Impact of Climate Change on Pacific tropical tunas and their fisheries in High Sea and Pacific Islands waters

WCPFC-SC14-2018/EB-WP-01

Inna Senina, Patrick Lehodey, Beatriz Calmettes, Morgane Dessert, John Hampton, Neville Smith, Thomas Gorgues, Olivier Aumont, Matthieu Lengaigne, Christophe Menkes, Simon Nicol, and Marion Gehlen

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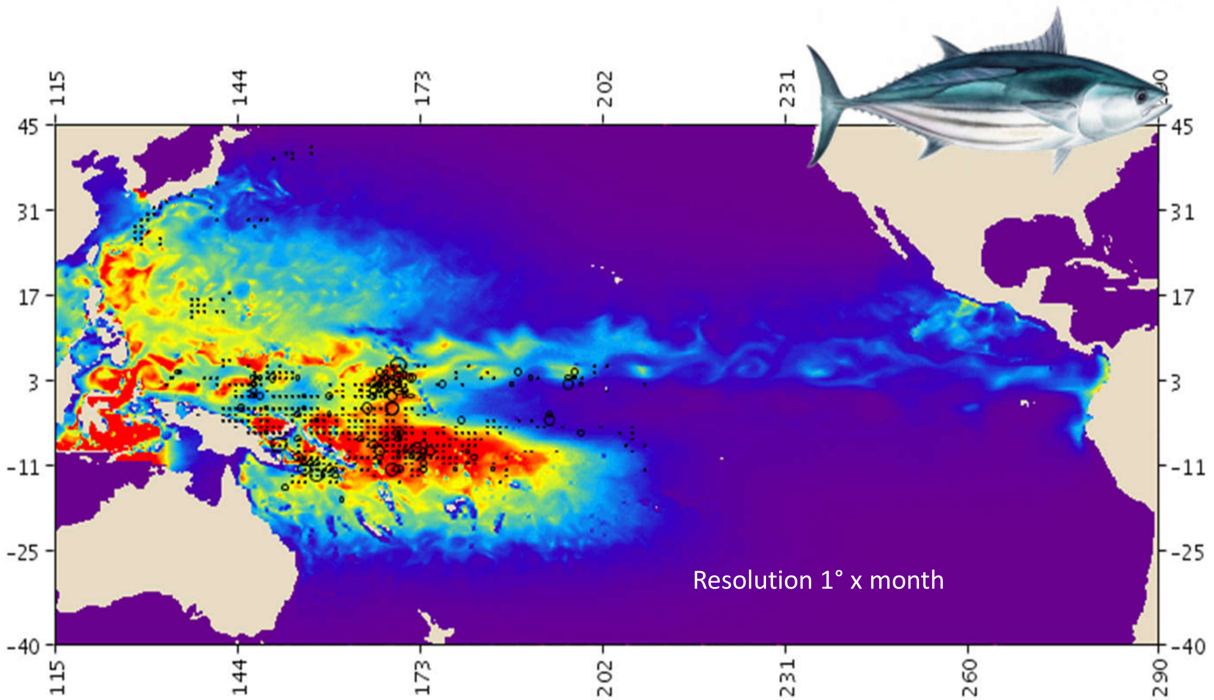
OVERVIEW

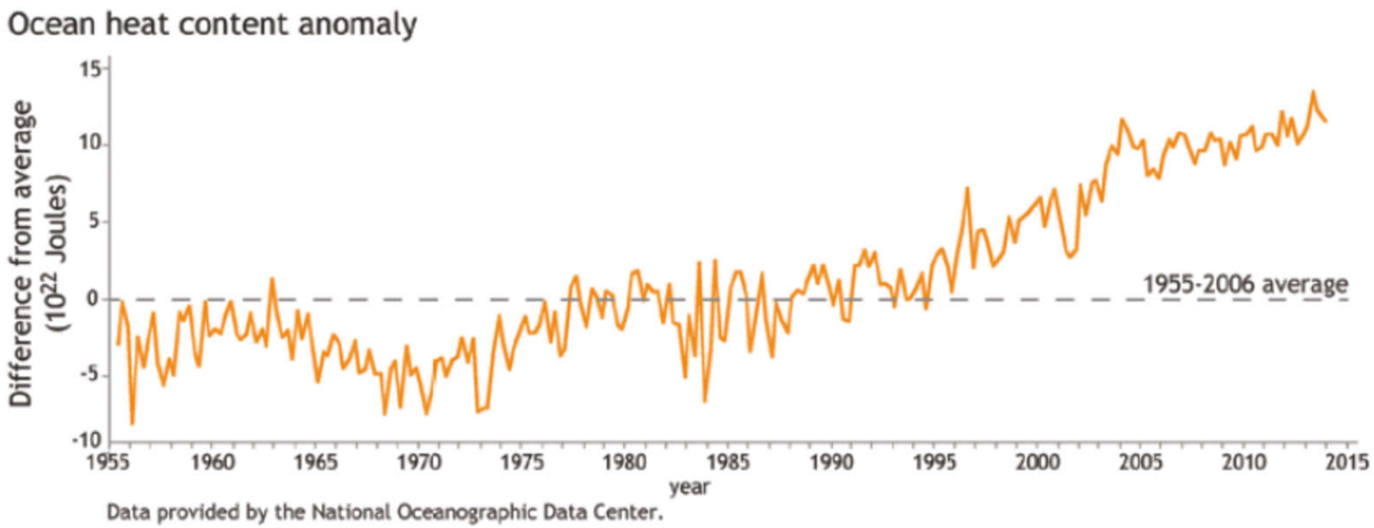
- Context
- Modelling
- Results
- Future Project 62 work
- Summary

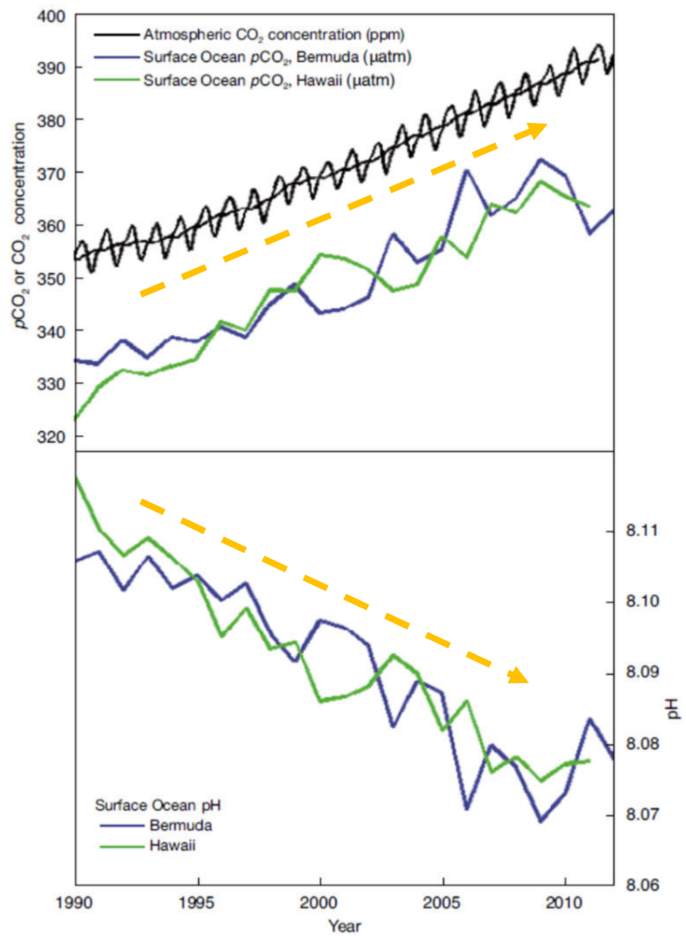


Hindcast of total predicted skipjack density (red high) and observed catch (proportional to circle size). 2016 SEAPODYM model output.

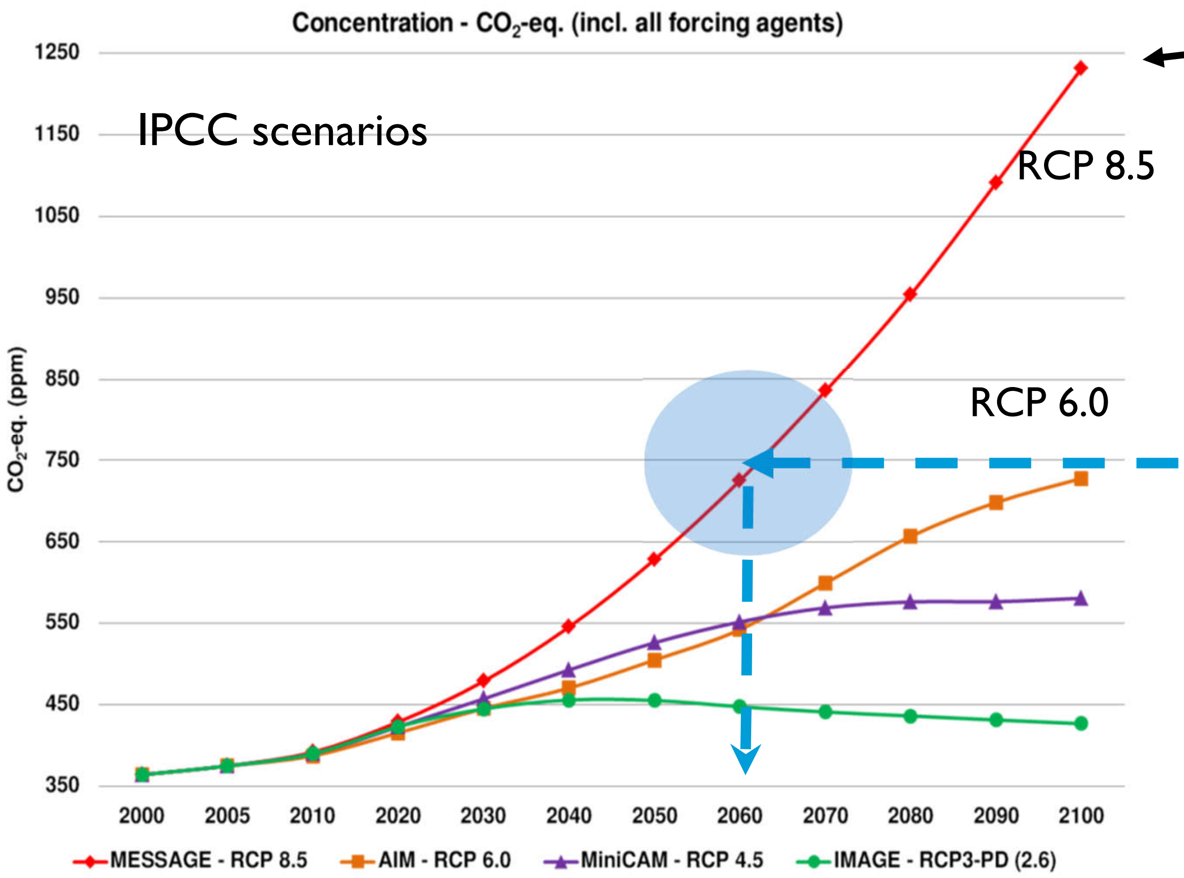
CONTEXT: OBSERVED CHANGES

Climate change has already modified the environment of Pacific tropical tunas





CONTEXT: CLIMATE CHANGE PROJECTIONS

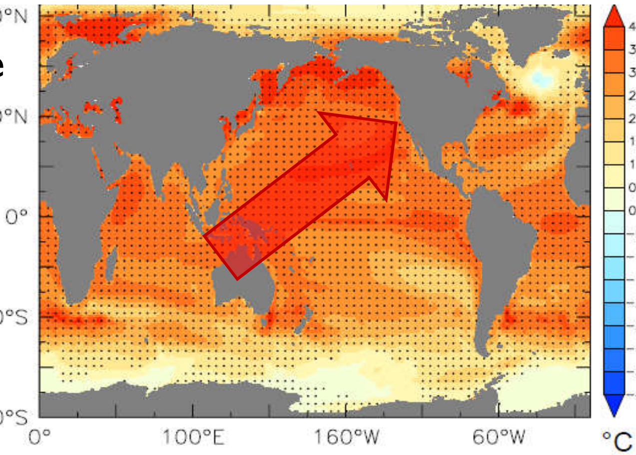


RCP 8.5 is a pessimistic business as usual high emissions scenario

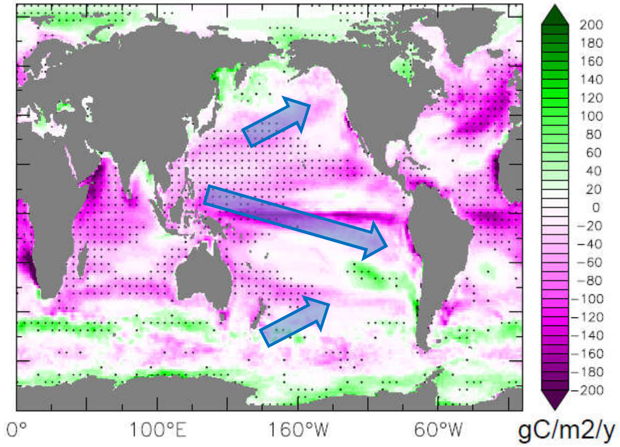
Projection under RCP 6.0 at the end of 21st Century would be close to model results for 2060 using RCP 8.5.

CONTEXT: PROJECTION DRIVERS

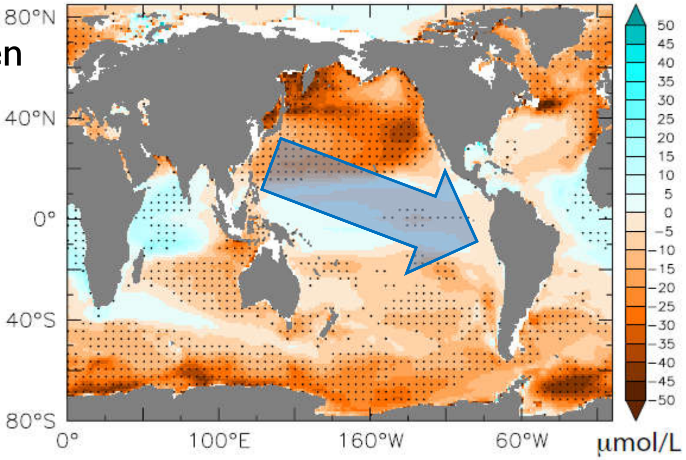
Temperature



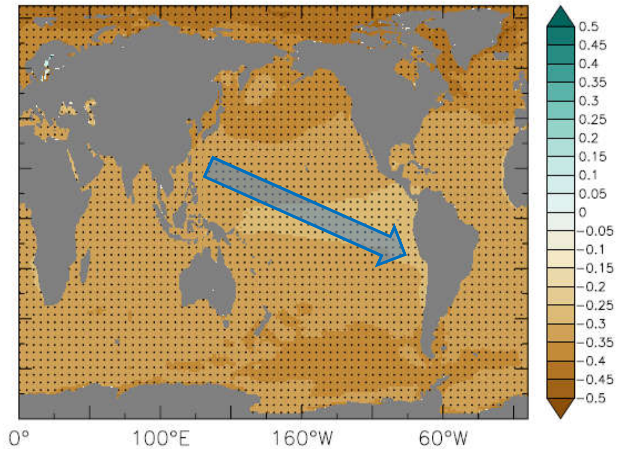
Productivity



Oxygen



Acidification (decreasing pH)



Source:
Bopp et al. 2013

MODELLING: I – OPTIMISATION 1980-2010

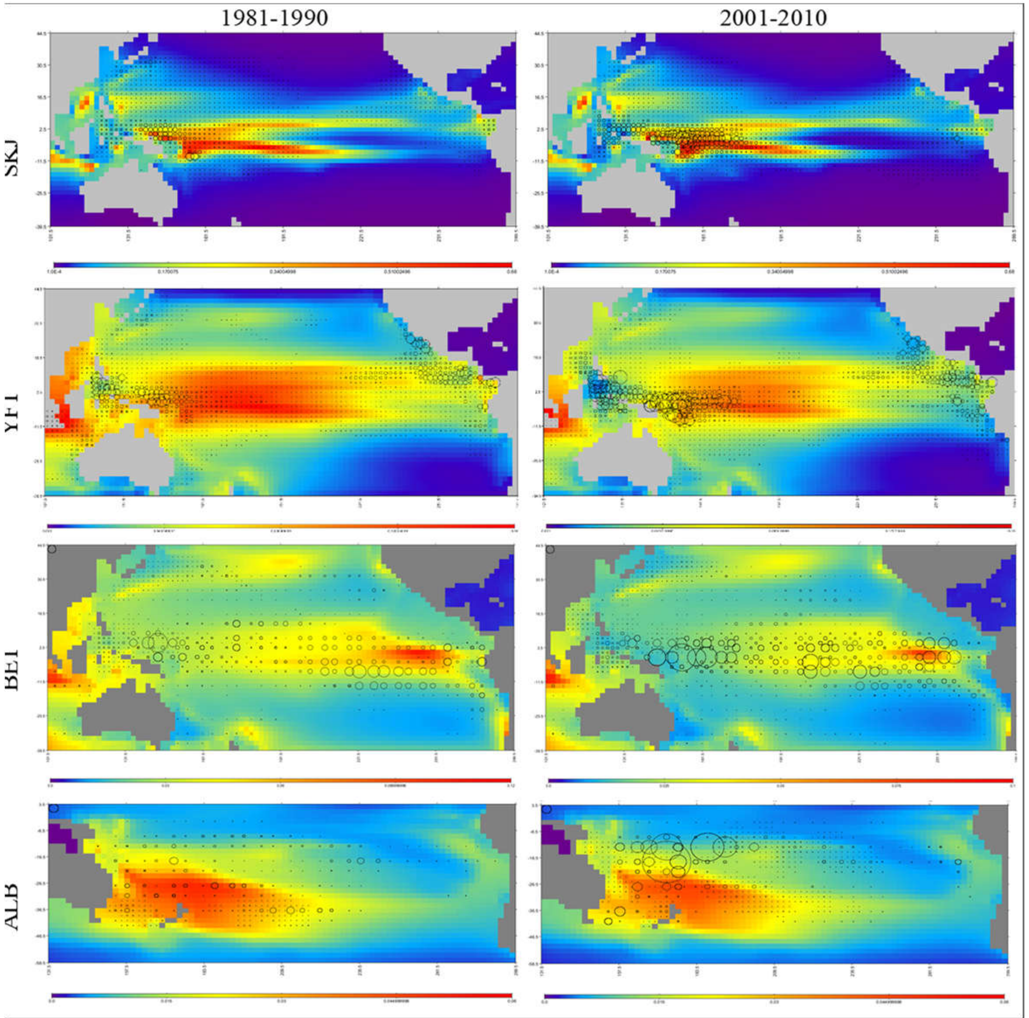
Comparison of predicted distributions for 1st and last decade of the historical time series. Total observed catches are shown with catch proportional to circles.

Skipjack - WCPFC SC12 & Senina et al, (sub)

Yellowfin: **-** WCPFC SC13

Bigeye – WCPFC14

South Pacific Albacore – WCPFC14



MODELLING: II – PROJECTIONS 2010-2100

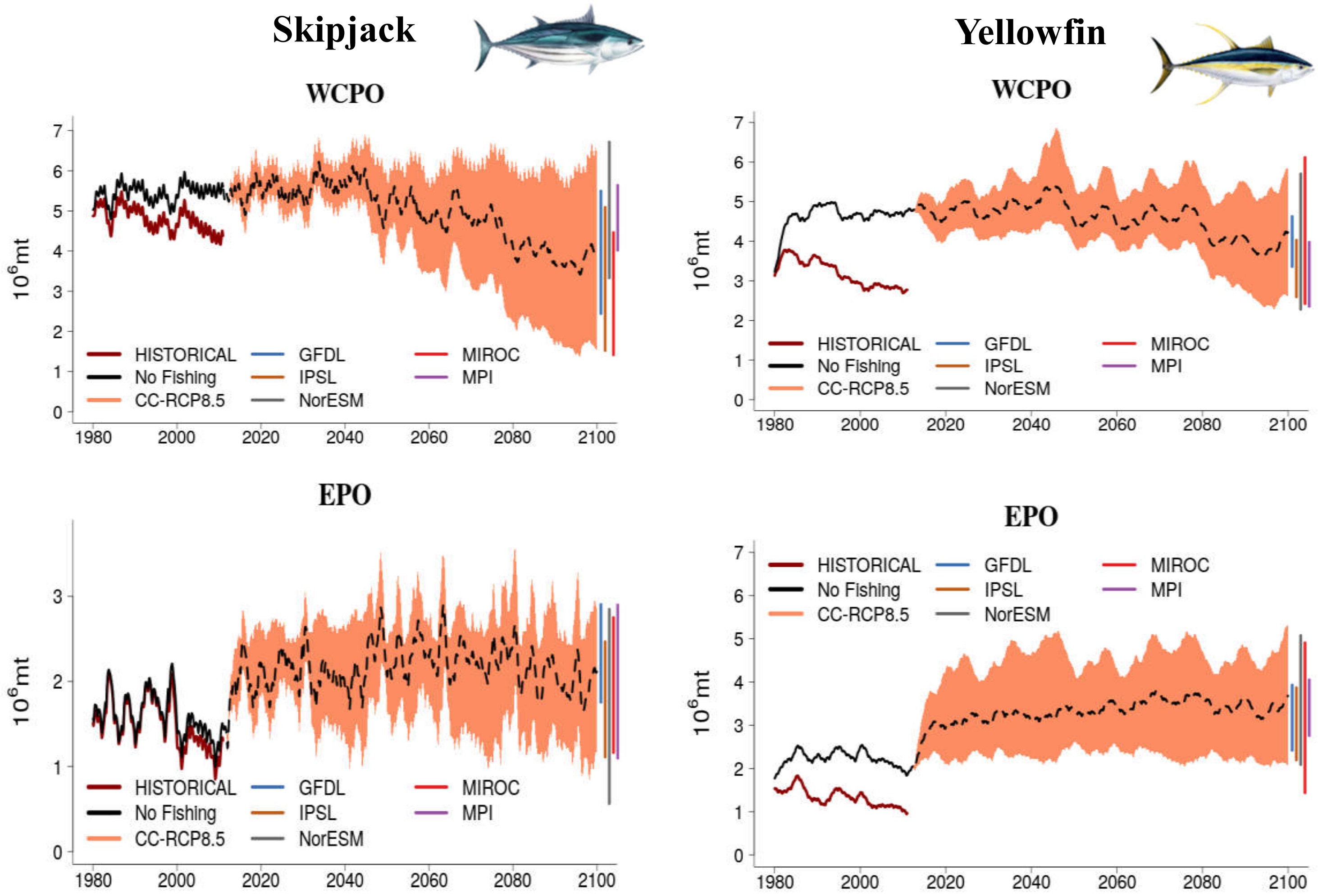
Uncertainty explored in the simulation ensembles produced for this study

Uncertainty in atmospheric forcing		**Structural uncertainty in biogeochemical model**	**Structural uncertainty in SEAPODYM**
Code	**CMIP5 model**		
IPSL	IPSL-CM5A-MR (Institut Pierre Simon Laplace, France)	- Primary production: Increase of PP by 10% (PP10) in tropical waters (defined by SST >27°C) - Dissolved Oxygen: No change (O2clim) = Use of climatological fields	- Genetic adaptation: Regular increase in optimal spawning temperature to reach + 2°C at the end of the Century - Ocean acidification: Additional mortality on larvae based on laboratory experiments with low medium and high sensitivity to pH (available only for yellowfin).
MIROC	MIROC-ESM (Model for Interdisciplinary Research on Climate, Japan)		
NorESM	NorESM1-ME (Norwegian Climate Centre, Norway)		
MPI	MPI-ESM-MR (Max Planck Institute for Meteorology, Germany)		
GFDL	GFDL-ESM2G (Geophysical Fluid Dynamics Laboratory, USA)		

Ensemble of 20 members for SKJ, BET and ALB projections and 35 for YFT (with additional Ocean acidification scenarios)

RESULTS

Envelope of predictions from simulation ensembles under RCP8.5 scenario for WCPO and EPO). The change in total biomass is presented with the average (dotted line) and its envelope bounded by the 5% and 95% quantile values of the simulation ensembles.



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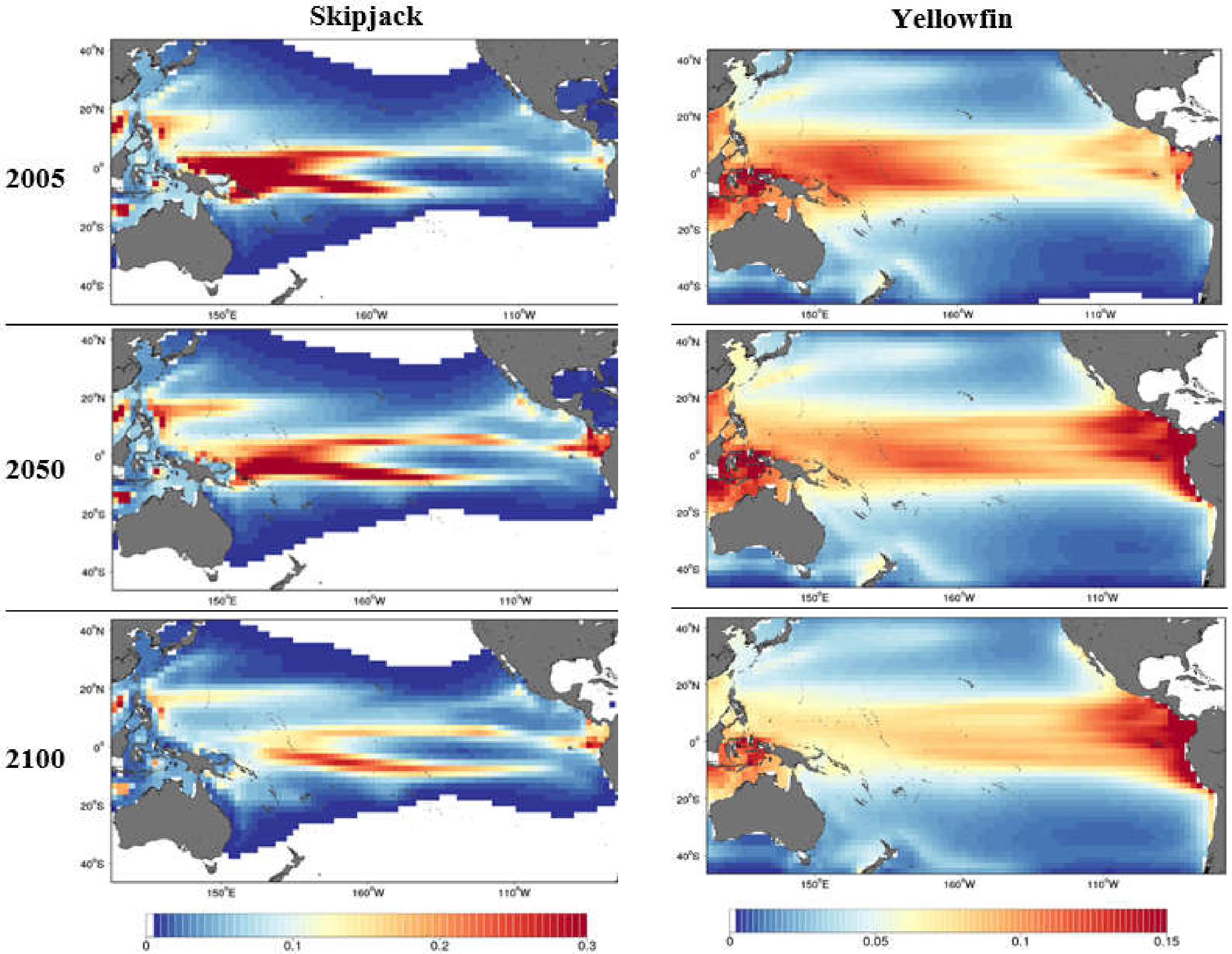
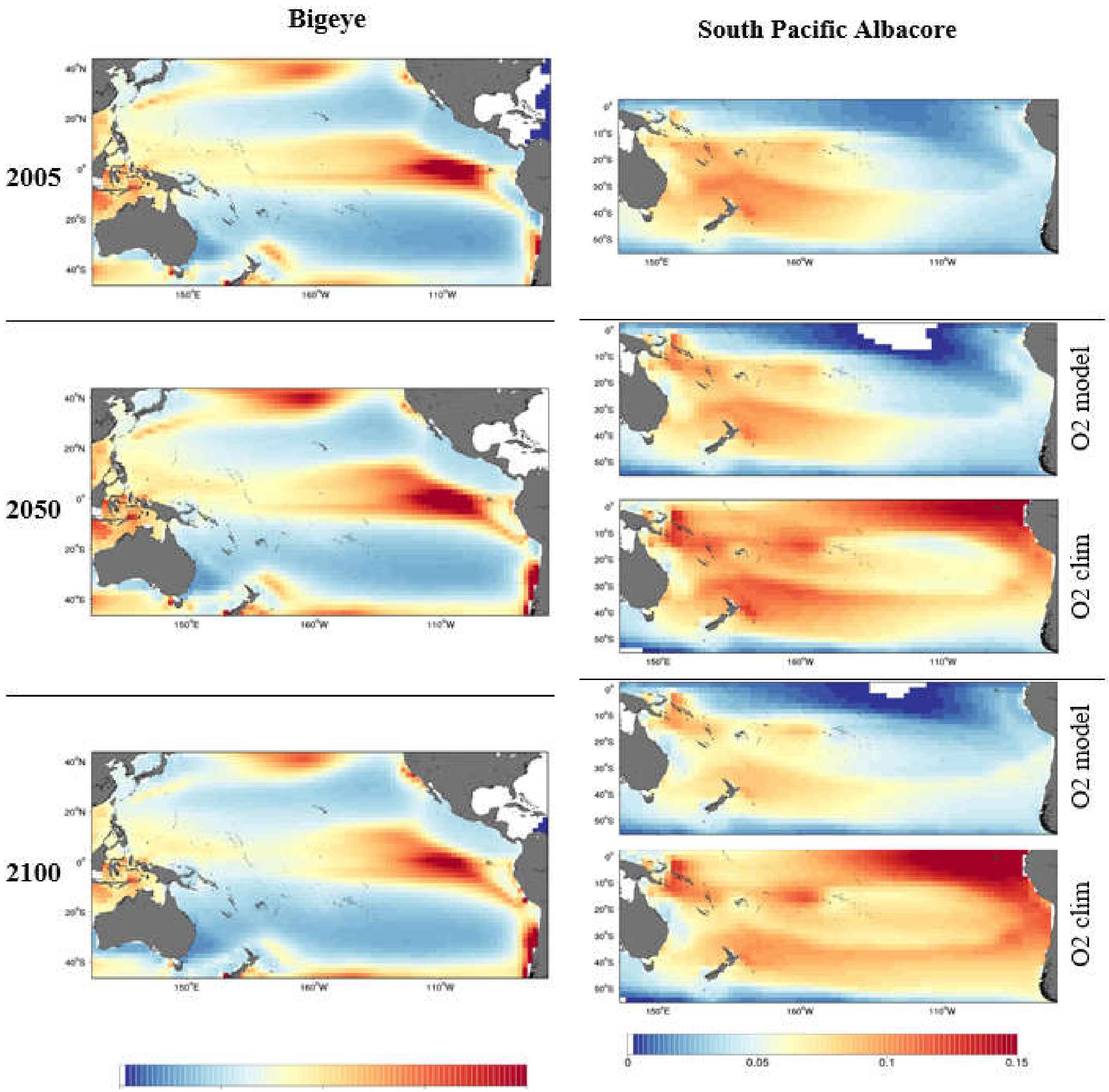
RESULTS



Projected mean distributions of biomass across the tropical Pacific Ocean under IPCC RCP8.5 for 2005 and from the simulation ensembles in the decades centred on 2045 and 2095 including projected average percentage changes for the outlined areas east and west of 150°W.

RESULTS

Projected mean distributions of biomass across the tropical Pacific Ocean under IPCC RCP8.5 for 2005 and from the simulation ensembles in the decades centred on 2045 and 2095 including projected average percentage changes for the outlined areas east and west of 150°W.



RESULTS

Mean biomass change (%) by EEZ for the decades 2046-2055 (2050) and 2091-2100 (2100) relative to 2001-2010 average. CNMI = Commonwealth of Northern Mariana Islands; FSM = Federated States of Micronesia.

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Area	Virgin biomass							
	SKJ		*YFT*		*BET*		*ALB*	
	2050	2100	2050	2100	2050	2100	2050 (-SO)	2100 (-SO)
West of 170°E								
CNMI	48	8	-1	-14	4	-5	-	-
FSM	-29	-55	-19	-37	3	-6	196 (32)	188 (22)
Guam	-5	-30	-16	-30	2	-3	-	-
Marshall Islands	-17	-31	-12	-31	-3	-12	216 (20)	211 (6)
Nauru	-8	-51	-16	-44	-4	-23	170 (31)	143 (6)
New Caledonia	8	49	-9	-25	-5	-18	14 (0)	-3 (-16)
Palau	-28	-54	-12	-29	4	-6	226 (58)	209 (48)
Papua New Guinea	-43	-72	-21	-42	-4	-16	72 (35)	64 (28)
Solomon Islands	-17	-37	-9	-30	-2	-14	62 (24)	46 (8)
East of 170°E								
Vanuatu	21	82	-2	-20	-1	-13	20 (4)	2 (-14)
American Samoa	42	61	23	9	4	-7	41 (9)	36 (-2)
Cook Islands	16	29	28	18	3	-7	47 (5)	39 (-7)
Fiji	14	14	6	-14	-1	-16	21 (1)	3 (-16)
French Polynesia	97	99	43	45	7	0	60 (4)	59 (-6)
Kiribati	18	-21	7	-17	1	-15	200 (14)	181 (-7)
Niue	24	15	20	6	3	-9	31 (6)	20 (-6)
Pitcairn Islands	60	41	55	72	10	7	68 (11)	85 (11)
Samoa	39	46	20	4	3	-8	36 (7)	29 (-4)
Tokelau	-14	-24	14	-7	-1	-17	92 (11)	69 (-10)
Tonga	15	3	13	-5	1	-14	25 (4)	14 (-9)
Tuvalu	-12	-45	3	-23	-2	-21	93 (13)	66 (-10)
Wallis and Futuna	26	21	14	-5	2	-11	39 (9)	28 (-6)

FUTURE PROJECT 62 WORK

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Future Project 62 work on SEAPODYM includes:

- incorporating fishing effort scenarios into the model projections
- integrating e-tagging data within a full likelihood approach for bigeye and yellowfin
- continuing to improve and validate over the historical period
- developing applications with higher resolutions
- investigating the change and impact of ENSO in combination with climate change
- considering other stocks (swordfish, north Pacific albacore, wahoo, mahi mahi)
- comparing with applications of SEAPODYM to tunas in other Oceanic basins
- regularly revisiting Earth Climate models for updated results and associated uncertainties

FUTURE PROJECT 62 WORK

- developing decadal projections with more realistic conditions over the coming 2-3 decades, combining climate change and natural variability (ENSO, PDO)
- developing a better methodology to correct climate model forcings before running the coupled physical-biogeochemical model
- a strong research effort (including in situ observations and laboratory experiments) to define the effects of optimal range of spawning temperature and the effect of pH on tunas, and
- better monitoring and modelling of future trends in dissolved oxygen concentration and pH to reduce uncertainty.

SUMMARY

- Most comprehensive update of SEAPODYM across all 4 species
- Complete ensemble approach used to describe uncertainties
- Better estimates of model parameters with better fit to data, and improved and consistent tuna distributions and dynamics
- Increased convergence in biomass estimates with independent stock assessment studies
- A comprehensive programme of work has been identified for the short and medium term to continue to develop SEAPODYM

ACKNOWLEDGEMENTS

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- Thanks for listening!

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