THE OPEN SOURCE VIEWER'S SPIRIT, AN OPPORTUNITY TO DO COLLABORATIVE SCIENCE WITH THE CESIUM INTERFACE

Anthony Lagain,
Chiara Marmo,
Omar Delaa,
Sylvain Bouley
François Costard
and the reviewer consortium

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A new global database of Mars impact craters ≥1 km:
1. Database creation, properties, and parameters

Stuart J. Robbins[1] and Brian M. Hynek[1,2]

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[1] Impact craters have been used as a standard metric for a plethora of planetary applications for many decades, including age-dating, geologic mapping and stratigraphic relationships, as tracers for surface processes, and as locations for sampling lower crust and upper mantle material. Utilizing craters for these and other investigations is significantly aided by a uniform catalog of craters across the surface of interest. Consequently, catalogs of craters have been developed for decades for the Moon and other planets. We present a new global catalog of Martian craters statistically complete to diameters $D \geq 1$ km. It contains 384,343 craters, and for each crater it lists detailed positional, interior morphologic, ejecta morphologic and morphometric data, and modification state information if it could be determined. In this paper, we detail how the database was created, the different fields assigned, and statistical uncertainties and checks. In our companion paper (Robbins and Hynek, 2012), we discuss the first broad science applications and results of this work.

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1. Introduction

[2] Since Galileo first turned his telescope to the Moon and identified the three-dimensionality of craters [*Galilei*, 1610], people have been cataloging craters on the solar system's solid bodies. Some of the first modern crater catalogs were generated in preparation for the *Apollo* missions in the 1960s with other geomorphologic features [e.g., *Kuiper*, 1960; *Schimerman*, 1973], followed by more methodic and global catalogs in the subsequent decades [*Pike*, 1977, 1980, 1988, and references therein; *Wood and Andersson*, 1978]. When the first images of Mars were returned by *Mariner 9*, craters were cataloged there, as well. The first global crater database of Mars was created by Nadine Barlow, published over two decades ago [*Barlow*, 1988], and it comprised 42,284 craters, mostly with diameters $D \geq 5$ km, identifiable from *Viking* images. This has stood as a reference set for the past two decades and is distributed as a standard package with other Mars data sets by the United States Geological Survey (USGS).

[3] Since that time, higher-quality and -resolution imagery has been gathered of Mars, as has topographic data, which can be used to produce a new generation of a Mars crater catalogs. Barlow is in the process of updating the "Catalog of Large Martian Impact Craters" [i.e., *Barlow*, 2003], which will update the locations and diameters, remove false positives, include missed craters $D \geq 5$ km from the original catalog, and have several additional parameters that can be calculated from recent data sets. Besides manual identification methods, automated approaches have been applied to cataloging Martian impact craters. Notably, *Stepinski et al.* [2009] published a catalog stated to be complete to roughly D~3 km (see section 7.5.2). It was created by purely automated machine-learning techniques utilizing the *Mars Global Surveyor*'s Mars Orbiter Laser Altimeter (MOLA) data [*Zuber et al.*, 1992; *Smith et al.*, 2001]. It contains the locations, diameters, and depths of all ~76,000 identified craters. An additional meta-approach has been used to combine existing crater catalogs into a single database and location [e.g., *Salamunićcar et al.*, 2011]. This method relies upon a computer algorithm to match craters across input databases and return an average location and size, subject to manual checking. This has resulted in a database with ~129,000 craters (see section 7.5.3).

[4] We have created an independent Martian crater catalog with 384,343 craters complete to diameters $D \geq 1.0$ km, though we possess and will distribute the additional ~250,000 craters used to ensure this completeness on an individual basis upon request. Craters $D < 3$ km are limited to full location and size information (from section 2), while those $D \geq 3$ km have other topographic, morphometric, and morphologic data. All craters were manually identified and measured as discussed in section 2. The catalog also contains detailed topographic information (section 3), interior

[1]Laboratory for Atmospheric and Space Physics, University of Colorado at Boulder, Boulder, Colorado, USA.
[2]Department of Geological Sciences, University of Colorado at Boulder, Boulder, Colorado, USA.

Corresponding author: S. J. Robbins, Laboratory for Atmospheric and Space Physics, University of Colorado at Boulder, UCB 600, Boulder, CO 80309, USA. (stuart.robbins@colorado.edu)

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Robbin's martian crater database

$D \geq 1$km
384 343 craters
$D < 3$km: location and diameter
$D \geq 3$km: topo, morphometric, morphologic

Built with ArcGIS
by using THEMIS data (100m/px)

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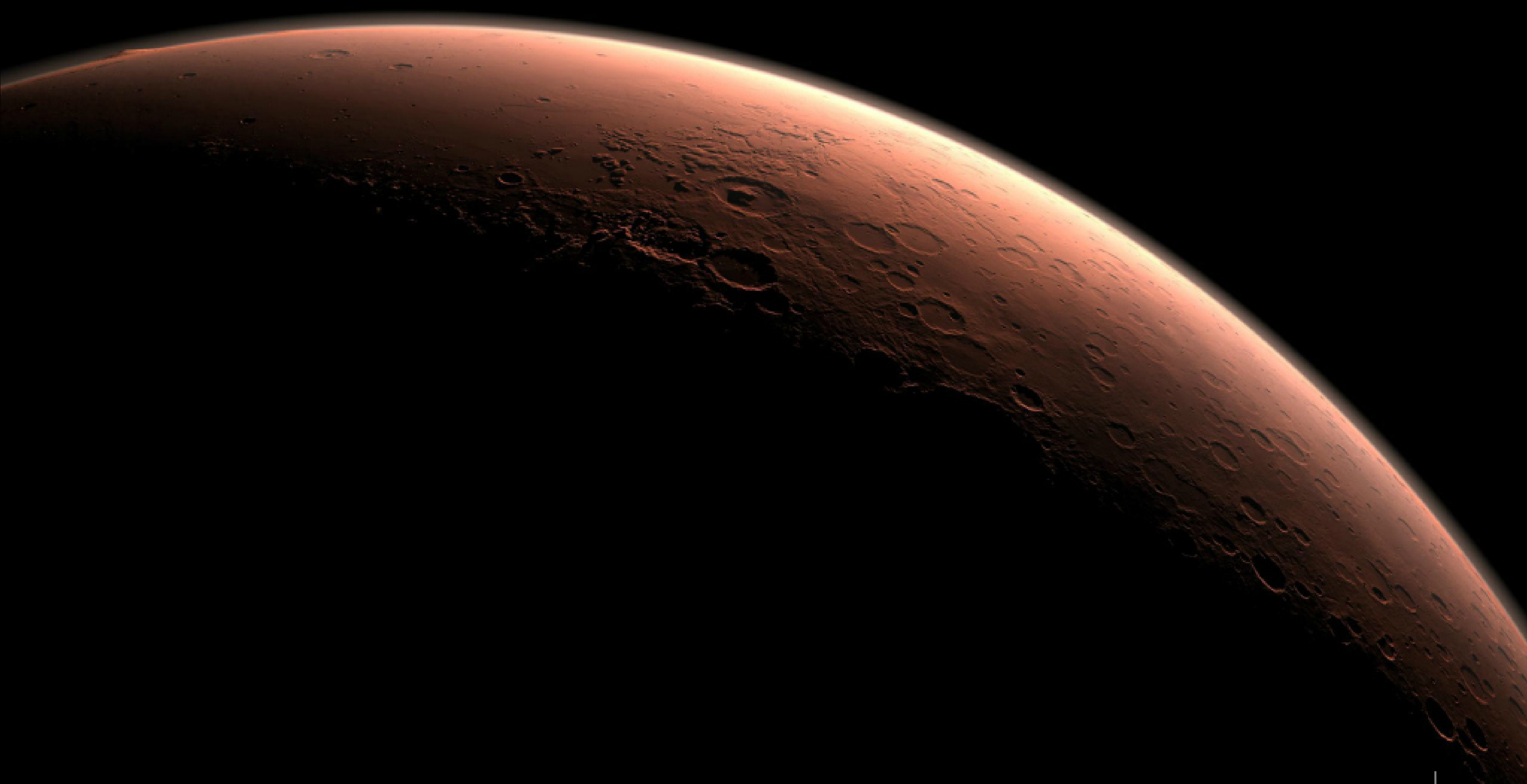
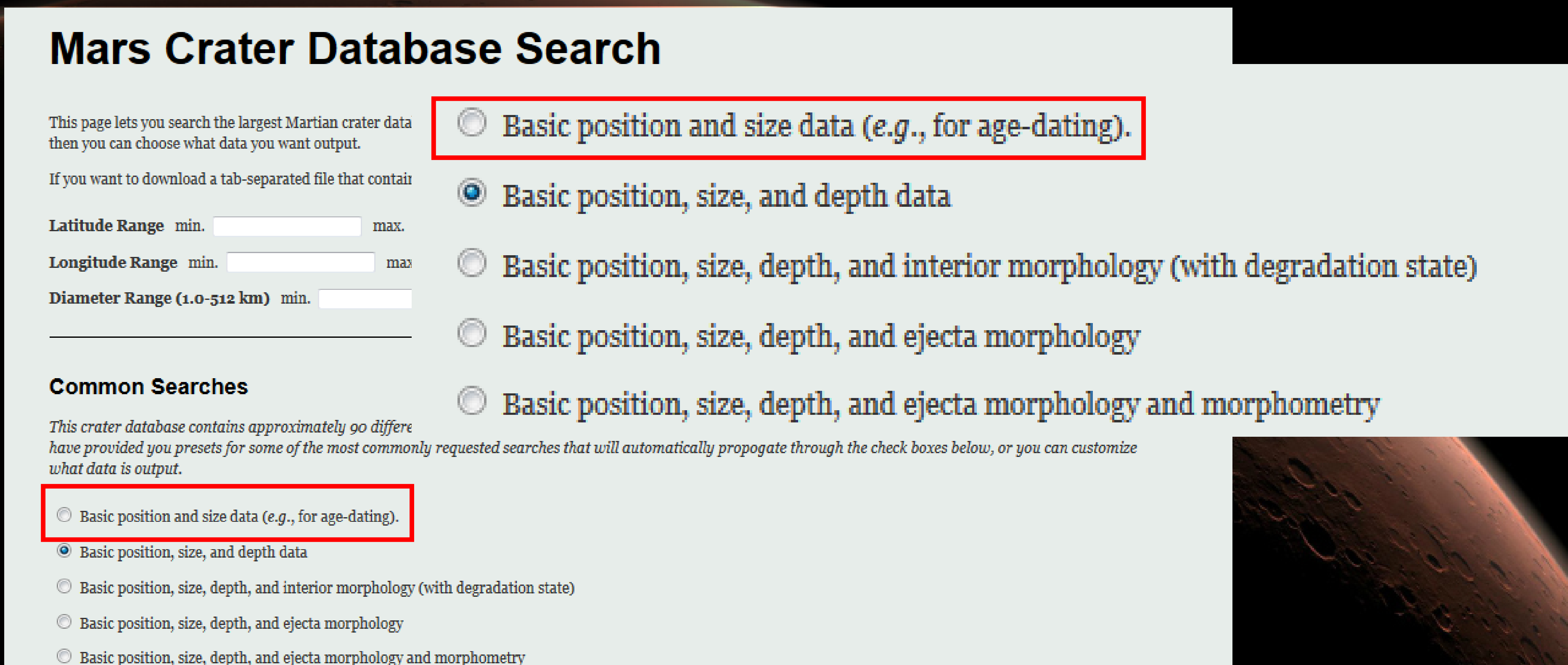
2 problems



2 problems

1. really adapted for dating ?

The database also contains a large number of secondary craters and ghosts



Mars Crater Database Search

This page lets you search the largest Martian crater data
then you can choose what data you want output.

If you want to download a tab-separated file that contai

Latitude Range min. max.

Longitude Range min. max

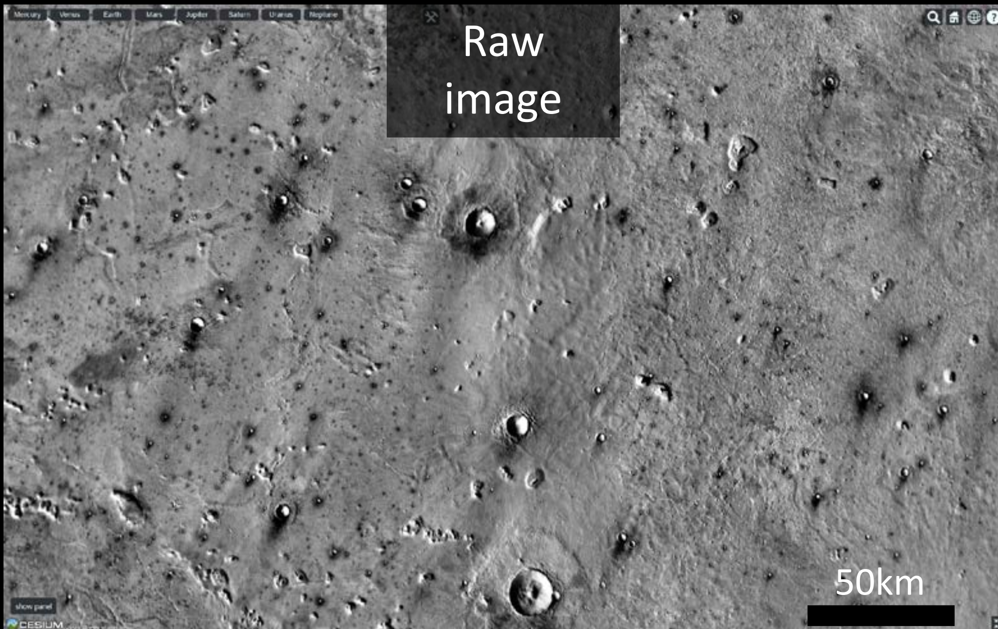
Diameter Range (1.0-512 km) min.

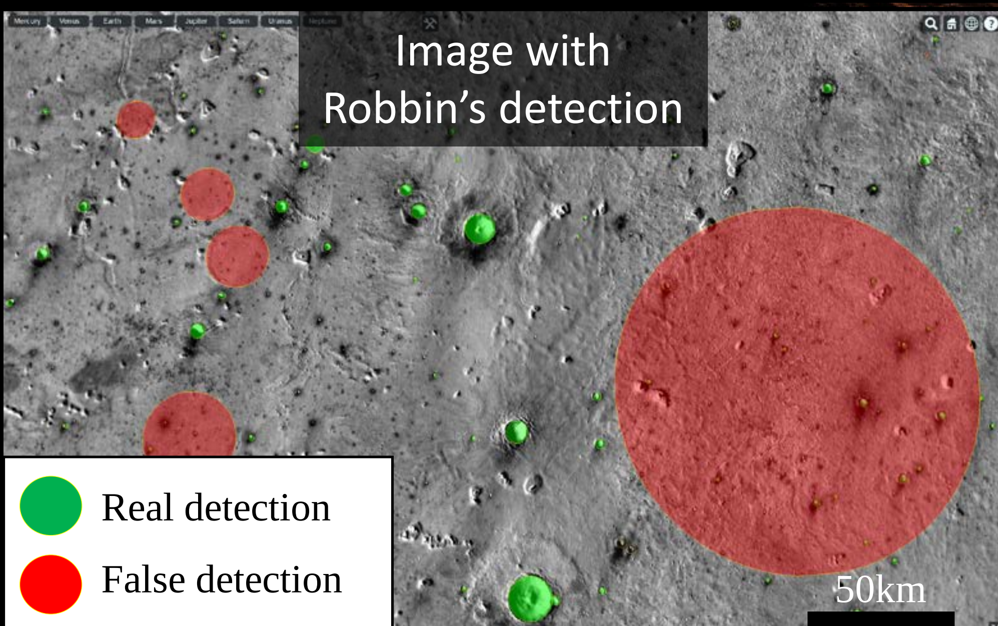
Basic position and size data (*e.g.*, for age-dating).
Basic position, size, and depth data
Basic position, size, depth, and interior morphology (with degradation state)
Basic position, size, depth, and ejecta morphology
Basic position, size, depth, and ejecta morphology and morphometry

Common Searches

This crater database contains approximately 90 differe have provided you presets for some of the most commonly requested searches that will automatically propogate through the check boxes below, or you can customize what data is output.

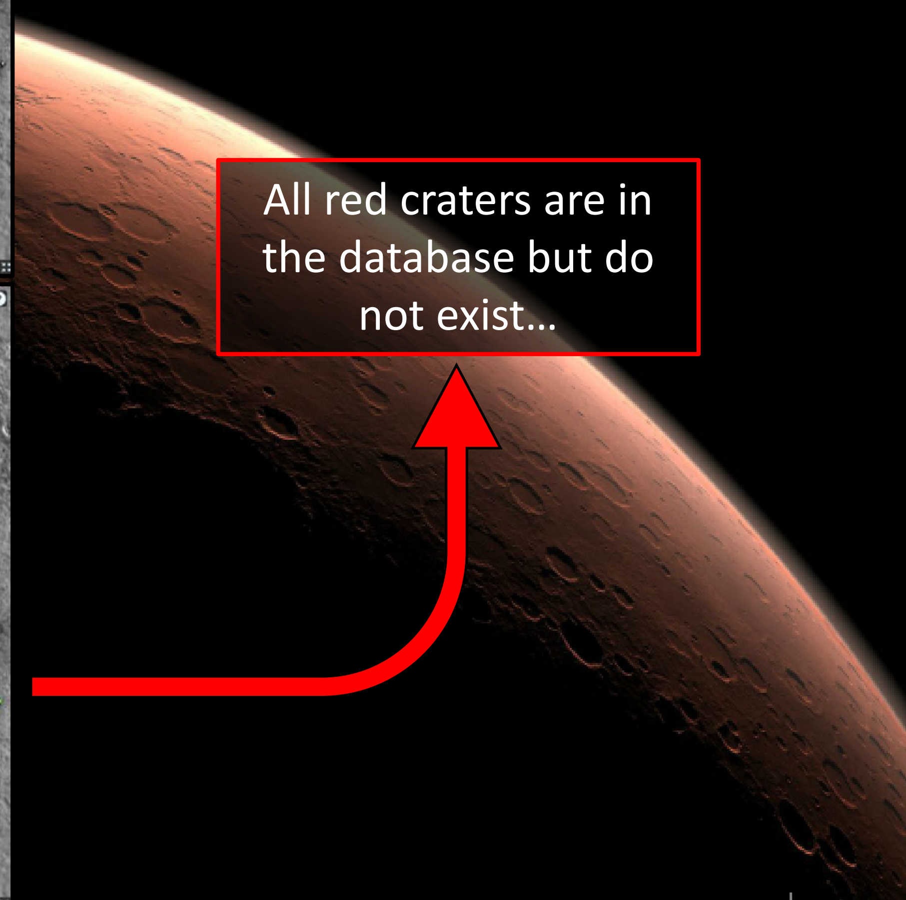
- Basic position and size data (*e.g.*, for age-dating).
- Basic position, size, and depth data
- Basic position, size, depth, and interior morphology (with degradation state)
- Basic position, size, depth, and ejecta morphology
- Basic position, size, depth, and ejecta morphology and morphometry





2 problems

1. really adapted for dating ?
2. false detections !



All red craters are in the database but do not exist…

Aim:

- To review the entire database by manual checking of each crater
- Catagorize them to exclude, if needed, secondaries and ghosts

Needs:

- Collaborate with as many people as possible
- Create a shareable and a standard tool
- Decrease the checking time for each crater

Aim:

- **To review the entire database by manual checking of each crater**
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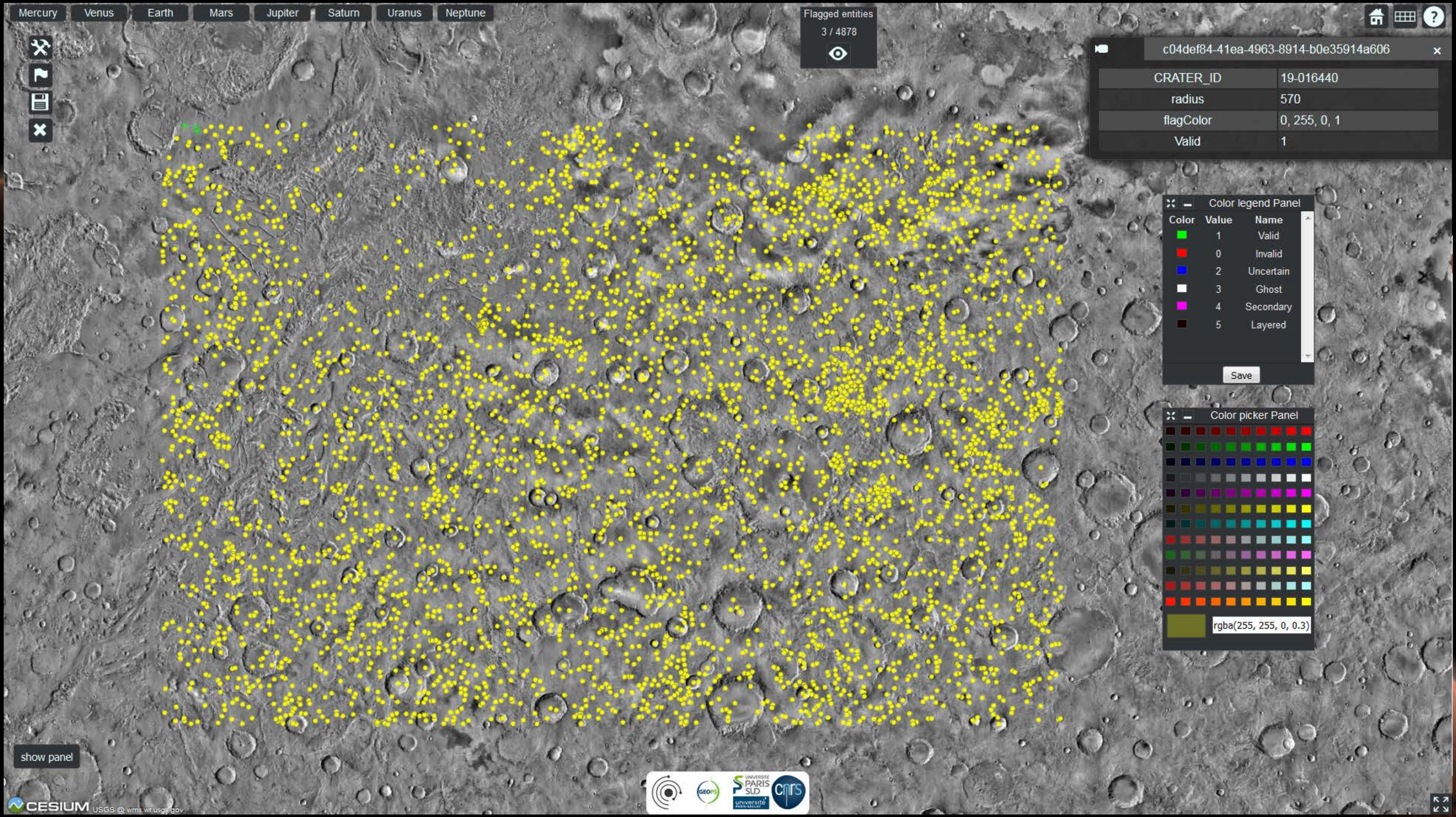
Needs:

- **Collaborate with as many people as possible**
- **Create a shareable and a standard tool**
- **Decrease the checking time for each crater**

→ Adaptation of the planetary data viewer: Cesium (see Delaa's talk)

Cutting of the database into 140 quandrangles
Distribution of a part of the database to all participants



This tool provide a reviewing at a speed of 1000 craters / hour !

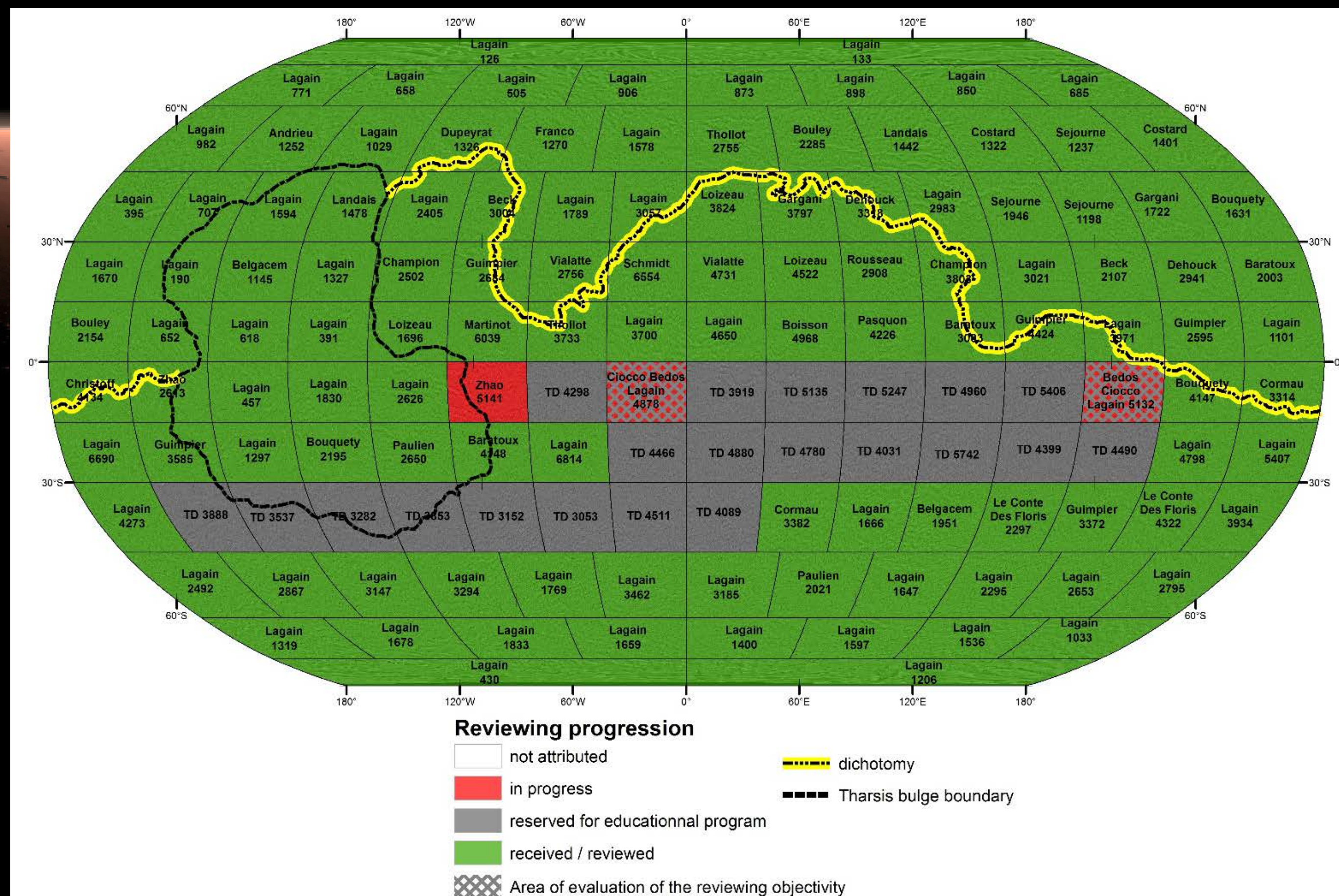
Cutting of the database into 140 quandrangles
Distribution of a part of the database to all participants

32 researchers
43 students
(75 reviewers)

2 technical managers

13 months duration

384383 craters to check and to categorize



→ **More than 4000 false detections have been found**

Perspectives

- Distribution of the reviewed database planned at the beginning of the summer just after the paper submission

- Several database will be available:
  - a global database with false detections
  - a global database without false detections
  - a database adapted to age-dating (without ghost and secondaries)

- Possibility to adapt the interface for many others projects (ISSI project, CTX mosaics ?)

- Using Cesium viewer:
  - increase the capabilities of a collaborative work
  - decreasing the working time
  - facilitate the trades between all collaborators
  - using of only one file extent

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