

Labex **UnivEarthS**

Cosmic rays in local clouds

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The Local Medium

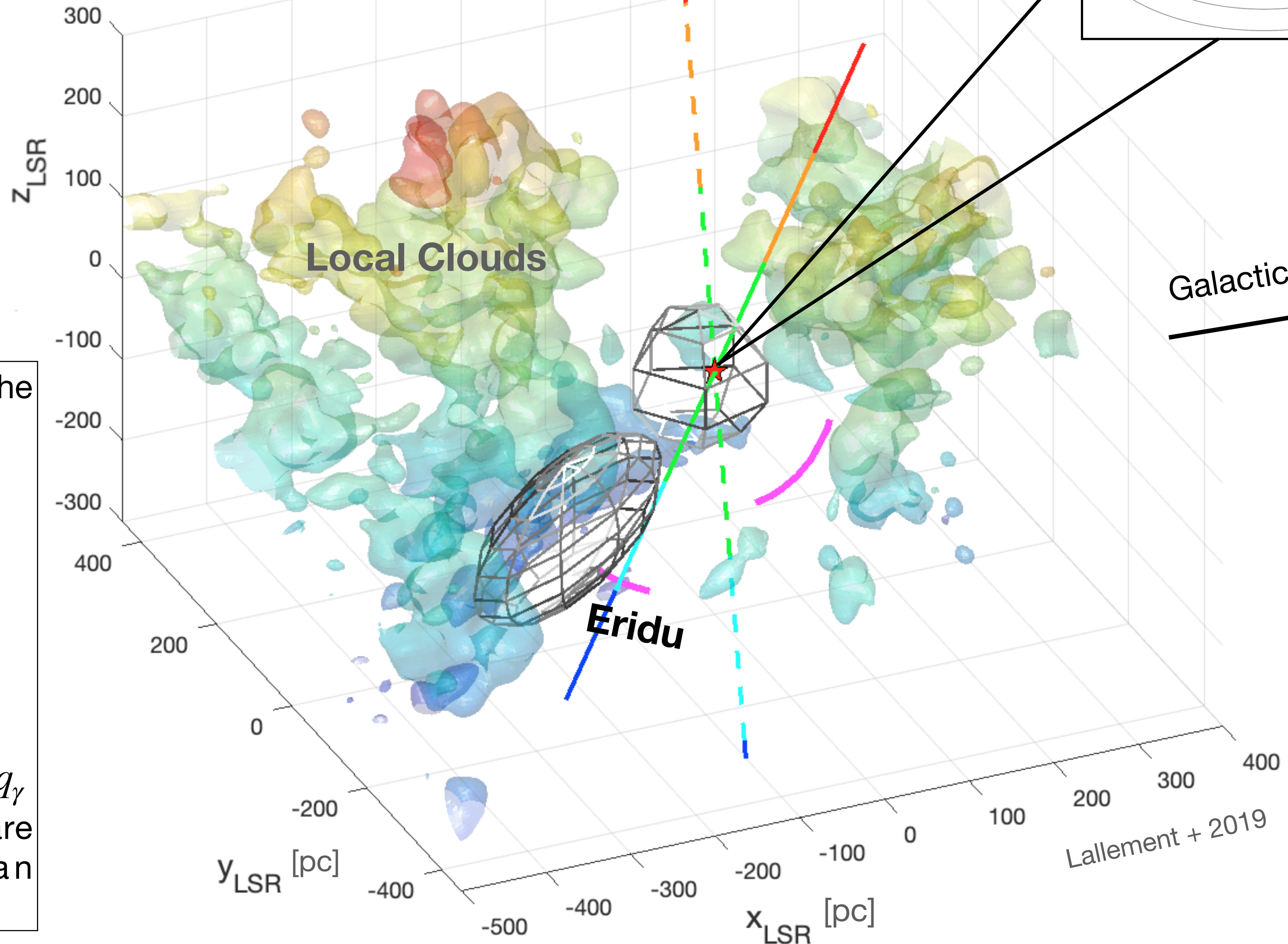
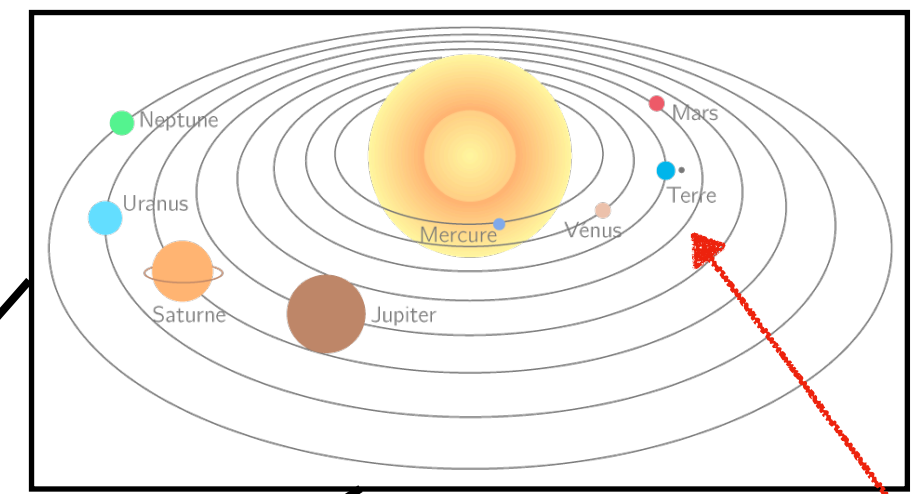
Galactic Plane

Local Clouds

2 possible directions
Of the magnetic field

We are Here

Galactic Center



Lallement + 2019

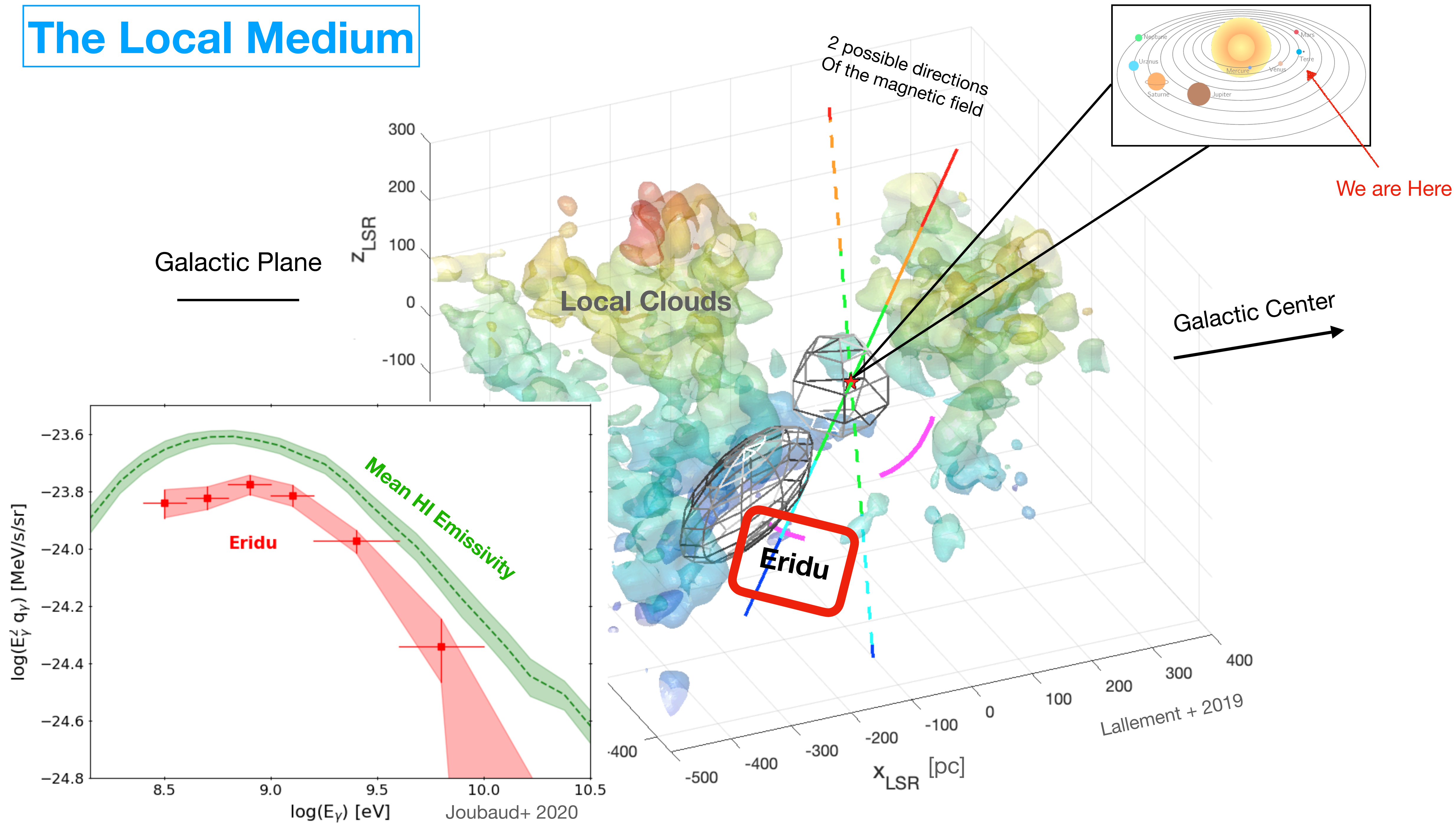
- 3D gas distribution around the Solar System
- Red : Above Galactic plane
- Bleu : Below Galactic plane

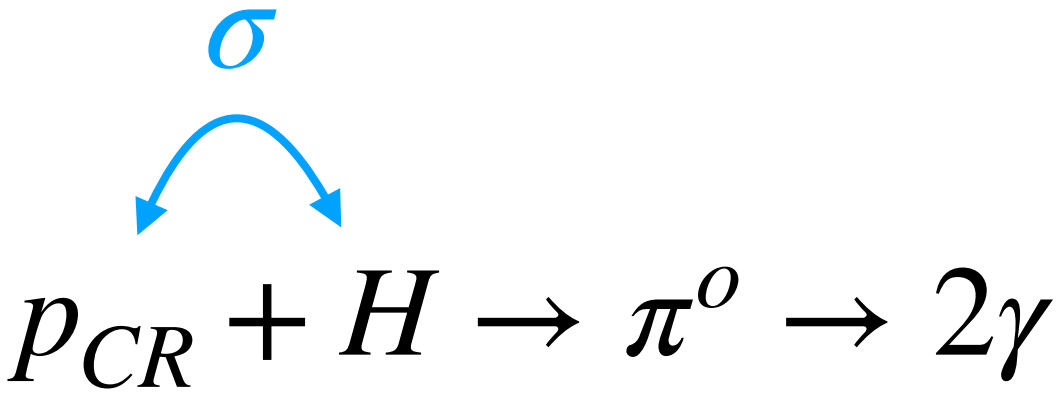
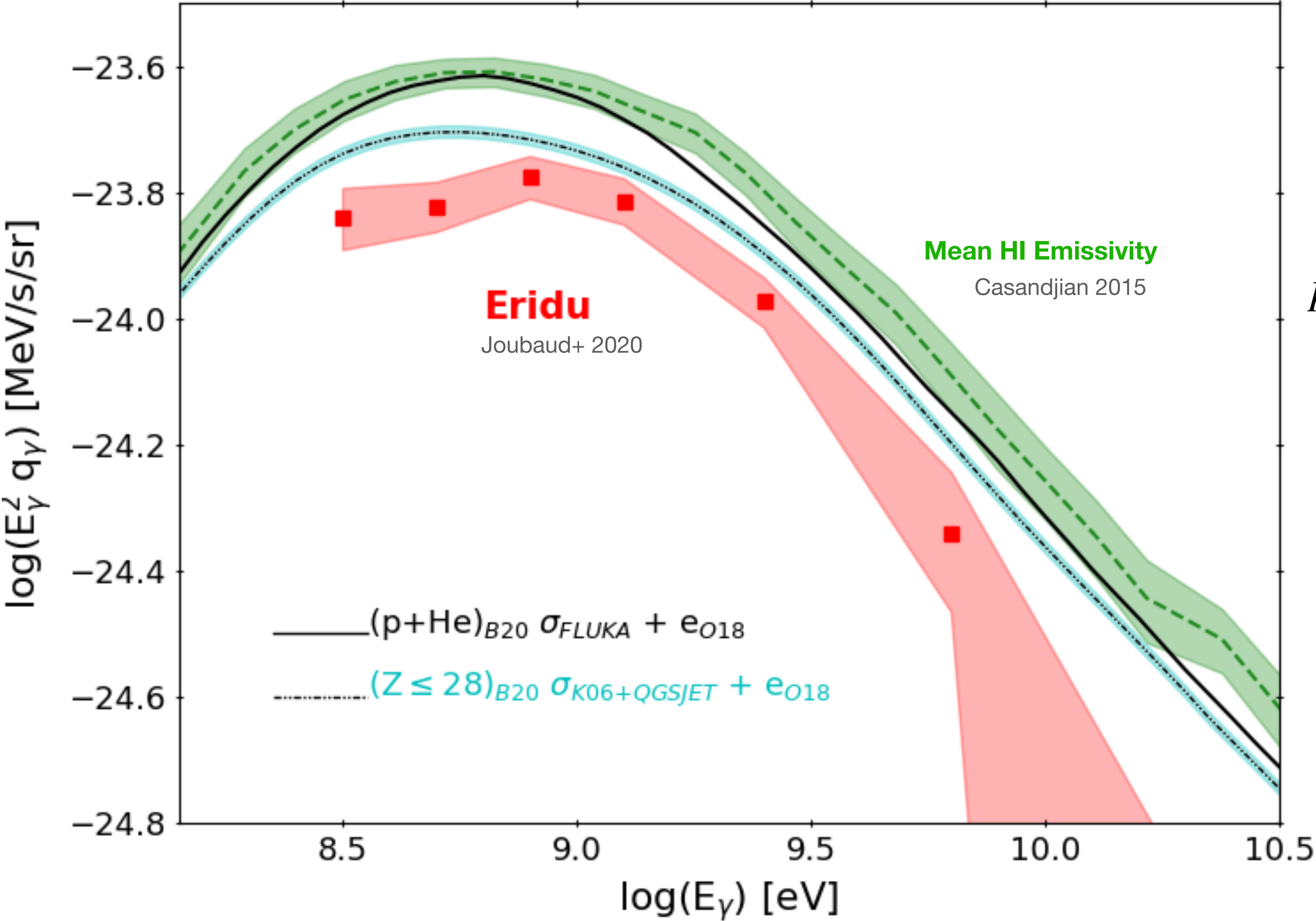
$$I_{\gamma} \propto \int n_{gas} n_{CR} dl$$

$$I_{\gamma} \approx q_{\gamma} \int n_{gas} dl$$

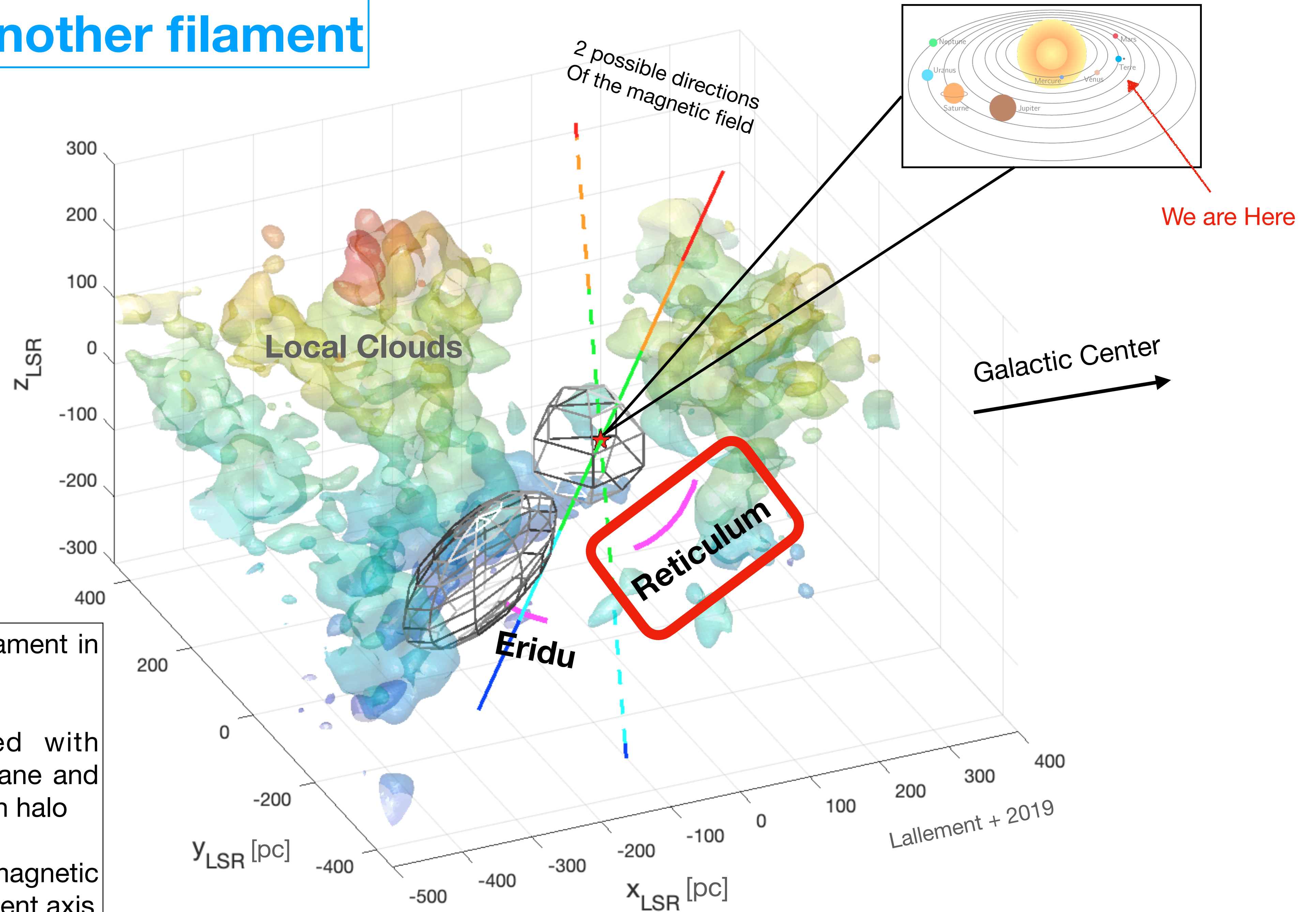
- Several measurements of q_{γ} showed that local clouds are consistent with the mean emissivity in the local medium

The Local Medium





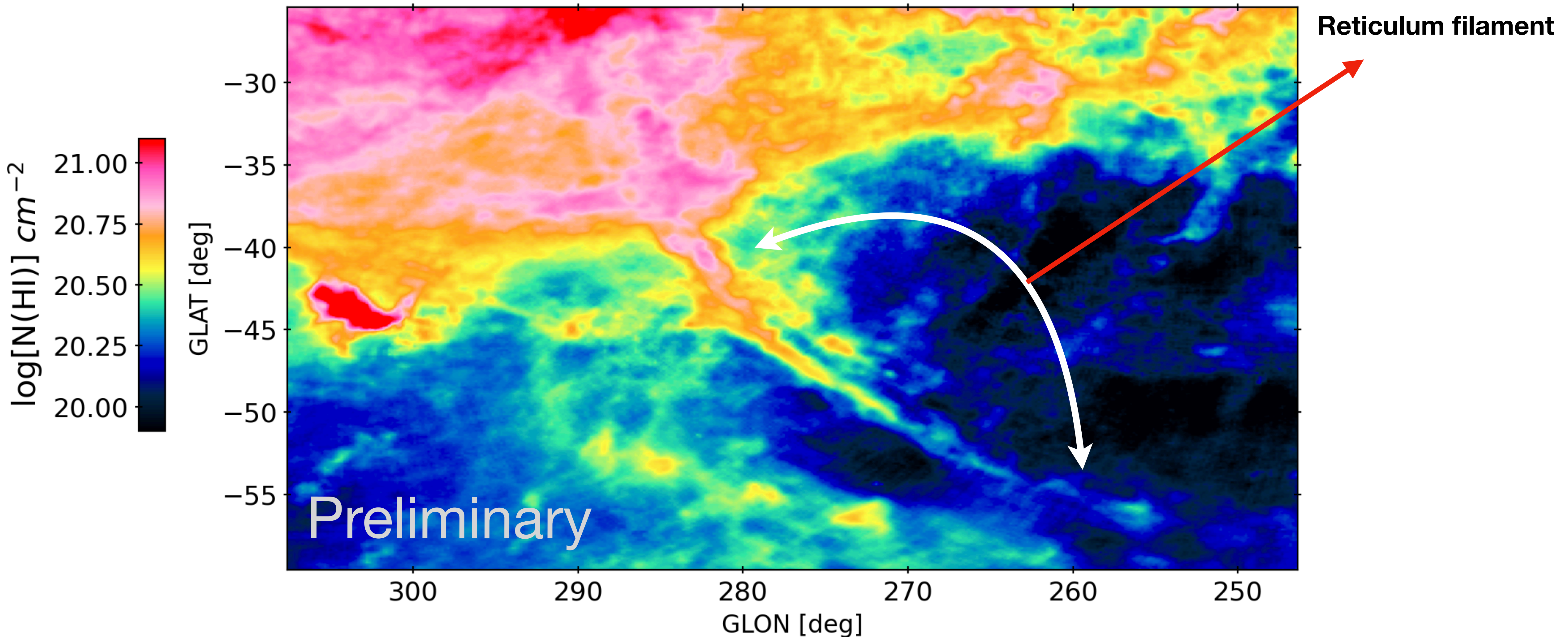
Looking for another filament



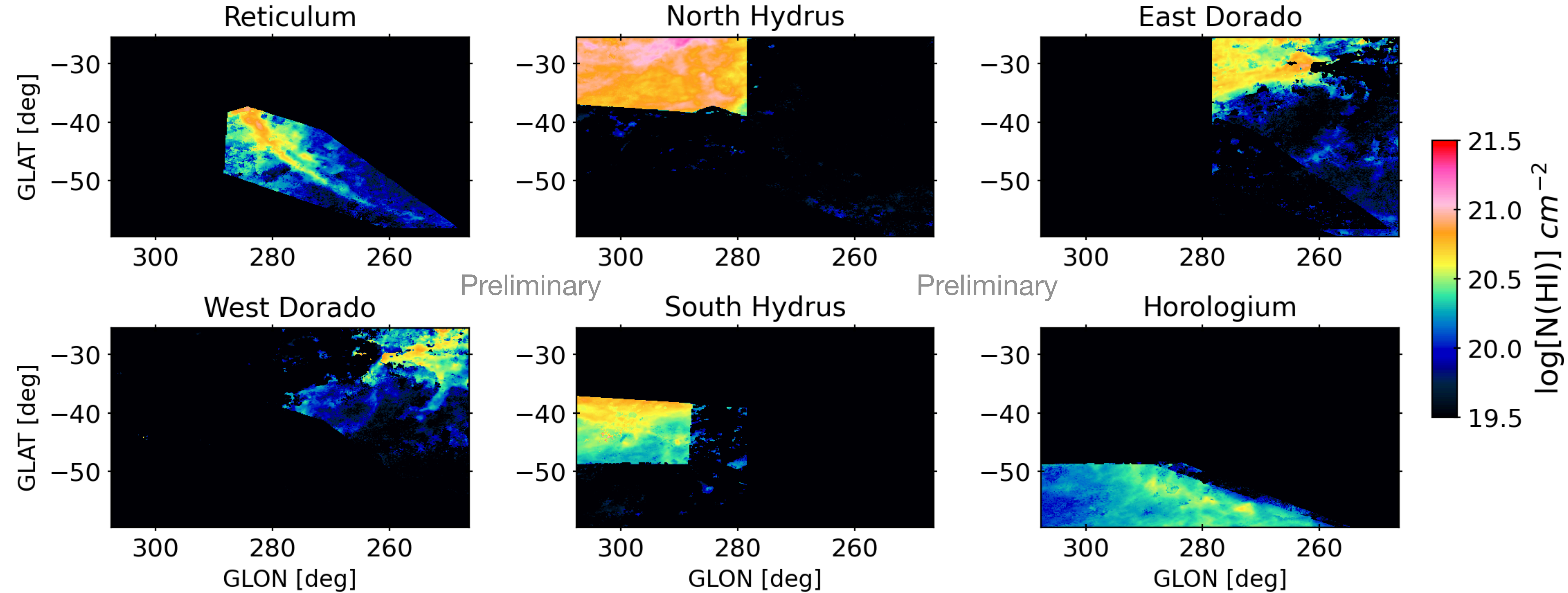
- Reticulum is an atomic filament in the local valley
- As Eridu, it is inclined with respect to the galactic plane and pointing towards the south halo
- Both of them have a magnetic field aligned with the filament axis

First, we need to measure the quantity of gas

Using GASS data at 21cm, we obtained the HI column density map



6 local atomic clouds

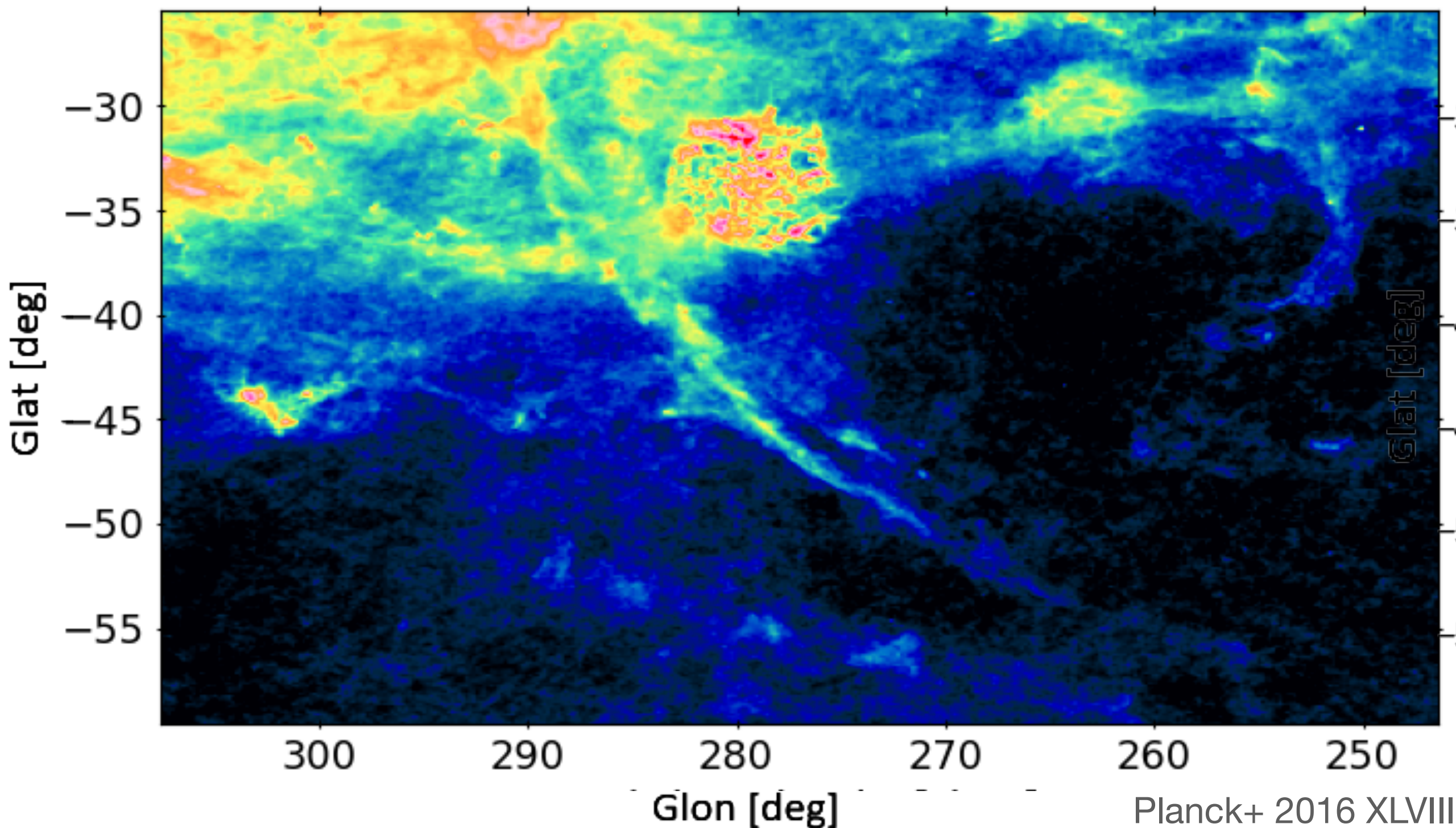


- Decomposition in space and velocity
- N(HI) derivation for optically thin HI or for self-absorption corrections with : $100K \leq T_{spin} \leq 800K$

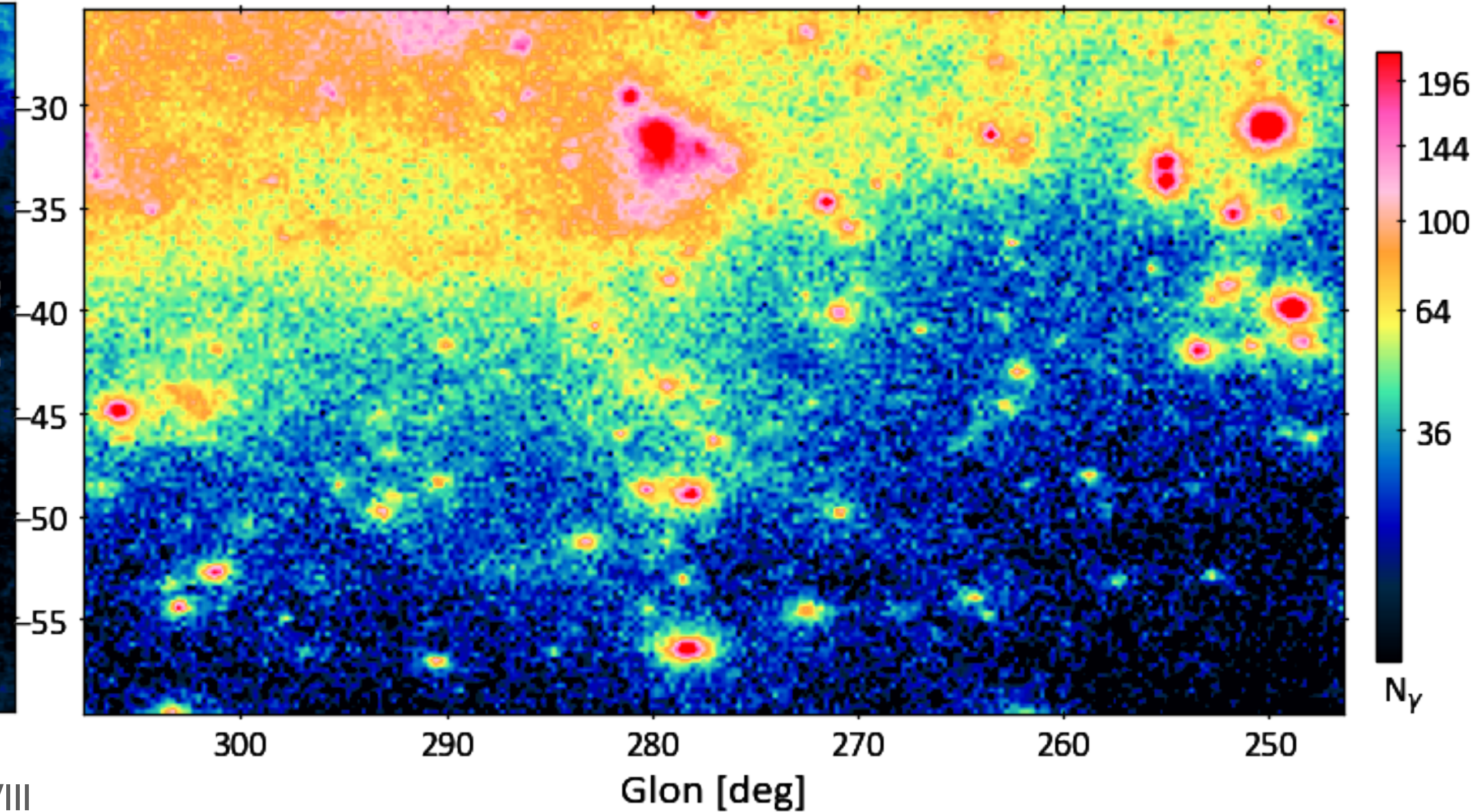
Is there additional gas ?

- No detected CO emission
- Dark Neutral Gas :
obtained by coupling the analyses of dust and γ rays as tracers of the total gas quantity

τ_{353GHz} Optical Depth by Planck



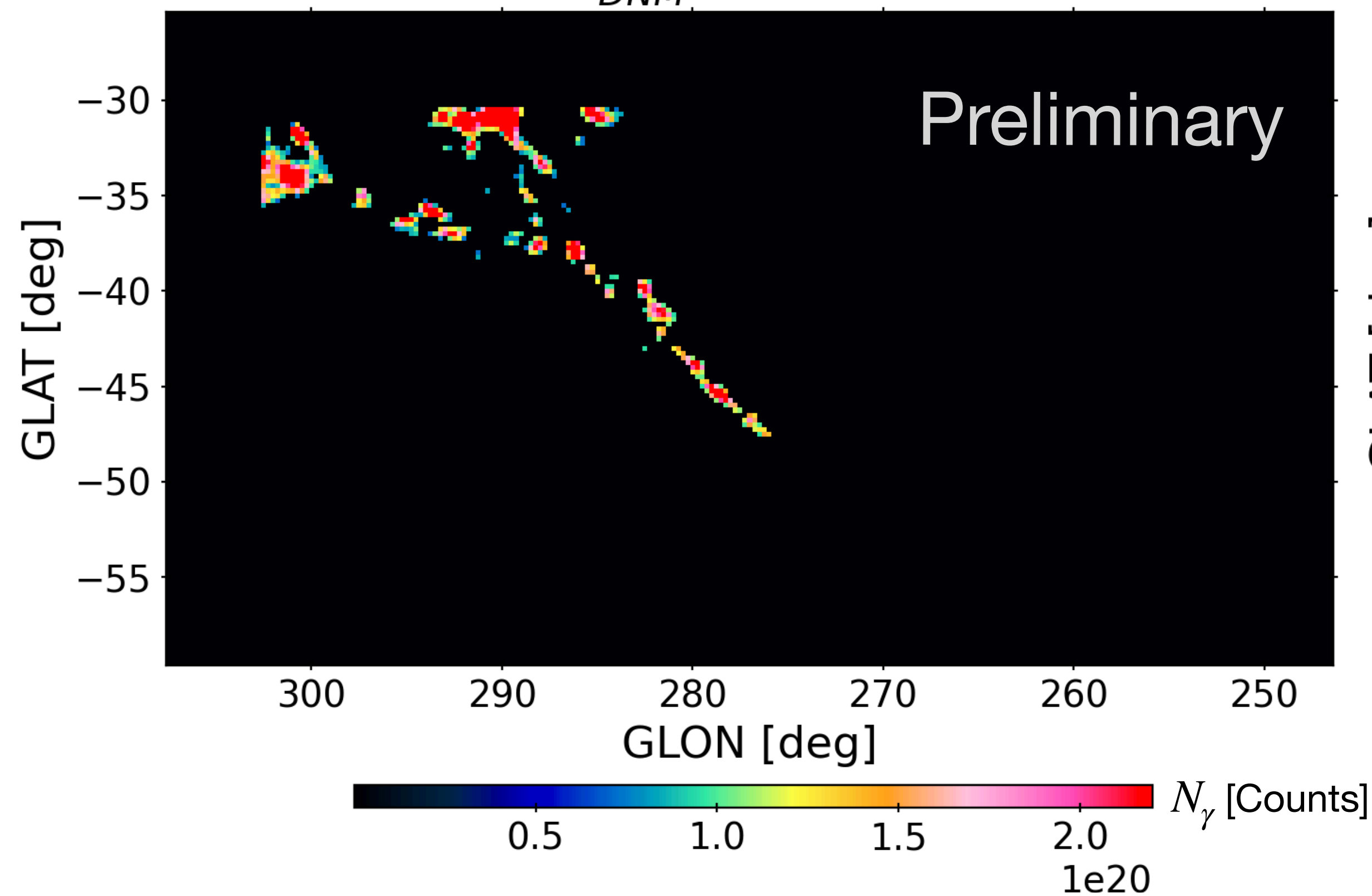
γ rays by Fermi-LAT between 0.3 and 50 GeV



Dark Neutral Medium extracted from dust and γ rays

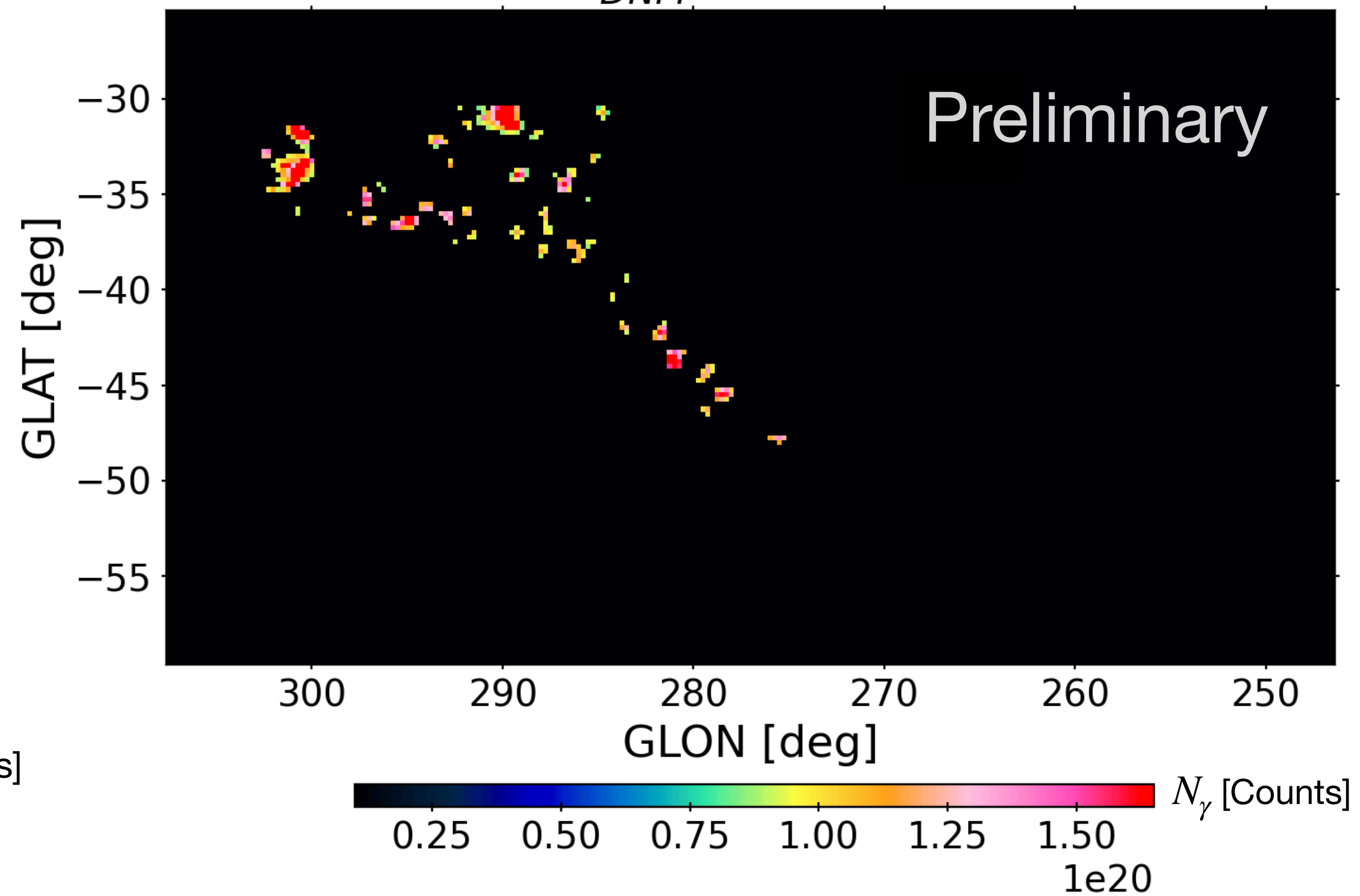
τ_{353GHz}

NH_{DNM} at Ts:T100

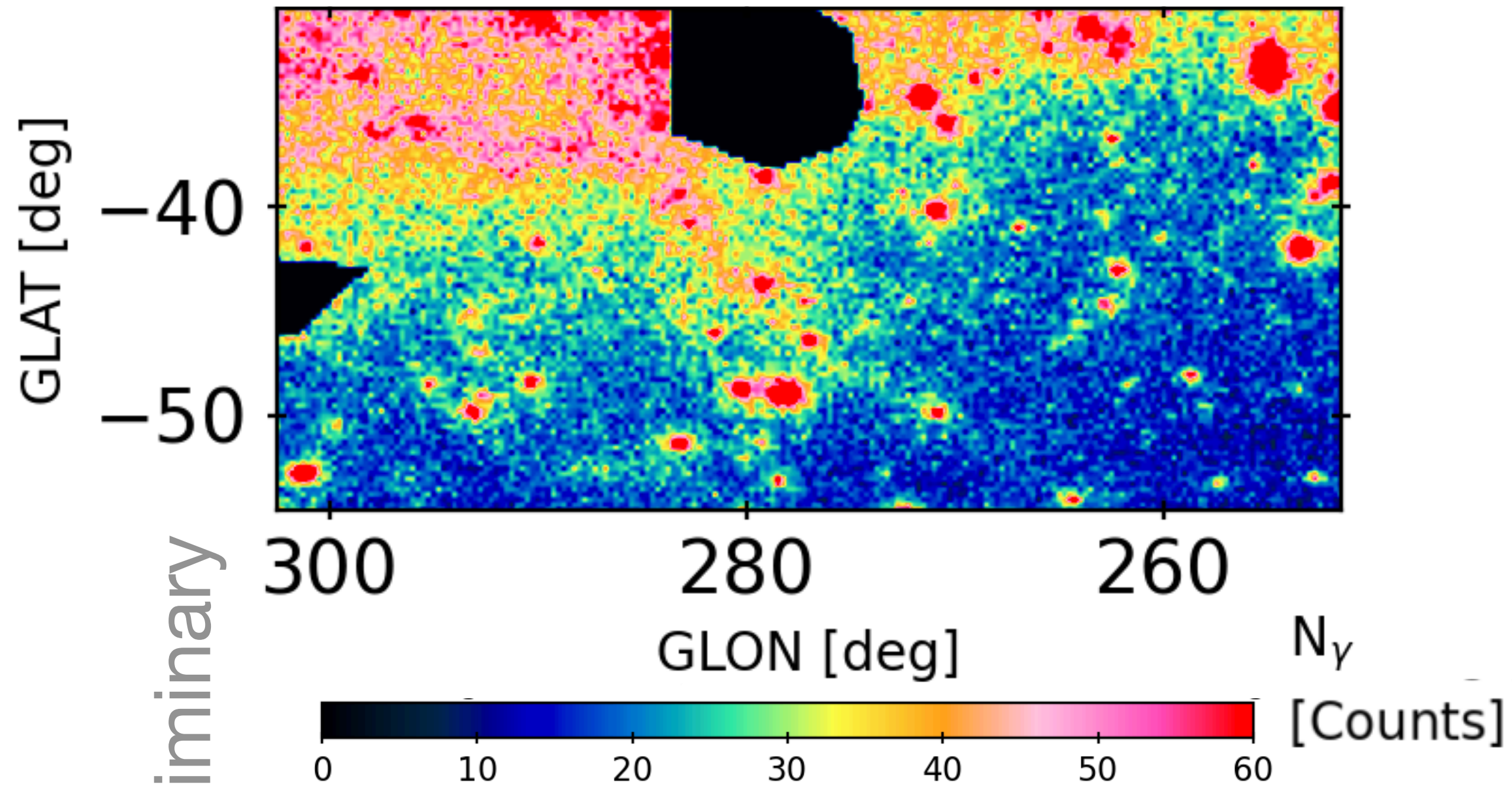


γ ray

NH_{DNM} at Ts:T100

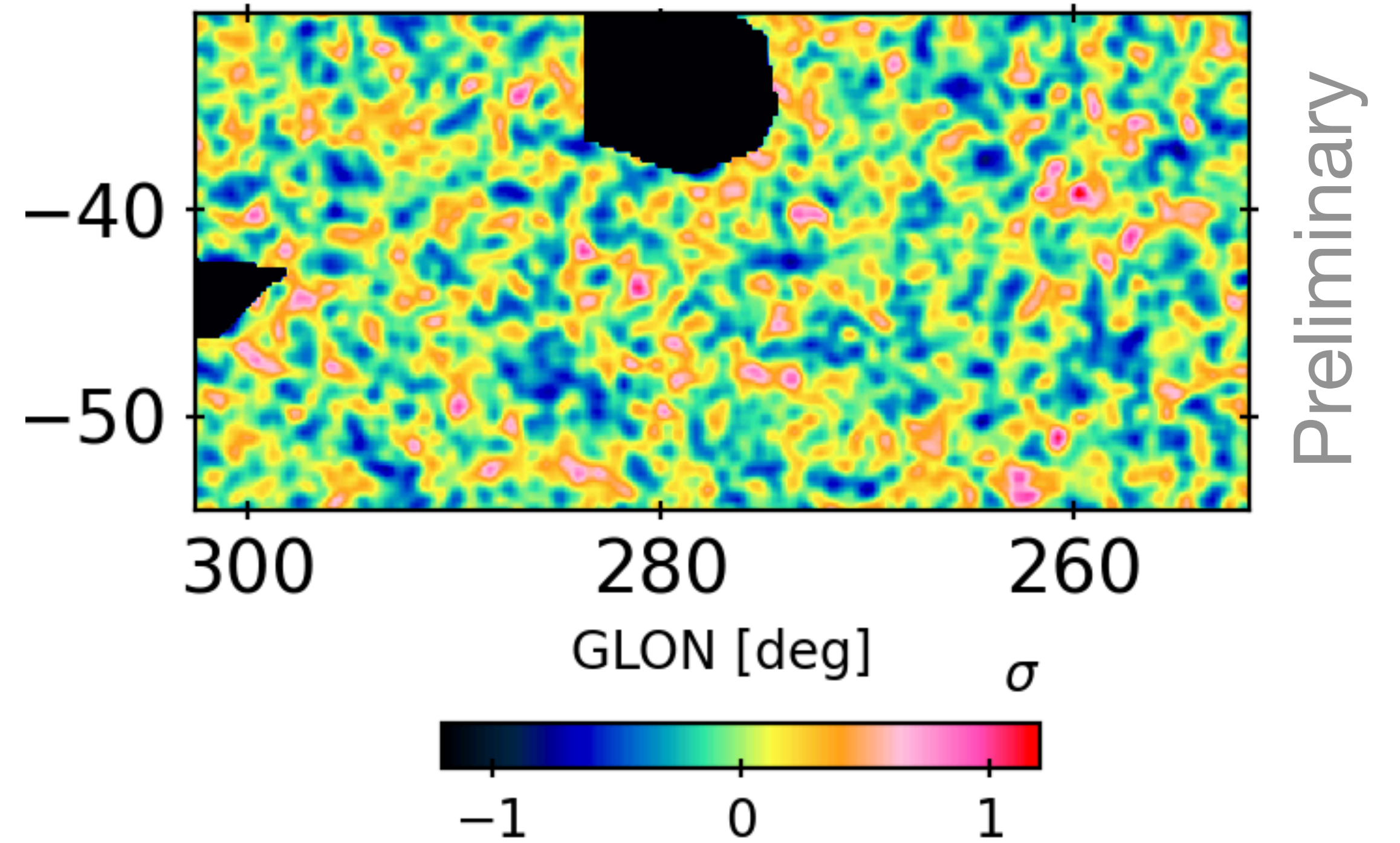


Observation between 0.3 to 50 GeV



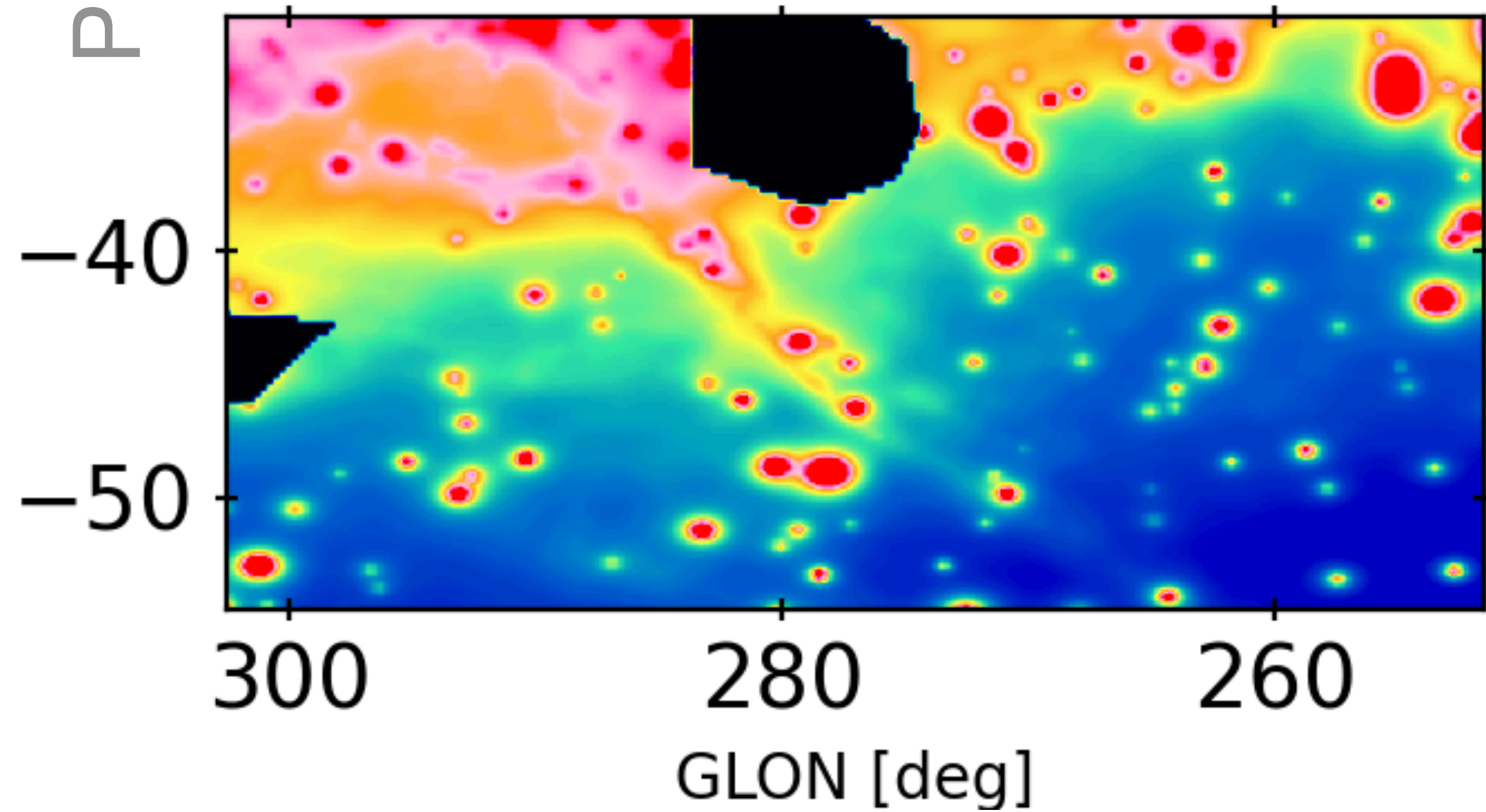
Preliminary

Residuals



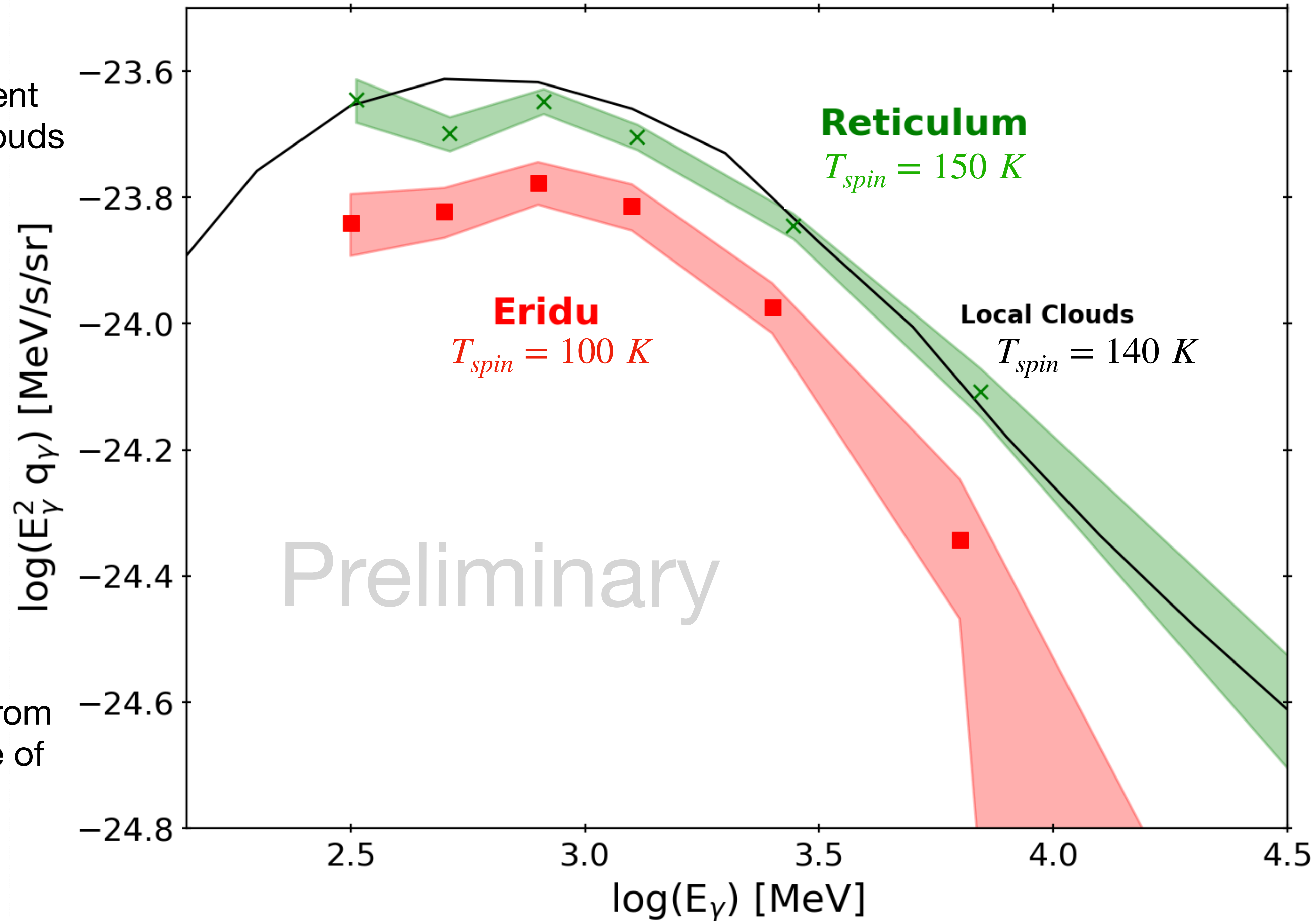
Preliminary

Model



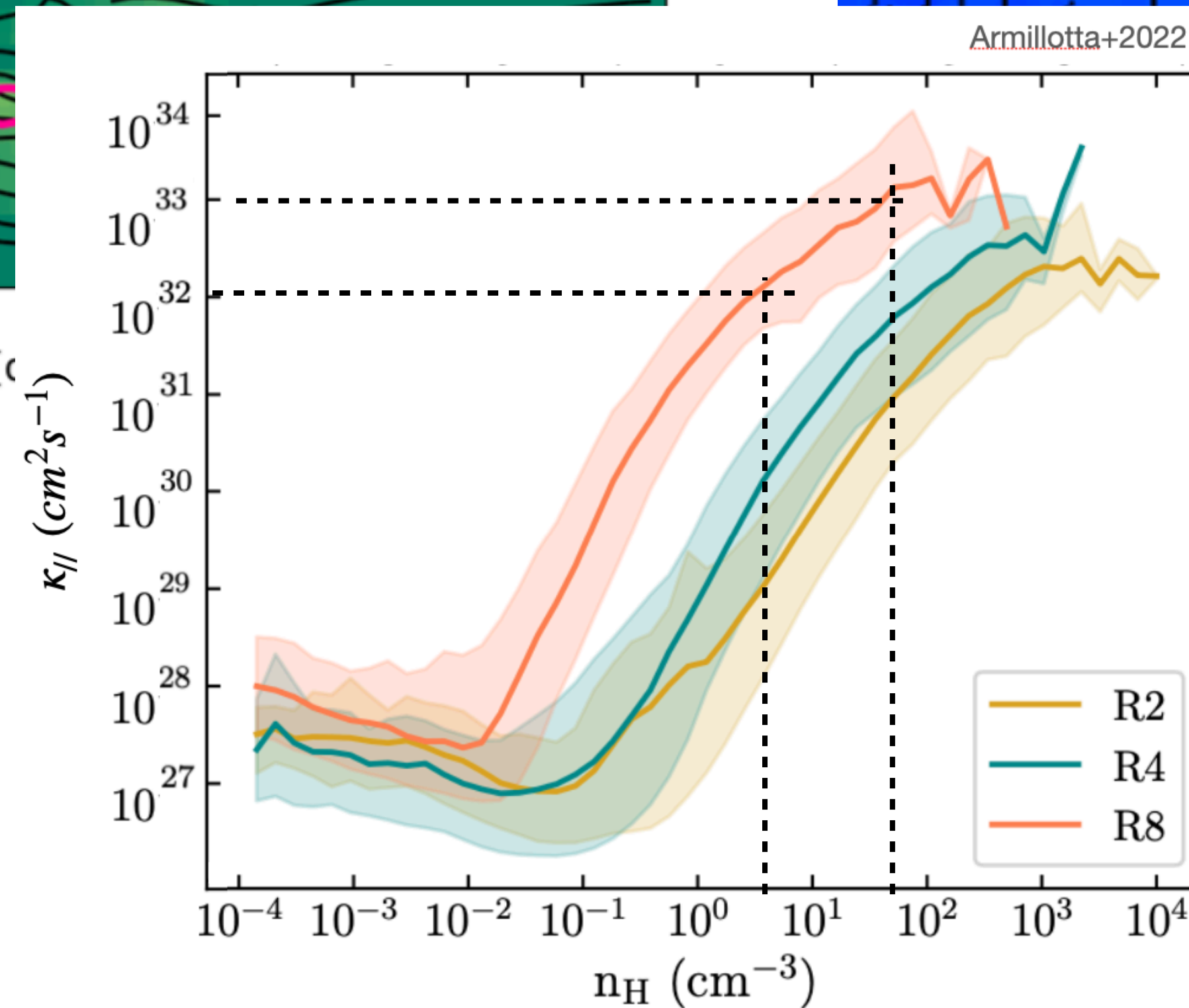
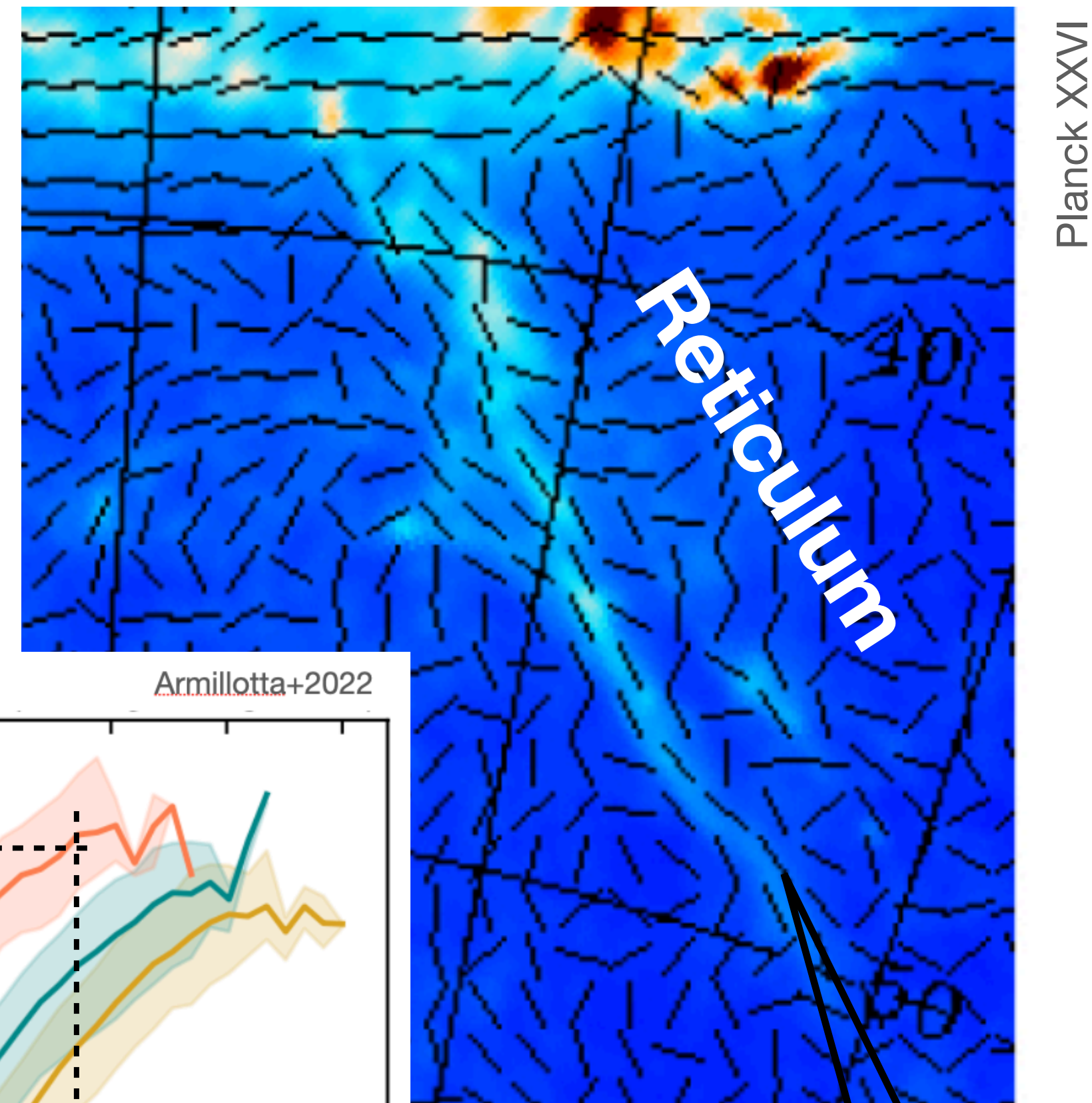
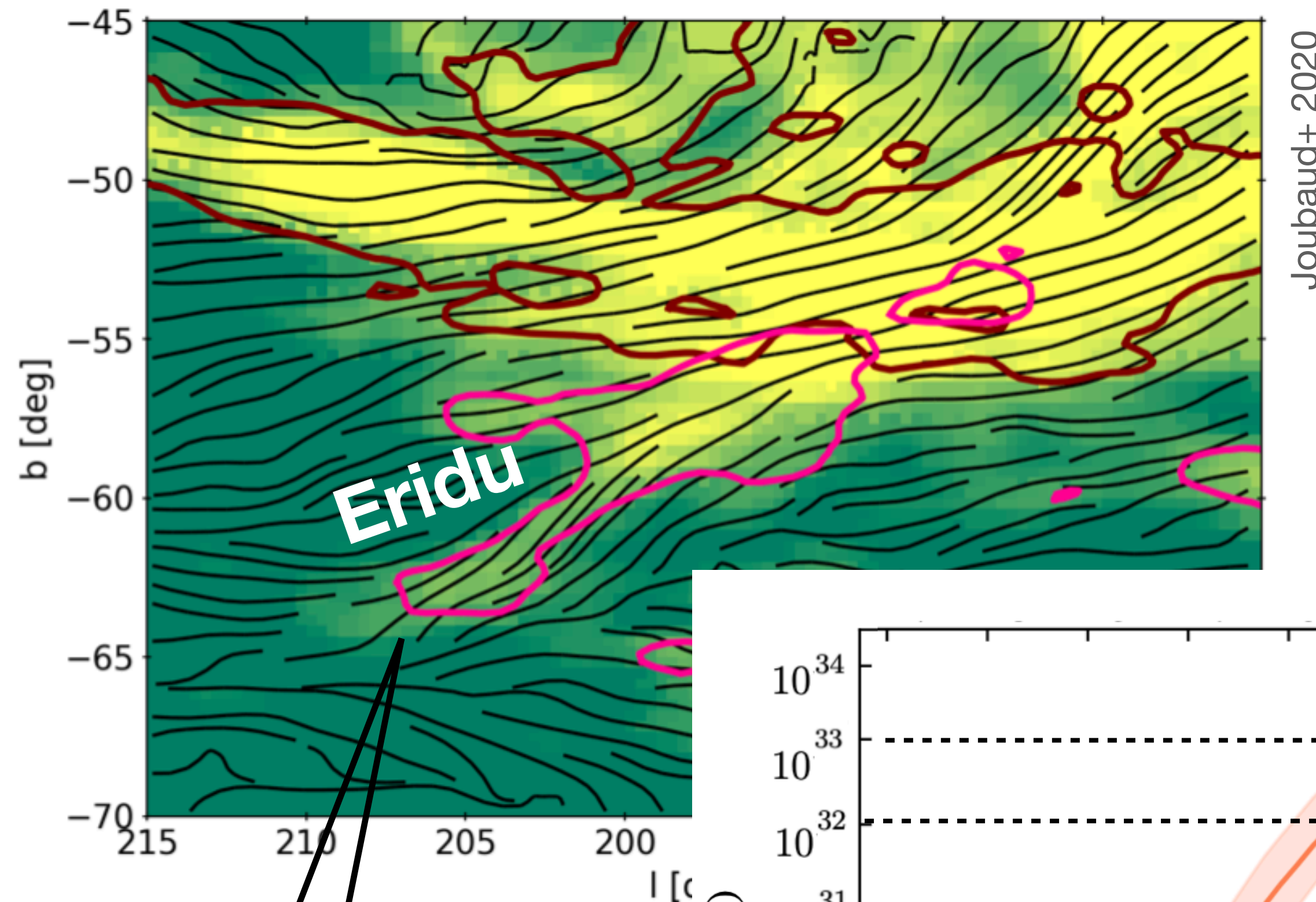
$$\begin{aligned}
 I(l, b, E) = & q_{LIS}(E) \left[\sum_{i=1}^8 q_{HI_i}(E) N_{HI_i}(l, b) + q_{DNM}(E) N_{DNM}(l, b) \right] \\
 & + q_{IC}(E) I_{IC}(l, b, E) + q_{iso}(E) I_{iso}(E) \\
 & + \sum_j q_{s_j}(E) S_j(E) \delta(l_j, b_j)
 \end{aligned}$$

Cosmic-ray flux in
Reticulum is consistent
with that in the local clouds



Eridu is still different from
them with a difference of
 $44 \pm 8\%$

Why 44 ± 8 % more CRs in Reticulum compared to Eridu ?



Pure HI gas
Vol. Density $< \text{few } \text{cm}^{-3}$
 $N(\text{HI}) \sim 1 - 5 \times 10^{20} \text{ cm}^{-2}$
~ordered B field - $B_{\text{sky}} = 5 \mu\text{G}$

HI + diffuse H₂ gas
Vol. Density $\sim 10^1 - 10^2 \text{ cm}^{-3}$
 $N(\text{HI}) \sim 10^{20} - 10^{21} \text{ cm}^{-2}$
More tangled B field

Thank You

