CCI+ PHASE 1 – NEW ECVS

PERMAFROST

CCN1 & CCN2

ROCK GLACIER KINEMATICS AS NEW ASSOCIATED PARAMETER OF ECV PERMAFROST

D2.4 Algorithm Development Plan (ADP)

VERSION 1.0

30 APRIL 2020

PREPARED BY

b’geos GAMMA REMOTE SENSING
Document Status Sheet

<table>
<thead>
<tr>
<th>Issue</th>
<th>Date</th>
<th>Details</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>27.02.2020</td>
<td>After confirmation from F.M. Seifert</td>
<td>L. Rouyet, T. Strozzi</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Author team

Line Rouyet and Tom Rune Lauknes, NORCE
Chloé Barboux, Aldo Bertone and Reynald Delaloye, UNIFR
Andreas Kääb, GUIO
Hanne H. Christiansen, UNIS
Alexandru Onaca and Flavius Sirbu, WUT
Valentin Poncos, TERRASIGNA
Tazio Strozzi, GAMMA
Annett Bartsch, B.GEOS

ESA Technical Officer:
Frank Martin Seifert

EUROPEAN SPACE AGENCY CONTRACT REPORT
The work described in this report was done under ESA contract. Responsibility for the contents resides in the authors or organizations that prepared it.
# TABLE OF CONTENTS

EXECUTIVE SUMMARY ........................................................................................................... 4

1 INTRODUCTION .................................................................................................................. 5

1.1 Purpose of the document .................................................................................................. 5

1.2 Structure of the document ............................................................................................... 5

1.3 Applicable documents ...................................................................................................... 5

1.4 Reference Documents .................................................................................................... 5

1.5 Bibliography ..................................................................................................................... 6

1.6 Acronyms ........................................................................................................................ 6

1.7 Glossary ........................................................................................................................... 7

2 ALGORITHM DEVELOPMENT PLAN .................................................................................. 8

3 REFERENCES ....................................................................................................................... 9

3.1 Bibliography .................................................................................................................... 9

3.2 Acronyms ........................................................................................................................ 9
EXECUTIVE SUMMARY

The European Space Agency (ESA) Climate Change Initiative (CCI) is a global monitoring program that aims to provide long-term satellite-based products to serve the climate modelling and climate data user community. Permafrost has been selected as one of the Essential Climate Variables (ECVs) that are elaborated during Phase 1 of CCI+ (2018-2021). As part of the Permafrost_cci baseline project, ground temperature and active layer thickness were considered to be the primary variables that require climate-standard continuity as defined by the Global Climate Observing System (GCOS). Permafrost extent and zonation are secondary parameters, but of high interest to users. The ultimate objective of Permafrost_cci is to develop and deliver permafrost maps as ECV products primarily derived from satellite measurements. Algorithms have been identified, which can provide these parameters by ingesting a set of global satellite data products (Land Surface Temperature LST, Snow Water Equivalent SWE, and Landcover) in a permafrost model scheme that computes the ground thermal regime. Annual averages of ground temperature and annual maxima of thaw depth (active layer thickness) were provided at 1 km spatial resolution during Year 1 of Permafrost_cci. The data sets were created from the analysis of lower level data, resulting in gridded, gap-free products.

In periglacial mountain environments, the permafrost occurrence is patchy, and the preservation of permafrost is controlled by site-specific conditions. Three options initiated within CCN1 and CCN2 address the need for additional regional cases in cooperation with dedicated users in characterizing mountain permafrost as local indicator for climate change and direct impact on the society in mountainous areas. Started in October 2018, CCN1 is led by a Romanian team focusing on case studies in the Carpathians. The specific objective of CCN1 is to develop and deliver maps and products for mountain permafrost, such as (i) rock glacier inventories, (ii) kinematical time series of selected rock glaciers and (iii) a permafrost distribution model, primarily derived from satellite measurements. Started in September 2019, CCN2 consists of two options led by Swiss and Norwegian teams focusing on the investigation and definition of a new associated ECV Permafrost product related to rock glacier kinematics. Early 2020, Rock Glacier Kinematics (RGK) has been proposed as a new product to the ECV Permafrost for the next GCOS implementation plan (IP). It would consist of a global dataset of surface velocity time series measured/computed on single rock glacier units. A proper rock glacier kinematics monitoring network, adapted to climate research needs, builds up a unique validation dataset of climate models for mountain regions, where direct permafrost (thermal state) measurements are very scarce or even lacking totally. The international Action Group Rock glacier inventories and kinematics, under the IPA (International Permafrost Association), gathering about one hundred members, supports this integration and CCN2 is working closely with this Action Group [RD-10 to RD-13]. Following the recommendations of this IPA Action Group, the overall goal of CCN2 is achieved through the development of two products: (i) regional rock glacier inventories and (ii) kinematical time series of selected rock glacier. User Requirements, Product Specifications and Data Access Requirements are described in D1.1-1.3 of CCN1-2 [RD-6 to RD-8].

Algorithm Development Plan (ADP) is not required for CCN1 and CCN2.
1 INTRODUCTION

1.1 Purpose of the document

The products required within CCN1 and CCN2 of the ESA Permafrost_cci project for mountain permafrost regions include (i) regional rock glaciers inventories, including a kinematical attribute (RGI), (ii) kinematical time series on selected rock glaciers (KTS), and (iii) a mountain permafrost distribution model in the Carpathians (MPDM). The Algorithm Development Plan (ADP) is stating that no algorithm development is currently foreseen in CCN1 and CCN2.

1.2 Structure of the document

• Section 1 provides information about the purpose and background of this document.
• Section 2 describes the algorithm development plan.

1.3 Applicable documents


1.4 Reference Documents


1.5 Bibliography
A complete bibliographic list that supports arguments or statements made within the current document is provided in Section 3.1.

1.6 Acronyms
A list of acronyms is provided in Section 3.2.
1.7 Glossary

A comprehensive glossary of terms relevant for the parameters addressed in Permafrost_cci is available as part of the Reference Documents of the baseline project [RD-1 to RD-5] and of CCN 1 & 2 [RD-6 to RD-9], as well as in [RD-14].
2 ALGORITHM DEVELOPMENT PLAN

CCN1/CCN2 comprise only one algorithm iteration over 18 months. No phases in algorithm development are therefore for the moment foreseen.
3 REFERENCES

3.1 Bibliography

- 

3.2 Acronyms

AD Applicable Document
ADP Algorithm Development Plan
ATBD Algorithm Theoretical Basis Document
AUC Area Under the Receiver Operating Curve
B.GEOS b.geos GmbH
BTS Bottom Temperature of Snow Cover
CCI Climate Change Initiative
CCN Contract Change Notice
CRS Coordinate Reference System
DARD Data Access Requirement Document
DEM Digital Elevation Model
ECV Essential Climate Variable
EO Earth Observation
ERT Electrical Resistivity Tomography
ESA European Space Agency
ESA DUE ESA Data User Element
E3UB End-to-End ECV Uncertainty Budget
GAMMA Gamma Remote Sensing AG
GCOS Global Climate Observing System
GFI Ground Freezing Index
GPR Ground Penetrating Radar
GST Ground Surface Temperature
GT Ground Temperature
GTOS Global Terrestrial Observing System
GUIO Department of Geosciences University of Oslo
INSAR Synthetic Aperture Radar Interferometry
IPA International Permafrost Association
KTS Kinematical Time Series
LST Land Surface Temperature
MAGT Mean Annual Ground Temperature
MAGST Mean Annual Ground Surface Temperature
MPDM Mountain Permafrost Distribution Model
MRI Mountains Research Initiative
MTD Miniature Temperature Data Loggers
NMA National Meteorological Administration
NORCE Norwegian Research Centre AS
NSIDC National Snow and Ice Data Center
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSD</td>
<td>Product Specifications Document</td>
</tr>
<tr>
<td>PVASR</td>
<td>Product Validation and Algorithm Selection Report</td>
</tr>
<tr>
<td>PVP</td>
<td>Product Validation Plan</td>
</tr>
<tr>
<td>RF</td>
<td>Random Forest</td>
</tr>
<tr>
<td>RD</td>
<td>Reference Document</td>
</tr>
<tr>
<td>RGI</td>
<td>Rock Glacier Inventories</td>
</tr>
<tr>
<td>RMSE</td>
<td>Root Mean Square Error</td>
</tr>
<tr>
<td>SAR</td>
<td>Synthetic Aperture Radar</td>
</tr>
<tr>
<td>S4C</td>
<td>Science for the Carpathians</td>
</tr>
<tr>
<td>SWE</td>
<td>Snow Water Equivalent</td>
</tr>
<tr>
<td>T</td>
<td>Temperature</td>
</tr>
<tr>
<td>UNIFR</td>
<td>Department of Geosciences University of Fribourg</td>
</tr>
<tr>
<td>UNIS</td>
<td>University Centre in Svalbard</td>
</tr>
<tr>
<td>URD</td>
<td>Users Requirement Document</td>
</tr>
<tr>
<td>UTM</td>
<td>Universal Transverse Mercator</td>
</tr>
<tr>
<td>WGS</td>
<td>World Geodetic System</td>
</tr>
<tr>
<td>WUT</td>
<td>West University of Timisoara</td>
</tr>
</tbody>
</table>