Modelling the multi-phase ISM shaped by star formation and feedback in the LMC

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ZENTRUM FÜR ASTRONOMIE

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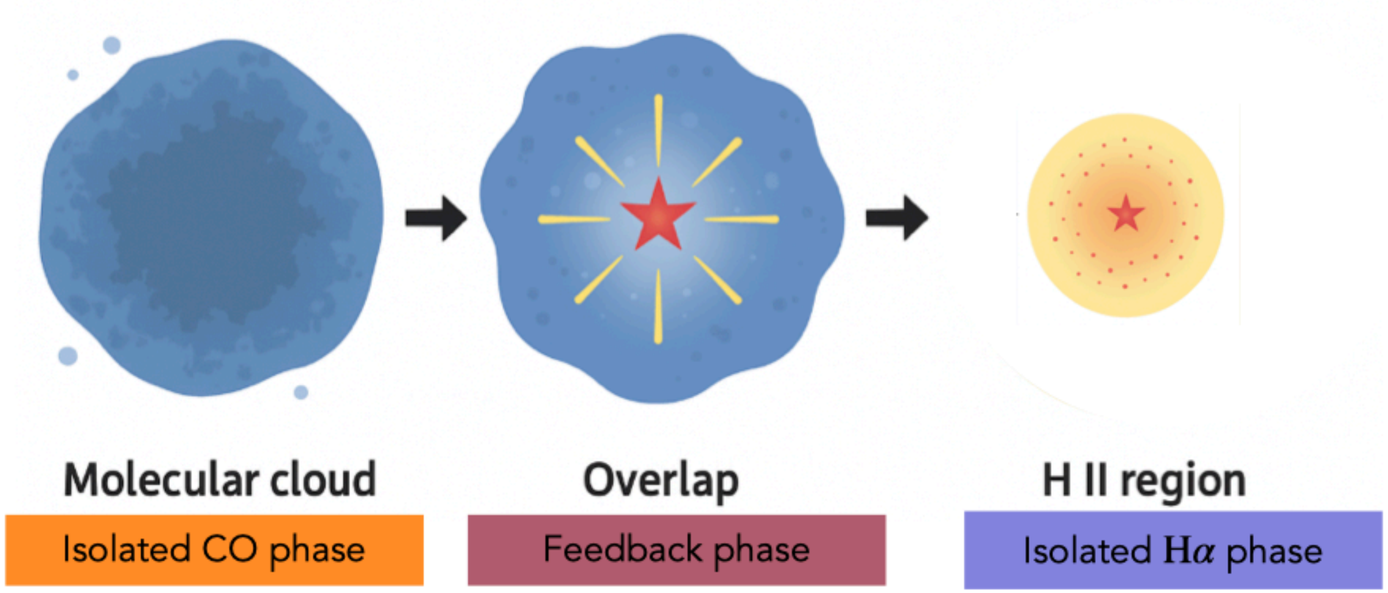
UNIVERSITÄT HEIDELBERG ZUKUNFT SEIT 1386

Introduction

The evolutionary path of giant molecular clouds (GMCs).



Introduction

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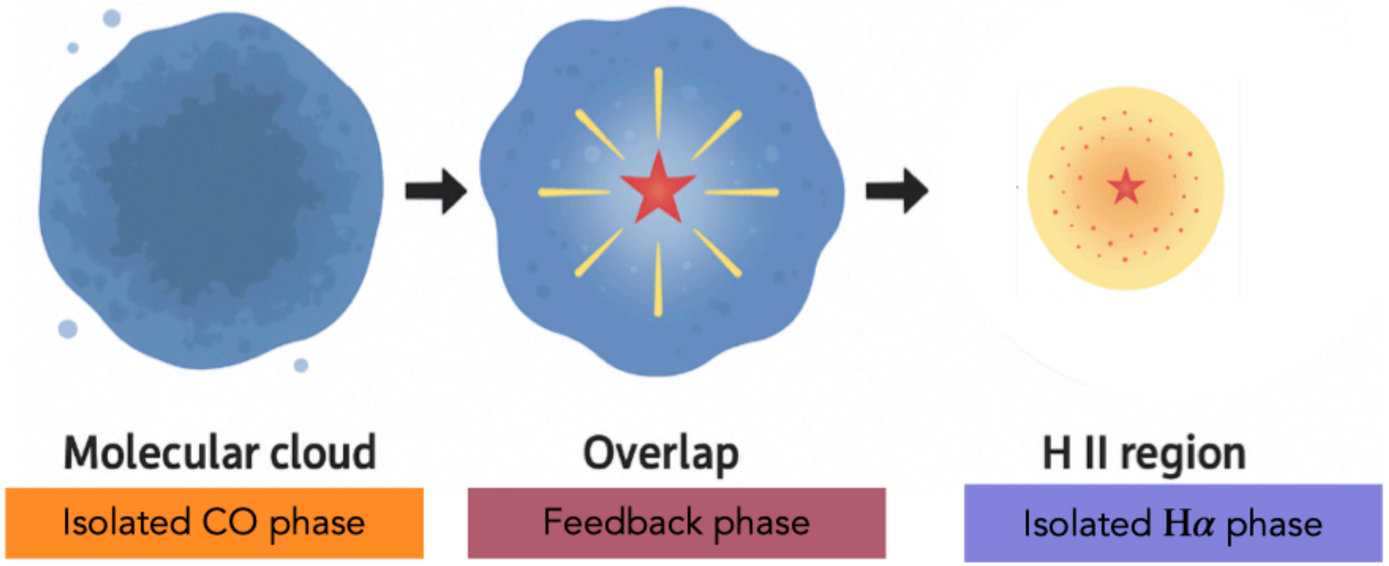
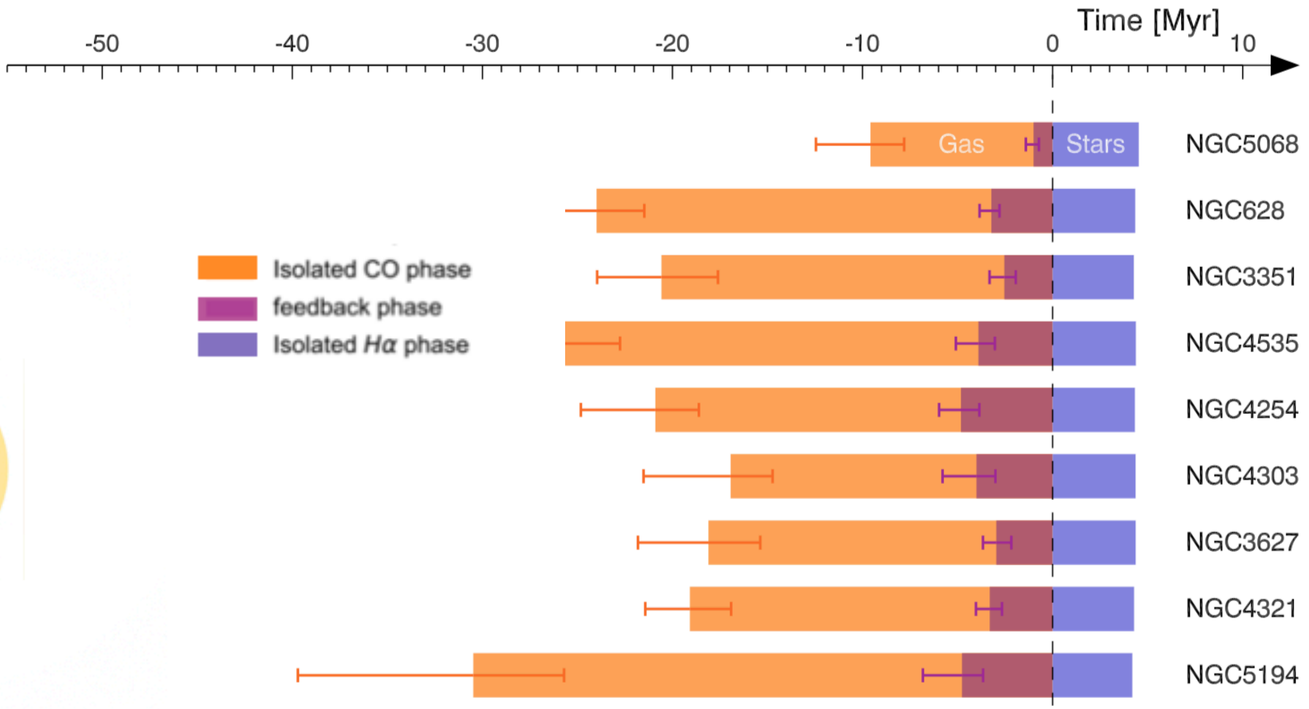
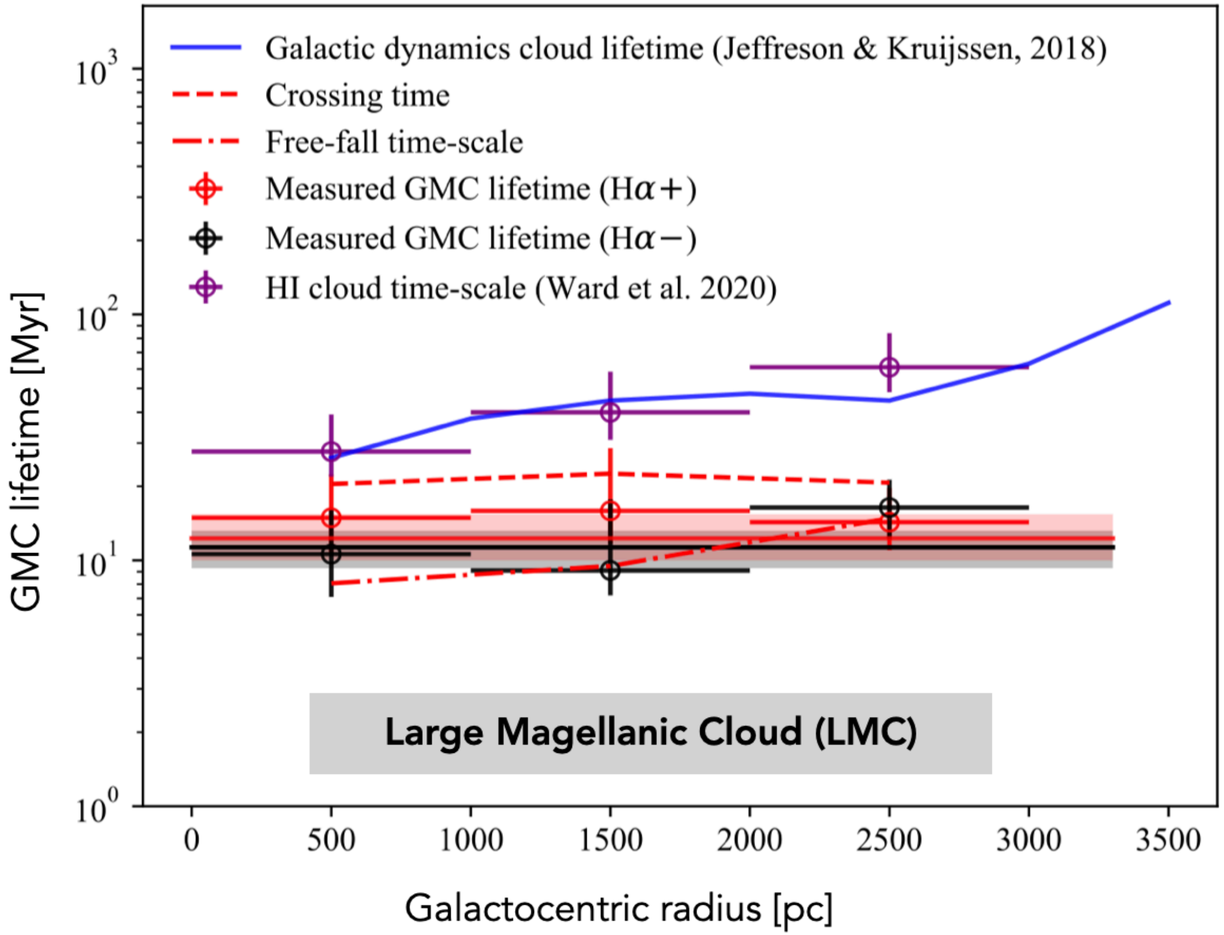




(Chevance et al. 2020)

GMC lifetime varies between galaxies!

Introduction



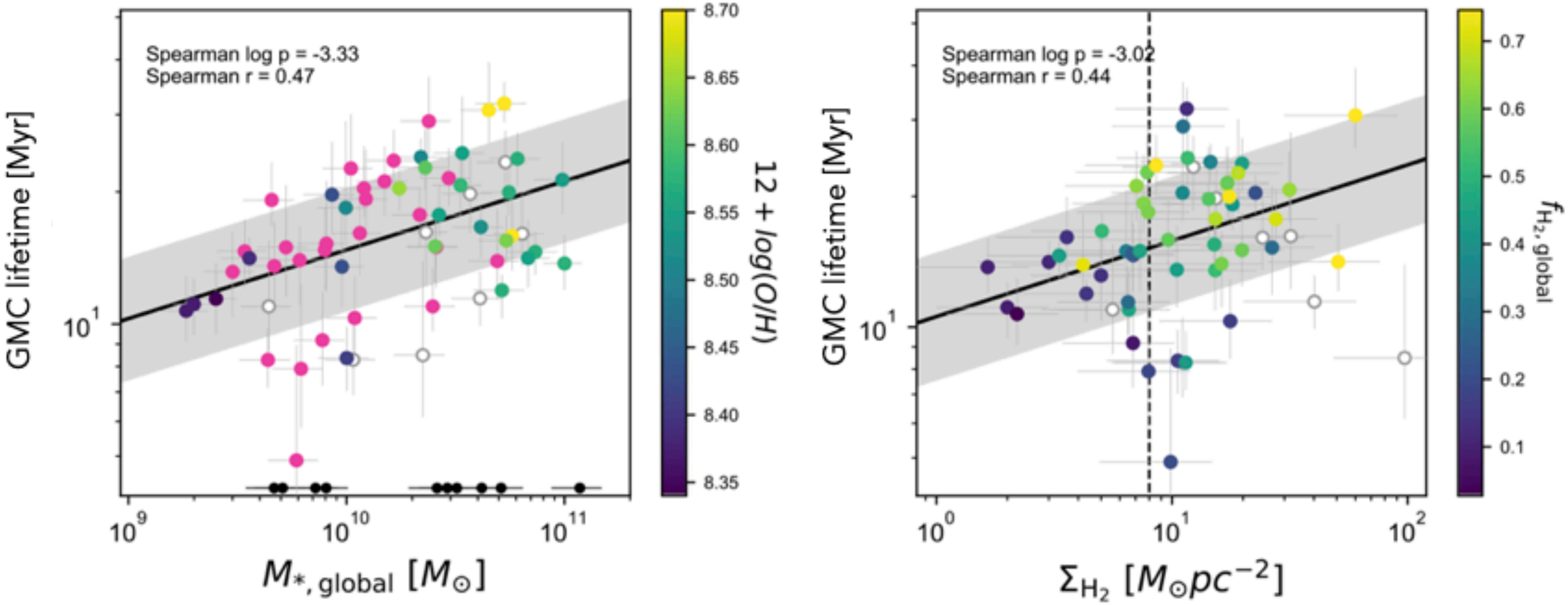
(Ward et al. 2022)

GMC lifetime also varies *within* galaxies!

Introduction

What regulates the GMC lifetime?

Global environmental properties and the small-scale GMC evolution.



(Kim et al. 2022)

Introduction

What regulates GMC lifetime?

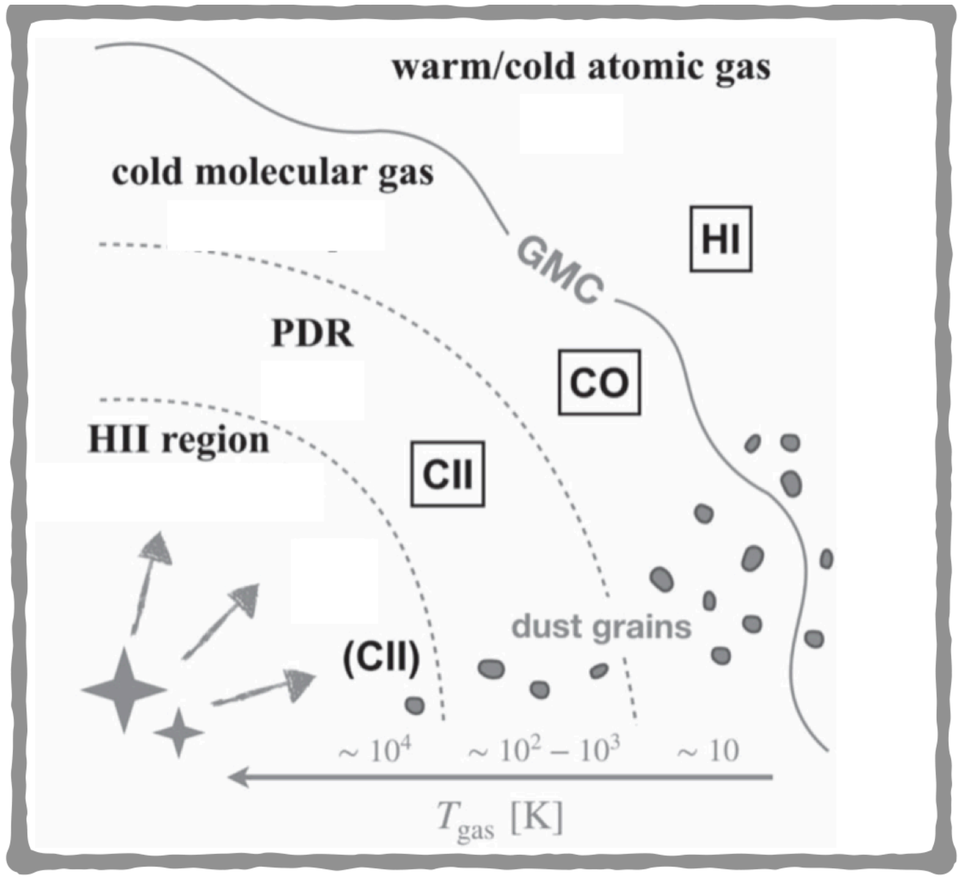
What is the role of the local environmental properties on the GMC evolution?

Introduction

What regulates GMC lifetime?

Multi-phase,

multi-components interstellar medium (ISM)!



1 star formation region = 1 ISM component = 1 set of ISM properties

(Sun et al. 2019)

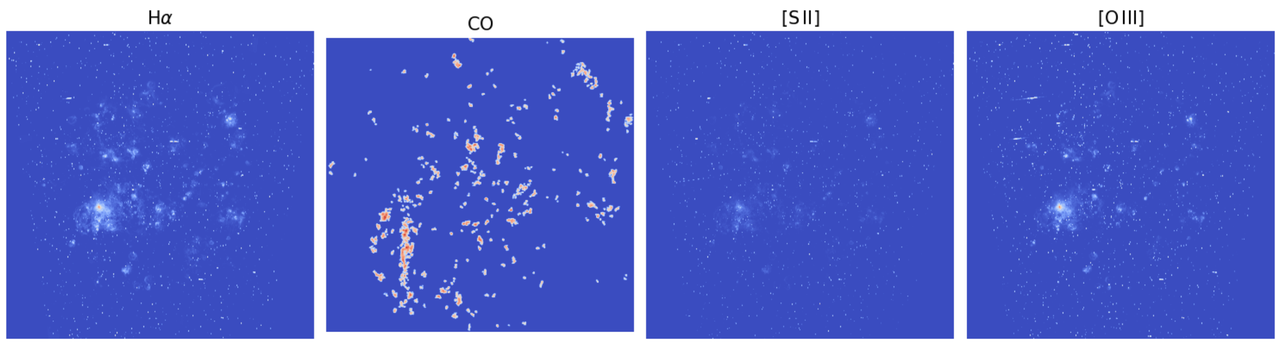
Observations

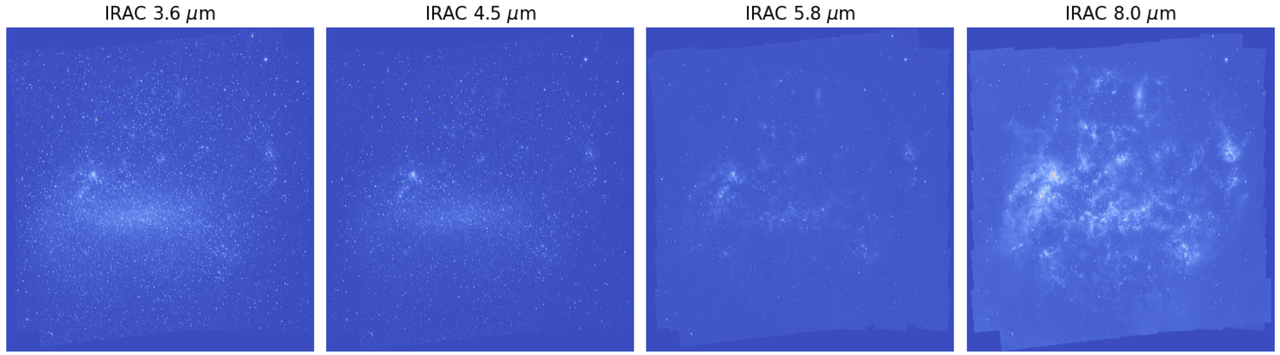
LMC

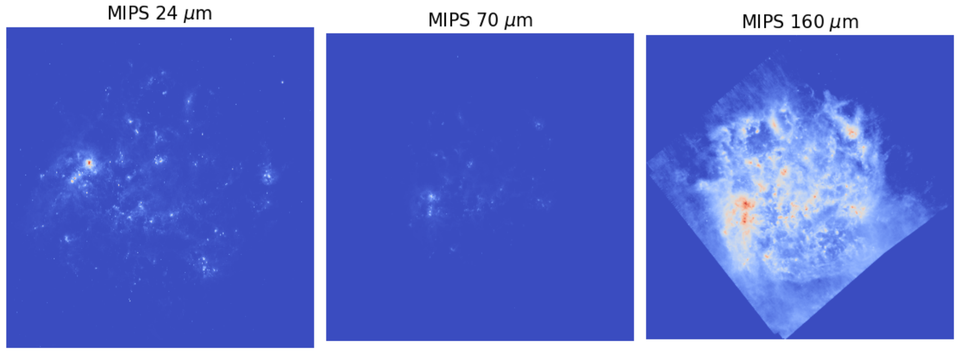
- **Molecular gas : CO(1-0)**
  (From MAGMA, Wong et al. 2011)

- **HII region: $\mathrm{H}\alpha$, [SII], [OIII]**
  (From MCELS, Smith & MCELS Team 1998)

- **Dust: 3.6μm; 4.5μm; 5.8μm; 8μm; 24μm; 70μm; 160μm**
  (From SAGE, Meixner et al. 2006)



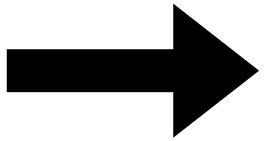




SCAN ME

Method

MULTIGRIS (Lebouteiller & Ramambason 2022),
a multi-component probabilistic grid search

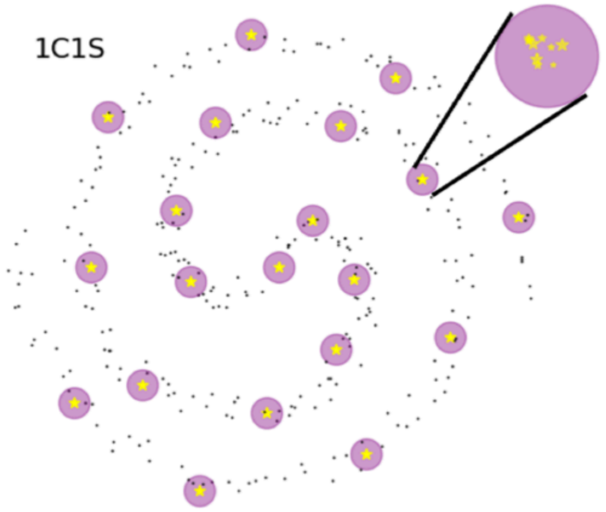


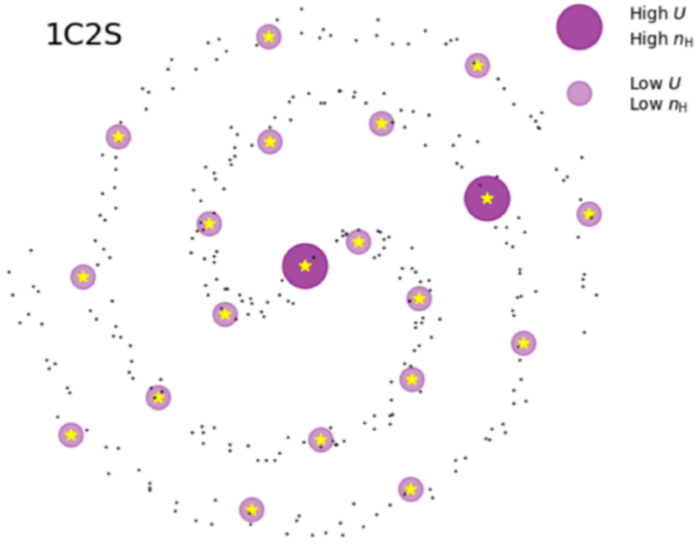
SCAN ME

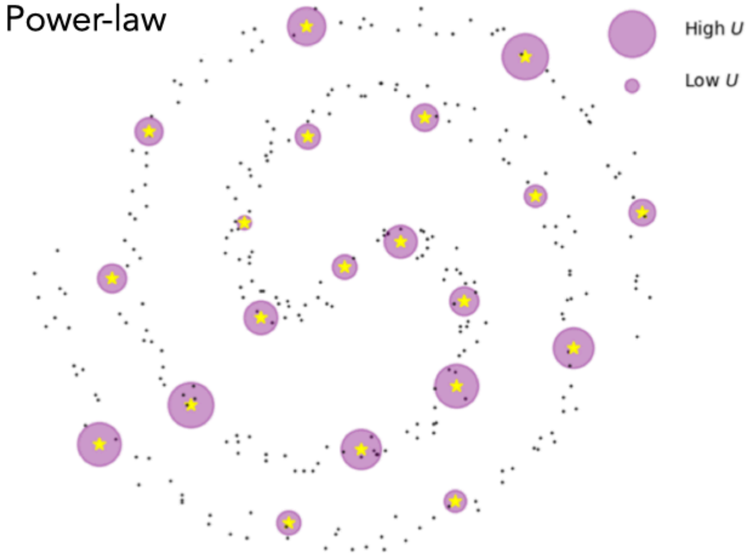
Method

1 star formation region = 1 component = 1 set of ISM properties

MULTIGRIS (Lebouteiller & Ramambason 2022), a multi-component probabilistic grid search







Lebouteiller et al. (2025)

1 ISM Component

$\{n_1, U_1, cut_1, \ldots\}$

2 ISM Components

$\{n_1, U_1, cut_1, \ldots$
$n_2, U_2, cut_2, \ldots\}$

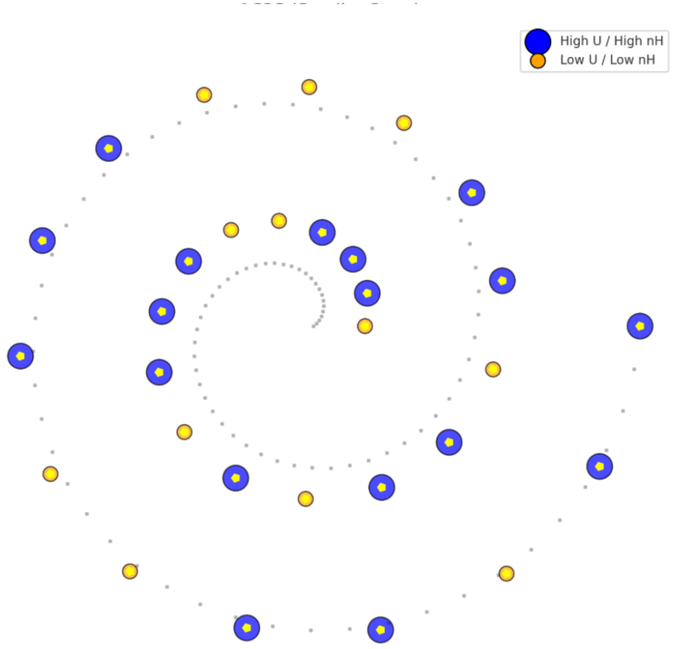
ISM components follow power-law distributions for n, U, and cut.

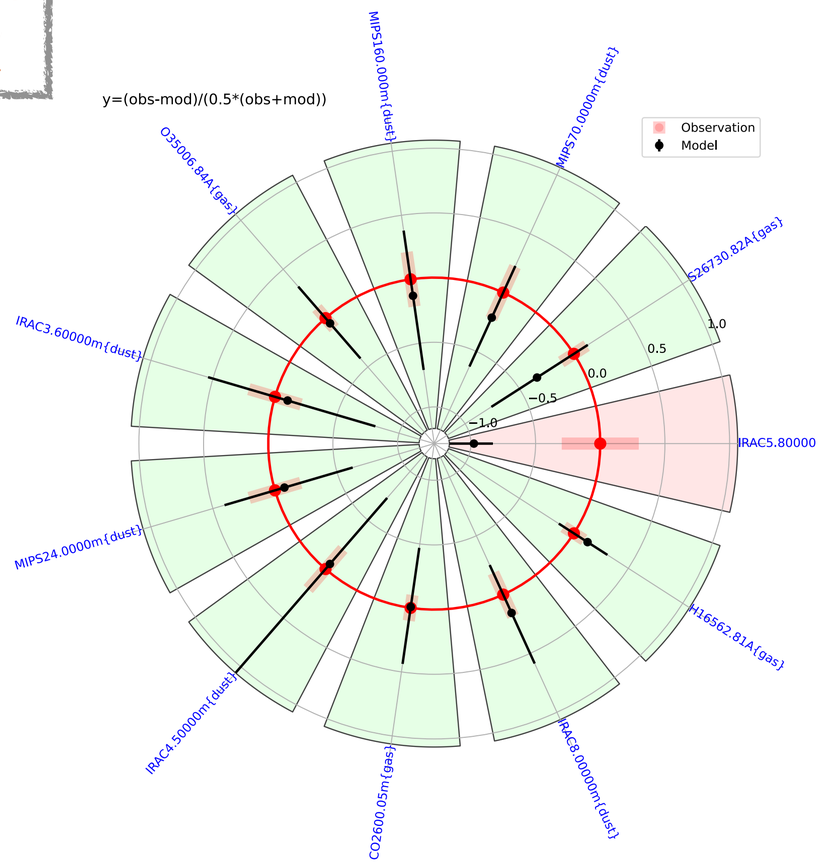
Method

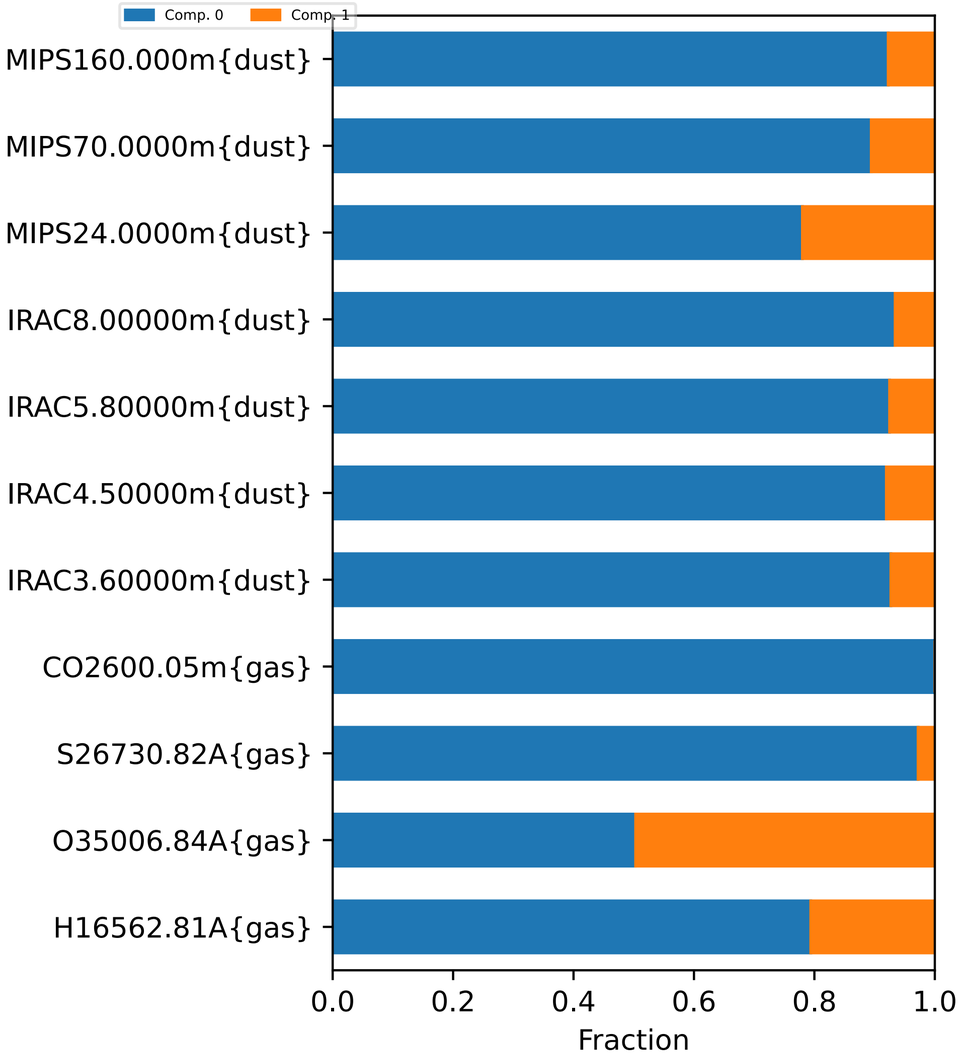
Illustration of 2 ISM Components

cut : $3.1^{+0.4}_{-0.7}$
log (n): $3.0^{+0.4}_{-0.1} cm^{-3}$
log (U): $-3.1^{+1.8}_{-0.6}$

cut : $1.5^{+1.3}_{-0.5}$
log (n): $2.5^{+0.9}_{-1.6} cm^{-3}$
log (U): $-2.4^{+1.7}_{-0.4}$



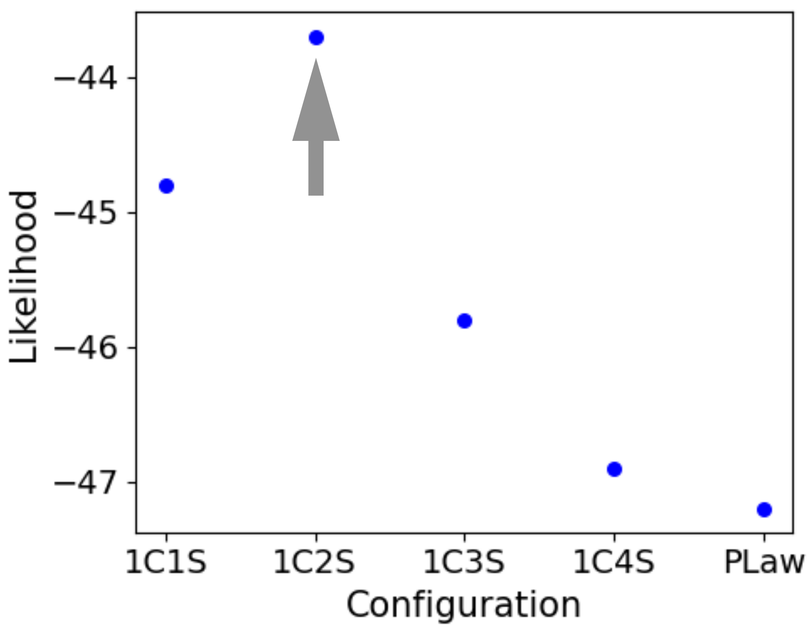




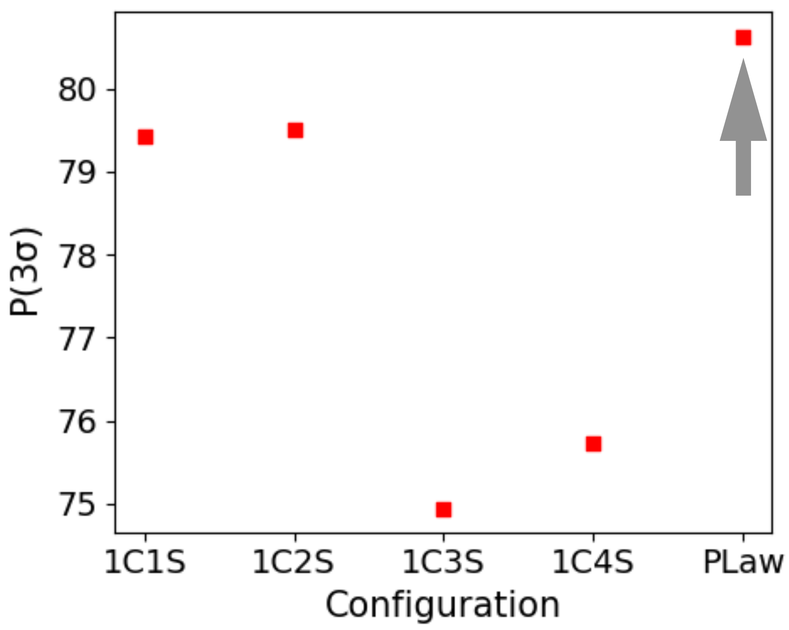
Configuration selection

A. Metrics comparison

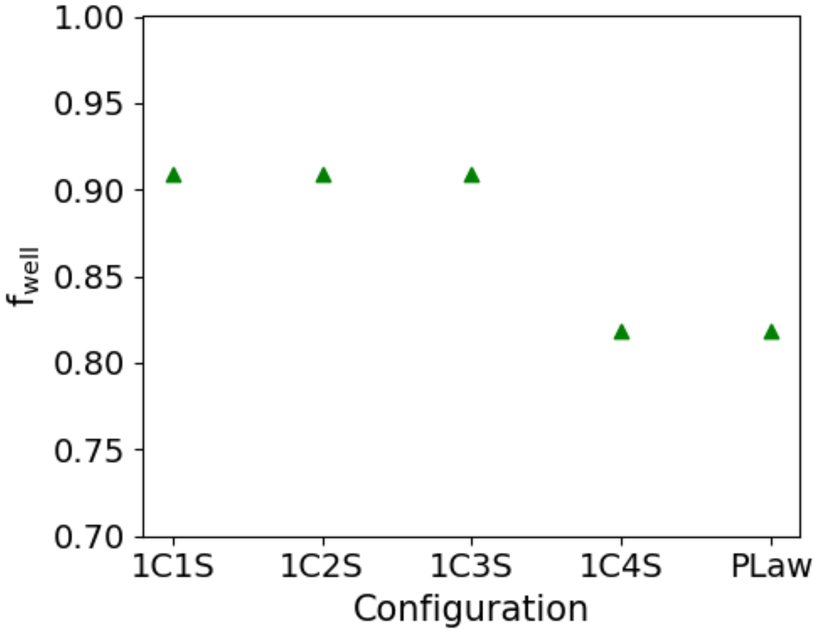
Likelihood



How close are the predictions to the observations



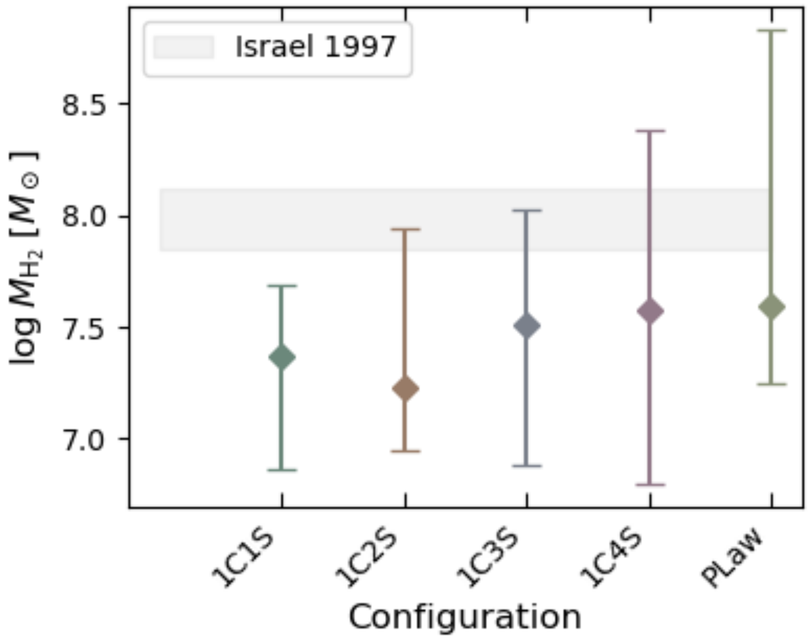
The fraction of well fitted lines

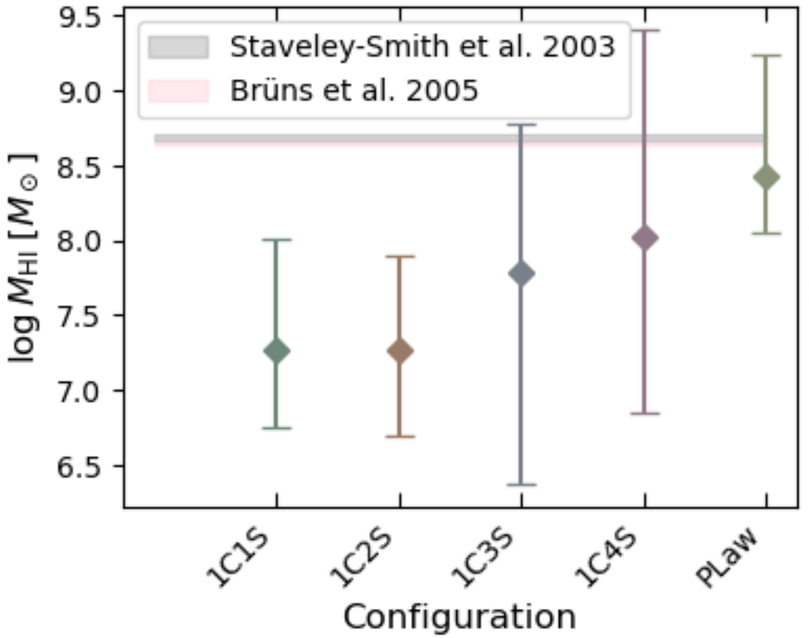


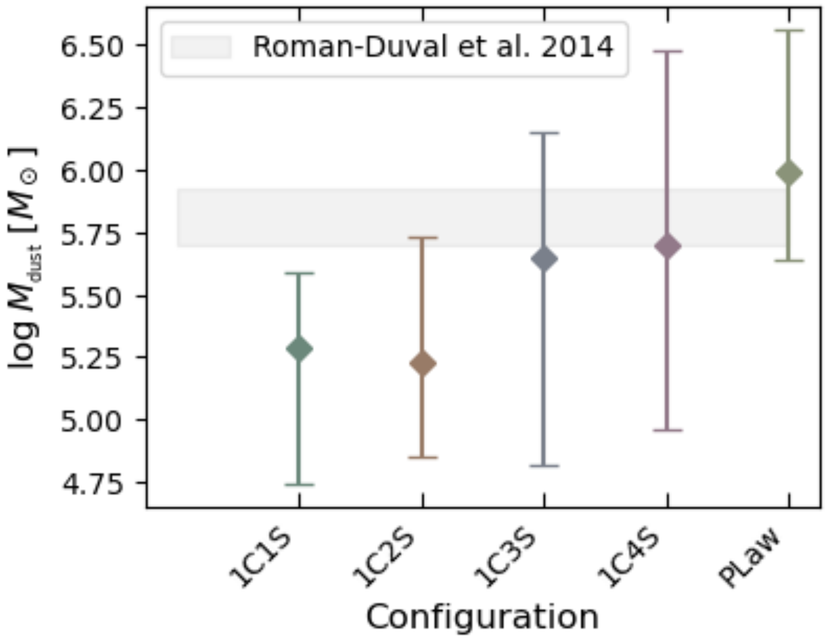
All the potential configurations perform well!

Configuration selection

B. Comparison with literature data





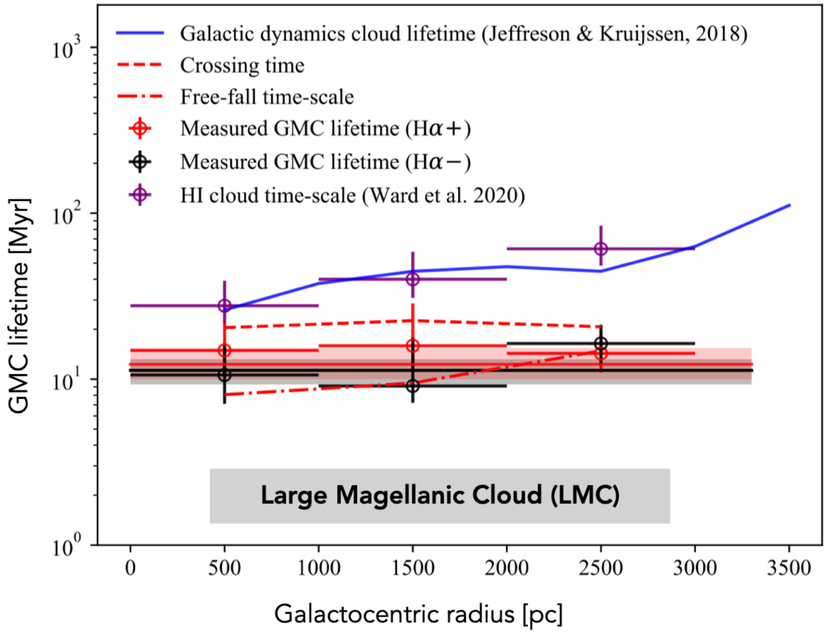


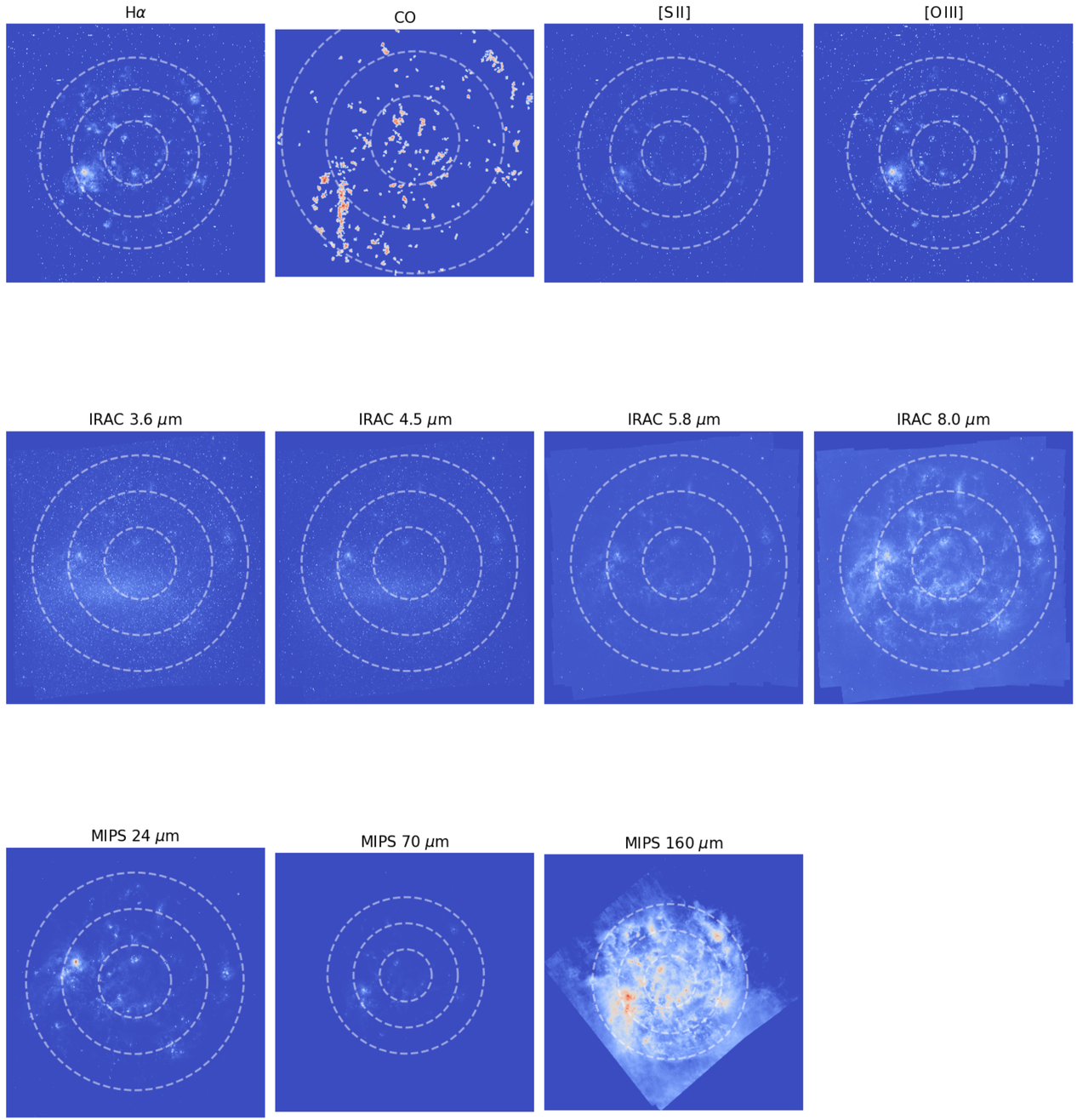
Power-law model is chosen!

Observations

LMC

Three radial bins of LMC used in this work, as well as in Ward et al. 2020 & 2022

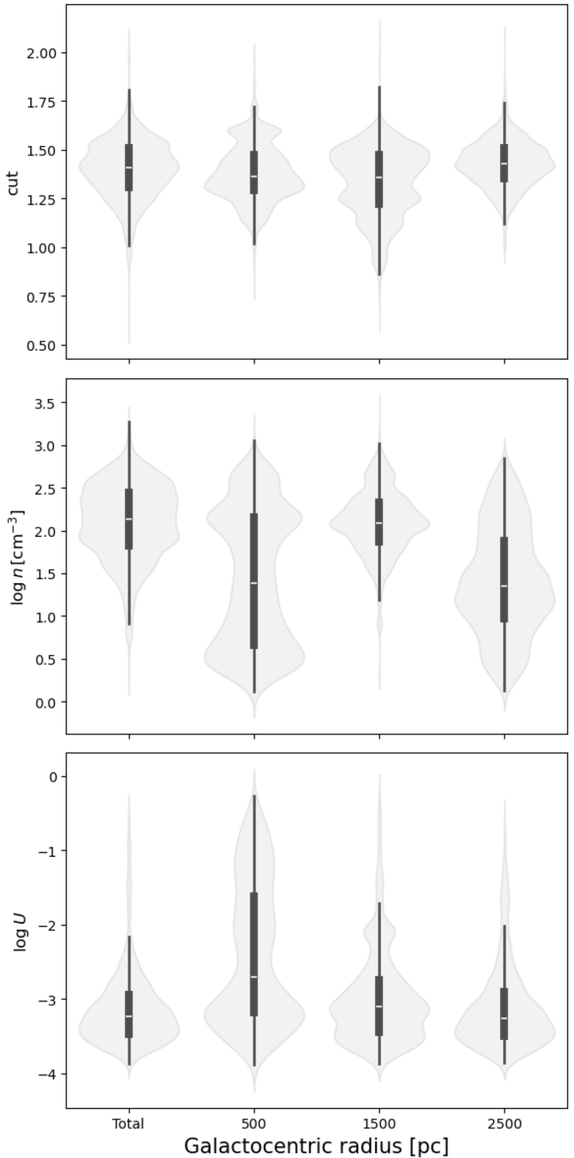




Radial distributions of ISM properties

Work in progress…

Best model parameters



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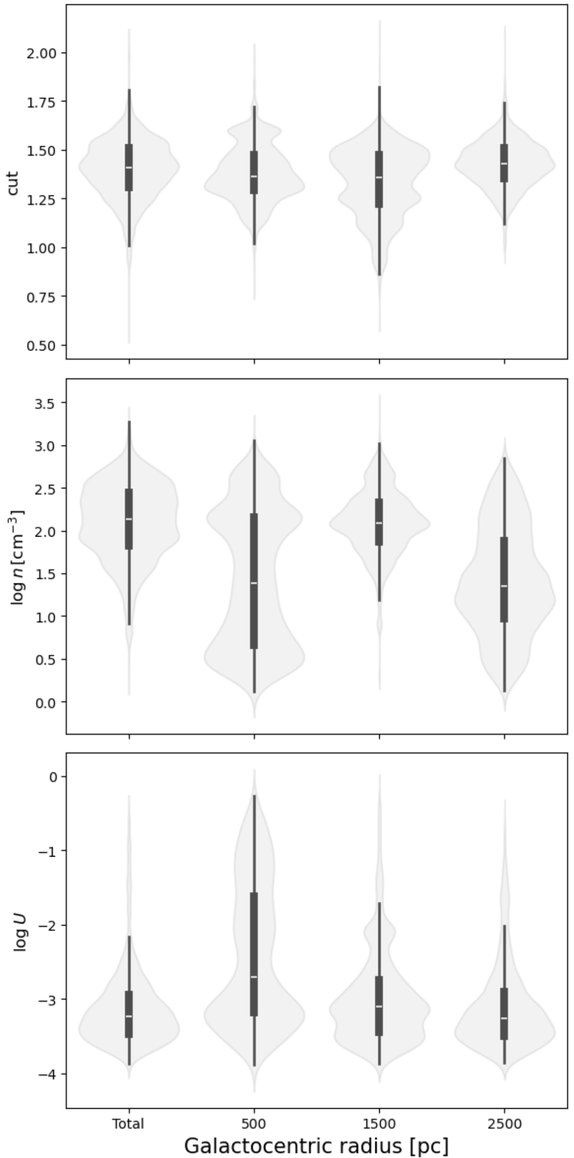
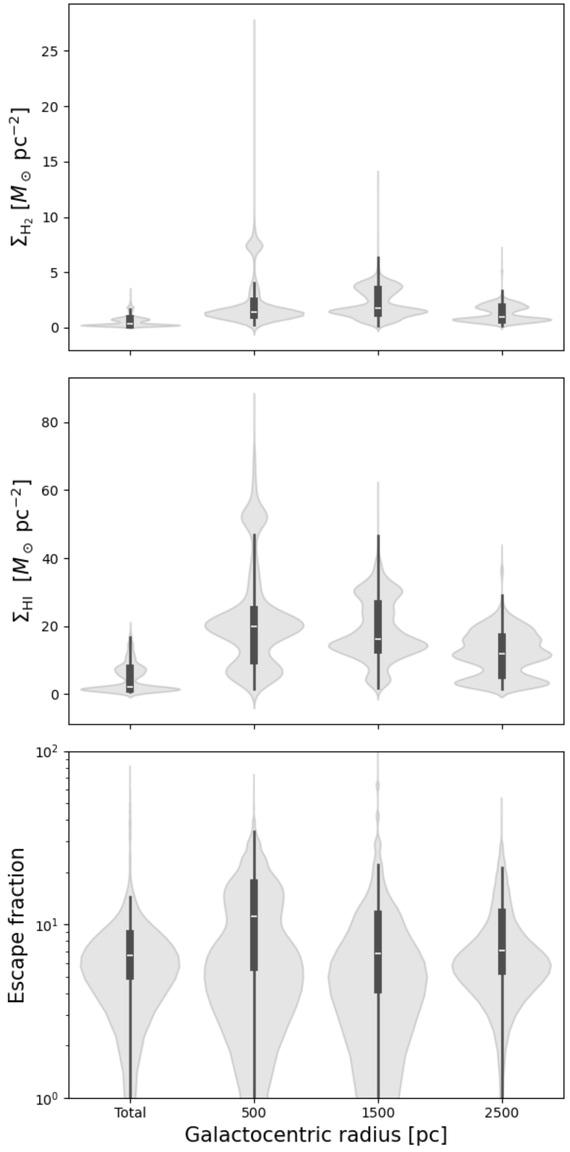


Derived physical quantities



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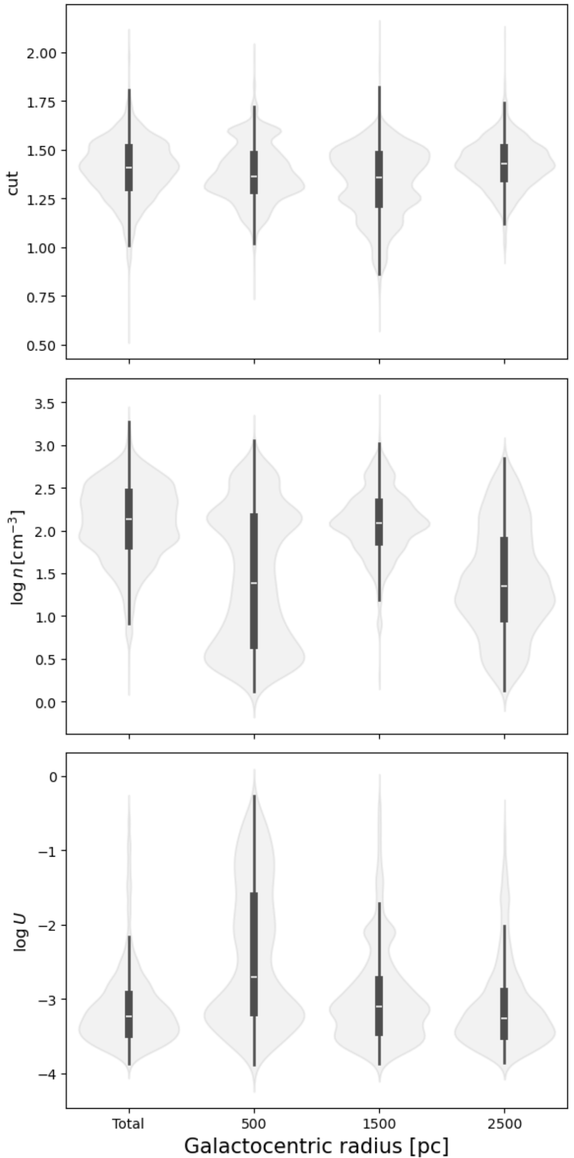

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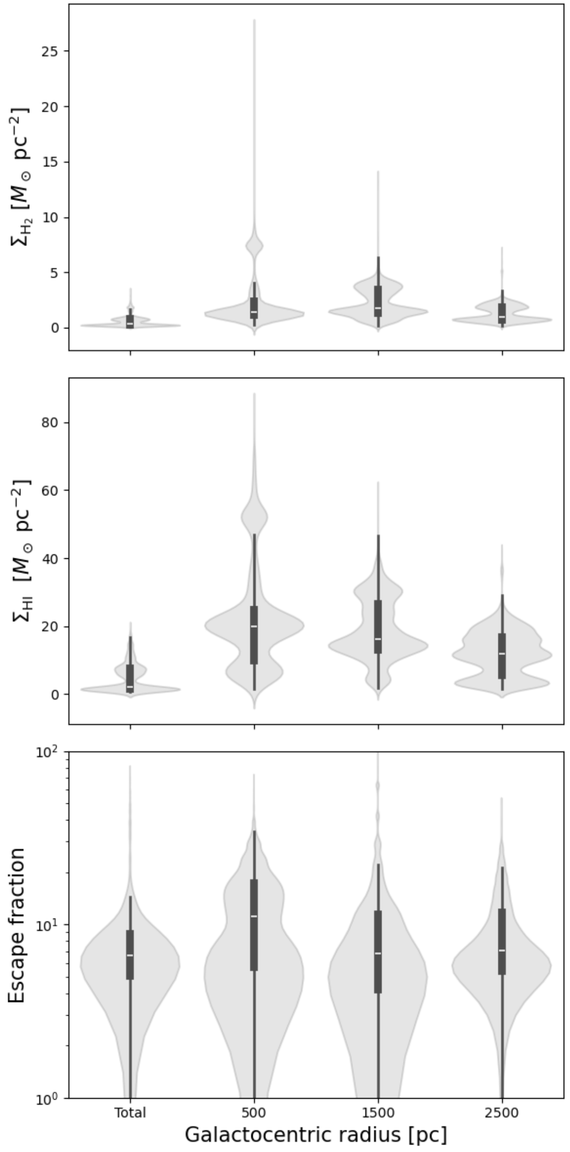

Preliminary results: **no strong radial dependence**

Radial distributions of ISM properties

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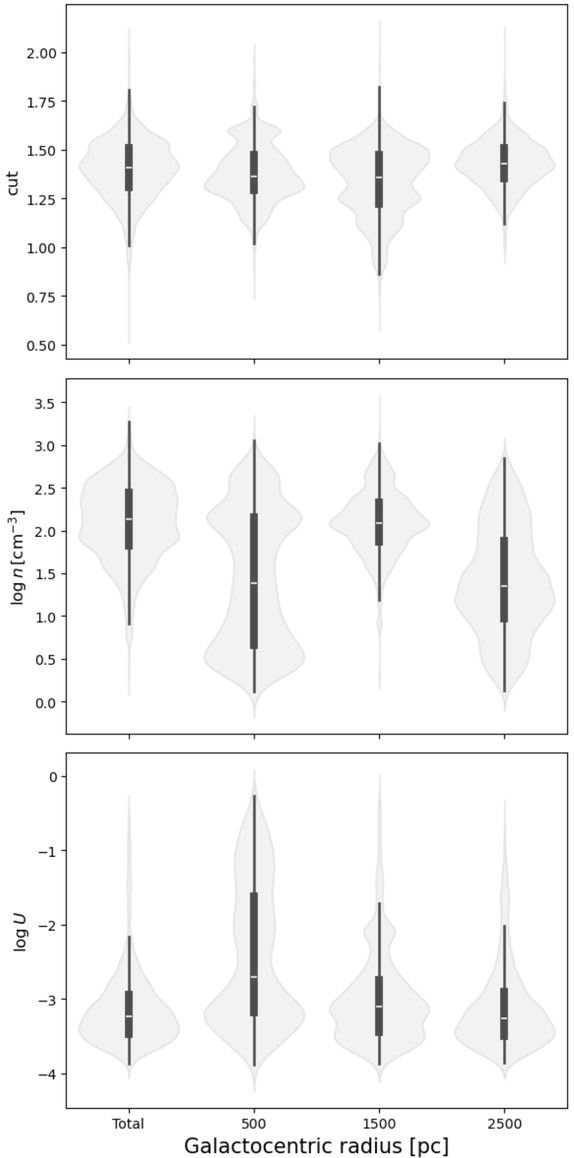

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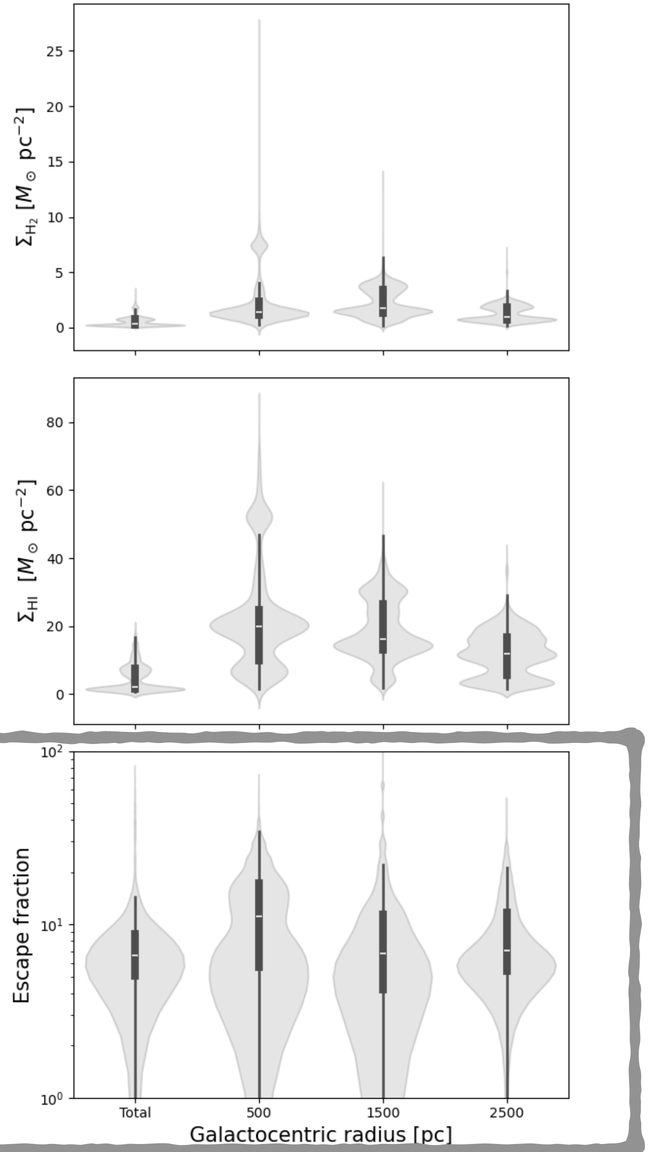
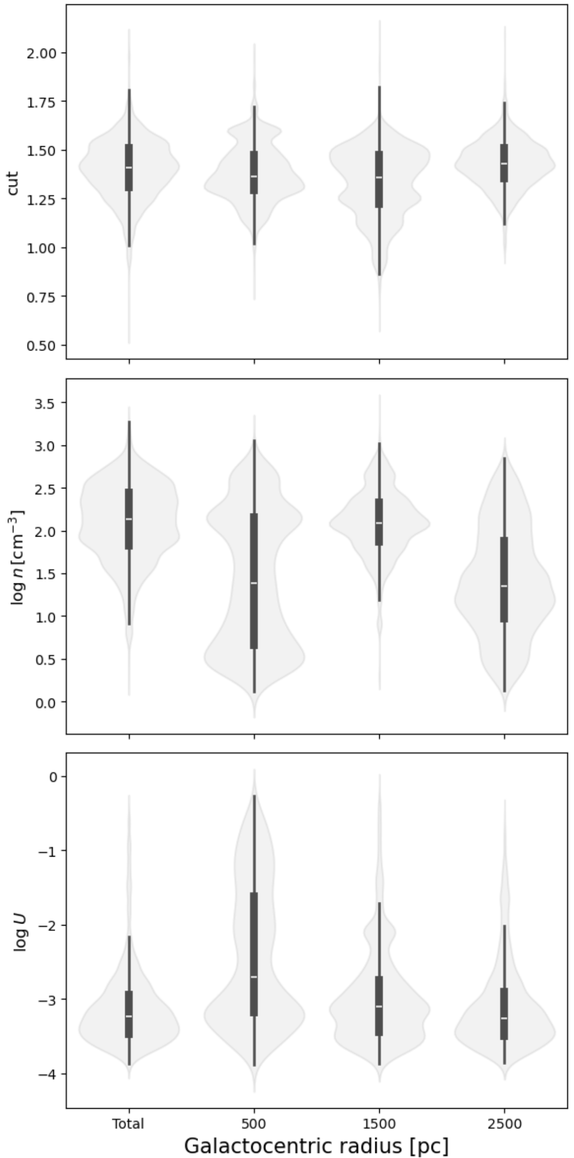


Radial distributions of ISM properties

Work in progress…

Best model parameters



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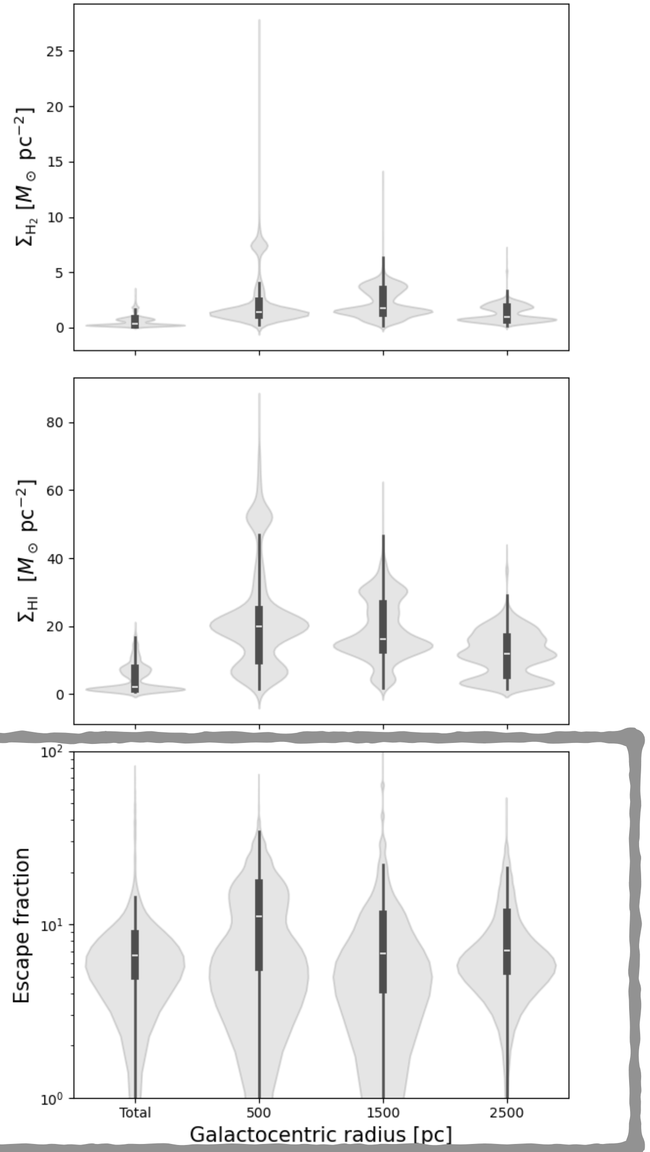
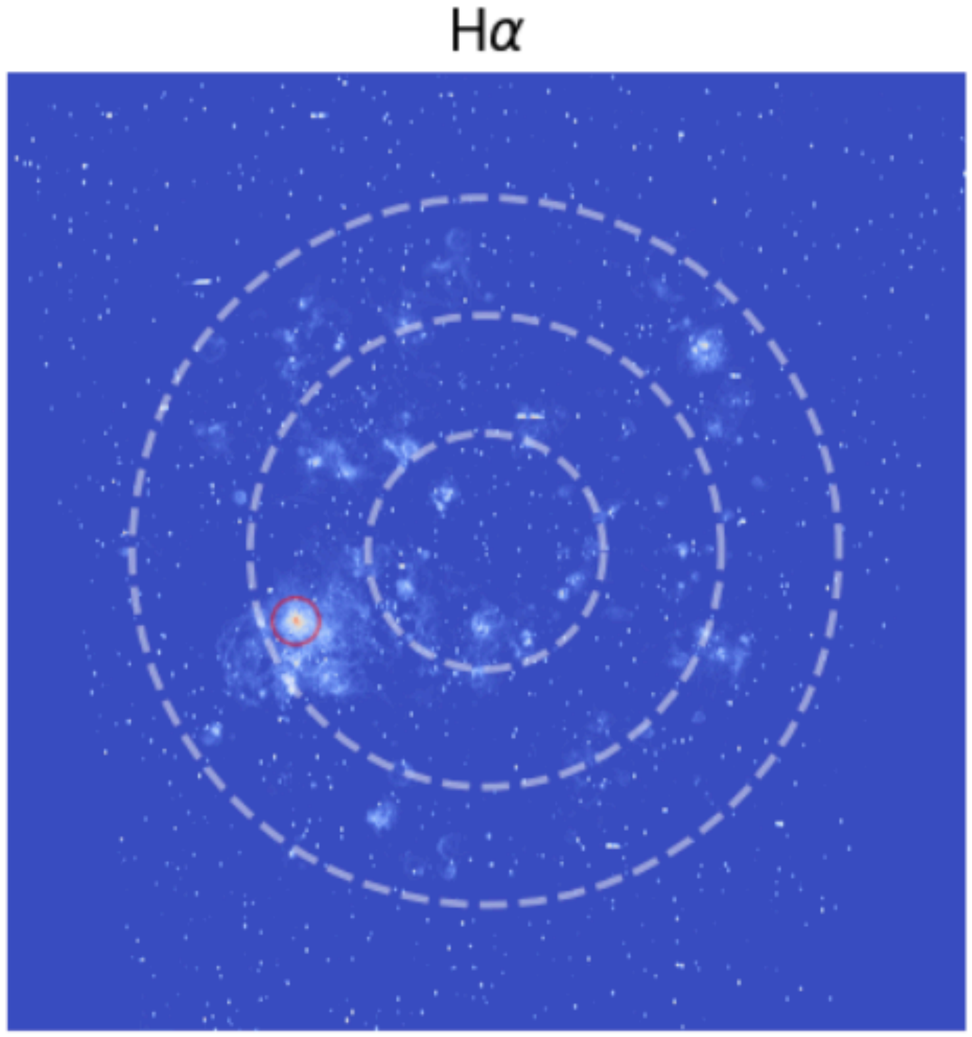


→ **More density-bounded regions in the centre?**

Radial distributions of ISM properties

Work in progress…

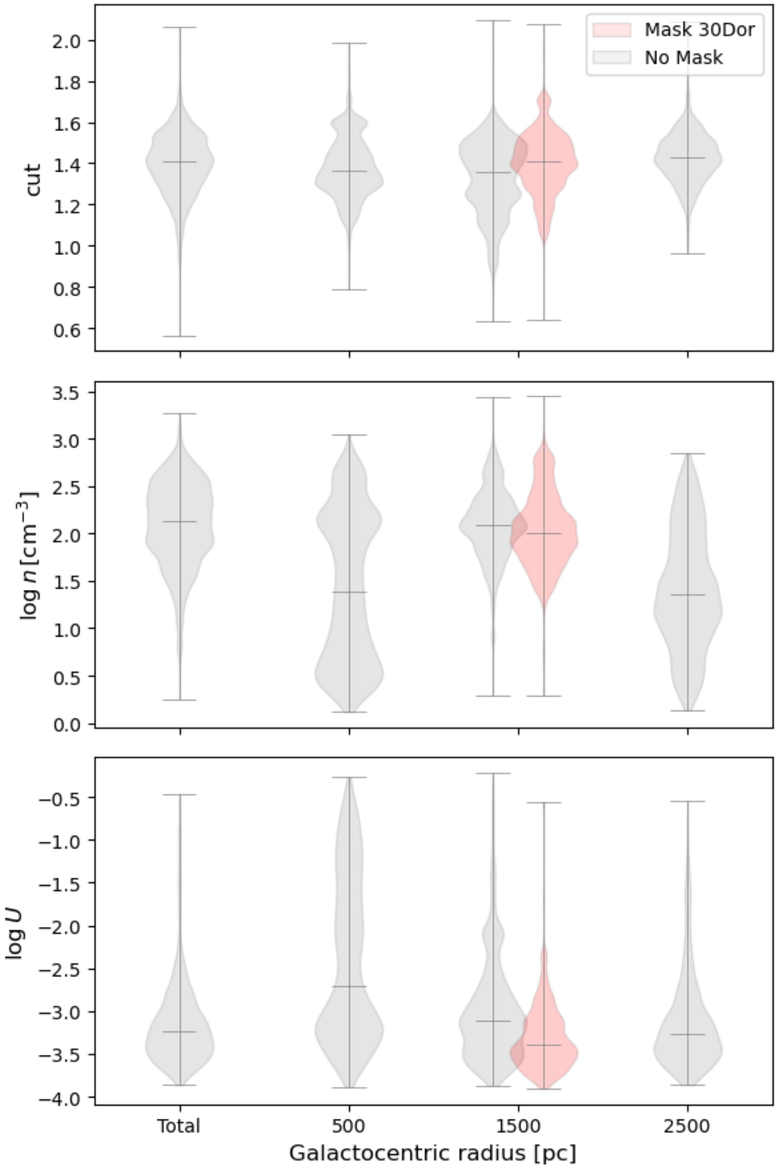
Contributions of 30 Doradus?



Radial distributions of ISM properties

Work in progress…

Best model parameters



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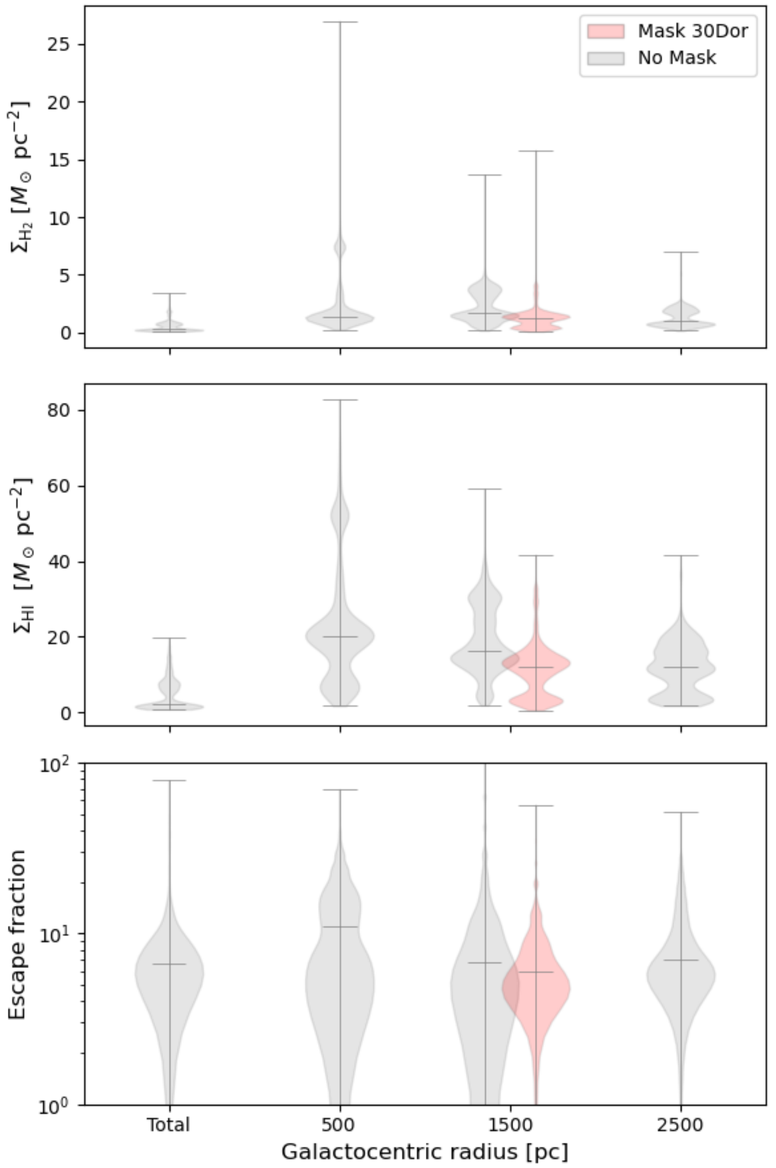

Radial distributions of ISM properties

Work in progress…

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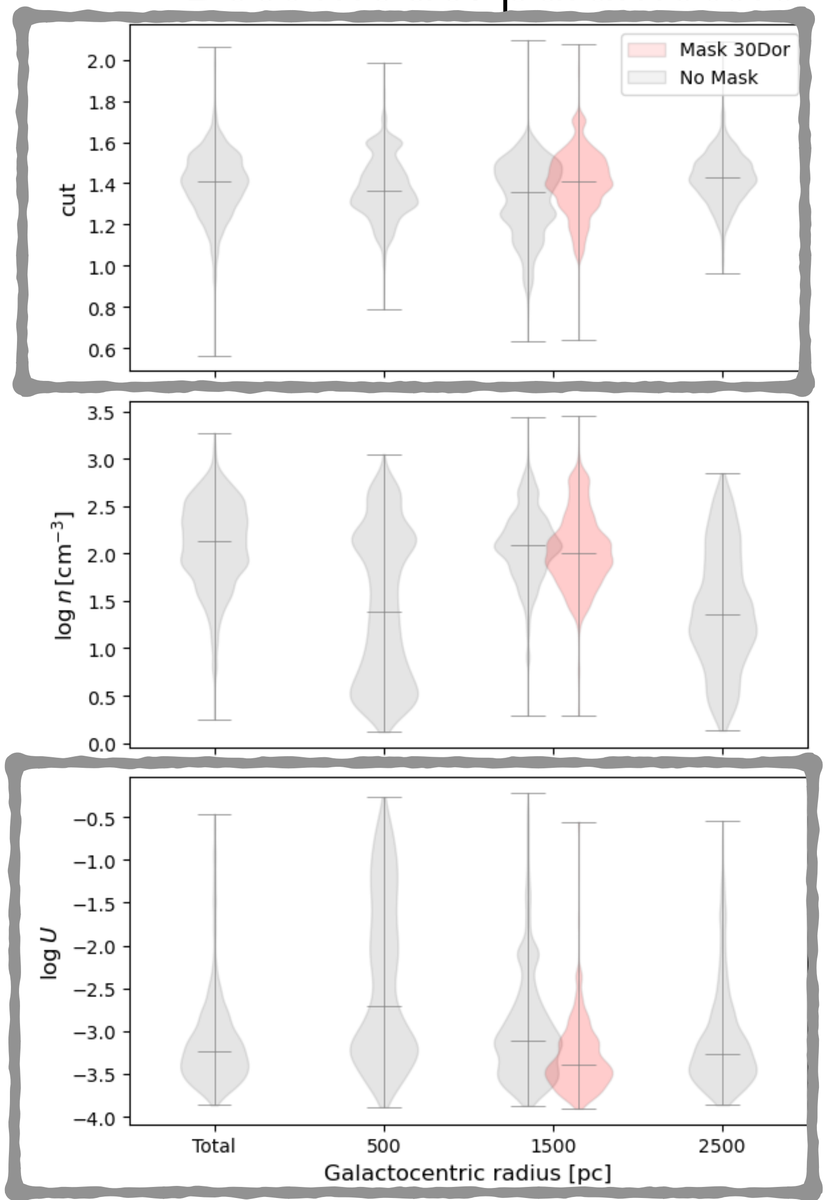

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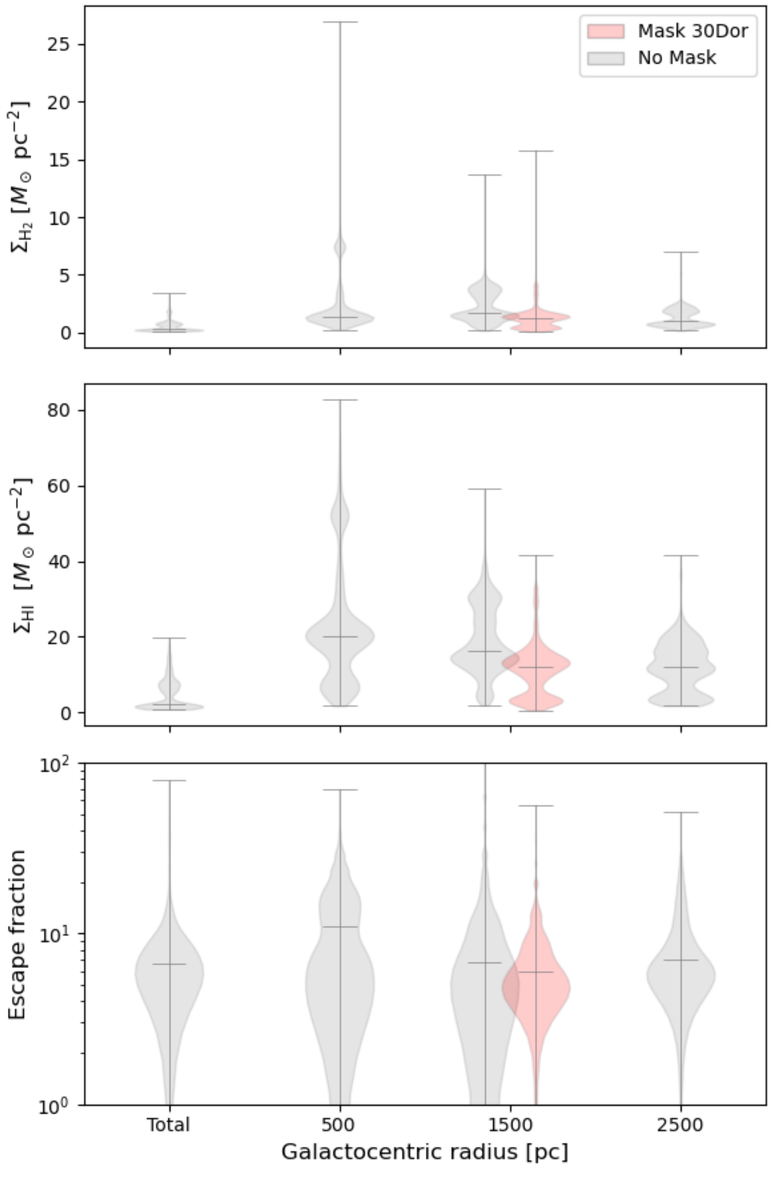


Preliminary results: **30 Dor is contributing to lower cloud depth and higher U**

Conclusions and future work

- For the model parameters and ISM properties, we *do not find a significant dependence on galactocentric radius.*
- By analyzing the radial profiles of the constrained ISM properties, we found that *there are more density-bounded regions in the inner part of the LMC*, as the escape fraction increases toward the center.
- We compare the radial profiles before and after *masking 30 Doradus* and found *30 Doradus is contributing to the lower cloud depth and higher ionization parameter.*

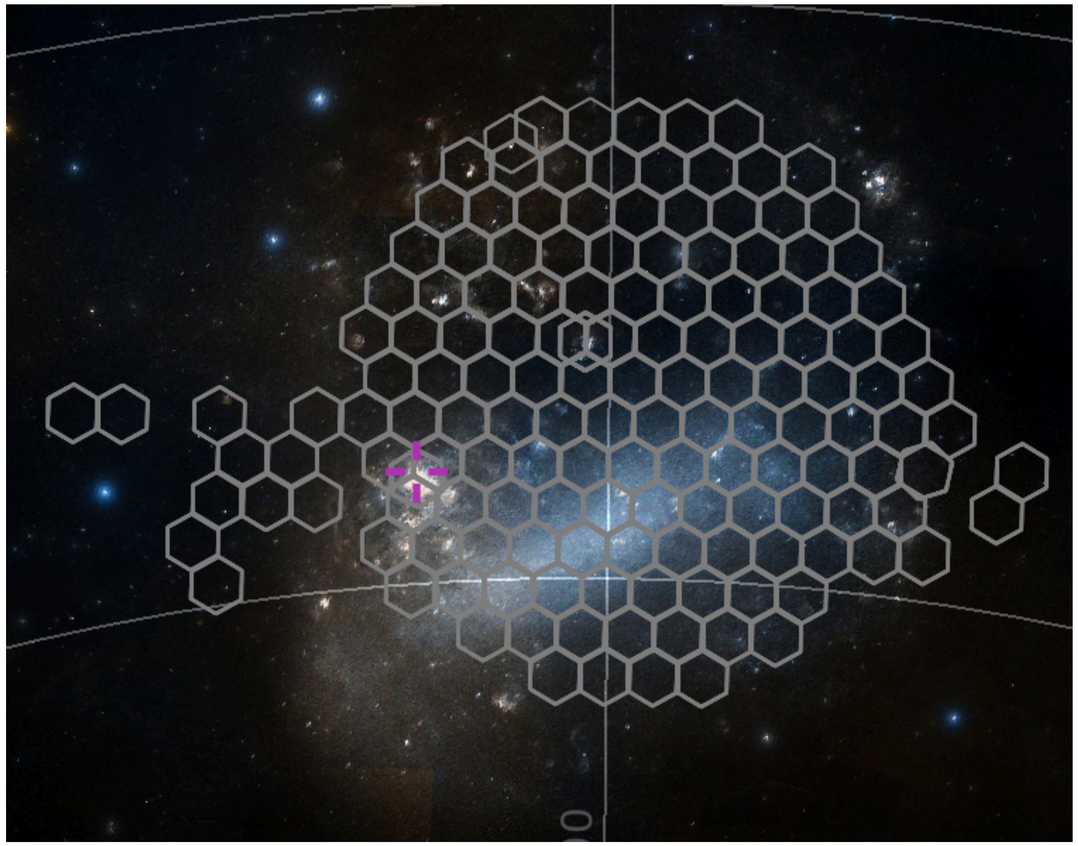
Next steps:

- Include more multi-wavelength observations from APEX (CO(3-2)), and LVM

Future work with LVM

- Replace and add more lines in to the current work, such as $\mathrm{H}\alpha$, **[OII], [OI], [NII]...**

- Explore individual star forming regions, to investigate how the properties of individual ISM regions are linked to the GMC lifetime.



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Next steps:

- Include more multi-wavelength observations from APEX (CO(3-2)), and LVM.
- Compare the radial distribution of the constrained parameters and their dispersion with the GMC evolution timeline (from Ward et al. 2022).