Introduction: Constant-scale natural boundary mapping [CSNB] transforms the surface of any essentially globular object—spherical, triaxial, or irregular—to the 2-dimensional plane in a manner which, unlike conventional projections, preserves proportion and adjacency of natural districts composing the object’s surface [1]. Because CSNB uses natural features to define the map edge, the map may—also unlike conventional projections—be organized to depict global-scale phenomena rationally and in tune with common sense, e.g., if a global ridge system is used as the map edge, then all gravity-induced flow will be inward on the map and, conversely, if a global valley system is used as map edge, then all gravity-induced flow will be outward on the map [2].

Cometary nuclei have far more transient morphologies than asteroids. Ongoing morphological change of the comet nucleus, which may have begun as a contact binary [3], results from differential loss of gas and solid material due to solar-induced heating, varying as a function of solar distance and seasonal exposure [4]. For Churyumov-Gerasimenko, the southern hemisphere ‘summer’ occurs at perihelion, whereas the northern hemisphere summer occurs at aphelion.

CSNB mapping uniquely captures and reveals the nature and extent of material loss relative to the most prominent ridges and, conversely, captures and reveals the nature and extent of material gain relative to the most prominent valleys. In this case, a major division occurs between surfaces as a function of solar irradiance: northern and southern hemispheres.

Here we apply CSNB to create a complementary pair of maps well suited to depict and study material transport on 67P/C-G, on which the southern hemisphere sheds material to the northern hemisphere [5].

Background: In 2016 we mapped 67P in CSNB with a ridge-hugging edge selection [6]. The map folded to a volume within which the comet’s shape fit nicely, indicating that regional shape distortion on the map was minimal, at least when compared to global maps of 67P made with conventional projections (see Fig. 1).

But the hemispherically dichotic morphology—south-to-north material transport—is not well represented by our ridge-hugging edge selection (see Fig. 2). We instead need a map where the receiving hemisphere is centrally positioned, surrounded by relevant regions constituting the other hemisphere, i.e., the north surrounded by the south. And, in order to study details of material loss in the southern hemisphere, we need a complementary map: the south surrounded by the north. (Note that CSNB methodology allows a projection to be defined and created solely by critical metrics and disposition of phenomena one wishes to explore. Further, transient morphology generates dynamic CSNB maps, because the edge can change in response to changing conditions.)

Figure 1: simple cylindrical map of 67P/C-G showing geomorphological districts.

Figure 2: CSNB map of 67P/C-G showing districts at nearly accurate relative size and shape. Some districts are interrupted where they transgress an edge-ridge.

In 2017 we created sketch-maps in CSNB using southern hemisphere primary ridges as the edge for one map (see Fig. 3), and northern hemisphere primary valleys as the edge for the complementary map (see Fig. 4). For 2018 we present hard-line, drafted maps based on the 2017 sketches.
perspectives and used by Mercator to prepare his map of 1569 [7] (see Fig. 5).

The CSNB method is amenable to digital coding within current software capabilities [8]. However, CSNB differs so substantially from current digital transmutations of analytic projection geometry that it could disrupt the incremental evolution of projection systems characterizing the field since Mercator’s era. But Mercator’s codifying progeny neither foresaw the need to map the surfaces of irregular objects, nor is their mature product suitable for comprehensive contemplation of global-scale phenomena, events, and issues.

Impact of digital CSNB on data storage and mission communications is uncertain but, due to the system’s underlying simplicity—each map reduces to a topological “tree”—possibly positive; Impact of digital CSNB on cross-platform compatibility is uncertain but possibly negative.

We actively seek partners to digitize CSNB.