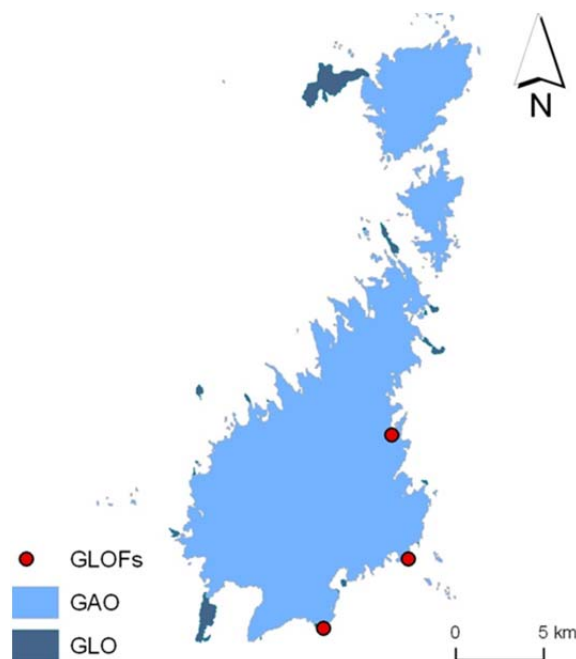


# CryoClim GAO and GLO product documentation

CryoClim sub-service for glaciers in mainland Norway



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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](http://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.

Glacier products from mainland Norway in the CryoClim service consist of Glacier Area Outline (GAO), Glacier Lake Outlines (GLO) and Glacier Periodic Photo series (GPP) products. The GAO and GLO products are derived from Landsat TM/ETM+ imagery and topographic maps using image analysis and GIS techniques. In this report we describe the GAO and GLO products.

## 2 Product overview

Category	Description
Cryospheric variable	Glacier Area Outline (GAO) and Glacier Lake Outline (GLO)
Version	1.0
Sensor(s)	Landsat TM and ETM+, topographic maps, air photos
Temporal aggregation periods	1895-1907, 1953-1985, 1988-1997, 1999-2006
File format and version	Shapefile
Spatial coverage	Norway
Spatial resolution	Shapefiles based on 30 m resolution raster data.
Temporal coverage	Irregular
Temporal resolution	1895-1907, 1953-1985, 1988-1997, 1999-2006
Projection	Geographical and UTM zone 33N, WGS84
Metadata format	DIF
Data file format	Shapefile
File size	8 Mbyte
Product dataset 1	Glacier area outline (GAO)
Product dataset 2	Glacier lake outline (GLO)
Expected accuracy	30 m
Product access	<a href="http://arcus.nve.no/data/bre/GAO/zip/">http://arcus.nve.no/data/bre/GAO/zip/</a> <a href="http://arcus.nve.no/data/bre/GLO/zip/">http://arcus.nve.no/data/bre/GLO/zip/</a>

## 3 Detailed product description

### 3.1 Product structure

The products are zipped Shapefiles per time epoch containing glacier outlines (GAO) or glacier lake outlines (GLO) for mainland Norway. For each product, both in geographical projection and UTM projection. The zipped file also contains a 'readme' file with metadata information.

### 3.2 Metadata

Each zipped file contains a 'readme' file describing the data. The file contains abstract and explanation to the variables.

### 3.3 Product time-series information

The table below explains which time periods have been covered with which sensors/satellite platforms.

Time period	Sensor	Platform	Comments
GAO			
1999-2006	TM/ETM+	Landsat	
1988-1997	TM	Landsat	
1953-1985	Topographic maps	N50	Main map series of Norway
1895-1907	Topographic maps	Gradteigskart	Old topographical maps for one region
GLO			
1999-2006	TM/ETM+	Landsat	
1988-1997	TM	Landsat	

### 3.4 File naming convention

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

Example: cryoclim\_GAO\_NO\_1999\_2006\_lat\_long.shp. This is the GAO product for the period 1999-2006 for mainland Norway in geographical projection.

The string elements are explained in the table below.

String element	Explanation
cryoclim	Service name
Product name	Either GAO (Glacier Area Outline) and GLO (Glacier Lake Outline)
Location	Location using www country code – NO=Norway
1999-2006	Period
Projection	lat_lon = Geographical, UTM = Universal Transverse Mercator

### 3.5 Known limitations of the product

No major limitations known.

### 3.6 Quality assessment

The outlines are based on visual analysis of orthorectified images and accurate within one pixel (30 m). Misclassification on debris-covered glaciers and boundaries covered by snow patches may occur in some places. For a detailed quality assessment of GAO see Andreassen et al. 2008 and Andreassen et al. 2012.

### 3.7 Software and tools

The files can be used by any GIS software capable of reading Shapefiles.



## 4 Sample products

GAO products:

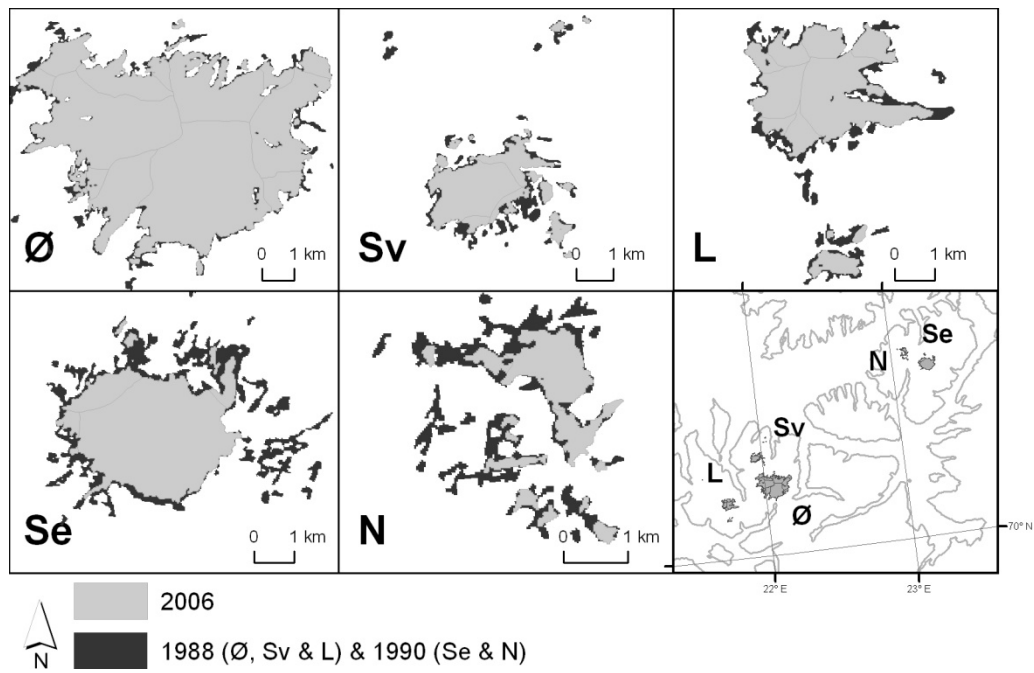


Figure 4.1: GAO products from 2006 and 1988/1990 for five icecaps in western Finnmark .

The GAO, GLO and GLOF products for Folgefonna.

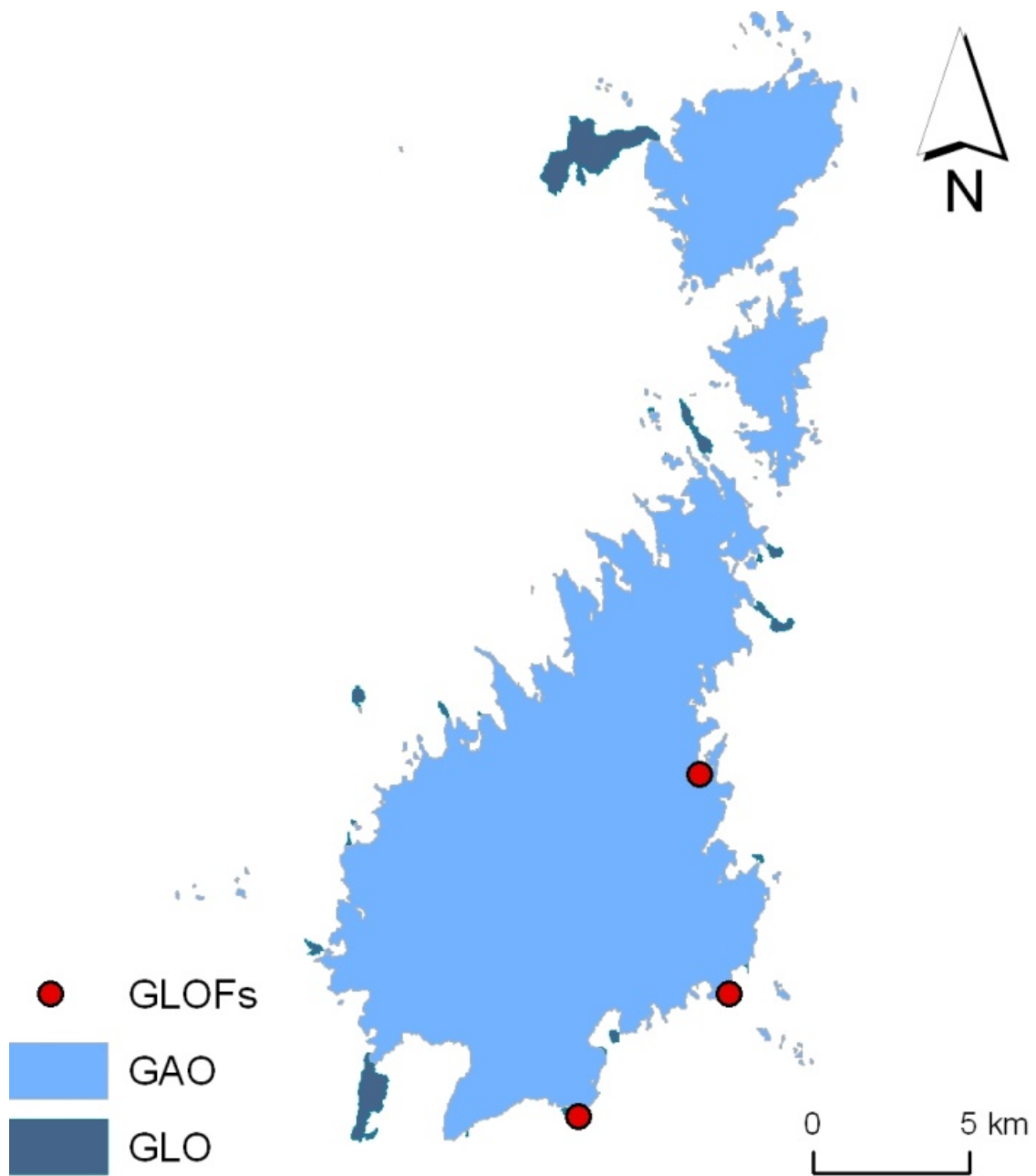


Figure 4.2: Mapped glacier area outline (GAO) and glacier lake outline (GLO) for a subset from Folgefonna, south-west Norway, and registered Glacier Lake Outburst Floods (GLOFs).

## 5 Product version history

Version	Release date	Comments
1.0	December 2012	First full version available through CryoClim

## 6 Citing products

When CryoClim products are used in a publication the dataset 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:

**GAO:**

L.M. Andreassen and S.H. Winsvold: Glacier Area Outline – Norway, v1.0, (2012). NVE.  
<http://arcus.nve.no/data/bre/GAO/zip/>. Delivered by CryoClim service

**GLO:**

S.H. Winsvold and L.M. Andreassen. Glacier Lake Outline – Norway, v1.0, (2012). NVE.  
<http://arcus.nve.no/data/bre/GLO/zip/>. Delivered by CryoClim service

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## 8 Acknowledgements

Jon Endre Hausberg, formerly at NVR, and Frank Paul, University of Zurich, contributed to producing the GAO 1999-2006 outlines.

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## References

Andreassen, L.M. , F. Paul, A. Kääb, and J.E. Hausberg. 2008. Landsat-derived glacier inventory for Jotunheimen, Norway, and deduced glacier changes since the 1930s. *The Cryosphere*, 2, 131-145.

Andreassen, L.M., S.H. Winsvold (eds.), F. Paul and J.E. Hausberg. 2012. *Inventory of Norwegian glaciers*. NVE Report 28, 236 pp.

## 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 Astronautic 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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