Table 1. Summary of the basic measurements from all stations.

		Position		Water composition			Conditions			Satlantic Spectrometer				Eye on Water			HydroColor				
Station	Date	Lat S	Long E	CHL	SPM	CDOM	Bottom	Secchi	Cloud	Satlantic	Satlantic	Satlantic	Satlantic	EOW	EOW	EOW	HC	HC	HC	HC SPM	HC
unit	ddmmyyyy	degrees	degrees	mg/m3	g/m3	m-1 at 440 nm	Depth (m)	Depth (m)	Cover (%)	hue angle degrees	X	Y	Z	FUI observer	FUI old	FUI new	X	Y	Z	g/m3	hue angle degrees
Atkinson	16/2/16	27.423	152.440	85.0	44.0	1.6	1.06	0.27	5	45.26	0.0180	0.0180	0.0049	17	16	16	0.0227	0.0187	0.0090	22.3	
Baroon	24/3/16	26.709	152.870	12.0	4.8	0.6	14.1	1.34	85	65.86	0.0121	0.0137	0.0064	10	11	11	0.0083	0.0093	0.0047	5.0	
Borumba	24/3/16	26.513	152.579	24.1	5.7	1.2	7.9	1.05	95	57.12	0.0048	0.0052	0.0021	15	14	14	0.0053	0.0055	0.0013	3.0	
BrisbaneRiver01	8/3/16	27.488	152.996	4.6	158.0	0.6	5.1	0.17	5					18	18	17					
BrisbaneRiver02	13/5/16	27.488	152.994				5.0	0.49	<5	45.76	0.0131	0.0131	0.0067	16	16	16	0.0303	0.0233	0.0147	41.7	
Clarendon	16/2/16	27.512	152.335	19.6	6.4	1.4	4.65	1.1	5	57.63	0.0076	0.0084	0.0030	13	11	11	0.0093	0.0107	0.0030	6.0	
Dyer	16/2/16	27.629	152.375	177.2	22.8	1.4	4.65	1.1	40	50.98	0.0168	0.0176	0.0055	16	14	14	0.0113	0.0107	0.0033	7.7	
Einbunpin	8/3/16	27.520	153.069	121.4	43.0	2.3	0.35	0.35	30	55.88	0.0199	0.0218	0.0059	13	13	12	0.0115	0.0113	0.0053	9.0	
Ewen Maddock	24/3/16	26.775	153.000	13.6	3.1	1.3	8.7	1.7	40-85	50.91	0.0088	0.0091	0.0044	17	15	15	0.0040	0.0037	0.0018	3.7	
Liddell01	2/3/16	32.351	150.992	26.7	5.2	0.5	4.7	1	30	66.90	0.0077	0.0088	0.0041	11	11	11	0.0227	0.0283	0.0143	22.3	
Liddell02	2/3/16	32.364	150.986	25.0	4.9	0.4	12.7	1.1	5~10	65.77	0.0080	0.0091	0.0045	11	11	11	0.0197	0.0235	0.0117	17.7	
Liddell03	2/3/16	32.379	150.985	21.8	4.9	0.3	6.7	1.2	10	67.52	0.0075	0.0084	0.0045	11	10	11	0.0190	0.0237	0.0123	16.7	
Liddell04	2/3/16	32.382	150.994	18.9	3.9	0.3	30	1.3	75	69.84	0.0095	0.0109	0.0056	10	10	10	0.0250	0.0320	0.0203	27.3	
Liddell05	2/3/16	32.378	151.003	19.2	5.7	0.3	24.8	1.25	75	68.17	0.0131	0.0151	0.0071	11	11	11	0.0237	0.0310	0.0167	27.7	
Liddell06	2/3/16	32.361	151.003	23.2	6.3	0.4	8	1.25	75-80	65.68	0.0088	0.0099	0.0049	10	11	11	0.0203	0.0247	0.0143	19.3	
Lostock01	1/3/16	32.332	151.457	11.3	2.4	1.2	14.9	1.5	15-20	56.17	0.0077	0.0082	0.0038	17	15	16	0.0040	0.0040	0.0017	0.7	
Lostock02	1/3/16	32.332	151.451	12.0	3.3	1.1	16.3	1.6	25-30	56.21	0.0077	0.0083	0.0037	16	14	14	0.0040	0.0043	0.0020	1.0	
Lostock03	1/3/16	32.329	151.439	22.0	3.9	1.0	5.4	1.5	30	56.87	0.0080	0.0087	0.0038	16	14	15	0.0067	0.0073	0.0033	1.0	
Lostock04	1/3/16	32.333	151.433	17.3	5.1	1.1	13.5	1.5	25	55.21	0.0091	0.0097	0.0041	15	15	15	0.0130	0.0130	0.0077	1.0	
Lostock05	1/3/16	32.339	151.438	14.0	4.1	1.3	11	1.25	25	54.37	0.0046	0.0049	0.0021	16	15	15	0.0053	0.0053	0.0027	1.3	
Lostock06	1/3/16	32.335	151.442	12.1	4.1	1.2	14.3	1.6	25	55.81	0.0082	0.0087	0.0039	16	15	15	0.0043	0.0043	0.0020	1.7	
Lostock07	1/3/16	32.337	151.451	10.8	3.1	1.2	20	2	20	55.60	0.0080	0.0086	0.0040	16	15	15	0.0047	0.0050	0.0027	1.3	
Somerset	22/3/16	27.102	152.568	10.5	2.9	0.5	1.3	1.9	95	64.29	0.0049	0.0056	0.0023	12	13	13	0.0100	0.0113	0.0073	8.0	
StClair01	3/3/16	32.356	151.272	2.3	1.2	0.5	25.6	5.1	<5	88.97	0.0097	0.0121	0.0073	11	9	9	0.0010	0.0027	0.0007	2.3	
StClair02	3/3/16	32.363	151.277	2.6	1.2	0.6	22	5	<5	88.81	0.0098	0.0122	0.0072	9	9	9	0.0017	0.0030	0.0017	2.3	
StClair03	3/3/16	32.360	151.283	1.8	1.4	0.4	19.7	5	<5	89.13	0.0099	0.0124	0.0073	10	10	10	0.0018	0.0038	0.0025	4.0	
StClair04	3/3/16	32.345	151.289	1.6	0.9	0.4	10	4.75	<5					9	9	9				9.7	
StClair05	3/3/16	32.329	151.628	3.0	1.6	0.4	16.5	3.25	<5	81.95	0.0120	0.0145	0.0084	9	10	10	0.0027	0.0050	0.0030	3.0	
StClair06	3/3/16	32.326	151.288	2.3	1.5	0.4	13.7	4	<5	83.90	0.0152	0.0185	0.0107	8	9	9	0.0027	0.0050	0.0027	2.7	
StClair07	3/3/16	32.326	151.280	3.9	1.8	0.4	17.5	4	<5	84.43	0.0061	0.0075	0.0042	9	10	10	0.0023	0.0047	0.0027	2.7	
Wivenhoe01	8/3/16	27.346	152.542	8.6	2.7	0.5	18.5	2.23	35	69.46	0.0109	0.0127	0.0056	13	12	12	0.0023	0.0033	0.0013	1.0	
Wivenhoe02	8/3/16	27.346	152.543	13.0	3.8	0.7	10.5	2	40	65.30	0.0059	0.0067	0.0030	10	10	10	0.004333	0.005333	0.003333	2.7	

Spectra at a turbid station

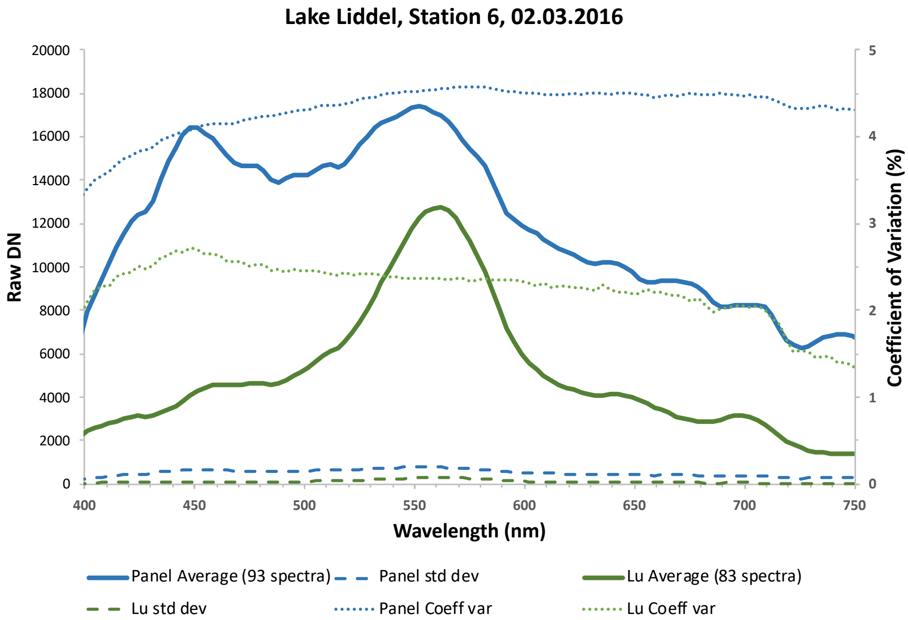

Figure 1. Mean raw spectra for panel (blue) and water surface (green, tip of the spectroradiometer just below the water surface) measurements made at Station 6 on Lake Liddell, 02.03.2016, presented together with standard deviation (dashed lines, same DN scale) and coefficient of variation (dotted lines, secondary axis). The measurements were made under 'wavy' conditions with our field notes indicating waves of 10-15 cm (as large as any waves were during our measurement campaign) and Secchi disk depth was 1.25 m. These comprise of 93 and 83 individual scans, respectively. For both sets of measurements the standard deviation is very low and there is greater variation about the panel measurements than for those made underwater. The coefficient of variation is ~4.2% for the panel measurements and ~2% for the water surface measurements.

HydroLight modelling

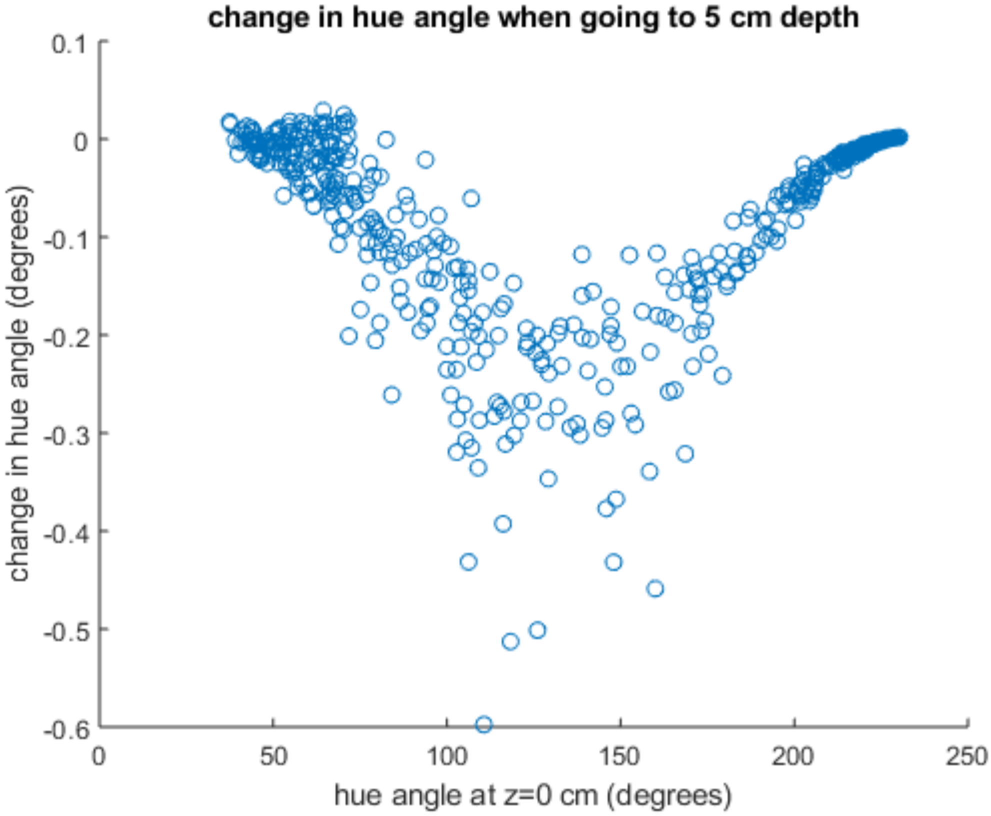

Figure 2. Model outcomes as reported in IOCCG report number 5 (IOCCG, 2006) to show changes in hue angle when a spectrometer is lowered to 5 cm depth in natural waters. The data is the result of Hydrolight modelling used to model reflectance based on the IOP and AOP of 500 natural waters covering a broad range in composition (CHL, NAP, CDOM), representing the full range of clearest ocean waters to turbid coastal and inland waters. The model parameters are reported for 500 different IOPs at a wavelength spacing of 10 nm over 400 and 800 nm. The results cover two parameters for remote sensing reflectance; Rrs (just above water) and rrs (just below the water surface). We estimated the impact of depth (z) as follows: first the upwelling radiance just below the surface was calculated from rrs and assuming a white irradiance spectrum (note that the whole procedure is not dependent upon the absolute value of this white illumination spectrum). Subsequently, the upwelling radiance was calculated at a depth of 5 cm or 0.05 m), a typical value for the Satlantic. This was done by calculating for each wavelength and each spectrum the attenuation by 5 cm of water as: exp(-Kd(0)*5/100). This upwelling radiance at 5 cm depth was subsequently divided by the irradiance spectrum near the surface, similar to what we have undertaken in our study. All spectra were then converted to the hue angle as described in the literature given above.

This figure shows that the broad range of coloured waters that were observed in Australia are covered by this dataset from IOCCG. An angle of 40 degrees belongs to the most brown waters and an angle of 230 degrees belongs to the bluest, most oligotrophic oceans.

The results confirm our confidence in the measurements undertaken. Holding the spectrometer at depth, albeit shallow, does give a different hue angle of the measurement. However, because all spectra are folded with the broad chromaticity curves and the relative contribution is taken, these changes are extremely small.

Reference

IOCCG. *Remote Sensing of Inherent Optical Properties: Fundamentals, Tests of Algorithms, and Applications*; Reports of the International Ocean-Colour Coordinating Group, No. 5; Lee, Z.-P., Ed.; IOCCG: Dartmouth, NS, Canada, 2006.