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1. TITLE

1.1 Data Set Identification

ISLSCP II NOAA 5-year Average Monthly Snow-free Albedo from AVHRR

1.2 File Name(s)

The NOAA National Environmental Satellite Data and Information Service (NESDIS) albedo data set from AVHRR provided here is made up of three types of files on common Earth grids with spatial resolutions of 1.0, 0.5, and 0.25 degree in both latitude and longitude:

1) Monthly albedo files (ASCII or text format map files),
2) "Difference" table files (with an extension of "**.dif**") that hold all the points from each albedo map that did not match the land/water mask used in the International Satellite land Surface Climatology Project (ISLSCP) Initiative II data collection, and were either removed or added through interpolation (one file for each albedo map),
3) a "change map" showing those points that were different from the ISLSCP II land/water mask and were thus removed or added (one ASCII map file per resolution).

The three sets of files are named using the following naming convention:

1) **noaa_albedo_5year_XX_mZZ.asc**: 12 Gridded monthly albedo map files, where **XX** can be either "1d", "hd", or "qd" for spatial resolutions of 1.0 degree, 1/2 degree, or 1/4 degree, respectively, in both latitude and longitude. **ZZ** is the month from 01 to 12. Note that this albedo data set represents the monthly average albedo using data from a five-year period from April 1985-December 1987 and January 1989-March 1991.

2) **noaa_albedo_5year_XX_mZZ.dif**: 12 ASCII tables of "differences", or points in the original data that did not match the ISLSCP II land/water mask, and were removed from or added to the ASCII map files (see sections 8.4 and 9.2.3 for more details on data processing).

3) **noaa_albedo_5year_XX_chngmp.asc**: Gridded ASCII map showing the differences between the ISLSCP II land/water mask and the original data set: All points with negative values ("-1") are those where the ISLSCP II mask showed water but where the original data set showed land. All points with a value of zero are those points where the two land/water masks agreed and all points with positive values were land points with no data over land in the original data set which were filled in from interpolation (see sections 8.4 and 9.2.3 for more details). There is one file per spatial resolution.

1.3 Revision Date of this Document
November 16, 2009

2. INVESTIGATOR(S)

2.1 Investigator(s) Name and Title
Dr. Ivan A. Csiszar
Cooperative Institute for Research in the Atmosphere
NOAA/NESDIS Office of Research and Applications

2.2 Title of Investigation
Monthly snow-free albedo climatology from AVHRR.

2.3 Contacts (For Data Production Information)

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2.4 Data Set Citation
Csiszar, I.A. 2009. ISLSCP II NOAA 5-year Average Monthly Snow-free Albedo from AVHRR. In Hall, Forrest G., G. Collatz, B. Meeson, S. Los, E. Brown de Colstoun, and D. Landis (eds.). ISLSCP Initiative II Collection. Data set. Available on-line [http://daac.ornl.gov/] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A. doi:10.3334/ORNLDAAC/959

2.5 ISLSCP Initiative II Collection Reference

Users of the International Satellite Land Surface Climatology (ISLSCP) Initiative II data collection are requested to cite the collection as a whole (Hall et al. 2006) as well as the individual data sets. Please cite the following publications when these data are used:

Hall, F.G., E. Brown de Colstoun, G. J. Collatz, D. Landis, P. Dirmeyer, A. Betts, G. Huffman, L. Bounoua, and B. Meeson, The ISLSCP Initiative II Global Data sets: Surface Boundary Conditions and Atmospheric Forcings for Land-Atmosphere Studies, *J. Geophys. Res.*, 111, doi:10.1029/2006JD007366, 2006.

Csiszar, I. and G. Gutman, 1999: Mapping global land surface albedo from NOAA/AVHRR. *J Geophys. Res.* 104, 6215-6228.

3. INTRODUCTION

3.1 Objective/Purpose

The objective of this work was to produce a monthly climatology of broadband surface albedos for use in global numerical weather prediction models at the National Centers for Environmental Prediction (NCEP). The data set is compatible in temporal coverage and spatial resolution with a monthly climatology of green vegetation fraction (Gutman and Ignatov, 1998) delivered earlier and currently in use at NCEP.

3.2 Summary of Parameters

Five-year monthly means of clear-sky, surface, broadband, snow-free albedos for overhead sun illumination angle using data from a five-year period from April 1985-December 1987 and January 1989-March 1991 and at spatial resolutions of 1.0, 0.5 and 0.25 degree. Files showing the differences between the original data set and the land/water mask used in the ISLSCP Initiative II collection are also provided.

3.3 Discussion

The clear-sky albedos were derived from the Advanced Very High Resolution Radiometer (AVHRR) channel 1 (visible) and channel 2 (near-IR) reflectances in the NOAA/NESDIS Third Generation Global Vegetation Index (GVI) data set on a 0.144 degree resolution Plate Caree global grid between 75 degrees N and 55 degrees S latitudes. The albedos were calculated from cloud-free weekly maximum (channel 2-channel 1) composite data, using narrow-to-broadband conversion and angular and atmospheric corrections. Data have been made consistent with the ISLSCP II land/water mask.

4. THEORY OF ALGORITHM/MEASUREMENTS

In the short-wave part of the radiometric spectrum, AVHRR provides narrow band, top-of-the-atmosphere radiance observations. To obtain cloud- and snow-free, physically meaningful input data for the albedo retrieval, pre-processing needs to be done, including calibration, i.e. the conversion of raw counts into reflectances; the removal of cloud contamination and the detection of snow cover (often using information from the IR and mid-IR channels also). The actual retrieval of broadband, surface instantaneous albedos, corresponding to a fixed solar and observation geometry, consists of several processing steps: narrow-to-broadband conversion to obtain an estimate of the reflected radiation in the entire short-wave spectral region; conversion of directional reflectances to hemispheric albedos; the removal of the effects of atmospheric scattering and absorption (atmospheric correction); and the normalization to a common solar illumination angle. In general, there is a certain degree of freedom in the order of applying the above procedures.

5. EQUIPMENT

5.1 Instrument Description

The instrument is the Advanced Very High Resolution Radiometer (AVHRR), providing measurements in the visible (0.58-0.68 μm), near-IR (0.725-1.1 μm), mid-IR (3.55-3.93 μm) and thermal IR window (10.5-11.5 and 11.5-12.5 μm) spectral regions. The nominal resolution of the original Local Area Coverage (LAC) data is 1.1 km at the sub-satellite point. This albedo product was generated from Global Area Coverage (GAC) data, which are derived from LAC data on board the satellite by averaging four out of every five samples along every third scan line. The resulting nominal resolution is 4 km (5x3 pixels) at the sub-satellite point. For further specifications of this instrument, see Kidwell (1997).

5.1.1 Platform (Satellite, Aircraft, Ground, Person)

AVHRR is flown on board the polar orbiter "NOAA" operational environmental satellite series. At a certain time, a "morning" and an "afternoon" satellite is operational, thus providing morning, afternoon, evening and nighttime observations approximately 6 hours apart. The local time of observations changes during a satellite's lifetime because of orbital drift.

5.1.2 Mission Objectives

AVHRR was designed for the instantaneous observation of clouds, ocean, land, ice and snow cover for weather analysis purposes. The multi-spectral measurements have been proven to be suitable for the quantitative measurement of a number of parameters that AVHRR was originally not designed for. The long data record also allows the use of AVHRR data for climate analysis purposes.

5.1.3 Key Variables

AVHRR provides reflected and emitted radiation measurements. The visible and near-IR data are usually converted into reflectances, whereas the IR window data are calibrated into radiances or brightness temperatures. The mid-IR channel, which is sensitive to both the emitted terrestrial and reflected solar radiation, is expressed as brightness temperature or radiance, but is also often separated into reflected and emitted components.

5.1.4 Principles of Operation

AVHRR, a scanning radiometer, is operated and maintained by the National Environmental Satellite Data and Information Service (NOAA/NESDIS). At a certain time, there are two operational satellites. Data from earlier satellites are also received and processed at a lower priority level.

5.1.5 Instrument Measurement Geometry

AVHRR operates with a cross-track scanning system with a maximum of 55.4° scan angle from the nadir. The nominal resolution of the sub-satellite point is 1.1 km for LAC and 4 km for GAC. The spatial resolution decreases substantially towards the edges of the orbital swath.

5.1.6 Manufacturer of Instrument

ITT.

5.2 Calibration

AVHRR has no on-board calibration capability for the visible and near-IR channels used for generating the albedo product. Pre-launch calibration coefficients should not be used because of the degradation of the instrument sensitivity. The channel 1 and 2 counts were converted to reflectances using post-launch calibration coefficients, using the formulae derived by Rao and Chen (1995, 1996).

5.2.1 Specifications

The LAC data have an Instantaneous Field of View (IFOV) of ~1.40 milliradians. There is a sampling overlap between IFOV's.

5.2.1.1 Tolerance

The visible and near-IR channels were designed to have a 3:1 signal-to-noise ratio at 0.5% albedo. The AVHRR counts have a 10-bit precision. The acceptable range of output counts is 40 to 990, corresponding to 0% and 100% reflectance at nadir view. Small variation from instrument to instrument exists.

5.2.2 Frequency of Calibration

The calibration coefficients were determined by time-continuous formulae provided by Rao and Chen (1995, 1996), applied to the date of observation.

5.2.3 Other Calibration Information

Not available at this revision.

6. PROCEDURE

6.1 Data Acquisition Methods

We used the NOAA/NESDIS Third Generation GVI data set weekly composites of AVHRR/GAC visible and near-infrared reflectances, with the corresponding solar and satellite zenith angles, mapped into 0.15 degree-resolution latitude/longitude arrays between 75 degrees N and 55 degrees S (Kidwell, 1997). This data set, available for the period 1985-present, can be used to derive both multi-year mean and currently observed global surface albedo. Daily maps are created by retaining the last GAC observation in the GVI gridbox. Then a weekly composite is made by selecting one pixel corresponding to the maximum difference between the channel 2 and channel 1 count during a 7-day period. This procedure retains the clearest pixel in the gridbox over the week, due to the larger differences in spectral response of vegetated surfaces in visible and near-infrared as compared to clouds. Post-composite cloud flags, based on channel 4 brightness temperature thresholds, were appended and surface type flags for desert, seasonal vegetation, evergreen forests and snow were generated within the NOAA/GVI project (Gutman et al., 1995).

6.2 Spatial Characteristics

6.2.1 Spatial Coverage

Meaningful data are available between 75 degrees N and 55 degrees S, covering most of the landmass except Antarctica and the permanently snow-covered parts of Greenland. Data over water, permanent snow/ice and beyond the above latitudinal range are fill values (-99 over water and –88 over land).

6.2.2 Spatial Resolution

The original resolution is 0.144 degrees. For this data collection, the data have been aggregated to 0.25 degrees, 0.5 degree and 1degree (Lat/long) spatial resolutions. The data are given in an equal-angle lat/long (geographical) grid.

6.3 Temporal Characteristics

6.3.1 Temporal Coverage

The base period for the 5-year means is: April 1985 to December 1987 and January 1989 to March 1991.

6.3.2 Temporal Resolution

The data have a monthly temporal resolution but are derived from an average of data acquired during the periods listed in section 6.3.1.

7. OBSERVATIONS

7.1 Field Notes

Not applicable to this data set.

8. DATA DESCRIPTION

8.1 Table Definition with Comments

Not applicable to this data set.

8.2 Type of Data

8.2.1 Parameter/ Variable Name	8.2.2 Parameter/ Variable Description	8.2.3 Data Range	8.2.4 Units of Measurement	8.2.5 Data Source
1) Albedo Maps (*.asc)				
albedo_5year	Five-year monthly	Min=5	Unitless	AVHRR

	climatology of clear-sky, snow free land surface albedo normalized to overhead sun.	Max=45 Water=-99 No Data over land=-88	fraction, expressed in percent (%)	GVI
2) Differences Tables (*.dif)				
Lat	Latitude for the center of a cell. South latitudes are negative.	Min=-90 Max=90	Decimal Degrees	Earth Grid
Lon	Longitude for the center of a cell. West longitudes are negative.	Min=-180 Max=180	Decimal Degrees	Earth Grid
Data_Removed	Albedo value in each cell of the original file that did not match the ISLSCP II land/water mask, and was removed.	Min=5 Max=45	Unitless fraction, expressed in percent (%)	Original data
Data_Added	Albedo value for each cell added to the original file because the ISLSCP II land/water mask indicated land, so an interpolated point was added.	Min=5 Max=45	Unitless fraction, expressed in percent (%)	Computed
Interpolation_ Level	The number of times the interpolation routine was run to get a value for this point. The higher the number, the less reliable the value is.	Min=1 Max=5	Unitless	Computed
3) Change Map (*_chngmp.asc)				
Point Changed	Differences between the ISLSCP II land/water mask and the original data: -1 = ISLSCP II mask is water and original data is land (data removed) 0 = Data sets agree over land or water (data unchanged) ≥1 = ISLSCP II mask is land and original data is water or missing (data interpolated)	Min=-1 Max=5	See 8.2.2	Computed

8.3 Sample Data Record

The "differences" files **noaa_albedo_5year_XX_mZZ.dif** are ASCII tables with some header lines, then the Lat and Lon coordinates of each removed point, plus the value of that point, and coordinates and data for all points added at the bottom of the file. See the sample below.

```
ISLSCP II Differences for file 'albedo_5year_1d_m01.asc'.
Contains Lat-Lon coordinates and data for each point in the original file
that differed from the ISLSCP II Land/Sea mask, and thus was removed.
Points added using interpolation are listed at the bottom of this file.

Lat,Lon,Data_Removed
75.5,-104.5,10.0
75.5,-93.5,18.3
75.5,-92.5,13.6
75.5,-19.5,7.1
75.5,-18.5,8.3
75.5,57.5,7.5
75.5,88.5,10.9
75.5,144.5,6.9
   "      "
   "      "
   "      "
   "      "
Lat,Lon,Data_Added,Interpolation_Level
68.5,-104.5,7.53,1
54.5,-57.5,6.8,1
46.5,52.5,14.28,1
41.5,53.5,15.47,1
```

8.4 Data Format

All of the data files in the ISLSCP Initiative II data collection are in the standard Arc GIS ASCII Grid format. The file format consists of six lines of header information followed by numerical fields of varying length, which are delimited by a single space and arranged in columns and rows. The files at different spatial resolutions each contain the following numbers of column and rows:

1.0 degree: 360 columns by 180 rows
0.5 degree: 720 columns by 360 rows
0.25 degree: 1440 columns by 720 rows

All files are gridded to a common equal-angle lat/long grid, where the coordinates of the upper left corner of the files are located at 180 degrees W, 90 degrees N and the lower right corner coordinates are located at 180 degrees E, 90 degrees S. Data in the map files are ordered from North to South and from West to East beginning at 180 degrees West and 90 degrees North. The files have all had the ISLSCP II land/water mask applied to them. Water bodies are encoded as -99 and missing data over land as -88.

The ASCII map files (with the extension of ".asc") have all had the ISLSCP II land/water mask applied to them. All points removed from the original files are stored in "differences" files (with the extension ".dif"). These ASCII files contain the Latitude and Longitude location of the cell-center of each removed point, and the data value at that point. At the bottom of these files are also a list of all points added to the file through "nearest neighbor averaging" interpolation (see Section 9.2.3), where the land/water mask indicated land but there was no data in the original file. There is also a column called "Interpolation_Level" that contains the number of times the interpolation routine was run to get a value for that point. The higher the number, the less reliable the value is. There is one ".dif" file for each ASCII map file.

The "change map" files show the results of applying the land/water mask, as a viewable ASCII map: all points added (positive number, containing the "Interpolation_Level", see above), all points unchanged ("0"), and all points removed ("-1"). There is one file per spatial resolution.

8.5 Related Data Sets

NOAA/NESDIS Third Generation Global Vegetation Index (GVI) data.

9. DATA MANIPULATIONS

9.1 Formulas

9.1.1 Derivation Techniques/Algorithms

We used the top-of-the atmosphere (TOA) narrow-to-broadband conversion equation from Hucek and Jacobowitz (1995):

$$R=a(M)R_1+b(M)R_2+c \quad (1)$$

where: *R*: TOA broadband reflectance
R_1: TOA visible reflectance
R_2: TOA near-IR reflectance
M: surface type from the GVI data set i.e. “clear vegetated land” and “clear desert”

We used the ERBE (Suttles et al., 1988) model to account for the bi-directional effects:

$$A(\theta_0)=R(\theta_0,\theta_s,\psi)/\eta(\theta_0,\theta_s,\psi) \quad (2)$$

where: *A*: TOA broadband hemispheric albedo
θ_0: solar zenith angle
θ_s: satellite zenith angle
ψ: relative azimuth angle
η: anisotropy coefficient

The atmospheric correction was done using the model by Li and Garand (1994):

$$A_s(\theta_0)=\alpha(\theta_0,p)+\beta(\theta_0,p)A(\theta_0) \quad (3)$$

where: A_s :surface albedo
p: precipitable water
α, β: coefficients for atmospheric correction

The normalization to overhead sun (θ_0=0) illumination angle was done by the formula from Briegleb et al. (1986):

$$A_0 = A_s(\theta_0) * \xi(\theta_0, M) \quad (4)$$

where: A_0: overhead sun albedo (θ_0=0)
ξ: sun angle dependence factor

9.2 Data Processing Sequence

9.2.1 Processing Steps and Data Sets

1. The weekly GVI cloud mask was used to identify cloud-free visible and near-IR reflectances.
2. Data with T4<280 °K and R1>20% were identified as potential snow and eliminated.
3. Surface type (desert or vegetated land) was determined for each gridbox.
4. Narrow-to-broadband conversion was carried out using Eq. (1).
5. BRDF correction was done by Eq. (2).
6. Precipitable water was extracted from the NASA Water Vapor Project (NVAP) data set (Randel et al., 1996).
7. Atmospheric correction was done after Li and Garand (1994) (Eq. 3 in Section 9.1.1).
8. Normalization to overhead sun was done using Eq. (4). In the sun angle normalization formula the Matthews (1985) vegetation types were used to determine the strong and weak solar angle dependence as follows. Strong dependence: 17, 18, 19, 20, 21, 22, 24, 25, 26, 27, 28, 29, 30, 32; weak dependence: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 23.
9. A 5-year mean of normalized albedos for each month was generated.
10. In case of empty gridcells (mostly due to winter snow cover) the latest snow-free albedo value was used.
11. For evergreen land cover type the lowest yearly value was used for all months to eliminate cloud-and aerosol contamination.
12. Remaining empty gridcells were filled by the Morphology-Dependent Interpolation Procedure.
13. The albedo maps were smoothed by a 3x3 average filter.
14. The original 0.144° resolution data were aggregated into 0.25°, 0.5° and 1° spatial means.

9.2.2 Processing Changes

Not available at this revision.

9.2.3 Additional Processing by the ISLSCP II Staff

The original files submitted by the Investigators have been modified by the ISLSCP II staff in order to match them exactly with the boundaries of the ISLSCP II land/water mask.

9.3 Calculations

9.3.1 Special Corrections/Adjustments

Not available at this revision.

9.4 Graphs and Plots

See Csiszar and Gutman (1999).

10. ERRORS

10.1 Sources of Error

1. The sampling and averaging procedure to derive GAC data from the original 1-km AVHRR measurements, and the sampling and compositing procedure to derive the weekly composites within GVI is believed not to introduce systematic errors.
2. Calibration: the time-dependent visible and near-IR calibration formula may provide calibration coefficients whose accuracy changes over time. However, the calibration of NOAA-9 AVHRR (whose data were mostly used in generating this product), is considered to be relatively good by several authors.
3. Cloud screening: the weekly compositing and the temperature-based cloud screening provide mostly cloud-free data over most of the globe. In areas with persistent cloudiness, such as the tropics, cloud contamination may have remained or the interpolated data from neighboring gridboxes with clear data may not be representative for that gridbox.
4. Snow screening: the GVI data set does not include mid-IR AVHRR data, which are the most sensitive to snow. The temperature and reflectance thresholds used to eliminate snow were intended to be rather conservative, but are still arbitrary. The data set appears to have some snow contaminated data during the melting period. In fact, this was the reason to retain the latest snow-free observations for the winter period, as there seems to be much less snow contamination in the fall.
5. Narrow-to-broadband conversion and BRDF correction. The techniques applied are rather simple empirical formulae. The TOA conversions implicitly assume near-average atmospheric conditions. In extreme cases (such as heavy aerosol loading) they may not work well.
6. Atmospheric correction: the formulae were developed by radiative transfer modeling, assuming a constant aerosol optical depth of 0.05 at 0.55 μm (clear atmosphere). Heavy aerosol loading introduces errors for extremely low or high albedos. The initial monthly product indeed showed an obvious aerosol signal in tropical evergreen regions; hence monthly values were replaced by yearly minima in those areas.
7. Sun angle normalization: the empirical formula may introduce errors in cases where the normalization to overhead sun is equivalent to simulating conditions that are substantially off the normal illumination conditions, such as high latitudes.
8. Interpolation, smoothing and spatial aggregation may introduce artifacts.

10.2 Quality Assessment

10.2.1 Data Validation by Source

The data were validated by comparison to in-situ measurements and to other satellite-derived data sets (for details see Csiszar and Gutman, 1999). Both methods have their own disadvantages: the satellite data, representing a spatially integrated signal that was collected by sampling in time and space, is not compatible with point measurements. Comparison with other (coarser resolution) satellite-derived data sets served as consistency check only.

Instantaneous albedos, without the sun angle correction, have been compared to corresponding instantaneous albedos from the CAGEX (CERES/ARM/GEWEX Experiment) central grid area. Daily mean albedos (derived using the same angular models) were compared to in-situ data from BOREAS (Boreal Ecosystem-Atmosphere Study) field experiments.

Daily mean albedos were compared to three other global albedo data sets: the satellite-based Earth Radiation Budget Experiment (ERBE; Li and Garand, 1994) and Surface Radiation Budget (SRB; Gupta et al., 1997) and the surface-based Matthews (1985) data sets.

10.2.2 Confidence Level/Accuracy Judgment

The albedo maps provide a realistic representation of the expected values. Some errors exist along the snow line in spring.

10.2.3 Measurement Error for Parameters and Variables

The error changes in both time and space. The retrieval is mostly sensitive to atmospheric effects over extremely dark (i.e. evergreen) and extremely bright (desert) surfaces.

10.2.4 Additional Quality Assessment Applied

Not available at this revision.

11. NOTES

11.1 Known Problems with the Data

No known problems other than quality issues discussed in 10.2.2. and the differences in land/water masks found with the ISLSCP II land/water mask.

11.2 Usage Guidance

The users need to be aware that these albedos represent overhead sun conditions as requested by NCEP. For most applications, the albedos need to be converted back to the specific solar zenith angle and, if daily means are needed, to be integrated over the appropriate angular domains.

11.3 Other Relevant Information

The original resolution data set is currently being tested for implementation within the NCEP models. While known problems exist with this data set a positive impact is expected on the models because of the higher resolution and the more realistic values in many areas.

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12.1 Satellite/Instrument/Data Processing Documentation

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12.2 Journal Articles and Study Reports

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13. DATA ACCESS

13.1 Data Access Information

The ISLSCP Initiative II data are archived and distributed through the Oak Ridge National Laboratory (ORNL) DAAC for Biogeochemical Dynamics at http://daac.ornl.gov.

13.2 Contacts for Archive

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

13.3 Archive/Status/Plans

The ISLSCP Initiative II data are archived at the ORNL DAAC. There are no plans to update these data.

14. GLOSSARY OF ACRONYMS

ARM	Atmospheric Radiation Measurement
AVHRR	Advanced Very High Resolution Radiometer
BRDF	Bidirectional Reflectance Distribution Function
BOREAS	Boreal Ecosystem-Atmosphere Study
CAGEX	CERES/ARM/GEWEX Experiment
CERES	Clouds and the Earth's Radiant Energy System
DAAC	Distributed Active Archive Center
DISC	Data and Information Service Center
DVD	Digital Video Disc
ERBE	Earth Radiation Balance Experiment
GAC	Global Area Coverage
GES	Goddard Earth Sciences
GSFC	Goddard Space Flight Center (NASA)
GVI	Global Vegetation Index
GEWEX	Global Energy and Water Cycle Experiment
IFOV	Instantaneous Field of View
ISLSCP	International Satellite Land Surface Climatology Project
ITT	International Telegraph and Telephone
LAC	Local Area Coverage
NASA	National Aeronautics and Space Administration
NCEP	National Centers for Environmental Prediction
NESDIS	National Environmental Satellite Data and Information Service (NOAA)
NOAA	National Oceanic and Atmospheric Administration
NVAP	NASA Water Vapor Project
ORNL	Oak Ridge National Laboratory
TOA	Top Of Atmosphere