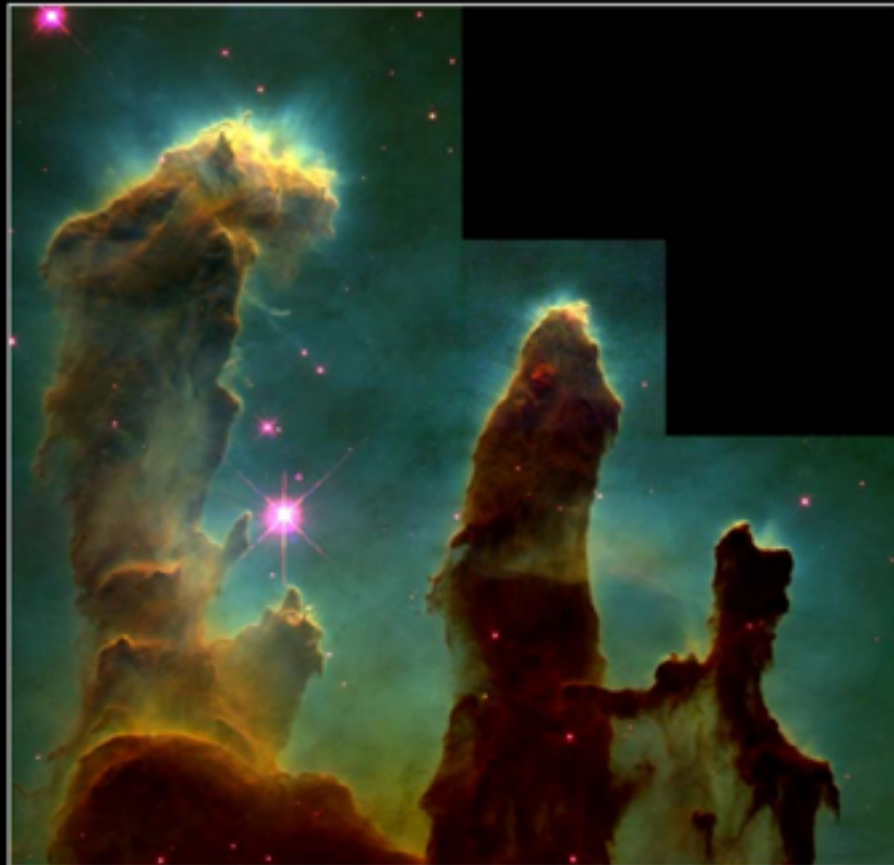


Photoionisation feedback in star formation simulations



Gaseous Pillars · M16

HST · WFPC2

PRC95-44a · ST ScI OPO · November 2, 1995
J. Hester and P. Scowen (AZ State Univ.), NASA

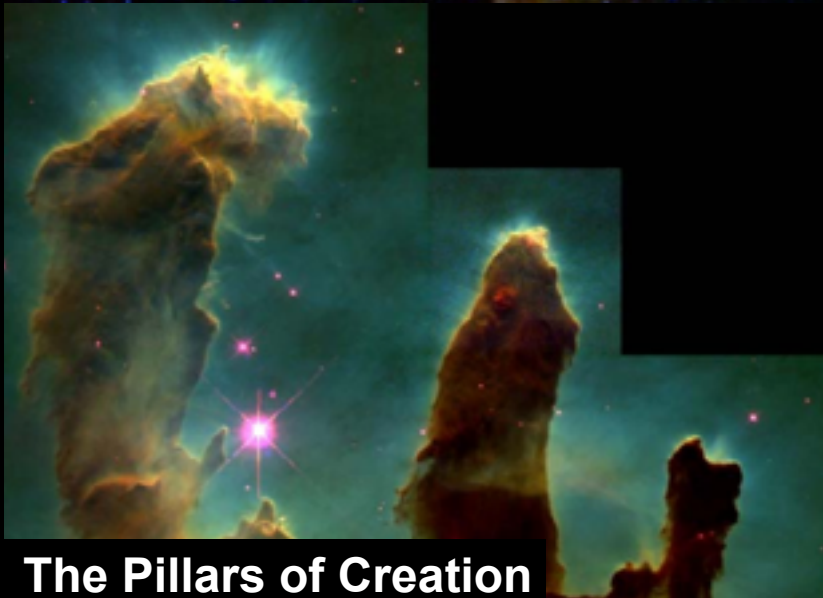
Barbara Ercolano
University of Exeter

with thanks to
M. Gritschneider

The Elephant Trunk



The Carina Nebula



The Pillars of Creation



30 Doradus

Can photoionisation Feedback...

- ...provide an upper limit to the mass of stars?
 - > *affect the IMF*
- ...disrupt the parent cloud and inhibit further SF?
 - > *affect SF efficiency (negative)*
 - > *affect cluster dispersal*
- ...trigger star formation ?
 - > *affect the SF efficiency (positive)*
- ...drive turbulence in the parent cloud?

How?

How?

Requires solution of RT and photoionisation problem simultaneously with hydro.

Grid-based codes include (e.g.):
Mellema+ (2006); Peters+ (2010)

SPH codes include :
Kessel-Deynet & Burkert (2003); Miao+(2006);
Dale+ (2007); Gritschneider+ (2009); Bisbas+(2009)

See e.g. reviews by Klessen+(2009), Mac Low (2007)

Some common approximations

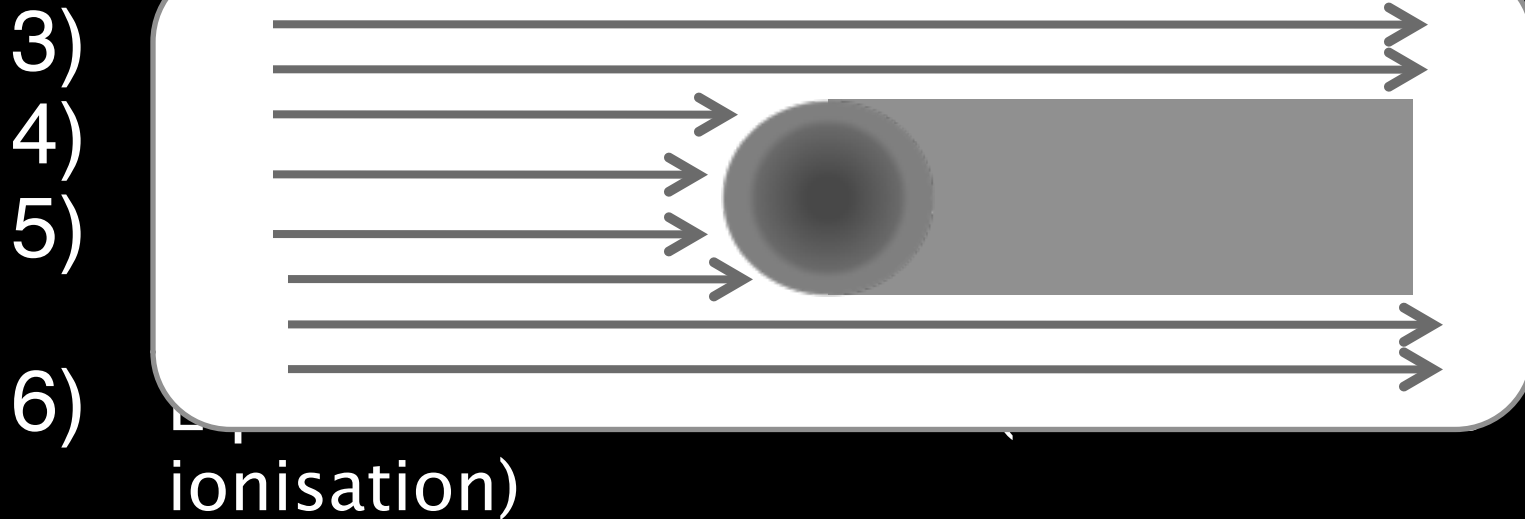
- 1) Monochromatic radiation field
- 2) On the spot approximation (no diffuse field)
- 3) Ionisation balance not solved
- 4) Heating and cooling is approximated
- 5) Temperature is a simple function of ionisation fraction
- 6) Equilibrium calculations (instantaneous ionisation)

Some common approximations

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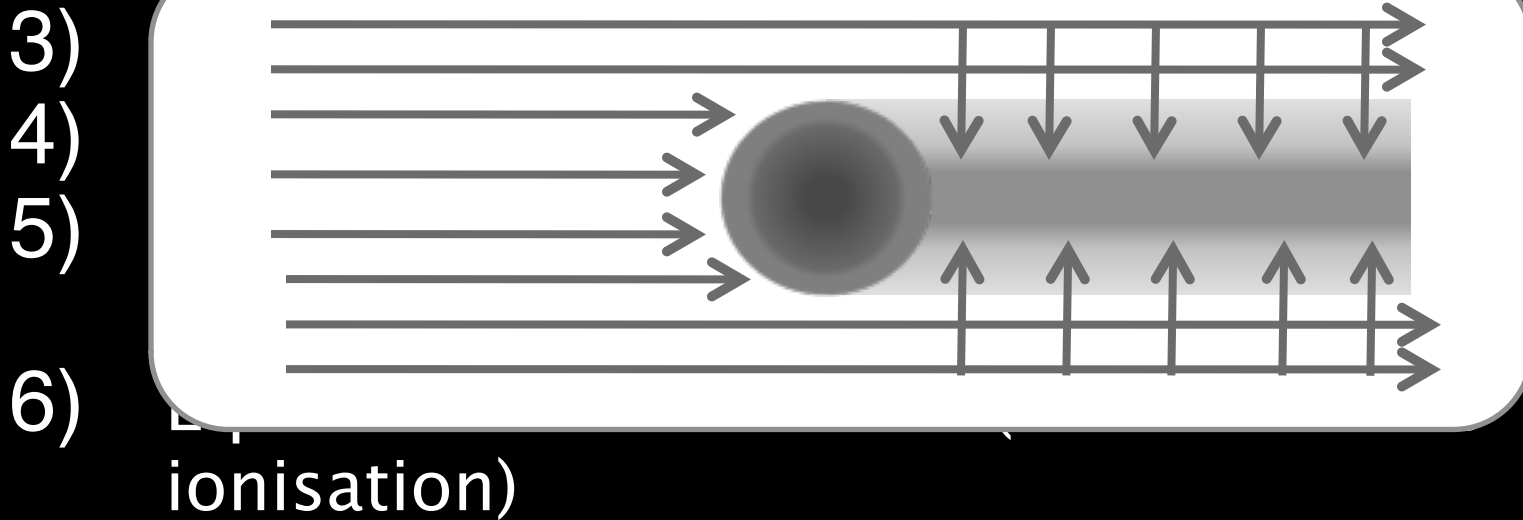
Some common approximations

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Some common approximations

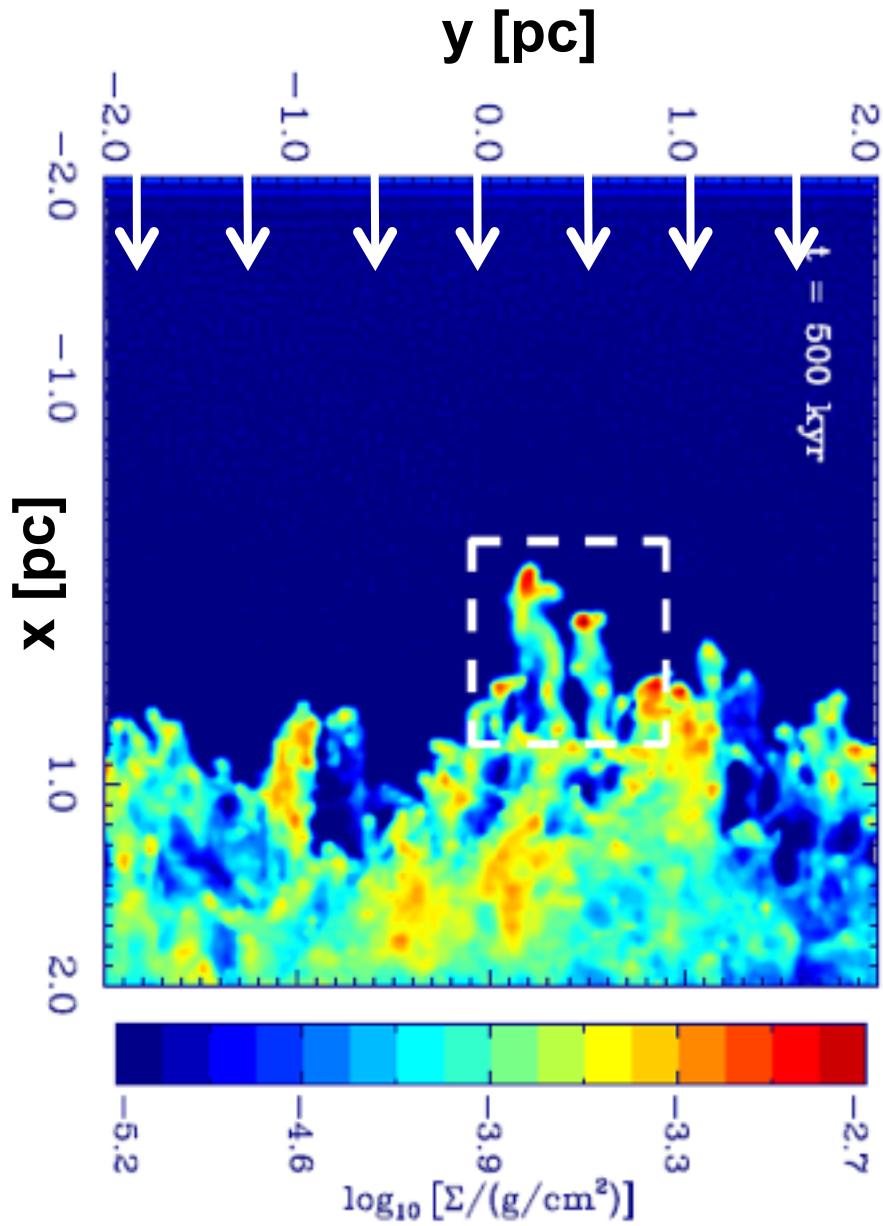
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How good are the approximations?

Test against fully 3D Monte Carlo
photoionisation code MOCASSIN
(Ercolano et al 2003, 2005, 2008)

Density snapshot
from the hydro → MOCASSIN → Temperature
& Ionisation



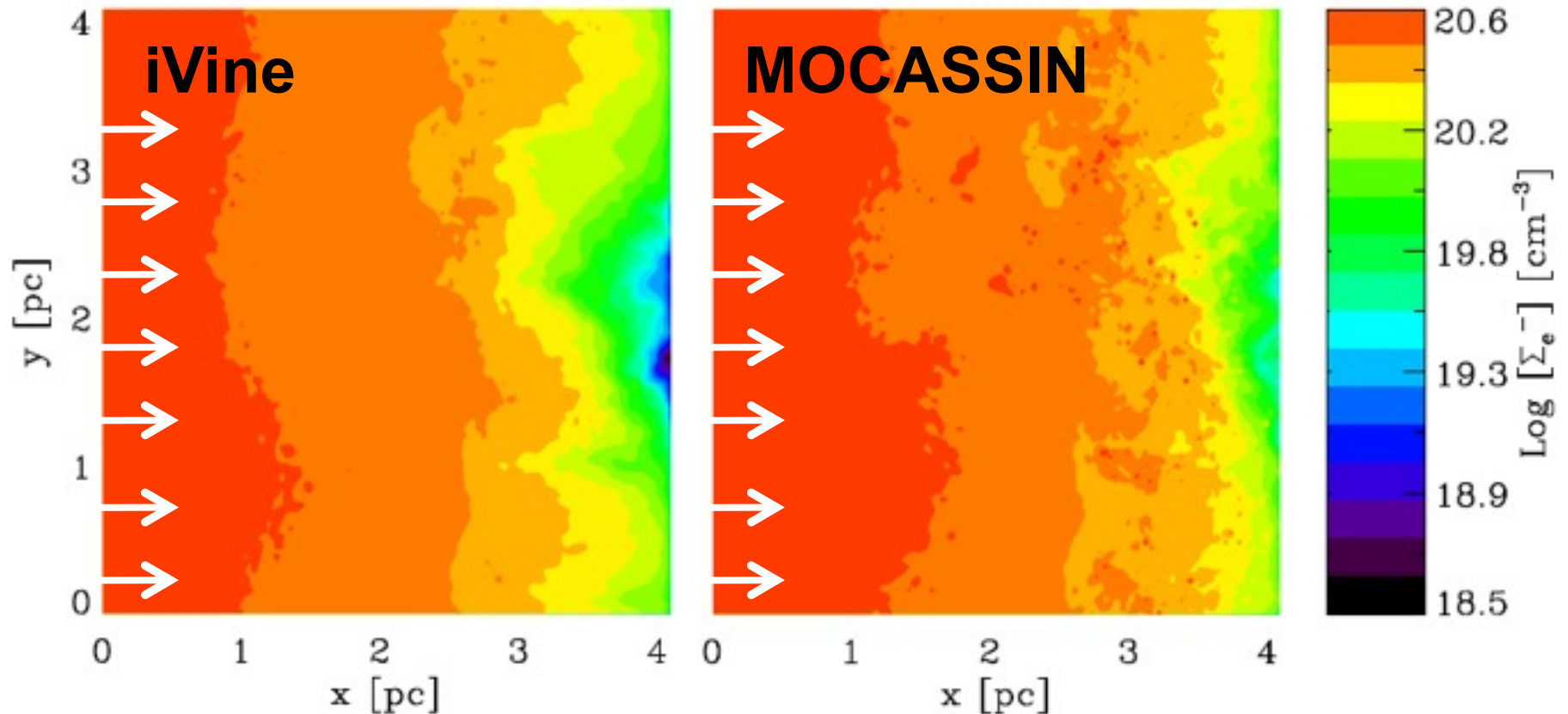
Gritschneider et al 2009

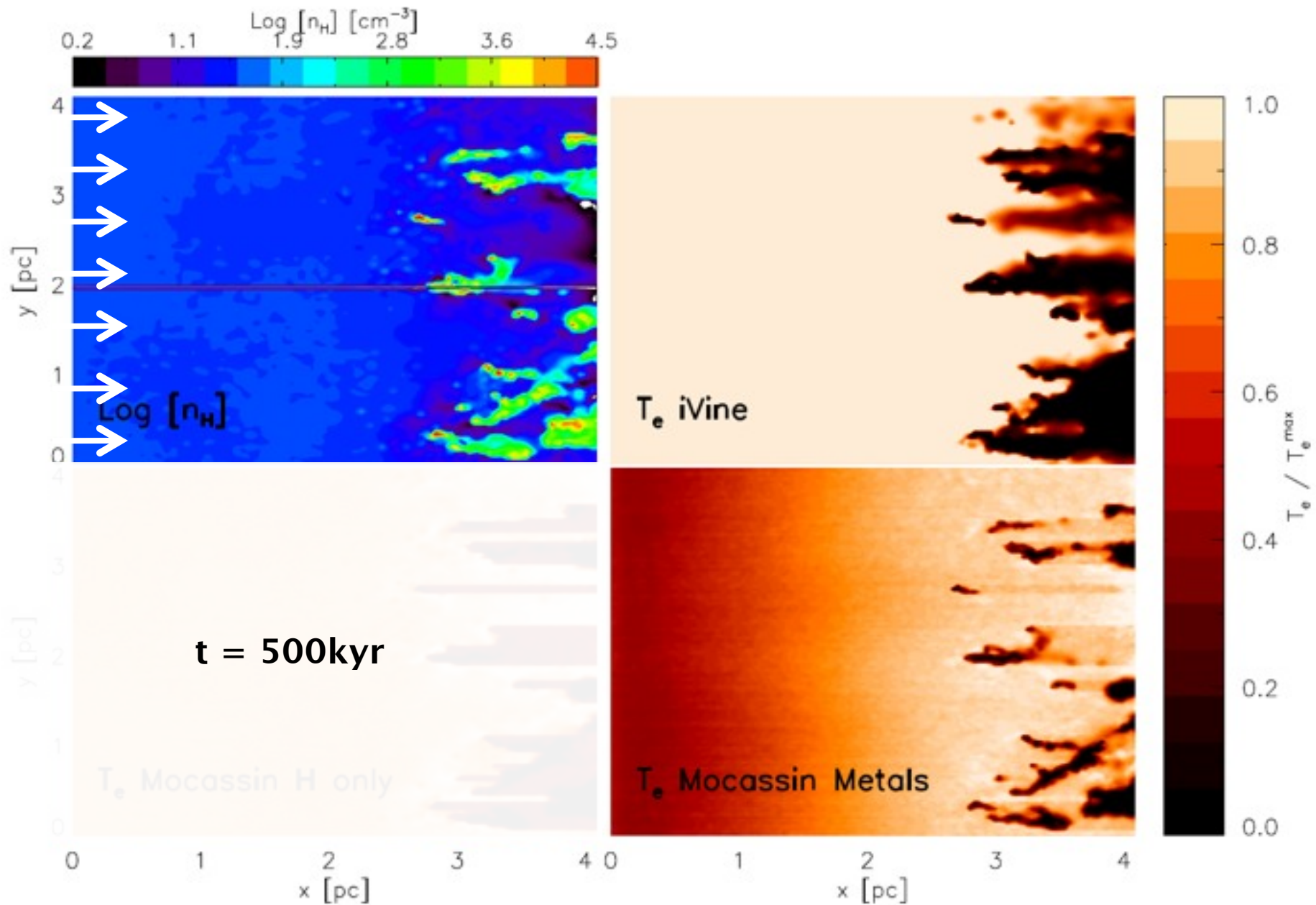
Total ionised mass fraction:

iVine = 13.9%

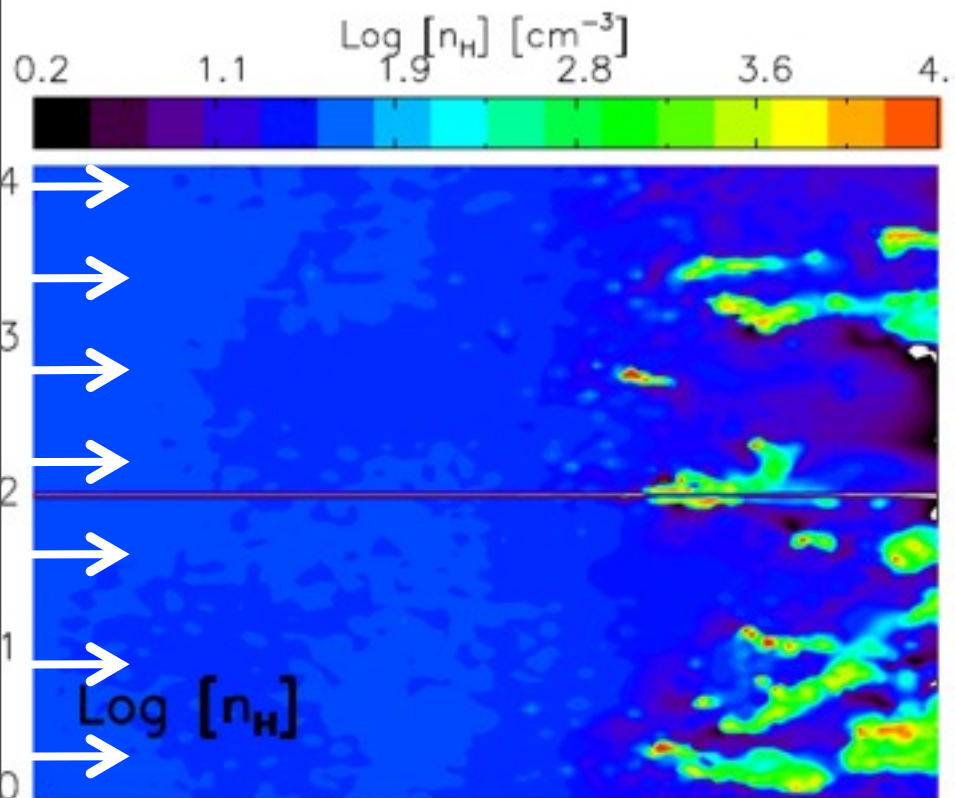
MOCASSIN = 14.1%

Surface electron density

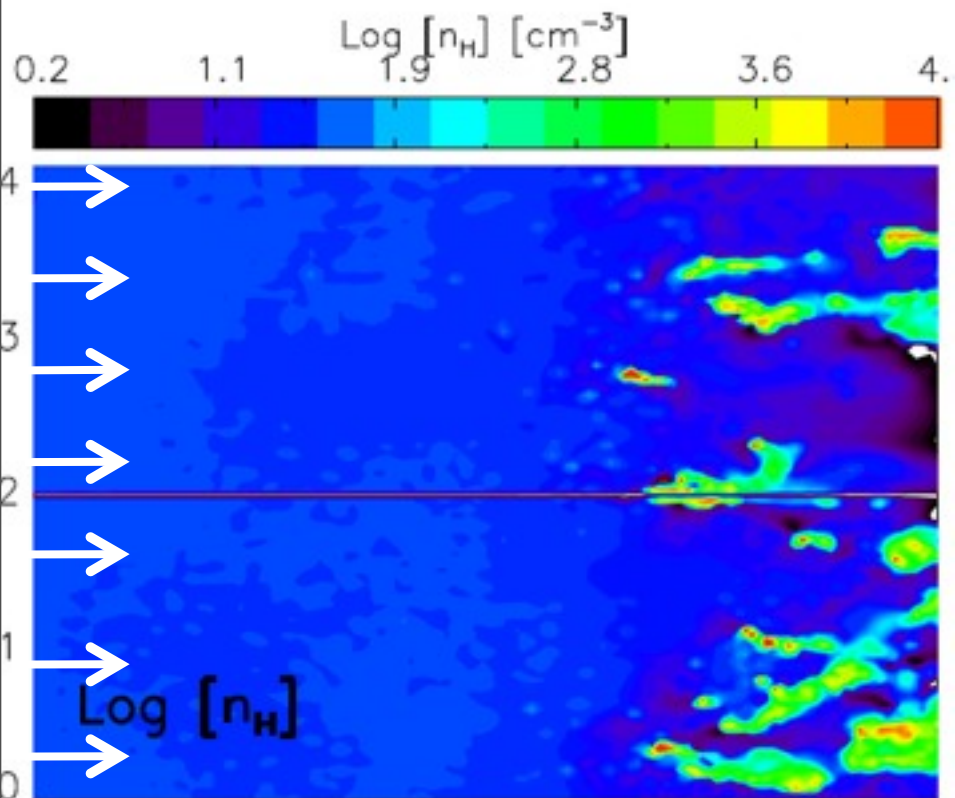




Ercolano, Gritschneider et al, 2010, in prep

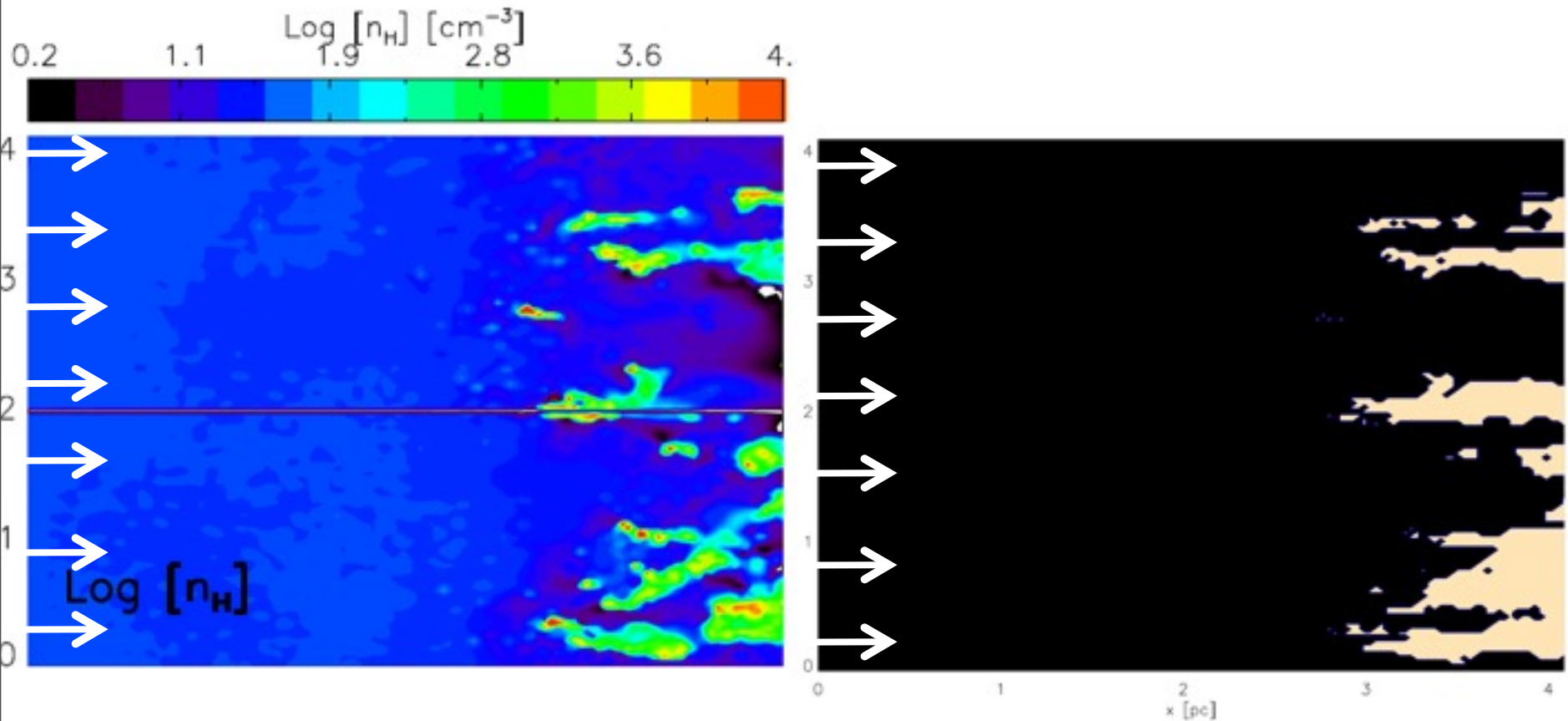


How can we approximate the effect of the diffuse field?



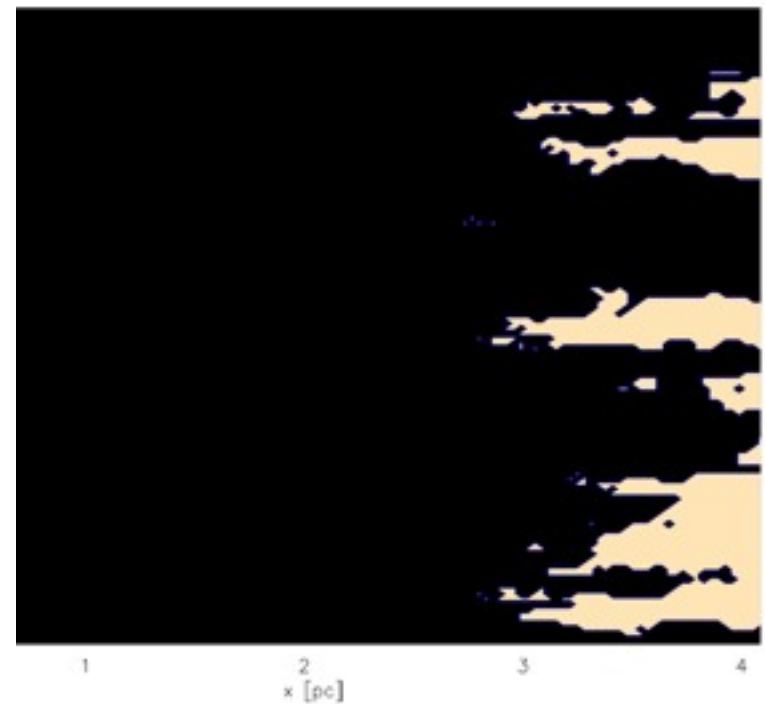
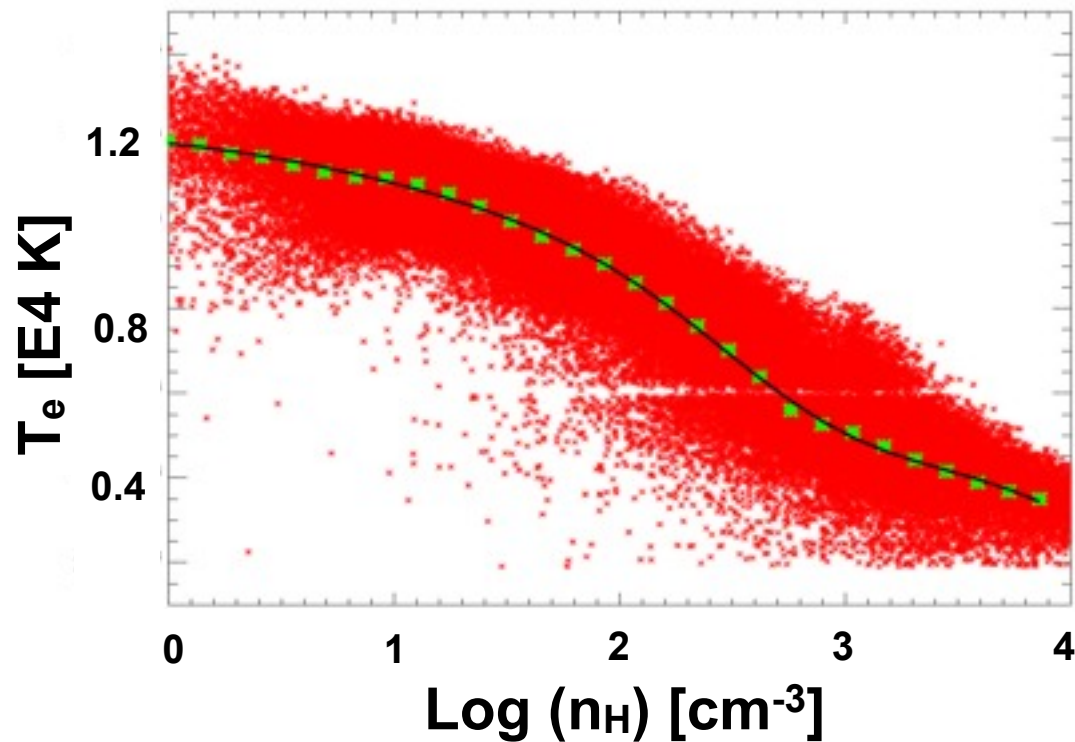
How can we approximate the effect of the diffuse field?

1) Identify the diffuse field dominated regions (shadow)



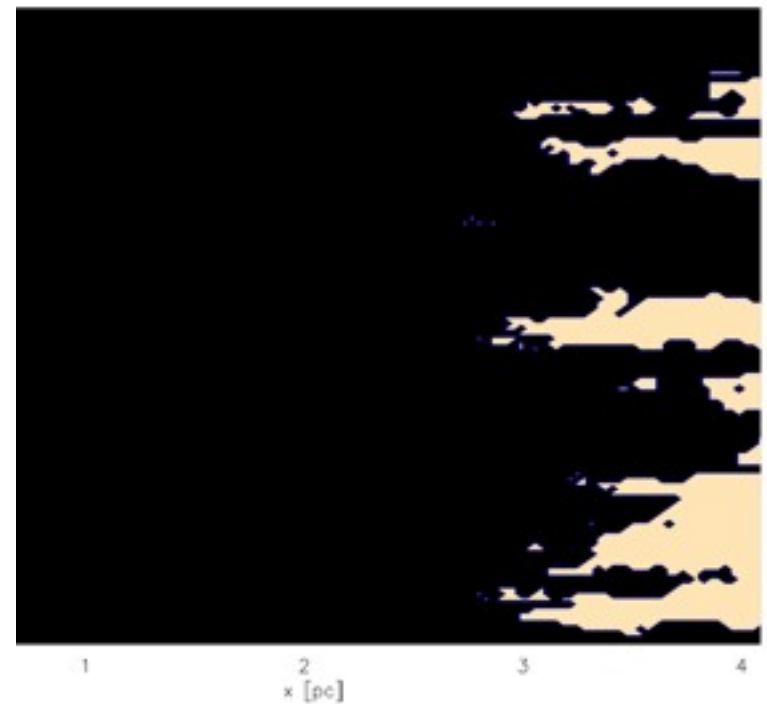
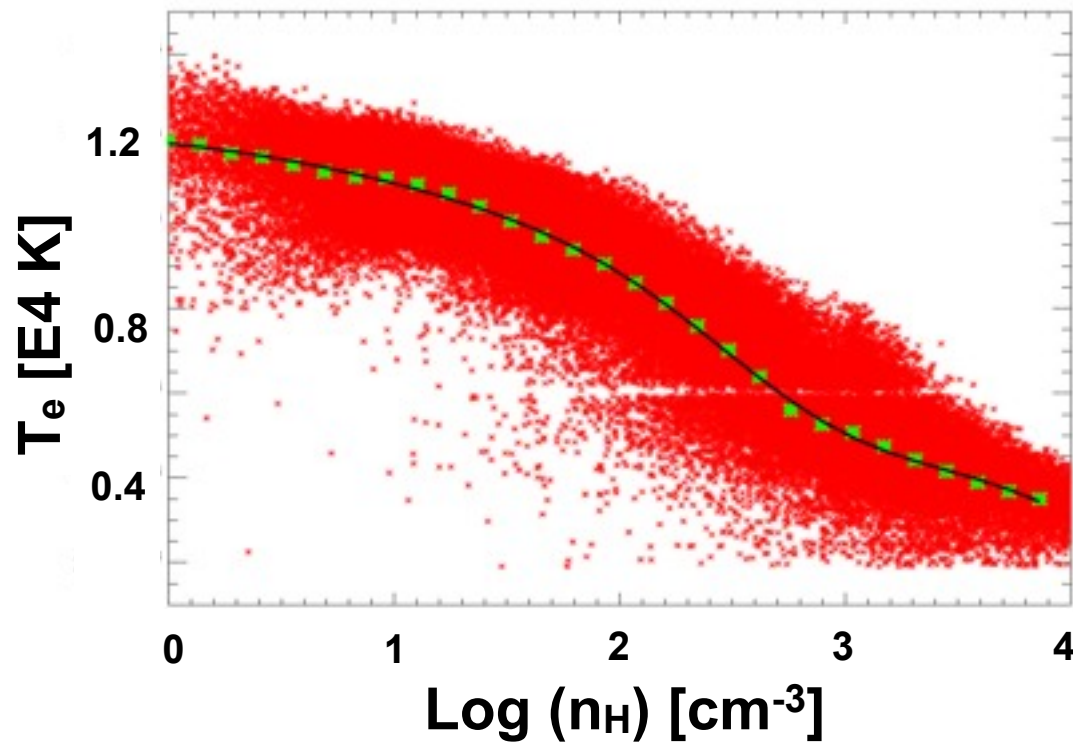
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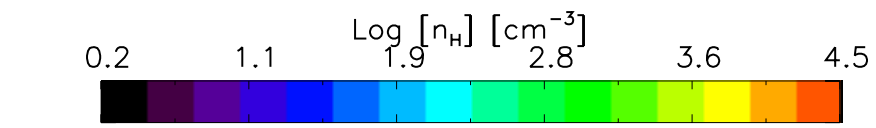
- 1) Identify the diffuse field dominated regions (shadow)
- 2) Characterise the temperature structure with MOCASSIN



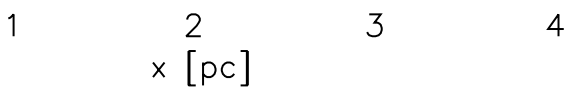
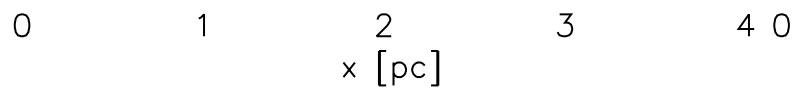
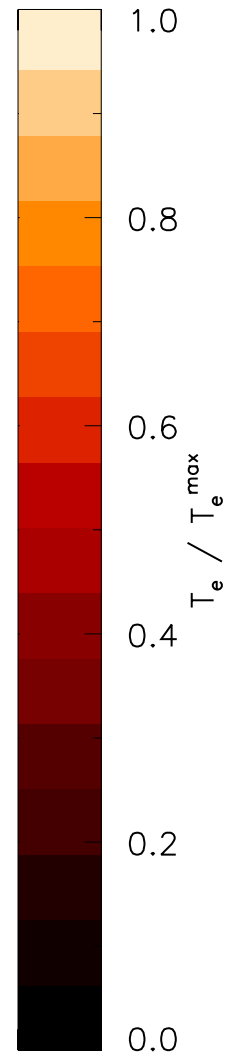
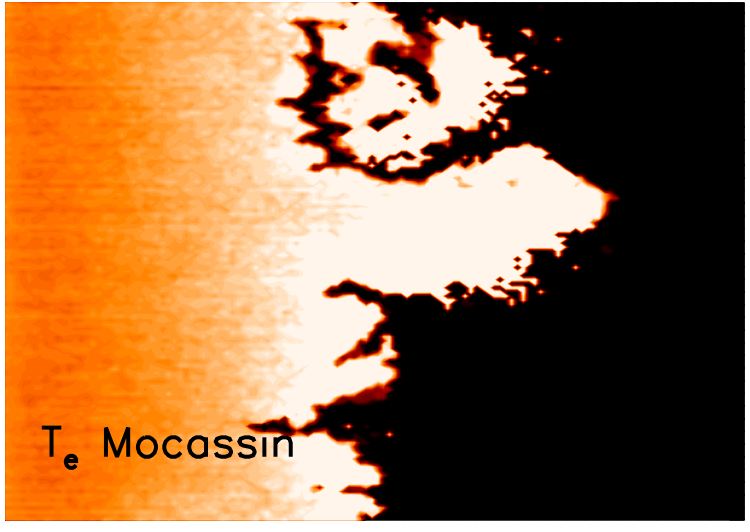
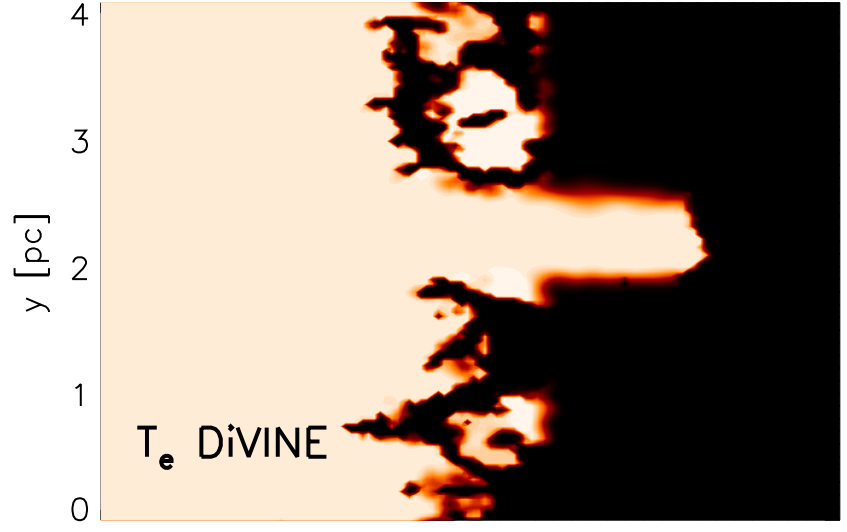
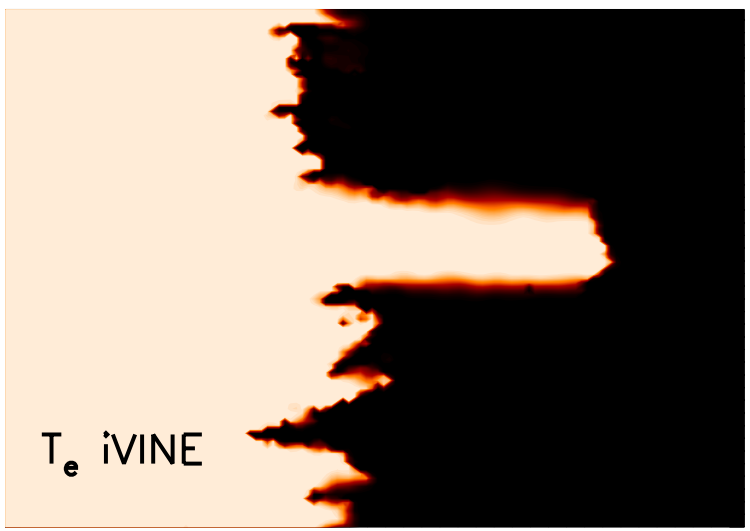
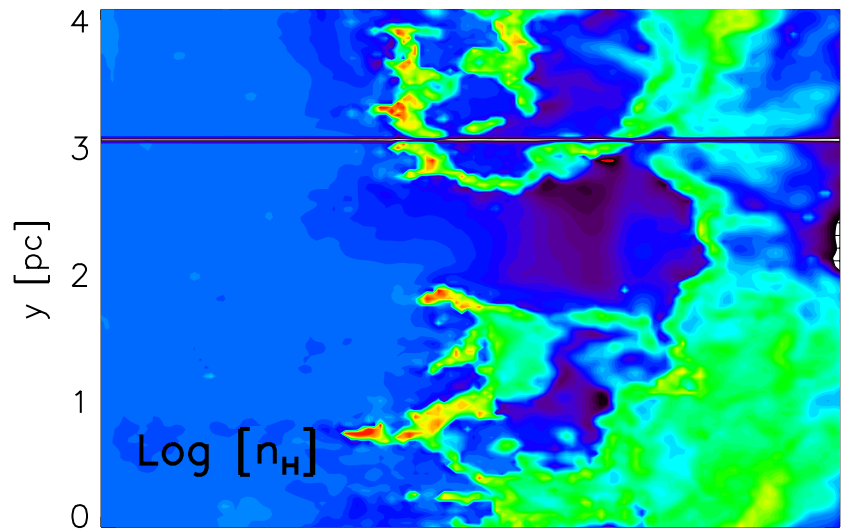
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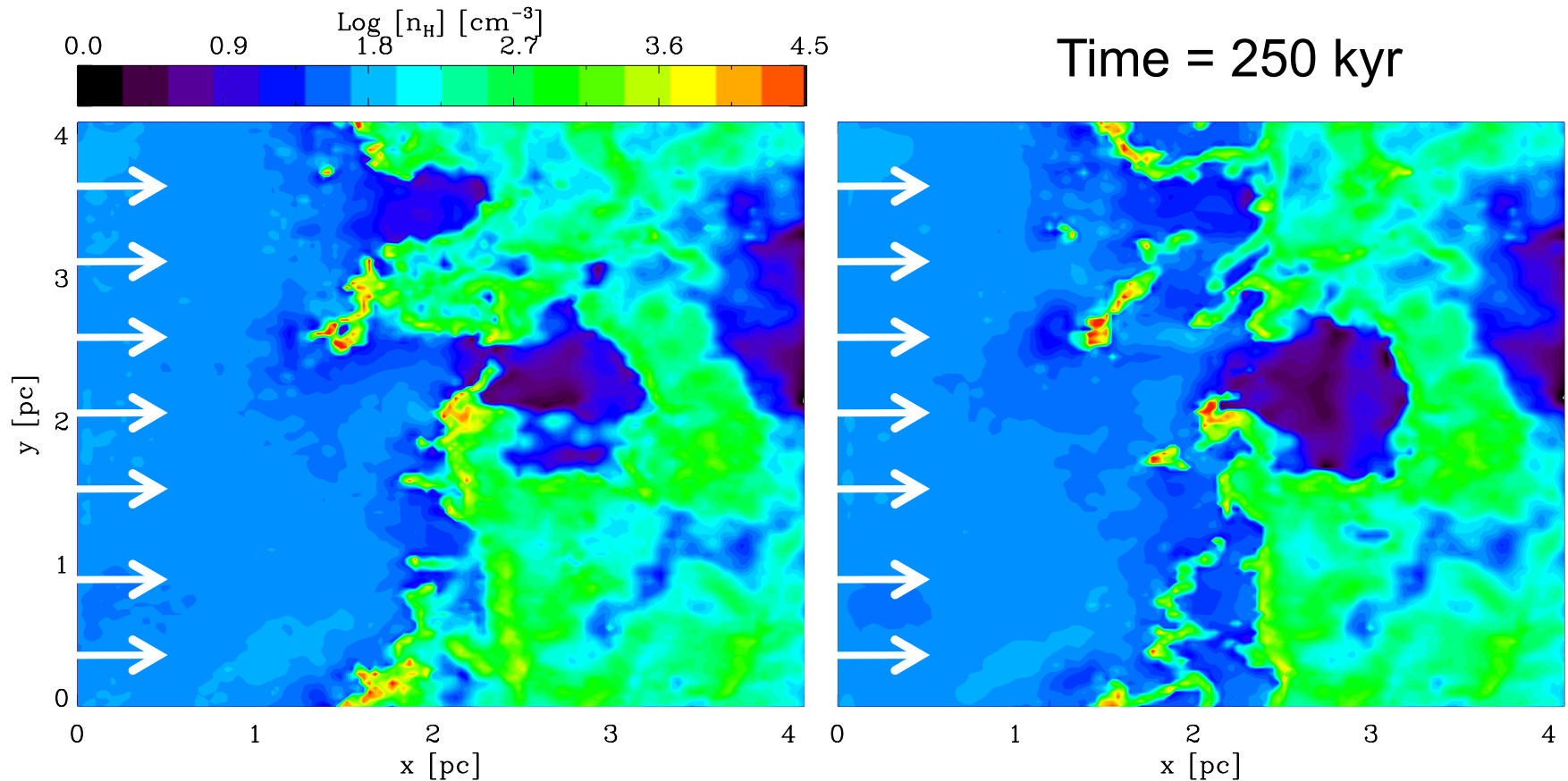
- 1) Identify the diffuse field dominated regions (shadow)
- 2) Characterise the temperature structure with MOCASSIN
- 3) Use a parameterised curve to describe T in iVINE





Time = 250 kyr

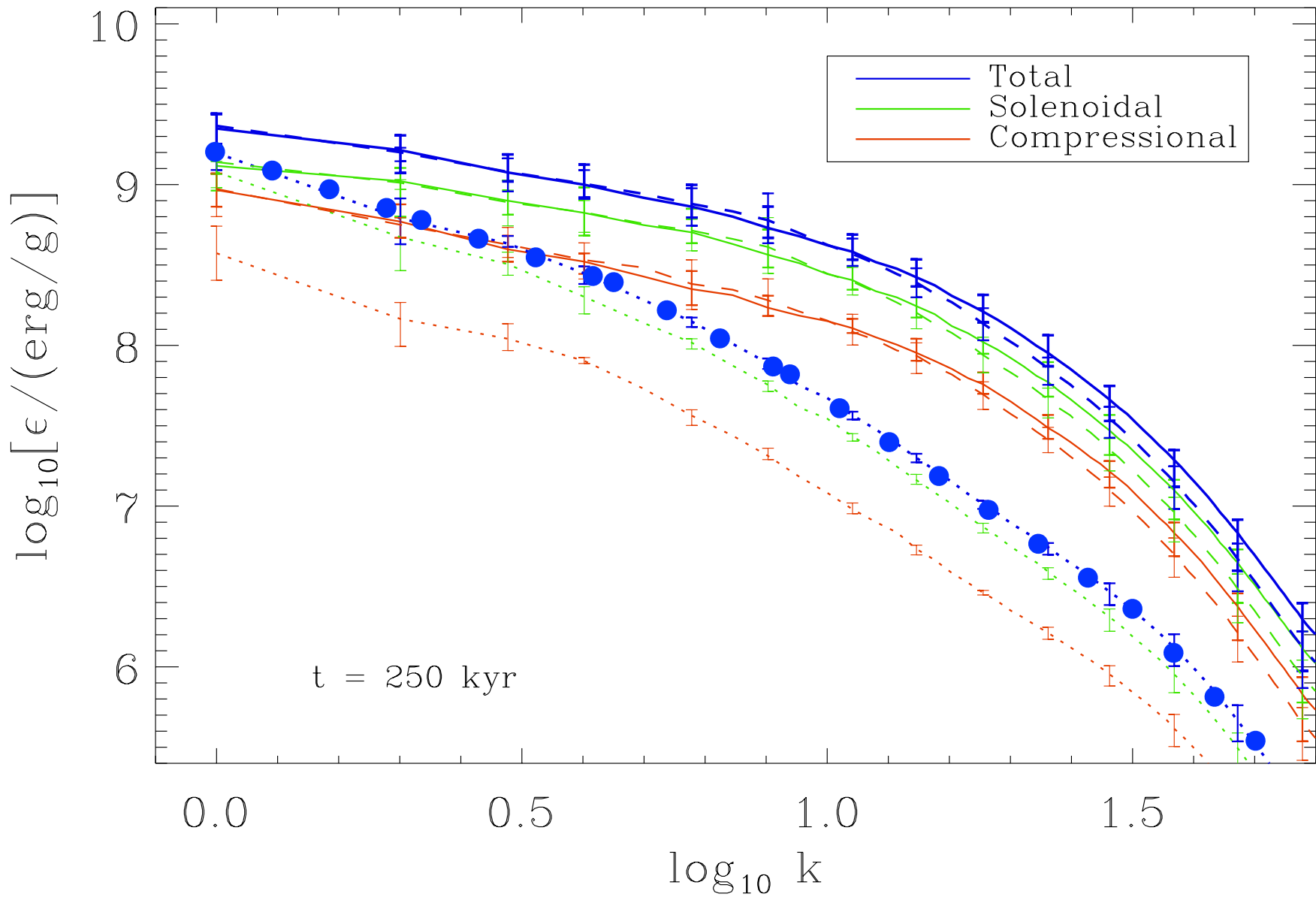




iVINE (no diffuse field)

DiVINE (with diffuse field)

Diffuse field seems to promote the detachment of structures



Tests so far have shown...

**Scope for improving current algorithms
to move from numerical experiments
to the realm of simulations**

Tests so far have shown...

- Approximations OK for estimating the ionised mass
- Temperature distribution is poorly represented
- Diffuse field can affect the evolution of structures
- Turbulence driving less efficient with diffuse field

**Scope for improving current algorithms
to move from numerical experiments
to the realm of simulations**

Thank you