A high-resolution comparison of HI and CO emission

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Overview

Molecular gas in Local Group Galaxies :

- Ability to resolve Giant Molecular Clouds
  (1"=4pc @M33, 1"=2.5pc @NGC6822)
- Easier to define distances compared to Milky Way.

Interesting environments to study molecular gas :

- Lower metallicity
- Higher star formation efficiency ?
- Similarities with $z \sim 0.5 - 1$ galaxies

Observing CO in M33

CO(2-1) 230 GHz line
HERA @ IRAM's 30m
OTF mapping

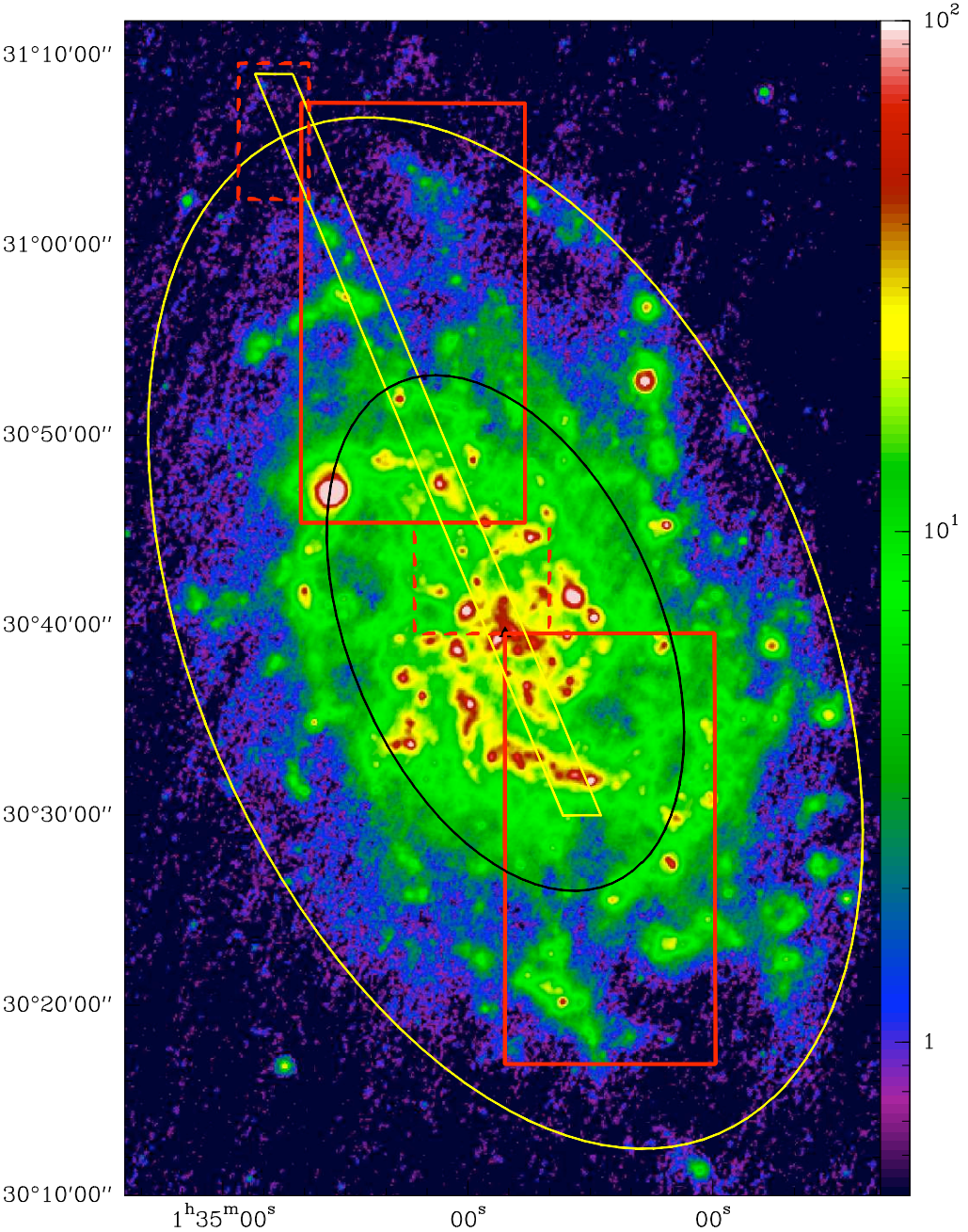
$12'' \times 12'' \times 2.6\text{km/s}$

Two $11' \times 21'$ data cubes
SW & NE

Next HERA pool 88h :
finish HIFI strip

HI 21cm data : VLA BCD
(1997 & 2001)

- calibrated and imaged in CASA
- using Multi-Scale Clean



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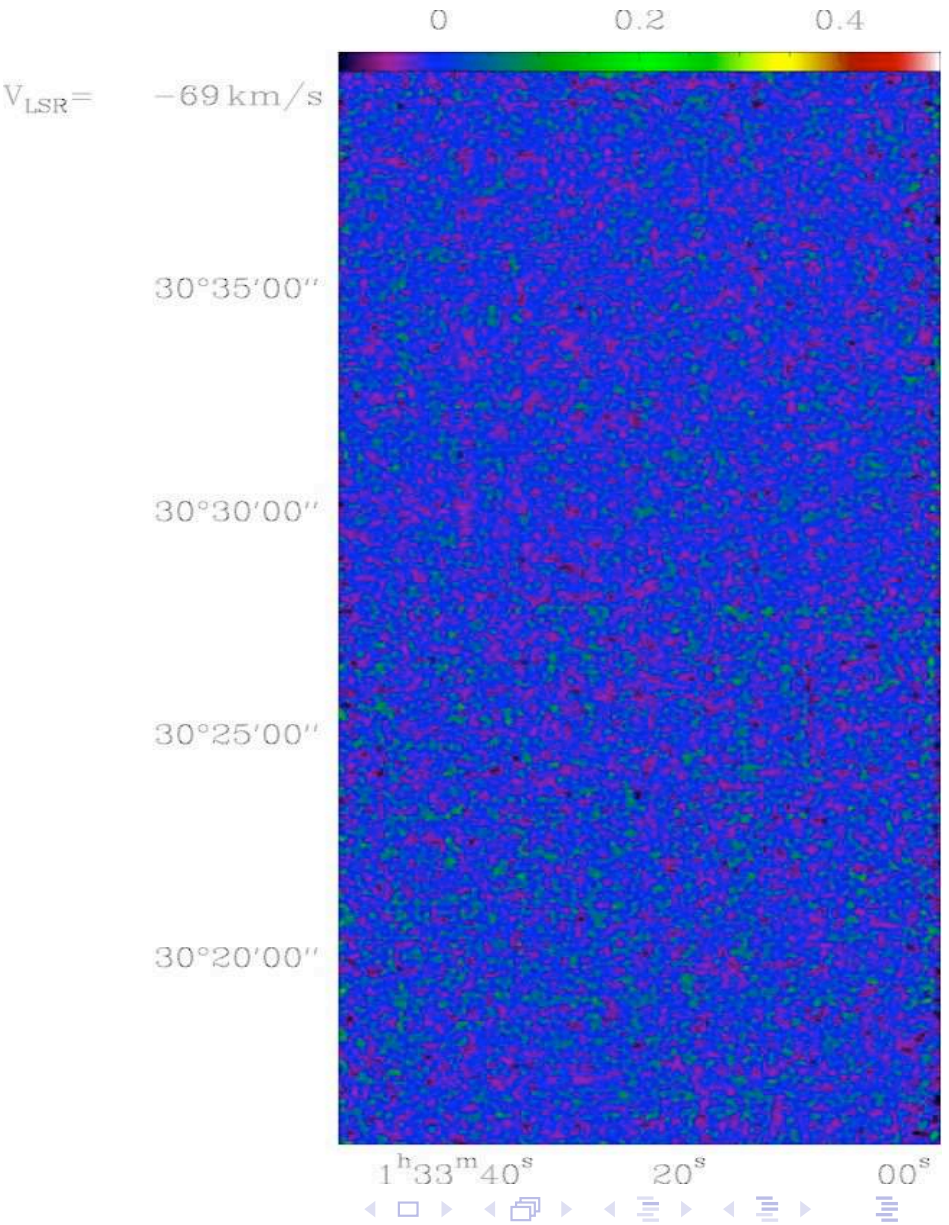
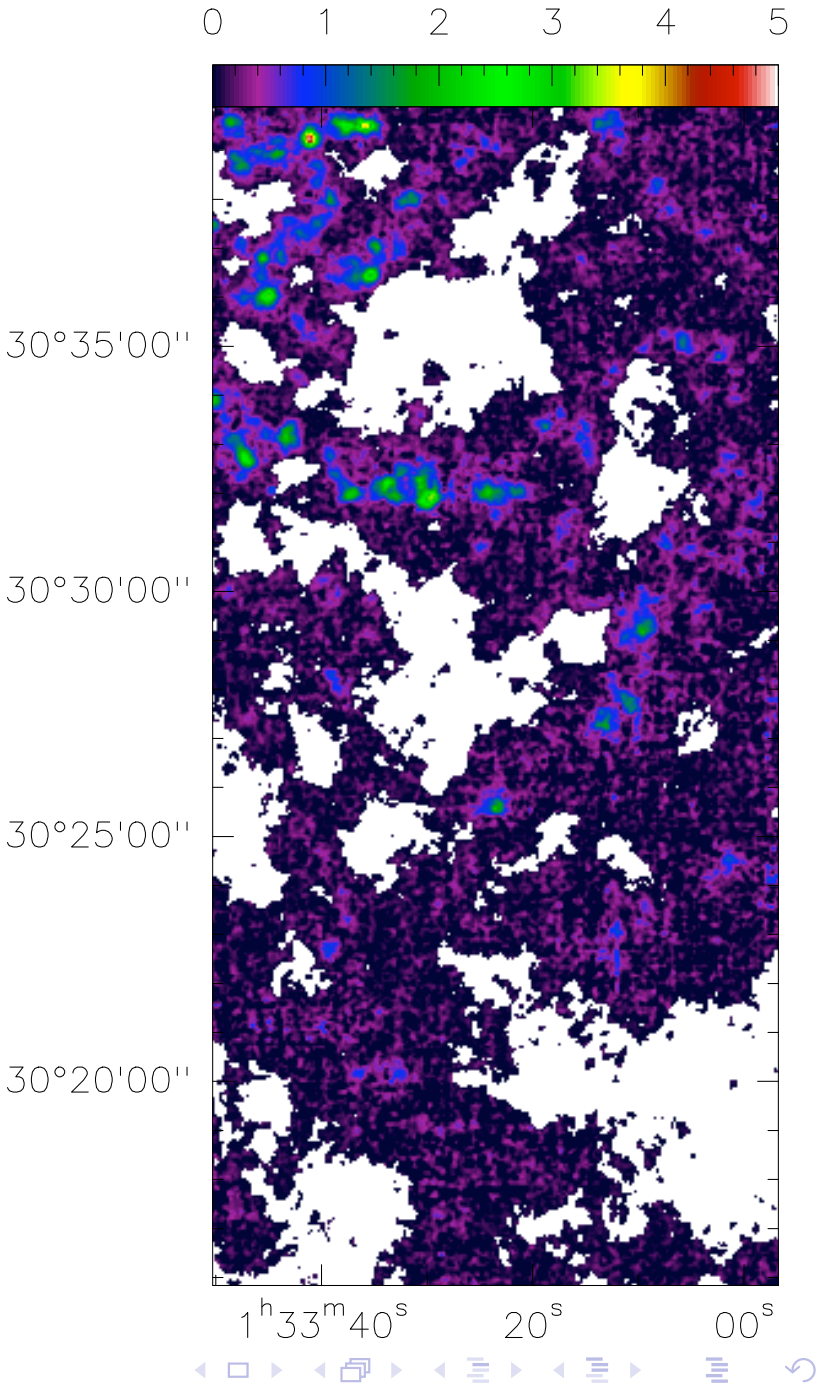


CO integrated intensity map

Unlikely to have CO without HI $\Rightarrow$ use the HI data to mask noisy CO channels

Velocity channel in CO contribute to the sum only if associated with HI above 4σ ($\sim$ 20K)

- Advantage : channels containing only noise are discarded
- Disdvantage : Non uniform noise



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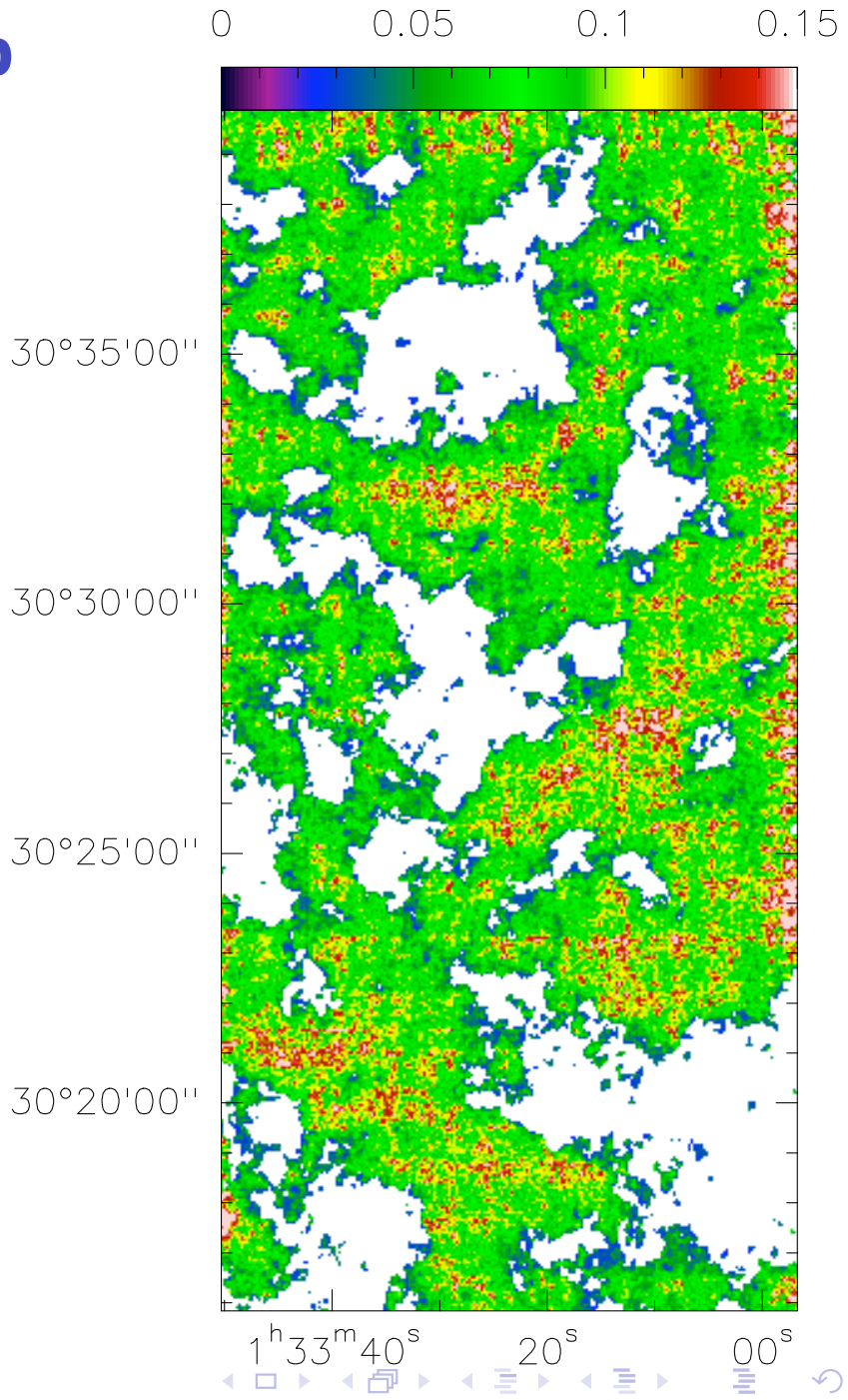

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Identifying clouds and measuring their properties

CPROPS (Rosolowsky and Leroy in PASP 118 2006)

- Assign volumes in the datacube to individual clouds
- Measure cloud properties ($\mathrm{V_{LSR}}, \mathrm{Radius}, \sigma_\mathrm{V}, \mathrm{L_{CO}}, M_{vir}, M_{lum}$)
  - Deconvolved from the beam size (for Radius)
  - Extrapolated to a 0K noise level (for $\mathrm{Radius}, \sigma_\mathrm{V}, \mathrm{L_{CO}}$)
  - Two mass estimates
    - $\mathrm{M_{vir}} \propto \mathrm{Radius} \times \sigma_\mathrm{V}^2$
    - $\mathrm{M_{Lum}} \propto \mathrm{L_{CO}}$ using an $\mathrm{H_2}$ to CO conversion factor

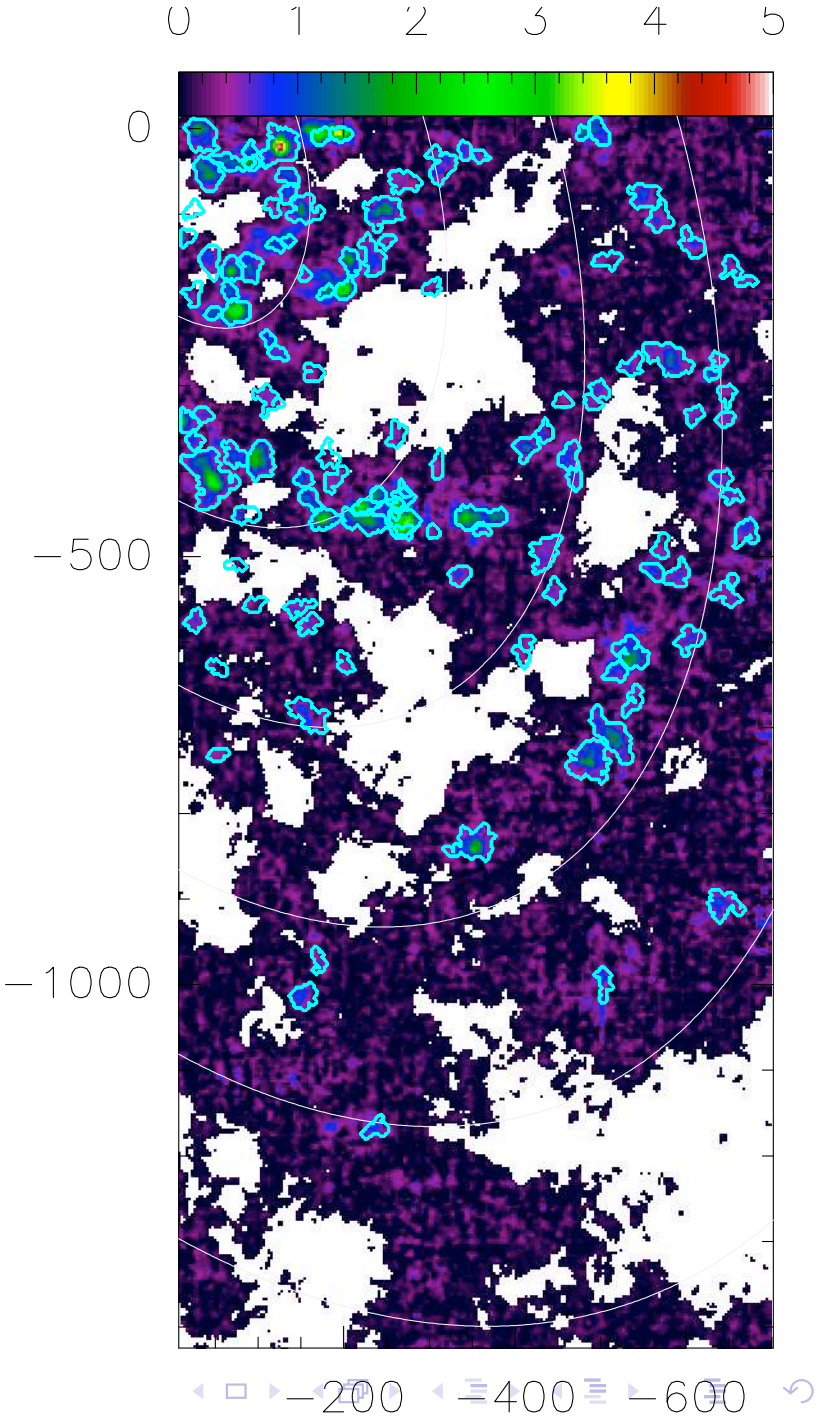
CPROPS **output**

Catalog of :

- physical cloud properties
- associated 2D contours of the sky projected CO emission

120 clouds for southern cube
Work to be done on northern cube and future M33 data.

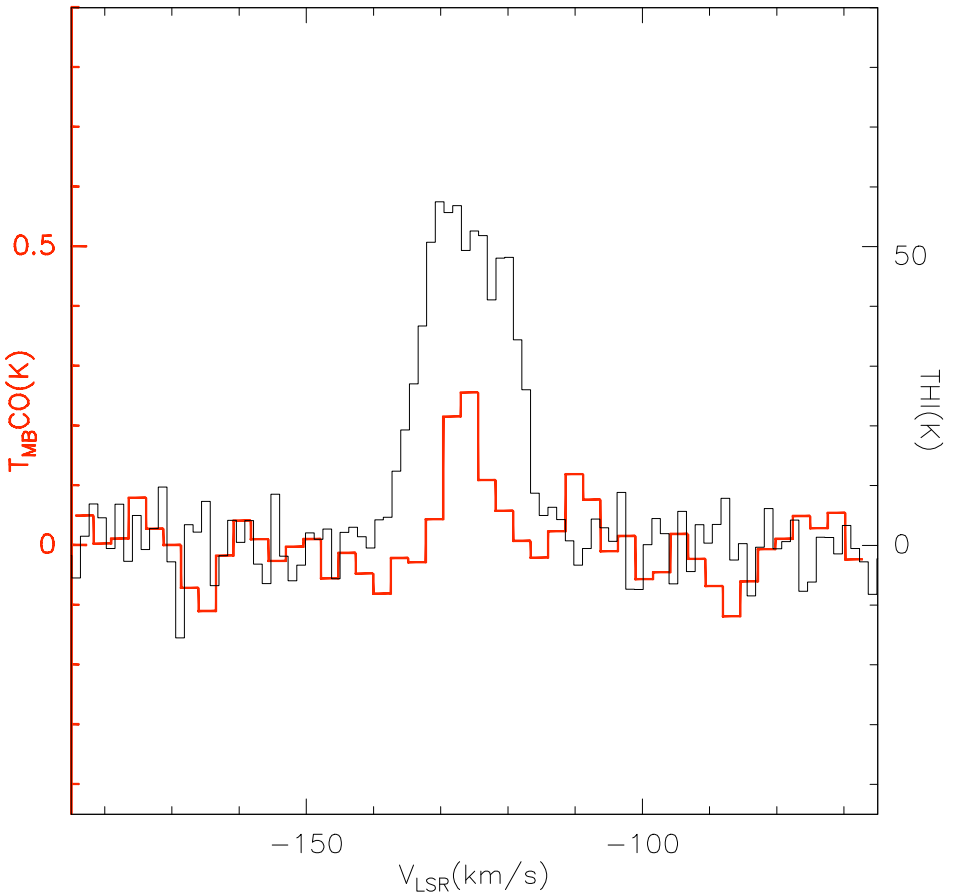
Use the lowest contour to make a CO and an HI spectrum for each clouds



Cloud Zoo (1)

Typical cloud

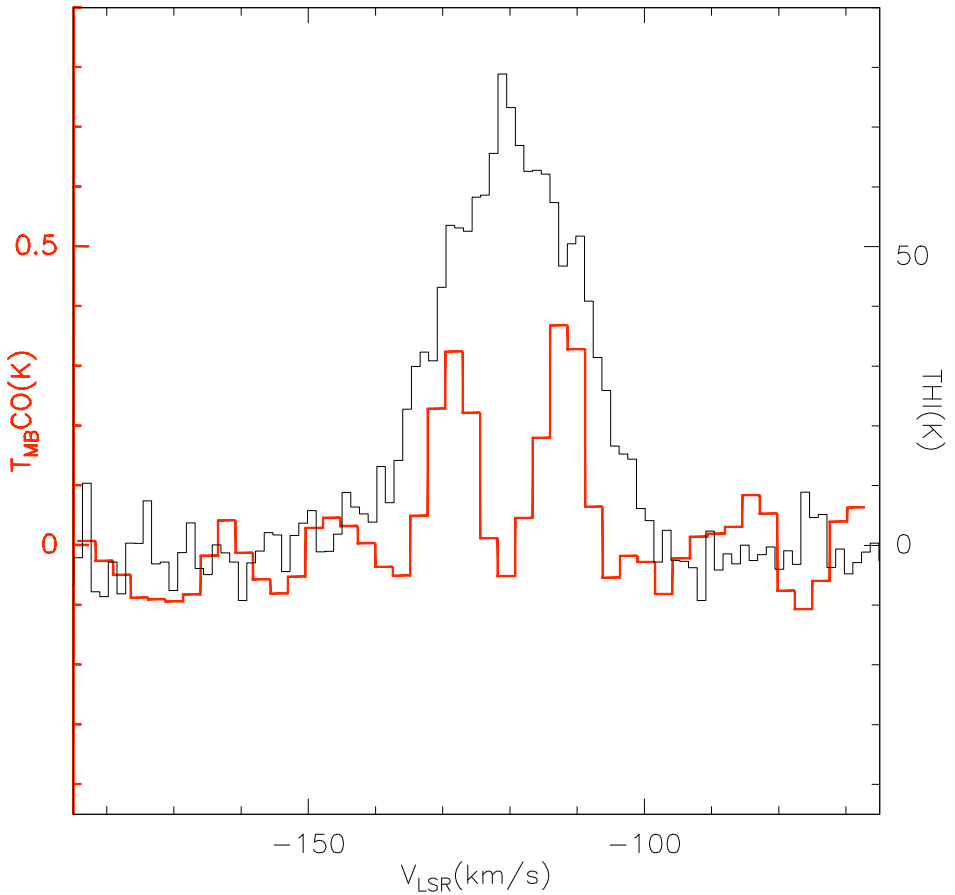
- CO narrower than HI
- CO and HI peak at the same velocity



Cloud Zoo (2)

Peculiar cloud :

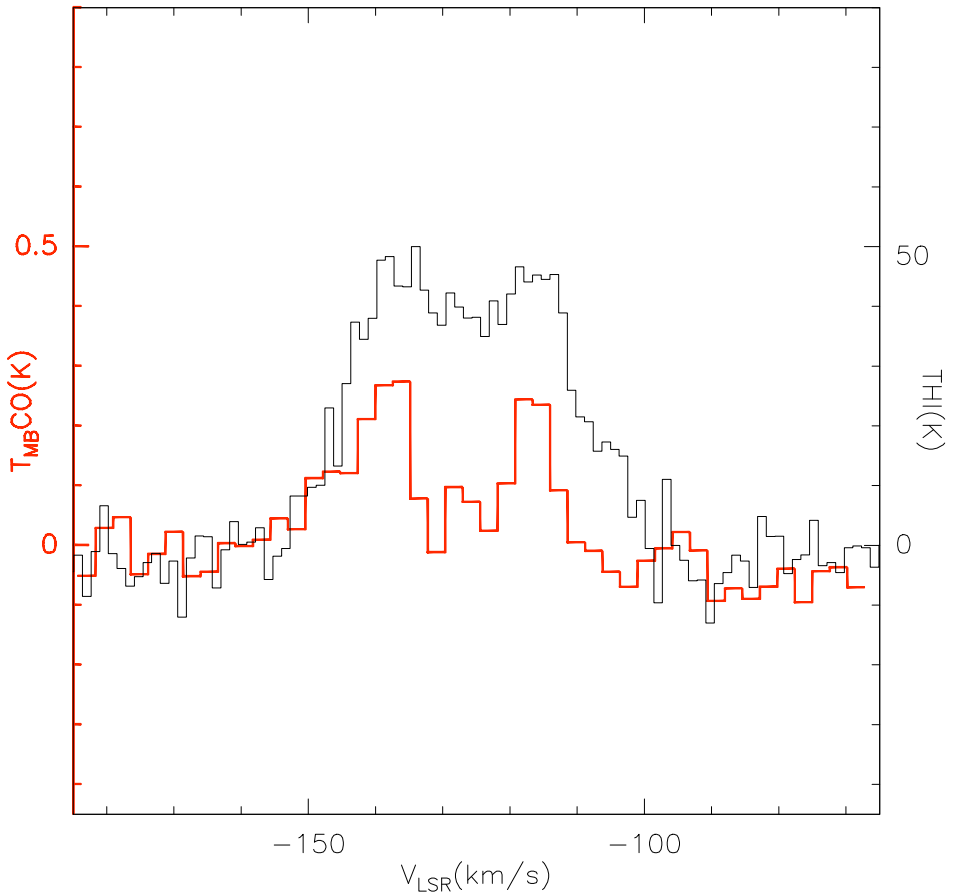
- One HI component
- Two CO components



Cloud Zoo (3)

Peculiar cloud :

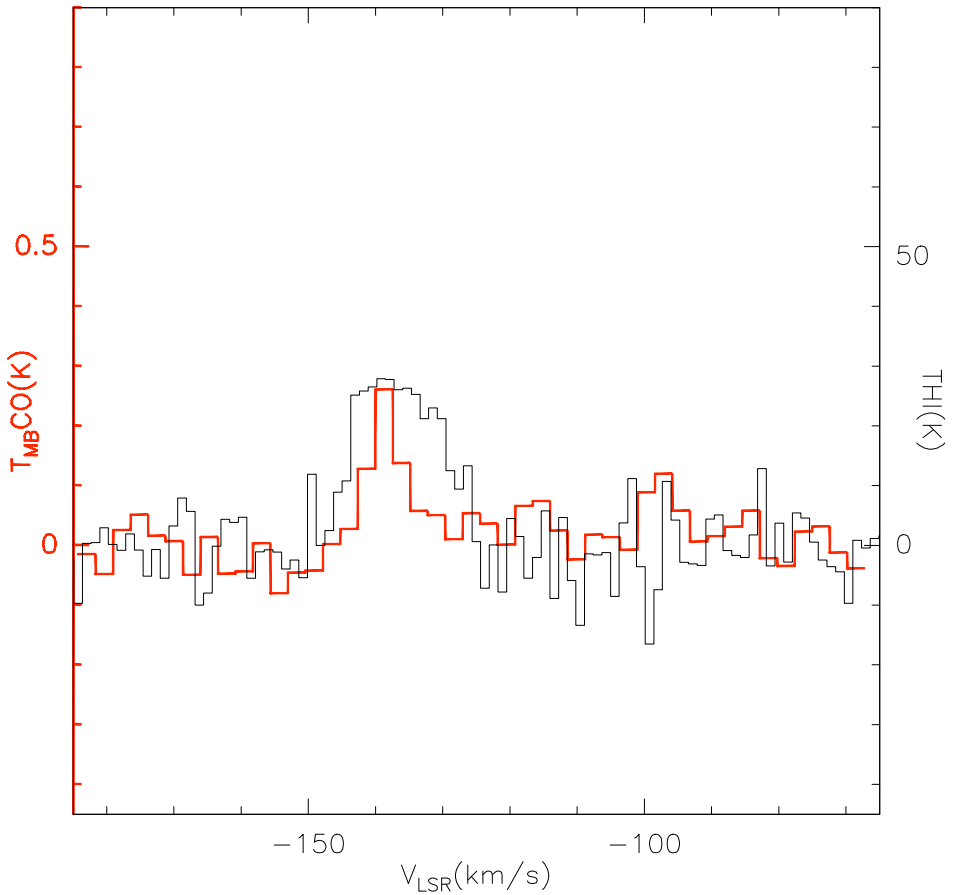
- Two HI components
- Two CO components
- Possible collision ?



Cloud Zoo (4)

Peculiar cloud :

- Typical CO
- Weak HI



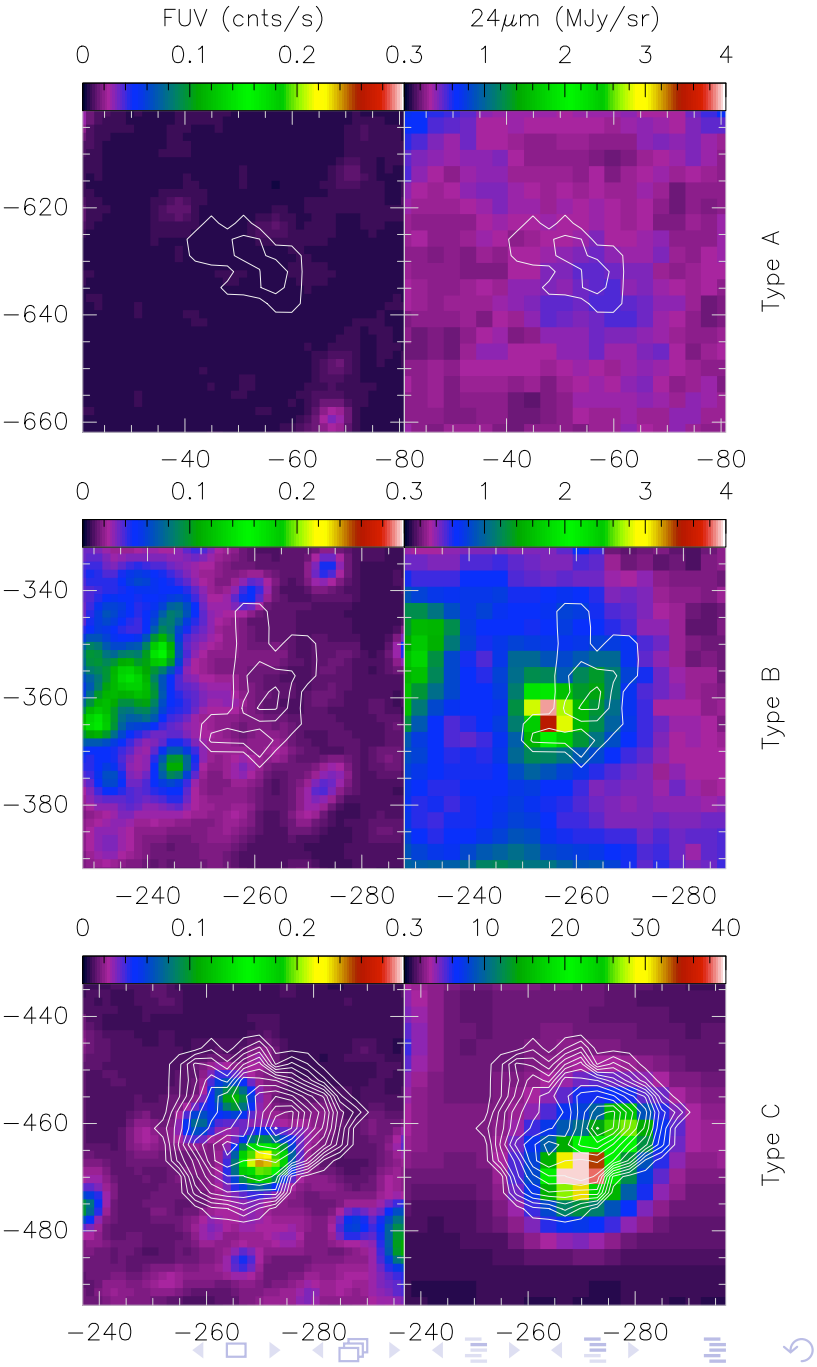
Cloud Classification : Method

Use two tracers as an indication of age :

- 24μm (SPITZER) : tracer of star formation (or Hα)
- FUV (GALEX) : tracer of OB clusters

In term of age :

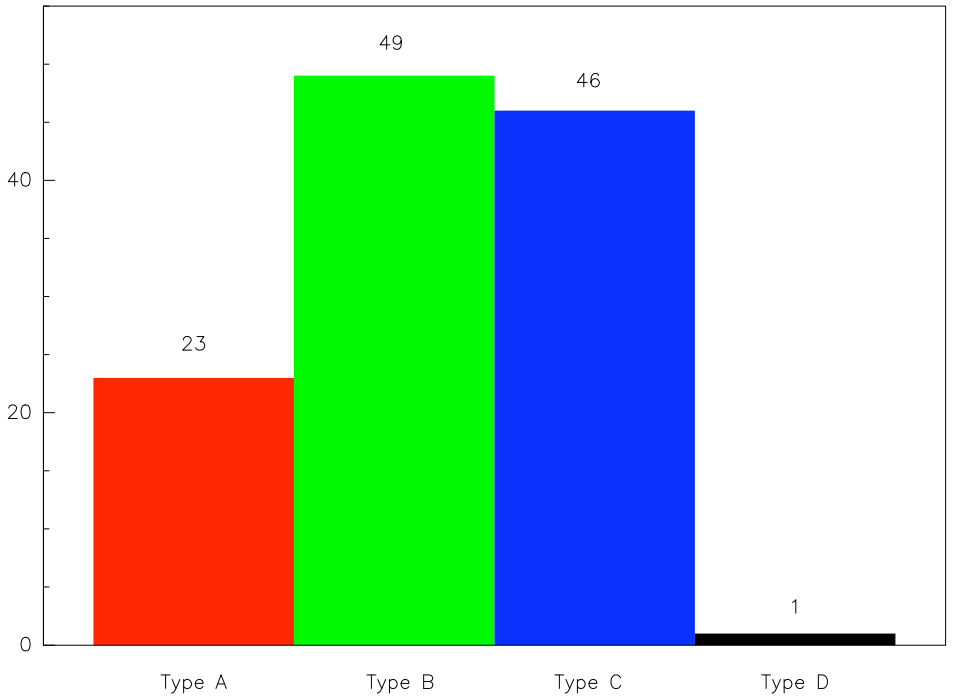
Type C $<$ Type B $<$ Type A



Cloud Classification : Results

For our sample of 120 clouds :

- Considering an uniform cluster formation rate
  $\longrightarrow$relative time scale of each phase $\propto$ ratio
- Need to know proportion of clusters associated w/ molecular clouds to get absolute numbers



Cloud Classification : Comparison with LMC

Kawamura et al

No exactly same types

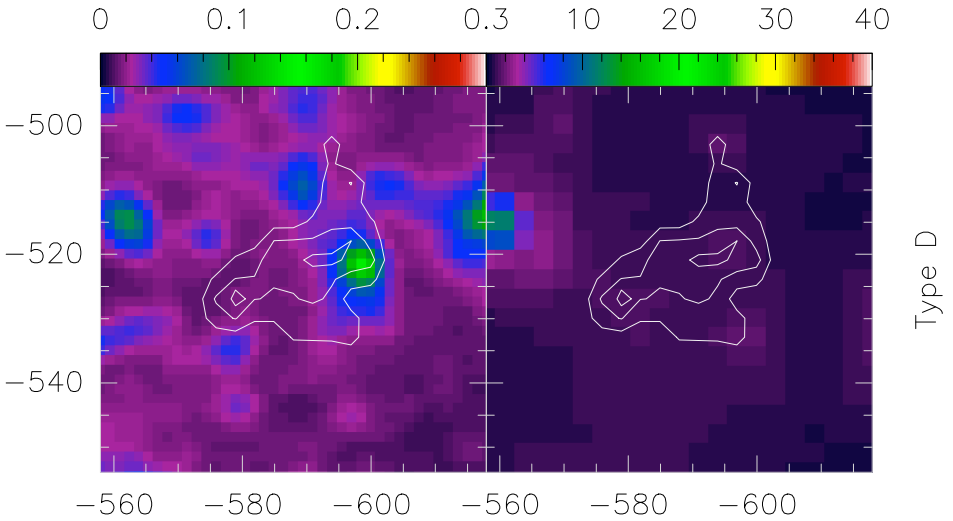
- Type I : starless, HIIless molecular clouds
- Type II : small HII ($L_{H_\alpha} < 10^{37}$erg/s)
- Type III :HII and young cluster ($L_{H_\alpha} > 10^{37}$erg/s)

	I/A	II/B	III/C
M33	20%	42%	38%
LMC	24%	50%	26%
	6My	13My	7 My

Cloud Classification : Type D

One type D cloud

- No 24μm / FUV peak
- Fortuitous alignment ?



Future work

CO observations :

- Finish HIFI strip
- Apply same cloud ID methods $\rightarrow \sim 250 - 300$ clouds
- Mass distribution, radial profiles.

CO-HI comparison :

- integrated intensity comparison (Wong et al. LMC)

CO-IR comparison :

- use 8μm as a tracer of total atomic+molecular gas column density ?
- Is CO still a correct tracer of H_2 in lower metallicity environments ?