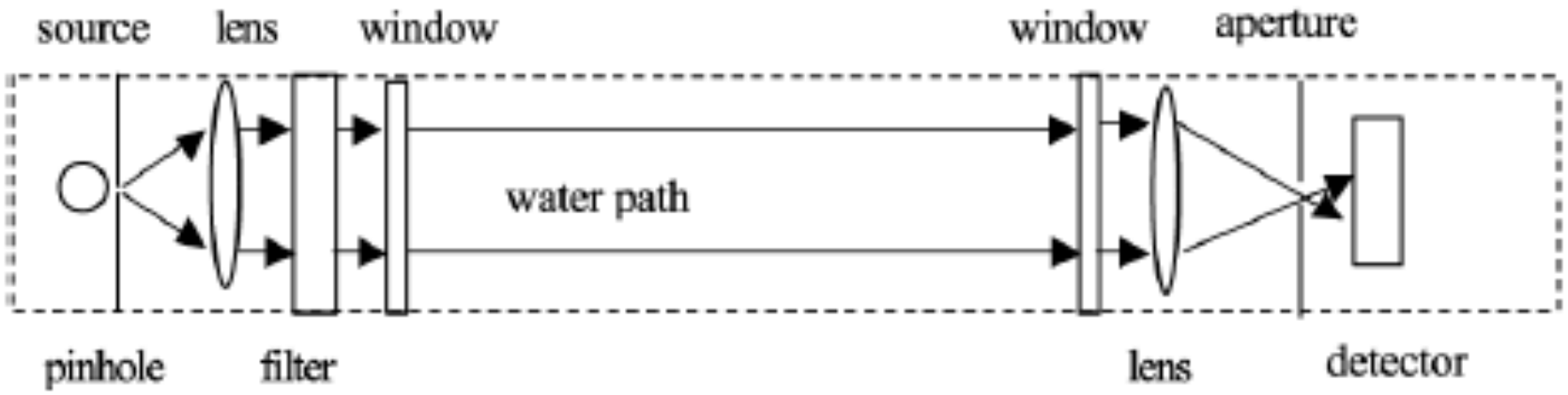
Updating protocols for beam attenuation

1. What are the current protocols?

2. What are novel findings that have not been (fully) addressed?

Current commercial design: direct path transmissometer with collimated light source.



Specs: wavelength (FWHM), pathlength, beam diameter, acceptance angle.

Existing commercial transmissomters:

Instrument	Manufacturer	Acceptance Angle (degrees, in-water)	Pathlength	Wavelength	FWHM	Beam diameter
C-STAR-10	WETLabs	1.2	10cm	650 nm	(20)nm	15mm
C-STAR-25	WETLabs	1.2	25cm	650 nm	(20)nm	15mm
AC-9-10	WETLabs	0.93	10cm	9 visible	(10)nm	8mm
AC-9-25	WETLabs	0.93	25cm	9 visible	(10)nm	8mm
AC-S-25	WETLabs	0.93	25cm	about 80 from 400 to 750	(15)nm	8mm
BAM	WETLabs	1	10cm	470, 532, or 650 nm	(10)nm	?
LISST-100(x)-B	Sequoia Scientific	0.0263	5cm	670 nm	(0.1)nm	6mm
LISST-100(x)-C	Sequoia Scientific	0.0132	5cm	670 nm	(0.1)nm	6mm
LISST-100(x)-FLOC	Sequoia Scientific	0.0043	5cm	670 nm	(0.1)nm	6mm
AlfaTracka	Chelsea	0.92	5, 10, 25cm	660nm (470, 565, 590nm optional)	(20)nm	15mm

Problem: regularly available in-line and on CTD rosette of UNOLS vessels w/o proper calibration. Data goes to NODC.

Novel deployment methods:

Gliders: BAM

Floats: C-rover (no specs on WETLabs website. Some issues on Bishop's and French floats). C-rover used, also, as particle collectors (Bishop, Estapa).

In-line w/ and w/o filter for calibration independent c_p (Slade et al., 2010).

***-UNOLS vessels have beam attenuation meters on CTD and in-line. Data may be going to NODC. Quality is ???? – need protocols for ship techs!!!!

What have we learned since the last protocols:

1. Contamination by ambient light near the surface (Andrews et al., 2011).

2. Interaction with density discontinuities (Mikkelsen et al., 2008).

3. Beam attenuation is strongly sensitive to acceptance angle (Boss et al., 2009). Algorithms to correct published (McKee et al., 2013). Require additional measurements.

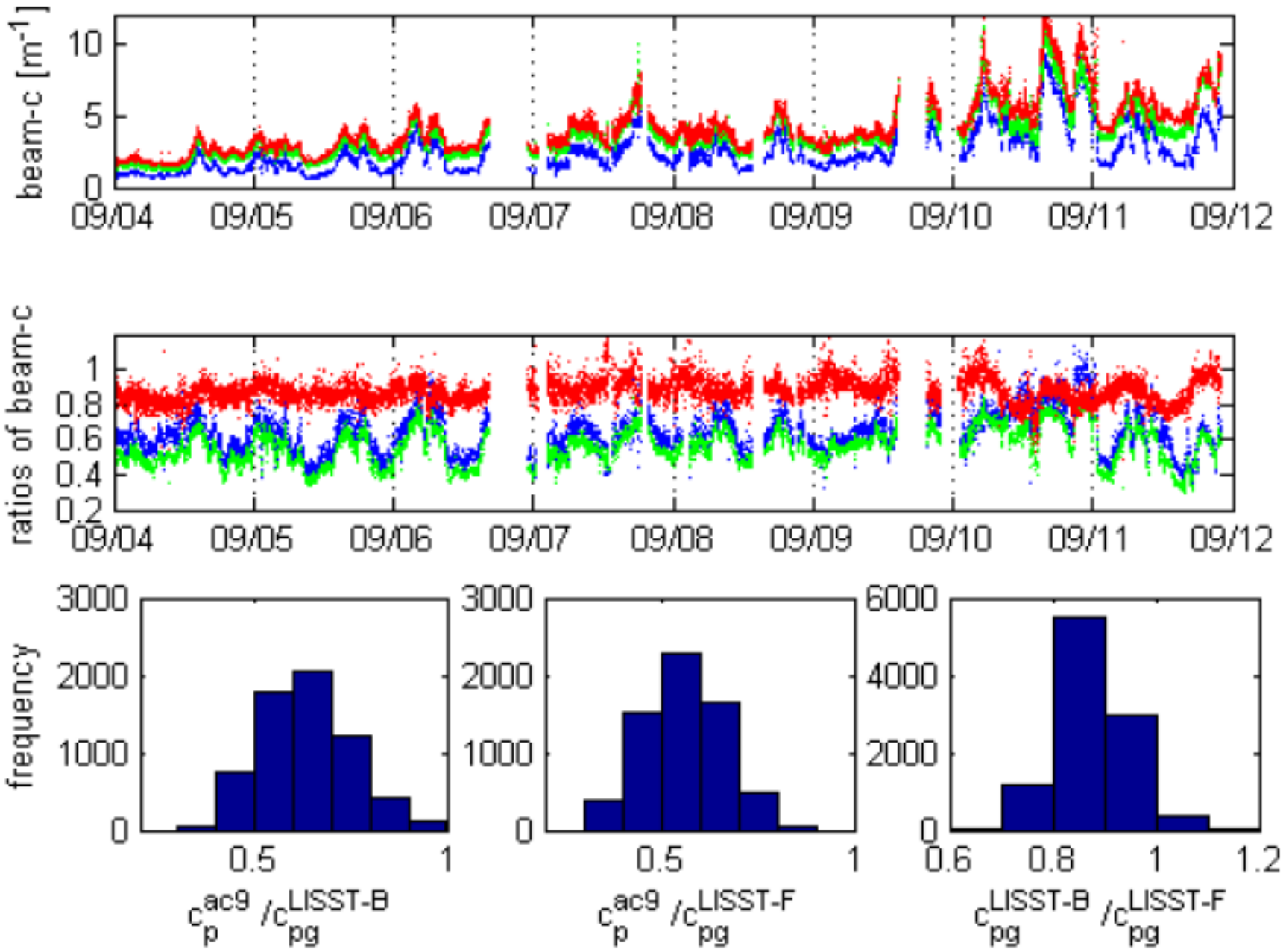
4. beam attenuation can be measured with $\Delta xc = \tau >> 1$ (Doxaran et al., 2007).

5. MC simulation quantified uncertainties (Leymarie et al., 2010, Piskozub).

6. We learned a lot about the spectral properties of the beam attenuation (could be used to check cals, closure), salinity/temperature correction updated (Sullivan et al., 2006).

7. Salinity affects measurements due to change in window's transmission (weak effect except in extreme cases, Boss et al., 2013).

Acceptance angle effect:



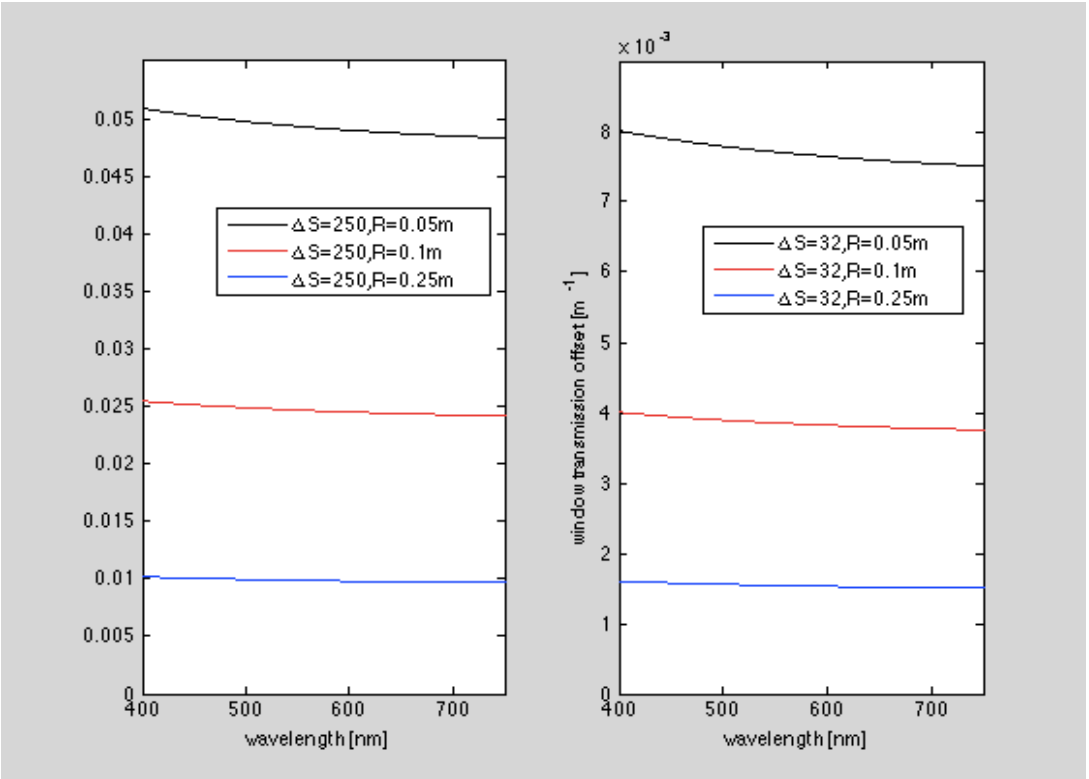
$$I_{DIW}(L) = I(0)T^2{}_{G\text{-}DIW}e^{-c_{DIW}L}$$

$$I_{sample}(L) = I(0)T^2{}_{G\text{-}SW}e^{-c_{sample+SW}L}$$

$$Tr = \frac{I_{sample}(L)}{I_{DIW}(L)} = \frac{T^2{}_{G\text{-}SW}}{T^2{}_{G\text{-}DIW}}e^{-\left(c_{sample+SW}-c_{DIW}\right)L}$$

$$c_{measured} = \frac{log(Tr)}{L} = c_{sample+SW} - c_{DIW} - \frac{2}{L}log\left(\frac{T_{G\text{-}SW}}{T_{G\text{-}DIW}}\right).$$

Transmission effect:



When using empirical salinity correction, effect is taken into account.