



What is a Giant Molecular Clouds?

Are Observers and Simulators Discussing the Same
Star-forming Clouds?

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Outline

Comparisons between observations and simulations become a key tool in understanding the results in ALMA era, but:

- 1. Are Observers and Simulators Discussing the Same Molecular Clouds?**
- 2. Do cloud properties change when different methods are used?**

- Introduction
- General comparison of Simulated and Observed clouds
 - Position and median cloud properties
- Match clouds properties
 - Simulation vs. Observation plots
- Observation prospects
 - What our clouds look like in ALMA observations?

Simulation versus Observation

Data
Structure

- **6 dimensions**

3D position (x, y, z)

3D velocity (v_x, v_y, v_z)



- **3 dimensions**

2D position (RA, Dec)

1D velocity (v_{los})

spectral cube, channel map



direct cloud properties

projected cloud properties

Cloud
Boundary

- **fixed threshold**

100 H/cc (CO)

1000000 H/cc (HCN)

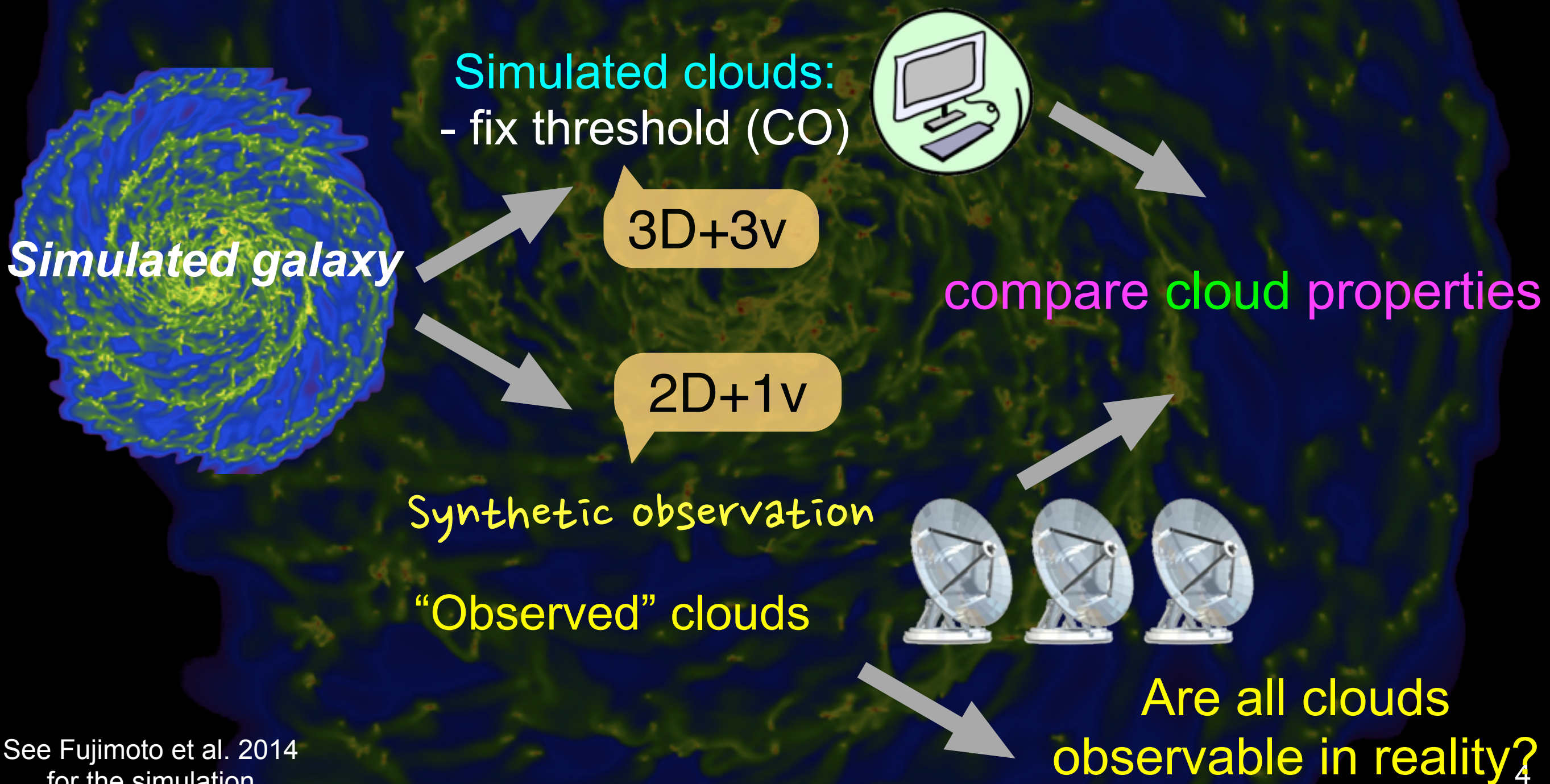
- **ratio of intensity to noise**

3 x noise level

5 x noise level

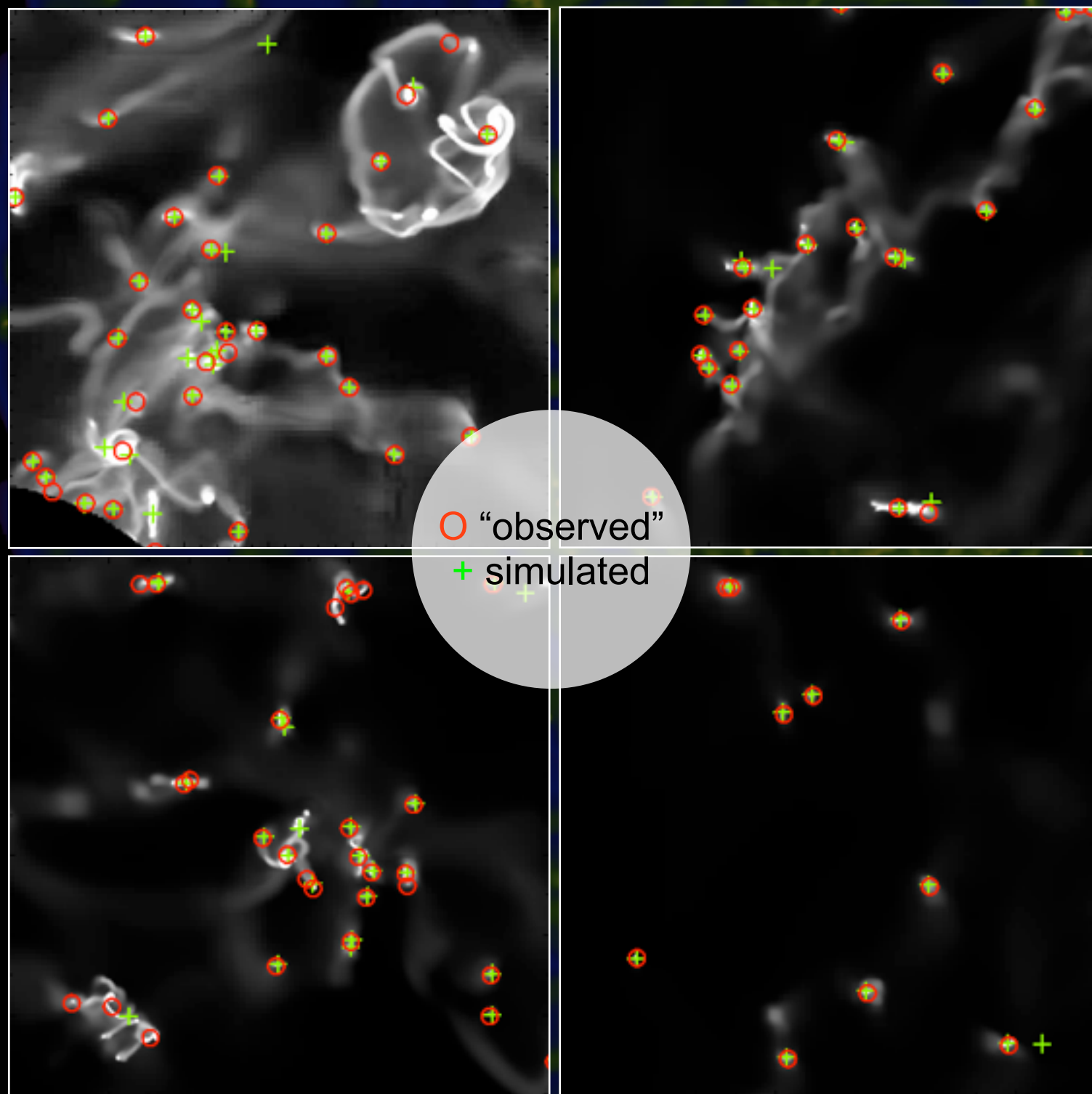
Methods

1. Are Observers and Simulators Discussing the Same Molecular Clouds?
2. Do cloud properties change when different methods are used?



General Cloud Properties

Positions



(Median) Properties

Simulated vs. Observed

Number

1029 vs. 971

Mass

$3.7e5$ vs. $3.6e5$
 M_{\odot}

Radius

14.2 vs. 14.2
 pc

velocity dispersion

4 vs. 5
 km/s

virial Parameter

1.0 vs. 1.0

Match Cloud Properties

A simulation cloud and an “observed” cloud are matched if they originate from the same density structure.

Clouds that have counterparts in another data structure: **70%**



- Plots: e.g., **Simulated mass** vs. **“Observed” mass**
Simulated radius vs. **“Observed radius”**

...

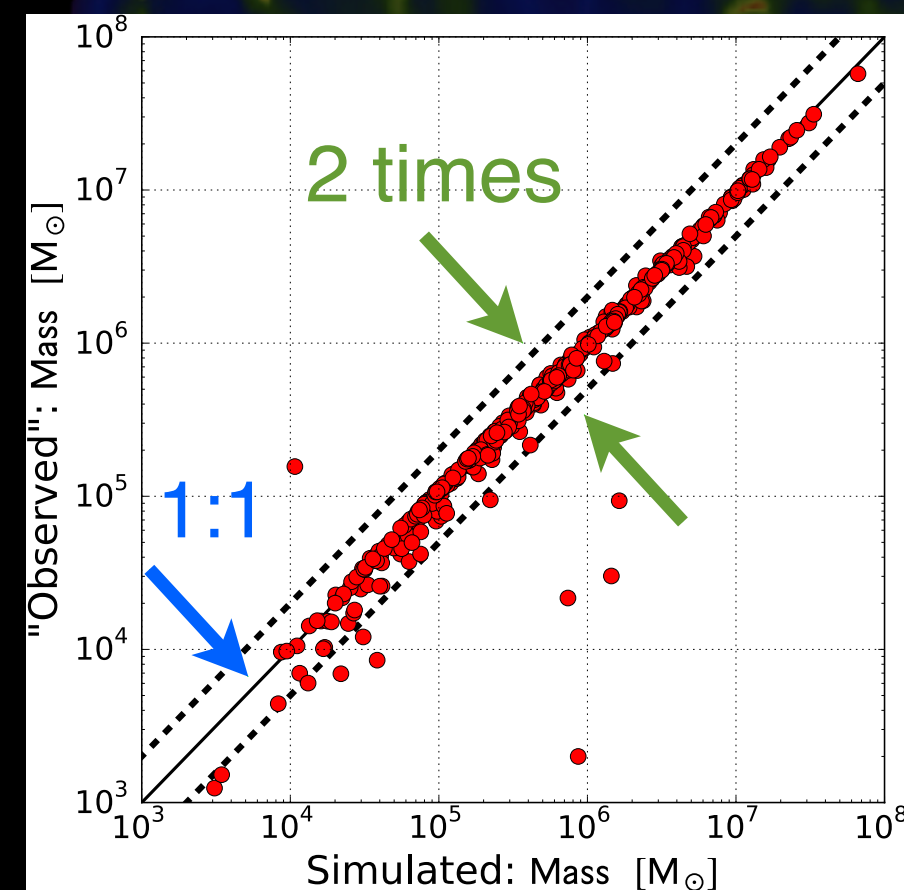
...

Do cloud properties change when different methods are used?

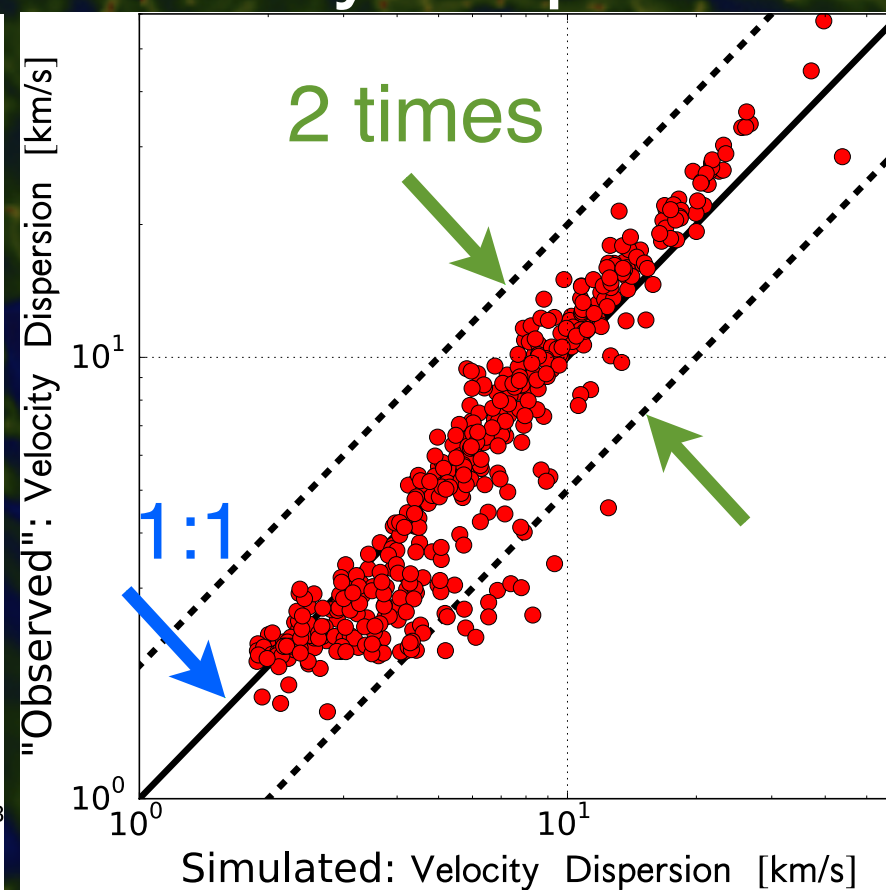
Match Cloud Properties

“Observed” versus Simulated
($2D+1v$ versus $6D$)

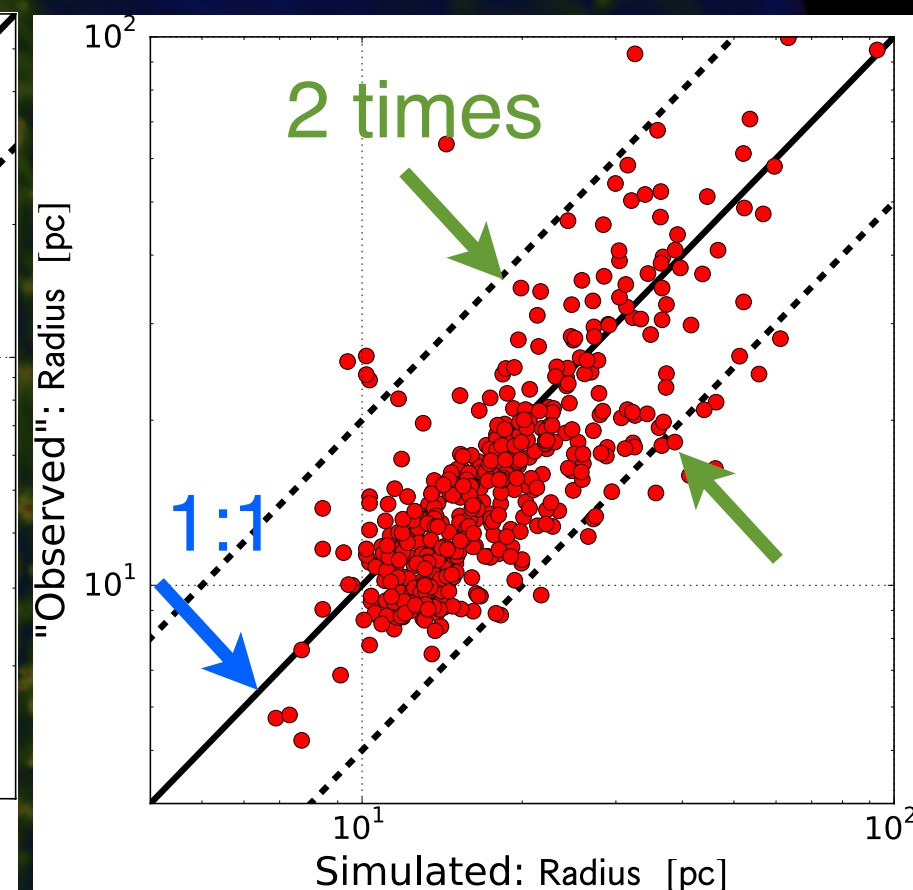
Mass



Velocity Dispersion

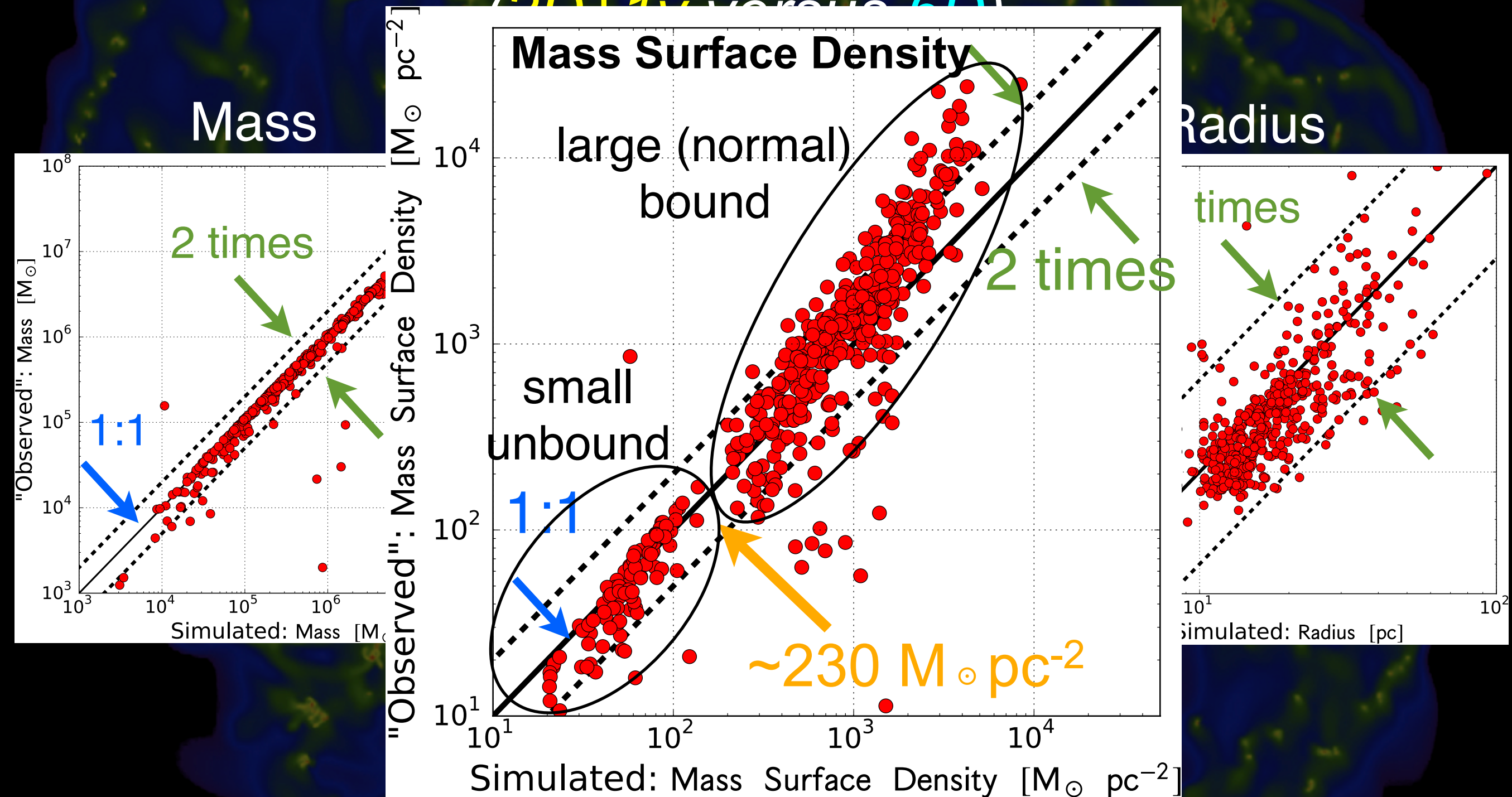


Radius



Match Cloud Properties

“Observed” versus Simulated
(2D+1, versus 6D)

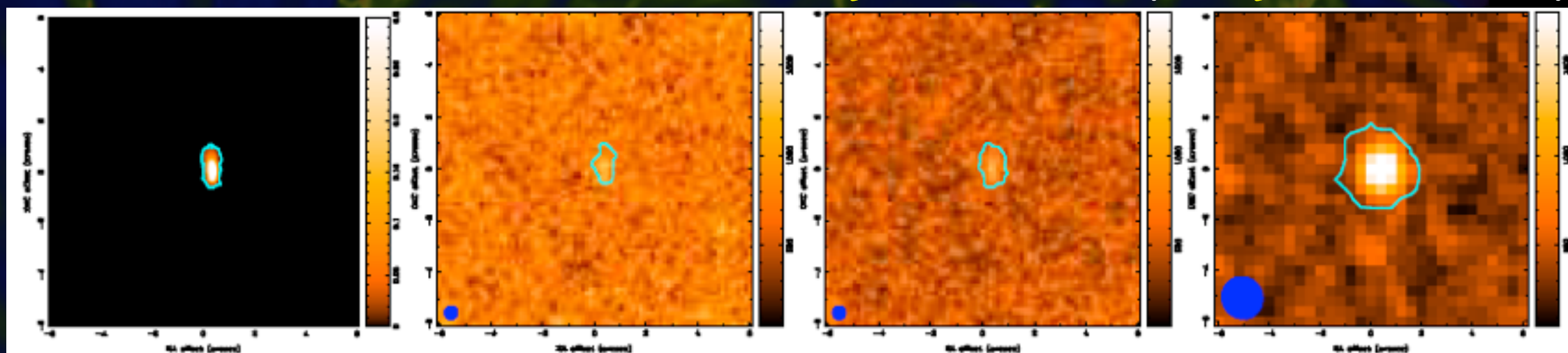


Observations of High- Σ Clouds

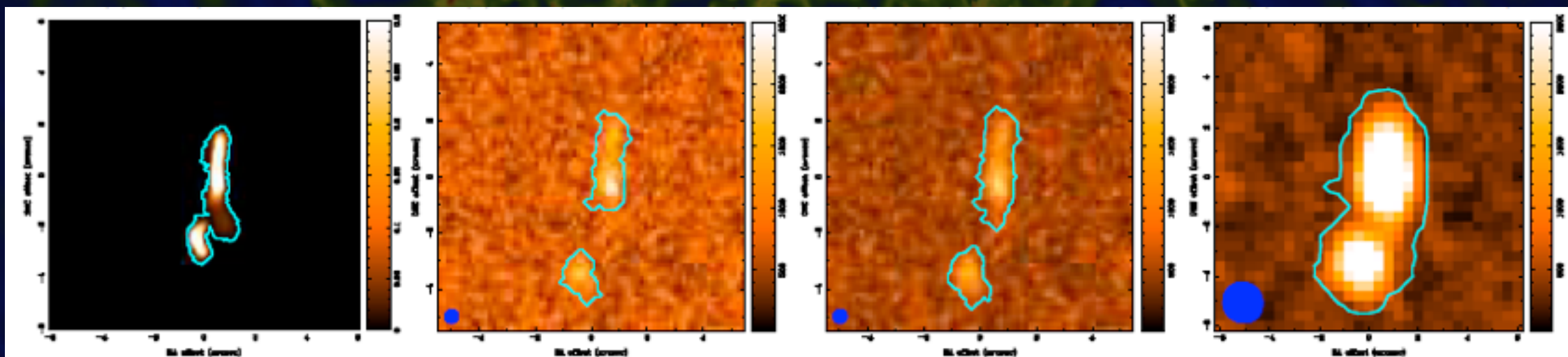


Simulated high resolution low sensitivity high resolution high sensitivity low resolution high sensitivity

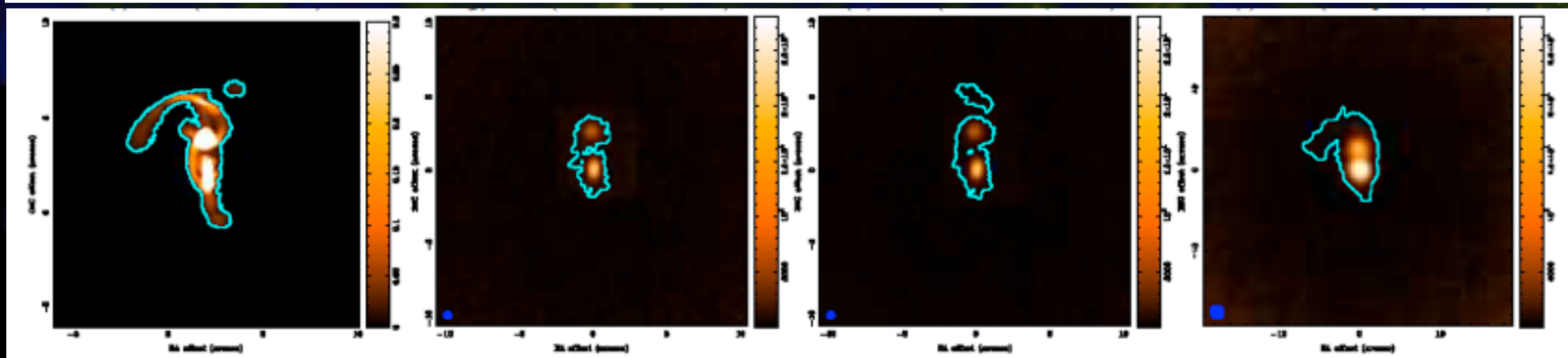
1.



2.



3.



Observations of Low- Σ Clouds

Simulated

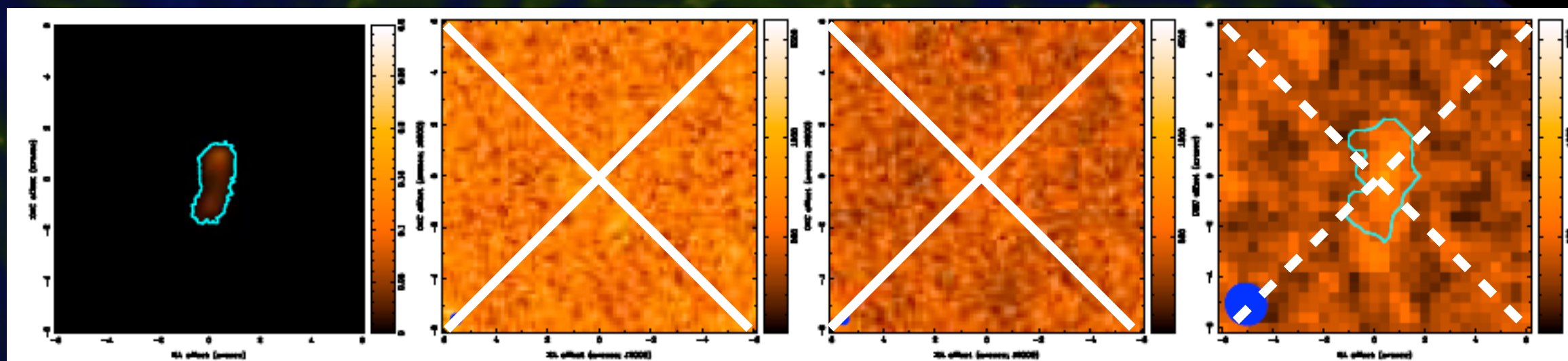
high resolution
low sensitivity

high resolution
high sensitivity

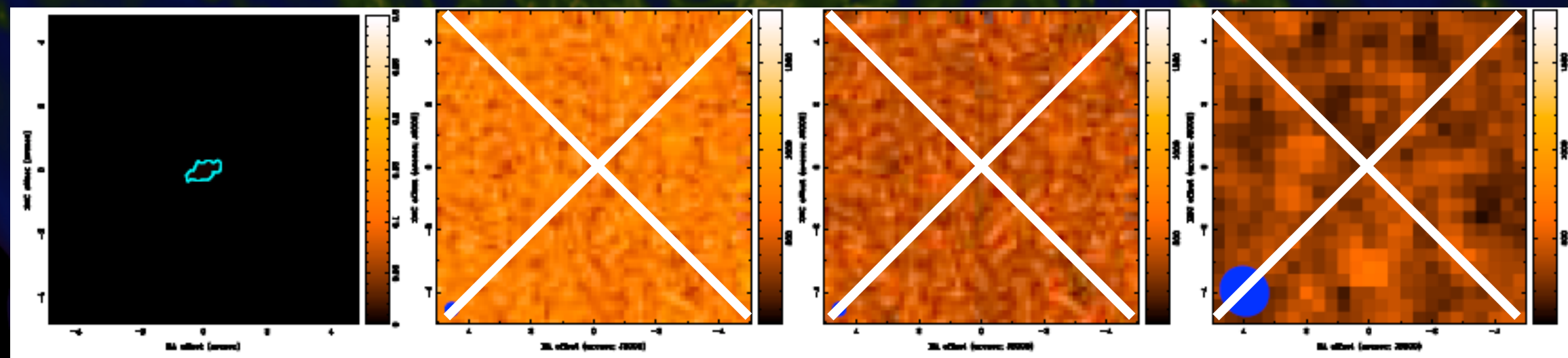
low resolution
high sensitivity



1.



2.



None of small clouds is detected!

Summary

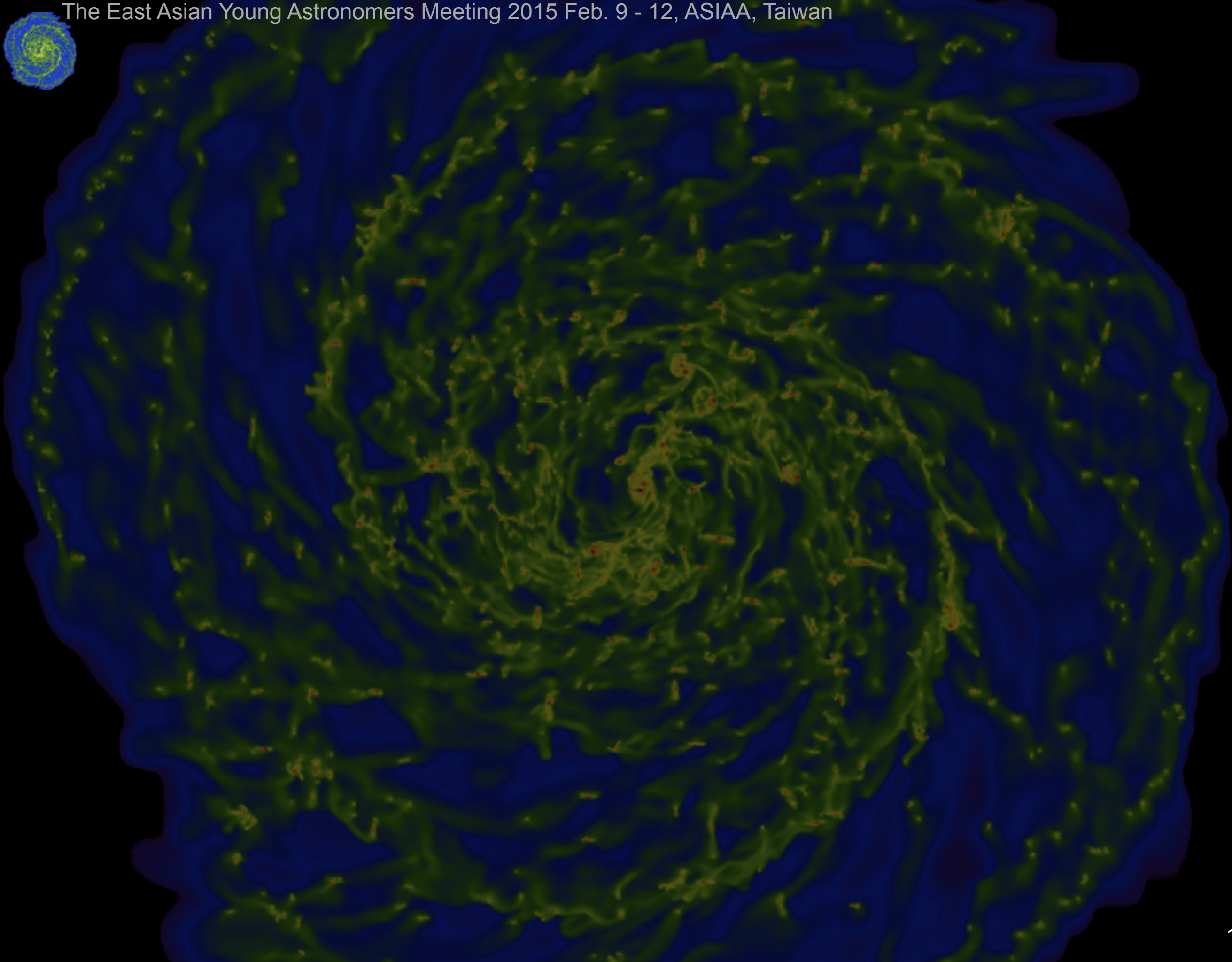
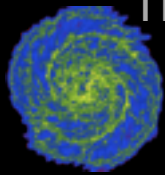
1. Are Observers and Simulators Discussing the Same Molecular Clouds?

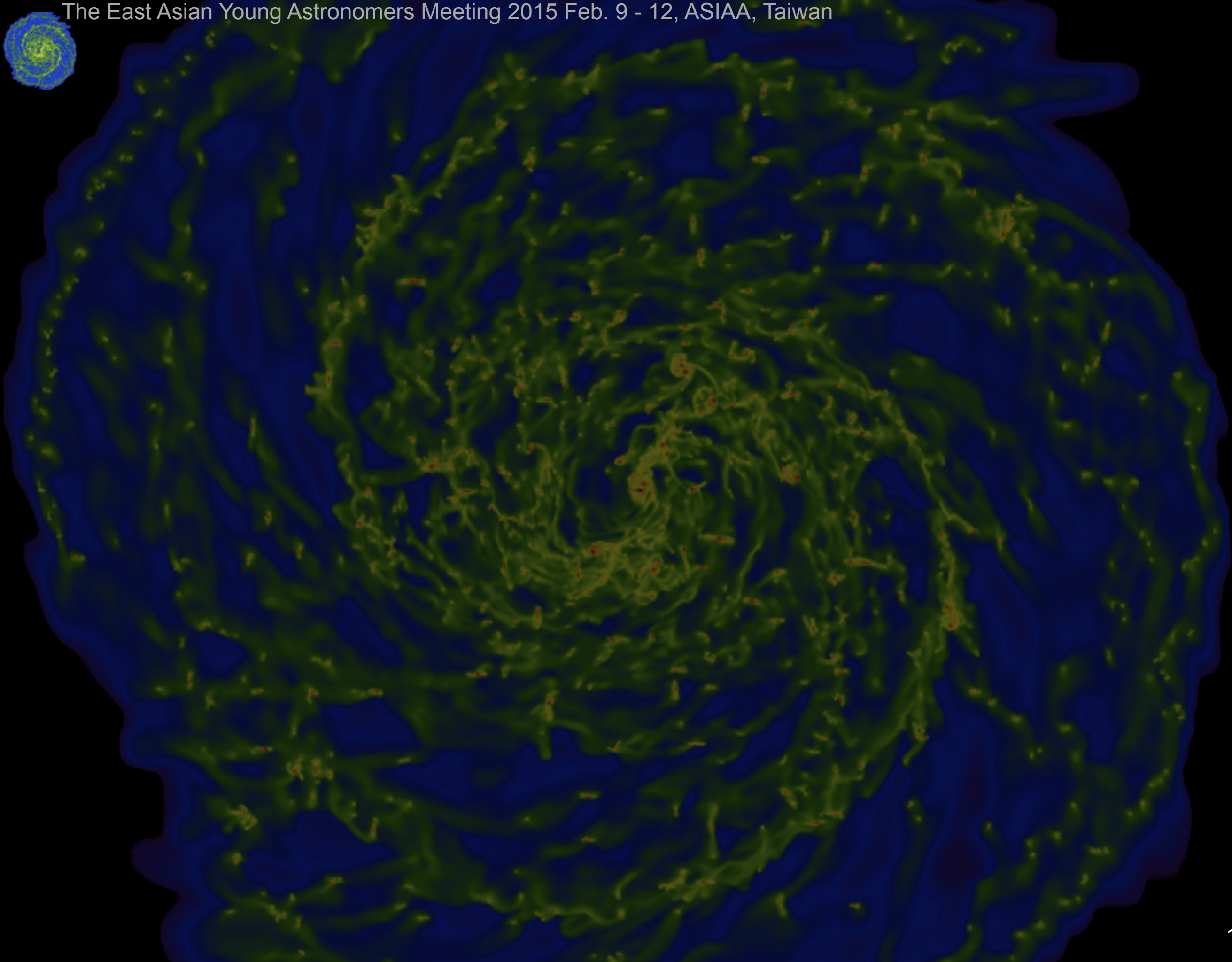
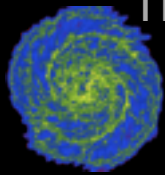
Ans: 70 % are the same

2. Do cloud properties change when different methods are used?

Ans: Scatter within a factor of two

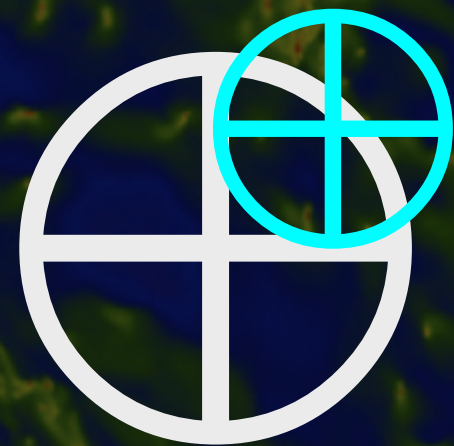
- We cataloged molecular clouds in a simulated galaxy in both 3D (simulated clouds) and 2D + 1v (observed clouds), then compared their properties.
- Typical (median) cloud properties such as number, mass, radius are consistent between the simulated and the “observed” clouds.
- 70% of clouds have counterparts in another data structure, cloud properties scatter within a factor of only two between two techniques.
- Both observations and simulations show bimodal mass surface density. The small objects are not observable with our synthetic observations of ALMA.





Match Cloud Properties

Match: distance of two centers is less than either one or both radii



Not Match

