GLEAM v3.6 Datasets

1. – GENERAL

The Global Land Evaporation Amsterdam Model[1,2] (GLEAM) is a set of algorithms that separately estimate the different components of terrestrial evaporation (i.e. '*evapotranspiration*') based on satellite observations: transpiration (*Et*), interception loss (*Ei*), bare-soil evaporation (*Eb*), snow sublimation (*Es*) and open-water evaporation (*Ew*). Intermediate outputs of the model include: potential evaporation (*Ep*), root-zone soil moisture (*SMroot*), surface soil moisture (*SMsurf*), and evaporative stress (*S*).

The rationale of the method is to maximize the recovery of information about evaporation contained in the available data stack of climatic and environmental observations from space. A Priestley and Taylor equation calculates *Ep* based on observations of surface net radiation and near-surface air temperature[3]. Potential evaporation estimates are converted into actual evaporation based on the multiplicative, evaporative stress factor *S*. The derivation of *S* is based on microwave observations of the vegetation optical depth – used as a proxy for the vegetation water content – and simulations of root-zone soil moisture. The latter is calculated using a multi-layer running water balance that describes the infiltration of observed precipitation through the vertical soil profile. To correct for random forcing errors, microwave observations of surface soil moisture are assimilated into the soil profile[4]. Interception loss is calculated separately based on the Gash analytical model of rainfall interception[4,5] driven by observations of precipitation and both vegetation and rainfall characteristics. Estimates of actual evaporation for regions covered by ice and/or snow are derived using a Priestley and Taylor equation adapted for ice and super-cooled waters. For a detailed description the reader is directed to Miralles *et al.* (2011)[1,2] and Martens *et al.* (2017)[6].

The version 3 of the model includes:

1. A new data assimilation scheme that was validated in Martens *et al*. (2017)[6].
2. An updated water-balance module that describes the infiltration rates as a function of the vertical gradient in soil moisture[6].
3. Updated evaporative stress functions (based on experimental evidence) that combine the vegetation optical depth and the root-zone soil moisture estimates[6].

As of 20th of June 2022, two datasets produced using **GLEAM v3** are currently available at the www.gleam.eu server: **GLEAM v3.6a** and **GLEAM v3.6b**.

2. – DATA CHARACTERISTICS

Differences between the GLEAM v3.6 and the previous v3.5 datasets are:

1. Both v3.6a and v3.6b use the latest version of MSWEP precipitation (v2.8), ESA-CCI soil moisture (v6.2), and VODCA Vegetation optical depth (Table 1).

2. The v3.6a dataset now uses the new Multi-Source Weather (MSWX) dataset for radiation and temperature (Table 1).
3. All forcing datasets have been updated to their last versions and extended until the end of 2021.
4. Next to the usual daily data, both monthly and yearly datasets are available now as well.
5. The dimension order in both v3.6a and v3.6b has been changed from **[time, longitude, latitude]** to **[time, latitude, longitude]**.

The two datasets available on this server differ only in their forcing and temporal coverage:

1. **GLEAM v3.6a**: a global dataset spanning the 42-year period 1980–2021. The dataset is based on reanalysis radiation and air temperature, a combination of gauge-based, reanalysis and satellite-based precipitation, and satellite-based vegetation optical depth (see Table 1).
2. **GLEAM v3.6b**: a global dataset spanning the 19-year period 2003–2021. The dataset is largely driven by satellite data (see Table 1).

Table 1 provides more information on the forcing variables used to produce these datasets. All GLEAM datasets are provided on a 0.25° x 0.25° latitude–longitude grid and with a daily temporal resolution.

Table 1: Overview of forcing datasets.

Forcing Variable	**GLEAM v3.6a**	**GLEAM v3.6b**
Radiation	MSWX[7]	CERES L3 SYN1deg Ed4.1[14]
Air Temperature	MSWX[7]	AIRS L3 RetStd v7.0[15]
Precipitation	MSWEP v2.8[8]	MSWEP v2.8[8]
Snow Water Equivalent	GLOBSNOW L3v2[9] & NSIDC v01[10]	GLOBSNOW L3v2[9] & NSIDC v01[10]
Vegetation Optical Depth	VODCA[11]	VODCA[11]
Surface Soil Moisture*	ESA-CCI v6.2[12,13]	ESA-CCI v6.2[12,13]
Vegetation Fractions	MEaSUREs VCF5KYR_001[16]	MOD44B v6.0[17]

*** Note that the surface soil moisture is assimilated into GLEAM thus is not a forcing variable as such.**

3. – FILE ORGANISATION

Datasets are organised in netcdf files. There is one netcdf file per variable and per year, and they are stored as a **3D array with dimensions *n-days* x 720 x 1440** (*n-days* is the number of days in the corresponding year). Therefore, the first cell corresponds to the 1 st of January of the corresponding year, and it is centred at latitude 89.875 and longitude -179.875. The following 10 variables are available:

1. ***E*** - Actual evaporation [mm/day]
2. ***Ep*** - Potential evaporation [mm/day]
3. ***Ei*** - Interception loss [mm/day]
4. ***Eb*** - Bare-soil evaporation [mm/day]
5. ***Es*** - Snow sublimation [mm/day]
6. ***Et*** - Transpiration [mm/day]
7. ***Ew*** - Open-water evaporation [mm/day]
8. ***S*** - Evaporative stress factor [-]
9. ***SMroot*** - Root-zone soil moisture [m3/m3]
10. ***SMsurf*** - Surface soil moisture; 0-10 [m3/m3]

Note that by definition: ***E = Et + Eb + Ew + Ei + Es*** and ***S = E/Ep***. Missing values in the files are masked with –999.

Next to the daily data, temporally aggregated files (monthly and yearly) are also available. There is one netcdf file per variable with the entire record at either monthly (dimensions ***n-days* x 720 x 1440**), or yearly (dimensions ***n-days* x 720 x 1440**) temporal resolution, date stamps are set to roughly the end (i.e. the end of the aggregation period) of the month or year, respectively.

4. – DATA POLICY

Datasets are freely available and can be downloaded from this server. Use of the data is however subject to the following terms and conditions:

1. **Acknowledgements.** Whenever GLEAM datasets are used in a scientific publication, the following references should be cited:
    - Martens, B., Miralles, D.G., Lievens, H., van der Schalie, R., de Jeu, R.A.M., Fernández-Prieto, D., Beck, H.E., Dorigo, W.A. and Verhoest, N.E.C.: GLEAM v3: satellite-based land evaporation and root-zone soil moisture, Geoscientific Model Development , 10, 1903–1925, doi: 10.5194/gmd-10-1903-2017, 2017.
    - Miralles, D.G., Holmes, T.R.H., De Jeu, R.A.M., Gash, J.H., Meesters, A.G.C.A., Dolman, A.J.: Global land-surface evaporation estimated from satellite-based observations, Hydrology and Earth System Sciences , 15, 453–469, doi: 10.5194/hess-15-453-2011, 2011.
2. **Scientific use only**. GLEAM datasets will not be used for commercial purposes.

5. – FINAL REMARKS

1. The reader is referred to the **references below for more detailed information** about the model.
2. Please consider having a look at our list of frequently asked questions and answers at www.gleam.eu.

3. Any feedback about the datasets and/or website is highly appreciated and can be sent through email to info@gleam.eu and/or to Akash Koppa (Postdoctoral Researcher, Hydro-Climate Extremes Lab, Ghent University, Belgium) at akash.koppa@ugent.be.

6. – REFERENCES

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