nm. The expected peaks in $z_{effective(\lambda)}$ around 620 nm and 680 nm had ranges of 606 – 629 nm and 662 – 680 nm, respectively. The expected minimums in the UVA and NIR demonstrated significant shifts in peak position, 330 - 390 nm and 750 – 769 nm, respectively. To better understand the causes of this spectral shift, we compared the wavelength of each peak with the optical properties of the lake samples (Table 1). An elevated correlation between the position of all maxima/minima and particulate concentrations was observed.

While the negative correlation between peak height and particulate concentrations is to be expected (an increase in particulate associated absorption and scattering should decrease in the effective depth), the strong correlation between particulate concentrations and the position (wavelength) of the maxima/minima is unexpected. The position of the UVA minimum and the mid visible maximum were both found to be shifted to higher wavelengths (red shifted) at high particulate concentrations, while expected minimums at 620 nm, 680 nm and in the NIR were shifted to lower wavelengths (blue shifted). Red shifts in the upwelling maxima have been reported for turbid waters [26], but shifts for both maxima and minima were not found in the current literature.

Spectral shifts in $z_{effective(\lambda)}$ may be important in the interpretation of remotely observed radiances from turbid waters. Knowing that such shifts occur allows for a more informed analysis of potential bottom effects. Furthermore, shifts in $z_{effective(\lambda)}$ maxima/minima are related to spectral variations in diffuse attenuation coefficients, which are basic parameters (e.g. K_{490}) in many ocean colour algorithms [27]. It should also be considered that spectral shifts in diffuse attenuation have been shown to influence species selection, for example in the vertical structuring of pico-phytoplankton in the ocean [28]. More research is necessary to determine whether spectral shifts are sufficient to influence the horizontal species distribution in shallow lakes. It should be noted that upwelling irradiance constitutes up to 21% of the total irradiance available (at 675 nm) in the Taihu Lake waters.

Table 1. Pearson correlation coefficients (r) between peaks (wavelength, peak value) of effective upwelling depth and CDOM absorption, total suspended particulate matter concentrations, chlorophyll a and phycocyanin concentrations.

	$a_{CDOM442}$ (m^{-1})	$a_{CDOM352}$ (m^{-1})	SPM ($g\ m^{-3}$)	Chl a ($mg\ m^{-3}$)	Phycocyanin ($mg\ m^{-3}$)
Peak values (m)					
min in UVA	–0.27	–0.44*	–0.72*	–0.46*	–0.40*
Max	–0.20	–0.31*	–0.49*	–0.31*	–0.38*
min 620	0.04	–0.20	–0.43*	–0.28	–0.34*
min 680	–0.17	–0.29	–0.77*	–0.44*	–0.44*
minNIR	–0.07	–0.10	–0.37*	–0.24	–0.29
Peak position (nm)					
λ of min UVA	0.23	0.45*	0.89*	0.65*	0.57*
λ of max depth	0.16	0.29	0.63*	0.24	0.19
λ of min ~620 nm	–0.18	–0.40*	–0.63*	–0.29	–0.32*
λ of min ~680 nm	–0.21	–0.42*	–0.65*	–0.52*	–0.40*
λ of min NIR	–0.28	–0.33*	–0.46*	–0.28	–0.22

* Significant correlations ($n = 84$, $p < 0.01$)

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