UNIVERSITY OF EXETER

The molecular gas content of simulated Milky Way(s)

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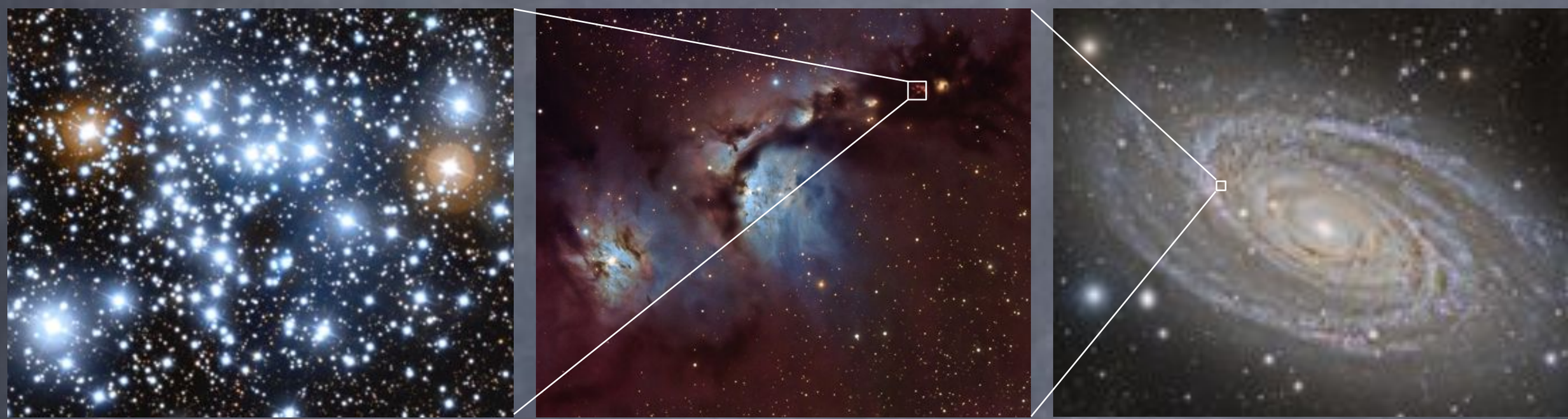
Based on Duarte-Cabral et al. 2014 (accepted)

Motivation



Stars ← Molecular clouds ← Galaxy

Star Formation

Molecular cloud formation

This work: assess how well the current numerical models reproduce the basic ISM properties of the Galaxy

Simulating the Milky Way

Fiducial SPH model of the Galaxy

- Four-armed spiral potential
- 8mil SPH particles of $312.5 M_\odot$
- Surface density of $8 M_\odot pc^{-2}$
- Self-gravity
- Cooling and heating
  (Glover & Mac Low 2007, Dobbs et al. 2008)
- Feedback
  (Dobbs et al. 2011)
- Chemistry (H_2 and CO)
  (Dobbs et al. 2006, 2008, Nelson & Langer 1997)

Simulating the Milky Way

Variations of the Fiducial model: testing different ingredients

- Stronger self shielding (reducing photodissociation rate)
- Higher surface density (16 $M_{\odot}pc^{-2}$)
- No feedback, no self-gravity

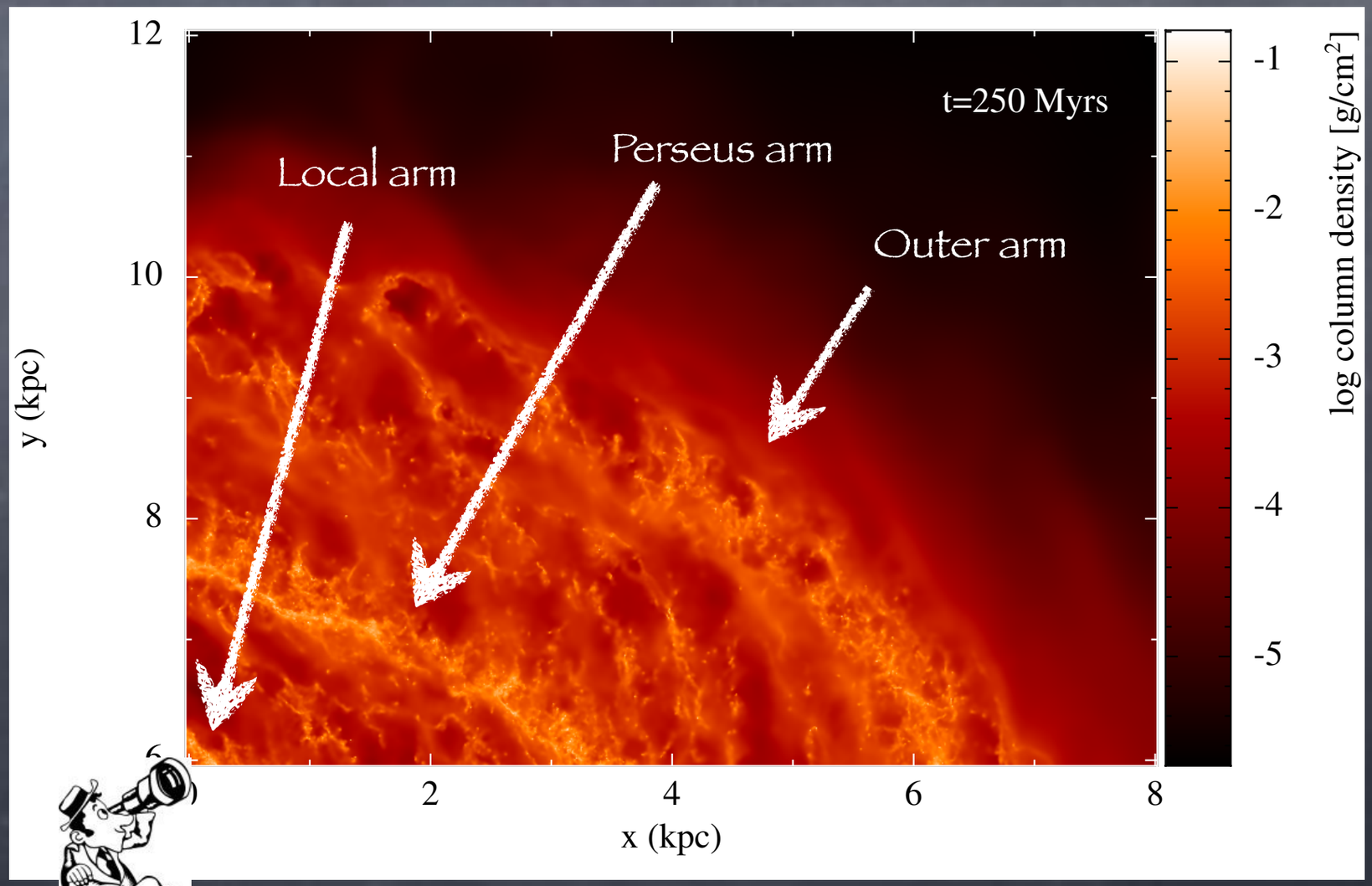
Synthetic Observations

An observer point of view

- Position observer in model Galaxy, so that we observe the Galactic 2Q

- Post-process the data with TORUS radiative transfer code (Harries 2000)

-> HI, HISA, CO & H_2



Reality check

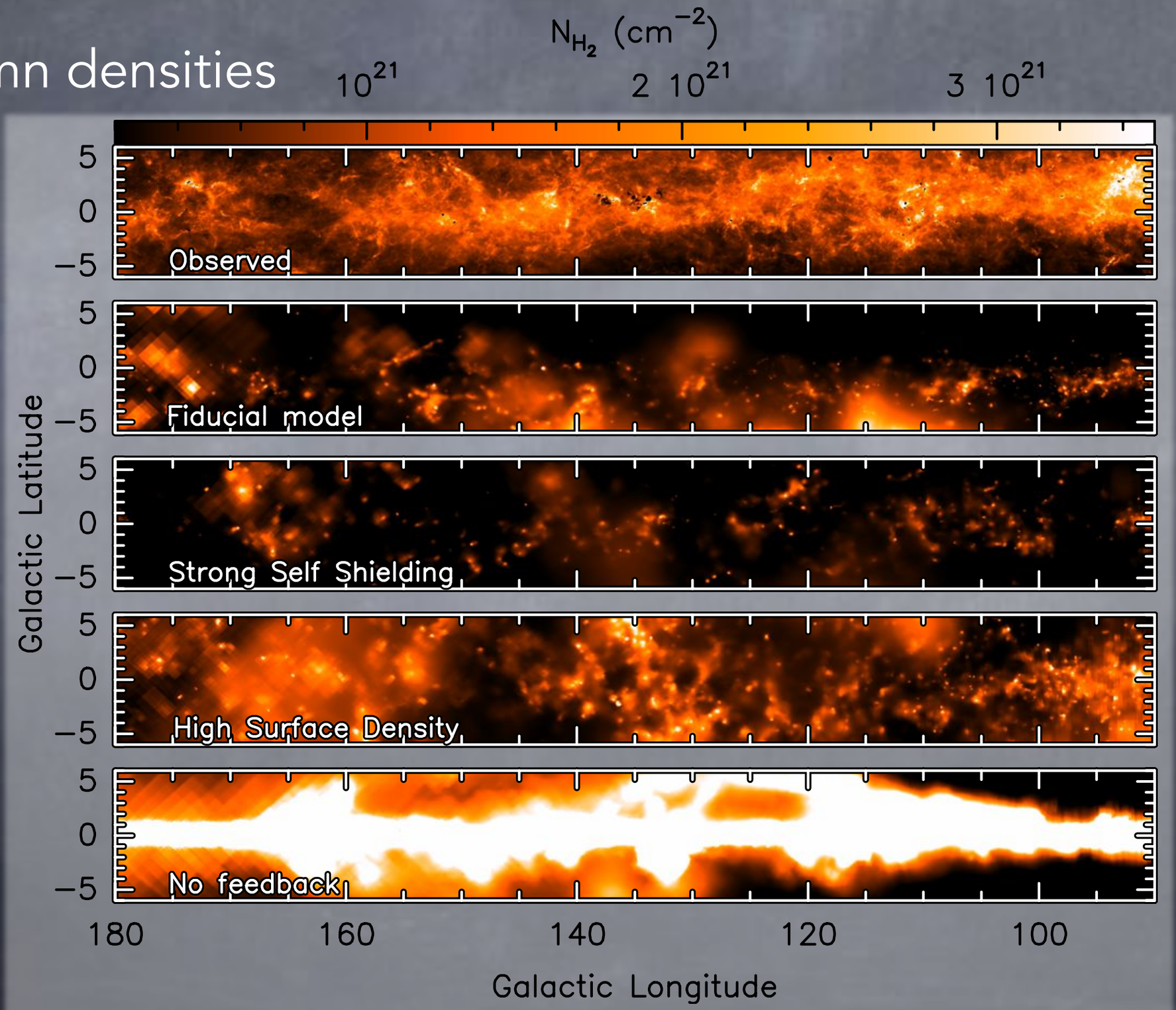
Real observations of the Galactic 2Q:

- H_2 column density from a SED fitting of data from Planck & IRAS
  (Planck Collaboration et al. 2013, Wheelock et al. 1994)
- HI (& HISA) from the Canadian Galactic Plane Survey
  (Taylor et al. 2003, Gibson et al. 2005)
- CO (1-0) from the FCRAO CO Galactic Plane and Outer Galaxy Surveys
  (Mottram & Brunt 2010, Heyer et al. 1998)

-> All data binned to 4′ resolution, and 1 kms^{-1} channels.

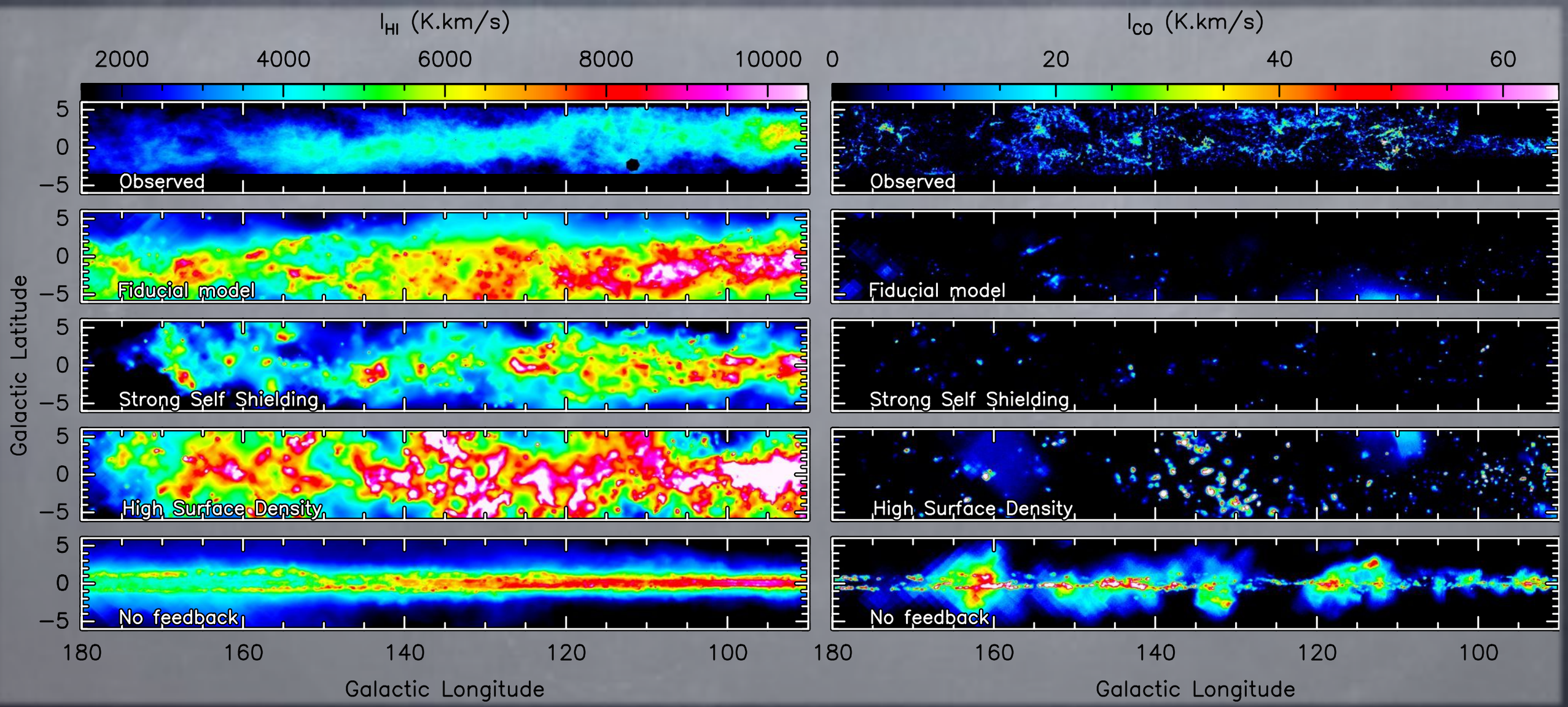
Reality check

H_2 column densities



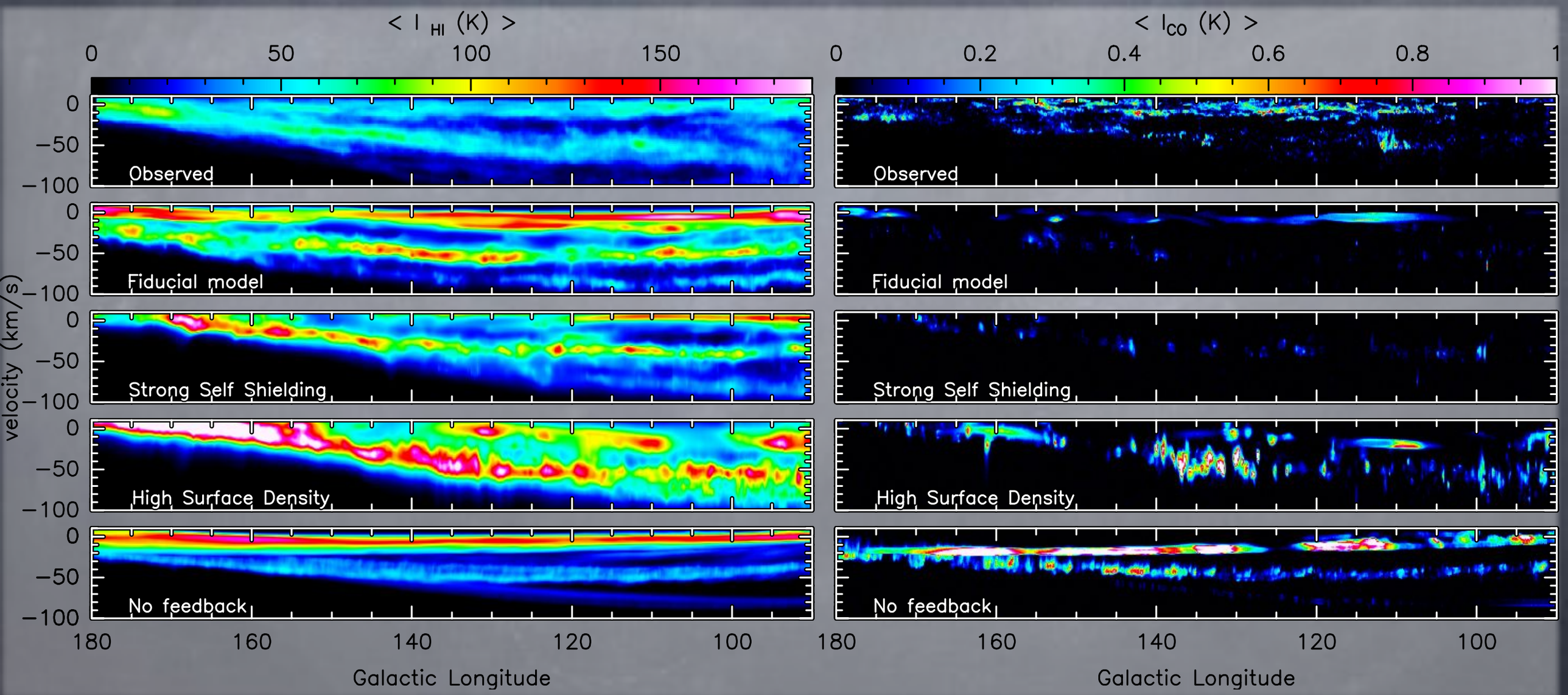
Reality check

HI and CO integrated intensity maps



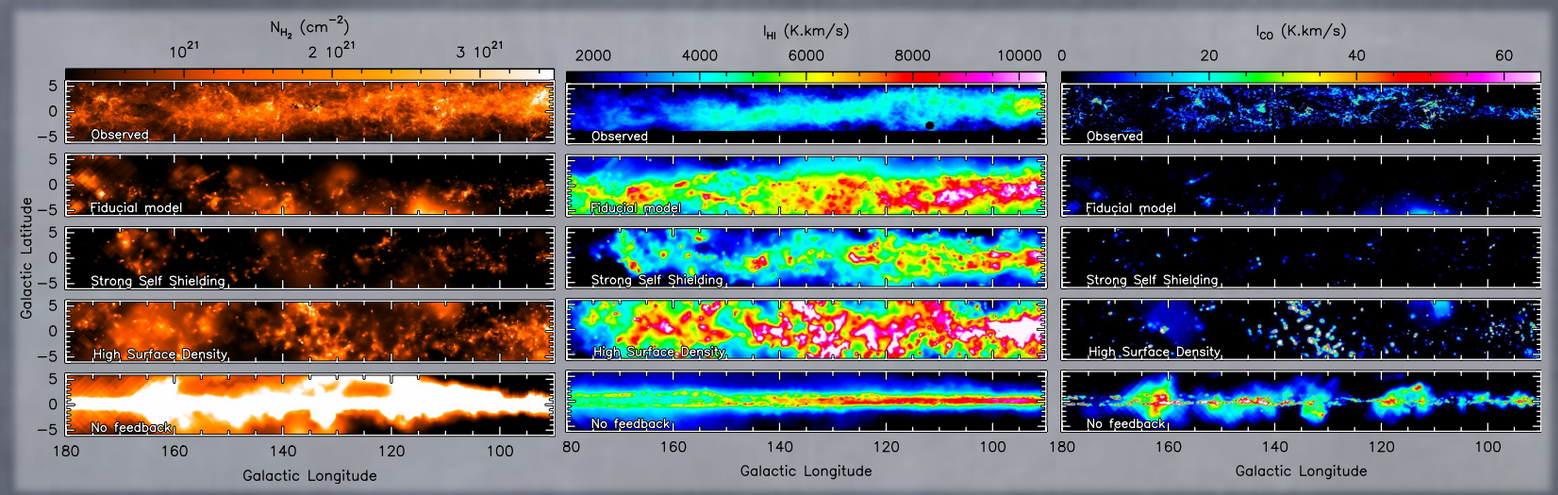
Reality check

HI and CO l-v maps

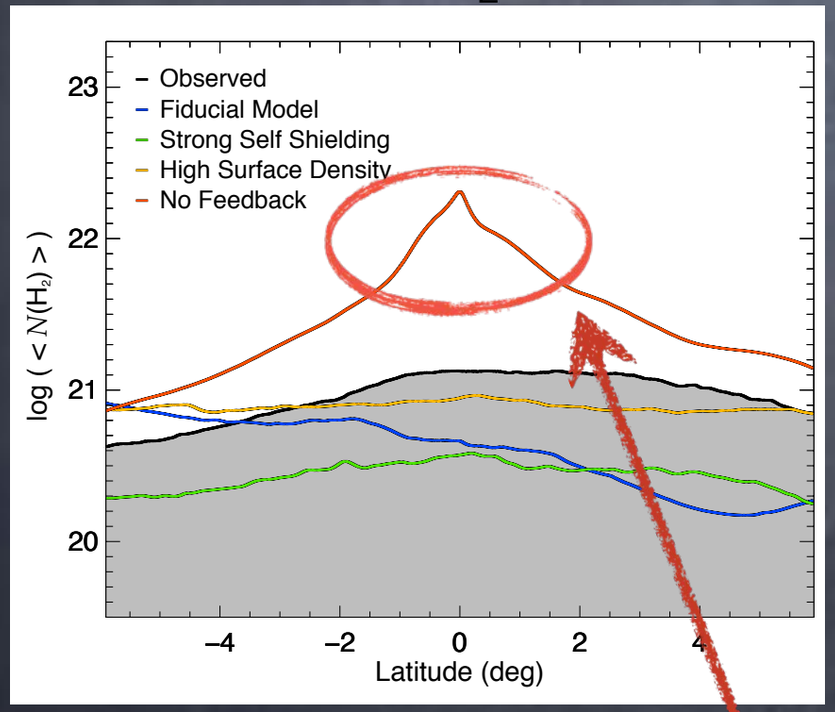


Reality check

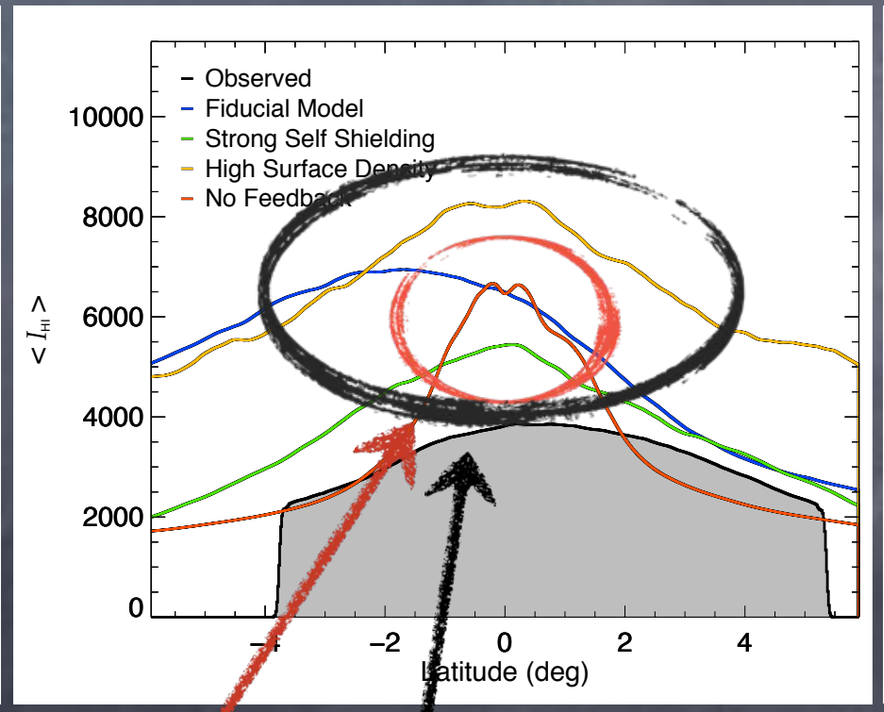
Latitude distribution



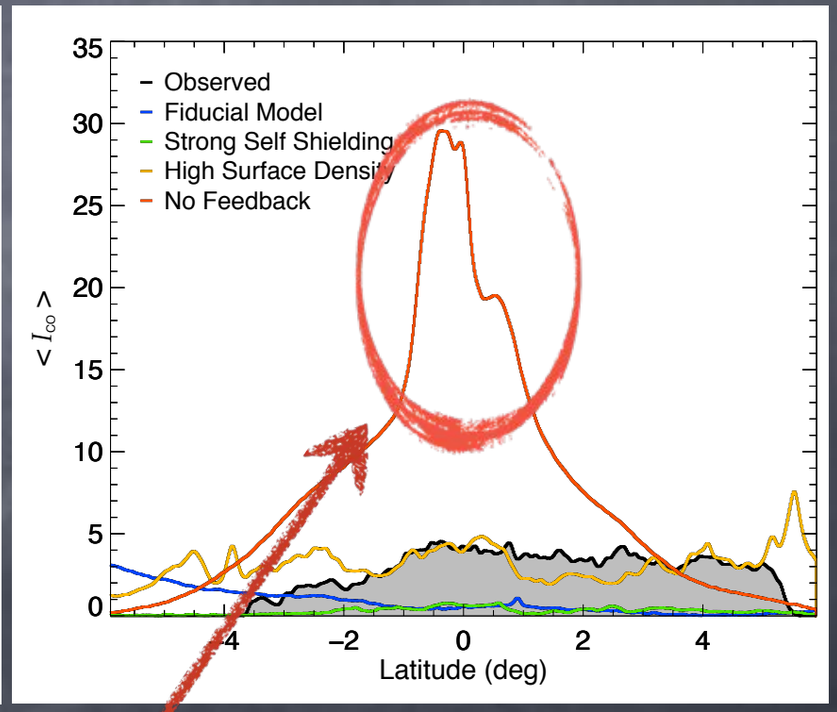
$N(H_2)$



HI



CO



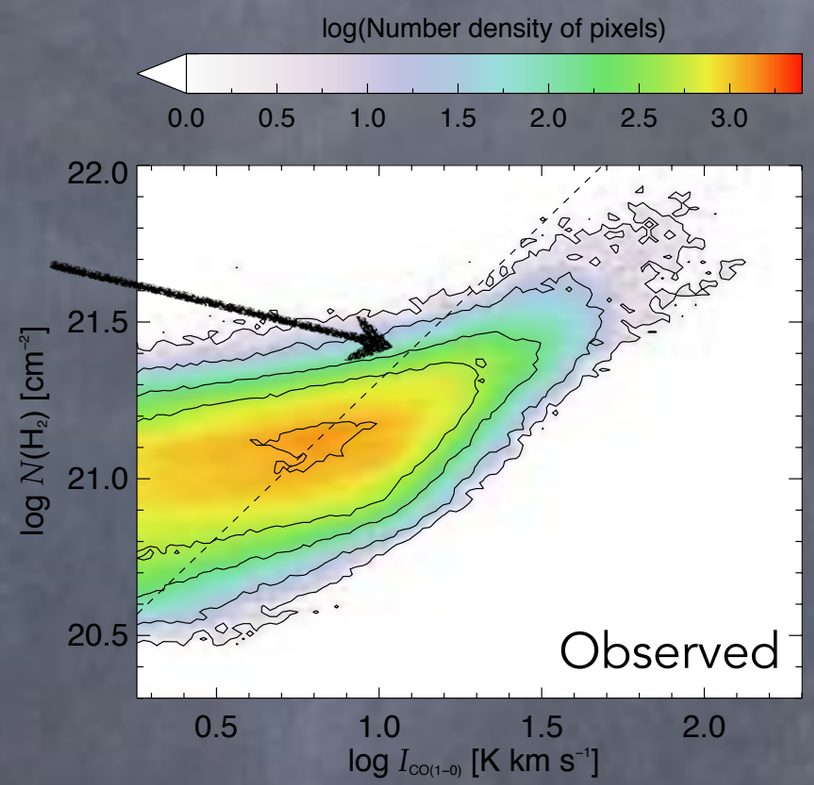
No Feedback -> too concentrated in plane!

All sims -> Too much HI

Reality check

The X_{CO} factor

$X_{CO}^{obs} \sim 2.0 \times 10^{20}$ cm^{-2} K^{-1} km^{-1} s

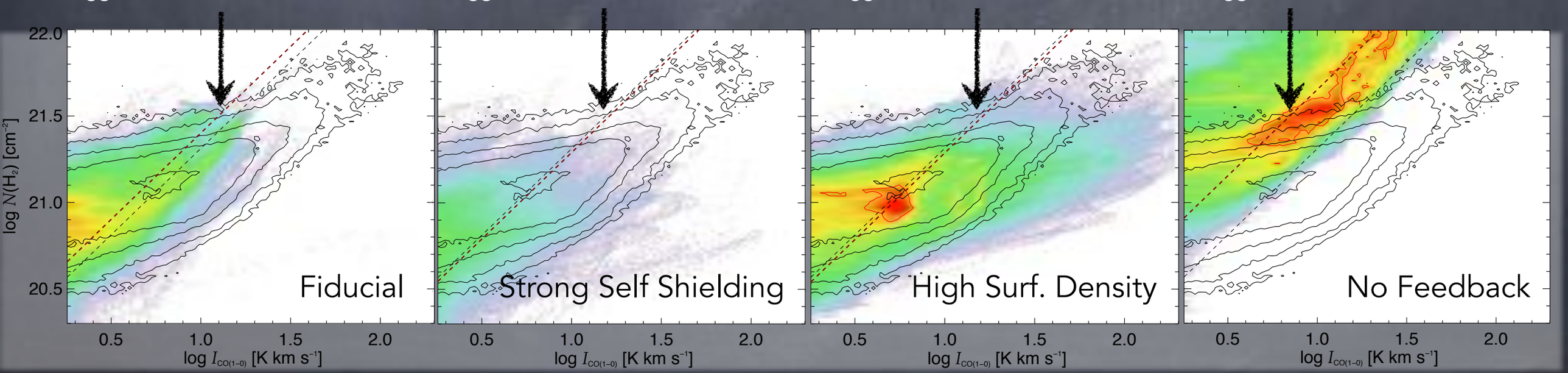


$X_{CO} \sim 2.5 \times 10^{20}$ cm^{-2} K^{-1} km^{-1} s

$X_{CO} \sim 1.9 \times 10^{20}$ cm^{-2} K^{-1} km^{-1} s

$X_{CO} \sim 1.9 \times 10^{20}$ cm^{-2} K^{-1} km^{-1} s

$X_{CO} \sim 4.5 \times 10^{20}$ cm^{-2} K^{-1} km^{-1} s



Reality check: conclusions

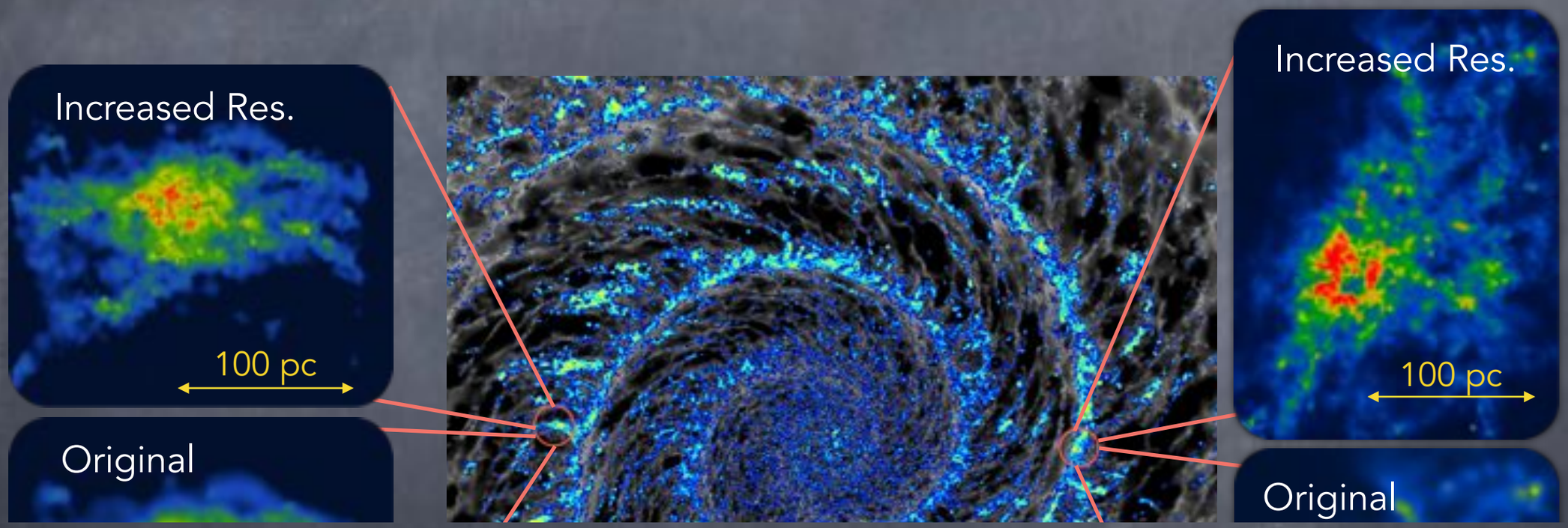
Duarte-Cabral et al. 2014 (MNRAS accepted)

- Self gravity and feedback → Essential !!
- Different recipes of chemistry/feedback implementation
  → Not great impact
- What is well reproduced → H_2 to CO, lat. distribution
- What is yet to be improved
  → HI to H_2
  → morphology of low density regions

TEST: Higher resolution simulations capable of tracing higher densities and lower temperatures, and better resolve lower density regions

What is next?

Trace the star formation at higher resolution with all the ingredients within individual GMCs (work of R. Rey-Raposo)



- → test effect on transition from HI to H_2
- → test the impact of clouds' morphologies and galactic context on the star formation histories.

Thank you!