CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD

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Molecular clouds in the inner Galaxy

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THE ROYAL SOCIETY

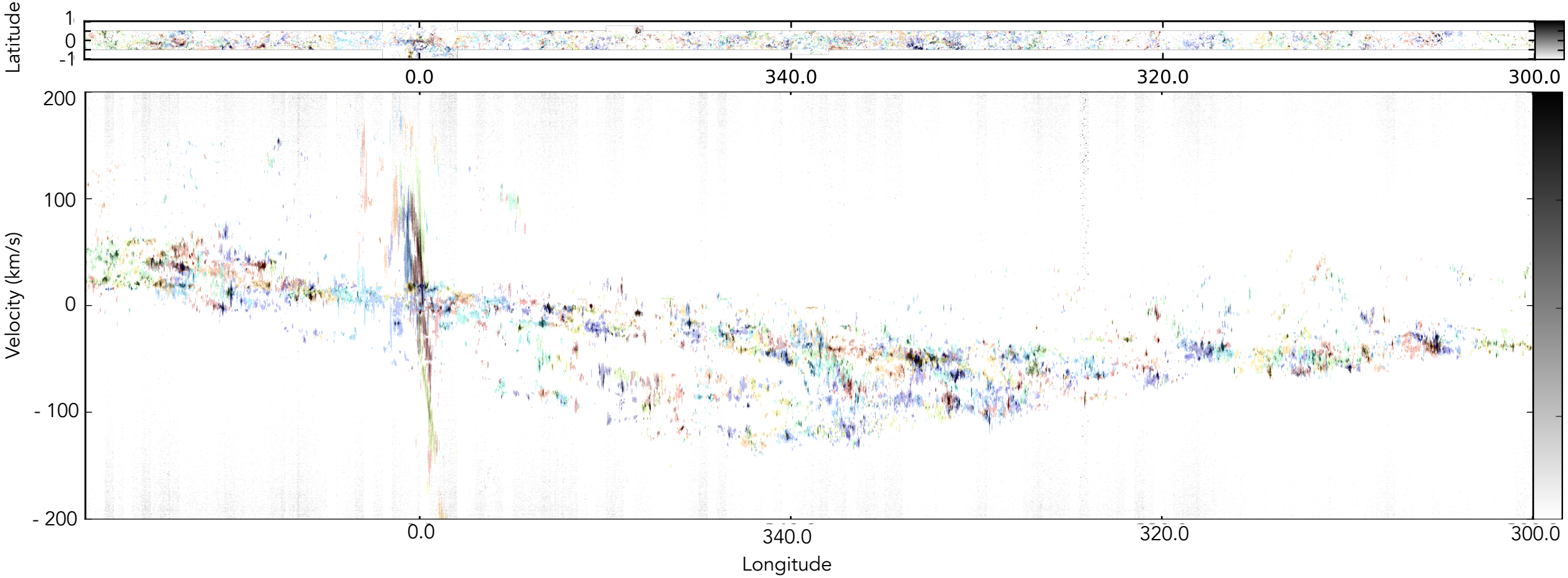
Duarte-Cabral et al. 2021

Cloud extraction from entire survey

SCIMES algorithm (Colombo et al. 2015) in a nutshell:

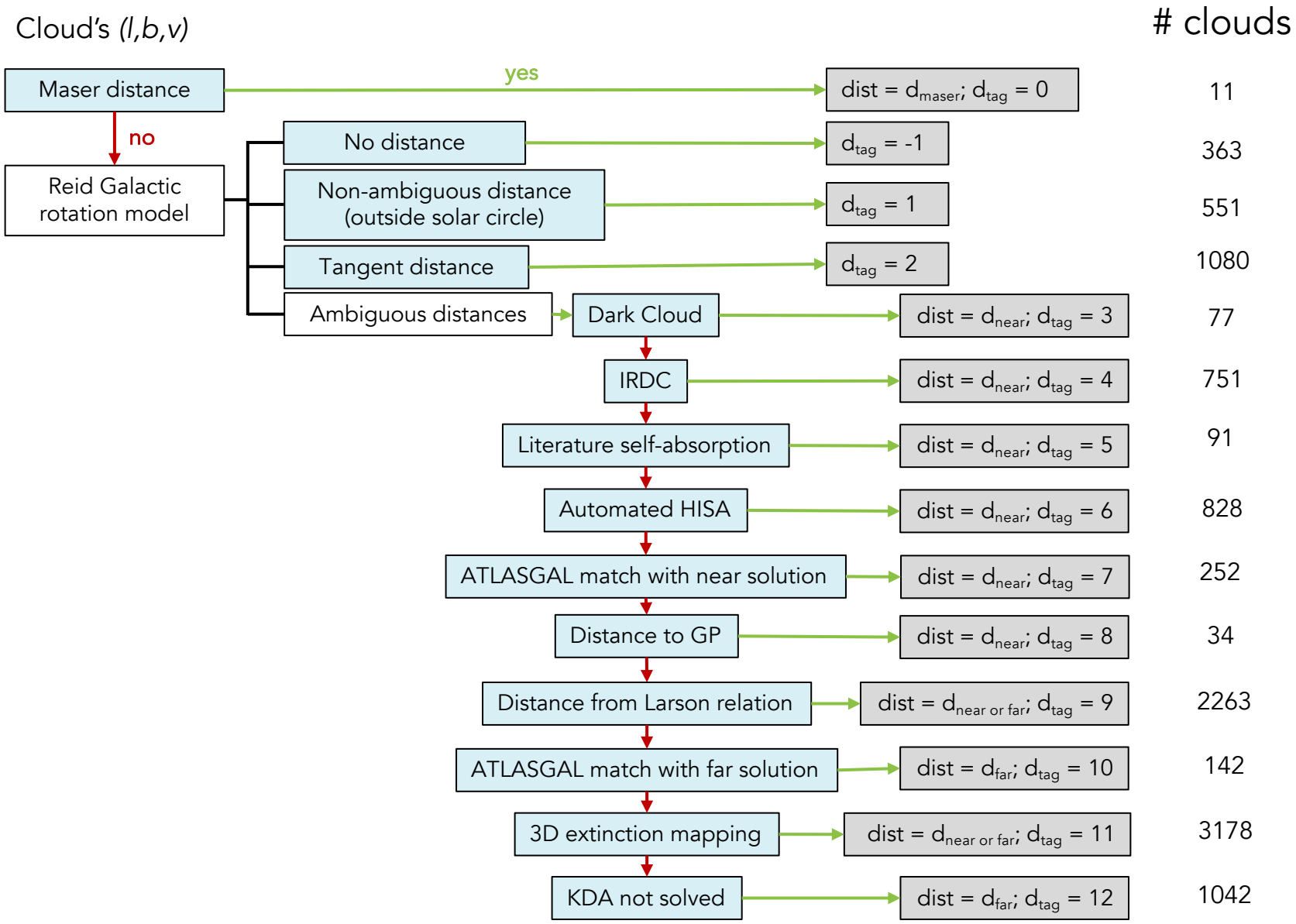
- Uses the 3D dendrogram of the emission
- Segments the data using spectral clustering and graph theory – groups peaks into larger interconnected structures

⇒ Extracted a total of 10663 clouds.



Determining distances

Duarte-Cabral et al. 2021



Duarte-Cabral et al. 2021

Data Products

Main cloud catalogue:

- Position of centroid in (l,b,v)
- Peak and integrated intensity
- Velocity dispersion
- Major and minor axis
- Total area and equivalent radius
- Medial axis length and width
- Aspect ratio (from PCA and Medial Axis)
- Distance (solutions, final distance, quality flag)
- Mass
- Surface density
- Galactocentric coordinates
- (…)

Data:

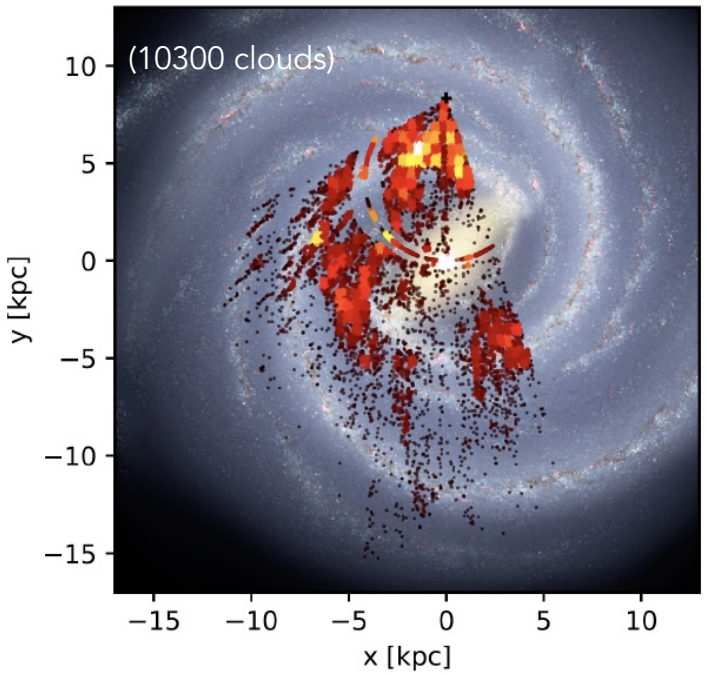
- Data cubes of cloud masks (fits format)
- Dictionaries with medial axis information

Ancillary catalogues:

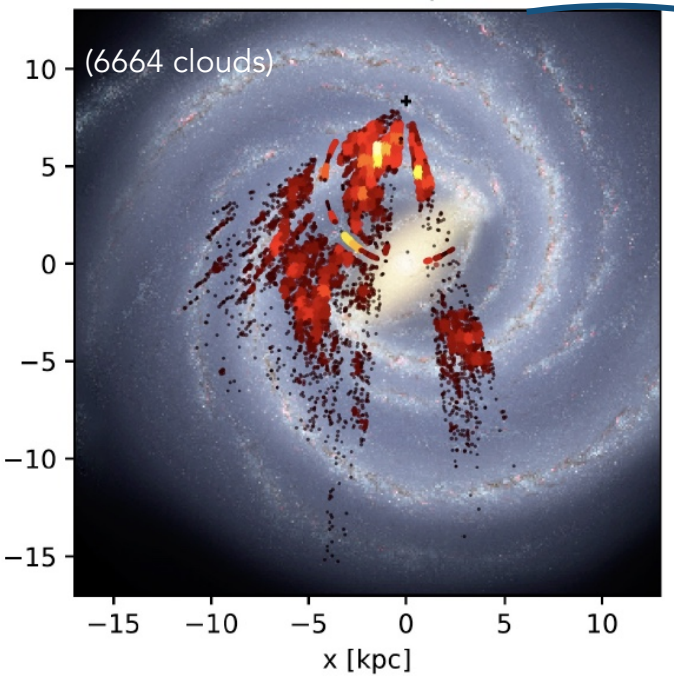
- Information on ATLASGAL matches
- Information on cross-matches with literature sources (for distances)

https://sedigism.mpifr-bonn.mpg.de

Full Sample



Science sample



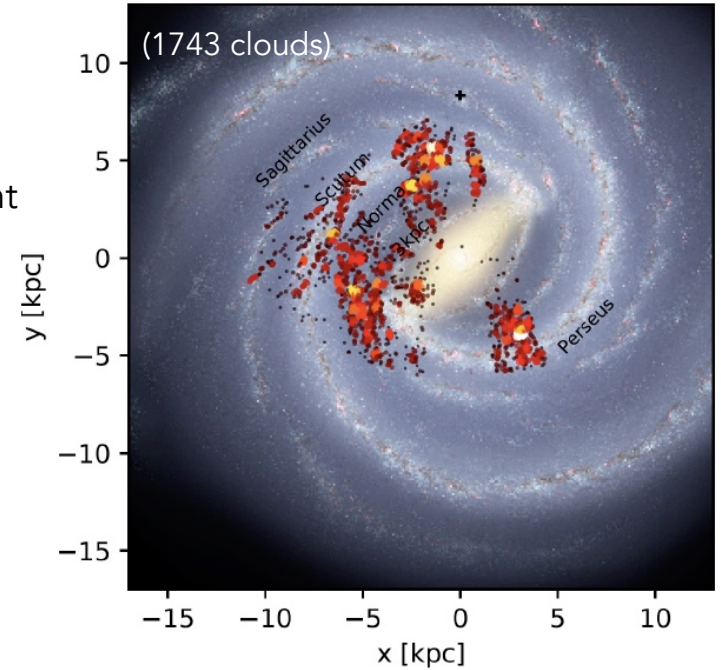
Duarte-Cabral et al. 2021

- Reliable distances
- Size larger than 3 beams
- Does not touch an edge

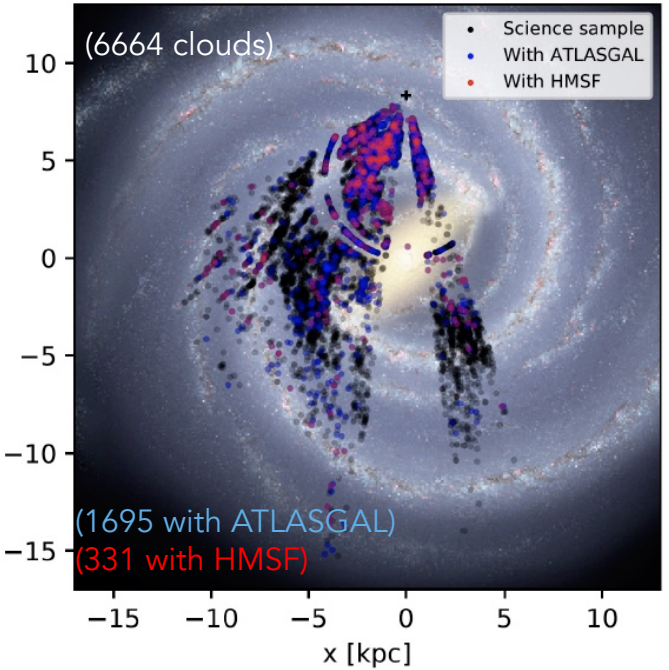
Science sample not at tangent distances, and above completeness limit:

- M > 2.6 x 10^3 Msun
- R > 2.9 pc
- D < 14.5 kpc

Complete science sample



Science sample with ATLASGAL/HMSF



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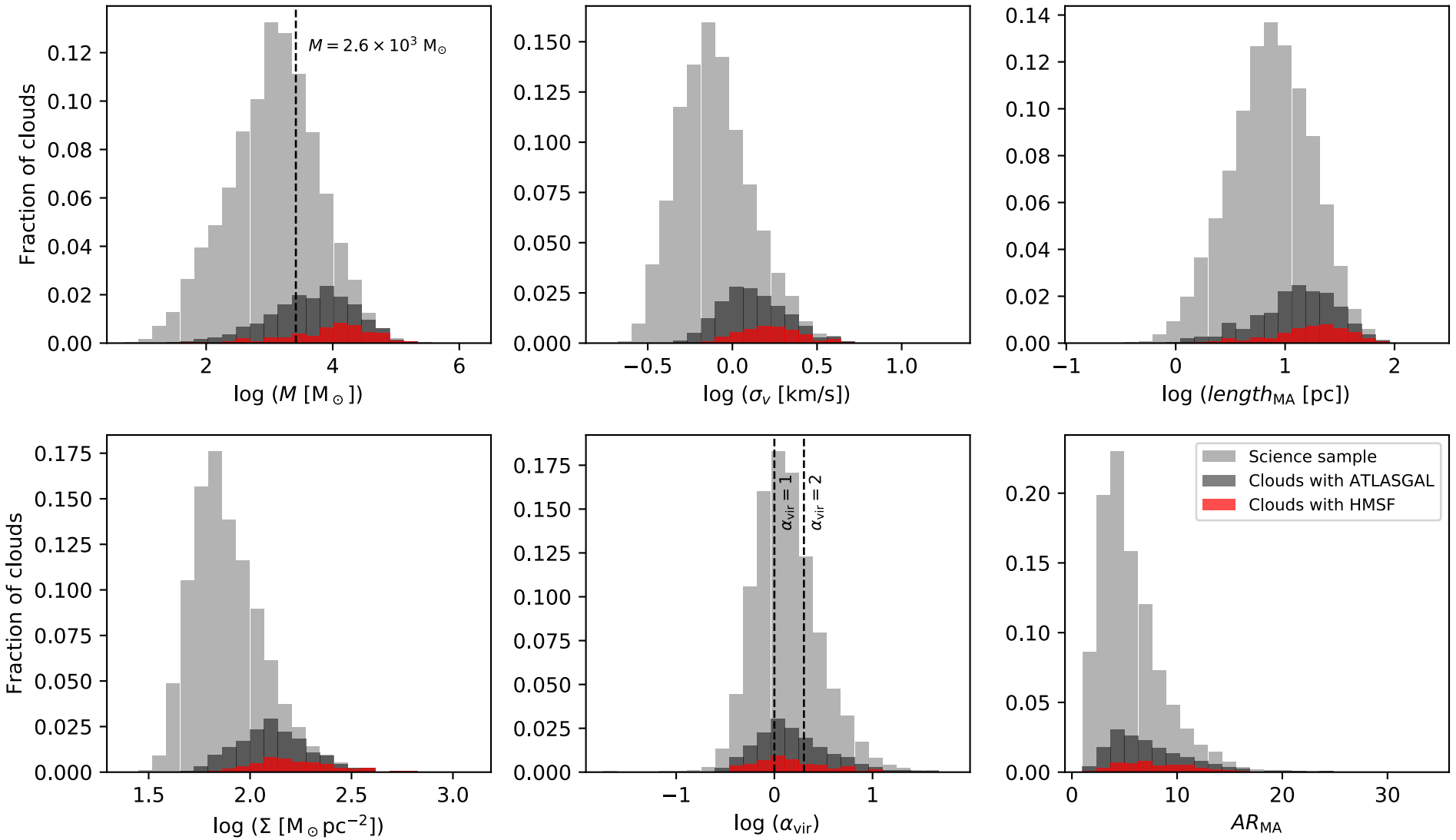
Global statistics of cloud properties



From science sample to ATLASGAL to HMSF:

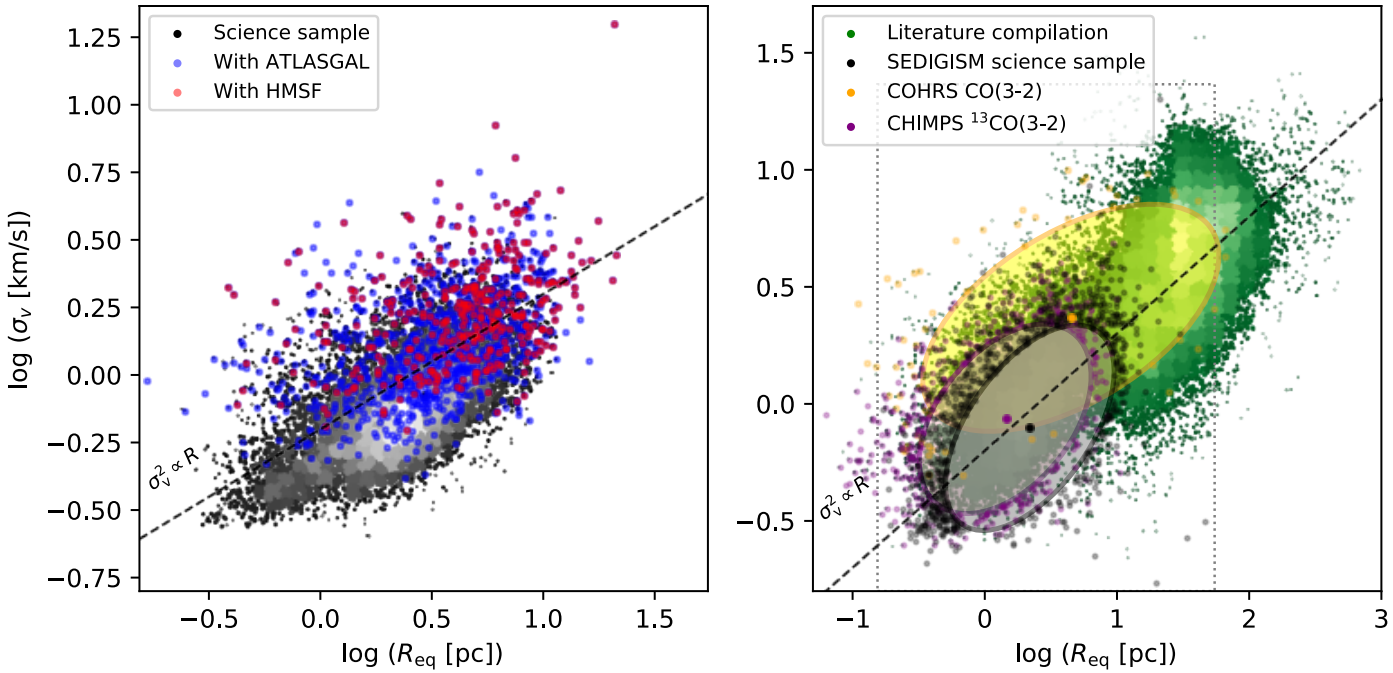
- Median values go up
- Distributions get flatter

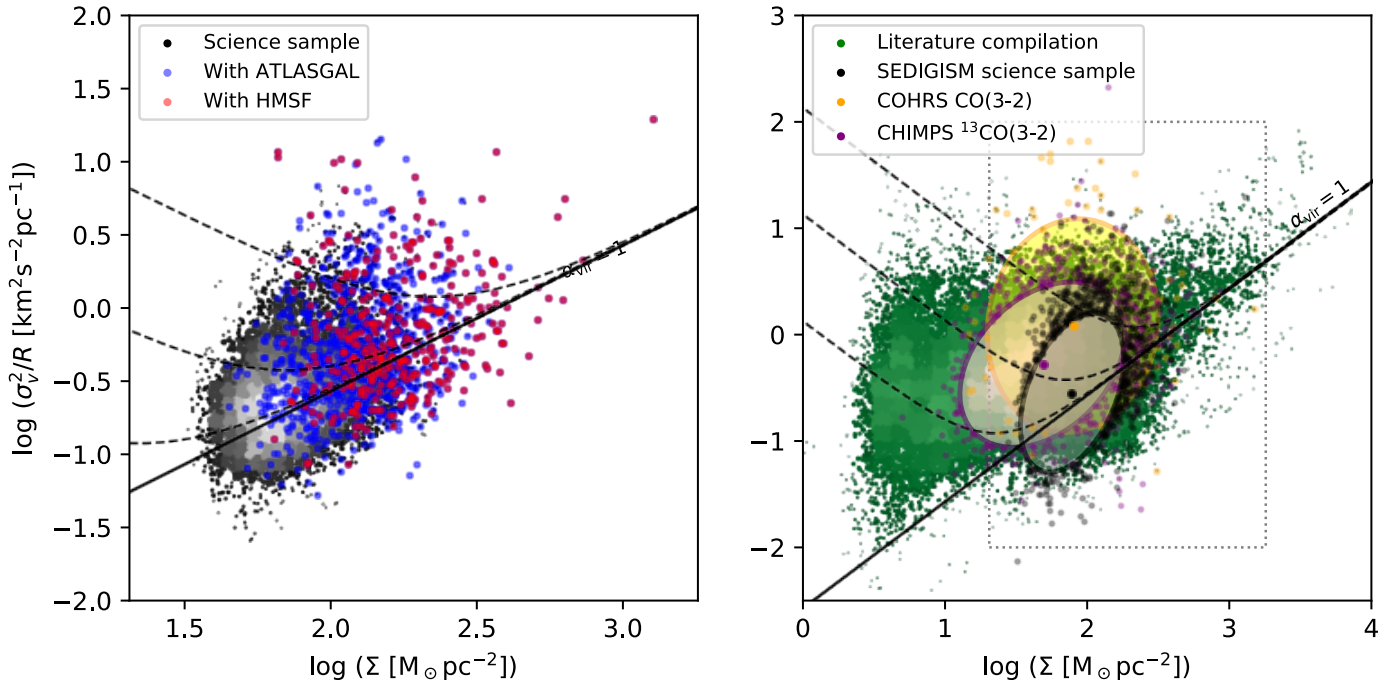
- HMSF clouds span large parameter space on all properties

⇒ no single property seems to be a good indicator of whether a cloud is undergoing HMSF by itself.

Scaling relations

Duarte-Cabral et al. 2021





- Large intrinsic scatter
- Global trends not so clear when looking at each sub-sample separately.
- Same clouds with different tracers show different trends.

Duarte-Cabral et al. 2021

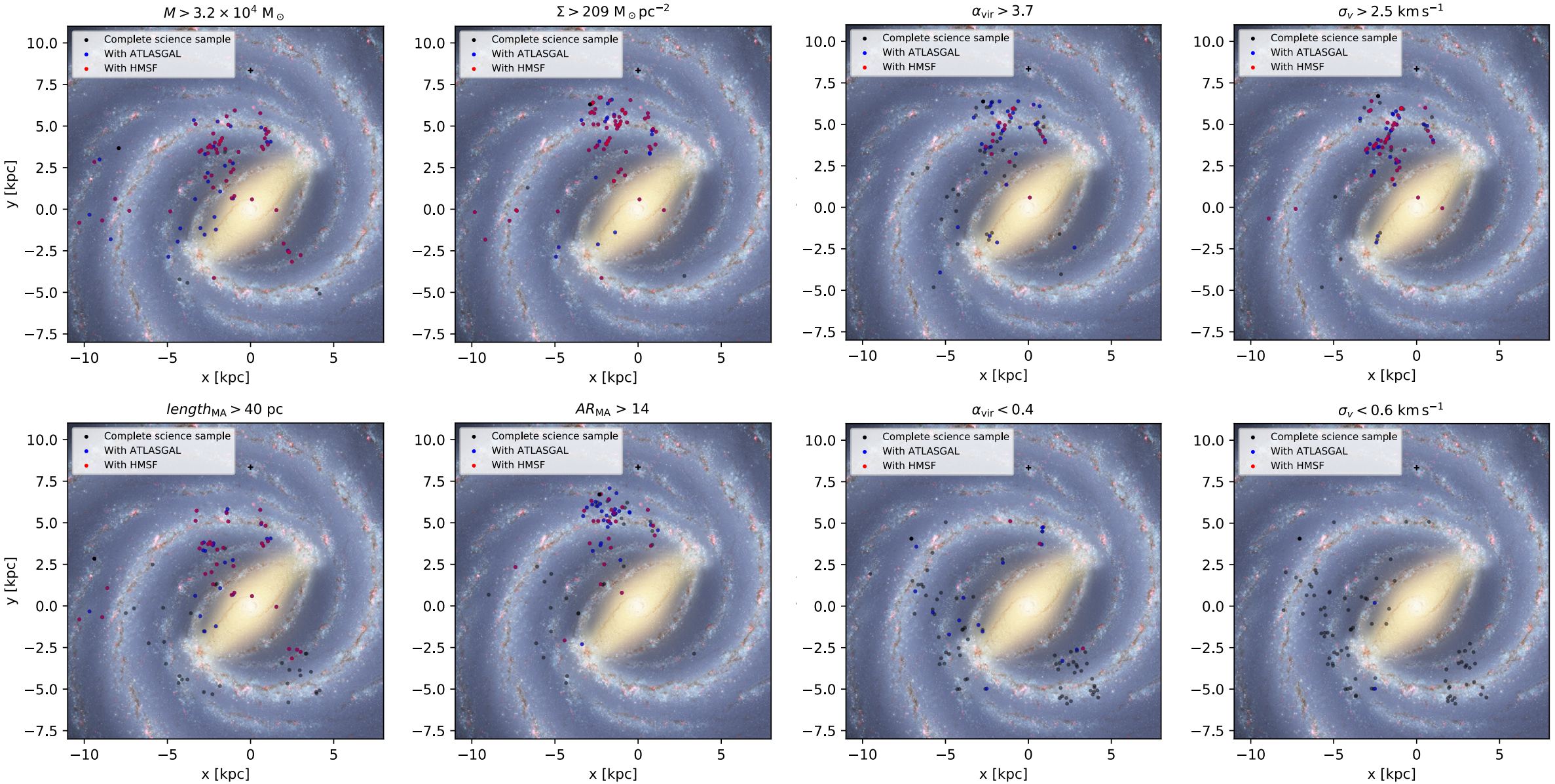
A first look at environmental trends

Suggested that global properties of clouds are blind to Galactic environment (arm/inter-arm), but tails of distributions might not be (e.g. Duarte-Cabral et al. 2016, 2017)

⇒ Looking at Galactic distribution of most extreme 100 clouds for each property

Duarte-Cabral et al. 2021

A first look at environmental trends

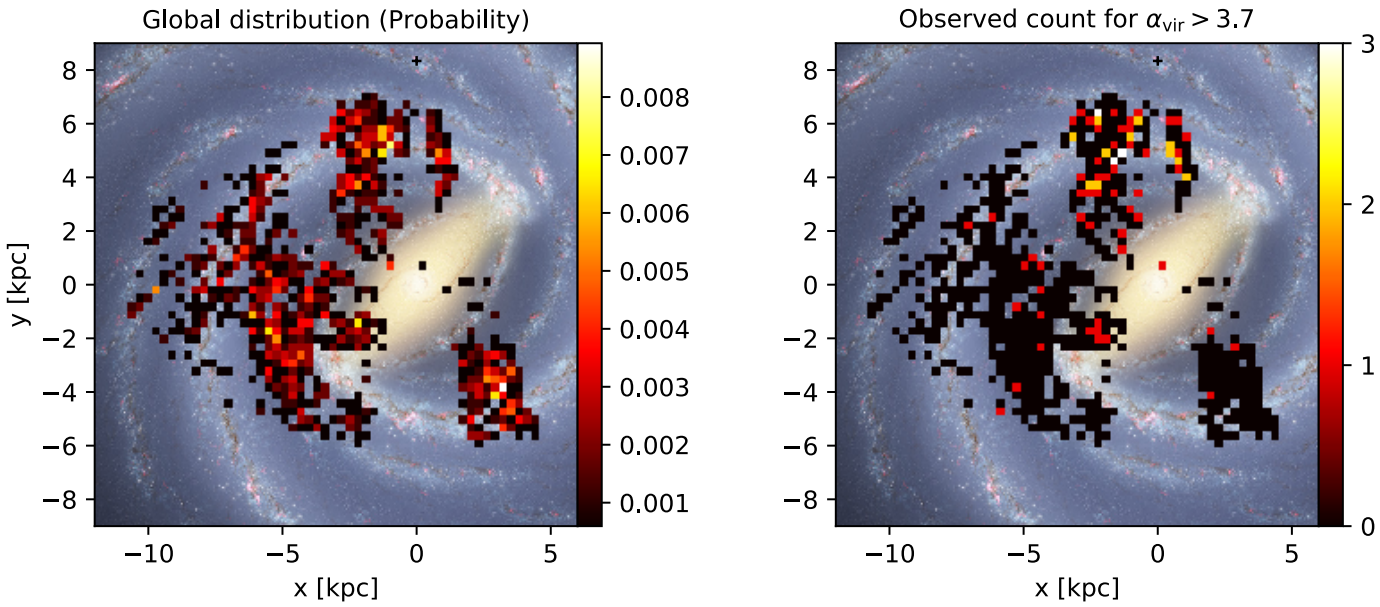


Duarte-Cabral et al. 2021

A first look at environmental trends

Position of the arms very uncertain.

⇒ Using a statistical test to tell us whether a given sub-sample is likely a random draw of the underlying distribution.



- Could assume that crowded areas ≡ spiral arms, and the least crowded areas ≡ inter-arms.

- Can visually inspect whether the excess or lack of expected counts is associated with a particular type of environment.

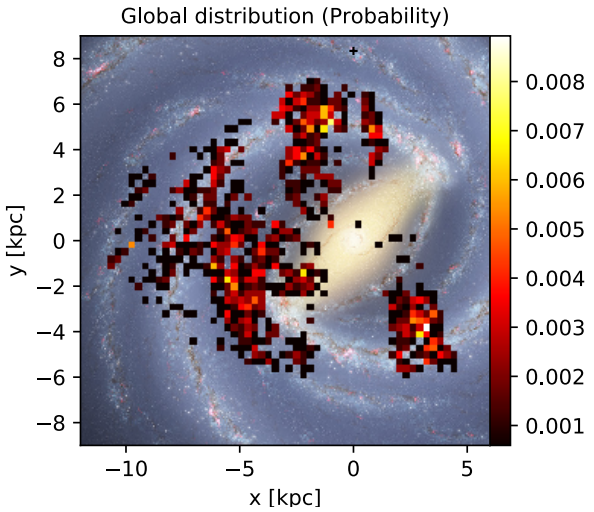
Duarte-Cabral et al. 2021

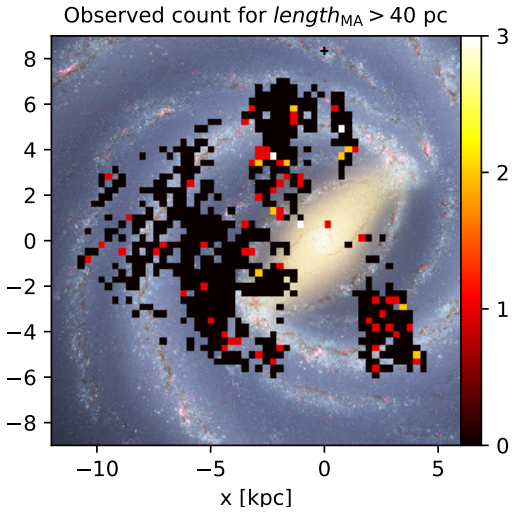
A first look at environmental trends

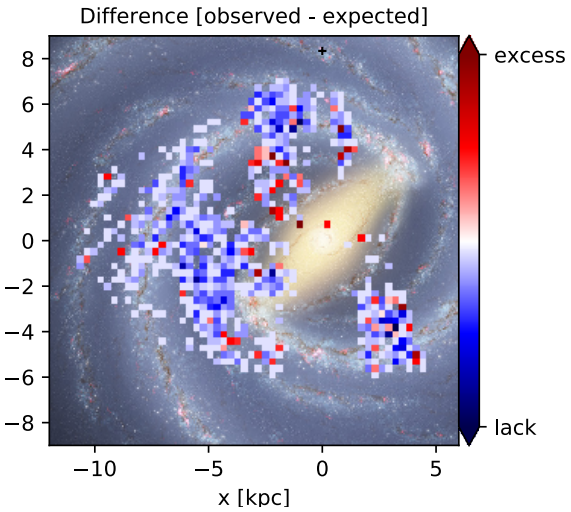
Examples of some tentative trends:

Longest MA clouds

- Excess in non-crowded areas
- AR does not show this trend (perhaps due to distance bias – unable to resolve width for more distant clouds?)

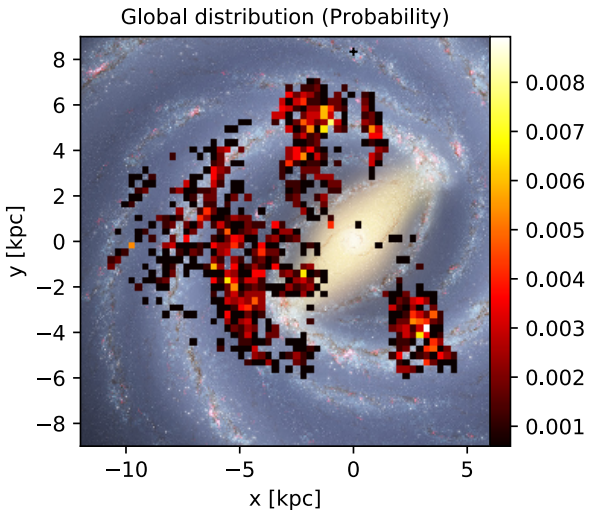


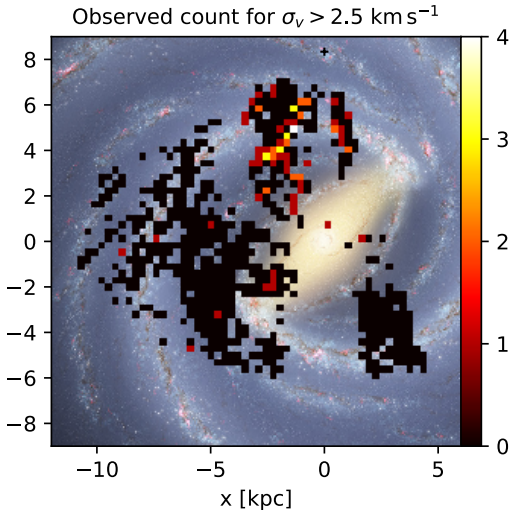


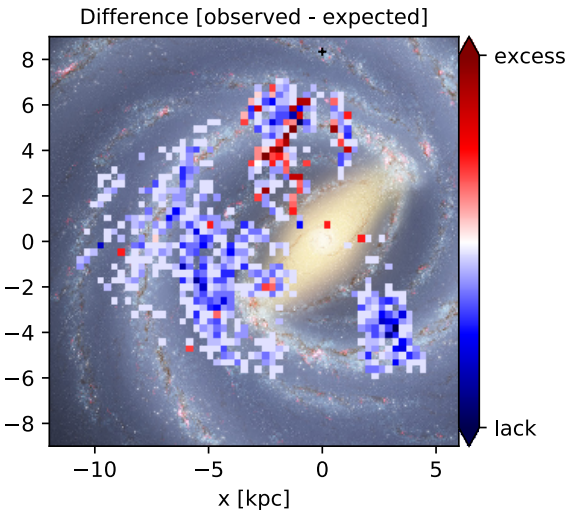


Most dynamically active clouds (high σ_v)

- Nearby, in crowded areas, with HMSF -> arms?
- Far away – no HMSF
- Observational bias?





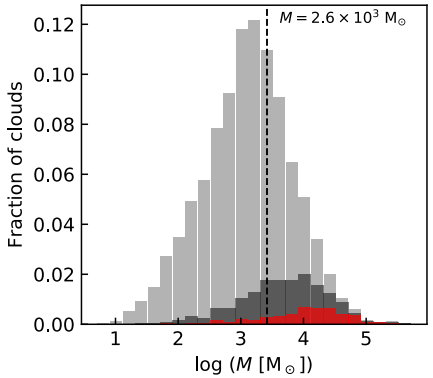


Duarte-Cabral et al. 2021

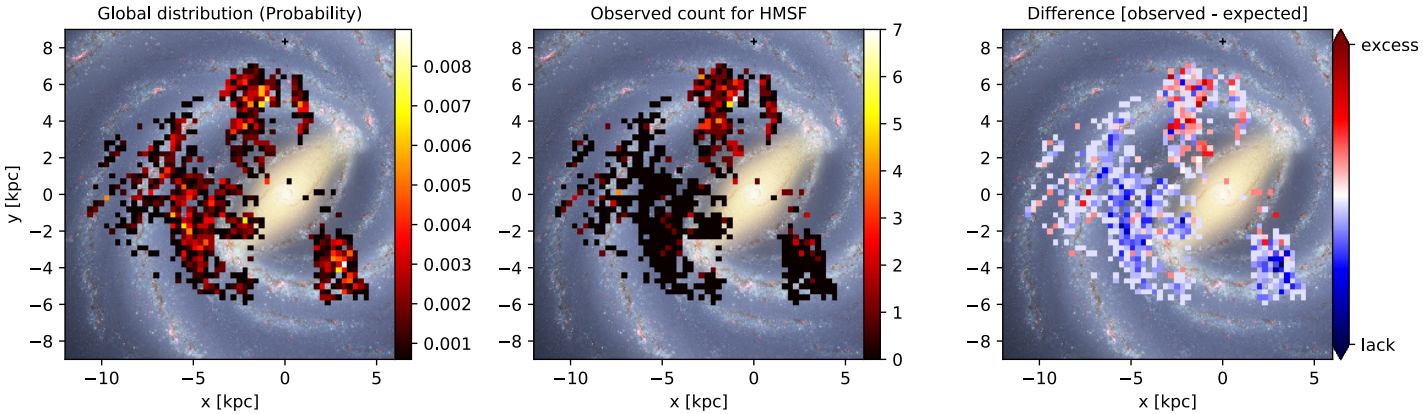
High-mass star-forming clouds

Clouds with HMSF have range of properties (flatter distributions)

- No single cloud property uniquely associated with HMSF?

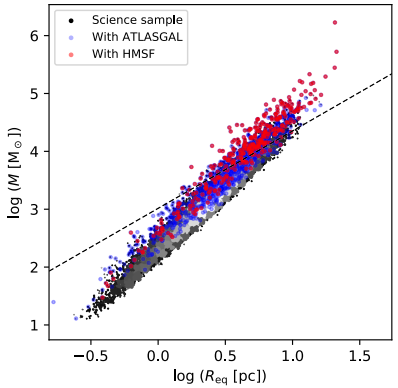


Some differences in the Galactic distribution
(but perhaps mostly due to completeness in HMSF tracers)



Threshold for HMSF does not seem to work for our clouds
(misses ~33% of true positives)

- More diffuse environment traced by 13CO compared to clumps from Kauffmann & Pillai 2010?



Summary

SEDIGISM molecular clouds in the inner Galaxy – Duarte-Cabral et al. 2021

- Extraction of >10000 molecular clouds, ~8000 of which with good distances
- Global cloud properties with ATLASGAL & HMSF peaking at higher values, but flatter.
- Scaling relations – very large scatter and highly dependent on tracer/resolution
- Effect of Galactic environment – some tentative trends, worth following up
- HMSF threshold – doesn't quite work
  (SEDIGISM tracing lower density material, with a shallower density profile?)