上海海洋大學
SHANGHAI OCEAN UNIVERSITY

Long-term variability of the large marine ecosystems in Southwest Atlantic and its responses to climatic regime shifts

Hewei Liu[1], Wei Yu[1,2,3,4,5]* and Xinjun Chen[1,2,3,4,5]

[1]College of Marine Sciences, Shanghai Ocean University, Shanghai 201306, China; [2]National Engineering Research Center for Oceanic Fisheries, Shanghai Ocean University, Shanghai 201306, China

[3]Key Laboratory of Sustainable Exploitation of Oceanic Fisheries Resources, Ministry of Education, Shanghai Ocean University, Shanghai 201306, China

[4]Key Laboratory of Oceanic Fisheries Exploration, Ministry of Agriculture and Rural Affairs;[5]Scientific Observing and Experimental Station of Oceanic Fishery Resources, Ministry of Agriculture and Rural Affairs, Shanghai, 201306, China

Introduction

Climate Change

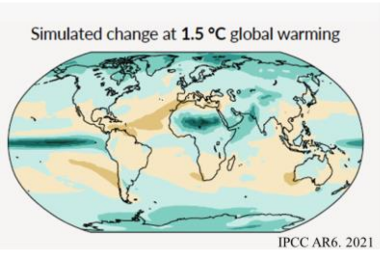

Fig. 1 Simulated change at 1.5℃ global warming.

- **Climate change**, habitat destruction, marine pollution, and overfishing are frequently occurring in global marine ecosystems and have an impact on ecosystems and the services and functions they provide.
- **Climate change plays a crucial role in changing the dynamics of marine ecosystems.**
- **Climate change** may lead to the reorganization of communities in both time and space, and **community reorganization** is one of the main consequences of climate change on **ecosystems**. Community restructuring may cause nutrient imbalance in ecosystems and further lead to changes in food relationships.

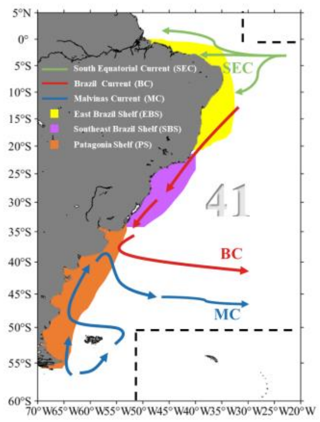

Fig. 2 Geographical Location and Overview of 41 Fishing Areas.

Southwest Atlantic Ocean

- The **Southwest Atlantic** is one of the most important fishing areas in the world, and the continental shelf and continental slope area connected to South America is one of the **highest primary productivity** areas in the world's oceans (Fig.2).

he Food and

square kilometers of ocean area off the east coast of South

America, including 1.96 million square kilometers of

from the north and MC from the south converge in this area,

forming a three stream convergence zone at the mouth of the

Qustion: What are the impacts of climate change on the ecosystem?

Methods

1: Integrated Trend Assessment (ITA)

① **Data sources**：Fishing data: http://www.seaaroundus.org/;
Environmental data: http://apdrc.soest.hawaii.edu/;
Climate data: https://psl.noaa.gov/data/correlation/.

② **Principal Component Analysis (PCA)**：
- Applying PCA for dimensionality reduction processing of data.
- Selecting n principal components that can represent data features for subsequent analysis according to Kaiser-Harris Criterion, Cattell Scree Test and Parallel Analysis.

③ **Sequential T-test Analyses of Regime Shifts (STARS)**:
- Using STARS to test the trend of time series and the occurrence nodes of regime shifts.

④ **Chronological Cluster Analysis (CCA)**
- Applying CCA to Determine the year of regime shifts in the Southwest Atlantic ecosystem.
- Perform sensitivity analysis on the above results using Bootstrap.

2: The importance of environmental and climate

① **Gradient Forest (GF):**
- R^2 of importance and cross validation of variables indicates the degree of influence of different variables.

② **Multiple Factor Analysis (MFA):**
- Exploring the roles and interrelationships of different factors based on MFA.

Results

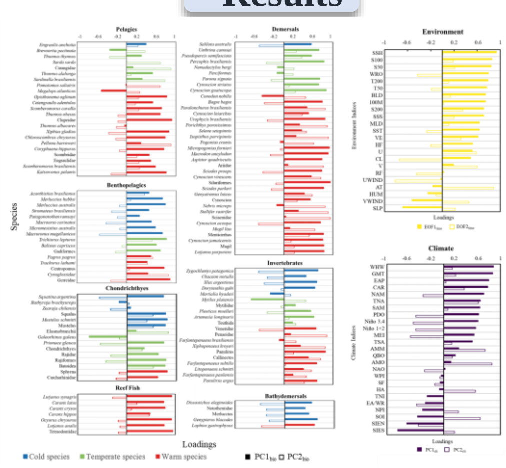

Fig.3 Loadings of PCA results for fishery data, environmental data, and climate data. $PC1_{bio}$ indicated the changing characteristics of most fishery resources in the ecosystem, while $PC2_{bio}$ indicated the changing characteristics of low latitude fishery resources.

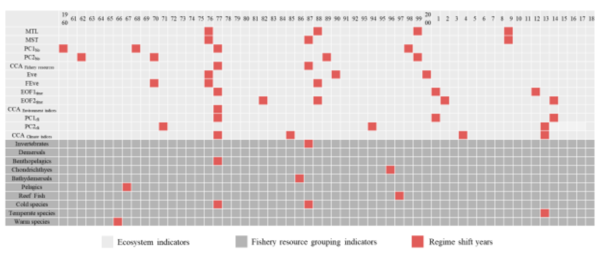

Fig. 4 Summarize the results and organize the years when the ecosystem undergoes regime shifts. The results showed that the regime shifts were mainly concentrated in **1976/1977**, **1987/1988** and **1998/1999/2000/2001.**

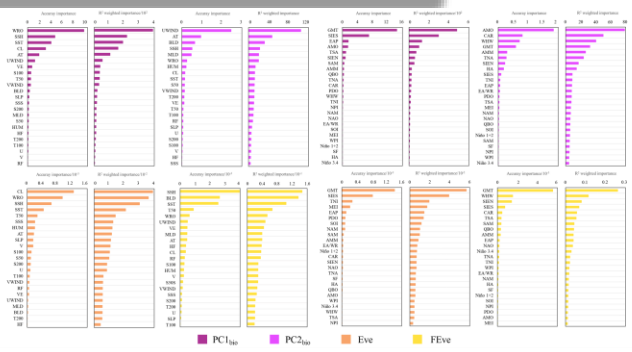

Fig. 5 The results of GF for environmental indices (A) and climate indices (B). For $PC1_{bio}$, which represented the majority of fishery resources in the ecosystem, the importance of **WRO** and **GMT** were significantly higher than other environmental and climate indices, followed by SSH, CL, SST, and SIES. For $PC2_{bio}$, which represented high suitable temperature and low nutrient level, **UWIND** and **AMO** were the most important, followed by AT, BLD, and SSH. In a word, **WRO**, **SSH**, **SST**, **GMT** and **AMO** were more important indices.

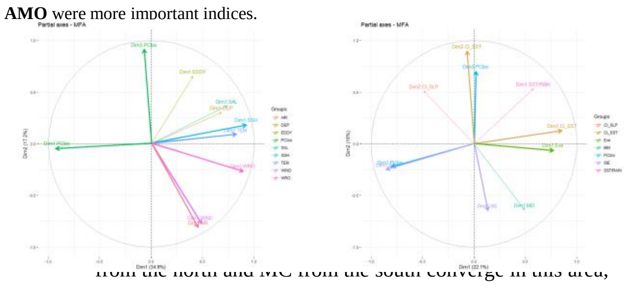

Fig. 6 The results of MFA for environmental indices (A) and climate indices (B). There was a significant negative correlation effect between Dim1. PC and WRO, SSH, TEM, Dim1. CI_SST, while there was a significant positive correlation effect between Dim1. PC and Dim1. SIE. There was a significant negative correlation effect between Dim2. PC and AIR, Dim1. WIND, while there was a significant negative correlation effect between Dim2. PC and Dim2. CI_SST, Dim2. SIE.

Conclusions: Changes in ecosystems under climate change.

① **The extracted feature vectors of PCA can better represent the changes in the ecosystem.**

② **The years of regime shifts mainly occurred in 1976/1977, 1987/1988 and. 1998/1999/2000/2001.**

③ **Environmental factors that had significant impacts on the Southwest Atlantic ecosystem include WRO, SSH, SST, and CL.**

④ **Climate indices that had significant impacts on the Southwest Atlantic ecosystem include GMT, AMO, and SIES.**

Future work

The impact mechanism of climate on the environment and the interaction between ocean and atmosphere

① Based on the results, an overview of the impact of ocean and atmosphere, environment and climate on the ecosystem of the Southwest Atlantic was integrated (Fig.7).

② The specific impact mechanism needs to be further explored in conjunction with the discipline of physical oceanography.

Fig.7 Overview of the impact of environment and climate on fishery resources in the southwest Atlantic ecosystem.

Establishing an ecosystem-based fisheries management plan under climate forcing

① Exploring more ecosystem indicators under the impact of climate change based on results.

② Establish an ecosystem-based comprehensive evaluation index system under climate forcing to provide scientific basis for fisheries management.

上海海洋大學 海洋科学学院
College of Marine Sciences Shanghai Ocean University

Email address:
Hewei Liu: hwLiu77@126.com
Wei Yu: wyu@shou.edu.cn