Distributional shifts in size structure of phytoplankton community

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Species distribution is changing with various rate and direction in response to global warming (Poloczanska et al., 2013). Climate velocity, which is derived as the ratio of temporal trend to spatial gradient of sea surface temperature (SST), predicts species migration and persistence as an expectation how species track their thermal niches (Burrows et al., 2011). However, past studies exposed independent changes in species distribution from climate velocity due to the complexity of biological interactions (e.g., Philippart et al., 2011). In this study, we estimated the velocity of shifts in phytoplankton size structure using remote sensing data to predict species distributional shifts through spatiotemporal changes in food web structure. Chlorophyll Size Distribution (CSD) model was developed by quantitating the relationships between size structure of phytoplankton community and spectral feature of phytoplankton absorption coefficient ($a_{ph}(\lambda)$) (Wang et al., 2015), and validation results suggested that the exponent of CSD (CSD slope) which describes synoptic size structure of phytoplankton community was derived with sufficient accuracy (RMSE = 26.6%). When comparing the velocities of CSD slope and SST, interesting differences in rate and direction were found. For instance, latitudinal patterns showed high velocities at high and low latitudes in both CSD slope and SST, while the median rate of velocity of CSD slope (92.1 km decade^{-1}) was approximately six times higher than that of SST (13.4 km decade^{-1}). In addition, direction of shifts suggest that species are required to shift their distribution toward not limited to simple pole-ward migration, and some regions exhibit opposite direction between the velocity of CSD slope and SST. These findings imply that combined approach, both together the velocity of phytoplankton size structure and that of SST, may produce more accurate prediction of species distributional shifts than existing studies which considering only variations in specie thermal niches. Our results could contribute to generate global and regional maps of the expected rate and directions of species distribution now and future.

References

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