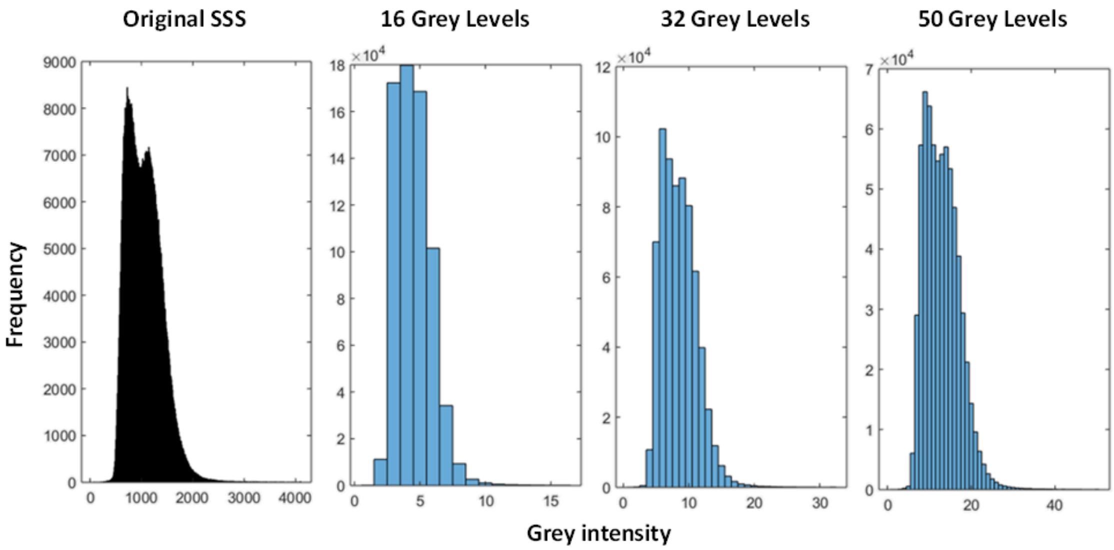
remote sensing

1

2 ## 1. Multiscale Textural Analysis



3

4 **Figure S1.** Histogram example of SSS mosaic at different grey levels. Thirty-two grey levels capture
5 the double peak yet remains computationally efficient.

6

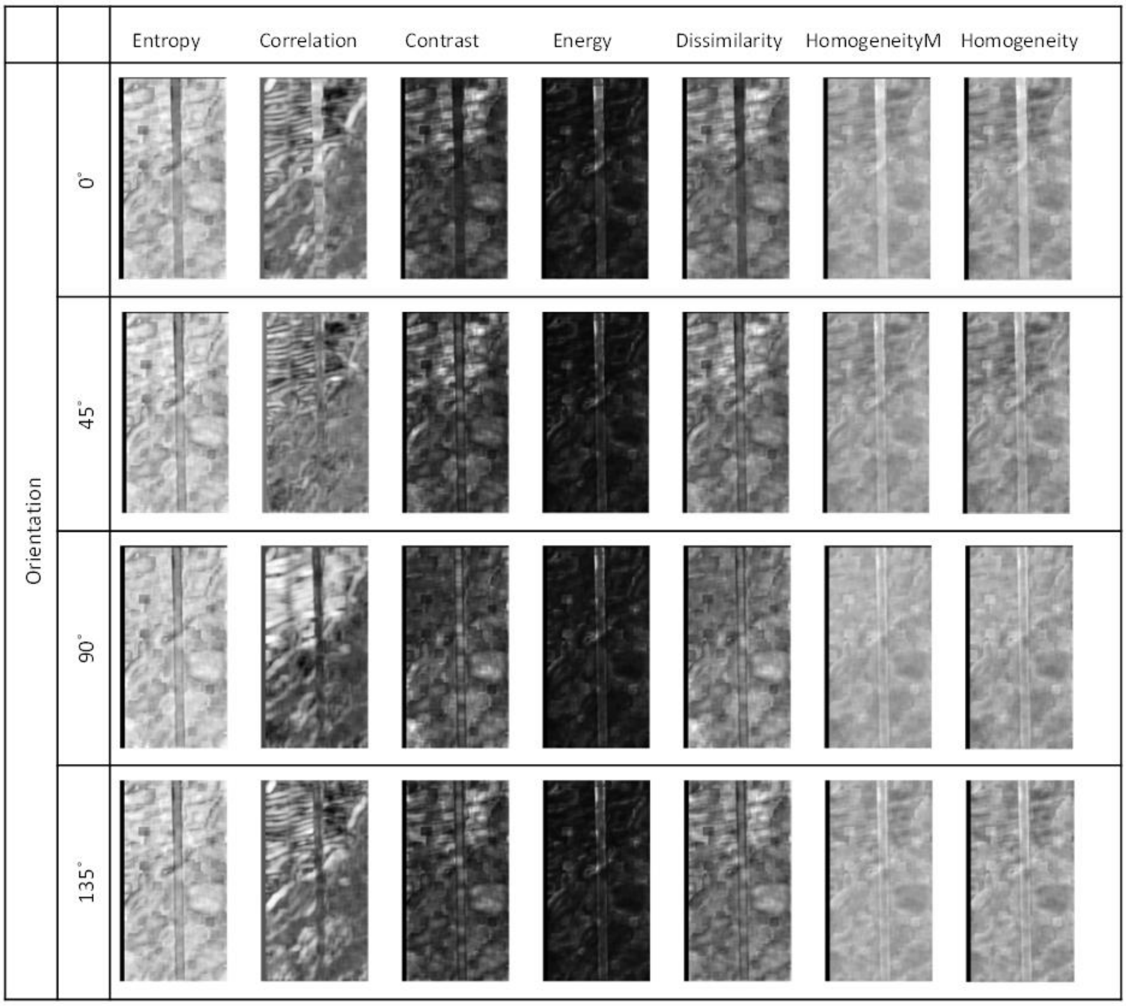


Figure S2. Example results of textural analysis with GLCM, using different statistics and different orientations at windows size of 51 pixels and inter-pixel distance of 12 pixels. Contrast and Correlation appear to capture the most variation in the SSS mosaic.

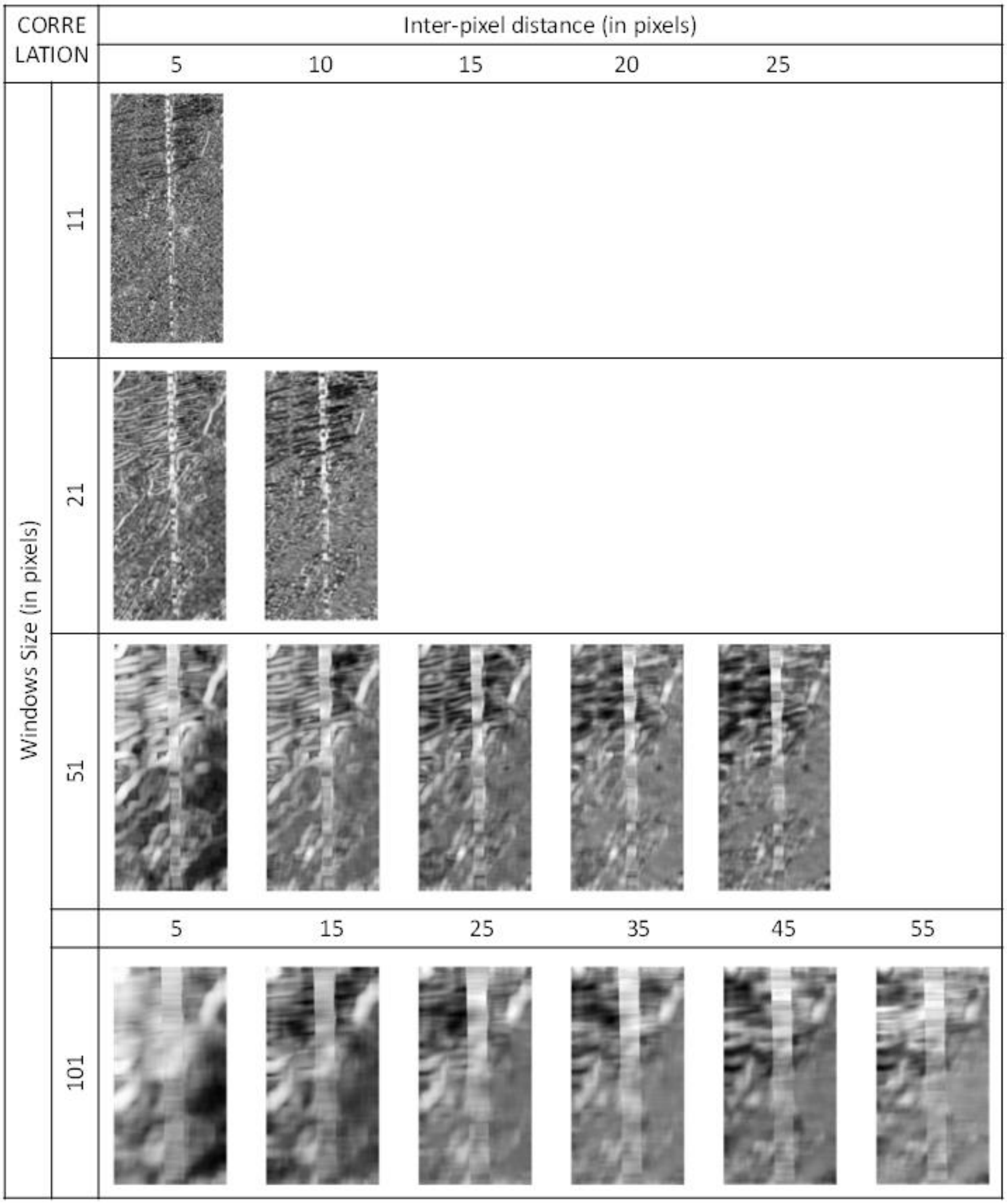


Figure S3. Example results of textural analysis with GLCM, calculated Correlation at different windows size and inter-pixel distance.

2. Multiscale Terrain Analysis

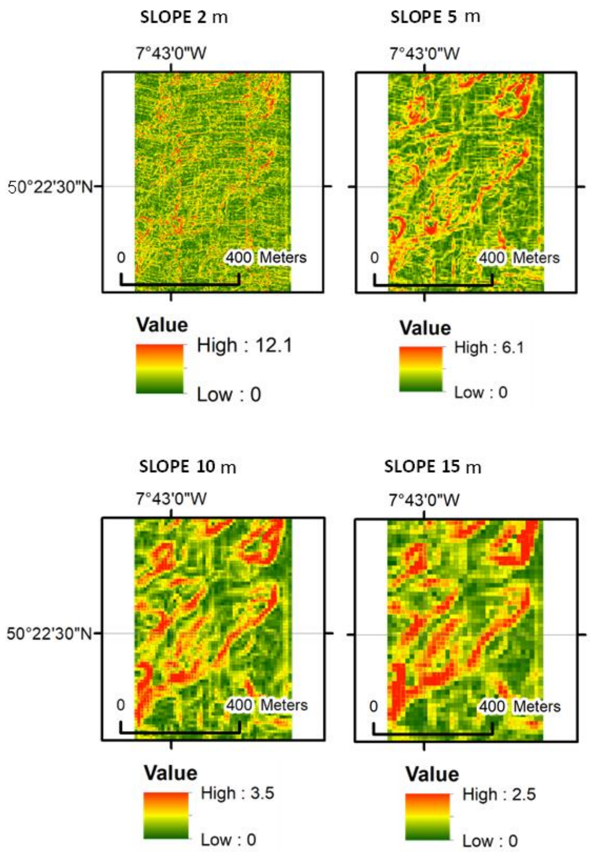


Figure S4. Example of terrain derivative slope at different scales

3. Feature Reduction

Table S1. Coefficients of the first three Terrain Derivative PCs for each year. These coefficients represent the correlation between the original variable and the PCs.

	Terrain Derivatives 2012			Terrain Derivatives 2015		
Feature	**PC1**	**PC2**	**PC3**	**PC1**	**PC2**	**PC3**
SLOPE 2	-0.19	0.28	0.01	-0.16	0.25	0.02
EASTNESS 2	0.26	0.18	0.24	0.22	0.12	0.27
NORTHNESS 2	-0.12	-0.14	0.30	-0.16	-0.18	0.26
SLOPE 5	-0.31	0.43	0.02	-0.30	0.44	0.09
EASTNESS 5	0.35	0.24	0.31	0.33	0.17	0.37
NORTHNESS 5	-0.21	-0.20	0.44	-0.25	-0.27	0.38
SLOPE 10	-0.33	0.46	0.04	-0.33	0.46	0.10
EASTNESS 10	0.38	0.25	0.31	0.37	0.17	0.38
NORTHNESS 10	-0.26	-0.21	0.46	-0.29	-0.28	0.40
SLOPE 15	-0.31	0.43	0.03	-0.31	0.43	0.10
EASTNESS 15	0.36	0.23	0.28	0.36	0.15	0.35
NORTHNESS 15	-0.26	-0.19	0.42	-0.29	-0.25	0.36

Table S2. Coefficients of the first five Gabor Textural PCs for each year. These coefficients represent the correlation between the original variable and the PCs.

			Textural Derivatives 2012					Textural Derivatives 2015				
Feature	**'λ'**	**'θ'**	**PC1**	**PC2**	**PC3**	**PC4**	**PC5**	**PC1**	**PC2**	**PC3**	**PC4**	**PC5**
Gabor1	3	0	0.13	-0.01	0.08	0.00	0.07	0.13	-0.02	0.03	0.07	0.00
Gabor2	6	0	0.09	0.01	0.14	0.00	0.09	0.09	-0.04	0.09	0.12	-0.02
Gabor3	11	0	0.01	0.00	0.22	0.06	0.10	0.01	-0.07	0.23	0.15	-0.06
Gabor4	23	0	-0.02	0.04	0.26	0.07	0.06	-0.02	-0.06	0.23	0.17	-0.07
Gabor5	45	0	-0.04	0.07	0.26	0.09	0.02	-0.03	-0.04	0.26	0.11	-0.08
Gabor6	91	0	-0.03	0.05	0.20	0.08	0.06	0.00	-0.03	0.18	0.02	-0.07
Gabor7	181	0	-0.01	0.06	0.05	0.10	0.06	0.01	0.00	0.09	0.02	-0.05
Gabor8	362	0	0.02	0.10	-0.13	0.24	-0.03	0.06	0.05	0.05	-0.16	-0.09
Gabor9	724	0	0.03	0.14	-0.09	0.27	0.07	0.06	0.05	0.05	-0.12	-0.11
Gabor10	1448	0	0.03	0.15	-0.12	0.28	0.06	0.04	0.05	0.02	-0.10	-0.07
Gabor11	3	45	0.07	-0.03	0.10	-0.03	0.15	0.07	-0.07	0.01	0.18	0.00
Gabor12	6	45	0.07	-0.02	0.11	-0.02	0.16	0.06	-0.07	0.02	0.20	-0.01
Gabor13	11	45	0.06	-0.01	0.12	-0.02	0.18	0.05	-0.06	0.03	0.23	-0.04
Gabor14	23	45	0.03	0.02	0.14	-0.03	0.20	0.02	-0.03	0.03	0.23	-0.12
Gabor15	45	45	-0.01	0.07	0.11	0.00	0.19	-0.02	0.02	0.03	0.20	-0.18
Gabor16	91	45	-0.01	0.09	0.05	0.03	0.19	-0.03	0.04	0.02	0.15	-0.18
Gabor17	181	45	-0.01	0.06	0.02	0.07	0.13	-0.02	0.04	0.01	0.10	-0.12
Gabor18	362	45	0.01	0.03	-0.01	0.13	0.08	-0.01	0.04	0.03	0.01	-0.13
Gabor19	724	45	0.02	0.10	-0.11	0.26	0.04	0.02	0.06	0.03	-0.07	-0.14
Gabor20	1448	45	0.02	0.12	-0.12	0.25	0.04	0.09	0.01	0.06	-0.09	-0.07
Gabor21	3	90	0.05	-0.01	0.09	-0.04	0.16	0.05	-0.06	0.02	0.17	-0.02
Gabor22	6	90	0.05	0.00	0.08	-0.05	0.19	0.05	-0.05	0.02	0.21	-0.03
Gabor23	11	90	0.05	0.04	0.05	-0.07	0.21	0.04	0.01	-0.02	0.21	-0.09
Gabor24	23	90	0.04	0.09	0.01	-0.09	0.21	0.02	0.09	-0.06	0.19	-0.15
Gabor25	45	90	0.03	0.13	-0.03	-0.06	0.20	0.00	0.14	-0.06	0.15	-0.20
Gabor26	91	90	0.02	0.13	-0.04	0.02	0.19	-0.01	0.12	-0.04	0.11	-0.19
Gabor27	181	90	0.03	0.11	-0.04	0.12	0.14	-0.01	0.07	-0.01	0.09	-0.13
Gabor28	362	90	0.03	0.11	-0.04	0.17	0.13	0.01	0.04	0.02	0.09	-0.10
Gabor29	724	90	0.04	0.13	-0.10	0.26	0.05	0.03	0.05	0.01	-0.09	-0.05
Gabor30	1448	90	0.02	0.13	-0.09	0.25	0.11	0.09	0.01	0.06	-0.05	-0.07
Gabor31	3	135	0.08	-0.03	0.10	-0.02	0.14	0.08	-0.06	0.01	0.15	0.01
Gabor32	6	135	0.07	-0.02	0.12	-0.03	0.16	0.07	-0.06	0.03	0.20	0.02
Gabor33	11	135	0.04	0.02	0.13	-0.07	0.17	0.03	-0.02	0.02	0.26	0.08
Gabor34	23	135	0.00	0.08	0.12	-0.12	0.13	-0.01	0.05	0.02	0.27	0.14
Gabor35	45	135	-0.02	0.11	0.09	-0.14	0.08	-0.04	0.10	0.02	0.23	0.15
Gabor36	91	135	-0.02	0.10	0.06	-0.11	0.03	-0.04	0.10	0.03	0.16	0.12
Gabor37	181	135	-0.01	0.04	0.03	-0.04	-0.01	-0.02	0.07	0.02	0.04	0.07
Gabor38	362	135	0.01	0.07	0.01	0.05	0.04	-0.01	0.06	0.03	0.00	-0.05
Gabor39	724	135	0.02	0.12	-0.09	0.20	0.01	-0.01	0.07	0.02	-0.06	-0.04
Gabor40	1448	135	0.02	0.04	-0.10	0.11	-0.11	0.06	0.00	0.04	-0.06	0.05

Table S3. Coefficients of the first five GLCM Textural PCs for each year. These coefficients represent the correlation between the original variable and the PCs.

	Textural Derivatives 2012	Textural Derivatives 2015

Feature	Statistic	WS	'δ'	'θ'	PC1	PC2	PC3	PC4	PC5	PC1	PC2	PC3	PC4	PC5
GLCM1	Contrast	11	5	0	0.11	0.01	-0.05	-0.01	-0.05	0.13	0.04	-0.05	-0.05	0.02
GLCM2	Contrast	11	5	45	0.09	0.05	0.01	0.00	-0.08	0.08	0.06	0.05	0.00	0.06
GLCM3	Contrast	11	5	90	0.11	-0.01	0.03	0.05	-0.10	0.13	0.00	0.05	-0.06	0.03
GLCM4	Contrast	11	5	135	0.07	0.00	0.00	0.04	-0.06	0.08	0.01	0.05	-0.04	-0.08
GLCM5	Contrast	21	5	0	0.16	-0.01	-0.05	0.00	-0.07	0.16	0.02	-0.03	-0.05	0.02
GLCM6	Contrast	21	5	45	0.16	0.02	0.00	0.01	-0.10	0.15	0.03	0.04	-0.02	0.05
GLCM7	Contrast	21	5	90	0.16	-0.02	0.01	0.04	-0.10	0.17	-0.01	0.03	-0.05	0.03
GLCM8	Contrast	21	5	135	0.14	-0.02	-0.01	0.04	-0.09	0.14	0.00	0.04	-0.05	-0.05
GLCM9	Contrast	21	10	0	0.15	0.04	-0.05	-0.02	-0.07	0.15	0.08	-0.05	-0.02	0.00
GLCM10	Contrast	21	10	45	0.12	0.09	0.01	-0.03	-0.13	0.12	0.12	0.04	-0.02	0.08
GLCM11	Contrast	21	10	90	0.15	0.02	0.04	0.04	-0.13	0.14	0.01	0.08	-0.04	0.04
GLCM12	Contrast	21	10	135	0.13	0.03	0.01	0.04	-0.08	0.14	0.04	0.04	-0.06	-0.09
GLCM13	Contrast	51	5	0	0.19	-0.01	-0.01	-0.01	-0.01	0.18	0.01	-0.01	-0.01	0.02
GLCM14	Contrast	51	5	45	0.19	0.00	0.01	-0.01	-0.02	0.18	0.01	0.02	0.01	0.03
GLCM15	Contrast	51	5	90	0.19	-0.01	0.02	0.00	-0.02	0.18	0.00	0.02	-0.01	0.02
GLCM16	Contrast	51	5	135	0.18	-0.02	0.00	-0.01	-0.01	0.18	-0.01	0.02	0.00	-0.01
GLCM17	Contrast	51	10	0	0.19	0.01	-0.01	-0.02	0.00	0.18	0.03	-0.03	0.01	0.01
GLCM18	Contrast	51	10	45	0.18	0.03	0.02	-0.03	-0.03	0.18	0.05	0.02	0.01	0.03
GLCM19	Contrast	51	10	90	0.18	0.00	0.04	0.00	-0.03	0.18	0.00	0.04	0.01	0.03
GLCM20	Contrast	51	10	135	0.19	0.01	0.02	0.00	-0.01	0.18	0.01	0.02	0.00	-0.03
GLCM21	Contrast	51	15	0	0.19	0.03	-0.02	-0.04	0.00	0.18	0.06	-0.03	0.01	0.00
GLCM22	Contrast	51	15	45	0.18	0.07	0.03	-0.04	-0.04	0.17	0.10	0.04	0.02	0.04
GLCM23	Contrast	51	15	90	0.18	0.02	0.05	0.00	-0.04	0.18	0.01	0.06	0.00	0.02
GLCM24	Contrast	51	15	135	0.18	0.03	0.03	0.00	0.00	0.18	0.03	0.03	0.00	-0.06
GLCM25	Contrast	51	20	0	0.18	0.05	-0.02	-0.05	0.00	0.17	0.09	-0.04	0.02	0.00
GLCM26	Contrast	51	20	45	0.17	0.10	0.03	-0.05	-0.05	0.16	0.14	0.05	0.01	0.06
GLCM27	Contrast	51	20	90	0.18	0.03	0.06	0.00	-0.05	0.17	0.03	0.07	0.00	0.03
GLCM28	Contrast	51	20	135	0.18	0.04	0.04	0.01	-0.01	0.17	0.05	0.04	-0.01	-0.08
GLCM29	Contrast	51	25	0	0.18	0.07	-0.03	-0.06	0.00	0.17	0.11	-0.04	0.02	-0.01
GLCM30	Contrast	51	25	45	0.15	0.13	0.02	-0.06	-0.07	0.14	0.16	0.05	0.00	0.07
GLCM31	Contrast	51	25	90	0.18	0.05	0.06	-0.01	-0.06	0.17	0.05	0.08	-0.01	0.04
GLCM32	Contrast	51	25	135	0.17	0.06	0.03	0.01	-0.01	0.16	0.07	0.04	-0.02	-0.10
GLCM33	Correlation	11	5	0	-0.02	0.01	0.11	0.06	-0.05	-0.05	-0.02	0.16	0.02	-0.01
GLCM34	Correlation	11	5	45	0.00	-0.05	-0.03	0.02	0.02	0.03	-0.05	-0.04	-0.05	-0.05
GLCM35	Correlation	11	5	90	-0.01	0.05	-0.06	-0.07	0.04	-0.07	0.07	-0.07	0.05	-0.05
GLCM36	Correlation	11	5	135	0.03	0.00	-0.01	-0.03	-0.01	0.04	0.00	-0.04	0.00	0.12
GLCM37	Correlation	21	5	0	-0.06	0.11	0.17	0.04	-0.08	-0.09	0.07	0.20	0.04	-0.01
GLCM38	Correlation	21	5	45	-0.04	0.04	0.00	0.00	0.00	0.01	0.05	0.00	-0.06	-0.10
GLCM39	Correlation	21	5	90	-0.04	0.16	-0.04	-0.10	0.02	-0.10	0.16	-0.03	0.06	-0.05
GLCM40	Correlation	21	5	135	0.02	0.12	0.03	-0.08	-0.04	0.02	0.13	0.00	0.03	0.15
GLCM41	Correlation	21	10	0	-0.04	-0.01	0.18	0.11	-0.10	-0.02	-0.06	0.25	-0.06	0.01
GLCM42	Correlation	21	10	45	0.03	-0.12	-0.03	0.06	0.05	0.03	-0.13	-0.03	-0.05	-0.08
GLCM43	Correlation	21	10	90	-0.01	0.06	-0.14	-0.09	0.08	0.01	0.12	-0.14	-0.01	-0.08
GLCM44	Correlation	21	10	135	0.02	-0.03	-0.04	-0.05	-0.02	0.01	-0.02	-0.03	0.03	0.20
GLCM45	Correlation	51	5	0	-0.10	0.21	0.12	0.00	-0.09	-0.12	0.17	0.17	0.01	-0.03
GLCM46	Correlation	51	5	45	-0.09	0.23	0.03	-0.06	-0.05	-0.06	0.25	0.08	-0.03	-0.07
GLCM47	Correlation	51	5	90	-0.08	0.24	0.00	-0.09	-0.02	-0.12	0.20	0.04	0.02	-0.05
GLCM48	Correlation	51	5	135	-0.03	0.27	0.05	-0.09	-0.07	-0.04	0.27	0.07	0.01	0.04
GLCM49	Correlation	51	10	0	-0.10	0.17	0.16	0.04	-0.14	-0.08	0.14	0.27	-0.06	0.00

GLCM50	Correlation	51	10	45	-0.03	0.16	0.02	0.01	-0.04	-0.04	0.13	0.12	-0.07	-0.13
GLCM51	Correlation	51	10	90	-0.07	0.24	-0.09	-0.11	-0.01	-0.05	0.28	-0.01	-0.03	-0.07
GLCM52	Correlation	51	10	135	-0.05	0.23	0.01	-0.13	-0.11	-0.06	0.23	0.08	0.02	0.16
GLCM53	Correlation	51	15	0	-0.07	0.10	0.21	0.09	-0.16	-0.06	0.04	0.31	-0.08	0.03
GLCM54	Correlation	51	15	45	0.02	-0.08	-0.03	0.08	0.05	0.03	-0.09	-0.02	-0.08	-0.16
GLCM55	Correlation	51	15	90	-0.03	0.20	-0.17	-0.12	0.03	-0.04	0.26	-0.12	-0.02	-0.07
GLCM56	Correlation	51	15	135	-0.02	0.13	-0.04	-0.15	-0.11	-0.03	0.16	0.00	0.04	0.29
GLCM57	Correlation	51	20	0	-0.05	0.02	0.23	0.14	-0.16	-0.04	-0.05	0.31	-0.10	0.03
GLCM58	Correlation	51	20	45	0.05	-0.19	-0.07	0.09	0.10	0.05	-0.20	-0.09	-0.04	-0.13
GLCM59	Correlation	51	20	90	0.00	0.13	-0.23	-0.12	0.08	-0.01	0.20	-0.19	-0.01	-0.09
GLCM60	Correlation	51	20	135	0.02	0.00	-0.07	-0.14	-0.07	0.01	0.05	-0.05	0.06	0.34
GLCM61	Correlation	51	25	0	-0.04	-0.04	0.23	0.16	-0.15	-0.03	-0.10	0.29	-0.10	0.02
GLCM62	Correlation	51	25	45	0.05	-0.22	-0.05	0.09	0.11	0.05	-0.22	-0.08	-0.01	-0.11
GLCM63	Correlation	51	25	90	0.02	0.07	-0.22	-0.10	0.12	0.01	0.14	-0.21	0.01	-0.11
GLCM64	Correlation	51	25	135	0.03	-0.08	-0.06	-0.09	-0.04	0.03	-0.04	-0.05	0.07	0.30

4. Classification

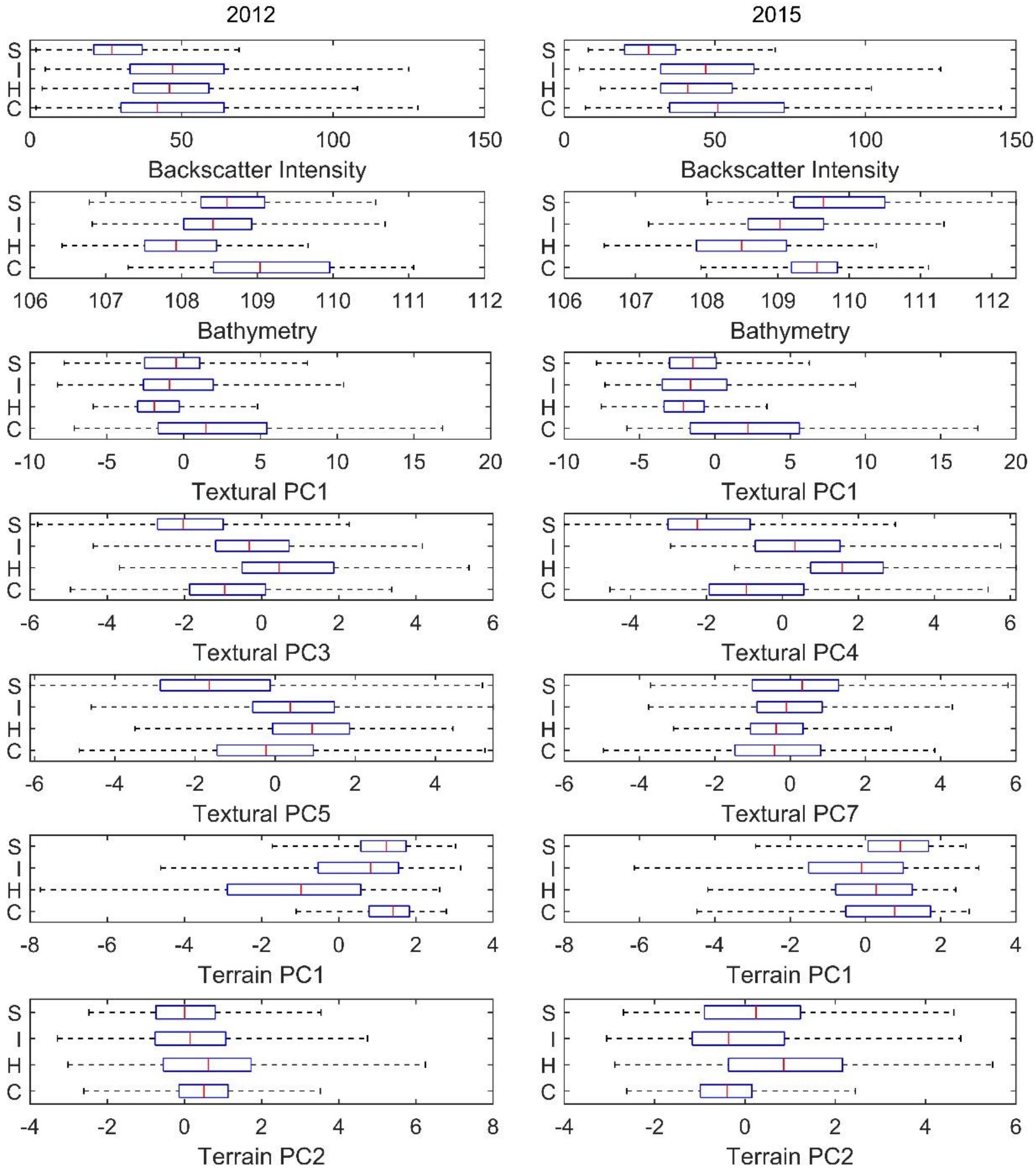


Figure S5. Box-plot showing habitat discrimination of 2012 and 2015 groundtruth data for SSS backscatter, Bathymetry, three top relevant Textural PCs (Figure 12) and first two Terrain PCs.

Table S4. RF algorithm confusion matrices from 2015 day 1 and day 2 models, and their pixel-by-pixel comparison.

		Groundtruth Class					
		Coarse	Hard	Int.	Sand	TOTAL	User's Accuracy
Predicted Class	Coarse	48	3	14	8	73	65.8%
	Hard	5	38	22	1	66	57.6%
	Int.	25	10	42	15	92	45.7%
	Sand	11	5	8	58	82	70.7%
	TOTAL	89	56	86	82	313	

	Producer's Accuracy	53.9%	67.9%	48.8%	70.7%		
Overall Accuracy = 59.4%			BER = 0.40			Kappa Coeff. = 0.46	
Values in table indicate number of validation groundtruth points							

		Groundtruth Class					
		Coarse	Hard	Int.	Sand	TOTAL	User's Accuracy
Predicted Class	Coarse	64	0	27	11	102	62.7%
	Hard	3	36	9	5	53	67.9%
	Int.	14	18	56	9	97	57.7%
	Sand	14	4	10	62	90	68.9%
	TOTAL	95	58	102	87	342	
	Producer's Accuracy	67.4%	62.1%	54.9%	71.3%		
Overall Accuracy = 63.7%			BER = 0.36			Kappa Coeff. = 0.51	
Values in table indicate number of validation groundtruth points							

		2015 Day 1					
		Coarse	Hard	Int.	Sand	TOTAL	User's Accuracy
2015 Day 2	Coarse	19	0.3	9.5	4.7	33.5	56.7%
	Hard	1.4	8.4	2.8	0.5	13.1	64.1%
	Int.	3.7	6.4	13.7	3.2	27	50.7%
	Sand	2.2	0.9	4.1	19.3	26.5	72.8%
	TOTAL	26.3	16	30.1	27.7	100	
	Producer's Accuracy	72.2%	52.5%	45.5%	69.7%		
Overall Accuracy = 60.3%			BER = 0.40			Kappa Coeff. = 0.46	
Values in table indicate percentage of total area							

Table S5. KNN algorithm confusion matrices from 2015 day 1 and day 2 models, and their pixel-by-pixel comparison.

		Groundtruth Class					
		Coarse	Hard	Int.	Sand	TOTAL	User's Accuracy
Predicted Class	Coarse	55	7	18	20	100	55.0%
	Hard	3	28	23	3	57	49.1%
	Int.	20	16	34	8	78	43.6%
	Sand	11	5	11	51	78	65.4%
	TOTAL	89	56	86	82	313	55.0%
	Producer's Accuracy	61.8%	50.0%	39.5%	62.2%		
Overall Accuracy = 53.7%			BER = 0.47			Kappa Coeff. = 0.38	

Values in table indicate number of validation groundtruth points

48

		Groundtruth Class					
		Coarse	Hard	Int.	Sand	TOTAL	User's Accuracy
Predicted Class	Coarse	57	18	34	21	130	43.8%
	Hard	3	29	10	6	48	60.4%
	Int.	17	8	43	10	78	55.1%
	Sand	18	3	15	50	86	58.1%
	TOTAL	95	58	102	87	342	43.8%
	Producer's Accuracy	60.0%	50.0%	42.2%	57.5%		
Overall Accuracy = 52.3%			BER = 0.48		Kappa Coeff. = 0.35		

Values in table indicate number of validation groundtruth points

49

		2015 Day 1					
		Coarse	Hard	Int.	Sand	TOTAL	User's Accuracy
2015 Day 2	Coarse	19.4	4.3	8.6	6.8	39.1	49.6%
	Hard	4.3	6.8	3.9	2.3	17.3	39.3%
	Int.	6.9	3.6	7.1	2.6	20.2	35.1%
	Sand	4.9	2.2	2.4	13.9	23.4	59.4%
	TOTAL	35.5	16.9	22	25.6	100	
	Producer's Accuracy	54.6%	16.9	32.3	54.3		
Overall Accuracy = 47.2%			BER = 0.55		Kappa Coeff. = 0.27		

Values in table indicate percentage of total area

50 **Table S6.** KMEANS algorithm confusion matrices from 2015 day 1 and day 2 models, and their pixel-
51 by-pixel comparison.

52

		Groundtruth Class					
		Coarse	Hard	Int.	Sand	TOTAL	User's Accuracy
Predicted Class	Coarse	37	0	16	11	64	57.8%
	Hard	7	30	12	3	52	57.7%
	Int.	19	15	39	30	103	37.9%
	Sand	23	11	23	36	93	38.7%
	TOTAL	86	56	90	80	64	57.8%
	Producer's Accuracy	43.0%	53.6%	43.3%	45.0%	312	
Overall Accuracy = 45.4%			BER = 0.54		Kappa Coeff. = 0.27		

Values in table indicate number of validation groundtruth points

		Groundtruth Class					
		Coarse	Hard	Int.	Sand	TOTAL	User's Accuracy
Predicted Class	Coarse	31	0	17	9	57	54.4%
	Hard	26	41	65	15	147	27.9%
	Int.	28	16	15	42	101	14.9%
	Sand	10	0	6	21	37	56.8%
	TOTAL	95	57	103	87	342	
	Producer's Accuracy	32.6%	71.9%	14.6%	24.1%		
Overall Accuracy = 31.6%			BER = 0.64			Kappa Coeff. = 0.11	
Values in table indicate number of validation groundtruth points							

		2015 Day 1					
		Coarse	Hard	Int.	Sand	TOTAL	User's Accuracy
2015 Day 2	Coarse	10.7	0	0	0	10.7	100%
	Hard	0	1.3	1.3	23.5	39.5	37.2%
	Int.	0	19.4	19.4	1	20.5	94.6%
	Sand	18.6	0.2	0.2	8.6	29.3	29.4%
	TOTAL	29.3	20.9	20.9	33.1	100	
	Producer's Accuracy	36.5%	88.0%	92.8%	26.0%		
Overall Accuracy = 53.4%			BER = 0.39			Kappa Coeff. = 0.39	
Values in table indicate percentage of total area							

5. Matlab Scripts

5.1. *GLCM Script*

```
% This script uses the function 'glcm2D_all'
% to calculate Correlation and Contrast in a set of windows size and
% inter-pixel distance (offset)

[SSS, GeoRef] = geotiffread('SSS_mosaic.tif');

windows = [11;21;51];

offset{1}=5;
offset{2}=5:5:10;
offset{3}=5:5:25;

gL=32; % Gray levels
```

```
I=SSS;

% Initialising variables
results=cell(8,1);
time=zeros(8,1);

count=1;
for i=1:size(windows,1)
    win=windows(i);
    off=offset{i};
    for j=1:size(off,2)
        offs=off(j);
        results{count}=glcm2D_all(I,gL,win,offs);
        count=count+1;
    end
end
```

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5.2. *GLCM Function*

```
function out = glcm2D_all(imageMatrix,grayLevels,windowSize,distance)

% This function calculates these GLCM statistics for a sliding window:
% Entropy, Dissimilarity, Contrast, Correlation, Energy, Homogeneity
% (as per Haralick), Homogeneity (Matlab equation).
%
% Given one imageMatrix, one grayLevel, one windowSize, and one
% interpixel distance. It can take long time in processing depending
% on the image size, be sure you test with a small subimage before.

I = imageMatrix;
n = grayLevels; % number of gray levels
ws = windowSize; % windows size in pixels must be odd
d = distance; % distance in pixels

origSize = size(I);
offset = [d 0; d d; 0 d; -d d];

% Padding
% it padds the image, mirroring the information in the borders to
```

```
% avoid black edges in the results.

padSize = (ws-1) / 2;
Ipad = padarray(I,[ padSize padSize ],'symmetric','both');
newSize = size(Ipad);

% initialises variables (for speed)
out.Entropy = zeros(origSize(1),origSize(2),5);
out.Dissimilarity = zeros(origSize(1),origSize(2),5);
out.Contrast = zeros(origSize(1),origSize(2),5);
out.Correlation = zeros(origSize(1),origSize(2),5);
out.Energy = zeros(origSize(1),origSize(2),5);
out.HomogeneityMatlab = zeros(origSize(1),origSize(2),5);
out.Homogeneity = zeros(origSize(1),origSize(2),5);

entro  = zeros (1,1,4);
diss = zeros (1,1,4);
hom = zeros (1,1,4);

% generates (i-j) matrix
ij=toeplitz(1:n)-1;
ij=tril(ij)-triu(ij);

for r = (ws-1)/2+1: newSize(1)-(ws-1)/2
    r % shows in the command window what row is the calculation in
    for c = (ws-1)/2+1:newSize(2)-(ws-1)/2
        % Cuts sliding window from the image
        subI = Ipad(r-(ws-1)/2:r+(ws-1)/2,c-(ws-1)/2:c+(ws-1)/2);

        % Generates GLCM matrices in each 4 directions 0 45 90 135
        glcm(:,:,1:4) = graycomatrix(subI, 'NumLevels',...
            n, 'offset', offset(1:4,:), 'Symmetric', true,...
            'GrayLimits', []);

        % Calculates matlab inbuilt statistics (with glcm not
        % normalised)

        stats=graycoprops(glcm(:,:,1:4));

        con = stats.Contrast;
        corr = stats.Correlation;
        ene = stats.Energy;
        homm = stats.Homogeneity; %notice homm is different than hom
```

```
        % Normalises the matrices
        glcm=glcm./sum(sum(glcm));

        % Vectorization of the loops
        entro = - sum(sum(glcm.*log(glcm+eps)));
        diss = sum(sum(glcm.*abs(ij)));
        hom = sum(sum(glcm./(ij.^2 + 1)));

        % For anisotropic calculations: results on each direction
        % 1st dim = horizontal 0
        % 2nd dim = diagonal 45
        % 3rd dim = vertical 90
        % 4th dim = diagonal 135

        out.Contrast(r-(ws-1)/2,c-(ws-1)/2,1:4) = con(1:4);
        out.Correlation(r-(ws-1)/2,c-(ws-1)/2,1:4) = corr(1:4);
        out.Energy(r-(ws-1)/2,c-(ws-1)/2,1:4) = ene(1:4);
        out.HomogeneityMatlab(r-(ws-1)/2,c-(ws-1)/2,1:4) = homm(1:4);
        out.Entropy(r-(ws-1)/2,c-(ws-1)/2,1:4) = entro(1:4);
        out.Dissimilarity(r-(ws-1)/2,c-(ws-1)/2,1:4) = diss(1:4);
        out.Homogeneity(r-(ws-1)/2,c-(ws-1)/2,1:4) = hom(1:4);

        % Haralick recomends to use average of 4 directions glcm.
        % 5th dim = mean

        out.Entropy(r-(ws-1)/2,c-(ws-1)/2,5) = mean(entro);
        out.Dissimilarity(r-(ws-1)/2,c-(ws-1)/2,5) = mean(diss);
        out.Contrast(r-(ws-1)/2,c-(ws-1)/2,5) = mean(con);
        out.Correlation(r-(ws-1)/2,c-(ws-1)/2,5) = mean(corr);
        out.Energy(r-(ws-1)/2,c-(ws-1)/2,5) = mean(ene);
        out.HomogeneityMatlab(r-(ws-1)/2,c-(ws-1)/2,5) = mean(homm);
        out.Homogeneity(r-(ws-1)/2,c-(ws-1)/2,5) = mean(hom);

    end
end
```

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5.3. *Gabor Filters Script*

```
% This scripts generates a bank of Gabor filters, and applies it
% to the input image

% Read the image
SSS=imread('SSS_mosaic.tif');

% Design Array of Gabor Filters
imageSize = size(SSS);
numRows = imageSize(1);
numCols = imageSize(2);

wavelengthMin = 4/sqrt(2);
wavelengthMax = hypot(numRows,numCols);
n = floor(log2(wavelengthMax/wavelengthMin));
wavelength = 2.^(0:(n-2)) * wavelengthMin;

deltaTheta = 45;
orientation = 0:deltaTheta:(180-deltaTheta);

g = gabor(wavelength,orientation);

%  Extract Gabor magnitude features from source image.
gabormag = imgaborfilt(SSS,g);
```

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5.4. *Groundtruth subdivision Script*

```
% This script subdivides the groundtruth in two,
% randomly and ensuring equal separation per class

load Tablegroundtruth.mat
% Tablegroundtruth is a 3 column table w/ headers: habitat | col | row
% Column 1 indicates the habitat
% Column 2 indicates the groundtruth location as column on the matrix
% Column 3 indicates the groundtruth location as row on the matrix

table=Table_groundtruth;

HABITAT=table.habitat; %Column 1
COLUMN=table.col; %Column 2
ROW=table.row; %Column 3
```

```

% Discard 'non-annotated' and 'no data' values
nnan= HABITAT~= 'not-annotated' & HABITAT~= 'no data';
HABITAT=HABITAT(nnan);
ROW=ROW(nnan);
COLUMN=COLUMN(nnan);

% Discard 'NaN' from rows and columns
nnan= ~isnan(ROW);
HABITAT=HABITAT(nnan);
ROW=ROW(nnan);
COLUMN=COLUMN(nnan);

% Separates 4 habitats
x= HABITAT == 'sand';
H{1}=HABITAT(x);
R{1}=ROW(x);
C{1}=COLUMN(x);

x= HABITAT == 'coarse';
H{2}=HABITAT(x);
R{2}=ROW(x);
C{2}=COLUMN(x);

x= HABITAT == 'intermediate';
H{3}=HABITAT(x);
R{3}=ROW(x);
C{3}=COLUMN(x);

x= HABITAT == 'hard';
H{4}=HABITAT(x);
R{4}=ROW(x);
C{4}=COLUMN(x);

rng(0)% for repeatability

for i=1:4;
    hab=H{i};
    row=R{i};
    col=C{i};
    max = length(hab);
    all = 1:max;
    log_1 = sort(randperm(max, round(max/2)));
```

```
    log_2 = setdiff(all,log_1);
    H_1{i} = hab(log_1);
    R_1{i} = row(log_1);
    C_1{i} = col(log_1);
    H_2{i} = hab(log_2);
    R_2{i} = row(log_2);
    C_2{i} = col(log_2);
end

% TRAINING SUBSET
HABITAT_1=[H_1{1};H_1{2};H_1{3};H_1{4}];
LOCATION_1=[R_1{1}, C_1{1};R_1{2}, C_1{2};R_1{3}, C_1{3};R_1{4}, C_1{4}];

% VALIDATION SUBSET
HABITAT_2=[H_2{1};H_2{2};H_2{3};H_2{4}];
LOCATION_2=[R_2{1},C_2{1};R_2{2},C_2{2};R_2{3},C_2{3};R_2{4}, C_2{4}];

% Shows histogram to confirm equal separation within class
figure; histogram(HABITAT_1)
hold on; histogram(HABITAT_2)
```

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