Revision of TMY3 Weather Files

White Box Technologies (WBT), in collaboration with the National Renewable Energy Laboratory (NREL), has revised the TMY3 weather files to correct inconsistencies in units for illuminances, improve the reporting of Liquid Precipitation, replace all missing records with interpolated or filled values (chiefly for visibility, ceiling height, aerosol optical depth, and albedo), and add a new variable for Present Weather.

Since their release in 2005, the TMY3 weather files covering 1,020 locations in the US and dependencies has become the standard set of weather files for use in computer simulations of solar energy conversion systems and buildings. For more information about the TMY3 data set, please go to http://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3.

The intent of this revision is not to redo the fundamental analysis, but to correct some known errors and make modest improvements in the reporting of subsidiary climate variables. The only changes that could affect building energy simulations are those for illuminance (used in daylighting programs such as *Radiance*), and Liquid Precipitation (used to model Green Roofs in *EnergyPlus*, and possibly other programs that model moisture migration in building envelope). Filling in missing data for Visibility, Ceiling Height, etc., should have no effect on any known simulation program, but makes the TMY3 files more usable for further analysis.

Explanation of changes in content:

1) Illuminance. The TMY3s contain values for Global Horizontal, Direct Normal, Diffuse Horizontal, and Zenith Illuminance that are calculated based on the sun position and solar radiation. Although the documentation states that the units are 100 lux for the first three illuminances, and 10 candela/m^2 for the Zenith Illuminance, all the TMY3 files used these units only for the period Jan. 2-31, and for the rest of the year used units of lux and candela/m^2, respectively. NREL put out a notice in August 2008 suggesting that users multiply the illuminances for Jan. 2-31 by 100 (for lux) or 10 (for candela), which would then make all the illuminance data have units of lux or candela/m^2. In this revision, we've decided to keep the units in the original TMY3 documentation, i.e., 100 lux or 10 candela/m^2, which is the same as what was in the TMY2, and avoids the otherwise superfluous five-digit precision.

2) Liquid Precipitation. The TMY3s are the first set of TMY files to contain Liquid Precipitation (rainfall). In the original TMY3 files, rainfall was taken directly from weather station reports with two numbers, one for the amount and the other for the duration in hours of the rainfall. The difficulties moving this reporting to hourly weather files are: (1) the rainfall needs to be apportioned to hourly values, and (2) there can be multiple or overlapping records that were ignored. Furthermore, by changing the precipitation units from 0.1mm to 1mm, the TMY3s contained significant round-off errors. In this revision, WBT went back to the raw weather reports from the National Climatic Data Center (NCDC) and applied a procedure developed for ASHRAE RP-1477 that checks for multiple records as well as disaggregate the rainfall to hourly values. To winnow out spurious reports, filters were added to limit the maximum amount of rainfall per hour, and to omit it if the dewpoint temperature dropped below freezing. Overall, the revised rainfall correlated much better to historical averages, although there probably remains significant undercounting in a number of locations. For example, 23 locations out of the 1,020 (2.3%) reported no rainfall throughout the year (see XXXX for a more detailed discussion of this work).

3) Filling in missing values. One of the main reasons to use processed weather files like TMY3s is the absence of missing records, as often found in raw weather data. Thus, it was surprising that the original TMY3s contained a lot of missing data, albeit almost all for secondary variables like Liquid Precipitation, Visibility, Ceiling Height, calculated variables like Aerosol Optical Depth and Albedo, and on one file (Mountain View CA) Wind Direction. Although none of these instances will likely cause problems for simulations, in the spirit of completeness all of them have been filled using either linear interpolation for continuous values (Visibility, Ceiling Height, etc.) or a step function for discrete values (Wind Direction, Present Weather).

4) Present Weather. This variable is a qualitative description of weather conditions, e.g., clear, rain, snow, etc., generally recorded using a numerical code. Although the TMY3s do not contain this variable, the previous TMY2s did using a 10-digit numerical code. Although Present Weather is not used directly in any calculations, it's a useful variable to corroborate other variables for precipitation, cloud cover, etc. For example, in revising the Liquid Precipitation described earlier, Present Weather was used to decide whether or not reported heavy rainfall was bogus. In this revision, an extra field has been added to the end of each line with the international METAR 2-digit code for Present Weather.

Explanation of changes in format

The canonical form of the TMY3 files are in the *.CSV format. Since the illuminance data revert back to the units in the TMY3 documentation, there are only two minor changes in the TMY3.CSV format: (1) unit for Liquid precipitation depth (Variable 65) is changed from 1mm to 0.1mm, (2) a 2-digit number for Present Weather has been added at the end of each line as Variable 69. For those familiar with ASHRAE's IWEC2 files, with these changes the data line format of the two types of files are now exactly the same, although the header line formats are still slightly different.

Conversion of the revised TMY3.CSV files to TMY2 or EPW should not be a problem, as long as the change in units for Liquid Precipitation has been noted, and the illuminance units are those in the original TMY3 documentation. Conversion of the revised TMY3.CSV files to BINM is unnecessary since the BINM files do not include any of the changed variables.

The updated TMY3 files are available on the NREL TMY3 web site at http://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3

The updated TMY3 files in EPW and BINM formats are available on the White Box Technologies web site at weather.whiteboxtechnologies.com/wd-TMY3 or by selecting File Type as "TMY3" at weather.whiteboxtechnologies.com/search .