

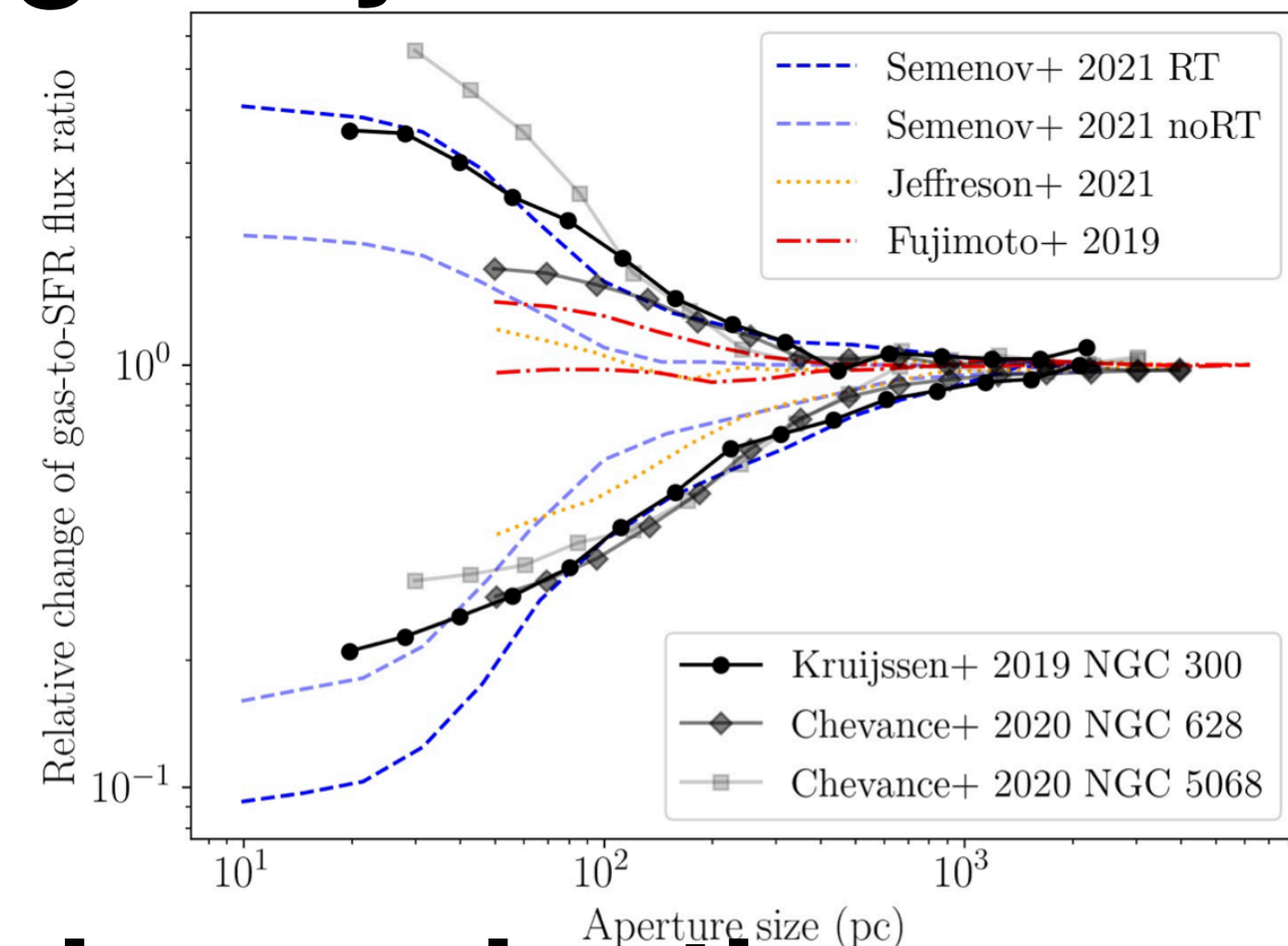
Discussion on stellar radiation feedback in galaxies

Joki Rosdahl, Potsdam Thinkshop, July 15 2025

My impression of stellar radiation feedback

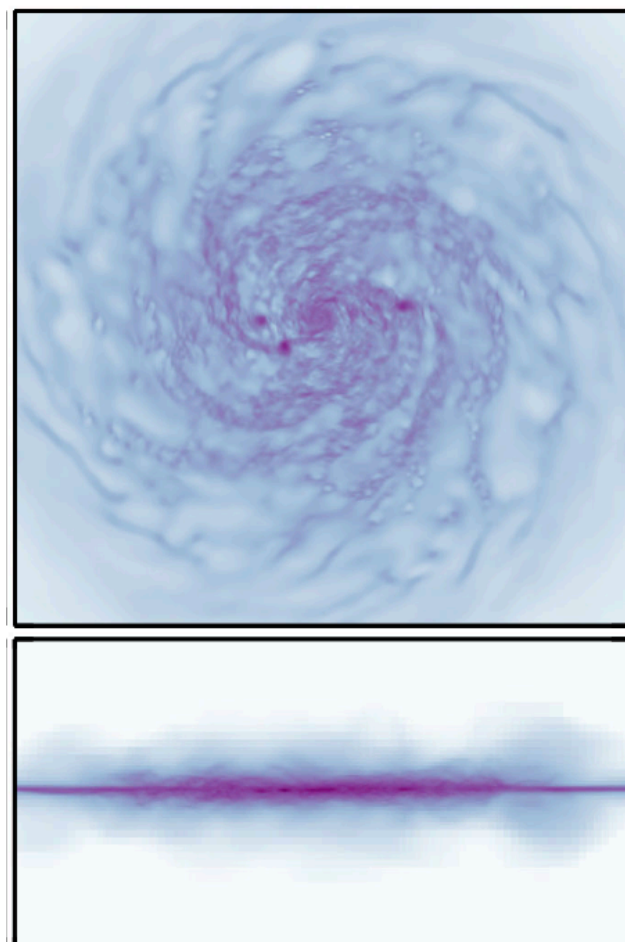
It is an **efficient** regulator of star formation and gas ejection

...on molecular cloud scales



It is an **inefficient** regulator of star formation and gas ejection

...on galaxy scales

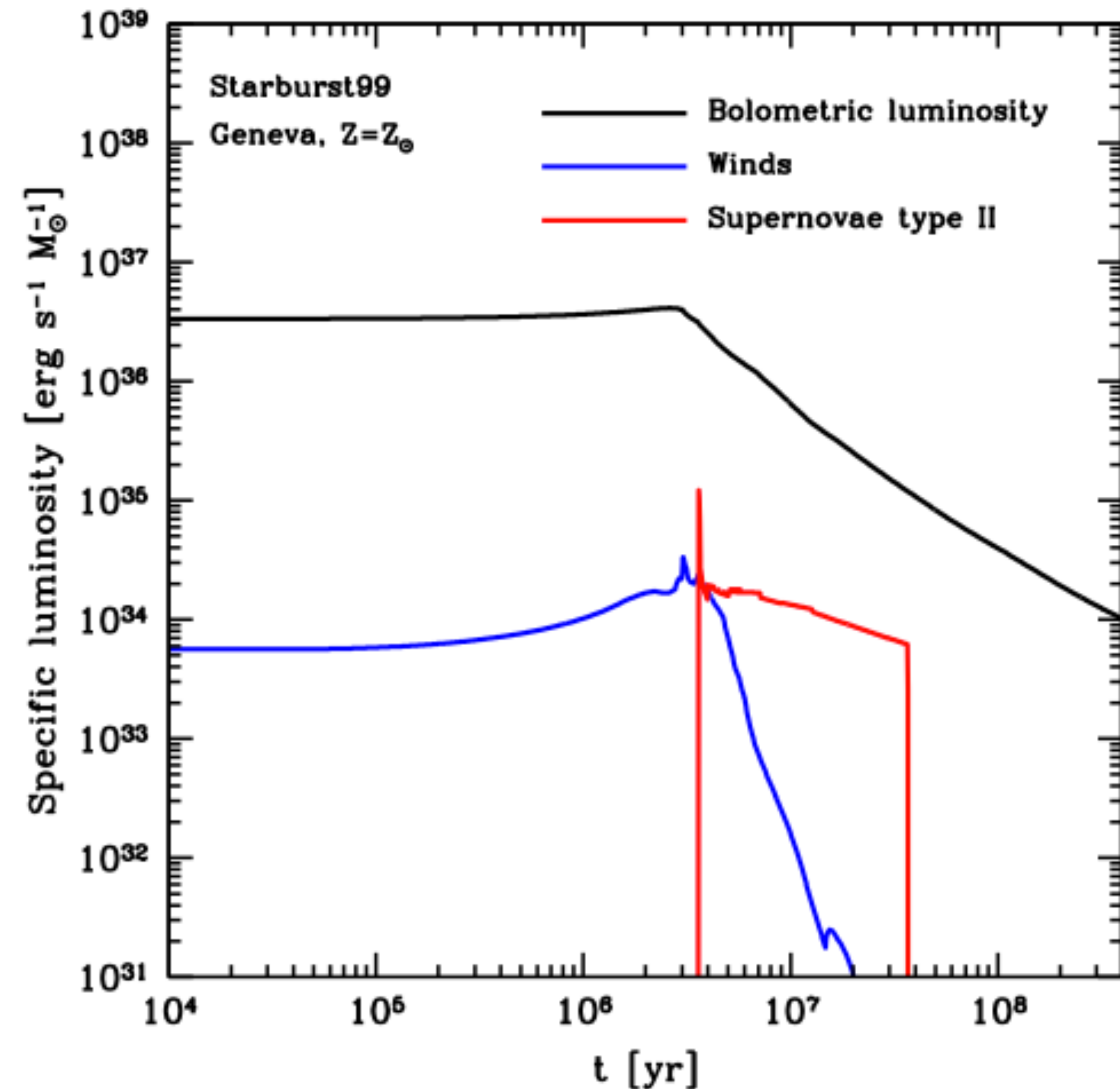


Way back in 2012

Stellar radiation dominates the feedback energy,
this inspired sub-grid models of efficient radiation
feedback (Agertz, Ceverino, FIRE, Nihao),
plus the famous IR boost in FIRE.

But:

- Continuous injection of energy vs bursty in SNe
- Heats the gas to only $\sim 10^4$ K
- Low momentum: total 'push' comparable to SNe
- Not obvious how well it couples to the gas



From Agertz et al (2012)

RHD simulations

In the 2010s, many codes had RHD implemented

The results were underwhelming:
mild SF suppression in low-mass galaxies,
smaller mass loading factors

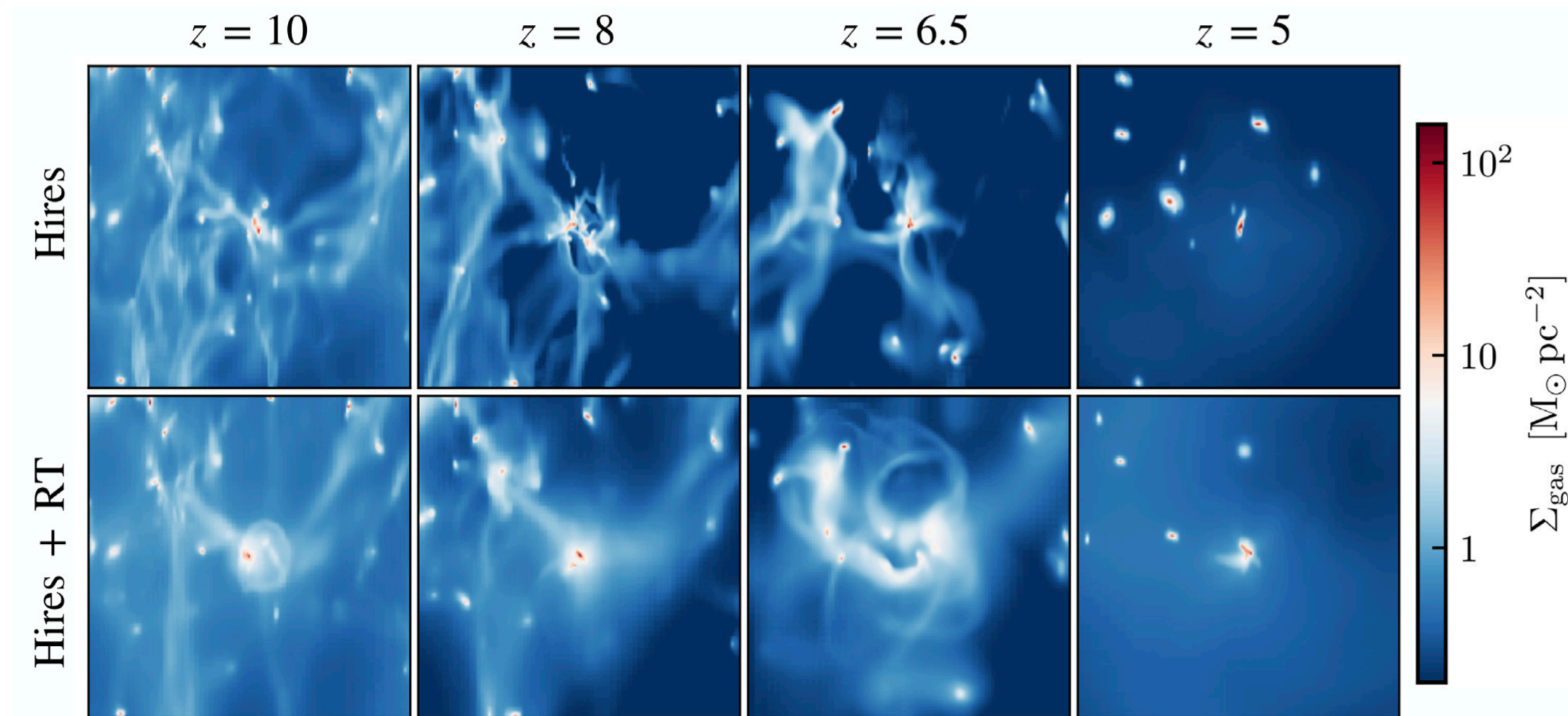
(Rosdahl+15, Kannan+18, Emerick+18,
Peters+16, Agertz+20, ...)

Hints of **positive** radiation feedback in
cosmological simulations, *enhancing* star
formation and outflows,

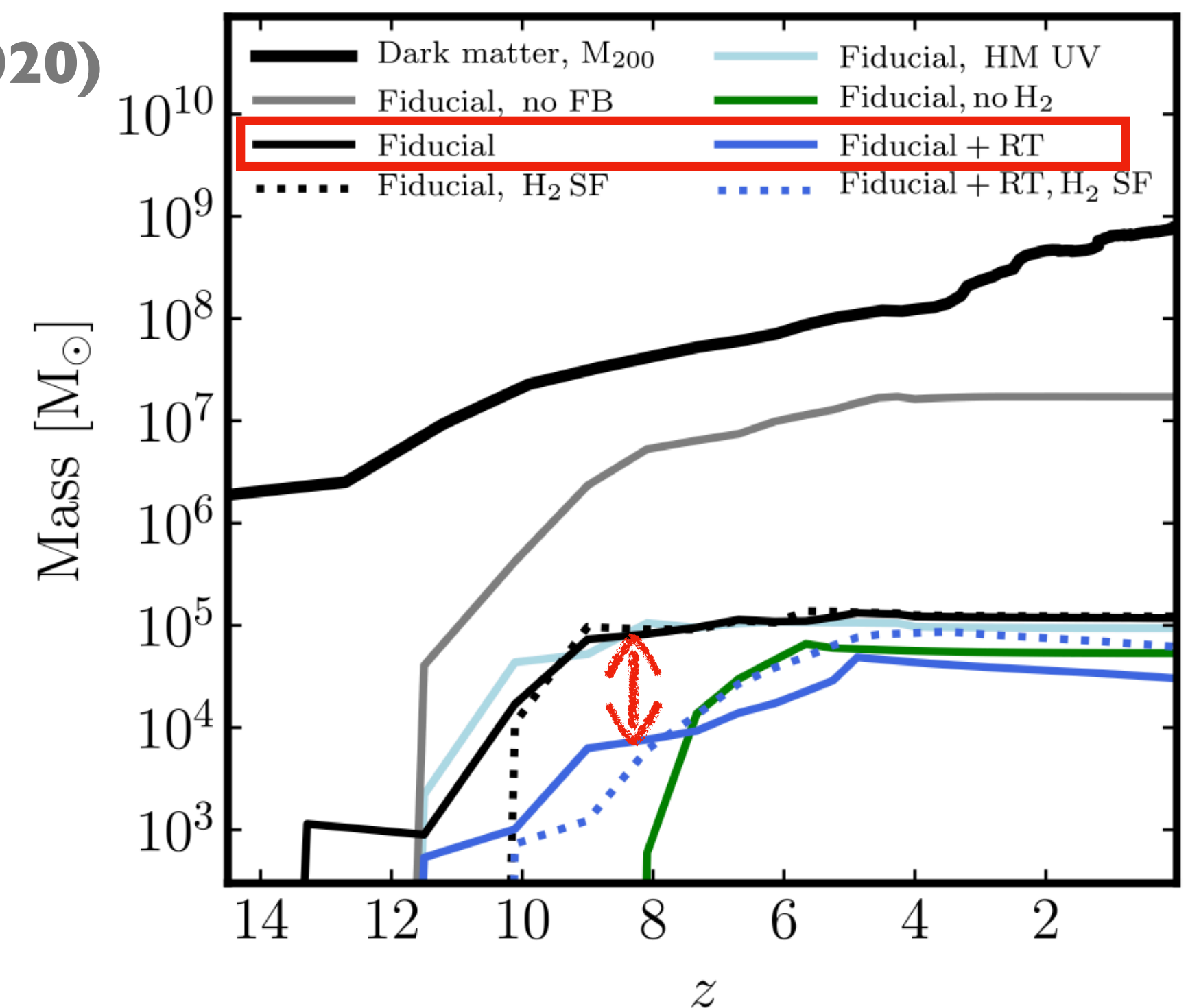
(M Smith+21, Rey+25, Sugimura+25)

..and all due to heating.

In simulations, radiation pressure seems to
do nothing, but observations may not
agree.

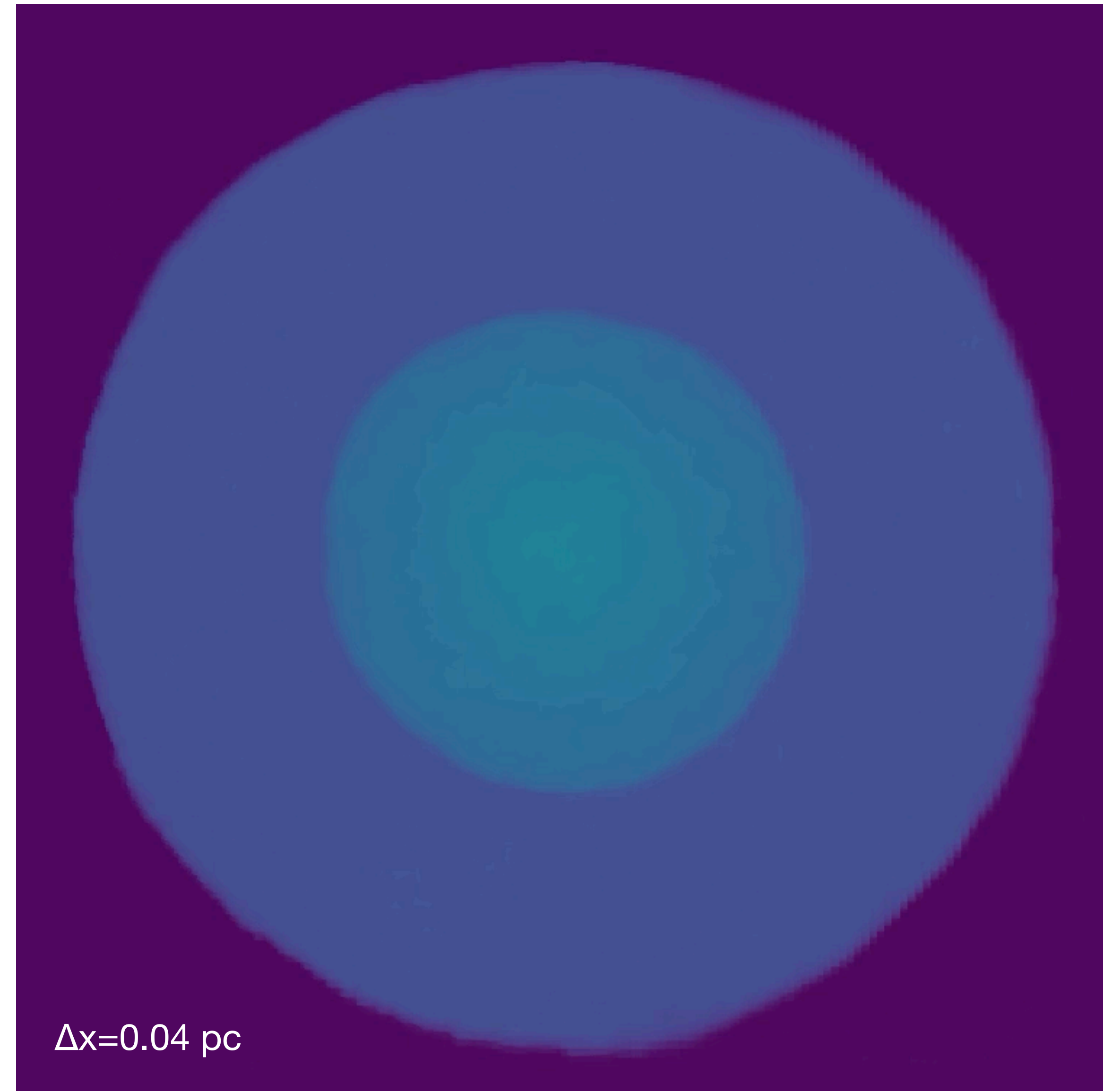
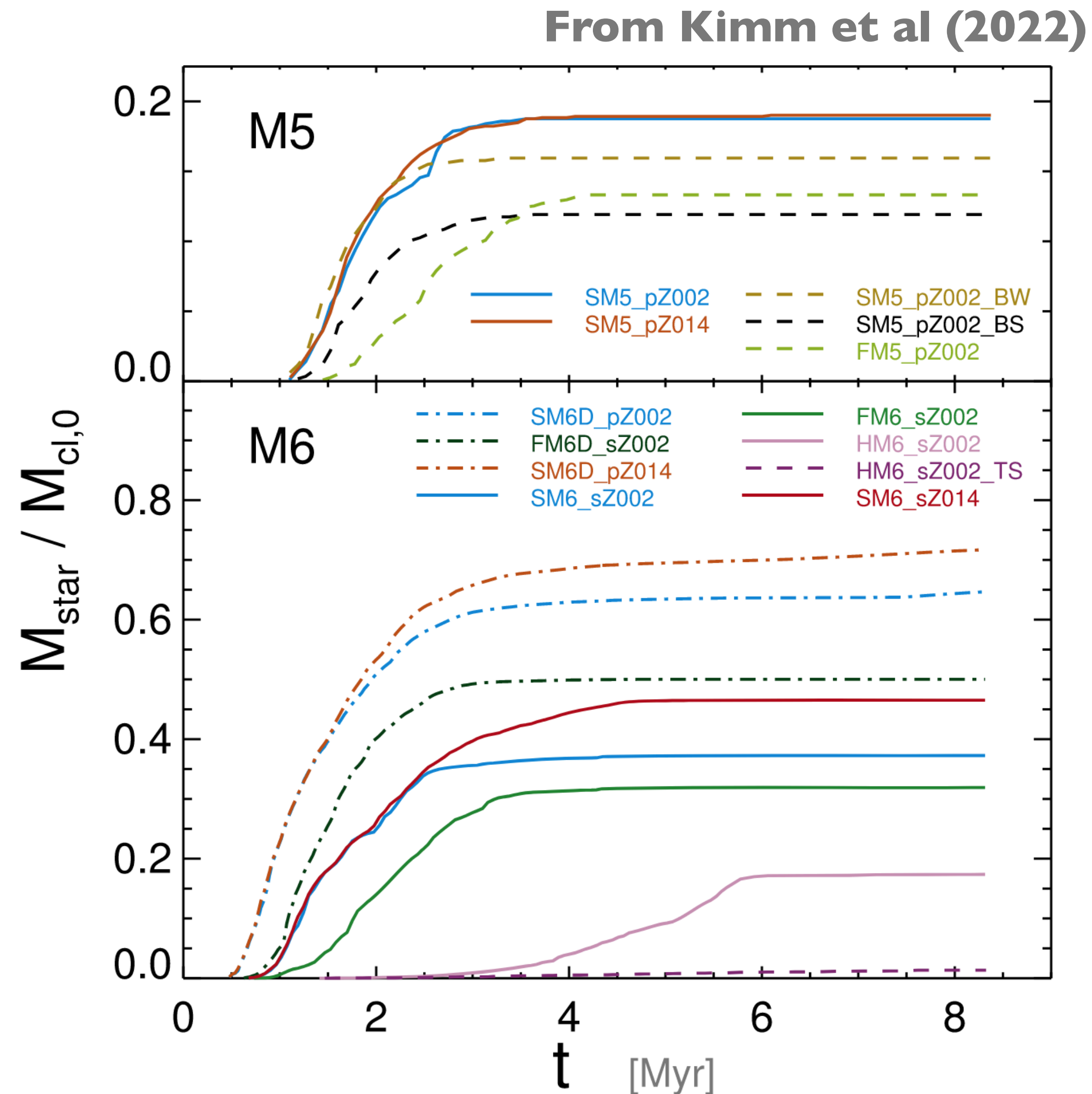


From Agertz et al (2020)



But different story in molecular clouds

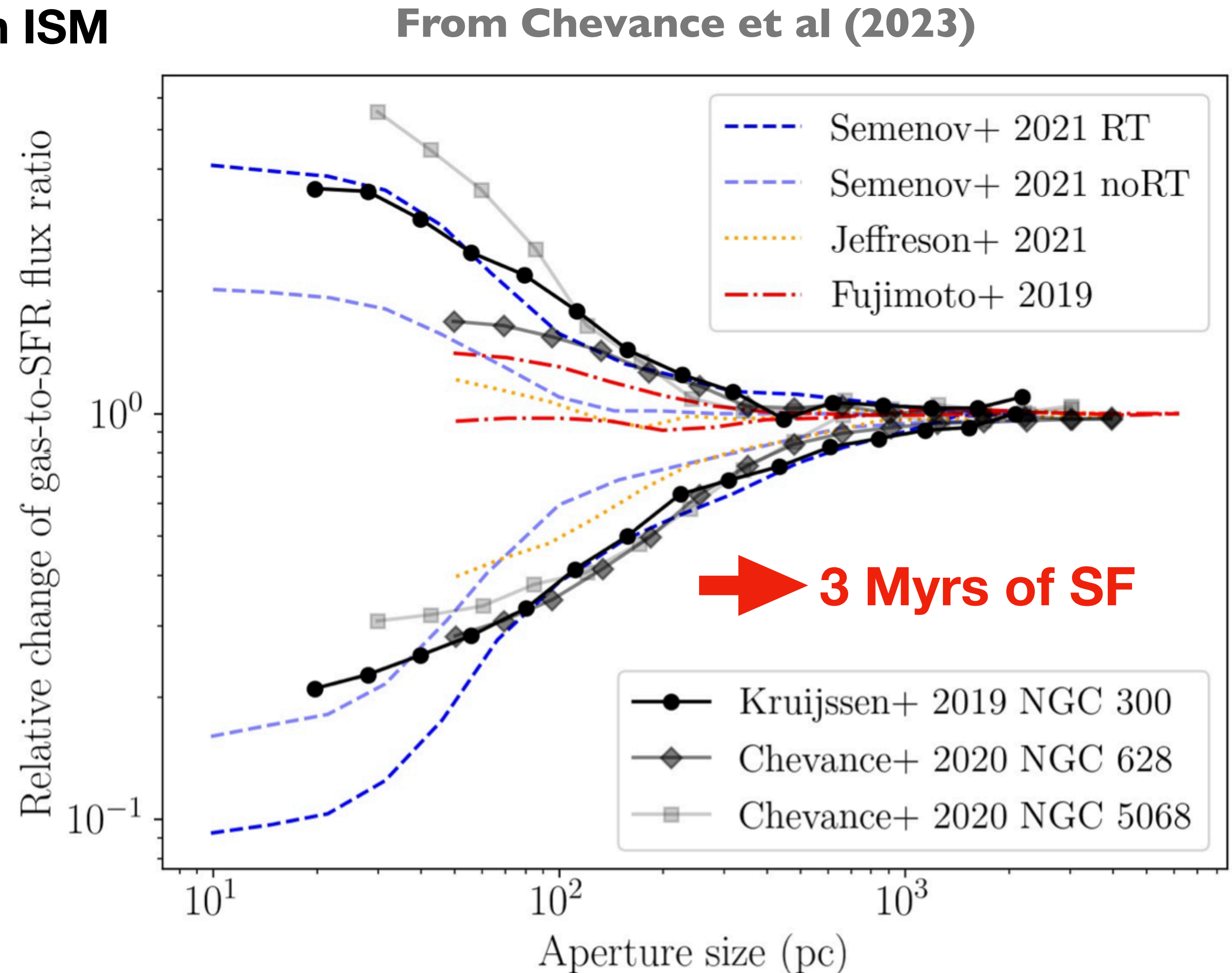
FUV radiation destroys clouds in ~3 Myrs, before SNe
(see Starforge project, Kim+18, Semenov+21)



But different story in molecular clouds

FUV radiation destroys clouds in ~3 Myrs, before SNe
(see 'Forged in FIRE', Kim+18, Semenov+21)

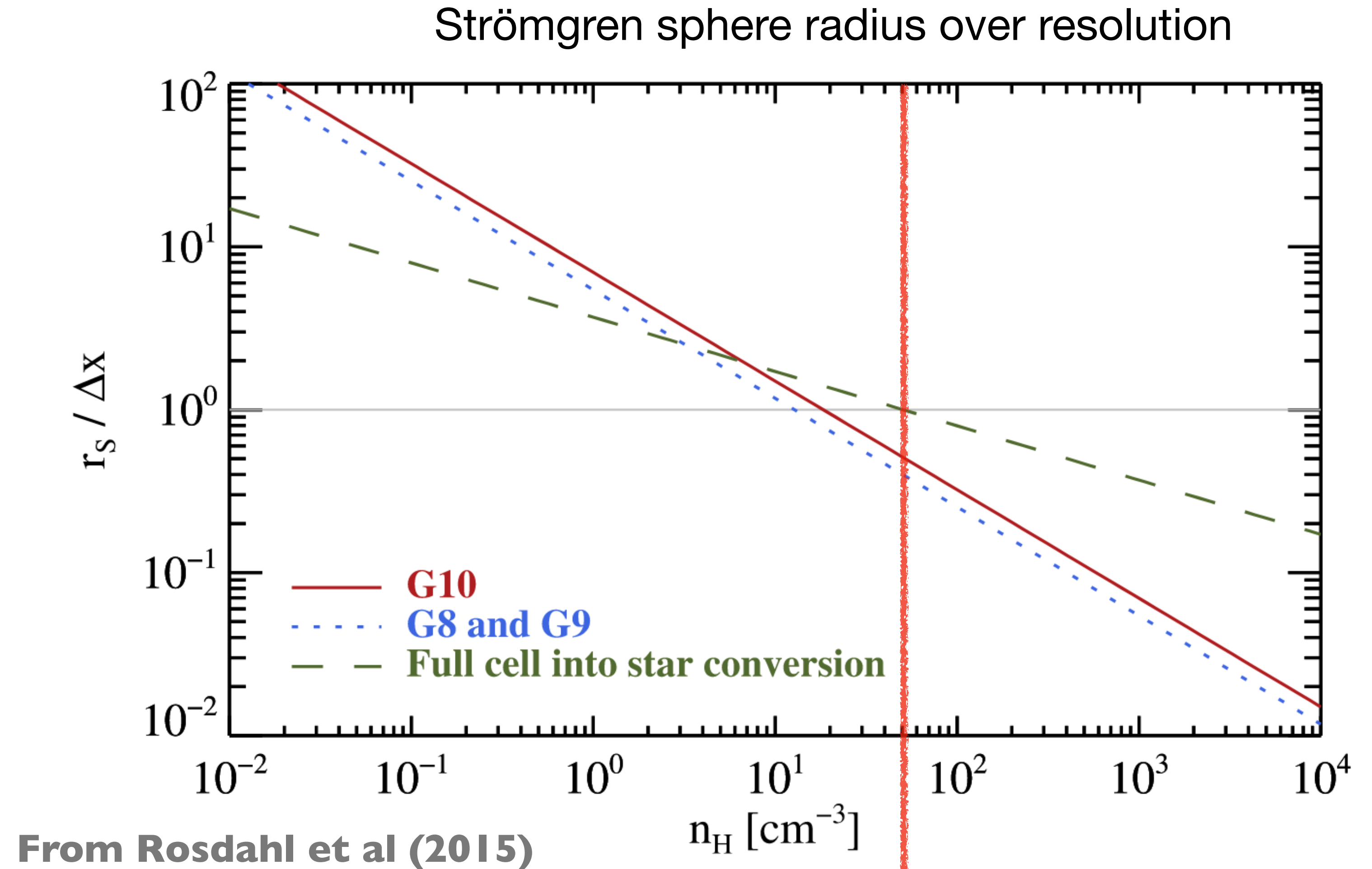
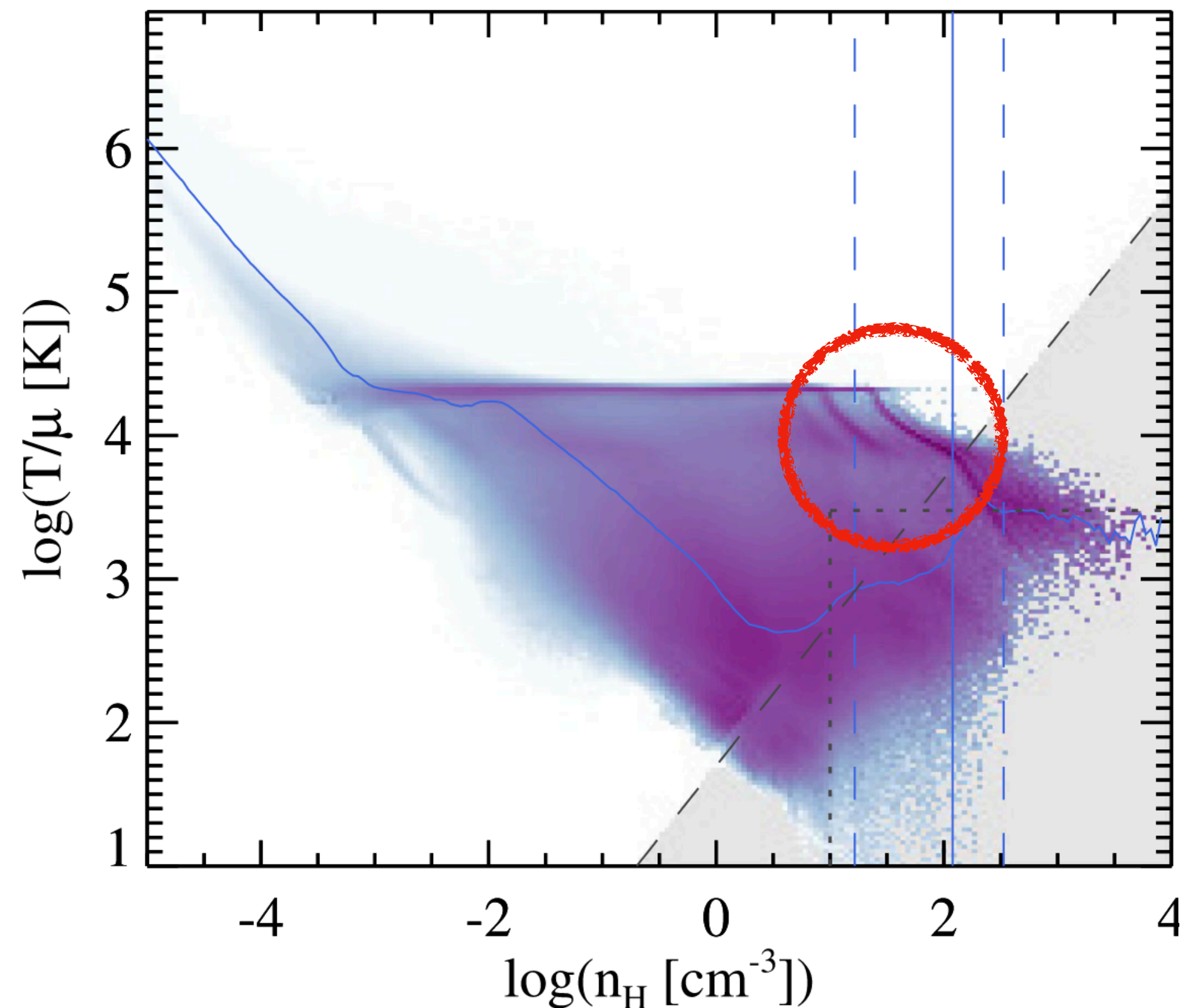
...more or less in agreement with high-resolution ISM observations! (Chevance+, Ramambason+25)



Can radiation feedback be both strong and weak?

Sure! But I don't trust the galaxy-scale simulations just yet.

Resolving Strömgren spheres is a big issue in simulations and requires a do-over in how stars are formed



HII regions are always unresolved for $n_H \gtrsim 50 \text{ H/cc}$

Key questions on radiation feedback

- Can we reconcile weak effects on galactic scales with strong effects in molecular clouds?
- Are we totally underestimating radiation feedback on galactic scales due to lack of resolution? How do we get around the resolution issue?
- Have we given up on radiation pressure and IR boost? See observations by Deb Pathak!
- How can we constrain these processes with observations and theory?
- What about Ly α radiation pressure?
- And reionisation-feedback?
- Photoelectric feedback?
- How does radiation feedback interplay with cosmic rays? Or stellar winds?