Argo salinity data: Bias and Uncertainty

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OceanPredict

Joint Workshop OS-Eval/CP/SynObs
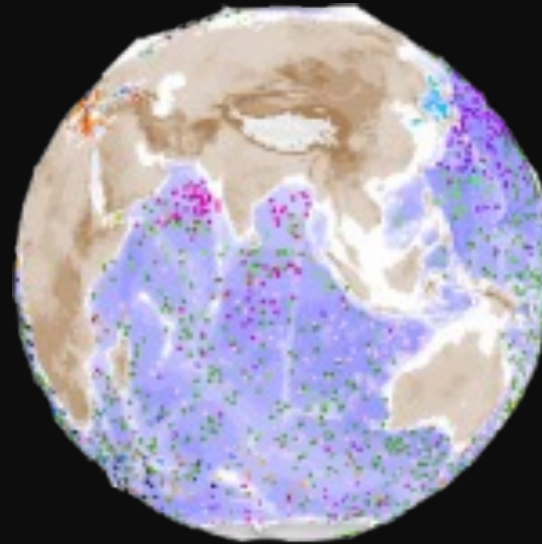
17th November, 2022, Japan

(remote presentation)

Argo's aim is to provide global sampling of subsurface ocean variables by using autonomous profiling floats.

Unfortunately the raw data can contain bias from various instrument problems.

Once a float is deployed, there are not many opportunities to retrieve it for re-calibration.
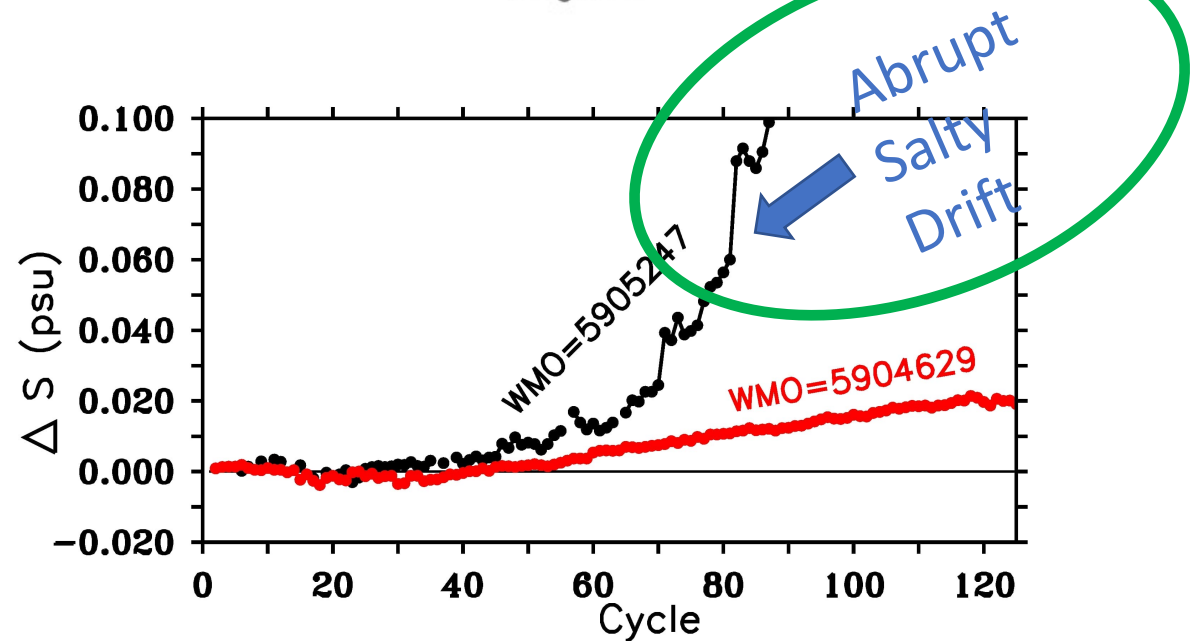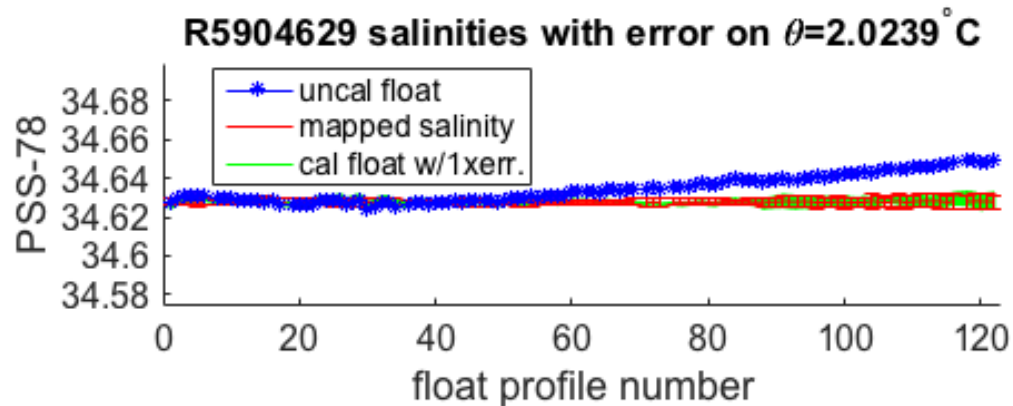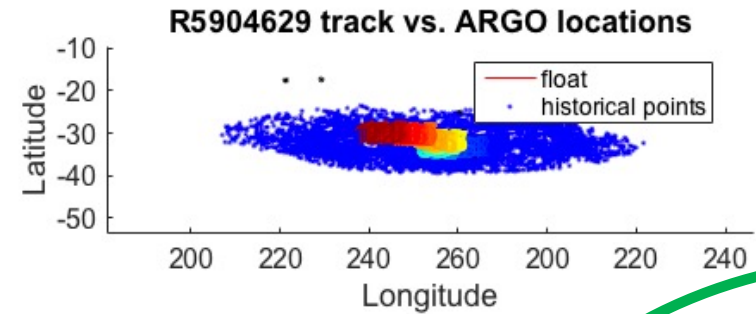
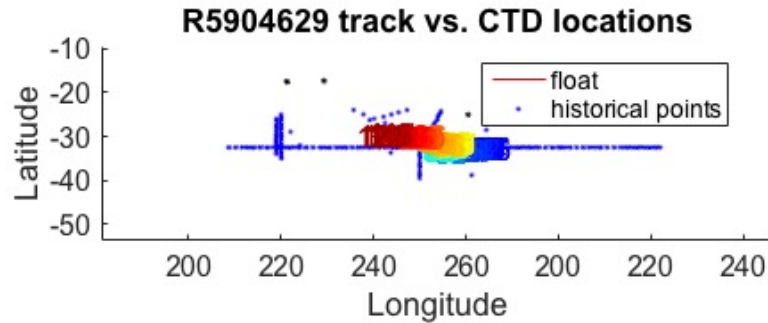# How to estimate float CTD data bias and uncertainty?

1. **CTD checks prior to deployment**

2. **Monitor long-term sensor stability in delayed-mode**

3. **Comparisons with independent shipboard data**

1. CTD checks *prior to* deployment

- Manufacturer-quoted initial accuracies for the SBE-41/41CP CTD are 2.4 dbar for pressure, 0.002°C for temperature, and 0.0035 PSS-78 for salinity.

- Some float groups perform independent CTD accuracy checks to ensure sensor calibrations are within specification before deployment.

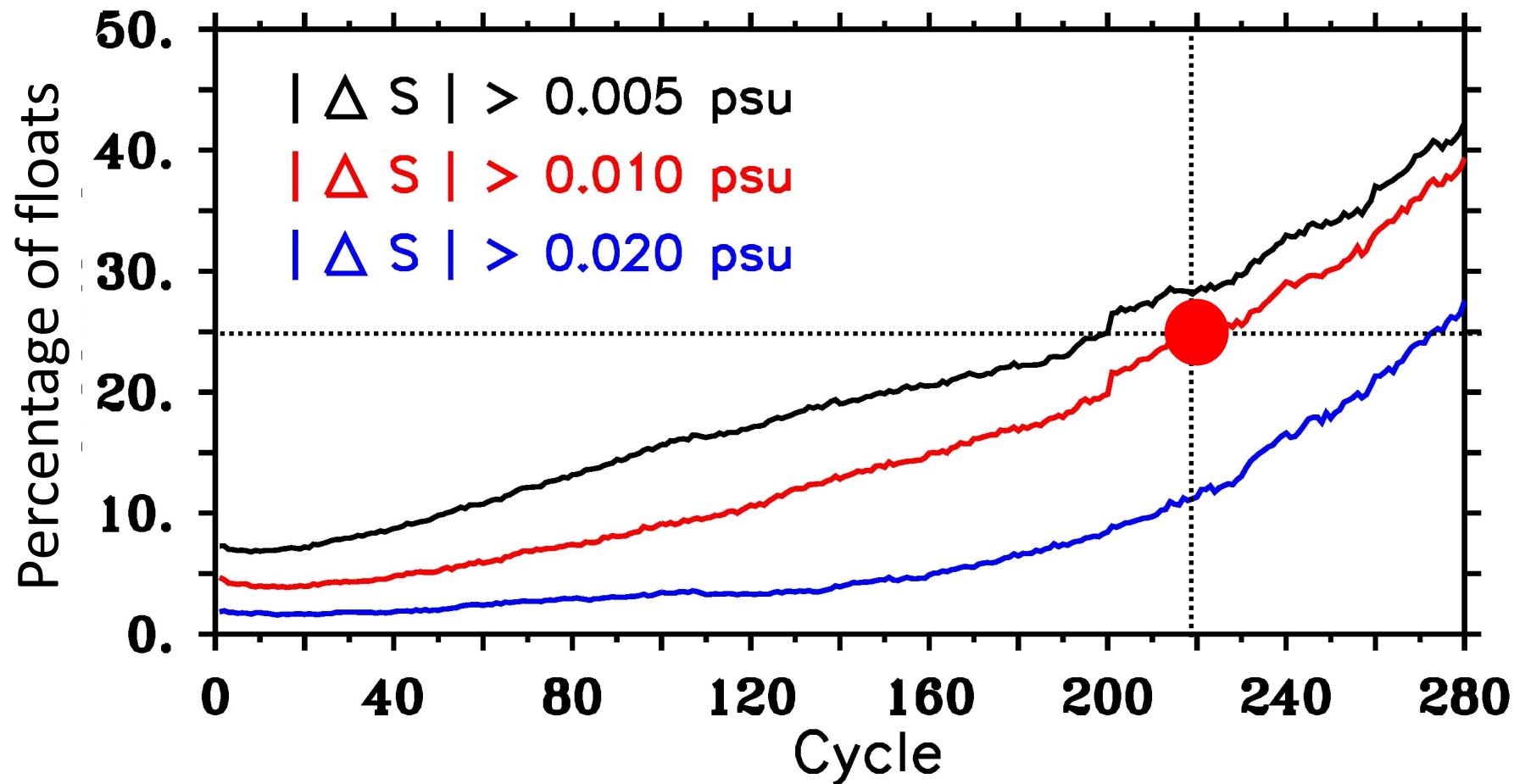- CTDs that fail the checks are returned to the manufacturer for recalibration.

2. A delayed-mode system that compares float salinity to nearby reference data to check for salinity bias *after* deployment
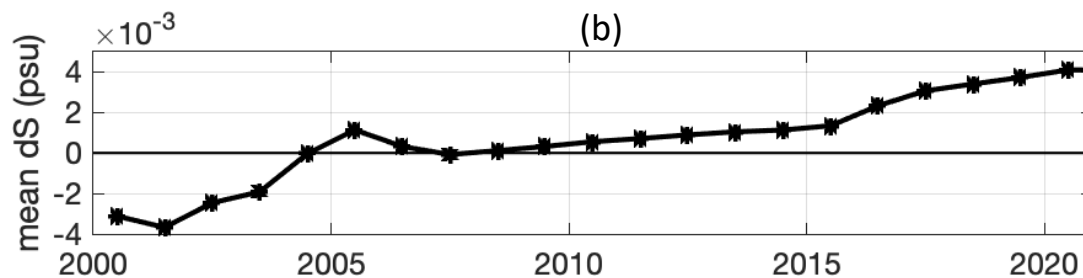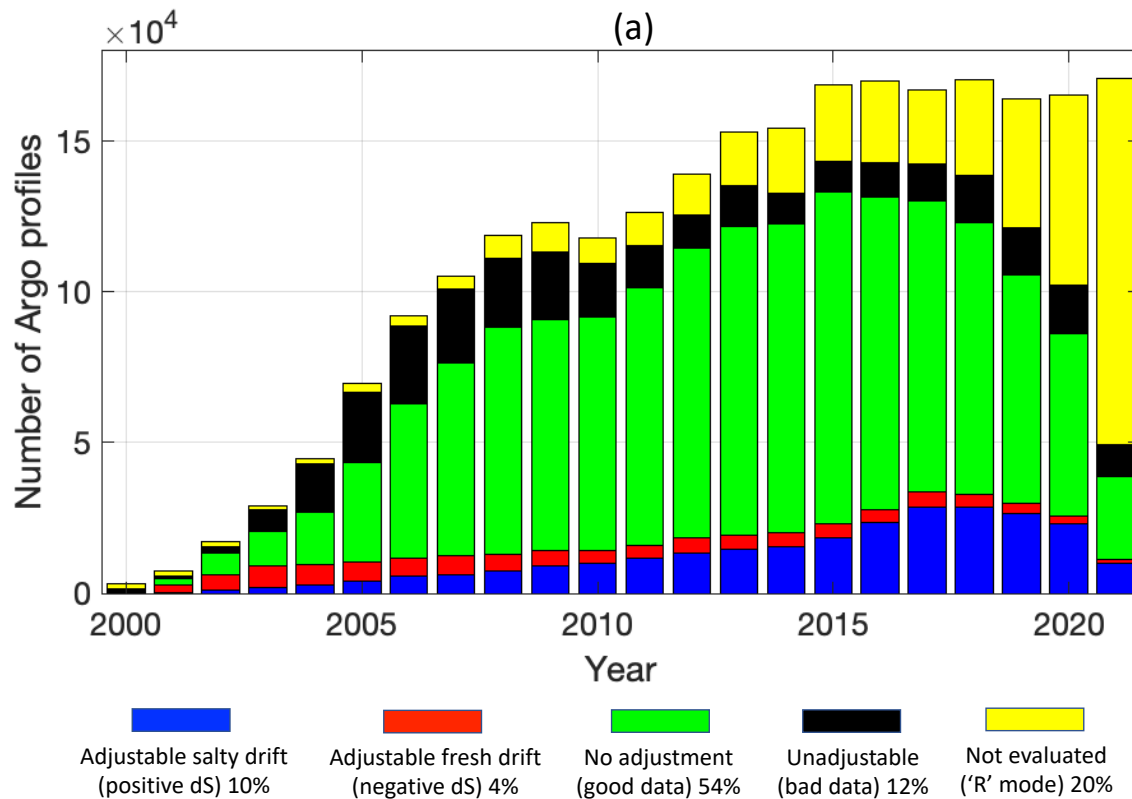
$$PSAL\_ADJUSTED = PSAL - \Delta S$$

On average, about 25% of floats will require a salinity bias correction of about 0.01 after 220 cycles (~6 years of 10-day cycling).

(Wong et al., 2020)

(a)

Legend:
- Adjustable salty drift (positive dS) 10%
- Adjustable fresh drift (negative dS) 4%
- No adjustment (good data) 54%
- Unadjustable (bad data) 12%
- Not evaluated ('R' mode) 20%

(b)

Based on data from the Argo GDACs in April 2022 (Wong et al., submitted)

> 2 millions Argo CTD profiles

(Top) Temporal distribution of Argo delayed-mode evaluation results for salinity.

(Bottom) Annual average of all delayed-mode salinity adjustments, which is an estimate of the adjustable bias in the raw Argo salinity data.
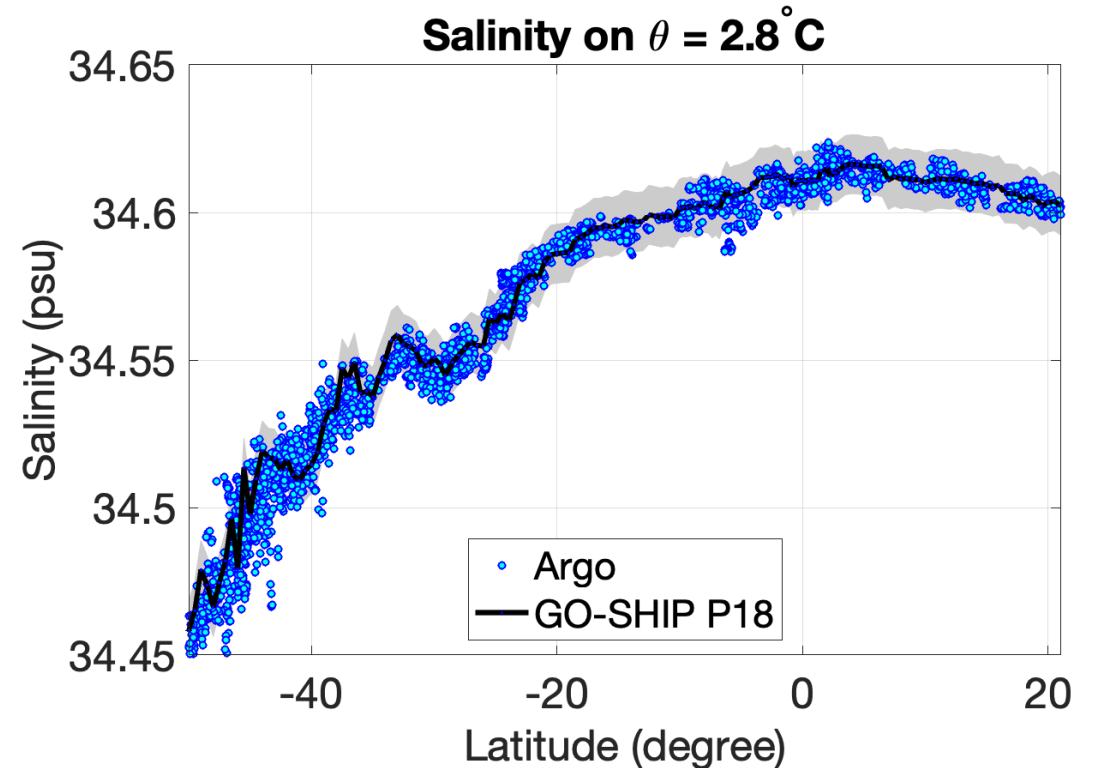
See also Toshio Suga's talk on Tuesday!

3. Comparisons with independent ship-board data

Uncertainty refers to the doubt about the validity of the evaluation and the adjustment.
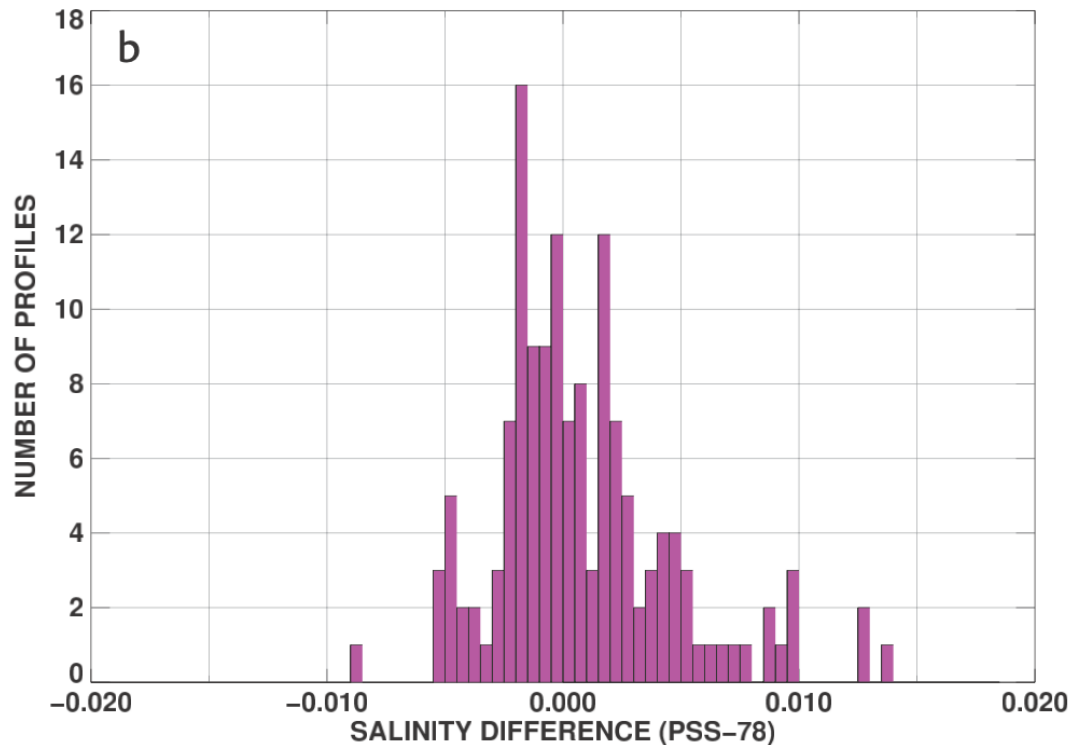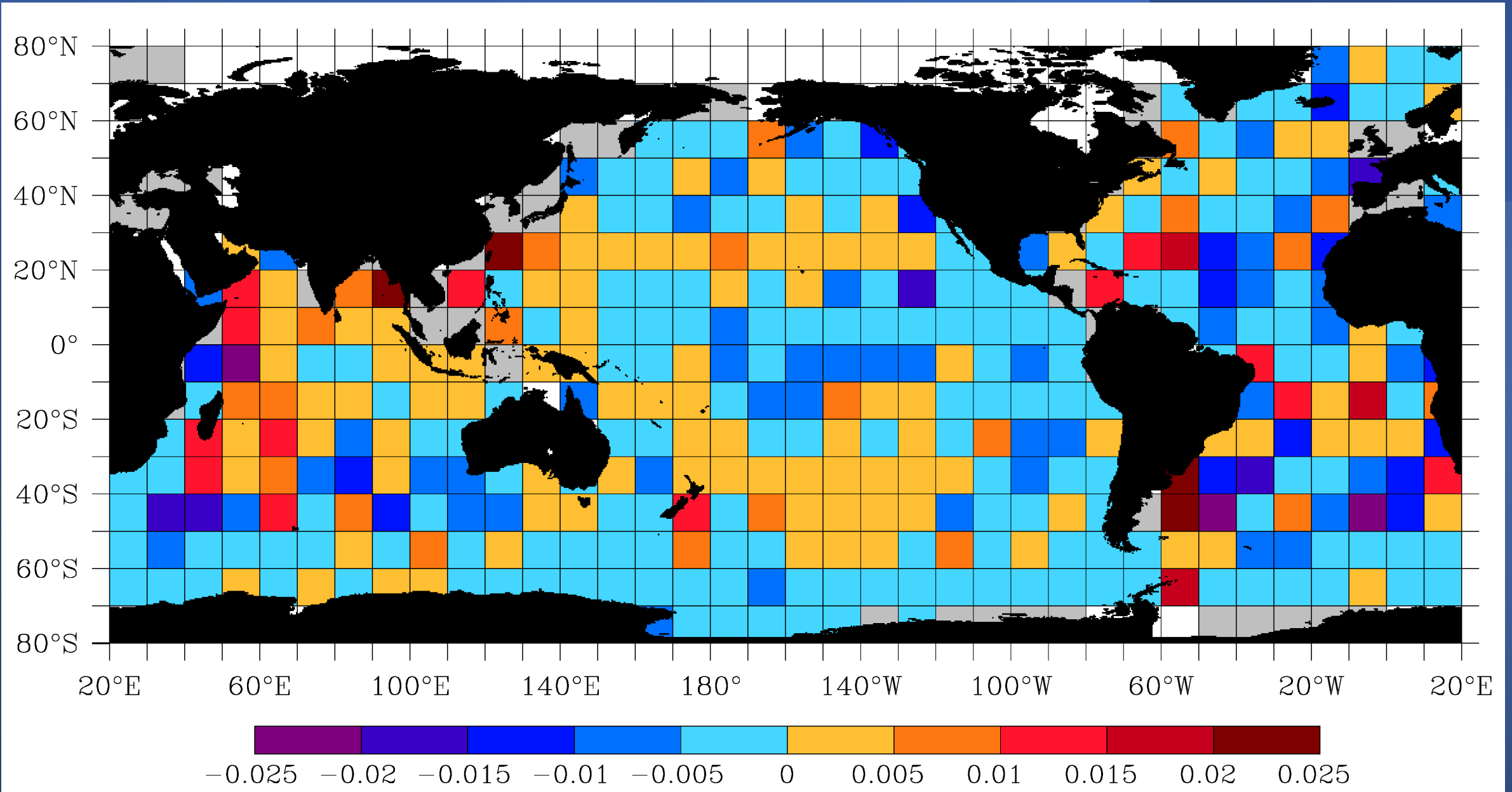

Salinity difference along 32°S in the Pacific
(Riser et al., 2008)

Salinity comparison along 110°W in the Pacific
(Wong et al., 2020)

A comparison of global Argo delayed-mode data against nearby independent shipboard CTD data: validation

ΔS ArgoD-refCTD, averaged in 10°x10° grid squares, as of April 2022 (Wong et al., submitted)

Statistical distribution of ΔS ArgoD-refCTD, as of April 2022
(only accounts for about 20% of the global Argo delayed-mode data)

Median = −0.0007
Mean = −0.0003
Standard deviation = 0.017
Skewness = +0.1
Kurtosis = 12.5
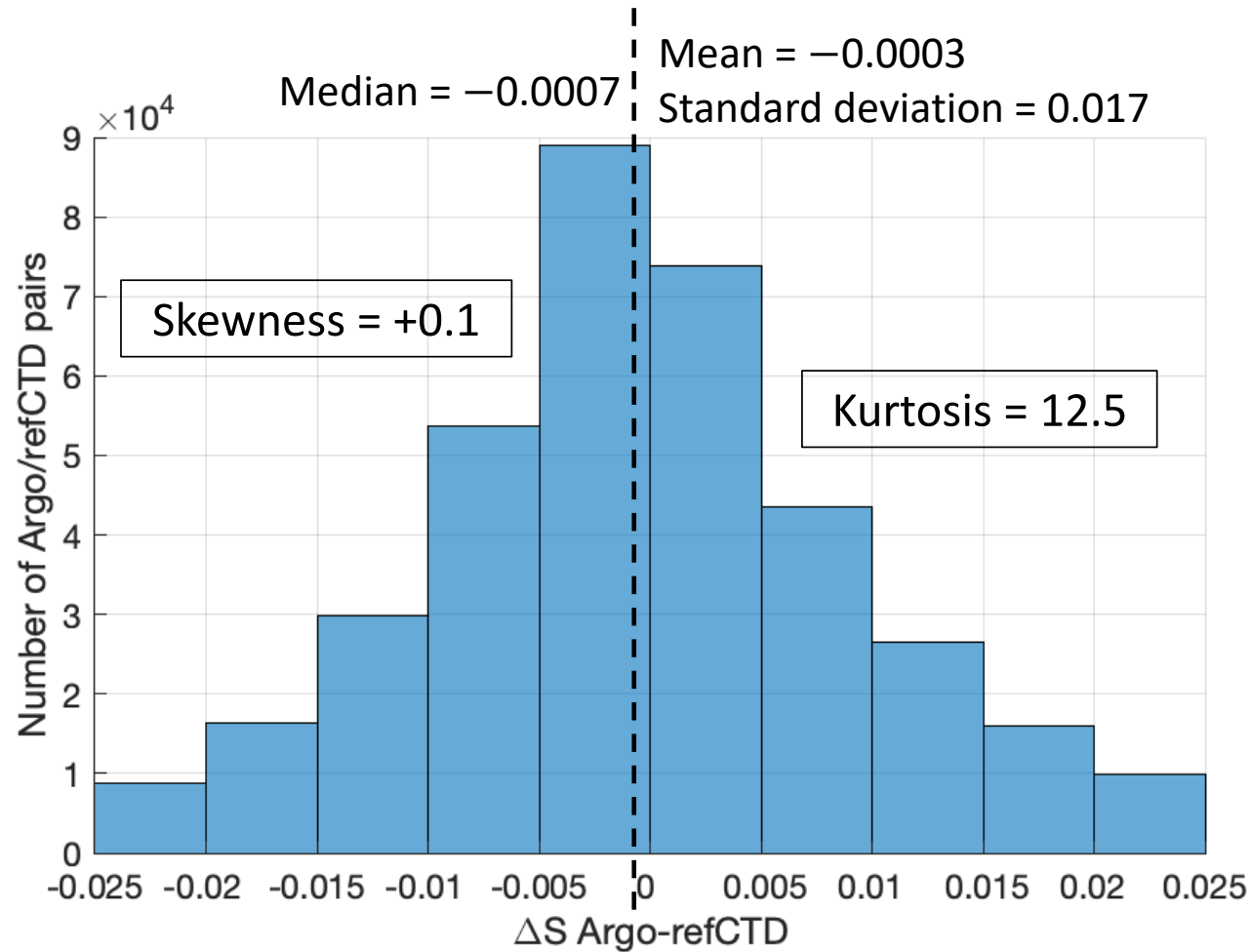
Note: A normal distribution has skewness = 0 and kurtosis = 3.

(Wong et al., submitted)

How to use Argo data?

In Argo data files, both the raw data and delayed-mode data are available.

Increasing time needed for data processing →

Real-time data files: available within 12-24 hrs
Filename convention: Rwmoid_cyclenumber

DATA_MODE = 'R' (real-time processing)

PARAM = raw measurement
PARAM_QC = qc flag of raw measurement
PARAM_ADJUSTED = not available
PARAM_ADJUSTED_QC = not available
PARAM_ADJUSTED_ERROR = not available

DATA_MODE = 'A' (adjusted in real-time)

PARAM = raw measurement
PARAM_QC = qc flag of raw measurement
PARAM_ADJUSTED = real-time adjusted value
PARAM_ADJUSTED_QC = qc flag of real-time adjusted value
PARAM_ADJUSTED_ERROR = not available

Delayed-mode data files: usually available after 12 months
Filename convention: Dwmoid_cyclenumber

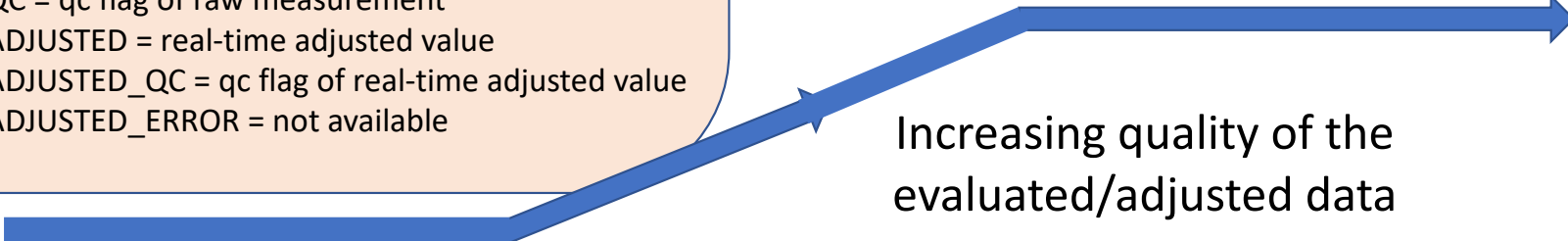DATA_MODE = 'D' (delayed-mode processing)

PARAM = raw measurement
PARAM_QC = qc flag of raw measurement
PARAM_ADJUSTED = delayed-mode adjusted value
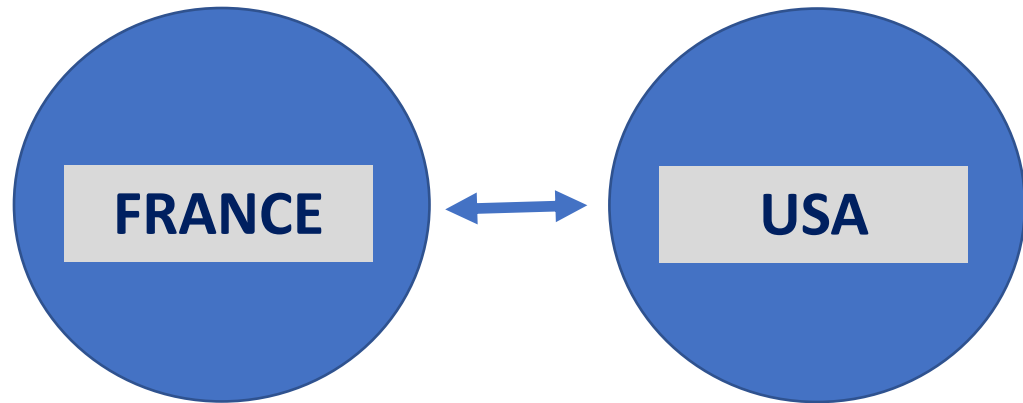PARAM_ADJUSTED_QC = qc flag of delayed-mode adjusted value
PARAM_ADJUSTED_ERROR = uncertainty of delayed-mode adjusted value

Increasing quality of the
evaluated/adjusted data →

Argo data are available from 2 Argo Global Data Assembly Centers

FRANCE ↔ **USA**

ftp ftp.ifremer.fr
ftp usgodae.org

Also available in real-time on the GTS (BUFR format includes QC flags)

External data products that include Argo data ?

Conclusions

- Raw Argo salinity data can contain instrument bias.

- Argo delayed-mode salinity are in good agreement with nearby shipboard CTD.

- Scientific applications sensitive to salinity error should use Argo delayed-mode data.

- Argo delayed-mode data can become available at different times and are subject to revisions. *Users, including data product producers, should refresh their data holding periodically.*

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Please email with any questions.

Argo salinity: bias and uncertainty evaluation
Preprint available at
https://essd.copernicus.org/preprints/essd-2022-323/