

Area changes of glaciers on active volcanoes in Latin America between 1986 and 2015 observed from multi-temporal satellite imagery

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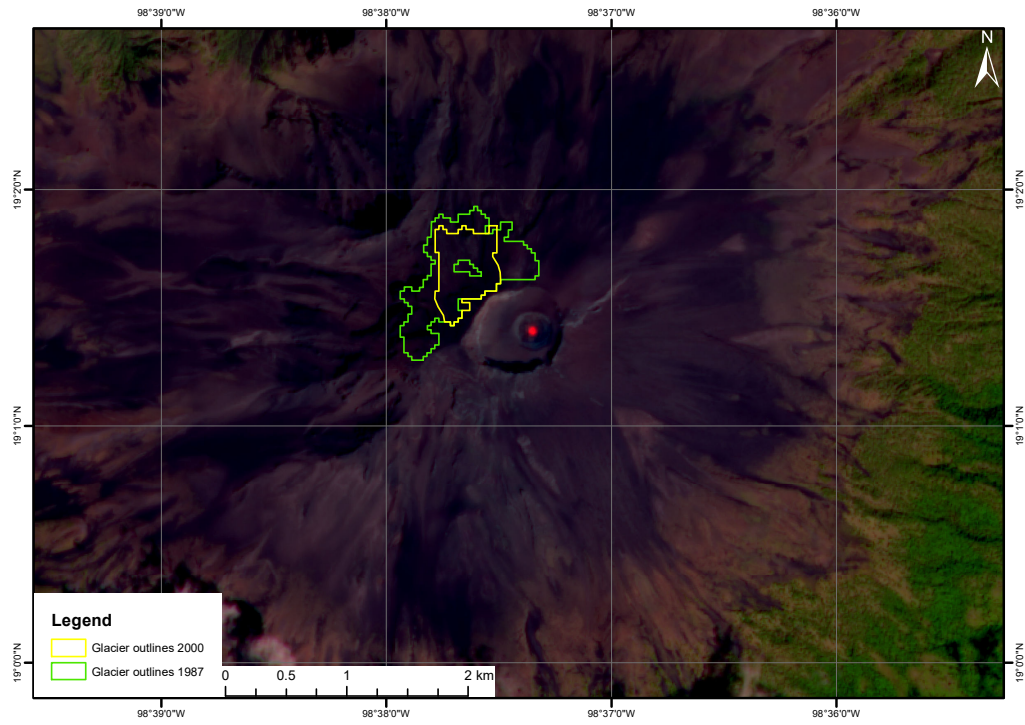


Fig. S1. Glacier outline overlays for Popocatepetl (5436 m) Mexico. Scene was taken in 2017, after the glacier already disappeared.

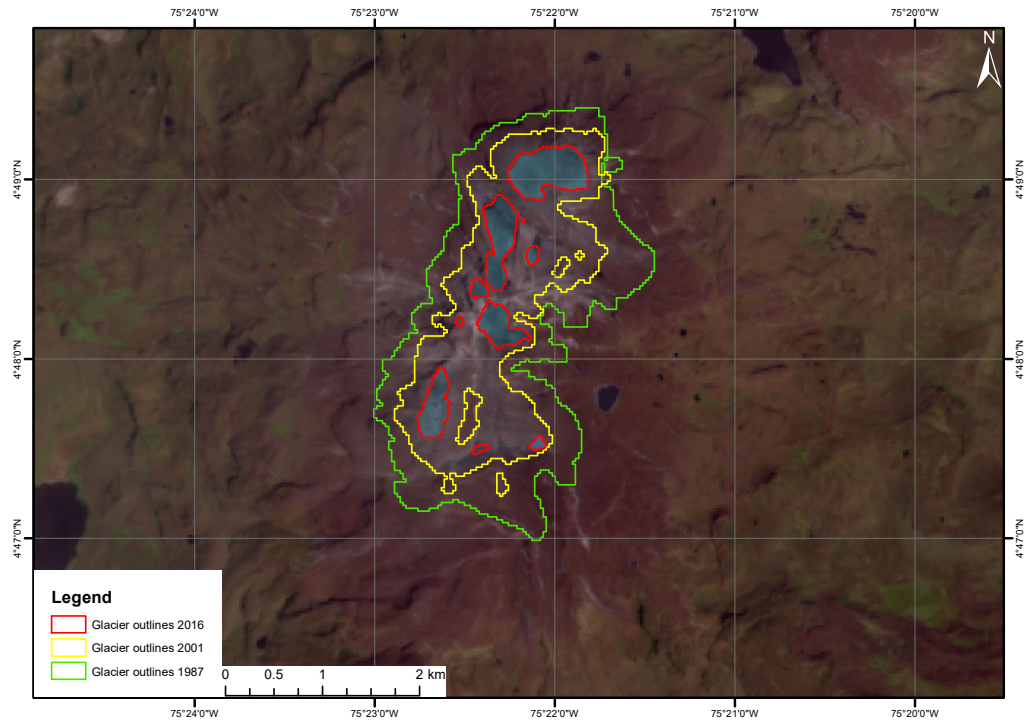


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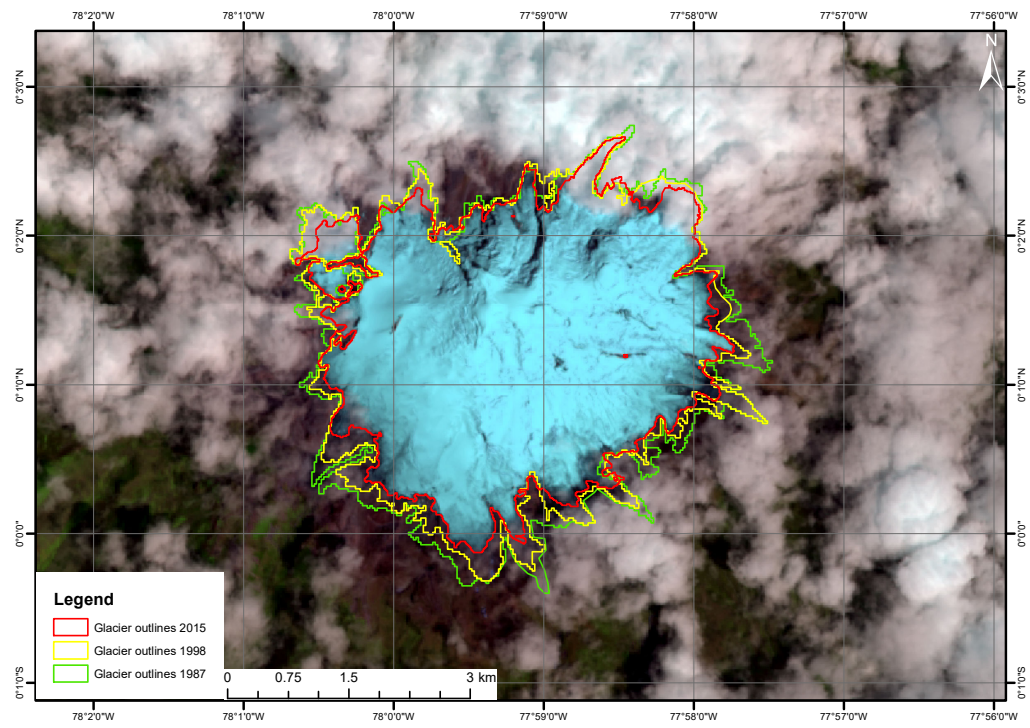


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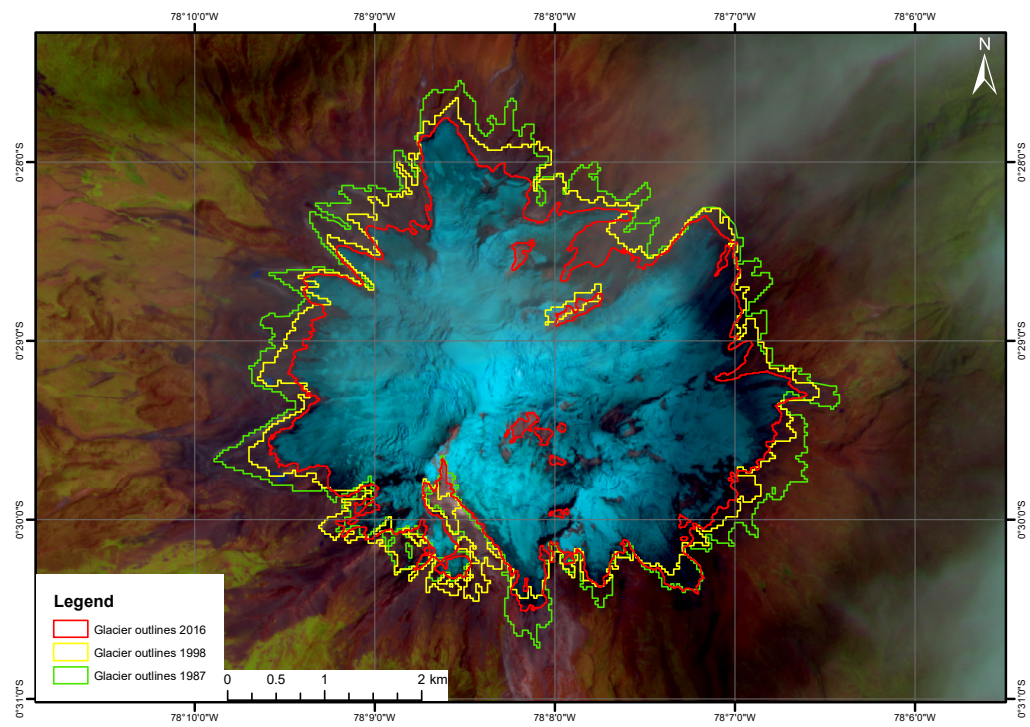


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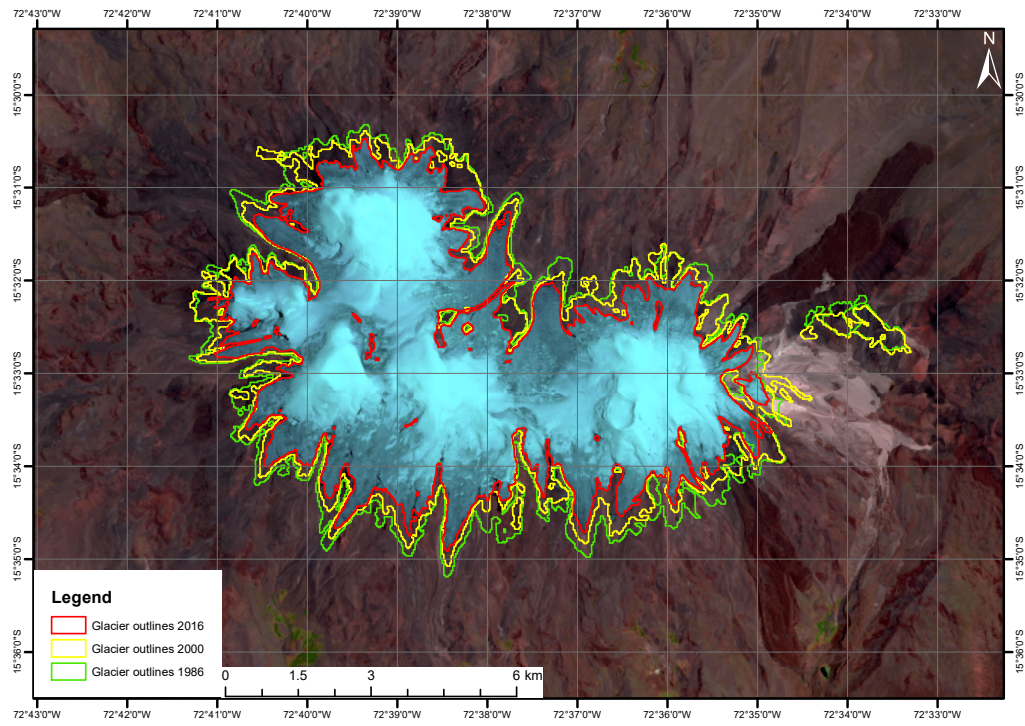


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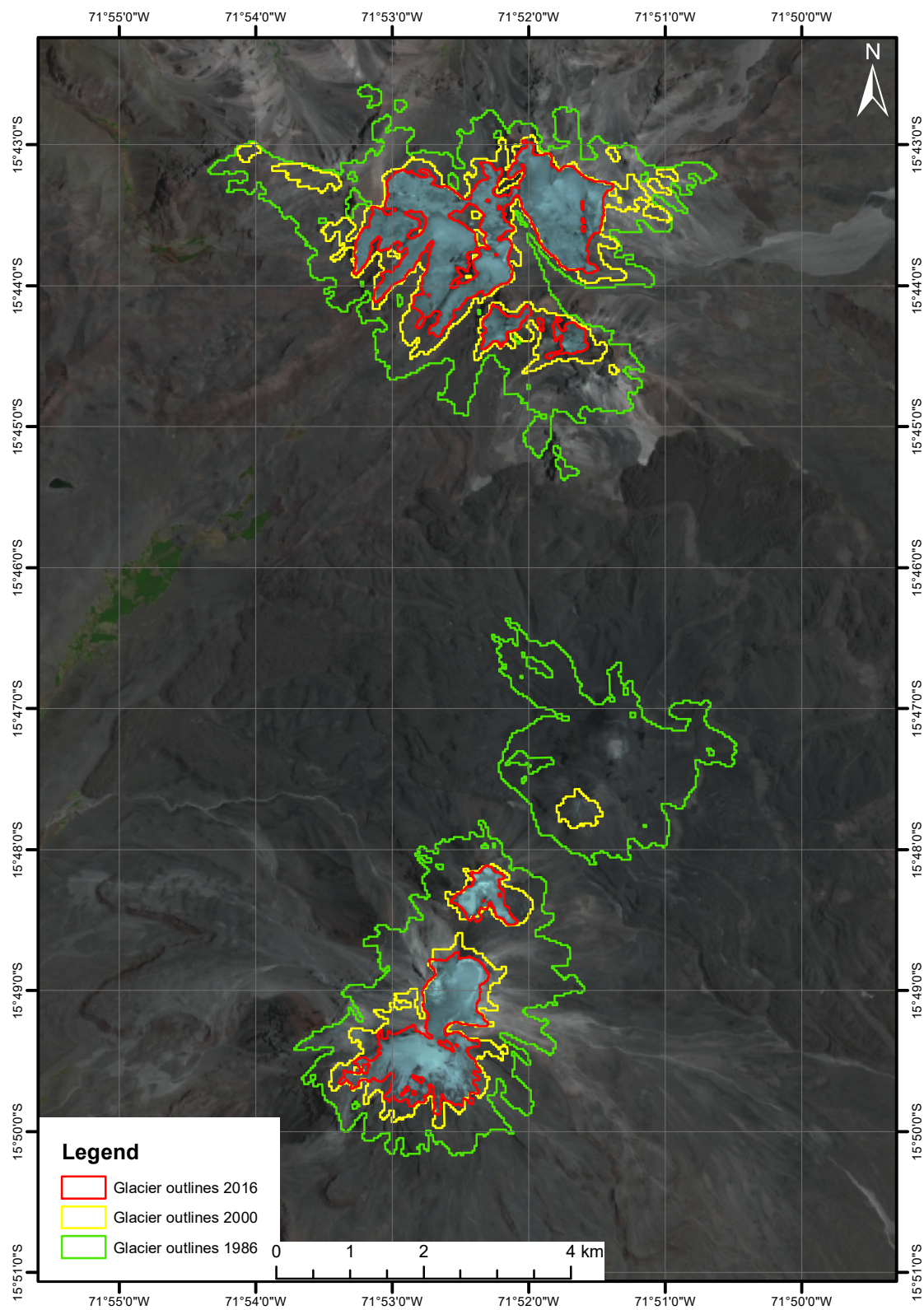


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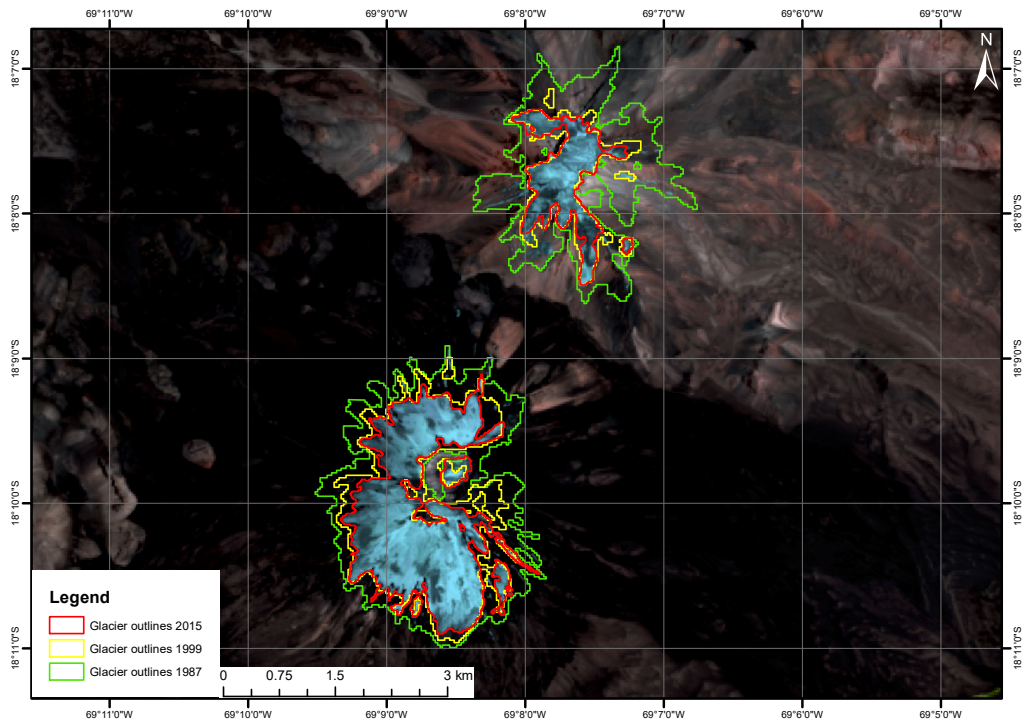


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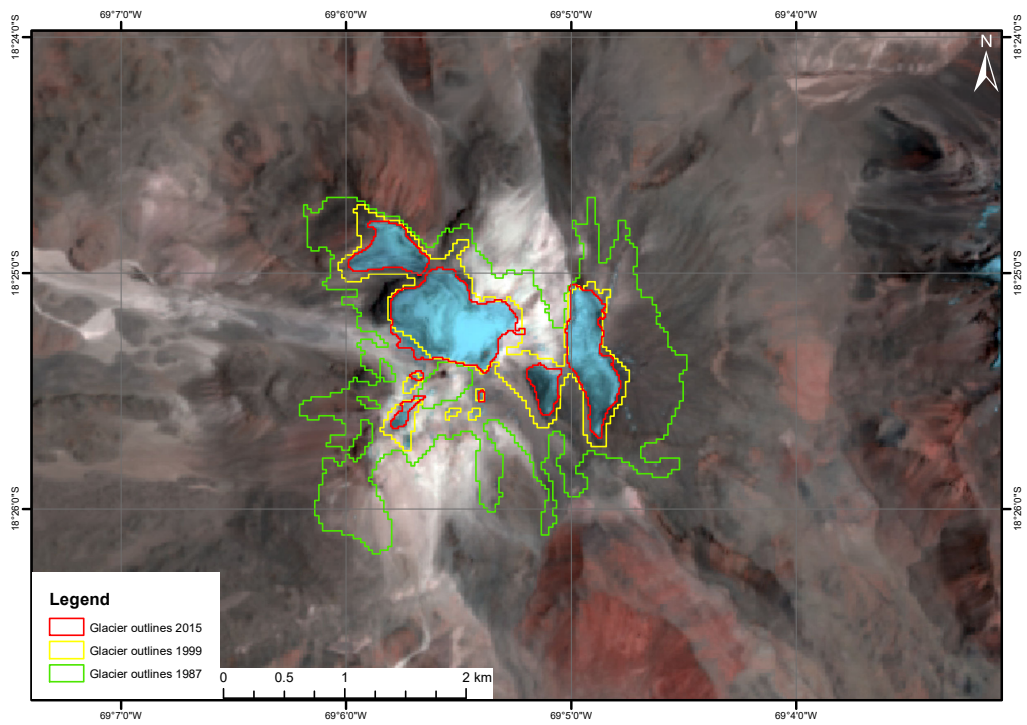


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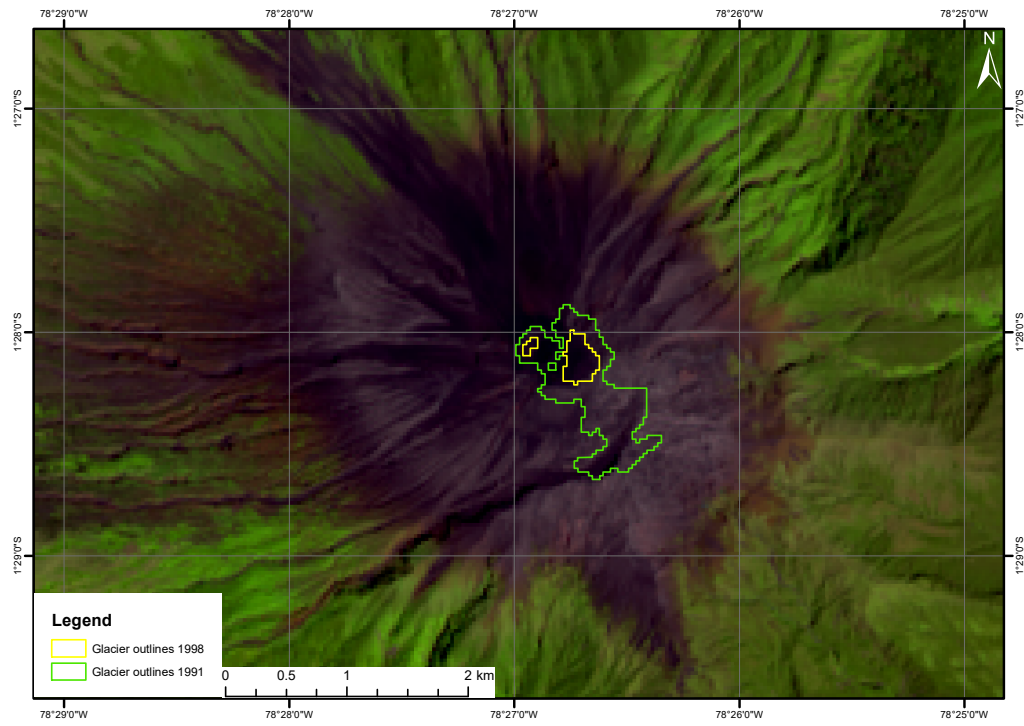


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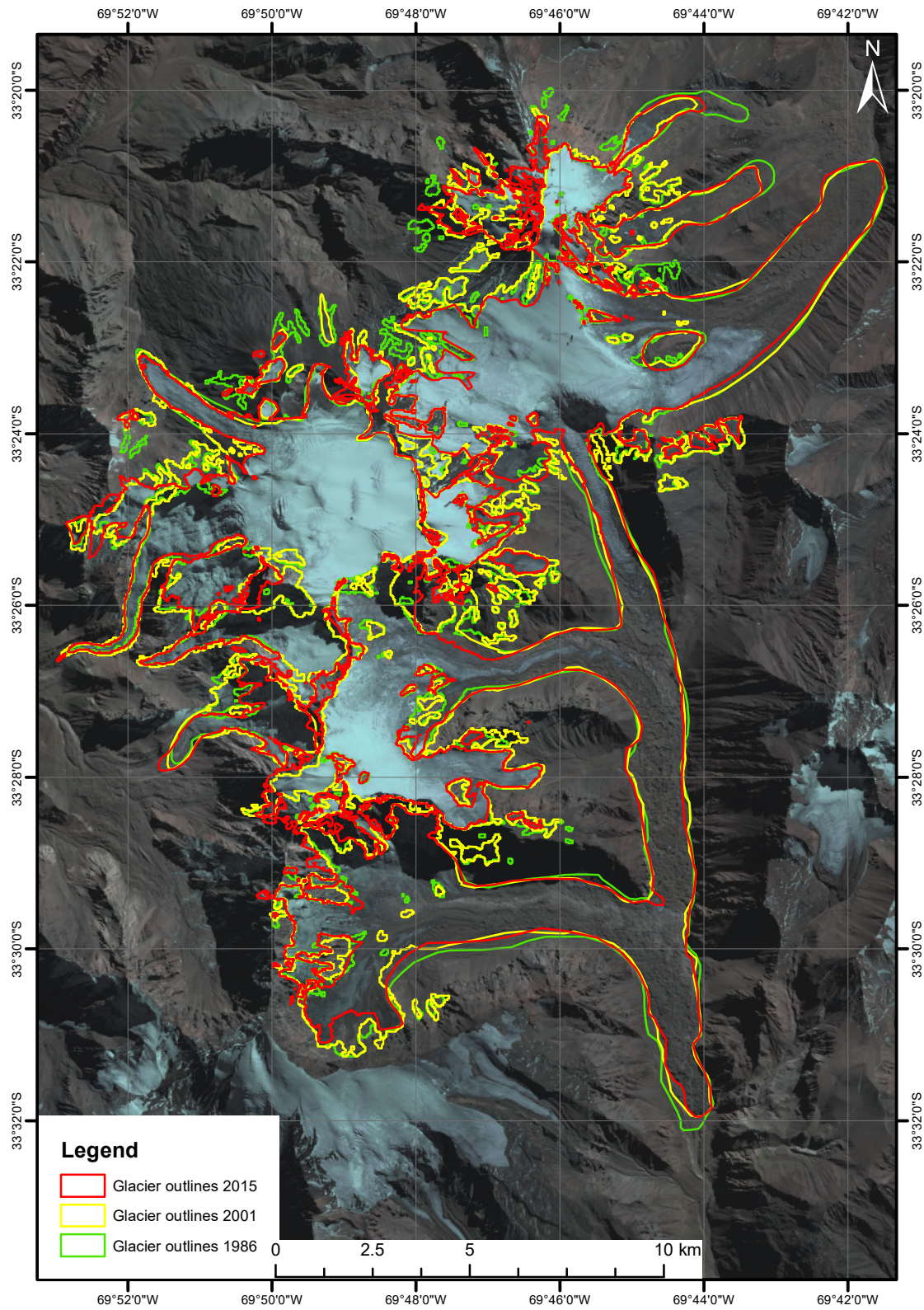


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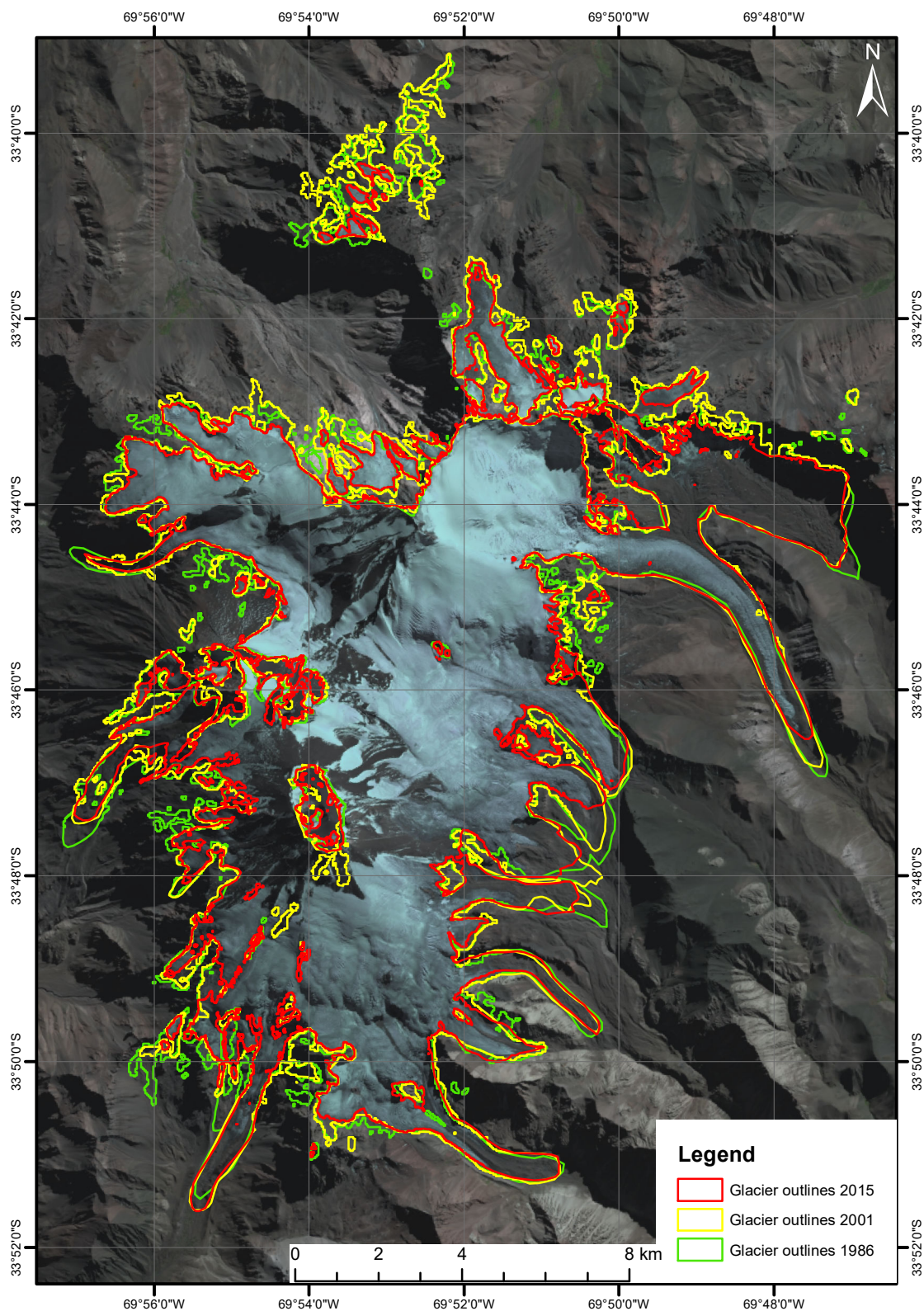


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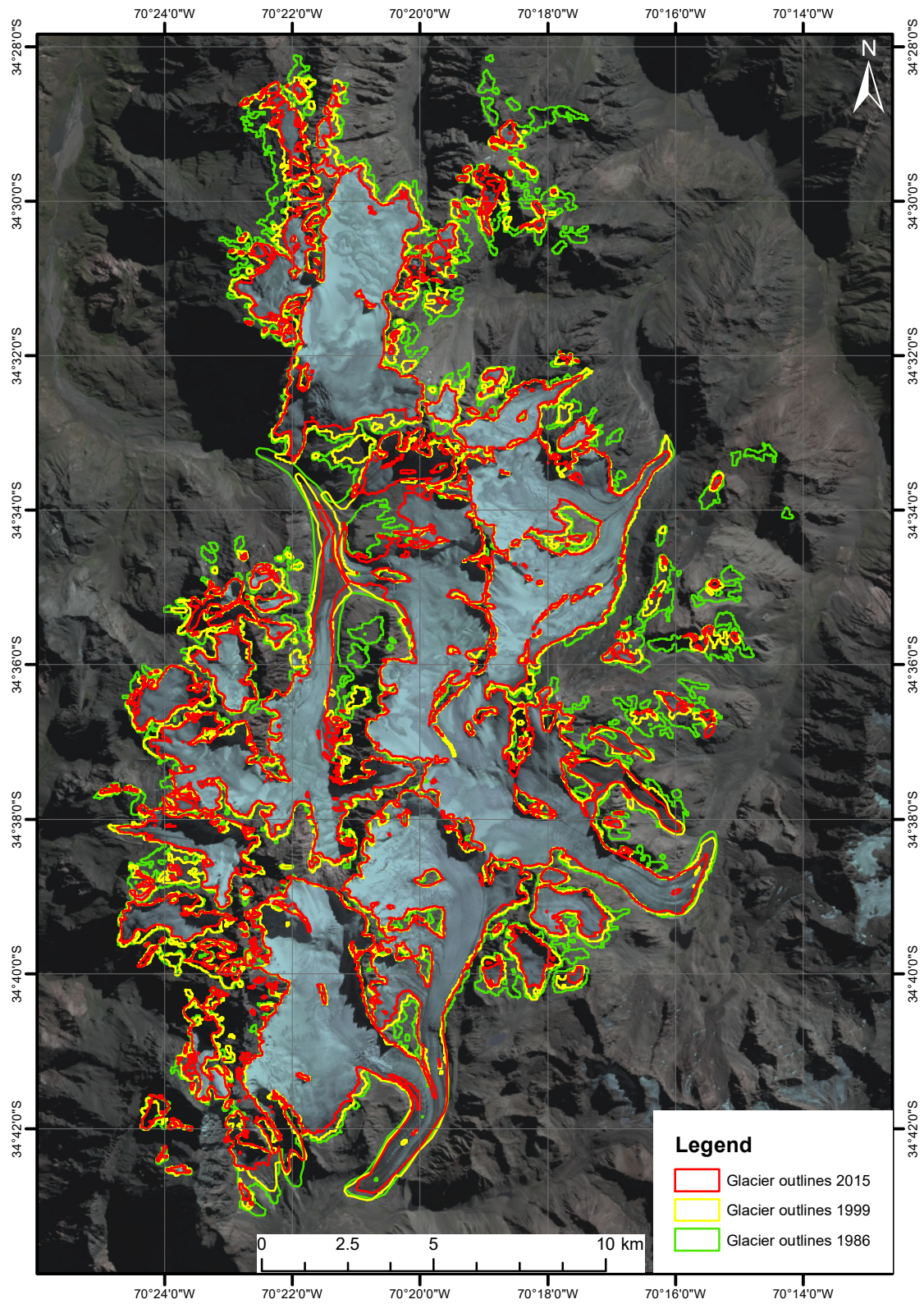


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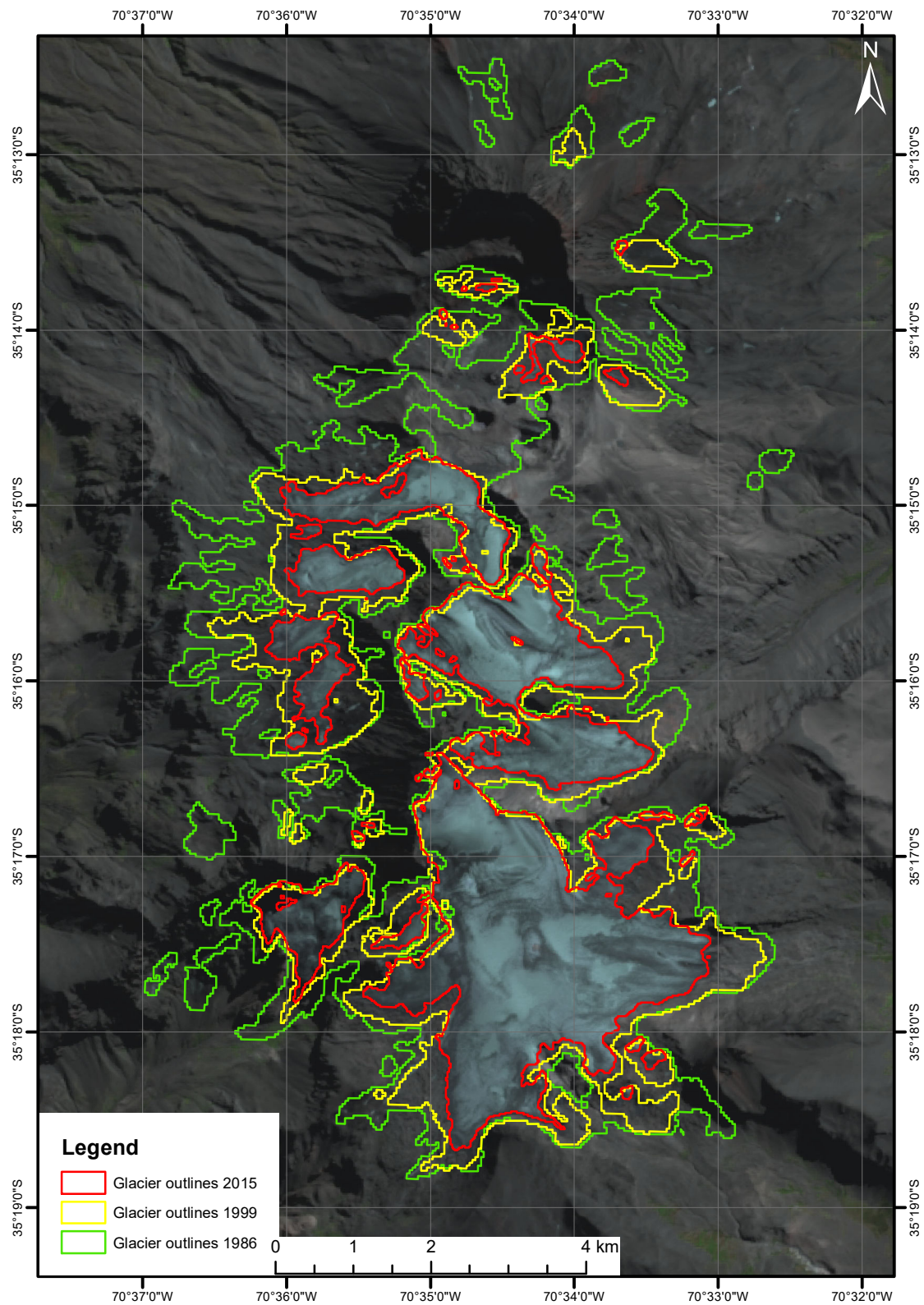


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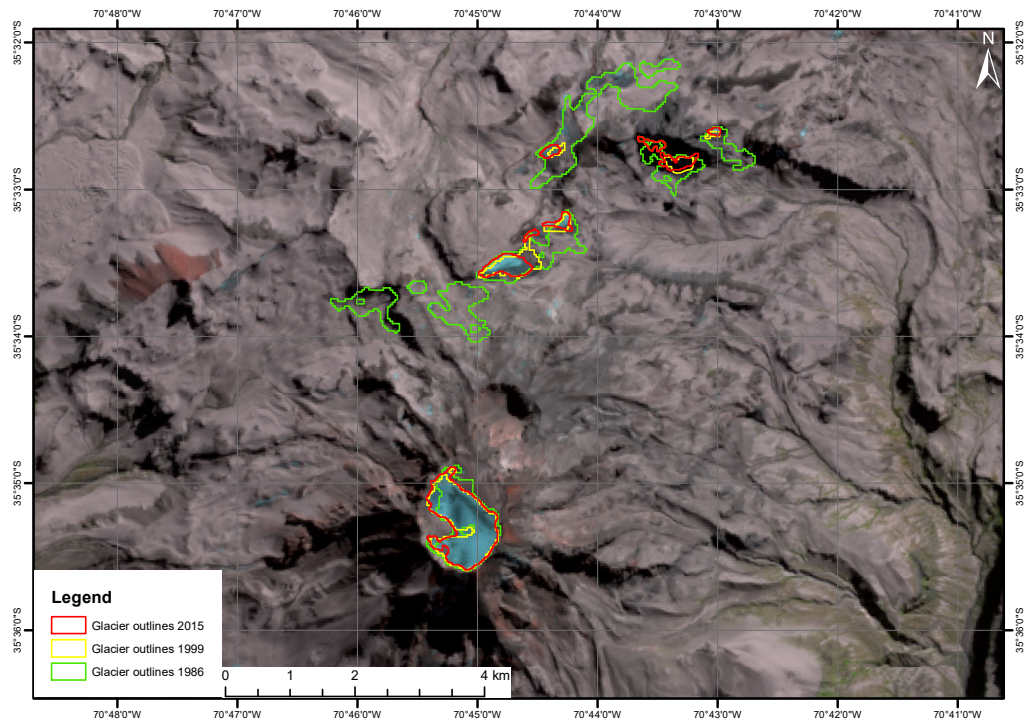


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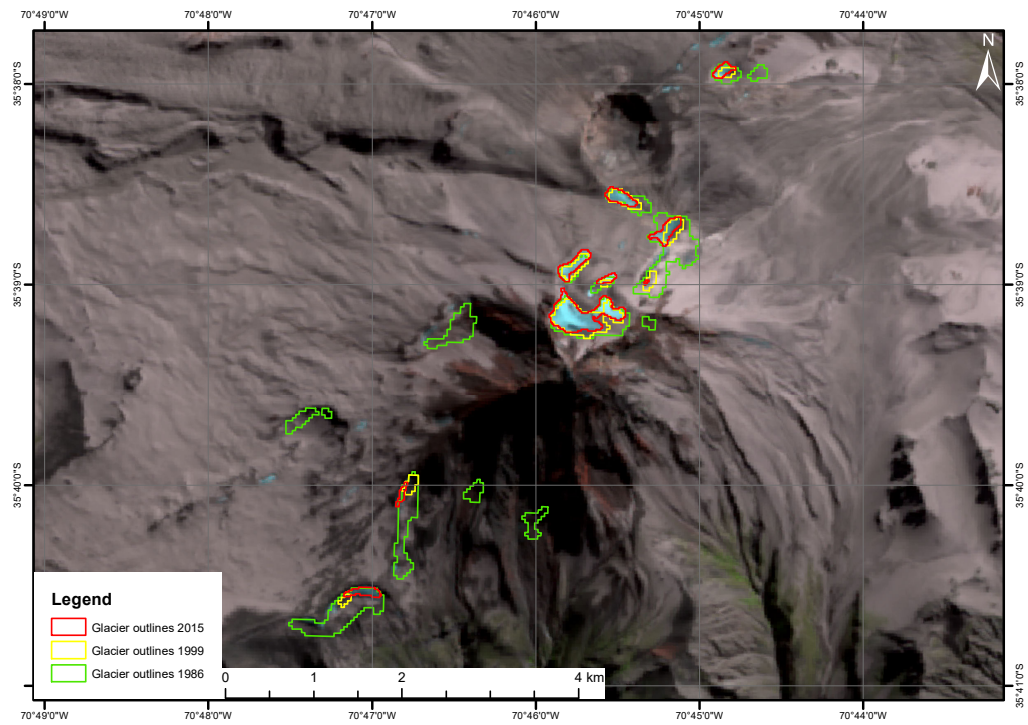


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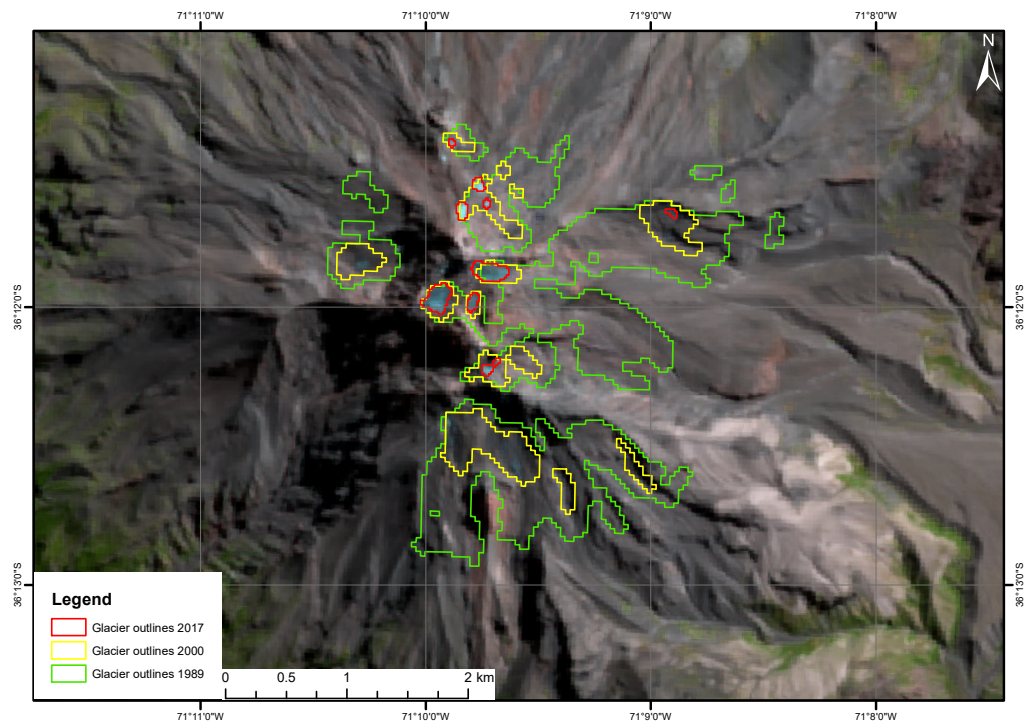


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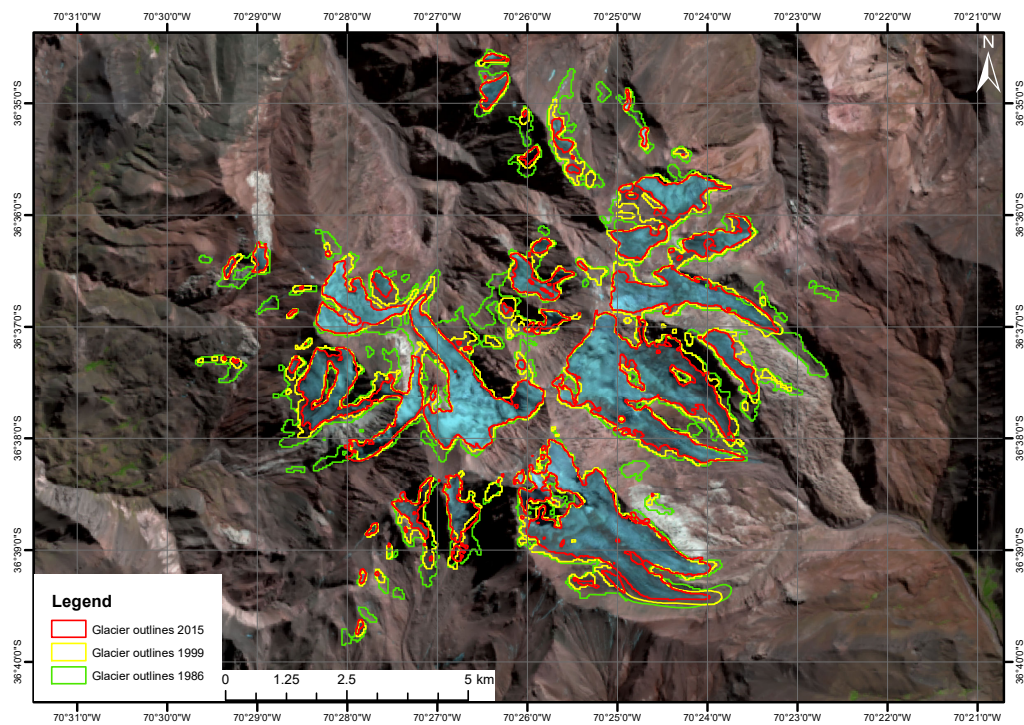


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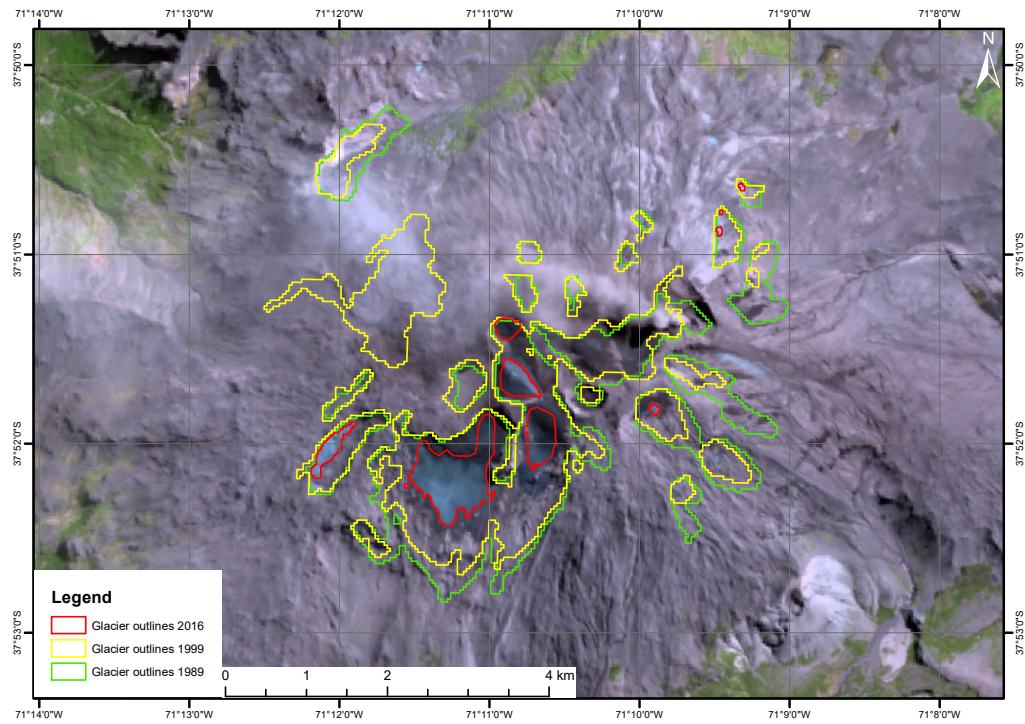


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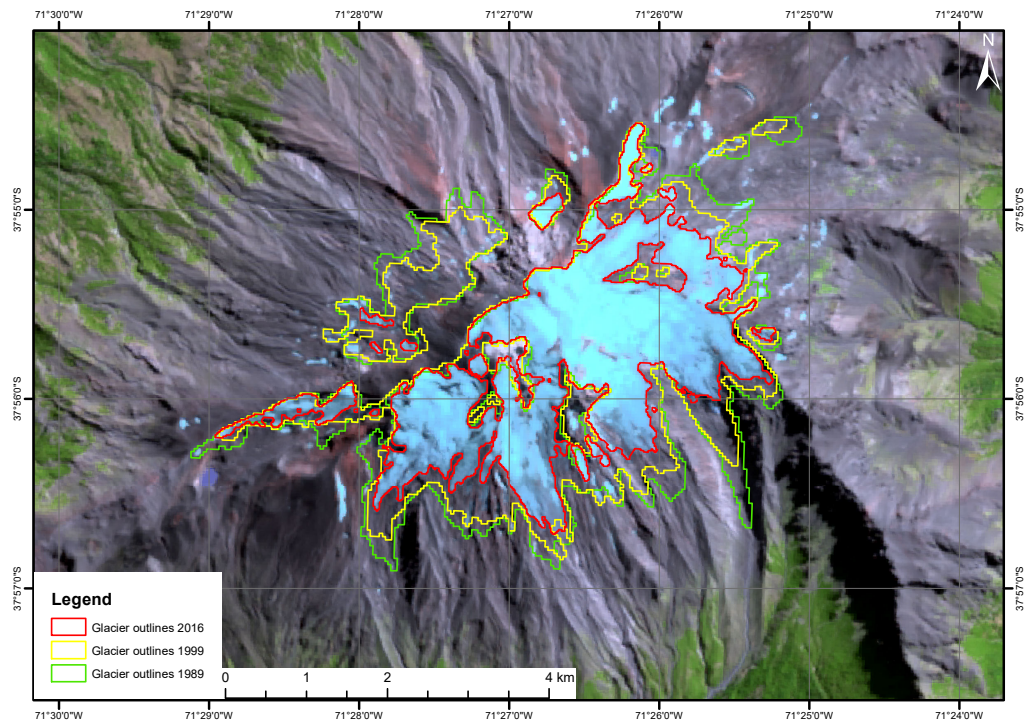


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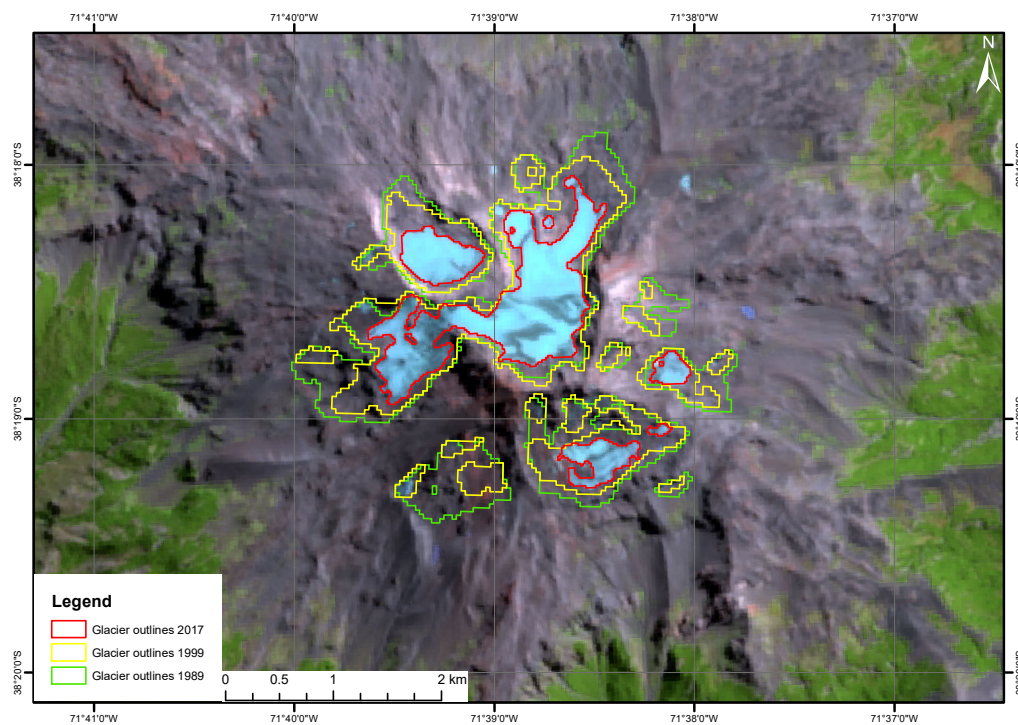


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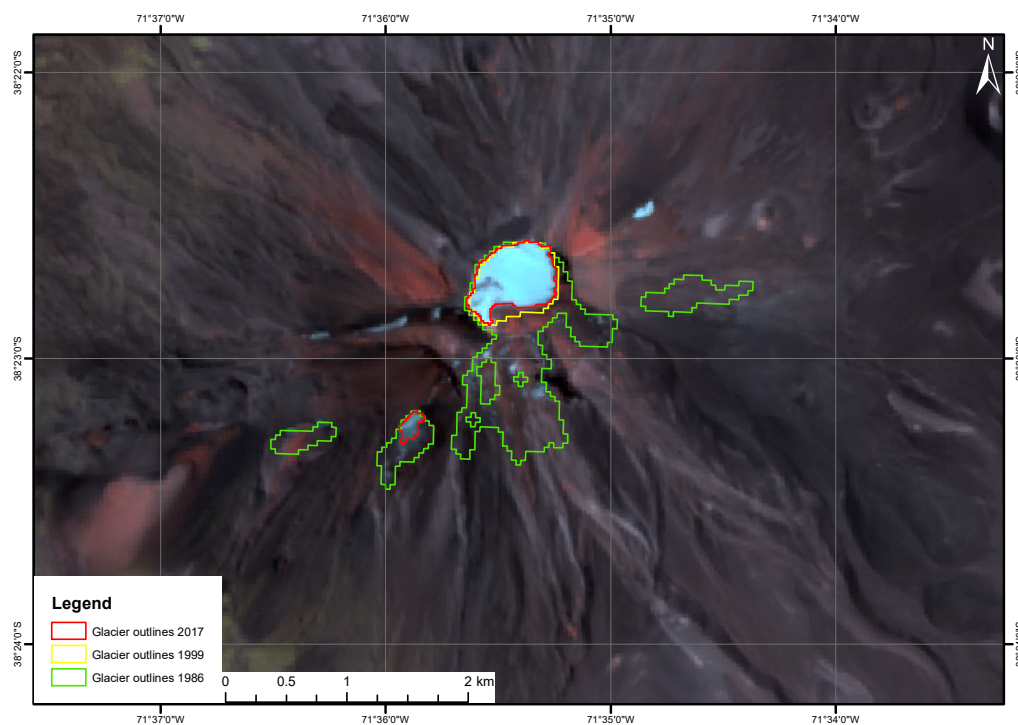


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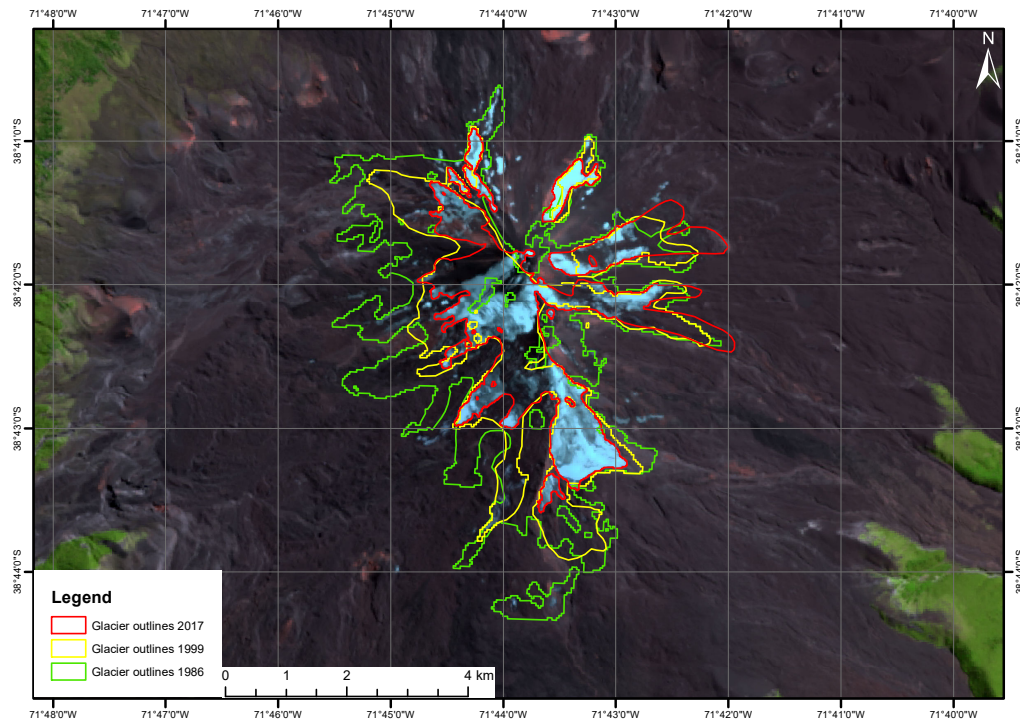


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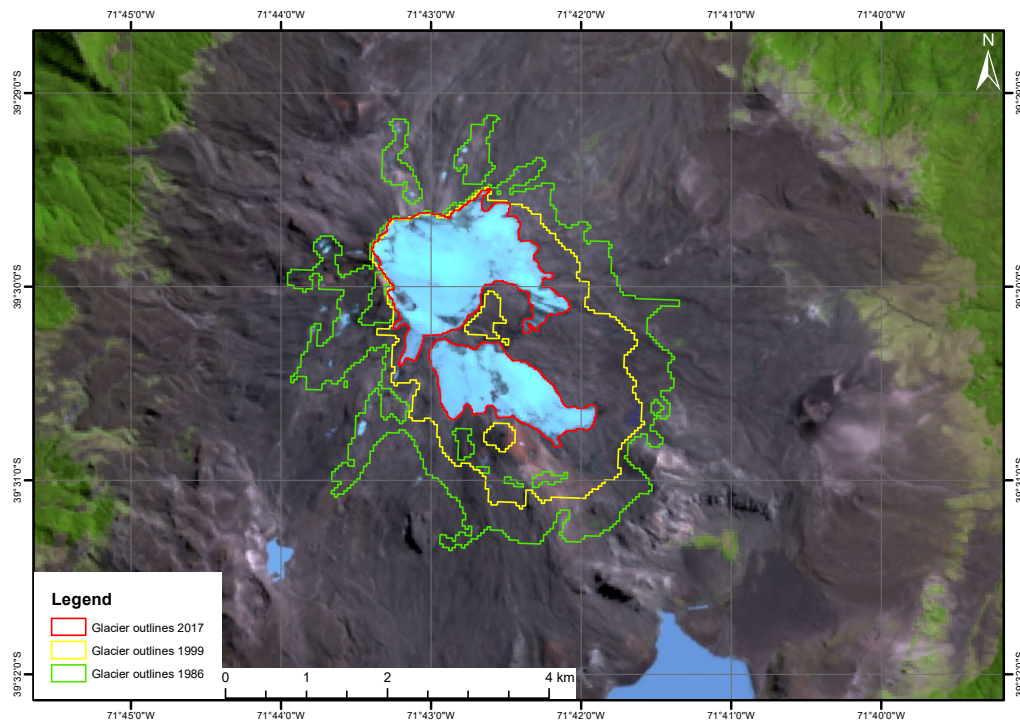


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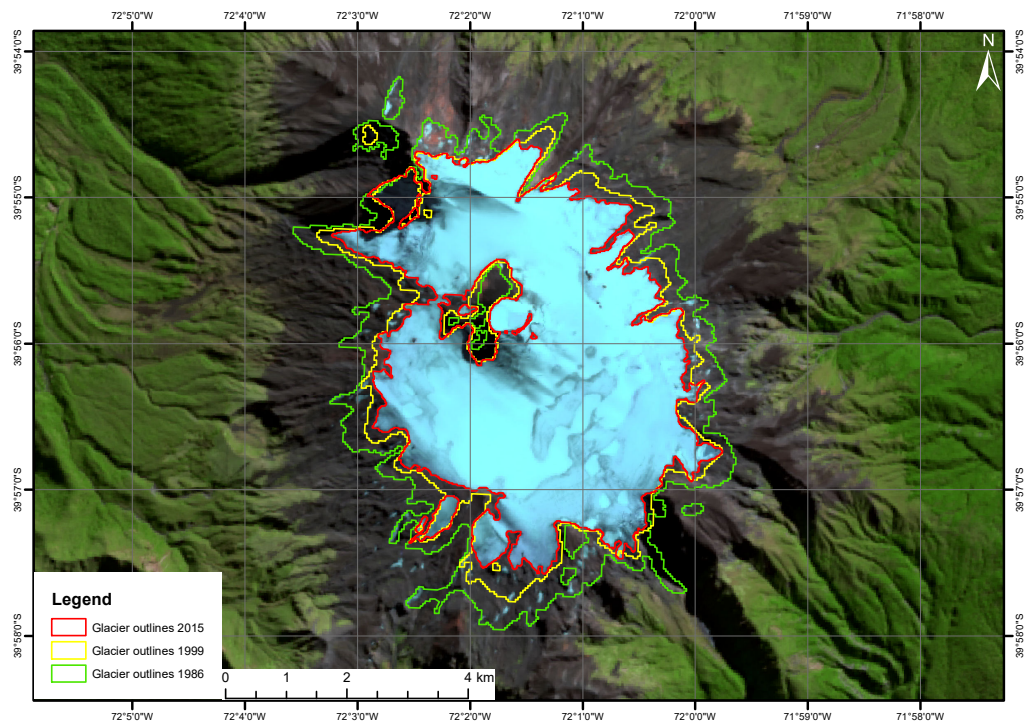


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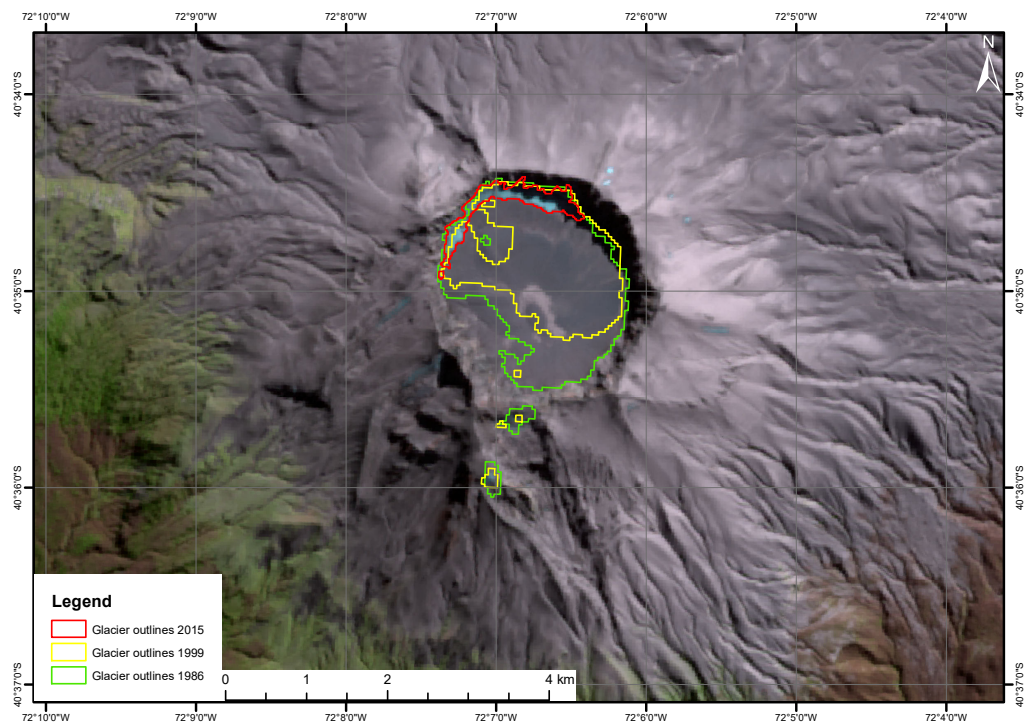


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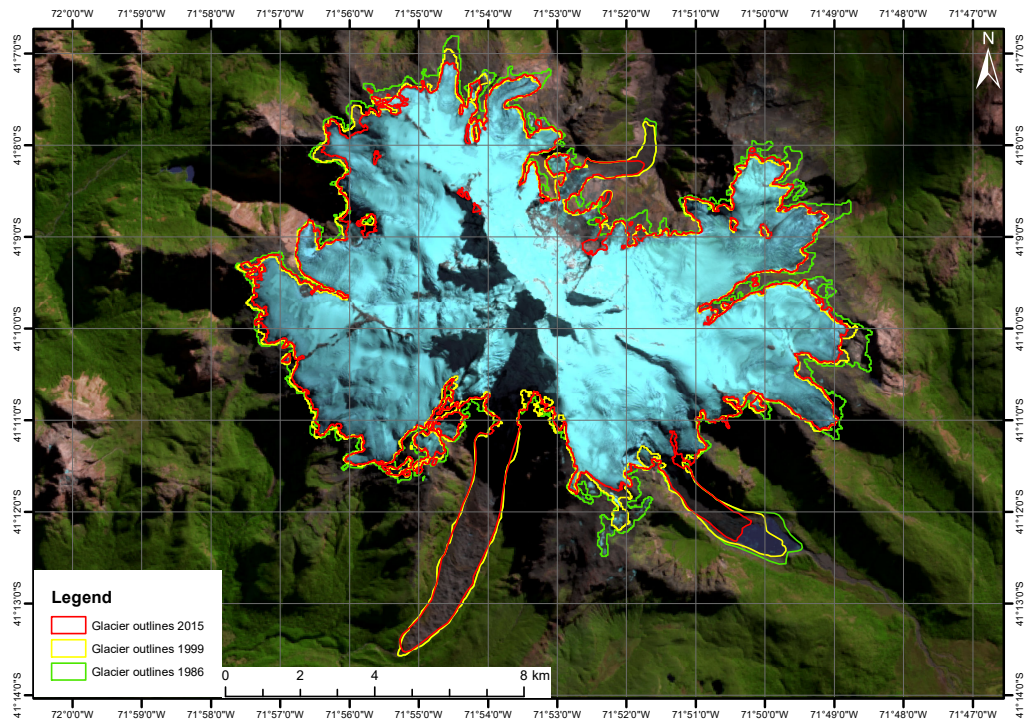


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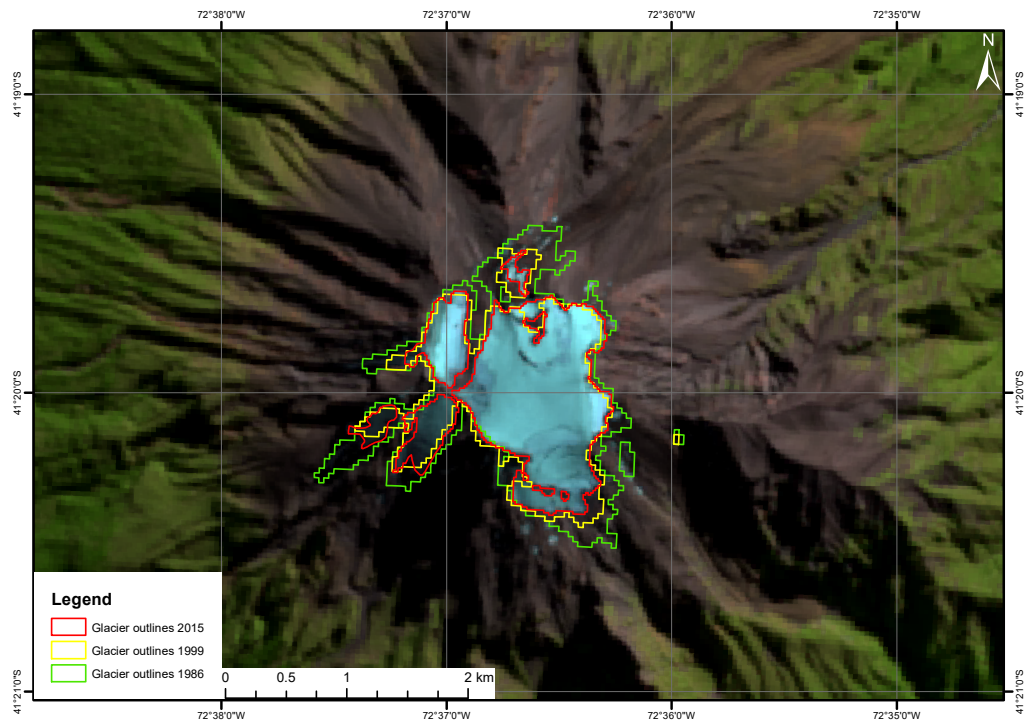


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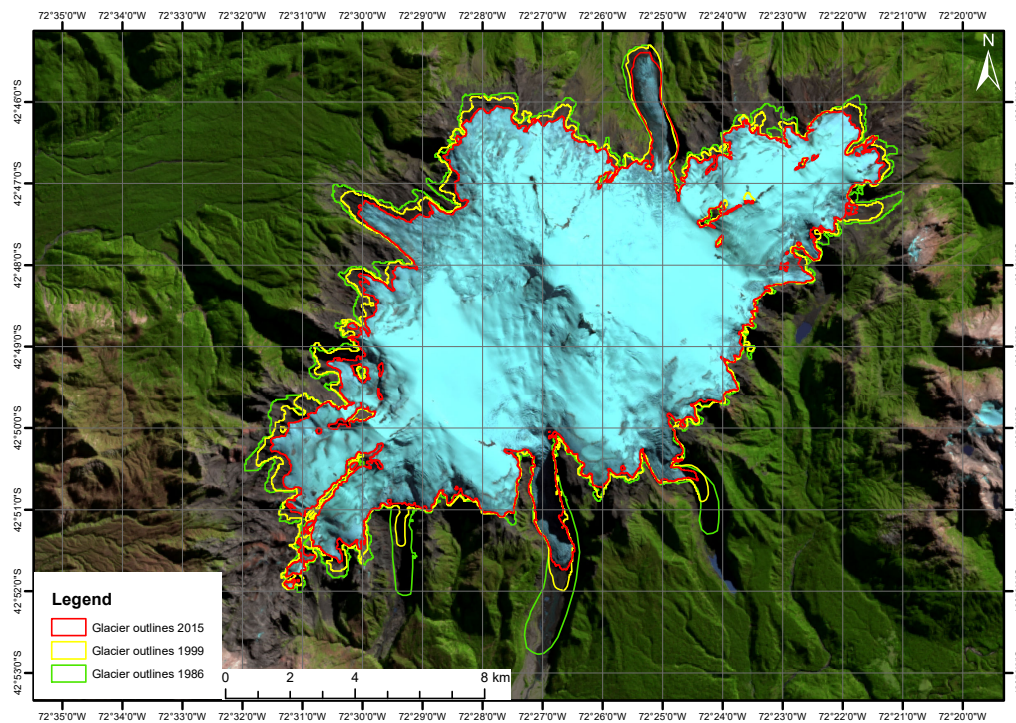


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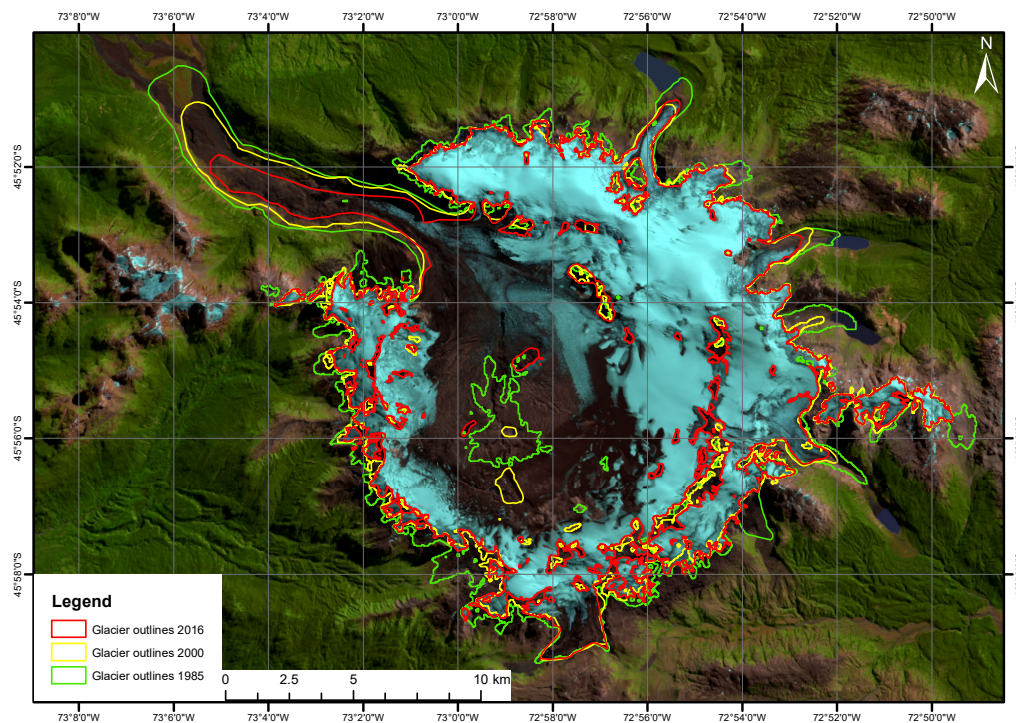


Fig. S29. Glacier outline overlays for Hudson Volcano (1905 m) Chile

Table S1. Glacier area results for all analysed volcanoes. Volcanoes listed from north to south.

Volcano name (altitude)	Eruptions	Area 1986 km^2 (date)	Area 1999 km^2 (date)	Area 2015 km^2 (date)	Area Change total (%)	%/y 1986- 1999	%/y 1999- 2015	%/y 1986- 2015	Figure refer- ence
Iztaccíhuatl (5230m)		0.567 (1987)	0.411 (2000)	0.241 (2017)	-57.6	-2.06	-1.74	-1.88	Figure 7a
Popocatepetl (5436m)	1994, 1996, 2004, 2005	0.567 (1987)	0.278 (2000)		-100	-3.81		-3.81	Figure S1
Pico de Orizaba (5636m)		1.651 (1986)	0.886 (1998)	0.560 (2017)	-66.1	-3.76	-1.02	-2.08	Figure 7b
Ruiz, Nevado del (5321m)	1985, 1994, 2012, 2014, 2015	17.744 (1987)	13.978 (2001)	8.068 (2016)	-54.5	-1.39	-2.3	-1.83	
Santa Isabel, Nevado (4944m)		7.093 (1987)	3.993 (2001)	0.908 (2016)	-87.2	-2.87	-3.01	-2.93	Figure S2
Tolima, Nevado del (5200m)		1.937(1987)	1.378 (2001)	0.656 (2016)	-66.1	-1.89	-2.58	-2.23	
Huila, Nevado del (5365m)	2007, 2008, 2008	16.000 (1987)	12.991 (2001)	8.847 (2016)	-44.7	-1.23	-1.79	-1.5	Figure 8a
Cayambe (5790m)		19.423 (1987)	18.046 (1998)	16.021 (2015)	-17.5	-0.59	-0.6	-0.6	Figure S3
Antisana (5753m)		19.505 (1987)	17.481 (1998)	15.036 (2016)	-22.9	-0.85	-0.71	-0.77	Figure S4
Illiniza (5248m)		0.995 (1987)	0.227 (1998)	0.203 (2016)	-79.6	-6.42	-0.13	-2.69	
Cotopaxi (5911m)	2015	14.417 (1987)	12.877 (2001)	11.422 (2016)	-20.8	-0.75	-0.66	-0.7	Figure 8b
Chimborazo (6310m)		15.408 (1986)	9.822 (2001)	7.123 (2016)	-53.8	-2.35	-1.09	-1.71	
Tungurahua (5023m)	1993, 1999, 2010, 2010, 2015	0.704 (1991)	0.101 (1998)		-100	-11.93		-11.93	Figure S9
Sangay (5286m)	1934-2016<	1.726 (1991)	0.921 (2001)	0.624 (2016)	-63.8	-4.93	-1.07	-2.5	
Coropuna (6377m)		60.868 (1986)	55.211 (2000)	44.709 (2016)	-26.5	-0.65	-1.05	-0.86	Figure S5
Sabancaya (5967m)	1986, 1987, 1988, 1990, 2000, 2003, 2014, 2015, 2016<	27.209 (1986)	9.837 (2000)	6.015 (2016)	-77.9	-4.46	-0.86	-2.54	Figure S6
Parinacota (6336m)		10.558 (1987)	5.666 (1999)	4.734 (2015)	-55.2	-3.66	-0.56	-1.94	Figure S7
Guallatiri (6071m)	2015	4.414 (1987)	1.511(1999)	1.034 (2015)	-76.6	-5.2	-0.68	-2.69	Figure S8
Tupungatito (5660m)	1986, 1987	119.885 (1986)	119.869 (2001)	112.839 (2015)	-5.3	-0.02	-0.4	-0.2	Figure S10
San José (6070m)		119.258 (1986)	118.314 (2001)	104.403 (2015)	-12.5	-0.05	-0.84	-0.42	Figure S11
Maipo (5323m)		10.518 (1986)	7.768 (1999)	5.942 (2015)	-43.5	-1.96	-1.05	-1.45	
Palomo (4860m)		164.743 (1986)	138.565 (1999)	119.434 (2015)	-27.5	-1.19	-0.7	-0.92	Figure S12
Tinguiririca (4280m)	1994	34.998 (1986)	24.025 (1999)	19.640 (2015)	-47.1	-2.35	-0.76	-1.47	
Risco Plateado (4999m)		4.704 (1986)	2.975 (1999)	2.134 (2015)	-54.6	-2.76	-1.08	-1.83	
Planchón-Peteroa (3977m)	1991, 1998, 2010, 2011	29.996 (1986)	19.181 (1999)	12.825 (2015)	-57.2	-2.7	-1.28	-1.92	Figure S13
Descabezado Grande (3953m)		2.694 (1986)	0.912 (1999)	0.942 (2015)	-65	-4.96	0.07	-2.18	Figure S14
Calabozos (3508m)		1.428 (1986)	0.221 (1999)	0.055 (2015)	-96.2	-6.34	-0.71	-3.22	
Azul, Cerro (3788m)		1.020 (1986)	0.273 (1999)	0.289 (2015)	-71.7	-5.49	0.1	-2.4	Figure S15
San Pedro-Pellado (3621m)		10.800 (1986)	3.024 (1999)	1.790 (2015)	-83.4	-5.4	-0.69	-2.79	
Longaví, Nevado de (3242m)		2.763 (1989)	0.623 (2000)	0.085 (2017)	-96.9	-6.85	-1.12	-3.38	Figure S16
Domuyo (4709m)		24.948 (1986)	18.437 (1999)	14.235 (2015)	-42.9	-1.96	-0.98	-1.41	Figure S17
Nevados de Chillán (3212m)	2003, 2009, 2016<	7.793 (1989)	3.037 (2000)	1.856 (2016)	-76.2	-5.37	-0.93	-2.75	
Tromen (3978m)		1.553 (1986)	0.612 (1999)	0.292 (2017)	-81.2	-4.57	-1.11	-2.55	
Antuco (2979m)		3.205 (1989)	2.196 (2000)	1.502 (2016)	-53.1	-2.77	-1.32	-1.92	
Copahue (2953m)	1992, 1994, 1995, 2000, 2012, 2014, 2015	7.045 (1989)	5.618 (1999)	0.811 (2016)	-88.5	-2	-3.88	-3.19	Figure S18
Callaqui (3164m)	2009, 2012	10.001 (1989)	8.730 (1999)	5.525 (2016)	-44.8	-1.26	-1.82	-1.61	Figure S19
Tolhuaca (2806m)		3.495 (1989)	2.755 (1999)	1.238 (2017)	-64.6	-2.09	-2.34	-2.25	Figure S20
Lonquimay (2832m)	1988	0.981 (1986)	0.228 (1999)	0.219 (2017)	-77.7	-5.8	-0.05	-2.45	Figure S21
Llaima (3125m)	1990, 1992, 1994, 1995, 1997, 1998, 1998, 2002, 2003, 2007, 2008	12.225 (1986)	7.098 (1999)	5.535 (2017)	-54.7	-3.17	-0.69	-1.73	Figure S22
Sollipulli (2282m)		16.222 (1986)	12.446 (1999)	11.098 (2017)	-31.6	-1.76	-0.45	-1	Figure 9a

Villarrica (2847m)	1991, 1992, 1994, 1995, 1996, 1996, 1998, 2003, 2004, 2008, 2009, 2009, 2012, 2013, 2014	31.214 (1986)	27.666 (1999)	23.636 (2017)	-24.3	-0.86	-0.7	-0.77	Figure 9b
Quetrupillán (2360m)		8.165 (1986)	5.029 (1999)	2.318 (2017)	-71.6	-2.91	-1.79	-2.26	Figure S23
Lanín (3776m)		9.399 (1990)	7.297 (1999)	6.546 (2015)	-30.3	-2.44	-0.48	-1.18	
Mocho-Choshuenco (2422m)		21.826 (1986)	16.677 (1999)	14.655 (2015)	-32.9	-1.79	-0.56	-1.1	Figure S24
Puyehue-Cordón Caulle (2236m)	1990, 2011	2.374 (1986)	1.565 (1999)	0.242 (2015)	-89.8	-2.58	-3.37	-3.02	Figure S25
Puntiagudo -Cordón Cenizos (2493m)		2.122 (1986)	1.210 (1999)	1.310 (2015)	-38.3	-3.26	0.29	-1.29	
Osorno (2659m)		7.096 (1986)	5.013 (1999)	4.658 (2015)	-34.4	-2.22	-0.3	-1.15	
Tronador (3491m)		70.930 (1986)	64.279 (1999)	62.115 (2015)	-12.4	-0.71	-0.18	-0.42	Figure S26
Calbuco (1974m)	2015	1.729 (1986)	1.239 (1999)	1.122 (2015)	-35.1	-2.15	-0.41	-1.18	Figure S27
Yate (2187m)		15.505 (1986)	12.458 (1999)	10.568 (2015)	-31.8	-1.49	-0.74	-1.07	
Michinmahuida (2452m)		90.025 (1986)	83.100 (1999)	75.746 (2015)	-15.9	-0.58	-0.49	-0.53	Figure S28
Yanteles (2049m)		40.590 (1986)	34.896 (1999)	30.765 (2015)	-24.2	-1.06	-0.61	-0.81	
Corcovado (1826m)		4.272 (1986)	3.742 (1999)	3.306 (2015)	-22.6	-0.94	-0.62	-0.76	
Melimoyu (2400m)		62.957 (1985)	57.462 (2000)	56.061 (2015)	-11	-0.57	-0.14	-0.36	
Mentolat (1660m)		4.387 (1985)	3.367 (2000)	3.077 (2015)	-29.9	-1.51	-0.43	-0.97	
Cay (2090m)		6.666 (1985)	6.015 (2000)	5.258 (2015)	-21.1	-0.64	-0.74	-0.69	
Macá (2960m)		37.161 (1985)	31.185 (2000)	26.163 (2015)	-29.6	-1.05	-0.88	-0.96	
Hudson Volano (1905m)	1991, 2011	148.730 (1985)	134.028 (2000)	121.380 (2016)	-18.4	-0.64	-0.52	-0.58	Figure S29
Monte Burney (1758m)		23.067 (1986)	19.996 (1998)	18.249 (2017)	-20.9	-1.07	-0.39	-0.66	

Table S2. List of analysed volcanoes including Long./Lat., scene ID and analyse date

Volcano name	Latitude	Longitude	Scene 1986	Anal date 1986	Scene 1999	Anal date 1999	Scene 2015	Anal date 2015
Iztaccíhuatl	19.17	-98.64	LT50260471987085AAA01	26/03/1987	LE70260472000113EDC00	22/04/2000	S2A_MSIL1C_20170216T170351_-N0204_R069_T14QNG_-20170216T171642	16/02/2017
Pico de Orizaba	19.04	-97.27	LT50250471986075XXX09	16/03/1986	LT50250471998092XXX01	02/04/1998	S2A_MSIL1C_20170223T165311_-N0204_R026_T14QPG_-20170223T165747	23/02/2017
Popocatepetl	19.03	-98.63	LT50260471987085AAA01	26/03/1987	LE70260472000113EDC00	22/04/2000		
Ruiz, Nevado del	4.88	-75.32	LT50090571987014XXX03	14/01/1987	LE70090572001012EDC00	12/01/2001	LC80090572016014LGN02	14/01/2016
Santa Isabel, Nevado del	4.8	-75.37	LT50090571987014XXX03	14/01/1987	LE70090572001012EDC00	12/01/2001	LC80090572016014LGN02	14/01/2016
Tolima, Nevado del	4.66	-75.33	LT50090571987014XXX03	14/01/1987	LE70090572001012EDC00	12/01/2001	LC80090572016014LGN02	14/01/2016
Huila, Nevado del	2.93	-76.03	LT50090581987014XXX01	14/01/1987	LE70090582001012EDC01	12/01/2001	LC80090582016014LGN02	14/01/2016
Cayambe	0.02	-77.99	LT50100601987005XXX03	05/01/1987	LT50100601998355XXX01	21/12/1998	LC80100602015322LGN01	18/11/2015
Antisana	-0.49	-78.14	LT50100601987021XXX03	21/01/1987	LT50100601998355XXX01	21/12/1998	S2A_OPER_MSI_L1C_TL_MTI_-20160202T154325_20160202T202339_-A003211_T17MRV_N02_01_01	02/02/2016
Illiniza	-0.66	-78.72	LT50100601987085XXX05	26/03/1987	LT50100601998355XXX01	21/12/1998	S2A_OPER_MSI_L1C_TL_MTI_-20160202T154325_20160202T202339_-A003211_T17MQV_N02_01_01	02/02/2016
Cotopaxi	-0.69	-78.43	LT50100601987085XXX05	26/03/1987	LE70100612001307EDC01	03/11/2001	S2A_OPER_MSI_L1C_TL_MTI_-20160202T154325_20160202T202339_-A003211_T17MQV_N02_01_01	02/02/2016
Chimborazo	-1.46	-78.81	LT50100611986034XXX04	03/02/1986	LE70100612001307EDC01	03/11/2001	LC80100612016325LGN01	20/11/2016

Tungurahua	-1.47	-78.44	LT50100611991352CPE04	18/12/1991	LT50100611998355XXX01	21/12/1998		
Sangay	-2.01	-78.34	LT50100611991352CPE04	18/12/1991	LE70100612001307EDC01	03/11/2001	LC80100612016325LGN01	20/11/2016
Coropuna	-15.55	-72.64	LT50040711986328XXX03	24/11/1986	LT50040712000319CUB00	14/11/2000	LC80040712016331LGN01	26/11/2016
Sabancaya	-15.77	-71.87	LT50040711986328XXX03	24/11/1986	LT50030712000312CUB00	14/11/2000	LC80040712016299LGN01	25/10/2016
Parinacota	-18.15	-69.14	LT50010731987342CUB00	08/12/1987	LE70010731999351AGS00	17/12/1999	LC80010732015339LGN01	05/12/2015
Guañatiri	-18.42	-69.09	LT50010731987342CUB00	08/12/1987	LE70010731999351AGS00	17/12/1999	LC80010732015339LGN01	05/12/2015
Tupungatito	-33.43	-69.79	LT52320831986037AAA03	06/02/1986	LE72320832001070EDC00	11/03/2001	LC82320832015117LGN01	27/04/2015
San José	-33.77	-69.88	LT52320831986037AAA03	06/02/1986	LE72320832001070EDC00	11/03/2001	LC82320832015117LGN01	27/04/2015
Maipo	-34.17	-69.83	LT52320841986053AAA06	22/02/1986	LT52320841999057COA00	26/02/1999	LC82320842015117LGN01	27/04/2015
Palomo	-34.6	-70.34	LT52320841986053AAA06	22/02/1986	LT52320841999057COA00	26/02/1999	LC82320842015117LGN01	27/04/2015
Tinguiririca	-34.79	-70.32	LT52320841986053AAA06	22/02/1986	LT52320841999057COA00	26/02/1999	LC82320842015117LGN01	27/04/2015
Risco Plateado	-34.93	-70.01	LT52320841986053AAA06	22/02/1986	LT52320841999057COA00	26/02/1999	LC82320842015117LGN01	27/04/2015
Planchón-Peteroa	-35.27	-70.58	LT52320851986053AAA13	22/02/1986	LT52320851999057COA00	26/02/1999	LC82320852015101LGN01	11/04/2015
Descabezado Grande	-35.56	-70.74	LT52320851986053AAA13	22/02/1986	LT52320851999057COA00	26/02/1999	LC82320852015101LGN01	11/04/2015
Calabozos	-35.57	-70.5	LT52320851986053AAA13	22/02/1986	LT52320851999057COA00	26/02/1999	LC82320852015101LGN01	11/04/2015
Azul, Cerro	-35.66	-70.77	LT52320851986053AAA13	22/02/1986	LT52320851999057COA00	26/02/1999	LC82320852015101LGN01	11/04/2015
San Pedro-Pellado	-35.98	-70.82	LT52320851986053AAA13	22/02/1986	LT52320851999057COA00	26/02/1999	LC82320852015101LGN01	11/04/2015
Longaví, Nevado de Domuyo	-36.2	-71.16	LT42330851989076XXX01	17/03/1989	LE72330852000091COA00	31/03/2000	LC82330852017081LGN00	22/03/2017
Nevados de Chillán	-36.62	-70.43	LT52320851986053AAA13	22/02/1986	LT52320851999057COA00	26/02/1999	LC82320852015101LGN01	11/04/2015
Tromen	-36.84	-71.4	LT42330861989060XXX06	01/03/1989	LE72330862000091AGS02	31/03/2000	LC82330862016079LGN01	19/03/2016
Antuco	-37.15	-70.05	LT52320861986085XXX03	26/03/1986	LT52320861999057COA00	26/02/1999	LC82320862017090LGN00	31/03/2017
Copahue	-37.42	-71.35	LT42330861989060XXX06	01/03/1989	LE72330862000091AGS02	31/03/2000	LC82330862016079LGN01	19/03/2016
Callaqui	-37.86	-71.18	LT42330861989060XXX06	01/03/1989	LT52330861999016COA00	16/01/1999	LC82330862016079LGN01	19/03/2016
Tolhuaca	-37.93	-71.44	LT42330861989060XXX06	01/03/1989	LT52330861999016COA00	16/01/1999	LC82330862016079LGN01	19/03/2016
Lonquimay	-38.31	-71.65	LT42330861989060XXX06	01/03/1989	LT52330861999016COA00	16/01/1999	LC82330862017065LGN01	06/03/2017
Llaima	-38.38	-71.59	LT52320871986085XXX03	26/03/1986	LT52320871999057COA00	26/02/1999	LC82330872017065LGN01	06/03/2017
Sollipulli	-38.71	-71.73	LT52320871986085XXX03	26/03/1986	LT52320871999057COA00	26/02/1999	LC82330872017065LGN01	06/03/2017
Villarrica	-38.98	-71.53	LT52320871986085XXX03	26/03/1986	LT52320871999057COA00	26/02/1999	LC82330872017065LGN01	06/03/2017
Quetrupillán	-39.43	-71.92	LT52320871986085XXX03	26/03/1986	LT52320871999041COA00	10/02/1999	LC82330872017065LGN01	06/03/2017
Lanín	-39.51	-71.71	LT52320871986085XXX03	26/03/1986	LT52320881999041COA00	10/02/1999	LC82330872017065LGN01	06/03/2017
Mocho-Choshuenco	-39.65	-71.51	LT42320881990056XXX02	25/02/1990	LT52320881999041COA00	10/02/1999	LC82320882015085LGN01	26/03/2015
Puyehue-Cordón Caulle	-39.94	-72.03	LT52320881986085XXX04	26/03/1986	LT52320881999041COA00	10/02/1999	LC82320882015101LGN01	11/04/2015
Puntiagudo-Cordón Cenizos	-40.58	-72.11	LT52320881986085XXX04	26/03/1986	LT52320881999041COA00	10/02/1999	LC82320882015101LGN01	11/04/2015
Osorno	-40.98	-72.27	LT52320881986085XXX04	26/03/1986	LT52320881999041COA00	10/02/1999	LC82320882015101LGN01	11/04/2015
Tronador	-41.11	-72.5	LT52320891986085XXX05	26/03/1986	LT52320891999041COA00	10/02/1999	LC82320892015101LGN01	11/04/2015
Calbuco	-41.16	-71.89	LT52320891986085XXX05	26/03/1986	LT52320891999041COA00	10/02/1999	LC82320892015101LGN01	11/04/2015
Yate	-41.33	-72.61	LT52320891986085XXX05	26/03/1986	LT52320891999041COA00	10/02/1999	LC82320892015101LGN01	11/04/2015
Michinmahuida	-41.78	-72.39	LT52320891986085XXX05	26/03/1986	LT52320891999041COA00	10/02/1999	LC82320892015101LGN01	11/04/2015
Corcovado	-42.81	-72.45	LT52320901986085XXX03	26/03/1986	LT52320901999041COA00	10/02/1999	LC82320902015101LGN01	11/04/2015
Yanteles	-43.2	-72.79	LT52320901986085XXX03	26/03/1986	LT52320901999041COA00	10/02/1999	LC82320902015101LGN01	11/04/2015
Melimoyu	-43.49	-72.8	LT52320901986085XXX03	26/03/1986	LT52320901999041COA00	10/02/1999	LC82320902015101LGN01	11/04/2015
Mentolat	-44.07	-72.87	LT52320911985066XXX12	07/03/1985	LE72320912000068SGS00	08/03/2000	LC82320912015085LGN01	26/03/2015
Cay	-44.7	-73.07	LT52320911985066XXX12	07/03/1985	LE72320912000068SGS00	08/03/2000	LC82320912015085LGN01	26/03/2015
Macá	-45.06	-72.98	LT52320911985066XXX12	07/03/1985	LE72320912000068SGS00	08/03/2000	LC82320912015085LGN01	26/03/2015
Hudson Volano	-45.14	-73.14	LT52320911985066XXX12	07/03/1985	LE72320912000068SGS00	08/03/2000	LC82320912015085LGN01	26/03/2015
Monte Burney	-45.91	-72.96	LT52320921985066XXX04	07/03/1985	LE72320922000068SGS00	08/03/2000	LC82320922016072LGN01	12/03/2016
	-52.32	-73.36	LT52310961986014XXX04	14/01/1986	LT52310961998047COA00	16/02/1998	LC82310962017035LGN00	04/02/2017