Warming from recent marine heatwave lingers in deep British Columbia fjord

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Jackson, et al., *Geophysical Research Letters*, 2018;

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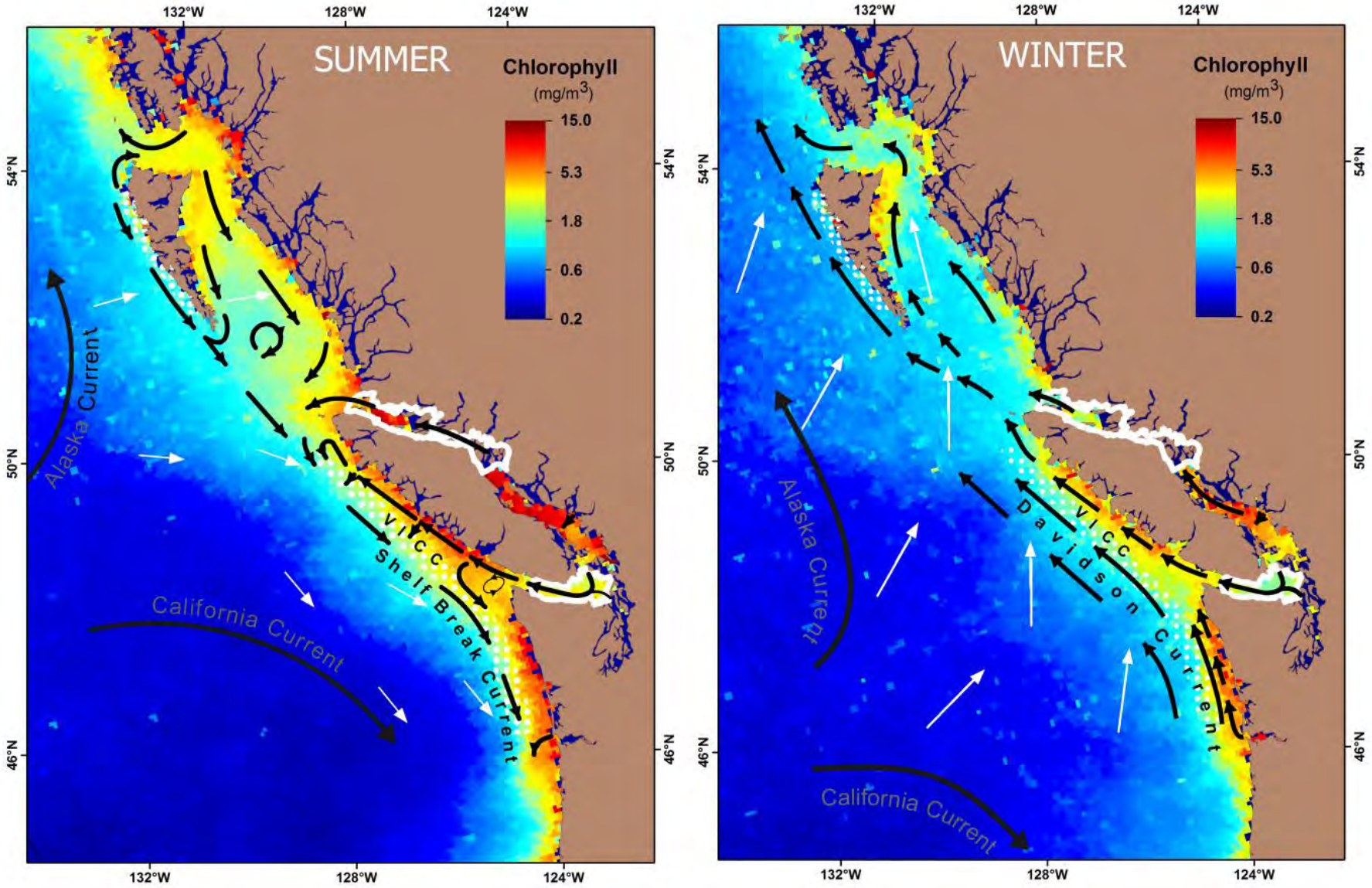
Outline

- Introduction to study area
- Description of the four datasets
- Evolution of 2014 – 2017 marine heatwave in the Gulf of Alaska
- Tracing the marine heatwave to BC central coast
- Possible influence on coastal ecosystem
- Correlation between offshore and coastal conditions – can coastal waters be predicted from open ocean data?
- Summary

Introduction to British Columbia

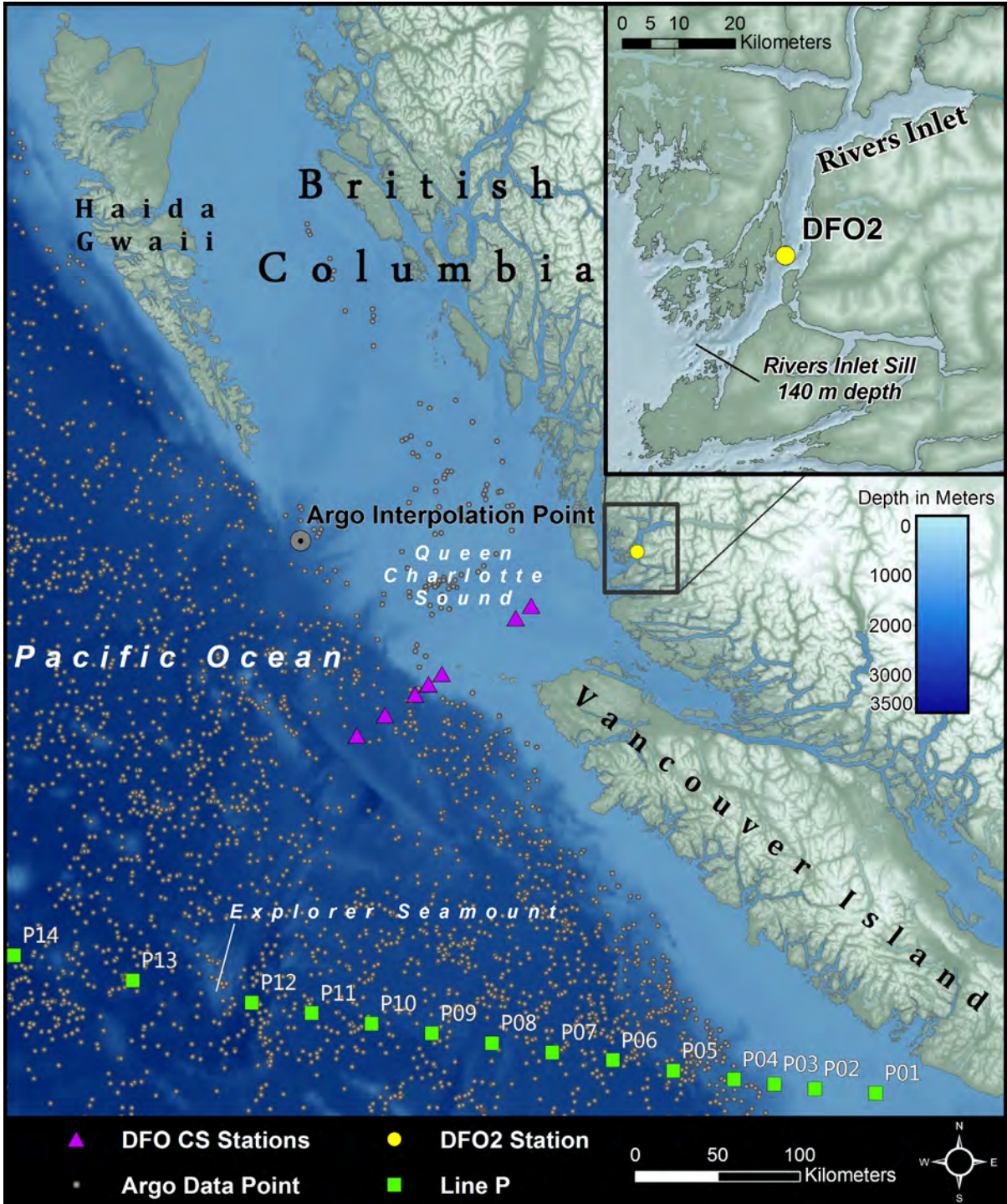


Jackson et al., JGR Oceans, 2015

Study region and datasets

- 4 different datasets were used:

1. Argo data interpolated to Queen Charlotte Sound shelf break from 2004 to 2018
2. DFO Line P data from 1959 to 2018
3. DFO CS line data from 1998 to 2017
4. DFO/Hakai Rivers Inlet data from 1998 to 2018



Introduction to Rivers Inlet

- Rivers Inlet is a fjord on British Columbia's central coast
- It is about 45 km long and 3 km wide
- The maximum depth is 340m and the sill depth is about 140m (Pickard, 1961)
- The mouth of Rivers Inlet is exposed to Queen Charlotte Sound
- There are approximately 53 inlets at least 18.5 km long in British Columbia

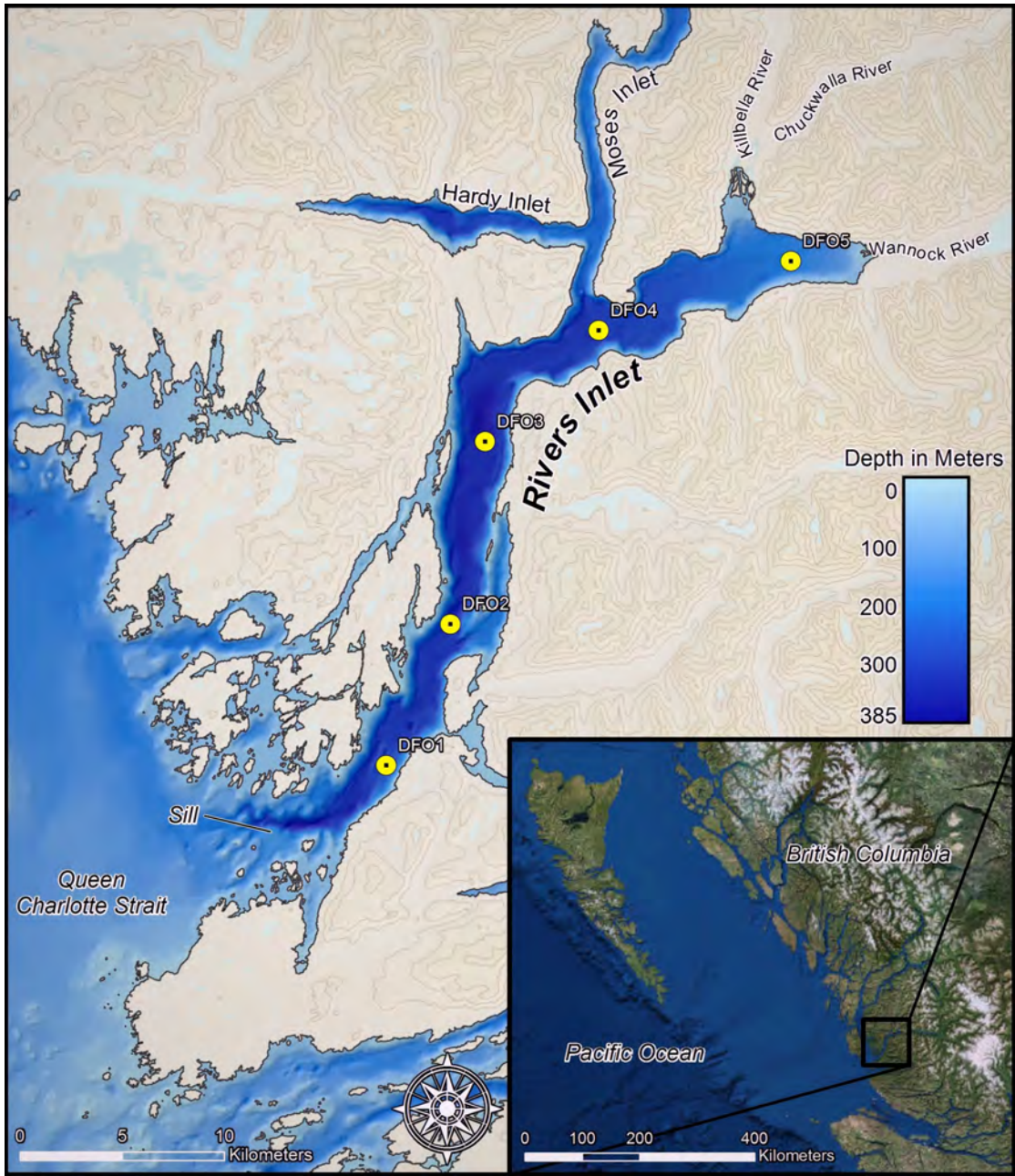
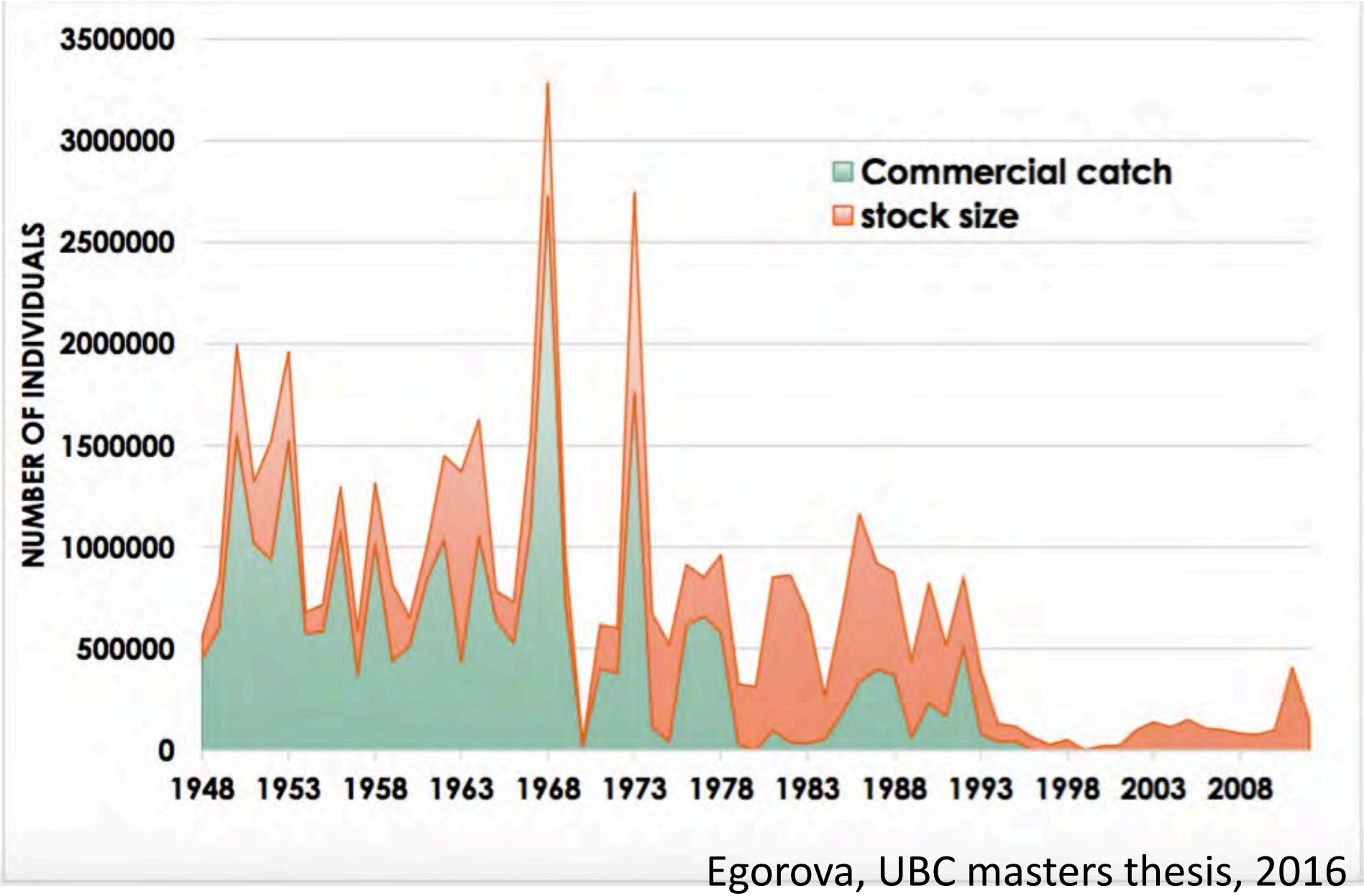


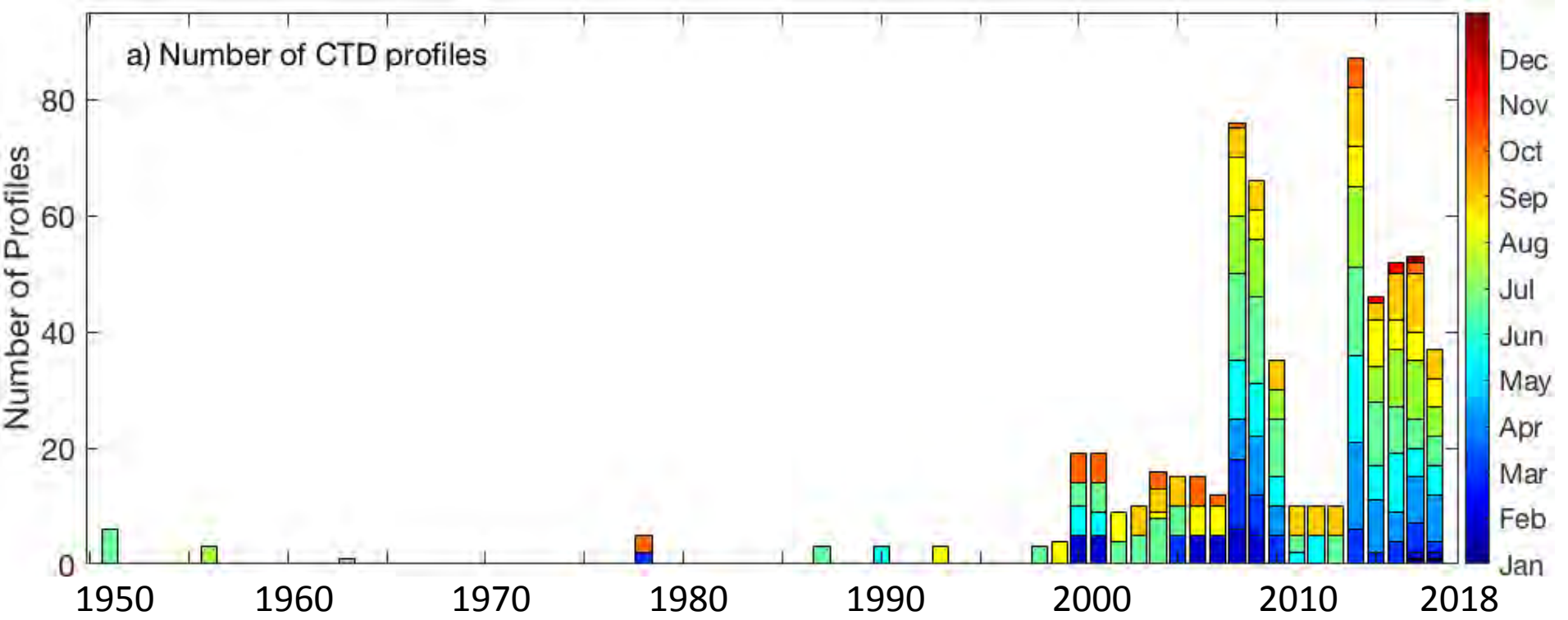
Image by Keith Holmes

Rivers Inlet sockeye salmon 1948 - 2012



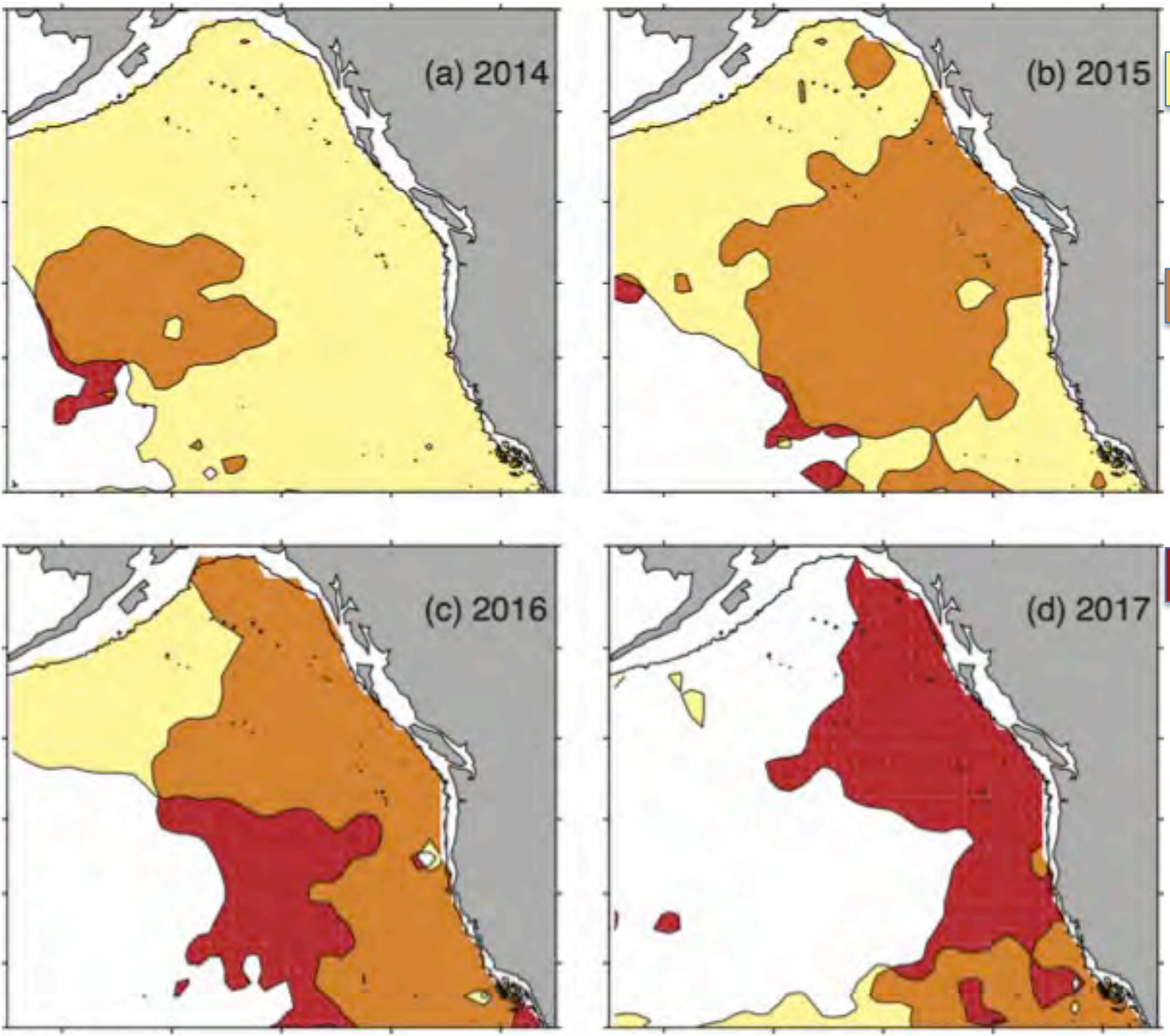
Egorova, UBC masters thesis, 2016

Rivers Inlet Time Series



- University of British Columbia collected data from 1951-1987 and 2008-2010
- Fisheries and Oceans Canada collected data from 1990-2018
- Hakai Institute collected data from 2013-2018
- This is the first time that the data have been brought together for analysis

Deepening of heat in the NE Pacific



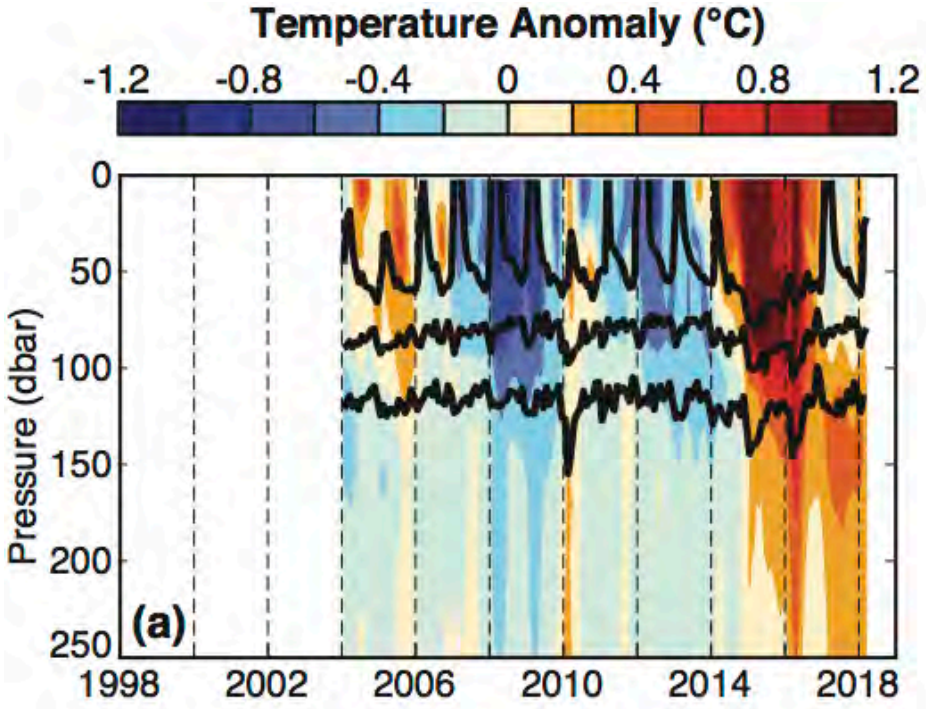
Surface >0.25°C warmer than average

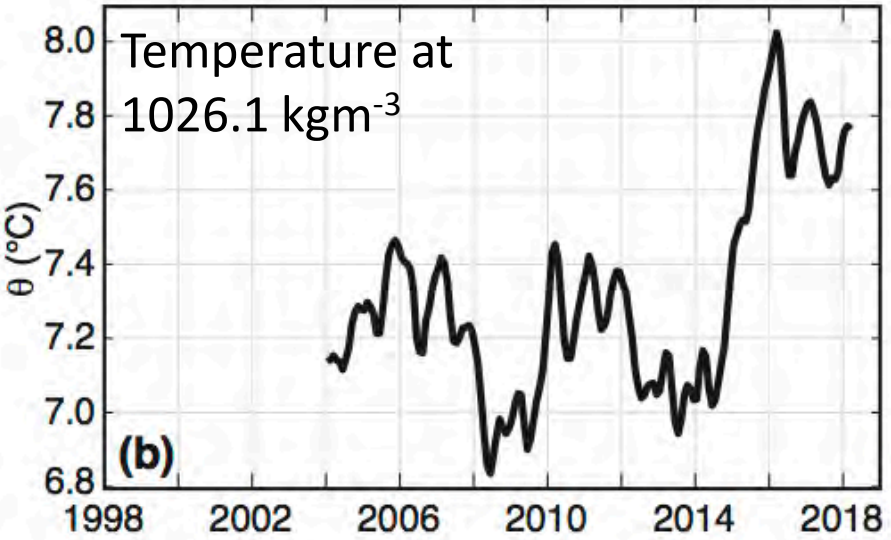
Surface and 140 m >0.25°C warmer than average

140 m >0.25°C warmer than average

*Results shown here are from Argo data

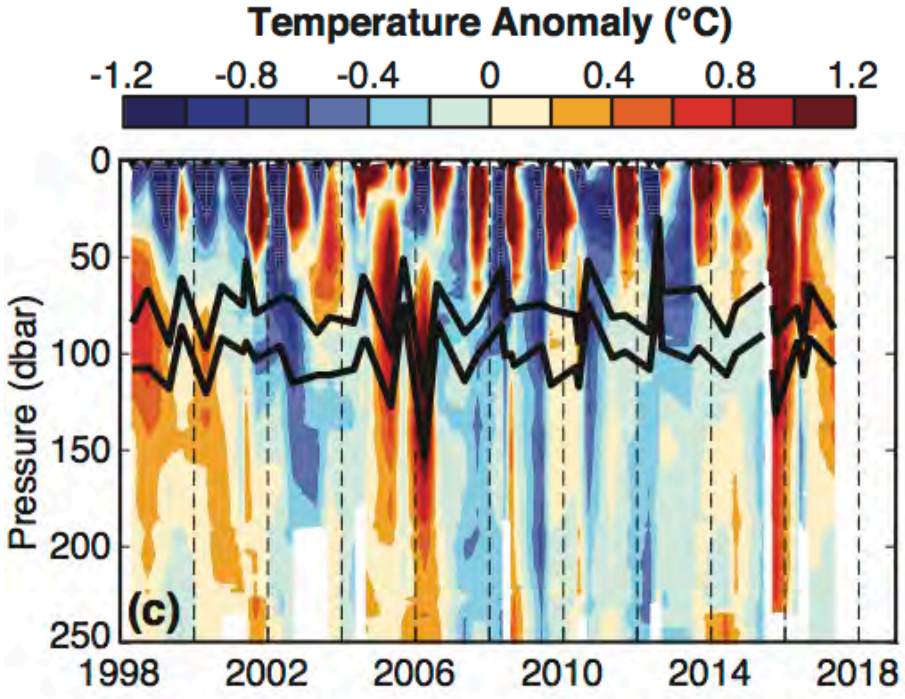
Tracing heat from the NE Pacific to the coast – Argo data

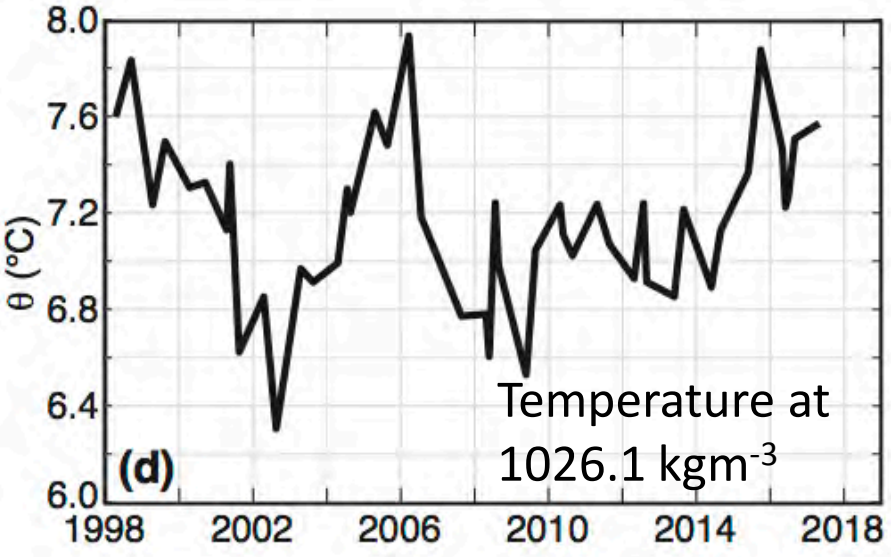




- Surface anomaly first observed spring 2014
- Subsurface anomaly observed fall 2014
- El Niño is clear in 2016
- Subsurface anomaly persists between 1025.6 kgm^{-3} and 1026.1 kg m^{-3} until at least March 2018

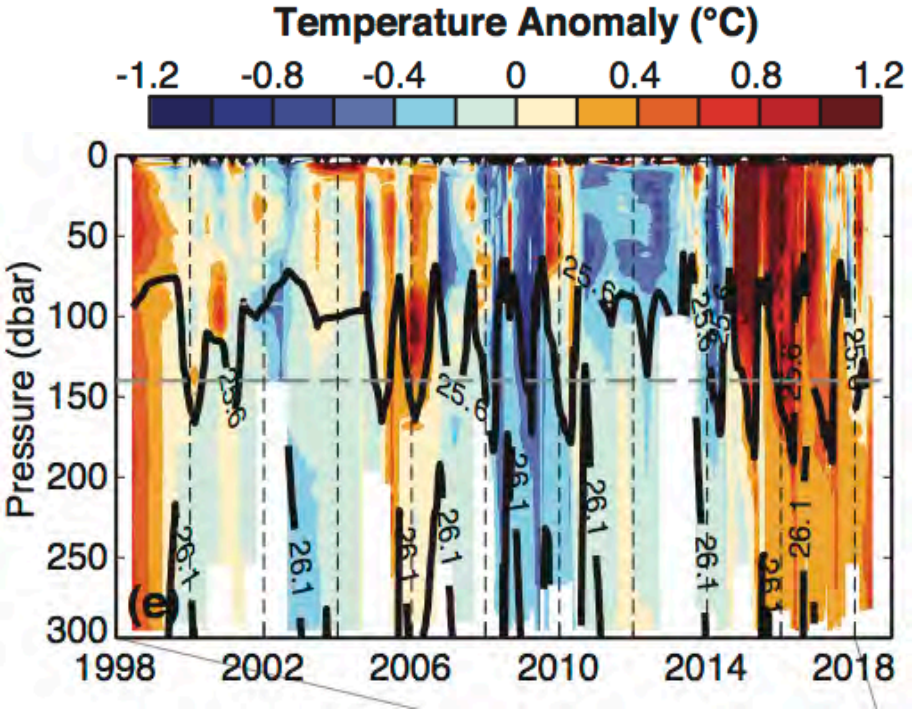
Tracing heat from the NE Pacific to the coast – Queen Charlotte Sound

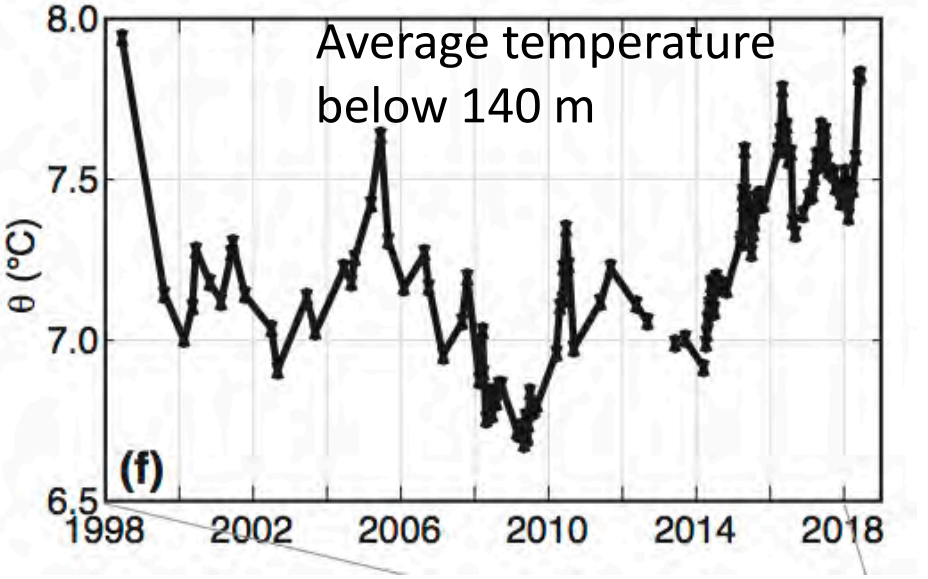




- These data only sampled twice a year so low temporal resolution
- El Niño is clear in 2016
- Subsurface anomaly persists between 1025.6 kgm^{-3} and 1026.1 kg m^{-3} until at least September 2017

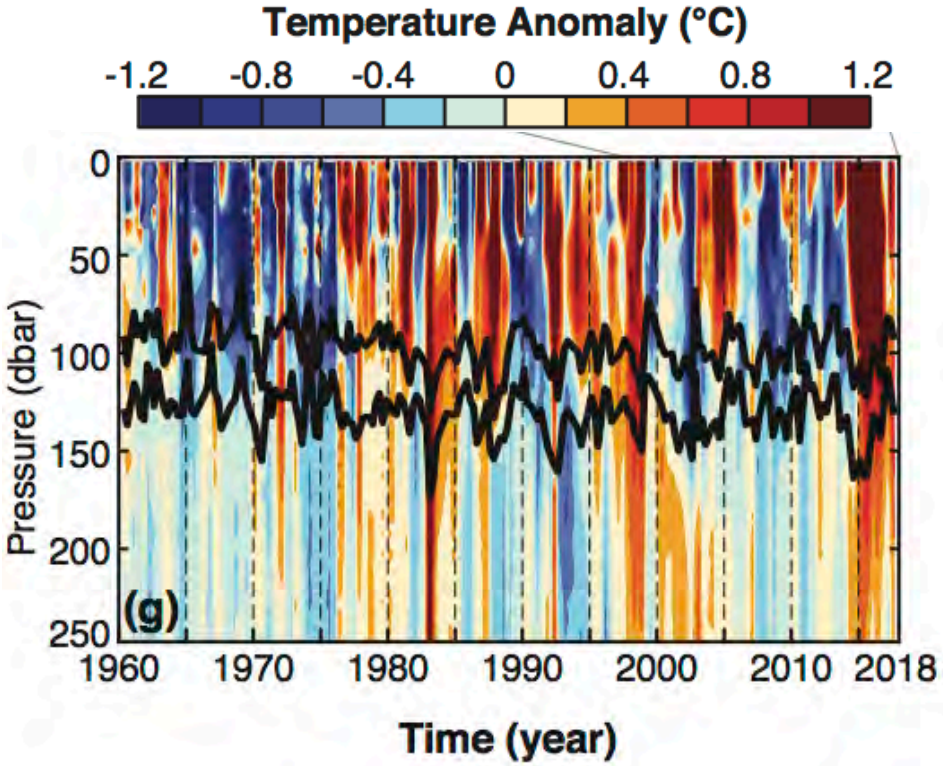
Tracing heat from the NE Pacific to the coast – Rivers Inlet

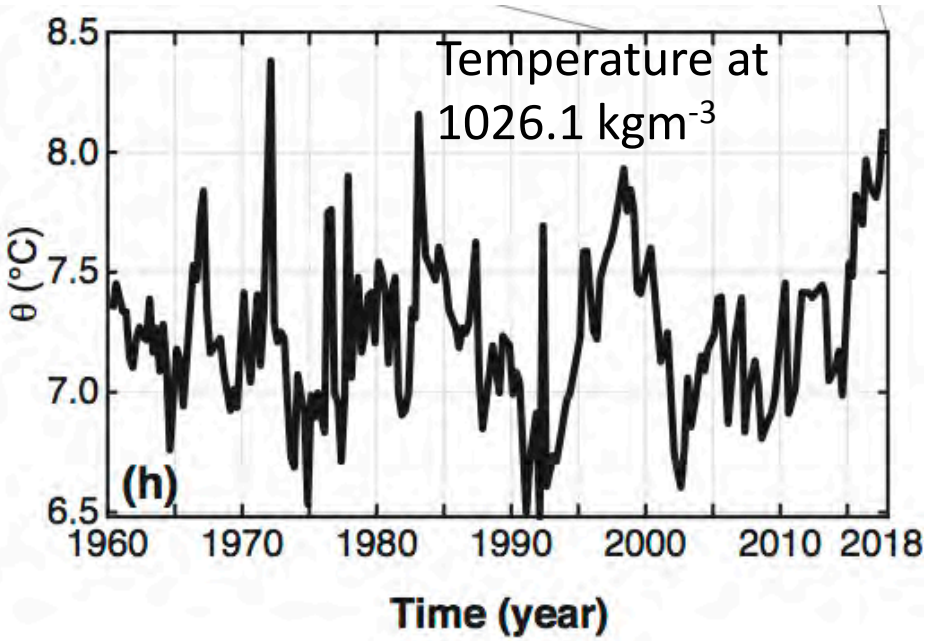




- Surface anomaly first observed spring 2015
- Subsurface anomaly observed fall 2015
- El Niño is clear in 2016
- Subsurface anomaly persists below 140 m until at least August 2018

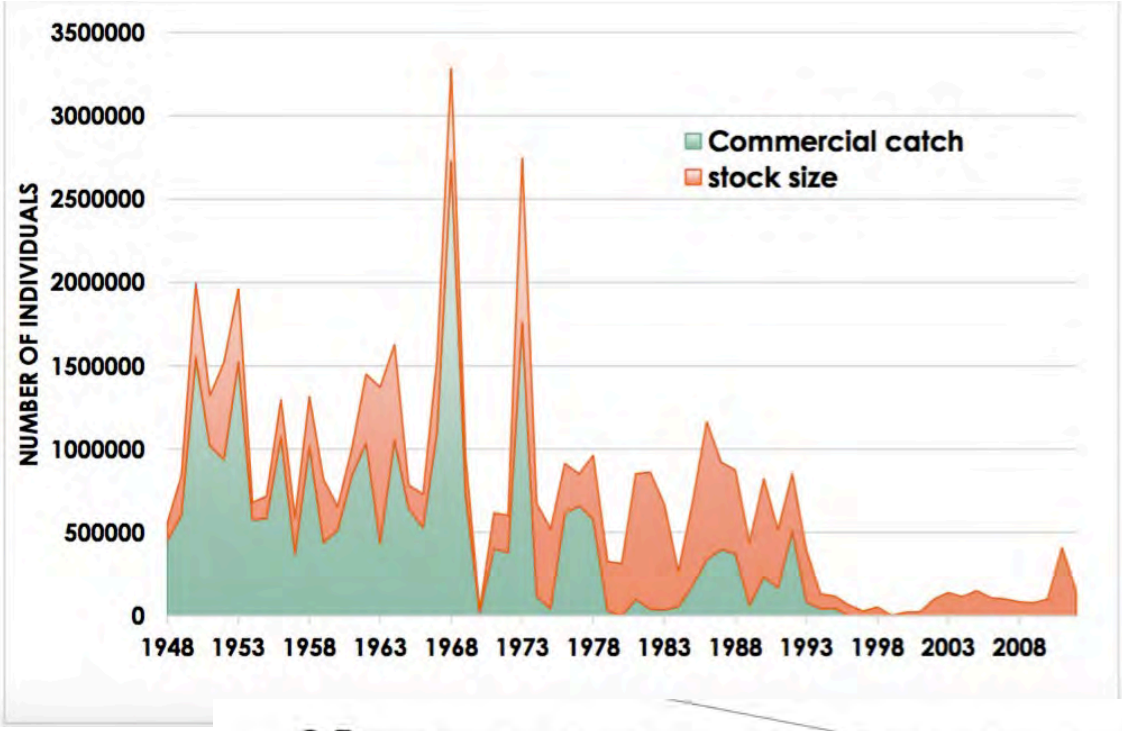
Extending the time series at Line P

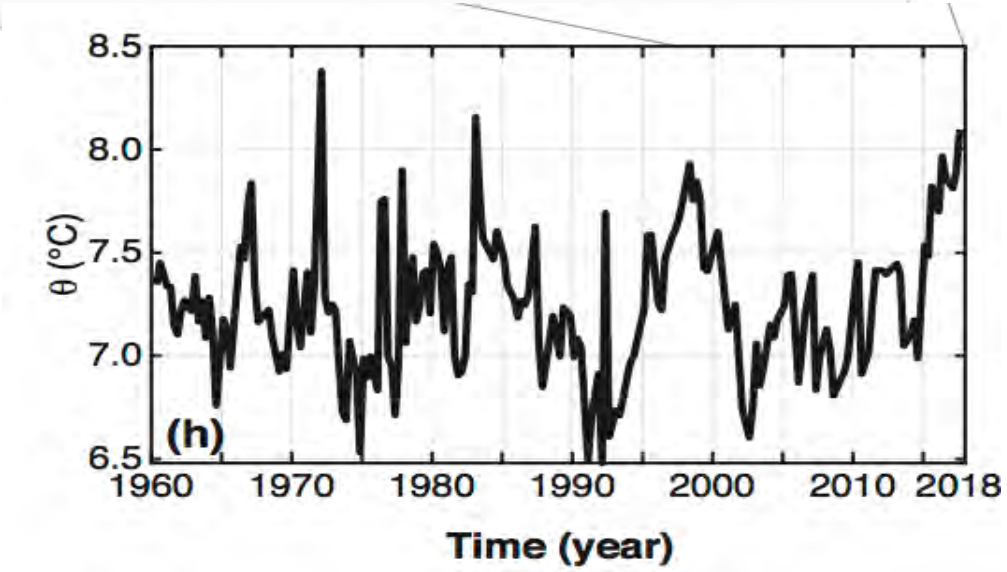




- The surface and subsurface anomalies were also observed at Line P
- Extending the time series shows that there have been other prolonged warm periods along 1026.1 kg m^{-3}
- Mid-1980s and 1993 to 1998 were times when water warmer

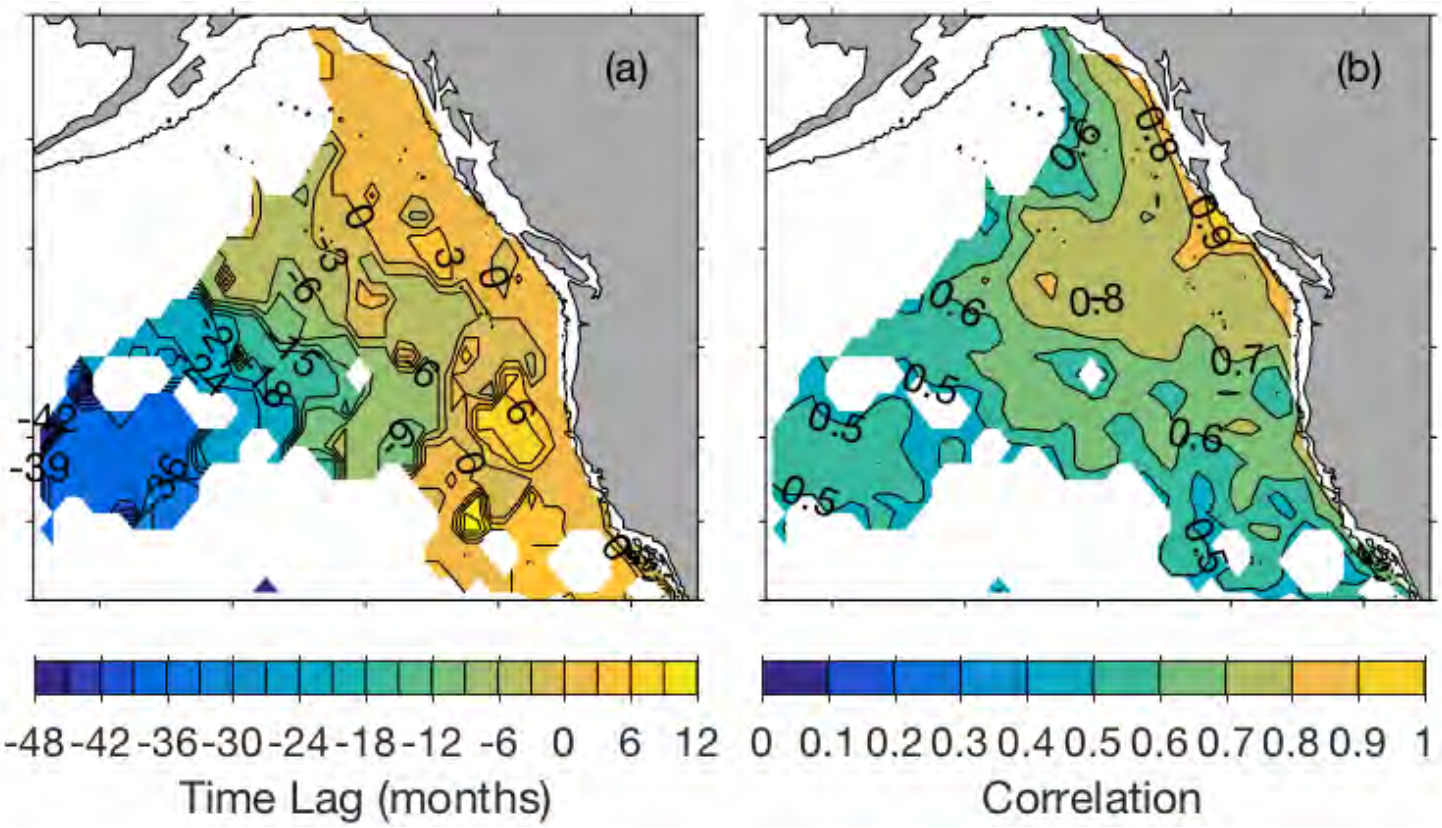
Possible consequences to ecosystem





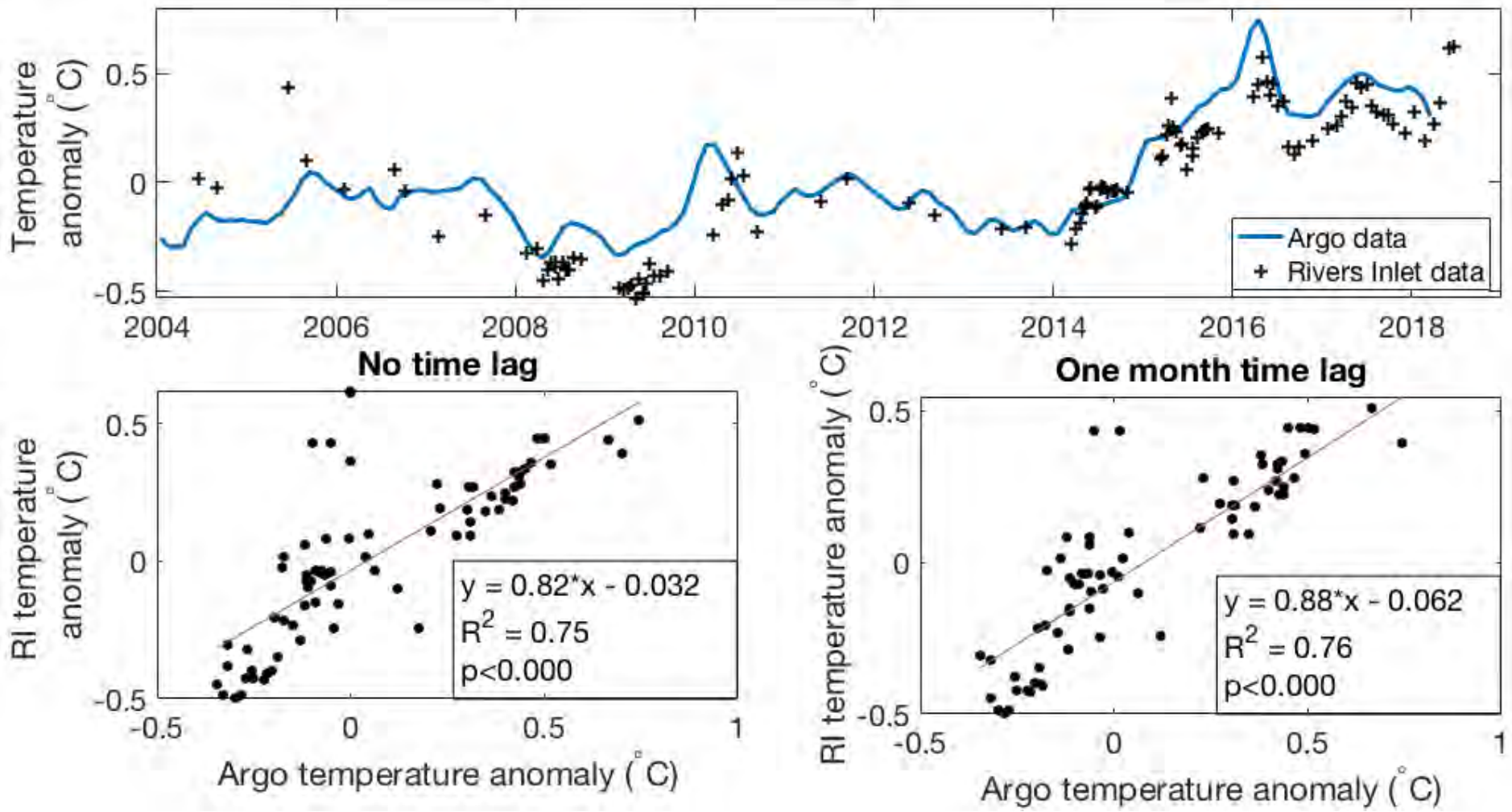
- Decline of Rivers Inlet sockeye salmon occurred at the same time when there was a warm anomaly at 140 m along Line P (1993 to 1998)
- Warm waters favour smaller, less lipid-rich zooplankton on the BC coast
- Is it possible that open ocean subsurface warm anomalies influence salmon?

Correlation between open ocean and shelf break



- Lagged maximum correlations at 140 m between Argo data and Argo interpolation point at Queen Charlotte Sound shelf break
- Points with correlation less than square root of 0.2 not shown
- Suggests a lag of 1 to 3 years from Blob's deep manifestation to warming at the coast

Correlation between shelf break and Rivers Inlet



- Temperature anomaly at Argo Interpolation point and Rivers Inlet are very well correlated, with a 0 to 2 month time lag

Summary

- Four datasets (Argo, Line P, DFO CS line and Rivers Inlet) were used to trace the subsurface marine heatwave from the open ocean to Rivers Inlet
- The marine heatwave persisted at 140 m in the open ocean until at least March 2018
- As of August 2018, deep water in Rivers Inlet was still 0.6°C warmer than the monthly average
- This subsurface warm anomaly could influence River Inlet ecosystem, including sockeye salmon
- The strong correlation between open ocean and BC coast suggest that bottom water in Rivers Inlet can be predicted