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MARTIAN DUST OPTICAL DEPTH, SIZE AND SHAPE FROM MSL ENGINEERING CAMERAS

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ESAC, Madrid
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1. INTRODUCTION

- **Dust** is the **main driver** of the Martian atmosphere: atmosphere properties, structure and dynamics governed by dust **spatial and seasonal distribution** and its **radiative properties**

- Dust radiative properties characterised by dust optical indices, **particle shape** and **particle size**

- Intensive dust study from both **orbiting** spacecrafts and **surface**, different instrumentation, techniques, wavelength.

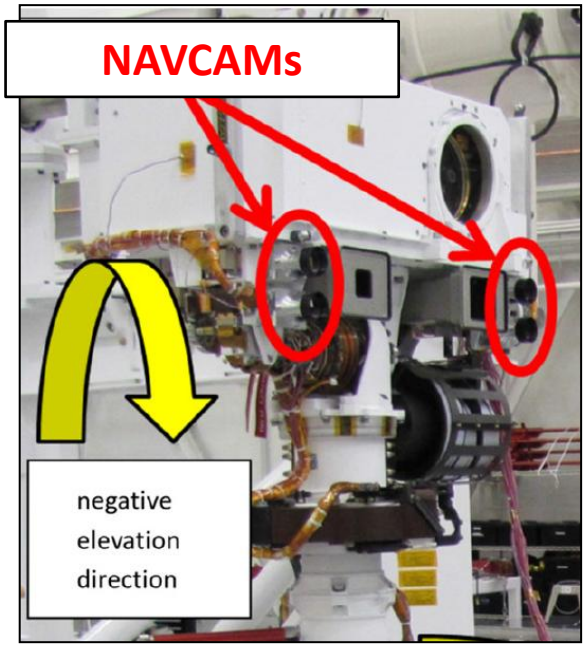
1. INTRODUCTION

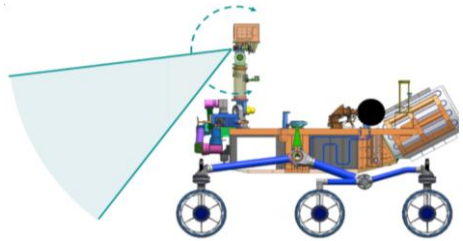
Objective of this study:

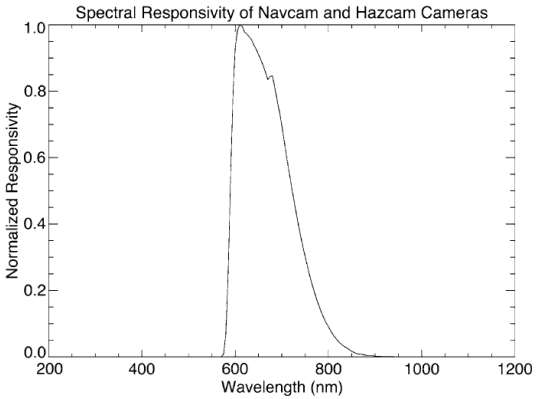
Validate the use of MSL Engineering Cameras observations to:

- Evaluate the amount of dust suspended in the atmosphere
- Constrain its physical properties
- Study its seasonal variation

2. MSL ENGINEERING CAMERAS







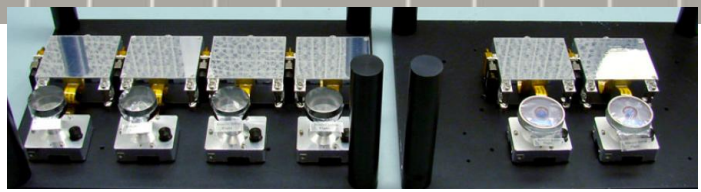


Table 2.1.2 - Navcam Operational Characteristics

Characteristic	Value
Field of View (FOV)	45 x 45 deg
Baseline Stereo Separation	42.4 cm
Angular Resolution	0.82 mrad/pixel at center
Spectral Bandpass	600 - 800 nm
Focal Length	14.67 mm
f/number	12
Depth of Field	0.5 m - infinity
Best Focus	1.0 m

Table 2.1.1 - Hazcam Operational Characteristics

Characteristic	Value
Field of View (FOV)	124 x 124 deg
Baseline Stereo Separation	16 cm for front, 10 cm for rear
Angular Resolution	2.1 mrad/pixel at center
Spectral Bandpass	600 - 800 nm
Focal Length	5.58 mm
f/number	15
Depth of Field	0.1 m - infinity
Best Focus	0.5 m

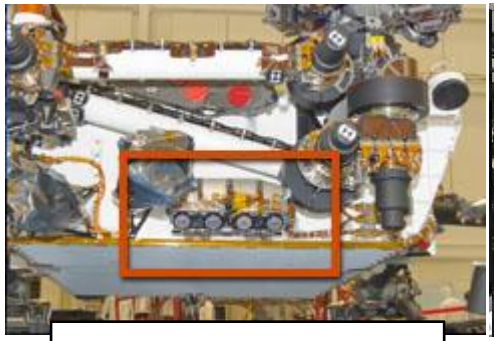
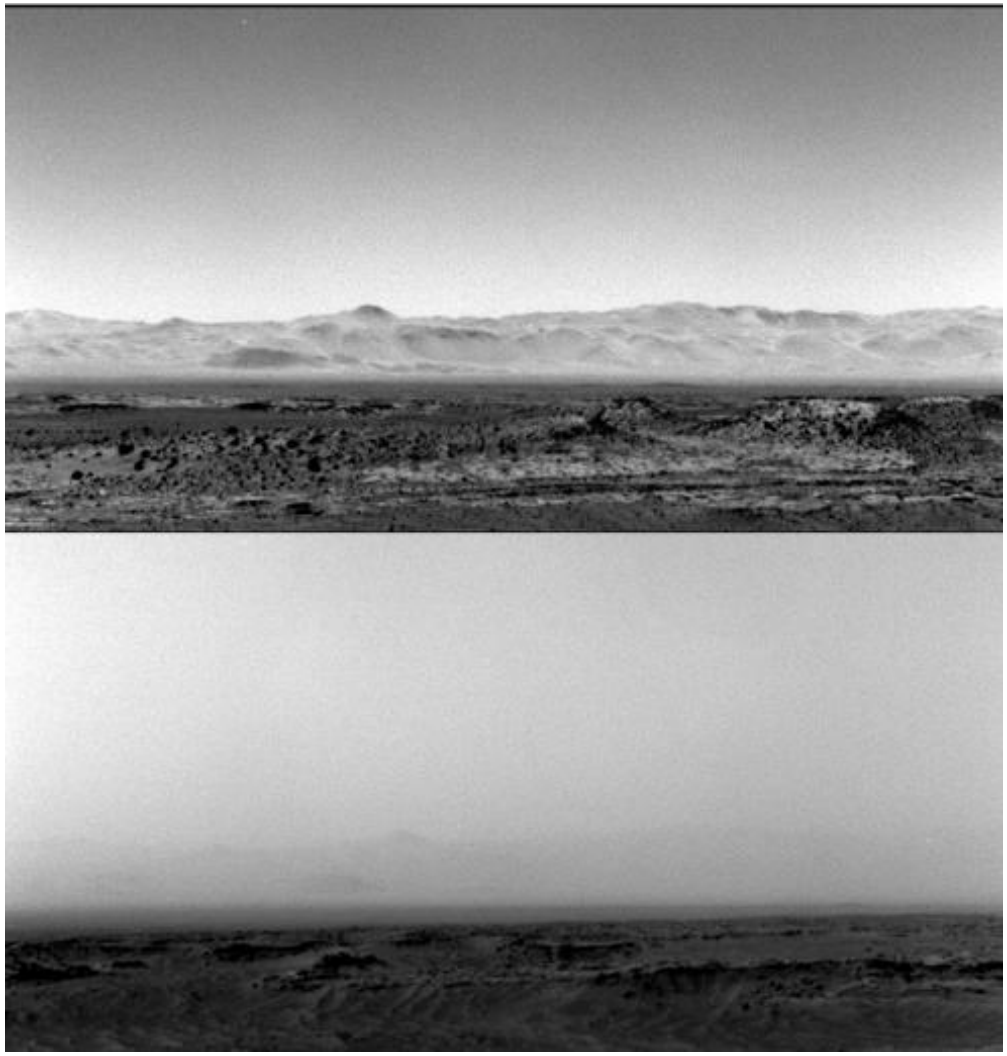


Image credits:
MSL Engineering Cameras, Maki et al. 2012
MALIN: MSL_CAMERA_SIS document
PETERS: MSL PPPCS document

2. MSL ENGINEERING CAMERAS

Although not designed for scientific use...

Ls = 133.4º



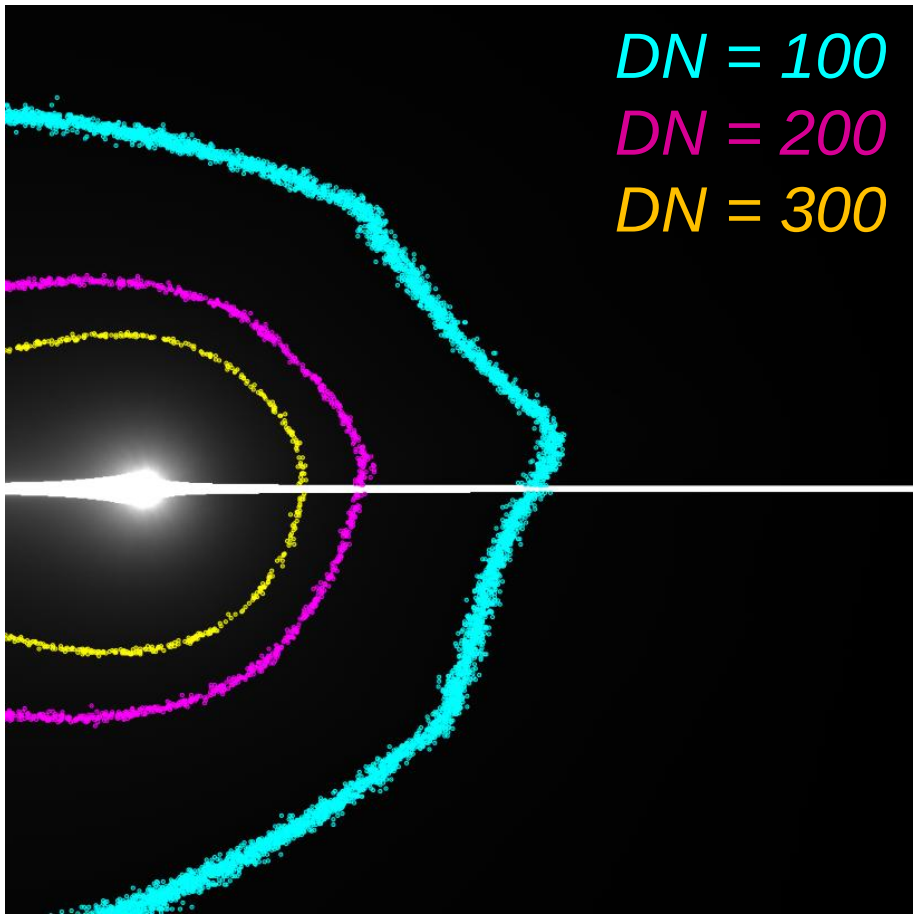
LTST ~ 13h

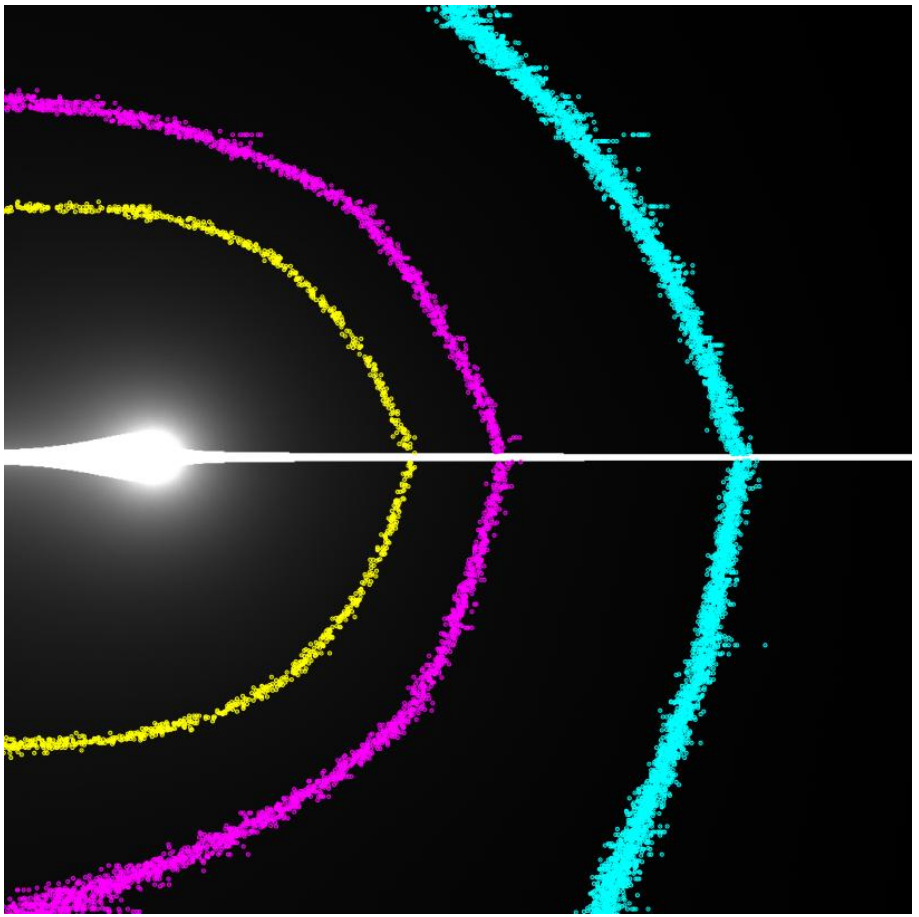
Ls = 225.6º

Moores et al., 2015
Moore et al., 2016

2. MSL ENGINEERING CAMERAS

Although not designed for scientific use...





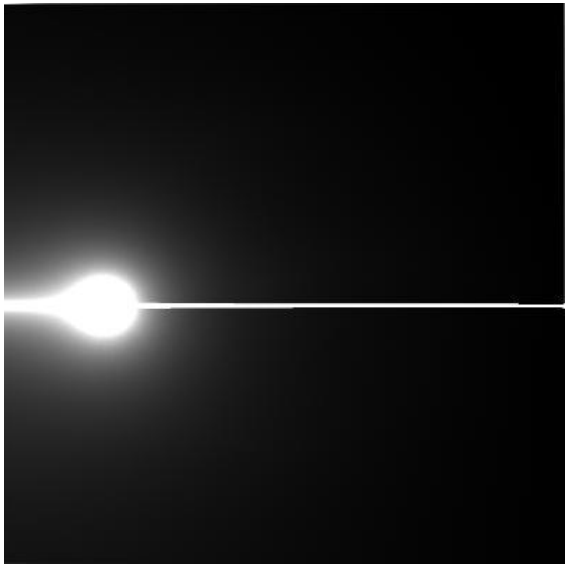
Ls = 134.4º

LTST ~ 13:40h

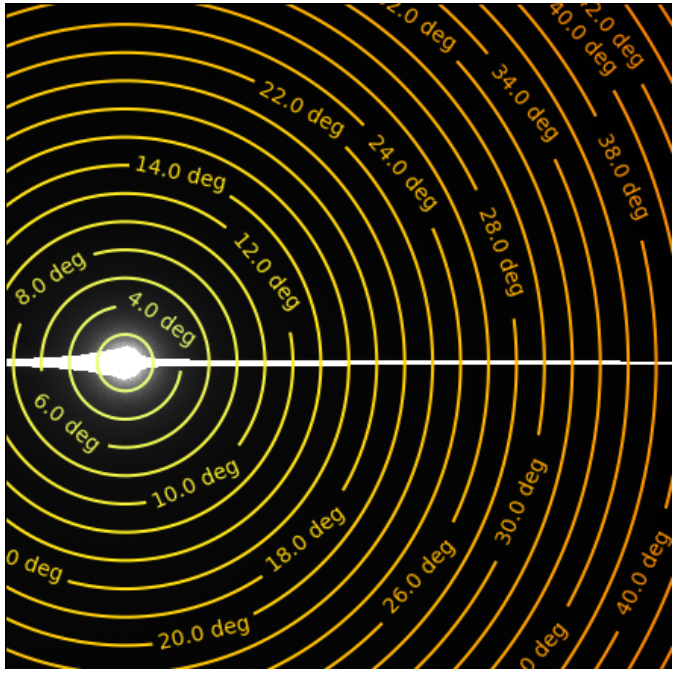
Ls = 269.7º

3. OBSERVATIONS

RAW EDR image



1. *Calibration*
2. *Navigation*



1. Photometric calibration: MER Navigation Cameras in-flight calibration (J. Soderblom et al., 2008)

2. Geometric Reduction: JPL CAHVOR Camera Model (Di and Li, 2004; Gennery et al., 2006)

4. RETRIEVAL METHODOLOGY

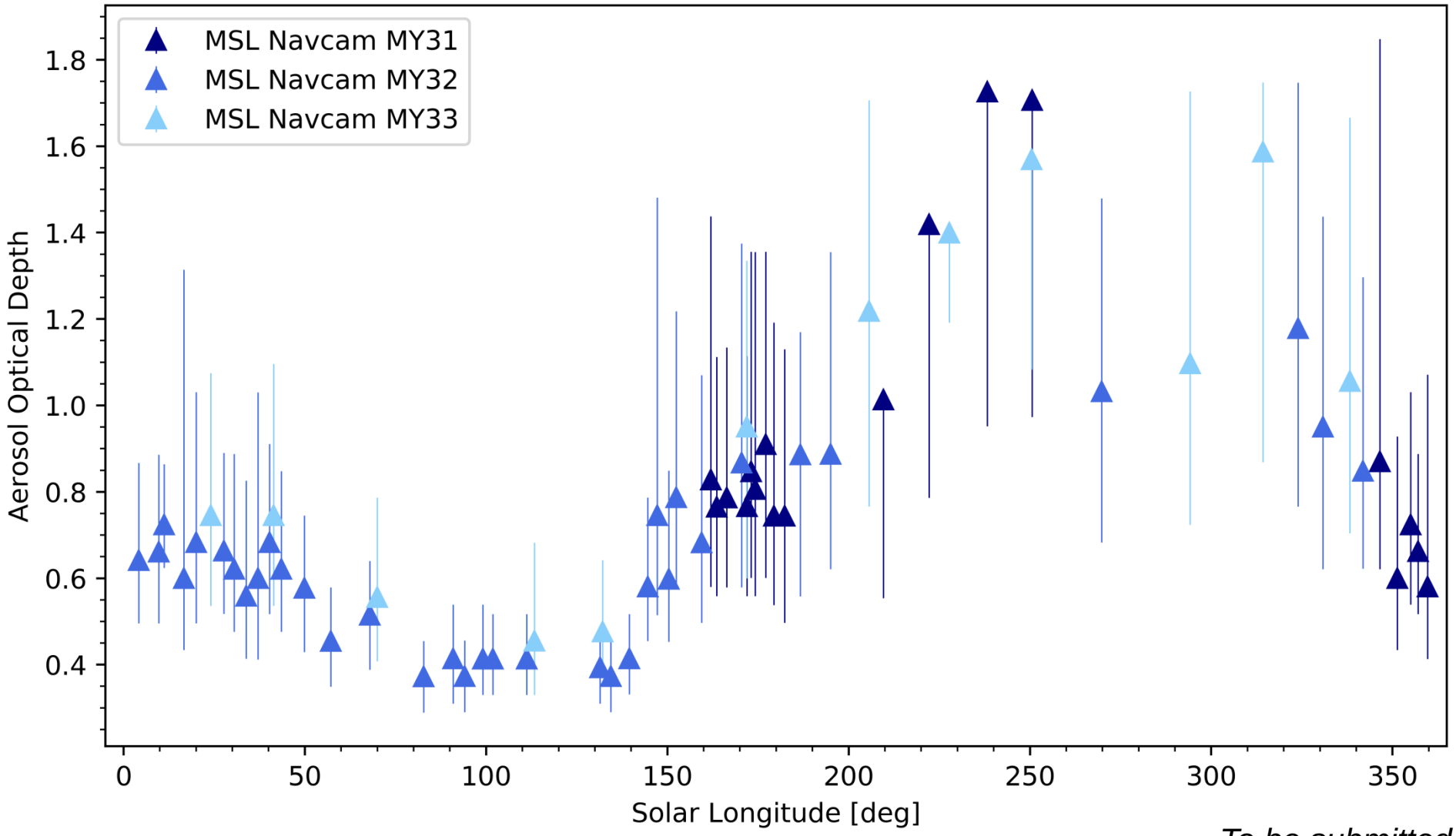
1. Raditive Transfer: Multiple scattering plane-parallel atmosphere code DISORT (Stamnes et al., 1988), implementation in Python (Adamkovics et al., 2016)

2. Atmosphere structure and composition: Input from Mars Climate Database (MCD v5.2, Forget et al., 1999; Millour et al., 2015) for the relevant Ls, LTST.

3. Aerosol model: T-matrix code (Mishchenko and Travis, 1998), cylinders D/L = 1, Log-normal PSD (Hansen and Travis, 1974), $\boldsymbol{\nu_{eff}}$ is fixed to 0.3, dust refractive indices from Wolff et al., 2009.

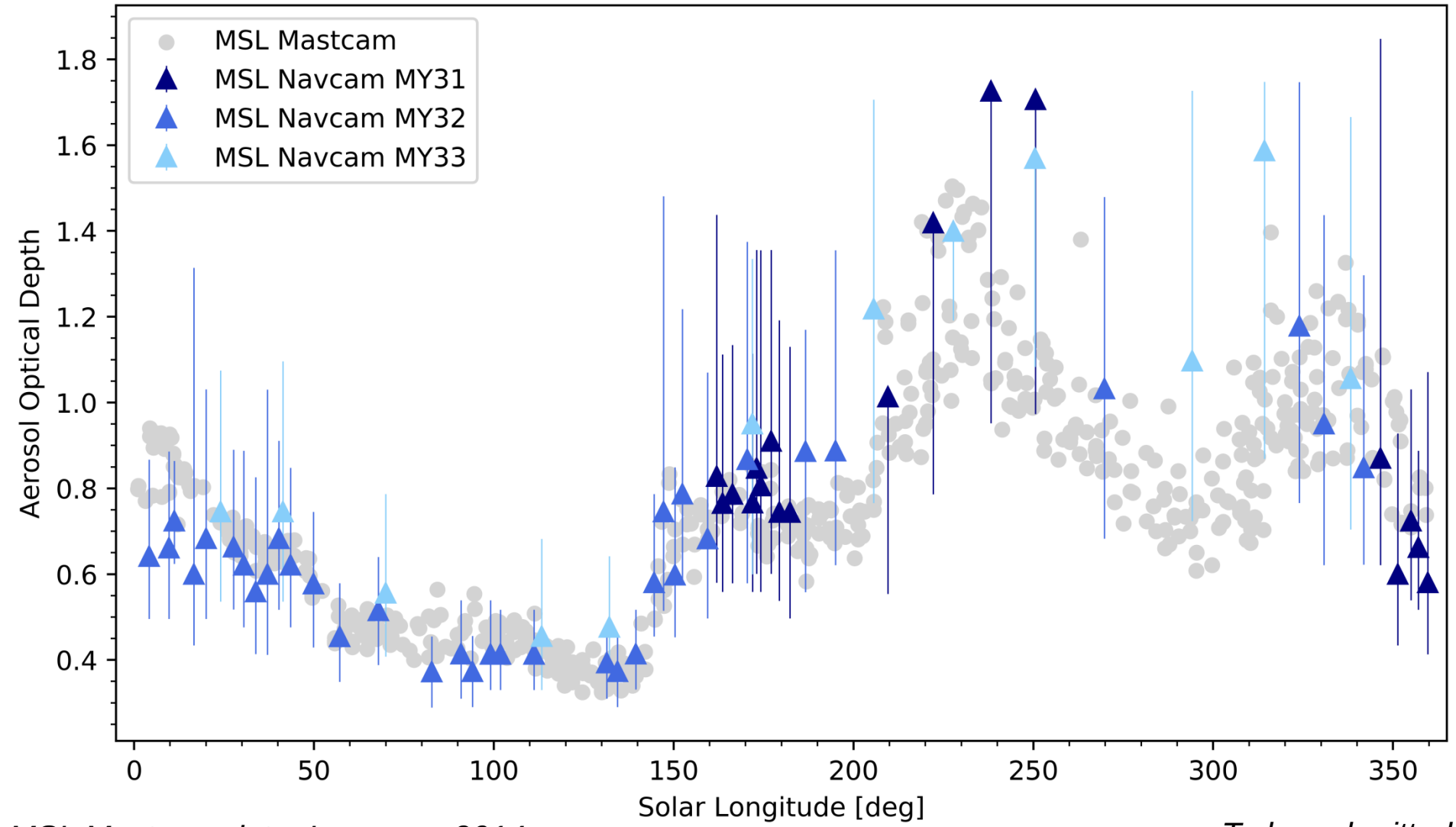
4. Retrieval: Navcam observation vs DISORT output sky brightness as a function of the scattering angle curves, best fitting curve under a lowest mean quadratic deviation χ^2 criteria.
Free parameters: $\boldsymbol{r_{eff}}$, aerosol column optical depth at ground ($\boldsymbol{\tau}$)

5. RESULTS



To be submitted

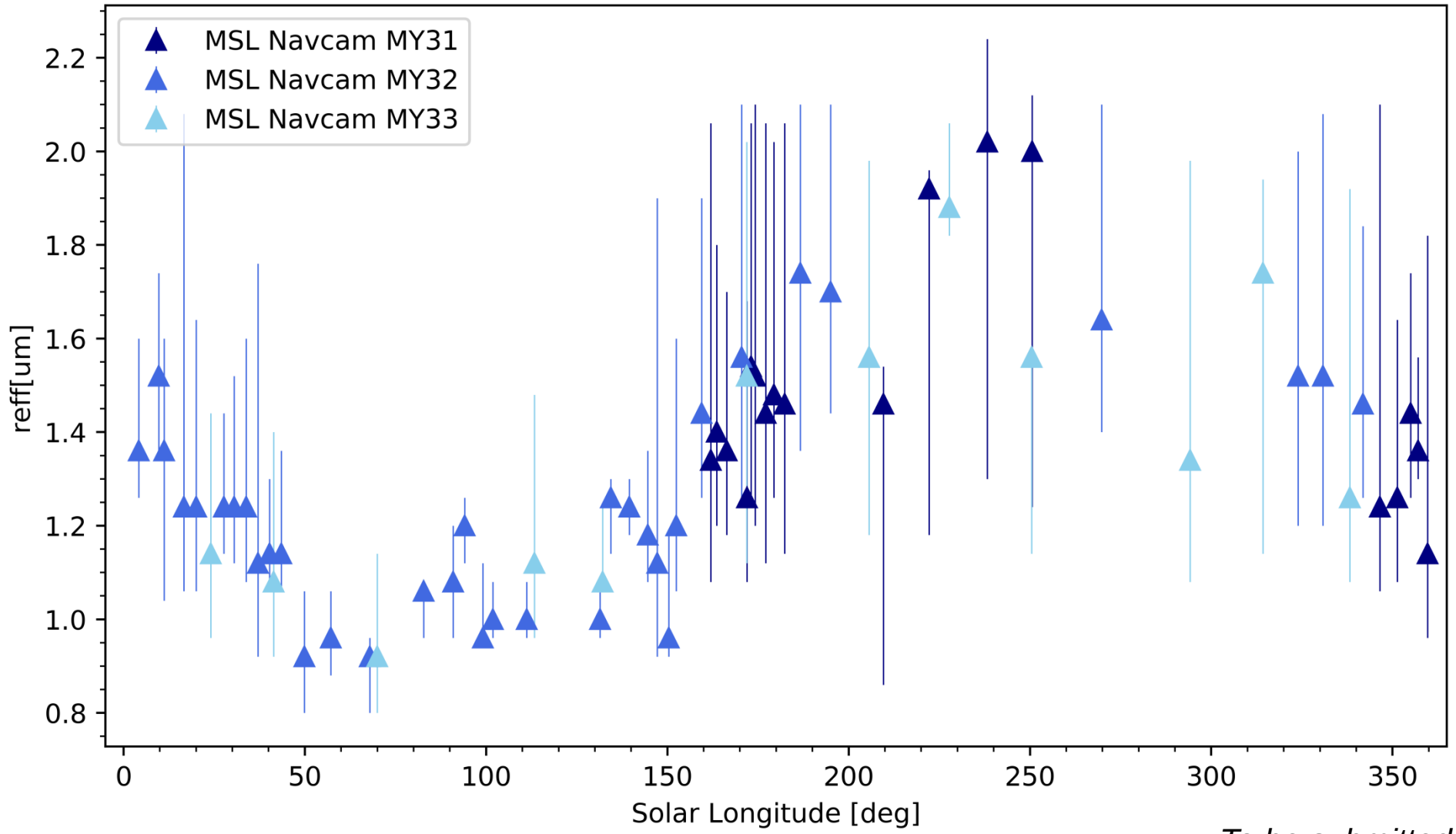
5. RESULTS



MSL Mastcam data: Lemmon, 2014

To be submitted

5. RESULTS



To be submitted

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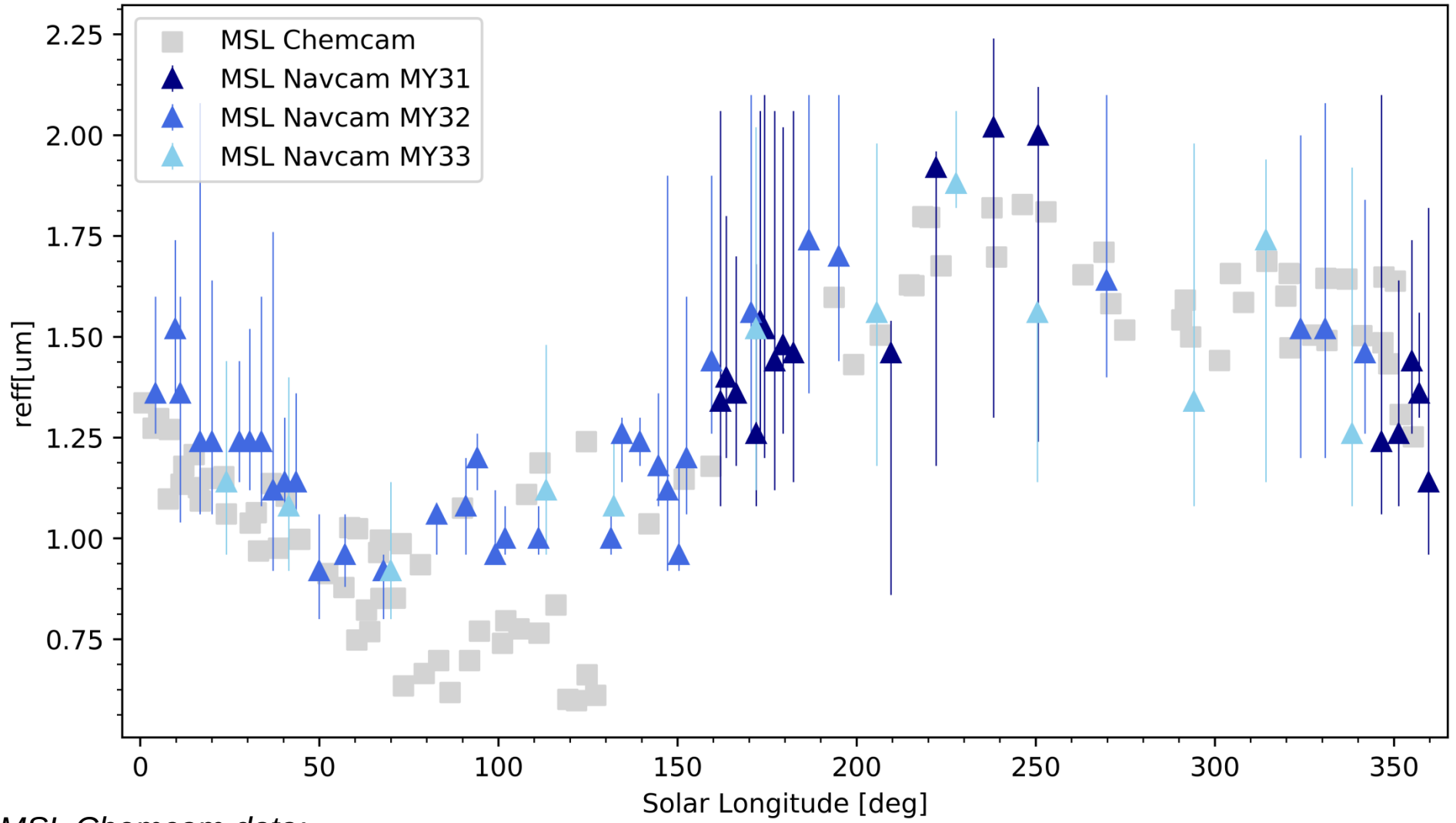
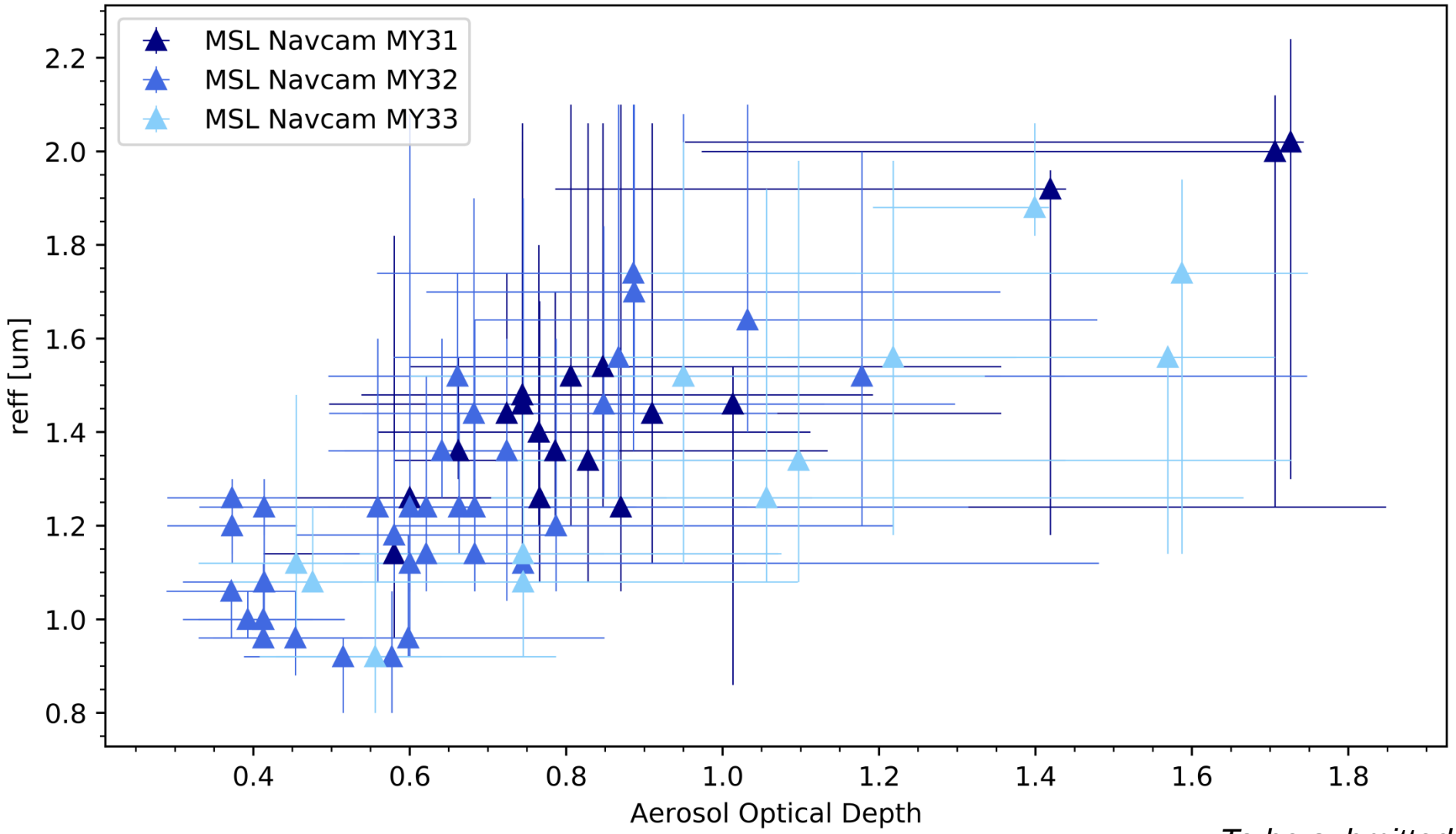


MSL Chemcam data:
McConnochie et al., 2017

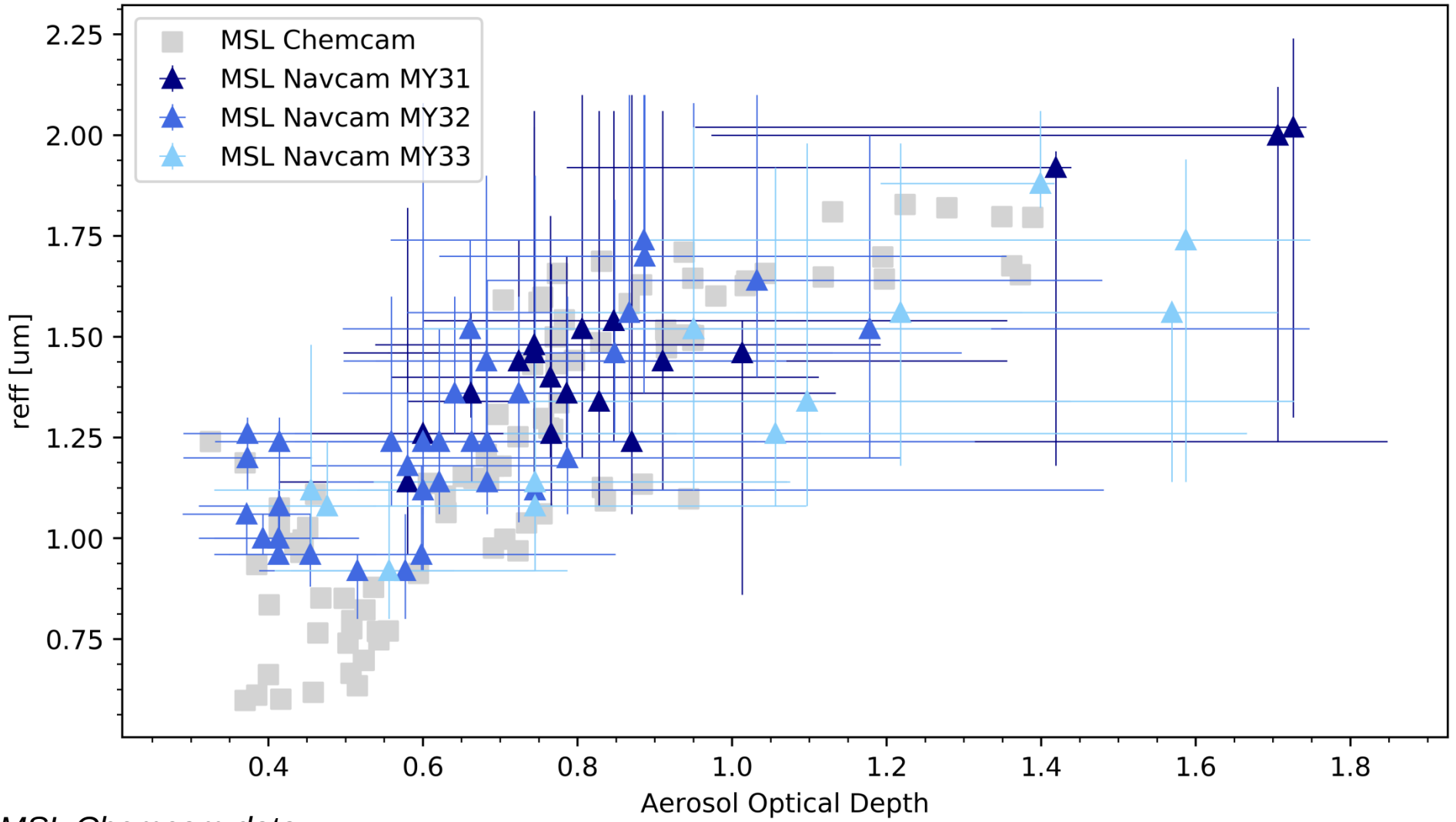
To be submitted

5. RESULTS



To be submitted

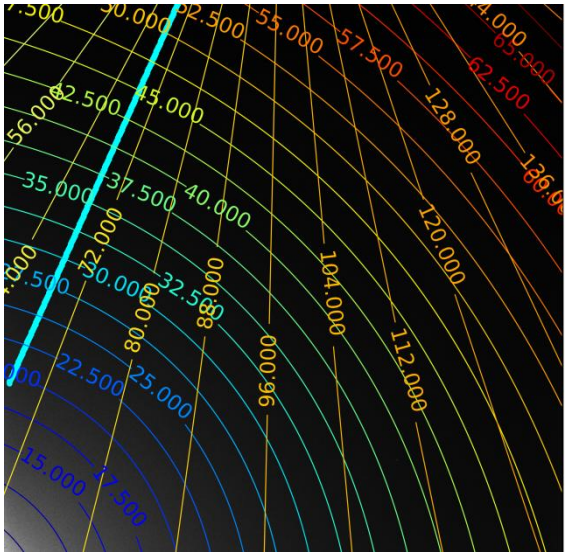
5. RESULTS

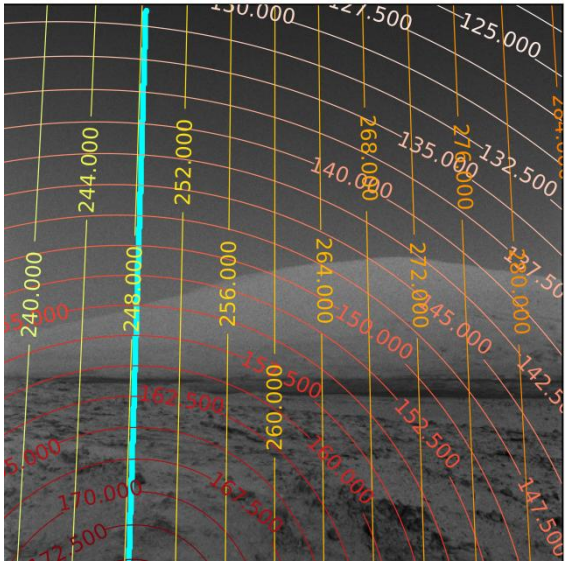


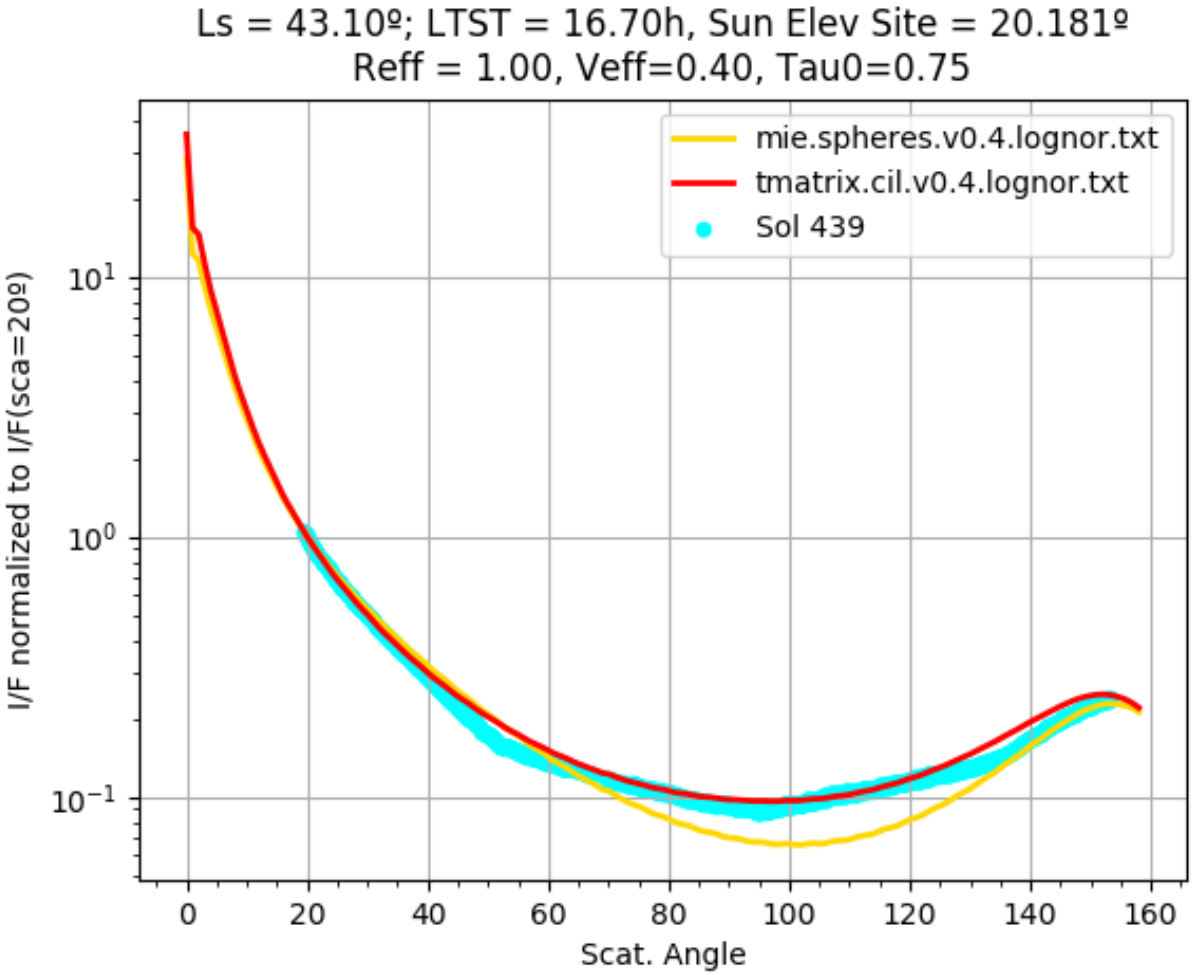
MSL Chemcam data:
McConnochie et al., 2017

To be submitted

6. ON-GOING WORK







7. CONCLUSION

MSL Navcam Sun-pointing images can be used to estimate the atmospheric dust loading and constrain the aerosol effective radius

Results present good agreement with previous studies. Seasonal variation can be identified, correlation between particle effective radius and optical depth.

We can take advantage of:
- Observational versatility of the engineering cameras
- Capability of covering wide regions
- Frequent nominal use rate

Contribute to the understanding of dust in Mars atmosphere

Thank your for your attention, Questions?