# STO Survey Strawman

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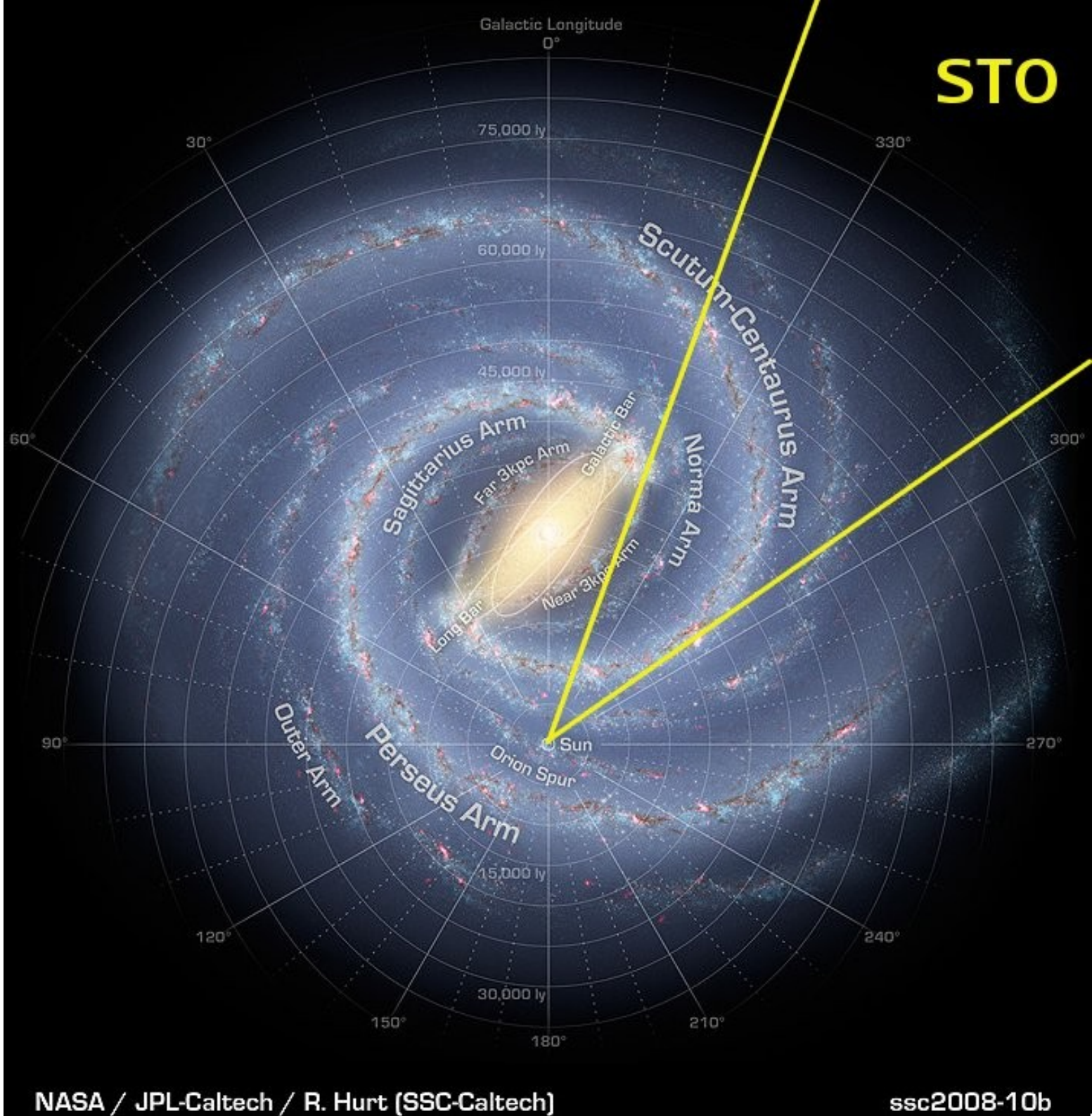
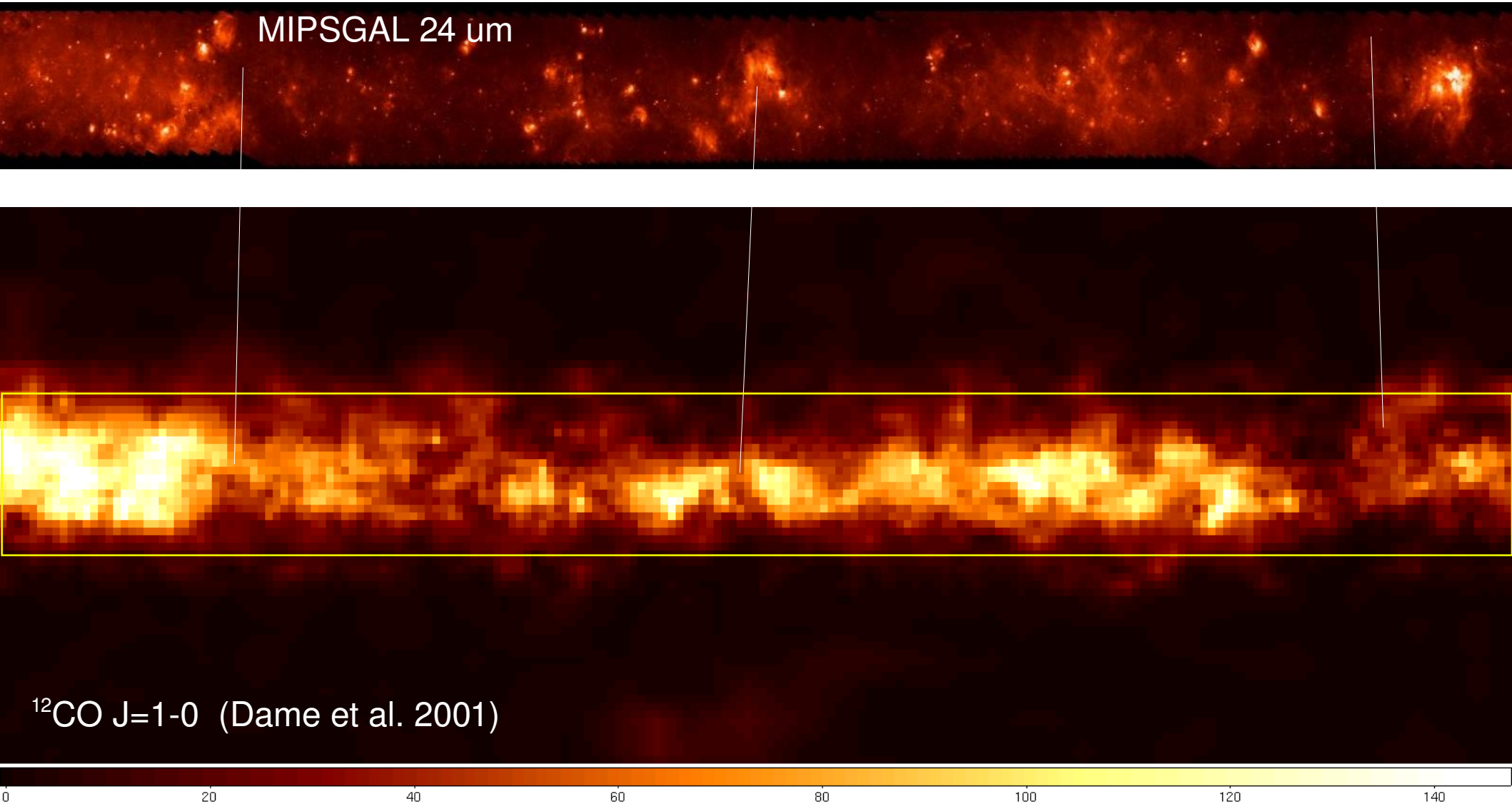
- Sensitivity comments
- Suggested modification to the nominal large-scale survey
- The Galactic Plane Survey as seen by GLIMPSE and MIPSGAL
- Goals of the Deep Survey and candidate target regions

Overview of Galactic structure, emphasizing the STO survey region from *l*=-20° to *l*=-55°



# STO Survey region seen by MIPS and in $^{12}$CO J=1-0




Coarse comparison of 24 um dust continuum to CO integrated intensity over the approximate STO Galactic Plane Survey area

# Survey Feasibility and Optimization (I)

Detecting diffuse clouds in the process of becoming GMCs represents the most challenging observations that we propose.

Typical line strengths for CNM clouds:

$2 \times 10^{-5}$ erg $s^{-1}$ $cm^{-2}$ $sr^{-1}$ (3 K km $s^{-1}$) per $N(H)=10^{21}$ $cm^{-2}$ column at R=3 kpc

$3 \times 10^{-6}$ erg $s^{-1}$ $cm^{-2}$ $sr^{-1}$ (0.5 K km $s^{-1}$) per $N(H)=10^{21}$ $cm^{-2}$ column at R=8.5 kpc

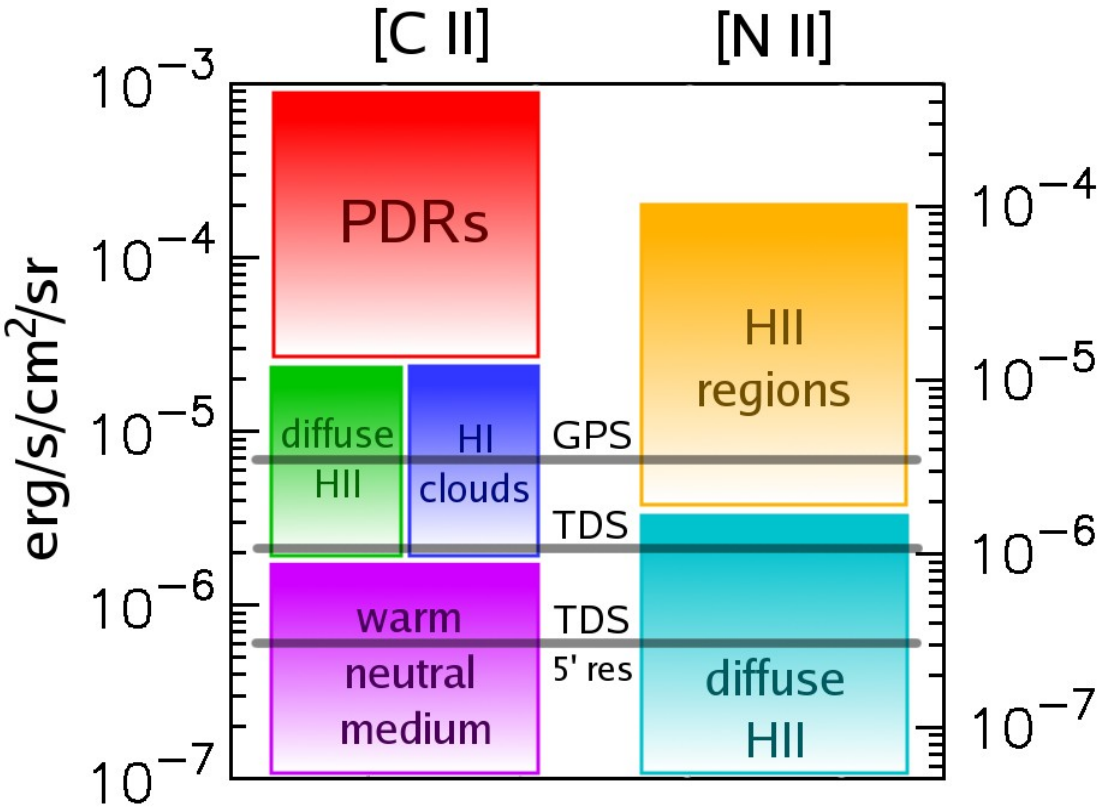
## Proposed Surveys

GPS: 35 $deg^2$ to $7 \times 10^{-6}$ erg/s/$cm^2$/sr (3σ)
TDS: 1 $deg^2$ to $2.6 \times 10^{-6}$ erg/s/$cm^2$/sr (3σ)

HOWEVER – the current mapping time estimates for these sensitivities are:

GPS: 2.5 $deg^2$ per 24 hours
TDS: 0.4 $deg^2$ per 24 hours

see following spreadsheet...



# Optimization spreadsheet – an example

| | A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | OTF Itime(s) | 30 | | Tsys | 4000 | | Motion (s) | 2 | | #pix/freq | 4 |
| 2 | Beam (') | 1.5 | | res (Mhz) | 4 | | Itime/dump | 1 | | #reps | 6 |
| 3 | Dumps2avg | 1 | | Ysampling | 2 | | Active b.e.'s | 2 | | wordlen( | 16 |
| 4 | | | | | | | | | | #chans | 1024 |
| 5 | dumps/OTF | 30 | | | | | | | | | |
| 6 | Sigma/dump | 2 | | Data rate (b/ | 32768 | | | | | | |
| 7 | | | | | | | | | | | |
| 8 | Rate ("/s) | Length (') | (beams) | ref Itime (s) | 1 OTF (s) | dumps/beam | sigma/beam | hrs/sqdeg | MB/sqdeg | smear | Eff (%) |
| 9 | 3 | 1.5 | 1 | 15 | 47 | 254.56 | 0.13 | 62.67 | 2250 | 0.03 | 63.83 |
| 10 | 5 | 2.5 | 1.67 | 11.25 | 43.25 | 152.74 | 0.17 | 34.6 | 1350 | 0.06 | 69.36 |
| 11 | 7 | 3.5 | 2.33 | 9 | 41 | 109.1 | 0.2 | 23.43 | 964.29 | 0.08 | 73.17 |
| 12 | 10 | 5 | 3.33 | 6.92 | 38.92 | 76.37 | 0.24 | 15.57 | 675 | 0.11 | 77.08 |
| 13 | 15 | 7.5 | 5 | 5 | 37 | 50.91 | 0.31 | 9.87 | 450 | 0.17 | 81.08 |
| 14 | 20 | 10 | 6.67 | 3.91 | 35.91 | 38.18 | 0.36 | 7.18 | 337.5 | 0.22 | 83.54 |
| 15 | 25 | 12.5 | 8.33 | 3.21 | 35.21 | 30.55 | 0.41 | 5.63 | 270 | 0.28 | 85.19 |
| 16 | 30 | 15 | 10 | 2.73 | 34.73 | 25.46 | 0.46 | 4.63 | 225 | 0.33 | 86.39 |
| 17 | 40 | 20 | 13.33 | 2.09 | 34.09 | 19.09 | 0.56 | 3.41 | 168.75 | 0.44 | 87.99 |

1 second spectrometer dumps

6 passes needed to reach the desired S/N

~25 sq degrees in 10 days

3 sigma = 1 K km/s

15"/s = sidereal rate
i.e. we do not move the telescope

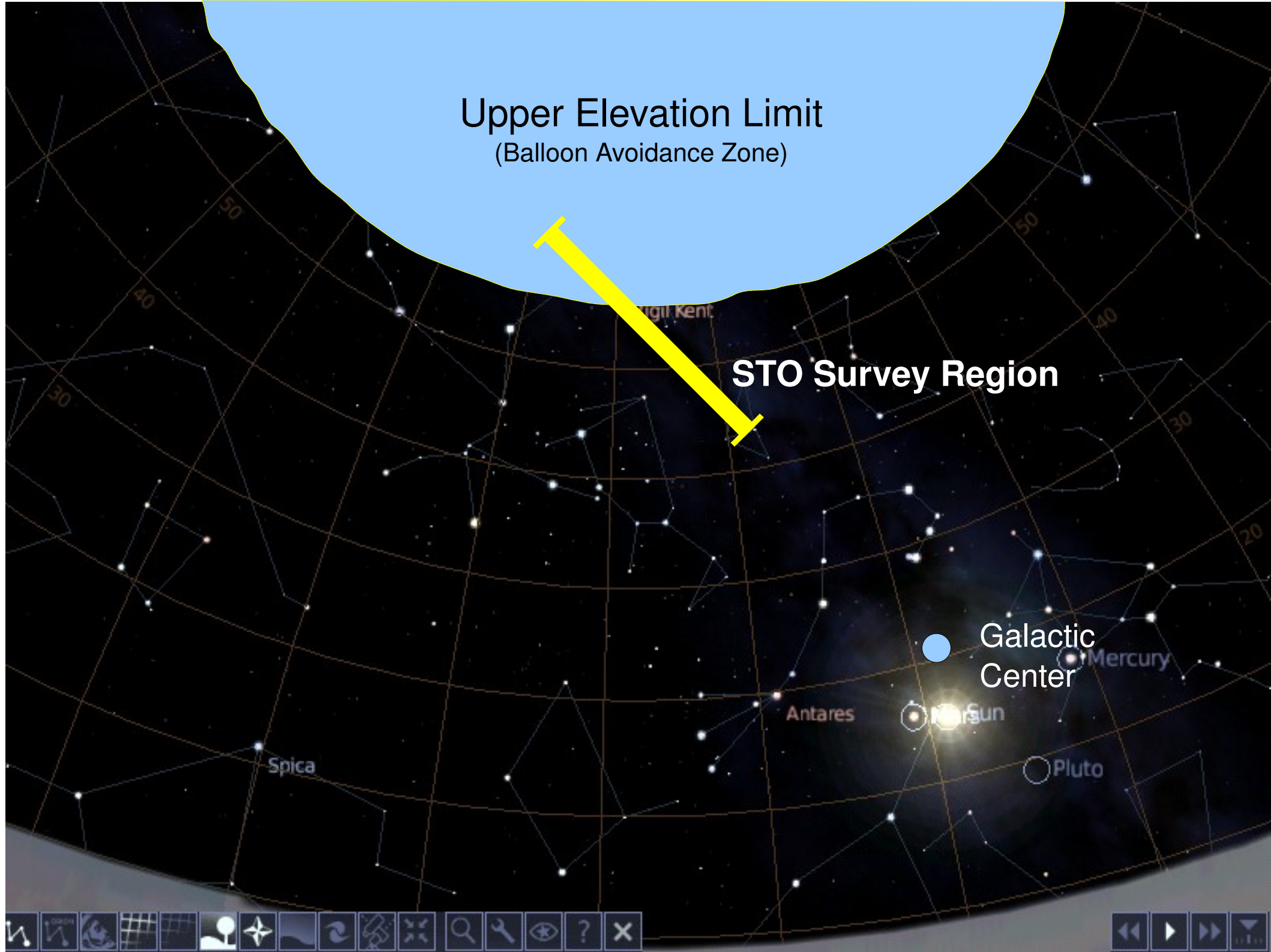
Summary: GPS survey looks okay... but we need to trim the main survey to 25-30 square degrees for completion within the nominal 10-14 day mission.

# Survey Feasibility and Optimization (II)

Not all of the STO survey area is visible at all times of the mission, due to pointing constraints. (see next slide)

l = -20 is visible 90% of the time
l = -40 is visible 45% of the time
l = -60 is visible 20% of the time

This places a restriction on the amount of time we will be able to observe at high Galactic longitude.


Upper Elevation Limit
(Balloon Avoidance Zone)
STO Survey Region
Galactic
Center
Mercury
Antares
Sun
Pluto
Spica
50
40
30
20

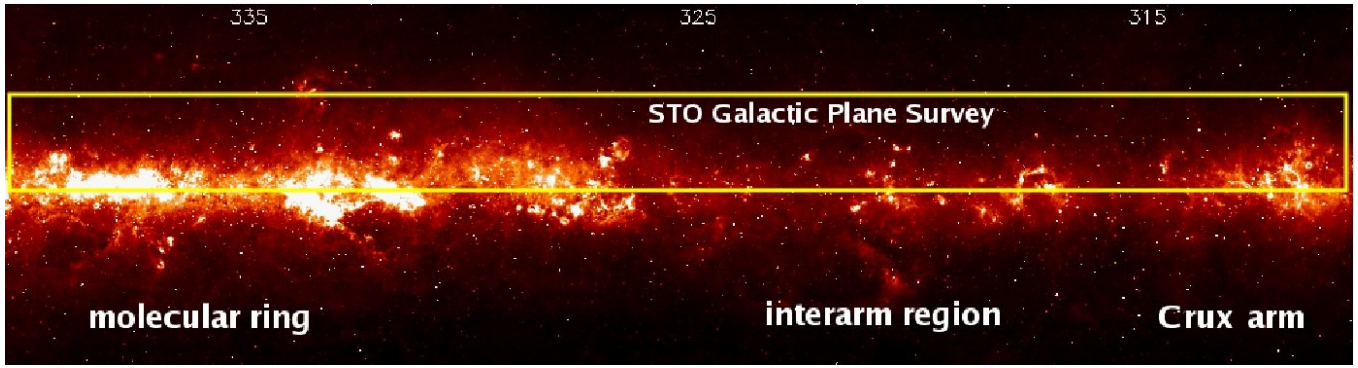
# Suggested modification to GPS coverage

To reduce the mapped area and the time spent at high longitude, while not sacrificing coverage of Galactic latitude:

Center *b* coverage on midplane and narrow it as we progress to high longitude.

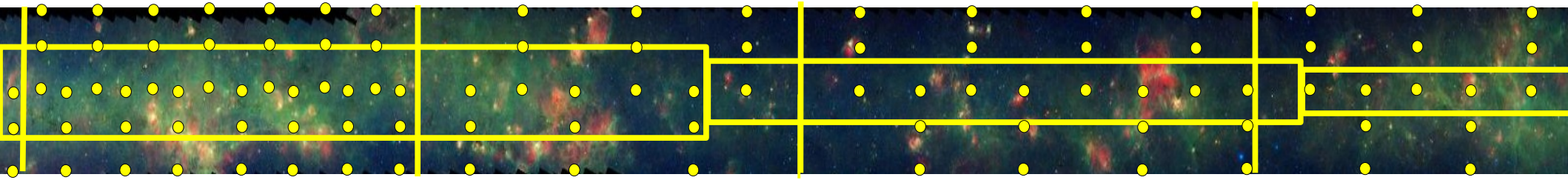
$|b|<0.5^\circ$ for $20^\circ<l<35^\circ$ (15 deg$^2$)
$|b|<0.35^\circ$ for $35^\circ<l<45^\circ$ (7 deg$^2$
$|b|<0.25^\circ$ for $45^\circ<l<51^\circ$ (3 deg$^2$)

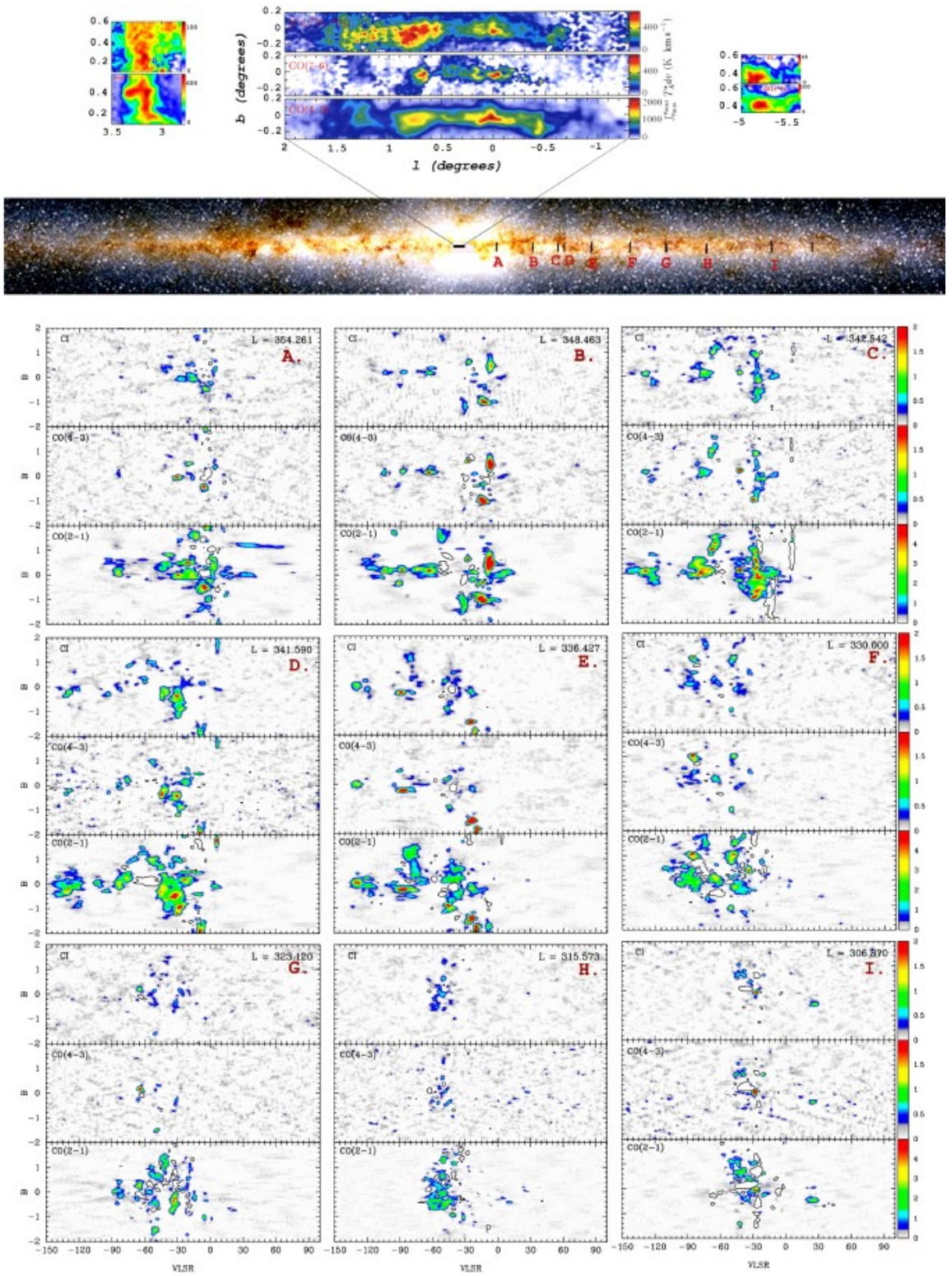
Add "b-strips" of ~0.1° width going up to |b|=1 to coincide with AST/RO b-strip survey and Herschel OTKP pointings in [C II], a total of ~1 sq deg.




as proposed

current suggestion
(-23°<l <-50° shown)






## AST/RO b-strip survey

We would overlap with 4-6 of the AST/RO strips. These would be ideal for a deep survey.

There are 28 Herschel pointings that we could potentially do, 14 from the midplane North to b=1°, and 14 from the midplane South to b=-1°.

Suggestion:
Point and integrate to target sensitivity.

# Selecting the Deep Survey Target(s)

- Maximize synergy with Langer/Goldsmith Herschel OTKP for [CII]: rectangular deep surveys oriented in *b* will hit two Herschel pointings.
- AST/RO performed deep *b*-strip cuts of the Galactic Plane in CO 2-1, 4-3, 7-6 and both J=1-0 and 2-1 lines of [CI]. Overlap in the deep surveys, or at least the regular GPS, is vital.
- Selecting for longitudes where the velocity-distance dispersion is optimized. i.e. select a tangent arm (i.e. *l* ~-33° for Norma arm) to maximize velocity 'pile-up' for inter-arm diffuse gas.
- Selecting for *IR-excess* clouds by subtracting HI (from SGPS) and CO (i.e. from NANTEN or Mopra) contribution to the total IRAS 100 um flux. This will highlight regions underrepresented by HI and CO emission, i.e. [CII] and $H_2$. This is tricky at low Galactic latitude.
- More observing time is available in the Inner Galaxy. We rapidly lose observing time at *l* <-30°.

# Goals of Targeted Survey

- **Formation of molecular clouds, assessing importance of the $H_2$ clouds not seen in CO, and estimating the CNM/WNM mass ratio.**
- We need to discuss whether we want to observe 1) isolated diffuse clouds or 2) including complex SF regions, targeting *feedback* and measuring the diffuse gas serendipitously.

# Deep Survey Strategy

It is difficult to select one or two regions to map deeply based on the dearth of good CO data to match to existing 1-2' HI surveys.

One interesting and feasible possibility is to use the 'b-strips' themselves as the deep survey regions!

# Just for reference:
# Spitzer's view of the STO survey region

In the GLIMPSE/MIPSGAL slides that follow, we dissect most of the GPS region. 1 $deg^2$ boxes are shown for scale atop interesting complex regions for GPS in [CII] and [NII] emission. Smaller, regions of isolated diffuse material near |b|=1 are shown also. Nominal deep survey locations from the proposal are shown in cyan.

Note that these mid-infrared maps highlight PDRs and HII regions.

INTER-ARM REGION I

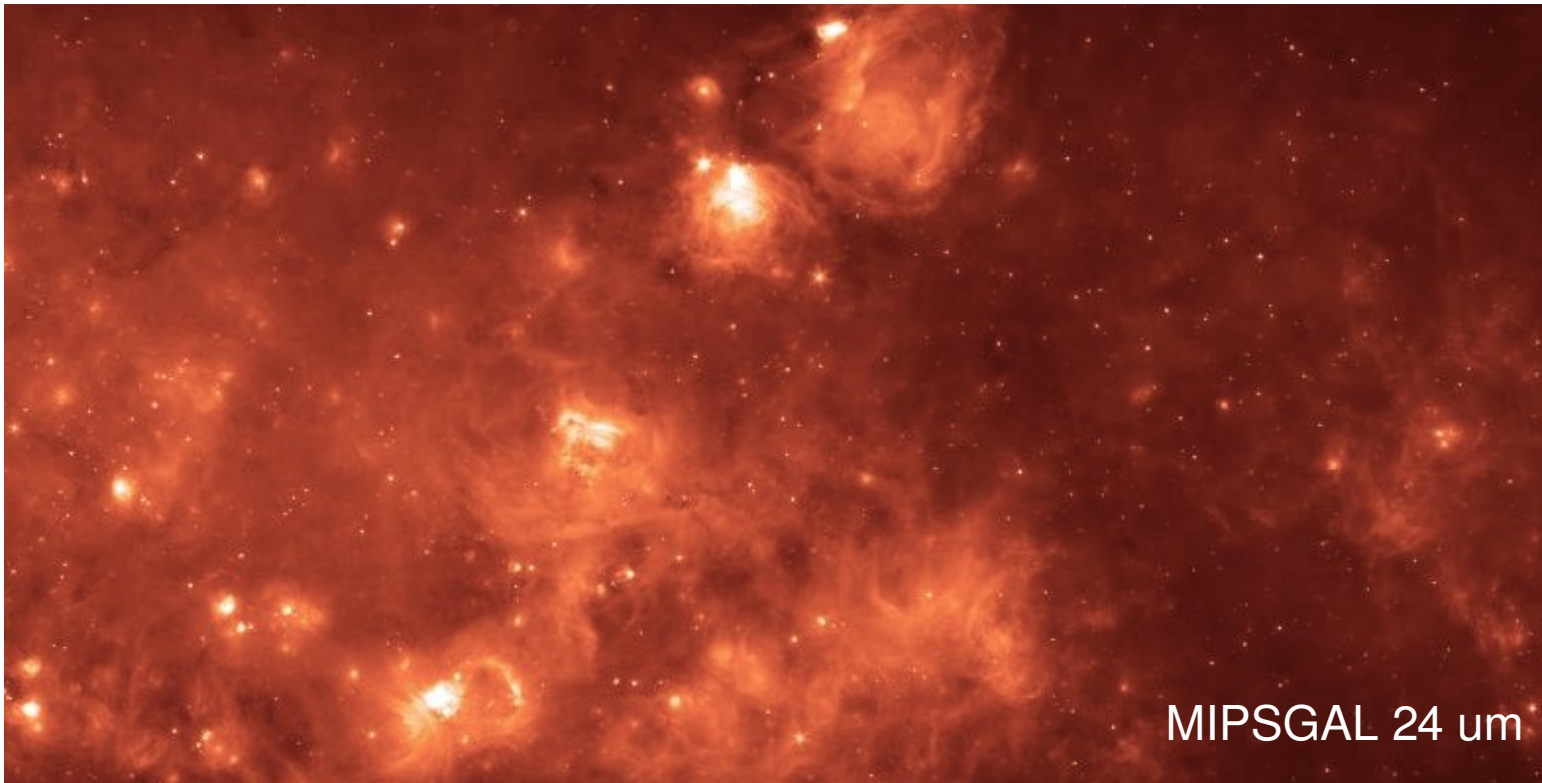
Map centered at
l = 326.6° = -33.4°

Box size: 1° square

In all color composites,

- GREEN is 8 um
(mostly PAH emission)

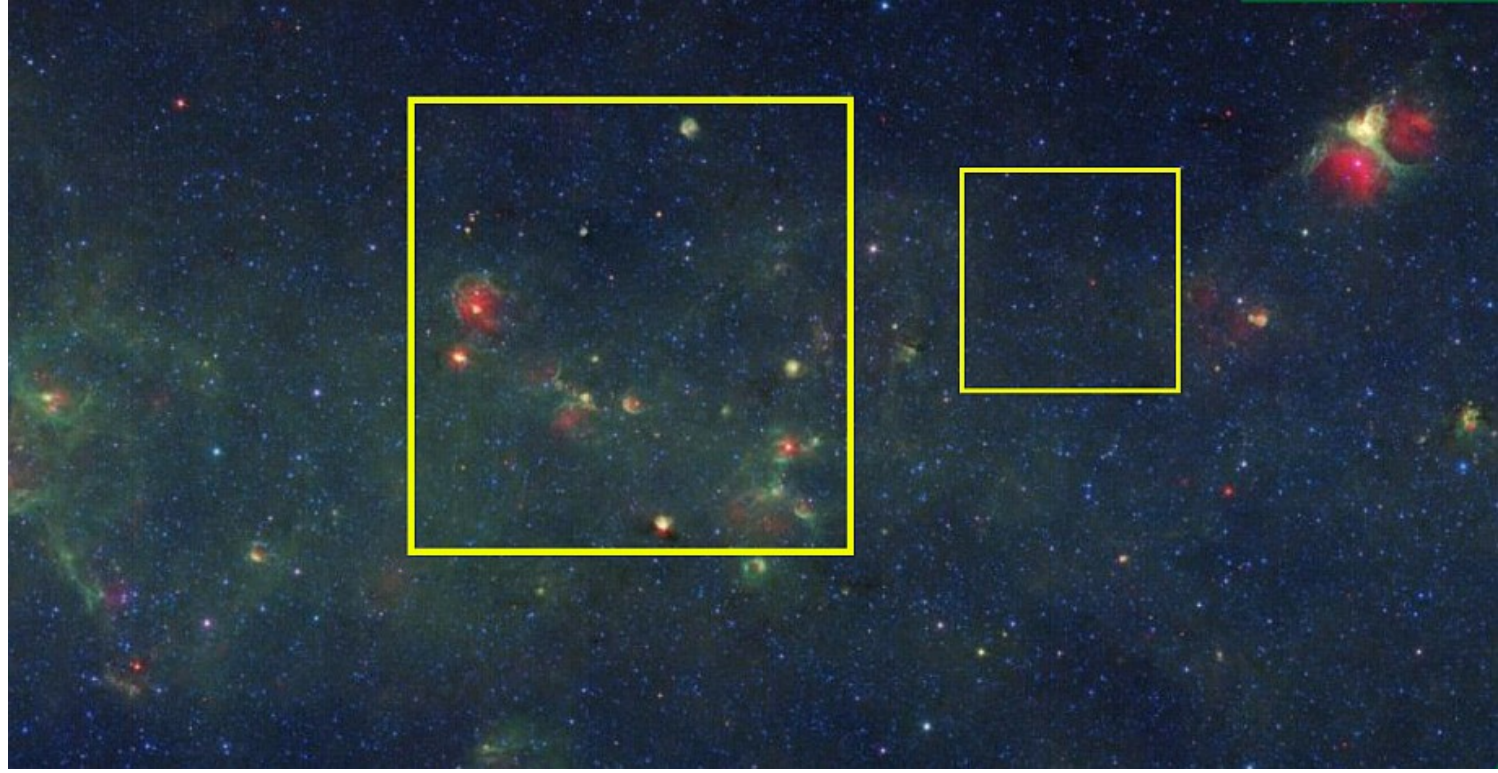
- RED is 24 um
(warm dust)

INTER-ARM REGION II

Map centered at
l = 323.6° = -36.4°

Box size: 1° square
and 0.5° square

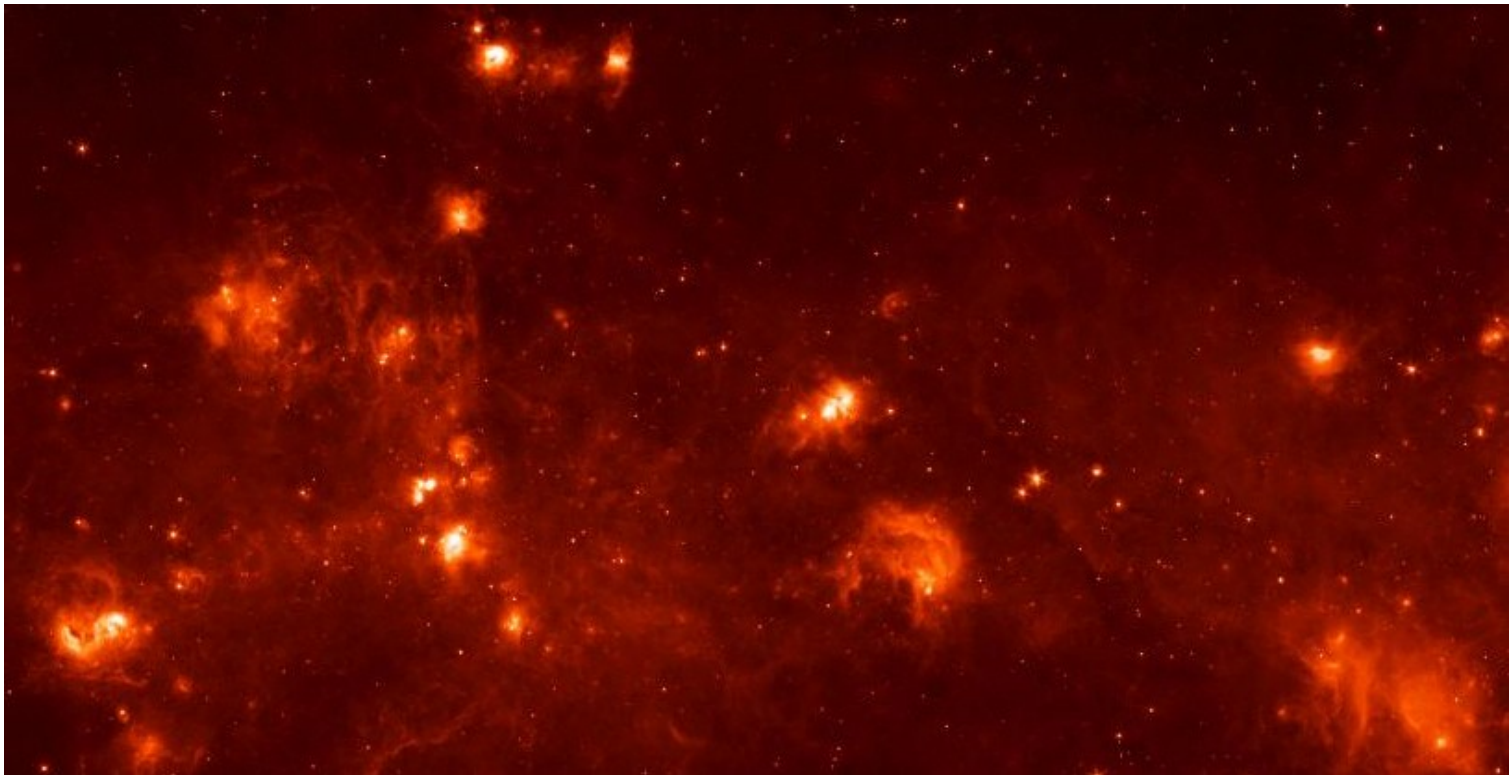


INTER-ARM REGION III

Map centered at
l = 319.5° = -40.5°

Box size: 1° square

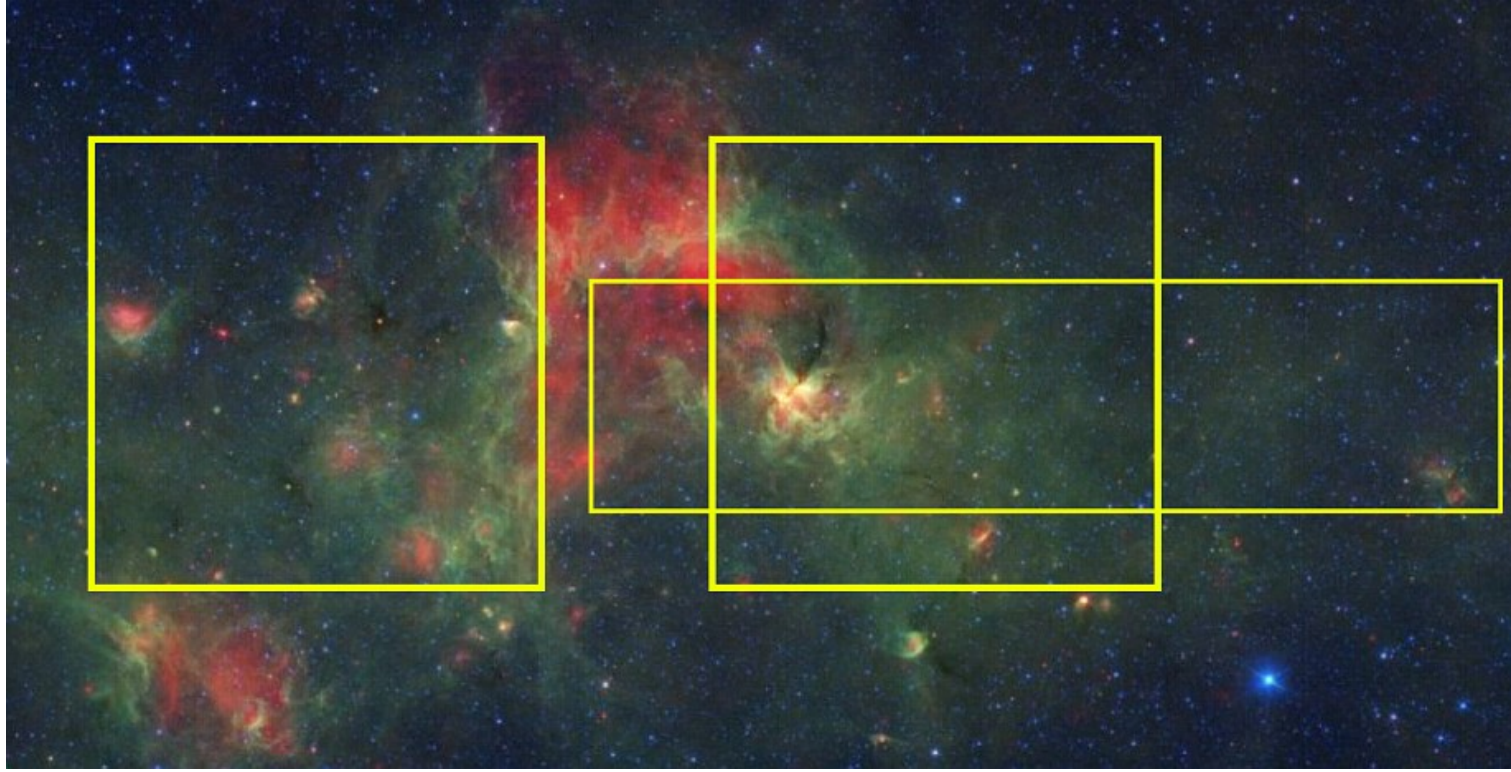
1° x 0.5° Deep Survey location from proposal shown in cyan!



INTER-ARM REGION IV

Map centered at
l = 316.9° = -43.1°

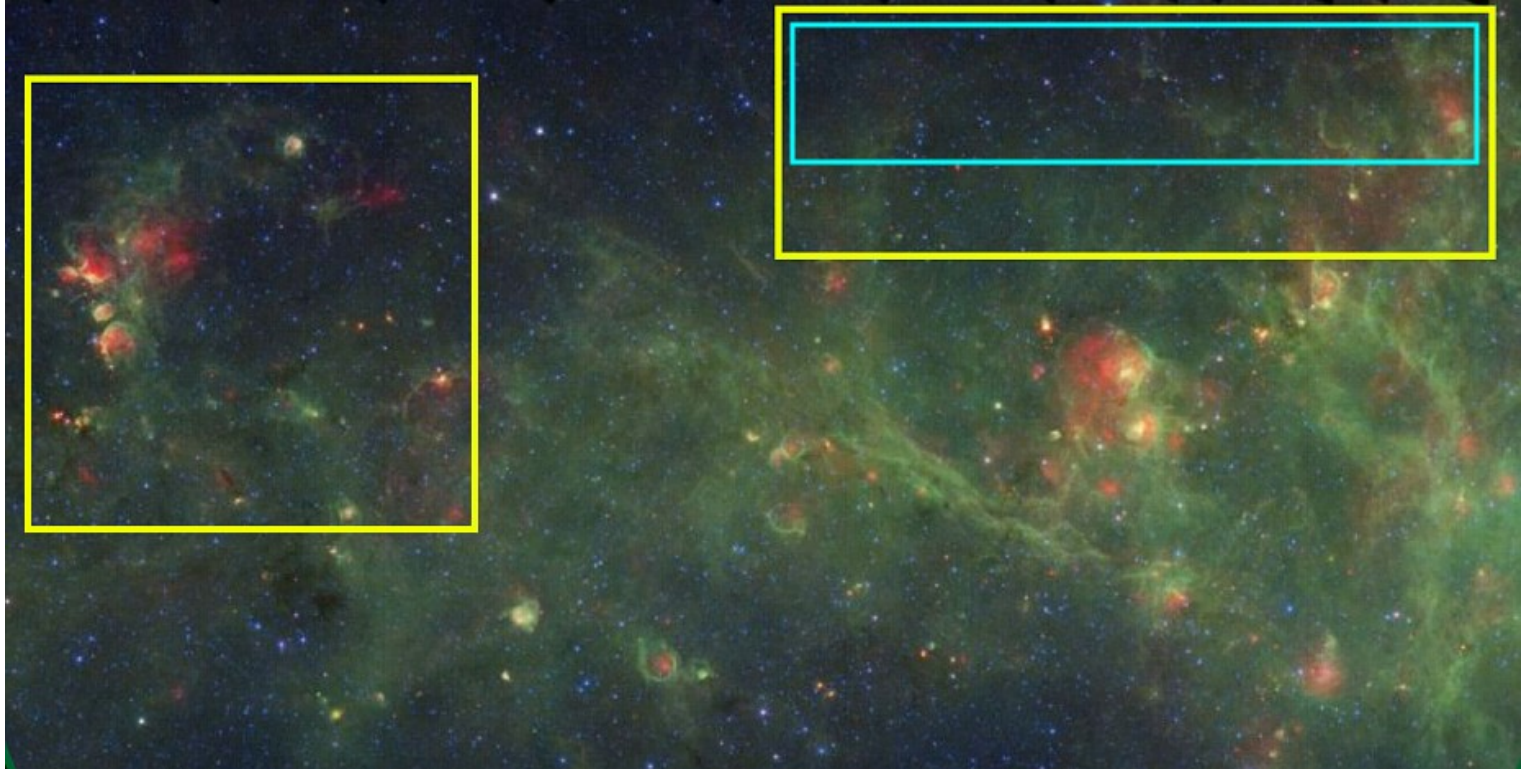
Box size: 1° square
and 2° x 0.5°



Scutum-Centaurus Arm I

Map centered at
l = 312.8° = -47.2°

Box size: 1° square
and 1.6° x 0.6°



Scutum-Centaurus Arm II

Map centered at
l = 309.1° = -50.9°

Box size: 1° square