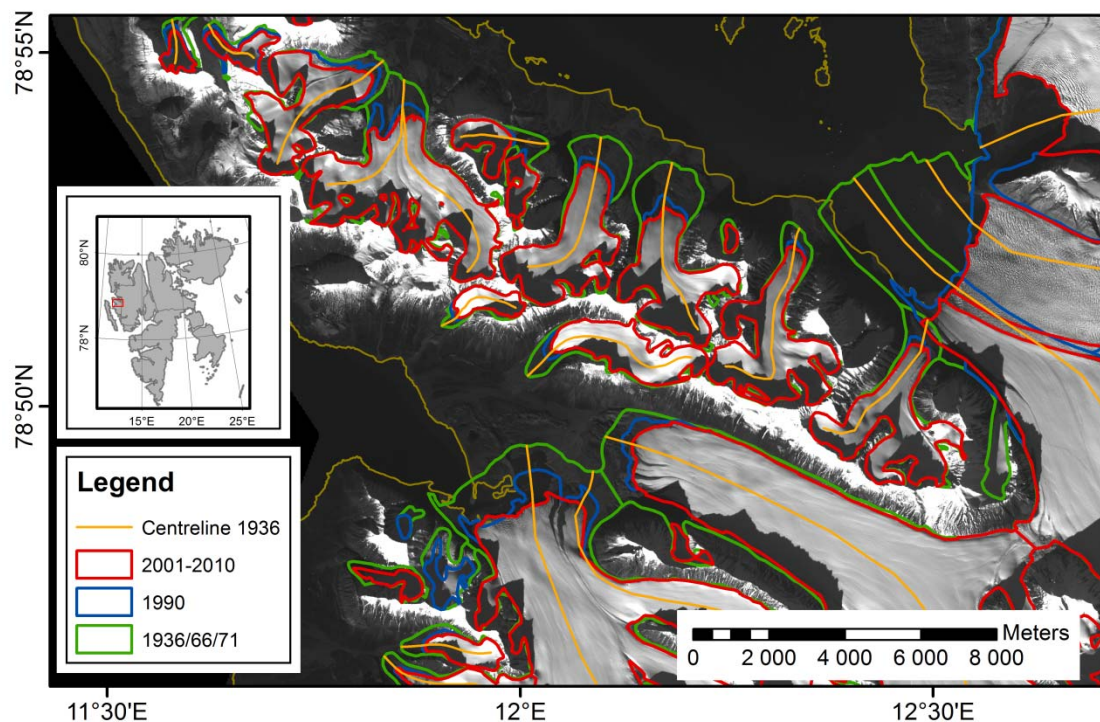


CryoClim GAO product documentation

CryoClim sub-service for glaciers Svalbard



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1 Introduction

CryoClim is an Internet service providing cryospheric climate products, primarily based on satellite observations. The service is delivered through a web service and web portal (www.cryoclim.net). The portal includes manual searching, viewing and downloading capabilities. CryoClim is an operational and permanent service for long-term systematic climate monitoring of the cryosphere. The product production and the product repositories are hosted by mandated organisations. The databases are connected over the Internet in a seamless and scalable network, open for inclusion of more databases/sub-services. CryoClim provides sea ice and snow products of global coverage and glacier products covering Norway (mainland and Svalbard). The service has been developed by CryoClim project (2008–2013) by the Norwegian Computing Center (NR; project coordinator), Norwegian Meteorological Institute (MET Norway), Norwegian Water Resources and Energy Directorate (NVE) and Norwegian Polar Institute (NPI). CryoClim was an ESA PRODEX project funded by the Norwegian Space Centre.

The Glacier Area Outline (GAO) product has been created for the years 1936, 1966-71, 1990 and 2001-10. For most glaciers, outlines are available from more than one year, thus documenting glacier retreat over time. Except for the 2001-10 data, glacier outlines were created using cartographic data from the original NPI topographic map series of Svalbard by delineating individual glaciers and ice streams, assigning unique identification codes relating to the hydrological watersheds, digitizing centre lines, and providing a number of attributes for each glacier mask. The 2001-10 glacier outlines are derived from orthorectified satellite images from SPOT-5 and ASTER sensors.

2 Product overview

Category	Description
Cryospheric variable	GAO – Glacier Area Outline
Version	1.0
Sensor(s)	SPOT, ASTER, air photos
Temporal aggregation periods	1936, 1966-71, 1990, 2001-10
File format and version	Shapefile
Spatial coverage	Svalbard
Spatial resolution	Shapefiles based on 40 m resolution raster data
Temporal coverage	Irregular
Temporal resolution	1936, 1966-71, 1990, 2001-10
Projection	EPSG:32633 - WGS 84 / UTM zone 33N
Metadata format	DIF
Data file format	Shapefile
File size	4 Mbyte
Product contents	Glacier outlines
Expected accuracy	40 m
Product access	http://data.npolar.no/dataset/89f430f8-862f-11e2-8036-005056ad0004

3 Detailed product description

3.1 Product structure

The product is a Shapefile per time epoch containing glacier outlines for all of Svalbard as much as available.

3.2 Metadata

The global attributes and description are found at <http://api.npolar.no/dataset/89f430f8-862f-11e2-8036-005056ad0004.dif>

Local attributes describing individual products. These are contained in the Shapefile's attribute table.

Local attribute	Description
OBJECTID	ID number
Shape	Describing shape type
NAME	Glacier Name
Comment	Analysts' comments
IDENT	Glacier ID
YEAR_	Year for this outline
DDMM	Day and Month for this outline
ANALYST	Name of Analyst producing outline
SOURCE	Satellite image used
SOURCE2	Additional Satellite image used
Satellitel	ID of satellite image
X_cent	X coordinate of centre point
Y_cent	Y coordinate of centre point
TIDEWATER	0 if terminating on land, 1 if terminating in water
NUMLINES	Number of centrelines digitized
xGLIMS	X coordinate for GLIMS centre point
yGLIMS	Y coordinate for GLIMS centre point

GLIMSID	GLIMS ID (www.glims.org)
LENGTH	Glacier length
FWIDTH	Front width
DEM	DEM used

3.3 Datasets

The data is available in three separate Shapefiles:

- 1) CryoClim_GAO_SJ_1936-72
- 2) CryoClim_GAO_SJ_1990
- 3) CryoClim_GAO_SJ_2001-2010

Each of the Shapefiles contain ~1600 polygons identified by Glacier ID (see attributes above).

3.4 Product time-series information

The 1936 and 1990 data are based on aerial photography from the mapping section of the Norwegian Polar Institute. The 2000s data are based on the following satellite images:

Source	Satellite ID	Date (dd.mm.yyyy)	# of	Glacier Area (km ²)
SPOT5-HRS	GES07-043	01.09.2007	214	3951
SPOT5-HRS	SPI08-024	07.06.2008	160	4185
SPOT5-HRS	SPI08-025	01.09.2008	414	7708
SPOT5-HRS	SPI08-026	23.07.2008	106	1147
SPOT5-HRS	SPI08-027	14.08.2008	73	6912
ASTER	AST-L1A.003:2003897557	19.08.2001	2	72
ASTER	AST-L1A.003:2007646255	01.07.2002	5	707
ASTER	AST-L1A.003:2007714532	12.07.2002	10	34
ASTER	AST-L1A.003:2007742577	13.07.2002	16	1331
ASTER	AST-L1A.003:2007910399	25.07.2002	35	71
ASTER	AST-L1A.003:2007986699	13.08.2002	30	297
ASTER	AST-L1A.003:2009046998	17.08.2000	1	1
ASTER	AST-L1A.003:2015307203	12.07.2003	59	133
ASTER	AST-L1A.003:2015307217	12.07.2003	7	29
ASTER	AST-L1A.003:2015307219	12.07.2003	50	106
ASTER	AST-L1A.003:2015475397	22.07.2003	32	289
ASTER	AST-L1A.003:2025002689	11.07.2004	32	79
ASTER	AST-L1A.003:2025063344	13.07.2004	24	63
ASTER	AST-L1A.003:2025063353	13.07.2004	2	331
ASTER	AST-L1A.003:2025063355	13.07.2004	10	775
ASTER	AST-L1A.003:2025232928	07.08.2004	26	181
ASTER	AST-L1A.003:2029911903	07.06.2005	79	151
ASTER	AST-L1A.003:2030201287	24.07.2005	10	360

ASTER	AST-L1A.003:2030201290	24.07.2005	11	39
ASTER	AST-L1A.003:2035266221	20.07.2006	25	51
ASTER	AST-L1A.003:2075205746	01.08.2009	2	6
ASTER	AST-L1A.003:2075205748	12.08.2009	9	12
ASTER	AST-L1A.003:2080297809	15.07.2010	57	247
Landsat	L71208005-00520020712	12.07.2002	6	31
Landsat	L71211002-00220070715	15.07.2007	1	647
Landsat	L71212004-00420020622	22.06.2002	1	1
Landsat	L71213004-00420050723	23.07.2005	6	6
Landsat	L71215002-00220010710	10.07.2001	7	3783
Landsat	L71215003-00320020713	13.07.2002	9	12
Landsat	L71219003-00320020709	09.07.2002	14	55
Landsat	L71220002-00220070714	14.07.2007	7	9
Landsat	L72215003-00320020713	13.07.2002	3	3
Landsat	L72217003-00320020711	11.07.2002	3	5
Landsat	L72219003-00320020709	09.07.2002	2	1

3.5 File naming convention

Product example name: CryoClim_GAO_SJ_2001-2010

The name is composed of a set of string elements separated by “_” as shown by this generic file name: CryoClim_<product name>_<location>_<period>

The string elements are explained in the table below.

String element	Explanation
CryoClim	Service name
Product name	GAO (Glacier Area Outline)
Location	Location using www country code – SJ=Svalbard
Period	Year or first year – last year (e.g. 1992 or 2001-2010)

3.6 Known limitations of the product

No major limitations known, see König et al. 2013 and Nuth et al. 2013 for detailed discussion.

3.7 Quality assessment

The outlines are based on visual analysis of orthorectified images and should therefore be very accurate. Misclassification for debris-covered glaciers and boundaries covered by snow patches may occur in some places. For a detailed quality assessment see König et al. 2013 and Nuth et al. 2013

3.7.1 Cryospheric variable accuracy

Area uncertainties (expressed as a relative difference) ranging between 2 and 30 %. Position of glacier boundary 40 m. For a detailed assessment see König et al. 2013 and Nuth et al. 2013

3.7.2 Positional accuracy

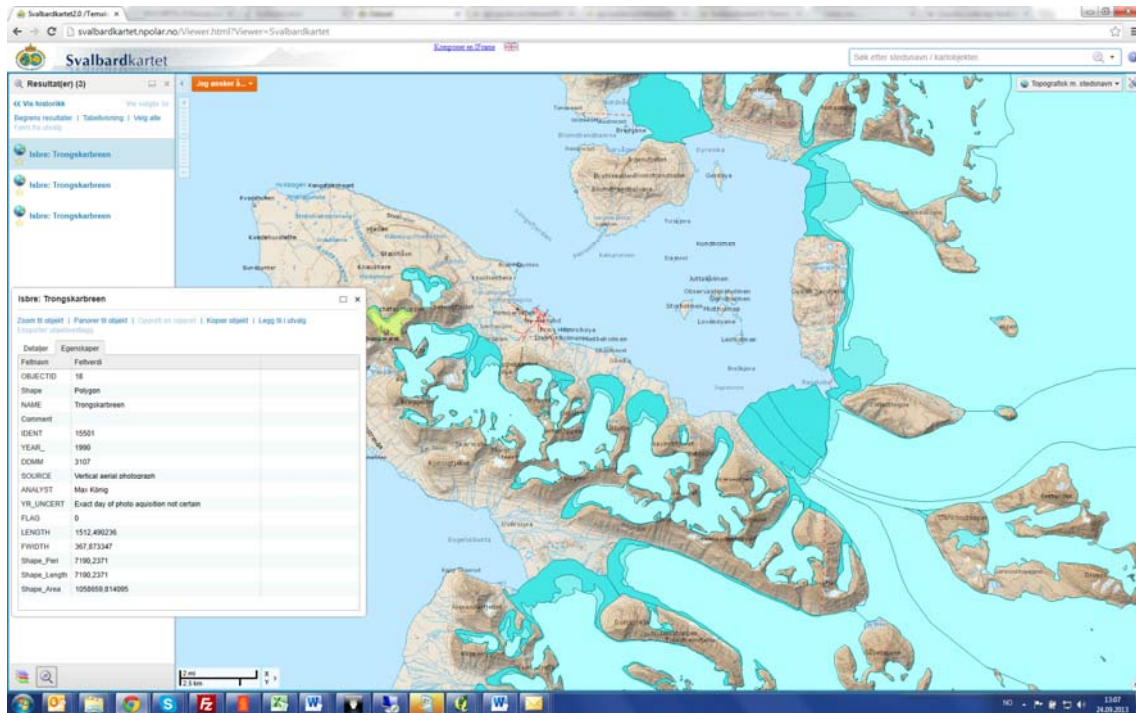
Position of glacier boundary 40 m. For a detailed assessment see König et al. 2013 and Nuth et al. 2013

3.8 Software and tools

Any GIS software capable of reading Shapefiles like, QuantumGIS, ArcGIS, GRASS.

4 Sample products

The screenshot below of <http://svalbardkartet.npolar.no> shows a selected glacier in Kongsfjorden with its attributes.



5 Product version history

Version	Release date	Comments
1.0	April 2013	First complete version available through CryoClim

6 Citing products

When CryoClim products are used in a publication, the data set is required to be cited. List the principal investigators, name of product, product version, year of product release, product producer and “Delivered by CryoClim service”, as shown in the following example:

*M. König, J. Kohler, C. Nuth. Glacier Area Outlines – Svalbard, v1.0, (2013).
<http://data.npolar.no/dataset/89f430f8-862f-11e2-8036-005056ad0004> Delivered by CryoClim service*

7 Contact information

Data Centre Norwegian Polar Institute data@npolar.no

8 Acknowledgements

The ASTER orthorectified images and SilcAst DEMs were provided within the framework of the Global Land Ice Measurements from Space project (GLIMS) through the USGS LPDAAC and are courtesy of NASA/GSFC/METI/ERSDAC/JAROS and the US/Japan ASTER science team. The SPOT5-HRS orthorectified images and DEM were obtained through the IPY-SPIRIT project (Korona et al., 2009) © CNES 2008 and SPOT Image 2008, all rights reserved. This work is a contribution to the ESA Climate Change Initiative Project "Glaciers CCI" (Essential Climate Variable CCI ECV glaciers and ice caps). The work is in part funded by the Norwegian Space Centre as part of ESA's PRODEX program through the CryoClim project.

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- Nuth, C., Kohler, J., König, M., von Deschwanden, A., Hagen, J. O., Kääb, A., Moholdt, G., and Pettersson, R. , 2013. Decadal changes from a multi-temporal glacier inventory of Svalbard, *The Cryosphere Discuss.*, 7, 2489-2532, doi:10.5194/tcd-7-2489-2013

Acronyms and definitions

AMSR-E	Advanced Microwave Scanning Radiometer - Earth Observing System
ASAR	Advanced Synthetic Aperture Radar
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
AVHRR	Advanced Very High Resolution Radiometer
CEOS	Committee of Earth Observation Satellites
CSW	Catalogue Services for the Web
DB	Data Base
DOKIPY	Data handling and coordination service for Norwegian IPY projects
DOS	Dark Object Subtraction
ECMWF	European Centre for Medium-Range Weather Forecasts
ECV	Essential Climate Variable
EEA	European Environment Agency
ERA-40	ECMWF 40 Year Re-analysis
ERS	European Remote-Sensing Satellite
ESA	European Space Agency
ETM+	Enhanced Thematic Mapper plus
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
FCC	False Colour Composite
FCDR	Fundamental Climate Data Record
FMI	Finish Meteorological Institute
FSC	Fractional Snow Cover
FTP	File Transfer Protocol
GAO	Glacier Area Outline
GBA	Glacier Balance Area
GCOS	Global Climate Observing System
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
GFL	Glacier Firn Lines
GLO	Glacier-dammed Lake Outline
GLOF	Glacier Lake Outburst Flood
GMES	Global Monitoring for Environment and Security
GPP	Glacier Periodic Photo series
GSL	Glacier Snow Lines
GST	Glacier Surface Type
GSV	Glacier Surface Velocity
HTTP	Hypertext Transfer Protocol
ICT	Information and Communication Technology
IGOS	Integrated Global Observing Strategy
IHS	Intensity-hue-saturation
INSPIRE	Infrastructure for Spatial Information in the European Community
IPY	International Polar Year
ISO 19115	Defines schema required for describing geographic info. and services
ISO 23950	Information retrieval, application service def. and protocol specification
LSA SAF	Land Surface Analysis Satellite Application Facility (EUMETSAT)
N50	The most detailed of the national map data bases in Norway
NASA	National Aeronautic and Space Administration
NDWI	Normalized Difference Water Index
NetCDF	Network Common Data Form
NOAA	National Oceanic and Atmospheric Administration
NPI	Norwegian Polar Institute
NPOESS	National Polar-orbiting Operational Environmental Satellite System
NR	Norwegian Computing Center

NRT	Near Real-Time
NSC	Norwegian Space Centre
NTNU	Norwegian University of Science and Technology
NVE	Norwegian Water Resources and Energy Directorate
METNO	Norwegian Meteorological Institute
MODIS	Moderate Resolution Imaging Spectroradiometer
MPI	Max Planck Institute for Meteorology
OAI-PMH	Open Archives Initiative - Protocol for Metadata Harvesting
OGC	OpenGeoSpatial Consortium
OpeNDAP	Open-source Project for a Network Data Access Protocol
OSI SAF	Ocean and Sea Ice Satellite Application Facility (EUMETSAT)
PHP	Originally, scripting language for web pages, now extended functionality
PMR	Passive Microwave Radiometer
PLT	Project Leader Team
PMB	Project Management Board
REST	Representational state transfer
RESTful	Systems following REST principles
RGB	Red Green Blue
SAR	Synthetic Aperture Radar
SCA	Snow Cover Area
SCE	Snow Cover Extent
SCF	Snow Cover Fraction
SCE	Snow Cover Extent
SD	Snow Depth
SIC	Sea Ice Concentration
SIE	Sea Ice Edge
SMMR	Scanning Multichannel Microwave Radiometer
SOA	Service Oriented Architecture
SRU	Search/Retrieve via URL
SSM/I	Special Sensor Microwave/Imager
STAG	Scientific and Technical Advisory Group
SWE	Snow Water Equivalent
THREDDS	Thematic Realtime Environmental Distributed Data Services
TM	Thematic Mapper
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
UNIDATA	Diverse community vested in sharing data and tools to access and visualize
URL	Uniform Resource Locator
UTM	Universal Transverse Mercator
WCRP	World Climate Research Programme
WCS	Web Coverage Service
Web portal	Presents information from diverse sources in a unified way
Web service	Supports interoperable machine-to-machine interaction over a network
WFS	Web Feature Service
WGS	World geodetic system
WIS	WMO Information System
WMO	World Meteorological Organisation
WMS	Web Map Service
WPS	Web Processing Service
XML	Extensible Markup Language



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