AT THE INTERSECTION OF GISCIENCE AND PLANETARY SCIENCE . J.R.Laura[1], [1]Astrogeology Science Center, U.S. Geological Survey, Flagstaff, Arizona 86001 USA (jlaura@usgs.gov).

Introduction: Across the planetary science community, we see increasing utilization of spatially enabled data and Geographic Information Systems (GISy). This shift suggests that collaboration with the broader Geographic Information Science (GISc) community could be exceptionally beneficial in driving forward multiple research agendas. To that end, this abstracts argues three points. First, we must adopt the broader geospatial vocabulary so that cross-discipline collaboration is both feasible and more efficient. This includes a reassessment of the term cartography (as discussed in [1,2]). Second, the work done by the GISc community in developing a unified Body of Knowledge [3, 4] should be explored and leveraged where possible. Third, in an era of big data, big process, and distributed research teams, cyberinfrastructure techniques developed for terrestrial application must be leveraged.

On Cartography: As a community, we broadly apply the "cartography" label to many data collection, storage, and analysis tasks. This, unfortunately, can cause confusion when interfacing with the public and larger scientific community who define cartography as "the discipline dealing with the conception, production, dissemination, and study of maps in all forms" [1]. The broader use of the word cartography is historically correct. Goodrick [2], writing in 1982, defines cartography as the end to end process encompassing by which a map is created. This includes data collection, data stewardship and manipulation, decisions of map representation (e.g., symbology), and map creation. This broad concept of cartography continues to be at the heart of the phrase as *planetary cartography* [5].

However, between 1982 and the present, we can chart significant technological changes with the wide spread utilization of computers and accompanying GISy, the emergence of GISc within the academic academy, and the rise of digitial, interaction data representation (i.e., geovisualizations). A product of this technological upheaval is the redefinition of cartography across academic, private-sector, and government entities. One can look to the National Geospatial Intelligence Agency for a modern definition of cartography which is the "application of mathematical, statistical, and graphical techniques to the science of mapping"[6,7]. While it still encompasses more than just maps, it It is clear that the definition of cartography has narrowed significantly over the past three decades with the introduction of entirely new domains that have arisen to deal with digital spatial data.

We wish to close this section by noting that replacement of cartography with "map" or "mapping" is not a suitable semantic correction as mapping is strictly defined as 'the mental interpretation of the world' [8]. While this terminology may seem like unnecessary semantics, we argue that commonality in vocabulary across scientific domains is an essential precursor to efficient collaboration. By using the term "cartography" to explain many of our endeavours, we consistently miscommunicate what functions are performed. We are domain area experts that leverage spatial data, GISy, and principles of GISc.

Geovisualization: In many ways, geovisualizations have supplanted the printed map as data interaction and exploratory spatial analysis tools can be more effective knowledge transfer tools. Geovisualization, as a field, sits at the intersection of cartography, graphical statistics, information science, and human-computer interaction. [9] offers a holistic perspective, suggesting that geovisualization is an essential component of not only the presentation of research results, but also an essential tool in data exploration, hypothesis formulation, knowledge synthesis and analysis, and finally evaluation. Within the GISc domain we see increasingly complex visualizations that support spatio-temporal data exploration, linked data views with traditional statistical visualizations coupled with geospatial representations, and increased interest in the effectiveness of information transfer in a visual form. The planetary science community can draw heavily on geovisualization research to support next generation Exploratory Spatial Data Analysis (ESDA) tools and services.

Geographic Information Science: Many planetary scientists are familiar with Geographic Information Systems, a digital solution that allows storage, manipulation, interaction, and visualization of spatially enabled data. [10] defines GIScience as a field focusing on the technological improvement of GISystems and the furthering of scientific discovery through the advancement of geographic information principals. It is from the domain of GISc that we, as a community can draw experience in dealing with spatially enabled data. This expertise spans the entire process from acquisition through the creation and dissemination of cartographic products.

The GISc community has developed a Geographic Information Science and Technology (GIS&T) Body of Knowledge (BoK) through extensive community-wide input with the goal of codifing the sub-domains which drive GISc research, usages, and educational efforts [3, 4]. The GISc BoK identifies ten knowledge areas, of which nine are directly mappable to the planetary science domain. These are (1) Conceptual Foundations that focus on the fundamental geospatial knowledge and techniques that support more complex tasks, (2) Analytical Methods such as the application of spatial statistics for crater counting or traditional GIS operations (e.g., overlay, buffer) for site selection, (3) Cartography and Visualization which could describe some of the geologic mapping tasks we undertake with respect to principals of map design, map production and evaluation, or input data considerations, (4) Design Aspects which look both at project management tasks and more information technology related tasks such as database design, for example the design of a spectral library, (5) Data Modeling that looks at the both data representation, for example decisions on geometries for feature representations (e.g., craters as points or polygons), (6) Data Manipulation such as , (7) Geocomputation, such as the application of thrust fault models or the heuristic search algorithms to model Gamma Ray-Neutron spectroscopy data, (8) Geospatial data that includes the essential planetary geodesy concerns, issues of data quality, image manipulation and photogrammetric control, mission planning with respect to data capture, and essential metadata and standards development, and (9) Organizational and Institutional Aspects, which focus on workforce development and infrastructural management.

Much of the "cartographic" work that is being performed across the planetary science community, maps to the above knowledge domains. This spans specializations, from atmospheric modeler to geologic mappers, mission designers to missions operations, software developers to PDS data archivists. The GIS&T BoK makes explicit reference to allied BoK, providing a path for us to leverage the work done by the GISc community.

CyberGIS: With the publication of the Atkins report [11], the National Science Foundation called for an integrated Cyberinfrastructure (CI) to support cross-domain, cross institution collaboration to drive the deployment, development, and utilization of High Performance Computing (HPC) resources. This report is a direct result of rapidly increasing data sizes and increasingly complex process models. [12] describes Geospatial Cyberinfrastructure (CyberGIS) as a unique incarnation of CI that leverages the unique properties of geospatial data to support utilization in CI environments. Within the context of planetary science a number of applications already benefit from the utilization of CI and CyberGIS. Within our own organization these include large scale, pixel level application of thermal inertia models and the generation of global control networks. As data sizes continue to grow and the analytical tasks become increasingly more expensive, we see continued utilization of HPC resources and CyberGIS.

Conclusion: [13], then director of the National Science Foundation, suggests that GISc, as an extension of geography, sits at the junction between many different scientific endeavors and that spatially enabled information can be a keystone to facilitating cross domain collaboration. We see great potential to leverage and contribute to the methods developed within the GISc community. These include the ability to better handle and process large data sets, deal with high velocity data ingestion, apply robust terrestrially tested methods to support complex analytical and modeling applications, and create high quality, derived, cartographic data products with high usability across the community. As the planetary science community, we bring experience working with "fuzzy" data with potentially unknown error characteristics, and expertise leveraging both current and legacy data to support answering complex scientific questions. An exploration of the GIS&T BoK clearly highlights the significant overlap and we suggest that this overlap should not be surprising as many of scientific disciplines find high similarity. Having said that, I caution against the redefinition of a well established concept, as proposed by [5], with more than thirty years of ontological and epistemological development. A key component of any collaboration is the development of a shared vocabulary.

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