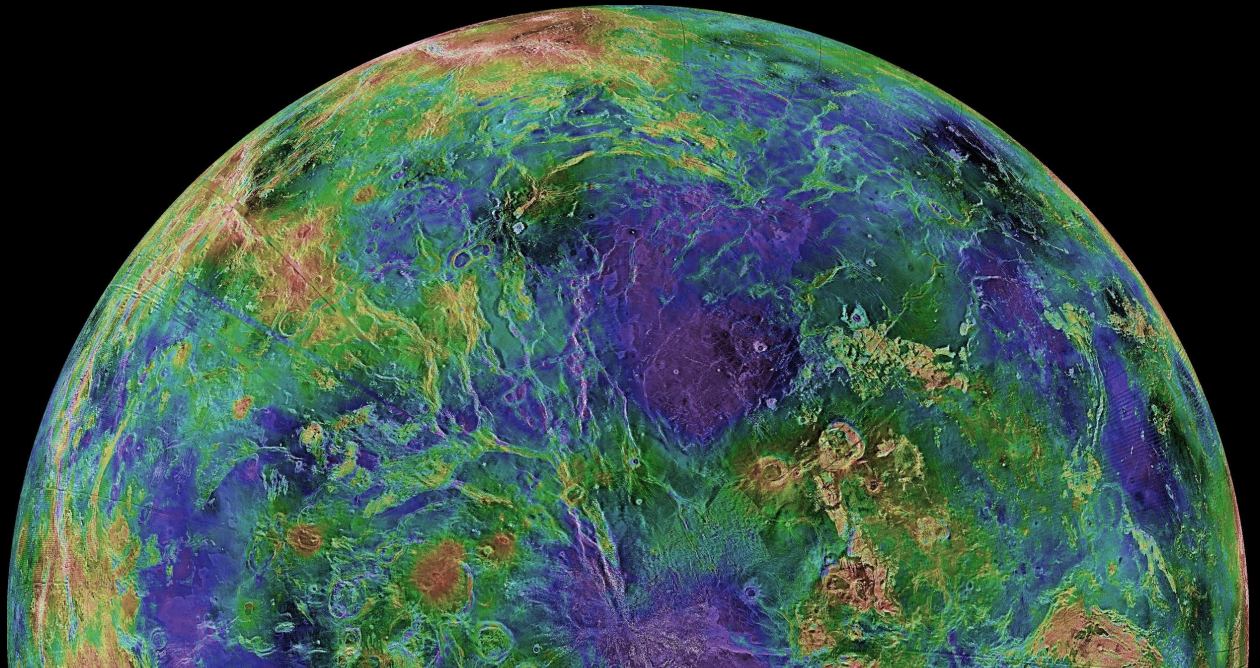
Chasing the Flows:

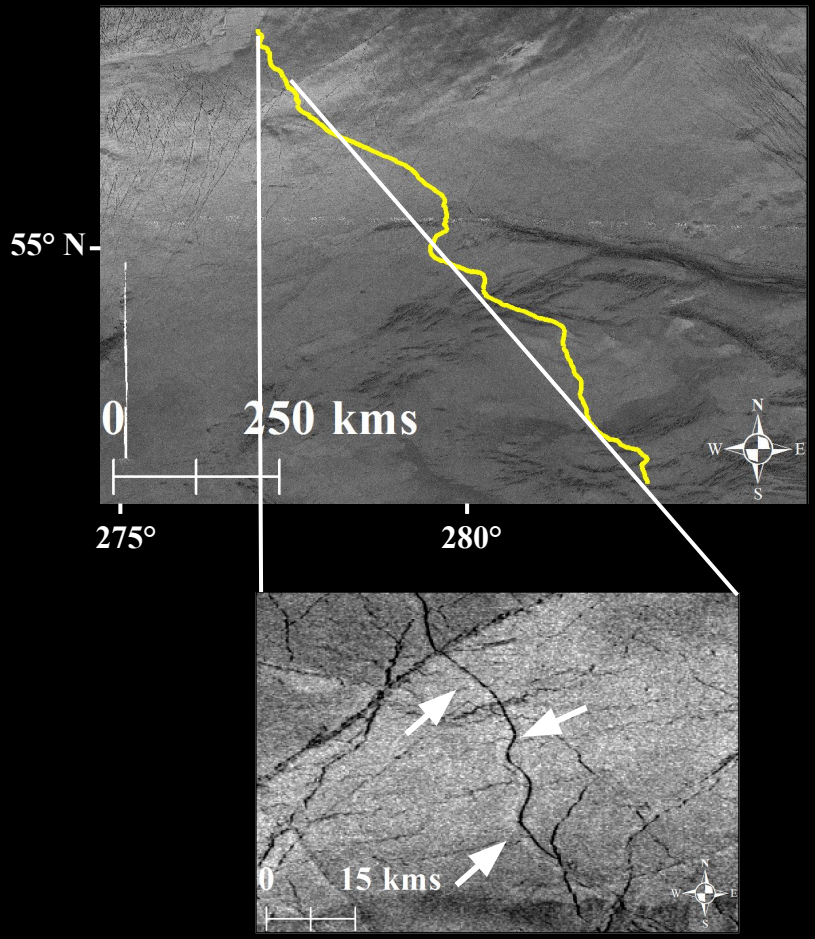
Constraining the Lithospheric Structure of Venus through Topographic Modification along Canali

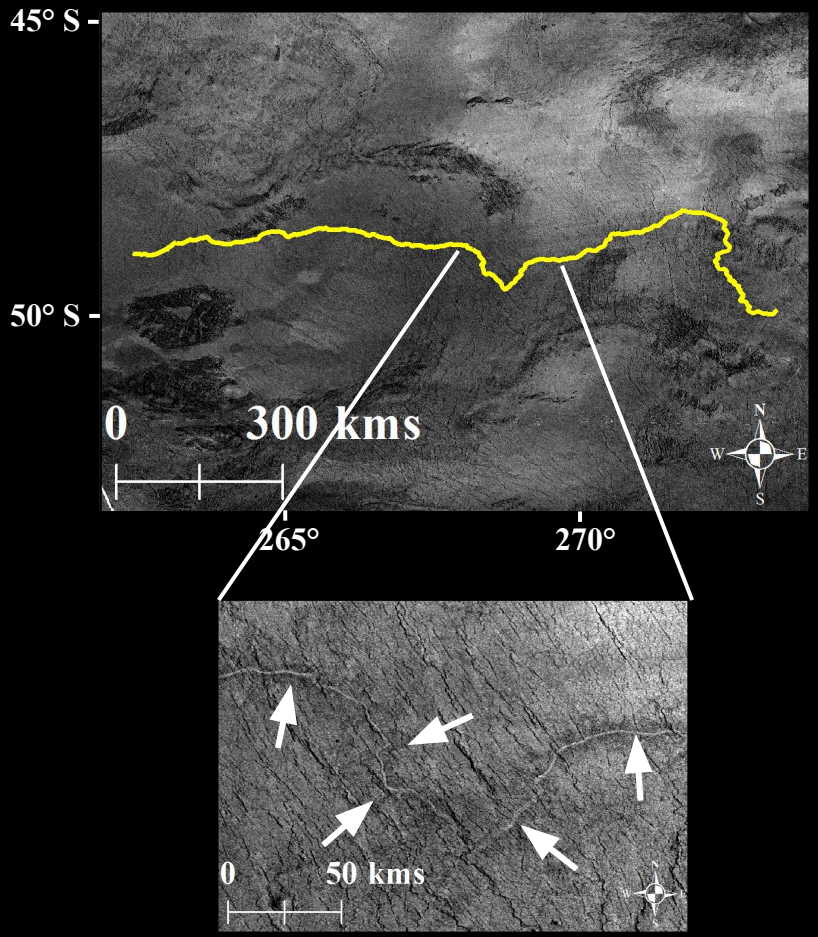
Abhinav Jindal[1], Alexander Hayes[1], Michael Manga[2]

[1]Cornell University, [2]UC Berkeley

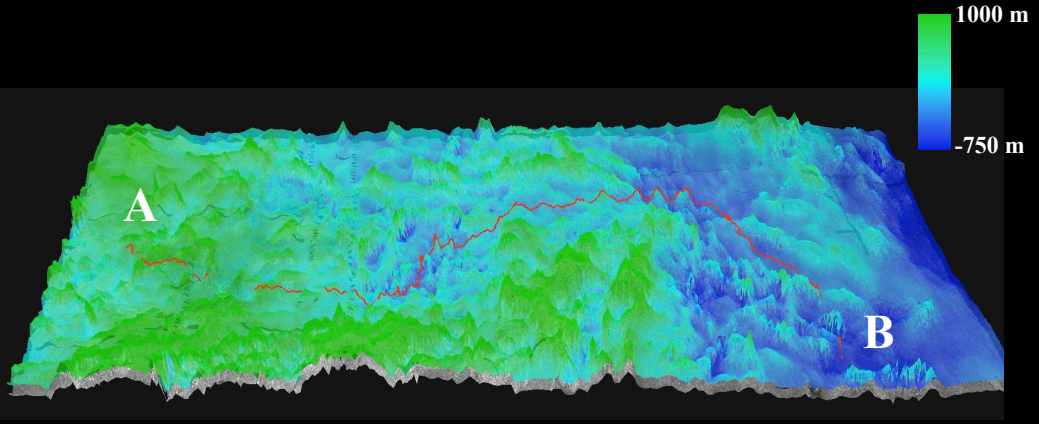


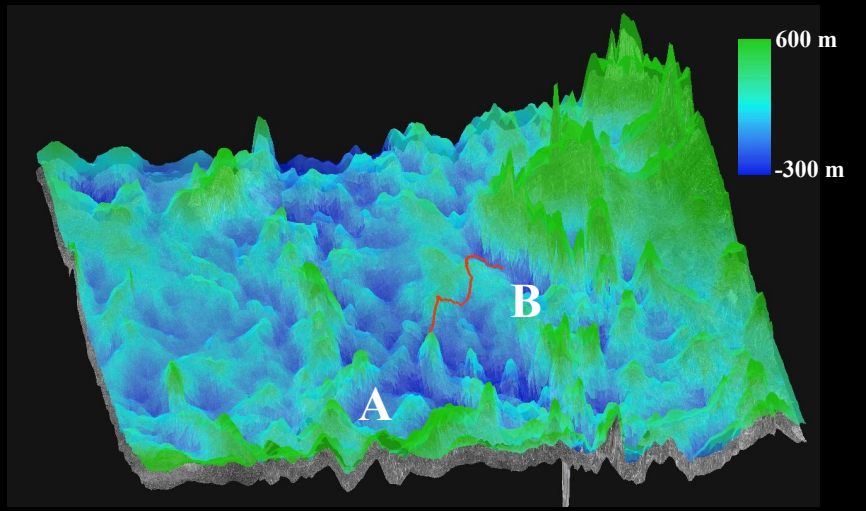
Some of the longest channels in our solar system!

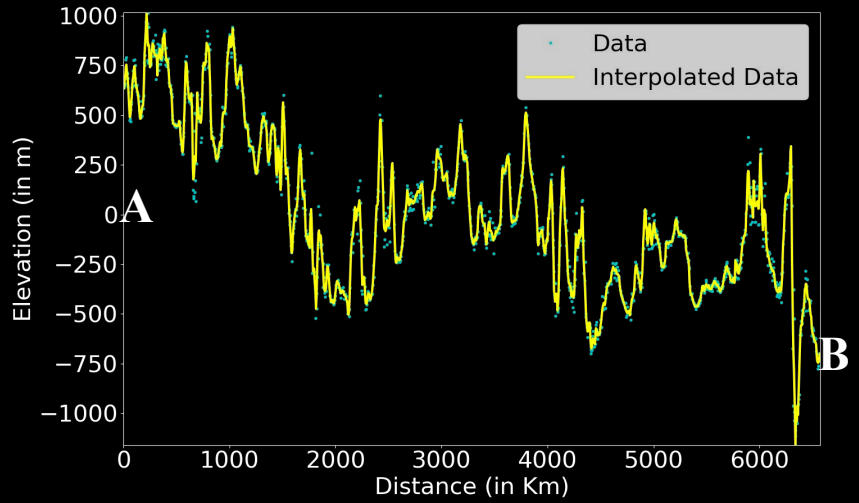


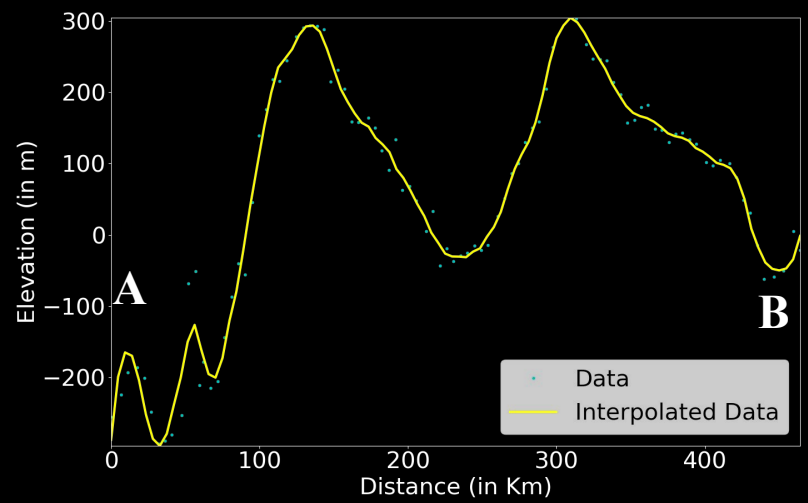


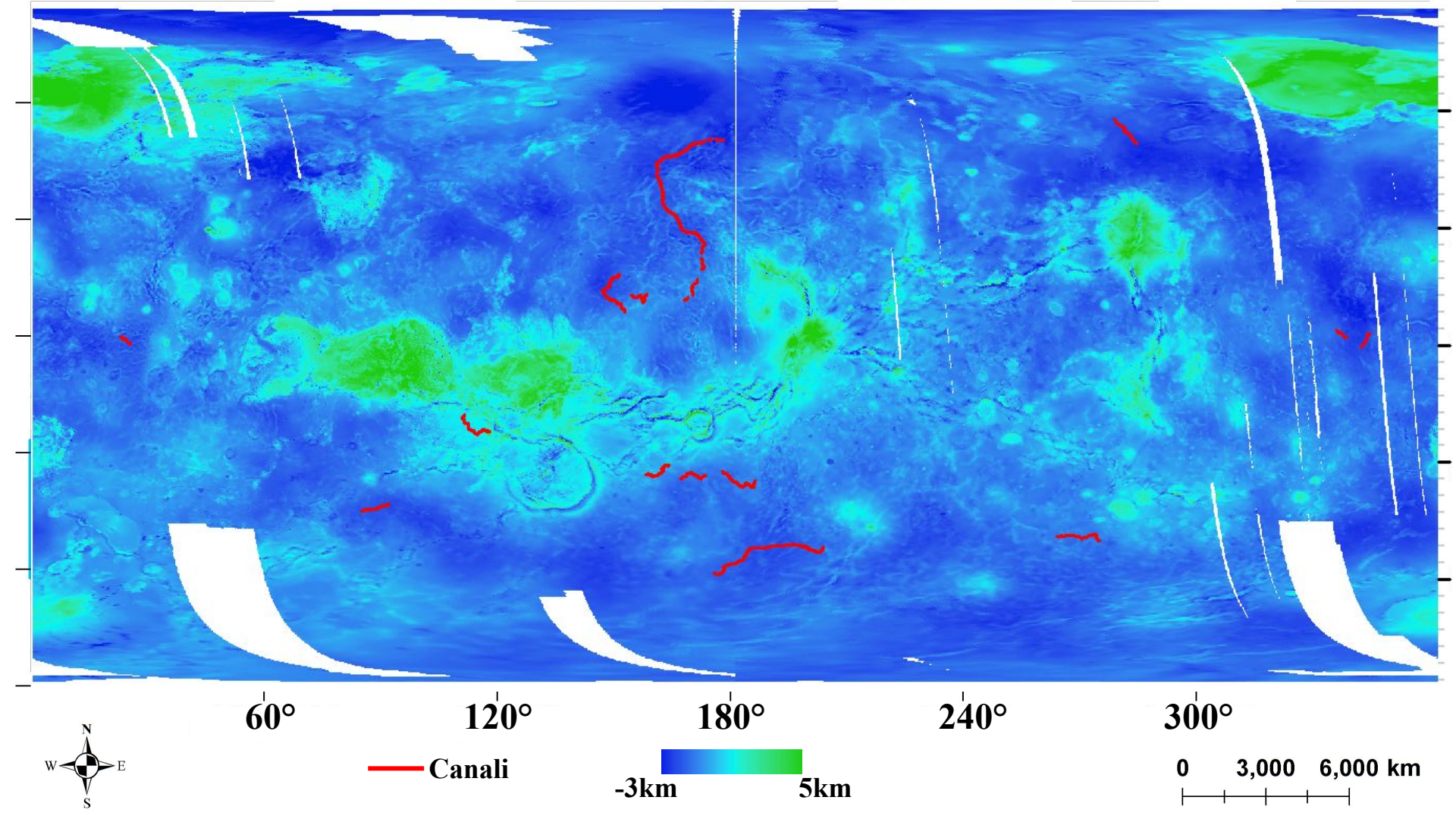
Roller-Coaster Canali



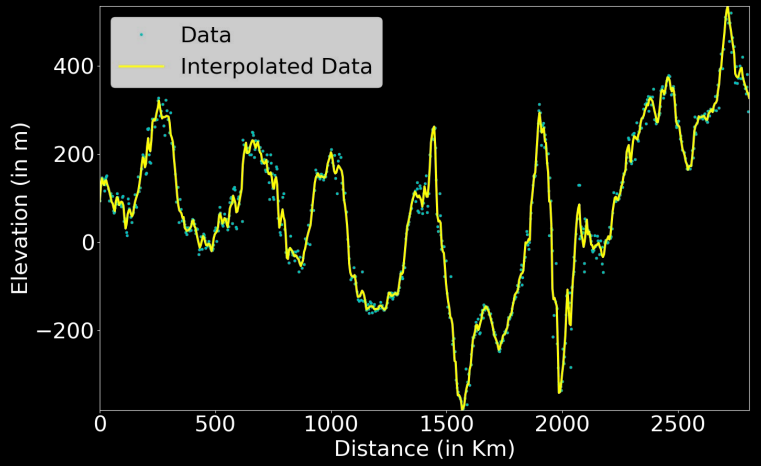


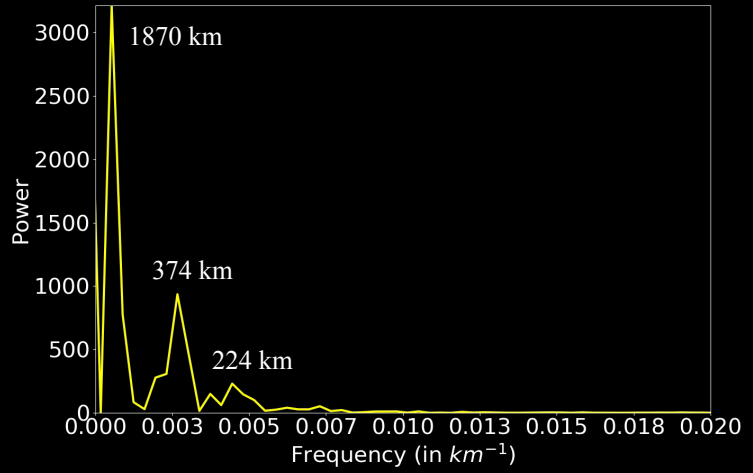


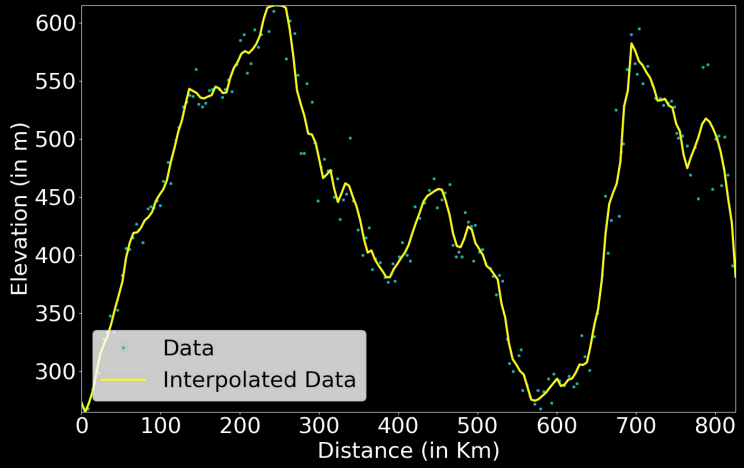


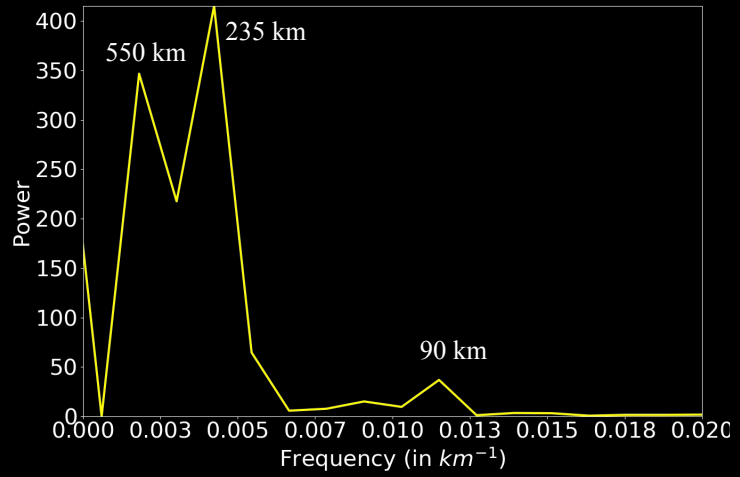

60°
120°
180°
240°
300°
N
W
E
S
Canali
-3km
5km
0
3,000
6,000 km

Fourier Analysis to search for periodic deformation

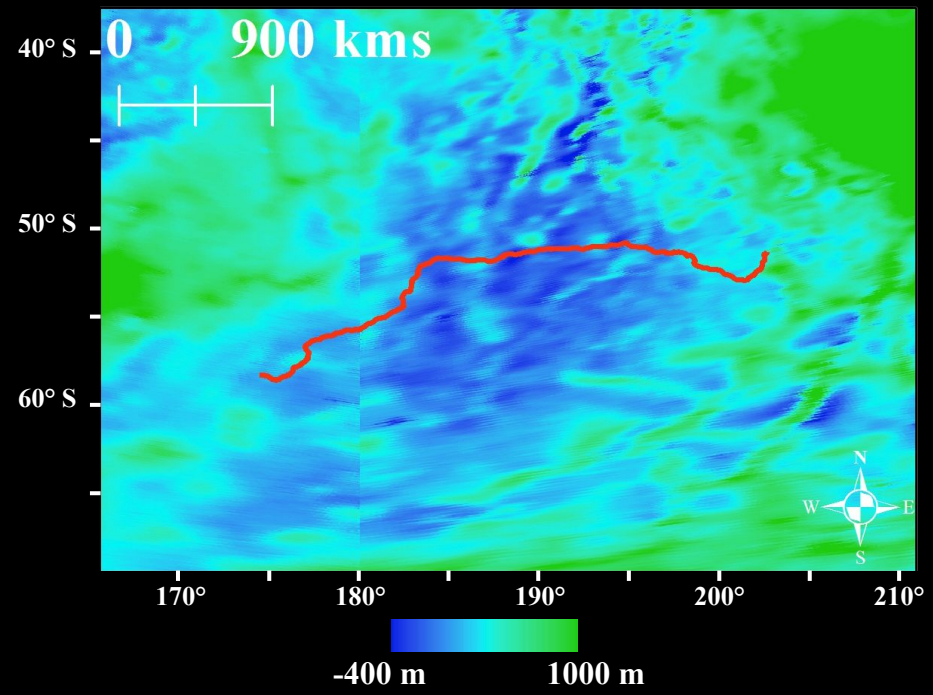


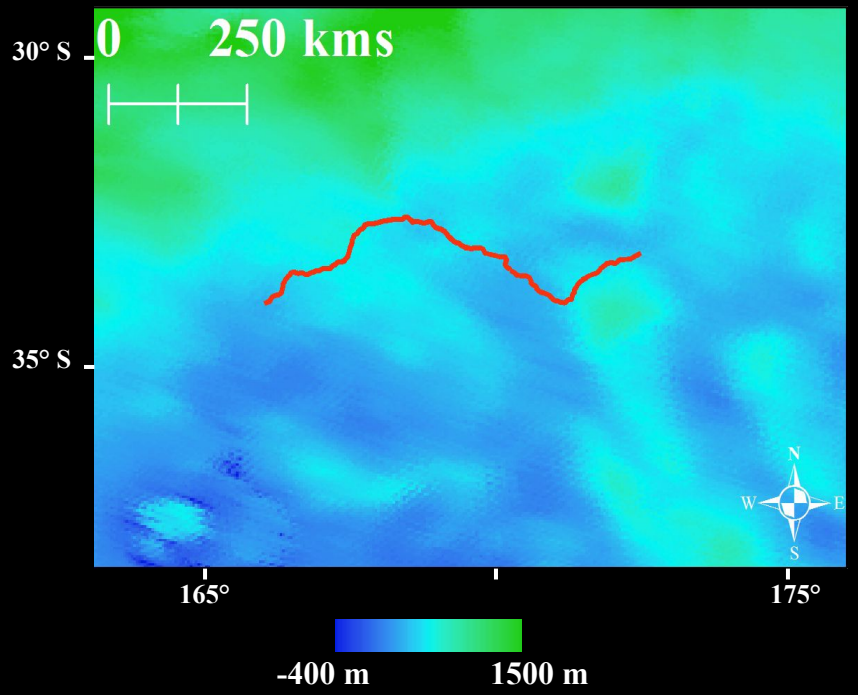




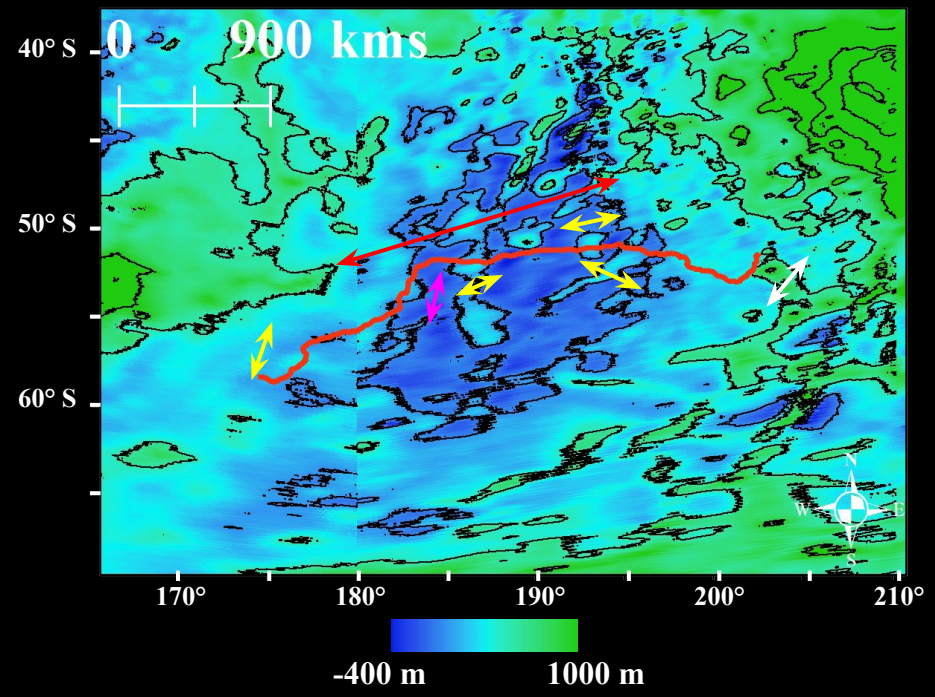


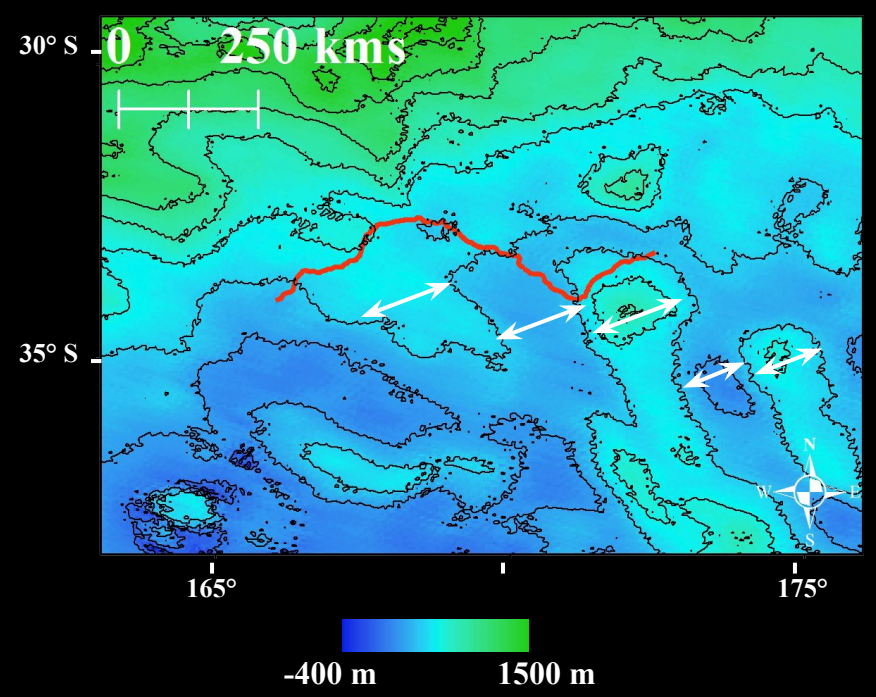
Visually inspecting deformation length scales





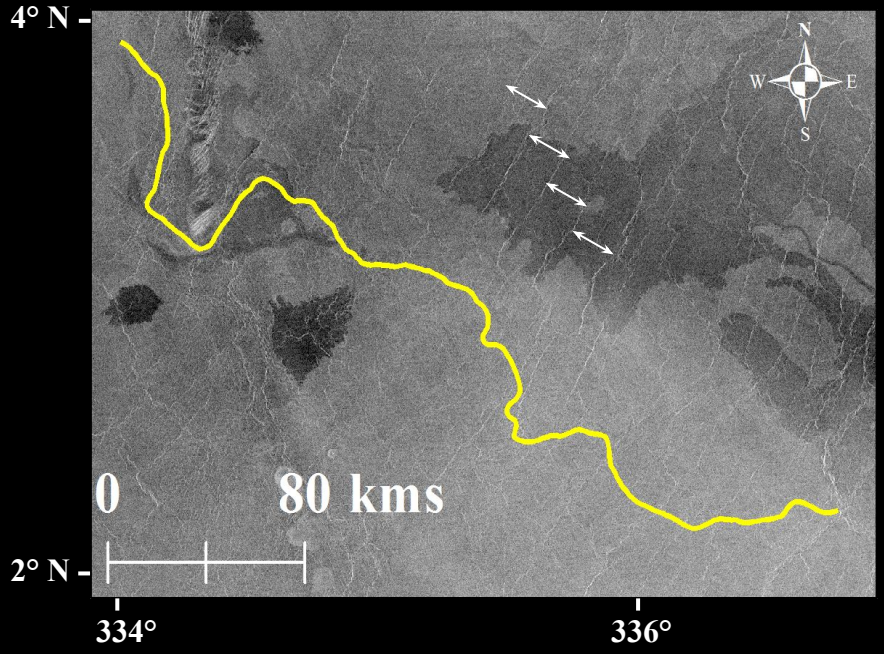
Visually inspecting deformation length scales

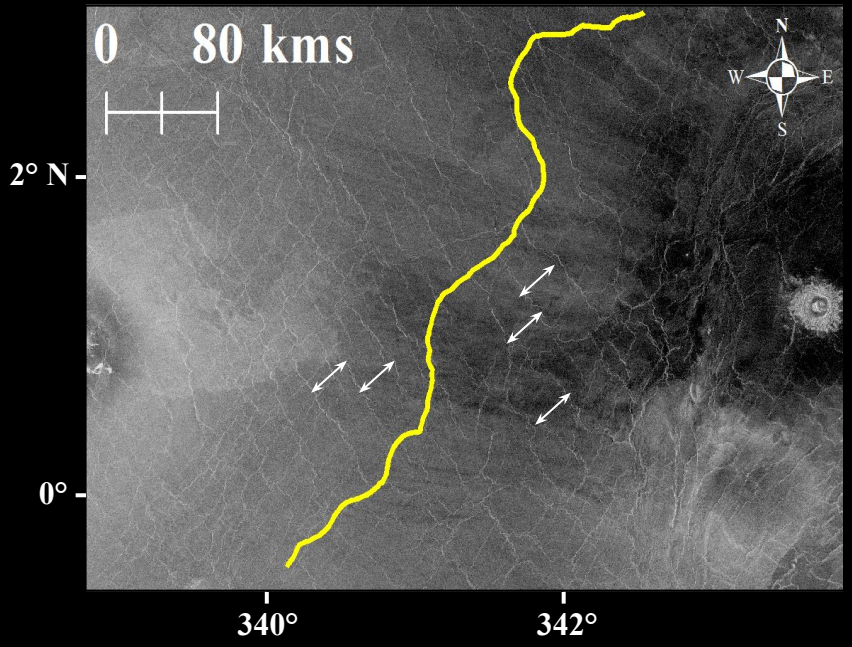




100 km 140-160 km 200-220 km 2000km

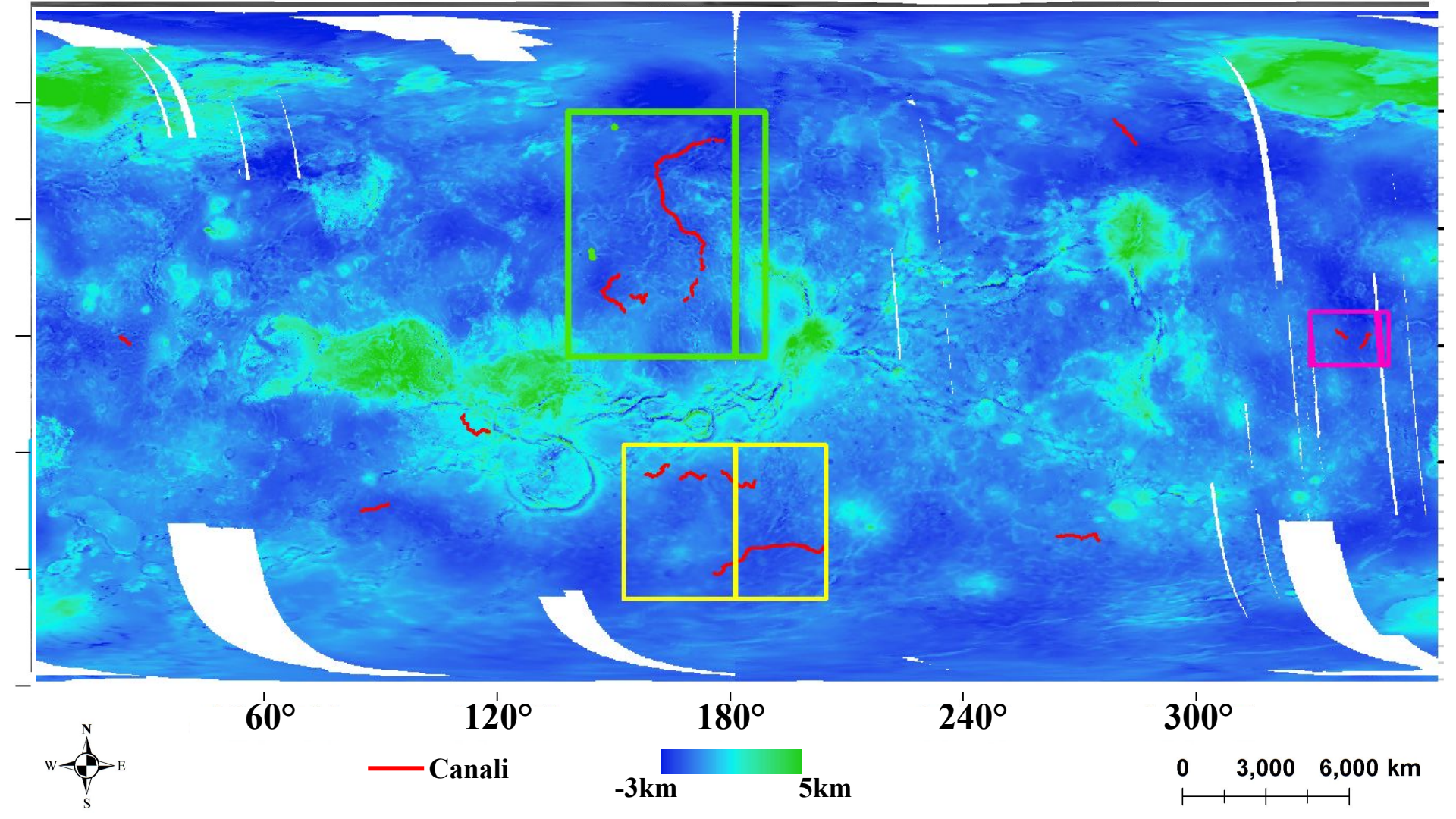
Shorter Length Scales from SAR





Wrinkle ridges are separated by 10-30 kms

Canali #	Latitude Range	Longitude Range	Length (in km)	Observed Length Scales (in km)	Wrinkle ridges Separation (in km)
1	10 - 56° N	147 -179° E	6000	80, 100, 150, 2100	15-25
2	10 - 15° N	150 - 160° E	900	130, 160	15-20
3	10 - 20° N	145 - 150° E	2000	80, 110, 130	15-20
4	28 - 72° S	148°E - 148°W	3000	100-150, 200, 2000	20-30
5	30 - 40° S	150-180° E	1000	90	No wrinkle ridges
6	30 - 40° S	150-180° E	800	200-220	25-30
7	30 - 40° S	150-180° E	1300	100, 120, 180	25-30
8	4° S - 9° N	19 - 27° W	600	90	15-20
9	4° S - 9° N	19 - 27° W	700	90-110	15-25
10	0 - 3° N	20 - 25° E	500	90, 150, 240	20-30
11	15 - 30° S	110 - 120° E	1200	80-90 ,180	No wrinkle ridges
12	45 - 50° S	85 - 100° W	1100	140, 190	25-30
13	50 - 60° N	75 - 85° W	1000	100	5-15
14	40 - 43° S	80 - 90° E	700	90-120, 230	20-30


60°
120°
180°
240°
300°
N
W
E
S
Canali
-3km
5km
0
3,000
6,000 km

Canali #	Latitude Range	Longitude Range	Length (in km)	Observed Length Scales (in km)	Wrinkle ridges Separation (in km)
1	10 - 56° N	147 -179° E	6000	80, 100, 150, 2100	15-25
2	10 - 15° N	150 - 160° E	900	130, 160	15-20
3	10 - 20° N	145 - 150° E	2000	80, 110, 130	15-20
4	28 - 72° S	148°E - 148°W	3000	100-150, 200, 2000	20-30
5	30 - 40° S	150-180° E	1000	90	No wrinkle ridges
6	30 - 40° S	150-180° E	800	200-220	25-30
7	30 - 40° S	150-180° E	1300	100, 120, 180	25-30
8	4° S - 9° N	19 - 27° W	600	90	15-20
9	4° S - 9° N	19 - 27° W	700	90-110	15-25
10	0 - 3° N	20 - 25° E	500	90, 150, 240	20-30
11	15 - 30° S	110 - 120° E	1200	80-90 ,180	No wrinkle ridges
12	45 - 50° S	85 - 100° W	1100	140, 190	25-30
13	50 - 60° N	75 - 85° W	1000	100	5-15
14	40 - 43° S	80 - 90° E	700	90-120, 230	20-30

Future Work - Modeling the length scales

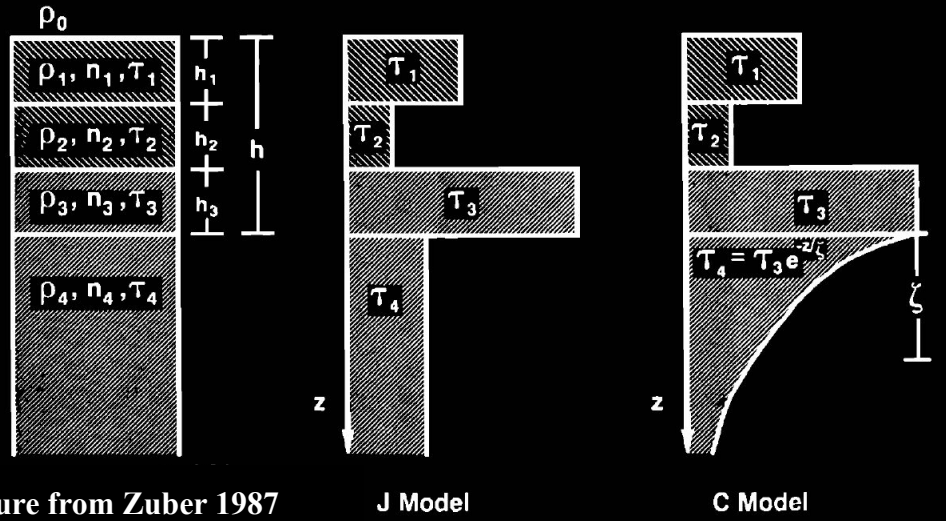


Figure from Zuber 1987 J Model C Model

$$\epsilon = \mathbf{A}(\sigma_1 - \sigma_3)^n e^{-Q/RT}$$

$$\tau = 2\bar{\mu}\,\bar{\epsilon}_{xx}$$

The governing equation for perturbing flow in a single viscous layer with uniform viscosity is given by:

$$\mathbf{D^4W - 2k^2(2/n_i - 1)\,D^2W + k^4W = 0}$$

where, D = d/dz

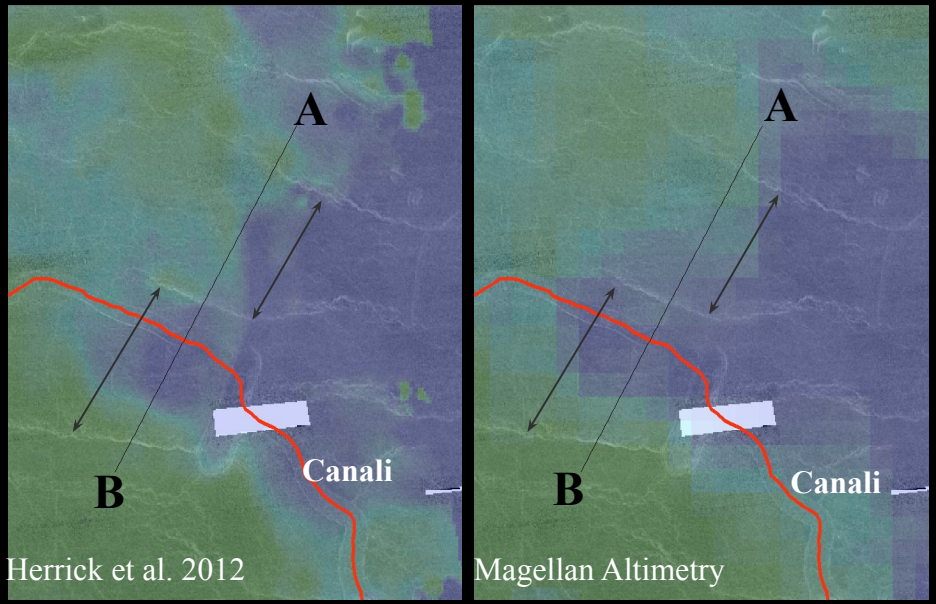
k = wave number

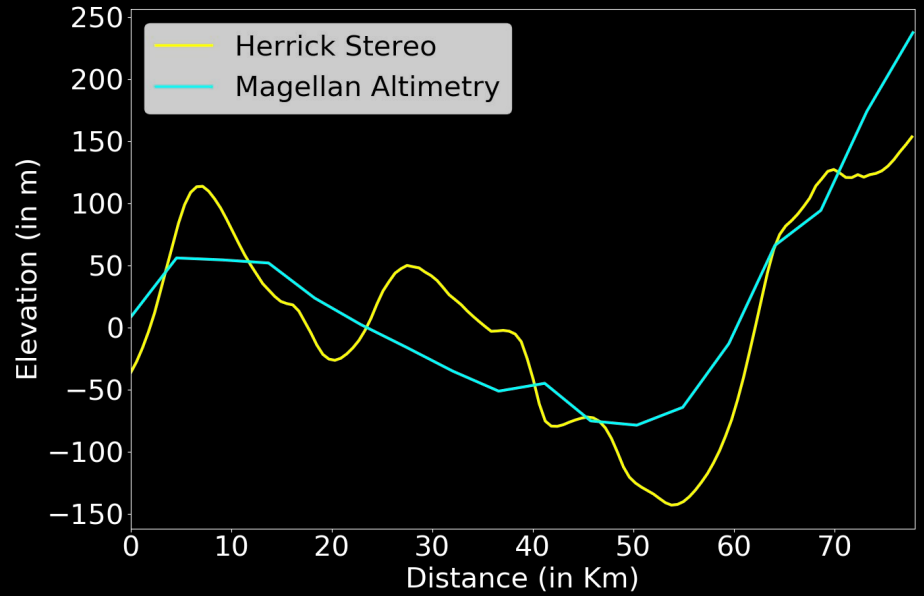
W = stream function

$\mathbf{n_i}$ = stress-exponent in i^{th} layer

The dominant wavelength of deformation is determined from the eigenvalue solution of the system of equations for the perturbing flow in each layer.

Future Work - Stereo Topography





Wrinkle ridges can be resolved in stereo topography data!

Conclusions

- We observe three deformation length scales.
- The **10-30 km** length scales are associated with ***wrinkle ridges*** and can be attributed to deformation in the **upper crust**.
- The **100-300 km** length scales are associated with ***ridge belts*** in the Venusian lowlands or smaller basins and can be attributed to a **strong upper mantle layer.**
- The **~1000 km** length scales are associated with ***basin-like structures*** which can be attributed to **mantle downwelling**.
- We observe regional correlations between observed length scales, with canali near each other showing similar deformation length scales