# Identifying boulders on 67P with ML

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**With Sebastien Besse[3] & Michael Küppers[3]**

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**2- New York University | Abu Dhabi**
**3- ESAC**

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# Astrophysical CIrcles Detector (ACID)

- **General purpose “astrophysical circles” detector.**

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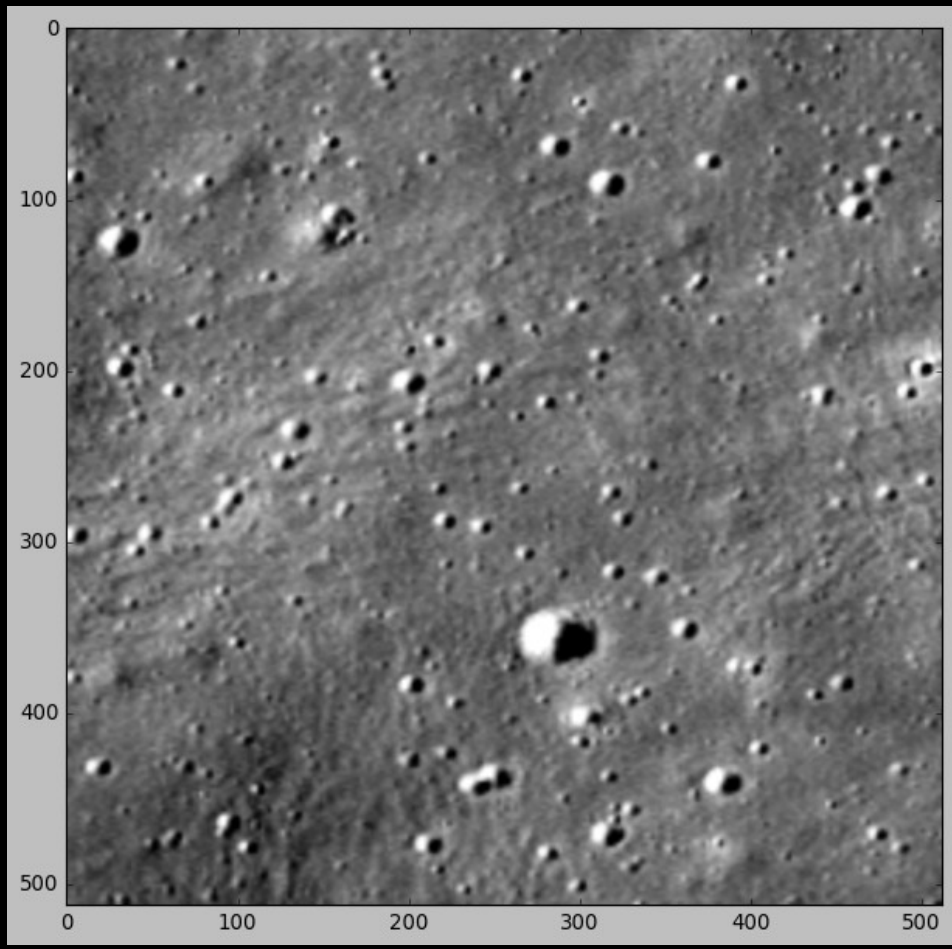
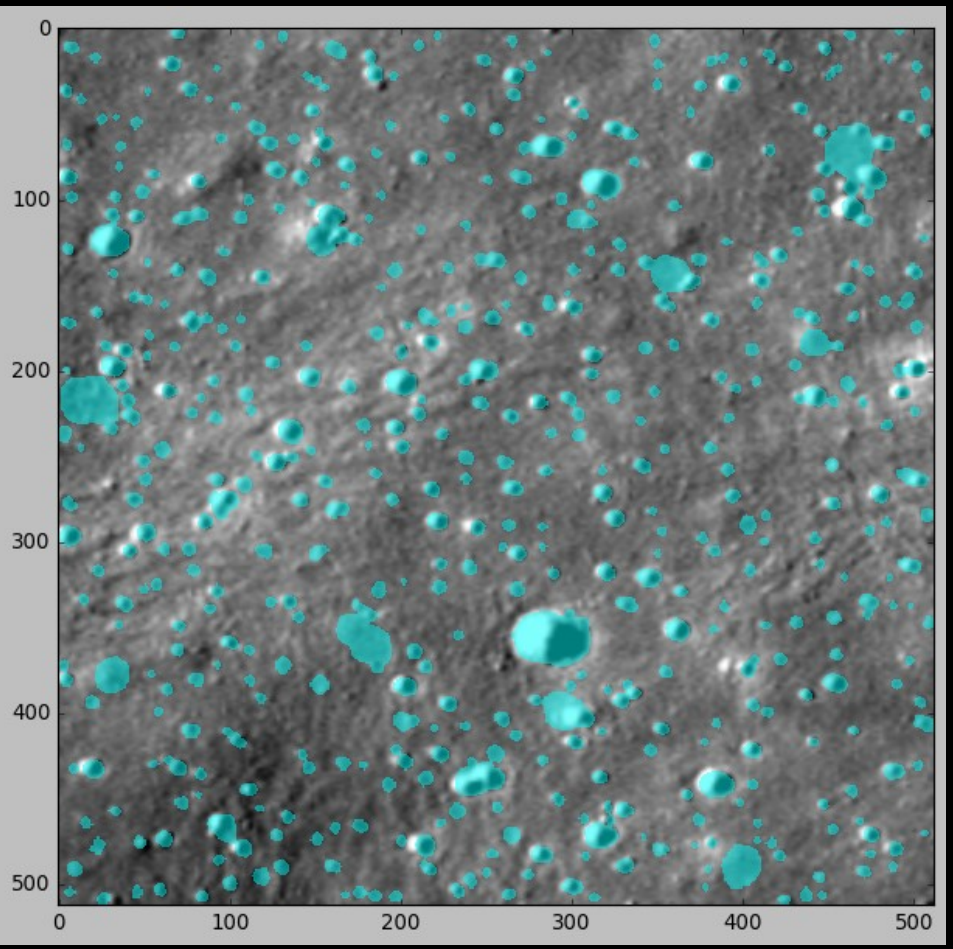



Raw image




ACID detections

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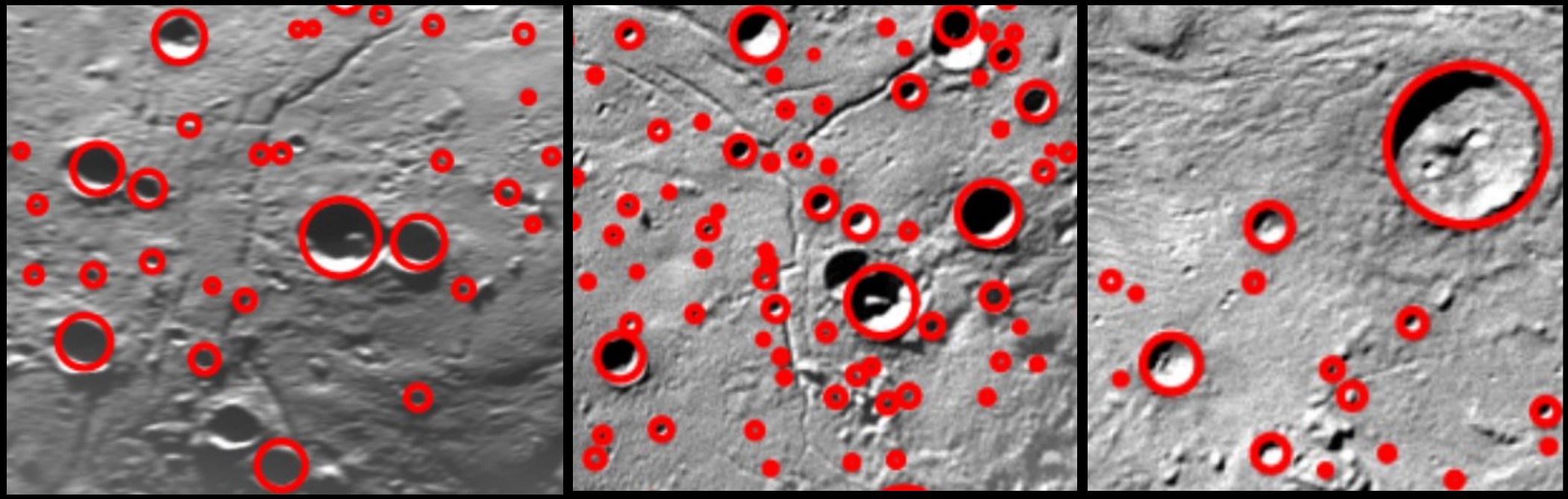

Ali-Dib, M. (2022), Icarus, in press.

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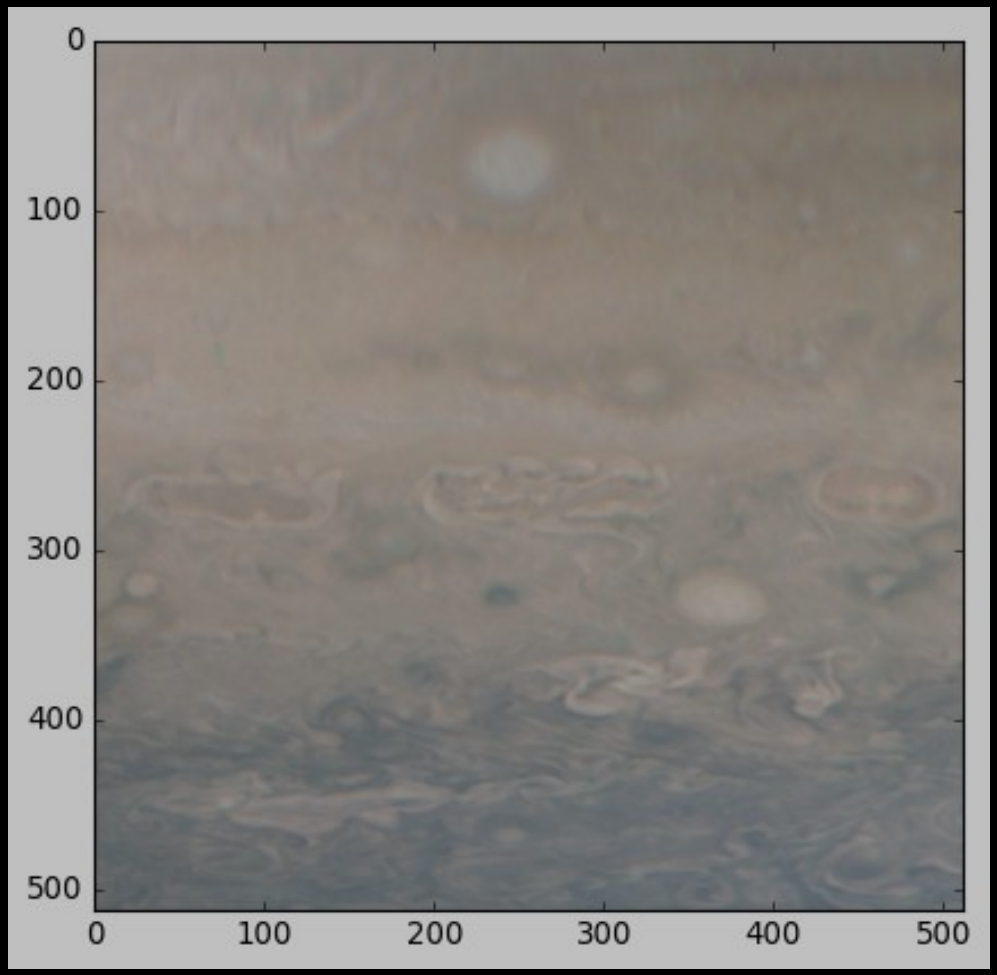


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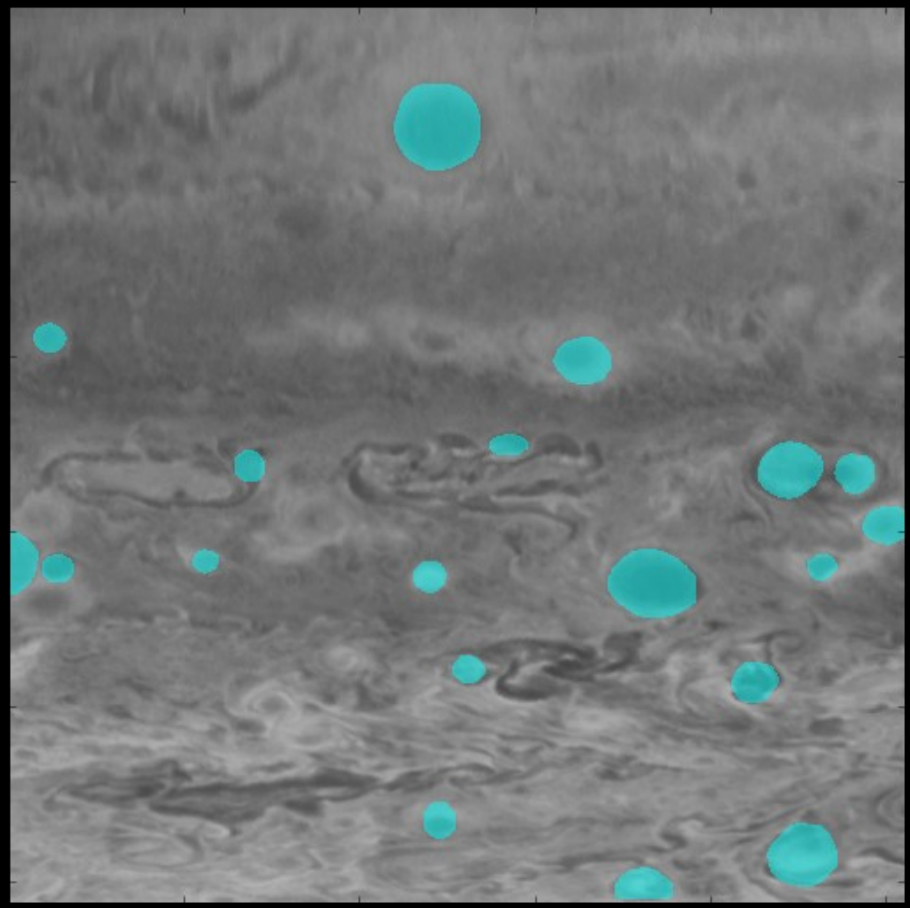

Acid detections

## Cyclones on Jupiter

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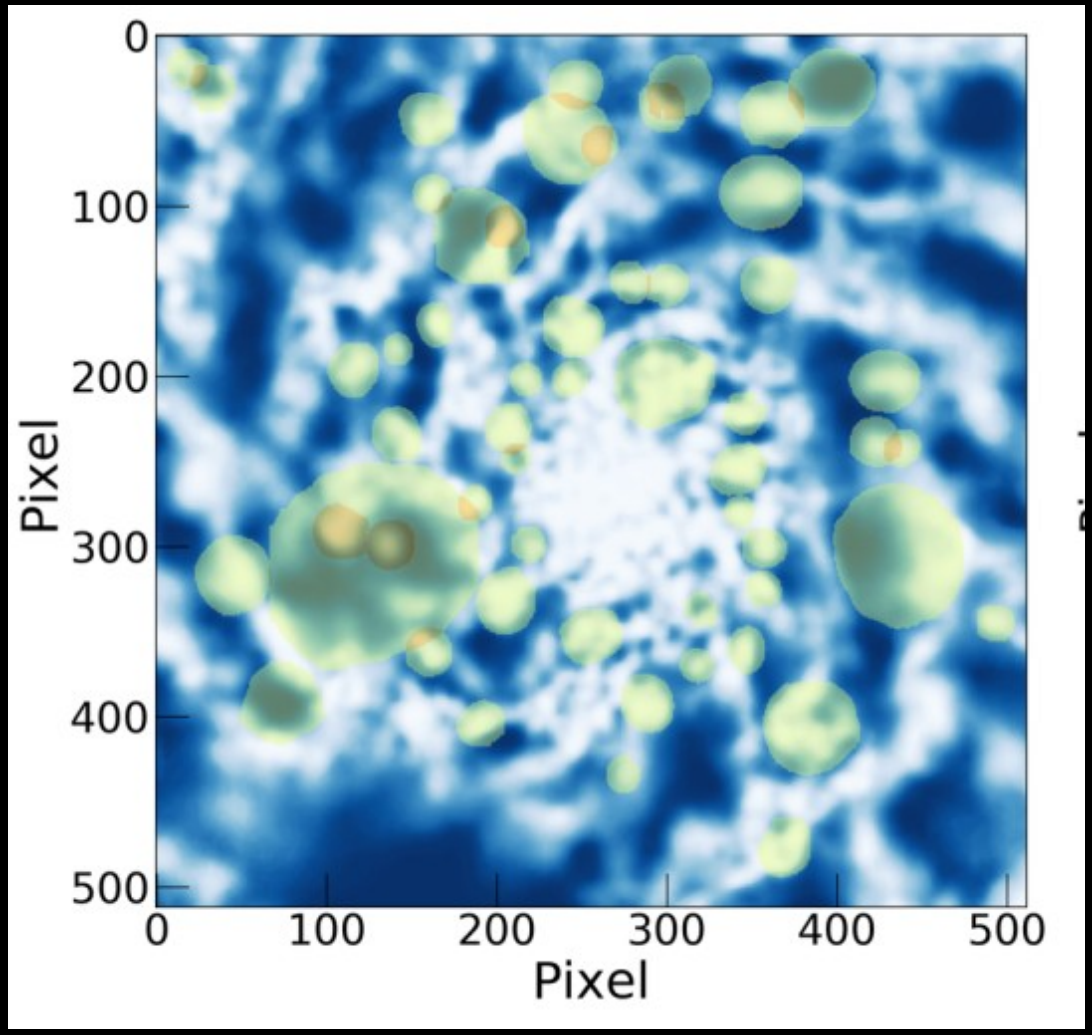


**Over/under densities in galaxies**

**Maccio, Ali-Dib et al. (2022) MNRAS.**

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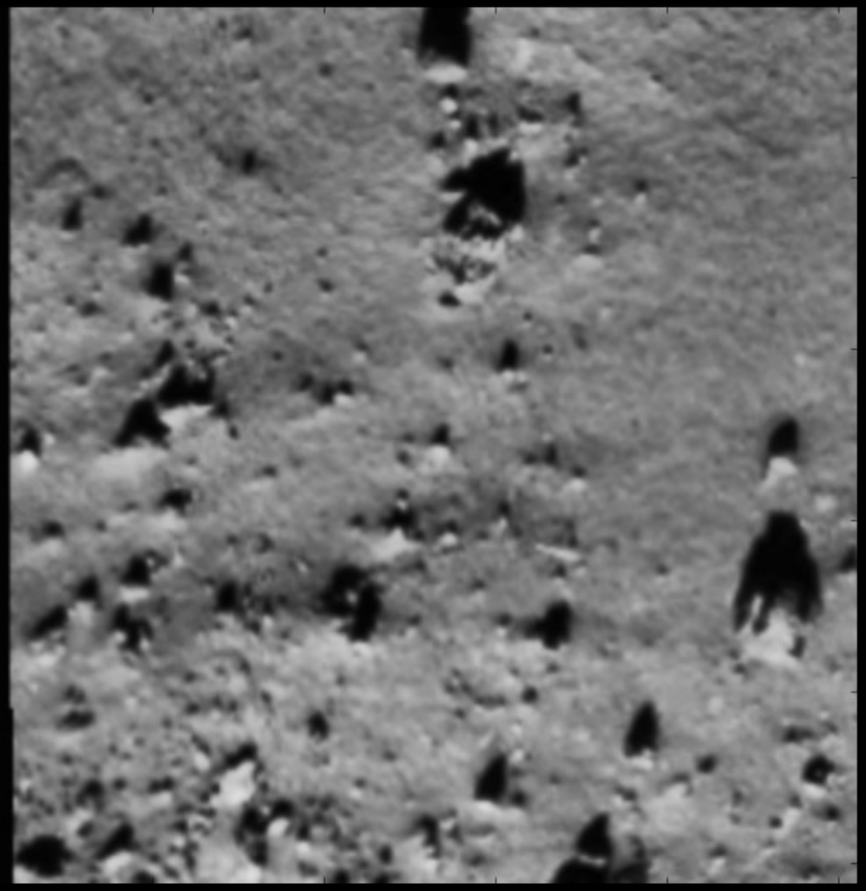

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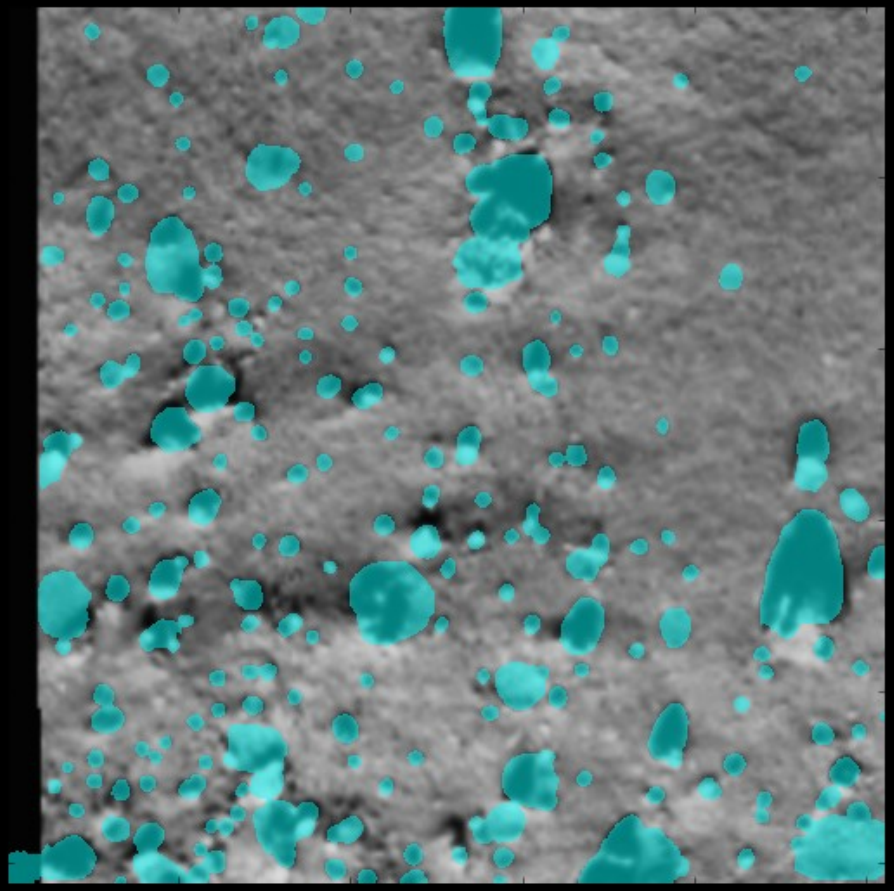

ACID detections

**Boulders on 67P/C-G**

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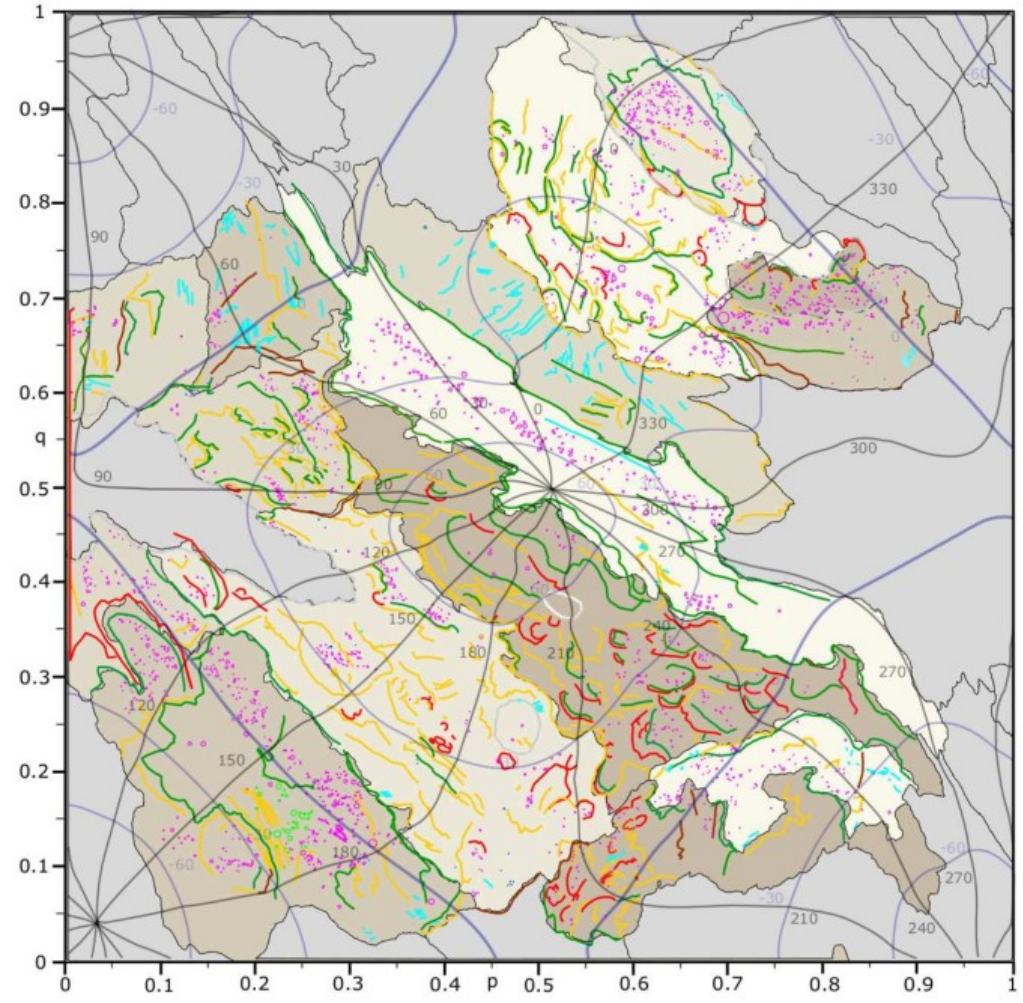
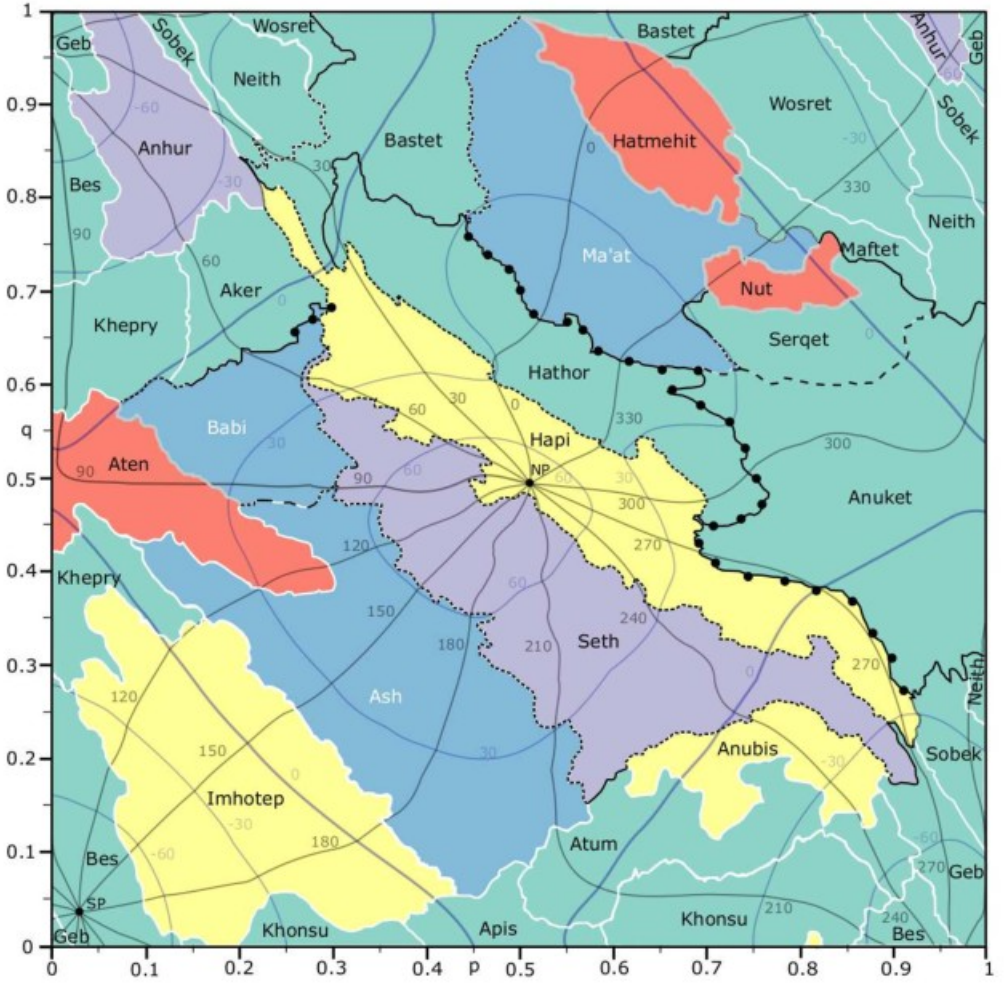
- Ali-Dib (2022, Icarus) + Separate paper on arxiv soon.

# Boulders on 67P: Methods




Northern hemisphere: images from Leon-Dasi+2021 (Sept 2014)

Resolution ranging from 0.5 to 2.2 m/pixel

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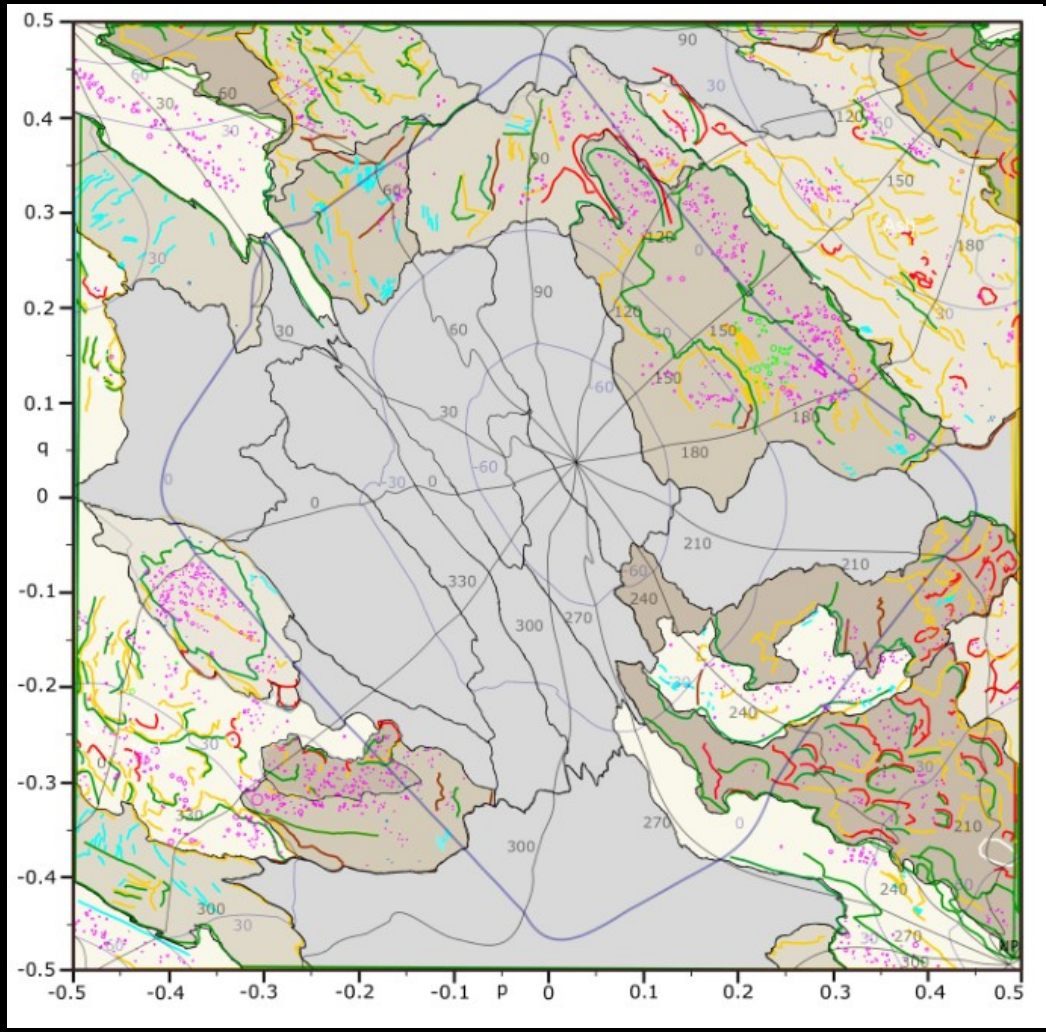
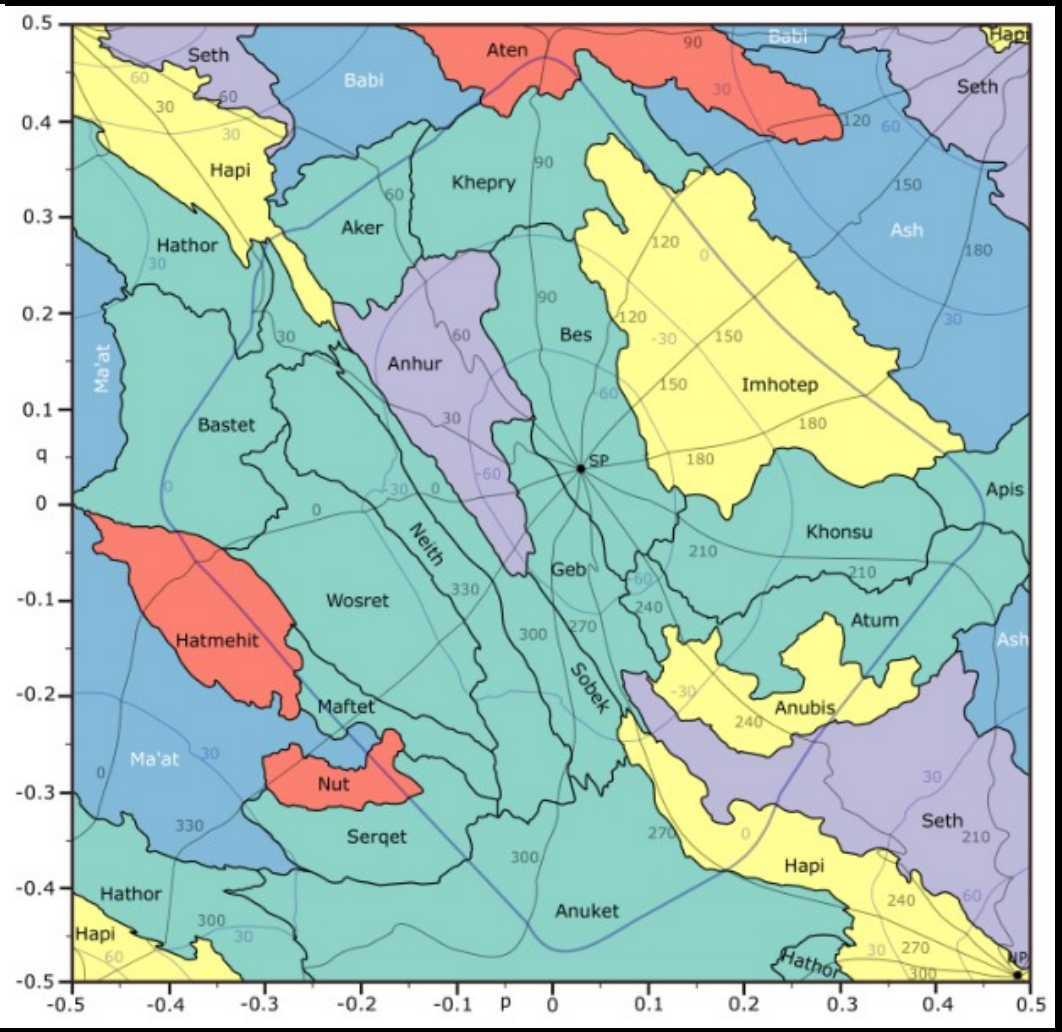
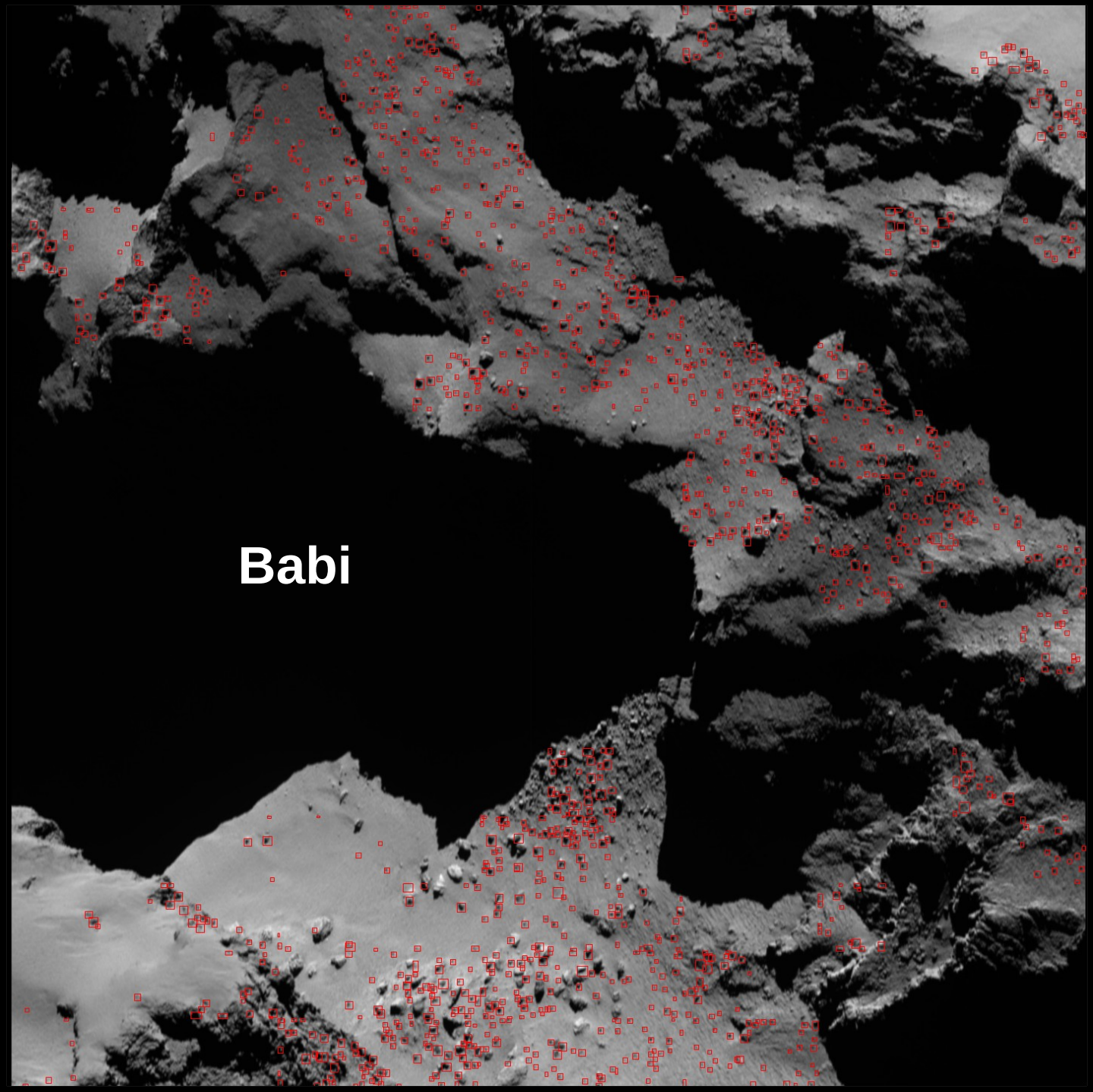





Southern hemisphere: images from El-Maarry+2016 (Jan/Feb 2016)

Resolution ranging from 0.8 to 2.3 m/pixel

# Boulders on 67P: Results



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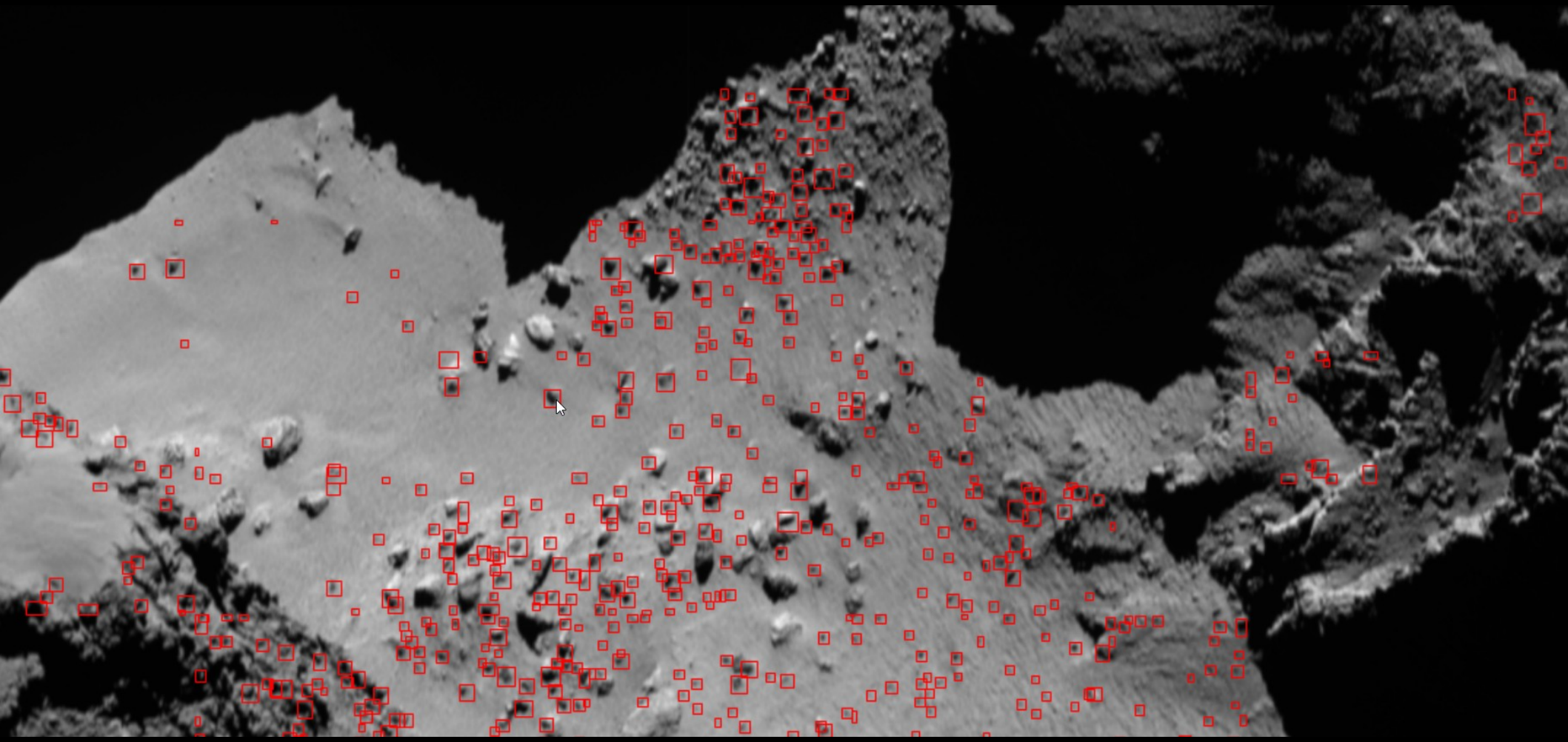

Babi

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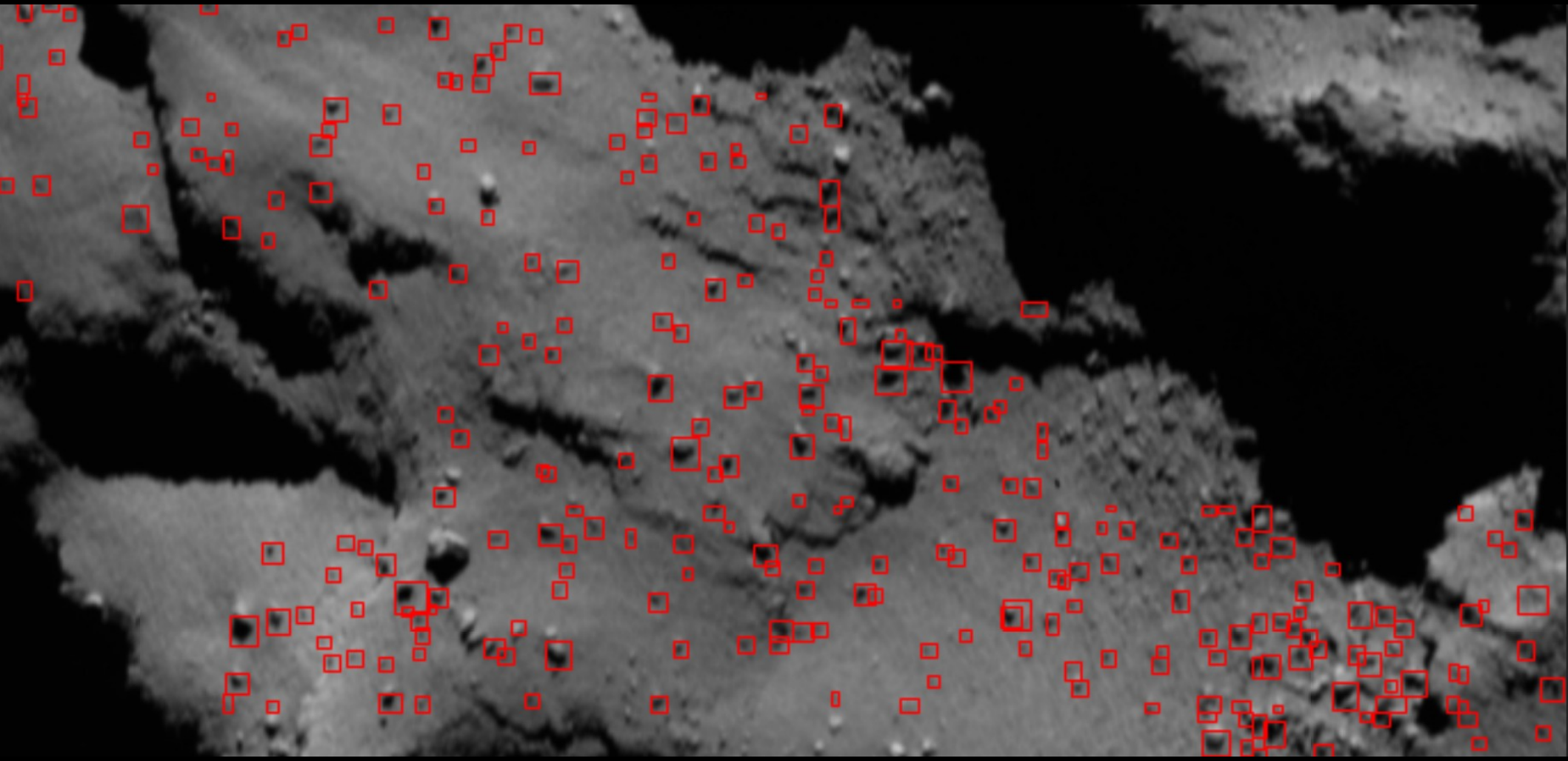

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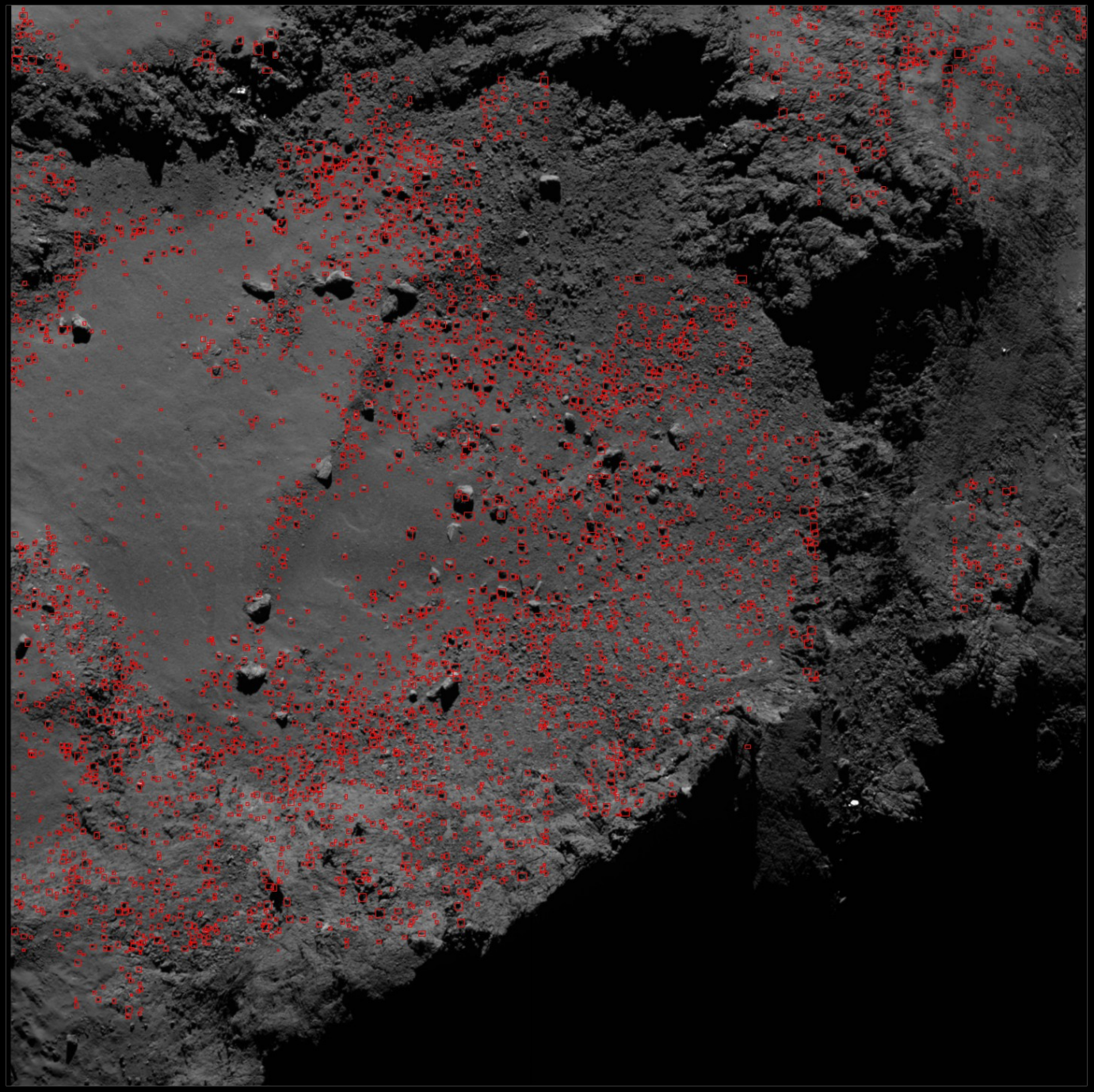

Hatmehit

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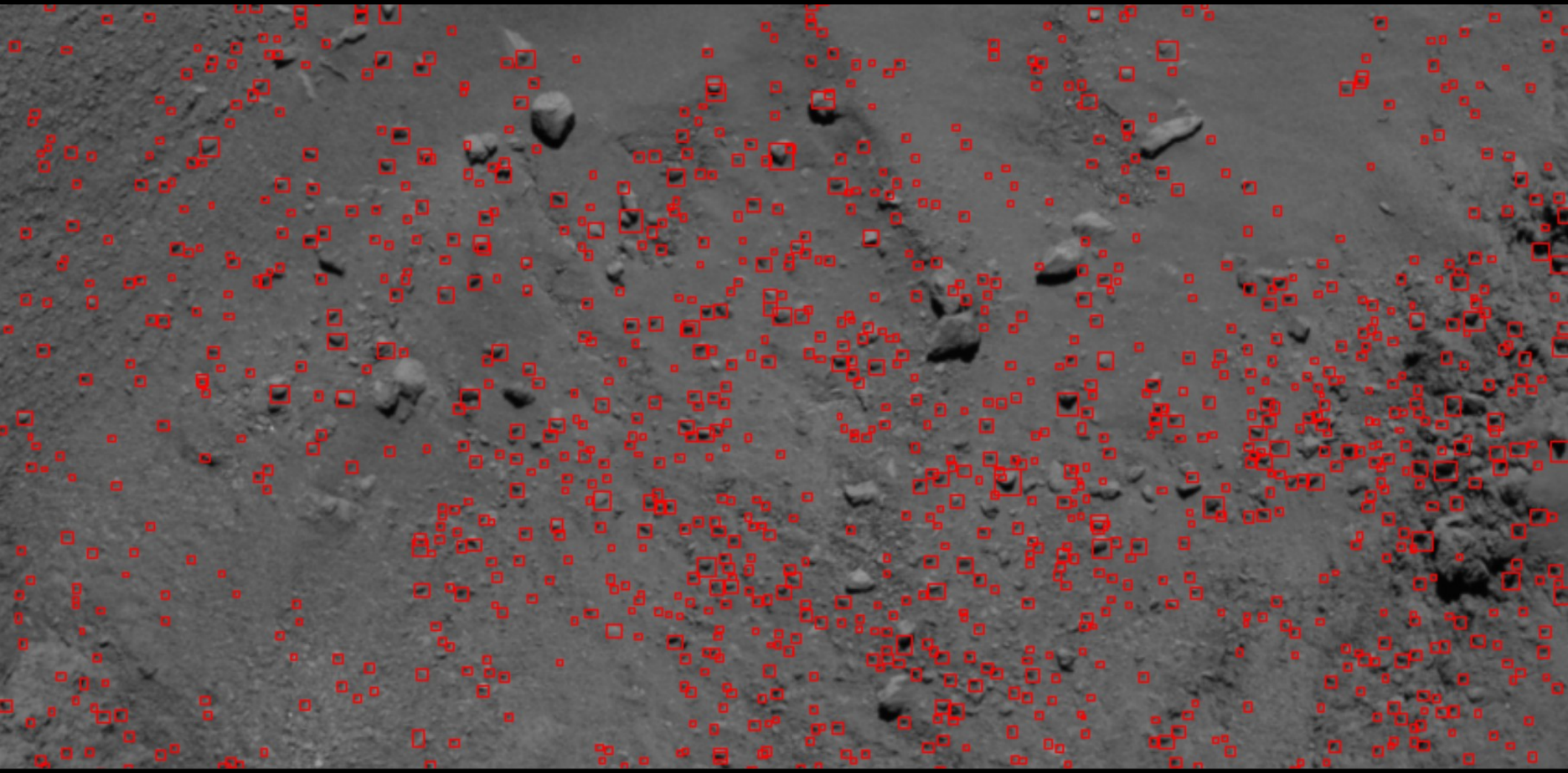

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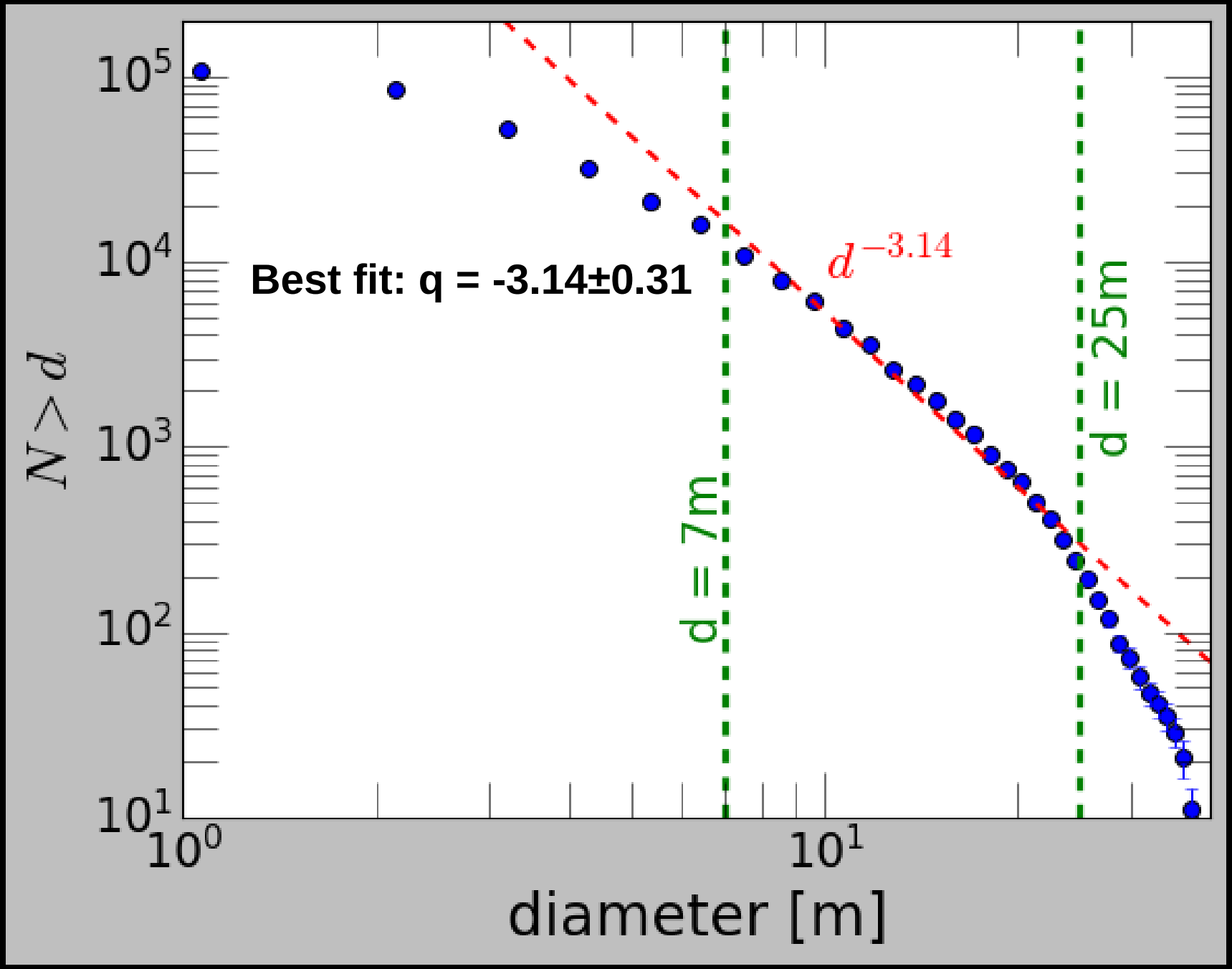
# Boulders on 67P: size-frequency distribution



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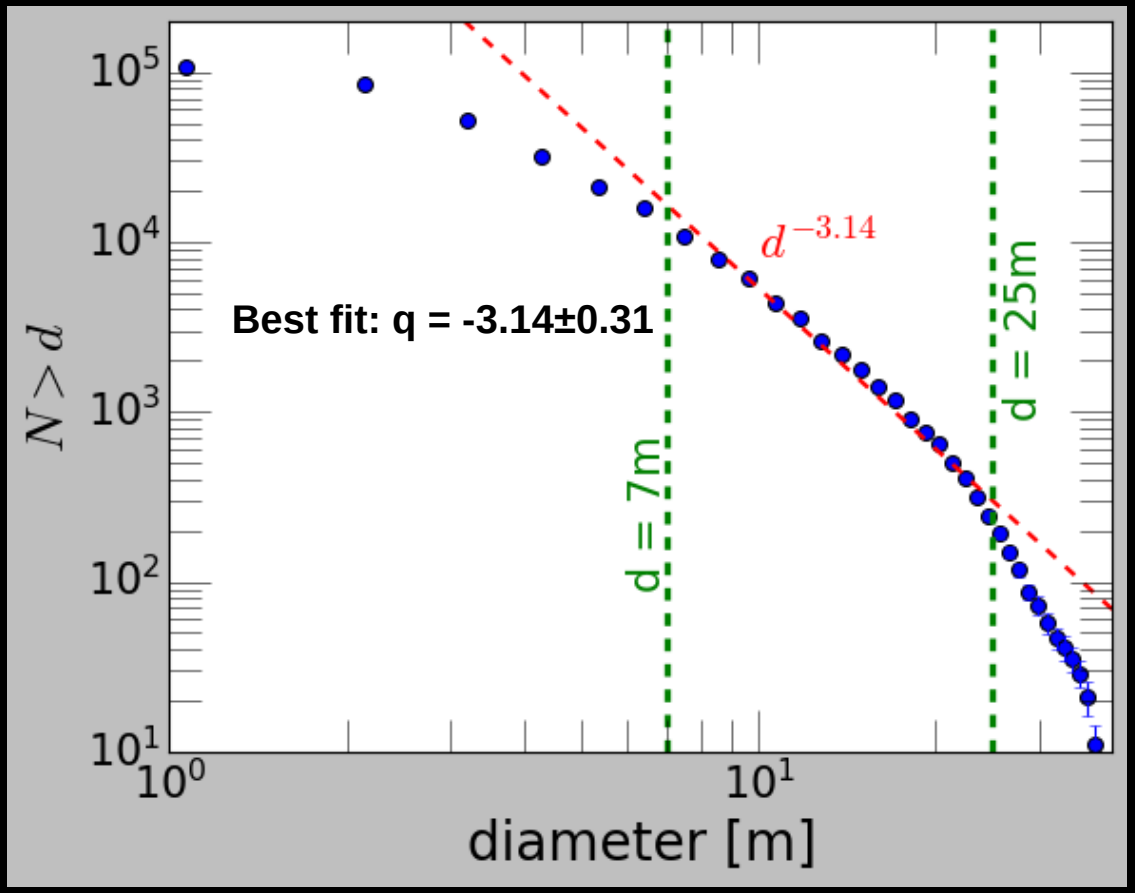


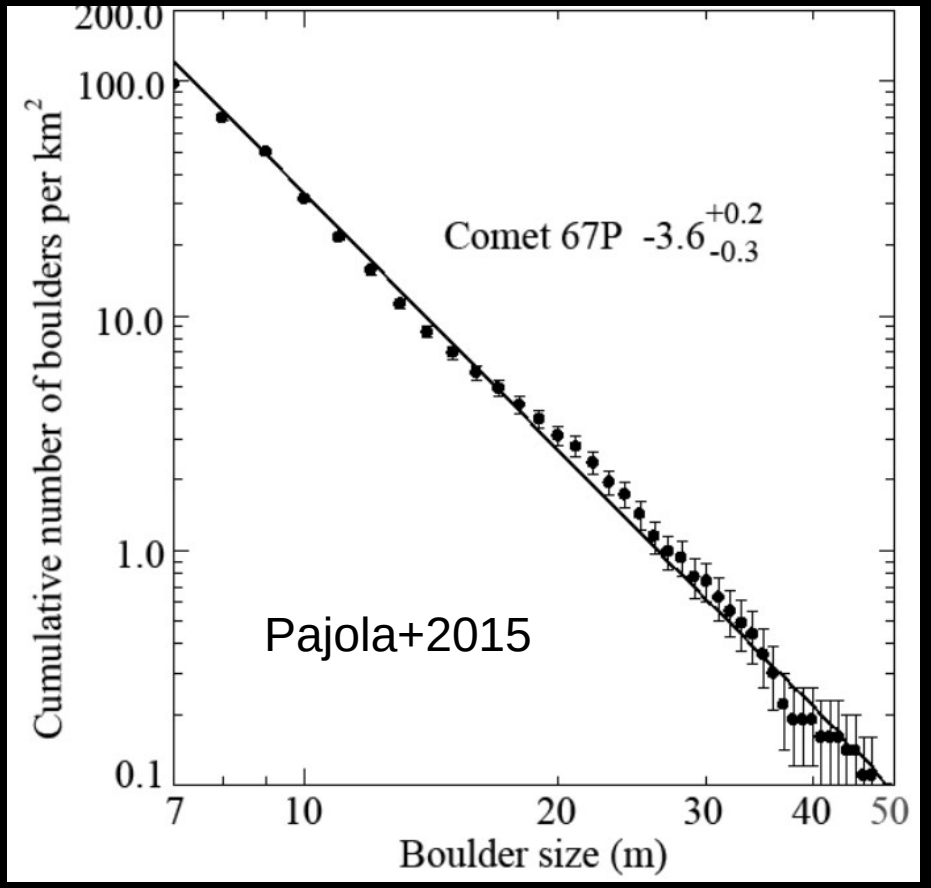

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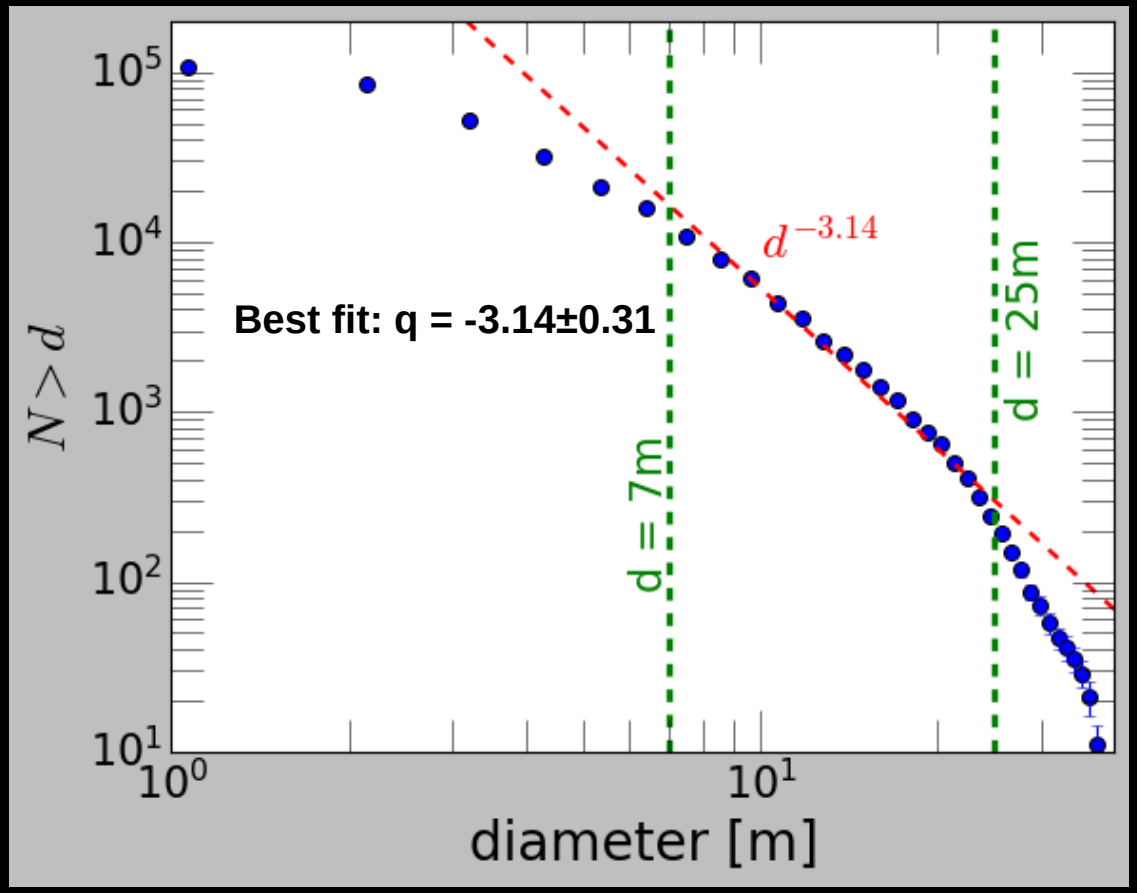


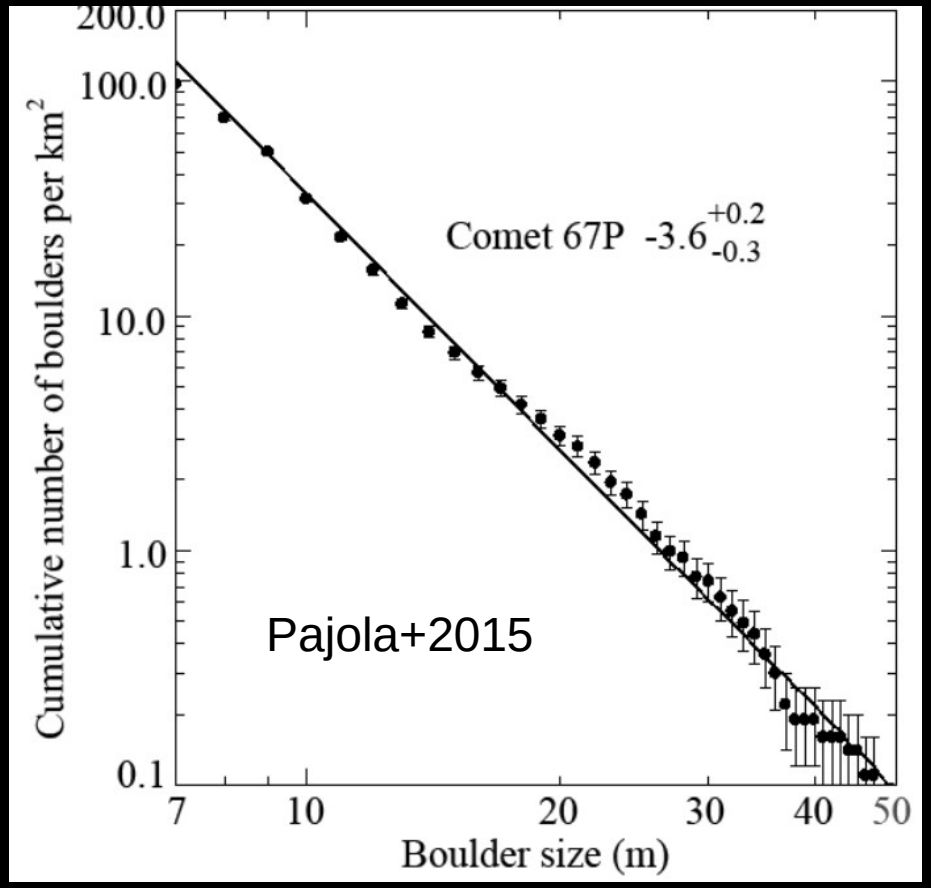


**Main asteroid belt for d < 200 m : q ≈ −2.7**

**KBOs for d < 20 m : q ≈ −3**

**(Morbidelli+2021)**

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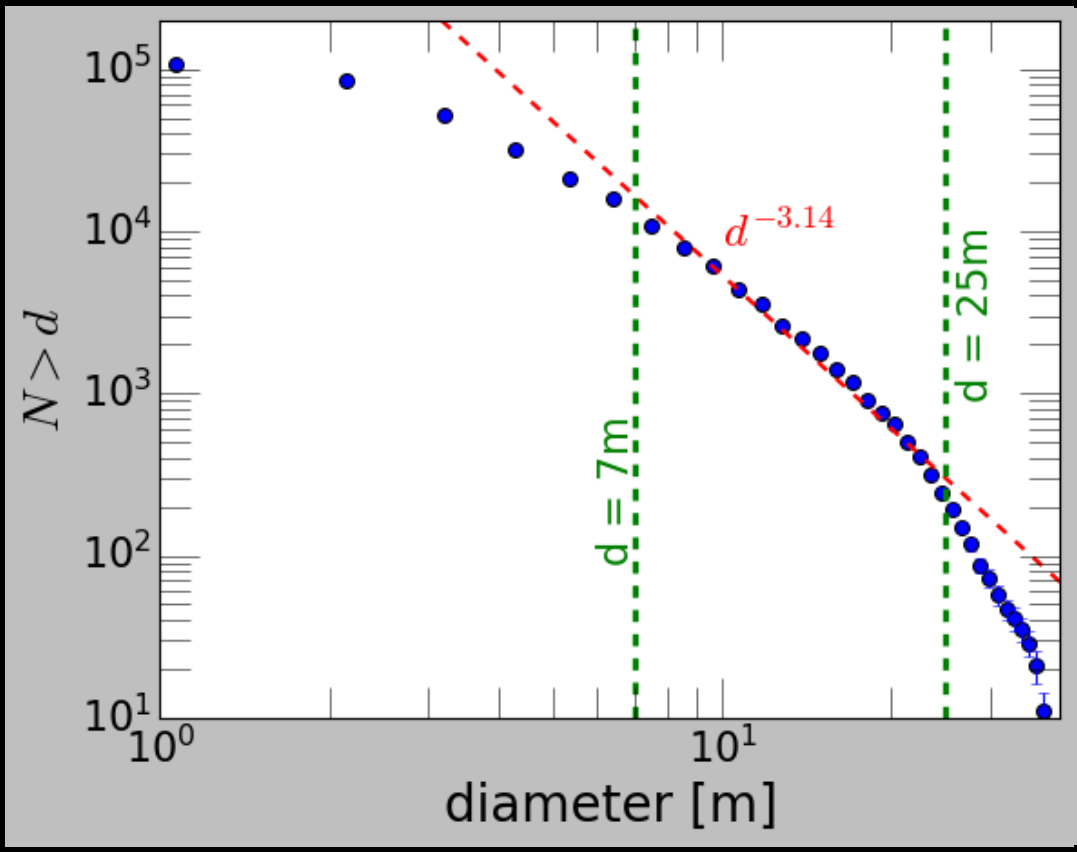
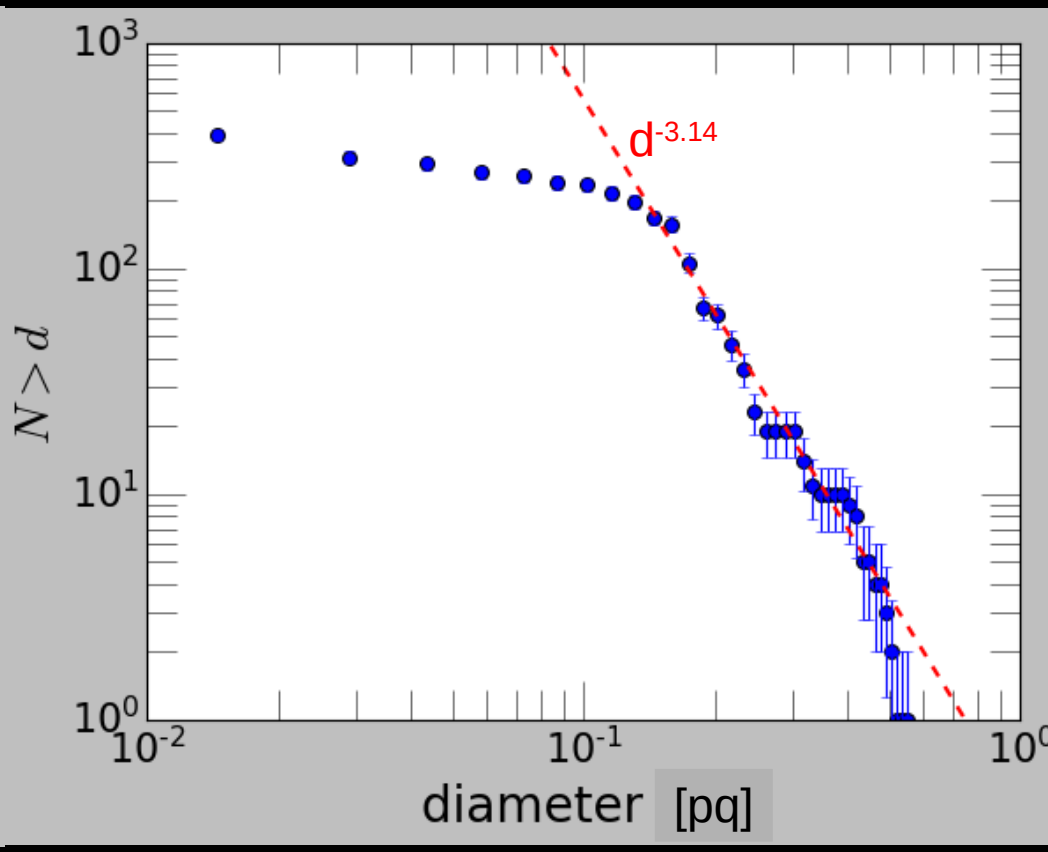



Unprojected NAC images




Projected QuACK images (Grieger 2019)

Quincuncial adaptive closed Kohonen (QuACK)

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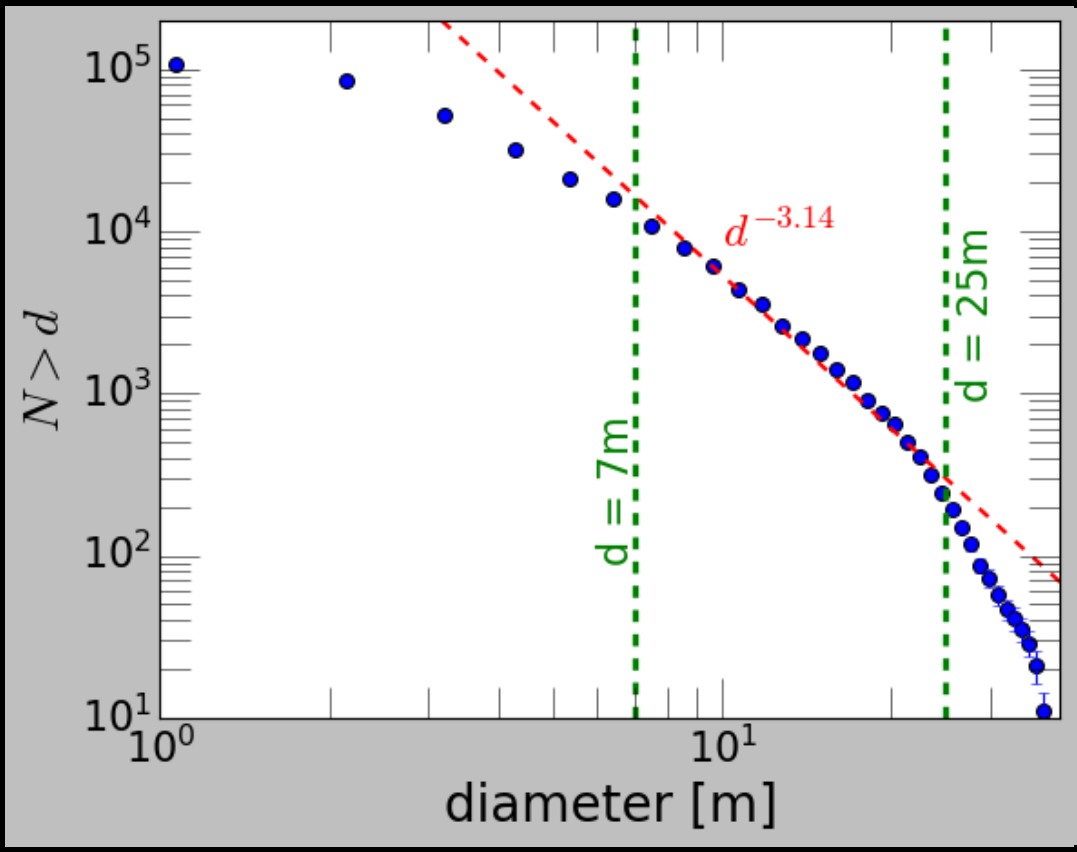


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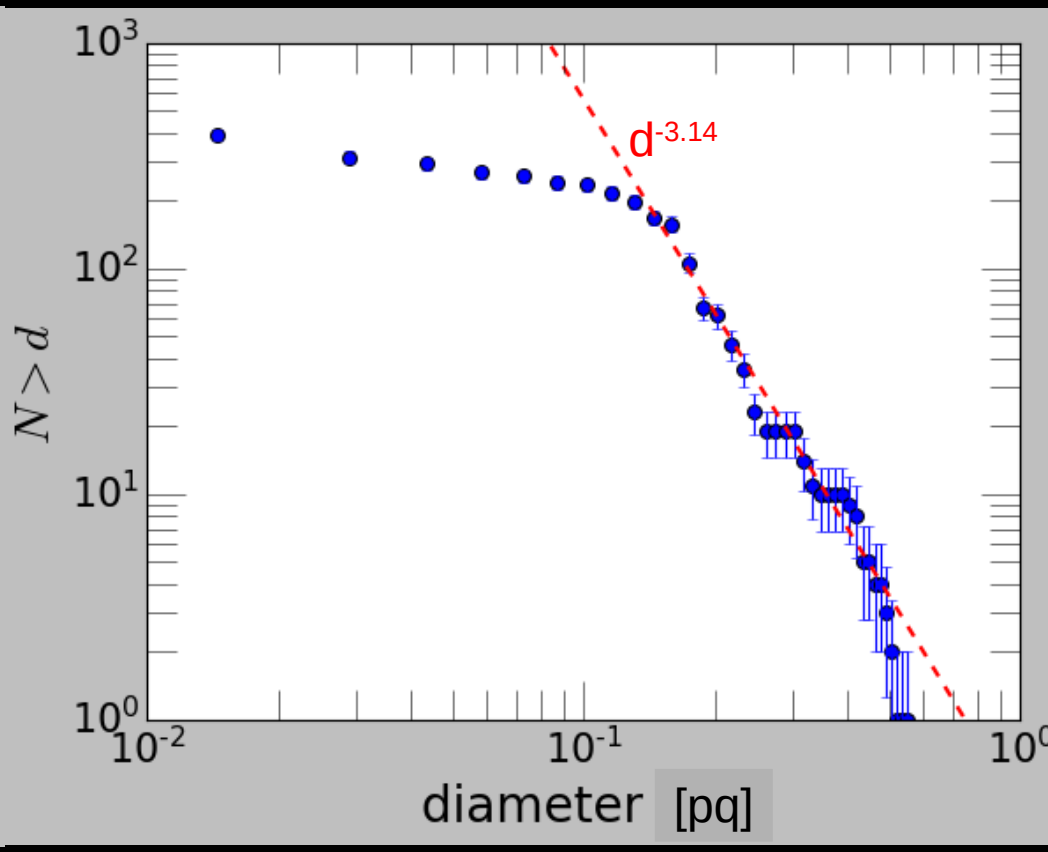


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No Statistically significant regional differences

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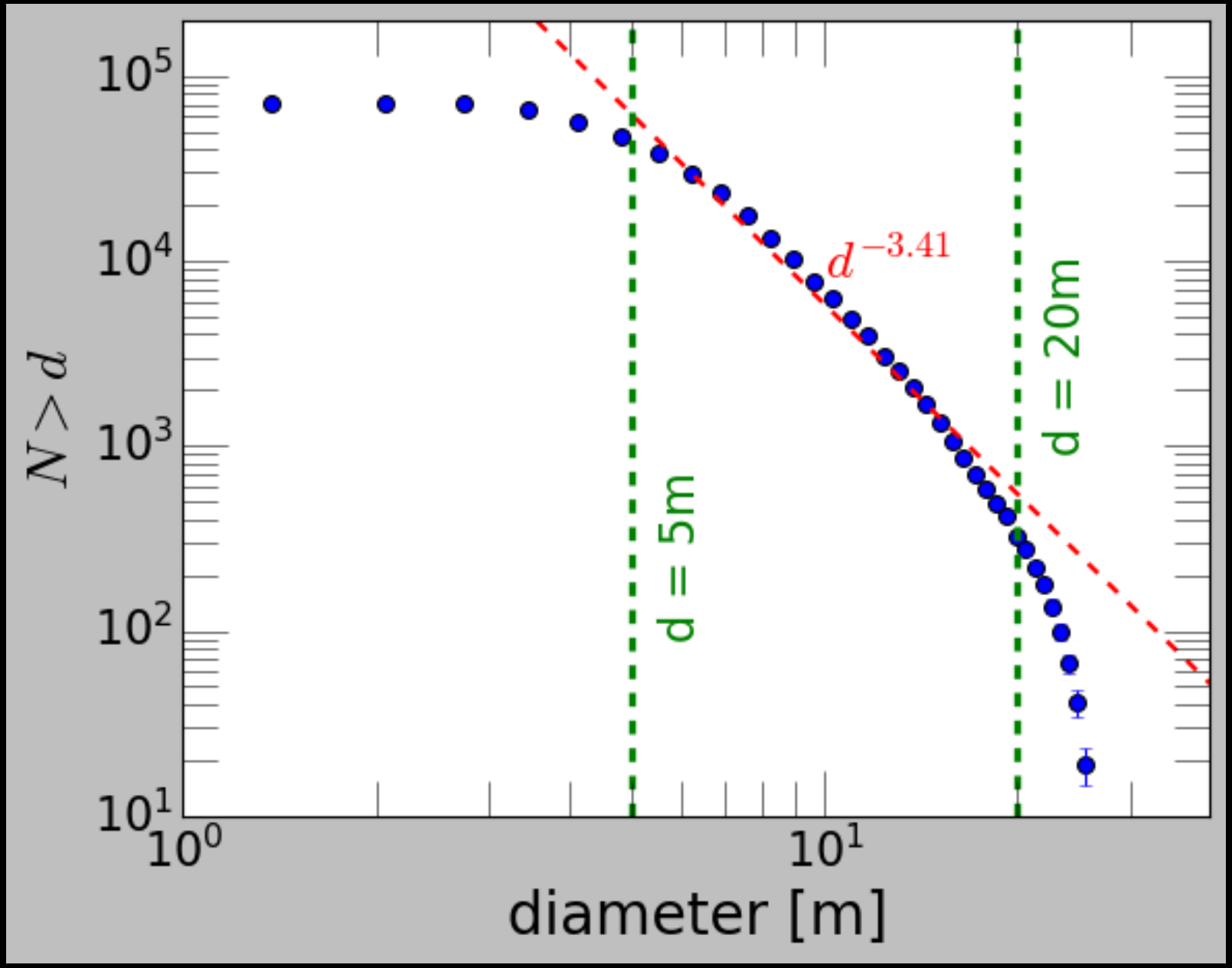
**Southern hemisphere: q = -3.41±0.30**



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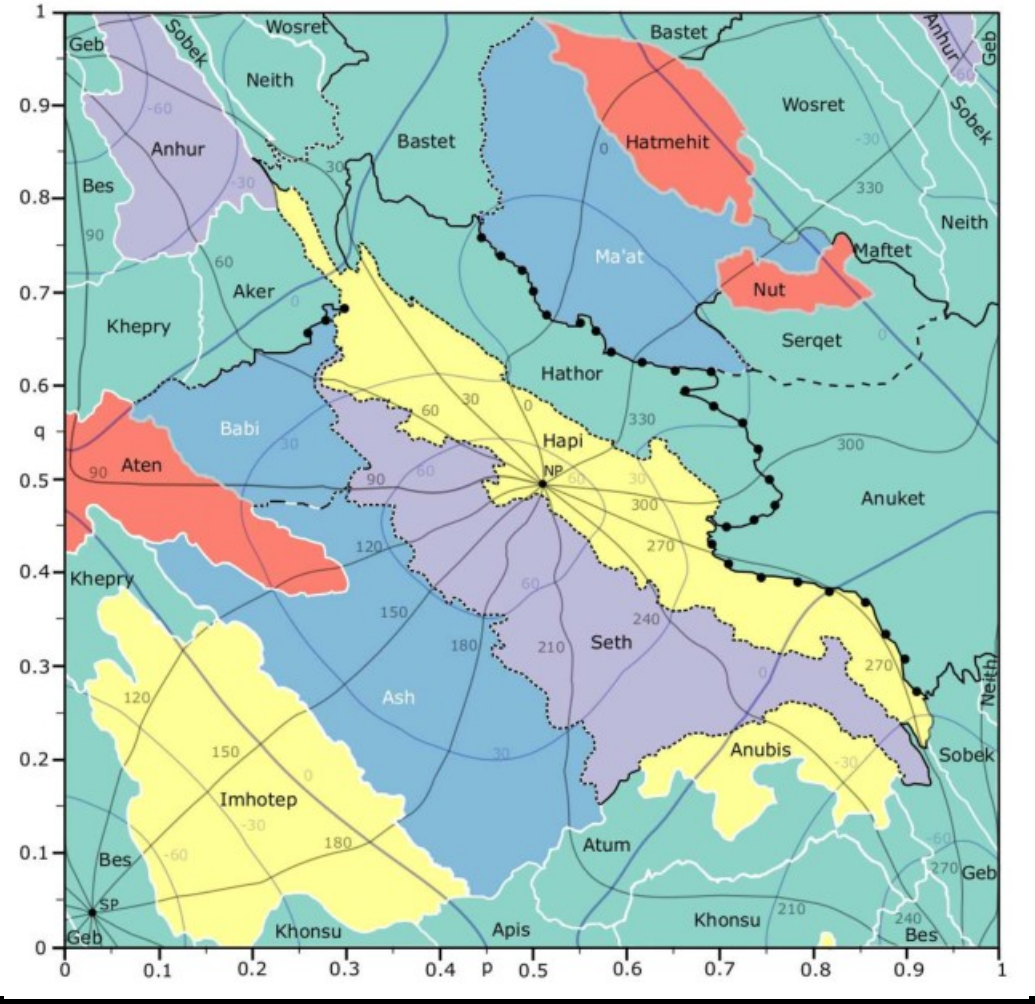


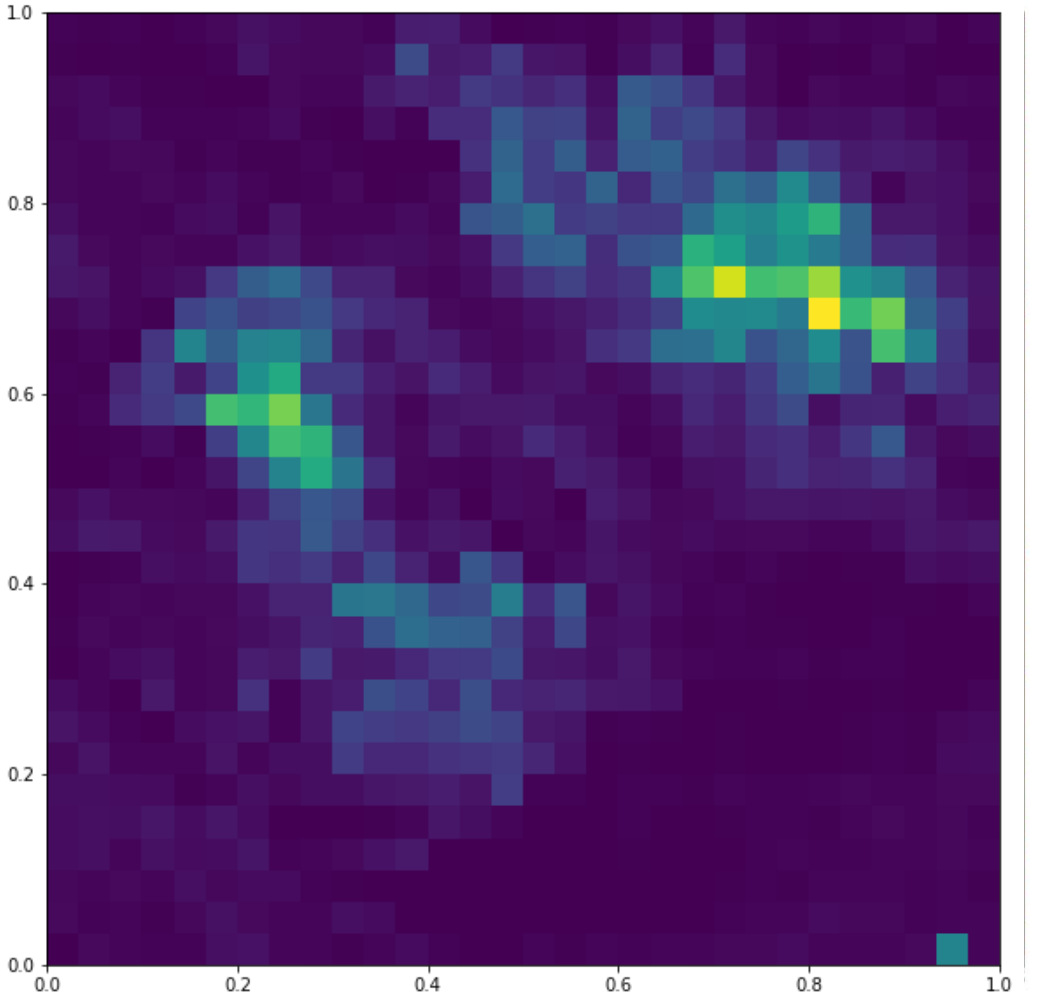

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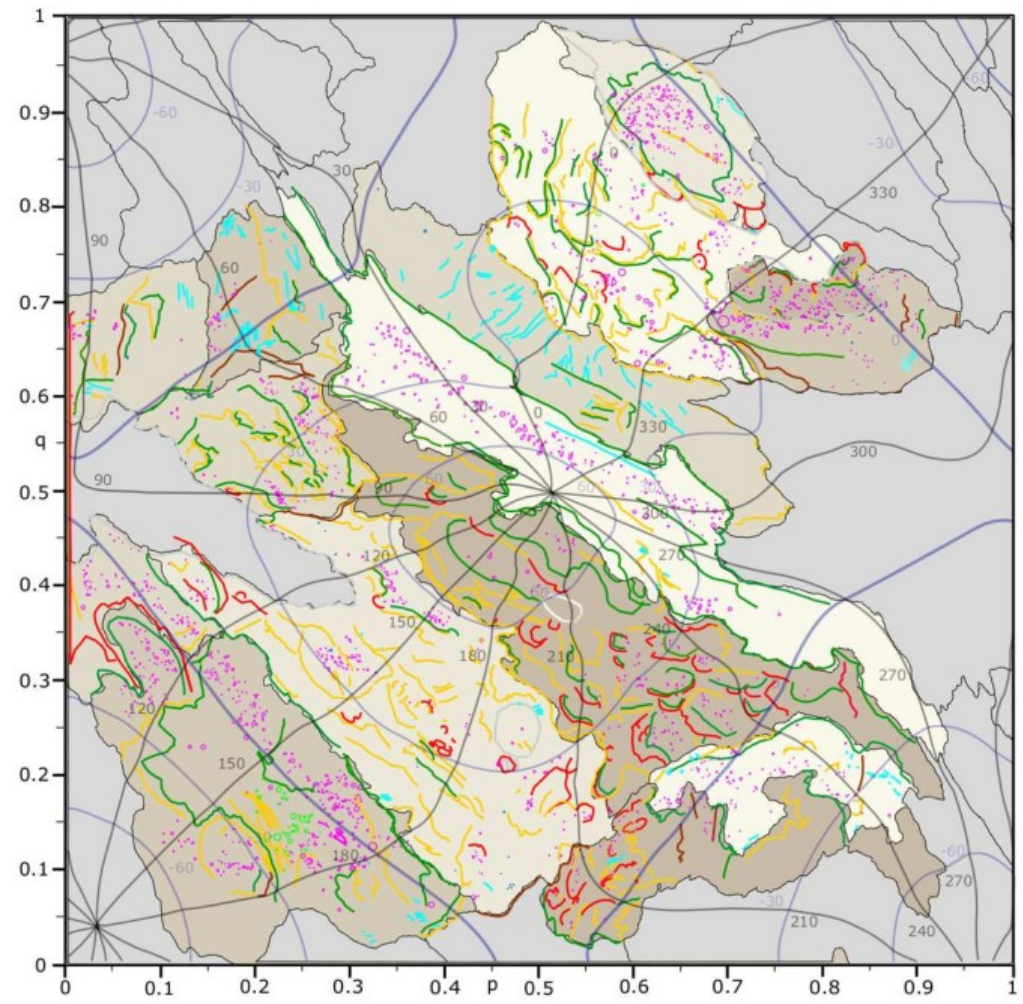


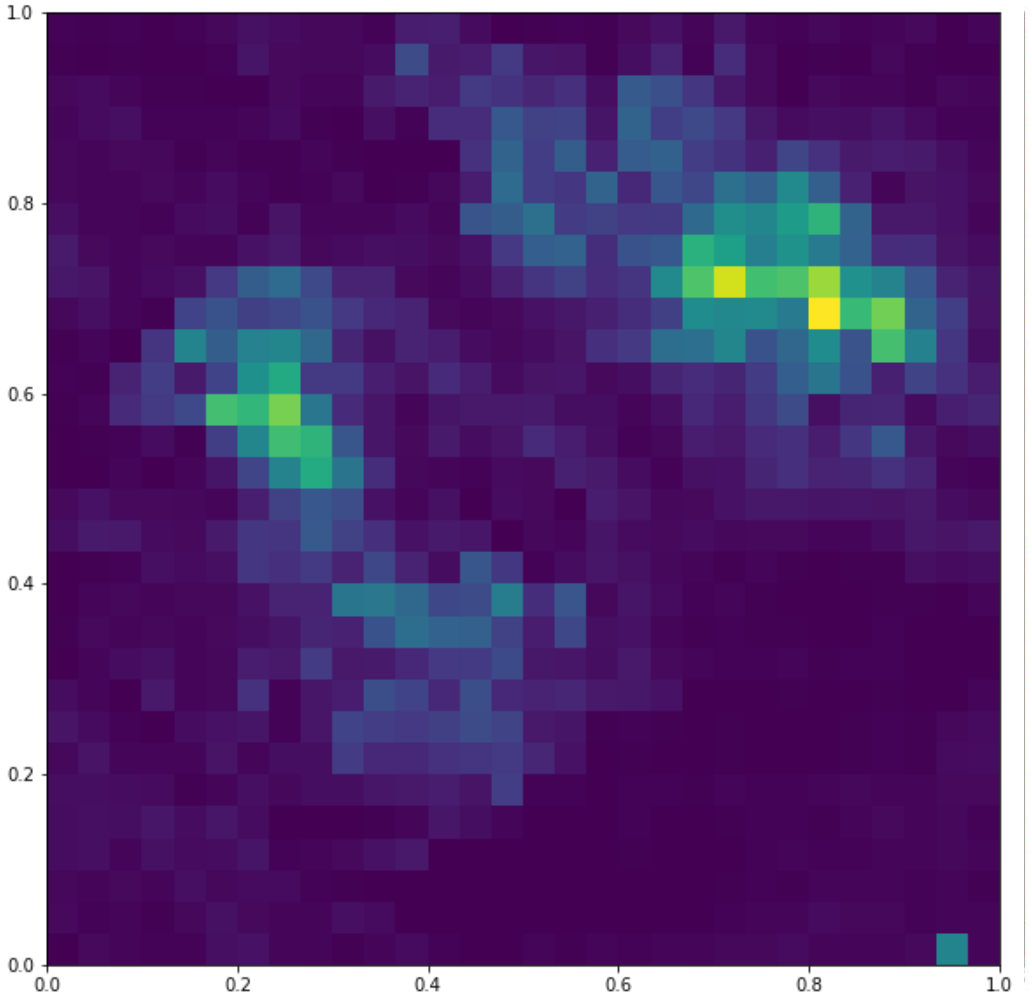

Leon-Dasi+2021

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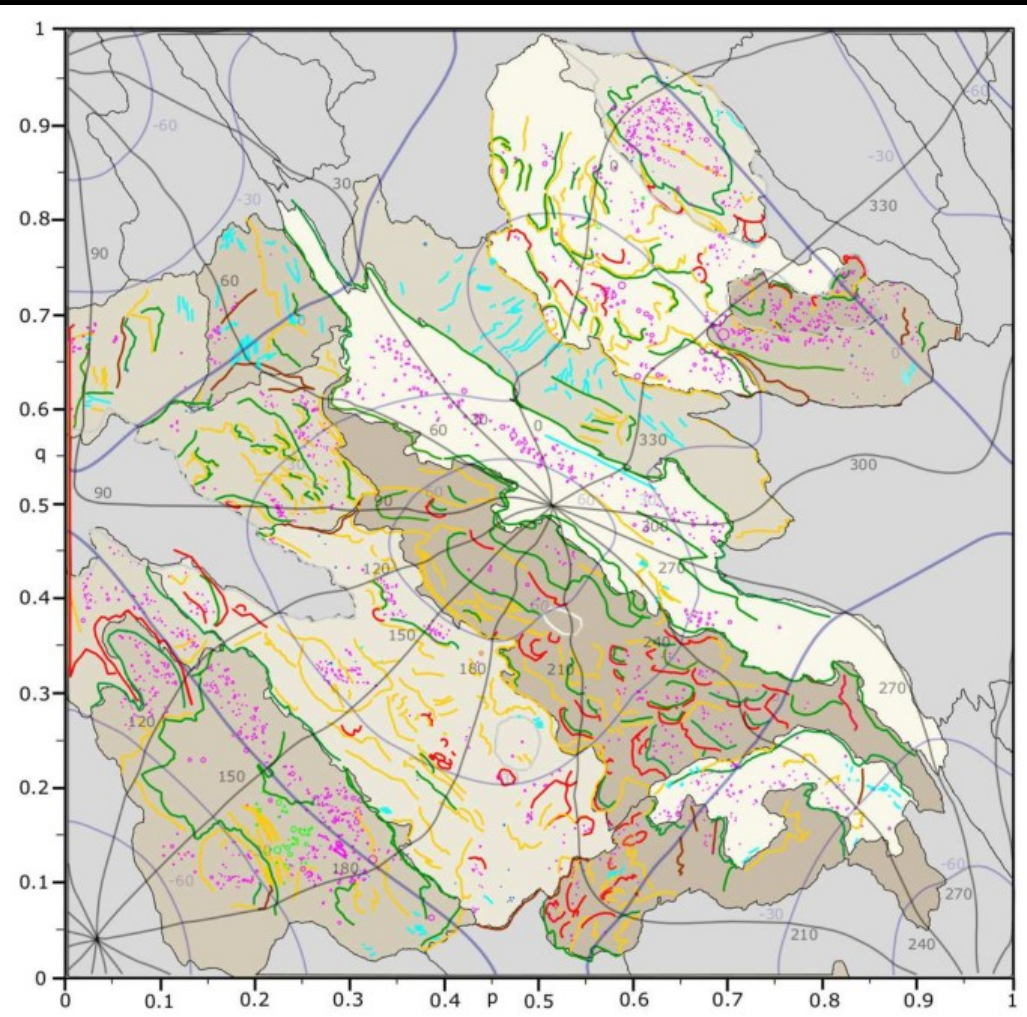


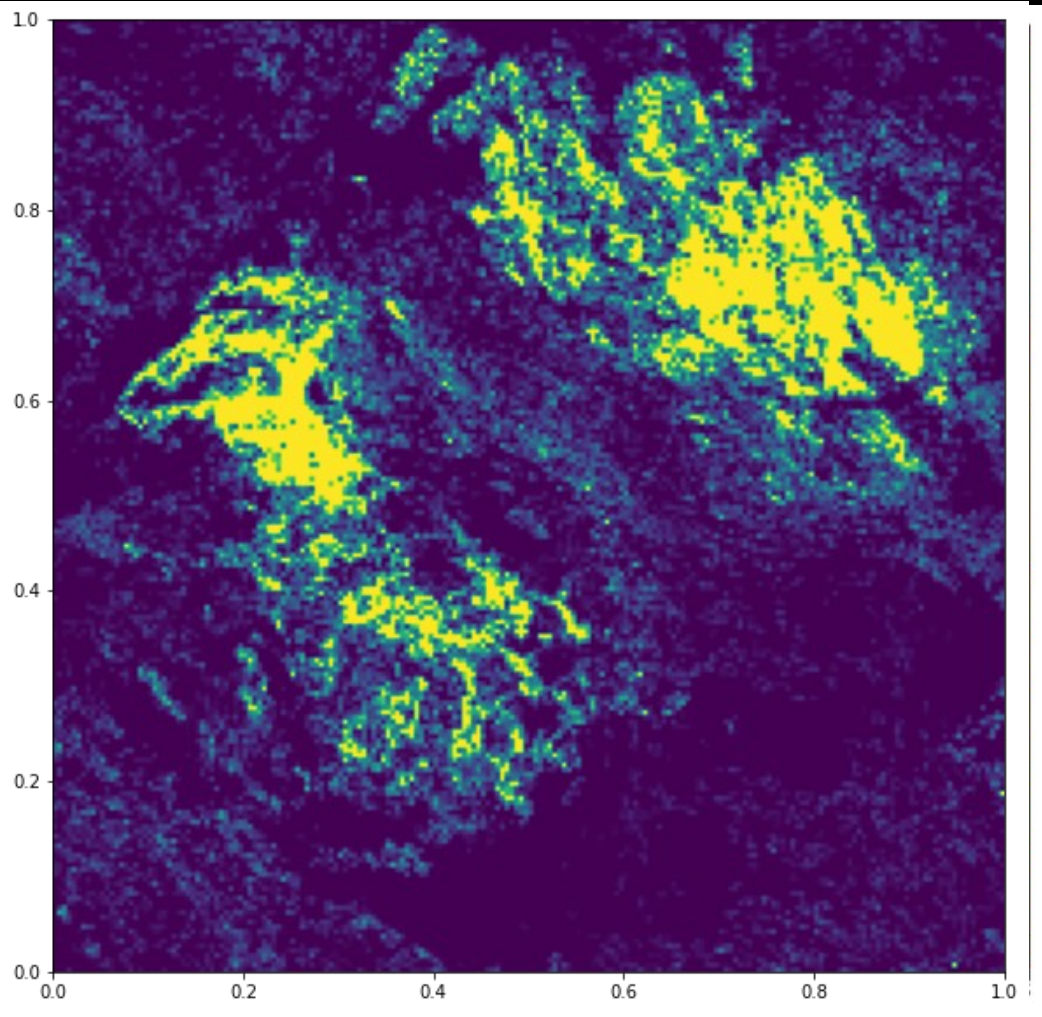

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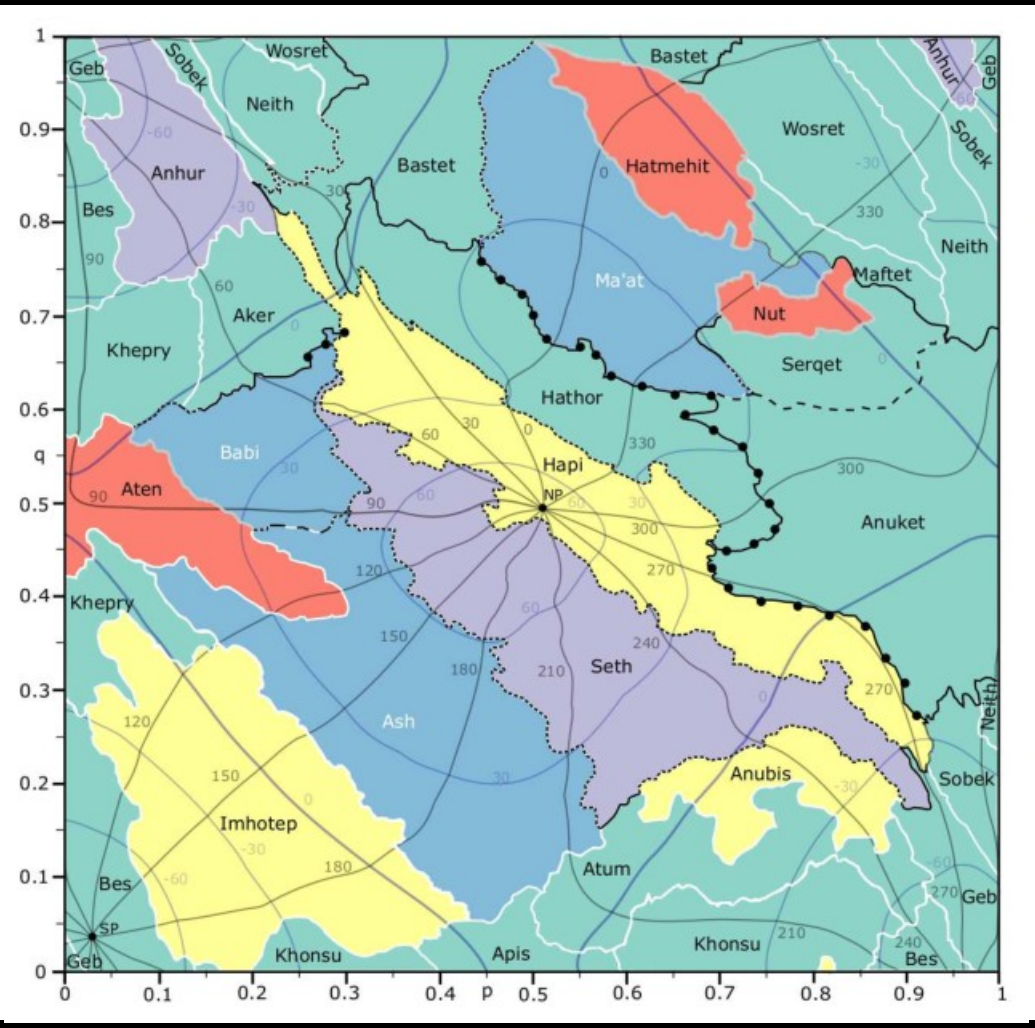


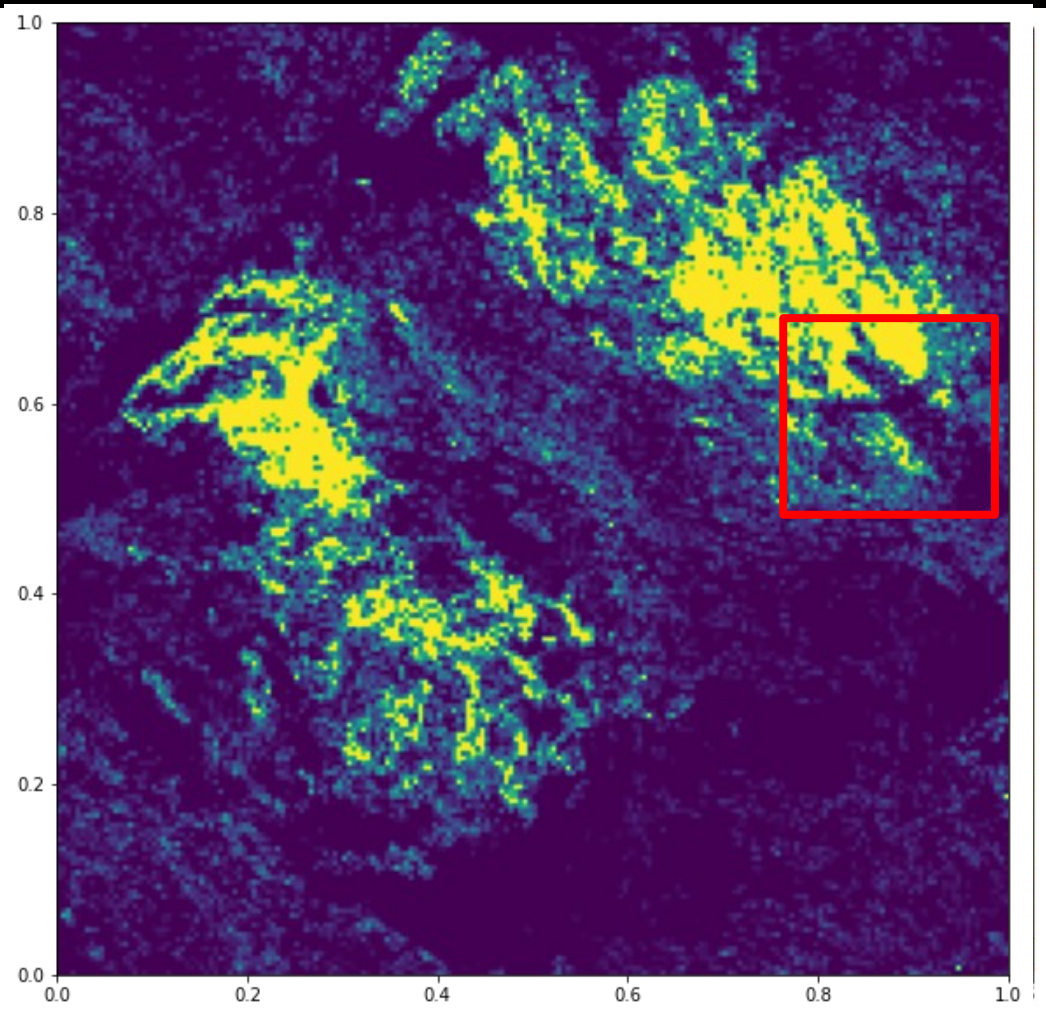

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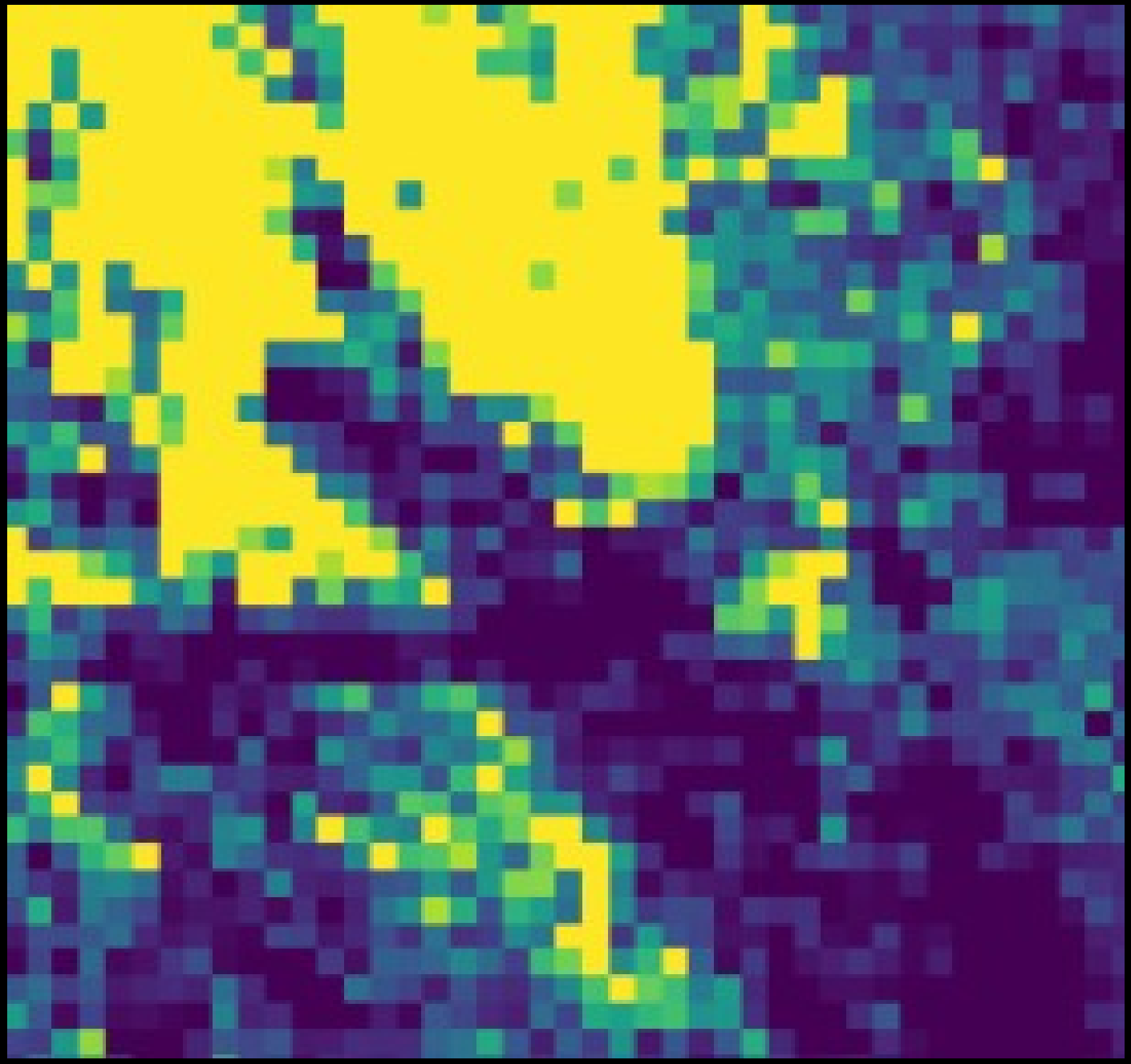

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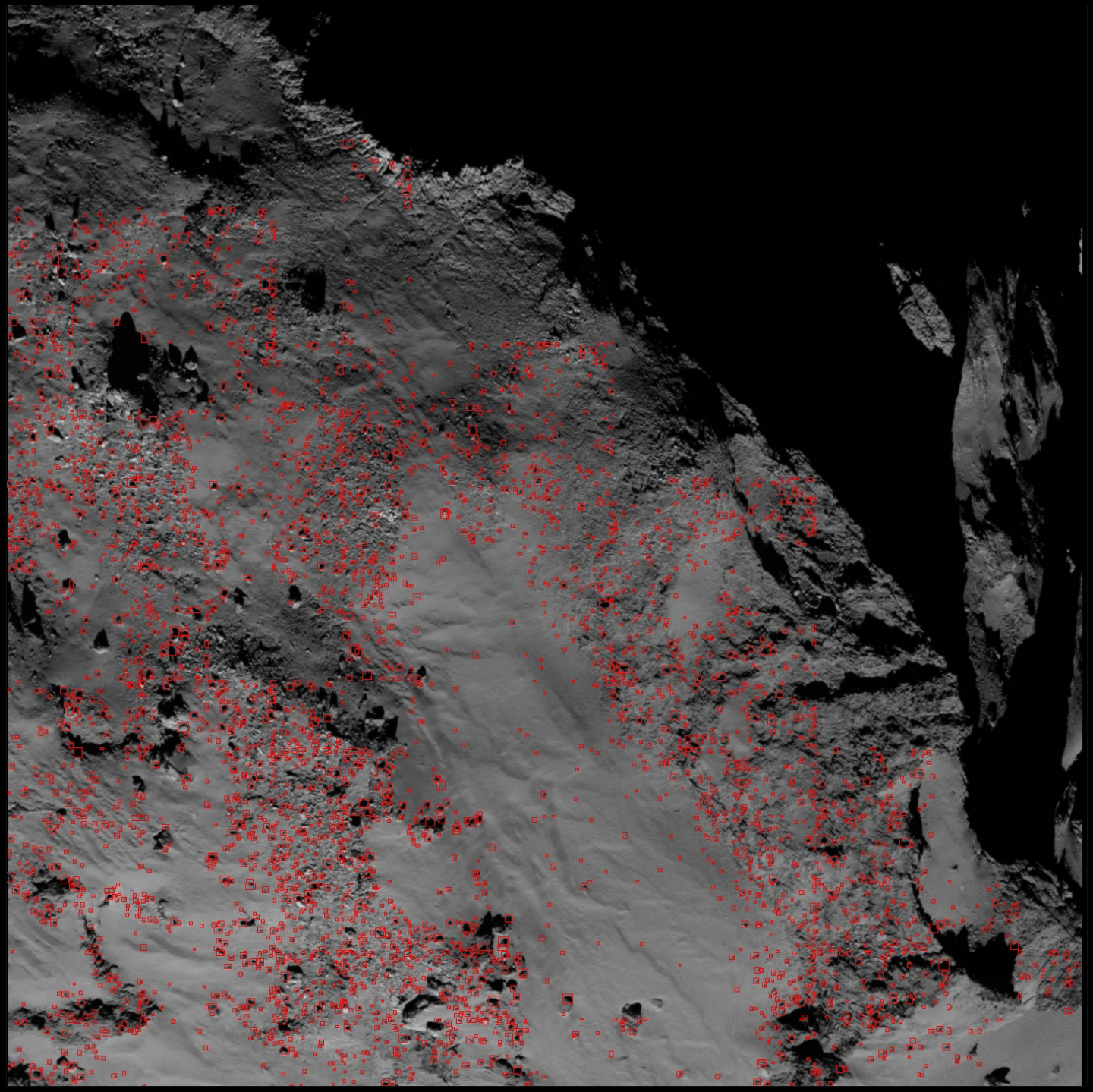

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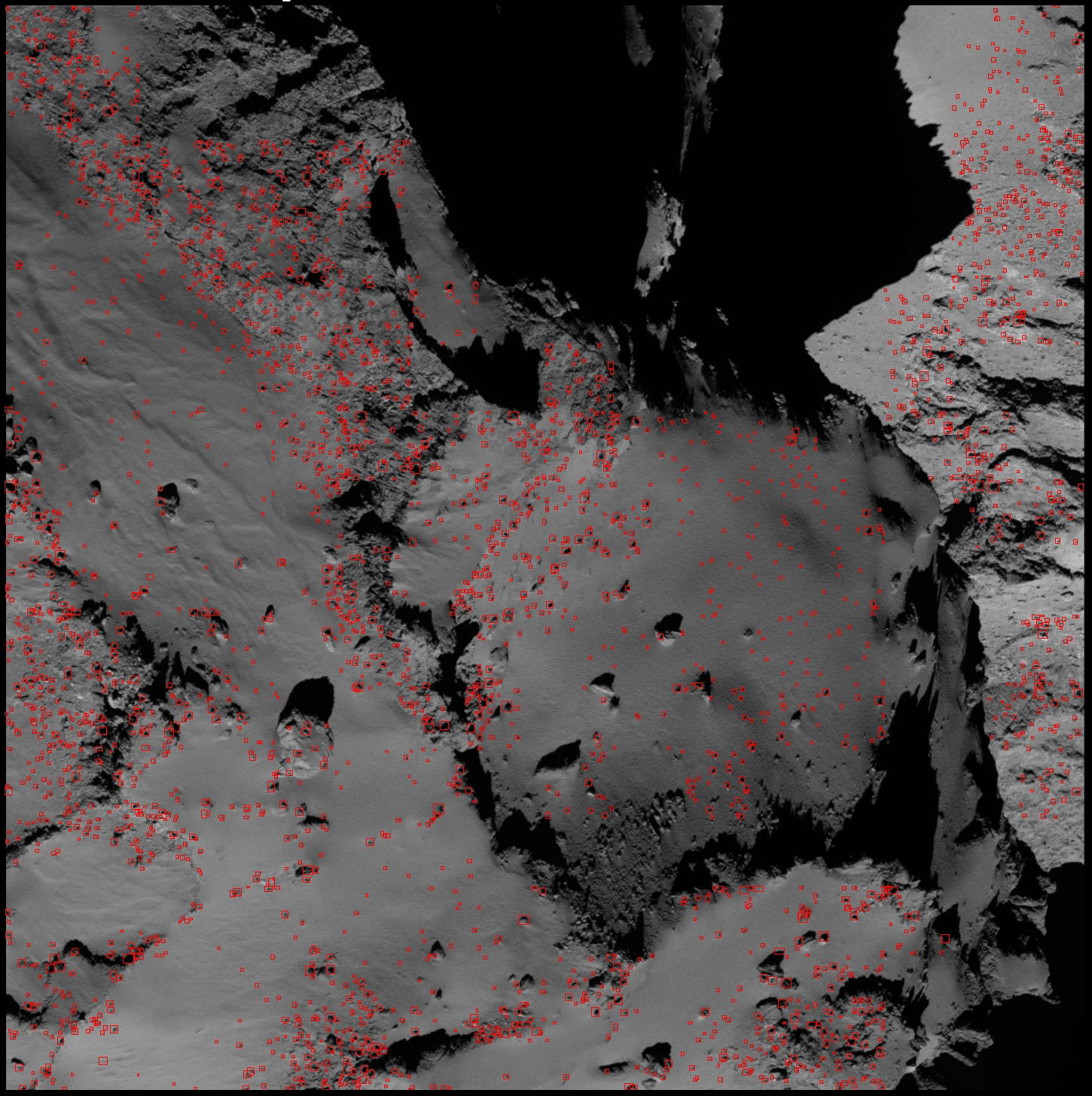

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**Future: JUICE/Clipper/Lucy data analysis**

**Thank you**
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