# IPCC Working Group II
# Chapter 30: The Ocean

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# IPCC Fifth Assessment Report
# Working Group II

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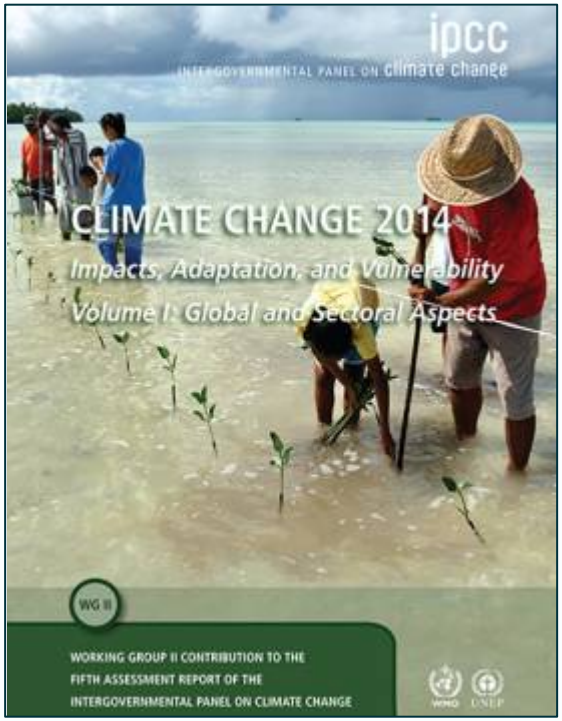
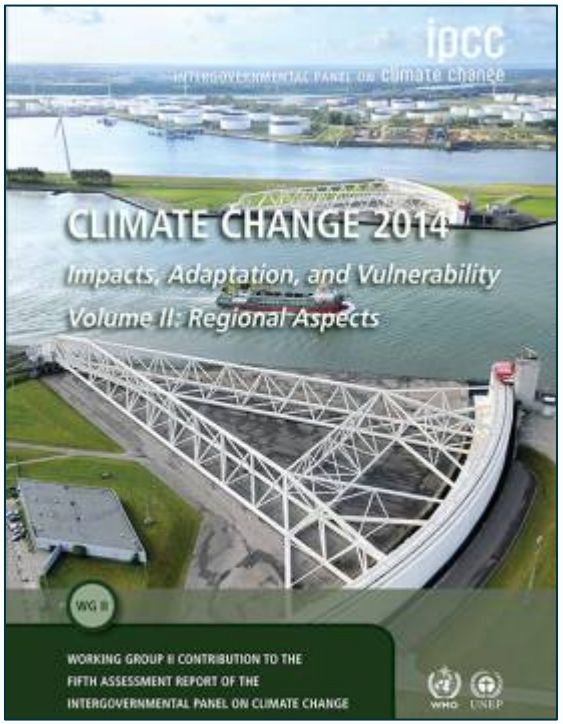


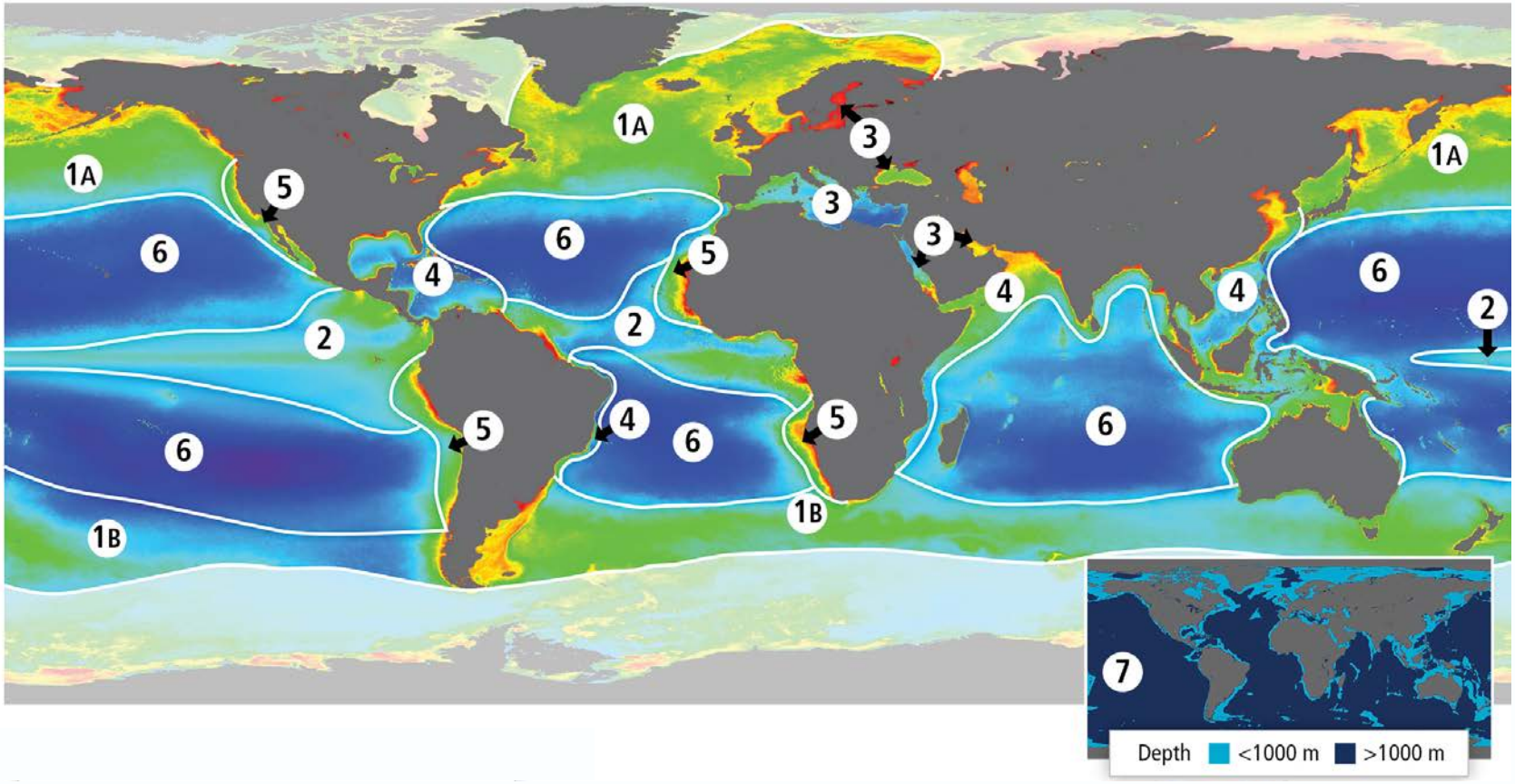

## What's new?

Increased focus on Adaptation (Chp 14-17) and on the **Ocean (Chp 6 and 30)**

# Why Regional Ocean?

- An integrated assessment of the impacts and risks of climate change and ocean acidification on the Ocean as a region was not included in recent IPCC assessments
- Gives opportunity to synthesizing the detection and attribution of climate change and ocean acidification across the physical, chemical, ecological, and socio-economic components of the Ocean
- Reflects the substantial increase in literature on observed and projected climate change and ocean acidification, and vulnerabilities and adaptation
- Provides a clear message of the risks to the Ocean ecosystems and sectors

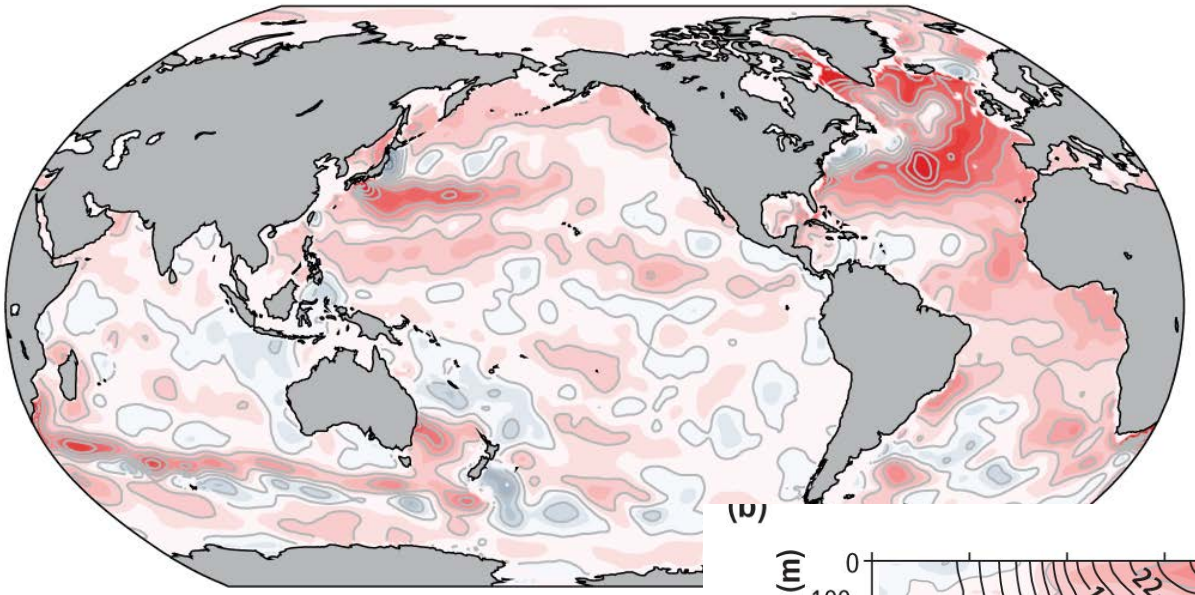
# Chapter 30 Regionalisation




1: High Latitude Spring Bloom Systems
2: Equatorial Upwelling Systems
3: Semi-Enclosed Seas
4. Coastal Boundary Systems
5: Eastern Boundary Upwelling Systems
6: Sub-Tropical Gyres
7: Deep Sea (>1000m)
8: (grey region) Polar Oceans

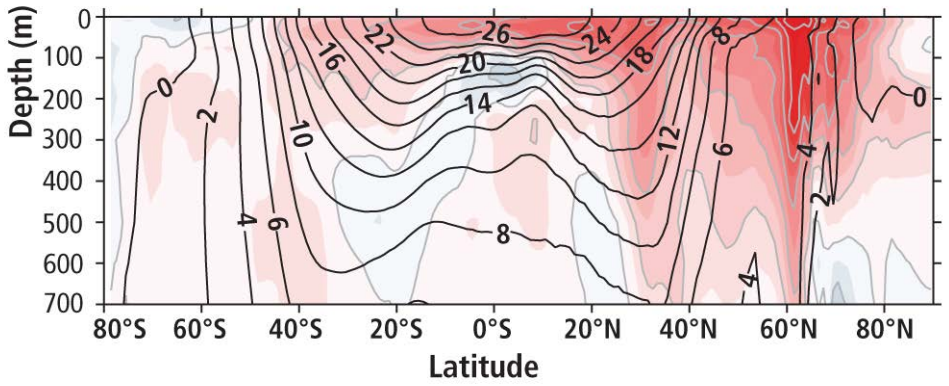
IPCC AR5 Chp 30 Fig 30-1, based on Barber 1988 in Concepts in Ecosystem Ecology

# It is *virtually certain* that the upper ocean (0 to 700 m depth) has warmed (1971-2010)



Depth-averaged (0-700m) temperature trend

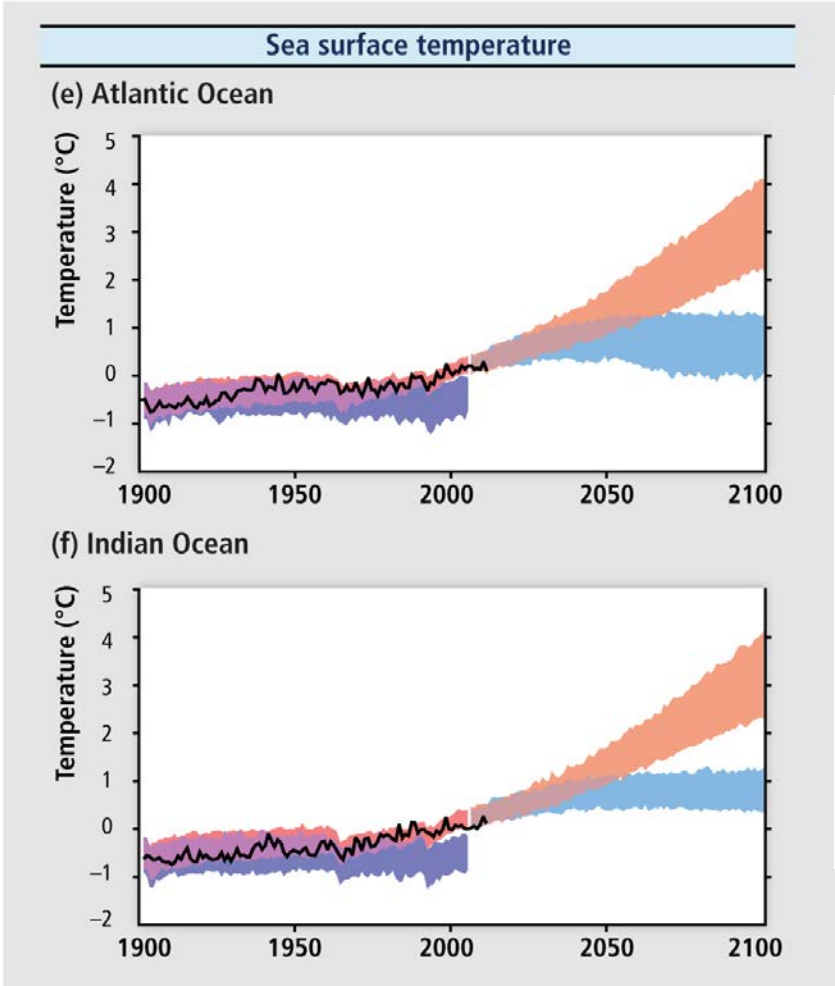
Zonally averaged temperature trend

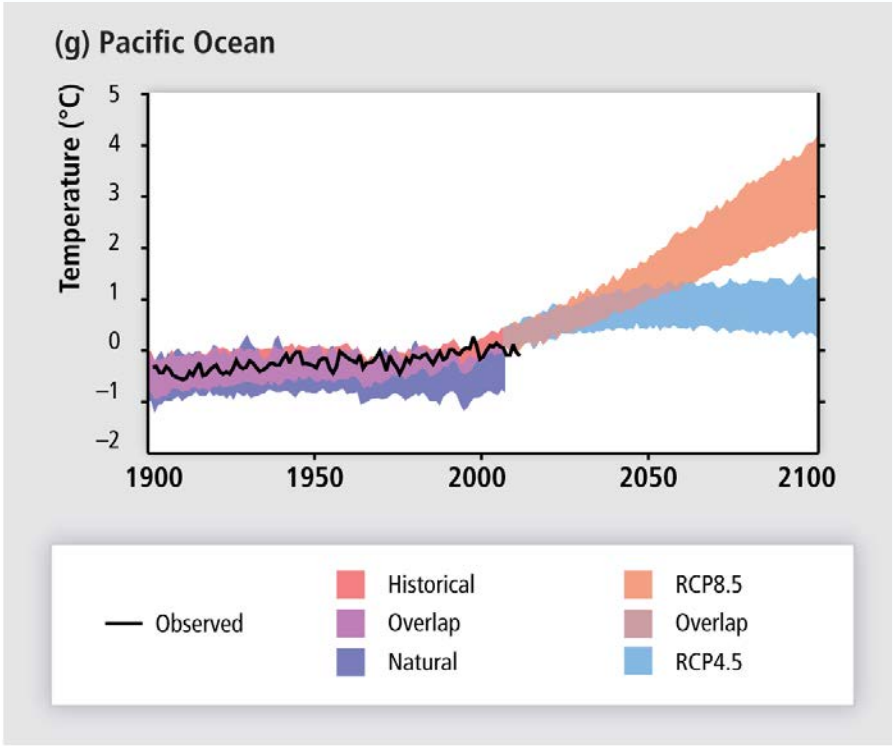




Temperature trend °C decade

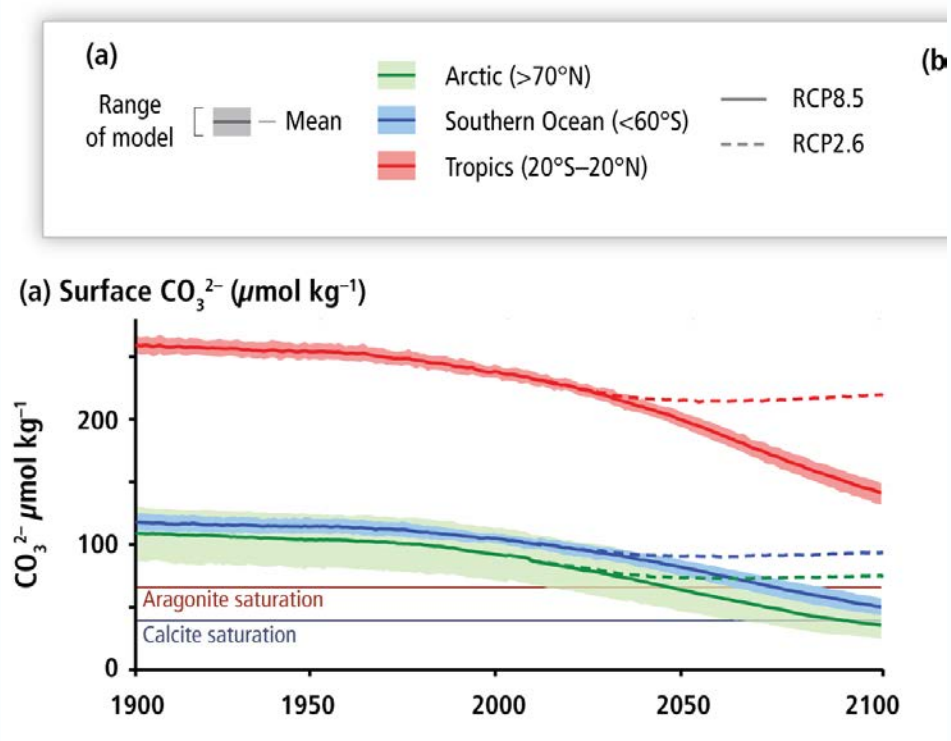
# Ocean warming includes a significant anthropogenic signal (*virtually certain)*

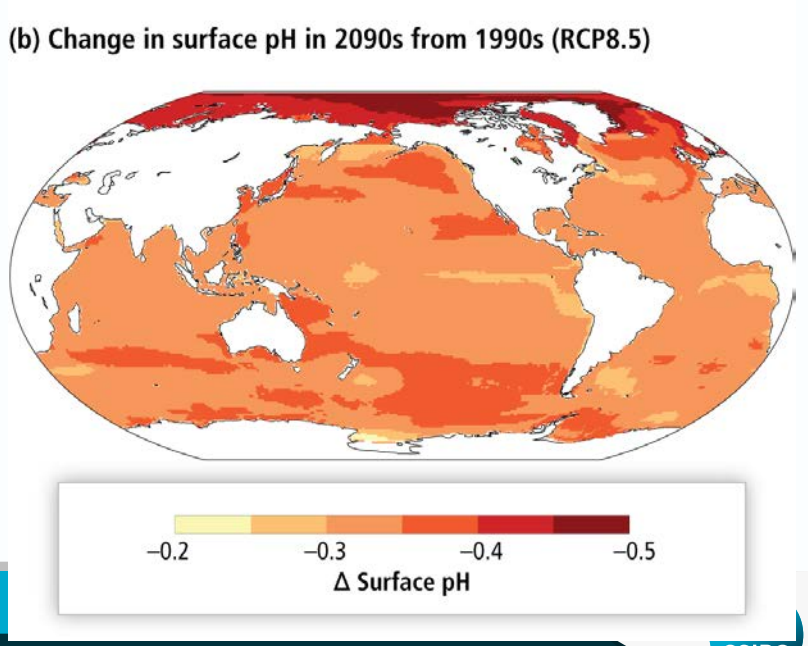



IPCC AR5 Chp 30 Fig 30-2e-g

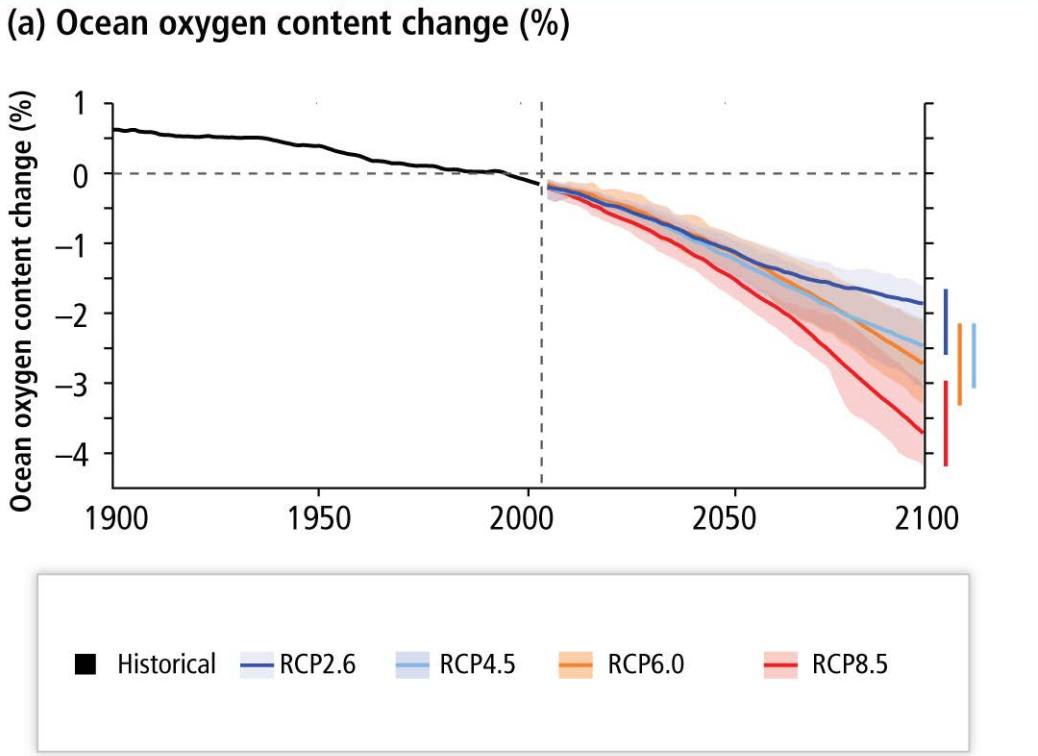
# Uptake of $CO_2$ has decreased ocean pH fundamentally changing ocean carbonate chemistry in all ocean sub-regions (*high confidence*)

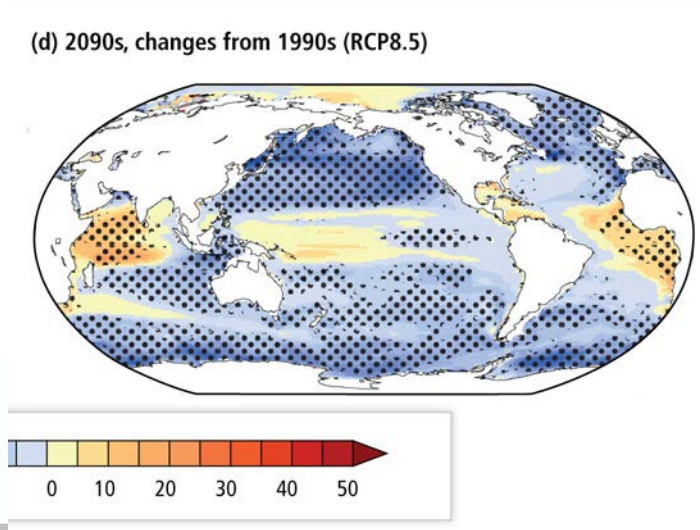



IPCC AR5 Chp 30 Fig 30-7, 30-8

# Oxygen concentrations have decreased in the upper layers of the Ocean since the 1960s, with anthropogenic forcing (*medium confidence*)

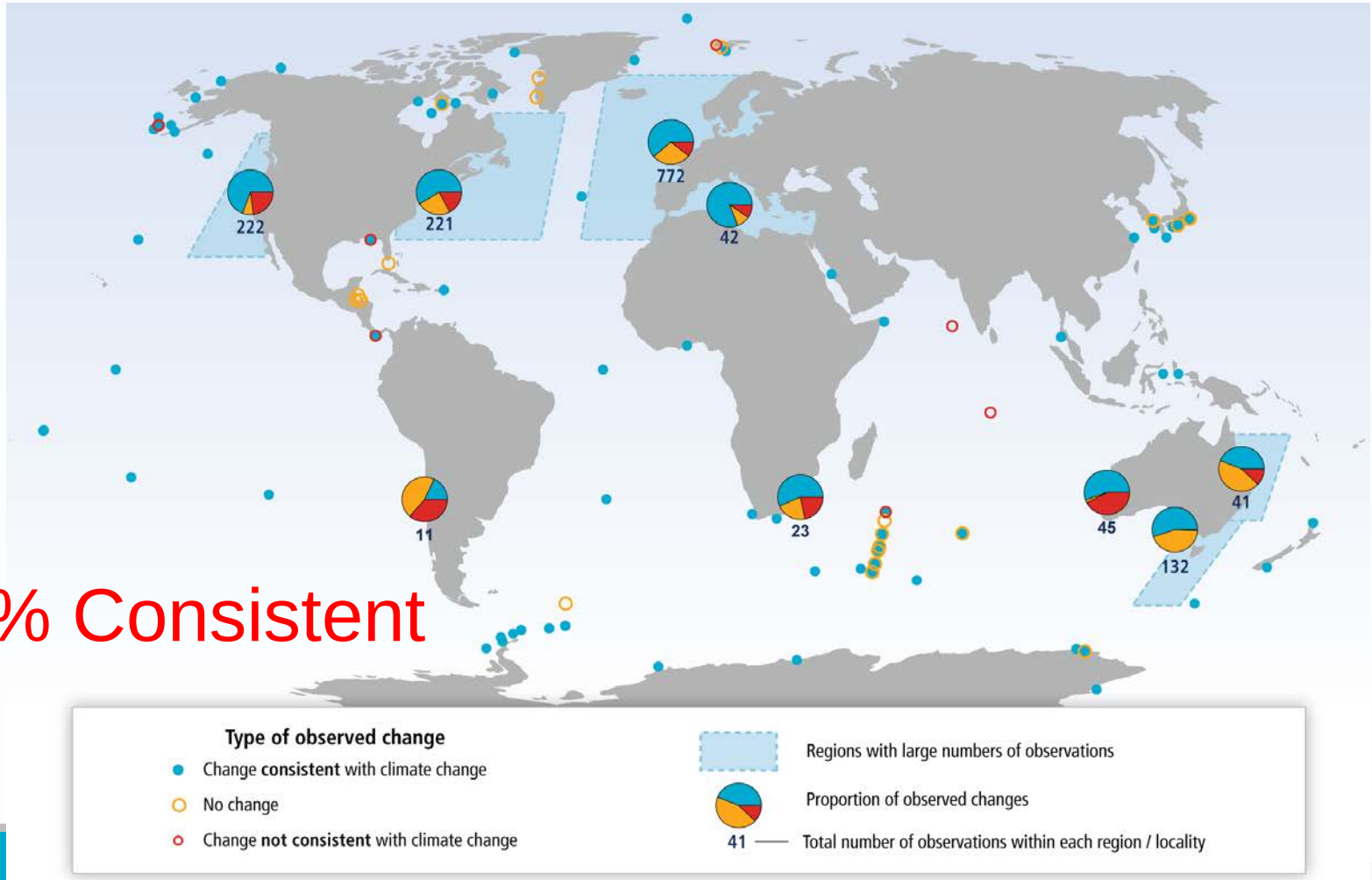



IPCC AR5 Chp 30 Fig 30-9

# Responses of species and ecosystems to climate change have been observed from every ocean subregion (*high confidence).*

1735 observations, 857 species, 208 studies




,

81% Consistent

IPCC AR5 Chp 30 Fig MB-1 Poloczanska et al 2013 Nature Climate Change

# Responding to climate change is a challenge in managing risks

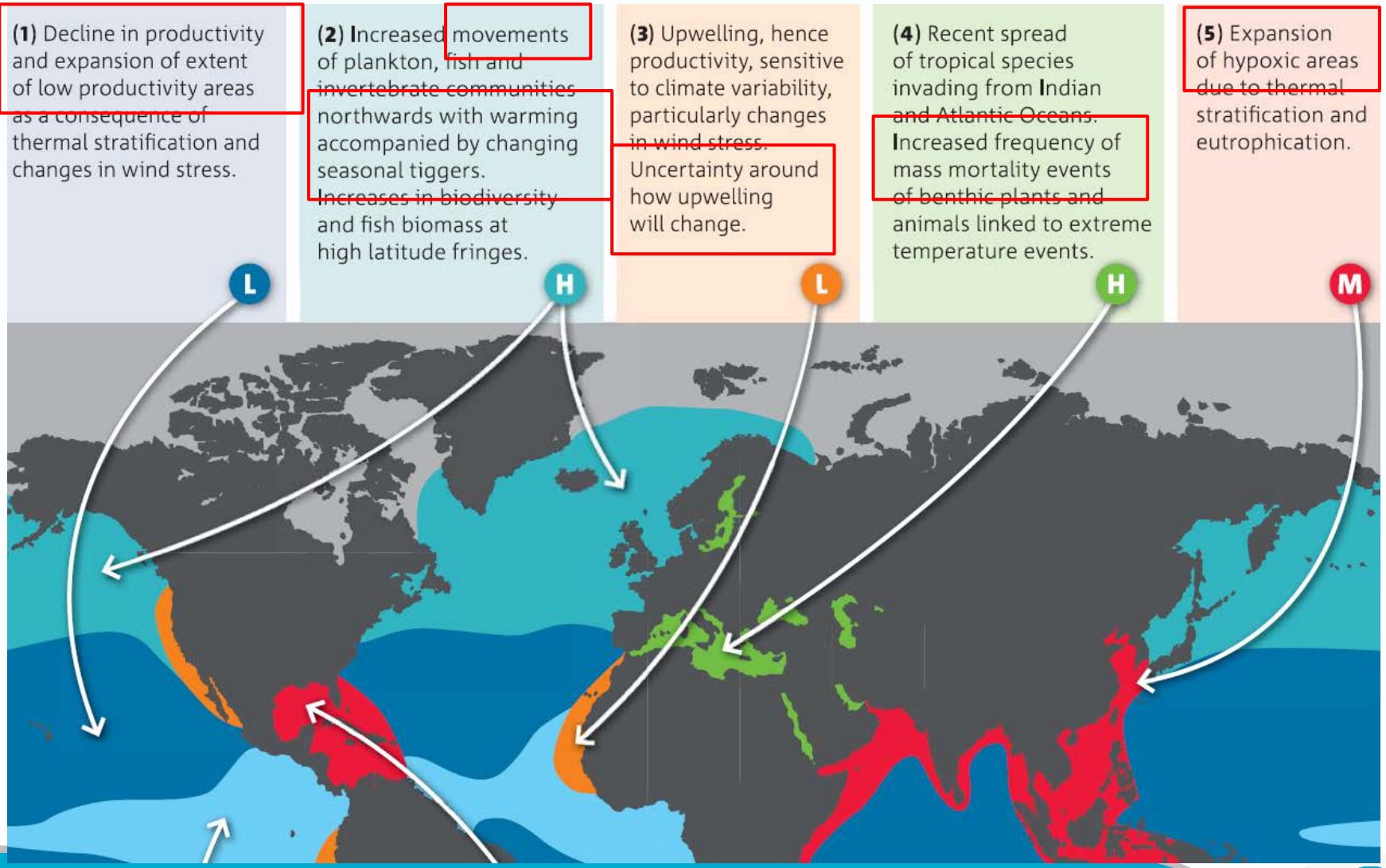
❖The Ocean environment is changing and responses of marine organisms have been recorded from all oceans

❖There is *medium to high agreement* that impacts on marine species and ecosystems pose significant uncertainties and risks to fisheries, aquaculture, and other coastal activities.

❖The associated risks will intensify as ocean warming and acidification continue

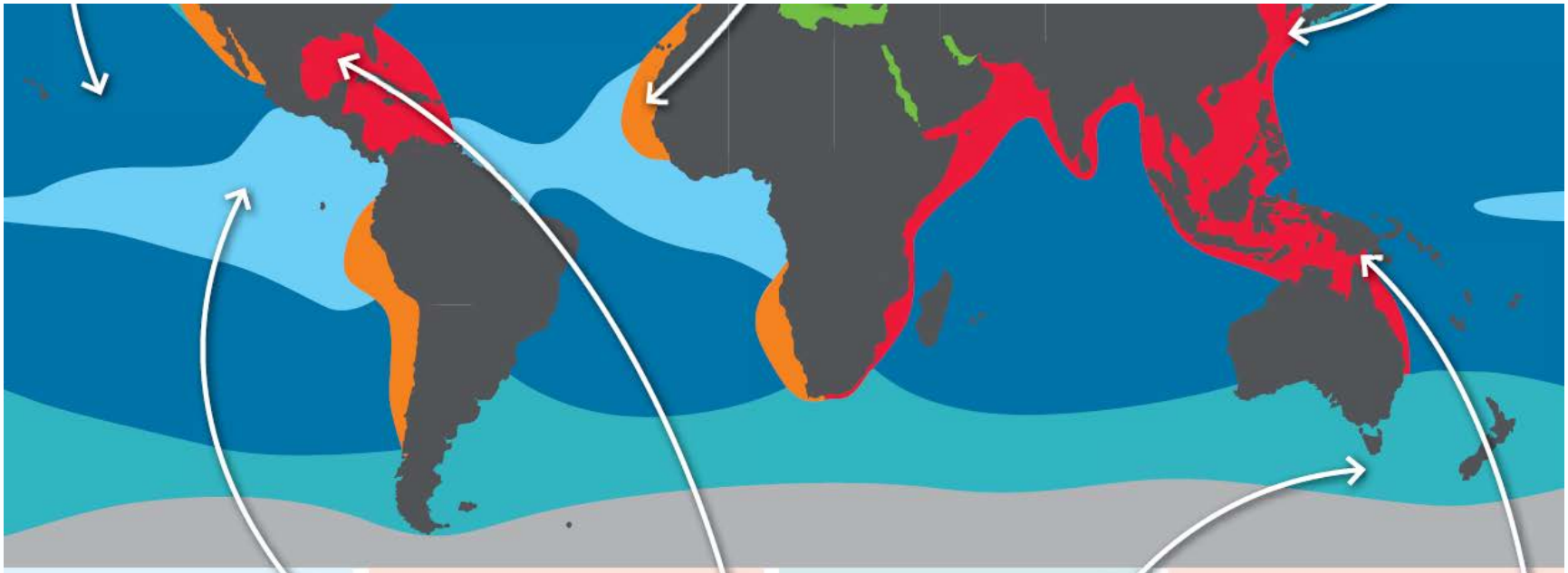
❖Regional risks and vulnerabilities to ocean warming and acidification can be compounded by non-climate related stressors such as pollution, nutrient runoff from land, and over-exploitation of marine resources, as well as natural climate variability (*high confidence).*

# Projected Regional Impacts and Vulnerabilities: 1




IPCC AR5 Chp 30 Fig 30-12

# Projected Regional Impacts and Vulnerabilities: 2



(6) Decline in dissolved oxygen through changes in oxygen solubility (temperature), and ocean ventilation and circulation. Uncertainty around how ENSO/PDO will change and influence equatorial upwelling. **M**

(7) Expansion in extent and number hypoxic areas due to thermal stratification and eutrophication. Mass coral bleaching events leading to degradation coral reefs and loss of associated biodiversity. Observed shifts in distributions of fish species. **H**

(8) Shoaling of aragonite saturation horizon at high latitudes reduces calcification and changes structure of plankton communities. Observed dissolution of shells of living polar pteropods suggests impacts have started. **H**

(9) Mass coral bleaching observed in response to high temperature and temperature-driven decline in growth rates of some corals leading to degradation of coral reefs and loss of associated biodiversity. **H**

IPCC AR5 Chp 30 Fig 30-12

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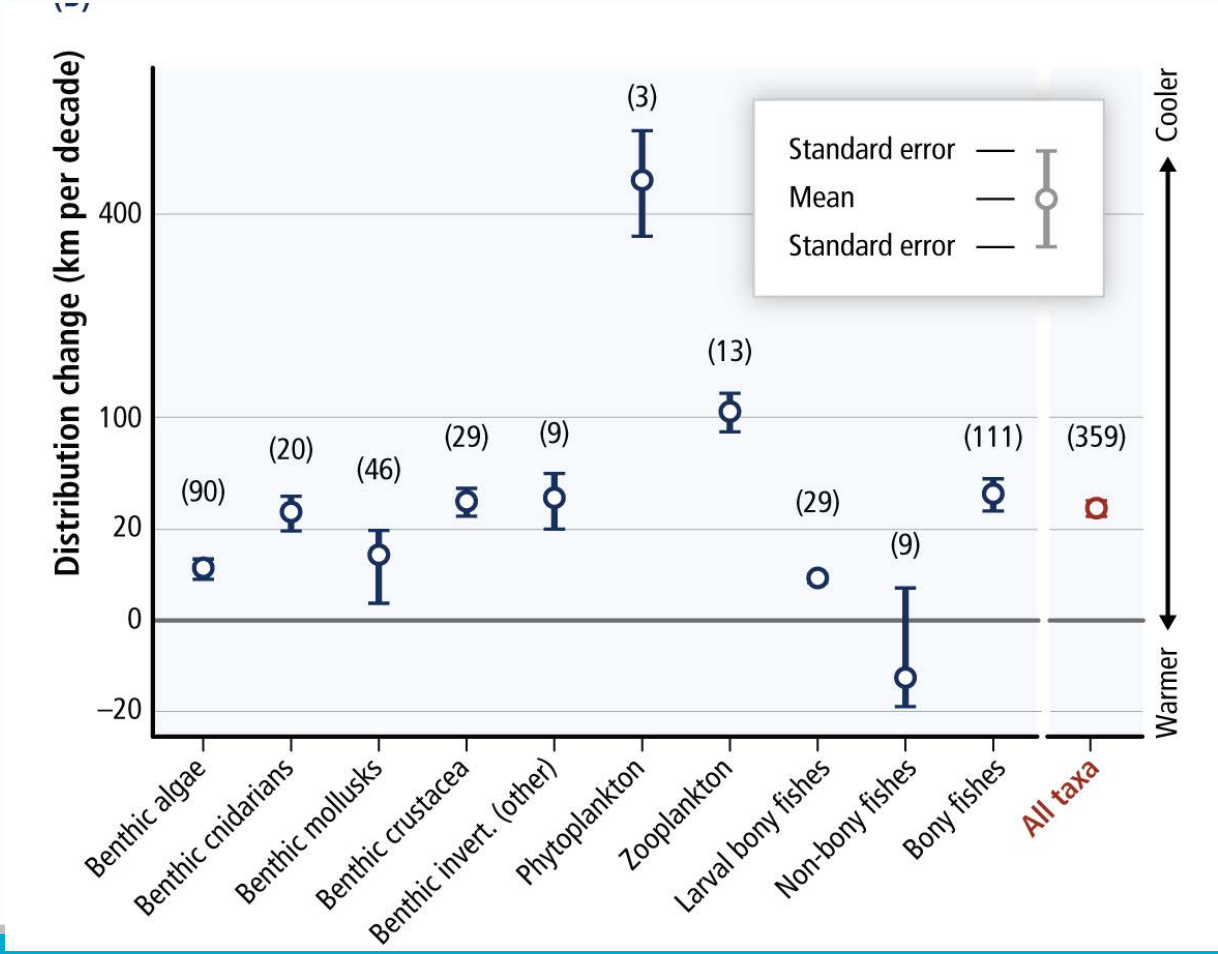
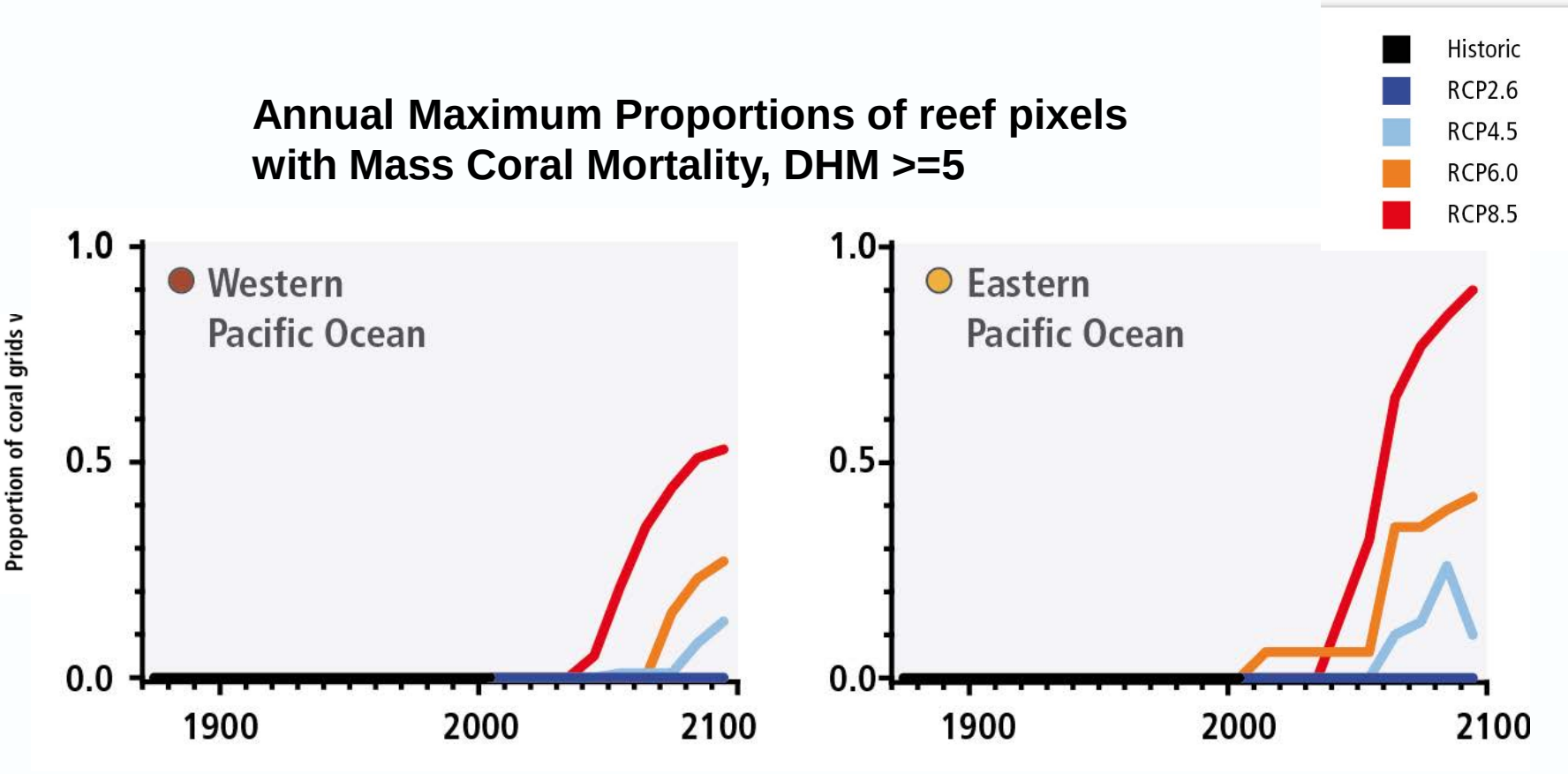
# Marine organisms are moving to generally higher latitudes, consistent with warming trends (*high confidence)*

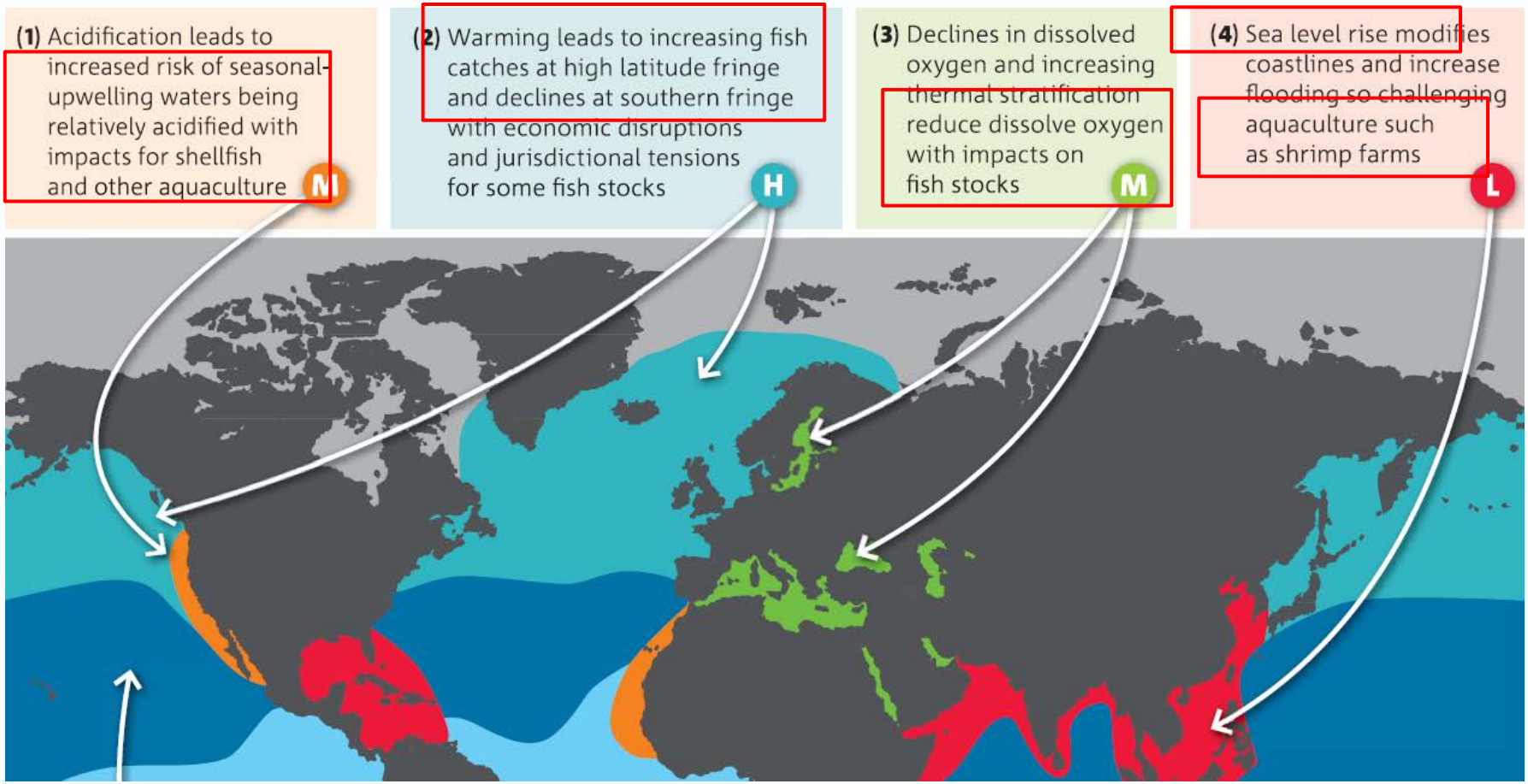


# Coral reefs may be lost from most sites globally by 2050 under mid to high rates of ocean warming (*very likely)*



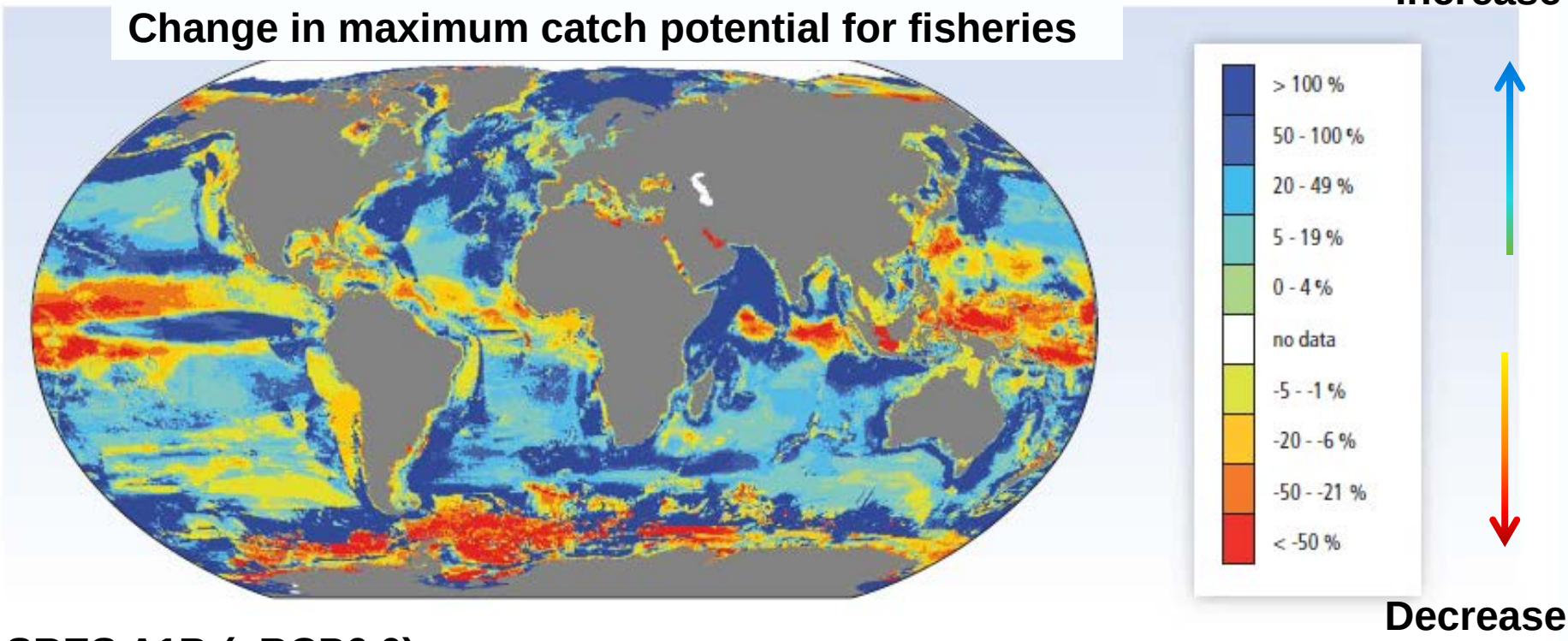

IPCC AR5 Chp 30 Fig 30_10

# Examples of Risks to Fisheries: 1




IPCC AR5 Chp 30 Fig 30-12

# Changes to the ocean environment are generating new challenges for fisheries, as well as benefits (*high agreement).*

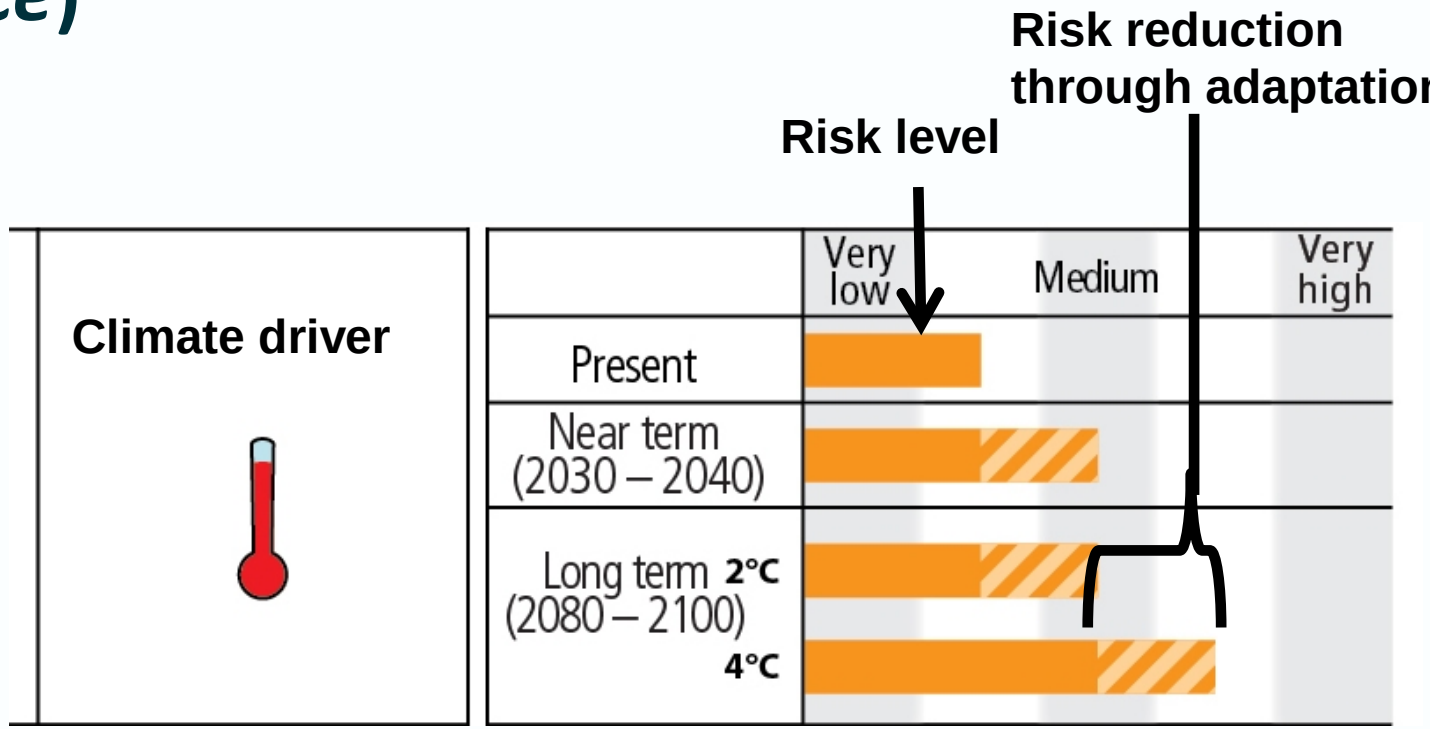



**SRES A1B (~RCP6.0)**
**Change in catch potential of fish and invertebrates by 2050**

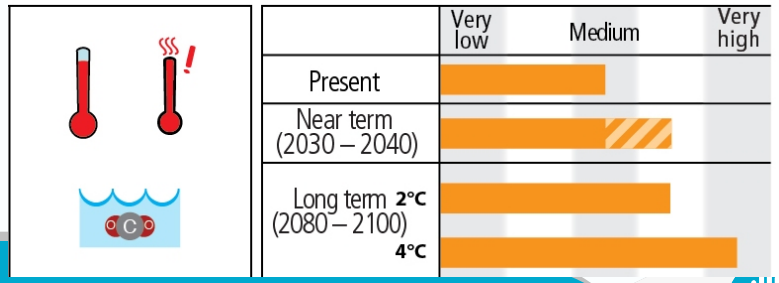
# Key Risk: Global redistribution of catches and decrease of low-latitude fisheries yields (*medium confidence*)

## Adaptation

**Alternate livelihoods, spatial management, technology**




**Risks to coral reef fishery catch**



**Adaptation strategies beyond coastal waters are generally poorly developed but will benefit from international legislation and expert networks, as well as marine spatial planning (*high agreement*)**

**International frameworks for collaboration and decision making are critically important for coordinating policy that will enable mitigation and adaptation by the Ocean sectors to global climate change**

# Ramifications, adaptation options, and frameworks for decision making for ocean regions: Changing primary production

| Primary driver(s) | Biophysical change projected | Key risks and vulnerabilities | Ramifications | Adaptation options | Policy frameworks and initiatives (examples) |
|---|---|---|---|---|---|
| ↑T, ↑OA | Spatial and temporal variation in primary productivity (*medium confidence* at global scales; Box CC-PP) | Reduced fisheries production impacts important sources of income to some countries while others may see increased productivity (e.g., as tuna stocks shift eastwards in the Pacific) (*medium confidence*). | Reduced national income, increased unemployment, plus increase in poverty. Potential increase in disputes over national ownership of key fishery resources (*likely*) | Increased international cooperation over key fisheries. Improved understanding of linkages between ocean productivity, recruitment, and fisheries stock levels. Implementation of the regional "vessel day scheme" provides social and economic incentives to fisheries and fishers for adaptation. | UNCLOS, PEMSEA, CTI, RFMO agreements, UNSFSA |

IPCC AR5 Chp 30 Table 30-4

# 10 Research needs and emerging issues

1. Long-term climate variability and extreme climatic events.
2. Coastal ecosystem response and climate change mitigation.
3. Observed and projected changes in regional primary production
4. Biogeochemical cycles (microbes and oxygen)
5. Ocean acidification
6. Species responses to climate change
7. Interactions among climate change and other stressors
8. Potential reorganisation of foodwebs
9. Economic, social and legal consequences
10. Adaptation planning and implementation

# Thank you

Download WGII assessment here:

http://ipcc-wg2.gov/AR5/