Using the Likelihood package to study transient sources

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29th October 2004

I ran the ScienceTools package v5r1p1 on my local machine at Bordeaux. The goal was to exercise the likelihood package written by Jim, with an emphasis on flaring sources.

My main problem was to get the linux installer running, since the required DBI and DBD_mysql perl packages were not installed on my machine. I tried first to use glastpack to install and compile the tools, as for GlastRelease. It worked well except that on running, the environment variables were not set and I had to figure out the names of the required variables and their values. As the final results from the likelihood application were markedly different from those in Jim' s tutorial, I (reluctantly) ended up installing the perl packages (with root privileges), used the installer (which then ran perfectly) and started the whole process again.

I went through the different steps of the tutorial, after generating my own (three) events files with obsSim for the Virgo region. The likelihood results are presented in the table. They are in good agreement with those given in the tutorial, but the Prefactor seems to be systematically overestimated as compared to that derived from the actual flux (MC) used by obsSim.

source	MC pref.	prefactor	pref. tut.	MC ind.	index	ind. tut.
3C273	2.4	4.4±1.3	5.3±1.4	-2.58	-2.75±0.3	-2.9±0.3
3C279	7.1	11.0±1.7	11.5±1.9	-1.96	-2.2±0.1	-2.2±0.1

Fig. 1 displays the obtained TsMap (40x40 pixels), after taking 3C273 out of the sources in the model file in the same way as in the tutorial. The limits of the sky region are [180, 200] in longitude and [-10, 10] in latitude. The scale limits are [-32123,-32100]. A maximum corresponding to 3C273 (ra=187.25, dec=2.17) is clearly visible.

I did this work again with the same event sets as Jim, which he recently made available on the confluence page. I obtained exactly the same results as his if I used the same initial values for the fit, as printed out in the likelihood example of the tutorial (these values are (Prefactor, Index)=(2.433,-2.58) and (7.123,-1.96) for 3C273 and 3C279 respectively, and not those given in Virgo_model.xml in the tutorial). I cannot overemphasize how useful such a well-defined test case is to check one's installation of the tools.

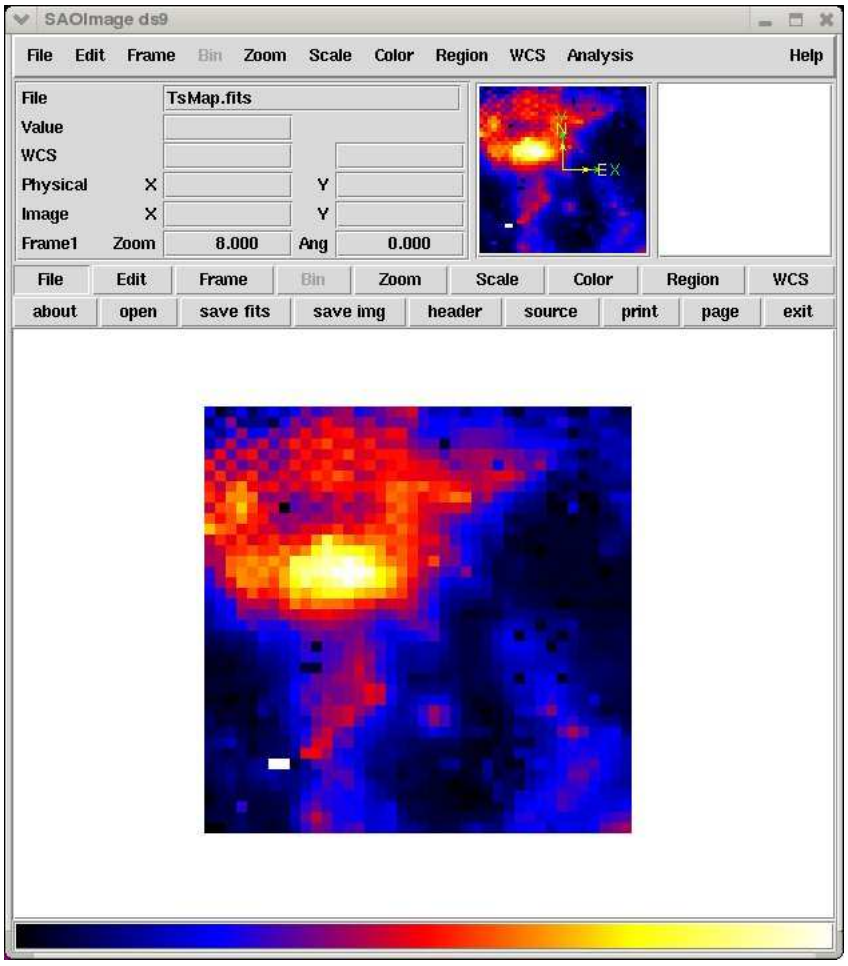

Figure 1: TsMap for the Virgo region

The next step was to look into the transient events Seth generated at (RA, DEC)=(80,20), taking place over 3 orbits. The events of the middle orbit (where the flux maximum occurs) were selected with the dataSubselector, and analyzed using the likelihood package. The found index is 2.00±0.08, in excellent agreement with the input value of 2.0, and the flux with E> 30 MeV is 0.284 $m^{-2}s^{-1}$, to be compared with the MC value of 0.3 $m^{-2}s^{-1}$ (deduced from the light curve Seth used and an overall average of 0.2 $m^{-2}s^{-1}$). The prefactor is 85±10. For this source (without considering diffuse emission), the found flux agrees with the MC value within the error bars.

Encouraged with these results, the 3C279 flare of June 1991 was studied using the template provided with obsSim. Event files for the whole period (12 days) were generated, the extragalactic and galactic diffuse emissions being taken into account. A script was written to create the input files for dataSubselector, makeExposure, exMap and likelihood, as well as the proper Roi.xml files so that event subsets spanning a time bin of 5.7 hours were created and analyzed iteratively. The time bin was chosen so as to roughly correspond to a quarter of the time spanned by a single event file (7 in total) generated by obsSim. Again, the different programs ran without problems.

The results are displayed in Fig.2. The panels show the temporal evolution of (from top to bottom): the number of events assigned to 3C279 (Npred from likelihood), the found index (average: -1.91, MC: -1.89), the found flux with E>30 MeV and the unnormalized input (MC) flux. The latter is normalized in obsSim so its average comes to 0.425 $m^{-2}s^{-1}$. The average flux found by likelihood is 0.45 $m^{-2}s^{-1}$, so the apparent overestimation mentioned above is less obvious in the present case.

Comments-raised questions

General tools: There is no tool dedicated to analyzing slowly-varying transients, like flaring blazars, although the different components are obviously there. Are the users supposed to write scripts the way I did or is something else envisioned in this respect?

obsSim: Is there a way to constrain the size of the sky region in which the events are simulated, so that the galactic and extragalactic diffuse emissions can be taken into account without creating huge event files, when only a small region is to be studied?

dataSubselector: Can it handle different input files to generate a single filtered file? The feature enabling one to input a file containing the event-file names (available in likelihood for instance) does not seem to be supported.

likelihood: Is there a way to get the error bars into an output file? I got around this problem by redirecting the output to a file and used "grep" to fetch this information, but there must be a better way.

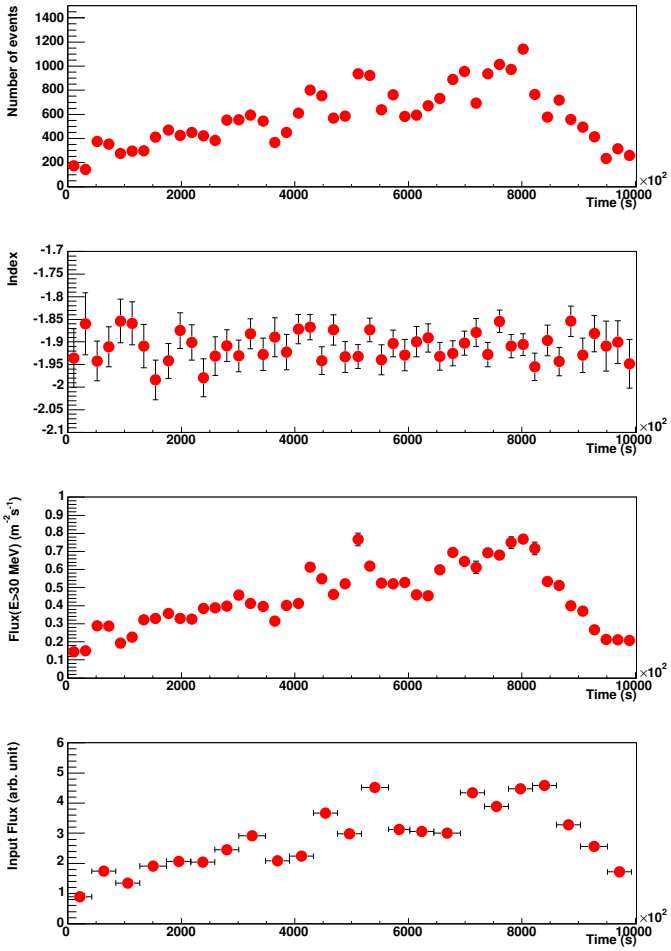

Figure 2: Temporal evolution of the number of photons for 3C273, the index and flux, as found by the likelihood (from top to bottom). The lower panel shows the (unnormalized) input flux used in the simulation.