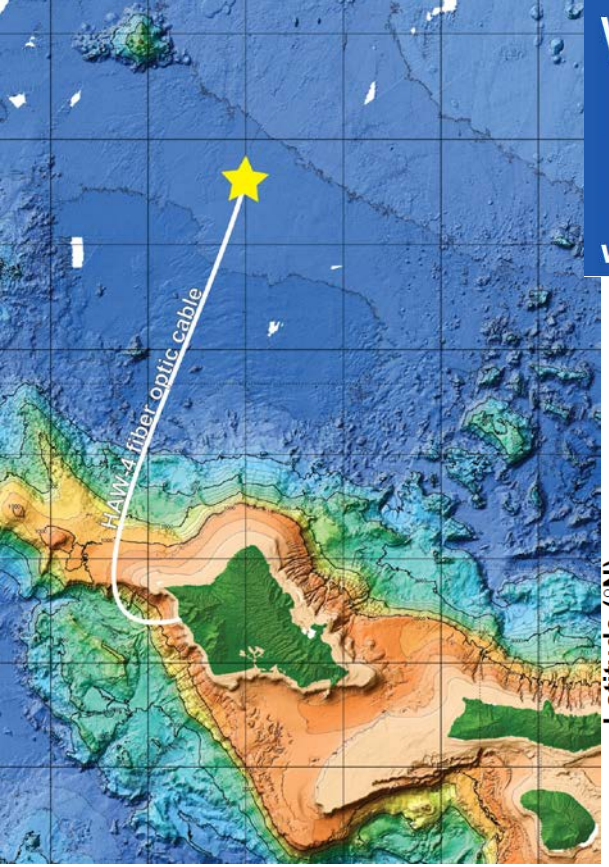
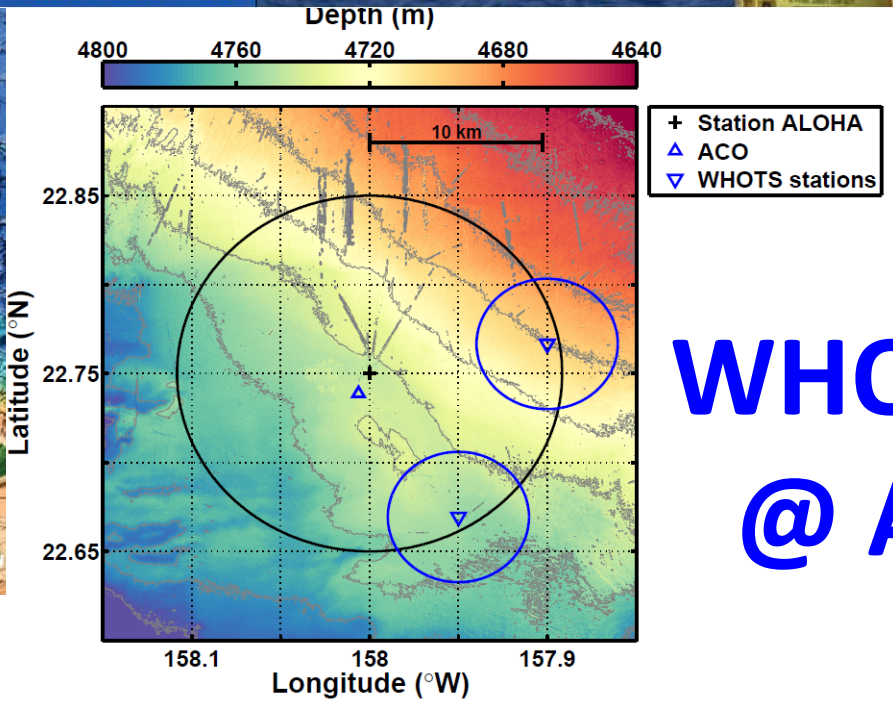


WHOTS

Woods Hole - Hawaii Ocean Time-series Site



WHOTS HOT @ ALOHA

Roger Lukas*, Fernando Santiago-Mandujano*, Robert Weller#, Albert Plueddemann#

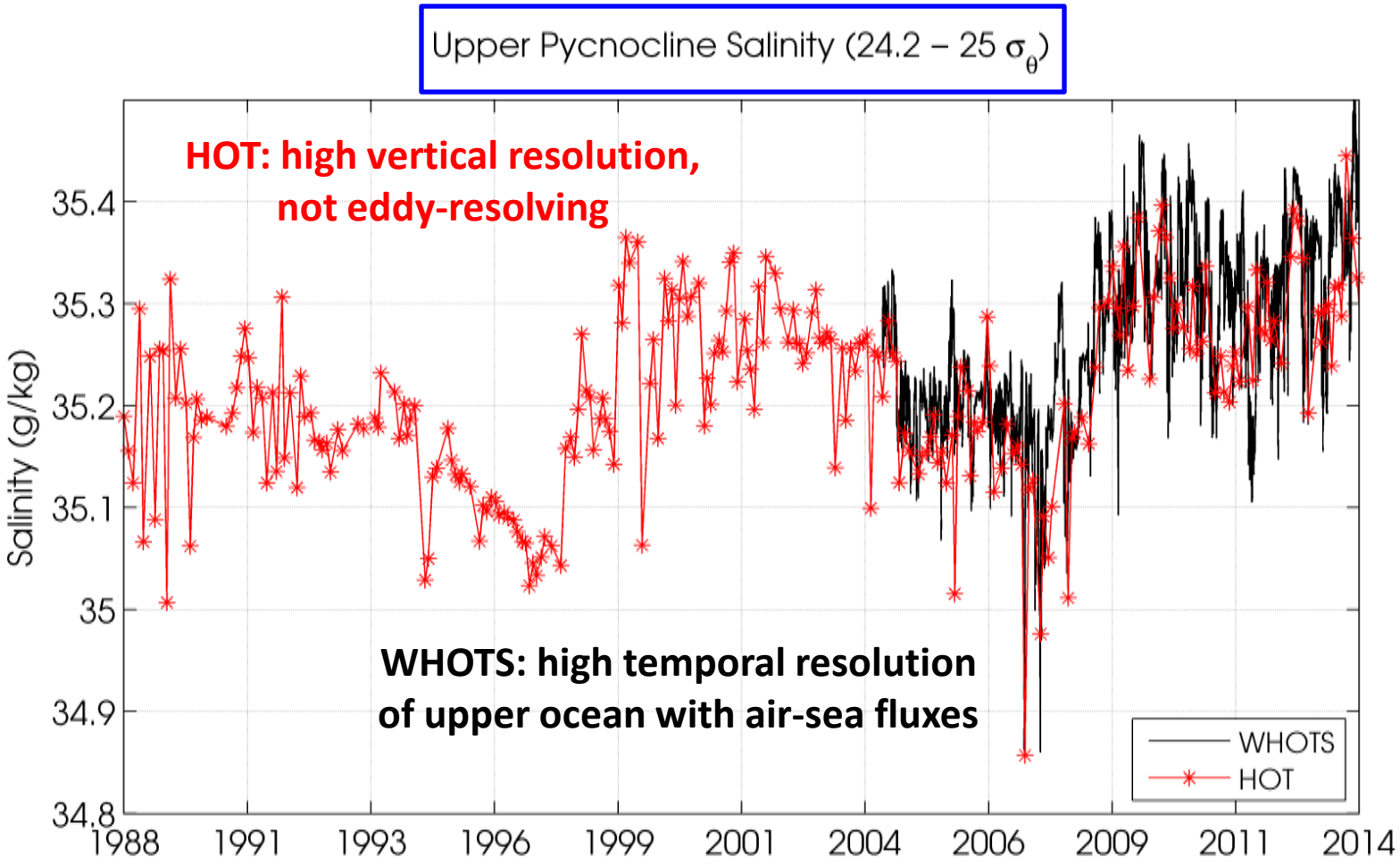
WOODS HOLE OCEANOGRAPHIC INSTITUTION 1930

SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY
UNIVERSITY OF HAWAI'I AT MĀNOA

* SOEST/University of Hawaii
\# Woods Hole Oceanographic Institution

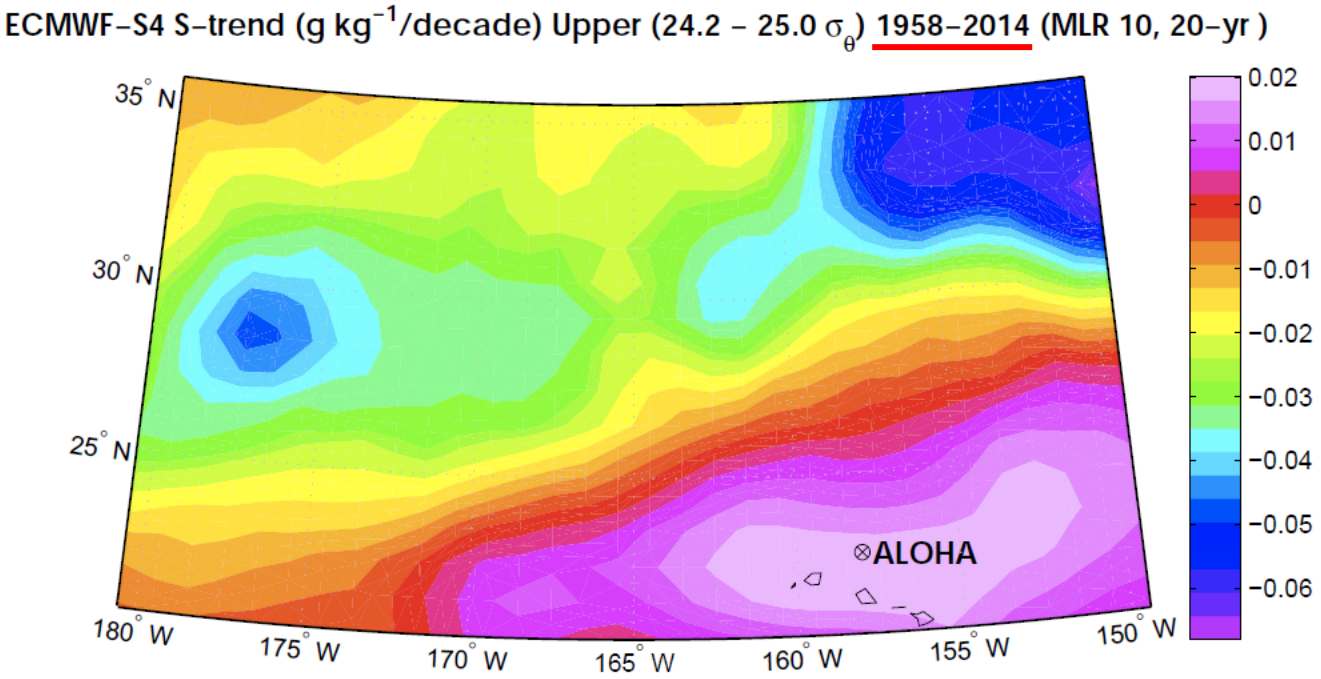
2016 OceanSITES Meeting
Southampton, U.K.

HOT and WHOTS Observations



Obvious salinification trend and quasi-decadal cycles

Understanding Salinity Trends in the Upper Pycnocline

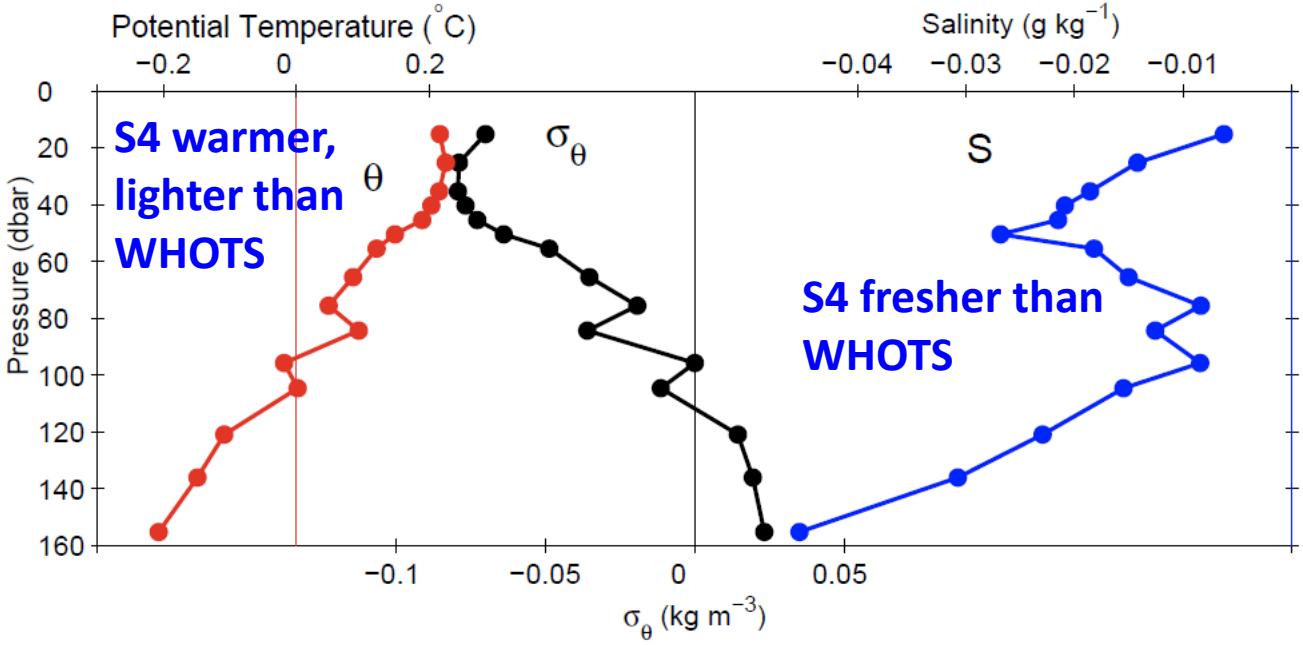


Using ocean reanalysis products, such as ECMWF's ORA-S4, to study major salinity trends in the North Pacific subtropical gyre, a primary question is, "*How good are the reanalysis products?*"

The WHOTS Ocean Reference Station helps to assess this question for the Station ALOHA region.

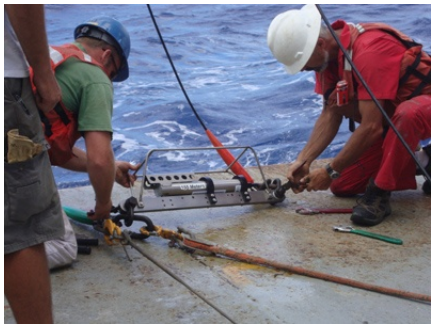
ORA-S4 vs. WHOTS (2004-2014)

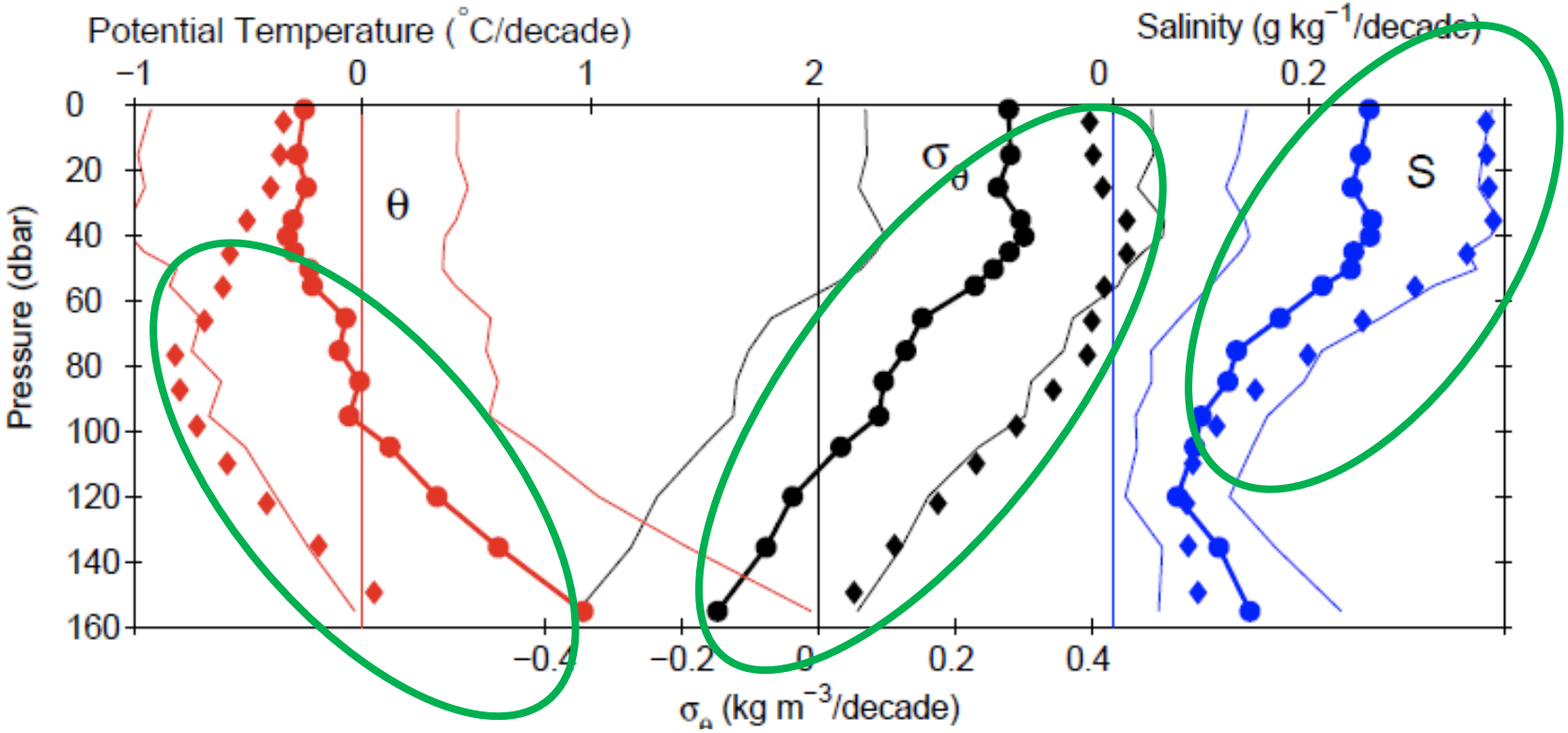
mean differences ORA-S4 - WHOTS



ECMWF ORA is reanalysis through 2010, near-real time analysis after. Considered to be one of the best ocean reanalysis products.

WHOTS Upper Ocean Trends (2004-2014) and ORA-S4

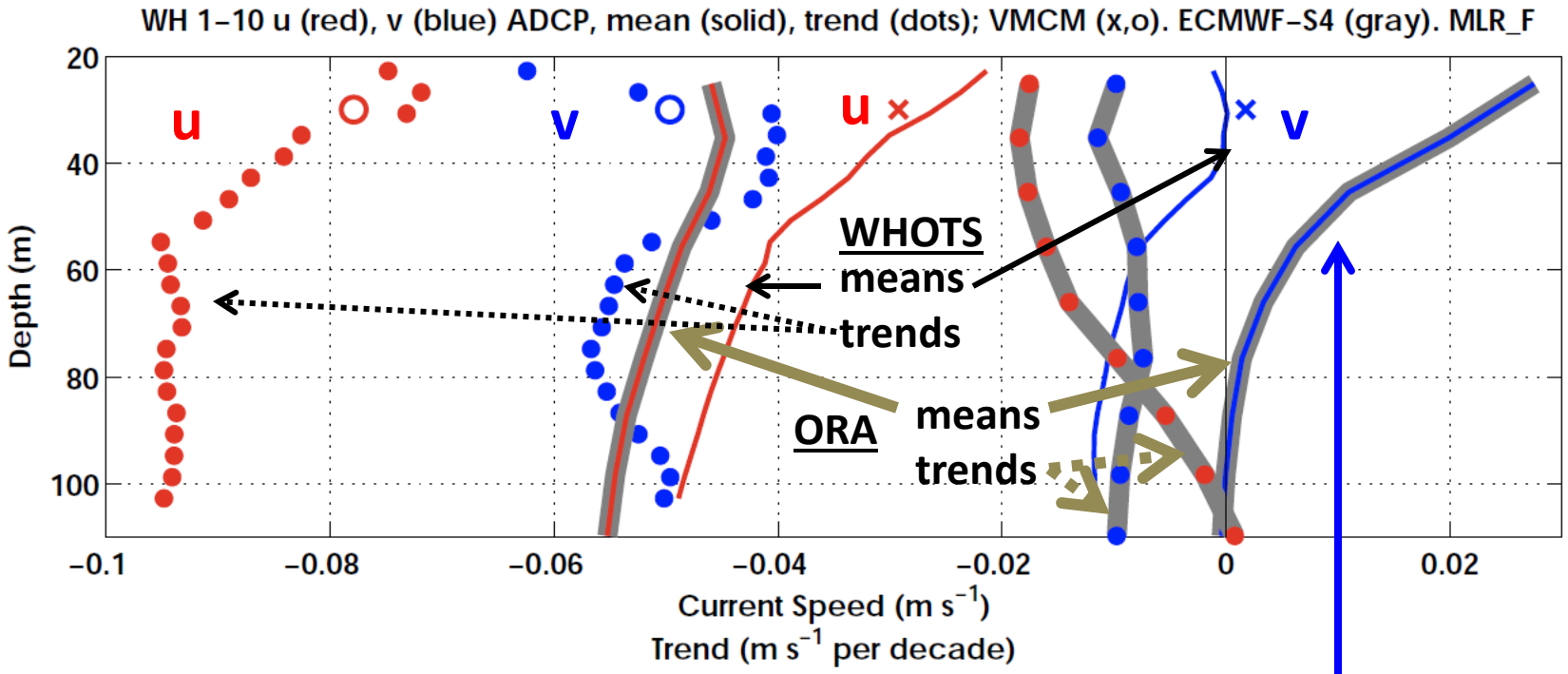




WHOTS 1-10 trends (solid circles) with 95% confidence intervals (light lines)

Diamond are trends from ORA-S4 for Station ALOHA over the same time period.
Salinity trend overestimated in ML; warming trend missed in upper pycnocline.

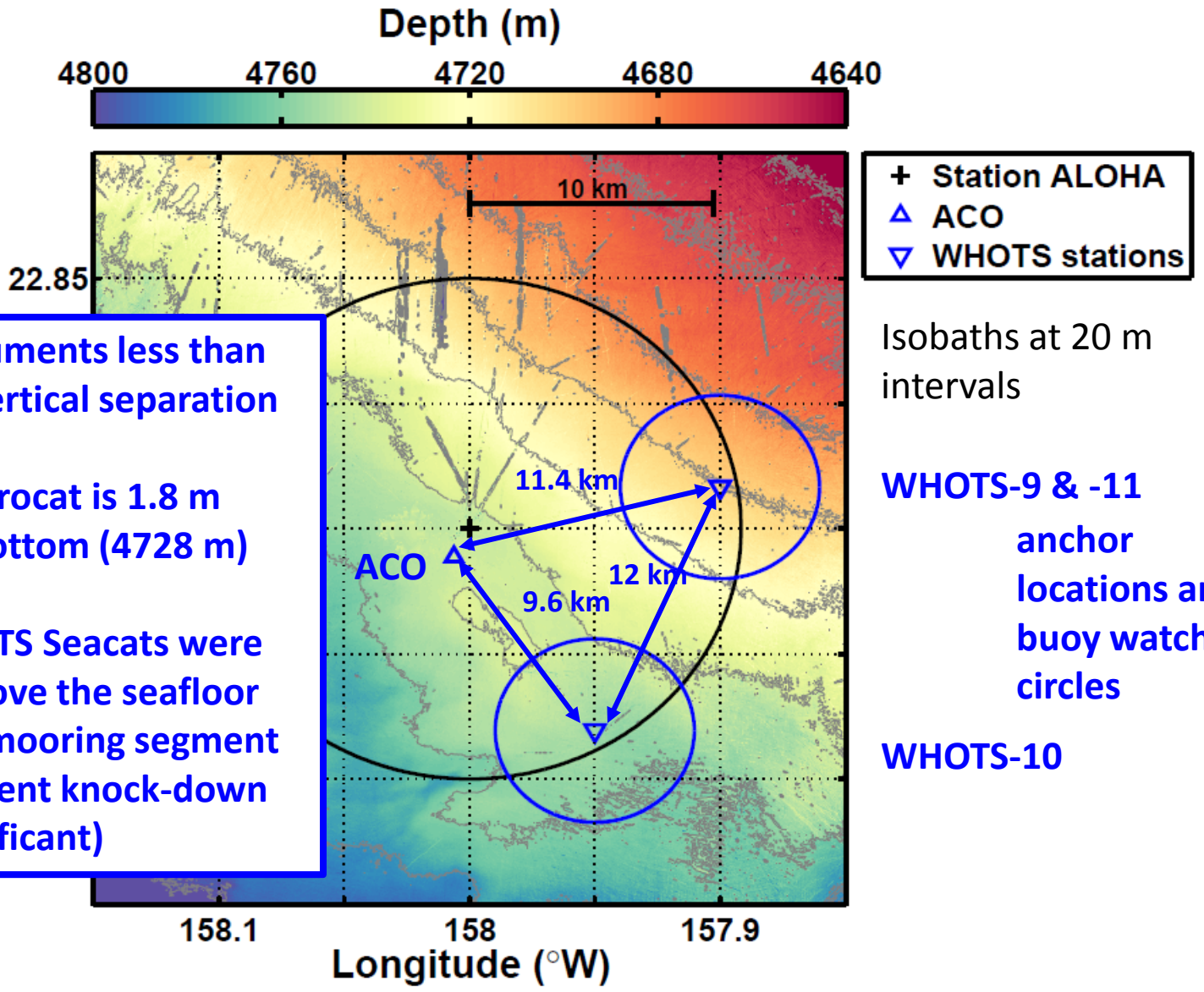
WHOTS vs ORA-S4 Currents



WHOTS current trends are much larger than S4

S4 upper ocean mean flow northward

Switching gears to the “quiet” Abyss



All instruments less than 100 m vertical separation

ACO Microcat is 1.8 m above bottom (4728 m)

All WHOTS Seacats were 37 m above the seafloor on taut mooring segment (instrument knock-down not significant)

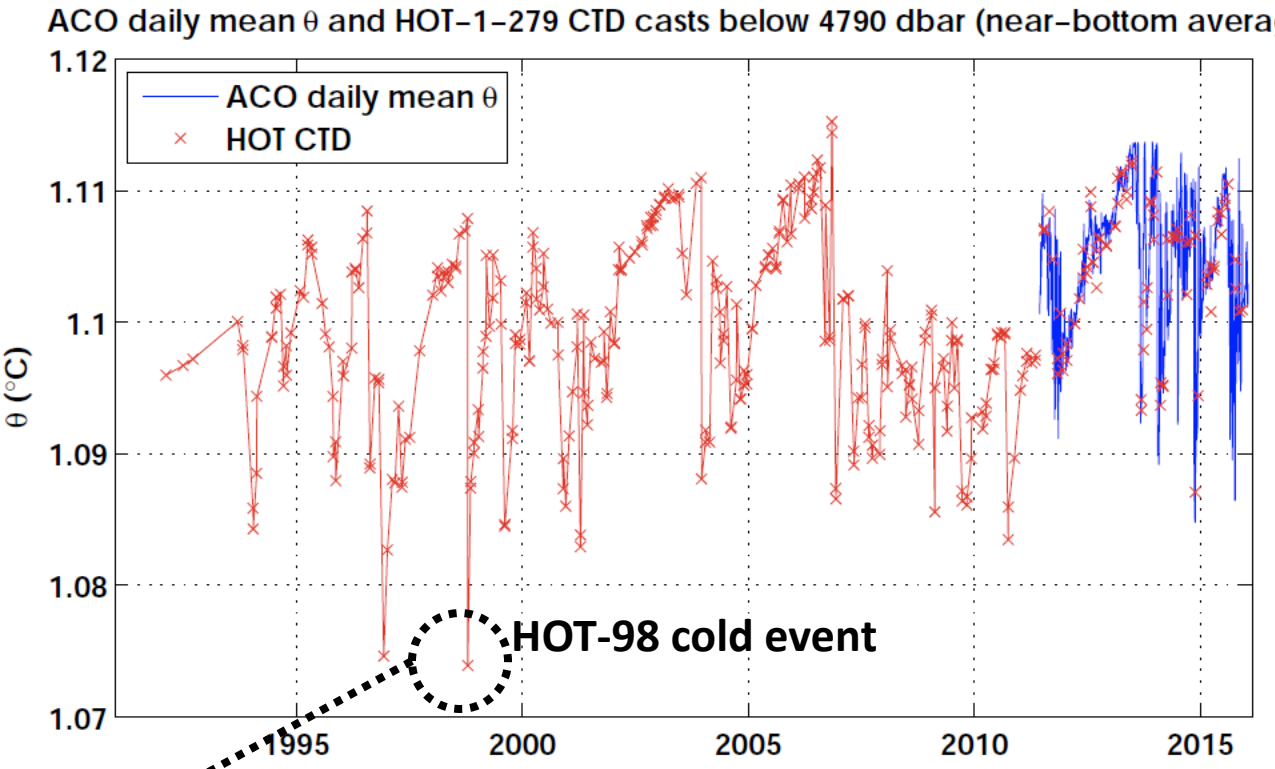
Isobaths at 20 m intervals

WHOTS-9 & -11 anchor locations and buoy watch circles

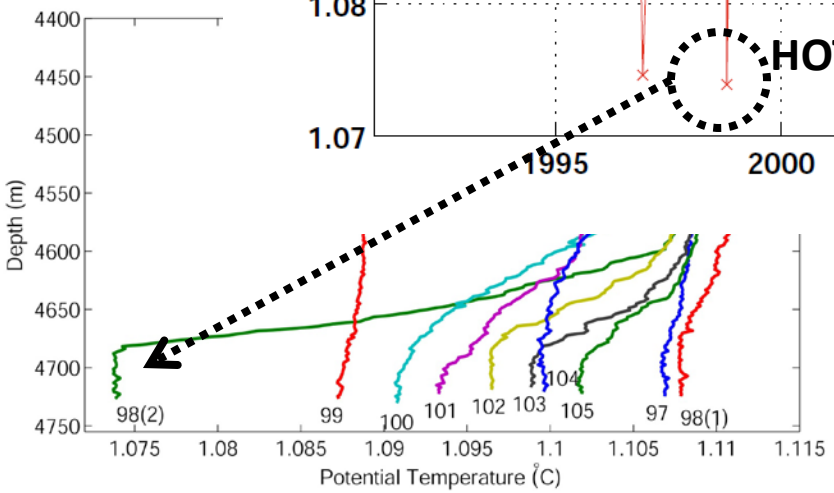
WHOTS-10

History of Cold Bottom Water Events at Station ALOHA

SBE-911+ CTD with SBE-3F T-sensors



SBE-37 Microcat 1.8 m above bottom (4728 m) on the ALOHA Cabled Observatory



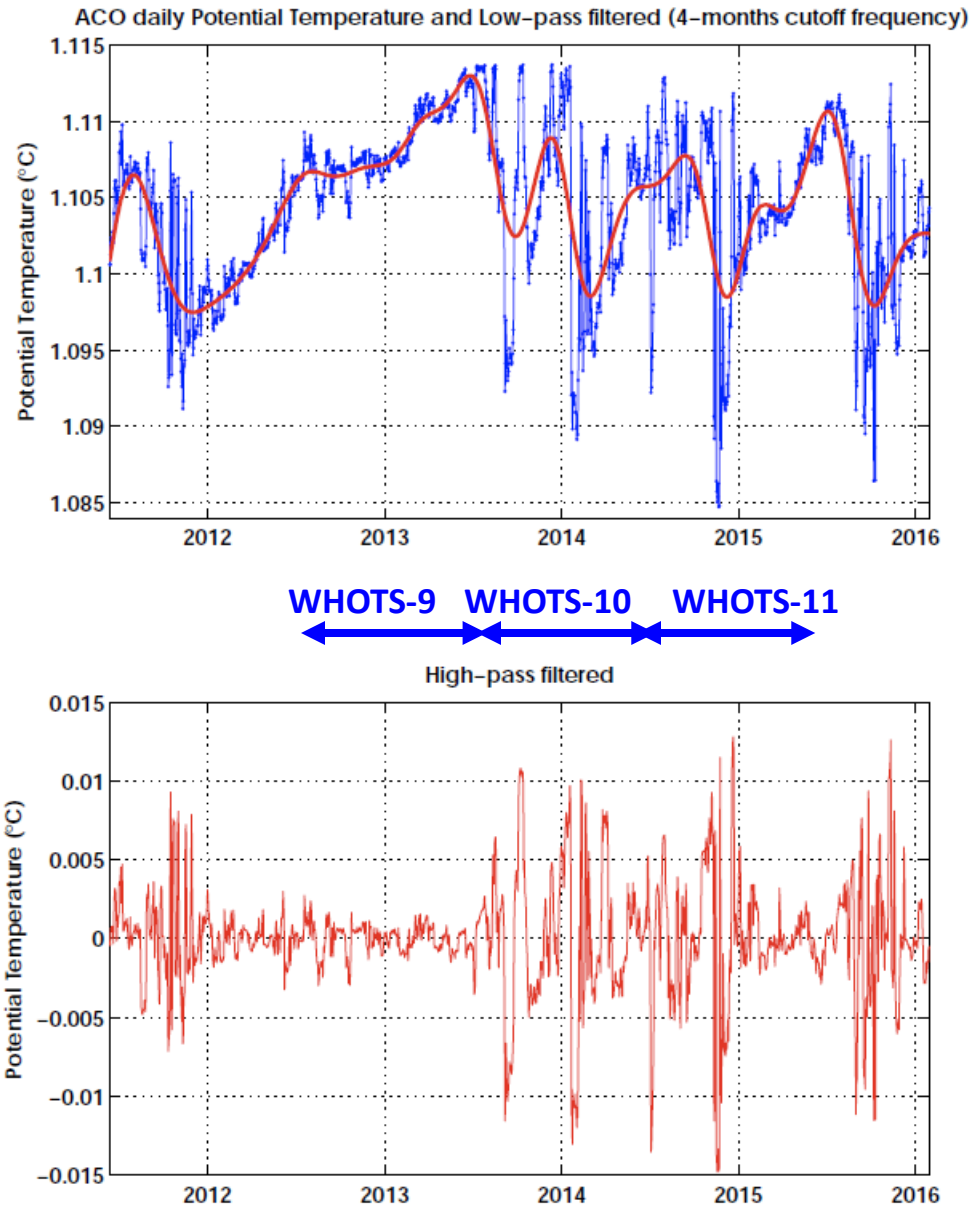
Hawaii Ocean Time-series (Lukas et al., 2001) and ALOHA Cabled Observatory (Alford et al., 2011)

Low-pass filtered (120-day cutoff) ACO signals are 15 mK peak-to-peak

WHOI-Hawaii Ocean Time-series Site moorings with dual SBE-16 Seacats 37 m above bottom

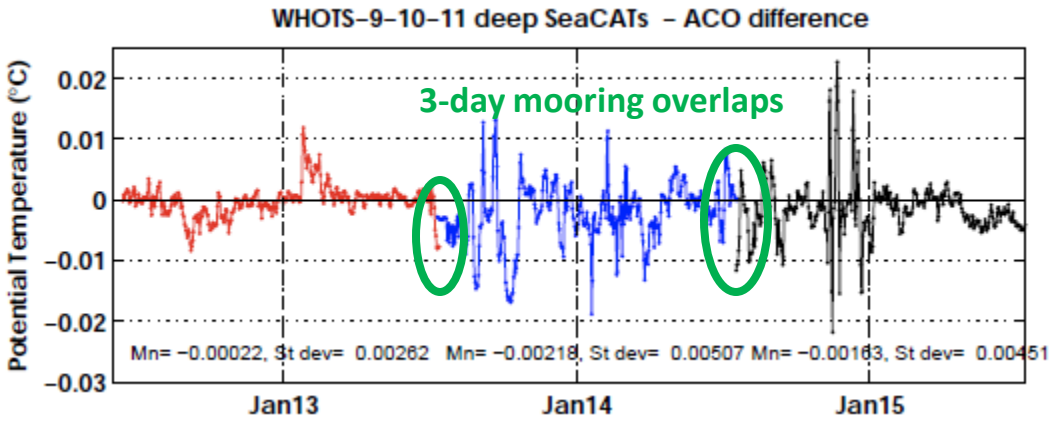
High-passed variability 27.6 mK p-p

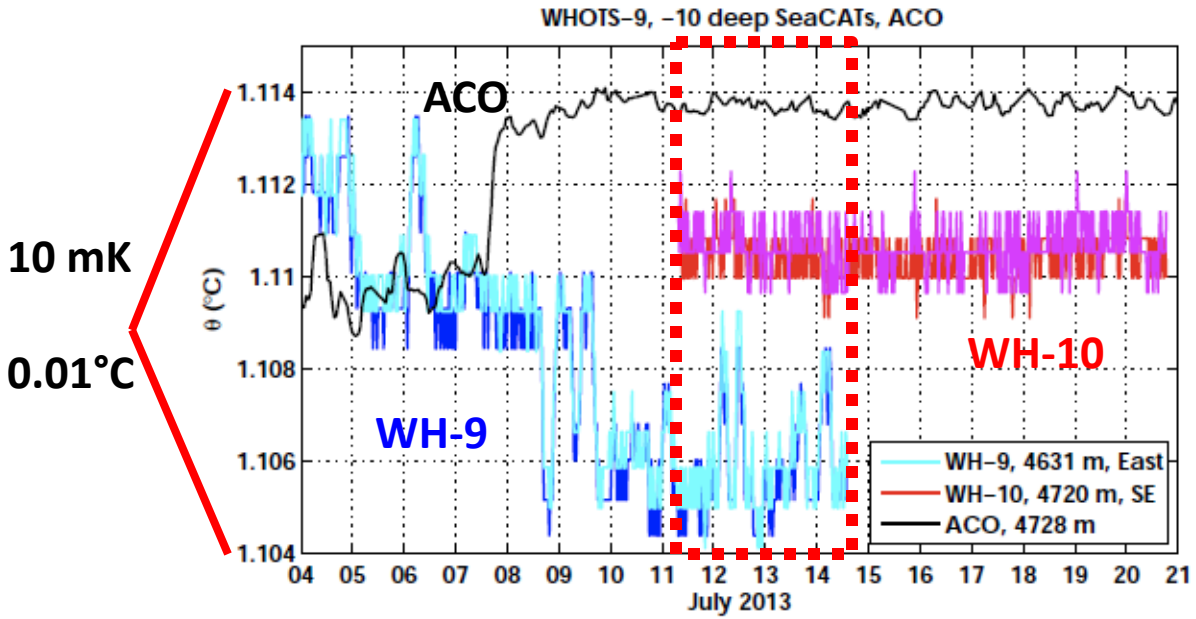
Cold events show increased variance an order of magnitude larger than measurement uncertainty



Three WHOTS mooring deployments each with dual SBE-16 Seacats above anchor releases, 37 m above bottom

Potential temperature differences from ACO reach more than ±0.02°C (20 mK).



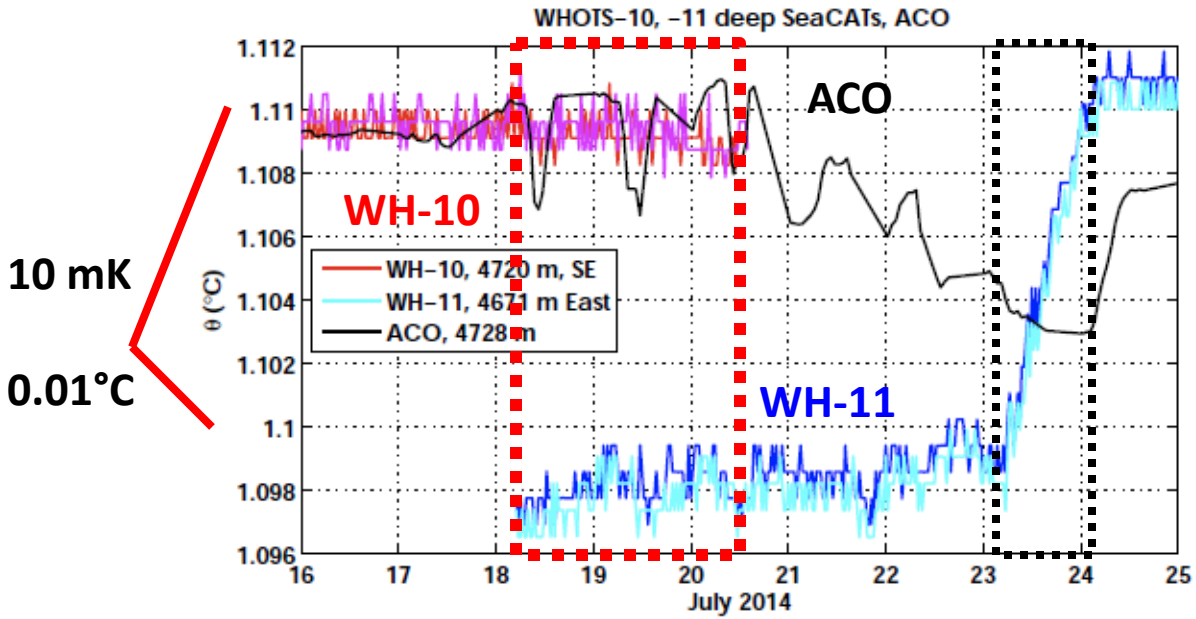


10 mK

0.01°C

Simultaneous θ differences across 10-12 km over three days

WHOTS-ACO differences 0-11 mK, WHOTS colder (9.6-11.4 km separation ~along isobaths)



10 mK

0.01°C

WHOTS-WHOTS differences 2-11 mK (12 km separation across isobaths)

11 mK warming in one day at WH-11

WHOTS-ACO
Potential Temperature Differences

WHOTS-ACO	WHOTS-9	WHOTS-10	WHOTS-11
Mean Δ	-0.22 mK	**-2.18 mK**	**-1.63 mK**
RMS Δ	**2.62 mK**	**5.07 mK**	**4.51 mK**

All instruments near bottom, with vertical separation < 100 m

~one-year mooring deployments

Mean θ differences from ACO highly significant for WHOTS-10 and -11, with WHOTS sites to east and southeast of ACO colder

Magnitude and variability of WHOTS-ACO θ differences changed markedly between WHOTS-9 and subsequent period

WHOTS-ACO Δθ Summary

RMS ACO-WHOTS simultaneous differences ~5 mK during 2014-2015 (~10 km separation)

Implications for designing abyssal ocean monitoring system for climate

One-year mean θ differences over 10 km are real and significant;

WHOTS colder than ACO is consistent with bottom water source to east — the Maui Deep

Simultaneous WHOTS-ACO differences exceed 1 mK/km over several days

Strong near-bottom baroclinic pressure gradients

Such non-tidal dynamics are likely occurring at many other locations along abyssal circulation pathways!

Funding

WHOTS is a collaborative effort between the Woods Hole Oceanographic Institution and the University of Hawaii at Station ALOHA, including significant institutional contributions

The WHOTS mooring and surface buoy are part of the Ocean Reference Station network funded by the U.S. National Oceanic and Atmospheric Administration

The U.S. National Science Foundation funds the Hawaii Ocean Time-series (including the WHOTS subsurface instrumentation) and the ALOHA Cabled Observatory at Station ALOHA