Guide to the constant files

There are two types of constant file in use – an annual file and an instrument file.

We’ll start with the annual file, which is named in the format DN<123><A><00>.DAT, where the brackets refer to <Dobson Number><calibration letter><year>. We’ll use DN031E19.DAT as an example and go through line by line:

Graphical user interface, application, table, Excel

Description automatically generated

-75.57 25.48 031

Latitude, Longitude, Dobson number. Note, the first two values should change every year or two for Halley, depending on how fast the Brunt Ice Shelf moves.

-0.040 -0.030 -0.030

S values for A, C and D. Note – S is also sometimes referred to as some variant of L0/Lo/lo, as S is a correction to L0.

-0.019 -0.028 0.000 0.197 0.379 0.000 0.612

Ground quartz plate values for C, D, C’ (first three numbers). Nickel Sulphate (NiSO4) values (next three numbers). Rhodium Plate value (final value).

GQP constants only used for Focussed Sun obs, we’re currently not doing FS obs because DS are sufficient for high mu values. Focussed Suns were observations with lenses on the periscope to focus the light of the sun and allow direct sun observations for lower sun elevations than were previously possible.

Nickel Sulphate filters have been taken out of the BAS instruments as they were potentially hazardous cargo. They were used to reduce scattered light within the instrument. At the time of writing there is still one in the Vernadsky instrument (Dobson #123), but it will likely be removed next time the instrument is reconditioned.

The rhodium plate has not been used for observations for a long time. It is still used for twin lamp tests, which is for calibration of the optical wedge. The value recorded in the file corresponds to an N value that can be added onto the readings if the rhodium plate is in.

2.370 15

C’ Zenith Blue and CD Direct Sun offsets

For C’ we don’t do those obs any more, so for future obs this number is of little concern.

CDDS offset is a “fudge factor”. If L0 values are spot on, then AD and CDDS will give exact same value, in practice they don’t always, so a fudge factor exists. It is assumed that AD is the most accurate value and CD needs correcting.

The reason AD is generally assumed to be correct is that the difference in dial reading is biggest between A and D, so any errors in dial reading are proportionally smaller. Furthermore, AD measurements generally have a lower residual value when compared to the average of all observations for a day. Finally, AD readings are taken over a smaller range of mu, this means that scattering effects (such as thin cloud or aerosols) are smaller when the sun is higher in the sky. For these reasons, AD are considered the “gold standard” of obs.

40 -15 -25 100 { AD, CD, CC, CDh }

AD, CD, C and CD high mu offsets.

These are the zenith equations:

A + B\*N + C\*N/MU + D\*(N/MU)^2 + E\*(N/MU)^3 + F/MU

The values above are equivalent to A. Whilst the derived zenith equation is taken to be valid across many years, the value of A changes year on year, hence its inclusion here.

Perhaps if S values were more accurate, this yearly tweak to the equation may not be necessary – although this is not something that has been attempted yet.

2020 06 30 00 00

Valid UNTIL: Year, month, day, hour, minute

If there is a step change in the data – optics gets cleaned or a component gets changed for some reason, then we can write a new set of constants within this file that appear after this datetime.

-0.010 0.012 0.006

-0.030 0.005 -0.002 {2017 12 23}

-0.020 -0.005 -0.005 {2018 01 29}

-0.022 -0.013 -0.011 {2018 01 30}

-0.030 -0.020 -0.025 {2019 01 14}

-0.040 -0.030 -0.030 {2020 01 10}

These numbers are not used for any calculations, but rather are historical values of S. This section acts as a notepad that does some change tracking. It may help to have change tracked values for demonstration purposes or to test out new values etc.

40 -15 -30 100 {-155} { AD, CD, CC, CDh 2019 01 14}

40 -15 -25 100 { AD, CD, CC, CDh 2020 01 10}

Similarly these are change tracked offsets. By having them in the file you can see how stable some of the constants are or if they drift over time.

Now we have the instrument file, which is updated every time it gets sent off to be recalibrated. It is named in the format D<123><A>.DAT, where the brackets refer to <Dobson number><calibration letter>. Every time an instrument gets recalibrated, it gets a new letter, starting with A. So using D031E.DAT, we can tell that this is 5th time it has been calibrated. Again, we’ll go through each line and discuss it:

Text, table

Description automatically generated

Constant file for Dobson 031 after refurbishment at Hoenpeissenberg

Simple description of the instrument and where it was refurbished

1.806 0.833 0.374 0.114 0.109 0.104

Bass-Paur constants. Alpha (ozone absorption coefficient) for A, C and D. Beta (Rayleigh Scattering coefficient) for A, C and D. These will not change with time, unless we decide to use new constants, in which case, we should change all these lines in all the files and re-analyse historic ozone data.

2.370 -0.002043 0.00000295 -0.05383

C' ZB equation coefficients. As mentioned earlier, the C’ observations are no longer performed.

0 54.77 0 1571 -1379 0

ADZ equation coefficients. As mentioned earlier, the equation is of the form :

A + B\*N + C\*N/MU + D\*(N/MU)^2 + E\*(N/MU)^3 + F/MU

The values above equate to A, B, C, D, E, F respectively. However, A is zero as a placeholder only, as this is updated annually in the annual file.

0 145.6 1554 0 0 43.05

CDZ equation coefficients, relating to A, B, C, D, E, F as with the ADZ constants.

0 124.4 871.9 0 0 182.1

CZ equation coefficients, relating to A, B, C, D, E, F as with the ADZ constants.

0 2583 -564.4 1111 0 0

CDZ high mu equation coefficients, relating to A, B, C, D, E, F as with the ADZ constants.

-0.318 -0.232 -0.149 -0.066 0.016 0.098 0.179 0.259 0.340 0.421

0.505 0.590 0.677 0.765 0.854 0.943 1.034 1.125 1.217 1.311

1.408 1.506 1.607 1.710 1.813 1.918 2.021 2.124 2.223 2.321 2.418

R-to-N table for A at 10 degree intervals from 0 to 300°.

-0.225 -0.142 -0.057 0.026 0.110 0.190 0.272 0.352 0.433 0.514

0.597 0.683 0.769 0.856 0.944 1.033 1.121 1.212 1.303 1.396

1.490 1.588 1.688 1.788 1.889 1.993 2.095 2.195 2.294 2.390 2.482

R-to-N table for C at 10 degree intervals from 0 to 300°.

-0.221 -0.136 -0.052 0.033 0.116 0.198 0.279 0.360 0.441 0.523

0.605 0.690 0.775 0.863 0.950 1.038 1.126 1.216 1.307 1.398

1.492 1.587 1.686 1.785 1.885 1.985 2.085 2.185 2.282 2.374 2.465

R-to-N tables for D at 10 degree intervals from 0 to 300°.

Notes and ideas for future development:

Note that the initial value in each of the zenith equations is over-written by the value in the annual file and can be set to 0. It is worth noting as well that the equation coefficients for CD Direct Sun observations at high mu values are directly coded into the processing software (in both Jon Shanklin’s PASCAL code and the Python code).

The lines that are effectively a notepad for change tracking could be made redundant by taking all the constant files and placing them in a single file of the format “.json”. These files are designed to be easily read by both humans and computers and could be easily added to and updated year by year. In this format, historical values could be seen alongside one another more easily, so these lines would become redundant. Furthermore, if better ozone absorption constants were found, these could be updated once, rather than being changed for all the files across all the years before reprocessing took place.

Finally, there is potential to replace any redundant values for a specific year with a placeholder value. For example in years where no C’ obs were taken or in years where the NiSO4 filters were taken out, these values could be replaced with a dummy variable (e.g. -999) and so the annual files for each instrument could act as a record of when certain changes took place.