Building a self-consistent stellar+ISM 3D model of the Milky Way: Current status

Julien Montillaud
Annie Robin, Mika Juvela

UTINAM, Besançon

June 2^{nd} 2016

Outline

Previous works: Drimmel & Spergel 2001 + Robitaille et al. 2012

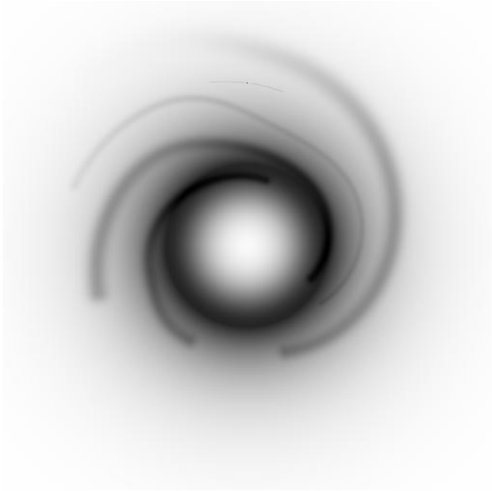


FIG. 13.—Surface density map of the dust, as inferred from the dust density model. Small black dot (*upper center*) shows the position of the Sun, which nearly lies on a small local feature, known as the Orion arm. Arms are incomplete on the side opposite the Sun owing to incomplete H II data.

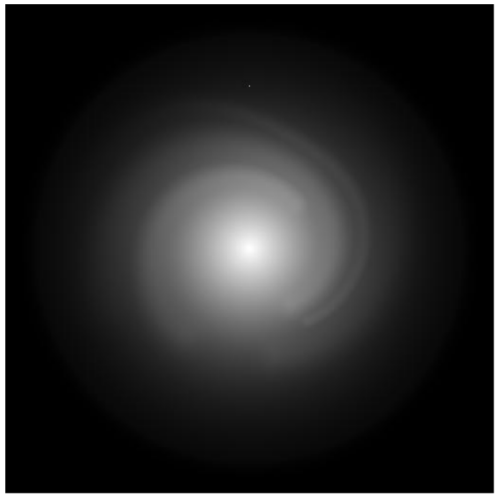


FIG. 14.—Surface brightness map of the Milky Way in the *K*-band. Bright dot (*upper center*) indicates the position of the Sun.

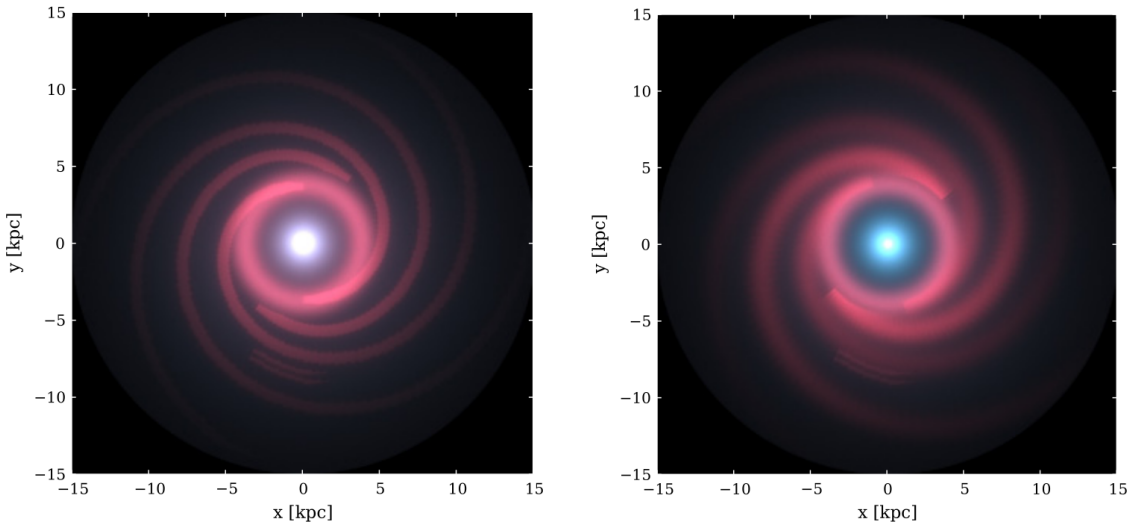


Fig. 10. Color composite view of the Galaxy model from an external viewpoint, viewed along the North Galactic Pole, for the initial model (*left*) and the final modified model (*right*). The Sun is located at $(x, y) = (0, -8.5\,\mathrm{kpc})$. The colors show IRAC 8.0 μm (red), IRAC 4.5 μm (green), and IRAC 3.6 μm (blue), all on a square-root intensity scale.

Drimmel & Spergel 2001: results

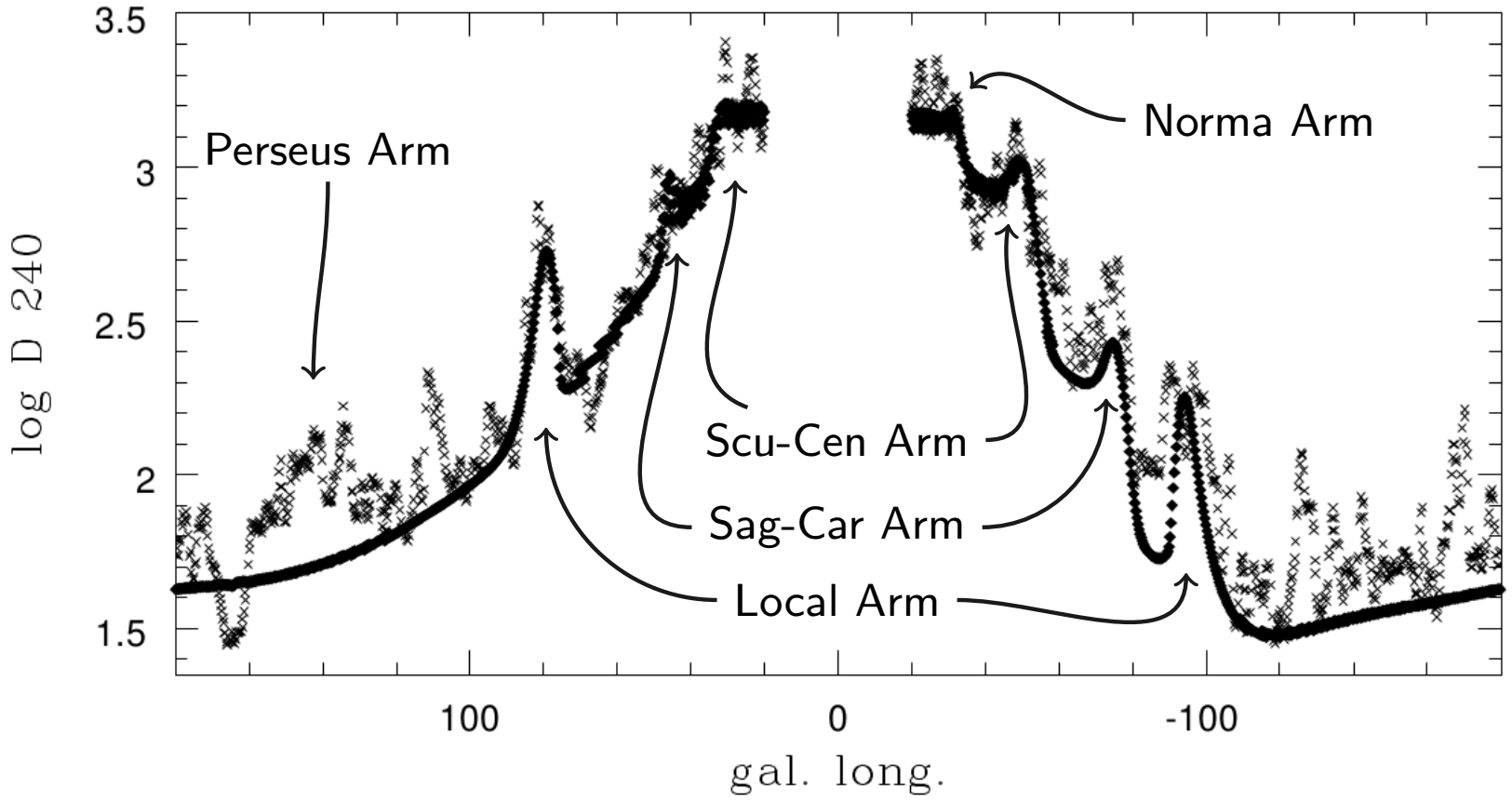


FIG. 5.—240 μm emission profile for the data (*crosses*) and model (*diamonds*) within 0°.17 of the GP ($b = 0$), on a logarithmic scale (log D).

Robitaille et al. 2012: results adding 50% of PAHs

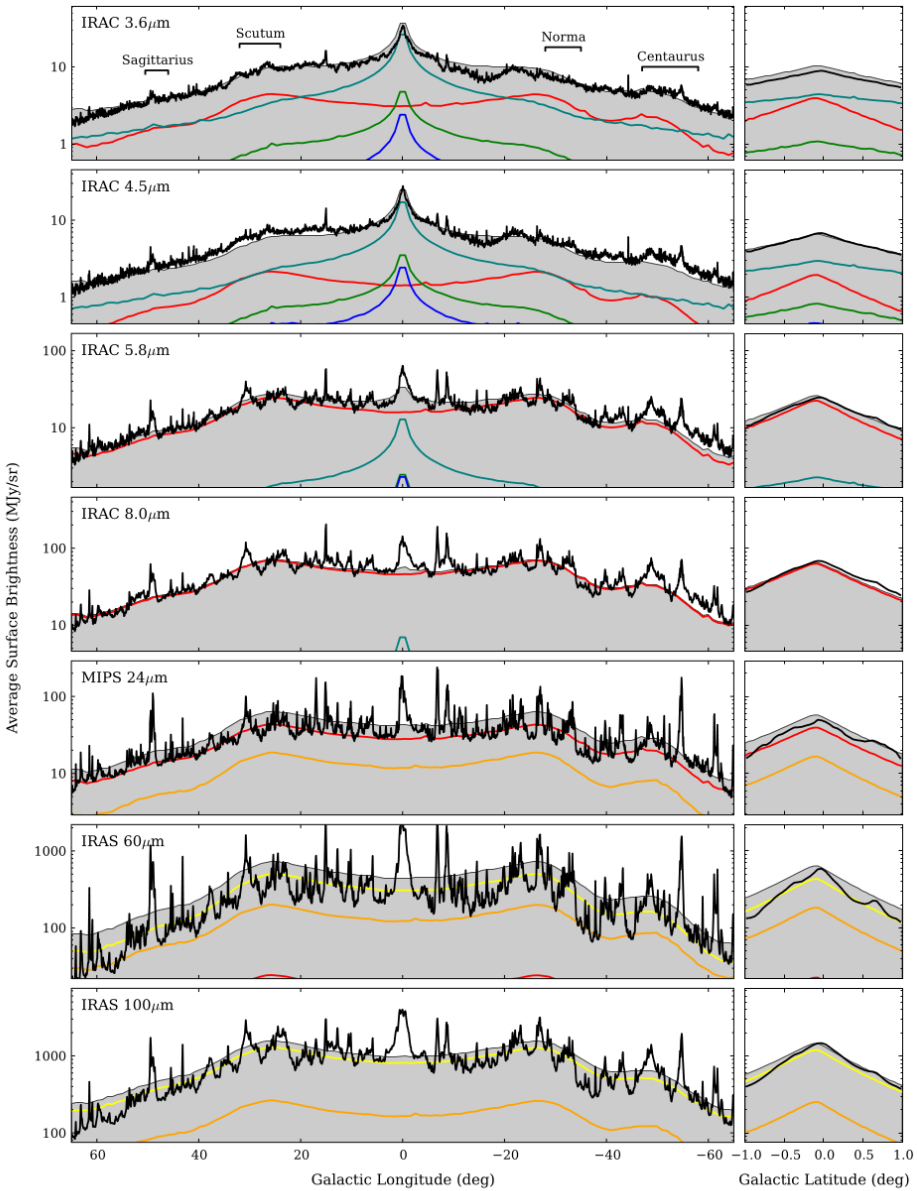


Fig. 5. Longitude and latitude surface brightness profiles as for Fig. 4, with 50% more PAHs (Sect. 4.2.3).

- 2 major + 2 minor arms
- exponential radial dust distribution with dust deficit in the central kpcs
- Dust composition from Draine & Li 2007 **+ 50% of PAHs**

Drimmel & Spergel 2001: method

Emission

DIRBE 240μm

Dust opt. prop.

Dust 3D

χ^2

Dust params \ ambiguities

Extinction

DIRBE J,K

Star emissivity — Fixed

Stars 3D — Parametric

χ^2

Star params + dust ambig.

Ambiguities: flux density $\propto \kappa \times \rho$, etc

Robitaille et al. 2012: method

IRAS 100 | IRAS 60 | MIPS 24 | IRAC 8.0 | IRAC 5.8 | IRAC 4.5 | IRAC 3.6

Emission Extinction

Dust opt. prop. — Hyperion — Dust 3D — Fixed

Star emissivity — SKY model — Stars 3D — Parametric

Dust params + Star params

Outline

Available tools

- **Besançon Galaxy Model:** 3D distribution of in the Galaxy
  - **IN**: large scale structures (parameters of analytic description)
  - **IN**: stellar atmosphere models
  - **OUT**: stellar emission $= f(R, l, b)$
- **DustEM**: 0D emission / extinction of dust
  - **IN**: dust optical and thermodynamic properties
  - **IN**: impinging radiation field spectrum
  - **OUT**: 0D emission / extinction of dust
- **CRT**: 3D radiative transfer
  - **IN**: outside or inside emission (stars + dust)
  - **IN**: dust properties
  - **OUT**: incoming light to each pixel (ISRF)

Outline

On-going work in Besançon: method (last year)

Same as Robitaille+12

Dust opt. prop.

DustEM

RT

Star emissivity

BGM

Dust 3D

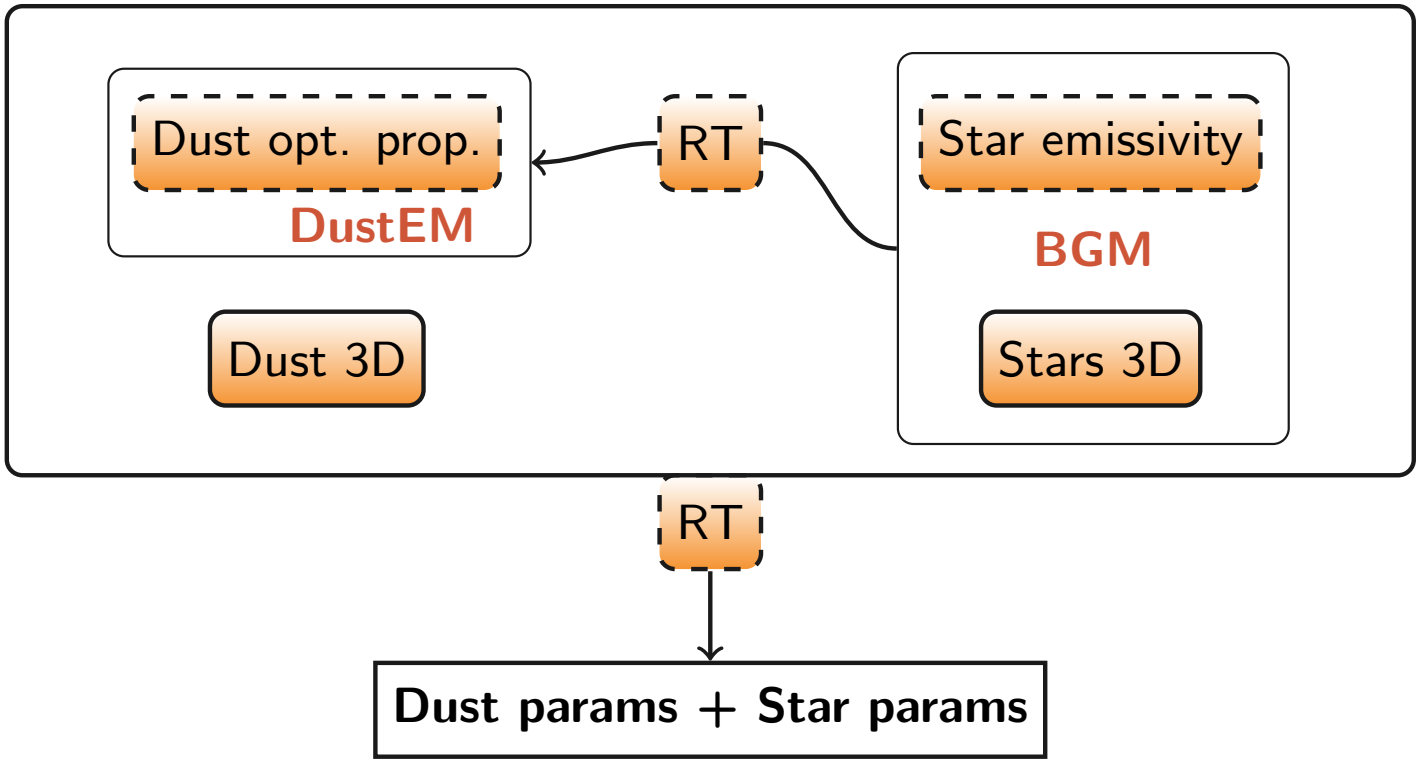
Stars 3D

RT

Dust params

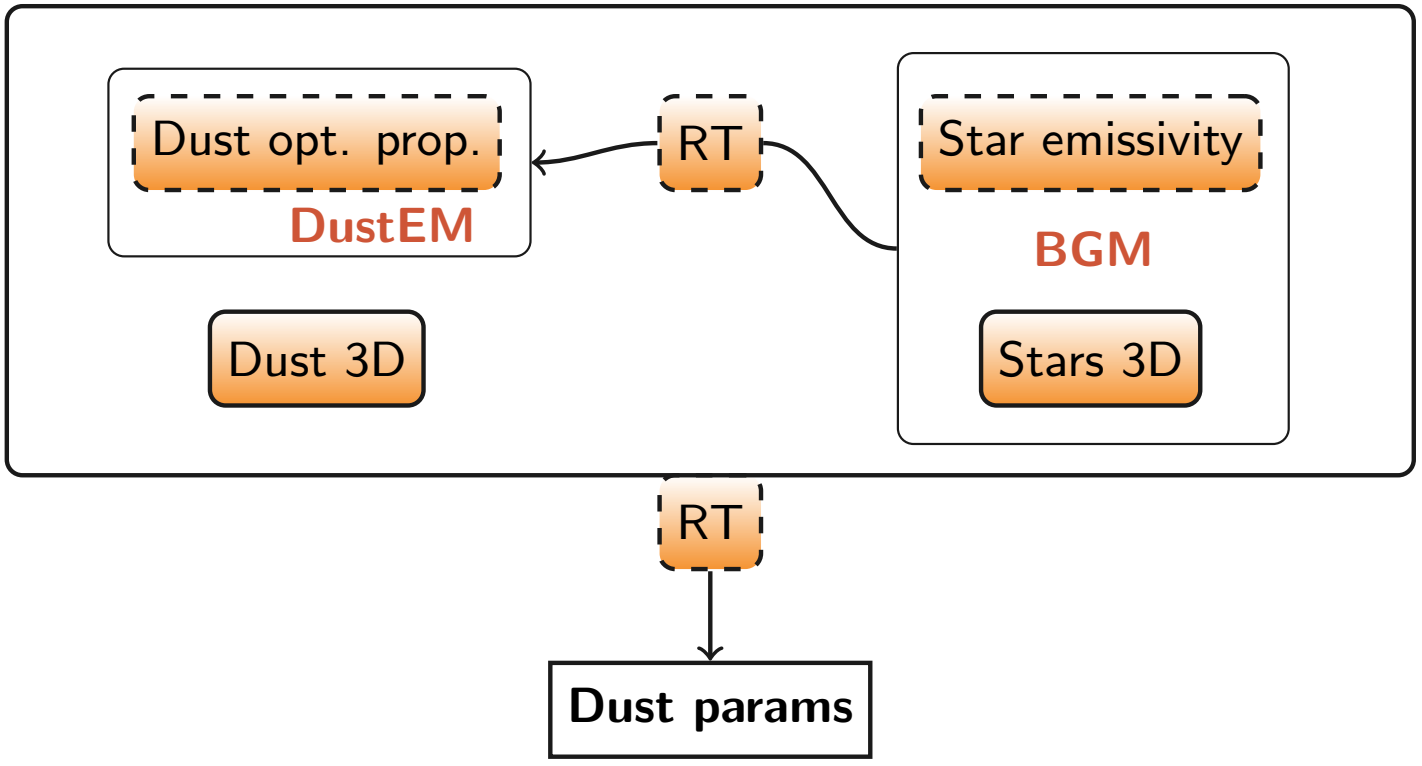
On-going work in Besançon: method (eventually)

All recent surveys (Planck, AKARI, WISE, 2MASS, ...)



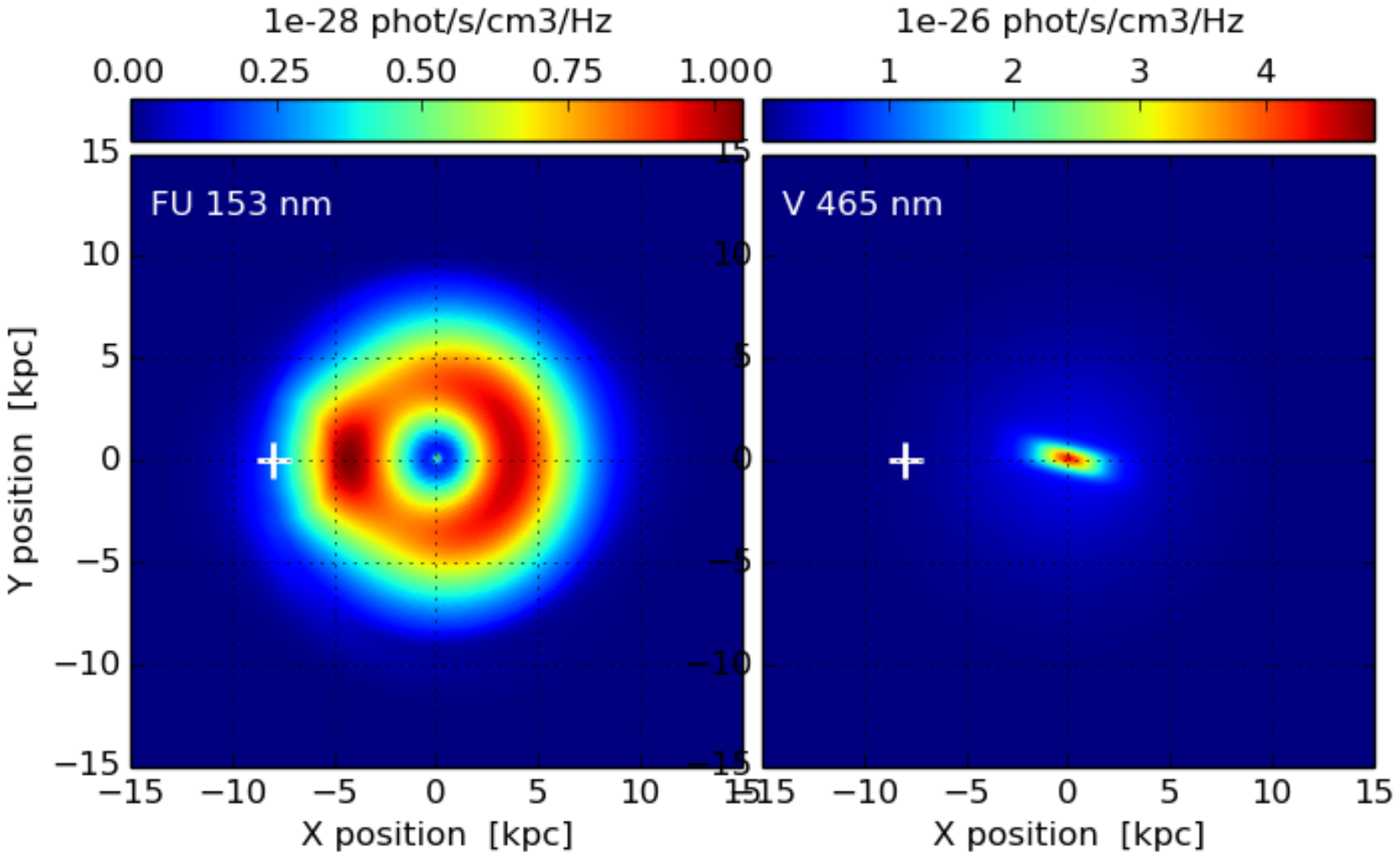
On-going work in Besançon: method (in progress)

Same as Robitaille+12



Outline

Stellar emission: 19 bands from FU(153nm) to 12mic

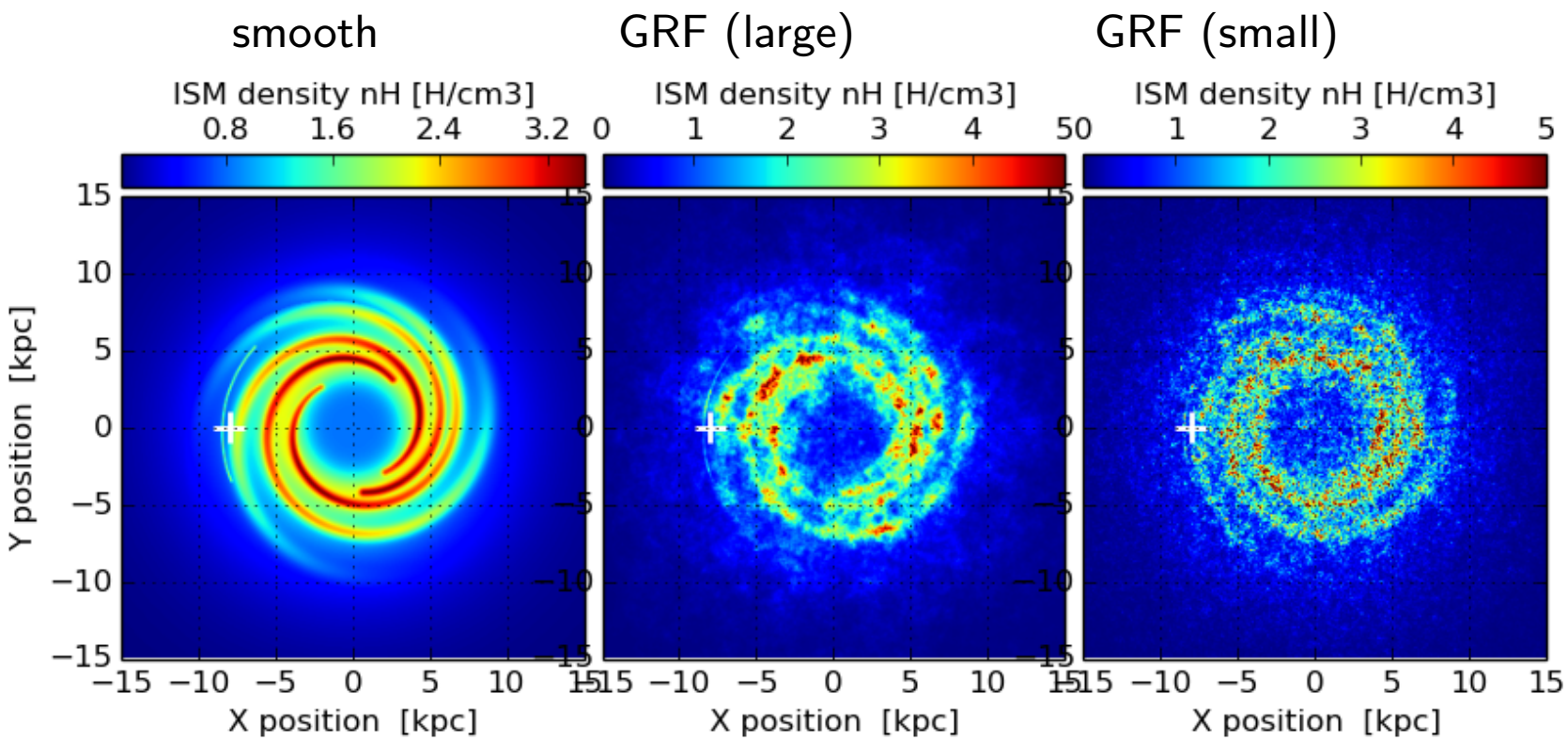


BUG1: bad interpolation in the UV

BUG2: bad conversion from colors to flux in the UV

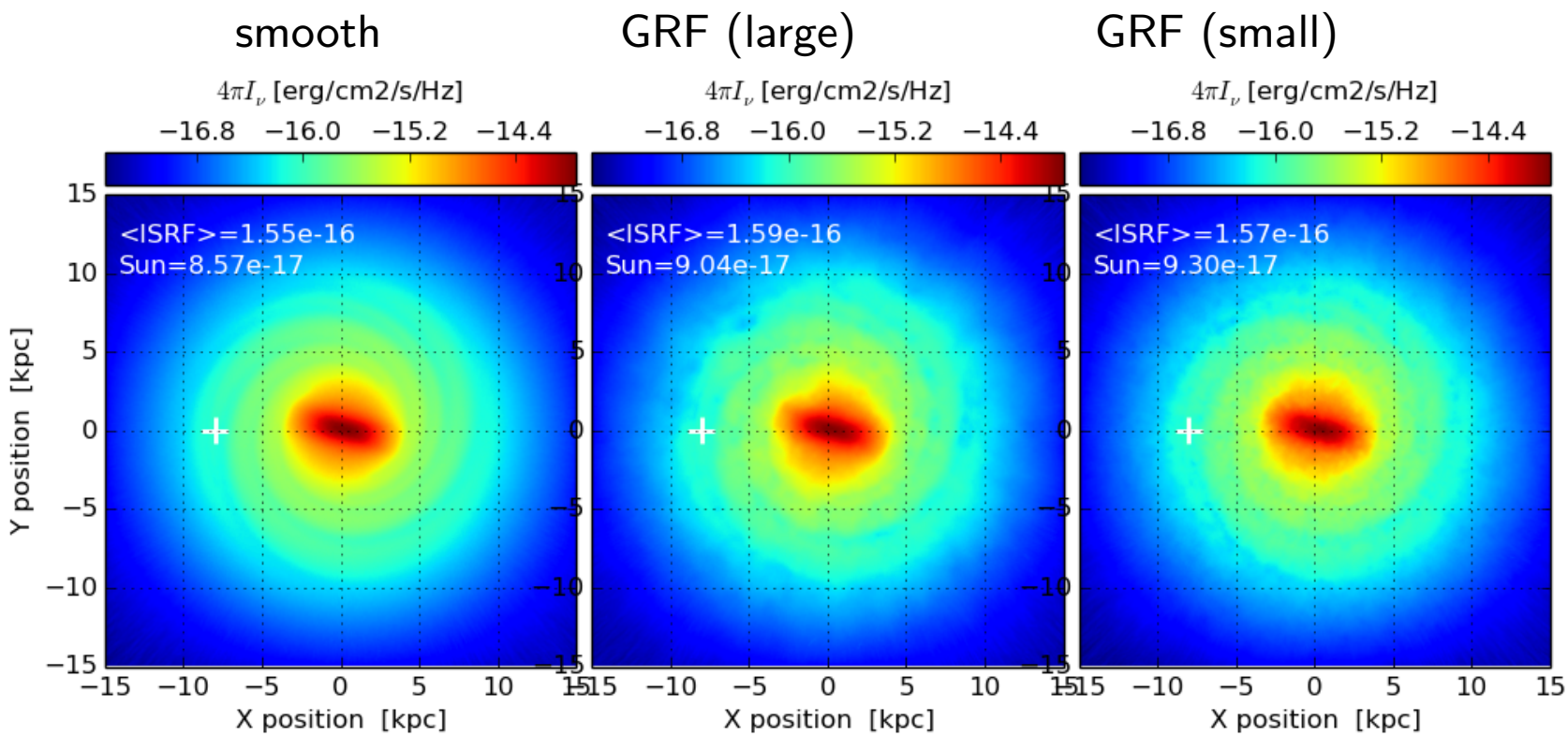
Outline

Dust 3D distribution



Outline

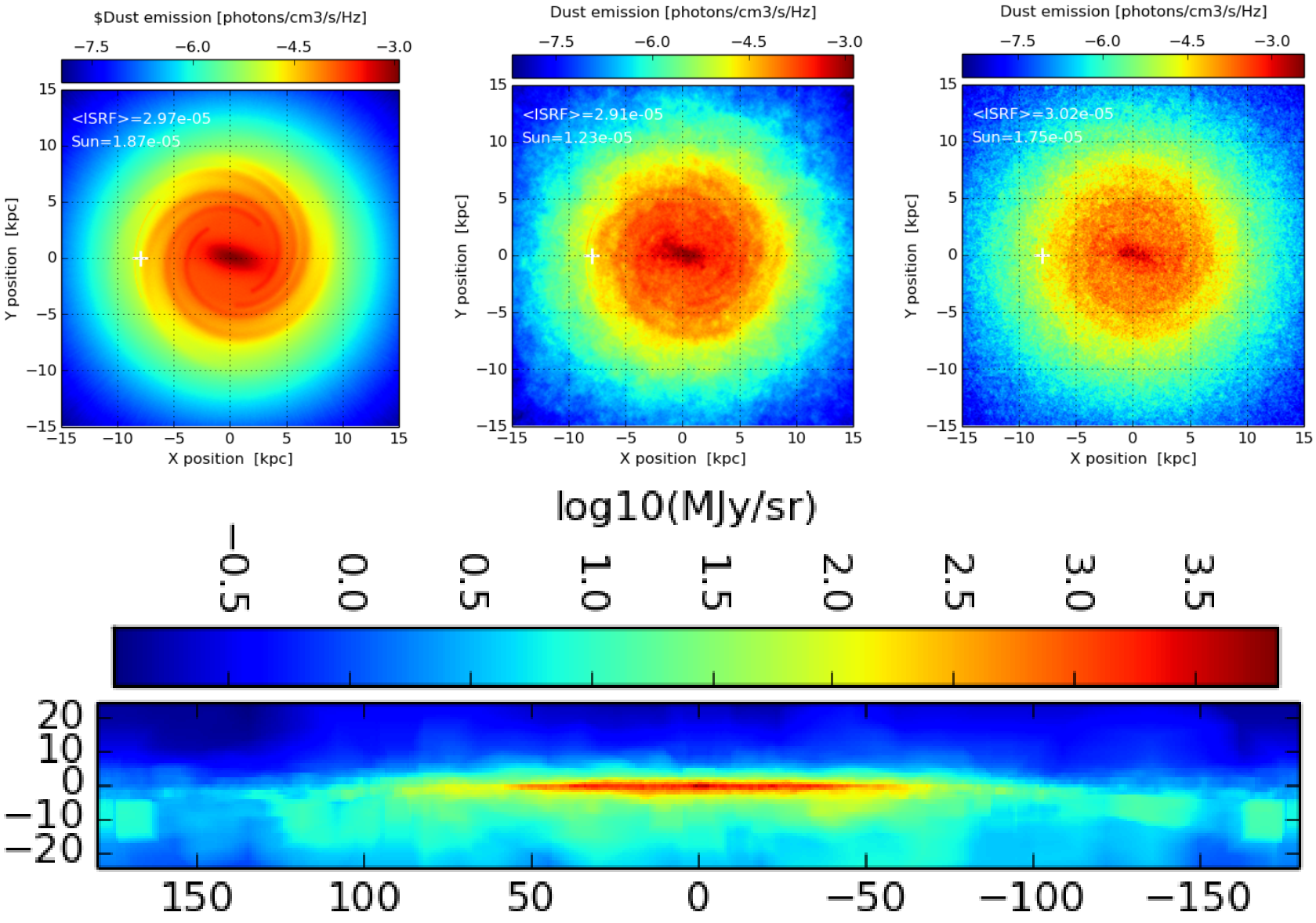
ISRF map



→ first look at the effect of clumpyness
→ no change in average
→ local fluctuations (shadowing effects)
→ still underestimated due to low resolution (100pc)

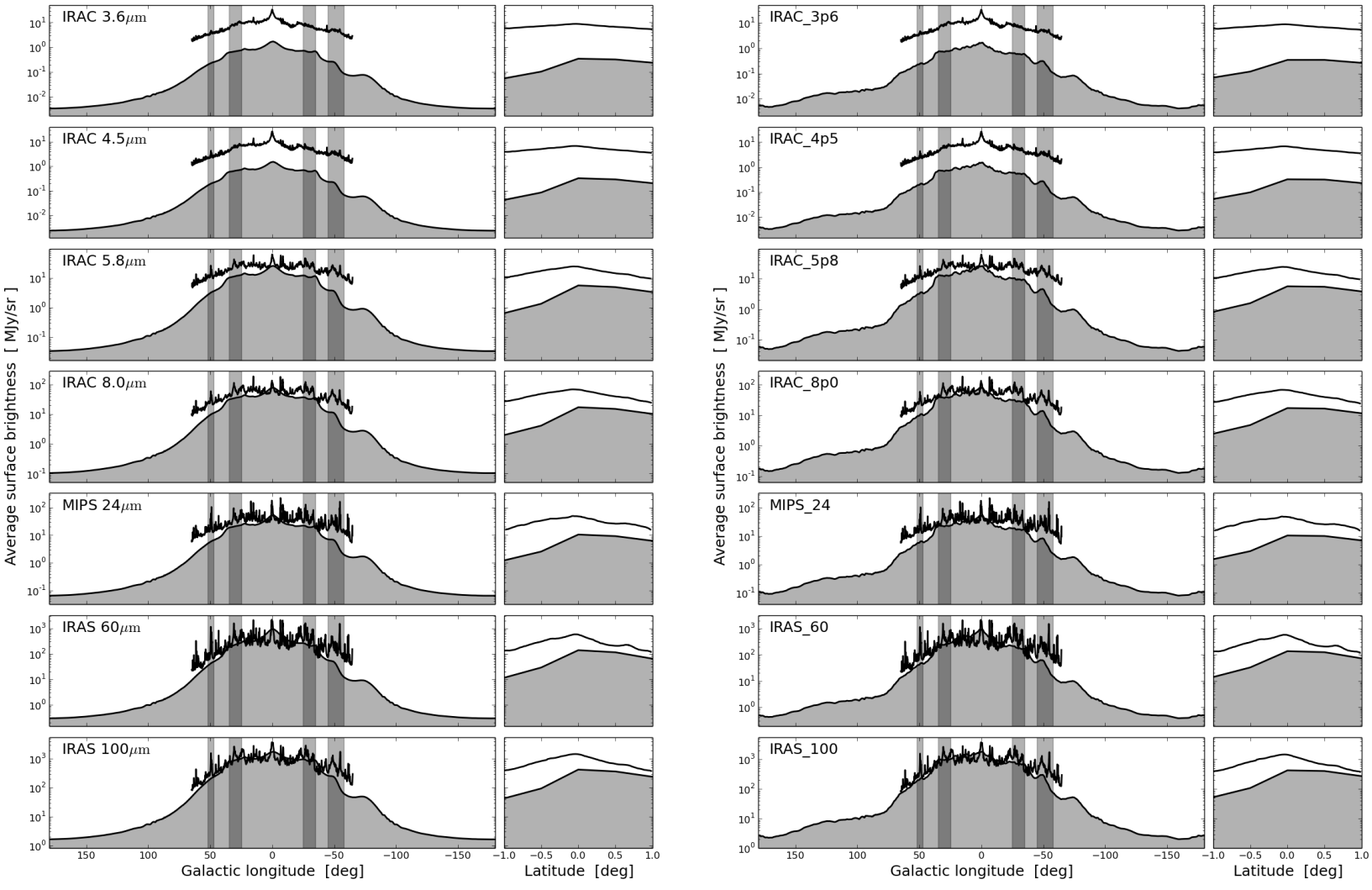
Outline

Dust emission

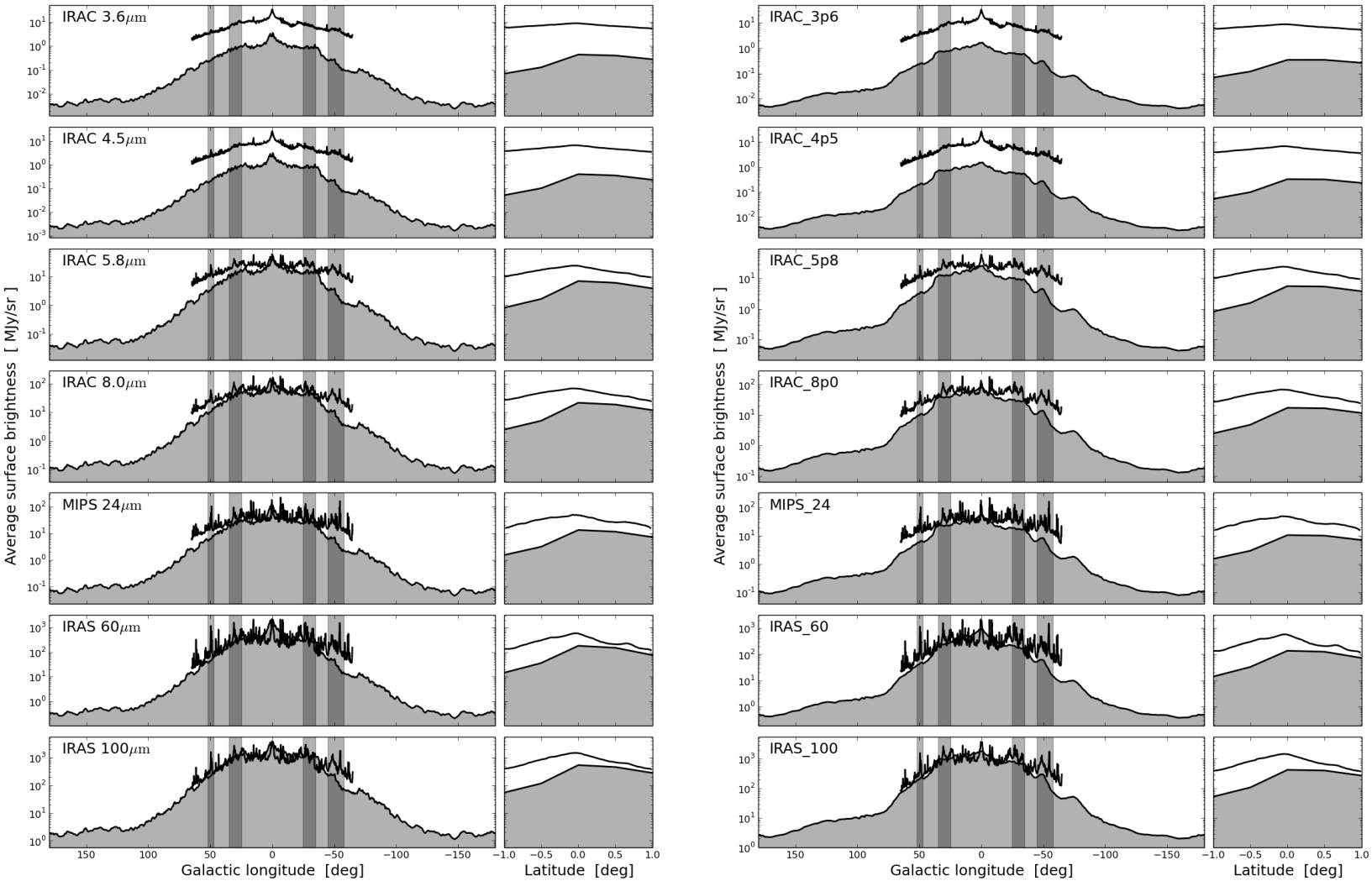


Outline

Comparison with observations: smooth vs large GRF



Comparison with observations: small GRF vs large GRF



Outline

Perspectives

- **TBD**
  - debug...
  - implement a dedicated photometric system in BGM
  - adaptive grid → Mika Juvela
- **Science**
  - Constraints on large Galactic structures
  - Comparison with 2D and 3D extinction maps
  - Provide an ISRF map
  - Environment of star forming regions