Investigation of Martian Dust Lifting

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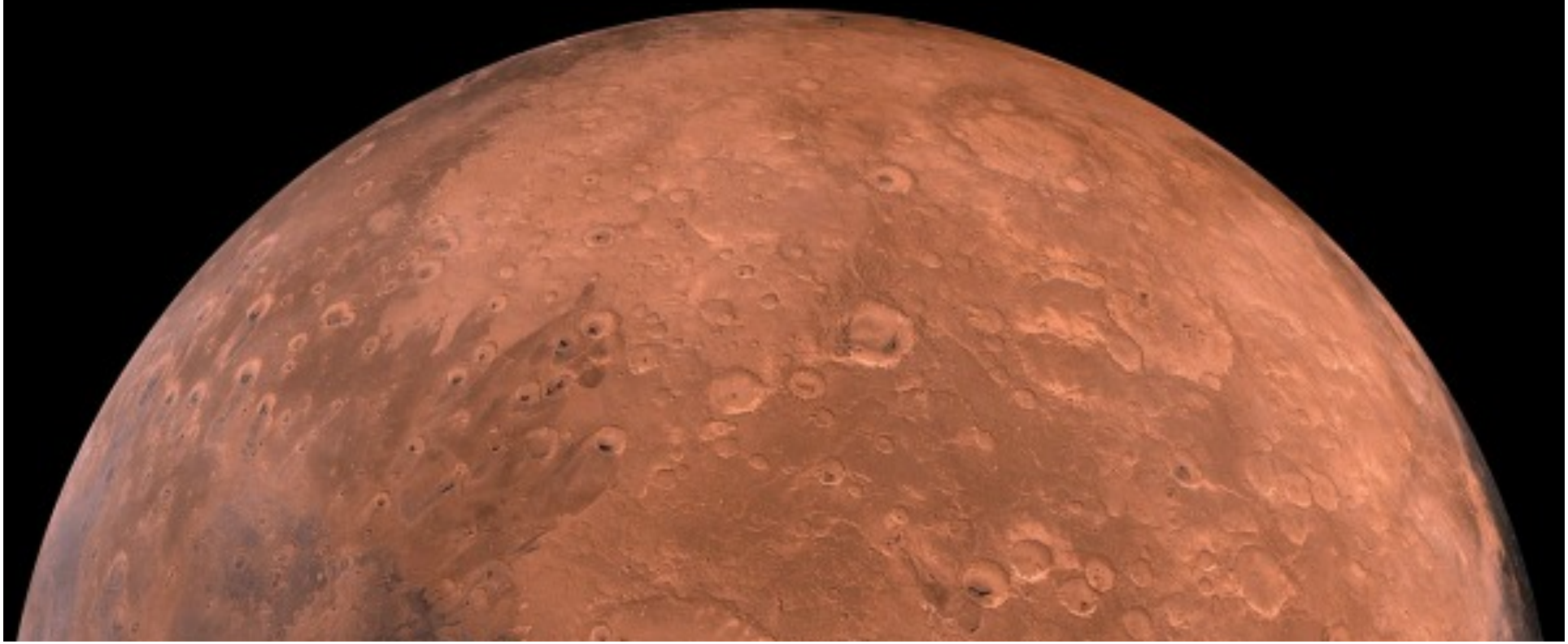


Why Study Martian Dust Lifting?

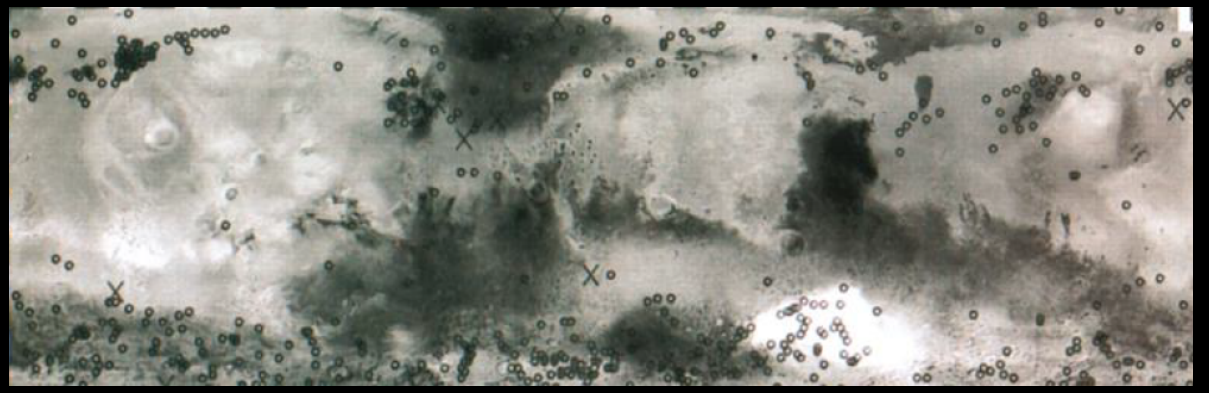
-First analysis of this kind

-Ground our understanding in actual events

- Temporal and spatial distribution can be used to put constraints on the Martian dust cycle

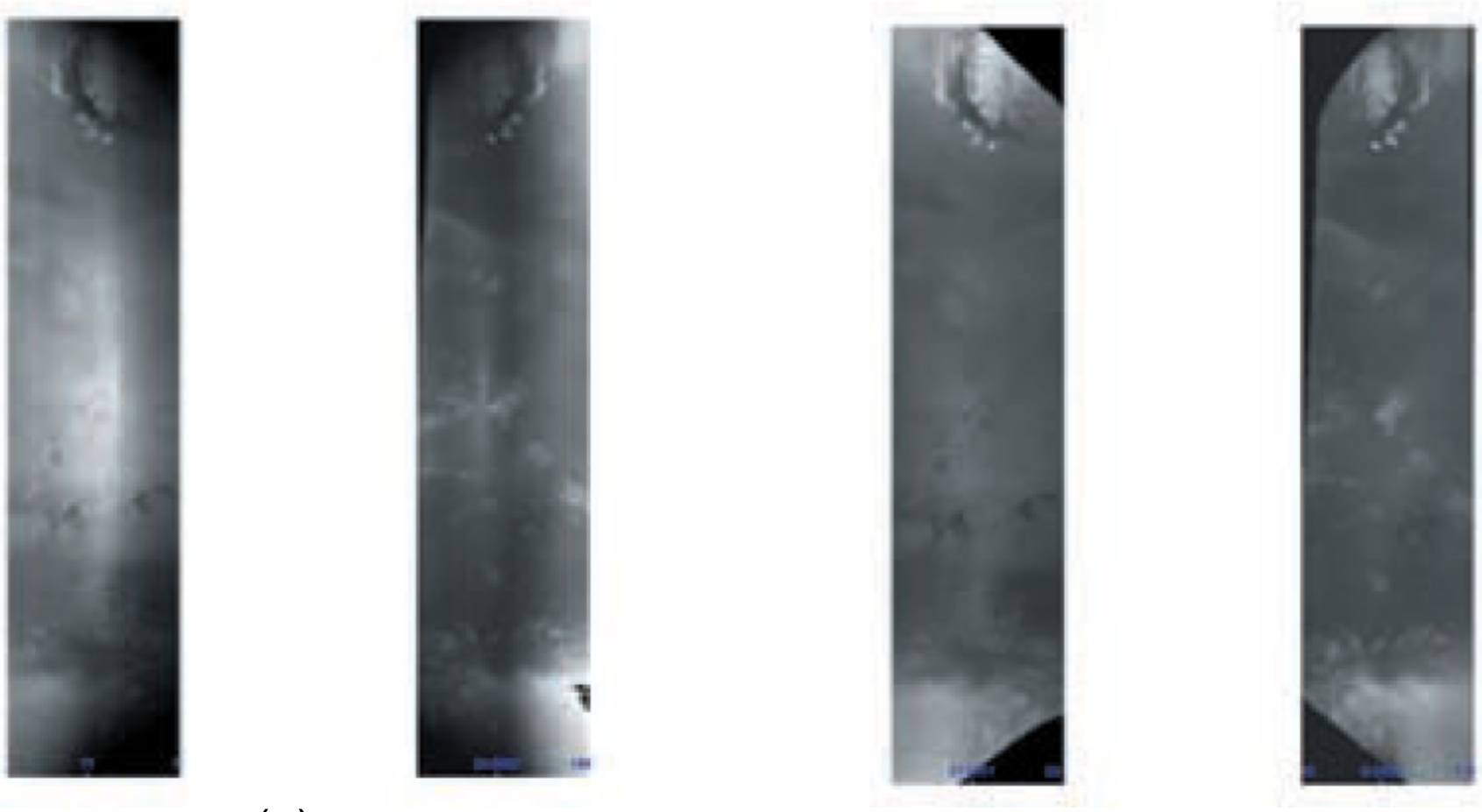
- Frequency of lifting helps us understand surface-atmosphere interaction

- Improve General Circulation Models (GCM)



Spatial distribution of dust storms between March of 1999 and December of 1999 [Cantor et al., 2001]

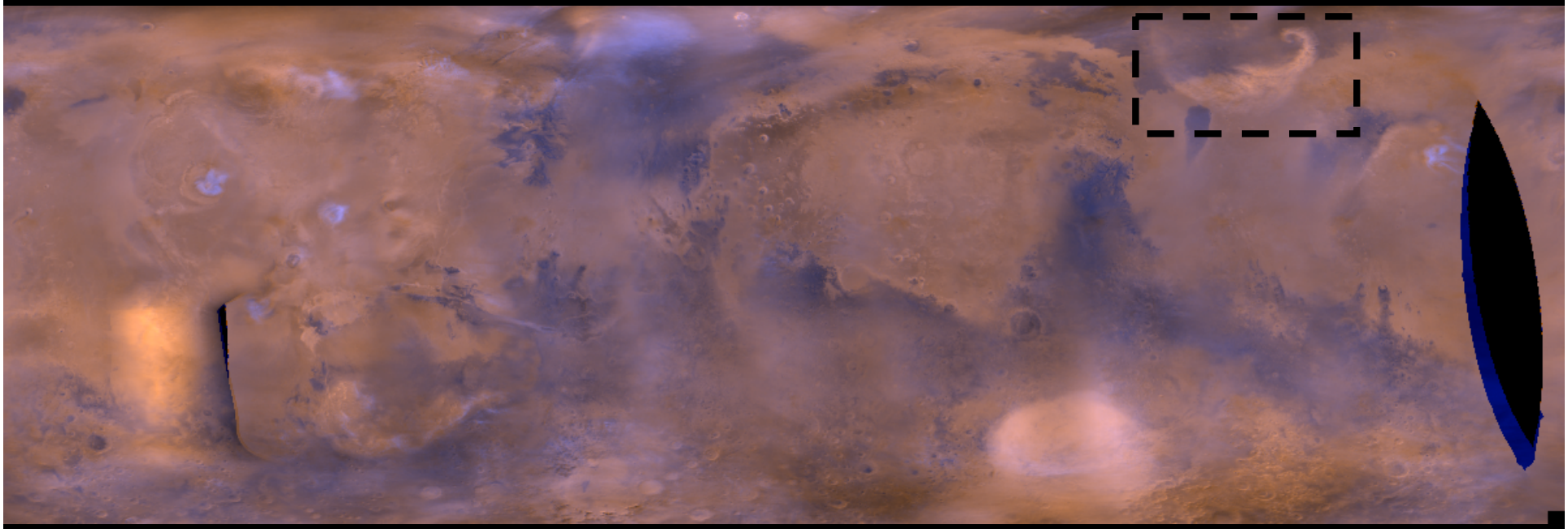
Data Collection



(a) (b)

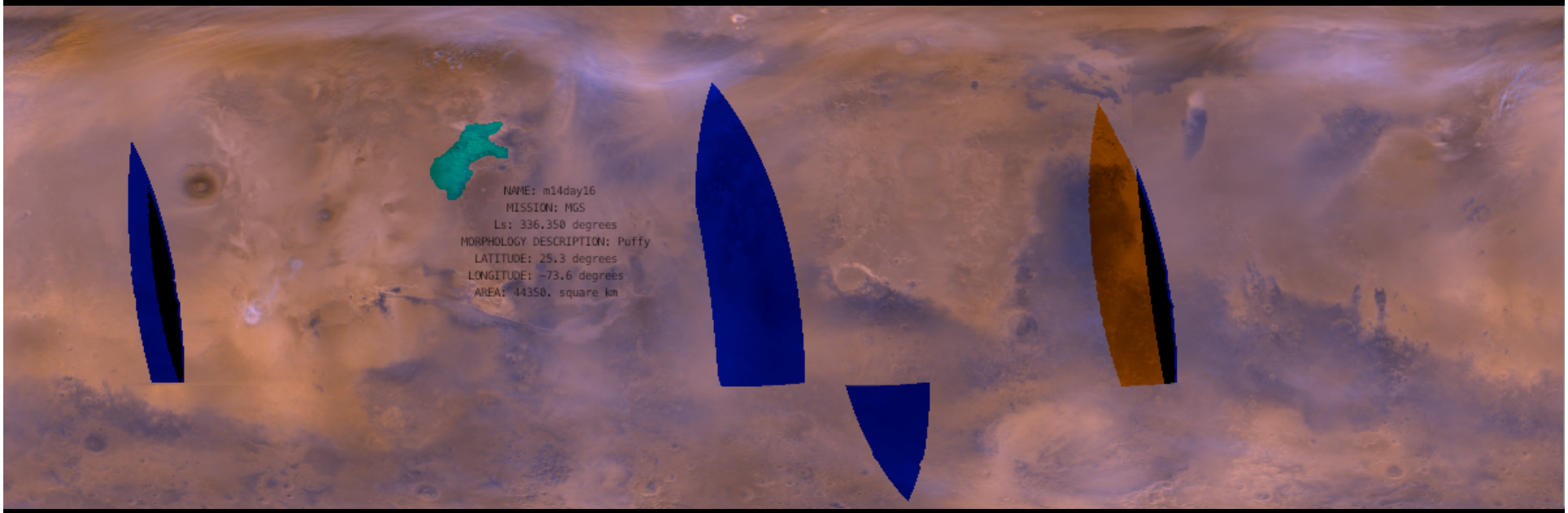
Sample MOC global map swaths: (a) raw red (left) and blue (right) filter images and (b) processed red and blue filter images. The blue image is flipped with respect to the red image [*Wang and Ingersoll*, 2002].

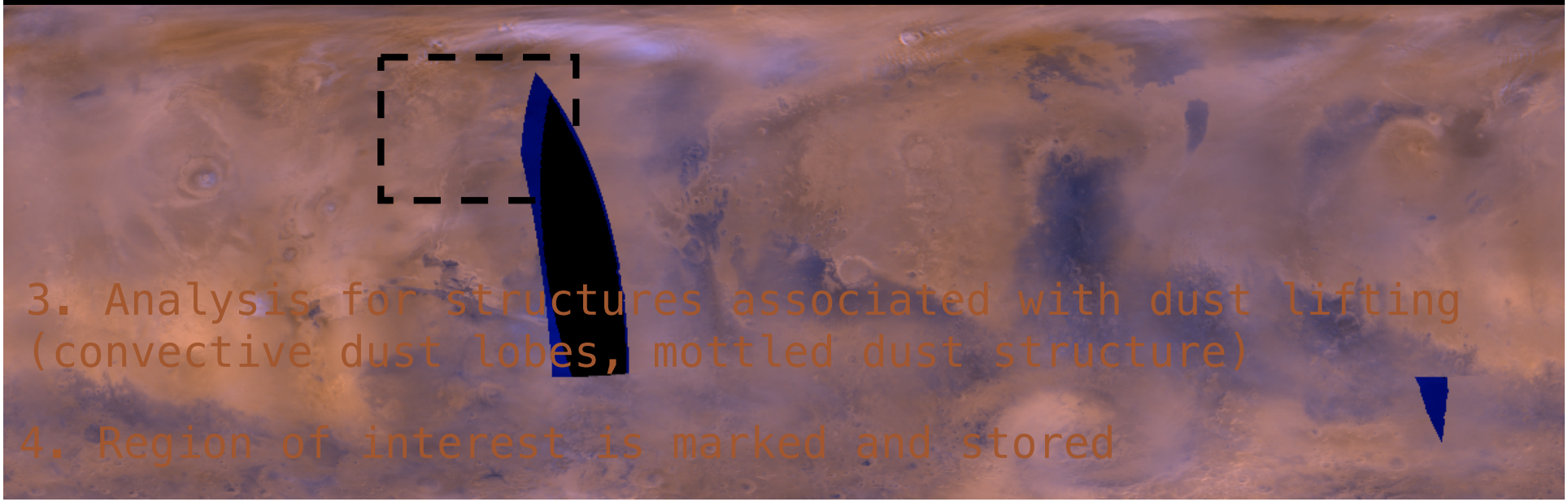
Mars Daily Global Map (MDGM)



- One map for each day
- Each map is generated from 13 pairs of red and blue MOC wide angle images
- Restricted to 2 PM local time
- Occasional missing data (black and blue sections)
- Dust storms appear orange, condensate clouds appear blue in MDGM

Identifying Dust Lifting

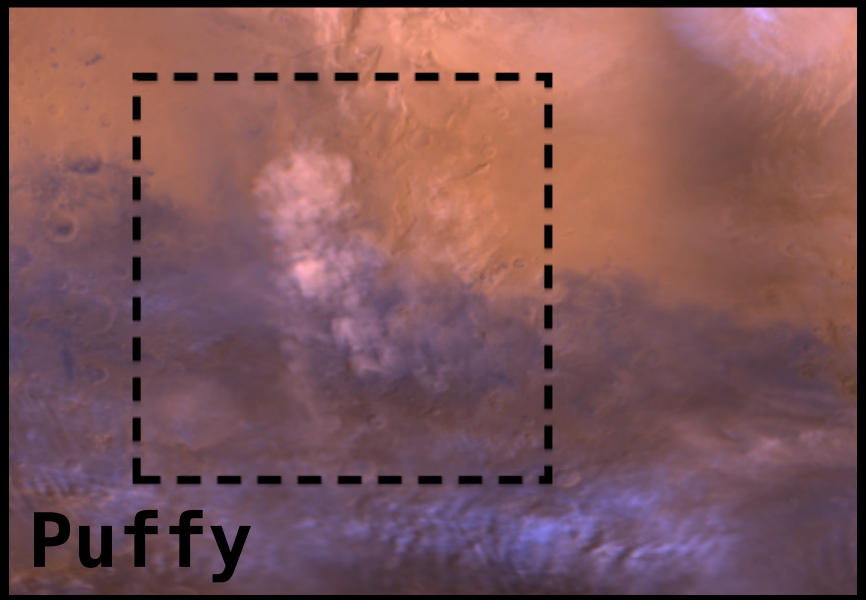


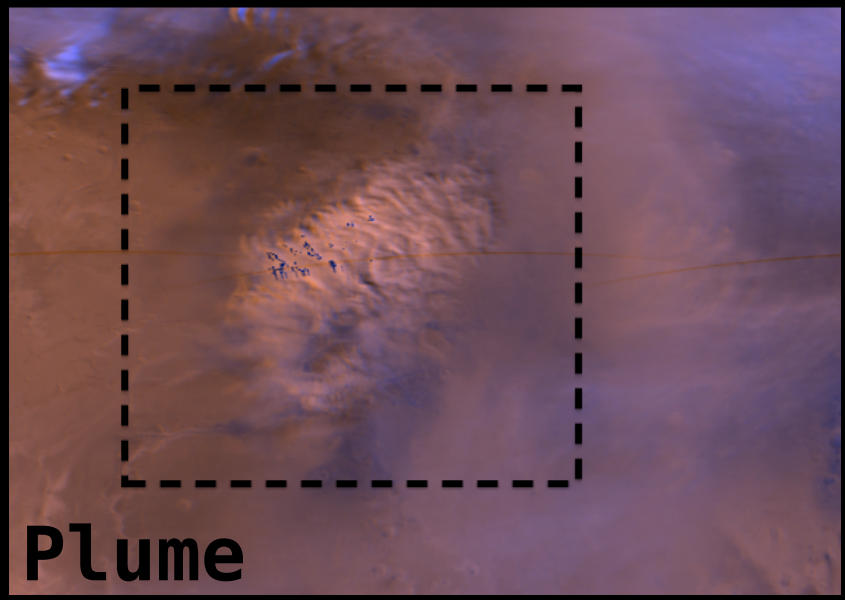


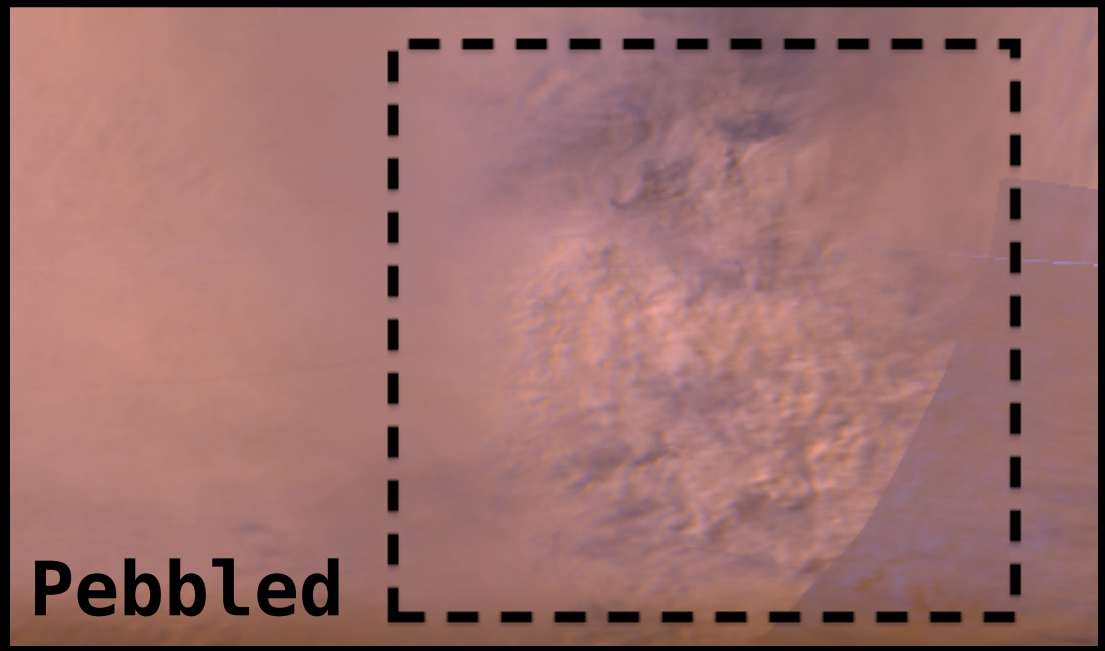
3. Analysis for structures associated with dust lifting (convective dust lobes, mottled dust structure)

4. Region of interest is marked and stored

Morphological Classifications





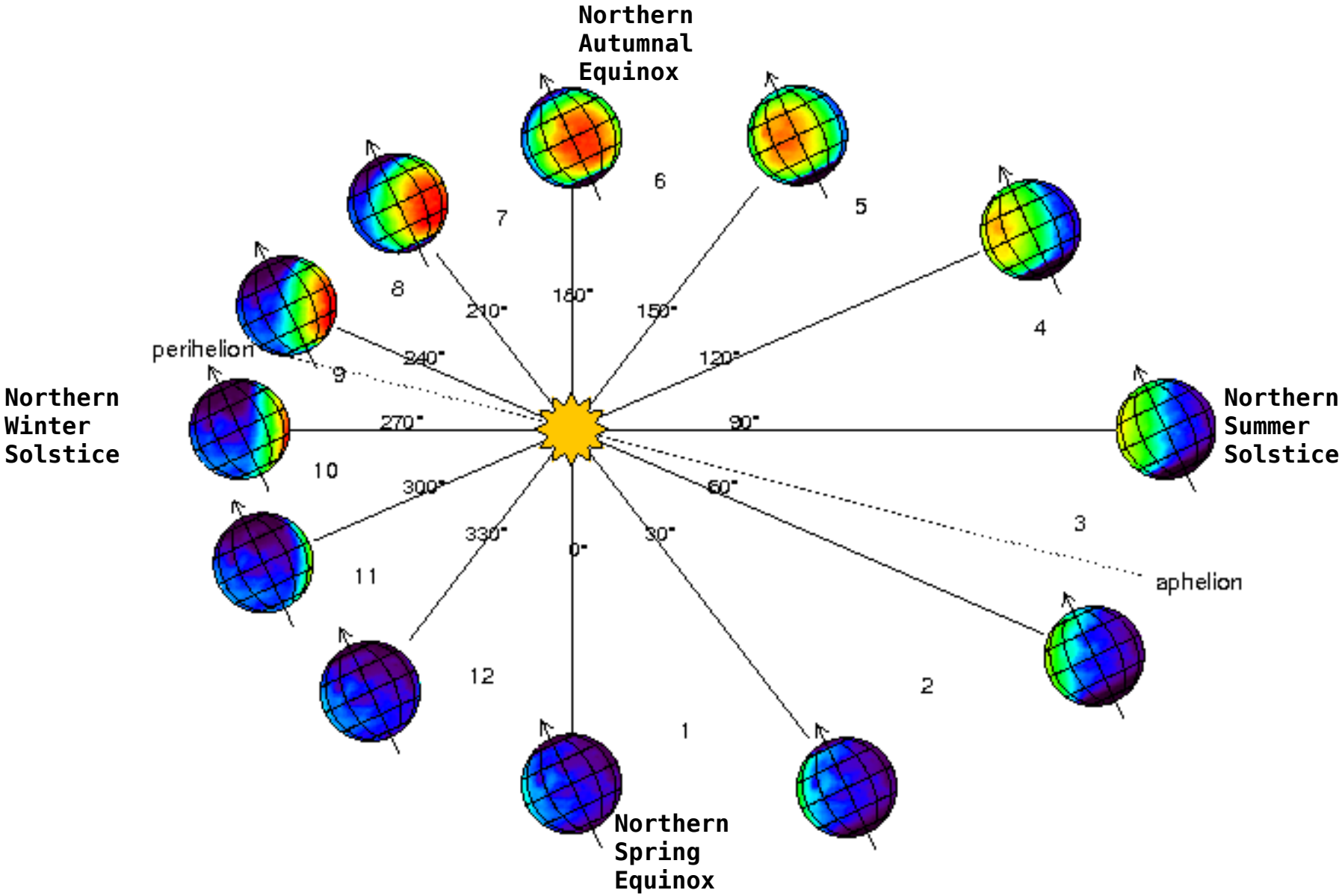


Analysis

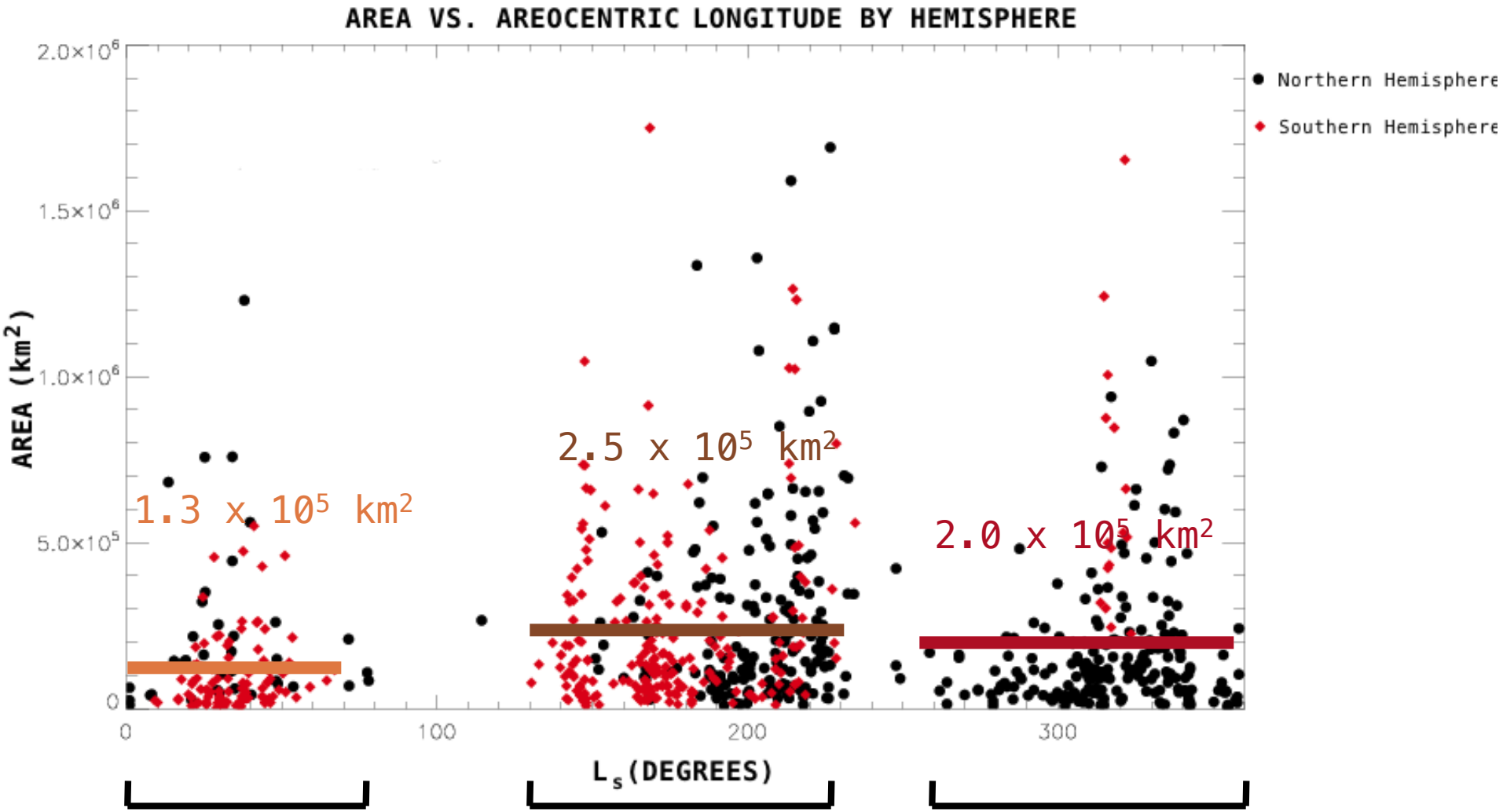
I. Seasonal & Size Distributions
II. Frequency Maps
III. Morphological Properties

I. Seasonal and Size Distribution

Areocentric Longitude (L_s)



Size Distribution

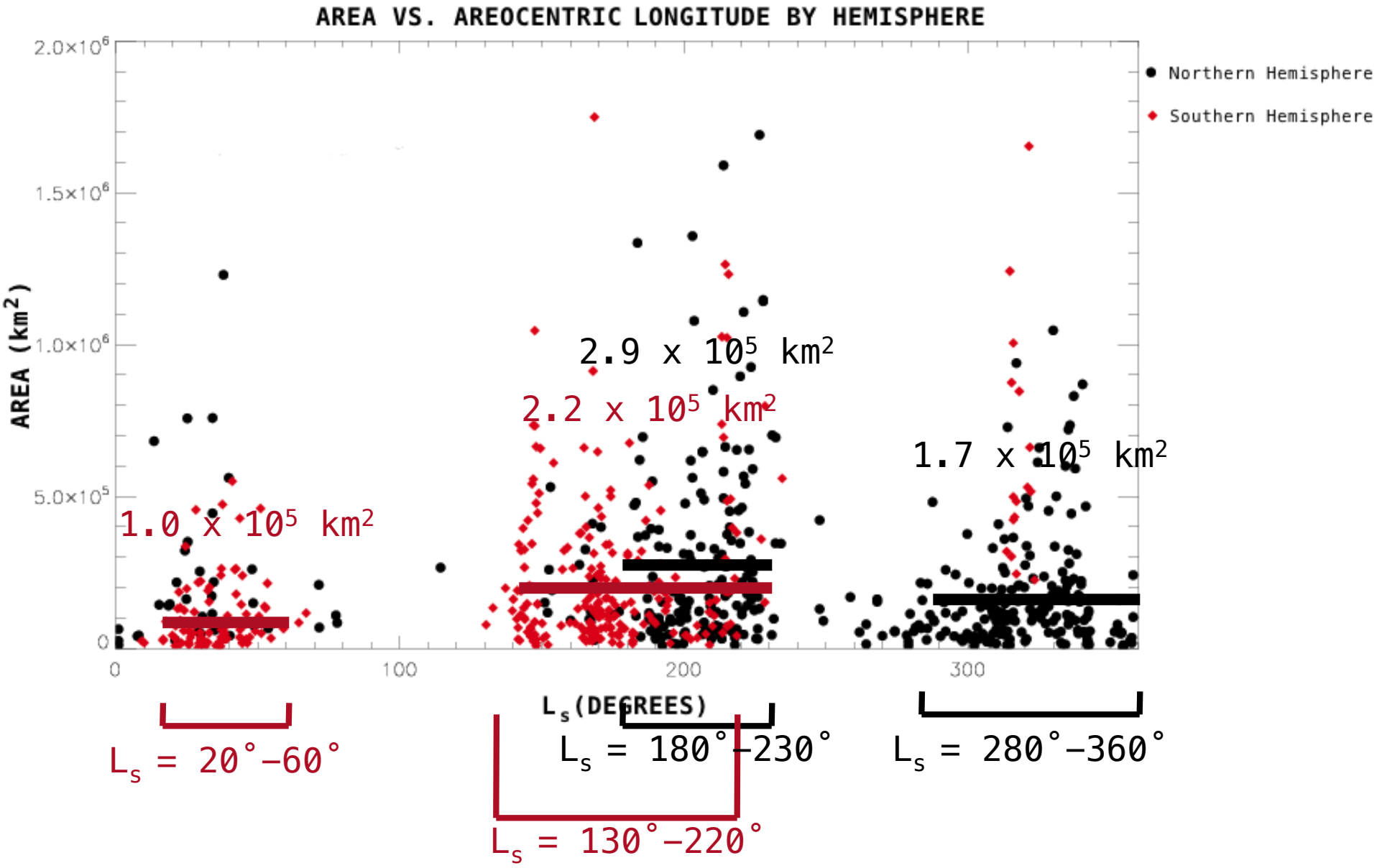


Seasonal Window 1 (L_s = 0°–80°)

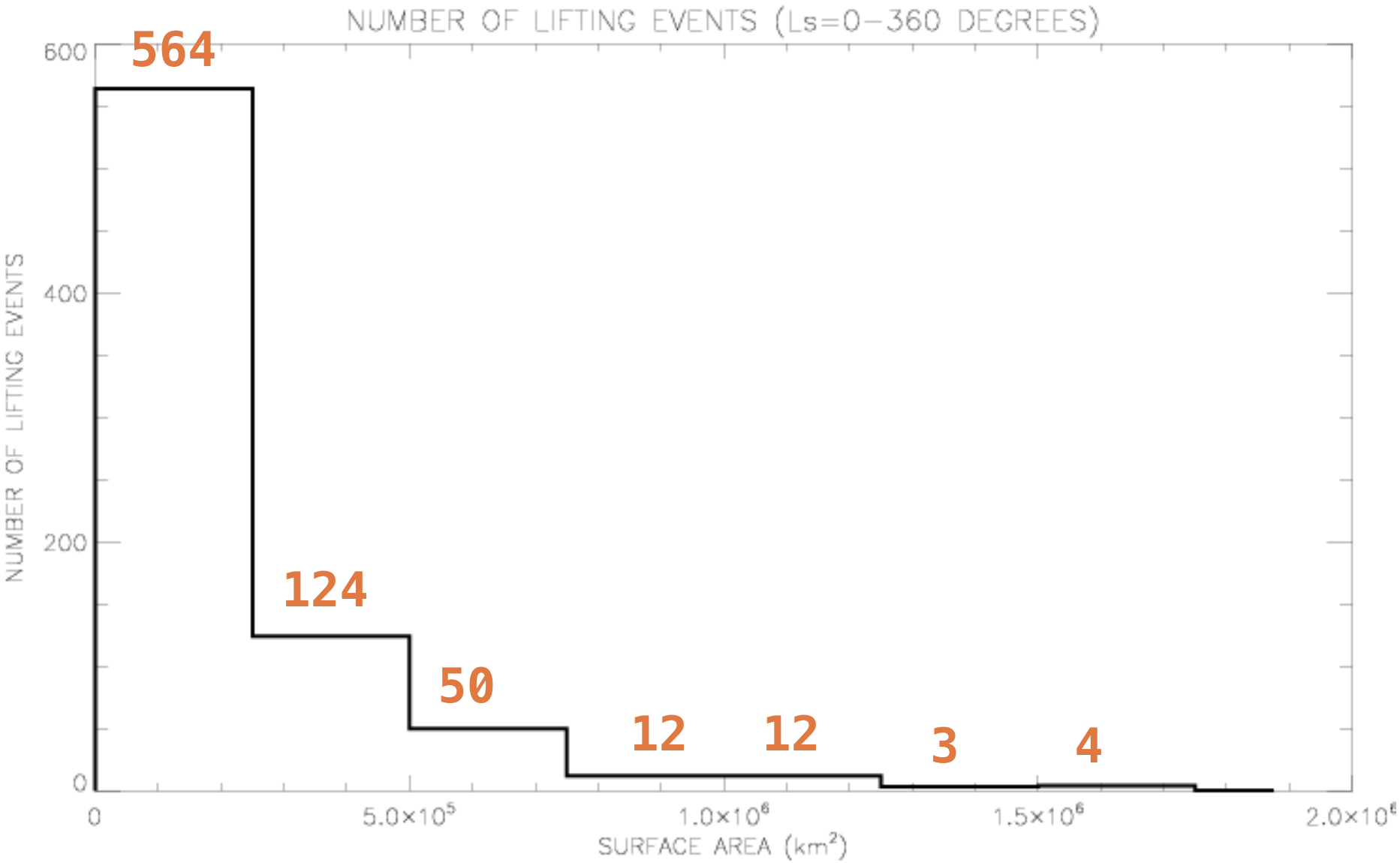
Seasonal Window 2 (L_s = 130°–230°)

Seasonal Window 3 (L_s = 260°–360°)

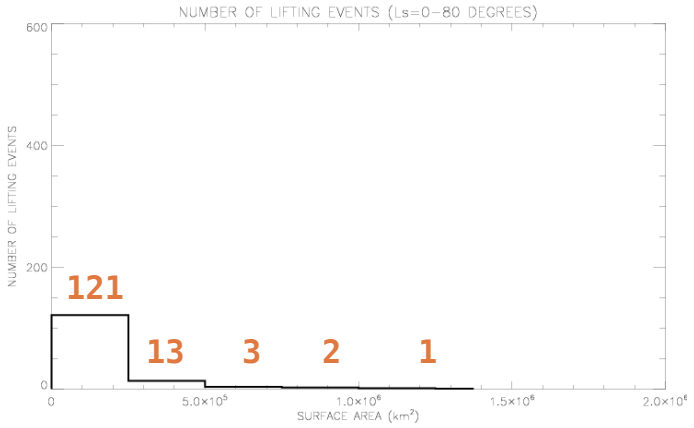
Size Distribution

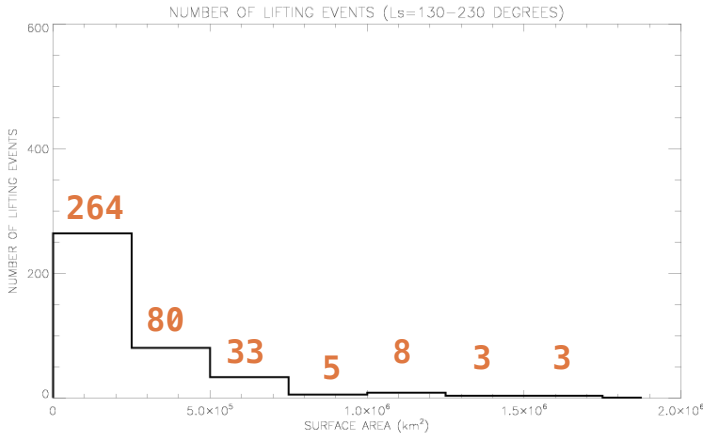


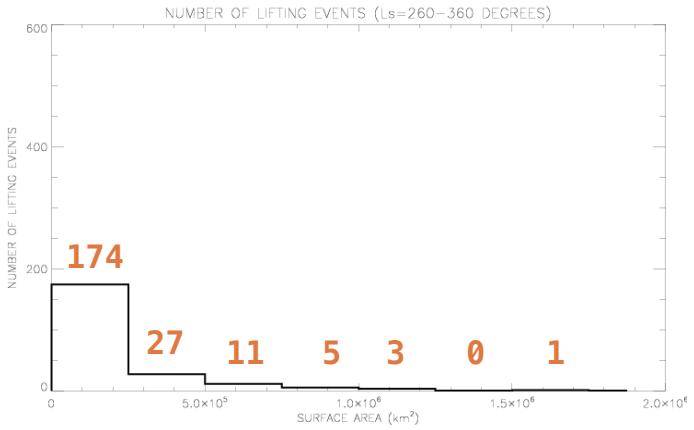
Size Distribution



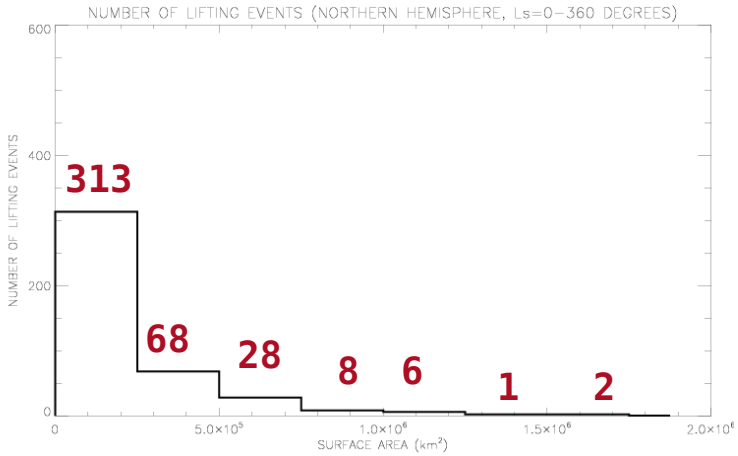
Seasonal Windows

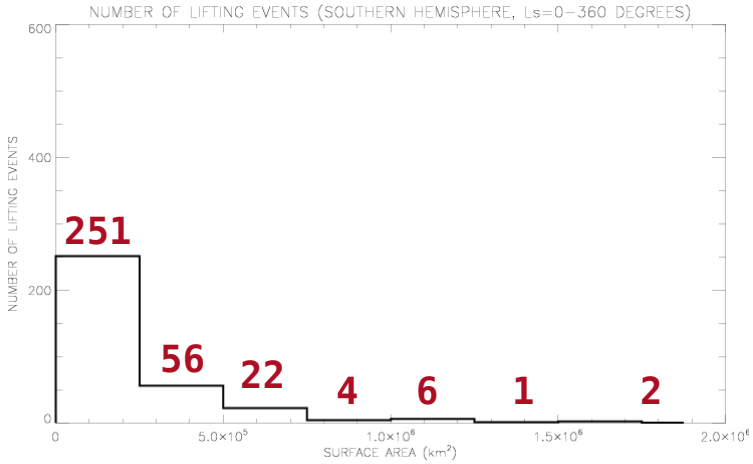






Northern and Southern Hemispheres





- **The rapid decay of the number of events with increasing area is true for all seasonal windows and both hemispheres**
- **The northern and southern hemispheres exhibit similar rates of decay**
- **Large scale storms tend to occur during the second seasonal window**

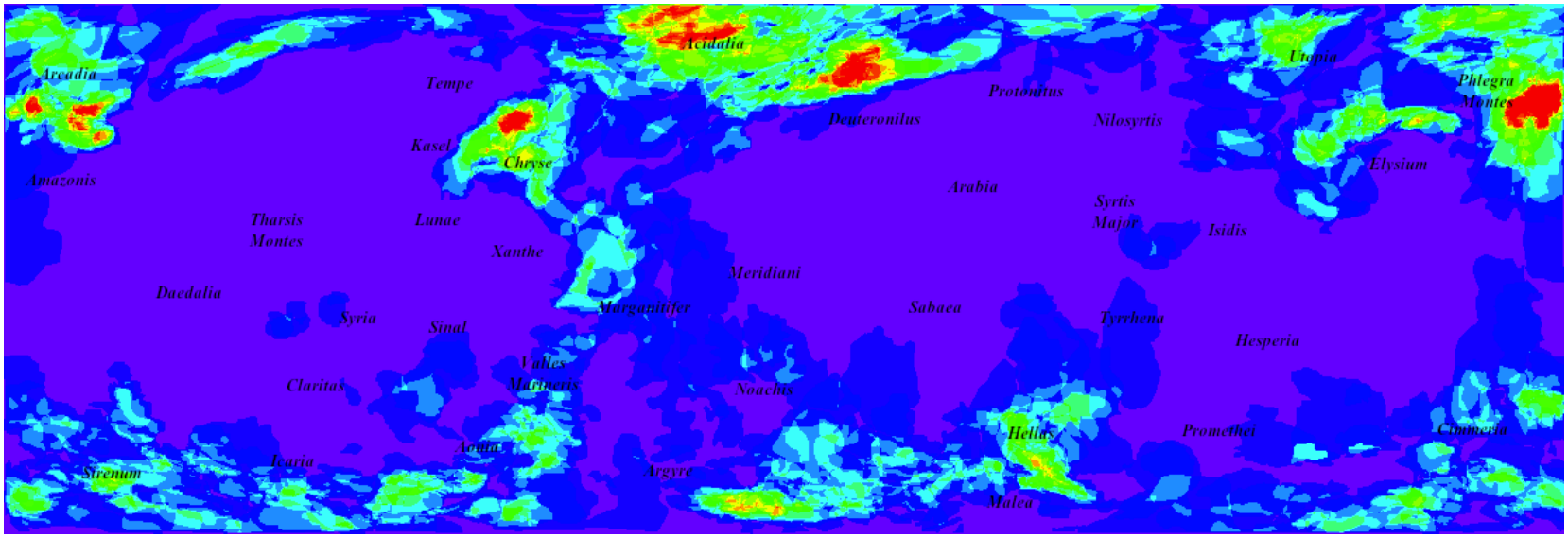
II. Frequency Distribution

Frequency Distribution

Northern Mid-Latitude Band

Low Latitude Population

Southern Mid-Latitude Band



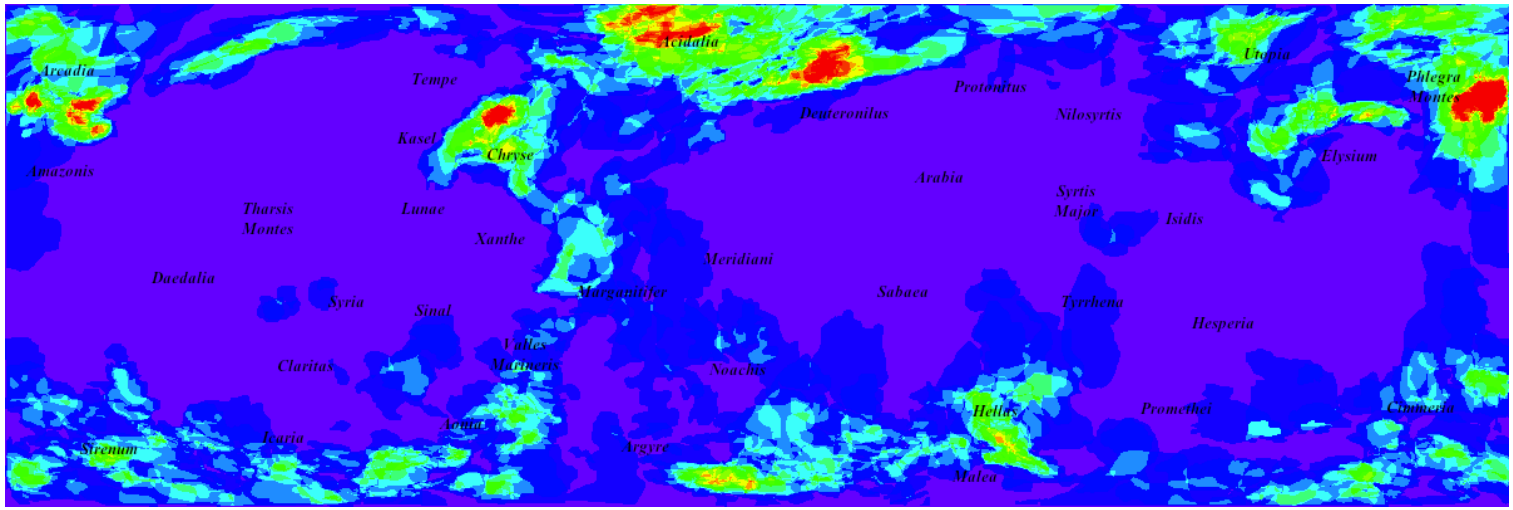
- Non-uniform dust distribution

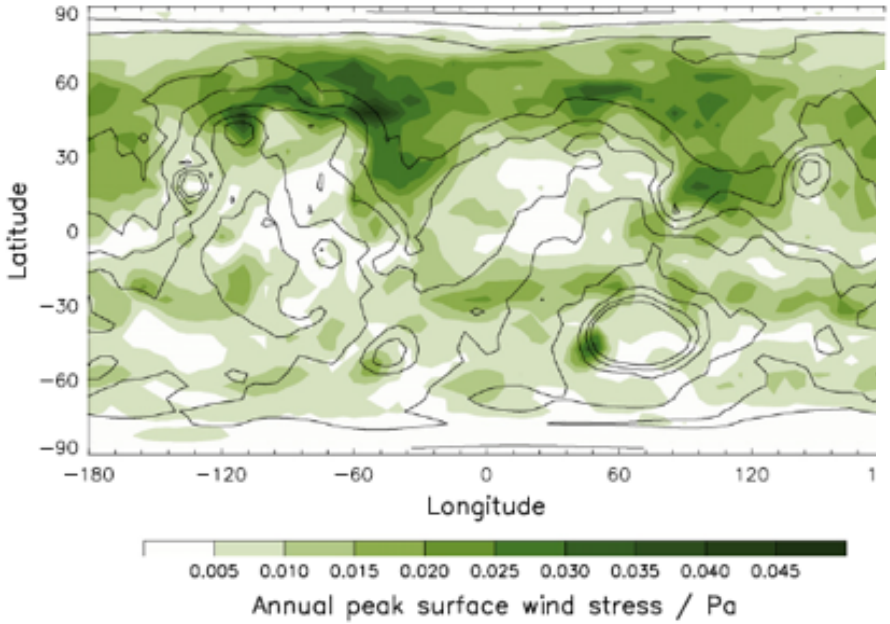
- Northern band includes regions with the highest dust lifting frequency (Arcadia, Acidalia, Cebrenia)

- Low latitude population has a highly asymmetric distribution

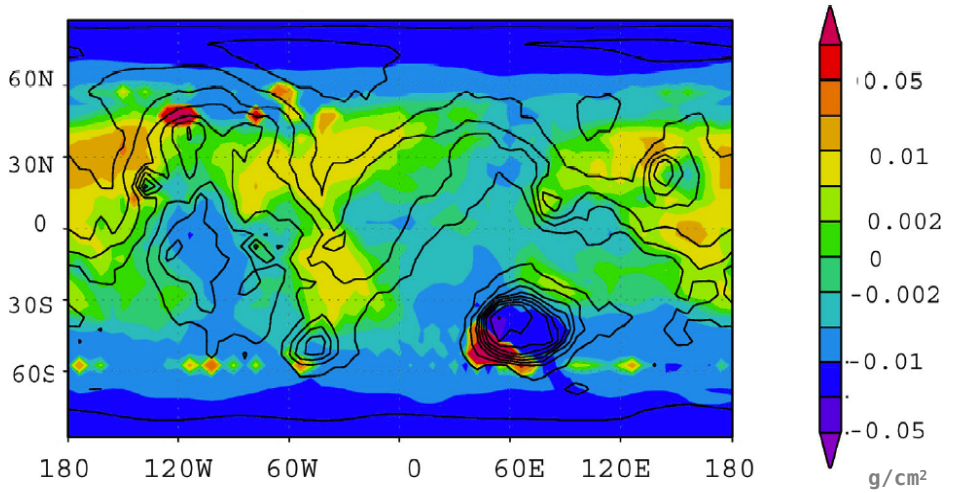
-Southern band has more zonal symmetry

Frequency Distribution





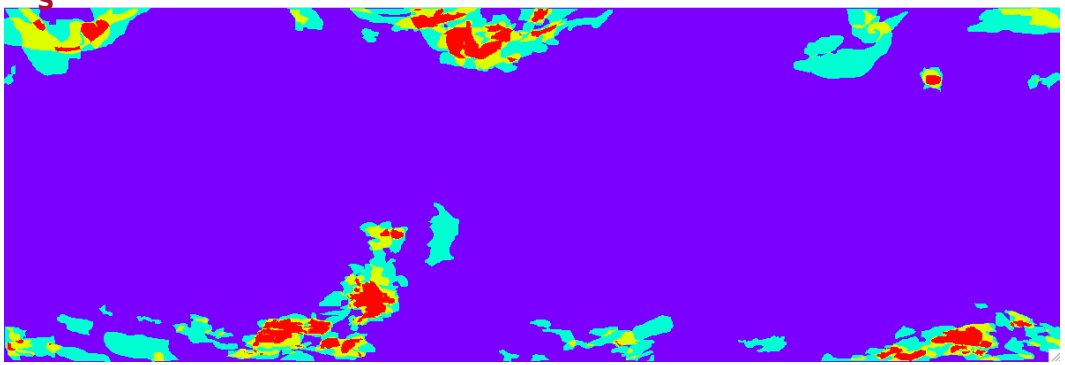
Peak annual wind stress predicted by GCM [*Mulholland et al.*, 2013]



Net annual erosion predicted by the GCM [*Basu et al.*, 2006]

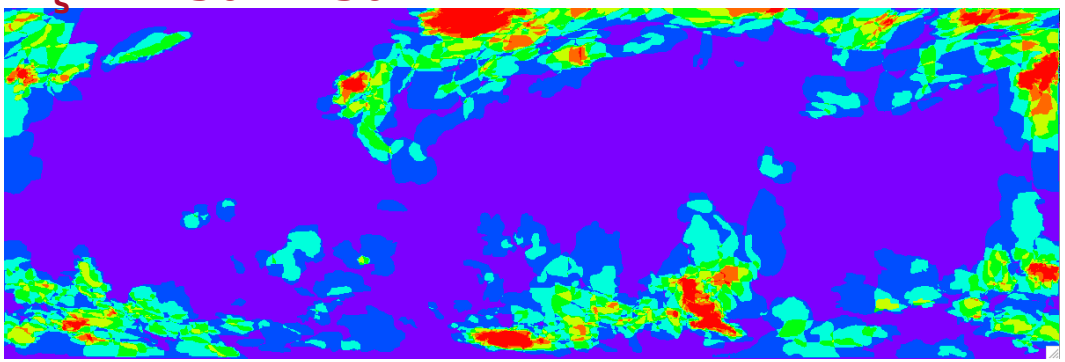
Frequency Distribution

L_s = 0°–80°



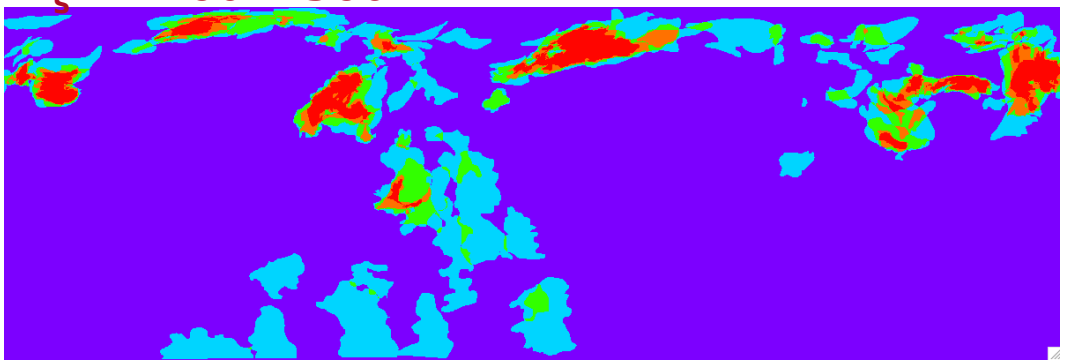
– Northern mid–latitude band and southern mid–latitude band are most active
– The low latitude population is relatively inactive

L_s = 130°–230°



– Most active period of dust lifting
– Lifting occurs in northern and southern bands and low latitude population
– Hellas basin becomes active
– Southern activity has greater zonal symmetry than the mid–latitude northern band or the low latitude population

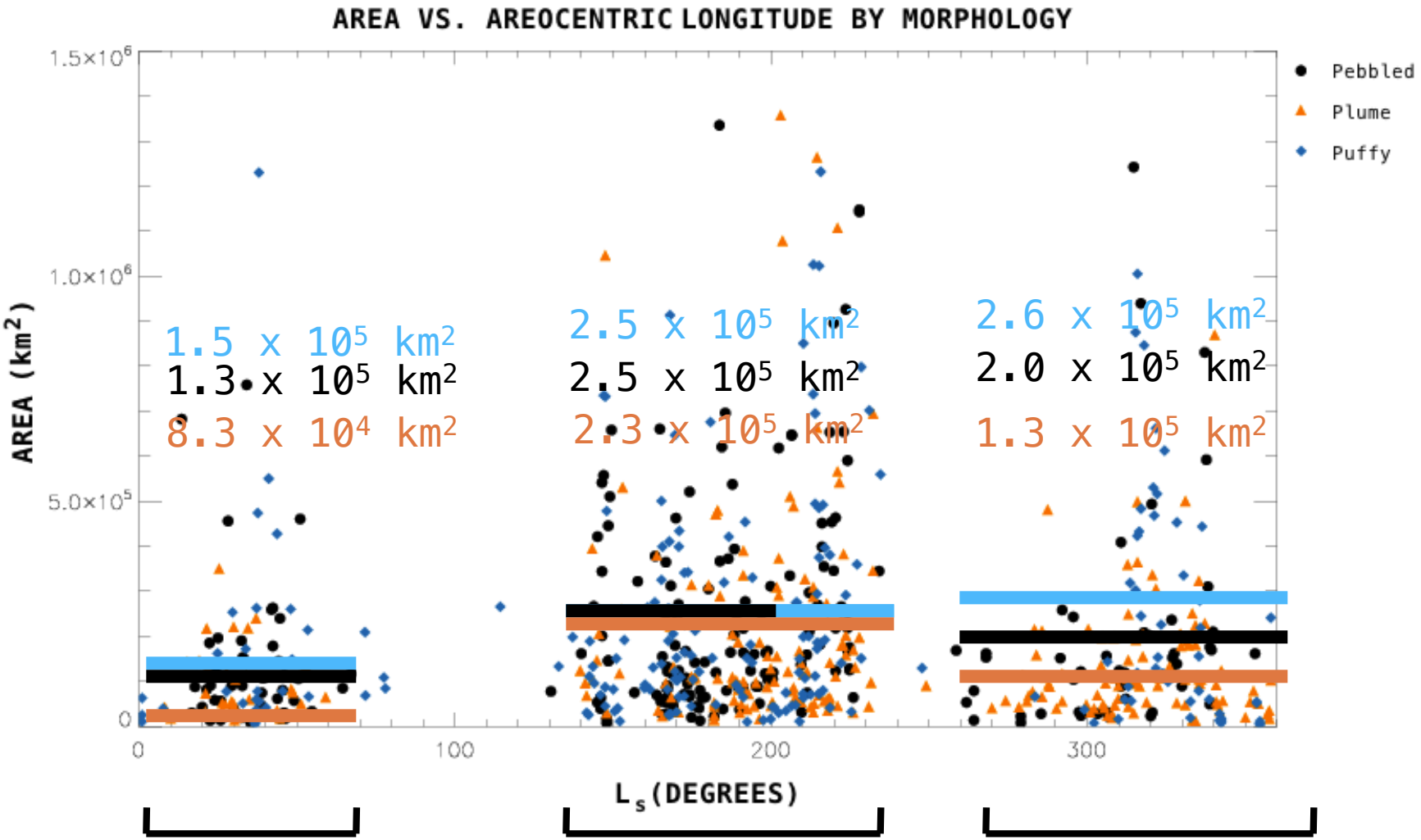
L_s = 260°–360°



– Northern mid–latitude band similar to second seasonal window
– South is much less active and restricted in zonal expanse
– Hellas is no longer active

III. Morphological Properties

Morphological Properties

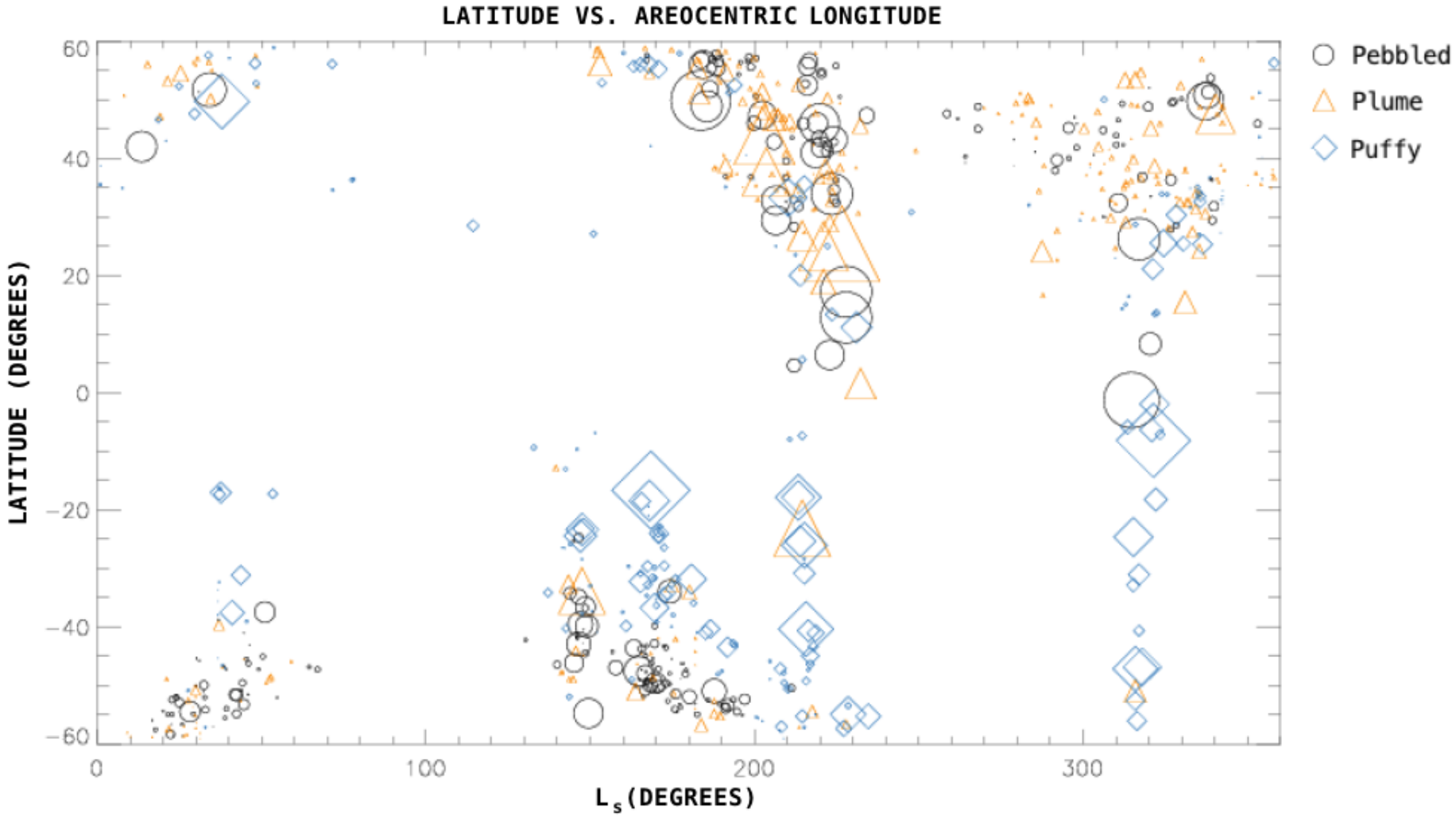


Seasonal Window 1 (L_s = 0°–80°)

Seasonal Window 2 (L_s = 130°–230°)

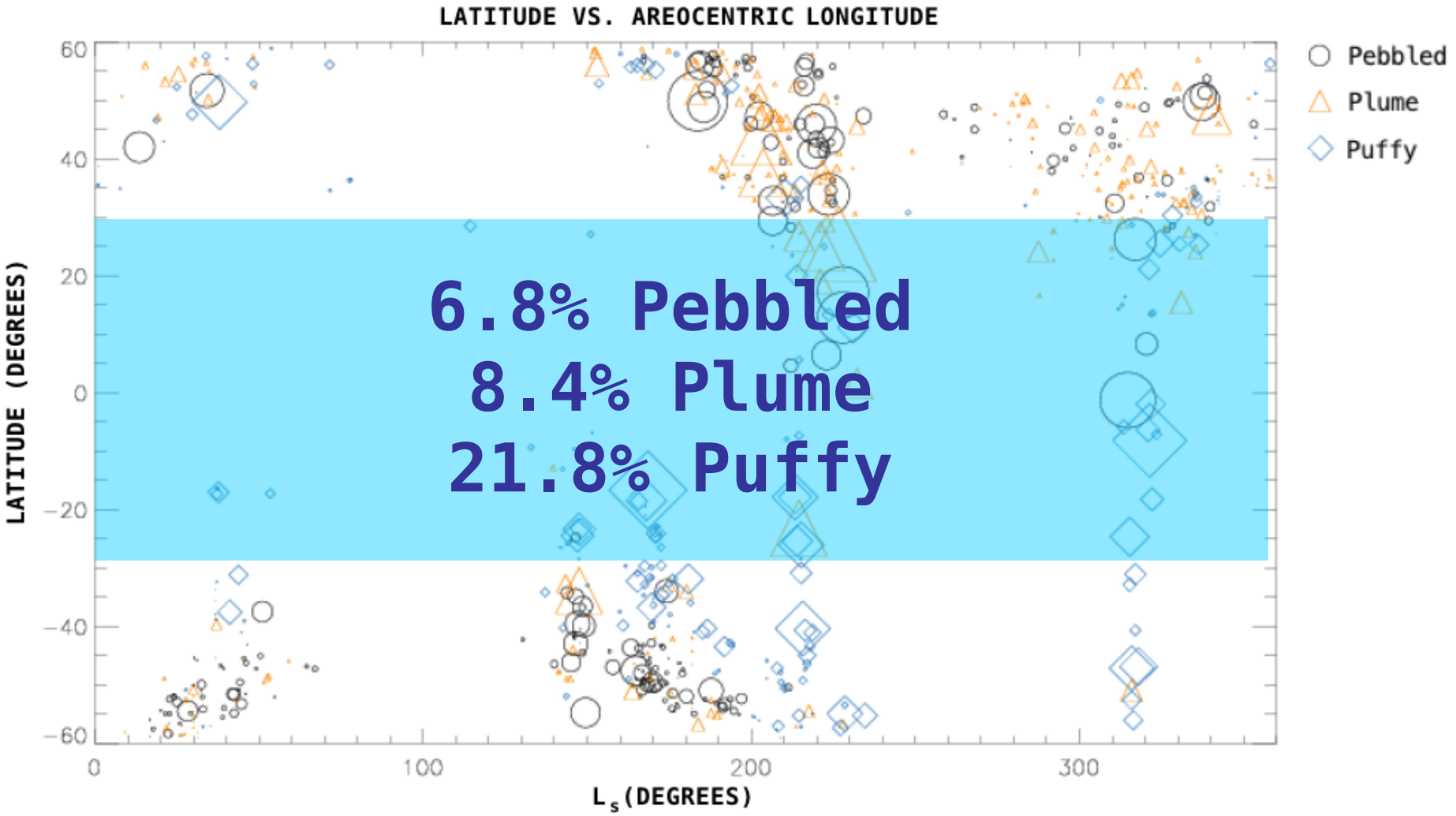
Seasonal Window 3 (L_s = 260°–360°)

Morphological Properties



Each symbol is proportional to the area of the lifting event

Morphological Properties



Concluding Remarks

–A definite seasonal pattern of dust lifting has been observed (L_s = 0°–80°, L_s = 130°–230°, and L_s = 260°–360°)

– The average size of dust lifting varies with season (largest during the second season window)

– Small scale lifting is more common than large scale lifting

– The north claimed more high frequency lifting areas than the south

– Lifting frequency appeared to be correlated with wind stress predicted by GCMs

– Pebbled and plume structures are concentrated in higher latitudes while puffy lifting structures are also found in lower latitudes.

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