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Updated Ganymede Mosaic from Voyager, Galileo, and Juno observations

European Space Agency
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CHANGE LOG

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1. INTRODUCTION

1.1 Executive Summary

The JANUS instrument team at the German Aerospace Center (DLR) has created a new global mosaic of Jupiter's moon Ganymede from NASA Voyager and Galileo images with a uniform spatial resolution of 359 m/pxl. Another version of the global mosaic has been created which enlarges the used input data by the Perijove 34 images from NASA's Juno mission in addition to the Voyager and Galileo images.

1.2 Extended Introduction

In preparation of the ESA JUICE mission with the primary target Ganymede a new controlled version of the global Ganymede image mosaic was generated using a combination of Voyager 1 and 2 and Galileo SSI images. Baseline for this work was the new 3D control point network from Zubarev et al., 2016, which uses the best available images from both missions and led to new position and pointing of the images. In a second iteration step the JunoCam images of Ganymede have been integrated into the network.

1.3 Instrument/Dataset Introduction

DLR_Ganymede_Voyager-Galileo_V1.0

In 1979 Voyager 1 and 2 flew by Jupiter to acquire 490 Narrow Angle Camera (NAC) and Wide Angle Camera (WAC) images of Ganymede's surface with resolutions ranging from 470 m/pxl down to 20 km/pxl. The Galileo spacecraft, with its Solid State Imaging (SSI) camera onboard, entered orbit around Jupiter in 1995 and took 149 images (<20 km/pxl) of Ganymede during 15 flybys. To create the new mosaic 118 Voyager and 88 Galileo images have been used including the best resolved Galileo images (<500 m/pxl) from three close encounters.

DLR_Ganymede_Voyager-Galileo-Juno_V1.0

Almost at the end of Juno's prime mission, in June 2021, the visible imager JunoCam took 75 continuous images of Ganymede during Perijove 34 from an altitude up to 1046 km. The used images to improve the DLR_Ganymede_Voyager-Galileo_V1.0 mosaic are on the leading side of Ganymede and range from 880 to 3000 m/pxl.

1.4 Abbreviations and Acronyms

DLR - German Aerospace Center

ESA - European Space Agency

JANUS - Jovis, Amorum ac Natorum Undique Scrutator

JUICE - JUpiter ICy moons Explorer

NAC - Narrow Angle Camera

NASA - National Aeronautics and Space Administration

WAC - Wide Angle Camera

1.5 Reference and Applicable Documents

Archinal, B.A., A'Hearn, M.F., Bowell, E., Conrad, A., Consolmagno, G.J., Courtin, R., Fukushima, T., Hestroffer, D., Hilton, J.L., Krasinsky, G.A., Neumann, G., Oberst, J., Seidelmann, P.K., Stooke, P., Tholen, D.J., Thomas, P.C., Williams, I.P., 2011. Report of the IAU Working Group on Cartographic Coordinates and Rotational Elements: 2009, Celest. Mech. Dyn. Astr., Vol. 109, pp. 101-135, DOI: 10.1007/s10569-010-9320-4.

Kersten, E., Zubarev, A. E., Roatsch, Th., and Matz, K.-D., 2021. Controlled Global Ganymede Mosaic from Voyager and Galileo Images, Planetary and Space Sciences, Vol. 206, 105310, https://doi.org/10.1016/j.pss.2021.105310.

Kersten, E., Zubarev, A. E., Nadezhdina, I. E., Roatsch, T., Matz, K.-D., and Szczech, C. C., 2022. Updated Ganymede Mosaic from Juno Perijove 34 Images, Europlanet Science Congress 2022, Granada, Spain, 18–23 Sep 2022, EPSC2022-450, https://doi.org/10.5194/epsc2022-450.

Zubarev, A. E., Nadezhdina, I. E., Brusnikin, E. S., Karachevtseva, I. P., Oberst, J., 2016. A Technique for Processing of Planetary Images with Heterogeneous Characteristics for Estimating Geodetic Parameters of Celestial bodies with the Example of Ganymede, Solar System Research, Vol. 50, No. 5, pp. 352–360, DOI: 10.1134/S0038094616050087.

2. SCIENTIFIC OBJECTIVES

In order to help with detailed planning of the JUICE science mission the new global mosaics of Ganymede were created. Ganymede is the largest moon in the Solar System, with a thick crust of ice on top of a global water ocean. The second half of the JUICE mission in the Jovian system in the early 2030s, called the GCO5000 orbital tour, the spacecraft will be in orbit around Ganymede for nine months to pry deeper into its secrets. The onboard JANUS camera will acquire high-resolution images of Ganymede's surface from two different altitudes (5000 and 500 km) reaching spatial resolutions from 400 to 7 m.

2.1 Acknowledgements

The authors thank Alexander Stark and Jürgen Oberst from DLR for their support and helpful discussions.

Users are requested to acknowledge the dataset by mentioning it in any relevant figure captions and within the reference section of their publications by citing the paper:

Kersten, E., Zubarev, A. E., Roatsch, Th., and Matz, K.-D., 2021. Controlled Global Ganymede Mosaic from Voyager and Galileo Images, Planetary and Space Sciences, Vol. 206, 105310, https://doi.org/10.1016/j.pss.2021.105310.

3. DATA PRODUCT GENERATION

The selected images were reprocessed with the new pointing and orientation data and then reprojected into the final Cylindrical Equidistant projection, where the small crater Anat defines the longitude system at 232° East (https://planetarynames.wr.usgs.gov/Feature/251).

Reviewing the single images revealed different artefacts that had to be removed manually by either cutting them off, in particular at the edges, or interpolating values from surrounding pixels. After artefact correction, images with similar observation times and resolutions i.e., from the same flyby, were set together to regional mosaics, which helps during the last step, the brightness and contrast correction. The regional mosaics can be handled like a single image due to the coherent illumination of the images that comes from the same direction. Putting it all together, the regional mosaics and the remaining single images, required major adjustments at the transition zones, where dark shadowed areas are often followed by bright illuminated ones and low contrast regions from nadir incidence angles alternate with high contrast from low solar altitudes. Same brightness and contrast corrections have been applied later on the Juno images as well as the removal of smeared and lower resolved parts at the edges. The Juno regional mosaic is now visible as a top layer in the global mosaic to keep the full impression of this newly achieved data.
Following planetary mapping convention, the map resolution of the final global mosaics was set to 128 pxl/deg, as it is a power of two, and thus results in a map scale of 358.7742 m/pxl (46080 by 23040 pixels large) assuming that the radius of the reference sphere is 2631.2 km (Archinal et al., 2011). The final global mosaics were then reprojected into Polar Stereographic projection of both hemispheres (each 29335 by 29335 pixels large).

4. ARCHIVE FORMAT AND CONTENT

The mosaic files for DLR_Ganymede_Voyager-Galileo-Juno_V1.0, are archived in GeoTIFF format for all purposes requiring full resolution and georeferencing and in PNG format for preview as follows:

Region	Projection	Center/Dimension	Resolution	Format
Global	Cylindrical Equidstant	C: 0°/0°E D: 90°N-90°S/180-180°E	358.7742 m/pxl	GeoTIFF
Global	Cylindrical Equidstant	C: 0°/0°E D: 90°N-90°S/180-180°E	2 km/pxl	PNG
Global	Cylindrical Equidstant	C: 0°/180°E D: 90°N-90°S/0-360°E	358.7742 m/pxl	GeoTIFF
Global	Cylindrical Equidstant	C: 0°/180°E D: 90°N-90°S/0-360°E	2 km/pxl	PNG
North Hemisphere	Polar Stereographic	C: 90°N/0°E D: 0-90°N/0-360°E	358.7742 m/pxl	GeoTIFF
North Hemisphere	Polar Stereographic	C: 90°N/0°E D: 0-90°N/0-360°E	2 km/pxl	PNG
South Hemisphere	Polar Stereographic	C: 90°S/0°E D: 0-90°S/0-360°E	358.7742 m/pxl	GeoTIFF
South Hemisphere	Polar Stereographic	C: 90°S/0°E D: 0-90°S/0-360°E	2 km/pxl	PNG

5. KNOWN ISSUES

There are still artefacts caused by image interpolation and brightness adjustments and one linear shift along the 180° meridian that we could not explain or eliminate from the mosaic. It looks like a vertical shift but turned out to be more than a simple offset. But, since it does not significantly influence the shape, brightness, or position of the features in that area, the user might get along with it.

6. SOFTWARE

The GeoTIFF files are raster images with embedded georeferencing information and can be used with geospatial software like GDAL or in a geoinformation system such as ArcGIS or the open-source version QGIS. The packages rgdal and raster provide the ability to handle such files in the R programming language. The PNG files are regular raster files that can be opened with any raster data program or viewer.