Impact des variations d'absorption atmosphérique sur la photométrie de LSST

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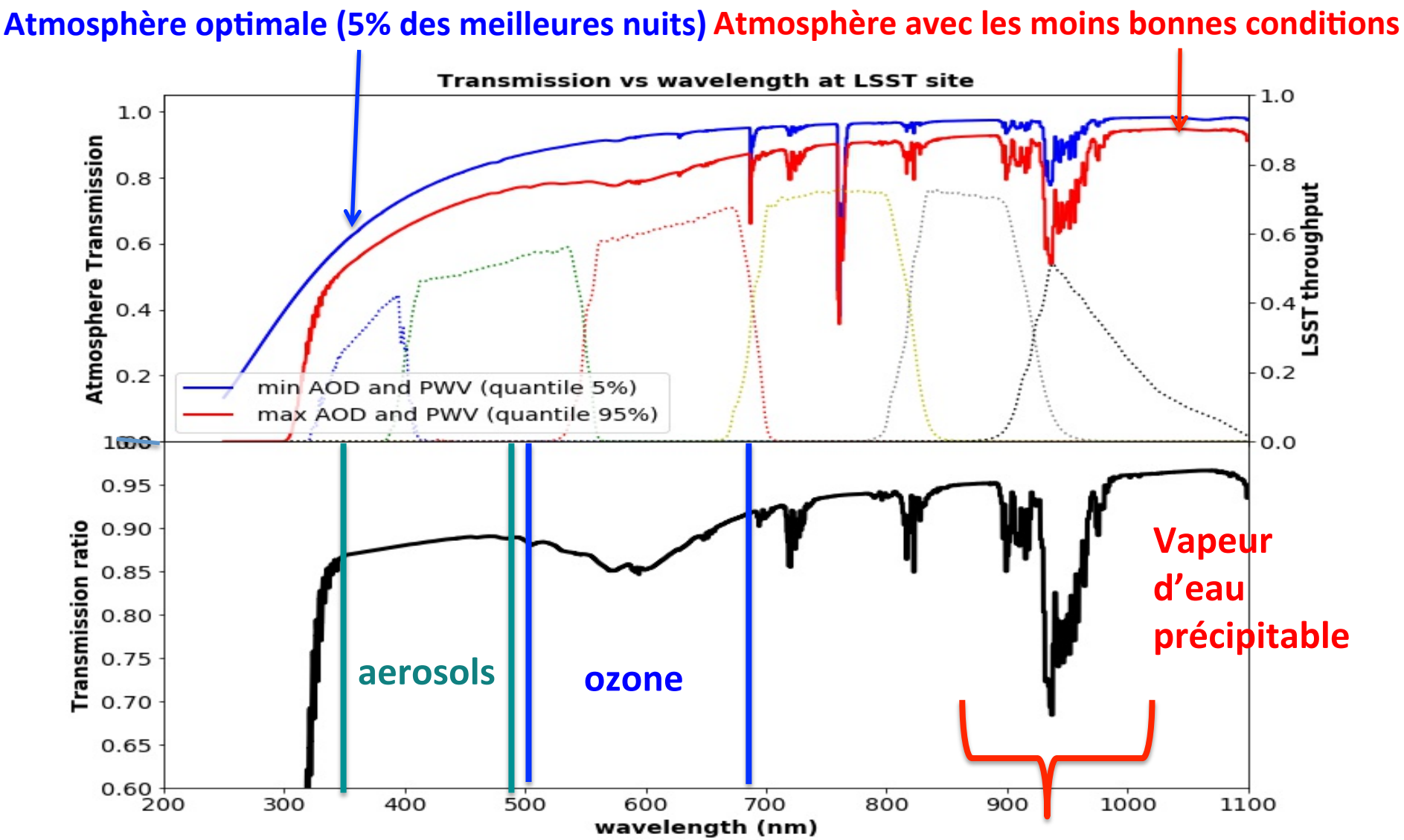
Objectif

- Déterminer les paramètres pertinents de l'atmosphère et la précision avec laquelle il faut les mesurer pour atteindre 5mmag de précision
- Paramètres considérés:
  - **Aérosols**: indice optique VAOD; concerne **U, B, V**
    - Etudié ici entre 0 et 0.5
    - attendu entre 0 et 0.1 à LSST
  - **Ozone**: de 0 DU à 600 DU; concerne **B, V**
  - **Vapeur d'eau précipitable**: PWV de 0 à 10mm; concerne **I, Z, Y**

Transmission de l'atmosphère

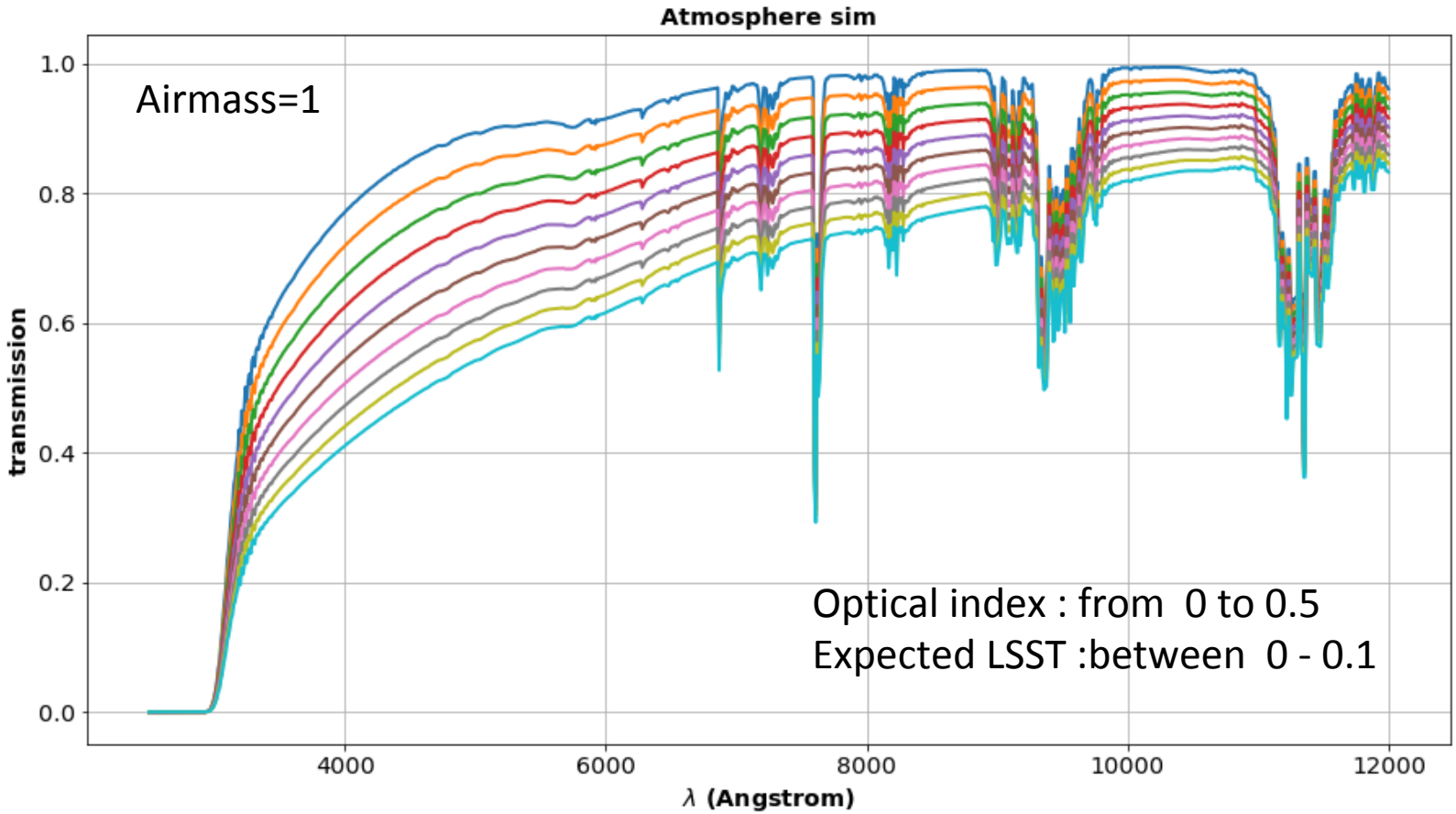


Les corrections dépendent des SEDs

Estimations photométrie LSST avec simulation LibRadTran et bandes passantes LSST

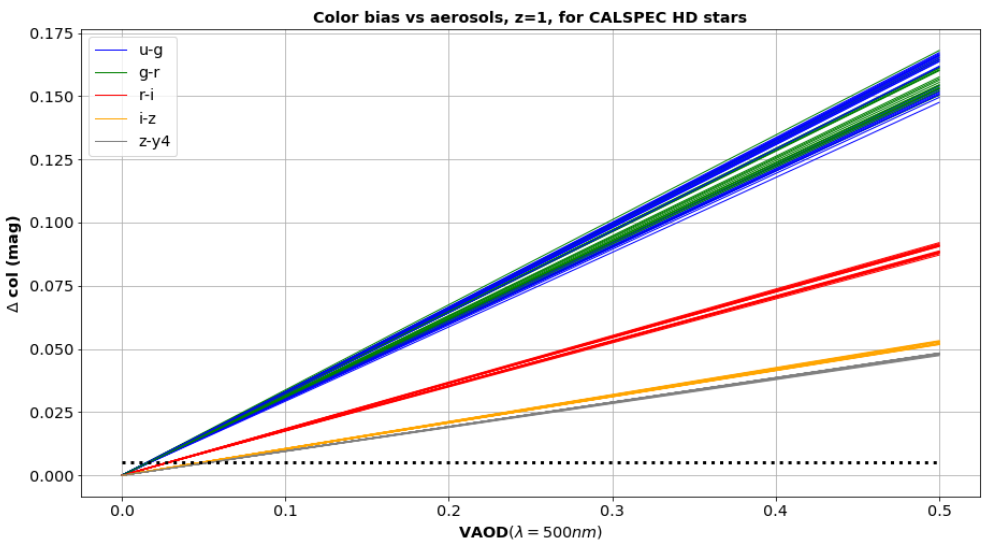
- Standarts CALSPEC
- Etoiles OBAFGK (modèle ck04)
- (Modèle corps noir)
- Galaxies (modèle bc95, Bruzual-Charlot)
- Galaxies redshiftée ***z=3***

Aerosol variations (big)



Default aerosol transmission profile i LibRadTran

Aerosols CALSPEC stars



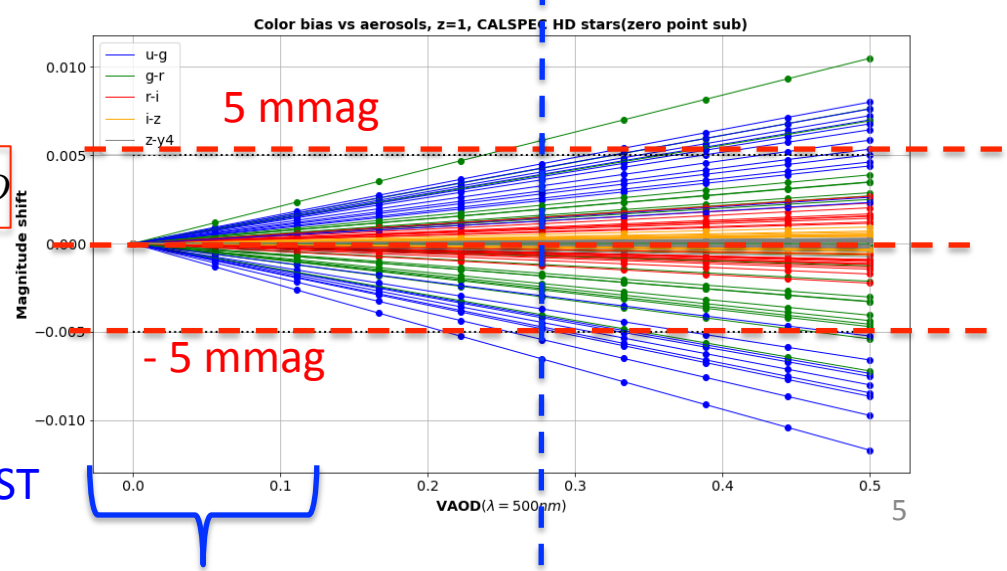
Color terms : I-J = U- G, G-R, R-I, I-Z, Z-Y4

$$\Delta(I-J) = (I-J)_{\tau} - (I-J)_{0}$$

5 mmag

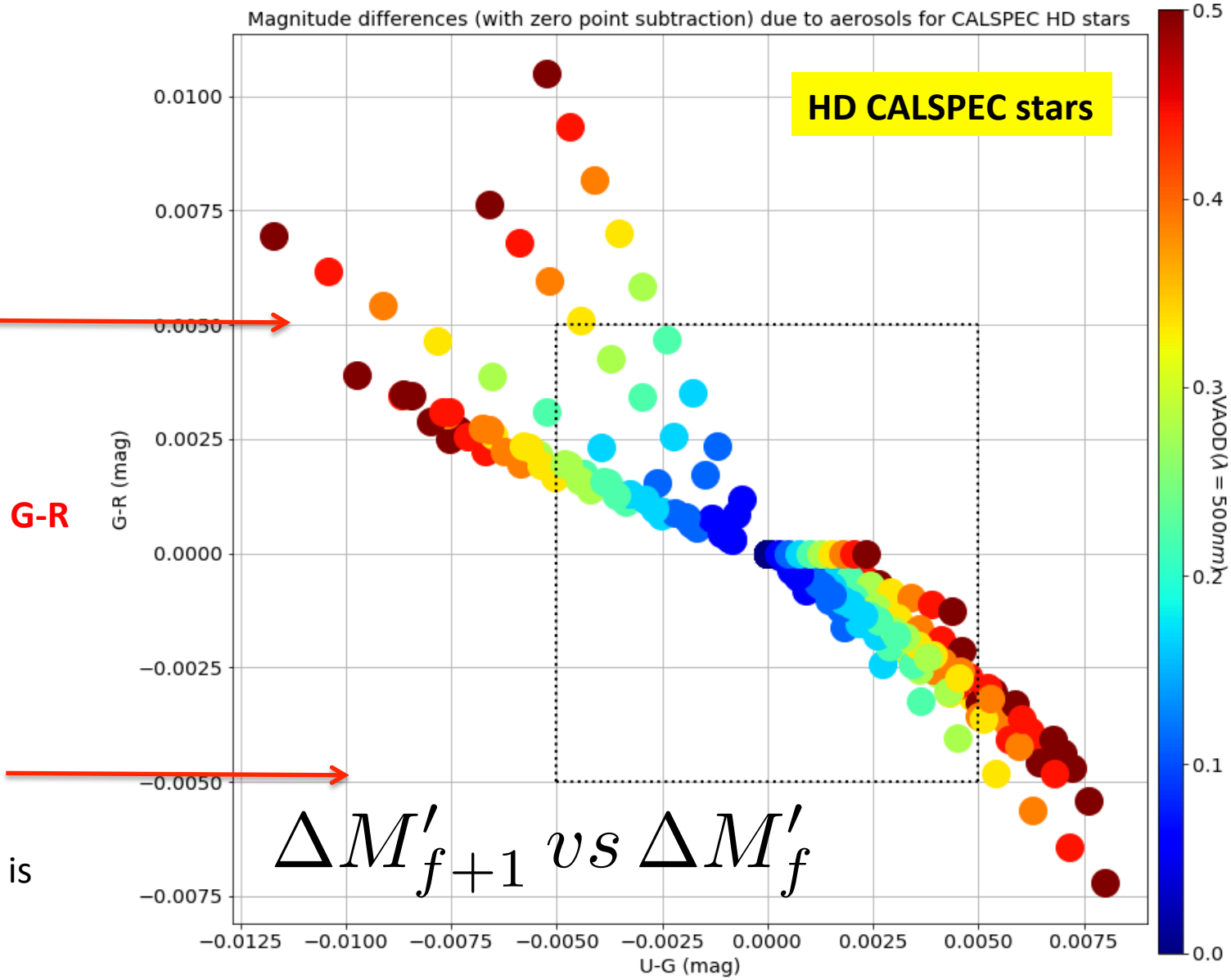
Zero point subtraction

$$\delta(I-J) = \Delta(I-J)_{SED} - <\Delta(I-J)>_{SED}$$



Range at LSST

Aerosol Variation (VAOD)



5 mmag

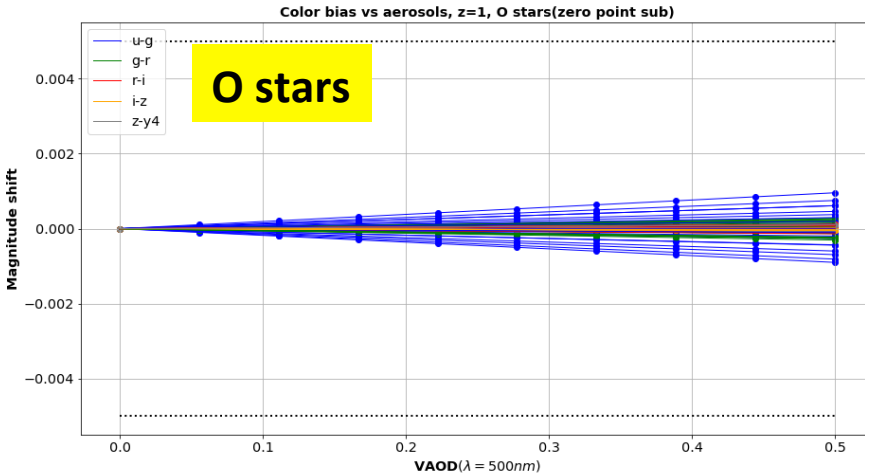
G-R

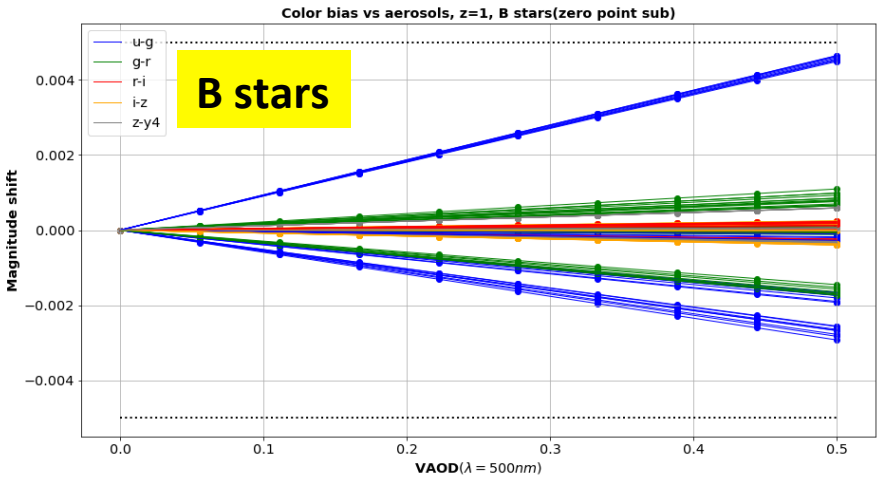
-5 mmag

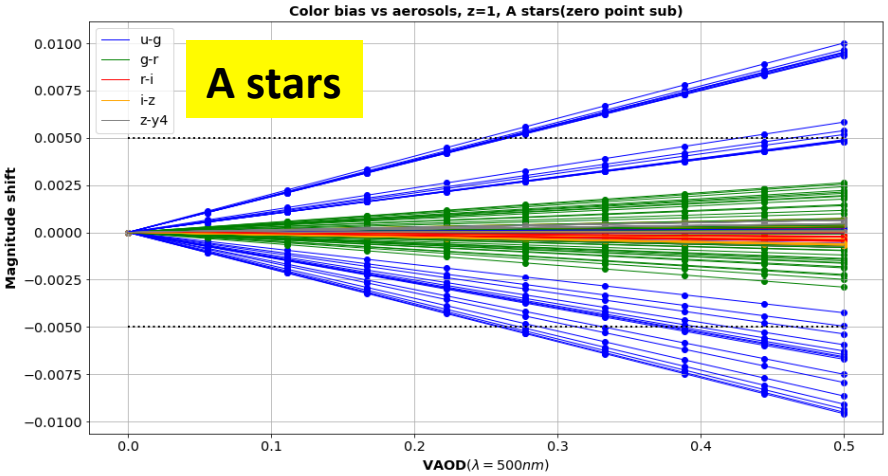
Each trajectory is one SED

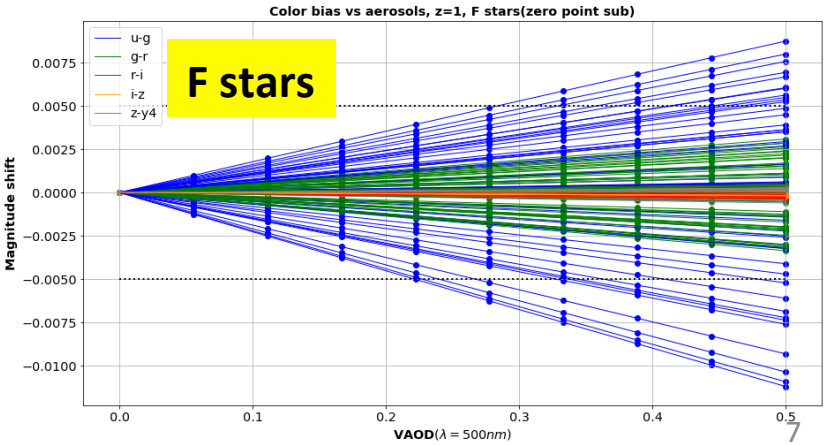
U-G

Aerosols effect **on ck04 models**



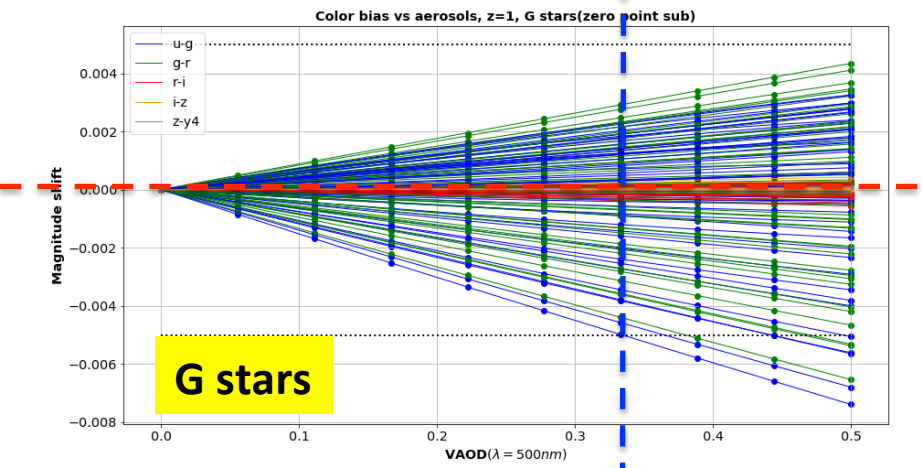


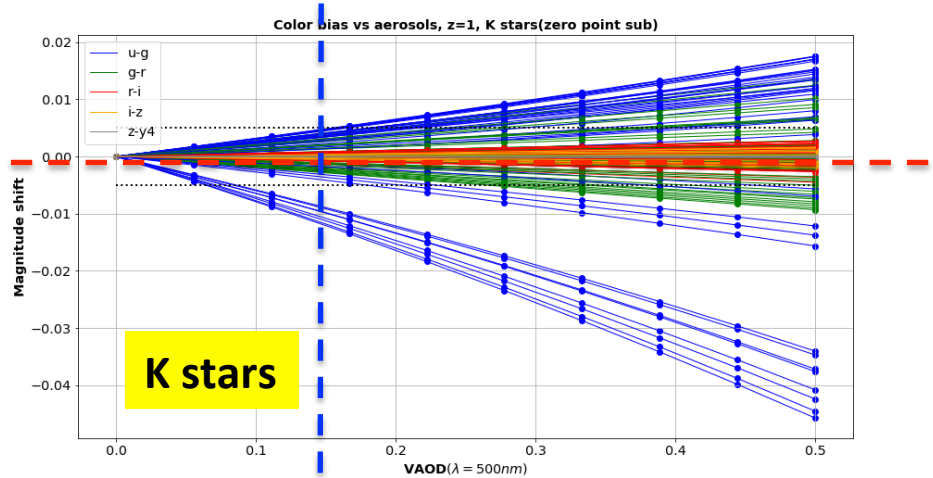




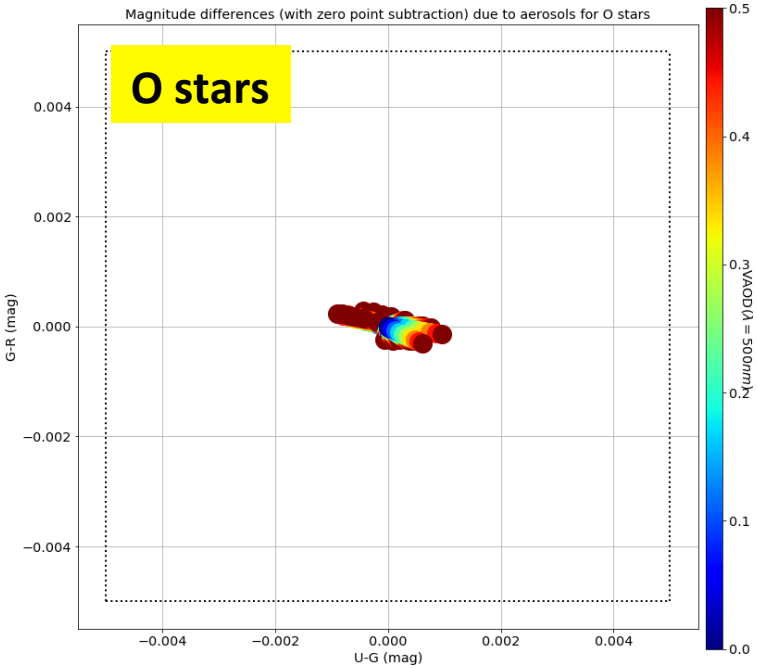
Aerosols effect on ck04 models

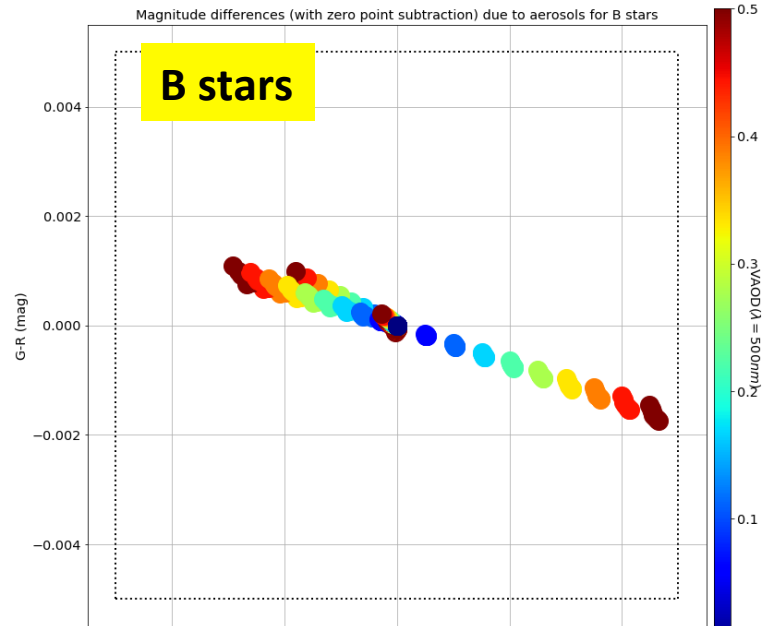
$$\Delta(I-J) = (I-J)_\tau - (I-J)_0$$

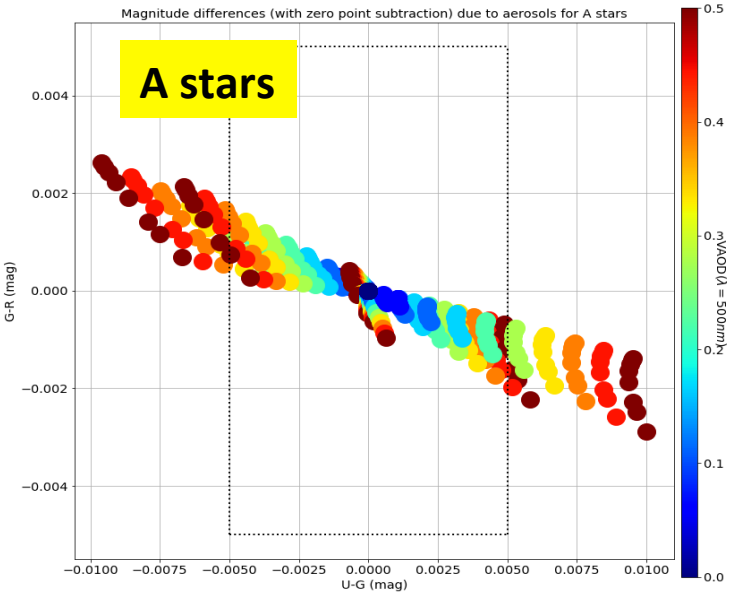


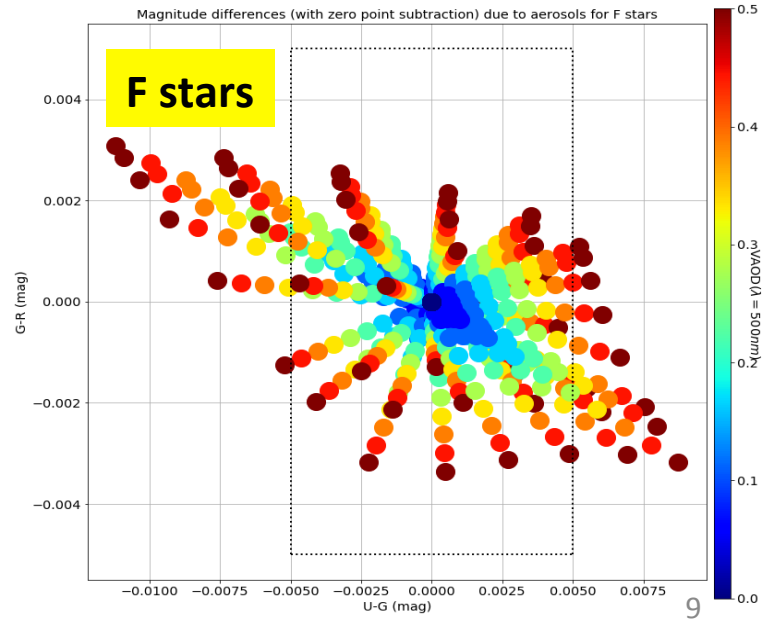


K star too sensitive to aerosols

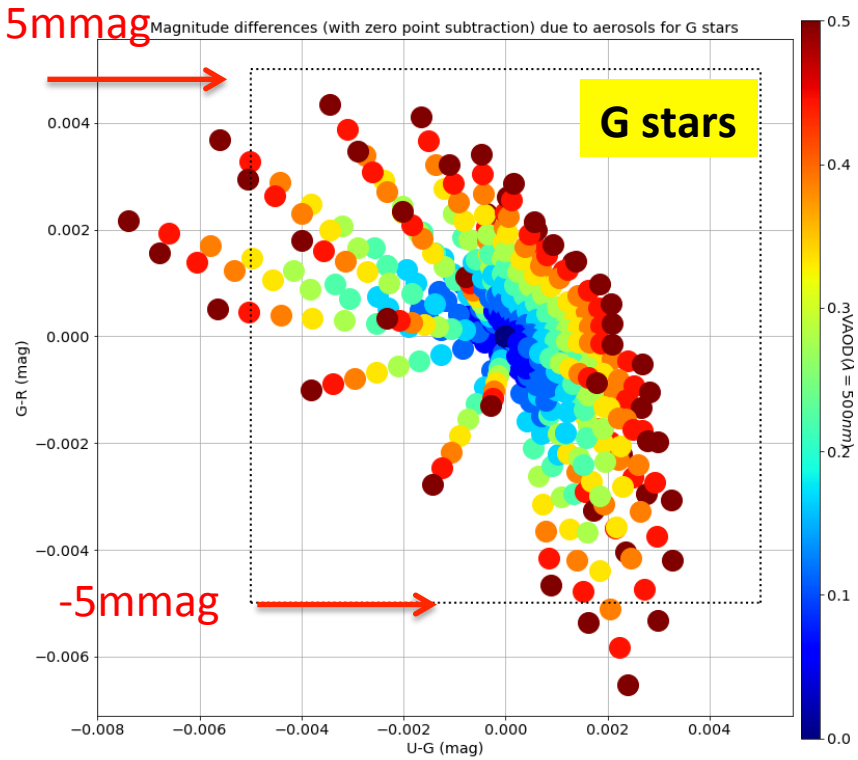

Magnitude differences (with zero point subtraction) due to aerosols for O stars
O stars
G-R (mag)
U-G (mag)
VAOD(λ = 500nm)

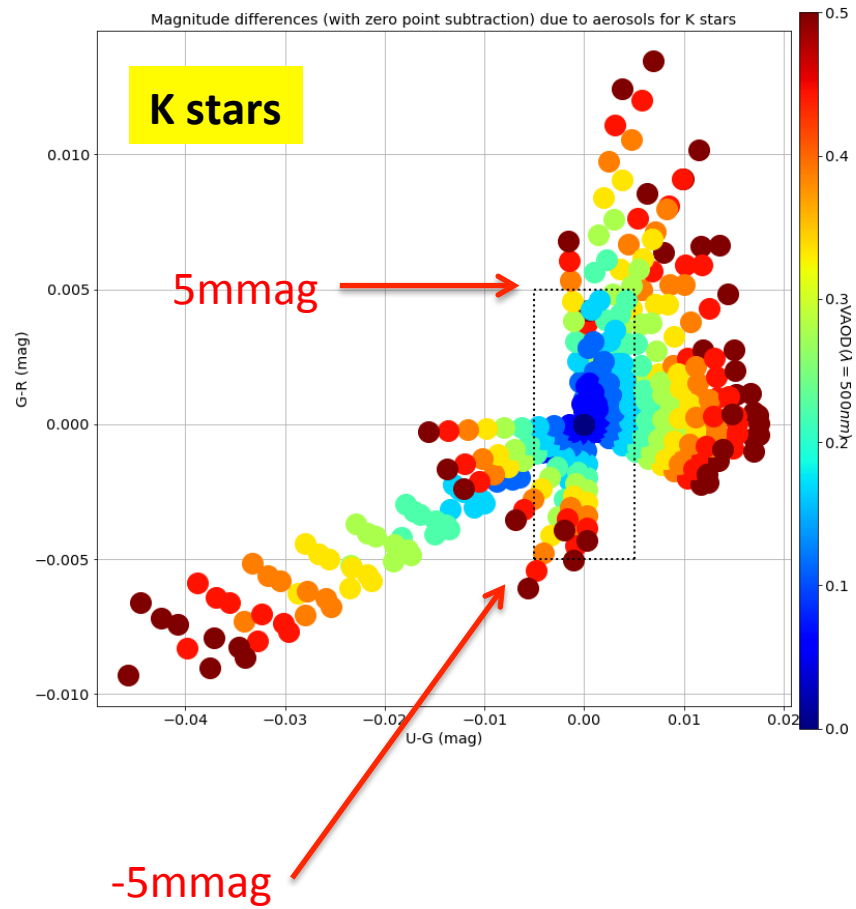

Magnitude differences (with zero point subtraction) due to aerosols for B stars
B stars
G-R (mag)
VAOD(λ = 500nm)


Magnitude differences (with zero point subtraction) due to aerosols for A stars
A stars
G-R (mag)
U-G (mag)
VAOD(λ = 500nm)

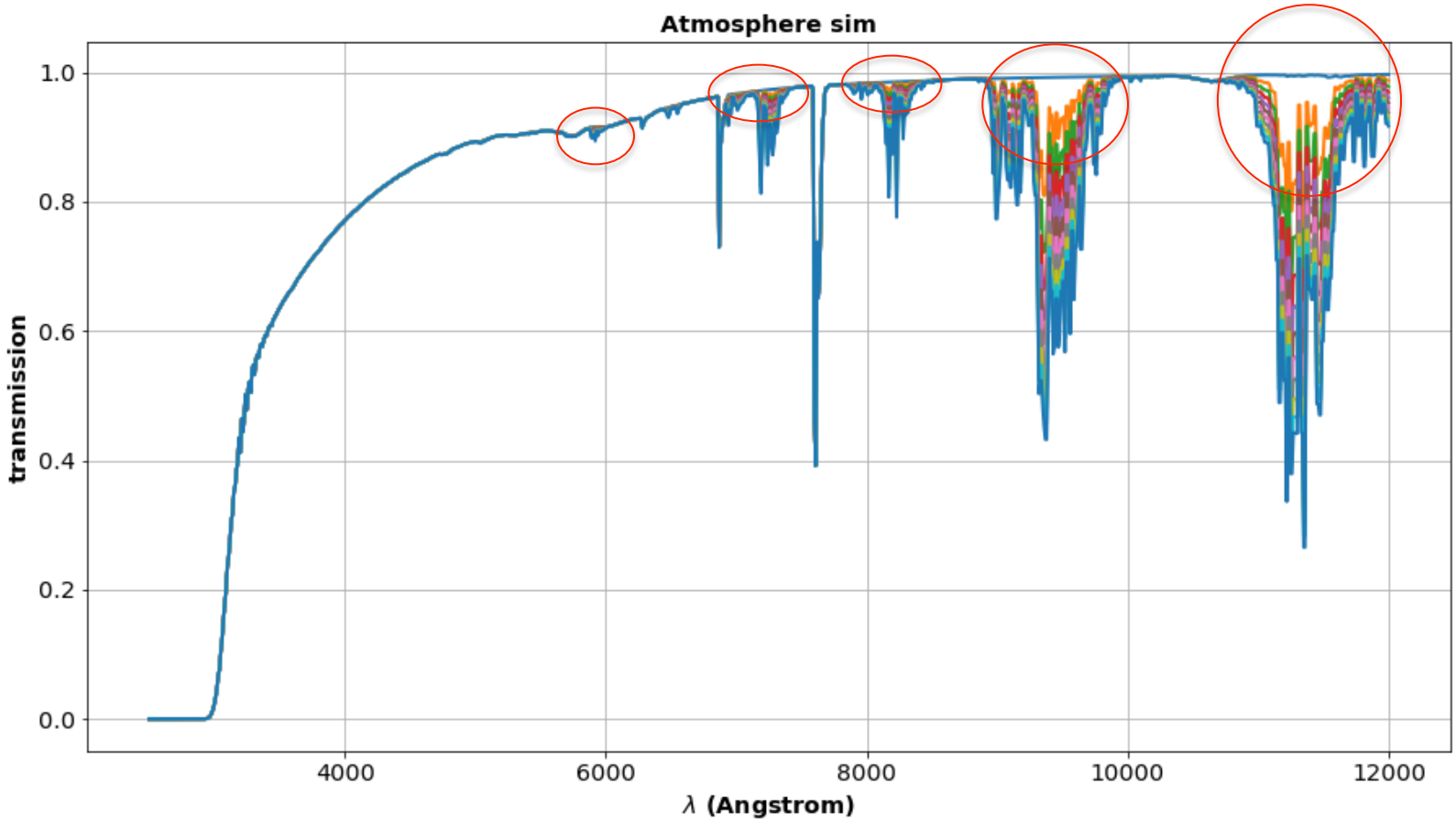

Magnitude differences (with zero point subtraction) due to aerosols for F stars
F stars
G-R (mag)
U-G (mag)
VAOD(λ = 500nm)

G-R vs U-G


5mmag
Magnitude differences (with zero point subtraction) due to aerosols for G stars
G stars
-5mmag
G-R (mag)
U-G (mag)
VAOD(λ = 500nm)


Magnitude differences (with zero point subtraction) due to aerosols for K stars
K stars
5mmag
-5mmag
G-R (mag)
U-G (mag)
VAOD(λ = 500nm)

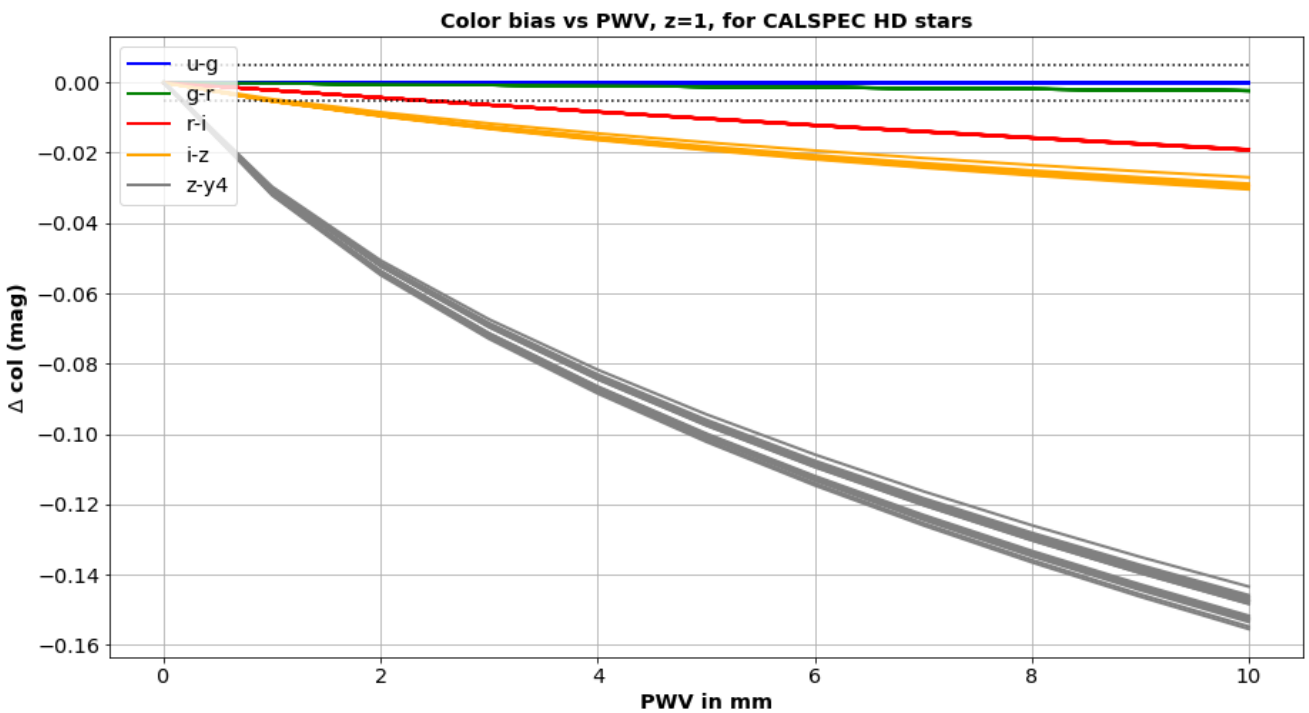
PWV variation



PWV - CALSPEC

Color terms : I-J = U- G, G-R, R-I, I-Z, Z-Y4

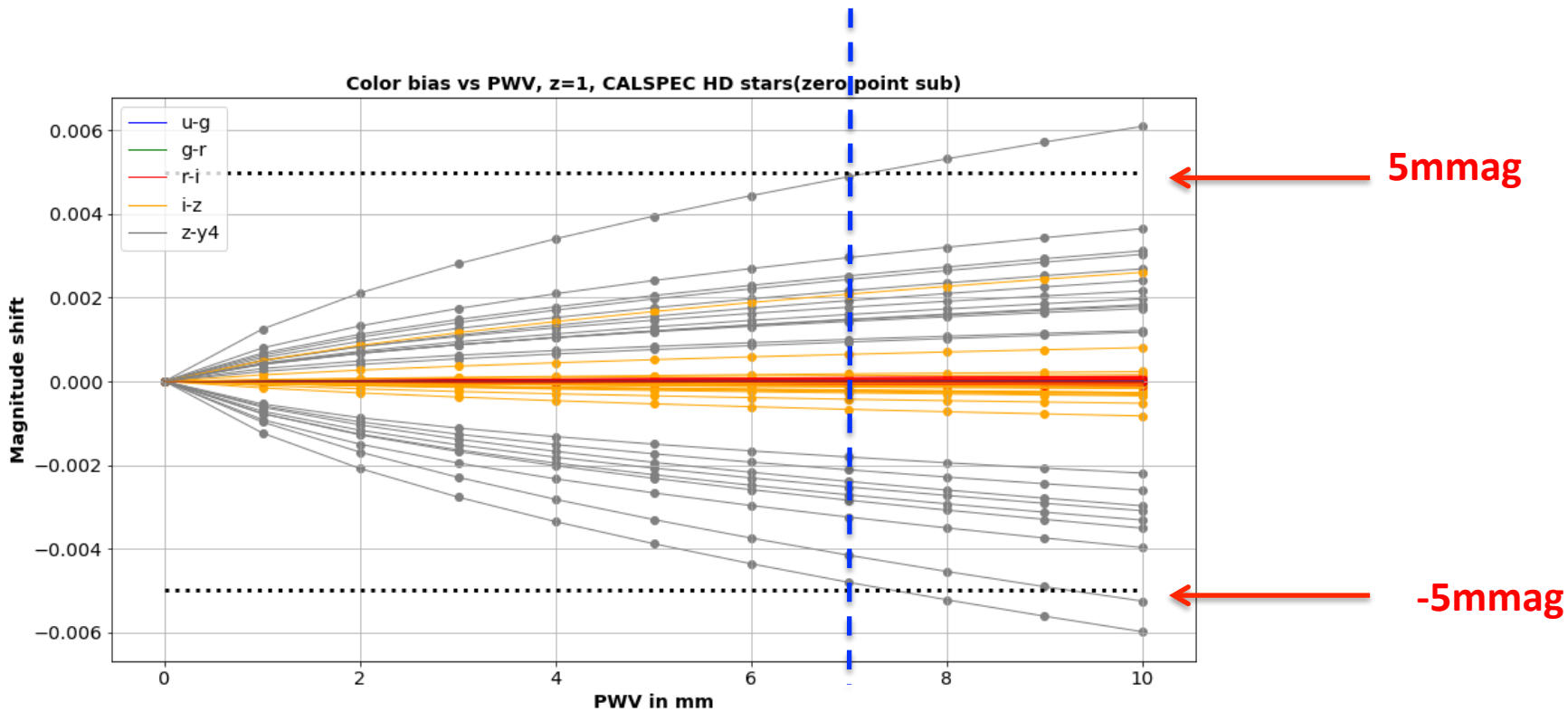
$$\Delta(I-J) = (I-J)_{H2O} - (I-J)_0$$



PWV – CALSPEC – Zero point subtraction

Zero point substraction

$$\delta(I-J) = \Delta(I-J)_{SED} - < \Delta(I-J) >_{SED}$$

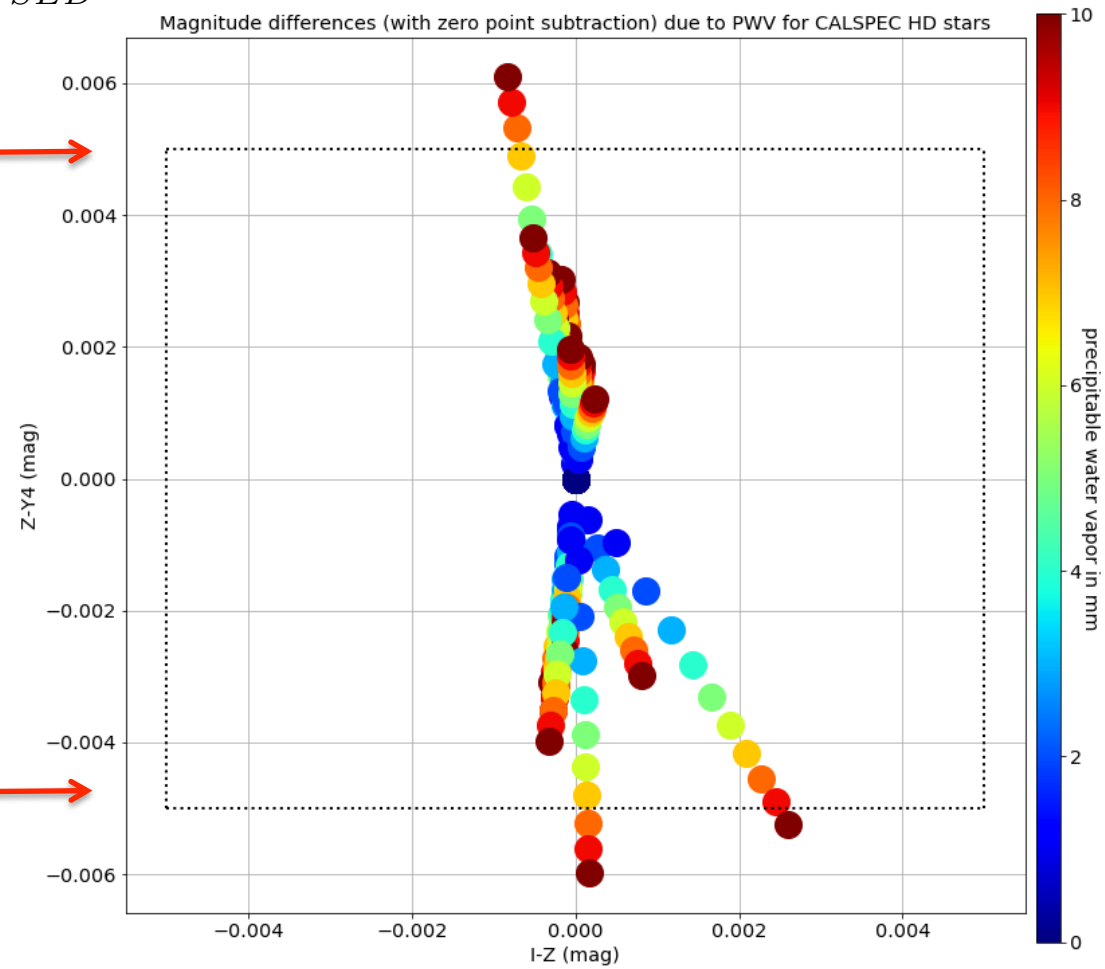


PWV Variation –CALSPEC – after zero point subtraction

$$\delta(I-J) = \Delta(I-J)_{SED} - <\Delta(I-J)>_{SED}$$

PWV

5mmag

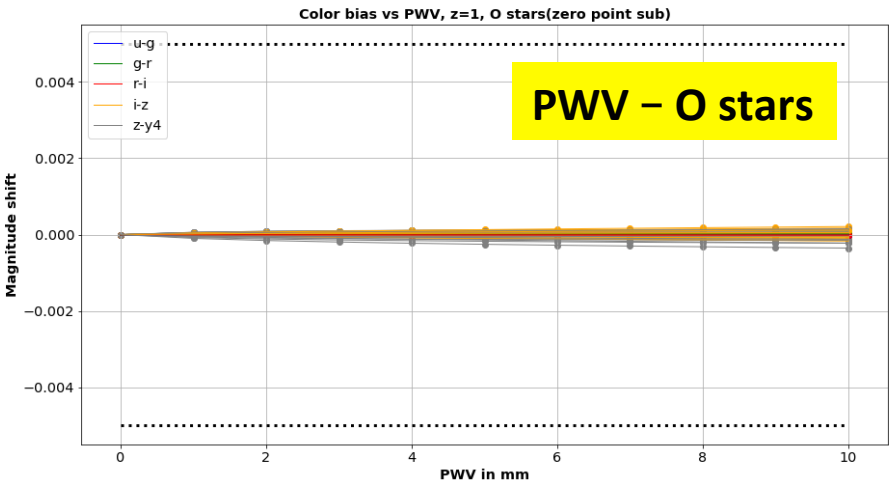


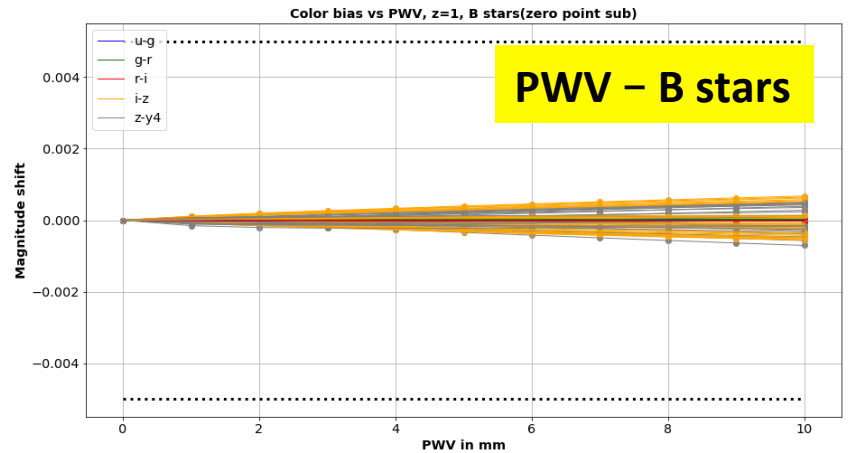
Z-Y4 vs I-Z

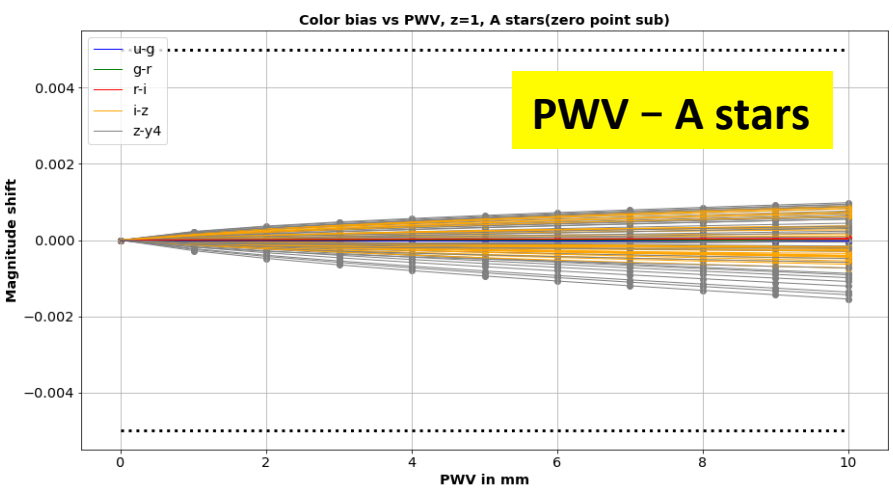
Each trajectory is one SED

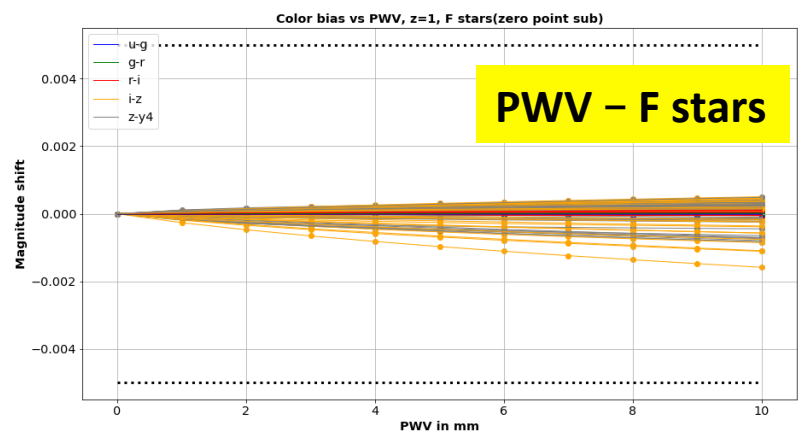
-5mmag

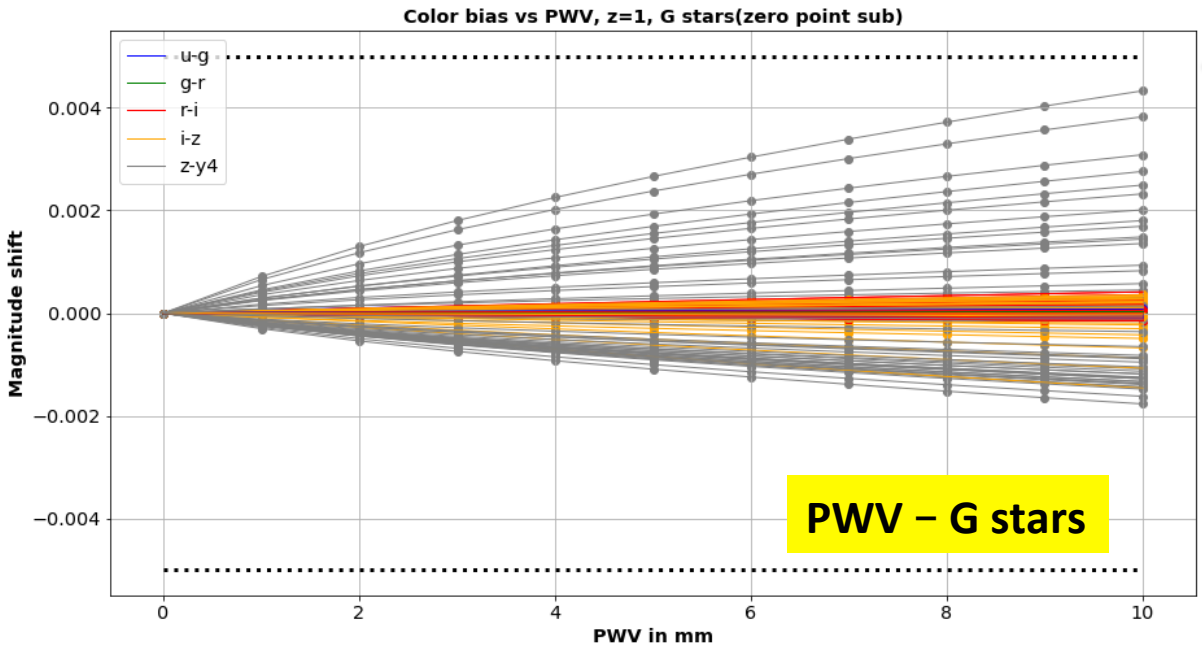
PWV effect on ck04 models











5mmag

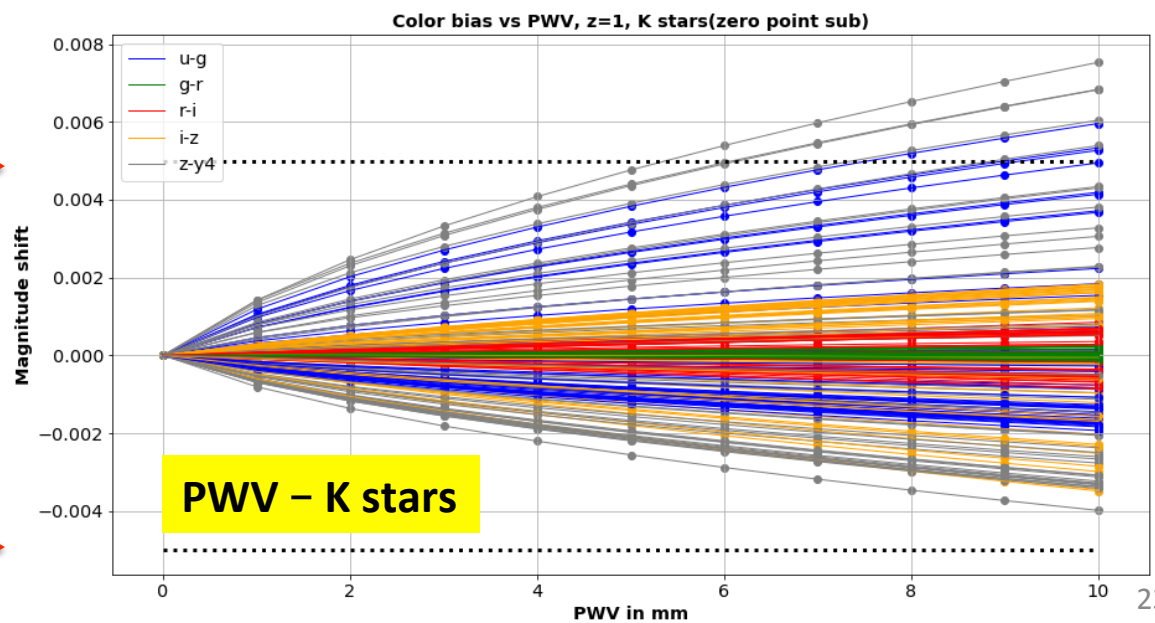
- 5mmag

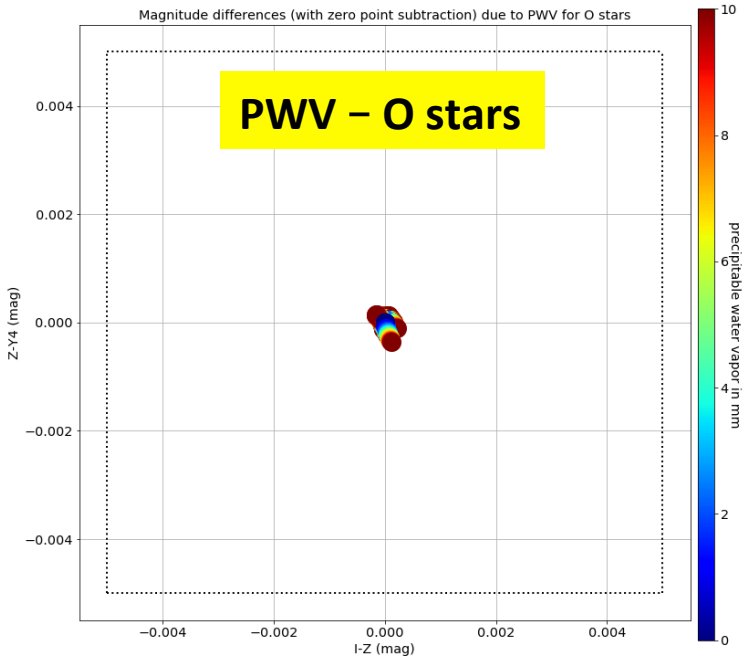
$$\Delta(I-J) = (I-J)_{H2O} - (I-J)_0$$

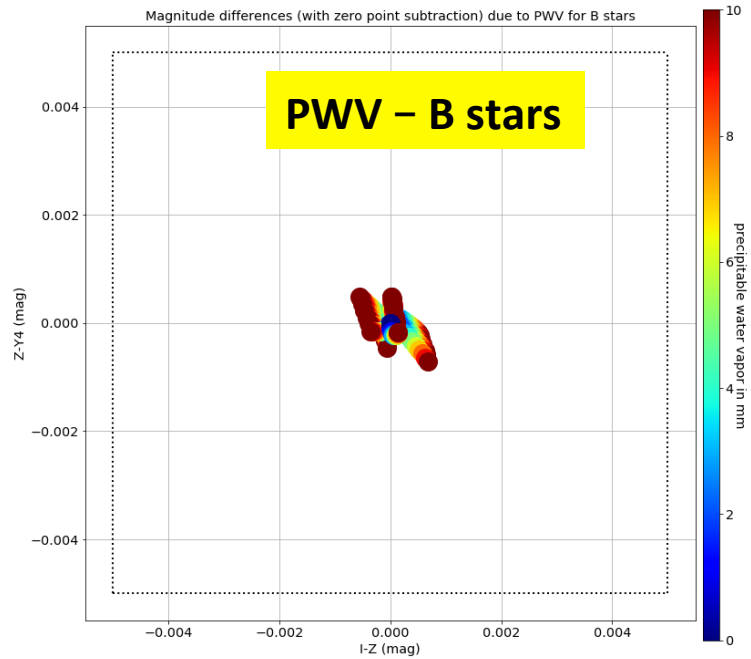
$$\Delta(I-J) = (I-J)_{H2O} - (I-J)_0$$

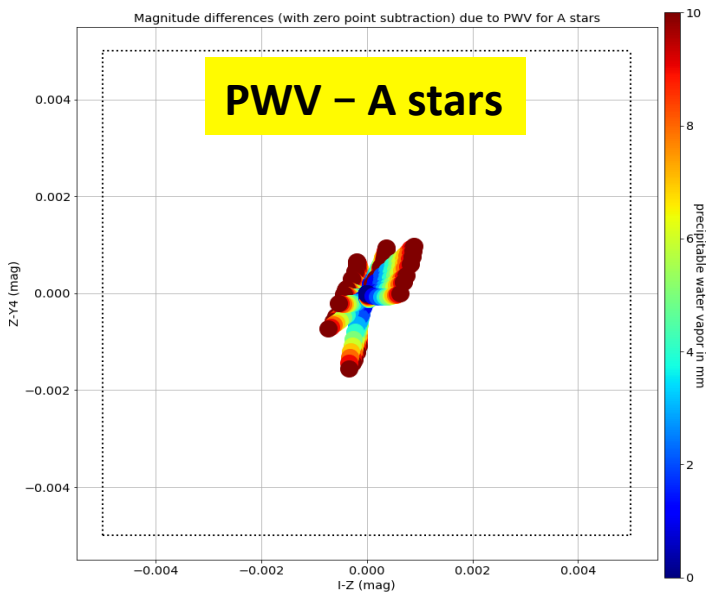
5mmag

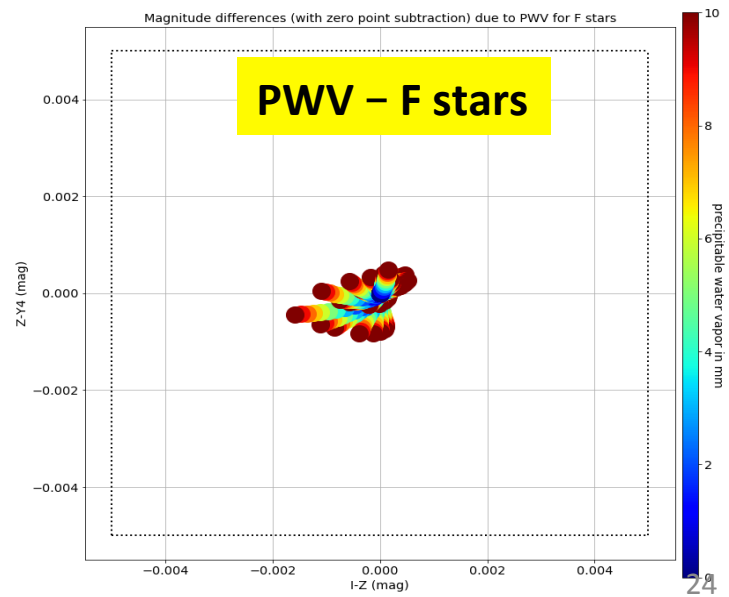
-5mmag




Magnitude differences (with zero point subtraction) due to PWV for O stars
PWV – O stars
Z-Y4 (mag)
I-Z (mag)
precipitable water vapor in mm

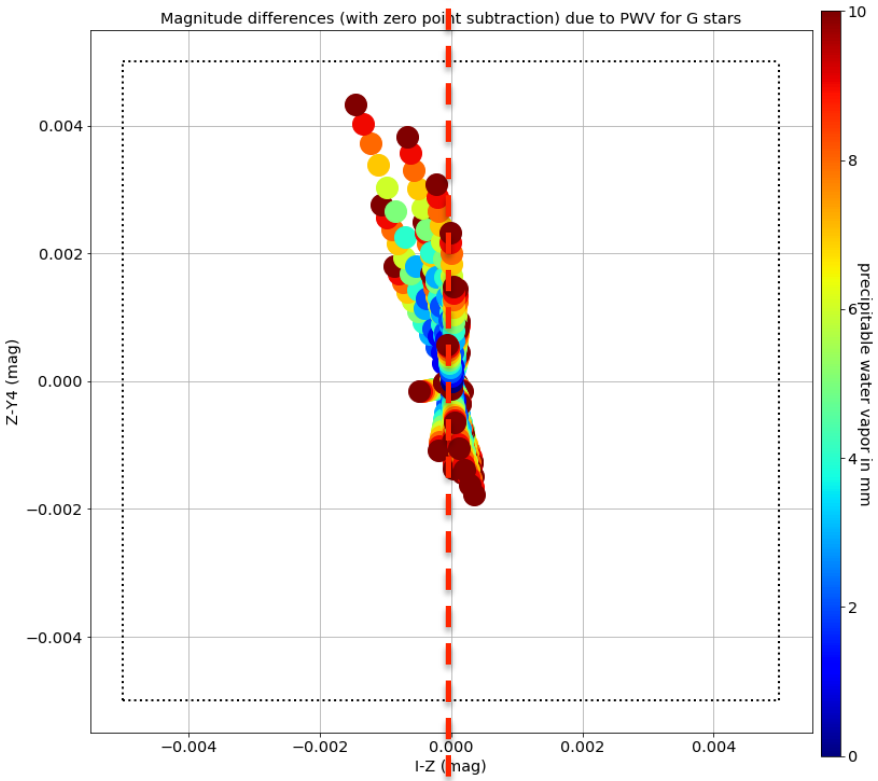

Magnitude differences (with zero point subtraction) due to PWV for B stars
PWV – B stars
Z-Y4 (mag)
I-Z (mag)
precipitable water vapor in mm


Magnitude differences (with zero point subtraction) due to PWV for A stars
PWV – A stars
Z-Y4 (mag)
I-Z (mag)
precipitable water vapor in mm

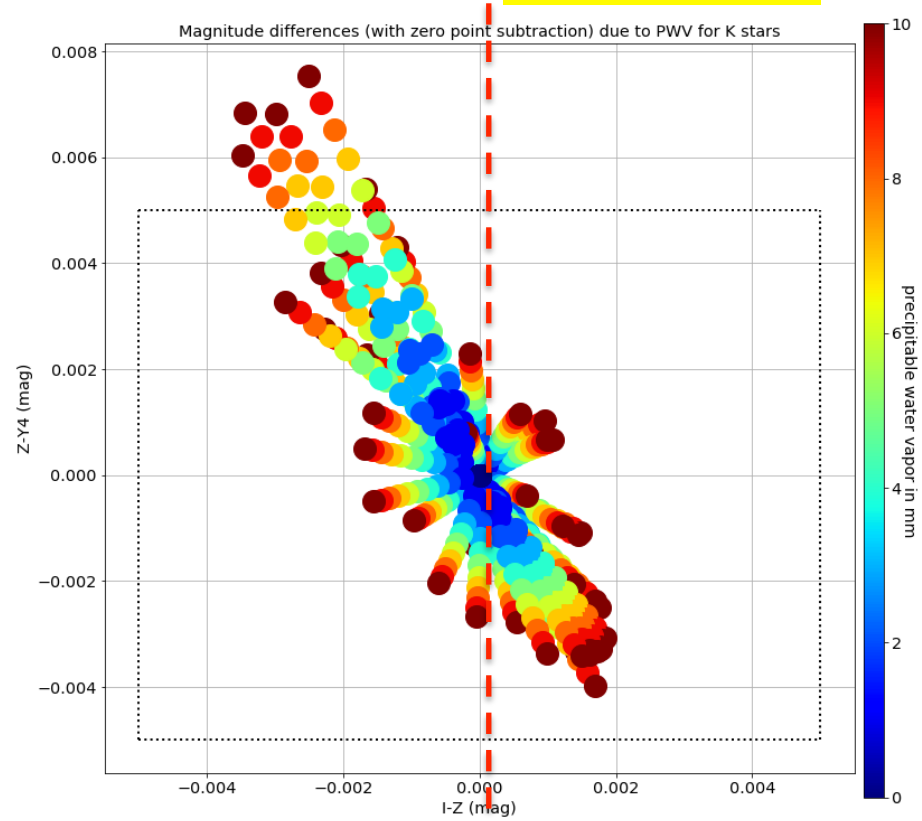

Magnitude differences (with zero point subtraction) due to PWV for F stars
PWV – F stars
Z-Y4 (mag)
I-Z (mag)
precipitable water vapor in mm

Z-Y4 vs I-Z

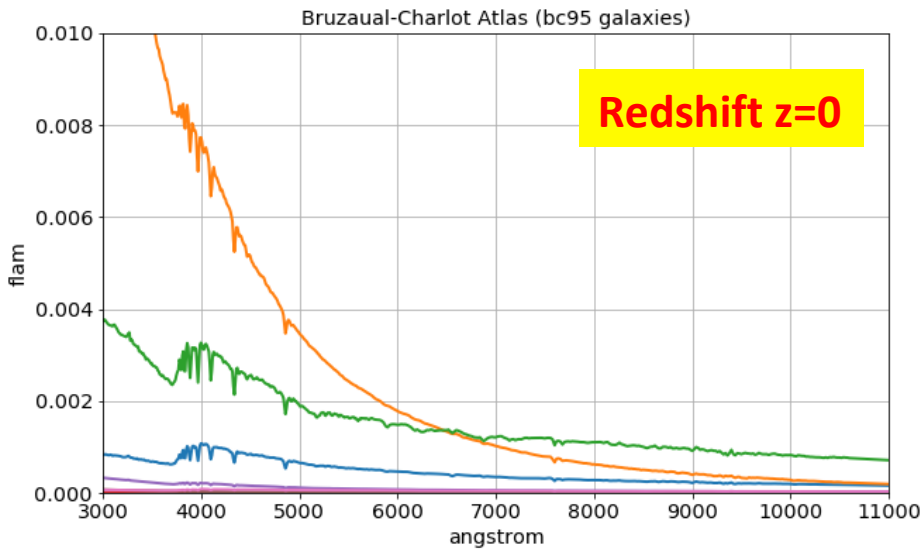
PWV – G stars

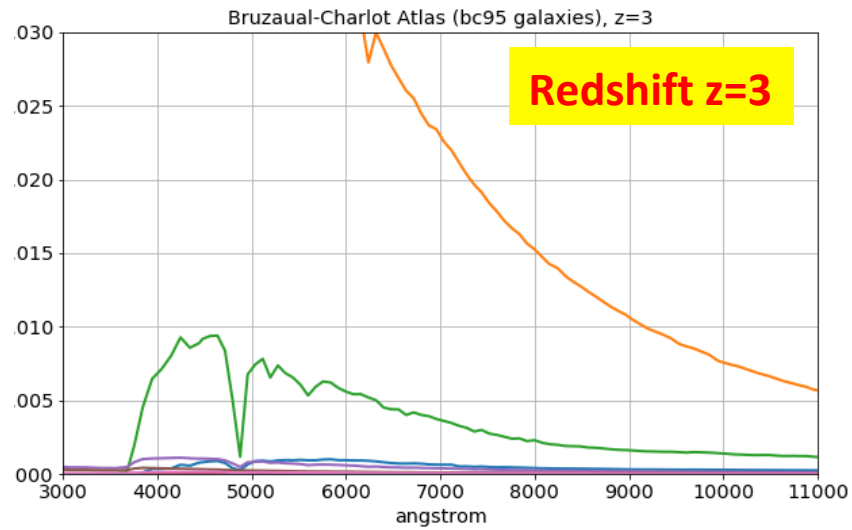


PWV – K stars



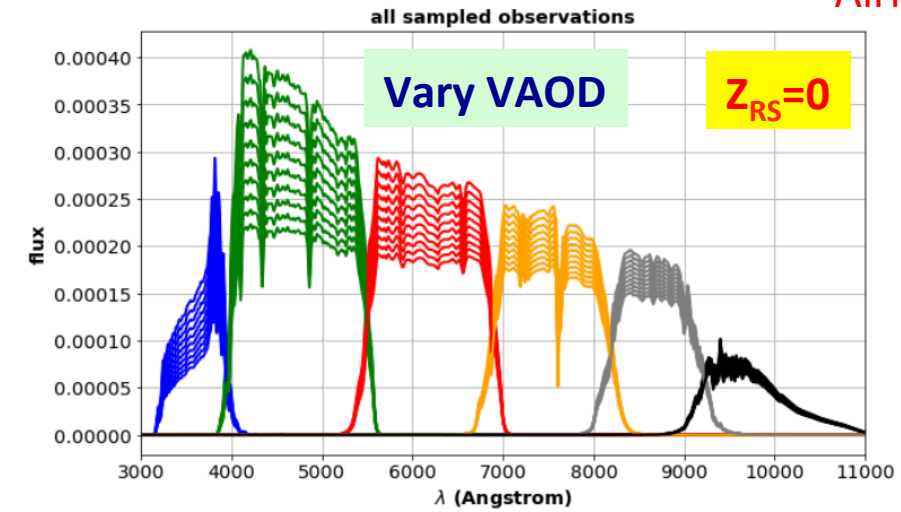
Galaxies BC95

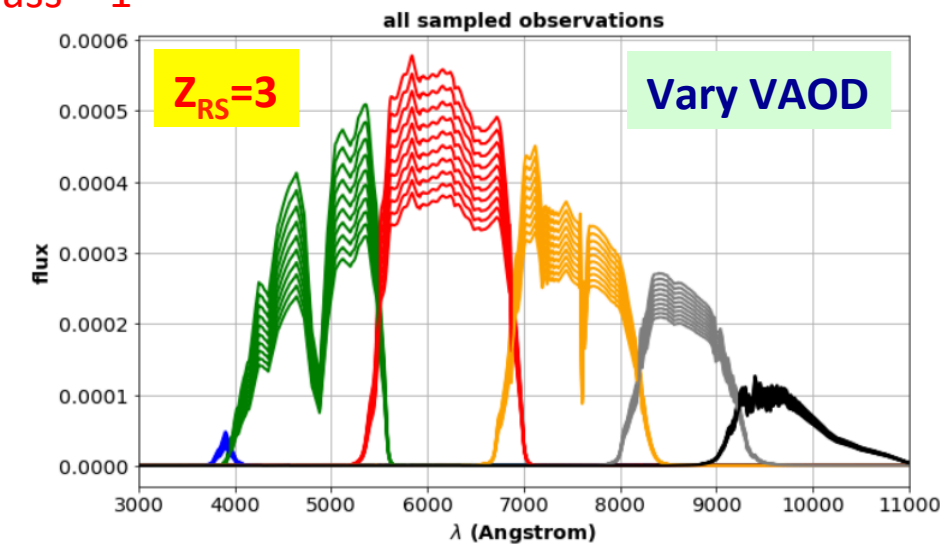


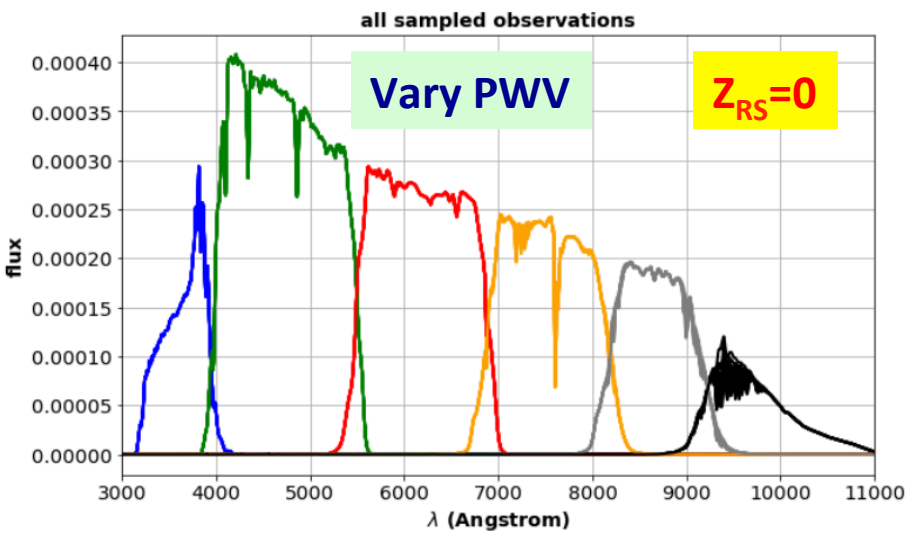


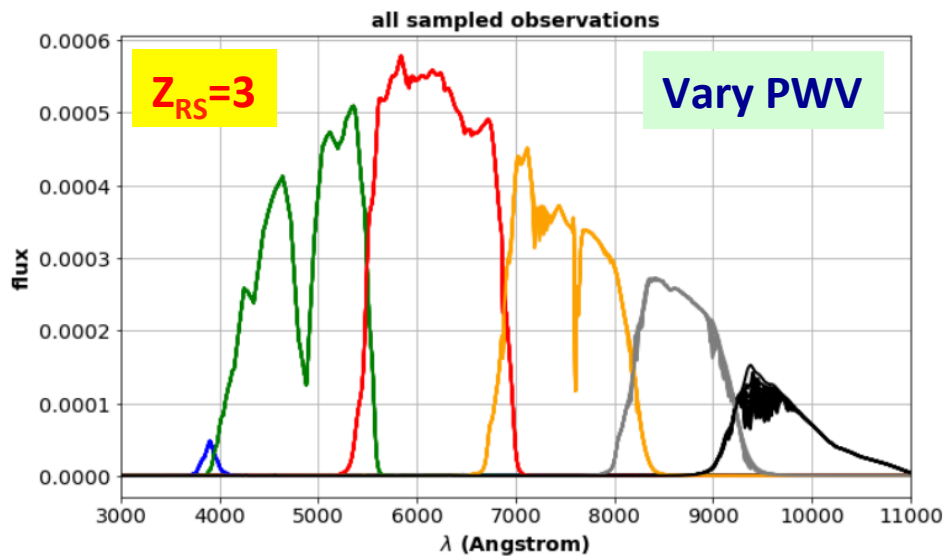
Observation of a BC95 galaxy in LSST

Airmass = 1







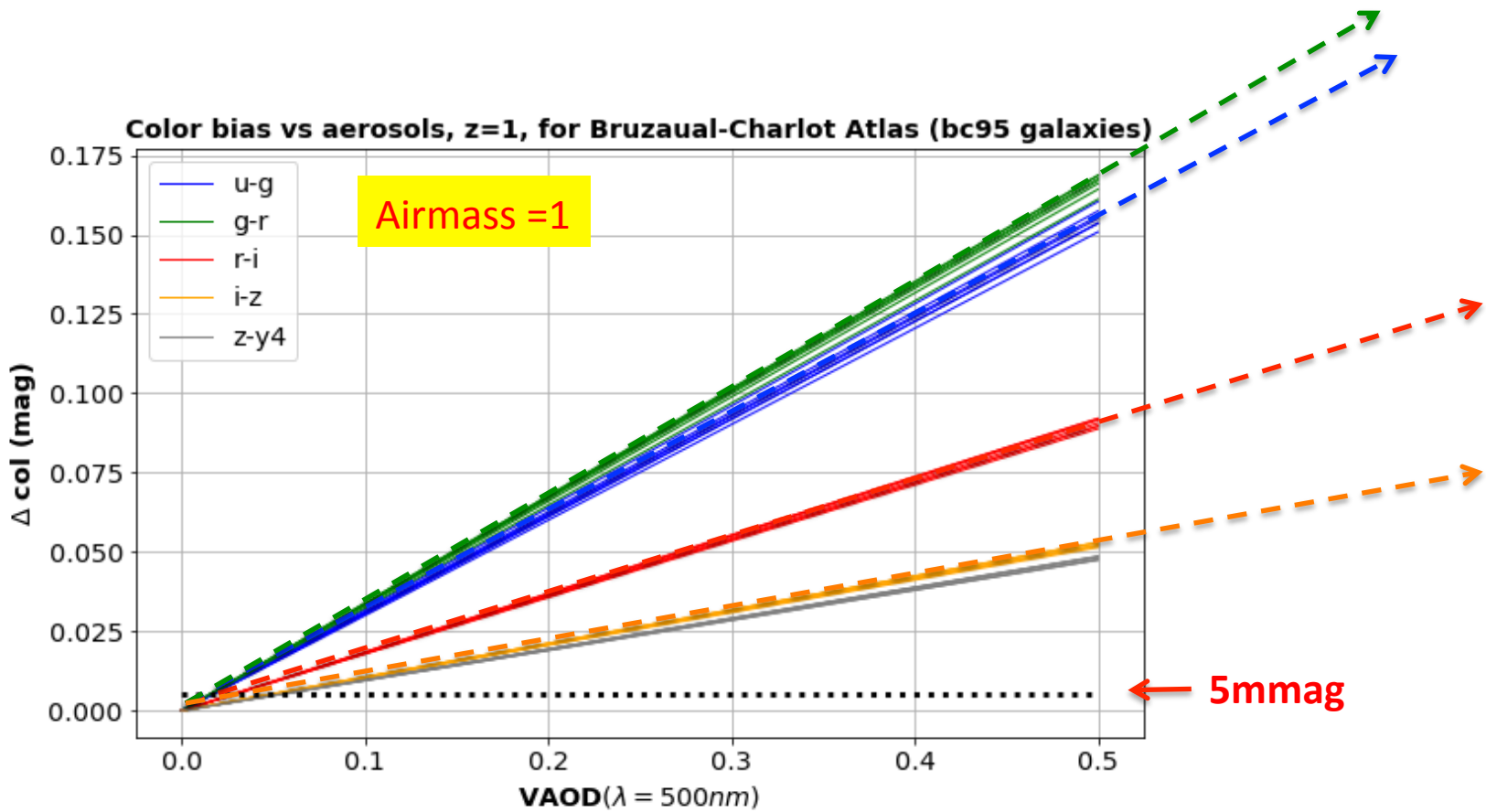


Magnitude bias wrt VAOD
« calibration bias correction curves »

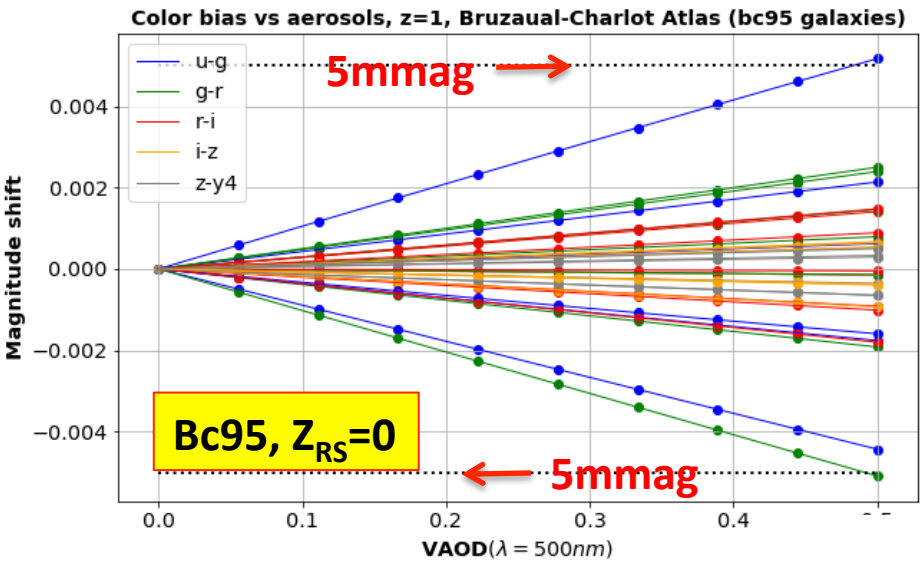
$$\Delta(I-J) = (I-J)_\tau - (I-J)_0$$

U-G
G-R
R-I

I-Z
Z-Y4



Zero point substraction at each VAOD



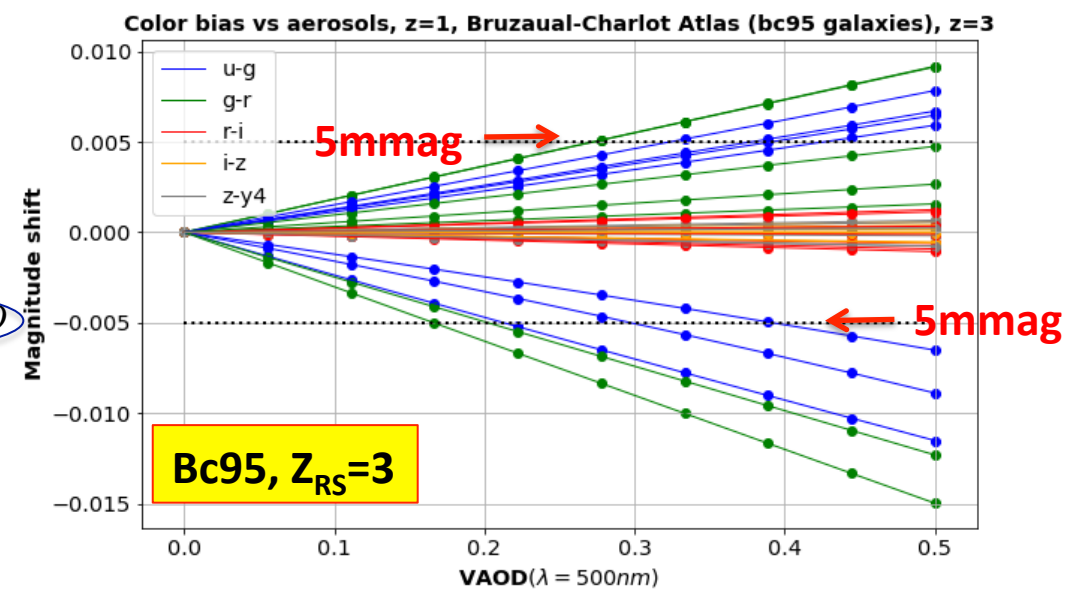
Airmass =1

U-G
G-R
R-I

I-Z
Z-Y4

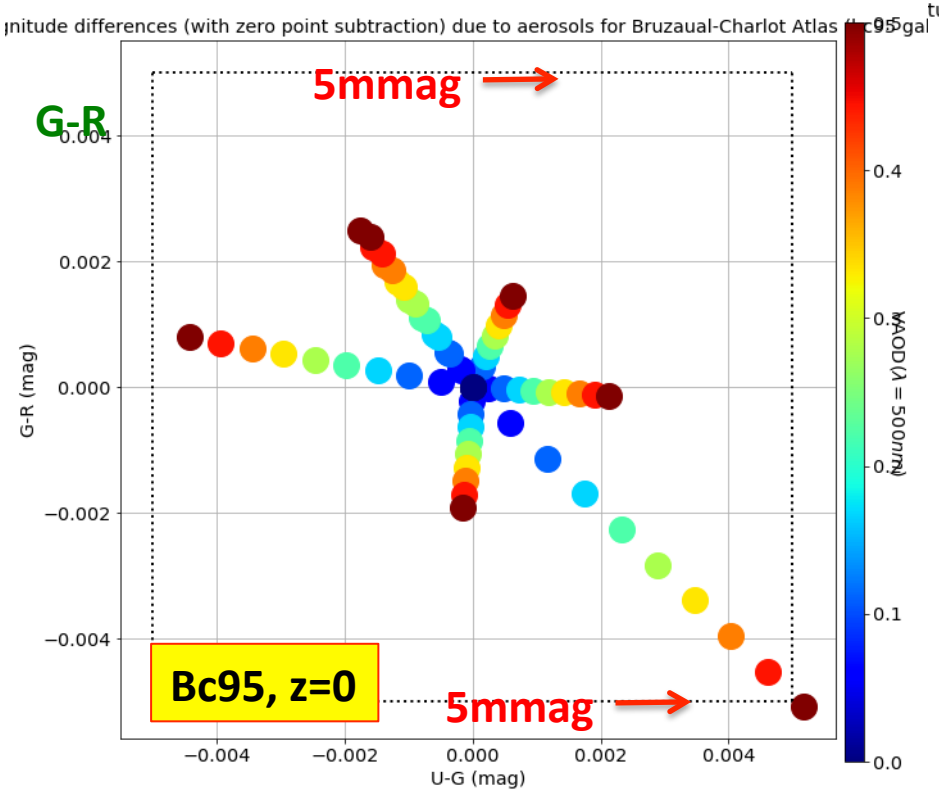
$$\delta(I-J) = \Delta(I-J)_{SED} - <\Delta(I-J)>_{SED}$$

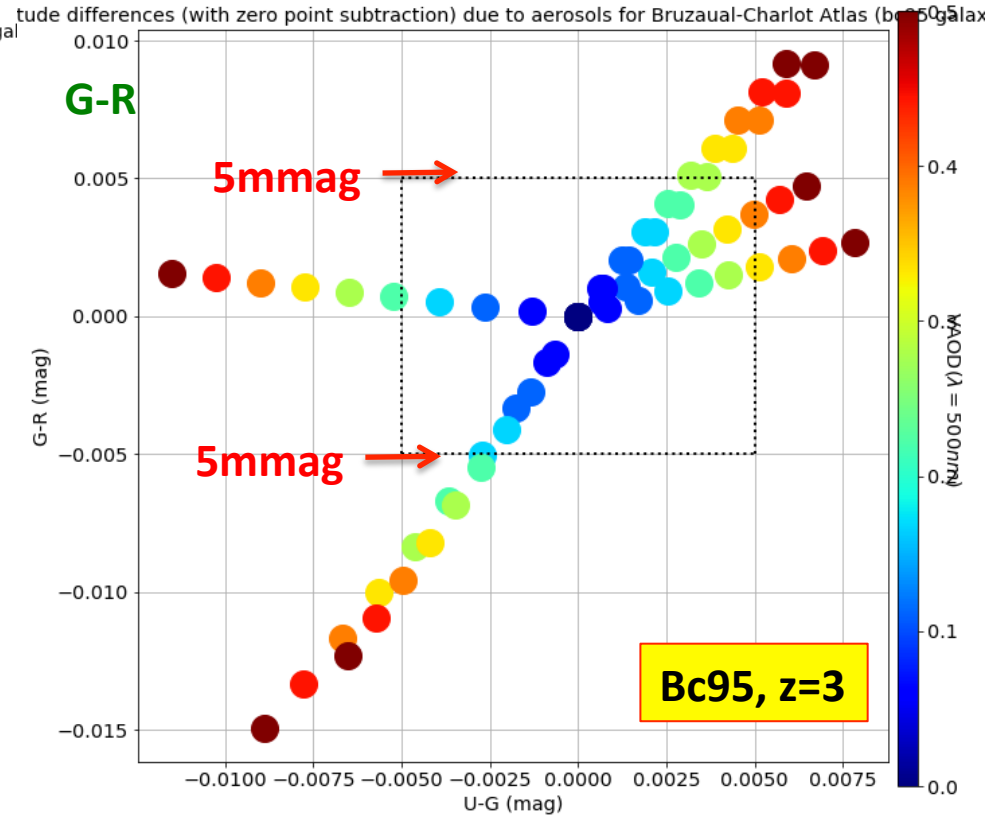
Zero Point Subtraction



Aerosols, colors (with zero point subtraction) comparison

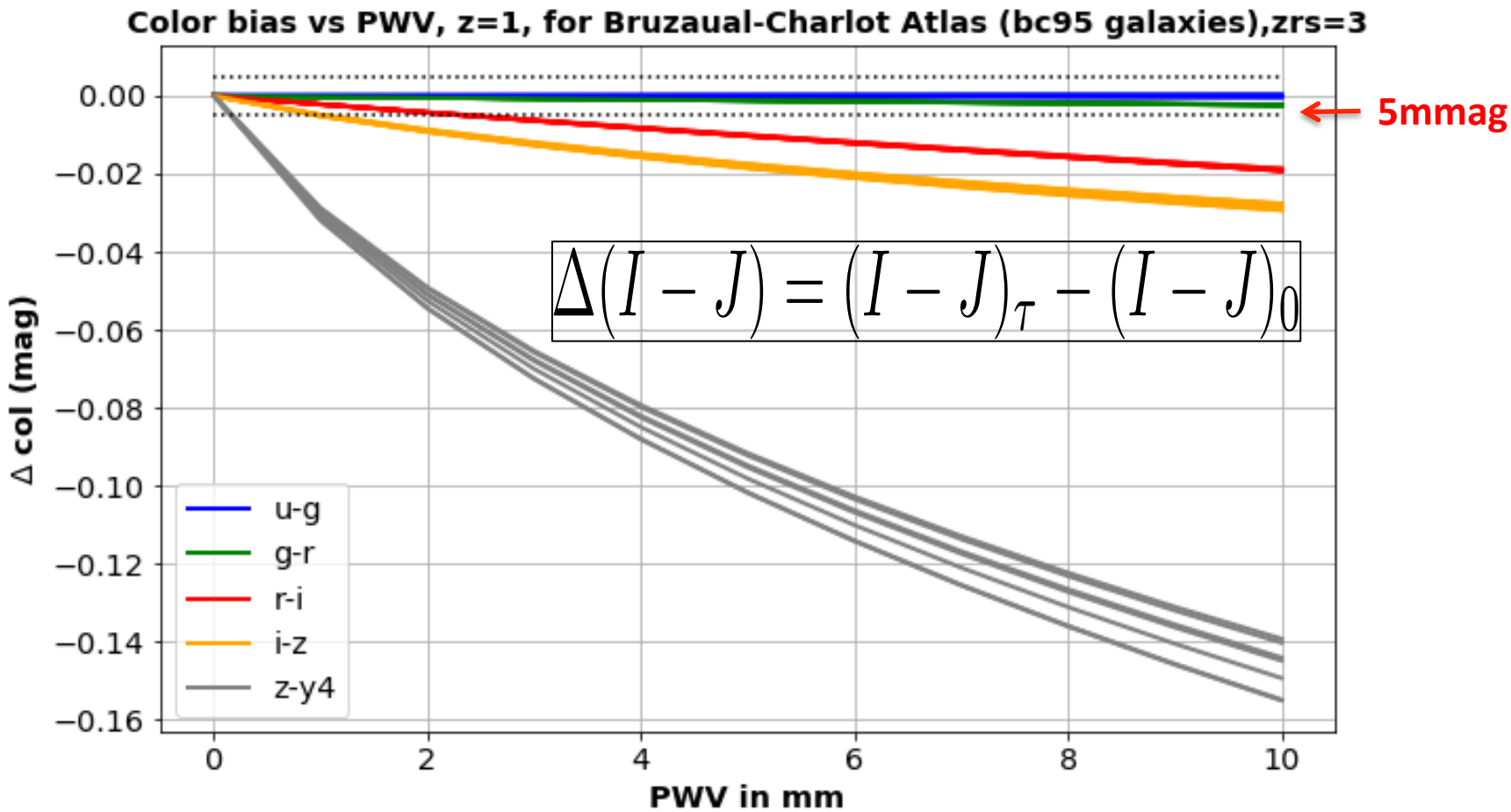
Airmass =1





Magnitude bias wrt PWV «calibration bias correction curves»

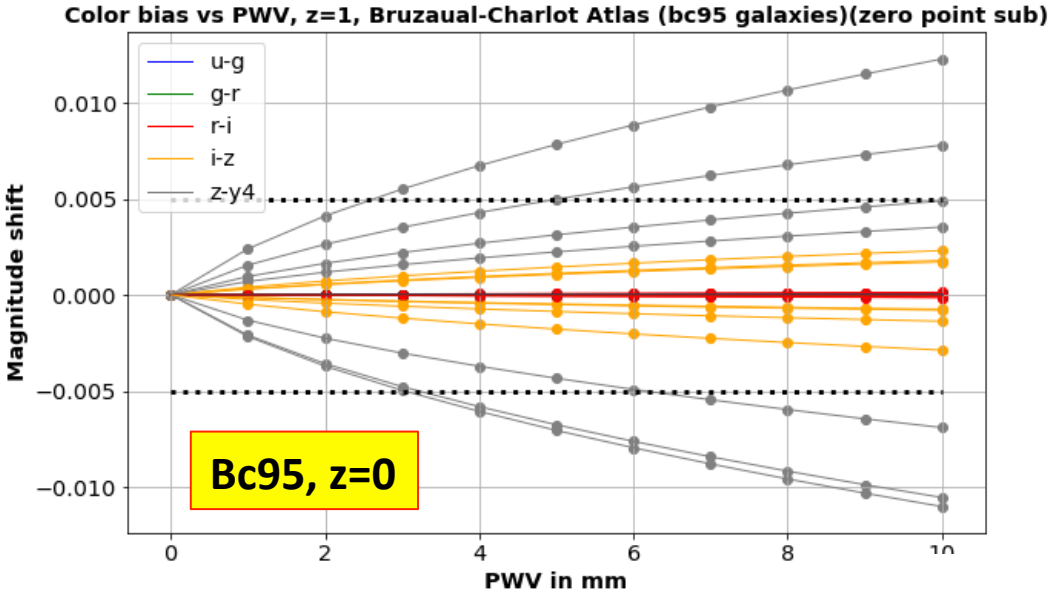
Airmass =1



$$\Delta(I-J) = (I-J)_\tau - (I-J)_0$$

Zero point substraction at each PWV

Airmass =1

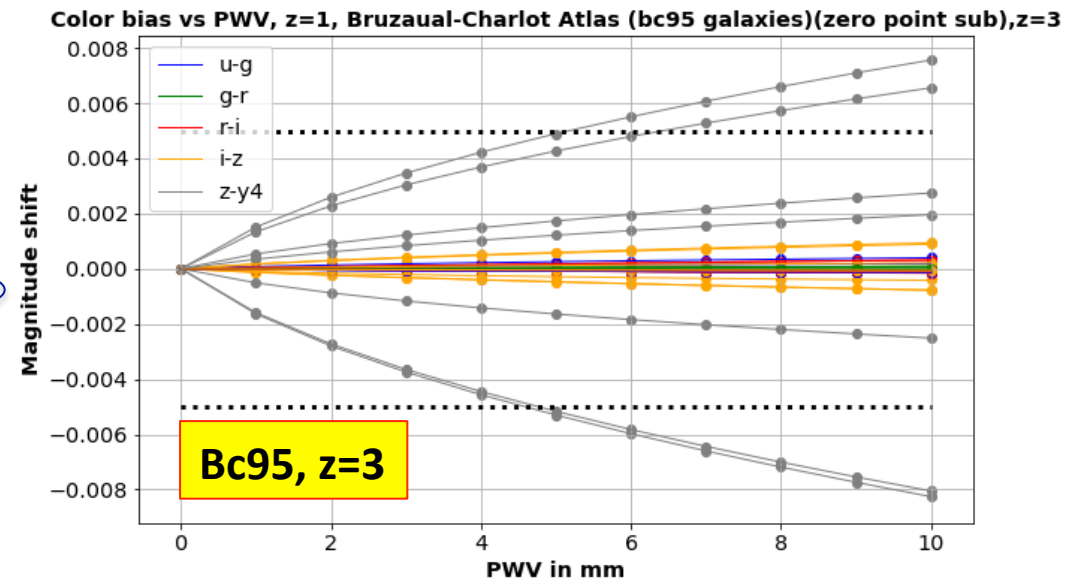


U-G
G-R
R-I

I-Z
Z-Y4

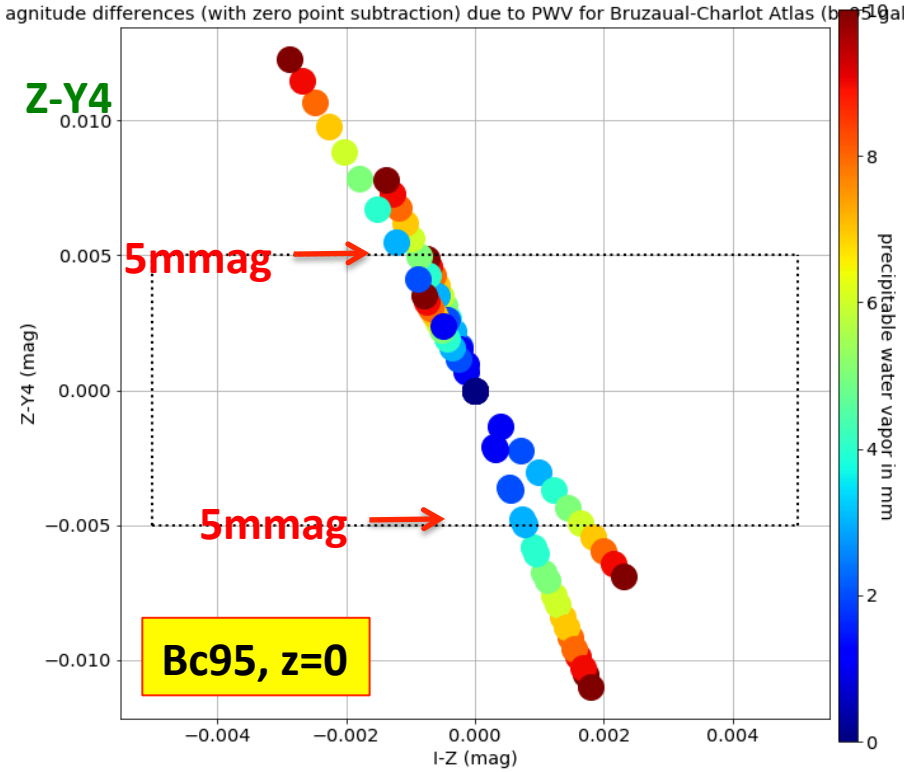
$$\delta(I-J) = \Delta(I-J)_{SED} - <\Delta(I-J)>_{SED}$$

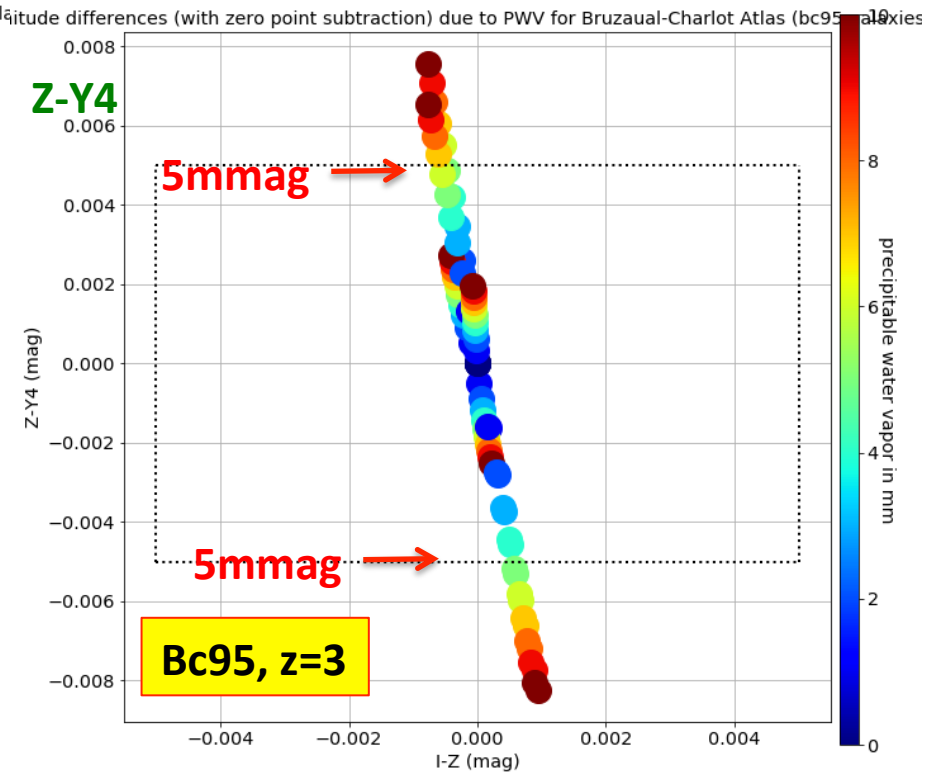
Zero Point Subtraction



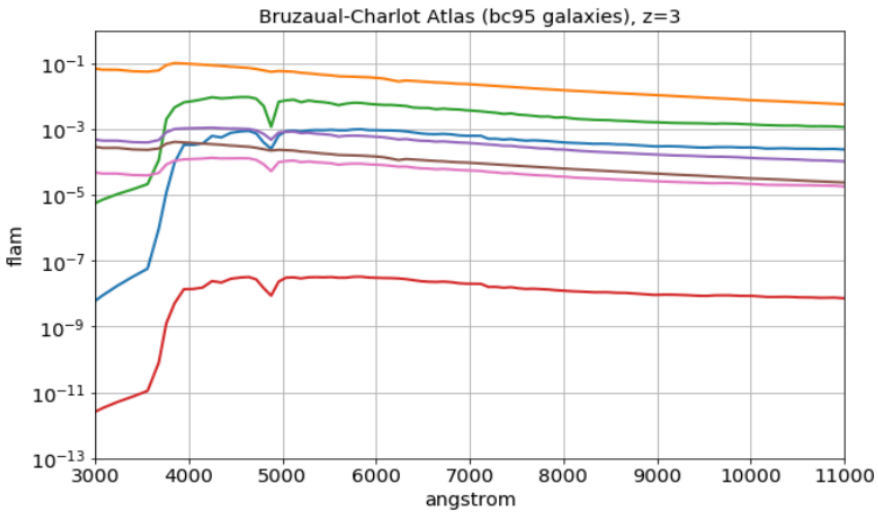
PWV, colors (with zero point subtraction) comparison

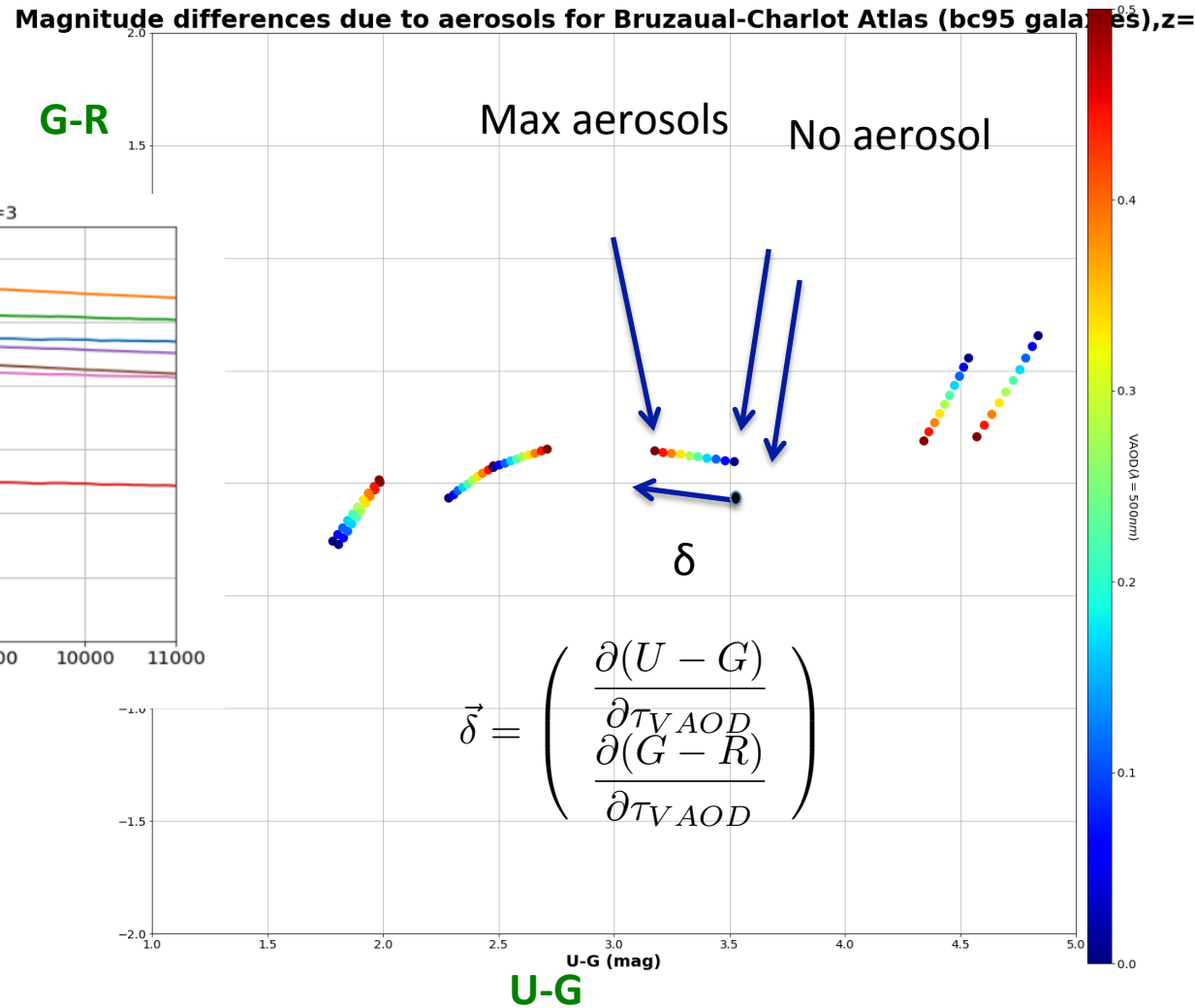
Airmass =1





Compute gradient of color shift





$$\vec{\delta} = \begin{pmatrix} \frac{\partial(U-G)}{\partial \tau_{VAOD}} \\ \frac{\partial(G-R)}{\partial \tau_{VAOD}} \end{pmatrix}$$

δ: magnitude-bias are magnified
By a factor 30

Procédure de correction d'atmosphère

- Déterminer le champ vectoriel de variation de couleur avec VAOD ou PWV dans les diagrammes *(G-R) vs (U-G)* [ou *(Z-Y) vs (I-Z)*]
- Connaître la position de l'objet dans les mêmes diagrammes pour les meilleures conditions atmosphériques
- Déterminer VAOD et PWD avec télescope auxilliaire (probablement à 10% près -> à consolider)
- (L'ozone ne semble pas induire de fortes variations de couleur avec la SED)
- Appliquer les vecteurs de correction correspondants