HARMONYANALYTICA

freeET Reference ET Specification

freeet.app · Rev 1 · October 8, 2026

freeET computes reference ET itself, every day, for any ZIP or postal code in the USA and Canada. It uses the ASCE Standardized Penman-Monteith method, the same one FAO-56 defines and irrigation science has used for 30 years, fed by seven weather inputs for that exact point. A second, independent source is printed beside the number as a check. Past days come from observed weather; today comes from forecast weather and says so.

WHAT GOES IN · SEVEN INPUTS, EVERY DAY

INPUT	WHAT IT DOES
High and low temperature	Sets how much moisture the air can hold
Humidity	Says how much it already holds; the gap is the pull
Wind	Carries moist air away; measured at 10 m, adjusted to 2 m
Solar radiation	The energy that evaporates water; the largest driver
Elevation	Air pressure, and the most sun physically possible
Latitude and date	Day length and the sun's angle

All weather inputs come from one request per place: 31 days back, 16 days ahead, in the place's own time zone. A day with any input missing is not computed. No guessing, no filling gaps.

WHERE THE DATA COMES FROM

	OPEN-METEO	GRIDMET
Role	Supplies all seven inputs	Independent check, never the number
What it is	National weather-model output (NOAA, ECMWF, DWD, Canada's GEM), interpolated to the point	4 km daily weather grid from the Climatology Lab, University of California Merced
Covers	USA and Canada	Contiguous US; 1 to 2 days behind

HOW WE TELL TIME

- **OBSERVED** Any day before today, computed from the record of what happened. Solid bar on screen.
- **FORECAST** Today and later, computed from forecast weather. Dashed bar and a tag until the day ends. The two are never averaged together.
- "So far today" adds up this morning's hourly ET to the current hour, as progress toward the forecast.

SOLAR RADIATION, THE ENERGY INPUT

What it is. The sun's energy reaching a flat patch of ground over the whole day, in megajoules per square metre. One unit evaporates about 0.4 mm of water. At 45°N a clear June day brings 25 to 28; the same day under heavy cloud, 8 to 10; a December day, 3 to 6. In most places for most of the year it decides more of the ET than any other input.

Where it comes from. Open-Meteo's daily shortwave radiation: the weather model's own estimate of sun at the surface, built from its cloud forecast and, for past days, its analysis of the day. **It is model output, not a measurement.** No pyranometer, weather station or satellite retrieval is in the chain today.

What we do with it.

1. **Cap it at clear sky.** We work out the most sun possible for that latitude, date and elevation. A value above it is a data error and is clipped.
2. **Take off what grass reflects.** About a quarter bounces back; 77% is absorbed and drives evaporation.
3. **Use the cloudiness twice.** Actual sun against clear-sky sun says how cloudy the day was, which also sets how much heat the ground radiates away at night. Clear days lose more.
4. **Net energy drives the number.** Sun in, minus heat out, becomes the radiation share of the day's ET; wind and dry air add the rest.

~0.18 mm
of ET per unit of sun on a 21 °C day

3.4 mm
clear vs overcast June day, same heat, humidity, wind

10–20%
typical forecast error in cloud; why today is tagged

What it means. Two days with the same high, humidity and wind can differ by half their ET on cloud alone, and a controller that runs on temperature never sees it. Past days are better than forecasts but still modelled; expect a few percent bias and 5 to 10% day-to-day scatter against a good pyranometer. Shade, slopes and lake-effect cloud below the model's grid are not resolved. A station at the site would replace the sun input with a measurement under the same method; that is planned, not built.

HOW WE KNOW IT IS RIGHT

- The code reproduces the FAO-56 handbook's own worked example (Bangkok, 6 July: **5.72 mm/day**) within 1%, plus its examples for humidity, wind and sun angle. These tests run on every build.
- Live at Traverse City, MI, in October 2026: the week's total within 7 to 10% of gridMET's, the expected gap between two weather models feeding one method.
- Next step: a side-by-side against a pyranometer-equipped reference station (CIMIS, AgriMet, Enviroweather).

Allen et al. 1998 (FAO-56) · ASCE-EWRI 2005 · Abatzoglou 2013 (gridMET) · open-meteo.com