Seasonal variability of dust on Mars Lessons learned from Earth for dust mass estimation

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DISPLAY MATERIAL

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- Atmospheric dustiness is a balance between lifting dust into the atmosphere and its sedimentation, following a seasonal cycle.
- Dust plays an important role in Mars' climate by acting as an internal forcing mechanism in the climate system.
- Sinks are more limited than on Earth (no oceans available) and there are fewer processes for dust deposition (as precipitation)
- Their impact is related to optical and microphysical properties of dust and its spatial distribution.

Several works identify dust sources by using global circulation models

The **objective** of this work is to obtain a **methodology** to study the **effective mass dust transport** by using **measurements**

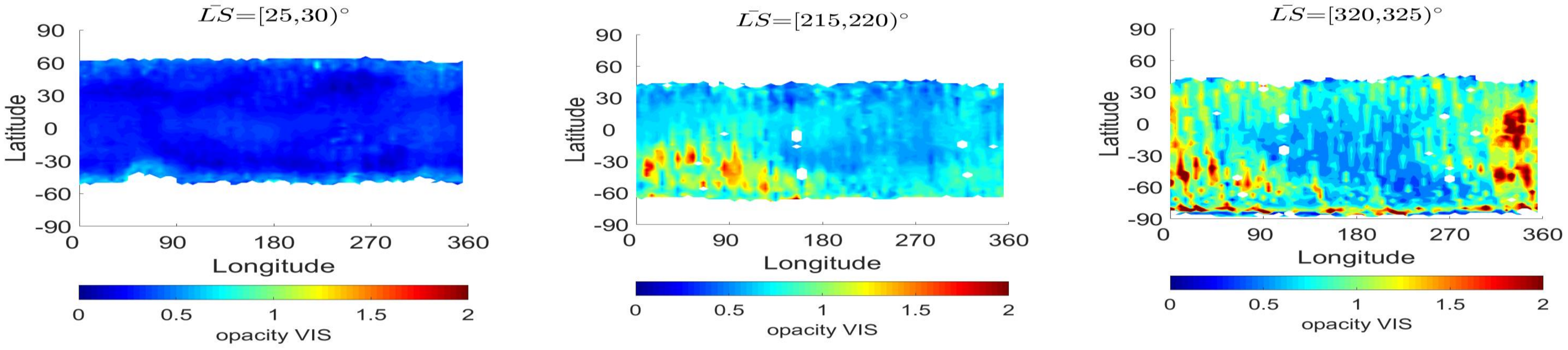
Mast-Cam Curiosity

Thermal Emission Spectrometer (TES)

- Climatology composed of 4 Martian years. We used the data flagged as ‘Best Quality for TES team.
- Provides, among others variables, the opacity: a measure of the columnar dust loading in the atmosphere.
- Conversion of the absorption opacity (IR) into extinction opacity (VIS) by applying a conversion factor of 2.6

  Smith, (2004); Lemmon et al., (2015)

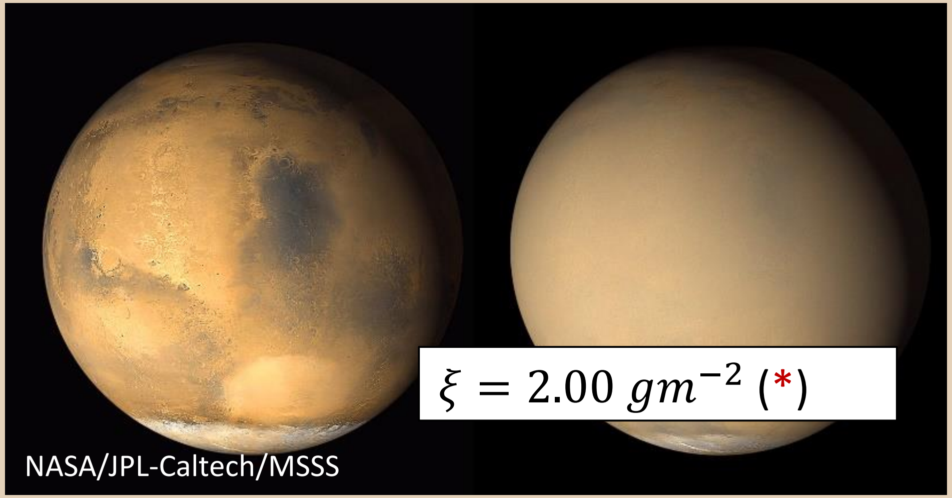
Examples of the non-dusty season (left) and dusty season (middle and right) opacity. The warmer colors represents higher values of opacity. Averaged each 5 LS.



- It is possible to convert opacity into mass, by applying a ***opacity-to-mass conversion factor*** which depends on ***optical*** and ***microphysical*** properties of dust.
- For Mars, in the literature we found a factor for the whole planet; however dust properties *could be* different depending on the Mars zone. This happens in Earth, where there are 5 different conversion factors depending on the size, composition and shape of the dust of different desserts. The differences between Mars-like and Earth-like conversion factor is $\pm 15\%$
- The mars-like opacity-to-mass conversion factor has been applied in this work, but a deeper study is necessary.

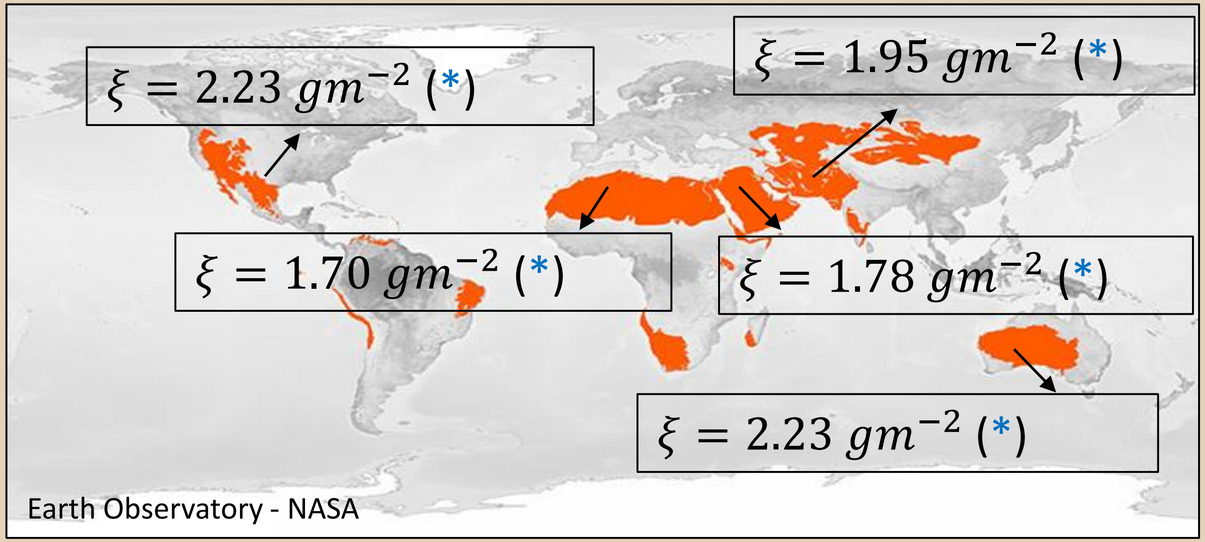
Mars-like conversion factor

(*) Forget & Montabone, (2017) and references therein



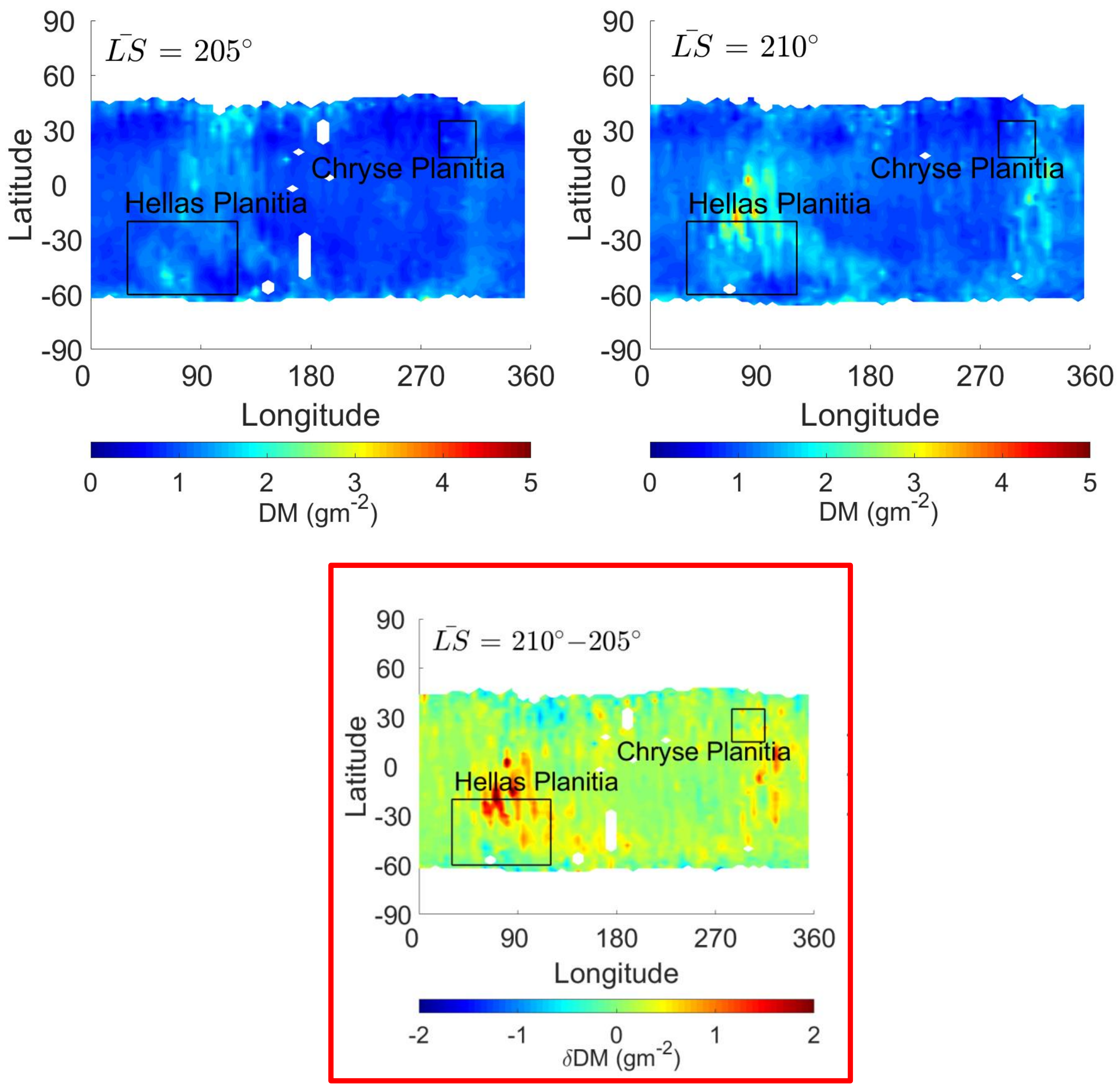
Earth-like conversion factor

(*) Ansmann et al. (2019)



Dust Lifting-Depletion Signature

- Applying the opacity-to-mass conversion factor it is possible to obtain the ***dust mass*** suspended in the atmosphere
- The ***dust lifting-depletion signature*** is calculated by subtracting the current values of mass, those values from the previous LS



The figure is an example for the beginning of the dust season, where can be seen the dust mass (DM) for 2 solar longitudes (top) and the dust lifting-depletion signature (bottom)

Dust Lifting-Depletion Signature

From warmer to cooler colors → Possible source

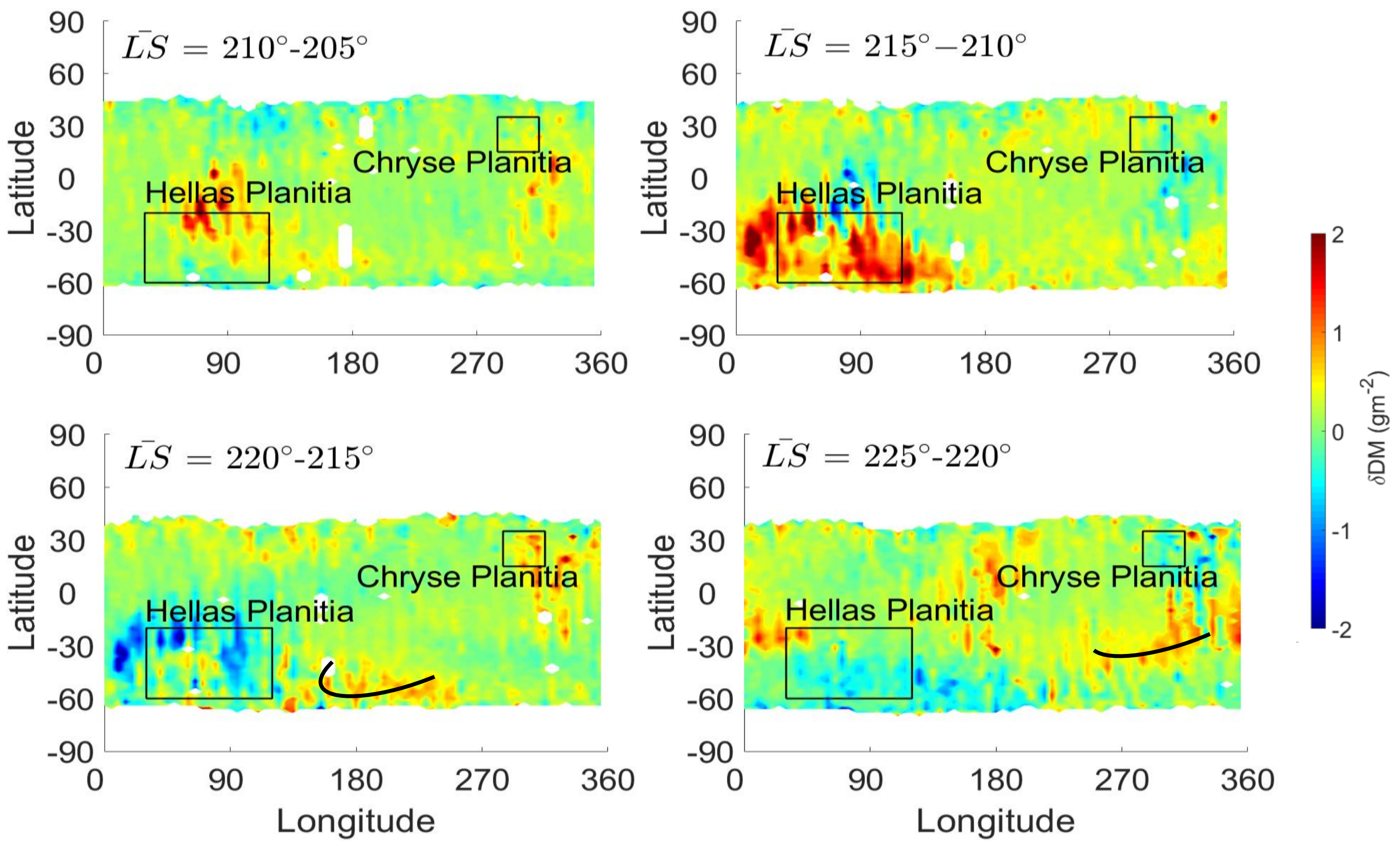


Figure: beginning of the dust season.

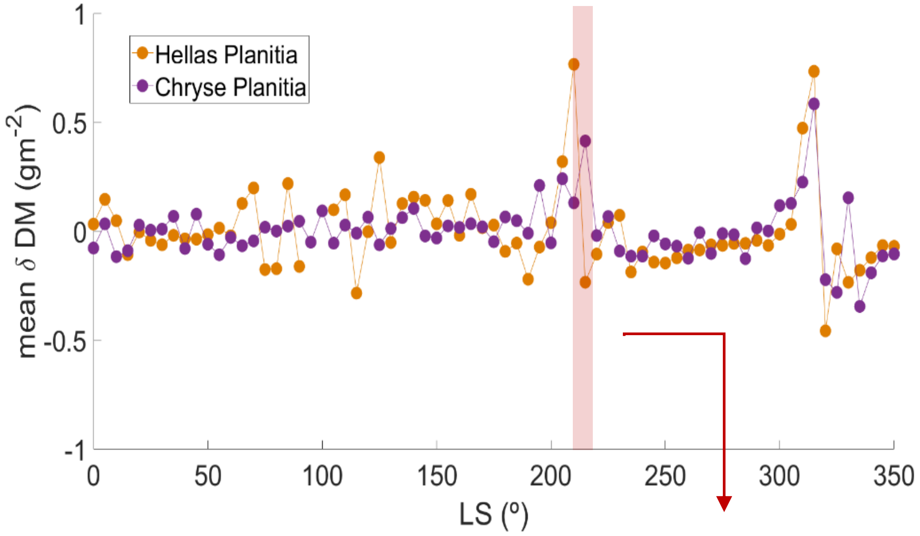
Focus on two points as an example:

- Hellas Planitia (south)
- Chryse Planitia (north)

As time passes, we see an increasing of the mass (red) following by a decay (blue)

This change could be related with the presence of a source. Dust could be transported to greater longitudes (black line)

Mean mass rate along time at different points



Hellas Plantia: LS (220 °-215°) mean $\delta DM \sim 1\ g\ m^{-2}$
Chryse Plantia: LS (225 °-220°) mean $\delta DM \sim 0.5\ g\ m^{-2}$

Estimate that ~ 1 and 0.5 gm^{-2} could be transported from Hellas and Chryse planitia at the beginning of the dust season.

Compare possible sources with those proposed by a model. As an example, the FINDUST model of *Newman and Richardson (2015)*. Not only the Hellas and Chryse Planitias are coincident, but also other possible sources.

Summary

This work is about a methodology to study mass transport on Mars by using opacity climatology. In this work TES retrievals have been used, but it could be extended to any opacity climatology.

Knowing the specific optical and microphysical properties of dust, it is possible to find a opacity-to-mass conversion factor which fits better at different sources. If their properties are similar to those for any Earth dust particles, one of the Earth conversion factors could be applied.

It is possible to compare the dust sources found by this methodology with those forecasted by models. Or even found areas where models do not forecast dust lifting.

THANK YOU!

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