SOLAB

Southern Senegal cOastal LABoratory

PLANCTONIC INTERACTIONS, ENVIRONMENTAL FACTORS AND BIOLOGICAL / GEOCHEMICAL CONSEQUENCES IN THE SOUTH-SENEGALESE COASTAL LABORATORY

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Consortium: SOLAB research builds on a number of previous research projects involving a large fraction of the present consortium, lead by members of CNRS, IRD, and Bergen university in the north and at UCAD in Senegal: AMMA 2050, LEFE EC2CO, Labex Mer IUEM, IRD AWA, FP7 PREFACE, LEFE FUSE.

DESCRIPTION

Coastal oceans and the services they provide are socially, economically and environmentally essential. These regions are subjected to major anthropogenic stressors, from local origin, and as a consequence of global changes. Among the disturbances are upper ocean warming, deoxygenation, acidification, overfishing, and various pollutions (heavy metals, waste waters ...). These disturbances can interact with each other, and spread/amplify in the ecosystem through modifications of key trophic interactions. To manage and anticipate their effects, environment monitoring and management tools are urgently needed. Unfortunately, in most coastal areas, scientific knowledge is insufficient to implement such tools. An illustration of this is the persistent reliance on single-species fish stock surveys to manage coastal fisheries. More specifically, fundamental aspects of ecosystem's functioning are poorly understood, e.g., concerning trophic interactions and energy pathways [1,2]. For instance, the basic conceptual model of coastal upwelling ecosystems based on a single short food chain, fueled by high nitrate fluxes, and reduced to diatoms feeding copepods, both filtered by small pelagic fishes (SPF) needs serious reconsideration [3,4].

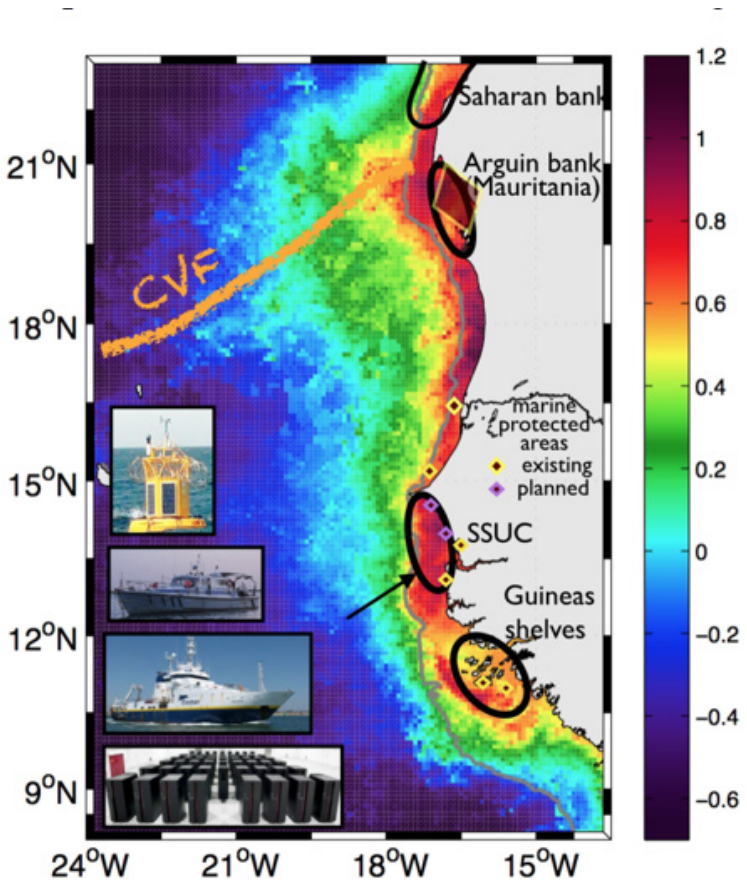


Fig.1: Seawifs chlorophyl climatology (log scale) showing high primary productivity over the West African continental shelf (delimited by the gray line). This highly productive upwelling area is in need of an ecosystem based approach to the management of the marine environment (EAMME). The southern Senegal upwelling sector (SSUS) is indicated along with three other SPF hotspots, the Arguin bank, Guinea/Guinea Bissau shelf and the Saharan Bank north of the Cabo Verde Front (CVF). Seasonality of the upwelling is increasingly pronounced south of the CVF. The SSUS transitions to a poorly documented downwelling regime during the summer/fall WA monsoon. The SSUS will be our SOLAB natural laboratory to develop WA EAMME science. Supercomputing, operations at sea involving local and French R/Vs, and moored instruments will be combined to improve our understanding of the SSUS ecosystem functioning. SOLAB's collaborative environment and strategy is aimed to foster similar research initiatives, e.g., in the other hotspots of the subregion.

SPECIFIC CHALLENGE

SOLAB's methodology relies on integrated multi-scale modelling and observations (in situ and satellite) with an emphasis on synoptic/submeso scales (from a few days to a few weeks and 1-10 km). Faster/finer physicalvprocesses will also be considered insofar as they contribute to aggregation/dispersion and affect the intensity of trophic transfers. SOLAB combines a wide range of observation methods (satellites, field campaigns, instruments on long-term moorings,measurements by acoustics, optics, chemistry analyzes, metabarcoding). Based on these state-of-theart observation activities, SOLAB is designed to contribute to the emergence of a new generation of coastal ocean numerical models of the coastal ocean covering physics, biogeochemistry, plankton functional biodiversity, and modelling of SPF life cycle (relying on the Dynamic Energy Budget - DEB - formalism).

APPROACH

SOLAB's general objective is to improve our ability to predict and manage coastal ocean evolutions. Because of its pivotal role in marine ecosystems, plankton will be the focus of SOLAB research. The project will investigate its dynamics, diversity, structure and variability. Specifically, we seek to 1) understand how the plankton ecosystem responds to variability of its physical/biochemical drivers on scales from minutes to months in time, and from 100 m to 100 km in space; 2) clarify the present-day impact of environment variability at these scales on SPF 3) integrate processes taking place at these scales into multidecadal evolution scenarios for coastal ecosystems

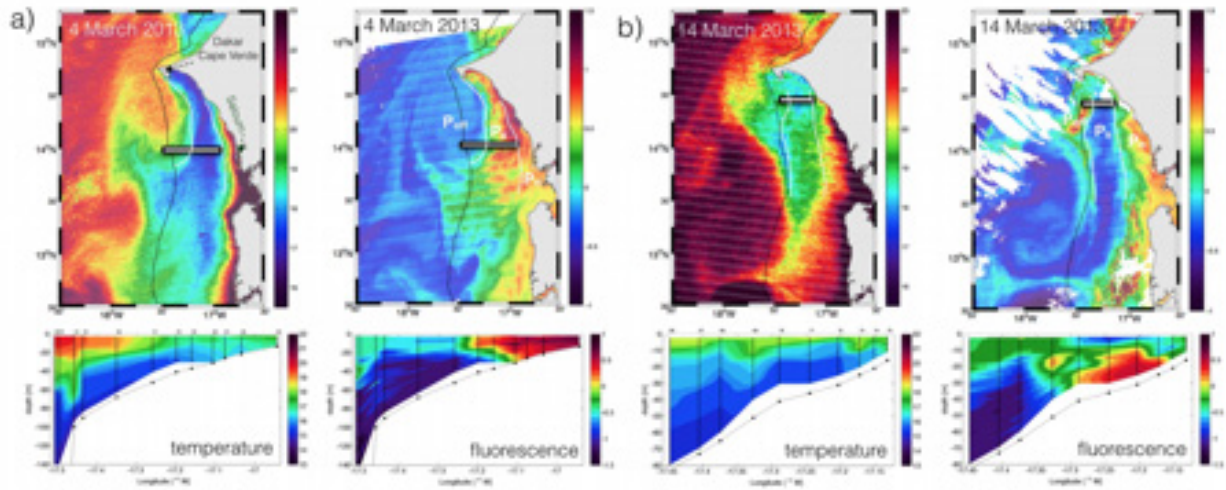
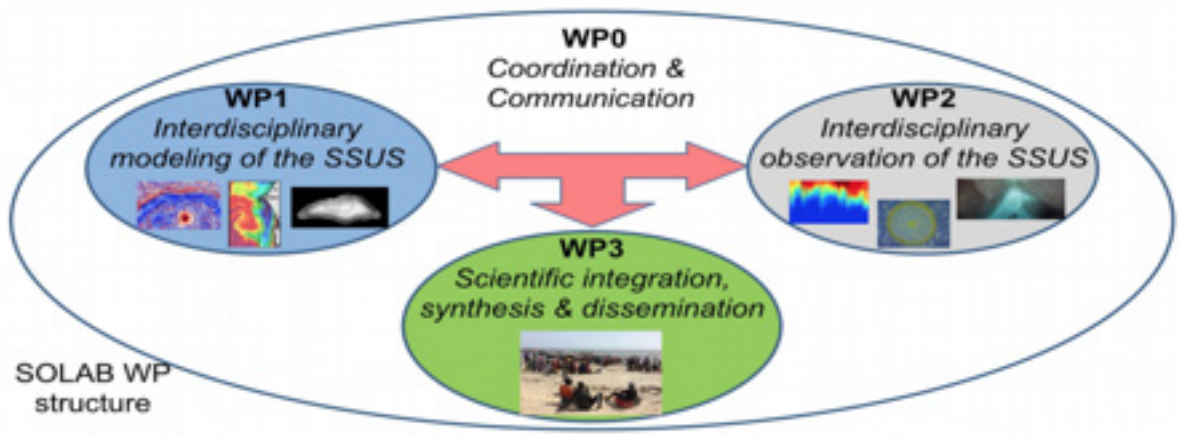


Fig. 2: Two synoptic states of the SSUS 10 days apart, corresponding respectively to sustained (a, left panels) upwelling and relaxation (b, right panels) conditions. Satellite observations are complemented with cross-shore sections (white bars) of in situ temperature and fluorescence (bottom panels) at 14°N (a) and 14°30N (b). Eco-provinces are delimited with white lines and referred to as Pn (nearshore), Ps (shelf) and Poff (offshore). On 4 March(a), the boundary between Poff and Ps is well marked and located in relatively shallow waters due to mesoscale structure impinging on the shelf. The boundary between Ps and Pn has a limited signature on the displayed variables but across-shore contrasts in plankton composition and turbidity were found at 14°N about the 15 m isobath (not shown). On 14 March, contrasts between provinces are well marked in Chla. Ps is characterised by a local surface chlorophyl minimum due to phytoplankton sinking. This is plausibly the trigger for severe subsurface hypoxia observed over the shelf the following days. Planned SOLAB field and modeling work will allow us to clarify this.

WORK PACKAGES DESCRIPTION

SOLAB is organized in four work packages.
WP0: Project coordination & reporting (X. Capet ; LOCEAN);
WP1: Interdisciplinary modelling of the SSUS (V. Echevin, T. Brochier; LOCEAN);
WP2: Interdisciplinary observation of the SSUS (E. Machu, M. Sourisseau; LOPS);
WP3: Scientific integration, syntheses and dissemination (P. Brehmer, X. Capet, E. Machu; LEMAR).
In particular, WP3 will ensure proper communication flow between WP1 modellers and WP2 observationalists.



SCOPE

SOLAB's scope is regional in terms of contribution to the ocean dynamics stock observations and global for the onset of a novel approach to study multi-scale physical and biological processes and contribute to the understanding of small pelagic fish recruitment variability.

• Geographically, SOLAB will contribute to the understanding of population dynamics of small pelagic fish present in Senegalese waters, within which are migratory species that largely contribute to the fisheries in the sub-region.

• Thematically, the scope of application of SOLAB's expected results are the coastal seasonal upwelling areas found in the eastern boundary upwelling ecosystems (EBUS), which provide about 20% of the annual global fish catch.

• Institutionally, SOLAB creates strong research interactions between researcher from France (CNRS, IRD, IFREMER) and Senegal (UCAD, CRODT).