

**Figure 1** Module structure in the network of Pearson correlations between time series of Chlorophyll-a concentration across all the sites across all the depths. Different panels indicate different depth (notice that the cluster-detection algorithm is applied for the whole dataset across different depths). The colors of the nodes indicate the cluster identity (“red” for one cluster and “blue” for another one) while the shading indicates the membership strength.



**Figure 2** a-b) Demonstration of time series of averaged Chl-a concentration across shallow (0-75 m; green) and deep (75-150 m; purple) water at two sites, the locations of which are shown in panel c. The values of Chl-a in shallow water are indicated by left y-axis, while the values of Chl-a in deep water are indicated by right y-axis. c) Pearson correlations between averaged Chl-a concentrations across shallow and deep water at each site. d) Pearson correlations between averaged Chl-a concentrations across shallow and deep water at each site as a function of the distance of the site from shore. The vertical dashed line indicates the distance of 240 km.



**Figure 3** Rose diagrams of phase angles across all frequency of the wavelet coherence between the averaged values of the three following measures across shallow (0-75 m) and deep (75-150 m) water: chlorophyll a (a-b), temperature (c-d), and nitrate (e-f). Panels in the left column indicate that only near-shore sites (distance < 240 km) are used, while panels in the right column mean that only off-shore sites (distance ≥ 240 km) are used. The phase angle close to 0 indicates in-phase fluctuations while close to π indicates anti-phase fluctuations. In panel a, coherence at long timescales was discarded because it is not significant.



**Figure 4** Rose diagrams of phase angles across all frequency of the wavelet coherence between chlorophyll a and temperature (red) or nitrate (blue) for shallow (a-b) or deep (c-d) water. Panels in the left column indicate that only near-shore sites (distance < 240 km) are used, while panels in the right column mean that only off-shore sites (distance ≥ 240 km) are used. The phase angle close to 0 indicates in-phase fluctuations while close to π indicates anti-phase fluctuations. In panel a, coherence at long timescales was discarded because it is not significant.



**Figure 5** Coefficient of variation (CoVar) of the average of Chl-a concentration in shallow and deep water at each site as a function of the distance of the site from shore. Error bars indicate the 2.5%-97.5% quantiles over the randomizations performed in which the correlation of Chl-a between shallow and deep water were destroyed (see Methods). Red point indicates the value of empirical CoVar is higher than the 97.5% quantile of the simulated values; purple point indicates the value of empirical CoVar is within the range of the 2.5%-97.5% quantiles; and green point indicates the value of empirical CoVar is lower than the 2.5% quantile.



**Figure S1** Phase angles of the wavelet coherence between the three following measures across shallow (0-75 m) and deep (75-150 m) water as a function of frequency: chlorophyll a (a-b), temperature (c-d), and nitrate (e-f). The red line in each panel indicates the *p*-values of the coherence as a function of frequency. Panels in the left column indicate that only near-shore sites (distance < 240 km) are used, while panels in the right column mean that only off-shore sites (distance ≥ 240 km) are used.



**Figure S2** Phase angles of the wavelet coherence between chlorophyll a and temperature (the left column of panels) or nitrate (the right column of panels) for shallow (a-d) or deep (e-h) water and near-shore (panels a, b, e, and f) or off-shore (panels c, d, g, and h) as a function of frequency. The red line in each panel indicates the *p*-values of the coherence as a function of frequency.



**Figure S3** *P*-values of the wavelet multiple linear regression of the models (in panel a: Chla.deep ~ Chla.shallow + (T.deep + N.deep); and in panel b: Chla.deep ~ Chla.shallow or Chla.deep ~ (T.deep + N.deep)). Blue lines indicate surrogating Chla.shallow, while red lines indicate surrogating (T.deep + N.deep).