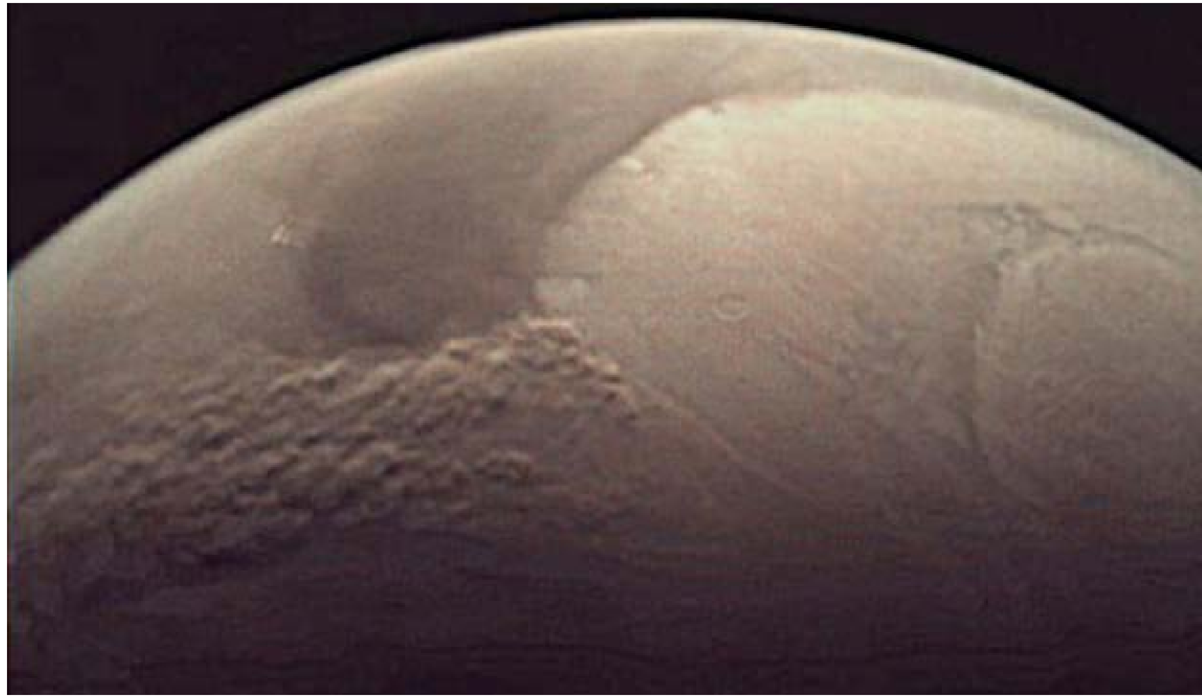
Universidad del País Vasco / Euskal Herriko Unibertsitatea
BILBOKO INGENIARITZA ESKOLA / ESCUELA DE INGENIERÍA DE BILBAO
Grupo de Ciencias Planetarias
Aula EspaZio Gela



Patterns in textured dust storms in Mars North Pole

A.Sánchez-Lavega[1], J. García-Morales[2], J. Hernández-Bernal [1,2], T. del Río-Gaztelurrutia[1], R. Hueso[1], E. Ravanis[3], A. Cardesín-Moinelo[3], D. Titov[4], S. Wood[5], D. Tirsch[6], E. Hauber[6], K.-D. Matz[6]

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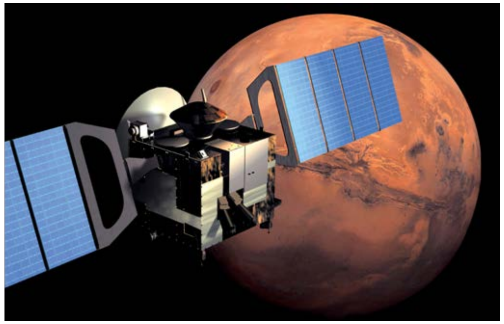
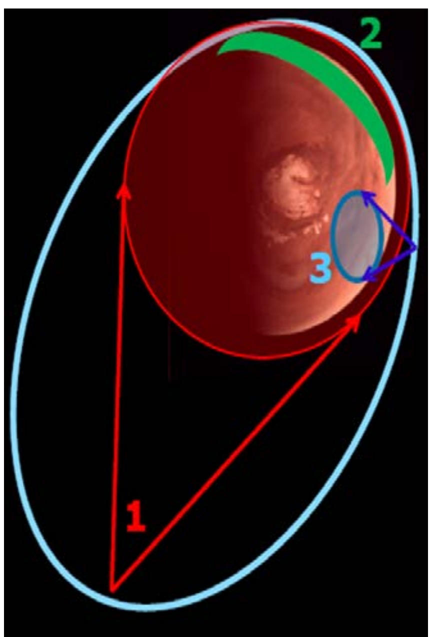
EPSC 2020 – Virtual Meeting – 2 October 2020

Observations & Data from Mars Express

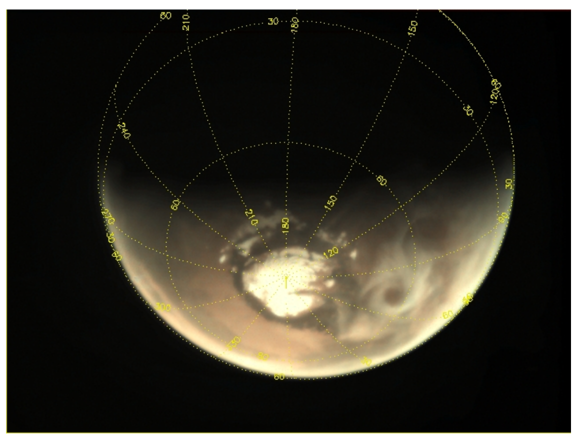


Mars Express (ESA)
Polar orbit:
Pericenter ~ 300 km
Apocenter ~ 10,000 km
Period ~ 7.5 hr



Visual Monitoring Camera
VMC

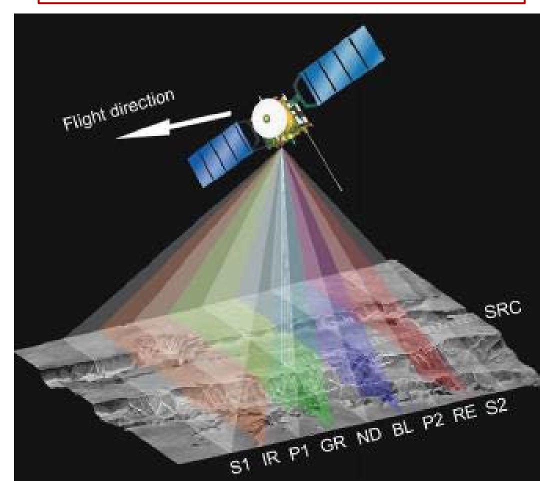
FOV: 40° x 31°
Bayer RGB (COLOR)
Wavelength: 400-650 nm



See E. Ravanis et al. presentation

High Resolution Stereo Camera
HRSC

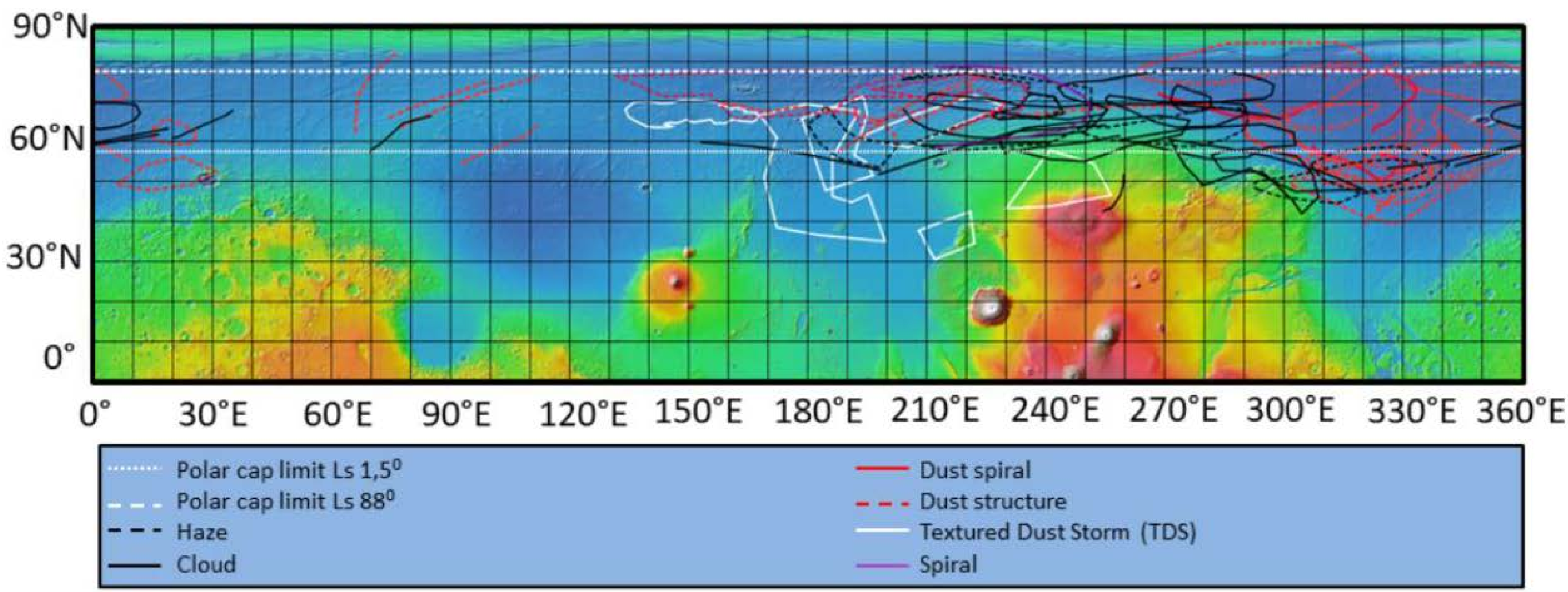
2 stereo channels (S1, S2)
2 photometry channels (P1, P2)
1 nadir channel (ND)
BL (blue channel 440 nm)
GR (green channel 530 nm)
RE (red channel 750 nm)
IR (near infrared channel 970 nm)
Maximum resolution = 10 m/pixel



Dynamical activity in Mars North Polar region in spring time

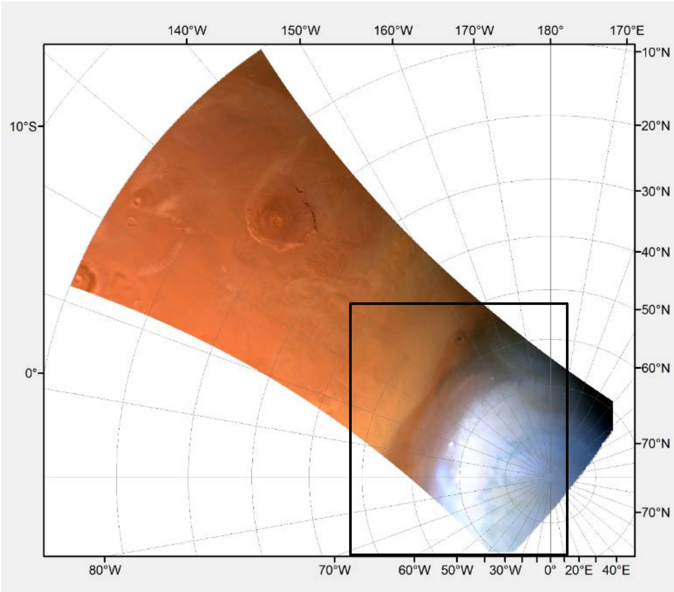
Period this study: 3 March – 17 July 2019
Ls = 350° (MY 34) - 54° (MY 35)
Aphelion is at Ls = 71°
Latitudes: 45°N - 90°N

Features: clouds and Hazes and a variety of local dust storms* (shapeless, arcs, fronts, spirals)

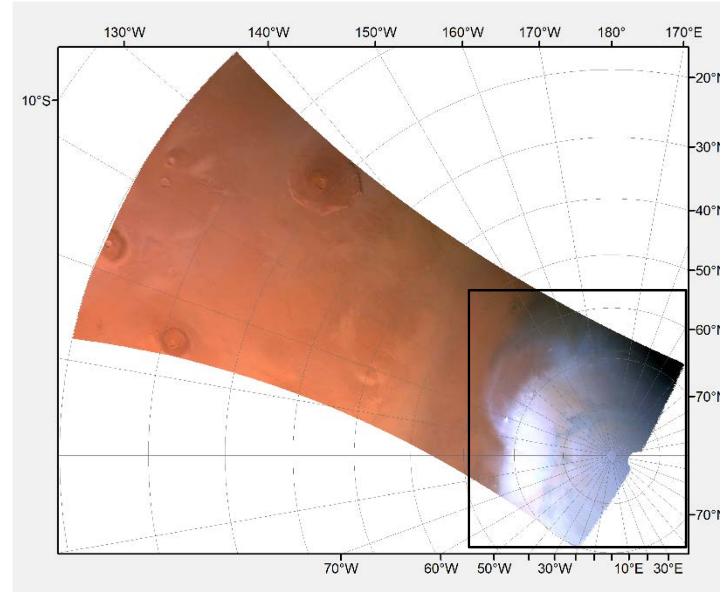


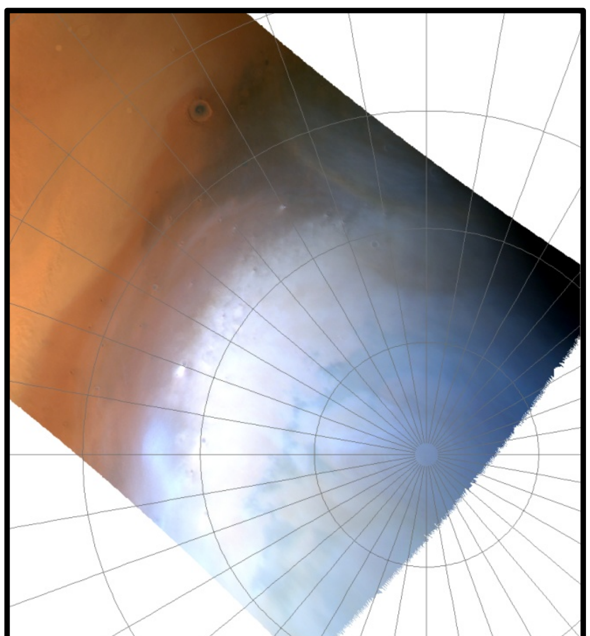
* Types of features in: Wang & Fisher (2009)

Shapeless dust areas over North Pole (HRSC)

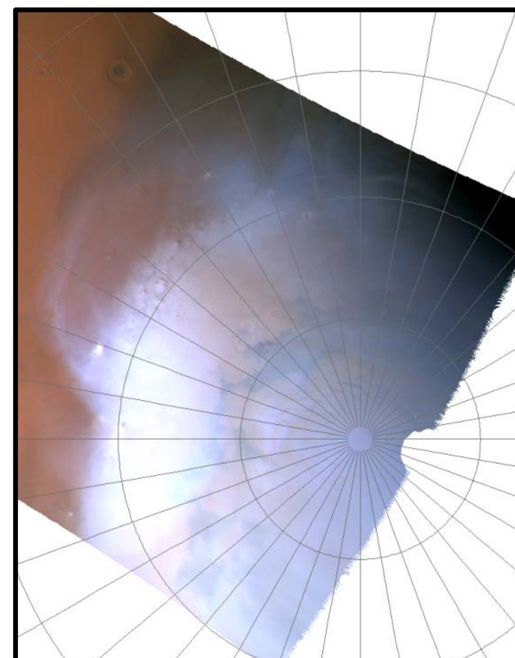


HRSC
6 June
Ls=35.4°

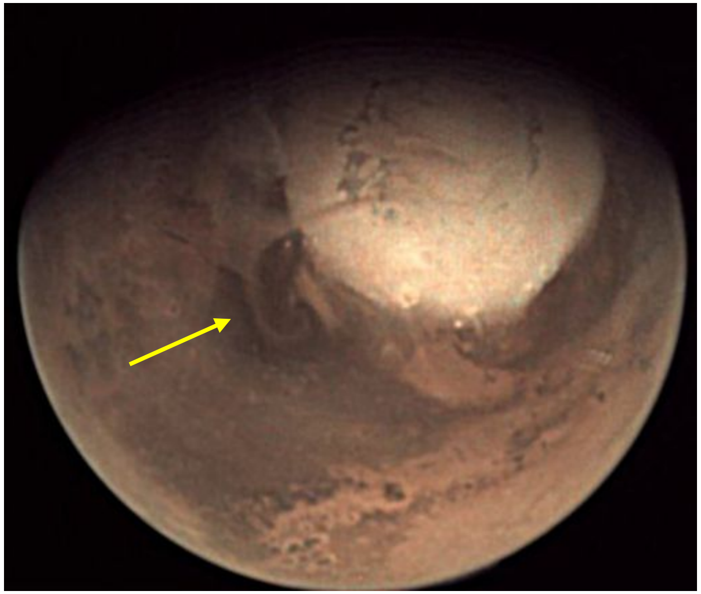




Dust patches
No texture
Dust total area:
7.92×10^5 km^2



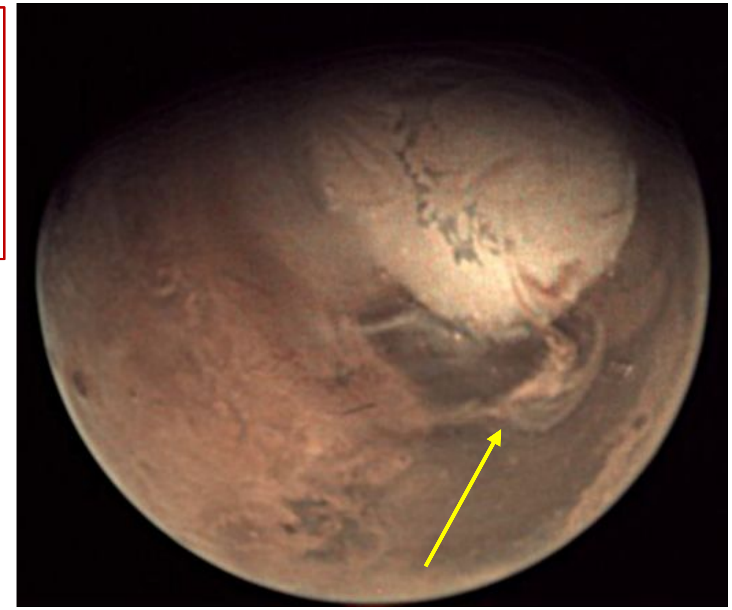
Long Filaments and Spirals (VMC)



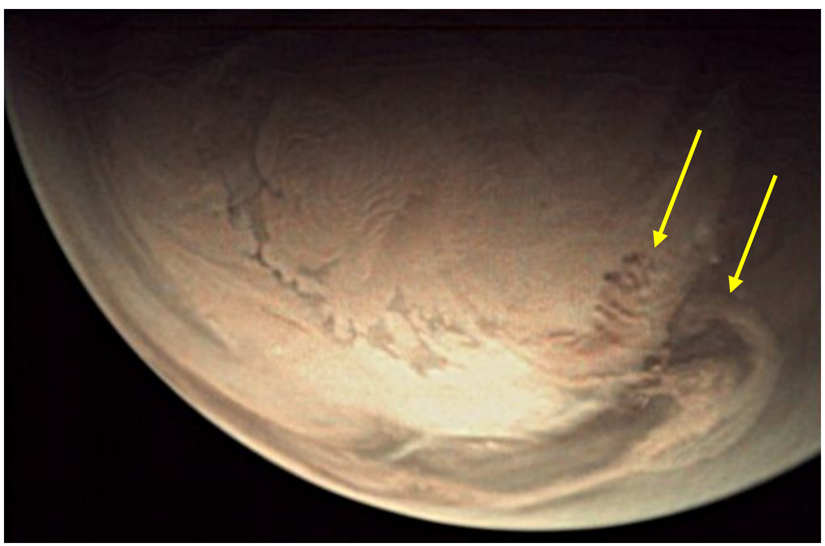
25 May

VMC

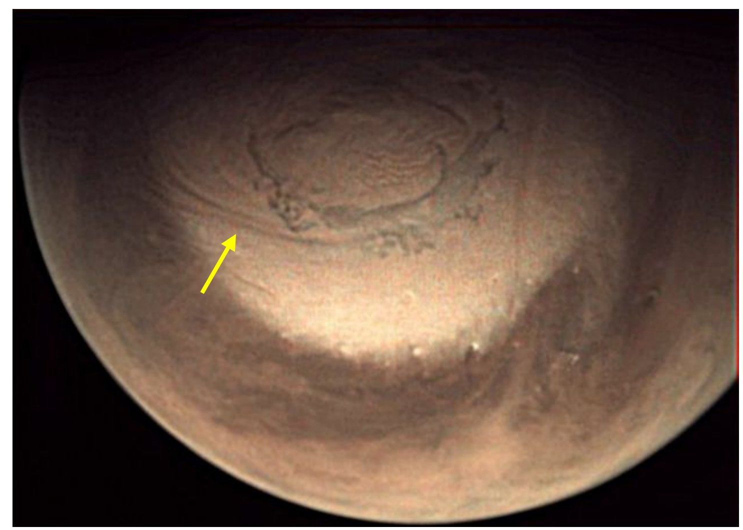
Ls=30-31^{o}



27 May

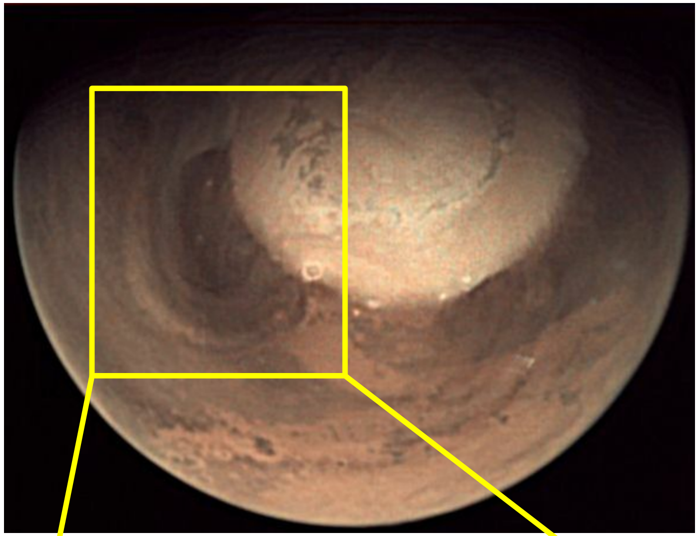


27 May

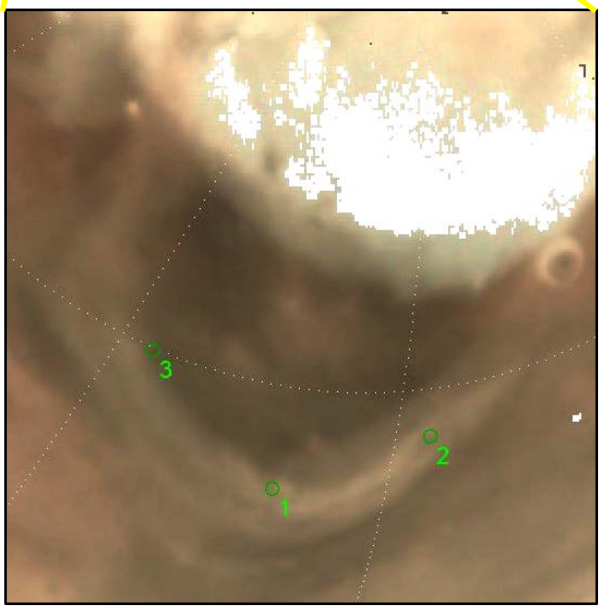


30 May

Arc shaped and "Flushing" dust storms (VMC)



3 June

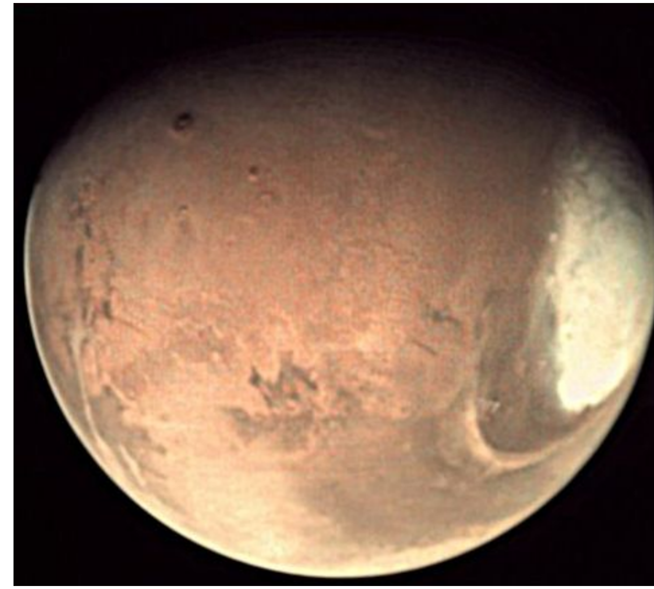


Ls = 45° - 50°

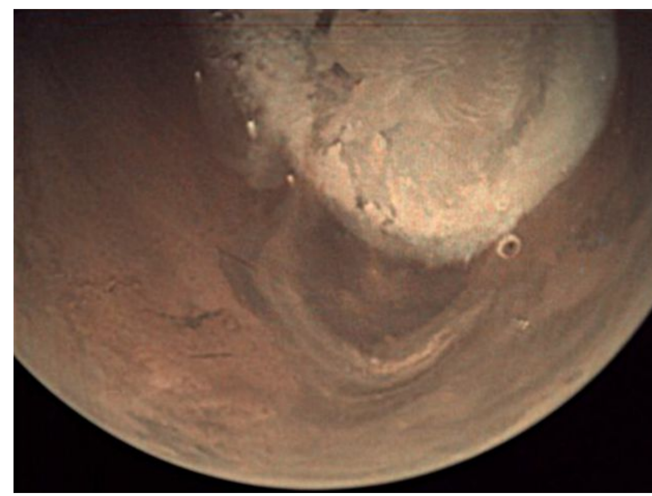
Acidalia Planitia
(300ºE - 330ºE)

Arcs:
Length ~ 2350 km
Width ~ 250 km

Expanding velocity:
Points (1-2-3)
V = 29 ms^{-1}



5 July

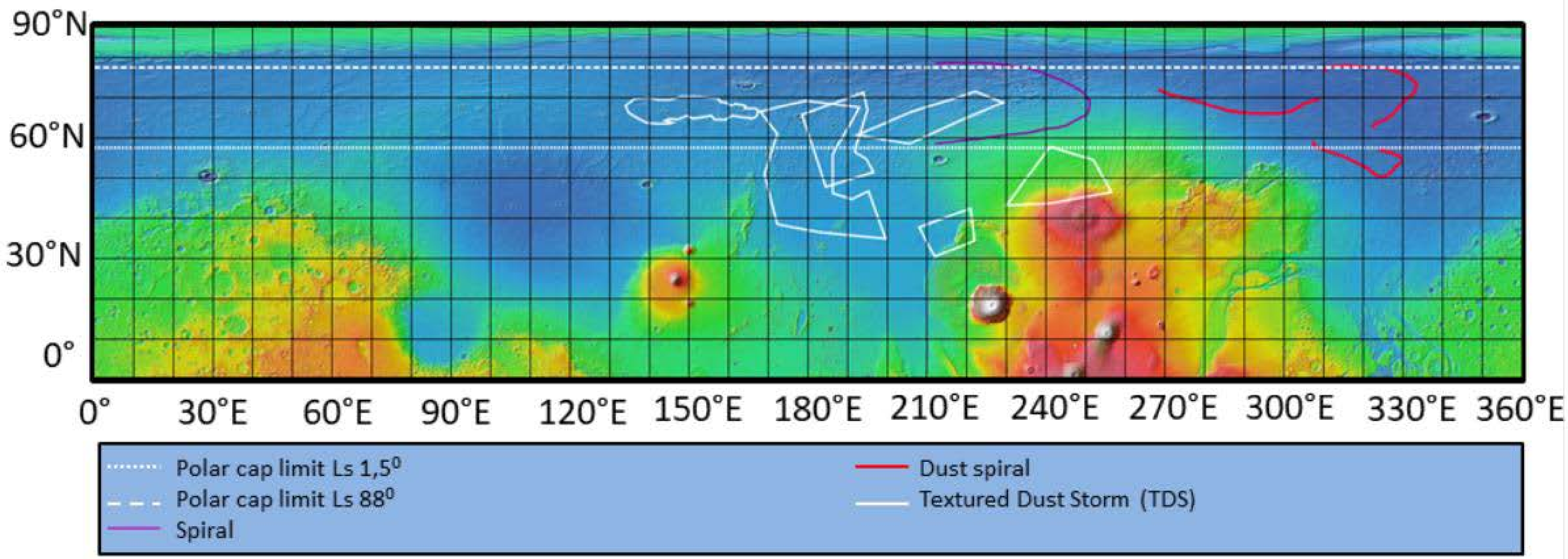


9 July

Flushing storms: Wang & Fisher (2009); Guzewhich+ (2015); Sánchez-Lavega+ (2018)

Textured Dust Storms (TDS)

May 22 – June 15 (2019)
Ls = 31° - 39°

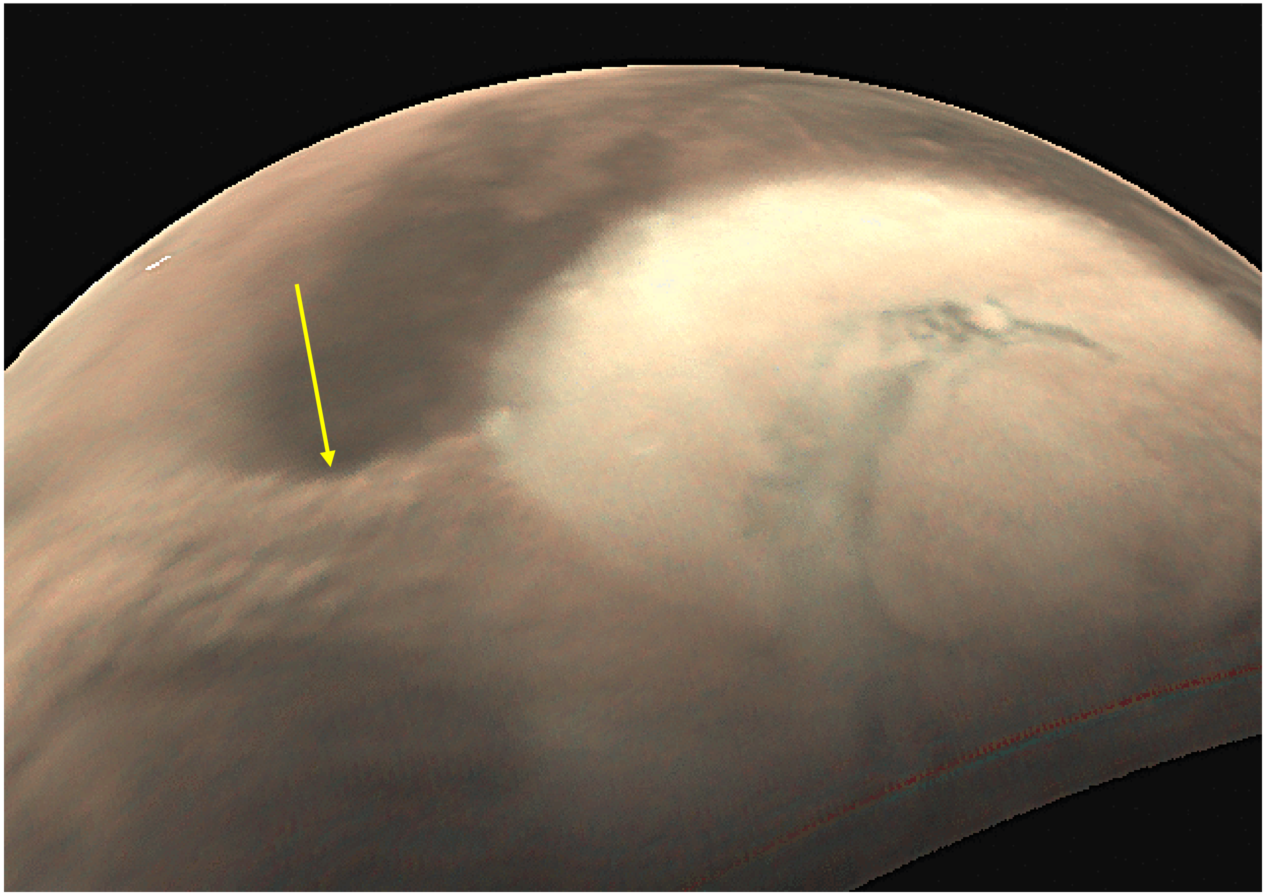


Local dust storms (*) showing texture at the top-surface (TDS)
Longitude range: 140ºE - 240ºE
Acidalia, Arcadia and Amazonis Planitias

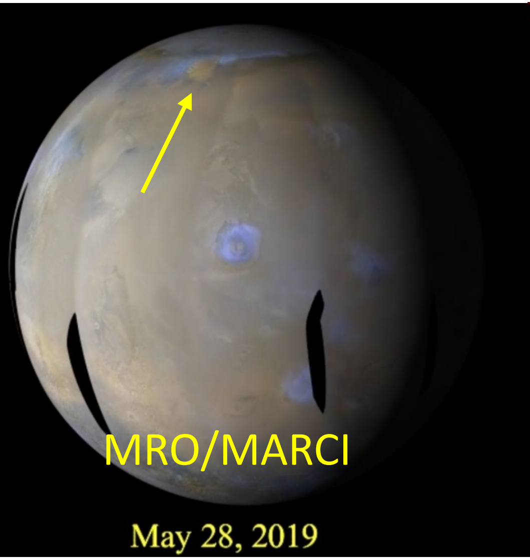
Local dust storm (*): area < 1.6 x 10^6 km^2

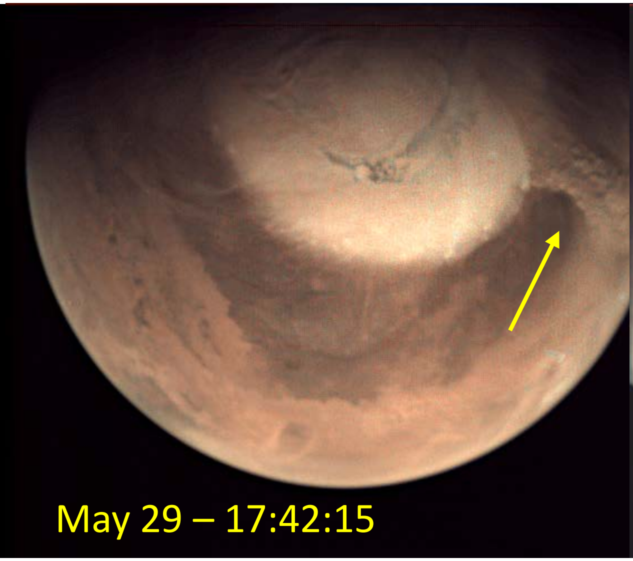
TDS1: 28 – 29 May 2019 (VMC)

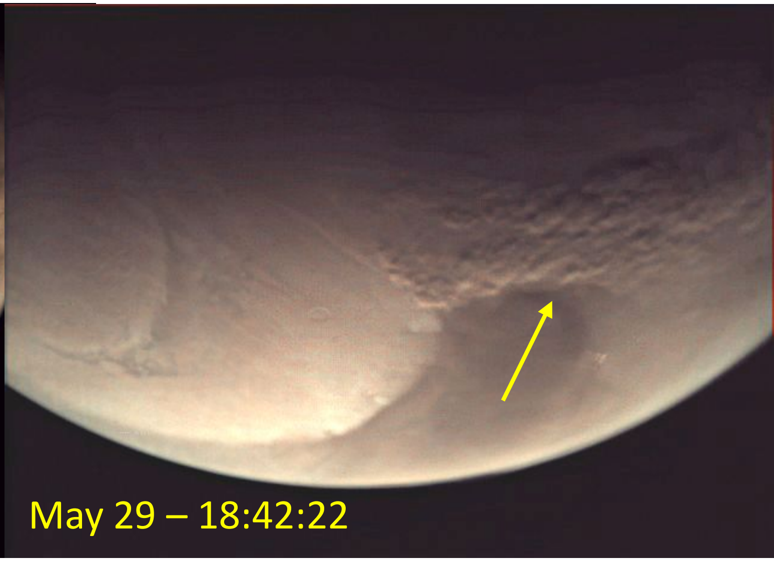
Local storm in Arcadia Planitia
Area = 1.36 x10^6 km^2
Ls = 32°

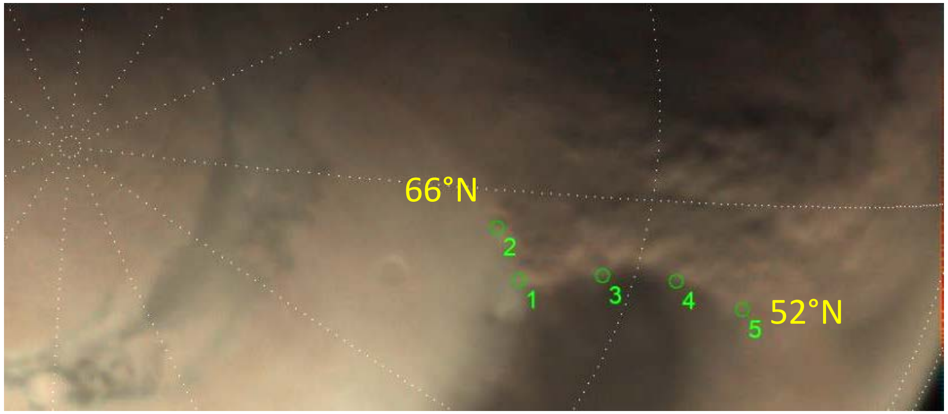


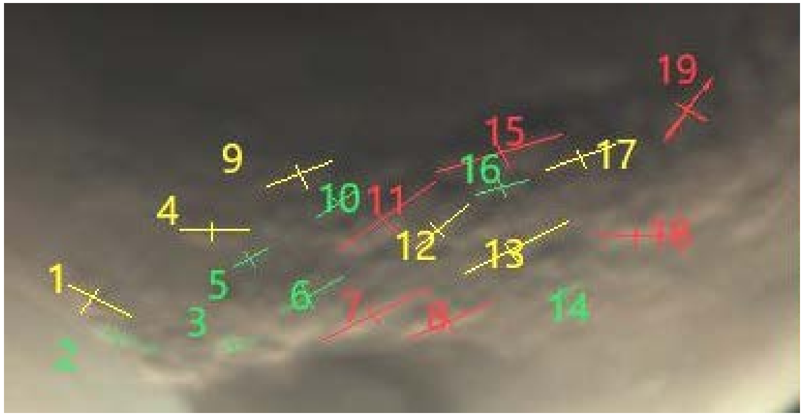
TDS1: 28 – 29 May 2019 (VMC)







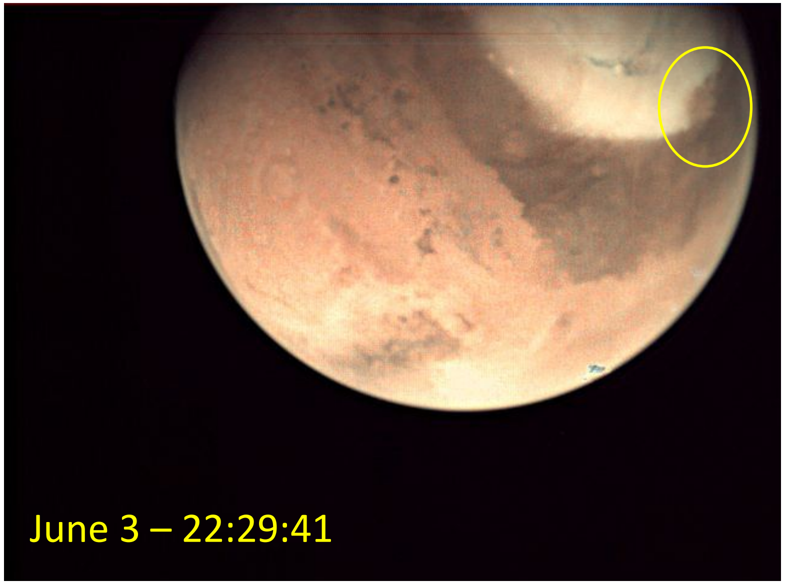


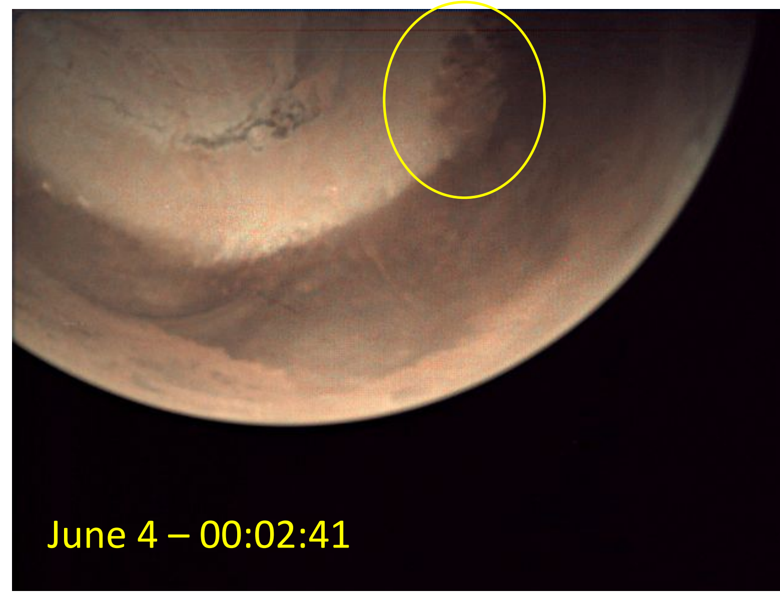


Texture type: pebbled-like
Cluster of cells ~ 20 - 40
Cells oriented by wind direction:
<V> = 28 ms^{-1} (20-40 ms^{-1})

Single cells:
Length = 140 ± 45 km
Width = 61 ± 15 km
length/with ~ 2.3
Separation = 180 ± 60 km

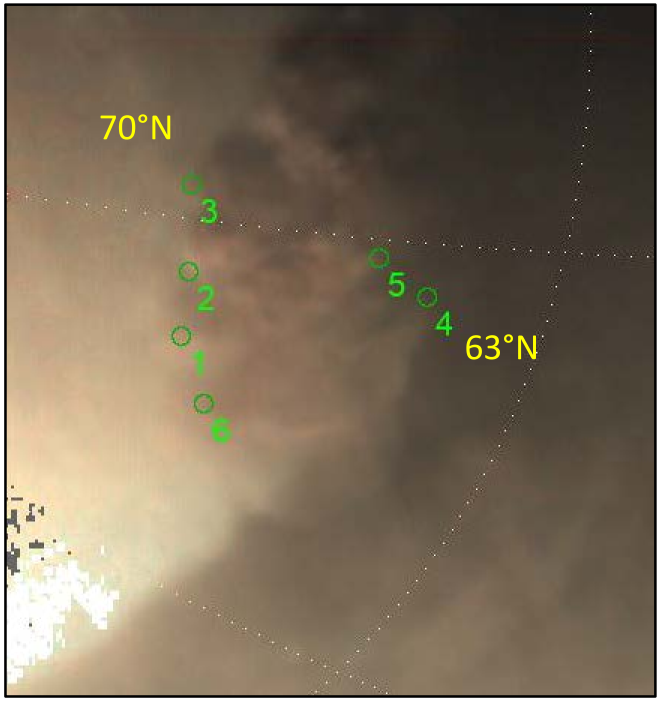
TDS2: 3 – 10 June 2019 (VMC)

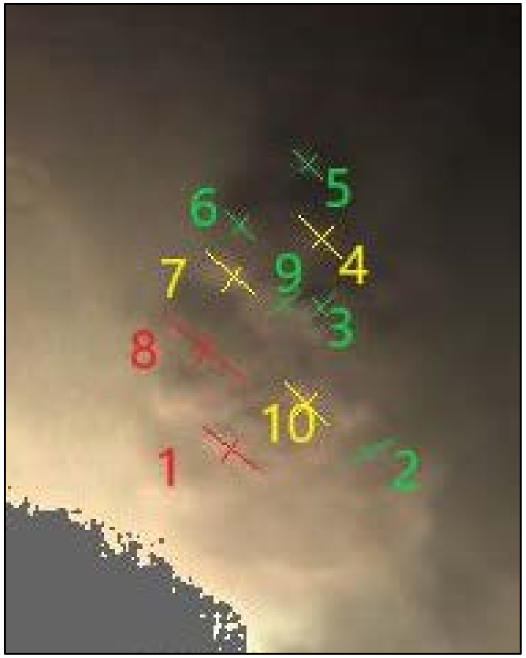




TDS2: 3 – 10 June 2019 (VMC)

Local storm in Arcadia Planitia
Area = 1.6-2.1 x10^5 km^2
Ls = 34°

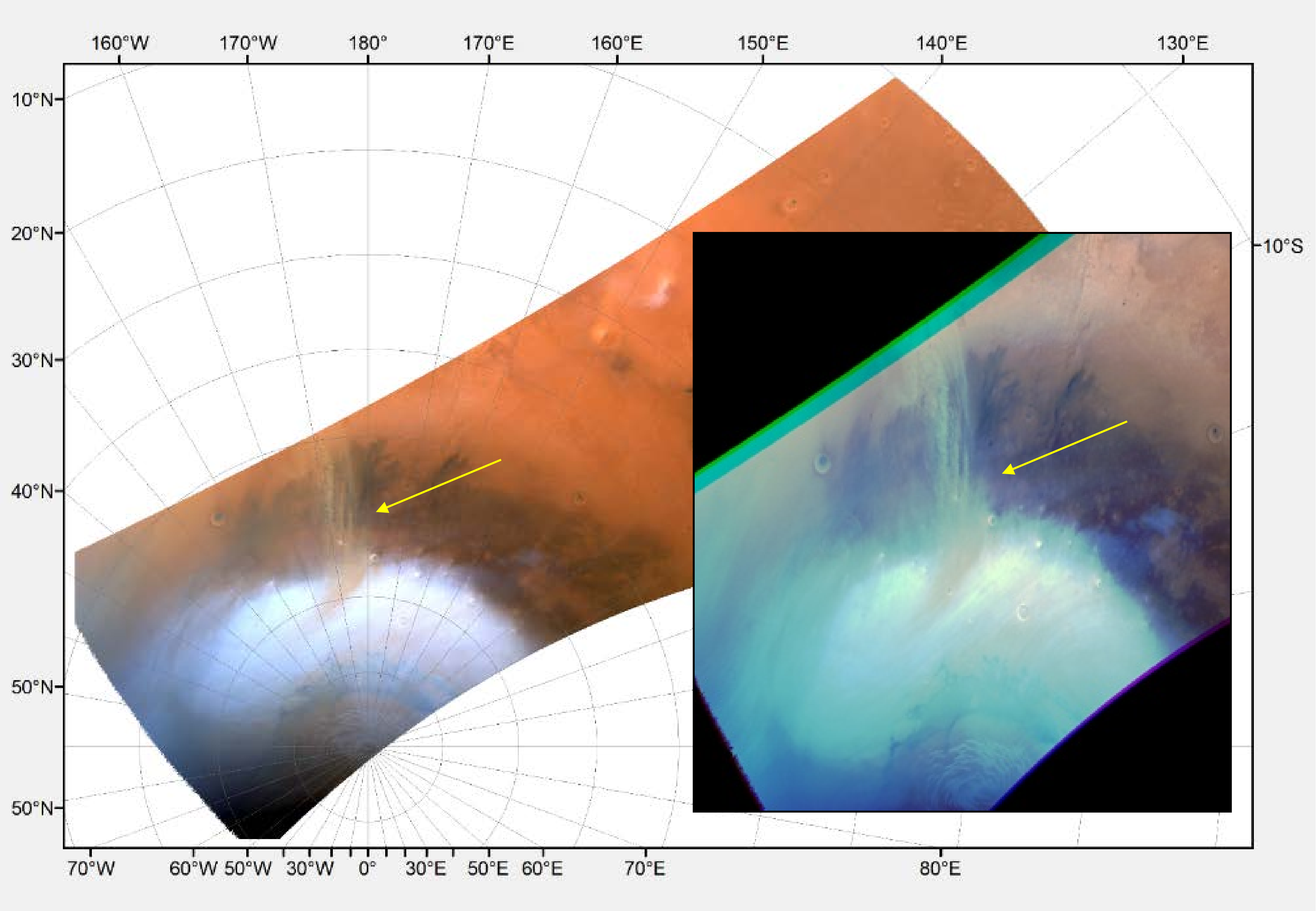




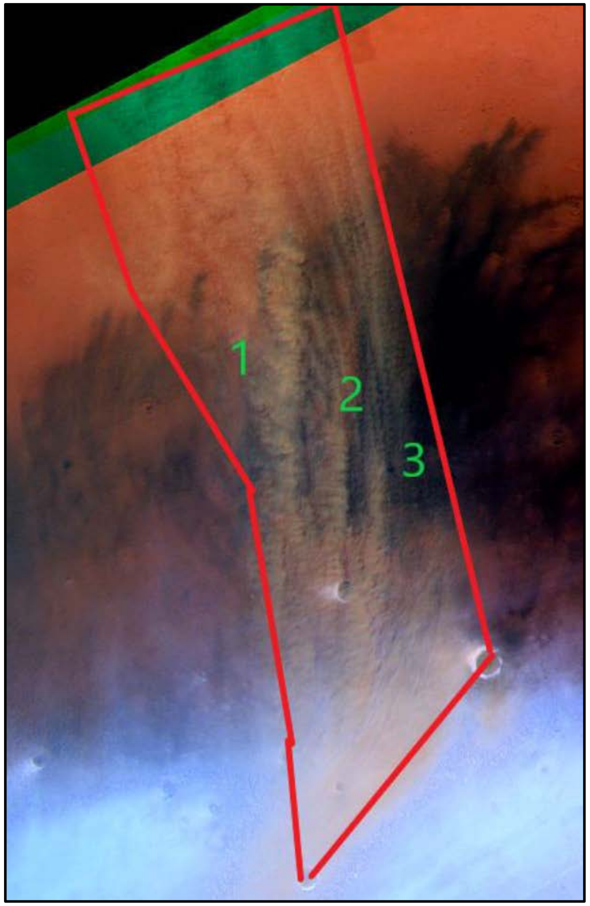
Texture type: pebbled-puffy
Cells oriented by wind direction:
<V> = 38 ms^{-1} (25-45 ms^{-1})

Single cells:
Length = 70 ± 18 km
Width = 42 ± 8 km
length/with ~ 1.6
Separation = 119 ± 32 km

TDS3: 22 May 2019 (HRSC)



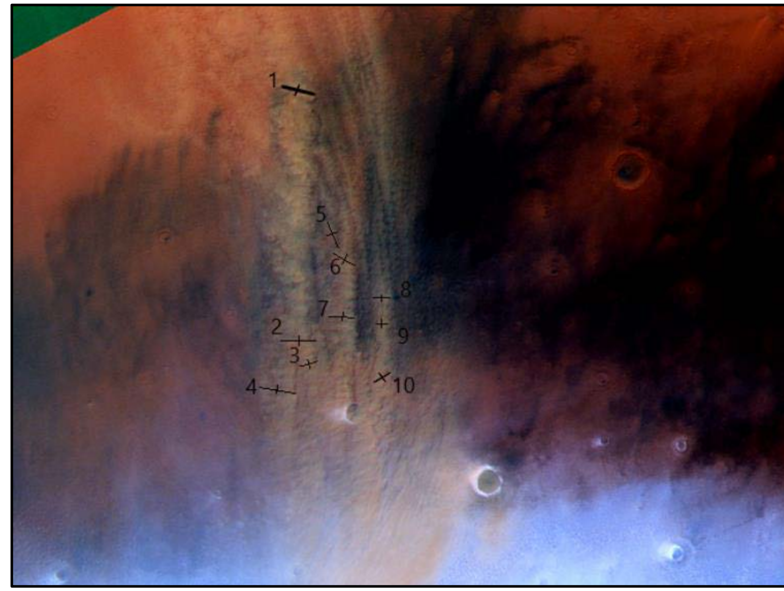
TDS3: 22 May 2019 (HRSC)



Local storm

Frontal shape
Three fronts:
Length = 950 km
Width = 85 km

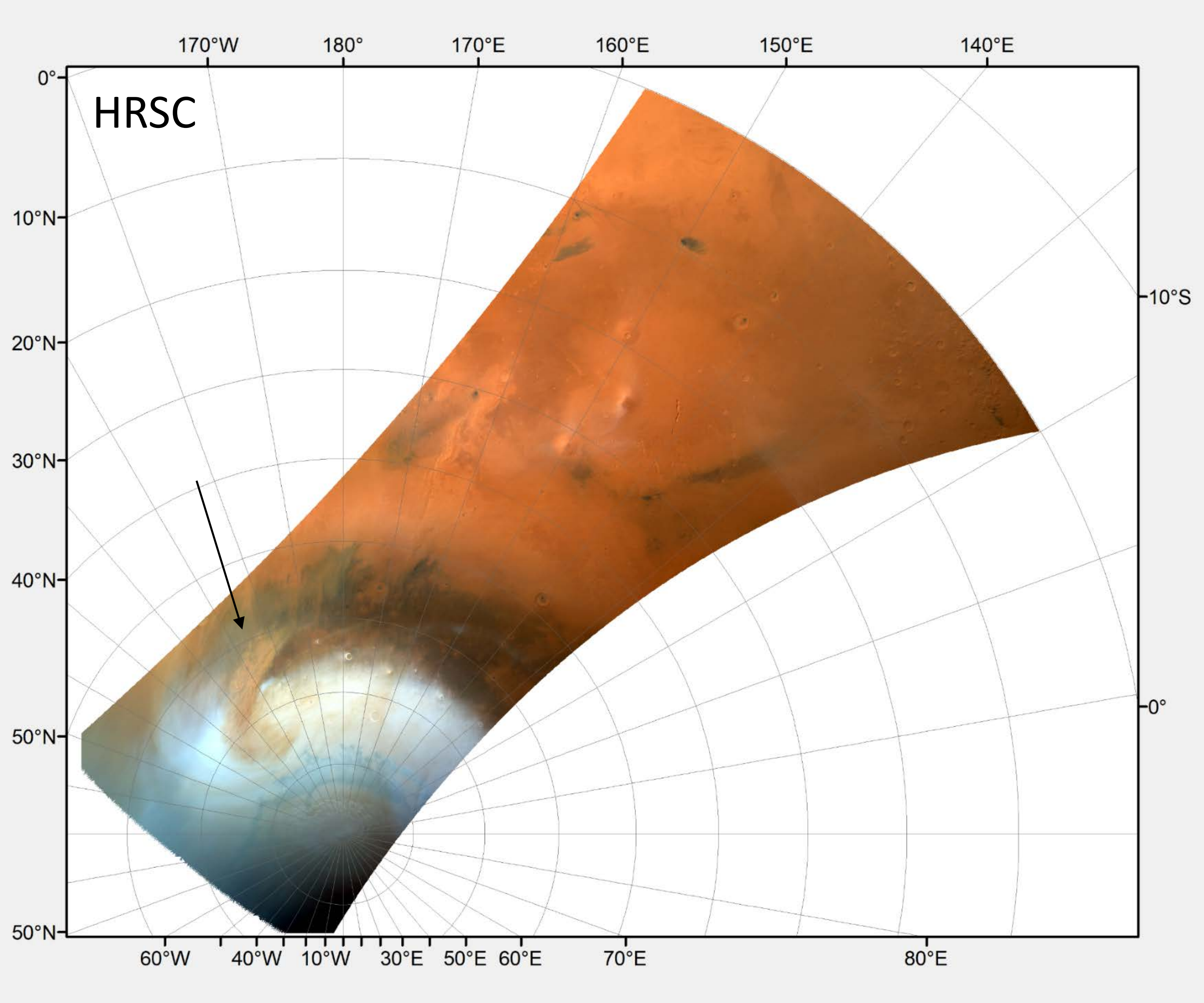
Area = 4.3 x10^5 km^2
Ls = 28°



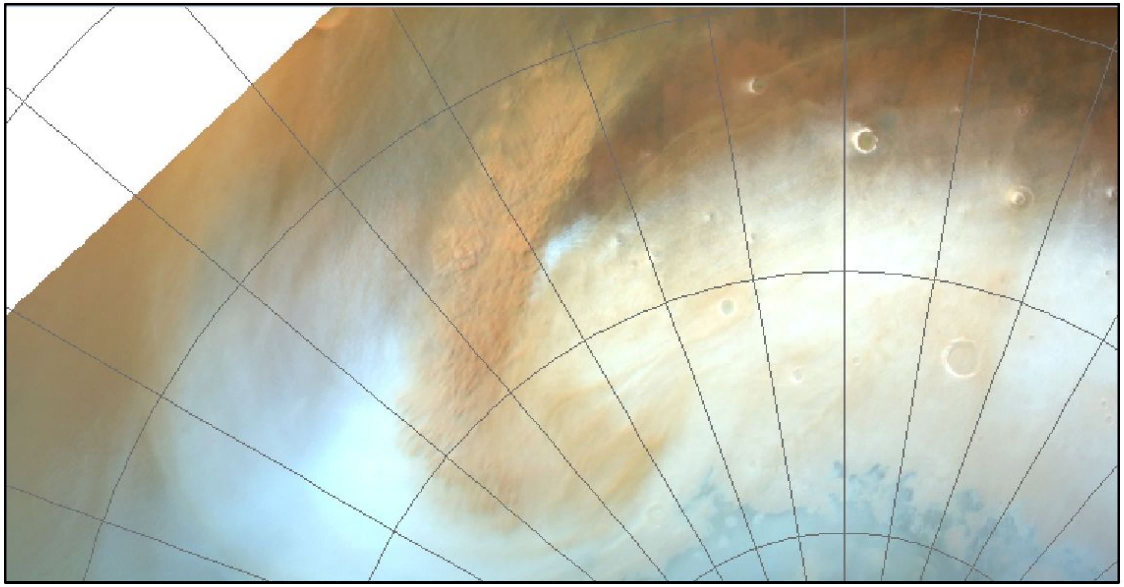
Cells clustered in the fronts
Cells oriented transversal to front direction

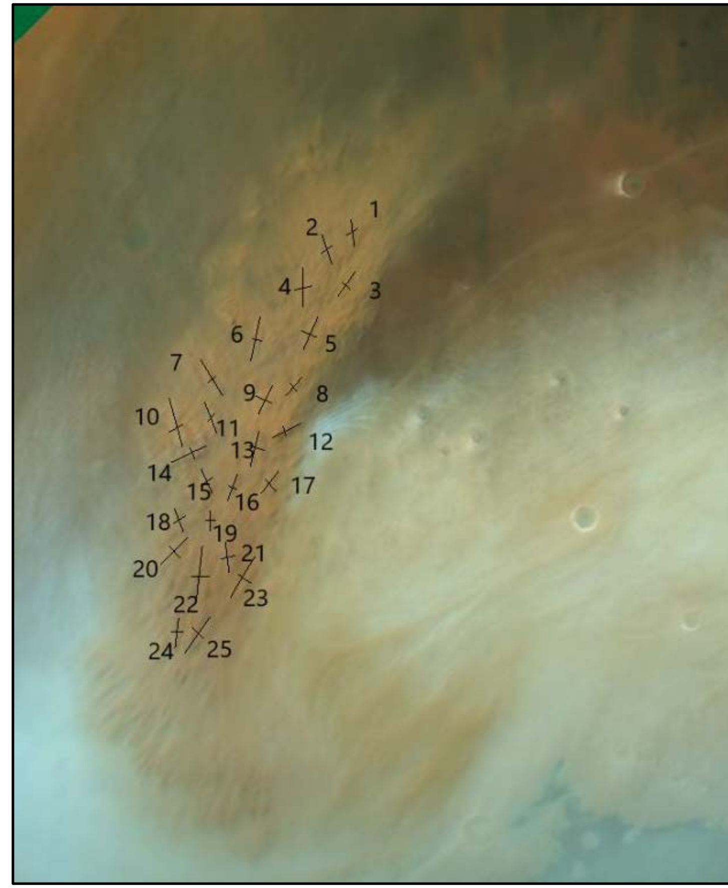
Single cells:
Length = 45 km
Width = 19 km
length/with ~ 1.5 -3.0
Separation = 35 - 40 km

TDS4: 26 May 2019 (HRSC)



TDS4: 26 May 2019 (HRSC)





Local storm
Spiral shape
Area = 2.6 x10^5 km^2
Ls = 30°

Mixture of dust and water ice clouds

Cells oriented and concentrated mainly along the spiral arm

Spiral resulting from dynamical instability (baroclinic nature?)

Single cells:
Length = 52 ± 13 km
Width = 21 ± 5 km
length/with ~ 2.5
Separation = 56 ± 15 km

Conclusions

Four textured **local dust storms** North Pole edge in springtime (Ls = 30° - 40°)
Formed by clusters of 20-50 cells structured in oriented patterns
Single cell: length = 50 – 140 km, width = 20 – 60 km
Cells tops show anisotropy (length/width ~1.5 – 3)
Cells show pebbled and puffy-like textures (Kulowski et al., 2017)

Dust updrafts mechanisms:

- Mean horizontal winds (V ~ 30 ms^{-1}) and high surface wind stresses
- Vertical wind shear due to dynamical instabilities (baroclinic)
- Dry convection driven dust heating (Spiga+, 2013; Heavens+, 2019)

Future work:

- Increase the number of cases studied
- Establish a relationship between wind speed and cell sizes
- Explore dust updraft models