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Supporting Information for

Classification of Sea Ice Summer Melt Features in High-resolution IceBridge Imagery

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Introduction

This supporting information describes the test images used for developing the classification algorithm. Table S1 lists the test images and provides information on time, date, location, ice features, and classification results. Image descriptions follow WMO Nomenclature (WMO, 1970). Figures S1 to S40 show (a) the original DMS image acquired from NSIDC (http://dx.doi.org/10.5067/OZ6VNOPMPRJ0) and (b) the classified image, where pixel classification is as follows: border (gray), undeformed ice (red), deformed ice (pink), open water (blue), dark melt pond (green), medium melt pond (yellow), light melt pond (cyan). Figure S41 is the same as Figure 7 in the paper but for a different image to illustrate the alternative method for calculating the threshold between open water and melt ponds in C_b.

Image	Description	Date	GPS Time (hh:mm:ss)	Lat (°N)	Lon (°W)	MPF (%)	SIC (%)	PCF_D (%)	PCF_M (%)	PCF_L (%)
S1	Flooded level first year ice.	13 July 2016	21:08:43	76.8	-150.0	66	100	0	0	100
S2	Ponded ice floe with drainage channels and thaw holes. Pond color varies.	13 July 2016	21:24:43	75.6	-150.0	30	99	27	30	44
S3	Predominantly open water with sun glint.	13 July 2016	21:26:11	75.5	-150.0	NA	3	94	0	6
S4	Heavily ponded level first year ice floe and deformed, ponded ice floe, separated by a lead. Evidence of ice algae.	13 July 2016	21:40:32	74.6	-149.5	27	81	67	0	33
S5	Deformed ice with melt ponds and drainage channels.	13 July 2016	21:42:11	74.5	-149.5	21	100	6	0	94
S6	Level, fractured floe with varying melt pond fraction. Evidence of snow melt.	14 July 2016	20:42:50	75.0	-164.9	25	100	29	46	24
S7	Heavily ponded, level first year ice with interconnected pond structure. Evidence of cracks and snow melt.	14 July 2016	20:52:44	75.4	-167.2	23	98	92	0	8
S8	Mixture of ice types. Heavily ponded level first year ice floes and thicker ponded ice with drainage channels. Evidence of snow melt.	14 July 2016	20:57:11	75.6	-168.3	22	97	85	0	15
S9	Multiyear ice floe with large melt ponds and drainage channels.	14 July 2016	20:58:25	75.6	-168.6	38	100	3	0	97
S10	Predominantly open water and unconsolidated, small floes with evidence of thaw holes.	14 July 2016	21:09:29	75.9	-169.0	9	29	75	0	25
S11	Multiple sea ice floes with elongated dark melt ponds and discrete light melt ponds.	14 July 2016	21:17:09	76.3	-167.7	23	91	86	0	14
S12	Mixture of large and small ice floes with elongated dark melt ponds and discrete light melt ponds	16 July 2016	0:51:51	73.6	-173.9	29	81	86	0	14
S13	Ice floes separated by lead. Mixture of light and dark ponds with drainage channels connecting ponds.	16 July 2016	1:00:06	73.8	-172.1	31	91	36	33	31
S14	Deformed ice floe with small light ponds in conjunction with pressure ridging. Dark, interconnected ponds elsewhere. Evidence of cracks.	19 July 2016	22:28:12	74.9	-173.0	23	87	86	0	14
S15	Unconsolidated ice floes with light and dark melt ponds with thaw holes.	16 July 2016	22:29:31	75.0	-173.1	24	61	77	0	23

S16	Heavily ponded floe with interconnected pond structure.	16 July 2016	22:35:57	75.4	-173.4	32	100	92	0	8
S17	Ponded ice flow with mixture of interconnected dark ponds and discrete light ponds. Evidence of snow melt.	19 July 2016	22:47:34	76.3	-173.9	17	99	84	0	16
S18	Multiple floes with mixture of elongated and interconnected dark and light ponds.	19 July 2016	22:50:04	76.4	-174.0	18	72	76	0	24
S19	Heavily ponded ice floe with drainage channels connecting ponds.	19 July 2016	23:04:49	76.5	-172.6	27	100	22	42	36
S20	Heavily ponded level ice with thaw holes and cracks.	19 July 2016	23:12:05	76.1	-170.9	20	84	92	0	8
S21	Deformed ice floes with interconnected light and dark ponds connected by narrow drainage channels. Evidence of cracks.	19 July 2016	23:15:17	76.0	-170.2	25	95	21	0	79
S22	Multiple, predominantly level ice floes undergoing melt but with low melt pond fraction.	21 July 2016	21:03:49	75.7	-140.0	5	73	93	0	7
S23	Consolidated, predominantly level ice floe undergoing melt but with low melt pond fraction.	21 July 2016	21:04:12	75.7	-140.0	3	100	13	74	13
S24	Predominantly level ice floe undergoing melt but with low melt pond fraction. Evidence of submerged ice. Light melt ponds in conjunction with pressure ridges.	21 July 2016	21:05:12	75.8	-140.0	12	87	80	0	20
S25	Consolidated, predominantly level ice floe undergoing melt with extensive drainage channels and thaw holes.	21 July 2016	21:08:14	76.0	-140.0	9	98	80	0	20
S26	Fragmented ice floes with undulating topography, rubble fields, and light melt ponds.	17 July 2017	14:52:56	83.3	-75.0	12	69	8	0	92
S27	Consolidated, deformed multiyear ice with light melt ponds and drainage channels.	17 July 2017	15:02:27	83.3	-80.7	6	99	2	0	98
S28	Fragmented, heavily deformed multiyear ice floes with light melt ponds.	17 July 2017	15:41:23	83.6	-79.3	9	74	4	0	96
S29	Consolidated multiyear ice with small and large light ponds. Evidence of cracks and very small fractures.	17 July 2017	15:41:26	83.6	-79.3	15	96	2	0	98
S30	Fractured multiyear ice floes with light melt ponds.	17 July 2017	15:42:37	83.7	-78.9	5	97	1	0	99
S31	Fractured, heavily deformed multiyear ice floes with light melt ponds.	17 July 2017	15:43:35	83.8	-78.7	7	95	38	0	62

S32	Consolidated deformed ice with light melt ponds. Evidence of pressure ridging.	18 July 2017	15:26:57	83.0	-88.0	6	99	4	0	96
S33	Heavily deformed multiyear ice with pressure ridges and light ponds varying in size and connected by drainage channels.	18 July 2017	16:18:12	84.0	-73.8	17	97	3	0	97
S34	Cracked and deformed ice with light, medium, and dark melt ponds connected by drainage channels.	24 July 2017	14:59:19	84.4	-43.2	18	97	14	38	47
S35	Fractured ice floes. Heavily deformed multiyear ice floe. Ponding in conjunction with pressure ridges.	24 July 2017	15:10:25	84.4	-49.3	16	88	21	0	79
S36	Fragmented ice floes with dark, medium, and light melt ponds and deformation along floe edges. Evidence of snow melt	24 July 2017	15:17:51	84.3	-54.5	15	97	21	36	43
S37	Large melt pond on deformed multiyear ice with undulating topography.	24 July 2017	15:38:55	83.1	-59.7	16	93	4	7	89
S38	Fragmented ice floes with large and small melt ponds. Diffuse lighting conditions.	25 July 2017	12:33:36	82.3	-94.6	10	95	39	27	34
S39	Heavily ponded consolidated ice floe with drainage channels connecting ponds. Diffuse lighting conditions.	25 July 2017	12:45:54	82.5	-100.9	28	100	0	0	100
S40	Fragmented, deformed ice floes with light and medium melt ponds connected by long drainage channels.	25 July 2017	17:05:50	83.3	-74.9	12	85	16	29	54

Table S1. List of test images used in algorithm development with derived parameters.

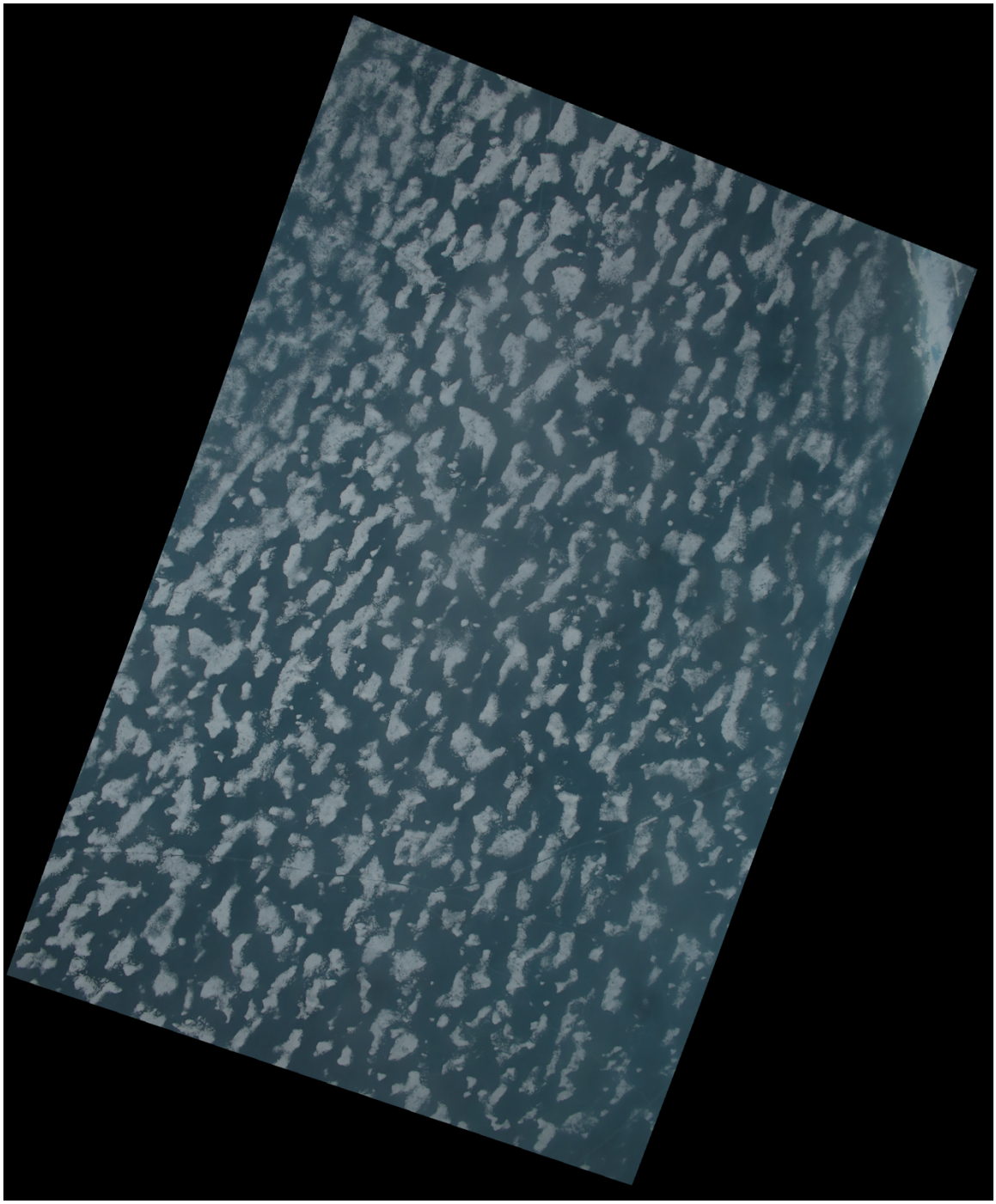


Figure S1a

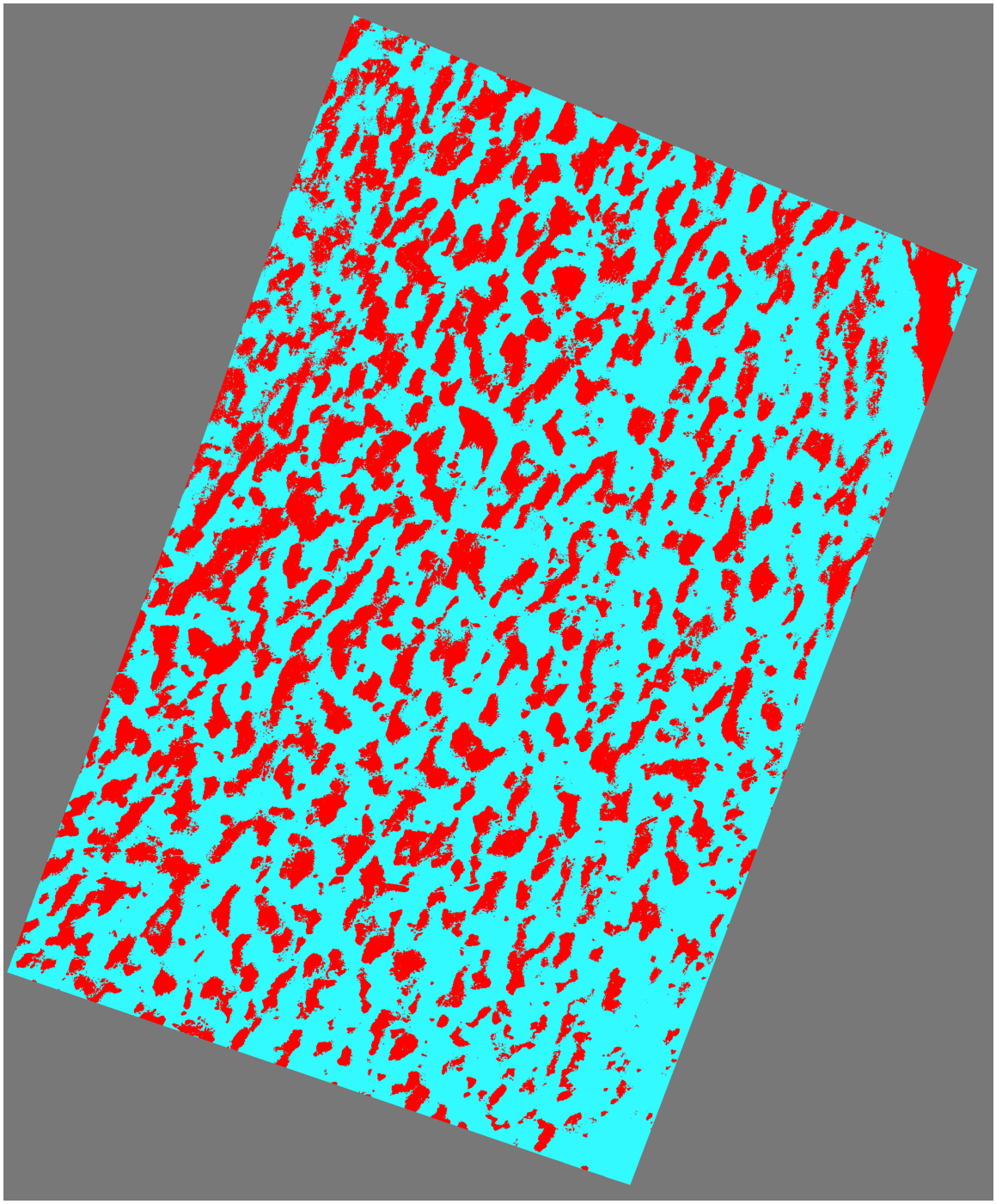
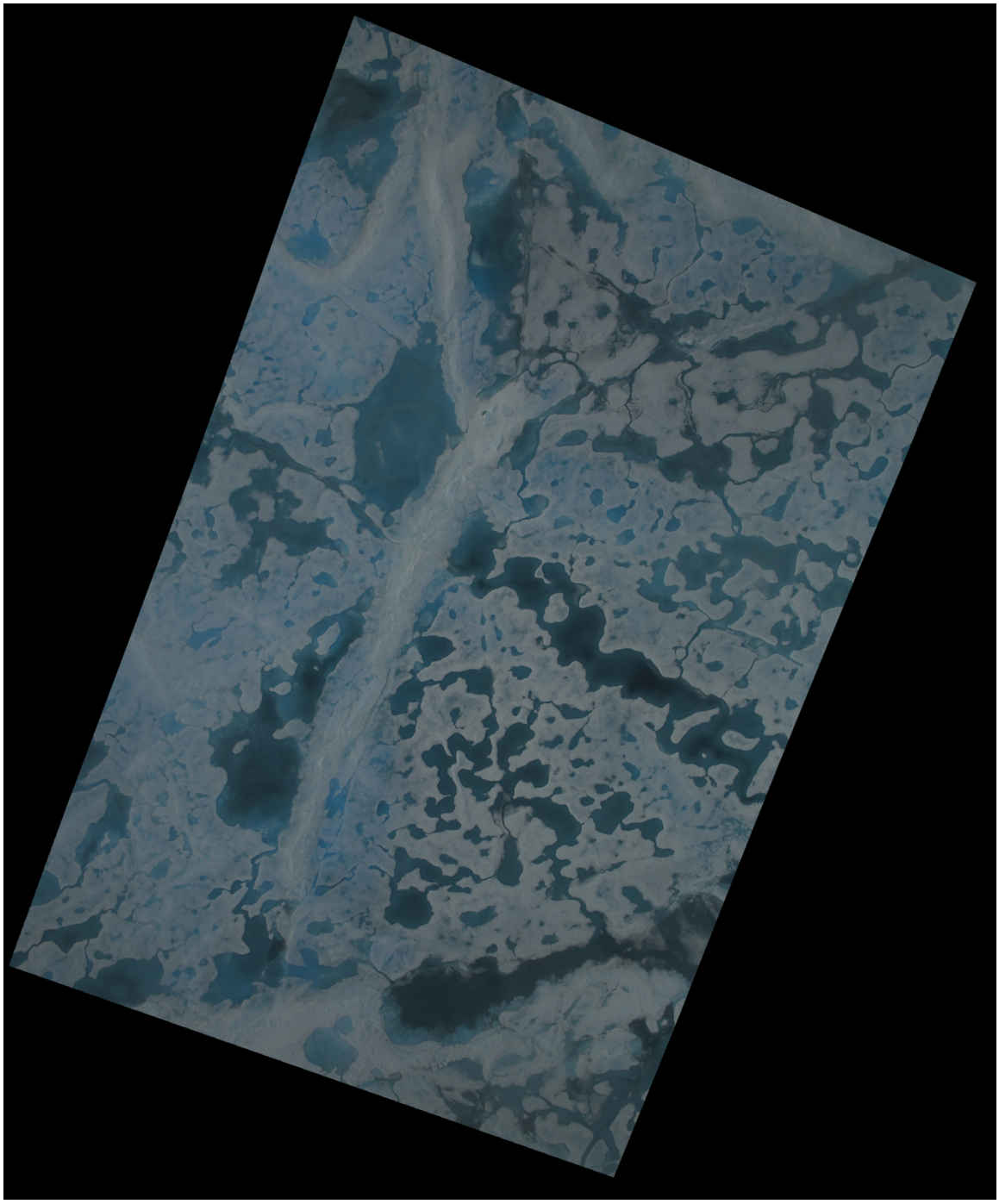


Figure S1b



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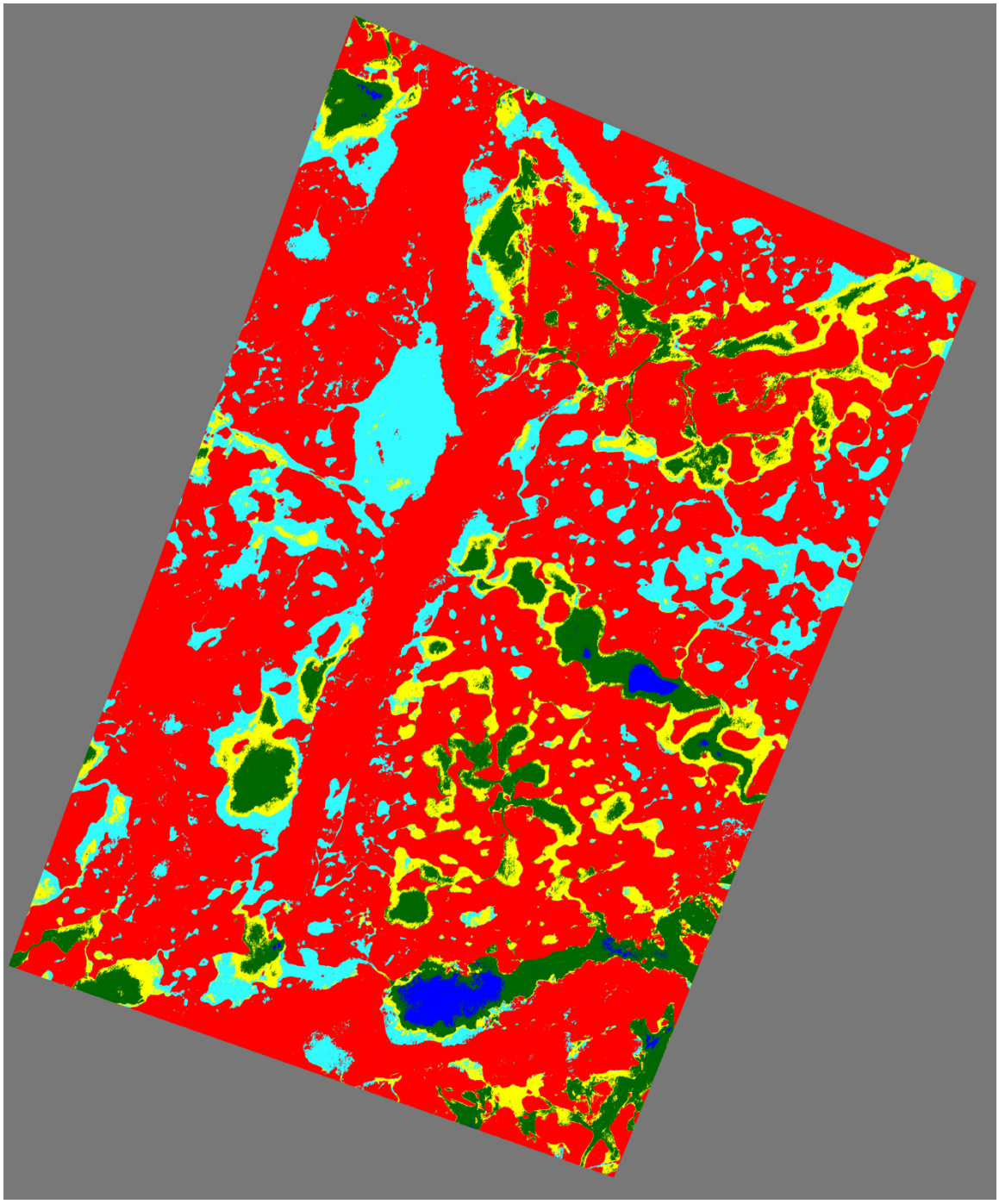

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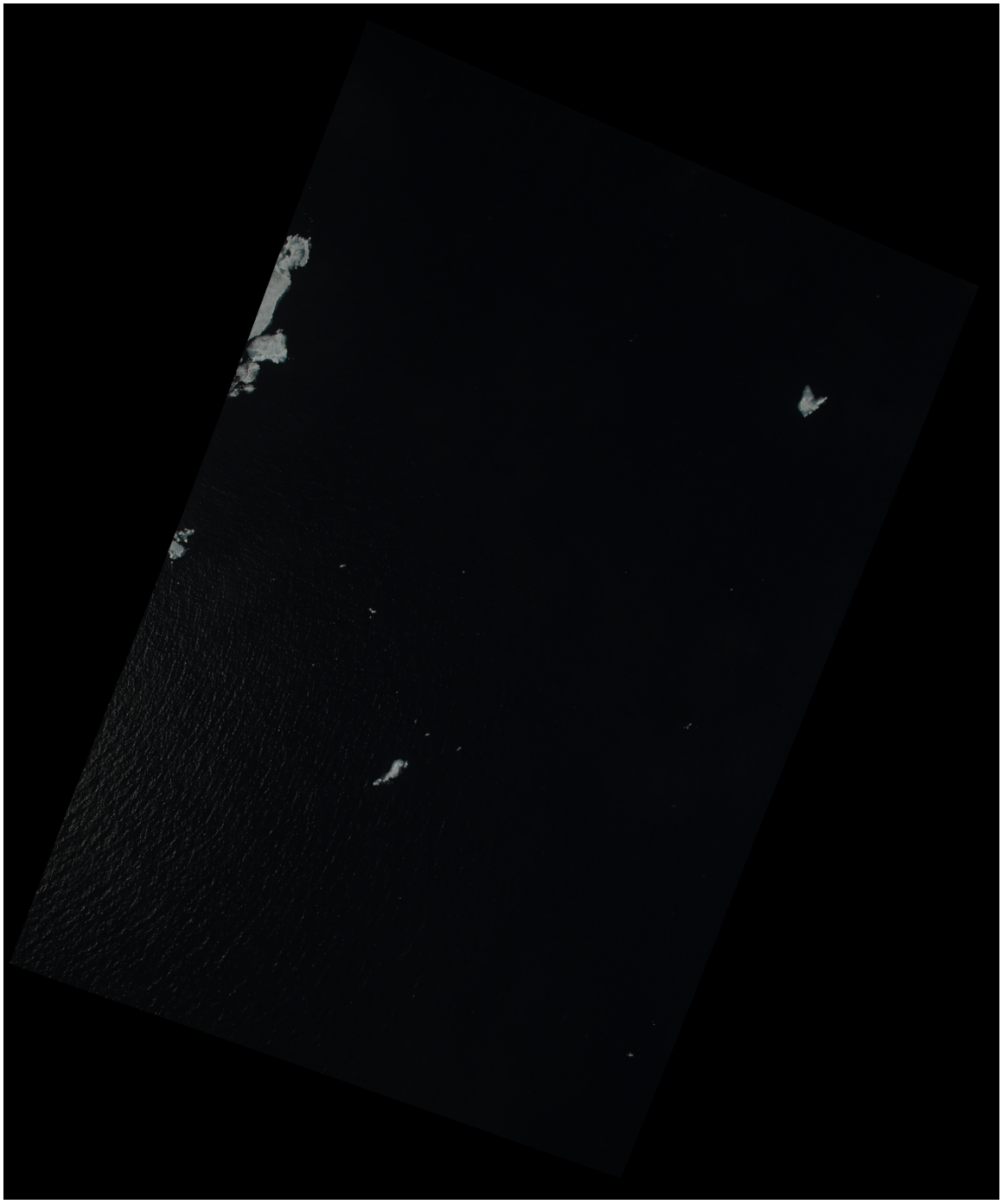

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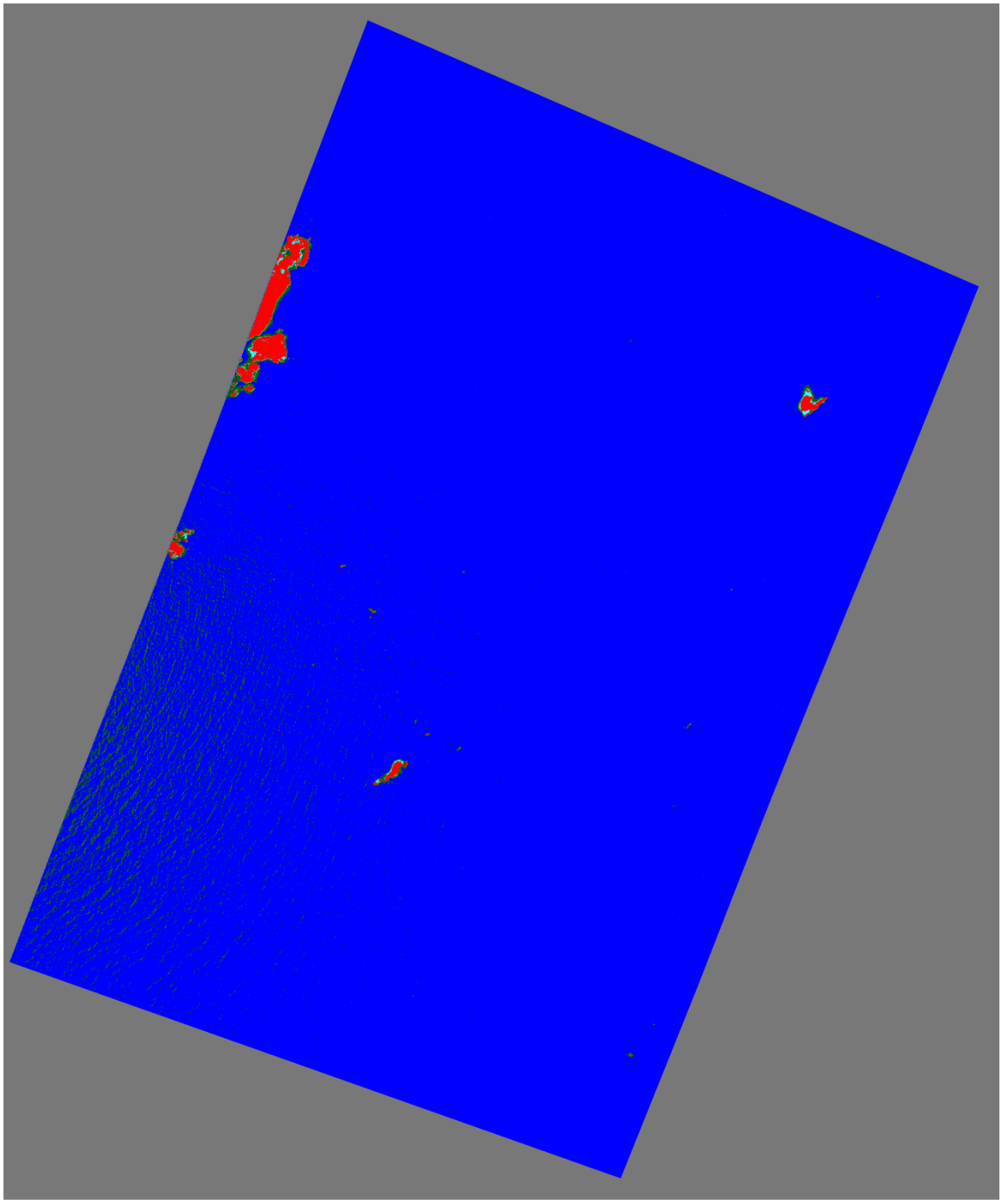

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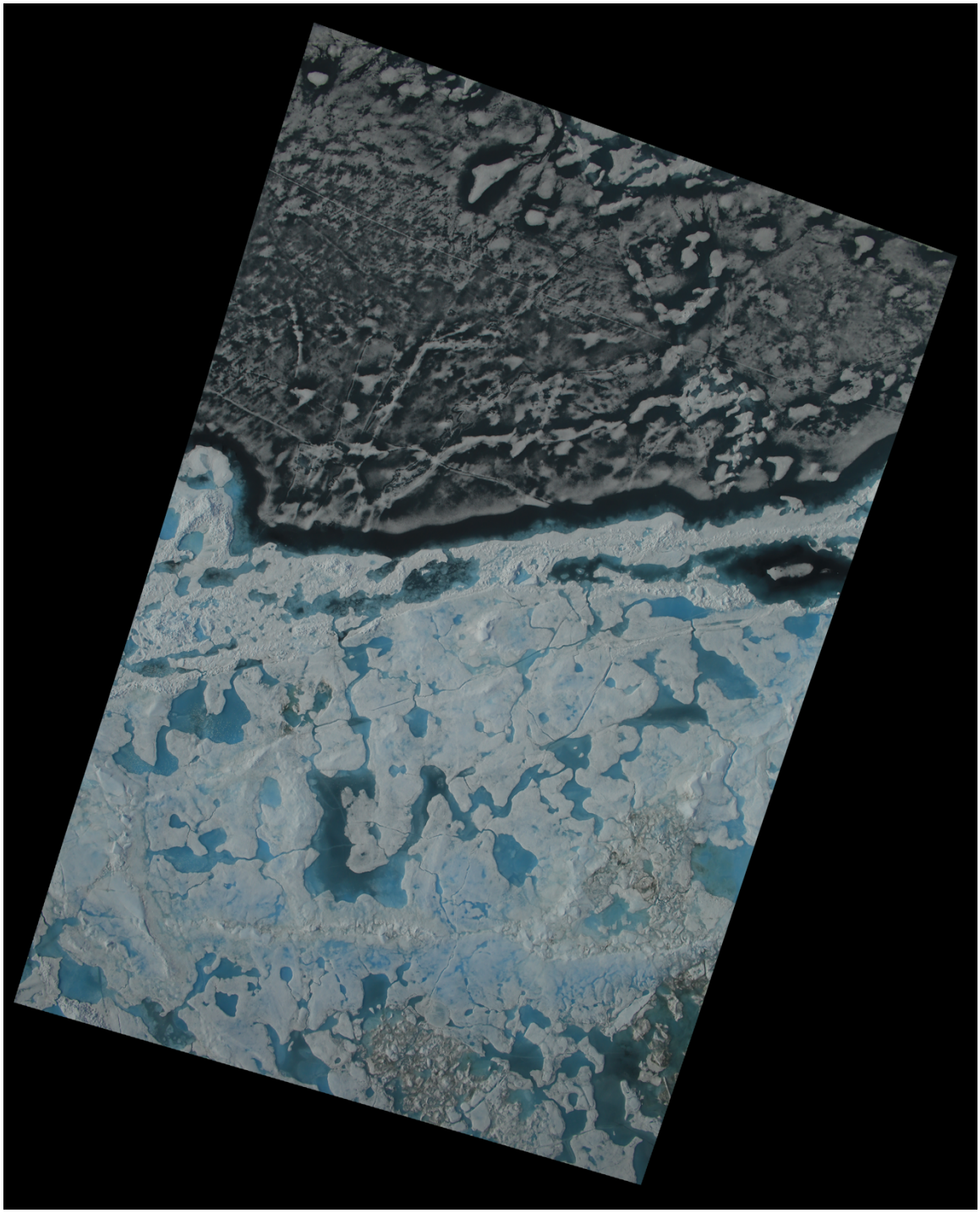

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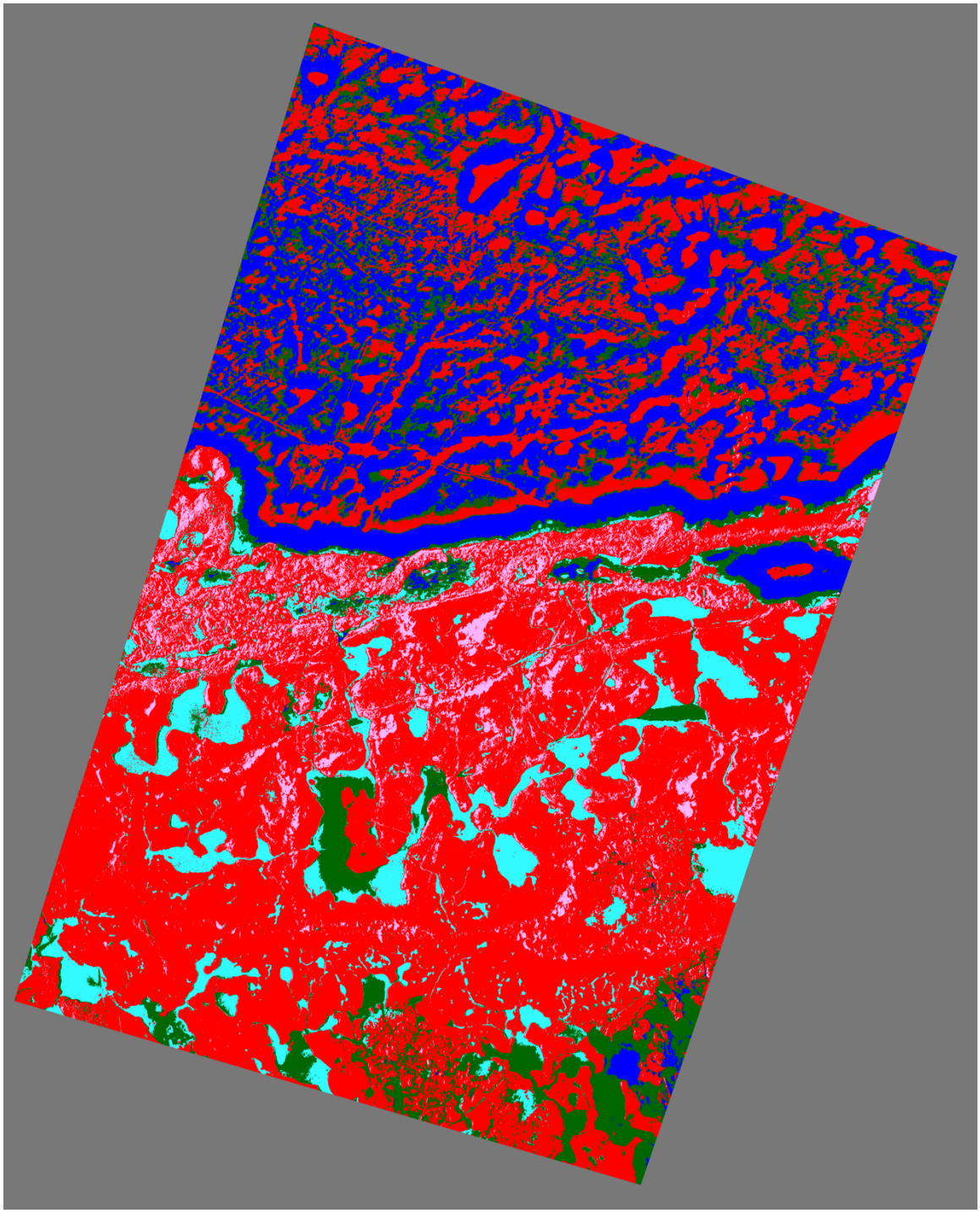

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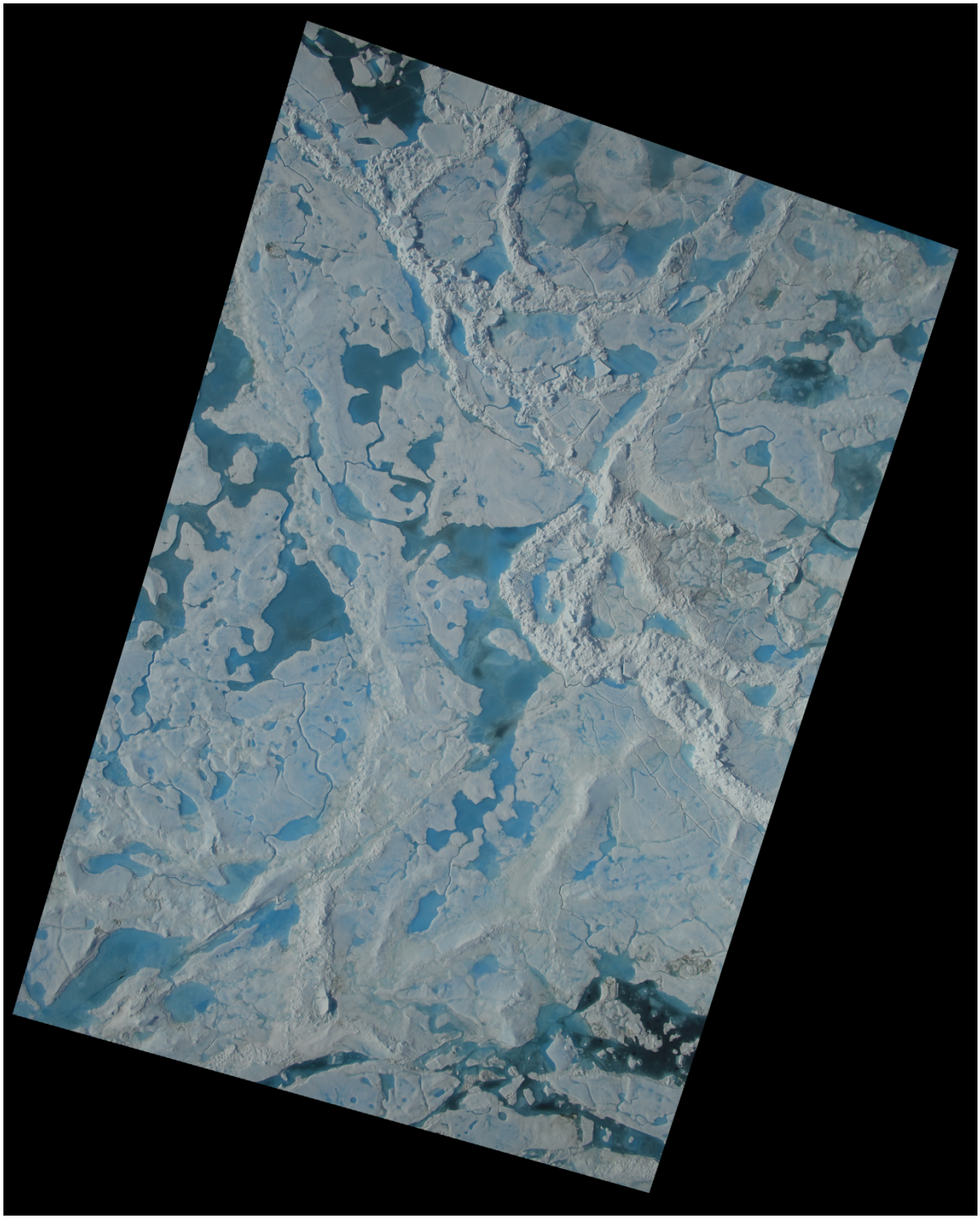

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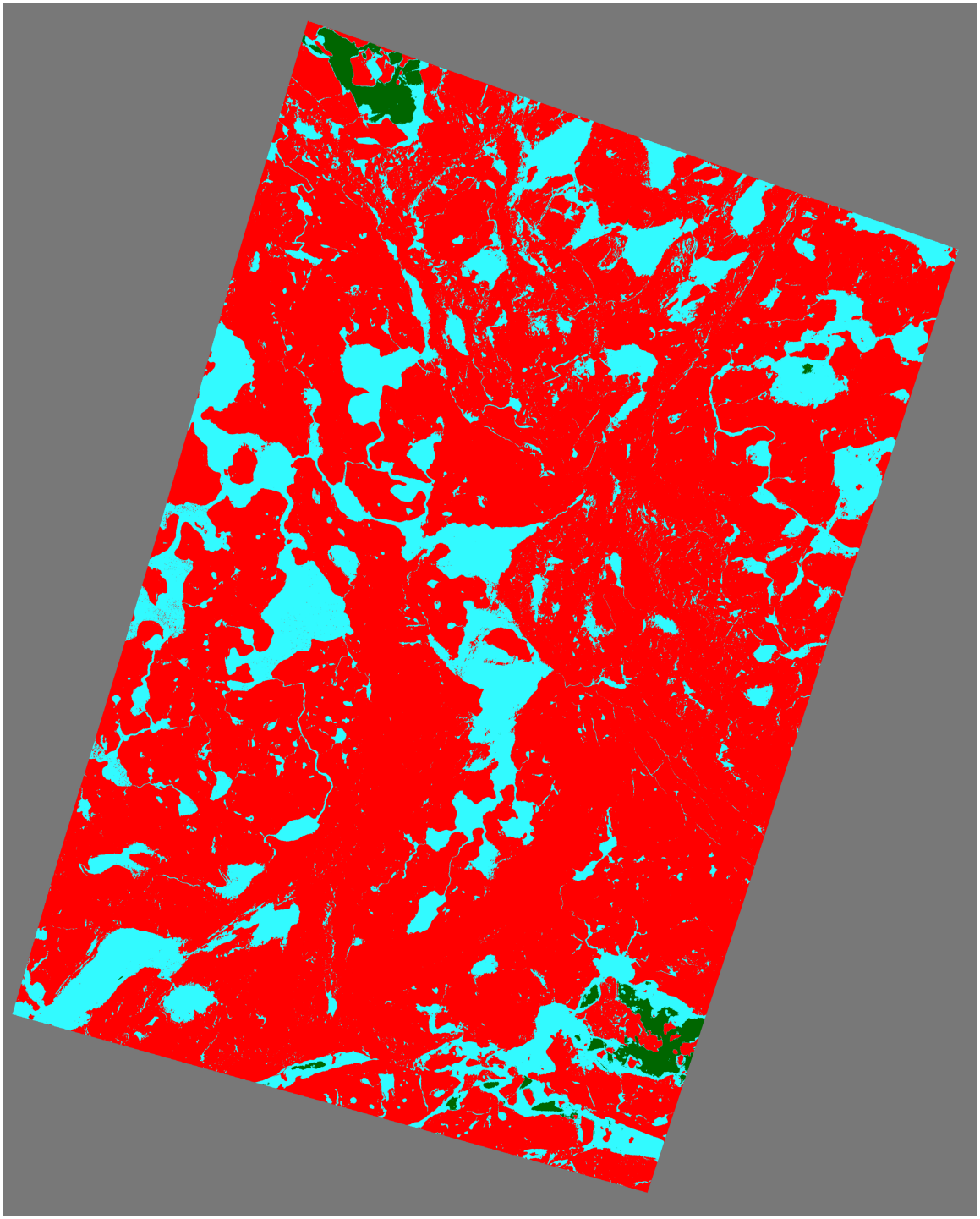

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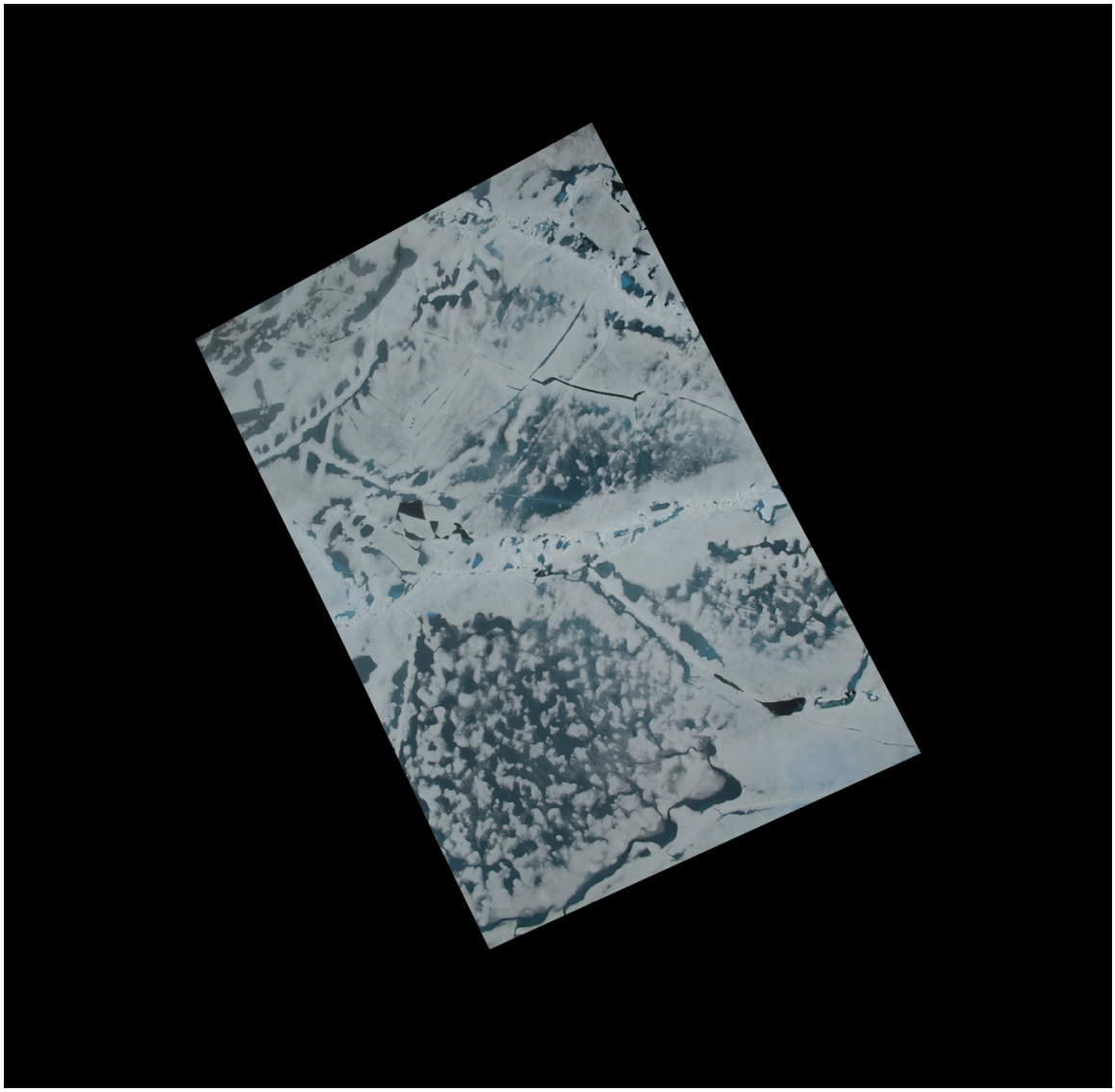

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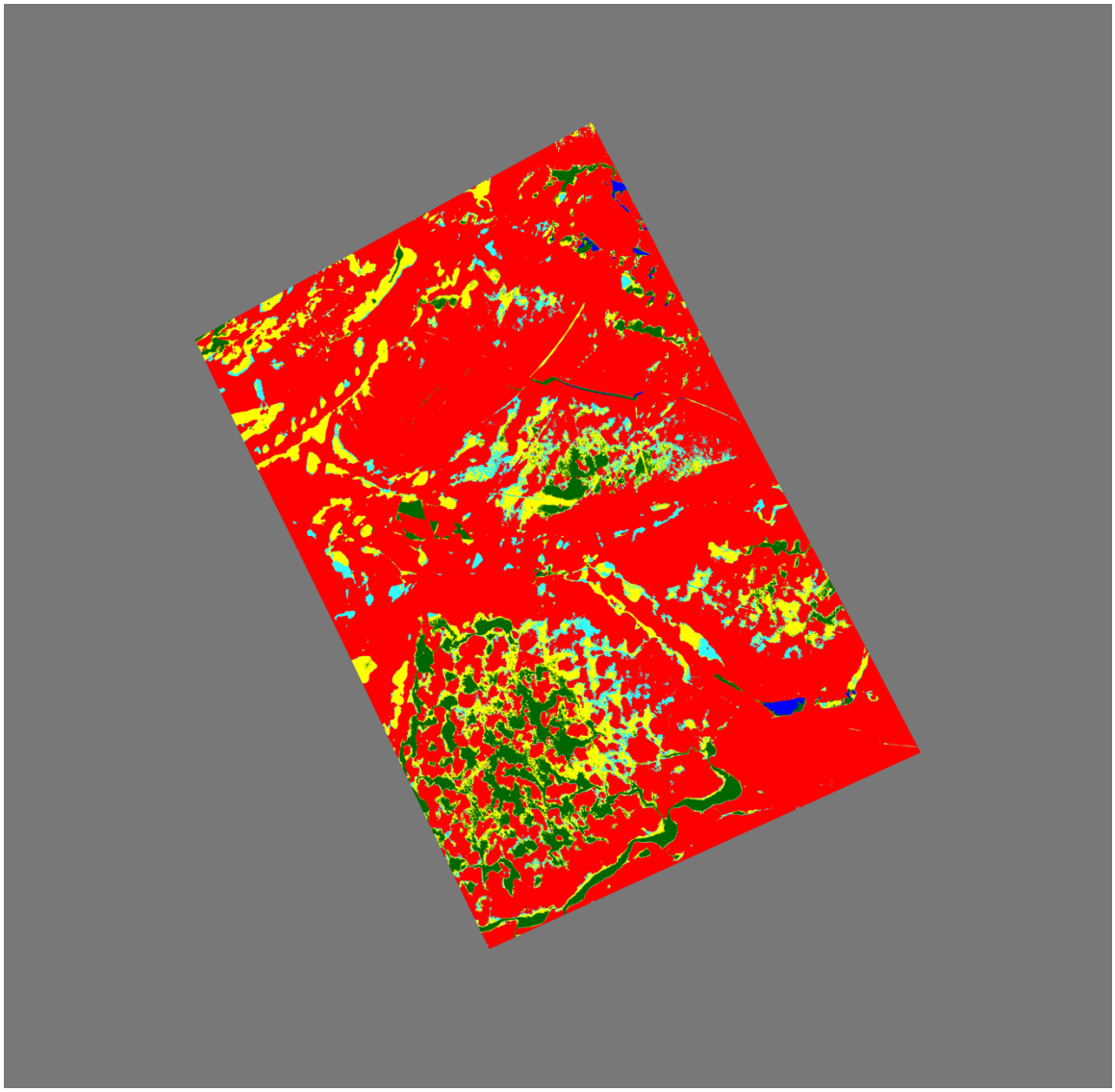

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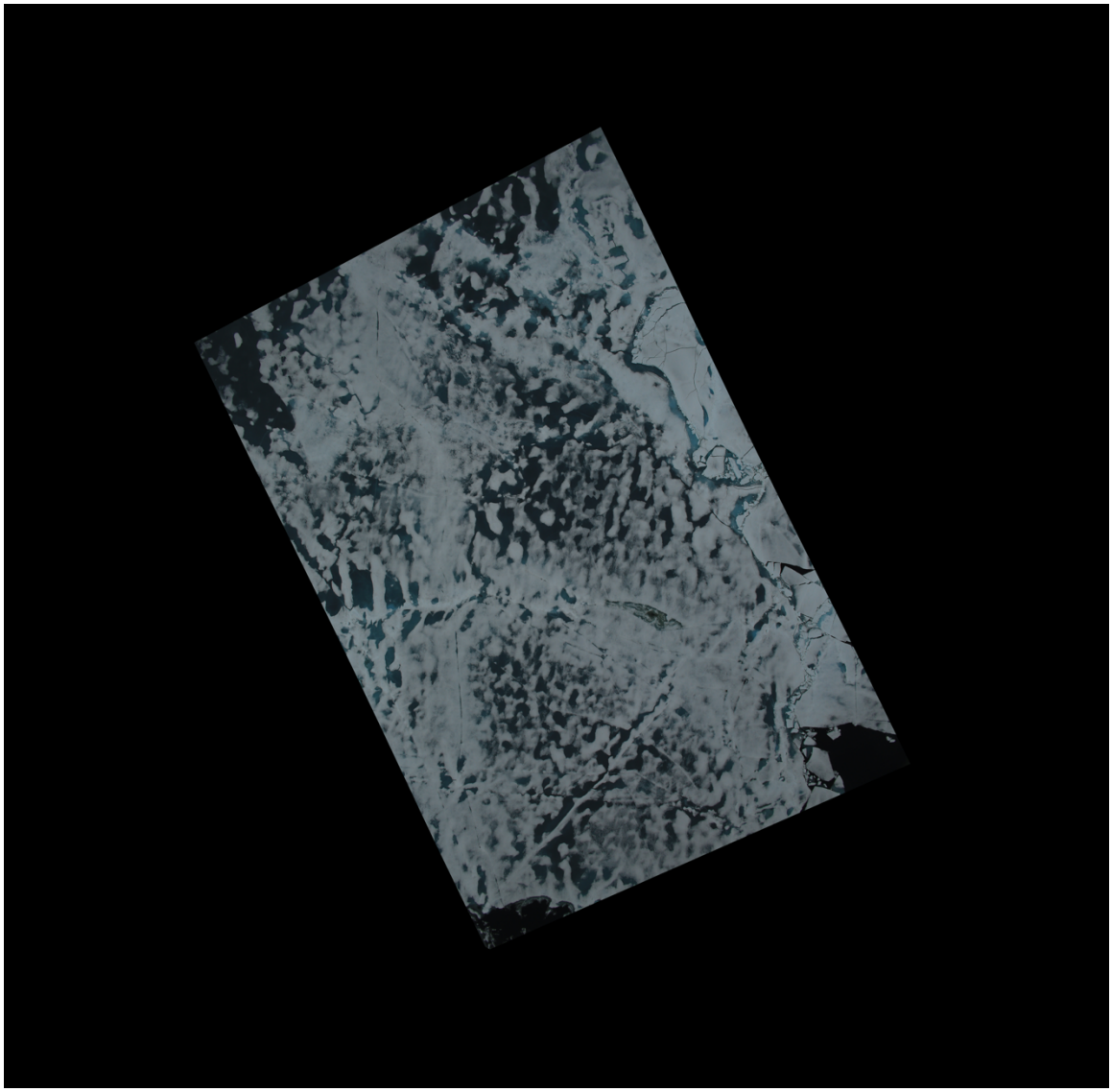

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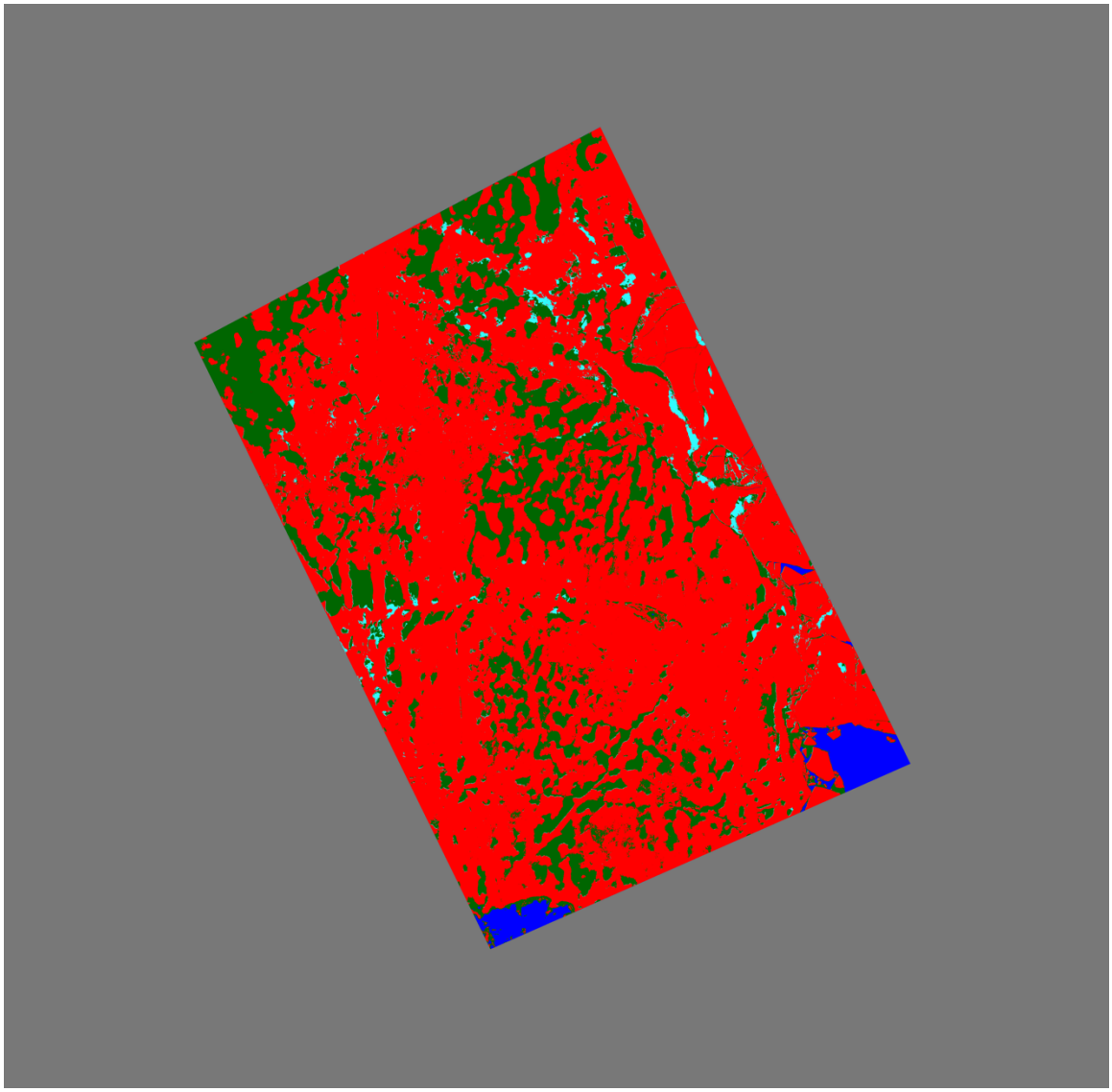

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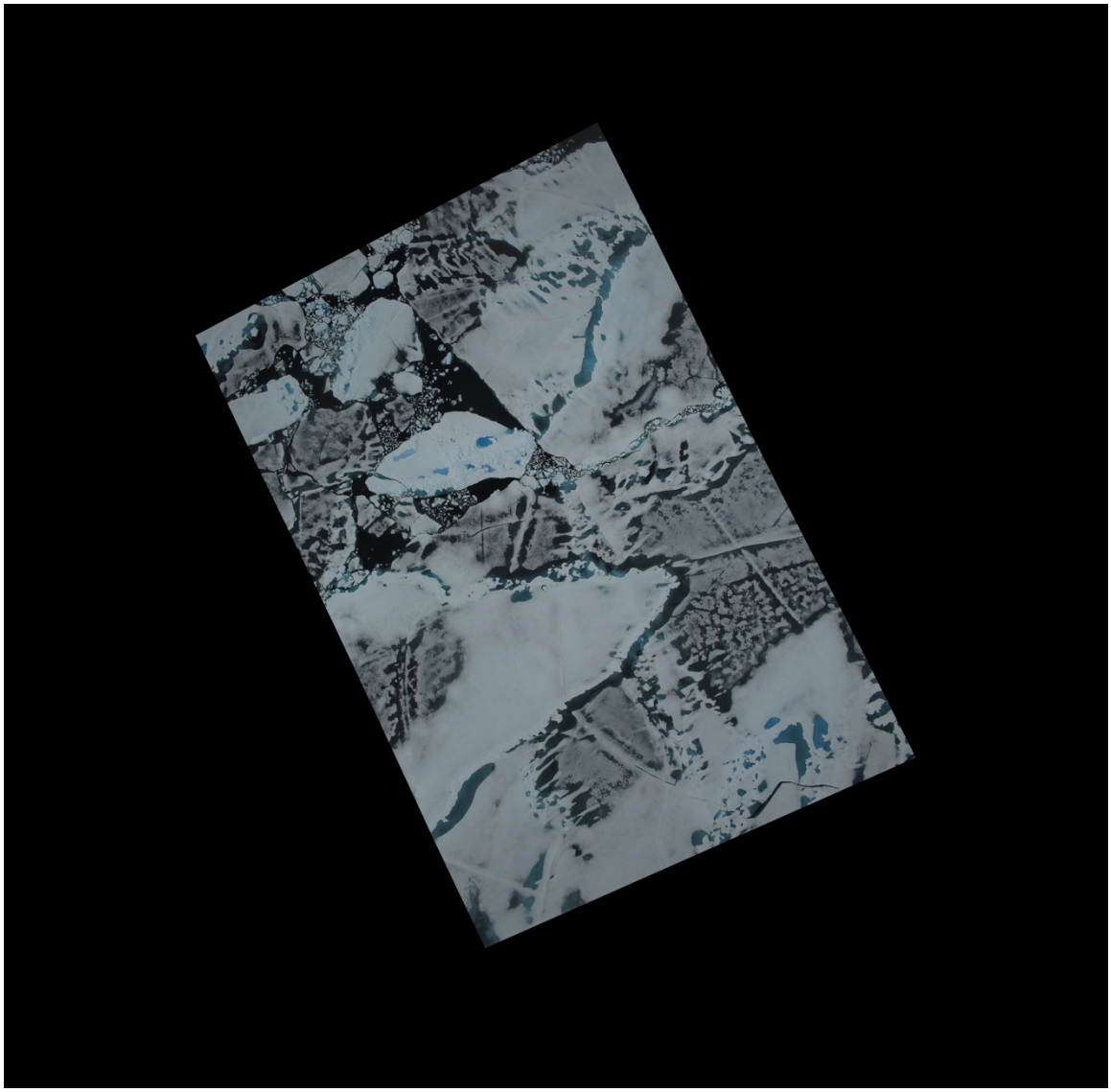

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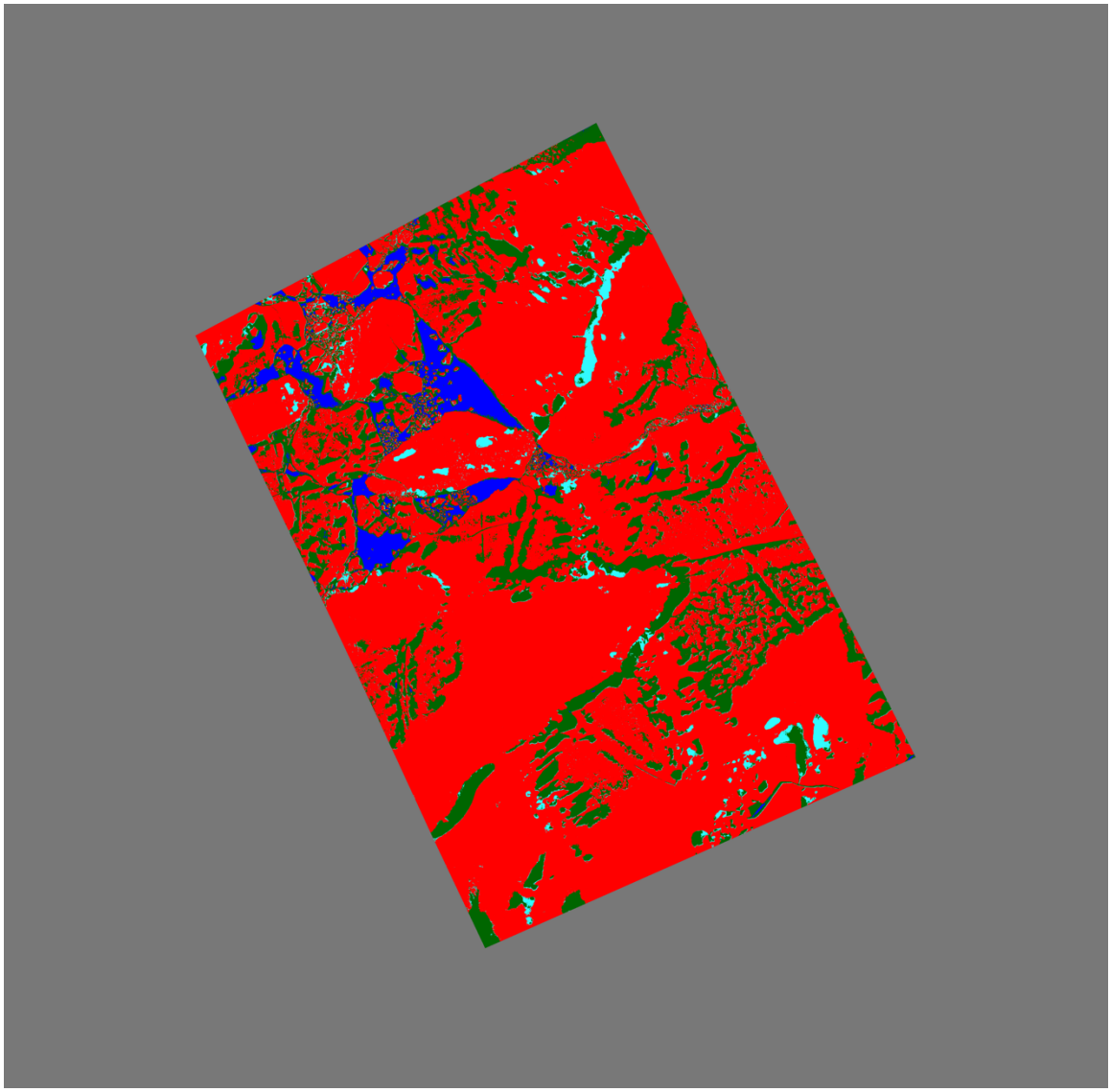
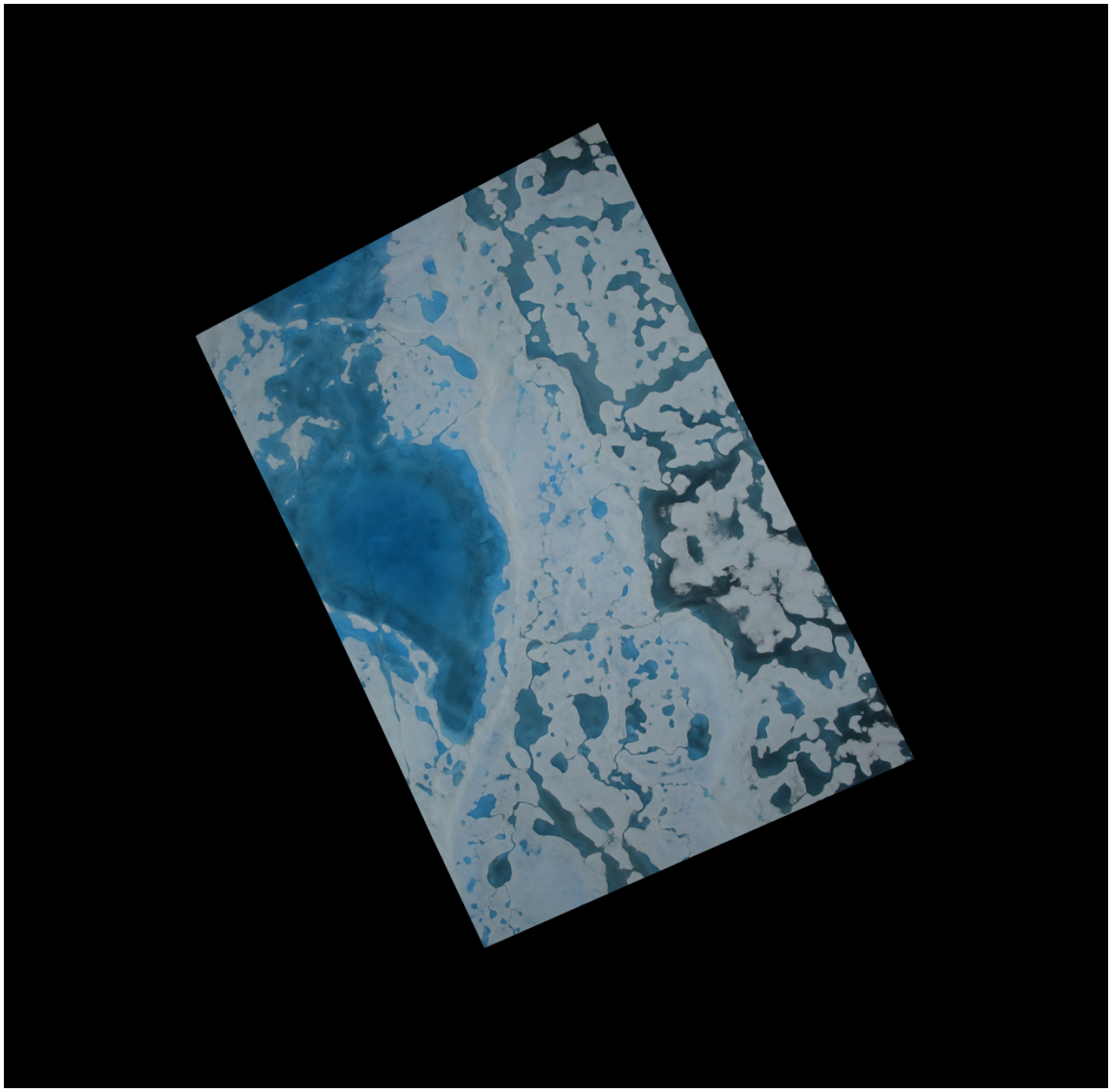


Figure S8b



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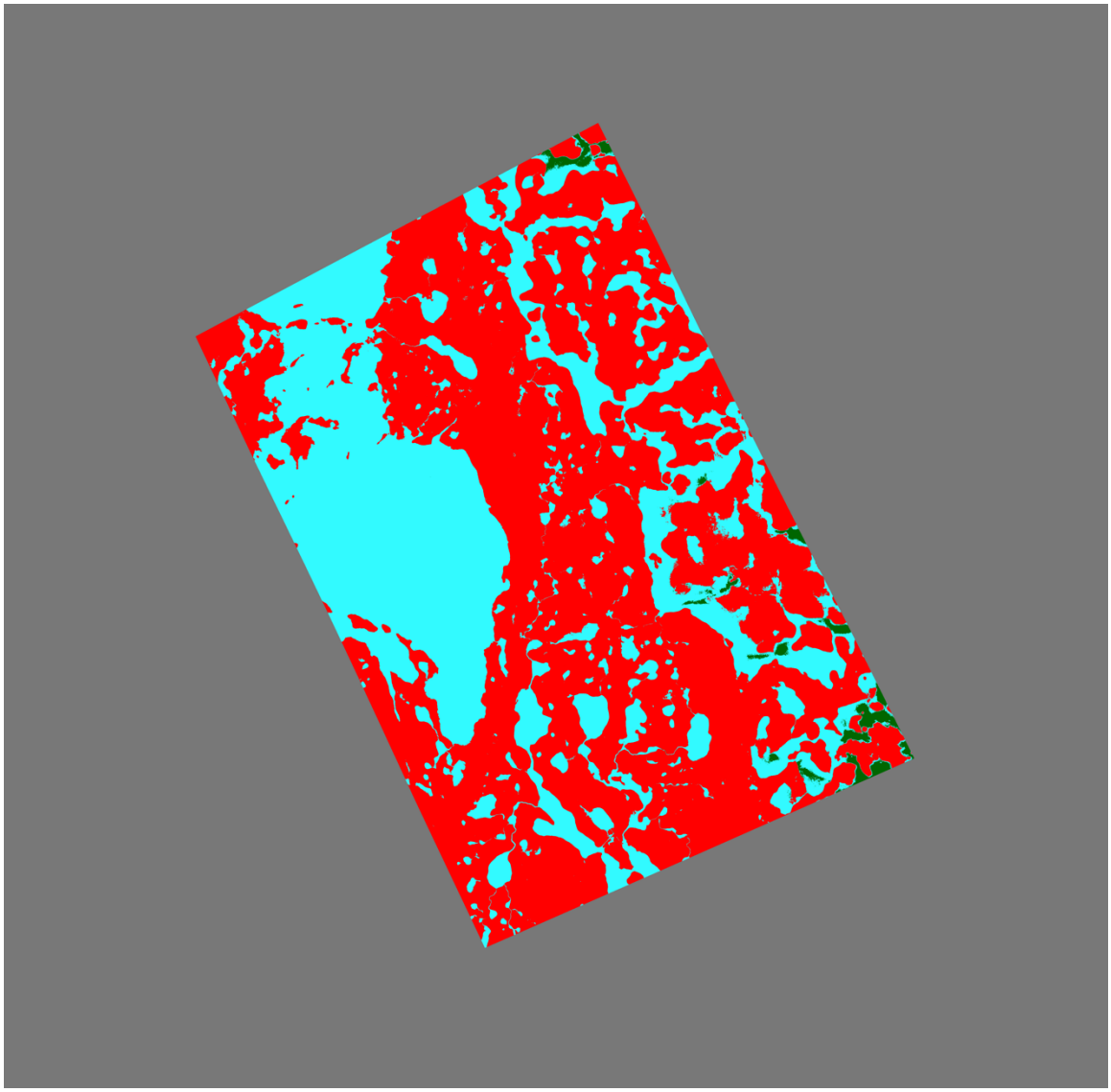
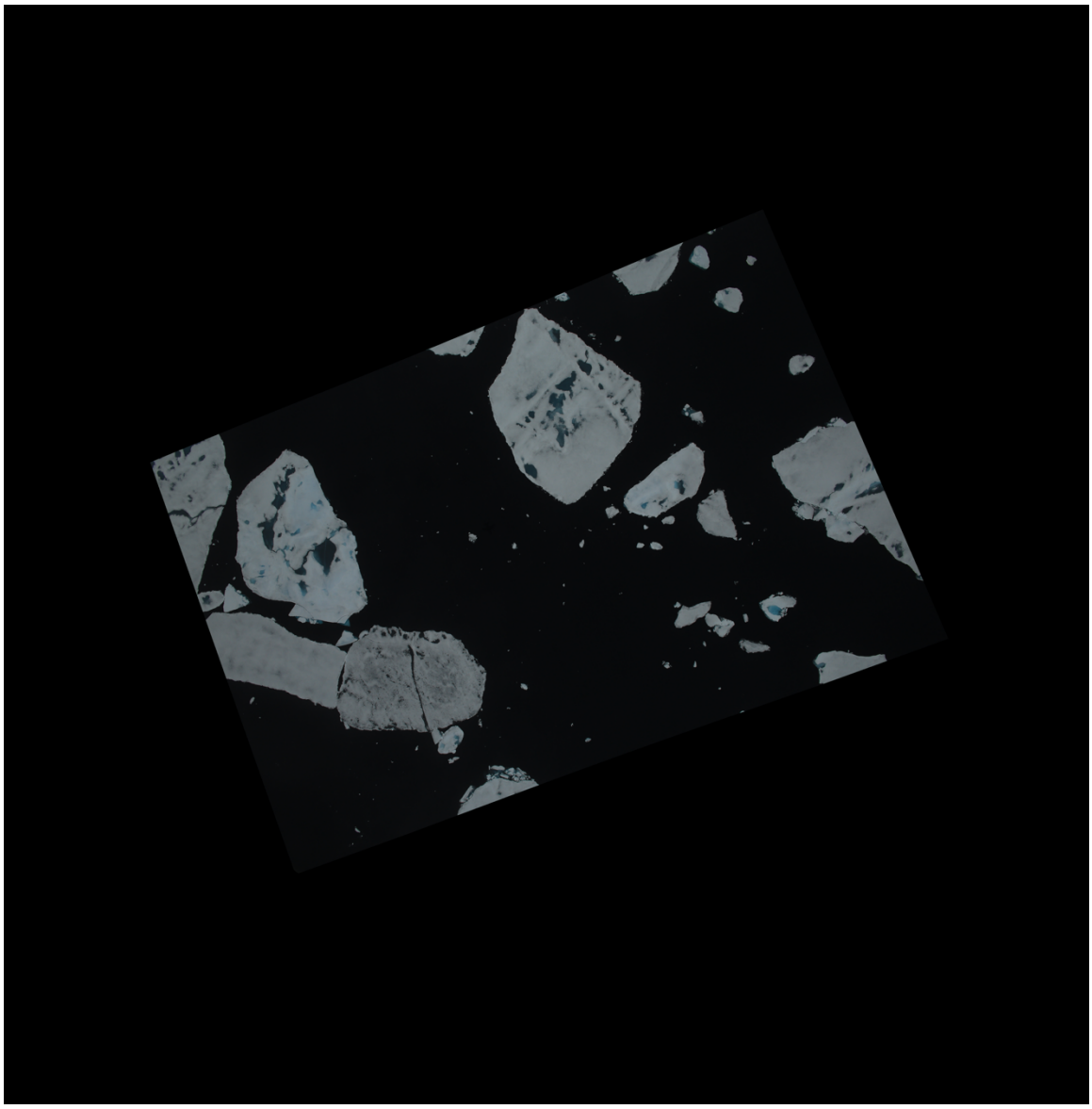


Figure S9b



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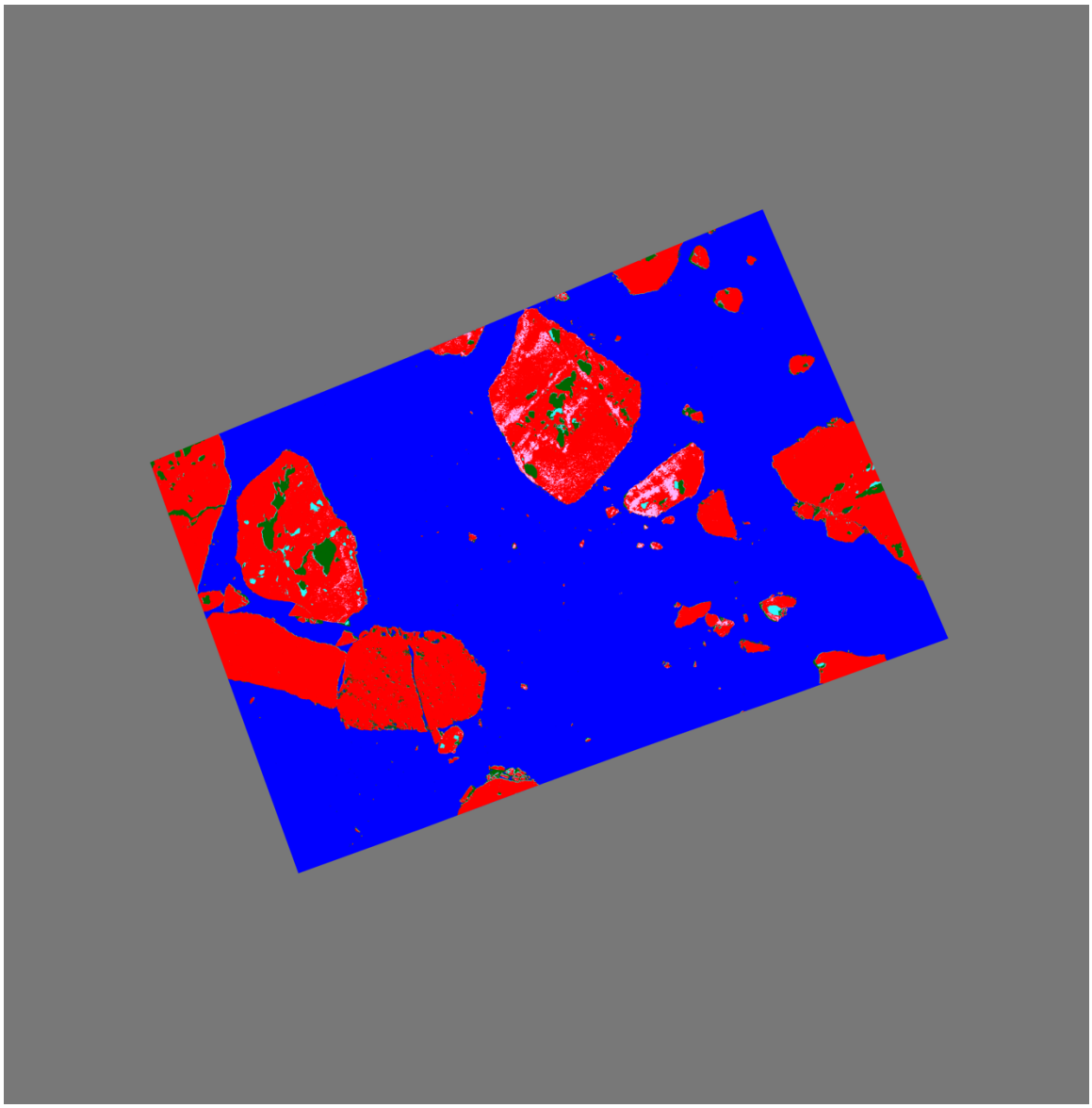

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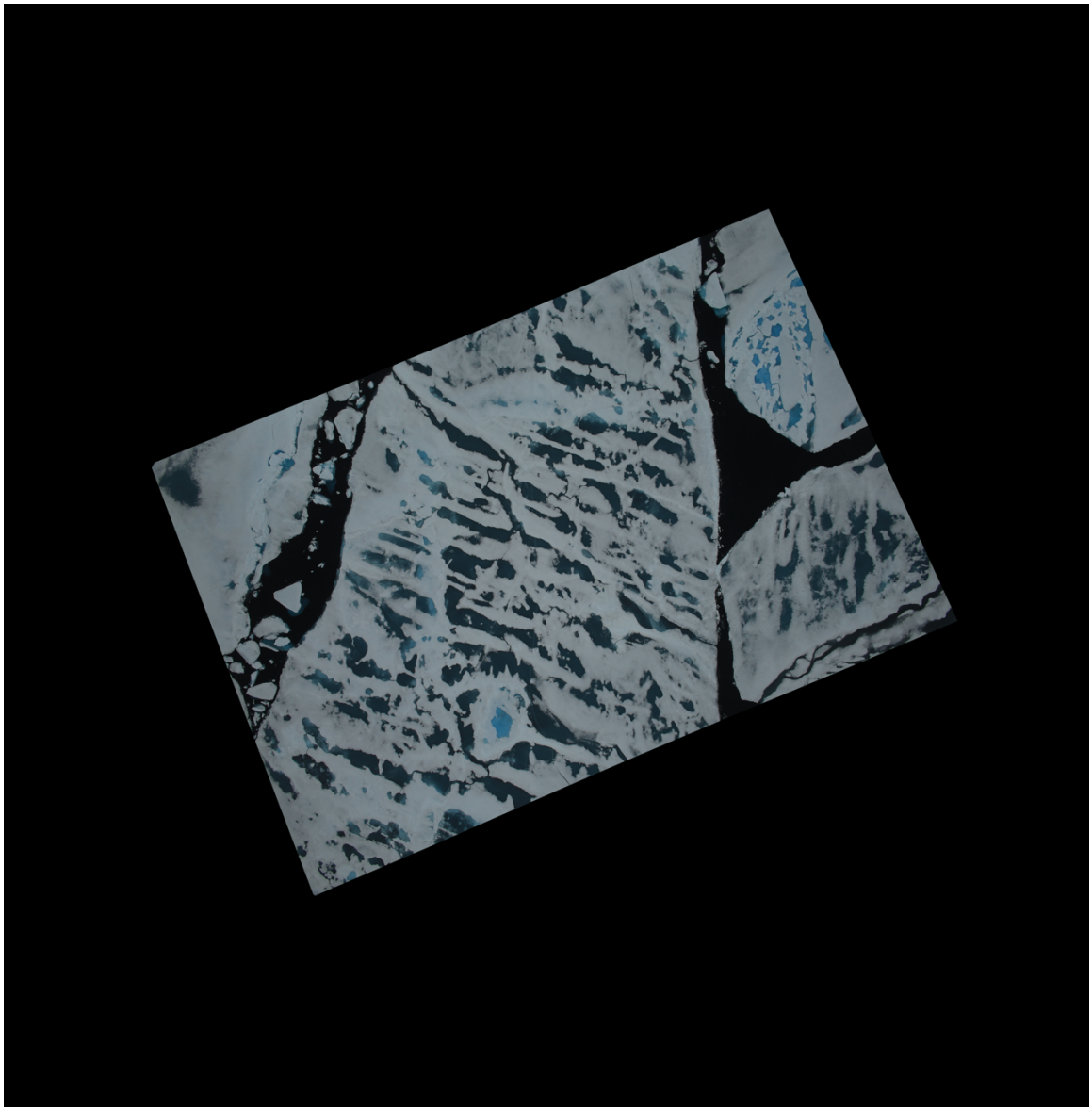

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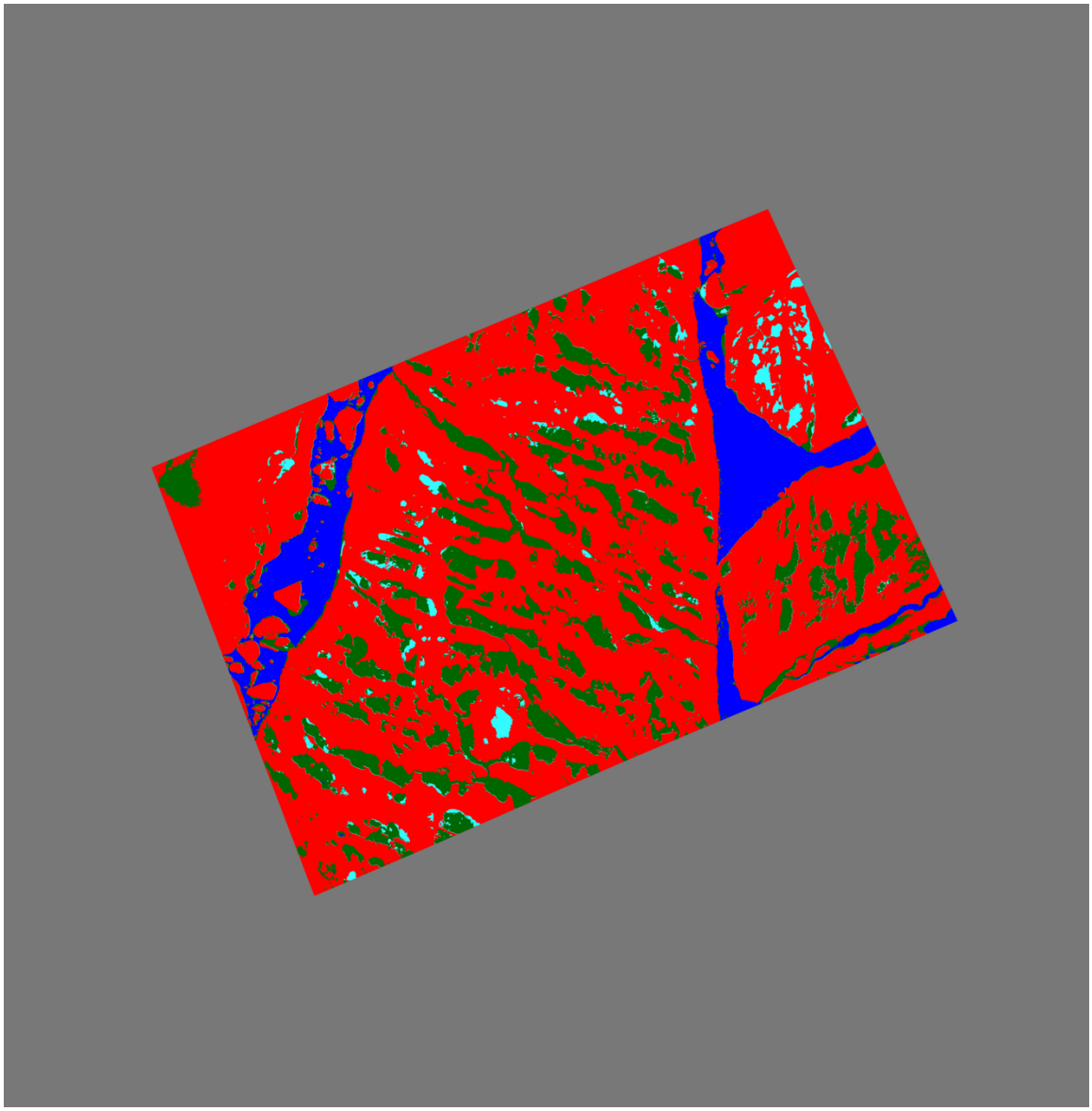

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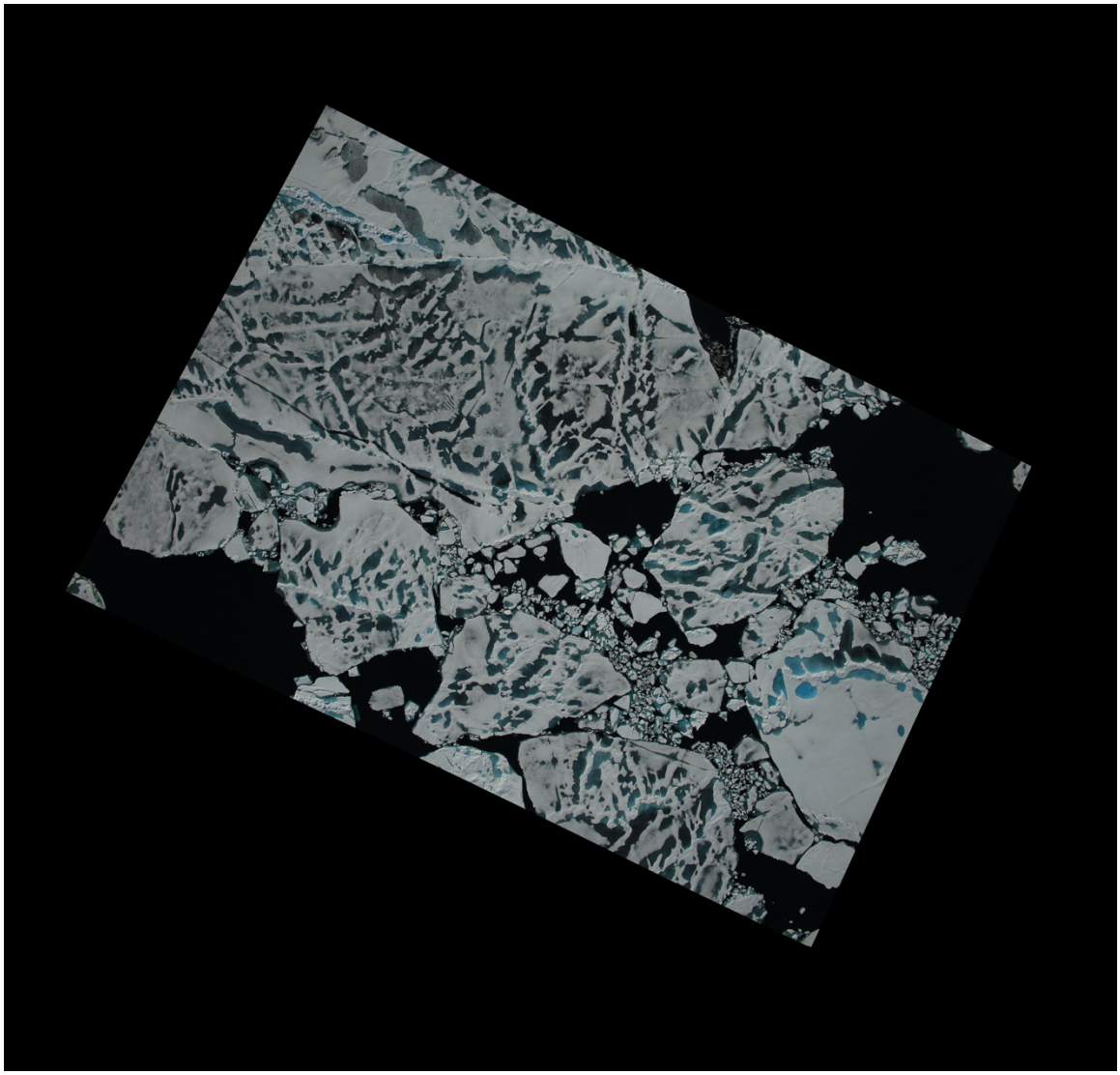

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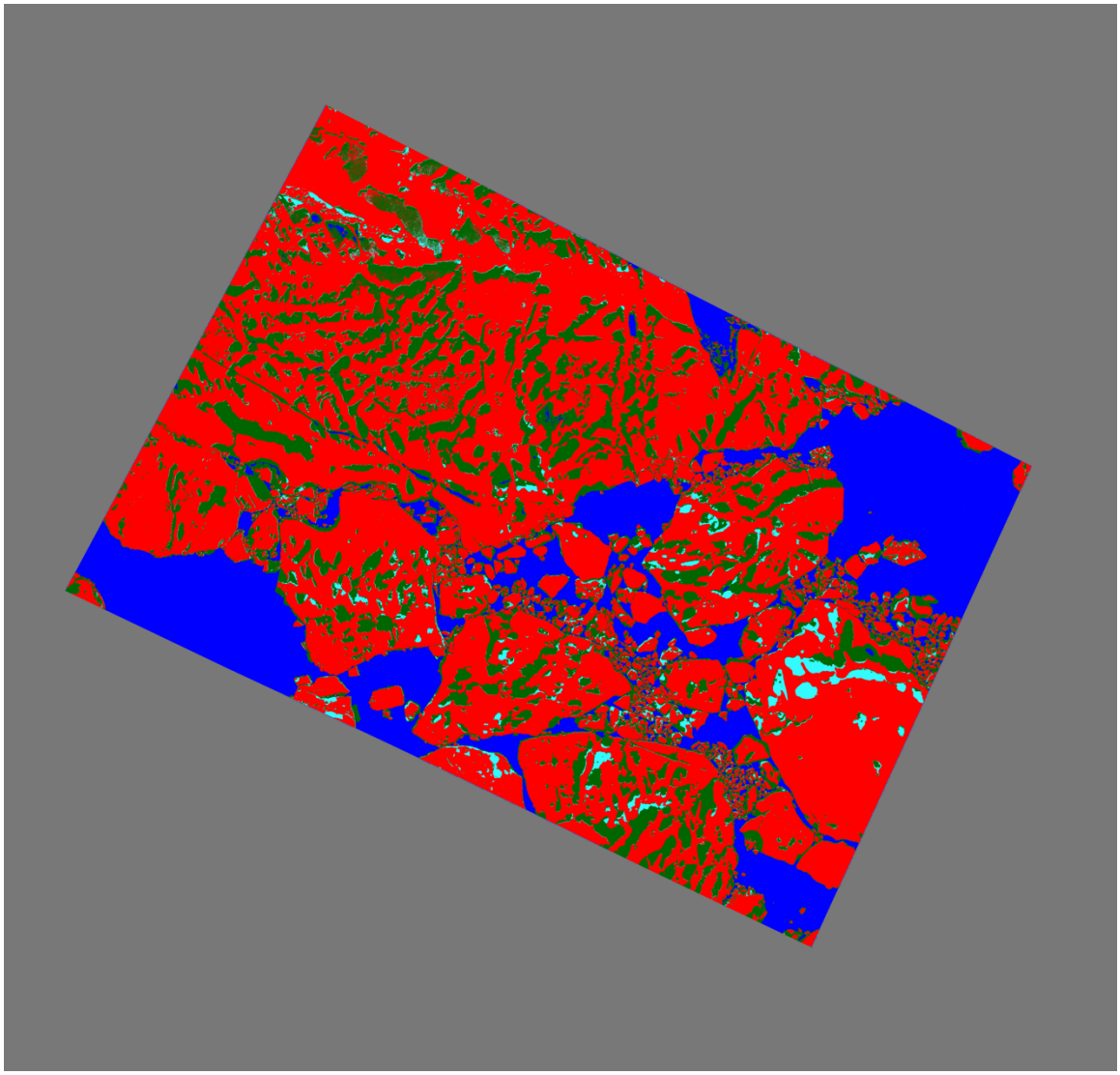
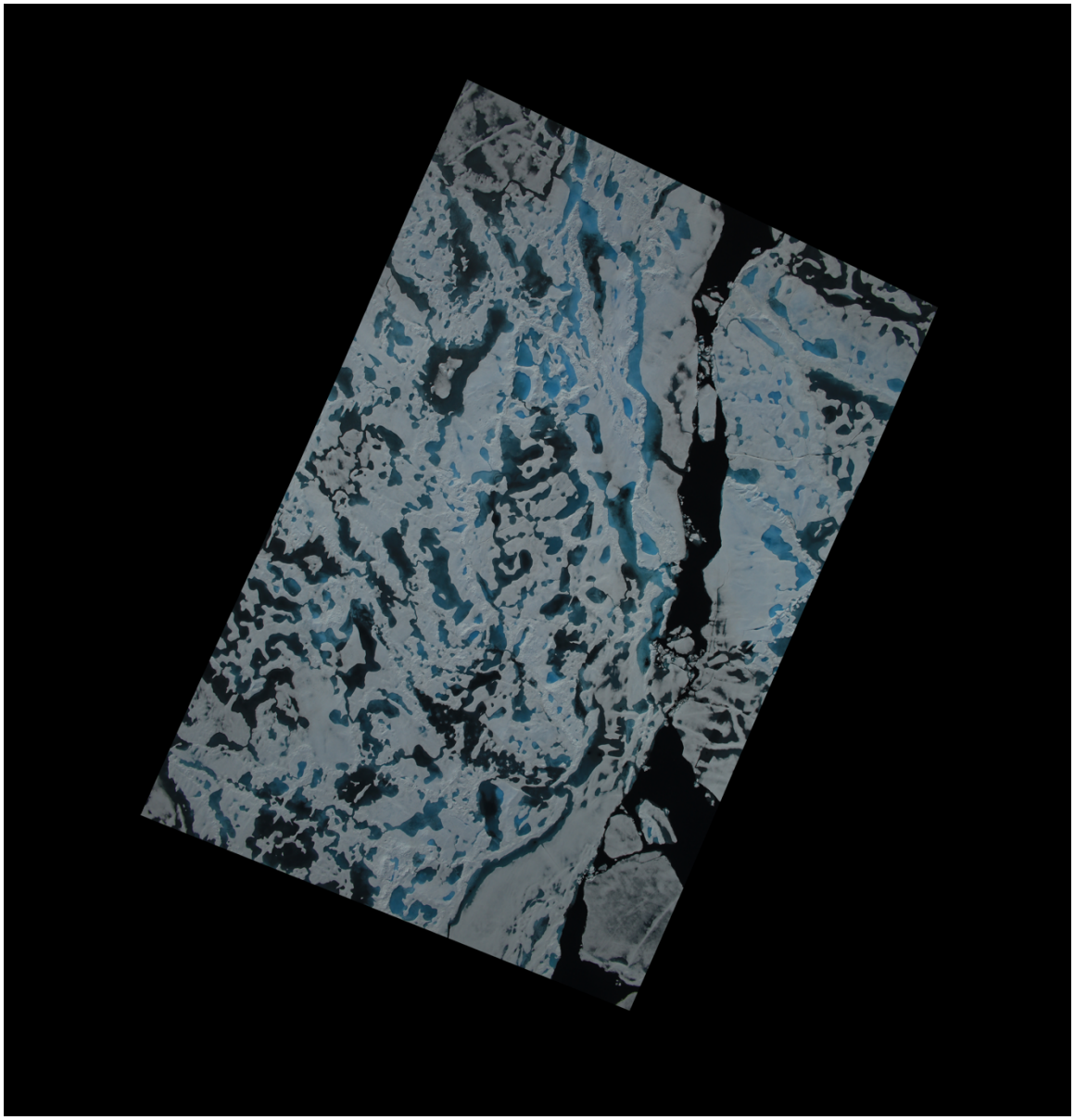


Figure S12b



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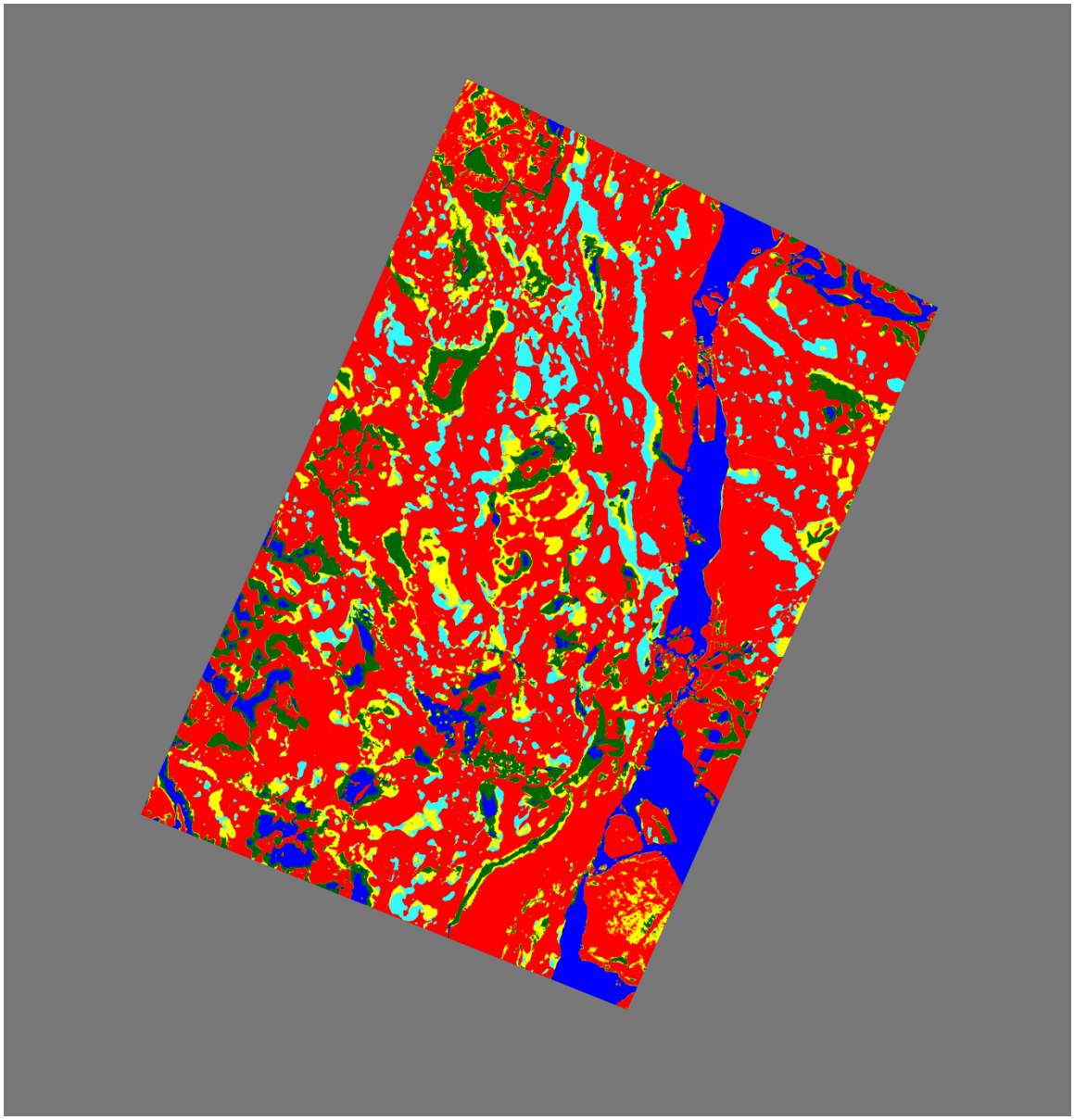

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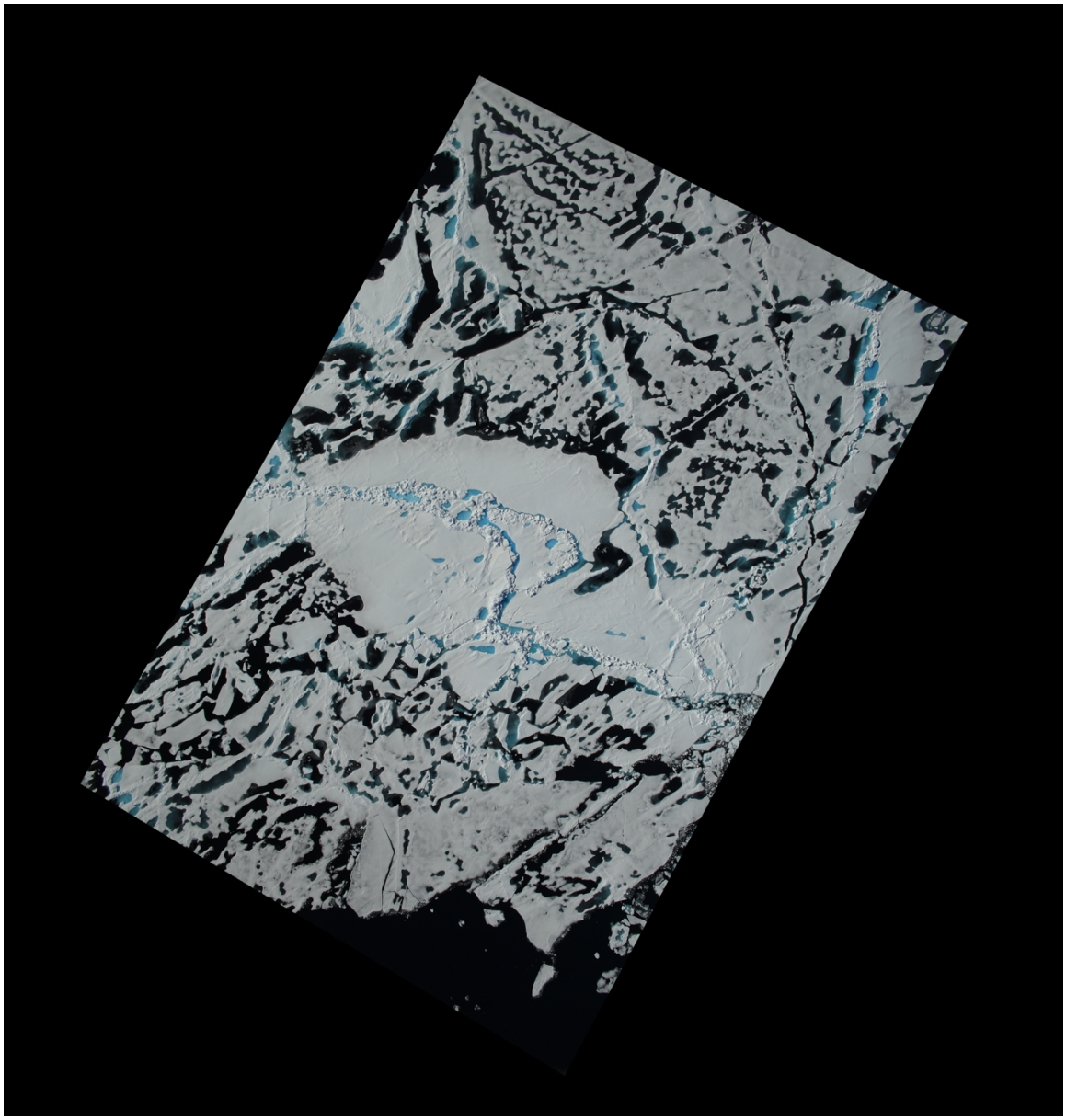

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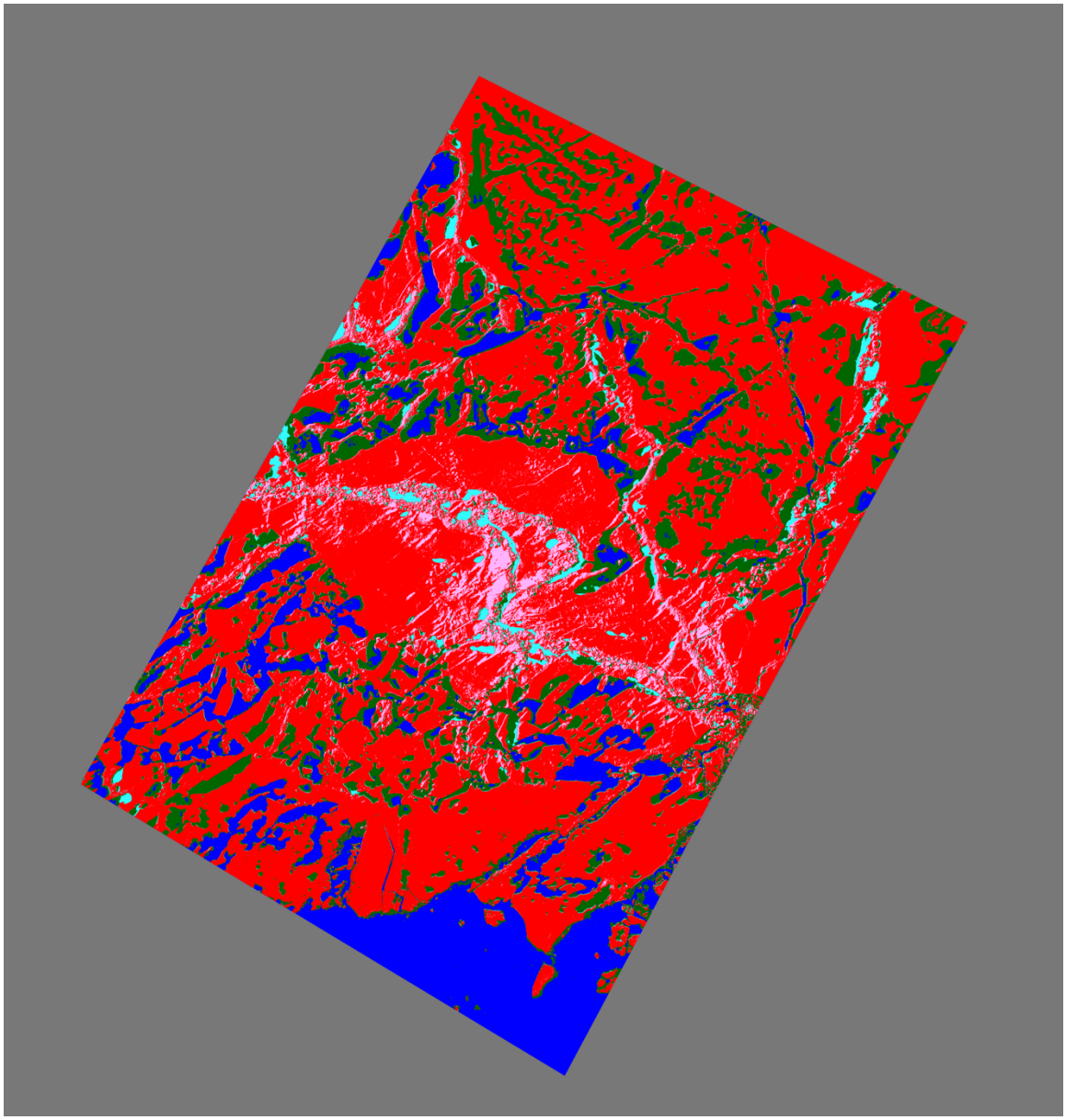

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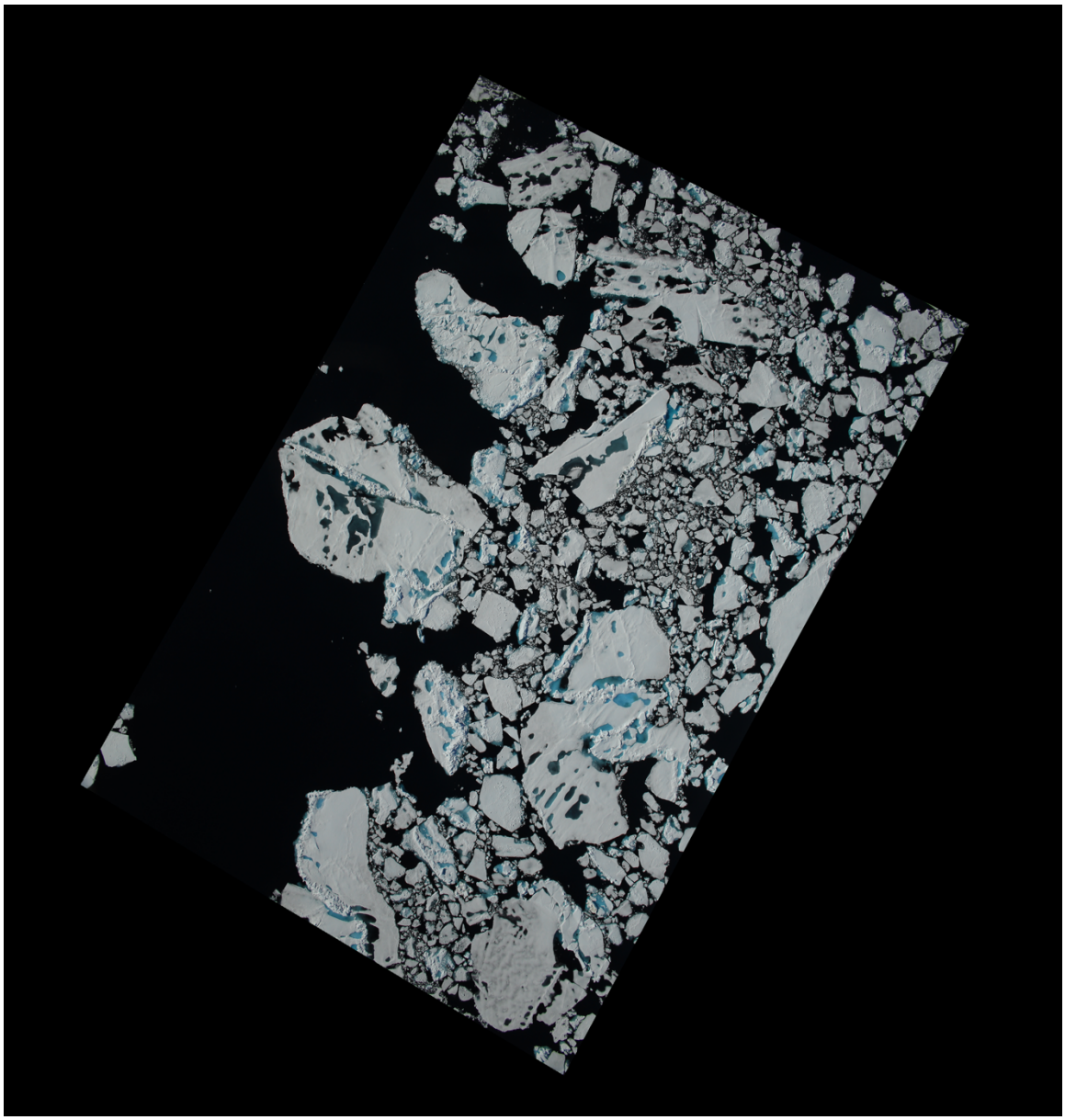

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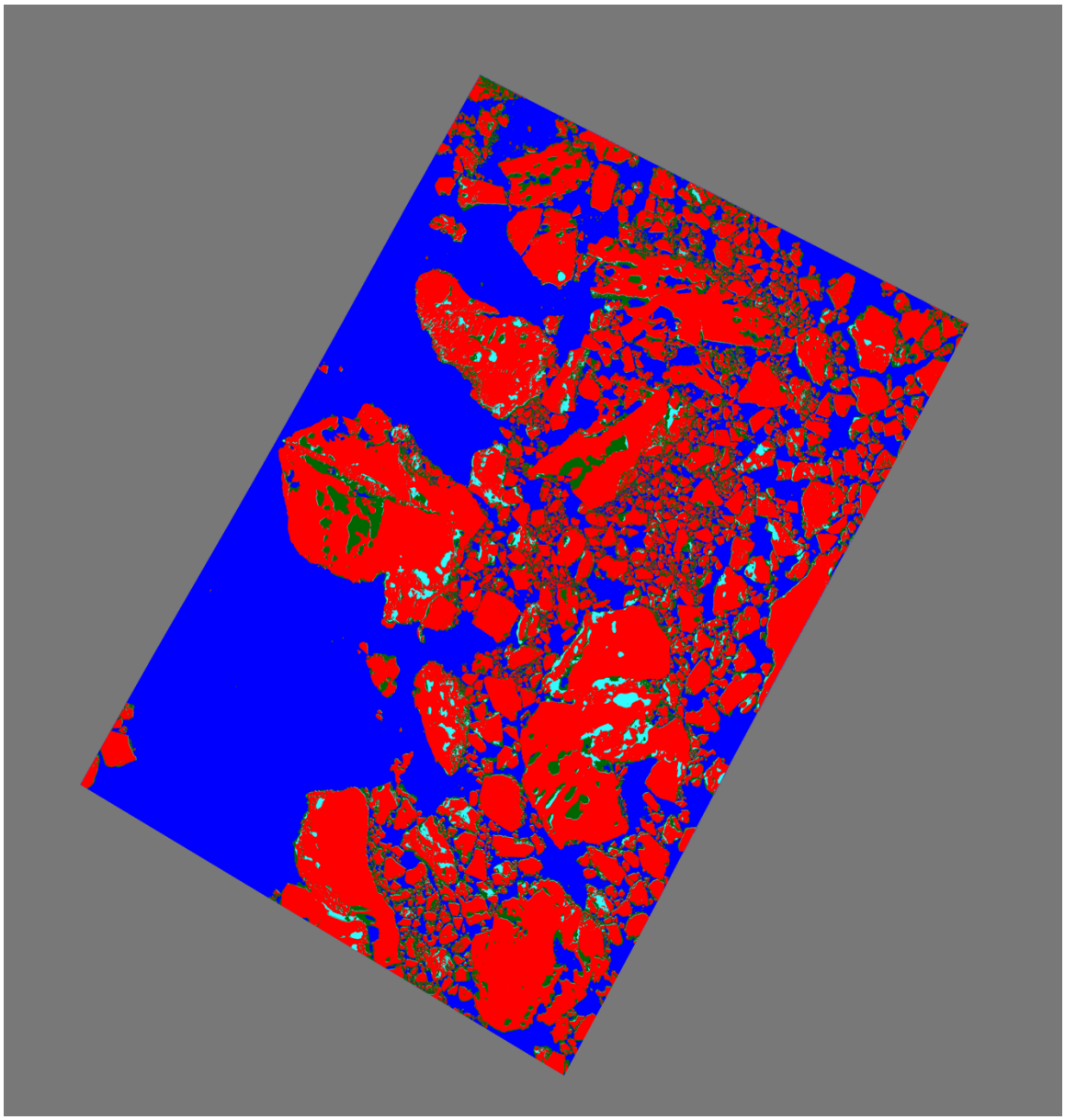

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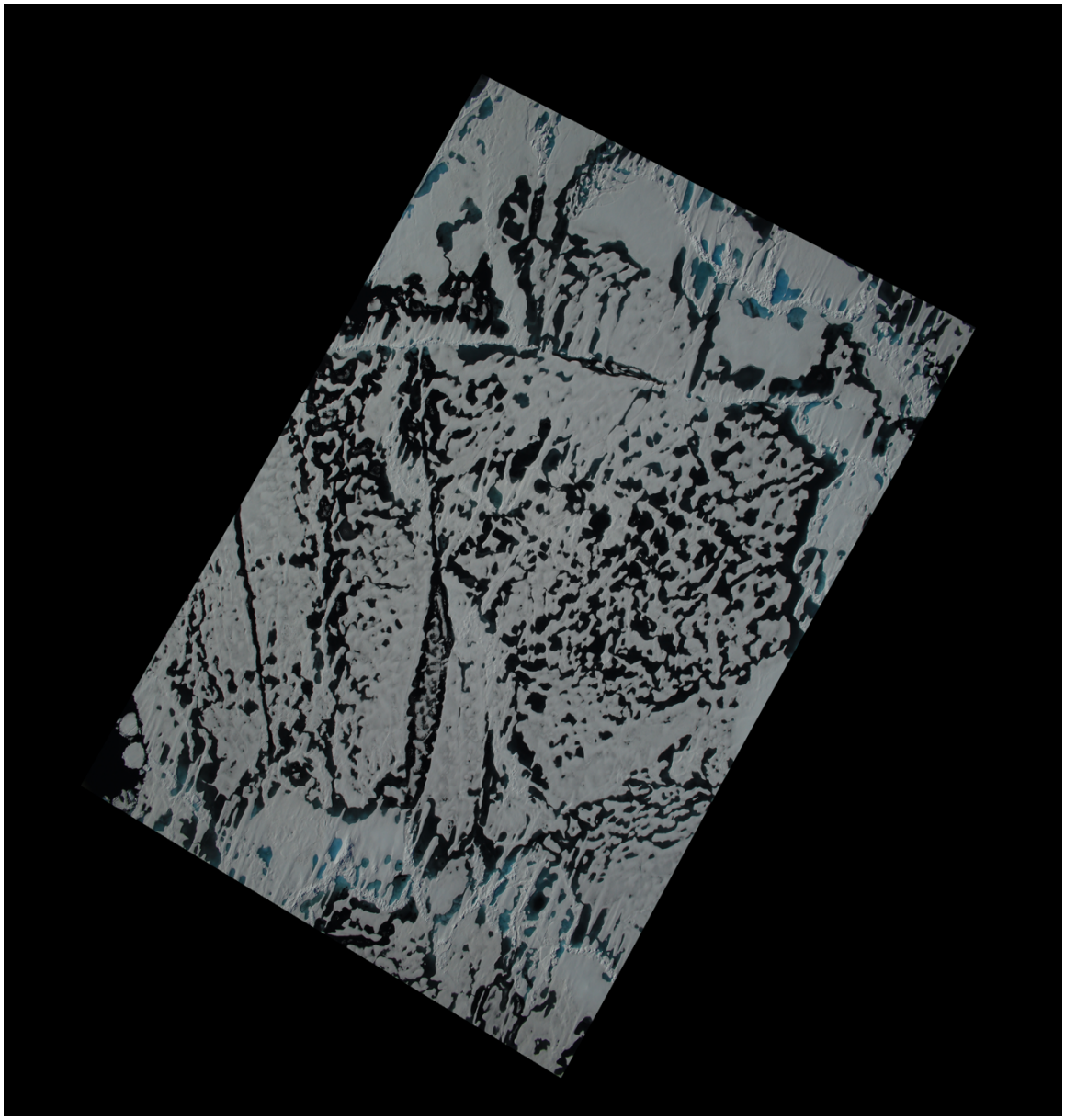

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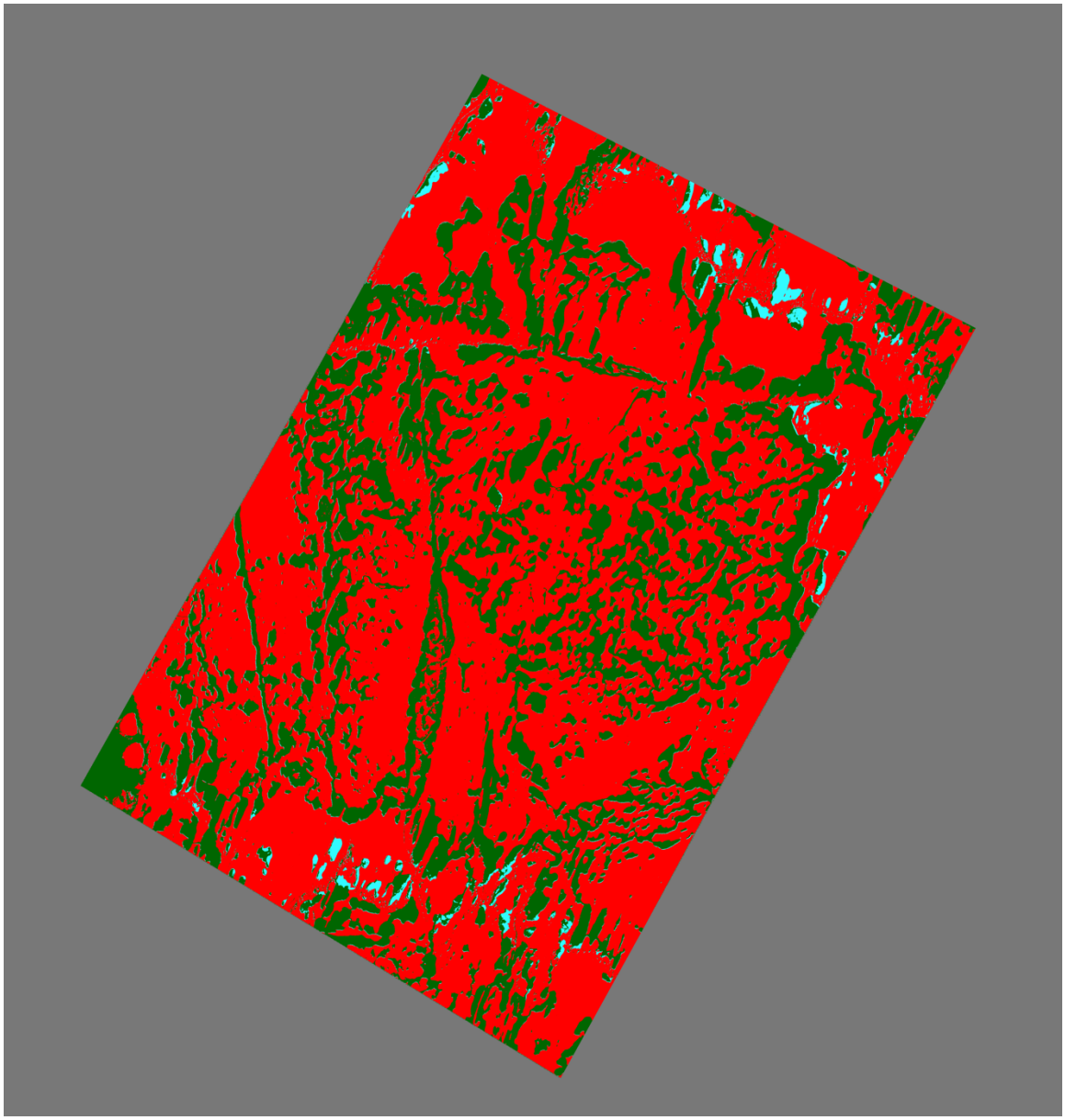

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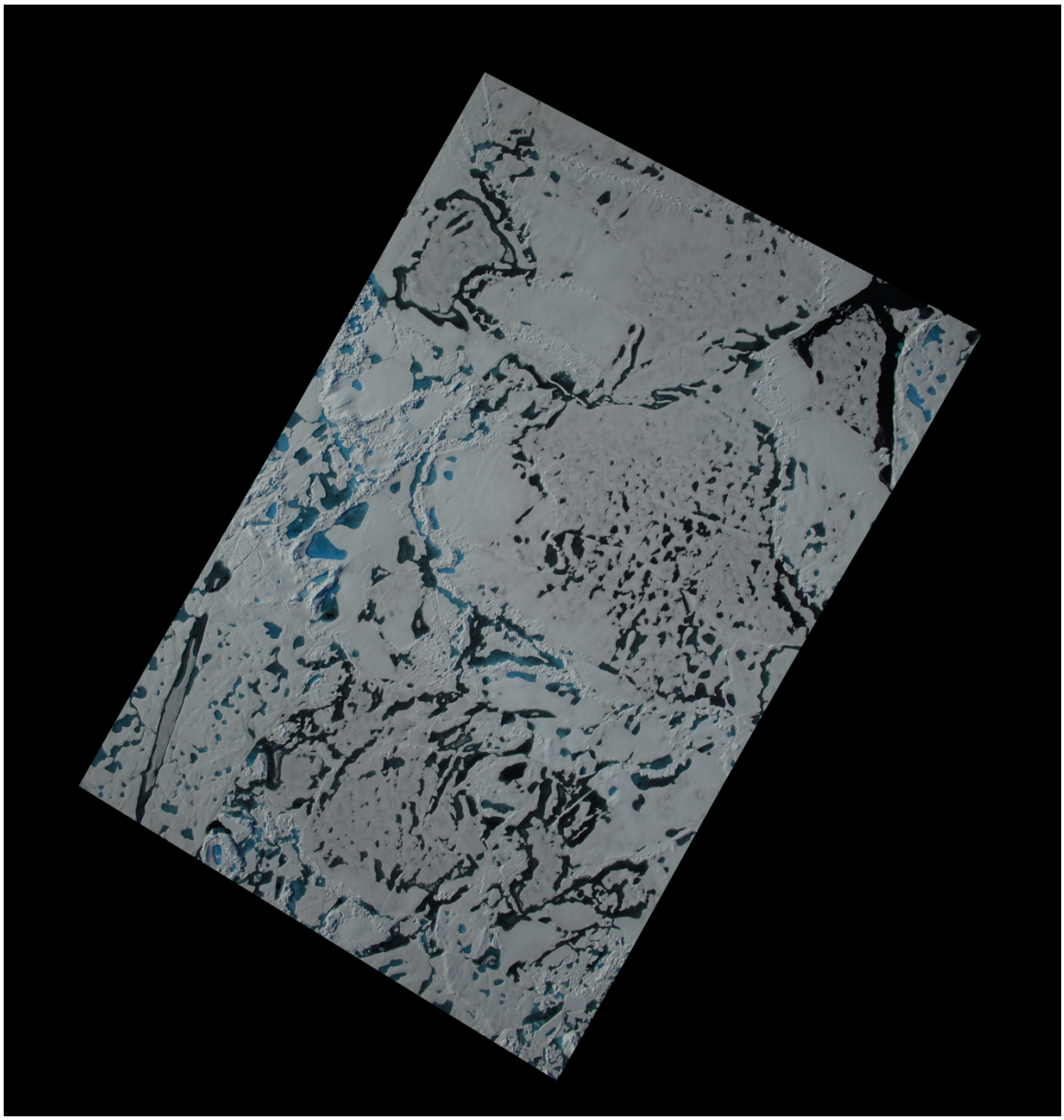

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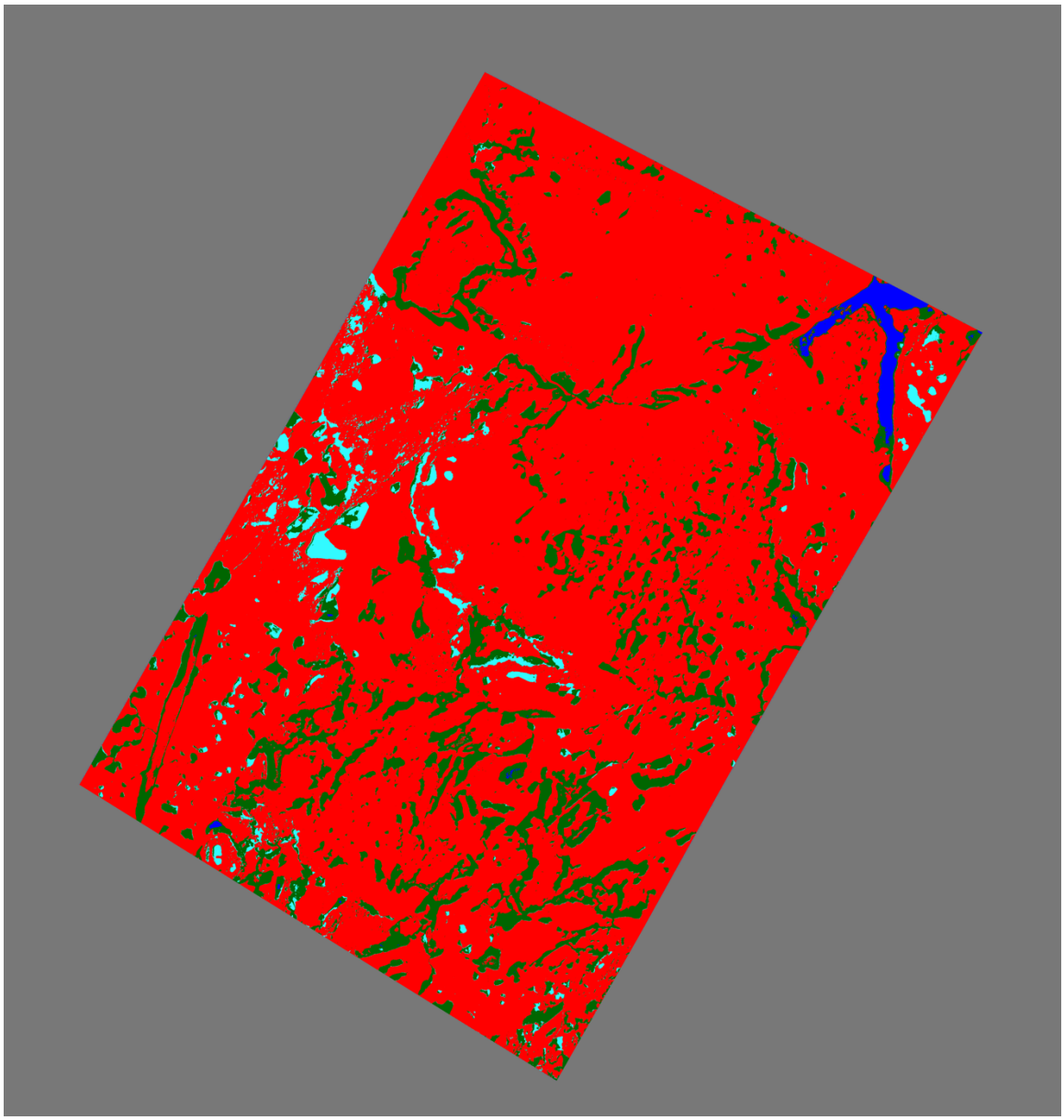
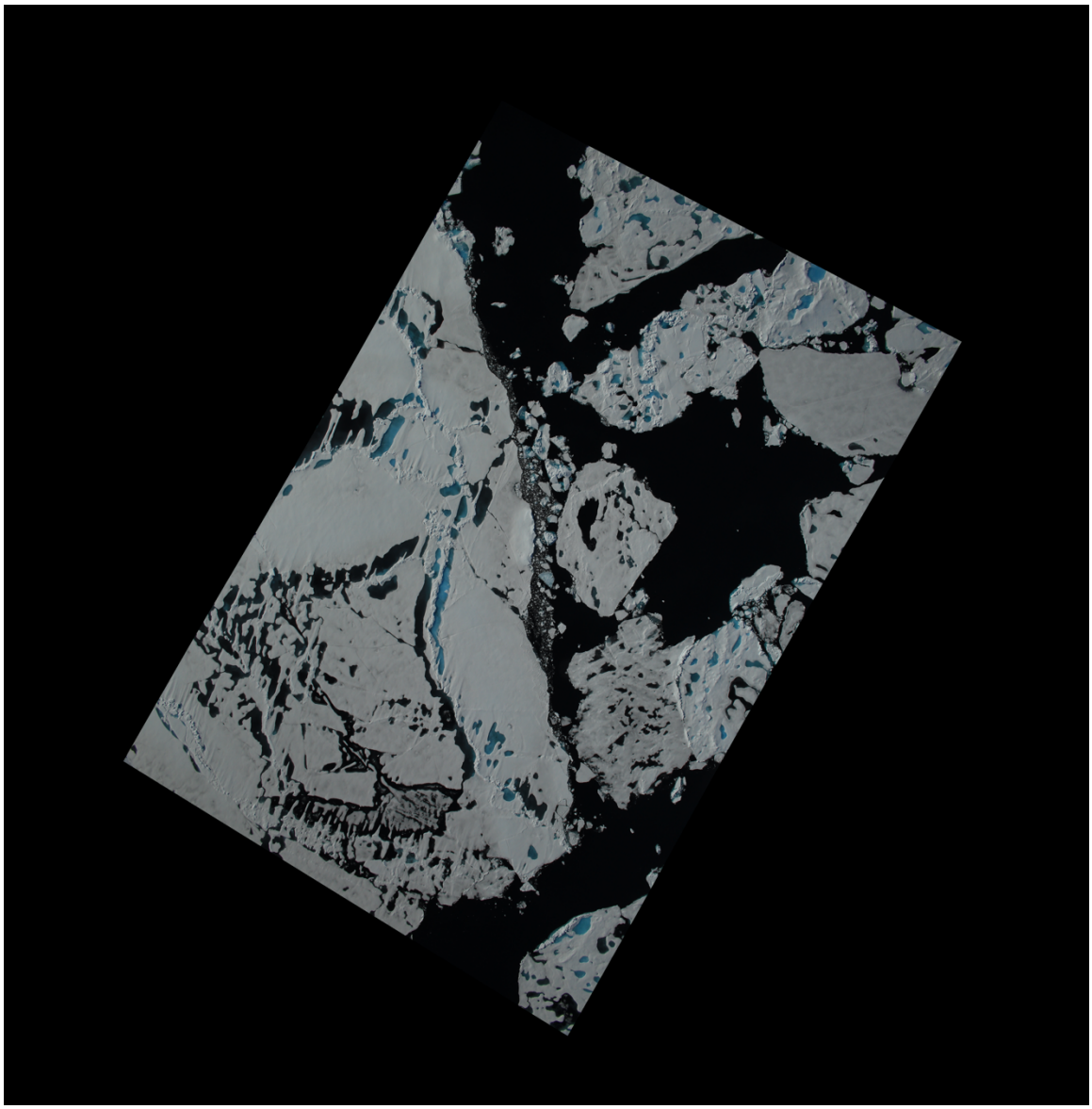


Figure S17b



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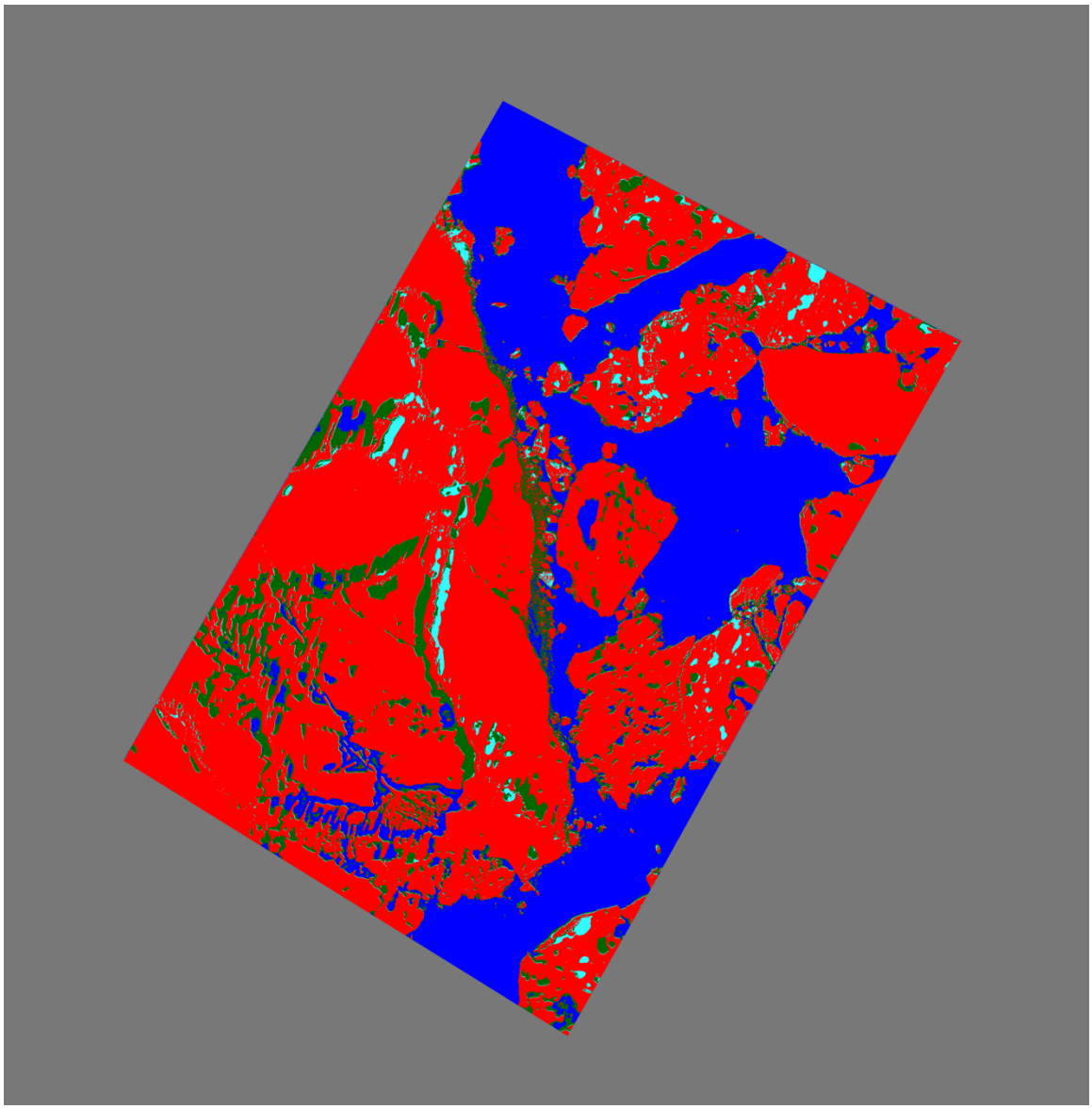

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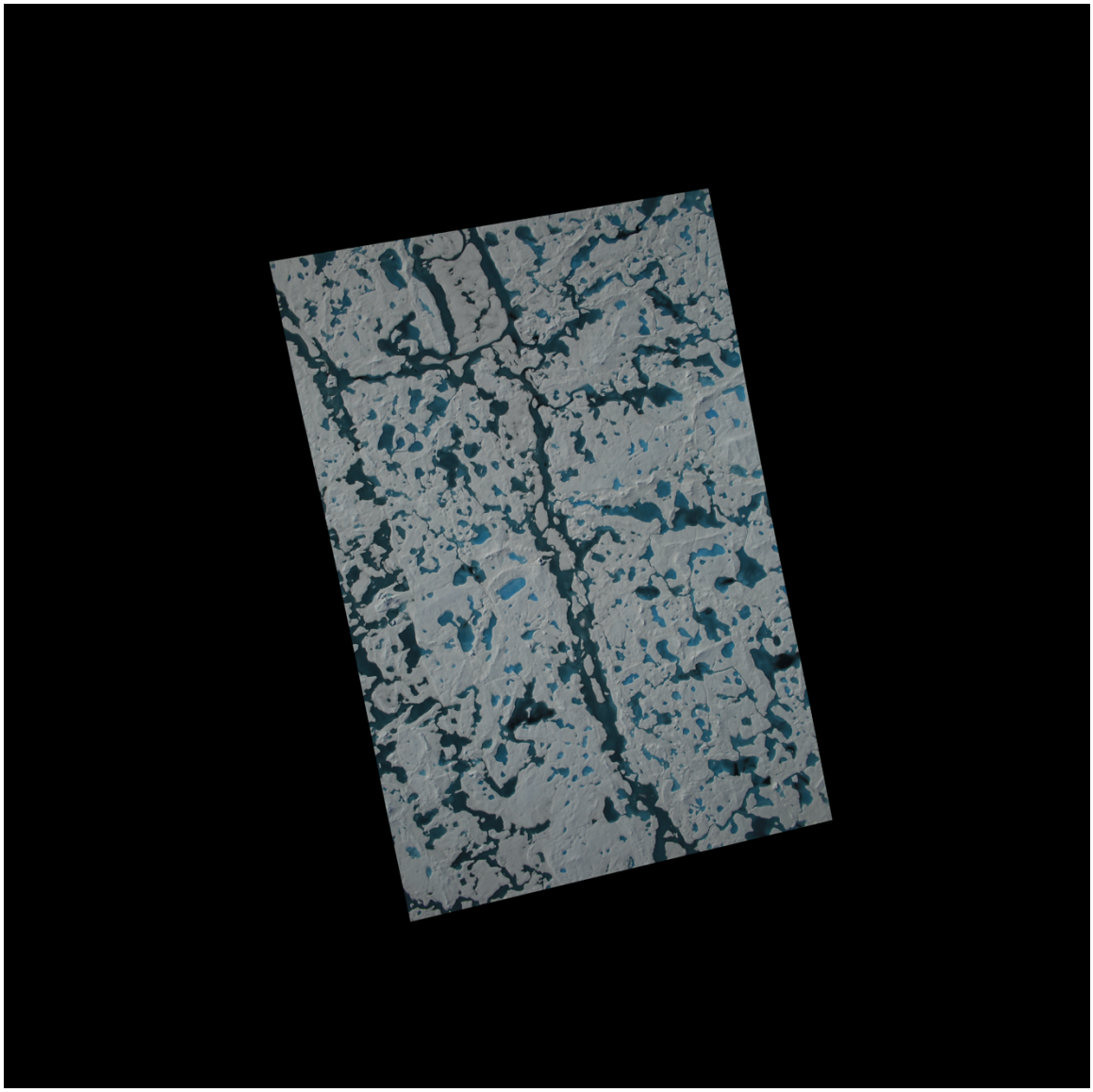

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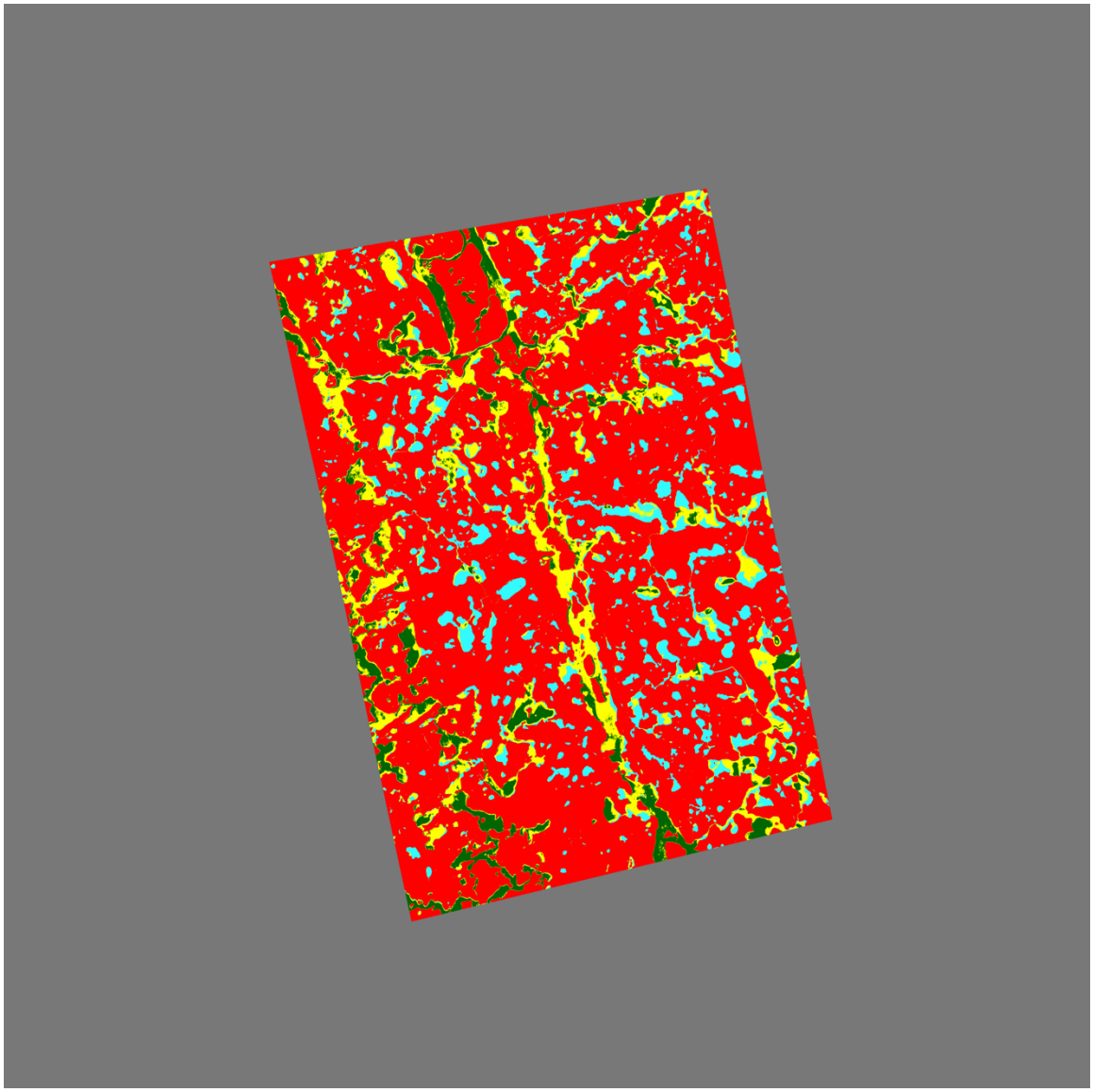

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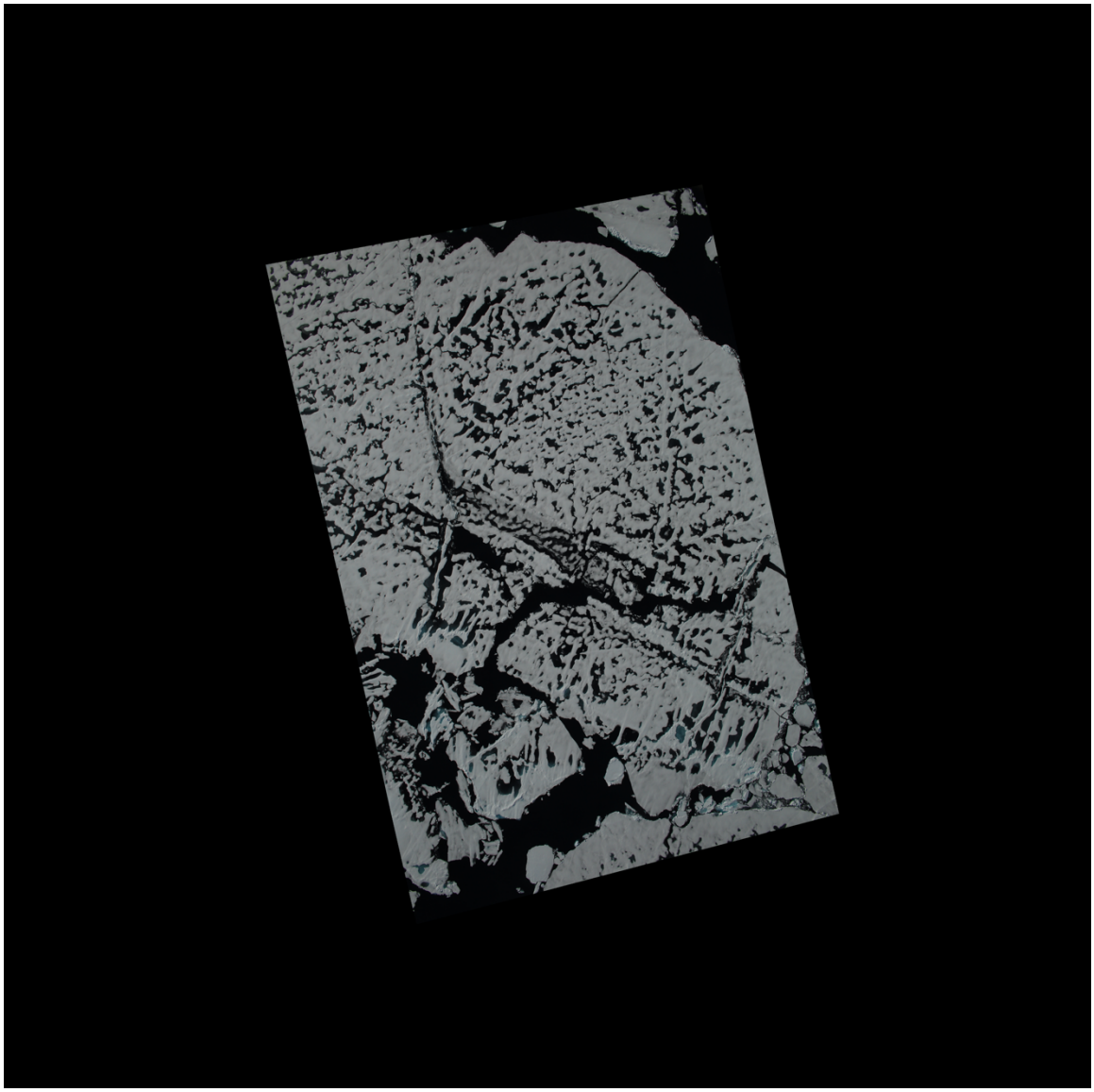

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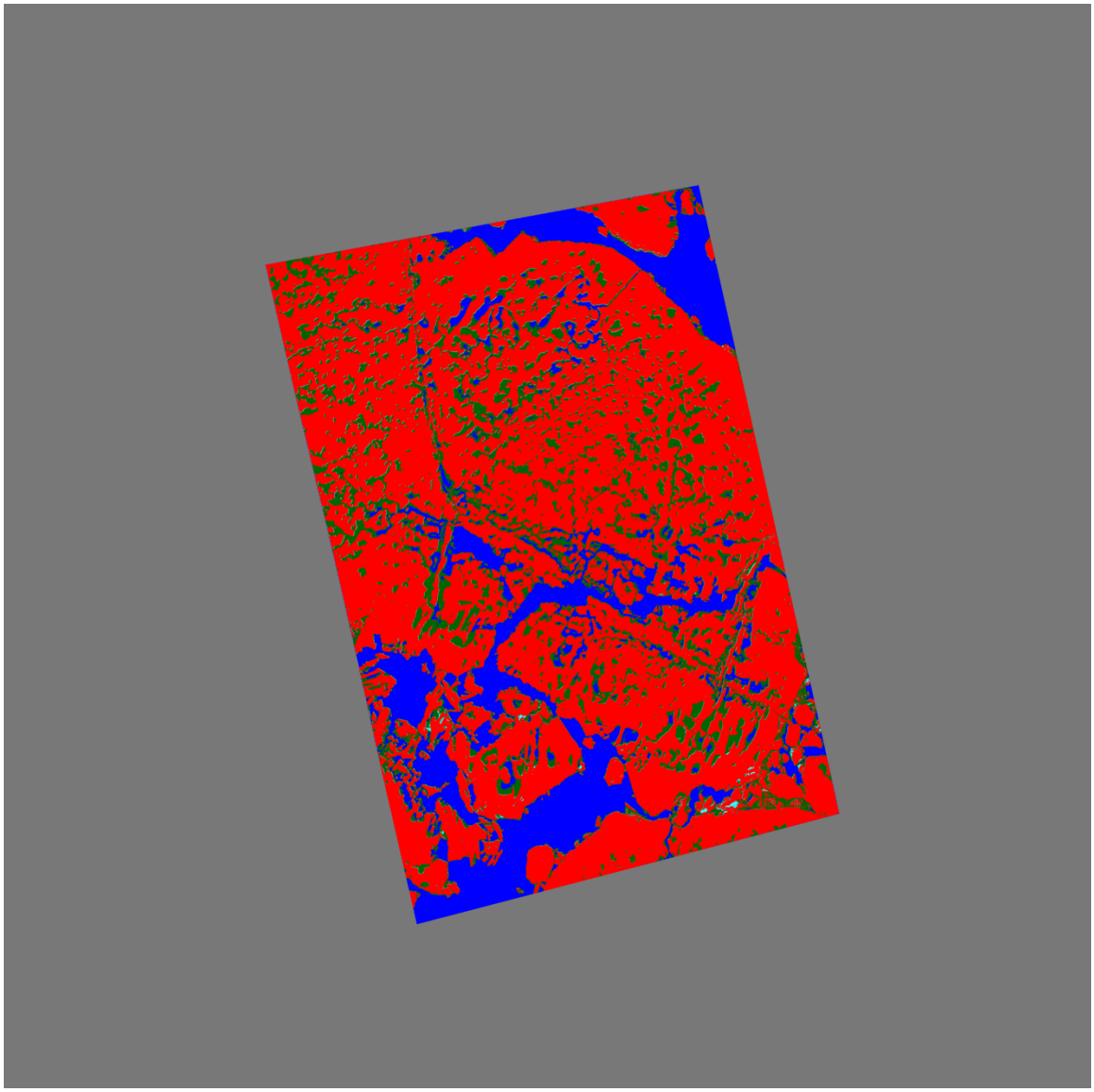

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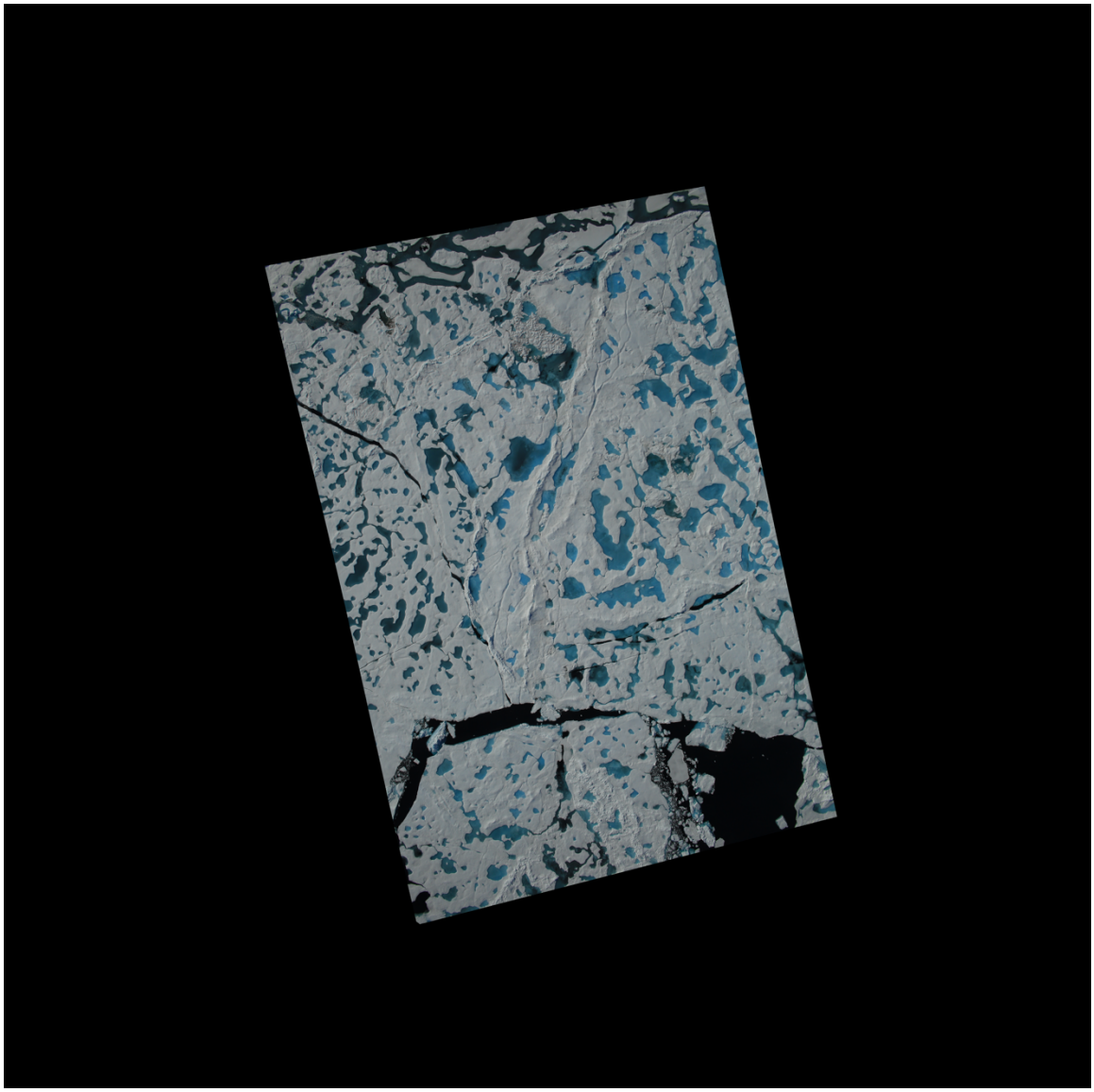

Figure S21a

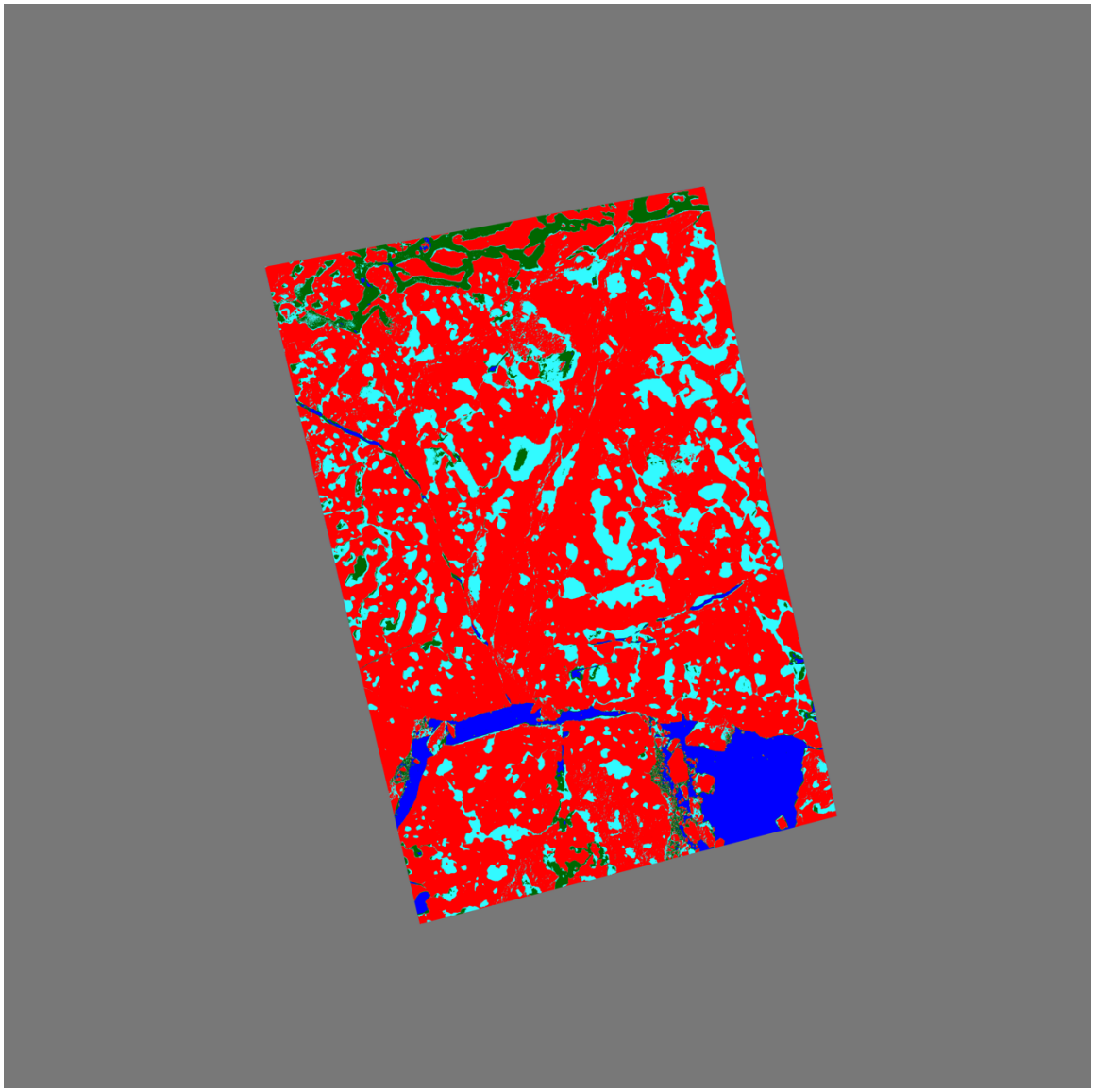

Figure S21b

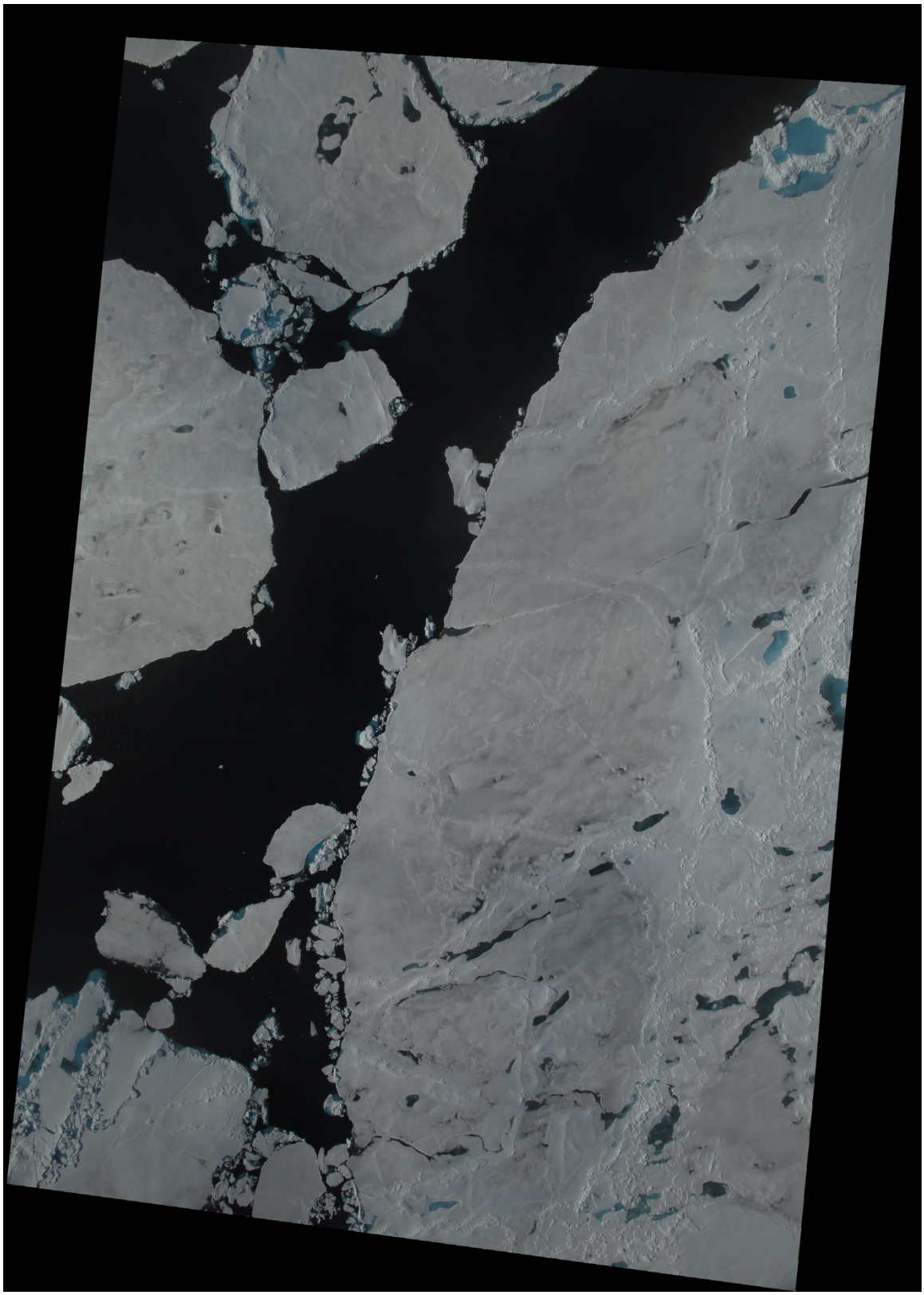

Figure S22a

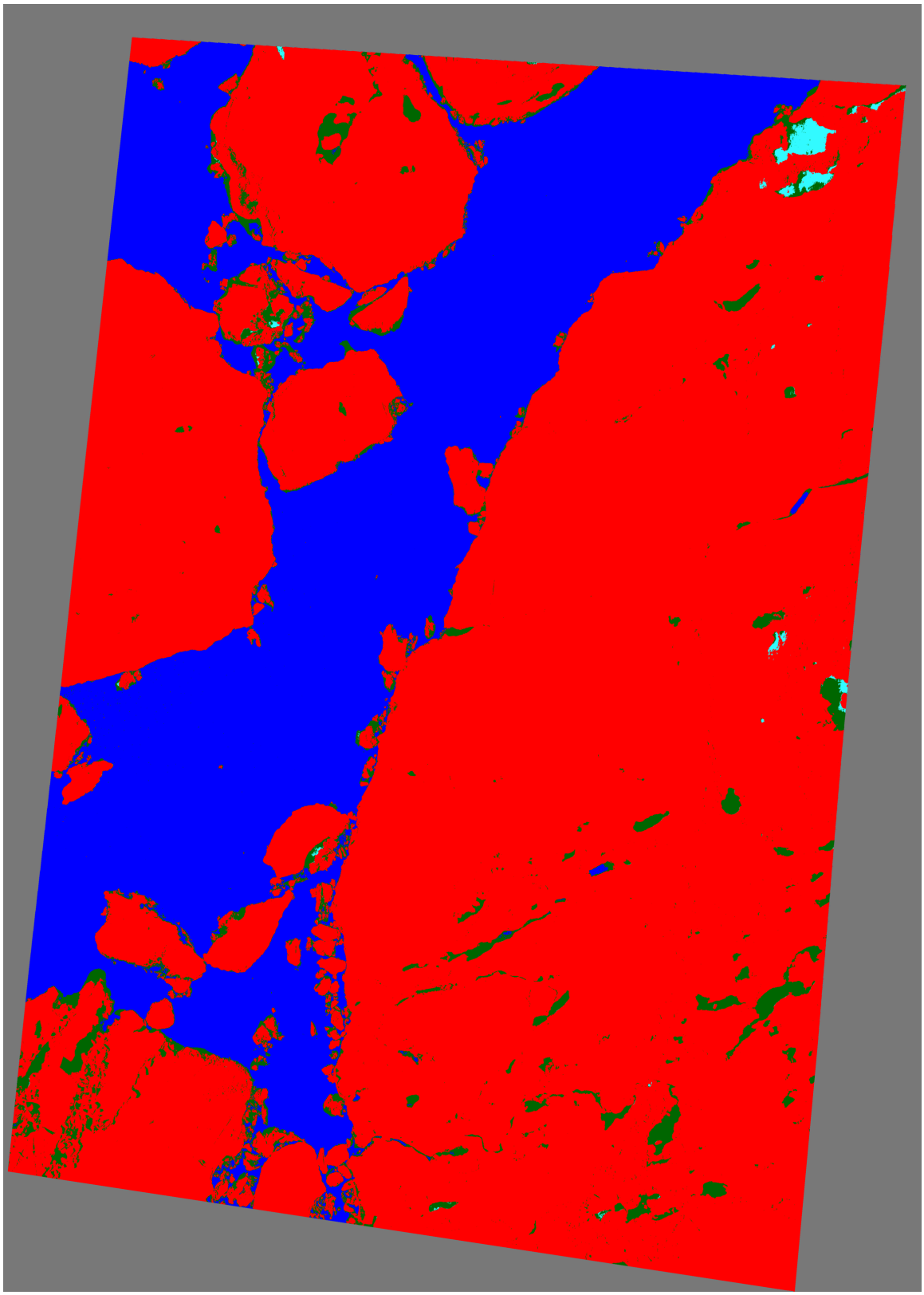

Figure S22b

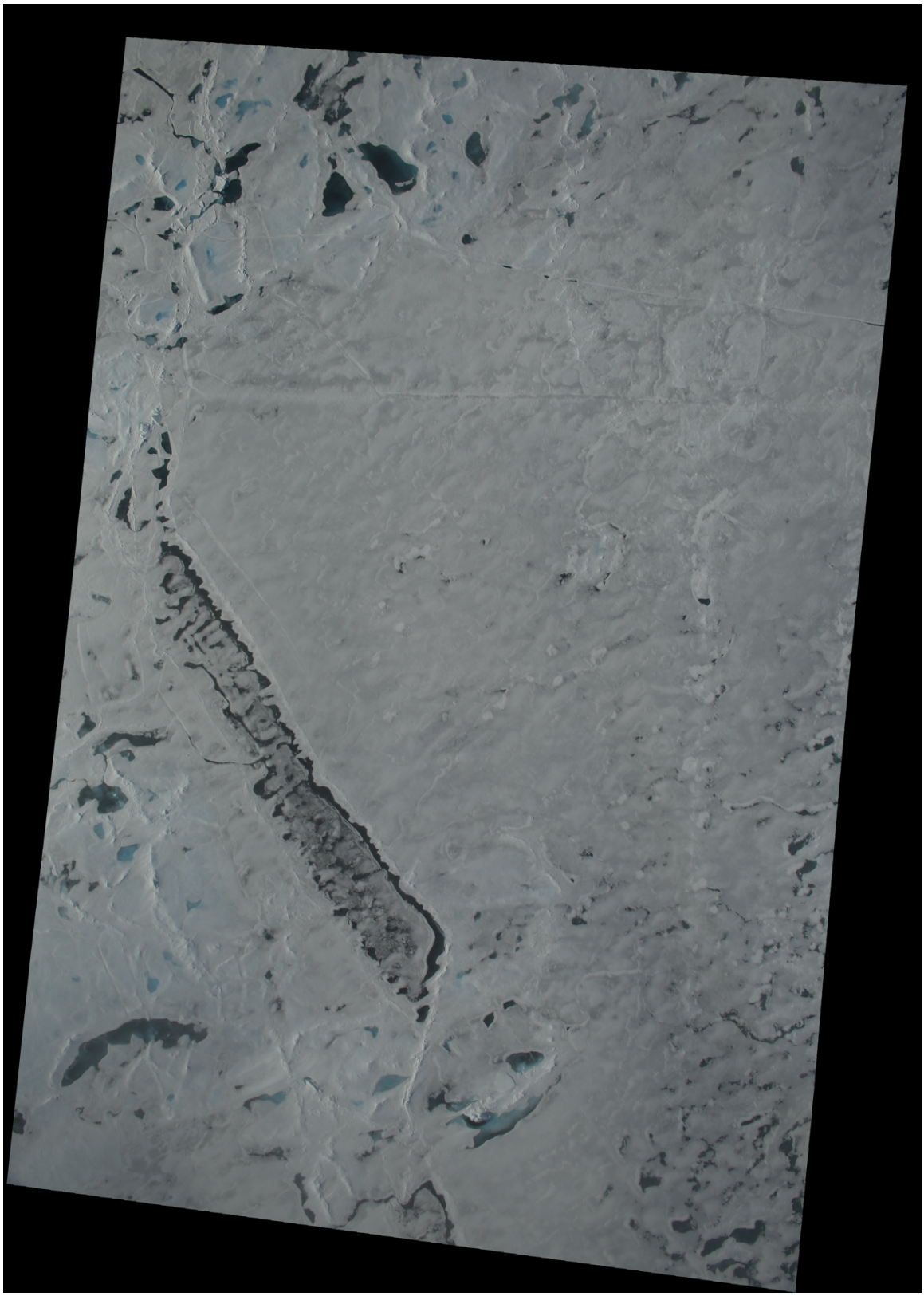

Figure S23a

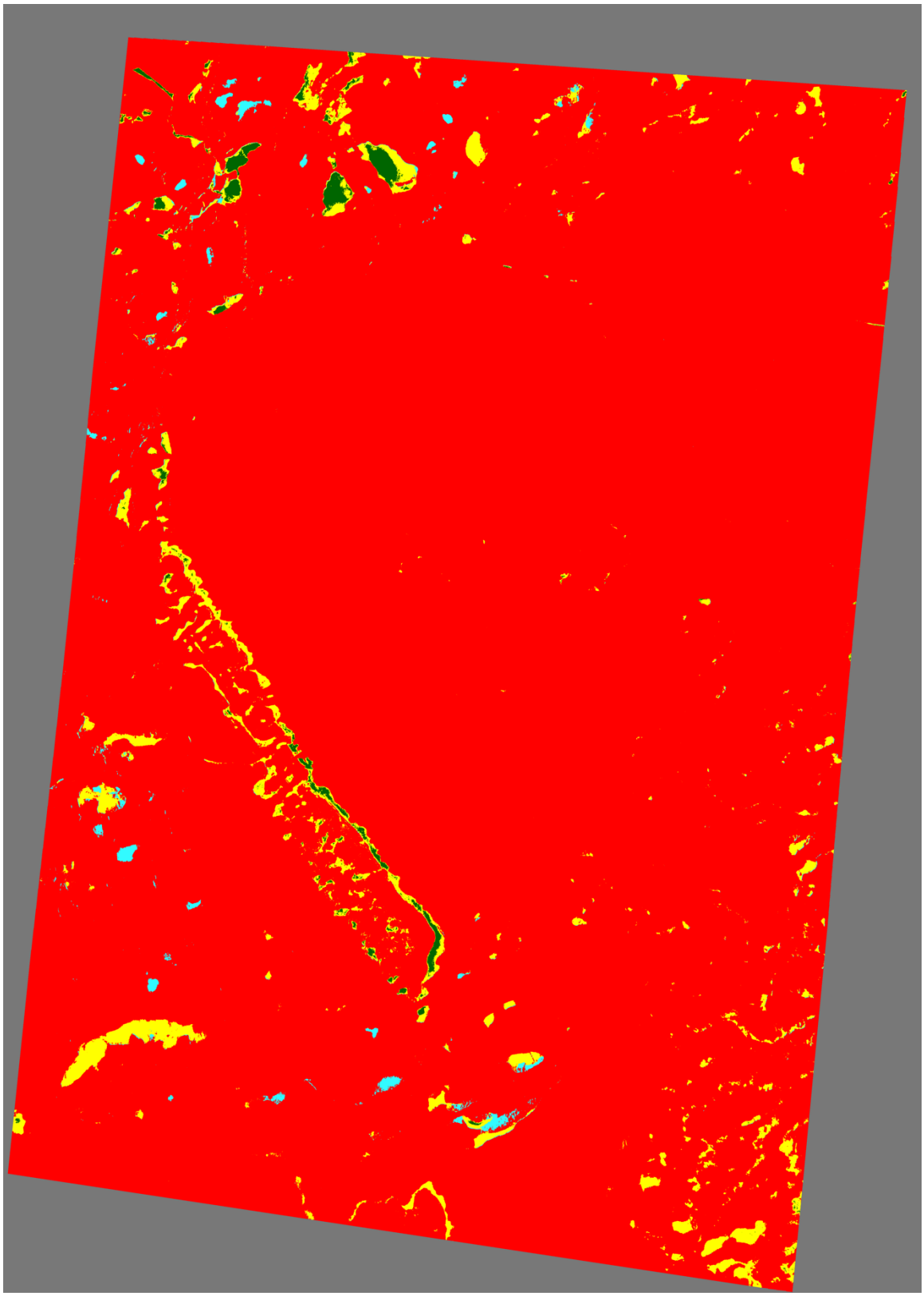

Figure S23b

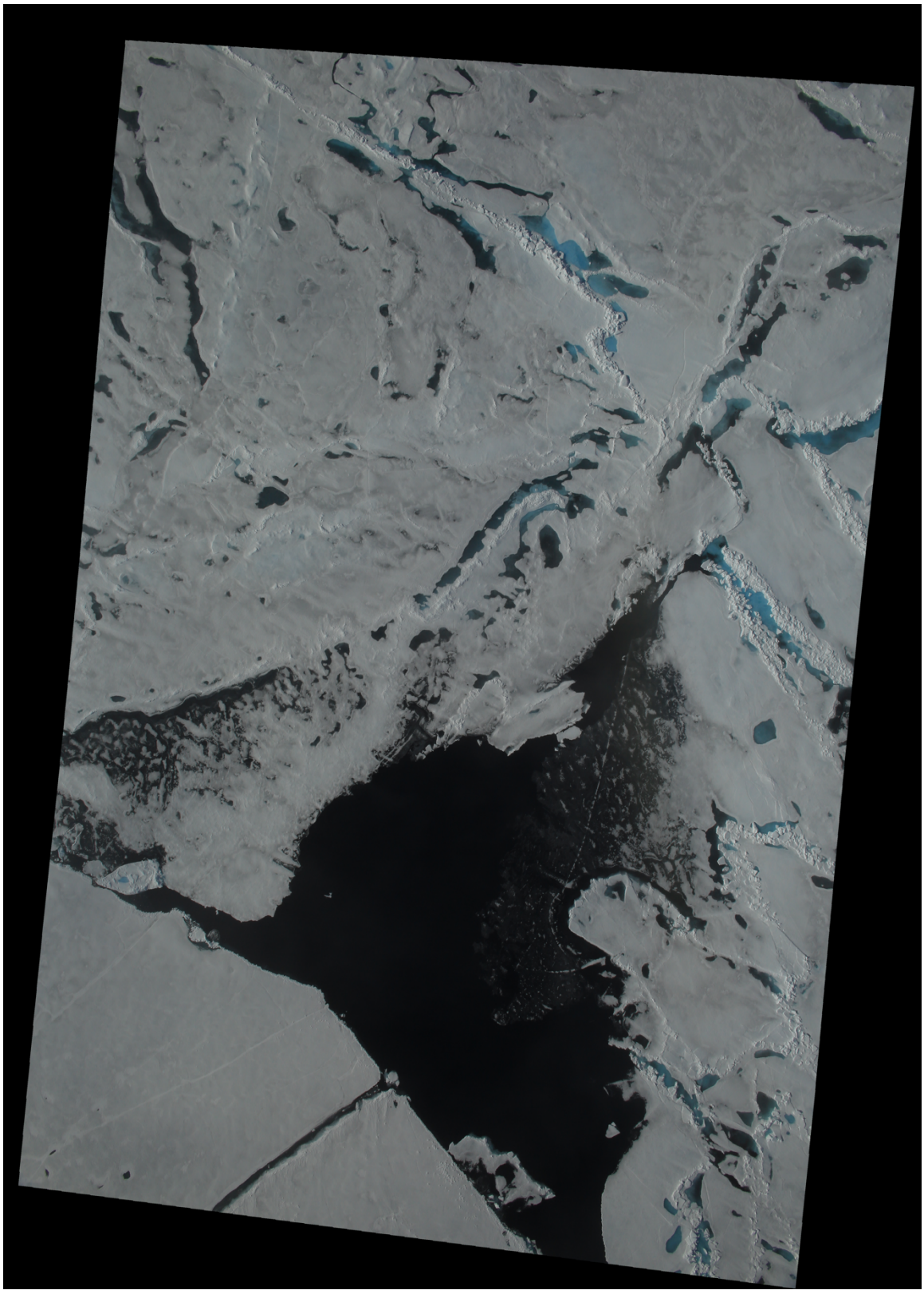

Figure S24a

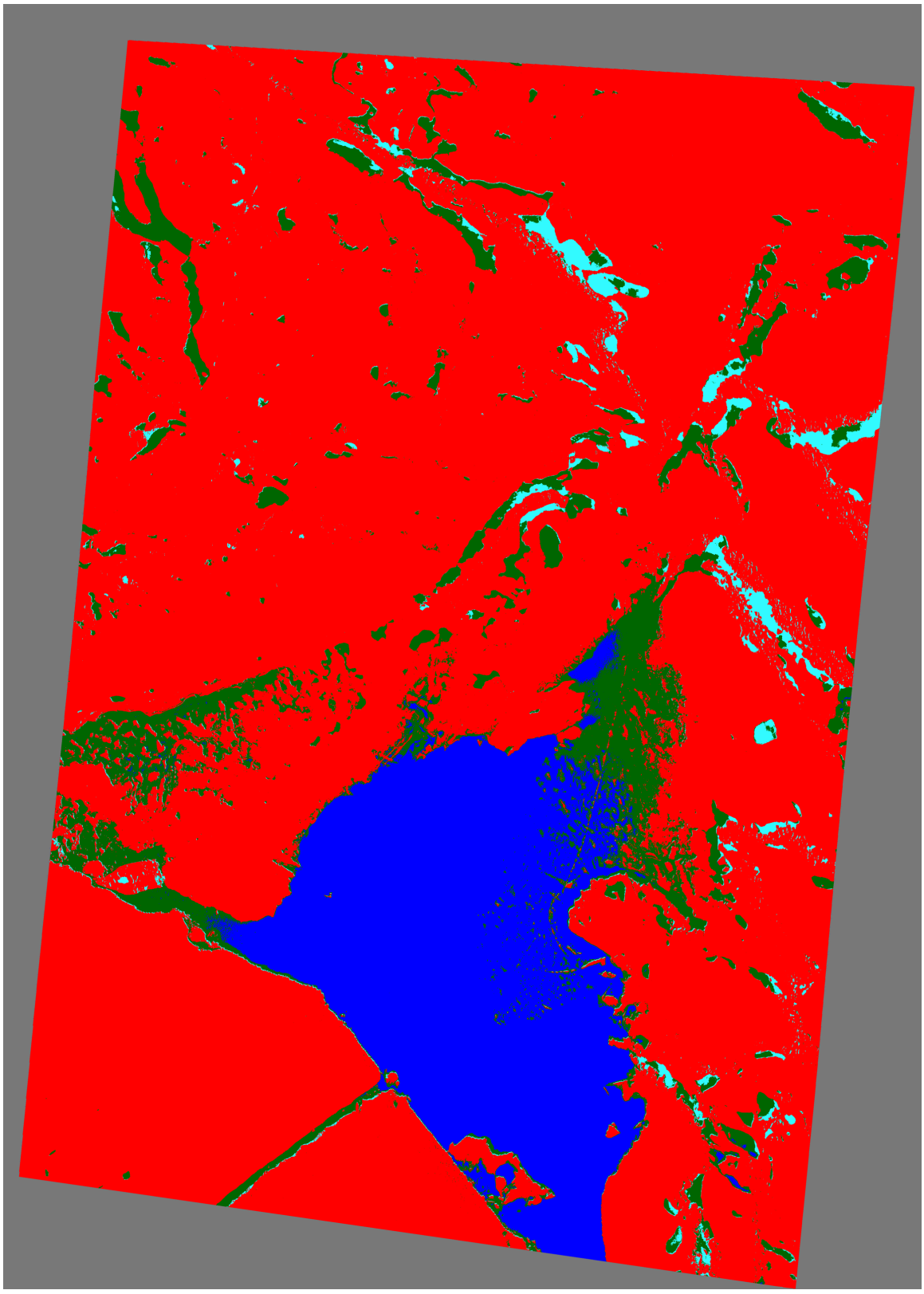

Figure S24b

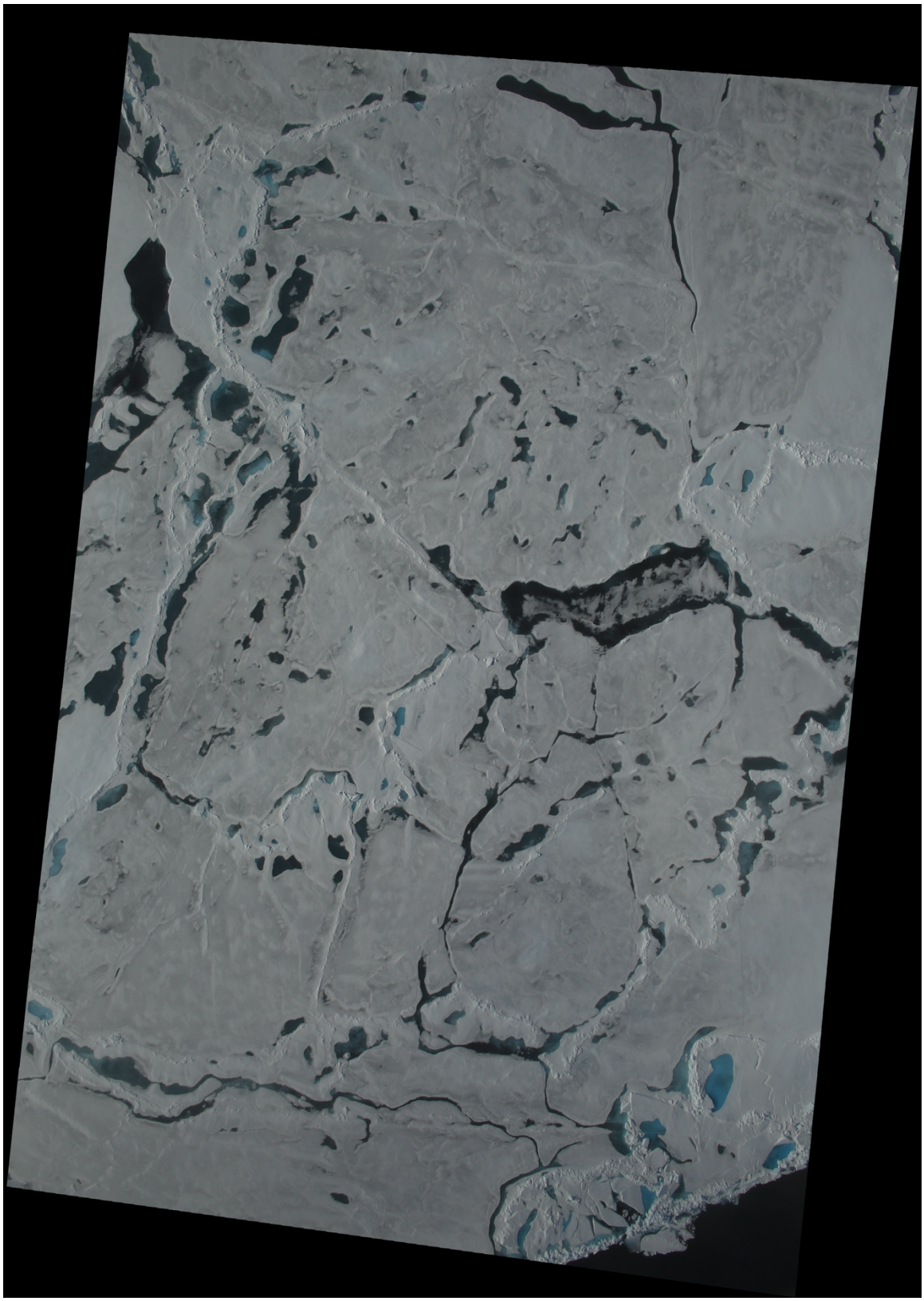

Figure S25a

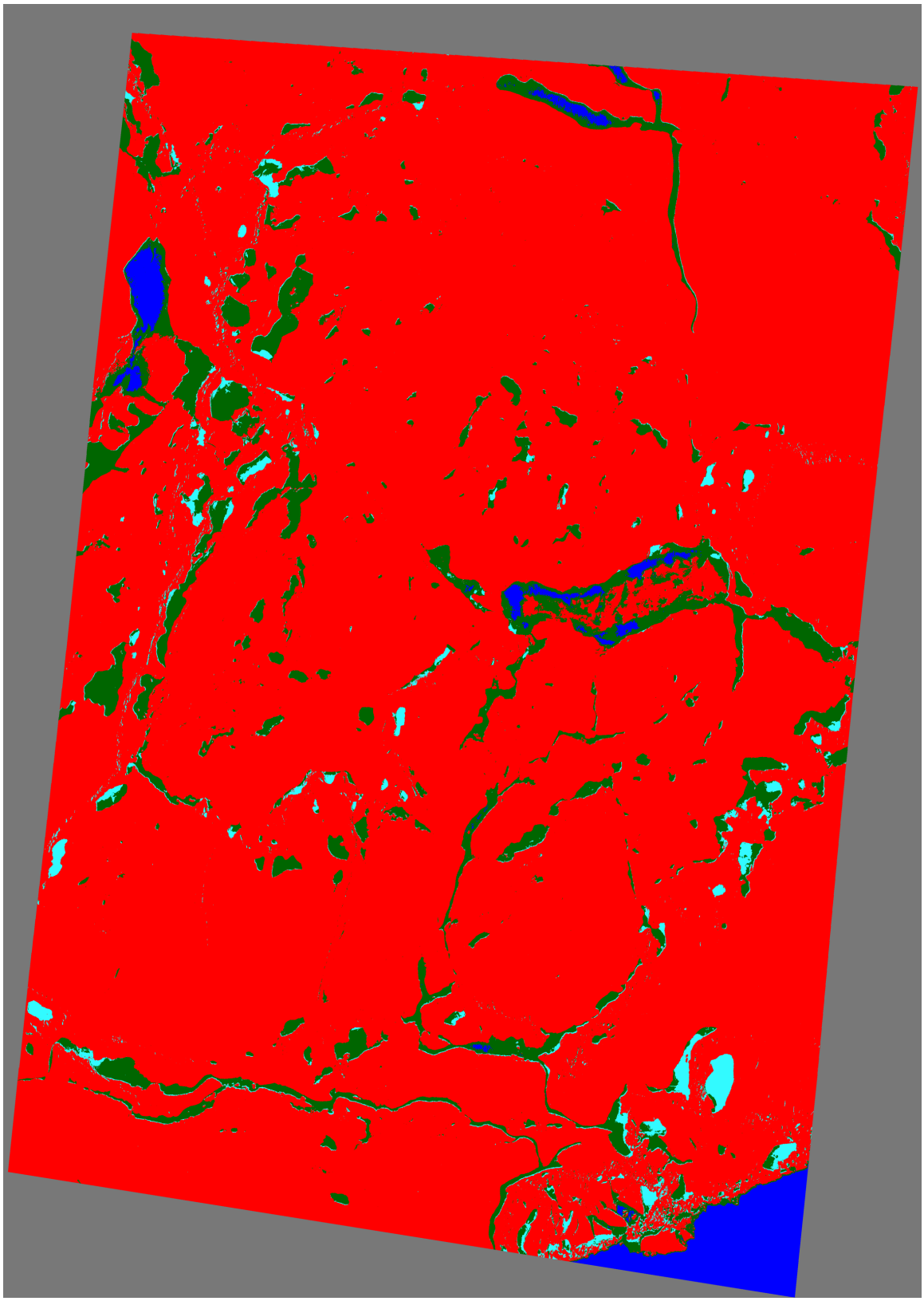

Figure S25b

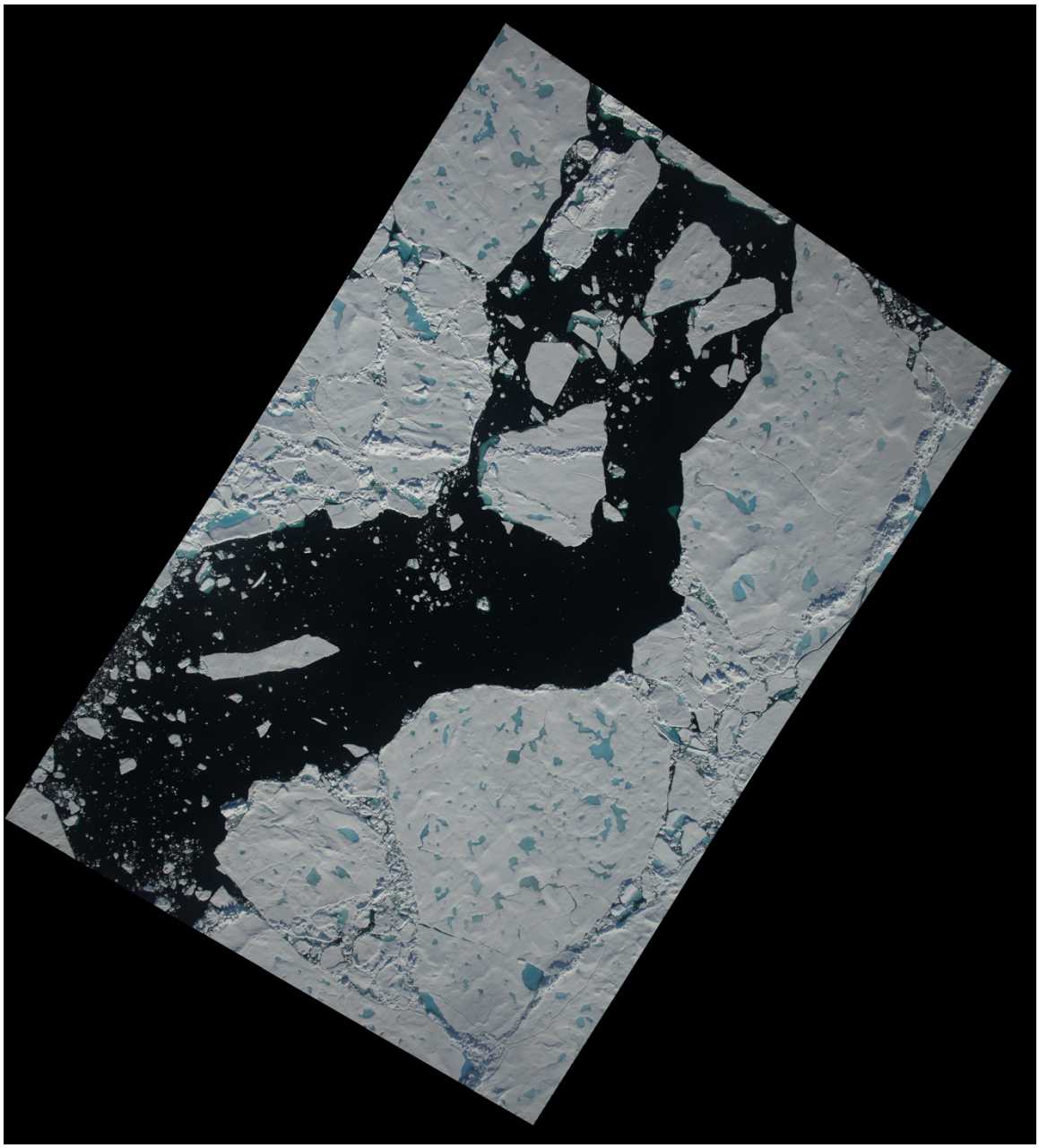

Figure S26a

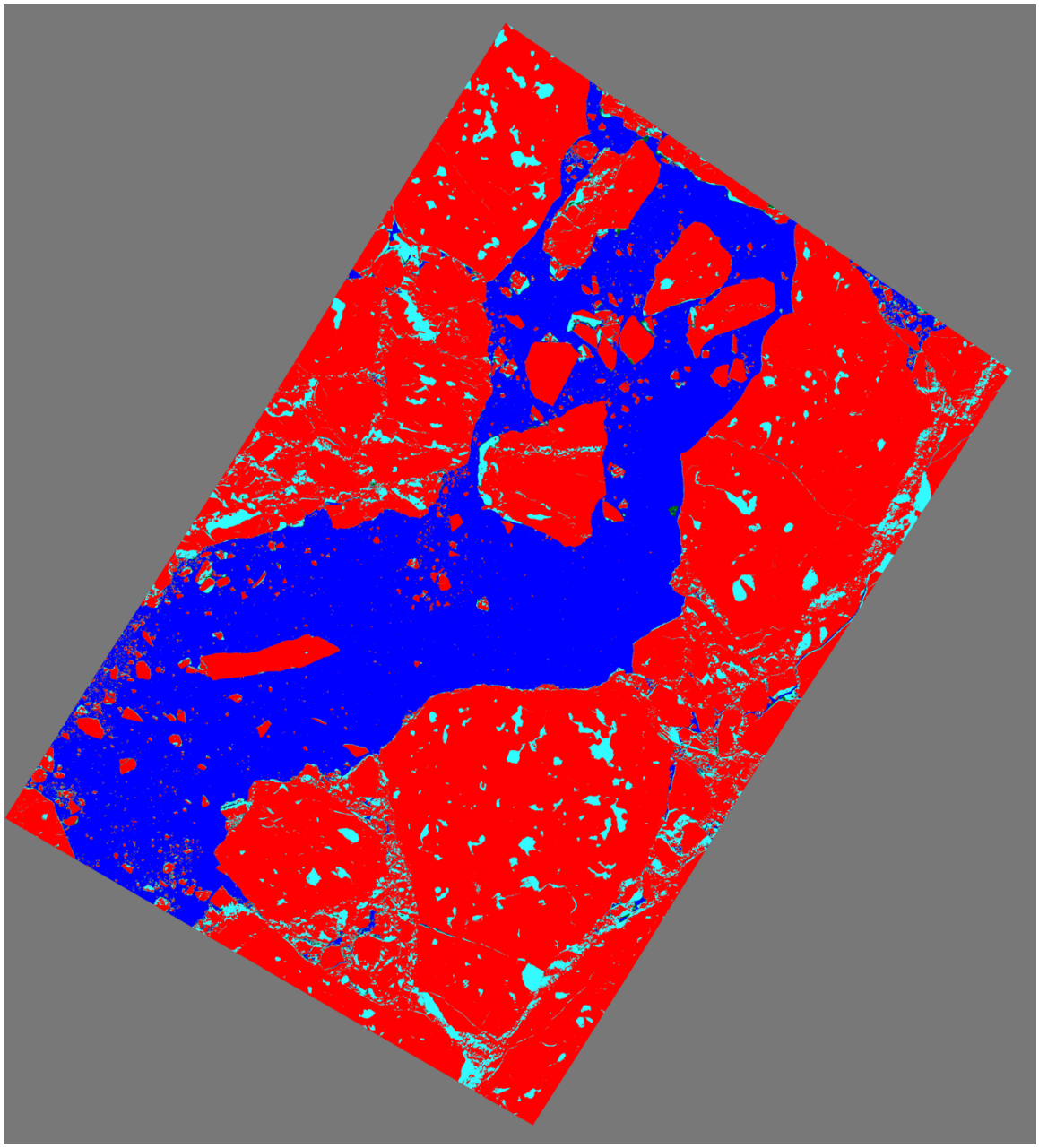

Figure S26b

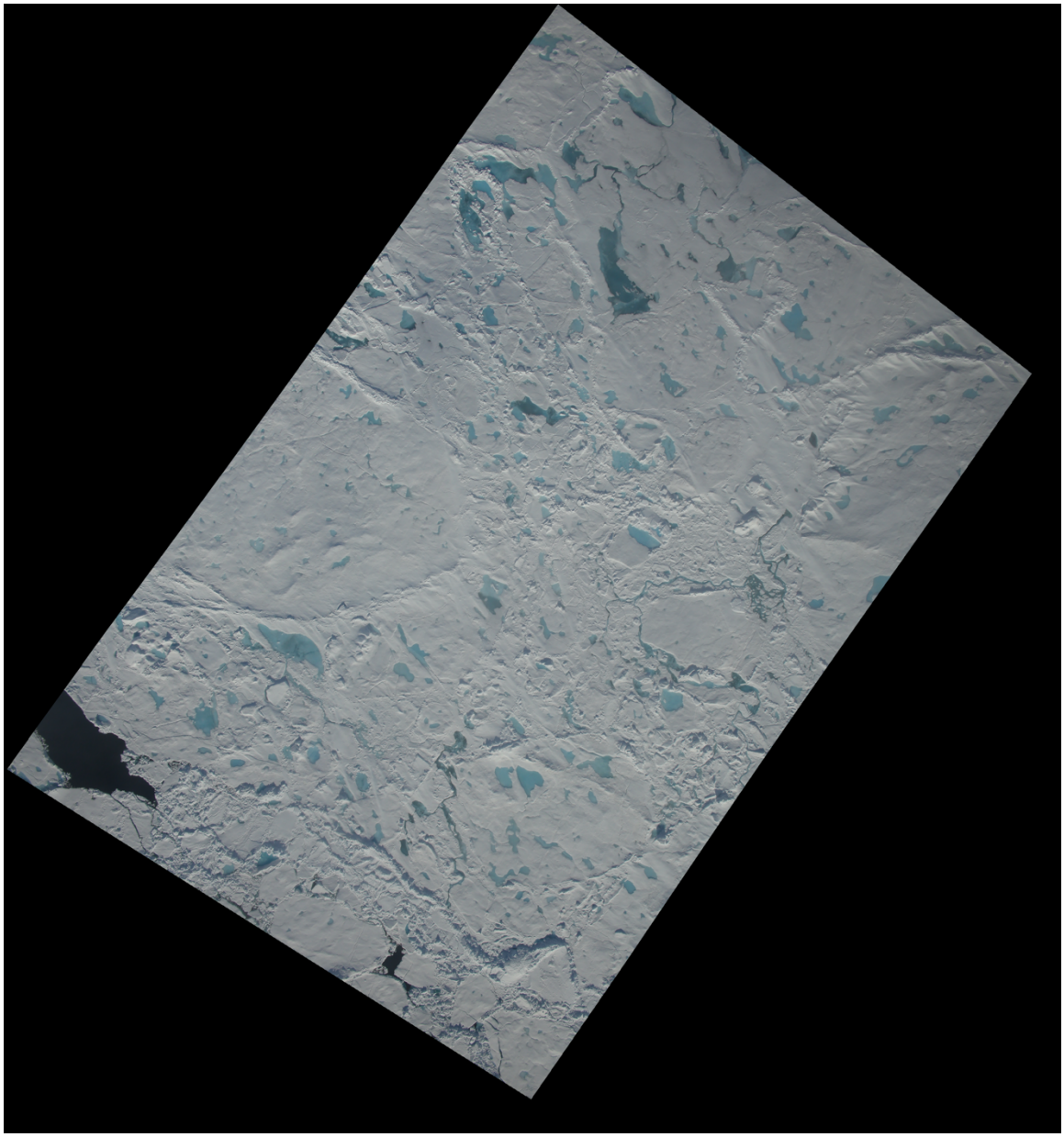

Figure S27a

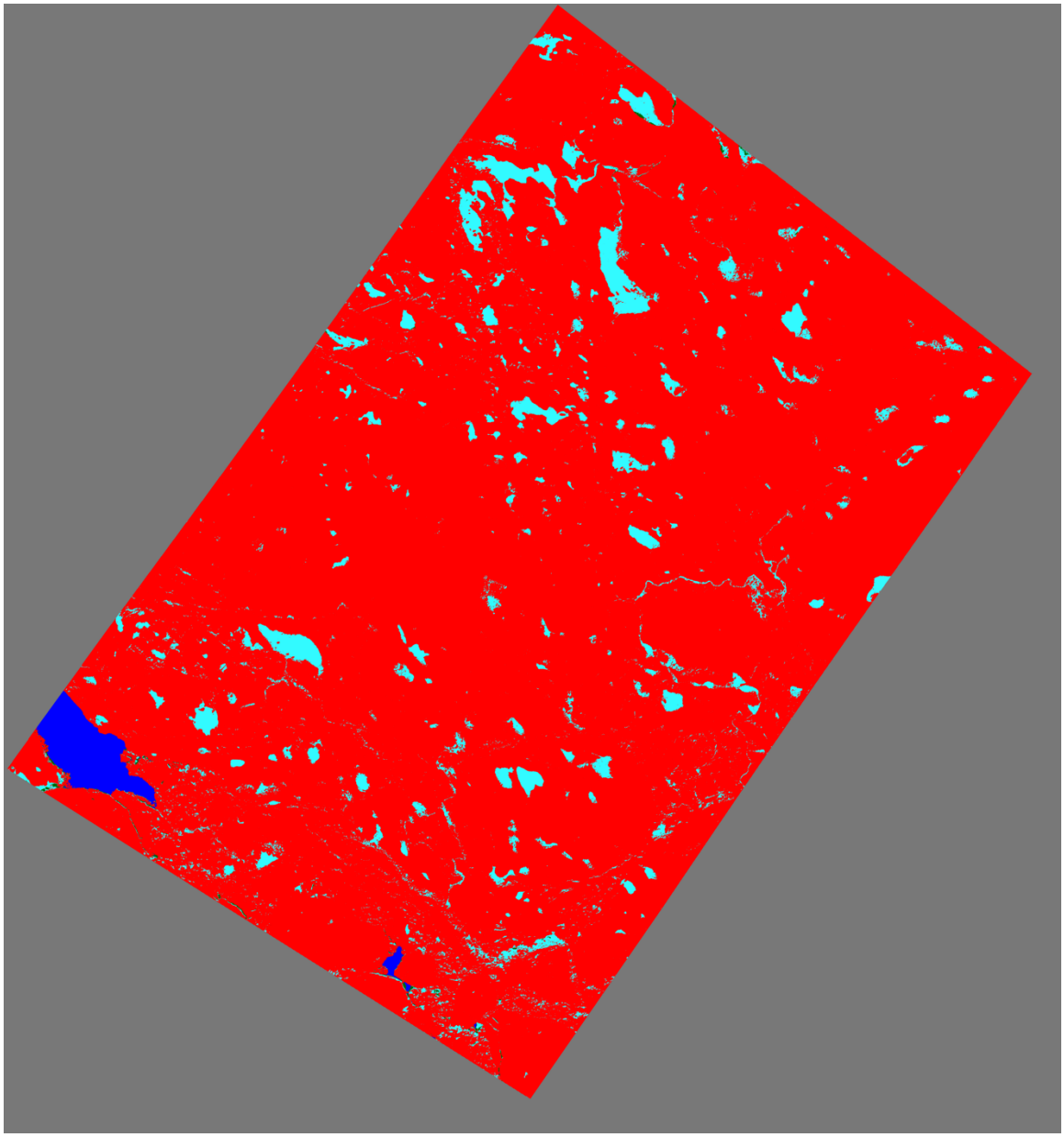

Figure S27b

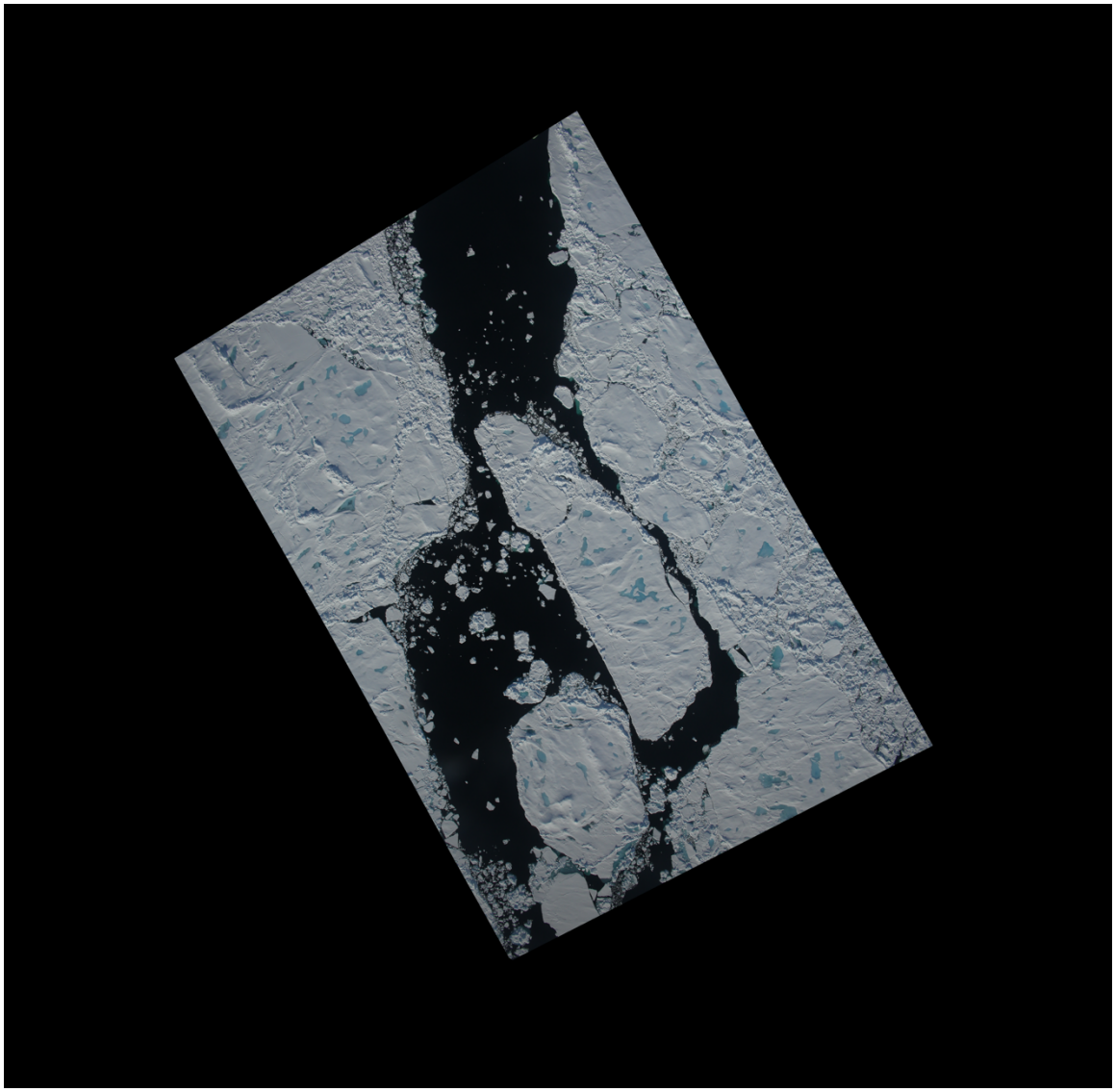

Figure S28a

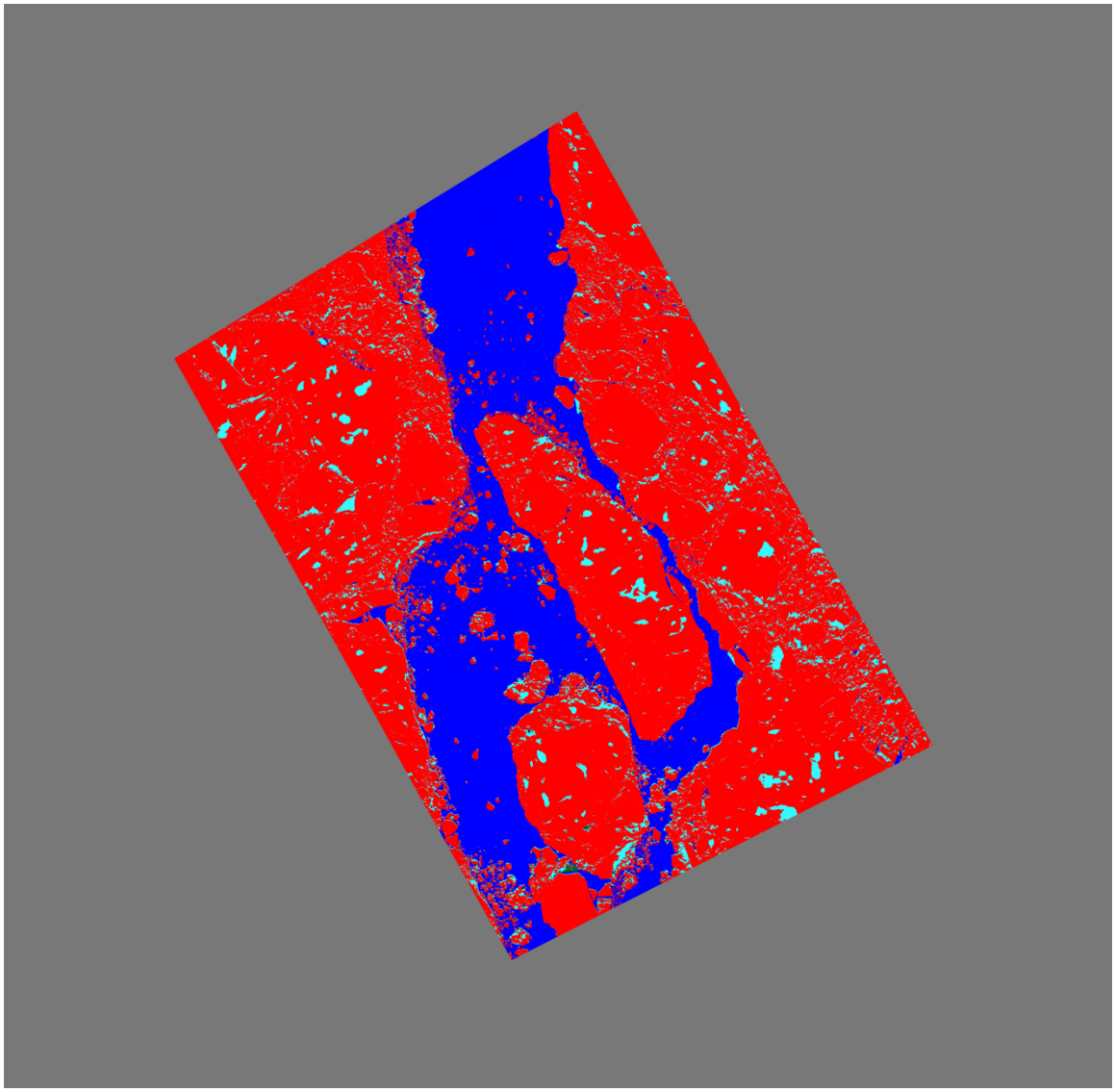

Figure S28b

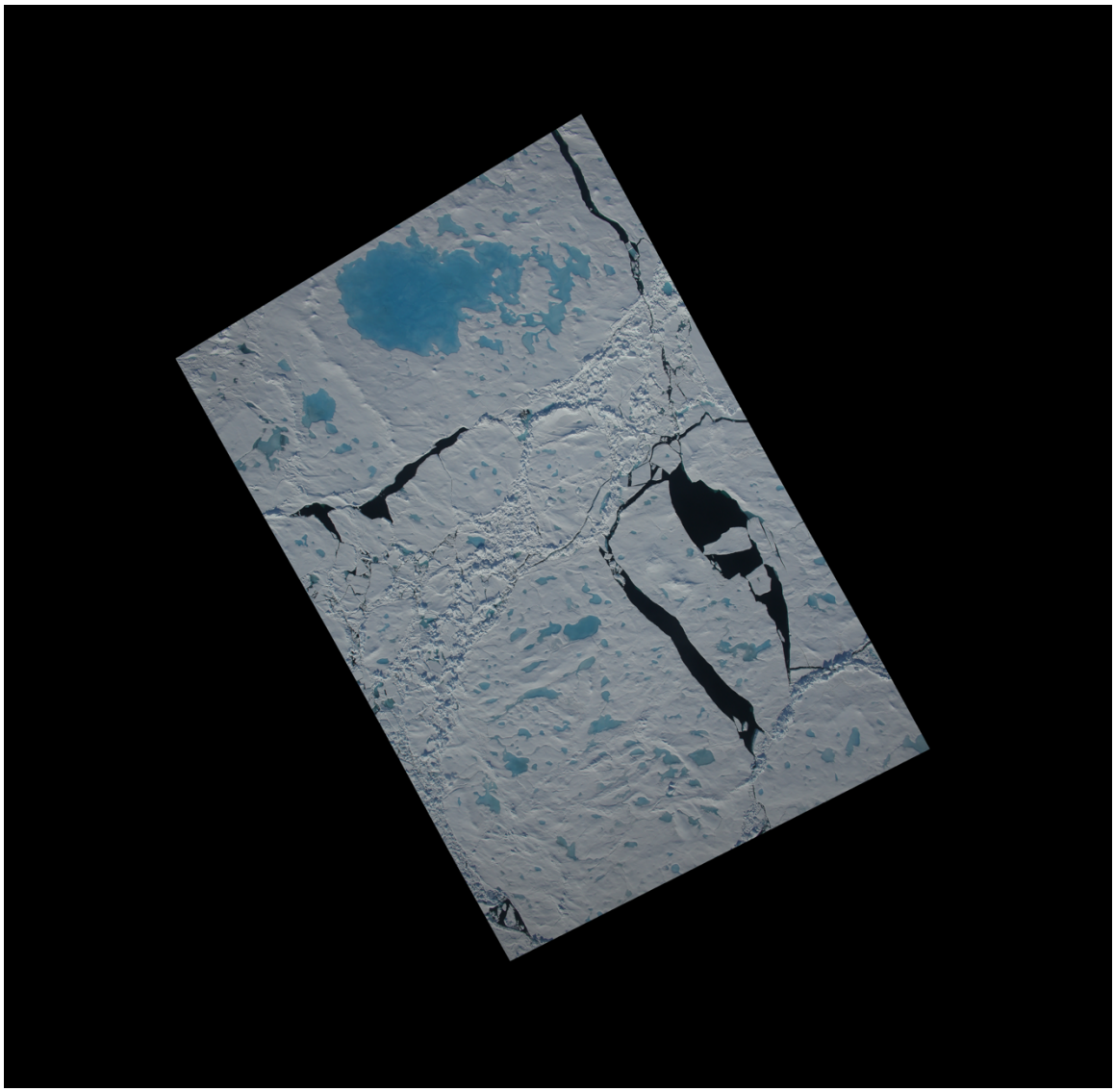

Figure S29a

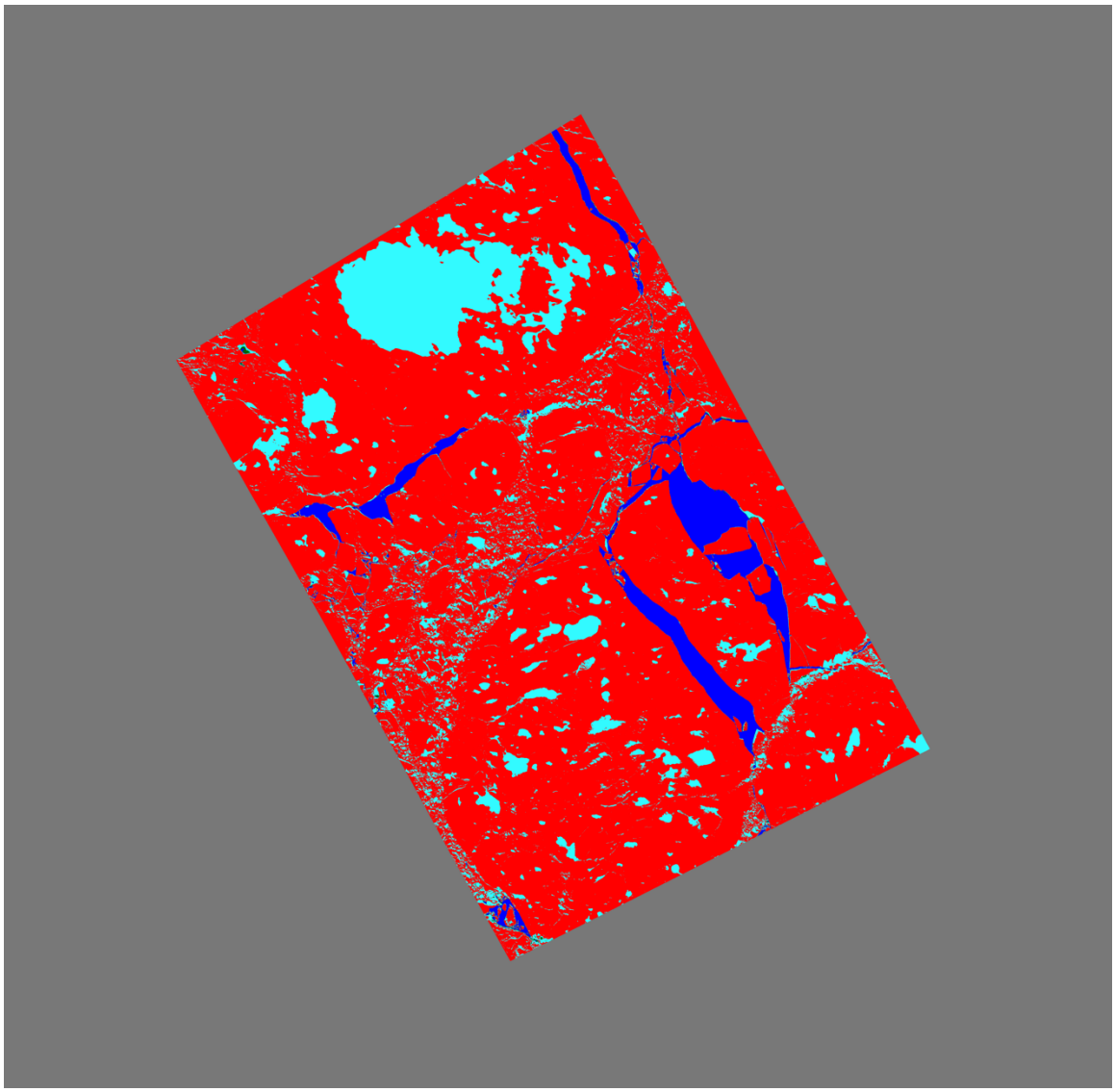

Figure S29b

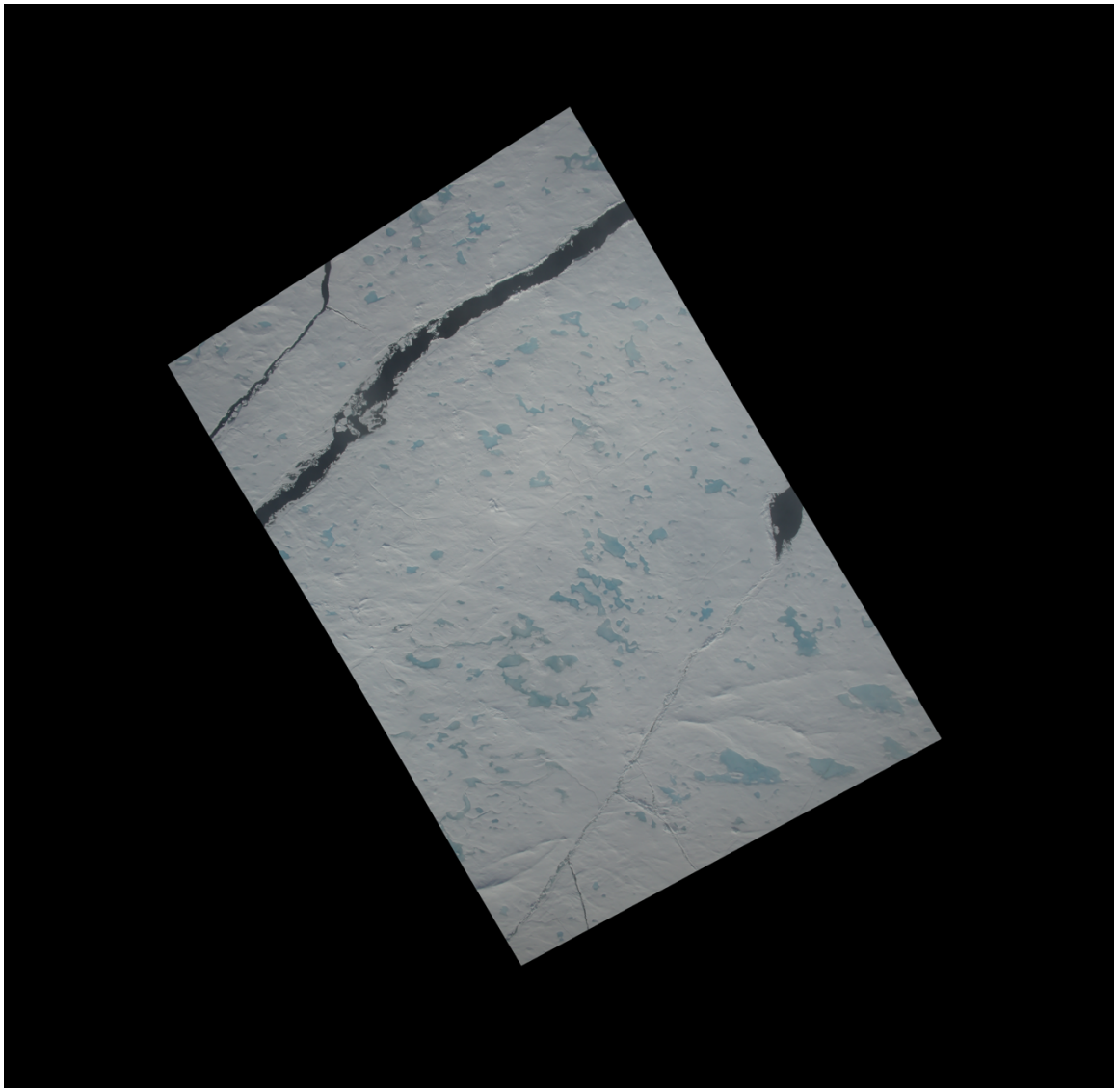

Figure S30a

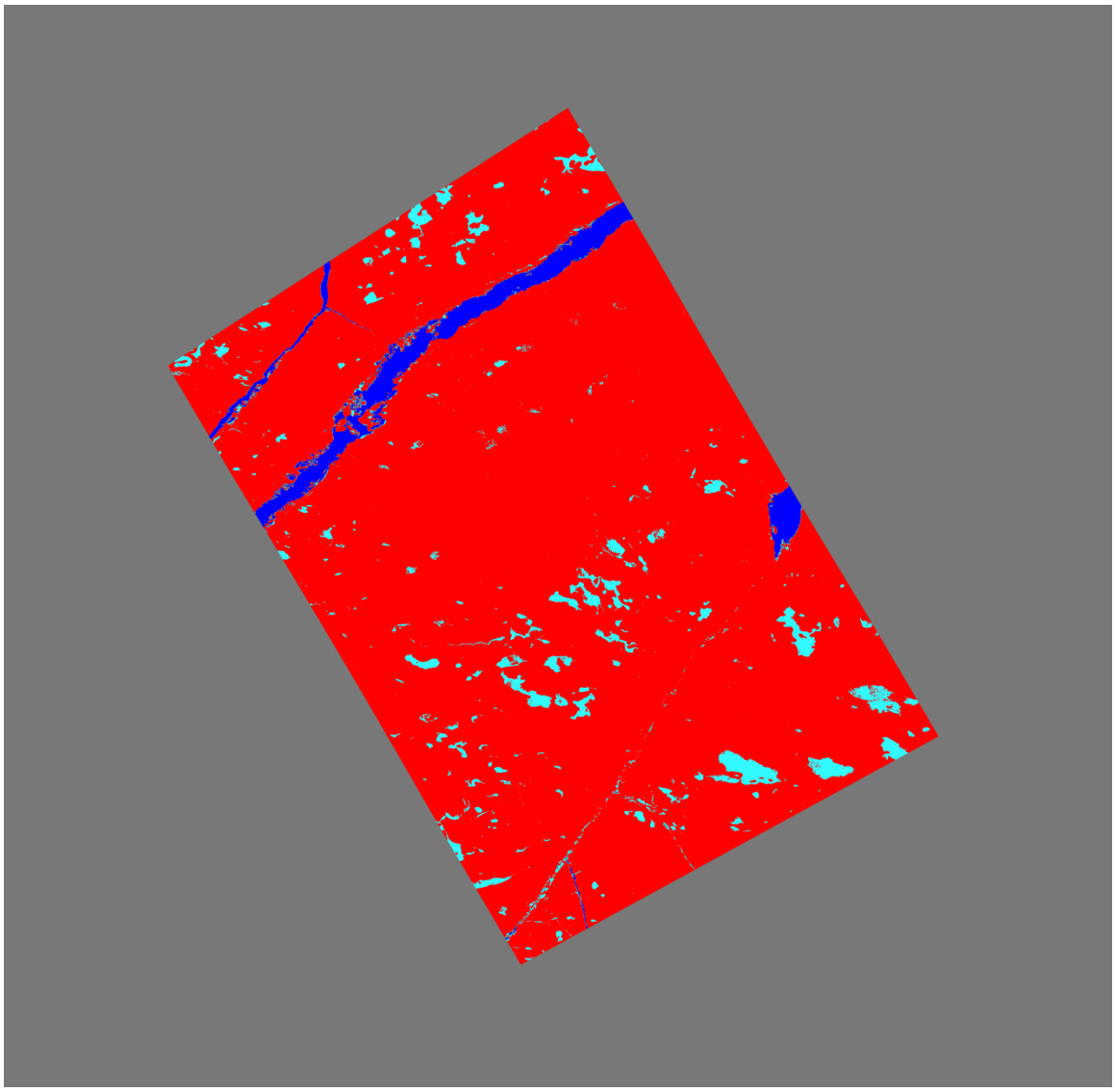

Figure S30b

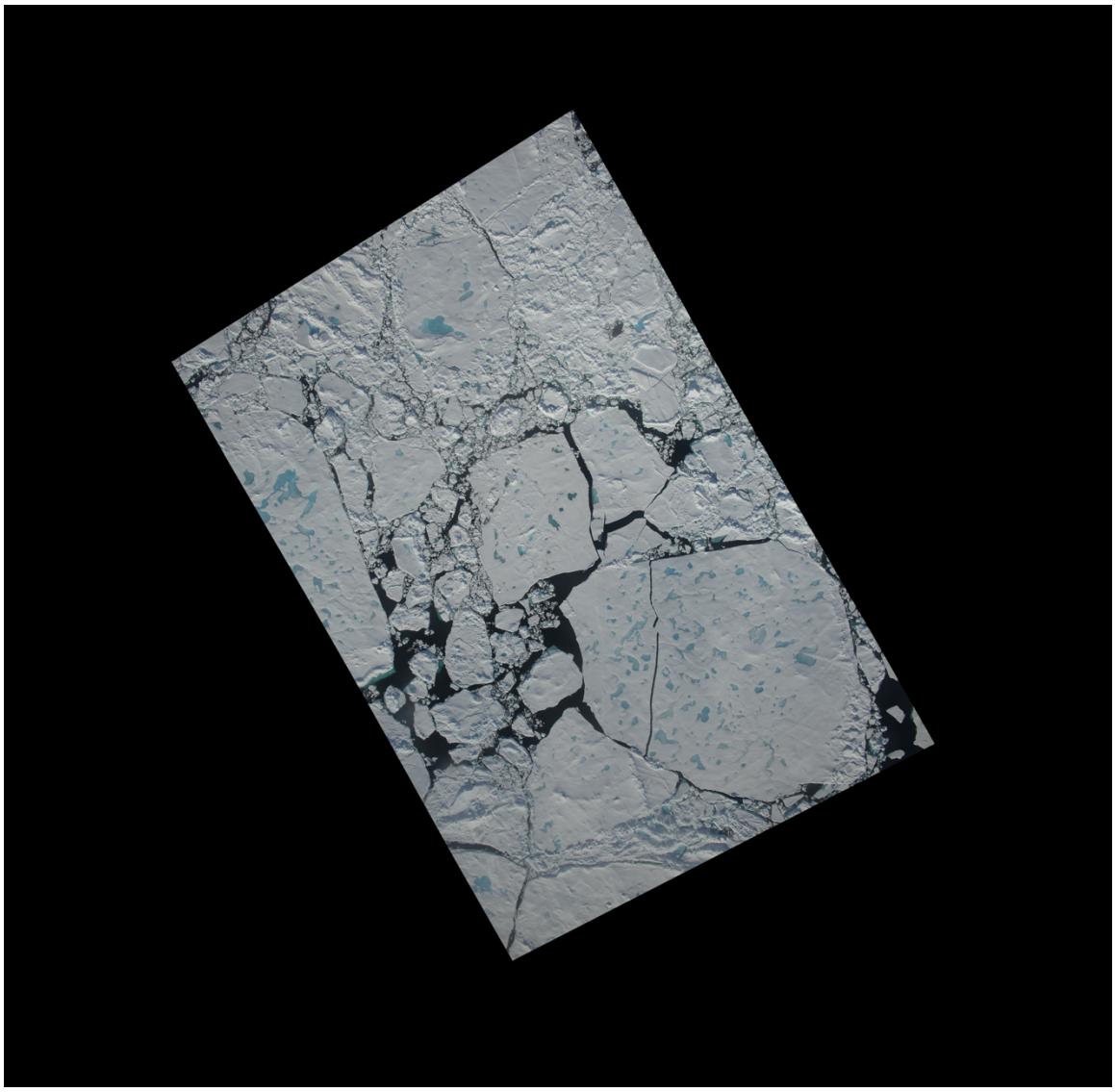

Figure S31a

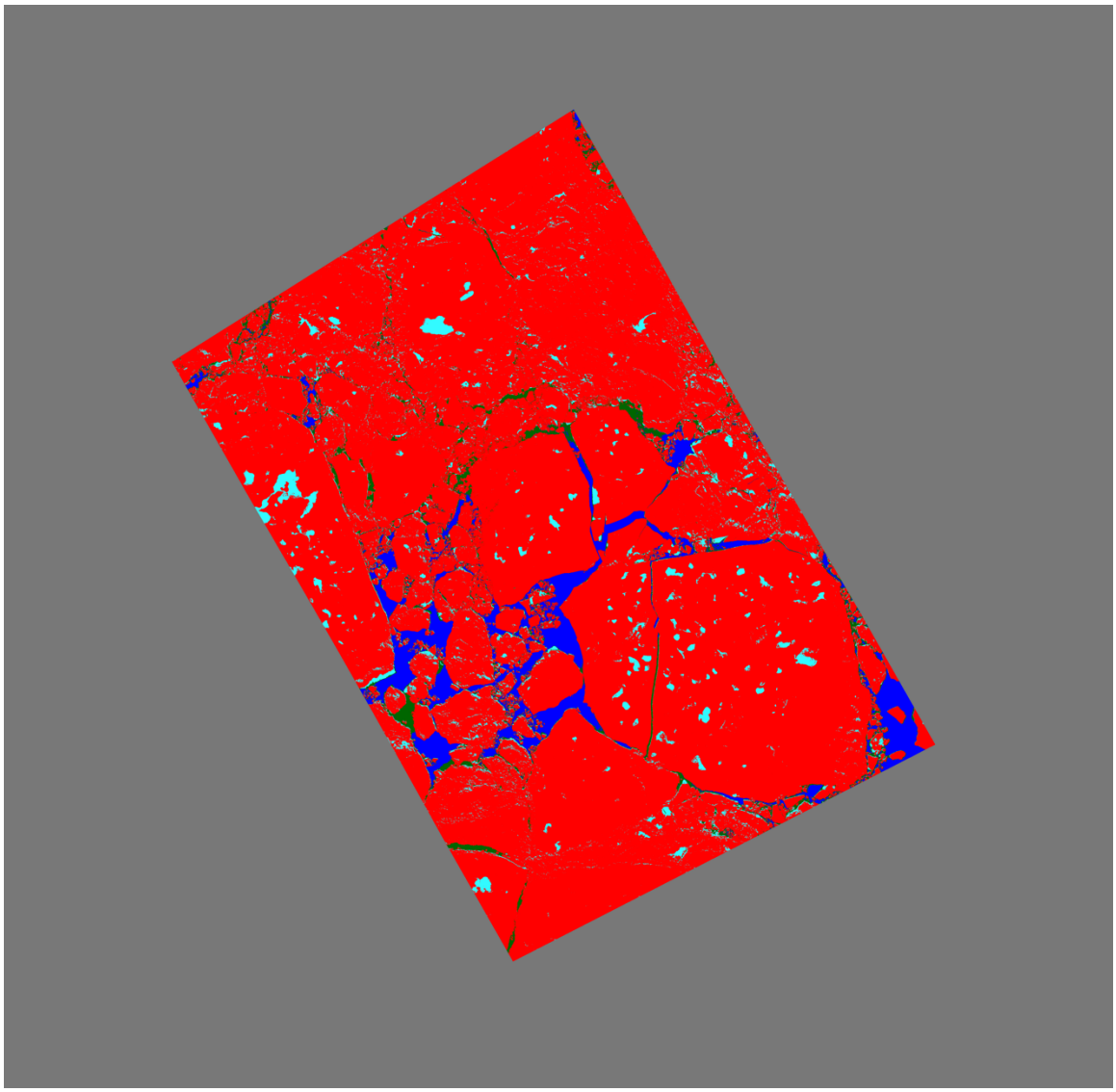

Figure S31b

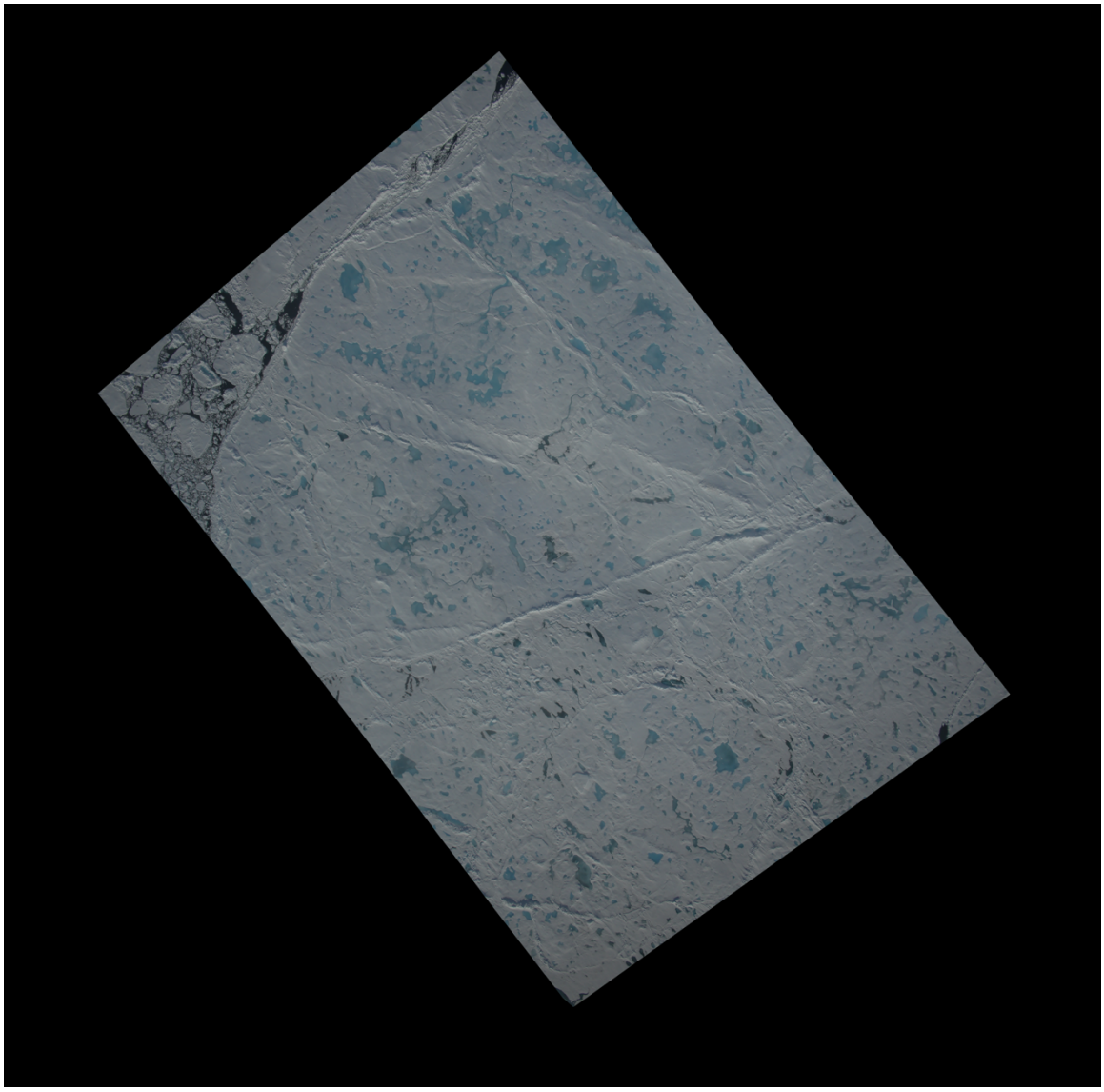

Figure S32a

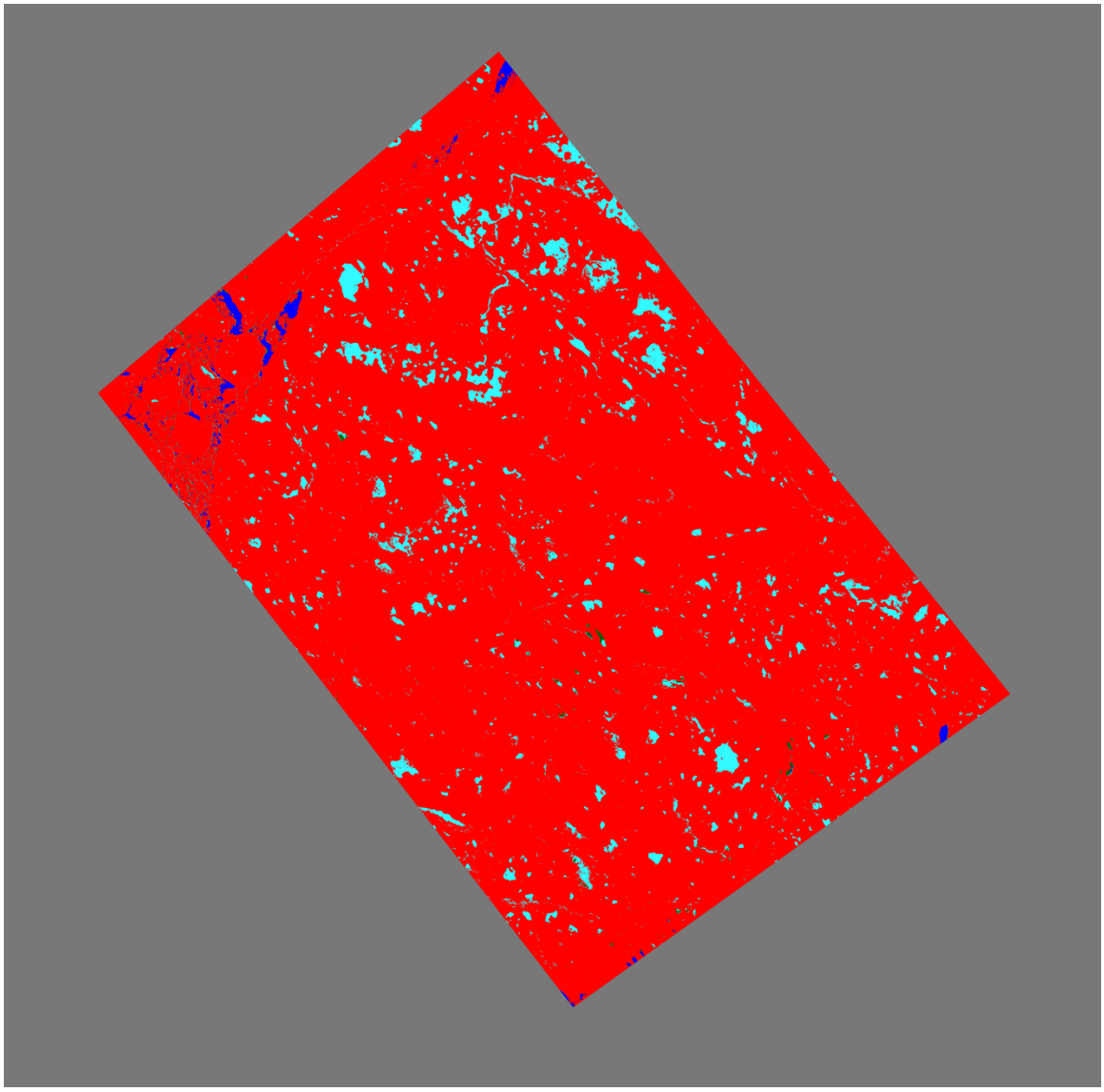

Figure S32b

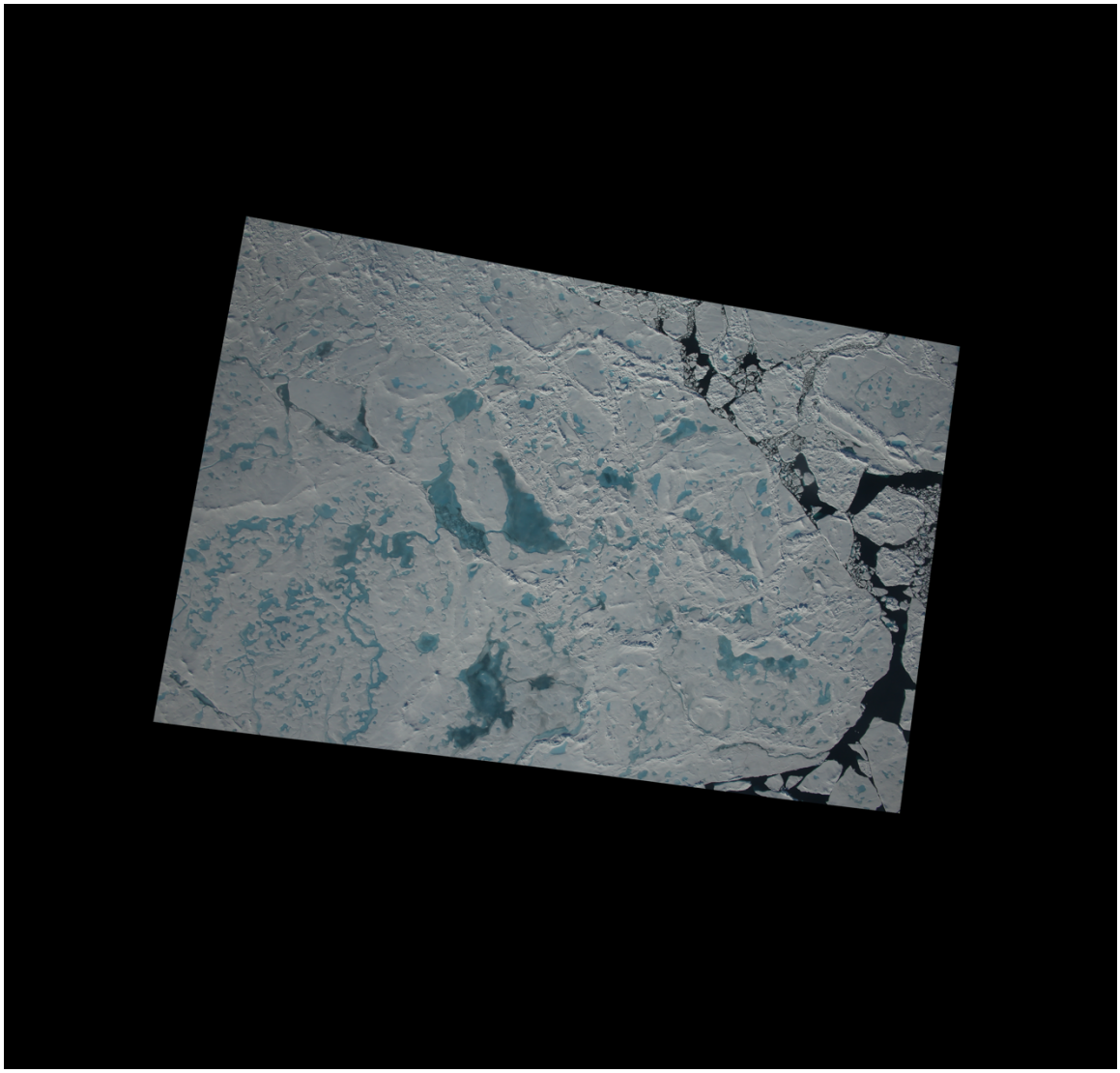

Figure S33a

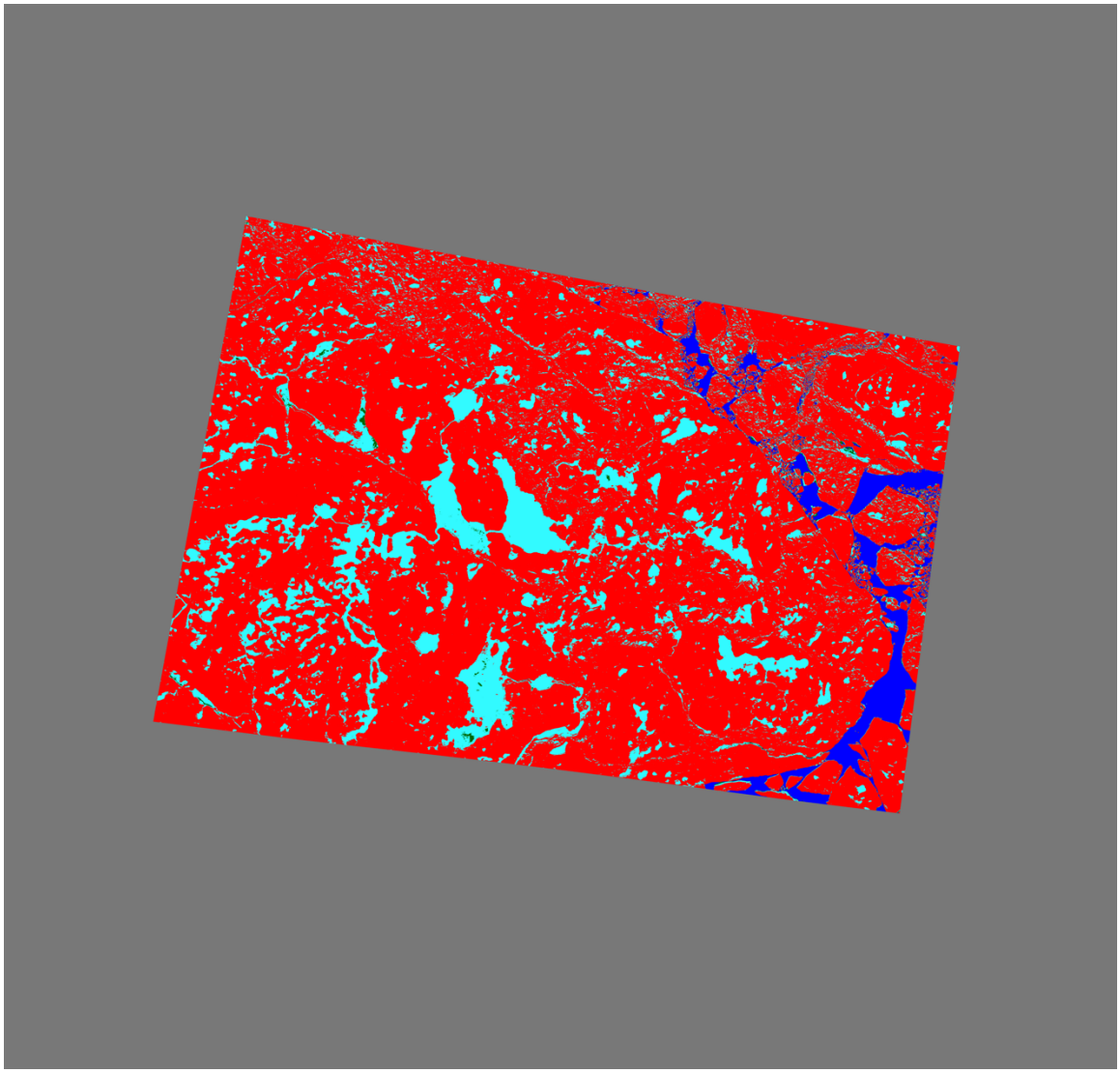

Figure S33b

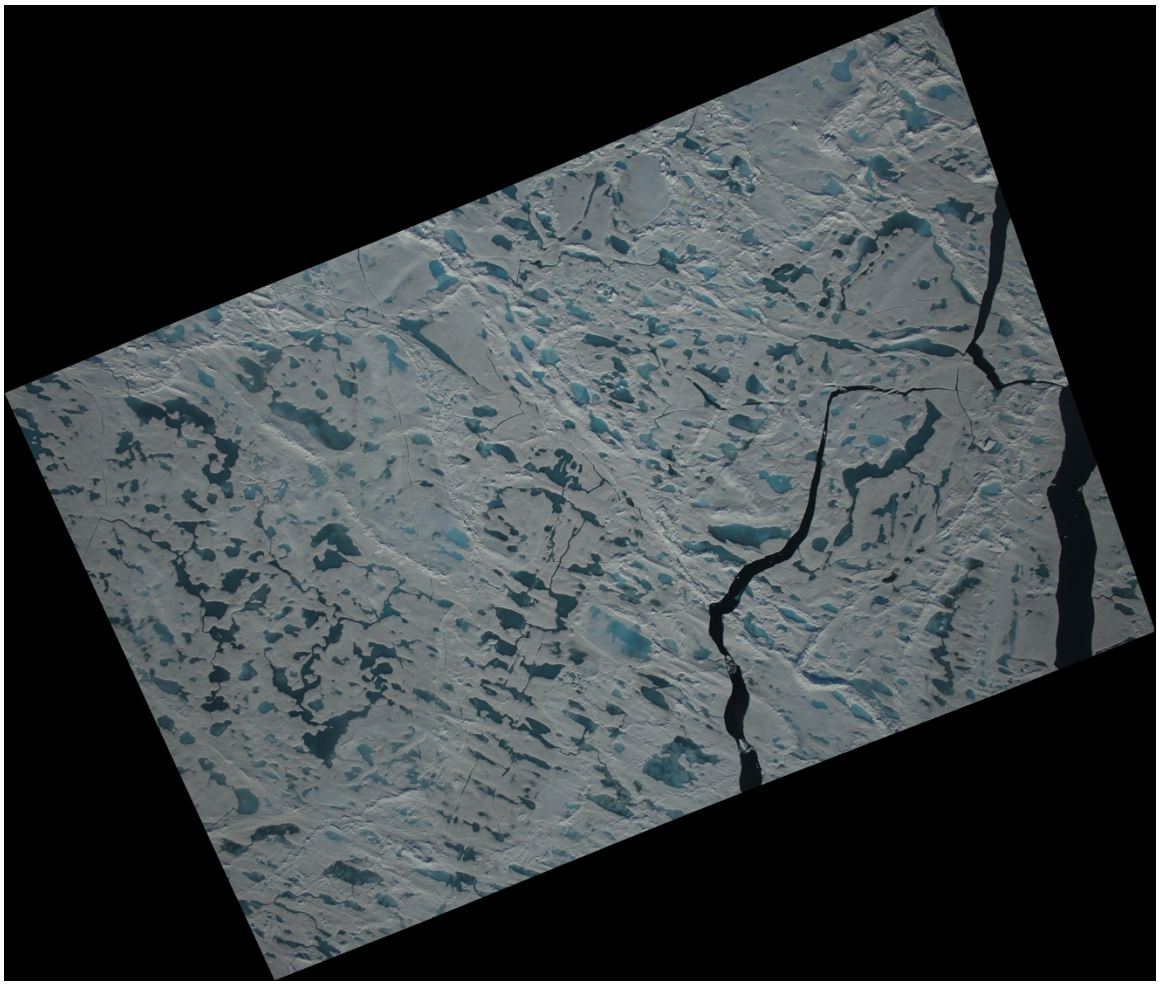

Figure S34a

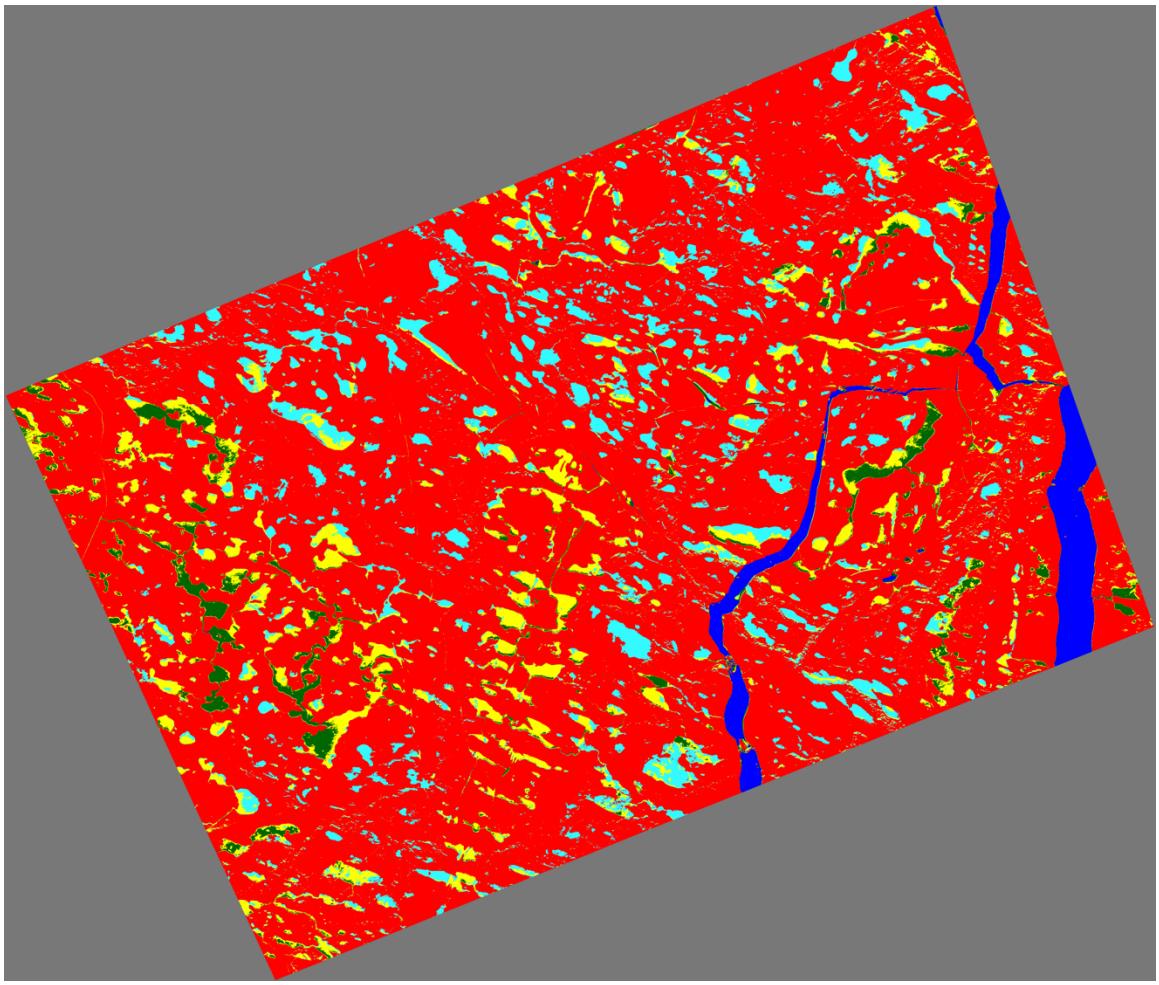

Figure S34b

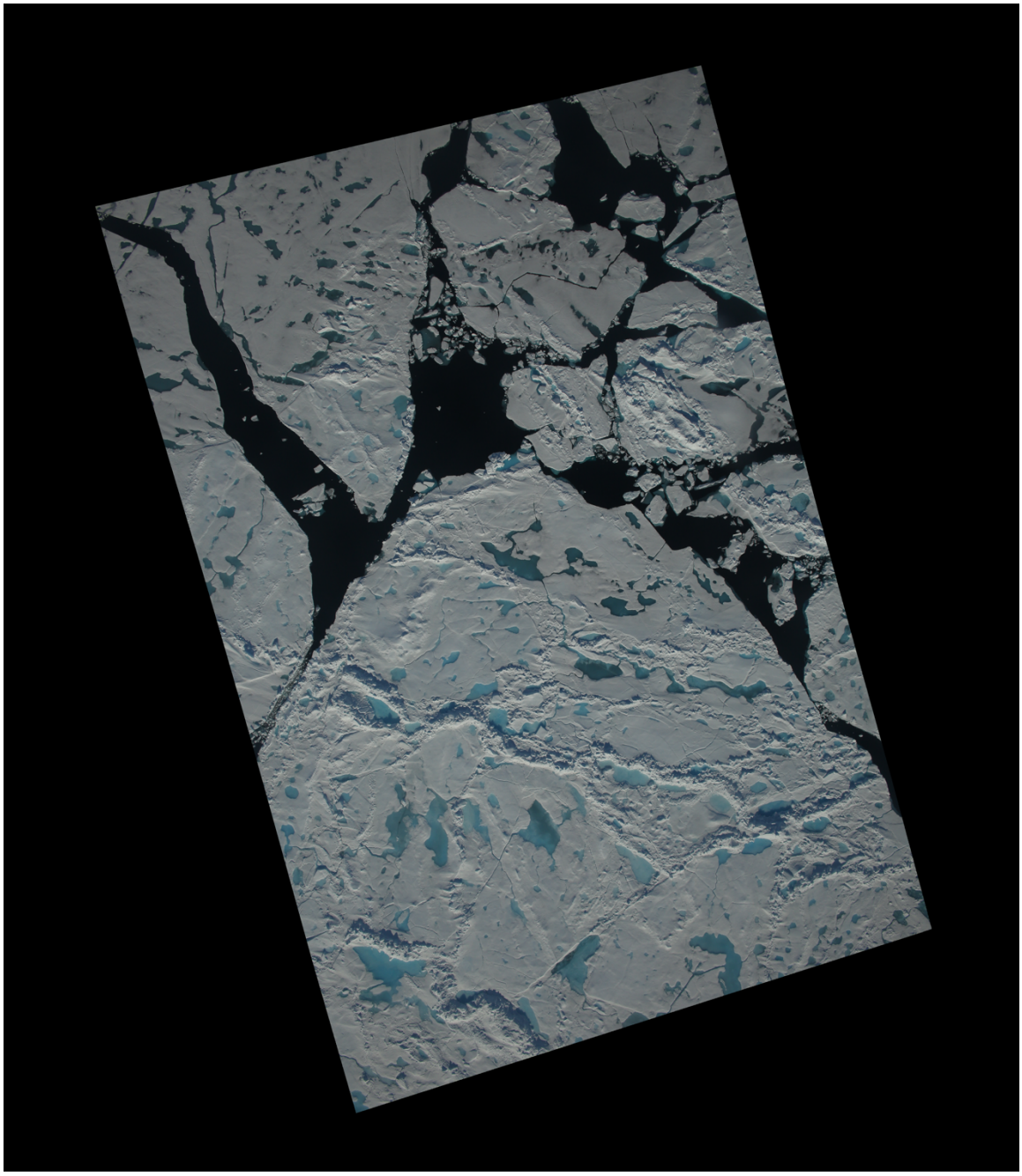

Figure S35a

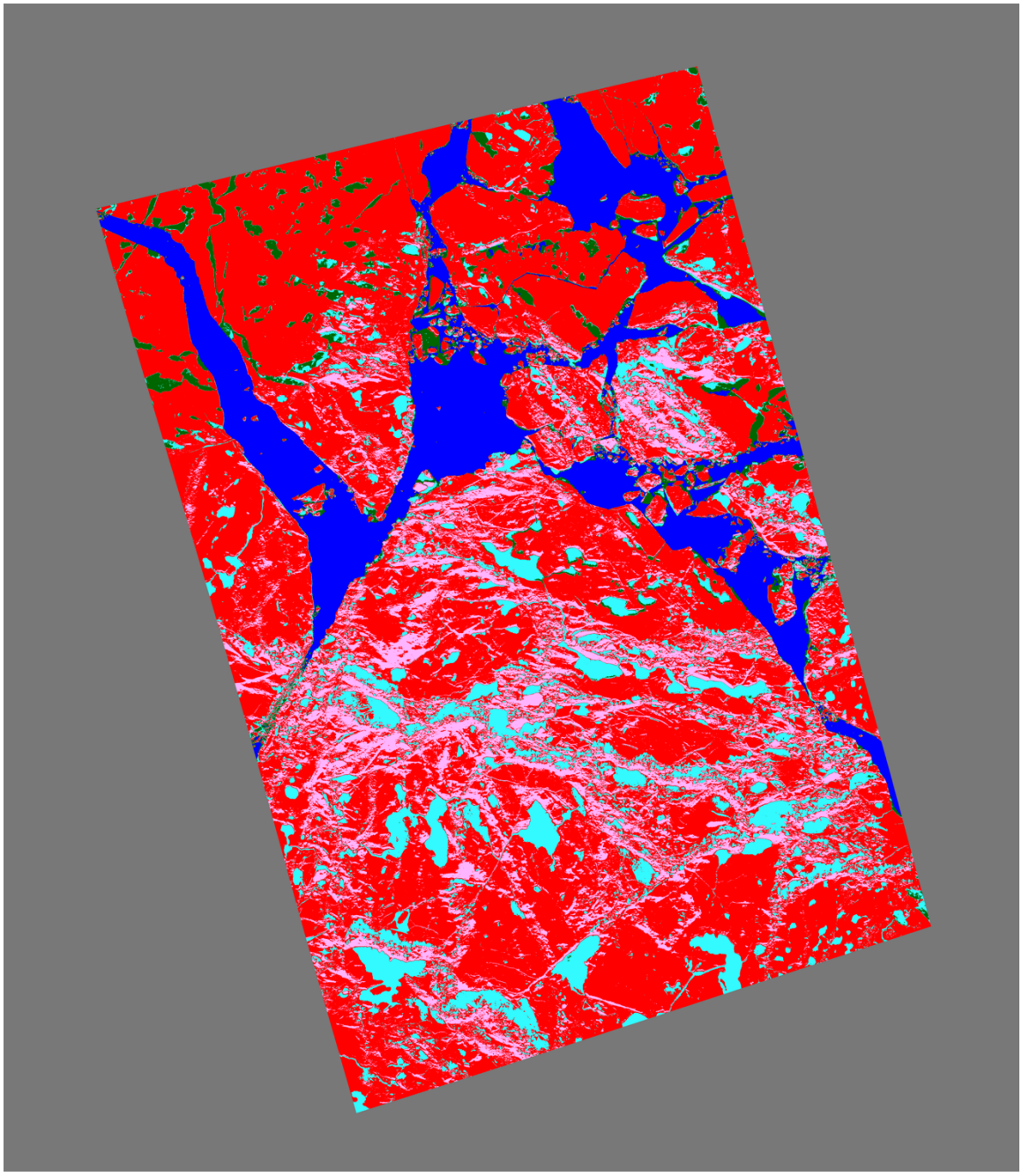

Figure S35b

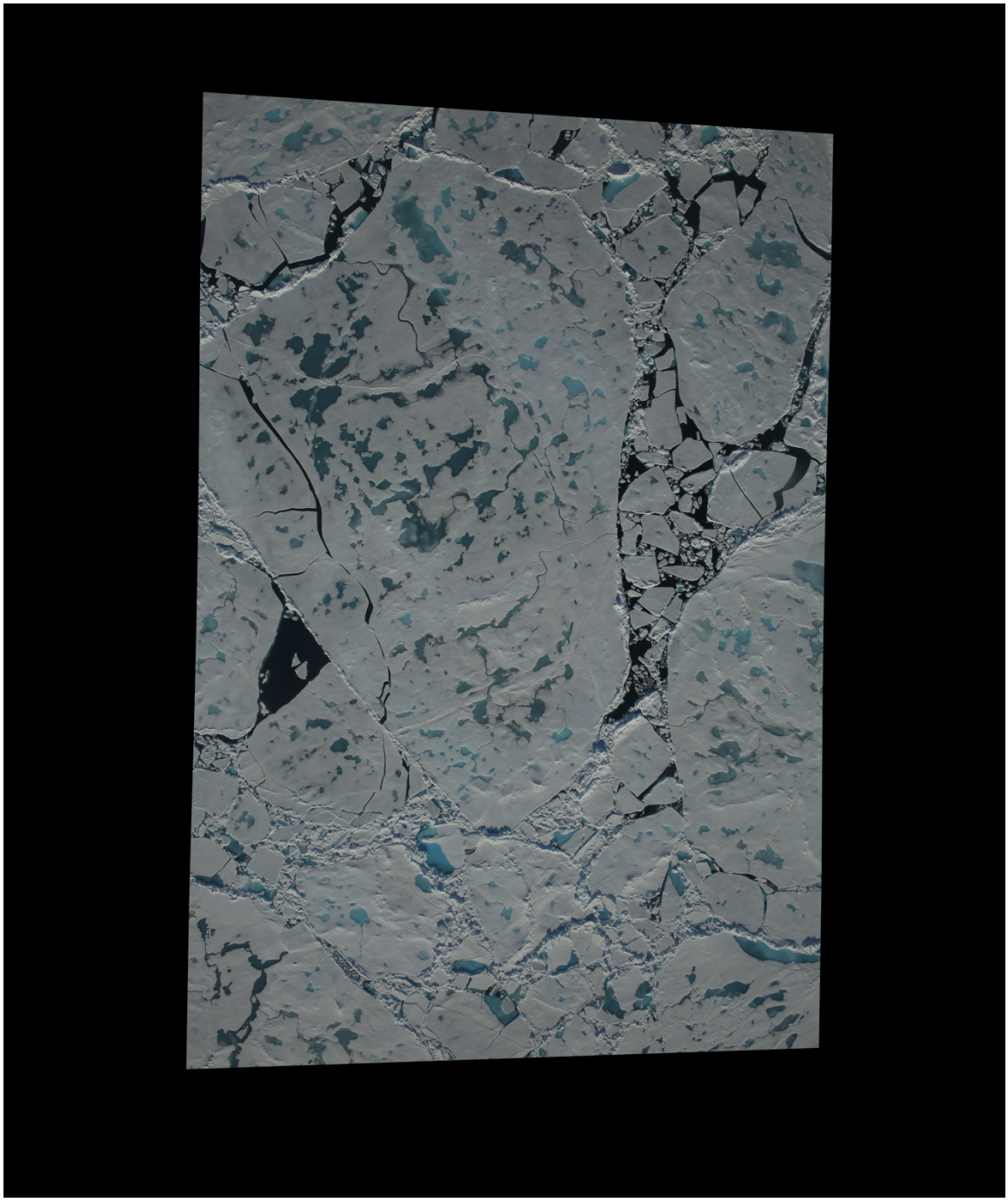

Figure S36a

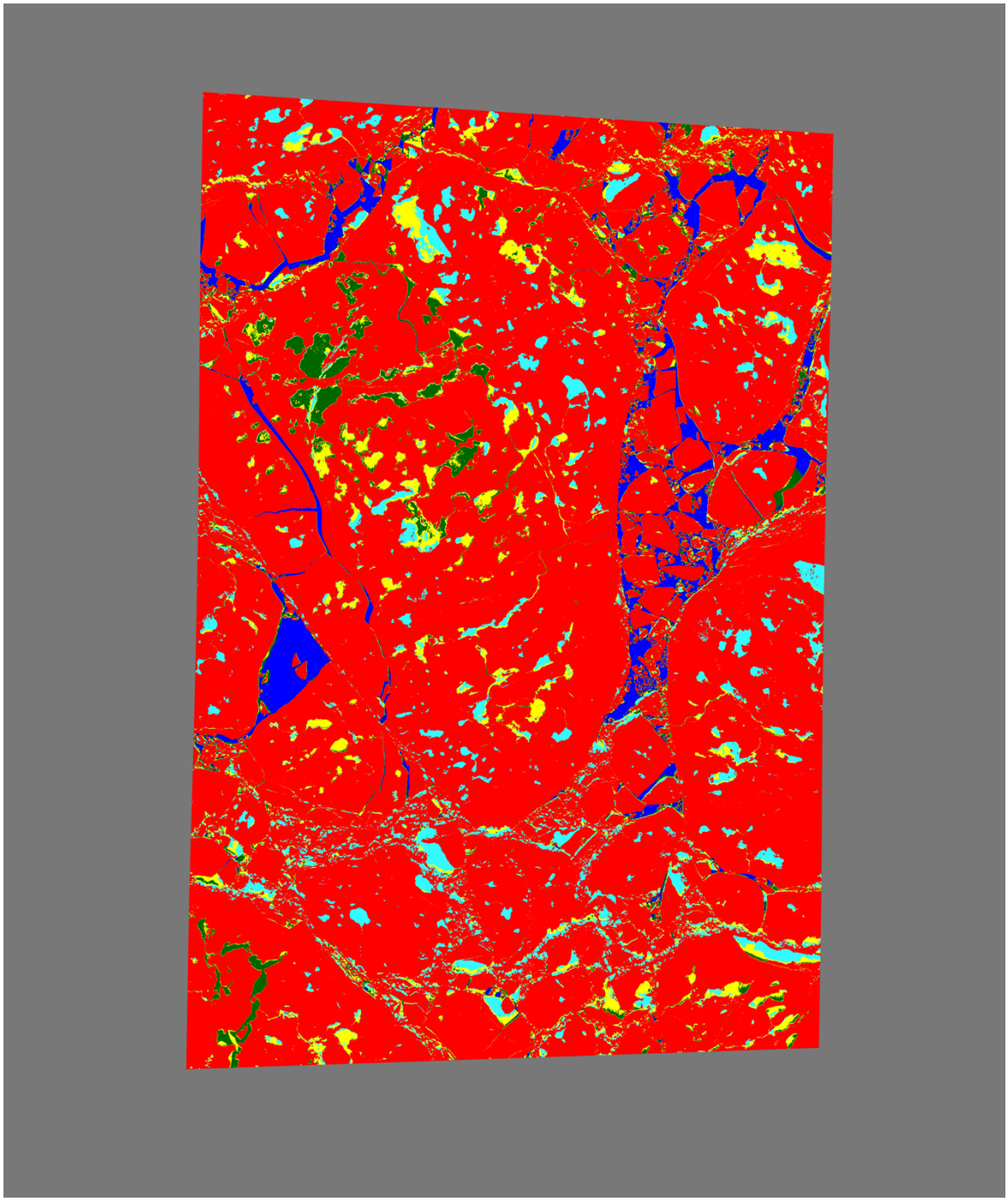

Figure S36b

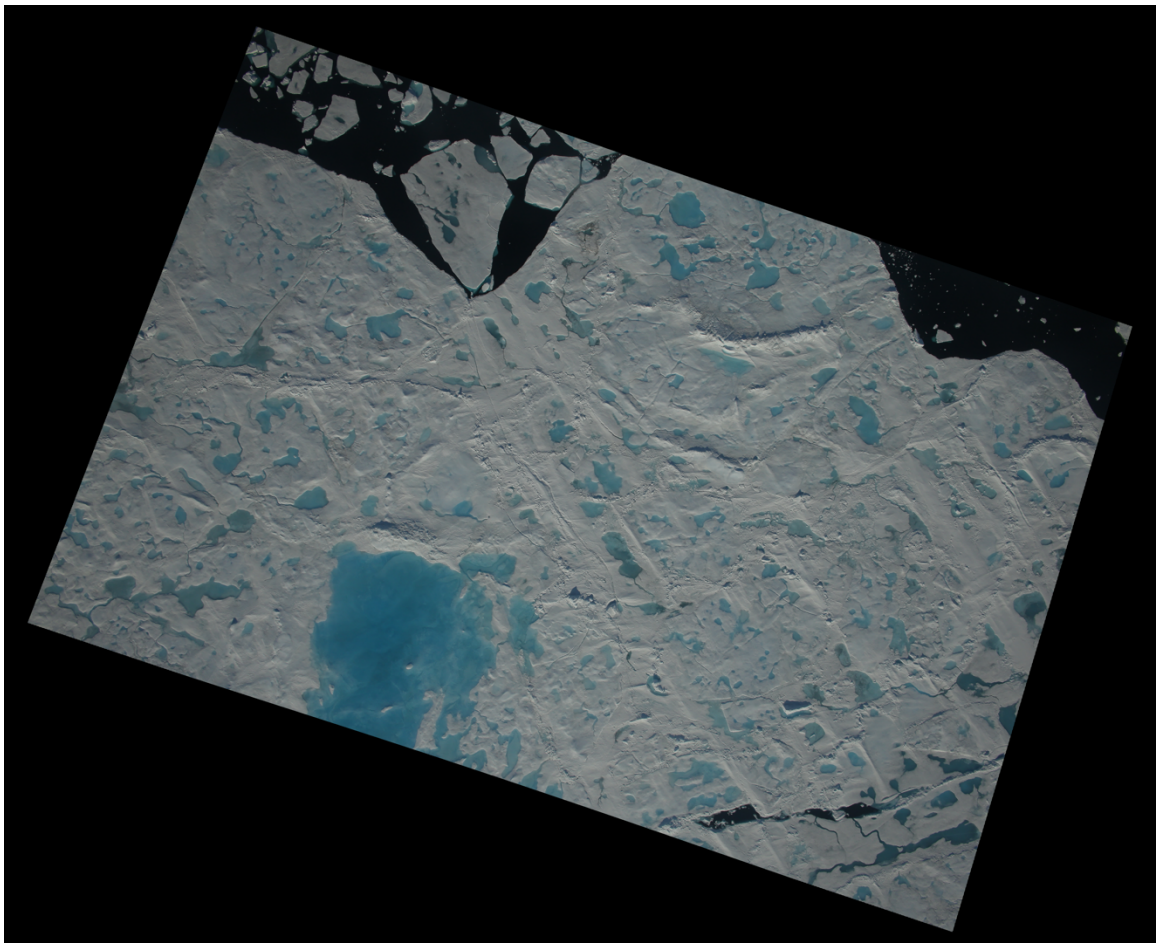

Figure S37a

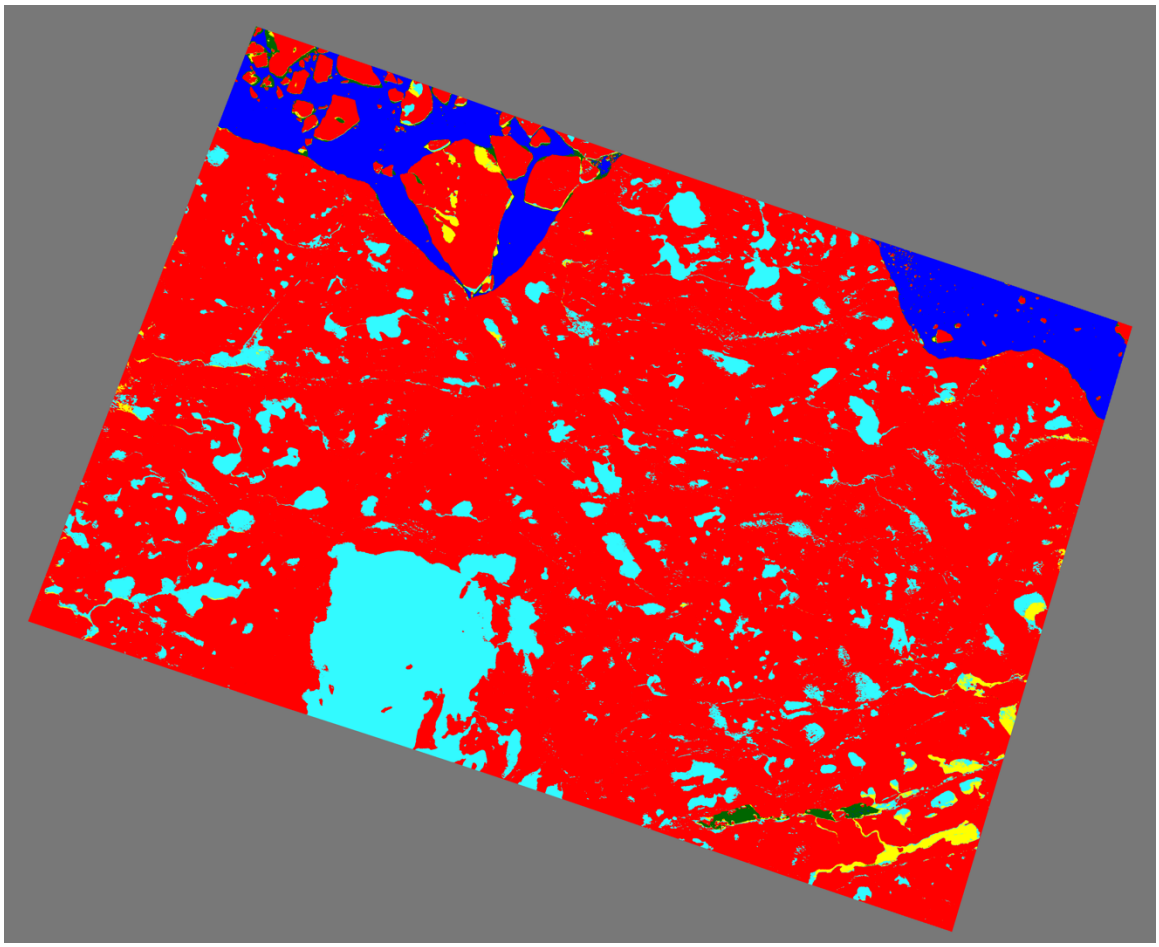

Figure S37b

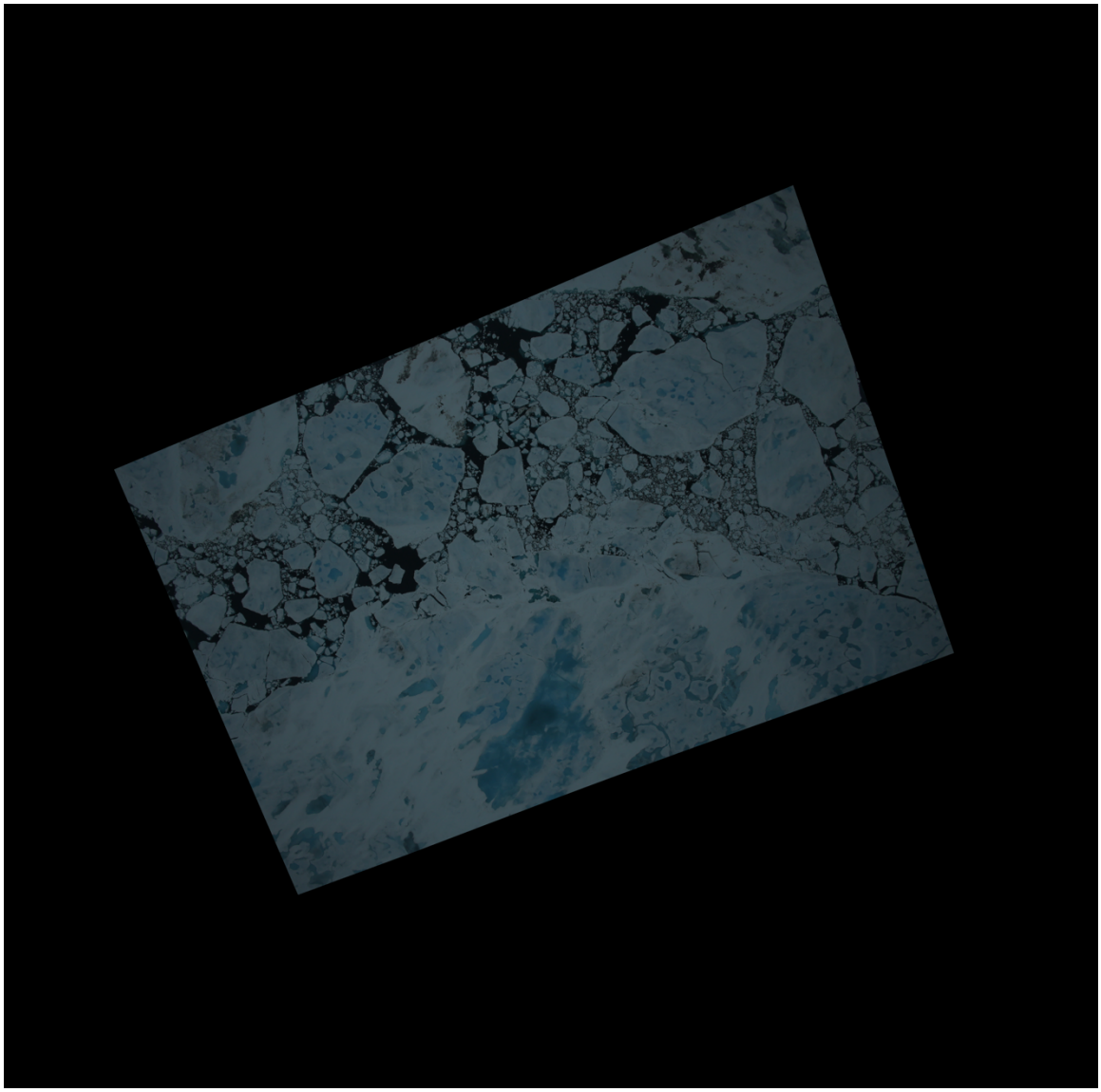

Figure S38a

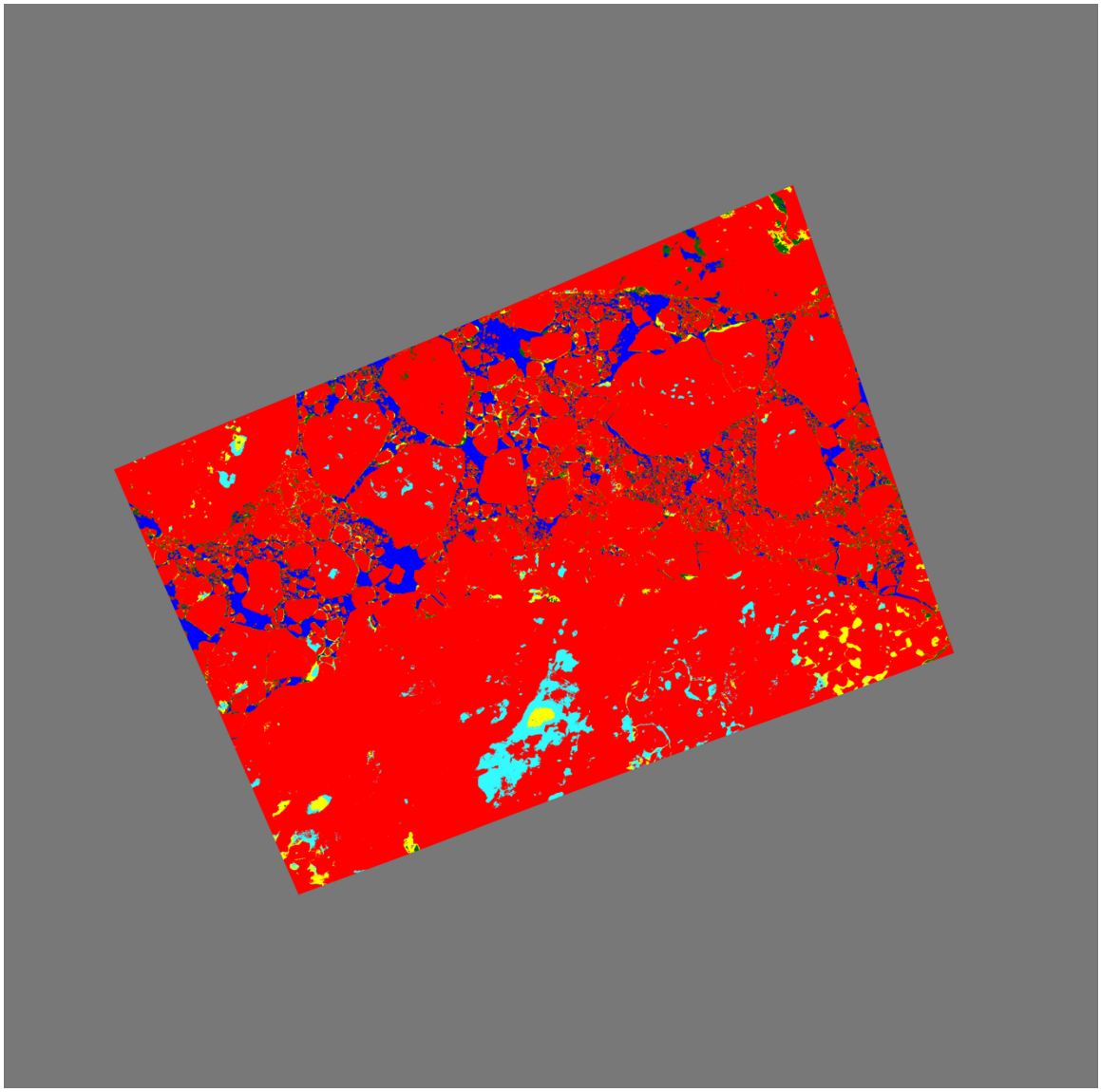

Figure S38b

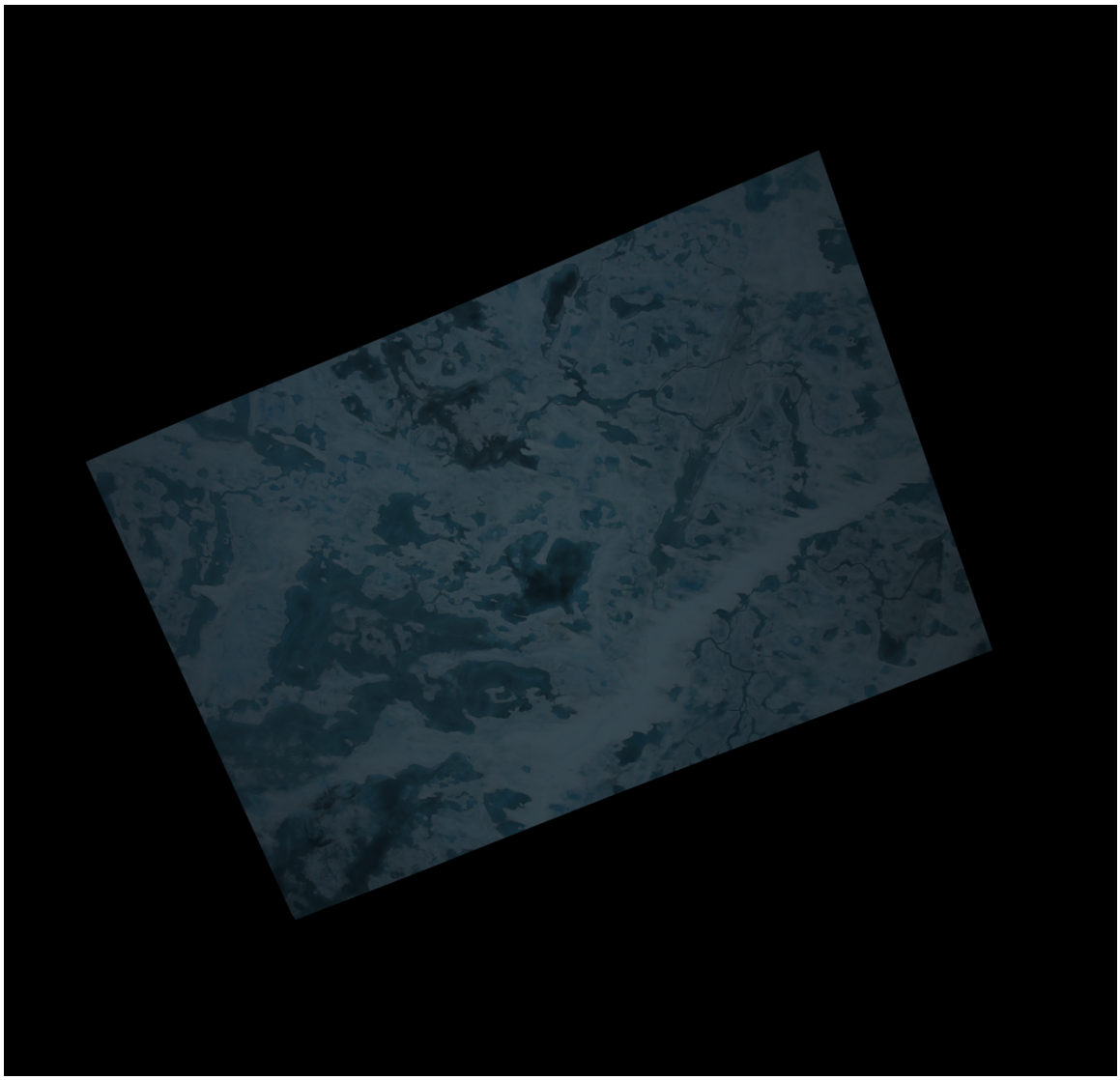

Figure S39a

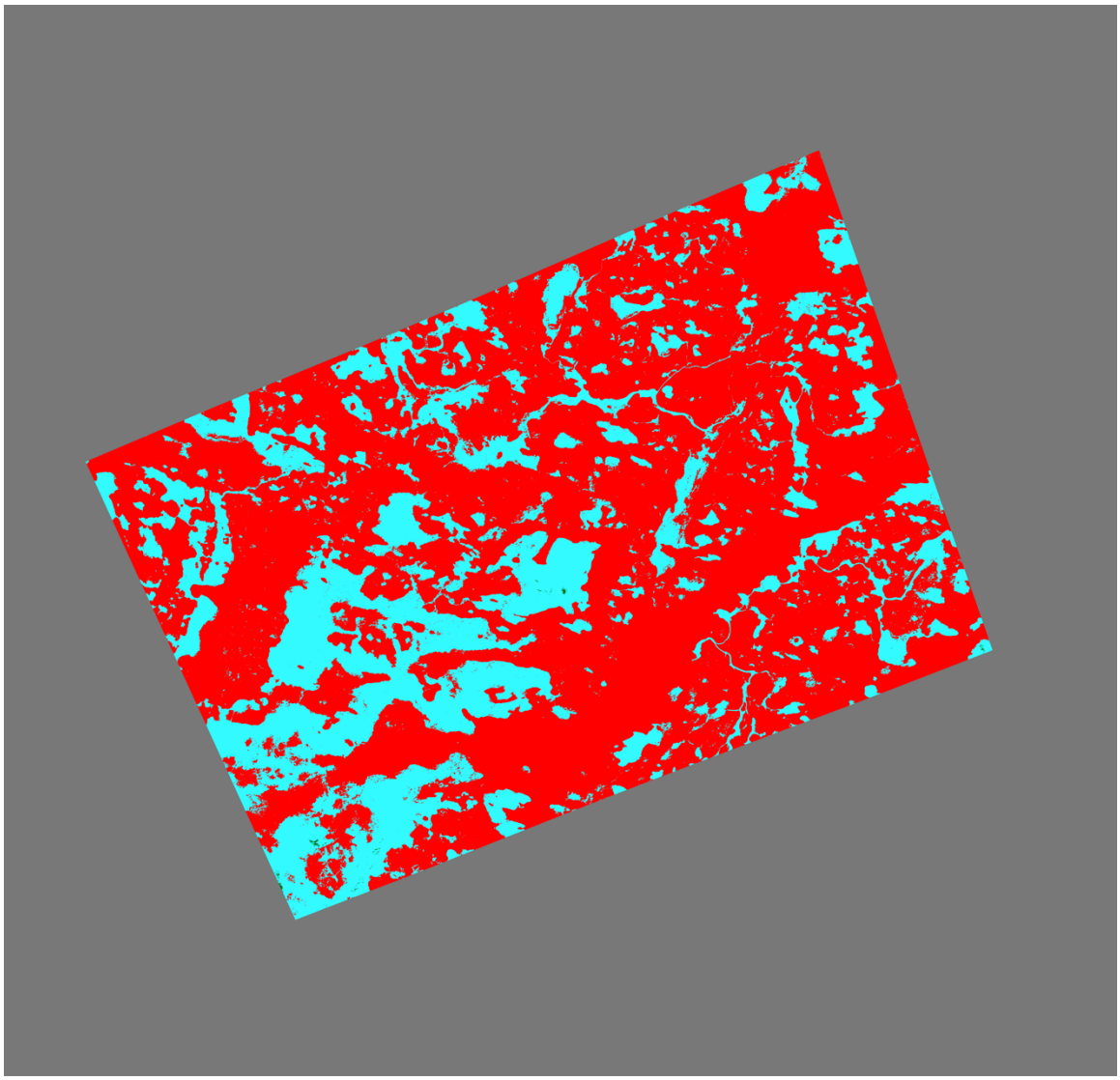

Figure S39b

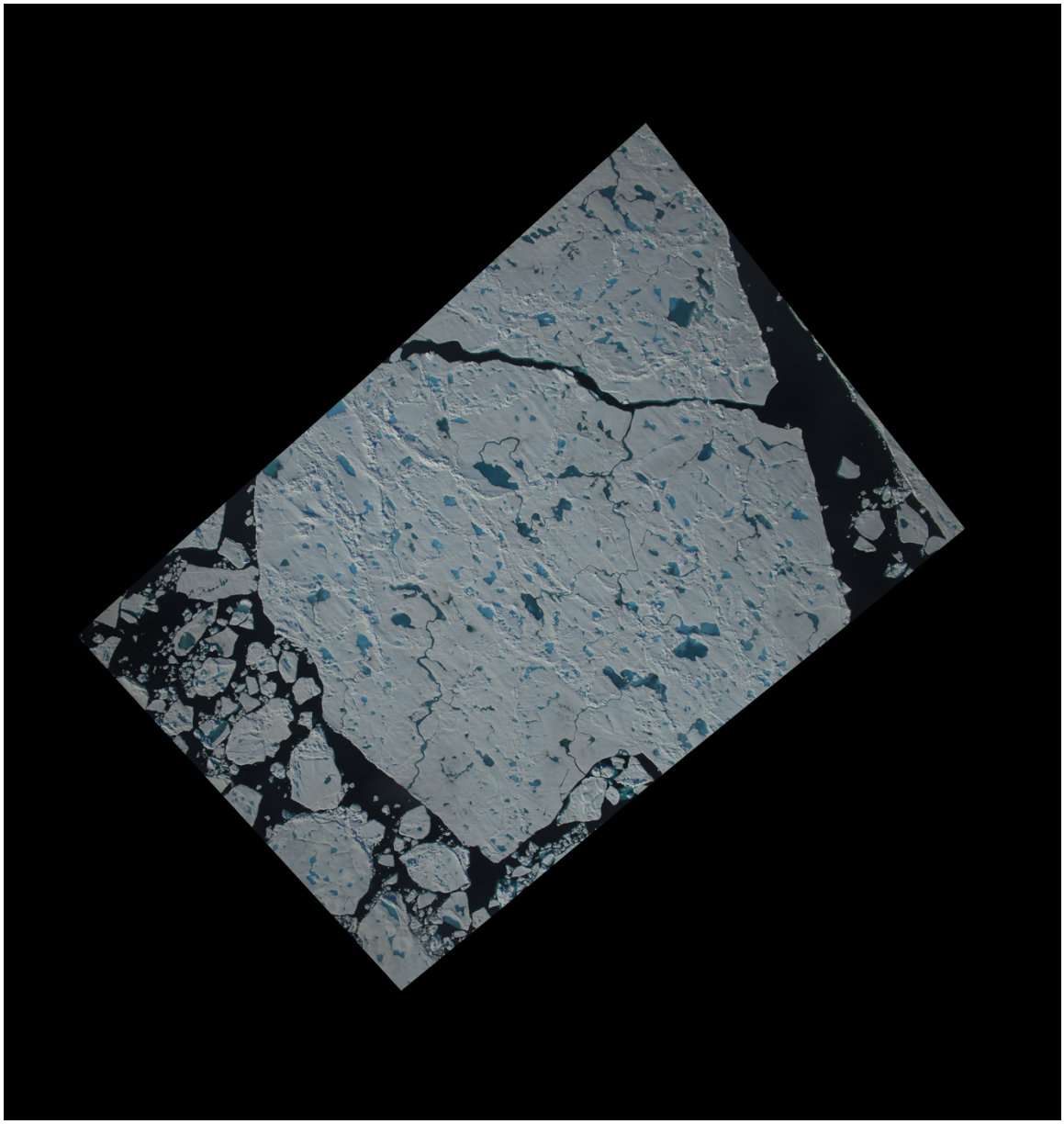

Figure S40a

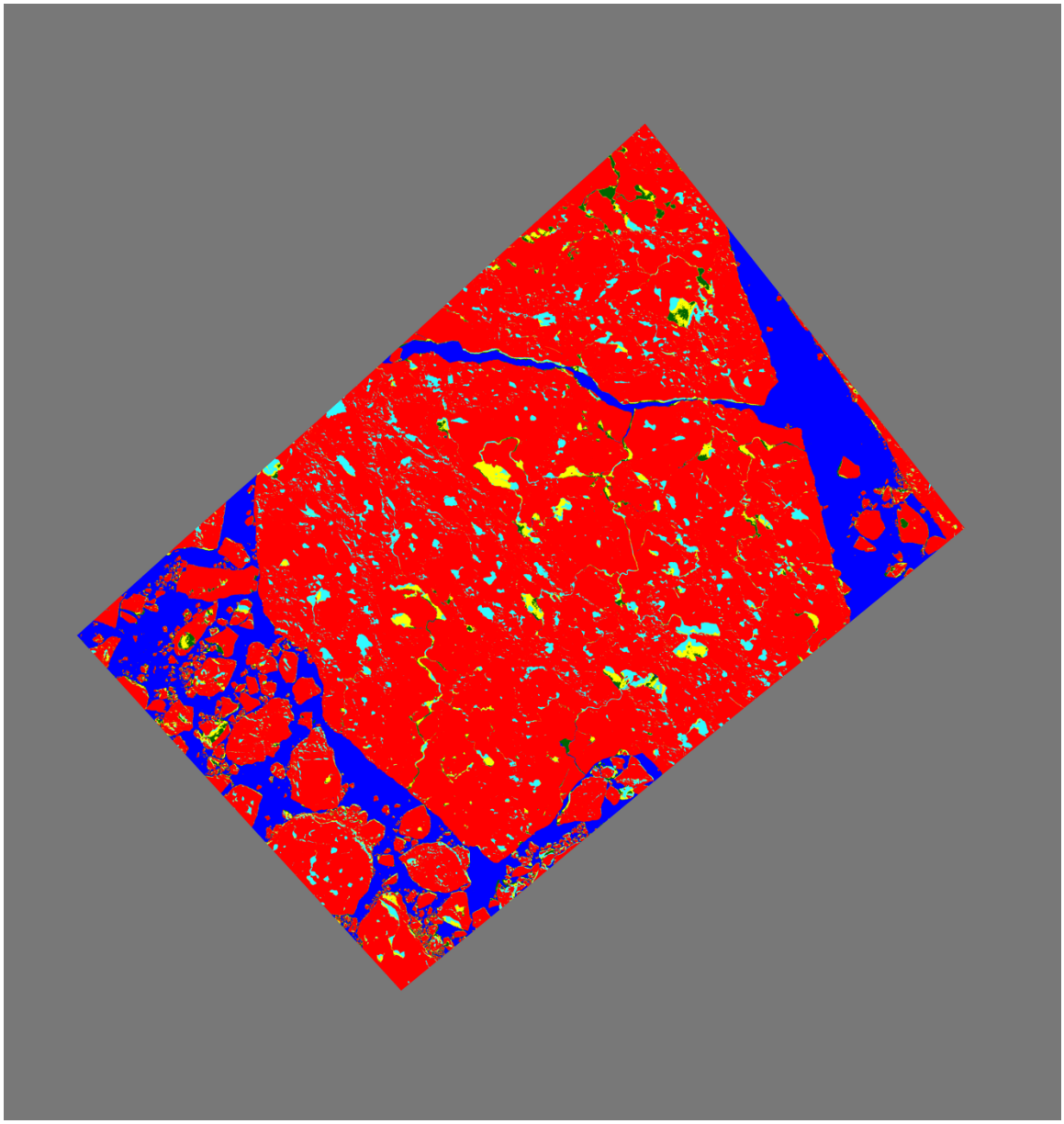

Figure S40b

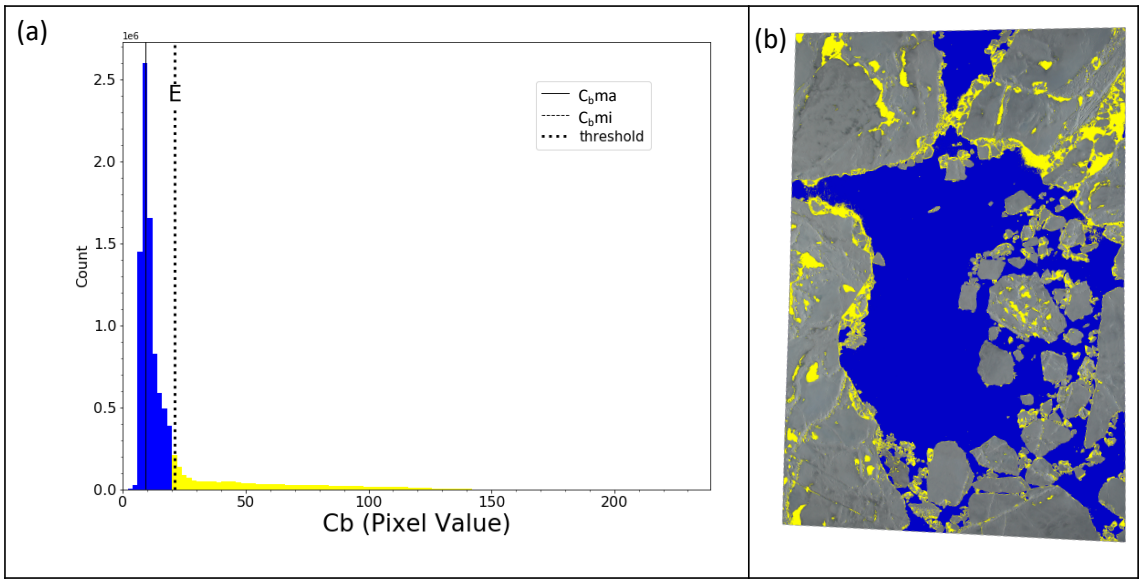

Figure S41. Methodology to identify open water pixels. (a) distribution of C_b pixels remaining after ice pixels have been classified. Threshold E separates open water pixels (blue) from MP pixels (yellow). (b) classified image showing open water pixels (blue), MP pixels (yellow), and ice pixels (natural color). Same as Figure 7 in the paper but an example where Threshold E was determined by Equation 10.