PML | Plymouth Marine Laboratory

Estimating the uncertainty of optical backscattering

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BBP uncertainties?

We need to associate uncertainty estimates to our BBP measurements.

How to do it?
There are formal methods to estimate uncertainties:
“Evaluation of measurement data - Guide to the expression of uncertainty in measurement”, Joint Committee for Guides in Metrology, 2008. (GUM2008)
(freely available on the web)

Estimating BBP uncertainties

Steps to estimate uncertainty in BBP:

1) **Define "measurement equation"**:

$$y = f(x_1, x_2, \ldots, x_N)$$

BBP700 =2*π*χ*[(BETA_BBP700 – DK_BBP700)*SC_BBP700 -BETASW700]

2) **Assign uncertainties to input terms:** $u(x_i)$
Either by quantifying these uncertainties directly (Type A), or by finding their values in the literature (Type B)

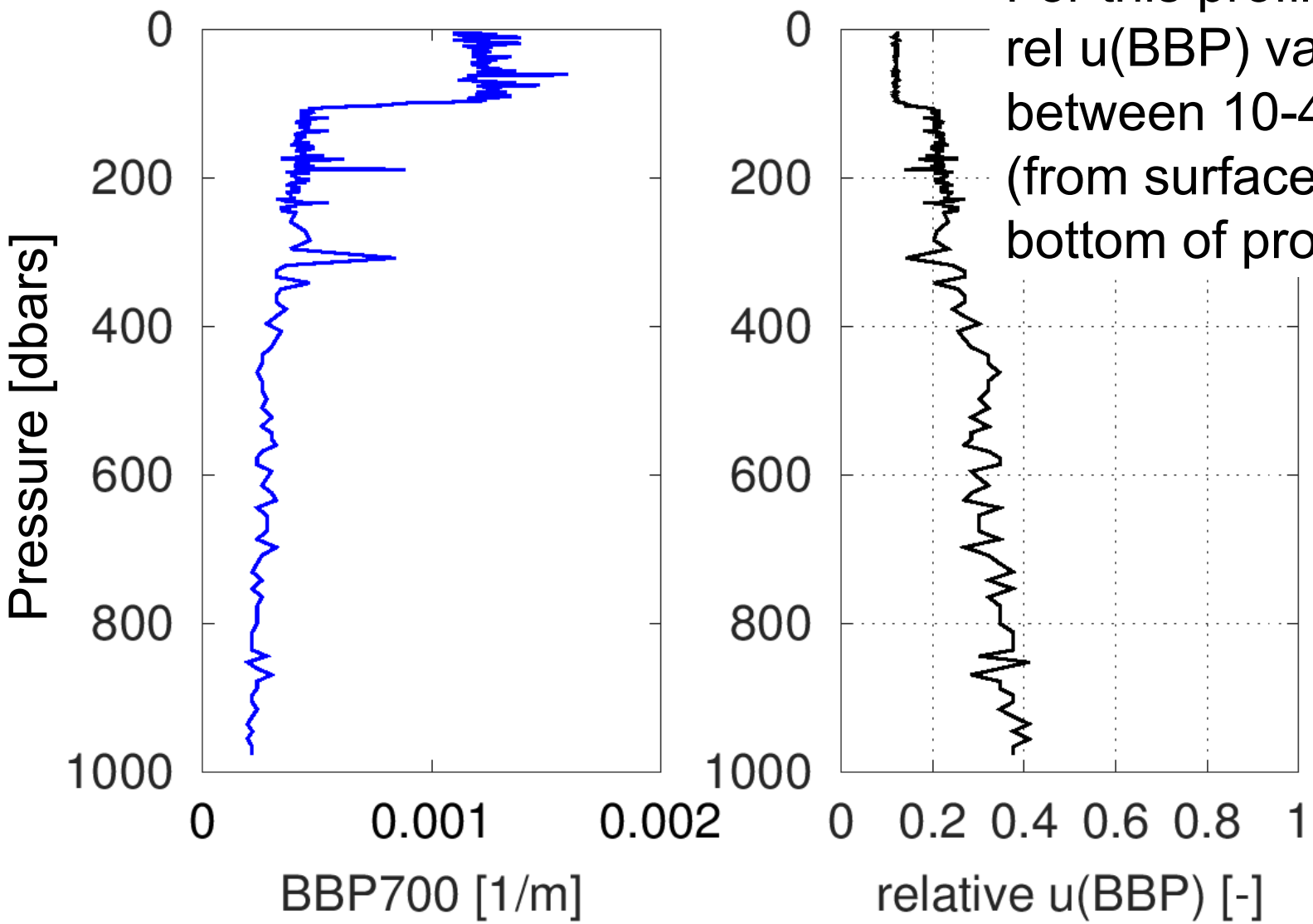
3) **Compute combined variance in BBP700** (*y* in the eq. below) due to the variances in input terms using (assume uncorrelated uncertainties):

$$u_c^2(y) = \sum_{i=1}^{N} \left(\frac{\partial f}{\partial x_i} \right)^2 u^2(x_i)$$

Assigning uncertainties in input terms

x_i	$u(x_i)$ [units of x_i]	Type	Ref
X	χ*0.0292	B	Sullivan and Twardowski, 2009
BETA_BBP700	Uncertainty in BBP counts	A	Estimate as robust std of residual from medfilt1 of profile?
DK_BBP700	2.5	B	grg's guesstimate (likely larger). We could estimate it by comparing darks from factory to darks measured by operators.
SC_BBP700	SC_BBP700*0.08	B	Based on the 8% (when one does NOT use 0.1-um NIST certified beads, e.g., if you use 2-um beads) from Sullivan et al. 2012 Light scattering review vol. 7 (see also Dall'Olmo et al., 2012)
BETASW700	BETASW700*0.0224	B	betaw_zhanghu09 is within 2% of Morel's measurements and the salinity correction is within 1% (on average)

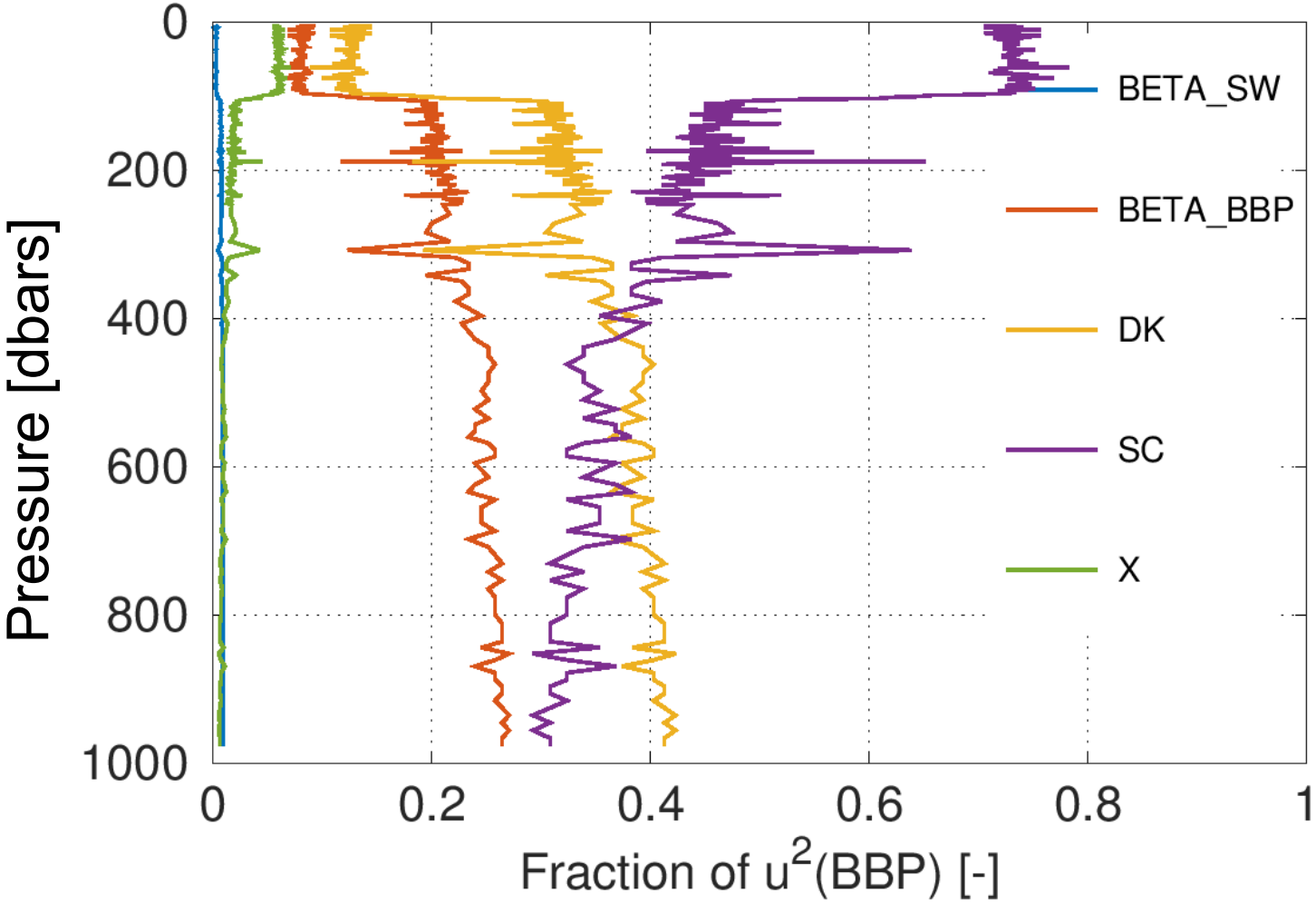
Resulting BBP uncertainties



For this profile the rel u(BBP) varies between 10-40% (from surface to bottom of profile)

Uncertainty budget

To estimate the role of each source of uncertainty in u(BBP):
Different sources of uncertainty are responsible for u(BBP) at surface vs. at depth



Surface: 70% of BBP variance due to u(SC)

Deep: BBP variance due to u(DK), u(SC) and u(BETA_BBP)