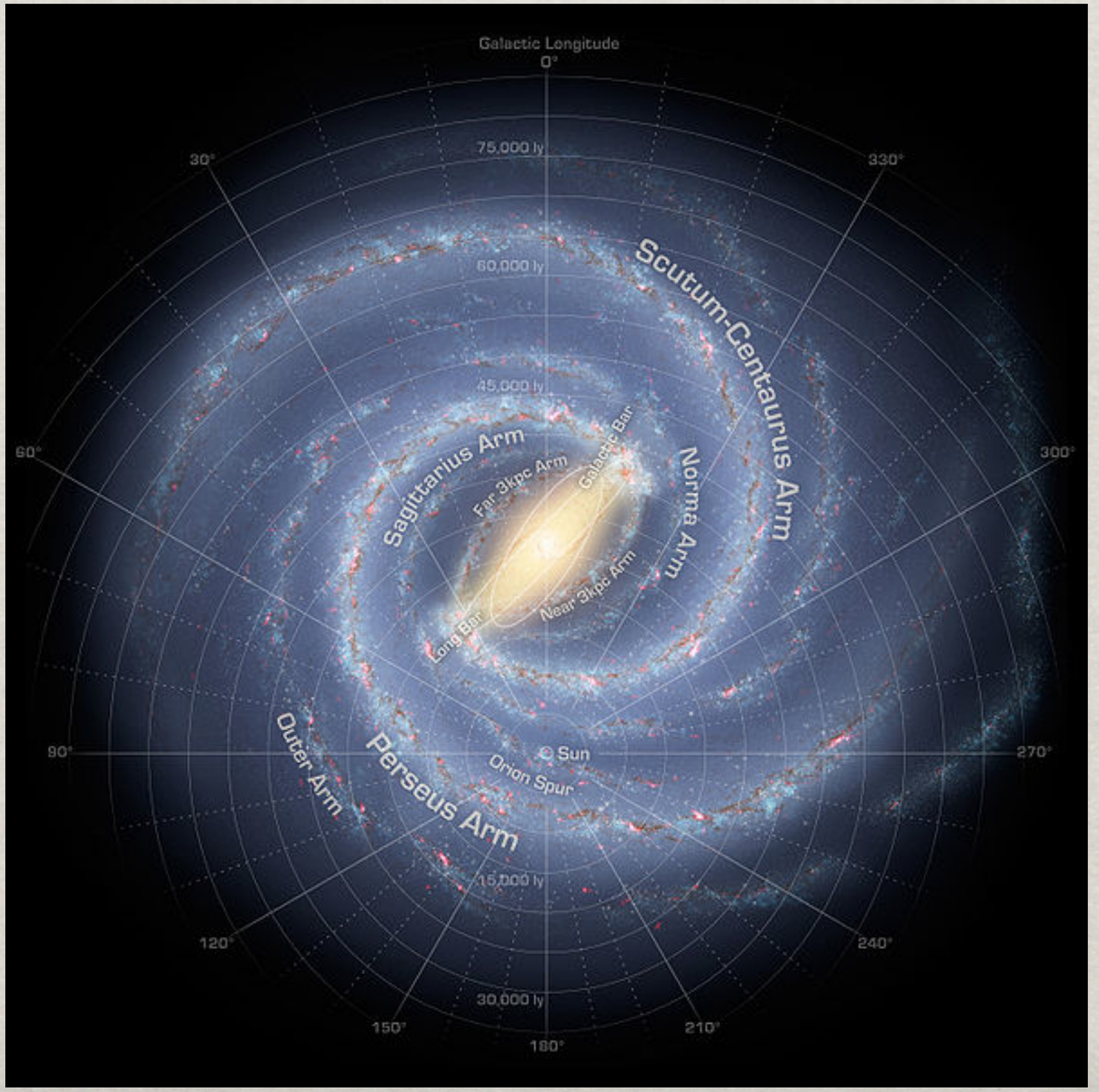
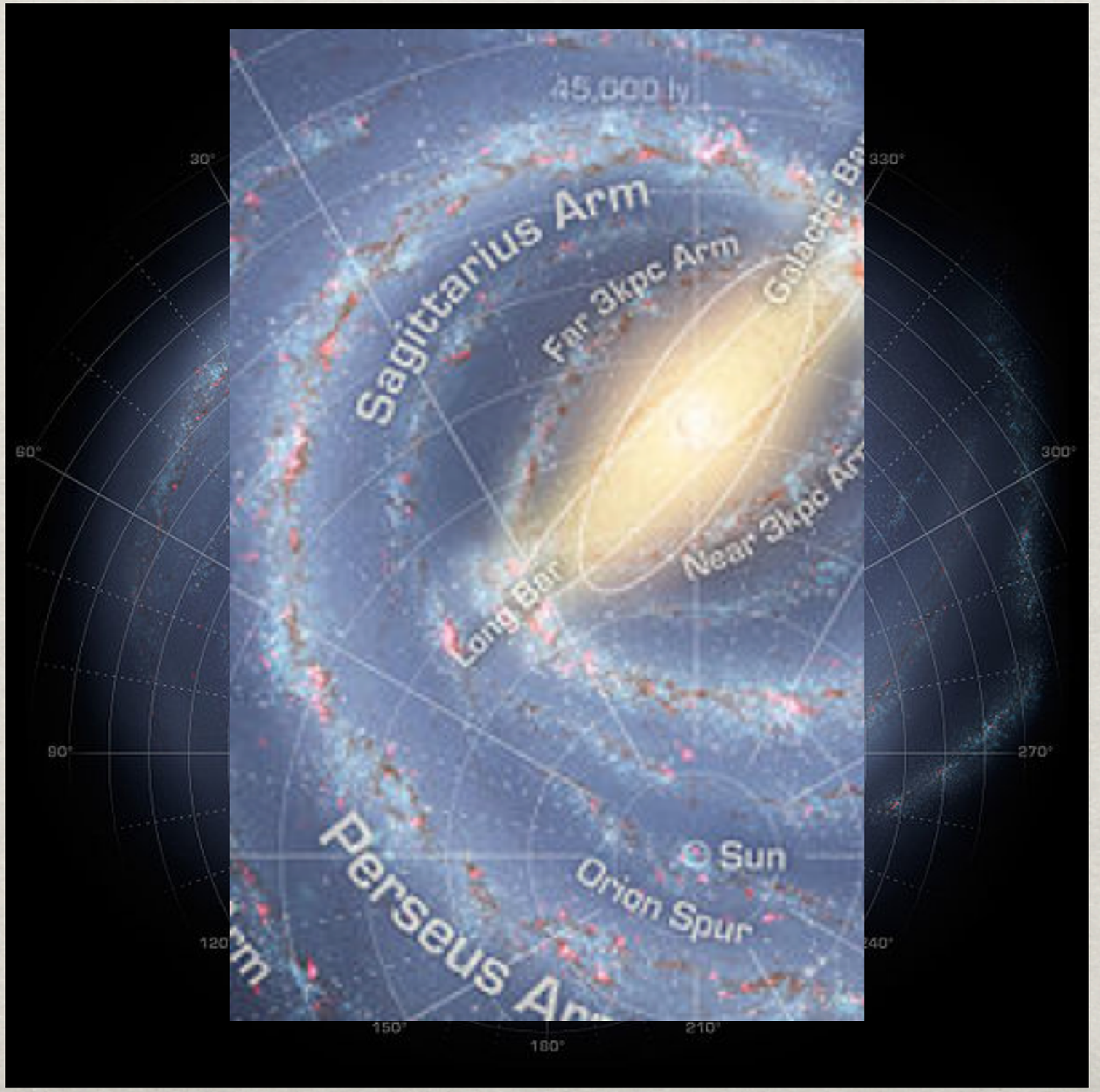
STAR FORMATION TOWARDS THE SCUTUM TANGENT REGION AND THE EFFECTS OF GALACTIC ENVIRONMENT

DAVID EDEN
ASTROPHYSICS RESEARCH INSTITUTE,
LIVERPOOL JOHN MOORES UNIVERSITY

$l = 30^\circ$

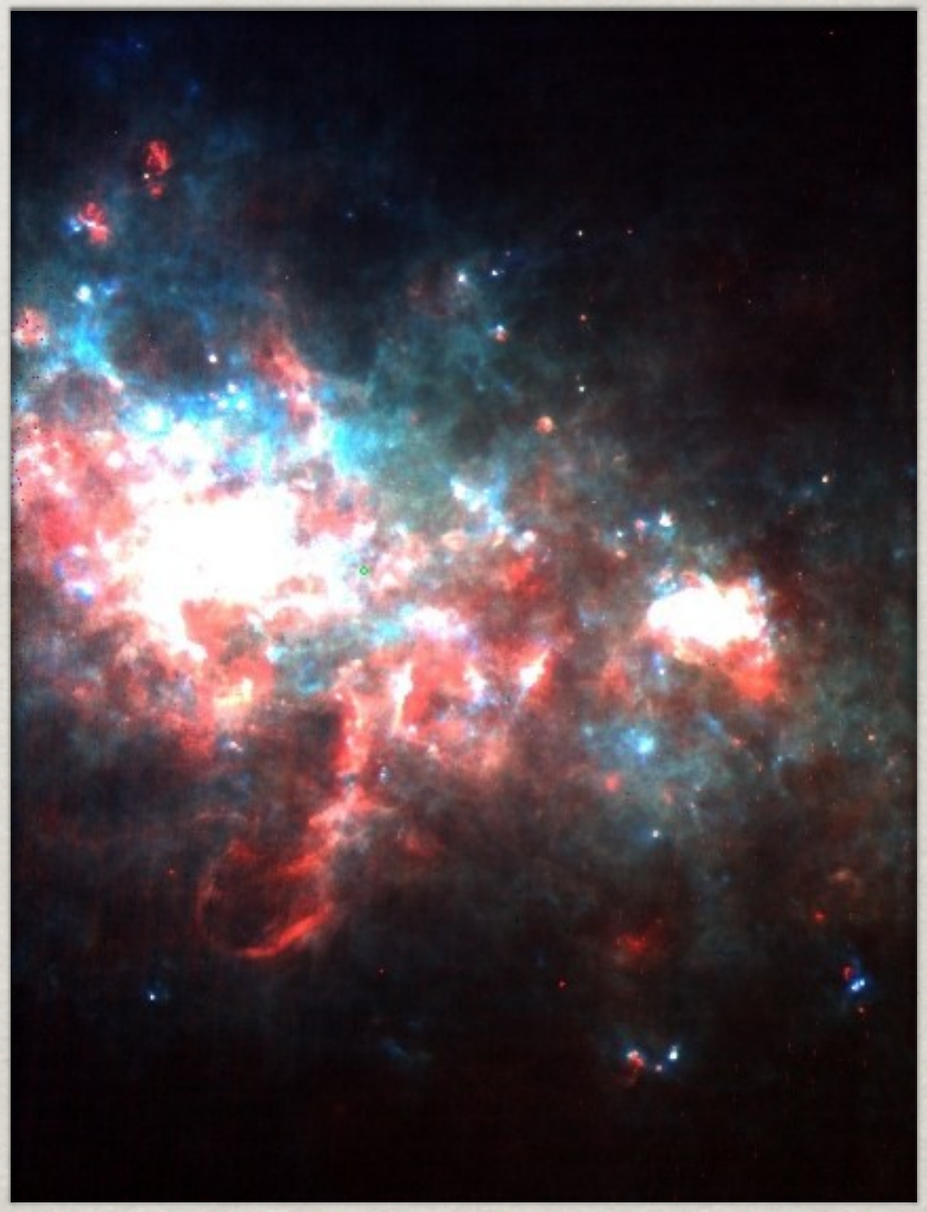

Galactic Longitude
0°
30°
330°
60°
300°
90°
270°
120°
240°
150°
210°
180°
75,000 ly
60,000 ly
45,000 ly
30,000 ly
15,000 ly
Scutum-Centaurus Arm
Sagittarius Arm
Norma Arm
Perseus Arm
Outer Arm
Far 3kpc Arm
Near 3kpc Arm
Galactic Bar
Long Bar
Sun
Orion Spur

$l = 30^\circ$


45,000 ly
Sagittarius Arm
Far 3kpc Arm
Galactic Bar
Near 3kpc Arm
Long Bar
Sun
Orian Spur
Perseus Arm
30°
330°
60°
300°
90°
270°
120°
240°
150°
210°
180°

W43 Giant Molecular Cloud

- HII Region with 10^{51} Lyman continuum photons s^{-1}
- 3.6×10^6 $L_\odot$ in the far-IR
- Forming 15 high-mass protoclusters with a SFR of 25 %/10^6 years



Aims

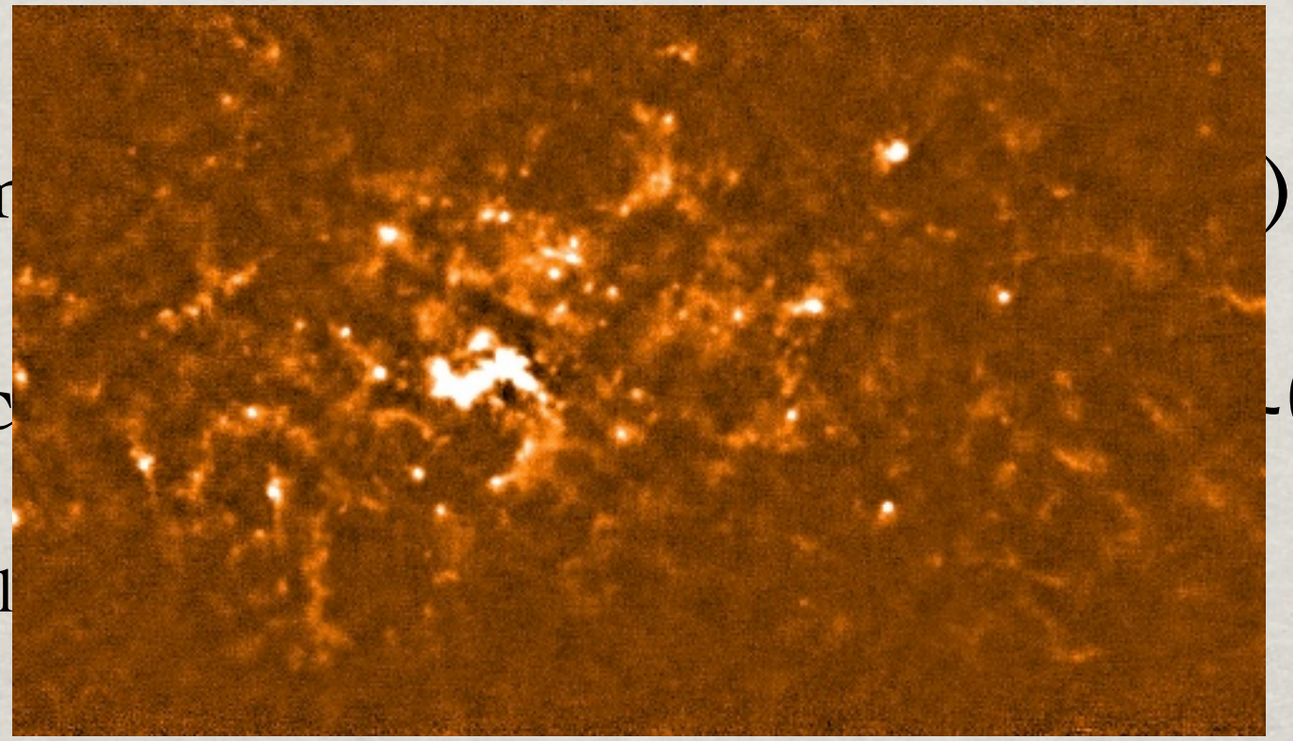
Measure the dense clump analogues (or precursors) of the IMF and SFE, the clump mass function and clump formation efficiency by using the Bolocam Galactic Plane Survey, and investigate their variations with Galactic structure.

Data

- Bolocam Galactic Plane Survey (BGPS) 1.1 mm
- Galactic Ring Survey (GRS) ^{13}CO J=1-0
- HARP ^{13}CO J=3-2

Data

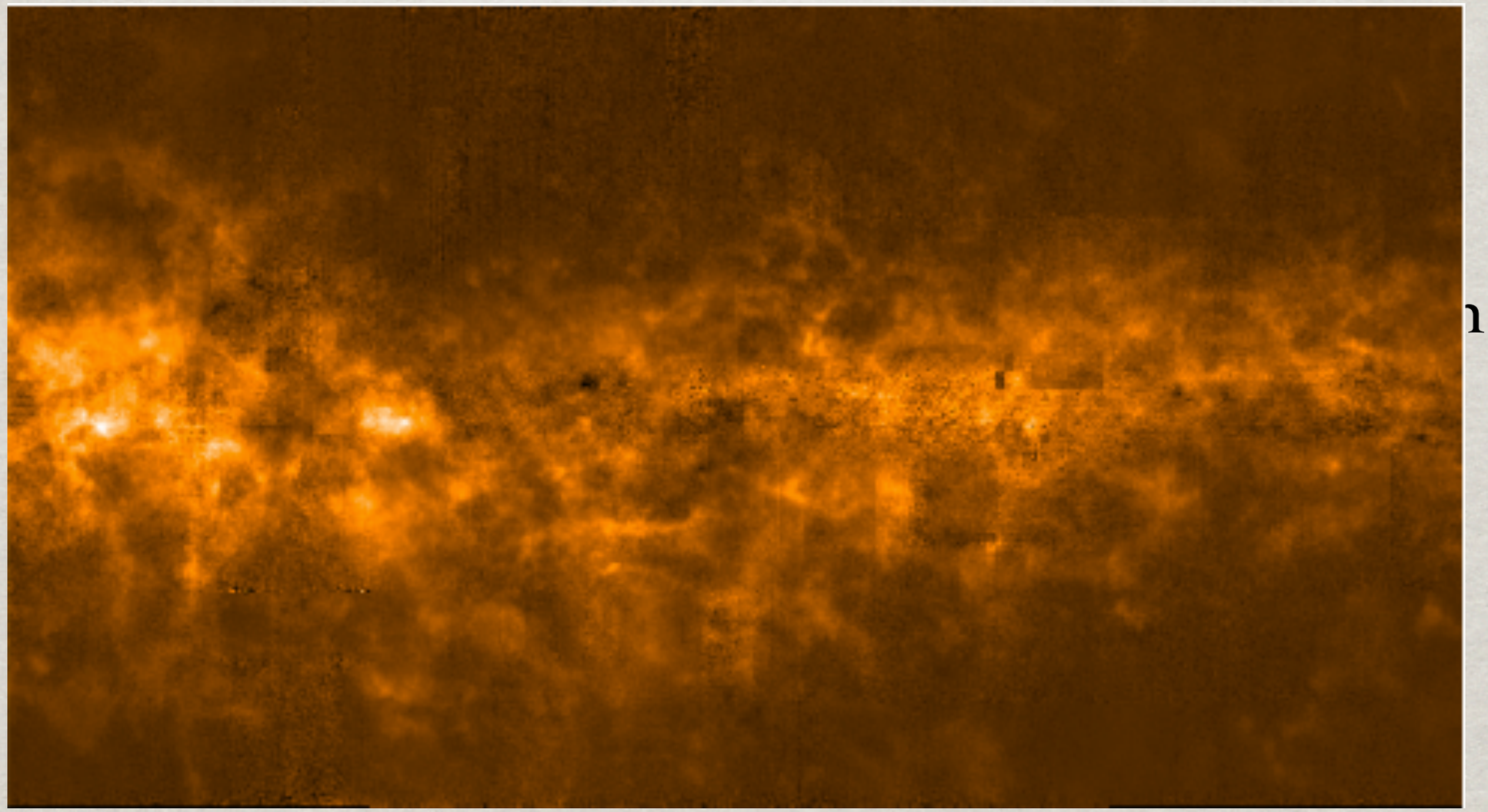
- Bolocam
- Galactic
- HARP



1.1 mm

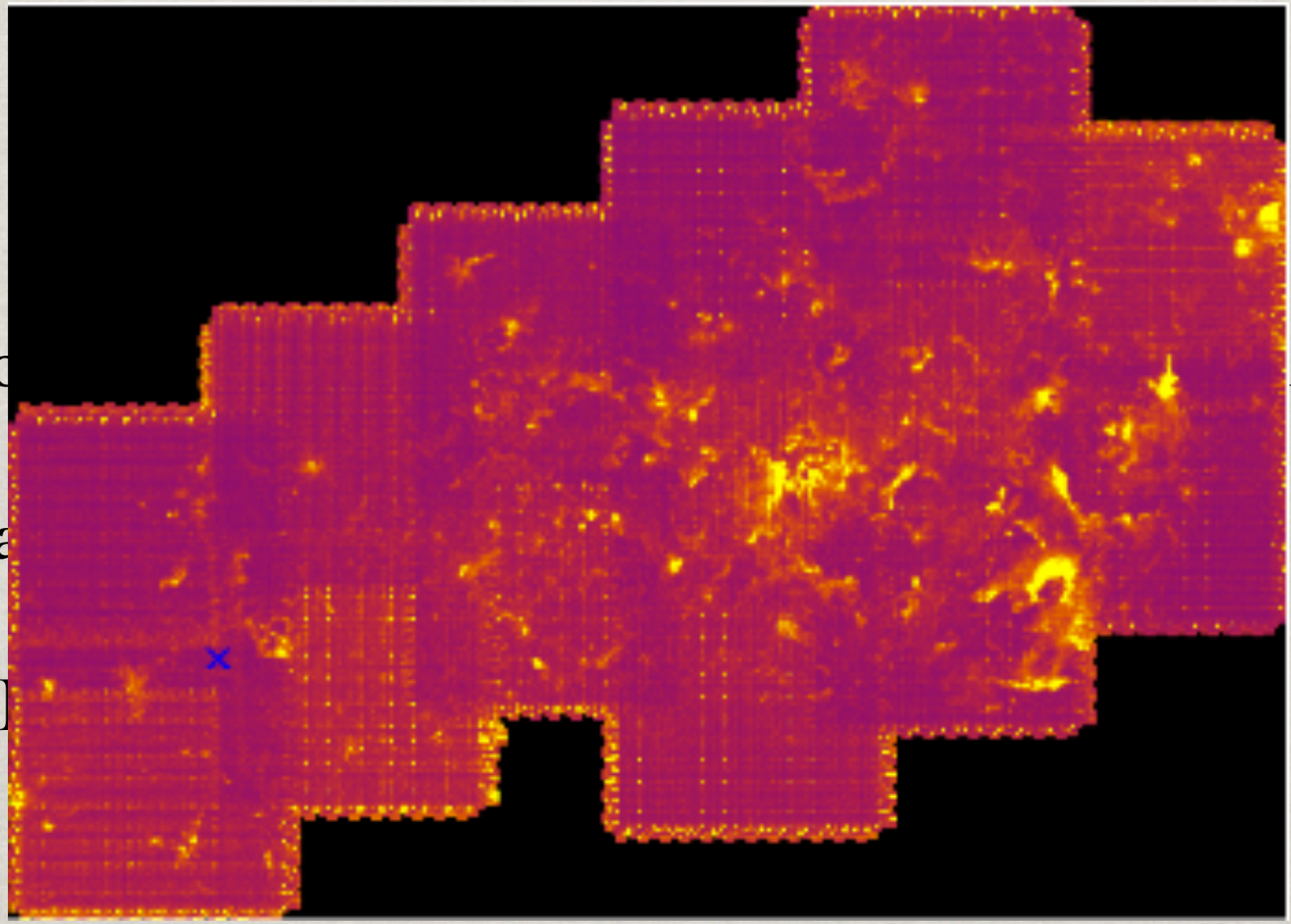
-0

Data



Data

- Bolo mm
- Gala
- HA



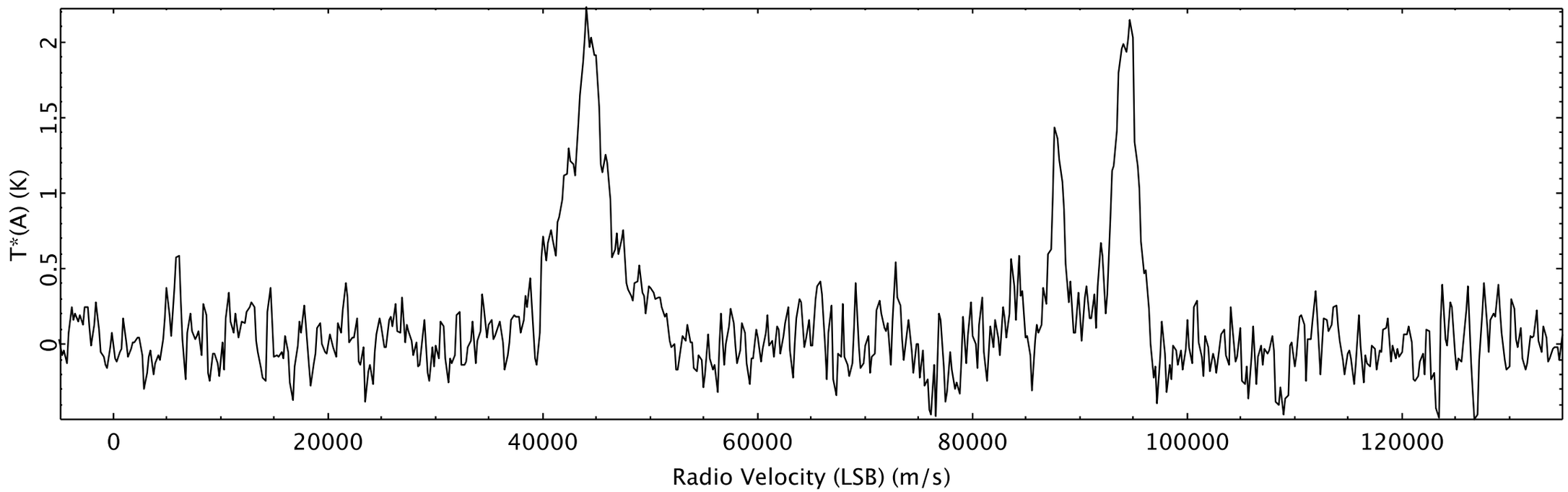
Source Distance Determination

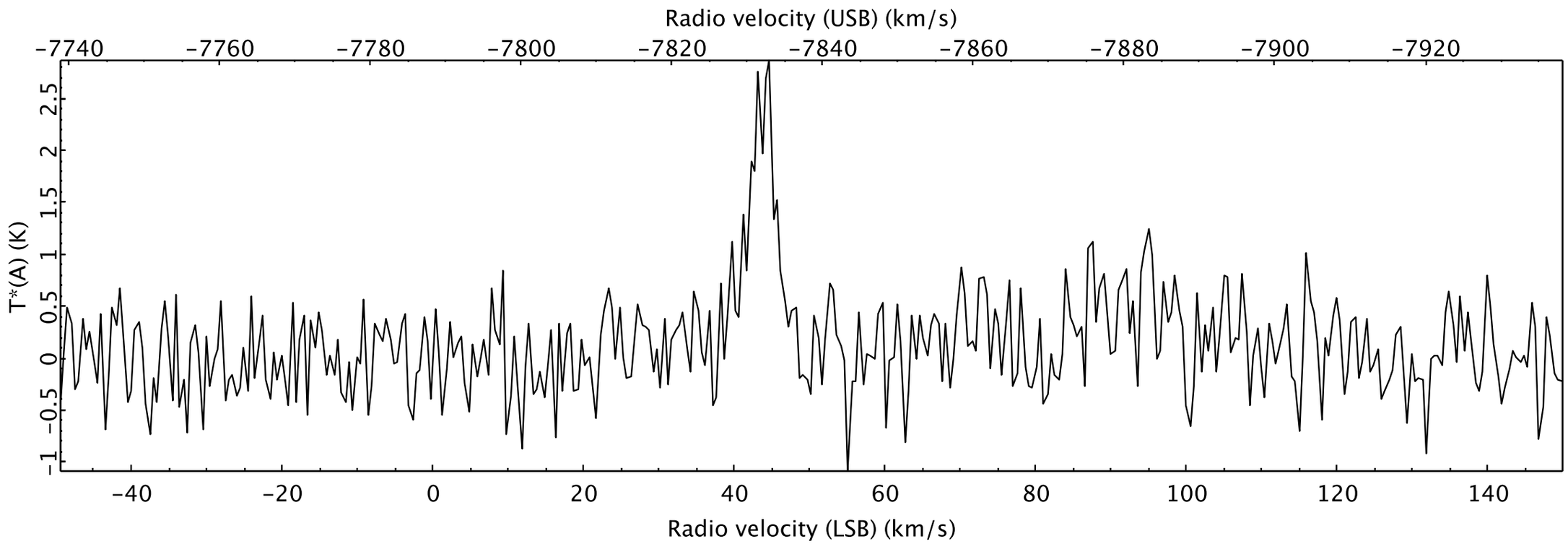
The GRS cloud distance catalogue (Roman-Duval et al., 2009) and the GRS mass catalogue (Roman-Duval et al., 2010) were combined to give masses of the clouds within the field.

The spectra at the positions of the BGPS sources, as identified from the catalogue in Rosolowsky et al. (2010) were extracted and the peak velocity as well as the position in longitude and latitude were cross-referenced with the GRS catalogues, allowing a distance to be assigned to the source.

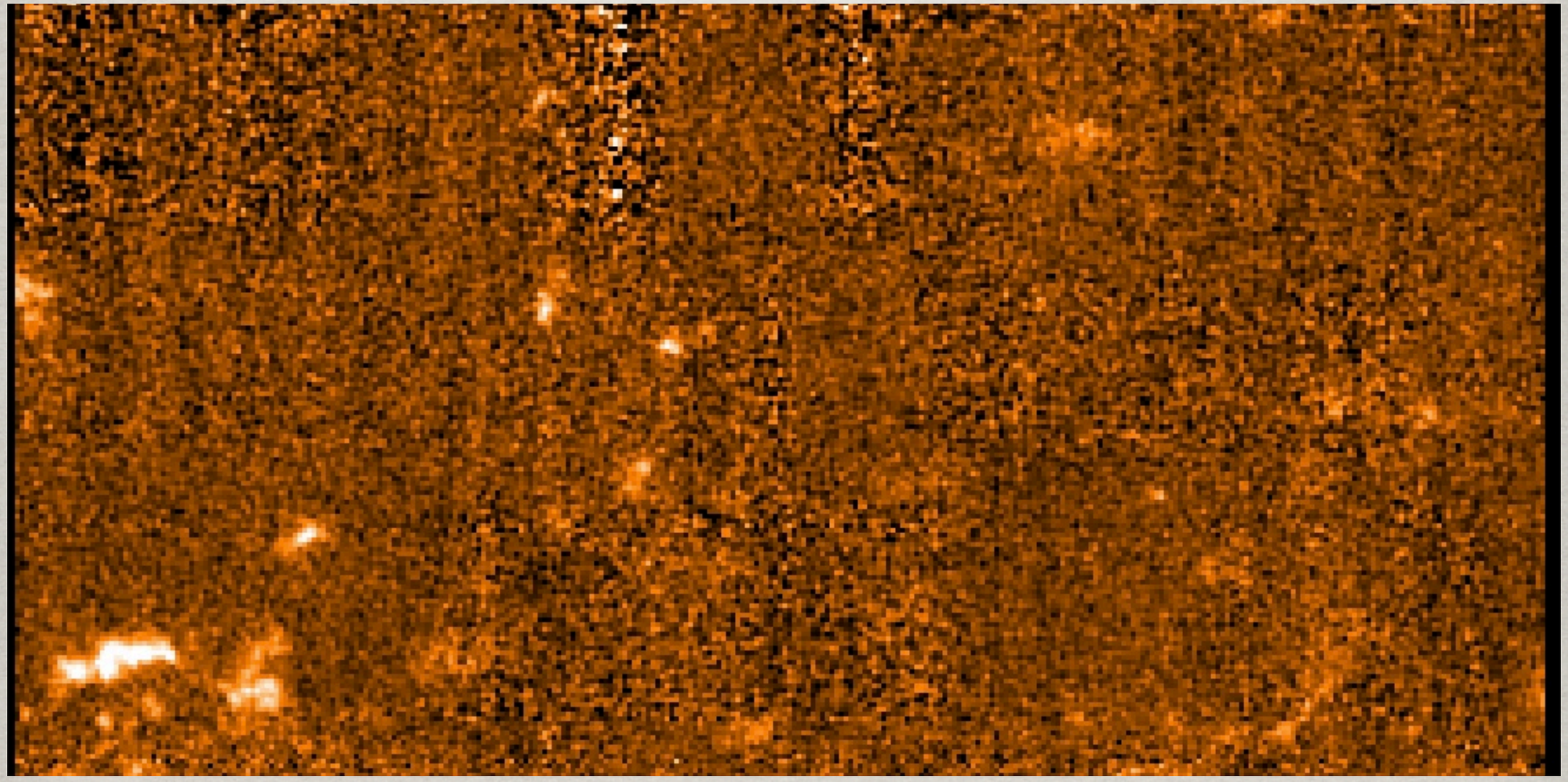
For spectra that displayed multiple peaks, the HARP data were used.

Spectra comparison

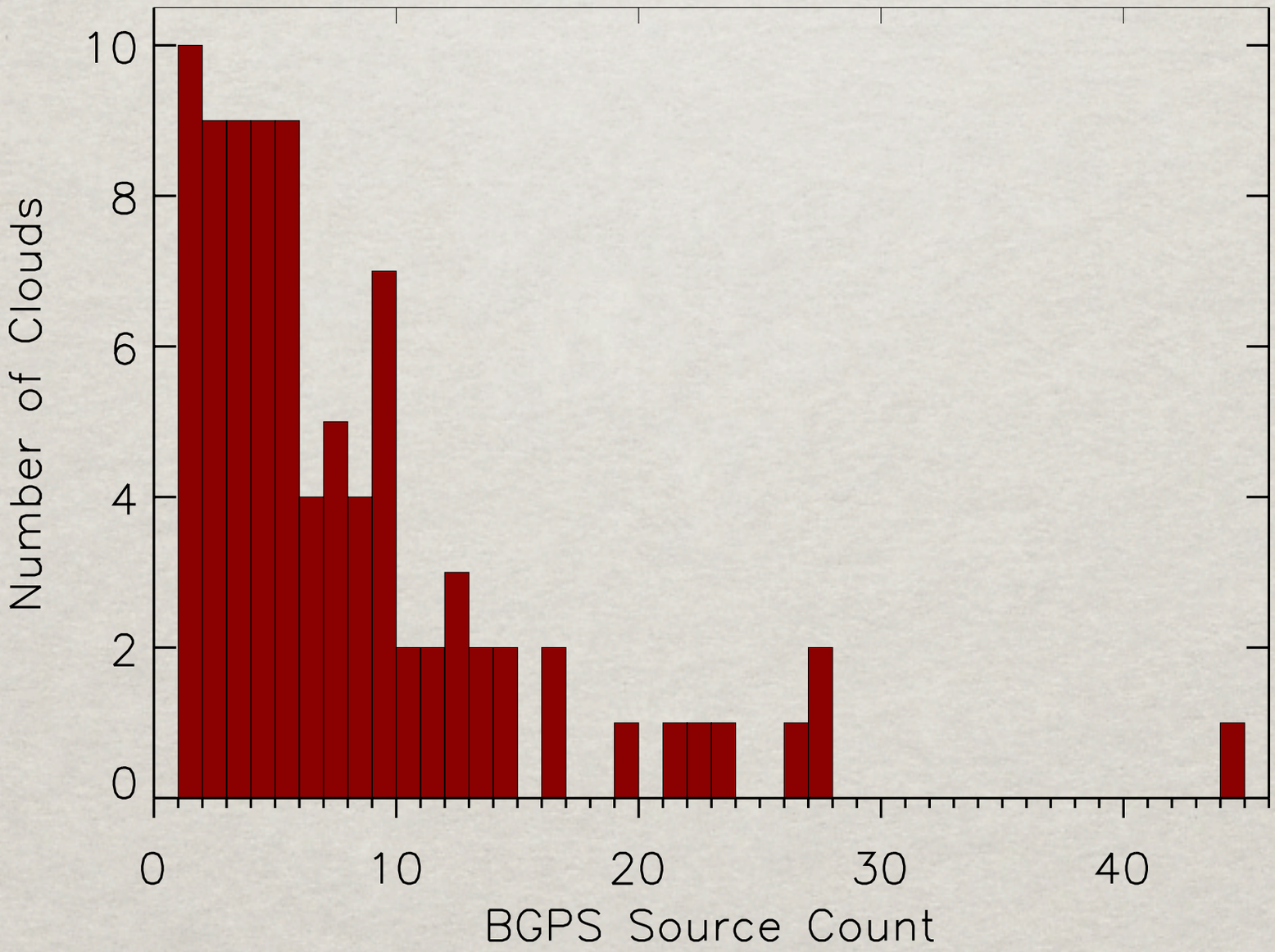




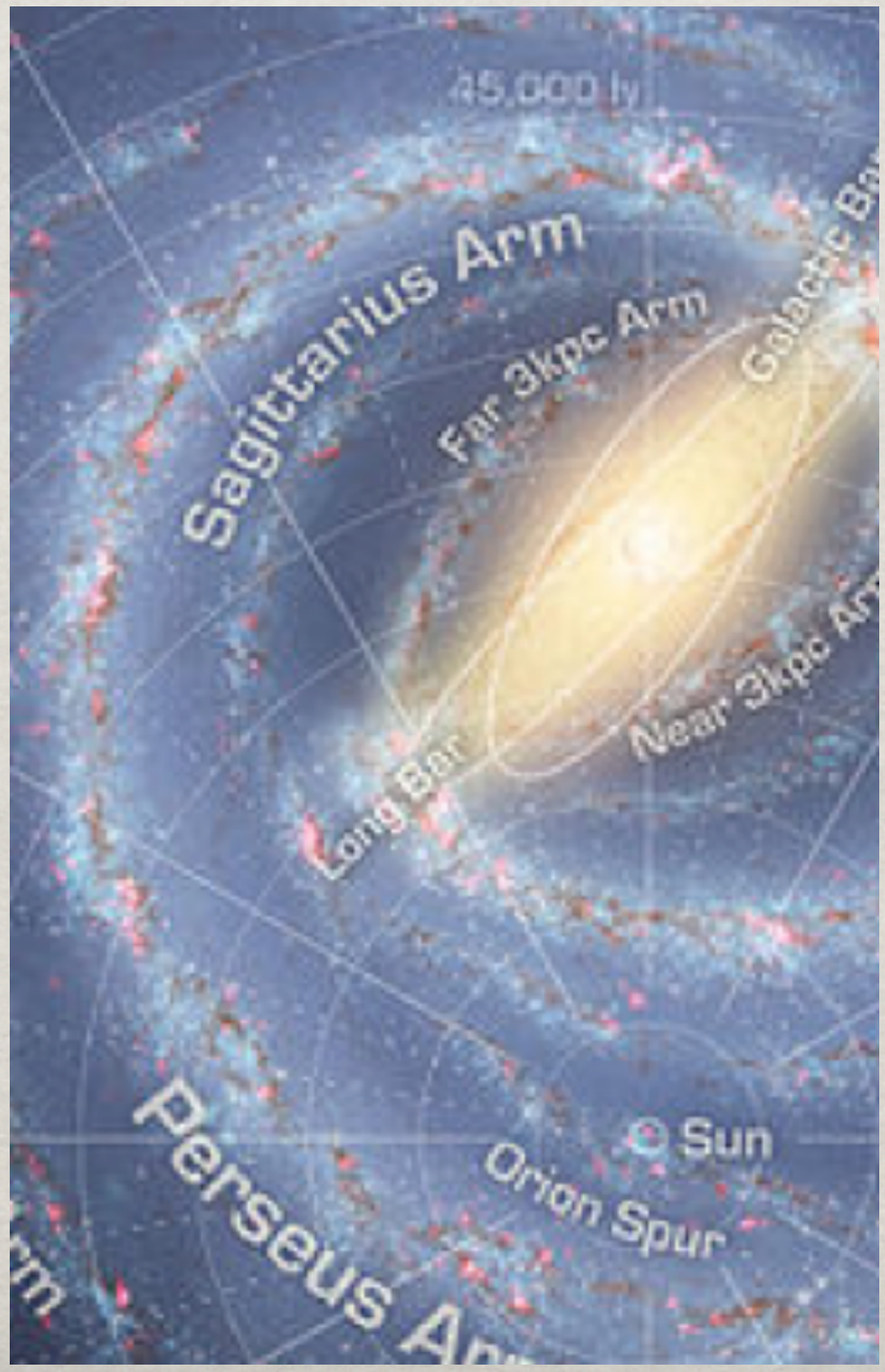
Unassigned sources



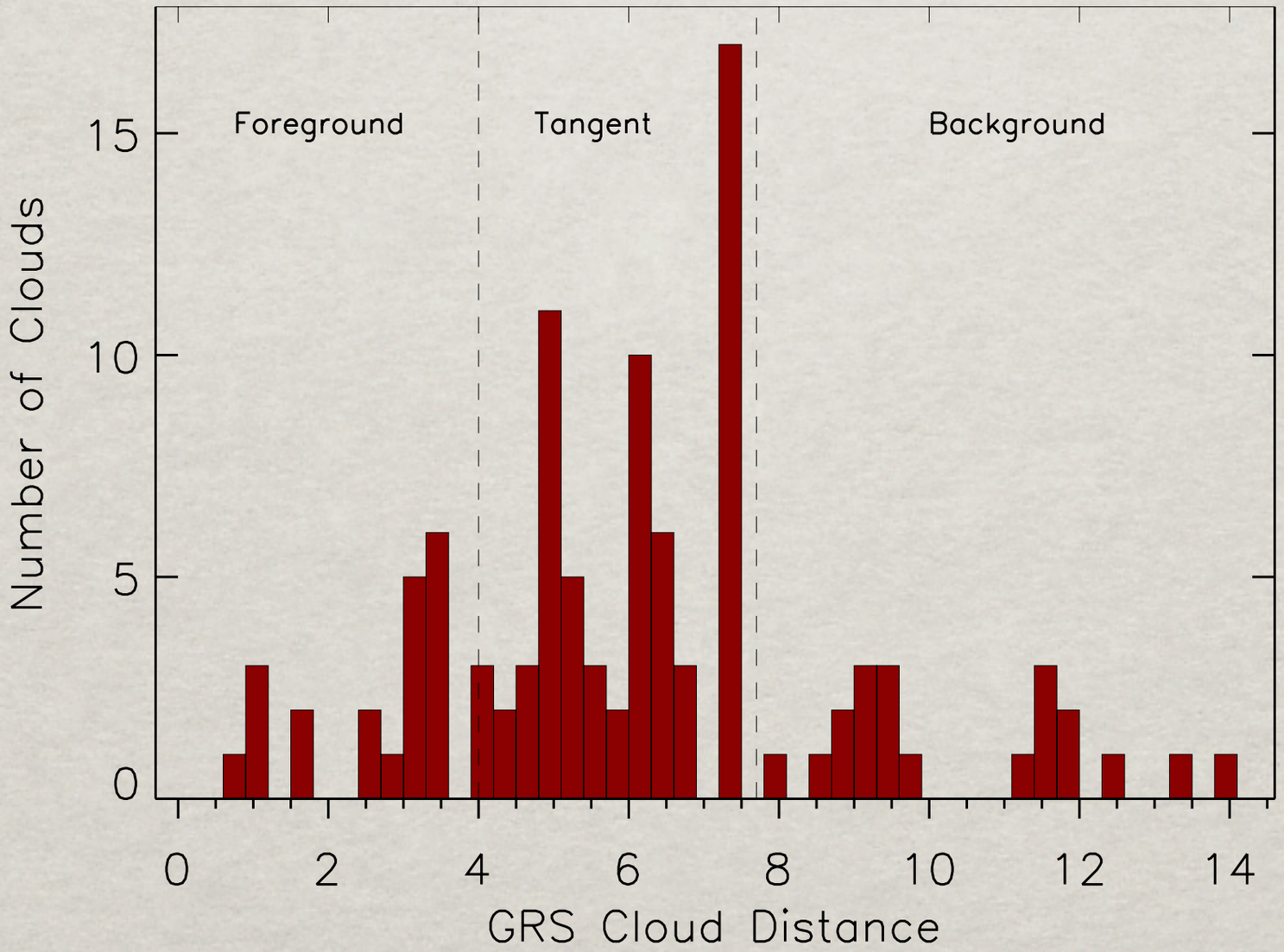
BGPS-GRS Cloud Associations



Populations within the l =30° Region



Populations within the l =30° Region

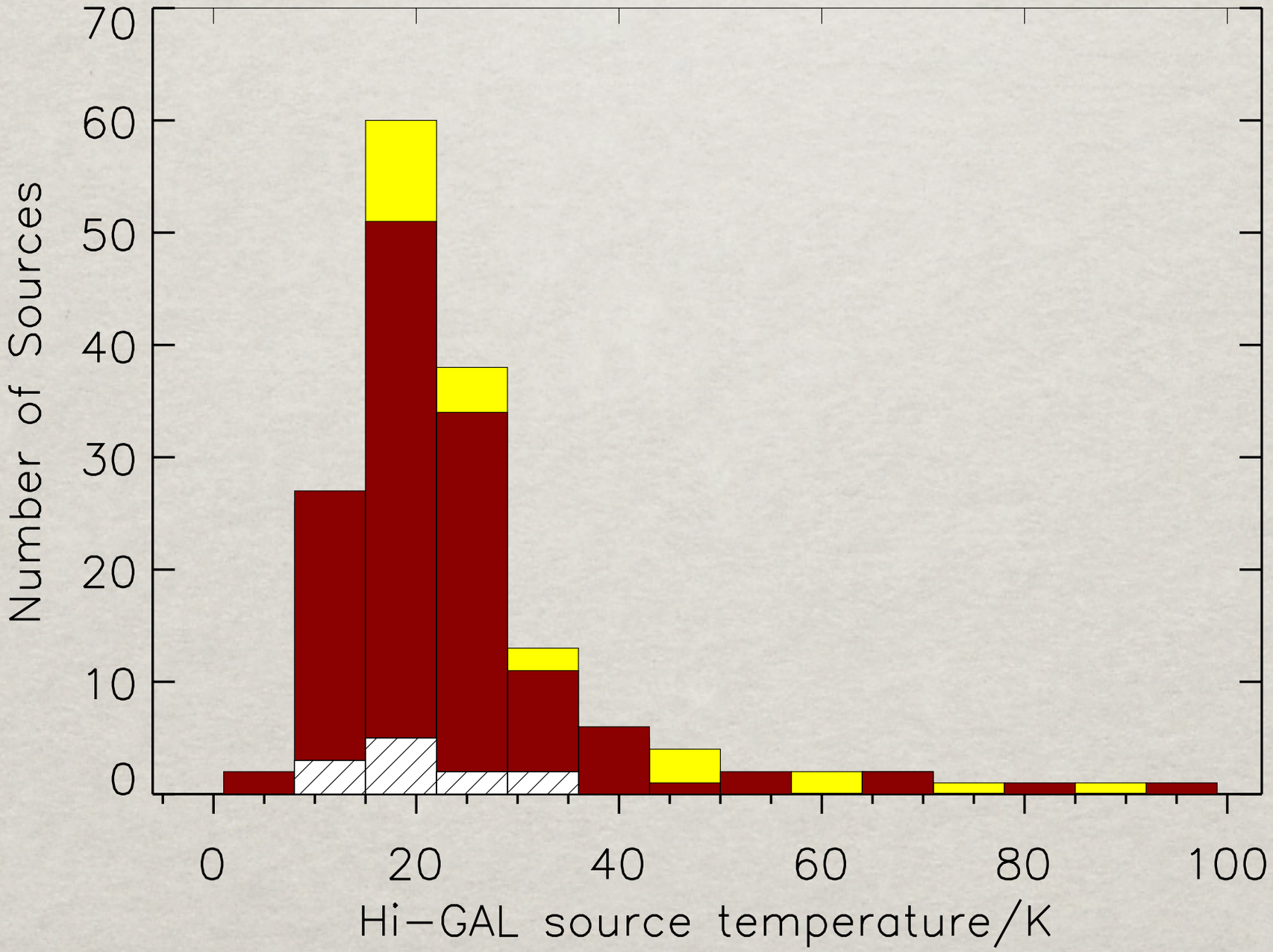


Masses of BGPS Sources

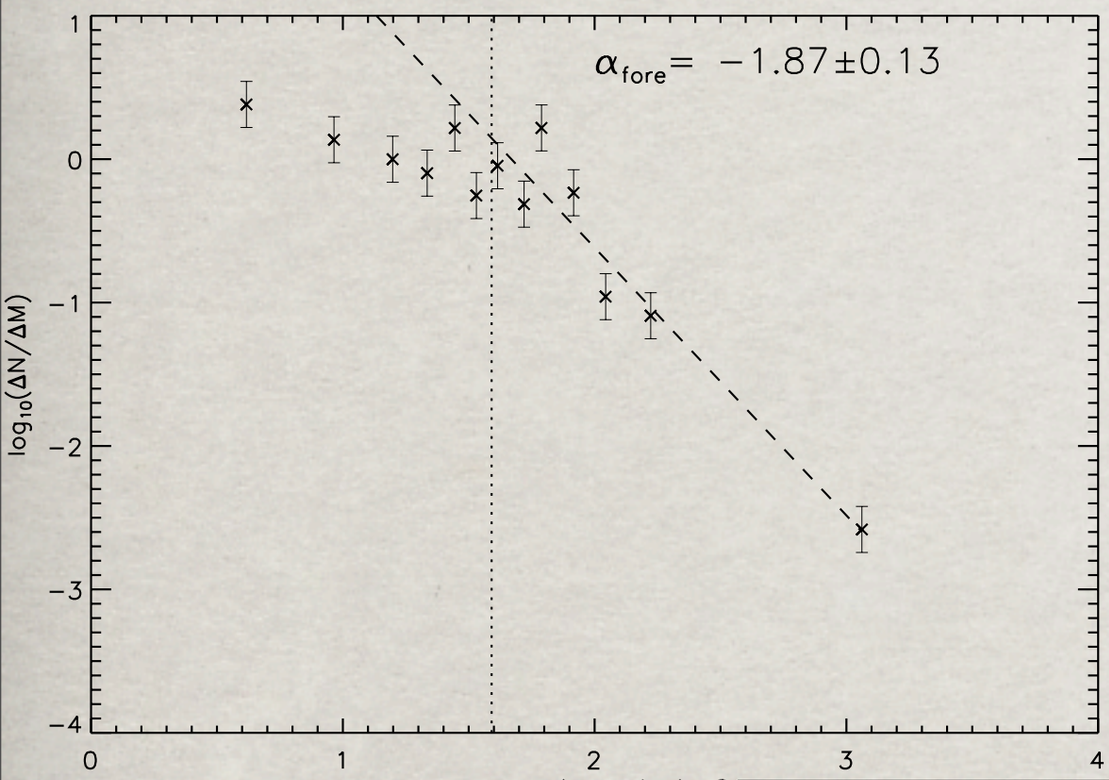
$$M = 13.1 M_{\odot} \left(\frac{S_{\nu}}{1Jy}\right) \left(\frac{D}{1kpc}\right)^2 (\mathrm{e}^{13.12/T_d} - 1)$$

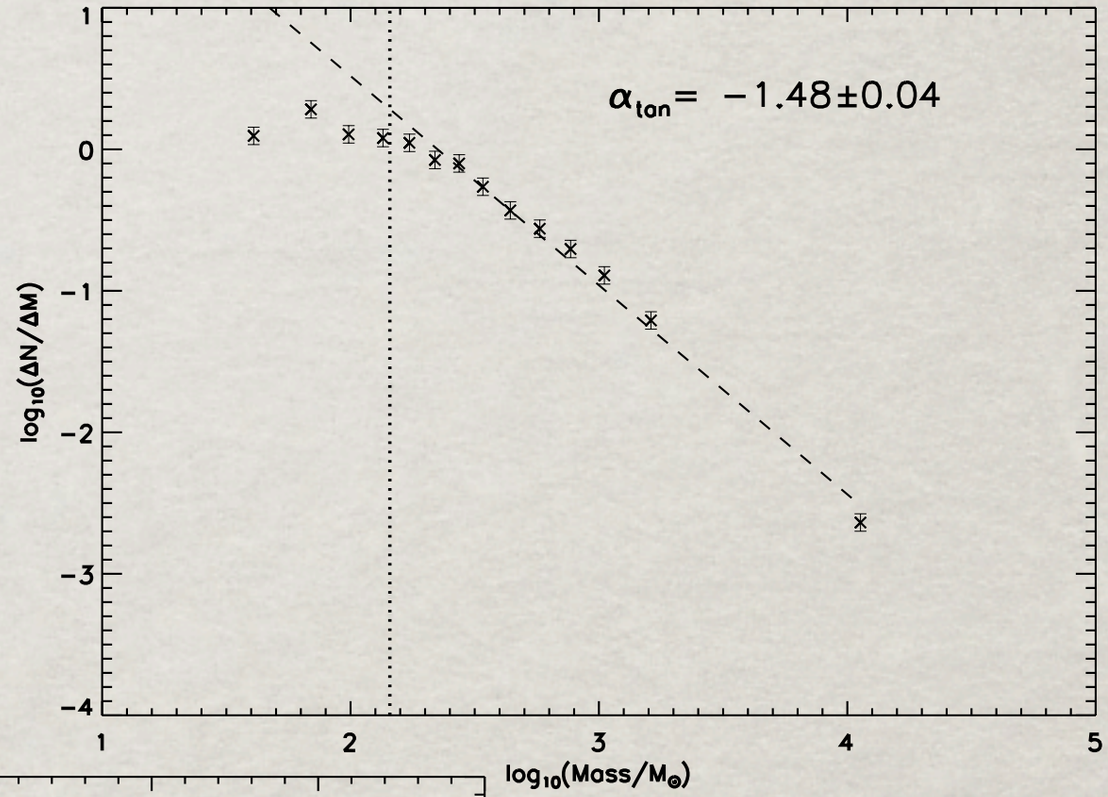
A flat distribution of 20 K was used, supported by the temperatures found in the Hi-GAL SDP field. All 3 populations peak at 20 K, and a K-S test on the three sub-samples show that they could be assumed to have the same temperatures

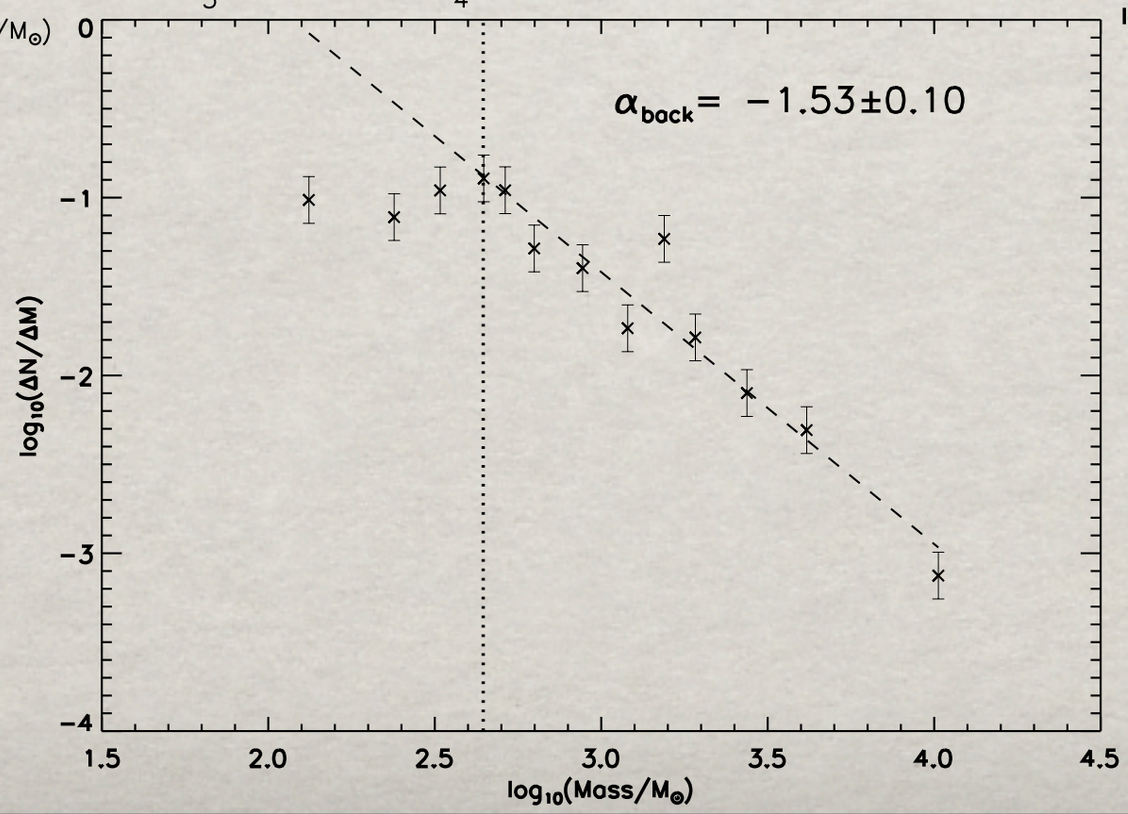
Hi-GAL Temperatures



Clump mass functions







Clump Formation Efficiencies

The clump formation efficiency (CFE) is a measure of what fraction of molecular gas has been converted into dense clumps. This quantity is analogous (or a precursor) to the star formation efficiency. The CFE must be viewed as an upper limit to the SFE.

The CFE is a measure of:

$$\frac{M_{clump}}{M_{cloud}} = \frac{1}{M_{cloud}} \int_0^t \frac{dM}{dt} dt$$

where dM/dt is the instantaneous clump formation rate. A high value for CFE can indicate either a high clump formation rate or a long formation timescale.

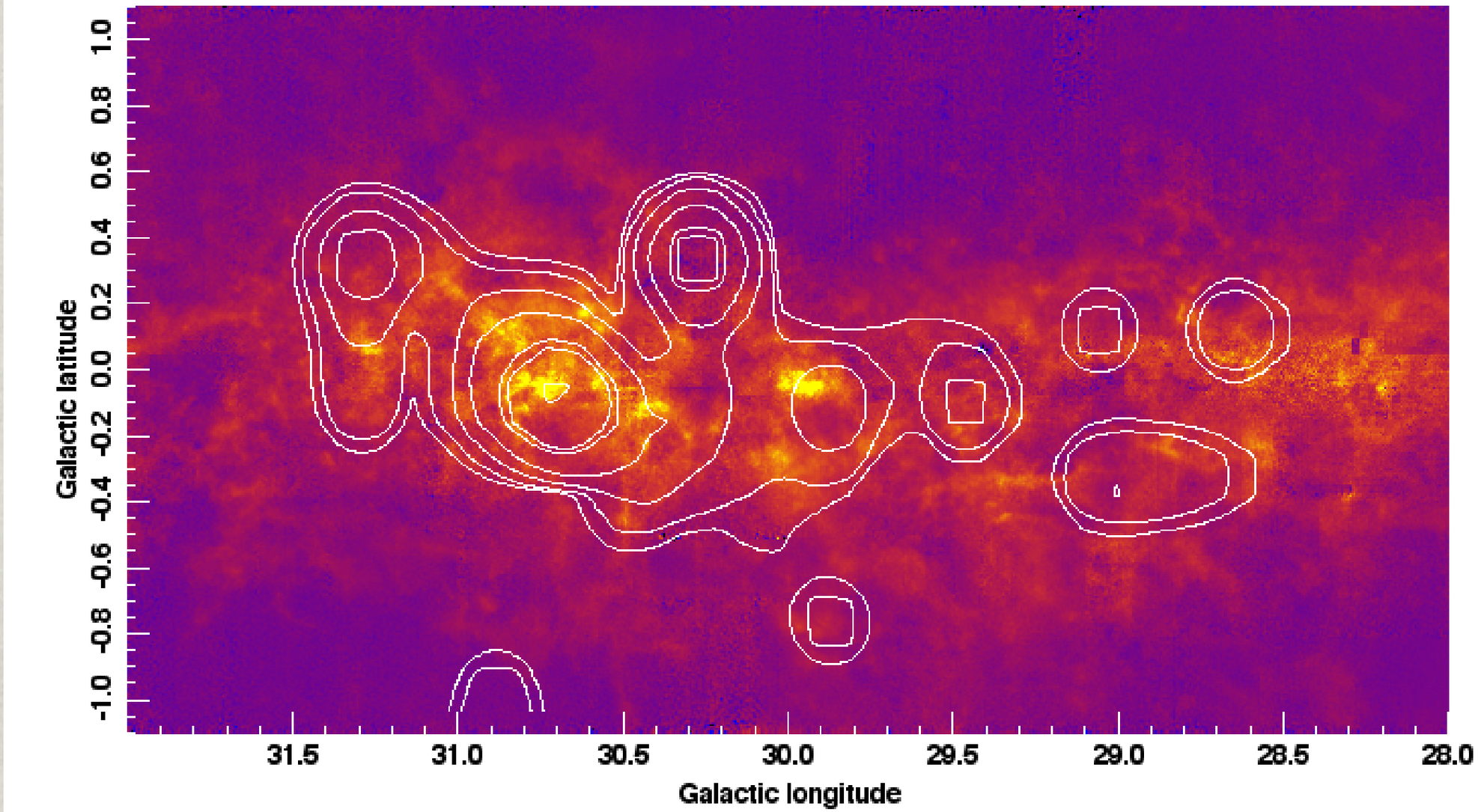
Clump Formation Efficiencies

Foreground: 13.00 ± 1.60 %

Tangent: 8.38 ± 0.30 %

Background: 8.52 ± 0.73 %

Clump Formation Efficiency within the Tangent Region



W43: a Mini-starburst Region?

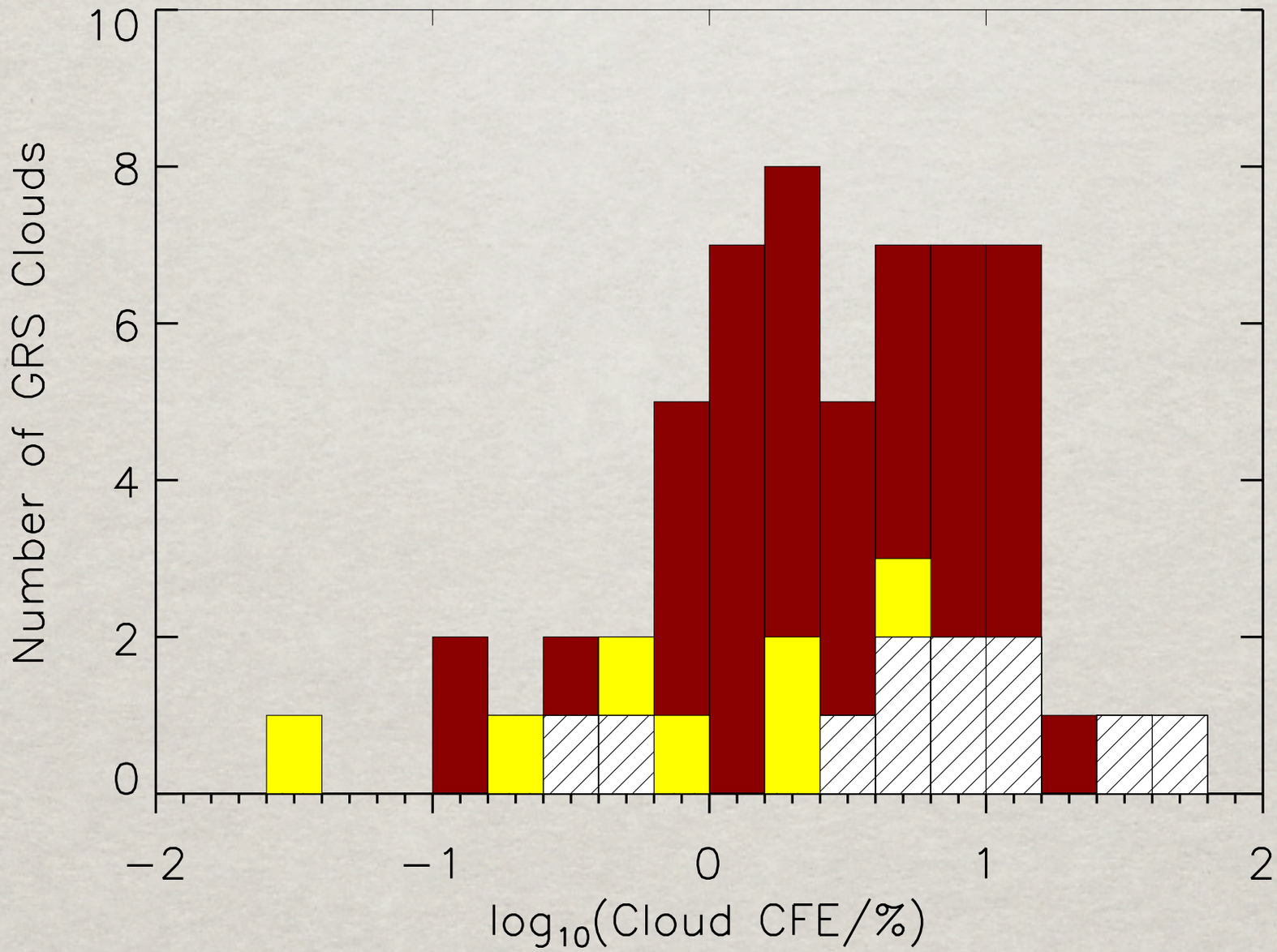
Since starbursts are associated with high star-formation efficiencies, if W43 were to be considered a mini-starburst region, it might be expected to have an unusually high CFE.

The median CFE values for the individual clouds:

Foreground: 7.15 ± 4.95 %
Tangent: 3.27 ± 2.28 %
Background: 3.78 ± 3.32 %

Since these are consistent within the uncertainties, it implies that the clouds within the tangent region are not, on average, in a significantly different physical state to those in the other two velocity bins.

W43: a Mini-starburst Region?



Galactic Bar Star Formation

Observations of other barred spiral galaxies have found large amounts of molecular material and extreme star-forming regions at the end of galactic bars where the gas and stars in normal circular orbits are in co-rotation with the pattern speed of the bar. The gas in the bar is expected to interact with the circularly orbiting clouds at the end of the bar.

Bar ends might, therefore, be expected to produce unusual numbers of extreme star-forming regions from increased rates of cloud-cloud collisions, which have been shown to induce star formation.

Conclusions

- Large variations in CFE are found to be coincident with well known HII regions, implying that local triggering due to feedback may be the dominant mechanism affecting the CFE, not large-scale structure.

- Despite having a very high star-formation rate, and containing one cloud with a very high CFE, the star formation associated with the Scutum-Centaurus tangent does not appear to be in any way abnormal or different to that in the other regions investigated.

- See: Eden et al. arXiv:1203.0295