Report from the Working Group on Cartographic Coordinates and Rotational Elements

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IAU Division A Fundamental Astronomy
Division Days
Outline

• Introduction to the WGCCRE
• Recent activities
• Seeking input on evolution of standards and the WGCCRE
• Examples, feedback needed
• Long term planning
• Summary – Discussion desired
IAU Working Group on Cartographic Coordinates and Rotational Elements

- Promotes the use of a standardized set of mapping parameters
- Makes recommendations, open to further modification when needed, intended to facilitate the use and comparison of multiple datasets!
- Issues reports with recommendations about coordinate systems and related parameters for making cartographic products of the Solar System bodies
- Starting in 1979 (Davies et al., 1980), reports every ~three years
  - Associated with IAU General Assemblies
- Current 2015 report published 2018 (Archinal et al.); correction published 2019

Current WGCCRE “2015” Report, published 2018
**CDMA, 130:22**

Current WGCCRE web site
http://astrogeology.usgs.gov/groups/IAU-WGCCRE
WGCCRE Operation

- Membership by invitation or volunteering
- Currently 16 members from 5 countries, from 4 to 46 years of membership!
- Considers new published coordinate system related determinations
- Recommends standards based on consensus
- No independent resources of its own
- Does not “bless” or “enforce” recommendations – their value is validity and consistency as a reflection of general consensus and use
- Recommendations are primarily for mapping, but other uses are quite common (e.g., dynamical systems, navigation)
- Does not deal with formats, “lower level” mapping standards

Current WGCCRE Membership

B.A. ARCHINAL (Chair)
U.S. Geological Survey, Flagstaff, AZ, U.S.A.

C.H. ACTON
Jet Propulsion Laboratory, Pasadena, CA, U.S.A.

A. CONRAD (Vice Chair)
Large Binocular Telescope Observatory, Tucson, AZ, U.S.A.

T. DUXBURY
George Mason University, Fairfax, VA, U.S.A.

D. HESTROFFER
IMCCE, Observatoire de Paris, CNRS, Paris, France

J.L. HILTON
U.S. Naval Observatory, Washington D.C., U.S.A.

L. JORDA
Laboratoire d’Astrophysique de Marseille, Marseille, France

R. Kirk
U.S. Geological Survey, Flagstaff, AZ, U.S.A.

S.A. KLIONER
Technische Universität Dresden, Lohrmann Observatory, Dresden, Germany

J.-L. MARGOT
University of California, Los Angeles, CA, U.S.A.

J. OBERST
DLR Berlin Adlershof, Berlin, Germany

F. PAGANELLI
National Radio Astronomy Observatory, Charlottesville, VA, U.S.A.

J. PING
National Astronomical Observatories of CAS, Beijing, China

P.K. SEIDELMANN
University of Virginia, Charlottesville, VA, U.S.A.

D.J. THOLEN
University of Hawaii, Honolulu, HI, U.S.A.

I.P. WILLIAMS
Queen Mary, University of London, London, U.K.
**WGCCRE – Recent Activities**

- Substantial activity 2020-2021, meeting presentations asking for input to WG
- More below, but mainly requesting input on WG recommendations, how the WG makes recommendations, and the future of the WG
- Abstracts/presentations at:
  - ISPRS, 2020
  - IUGG/IAG, 2019
  - LPSC, 2019 & 2020
  - NASA MAPSIT, 2020
  - Planetary Data Workshop, 2019 & 2021
  - International Cartographic Conference, 2021
  - Planetary Science Informatics and Data Analytics, 2022
- 2020 White paper to NASA Decadal Survey
- Not particularly successful at getting much input, partially due to nature of virtual meetings – may try community survey route
- Continuing with Annual and Triennial reports to Divisions A and F
- Always seeking new members for WG
- Some recent volunteers
- Currently completing a “new members’ packet; then inviting new members to join
  - *Further volunteers always welcome!*

- Next main WG report
  - Delayed, due to...
  - Pandemic
  - Effort to make presentations and collect input
  - Chair (Archinal) workload
  - Hope to get on track and complete version this year
  - Publication by early next year?
  - Some details on possible contents follow
Seeking Input on the Evolution of the WGCCRE

- After 46 years of operation, the WGCCRE is considering what changes may be needed.
- Considering issues and accumulated experience over years of operation.
- Many other groups do related work:
  - E.g., international, national, space agencies, international organizations.
  - What type of coordination is needed?
- In 2020, submitted a white paper for NASA Planetary Science and Astrobiology Decadal Survey 2023-2032 about coordinate system recommendations and evolution of the WGCCRE.

### International Astronomical Union
- Working Group on Cartographic Coordinates and Rotational Elements
- Division F Planetary Systems and Astrobiology
- Division A Fundamental Astronomy
- IAU Commission A3 on Fundamental Standards
- IAU Working Group on Planetary System Nomenclature (WGPSN)

### Other International Groups
- International Association of Geodesy (IAG)
- ISPRS ICWG Commission III/II Planetary Remote Sensing and Mapping WG
- International Cartographic Association Commission on Planetary Cartography
- International Planetary Data Alliance (IPDA)
- Regional and National Space Agencies Committee on Space Research (COSPAR)

### NASA groups
- Mapping And Planetary Spatial Infrastructure Team (MAPSIT)
- Other analysis and assessment groups
- Planetary Data System (PDS)
Examples: Possible changes for next main report

Next report:

- Improve lunar coordinate frame?
- Mars: Possibly remove artificial ~100 m offset between previous and current longitude systems
- Updates from missions: Mercury, Saturnian satellites, Pluto and satellites, Vesta, Ceres, Ryugu, Bennu, Comet Churyumov–Gerasimenko
- Updates from terrestrial observations of asteroids
- Continue to assist on coordinate system and mapping issues
- Aiming for late 2022 - early 2023 publication
Past problems and issues – What changes could be made?

- For many bodies, particularly the Moon and Mars, most datasets have never been well registered to each other, making data comparison and fusion difficult and lowering the value of such datasets.
- The NASA/DLR/ASI Dawn mission initially did not update and register its data to the existing coordinate system for Vesta, resulting in great (and continued) confusion as to which system the data are in.
- Planetographic coordinates have been used for mapping most planetary bodies in the past. What are the advantages and disadvantages, if any, in switching to planetocentric coordinates as some missions have proposed?
- Some open coordinate systems issues for specific bodies remain unresolved, e.g., Moon, Mars, Jupiter, Saturn

Coordinates for planets and their satellites; planetographic or planetocentric; should existing system usage be preferred?

These issues have caused problems for space agencies, missions, instrument teams, and the planetary community in general – including you!
Specific Recommendations – Feedback Welcome

- Additional personnel and funding may be needed for the WGCCRE or some new group(s) as increasing workload (e.g., Mars, lunar systems update; studying proposed changes from planetographic coordinates) is not being addressed.

- Missions and instrument teams should follow best practices for cartographic and rotational standards or work to update them if needed.

- The previous Mars and Lunar Geodesy and Cartography and other “body focused” WGs or something like them need to be reactivated with appropriate resources.

- Appropriate planetary spatial data infrastructure (PSDI) with international scope needs to be developed body-by-body or as a single infrastructure for the whole Solar System.
What options are there for the long(er) term future of the mapping recommendations process?

- Continue the WGCCRE in expanded form, with additional resources
- Supplement the WGCCRE with support of other GCWGs and other groups noted previously
- Consider new organizational structures, such as used by the International Earth Rotation and Reference Systems (IERS)
  - Operational components for cartography & standards
  - Oversight handled by replacing the WGCCRE with an oversight board
  - Could employ dedicated staff at various institutions, possibly supported by various space agencies
  - Amount of work by IERS may be greater, but work of the WGCCRE may be at least as complex => Handling 1 vs. 97 bodies!

An example: the IERS
- Serves the terrestrial and astronomical communities
- Includes a Directing Board that oversees policy and operation and the development of standards, and operational components that perform the routine work of the organization
- Maintains coordinate systems for the Earth and inertial space and the connection between the two (Earth rotation)
For additional details, see:

- Abstract for this presentation
- Annual and Triennial Activities report to IAU
- The most recent WGCCRE report, Section 9
  - Available from http://astrogeology.usgs.gov/groups/IAU-WGCCRE

Questions and discussion welcome
Input on recommendations?
Input on future of WGCCRE?
Comments? Interest in membership?
E-mail Brent Archinal (barchinal@usgs.gov)
http://astrogeology.usgs.gov/groups/IAU-WGCCRE