

Mercury Reference Frame and Topographic Base Map

from combined

MESSENGER Stereo Photogrammetry and Laser Altimetry

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M. E. Perry, G. A. Neumann, M. T. Zuber, D. E. Smith, S. C. Solomon.

Knowledge for Tomorrow



Co-registration

Idea:

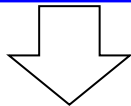
Mercury Laser Altimeter (**MLA**) profiles and stereo digital terrain models (DTMs) from Mercury Dual Imaging System (**MDIS**) form complementary topographic data sets

Co-registration of a **time-dependent** and **spatially distributed** network of MLA profiles to a **static** and **rigid** stereo DTM.

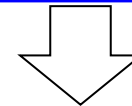
à minimization of height differences in a least-squares sense

à simultaneous inversion for adjustment parameters of the DTM (static) and rotational parameters of Mercury (dynamical)

à **more details in (Stark et al., 2015, PSS, in press)**



Reference Frame
(rotational parameters)

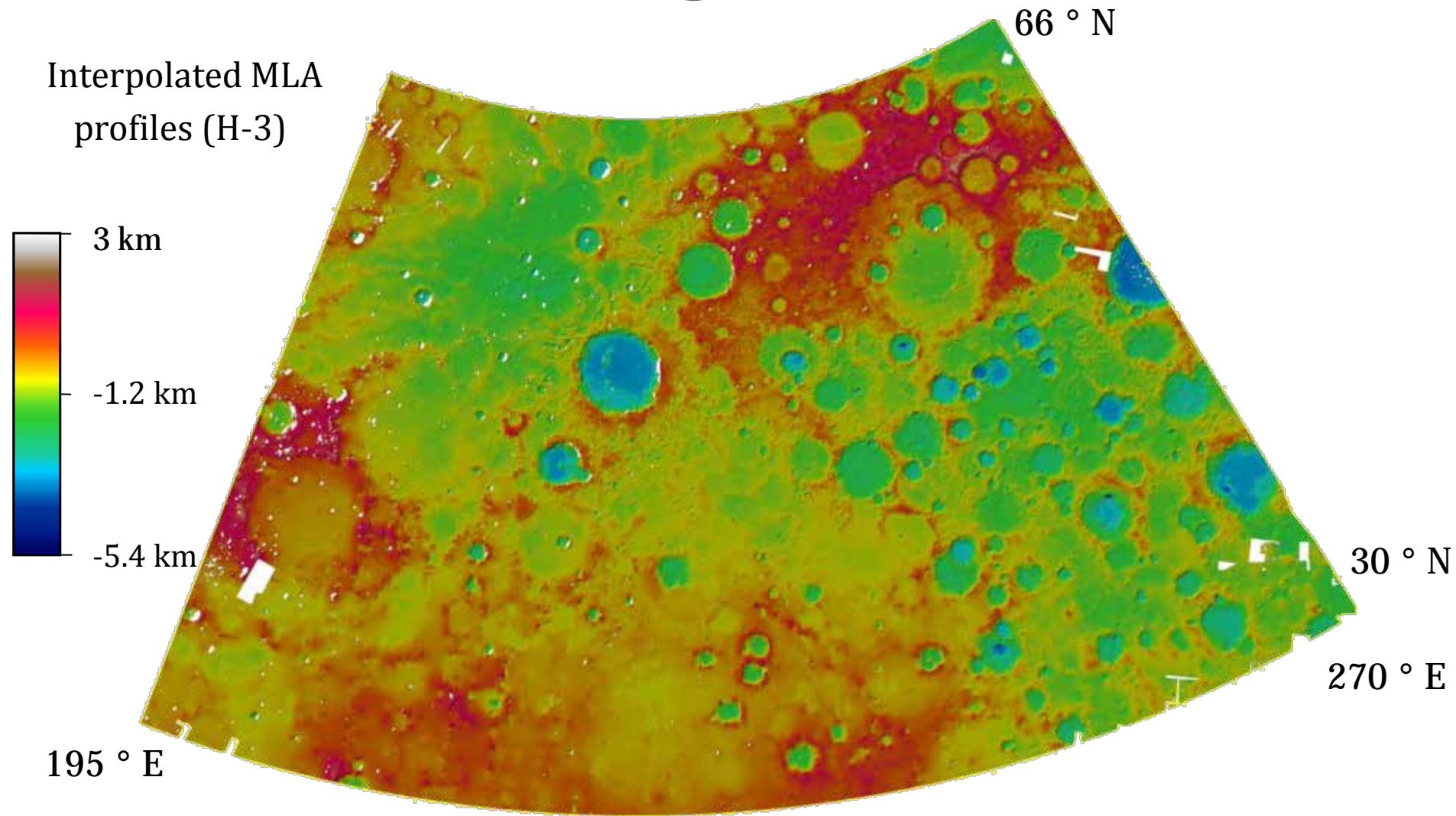


Topographic Basemaps
(co-registered DTMs)



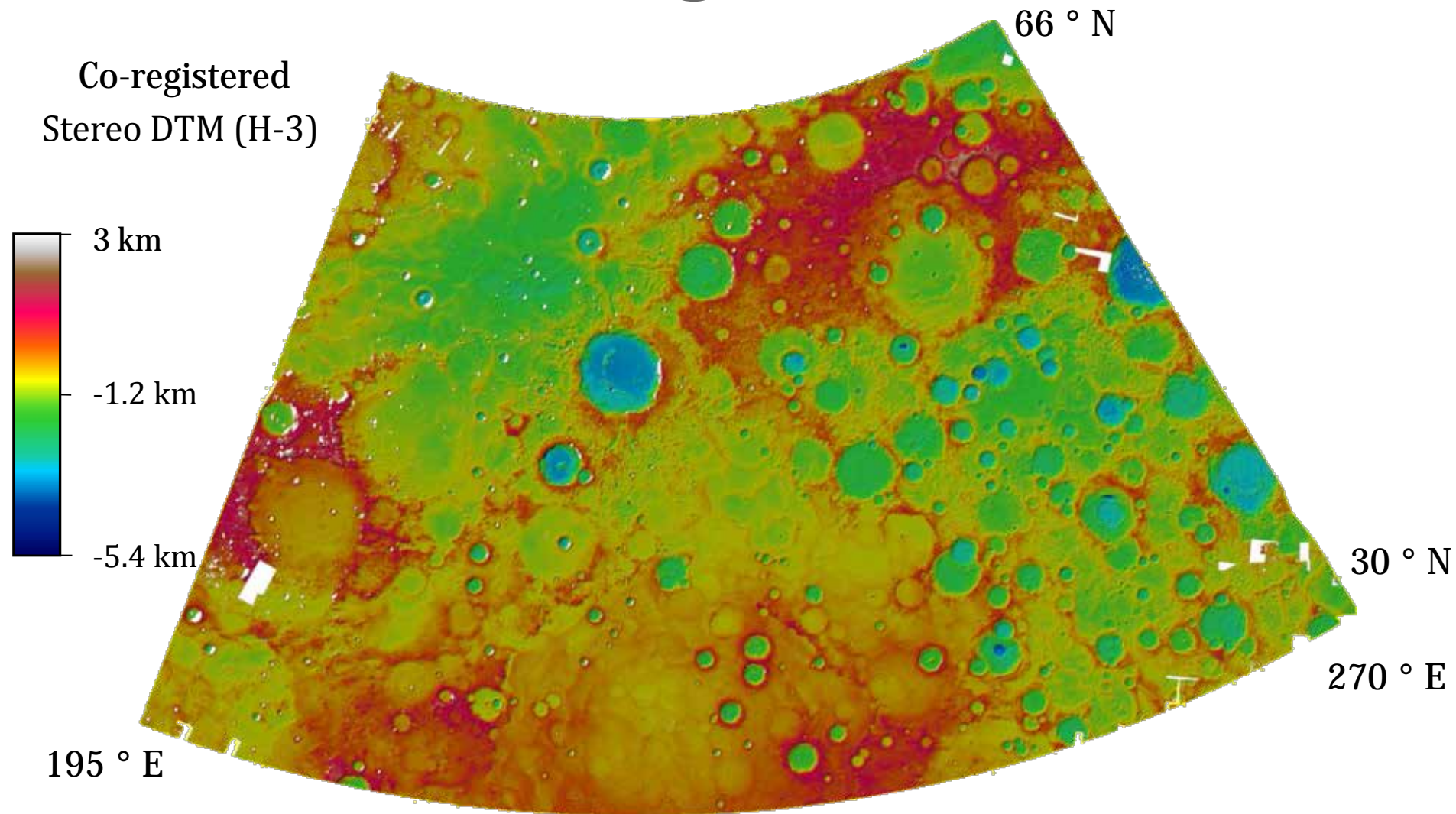
Co-registration

Interpolated MLA
profiles (H-3)



Co-registration

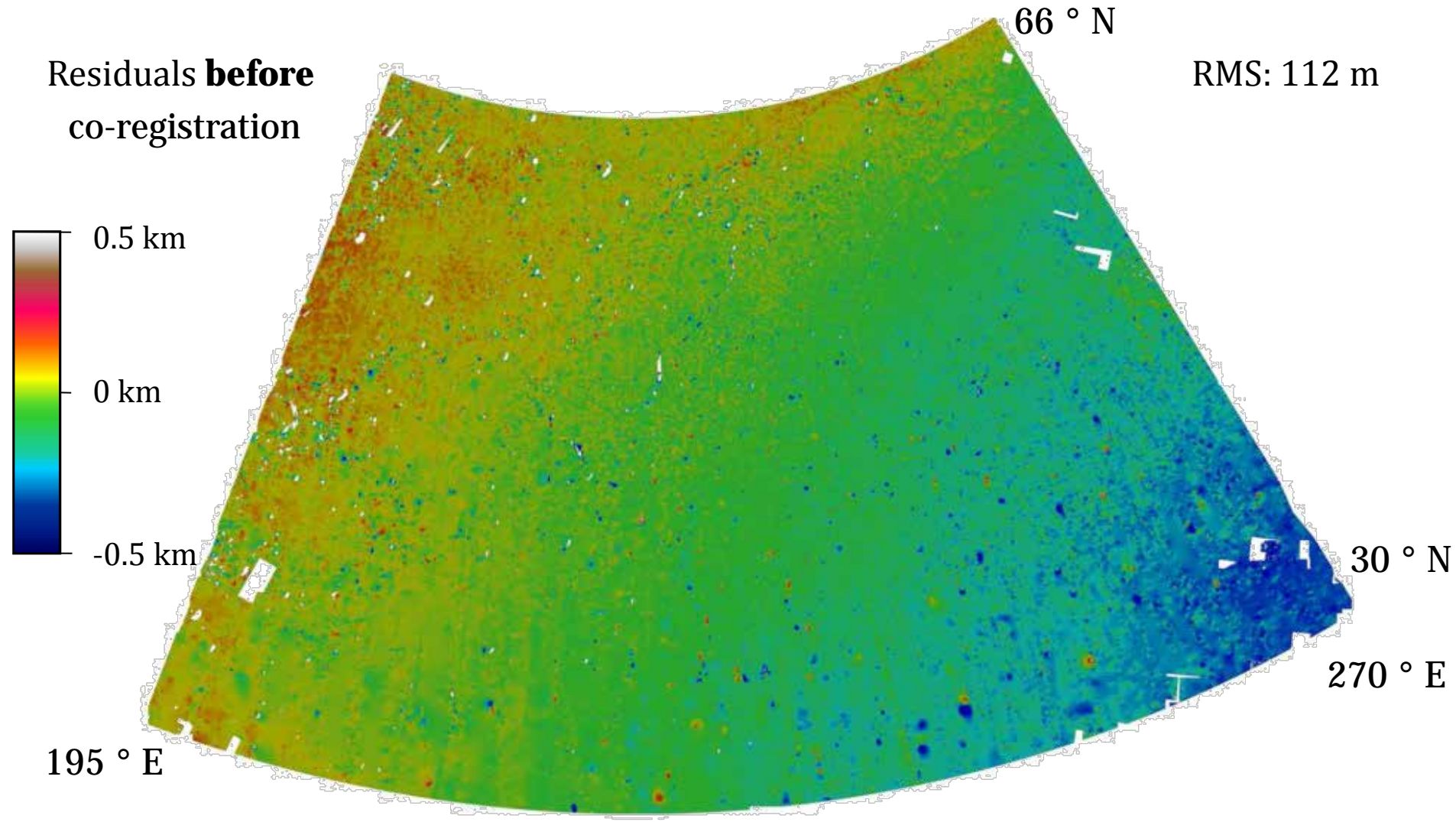
Co-registered
Stereo DTM (H-3)



Co-registration

Residuals **before**
co-registration

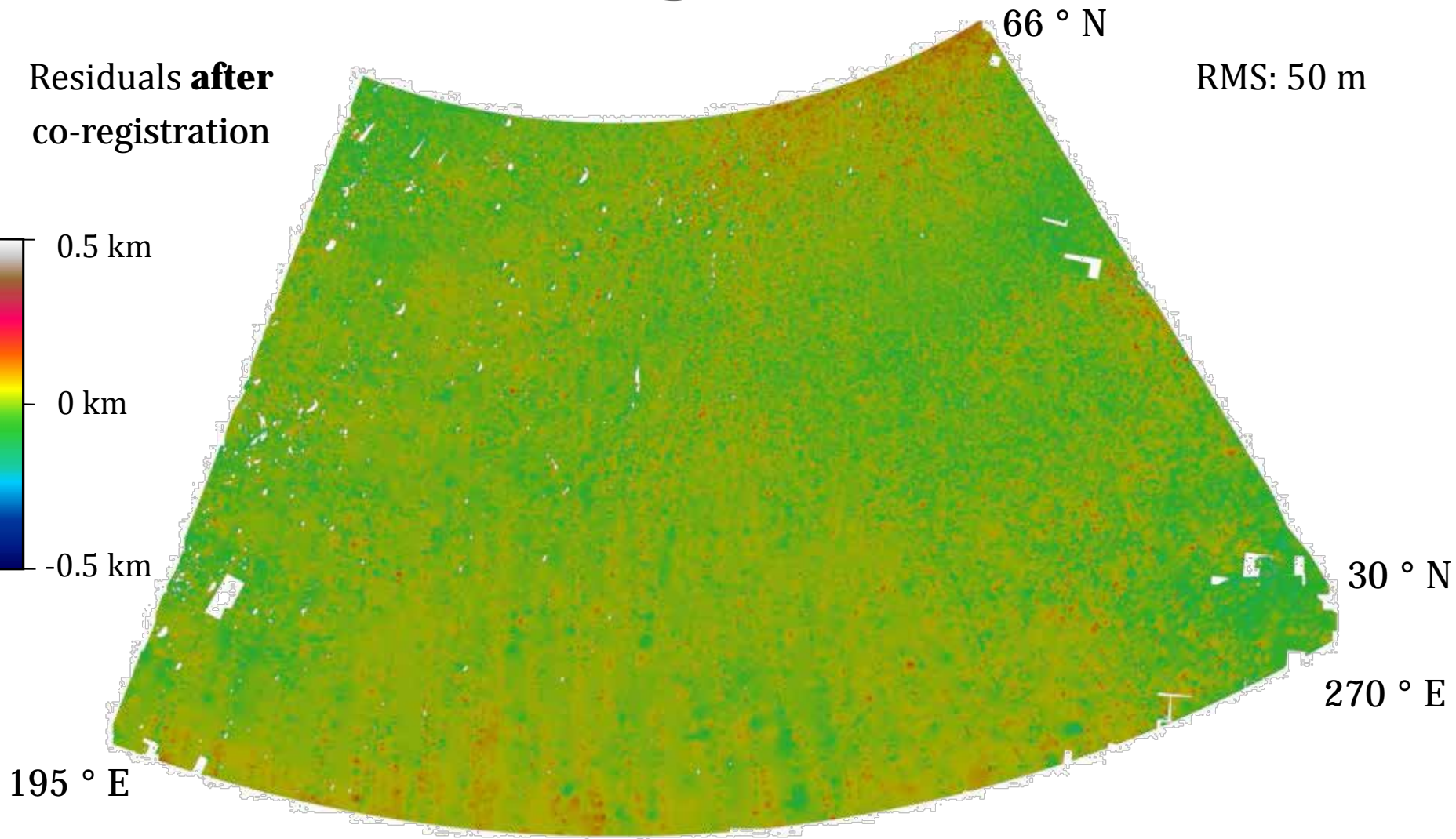
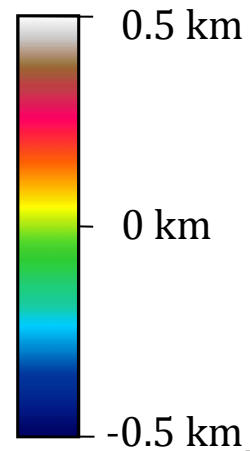
RMS: 112 m



Co-registration

Residuals **after**
co-registration

RMS: 50 m



Reference Frame



Resonant Rotation of Mercury

- § recent JPL ephemeris DE432 (with 2 years of MESSENGER ranging)
- § perfect 3:2 resonant rotational model based on mean and secular orbital elements

Results:

- § **resonant rotation rate:**
6.1385068390 deg/day
(IAU value: 6.1385025 deg/day)

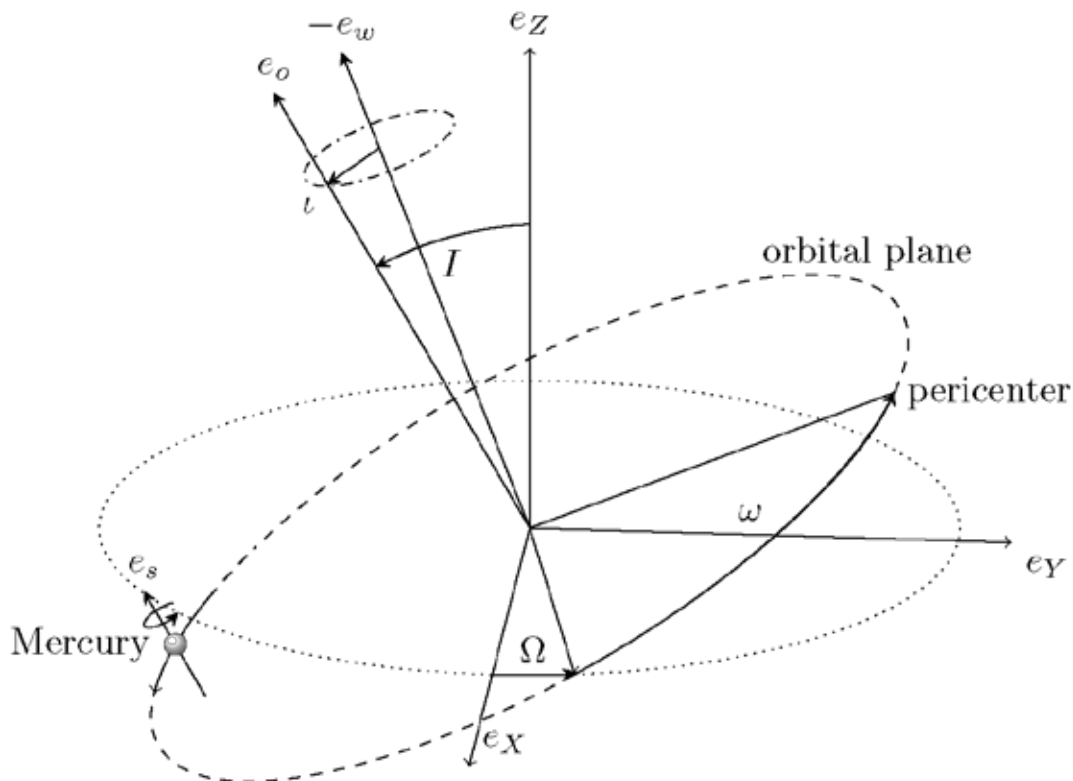
- § **main libration period and phase:**

- § **orientation of the orbital plane**

- § **orientation of the Laplace plane**

à **Stark et al. (2015)**, submitted to
Celestial Mechanics

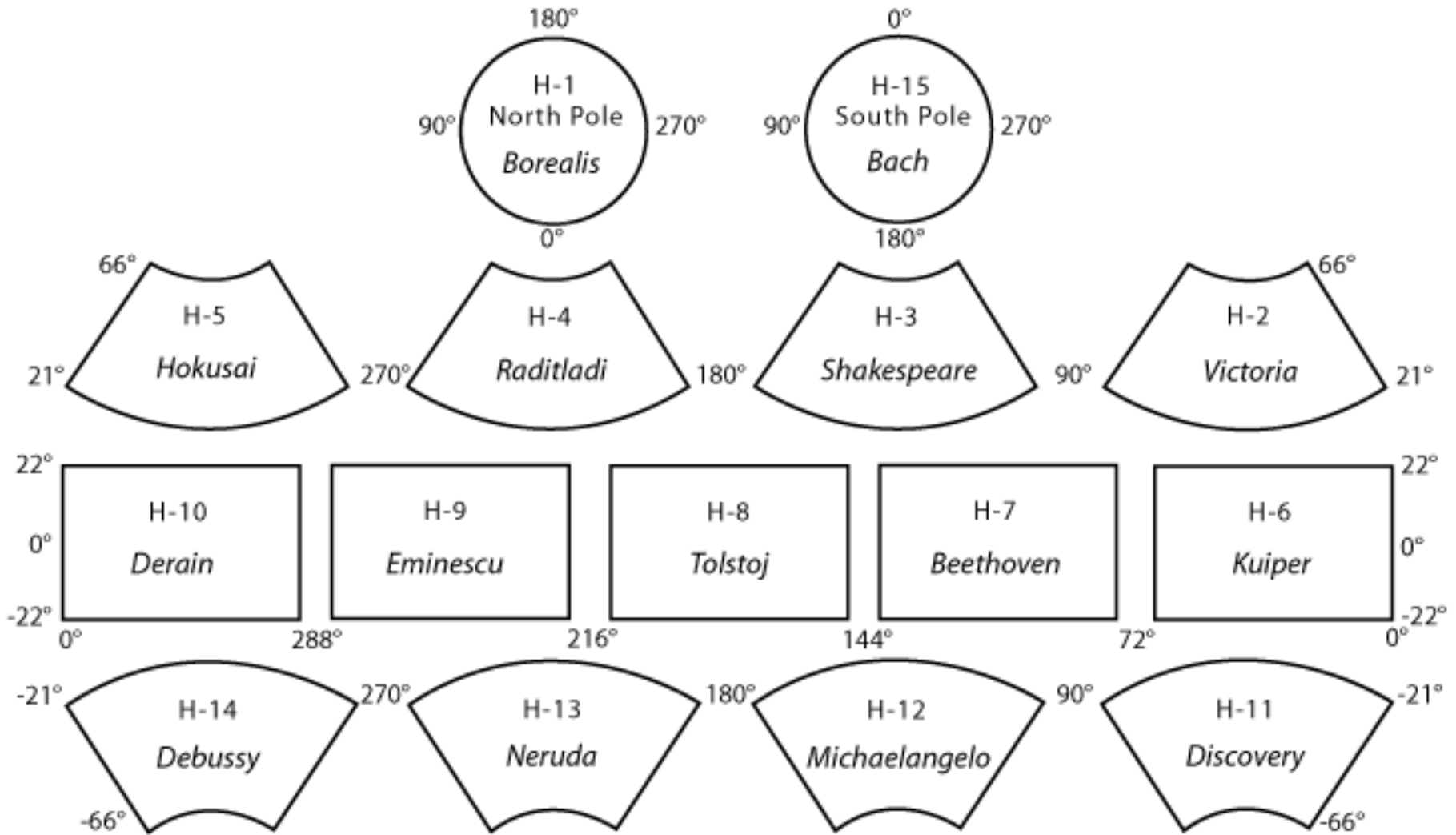
<http://arxiv.org/abs/1506.00008>



Topographic Basemaps

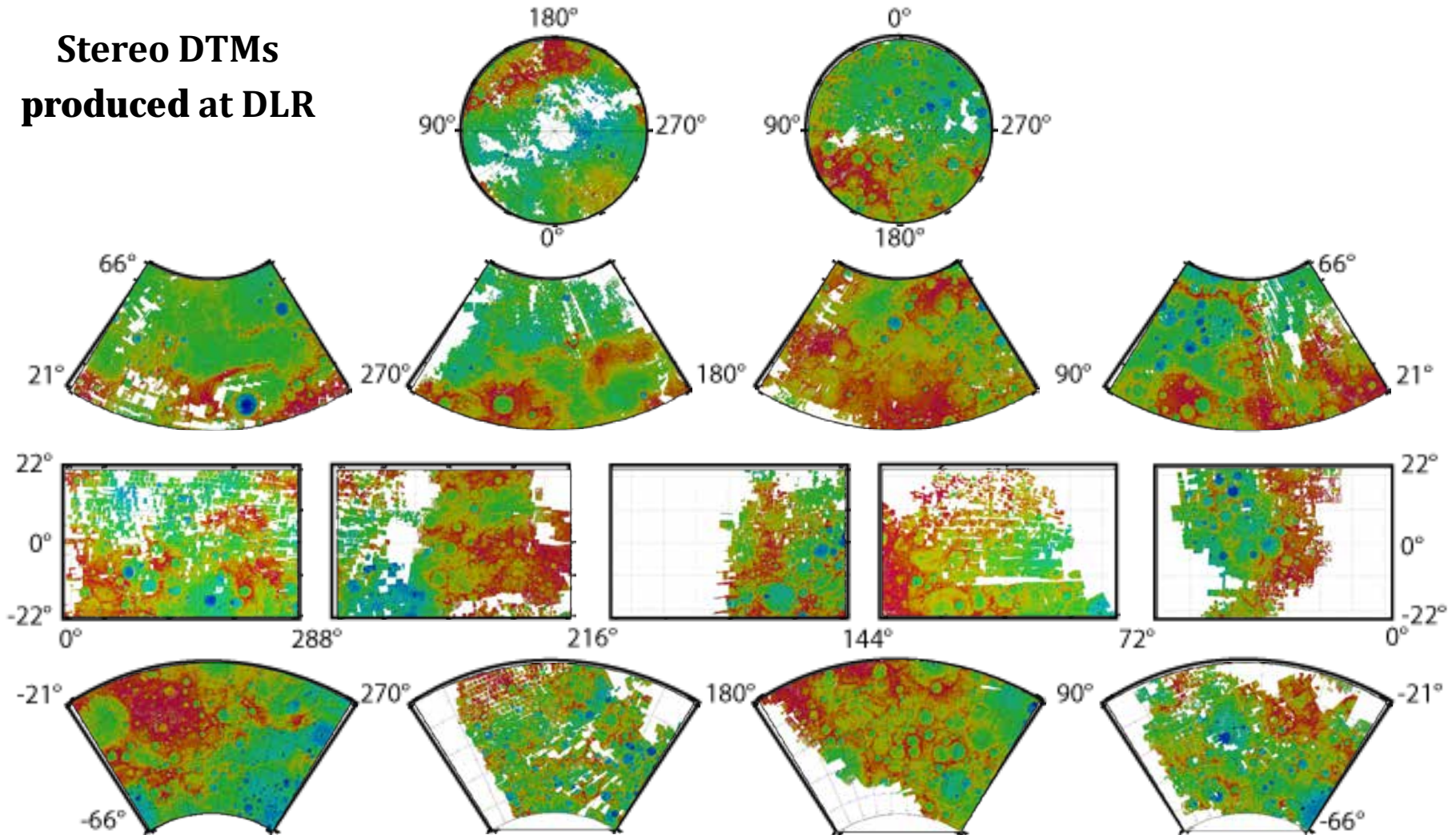


Mercury – Quadrangles (H-1 H-15)

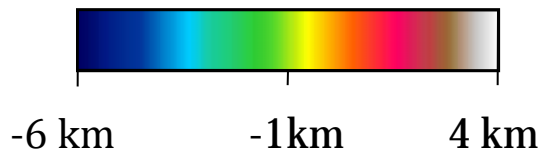
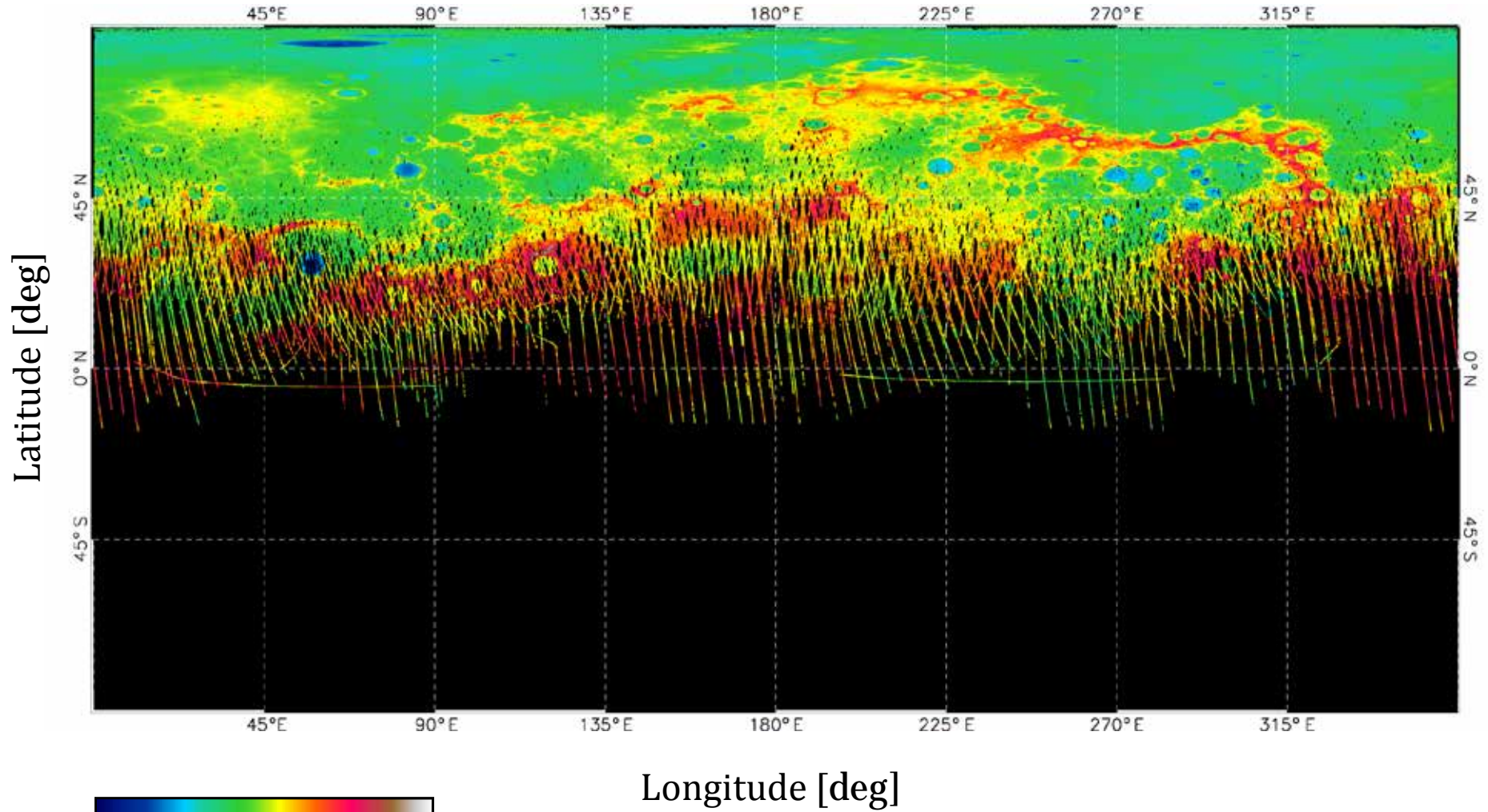


Mercury – Quadrangles (H-1 H-15)

**Stereo DTMs
produced at DLR**



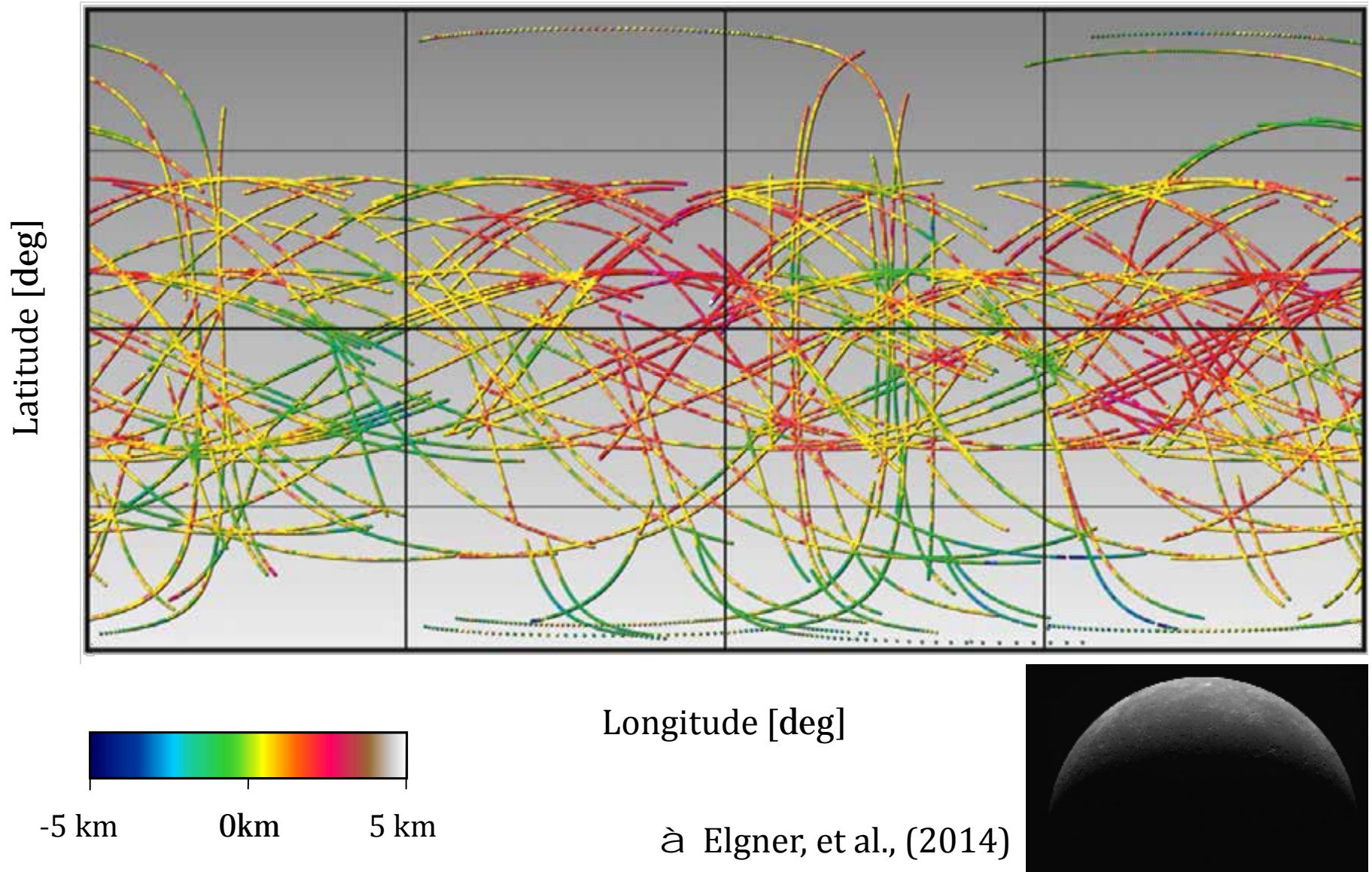
Global Control - Northern Hemisphere (MLA)



Smith, et al., (2012)

Gregory A. Neumann, PDS Release

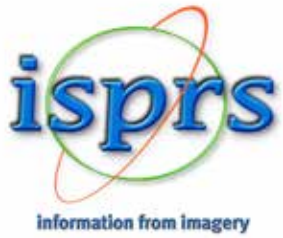
Global Control - Southern Hemisphere (Limbs)



Summary

- § We have updated Mercury reference orbit and rotation parameters and defined a new reference frame
- § We created a topographic base map for the Northern Hemisphere, aligned with the reference frame
- § Southern Hemisphere: Work in progress





ISPRS Working group meeting
WG IV/8: Planetary Mapping and Spatial Databases

Working group chair: Prof. Jürgen Oberst (Juergen.Oberst@dlr.de)

Location: **Technical University Berlin**
Time: **24. and 25. of September 2015**

Organized by:

