Institut für Planetologie
Westfälische Wilhelms-Universität Münster

The Multi-Temporal Database of Planetary Image Data (MUTED): A Tool to Study Dynamic Mars

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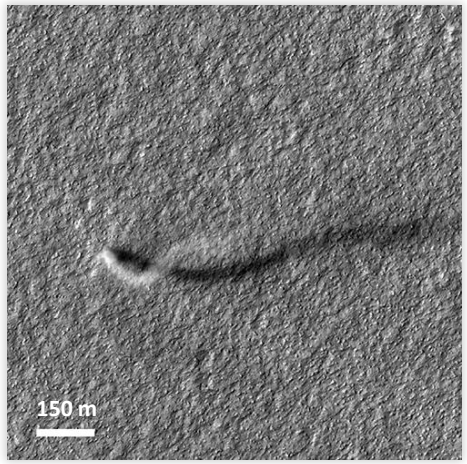
MUTED Introduction

- Multi-temporal observations are key to detect & understand surface changes
- Surface of Mars is very dynamic due to various exogenic processes
- e.g. eolian, frost, cratering, mass-wasting processes



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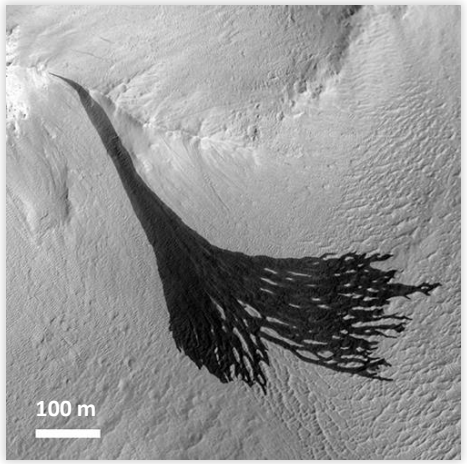

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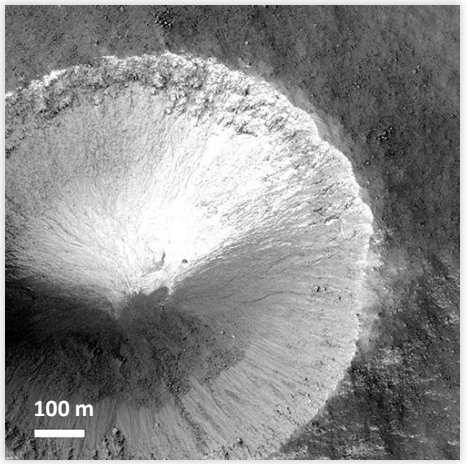

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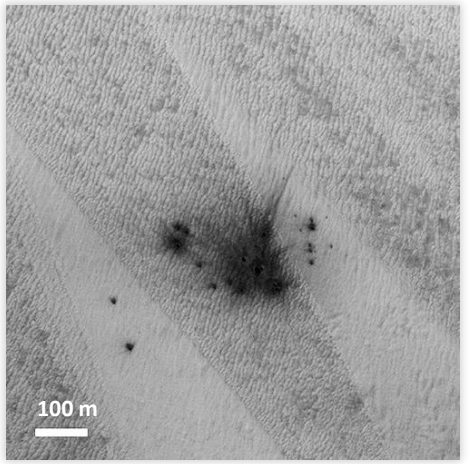

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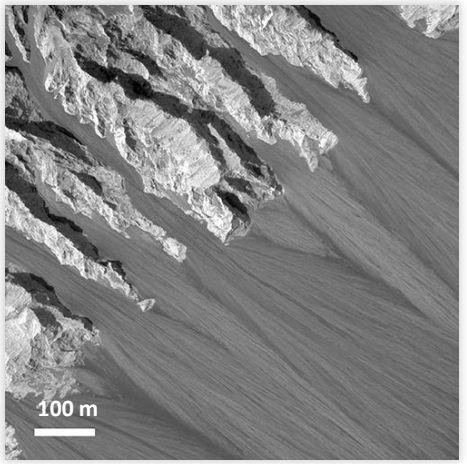
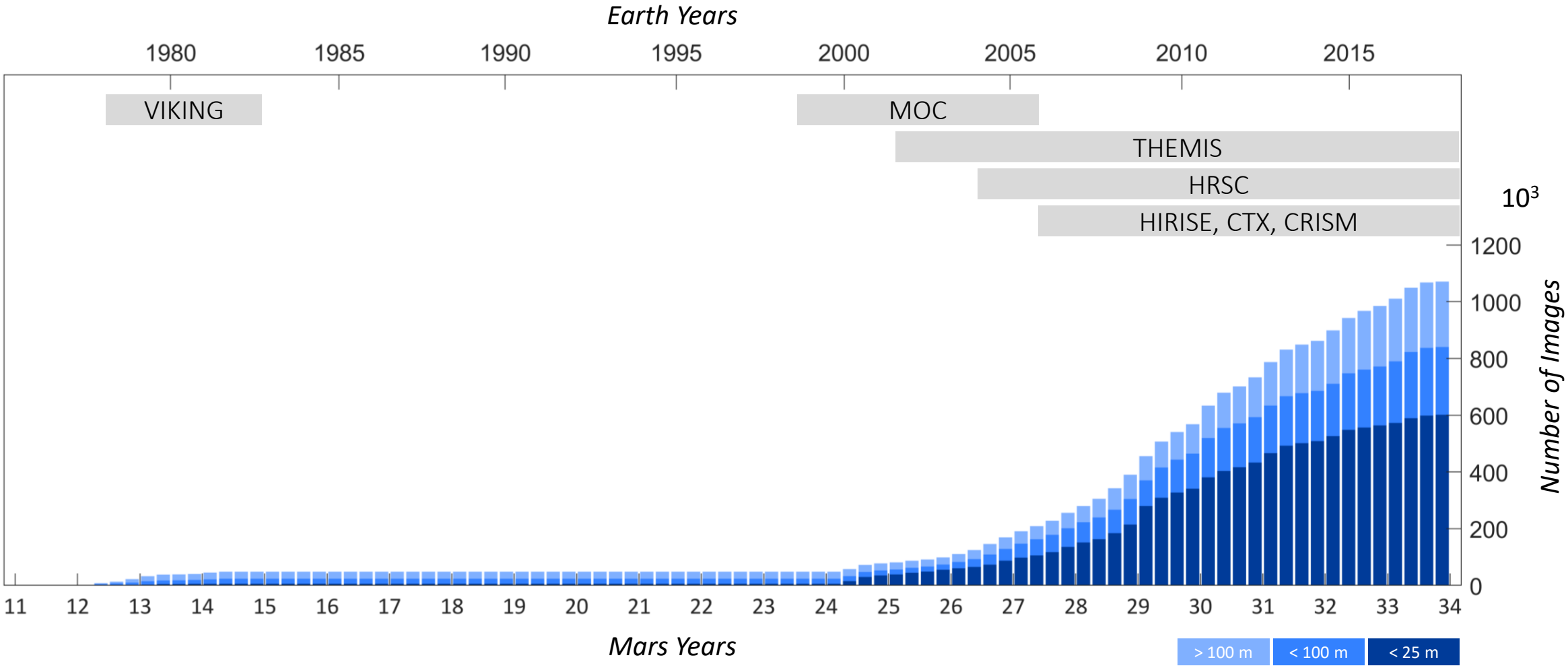
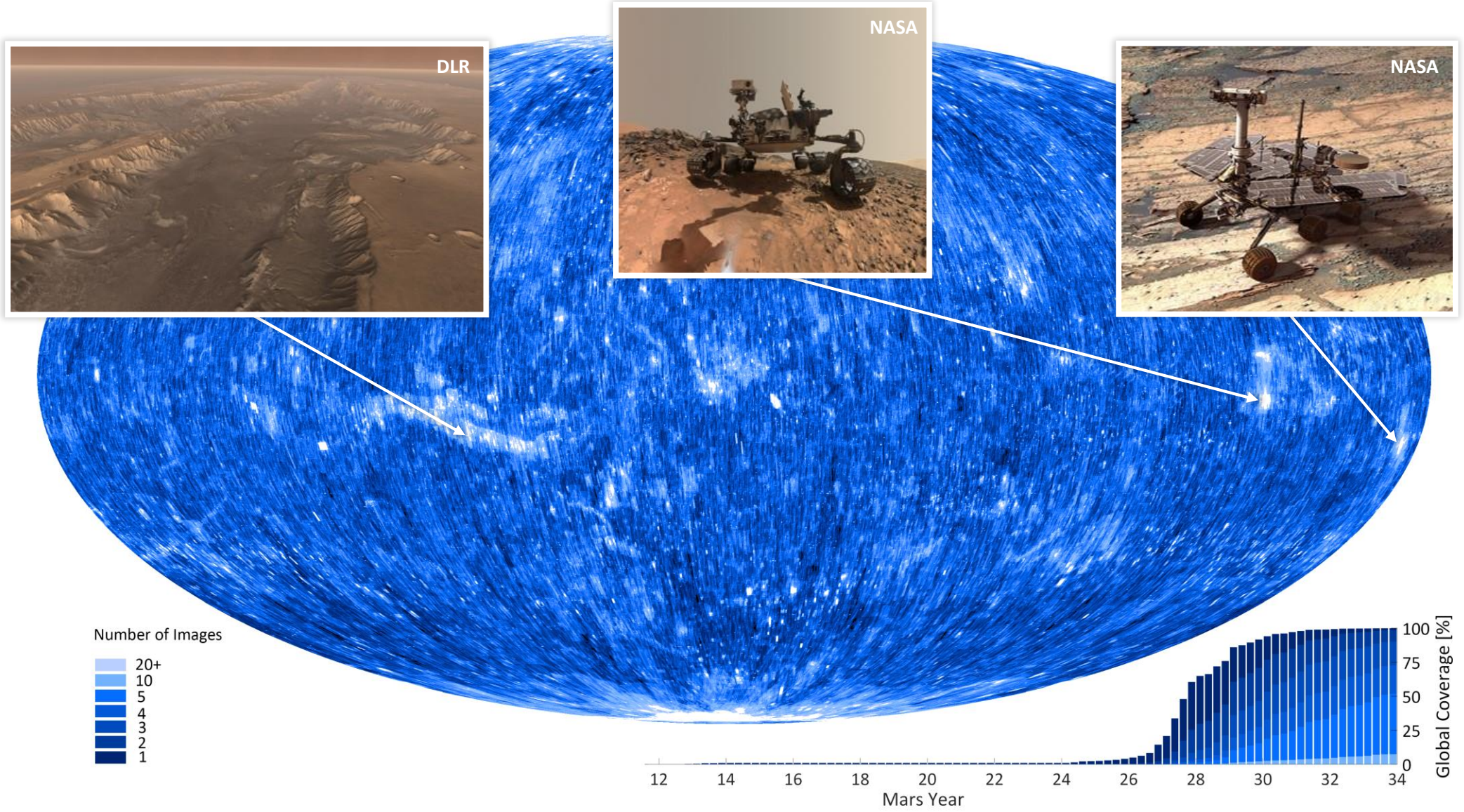


ESP_022632_1670

- Today more than 1 million orbital images of Mars are available



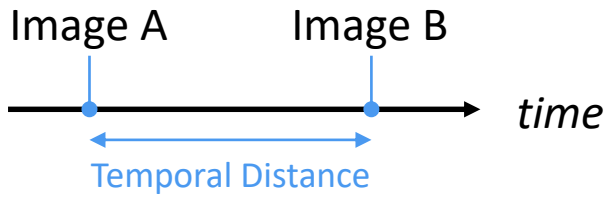
MUTED Introduction



Global coverage of high-resolution images (≤ 25 m/px)

MUTED Basic Concept

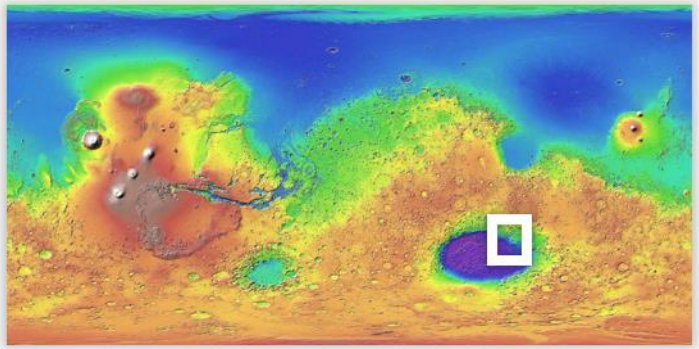
- Image search based on temporal relationship



HRSC observation of dust devil activity (H2054_0000)

MUTED Basic Concept

Location-Driven Search



Filter

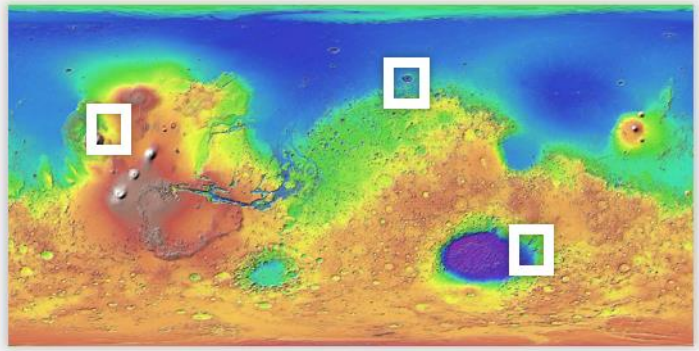
Images

Data-Driven Search

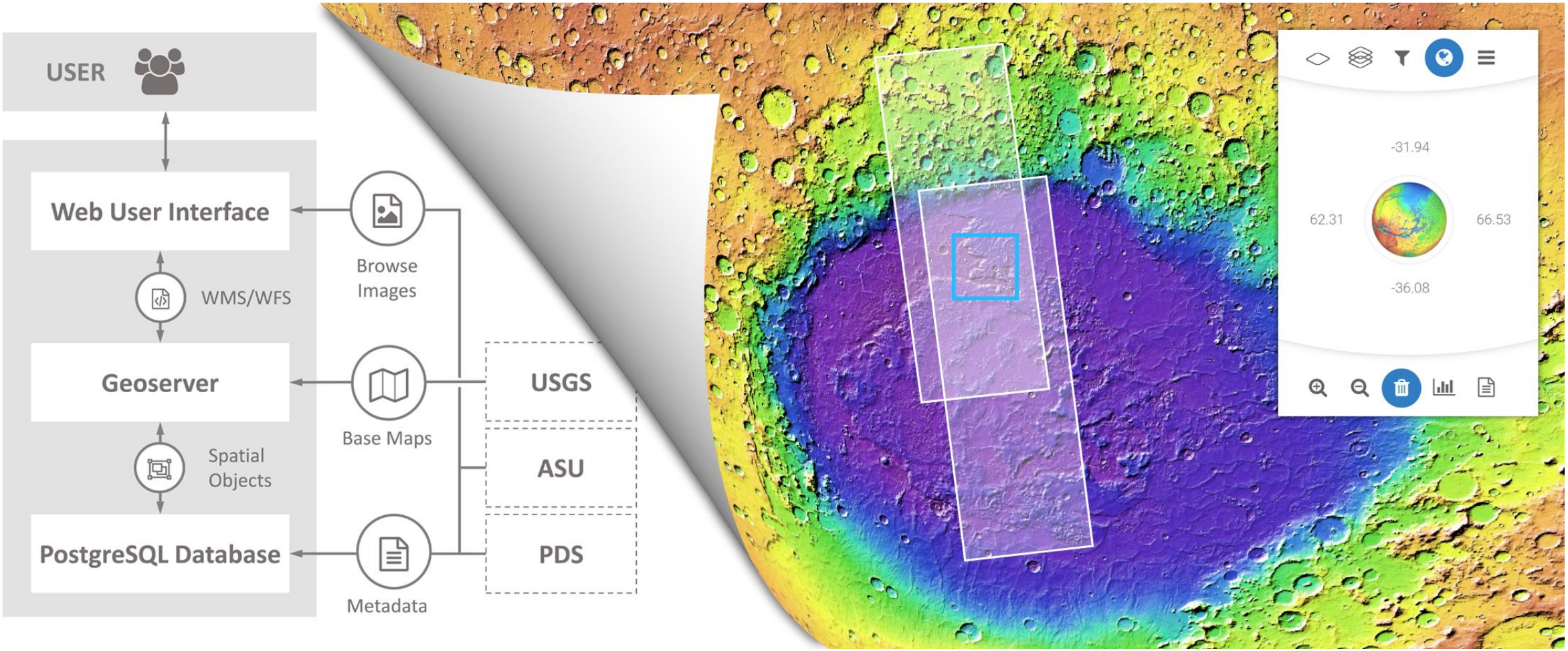
Datasets

Temporal Relation

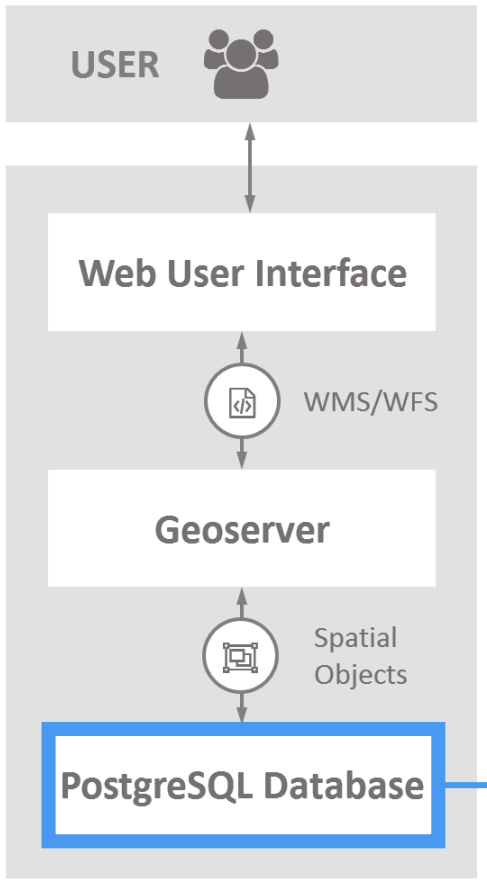
Filter



MUTED Architecture

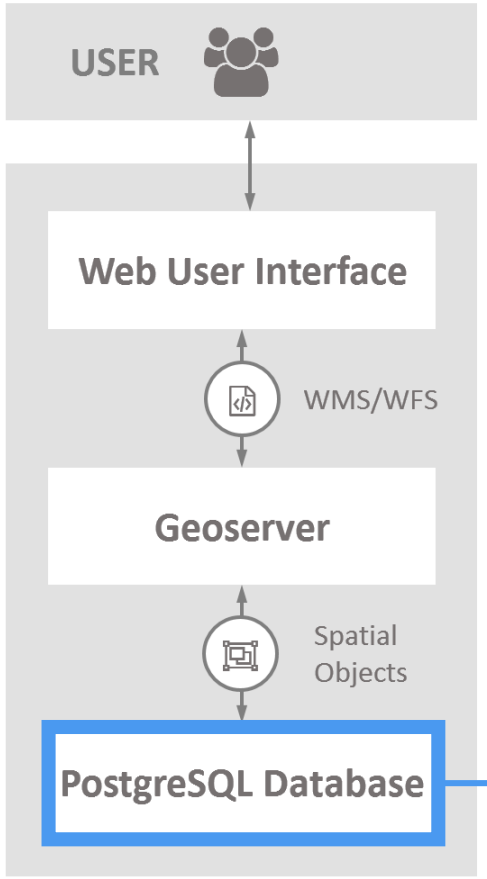


MUTED Architecture



- PostGreSQL database + PostGis Extension
- Import Metadata from PDS & DLR
- Datasets were filtered, unified, stored in separate tables
- Additional information are derived (L_s)
- Time-Overlap-Tables were created

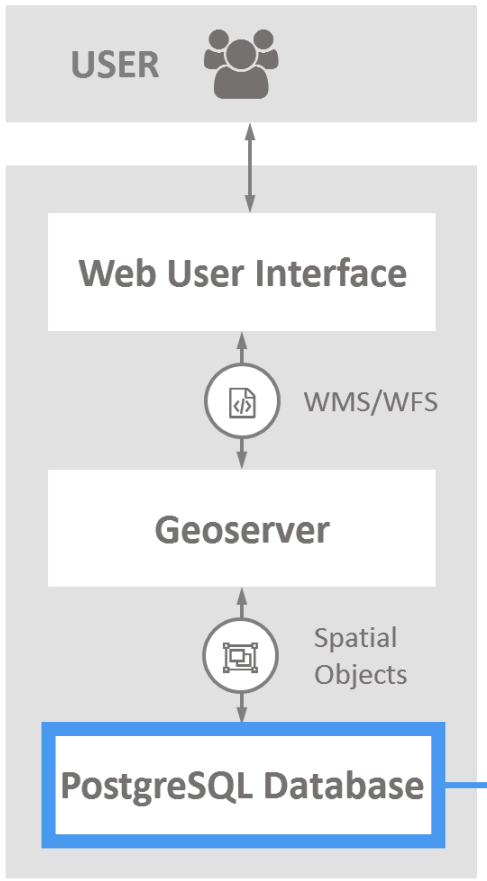
MUTED Architecture



Time-Overlap-Table (~10^{12} possibilities)

HRSC	CTX				MOC			
	IMG 1	IMG 2	IMG 3	IMG *n*	IMG 1	IMG 2	IMG 3	IMG *n*
IMG 1								
IMG 2								
IMG 3								
IMG *n*								

MUTED Architecture



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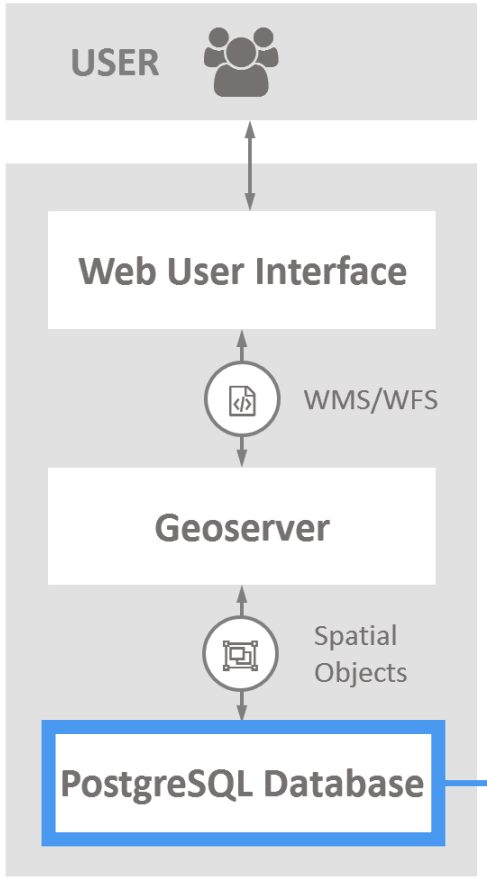
	IMG 1	IMG 2	IMG 3	IMG *n*	IMG 1	IMG 2	IMG 3	IMG *n*
IMG 1								
IMG 2								
IMG 3								
IMG *n*								

NO OVERLAP

MUTED Architecture

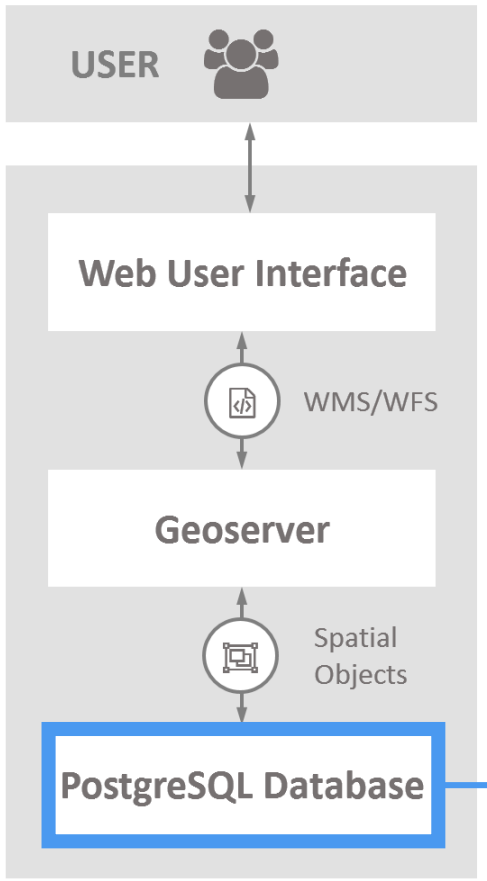


Time-Overlap-Table (~10^{12} possibilities)

HRSC	CTX				MOC			
Δt	IMG 1	IMG 2	IMG 3	IMG *n*	IMG 1	IMG 2	IMG 3	IMG *n*
IMG 1		2		6	1			2
IMG 2	4			9				8
IMG 3		3	8	4		3	5	
IMG *n*			5		4		2	7

TIME DIFFERENCE

MUTED Architecture



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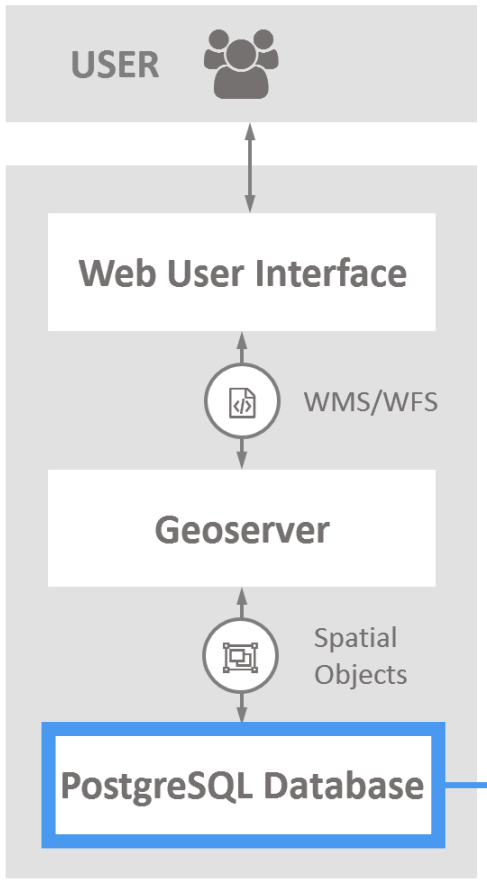
Δt	IMG 1	IMG 2	IMG 3	IMG *n*	IMG 1	IMG 2	IMG 3	IMG *n*
IMG 1		2		6	1			2
IMG 2	4			9				8
IMG 3		3	8	4		3	5	
IMG *n*			5		4		2	7

Minimal Time difference

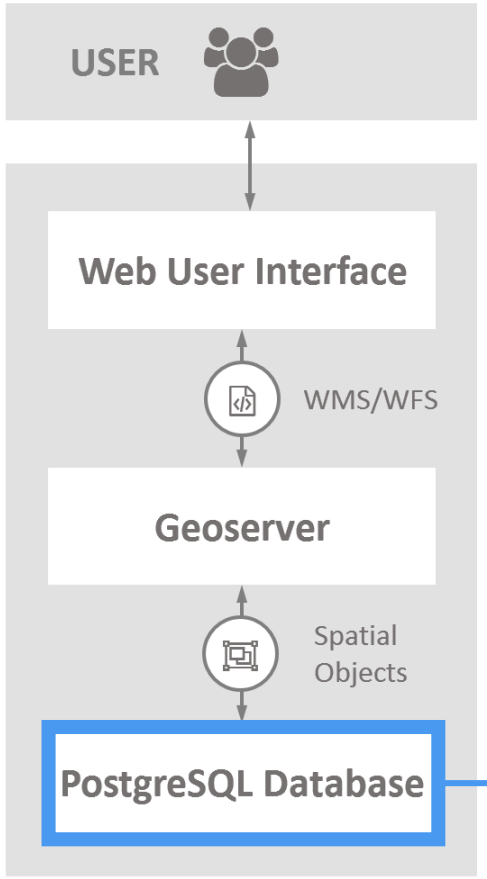
MUTED Architecture



Resulting Time-Overlap-Table

HRSC	CTX	MOC
	min(Δt)	min(Δt)
IMG 1	2	1
IMG 2	4	8
IMG 3	3	3
IMG *n*	5	2

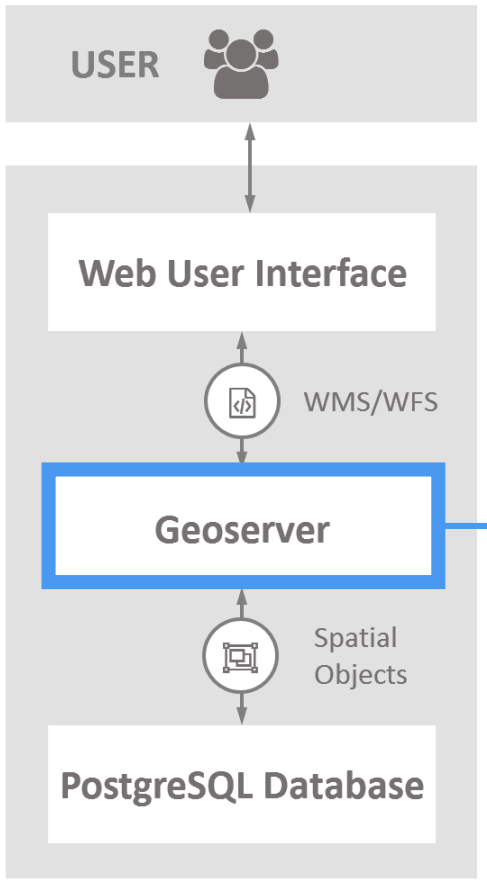
MUTED Architecture



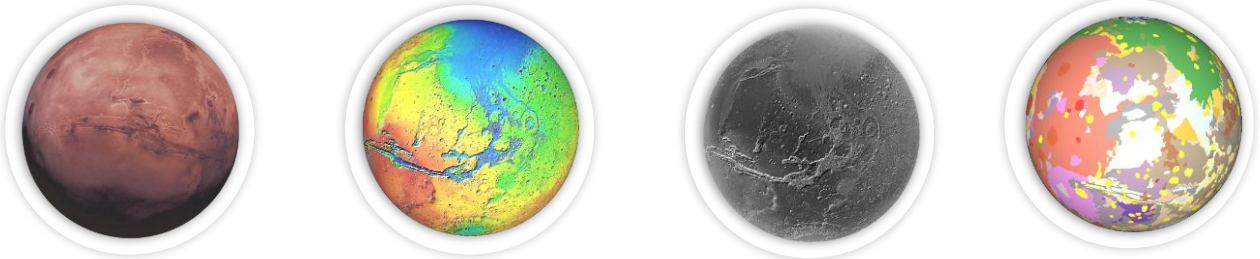
Resulting Time-Overlap-Table

HRSC	CTX	MOC	CTX	MOC
	min(*Δt*)	min(*Δt*)	∑ IMG	∑ IMG
IMG 1	2	1	2	2
IMG 2	4	8	2	1
IMG 3	3	3	3	2
IMG *n*	5	2	1	3

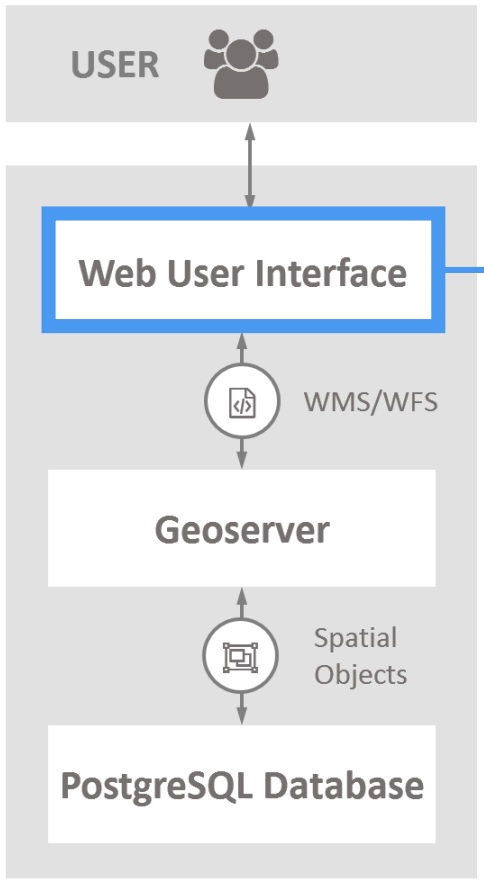
MUTED Architecture



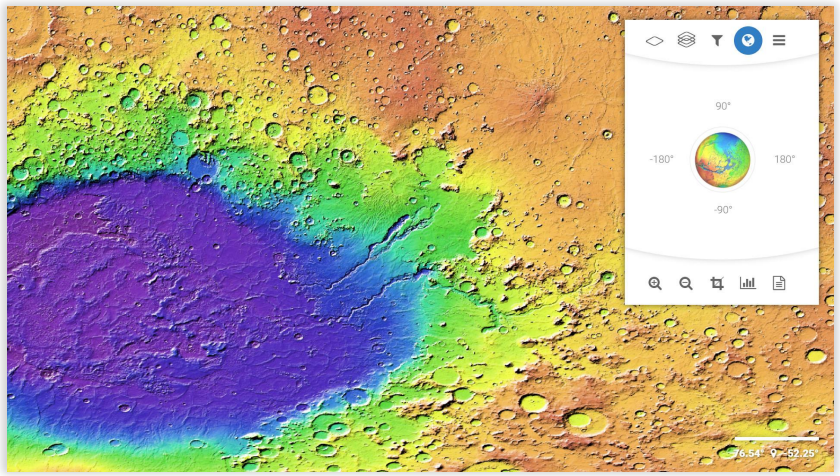
- Translation into Web Map Services (WMS) and Web Feature Services (WFS)
- Standards from Open Geospatial Consortium (OGC)
- Filtering using Common Query Language (CQL)
- Additional base maps



MUTED Architecture

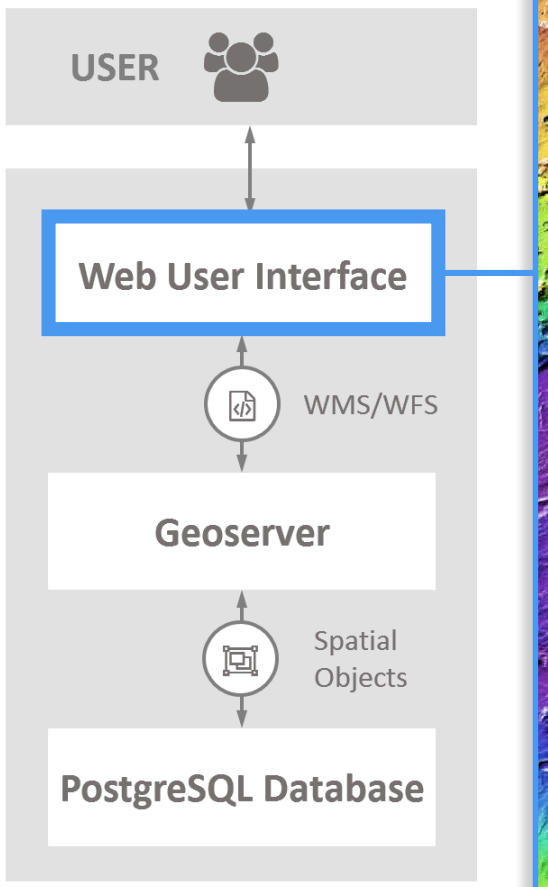


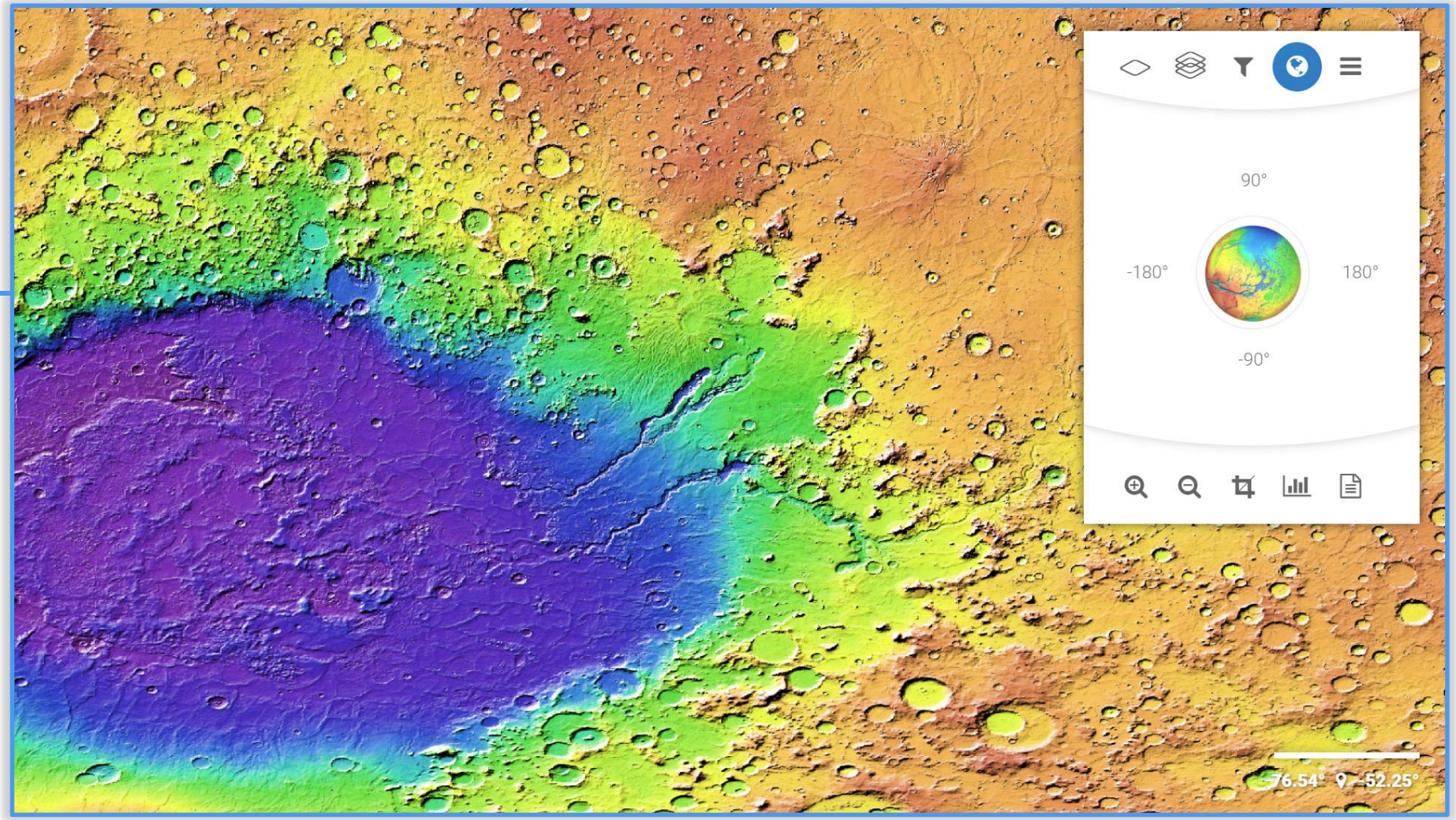
- Using PhP, HTML, JavaScript, Openlayers
- several features for data selection, filtering, and visualization



Web User Interface

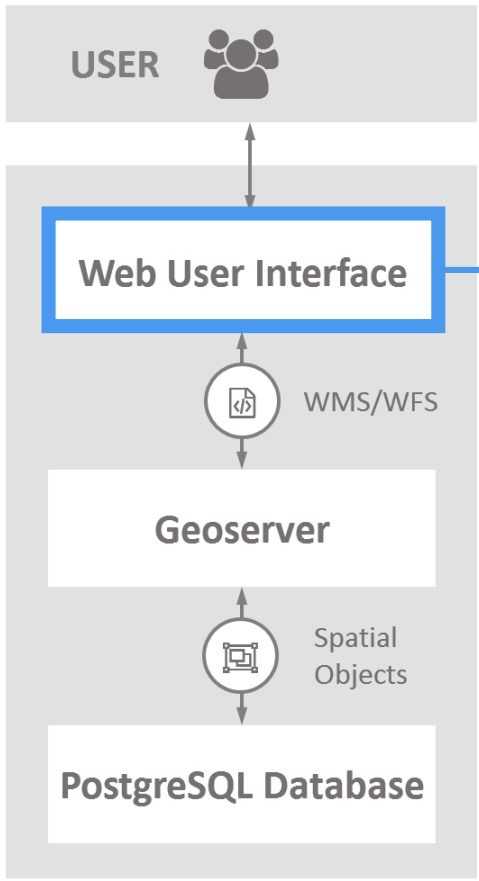
MUTED Architecture

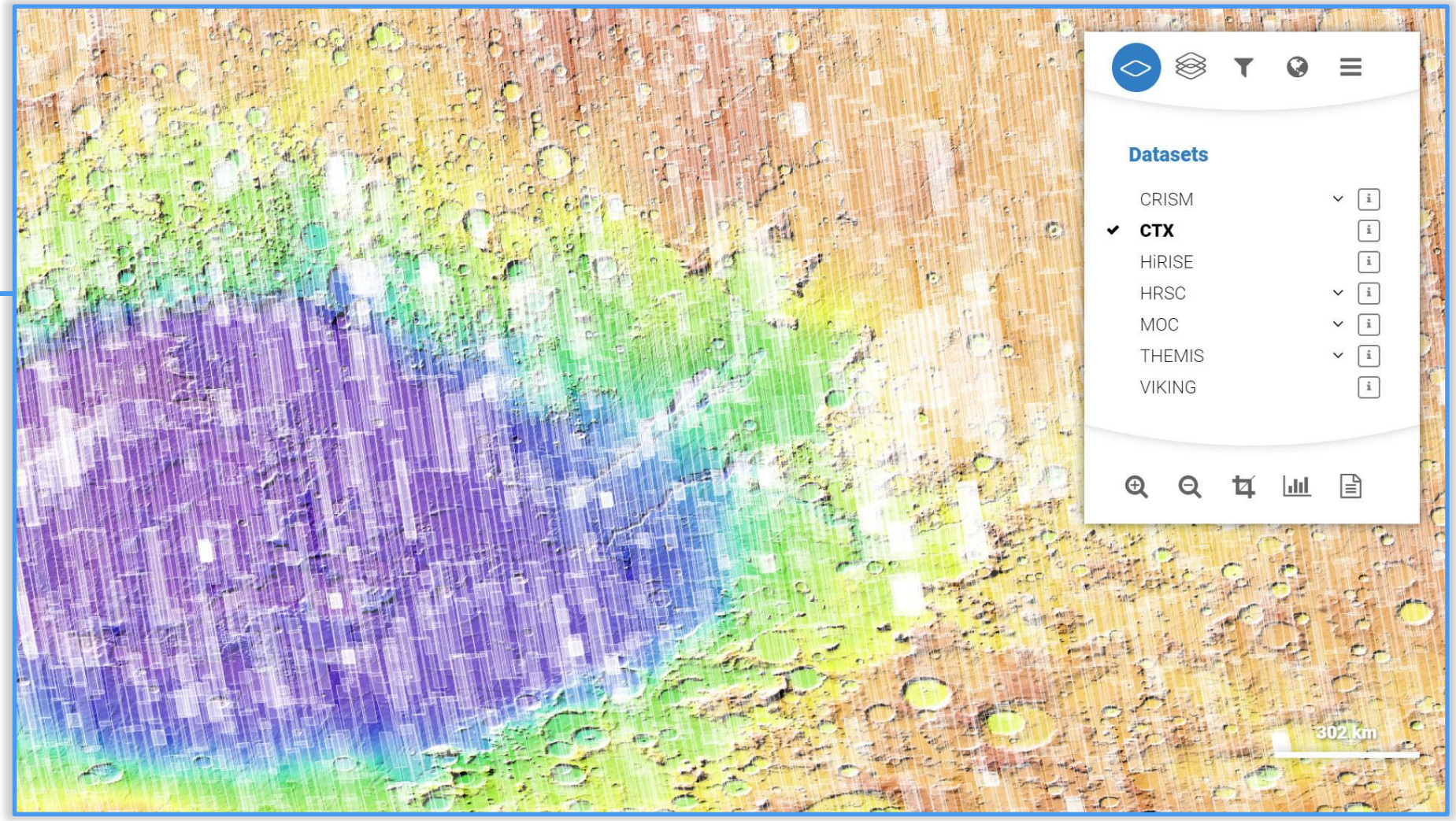




Navigation menu and base map selection

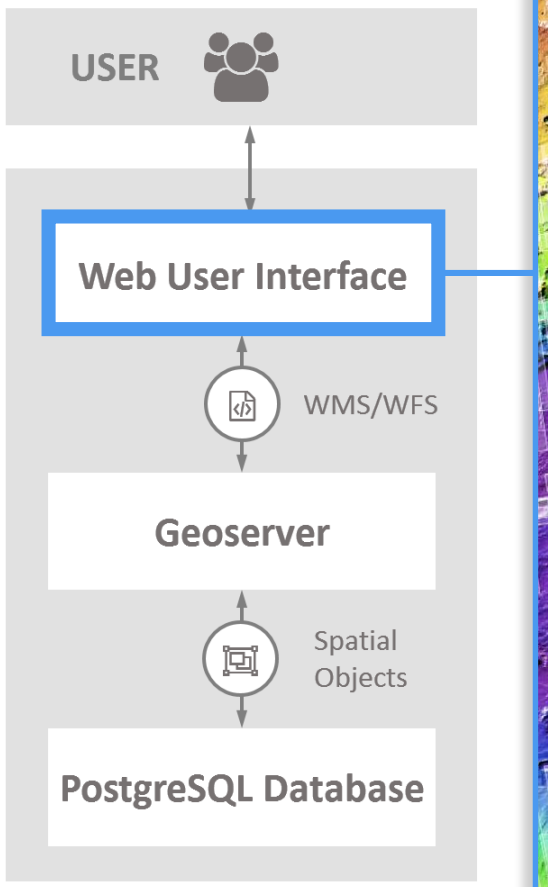
MUTED Architecture

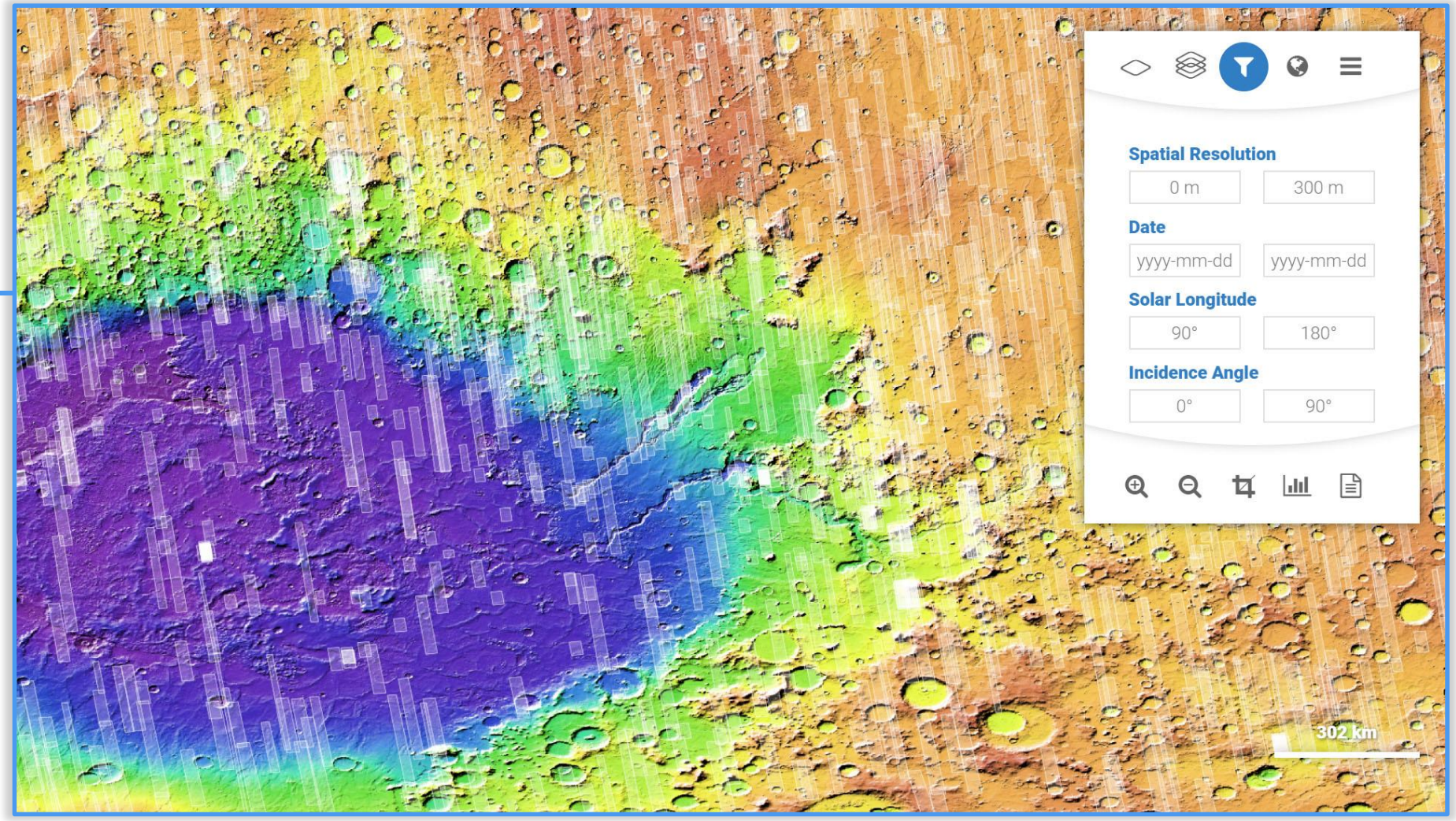




Data selection and information

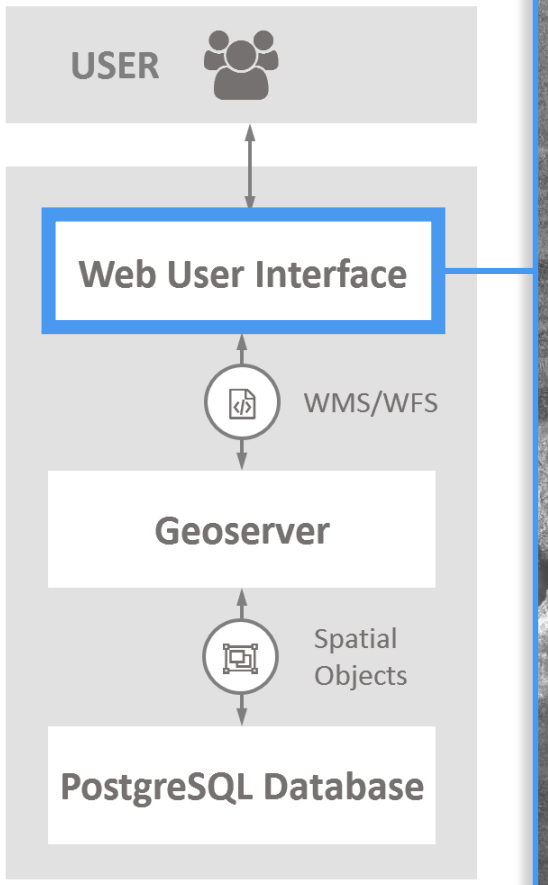
MUTED Architecture





Data filter options

MUTED Architecture



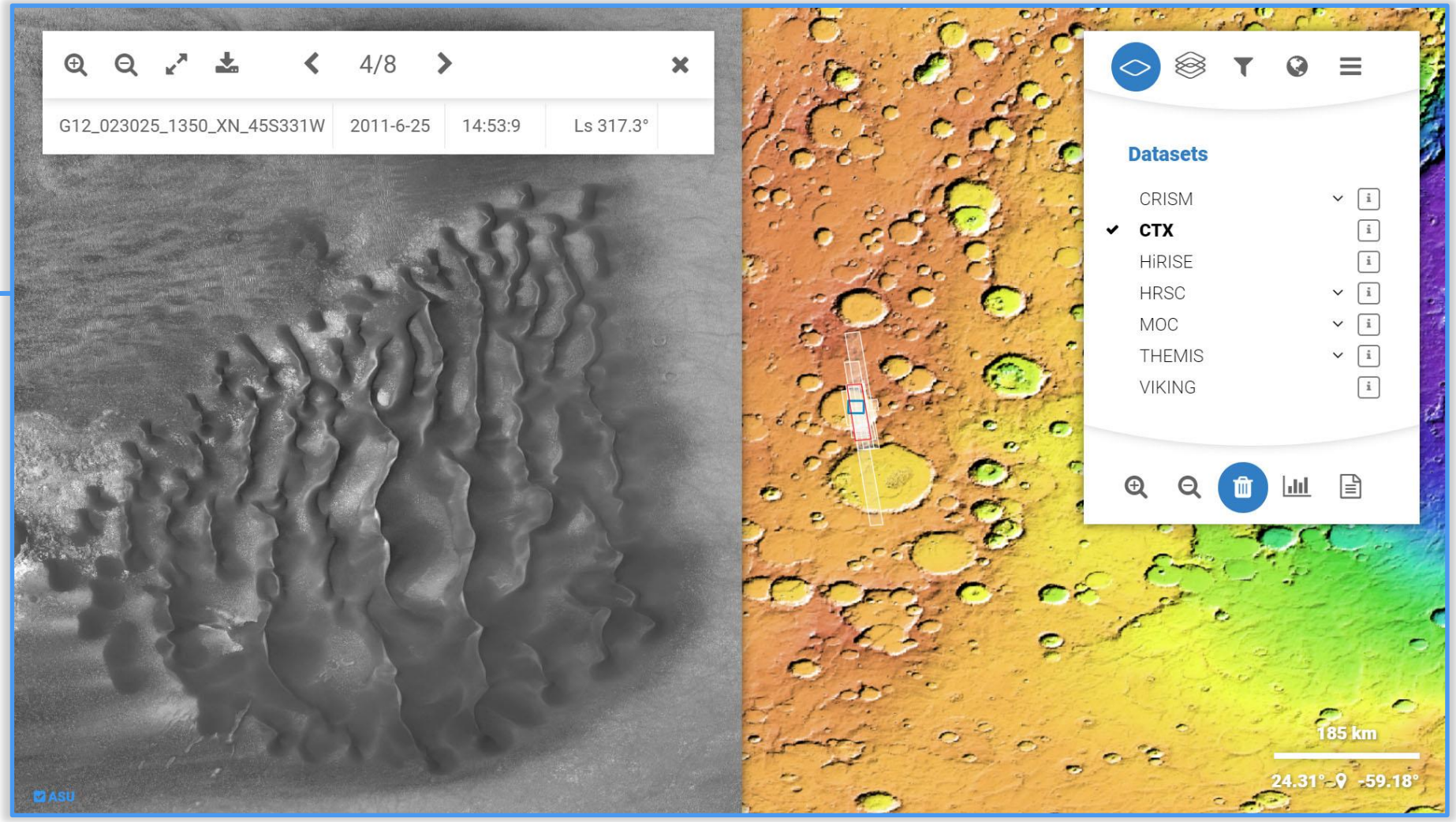
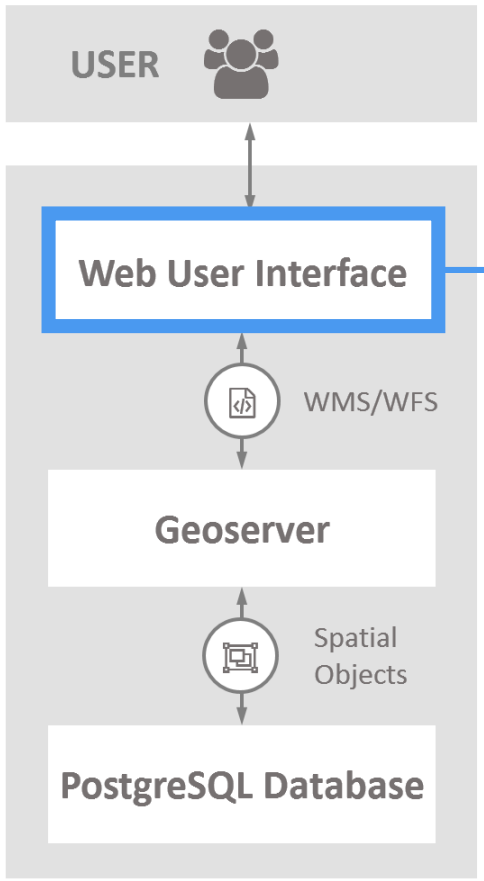
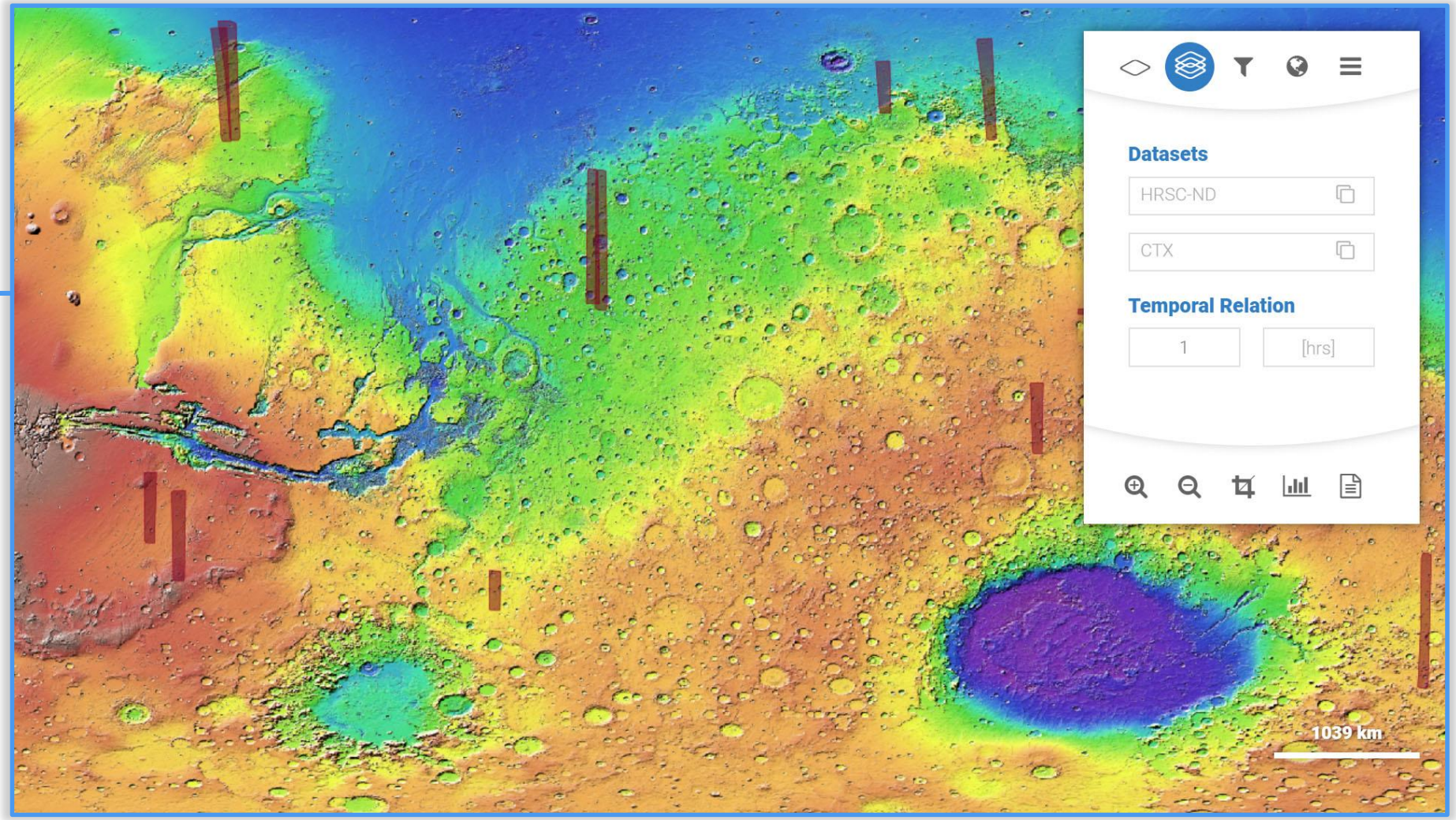


Image meta data and preview

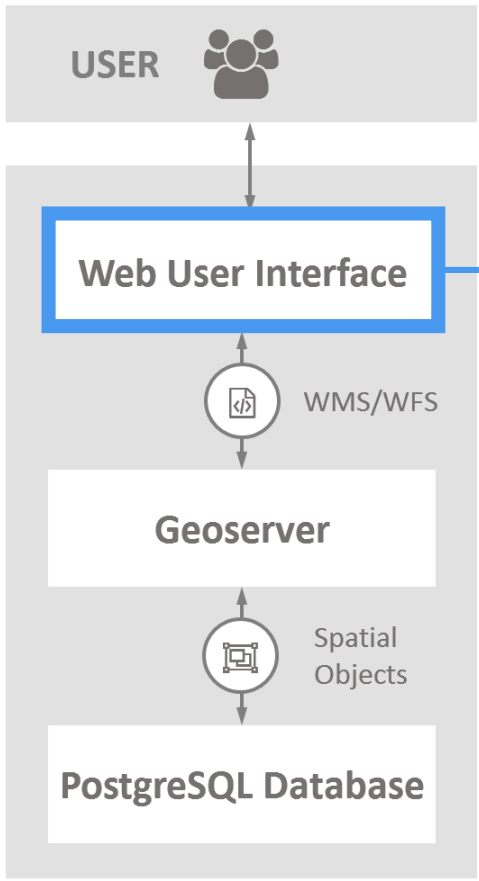
MUTED Architecture

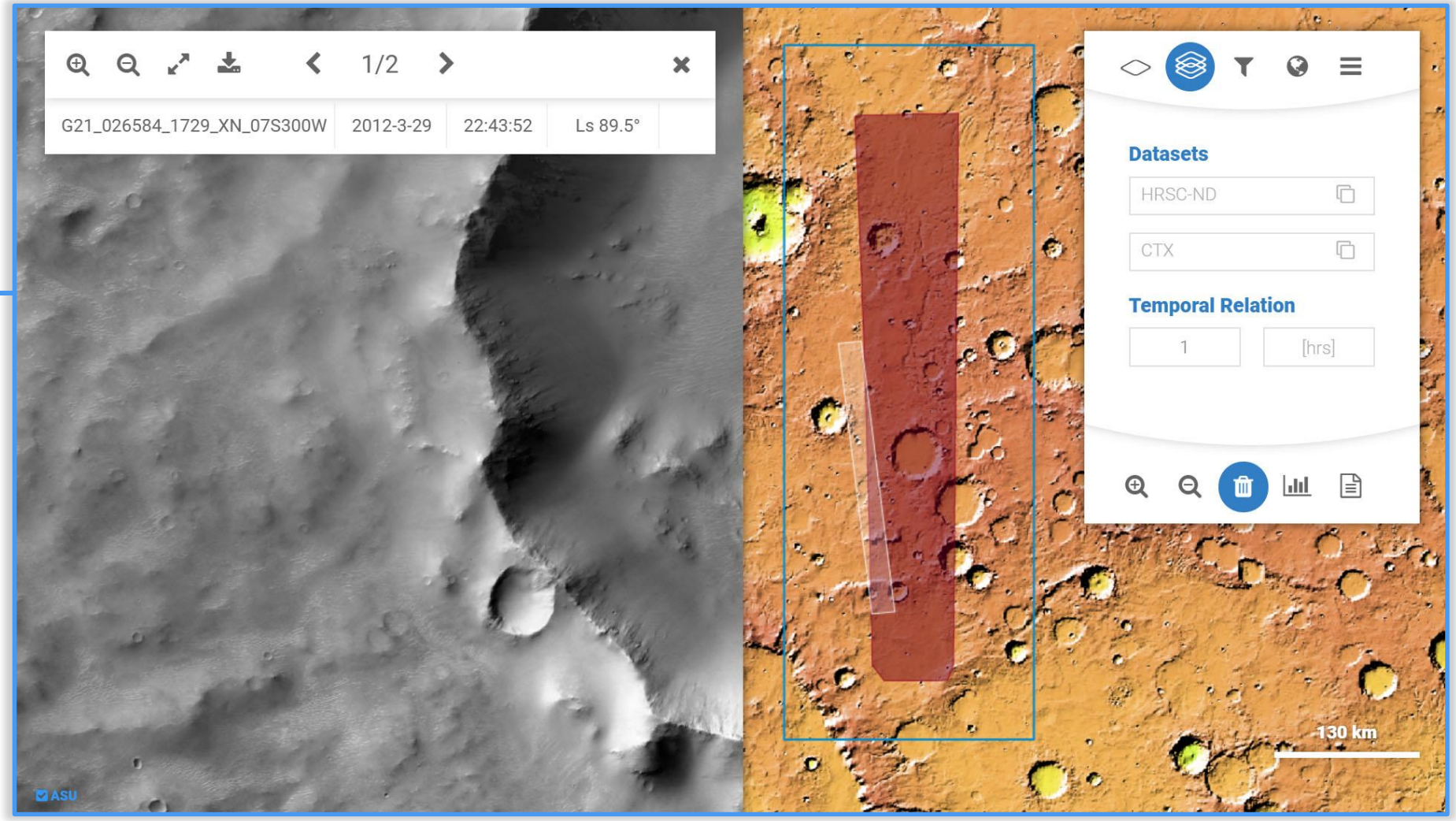




Multi-temporal data search (HRSC and CTX within one hour time interval)

MUTED Architecture





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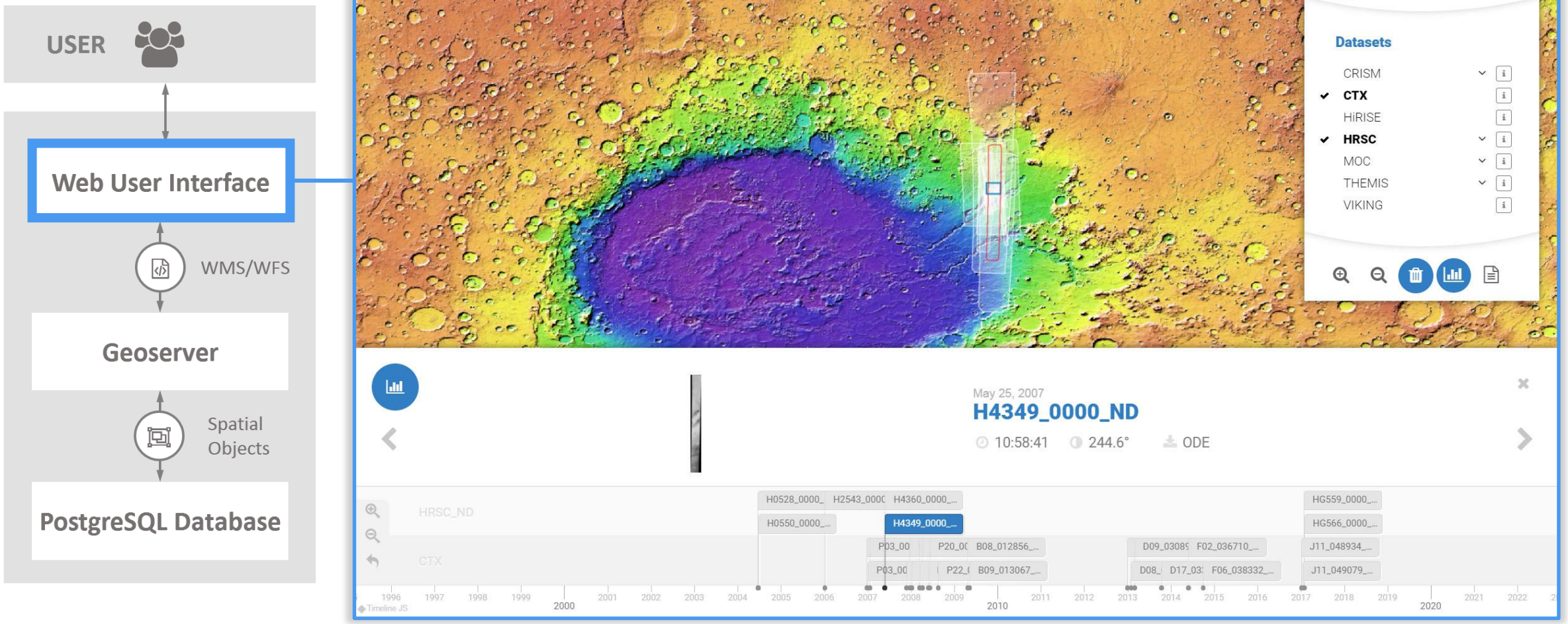
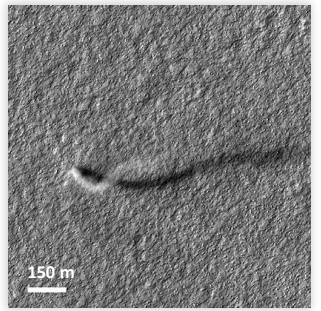


Time-line of image selection

MUTED Scientific Applications

- Define time interval between overlapping images:
  - Short-term and temporally high variable processes
- Define L_s or difference in L_s:
  - Seasonal processes
- Define the number of overlapping images:
  - Long-term changes of the surface



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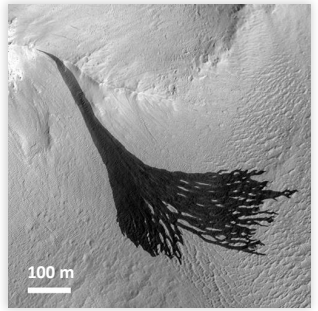

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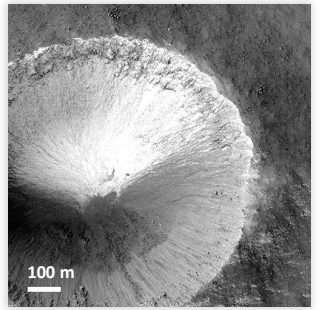

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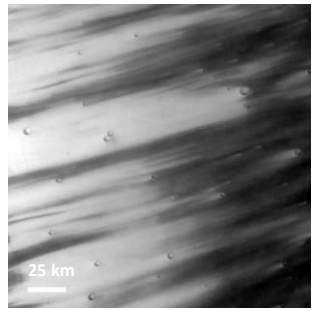

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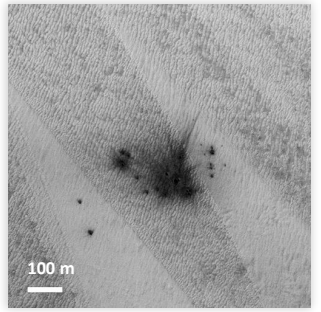

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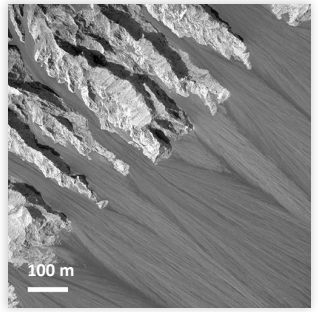
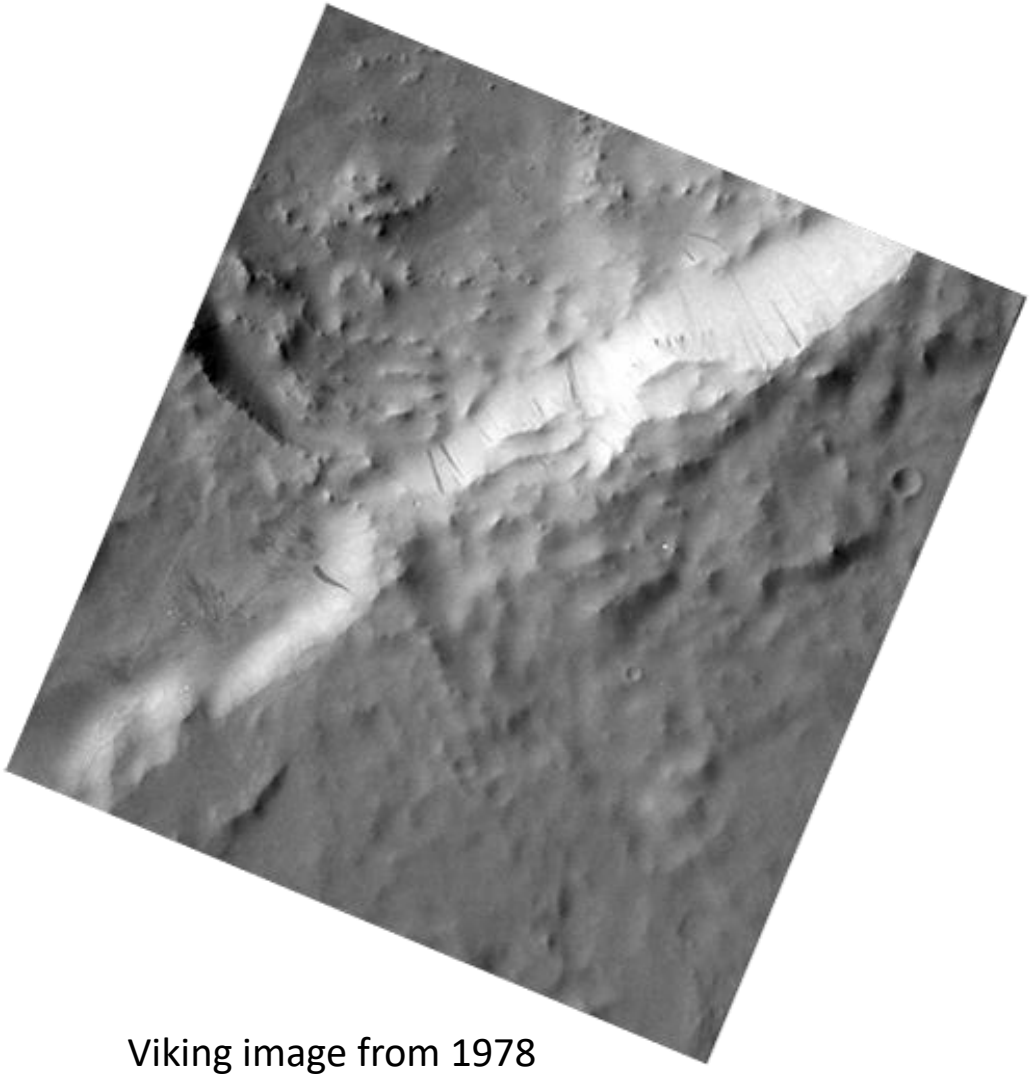


ESP_022632_1670

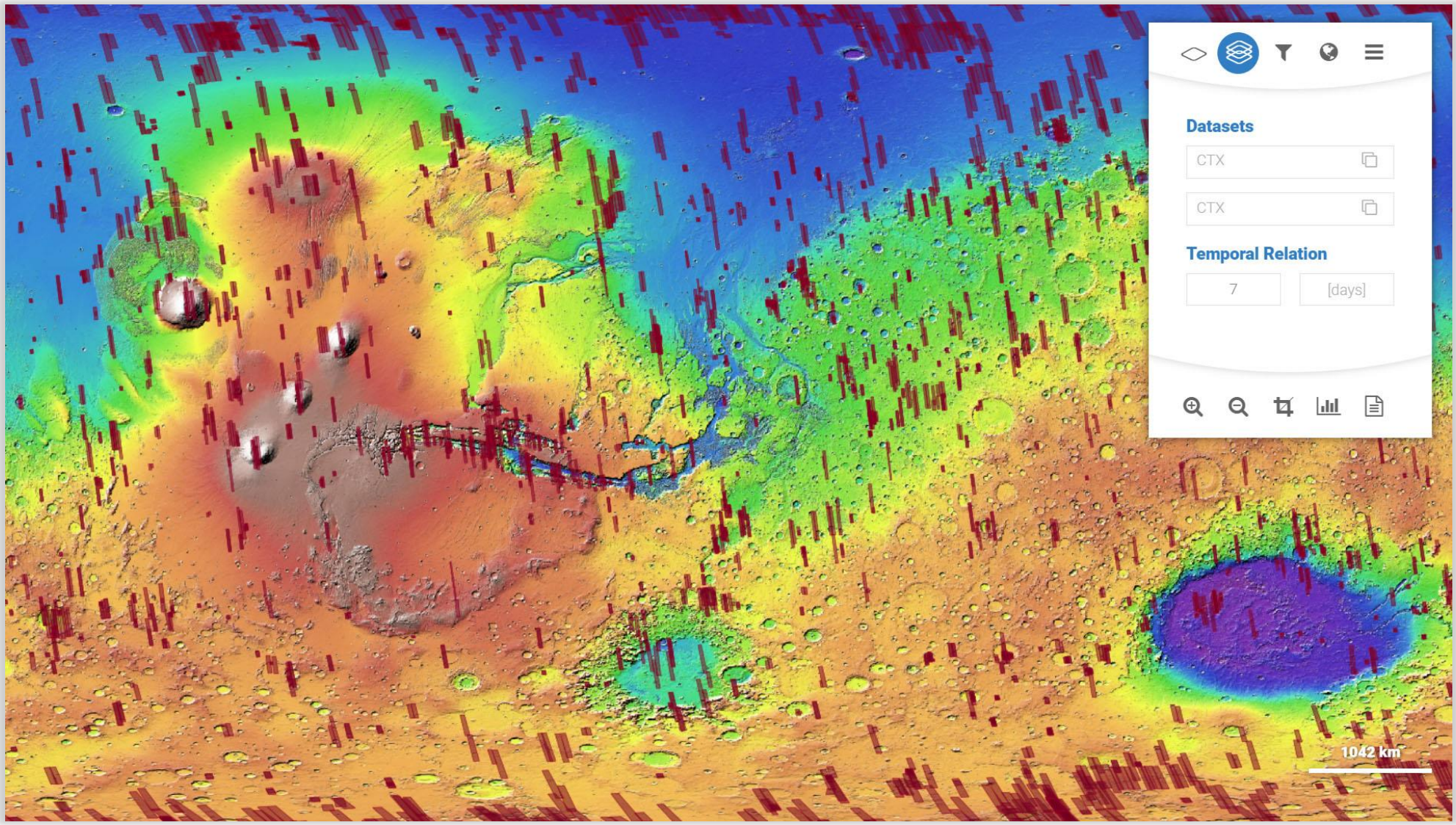
MUTED Example - Slope Streaks

- Narrow fan-shaped albedo features on steep slopes
- First observed in Viking images (Ferguson & Lucchitta 1984)
- Actively forming (Sullivan et al. 2001)
- Growth or reactivation has never been observed
- Various proposed dry- and wet-based formation mechanisms



Viking image from 1978 (713A57)

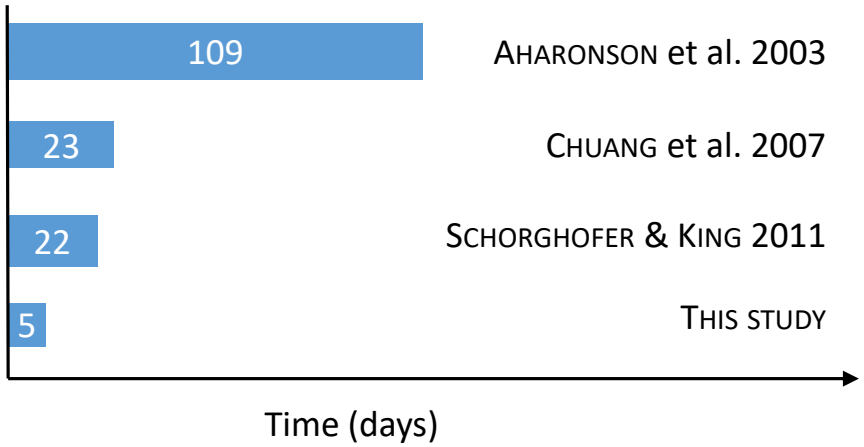
MUTED Example - Slope Streaks



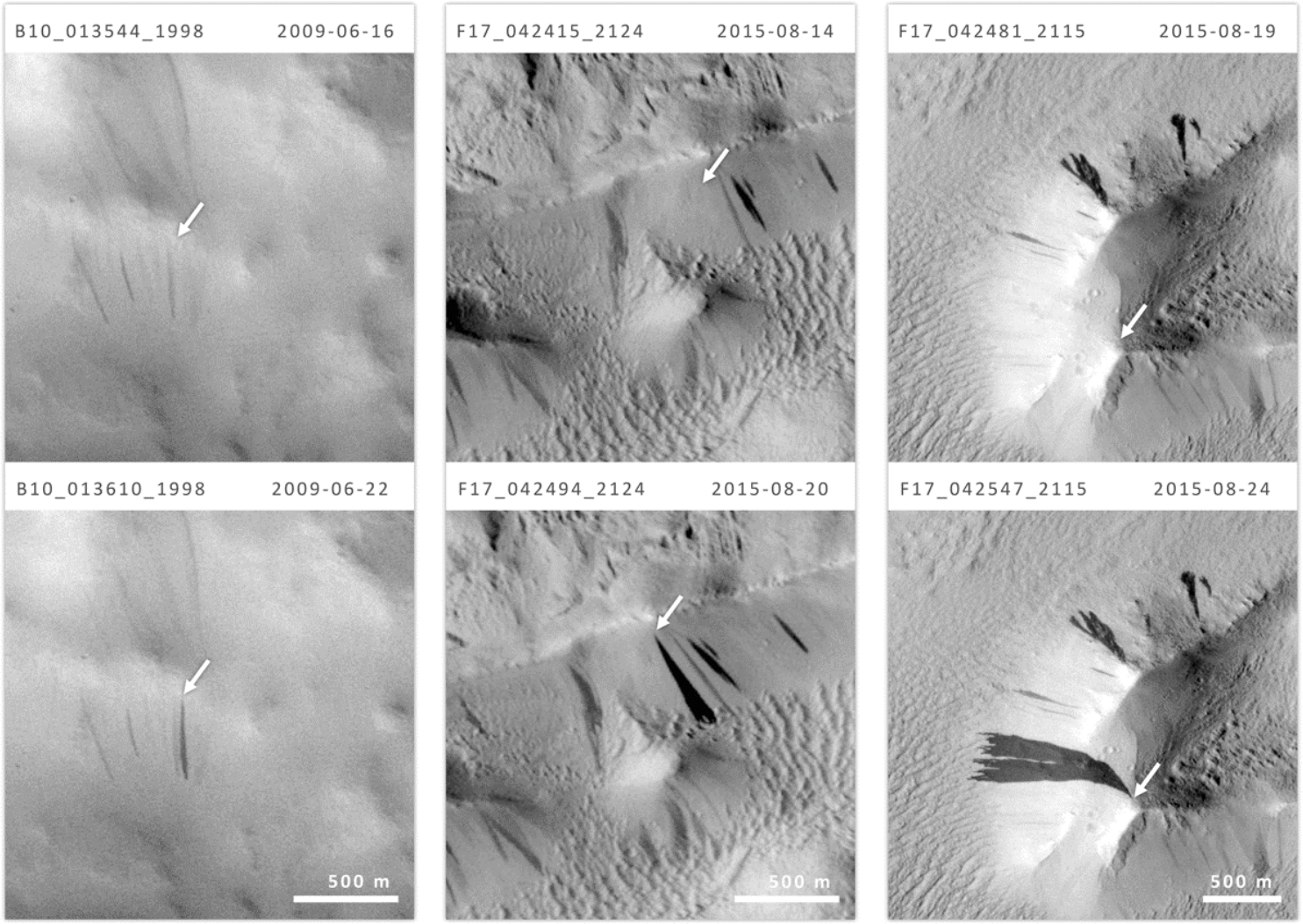
Overlapping CTX observations with a temporal distance of < 7 days

MUTED Example - Slope Streaks

- Streak formation within a ~5 day time interval in different regions on Mars

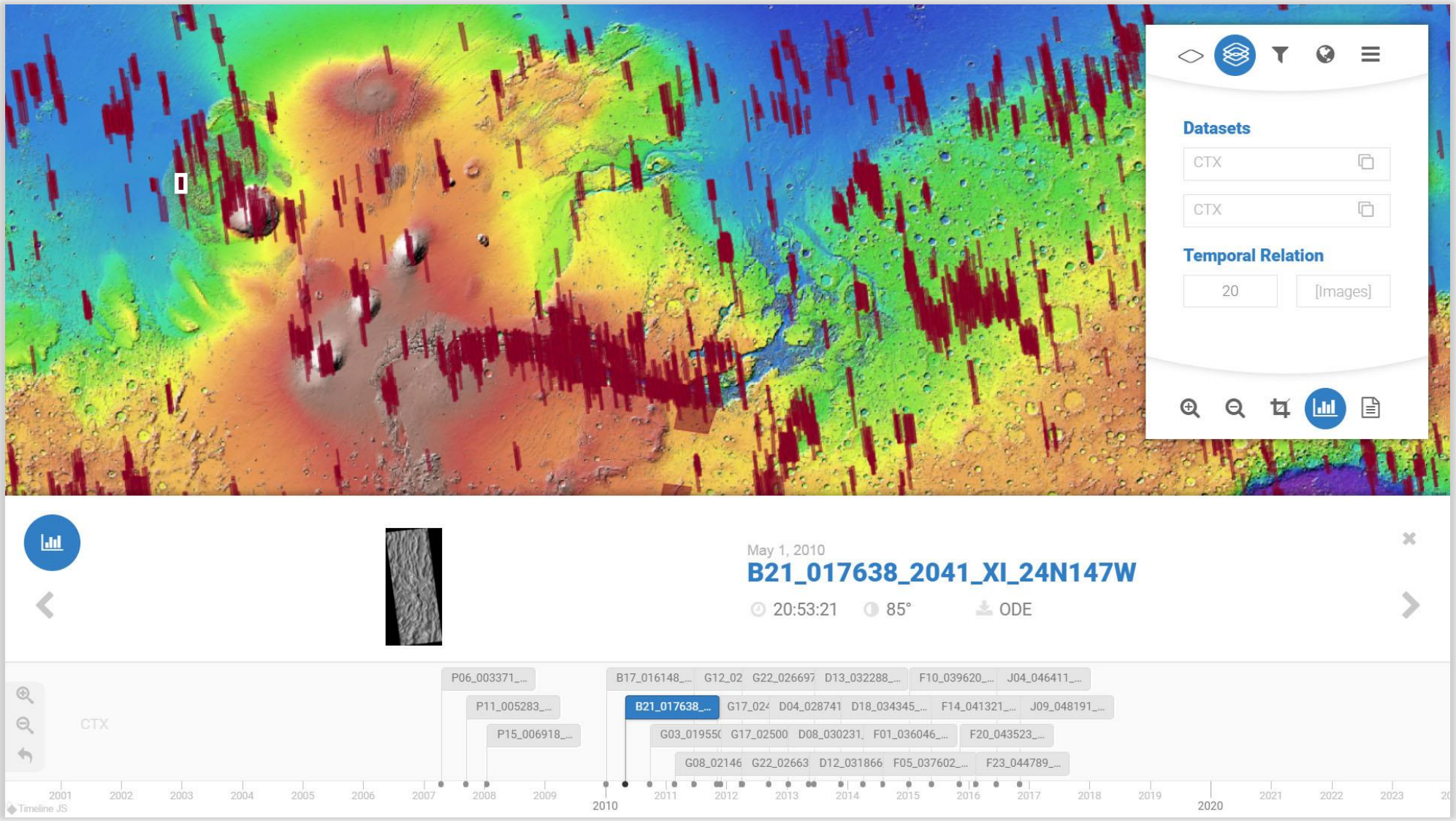


Time constraints of streak formation



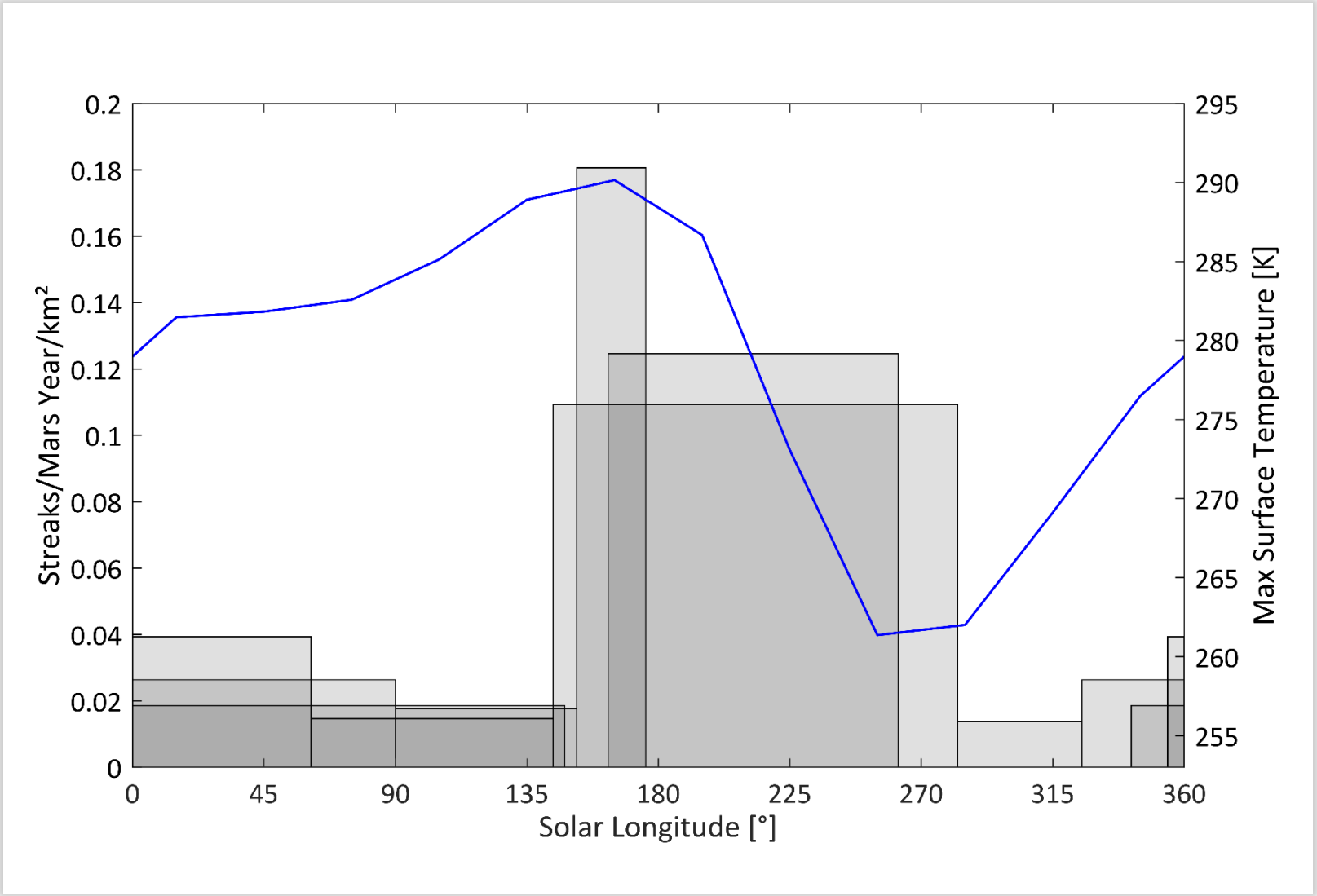
Newly formed slope streaks within a time interval ~5 days

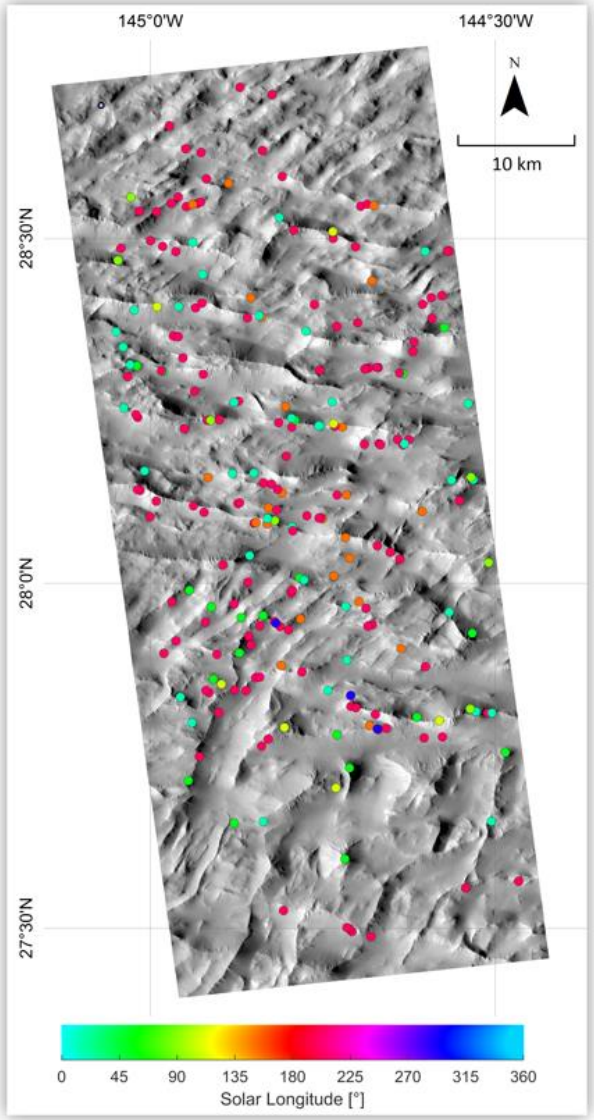
MUTED Example - Slope Streaks



Overlapping CTX observations with a minimum number of 20 images

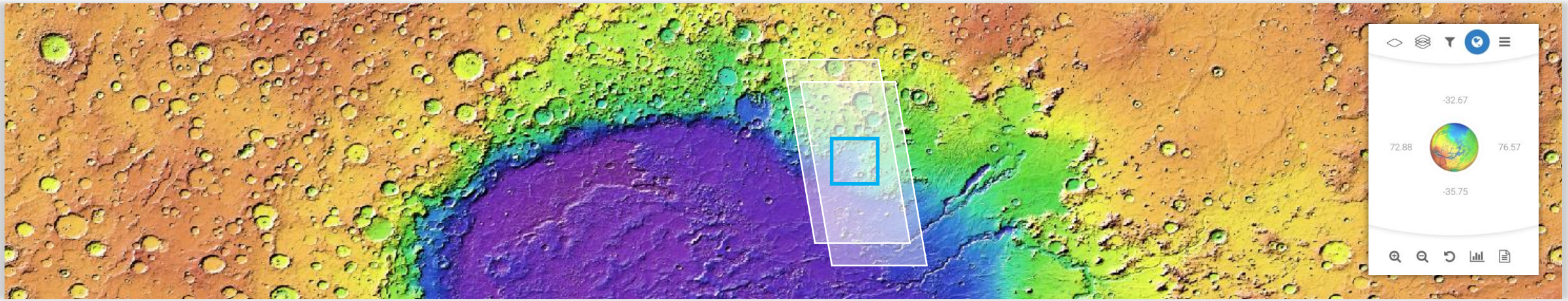
MUTED Example - Slope Streaks





Slope streak formation rate within the Olympus Mons Aureole

MUTED Summary



http://muted.wwu.de

- Image search in spatial and temporal relation to other images
- Area of interest based on global spectral, topographical or geological information
- Filter data by time, solar longitude or based on the spatial resolution
- Show data statistics and temporal context to other images