

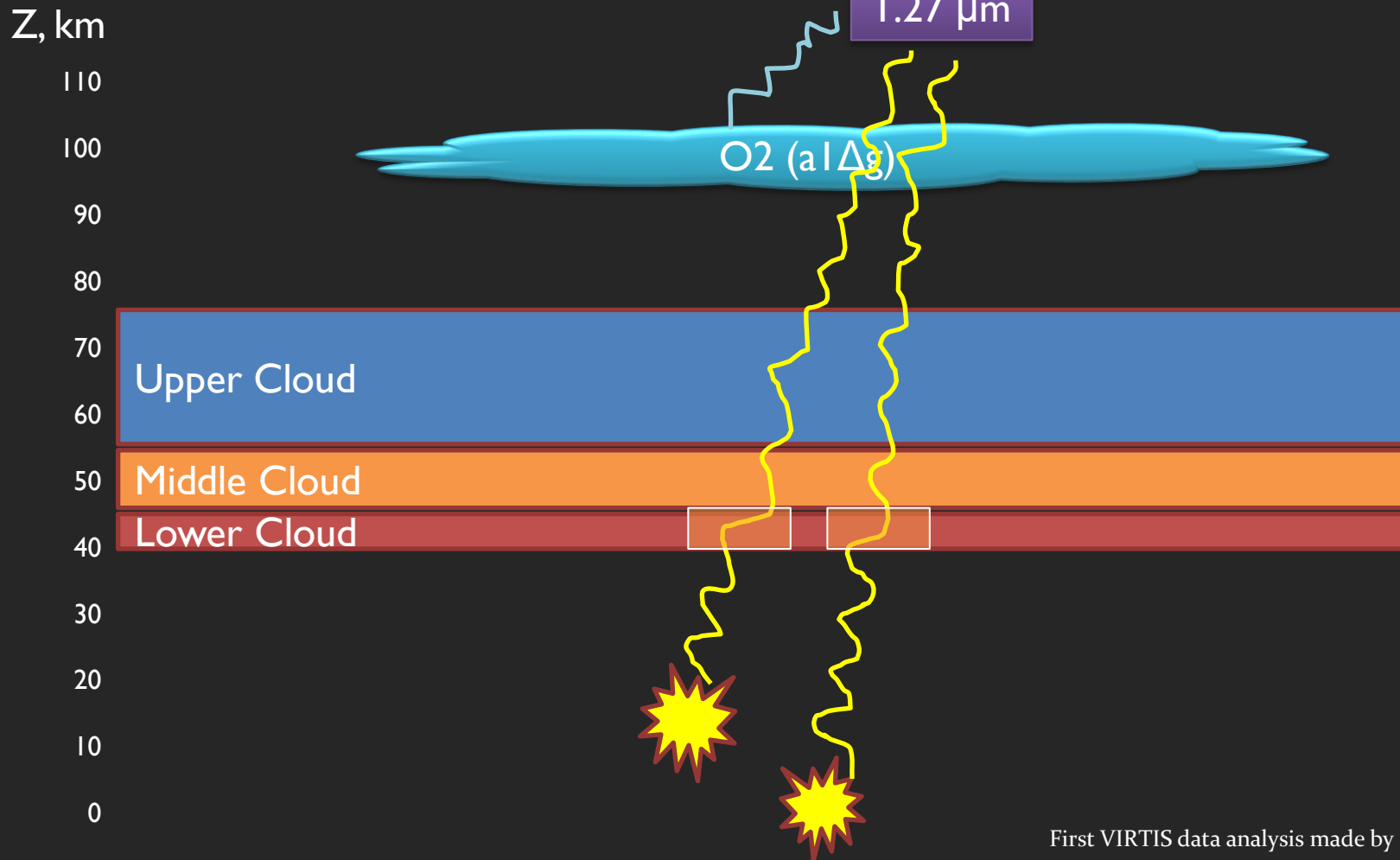
Circulation of Venusian atmosphere at 90-110 km based on apparent motions of the O₂ 1.27 μm nightglow from VIRTIS-M (Venus Express) data

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Niseko, International Venus Conference



Z, km

1.27 μm

O₂ (a₁ Δ g)

False RGB
example of
1.27 μm
nightglow

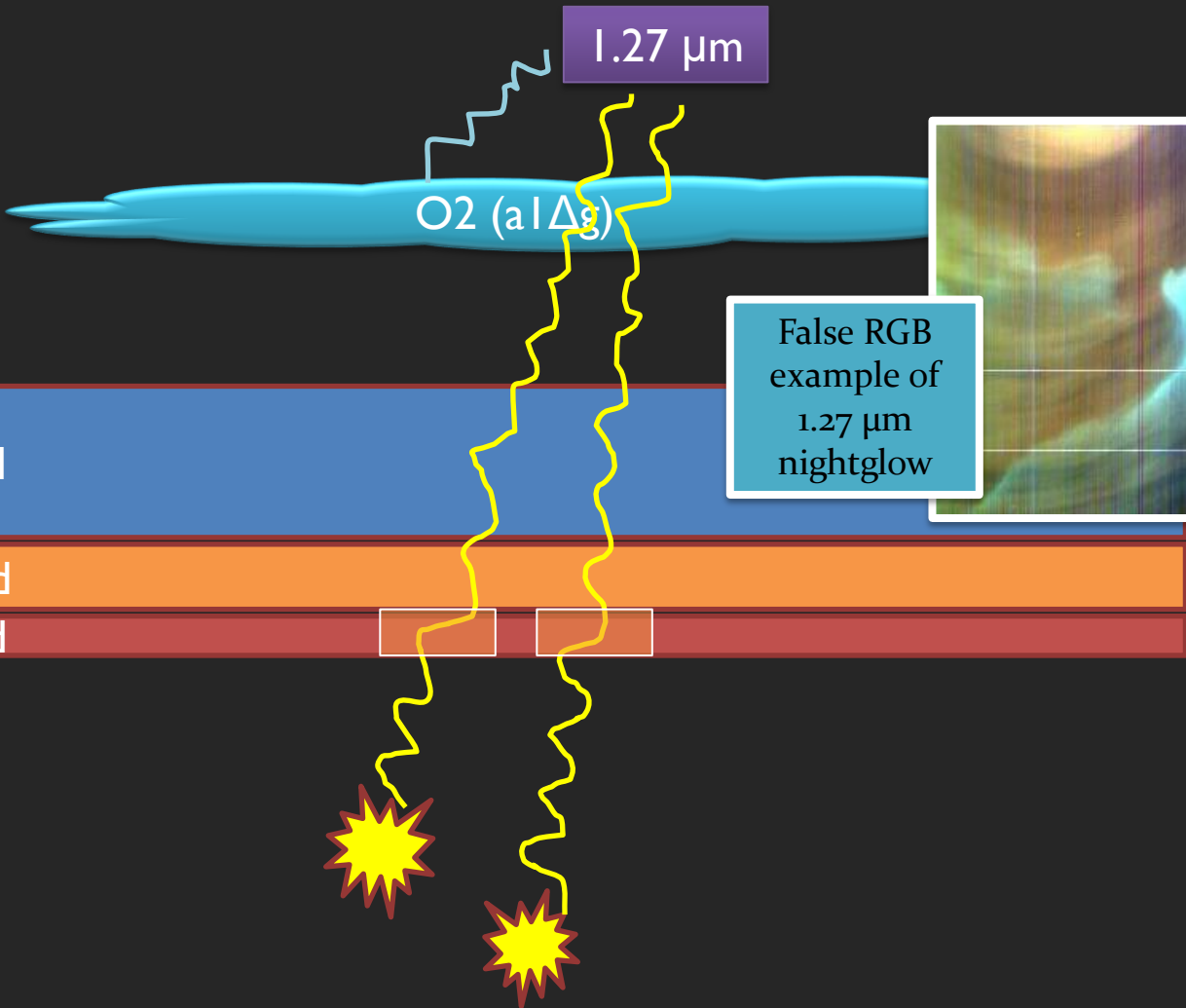


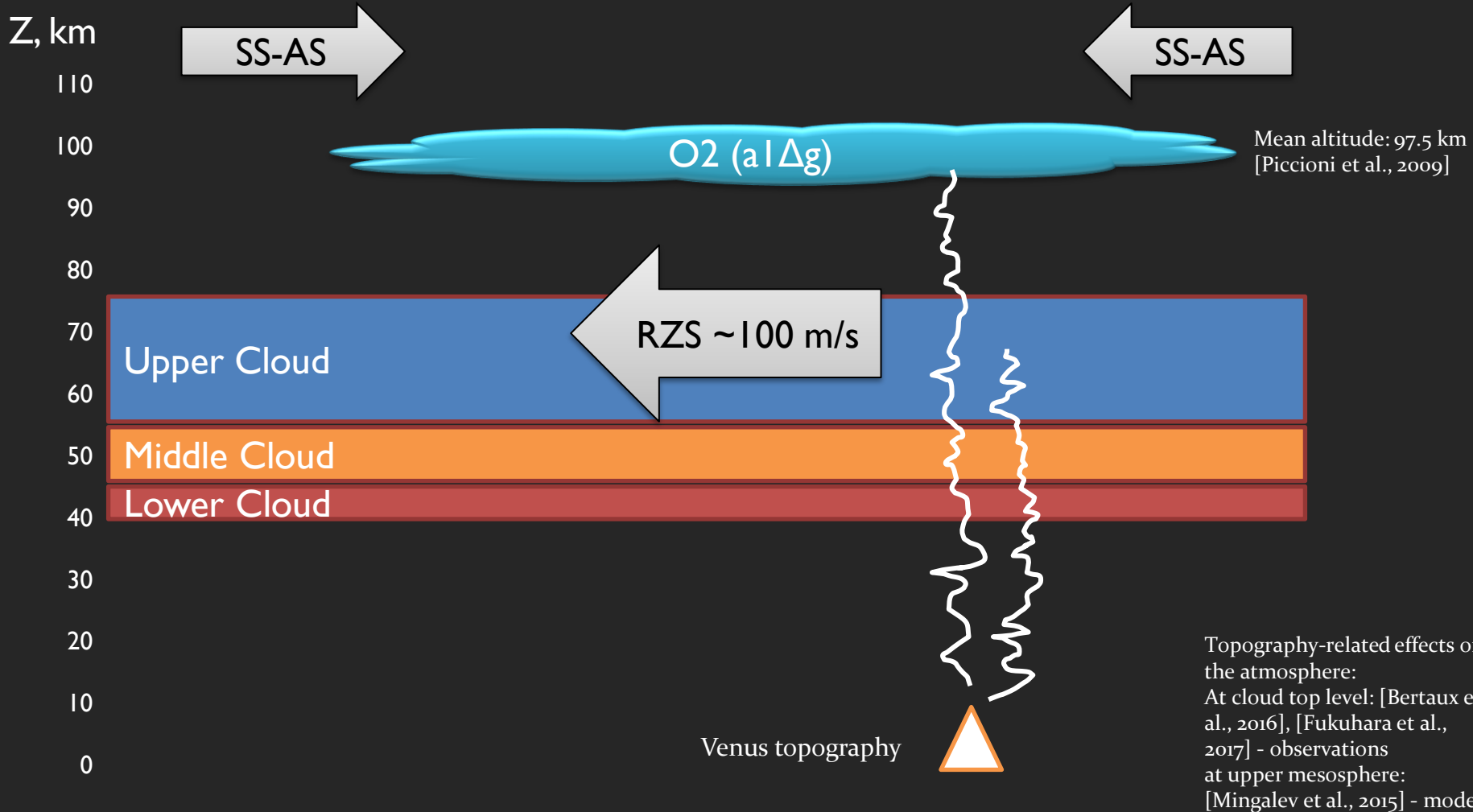
110
100
90
80
70
60
50
40
30
20
10
0

Upper Cloud

Middle Cloud

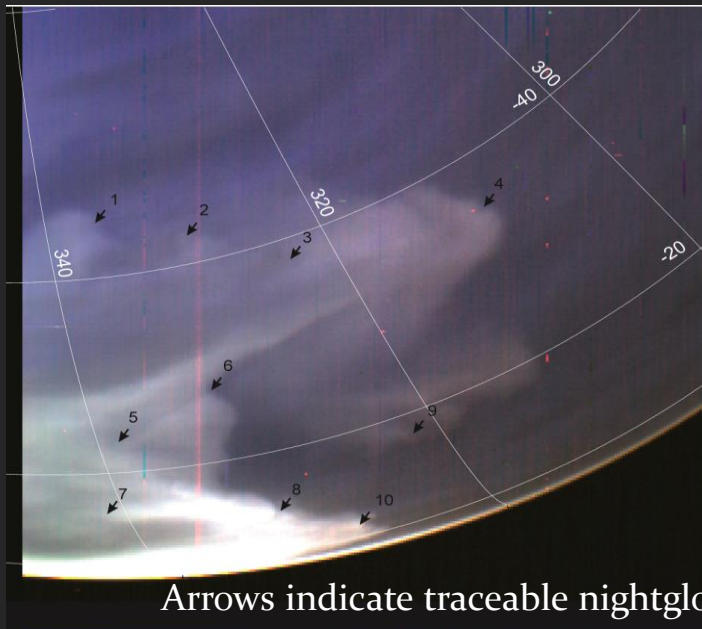
Lower Cloud



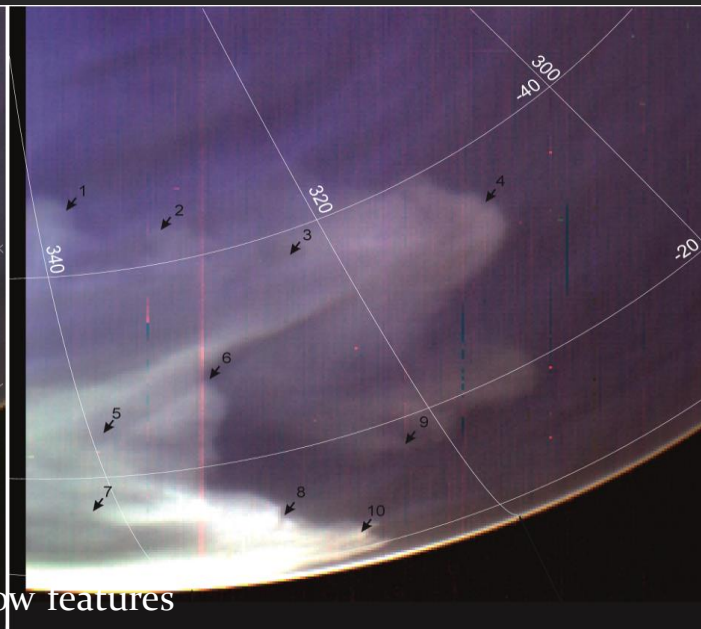


Measurements of the wind velocity by O₂ nightglow manual cloud tracking

372_01



Arrows indicate traceable nightglow features



372_02

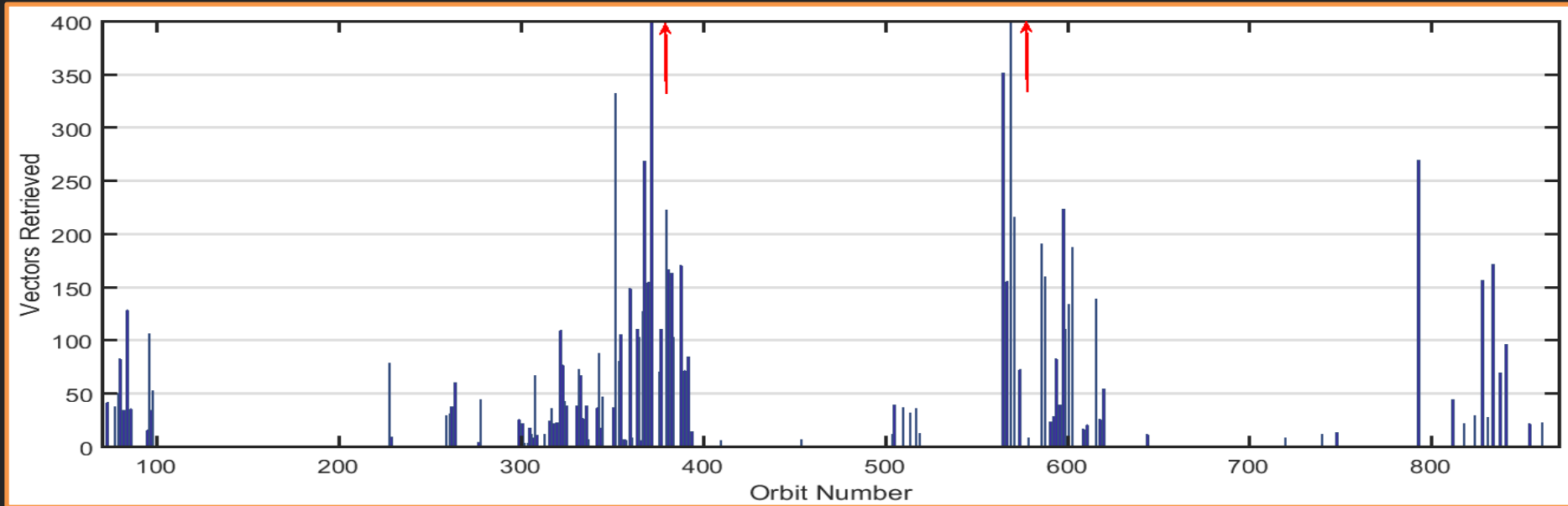


Intervals range from
0.5 to 3 hours

Cloud tracking algorithm from
Khatuntsev et al., 2013

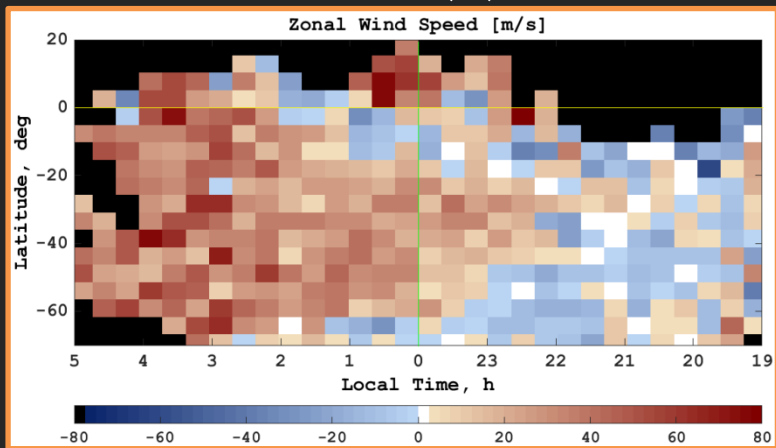
VIRTIS-M-IR data for analysis

"Season" Number	Begin/End	Orbit range	Orbits	Vectors
I	2006-07-02/2006-12-05	0073-0229	14	724
II	2007-01-04/2007-07-19	0259-0454	67	4833
III	2007-09-06/2008-01-20	0504-0644	28	3259
IV	2008-04-09/2008-08-28	0720-0861	14	971
All	2006-07-02/2008-08-28	0073-0861	123	9787



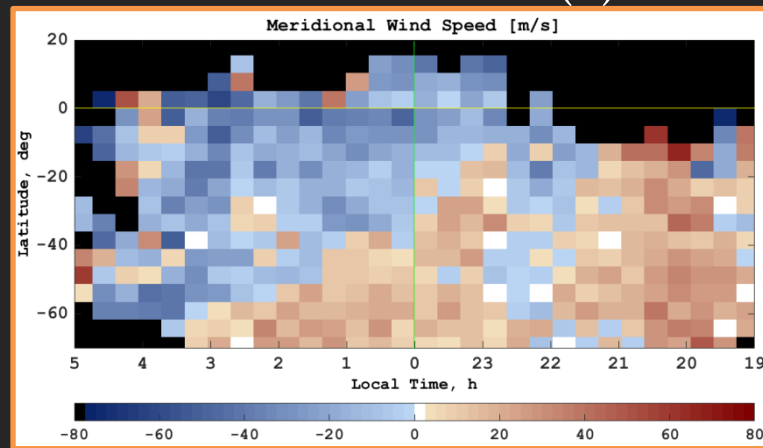
Mean zonal and meridional winds

Zonal (u):



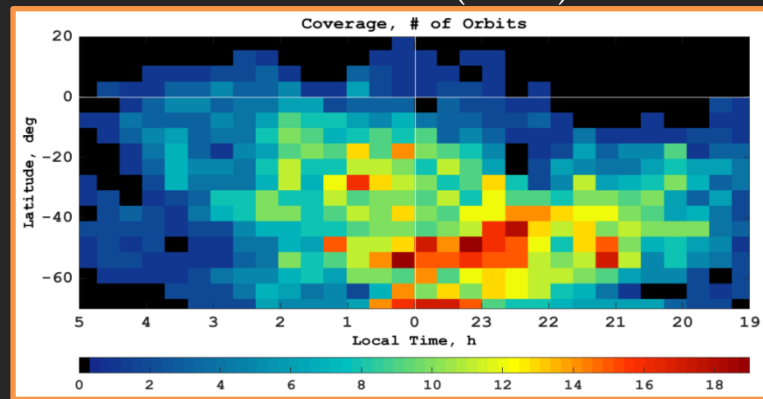
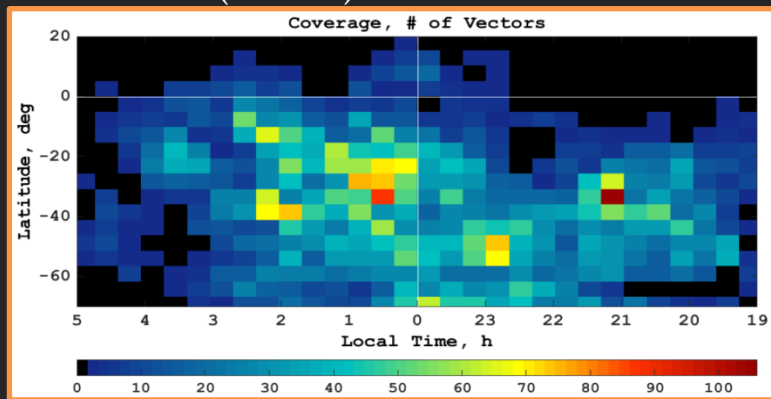
(vectors)

Meridional (v):



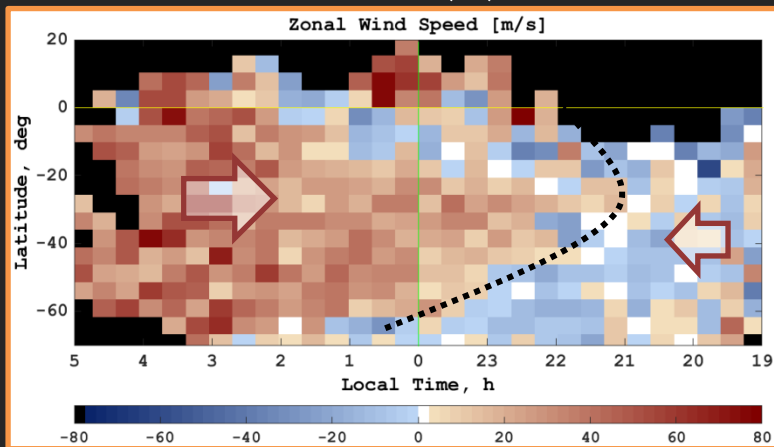
(orbits)

Coverage:



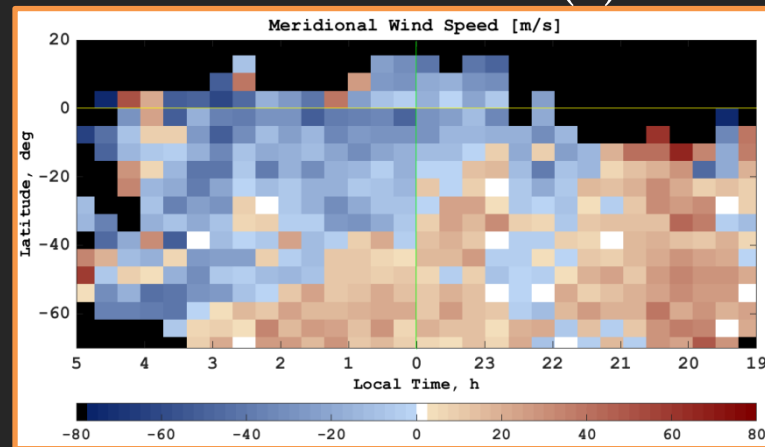
Mean zonal and meridional winds

Zonal (u):



(vectors)

Meridional (v):

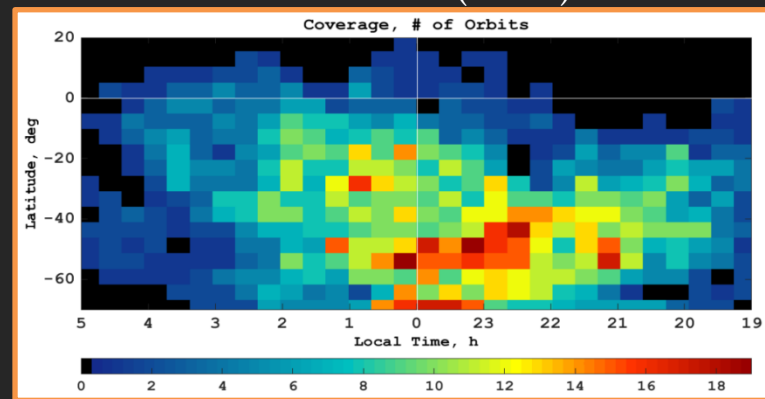
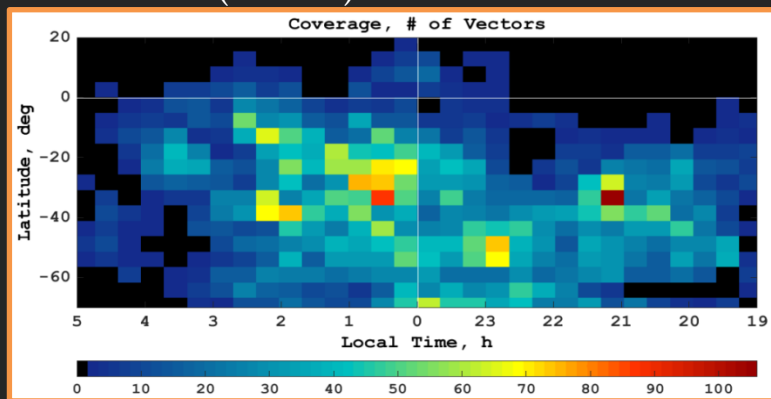


(orbits)

RZS

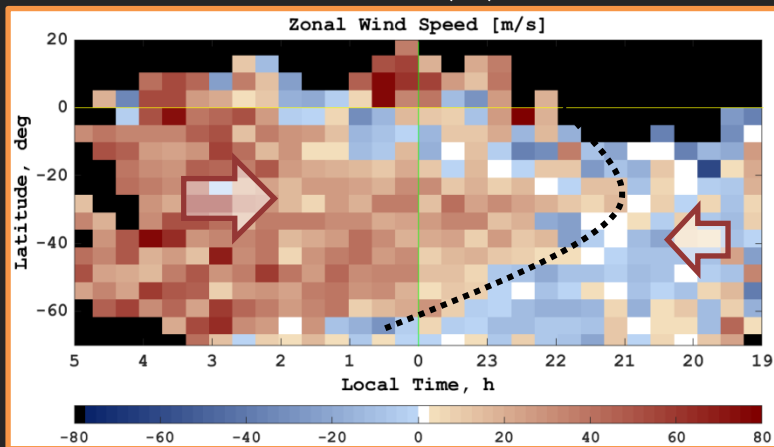


Coverage:



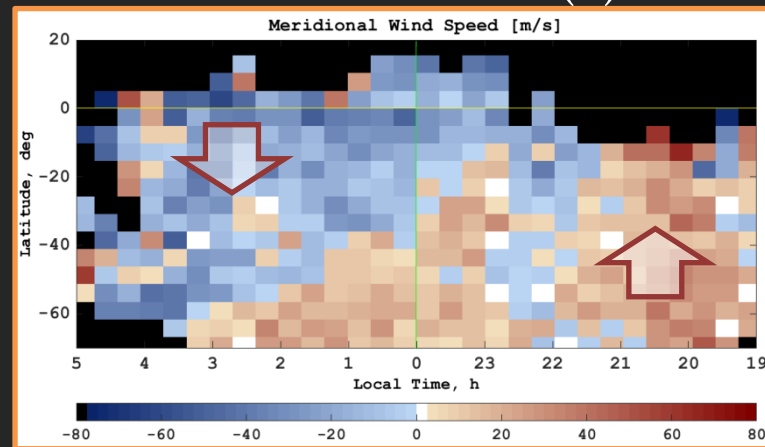
Mean zonal and meridional winds

Zonal (u):



(vectors)

Meridional (v):

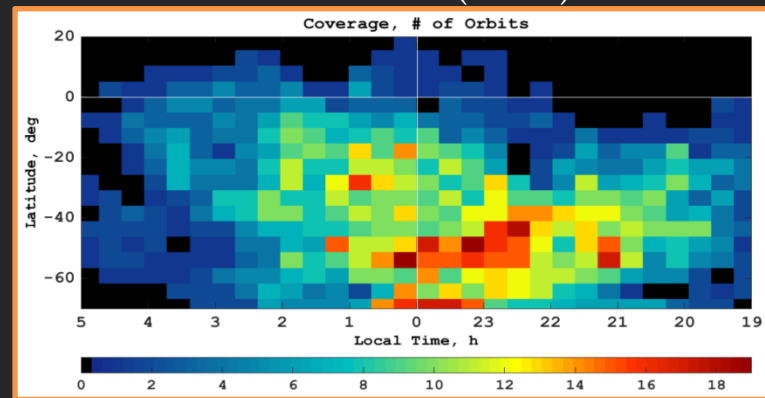
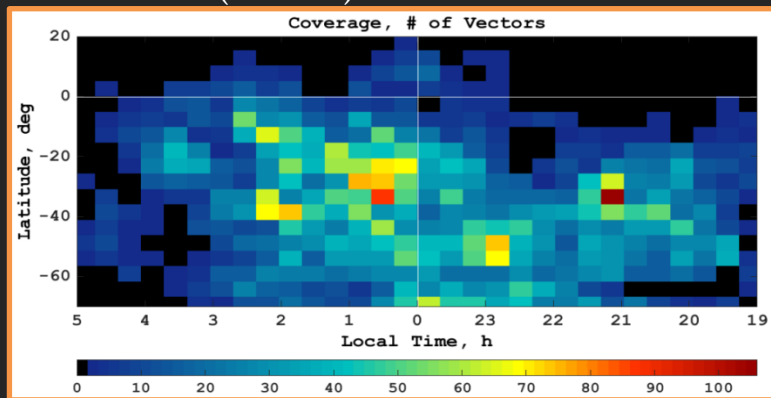


(orbits)

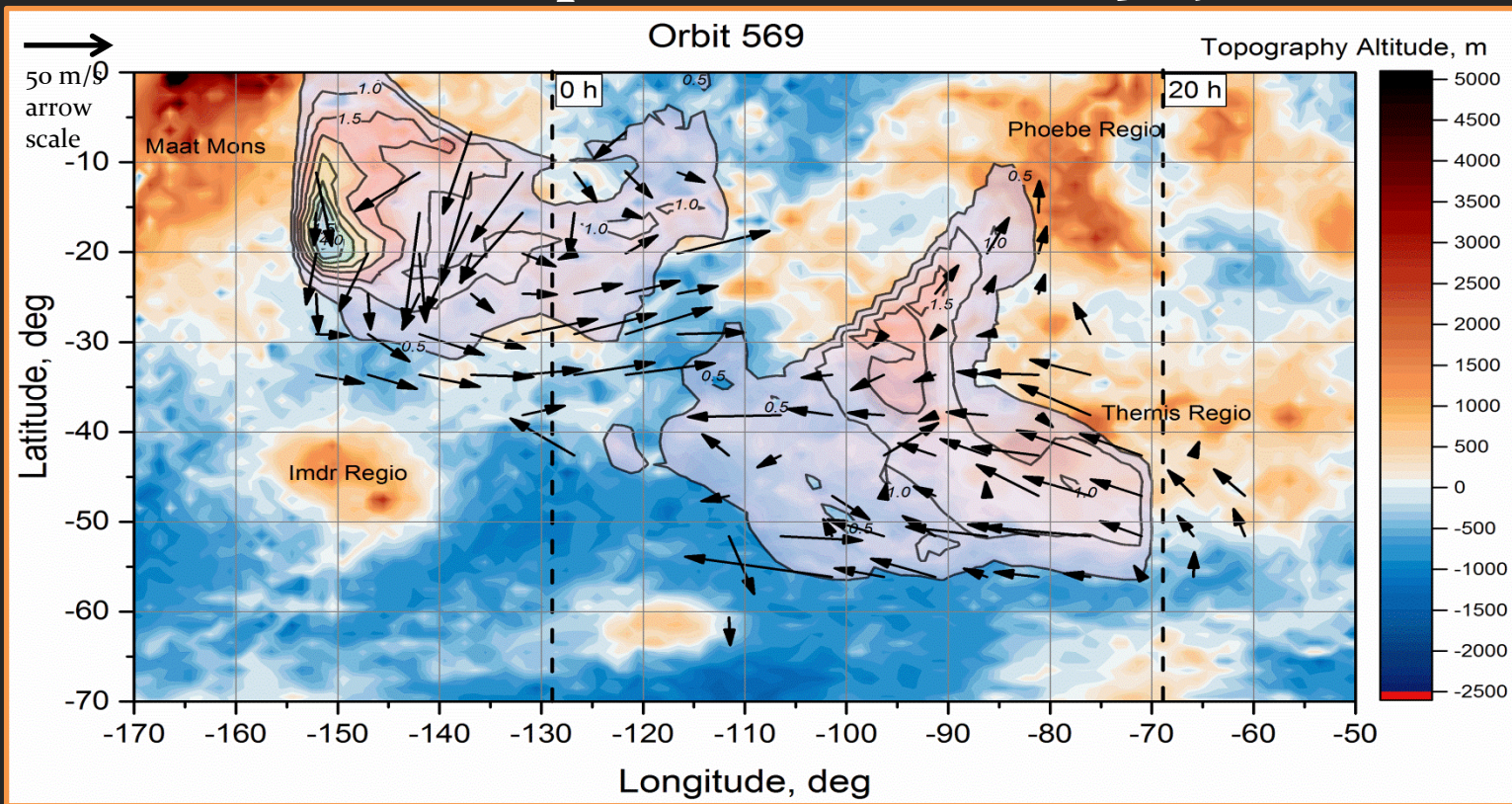
RZS



Coverage:

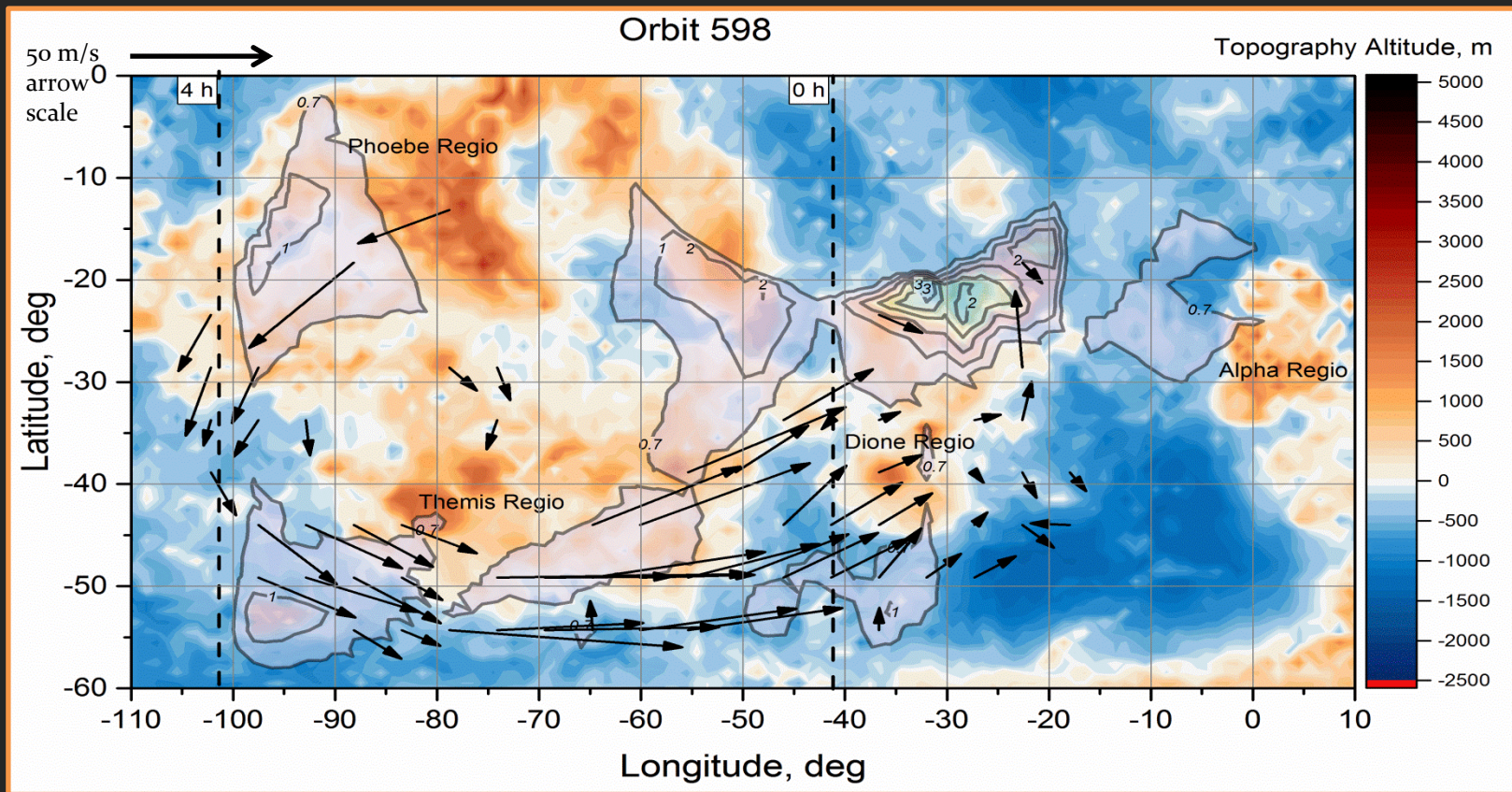


Examples of orbits: VI0569



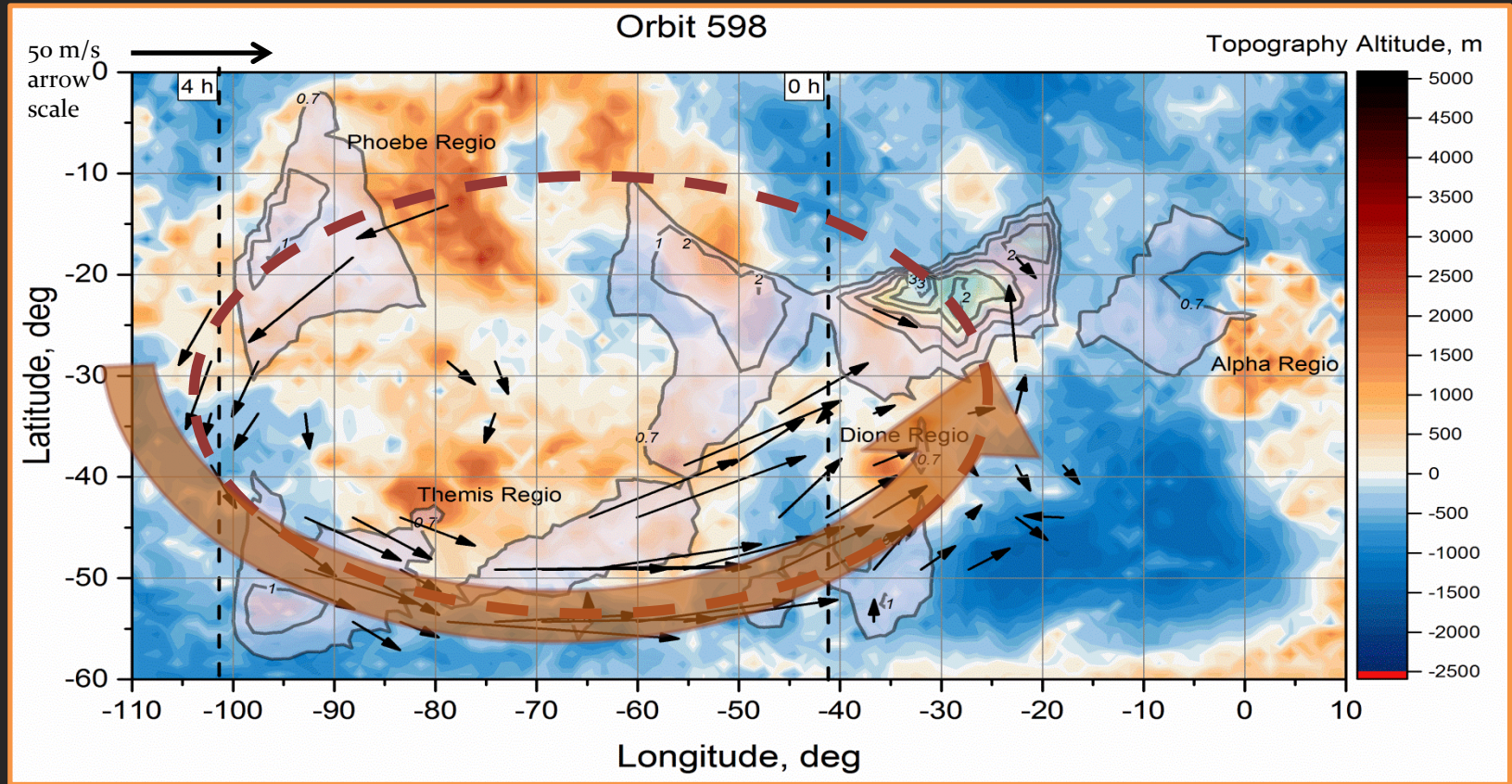
Contours: nightglow in MR;
1st isoline at 0.5 MR

Examples of orbits: VI0598

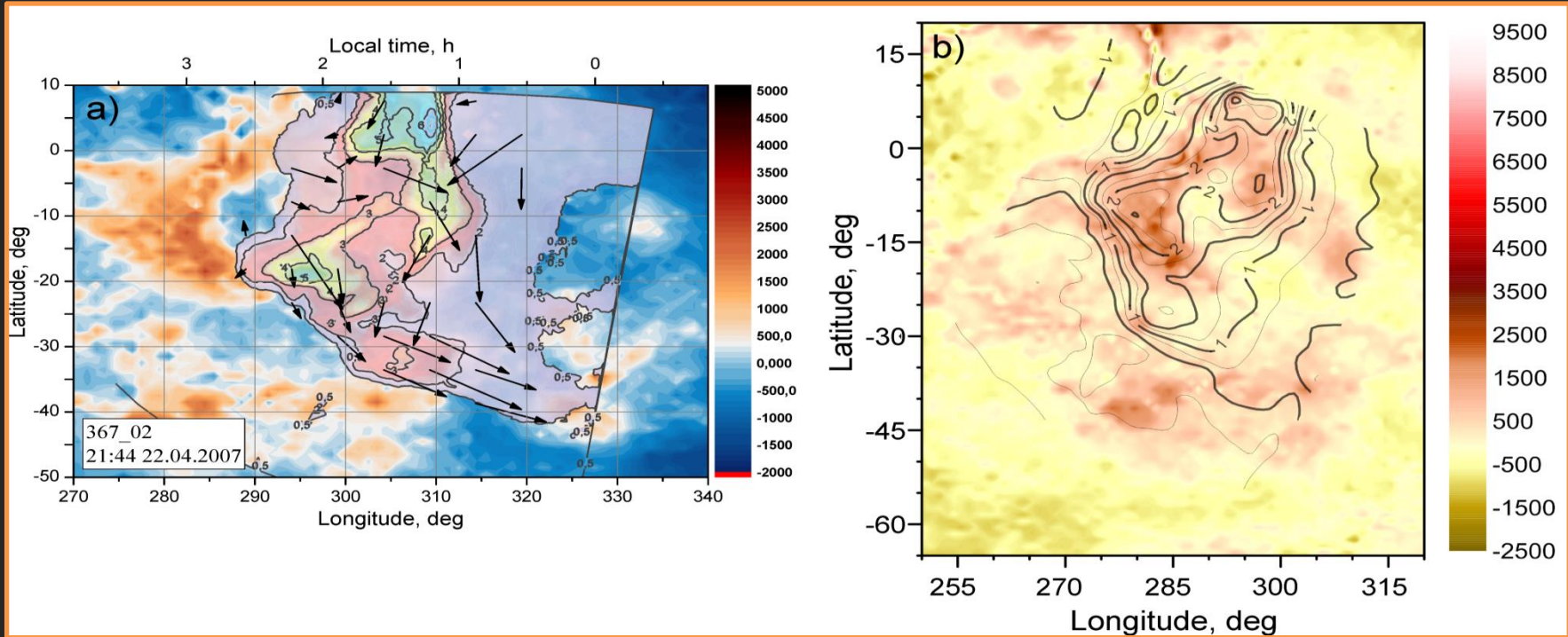


Contours: nightglow in MR;
1st isoline at 0.7 MR

Examples of orbits: VI0598



Nightglow and topography



a) Orbit 367, nightglow (contours), horizontal wind (arrows) over topography (background color)

b) Shift against the wind speed: 20° west, 7° north, 14° clockwise turn

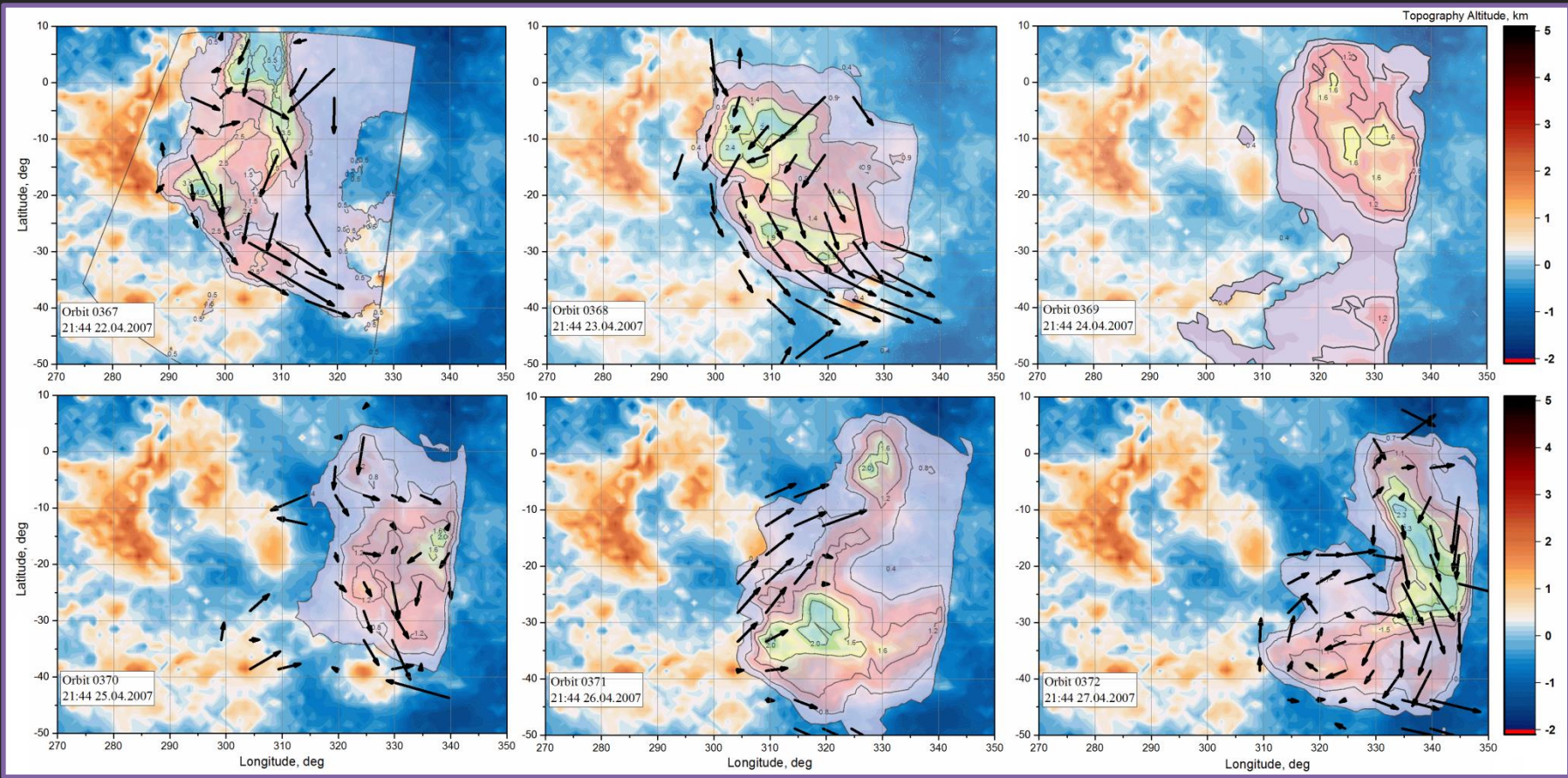
Max. of correlation function = **0.61** on 5°×5° grid

Orbit-to-orbit
variation

367

368

369



370

371

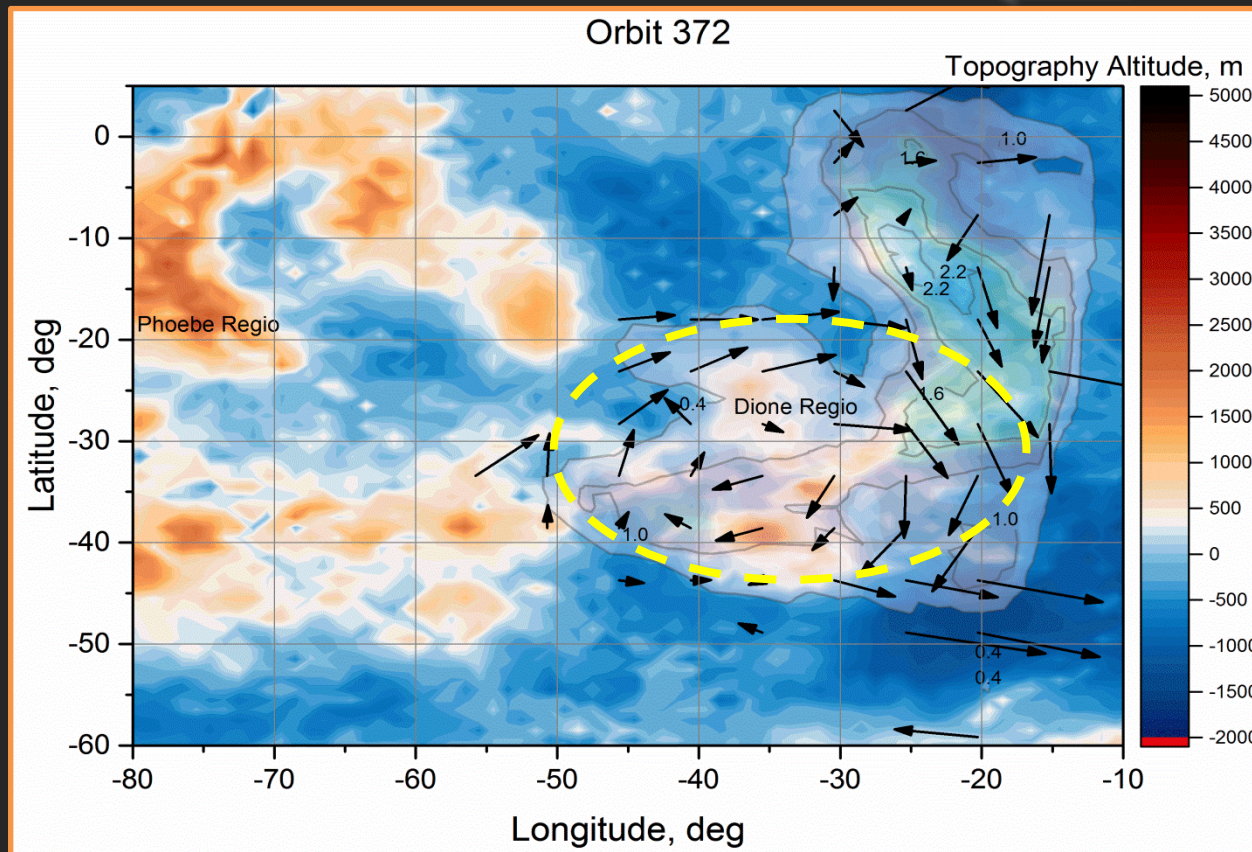
372

$\Delta t = 24$ h

Orbit-to-orbit variation, circular motion

← RZS

Area of circular motion,
 $D \sim 1500$ km



Nightglow in MR; 1st isoline at 0.4 MR

Summary & Conclusions

- The circulation at 90-110 km on the nightside of Venus is represented by **asymmetric flows** emanating from terminators.
- The asymmetry usually presents itself at individual orbits and at the mean velocity distribution: **zonal flow changes direction at 22.5 ± 0.5 h, meridional at 22 to 3 h** (depending on latitude).
- On average zonal wind speed from the morning side **exceeds** the evening velocity **by 20-30 m/s**.
- Suggested **influence of the underlying topography**: areas of nightglow are in some cases found above mountainous areas (regio), observed directly above or shifted up to 15 deg along the current direction of the wind, often repeating the shape of the highland on the surface. The topographic areas seemingly cause disturbances in the flow, acting as if they were “obstacles”.
- The **regions of clockwise or counterclockwise circular motion** reaching 500 – 4000 km in diameter sometimes occur, observed above highlands.
- The analysis can be continued by **comparing these results with ground-based observations** (including orbit-to-orbit variations).

Results are published in Gorinov, D. A., Khatuntsev, I. V., Zasova, L. V., Turin, A. V., & Piccioni, G. (2018). Circulation of Venusian atmosphere at 90–110 km based on apparent motions of the O₂ 1.27 μm nightglow from VIRTIS-M (Venus Express) data. *Geophysical Research Letters*, 45