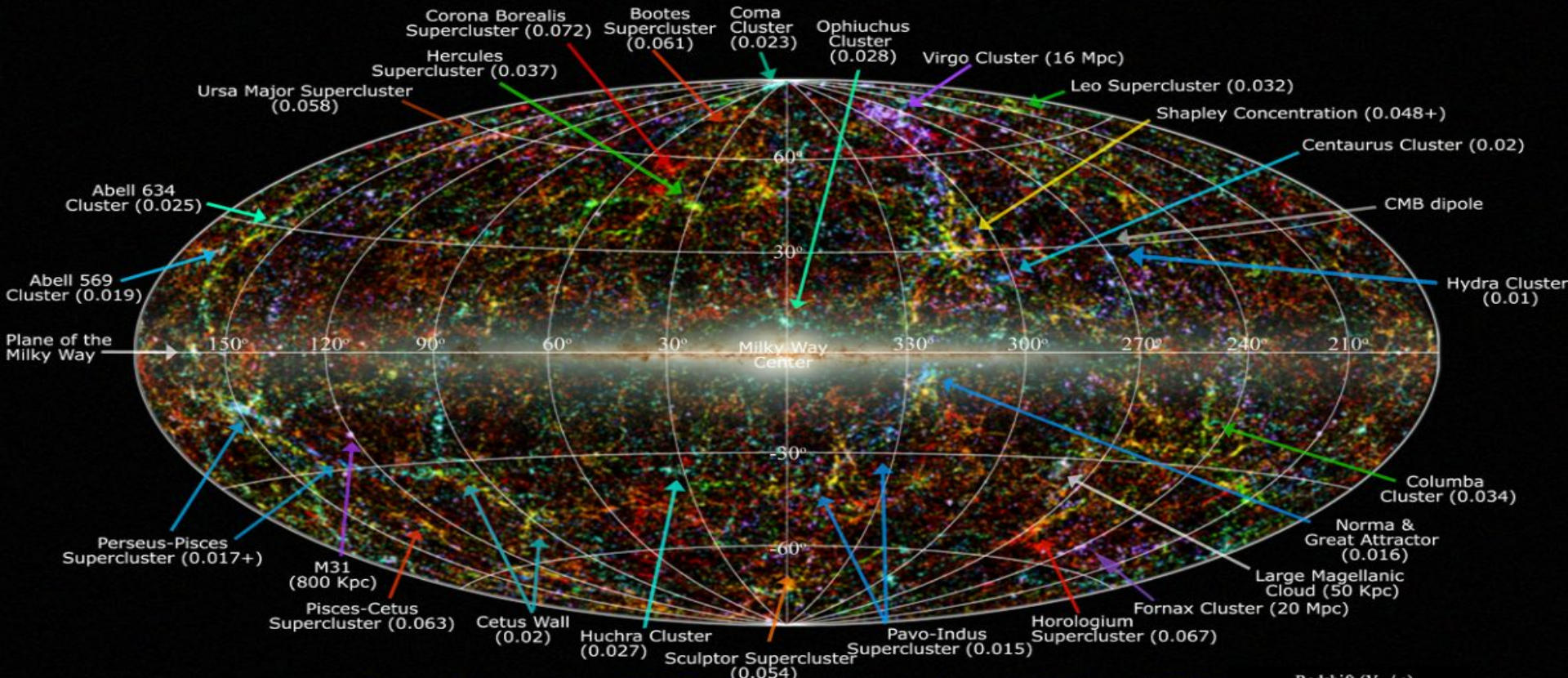# Probing local anistopries with type Ia Supernovae data

LSST France LPNHE,
22-24, November 2021

Speaker : Mélissa AMENOUCHE
Director : Philippe ROSNET
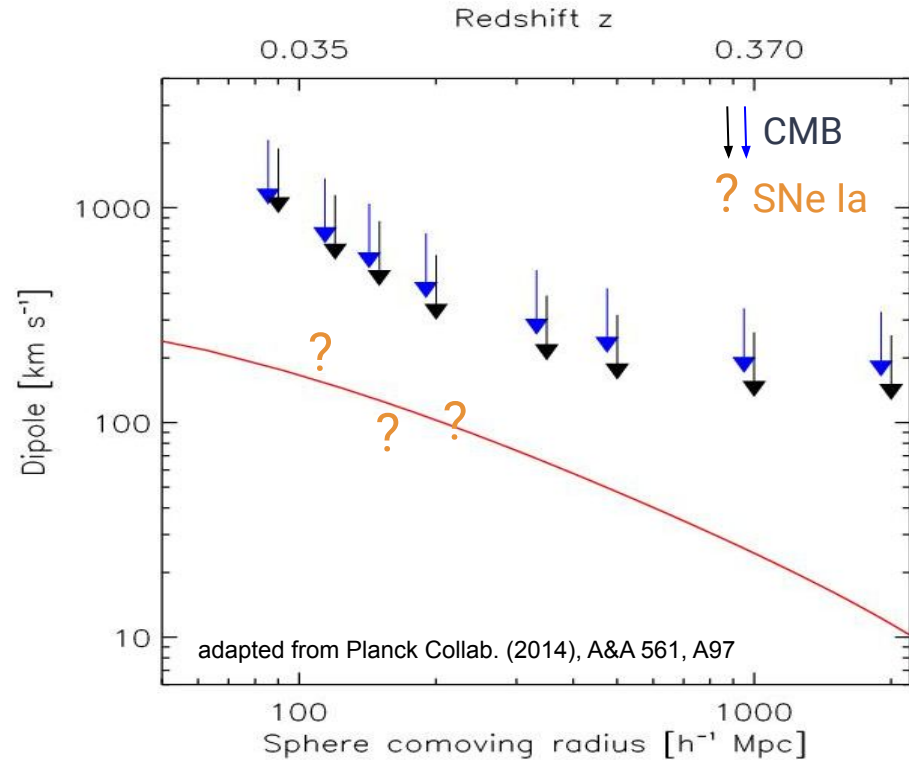
Large Scale Structure in the Local Universe

Corona Borealis Supercluster (0.072)
Bootes Supercluster (0.061)
Coma Cluster (0.023)
Ophiuchus Cluster (0.028)
Hercules Supercluster (0.037)
Virgo Cluster (16 Mpc)
Ursa Major Supercluster (0.058)
Leo Supercluster (0.032)
Shapley Concentration (0.048+)
Centaurus Cluster (0.02)
Abell 634 Cluster (0.025)
CMB dipole
Abell 569 Cluster (0.019)
Hydra Cluster (0.01)
Plane of the Milky Way
Milky Way Center
Perseus-Pisces Supercluster (0.017+)
Columba Cluster (0.034)
Norma & Great Attractor (0.016)
M31 (800 Kpc)
Large Magellanic Cloud (50 Kpc)
Pisces-Cetus Supercluster (0.063)
Cetus Wall (0.02)
Huchra Cluster (0.027)
Pavo-Indus Supercluster (0.015)
Horologium Supercluster (0.067)
Fornax Cluster (20 Mpc)
Sculptor Supercluster (0.054)

Redshift (V_H / c)

Legend: image shows 2MASS galaxies color coded by redshift (Jarrett 2004) familiar galaxy clusters/superclusters are labeled (numbers in parenthesis represent Graphic created by T. Jarrett (IPAC/Caltech)
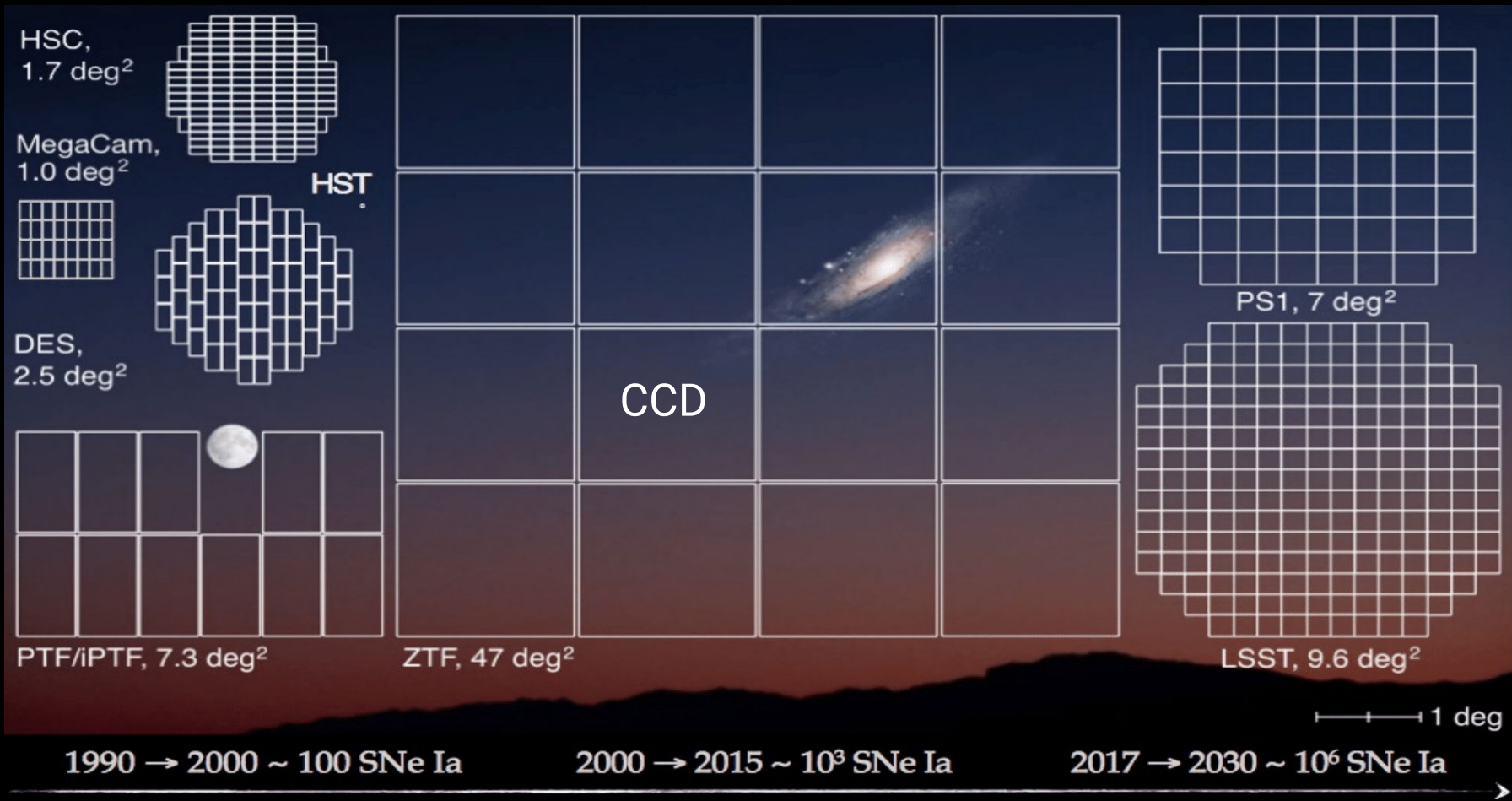
2

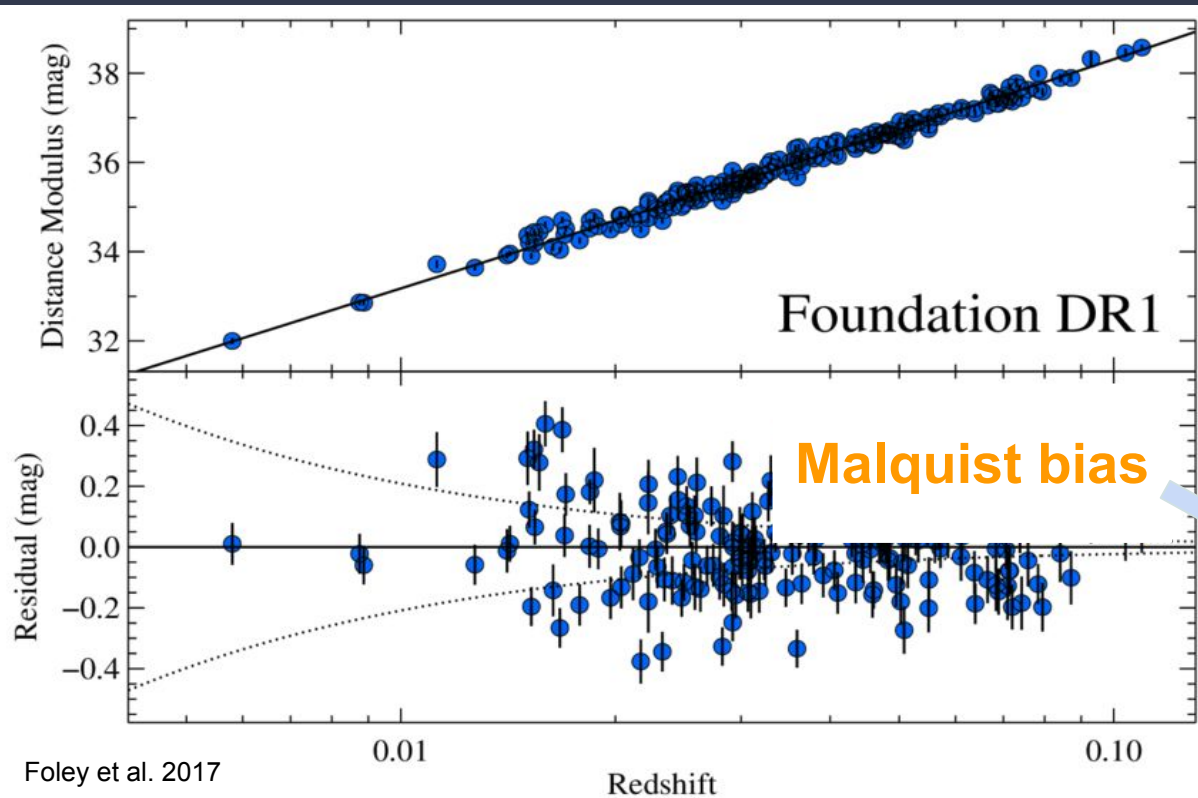# Bulk flows measurements

What would it look like with SNe Ia data ?

adapted from Planck Collab. (2014), A&A 561, A97

ZTF camera Field Of View (full visible sky)

HSC, 1.7 deg²

MegaCam, 1.0 deg²

HST

DES, 2.5 deg²

CCD

PS1, 7 deg²

LSST, 9.6 deg²

PTF/iPTF, 7.3 deg²

ZTF, 47 deg²

1 deg

1990 → 2000 ~ 100 SNe Ia

2000 → 2015 ~ 10³ SNe Ia

2017 → 2030 ~ 10⁶ SNe Ia

Hubble diagram

Foley et al. 2017

Hubble diagram with ZTF

Malquist bias

How do we measure it for ZTF ?

5

We need simulations

- Sky coverage and survey cadence

- Data quality (signal to noise, …)

- Biases (list them)

Dhawan et al. 2021
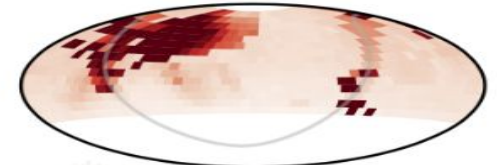
Number of observations [2018]

Simsurvey (Feindt et al. 2019)

ZTF transient light-curves simulator based on an observing strategy

Observing strategy

- Dates of observations
- Observed fields
- associated skynoise

Transient generator

- SED template
- How many transients
- Redshift range ...

Example simsurvey output
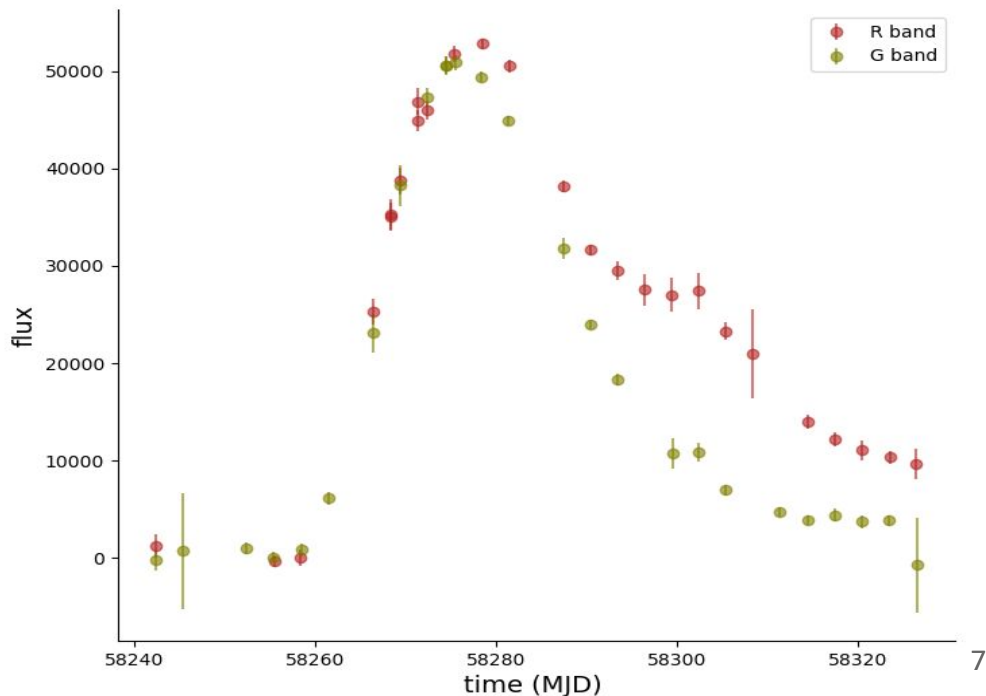
Simulating ZTF DR2

Targeted way to use simsurvey
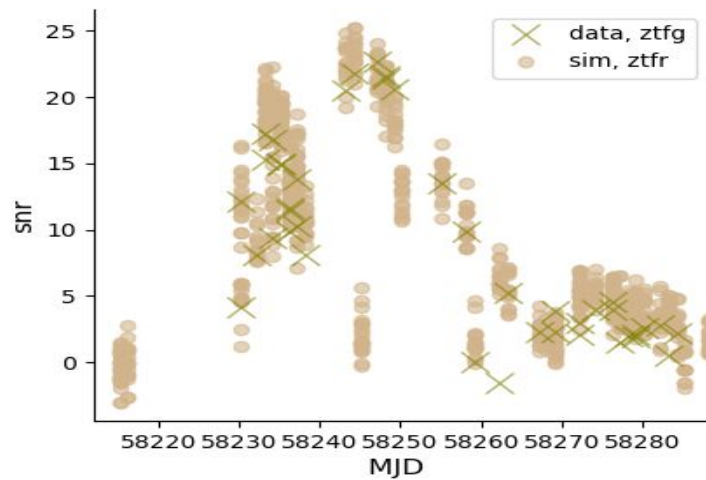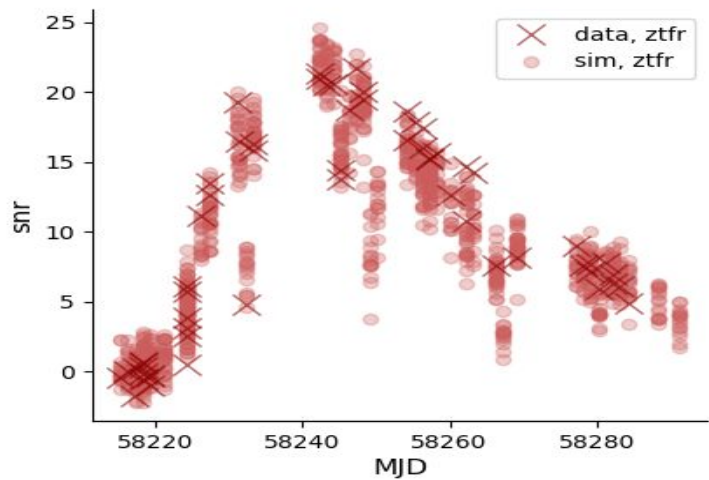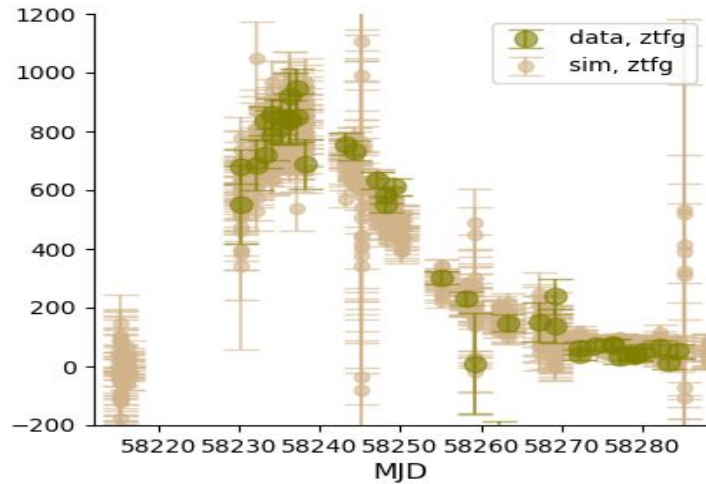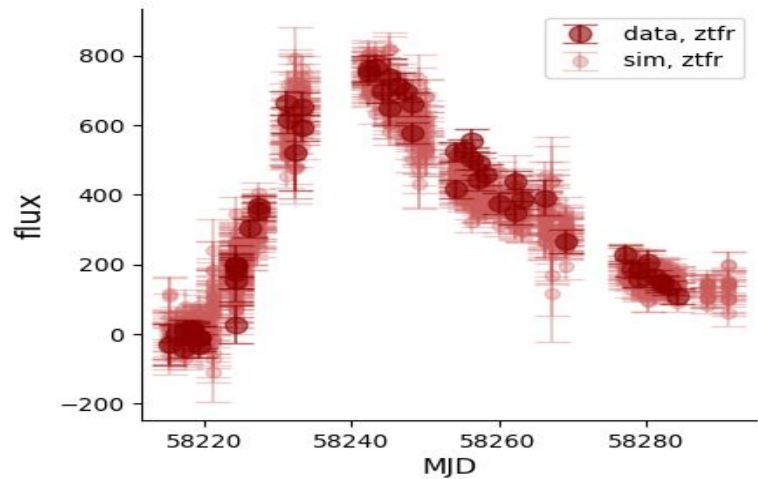
Observing strategy :
    focusing on objects (fixed coordinates)

transient :
use the salt2 parameters of the object

ZTF18ablqlzp, z= 0.0413
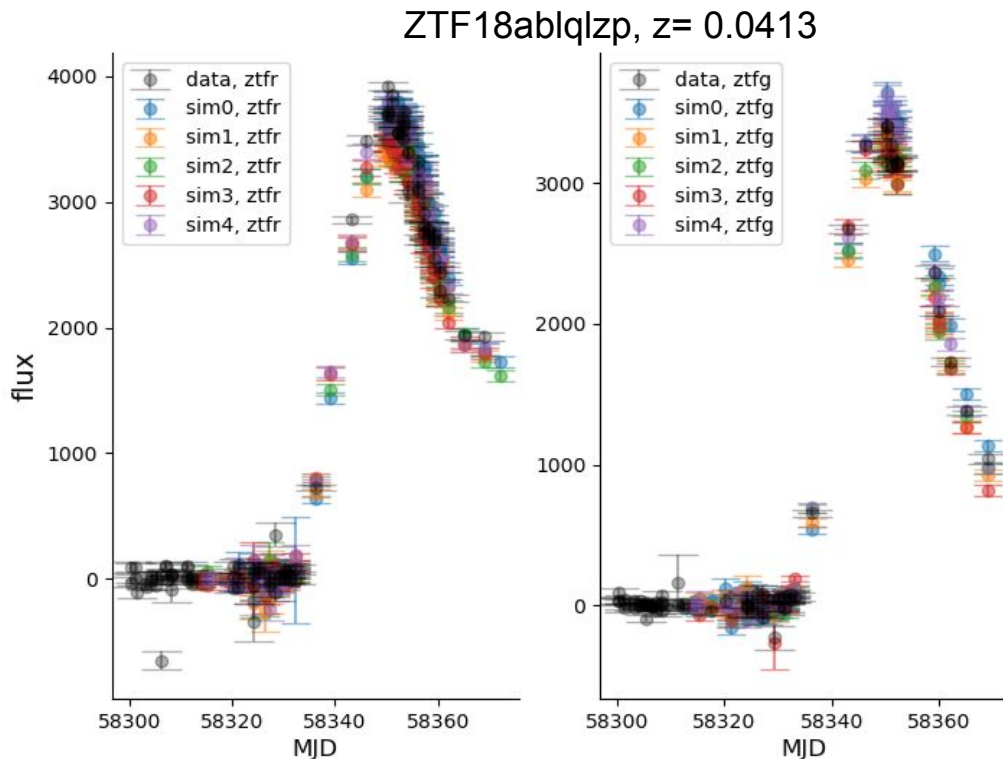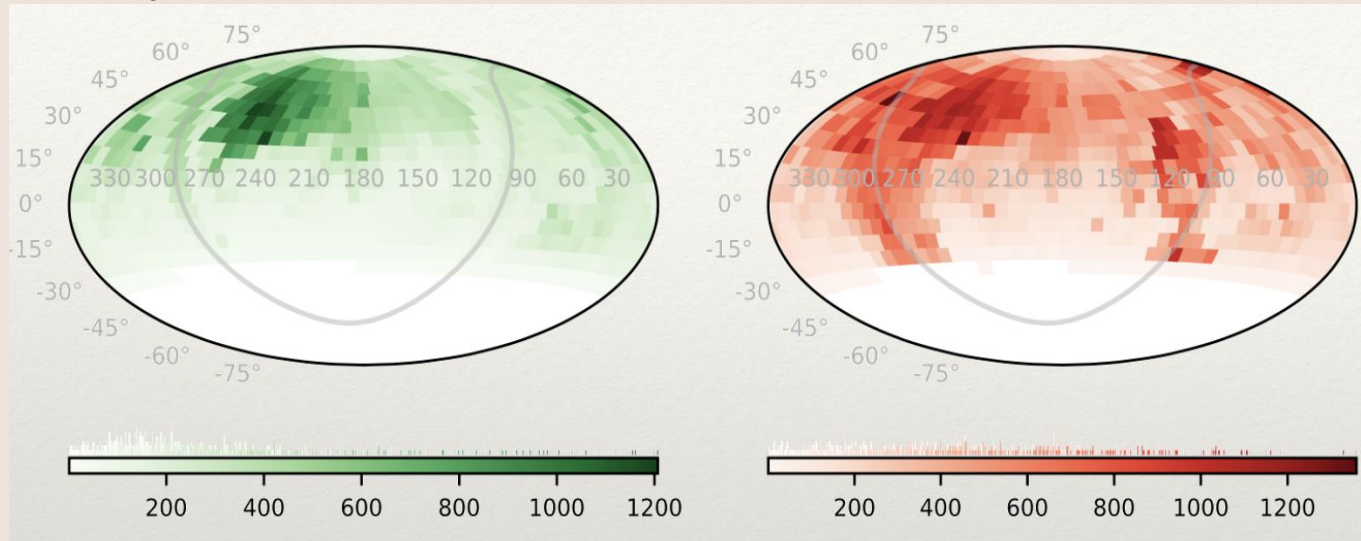
Focus on the errors
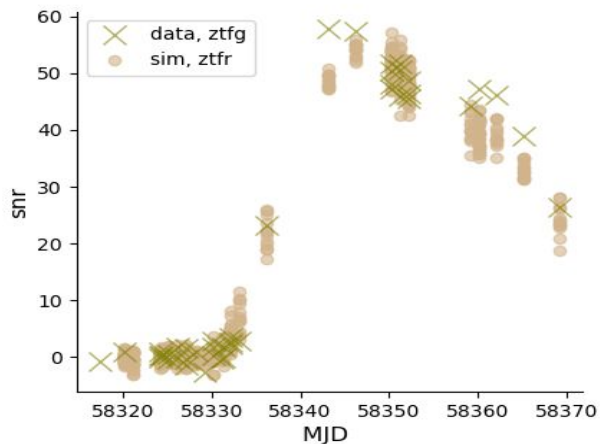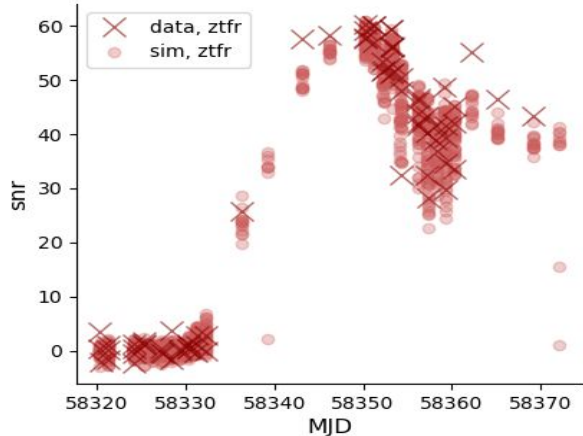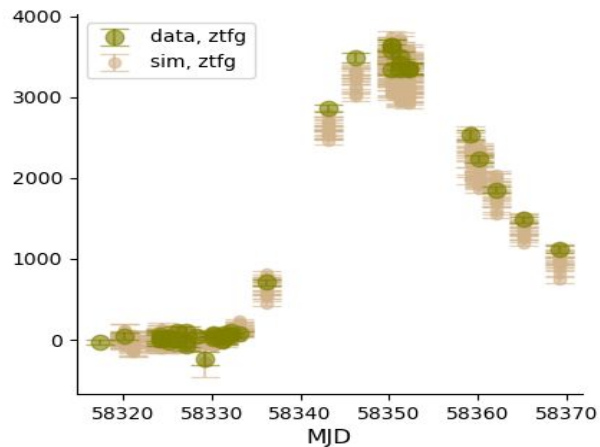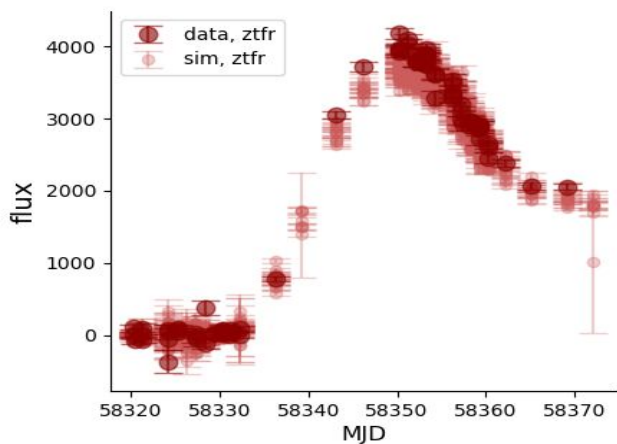
ZTF18aakoylt

z=0.0876

Good news : the simulations replicate the data

Now :

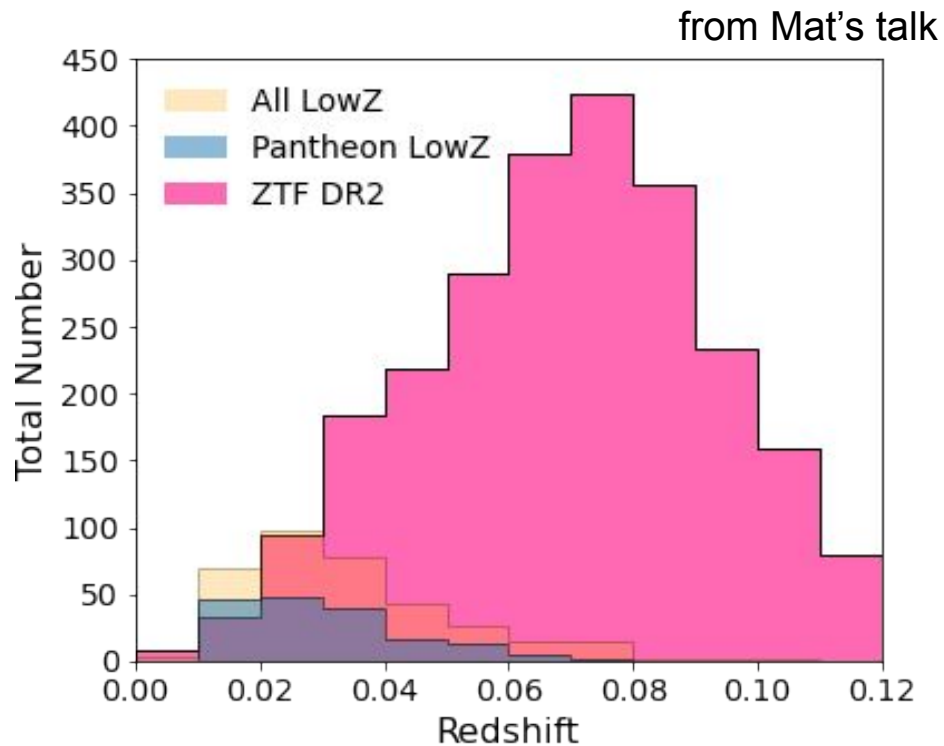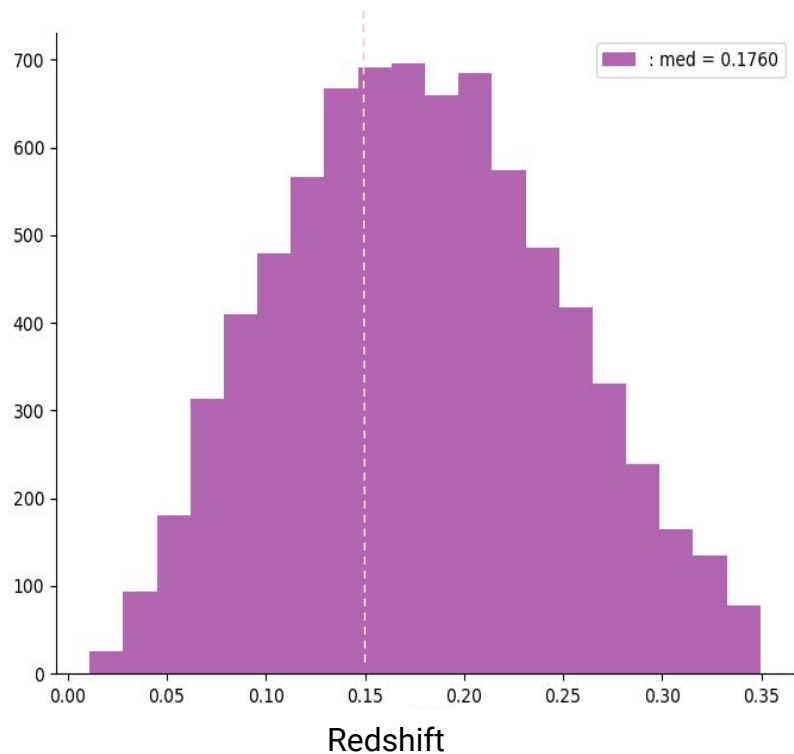- How well ZTF is doing for **any** SN ?

- Is it biased ?

from M. Rigault

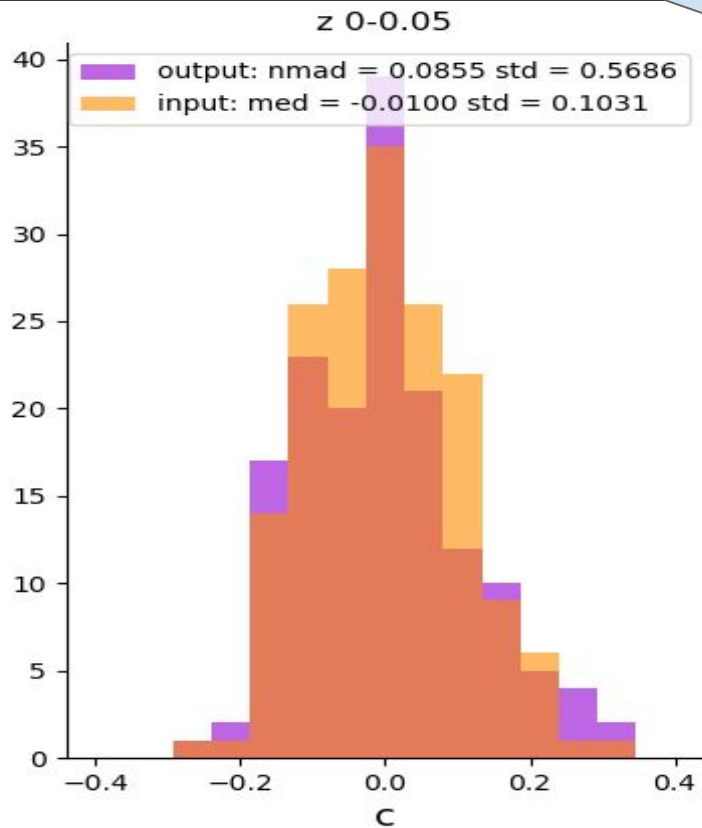What if we observed in a specific patch of the sky than in another ?

untargeted simulations

from Mat's talk

Redshift
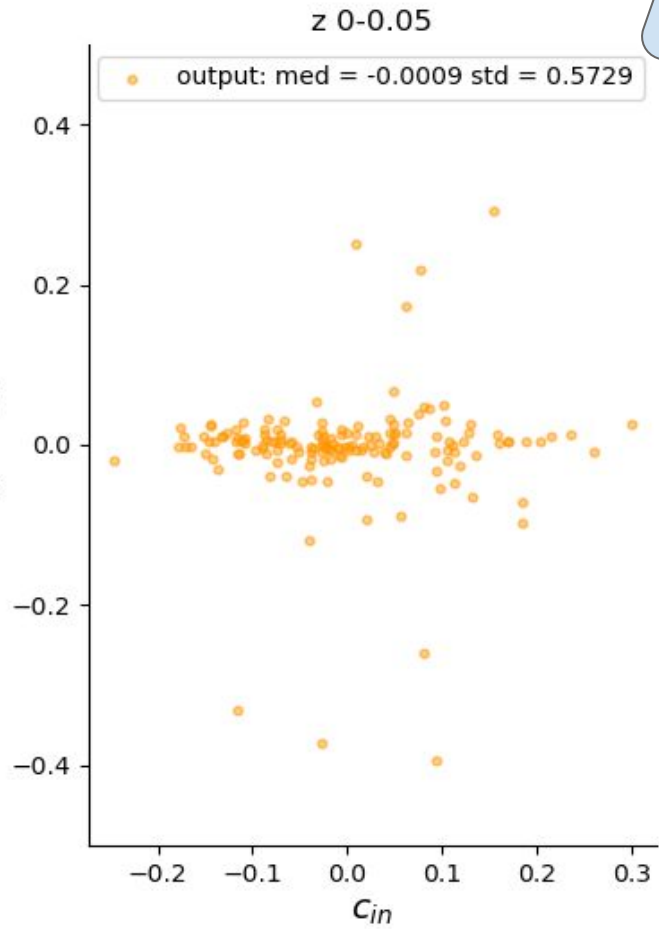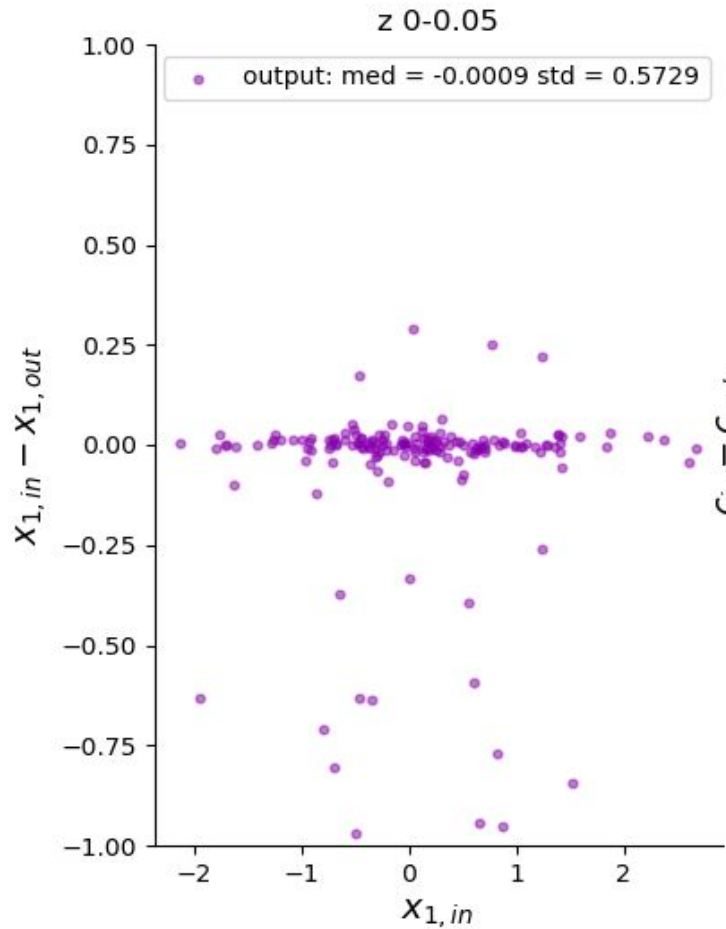
Redshift

12

What do we put, what do we get ?

Very local

z 0-0.05
output: nmad = 0.7020 std = 1.5745
input: med = 0.0880 std = 0.8844

z 0-0.05
output: nmad = 0.0855 std = 0.5686
input: med = -0.0100 std = 0.1031

z 0-05

output: med = -0.0009 std = 0.5729

z 0-05

output: med = -0.0009 std = 0.5729
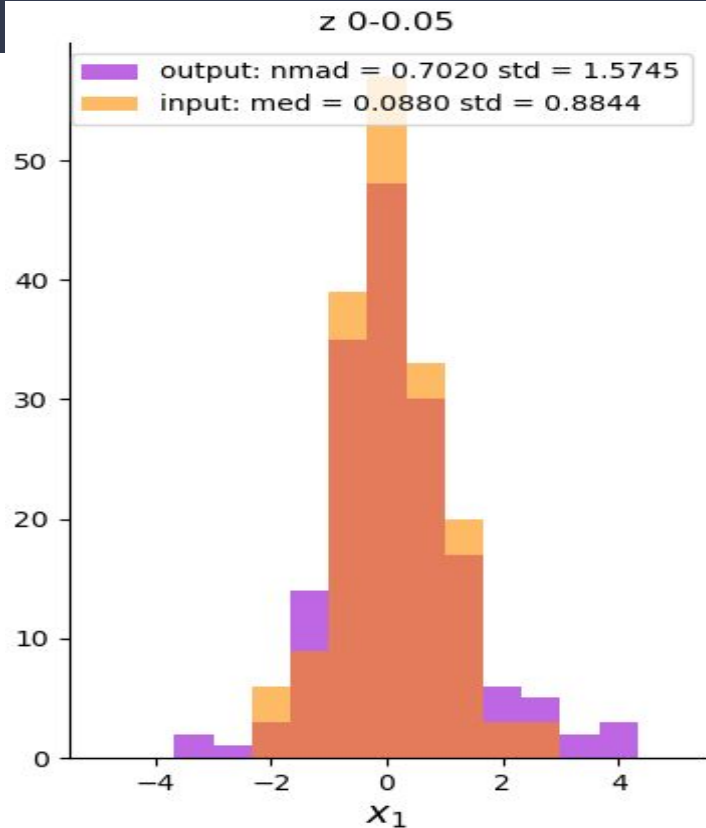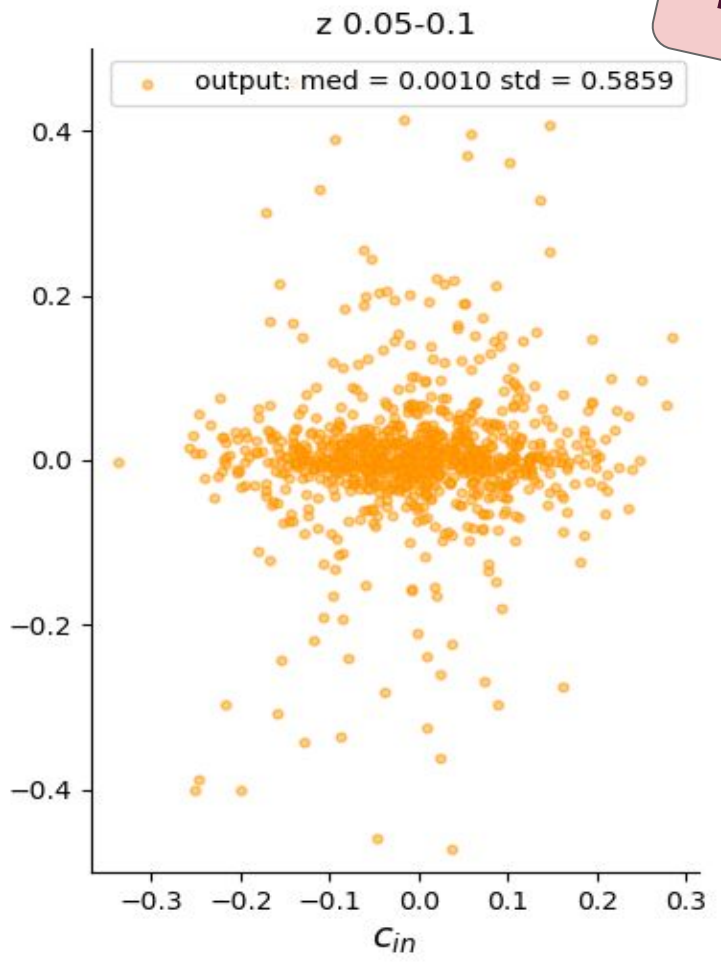
Very local

Small scatter

14

z 0.05-0.1

output: nmad = 0.8461 std = 5.3874
input: med = -0.0278 std = 1.0158

x_1

z 0.05-0.1

output: nmad = 0.0793 std = 0.5932
input: med = -0.0062 std = 0.0985

c

intermediate z

intermediate z

z 0.05-0.1

output: med = 0.0010 std = 0.5859

z 0.05-0.1

output: med = 0.0010 std = 0.5859

still consistent

16

z 0.1-0.15

output: nmad = 0.9074 std = 19.9230
input: med = 0.1234 std = 0.9799

z 0.1-0.15

output: nmad = 0.0836 std = 0.5268
input: med = -0.0098 std = 0.0980

high z

17

Bias

z 0.1-0.15

high z
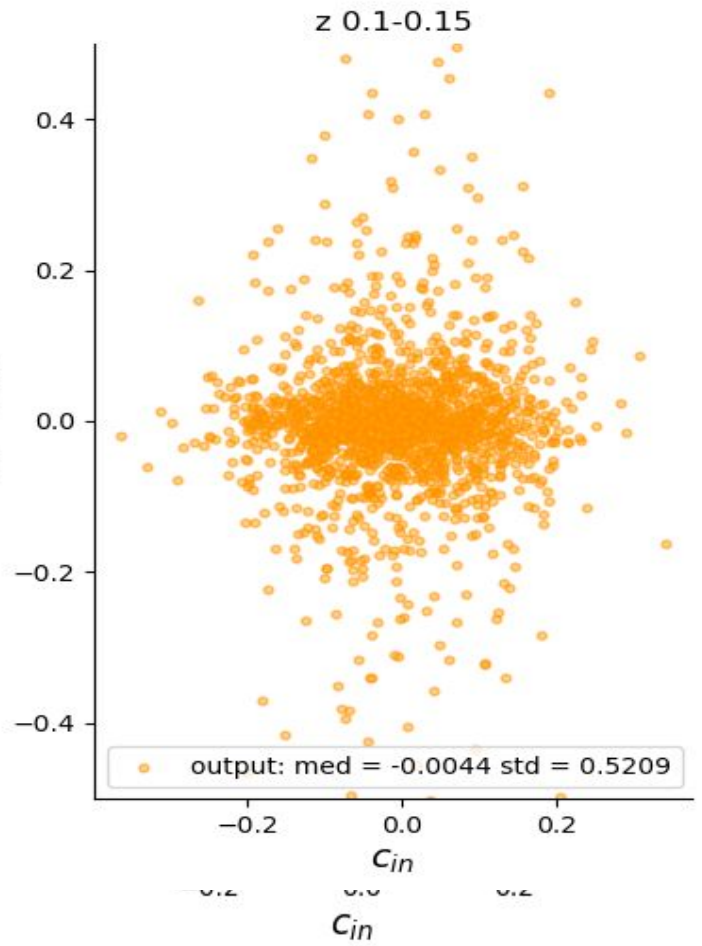
z 0.1-0.15

output: med = -0.0044 std = 0.5209

output: med = -0.0044 std = 0.5209
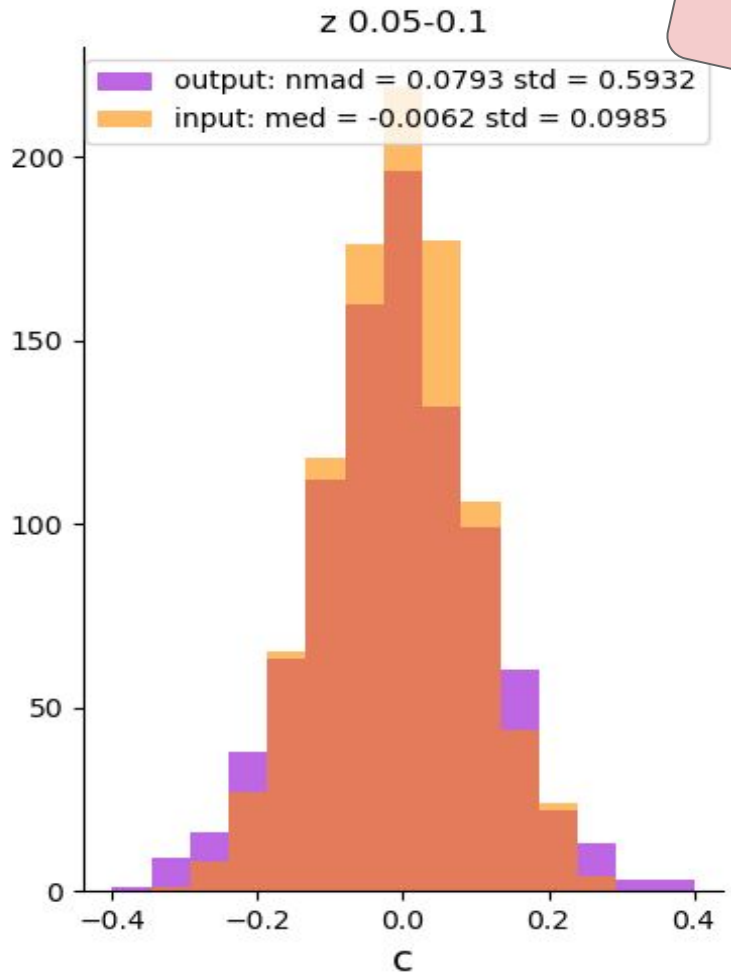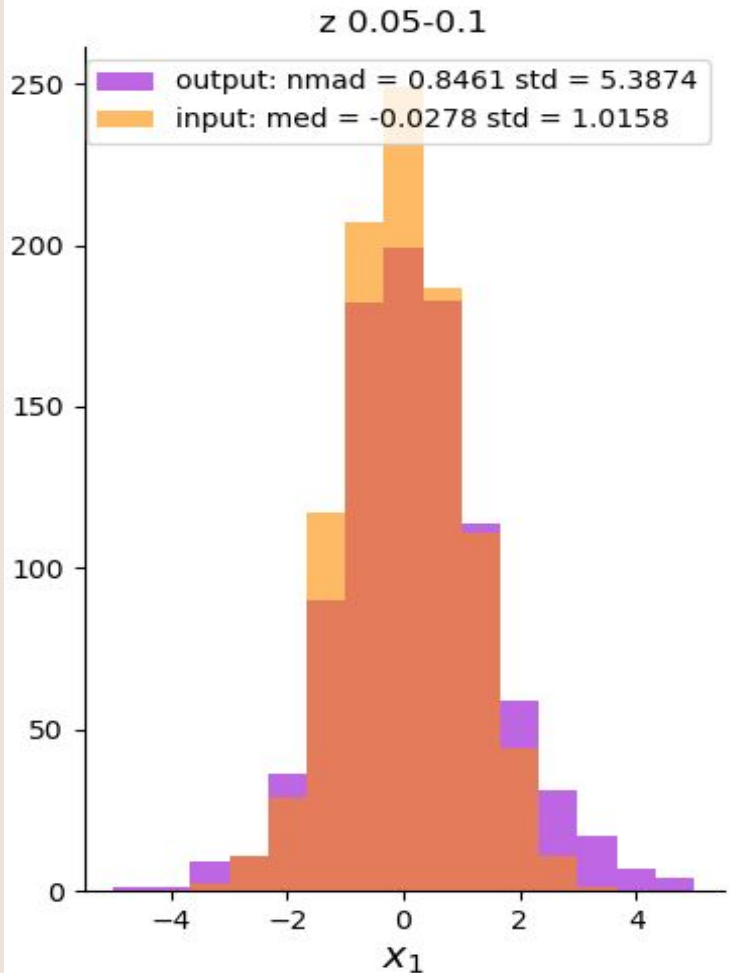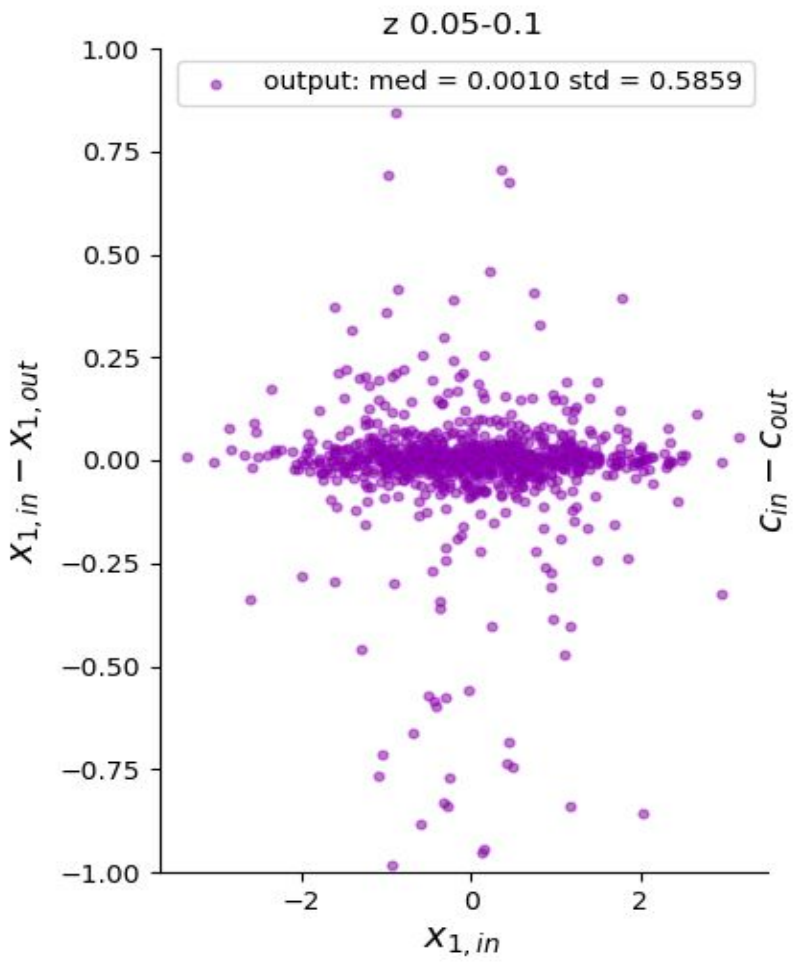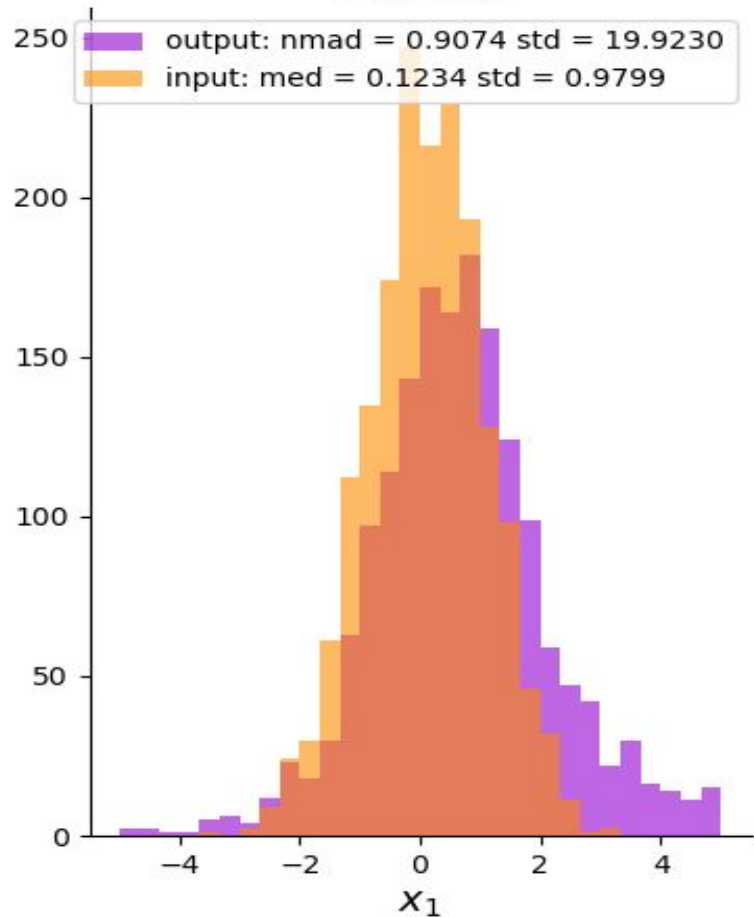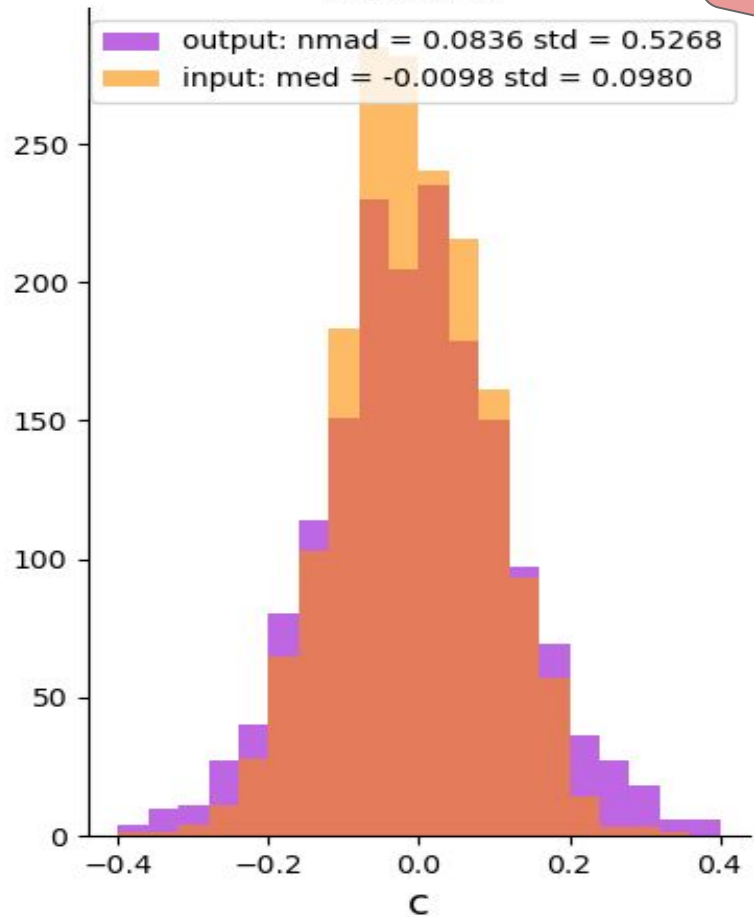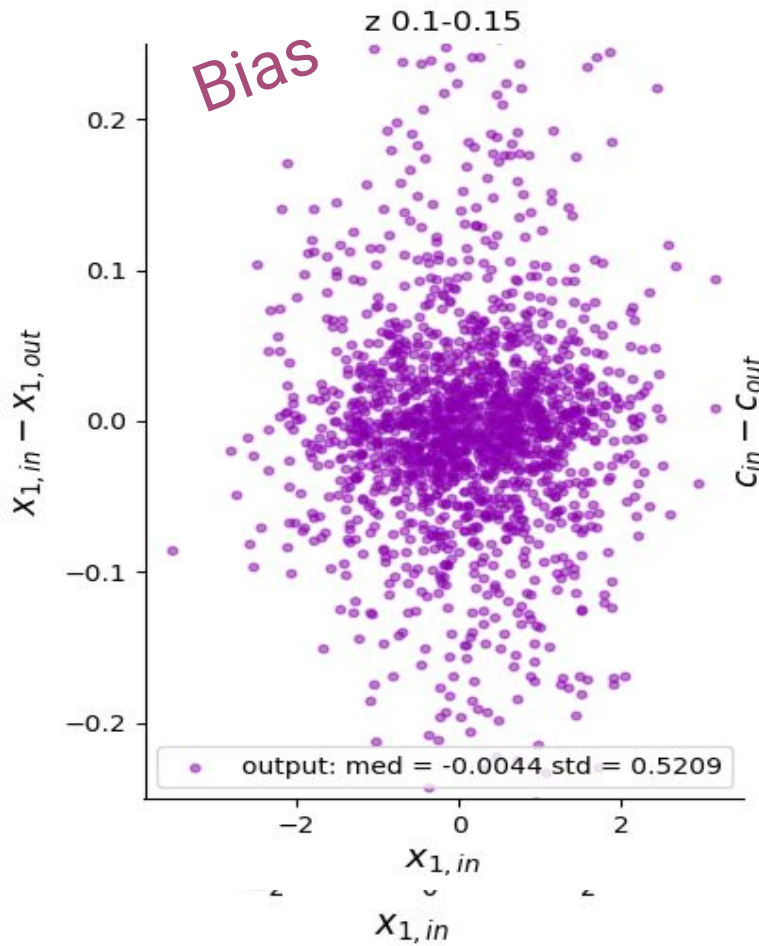
Conclusion and further

- Bulk flows measurements are important to test LCDM

- ZTF SNe constitute a unique low-z sample for measuring bulk flows

- The simulations match the data for individual objects

Future work :

- Go for realistic population simulations

- Include the survey geometry in the simulations