îledeFrance Action financée par la Région Ile-de-France

Modelling scattering

Between 3 and 8 *μ*m

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the "Hunting Coreshine with Spitzer" consortium

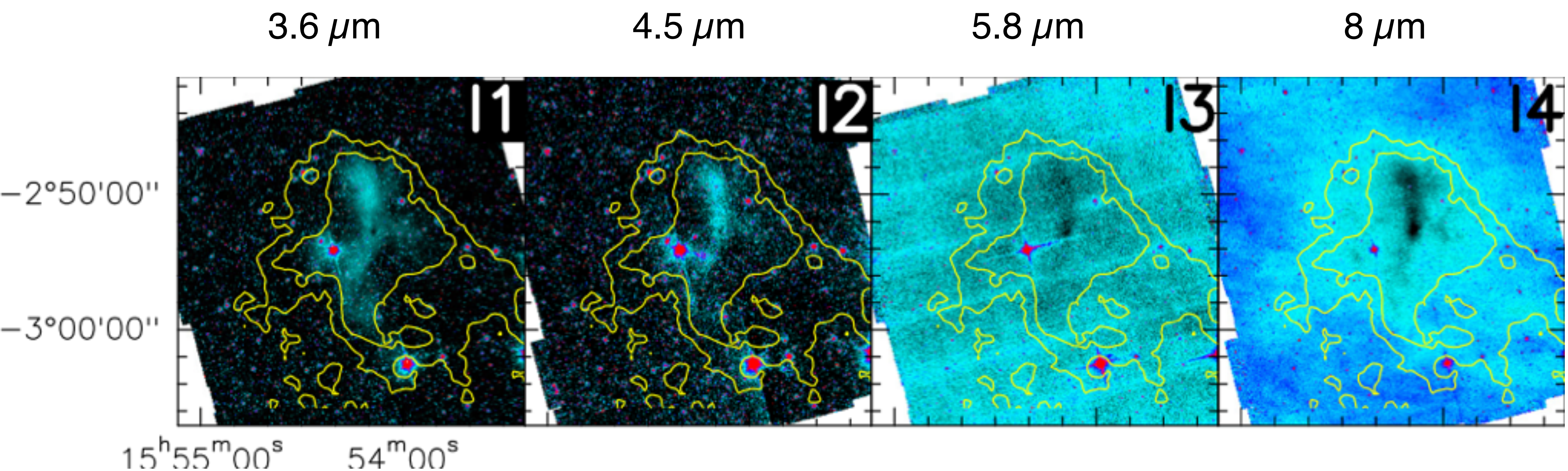
Outline

- MIR scattering
  - What, where, why?
  - Link to the dust properties

- Starless core modeling :
  - Simple cloud model : focus on dust properties
  - Towards a real cloud model build with NIR extinction and N2H+

L183 Spitzer/IRAC images

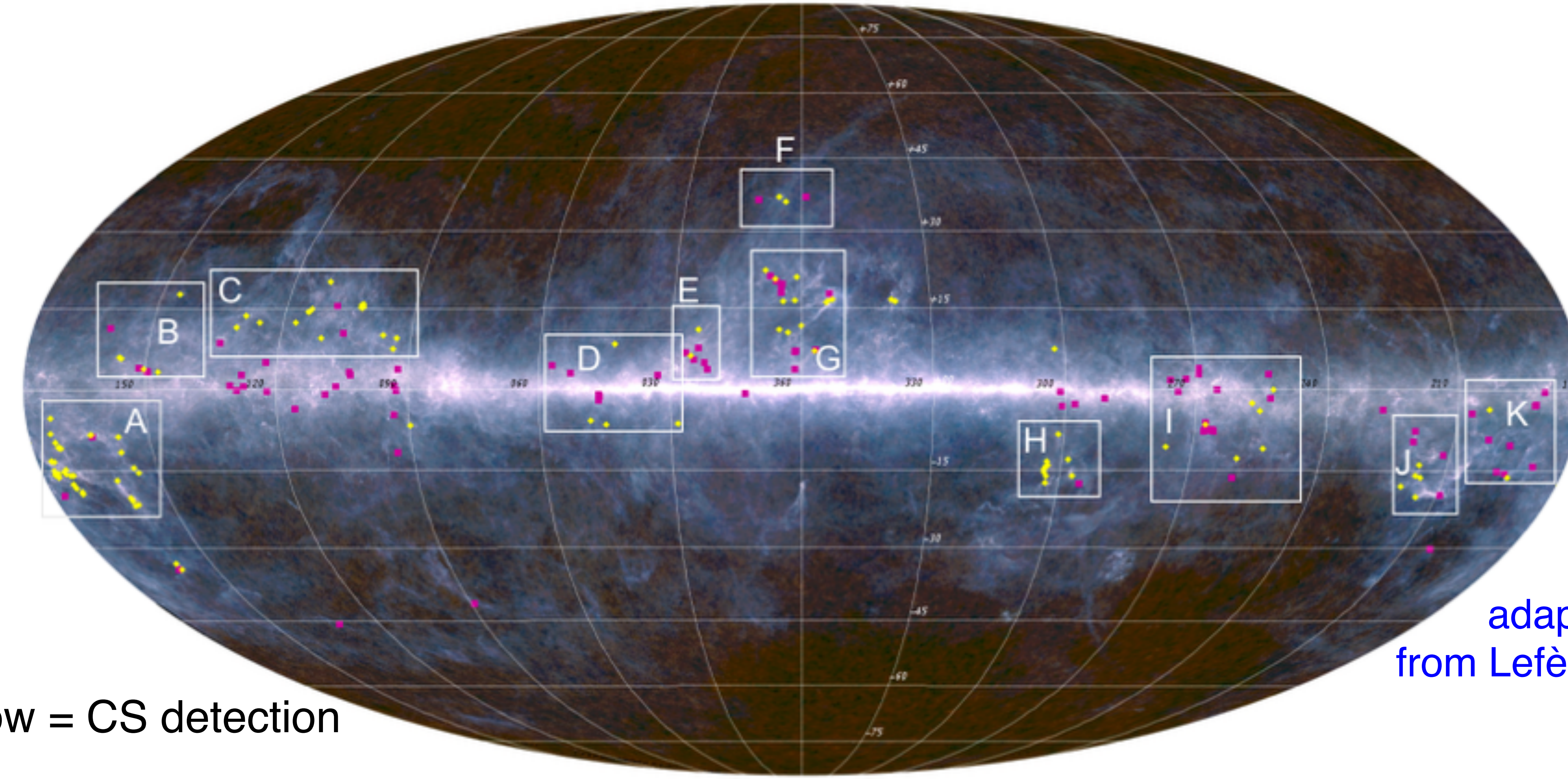
contours : Av = 5 and 10 mag



Coreshine : Scattered light seen in MIR

Steinacker et al. 2010
Pagani et al. 2010

A widespread phenomenon



adapted
from Lefèvre 2014

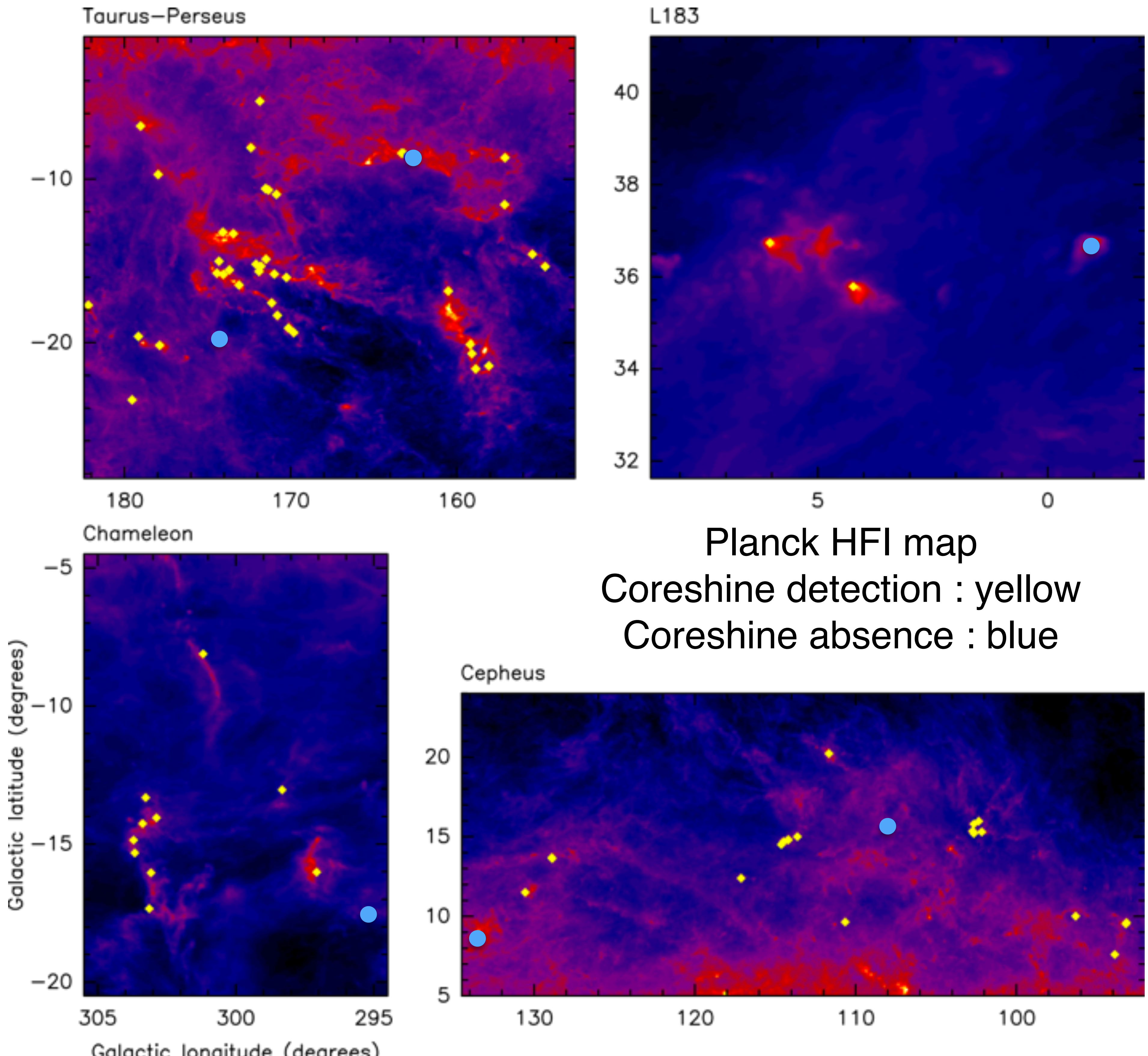
Yellow = CS detection

Pagani 2010 + **Hunting coreshine** survey (PI: Paladini) gives at least 50% of Moc show coreshine

	Taurus	Auriga	**Cepheus**	Aquila	Serpens	**L183 complex**	Rho Oph	**Chameleon**	Gum/Vela	Monoceros	Orion	Others	**Total**
	A	B	**C**	D	E	**F**	G	**H**	I	J	K		
Nb	42	9	22	11	7	**4**	23	11	24	9	11	33	**206**
CS	40	5	20	4	2	**2**	14	10	7	5	2	7	**118**
%	**95**	55	**91**	36	29	**50**	61	**91**	29	56	18	21	**57**

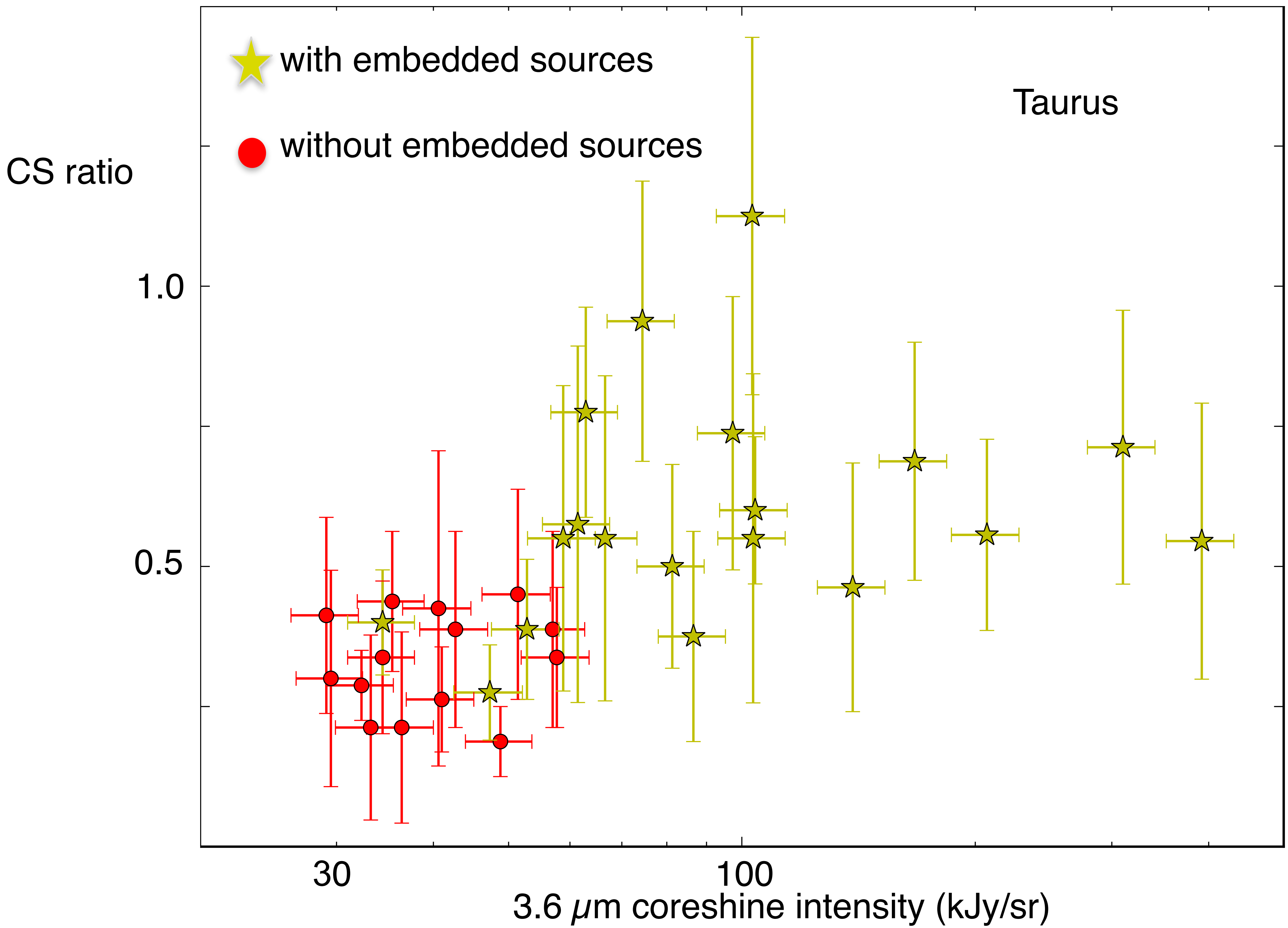
4 regions : 100% positive cases ?

Taurus/Perseus
L183
Chameleon
Cepheus

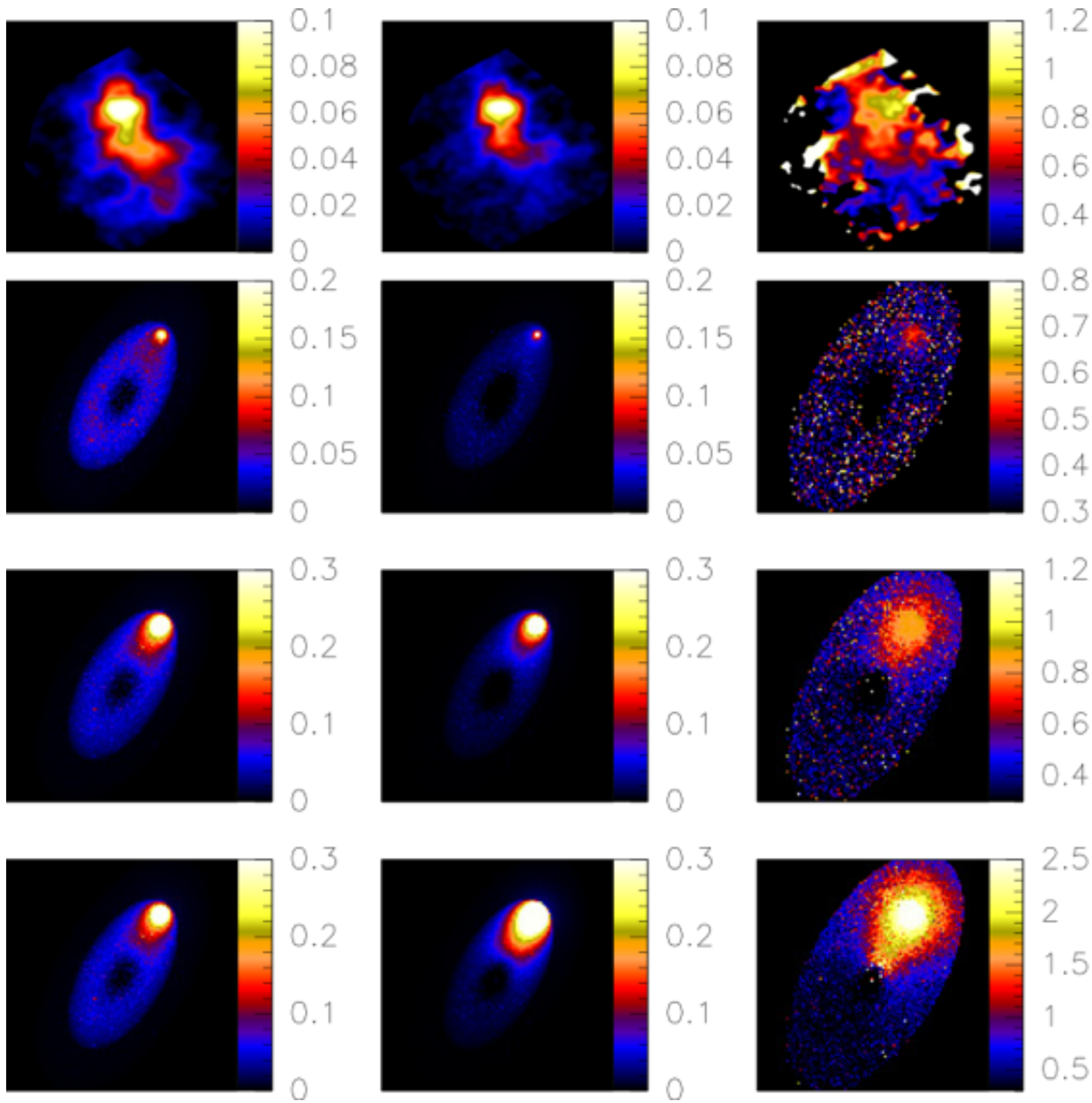


Planck HFI map
Coreshine detection : yellow
Coreshine absence : blue

Embedded sources = higher CS ratio



Class O/I enhance the CS ratio



IRAM 04191

2150 K

950K

400K

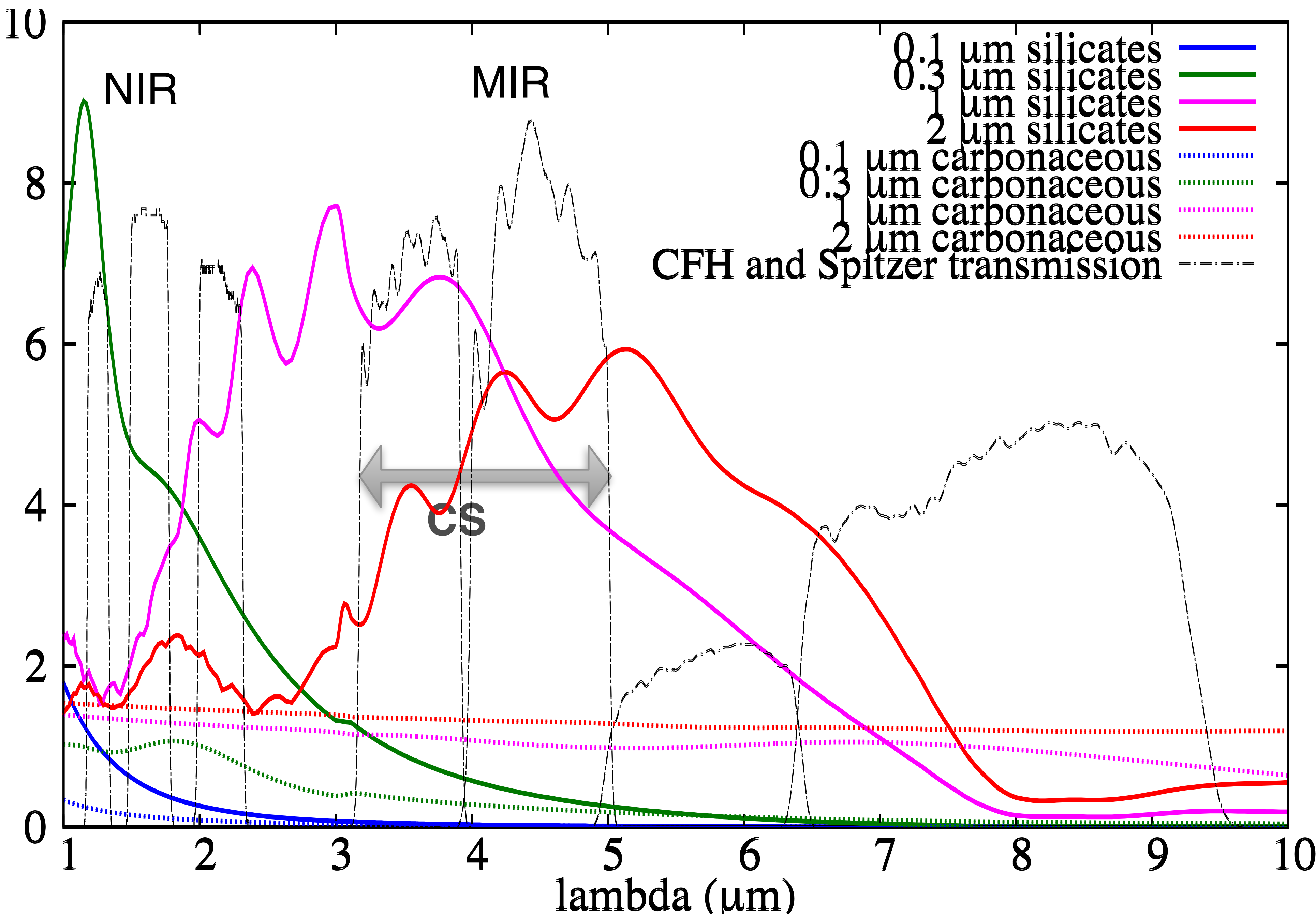
I1 intensity

I2 intensity

CS ratio

Grain properties function of their size, composition and wavelength

Qsca/Qabs – DustEm – Compiègne 2011 grains



Modeling to be compared with Observations + Wavelength ratio

Diffusion > Absorption

Large grains (0.5 ~ 1 µm) able to explain coreshine

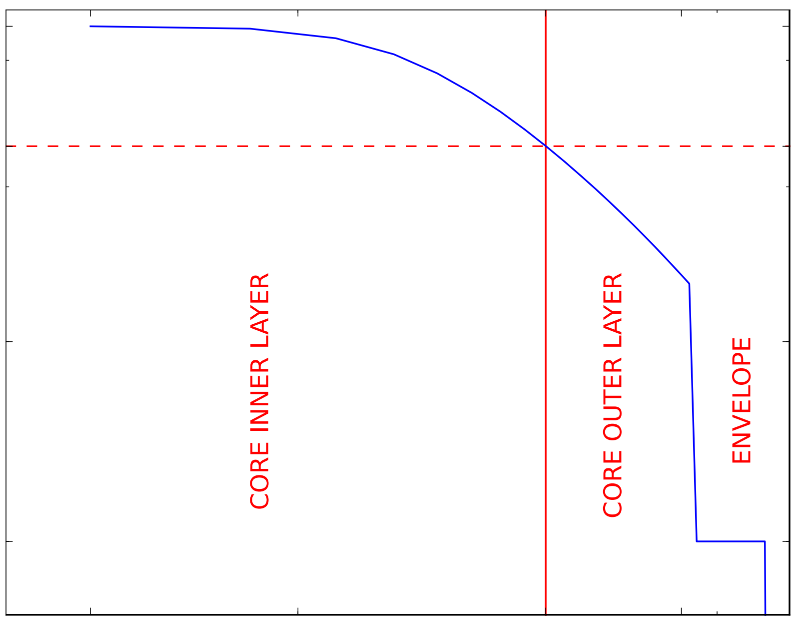
Starless Core Modelling

- Scattering between 3 and 8 µm
  - coreshine 3.6 and 4.5 μm scattering : what, where, why?
  - Link to the dust properties

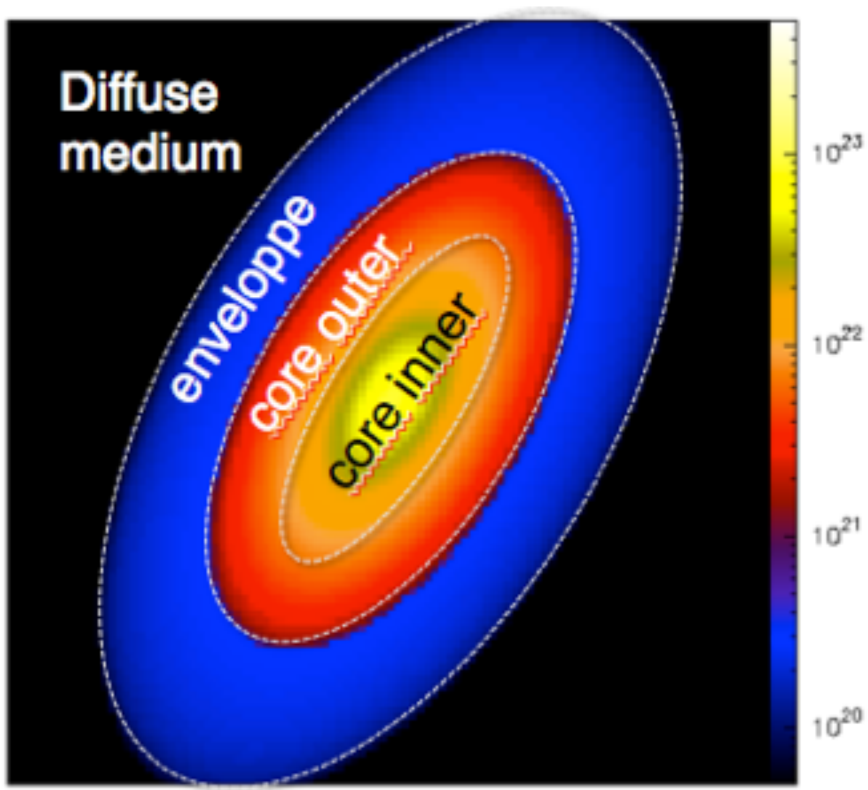
- Starless core modeling :
  - Simple cloud model : focus on dust properties
  - Towards a real cloud model : L183 with molecular features, NIR extinction

Modeling : Cloud model + ISRF

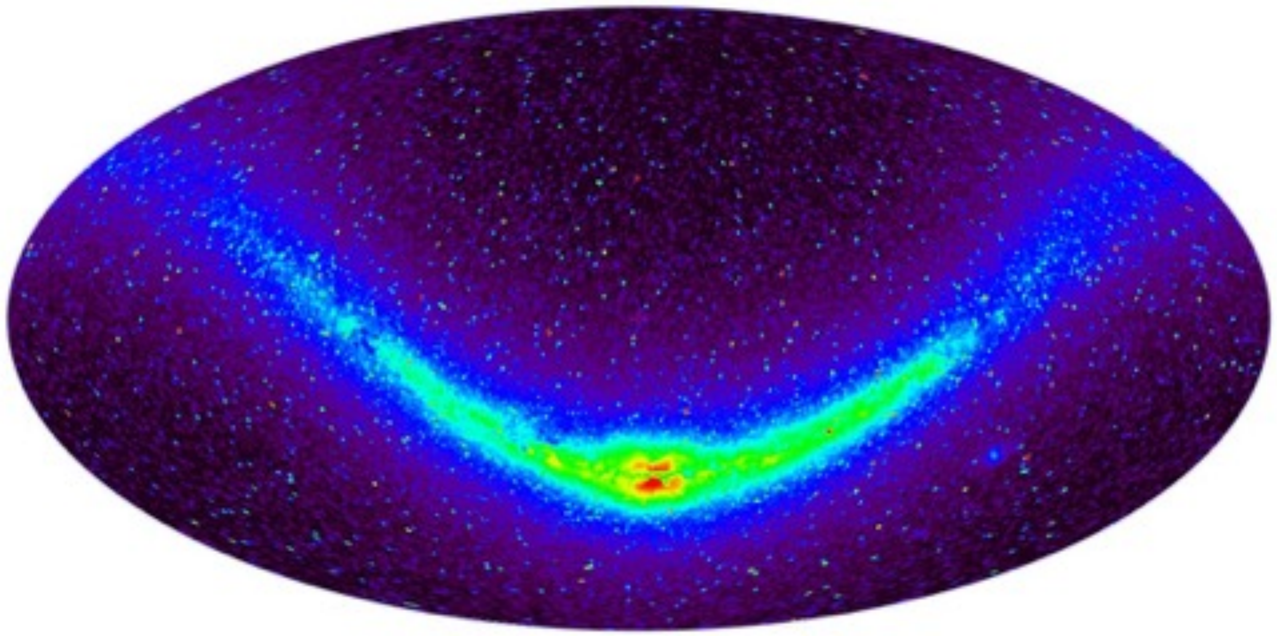
Plummer density profile



Column density map



ISRF intrinsically anisotropic : DIRBE maps



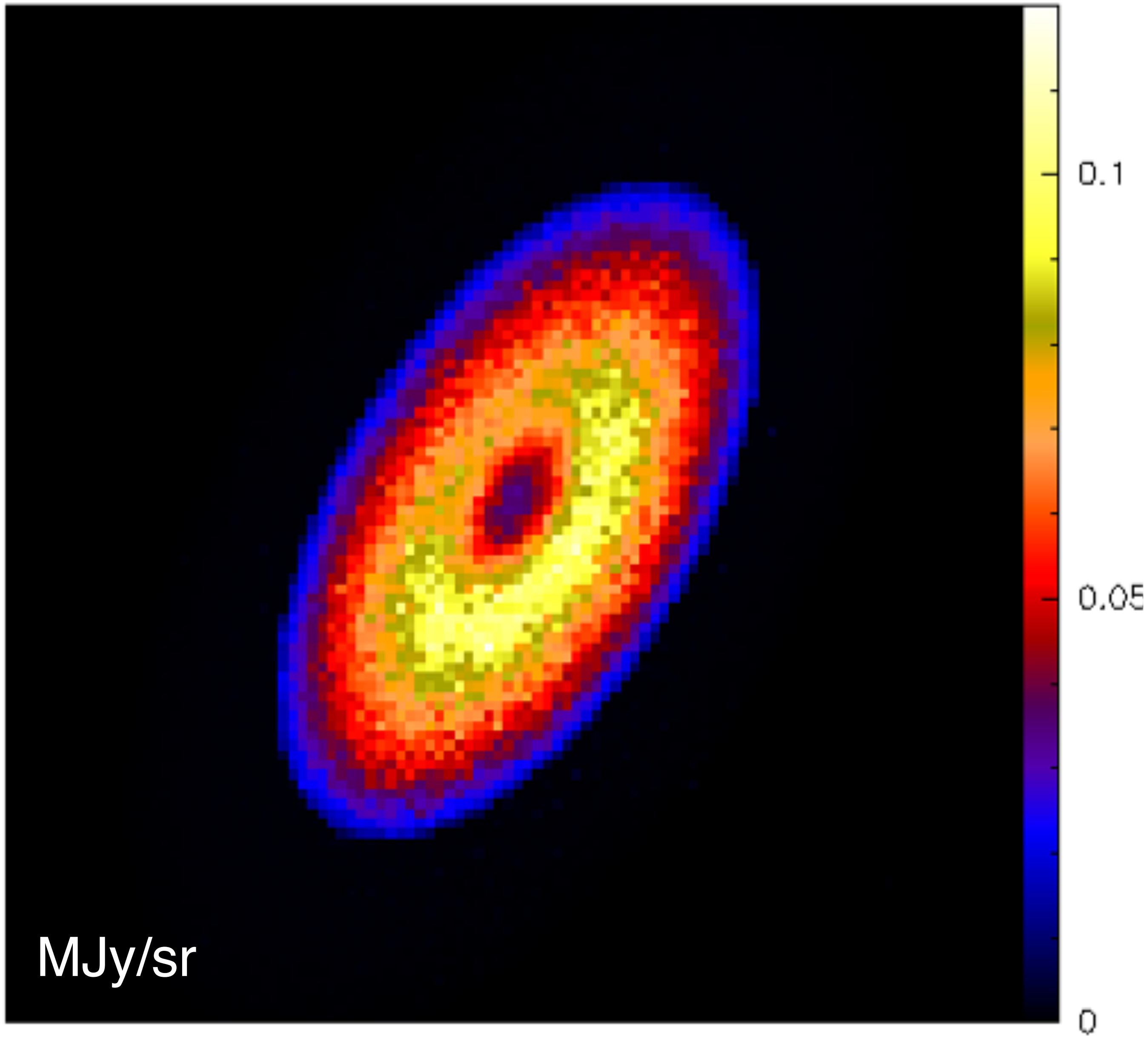
Inputs for the CRT radiative transfer code

Juvela & Padoan (2005)

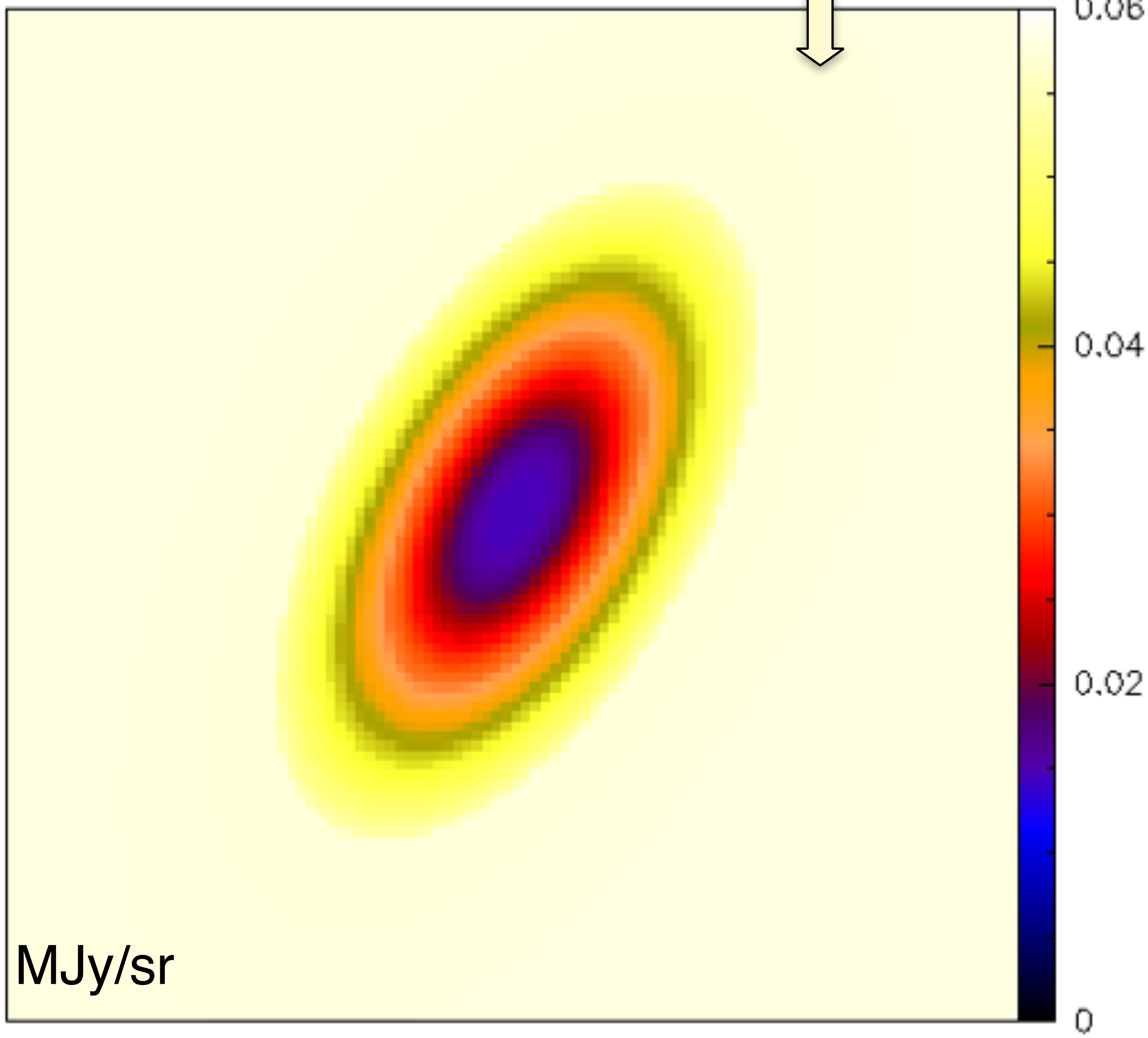
Modeling : Combination scattering/absorption

CORESHINE INTENSITY = Scattering + bg*Iback*exp(-tau) - Iback !

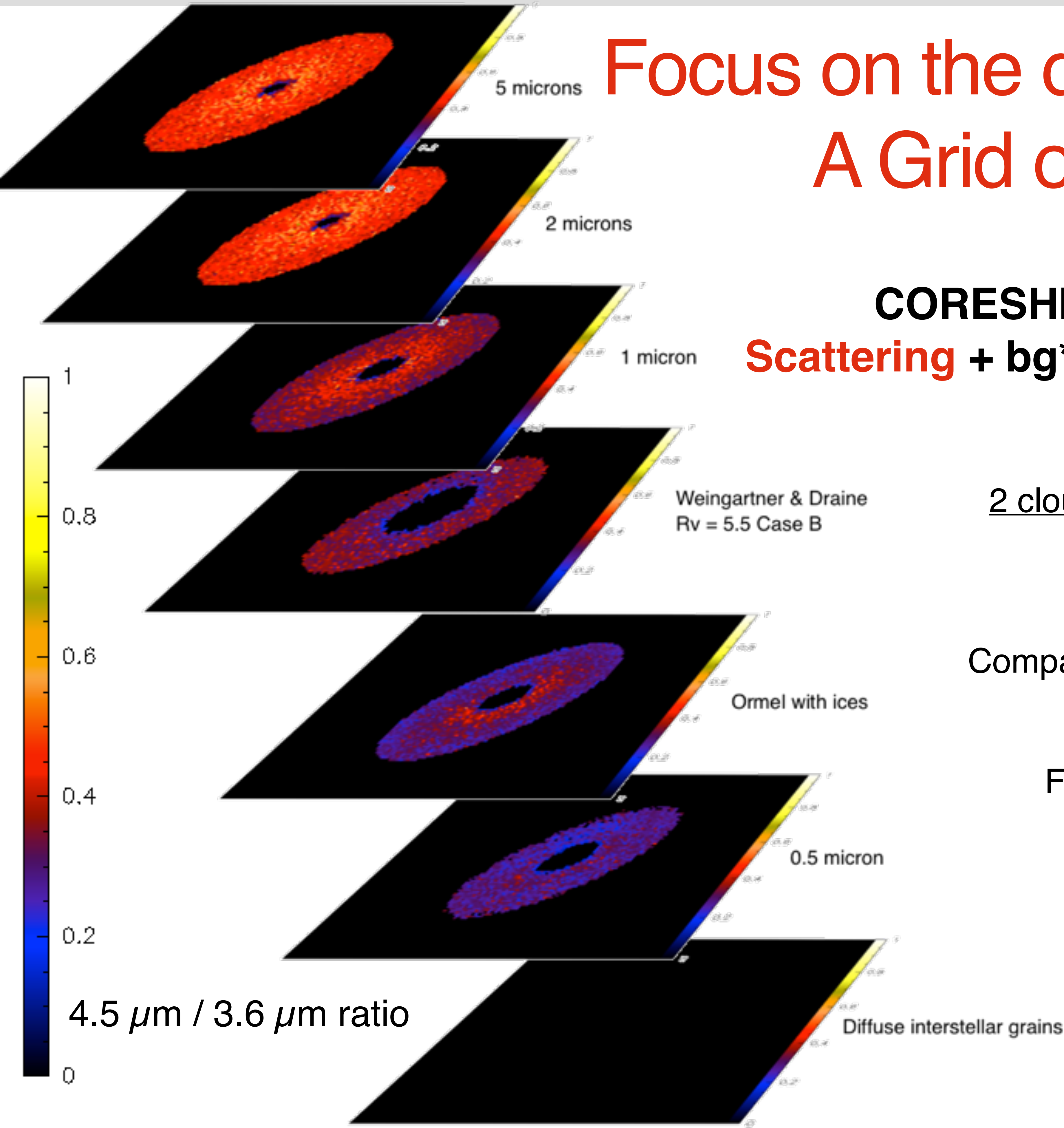
Scattering map



Cloud background field attenuation



Focus on the dust properties : A Grid of models



CORESHINE INTENSITY =
Scattering + bg*Iback*exp(-tau) - Iback

2 cloud central densities

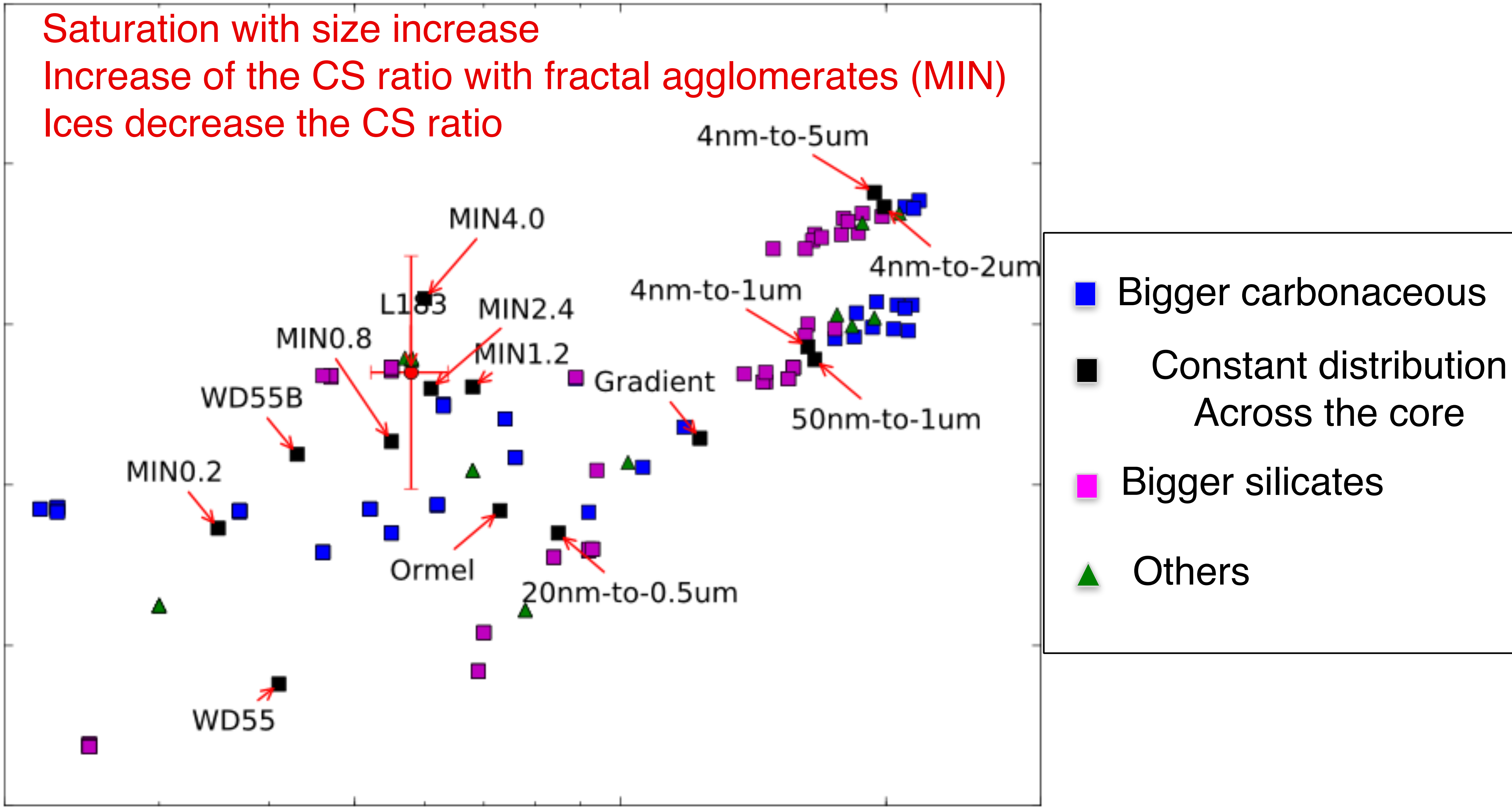
Grain types :

Compact spherical (Compiègne 2011)
Ice mantles (Ormel 2009)
Porosity (Ysard 2013)
Fractal aggregates (Min in prep.)

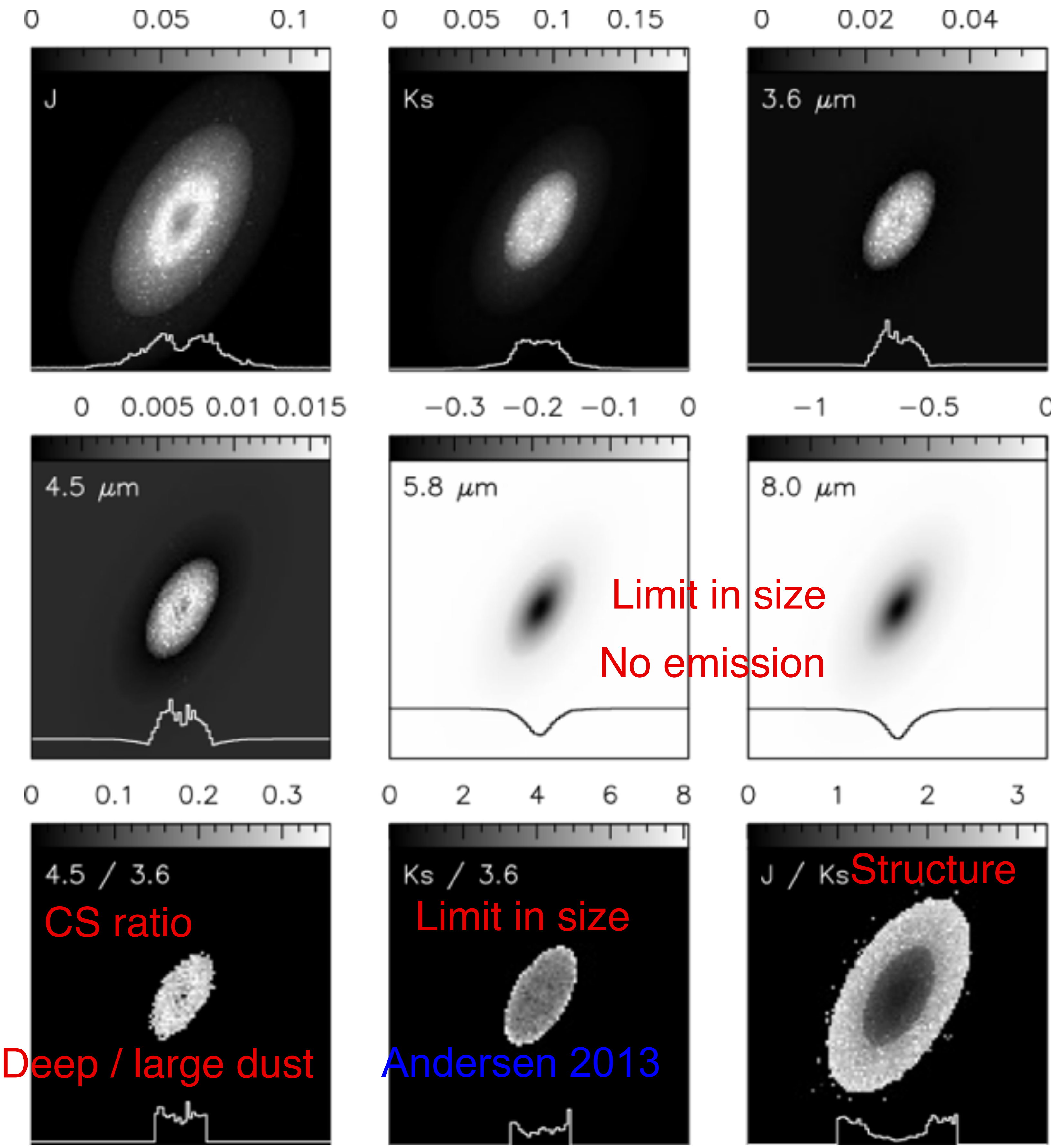
Sizes : From 5nm to 5μm

CS ratio sorts the dust models for starless cores

4-50nm no influence
Saturation with size increase
Increase of the CS ratio with fractal agglomerates (MIN)
Ices decrease the CS ratio

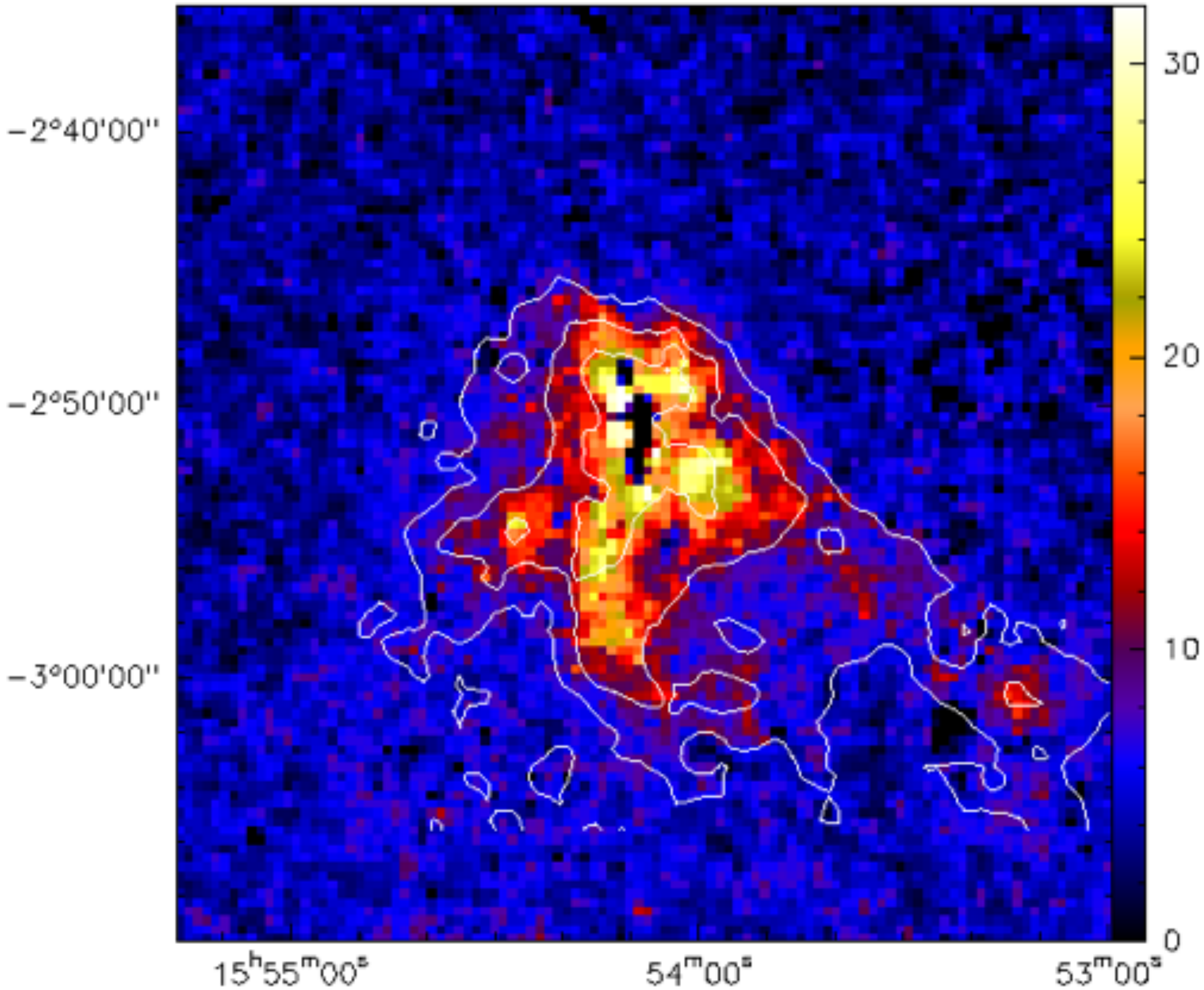


Towards a multiwavelength modeling

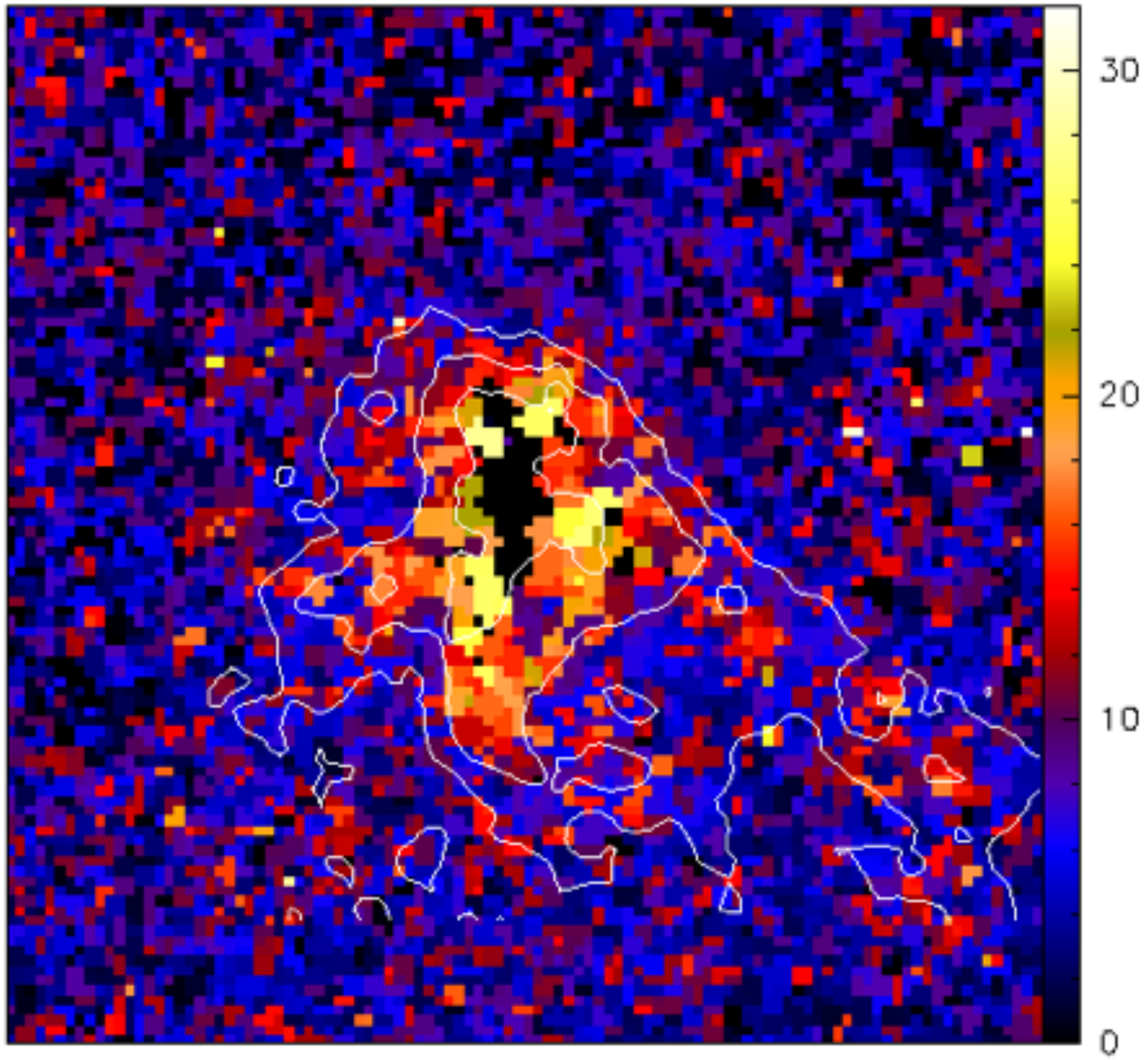


Towards a real cloud model : L183
1- NIR extinction (H-K) VISTA data

Method : NICER (Lombardi&Alves 2001)
J, H, K, Fixed cell size



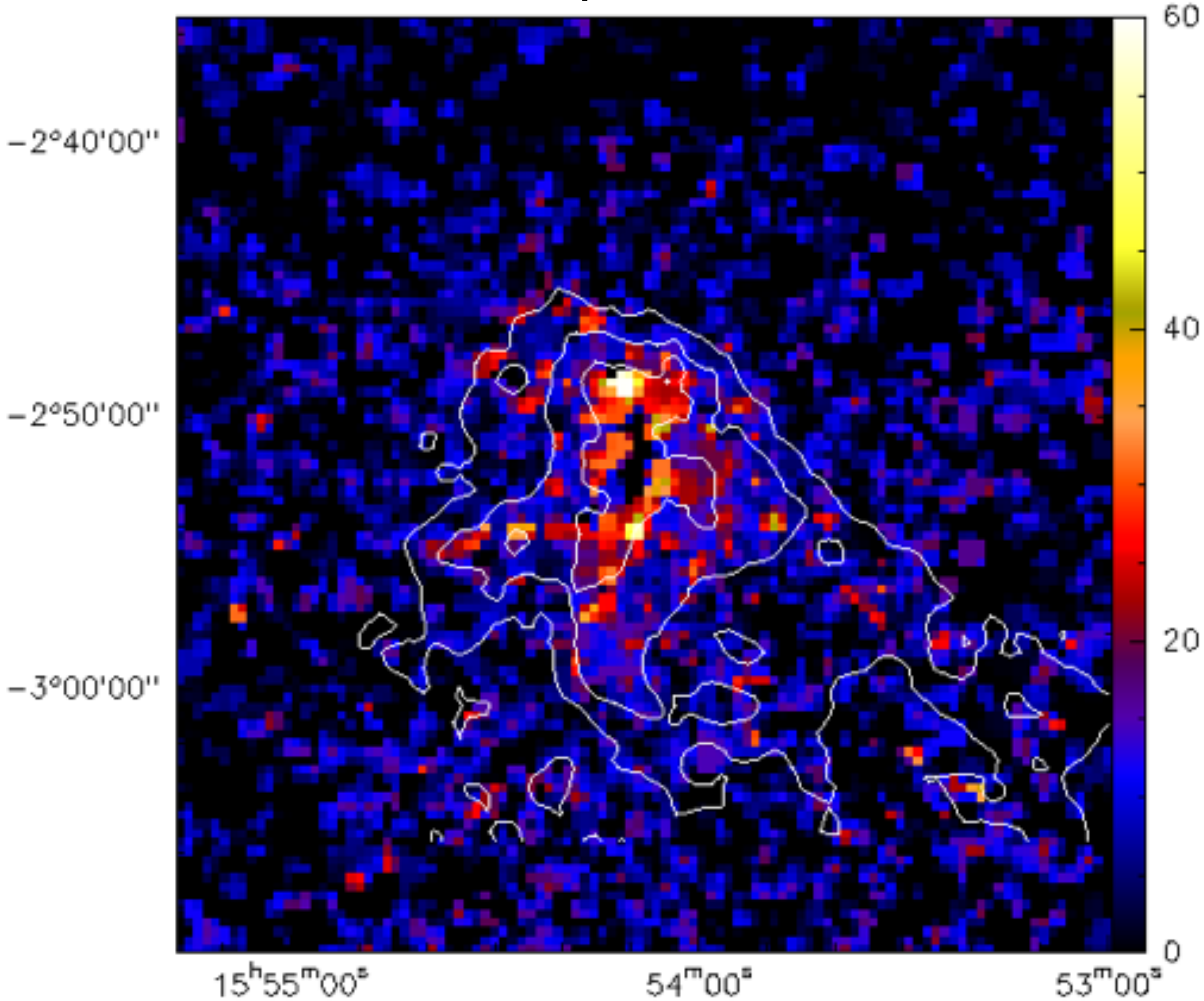
Method : Cambrésy 2002
H, K Fixed number of stars per cell



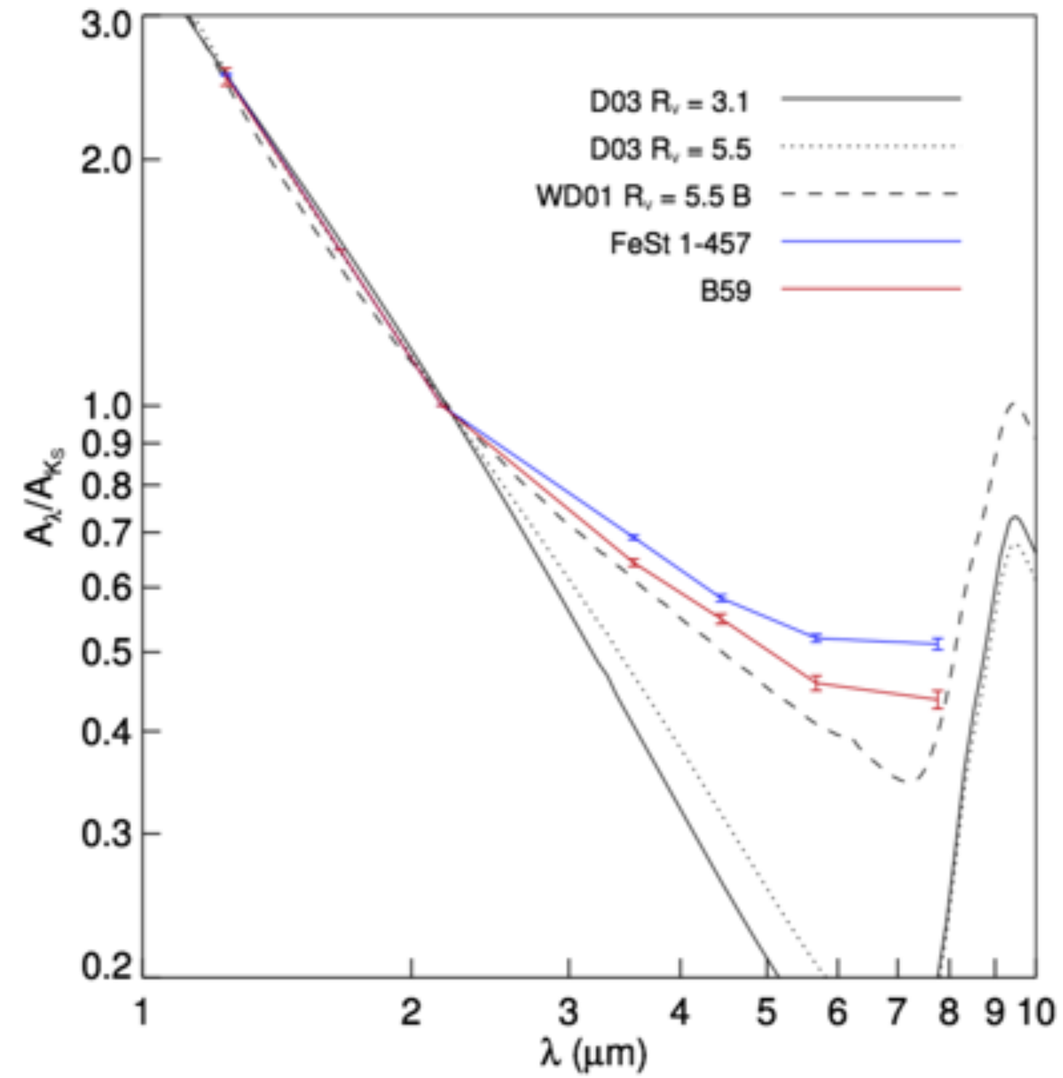
NIR extinction (H-K) up to Av ~ 30 mag
(RV = 3.1) Rieke&Lebofsky 1985

Towards a real cloud model : L183
2- NIR/MIR VISTA + WISE (3.4 μm) + Spitzer (3.6 μm) data

Method : NICER (Lombardi&Alves 2001)
K, H, WISE1+Spitzer1, Fixed cell size



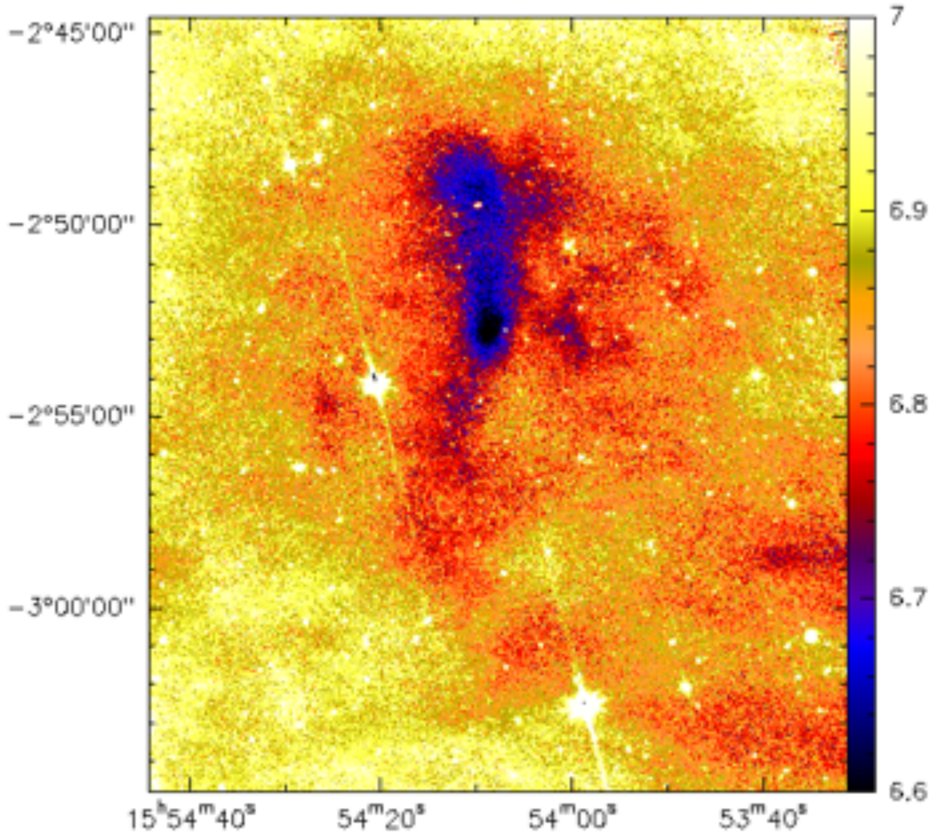
Ascenso 2013 : WD01, RV=5.5B
Closer to observations



NIR/MIR extinction up to Av ~ 60 mag
Conversion Weingartner&Draine 2001 5.5B

Towards a real cloud model : L183
3- How to retrieve the central part?

Thanks to the Spitzer 8 µm map?



Towards a real cloud model : L183
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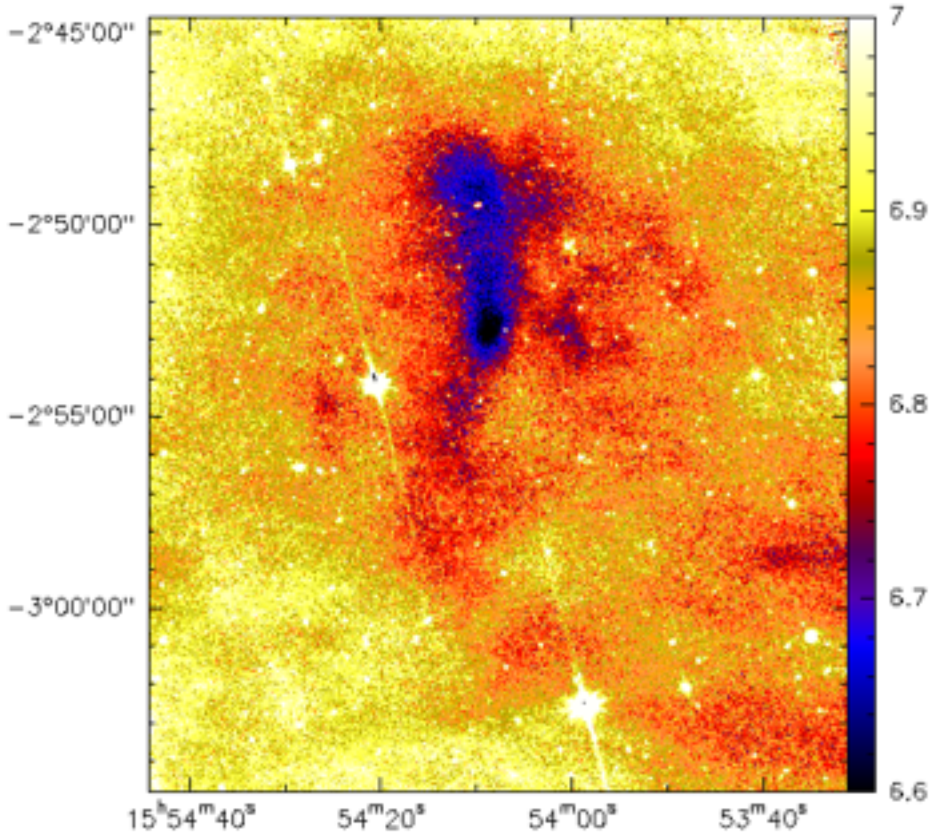
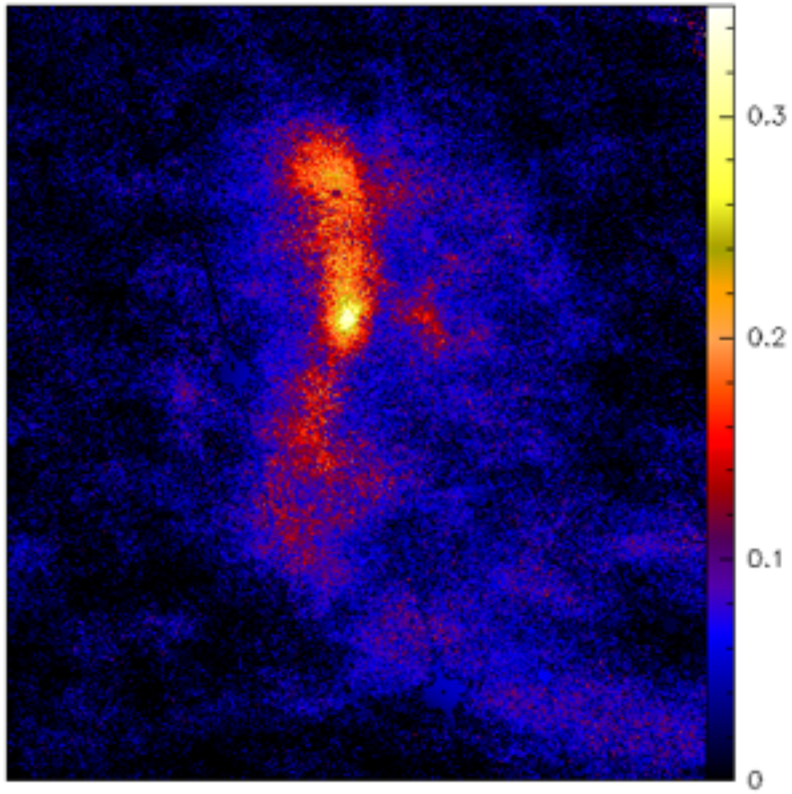


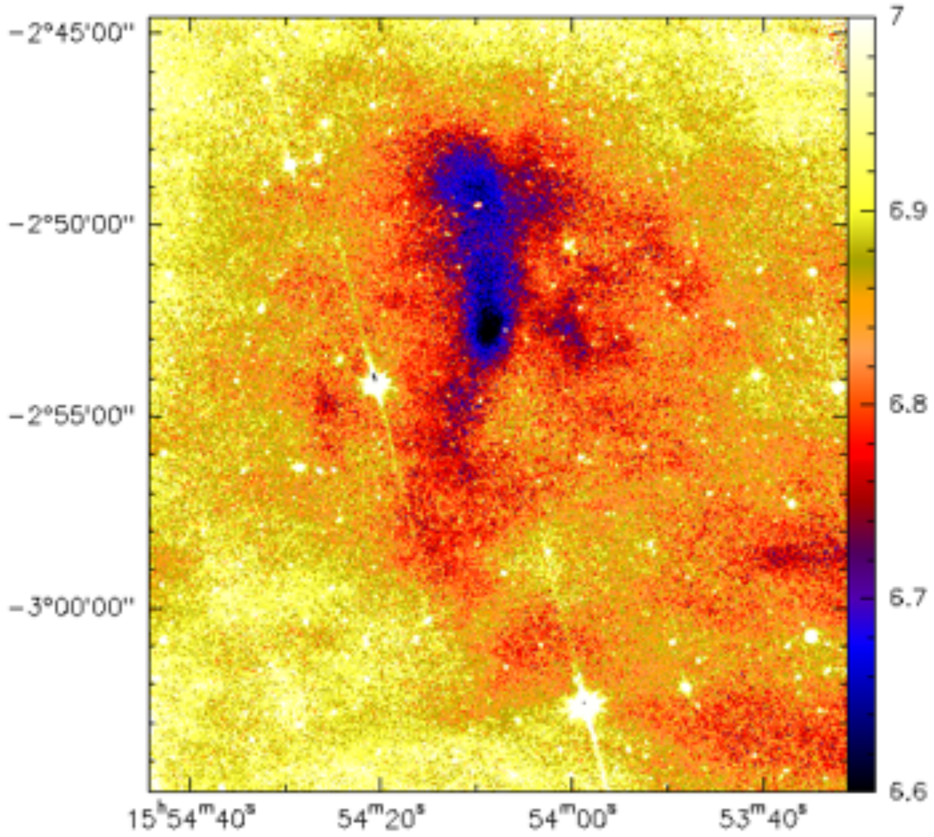


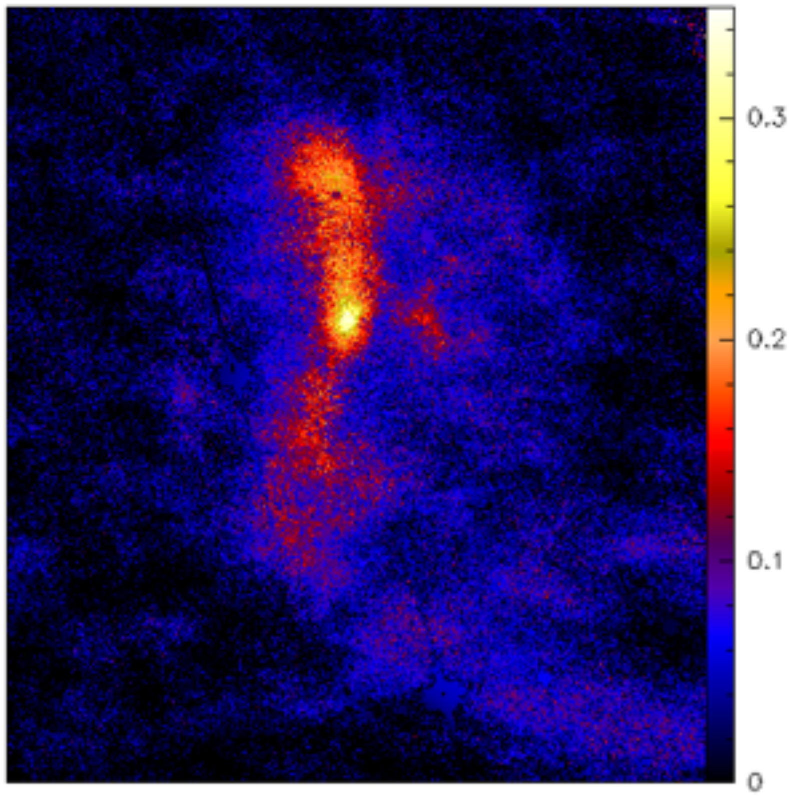
Δmax ~ 0.35 MJy/sr!

-Δ = Ibg(exp(-tau)-1)

Towards a real cloud model : L183
3- How to retrieve the central part?

Thanks to the Spitzer 8 μm map?





Δmax ~ 0.35 MJy/sr!
-Δ = Ibg(exp(-tau)-1)

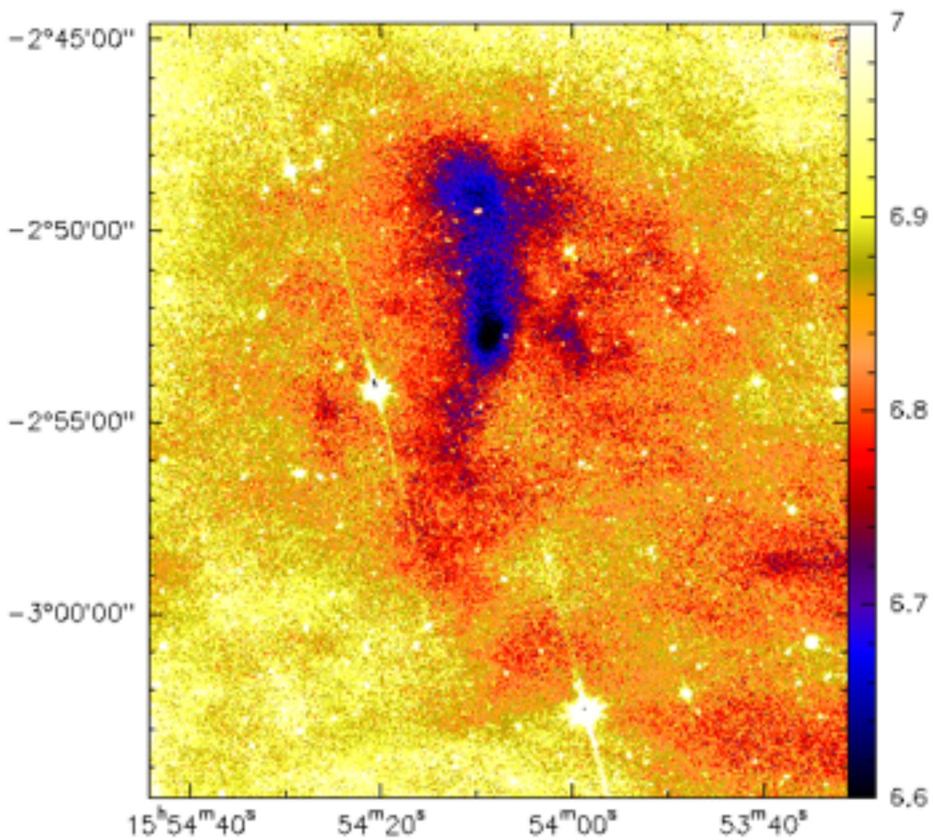
tau(8μm) = -ln(-Δ/Ibg +1)

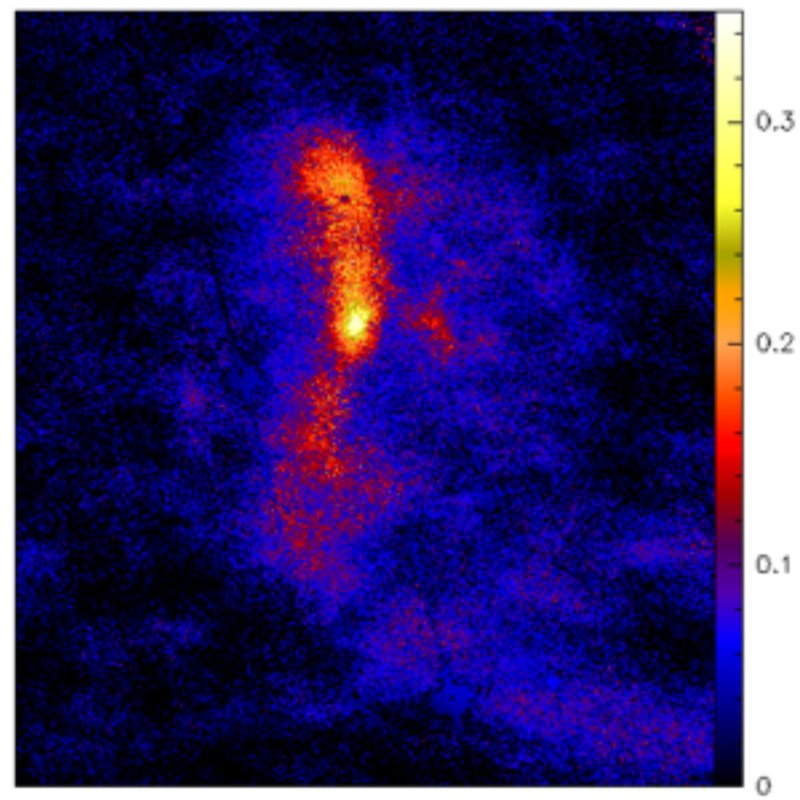
N(H2) ~ 1.09e22*tau(8μm)

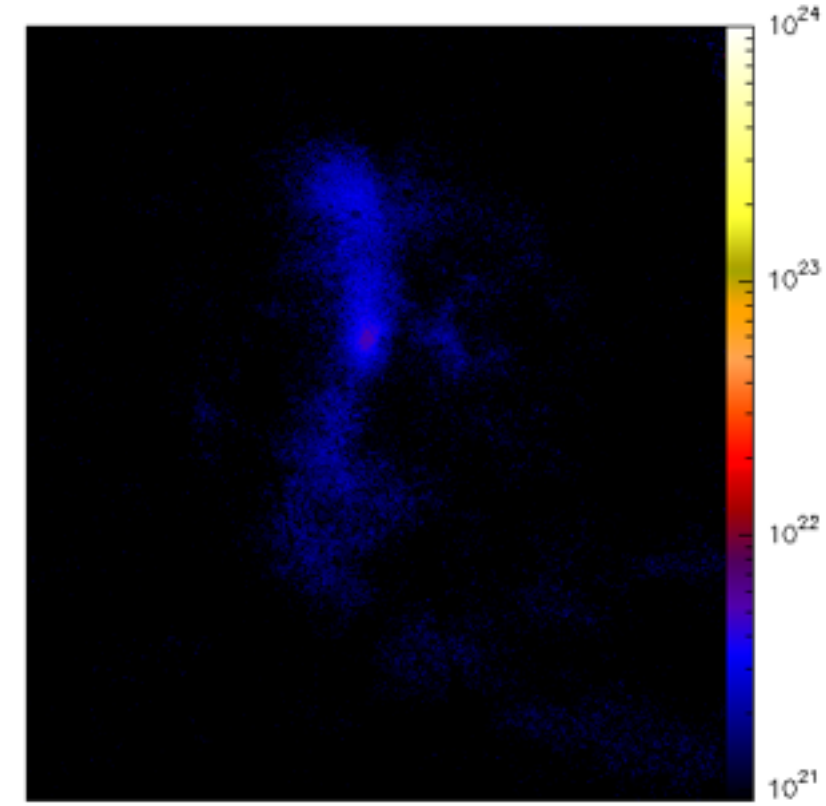
Towards a real cloud model : L183
3- How to retrieve the central part?

Thanks to the Spitzer 8 μm map?

Ibg = 0.9 MJy/sr -> peak ~1e22







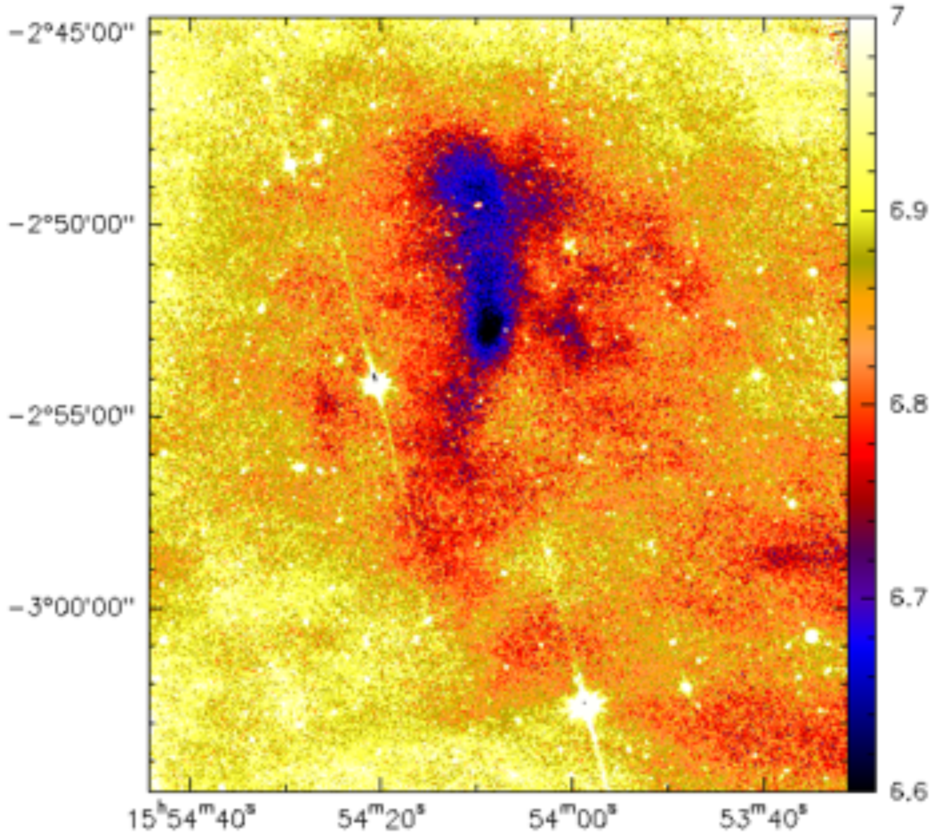
Δmax ~ 0.35 MJy/sr!
-Δ = Ibg(exp(-tau)-1)

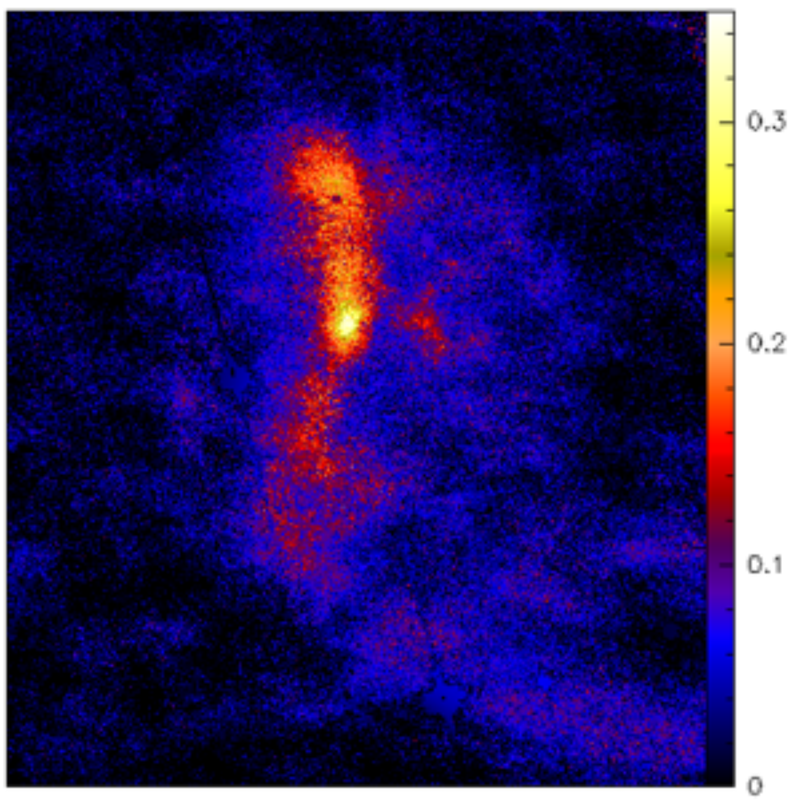
tau(8μm) = -ln(-Δ/Ibg +1)

N(H2) ~ 1.09e22*tau(8μm)

Towards a real cloud model : L183
3- How to retrieve the central part?

Thanks to the Spitzer 8 μm map?

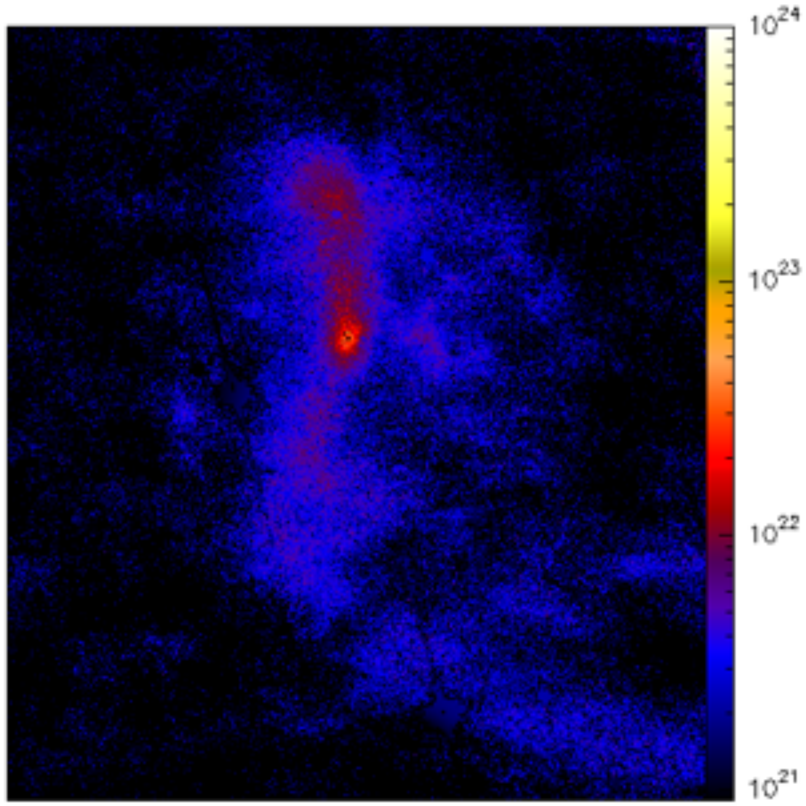




Δmax ~ 0.35 MJy/sr!

$-\Delta$ = Ibg(exp(-tau)-1)

Even with Ibg -> 0.35 MJy/sr
peak ~2e22
while N2H+ tells 1.3e23



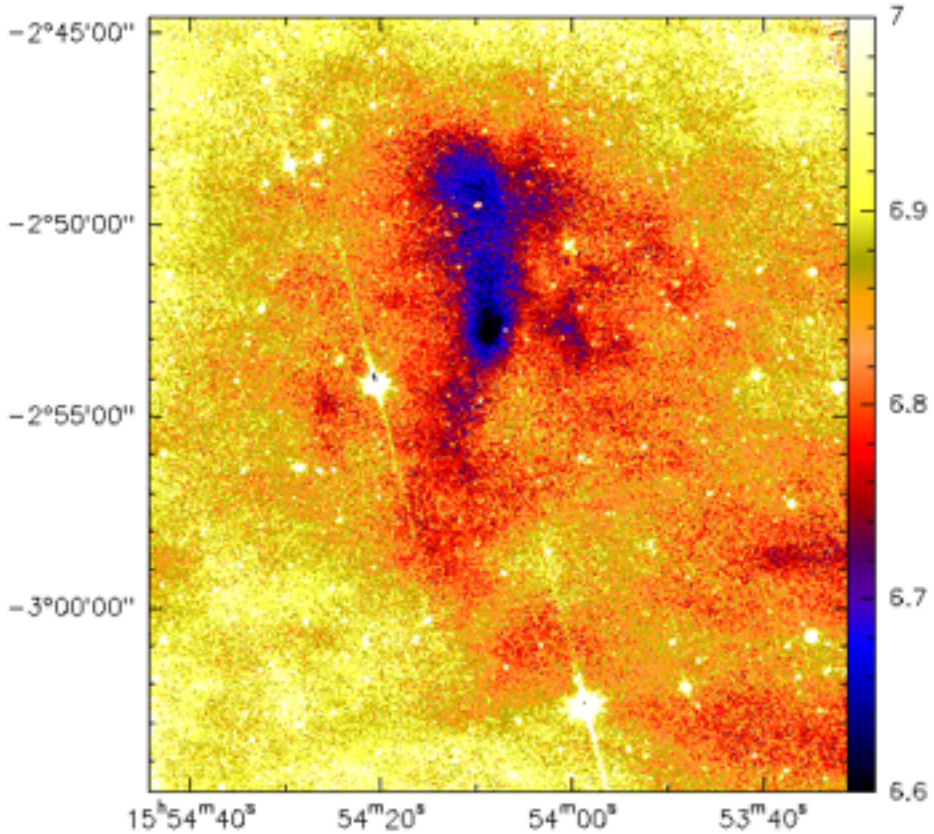
tau(8μm) = -ln(-Δ/Ibg +1)

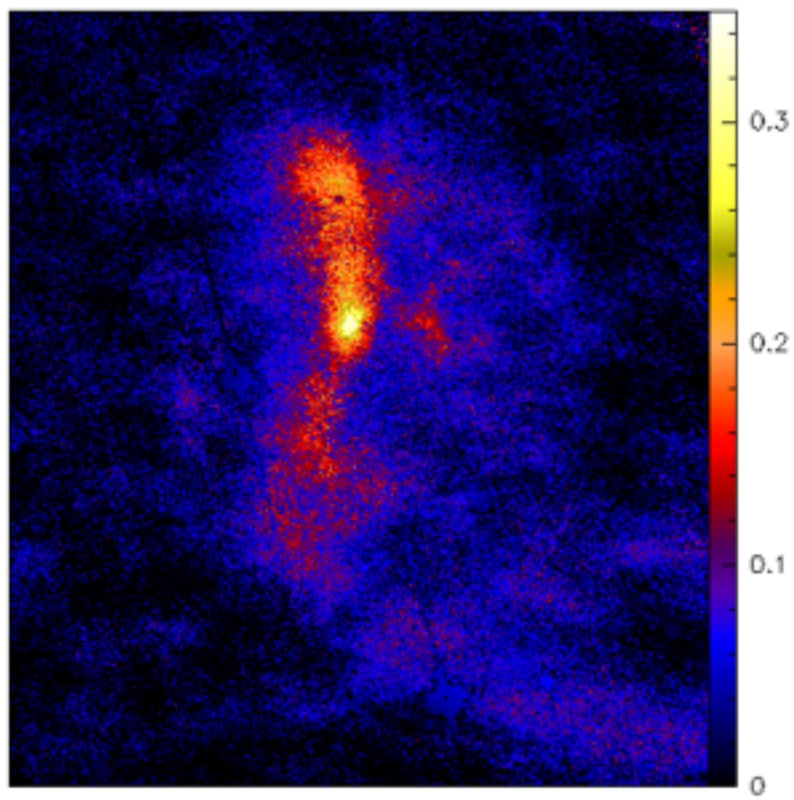
N(H2) ~ 1.09e22*tau(8μm)

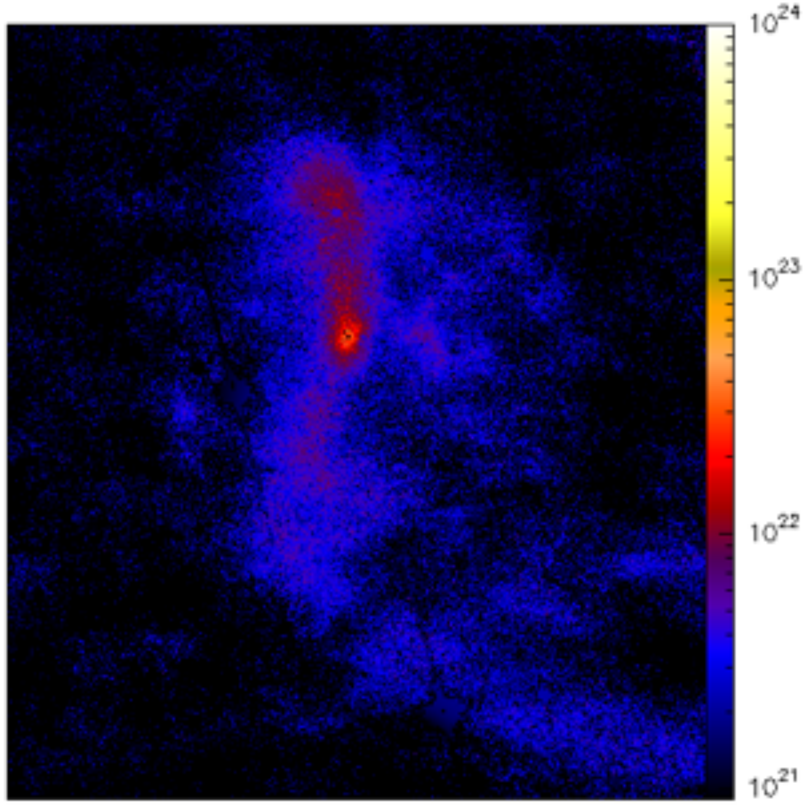
Towards a real cloud model : L183
3- How to retrieve the central part?

Thanks to the Spitzer 8 μm map?

Even with Ibg -> 0.35 MJy/sr
peak ~2e22
while N2H+ tells 1.3e23~140Av







Δmax ~ 0.35 MJy/sr!
~~-Δ = Ibg(exp(-tau)-1)~~

tau(8μm) = -ln(-Δ/Ibg +1)

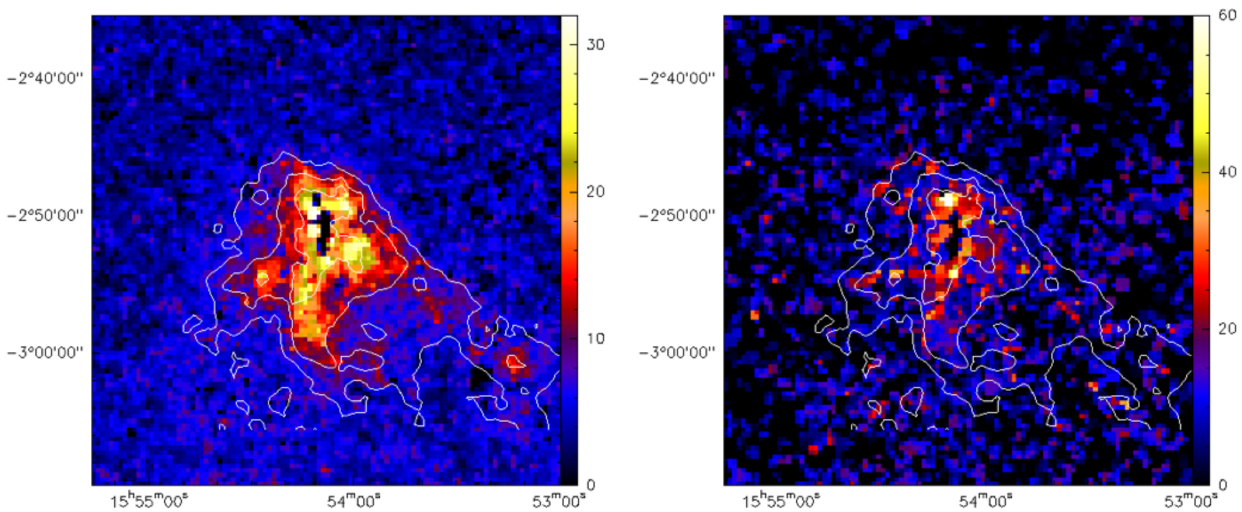
N(H2) ~ 1.09e22*tau(8μm)

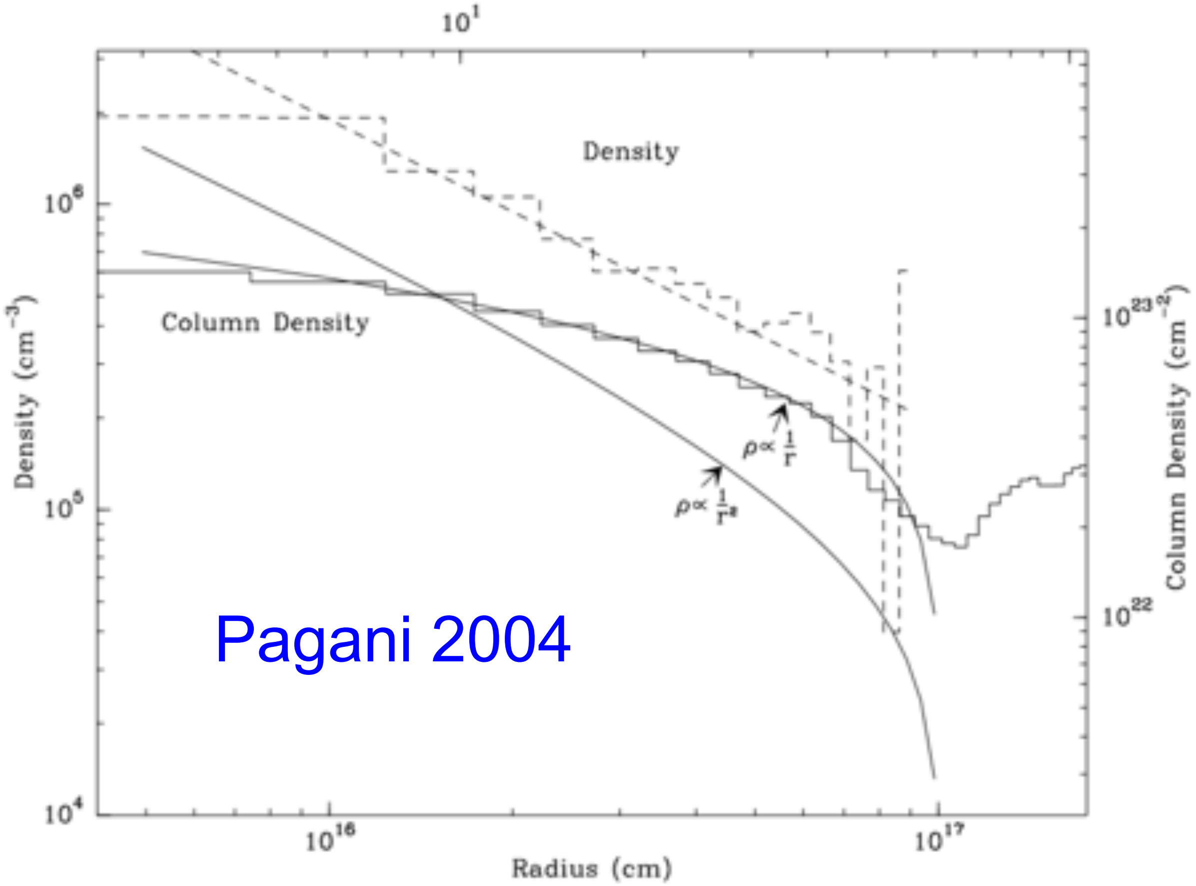
-Δ = Ibg(exp(-tau)-1) + Isca
True Delta = Δ + Isca

Going back to the model cloud

DATA :

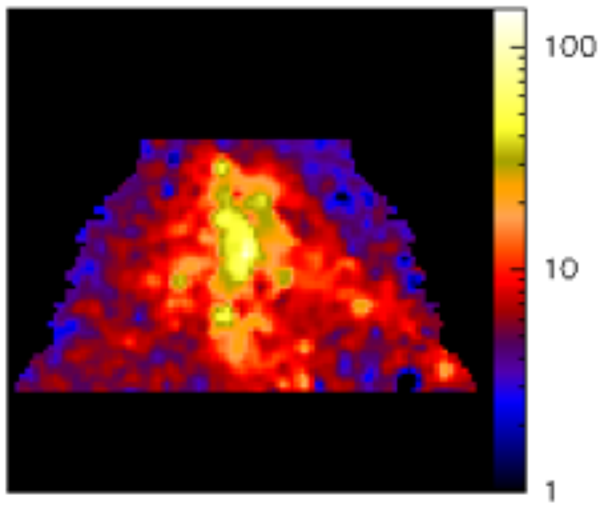
H-K, K-W1, N2H+ (Pagani 2004)

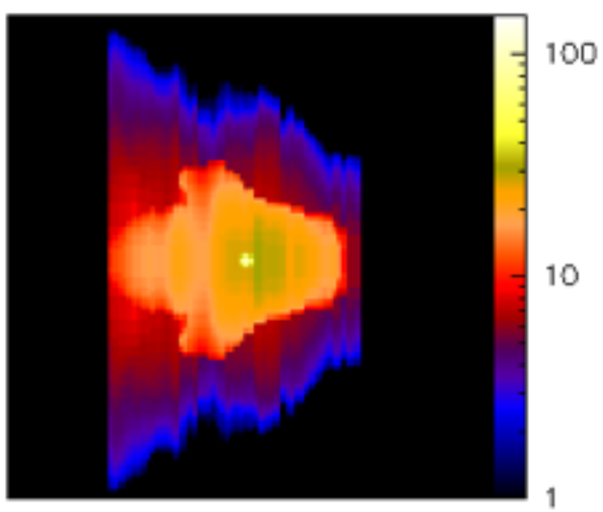


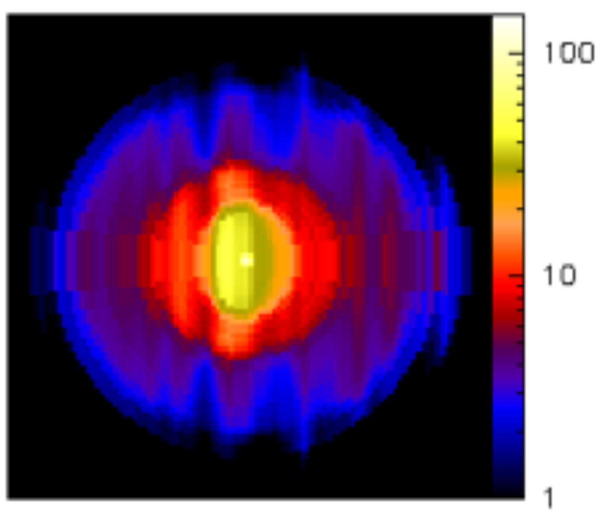


Pagani 2004

CYLINDRICAL SYMETRIC MODEL



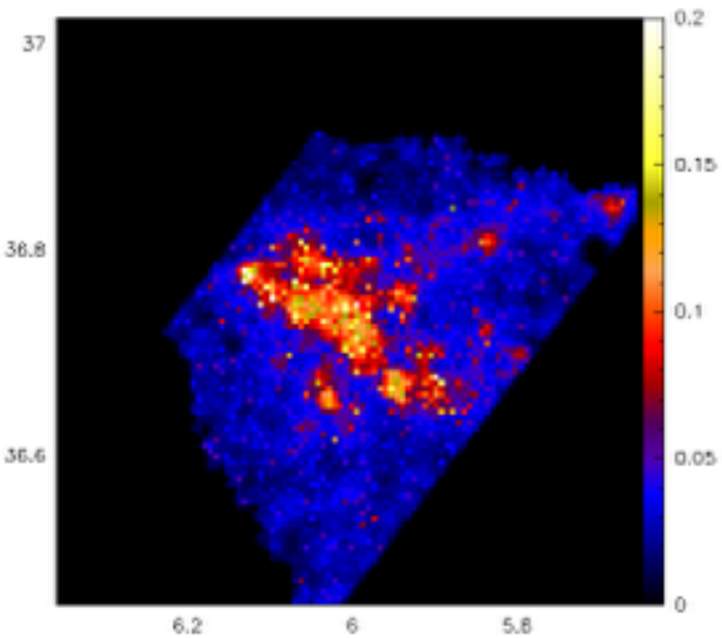




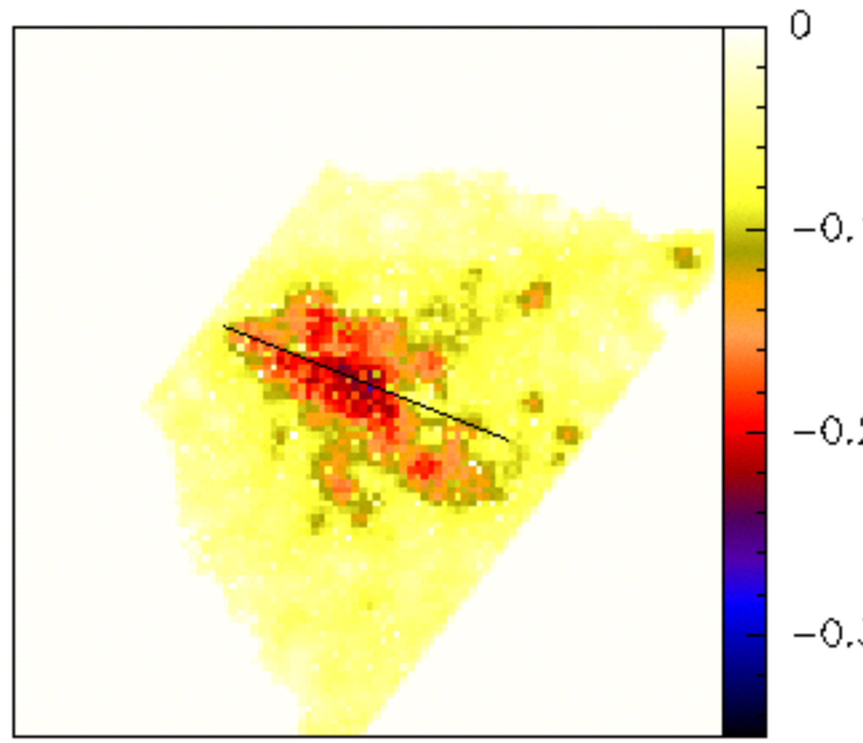
Towards a real cloud model : L183

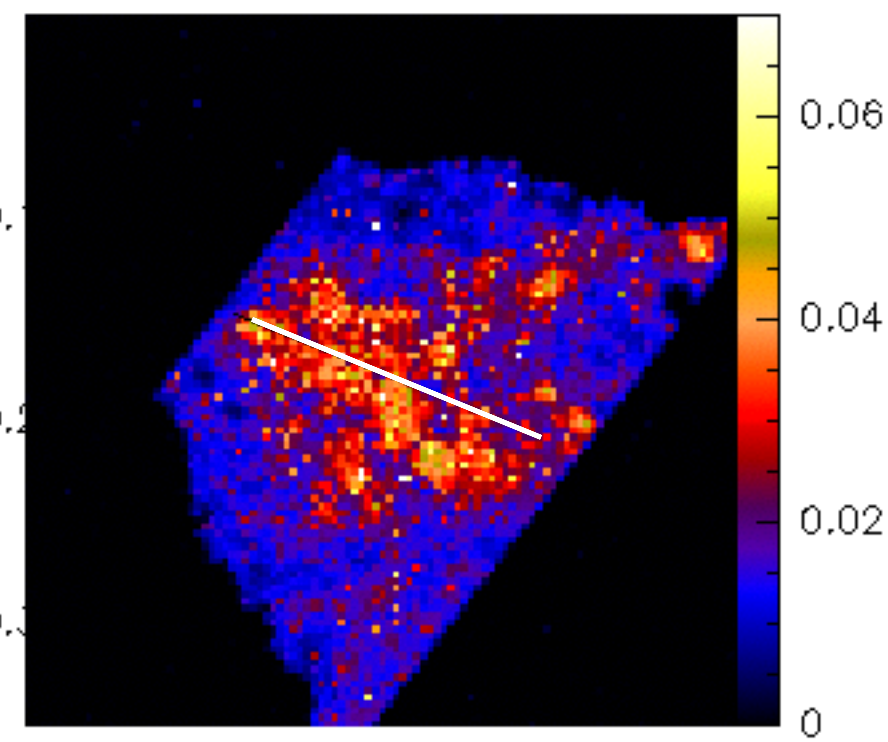
DELTA_I4 = Ibg*exp(-tau) + **Isca**

Scattering does contribute even at 8µm !

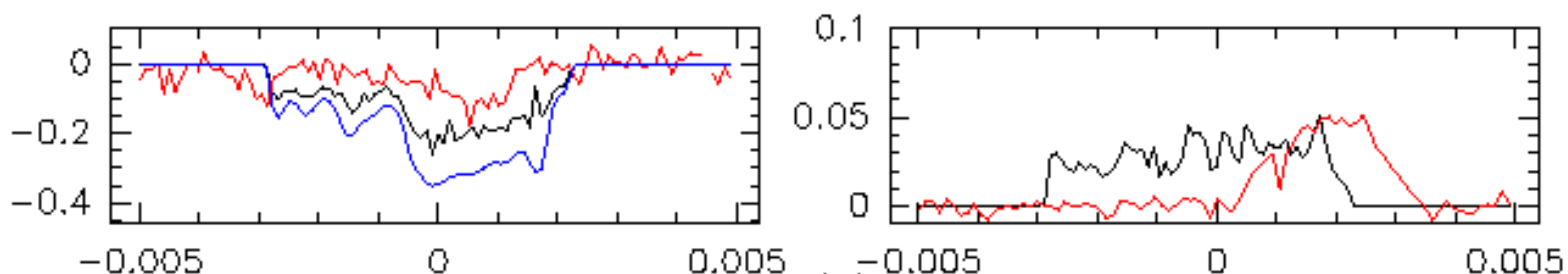


Isca ~0.1/0.15 MJy/sr

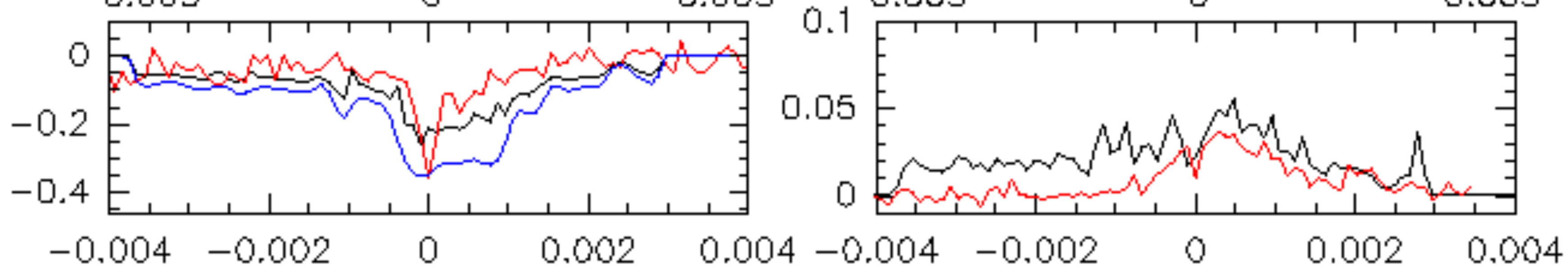




Along the filament

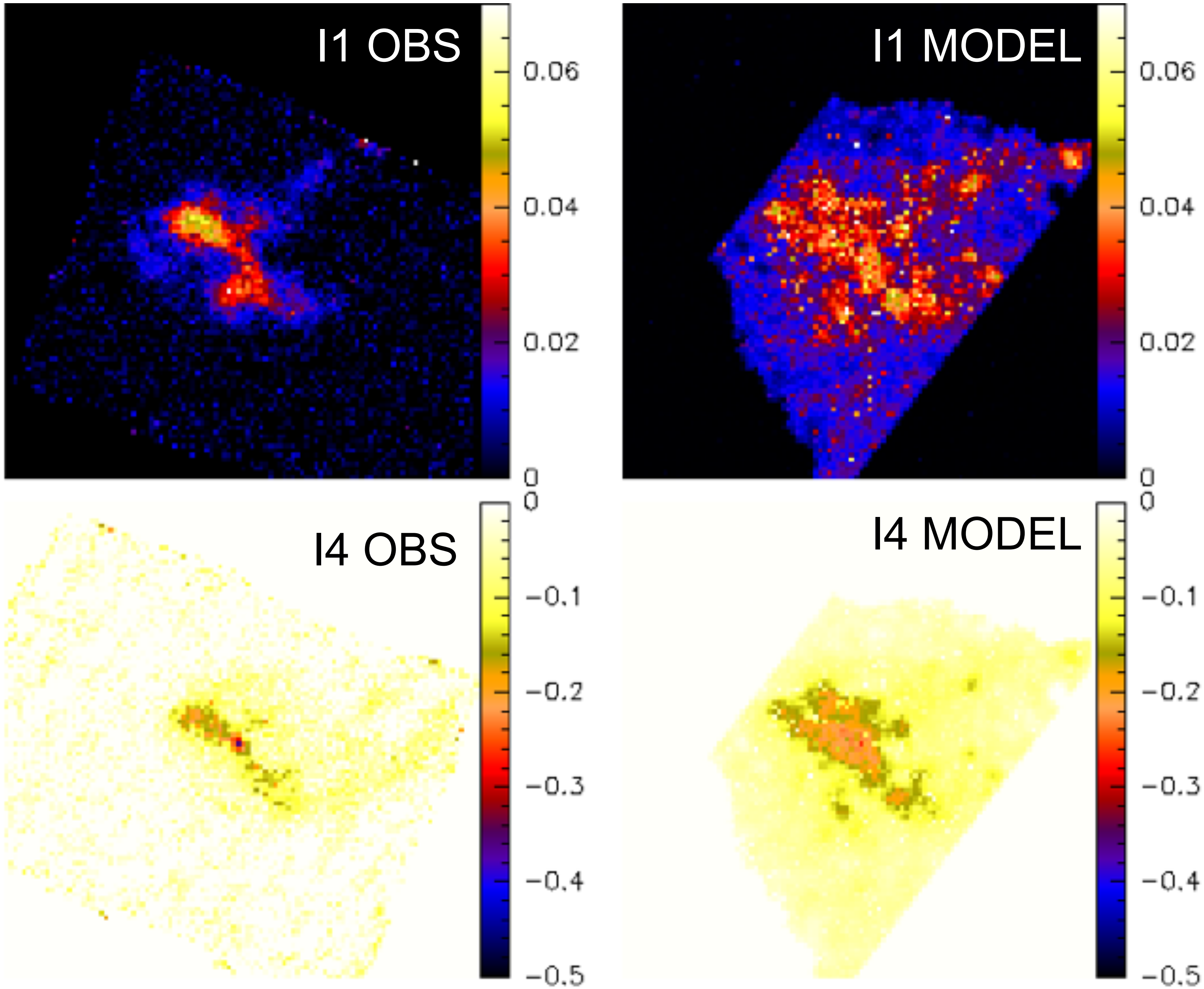


Horizontally through the centre



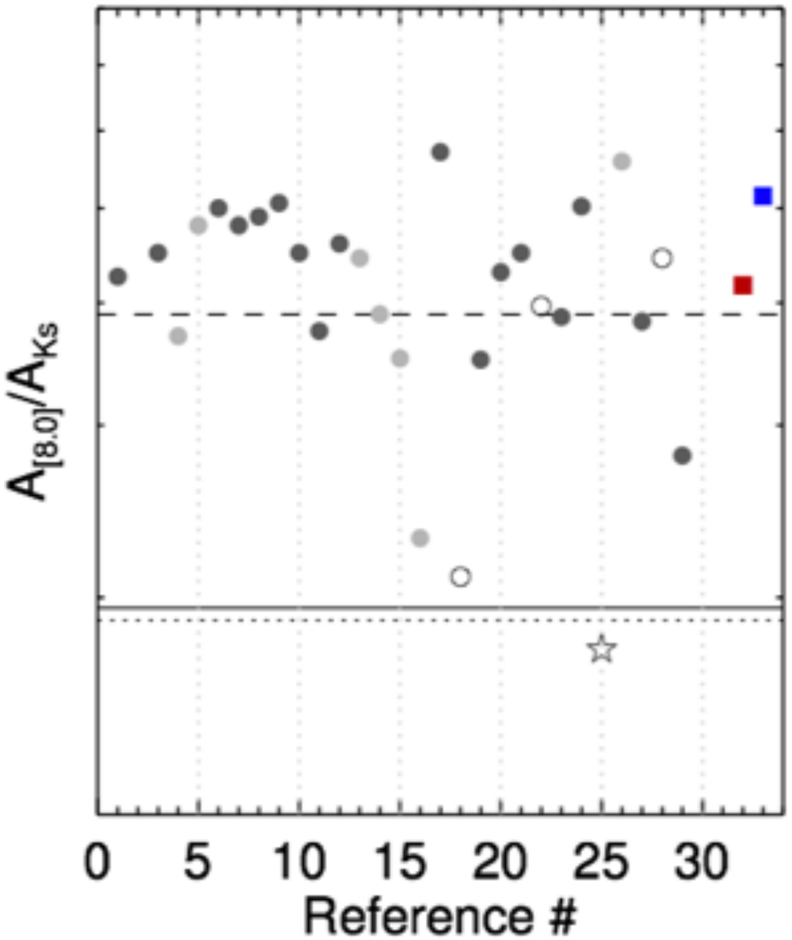
Model with a mix of WD01 RV=3.1 and WD01 RV=5.5B

Comparison Model/Observations



Lefèvre et al. in prep

A8/AK - Ascenso 2013



Rv=5.5B : A[8.0]/AKs ~ 0.4

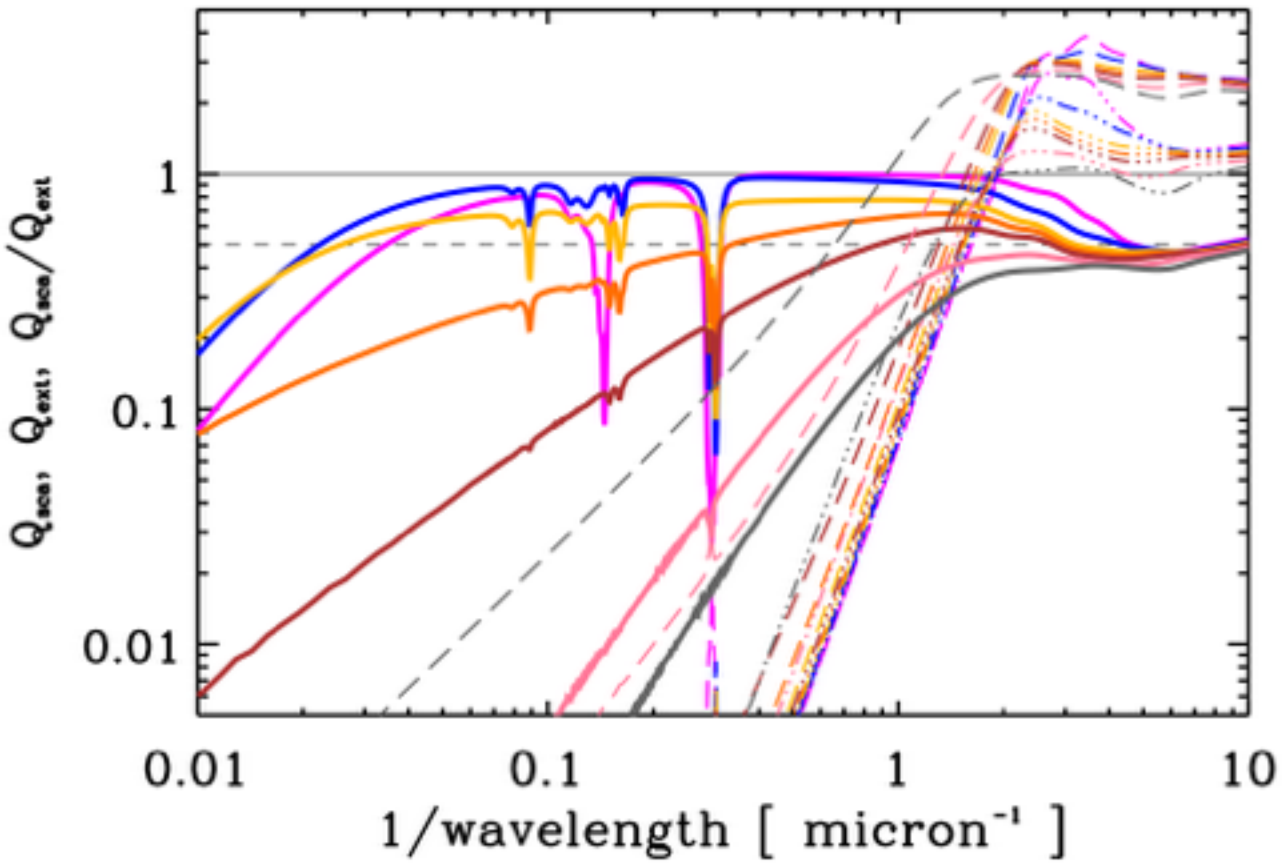


Fig. 19. Q_{ext} (dashed), Q_{sca} (triple-dotted-dashed) and Q_{sca}/Q_{ext} (solid lines) as a function of E_g (0, 0.5, 1.0, 1.25, 1.5, 2.0 and 2.5 eV, from *bottom to top*) for grains of radius a = 100 nm.

Conclusion and Perspectives

- 8 µm scattering is brighter than you think!

- Coreshine cannot be due to a-C:H but probes once again a mix with **big grains** and/or fluffy aggregates.

- Consequences on mass estimates from extinction maps (from cores to IRDC)

- 8µm map brings New constraints on the modelling to obtain a self-consistent model.

- **To be improved (ongoing work):**

- Validation of the dust model with stellar absorption (ices, silicates)
- Cloud model structure at shorter wavelength and N-PSC
- Background value check (Ibg = 0.35 Mjy/sr = inferior limit)

Thanks for your attention!