value) (fixed,scale=1,gradient)  
 2021-10-14T13:00:00: Number of scale par's .....: 0

Here the summary for various extended models:

Model	logL	TS	RA	Dec	Extension	Prefactor (1e-5)	Index
Point source	-67045.599	1004.162	83.79 ± 0.11	21.63 ± 0.10		167.64 ± 8.56	-2.149 ± 0.038
Disk	-67047.212	1110.294	83.78 ± 0.12	21.65 ± 0.11	1.24 ± 0.41	182.32 ± 9.34	-2.147 ± 0.036
Gauss	-67047.334	1125.538	83.78 ± 0.12	21.66 ± 0.10	0.63 ± 0.21	181.91 ± 9.30	-2.147 ± 0.036
Elliptical disk	-67046.386	1043.938	83.76 ± 0.05	21.69 ± 0.09	1.00 ± 0.006, 0.49 ± 0.004, 93.31 ± 0.20	174.04 ± 8.72	-2.147 ± 0.038
Elliptical Gauss	-67048.461	1128.269	83.78 ± 0.11	21.65 ± 0.11	1.01 ± 0.07, 0.38 ± 0.04, 331.10 ± 0.57	184.20 ± 8.90	-2.146 ± 0.036

While the disk and gauss model seem to give reasonable results, the elliptical disk model does not seem to adjust the spatial parameters, the elliptical gaussian model looks kind of ok.

**#12 - 10/19/2021 10:37 AM - Knödseder Jürgen**

I changed the step size for numerical gradient computation to 0.01 deg for COMPTEL. This gave the following results:

Model	logL	TS	RA	Dec	Extension	Prefactor (1e-5)	Index
Point source	-67045.600	1004.180	83.79 ± 0.11	21.63 ± 0.10		167.64 ± 8.56	-2.149 ± 0.038
Disk	-67047.201	1108.352	83.79 ± 0.12	21.65 ± 0.11	1.28 ± 0.39	182.61 ± 9.37	-2.147 ± 0.037
Gauss	-67047.341	1127.352	83.76 ± 0.12	21.65 ± 0.11	0.68 ± 0.20	182.81 ± 9.35	-2.147 ± 0.036
Elliptical disk	-67044.650	1027.074	83.75 ± 0.09	21.72 ± 0.09	1.16 ± 0.05, 0.56 ± 0.04, 90.60 ± 0.21	173.17 ± 8.76	-2.145 ± 0.038
Elliptical Gauss	-67047.869	1087.553	83.78 ± 0.11	21.67 ± 0.11	0.17 ± 0.06, 0.80 ± 0.23, 86.06 ± 1.84	182.06 ± 9.38	-2.150 ± 0.037

**#13 - 10/19/2021 11:43 AM - Knödseder Jürgen**

And here the results for a step size of 0.05 degrees.

Model	logL	TS	RA	Dec	Extension	Prefactor (1e-5)	Index
Point source	-67045.600	1004.167	83.79 ± 0.11	21.63 ± 0.10		167.64 ± 8.56	-2.149 ± 0.038
Disk	-67047.203	1109.582	83.79 ± 0.12	21.65 ± 0.11	1.25 ± 0.40	182.45 ± 9.35	-2.147 ± 0.036
Gauss	-67047.336	1125.941	83.77 ± 0.12	21.66 ± 0.11	0.67 ± 0.20	182.48 ± 9.34	-2.147 ± 0.036
Elliptical disk	-67046.433	1024.404	83.78 ± 0.12	21.66 ± 0.11	1.20 ± 0.23, 1.03 ± 0.29, 86.66 ± 1.65	173.49 ± 10.06	-2.143 ± 0.038
Elliptical Gauss	-67048.159	1101.335	83.80 ± 0.11	21.67 ± 0.11	0.20 ± 0.07, 0.88 ± 0.24, 85.03 ± 3.90	183.11 ± 9.48	-2.150 ± 0.037

Now, the location uncertainties are consistent for all model types and also the extension uncertainties look reasonable, except for the elliptical disk model that still gives relatively small uncertainties.

#14 - 10/22/2021 02:31 PM - Knödseder Jürgen

I added some logic to comlifixit that fixes spatial extension parameters for the initial fit iteration and then free's the fixed parameters for the subsequent iterations. The goal is to stabilise the iterative fitting procedure. Here the results for a disk model as function of the initial radial extent:

Initial extent	logL	TS	RA	Dec	Extension	Prefactor (1e-5)	Index
0.1	-67047.065	1083.671	83.79 ± 0.12	21.66 ± 0.11	1.13 ± 0.44	179.17 ± 9.30	-2.146 ± 0.037
1.0	-67047.095	1089.352	83.78 ± 0.12	21.66 ± 0.11	1.16 ± 0.43	179.85 ± 9.31	-2.146 ± 0.037
5.0	-67046.970	1078.175	83.78 ± 0.12	21.66 ± 0.11	1.12 ± 0.45	177.99 ± 9.28	-2.143 ± 0.037

And below the same analysis results for a gradient step size of 0.005 instead of 0.05 that was used for the table above:

Initial extent	logL	TS	RA	Dec	Extension	Prefactor (1e-5)	Index
0.1	-67047.046	1081.959	83.78 ± 0.12	21.66 ± 0.11	1.10 ± 0.45	178.83 ± 9.29	-2.147 ± 0.037
1.0	-67047.089	1088.232	83.78 ± 0.12	21.66 ± 0.10	1.11 ± 0.45	179.43 ± 9.29	-2.147 ± 0.037
5.0	-67046.957	1076.793	83.79 ± 0.12	21.66 ± 0.11	1.11 ± 0.45	177.80 ± 9.27	-2.143 ± 0.037

With the smaller step size the resulting extensions are less dependent on the initial extension value, hence I prefer keeping that smaller value. Note that the TS value surprisingly depends on the initial extension value, while the logL is much less sensitive. Not clear why the TS values show such a scatter.

I recognised that some DRB bins were negative, so I added some code that sets all negative bins to zero. Here the results for the new code:

Initial extent	logL	TS	RA	Dec	Extension	Prefactor (1e-5)	Index
0.1	-67047.046	1081.959	83.78 ± 0.12	21.66 ± 0.11	1.10 ± 0.45	178.83 ± 9.29	-2.147 ± 0.037
5.0	-67046.957	1076.793	83.79 ± 0.12	21.66 ± 0.11	1.11 ± 0.45	177.80 ± 9.27	-2.143 ± 0.037

#15 - 10/27/2021 02:00 PM - Knödseder Jürgen

I created issue #3889 to follow-up on the fit of extended disk models.

**#16 - 03/14/2022 12:25 PM - Knödlseher Jürgen**

- *Status changed from In Progress to Closed*

- *% Done changed from 80 to 100*

The COMPTEL interface is now settled.