

WeatherDriversResultsFiles.zip included Files:

Annual and Monthly Summaries (pdf files ending with \_summary\_charts)

Each file includes charts with results for each output variable aggregated annually and monthly. For the variables that are included in the weather files, the aggregated totals and the absolute error between the program results and the values in the weather file are displayed. The absolute errors are simply the difference between the weather file totals and the program totals. For the variables that are derived from the values in the weather files, the aggregated totals and a box-whisker plot of the results are given. The box-whisker plot shows the individual results on top of the IQR box and the whiskers at 1.5 times the IQR. Points outside of the whiskers could be considered outliers.

There are individual files for each test case and for the differences between WD600 results and WD100 results to test the effect of adding ground reflectance.

The summary\_analysis.csv file includes all of the annual and monthly results that are plotted in the other files.

Integrated Summaries

The file integration\_charts.pdf includes comparisons between the program results integrated hourly and the values in the weather files. These comparisons are an indication of how well the programs recreate the values from the weather files that are totals over the hour (total horizontal solar radiation and horizontal diffuse solar radiation). (The weather file includes direct normal radiation which is not a direct comparison to horizontal beam radiation.) Two different comparisons are given for each variable for each test: Mean Bias Error and Root Mean Square Error.

Daily Plots

Each file includes plots of one day of results for each program and the weather file (as appropriate). These are the timestep outputs from each program. Since each program and the weather file each use different timesteps and output standards no error plots are provided for the daily outputs. There are also charts of the hourly integrated total and diffuse horizontal solar radiation for comparison with the values from the weather file.

## Individual Program Comments

Some of the programs required corrections to the submitted spreadsheets before we could perform the data analysis. These corrections are listed under “Corrections to submitted results”.

There are a large number of plots in all of the files. For each program we have gone through the plots and highlighted potential issues in the results. These are simply our interpretations and you might find the issues insignificant and/or you might see other issues for investigation.

### Program A

Corrections to submitted results:

- Solar radiation values needed to be divided by 1000
- Cloud cover values are always 0. (If these are not output from the program they should be blank.)

Some potential issues for discussion we noticed (you may notice others):

- Sky temperatures differ from other programs even if they are using the same algorithms.
- Solar radiation on tilted surfaces differs from the other programs – especially the East and West surfaces. The daily plots show differences from programs that use the same algorithms for tilted surface radiation. Some of the daily plots show a possible time lag on the radiation.
- Relative humidity sometimes differs (WD200, WD400)
- WD600-WD100: Radiation shows less of an effect of ground reflectance than other programs
- WD600-WD100 4/14: Radiation shows a potential time shift between the two test cases
- Hourly integrated total horizontal radiation – daily plots (WD100 5/4, WD100 7/14, WD100 9/6, WD200 5/24, WD200 8/26, WD300 2/7, WD300 8/13, WD400 7/1, WD500 3/1, WD500 9/14)
- Hourly integrated diffuse horizontal radiation – daily plots (WD100 5/4, WD100 7/14, WD100 9/6, WD200 5/24, WD200 8/26, WD300 2/7, WD300 8/13, WD400 7/1, WD500 3/1, WD500 9/14)

### Program B

Some potential issues for discussion we noticed (you may notice others):

- Solar radiation – both direct/diffuse split and tilted surface radiation show differences from the other programs
- Relative humidity sometimes differs
- Hourly integrated total horizontal radiation – daily plots (WD100 9/6, WD200 8/26, WD300 2/7, WD300 8/13, WD400 7/1, WD500 3/1, WD500 9/14)
- Hourly integrated diffuse horizontal radiation – daily plots (WD100 7/14, WD100 9/6, WD200 8/26, WD300 2/7, WD300 8/13, WD400 7/1, WD500 3/1, WD500 9/14)

### Program C

Corrections to submitted results:

- Station Pressure needed to be divided by 100
- Wind Direction – when the wind speed is 0, wind direction is not reported (this causes data processing issues and the wind direction has been set to 0 for these periods)

Some potential issues for discussion we noticed (you may notice others):

- Relative humidity sometimes differs (WD200, WD400)
- WD200 5/24 – tilted surface radiation
- WD100 5/4 – tilted surface radiation
- WD200 – south surface radiation
- WD400 – tilted surface radiation
- WD500 – south surface radiation

#### Program D

Corrections to submitted results:

- Time of Year – should be the hour of the year
- Solar Radiation – values needed to be multiplied by 6

Some potential issues for discussion we noticed (you may notice others):

- Wet Bulb Temperatures differ from the other programs
- Hourly integrated total horizontal radiation – daily plots (WD100 9/6)

#### Program E

Some potential issues for discussion we noticed (you may notice others):

- WD300 and WD500 – appear to have a time shift in the results
- WD300 & WD500 – East and West solar radiation
- WD100 & WD400 daily plots – diffuse radiation
- WD300 2/7 – station pressure
- WD300 & WD500 – integrated solar radiation
- Hourly integrated total horizontal radiation – daily plots (WD100 9/6, WD200 5/24, WD400 7/1, WD500 9/14)
- Hourly integrated diffuse horizontal radiation – daily plots (WD100 9/6, WD200 5/24, WD200 8/26, WD400 7/1, WD500 3/1)

#### Program F

Some potential issues for discussion we noticed (you may notice others):

- WD100 5/4 – blip on total and diffuse horizontal
- WD100 9/6 – solar radiation (especially East 90)
- WD200 5/24 – solar radiation
- WD400 7/1 – solar radiation North 90
- WD600-WD100 9/6 – solar radiation differences
- Hourly integrated total horizontal radiation – daily plots (WD400 7/1)

- Hourly integrated diffuse horizontal radiation – daily plots (WD400 7/1)

## Program G

Corrections to submitted results:

- Time of Year – should be the hour of the year
- Station Pressure – values needed to be divided by 100

Some potential issues for discussion we noticed (you may notice others):

- WD100 – annual average wind direction
- WD300 8/13 – solar radiation South 30
- WD600-WD100 9/6 – solar radiation differences
- Hourly integrated total horizontal radiation – daily plots (WD100 9/6, WD200 5/24, WD200 8/26, WD300 8/13, WD400 7/1, WD500 9/14)
- Hourly integrated diffuse horizontal radiation – daily plots (WD100 9/6, WD200 5/24, WD200 8/26, WD300 2/7, WD300 8/13, WD400 7/1)

## Program H

Some potential issues for discussion we noticed (you may notice others):

- Dew point temperature
- Wind Speed
- December Monthly results (this is likely a data processing error but we have not isolated the issue yet)
- WD200 Wind Direction
- WD300 – solar radiation North 90, South 30
- WD600-WD100 – minor differences but the only program showing any differences
- Hourly integrated total horizontal radiation – daily plots (WD100 9/6, WD200 5/24, WD300 8/13, WD400 7/1, WD500 9/14)
- Hourly integrated diffuse horizontal radiation – daily plots (WD100 9/6, WD200 5/24, WD200 8/26, WD300 2/7, WD300 8/13, WD400 7/1, WD500 3/1)

## Next Steps

### Test Spec

The test spec has remained the same through the second field trial. At this point we anticipate only minor changes for clarification purposes as we work through the analysis of the results. We are hoping to bring the test spec to the full 140 Committee for consideration at the 2021 Winter ASHRAE meeting.

### Example Results

Most of the work remaining on the test suite is in developing the example results. The steps remaining in developing the example results:

- Continue the data analysis to provide useful charts and statistical analysis
- Work with the individual programs to address results difference (if desired)
- Poll for revealing the names of the programs
- Decide which results will be included in example results
- Poll for programs to be officially included in example results
- Develop final example results for inclusion in Standard 140

### Results Automation

Part of our work is to bring more automation to Standard 140 to (hopefully) make the testing and analysis process easier for program developers and users. We will be working to develop 'on-demand' analysis of results from the Weather Drivers test suite to plot and view results comparisons of the different programs. The routines we are using to analyze the field trial results will be taken as a starting point for this effort.