

# IAU Working Group - Cartographic Coordinates and Rotational Elements

Brent Archinal - Chair

## Annual Report 2016

Following is a summary of the activities of the IAU Working Group on Cartographic Coordinates and Rotational Elements for 2016.

- The main activity and product of the WG is the production of a report, produced roughly in conjunction with each IAU General Assembly, making recommendations regarding the creation and maintenance of cartographic planetary coordinate systems. This is an effort the WG began upon its creation in 1976. Our “2015” report has been delayed further than we would like, but we are closing in on an expected publication in the spring of 2017. Significant changes from our last report planned so far include:

- A procedure is described for submitting questions about the recommendations given or the application of the recommendations for creating a new or updated coordinate system for a given body.

Regarding body orientation, the Mercury orientation model has been updated based on MESSENGER results, approximate expressions for the Earth have been removed in order to avoid confusion; the Mars orientation model will be improved using new modeling; the expression for the rotation of Neptune has been updated; the previously on-line only recommended orientation model for (4) Vesta is repeated and an explanation of how it was updated given; an orientation model is given for (52) Europa, the orientation model for (2867) Šteins has been improved; and corrections have been made for the rotation model for Pluto and its satellite Charon, and the orientation model has been corrected for (243) Ida. Information has been added on the rotational states of Comets 9P/Tempel 1, 19P/Borrelly, 67P/Churyumov-Gerasimenko, and 103P/Hartley 2, noting that such information is valid only between specific epochs. The difficulty of mapping 67P/Churyumov-Gerasimenko is discussed. Regarding body shape, text has been included to explain the expected uses of such information, and the relevance of the cited uncertainty information.

The radius of the Sun has been updated and notation added that the size and the ellipsoidal axes for the Earth and Jupiter have been recommended by an IAU Resolution. The distinction of a reference radius for a body (here, the Moon and Titan) is made between cartographic uses, and for ortho-projection and geophysical uses. The recommended radius for Mercury has been updated based on MESSENGER results. The recommended such radius for Titan is returned to its previous value. Size information has been given for (16) Psyche and (52) Europa. The size of (25143) Itokawa has been corrected. In addition, the discussion of terminology for the poles (hemispheres) of small bodies has been modified and a discussion on cardinal directions added.

- The current citation for this publication is: B. A. Archinal, C. H. Acton, M. F. A’Hearn, A. Conrad, G. J. Consolmagno, T. Duxbury, D. Hestroffer, J. L. Hilton, L. Jorda, R. Kirk, S. A. Klioner, D. McCarthy, K. Meech, J. Oberst, J. Ping, P. K. Seidelmann, D. J. Tholen, P. C. Thomas, I.P. Williams (2017). “Report of the IAU Working Group on Cartographic Coordinates and

Rotational Elements: 2015,” in preparation, to be submitted to Celestial Mechanics and Dynamical Astronomy.

- The WGCCRE continues to maintain its website at <http://astrogeology.usgs.gov/groups/IAU-WGCCRE>. Given there is a brief history of the WG and links to all our (major) reports, from 1979 to 2011, and a special statement on the recommended coordinate system for Vesta (2013).
- The WG currently consists of 19 members, from 6 countries, with membership lengths from 4 to 40 years. Brent Archinal (U. S. Geological Survey) serves as the current chairman, and Al Conrad (Large Binocular Telescope Observatory) serves as the acting Vice-Chairman.
- The WG chair and some of the WG members spend significant time answering questions from NASA, missions, mission instrument teams, individual researchers, and the public, on various issues related to planetary coordinate systems. There are ongoing regular questions about the coordinate systems for the Moon and Mars, and regular questions from the various components of the NASA Planetary Data System. Some of our members have also provided information to the various archiving organizations such as ESA’s Planetary Science Archive, to JAXA’s and IKI’s archiving arms, as well as to the International Planetary Data Alliance.
- The WG, in response to queries from the Division A and F Presidents, in 2016 developed a policy for soliciting new members and having an open membership. The WG agreed to make it clear that it was open to anyone applying for membership, and that we would fairly regularly (e.g. yearly at least) make a significant effort to make announcements that new members would be welcome to apply. That would likely be done via announcements in appropriate newsletters, mass e-mail to Division members, and via presentations at meetings (more below). It could also be done by regularly directly contacting experts in the field and any others who would likely be interested and could help. We also plan to ask applicants and periodically current members what expertise they feel they are bringing to the WG and how they plan to contribute to our main report. Only in highly unusual cases and with the approval of the Division A and F Presidents as well would an applicant be turned down. Announcements to solicit new members are planned for mid-2017.
  - The WG also agreed to continue to its various efforts to make its efforts known by various publications and community presentations. Specifically:
  - We will continue to publish our “main” WG report, to be published approximately triennially, following each IAU General Assembly.
  - If requested/desired from the Divisions or editors, a triennial report on WG operations could be made available for publication in the IAU Transactions.
  - The WG will also make a brief annual report (i.e. this document) to Divisions F and A on the WG’s activities. We are also willing to continue to make oral reports at the General Assembly Division meetings.
  - We will provide occasional reports, on items of interest (e.g. a new main WG report), for submittal to the IAU News.
  - To make our work better known, we will continue to submit abstracts and presentations to various planetary science meetings, describing the activities of the WG and our reports. These would include occasional presentations at the Lunar and Planetary Science Conference and the Planetary Data Workshop (2017 June), and possibly other meetings such as NASA Analysis Group meetings (<http://www.lpi.usra.edu/analysis/>), the AAS Division of Planetary Sciences meeting, COSPAR (2018 July), etc. Publications from 2016 along these lines are listed following:

## **WG Publications, 2016**

- M. F. A'Hearn (2016). "Small Solar System Bodies: Products and Standards," Proceedings of the 47th Lunar and Planetary Science Conference, 2016 March 21-25, The Woodlands, Texas, abstract no. 2739. Available as <http://www.hou.usra.edu/meetings/lpsc2016/pdf/2739.pdf>. Presentation available as <http://www.lpi.usra.edu/mapsit/meetings/lpsc-2016/AHearn.pdf>.
- (Aside from the above paper, other papers from the LPSC session "Planetary Spatial Infrastructure: At the Intersection Of GIScience and Planetary Science", may also be of interest. These are not really papers from the WG, but this session was partially organized and supported by WG members (A'Hearn, Archinal, and Kirk). See <http://www.lpi.usra.edu/mapsit/meetings/archive/> for access to abstracts and presentations.)
- B. A. Archinal and the IAU Working Group on Cartographic Coordinates and Rotational Elements (2016). "Update on the IAU Working Group on Cartographic Coordinates and Rotational Elements and its Upcoming 2015 Report," Proceedings of the 47th Lunar and Planetary Science Conference, 2016 March 21-25, The Woodlands, Texas, abstract no. 2963. Available as <http://www.hou.usra.edu/meetings/lpsc2016/pdf/2963.pdf>.
- Catherine Hohenkerk, Brent Archinal, and Brian Luzum (2016). "IAU Division A— Fundamental Standards," Workshop on "Understanding the Earth core and nutation", Royal Observatory of Belgium, September 19-21. Abstract. To be available(?) on-line at <https://register-as.oma.be/rotanutWS/>.