ATSR Reprocessing for Climate Lake Surface Temperature: ARC-Lake

Technical Note 1
Lake Definition and Validation Strategy

Title: ATSR Reprocessing for Climate Lake Surface Temperature: ARC-Lake: Technical Note 1 – Lake Definition and Validation Strategy

Document Number: ARC-Lake-Technical-Note-1-v1.0

Issue: 1

Revision: 1.0

Date: 8 October 2010

Signature Table

	Name	Function	Company	Signature	Date
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Approved					
Released					

Document Change Record

Version	Date	Author	Description
1.0	8 Oct 2010	SM, CM	

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1 INTRODUCTION

1.1 Acronyms and Abbreviations

AATSR	*Advanced ATSR*
ARC	*ATSR Reprocessing for Climate*
ATSR	*Along-Track Scanning Radiometer*
GLWD	*Global Lakes and Wetlands Database*
LIC	*Lake Ice Concentration*
Lake ST	*Lake Surface Temperature*
MD	*Match-up Dataset*

1.2 Purpose and Scope

This document is a Technical Note which defines what a "lake" is for the purpose of this project, describes the process by which the list of target lakes was obtained, and outlines the strategy for validation of Lake Surface Temperature (Lake ST) and Lake Ice Concentration (LIC) products from Along-Track Scanning Radiometer (ATSR) imagery.

In terms of scope, this Technical Note covers lakes identified in Phase one of the ARC-Lake project.

1.3 Technical Note Overview

The Technical Note provides details of the following:

- definition of a "lake"
- identification of lakes meeting this criteria
- exclusions from and additions to the list of target lakes
- validation strategy for Lake ST and LIC products

2 DEFINITION OF A LAKE

There are various definitions of what a lake is, using criteria such as volume, surface area and depth. However the process of distinguishing lakes from other water bodies is prone to a great deal of ambiguity. Examples of where such ambiguity arises are: lakes in floodplains, lakes adjacent to the sea, lakes in wetlands, and slow-flowing rivers. A common definition of a lake is a permanent still (lentic) water body without direct connection to the sea (Lehner and Doll, 2004). A further distinction may be made to separate natural lakes from manmade reservoirs. In the ARCLake project, lakes are defined as in Lehner and Doll (2004). That is as above, with the inclusion of saline lakes and lagoons (but not lagoon areas), and with the exclusion of intermittent or ephemeral water bodies. Lehner and Doll (2004) consider the minimum size of a lake to be 0.01 km^2, but for ARCLake the minimum lake size considered will be determined by the satellite resolution.

The ARCLake project assesses natural lakes, based on the definition of lakes as given by Lehner and Doll (2004) (i.e. reservoirs are not included). Phase one of ARCLake focuses on natural lakes with surface area > 500 km^2. Phase two will extend this to consider all lakes of size large enough to be resolved by the (Advanced) Along Track Scanning Radiometers (A)ATSR series of satellite instruments, without contamination from surrounding land surfaces. The lower limit of lake area for ARCLake is estimated to be 50 km^2, assuming a simple geometric (circular) shape for the lake, but what in practice will be achieved is a question to be addressed in Phase three.

3 IDENTIFICATION OF LAKES

The inventory of 253 large lakes defined by Herdendorf (1982) was used as a starting point for defining the Phase One target lakes. This inventory was intended to include all of the world's natural lakes with surface area >500 km^2. Herdendorf (1982) include both fresh and salt water lakes, and coastal lagoons in their definition of natural lakes, but do not include reservoirs. This inventory contains data such as lake area, depth, elevation and water quality, and is considered to be nearly comprehensive (Meybeck, 1995). To make a more comprehensive database, the Herdendorf (1982) inventory was merged with the Global Lakes and Wetlands Database (Lehner and Döll, 2004), creating the foundation of the ARCLake Phase One database.

The GLWD, described in detail by Lehner and Döll (2004), is a GIS database containing shoreline polygons along with some basic information for water bodies with surface area > 0.1 km^2. In addition to lakes, the GLWD includes reservoirs, rivers and wetlands, but also classifies each water body as such. The GLWD is split into three levels, the first of which contains only lakes and reservoirs with surface area > 50 km^2. This database is the result of the consolidation of the following data sets: MSSL Global Lakes Database (Birkett and Mason, 1995), Data set of Large Reservoirs (Vörösmarty et al, 1997), and the World Register of Dams (ICOLD, 1988 & 1998).

Considerable efforts were made to merge the Herdendorf (1982) inventory and the GLWD, to successfully provide a coherent database for ARCLake. The resulting database contained some lakes that did not meet the definition outlined in §2, e.g. Herdendorf (1982) includes intermittent lakes such as Lake Amadeus, Australia. Details of the filtering criteria applied to remove these lakes and details of further quality control measures are given in §4.

4 EXCLUSIONS AND ADDITIONS OF LAKES

The merged Herdendorf – GLWD database was filtered using the following criteria. To be included each lake must:

• have minimum surface of area > 500 km^2 in the GLWD or Herdendorf (1982) inventory

• be classed as a lake in the GLWD

• have a range in surface area in Herdendorf (1982) that does not exceed 25% of the maximum surface area

A total of 19 lakes are excluded using the surface area criteria. Details of these are given in §7.1. A further 9 lakes present in Herdendorf (1982) but not in GLWD. These are excluded on the grounds that they do not meet the lake definition adopted by the ARCLake project from the GLWD. Before exclusion, these lakes were investigated to establish why they did not meet the GLWD definition of a lake. The list of 9 lakes and the results of this investigation are given in §7.2.

The GLWD classifies water bodies as lakes or reservoirs. Thirteen water bodies in Herdendorf (1982) are classed as reservoirs in GLWD and are excluded from the ARCLake database (§7.3).

Defining lake boundaries is not a trivial task and is open to interpretation, resulting in ambiguity across different studies and data sources, with the same water bodies being classified as single or multiple lakes. Herdendorf (1982) contains 5 lakes which are classed as multiple lakes in GLWD, while the GLWD contains 2 lakes that are classed as multiple lakes in Herdendorf (1982). In all such cases (§7.4) the GLWD definition is used.

Further manual assessment of each lake was then carried out using Google Earth (visual inspection, useful in particular to identify lakes whose boundaries have undergone recent dramatic changed, either natural or engineered), alternative databases (LakeNet [http://www.worldlakes.org/] and ILEC [http://wldb.ilec.or.jp/]), and other resources, to eliminate remaining cases with highly variable surface areas or that appeared to have been misclassified as lakes. This analysis resulted in a further 15 lakes (§7.5) being excluded.

After merging and filtering as described above the ARCLake database consisted of 253 lakes. Following consultation with the ARCLake user group, another 5 lakes were added to the database. These consisted of 3 water bodies classed as reservoirs in GLWD (added at the request of Environment Canada [http://www.ec.gc.ca/]) and 2 lakes with surface area < 500 km^2 (added at the request of the Finnish Environment Institute [http://www.ymparisto.fi]). Five more lakes that had failed the initial selection criteria were also added, in response to recent publications (Schneider *et al*, 2009). Details of all 10 lakes added at this stage are given in §7.6.

The final ARCLake Phase One database consists of 263 large lakes with global distribution. §7.7 provides the complete list of these lakes and their locations. In addition to the wide geographic distribution, this set of lakes contains lakes across a wide range of altitudes (-404 m below sea level to 5007 m above sea level). Physical characteristics (e.g. shape, depth, and salinity) also vary tremendously across the set of lakes (e.g. depth ranges from 1 m to 1741 m). The ARCLake Phase One database therefore provides a comprehensive set of large lakes, with good geographic coverage and covering the full range of physical properties of large lakes (i.e. no limitations are placed on characteristics such as shape and salinity, aside from the spatial resolution of the ATSRs).

5 VALIDATION STRATEGY FOR LAKE ST AND LIC PRODUCTS

Two methods of assessment of the Lake ST retrieval algorithm are proposed: analysis of performance for case study images at full AATSR resolution and point comparisons with in situ observations. These twin approaches are adopted to provide qualitative visual assessments of algorithm performance across spatial domains and to provide a quantitative measure of the overall performance relative to in situ observations.

For the qualitative analysis a set of 12 AATSR scenes were selected as case studies. These were chosen such as to provide examples over a range of different geographical locations, altitudes, lake sizes, and meteorological conditions. The case studies selected cover the following lakes: Great Slave, the Great Lakes, Titicaca, Onega, Ladoga, Vanern, Vattern, Victoria, Superior, Bay, Winnipeg, Huron, Nyasa, and a number of other smaller lakes.

For the quantitative analysis a match-up dataset (MD) was constructed from the in situ temperature data currently available. This consists of 52 observation locations covering 16 of the Phase One lakes. Details of the in situ data are given in Table 1. As the in situ data are from a variety of sources, with different formats, considerable effort has been put in to consolidate this data to a standard format for use in ARCLake, and to apply quality control measures.

Source	Lake Names (number of observation locations)
National Data Buoy Center (NDBC)	Superior (3), Huron (4), Michigan (2), Erie (1), Ontario (1)
Fisheries and Oceans Canada (FOC)	Superior (1), Huron (2), Great Slave (2), Erie (2), Winnipeg (3), Ontario (3), Woods (1), Saint Clair (1), Nipissing (1), Simcoe (1)
Swedish University of Agricultural Sciences (SLU)	Vanern (5), Vattern (2), Malaren (13)
GLobal Lake Ecological Observatory Network (GLEON)	Balaton (1)
King's College London (KCL)	Nyasa (3)

Table 1. Details of in situ data consolidated into the ARCLake MD.

A combination of quantitative and qualitative assessment is also proposed for the LIC product. The set of 12 AATSR scenes selected as case studies for analysis of the Lake ST contain 3 cases where the presence of ice is clear in the visible channel imagery (covering the Great Lakes, Lake Winnipeg and Lake Onega). These 3 cases form the starting point of a set of case study images for ice detection, with further test cases to be identified using knowledge from in-situ observations.

Quantitative assessment of the LIC product will be conducted using ice observations obtained from the NOAA Great Lakes Ice Atlas (Assel, 2003) and the National Ice Center (http://www.natice.noaa.gov). Both of these sources provide ice charts for the Great Lakes: Superior, Huron, Michigan, Erie, and Ontario. These ice charts, described by Assel (1983), are a blend of observations from different data sources (ship, shore, aircraft, and satellite) and cover the full lifetime of the ATSR series of instruments. Ice concentration data are provided as the fraction of a unit of lake surface area that is completely covered with ice, where each grid cell has a nominal resolution of 2.5 km x 2.5 km (Assel *et al*, 2002). This data will be used to provide a quantitative indicator of the performance of the ice detection algorithm, under clear-sky conditions.

6 References

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7 Appendix

7.1 Lakes excluded as a result of high variability in surface area.

Amadeus, Austin, Bangweulu, Chad, Chany, Eyre, Frome, Gairdner, Goose, Helmand, Ilmen, Mai-Ndommbe, Pyramid, Rukwa, Sap, Scutari, Torrens, Tungting, and Urmia

7.2 Lakes excluded as they do not meet the GLWD lake definition

Coastal lagoon areas: Chiriqui, Kurisches, Manzala, Maracaibo, Oder, Patos, and Terminos

Deltic levee: Pontchartrain

Connection to open ocean: Melville

7.3 Lakes excluded as they are classed as a reservoir in GLWD

Lobstick, Michikamua, Zaysan, Cedar, Southern Indian, Seul, Saimaa, Saint-Jean, Imandra, Ilmen, Abitibi, Oulu, Flathead, and Grand

7.4 Lakes with ambiguous definitions

Herdendorf Name(s)	**GLWD Name(s)**
Kyoga	Kyoga, Kwania
Moose	South Moose, North Moose
Pangong	Bangong, Pangong
Rukwa	Rukwa, No Name
Saimaa	Saimmaa, Puruvesi, Orivesi, Haukivesi
lobstick, Michikamua	Smallwood
Eskimo North, Eskimo Southern	Eskimo

7.5 Lakes excluded after assessment with Google Earth imagery and alternative databases

Hedentrom, Salada, Kabalebo, Fortin, Erepeacu, Colorados, Great Salt Lake Desert, Kuskokwim, Faguibine, Great Salt, Hammar, Lop, Poyang, Salines Grandes, and Tuz

7.6 Lakes added to the database

Environment Canada: Cedar, Smallwood, and Saint-Jean

Finnish Environment Institute: Pyhajarvi and Vesijarvi

Schneider et al (2009): Pyramid, Mono, Walker, Clear, and Almanor

7.7 Final list of target lakes for ARCLake, Phase One

Name	Latitude	Longitude	Nation(s)
ABAYA	6.30	37.83	Ethiopia
ABE	11.17	41.79	Djibouti, Ethiopia
ABERDEEN	64.55	-98.59	Canada (NWT)
ABY	5.23	-3.23	Cote d'Ivoire
ALAKOL	46.11	81.75	Kazakhstan
ALBERT	1.67	30.91	Uganda, Democratic Republic of the Congo
ALEXANDRINA	-35.52	139.09	Australia (South Australia)
ALMANOR	40.26	-121.19	USA (California)
AMADJUAK	64.99	-71.13	Canada (NWT, Baffin Island)
ANG-LA JEN	31.53	83.09	China
ANGIKUNI	62.27	-100.04	Canada (NWT)
ARAL	45.13	60.08	Kazakhstan, Uzbekistan
ARGENTINO	-50.33	-73.03	Argentina (Santa Cruz)
ARTILLERY	63.17	-107.82	Canada (NWT)
ASHUANIPI	52.69	-66.14	Canada (Newfoundland)
ASTRAY	54.38	-66.32	Canada
ATHABASCA	59.10	-109.96	Canada (Alberta, Saskatchewan)
ATLIN	59.57	-133.75	Canada (British Columbia,Yukon)
AYAKKUM	37.55	89.35	China
AYLMER	64.15	-108.46	Canada (NWT)
BAGHRASH	41.98	87.07	China (Sinkiang)

BAIKAL	53.63	108.14	Russia
BAKER	64.13	-95.28	Canada (NWT)
BALATON	46.88	17.83	Hungary
BALKHASH	45.91	73.95	Kazakhstan
BANGONG	33.61	79.71	China(Tibet),India (Jammu and Kashmir)
BARUN-TOREY	50.07	115.81	Russia
BAY	14.36	121.26	Philippines (Luzon Island)
BECHAROF	57.85	-156.40	USA (Alaska)
BELOYE	60.18	37.64	Russia
BEYSEHIR	37.78	31.52	Turkey
BIENVILLE	55.05	-72.98	Canada (Quebec)
BIG TROUT	53.77	-90.02	Canada (Ontario)
BIWA	35.25	136.08	Japan (Honshu Island)
BLACK	59.05	-105.73	Canada
BRAS D'OR	45.95	-60.83	Canada (Nova Scotia)
BUENOS AIRES	-46.66	-72.50	Argentina (Santa Cruz), Chile (Aisen)
BUFFALO	60.22	-115.49	Canada (NWT)
BUYR	47.81	117.69	China, Mongolia
CARATASCA	15.35	-83.85	Honduras
CASPIAN	41.85	50.36	Iran, Russia, Kazakhstan, Turkmenistan, Azerbaijan
CAXUANA	-2.04	-51.50	Brazil
CEDAR	53.33	-100.14	Canada (Manitoba)
CHAMPLAIN	44.45	-73.27	Canada, USA

CHAO	31.57	117.57	China (Anhwei)
CHAPALA	20.21	-103.05	Mexico (Jalisco, Michoacan)
CHILKA	19.69	85.38	India (Orissa)
CHILWA	-15.32	35.71	Malawi, Mozambique
CHIQUITA	-30.74	-62.61	Argentina (Cordoba)
CHISHI	-8.71	29.72	Zambia
CHURCHILL	55.96	-108.29	Canada (Saskatchewan)
CLAIRE	58.59	-112.08	Canada (Alberta)
CLEAR	39.02	-122.77	USA (California)
CLINTON COLDEN	63.94	-107.45	Canada (NWT)
COARI	-4.25	-63.37	Brazil
COLHUE HUAPI	-45.47	-68.76	Argentina (Chubut)
CONSTANCE	47.65	9.28	Austria, Switzerland, Germany
CONTWOYTO	65.59	-110.66	Canada (NWT)
CORO	11.56	-69.86	Venezuela
CREE	57.47	-106.64	Canada (Saskatchewan)
CROSS	54.71	-97.58	Canada (Manitoba)
DAUPHIN	51.27	-99.77	Canada (Manitoba)
DEAD	31.52	35.49	Israel, Jordan
DESCHAMBAULT	54.78	-103.45	Canada (Saskatchewan)
DORE	54.76	-107.28	Canada (Saskatchewan)
DUBAWNT	63.13	-101.44	Canada (NWT)
EAU CLAIRE	56.15	-74.40	Canada (Quebec)

EBI	44.86	82.92	China (Sinkiang)
EBRIE	5.30	-4.26	Cote d'Ivoire
EDWARD	-0.39	29.61	Uganda, Democratic Republic of the Congo
EGRIDIR	38.07	30.85	Turkey
ENNADAI	60.96	-101.31	Canada (NWT)
ENRIQUILLO	18.49	-71.58	Dominican Republic
ERIE	42.25	-81.16	Canada, USA
ESKIMO	69.10	-132.76	Canada (NWT)
EVANS	50.97	-77.02	Canada (Quebec)
EVORON	51.48	136.51	Russia
EYASI	-3.58	35.04	Tanzania
FAGNANO	-54.55	-68.03	Argentina (Tierra del Fuego), Chile (Magallanes)
FERGUSON	69.41	-105.27	Canada (NWT)
FROBISHER	56.37	-108.22	Canada (Saskatchewan)
GARRY	65.95	-99.40	Canada (NWT)
GENEVA	46.37	6.25	France, Switzerland
GODS	54.62	-94.21	Canada (Manitoba)
GRANVILLE	56.40	-100.21	Canada
GRAS	64.54	-110.38	Canada (NWT)
GREAT BEAR	65.91	-121.30	Canada (NWT)
GREAT SLAVE	62.09	-114.37	Canada (NWT)
GUILLAUME-DELISLE	56.33	-76.28	Canada (Quebec)

HAR	48.05	93.21	Mongolia
HAR US	48.06	92.30	Mongolia
HAR-HU	38.31	97.59	China
HAUKIVESI	62.10	28.52	Finland
HAZEN	81.80	-70.94	Canada (NWT)
HIGHROCK	55.83	-100.44	Canada
HOTTAH	64.95	-118.44	Canada (NWT)
HOVSGOL	51.02	100.48	Mongolia
HULUN	48.97	117.38	China (Inner Mongolia)
HUNGTZE	33.34	118.53	China (Anhwei, Kiangsu)
HURON	44.78	-82.21	Canada, USA
HYARGAS	49.13	93.30	Mongolia
ILIAMNA	59.56	-154.90	USA (Alaska)
INARI	69.04	27.83	Finland
INDIAN RIVER	28.24	-80.64	USA (Florida)
ISLAND	53.85	-94.70	Canada (Manitoba)
ISSYKKUL	42.46	77.25	Kyrgyzstan
ISTADA	32.48	67.92	Afghanistan
IZABAL	15.57	-89.11	Guatemala
KAGHASUK	60.79	-164.22	USA (Alaska)
KAMINAK	62.20	-94.90	Canada (NWT)
KAMINURIAK	62.96	-95.79	Canada (NWT)
KAMILUKUAK	62.28	-101.73	Canada (NWT)

KAOYU	32.87	119.31	China (Anhwei, Kiangsu)
KARA-BOGAZ-GOL	41.23	53.54	Turkmenistan
KASBA	60.34	-102.27	Canada (NWT)
KEITELE	62.89	25.99	Finland
KHANKA	44.94	132.42	China, Russia
KHANTAYSKOE	68.36	91.18	Russia
KIVU	-2.04	29.23	Rwanda, Democratic Republic of the Congo
KOKO	36.89	100.18	China (Tsinghai)
KRASNOE	64.53	174.44	Russia
KULUNDINSKOE	52.98	79.58	Russia
KWANIA	1.72	32.65	Uganda
KYARING	31.13	88.32	China (Tibet)
KYOGA	1.50	33.01	Uganda
LABAZ	72.27	99.57	Russia
LADOGA	60.84	31.39	Russia
LESSER SLAVE	55.43	-115.49	Canada (Alberta)
LIMFJORDEN	56.78	9.17	Denmark
LLANQUIHUE	-41.14	-72.79	Chile (Llanquihue, Osorno)
LOWER SEAL	56.49	-73.42	Canada (Quebec)
LUANG	7.46	100.38	Thailand
MACKAY	63.96	-111.30	Canada (NWT)
MADRE	24.64	-97.66	Mexico
MALAREN	59.44	16.19	Sweden

MALHEUR	43.34	-118.83	USA (Oregon)
MANAGUA	12.32	-86.35	Nicaragua
MANGUEIRA	-33.16	-52.84	Brazil
MANITOBA	50.99	-98.80	Canada (Manitoba)
MANOUANE	50.76	-70.99	Canada (Quebec)
MANYCH-GUDILO	46.26	42.98	Russia
MARTRE	63.33	-117.91	Canada (NWT)
MICHIGAN	43.86	-87.09	USA (Illinois, Indiana, Michigan, Wisconsin)
MILLE LACS	46.24	-93.65	USA (Minnesota)
MINTO	57.34	-74.71	Canada (Quebec)
MIRIM	-32.89	-53.25	Brazil, Uruguay
MISTASSINI	50.82	-73.81	Canada (Quebec)
MONO	38.01	-118.96	USA (California)
MURRAY	-6.95	141.53	Papua New Guinea
MWERU	-9.01	28.74	Democratic Republic of the Congo, Zambia
NAHUEL HUAPI	-40.92	-71.52	Argentina (Neuquen, Rio Negro)
NAKNEK	58.64	-155.67	USA (Alaska)
NAM	30.71	90.66	China (Tibet)
NATRON	-2.34	36.02	Tanzania
NERPICH'YE	56.39	162.77	Russia
NETILLING	66.42	-70.28	Canada (NWT)
NGORING	34.93	97.71	China (Tsinghai)

NICARAGUA	11.57	-85.36	Nicaragua
NIPIGON	49.80	-88.55	Canada (Ontario)
NIPISSING	46.24	-79.92	Canada (Ontario)
NONACHO	61.82	-108.92	Canada (NWT)
NORTH MOOSE	54.05	-100.16	Canada (Manitoba)
NUELTIN	60.25	-99.40	Canada (Manitoba, NWT)
NYASA	-11.96	34.59	Malawi, Mozambique, Tanzania
OKEECIIOBEE	26.95	-80.86	USA (Florida)
OLING	34.92	97.27	China (Tsinghai)
OMULAKH	72.29	145.59	Russia
ONEGA	61.90	35.35	Russia
ONTARIO	43.85	-77.77	Canada, USA
ORIVESI	62.35	29.59	Finland
PAIJANNE	61.71	25.49	Finland
PANGONG	33.82	78.61	China(Tibet),India (Jammu and Kashmir)
PAYNE	59.40	-73.82	Canada (Quebec)
PEIPUS	58.41	27.59	Estonia, Russia
PERLAS	12.54	-83.67	Nicaragua
PETER POND	55.84	-108.55	Canada (Saskatchewan)
PIELINEN	63.16	29.71	Finland
PLAYGREEN	54.07	-97.75	Canada (Manitoba)
POINT	65.31	-113.84	Canada (NWT)
POMO	28.55	90.40	China (Tibet),

POOPO	-18.81	-67.06	Bolivia
PRINCESS MARY	63.93	-97.66	Canada (NWT)
PURUVESI	61.77	29.02	Finland
PYA	66.07	30.98	Russia
PYASINO	69.77	87.78	Russia
PYHAJARVI	61.00	22.28	Finland
PYRAMID	40.03	-119.55	USA (Nevada)
RAINY	48.61	-92.97	Canada, USA
RAZELM	44.83	28.97	Romania
RED	48.04	-95.08	USA (Minnesota)
REINDEER	57.19	-102.27	Canada (Manitoba,Saskatchewan)
ROGOAGUADO	-12.91	-65.73	Bolivia
RONGE	55.11	-104.83	Canada (Manitoba, Saskatchewan)
RUDOLF	3.53	36.08	Ethiopia, Kenya
SAINT CLAIR	42.50	-82.73	Canada, USA
SAINT JEAN	48.66	-72.02	Canada (Quebec)
SAINT JOSEPH	51.04	-90.81	Canada (Ontario)
SAKAMI	53.22	-76.75	Canada (Quebec)
SALTON	33.30	-115.83	USA (California)
SAN MARTIN	-48.75	-72.84	Argentina (Santa Cruz),Chile (Aisen)
SANDY	53.00	-93.03	Canada (Ontario)
SARYKAMYSHSKOYE	41.88	57.61	Turkmenistan, Uzbekistan
SASYKKOL	46.58	80.91	Kazakhstan

SCOTT	60.02	-106.07	Canada
SEG	63.32	33.76	Russia
SELAWIK	66.51	-160.73	USA (Alaska)
SELETYTENIZ	53.23	73.18	Kazakhstan
SELWYN	60.00	-104.68	Canada (NWT, Saskatchewan)
SEVAN	40.39	45.29	Armenia
SHAMO	5.83	37.55	Ethiopia
SHERMAN	67.79	-97.73	Canada
SIMCOE	44.47	-79.42	Canada (Ontario)
SMALLWOOD	54.19	-64.31	Canada (Newfoundland and Labrador)
SNOWBIRD	60.64	-102.94	Canada (NWT)
SOUTH HENIK	61.37	-97.29	Canada (NWT)
SOUTH MOOSE	53.83	-100.04	Canada (Manitoba)
SUPERIOR	47.72	-88.23	Canada, USA
SYVASH	45.96	34.74	Ukraine
TAHOE	39.09	-120.04	USA (California, Nevada)
TAI	31.21	120.24	China (Chekiang, Kiangsu)
TAKIYUAK	66.28	-113.17	Canada (NWT)
TAMIAHUA	21.66	-97.57	Mexico
TANA	11.95	37.31	Ethiopia
TANGANYIKA	-6.07	29.46	Burundi, Tanzania, Democratic Republic of the Congo, Zambia
TANGRA	31.05	86.59	China (Tibet)
TAPAJOS	-2.88	-55.14	Brazil

TATHLINA	60.54	-117.64	Canada (NWT)
TAUPO	-38.81	175.90	New Zealand (North Island)
TAYMYR	74.48	100.76	Russia
TEBESJUAK	63.76	-98.98	Canada (NWT)
TENGIZ	50.44	68.90	Kazakhstan
TERINAM	30.90	85.61	China (Tibet)
TESHEKPUK	70.59	-153.60	USA (Alaska)
TITICACA	-15.92	-69.30	Bolivia, Peru
TOBA	2.61	98.90	Indonesia (Sumatra Island)
TOP	65.62	32.09	Russia
TOWUTI	-2.79	121.52	Indonesia
TROUT	60.58	-121.13	Canada (NWT)
TULEMALU	62.99	-99.48	Canada (NWT)
TUMBA	-0.82	17.98	Democratic Republic of the Congo
UBINSKOE	55.47	80.05	Russia
ULUNGUR	47.22	87.30	China (Sinkiang)
UPEMBA	-8.65	26.40	Democratic Republic of the Congo
UVS	50.33	92.81	Mongolia
VAN	38.66	42.98	Turkey
VANERN	58.88	13.22	Sweden
VATTERN	58.33	14.57	Sweden
VESIJARVI	61.09	25.39	Finland
VICTORIA	-1.30	33.23	Kenya, Tanzania, Uganda

VIEDMA	-49.59	-72.56	Argentina (Santa Cruz)
VYG	63.54	34.84	Russia
WALKER	38.70	-118.71	USA (Nevada)
WEISHAN	34.61	117.24	China (Kiangsu, Shantung)
WHOLDAIA	60.69	-104.15	Canada (NWT)
WINNEBAGO	44.02	-88.42	USA (Wisconsin)
WINNIPEG	52.12	-97.25	Canada (Manitoba)
WINNIPEGOSIS	52.37	-100.05	Canada (Manitoba)
WOLLASTON	58.30	-103.33	Canada (Saskatchewan)
WOODS	49.38	-94.91	Canada, USA
XINGU	-2.16	-52.20	Brazil
YAMDROK	28.97	90.76	China (Tibet)
YATHKYED	62.69	-98.07	Canada (NWT)
ZILING	31.77	88.95	China (Tibet)