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Pre-ABOVE: Circumpolar Arctic Vegetation, Geobotanical, Physiographic Data, 1982-2003

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Documentation Revision Date: 2016-09-27

Data Set Version: V1

Summary

This data set provides the spatial distributions of vegetation types, geobotanical characteristics, and physiographic features for the circumpolar Arctic tundra biome for the period 1982-2003. Specific attributes include dominant vegetation, bioclimate subzones, floristic subprovinces, landscape types, lake coverage, Arctic treeline, elevation, and substrate chemistry data. Vegetation indices, trends, and biomass estimate products for the circumpolar Arctic through 2010 are also provided.

These products were developed under the Circumpolar Arctic Vegetation Map (CAVM) project, an international effort to map the vegetation and associated characteristics of the circumpolar region using a common base map. The area of interest was defined by tundra vegetation, an Arctic climate and flora, with the tree line defining the southern limit. Mapping experts within nine Arctic regions prepared draft maps relying on literature sources and using geographic information technology for their portion of the Arctic, which were later synthesized to make the final geobotanical data products. It was the first vegetation map of an entire global biome at a comparable resolution (Walker et al., 2005). Additional circumpolar map products related to CAVM by area and attributes (e.g., landscapes and bioclimatic zones) that include more recent field and remote sensing data are also provided.

This data set is distributed in 11 data files. This includes four compressed directories (*.zip) containing shapefiles and seven files in GeoTIFF (*.tif) format.

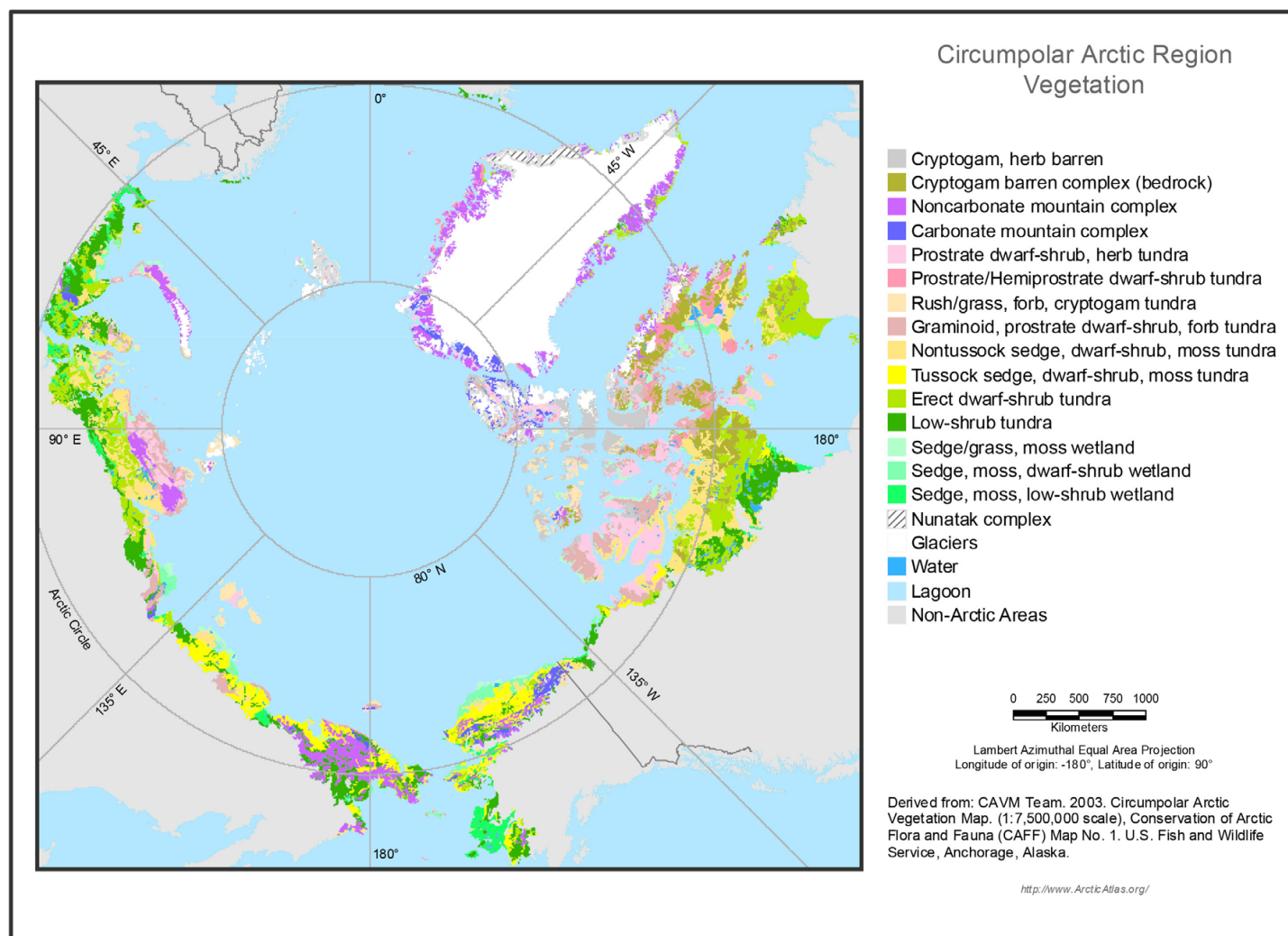


Figure 1. Circumpolar Arctic vegetation.

Citation

Walker, D.A., and M.K. Raynolds. 2016. Pre-ABOVE: Circumpolar Arctic Vegetation, Geobotanical, Physiographic Data, 1982-2003. ORNL DAAC, Oak Ridge, Tennessee, USA. <http://dx.doi.org/10.3334/ORNLDAAC/1323>

Table of Contents

1. [Data Set Overview](#)
2. [Data Characteristics](#)
3. [Application and Derivation](#)
4. [Quality Assessment](#)
5. [Data Acquisition, Materials, and Methods](#)
6. [Data Access](#)
7. [References](#)

1. Data Set Overview

This data set provides the spatial distributions of vegetation types, geobotanical characteristics, and physiographic features for the circumpolar Arctic tundra biome for the period 1982-2003. Specific attributes include dominant vegetation, bioclimate subzones, floristic subprovinces, landscape types, lake coverage, Arctic treeline, elevation, and substrate chemistry data. Vegetation indices, trends, and biomass estimate products for the circumpolar Arctic through 2010 are also provided.

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Project: Arctic-Boreal Vulnerability Experiment (ABOVE)

The [Arctic-Boreal Vulnerability Experiment](#) (ABOVE) is a NASA Terrestrial Ecology Program field campaign that will take place in Alaska and western Canada between 2016 and 2021. Climate change in the Arctic and Boreal region is unfolding faster than anywhere else on Earth. ABOVE seeks a better understanding of the vulnerability and resilience of ecosystems and society to this changing environment.

Acknowledgements:

These data were obtained from the Alaska Arctic Geocological Atlas (<http://agc.portal.gina.alaska.edu>), which provides access to existing Arctic vegetation plot and map data in support of the ABOVE campaign.

Related Publications:

Epstein, H.E., Reynolds, M.K., Walker, D.A., Bhatt, U.S., Tucker, C.J. and Pinzon, J.E., 2012. Dynamics of aboveground phytomass of the circumpolar Arctic tundra during the past three decades. *Environmental Research Letters*, 7(1), p.015506. <http://dx.doi.org/10.1088/1748-9326/7/1/015506>

Raynolds, M.K., Walker, D.A., Epstein, H.E., Pinzon, J.E. and Tucker, C.J., 2012. A new estimate of tundra-biome phytomass from trans-Arctic field data and AVHRR NDVI. *Remote Sensing Letters*, 3(5), pp.403-411. <http://dx.doi.org/10.1080/01431161.2011.609188>

Raynolds, M.K. and Walker, D.A., 2009. Effects of deglaciation on circumpolar distribution of arctic vegetation. *Canadian Journal of Remote Sensing*, 35(2), pp.118-129. <http://dx.doi.org/10.5589/m09-006>

Raynolds, M.K., Comiso, J.C., Walker, D.A. and Verbyla, D., 2008. Relationship between satellite-derived land surface temperatures, arctic vegetation types, and NDVI. *Remote Sensing of Environment*, 112(4), pp.1884-1894. <http://dx.doi.org/10.1016/j.rse.2007.09.008>

Walker, D.A., Raynolds, M.K., Daniëls, F.J., Einarsson, E., Elvebakk, A., Gould, W.A., Katenin, A.E., Kholod, S.S., Markon, C.J., Melnikov, E.S. and Moskalenko, N.G., 2005. The circumpolar Arctic vegetation map. *Journal of Vegetation Science*, 16(3), pp.267-282. <http://dx.doi.org/10.1111/j.1654-1103.2005.tb02365.x>

Walker, D.A., Gould, W.A., Maier, H.A. and Raynolds, M.K., 2002. The Circumpolar Arctic Vegetation Map: AVHRR-derived base maps, environmental controls, and integrated mapping procedures. *International Journal of Remote Sensing*, 23(21), pp.4551-4570. <http://dx.doi.org/10.1080/01431160110113854>

2. Data Characteristics

Spatial Coverage: Arctic Tundra Biome

Spatial Resolution: 1 km

Temporal Coverage: 1982-06-01 to 2010-09-03

Temporal Resolution: Annual

Study Area: (all latitudes and longitudes given in decimal degrees)

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Circumpolar Arctic	-180	180	90	55.8

Data File Information:

This data set is distributed in 11 data files: four compressed directories (*.zip) containing shapefiles (*.shp) and seven files in GeoTIFF (*.tif) format. The directory 'geobotanical_2003_layers.zip' contains six shapefiles.

Shapefiles

The shapefiles and their descriptions are listed in the Table 1. These files provide the distributions of various features in the circumpolar arctic region in *.shp format. The *.zip files contain the .shp, .shx, .dbf, .prj files, that support the shapefile and a .lyr file. Some of the files also contain additional files such as .sbn or .sbx (spatial index files). All shapefiles are stored in the GCS_WGS_1984 geographic coordinate system and Lambert_Azimuthal_Equal_Area projection.

Table 1: Shapefiles and their descriptions

File Name	Description
aga_CAVM.zip	This is the circumpolar Arctic vegetation product (CAVM), which may be used to produce a geobotanical map of the entire Arctic.
	The circumpolar arctic region tree line. The extent is the Arctic, defined as the Arctic Bioclimate Zone, and the tree line

aga_circumpolar_coastline_treeline_2003.zip	defines the southern limit of this zone. This excludes tundra regions that lack an Arctic flora, such as the boreal oceanic areas of Iceland, the Aleutian Island, and the alpine tundra regions south of latitudinal tree line. In some regions of the Arctic, especially Canada and Chukotka, the forest tundra transition is gradual and interpretation of tree line directly from the AVHRR imagery was not possible. Coastline is from the Digital Chart of the World (ESRI,1993). Small islands less than 49 km ² were deleted, and the coastlines were simplified by removing arc vertices that were closer together than 5,000 m.
aga_circumpolar_landscape_age_2009.zip	Landscape age indicating the length of time (in thousands of years) that Arctic landscapes have been available for plant colonization and the development of plant communities.
geobotanical_2003_layers.zip	Contains the following six shapefiles, which were extracted from the geobotanical data contained in the fields of the file: <i>aga_CAVM.shp</i> .
circumpolar_arctic_bioclimate_subzones_2003	Circumpolar Arctic bioclimatic subzones from A-E, where A is the coldest and E is the warmest
aga_circumpolar_floristic_2003	Floristic sectors of the circumpolar Arctic
aga_circumpolar_landscape_2003	Physiography of the circumpolar arctic region
aga_circumpolar_substrate_ph_2003	Identifies acidic areas, carbonate, neutral, saline, and glacier or ice cap areas in the circumpolar Arctic region.
aga_circumpolar_vegetation_2003	Zonal vegetation types within each identified polygon and over five broad physiognomic categories
aga_circumpolar_lake_cover_2003	Lake cover based on the number of AVHRR water pixels in each mapped polygon, divided by the number of pixels in the polygon; pixels within 2 km of the coastline were excluded to avoid ocean water.

Table 2: Geographic extent of the shapefiles

Shapefile Name	Geographic Extent			
	North	South	East	West
aga_CAVM	83.627419	55.796231	-180	180
circumpolar_arctic_bioclimate_subzones_2003	83.627419	55.796231	-180	180
aga_circumpolar_floristic_2003	83.627419	55.796231	-180	180
aga_circumpolar_landscape_2003	83.627419	55.796231	-180	180

aga_circumpolar_substrate_ph_2003	83.627419	55.796231	-180	180
aga_circumpolar_vegetation_2003	83.627419	55.796231	-180	180
aga_circumpolar_lake_cover_2003	83.627419	55.796231	-180	180
aga_circumpolar_coastline_treeline_2003	90	39.71032	-180	180
aga_circumpolar_landscape_age_2009	83.627419	55.796231	-180	180

Data Descriptions:

The attribute names, units, and descriptions for each of the shapefiles are listed below.

Table 3: aga_CAVM.shp

Attribute Name	Description
BIOZONE	Bioclimate Subzone
PHYTO	Floristic Provinces
LAND	Landscape
CHEM	Substrate pH
PHYSIOG	Vegetation
PCTWATER	Lake Cover

Table 4: Circumpolar_arctic_bioclimate_subzones_2003.shp

Attribute Name	Description
BIOZONE	Bioclimatic subzones: 0 = Glaciers 1 = Subzone A 2 = Subzone B 3 = Subzone C 4 = Subzone D 5 = Subzone E 6 = Non Arctic

Table 5: aga_circumpolar_floristic_2003.shp

Attribute Name	Description
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PHYTO	<p>Floristic provinces:</p> <ul style="list-style-type: none"> 0= Glaciers 1= North Beringian Islands 2= Beringian Alaska 3= Northern Alaska 4= Central Canada 5= West Hudsonian 6= Baffin - Labrador 7= Ellesmere-North Greenland 10= North Iceland - Jan Mayen 11= North Fennoscandia 12= Svalbard - Franz Josef Land 13= Kanin - Pechora 14= Polar Ural - Novaya Zemlya 15= Yamal - Gydan 16= Taimyr 17= Anabar - Olenyek 18= Kharaulakh 19= Yana - Kolyma 20= West Chukotka 21= East Chukotka 22= South Chukotka 23= Wrangell Island 81= Northwest Greenland 82= Southwest Greenland 83= Central west Greenland 84= South Greenland 91= Southeast Greenland 92= Central east Greenland 93= Northeast Greenland
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Table 6: aga_circumpolar_landscape_2003.shp

Attribute Name	Description
LAND	<p>Physiography:</p> <ul style="list-style-type: none"> 0= Ocean 1= Glacier 2= Lake 4= Plain 5= Plateau 6= Hill 7= Mountain 8= Nunatak Area 9= Lagoon

Table 7: aga_circumpolar_substrate_ph_2003.shp

Attribute Name	Description
CHEM	<p>Parent material chemistry:</p> <ul style="list-style-type: none"> 2= Acidic 4= Circumneutral 4= Carbonate 5= Saline 9=Glacier or Ice cap

Table 8: aga_circumpolar_vegetation_2003.shp

Attribute Name	Description
PHYSIOG	<p>There are there are 21 distinct physiognomic unit codes: 14 vegetation types and seven large areas of azonal vegetation that are dependent on specific soil or hydrological conditions, such as mountain ranges and large wetlands.</p> <ul style="list-style-type: none"> 1= Cryptogam, herb barren 2= Rush/grass, forb, cryptogam tundra 3= Cryptogam barren complex (bedrock) 4= Prostrate dwarf-shrub, herb tundra 5= Graminoid, prostrate dwarf-shrub, forb tundra 6= Prostrate/Hemiprostrate dwarf-shrub tundra 7= Nontussock sedge, dwarf-shrub, moss tundra 8= Tussock-sedge, dwarf-shrub, moss tundra 9= Erect dwarf-shrub tundra 10= Low-shrub tundra 12= Sedge/grass, moss wetland 13= Sedge, moss, dwarf-shrub wetland 14= Sedge, moss, low-shrub wetland 15= Noncarbonate mountain complex 16= Carbonate mountain complex 17= Nunatak complex 18= Glaciers 19= Water 20= Lagoon 21= Non-Arctic areas <p>These physiognomic unit codes are over five broad physiognomic categories: B-barrens, G-graminoid-dominated tundras, P-prostrate-shrub-dominated tundras, S-erect-shrub-dominated tundras, and W-wetlands.</p>

Table 9: aga_circumpolar_lake_cover_2003.shp

Attribute Name	Description
PCTWATER	<p>Percent lake cover</p> <ul style="list-style-type: none"> 1 = < 2% 2 = 2-10% 3 = 10-25% 4 = 25-50% 5 = 50-75% 6 = > 75%

Table 10: aga_circumpolar_coastline_treeline_2003.shp

Attribute Name	Description
WATER	<p>Presence or absence of water</p> <ul style="list-style-type: none"> 0 = Ocean 1 = Terrestrial areas within the Arctic Bioclimate Zone 2 = Terrestrial areas outside of the Arctic Bioclimate Zone

Table 11: aga_circumpolar_landscape_age_2009.shp

Attribute Name	Description
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AGE	Landscape age; 1000s of years; 9999= unknown
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GeoTIFF Files

The seven GeoTIFF (.tif) files along with their descriptions are listed in Table 12. All the GeoTIFF files are in WGS84 datum with map units in meters. The spatial attributes of each of the GeoTIFF files are listed in Table 13.

Table 12: GeoTIFF (.tif) files and their descriptions

File Name	Description
aga_circumpolar_avhrr_cir_1995.tif	Advanced Very High Resolution Radiometer (AVHRR) Channel 1 and Channel 2 data, displayed as false color-infrared. Pixel values are a maximum NDVI value composite from 11 July to 30 August 1993 and 1995 in the circumpolar arctic region.
aga_circumpolar_avhrr_ndvi_1995.tif	NDVI calculated from Channel 1 and Channel 2 data. Pixel values are a maximum NDVI value composite from 1 April to 31 October 1993 and 1995 in the circumpolar arctic region.
aga_circumpolar_avhrr_ndvi_trend_1982-2010.tif	NDVI trend in Arctic NDVI calculated from a linear regression of NDVI values for all years 1982-2010. Pixels with significant trends ($p < 0.05$) were retained.
aga_circumpolar_avhrr_biomass_2010.tif	Estimated above ground plant biomass for the tundra biome based on trans-Arctic field data and AVHRR NDVI. Cell values: Arctic biomass; kg/m ² .
aga_circumpolar_avhrr_biomass_trend_1982-2010.tif	Arctic biomass calculated from a linear regression of biomass values for all years 1982-2010 (Epstein et al., 2012). Pixels with significant trends ($p < 0.05$) were retained. Cell values: Change in phytomass; kg/m ² /yr.
aga_circumpolar_avhrr_swi_1982-2003.tif	Summer Warmth Index (SWI) based on AVHRR surface temperature data (Raynolds et al, 2008). SWI is the sum of monthly mean temperatures above 0 degrees Celsius. Data in degrees C for the months of May-September, averaged for the years 1982-2003 in the circumpolar arctic region.
aga_circumpolar_elevation.tif	Landform elevations in the circumpolar arctic region based on Digital Chart of the World (ESRI, 1993)

Data Descriptions:

Table 13: Geographic extent and attributes of the GeoTIFF files

File Name	Geographic Extent				Fill Value	Data Type	Number of Bands	Range of Values
	North	South	East	West				

aga_circumpolar_avhrr_cir_1995.tif	90	31.28806	180	-180	-32768	int16	2	
aga_circumpolar_avhrr_ndvi_1995.tif	90	31.28806	180	-180	127	float32	1	117 to 245
aga_circumpolar_avhrr_ndvi_trend_1982-2010.tif	90	29.01694	180	-180	-3.4E+38	float32	2	-0.036 to 0.459
aga_circumpolar_avhrr_biomass_2010.tif	90	44.305	180	-180	-3.4E+38	float32	1	0.083 to 0.97
aga_circumpolar_avhrr_biomass_trend_1982-2010.tif	90	44.305	180	-180	-3.4E+38	float32	1	-0.029 to 0.03
aga_circumpolar_avhrr_swi_1982-2003.tif	90	30.96583	180	-180	-3.4E+38	float32	1	0 to 136.142
aga_circumpolar_elevation.tif	90	17.7625	180	-180	-32768	int16	1	-142 to 5927

Companion File Information: There are two companion files - **CAVM_procedure.pdf** which describes the method for creating the Circumpolar Arctic Vegetation Map (CAVM) and **Circumpolar_Map_Images.zip** that contains images derived from the maps.

3. Application and Derivation

These data have consistent treatment of vegetation types, geobotanical characteristics, and physiographic features across the circumpolar Arctic tundra and would be useful to land-use and climate change applications.

4. Quality Assessment

The accuracy of the bioclimate subzone boundaries is an issue. More accurate maps of temperatures that portray maritime-continental influences and elevation would help to more accurately delineate the boundary zones (Walker et al., 2005). In addition, zonal vegetation is dependent on temperature, precipitation, landscape age and substrate chemistry and it is often not clear what the zonal vegetation in a given subzone should be.

5. Data Acquisition, Materials, and Methods

Site description

The circumpolar Arctic tundra vegetation region is north of the climatic limit of trees and is characterized by an arctic climate, arctic flora, and tundra vegetation. It excludes tundra regions that have a boreal flora such as the boreal oceanic areas of Iceland and the Aleutian Islands and alpine tundra south of the latitudinal treeline.

Mapping Procedure

The products included with this data set were developed under the Circumpolar Arctic Vegetation Map (CAVM) project, an international effort to map the vegetation and associated characteristics of the circumpolar region using a common base map. The mapping procedure relied mostly on literature, expert knowledge, and close examination of AVHRR imagery used as the base map (Walker et al, 2002):

1. The base map (**aga_circumpolar_avhrr_cir_1995.tif**) is a 1:4-million-scale false color infrared (CIR) image derived from the Advanced Very High Resolution Radiometer (AVHRR).
2. Mapping experts within nine Arctic regions (Canada, Greenland, Iceland, Norway including Svalbard, European Russia, West Siberia, East Siberia, Chukotka, and Alaska) collected relevant maps and literature sources for their region and prepared draft maps using geographic information technology (ArcInfo) of their portion of the Arctic. All hard copy maps that were deemed useful for helping to define vegetation boundaries were then photographically reproduced to the 1:4 M scale of the base map, and the boundaries adjusted to match the AVHRR CIR image.
3. The third step was to define the vegetation transitions in the Arctic, and it was decided to use the approach of the Panarctic Flora (PAF) initiative (Elvebakk et al., 1999) which considered the Arctic to be equivalent to the five Arctic Bioclimate Zones, the area of the Earth with tundra vegetation, an Arctic climate and Arctic flora, with the tree line defining the southern limit. The five bioclimate subzones are based on a combination of summer temperature and vegetation. Subzone A is the coldest and most barren subzone, and Subzone E is the warmest and most lushly vegetated.
4. After the base map was established with the bioclimate subzones, additional geobotanical features were examined including the floristic features, elevation and landscapes, lake cover, and substrate pH.

The attributes from the maps in the steps above were later integrated to make the final circumpolar Arctic vegetation map (**aga_CAVM.zip**). Area analysis of the map was done according to bioclimate subzones, and country. The integrated mapping procedures resulted in other maps of vegetation, topography, soils, landscapes, lake cover, substrate pH, and above-ground biomass.

The mapping was done by drawing polygon boundaries on frosted Mylar sheets overlaid on the AVHRR imagery. Boundaries were drawn around areas of homogeneous color and texture, guided by boundaries from the other source maps.

Look-up tables of dominant plant community types were made for most regions of the map based on the vegetation literature from each region. Separate tables were also made for each floristic subprovince within a given region. The literature sources were provided in the tables. From the look-up tables, the expected dominant plant community type was derived for each combination of floristic subprovince, bioclimate subzone, soil reaction class, and topographic position.

Since very steep bioclimate gradients occur in mountains these areas were mapped as complexes of elevation belts. The mountainous areas are shown as hachures—the background color indicates the nature of the bedrock and the color of the hachure indicates the bioclimate subzone at the base of the mountains.

The final result (**aga_CAVM.zip**) is a single Arc/Info coverage where each polygon was coded with the following attributes: dominant vegetation, bioclimate subzone, floristic subprovinces, landscape type, lake cover, and substrate chemistry. Elevation and maximum NDVI are in separate raster coverages at 1-km pixel size (Walker et al., 2005, 2002).

Detailed Product-Attribute Information

This section provides additional information pertaining to the geobotanical attributes provided in each data file. In this section, CAVM products are described first and then related data products.

CAVM map products

aga_CAVM.zip: The Circumpolar Arctic Vegetation Map (CAVM), is a geobotanical map of the entire Arctic. It is the first vegetation map of an entire global biome at a comparable resolution (Walker et al., 2005). The **aga_CAVM.zip** map file attributes are dominant vegetation, bioclimate subzone, floristic subprovince, landscape type, lake cover, and substrate chemistry data. Individual shapefiles of these attributes are also provided.

aga_circumpolar_avhrr_cir_1995.tif: This was the base map false color infrared (CIR) image derived from the AVHRR, a sensor on board the National Oceanic and Atmospheric Administration (NOAA) satellites. This is a map of vegetation green-up-to-senescence period from 11 July to 30 August 1993 and 1995 in the circumpolar arctic region (Walker et al, 2002). The image was composed of 1-km x 1-km picture elements (pixels). Each pixel portrays the vegetation at the maximum greenness during two years of 10-day composite data (USDA-NRCS, 2004) between 11.07 and 30.08 in 1993 and 1995. Shorelines were adapted from the Digital Chart of the World (DCW). Small islands less than 49 km² were deleted from the DCW files, and the coastlines were simplified by removing arc vertices that were closer together than 5,000 m. Glaciers, oceans and sea ice were masked out of the image using information from the DCW. The final image shows the Arctic at maximum greenness with minimum snow and cloud cover.

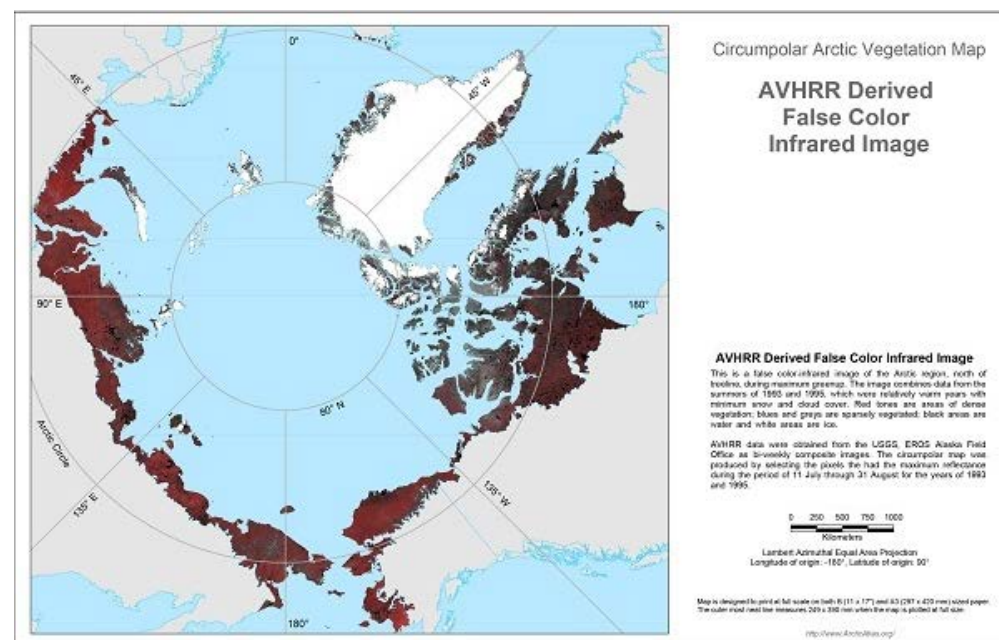


Figure 2. AVHRR false color infrared image used to make the base map.

circumpolar_arctic_bioclimate_subzones_2003.zip: A shapefile of bioclimate subzones from A-E, where A is the coldest and E is the warmest. In order to characterize the transitions in vegetation that occur across the Arctic's roughly 10 degrees C difference in mean July temperature, the approach of (Elvebakk et al., 1999) was adopted with some modification.

aga_circumpolar_floristic_2003.zip: A shapefile of the floristic sectors based on the PAF project (Elvebakk et al., 1999). The Arctic has a relatively consistent core of plant species that occur around the circumpolar region, but there is also considerable east to west variation in the regional floras, particularly in subzones C, D, and E. This variation is due to a number of factors, including different histories related to glaciations, land bridges, and north-south trending mountain ranges, primarily in Asia. These influences have restricted the exchange of species between parts of the Arctic. Russian geobotanists have described a set of floristic subdivisions based primarily on these floristic differences (Yurtsev 1994). The map was adapted from the PAF project (Elvebakk et al., 1999) based largely on Yurtsev's approach.

aga_circumpolar_substrate_ph_2003.zip: A shapefile depicting acidic areas, carbonate, circumneutral, saline, and glacier or ice cap areas. This product was derived from a wide variety of available sources including soil, surface-geology, and bedrock-geology maps, and from spectral patterns that could be recognized on the AVHRR base image. The pH values of the three categories were based on the field experience and hundreds of Arctic vegetation releve plots sampled by D.A. Walker on the North Slope and Seward Peninsula of Alaska, in consultation with F.J.A. Daniëls (Greenland) and N.G. Moskalenko (Yamal and Gydan Peninsulas, Russia).

aga_circumpolar_vegetation_2003.zip: A shapefile of zonal vegetation within each mapped polygon. The legend contains five broad physiognomic categories:

- B-barrens
- G-graminoid-dominated tundras
- P-prostrate-shrub-dominated tundras
- S-erect-shrub-dominated tundras, and
- W-wetlands

The five categories were divided into 21 subunits: 14 of vegetation and seven large areas of azonal vegetation that are dependent on specific soil or hydrological conditions, such as mountain ranges and large wetlands. The units are named according to dominant plant functional types except in the mountains where complexes of vegetation are named according to the dominant bedrock (carbonate and noncarbonate mountain complexes). The plant functional types are based on a variety of criteria including growth form (e.g., graminoids, shrubs), size (e.g., dwarf and low shrubs), and taxonomical status (e.g., sedges, rushes, grasses). The vegetation units take into special consideration the stature of woody shrubs, which is a major diagnostic feature of zonal vegetation in the Arctic (Walker et al., 2002, Yurtsev 1994). The very steep bioclimate gradients in the mountainous areas were classified as complexes of elevation belts.

Vegetation in mountainous regions changes with elevation, forming distinct elevation belts which correspond approximately to bioclimatic subzones. Vegetation is also modified by local topographic effects such as slope, aspect, and cold-air drainage.

aga_circumpolar_landscape_2003.zip: A shapefile of seven surface features (physiography) in the circumpolar arctic region. The landscape type was derived from visual interpretation of the AVHRR false-CIR image supplemented with the topographic data and regional physiographic maps to show areas with plains, hills and mountains.

aga_circumpolar_lake_cover_2003.zip: A shapefile of lake cover based on the number of AVHRR water pixels in each mapped polygon, divided by the number of pixels in the polygon; pixels within two km of the coastline were excluded to avoid ocean water. Since the imagery has a pixel size of 1-km², lake cover is underestimated for areas with many small lakes. No pixels were sampled within two pixels (2 km) of the coastline to avoid including ocean pixels. The percent cover data were grouped into six categories: < 2%, 2-10%, 10-25%, 25-50%, 50-75%, and 75-100%. Since the sum of the last three categories was only 1.5%, (the 75-100% category covered 1% of the map), they were combined one category, >25%.

Related Map Products:

aga_circumpolar_avhrr_ndvi_1995.tif: A GeoTIFF of NDVI from 11 July to 30 August 1993 and 1995 in the circumpolar arctic region. NDVI was calculated as: $NDVI = (NIR - R) / (NIR + R)$, where NIR is the spectral reflectance in the AVHRR near-infrared channel (0.725-1.1 μ m, channel 2) where light-reflectance from the plant canopy is dominant, and R is the reflectance in the red channel (0.5 to 0.68 μ m, channel 1), the portion of the spectrum where chlorophyll absorbs maximally (Bhatt et al., 2010). Advanced Very High Resolution Radiometer (AVHRR) data were obtained from the USGS Global AVHRR 10-day composite data (<http://earthexplorer.usgs.gov/>). Glaciers and oceans were masked out using information from the Digital Chart of the World (ESRI 1993). The image is composed of 1 x 1-km pixels. The color of each pixel was determined by its reflectance at the time of maximum greenness, selected from 10-day composite images from 11 July to 30 August 1993 and 1995 (Markon et al., 1995). These intervals cover the vegetation green-up-to-senescence period during two relatively warm years when summer-snow cover was at a minimum in the Arctic (Markon et al., 1995).

Circumpolar_AVHRR_NDVI_trend_1982_2010.tif: A GeoTIFF of NDVI trend in Arctic NDVI calculated from a linear regression of NDVI values for all years 1982-2010. NDVI was calculated as: $NDVI = (NIR - R) / (NIR + R)$, where NIR is the spectral reflectance in the AVHRR near-infrared channel (0.725-1.1 μ m, channel 2) where light-reflectance from the plant canopy is dominant, and R is the reflectance in the red channel (0.5 to 0.68 μ m, channel 1), the portion of the spectrum where chlorophyll absorbs maximally. Trend in Arctic NDVI was calculated from a linear regression of NDVI values for all years 1982-2010. Pixels with significant trends ($p < 0.05$) were retained (Bhatt et al., 2010).

aga_circumpolar_elevation_2003.tif: A GeoTIFF of landform elevations in the circumpolar arctic region. The elevations were derived from the Digital Chart of the World (ESRI 1993). The relationship between elevation and temperature corresponds to the ecological adiabatic lapse rate of -6 degrees C per 1,000- m elevation (Barry & Chorley 1987). An additional < 100-m belt delineates the extensive low flat plains of the Arctic. The topography was used to help develop a landscape distribution that showed broad physiographic regions.

aga_circumpolar_avhrr_swi_1982_2003.tif: A GeoTIFF of Summer Warmth Index (SWI) temperatures in degrees C for the months of May-September, and for the years 1982-2003 in the circumpolar arctic region. SWI is the sum of monthly mean temperatures above 0 degrees Celsius. These data were calculated from monthly AVHRR thermal infrared data (Raynolds et al, 2008).

aga_circumpolar_avhrr_biomass_2010.tif: A GeoTIFF of estimated above ground plant biomass for the tundra biome based on trans-Arctic field data and AVHRR NDVI (Raynolds et al., 2012). Above-ground phytomass was sampled on transects along the Arctic bioclimate gradient in North America (1750 km long, eight locations sampled 2003-2006) and Eurasia (1,500 km, five locations sampled 2007-2010). The study locations were chosen to represent each of the five Arctic bioclimate sub-zones. NDVI values for each phytomass sampling site were extracted from two different NDVI data sets with different spatial resolutions. The maximum NDVI for the specific year during which the phytomass data were collected for each sampling site was extracted from the 8-km GIMMS3g AVHRR data. The relationship between landscape-level zonal phytomass sampled along the Arctic transects and satellite NDVI values were compared using logarithmic regression ($y = 0.383 \ln x + 0.994, R^2 = 0.94, p < 0.001$). A logarithmic equation has been shown to best correlate with phytomass, since NDVI is asymptotically non-linear as it approaches its maximum value of 1 for areas with dense plant cover. The regression equation relating above-ground phytomass to the GIMMS3g data for the years sampled was applied to all pixels within that image to create a map showing the distribution of Arctic phytomass and to calculate an estimate of total Arctic aboveground phytomass.

aga_circumpolar_avhrr_biomass_trend_1982-2010.tif: A GeoTIFF of Arctic biomass calculated from a linear regression of biomass values for all years 1982-

2010 (Epstein et al., 2012). Biomass was calculated from the relationship between AVHRR NDVI and ground sampling of biomass. Above-ground phytomass was sampled on transects along the Arctic bioclimate gradient in North America (1,750-km long, eight locations sampled 2003-2006) and Eurasia (1,500 km, five locations sampled 2007-2010). The study locations were chosen to represent each of the five Arctic bioclimate sub-zones. The relationship between landscape-level zonal phytomass sampled along the Arctic transects and satellite NDVI values were compared using logarithmic regression ($y = 0.383 \ln x + 0.994$, $R^2 = 0.94$, $p < 0.001$). This relationship was applied to the GIMMS3g maximum annual NDVI data (1982–2010) to calculate biomass. Trends in biomass were calculated by applying a linear regression to the time series for each pixel. Pixels with significant trends ($p < 0.05$) were retained (Epstein et al., 2012).

aga_circumpolar_coastline_tree_line_2003.zip: A shapefile of the circumpolar arctic region tree line. The spatial extent is the Arctic, defined as the Arctic Bioclimate Zone, and the tree line defines the southern limit of this zone. This map excludes tundra regions that lack an Arctic flora, such as the boreal oceanic areas of Iceland, the Aleutian Island, and the alpine tundra regions south of latitudinal tree line. In some regions of the Arctic, especially Canada and Chukotka, the forest tundra transition is gradual and interpretation of tree line directly from the AVHRR imagery was not possible. Additional sources for the tree line included:

- Alaska: The Ecoregions map of Alaska (Joint Federal State Land Use Planning Commission for Alaska 1973)
- Canada: Canadian maps of tree line (Timoney et al., 1992) and the extensive personal experience of S. Zoltai, who had studied the Canadian boreal forest for several decades
- Russia: Vegetation maps at 1:2.5 million and 1:4 million scales and the personal communication of Natalia Moskalenko (Earth Cryosphere Institute) and Alexei Polezhaev (Zonal Research Institute of Northeast Agriculture, Magadan).

The coastline was derived from the Digital Chart of the World (ESRI, 1993). Small islands less than 49 km² were deleted, and the coastlines were simplified by removing arc vertices that were closer together than 5,000 m.

aga_circumpolar_landscape_age.zip: A shapefile of landscape age indicating the length of time (in thousands of years) that Arctic landscapes have been available for plant colonization and the development of plant communities (Raynolds et al., 2009). Areas for which no Wisconsin glaciation is known, were coded as 9999. These data came mostly from Ehlers, J. and P. L. Gibbard (2004). The product was based on the Circumpolar Arctic Vegetation Map shapefile (**aga_CAVM.zip**), with an attribute added for landscape age. Polygon boundaries were modified where necessary to follow glaciation data.

This data set was provided by the GINA repository at <http://geobotanical.portal.gina.alaska.edu/catalogs/9603-circumpolar-arctic-vegetation-map-all-layers>. For more information on this dataset please refer to <http://www.arcticatlas.org/maps/themes/cp/>

6. Data Access

These data are available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

[Pre-ABOVE: Circumpolar Arctic Vegetation, Geobotanical, Physiographic Data, 1982-2003](#)

Contact for Data Center Access Information:

- E-mail: uso@daac.ornl.gov
- Telephone: +1 (865) 241-3952

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