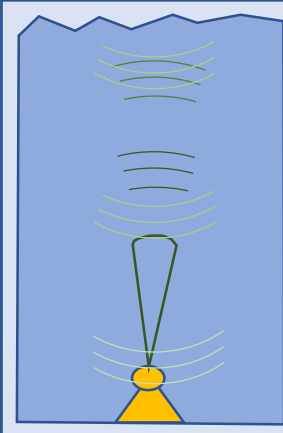


Can PIES (Pressure Inverted Echo Sounders) replace tall moorings to monitor the AMOC?

BEN MOAT¹, ELEANOR FRAJKA-WILLIAMS¹, JOANNE WILLIAMS², CHRIS MEINAN³. joll@noc.ac.uk

¹National Oceanography Centre, Southampton, UK; ²National Oceanography Centre, Liverpool, UK; ³NOAA, US

1/5

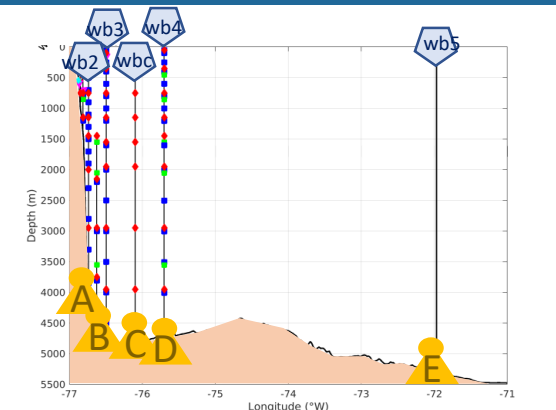
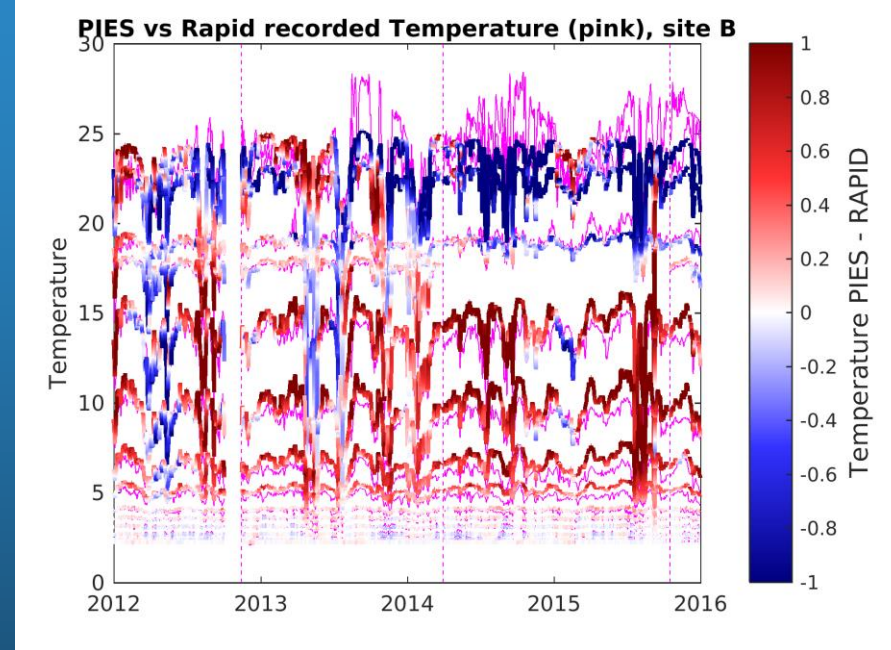
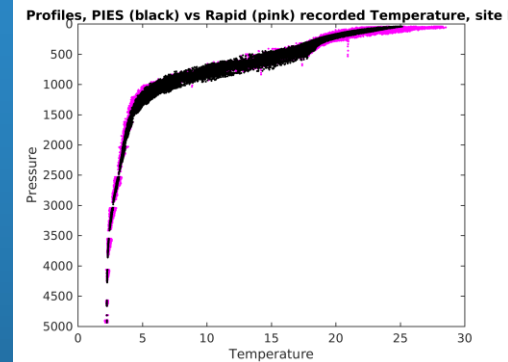


PIES: How it works in theory

Inverted Echo Sounder on the sea bed.
Travel time depends on depth and water properties.

Correct for depth (Pressure) to find average water properties.
With enough data about typical profiles (Gravest Empirical Modes), deduce the likely temperature and salinity profile

Eg Meinan et al 2004 DSR 151.



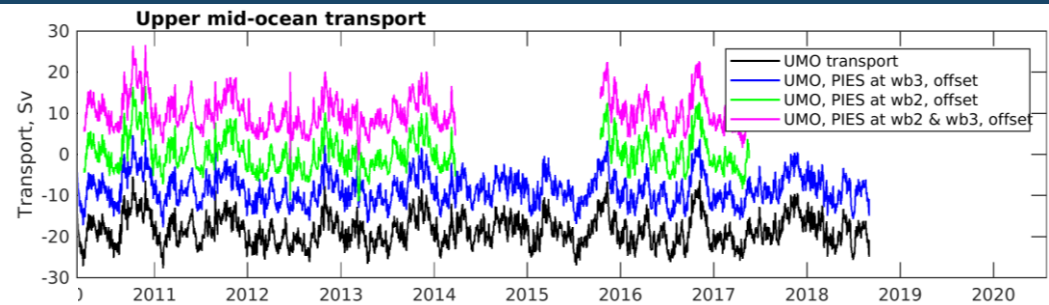
Layout of RAPID moorings and PIES
on Atlantic Western Boundary

Thanks to David Smeed

Existing data to test
PIES records overlap
with Rapid moorings
and CTD data. Can we
reproduce the
profiles?

Pessimist's view:

PIES-derived
temperature profiles
have consistent long
term biases we don't
understand.



Optimist's view:

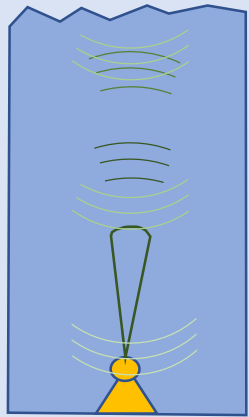
Substituting PIES-derived
temperatures for mooring data at
WB2 and WB3 has only small effect
on the Upper Mid Ocean transport.

Can PIES (Pressure Inverted Echo Sounders) replace tall moorings to monitor the AMOC?

BEN MOAT¹, ELEANOR FRAJKA-WILLIAMS¹, JOANNE WILLIAMS², CHRIS MEINAN³. joll@noc.ac.uk

¹National Oceanography Centre, Southampton, UK; ²National Oceanography Centre, Liverpool, UK; ³NOAA, US

2/5



PIES: How it works in theory

- Inverted Echo Sounder on the sea bed. Travel time depends on depth and water properties.
- By correcting for depth (Pressure) we find average water properties.
- With enough data about typical profiles (Gravest Empirical Modes) we can deduce the likely temperature and salinity profile

Eg Meinan et al 2004 DSR 151.

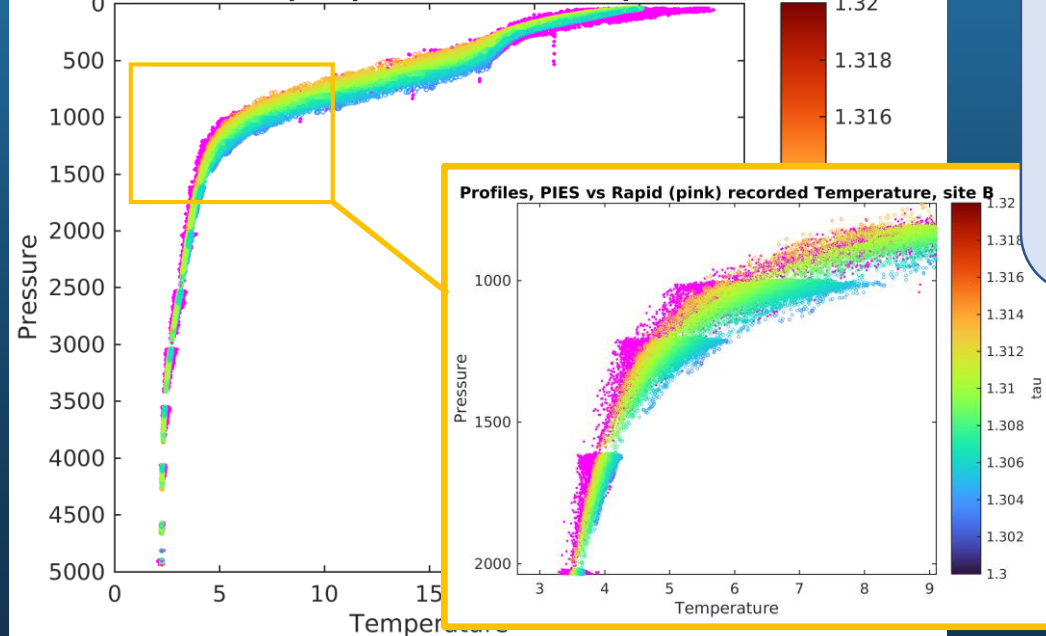
Problem

- The same travel time can be due to different combinations of temperature. What if we choose the wrong profile?
- What if water mass properties fundamentally change? How do we know we're still using the right profiles?

Profile selection

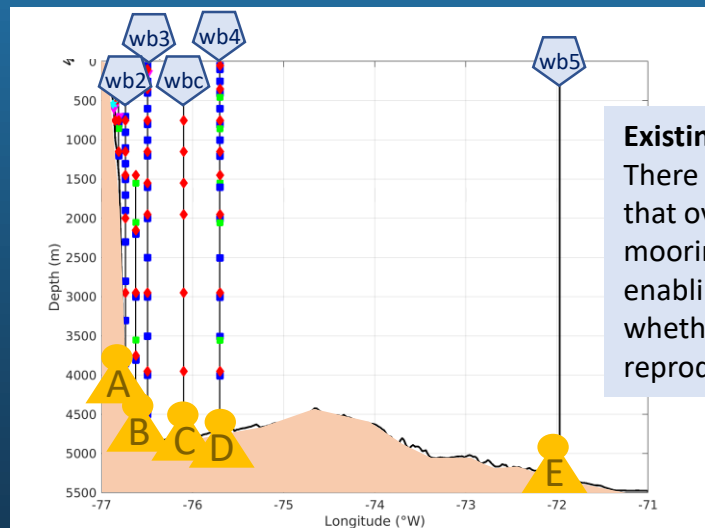
PIES-derived temperature profiles are coloured according to tau, pressure-corrected travel time. Profiles from equivalent Rapid moorings are shown in pink.

Profiles, PIES vs Rapid (pink) recorded Temperature, site B



Pessimist's view:

PIES-derived temperature profiles have biases we don't understand.



Layout of RAPID moorings and PIES on Atlantic Western Boundary

Thanks to David Smeed

Existing data to test

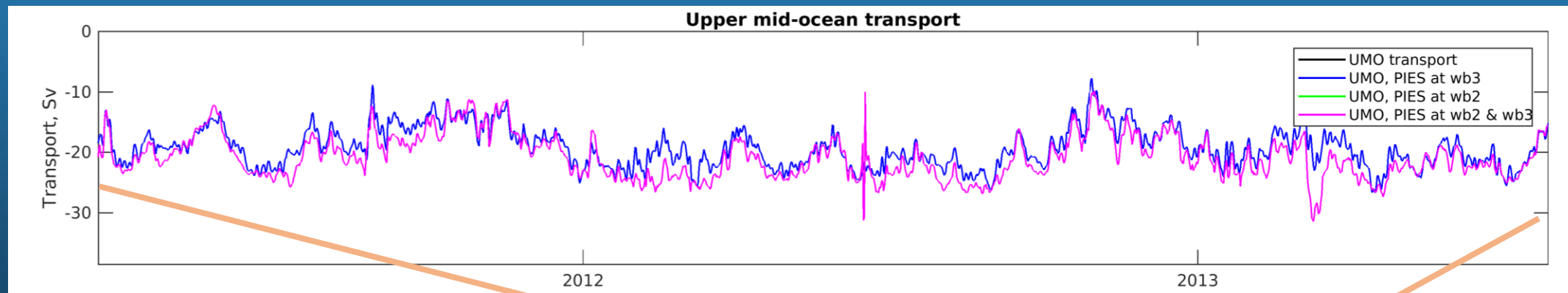
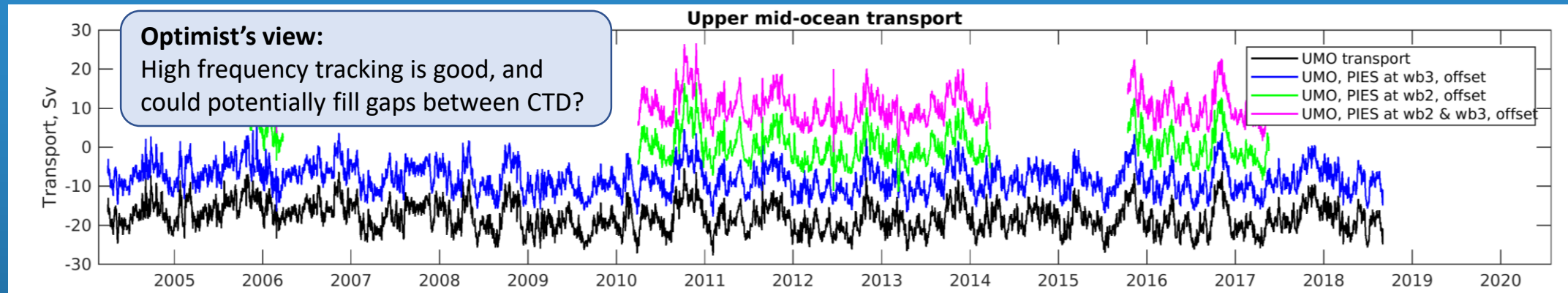
There are PIES records that overlap with Rapid moorings and CTD data, enabling us to test whether we can reproduce the profiles.

Can PIES (Pressure Inverted Echo Sounders) replace tall moorings to monitor the AMOC?

BEN MOAT¹, ELEANOR FRAJKA-WILLIAMS¹, JOANNE WILLIAMS², CHRIS MEINAN³. joll@noc.ac.uk

¹National Oceanography Centre, Southampton, UK; ²National Oceanography Centre, Liverpool, UK; ³NOAA, US

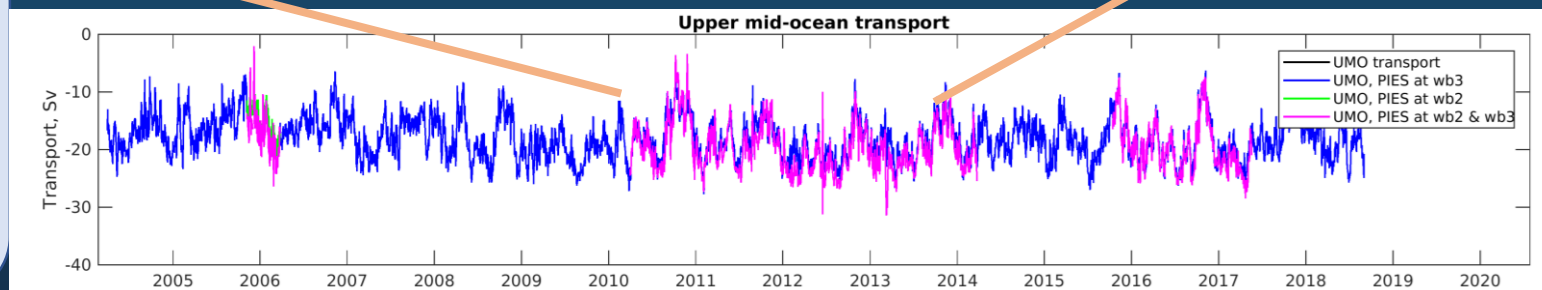
3/5



Optimist's view:

If we substitute PIES-derived temperatures for mooring data at WB2 and WB3, it has only small effect on the Upper Mid Ocean transport.

Note: WB3 is only used for a short period of the calculation



Can PIES (Pressure Inverted Echo Sounders) replace tall moorings to monitor the AMOC?

BEN MOAT¹, ELEANOR FRAJKA-WILLIAMS¹, JOANNE WILLIAMS², CHRIS MEINAN³. joll@noc.ac.uk

¹National Oceanography Centre, Southampton, UK; ²National Oceanography Centre, Liverpool, UK; ³NOAA, US

4/5

Timeseries of RAPID mooring measurements (pink).

- As the mooring moves, the instruments change depth, contributing to temperature variability.

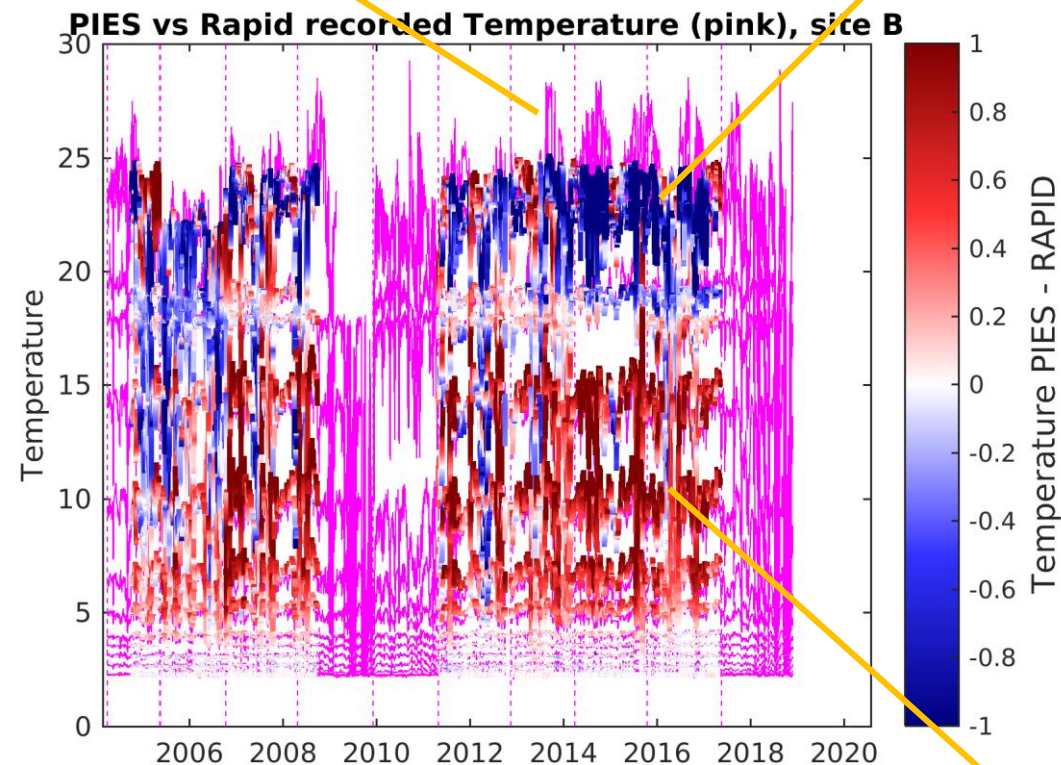
PIES-derived temperatures are shown at the same depths as each mooring instrument, **coloured by the difference to the RAPID** result in each case.

- Red: PIES estimate is warmer than RAPID
- Blue: PIES estimate is cooler than RAPID

- At B/WB3 there is a consistent difference in the profiles. The upper part is biased cool, and below is biased warm. In deep water there's little absolute bias.
- The exception is mid-2012, where the whole column has a cool bias on the PIES relative to Rapid.
- At A2/WB2 there is a similar pattern, with cool bias in the upper ocean, and warm below.

Surface seasonality not tracked

PIES too cool



Pessimist's view:

PIES-derived temperature profiles have consistent long term biases we don't understand.

PIES too warm

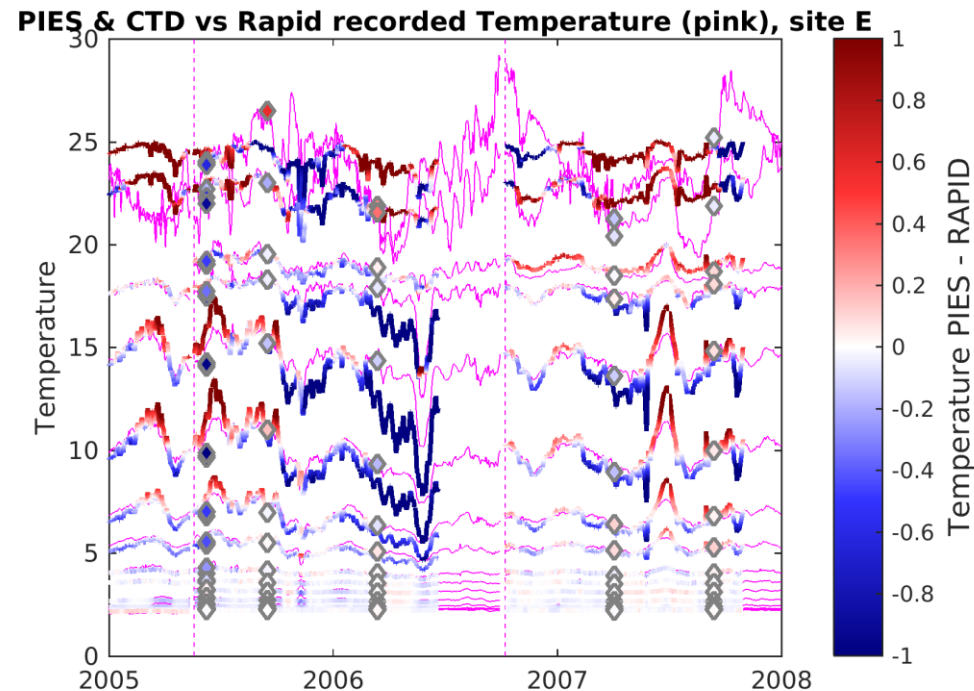
Can PIES (Pressure Inverted Echo Sounders) replace tall moorings to monitor the AMOC?

BEN MOAT¹, ELEANOR FRAJKA-WILLIAMS¹, JOANNE WILLIAMS², CHRIS MEINAN³. joll@noc.ac.uk

¹National Oceanography Centre, Southampton, UK; ²National Oceanography Centre, Liverpool, UK; ³NOAA, US

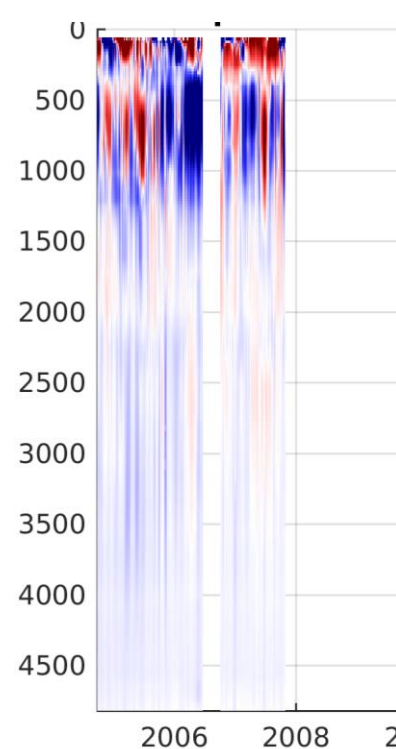
5/5

- At E/WB5 bias related to the depths of the mooring?
- Mooring is lower in the water -> the PIES says it's cooler.
- Mooring is higher in the water -> the PIES says it's warmer.
- The difference persists between Rapid deployments, and even onto the second PIES deployment. So it is not instrumental.
- Could the GEM field be based on samples too far away?

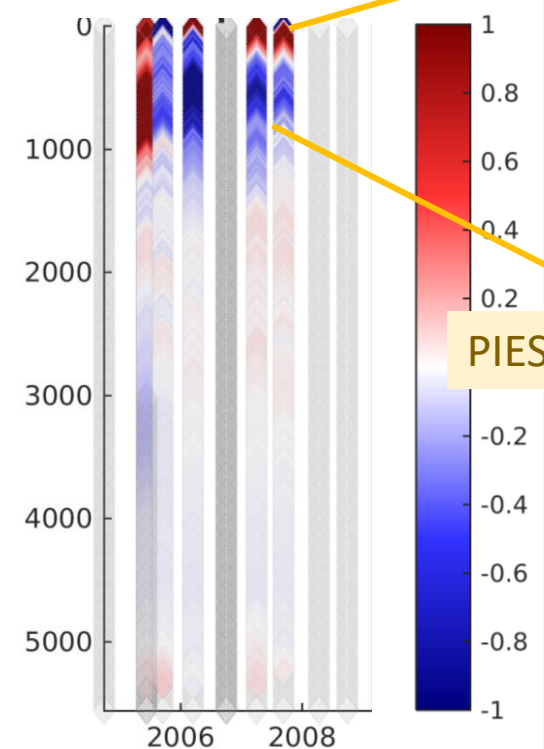


Temperature differences

PIES - mooring



PIES - CTD



PIES too warm

PIES too cool

Pessimist's view

PIES – derived temperature profiles have consistent long term biases we don't understand.

We see the same patterns comparing PIES with CTD as with the Rapid moorings – so we know it's an issue with the PIES estimate, not RAPID.