Are BBP meters on REM-A more likely to fail?

Giorgio Dall'Olmo
with inputs from Catherine and Antoine

REM-A sensor

- Combines ECO and ORC504
- Only one cable to the float
- REM-B sensor = REM-A + C-rover (included)

Problem

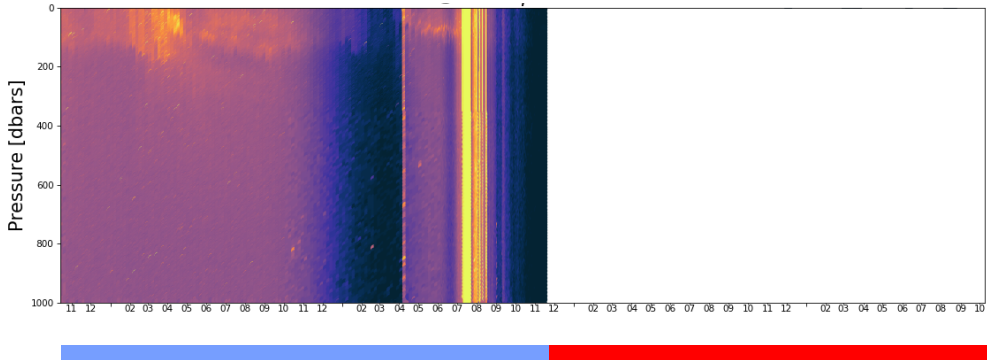
- Anecdotally: high failure rates

Objective

- Compare failure rates of ECO sensors mounted on REM-A sensors vs. other ECO sensors

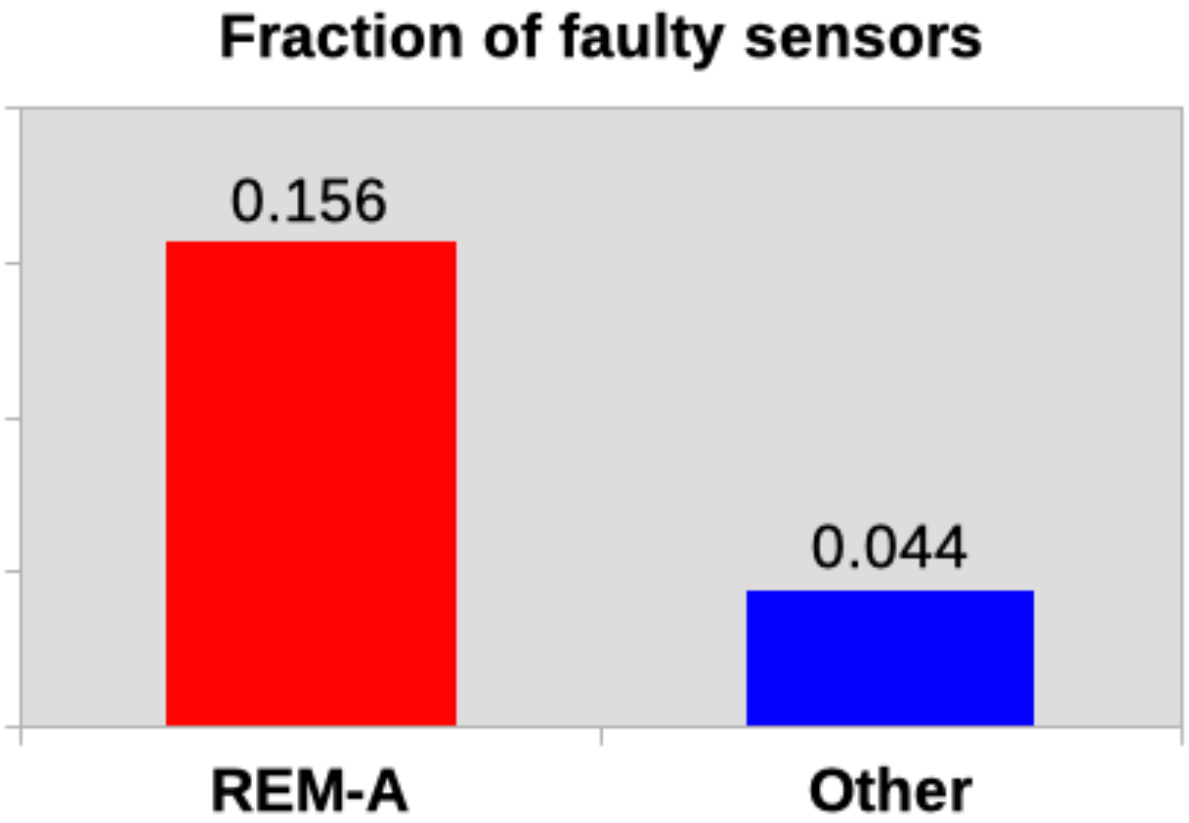
Method

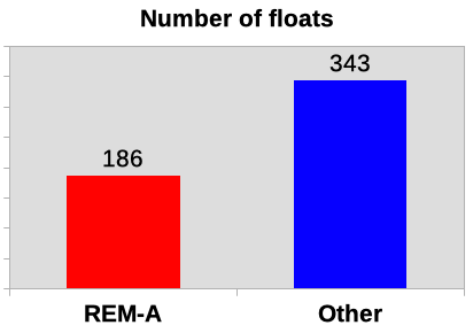
- Extract from `argo_bio-profile_index.txt` list of floats with BBP and CHLA
- Define “REM-A float” if PROVOR + BBP + CHLA + IRRADIANCE (Catherine + Antoine)
- Using Sprof files, count number of “NaN” BBP profiles for REM-A and other floats

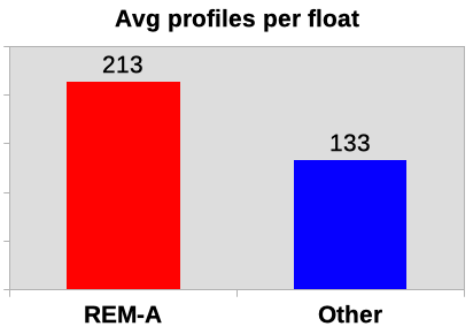


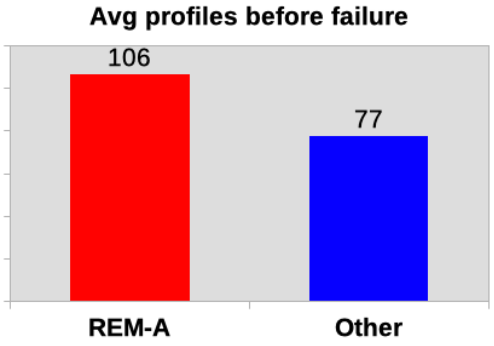
- Compute fraction of missing profiles: `fract_missing`
- Define faulty sensor if `fract_missing > 0.2`
- Compute fraction of faulty REM-A floats vs. other floats

Results









ECO on REM-A is 3.5 times more likely to fail than without REM-A

No dependence on year of deployment (“strengthened” version may not be good enough)
No clear dependence on max PRES before failure

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Estimating the uncertainty of optical backscattering

Giorgio Dall'Olmo

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)

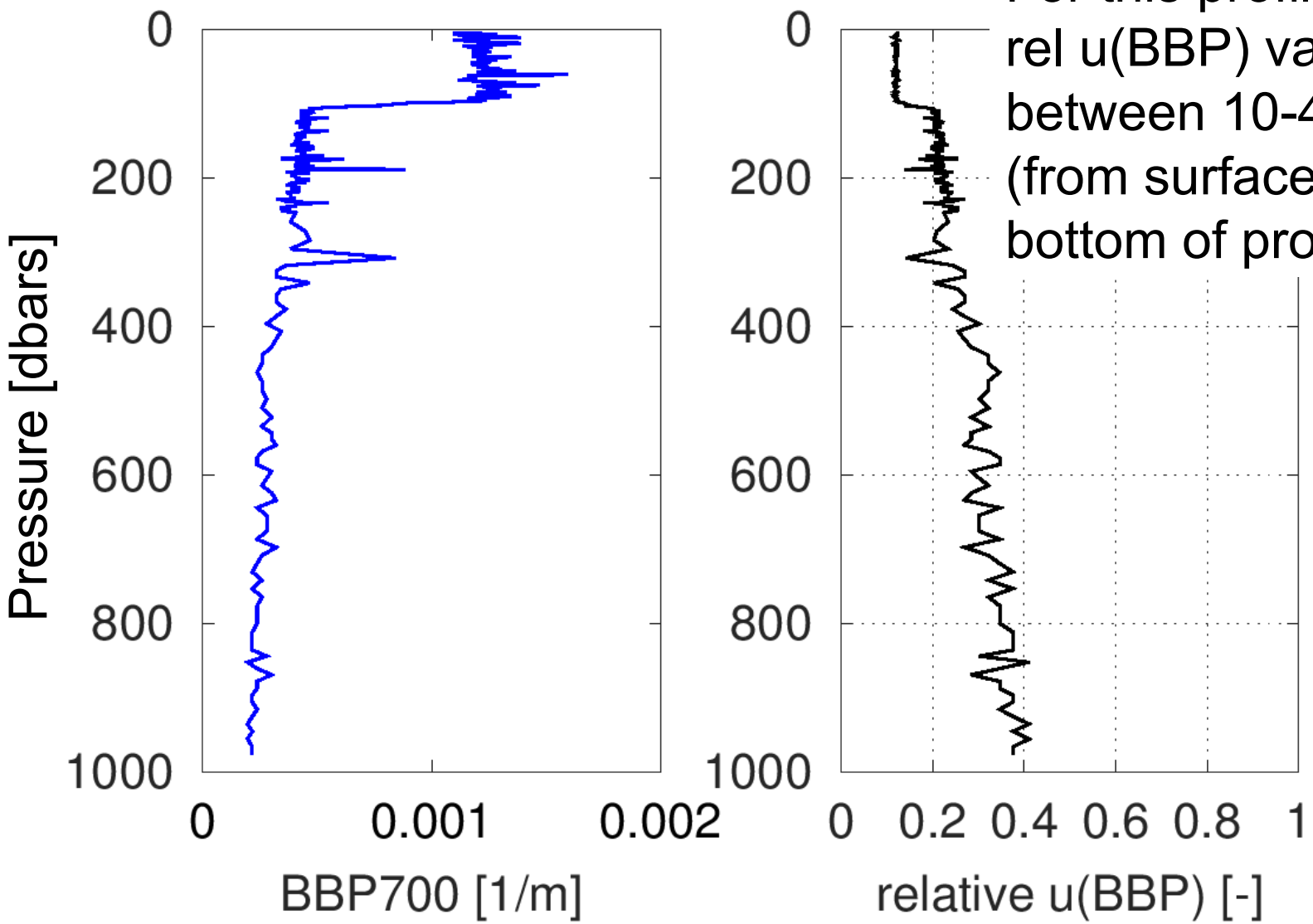
3) **Compute combined variance in BBP700** (*y* in the eq. below) due to the variances in input terms using (assume uncorrelated uncertainties):

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

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)

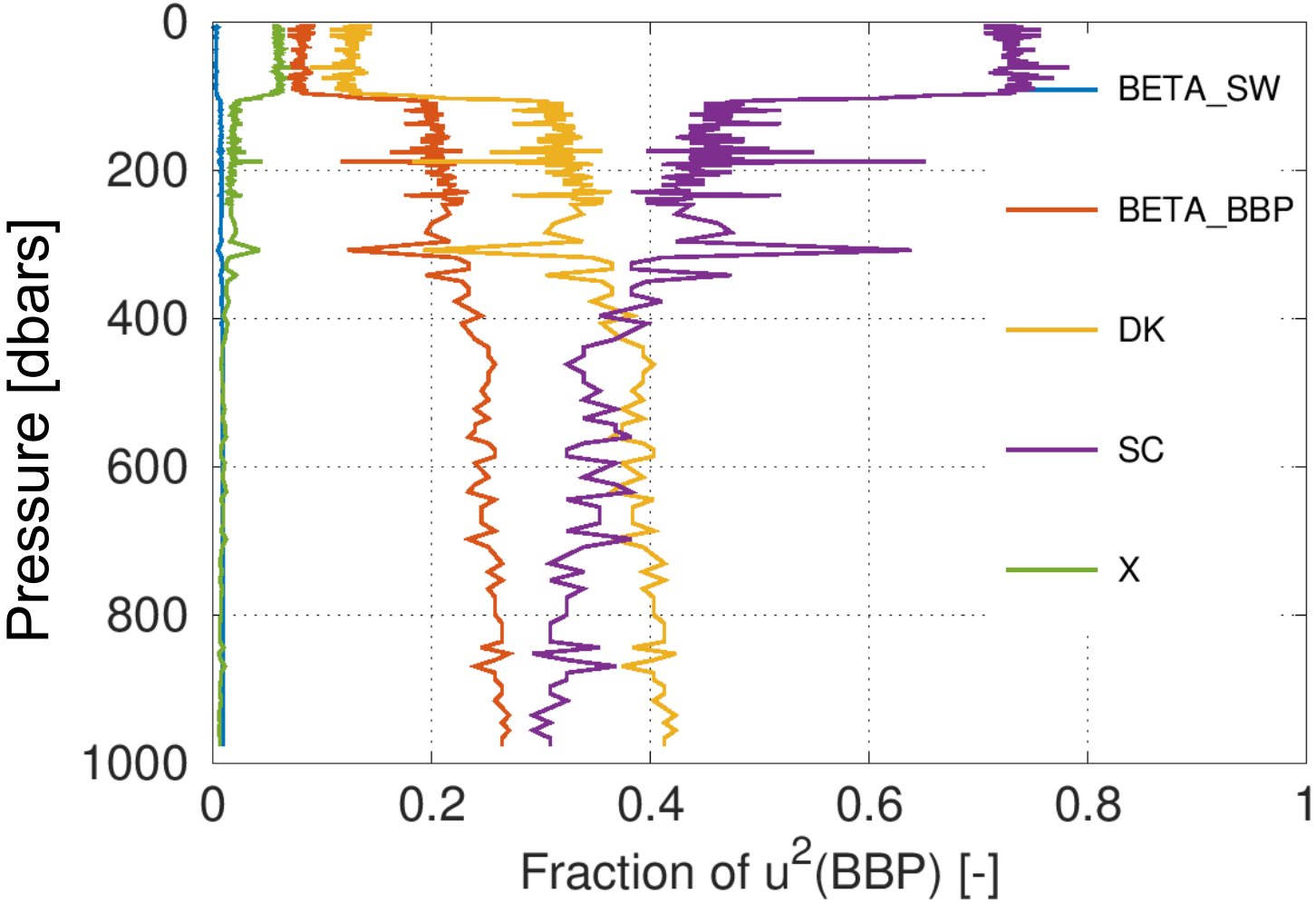
Resulting BBP uncertainties



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)

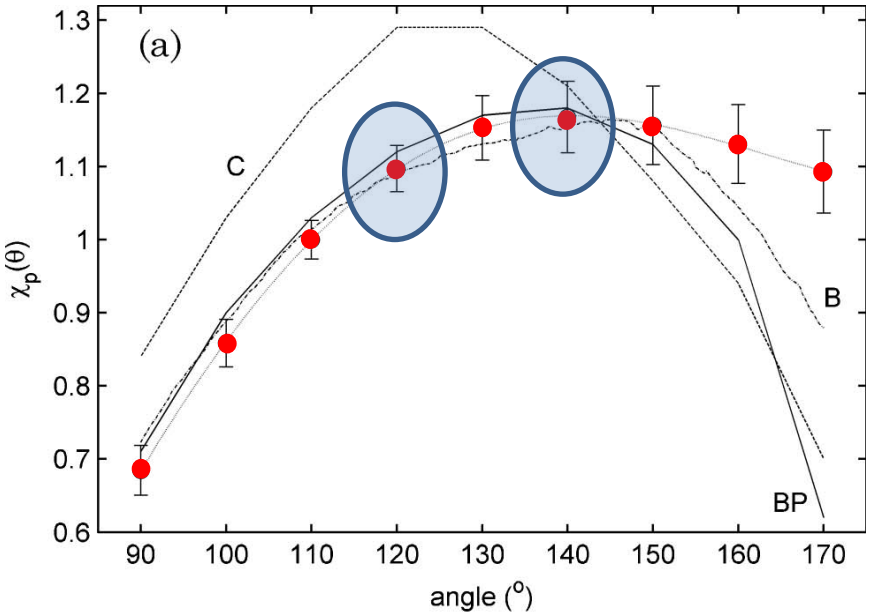
Initial discussion (end of April 2020)

- EB: I think that our current total uncertainty are on the O(20%) when signals are significant due to the angular response of the sensor and uncertainties in the Xi factor (S&T were very optimistic...). A: it would be good to be able to make choices based on published results. S&T estimates are based on many measurements in natural waters. Why don't we like their results? Do we have anything better?

- EB: Comparison between sensors with different angular response (MCOMS, FLBB, ECOBB), as was done in Poteau et al, are useful to test that our accounting of uncertainties is not overly optimistic. A: I agree, but it may not be enough.

- NB: Giorgio's analysis understates uncertainty in the Xi factor. A: To reach 20% at the surface, sXi=20% which would make it the largest contributor to the total uncertainty.

Independently published data suggest the uncertainties in Xi are not much larger than the uncertainty I assigned it.



From Sullivan and Twardowski 2009

Initial discussion (end of April 2020)

- TM: do we really need approximations? A: Probably not.
- KJ: compare the data from large arrays of floats to well controlled, ship-board measurements. A: Unfortunately, we do not have “well controlled ship-board measurements” of bbp.
- KJ: More or less that's what Antoine Poteau has done in his deep bbp paper. Are the histograms he showed compatible with your error estimates? A: Important to compare different instrument models.

By comparing deep values we may only look at a part of the uncertainty.

Next steps

- Apologies, I have not managed to make more progress on this.

- Compare deep-bbp variability with uncertainty estimates?

Possibly, but note that the relative importance of the different sources of uncertainty varies with the signal strength. Do we also need to compare surface values, which is much more problematic?

- Agree on magnitude of sources of uncertainty based on published results?

When new results appear we can update the uncertainties.