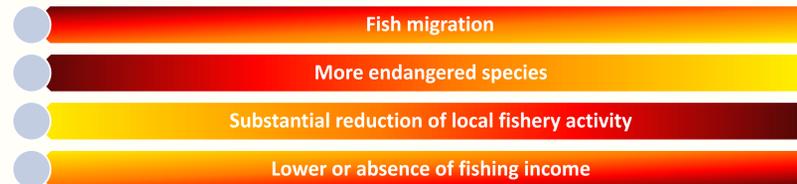


SUMMARY: The contribution of fisheries to global food security is quite relevant. Millions of fishermen, fish farmers and their families around the world are dependent of the fishing outcome. The world marine fishery has reduced sharply, either by the total exploitation or the overexploitation of some species. The sardines and other small pelagics are just some of the endangered species under climate change. The success of the maintenance of these fish stocks are related to the environmental variability of the oceans. This paper compares future scenarios of sea surface temperature (SST) anomaly in Southeast Brazilian Bight (SBB), in the North (NBCS) and South Brazilian Continental Shelf (SBCS). The Brazilian Earth System Model (BESM-OA) v.2.3 was used to represent two future scenarios (2006-2100) considering the Representative Concentration Pathway RCP4.5 and RCP8.5. We validated our results with satellite observations and compared them to Coupled Model Intercomparison Project, Phase 5 (CMIP5). BESM results are consistent with CMIP5 models and observations. The long-term simulation in the RCP4.5 scenario indicates an increase of the SST anomaly, up to the year 2100, 2°C in the NBCS, 1.2°C in the SBB and 0.5°C in the SBCS. In the RCP8.5 situation, there is an increase of 4.5°C in the SST anomaly of the NBCS, 2.9°C for SBB and 1.9°C on the SBCS. The increase in the SST will move the stocks to the optimum conditions of survival region, changing the current fishing reality. Other variables such as changes in the winds and the acidification of the oceans also interfere with the future of fishing around the world. Even with the decline in marine fish stocks, the global search for fish should continue to increase. This demand should be balanced by aquaculture which has shown continued growth in the animal food production sector.

HOW DEEP COULD THE CLIMATE CHANGE IMPACT LOCAL FISHERY?

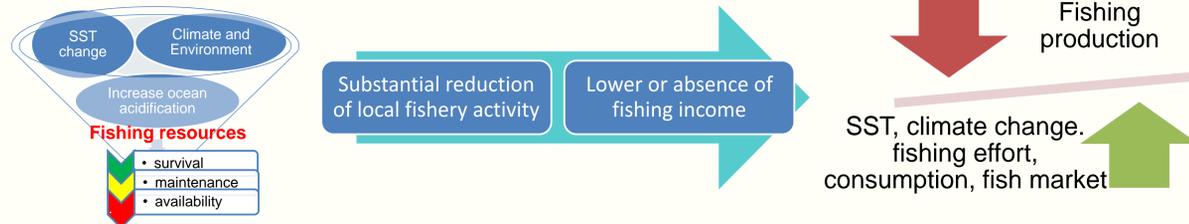


➤ Visual analyses of the series of fish production and the anomaly of the sea surface temperature (Fig. 1) indicate that the negative anomalies tend to increase the fish production of the analyzed species. Likewise, positive values of anomaly of this variable lead to a reduction in fishing.

➤ World fisheries production ranged from 93.7 to 88.2 million tonnes / year and an average of 90.9 million tonnes (standard deviation of 1.6 million tonnes) for the 1999-2012 period.

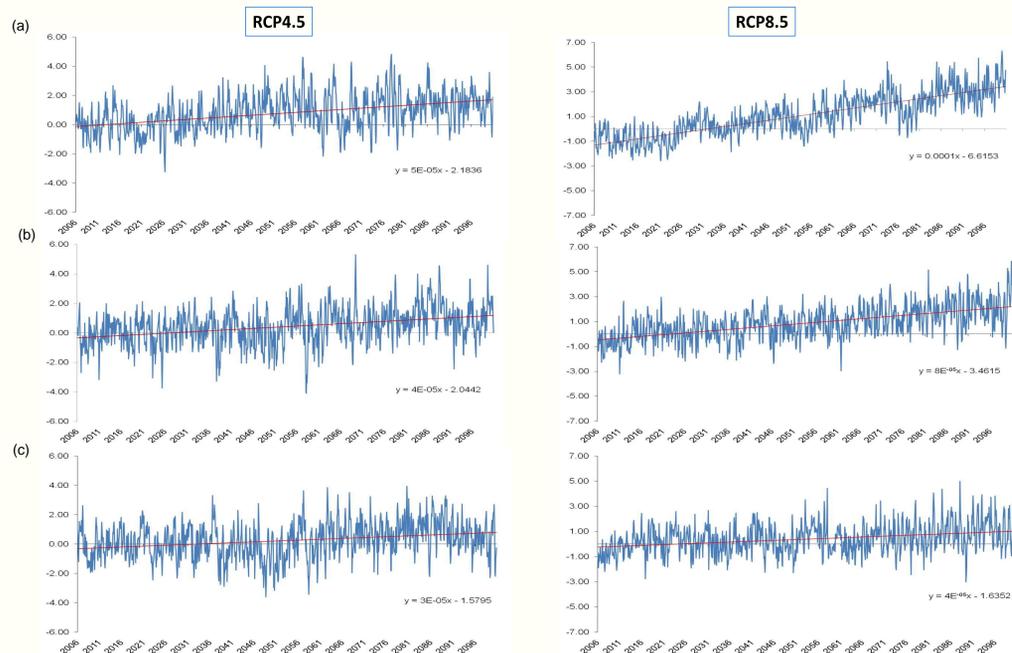
➤ World fishing studies already demonstrated that Peru, Chile, Argentina, Venezuela and Canada have decreased their share while Mexico, Brazil, Ecuador and the United States have increased their catch contribution.

➤ In this study we consider the one of main coastal fishing resource: *Cynoscion acoupa* (Acoupa weakfish) in the North Brazilian Continental Shelf; *Sardinella brasiliensis* (Brazilian sardine) in the Southeast Brazilian Bight and *Micropogonias furnieri* (Whitemouth croaker) in the South Brazilian Continental Shelf.



Increase (approximately) of the SST anomaly, up to the year 2100

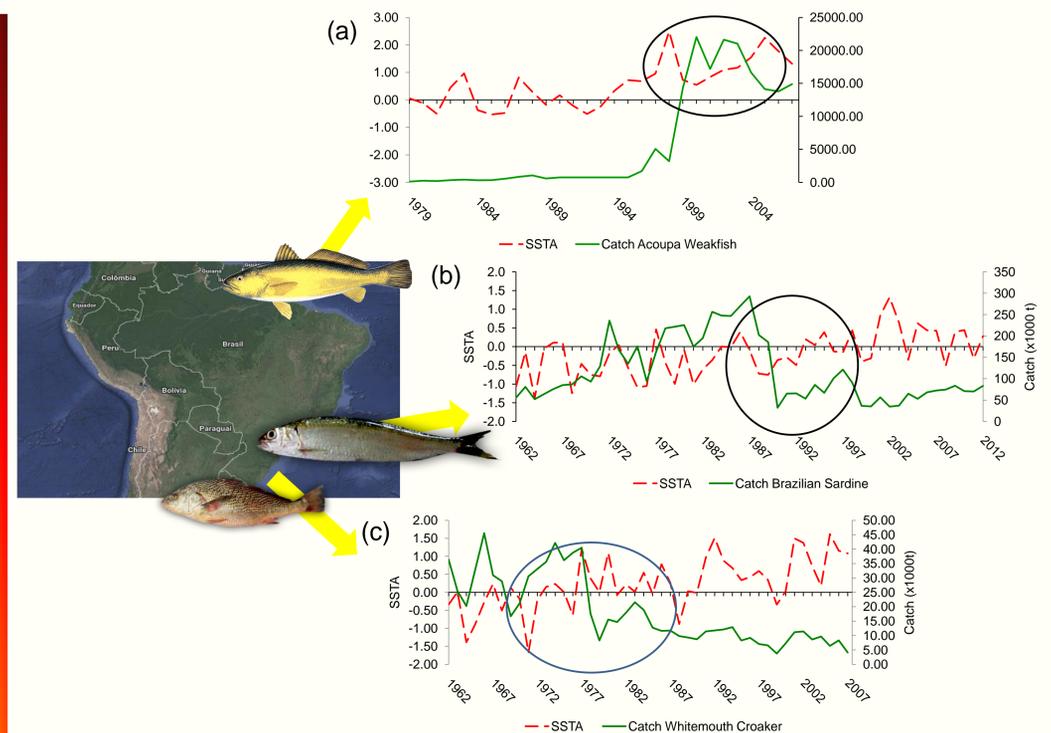
| | | | |
|---------------|---------------------------|---------------|--------------------------|
| RCP4.5 | 2.0°C in the NBCS | RCP8.5 | 4.5°C in the NBCS |
| | 2.9°C for SBB | | 1.2°C in the SBB |
| | 0.5°C in the SBCS. | | 1.9°C on the SBCS |



Time series of sea surface temperature anomaly considering the Representative Concentration Pathway RCP4.5 and RCP8.5 simulated from the Brazilian Earth System Model (BESM-OA) v.2.3 for the 2006-2100 period. (a) North Brazilian Continental Shelf, (b) Southeast Brazilian Bight, (c) South Brazilian Continental Shelf.

| Data | Variable | Period | Source |
|---------------------------------|---------------|-----------|--|
| Fishing | Landing (ton) | 1962-2007 | MMA/IBAMA (Freire et al., 2014) |
| Ocean reanalysis data | SST (°C) | 1948-2016 | NOAA/ESRL |
| Future Scenarios RCP4.5 and 8.5 | SST (°C) | 2006-2100 | Brazilian Earth System Model (BESM-OA) v.2.3 |

Fish Production and SSTA



Time series of annual fishing production (green line) of (a) *Cynoscion acoupa* (Acoupa weakfish) in the North Brazilian Continental Shelf; (b) *Sardinella brasiliensis* (Brazilian sardine) in the Southeast Brazilian Bight and (c) *Micropogonias furnieri* in the South Brazilian Continental Shelf and sea surface temperature anomaly (red line), period from 1962 to 2007.

Fish migration



Early signs of migration to optimum environment condition:

- 1) Acoupa weakfish moves from Pará coast to Amapá coast
- 2) Brazilian Sardine typically found in SBB has already been found in Rio Grande do Sul Continental Shelf

Scheme of possible migration (1) *Cynoscion acoupa* (Acoupa weakfish) from coastal region of Pará State to the Amapá State located further north and (2) the *Sardinella brasiliensis* (Brazilian sardine) from to SBCS, southern of Brazil

