

CHIMPS2

Resolving Star Formation in the Galactic Plane

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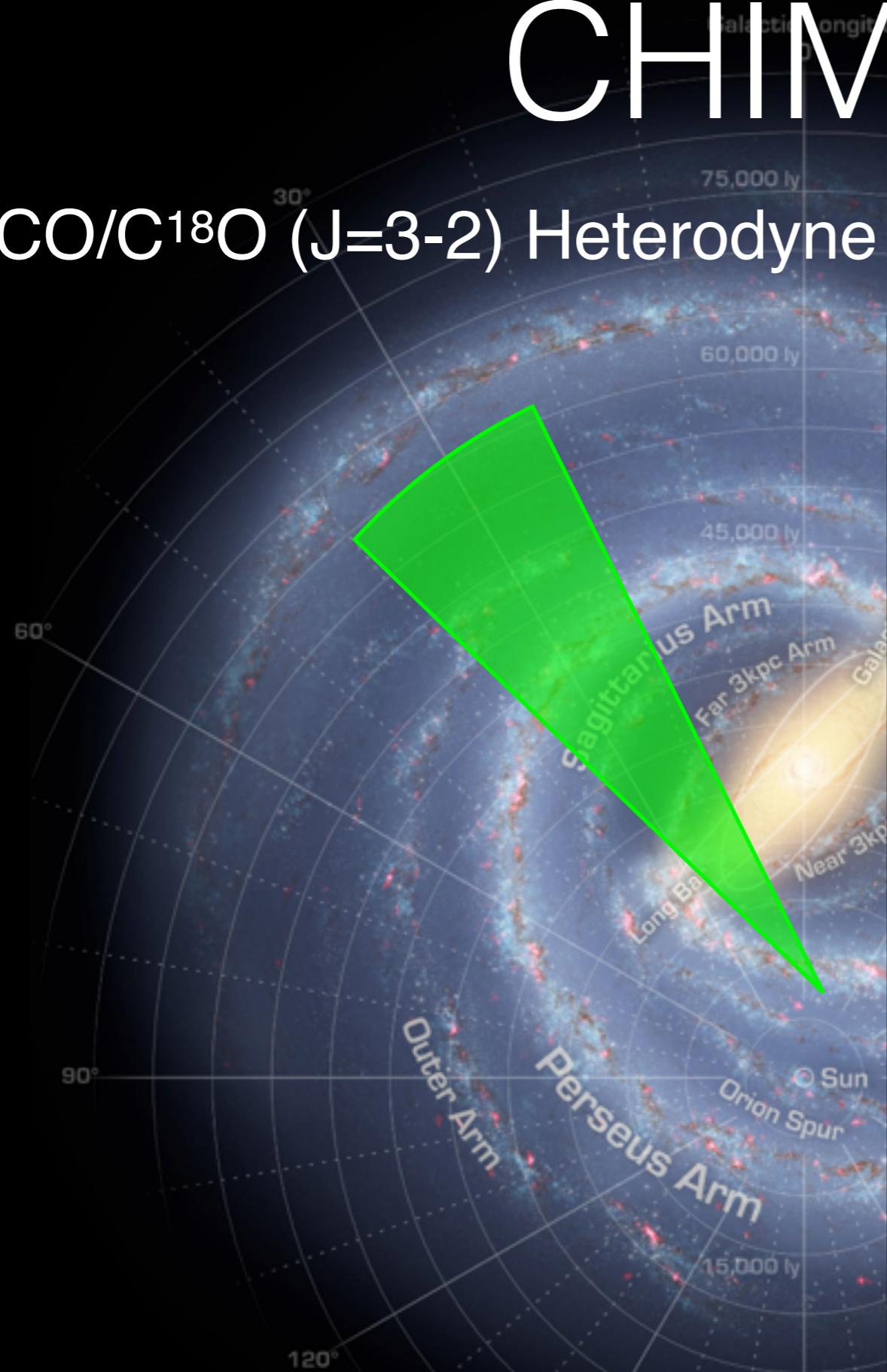
Tracing the Flow: Galactic Environments and the Formation of Massive Stars
3rd July, 2018

Outline

- Introduce CHIMPS
- The LTE analysis performed on these data, and the resulting column density maps.
- Maps of clump formation efficiency
- CHIMPS2 Introduction and early data
- Very early science from the new survey

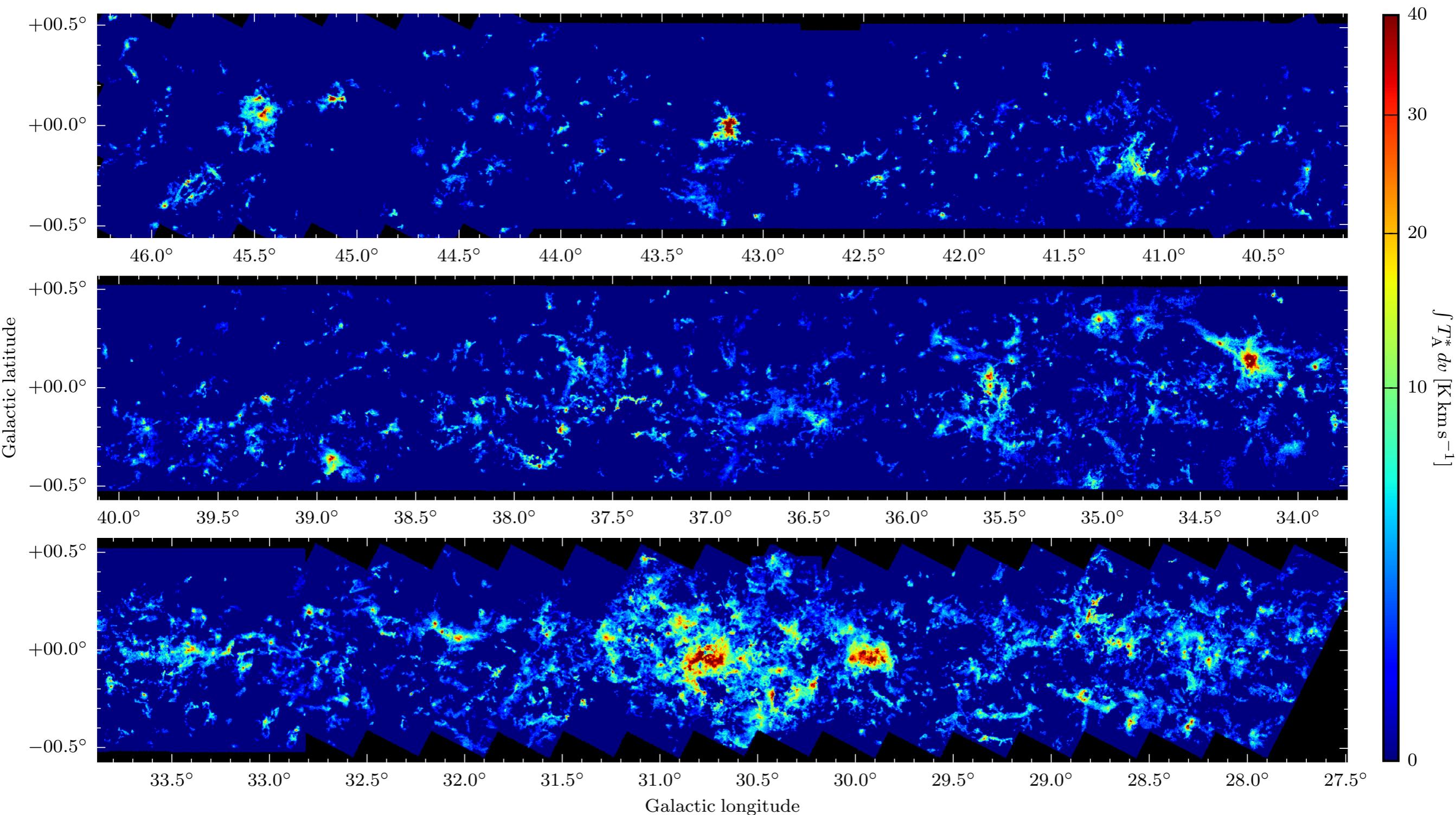
CHIMPS

The $^{13}\text{CO}/\text{C}^{18}\text{O}$ (J=3-2) Heterodyne Inner Milky Way Plane Survey

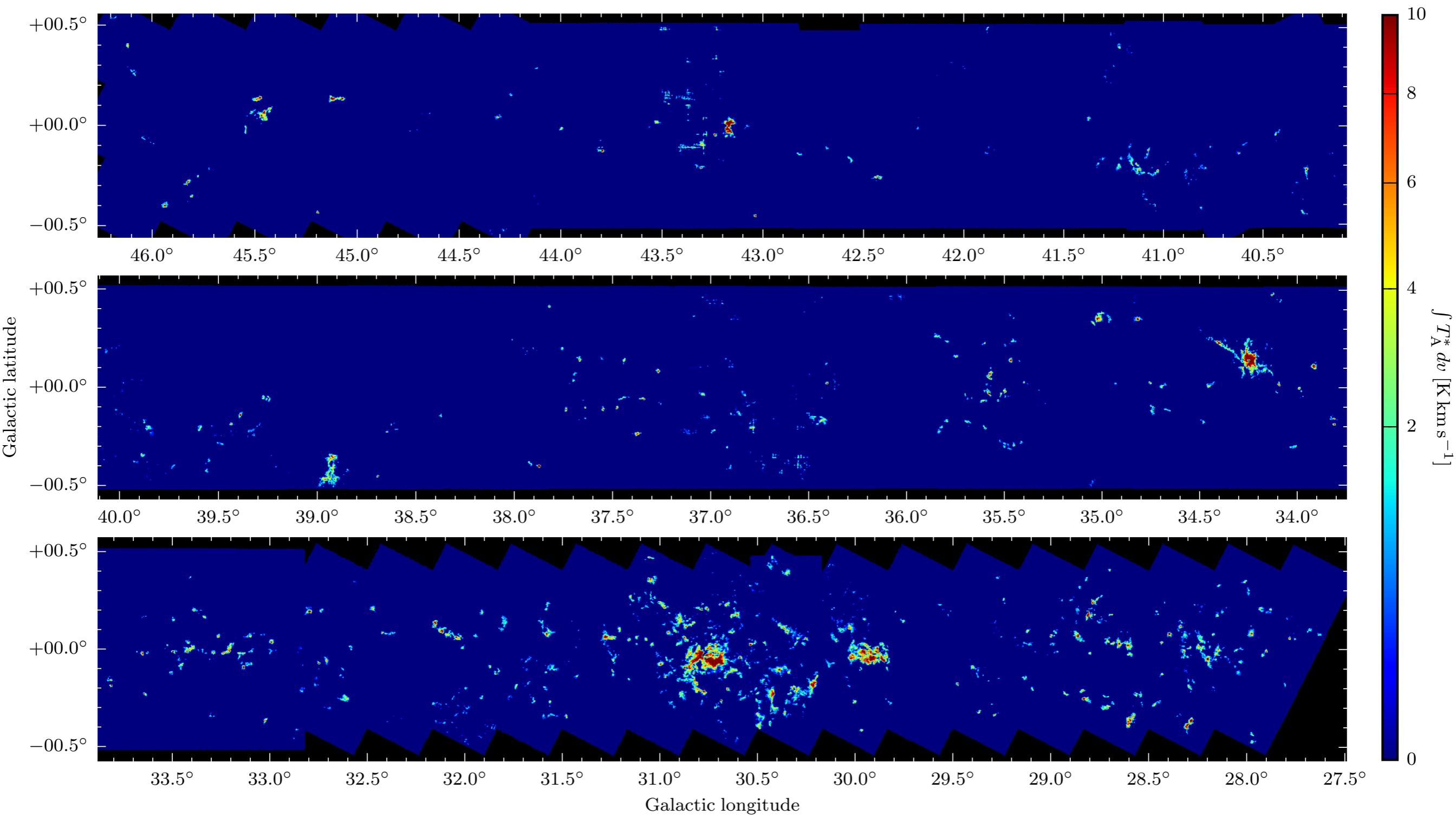


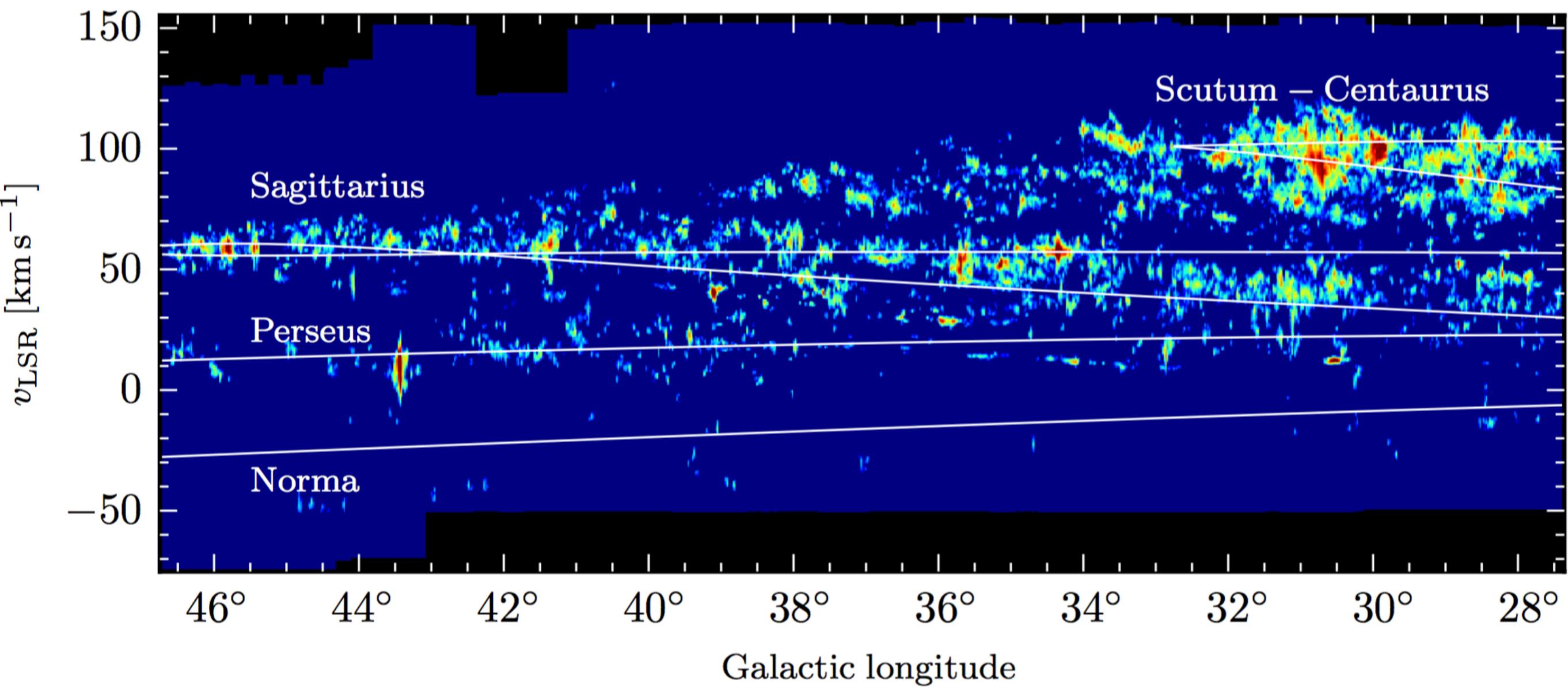
- JCMT (15m) with HARP
 - ▶ ^{13}CO (3–2) & C^{18}O (3–2)
 - ▶ Dense gas ($n_{\text{crit}} \sim 10^4 \text{ cm}^{-3}$)
 - ▶ High optical depth: cloud interiors
- $27.5^\circ < |l| < 46.3^\circ$ and $|b| < 0.5^\circ$ (19 deg²) spectral survey
- Spatial resolution $\sim 15''$
- Velocity resolution 0.5 km/s (raw channel width 0.055 km/s)
- 200 km/s coverage $\sim -50\text{--}150 \text{ km/s}$
- Sensitivity $\sigma (T_{\text{mb}}) < 1 \text{ K}$ per channel
 - ▶ $T_A^* \sim 0.6 \text{ K/channel}$ for ^{13}CO
 - ▶ $T_A^* \sim 0.7 \text{ K/channel}$ for C^{18}O

^{13}CO (3–2)



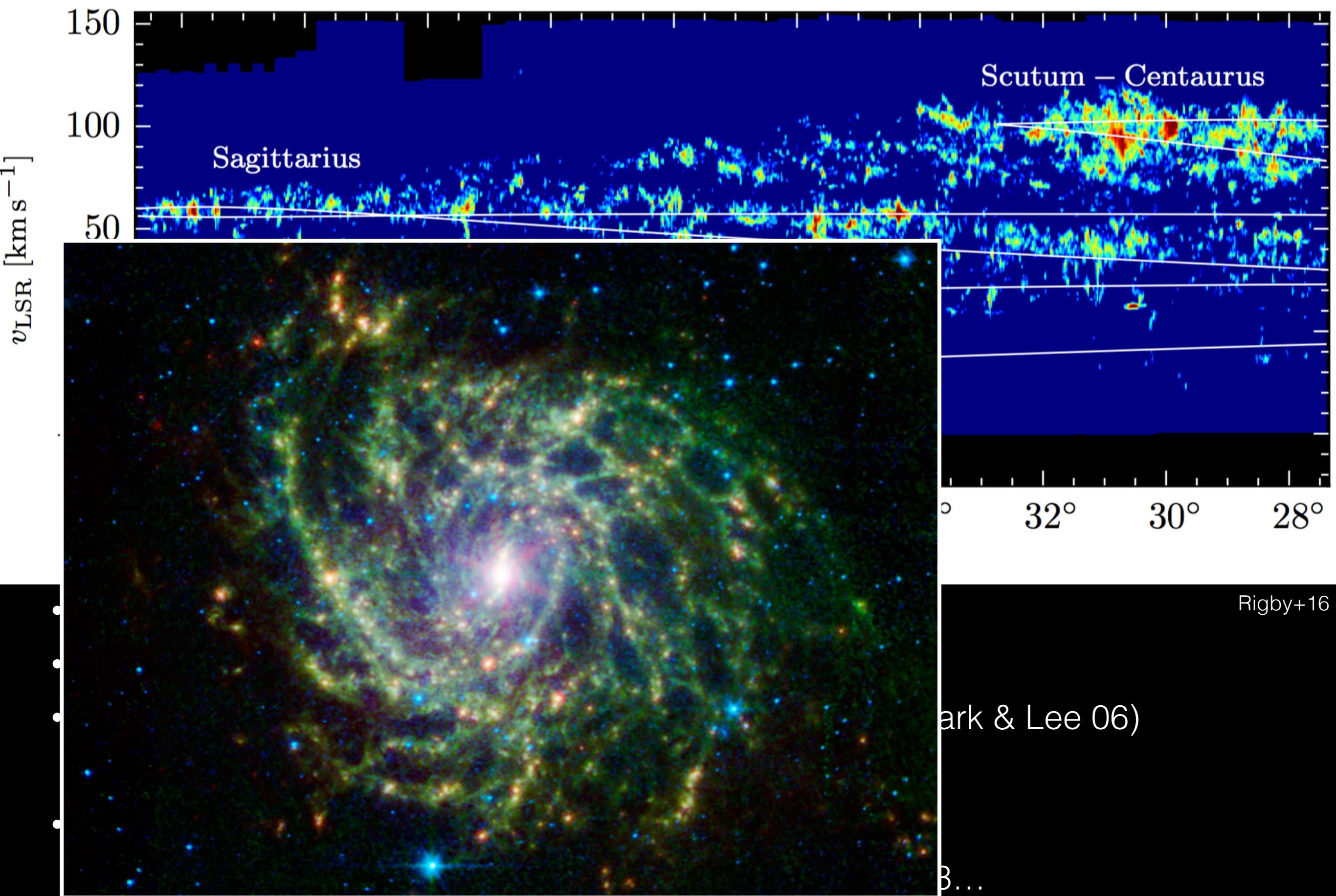
C^{18}O (3–2)





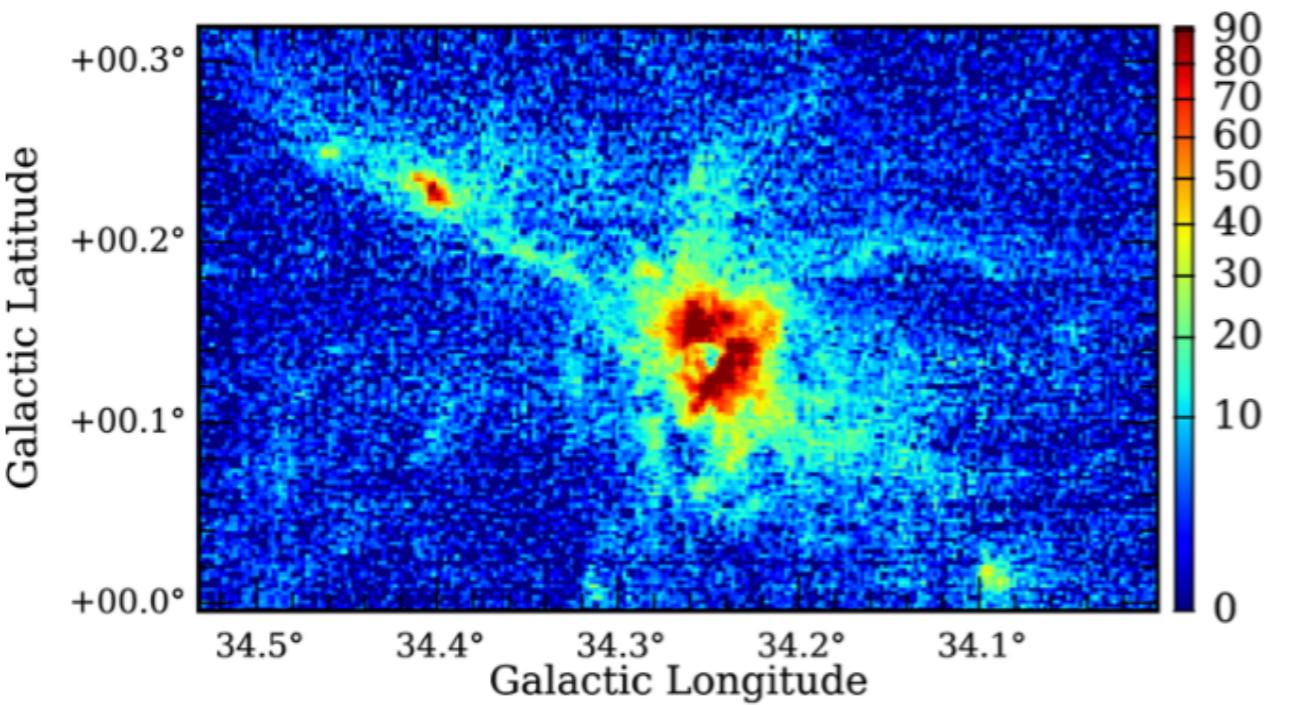
- Exceptional clarity of spiral structure
- Test of spiral models (Taylor+Cordes93, Cordes+04)
- Structure between Scutum and Sagittarius arms (e.g. Stark & Lee 06)
 - ▶ Armlet/ inter-arm filament/ filaments?
- More large-scale filaments ('bones')?
 - ▶ e.g. Abreu-Vicente+16, Ragan+14, Zucker+14, Li+13...

Rigby+16

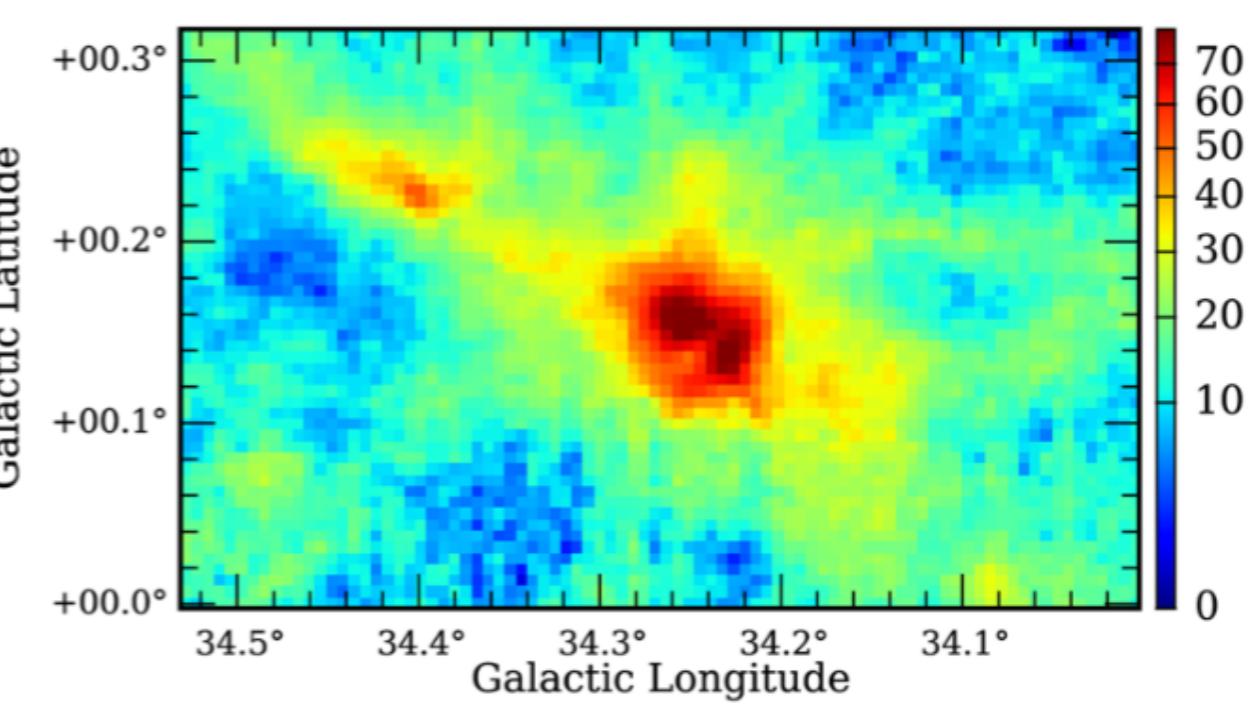


CHIMPS, COHRS, GRS

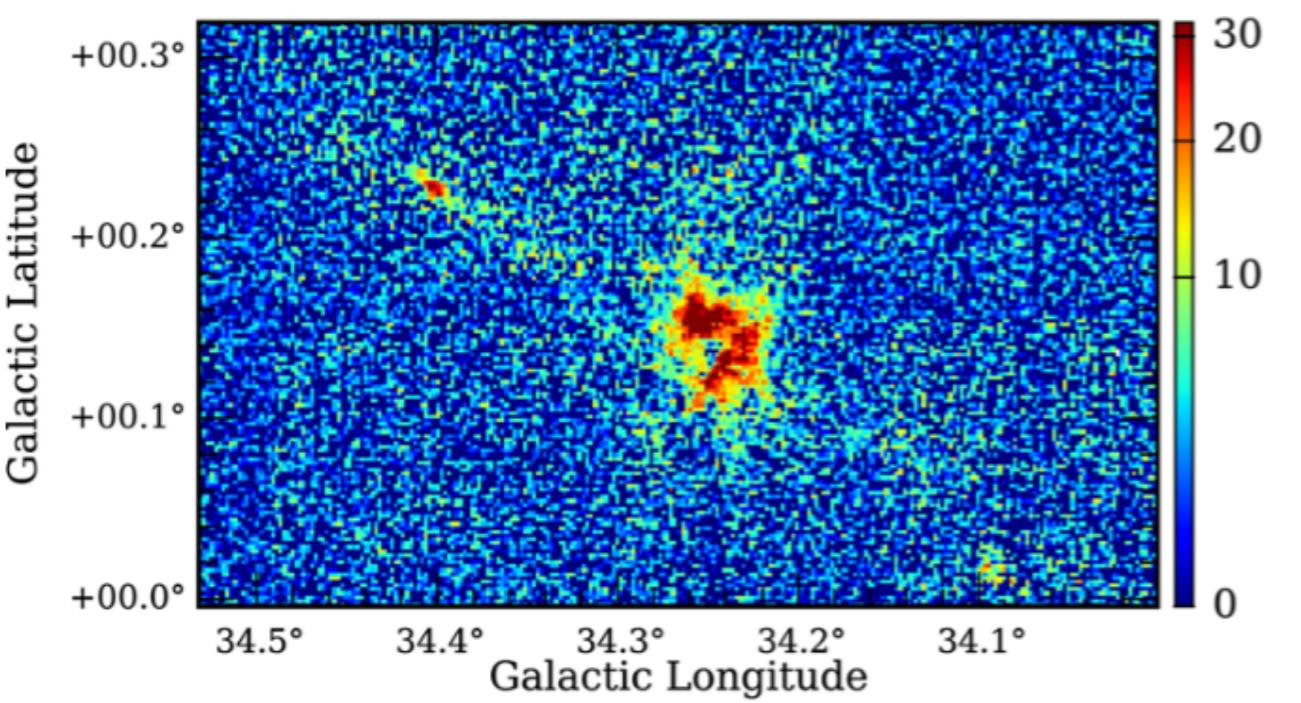
CHIMPS ^{13}CO ($J=3 \rightarrow 2$)



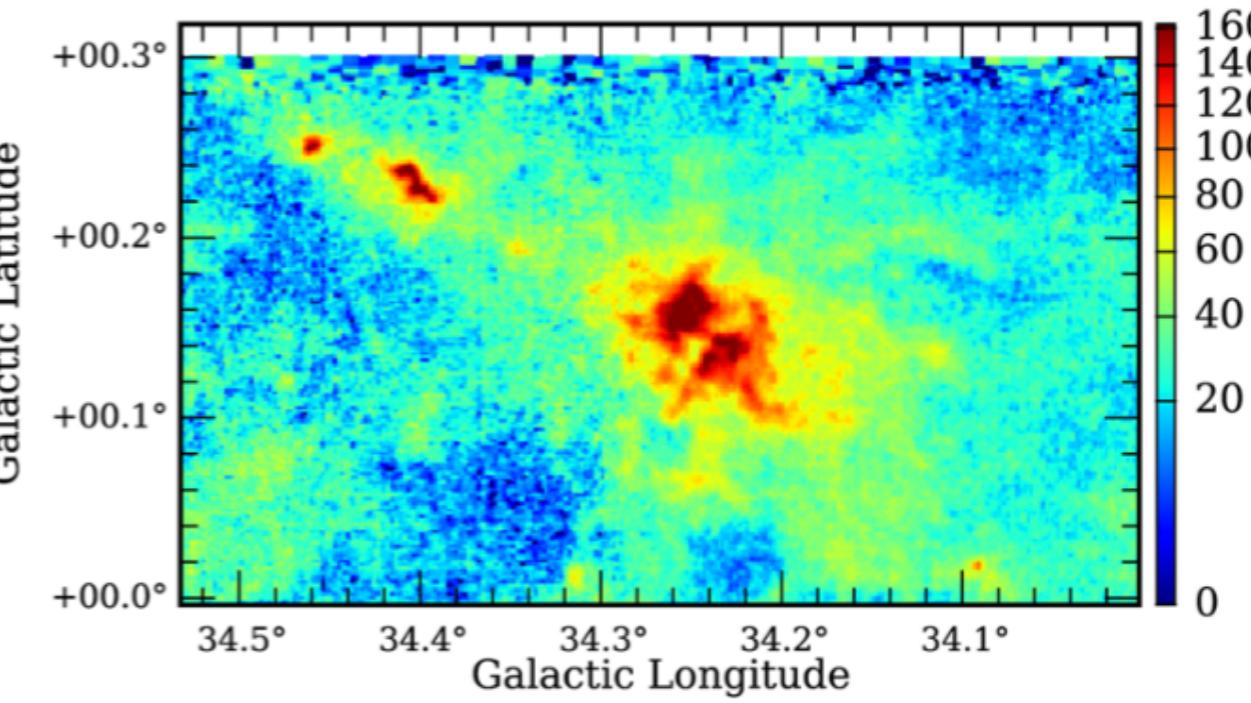
GRS ^{13}CO ($J=1 \rightarrow 0$)



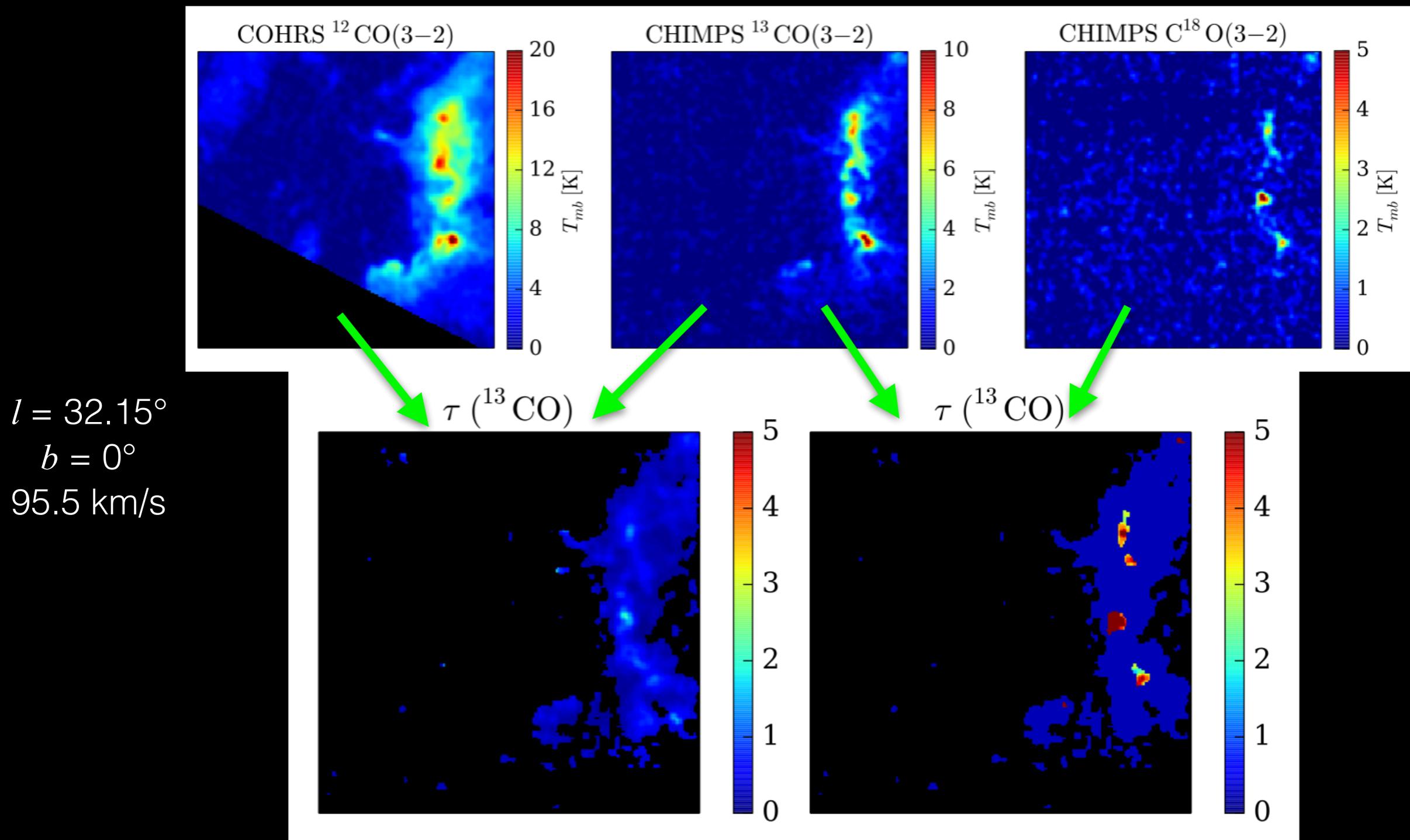
CHIMPS C^{18}O ($J=3 \rightarrow 2$)



COHRS ^{12}CO ($J=3 \rightarrow 2$)

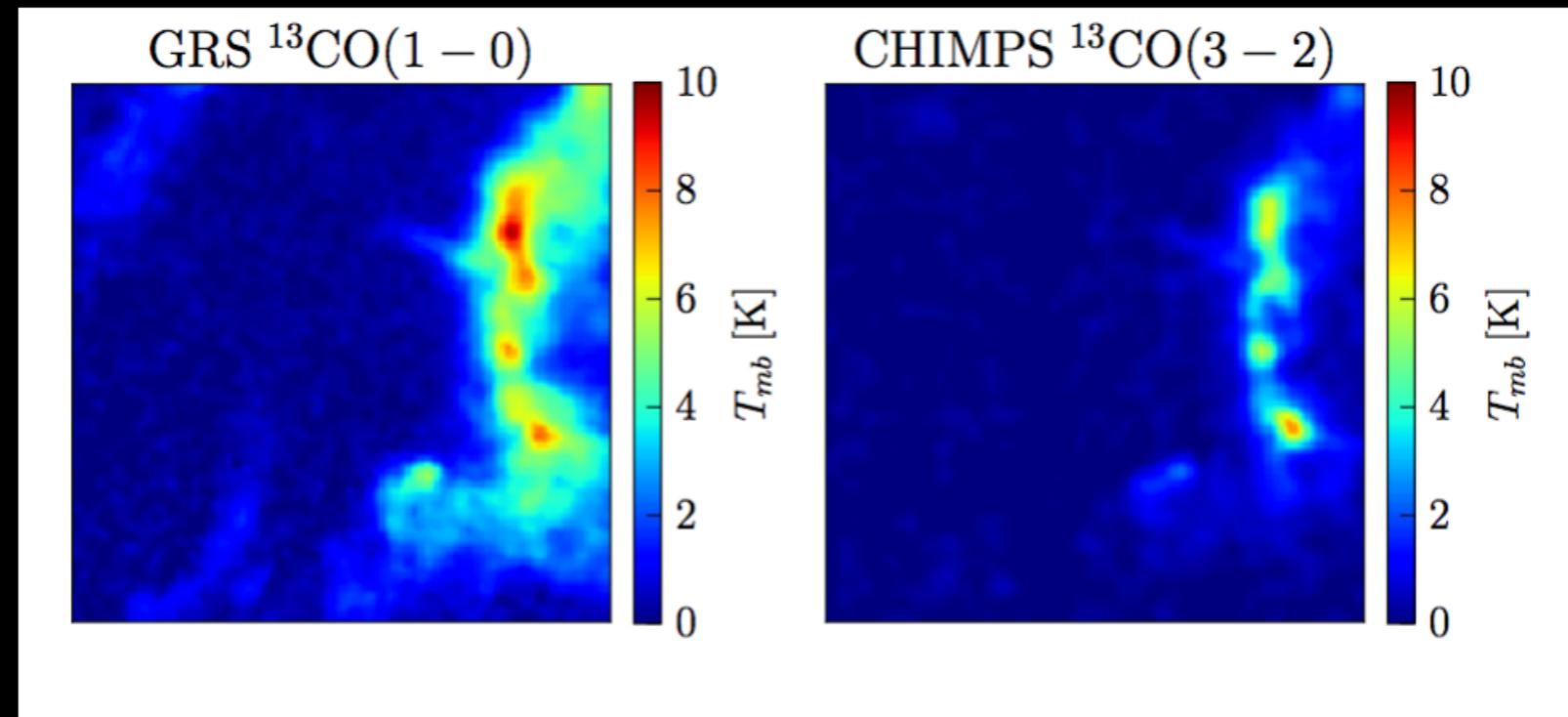


Optical depth



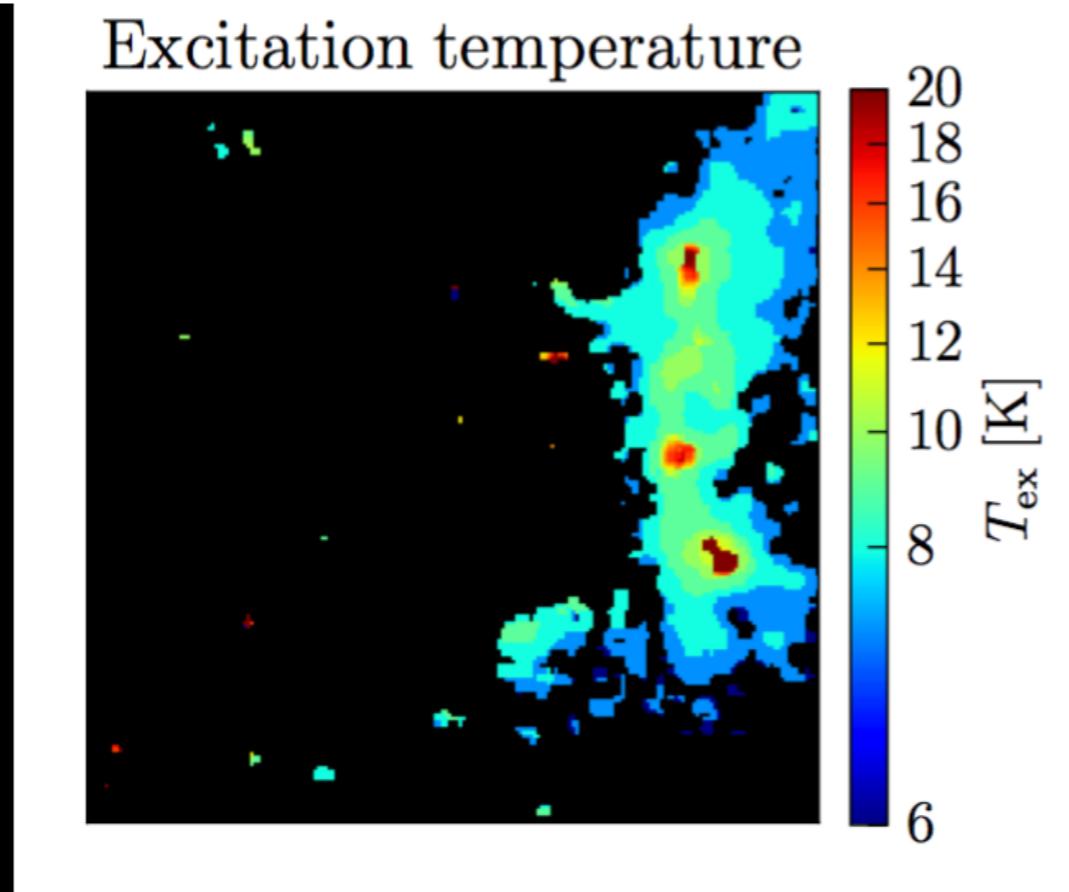
- Not quite a full complement of isotopologue tracers

Excitation temperature



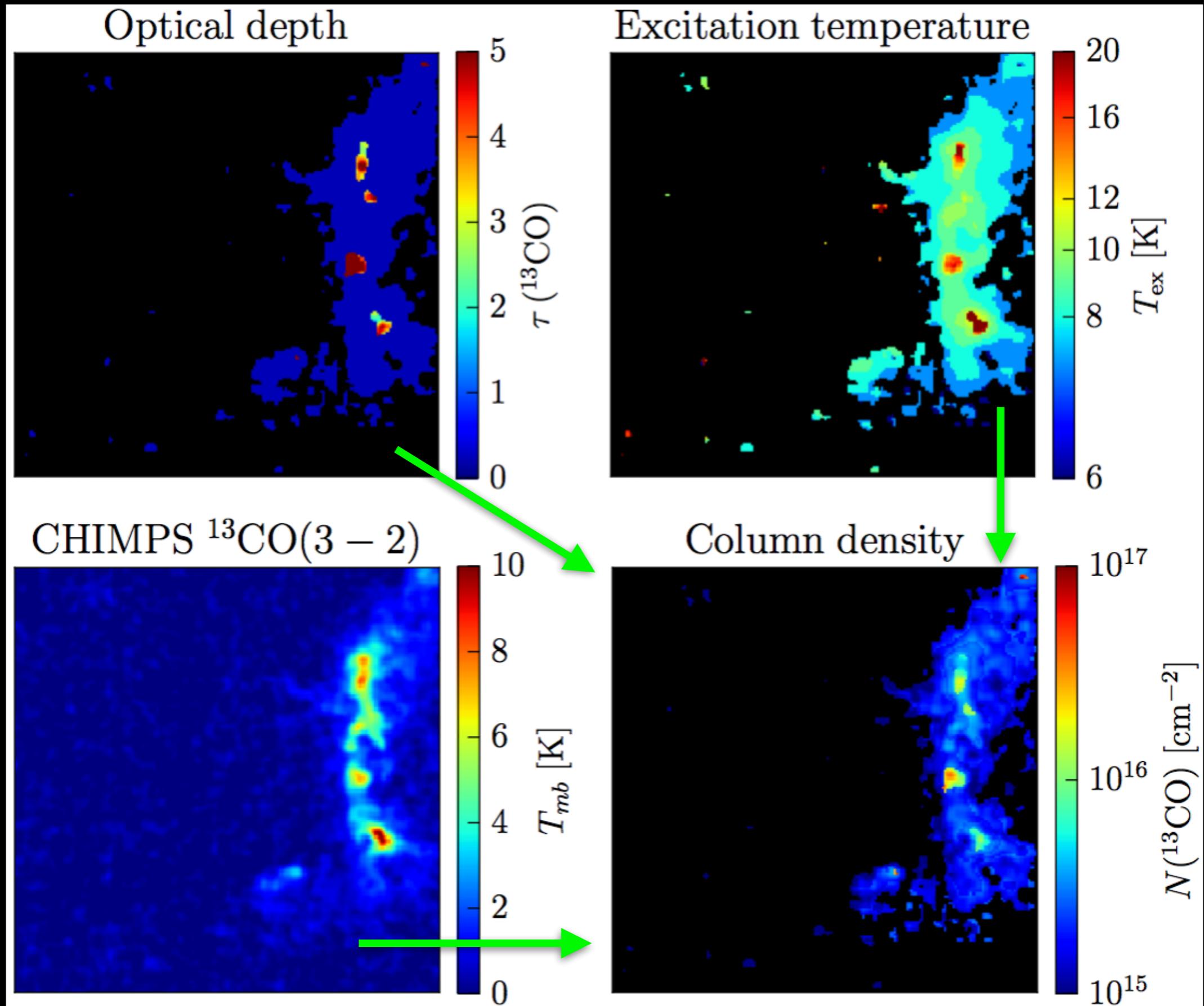
$l = 32.15^\circ$
 $b = 0^\circ$
95.5 km/s

- 46" resolution, interpolated to 27.4"
 $\Rightarrow \pm 30\%$ in N

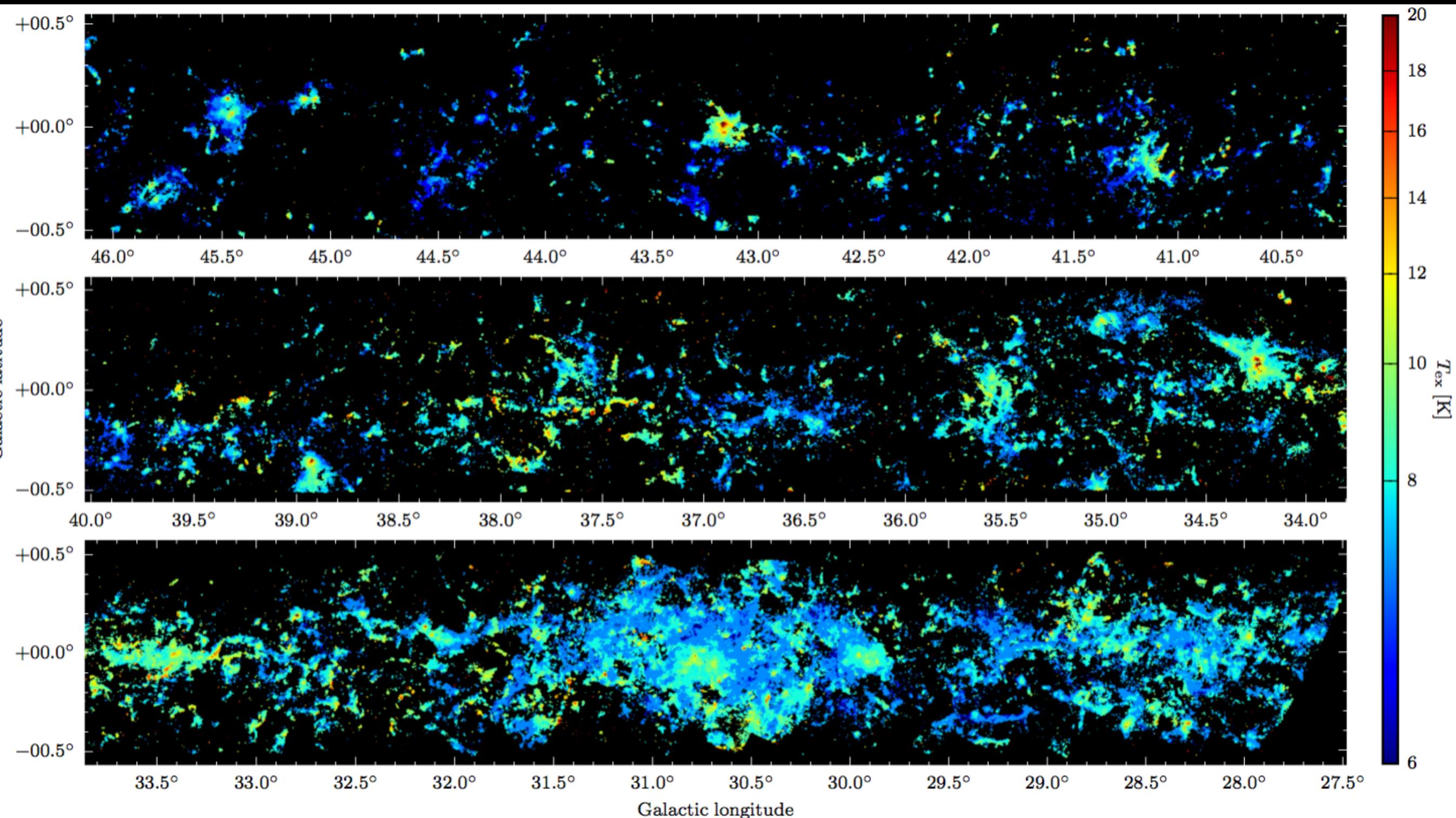


Approximated in an optically thin and optically thick case due to lack of C^{18}O (1-0)

$l = 32.15^\circ$
 $b = 0^\circ$
95.5 km/s



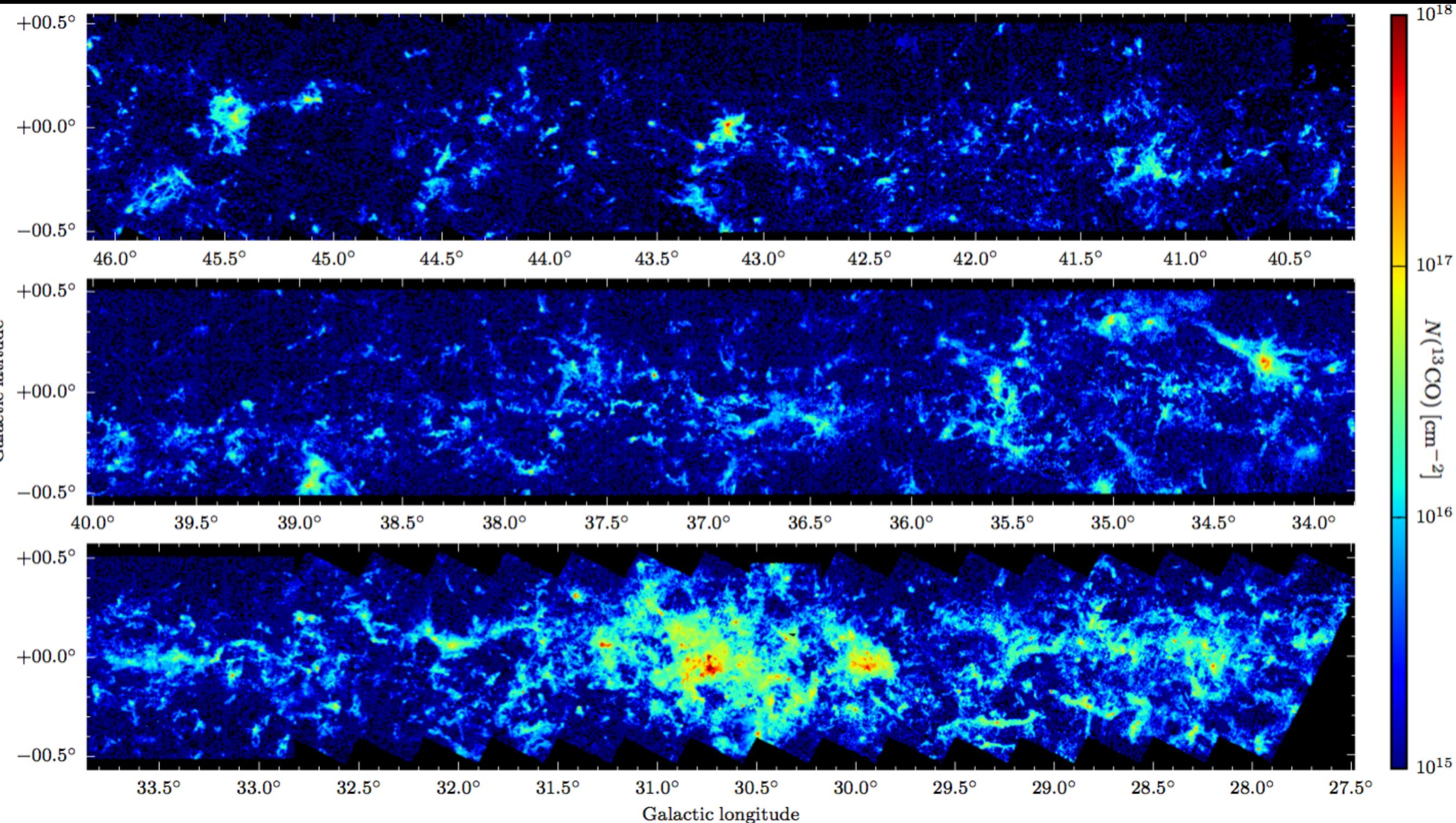
Median excitation temperature /spectrum $\sim 8 - 10$ K



46" resolution

^{13}CO (3 – 2) column density

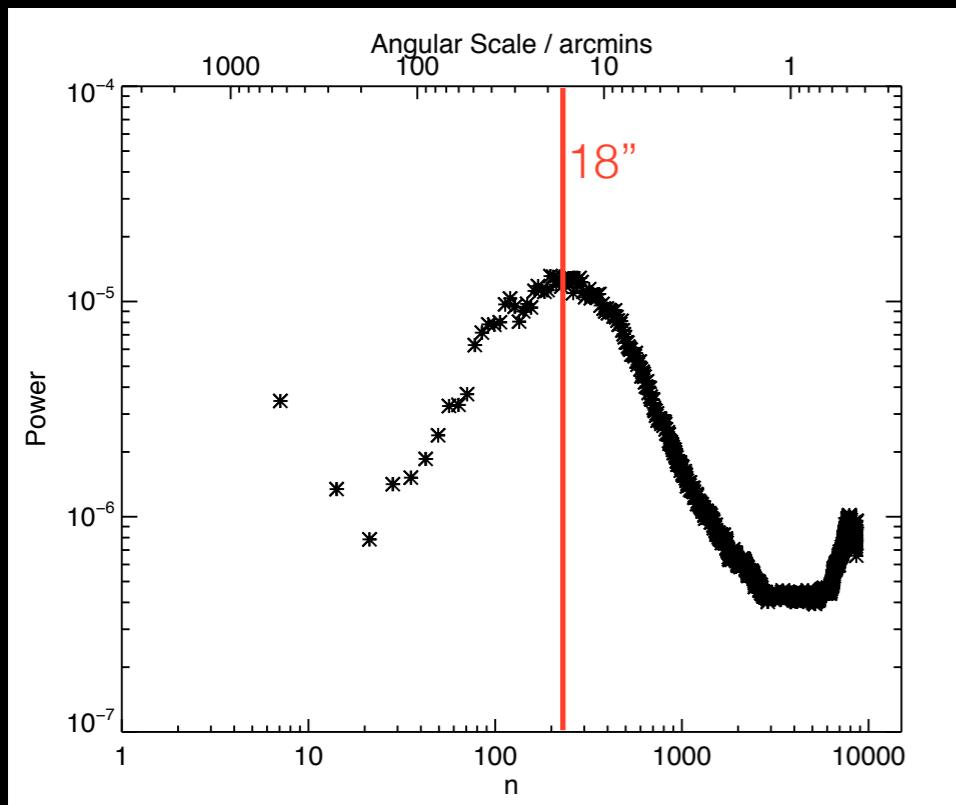
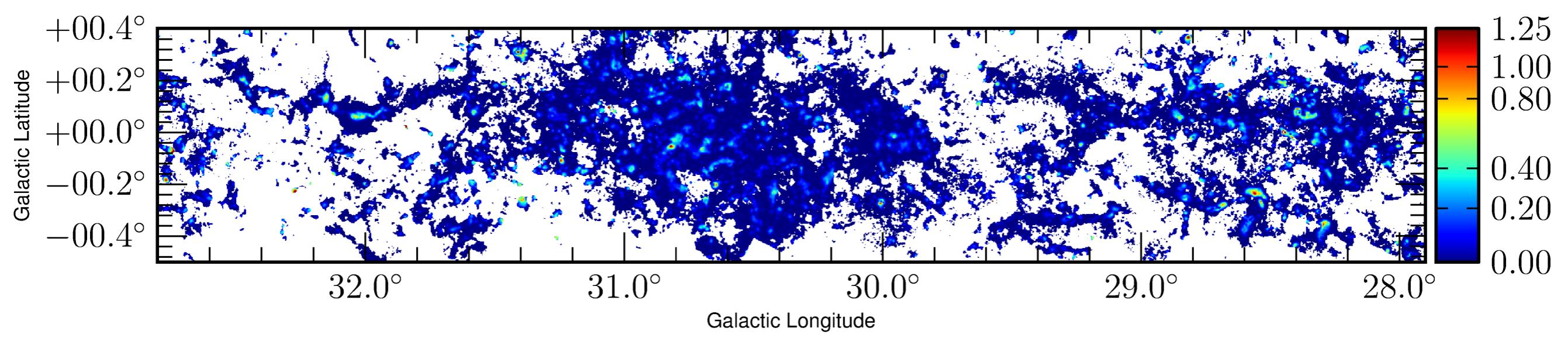
$N(\text{H}_2) \sim 10^{24} \text{ cm}^{-2}$



27.4" resolution

$N(\text{H}_2) \sim 10^{21} \text{ cm}^{-2}$

CFE Maps

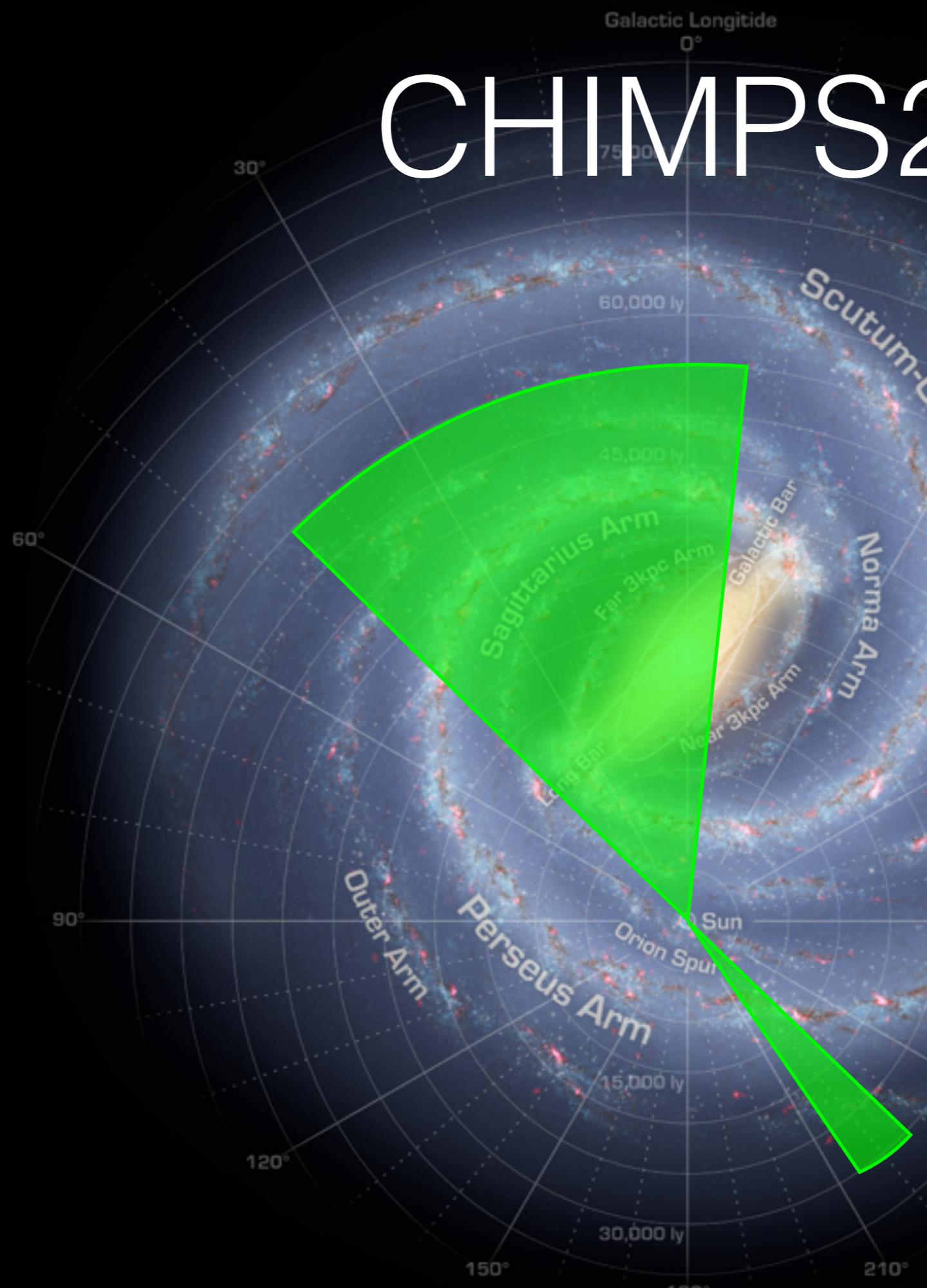


Clump formation efficiency (CFE) maps -
using JCMT Plane Survey data (Eden+17)
and CHIMPS data

Improvements coming!

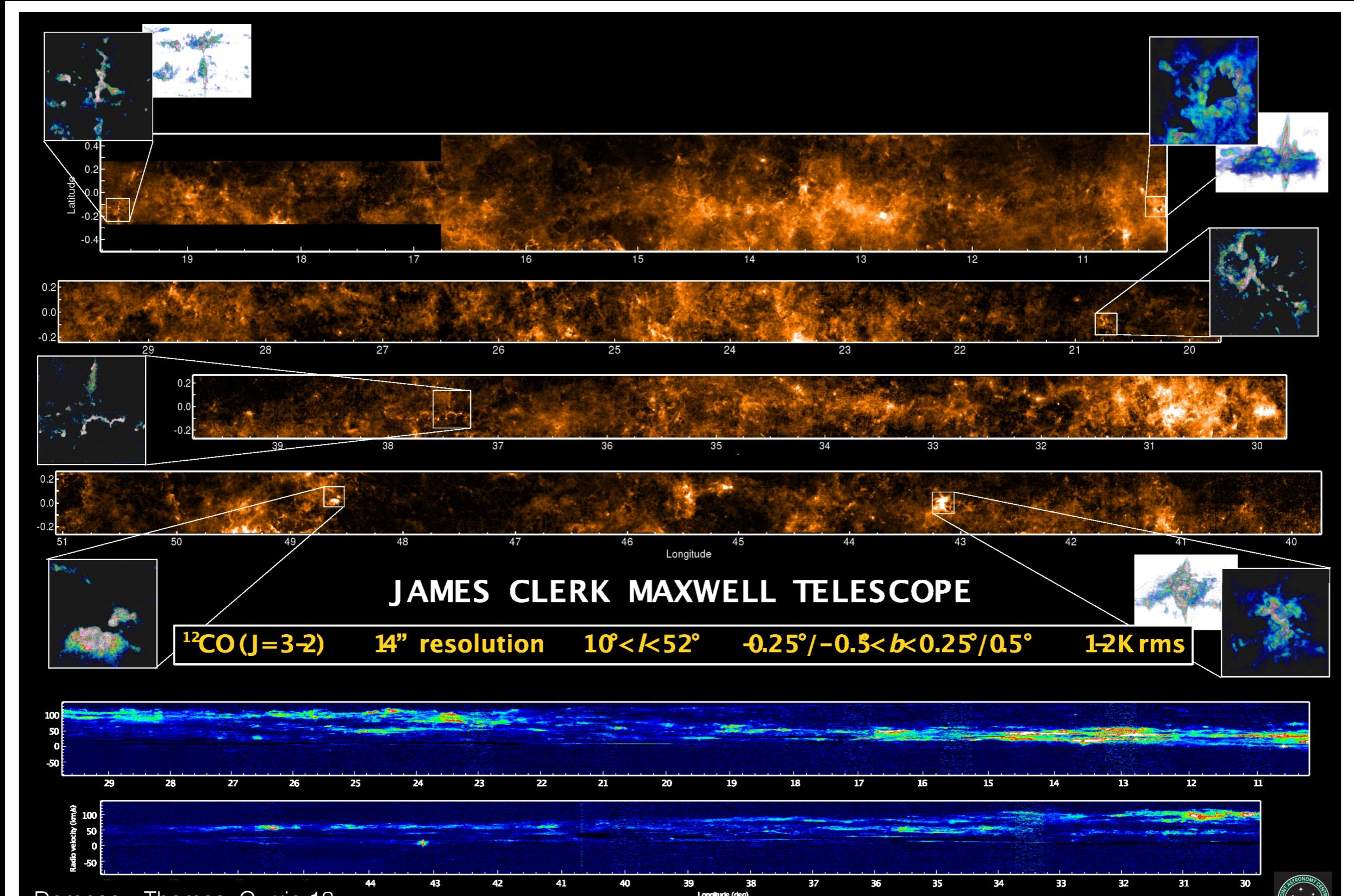
- JPS column densities calculated using the PPMAP method
- Comparisons to simulations

CHIMPS2

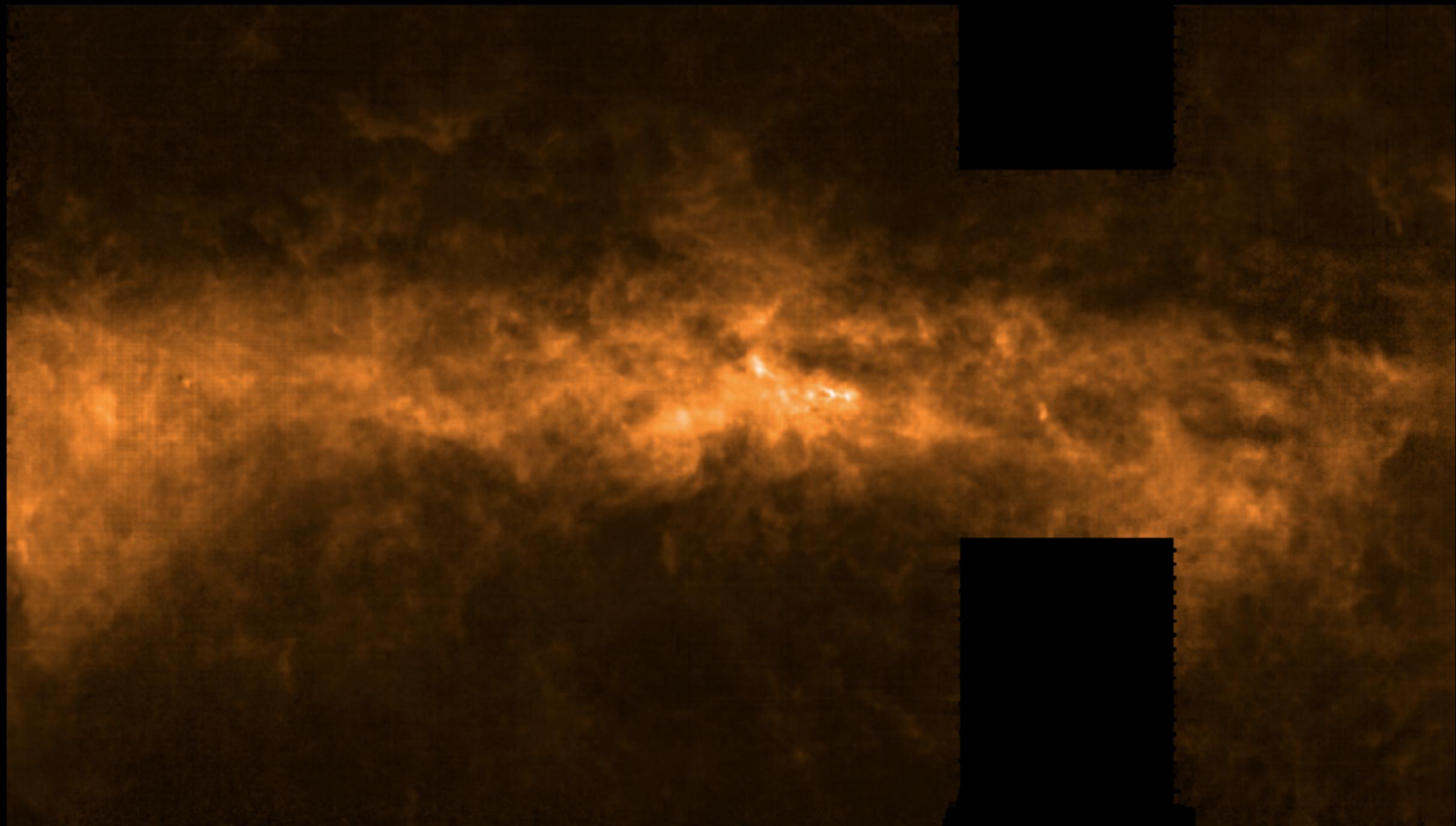


- Incorporate new COHRS survey
- Improve coverage in ^{12}CO , ^{13}CO and C^{18}O (3-2)
- Extend to Inner Galaxy and Central Molecular Zone, and a section in the Outer Galaxy.
- Large overlap with FUGIN with 1-0 lines at matching resolution.
- Awarded 404 hours. Observations are ongoing

COHRS - 12CO

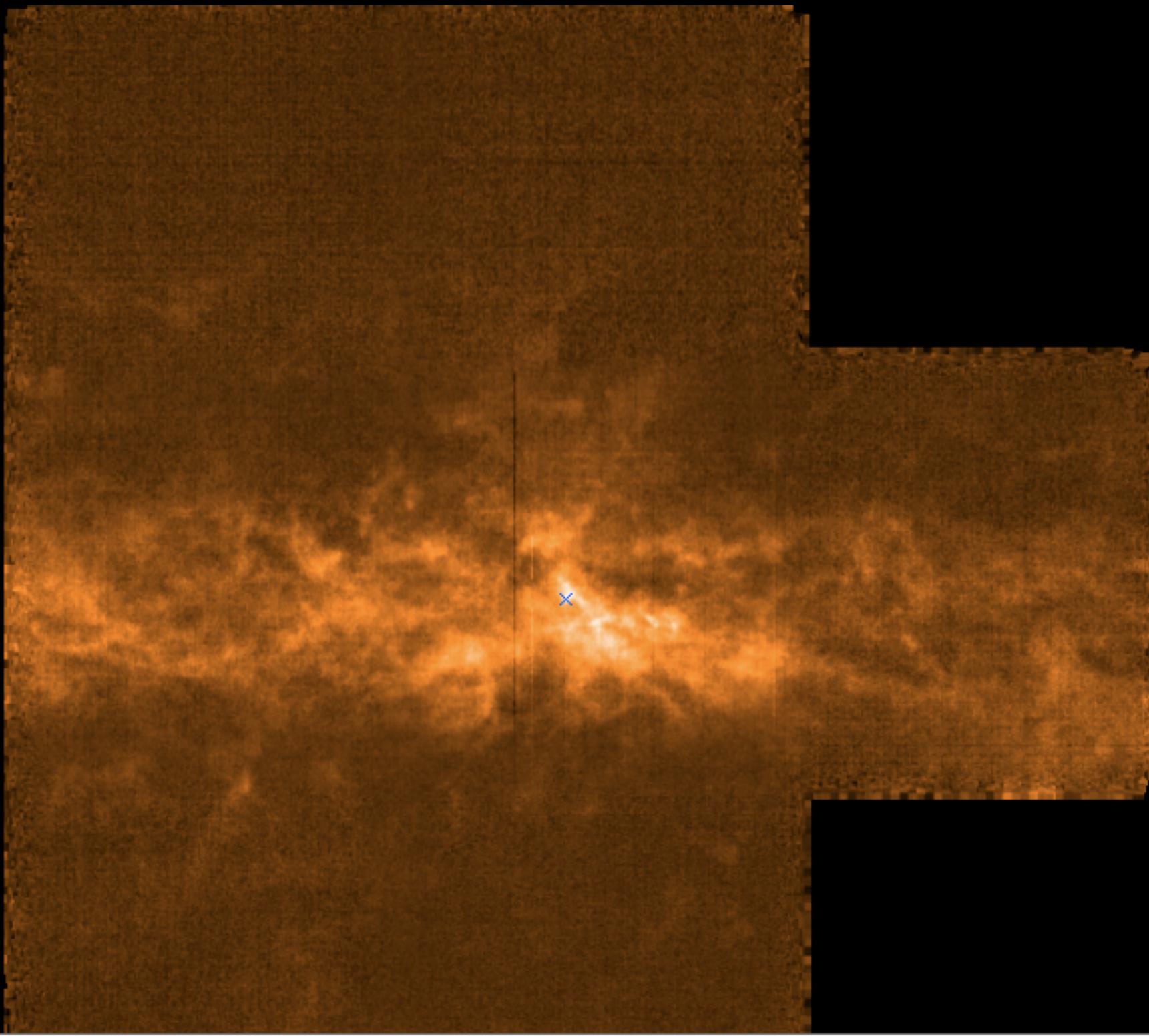


CHIMPS2 CMZ



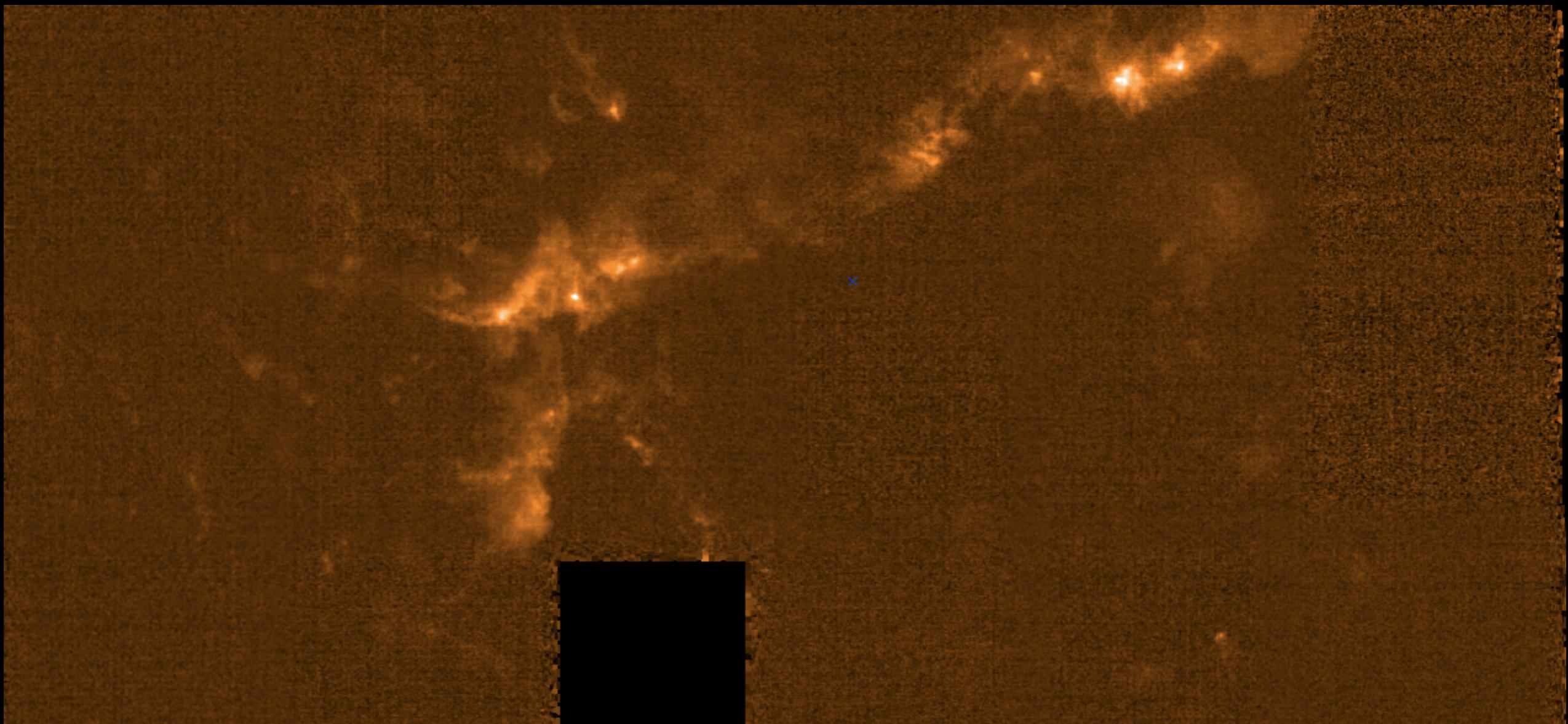
^{12}CO

CHIMPS2 CMZ



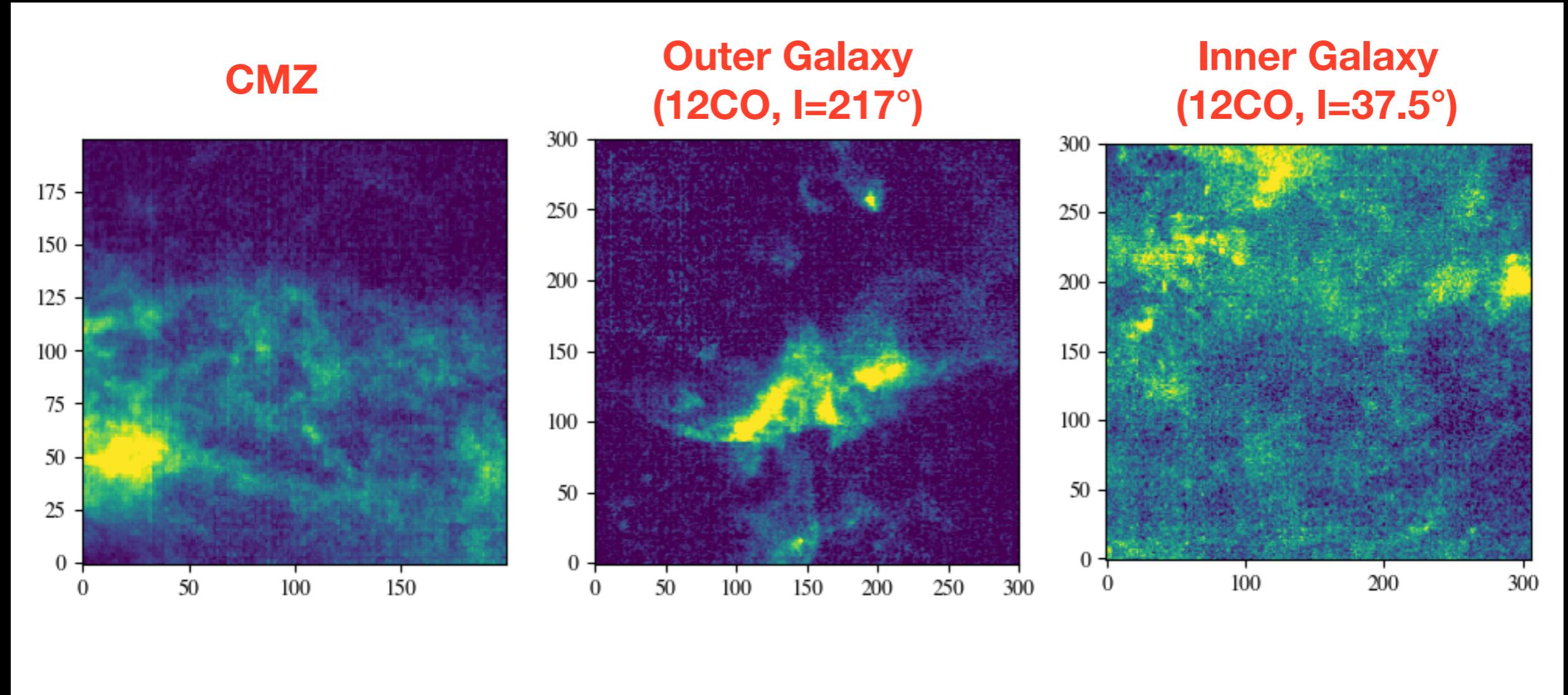
^{13}CO

CHIMPS2 Outer Galaxy



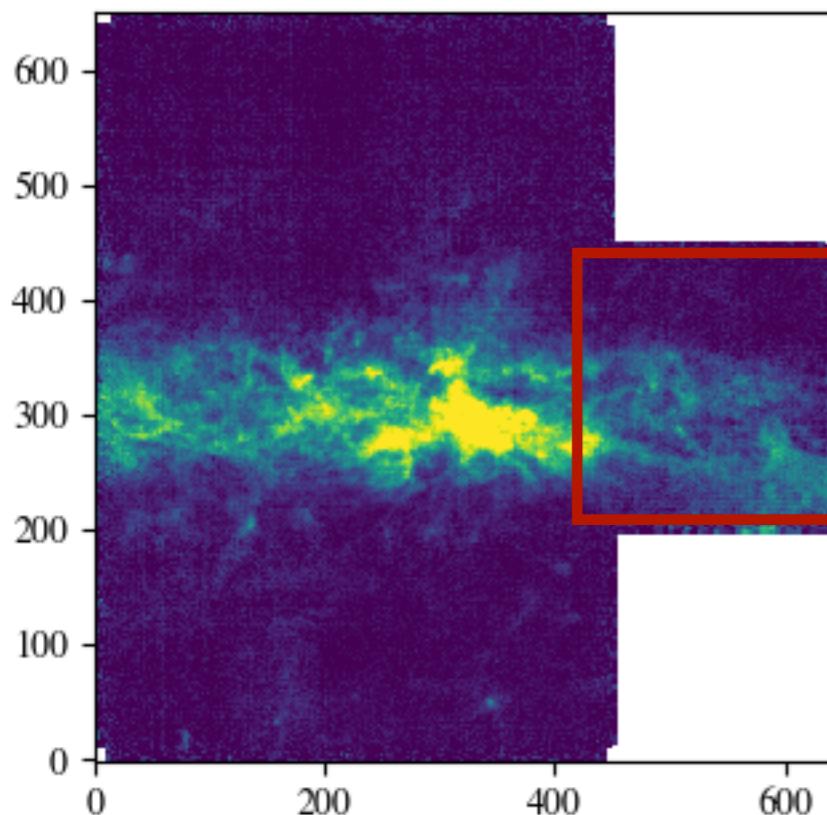
^{12}CO

Turbulent Properties

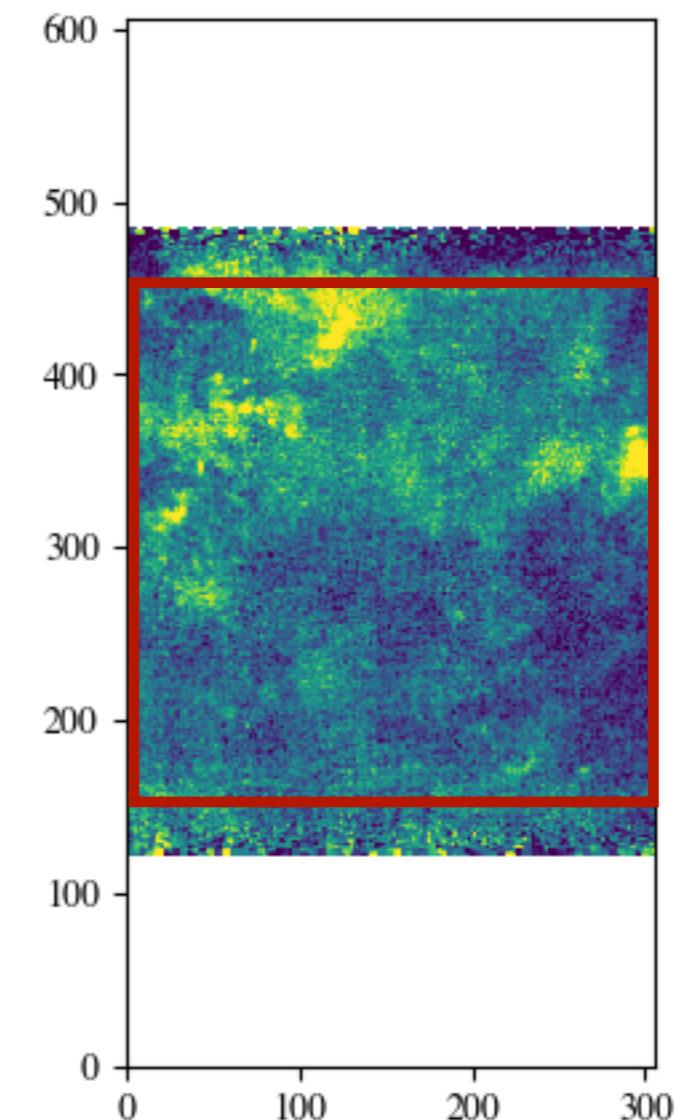
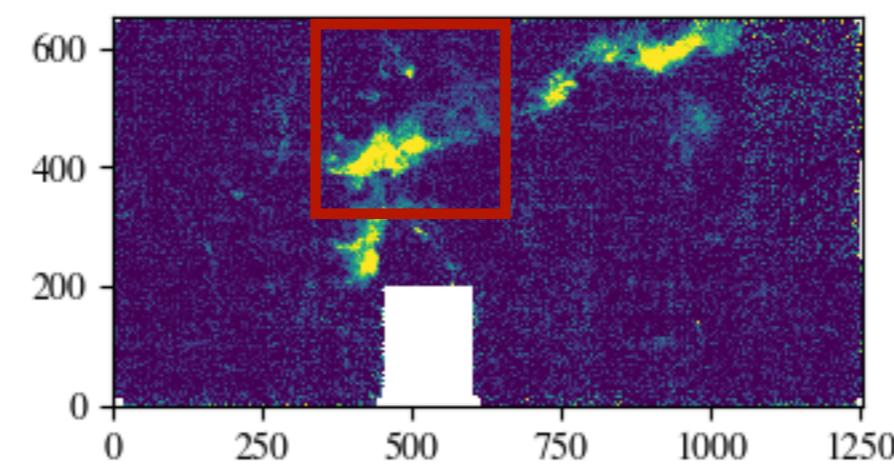


Inner Galaxy (12CO, $l=37.5^\circ$)

CMZ

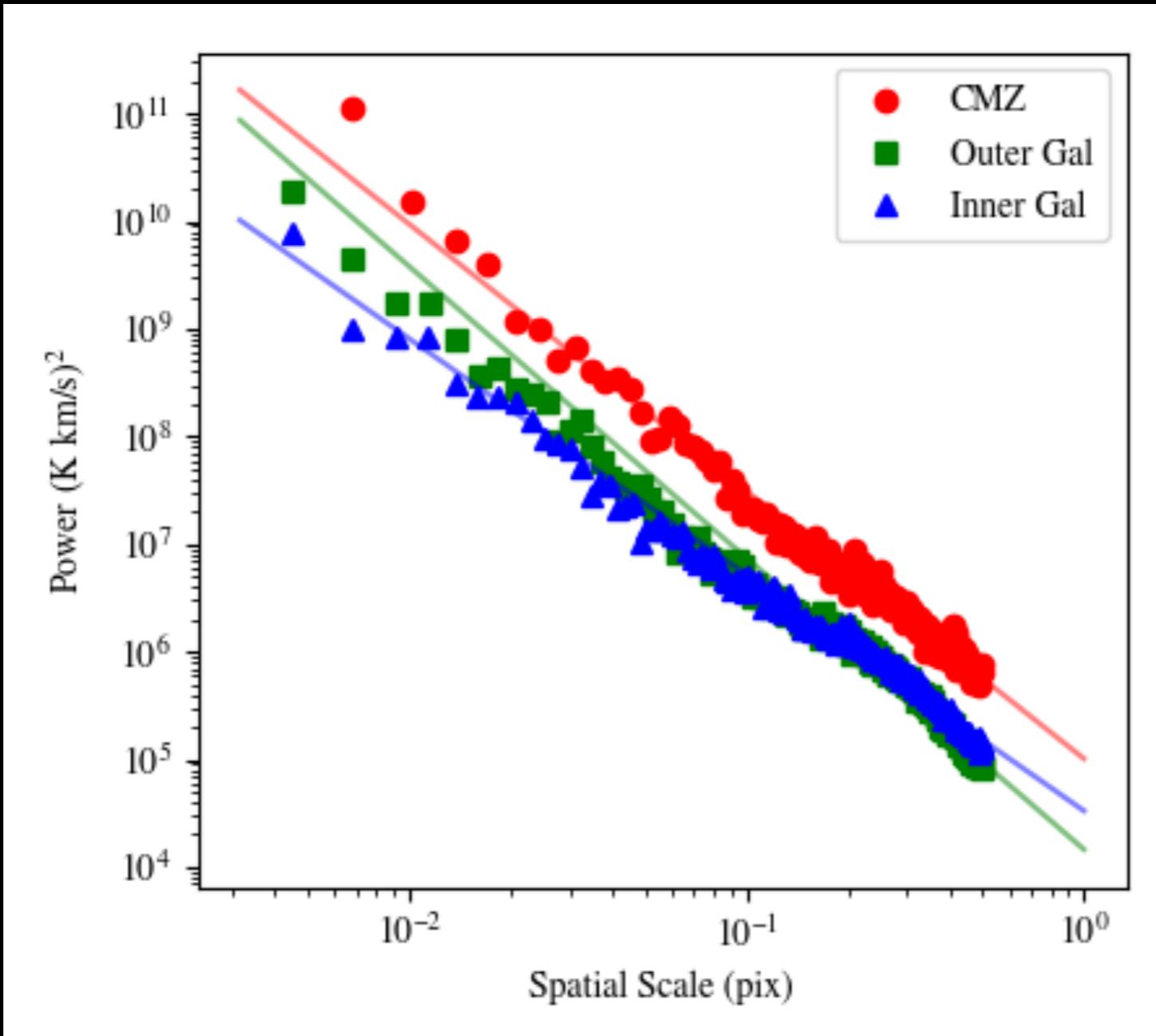


Outer Galaxy (12CO, $l=217^\circ$)



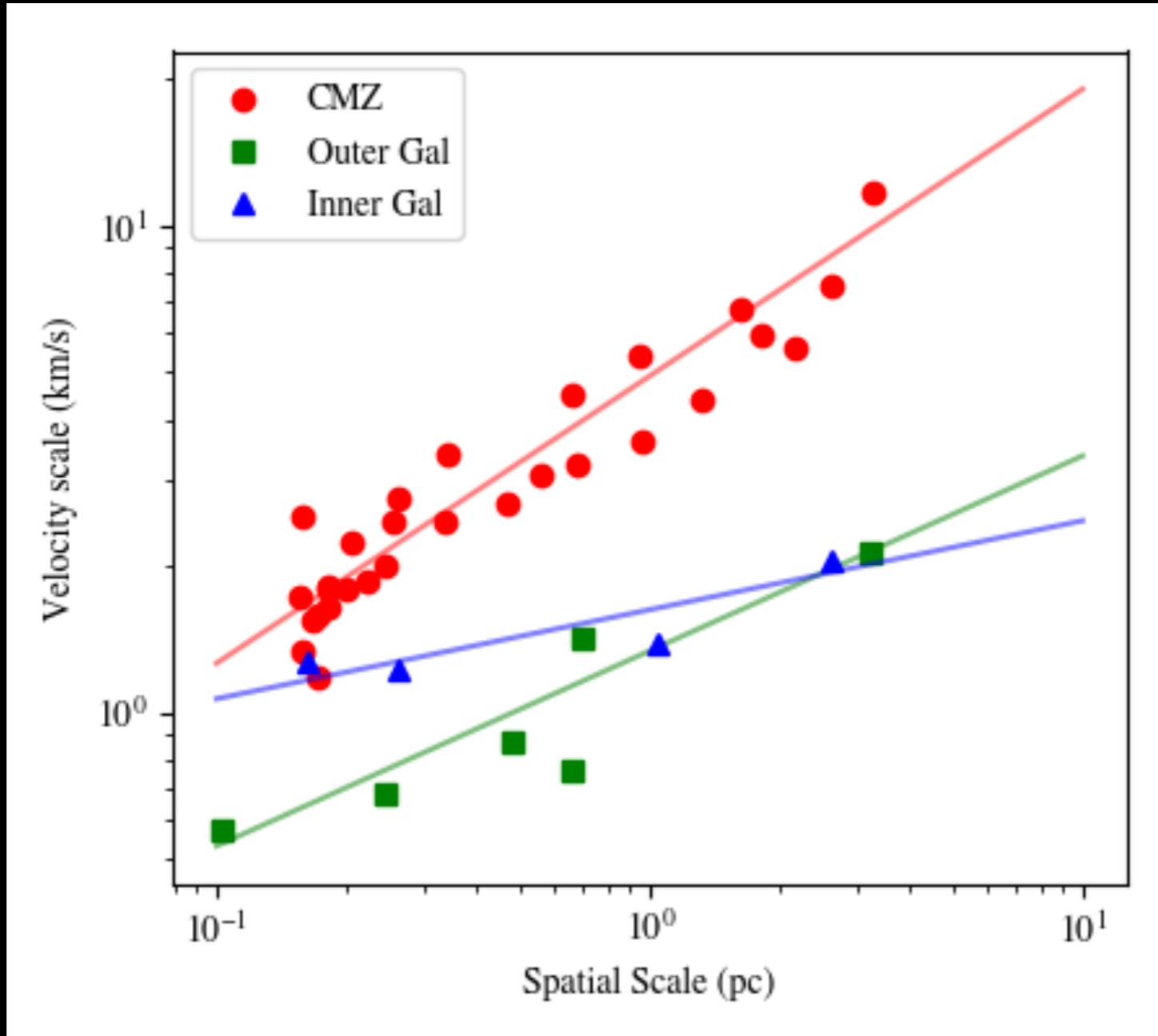
Extract boxes for analysis using TurbuStat package
(Koch+17)

Comparing Spatial Power Spectrum

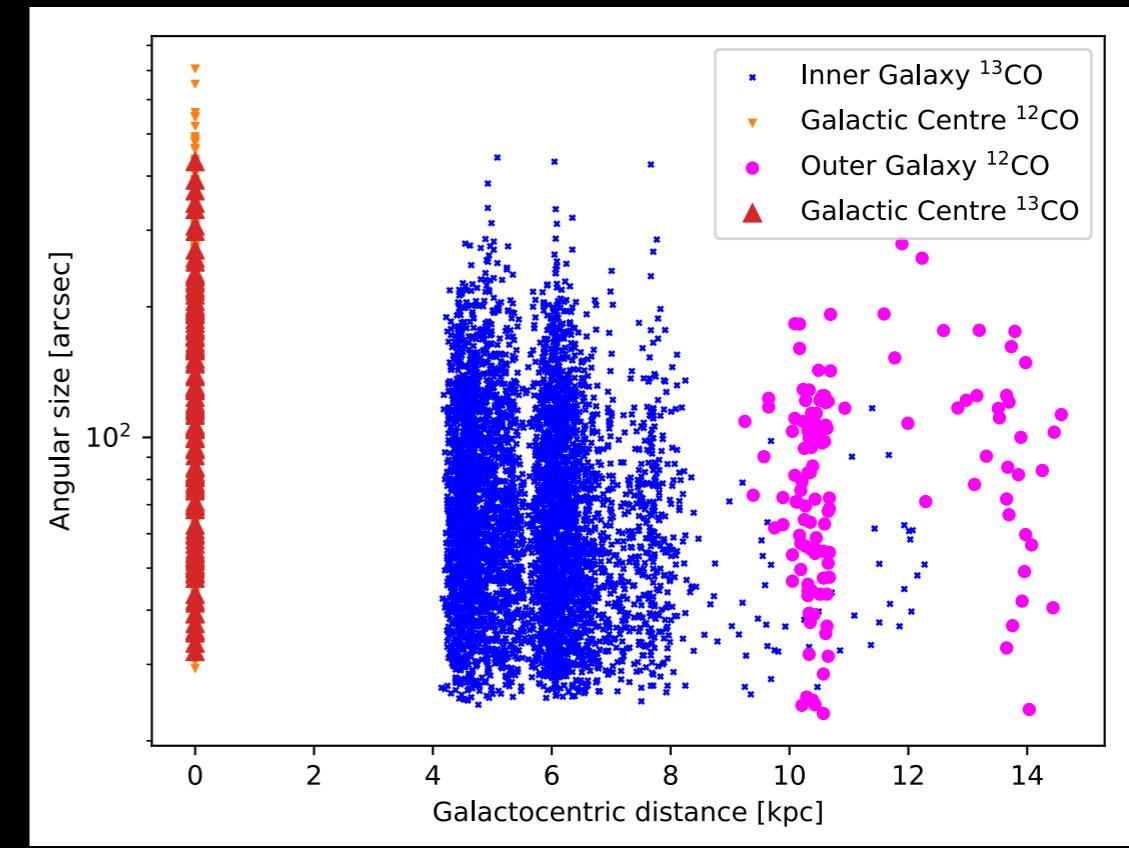
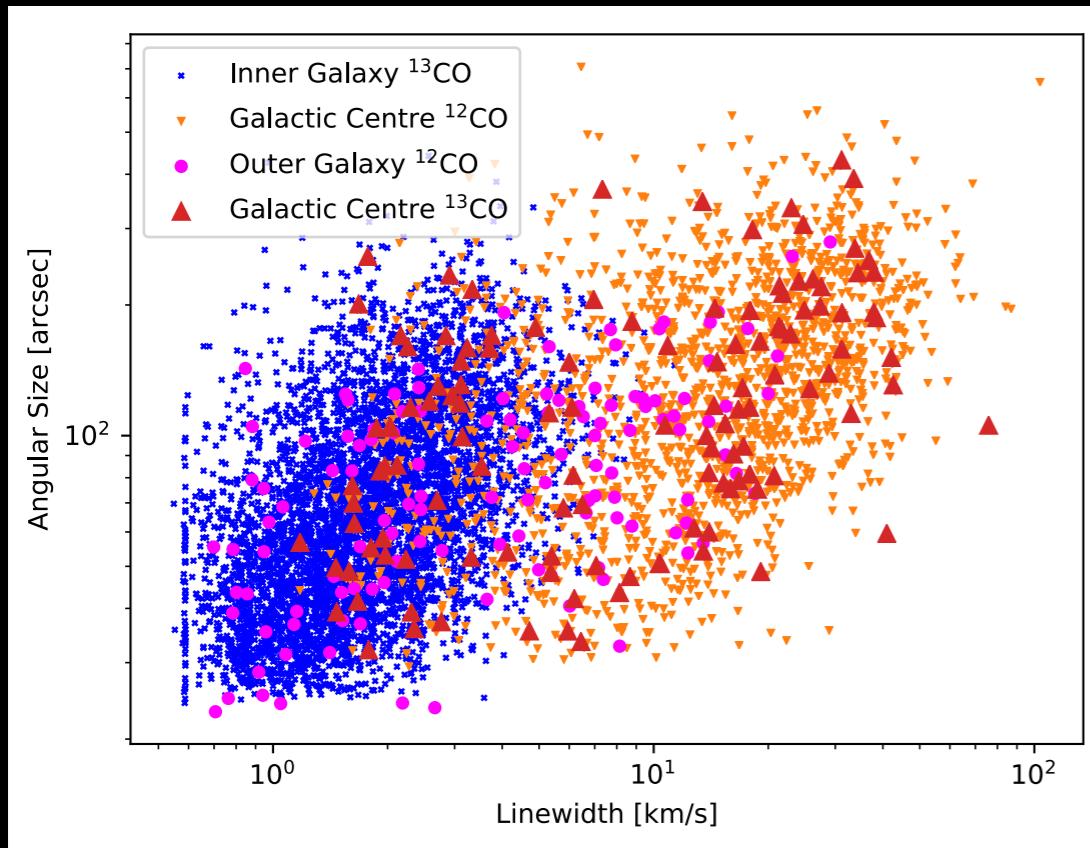
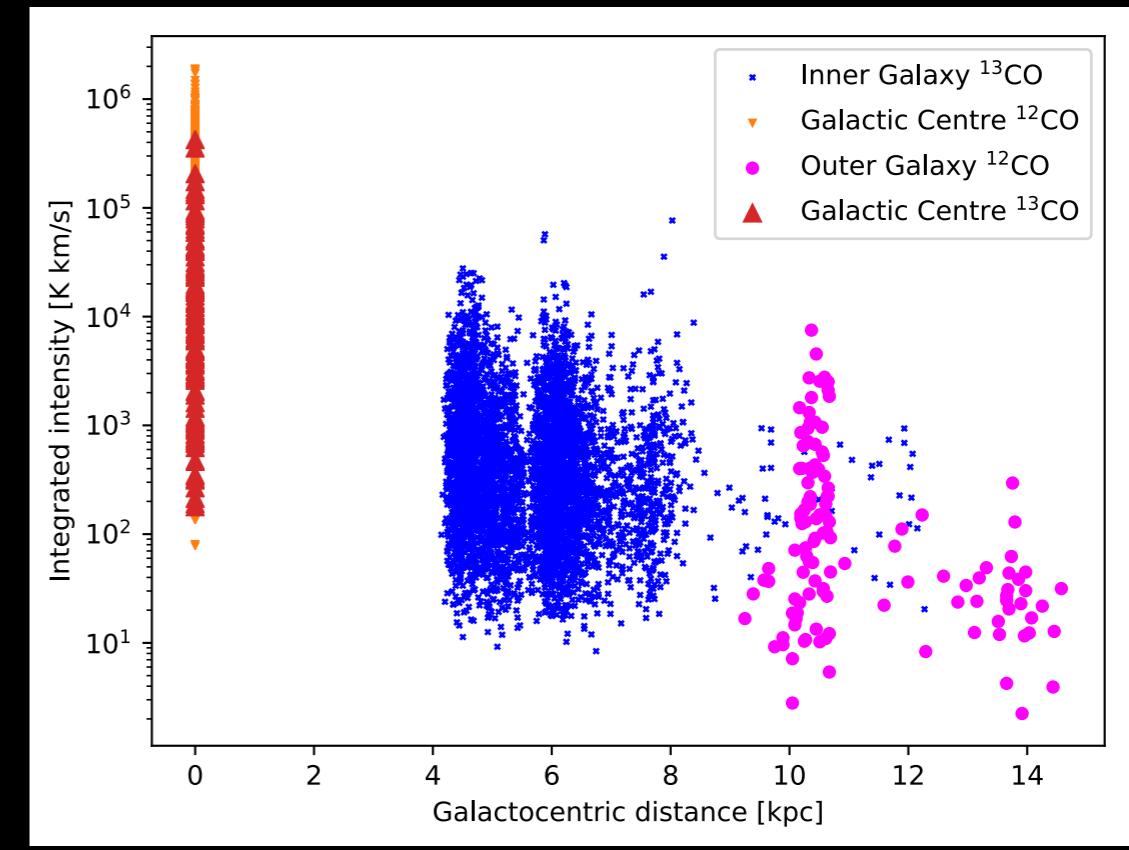
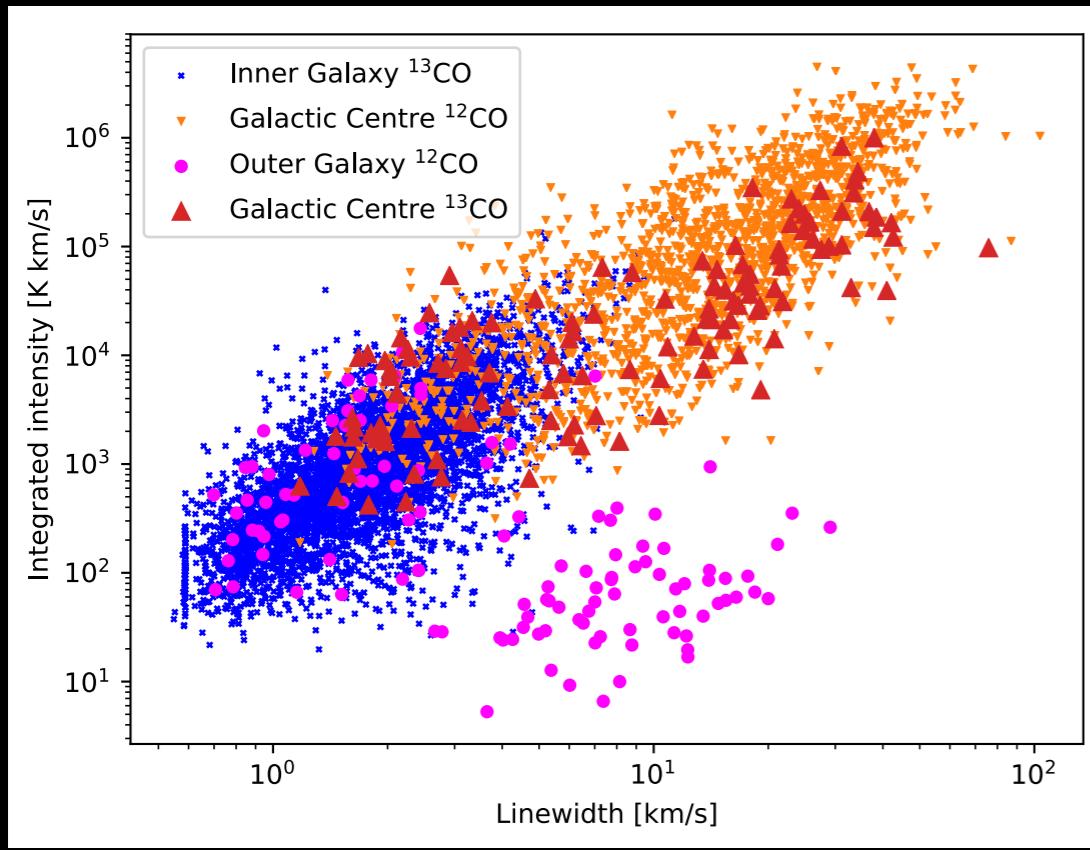


Similar slopes across regions

PCA Analysis of size-line width



PCA attempts to measure the size-line width relationship within resolved molecular clouds. CMZ shows increased velocity widths at common spatial scale.



Conclusions

- CHIMPS data is available
- CHIMPS column density and temperature maps coming soon
- New JCMT survey, CHIMPS2 supplying new molecular data across vast Galactic environments.