Ocean Surface Topography Science Team Meeting (OSTST)

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Virtual meeting

Comparison and evaluation of high-resolution gravity recovery via sea surface heights or sea surface slopes

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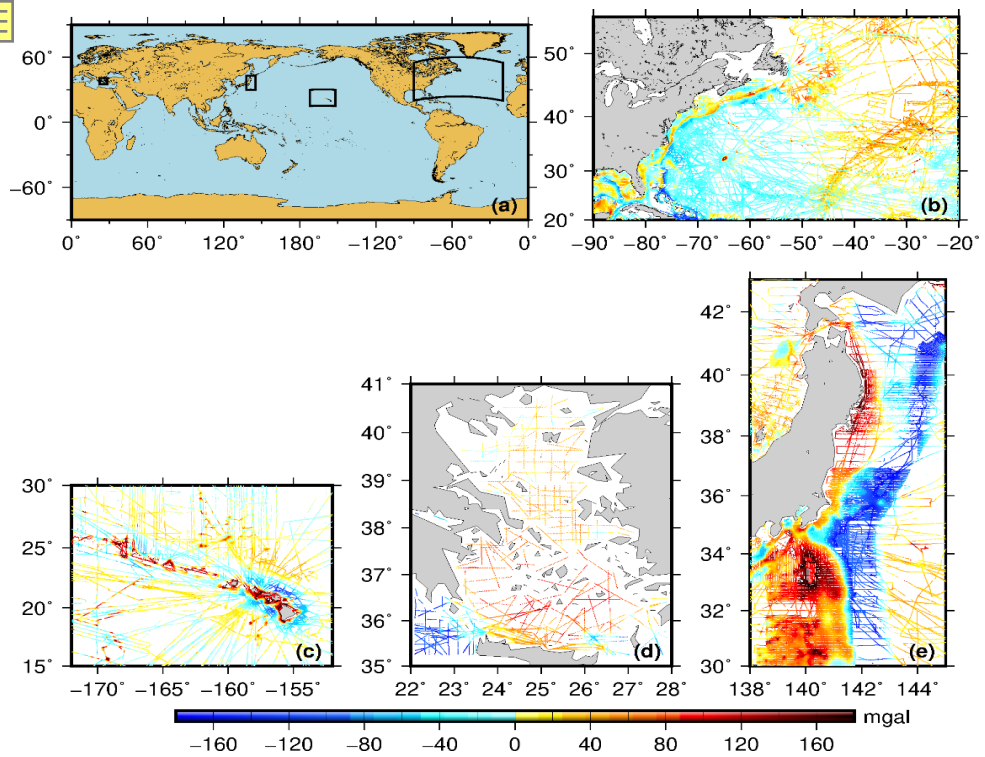
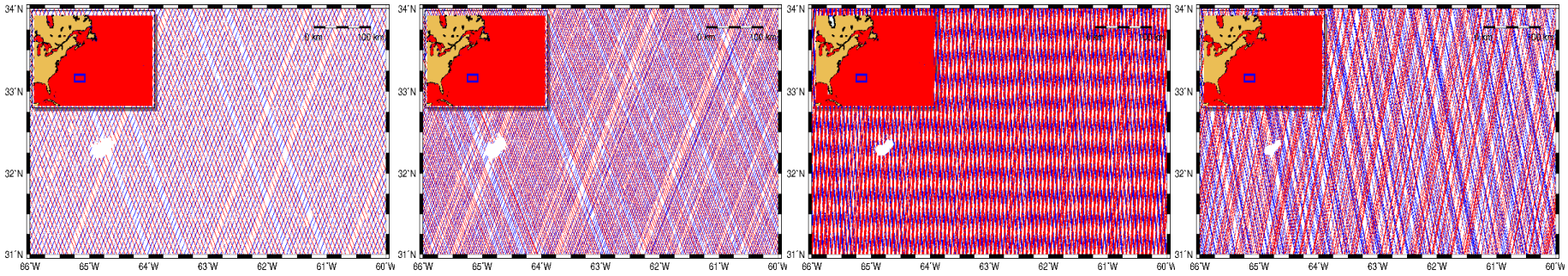
Study areas and marine data distribution



(b) Northwestern Atlantic (20°–90°W, 20°–55°N)
(c) Hawaii area (152°–172°W, 15°–30°N)
(d) Aegean Sea (22°–28°E, 35°–41°N)
(e) Mariana trench area (138°–145°E, 30°–43°N)

Altimetry data distribution over the Bermuda region (60°–66°W, 31°–34°N) Left to right: Jason-1 GM, Jason-2 GM, CryoSat-2 LRM, SARAL/AltiKa GM

Mission	Time Scope	Cycle Range	Orbital Inclination	Cross-track distance
Jason-1 GM	20120507-20130621	C500-C537	66°	~8 km
Jason-2 GM	20170711-20191001	C500-C537 C600-C644	66°	4~5 km
SARAL/AltiKa GM	20160704-20191111	C100-C134	98.5°	N/A
CryoSat-2 LRM	20100716-20131228	C004-C048	92°	~8 km

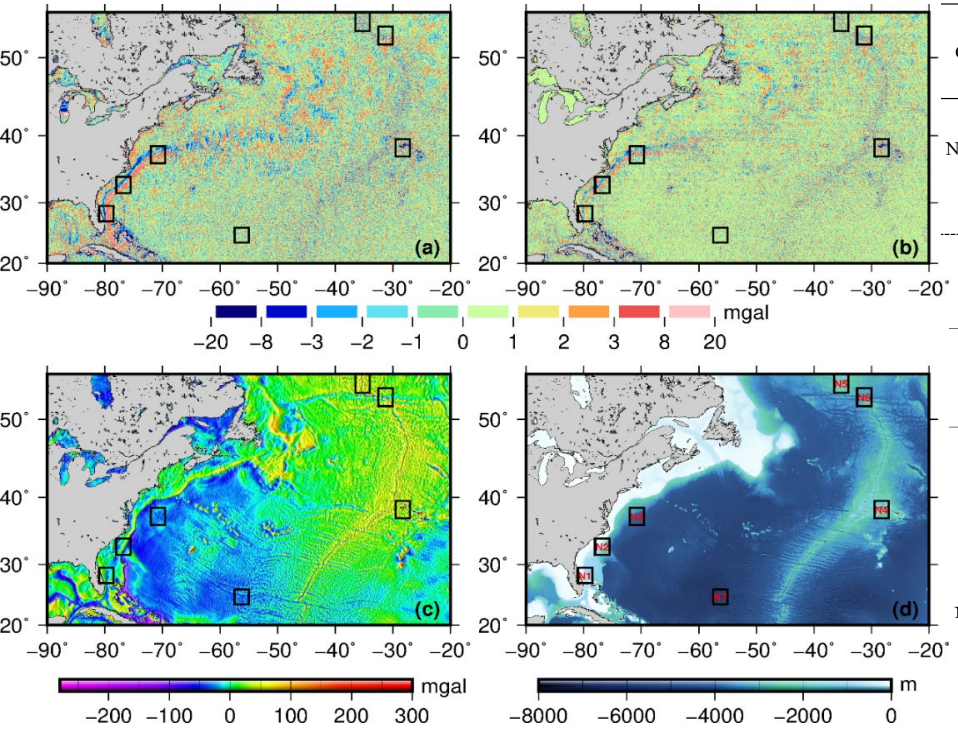


Validation information in Northwestern Atlantic

Ocean area	Description	STD of Height anomaly/m	Count of Altimeter data	Count of marine data	**SSS-based method**	**SSH-based method**	EGM08	DTU17	V27.1
Northwestern Atlantic	Entire	--	--	1409700	**3.113**	**2.787**	2.883	2.642	3.005
	0-15km	0.419	122990	59946	**4.679**	**3.031**	2.667	2.632	5.022
	15-50 km	0.412	347936	170768	**3.623**	**2.919**	2.779	2.640	3.531
	50+ km	0.431	8837064	1177745(83.5%)	**2.877**	**2.733**	2.899	2.632	2.736

General information of selected boxes

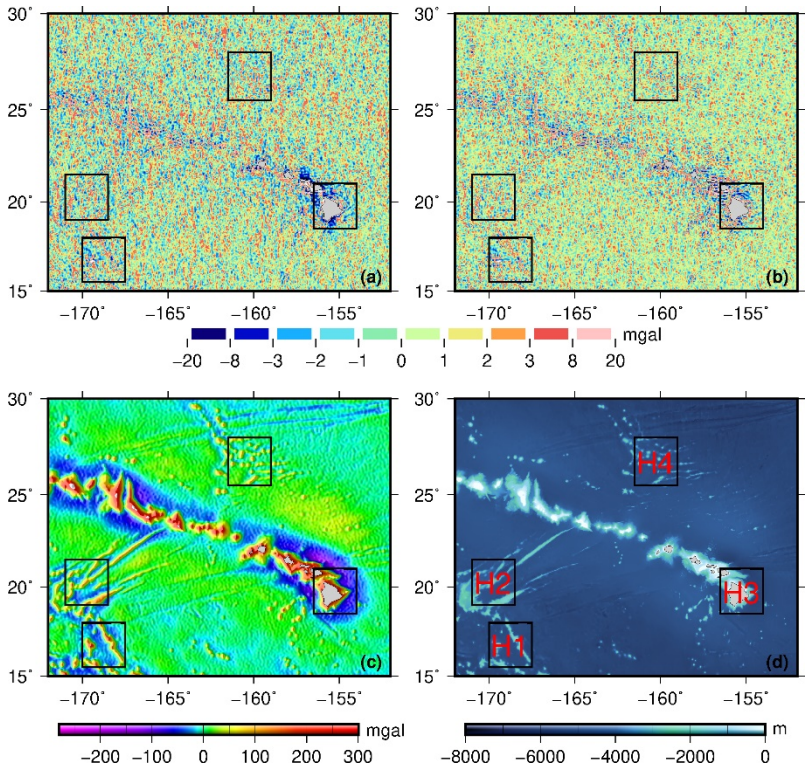
Ocean area	Number	Long. range Lat. range	STD of Height anomaly/m	STD of Gravity/mGal	Depth range/m	Mean depth/m	Comments
Northwestern Atlantic	Entire	270~340 20~55	--	28.59	-8155~2065	-2861.5	--
	N1	279.0~281.5 27.0~29.5	0.3023	20.63	-961~30	-387.7	Ocean Current (flow north)
	N2	282.0~284.5 31.5~34.0	0.3376	27.73	-3617~9	-1288.6	Ocean Current (flow northeast)
	N3	288.0~290.5 36.0~38.5	0.5161	6.96	-4627~-2807	-3922.6	Ocean Current (flow east)
	N4	330.5~333.0 37.0~39.5	0.1195	27.86	-3536~2065	-1596.7	Mid-ocean Ridge (large residual signal)
	N5	323.5~326.0 53.0~55.0	0.1045	19.29	-3418~-714	-2134.1	Mid-ocean Ridge (north-south ridge)
	N6	327.5~330.0 51.5~53.5	0.1597	26.16	-4859~-824	-3076.9	Mid-ocean Ridge (east-west trench)
	N7	302.5~305.0 23.5~26.0	0.1029	10.58	-6892~-4405	-5856.7	Abyssal Plain (smooth region)



Residual marine gravity anomalies derived from the SSS-based method (a) and the SSH-based method (b) over the Northwestern Atlantic area. The subfigures (c) and (d) show the marine gravity anomalies (EGM2008) and ocean depth (GEBCO_2020).

Validation information in selected boxes

Ocean area	Specific region	Count of marine data	**SSS-based method**	**SSH-based method**	EGM08	DTU17	V27.1
Northwestern Atlantic	N1	62051	4.015	2.401	1.744	1.764	4.096
	N2	63915	2.859	2.336	1.809	1.853	2.668
	N3	6754	3.937	3.839	2.570	3.015	3.933
	N4	5399	3.664	3.836	3.641	3.188	3.389
	N5	1176	2.977	3.134	3.829	3.146	2.906
	N6	1880	3.269	4.101	4.692	3.570	3.105
	N7	2219	2.785	2.748	2.958	2.709	2.689



Residual marine gravity anomalies derived from the SSS-based method (a) and the SSH-based method (b) over the Hawaii ocean area. The subfigures (c) and (d) show the marine gravity anomalies (EGM2008) and ocean depth (GEBCO_2020).

Validation information in Hawaii area

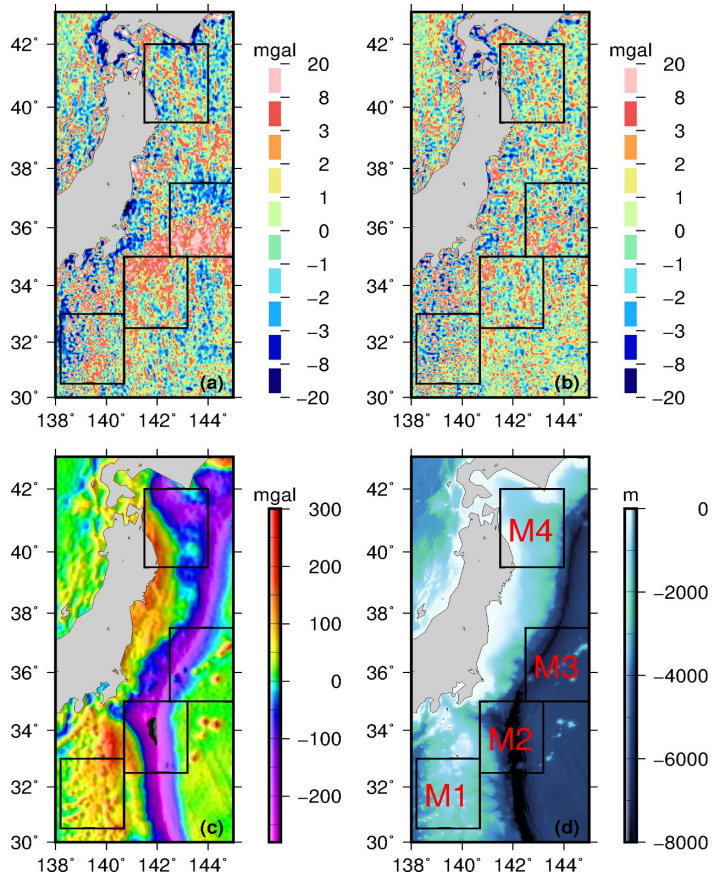
Ocean area	Description	STD of Height anomaly/m	Count of Altimeter data	Count of marine data	**SSS-based method**	**SSH-based method**	EGM08	DTU17	V27.1
Hawaii	Entire	--	--	153578	**5.507**	**5.214**	5.520	5.175	5.445
	0-15km	0.123	8314	7953	**12.892**	**10.468**	10.562	10.264	13.121
	15-50 km	0.121	37936	15915	**6.934**	**6.862**	7.056	6.583	6.863
	50+ km	0.141	1874265	129489(84.3%)	**4.337**	**4.384**	4.779	4.423	4.234

General information of selected boxes

Ocean area	Number	Long. range Lat. range	STD of Height anomaly/m	STD of Gravity/mGal	Depth range/m	Mean depth/m	Comments
Hawaii	Entire	188.0~208.0 15.0~30.0	--	45.41	-6849~ 4120	-4753.5	--
	H1	190.0~192.5 15.5~18.0	0.1191	46.00	-5558~ 206	-4473.9	Seafloor topography (northwest-direction)
	H2	189.0~191.5 19.0~21.5	0.1196	36.99	-5500~ -939	-4029.2	Seafloor topography (northeast-direction)
	H3	203.5~206.0 18.5~21.0	0.1263	168.59	-5835~ 4120	-3017.1	Sea islands (coastal region)
	H4	198.5~201.0 25.5~28.0	0.1158	18.68	-5824~ -1426	-4662.7	Seafloor topography (east-west direction)

Validation information in selected boxes

Ocean area	Specific region	Count of marine data	**SSS-based method**	**SSH-based method**	EGM08	DTU17	V27.1
Hawaii	H1	3096	3.769	3.901	4.267	3.805	3.538
	H2	1450	4.586	4.790	5.411	5.003	4.496
	H3	13504	8.114	6.968	7.083	6.760	7.921
	H4	2666	4.962	5.190	5.743	5.223	4.931



Residual marine gravity anomalies derived from the SSS-based method (a) and the SSH-based method (b) over the Mariana Trench area. The subfigures (c) and (d) show the marine gravity anomalies (EGM2008) and ocean depth (GEBCO_2020).

Validation information in Mariana area

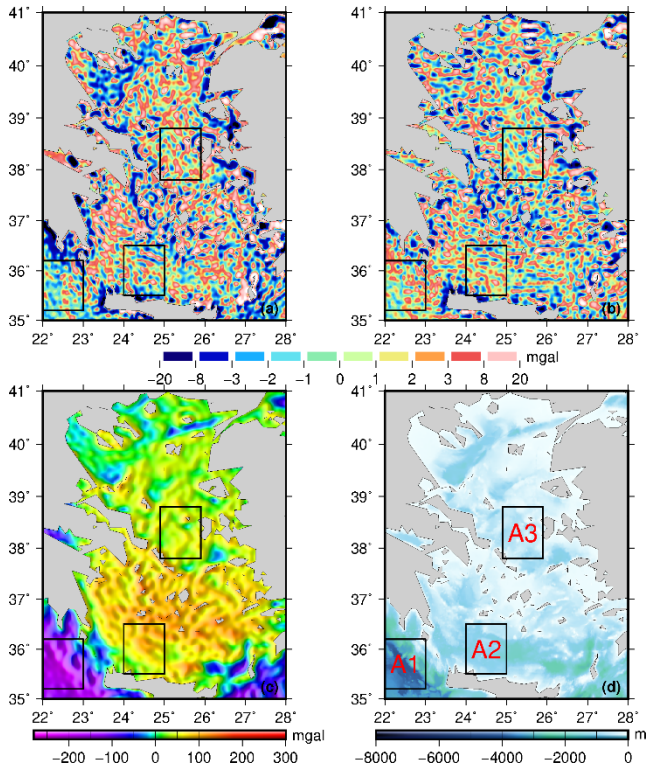
Ocean area	Description	STD of Height anomaly/m	Count of Altimeter data	Count of marine data	**SSS-based method**	**SSH-based method**	EGM08	DTU17	V27.1
Mariana	Entire	--	--	190825	**5.923**	**5.876**	6.203	5.817	5.697
	0-15km	0.263	23484	11409	**9.201**	**8.608**	9.106	8.765	9.145
	15-50 km	0.327	62255	39936	**6.239**	**6.175**	6.452	6.157	6.020
	50+ km	0.524	378578	139318(73.0%)	**5.443**	**5.494**	5.808	5.386	5.190

General information of selected boxes

Ocean area	Number	Long. range Lat. range	STD of Height anomaly/m	STD of Gravity/mGal	Depth range/m	Mean depth/m	Comments
Mariana	Entire	138.0~145.0 30.0~43.0	--	90.46	-9726~ 3664	-2724.0	--
	M1	138.2~140.7 30.5~33.0	0.3134	34.29	-4055~ 301	-1885.4	Seafloor topography (rapid-change depths)
	M2	140.7~143.2 32.5~35.0	0.2849	122.23	-9450~ -931	-5799.2	Trench (north-south direction)
	M3	142.5~145.0 35.0~37.5	0.4801	71.17	-8046~ -1073	-5754.5	Long-wavelength residual signal
	M4	141.5~144.0 39.5~42.0	0.1512	94.50	-4995~ 1598	-1235.7	Coastal (rapid-change depths)

Validation information in selected boxes

Ocean area	Specific region	Count of marine data	**SSS-based method**	**SSH-based method**	EGM08	DTU17	V27.1
Mariana	M1	54823	5.313	5.595	6.375	5.627	4.978
	M2	16037	5.351	5.281	5.174	5.099	5.226
	M3	5697	7.428	7.301	7.039	7.008	7.163
	M4	4959	6.369	6.351	6.230	6.189	6.314



Residual marine gravity anomalies derived from the SSS-based method (a) and the SSH-based method (b) over the Aegean Sea area. The subfigures (c) and (d) show the marine gravity anomalies (EGM2008) and ocean depth (GEBCO_2020).

Validation information in Aegean area

Ocean area	Description	STD of Height anomaly/m	Count of Altimeter data	Count of marine data	**SSS-based method**	**SSH-based method**	EGM08	DTU17	V27.1
Aegean	Entire	--	--	19645	**5.673**	**5.623**	7.052	6.261	6.031
	0-15km	0.137	27951	7375	**7.005**	**6.241**	8.186	7.324	7.680
	15-50 km	0.103	27846	9418	**4.947**	**5.469**	6.408	5.725	5.040
	50+ km	0.095	6685	2852(14.5%)	**3.748**	**4.257**	4.997	4.449	3.682

General information of selected boxes

Ocean area	Number	Long. range Lat. range	STD of Height anomaly/m	STD of Gravity/mGal	Depth range/m	Mean depth/m	Comments
Aegean	Entire	22.0~28.0 35.0~41.0	--	59.97	-4791~ 2724	-323.2	--
	A1	22.0~23.0 35.2~36.2	0.0982	51.28	-4791~ 385	-3149.6	Deep water
	A2	24.0~25.0 35.5~36.5	0.0854	25.41	-1768~ 356	-896.8	Medium depths
	A3	24.9~25.9 37.8~38.8	0.0919	16.84	-970~ 732	-448.7	Shallow water

Validation information in selected boxes

Ocean area	Specific region	Count of marine data	**SSS-based method**	**SSH-based method**	EGM08	DTU17	V27.1
Aegean	A1	3448	4.158	4.591	5.218	4.703	4.127
	A2	3664	4.686	3.874	5.027	4.419	4.747
	A3	442	4.183	4.666	5.918	5.376	4.157

Conclusions

(1) The SSH-based method has minor advantages in the overall accuracy level because of consistency over both coastal and open ocean areas. The advantage of the SSH-based method is especially prominent over coastal regions. The SSS-based method performs better in calculating marine gravity anomalies over the open ocean.

(2) The SSS-based method is more sensitive to seafloor topography except when the orientation of topography (e.g., trench) is parallel to the orientations of altimeter ground tracks. Also, the SSS-based method is more vulnerable to the energetic western boundary currents, as these generally flow along the direction of ground tracks.

(3) In the deep ocean areas where the seafloor topography is plain and smooth, there is no significant difference between the two methods.