Magnetic Maps and Models for Alternative Navigation

Annette Balmes (CIRES-NOAA Affiliate) | **Rick Saltus** (CIRES-NOAA Affiliate) | **Jordan Schweitzer** (CIRES-NOAA Affiliate) | **Arnaud Chulliat** (CIRES-NOAA Affiliate) | **Brian Meyer** (NOAA)

Abstract

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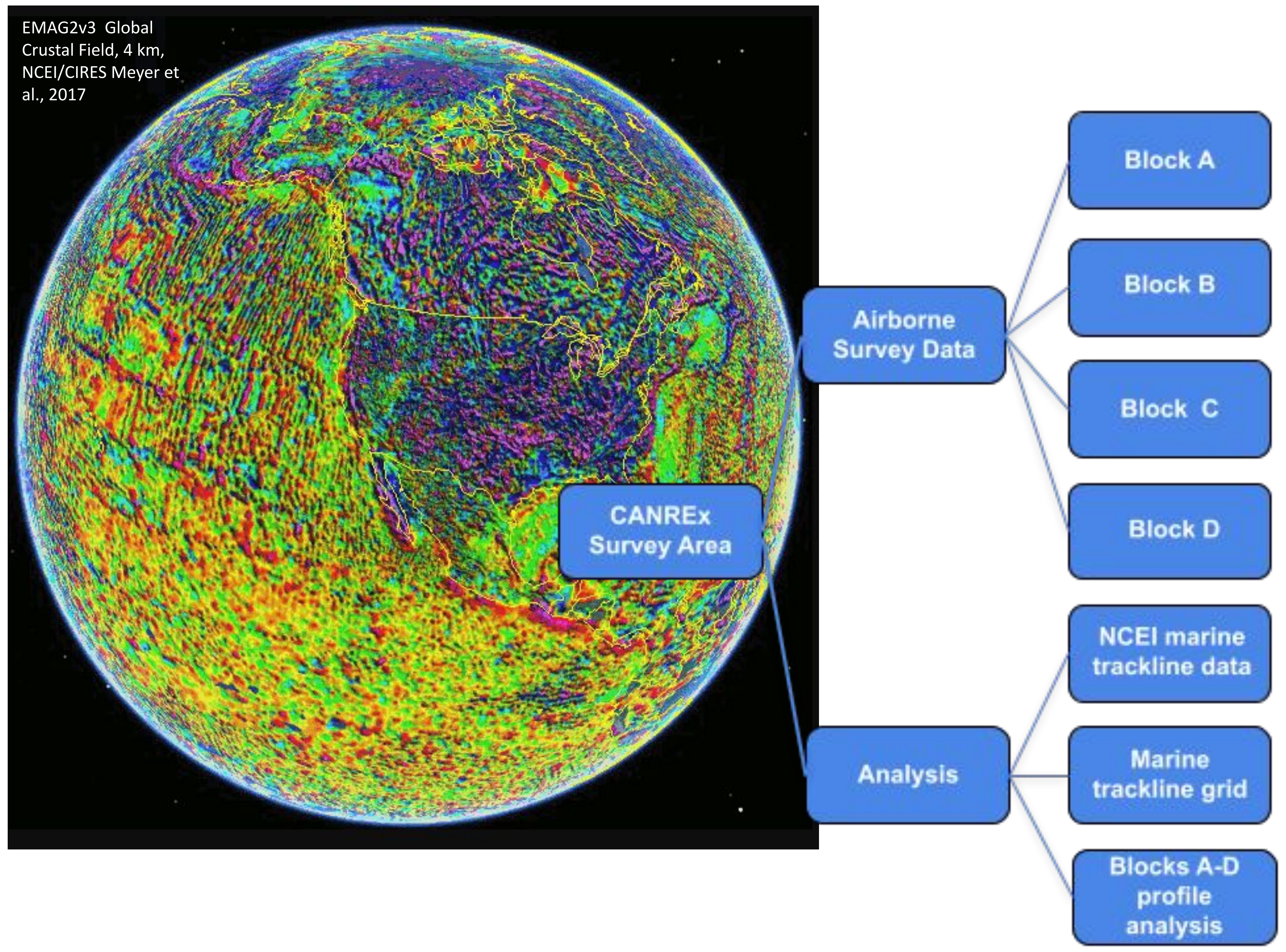
This poster will explore how core field modeling, magnetic anomaly mapping techniques, and field disturbance models can provide useful and trustworthy components of holistic geomagnetic models for advanced applications.

[1] Saltus, R., Chulliat, A., Meyer, B., Bates, M., and Sirohey, A. (2023). Magnetic Anomaly Grid and Associated Uncertainty from Marine Trackline Data: The Caribbean Alternative Navigation Reference Experiment (CANREx). Submitted to Earth and Space Science.

[2] Saltus, R., CIRES/NOAA Geomagnetism Team (2023). Magnetic Maps and Models for Alternative Navigation. IEEE Position Location and Navigation Symposium 2023. (conference proceedings in press).



EMAG2v3 Global Crustal Field, 4 km, NCEI/CIRES Meyer et al., 2017

CANREx Survey Area

Airborne Survey Data

Block A

Block B

Block C

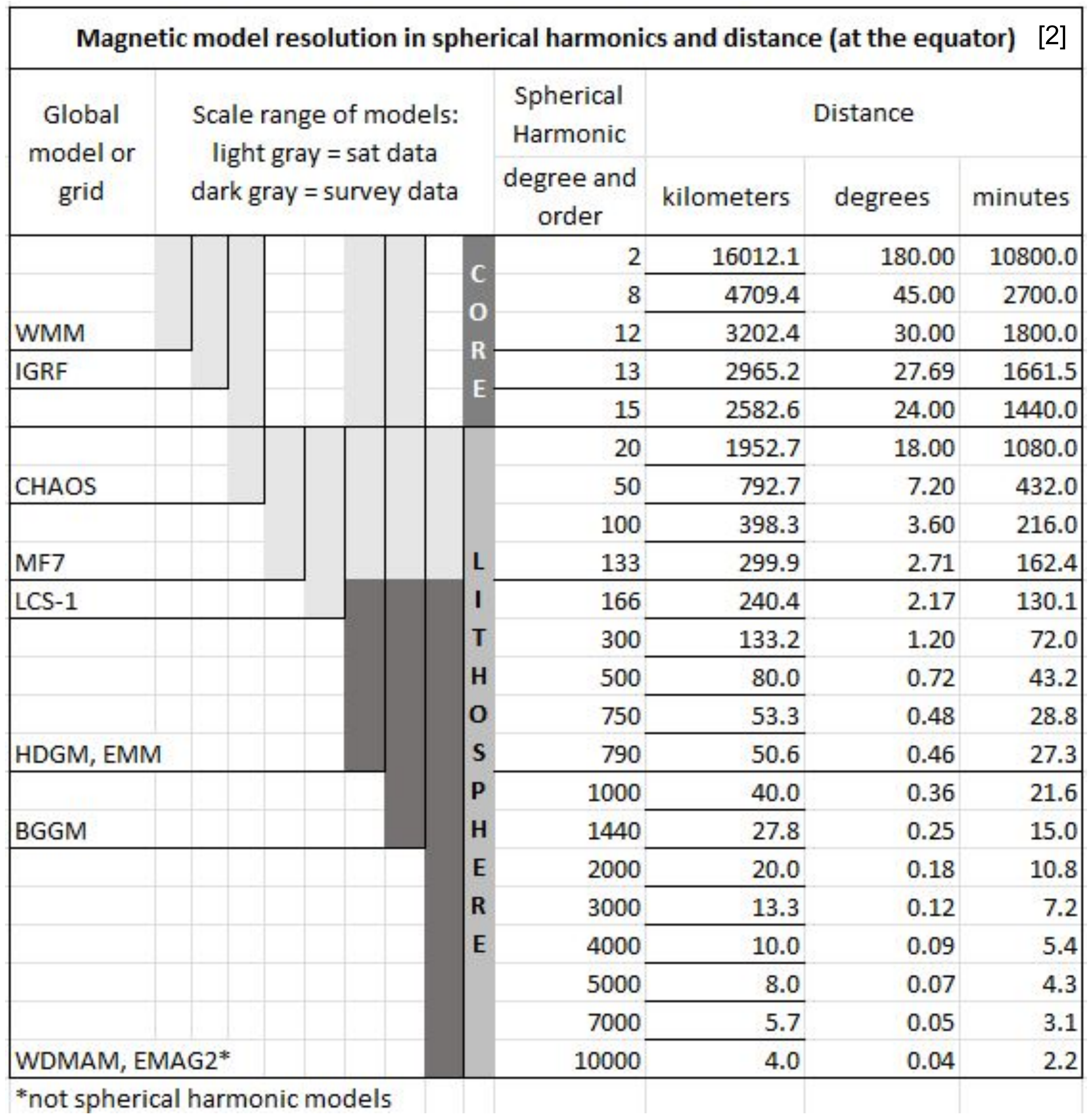
Block D

Analysis

NCEI marine trackline data

Marine trackline grid

Blocks A-D profile analysis



Magnetic model resolution in spherical harmonics and distance (at the equator) [2]					
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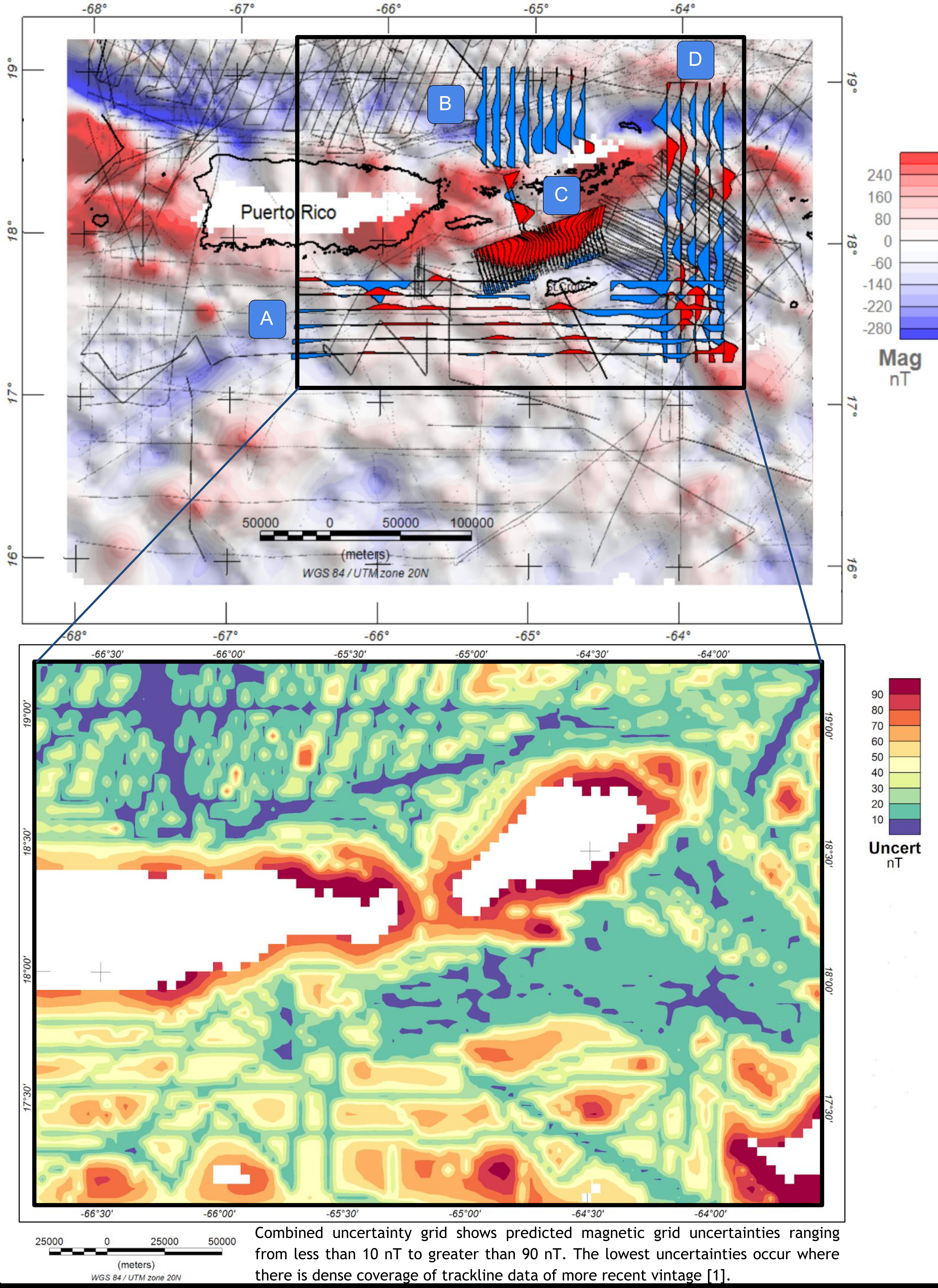
WDMAM, EMAG2*		10000	4.0	0.04	2.2

*not spherical harmonic models

Summary map for the CANREx study. Thin black lines show the NOAA/NCEI marine tracklines. The colored background image shows the predicted magnetic anomaly field calculated from the trackline data. The Sander Geophysics survey profiles are shown with areas of positive measured anomalies colored in red and negative measured anomalies in blue, in areas denoted, A, B, C, D [1].



Combined uncertainty grid shows predicted magnetic grid uncertainties ranging from less than 10 nT to greater than 90 nT. The lowest uncertainties occur where there is dense coverage of trackline data of more recent vintage [1].

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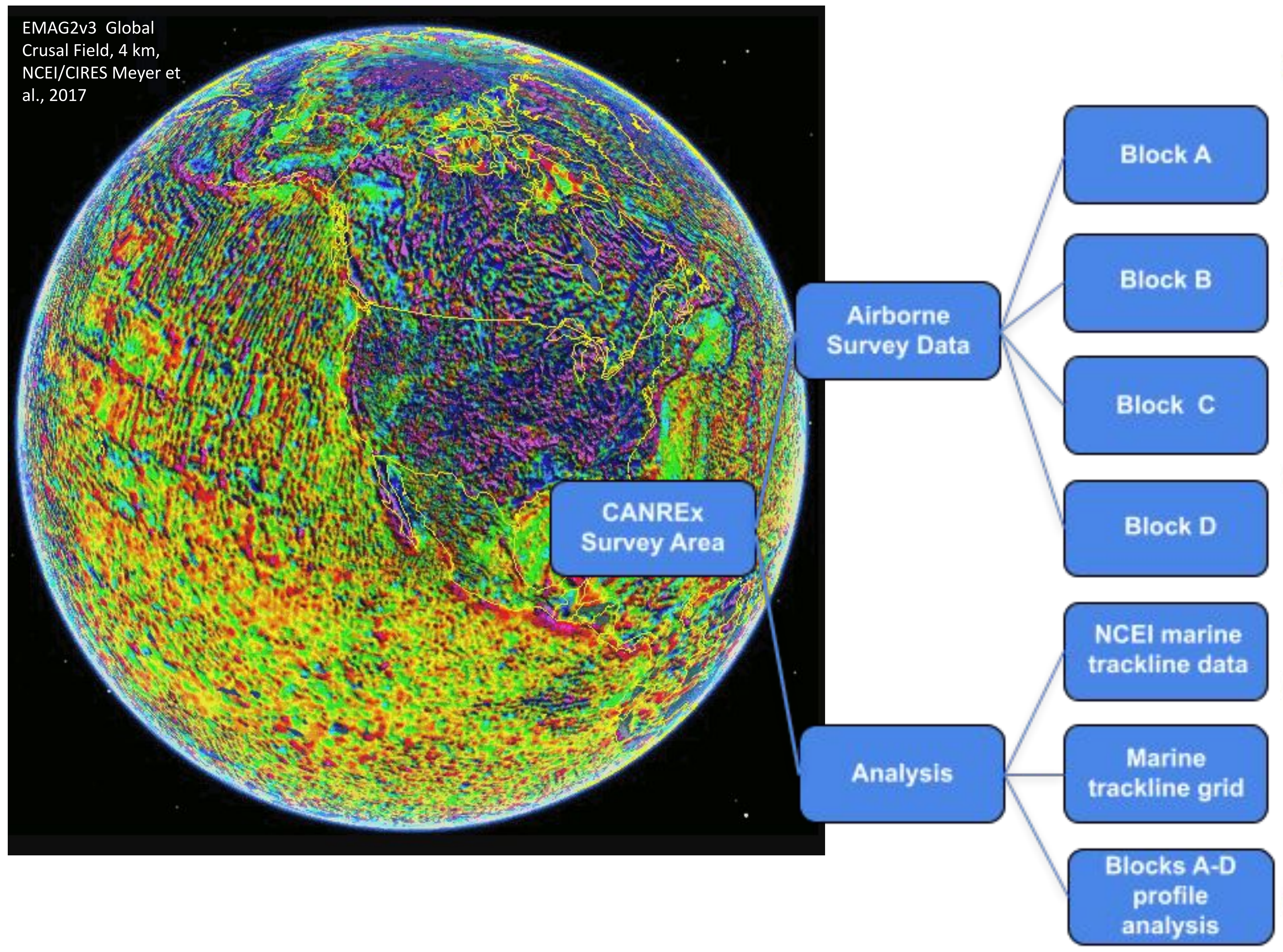
EMAG2v3 Global Crusal Field, 4 km, NCEI/CIRES Meyer et al., 2017

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Airborne Survey Data
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- Block B
- Block C
- Block D

Analysis
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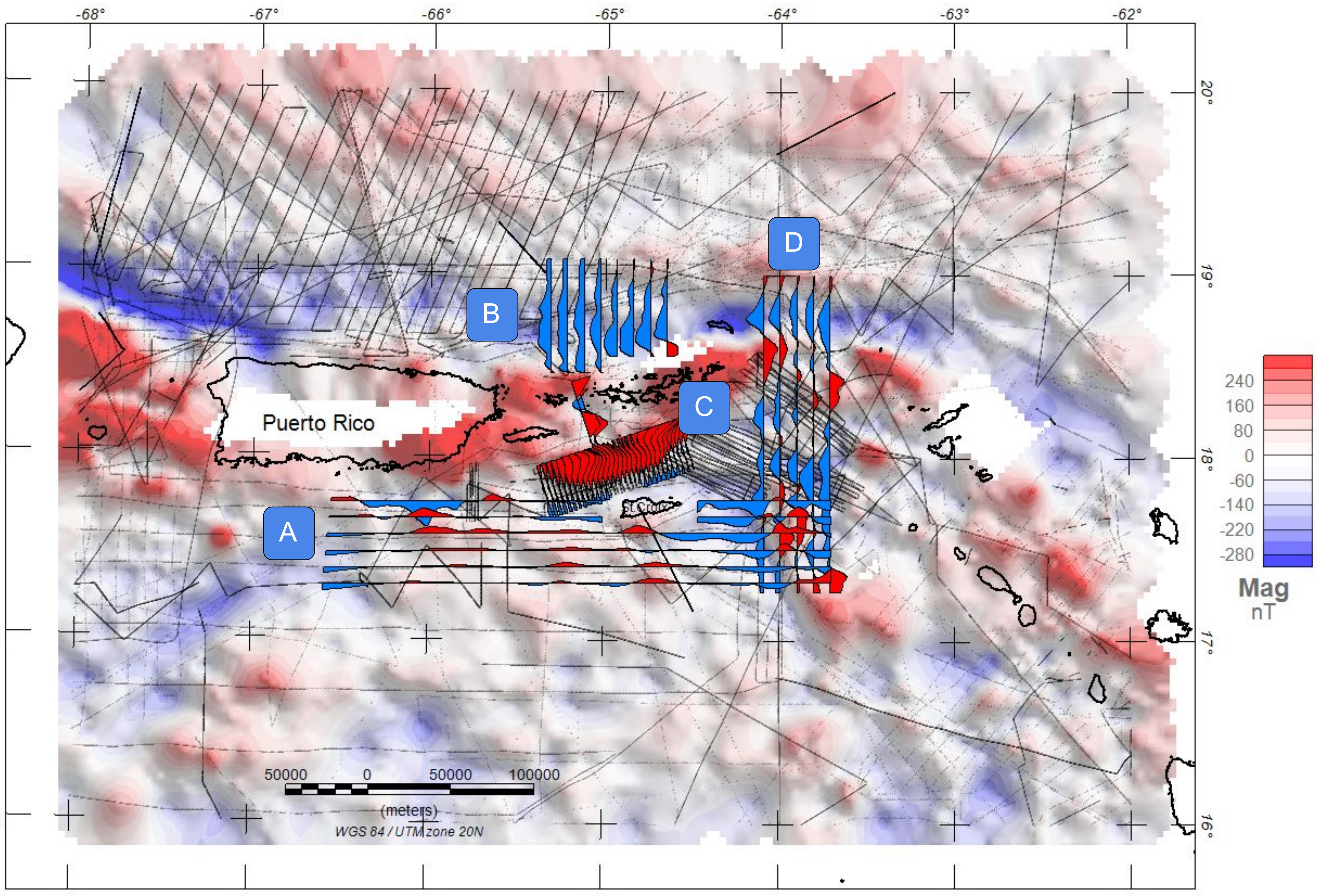
- Marine trackline grid
- Blocks A-D profile analysis



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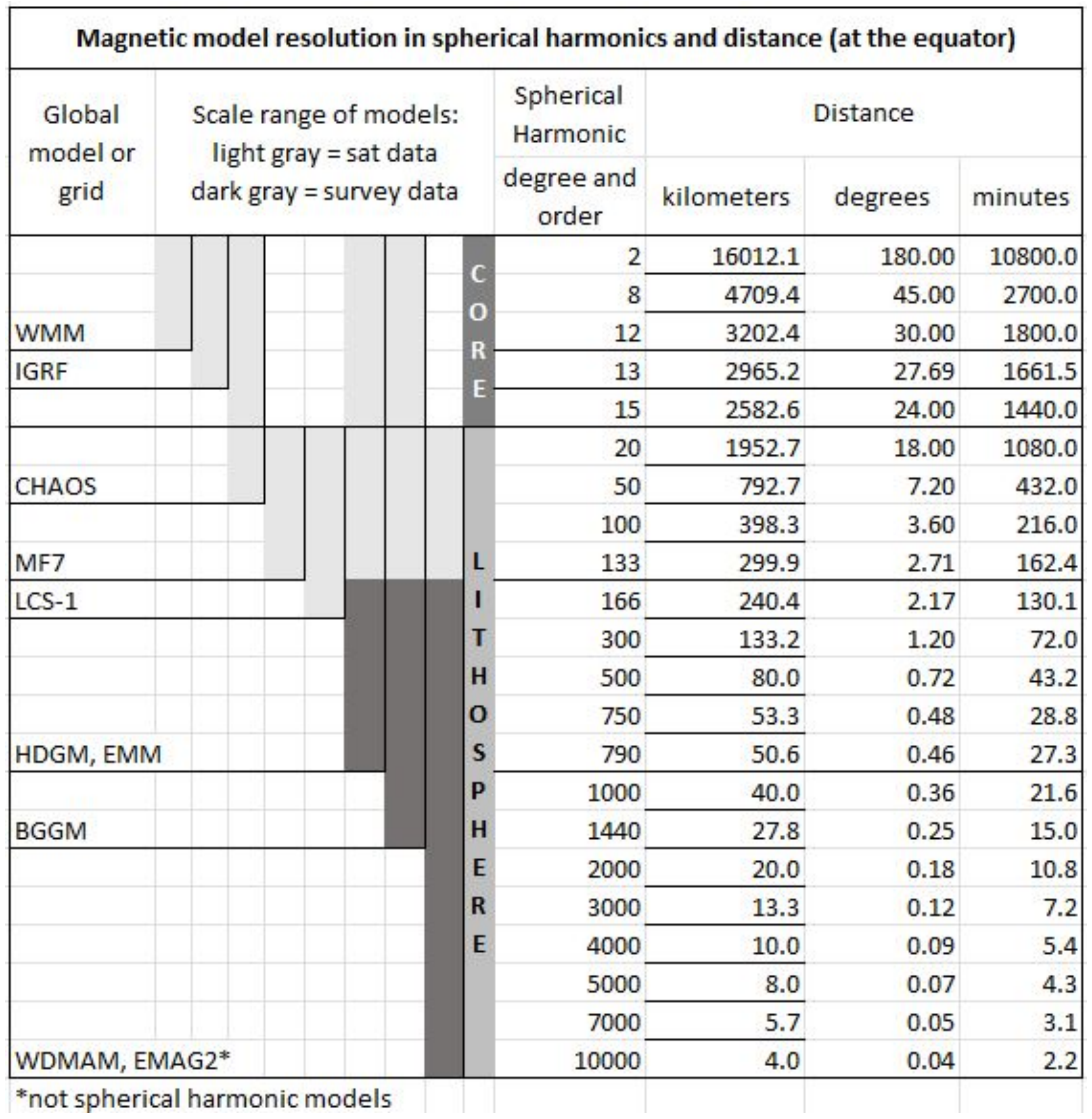

Magnetic model resolution in spherical harmonics and distance (at the equator)

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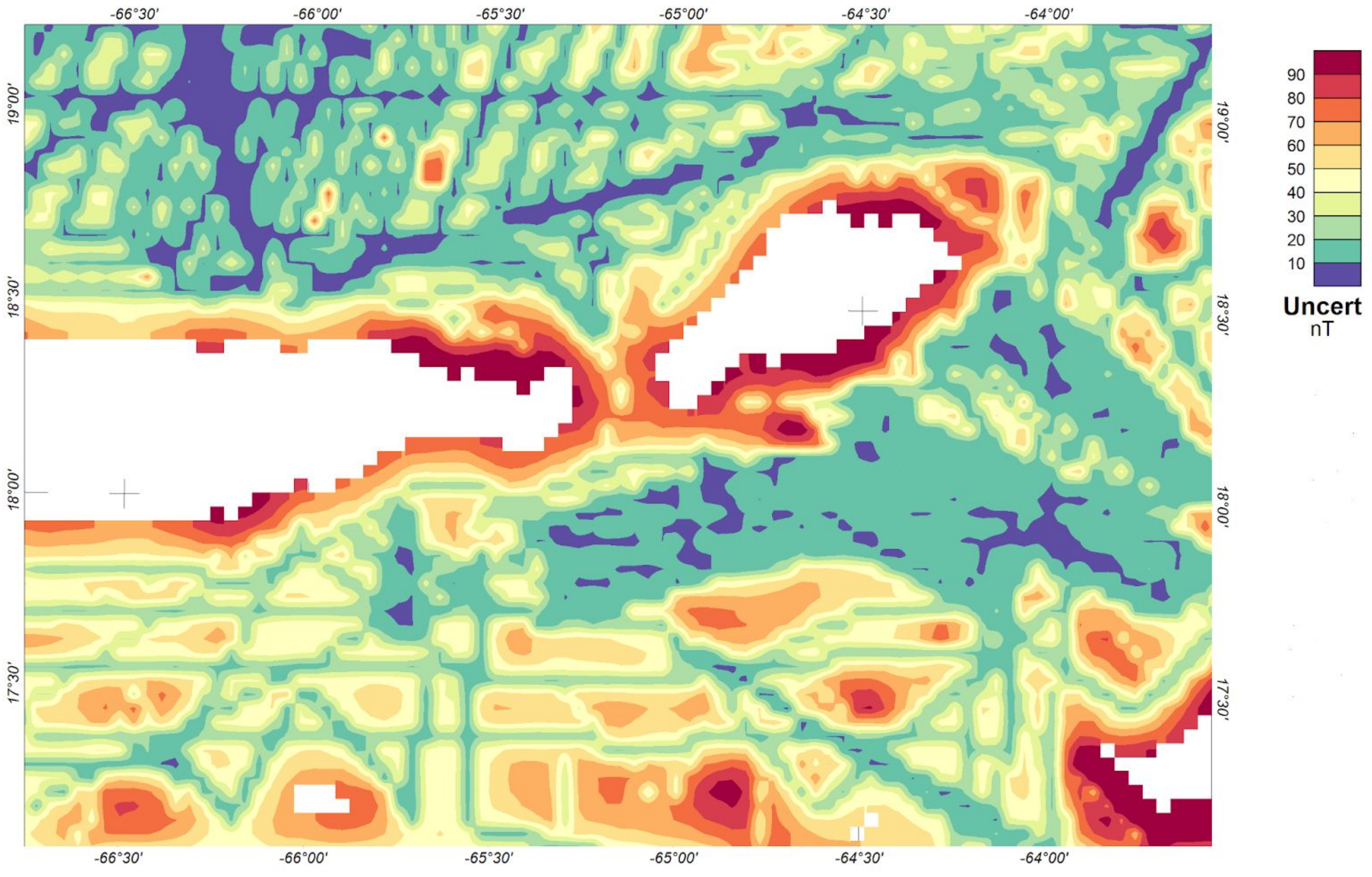

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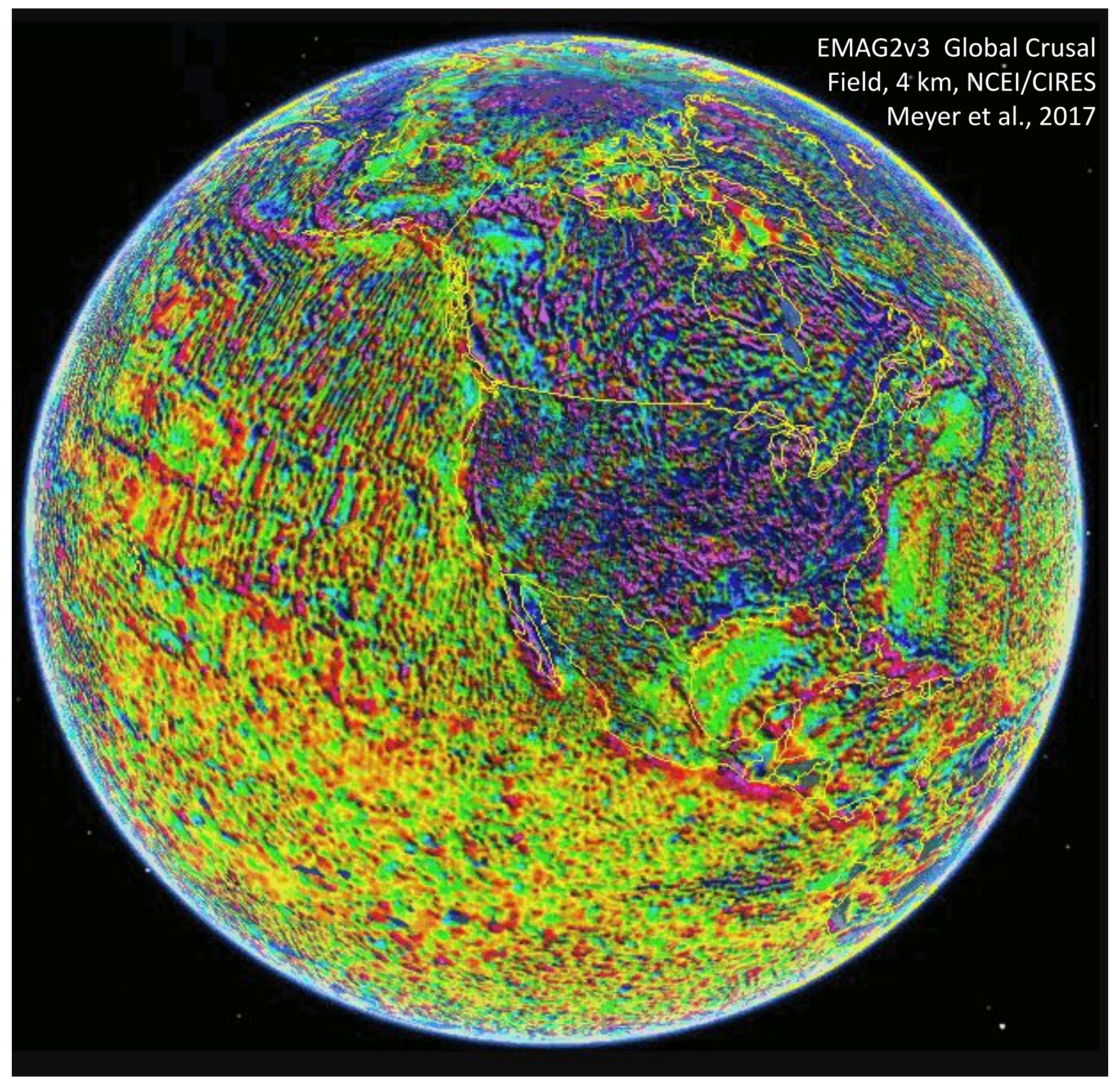
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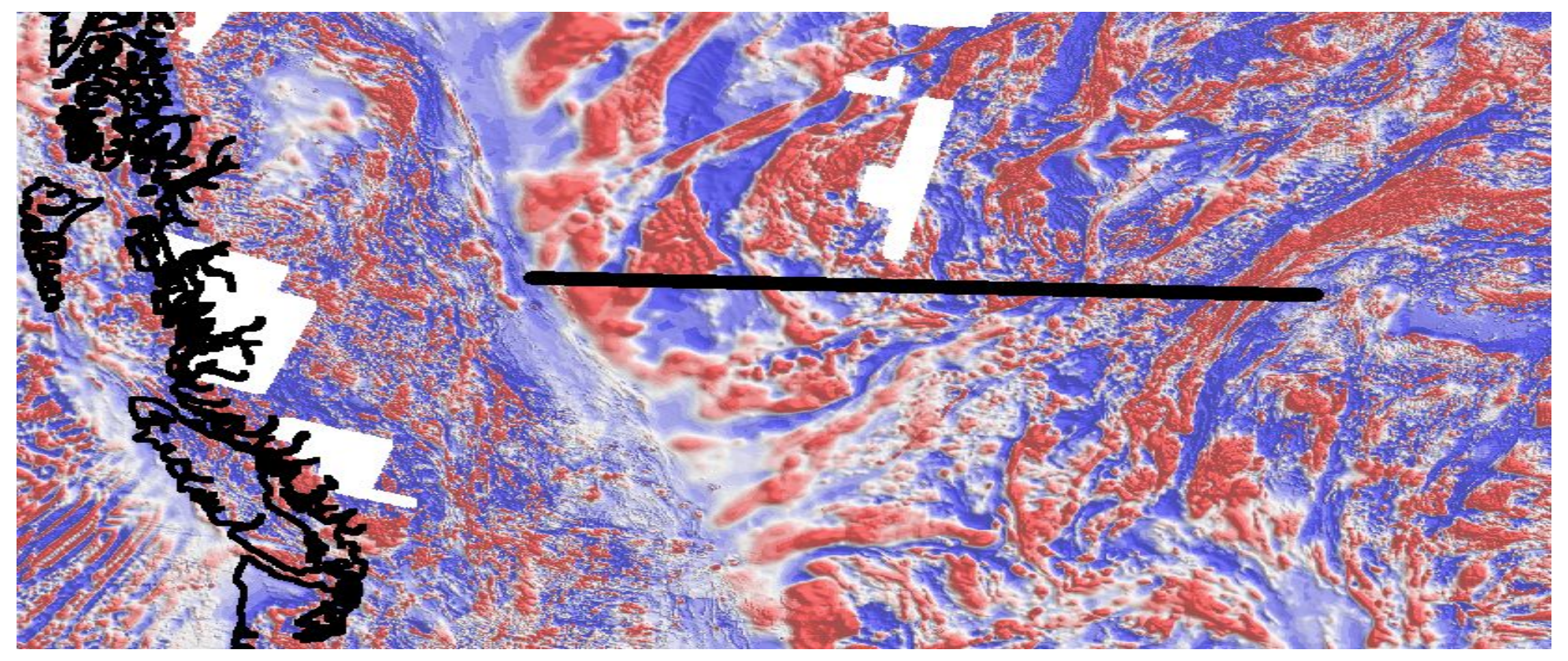
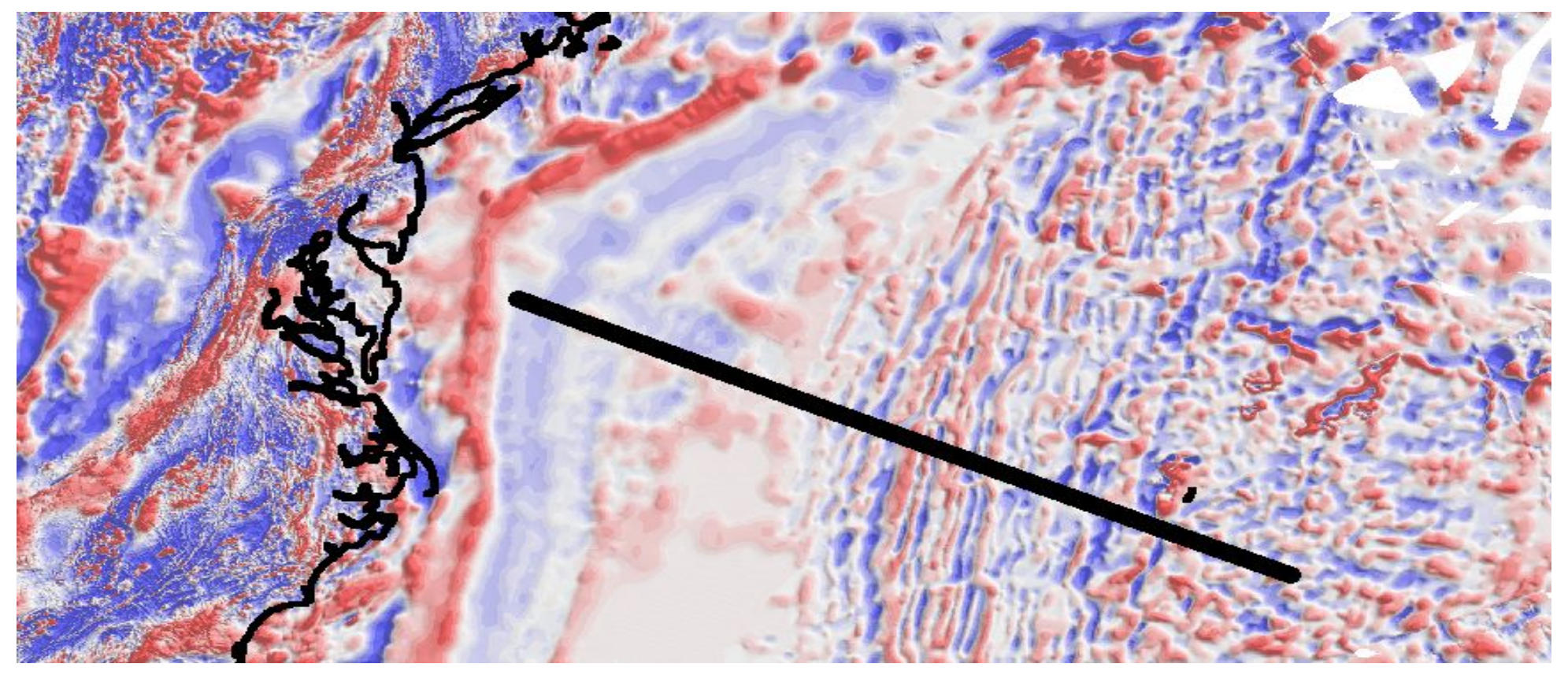
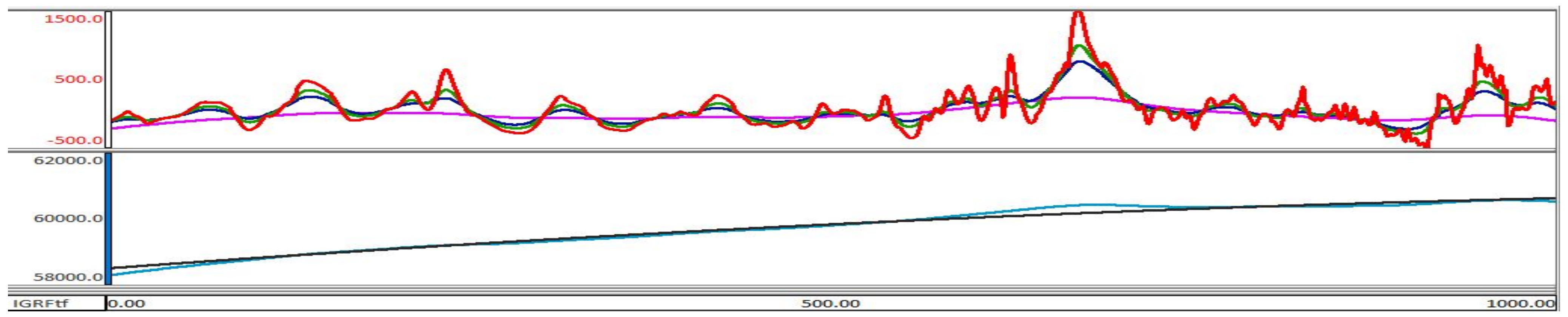
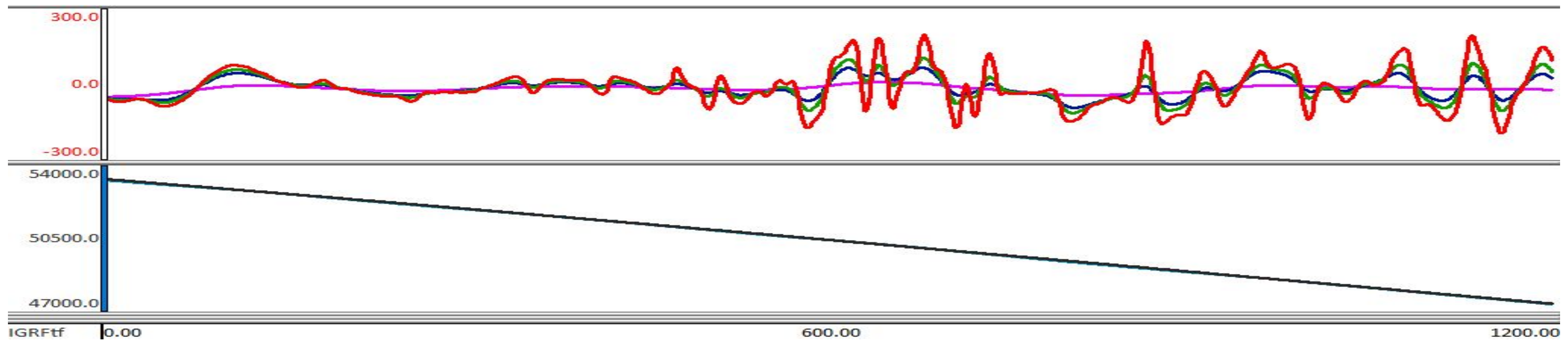
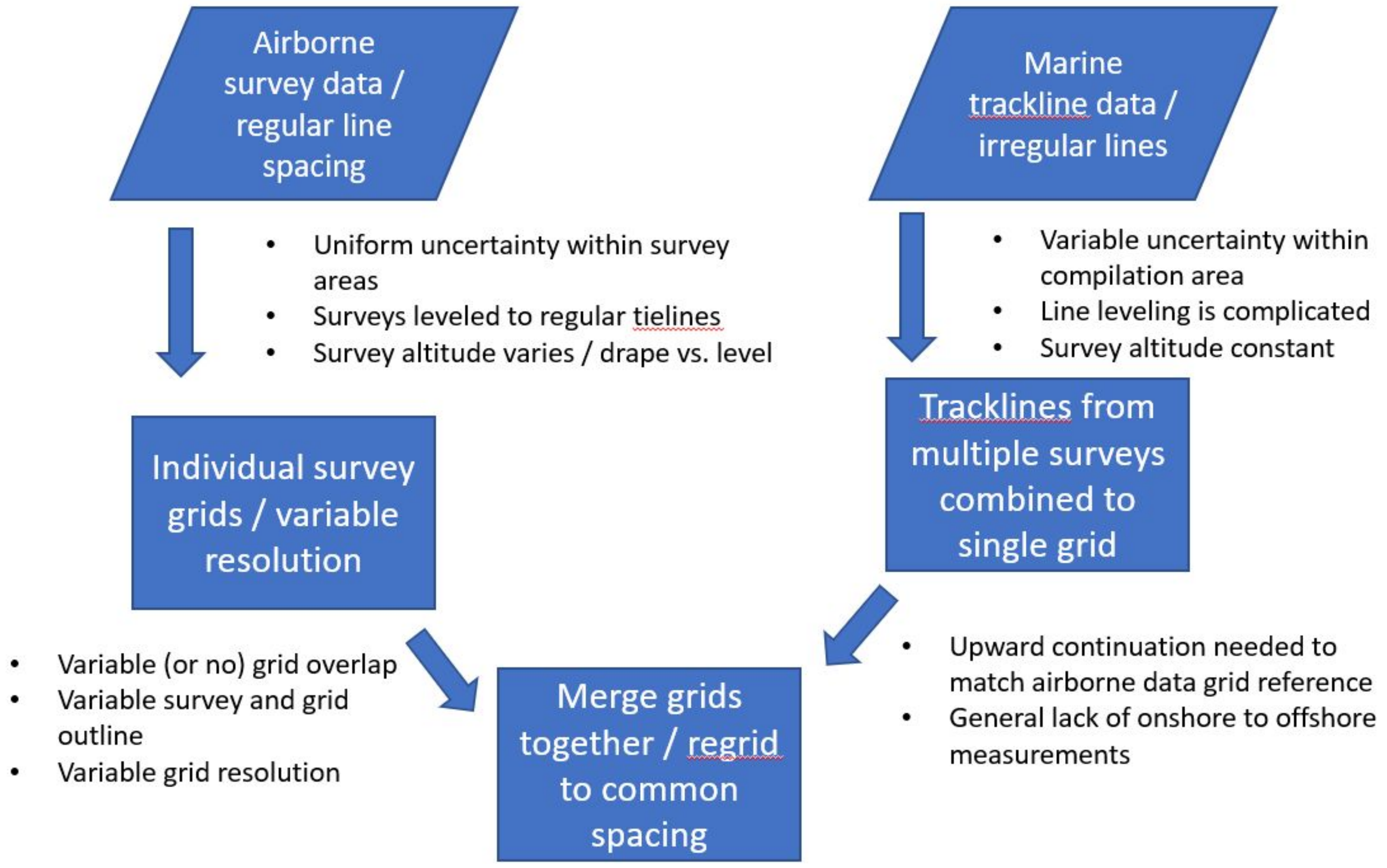










Airborne survey data / regular line spacing

- Uniform uncertainty within survey areas
- Surveys leveled to regular tielines
- Survey altitude varies / drape vs. level

Individual survey grids / variable resolution

- Variable (or no) grid overlap
- Variable survey and grid outline
- Variable grid resolution

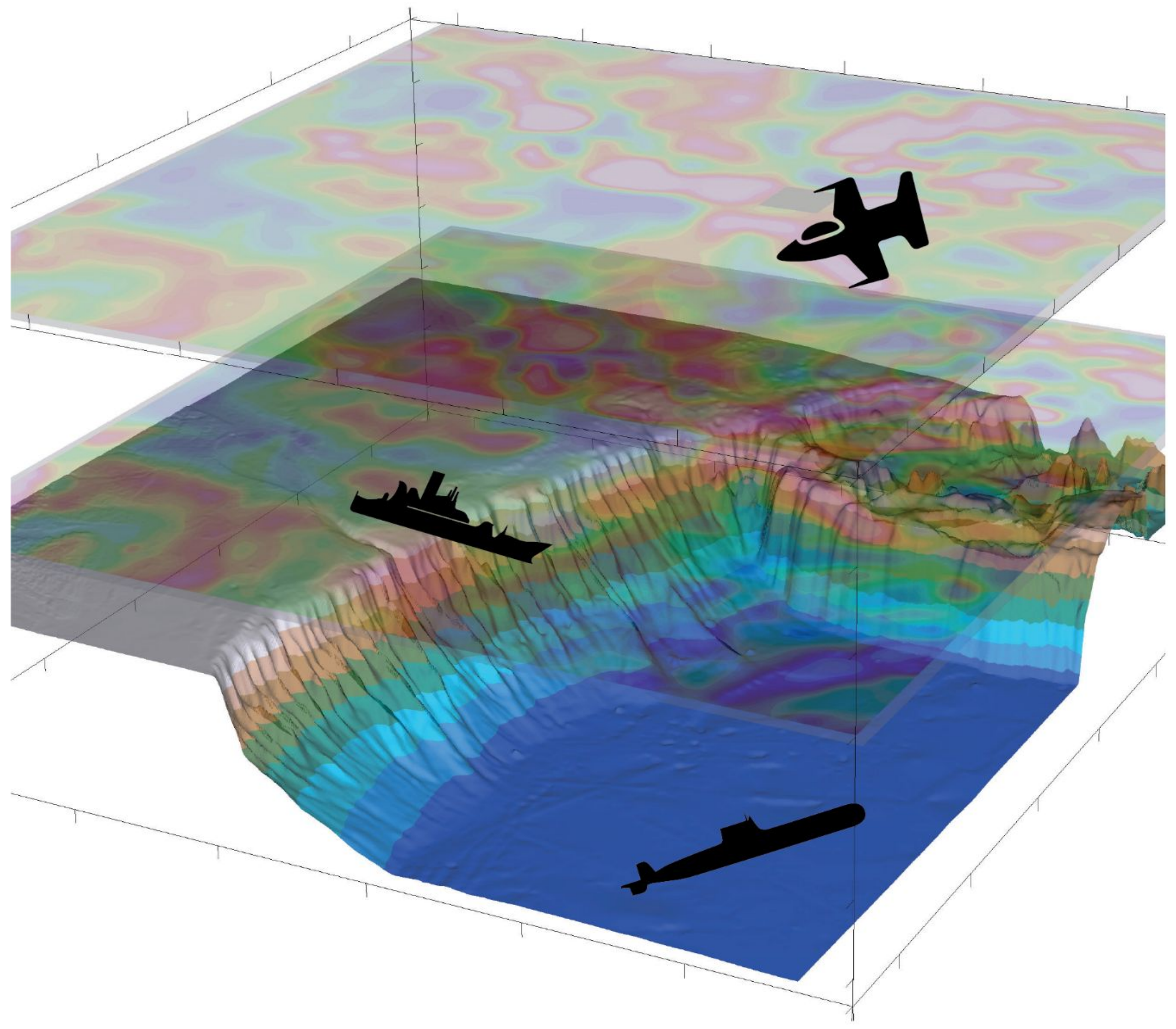
Marine trackline data / irregular lines

- Variable uncertainty within compilation area
- Line leveling is complicated
- Survey altitude constant

Tracklines from multiple surveys combined to single grid

- Upward continuation needed to match airborne data grid reference
- General lack of onshore to offshore measurements

Merge grids together / regrid to common spacing



LAND	Amplitudes (nT)					Gradients (nT/km)				Uncert	Gradient Signal (nT/min) at Velocity (km/hr)					
Altitude	Min	Max	Mean	AbsMean	Stdev	Min	Max	AbsMean	Stdev	%	10 km/hr	25 km/hr	115 km/hr	170 km/hr	800 km/hr	4800 km/hr
1	-525	1517	28	192	200	-261	280	31	44	0.7	3.6	9	41.6	61.5	289.3	1736
5	-283	1010	23	144	149	-29	43	9	12	0.4	0.6	1.5	6.9	10.2	48	288
10	-215	774	18	121	124	-19	23	6	7	0.5	0.5	1.3	5.8	8.5	40	240
50	-262	245	-14	72	66	-4	2	1	2	0.6	0.1	0.3	1.2	1.7	8	48
IGRF 1 km	58519	60687	59802		635	1	3	2	1	1	0.3	0.8	3.8	5.7	26.7	160
OCEAN	Amplitudes (nT)					Gradients (nT/km)				Uncert	Gradient Signal (nT/min) at Velocity (km/hr)					
Altitude	Min	Max	Mean	AbsMean	Stdev	Min	Max	AbsMean	Stdev	%	10	25	115	170	800	4800
1	-191	198	-11	58	73	-51	43	7	11	0.5	0.6	1.5	6.7	9.9	46.7	280
5	-112	106	-12	39	46	-14	13	3	4	0.4	0.2	0.5	2.3	3.4	16	96
10	-91	67	-12	30	35	-6	7	2	2	0.5	0.2	0.4	1.9	2.8	13.3	80
50	-48	10	-16	17	13	-0.5	0.6	0.2	0.3	0.6	0	0.1	0.2	0.3	1.6	9.6
IGRF 1 km	47403	53351	50426		1728	-5.1	-4.6	5	0.2	1	0.8	2.1	9.6	14.2	66.7	400

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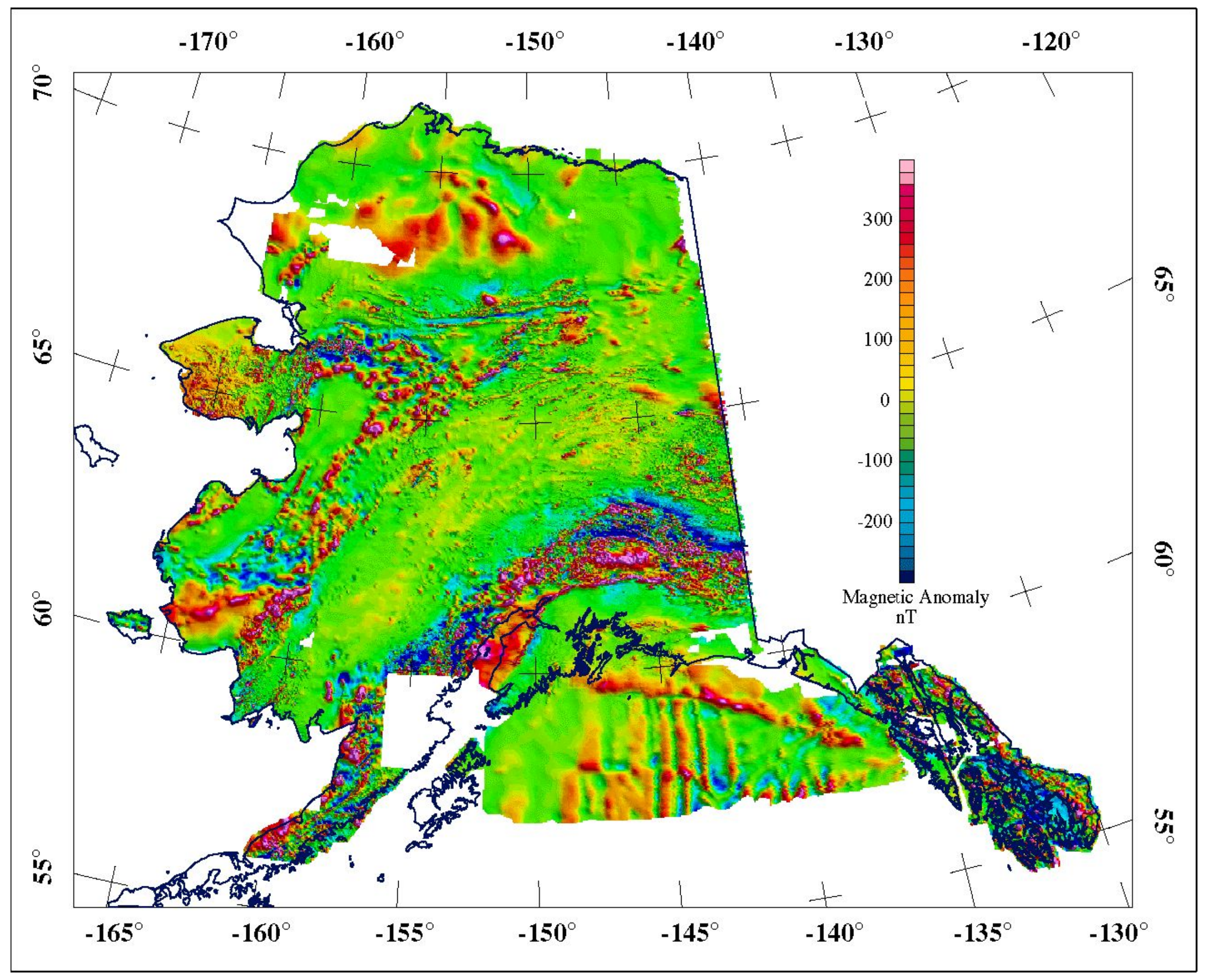

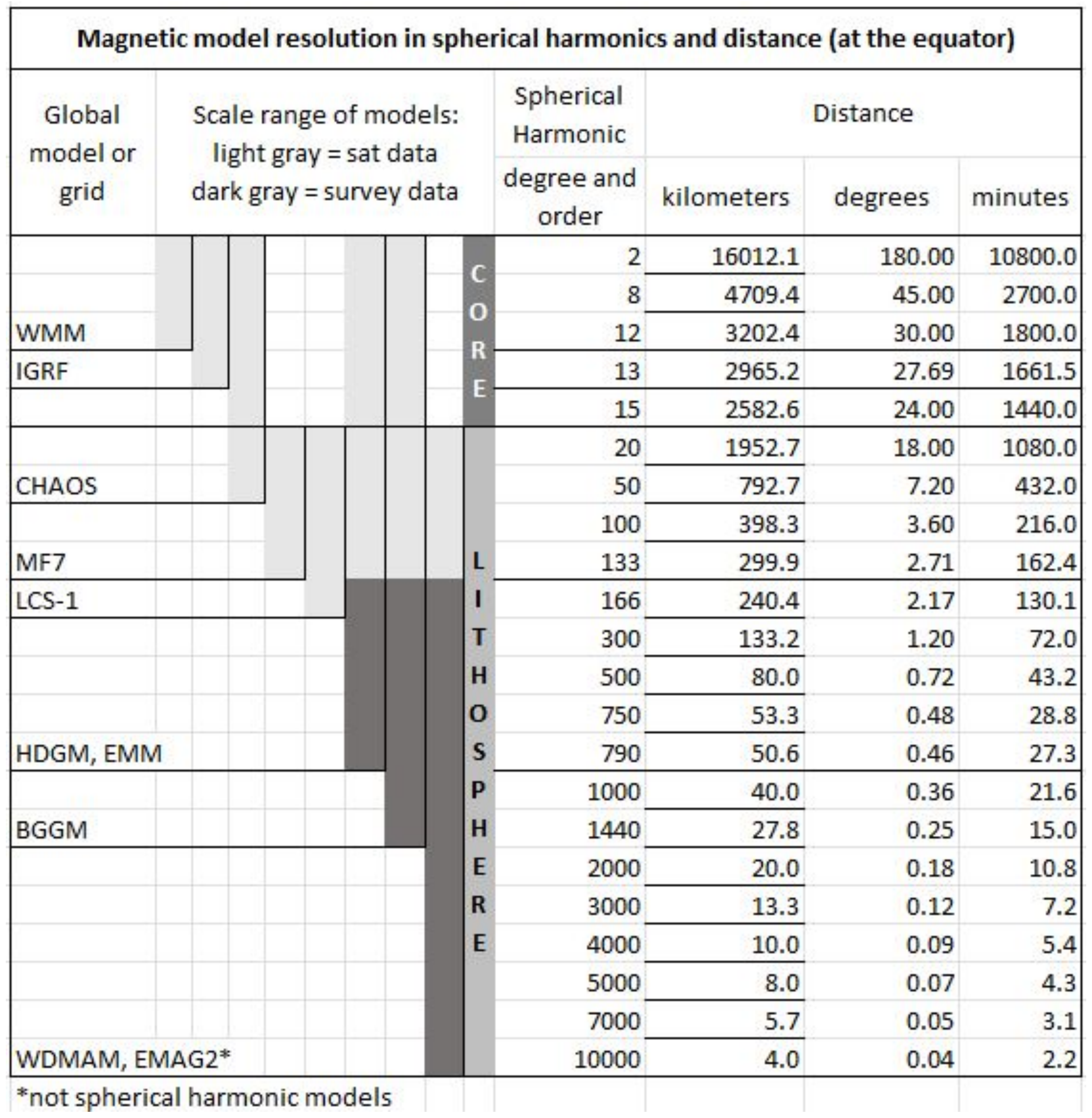

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