Temporal changes of surface chlorophyll in the sea of south of Sri Lanka based on satellite data from 2005 to 2015

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Abstract

Sri Lanka is located in an unique location in the Indian Ocean and oceanographic conditions around Sri Lanka are highly affected by bi-directional monsoon winds. Study area is located in South of Sri Lanka from latitudes 2.5 °N to 7.5 °N and longitudes 76 °E to 86 °E. Ocean colour images from various satellites have been used to estimate the chlorophyll concentrations as an indicator of the abundance of phytoplankton. The analysis of chlorophyll in southern Sri Lankan waters were based on Globcolour multiple satellite instruments merged monthly data products of 25 km spatial resolution from 2005 to 2015. The spatial mean of surface chlorophyll concentration during the study period shows a strong seasonal cycle with a maximum value in the South West (SW) monsoon (SWM) period and a minimum value during the first inter-monsoon. The seasonal chlorophyll variation study area is bi-model distribution with prominent SW monsoon peak and minor peak in North East monsoon. High chlorophyll content (>5mgm^{-3}) has been observed during the SW monsoon period along the southern coast of Sri Lanka. The southern coast of Sri Lanka which has been observed to havea high productivity during SW monsoon, possibly due to upwelling.

Keywords: chlorophyll, upwelling, Sri Lanka, GlobColour

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Introduction

Sri Lanka is located in a unique location in the Indian Ocean where Arabian Sea and Bay of Bengal meet. Also oceanographic conditions around Sri Lanka are highly affected by bi-directional monsoon winds. The zonal monsoon circulation in the south of India/Sri Lanka region is a crucial link for the exchange between the northeastern and the northwestern Indian Ocean (Schott et al. 1994). SWM season prevails from mid-Mayto September and North East monsoon from December to February. In between two monsoon seasons: First Inter-monsoon (March-May) and Second Inter-monsoon (October-November) seasons prevail. Study area is located in South of Sri Lanka from latitudes 2.5 °N to7.5 °N and longitudes 76 °E to 86 °E.

Remote sensing technology provides an opportunity to continuous monitoring and studying the marine environment. Ocean colour images from various satellites have been used to estimate the chlorophyll concentrations as an indicator of the abundance of phytoplankton.

The chlorophyll *a* in the upper layer of tropical oceans is, in general, limited by the availability of nutrients (Vinayachandran*et al.*2004). Therefore, oceanic processes that can bring nutrients into the euphotic zone are of prime importance. Nutrients can be brought in by coastal upwelling driven by alongshore winds, open ocean upwelling driven by Ekman spiral,

entrainment due to wind stirring at the base of the mixed layer and by horizontal advection due to ocean currents (Vinayachandran *et al.* 2004).

Materials and methods

The analysis of chlorophyll in southern Sri Lankan waters were based on merged monthly data products from multiple satellite instruments with 25 km spatial resolution for a period from 2005 to 2015. The data used in this study were acquired from HERMES web interface (http://hermes.acri.fr/) of Globcolour project. The GlobColour merged products are generated by Garver, Siegel, Maritorena (GSM) model (Maritorena and Siegel, 2005). Monthly mean concentrations of chlorophyll were calculated by averaging all the data in the same month from 2005 through 2015 to characterize the chlorophyll distribution in the southern Sri Lanka. Time series analysis was obtained from monthly mean chlorophyll. Complete analysis was done using R statistical programming (R version 3.2.2, CRAN).

Results

Monthly variations of surface chlorophyll in South of Sri Lanka at different months demonstrated that July, August and September (SW monsoon) had the highest and March and April had the lowest amount (Fig.1). The magnitude of the maximum values in August and the lowest in January. The spatial mean of surface chlorophyll concentration during the 2006-2015 period (Fig.2), shows a strong seasonal cycle with a maximum value in SW monsoon and a minimum value in first inter-monsoon. Seasonal chlorophyll variation is bi-model distribution with prominent SW monsoon peak and minor peak in NE monsoon (Fig.1).

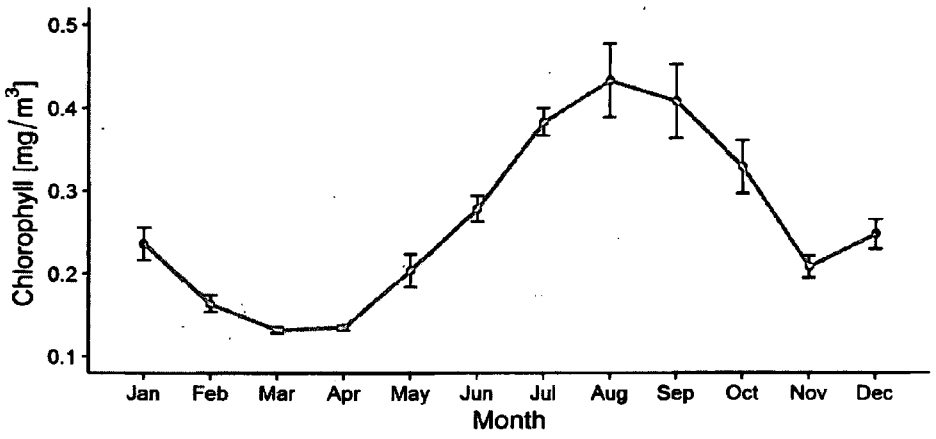

Fig.1: Annual variations of surface chlorophyll anomaly in South of Sri Lanka

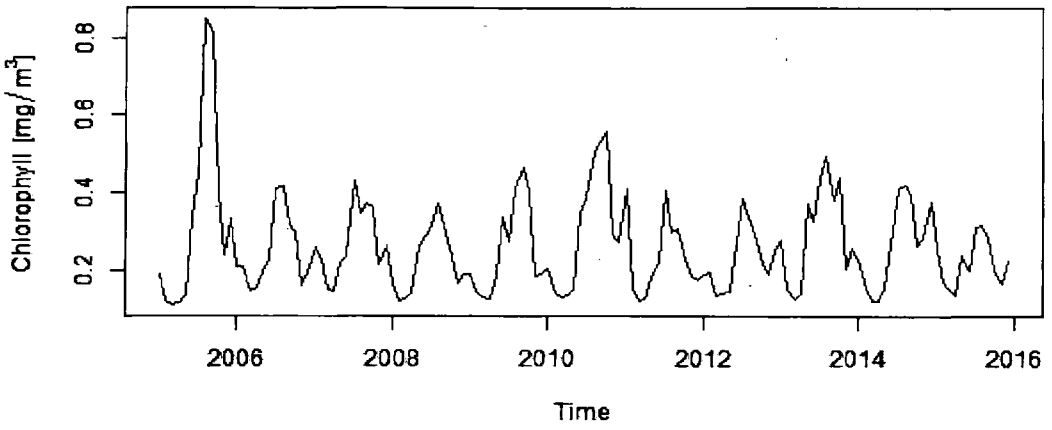

Fig.2: Time series of chlorophyll content in South of Sri Lanka

Discussion

The spatiotemporal pattern of the mean surface chlorophyll reveals an extremely oligotrophic environment for the southern Sri Lanka with surface chlorophyll mean values lower than 0.1 mg/m^3 during months of March and April. The ocean around Sri Lanka is nearly oligotrophic during the month of March but a dramatic increase in chlorophyll takes place with the onset of the SW monsoon (Vinayachandran, 2009).

High chlorophyll content ($>5mgm^{-3}$) has been observed during the SWM period along the southern coast of Sri Lanka. Vinayachandran *et al.*, (2004) also observed same observation with Ocean Color Monitor (OCM) images from 1998 – 2002. Yapa (2000) also observed high chlorophyll content closer to southern coast during SW monsoon from images obtained from CZCS from 1978 to1986 observed that chlorophyll concentrations reach peak values in the South region of Sri Lanka during June to September.GlobColour merging multi satellite chlorophyll products are very useful to overcome limitations due to lack of data of previousstudies.NE monsoon period has been observed second chlorophyll peak period but the chlorophyll content can be comparatively low (Fig.2). But high chlorophyll content can be observed as a flume closer to southern Sri Lanka throughout the year. This flume may be indication of coastal upwelling due to alongshore currents. Further analysis of the dynamics and various processes are required to confirm and quantification of coastal upwelling process.

Conclusion

Seasonal chlorophyll variation is shown bi-model distribution (semiannual cycle). Southern coast of Sri Lanka has been observed high productivity during SW monsoon and possible upwelling zone. Therefore it is important to identify upwelling process to improve the fishery industry and ecotourism focused on marine mammals.

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