

Atmospheric modes of variability and eutrophication control phytoplankton development at different temporal scales in a deep lake south of the Alps

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In this contribution we analyzed the impact of temporal trophic gradients and climate variability on the phytoplankton community of Lake Garda. The station "Lago di Garda" was included in the Long Term Ecological Research network since 2007. We related the long-term development of phytoplankton and cyanobacteria to the fluctuations in the availability of nutrients at different temporal scales - from decadal to annual - and to the temporal variations in the principal teleconnection patterns. The development of cyanobacteria showed a strong dependence from the decadal development of phosphorus. Similarly, at the annual temporal scale, cyanobacteria and diatoms showed a strong dependence from the surface spring availability of TP. In turn, spring nutrient replenishment was related to deep mixing dynamics and specific large-scale atmospheric circulation patterns in the Mediterranean and southern subalpine region. Nevertheless, temporal trophic gradients showed a differential impact on the different groups of cyanobacteria. While the Oscillatoriales (in the whole range of temporal scales) and Chroococcales (decadal temporal scales) were closely linked to P fluctuations, the Nostocales (mainly *Anabaena lemmermannii*) appeared unaffected. Unexpectedly, this algal group increased its importance not only in Lake Garda, but also in other deep southern subalpine lakes just in the period coinciding with their oligotrophication (Maggiore, Como) or stabilization of nutrients (Garda, Iseo). Overall, these results suggest the need to change our present vision on the factors controlling the development of cyanobacteria, with important implications on water quality assessment criteria and lake management.