Long-Term Arctic Growing Season NDVI Trends from GIMMS 3g, 1982-2012

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Revision Date: March 11, 2015

Summary

This data set provides normalized difference vegetation index (NDVI) data for the arctic growing season derived primarily with data from Advanced Very High Resolution Radiometer (AVHRR) sensors onboard several NOAA satellites over the years 1982 through 2012. The NDVI data, which show vegetation activity, were averaged annually for the arctic growing season (GS; June, July and August). The products include the annual GS-NDVI values and the results of a cumulative GS-NDVI time series trends analysis. The data are circumpolar in coverage at 8-km resolution and limited to greater than 20 degrees N.

These normalized difference vegetation index (NDVI) trends were calculated using the third generation data set from the Global Inventory Modeling and Mapping Studies (GIMMS 3g). GIMMS 3g improves on its predecessor (GIMMS g) in three important ways. First, GIMMS 3g integrates data from NOAA-17 and 18 satellites to lengthen its record. Second, it addresses the spatial discontinuity north of 72 degrees N, by using SeaWiFS, in addition to SPOT VGT, to calibrate between the second and third versions of the AVHRR sensor (AVHRR/2 and AVHRR/3). Finally, the GIMMS 3g algorithm incorporates improved snowmelt detection and is calibrated based on data from the shorter, arctic growing season (May-September) rather than the entire year (January-December).

The annual GS-NDVI data are provided in a single NetCDF v4 file. The GS-NDVI trends, significance of these trends, and a land cover map (GLC2000) are provided as three GeoTIFF files.

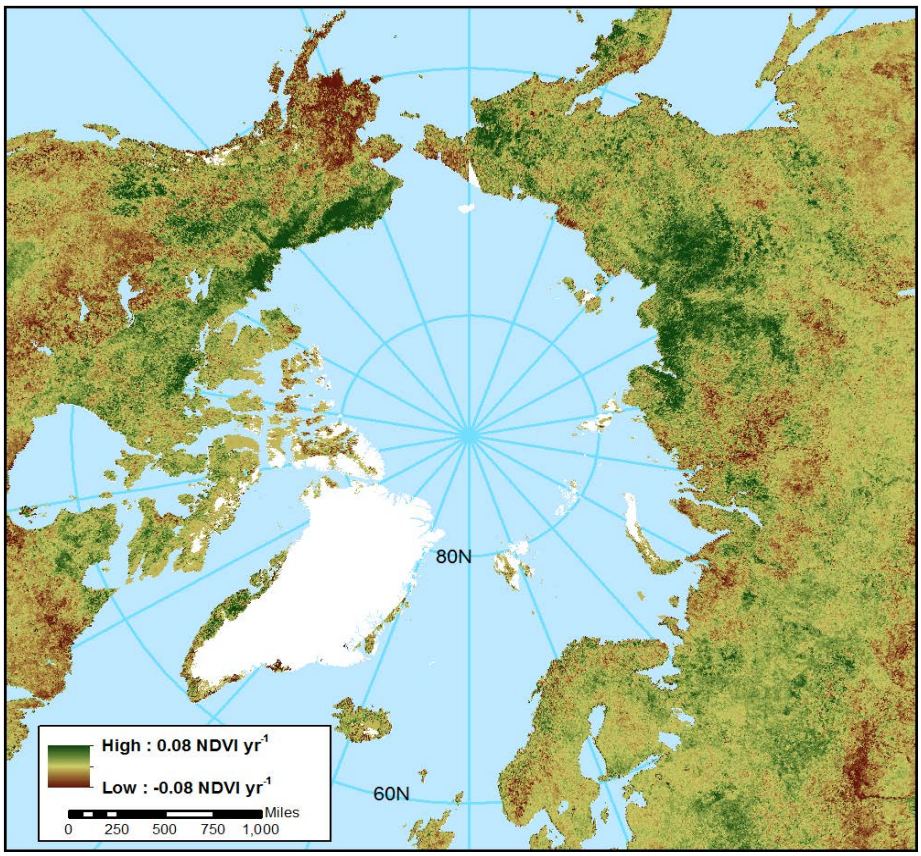

Figure 1: NDVI Arctic Growing Season Trends from GIMMS 3g, 1982-2012.

ACKNOWLEDGEMENTS

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Data and Documentation Access:

Get Data: http://daac.ornl.gov/cgi-bin/dsviewer.pl?ds_id=1275

Data Citation:

Cite this data set as follows:

Guay, K.C., P.S.A. Beck, and S.J. Goetz. 2015. Long-Term Arctic Growing Season NDVI Trends from GIMMS 3g, 1982-2012 . Data set. Available on-line [http://daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, USA. http://dx.doi.org/10.3334/ORNLDAAC/1275

Table of Contents:

1. Data Set Overview:

This data set provides normalized difference vegetation index (NDVI) data for the arctic growing season derived primarily with data from the Advanced Very High Resolution Radiometer (AVHRR) aboard several NOAA satellites over the years 1982 through 2012. The NDVI data were averaged annually for the arctic growing season (GS; June, July and August). The products include the annual GS-NDVI values and the results of a cumulative GS-NDVI time series trends analysis. The data are circumpolar in coverage at 8-km resolution and limited to greater than 20 degrees N.

This third generation Global Inventory Modeling and Mapping Studies (GIMMS 3g) product is a ca. 8-km resolution, 15-day maximum value composite (MVC), bimonthly, global NDVI product generated from AVHRR data (NOAA-7, 9, 11, 14, 16-19). GIMMS 3g integrates data from NOAA-17 and -18, to improve the length and quality of the GIMMS-NDVI record and uses SeaWiFS (along with SPOT VGT) data to combine the AVHRR/2 and AVHRR/3 data sets to address the discontinuity north of 72 degrees N, present in GIMMSg (Pinzon et al., 2007; Pinzon and Tucker 2014). The GIMMS 3g algorithm also has improved snow-

melt detection and is calibrated based on data from the shorter, arctic growing season (May–September), rather than the entire year (January–December).

GS-NDVI time series trends (brownness-greenness) were calculated using the Theil-Sen method (Theil, 1992). Areas defined as cropland, permanent snow and ice or other unnatural vegetation types in the Global Land Cover 2000 map (GLC2000; Table 1) were masked out. The GLC2000 map has been resampled (using the nearest neighbor method) to match the GIMMS 3G 8-km grid and is included in this data set (Guay et al. 2014).

2. Data Characteristics:

Spatial Coverage

Northern hemisphere north of 20 degrees N.

Spatial Resolution

8 km

Site boundaries: (All latitude and longitude given in decimal degrees)

Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
-180	180	90	20

Temporal Coverage

AVHRR source data from 1982-06-01 to 2012-08-31.

Temporal Resolution

Annual growing season average (June, July, August) and 31-year compiled trend results

Data File Information

The annual GS-NDVI data are proved in a single NetCDF v4 file. The GS-NDVI trends, the significance of trends, and the land cover map (GLC2000) are provided in GeoTIFF format.

GS-NDVI Trends

gimms3g_gs_ndvi_trend_8km_1982_2012_20deg_trend.tif

- GIMMS 3g GS-NDVI trends using Theil-Sen method (Theil, 1992 in Guay et al., 2014)

gimms3g_gs_ndvi_trend_8km_1982_2012_20deg_significance.tif

- Significance of trend using Mann-Kendall test (Mann, 1945) - Guay et al. (2014) uses a significance threshold of $p<0.005$

gimms3g_gs_ndvi_trend_8km_1982_2012_20deg_landcover.tif

- Land cover map (GLC2000) with 23 classes. Guay et al. (2014) masked out land cover classes greater than or equal to 16.

GeoTIFF Spatial Data Properties

```
Spatial Representation Type: Raster
  Compression Type: LZW
  Number of Bands: 1
  Raster Format: GeoTIFF
  No Data Value: -1.79769313486232e+308
  Scale Factor: 1

Number Columns: 4320
  Column Resolution: 8 km
  Number Rows: 840
  Row Resolution: 8 km

Extent in the items coordinate system
  North: 90
  South: 20
  West: -180
  East: 180

Spatial Reference Properties

Type: Geographic
```

```
Geographic Coordinate Reference: WGS 1984

Open Geospatial Consortium (OGC) Well Known Text (WKT)
  GEOGCS["WGS 84",
  DATUM["WGS_1984",
  SPHEROID["WGS 84",6378137,298.257223563,
   AUTHORITY["EPSG","7030"]],
   AUTHORITY["EPSG","6326"]],
  PRIMEM["Greenwich",0],
  UNIT["degree",0.0174532925199433],
   AUTHORITY["EPSG","4326"]]
Origin = (-180.000000000000000,90.000000000000000)
Pixel Size = (0.083333333333333,-0.083333333333333)
```

Land Cover Classes

Global Land Cover 2000 Map (GLC2000) was resampled to match the GIMMS 3g grid. The following classes were masked in Guay et al. (2014).

VALUE	CLASS NAME	MASKED
1	Tree Cover, broadleaved, evergreen	NO
2	Tree Cover, broadleaved, deciduous, closed	NO
3	Tree Cover, broadleaved, deciduous, open	NO
4	Tree Cover, needle-leaved, evergreen	NO
5	Tree Cover, needle-leaved, deciduous	NO
6	Tree Cover, mixed leaf type	NO
7	Tree Cover, regularly flooded, fresh water	NO
8	Tree Cover, regularly flooded, saline water	NO
9	Mosaic: Tree Cover / Other natural vegetation	NO
10	Tree Cover, burnt	NO
11	Shrub Cover, closed-open, evergreen	NO
12	Shrub Cover, closed-open, deciduous	NO
13	Herbaceous Cover, closed-open	NO
14	Sparse herbaceous or sparse shrub cover	NO
15	Regularly flooded shrub and/or herbaceous cover	NO
16	Cultivated and managed areas	YES
17	Mosaic: Cropland / Tree Cover / Other natural vegetation	YES
18	Mosaic: Cropland / Shrub and/or grass cover	YES
19	Bare Areas	YES
20	Water Bodies	YES
21	Snow and Ice	YES
22	Artificial surfaces and associated areas	YES
23	No data	YES

Annual GS-NDVI data in NetCDF v4 file

gimms3g_ndvi_1982-2012.nc4

- The data file covers the years of 1982 through 2012 (31 bands) but only the average NDVI of growing season months June, July, and August of each year. An additional time boundary dimension (nv) is included in the data set to account for the seasonal nature of the data.

NetCDF v4 Header -- CF compliant

```
Parameter, Parameter Abbreviation, Unit, and Description

  Parameter: GIMMS 3G NDVI in growing season (June, July, and August)
   Parameter Abbreviation: NDVI
Unit: GS-NDVI
Description: Mean Normalized Difference Vegetation Index in growing season (June, July, and August)

Spatial Data Properties
```

```
  Spatial Representation Type: Raster
  Pixel Depth: 64 bit
   Pixel Type: double precision
  Number of Bands: 31
   Band Information: time
  Raster Format: netCDF
  Source Type: Generic
  No Data Value: -9999
  Scale Factor: none
  Number Columns: 4320

Column Resolution: 8 km
  Number Rows: 840
Row Resolution: 8 km

Extent in the items coordinate system
  North: 90
  South: 20
  West: -180
  East: 180

Spatial Reference Properties

Type: Geographic
  Geographic Coordinate Reference: WGS 1984

Open Geospatial Consortium (OGC) Well Known Text (WKT)
  GEOGCS["WGS 84",
   DATUM["WGS_1984",
    SPHEROID["WGS 84",6378137,298.257223563,
  AUTHORITY["EPSG","7030"]],
  AUTHORITY["EPSG","6326"]],
  PRIMEM["Greenwich",0],
  UNIT["degree",0.0174532925199433],
   AUTHORITY["EPSG","4326"]]
  Origin = (-180.000000000000000,90.000000000000000)
  Pixel Size = (0.083333333333333,-0.083333333333333)
```

Data Archive Center Processing:

The single netCDF file was created by combining 31 individual annual GS-NDVI GeoTIFFs using Geospatial Data Abstraction Library (GDAL) and netCDF Operator (NCO) software. The NCO software was then utilized to edit the netCDF header to bring it into Climate and Forecast (CF) compliance.

3. Data Application and Derivation:

The AVHRR-based GIMMS-NDVI version G (GIMMS g) series, and its recent successor version 3g (GIMMS 3g), as well as the shorter NDVI records generated from the more modern sensors, SeaWiFS, SPOT-VGT, and MODIS were compared. The data sets from the latter two sensors were provided in a form that reduces the effects of surface reflectance associated with solar and view angles (Guay et al., 2014).

4. Quality Assessment:

See Pinzon and Tucker (2014) for discussion of specific comparisons between GIMMS 3g and independently measured appropriate climate phenomena needed to improve our understanding of uncertainty the AVHRR GIMMS 3g product.

5. Data Acquisition Materials and Methods

This data set provides normalized difference vegetation index (NDVI) data for the arctic growing season derived primarily with data from Advanced Very High Resolution Radiometer (AVHRR) sensors aboard several NOAA satellites over the years 1982 through 2012. The NDVI data were averaged annually for the arctic growing season (GS; June, July and August).

The data are circumpolar in coverage at 8-km resolution and limited to greater than 20 degrees N. Like its predecessor, the third generation Global Inventory Modeling and Mapping Studies (GIMMS 3g) product is a ca. 8-km resolution, 15-day maximum value composite (MVC), bimonthly, global NDVI product generated from AVHRR data (NOAA-7, 9, 11, 14, 16-19). GIMMS 3g integrates data from NOAA-17 and -18, to improve the length and quality of the GIMMS-NDVI record and uses SeaWiFS (along with SPOT VGT) data to combine the AVHRR/2 and AVHRR/3 data sets to address the discontinuity north of 72 degrees N, present in GIMMS g (Pinzon et al., 2007; Pinzon and Tucker 2014). The GIMMS 3g algorithm also has improved snowmelt detection and is calibrated based on data from the shorter, arctic growing season (May–September), rather than the entire year (January–December).

As described in Guay et al. (2014), the temporal trends in the GS-NDVI annual time series were estimated using the Theil-Sen approach (Theil, 1992). Trends were not estimated for pixels that were missing data anywhere in the time series. The Mann-Kendall test was used to assess trends for statistical significance (Mann, 1945), regarding pixels as significant when $P < 0.05$.

Compared to a simple linear regression, the Theil-Sen slope estimator is more robust to outliers, as it estimates the slope of a time series as the median of all slopes between pairs of observations in the time series. We explored using this population of slopes to empirically determine 95% confidence intervals around the slope estimate as an alternative assessment of statistical significance. However, the Mann-Kendall test was far more conservative when applied to the common record. Trend analyses were performed using the tools in the zyp package (Bronaugh & Werner, 2012) in R (R Core Team, 2012).

The GIMMS 3g data product used as a source for this data set and those described in Guay et al. (2014) in Pinzon and Tucker (2014), are available from the NASA Earth Exchange (NEX), a platform for scientific collaboration, knowledge sharing and research for the earth science community. Access link: https://nex.nasa.gov/nex/projects/1349/

6. Data Access:

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

Data Archive Center:

Contact for Data Center Access Information:

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

7. References:

Bronaugh D, Werner A (2012) zyp: Zhang + Yue-Pilon Trends Package. R Foundation for Statistical Computing, Vienna.

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Theil H (1992) A rank-invariant method of linear and polynomial regression analysis. In: Econometric Theory and Methodology, Vol. 23 (eds Raj B, Koerts J), pp. 345–381. Springer, Houten, the Netherlands.