



*National Aeronautics and Space  
Administration Goddard Earth Science Data  
Information and Services Center (GES DISC)*

## **README Document for**

### **NASA Energy and Water cycle Study (NEWS) Climatology of the 1<sup>st</sup> decade of the 21<sup>st</sup> Century Dataset**

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# Revision History

| <i>Revision Date</i> | <i>Changes</i>  | <i>Author</i>   |
|----------------------|---|-----------------|
| 09/16/2015           | Initial version based on information from Hiroko Beadoing | Hualan Rui      |
| 09/18/2015           | Review and revise   | Hiroko Beadoing |
| 06/05/2017           | Add DOI information                                       | Hualan Rui      |
| 07/21/2017           | Update URLs to comply with GES DISC new Web site          | Hualan Rui      |

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## Introduction

This dataset summarizes the original observationally-based mean fluxes of Water and Energy Budget (WEB) components during the first decade of the 21<sup>st</sup> Century, for each continent and ocean basin on monthly and annual scales as well as means over all oceans, all continents, and the globe. A careful accounting of uncertainty in the estimates is included. Also, it includes optimized versions of all component fluxes that simultaneously satisfy energy and water cycle balance constraints. This dataset is a product of the companion papers: Rodell et al. 2015 and L'Ecuyer et al. 2015.

*Basic characteristics of the NEWS WEB Climatology data*

**Table 1. Basic characteristics of the NEWS WEB Climatology data.**

|                     |  |
|---------------------|--|
| Contents            | Water and Energy Budget                                |
| Input data          | Observationally-based fluxes and states                |
| Spatial Coverage    | Global   |
| Spatial resolution  | Continents and ocean basins                            |
| Temporal resolution | Annual climatology<br>Monthly climatology              |
| Temporal coverage   | 1 <sup>st</sup> decade of the 21 <sup>st</sup> Century |
| Format              | xlsx, csv, NetCDF                                      |
| Missing value       | -999.00  |

## Updates

Please periodically check the [GES DISC web site](#) and [GES DISC Hydrology Documentation](#) for the latest release.

## Acknowledgment

NASA requests that you include the following acknowledgment in papers published using these data:

*"The data used in this study were acquired as part of the mission of NASA's Earth Science Division and archived and distributed by the Goddard Earth Sciences (GES) Data and Information Services Center (DISC)."*

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## Data Organization

The data are organized in two data products, annual climatology and monthly climatology, and named as:

NEWS\_WEB\_ACLIM.1.0  
 NEWS\_WEB\_MCLIM.1.0

Where “ACLIM” denotes annual climatology and “MCLIM” indicates monthly climatology.

The data are presented in four different units, namely; mm/day, W/m<sup>2</sup>, cm/year (or cm/month), and 1000km<sup>3</sup>, and archived in three different formats, NetCDF(.nc4), Excel (.xlsx), comma delineated text (.csv). The file names are listed in the Table 2.

**Table 2. File names for NEWS WEB Climatology data**

| Format | Annual Climatology File Name   | Monthly Climatology File Name  | Unit                 |
|--------|--------------------------------|--------------------------------|----------------------|
| Excel  | NEWS_WEB_ACLIM.1.0.xlsx        | NEWS_WEB_MCLIM.1.0.xlsx        | *                    |
| csv    | NEWS_WEB_ACLIM.1.0_Wm-2.csv    | NEWS_WEB_MCLIM.1.0_Wm-2.csv    | W/m <sup>2</sup>     |
| csv    | NEWS_WEB_ACLIM.1.0_1000km3.csv | NEWS_WEB_MCLIM.1.0_1000km3.csv | 1000km <sup>3</sup>  |
| csv    | NEWS_WEB_ACLIM.1.0_cmyr-1.csv  | NEWS_WEB_MCLIM.1.0_cmmon-1.csv | cm/year or<br>cm/mon |
| csv    | NEWS_WEB_ACLIM.1.0_mmday-1.csv | NEWS_WEB_MCLIM.1.0_mmday-1.csv | mm/day               |
| NetCDF | NEWS_WEB_ACLIM.1.0.nc4         | NEWS_WEB_MCLIM.1.0.nc4         | **                   |
| NetCDF | NEWS_WEB_REGIONMAP.nc4         | NEWS_WEB_REGIONMAP.nc4         | ***                  |

\* Excel file includes the flux data in all four units, along with the area.

\*\* NetCDF file includes the flux data in all four units, along with names and areas of continents, ocean basins, World Land, World Ocean, and World. Variables are named following the convention:

Vaname\_STATUS\_UNITSNAME

where STATUS is “obs” for observed or “opt” for optimized; UNITSNAME are “volume”, “height”, “rate”, or “flux” for 1000km<sup>3</sup>, cm/year (or cm/month), mm/day, and W/m<sup>2</sup>, respectively.

\*\*\* The data for the map of continents/ocean basins delineation used in the study (Figure 1) is provided in NetCDF format.

## Data Contents

The data set contains the original observationally-based mean fluxes of water and energy budget components during the first decade of the 21<sup>st</sup> Century, for each continent and ocean basin on monthly and annual scales as well as means over all oceans, all continents, and the globe. A careful accounting of uncertainty in the estimates is included. Also, it includes optimized versions of all component fluxes that simultaneously satisfy energy and water cycle balance constraints.

The observationally-based mean fluxes and stores are predominantly satellite based measurements. The model outputs included in the analysis have been constrained by in-situ or remote sensing observations. The sources of data are listed in Table 2 of Rodell et al for water budget and Table 1 of L'Eculyer et al for energy budget components, respectively.

The climatology base period is roughly 1998-2010 where individual dataset covers various periods starting as early as 1998 and as late as 2002, not all extending to 2010.

The continents and Ocean basins boundaries map (Figure 1) is used in this study to compute regional means. The Ocean basin data was provided by Kyle Hilburn and Chelle Gentemann at Remote Sensing Systems. The land portion and some inland water bodies of the data are delineated into continents. The boundaries are defined to be comprehensive global coverage and relevant to past studies. The Table 3 lists the continents and ocean basins, along with the corresponding area in square kilometer. World Land consists of the sum of all continents. Similarly, World Ocean is the sum of all basins. World is the total area.

Figure 1. Continents and Ocean Basins for NEW WEB climatology data

**Continents and Ocean Basins for  
NASA Energy and Water cycle Study (NEWS) Climatology of the 1<sup>st</sup> decade of the 21<sup>st</sup> Century Dataset**



Table 3. Continents and Ocean Basins for NEWS WEB Climatology Data

|   | <b>Region</b>                       | <b>Area (KM<sup>2</sup>)</b> |
|---|-------------------------------------|------------------------------|
| 1 | North America                       | 24030089                     |
| 2 | South America                       | 17737690                     |
| 3 | Eurasia                             | 53234055                     |
| 4 | Africa                              | 29903956                     |
| 5 | Mainland Australia                  | 7560766                      |
| 6 | Australasian and Indonesian Islands | 1484627                      |

|    |                   |           |
|----|-------------------|-----------|
| 7  | Antarctica        | 12705364  |
| 8  | World Land        | 146656546 |
| 9  | Arctic            | 10153134  |
| 10 | North Pacific     | 81774276  |
| 11 | South Pacific     | 99933892  |
| 12 | North Atlantic    | 43384135  |
| 13 | South Atlantic    | 46513141  |
| 14 | Indian            | 75370126  |
| 15 | Caribbean Sea     | 4345760   |
| 16 | Mediterranean Sea | 2604532   |
| 17 | Black Sea         | 472006    |
| 18 | World Ocean       | 364551002 |
| 19 | World             | 511207548 |

*Annual Climatology Data (NEWS\_WEB\_ACLIM.1.0)*

The data product contains 18 variables (Table 4), consisting of 14 flux components, 2 budget terms, and 2 residuals. Each flux variable contains values for mean and uncertainty. All variables contain observed and optimized estimates per region.

**Table 4. Variables in NEWS WEB Annual Climatology Data**

| No. | Short Name (key) | Description   |
|-----|------------------|---|
| 1   | P                | precipitation (atmospheric latent heat)                       |
| 2   | ET/E             | evapotranspiration or ocean evaporation (surface latent heat) |
| 3   | Q                | total runoff  |
| 4   | Q_RUN            | surface runoff portion of Q                                   |
| 5   | Q_SDG            | submarine discharge portion of Q                              |
| 6   | C                | net atmospheric convergence                                   |
| 7   | DLR              | downwelling longwave radiation at surface                     |
| 8   | DSR              | downwelling shortwave radiation at surface                    |
| 9   | ULW              | upwelling longwave radiation emitted by the surface           |
| 10  | USW              | upwelling shortwave radiation reflected by the surface        |
| 11  | SH               | sensible heat flux  |
| 12  | OSR              | outgoing shortwave radiation at top of atmosphere             |
| 13  | OLR              | outgoing longwave radiation at top of atmosphere              |
| 14  | F                | incoming solar radiation at top of atmosphere                 |
| 15  | SWB              | surface water budget residual                                 |
| 16  | AWB              | atmospheric water budget residual                             |
| 17  | NET              | surface energy budget   |
| 18  | NETA             | atmospheric energy budget                                     |
|     | error            | uncertainty of associated flux                                |

Note:

1. “Residual” indicates imbalance in surface and atmospheric water budget where dS and dW are zero at annual scale. They are computed as follows:  
 $SWB = P - ET - Q - dS$  (Land)       $SWB = P - E + Q - dS$  (Ocean)  
 $AWB = P - ET - C + dW$  (Land and Ocean)
2. Energy budget equations for Land and Ocean:  
 $NET = DLR + DSR - ULW - USW - E - SH$   
 $NETA = F - OSR - OLR + P + SH - DLR - DSR + ULW + USW$
3. OSR, OLR, and F are used to constrain NETA at global scale only (World).
4. NET is computed at continents, World Land, World Ocean, and World (no individual basins).
5. Surface runoff and submarine discharge estimates are available only for “observed” because they are not distinguished in the optimization.

*Monthly Climatology Data (NEWS\_WEB\_MCLIM.1.0)*

The data product contains 16 variables (Table 5), consisting of 14 flux and storage/budget variables and 2 residuals. Each of these flux and storage/budget variables has mean and uncertainty. All variables contain observed and optimized monthly estimates per region,

**Table 5. Variables in NEWS WEB Monthly Climatology Data**

|    | <b>Short Name (key)</b> | <b>Description</b>  |
|----|-------------------------|---|
| 1  | P                       | precipitation (atmospheric latent heat)                       |
| 2  | ET/E                    | evapotranspiration or ocean evaporation (surface latent heat) |
| 3  | Q                       | total runoff  |
| 4  | Q_RUN                   | surface runoff portion of Q                                   |
| 5  | Q_SDG                   | submarine discharge portion of Q                              |
| 6  | C                       | net atmospheric convergence                                   |
| 7  | dS                      | change in surface water storage                               |
| 8  | dW                      | change in precipitable water in the atmospheric column        |
| 9  | DLR                     | downwelling longwave radiation at surface                     |
| 10 | DSR                     | downwelling shortwave radiation at surface                    |
| 11 | ULW                     | upwelling longwave radiation emitted by the surface           |
| 12 | USW                     | upwelling shortwave radiation reflected by the surface        |
| 13 | SH                      | sensible heat flux  |
| 14 | SWB                     | surface water budget residual                                 |
| 15 | AWB                     | atmospheric water budget residual                             |
| 16 | NET                     | surface energy budget   |
|    | error                   | uncertainty of associated flux                                |

Note:

1. “Residual” indicates imbalance in surface and atmospheric water budget and they are computed as follows:  
 $SWB = P - ET - Q - dS$  (Land)       $SWB = P - E + Q - dS$  (Ocean)  
 $AWB = P - ET - C + dW$  (Land and Ocean)



2. Energy budget equation:

$$\text{NET} = \text{DLR} + \text{DSR} - \text{ULW} - \text{USW} - \text{ET} - \text{SH (Land)}$$

$$\text{NET} = \text{DLR} + \text{DSR} - \text{ULW} - \text{USW} - \text{E} - \text{SH (Ocean)}$$

*Region Map Data (NEWS\_WEB\_REGIONMAP)*

The map data contains indexes ranging from 1 to 19 (Table 6). The indexes are mapped into the NEWS Region (right column) to arrive at the regions used in this study (Figure 1).

**Table 6 NEWS WEB REGIONMAP Data**

| Value | Key                                 | NEWS Region                         |
|-------|-------------------------------------|-------------------------------------|
| 1     | Arctic                              | Arctic                              |
| 2     | Caribbean Sea                       | Caribbean Sea                       |
| 3     | Mediterranean Sea                   | Mediterranean Sea                   |
| 4     | Black Sea                           | Black Sea                           |
| 5     | Caspian Sea                         | Eurasia                             |
| 6     | Great Lakes                         | North America                       |
| 7     | North Pacific                       | North Pacific                       |
| 8     | North Atlantic                      | North Atlantic                      |
| 9     | Indian                              | Indian                              |
| 10    | South Pacific                       | South Pacific                       |
| 11    | South Atlantic                      | South Atlantic                      |
| 12    | Antarctica                          | Antarctica                          |
| 13    | South America                       | South America                       |
| 14    | North America                       | North America                       |
| 15    | Africa                              | Africa                              |
| 16    | Eurasia                             | Eurasia                             |
| 17    | Mainland Australia                  | Mainland Australia                  |
| 18    | Australasian and Indonesian Islands | Australasian and Indonesian Islands |
| 19    | Greenland                           | North America                       |

## Reading the Data

The NEWS WEB Climatology Data are archived in xlsx, csv, and NetCDF formats.

The xlsx and csv files can be opened by Excel.

NetCDF is a self-describing and machine-independent NetCDF format. A Unidata page, <http://www.unidata.ucar.edu/software/netcdf/software.html>, provides a list of software for manipulating or displaying NetCDF Data.

### *Reading/viewing the data by Panoply*

Panoply, <http://www.giss.nasa.gov/tools/panoply/>, is a cross-platform application that plots geo-referenced and other arrays from NetCDF, HDF, GRIB, and other data sets.

The [HowTo](#) of NASA GES DISC provides a recipe for [Quick View Data with Panoply](#).

## **Data Access**

The NASA GES DISC maintains archives of the NEWS WEB Climatology Data and many other Hydrology data sets. The archived data can be accessed via HTTP network transfer. The data can be accessed via the GES DISC Unified User Interface (UI) at <https://disc.sci.gsfc.nasa.gov/datasets?keywords=NEWS>.

### *Data Volume*

Since the data are climatology data, total data volume is less than 10 MB, including 0.3 MB for annual mean data and 1.2 MB for monthly mean data, and 4.1 MB for the Region Map data.

### *Search and download data via Mirador*

The NEWS WEB Climatology Data can be searched through a keyword (e.g., NEWS) and downloaded via Mirador, <http://mirador.gsfc.nasa.gov/>.

### *HTTP Access*

The NEWS WEB Climatology Data can be downloaded directly via the GES DISC HTTP server: <https://hydro1.gesdisc.eosdis.nasa.gov/data/NEWS/>.

## **Points of Contact**

For information about or assistance in using any GES DISC data, please contact the GES DISC Help Desk at:

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## DOI

A Digital Object Identifier or DOI is a unique alphanumeric string used to identify a digital object and provide a permanent link online. DOIs are often used in online publications in citations. The table 3 list DOI for the NEWS WEB Climatology Data Version 1.0 data product.

**Table 6. DOI for NEWS WEB Climatology Data Products**

| Short Name        | Product Description  | DOI   |
|-------------------|--|---|
| NEWS_WEB_ACLIM.10 | NASA Energy and Water cycle Study (NEWS) Annual Climatology of the 1st decade of the 21st Century  | <a href="https://doi.org/10.5067/7VZB10AK8S3D">10.5067/7VZB10AK8S3D</a> |
| NEWS_WEB_MCLIM.10 | NASA Energy and Water cycle Study (NEWS) Monthly Climatology of the 1st decade of the 21st Century | <a href="https://doi.org/10.5067/H3TJ8AZDTOXS">10.5067/H3TJ8AZDTOXS</a> |

The DOI in the Table 6 will be linked to the corresponding data product page and Data Citation for the data product is on top of the page. If you use the data in your research or applications please include a reference in your publication(s) similar to the following example:

Matthew Rodell, Tristan L'Ecuyer, and Hiroko Kato Beaudoin, NASA/GSFC/HSL (10.01.2015), NASA Energy and Water cycle Study (NEWS) Monthly Climatology of the 1st decade of the 21st Century *Version 1.0*, Greenbelt, Maryland, USA: Goddard Earth Sciences Data and Information Services Center (GES DISC), Accessed **Enter User Data Access Date** at doi: 10.5067/H3TJ8AZDTOXS.

## References

Rodell, M., H. Beaudoin, T. L'Ecuyer, W. Olson, J. Famiglietti, P. Houser, R. Adler, M. Bosilovich, C. Clayson, D. Chambers, E. Clark, E. Fetzer, X. Gao, G. Gu, K. Hilburn, G. Huffman, D. Lettenmaier, W. Liu, F. Robertson, C. Schlosser, J. Sheffield, and E. Wood, 2015: The Observed State of the Water Cycle in the Early 21st Century. *J. Climate*. doi:10.1175/JCLI-D-14-00555.1, in press.

L'Ecuyer, T., H. Beaudoin, M. Rodell, W. Olson, B. Lin, S. Kato, C. Clayson, E. Wood, J. Sheffield, R. Adler, G. Huffman, M. Bosilovich, G. Gu, F. Roberston, P. Houser, D. Chambers, J. Famiglietti, E. Fetzer, W. Liu, X. Gao, C. Schlosser, E. Clark, D. Lettenmaier, and K. Hilburn, 2015: The Observed State of the Energy Budget in the Early 21st Century. *J. Climate*. doi:10.1175/JCLI-D-14-00556.1, in press.

## Appendices

### A. Acronyms

The following acronyms and abbreviations are used in this document.

|          |  |
|----------|--|
| DOI      | Digital Object Identifier  |
| GES DISC | Goddard Earth Sciences Data and Information Services Center      |
| HDF      | Hierarchical Data Format   |
| HDISC    | Hydrology Data and Information Services Center                   |
| HSL      | Hydrological Sciences Laboratory                                 |
| Mirador  | Fast interface for searching Earth science data at NASA GES DISC |
| NEWS     | NASA Energy and Water cycle Study                                |
| NASA     | National Aeronautics and Space Administration                    |
| NetCDF   | Network Common Data Form   |
| WEB      | Water and Energy Budget  |