

Likelihood Diffuse Component Tests

Comparison of gtdiffrsp output with gtsrcmaps values

- The diffuse response quantities are proportional, up to an energy-dependent factor $S(\hat{p})$ (i.e., the spectrum), to the probability densities of a given event for the corresponding source models. If $\tilde{S}(\hat{p})$ is the spatial distribution of the diffuse component, then the diffuse response is

$$d_0(\epsilon', \hat{p}') = \int d\hat{p} \tilde{S}(\hat{p}) P(\hat{p}'; \epsilon, \hat{p}, t) A(E, \hat{p}, t) D(\epsilon'; \epsilon, \hat{p}, t) \quad (1)$$

$$= \int d\hat{p} \tilde{S}(\hat{p}) P(\hat{p}'; \epsilon', \hat{p}, t) A(\epsilon', \hat{p}, t) \quad (2)$$

Here, \hat{p} and ϵ are true photon direction and energy, t is the arrival time, primes indicate measured quantities, P is the PSF, A is the effective area, and D is the energy dispersion (taken to be a delta function in energy in the second line).

- In gtsrcmaps the spatial distribution is multiplied by the time-integrated exposure, E , and convolved with the mean PSF, P_{avg} :

$$E(\epsilon', \hat{p}) = \int dt A(\epsilon', \hat{p}, t) \quad (1)$$

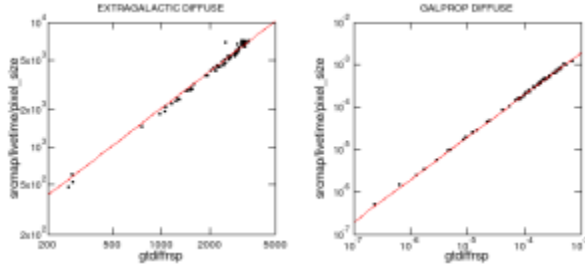
$$P_{avg}(\hat{p}'; \epsilon', \hat{p}) = \frac{1}{E(\epsilon', \hat{p})} \int dt A(\epsilon', \hat{p}, t) P(\hat{p}'; \epsilon', \hat{p}, t) \quad (2)$$

$$d_1(\epsilon', \hat{p}') = \int_{\Delta\hat{p}'} d\hat{p}' \int d\hat{p} E(\epsilon', \hat{p}) P_{avg}(\hat{p}'; \epsilon', \hat{p}) \tilde{S}(\hat{p}) \quad (3)$$

The integral over \hat{p}' is over the pixel size, $\Delta\hat{p}'$. For an inertial pointing, E is just the effective area times the livetime Δt and we should have

$$d_0 = \frac{d_1}{\Delta t \Delta\hat{p}'} \quad (4)$$

The lhs of the above equation is plotted vs the rhs below for extragalactic (isotropic) and galprop_v02.fit diffuse models. The red curves are best fit power-laws with the index fixed to unity. Other than a constant factor of approximately 2 in both plots (2.04 and 1.95, respectively), the relation holds fairly well. Replacing the gtdiffrsp values in the FT1 file with the gtsrcmaps values does not result in a substantial change in the fit of the two components.

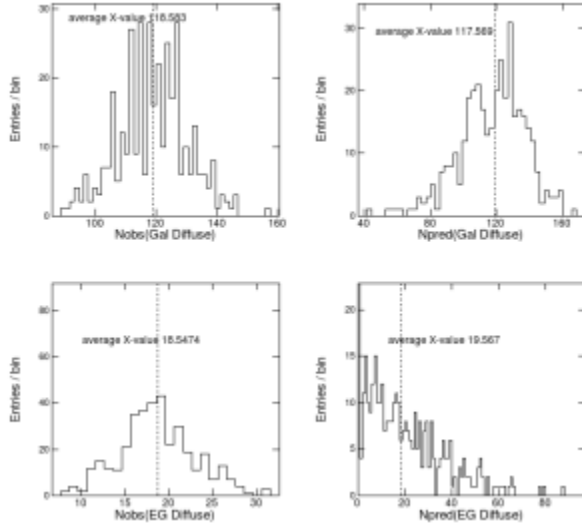


Npred Tests

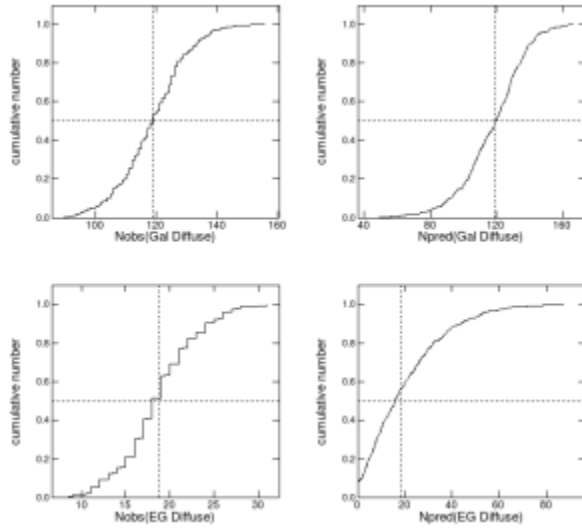
I have run a number of 1-day simulations (idealized rocking) using Galactic (gll_iem_v02.fit) and extragalactic (isotropic, index=-2.1, EGRET >100 MeV flux) diffuse components, and made nominal selections at the Galactic anticenter (0.1-100 GeV; ra, dec, rad = 86.4, 28.9, 15). For each realization, I fit the two components using unbinned likelihood, compute Npred from the fit and determine Nobs (the observed number of events with the ROI) for each component. In order to search for biases, I compare the distributions of Npred and Nobs to the Npred values that are obtained using the MC values for the normalization and spectral parameters of the two components.

The Npred values using the MC parameters are Npred(GalProp) = 118.864 and Npred(EG Diffuse) = 18.726. These are plotted as the dashed vertical and horizontal lines in the figures.

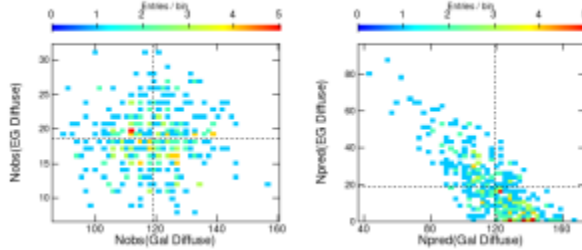
- Histograms of Npred and Nobs. Mean values of the distributions are given as the "average X-value".



- Normalized cumulative distributions. The horizontal lines at 0.5 indicate the median values on the distributions.



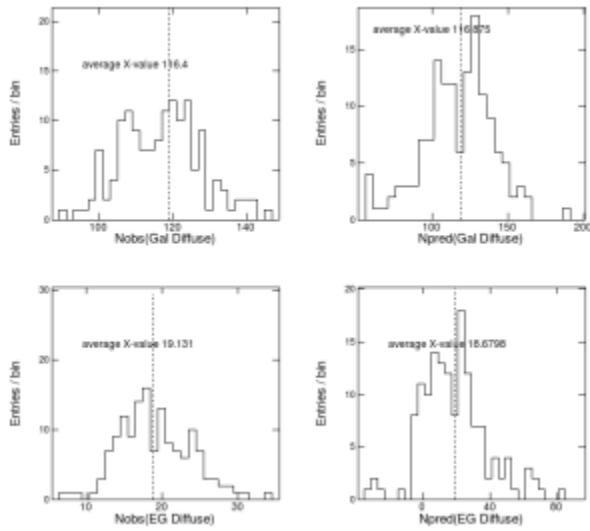
- 2D distributions.



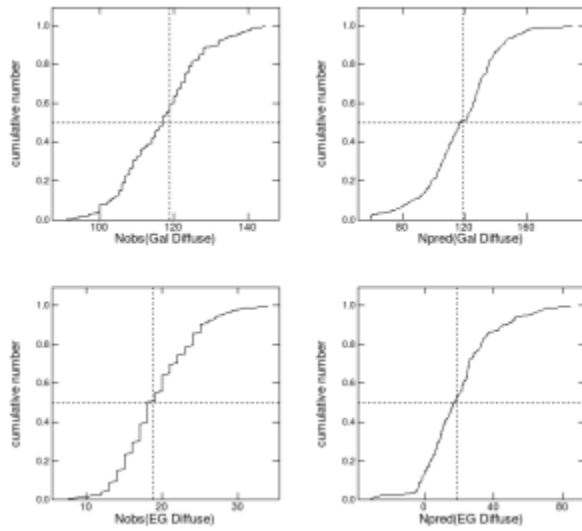
Relaxing Npred(EG Diffuse) > 0 constraint

These are the same plots, but in the fitting, the normalization of the extragalactic diffuse emission was allowed to go negative. A positive lower limit was placed on the Galactic component normalization to help prevent negative overall probability densities, but some cases (4 out of 149) still arose in the process of the optimization. These were omitted from the distributions and probably lie in the negative Npred(EG Diffuse) range, so these results are slightly biased.

- Histograms of Npred and Nobs. Mean values of the distributions are given as the "average X-value".



- Normalized cumulative distributions. The horizontal lines at 0.5 indicate the median values on the distributions.



- 2D distributions.

