CLOUD-TRACKED MARTIAN WINDS AS SEEN FROM HST IN OPPOSITION 2003

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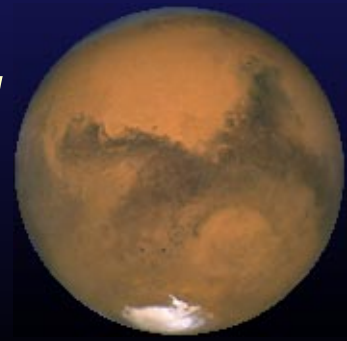
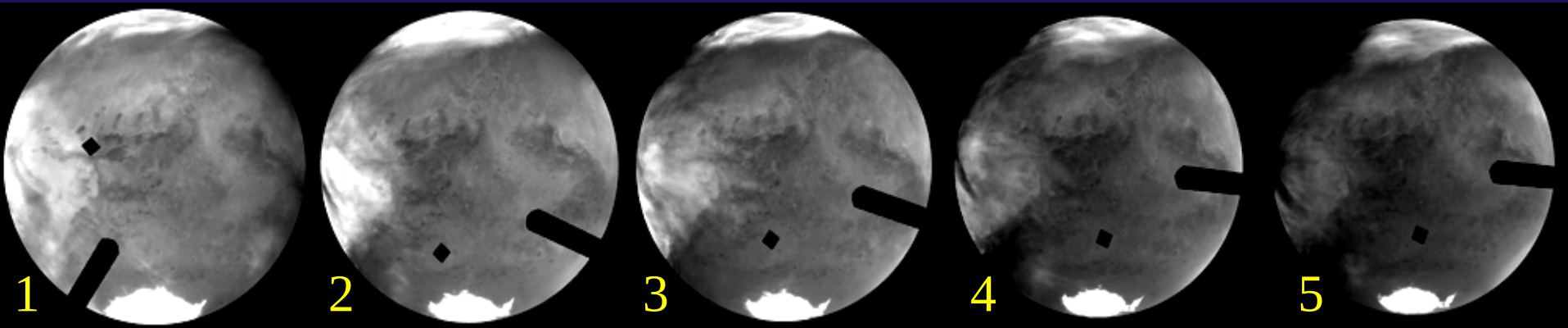


HST observations of Mars Opposition 2003

- **Camera**: ACS/HRC
- **Disk size** ~ 1000 pixels
- **Highest resolution:** (disk center) ~ 7 km/pixel

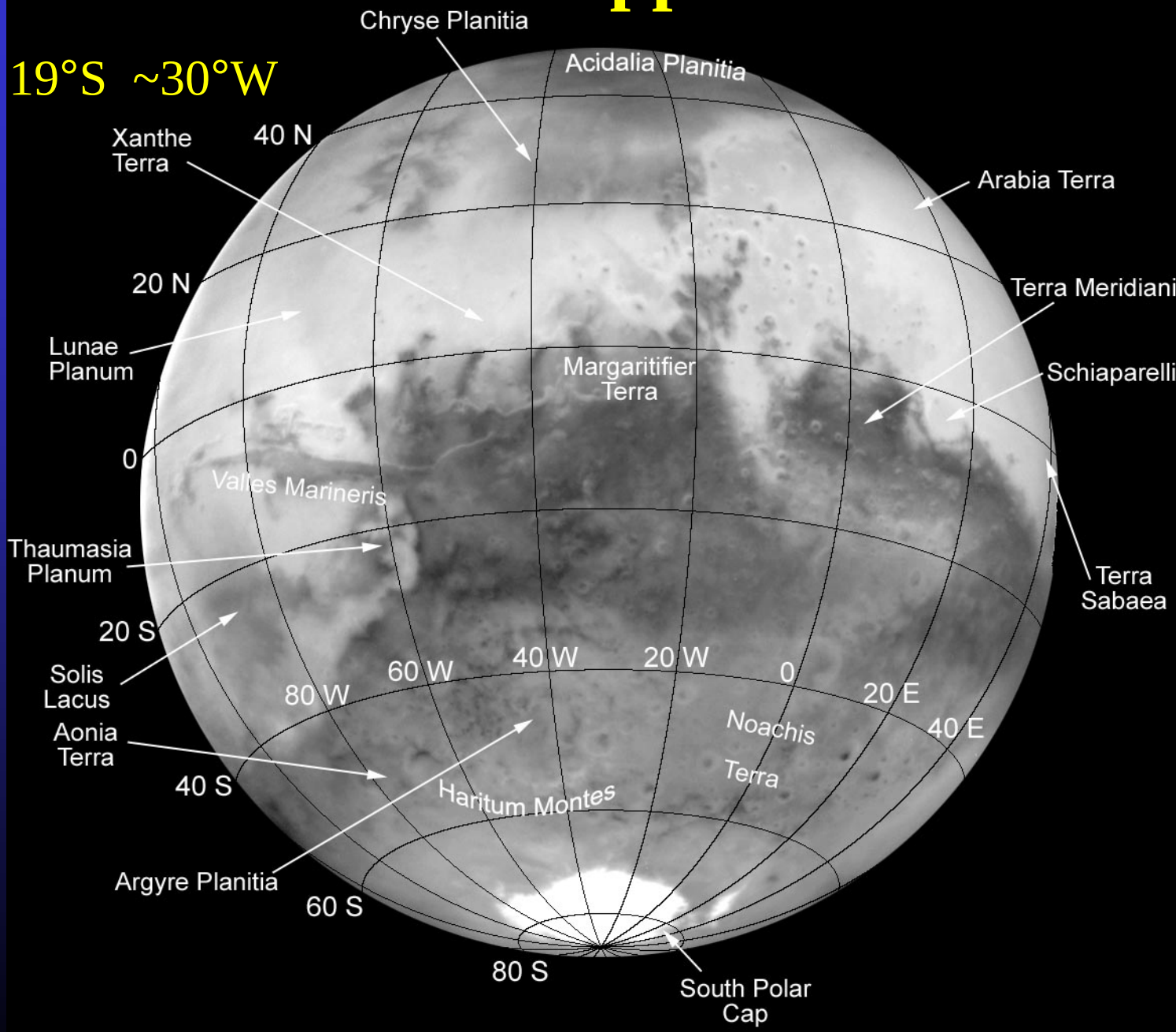
Date of Year 2003		L_s, deg.	Spectral filters	
1	Aug., 24	247	250 nm	**UV I (**+ 3 polarizations)
2	Sept., 05	254.5	330 nm	**UV II (**+ 3 polarizations)
3	Sept., 07	255.8	435 nm	**Blue (**+ 3 polarizations)
4	Sept., 12	259	502 nm	**Green**
5	Sept., 15	261	658 nm	**Red**
			892 nm	**IR**

Clouds: •Northern cloud belt • changing clouds system (west)



HST observations of Mars Opposition 2003

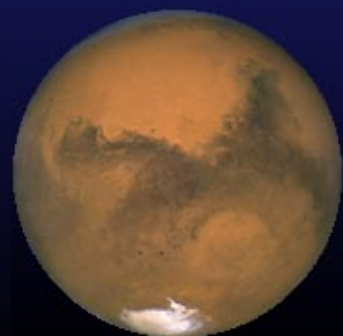
- **Disk center**: 19°S ~30°W
- **Season:** summer in southern hemisphere



Red filter,
Sept. 15, 2003

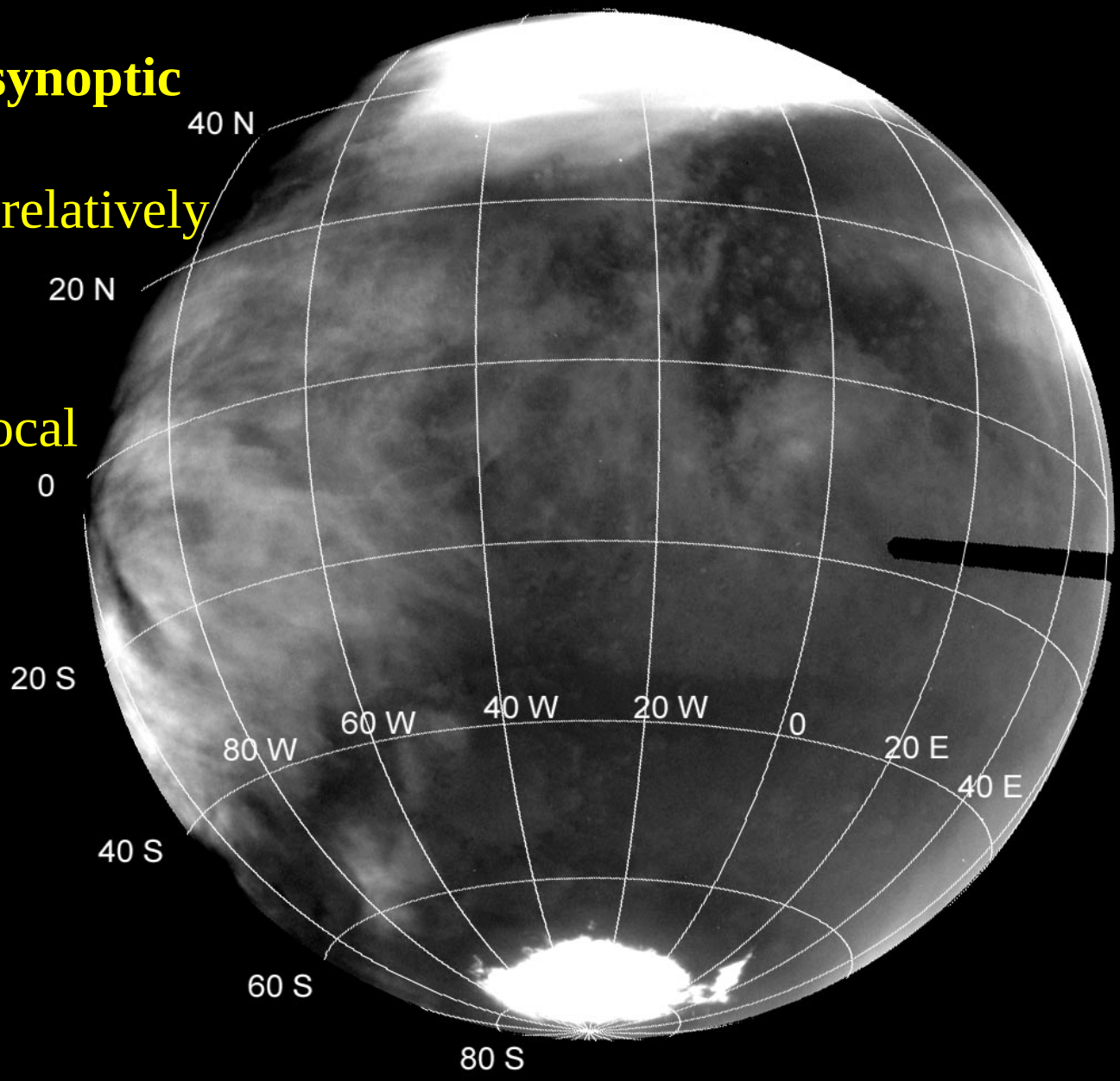
Image data processing

- **Standard pipeline calibration**
  - dark current
  - flat field
  - geometric distortion
- **Cosmic-ray-tracks removal** (abundant in the near-UV)
- **Coregistration**
  - 3 successive images within each near-UV set
  - Time lag ~2 min between images (Mars rotation)
  - Mapping into a similar projection
  - Smoothing



Wind speed measurements: cloud shifts

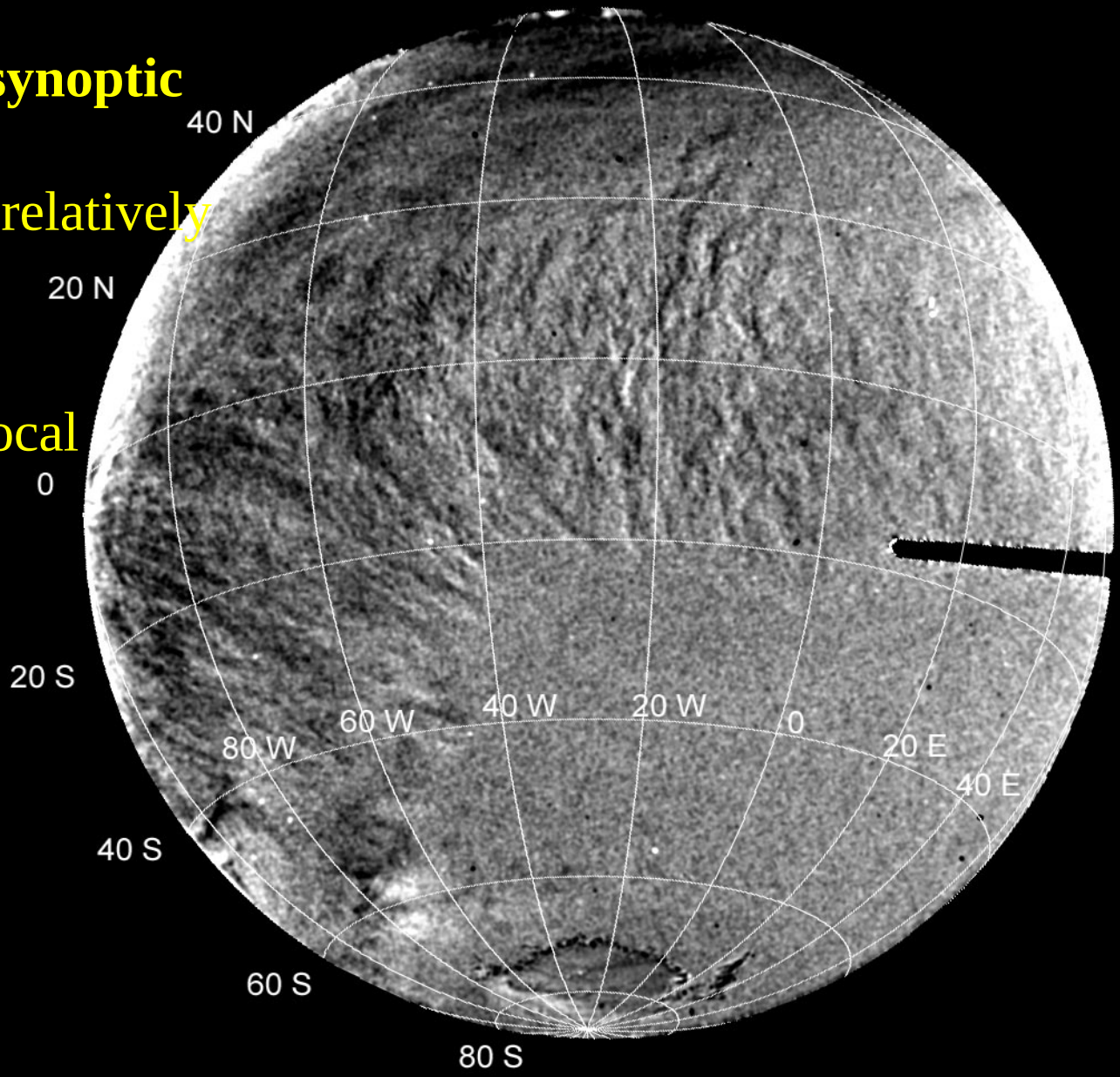
- **Detection of the synoptic motion:**
- clouds movement relatively to the surface
- **c**oregistration – maximization of local covariation of images



UV II,
Sept. 15, 2003

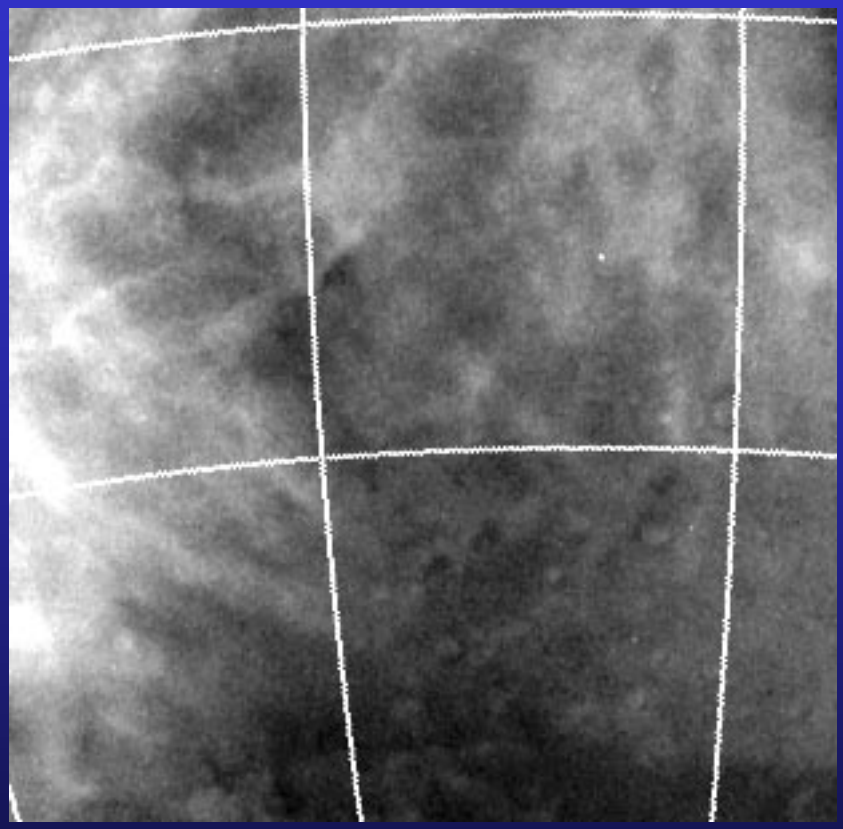
Wind speed measurements: cloud shifts

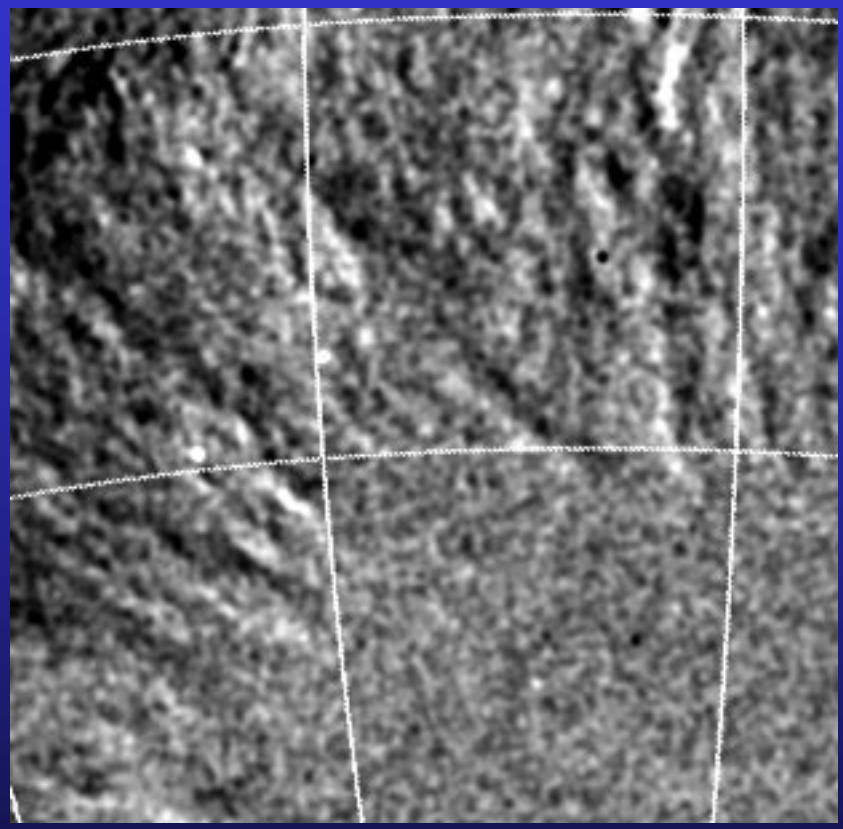
- **Detection of the synoptic motion:**
- clouds movement relatively to the surface
- **c**oregistration – maximization of local covariation of images



UV II Ratio: POL120/POL0, Sept. 15, 2003

Wind speed measurements: cloud shifts





UV II

UV II Ratio: POL120/POL0

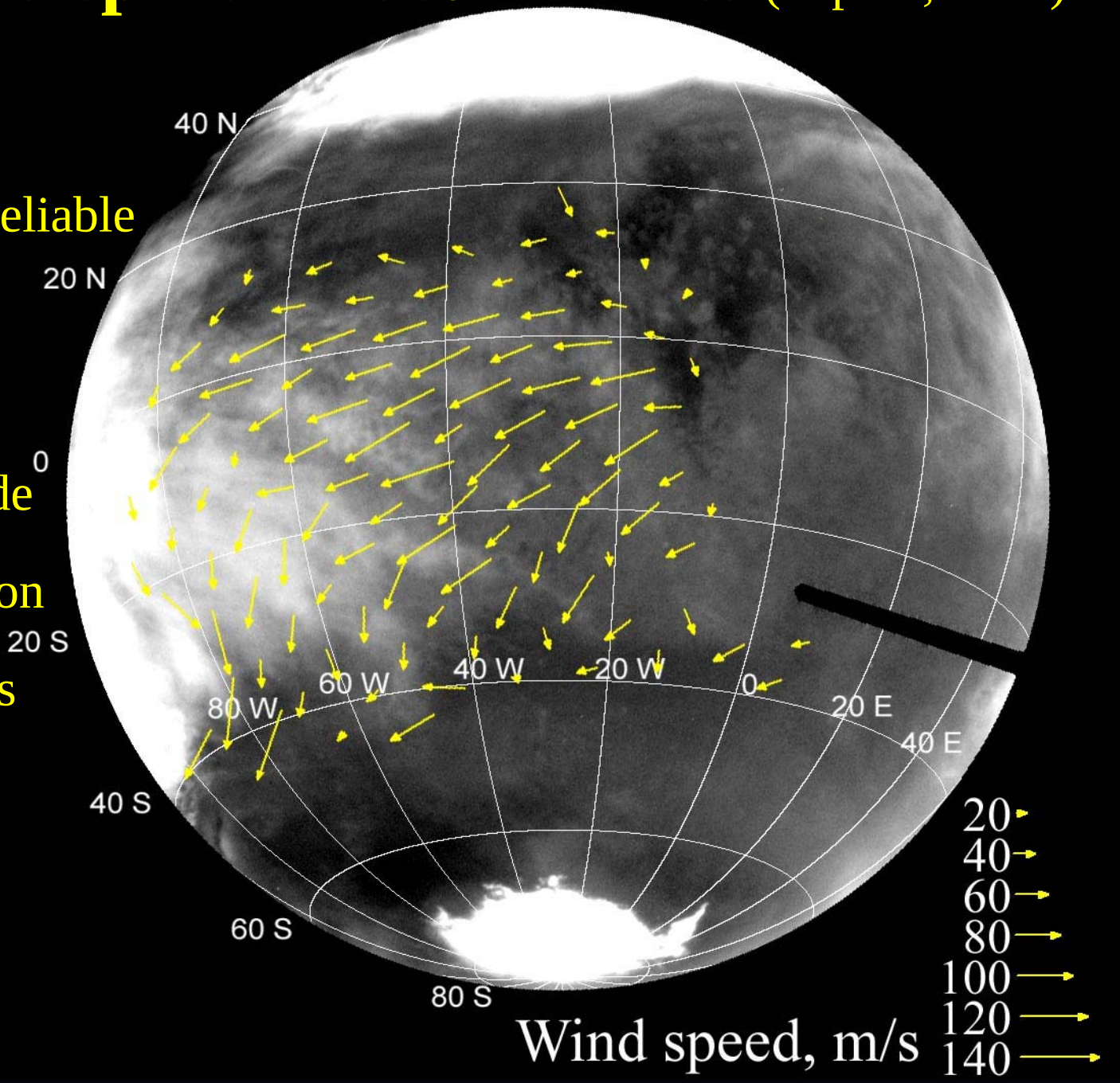
Sept. 15, 2003

Results: wind speed measurements (Sept. 7, 2003)

- Determination:

Tharsis rise: most reliable

- Features:
- Blowing retrograde
- Poleward deflection
- Orographic effects (Tharsis edge)



Results: wind speed measurements (Sept.15, 2003)

- Determination:

Tharsis rise: most reliable

- Features:
- Blowing retrograde
- Poleward deflection
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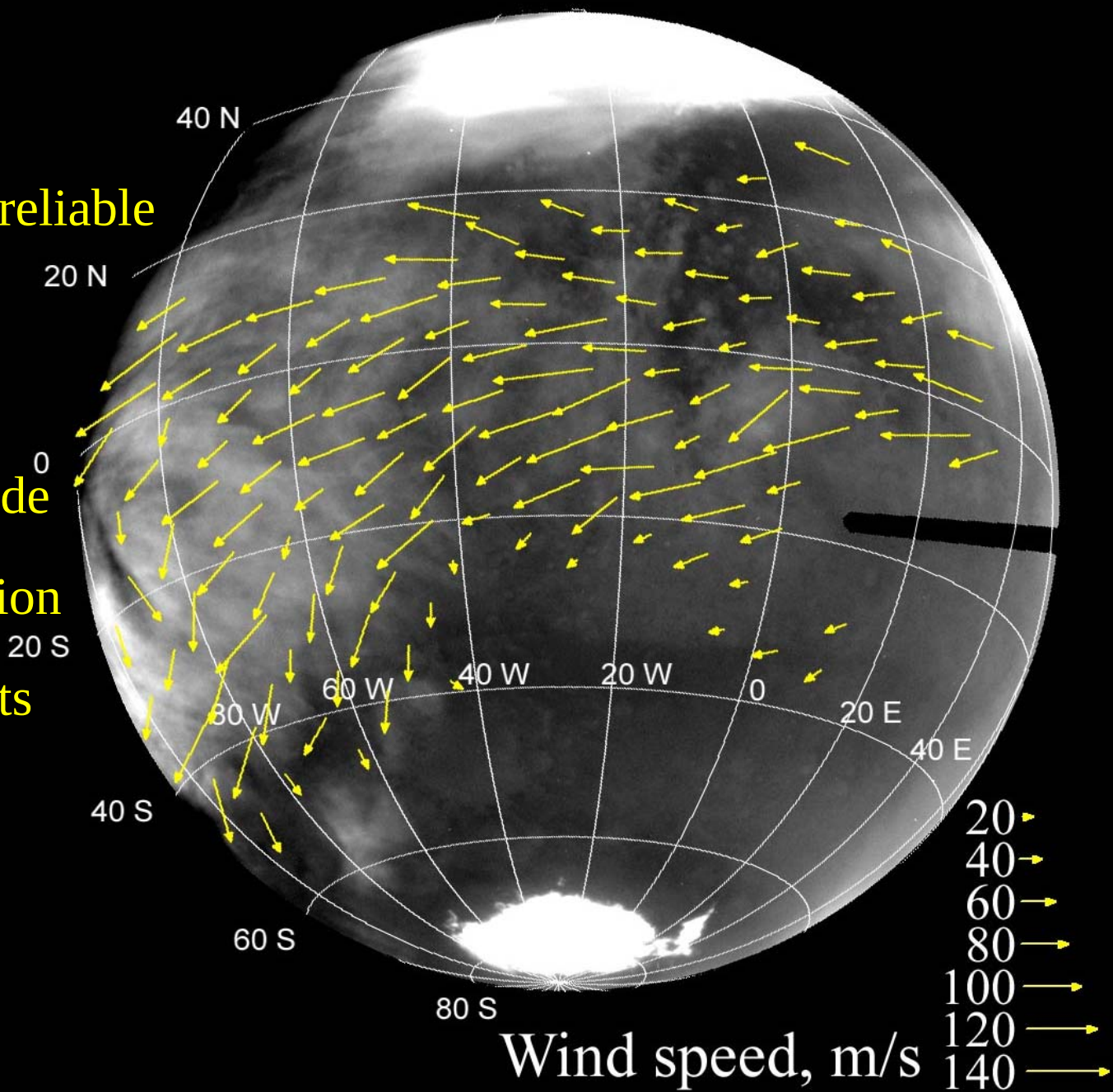
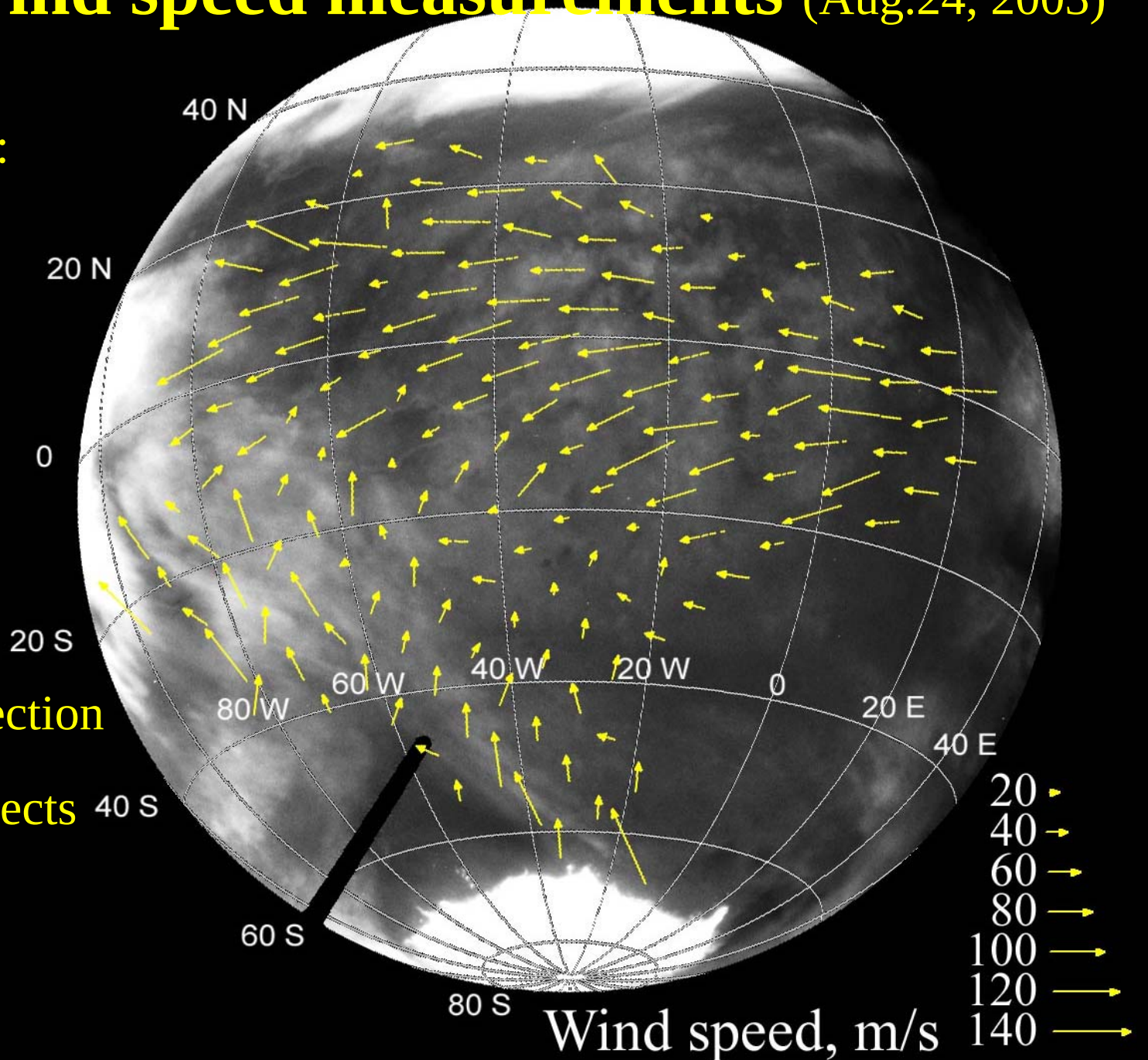


Results: wind speed measurements (Aug.24, 2003)

- Determination:

Tharsis rise: most reliable

- Features:
- Blowing retrograde
- Poleward deflection
- Orographic effects (Tharsis edge)



Wind speed measurements: source of errors

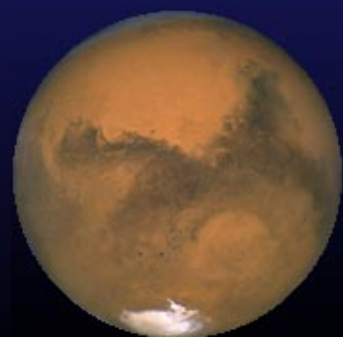
- maximization of local covariation of images:

  ±0.1 px -> ~ ± 3 m/s & ± 6 deg.
- inaccuracy of scale knowledge (at 10^{-3} level)
- inaccuracy in the location of the Mars disk center
- individual field of view distortion of the polarization filters

  (Biretta et al., *ACS 2004-09*, Baltimore: STScI, 2004):

  ±0.3 px -> ~ ± 10 m/s & ± 17 deg.

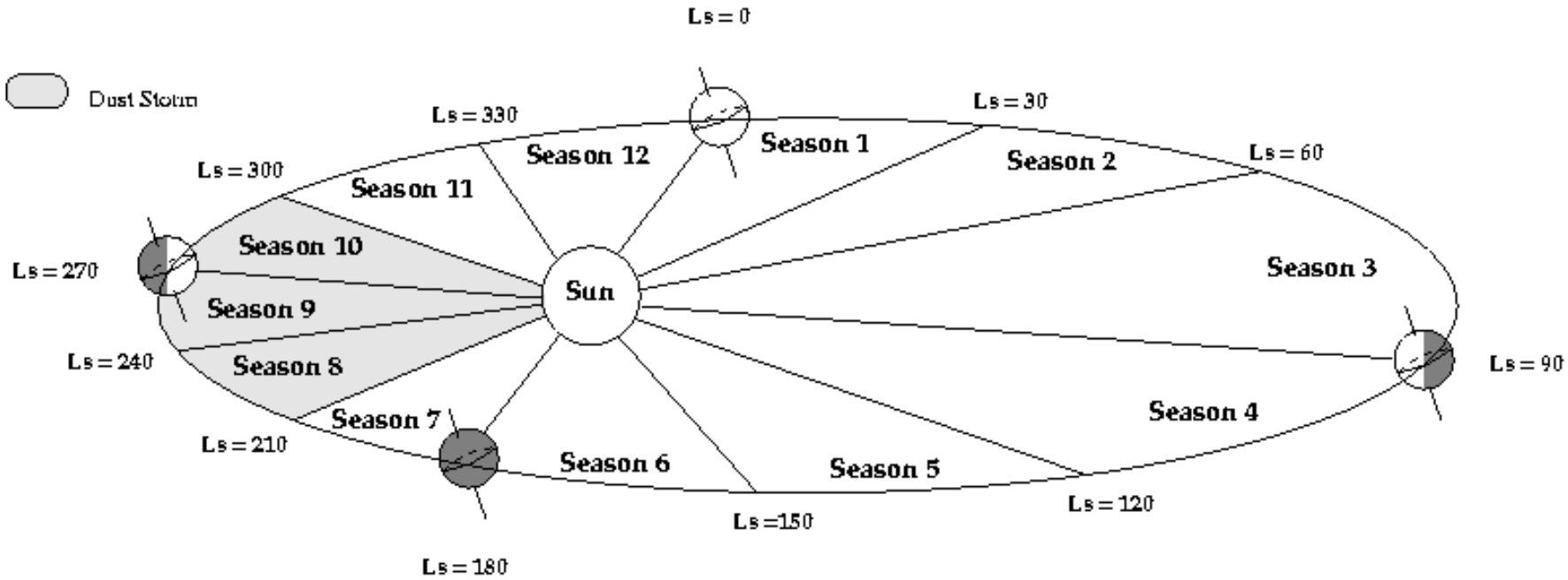
  (smoothly spatially varying geometric distortion)



Wind speed: comparison with the Mars climate database

THE EUROPEAN MARS CLIMATE DATABASE

[Lewis, S.R., Collins, M. and Forget, F. (2001a) Mars Climate Database v3.0] http://www.lmd.jussieu.fr/mars.html



L_s = 240° - 270° (Season 9 – perihelion)

Wind speed: comparison with the Mars climate database

Dust scenario: Low / High ??

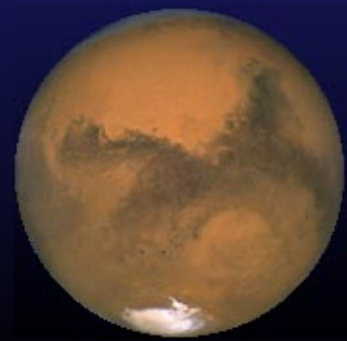
MGS TES atmospheric dust opacity (9.7 μm) retrievals (Sept., 2003):

- the atmosphere was relatively dusty in comparison to the aphelion
- the dust is evenly distributed in the atmosphere
- TES data do not show any pronounced dust-lifting events

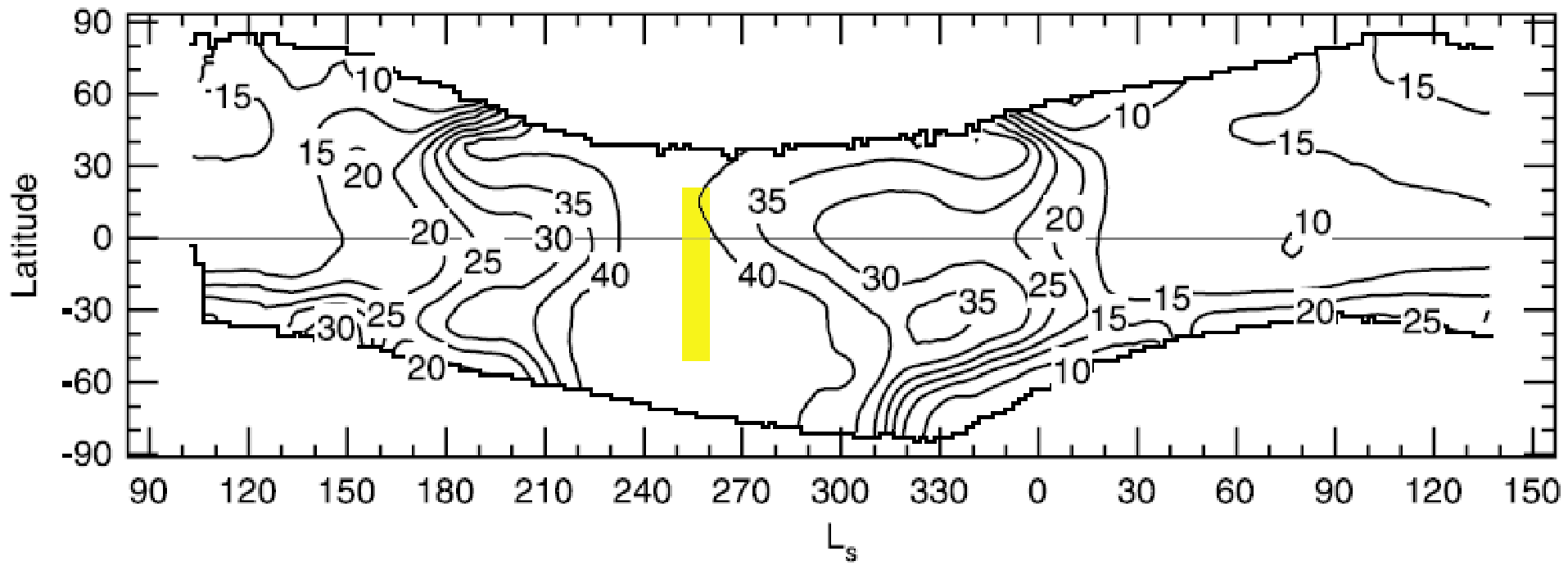
MGS Dust Scenario & **"Viking Lander"** Dust Scenario

Diurnal cycle:

HST images → morning for western part of disk,
evening for the eastern part



Altitude of upper cloud layer ?

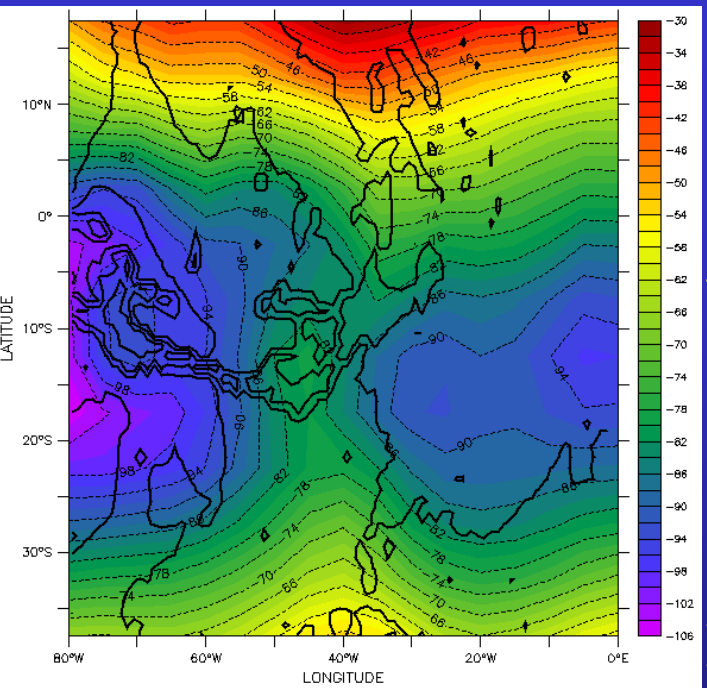


The height in km above the surface of water condensation level

[From: Smith, M.D., JGR, 2002, vol.107, No.E11, 5115]

- Highest condensation levels ≥ 40 km
- Altitude of optically thick clouds for wind tracking ??

MGS dust scenario - Zonal wind



←LT 12:00

U

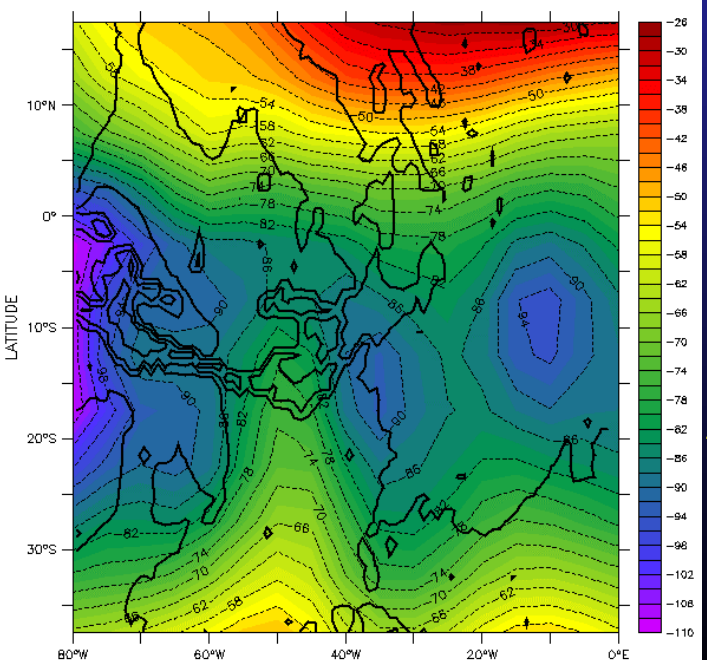
-100 …-30 m/s

Layer 17
(43km) –
σ = 0.011008

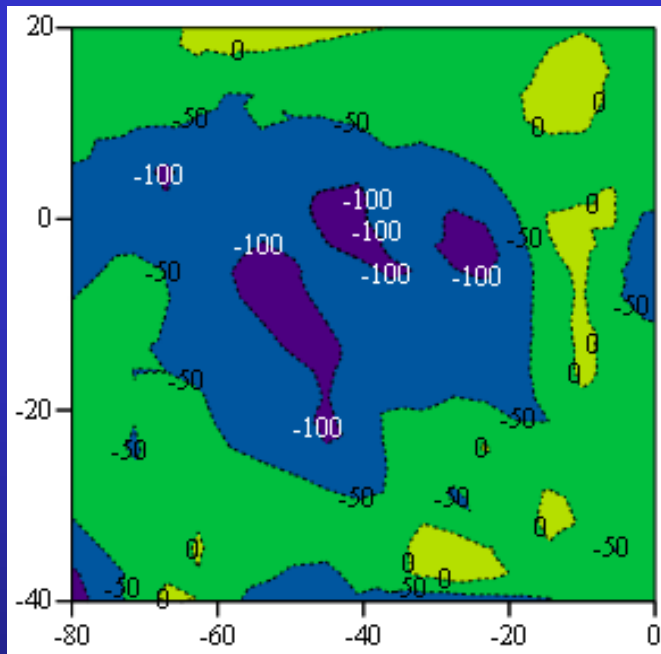
← LT 08:00

U

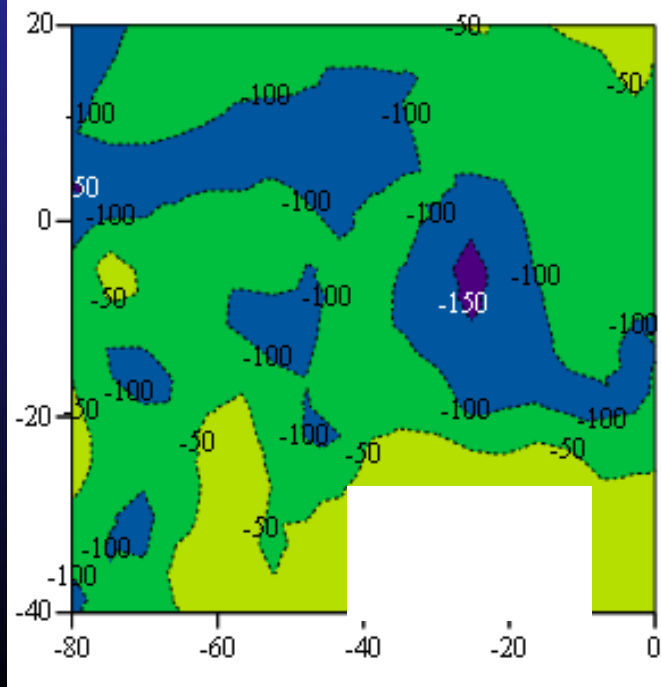
-110 …-30 m/s



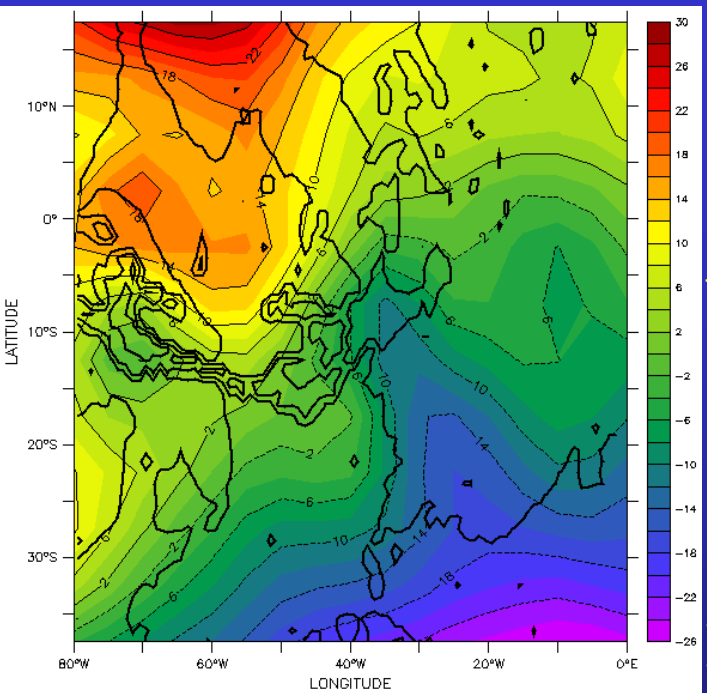
Sept.,7



Sept., 13



MGS dust scenario - Meridional wind

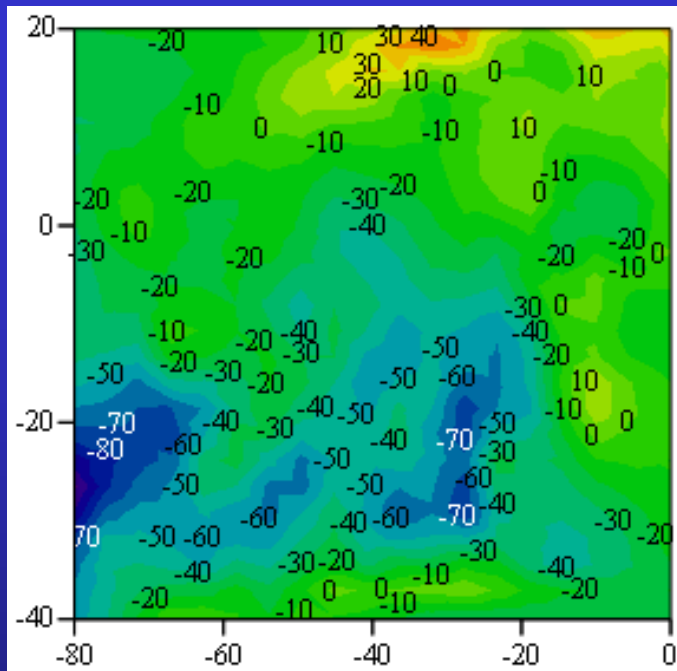


←LT 12:00

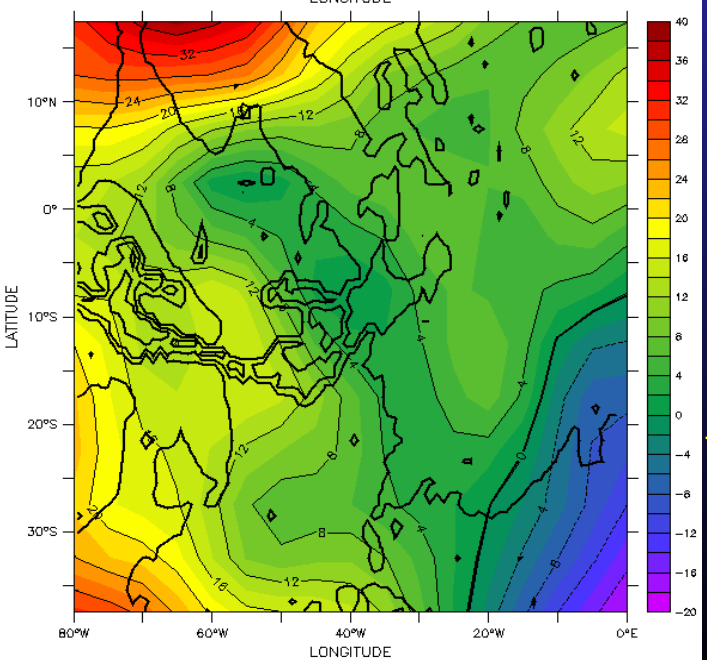
V

-30 …30 m/s

Sept,7



Layer 17 (43km) – σ = 0.011008

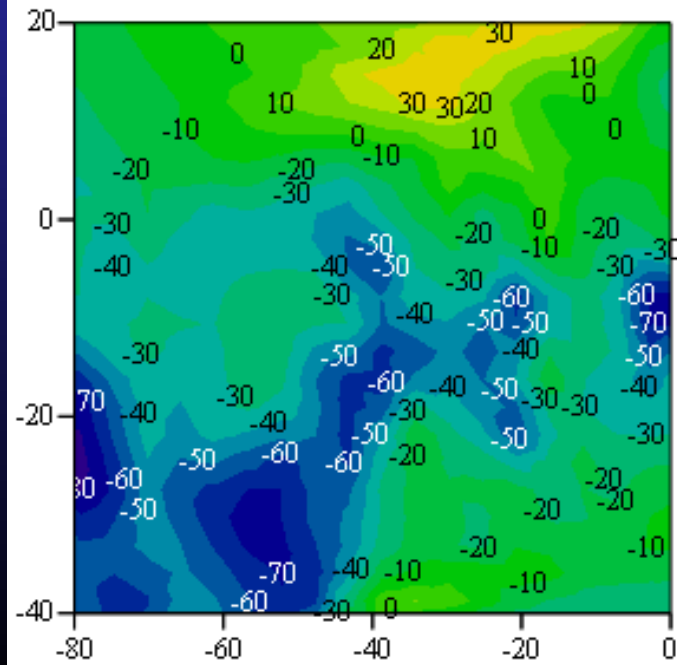


← LT 08:00

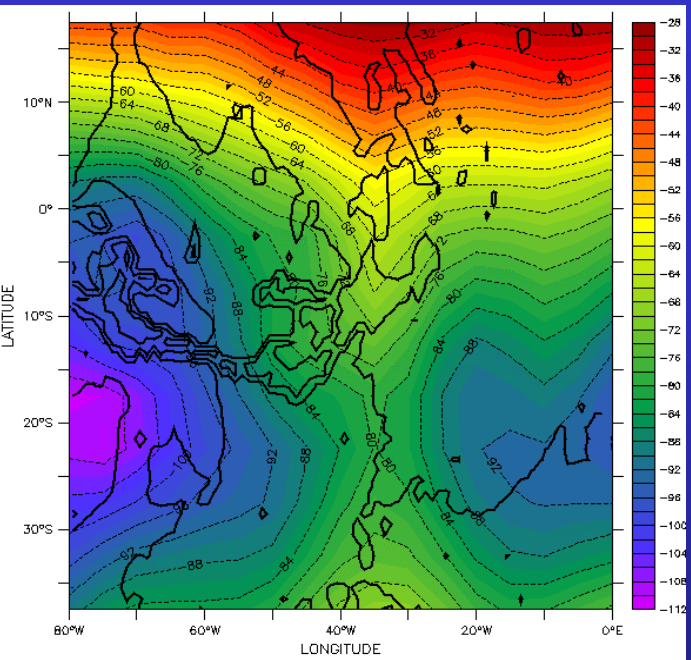
V

-20 …40 m/s

Sept, 13



Viking dust scenario - Zonal wind



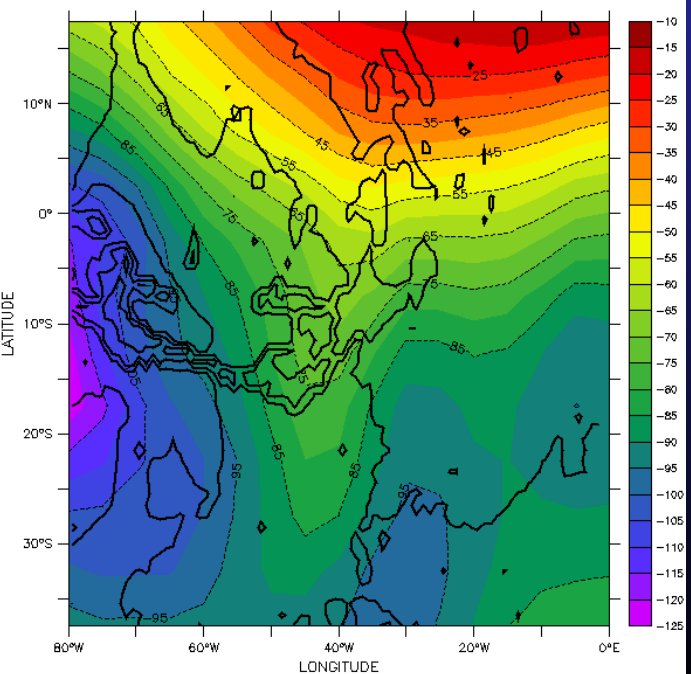
←LT 12:00

U

-110 …-30 m/s

Sept,7

Layer 17
(43km) –
σ = 0.011008

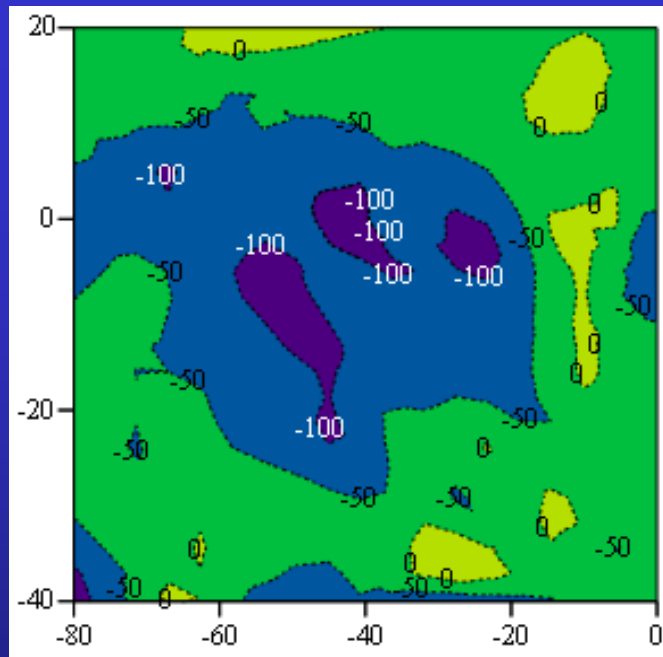


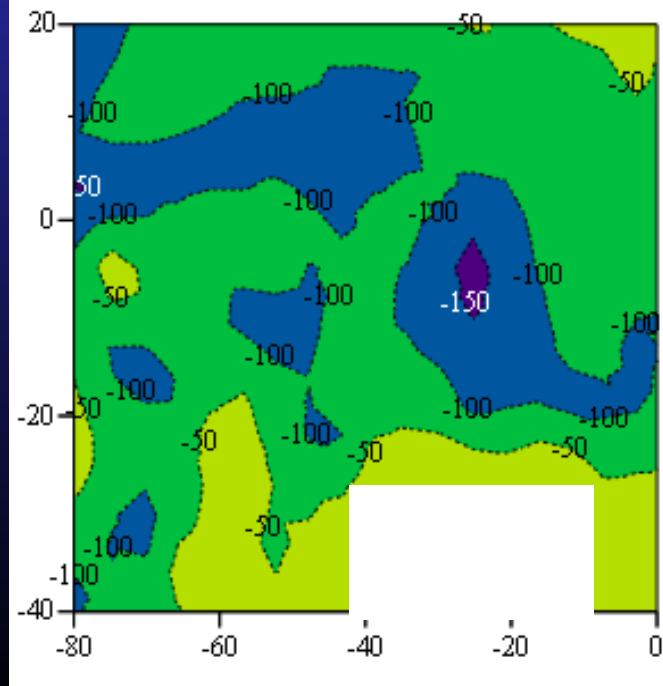
← LT 08:00

U

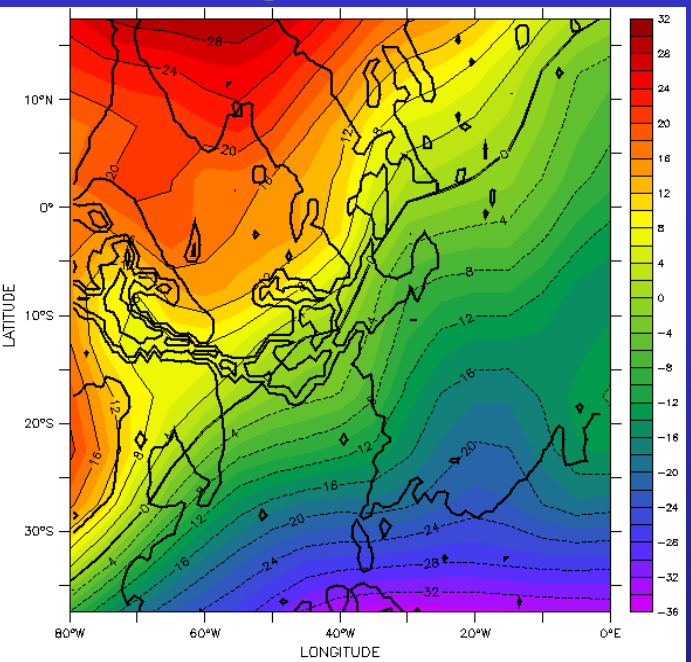
-125 …-10 m/s

Sept, 13





Viking dust scenario - Meridional wind

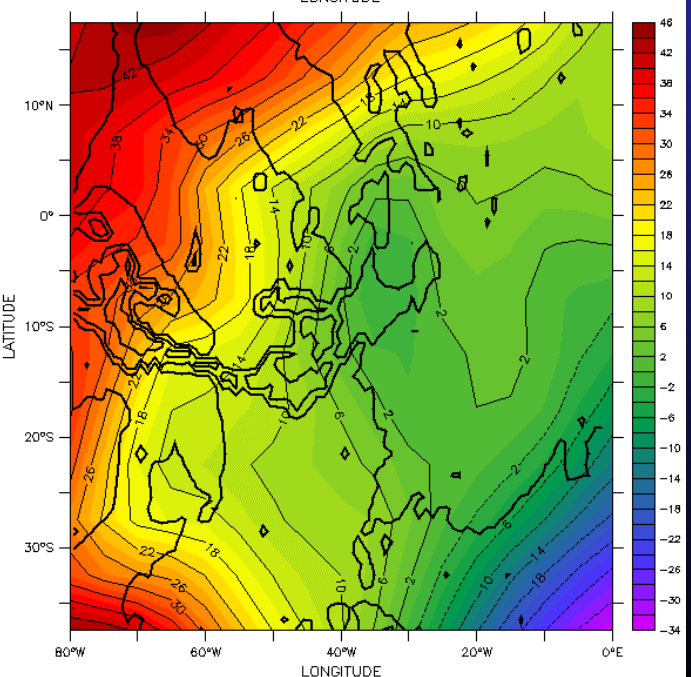


←LT 12:00

V

-35 …35 m/s

Layer 17 (43km) – σ = 0.011008

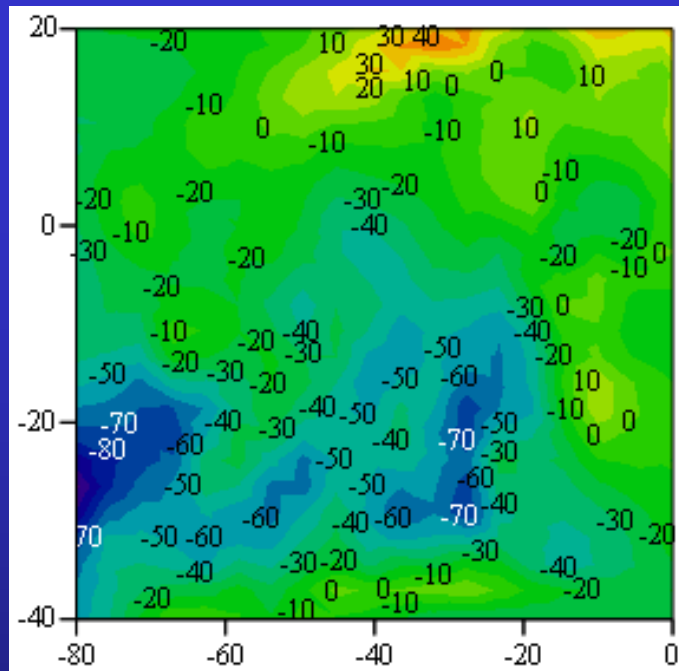


← LT 08:00

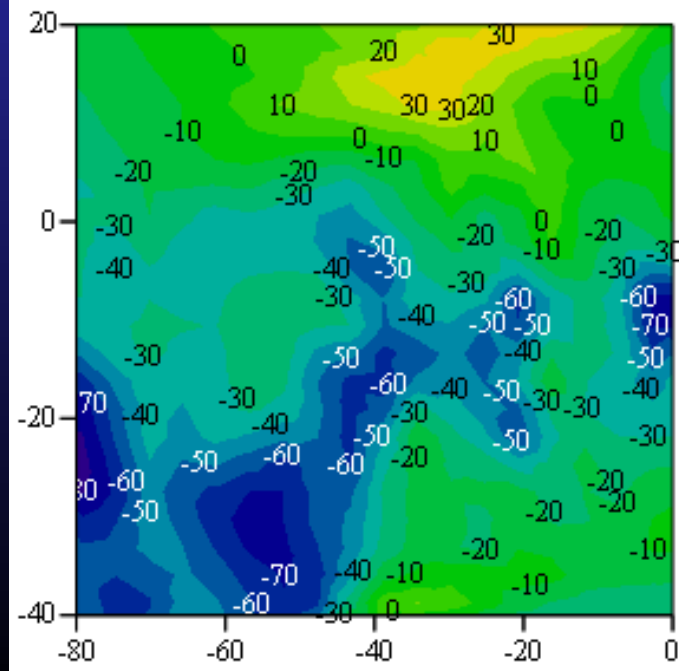
V

-35 …45 m/s

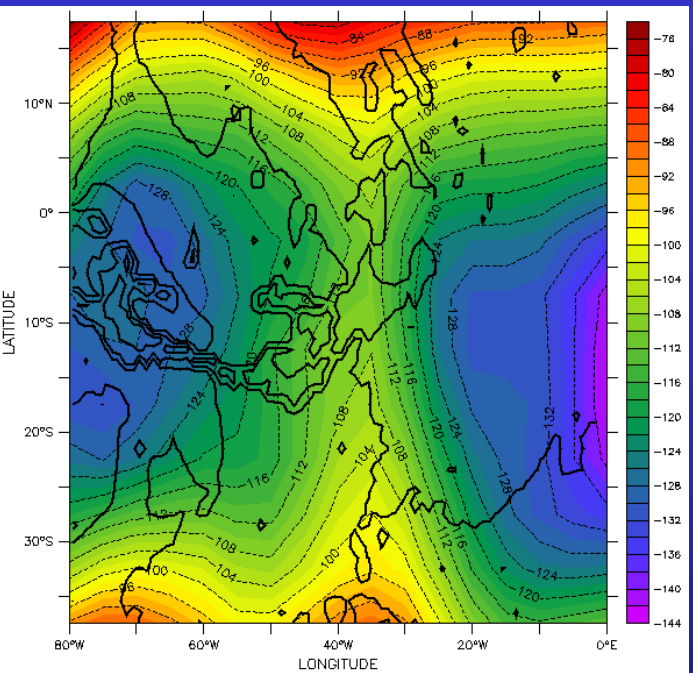
Sept,7



Sept, 13



Viking dust scenario – Zonal wind

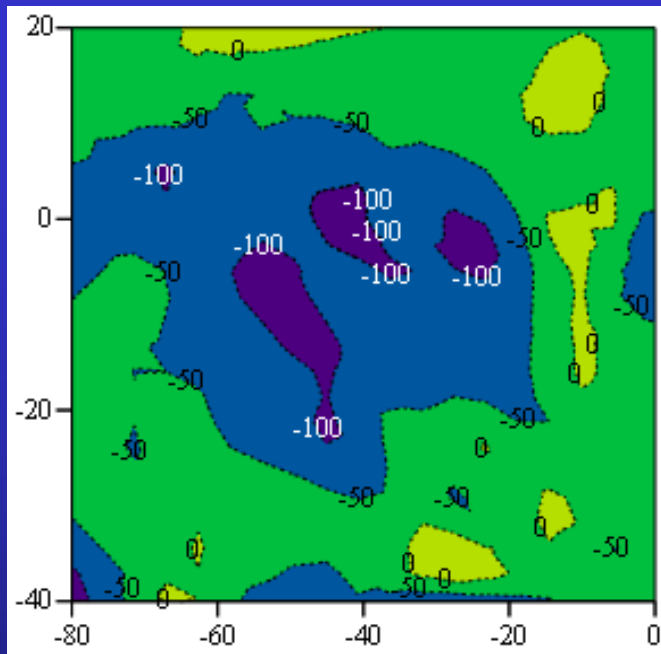


←LT 12:00

U

-145 …-75 m/s

Sept,7

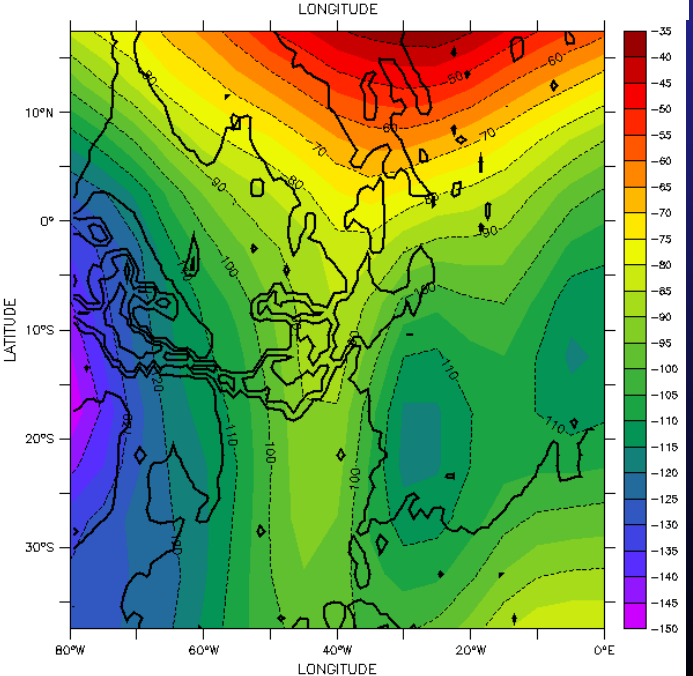


Layer

(65km) –

$\sigma = 0.00277$

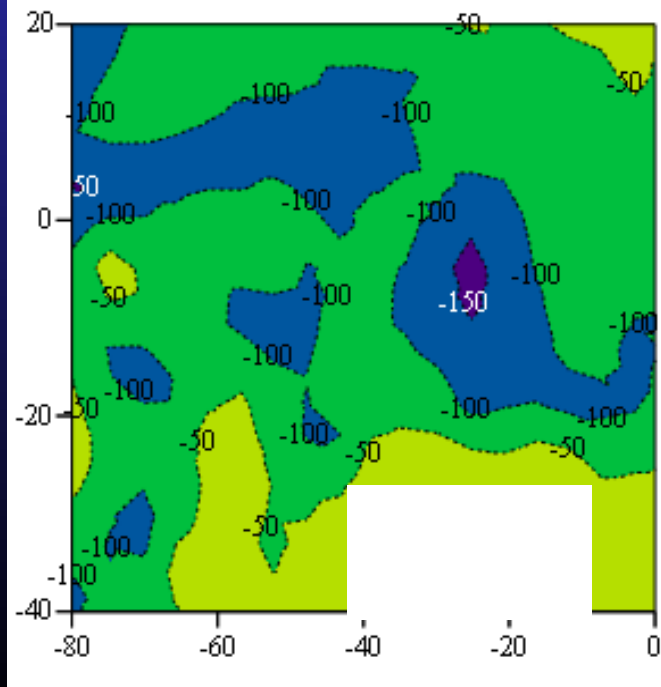
Sept, 13



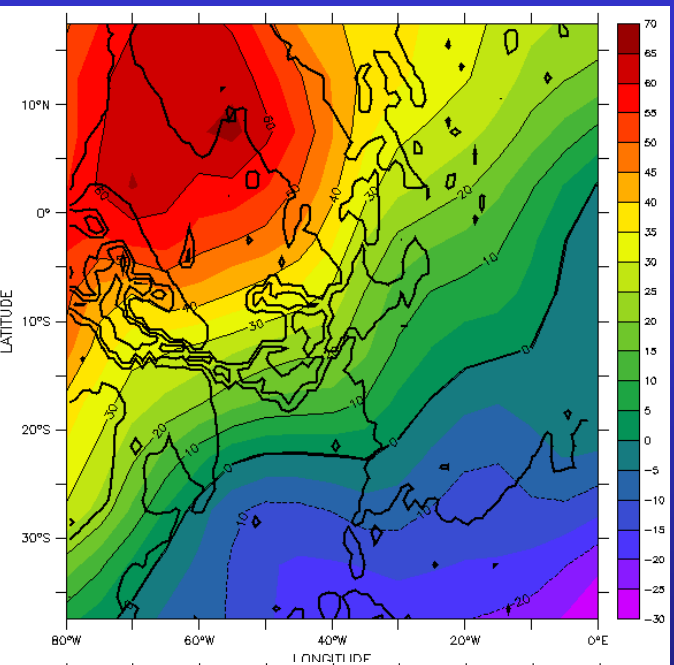
← LT 08:00

U

-150 …-35 m/s



Viking dust scenario - Meridional wind



←LT 12:00

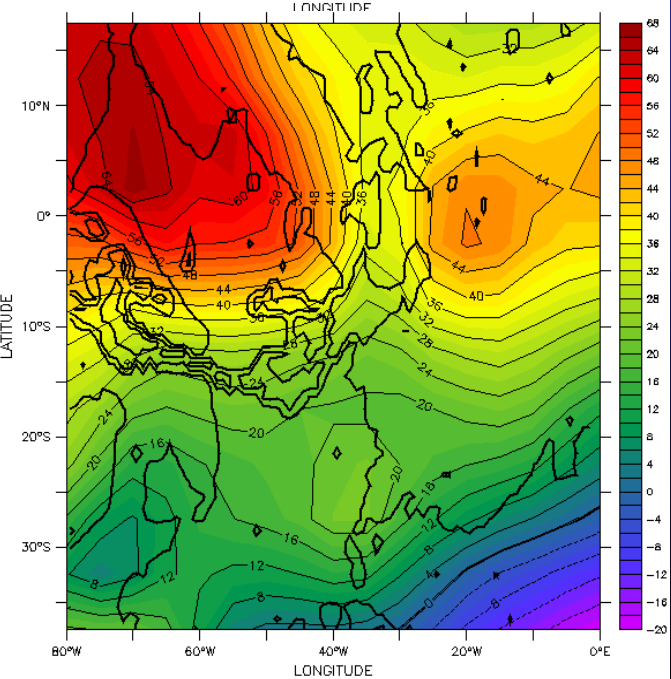
V

-30 …70 m/s

Layer

(65km) –

σ = 0.00277

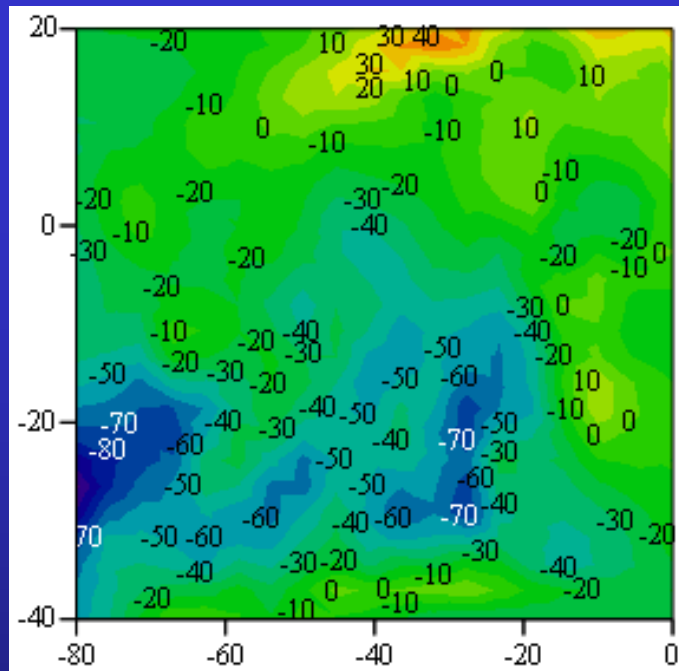


← LT 08:00

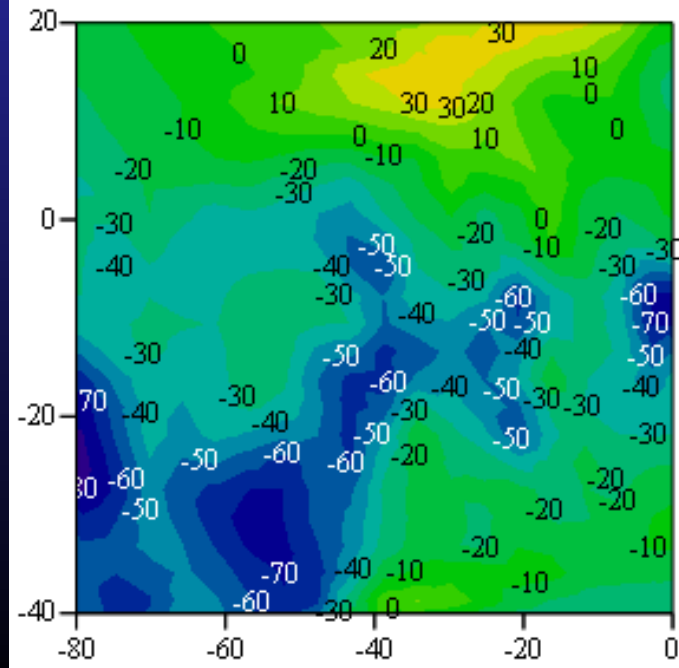
V

-20 …65 m/s

Sept,7



Sept, 13



Conclusions

- **Wind field features**:

√ Retrograde to the planetary motion
(pole-equator temperature gradient)
√ Poleward deflection (southern latitudes)
√ Deviation of wind direction pattern near Eastern edge of Tharsis rise

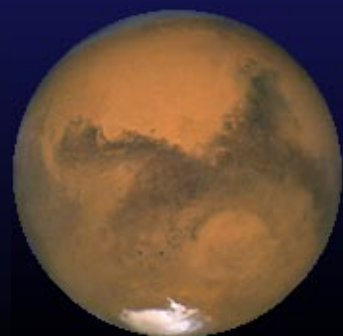
- **MARS CLIMATE DATABASE comparison**:

√ General consistency assuming clouds condensation level ≥ 40 km

√ Higher negative ***U*** and ***V*** observed

- **Synchronous HST and MeX (PSF) observations:**

√ Complementary measurements of Martian winds



Thank you
for attention!