Study of Transmissivity Calculation

The following table explains the different variables used in calculations of transmissivity.

Measurements	In equation from SeaBird	Factory
Transmissivity – volts		Tr
Transmissivity - %/m	Light Transmission	
Voltage in Air – Factory	A0	Vair
Voltage in Air – Lab (current)	A1	n/a
Blank Voltage – Factory	Y0	Vd
Blank Voltage – Lab (current)	Y1	n/a
Voltage in pure water – factory	W0	Vref
Transmission % in pure water relative to air	100%	n/a
Transmission % in pure water relative to water	90.2% * - for red wavelength	n/a
Slope	M	n/a
Offset	B	n/a

The values that go into a SeaBird configuration file are M and B.

Up until about 2000 the slope and offset were calculated as follows:
$$M=20*(A0-Y0)/(A1-Y1)$$
$$B=-M*Y1$$

From 2000 to 2011 calculations were either done by Doug Anderson, or after his death, were done following his method by Germaine Gatien. The method changed soon after Doug took over. His method was as follows:
$$M=(Tw/W0)*(A0-Y0)/(A1-Y1)$$
$$B=-M*Y1$$
Doug had a list of values for Tw and W0 for each instrument. He always used 90.2% for Tw.

From SeaBird Application Note No. 91 (2011) the calculation should be done as follows:
$$M=(Tw/(W0-Y0))*(A0-Y0)/(A1-Y1)$$
$$B=-M*Y1$$

So Doug's used W0 where we are now told to use W0-Y0. Perhaps this is a change in advice, or perhaps he just made an error in setting up the spreadsheet.

TR s/n	W0-Y0	W0	Difference
333	4.791	4.753	0.038
498	4.829	4.765	0.064
732	4.700	4.637	0.063
953	4.768	4.719	0.049
983	4.727	4.674	0.053
1005	4.707	4.674	0.033
1185	4.742	4.719	0.023

For sensor #1185 the following are the initial calculations of M and B using the 3 methods.
Old Method: 20.0000 / -1.2400
Doug's Method: 19.1142 / 1.1851
SeaBird Method: 19.0215 / 1.1793
And the factory and lab values for initial calibration and 2 years later were:

Values from factory and lab tests					
1185	A0	A1	Y0	Y1	W0
Oct-08	4.804	4.804	0.062	0.062	4.719
Aug-10	4.804	4.769	0.062	0.057	4.719

The resulting calculations of M and B using these values and 3 methods are:

Slope/Offset Results for Different Methods					
Old Method		DA method		SeaBird method	
M	B	M	B	M	B
20.0000	-1.2400	19.1142	-1.1851	19.3687	-1.2009
20.1273	-1.1473	19.2359	-1.0965	19.4920	-1.1110

And to see how big a difference there is in calculated transmissivity in %/m. the following are the results for the August 2010 calibration and the differences between the SeaBird results and the two other methods for a range of input voltages:

Voltage Measured	Old Method	Doug A's Method	SB Method	SeaBird - Doug A.'s method	SeaBird- Old Method
1	18.9801	18.1395	18.3810	+0.2415	-0.5991
2	39.1074	37.3754	37.8730	+0.4976	-1.2344
3	59.2347	56.6113	57.3650	+0.7537	-1.8697
4	79.3621	75.8472	76.8570	+1.0098	-2.5051

If we now start using the SeaBird method then values will be somewhat higher, but we can make a note in the headers that all transmissivity conversions done for cruises from January 2011 onwards will use the method outlined in SeaBird Application Note 91.

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