Ceres Coordinate System Description
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The Ceres coordinate system has been updated from the values published by Archinal et al. (2011) using data obtained by the Dawn mission. As a part of the Ceres gravity science investigation, the Ceres body-pole direction and rotation rate were determined together with its gravity field by processing the DSN radio data (8.4 GHz X-band) and optical imagery (IFOV of 93.3 μrad/pixel). At this time, the final parameters have been determined using the full Dawn data set, including the High- and Low-Altitude Mapping Orbit (HAMO, LAMO) data. The final parameters agree well with the interim post-Survey update, published in the previous description of the Cerean coordinate system (Oct 2015). The gravity field is modeled by Park et al. (2016) in a Ceres-fixed frame, and its inertial orientation in the International Celestial Reference Frame (ICRF; Archinal et al., 2011) is modeled with $\{\alpha, \delta, W_0 + \Omega\Delta t\}$, where α represents the spin pole right ascension, δ represents the spin pole declination, W_0 represents the prime meridian angle (fixed to 170.65°), Ω represents the rotation rate, and Δt represents the time elapsed since J2000 = JD 2451545.0, i.e. 2000 January 1 12 hours TDB. Since the gravity field of Ceres perturbs Dawn's orbit, both gravity field and rotational parameters can be estimated by accurately tracking the spacecraft motion. The pole parameters are also estimated while solving for the topography within the stereophotogrammetry processing pipeline, with a map resolution of 0.41015 km/pixel or 20 pxl/deg (Preusker et al., 2016). These independent analyses produce rotation parameters that agree within measurement errors. The final pole parameters and body axes derived from Dawn data are given in Table 1, along with the previous IAU system. In the previous post-Survey update, the rotation rate was left unchanged as that value was consistent with the short-arc of Dawn measurements. Table 1 reports the equivalent spherical body radius, **R,** the average equatorial radius of the oblate spheroidal shape, **A**, and the polar radius **B**. The Dawn project's configuration-controlled Planetary Constants and Models Document (JPL D-41251) archives the updates to the PCK.

Table 1. Comparison of pre-Dawn and post-Dawn coordinate systems.

	α [deg]	δ [deg]	W_0 [deg]	Ω [deg/day]	R [km]	A [km]	B [km]
Previous system [1]	291 ± 5	59 ± 5	170.90	952.1532± 0.00003	476.2 ± 1.7	487.3 ± 1.8	454.7 ± 1.6
Dawn post-Survey Update (*dawn_ceres_v05.tpc*)	291.418 ± 0.03	66.764 ± 0.03	170.650	952.1532 ± 0.00003[2]	470	482	446
Dawn Final (*dawn_ceres_v06.tpc*)	291.42763 ± 0.0002	66.76033 ± 0.0002	170.309 ± 0.011	952.1532635 ± 0.000002	469.73 ± 0.15	482.10 ± 0.15	445.94 ± 0.15

[1]Archinal et al. (2011), [2]Unchanged from previous system.

The previous coordinate system was anchored to a bright feature in the Hubble Space Telescope (HST) data (Thomas et al., 2005) that was dubbed "Feature #1" in Li et al. (2006). Feature #1 is centered at 1ºE, 12ºN in their map (Fig. 5 of Li et al., 2006) and is well-expressed in the F330W and F220W filters and much smaller and muted in the F555W filter. A bright crater of ~32 km diameter named Haulani is observed in the region of Feature #1, surrounded by a generally brighter ejecta deposit that together define a higher albedo region. The Dawn team was not able to confidently or exactly identify the location of Haulani with respect to Feature #1. Thus, the Dawn team has chosen a small crater (~0.8 km diameter) nearby Haulani to define the prime meridian. The location of this small crater is within the envelope of the broad feature identified in HST data to which the previous system was anchored. This small crater named 'Kait' defines the 0° longitude position. The location of Kait is illustrated in Fig. 1. One of the Survey images was used to display the crater Kait (white arrows), which serves as the reference crater for the definition of zero-longitude for Ceres' body fixed-frame, which is described in detail in Preusker et al. (2016). After the original article (Roatsch et al., 2016) was published, HAMO and LAMO images became available and the authors recognized that, because of the low Survey image resolution, the upper right insert of Fig. 1 is not precise enough and somewhat misleading. An updated figure (Fig. 2) shows Kait's precise location in both a HAMO and a LAMO image. The correctness of already published Dawn results (e.g. image mosaics, atlases, etc.), as well as of archived products at the Planetary Data System Small Bodies Node is not affected by this update.

The pole in the updated coordinate system moved away from the previous estimate reported in Thomas et al (2005) by more than the (one-sigma) error of "~5 degrees" and the shape of the body is also smaller by an amount that exceeded the previous estimate's error of ±1.7 km. The pole RA and dec have changed such that the previously-defined IAU pole moves on the surface of Ceres along the latitude of 82.231 degrees as Ceres rotates.
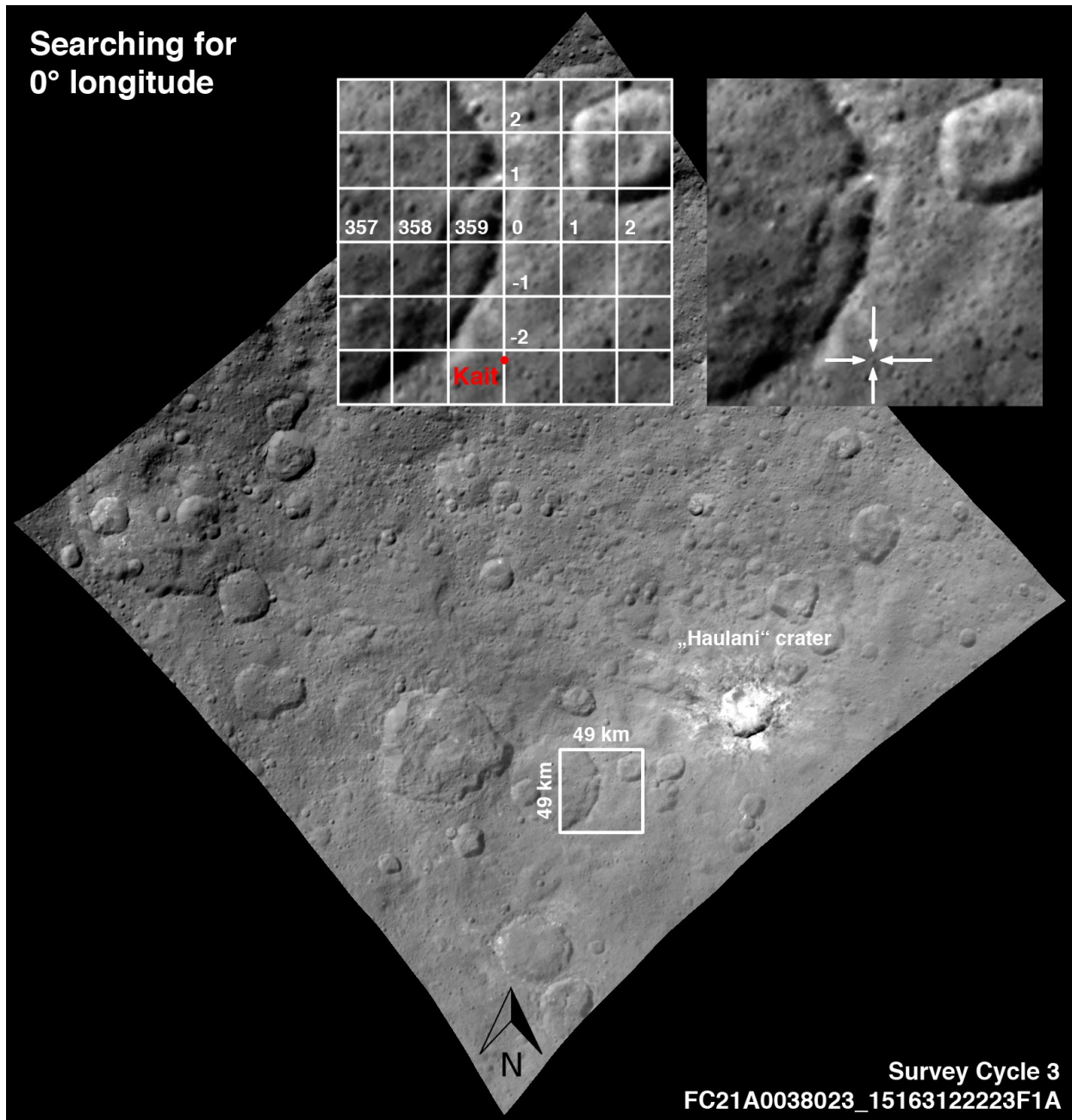
Figure 1. The tiny Kait crater defines the 0° longitude position in the updated coordinate system described in Roatsch et al. (2016). Kait can be located within the inset region (shown by white box) of this camera image. The inset region image at top right points out the tiny crater Kait. The inset at the top middle position shows Kait's location exact location of 0° lon, -2.1° lat on a plot gridded in one-degree increments. Kait anchors the prime meridian. A small adjustment was made to W_0 in the final update to maintain the system, as the rotation rate (Ω) changed to a more precise value.
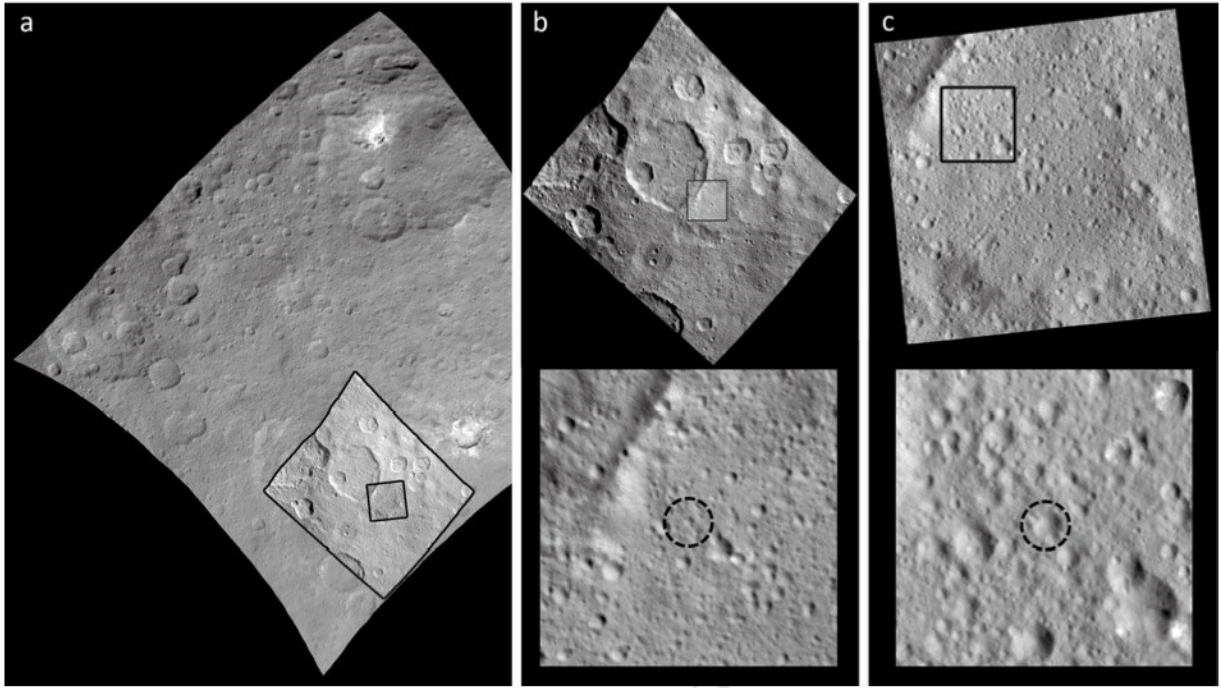
Fig. 2: Crater Kait in (a) Survey image FC21A0038023, (b) HAMO image FC21A0042363, and (c) LAMO image FC21A0054621. Crater Kait can now clearly be identified in the center of the black dotted circles. From Roatsch et al. (2017).

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