

# Anticipated Impacts of Global Warming On the Coldwater Prawn Fishery

**Art Miller**

*Head, Oceans and Atmosphere Section*

*Scripps Institution of Oceanography*

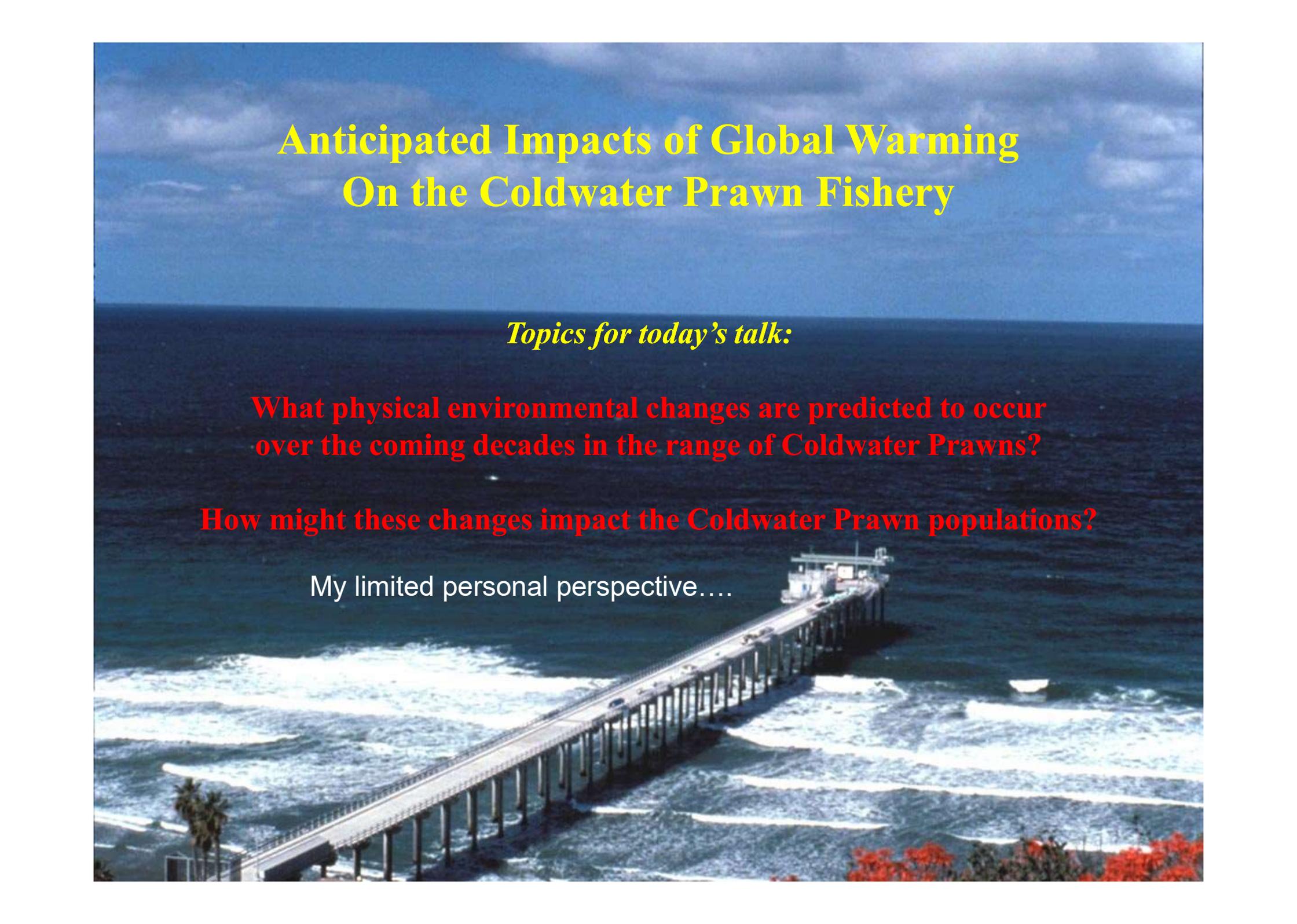
*University of California, San Diego*

*La Jolla, CA*

***International Coldwater Prawn Forum (ICWPF)***

***Reykjavik, Iceland***

***November 9, 2017***

An aerial photograph of a long, multi-lane pier extending from a coastline into the ocean. The pier is supported by numerous vertical pilings. At the end of the pier, there is a small structure, possibly a boat house or a control room. The ocean is dark blue with white-capped waves breaking against the pier and the shore. The sky is a deep blue with scattered white clouds. In the bottom right corner, there are some red flowers in the foreground.

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*Topics for today's talk:*

**What physical environmental changes are predicted to occur over the coming decades in the range of Coldwater Prawns?**

**How might these changes impact the Coldwater Prawn populations?**

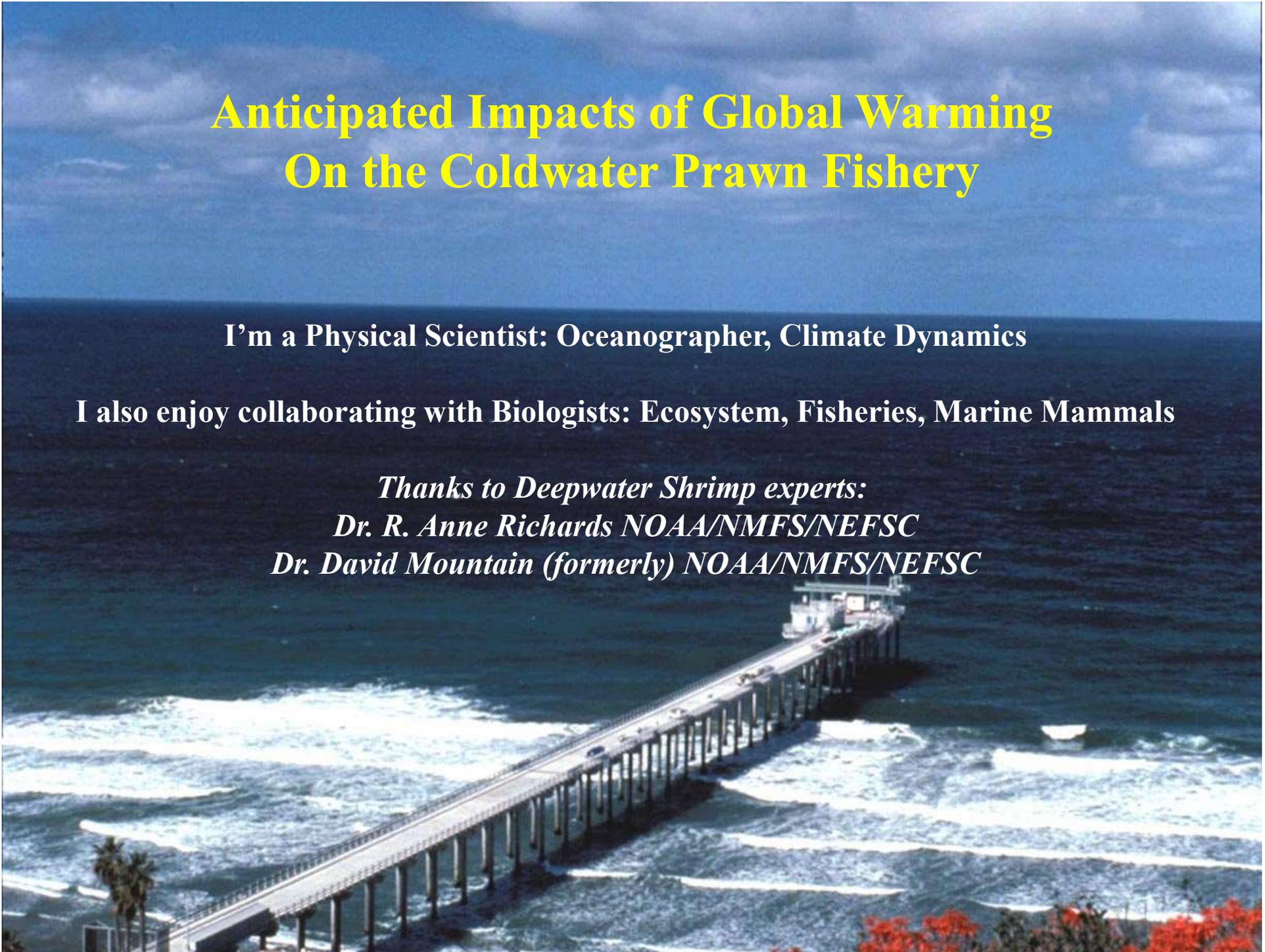
My limited personal perspective....

# Anticipated Impacts of Global Warming On the Coldwater Prawn Fishery

I'm a Physical Scientist: Oceanographer, Climate Dynamics

I also enjoy collaborating with Biologists: Ecosystem, Fisheries, Marine Mammals

*Thanks to Deepwater Shrimp experts:  
Dr. R. Anne Richards NOAA/NMFS/NEFSC  
Dr. David Mountain (formerly) NOAA/NMFS/NEFSC*

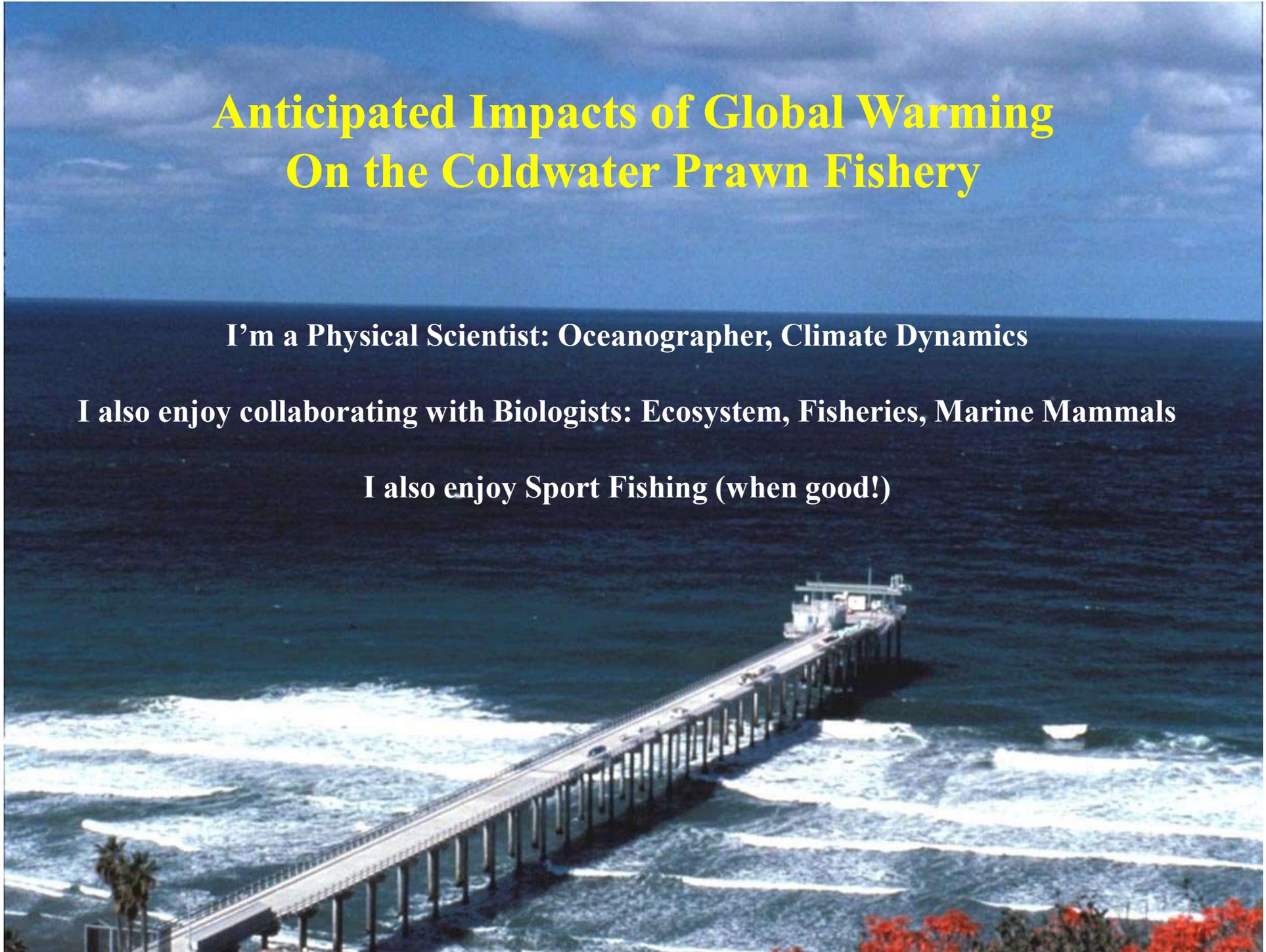


# **Anticipated Impacts of Global Warming On the Coldwater Prawn Fishery**

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**I also enjoy Sport Fishing (when good!)**



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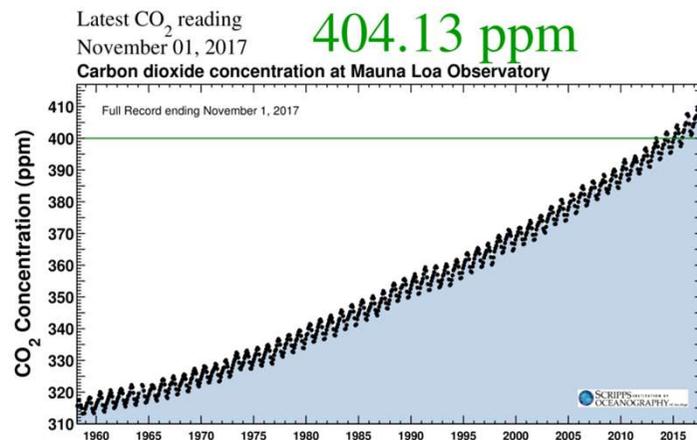


# Global Warming, Quickly

- **Greenhouse Effect** already keeps us warm

Average Earth Surface Temp: 57F vs. -2F or 14C vs. -19C

- **Enhanced Greenhouse Effect** (i.e., Global Warming) due to anthropogenically released greenhouse gases increasingly traps additional heat in the Air, Ocean, Land, Ice system



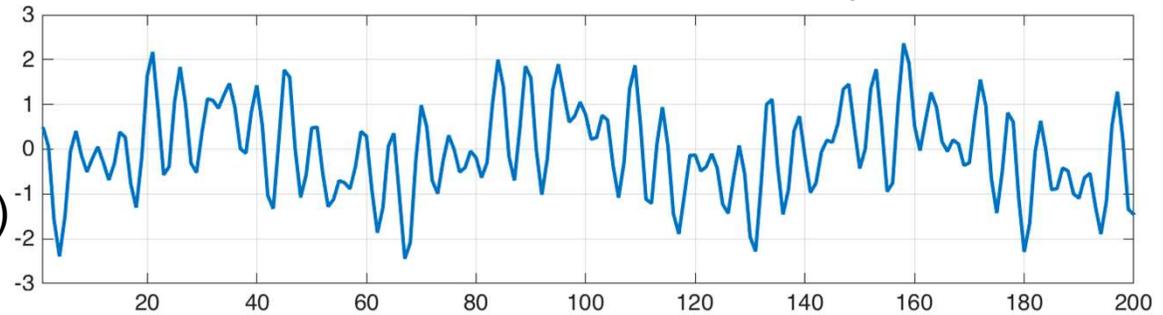
90% of extra heat goes into **oceans**  
--- the rest melts ice, warms land,  
warms air, etc.

# What can we actually expect to predict in the coming decades?

Schematic!

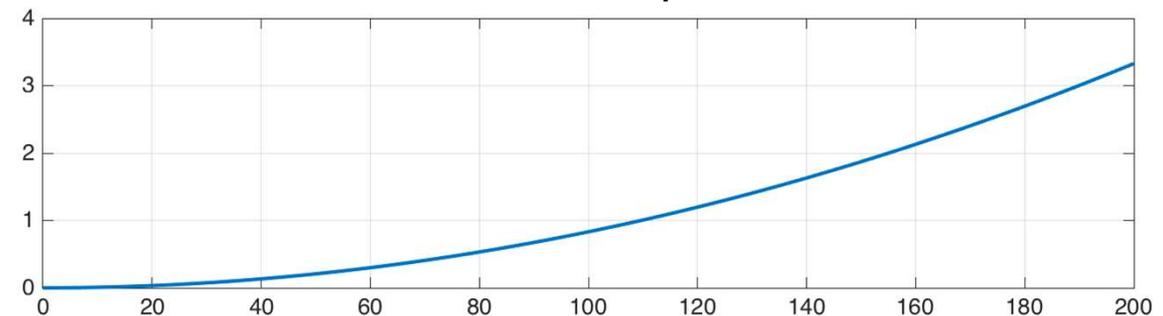
**Unpredictable part**  
(due to natural variations)

### Natural Climate Variability



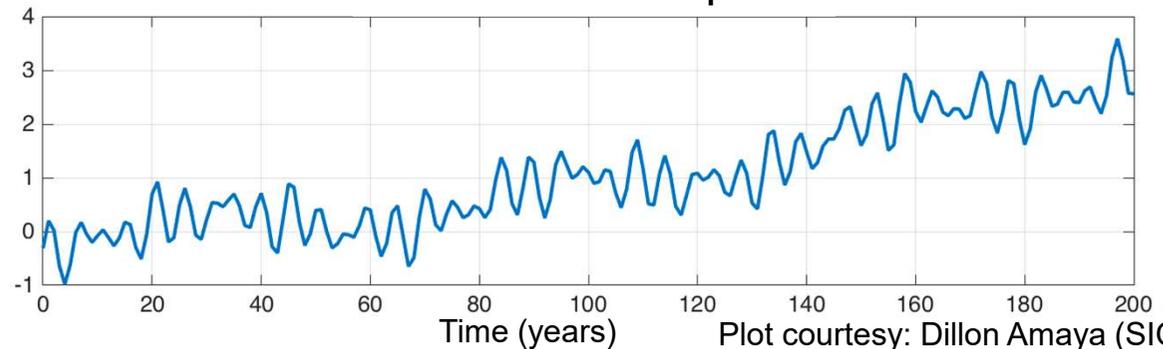
**Predictable part**  
(due to known forcing  
by greenhouse gases  
released by humanity)

### Forced response



Together they comprise  
the **one realization**  
we experience on earth

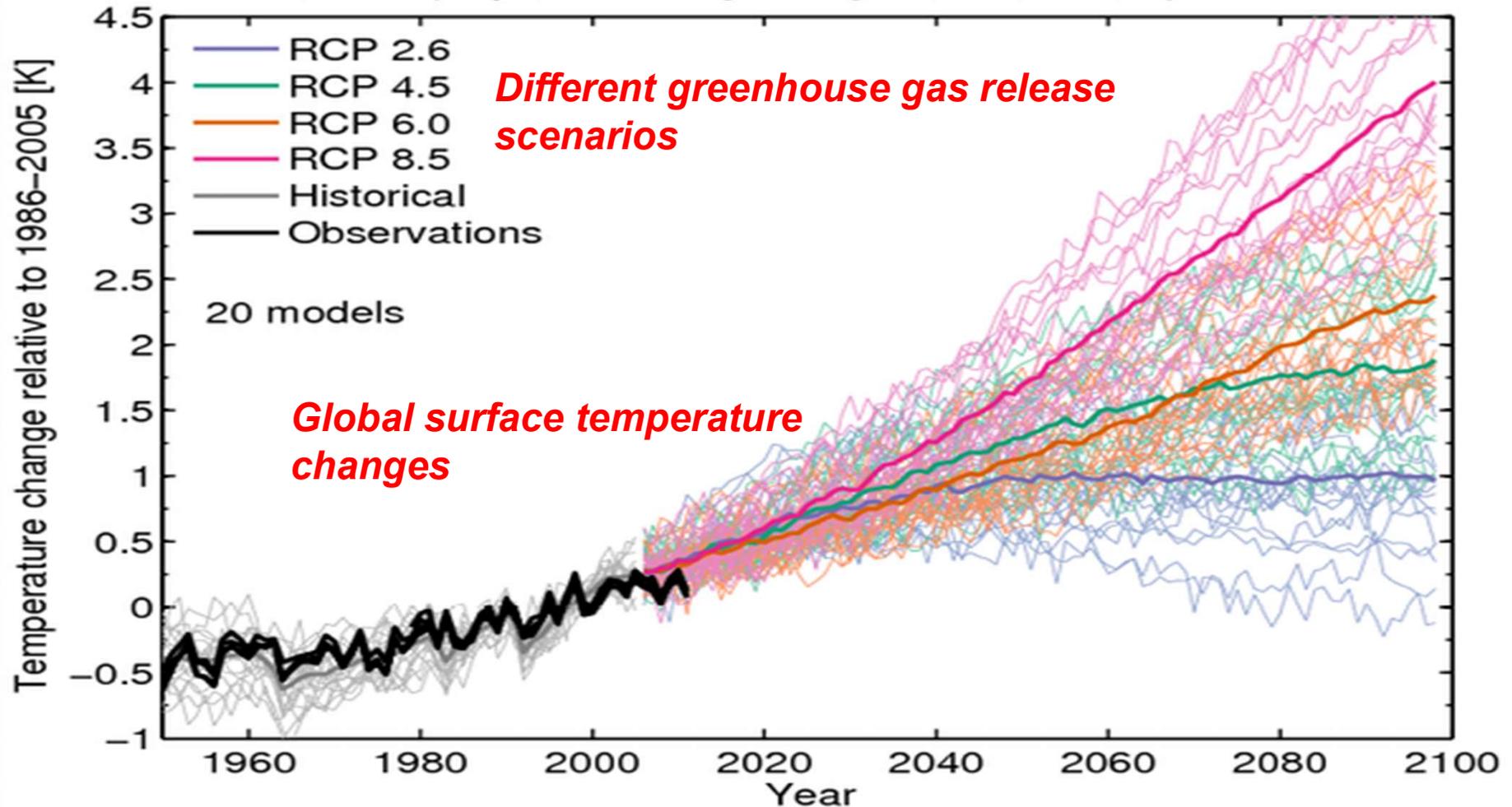
### Sum of the two parts



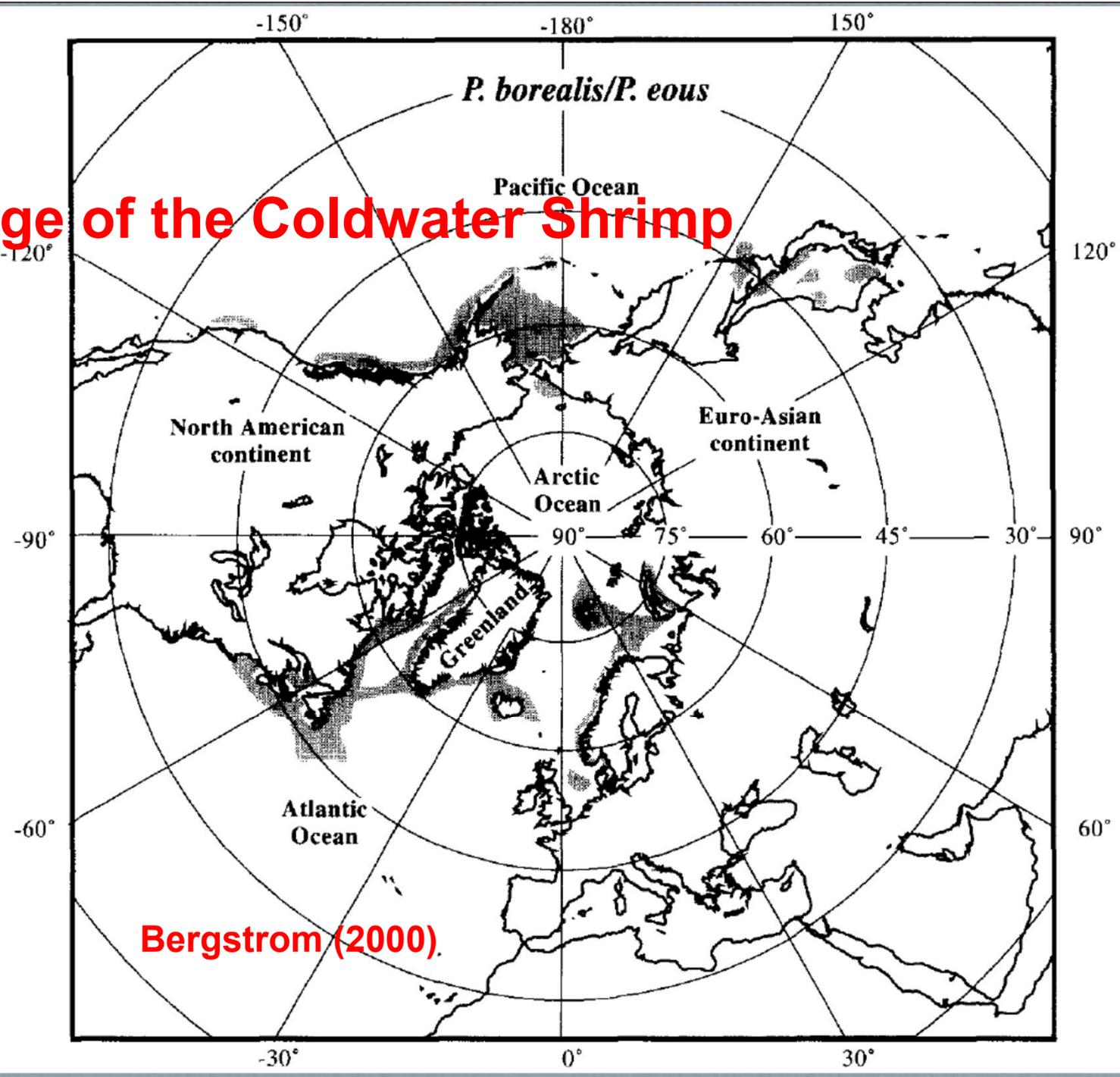
Plot courtesy: Dillon Amaya (SIO)

# Model Projections of Global Warming

CMIP5 projected changes in global mean temperature



# Range of the Coldwater Shrimp



**Bergstrom (2000)**

# Global Warming, Quickly

## *Regional Impacts Relevant to Deepwater Prawns*

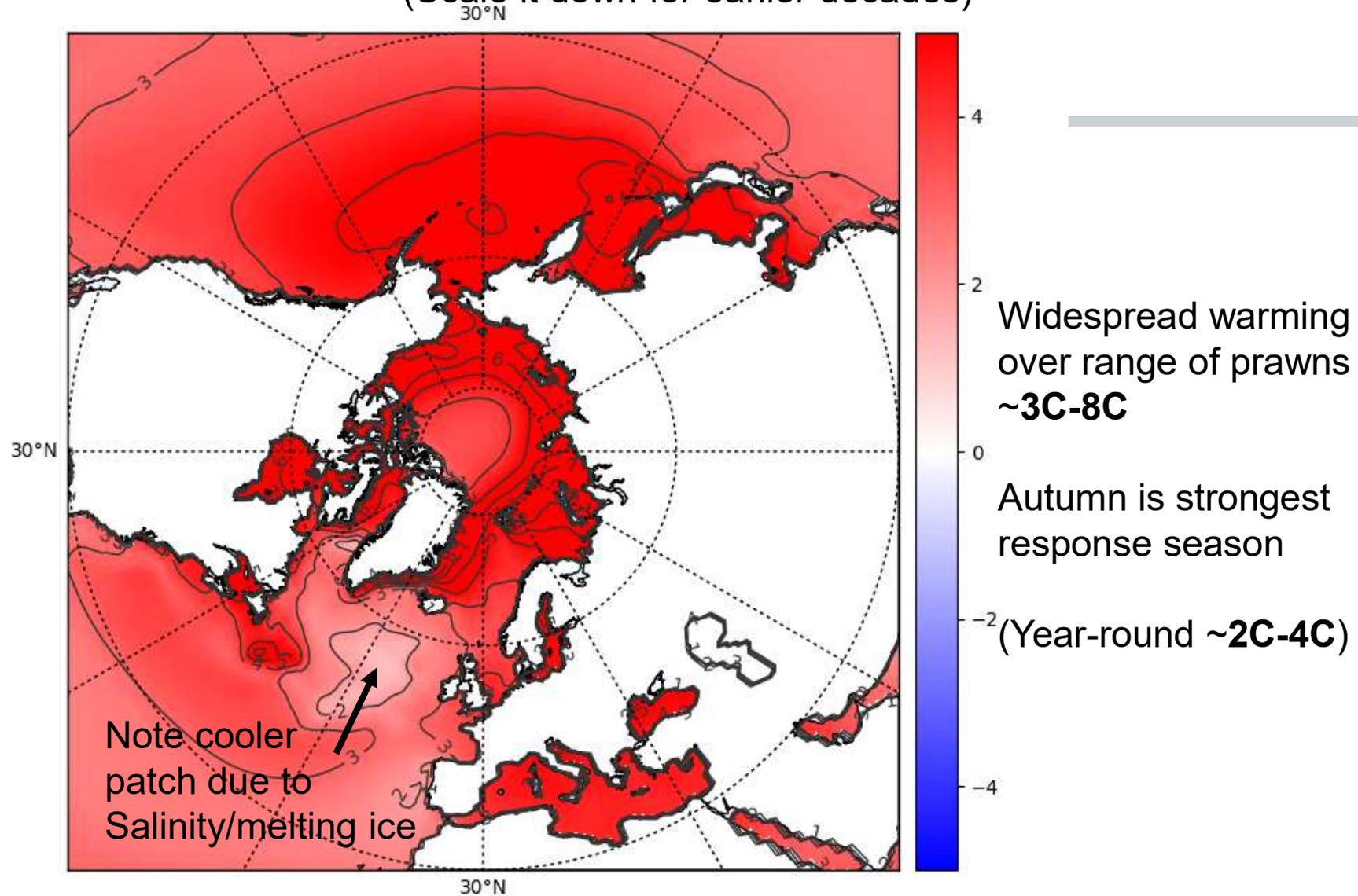
- **Arctic Amplification** means strongest temperature signals north of 50N latitude
- **Arctic sea ice loss**
- Atmospheric **storm tracks** shift northward
- Oceans become more **acidic**, affecting Calcium-shell-based organisms
- **Sea level rise and fresh-water input** from land-locked ice

# Climate Model Projections

- Here, we use NCAR's Large Ensemble for CESM (Community Earth System Model)
- Take 25-year average of future climate **2076-2100** compared to the average of **1981-2005**
- Average 33 ensemble members together to suppress natural variability and *isolate forced part*
- Greenhouse gas release scenario RCP8.5 (relatively high)

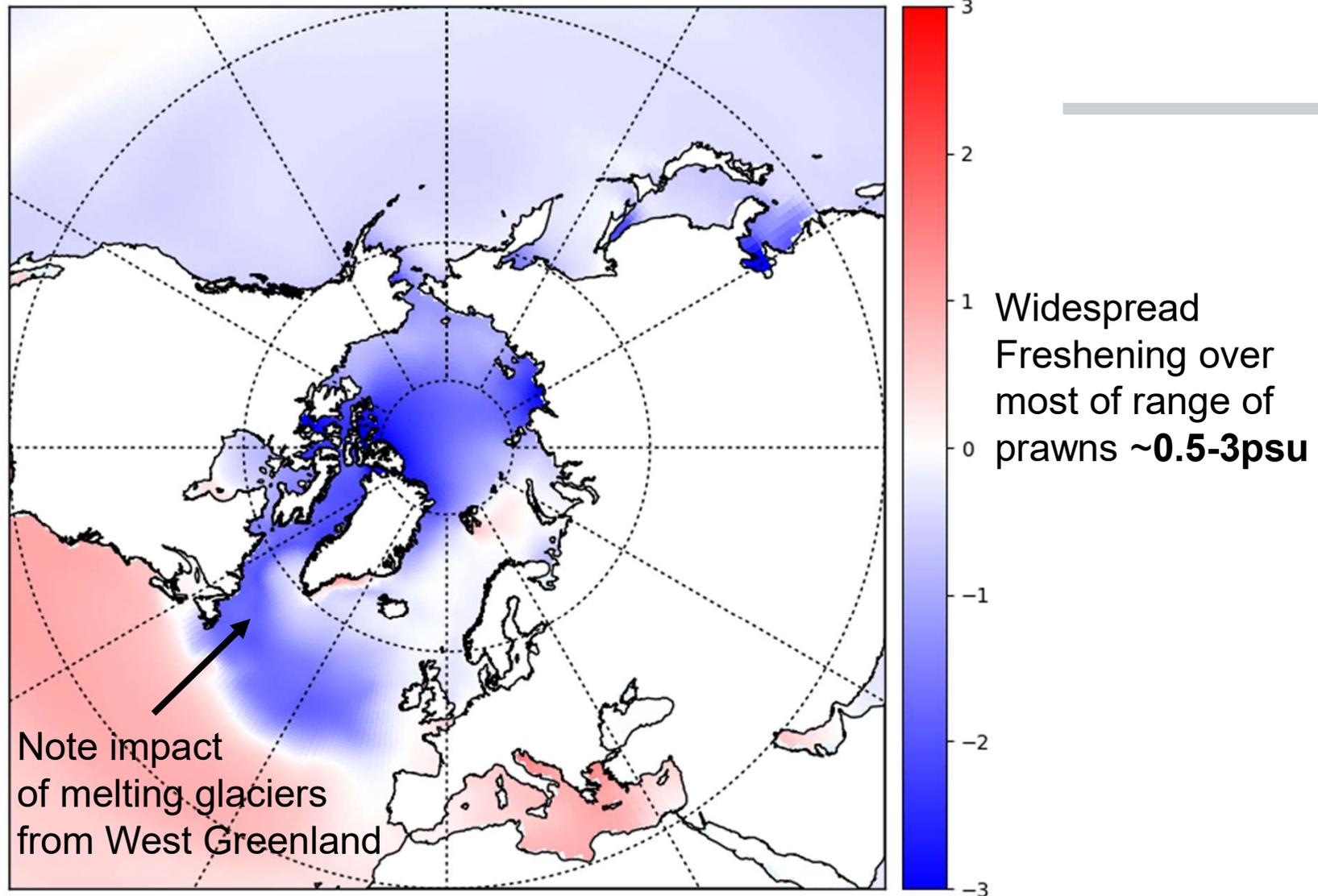
**Calculations by post-doc Dr. Liz Drenkard (SIO)**

Average Sea Surface Temperature Change (2076-2100, **September**)  
(Scale it down for earlier decades)



Courtesy: Dr. Liz Drenkard (SIO)

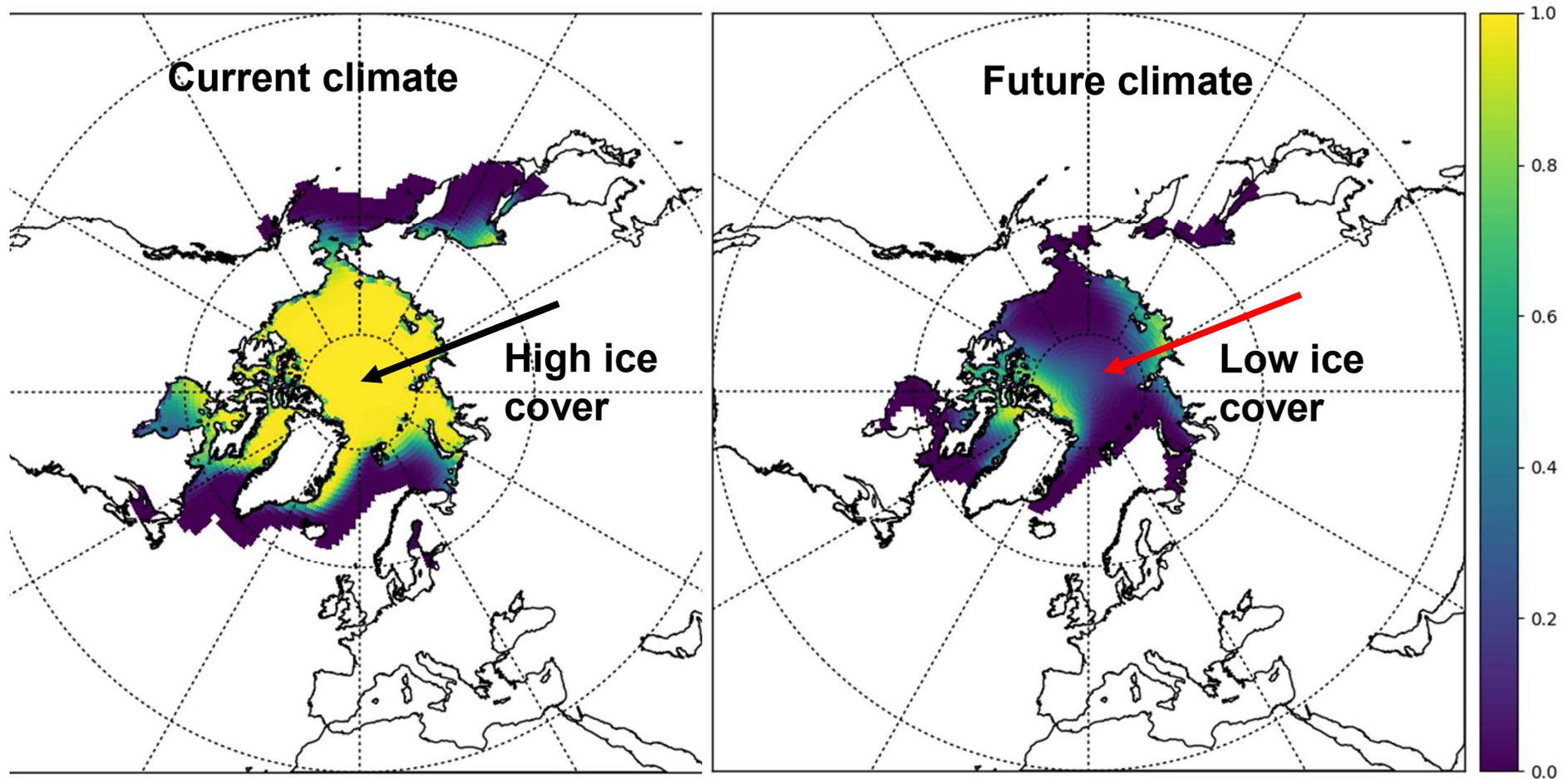
Average Sea Surface Salinity Change (2076-2100, **Annual**)  
(Scale it down for earlier decades)



Courtesy: Dr. Liz Drenkard (SIO)

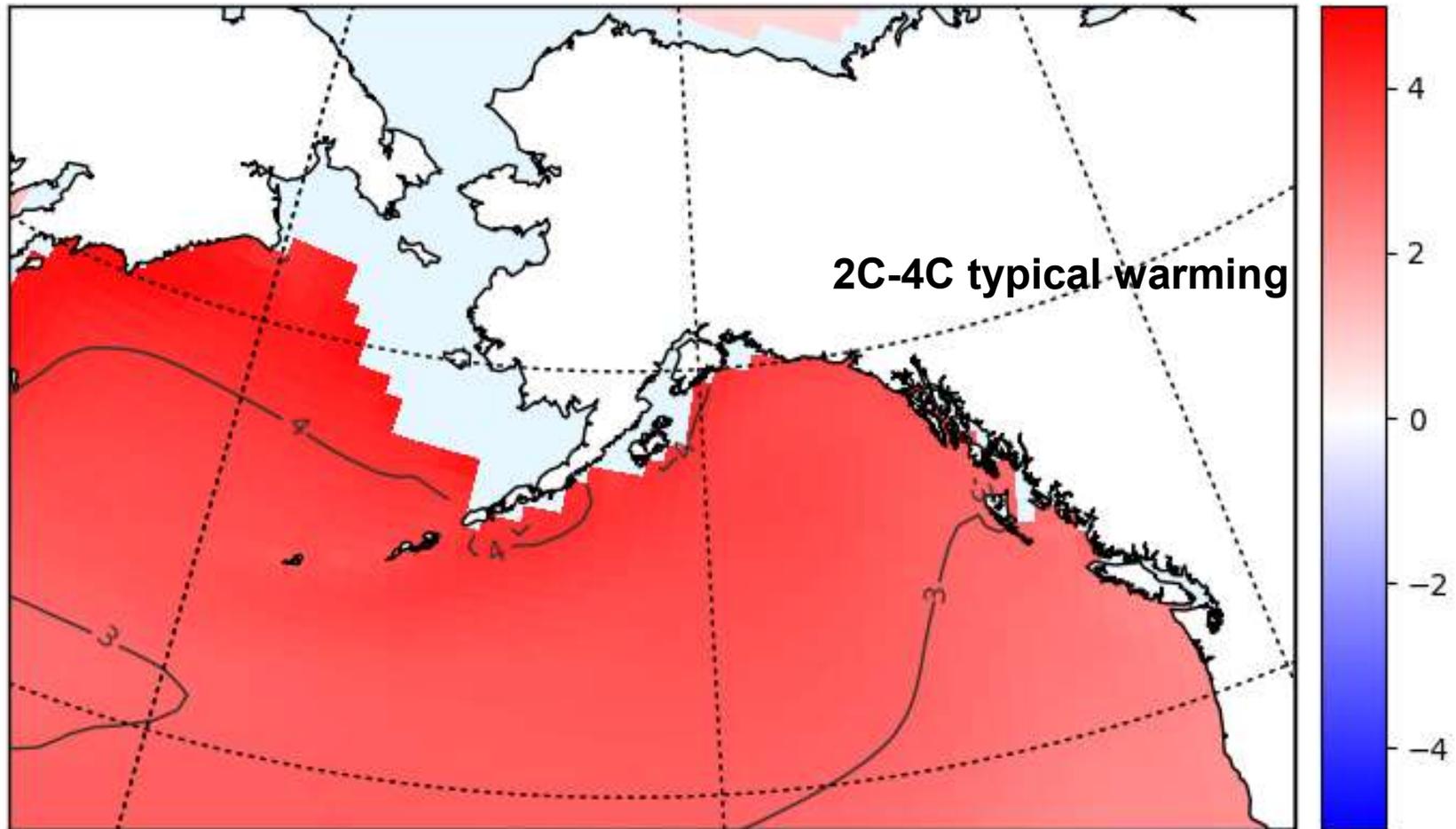
## Average Sea Ice Fraction and Extent Change (2076-2100, **December**)

- Loss of sea ice leaves Arctic Ocean open in December
- Deeper into winter (Jan, Feb, Mar) the ice still develops



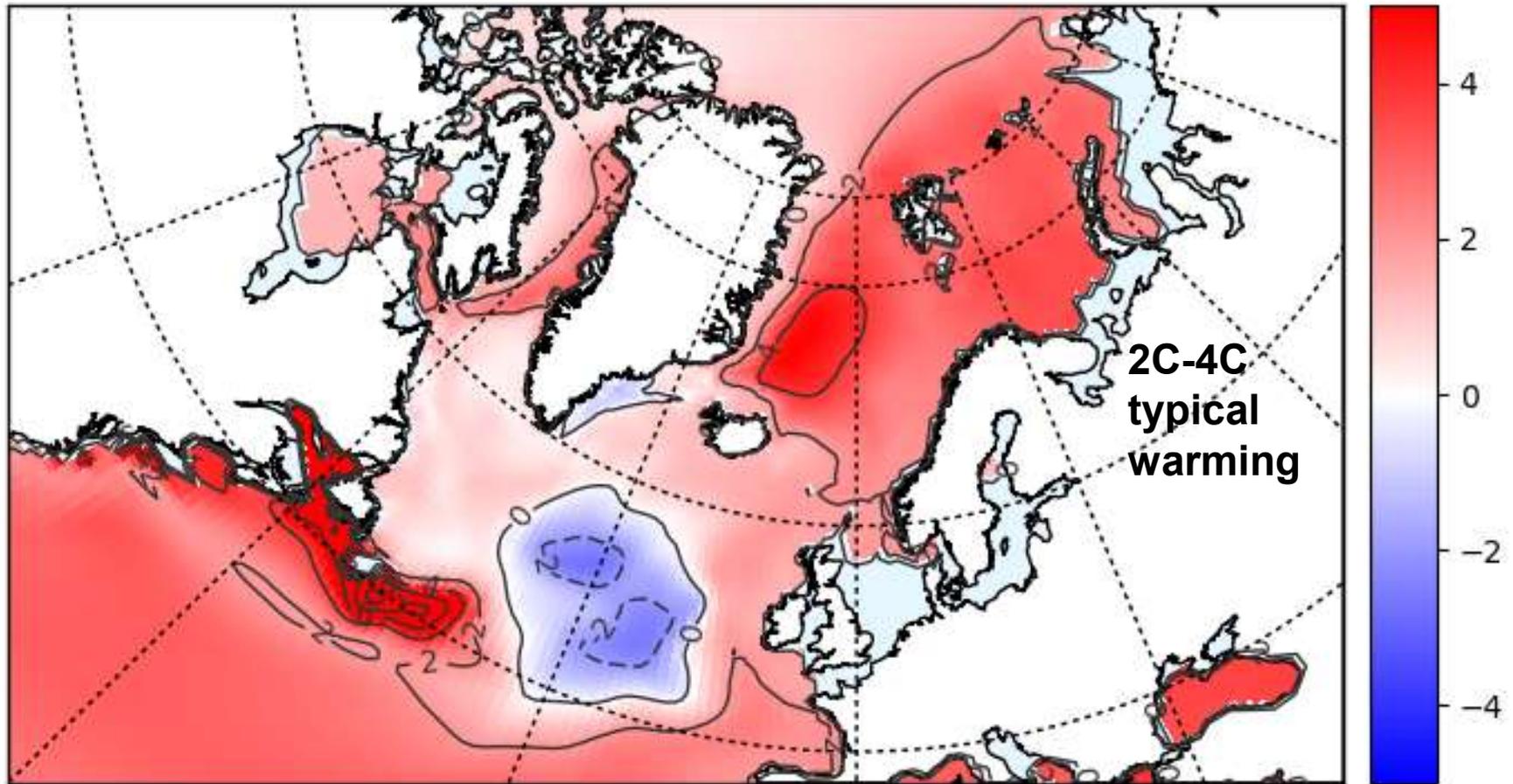
Courtesy: Dr. Liz Drenkard (SIO)

# Pacific **Deepwater 100m** Temperature Change (Annual Average)



Courtesy: Dr. Liz Drenkard (SIO)

# Atlantic Deepwater 100m Temperature Change (Annual Average)



Courtesy: Dr. Liz Drenkard (SIO)

# Deepwater Shrimp, Possible Impacts

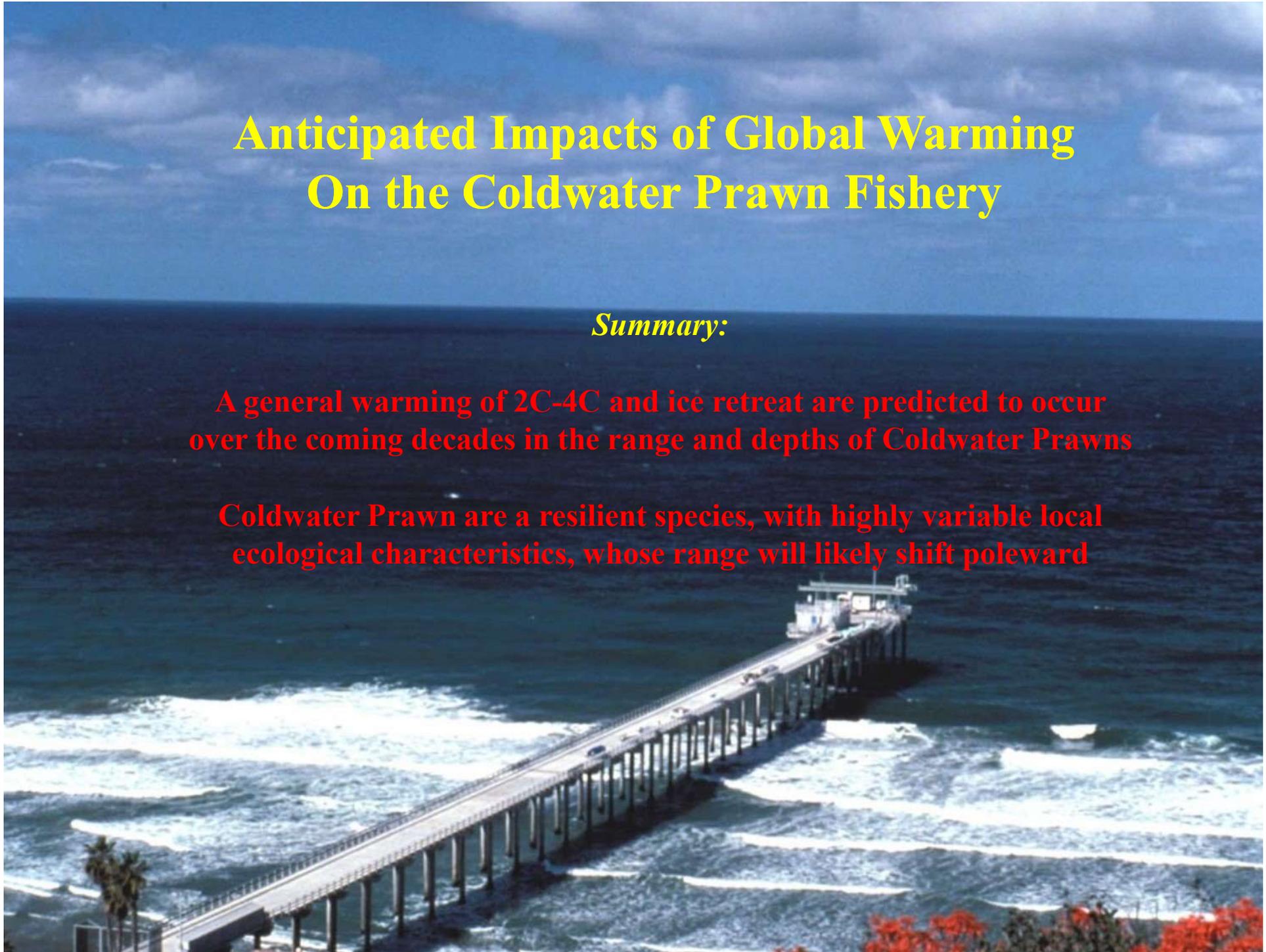
- **Healthy shrimp adult temperature range at depth threatened, may *contract southerly range***
- **Healthy shrimp *larval development* temperature range near surface threatened**
- **Shifts in *spring bloom* and consequent prey availability may affect shrimp larval development**
- ***Altered ranges of shrimp predators* may cause enhanced predation**
- **Retreating sea ice and warming may *expand northerly range***
- ***Acidification* may delay shrimp larval development and reduce exoskeleton transparency**

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## *Summary:*

**A general warming of 2C-4C and ice retreat are predicted to occur over the coming decades in the range and depths of Coldwater Prawns**

**Coldwater Prawn are a resilient species, with highly variable local ecological characteristics, whose range will likely shift poleward**



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**Thanks!**

