



*7th Euro-Argo Science Meeting
Athens, 22-23 October 2019*

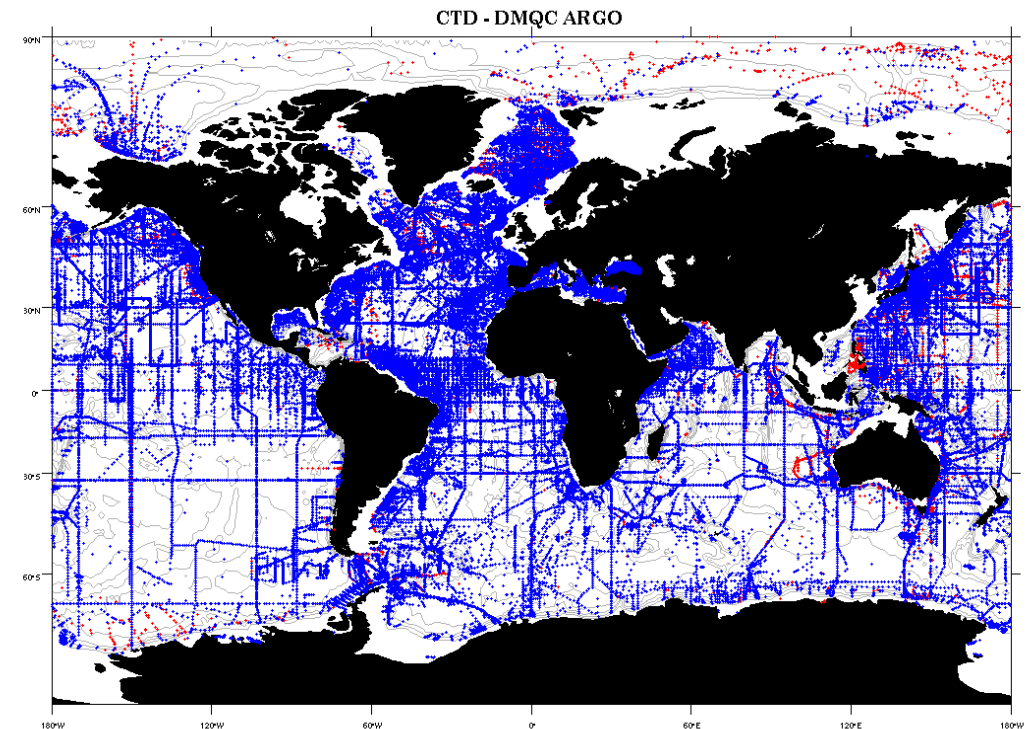
Delayed Mode Quality Control of Argo floats In the Nordic Seas

Improvement of the CTD reference database

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Salinity Delayed-mode quality control (DMQC)

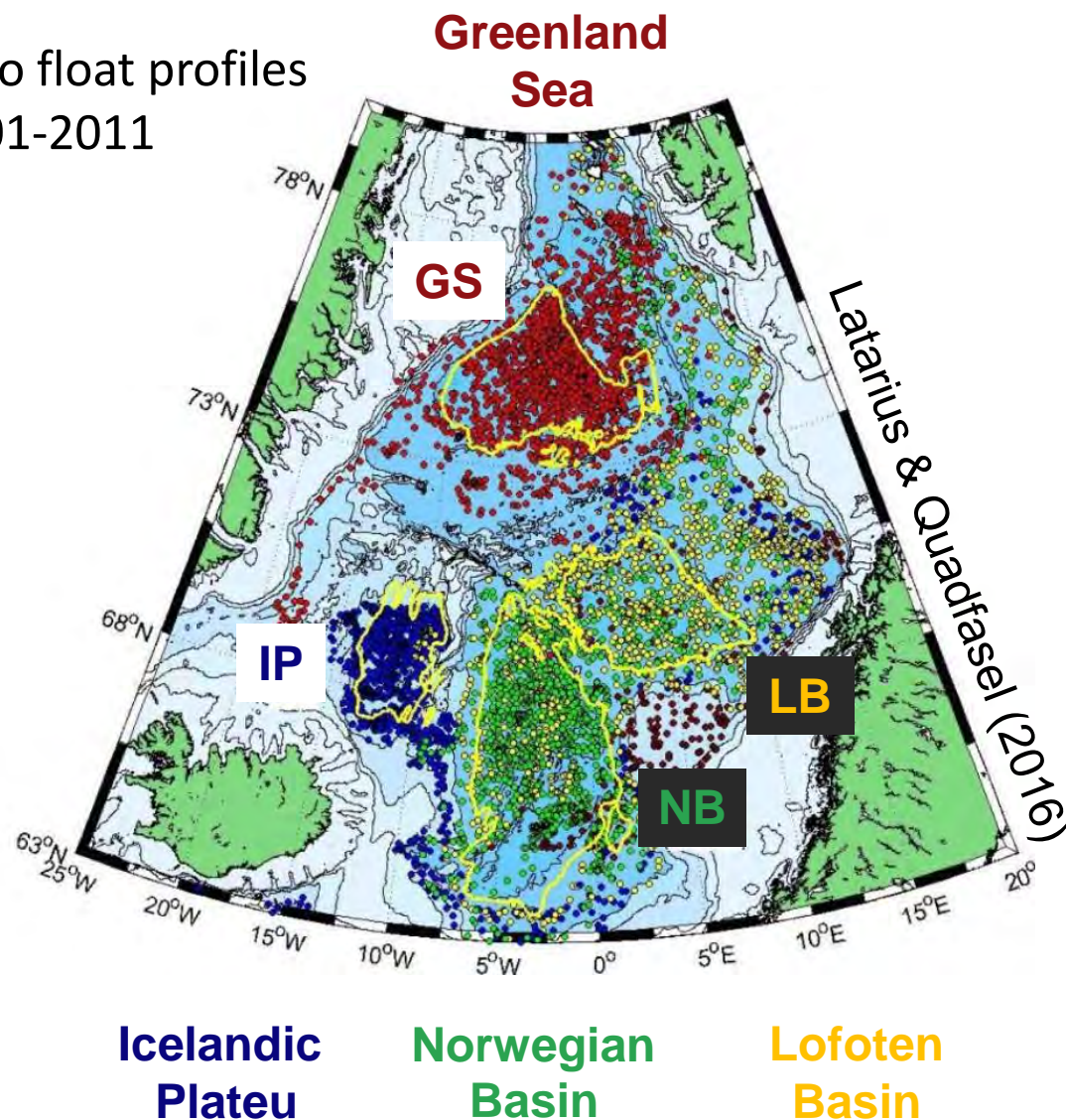
- 0.01 PSU Target accuracy (Argo Science Team, 2000).
- Check for drifts and offsets in salinity relying in reference datasets and statistical methods.
- OW (Owens & Wong, 2009) and OWC methods (OW + Cabanes et al. 2016)
 - Uses climatological salinity interpolated (objective mapping) to the float positions and observed θ surfaces.
 - Chooses 10 'best' levels that are within well-mixed mode waters or deep homogeneous water masses.
- Quality of the correction depends on the quality of the references databases!



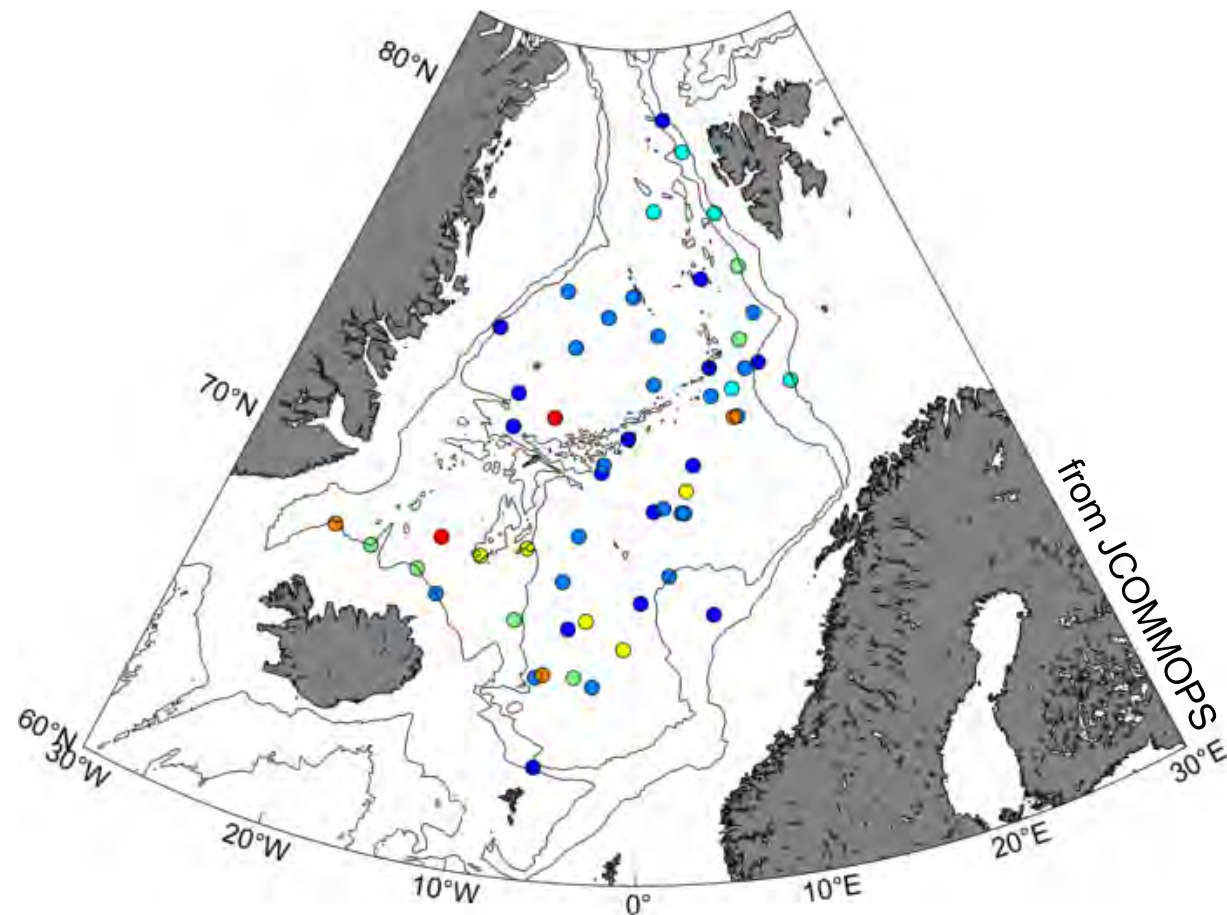
CTD Reference Database 2018v02
C. Coatanoan (Ifremer)

The Nordic Seas

Argo float profiles
2001-2011



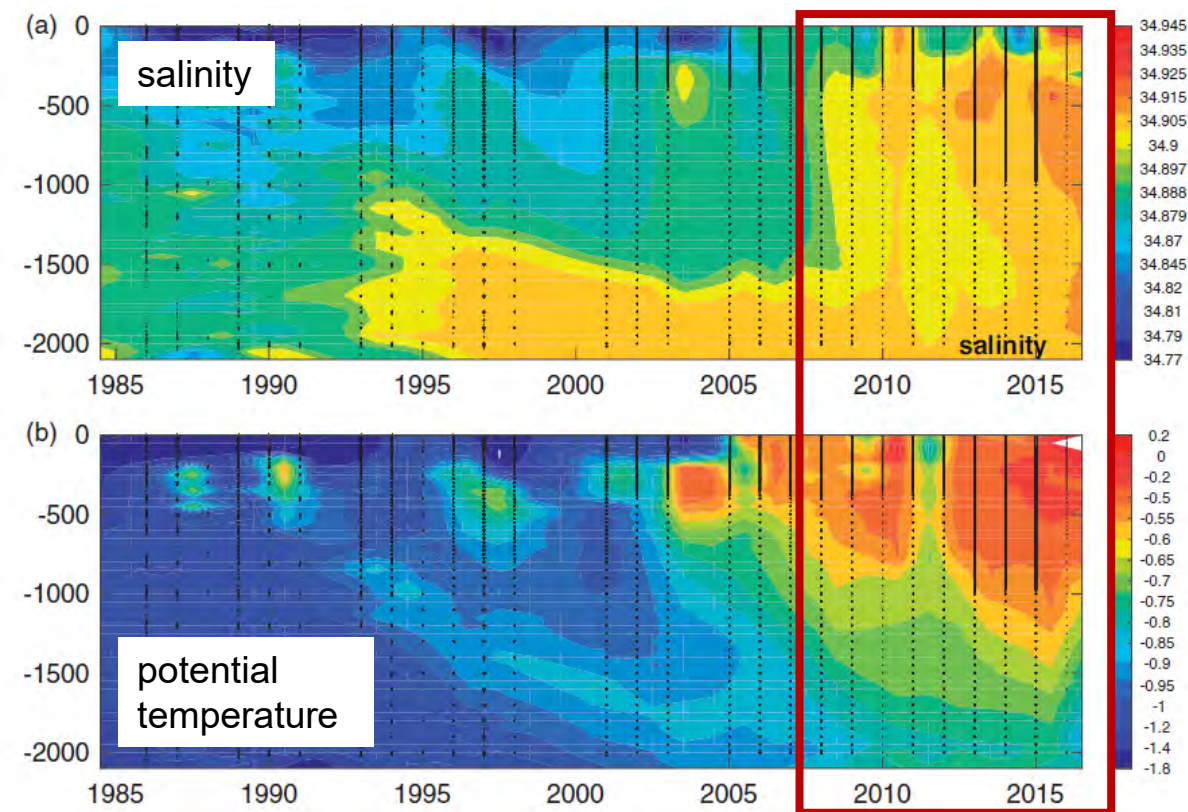
- Four deep basins important for water mass transformation
- Low natural variability in T and S (>900 dbar)
- Monitored with Argo since 2001
- The BSH Argo Team is the main DMQC operator for the region



- 56 active floats
- BSH is responsible for the DMQC of 44 floats

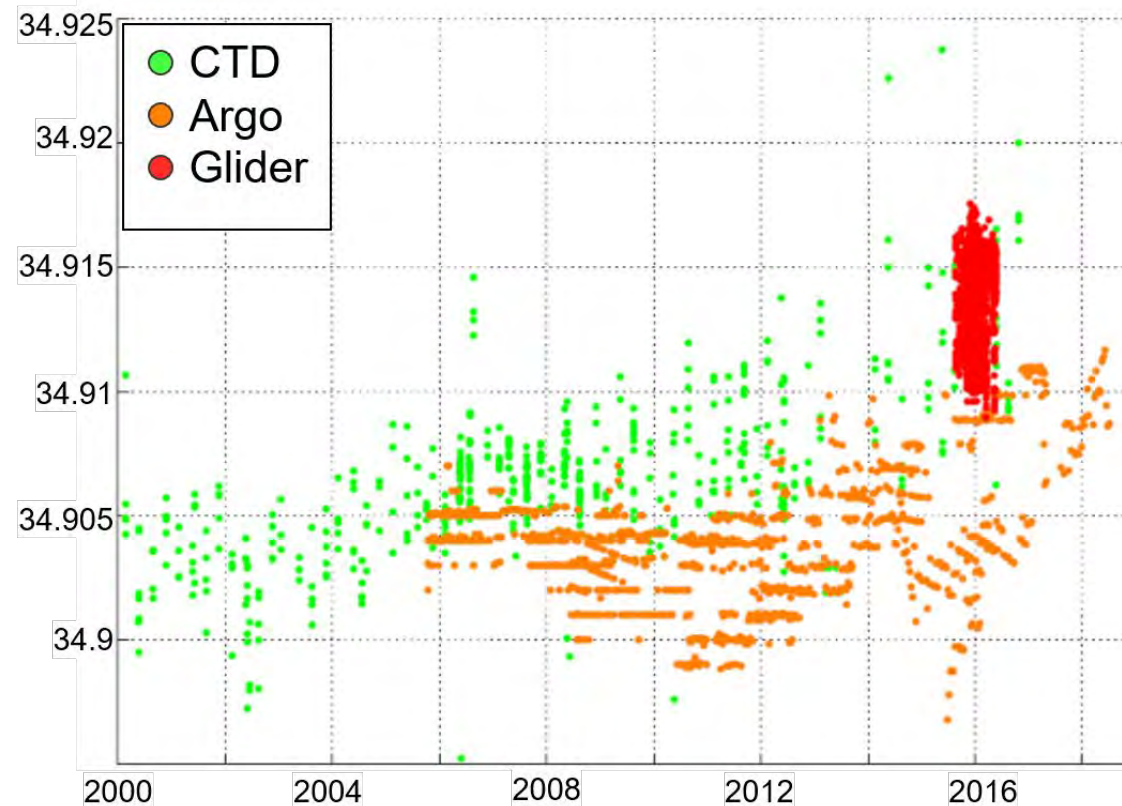
Last positions of active floats in the region
(22.10.2019)

Salinification trend in the **Greenland Sea** at 1000m:
 $0.0008 \pm 0.0001 \text{ PSU year}^{-1}$

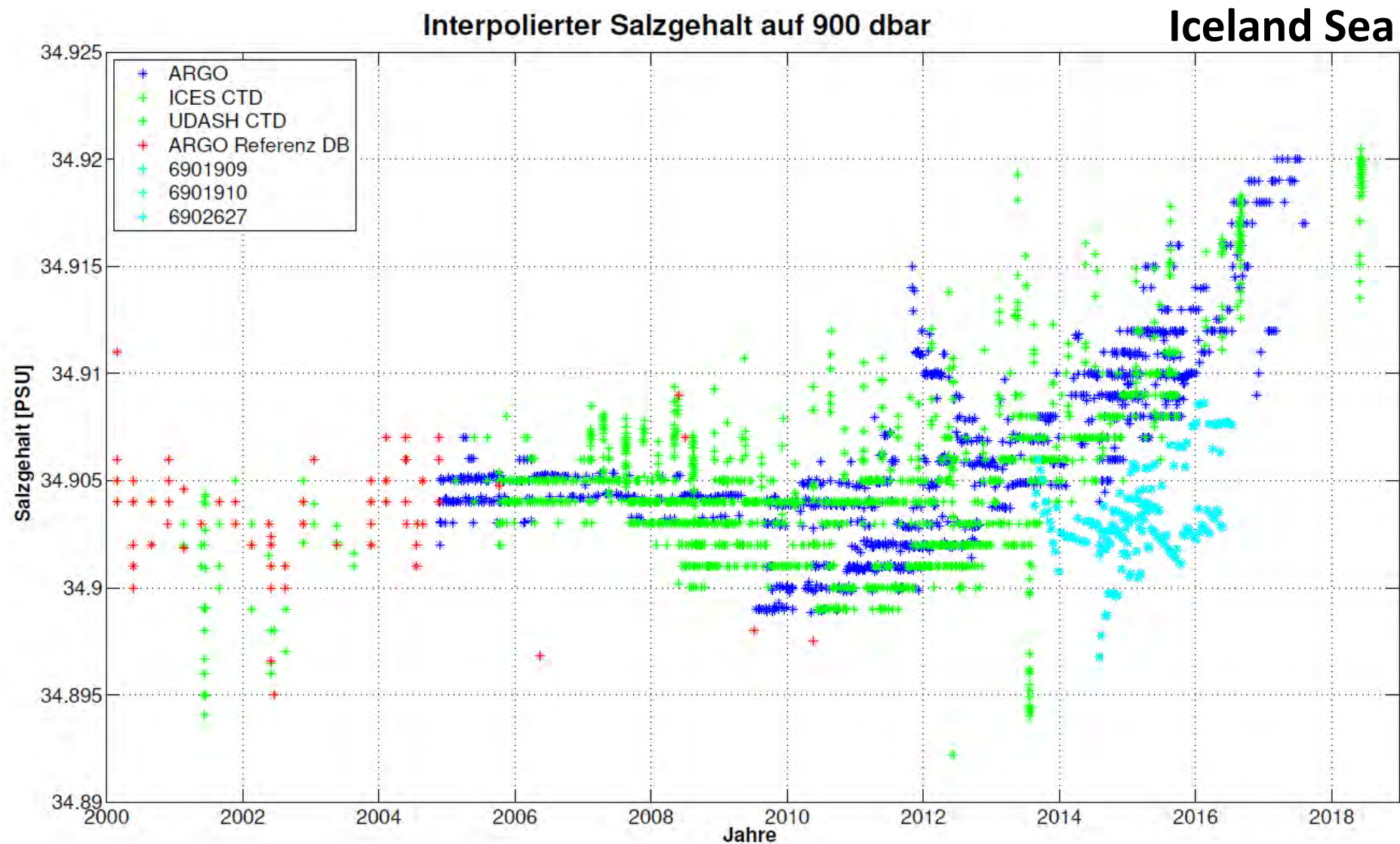


Lauvset et al., (2018) - Ship-based CTD data

Discrepancy of $\sim 0.002 \text{ PSU}$ between calibrated glider and Argo at 900 dbar in the **Iceland sea**



M. Albracht - K. Våge, personal communication (2019)

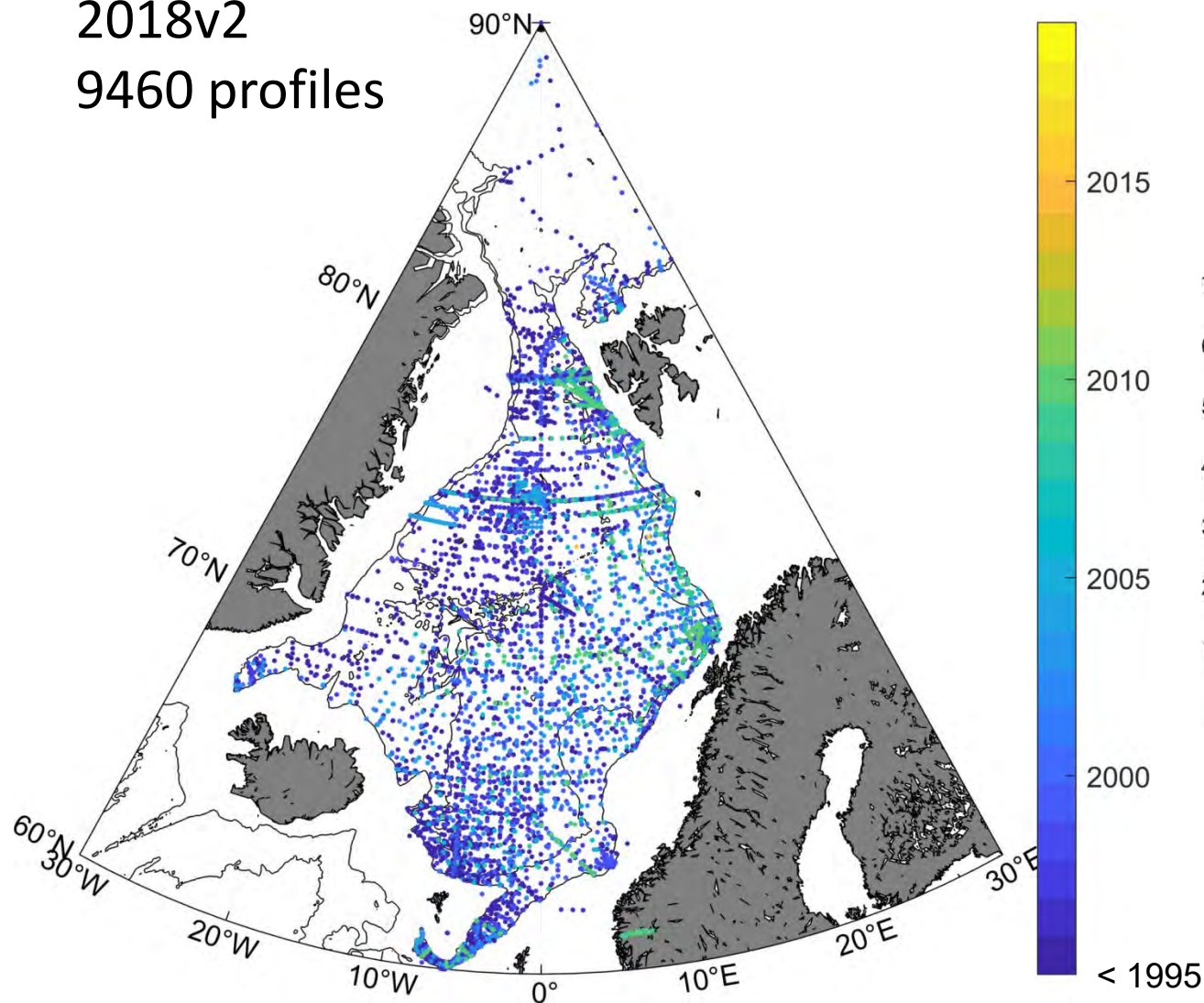


Argo floats data is shown with salinity correction (DMQC 2019-04-27)

Floats 6901909, 6901910 and 69026227 with OW offset salinity corrections of -0.009, -0.002, -0.0025 respectively

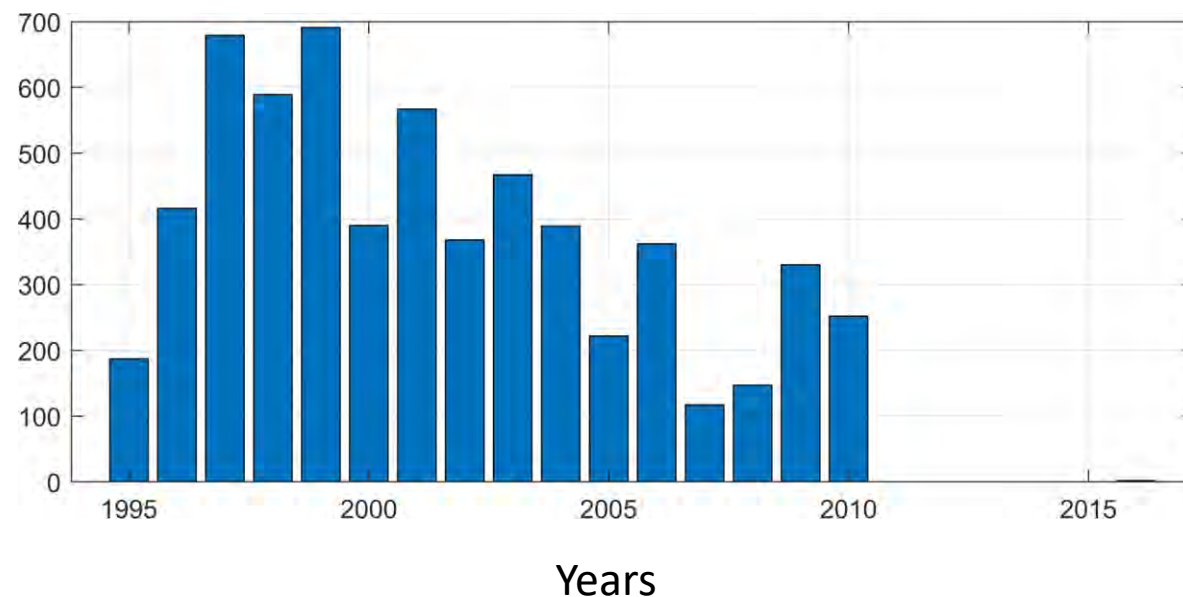
In the next DMQC (2019-06-17) the salinity correction was removed!

2018v2
9460 profiles



Spatial distribution, color-coded for time

Number of CTD profiles per year



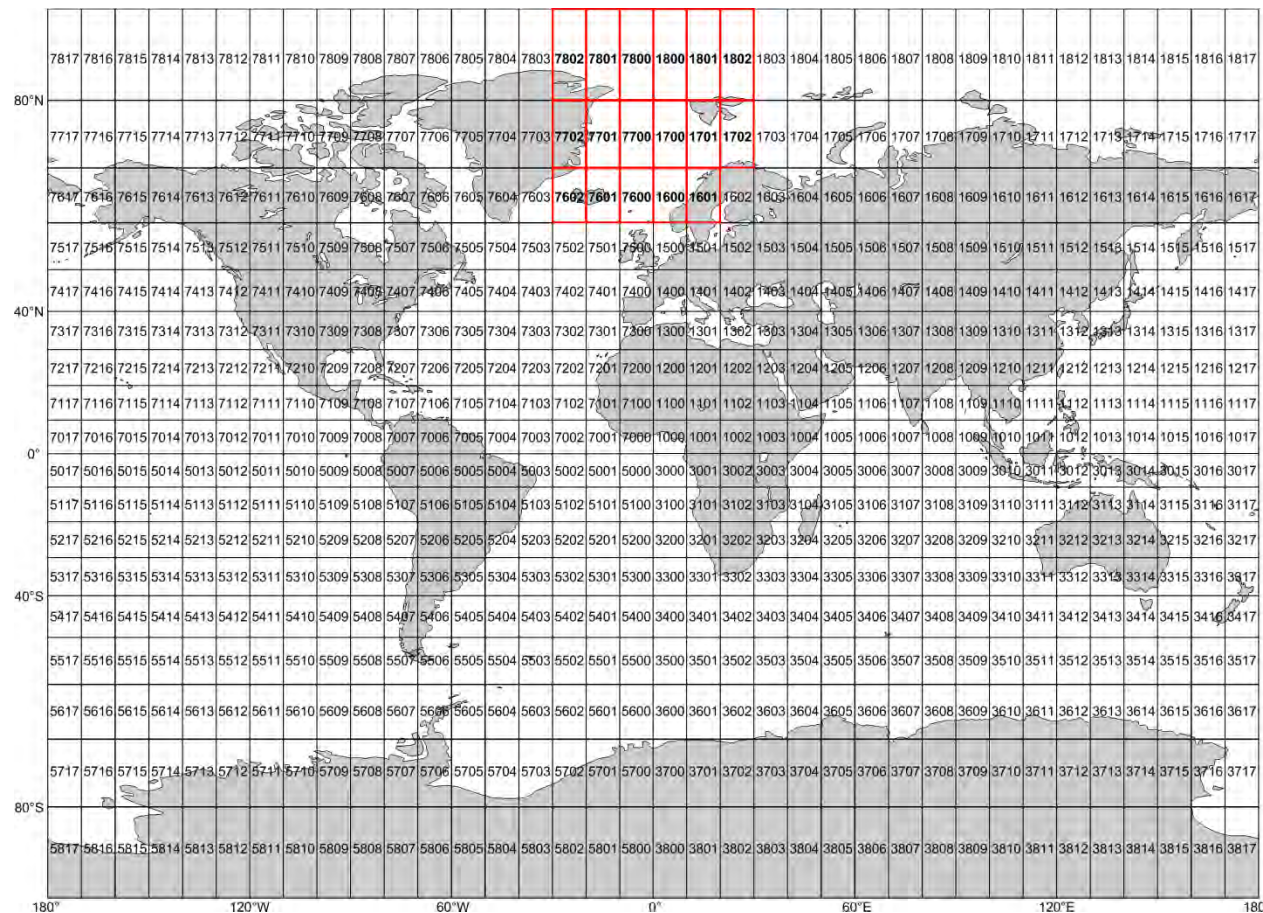
35% of the profiles were collected before 1995

- Contents

- Metadata: latitude, longitude, dates (timestamp), source (profile ID) and qclevel (origin of the data)
- Data: Pressure, Temperature, Salinity and Potential Temperature

- Selection requirements

- Casts deeper than 900 dbar (to exclude coastal stations). Full profile is stored.
- Only good quality data
- Unique stations by removing duplicates

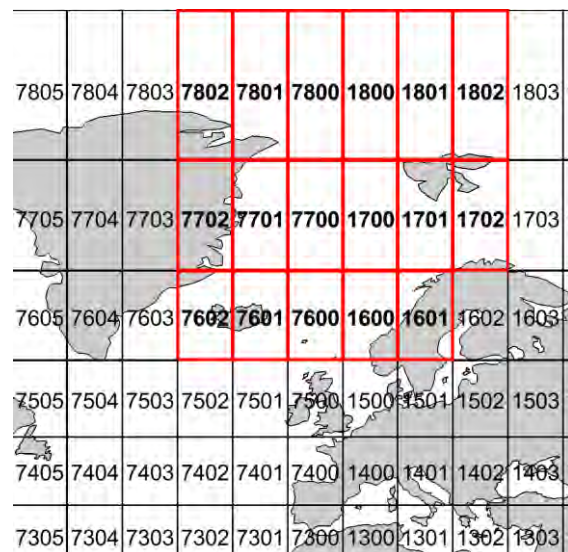


Issues

- Lack of profiles after 2010
- Not paired values (pres,temp,sal)
- Duplicated profiles (header and content)
- Misslabeled stations (boxes 1700, 7701, 7600)
- Traceability is limited (Coriolis internal profile ids)

Improvements for 2019v1

- Temporal and spatial coverage: *Adding profiles from alternative data sources*
- Traceability: *meaningful profile ID code*
- Quality: *Remove redundant (duplicates) and faulty (outliers) and uncertain data*



CTD reference database for DMQC – Data sources

DATABASE (qclevel)	PROFILE ID (source)
Directly from PIs (SPI)	Cruise + station (traceable)
CLIVAR and Carbon Hydrographic Data Office -CCHDO (CCH)	Cruise name (semi-traceable)
Ocean Library – WOD (OCL) – through COR	Coriolis internal ID code (untraceable)
Coriolis (COR)	Coriolis internal ID code (untraceable)
UDASH: Unified Database for Arctic and Subarctic Hydrography (Behrendt et al., 2018) – up to 2015	UDASH profile number (traceable back to WOD13)
ICES: International Council for the Exploration of the Sea (after 2015)	SHIP ID + Coriolis internal ID cde (semi-traceable)

For all data:

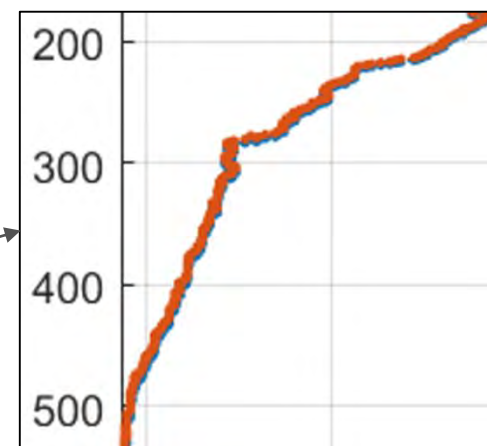
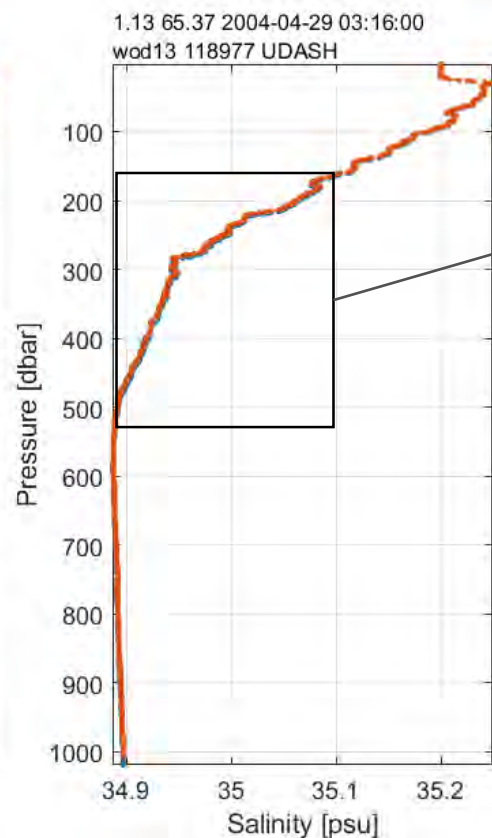
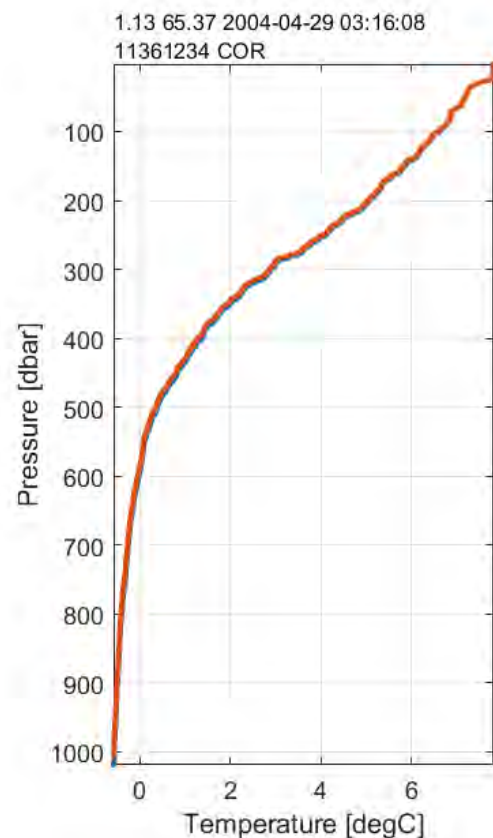
- Clean samples with invalid values in pressure, salinity and temperature
- Check for multiple profiles in the same cast

ICES: Requires extra quality control!

- Manually removed outliers
- Suspicious profiles in “quarantine”, until quality is assured

CTD reference database for DMQC – Data redundancy

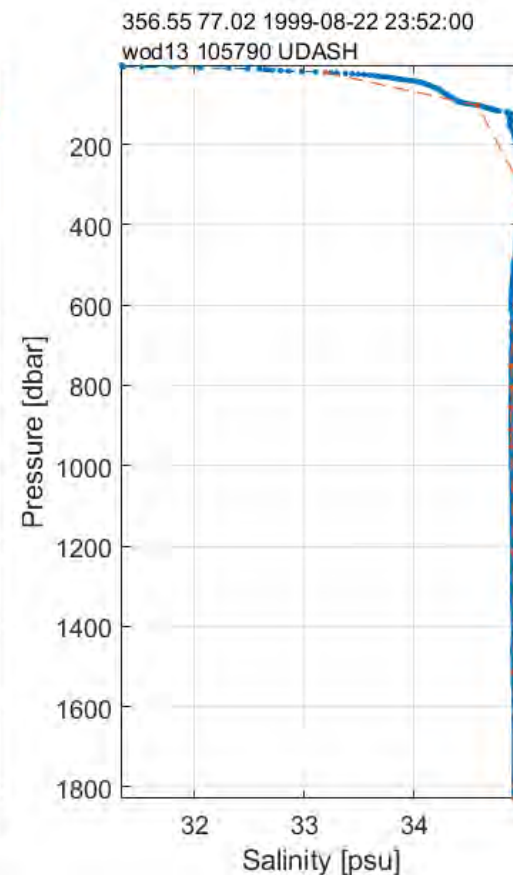
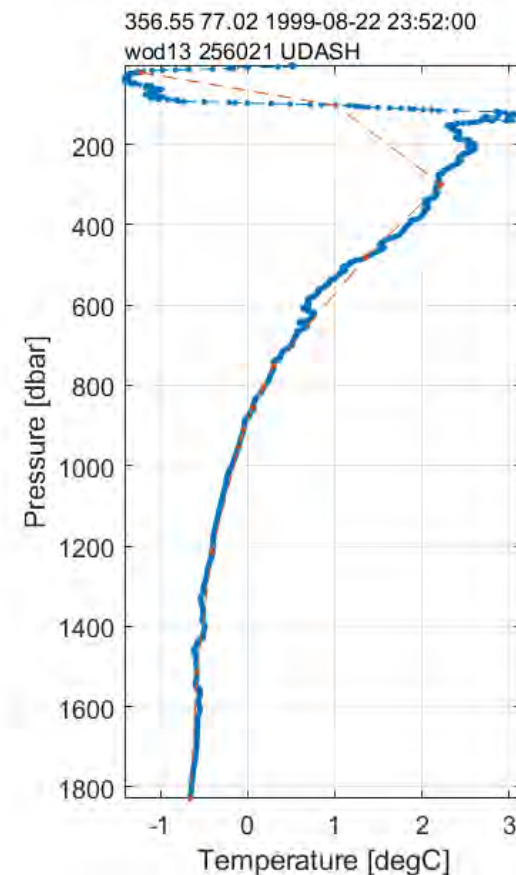
- High data redundancy is expected: Main source of UDASH is WOD 13
- Same profiles are slightly different between databases: Challenge for duplicate check



1.13 65.37 2004-04-29 03:16:00
wod13 118977 UDASH

1.13 65.37 2004-04-29 03:16:08
11361234 COR

- Comparing contents (Gronell & Wijffels, 2008)
 - Exact duplicates (sum of pressure, sum of temperature, sum of salinity)
 - Near duplicates: % similarity between samples
 - ✓ Profile with highest vertical resolution is interpolated to the pressure levels of the one with lowest resolution (overlapping pressure levels)
 - ✓ Compare sample by sample. Rounding and truncation are used: 1 decimal digit for temperature and 2 for salinity
 - ✓ This detects pairs were interpolated to different vertical resolutions, pairs that extend to different depths, pairs with salinity stored with different number of decimal digits.
 - ✓ If similarity
 - >95% in both temperature and salinity = Duplicate
 - >75% Confirm with visual check



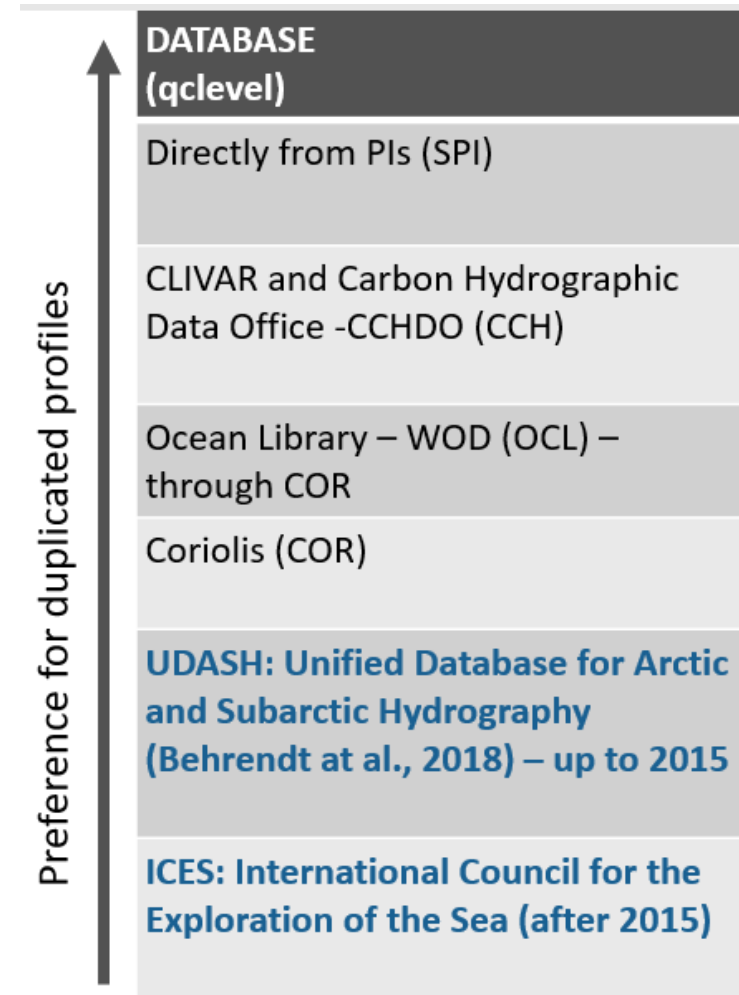
- Comparing metadata
 - Use rounding and truncation to compare geographical positions (1 decimal digit) and timestamp (YYYYMMDD)
- Fast near duplicate test
 - Gronell & Wijffels near duplicate test (computationally heavy)
 - Interpolate to common pressure levels and then apply the exact duplicate algorithm (Fast version of near duplicates)
 - If the comparison is large enough compare sample by sample

Deciding which profile to keep

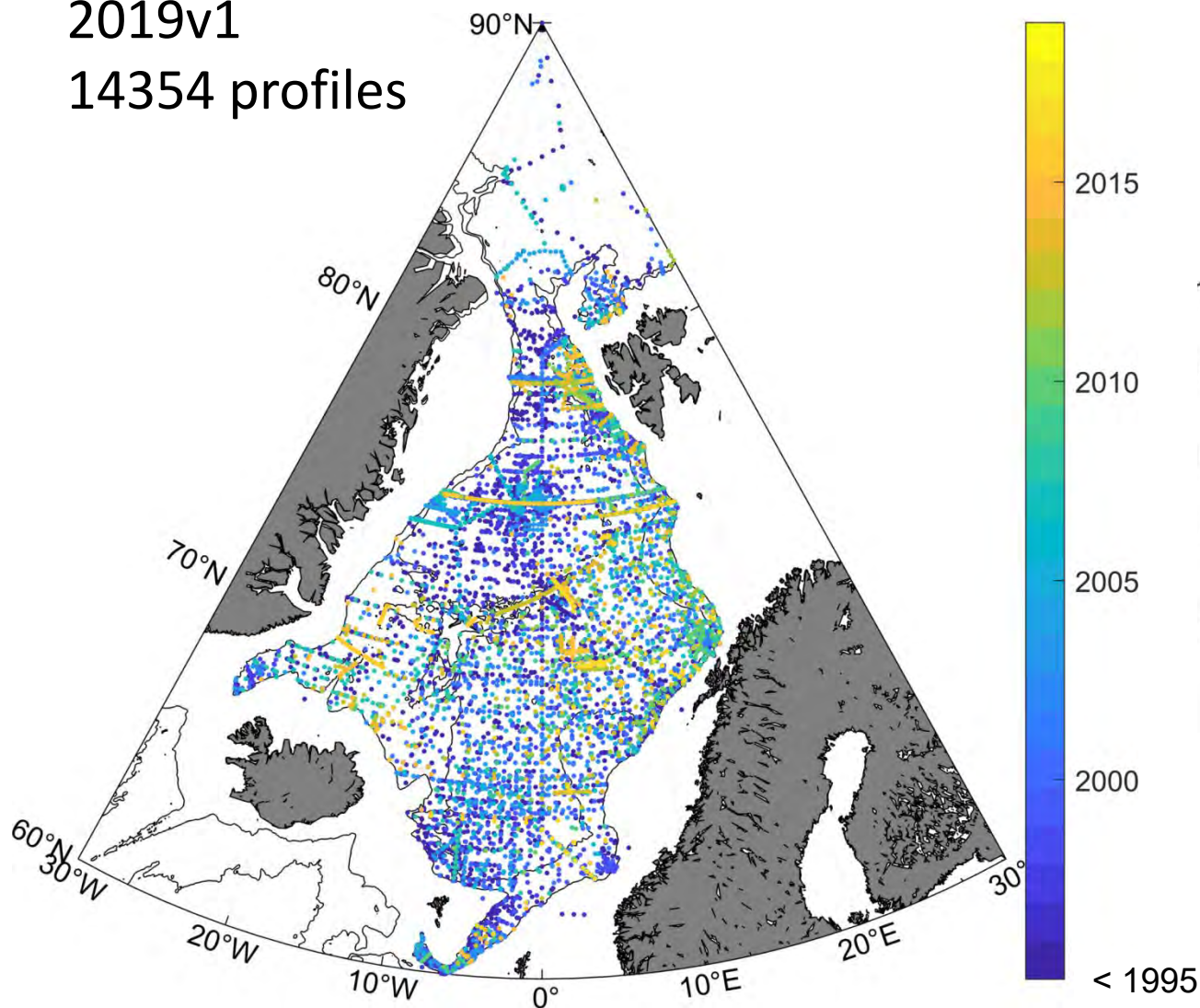
Position	Date	Content	Decision
=	=	=	Select randomly
≈ (3 km)	≈ (3 days)	=, ≈	Select best profile
≠	≠	=, ≈	Exclude both Quarantine*

CTD reference database for DMQC – Best profile?

- Metadata
 - Quality control level
 - Latest version added to the database (source number COR): resubmitted data is supposed to have better quality
- Information content
 - Maximum recorded depth
 - Vertical resolution: Number of samples per dbar
 - Salinity resolution: Number of decimal digits

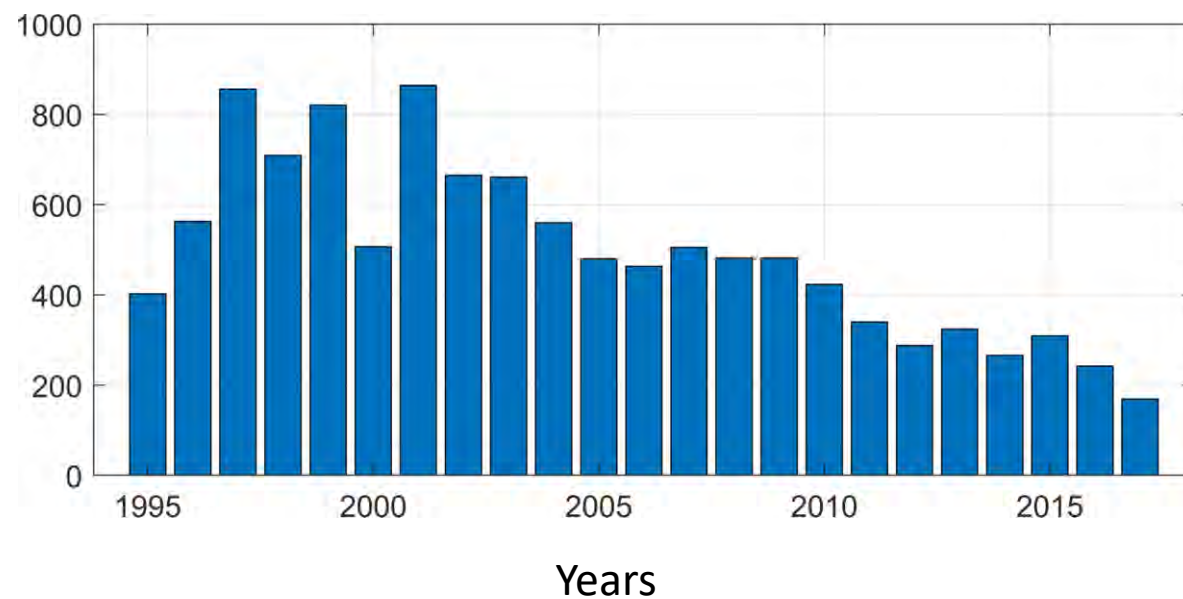


2019v1
14354 profiles



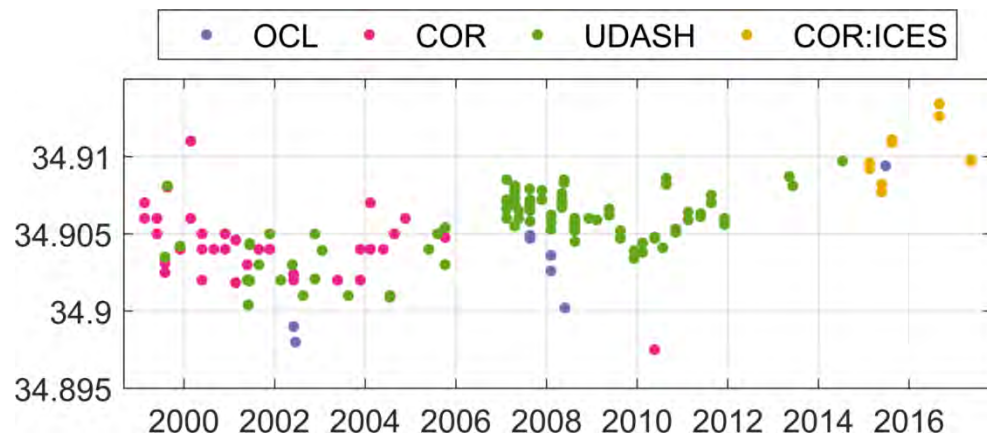
Spatial distribution, color-coded for time

Number of CTD profiles per year

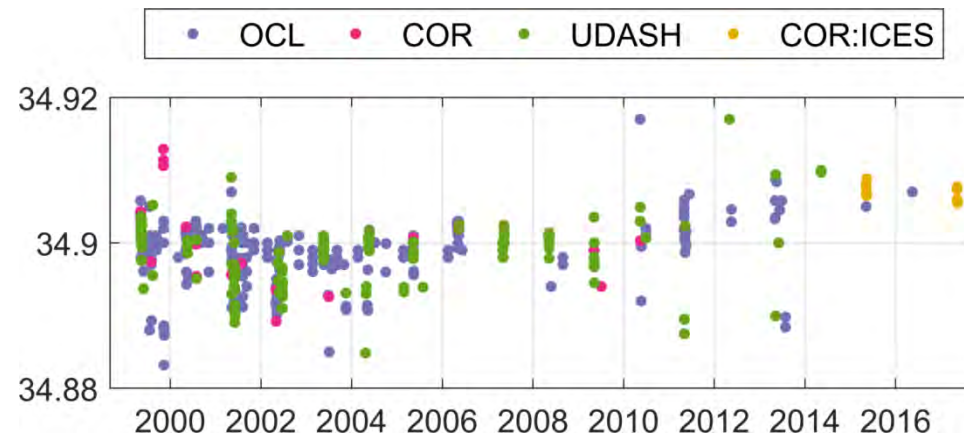


Salinification trend is represented in 2019v1 – Interpolation to 900 dbar

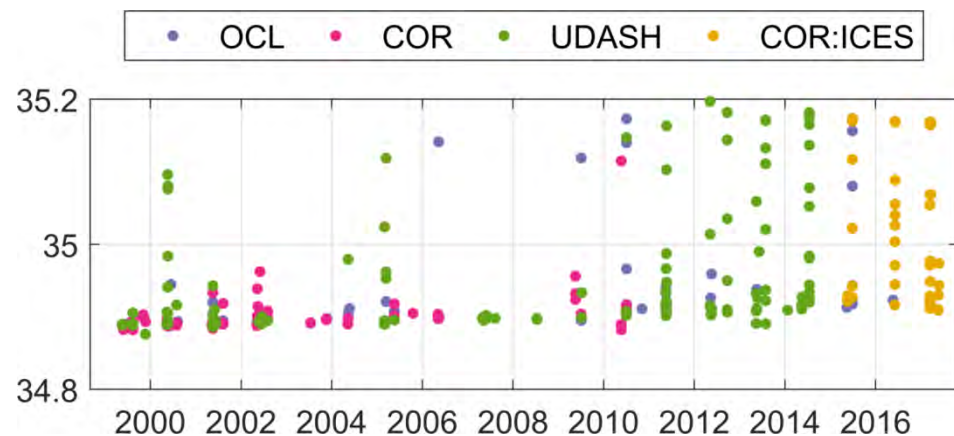
Iceland Sea



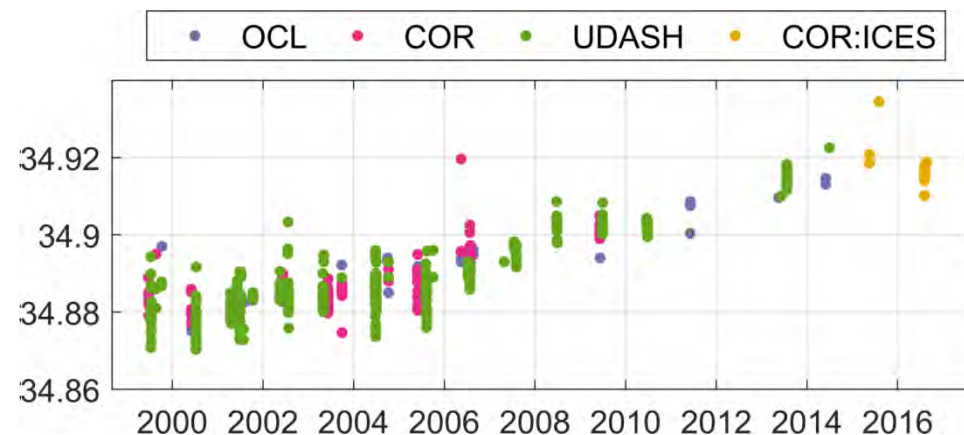
Norwegian Basin



Lofoten Basin



Greenland Sea



- Updated database will be used to reprocess floats in the Nordic Seas using OWC
- Content duplicate checks implemented for the Nordic Seas will be used for the 2020 version of the global reference database (C. Coatanoan ADMT20)
- Feedback to data sources will contribute to the improvement of the data sources
 - Duplicated profiles reported back to UDASH
 - Profiles containing bad samples or calibration errors reported back to ICES: possibility to get a good version of those profiles
- Further improvement: Obtain data directly with PIs
- DMQC operators: Check the reference database for your region!



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