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--- Method Description ---

GLEAM (Global Land Evaporation: the Amsterdam Model) is a set of algorithms driven by observations that separately estimate the different components of land evaporation (or evapotranspiration, E): transpiration, interception loss, bare-soil evaporation, snow sublimation and open-water evaporation.

Additionally, GLEAM calculates root-zone soil moisture and evaporative stress conditions. The rationale of the method is to maximize the recovery of information about evaporation contained in the current satellite observations of climatic and environmental variables.

The Priestley and Taylor (PT) equation used in GLEAM calculates potential evaporation based on observations of surface net radiation and surface air temperature. Potential evaporation estimates for the fractions of vegetation and bare soil within each pixel (see below) are converted into transpiration and soil evaporation (respectively) using a multiplicative evaporative stress factor (S).

The derivation of S is based on observations of vegetation optical depth (a proxy for vegetation water content) and estimates of root-zone soil moisture. The latter is calculated at daily time steps based on a multi-layer running water balance that describes the infiltration of precipitation (observations) through the vertical soil profile, and in which the estimates of E from the previous time step are substracted. Microwave surface soil moisture observations are also be assimilated into the profile.

To derive interception, a Gash analytical model of rainfall interception is driven by observations of precipitation while considering different vegetation characteristics (e.g. fraction of tall canopy per pixel, canopy storage properties, etc.). For water bodies and for regions covered by ice and snow are calculated based on a PT equation run with look-up table parameter values for open water and ice respectively.

The main features of the approach are:
(a) the consideration of soil moisture constraints acting on evaporation,
(b) the detailed parameterization of interception loss, and
(c) the extensive use of microwave observations (an asset under cloudy conditions).
Details of the method are presented in the References below.

--- Dataset Description ---

GLEAM has been run with a large variety of inputs since 2011 (see References for some examples); the versions v2A and v2B that we hold here are based on the sets of inputs described below.

The v2A product is based on gauge precipitation and reanalysis radiation, among the rest of (satellite-based) inputs. It spans the period 1980-2011 at the global scale (90N – 90S), daily resolution, 0.25 degree lat/lon.

List of dynamic inputs to GLEAM v2A:

- Radiation: ERA Interim [Dee et al., Quart. J. Roy. Meteorol. Soc. 137, 553-597 (2011)]
- Precipitation: CPC-Unified [Joyce et al., J. Hydrometeorol. 5, 487-503 (2004)]
- Air Temperature: ISCCP+AIRS [Rossow & Dueñas, Bull. Am. Meteorol. Soc., 85, 167-172 (2004)]
- Surface soil moisture: WACMOS-CCI [Liu et al. Remote Sens. Environ. 123, 1-18 (2012)]
- Vegetation Optical Depth: LPRM-NASA [Liu et al., Global Ecol. Biogeogr., 22, 692-705 (2013)]
- Snow water equivalents: GlobSnow [Luojus & Pulliainen, Globsnow product guide. Helsinki, Finland (2010)]

The v2B product is a priori (and based on site comparisons) and overall better product. It is fully based on satellite inputs. It spans the period 2000-2011. The latitudal domain ranges from 59N to 59S (CMORPH domain). Daily resolution, 0.25 degree lat/lon.

List of dynamic inputs to GLEAM v2B:

- Radiation: CERES SYN1deg [Wielicki et al., Bull. Am. Meteorol. Soc. 77, 853-868 (1996)]
- Precipitation: CMORPH v1 [Joyce et al., J. Hydrometeorol. 5, 487-503 (2004)]
- Air Temperature: AIRS v7 [Braverman et al., Technometrics 54, 1-15 (2012)]
- Surface soil moisture: WACMOS-CCI [Liu et al. Remote Sens. Environ. 123, 1-18 (2012)]
- Vegetation Optical Depth: LPRM-NASA [Liu et al., Global Ecol. Biogeogr., 22, 692-705 (2013)]
- Snow water equivalents: GlobSnow [Luojus & Pulliainen, Globsnow product guide. Helsinki, Finland (2010)]

-- Dataset Format ---

The files contain global maps at 0.25 degree lat/lon spatial resolution, regrouped in annual netcdf files. For v2A the file size is therefore 720x1440x365 gridcells (latitude x longitude x days), with leap years 720x1440x366. For v2B the file size is 472x1440x365, and 472x1440x366 for leap years.
They are netcdf 4 that have been produced using Matlab.

Values of '-9' indicate no values. Oceans are masked out.

There are 4 variables listed separately (in independent annual netcdf files):
- E: total evaporation (i.e. evapotranspiration)
- T: transpiration
- I: forest interception loss
- E_b: (bare) soil evaporation

Units are mm/day.
The first number in each file will correspond to the top-left corner of the map for January 1st of the corresponding year. Considering the 0.25 degree resolution, for v2A, the first cell will be centered at latitude: 90-0.25/2, longitude: -180+0.25/2.

-- Usage Policy --

Please inform Diego Miralles (diego.miralles@ugent.be) if you plan to publish results based on this data.

Publication should be accompanied by reference to:

Miralles, D.G., Holmes, T.R.H., De Jeu, R.A.M., Gash, J. H., Meesters, A.G.C.A., and Dolman, A.J.: Global land-surface evaporation estimated from satellite-based observations, Hydrol. Earth Syst. Sci., 15, 453-469, 2011.

Miralles, D.G., De Jeu, R.A.M., Gash, J.H., Holmes, T.R.H., and Dolman, A.J.: Magnitude and variability of land evaporation and its components at the global scale, Hydrol. Earth Syst. Sci., 15, 967-981, 2011.

-- Other References --

Miralles, D.G., Gash, J.H., Holmes, T.R.H., De Jeu, R.A.M. & Dolman A.J. Global canopy interception from satellite observations. J. Geophys. Res. D: Atmos., 115, D16122, doi: 10.1029/2009JD013530, 2010.

Mueller, B., Hirschi, M., Jimenez, C., Ciais, P., Dirmeyer, P.A., Dolman, A.J., Fisher, J.B., Jung, M., Ludwig, F. Maignan, F., Miralles, D.G., McCabe, M.F., Reichstein, M., Sheffield, J., Wang, K., Wood, E.F., Zhang, Y. & Seneviratne, S.I. Benchmark products for land evapotranspiration: LandFlux-EVAL multi-dataset synthesis. Hydrol. Earth Syst. Sci., 10, 769-805, 2013.

Miralles, D.G., van den Berg, M.J., Gash, J.H., Parinussa, R.M., de Jeu, R.A.M., Beck, H.E., Holmes, T.R.H., Jimenez, C., Verhoest, N.E.C., Dorigo, W.A., Teuling, A.J., and Dolman, A.J. El Niño-La Niña cycle and recent trends in continental evaporation, Nature Clim. Change, 4, 122-126, 2014.

Miralles, D.G., Teuling, A.J., van Heerwaarden, C.C., de Jeu, R.A.M., and Vila-Guerau de Arellano, J. Megaheatwave temperatures due to combined soil desiccation and atmospheric heat accumulation, Nature Geosc., 7, 3453-49, 2014.