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Supplement of

Differing pre-industrial cooling trends between tree rings and lower-resolution temperature proxies

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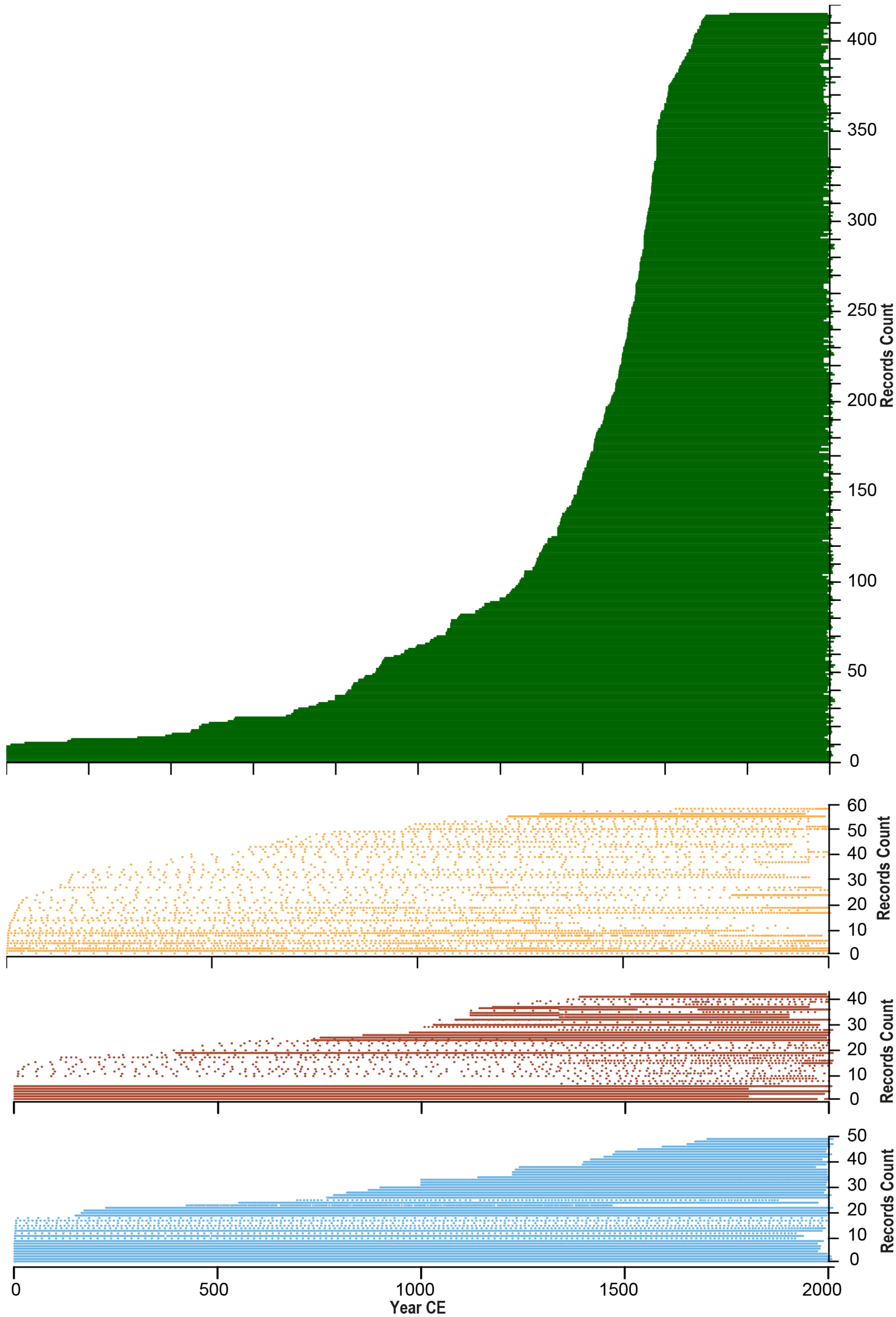

Fig. S1. Temporal distribution and resolution of the tree-ring (green), lake sediment (red), marine sediment (orange) and glacier ice (blue) proxy records from the PAGES 2k 2.0.0 database. (Dashed) lines indicate proxy resolution ranging between sub-annual and 145 years.

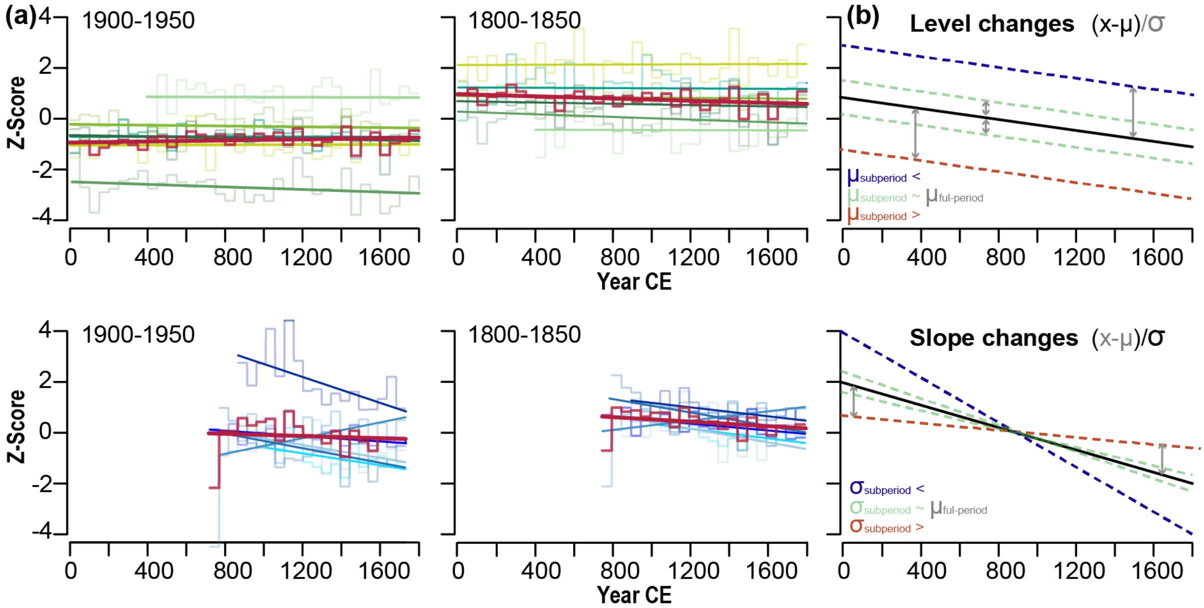

Fig. S2. (a) Differently normalized tree-ring records (green, blue), their chronology means (red) and corresponding pre-industrial temperature trends (1-1800 CE) and (b) explanation, why level and slope change dependent on the period chosen for tree-ring normalization.

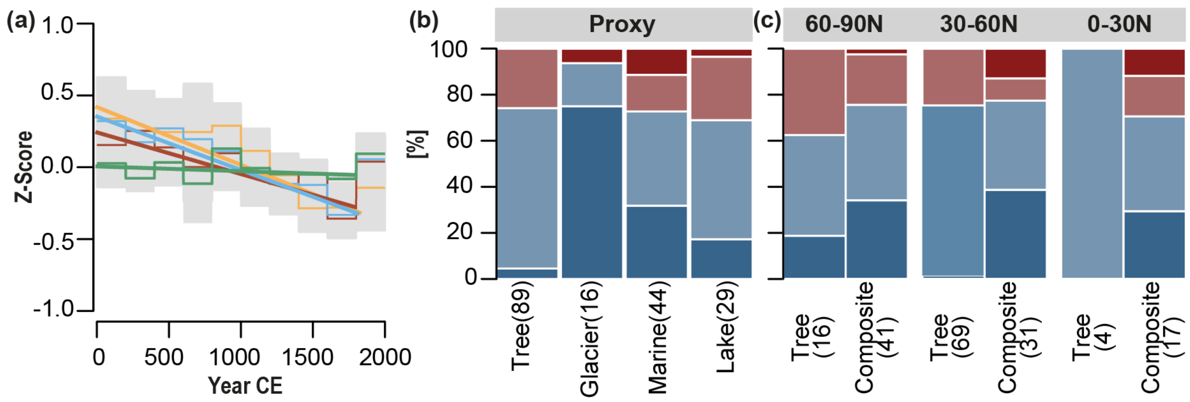

Fig. S3. Summary of NH long-term trends from tree-ring, glacier ice, marine and lake sediment records. (a) Compilation of NH temperature-sensitive proxy records from the PAGES2k initiative. 200-year binned composites from 49 marine sediment (orange), 36 lake sediment (red), 23 glacier ice (blue) and 402 tree-ring (green) records expressed in standard deviation units. Straight lines highlight the pre-industrial temperature trends (1-1800 CE). Grey shadings indicate 95% bootstrap confidence intervals with 500 replicates. The fraction of 200-year binned records (only records > 800 years) that exhibit a significant negative (dark blue) and non-significant cooling (blueish) trend or significant (red) and non-significant (reddish) warming trend at $p < 0.05$ over the pre-industrial (1-1800 CE) period derived from the statistical significance of the slope of least-squares linear regressions through each individual 200-year binned proxy record. Pre-industrial summaries are split by (b) proxy and (c) latitude. The category composite includes glacier, marine and lake sediments, and brackets indicate the number of records per category.

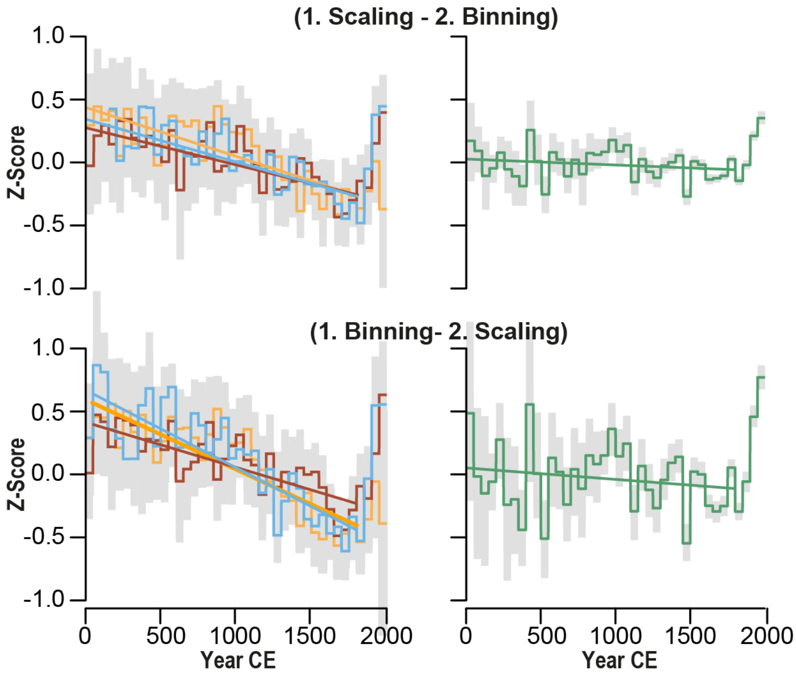

Fig. S4. Same as in Fig.2 (upper panel). In the lower panel, the binning and normalization procedure were reversed: First glacier ice (blue), lake sediment (red), marine sediment (orange) and tree (ring) records were set to a 50-year resolution and in a second step records were normalized over their individual length.

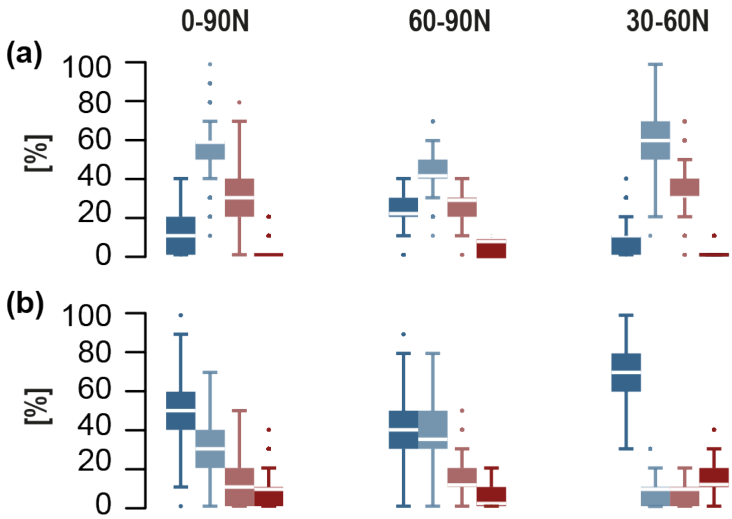

Fig. S.5. Effects of orbital forcing on low-frequency trends. Uncertainty estimates of a selection of plots displayed in Fig. 5a. Randomly 1000 times, 10 (a) tree-ring and (b) marine, lake sediment and glacier ice records from the latitudinal bands 0-90N, 60-90N and 30-60N were selected. The fraction of 50-year binned records that exhibit a significant negative (dark blue) and non-significant cooling (blueish) trend or significant (red) and non-significant (reddish) warming trend at $p < 0.05$ over the pre-industrial (1-1800 CE) and derived from the statistical significance of the slope of least-squares linear regressions through each individual 50-year binned proxy record was assessed.

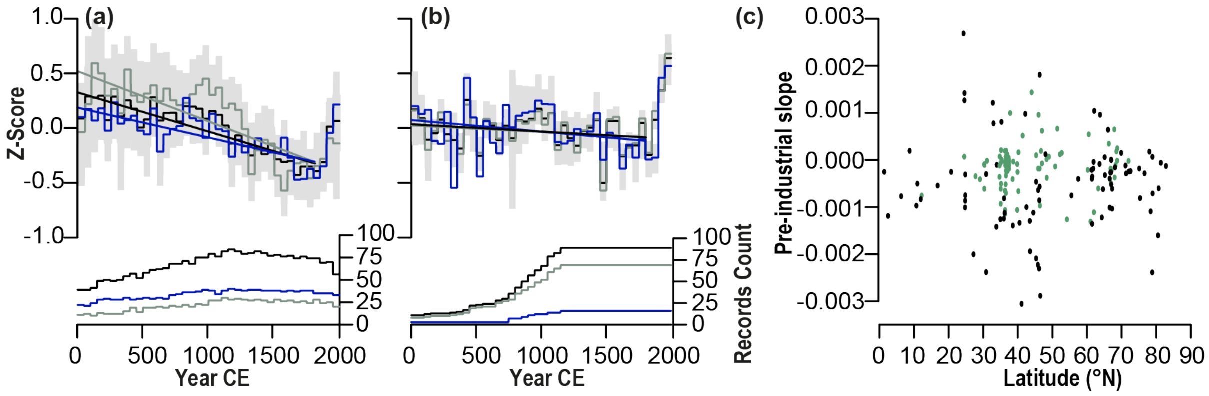

Fig. S.6. Compilation of NH and at least 800 year-long temperature-sensitive proxy records from the PAGES 2k initiative. 50-year binned composites from different latitudinal bands, 0-90°N (black), 30-60°N (green), and 60-90°N (blue) including (a) marine sediment, lake sediment and glacier ice records expressed in standard deviation units. Straight lines highlight the pre-industrial trends (1-1800 CE) and lower panels show the corresponding temporal distribution of the records. Grey shadings indicate 95% bootstrap confidence intervals with 500 replicates. (b) Same as in a for tree-rings. (c) Pre-industrial trend as a function of NH latitude. Black dots indicate marine sediment, lake sediment and glacier ice records and green dots are tree-ring records.

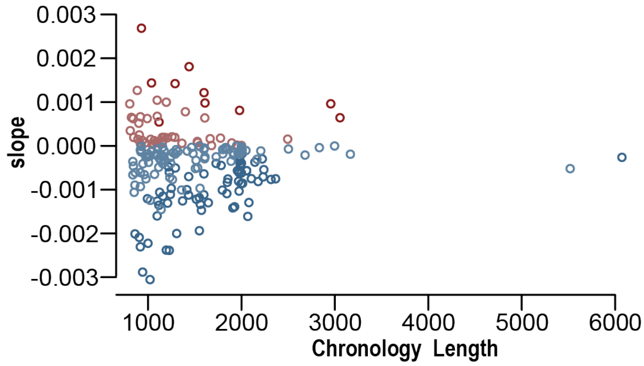

Fig. S7. Relationship between the slope over the pre-industrial period (1-1800 CE) and the absolute length of the tree-ring, glacier ice, marine and lake sediment records from the NH. Red refers to a significant warming, reddish to an non-significant warming, blueish to an non-significant cooling and blue to a significant cooling.

Table S.1. Information about 67 tree-ring records used for the detrending test, listed in and retrieved from Pages 2k 2017 (Pages 2k Consortium, 2017) metadata base.

Series	Lat	Lon	Country	Site Name	Proxy	First	Last
Arc 008	67.90	-140.70	Canada	Yukon	TRW	1177	2000
Arc 061	66.90	65.60	Russia	Polar Urals	MXD	891	2006
Arc 062	68.26	19.60	Sweden	Tornetrask	MXD	557	2008
Arc 065	66.30	18.20	Sweden	Arjeplog	ΔDensity	1200	2010
Arc 079	66.80	68.00	Russia	Yamalia	TRW	914	2003
Asi 048	36.30	98.08	China	CHIN006	TRW	159	1993
Asi 049	37.00	98.08	China	CHIN005	TRW	840	1993
Asi 051	35.07	100.35	China	MQAXJP	TRW	1082	2001
Asi 052	34.78	99.78	China	MQBXJP	TRW	470	2002
Asi 053	34.72	99.67	China	MQDXJP	TRW	1163	2001
Asi 077	38.70	99.68	China	HYGJUP	TRW	540	2006

Asi 084	37.47	97.23	China	CHIN050	TRW	843	2001
Asi 085	37.47	97.22	China	CHIN051	TRW	828	2001
Asi 086	37.45	97.53	China	CHIN052	TRW	404	2002
Asi 087	37.43	98.05	China	CHIN053	TRW	451	2002
Asi 088	37.45	97.78	China	CHIN054	TRW	711	2003
Asi 094	37.32	98.40	China	CHIN060	TRW	943	2003
Asi 095	37.03	98.63	China	CHIN061	TRW	857	2003
Asi 096	37.03	98.67	China	CHIN062	TRW	845	2001
Asi 097	36.75	98.22	China	CHIN063	TRW	681	2001
Asi 098	36.68	98.42	China	CHIN064	TRW	900	2001
Asi 119	30.33	130.45	Japan	JAPA018	TRW	1141	2005
Asi 125	40.17	72.58	Kyrgyzstan	KYRG007	TRW	1157	1995
Asi 127	39.92	71.47	Kyrgyzstan	KYRG009	TRW	1019	1995
Asi 129	39.83	71,50	Kyrgyzstan	KYRG011	TRW	694	1995
Asi 145	48.35	107.47	Mongolia	MONG021	TRW	996	2002
Asi 175	27.78	87.27	Nepal	NEPA030	TRW	856	1996
Asi 195	36.33	74.03	Pakistan	PAKI006	TRW	1032	1993
Asi 196	36.33	74.03	Pakistan	PAKI007	TRW	1141	1993
Asi 202	36.58	75.08	Pakistan	PAKI009	TRW	476	1990
Asi 203	36.58	75.08	Pakistan	PAKI010	TRW	968	1990
Asi 204	36.58	75.08	Pakistan	PAKI011	TRW	554	1990
Asi 205	36.58	75.08	Pakistan	PAKI012	TRW	1069	1990
Asi 211	35.17	75.50	Pakistan	PAKI015	TRW	736	1993
Asi 212	35.17	75.50	Pakistan	PAKI016	TRW	388	1993
Asi 221	31.12	97.03	China	CHIN046	TRW	449	2004
Asi 222	29.07	93.95	China	CHIN044	TRW	1047	1993
Asi 224	30.30	91.52	China	CHIN048	TRW	1080	1998
Asi 227	24.53	121.38	Taiwan	TW001	TRW	907	2007
Asi 229	12.22	108.73	Vietnam	VIET001	TRW	1030	2008
Eur 003	68.00	25.00	Finland	NSCAN	MXD	1	2006
Eur 004	49.00	20.00	Slovakia	Tatra	TRW	1040	2011
Eur 007	46.40	7.80	Switzerland	Lötschental	MXD	755	2004
Eur 008	44.00	7.50	France	French Alps	TRW	969	2007
NAm 001	35.30	-111.40	USA	San Francisco Peaks	TRW	1	2002
NAm 002	67.10	-159.60	USA	Kobuk/Noatak	TRW	978	1992
NAm 003	60.50	-148.30	USA	Prince William Sound	TRW	873	1991
NAm 007	36.50	-118.20	USA	Flower Lake	TRW	898	1987
NAm 008	36.30	-118.40	USA	Timber Gap Upper	TRW	699	1987
NAm 009	36.30	-118.20	USA	Cirque Peak	TRW	917	1987
NAm 011	37.20	-118.10	USA	Sheep Mountain	TRW	1	1990
NAm 013	37.80	-119.20	USA	Yosemite National P.	TRW	800	1996
NAm 018	36.30	-118.30	USA	Boreal Plateau	TRW	831	1992
NAm 019	36.40	-118.20	USA	Upper Wright Lakes	TRW	1	1992
NAm 026	51.40	-117.30	Canada	Athabasca	MXD	1072	1991

NAm 029	52.70	-118.30	Canada	Bennington	TRW	1104	1996
NAm 030	50.80	-115.30	Canada	French Glacier	TRW	1069	1993
NAm 032	60.20	-138.50	Canada	Landslide	TRW	913	2001
NAm 044	45.30	-111.30	USA	Yellow Mountain Ridge	TRW	470	1998
NAm 045	46.30	-113.20	USA	Flint Creek Range	TRW	999	1998
NAm 046	46.00	-113.40	USA	Pintlers	TRW	1200	2005
NAm 049	40.20	-115.50	USA	Pearl Peak	TRW	320	1985
NAm 050	38.50	-114.20	USA	Mount Washington	TRW	825	1983
NAm 071	37.00	-116.50	USA	Great Basin Composite	TRW	1	2009
NAm 104	68.70	-141.60	USA	Firth River 1236	MXD	1073	2002
NAm 151	52.20	-117.20	Canada	Athabasca Glacier 2	TRW	920	1987
NAm 203	41.40	-106.20	USA	Sheep Trail	TRW	1097	1999