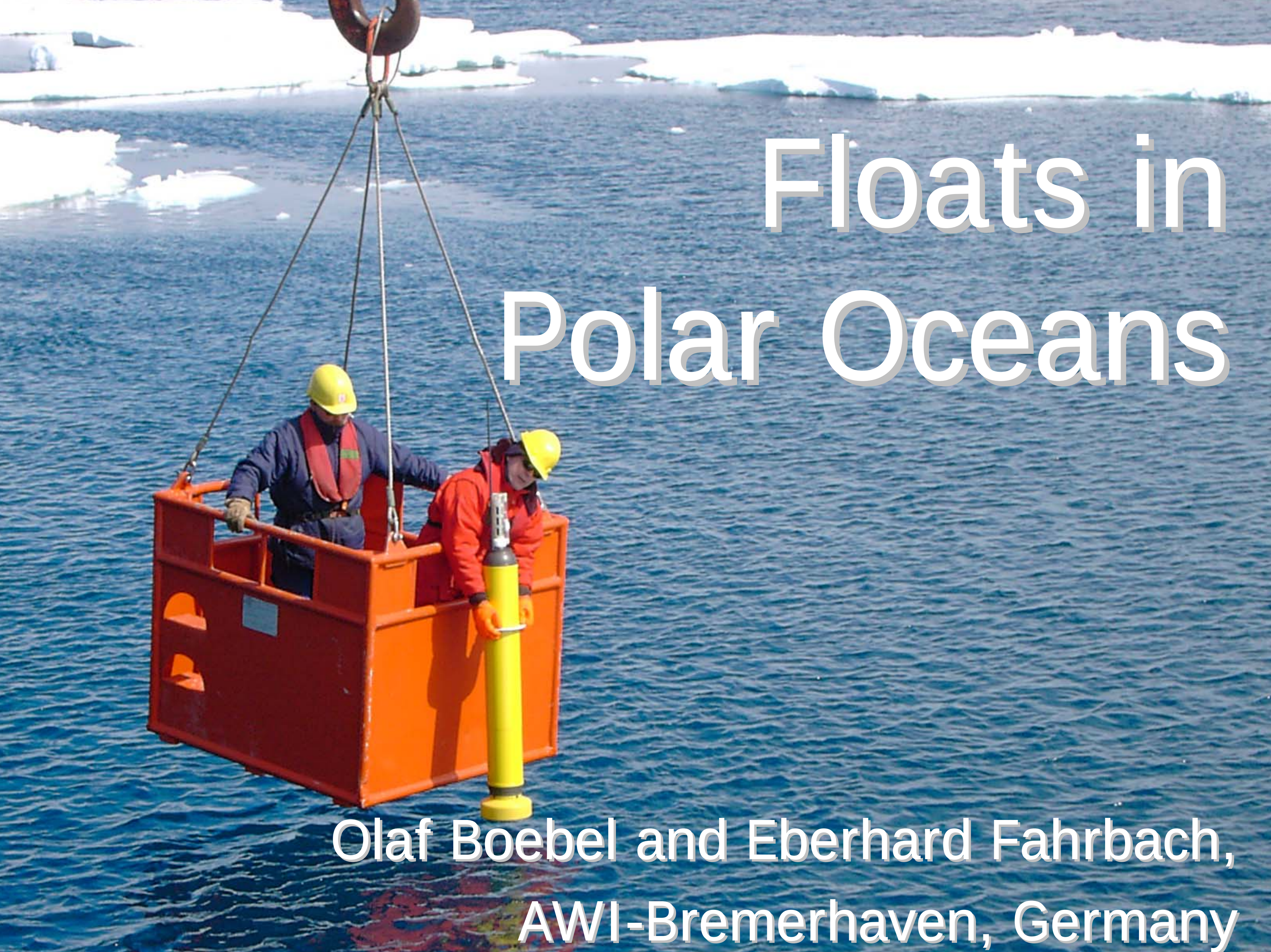

Floats in Polar Oceans

Olaf Boebel and Eberhard Fahrbach,
AWI-Bremerhaven, Germany

Floats in Polar Oceans: Strategy

- Development of a system for bipolar use in the Antarctic because of easier conditions: 80% of ice melts in summer
- 1. priority: measurements of water mass properties by profiling floats
- Floats are part of a comprehensive system of observations which can be realised stepwise. On each level useful data can be obtained
- Prototype system will be available during IPY 2007/2008

AWI Alfred Wegener Institute
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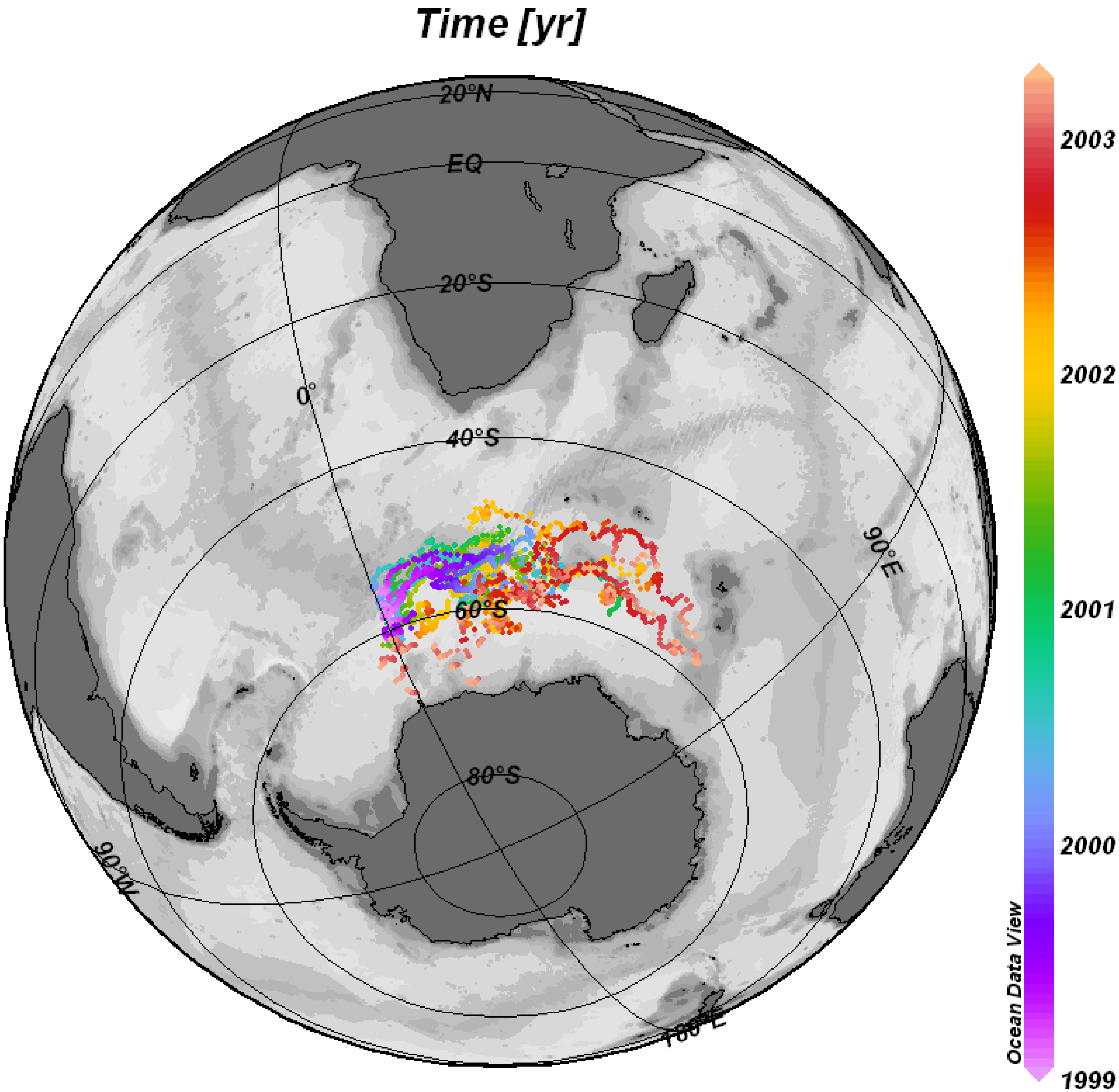
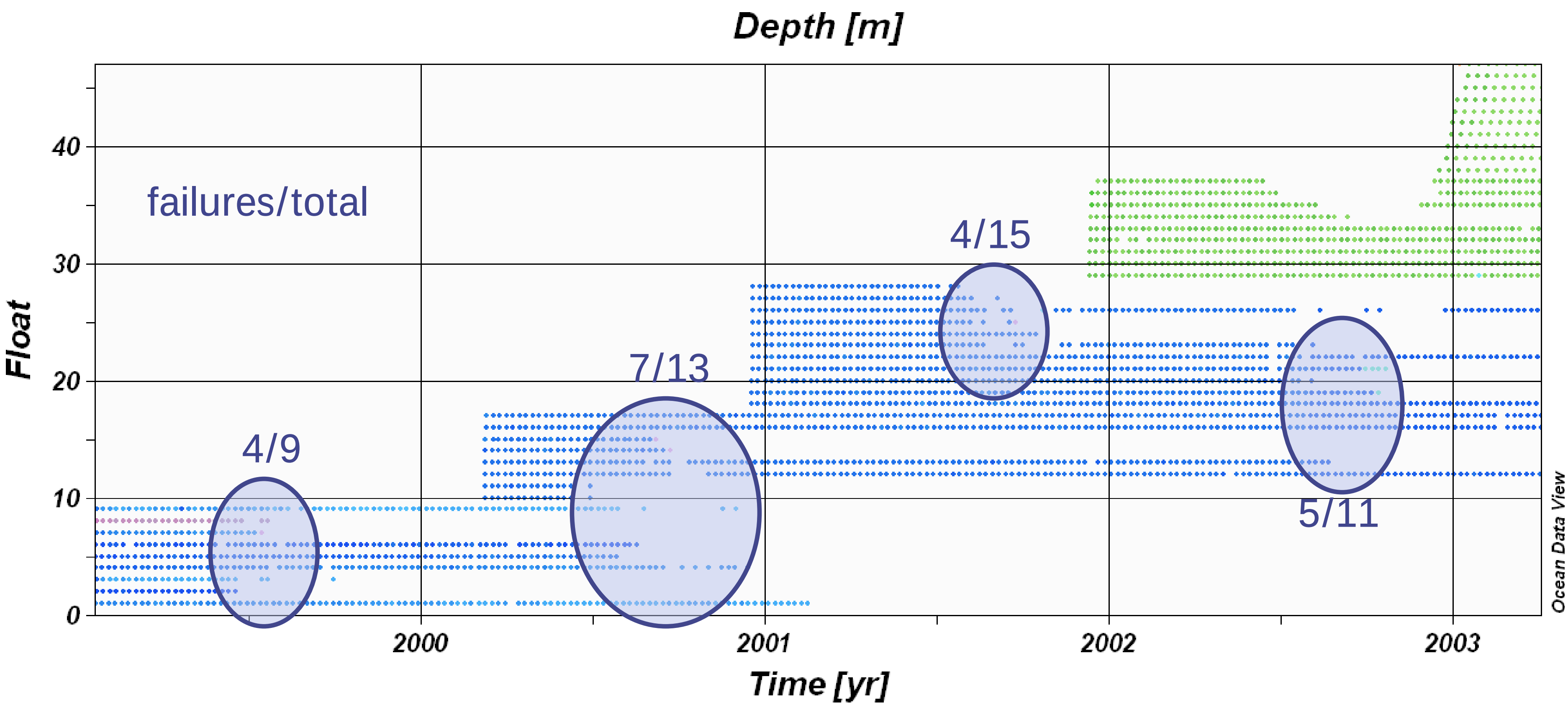
1999-2004: 49 Antarctic profiling floats by AWI



Profiles transmitted



~ 50% wintertime float failures !

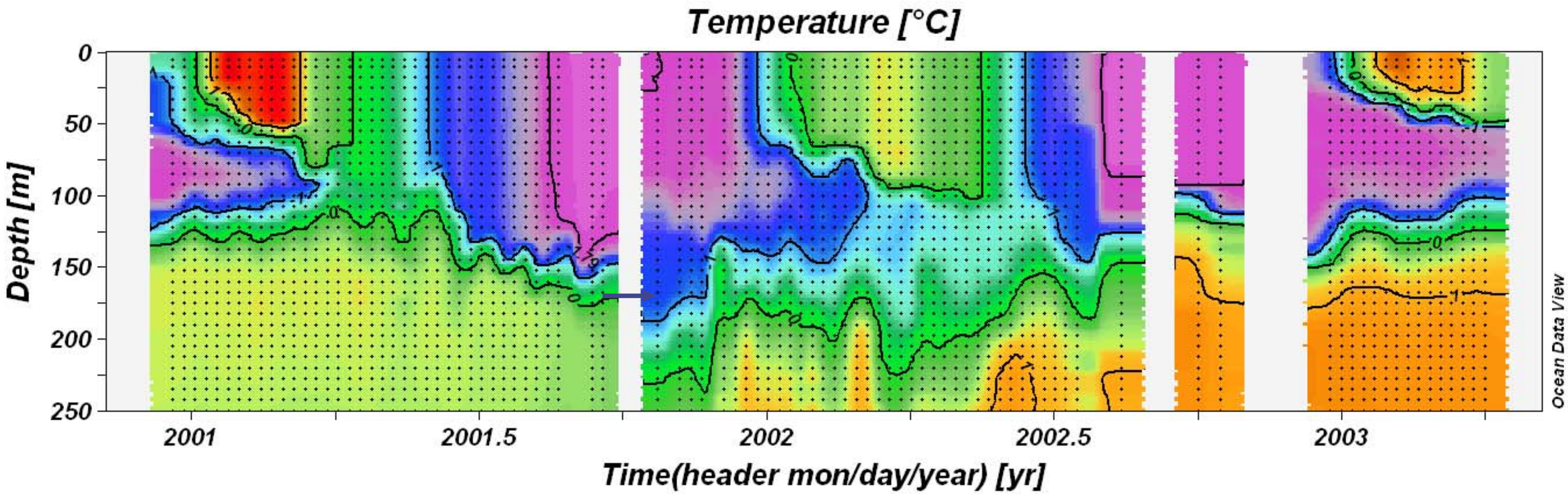
Causes for missing profiles

- Ice coverage – no transmission
- Float destruction

Causes for float destruction

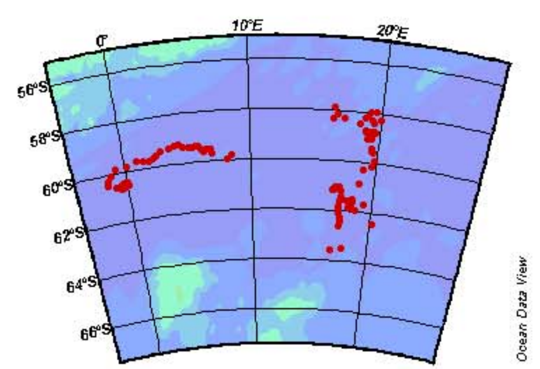
- Float damaged when surfacing under ice?
- Float damaged when trapped within ice?
- Energy (program trapped during ascend or descend attempts) ?

Trapping mechanisms: Detection from ice maps and float behaviour



500 km in 35 days ~ ...... ~ 17 cm/s

Higher velocities are associated with data gaps......remains to be tested.



Working hypothesis:

- Floats are likely to be damaged when surfacing within partially ice-covered region (during the onset of winter).

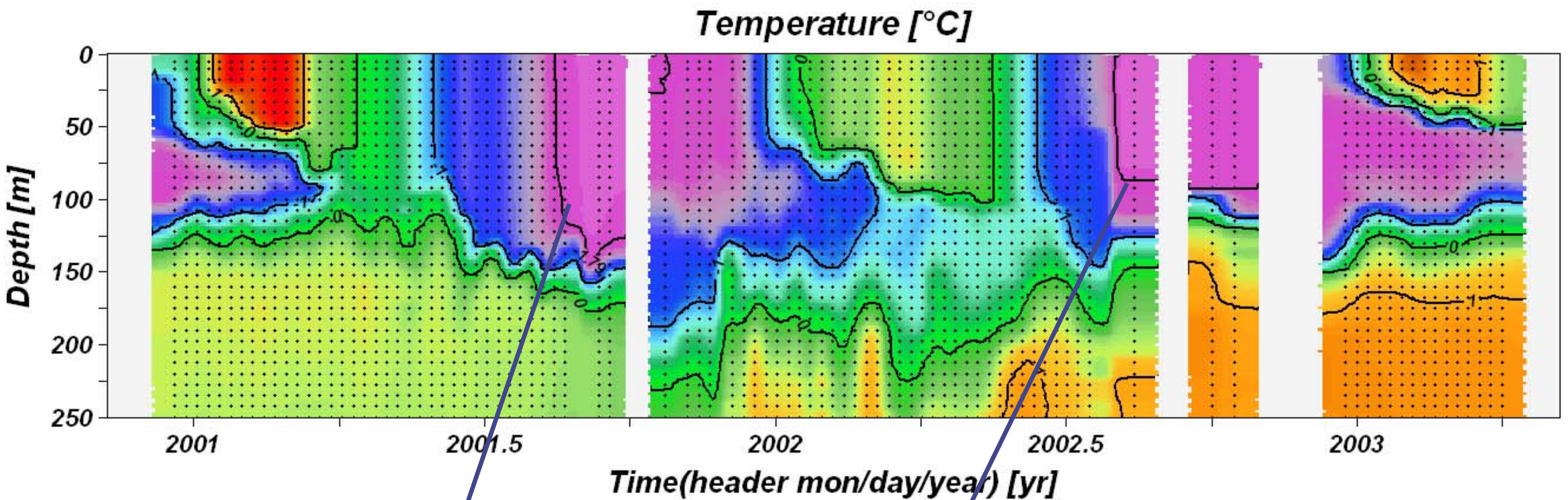
It is not sufficient to detect ice on top of float when surfacing

- Local statement – neglects ice drift during time at surface (ARGOS transmissions)
- Energy budget and costs limit potential sensors for ice detection

Alternative approach

- Determine likeliness of ice presence by considering near-surface temperature profile
- Exploit wintertime surface thermostat
- Integral statement on ice conditions
- No need of additional sensor

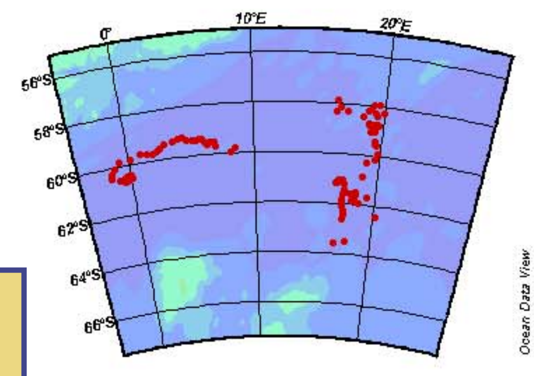
Temperature algorithm



T = -1.79 °C braces missing profiles

Median ($T_{|p=(50,45,40,35,30,25,20\ \mathrm{dbar})} \leq -1.79$ °C):

-> abort surface attempt



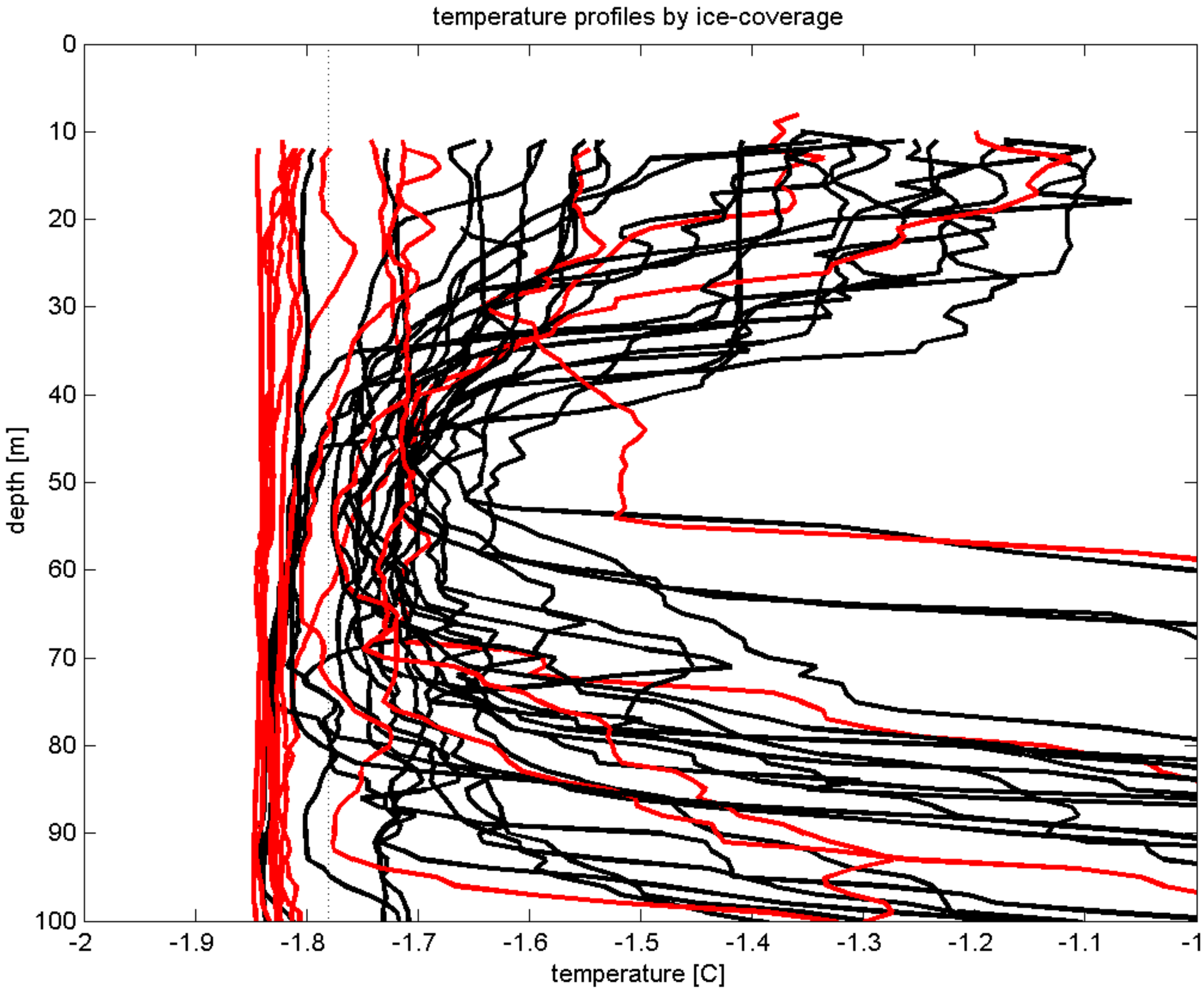
AWI_028

Test: springtime CTD temperature profiles

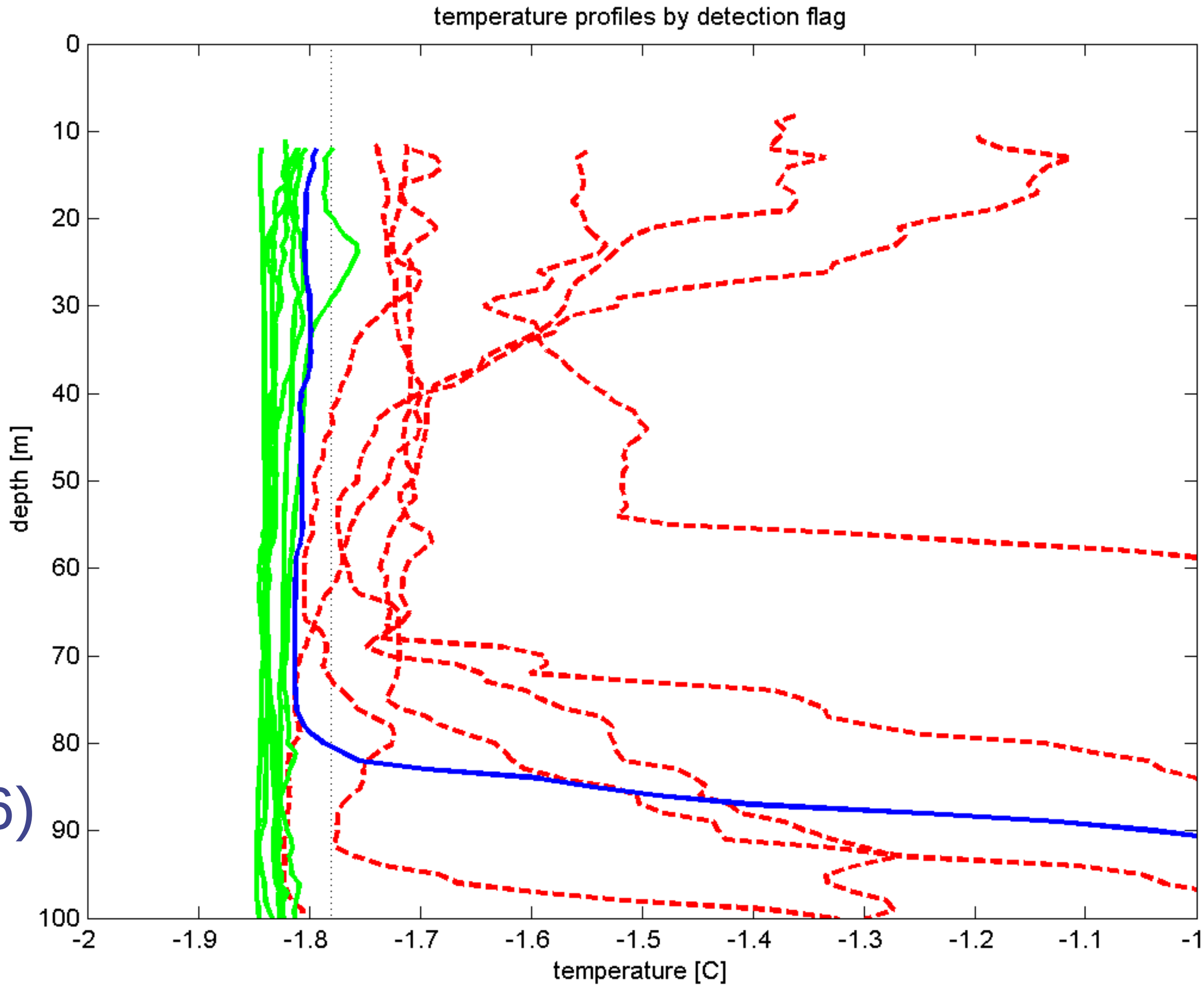
CTD profiles and ice observations from Polarstern

red:
ice coverage > 6

black:
ice coverage ≤ 5



Temperature profiles by detection flag



green:
ice detected (7)

red/dashed:
ice not detected (6)

blue:
detected but no ice (1)

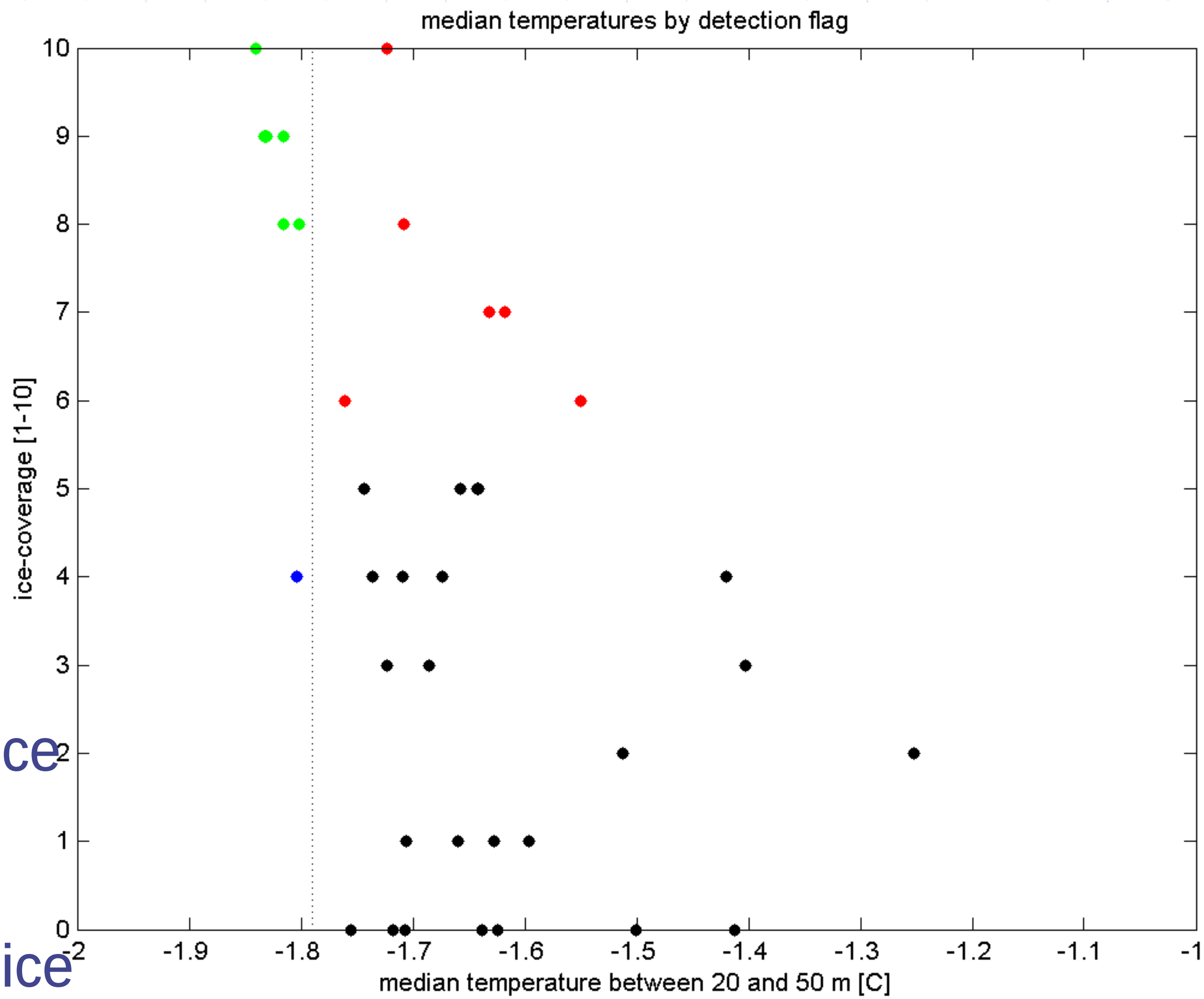
Median temperature by detection flag

green (7):
ice detected

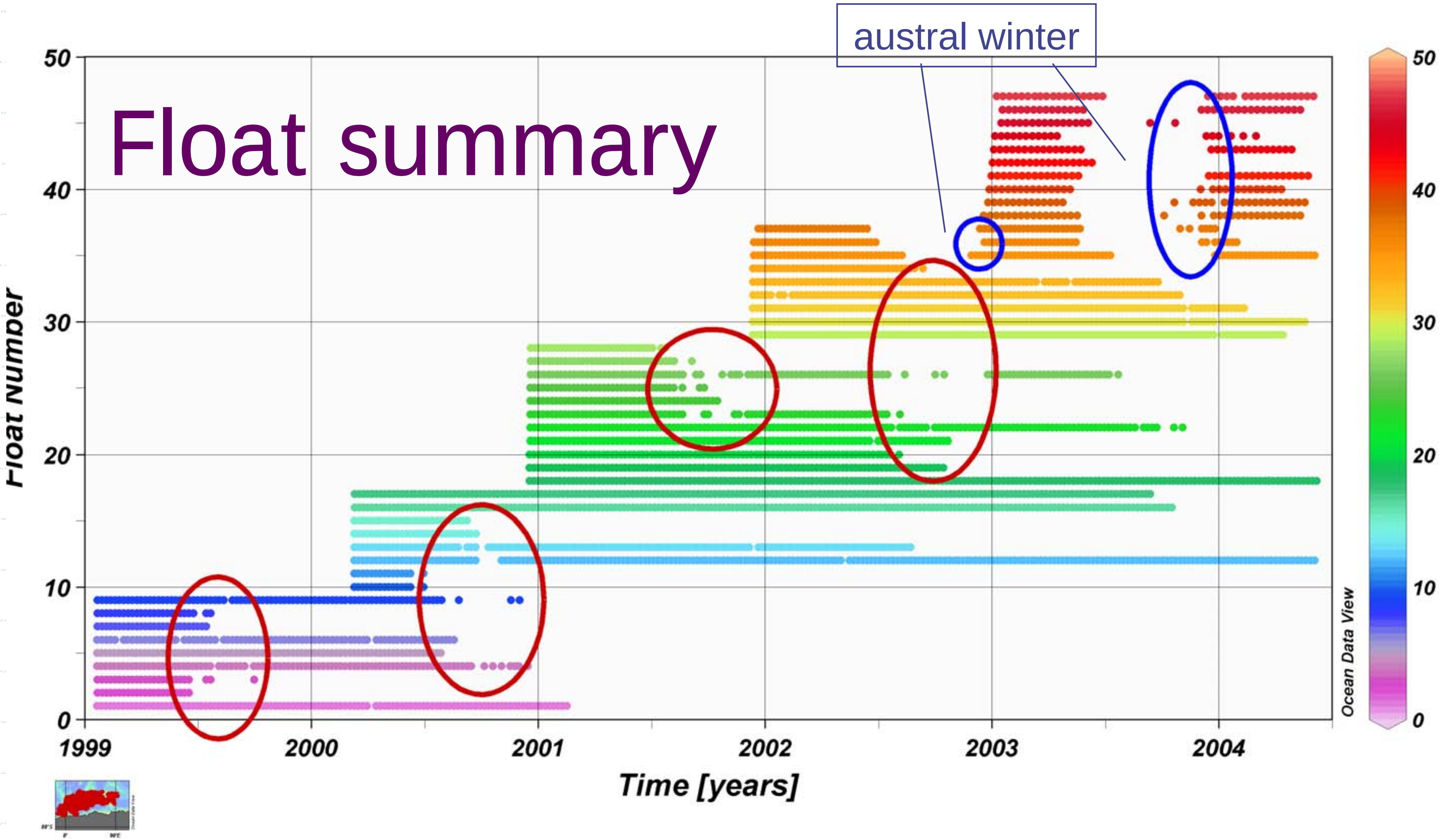
red (6):
ice not detected

blue (1):
detected but little ice

black (16):
no detection, little ice



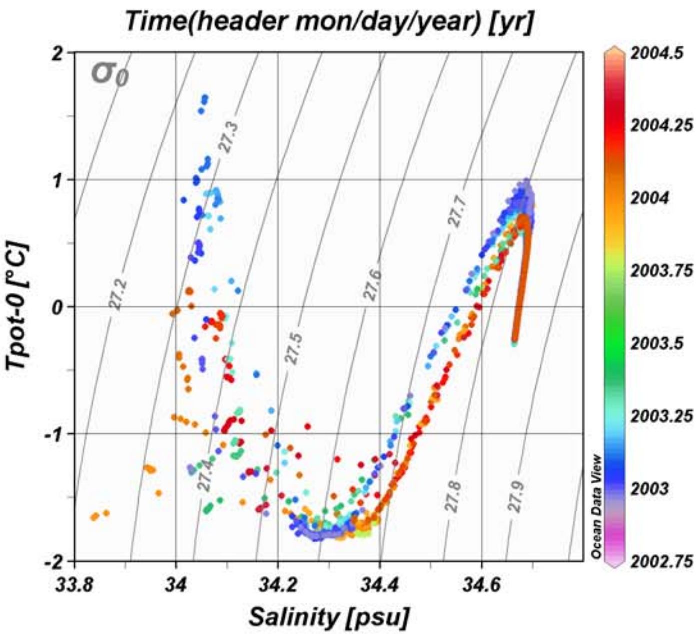
Float summary

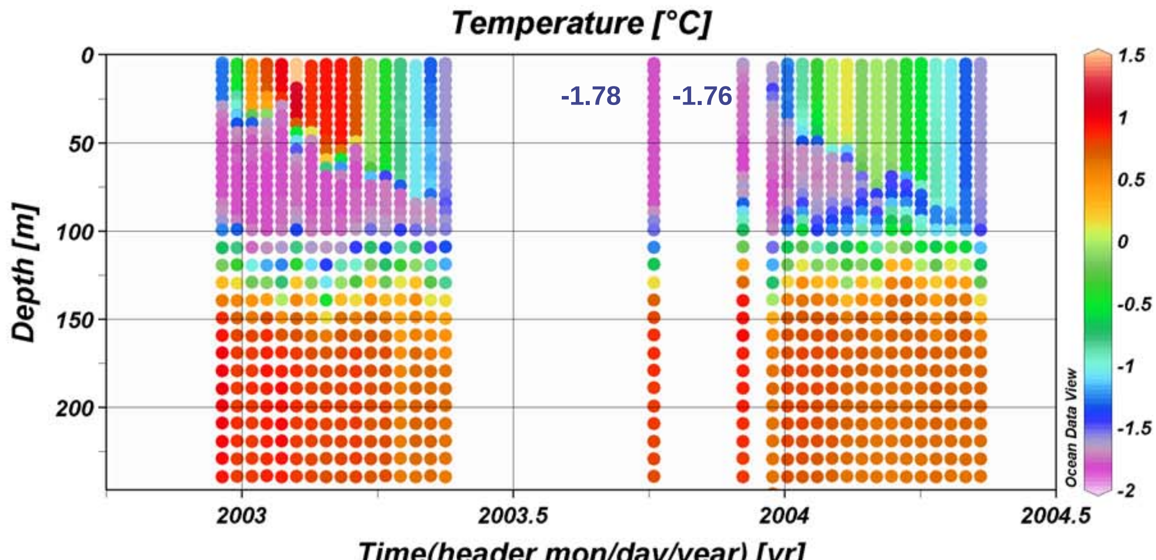


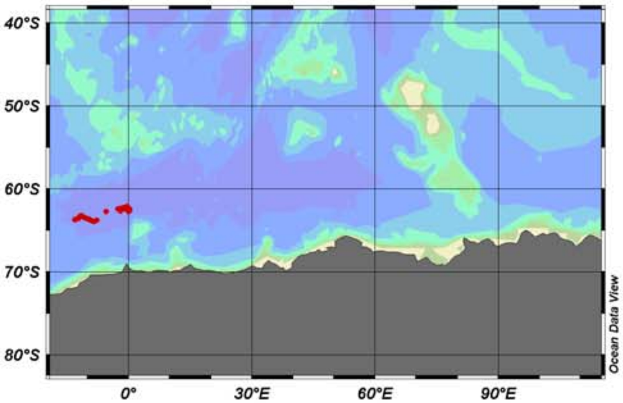
: float die off

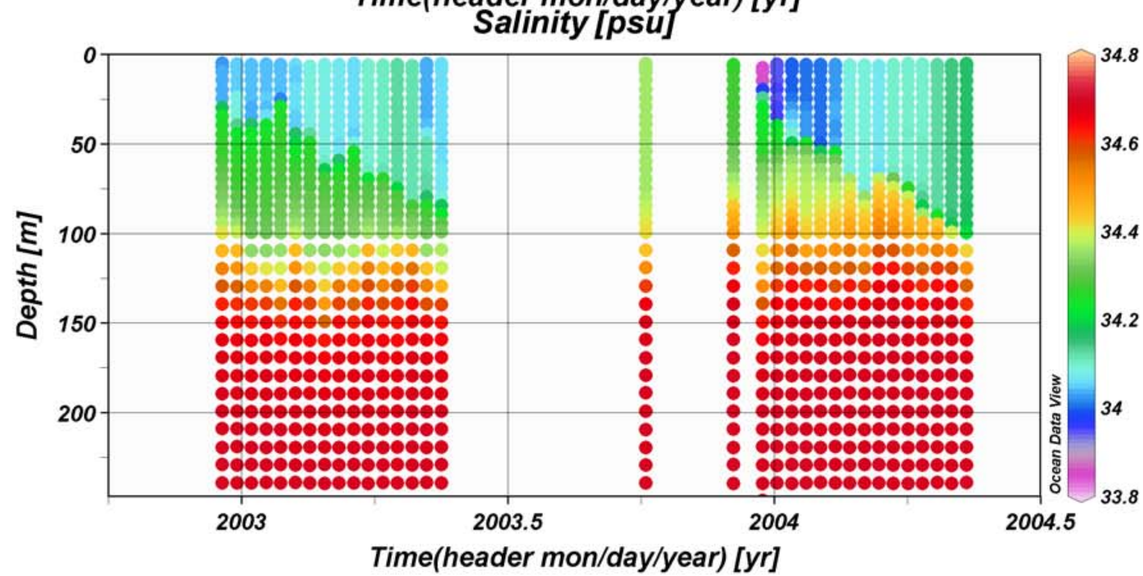
: float bloom

Float AWI 040

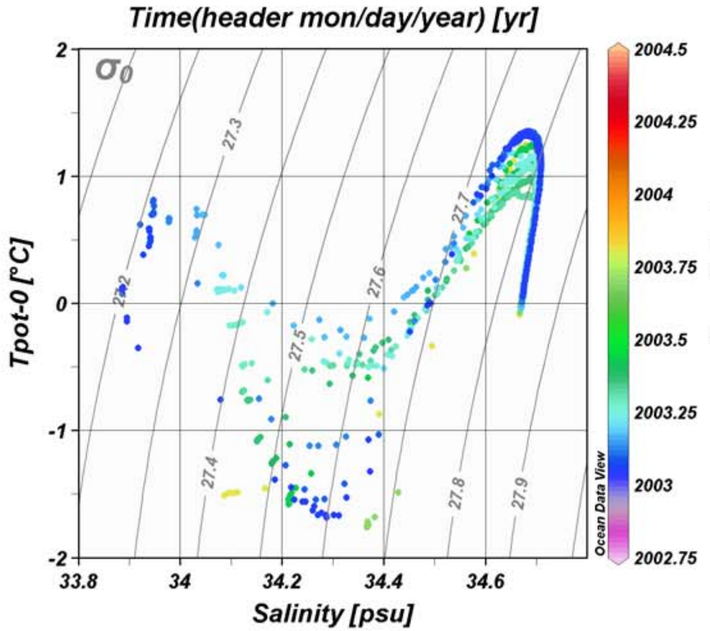


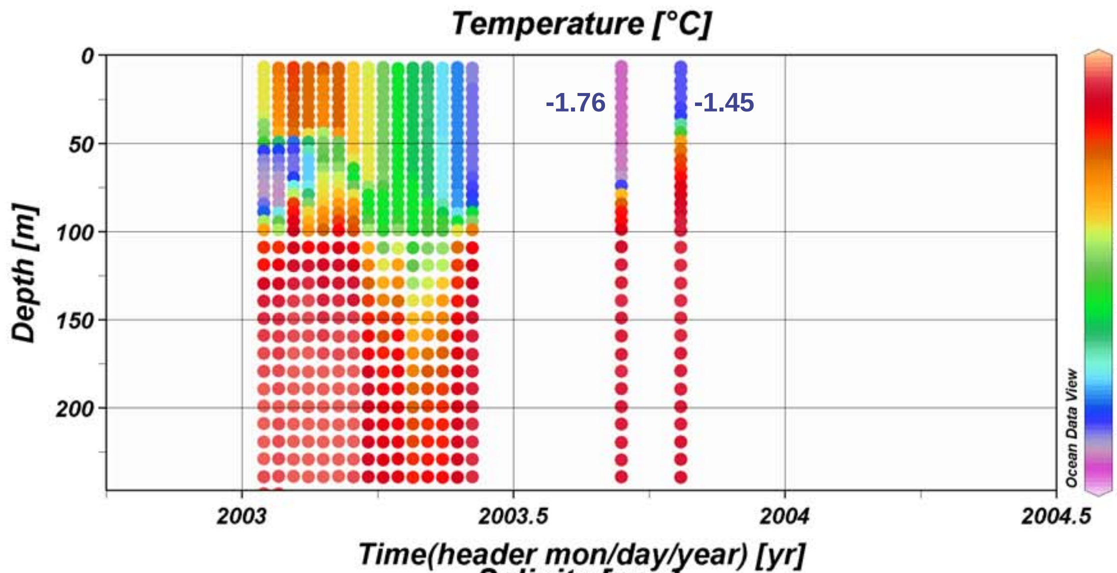


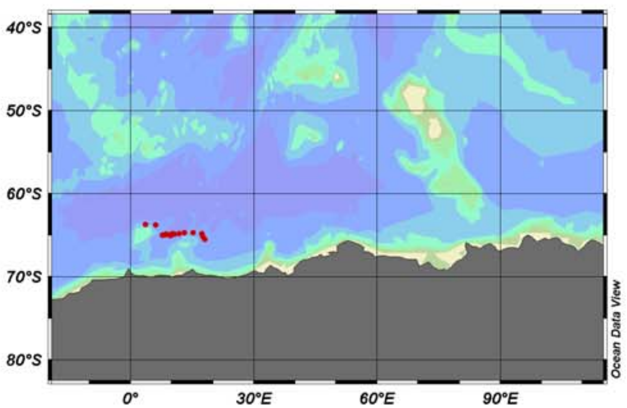


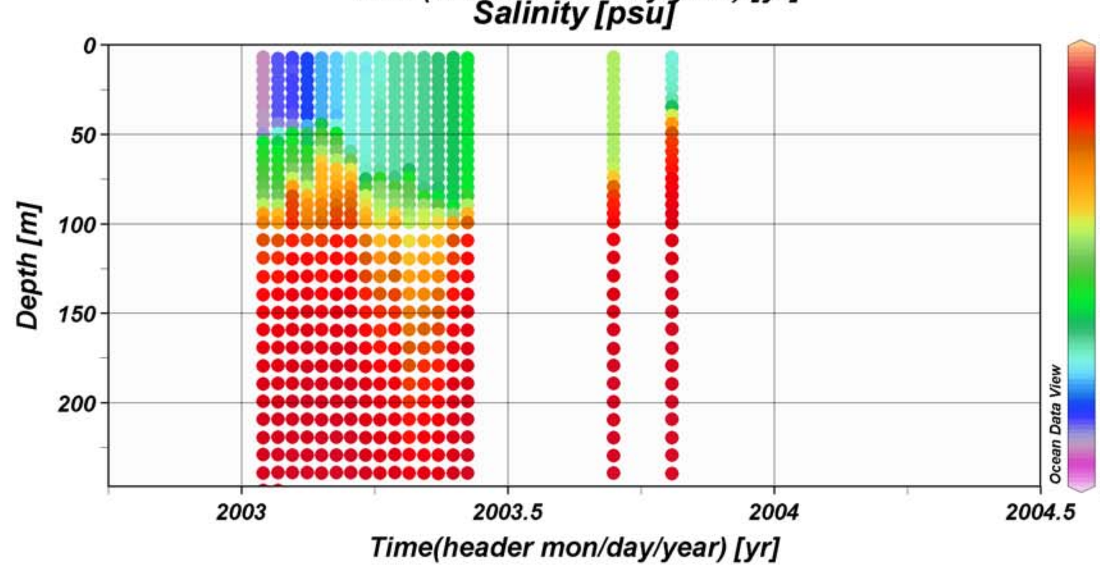


Float AWI 047







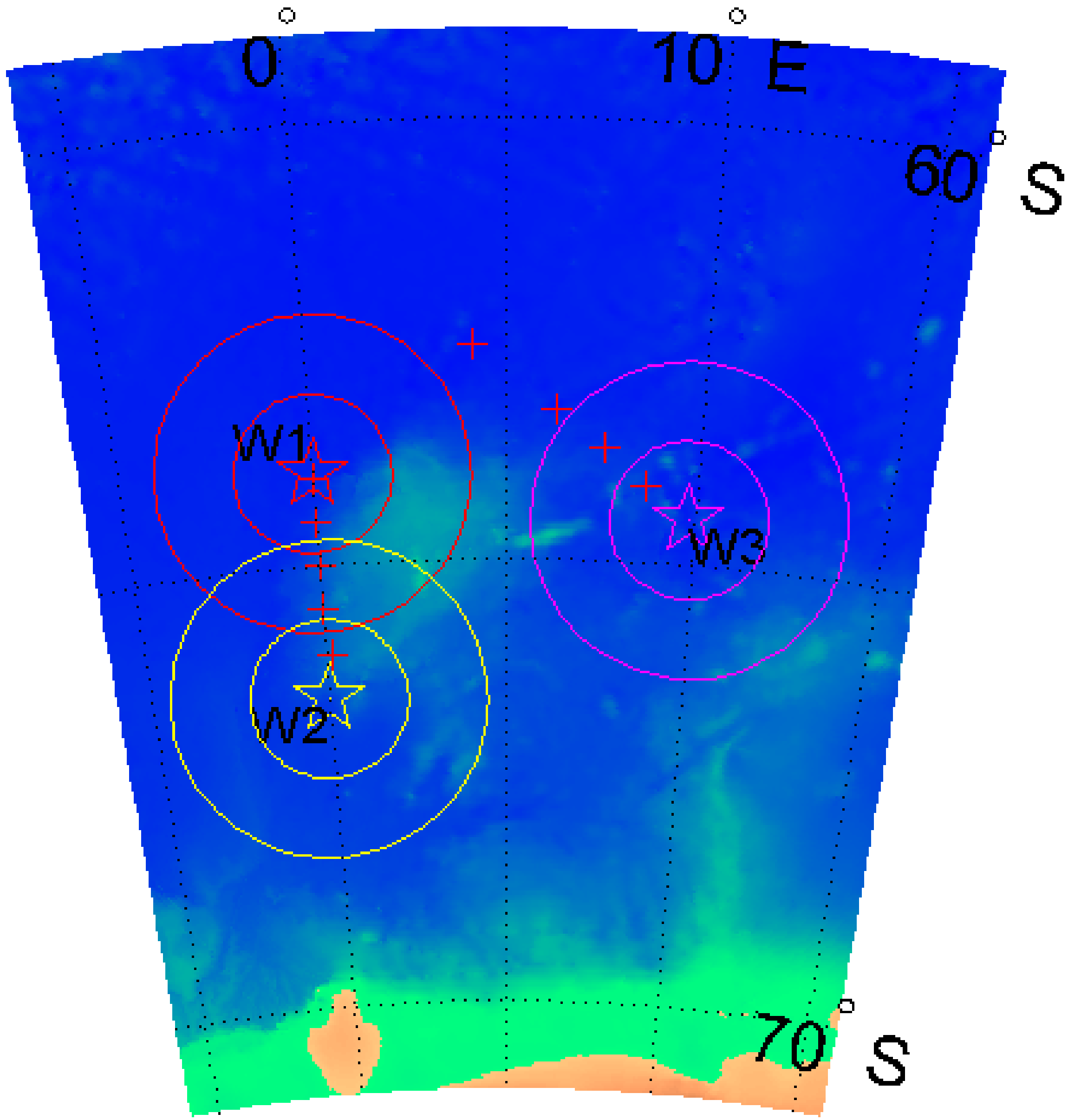


MARE

Maud Rise Pilot Experiment
2003 - 2004

3 Standard Sosos
(260 Hz, 80s)
9 RAFOS floats

5 surfaced
600 – 700 km
Minimum range
in winter



Present status

Ice sensing algorithm (ISA)	RAFOS	Interim storage
Checks temperature in upper 50m, ascent aborted if near freezing	Provides subsurface profile position when surfacing impossible	Provides delayed mode profile when surfacing impossible
Tested successfully in 2002/3 with 3 and 2003/4 with 13 APEX floats, about 80% survival rate.	Tested in 2003/4 with 5 RAFOS floats: tracking range at least 600 km throughout season. 5 APEX currently on deployment	- no tests yet –
Now standard for all AWI float orders (APEX and NEMO)	To be ordered for 2004/5 season: 15 (ger. ARGO) & 5 (MERSEA) APEX.	Ordered for 8 NEMO

Further progress

- Extent algorithm
  - Evaluate Arctic conditions
  - Consider coupled abort conditions:
    T, S, t, position
- Float technology
  - Build NEMO (Navigating European Marine Observer)
  - Add GPS receiver and use “missing downlink condition” to abort surfacing attempts
  - Save all profiles for delayed download
  - Increase data transmission speed
  - Use acoustic navigation
- Install acoustic data transmission

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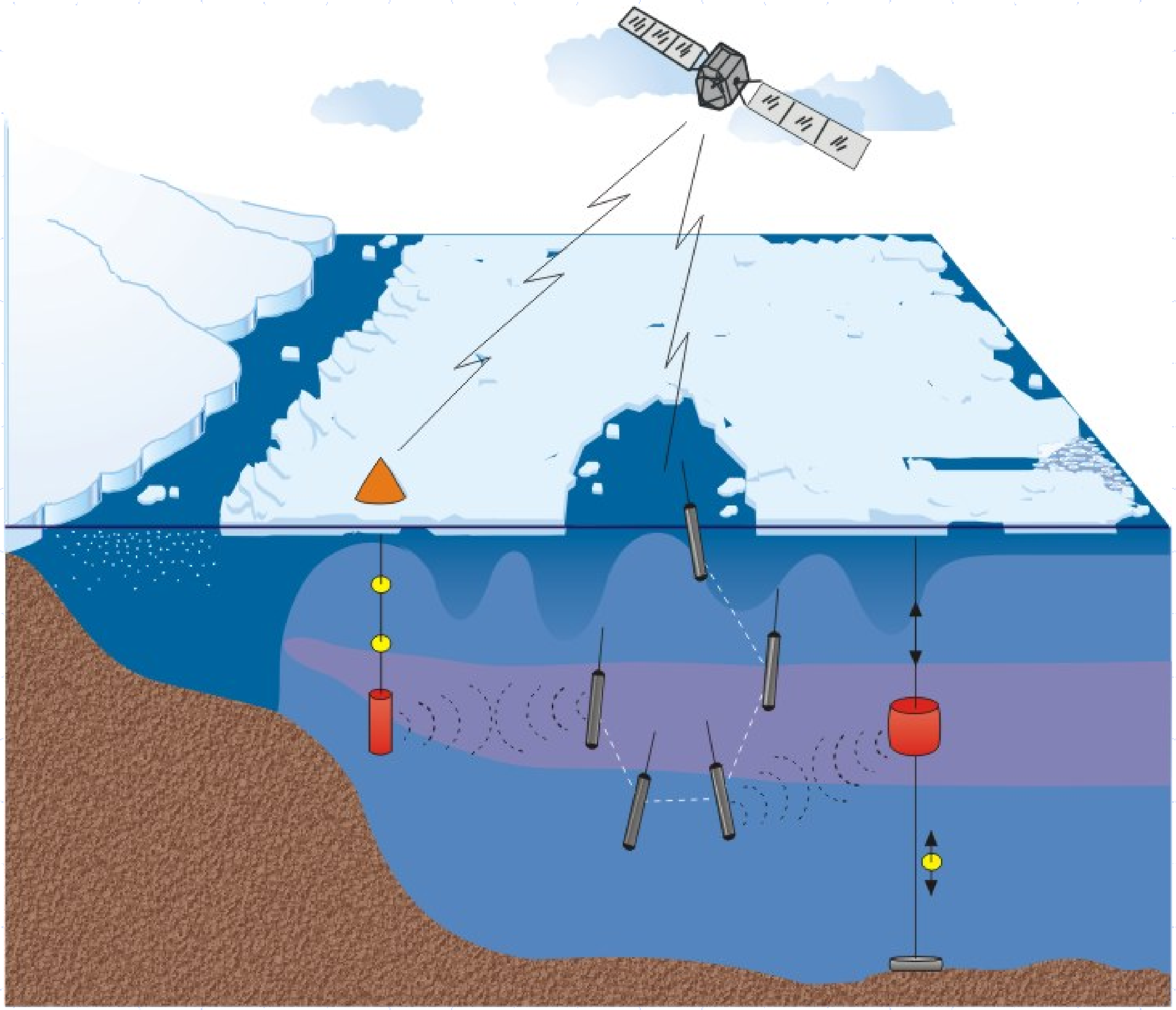
Hybrid Arctic Float System HAFOS



Components of HAFOS

- **75 profiling floats (15 deployments per year)**
  Depth range: 25 m to 1000 m
  Acoustically tracked and transmission of reduced data set: 10 inflection points
  In open water full data transmission by satellite link
- **5 to 10 sea ice drifters (2 redeployments per year)** with
  bi-directional acoustic and satellite communication
  shallow CT sensors
- **5 to 10 moored bases (5 redeployments every second year)** with
  bi-directional acoustic and satellite communication
  deep profiling CTD
  shallow profiling CTD

The HAFOS concept ………………..

- How to extend ARGO into predominantly ice covered oceans?

  - Use SOFAR floats in the Arctic Ocean,
  - tracked by autonomous listening stations (ALS),

  - Add T/S profiling capability to floats,
  - which transmit profiles' EOF parameters acoustically,
  - using time delay method.

  - Sporadic high resolution direct data dump (DDD) when surfacing is possible.

Conclusion: Successful and future steps towards HAFOS

- Determination of the range of the SOFAR under ice

  MARE: Maude Rise Pilot Experiment studies SOFAR/RAFOS ranges with and without sea ice coverage at Maude Rise, Weddell Sea during Jan 2003 to Feb 2004.

  Ranges of 600 – 700 km were found in the Weddell Sea.
- Floats detect and avoid ice

  APEX & NEMO: ARGO type profiling floats modified to estimate likeliness of sea ice and to abort surfacing.

  80% of floats survived the first winter.
- Combine systems of floats, ice drifters and moorings
- Transmit data by acoustics