

A Comparison of the Anomalous Ocean Conditions observed off the West Coast of Canada in 2014 and 2015.



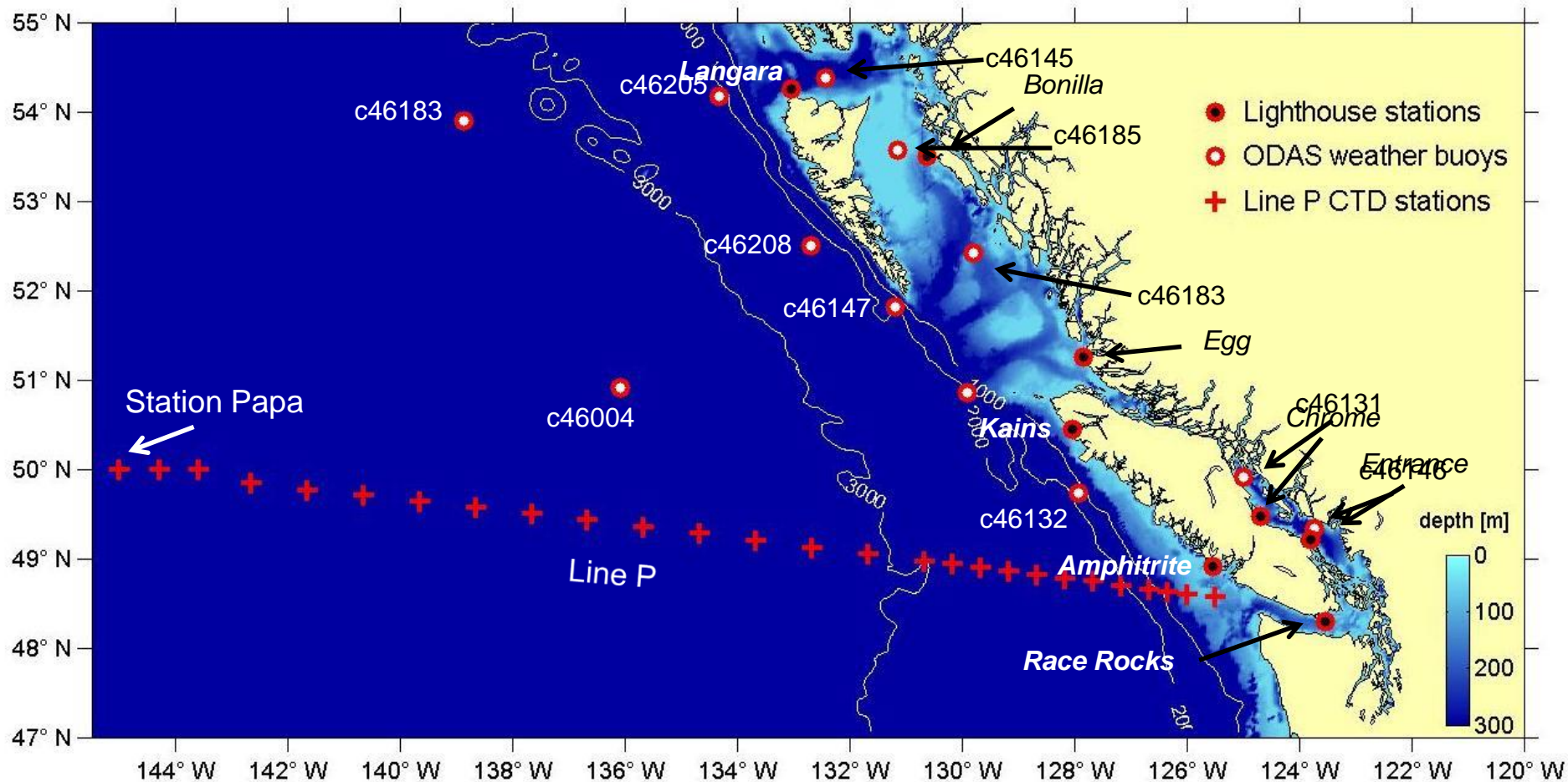
Peter Chandler, Marie Robert, Moira Galbraith

Institute of Ocean Sciences, Fisheries and Oceans Canada, Sidney , B.C.

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Photo: Chrome Island Light

1. Daily observations of SST from 8 lighthouse stations.
2. Hourly observations of SST from 12 weather buoys.
3. Line P CTD profiles (February, June and August/September).



Shore Stations

45-93 years of data

The standard sampling procedure involves collecting a water sample with a bucket immersed in the top 1 m of the sea surface within 1 hour of the daytime high tide.

The program is undergoing a transition from measuring the temperature of the water with a thermometer and the density with an hydrometer.

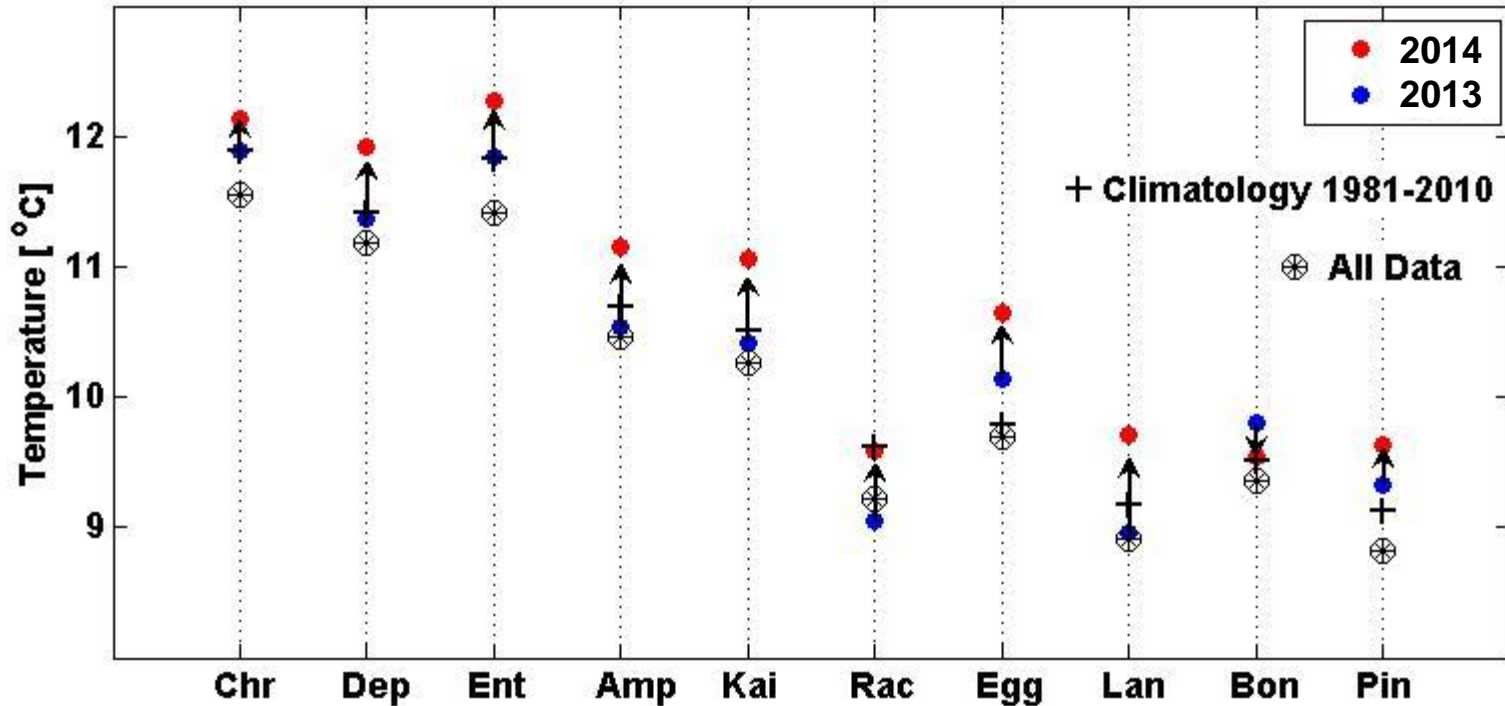
In 2014 each station was supplied with a YSI Pro30 meter with a temperature accuracy/resolution $\pm 0.2^{\circ}\text{C} / 0.1^{\circ}\text{C}$.

Weather Buoys

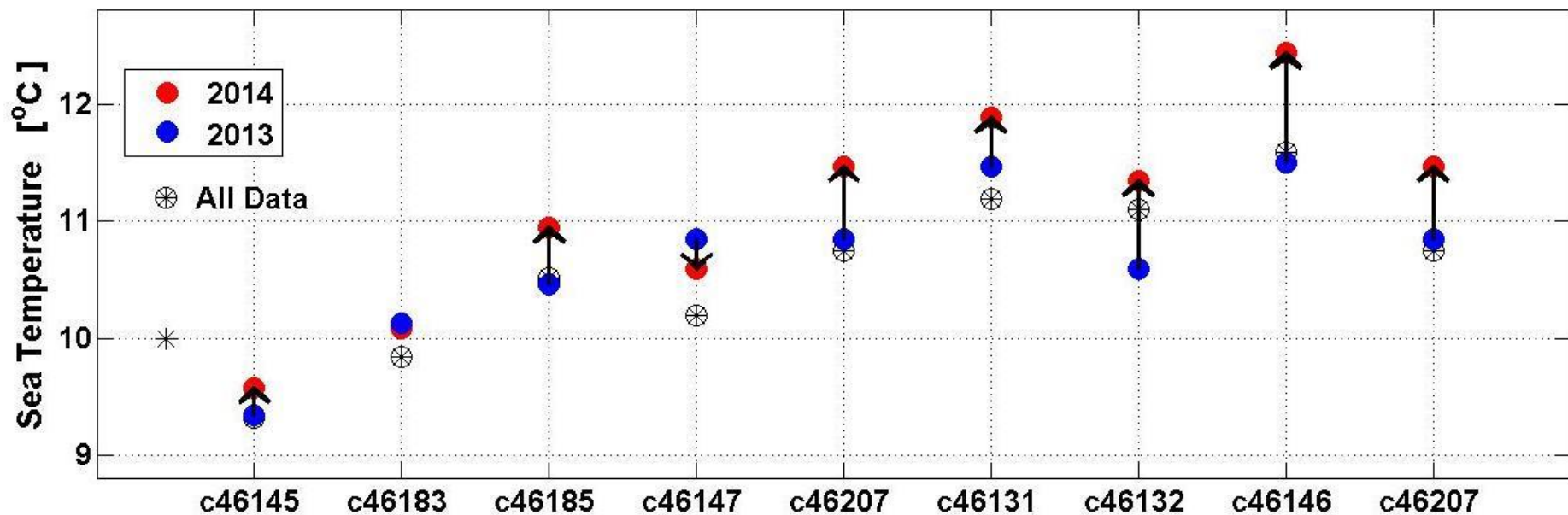
19-26 years of data

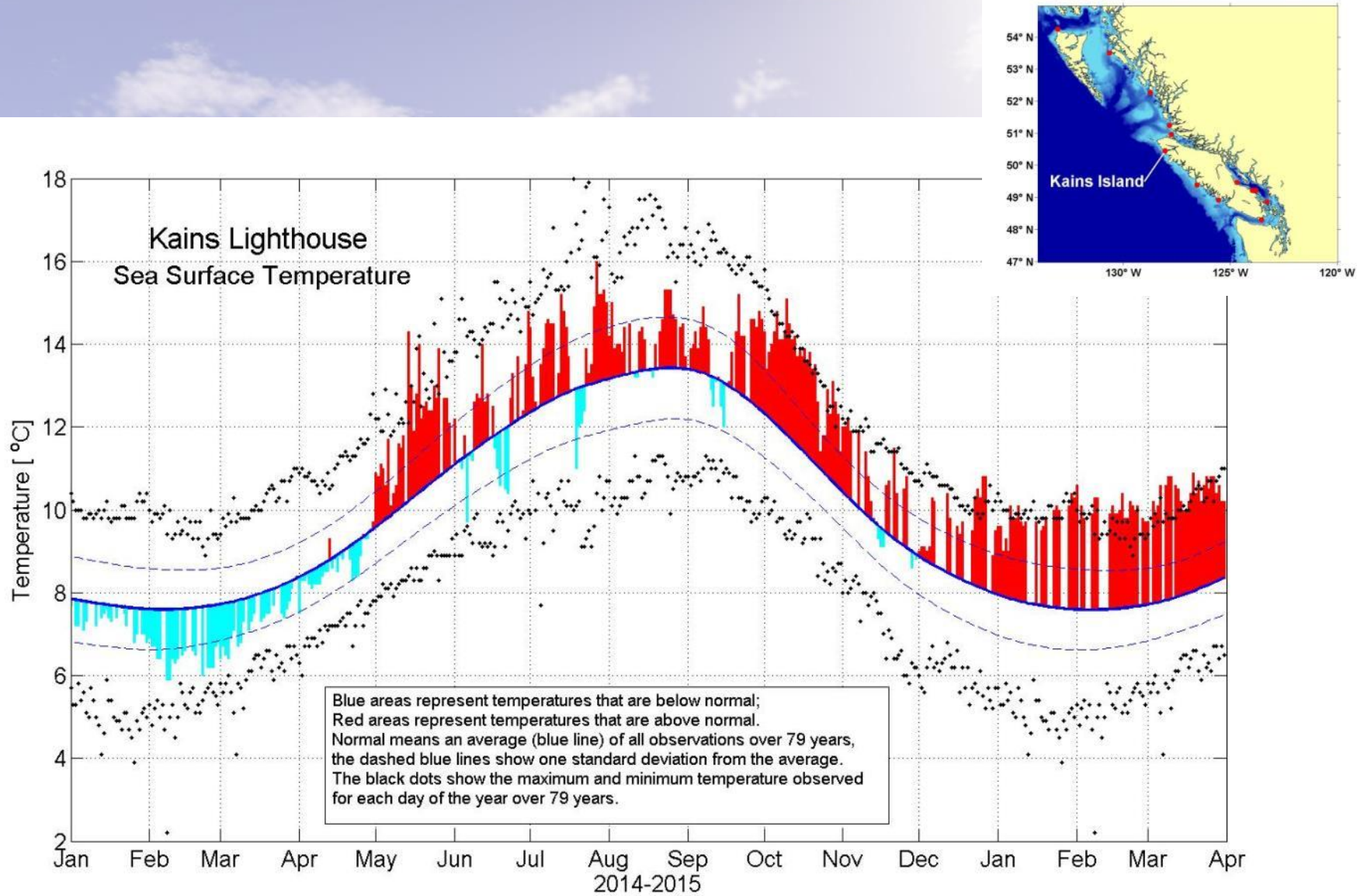
The temperature is measured by a thermistor composite element connected to the buoy hull below the water line. Data are collected at 4 Hz for a ten minute period every hour, averaged and then transmitted via satellite. The sensors are designed to provide accuracy to within 0.15°C .

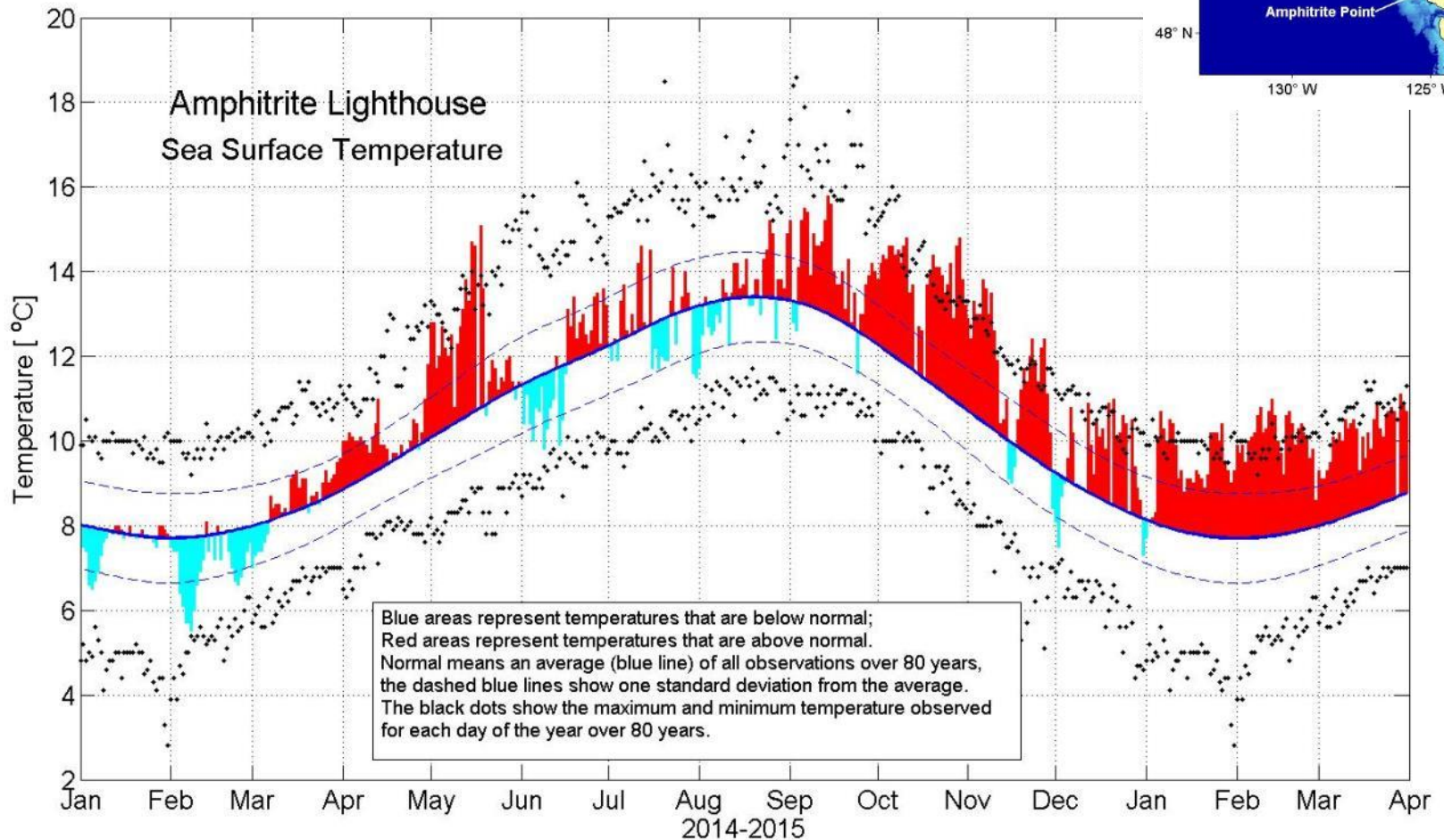
Lighthouse Station Mean Annual Sea Surface Temperature

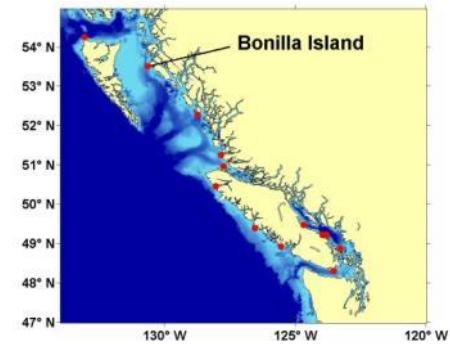
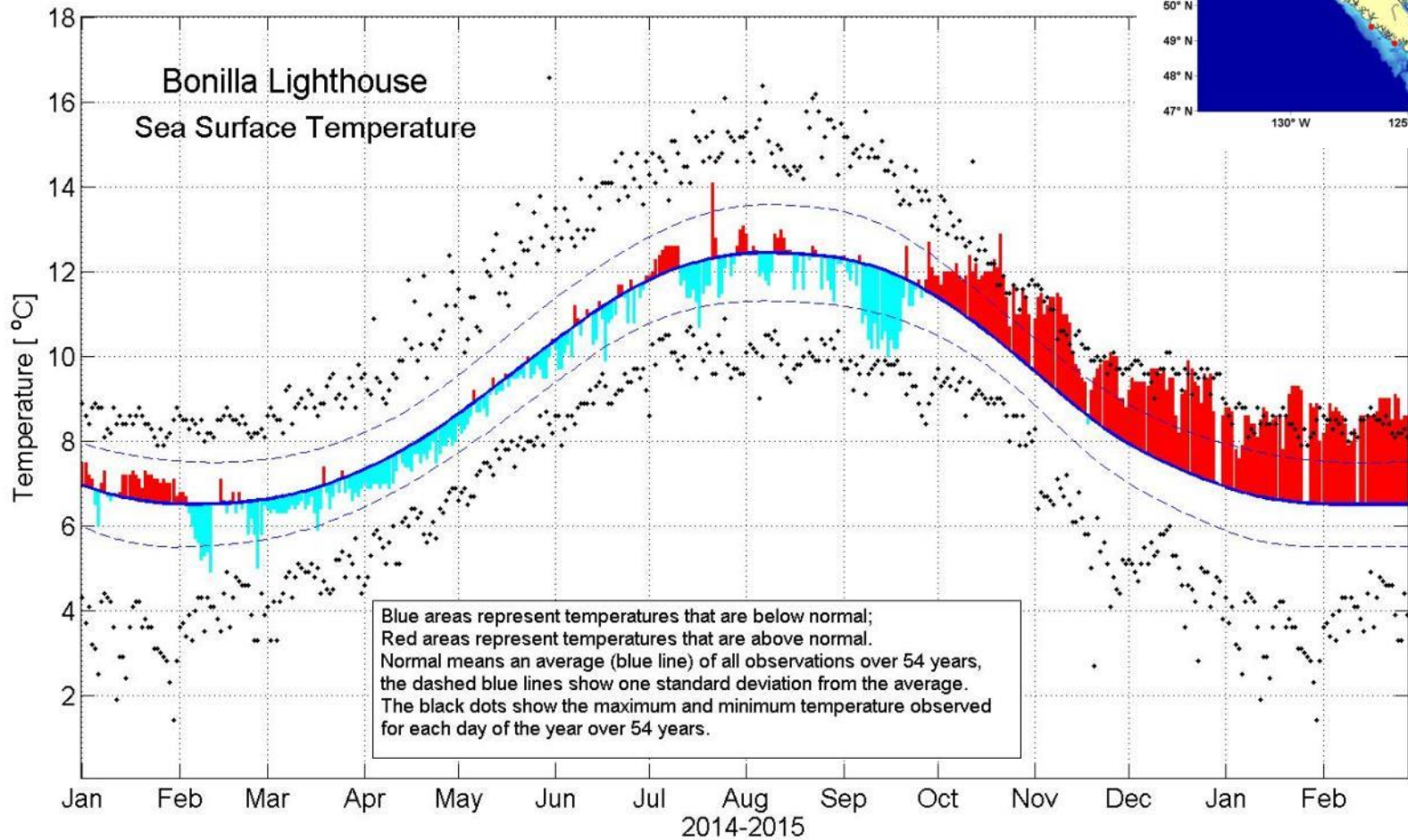


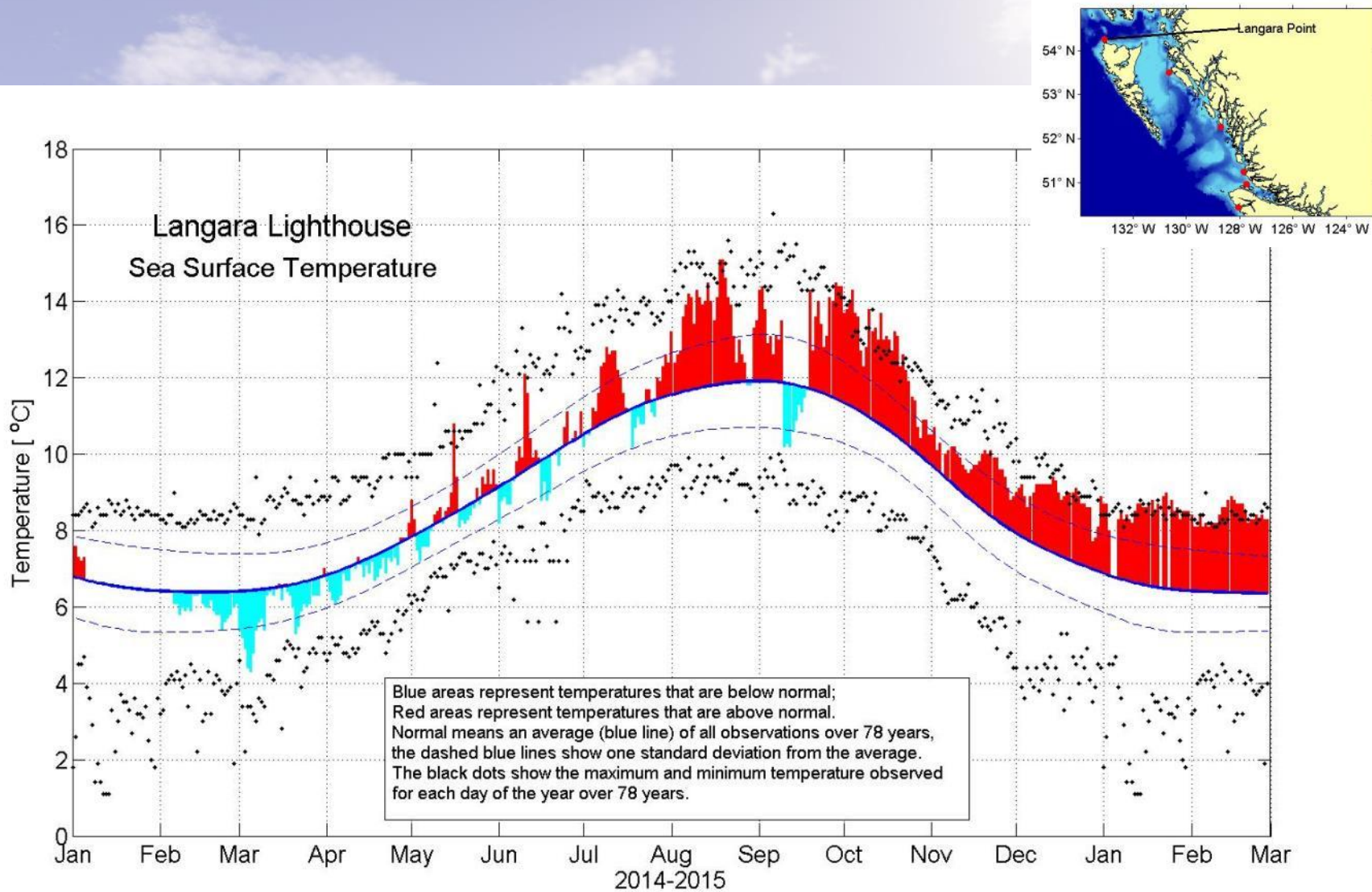
Weather Buoy Mean Annual Sea Surface Temperature

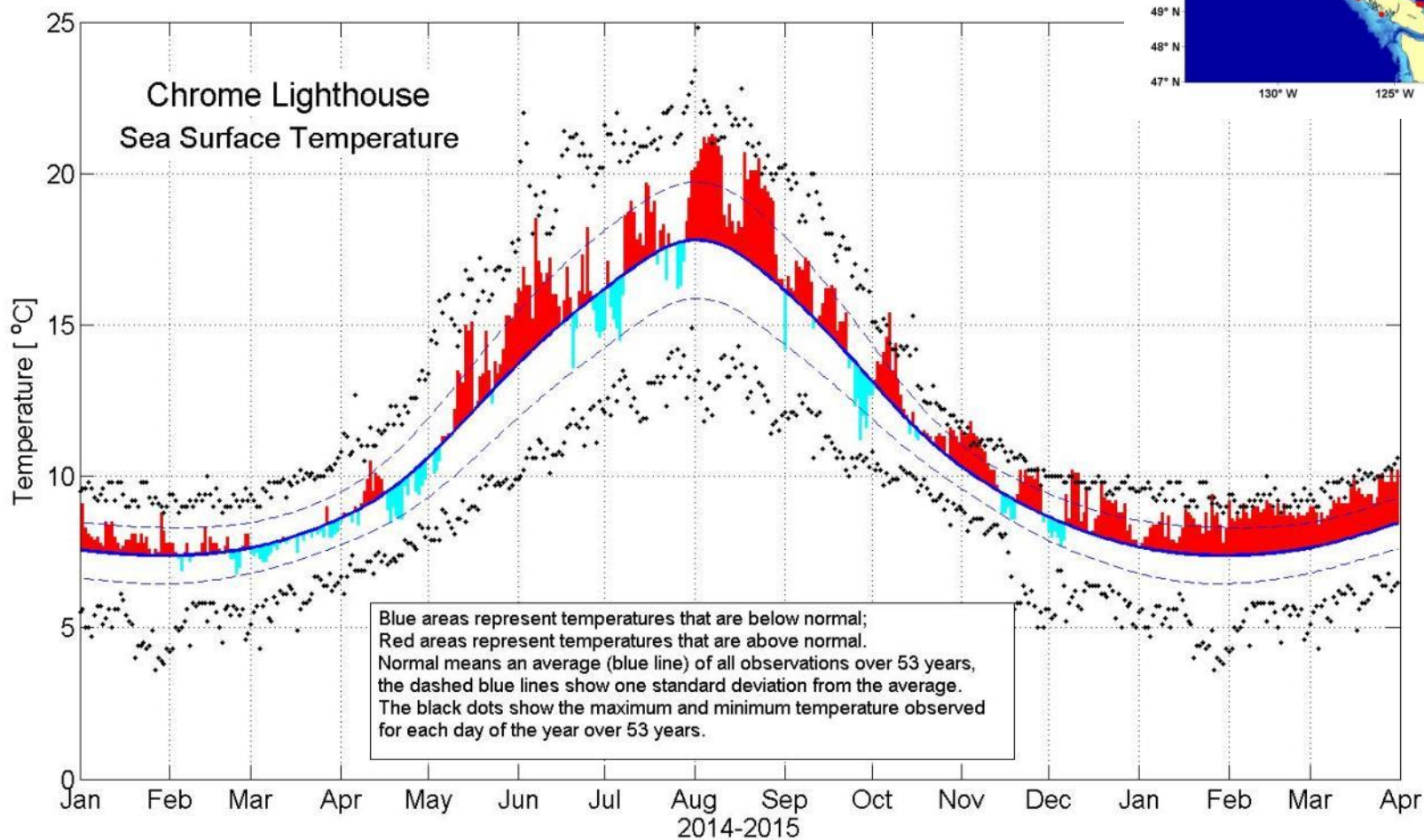


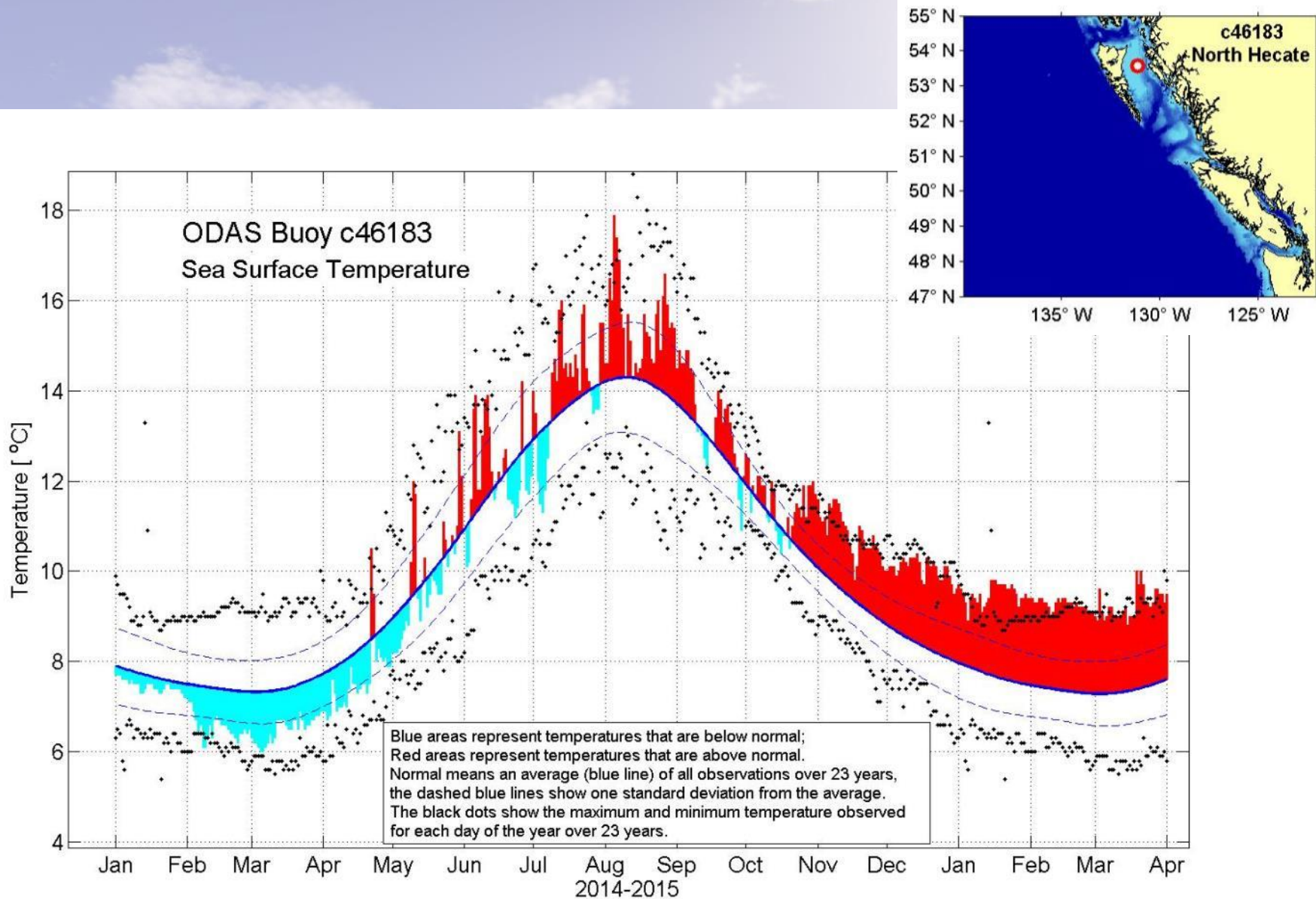


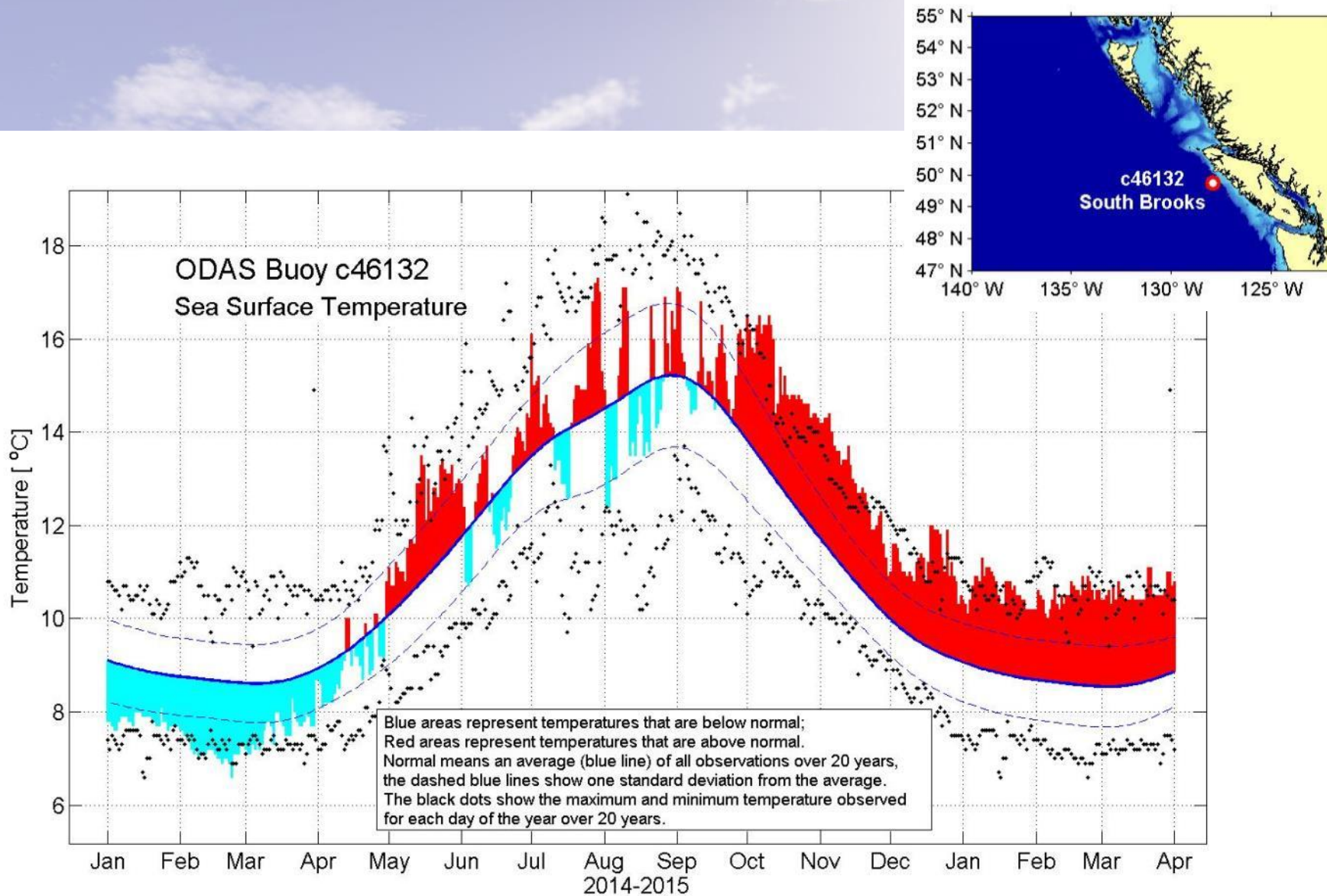


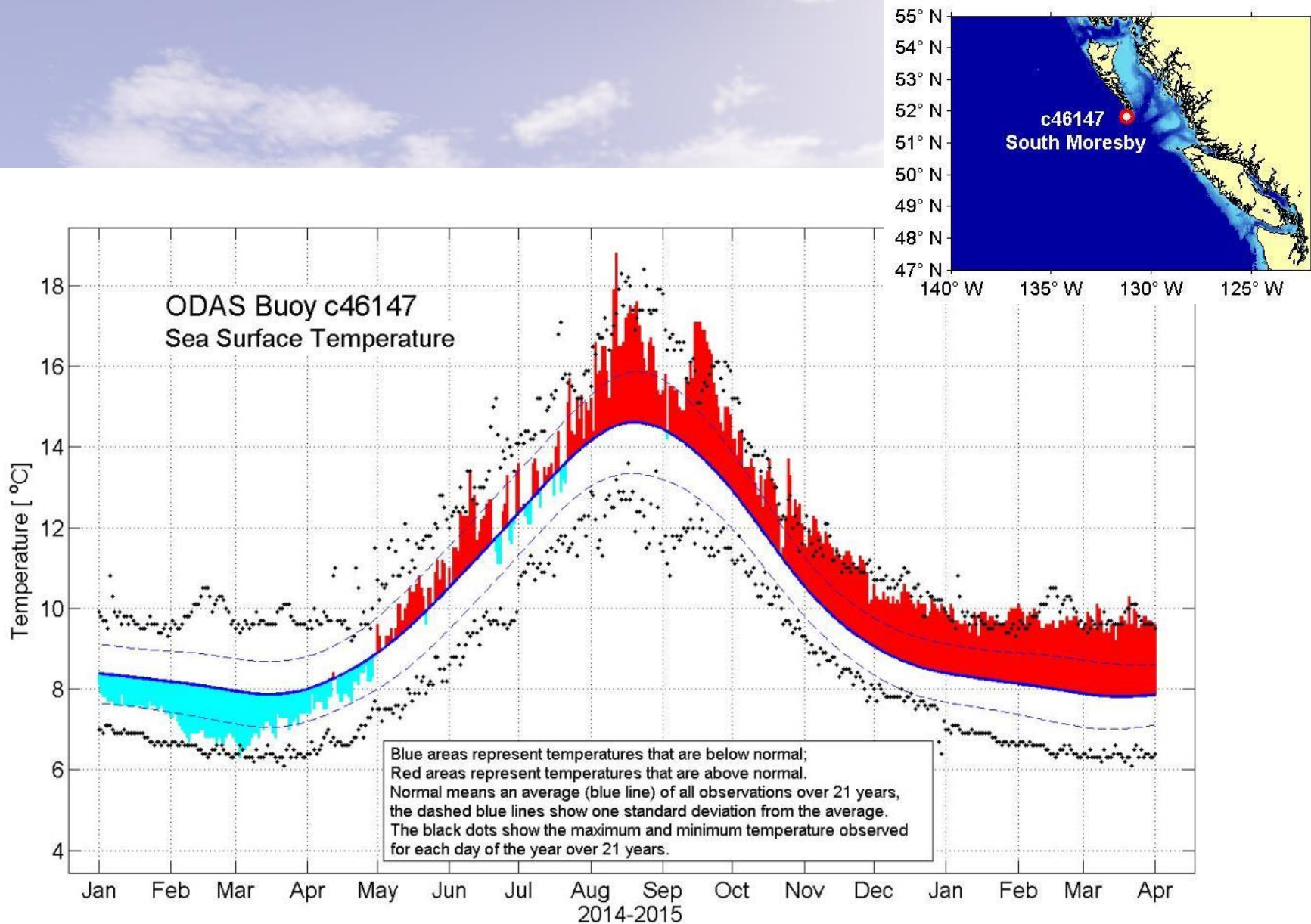


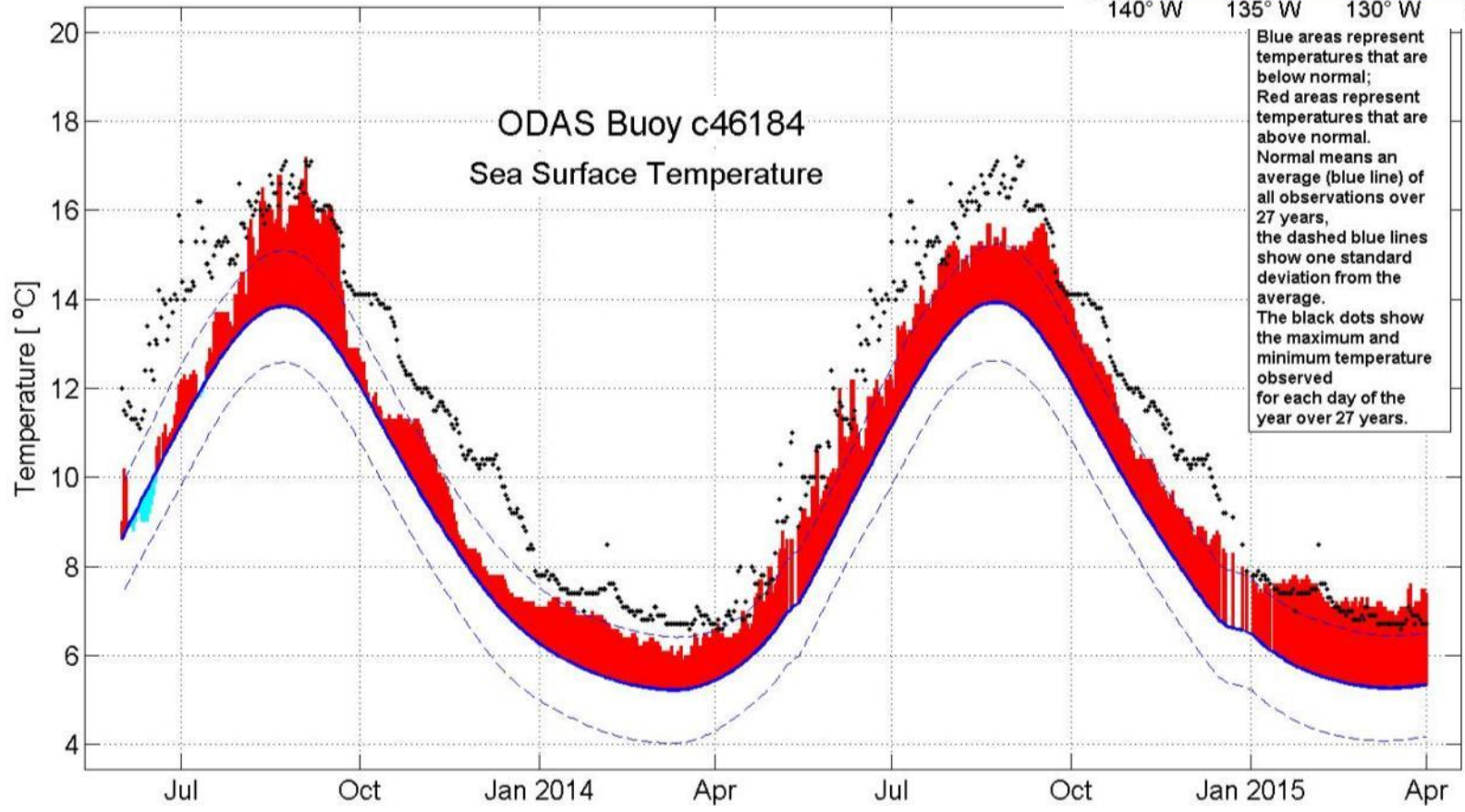
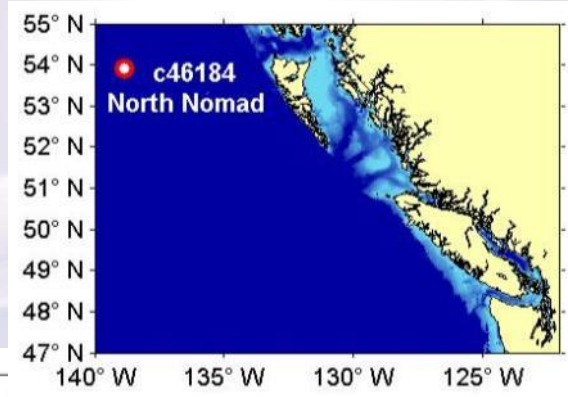






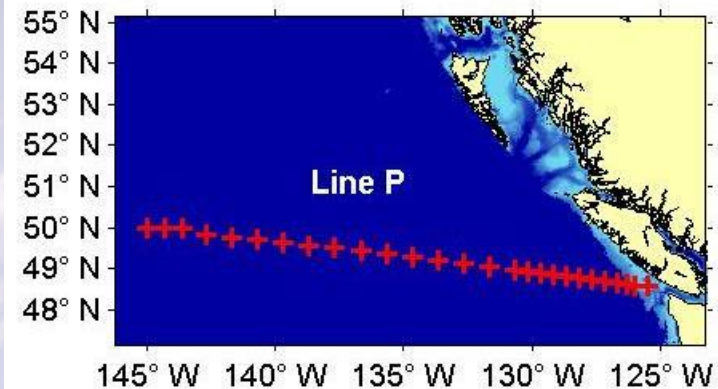
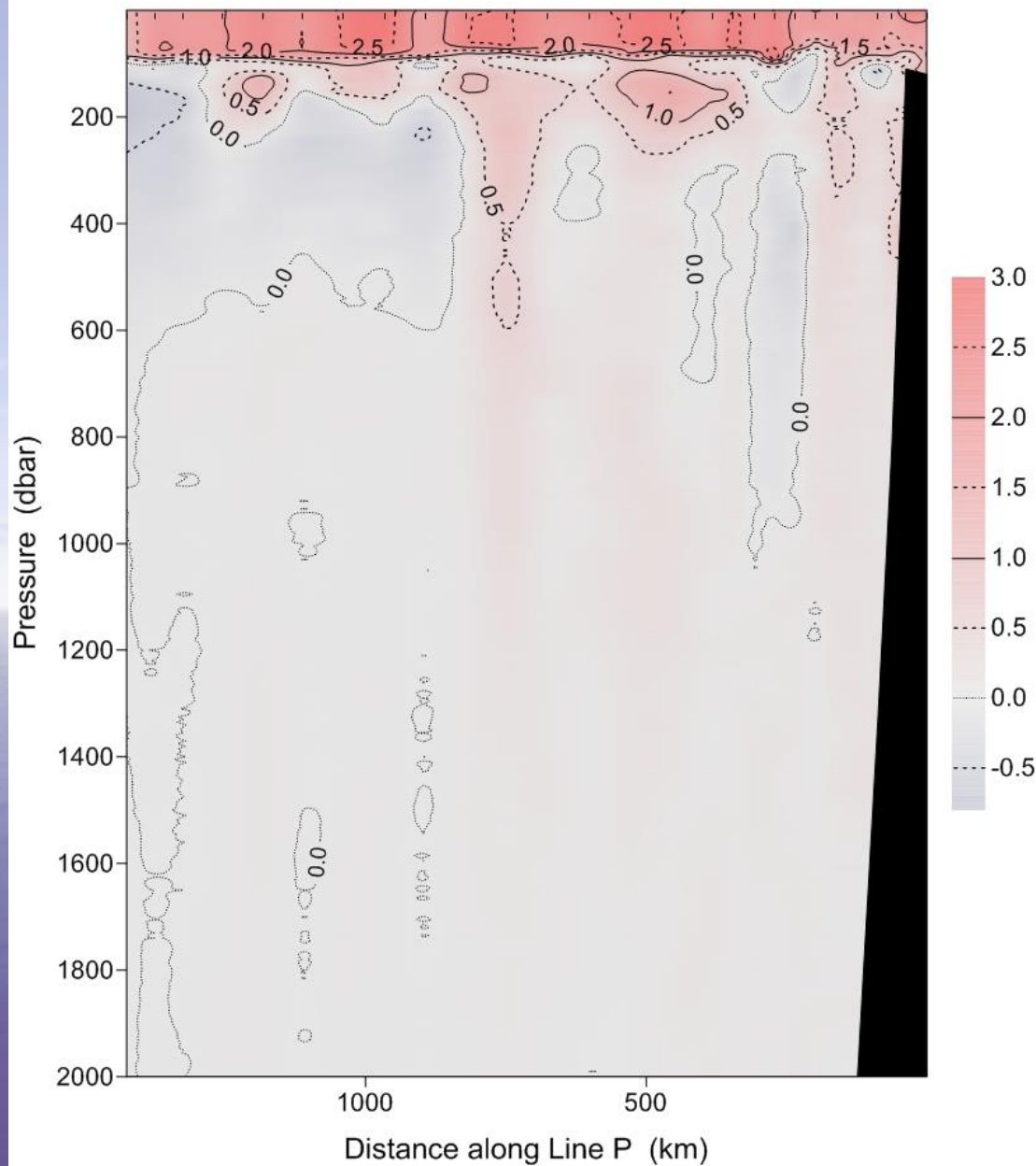






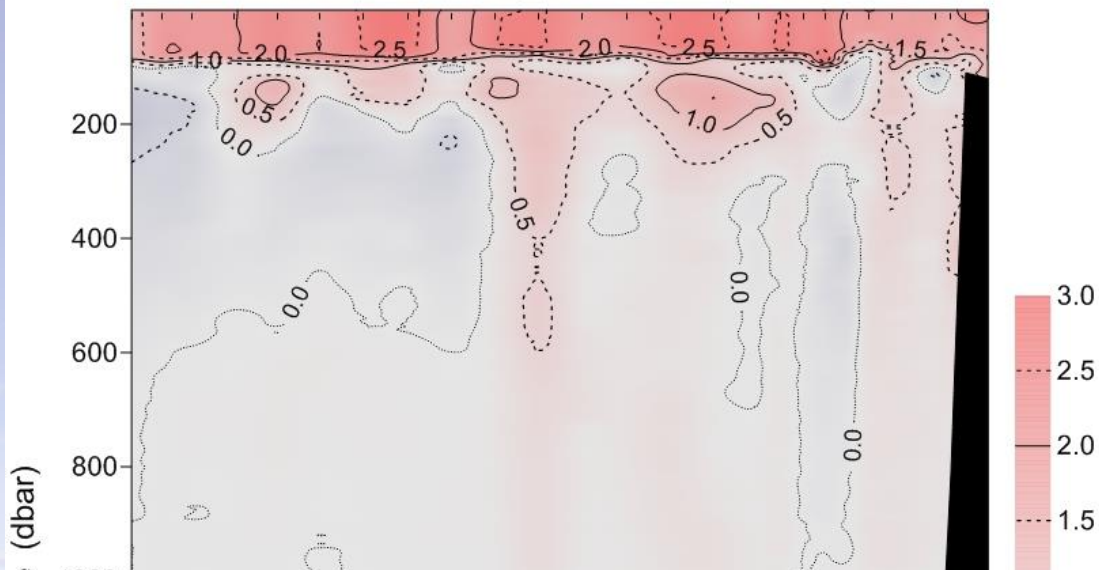
Temperature Anomaly ($^{\circ}\text{C}$ - ITS90) w.r.t. 1981-2010 averages

Cruise 2015-01, February 2015

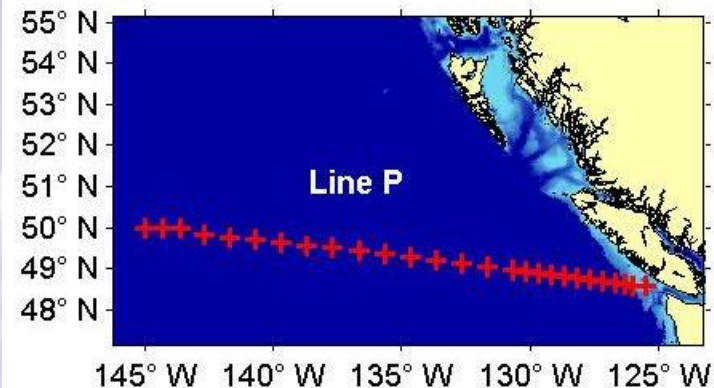
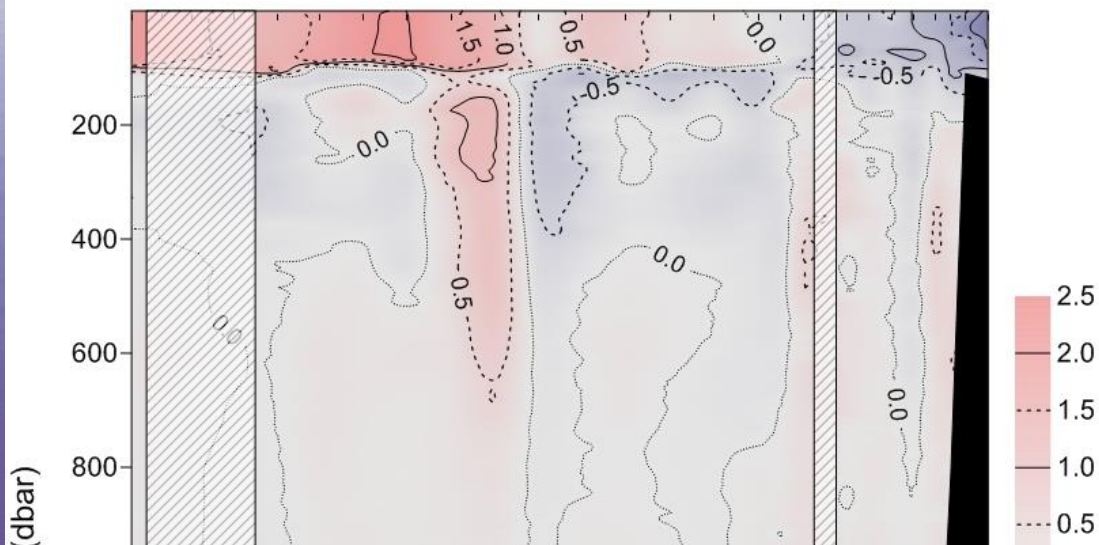


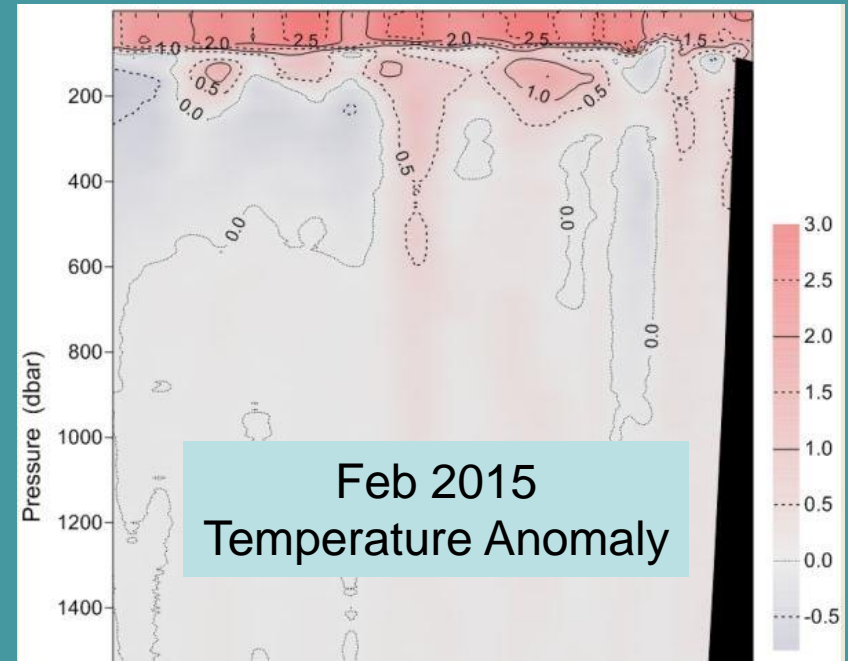
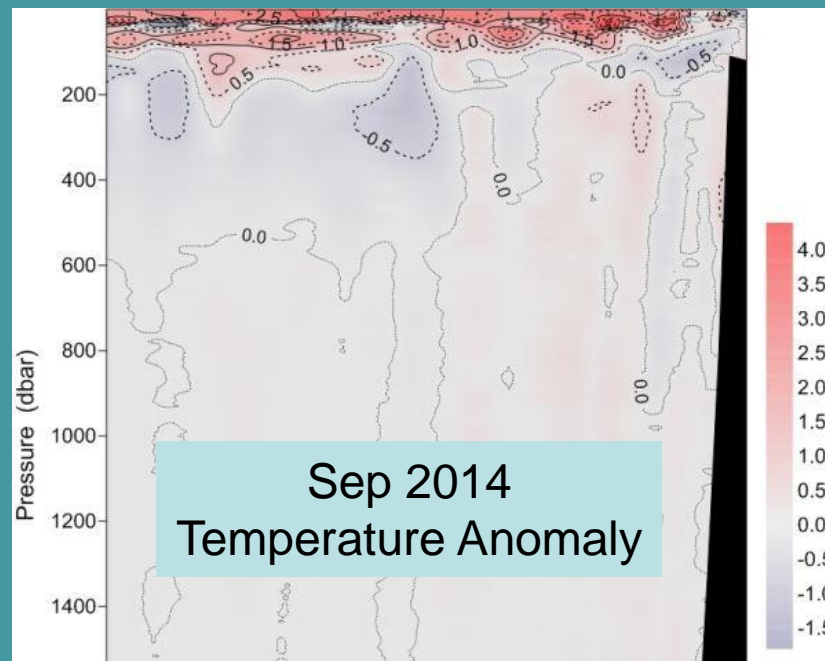
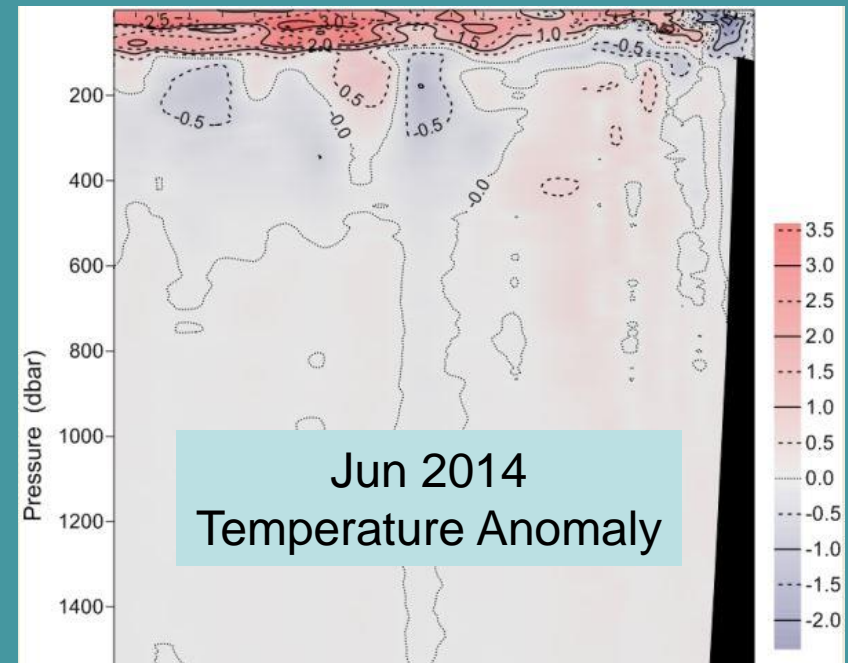
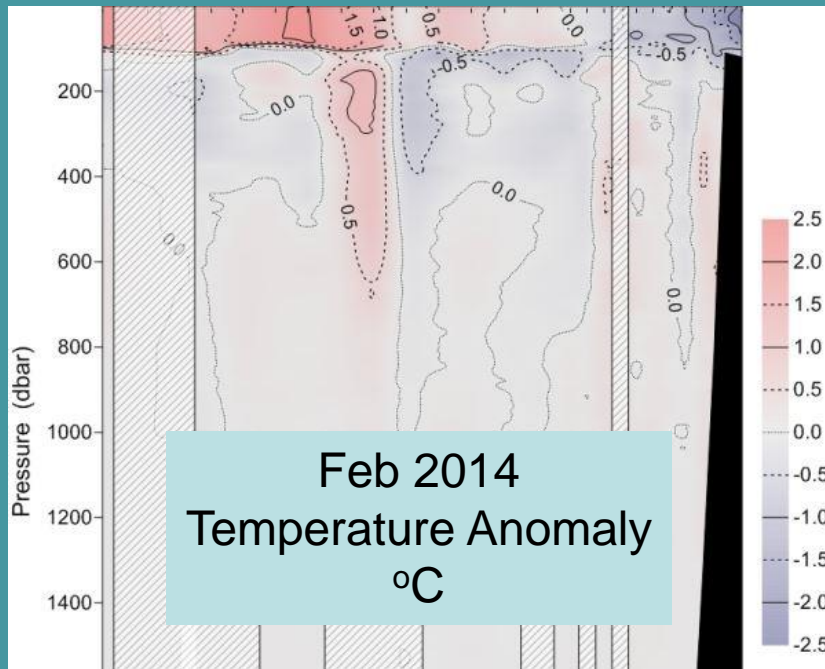
Temperature Anomaly ($^{\circ}\text{C}$ - ITS90) w.r.t. 1981-2010 averages

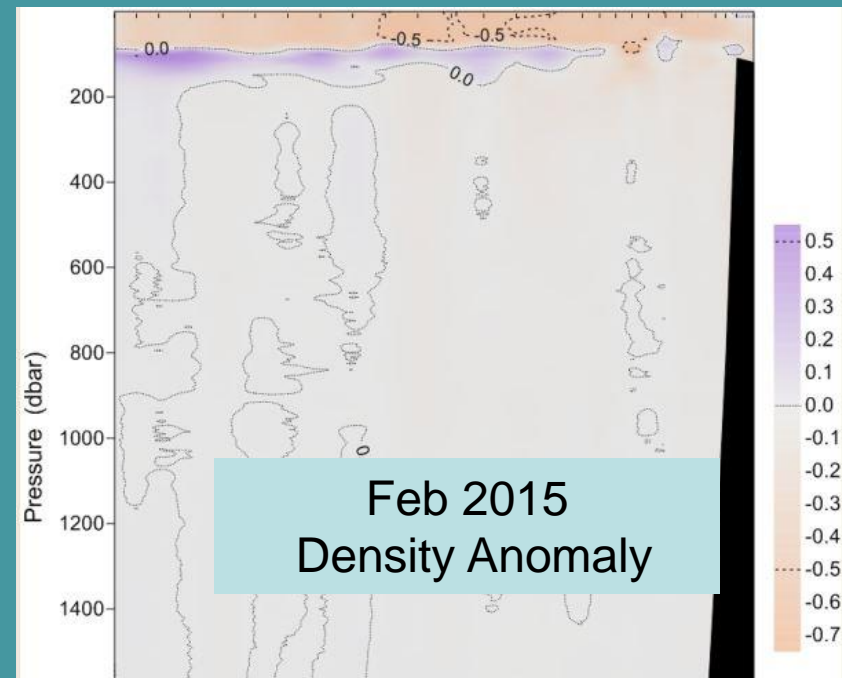
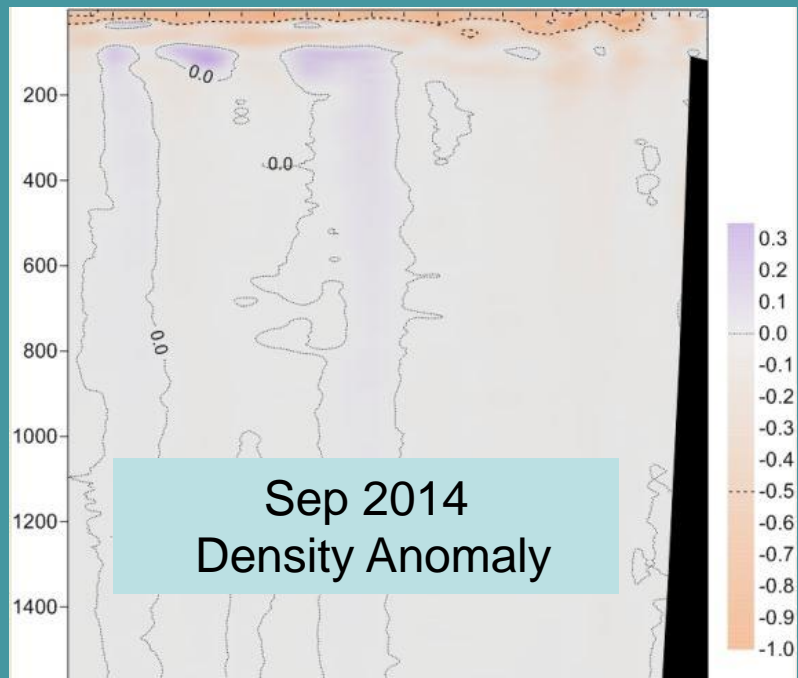
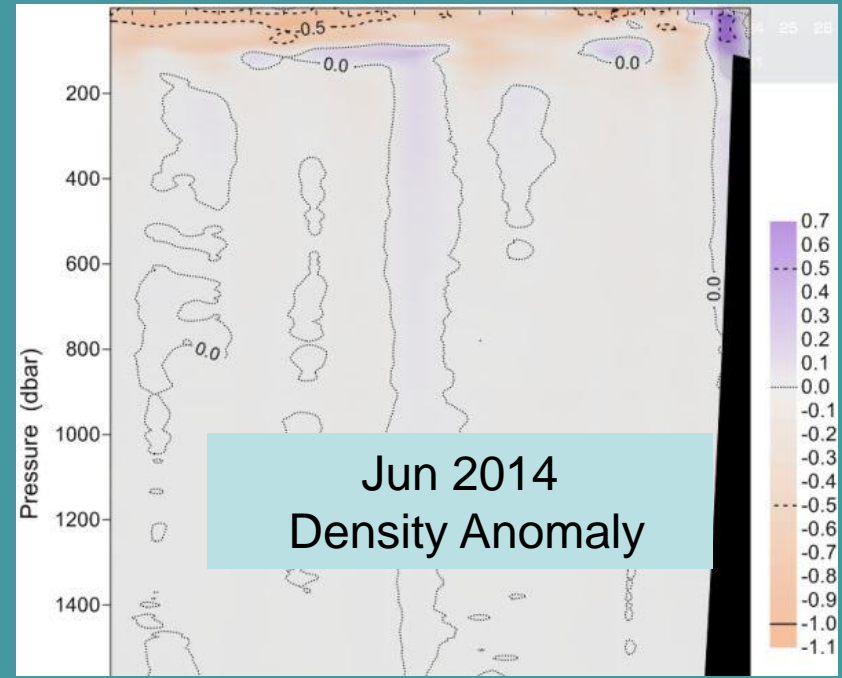
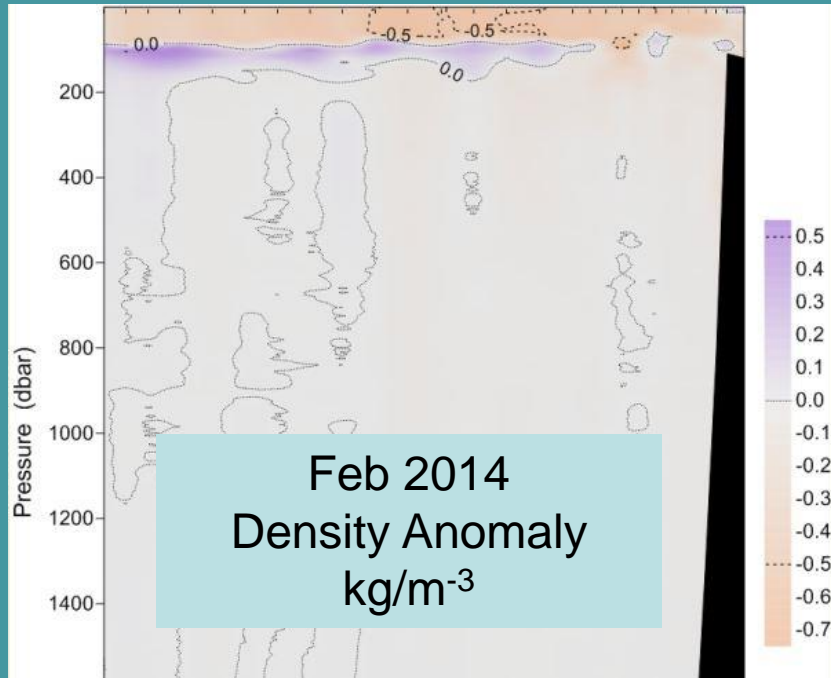
Cruise 2015-01, February 2015

Temperature Anomaly ($^{\circ}\text{C}$ - ITS90) w.r.t. 1981-2010 averages

Cruise 2014-01, February 2014

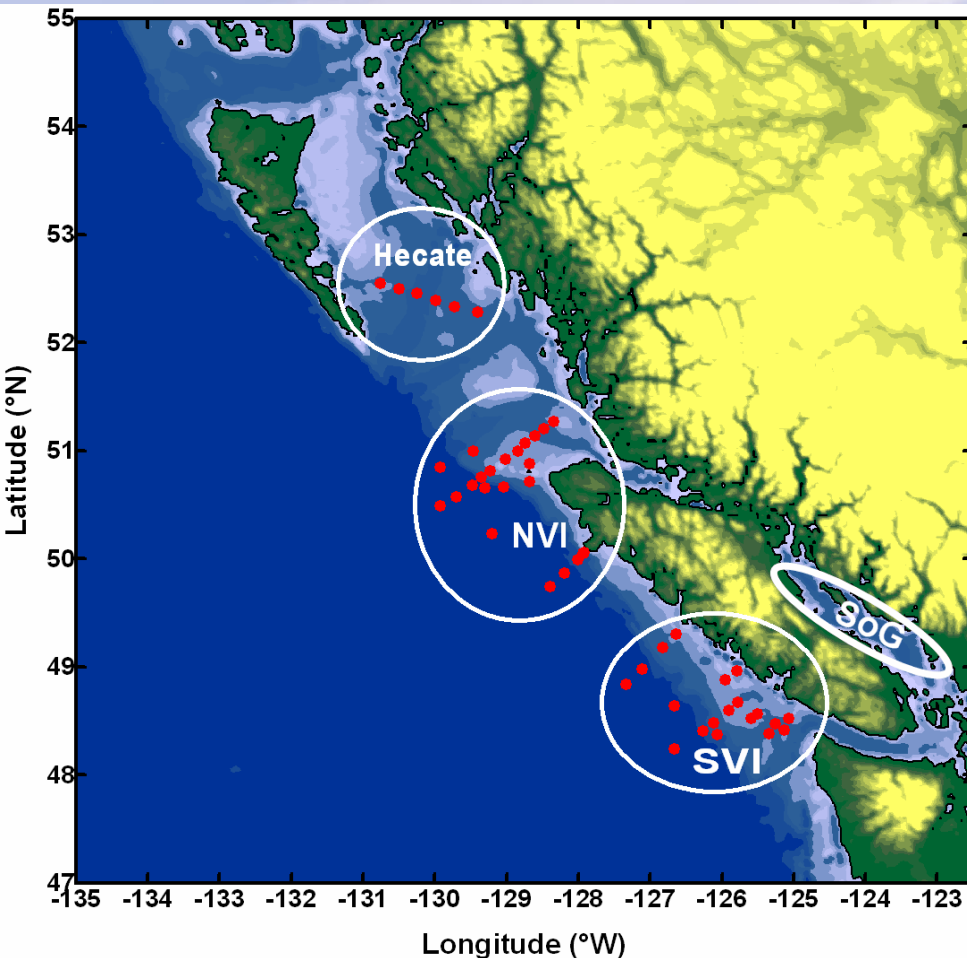






Zooplankton time series

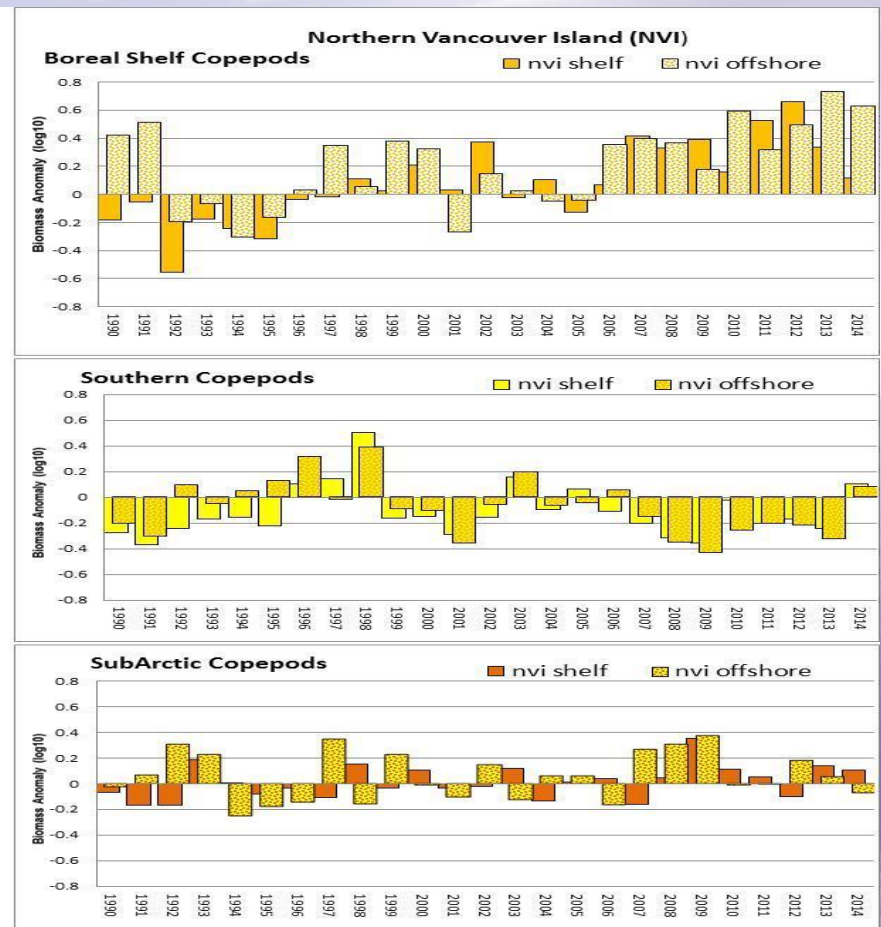
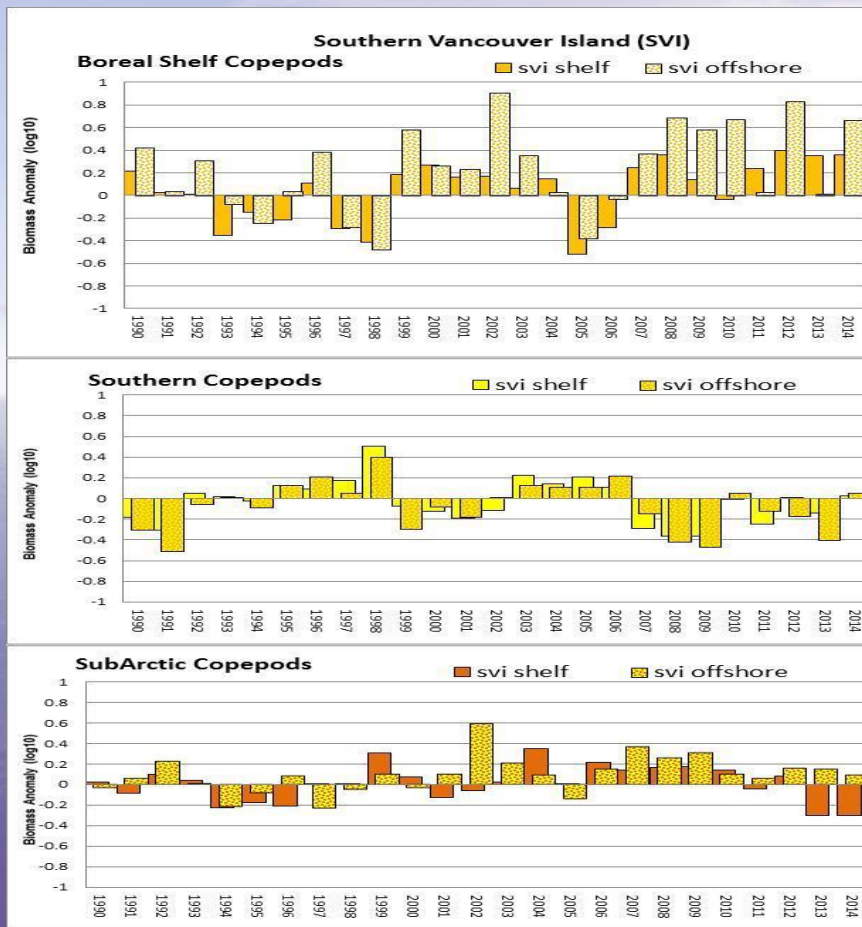
From 1979 for southern Vancouver Island (SVI) , from 1990 for northern Vancouver Island (NVI).



Samples are collected during DFO research surveys using vertical net hauls with black bongo nets (0.25 m² mouth area, 0.23 mm mesh aperture), from near-bottom to sea surface on the continental shelf and upper slope, and from 250 m to surface at deeper locations.

Summarize the interannual variability of multiple species by averaging annual anomalies within species groups. For example:

1. 'southern copepods' is a composite of species from the five genera *Clausocalanus*, *Calocalanus*, *Ctenocalanus*, *Mesocalanus* and *Paracalanus*,
2. 'boreal shelf copepods' is a composite of the copepods *Calanus marshallae*, *Pseudocalanus mimus*, and *Acartia longiremis*,
3. 'subarctic oceanic copepods' is a composite of *Neocalanus plumchrus*, *N. cristatus*, and *Eucalanus bungii*.



Discussion

All lighthouse stations except Bonilla Island were warmer in 2014 than 2013. The average annual increase in SST for all stations was 0.45°C (standard deviation of 0.28°C).

The lighthouse SSTs show a period of cooler than normal water during early 2014 but all stations show sustained positive SST anomalies from late summer 2014 and continuing to the present. The Strait of Georgia stations showed less warming than those on the outer coast.

The wave buoy data also showed a higher mean annual SST in 2014 than in 2013 for all stations except North Hecate (in the same area as the Bonilla lighthouse), and South Moresby (due to the significant negative SST anomalies in the first four months of 2014).

Discussion continued

The furthest offshore wave buoy (139°W) shows an extended period of positive SST anomalies since June 2013.

The February 2015 Line P data show a strong positive SST anomaly in the top 100 m. The coastal band of cooler than normal water seen in 2014 is not evident in 2015. The February 2015 temperature anomaly is more positive than seen in 2014.

The Line P density anomaly shows a continuing surface layer of less dense water; a potential barrier to mixing.

Discussion continued

Zooplankton sampling on the WCVI shows energy-rich northern species in the first half of 2014 replaced by southern copepods later in the year.

Plankton feeding seabirds showed good fledgling success in Spring 2014 but mass mortalities in October by starving (Hipfner et al. SOPO 2105 report, in prep.).

A record high 96% diversion of returning Fraser River sockeye salmon via northern Vancouver Island (LaPointe et al. SOPO 2105 report, in prep.).

Summary

Coastal ocean conditions on the west coast of Canada in 2014 were characterised by negative SST anomalies in early 2014 and positive anomalies since late summer 2104.

All stations in 2015 show a very strong positive SST anomaly, in many locations exceeding historical maximum temperature records.

Changes in SST coincide with changes in zooplankton, pelagic fish, and plankton feeding seabirds.

*Photo: Amphitrite Point
Brian Congdon*

I would like to acknowledge the considerable help provided by:

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- Marie Robert (Line P program)
- Ian Perry (State of the Pacific Ocean)

Thank you