

Atmospheric variations Mini Data Challenge

A mini dataset to test the performances of estimators
of atmospheric transparency for each visit

Sylvie Dagoret-Campagne, Marc Moniez

LAL/IN2P3/CNRS



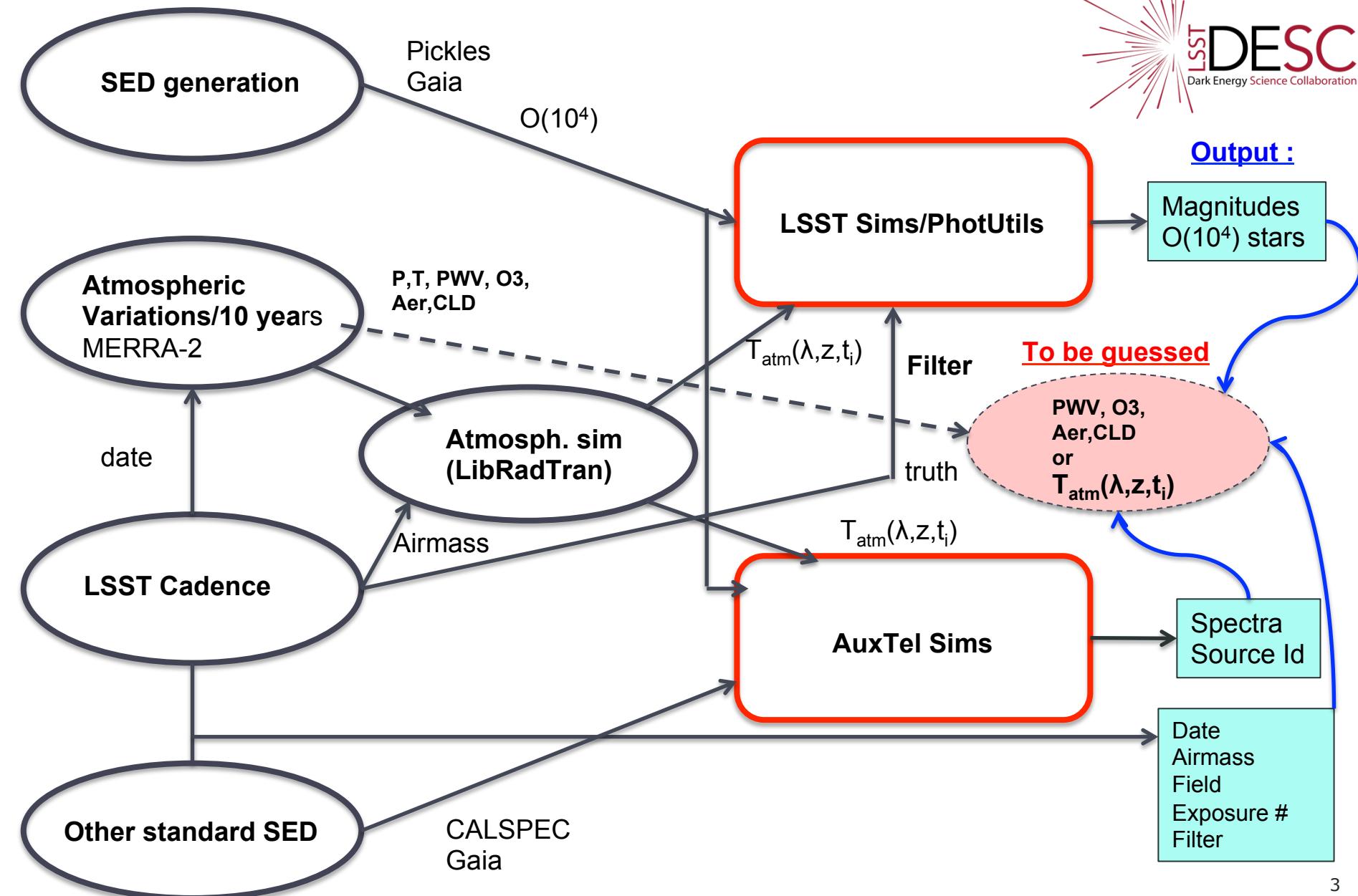
Outline



- 12962 generated star SEDs from 131 Pickles UVK star SEDs:
 - With AB magnitudes distributions matching SNLS catalog
- Use Cadence Minion_1016 time sequence of visits:
 - Field #1000
 - Airmass sequence (z in [1.02, 1.50])
 - Sky brightness ([17,22] mag/arcsec 2)
 - seeing sequences ([0.9,1.1] arcsec)
- Atmospheric parameters spanning MERRA2 distributions (without time correlations)
 - VAOD (Vertical Aerosol Optical Depth) in [0.02,0.13]
 - PWV (precipitable water vapor) in [0,30] mm
 - O₃ in [225,350] DbU
 - Clouds, grey transmission in [0.35, 1.]
- Compute Instrumental Magnitudes and errors with LSST Sims photUtils
 - Official LSST throughput and Quantum efficiency

Goal : use these data to test your estimator of atmospheric transparency for each visit

Mini Data Challenge Framework

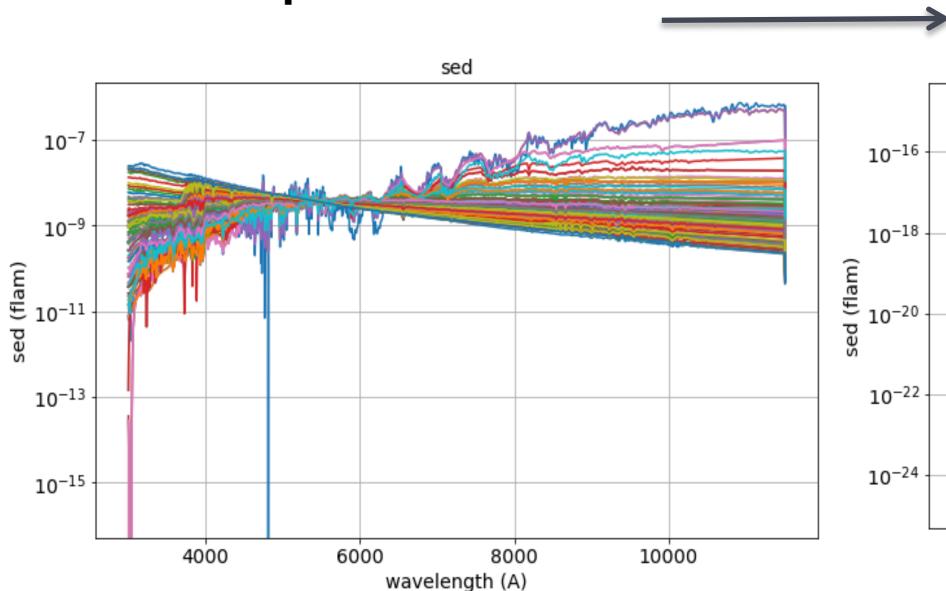


SEDs generation

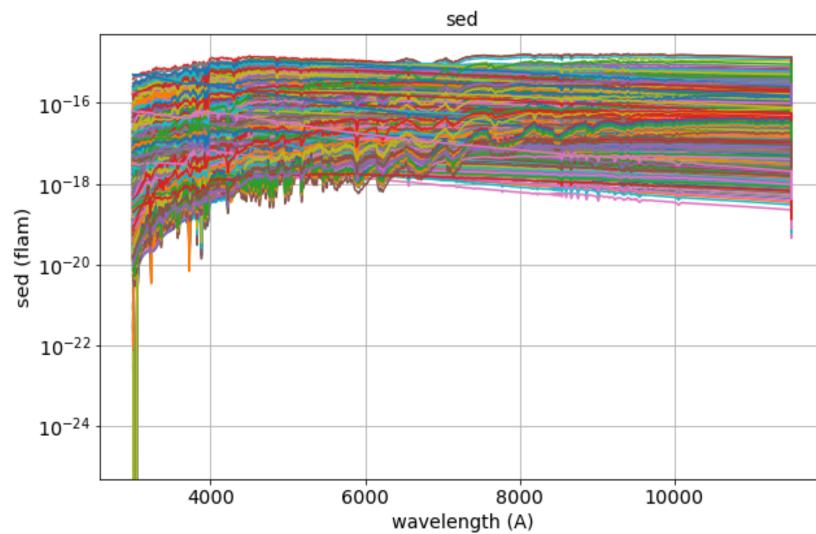


Procedure to generate a SEDs catalog from Pickles,
matching SNLS magnitudes

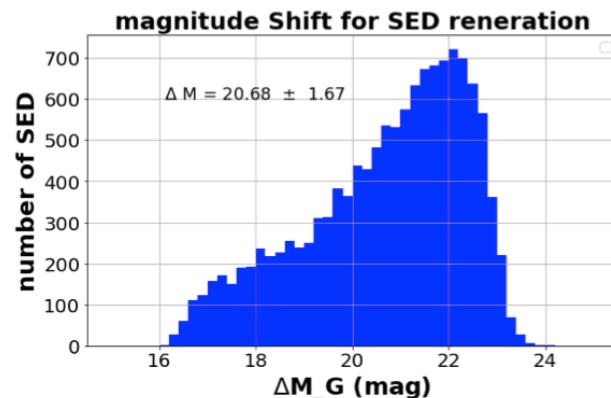
131 pickles UVK



12962 generated SED
from the 131 pickles



(Average shift of ~
20.7 magnitudes)

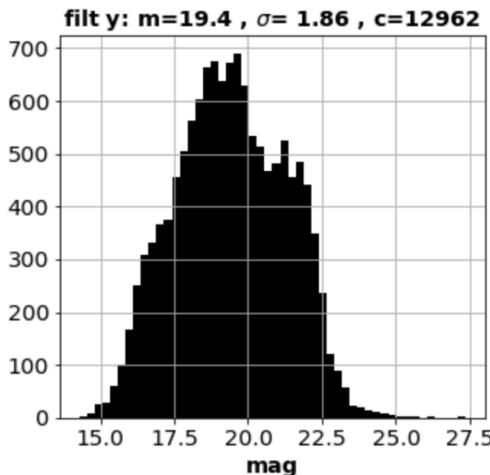
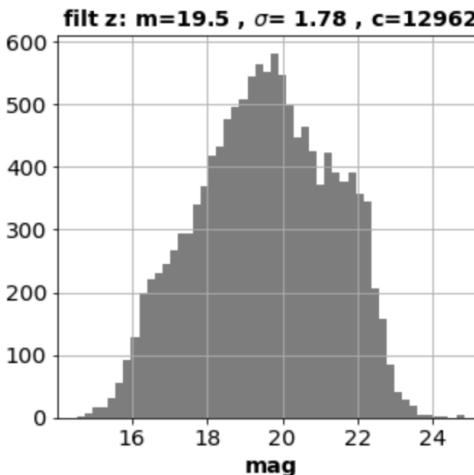
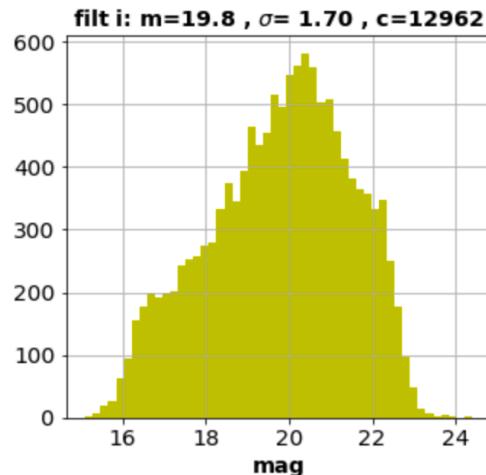
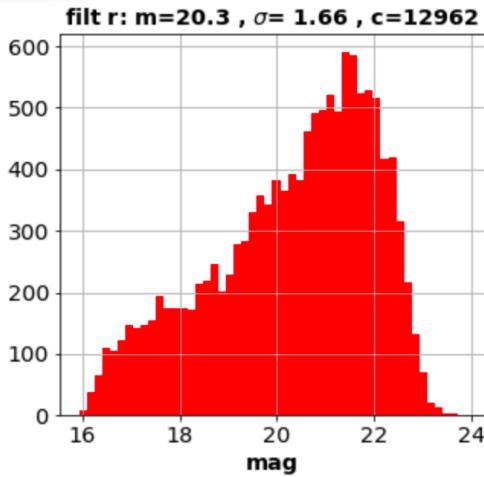
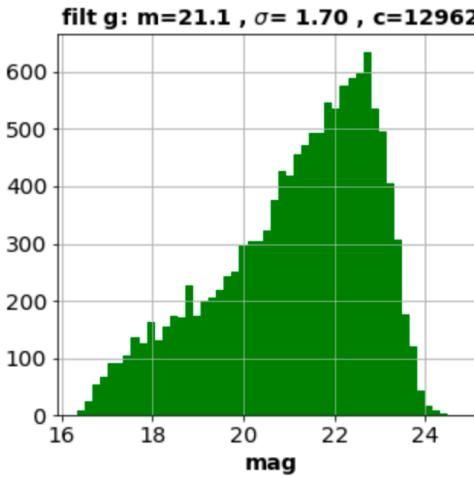
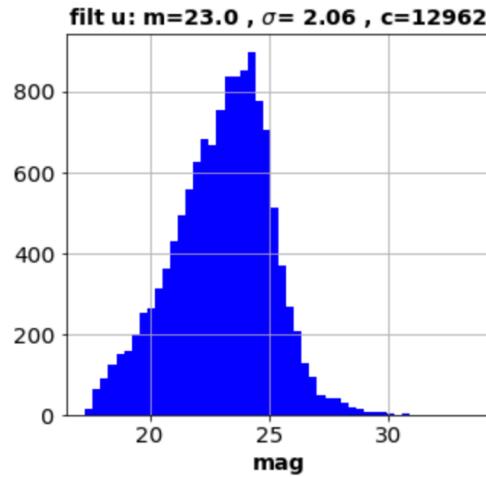


AB magnitudes (LSST SIM calculations and mag err) from generated SEDs

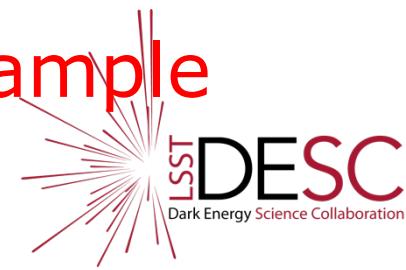


For airmass=1.2, no aerosols

LSST AB magnitudes of regenerated SED randomized sample



LSST Color plots for generated SEDs sample



For airmass=1.2, no aerosols

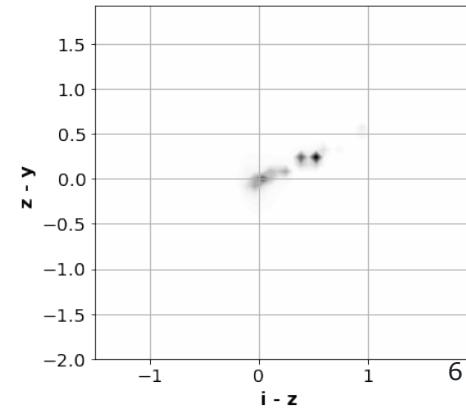
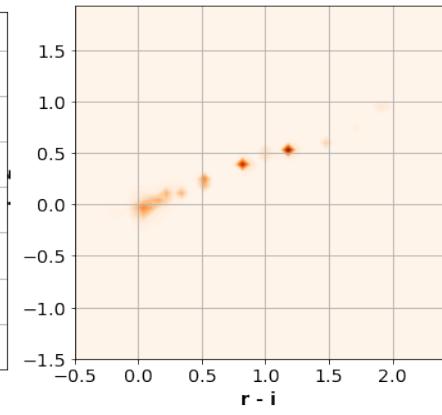
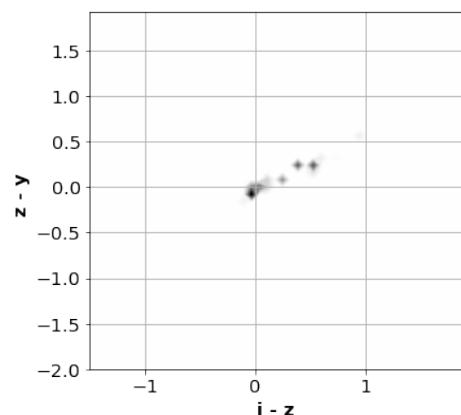
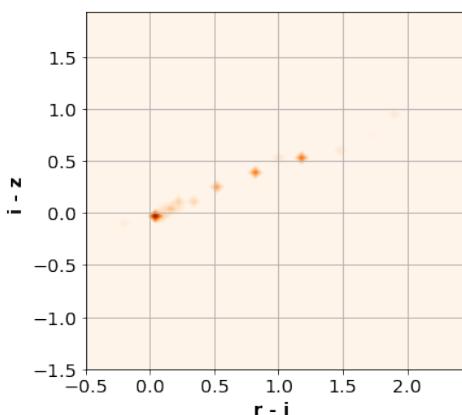
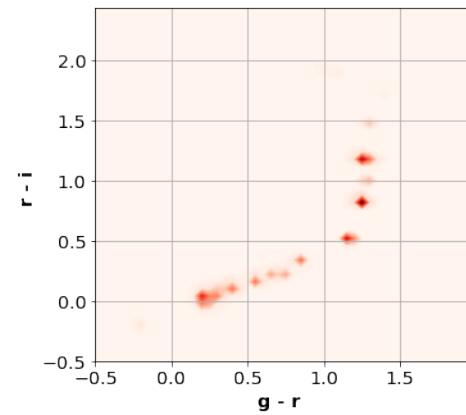
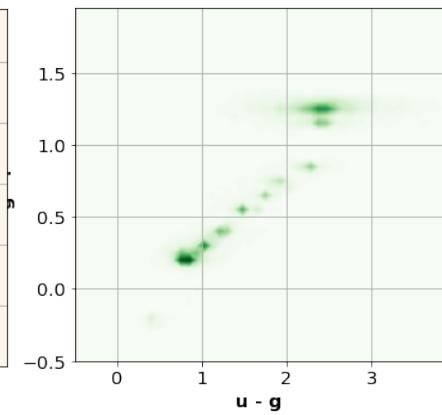
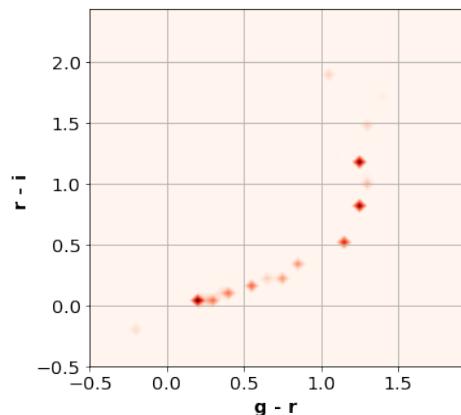
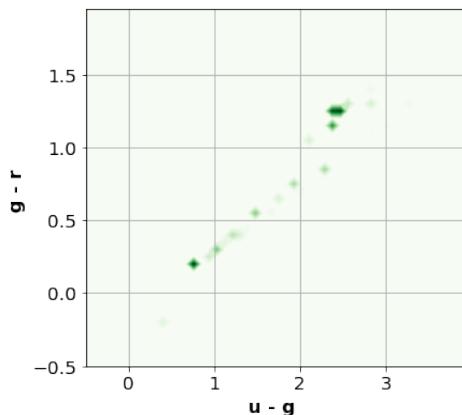
Magnitudes not randomized by their mag errors



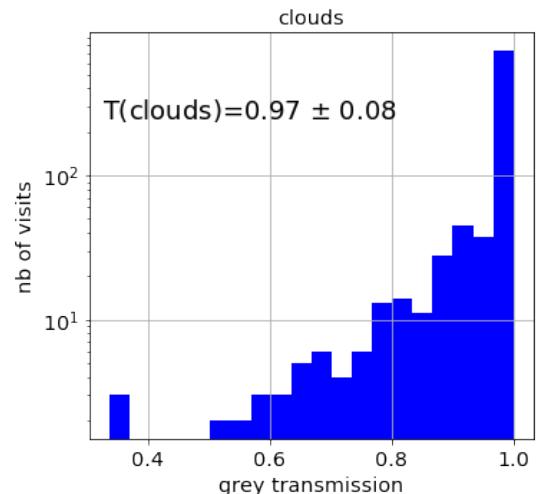
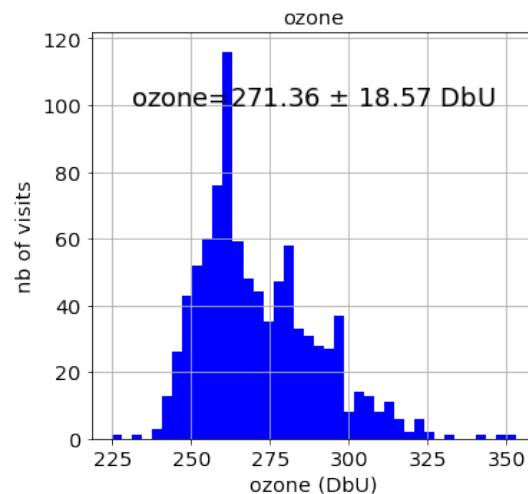
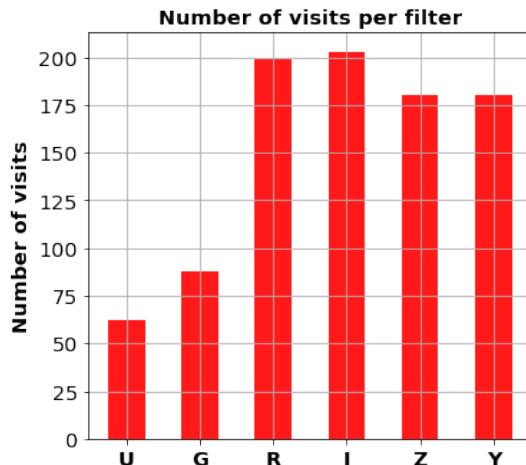
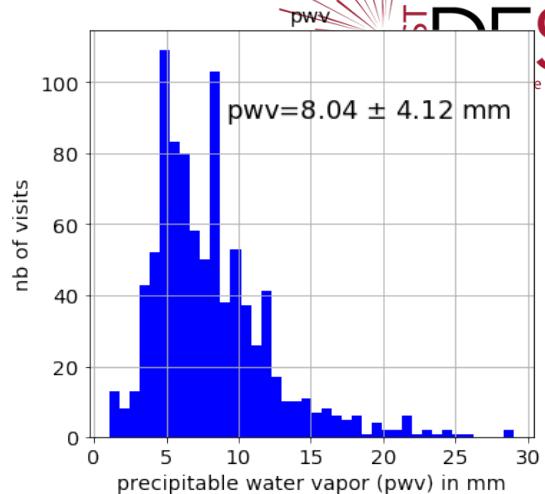
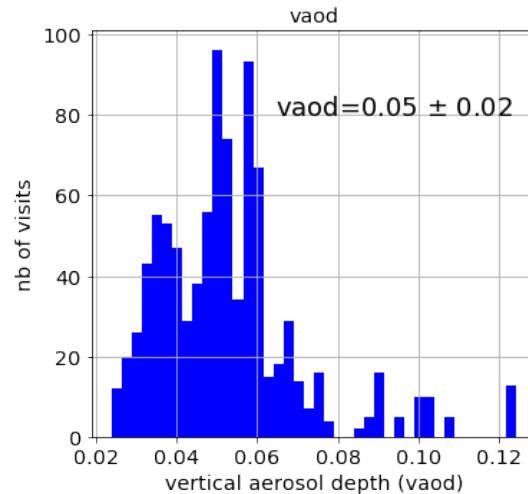
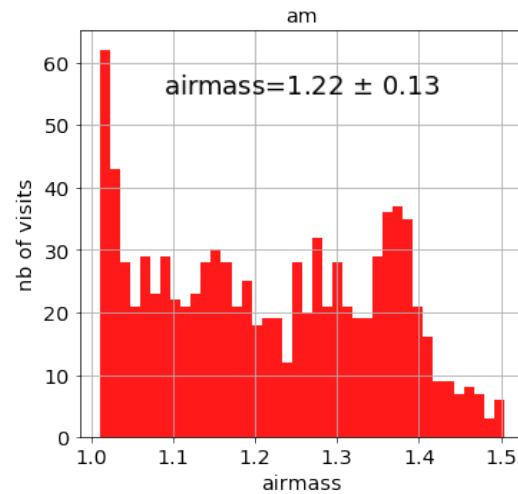
Magnitudes randomized with their mag errors
(according photoelectron statistics)

LSST colors of regenerated SED not randomized sample

LSST colors of regenerated SED randomized sample



Mini Data Challenge : input parameter variations

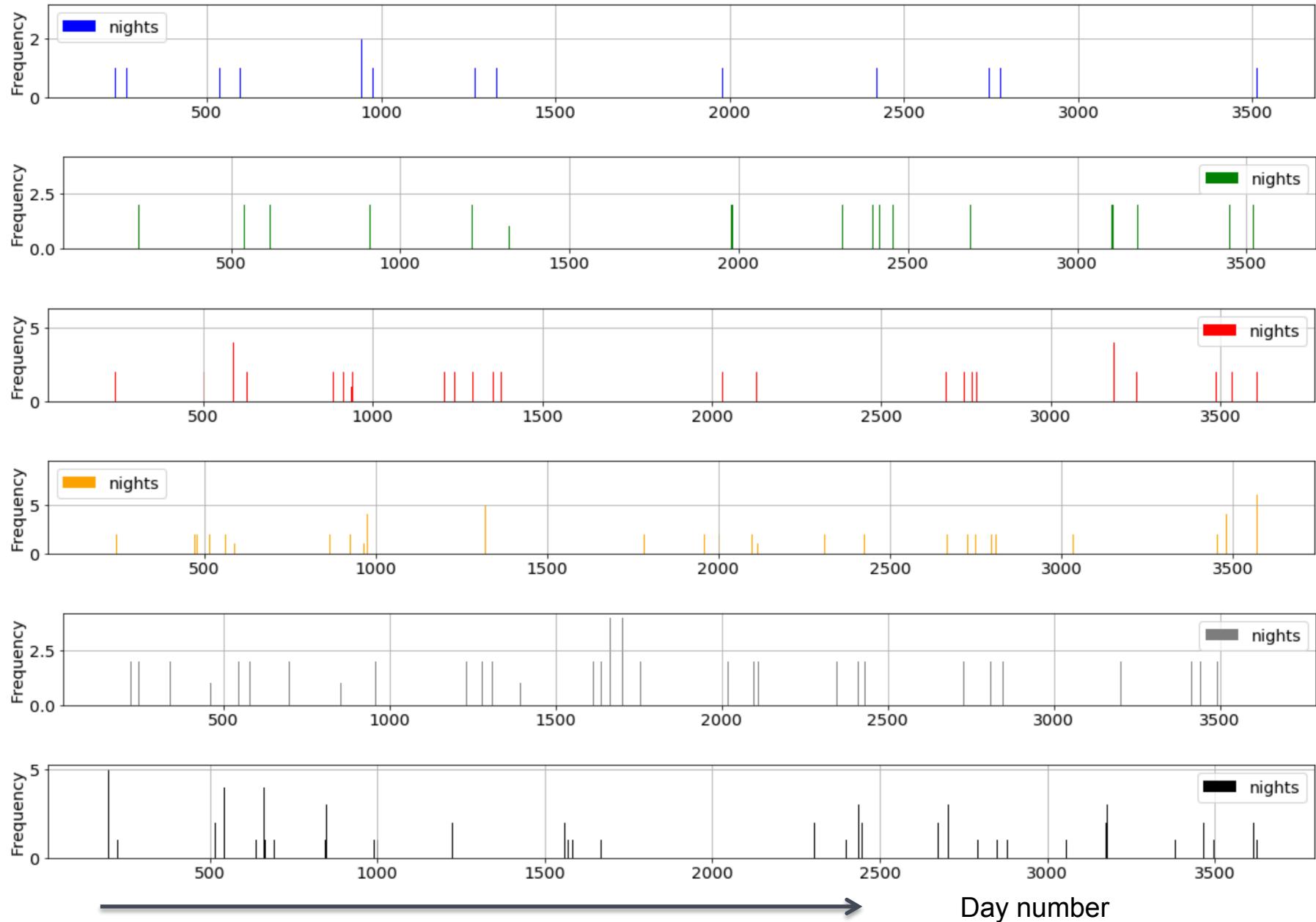


Distributions from Cadence (+ Sky brightness and Seeing)

Atmospheric variations (typical realistic distributions, from MERRA2), no time correlation

Cadence in field #1000 for MINION1016 \ //

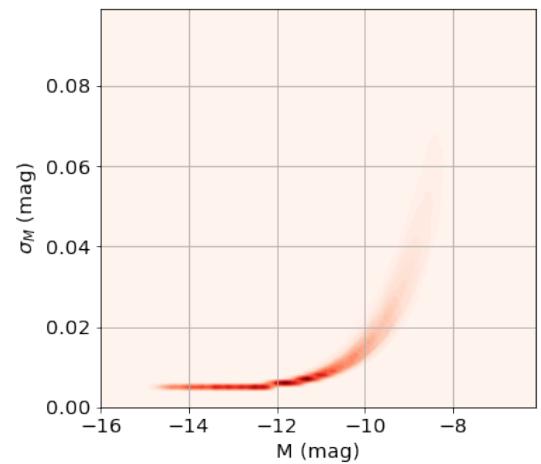
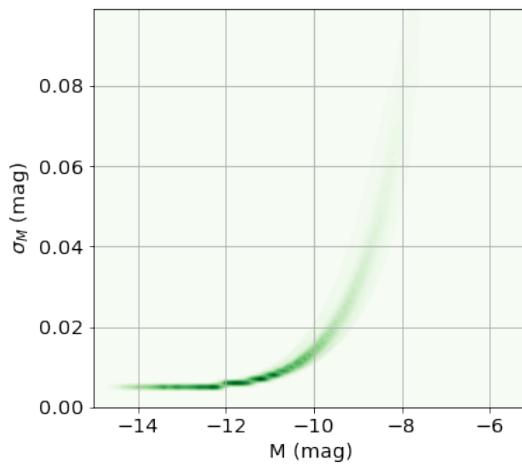
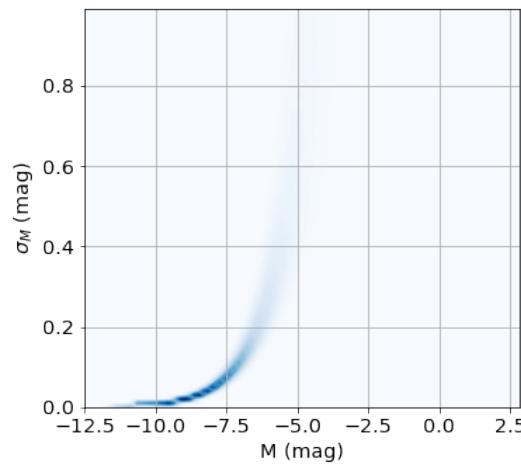
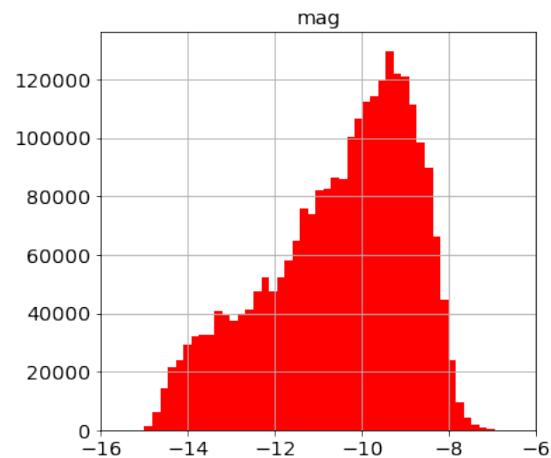
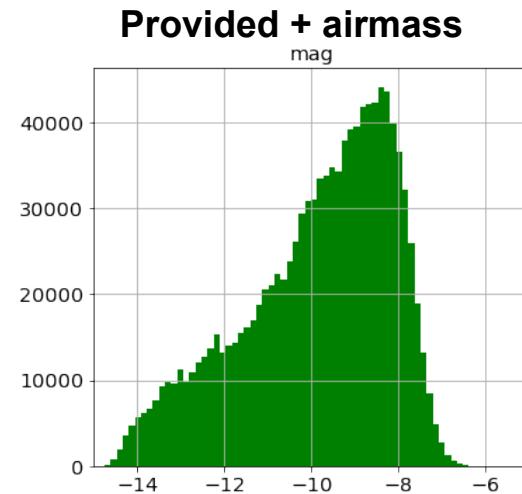
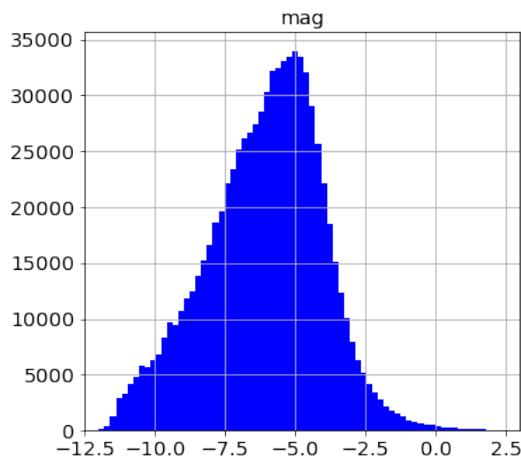
ration



This Mini Data Challenge : LSST Instrumental Magnitudes



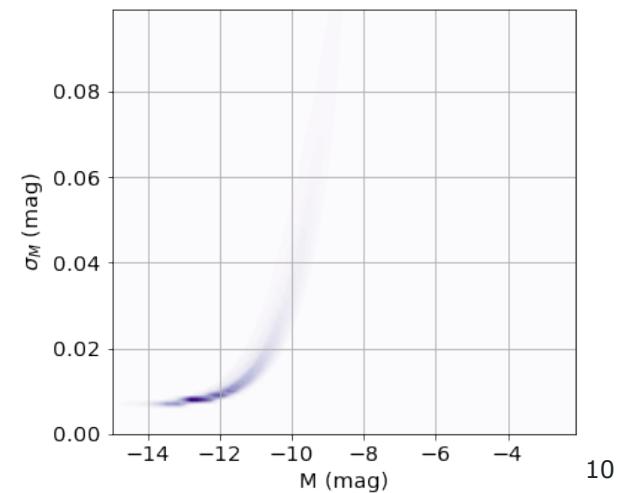
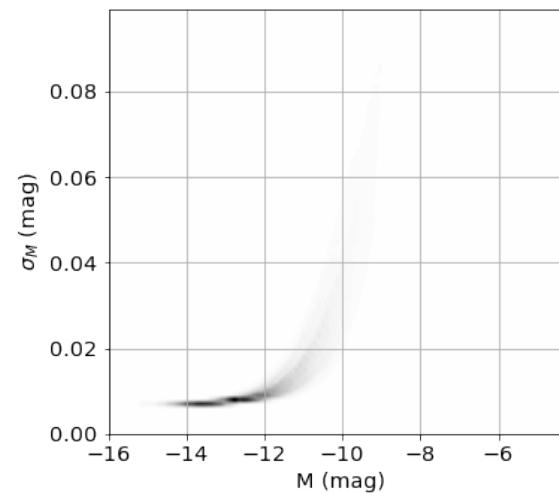
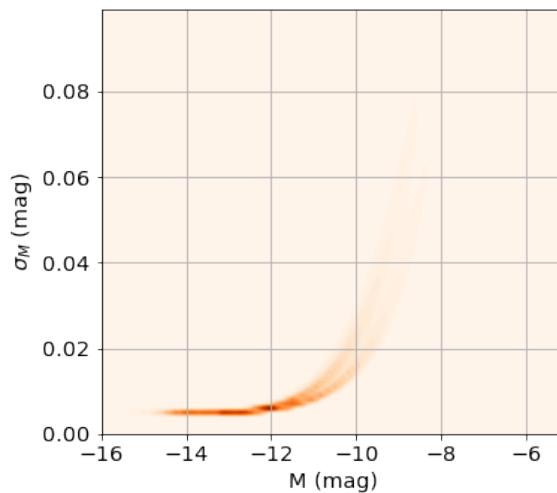
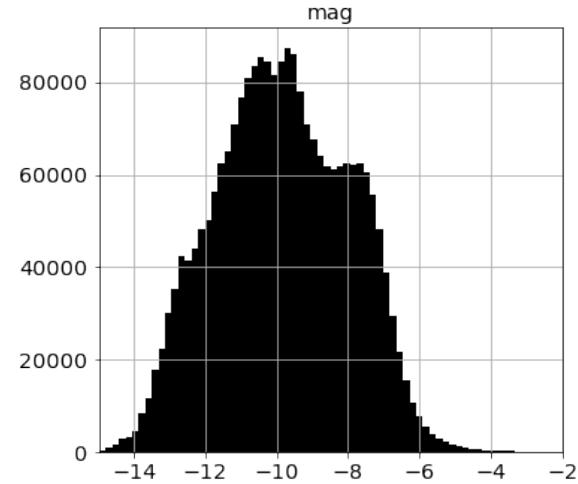
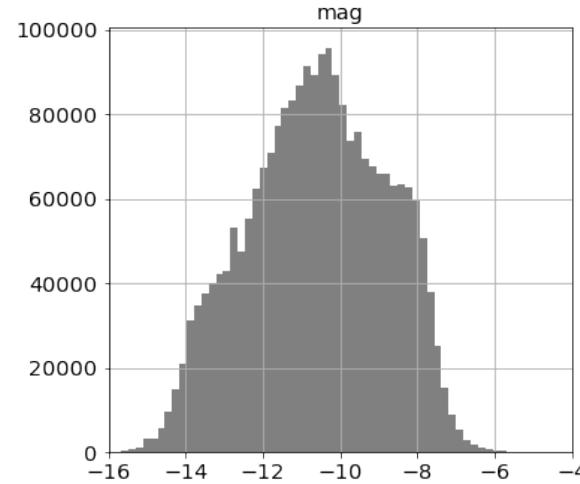
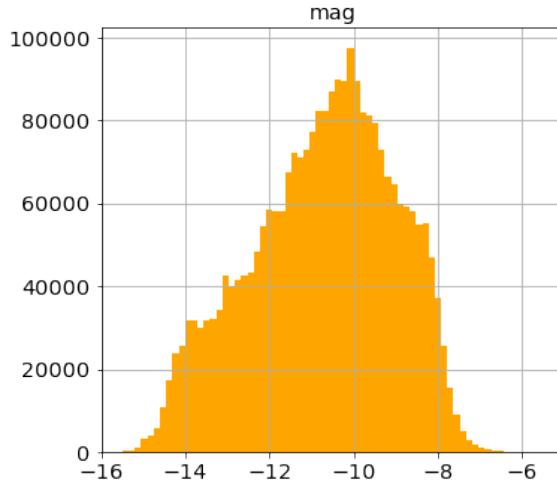
Instrumental magnitudes and errors in filters U, G, R



This Mini Data Challenge : LSST Instrumental Magnitudes



Instrumental magnitudes and errors in filters I,Z,Y
Provided + airmass



Choose one SED among the generated SET

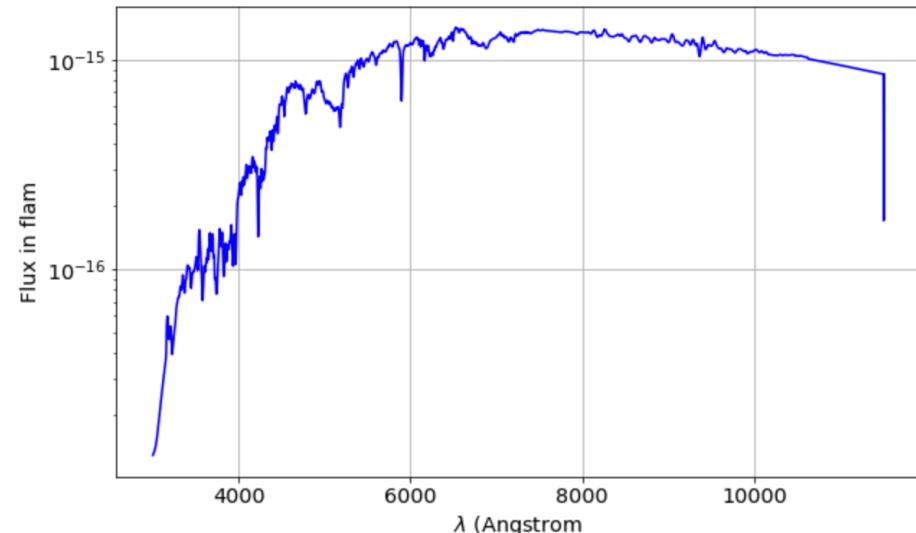
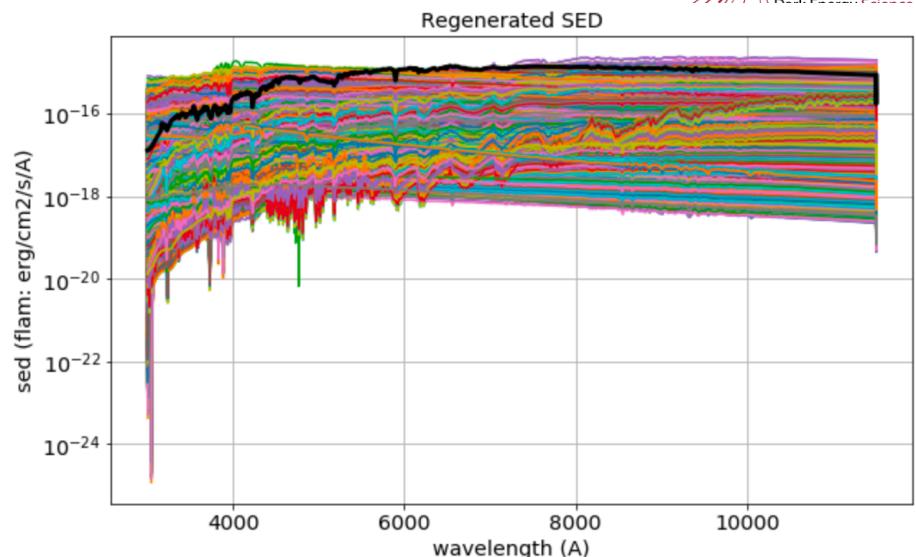


This SED



In LSST throughput, airmass=1.2

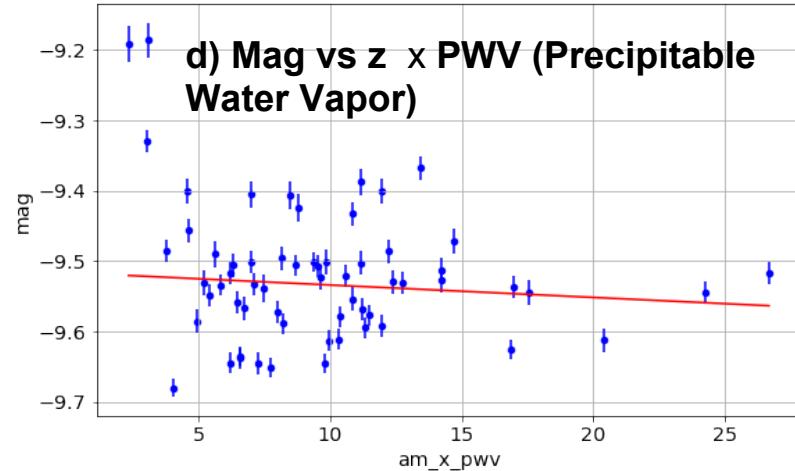
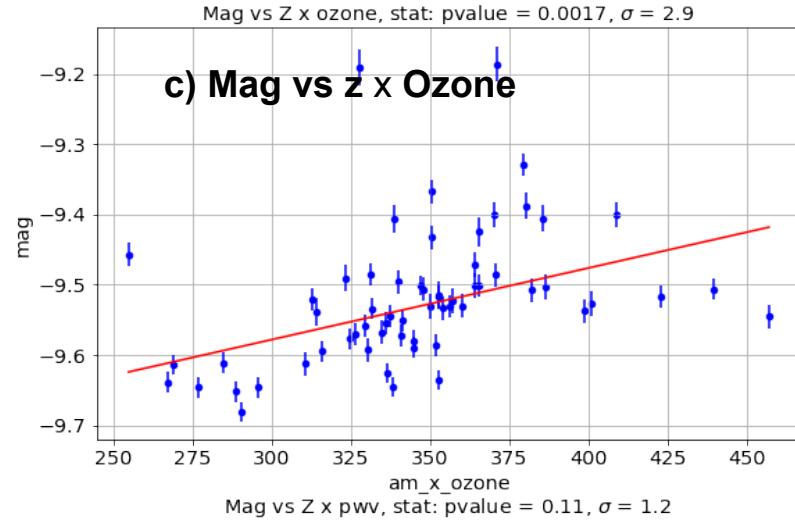
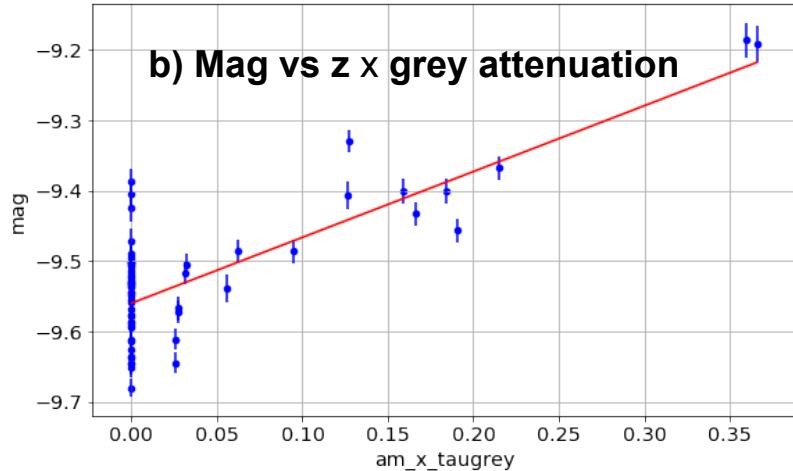
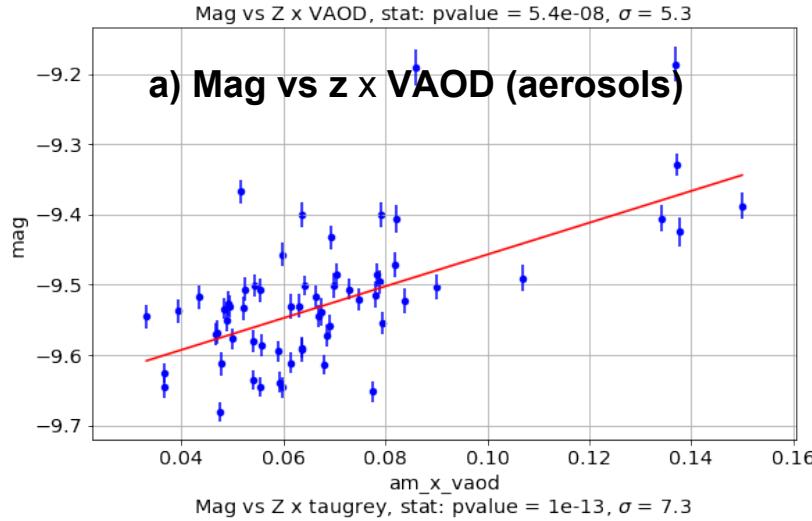
u , mag_AB= 19.59 , mag_err= 0.015
g , mag_AB= 17.13 , mag_err= 0.005
r , mag_AB= 15.94 , mag_err= 0.005
i , mag_AB= 15.39 , mag_err= 0.005
z , mag_AB= 15.14 , mag_err= 0.008
y , mag_AB= 15.02 , mag_err= 0.008



U filter : Correlation of Mag wrt Atmospheric parameters



Correlations Magnitudes - atm parameter in U filter

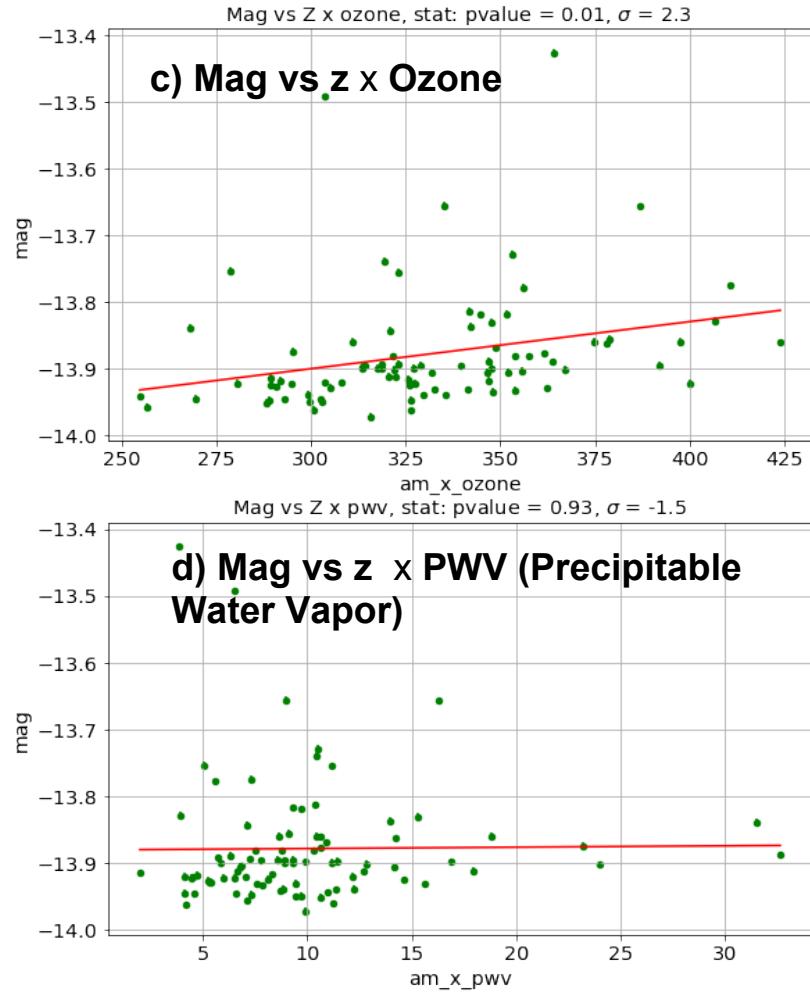
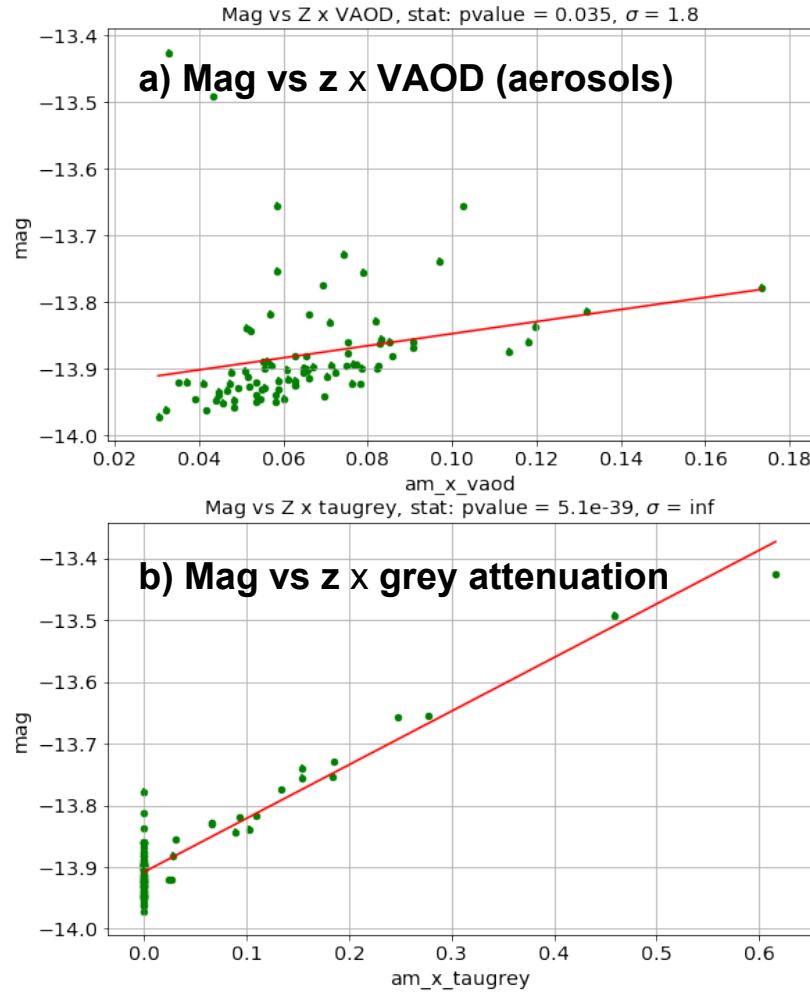


- Correlation of Mag wrt VAOD, Ozone, Grey attenuation

G filter : Correlation of Mag wrt Atmospheric parameters



Correlations Magnitudes - atm parameter in G filter

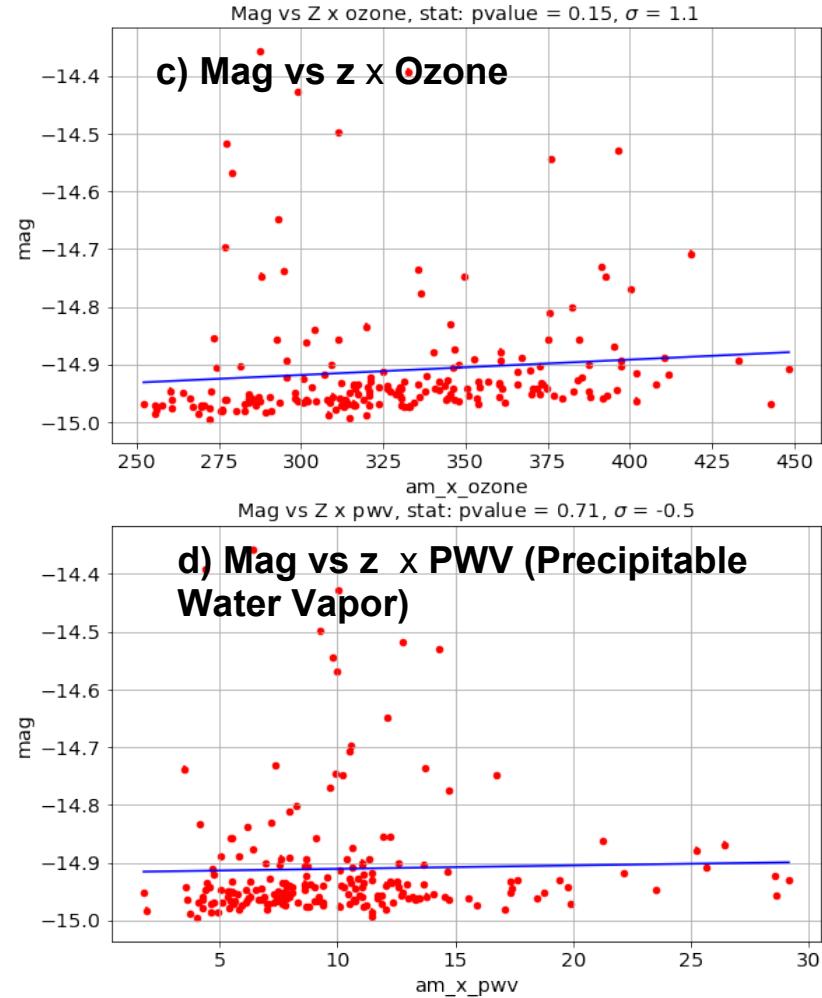
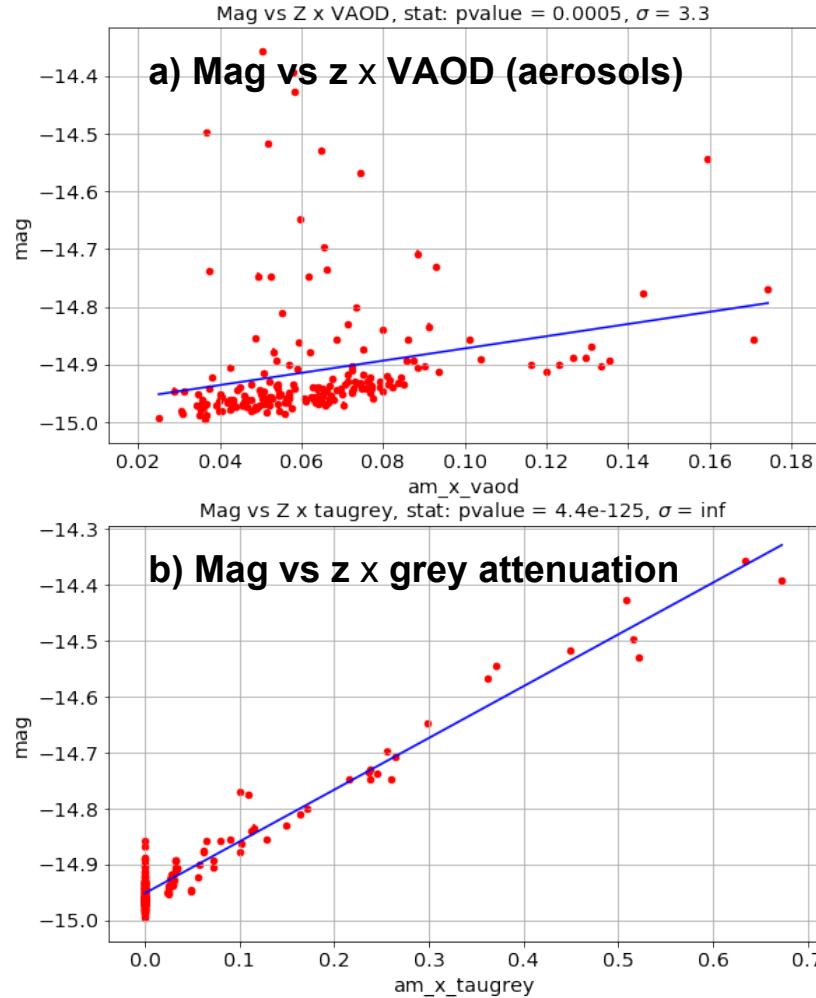


- Significative Correlation wrt grey attenuation

R filter : Correlation of Mag wrt Atmospheric parameters



Correlations Magnitudes - atm parameter in R filter

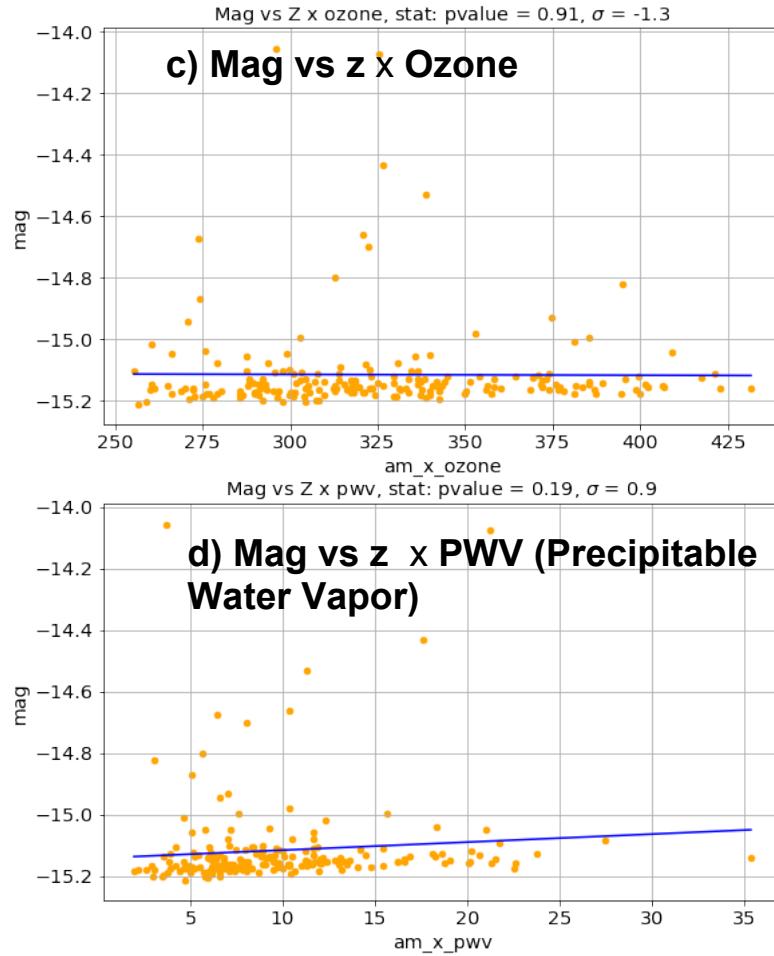
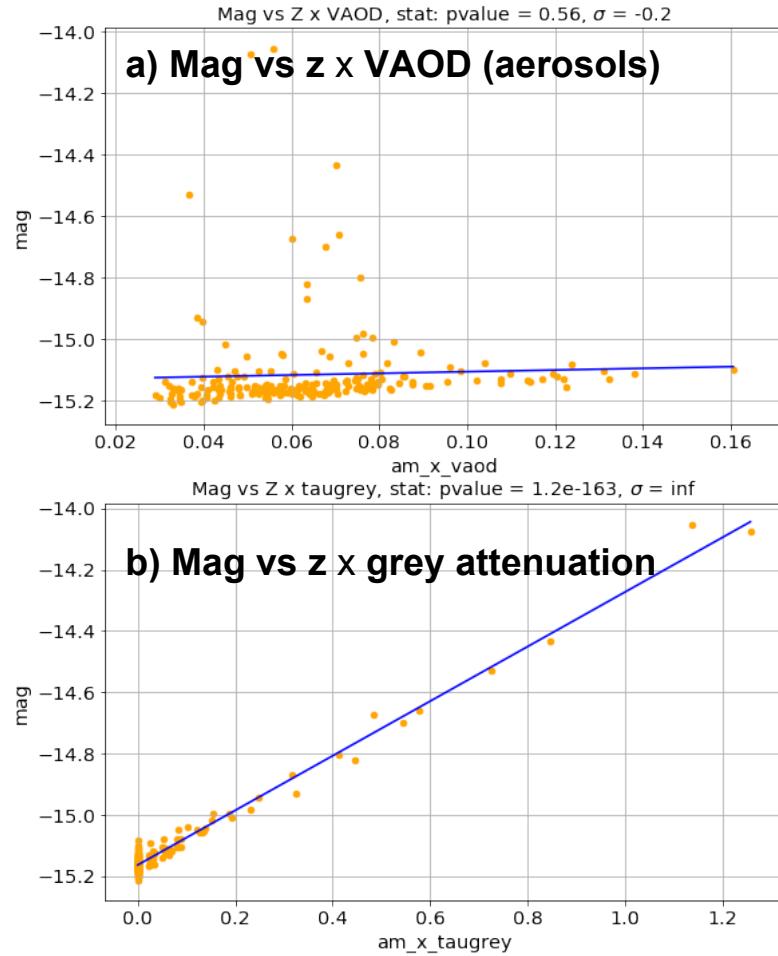


- Significative Correlation wrt grey attenuation

I filter : Correlation of Mag wrt Atmospheric parameters



Correlations Magnitudes - atm parameter in I filter

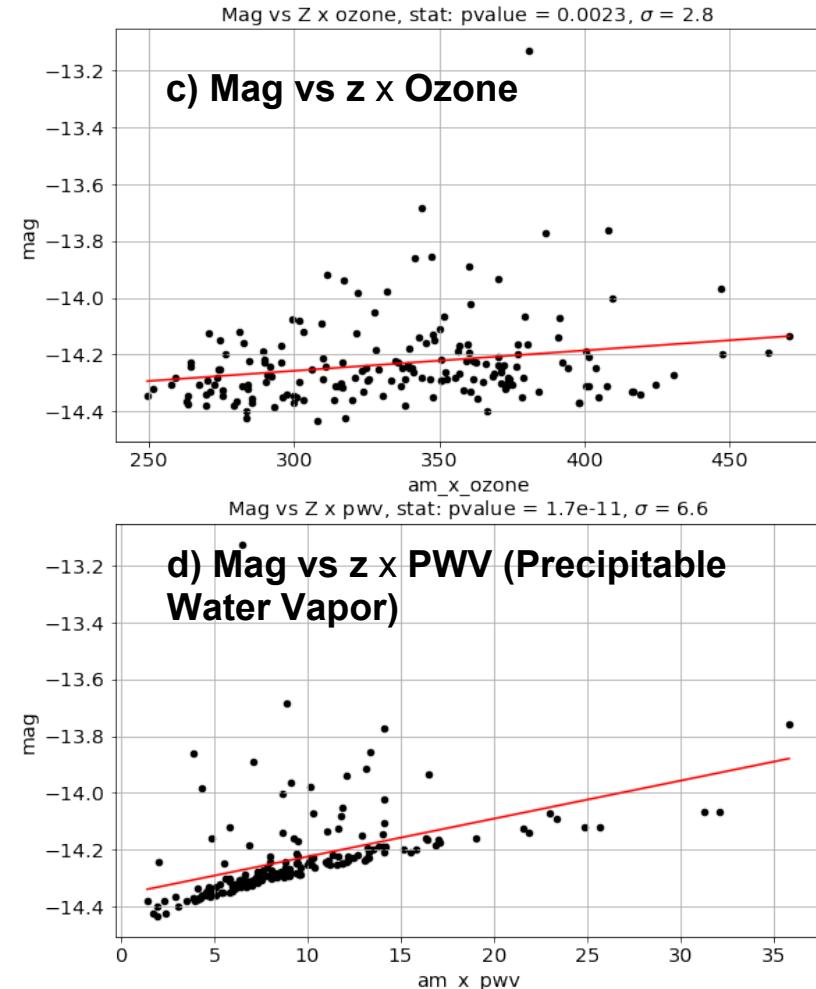
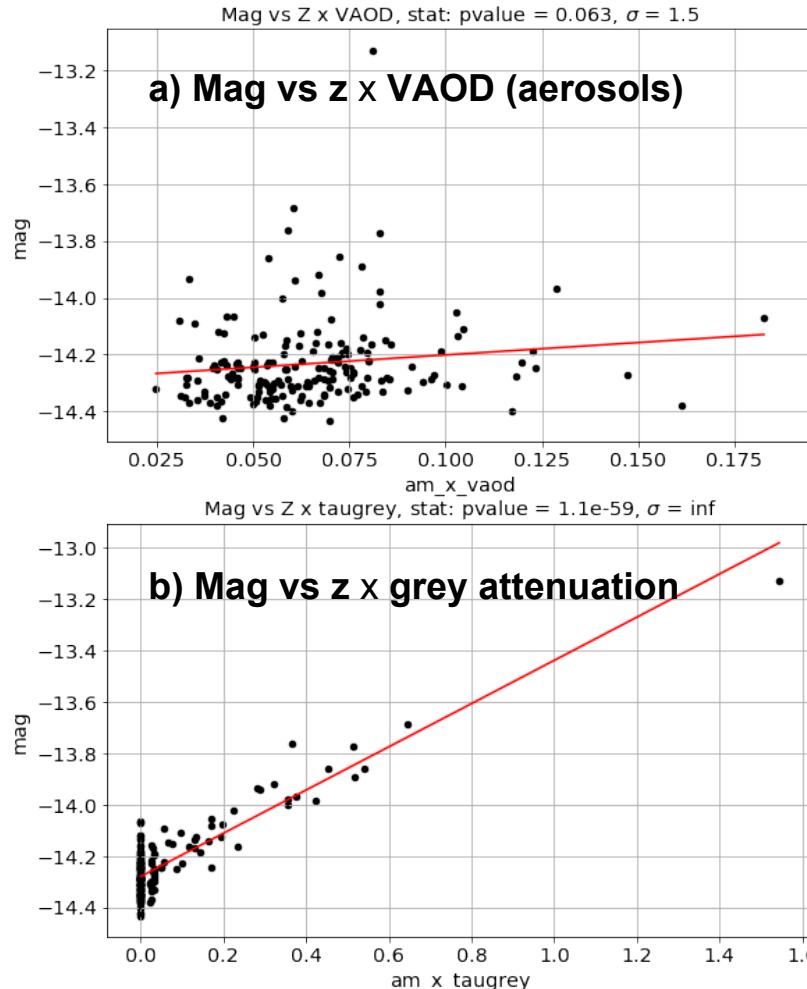


- Only significative Correlation with grey attenuation only

Y filter : Correlation of Mag wrt Atmospheric parameters



Correlations Magnitudes - atm parameter in Y filter



- Correlation wrt grey attenuation and PWV

DESC notes in preparation



Note related to this work

Draft 1

LSST DESC Notes



Generation of a star SED catalog

S. Dagoret-Campagne¹
(LSST Dark Energy Science Collaboration)

¹LAL, Univ. Paris-Sud, CNRS/IN2P3, Université Paris-Saclay, Orsay, France

(Dated: September 25, 2018, version : V0.2)

Describe how the catalog of realistic SED has been build.

The original note note without changed points
There another file.

Sed feugiat. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Ut pellentesque augue sed urna. Vestibulum diam eros, fringilla et, consectetur eu, nonummy id, sapien. Nullam at lectus. In sagittis ultrices mauris. Curabitur malesuada erat sit amet massa. Fusce blandit. Aliquam erat volutpat. Aliquam euismod. Aenean vel lectus. Nunc imperdiet justo nec dolor.

Sed feugiat. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Ut pellentesque augue sed urna. Vestibulum diam eros, fringilla et, consectetur eu, nonummy id, sapien. Nullam at lectus. In sagittis ultrices mauris. Curabitur malesuada erat sit amet massa. Fusce blandit. Aliquam erat volutpat. Aliquam euismod. Aenean vel lectus. Nunc imperdiet justo nec dolor.

Sed feugiat. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Ut pellentesque augue sed urna. Vestibulum diam eros, fringilla et, consectetur eu, nonummy id, sapien. Nullam at lectus. In sagittis ultrices mauris. Curabitur malesuada erat sit amet massa. Fusce blandit. Aliquam erat volutpat. Aliquam euismod. Aenean vel lectus. Nunc imperdiet justo nec dolor.

Draft 2

LSST DESC Notes



Comparison of atmospheric transparency in Modtran and LibRadTran

S. Dagoret-Campagne¹ and K. Gilmore²
(LSST Dark Energy Science Collaboration)

¹LAL, Univ. Paris-Sud, CNRS/IN2P3, Université Paris-Saclay, Orsay, France

²SLAC National Accelerator Laboratory, Menlo Park, CA 94025, USA

(Dated: September 19, 2018, version : V0.5, DESC-LSST-Note-LAL-2018-09-002)

We compare atmospheric light transmission for Modtran and LibRadTran in the LSST wavelength range.

1. Introduction

Reliable and realistic atmospheric transmission models are required to achieve milli-magnitude photometric calibration at LSST. Atmospheric light transport codes provide such accurate models well tested over decade by earth sciences. However slight discrepancies in modelling may have an impact on the photometric calibration accuracy. We propose to compare the atmospheric transmission predicted by two light transfer codes : Modtran (3), (2) (version 5) and LibRadTran (5) (version v2.0.1).

The prediction of the air transparency from an atmospheric transmission model depends on the observation altitude, the airmass and also the atmospheric vertical profiles of pressure, temperature as well as vertical distribution of atmospheric chemical components which induce light absorption. Thus the models comparison must be performed at similar

Draft 3

LSST DESC Notes



A Mini Data Challenge to extract atmospheric transparency from measured magnitudes in LSST telescope

S. Dagoret-Campagne¹
(LSST Dark Energy Science Collaboration)

¹LAL, Univ. Paris-Sud, CNRS/IN2P3, Université Paris-Saclay, Orsay, France

(Dated: October 1, 2018, version : V0.6, DESC-LSST-Note-LAL-2018-09-003)

We describe the framework designed to generate a dataset representative of 10 years of LSST magnitudes, submitted to realistic atmospheric variations from which DESC team can evaluate the performances of its algorithms to extract for each exposure the atmospheric transparency along its observation direction.

1. Introduction

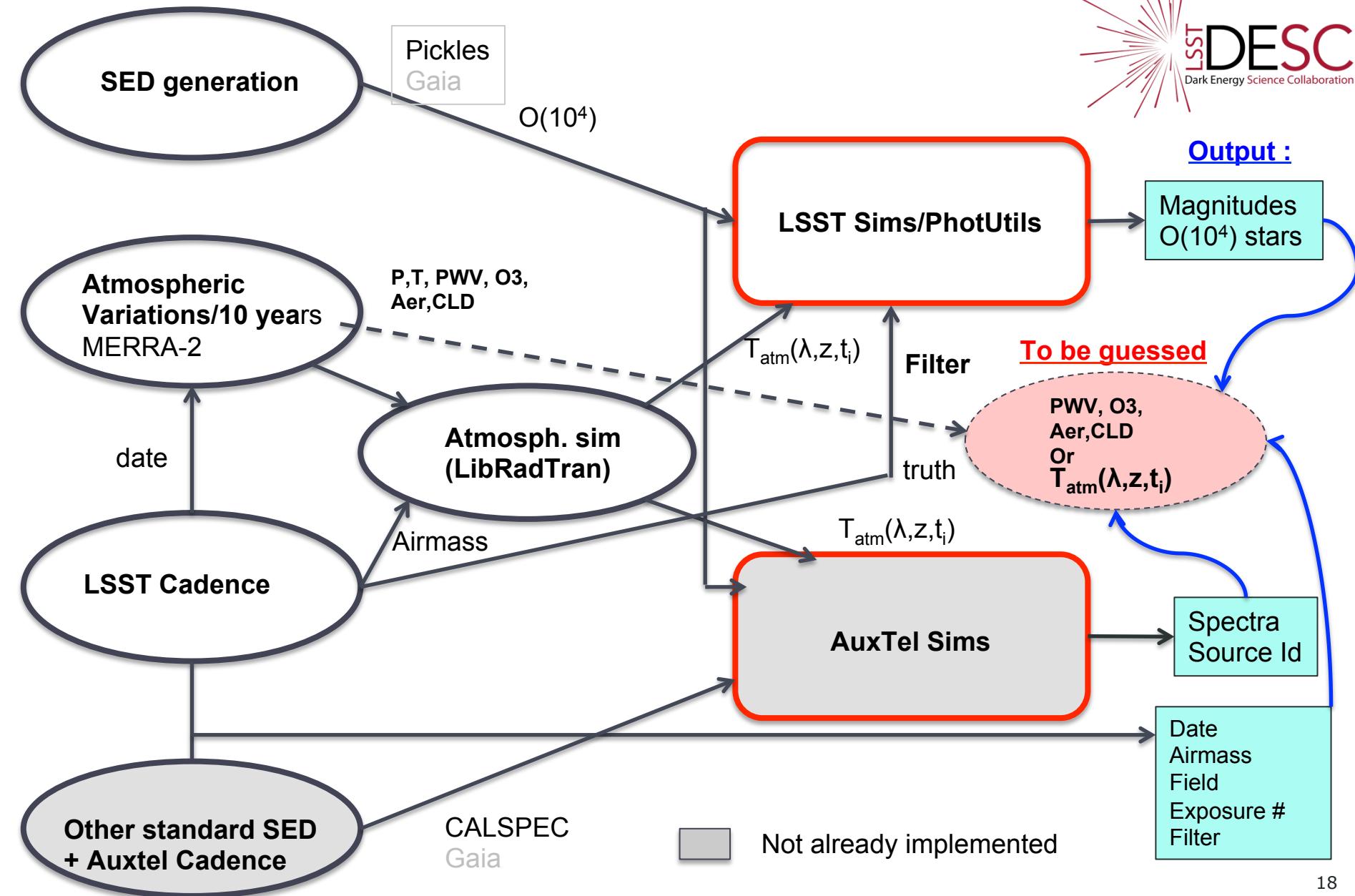
LSST will start its commissioning in years 2022. The knowledge of the atmospheric transparency is a key ingredient of the photometric calibration of its observations as well as the instrument calibration by itself. Basically, it is assumed that atmospheric calibration could not only be derived from LSST data itself but also from the auxiliary telescope so-called AUXTEL. Indeed, AUXTEL should start early 2019, probing atmospheric transparency by measuring star spectra. The goal of atmospheric photometric calibration is to be able to estimate the atmospheric transparency for each exposure, over the whole range of wavelength range, that is from 350 nm to 1000 nm, whatever the airmass is. The associated

How to build an SED catalog
Useful for using Gaia data

Modtran/LibRadTran :
Are atmospheric models
Equivalents ?

How data are generated ?

Mini Data Challenge Framework



Conclusions 1/2

- **10 years of LSST instrumental mag & err in one Field for 13000 stars, with realistic atmospheric variations:**
 - VAOD, PWV, ozone, clouds
- **Preliminary check:**
 - U filter sensitive to aerosols and ozone
 - Y filter mandatory to estimate PWV
 - Cloud (grey transmission) can be estimated in each band
 - Sensitivity of G on aerosols and ozone to be further investigated
- **To Do List**
 - Augment SED catalog with Gaia
 - Include Galaxy catalog
 - Time correlation on MERRA2 data
 - More Cadence fields to have a better atmospheric time sampling

Conclusions 2/2

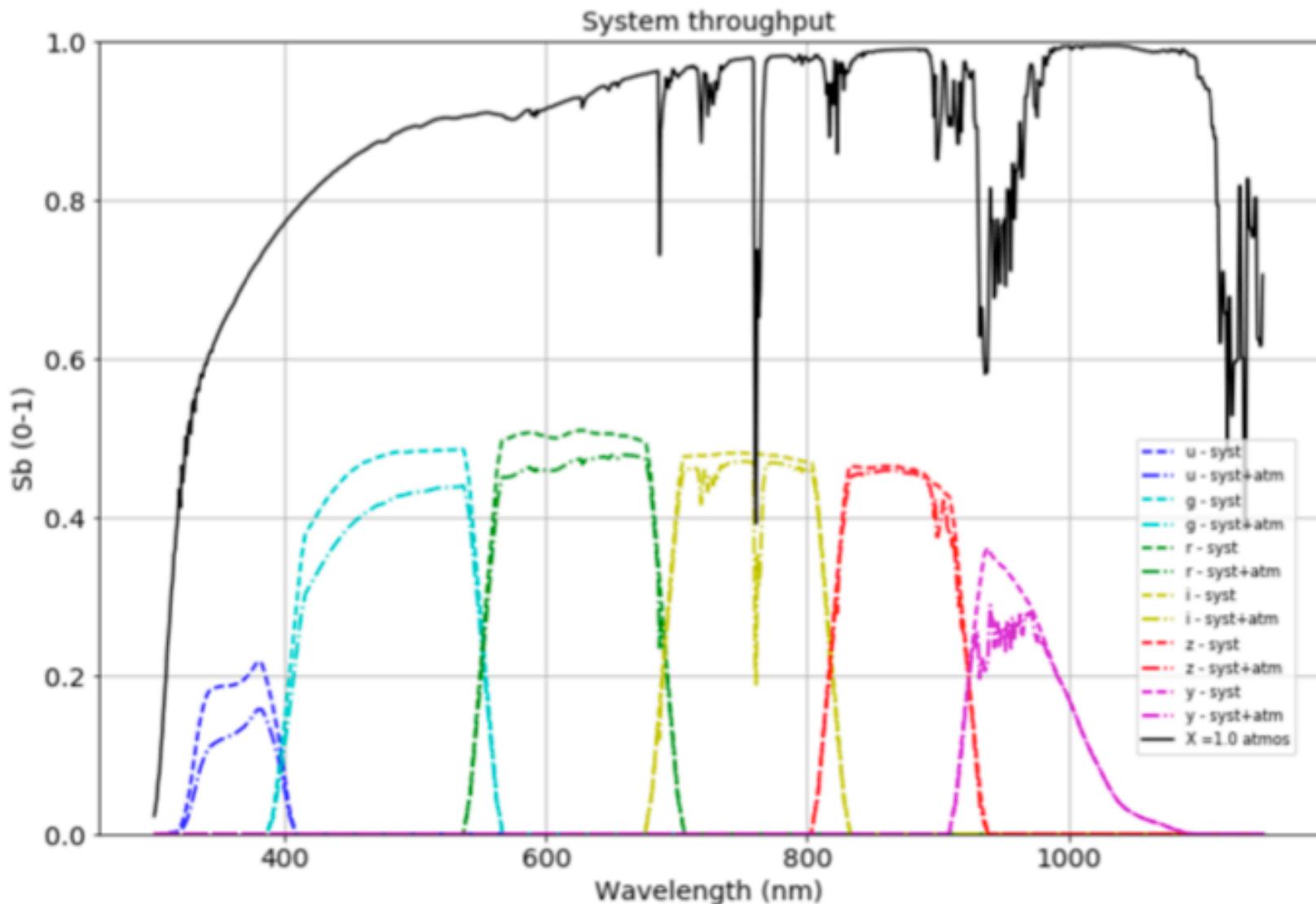


- **Auxtel spectro/photometric simulation:**
 - LSSTsims/PhotUtils like simulation
 - Need optical throughput
 - Needs disperser transmission and wavelength resolution
- **Auxtel Cadence ?**
 - CALSPEC/Gaia standards ?
- **Data type : trainning (with true values) + test set ?**
- **Data delivery for the Mini Data Challenge:**
 - CCIN2P3
 - /sps/lsst/data/MiniDataChallenge_Delivery/
July1518/pickles_uvk (416 Mbytes)
- **Code :** <https://github.com/LSSTDESC/OpenAtmMiniDataChallenge>

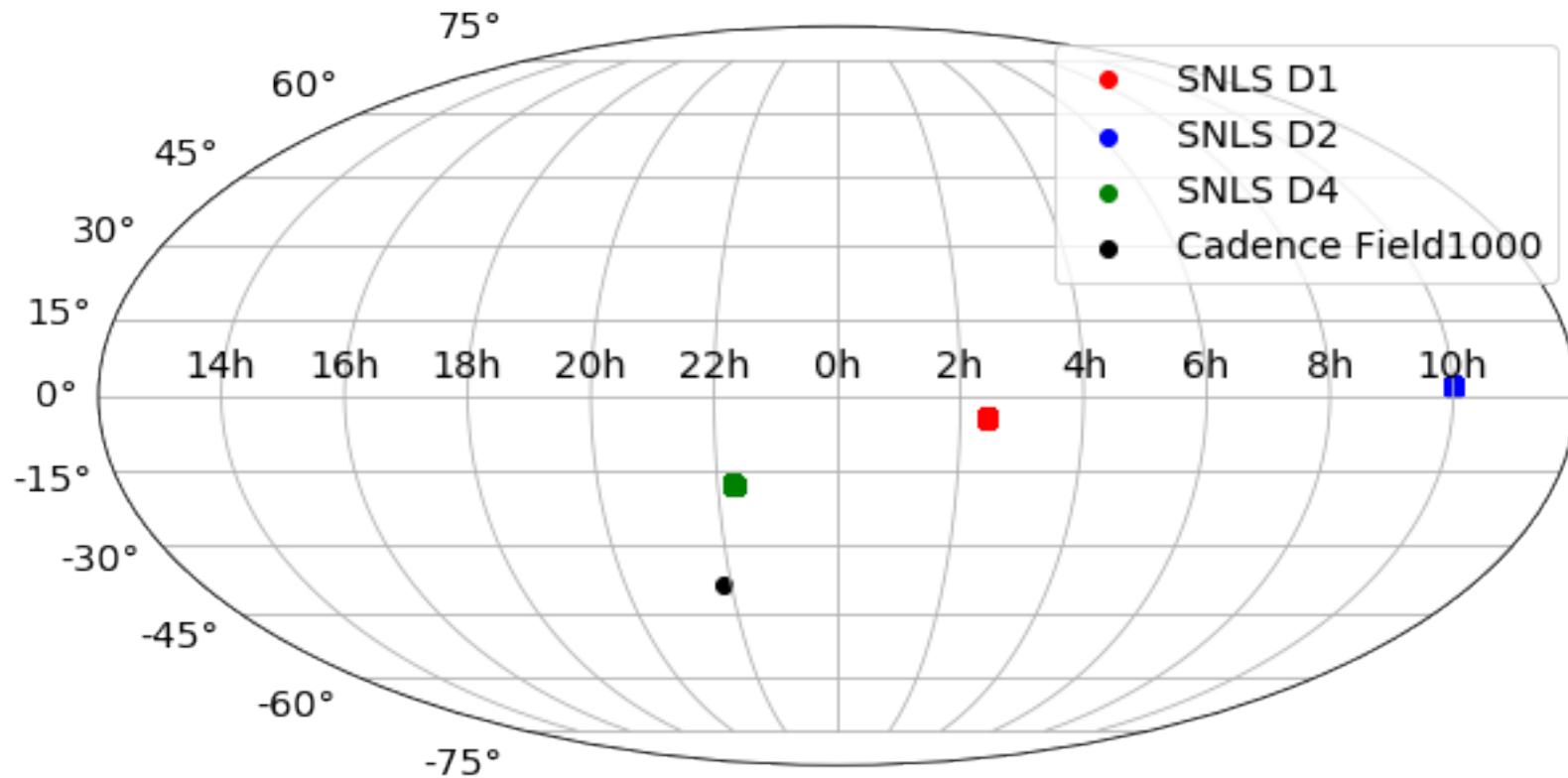
BACKUP : additional piece of information



Atmospheric transparency



Sky regions of SNLS catalog and selected Cadence field



SNLS Magnitudes catalog sets D1,D2,D4 shows similar magnitudes and color distributions

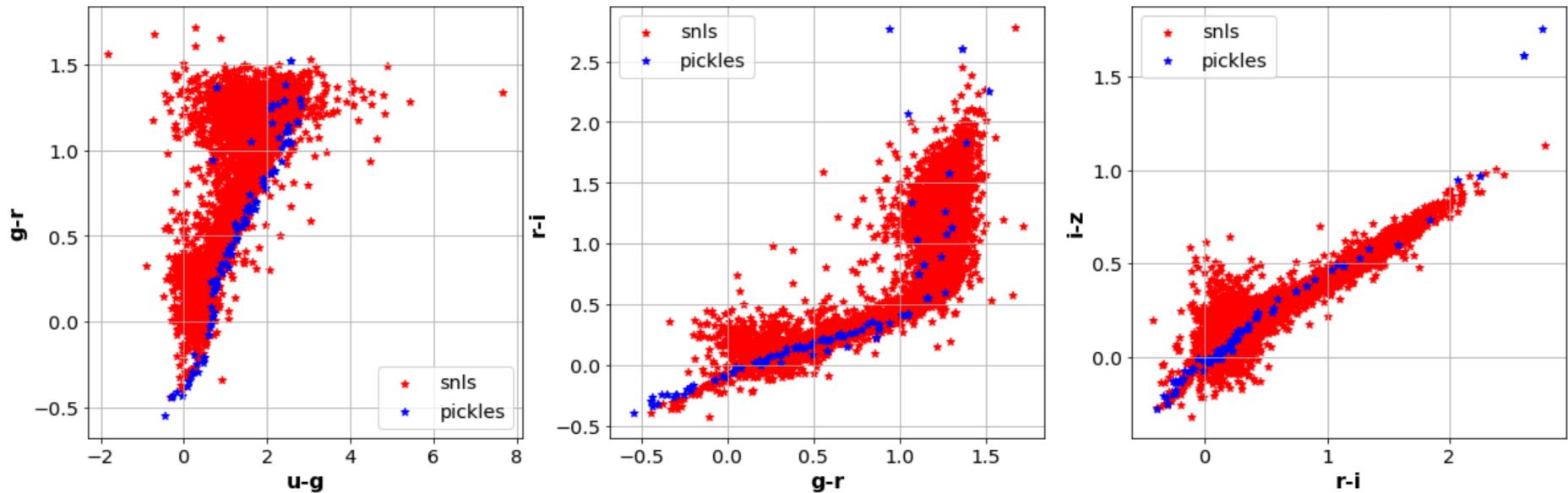
Comparison of Pickles SEDs colors (through SNLS filters with SNLS star magnitude catalog)



A STELLAR SPECTRAL FLUX LIBRARY BY A.J. PICKLES (1998) (PASP 110, 863)

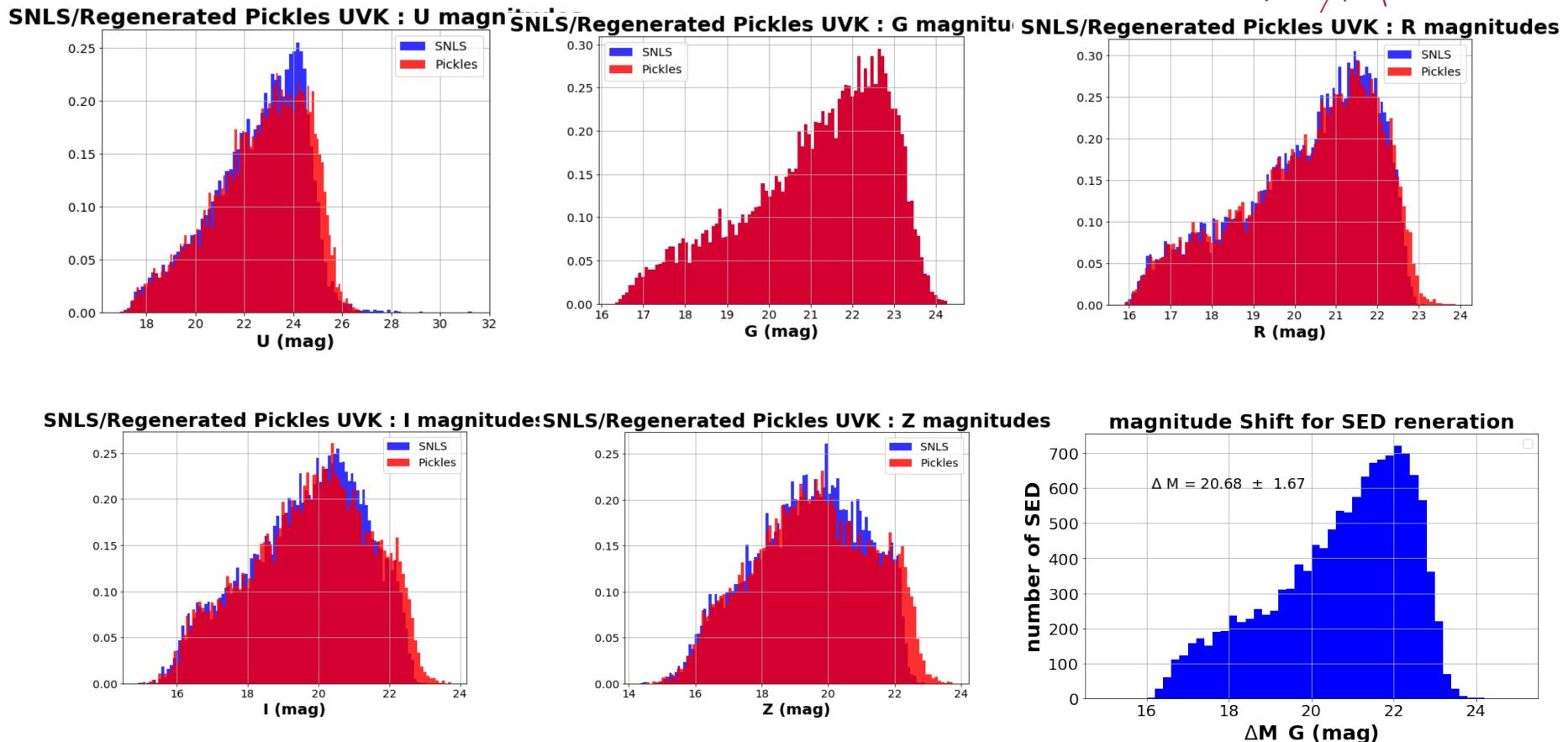
All normal spectral types and luminosity classes at solar abundance, and metal-weak and metal-rich F-K dwarf and G-K giant components.

2D color plot SNLS/Pickles UVK



Relatively good color matching between SNLS star catalog and Pickles UVK

Generated SED AB-magnitudes in SNLS filters

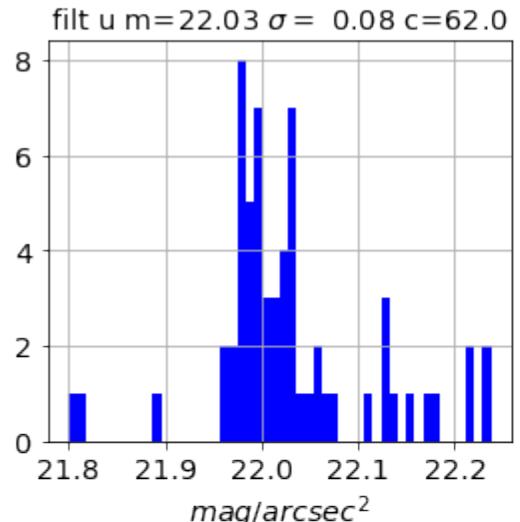


- Acceptable magnitude distribution matching
- SED Normalisation of Pickles wrt SNLS done in filter G

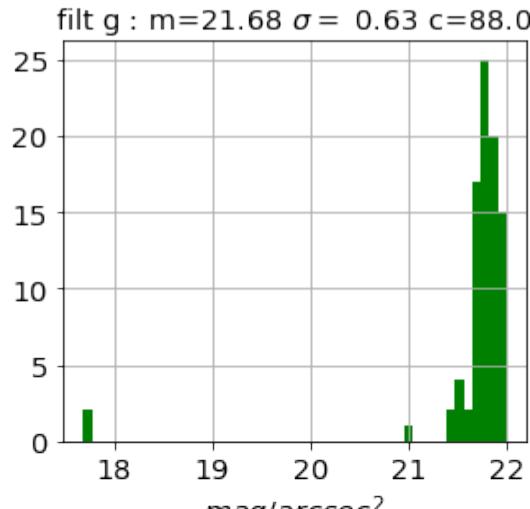
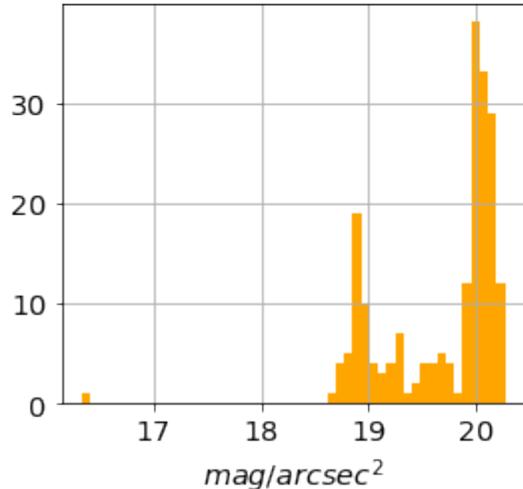
Mini Data Challenge : cadence input parameters variations : Sky Brightness



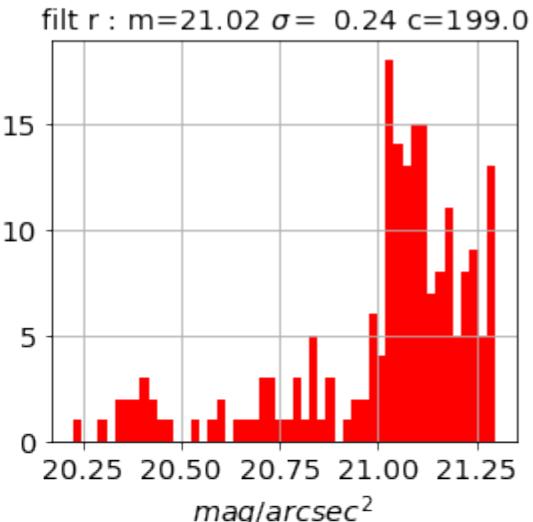
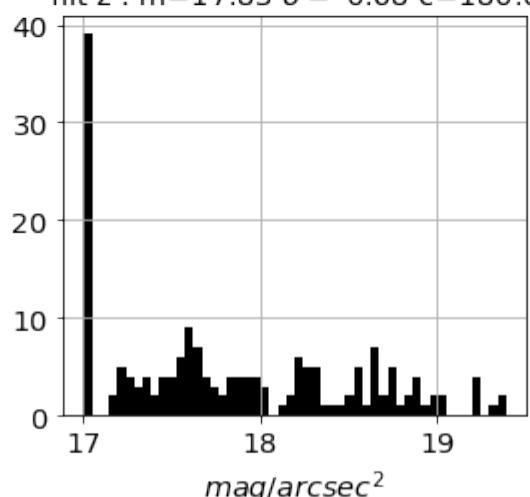
sky brightness (LSST cadence)



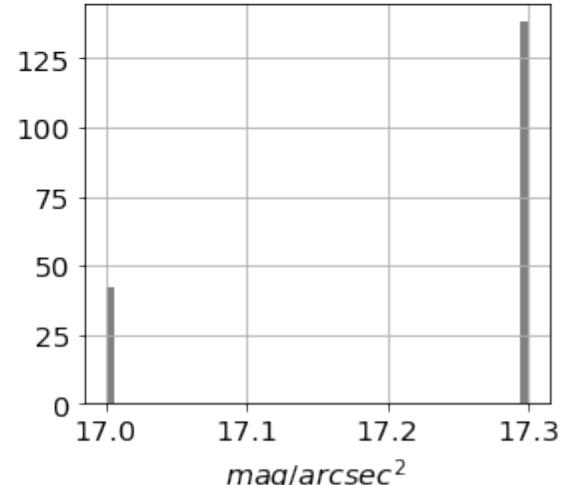
filt i : $m=19.70 \sigma = 0.55 c=203.0$



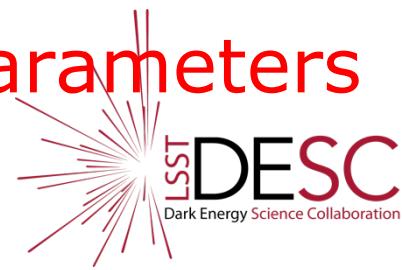
filt z : $m=17.83 \sigma = 0.68 c=180.0$



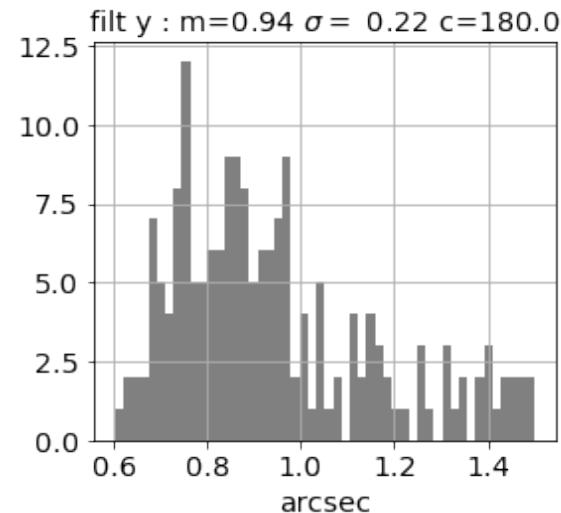
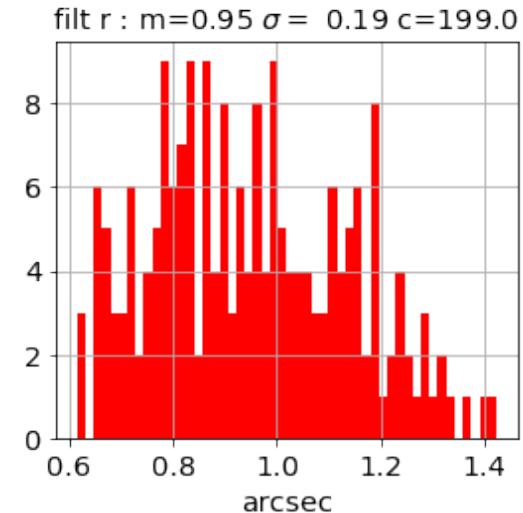
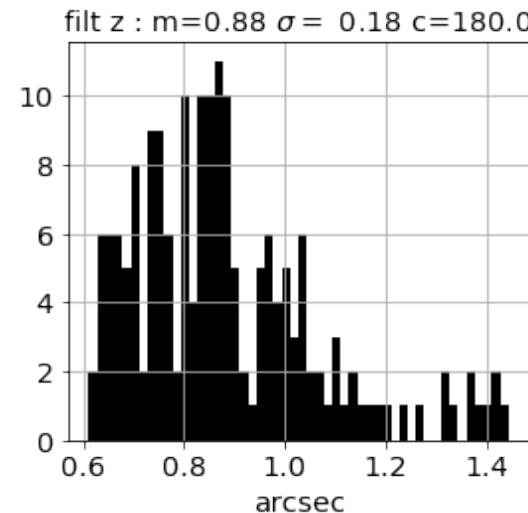
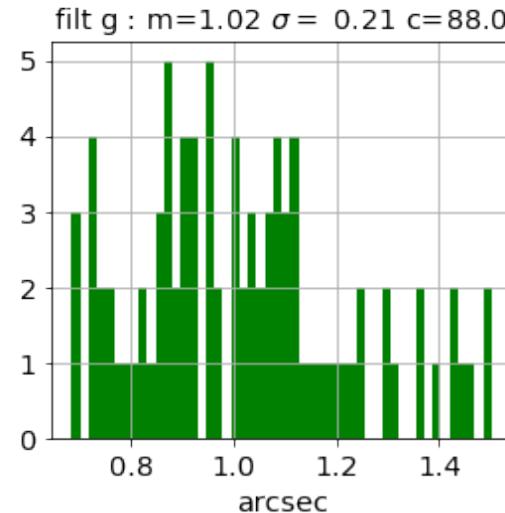
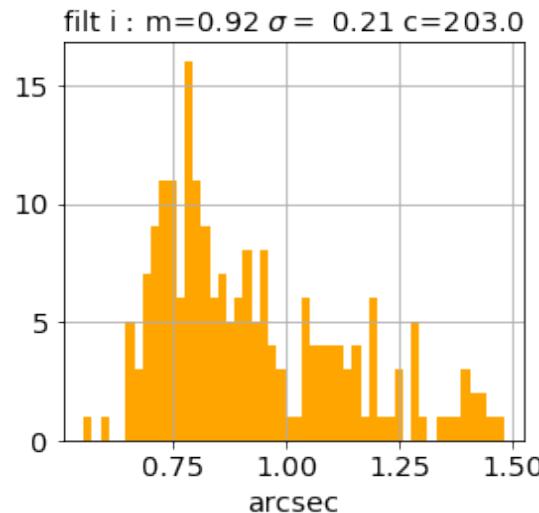
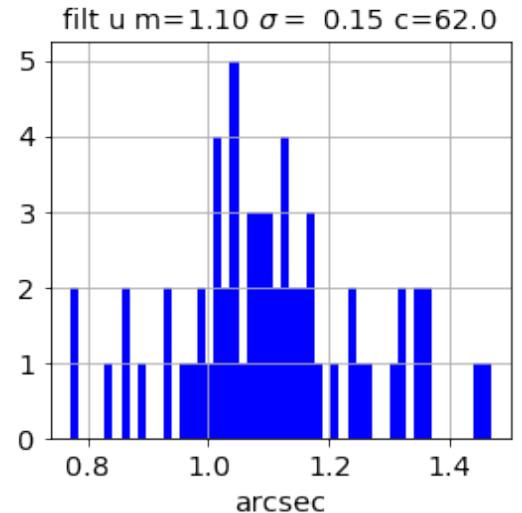
filt y : $m=17.23 \sigma = 0.13 c=180.0$



Mini Data Challenge : cadence input parameters variations : « Geometrical » Seeing

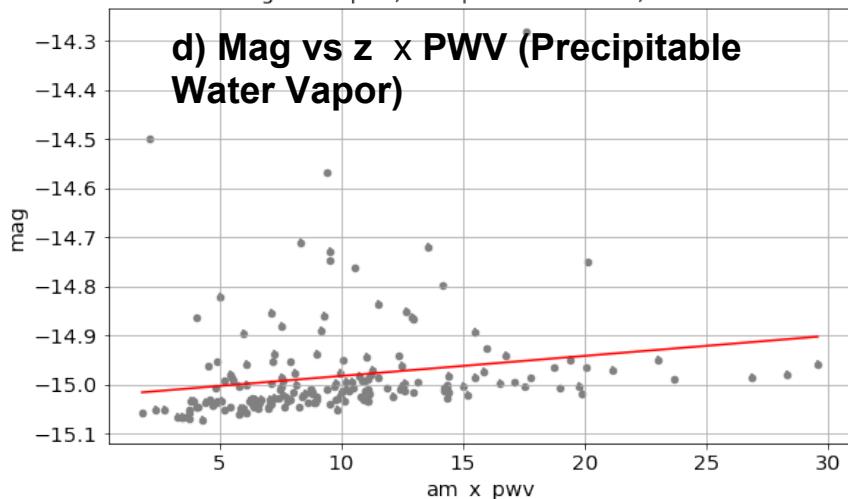
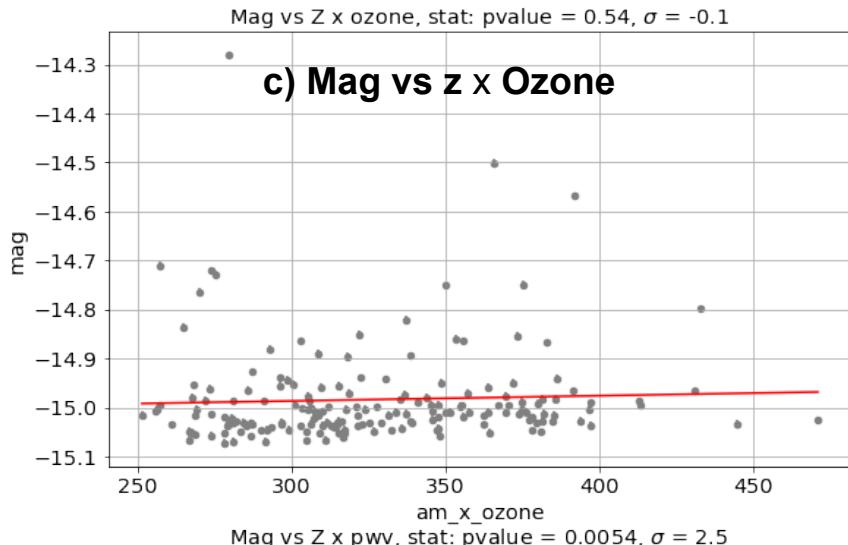
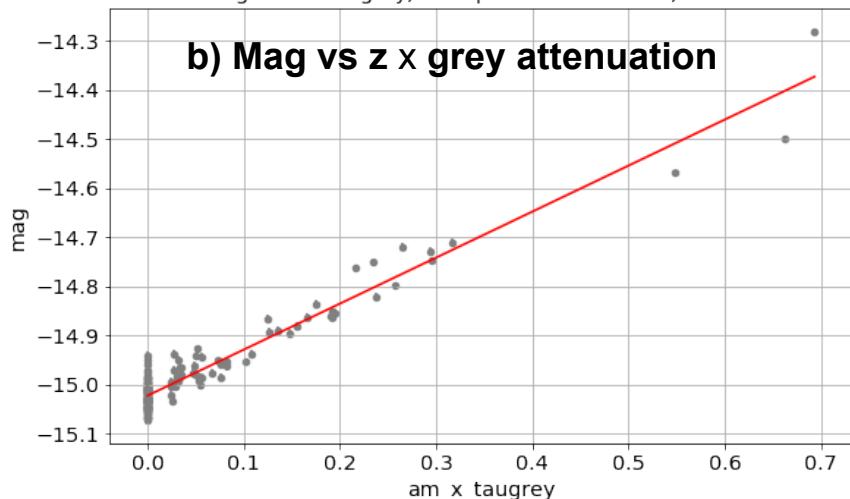
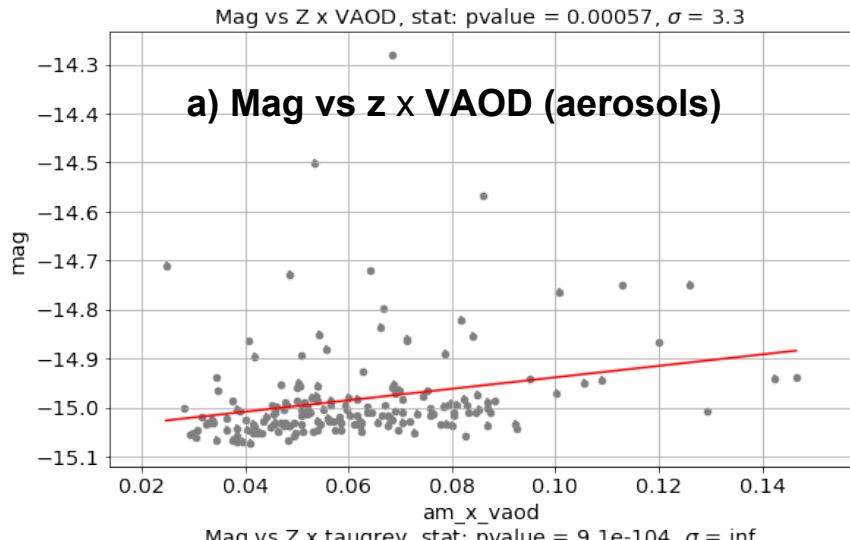


Seeing (LSST cadence)



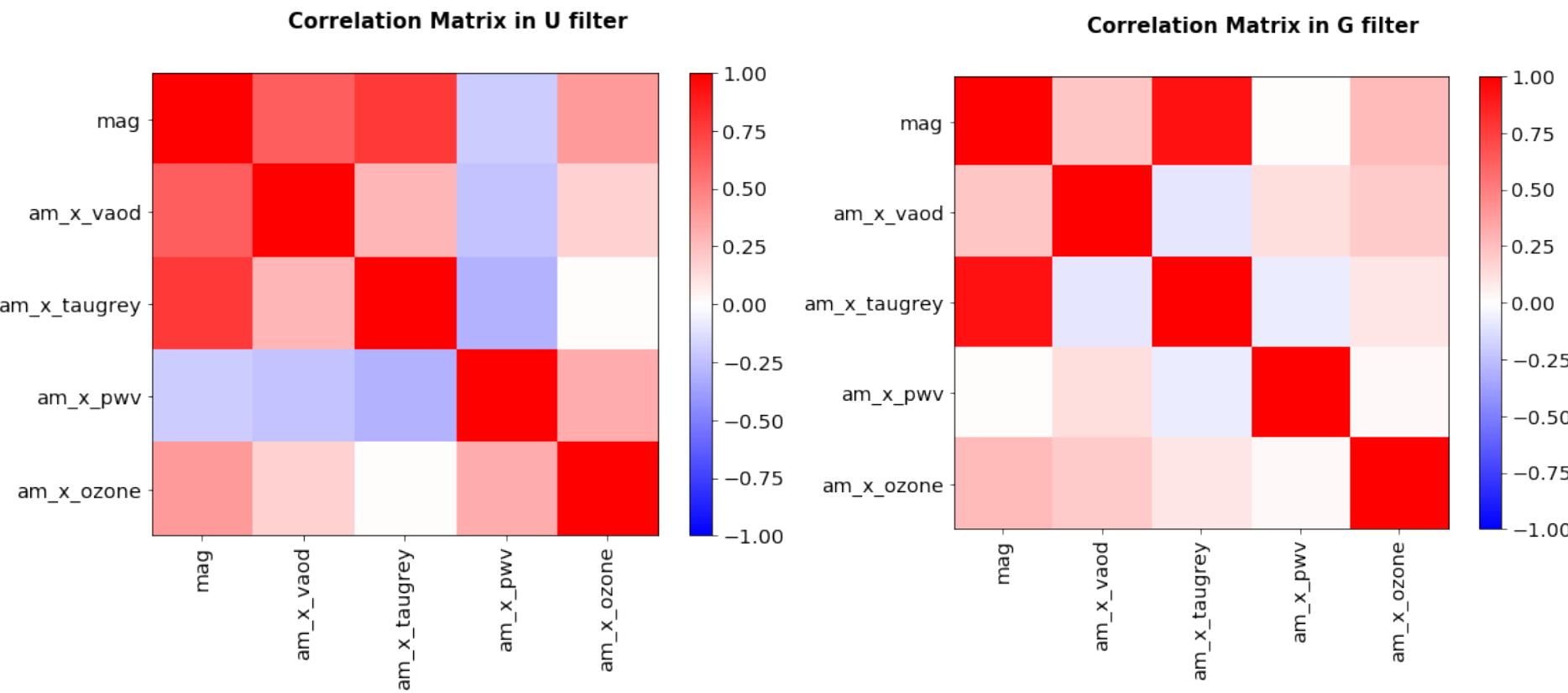
Z filter : Correlation of Mag wrt Atmospheric parameters

Correlations Magnitudes - atm parameter in Z filter



- Only Significative Correlation wrt grey attenuation

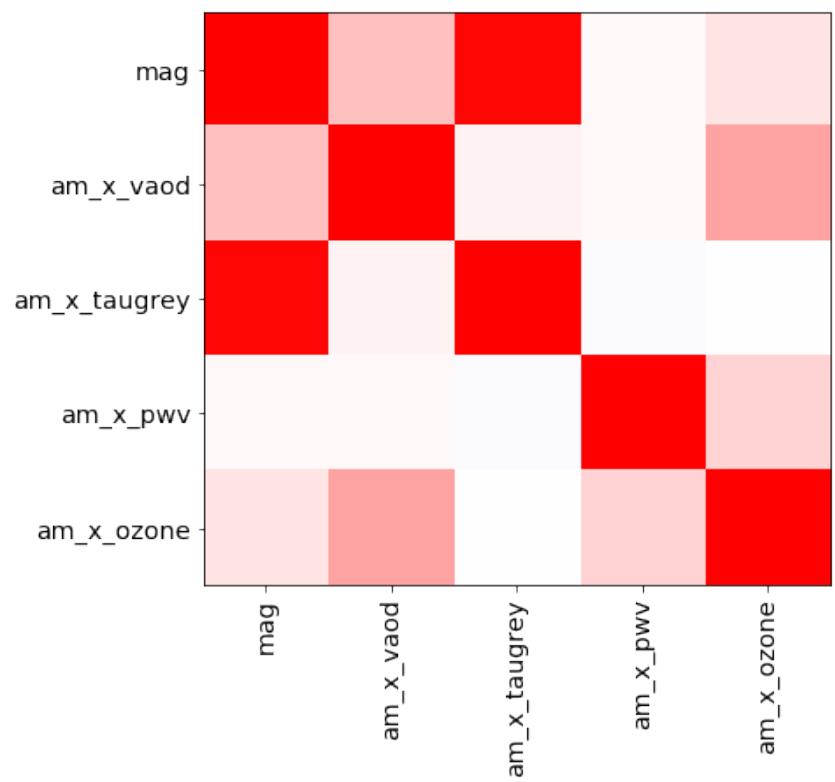
Correlation Matrix in U and G filters



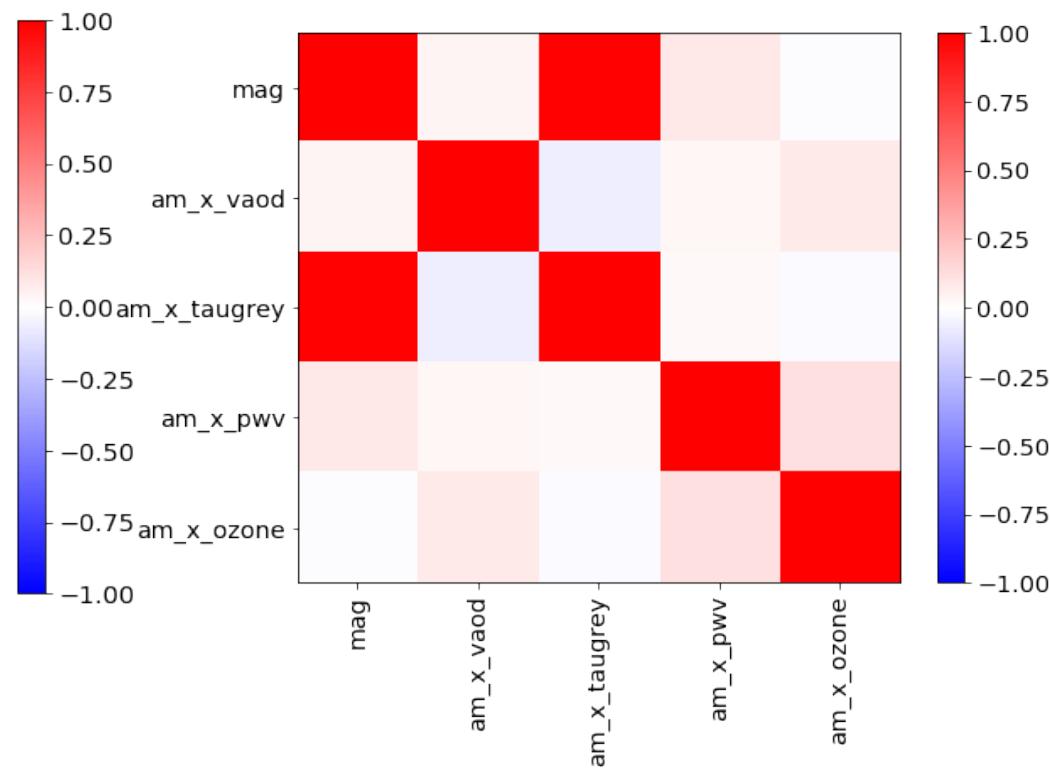
Correlation Matrix in R and I filters



Correlation Matrix in R filter



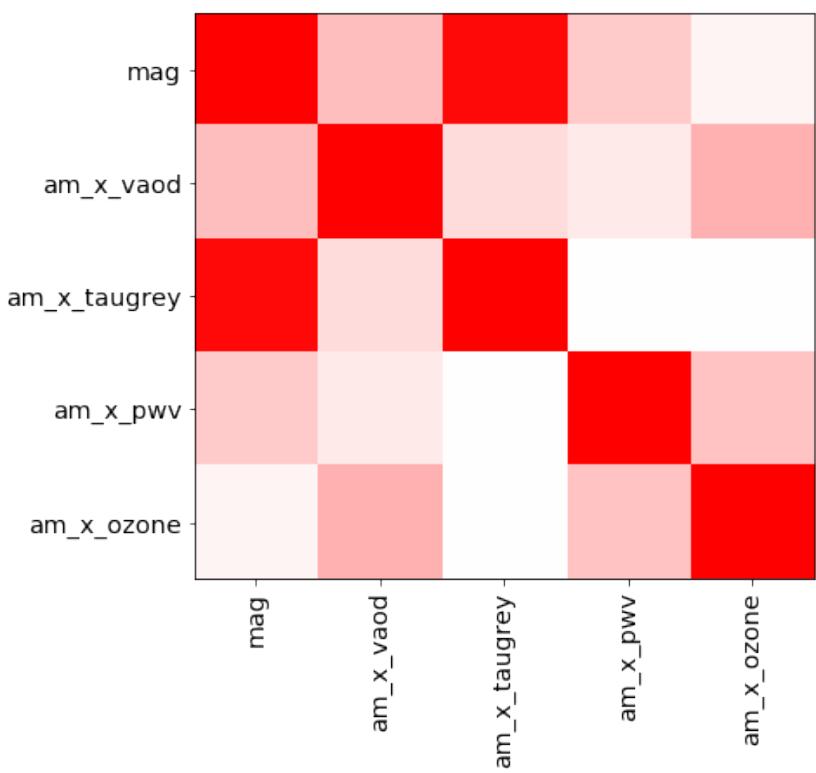
Correlation Matrix in I filter



Correlation Matrix in Z and Y filters



Correlation Matrix in Z filter



Correlation Matrix in Y filter

