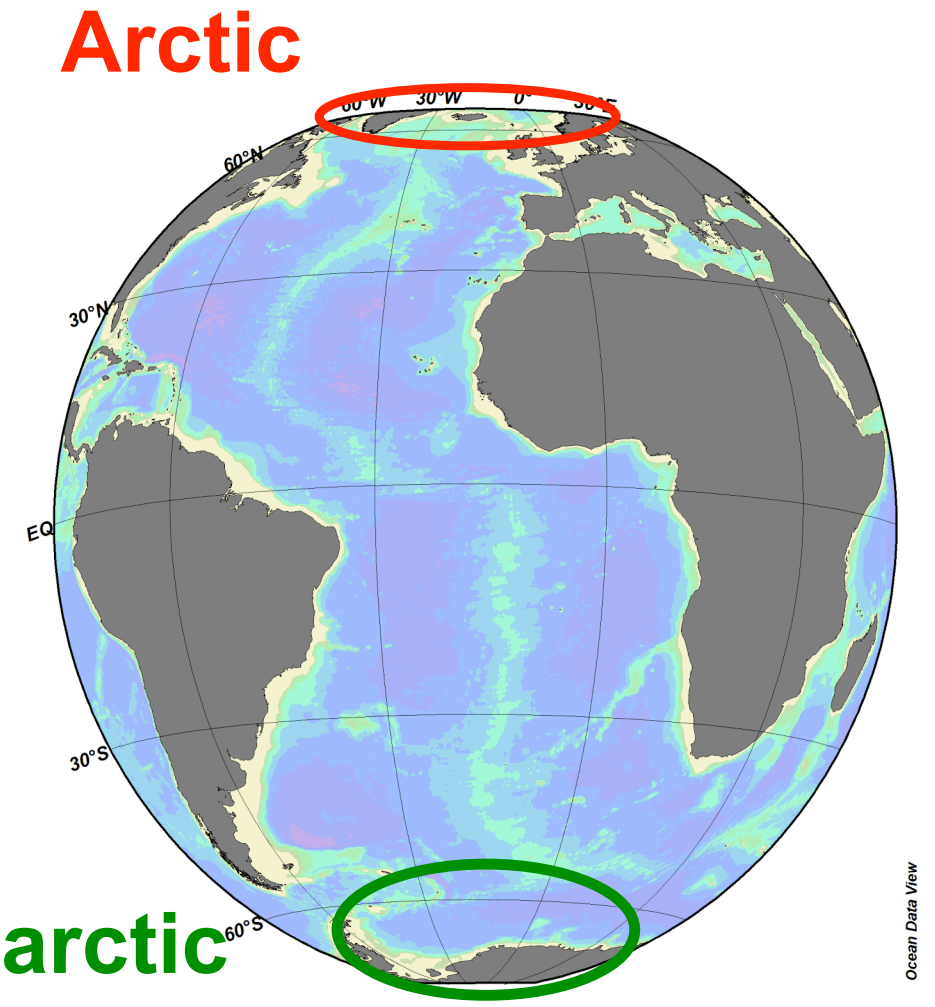
Using Argo under sea ice

Olaf Klatt
Olaf Boebel
Eberhard Fahrbach

Alfred-Wegener-Institut, Bremerhaven

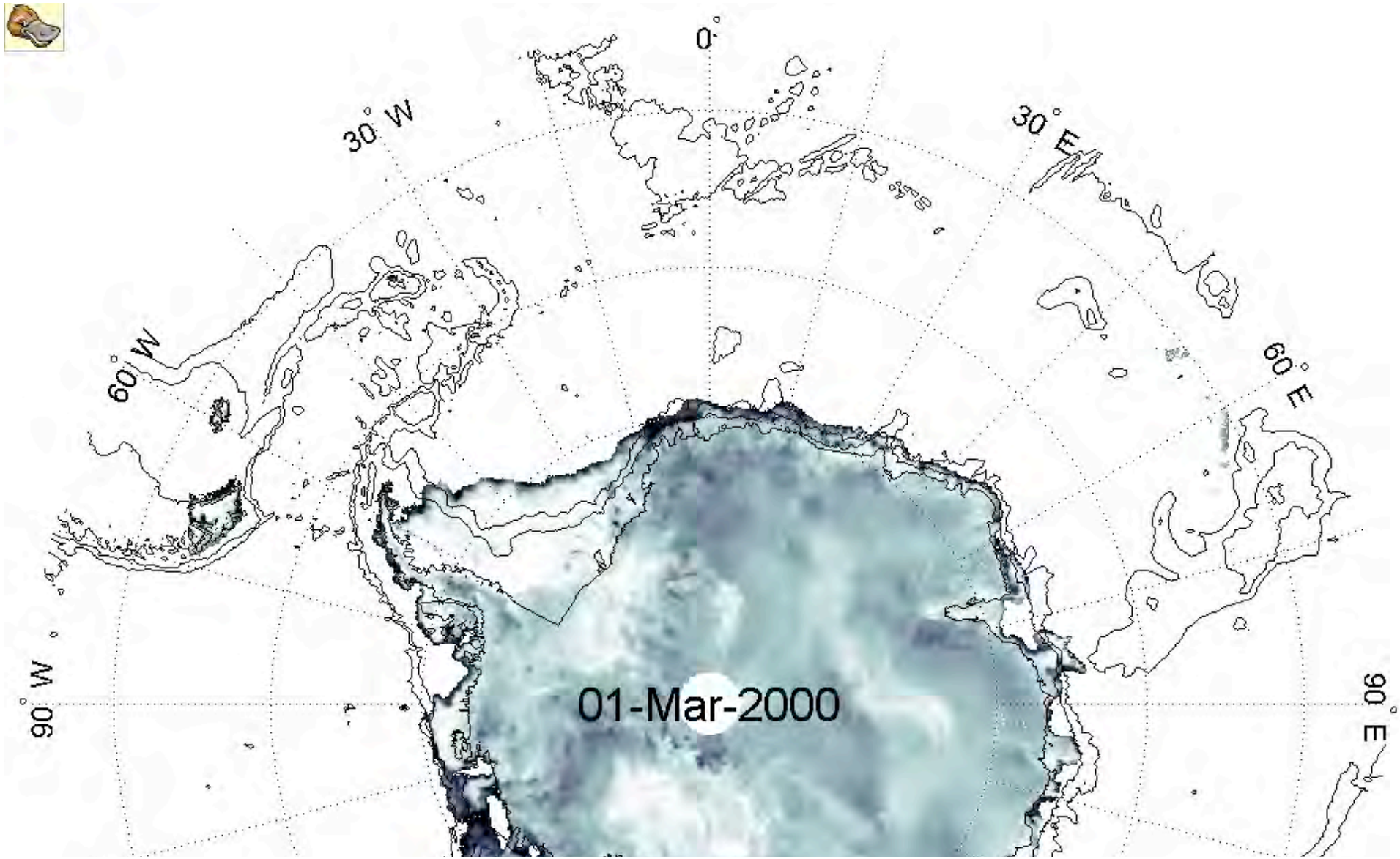


Outline

- Antarctic
  - Towards ice compatible floats
    - Ice Sensing Algorithm
    - Interim Store
    - RAFOS-Receivers
  - Array of Sound sources
- Arctic to be done
  - Arctic ISA
- Outlook

AWI

Floats in the sea ice



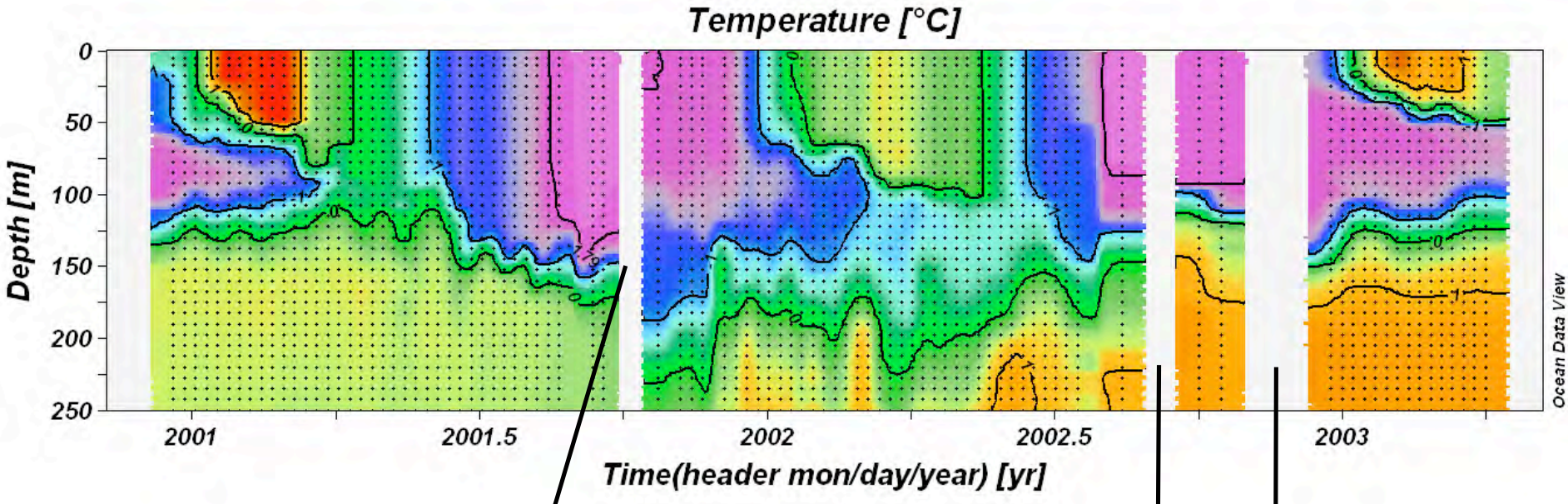
Ice compatibility of Argo floats: a 3 step process

Ice sensing algorithm (ISA) 2003	Interim storage (iStore) 2005	RAFOS 2004
Aborts ascent when sea –ice is expected at the surface	Provides delayed mode profile when surfacing impossible	Provides subsurface profile position when surfacing impossible

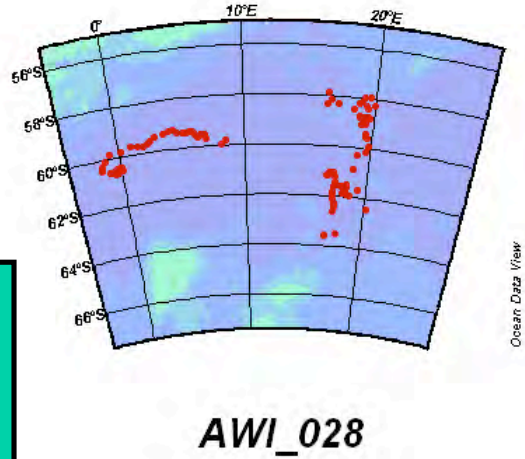
Ice compatibility of Argo floats: a 3 step process

Ice sensing algorithm (ISA) 2003	Interim storage (iStore) 2005	RAFOS 2004
Aborts ascent when sea –ice is expected at the surface	Provides delayed mode profile when surfacing impossible	Provides subsurface profile position when surfacing impossible

Ice Sensing Algorithm



T = -1.79 °C braces missing profiles

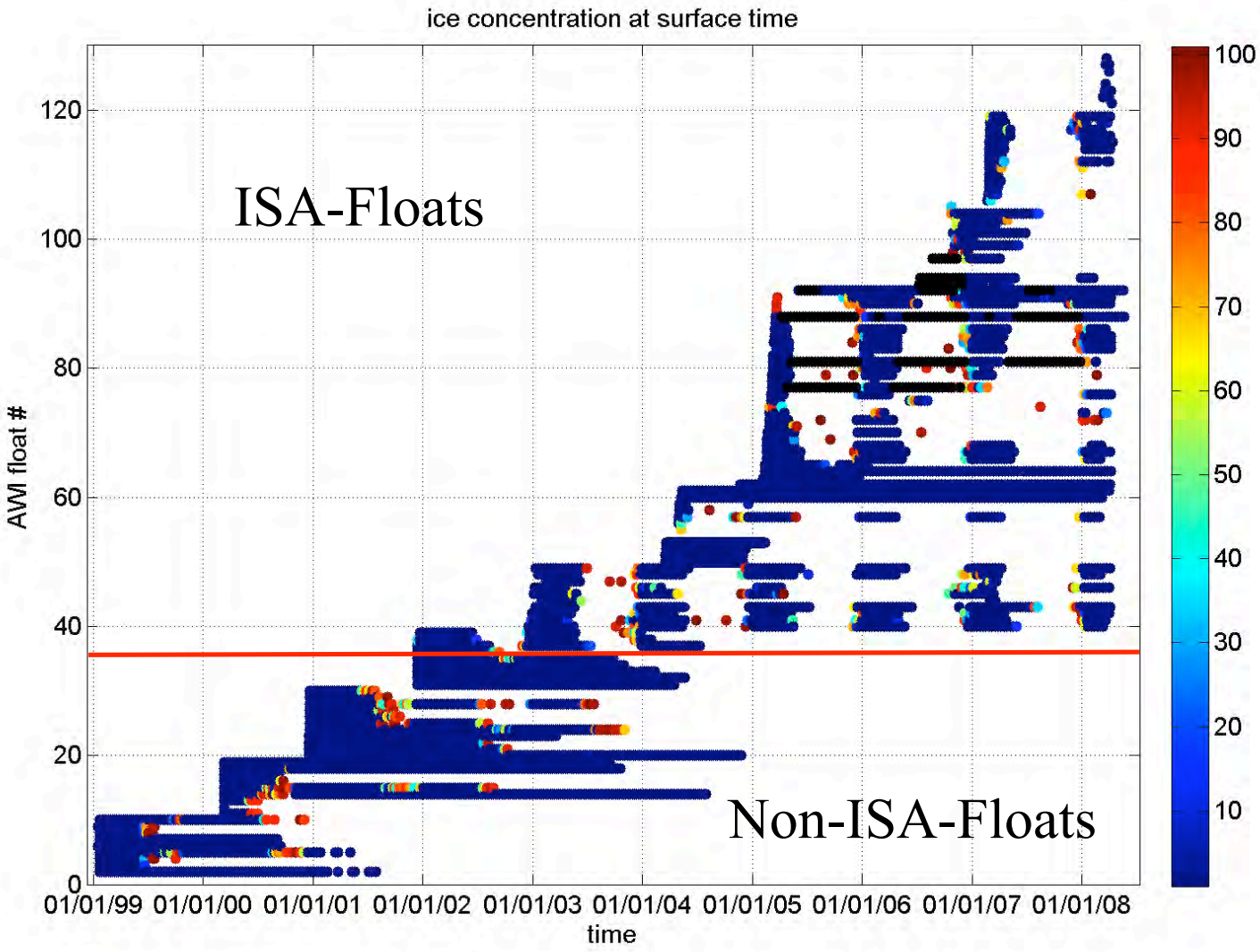


AWI_028

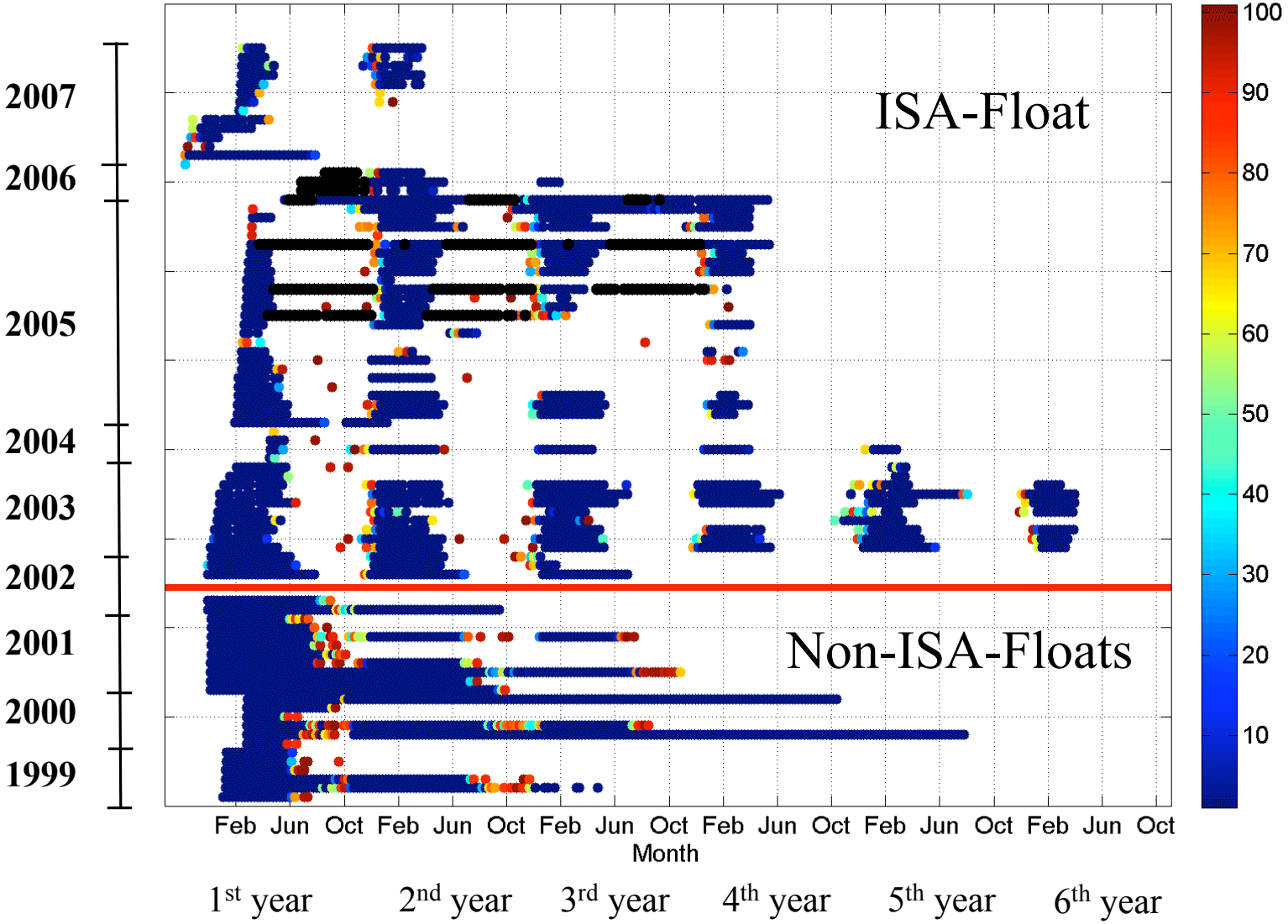
Median ($T_{|p=(50,45,40,35,30,25,20\ dbar)}$ ≤ -1.79 °C):

-> abort surface attempt

Floats vs. ice coverage

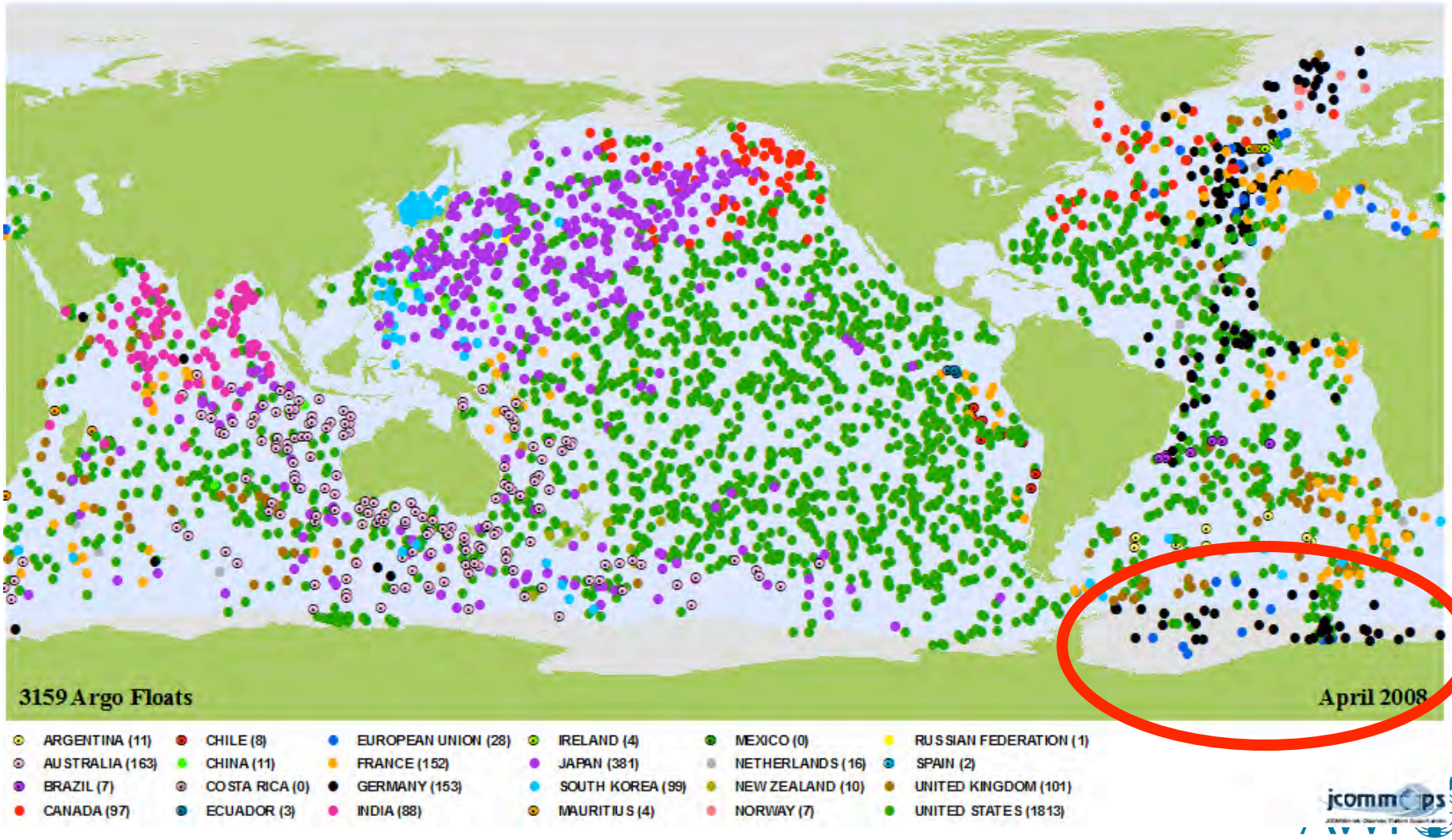


Floats vs. ice coverage

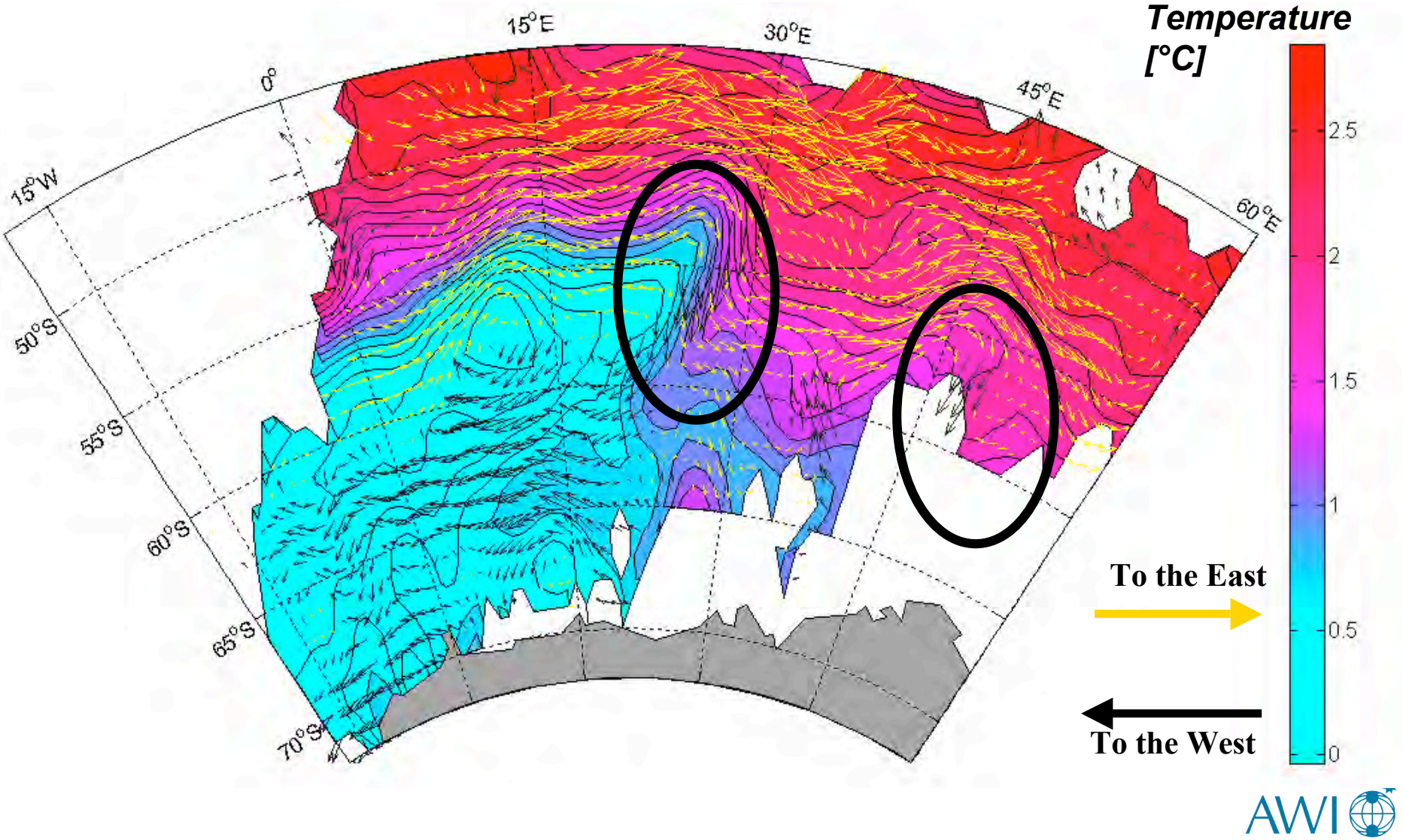


AWI

Recent ARGO float distribution



Velocity vs. temperature



Ice compatibility of Argo floats: a 3 step process

Ice sensing algorithm (ISA) 2003	Interim storage (iStore) 2005	RAFOS 2004
Aborts ascent when sea –ice is expected at the surface	Provides delayed mode profile when surfacing impossible	Provides subsurface profile position when surfacing impossible
Succesfully 80% survival rate modifications are planed		

AWI

Ice compatibility of Argo floats: a 3 step process

Ice sensing algorithm2 (ISA2) 2007	Interim storage (iStore) 2005	RAFOS 2004
Aborts ascent when sea –ice is expected at the surface **+Retarded response**	Provides delayed mode profile when surfacing impossible	Provides subsurface profile position when surfacing impossible
Successful **Update under test**		

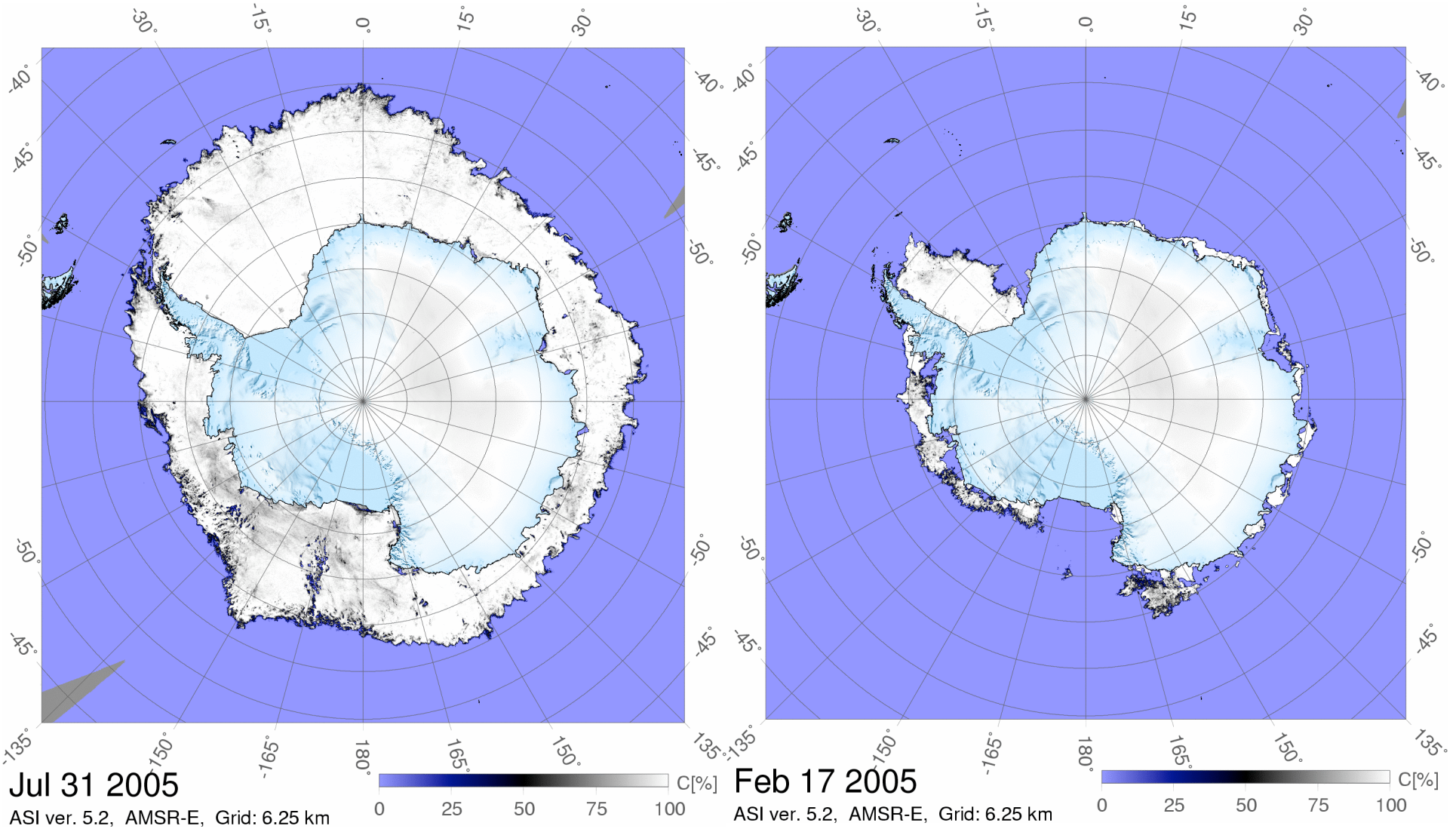
AWI

Ice compatibility of Argo floats: a 3 step process

Ice sensing algorithm2 (ISA2) 2007	**Interim storage (iStore) 2005**	RAFOS 2004
Aborts ascent when sea –ice is expected at the surface +Retarded response	**Provides delayed mode profile when surfacing impossible**	Provides subsurface profile position when surfacing impossible
Successful Update under test		

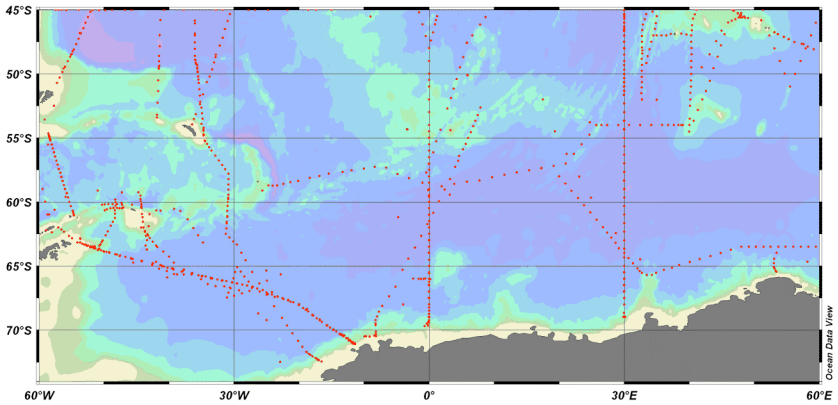
AWI

Interim data Storage (iStore)



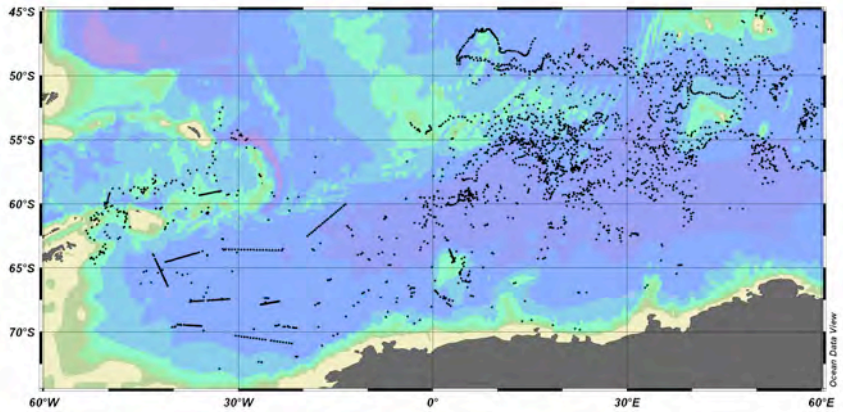
Weddell Sea data

WOCE: CTD-stations winter



< 300 CTD casts

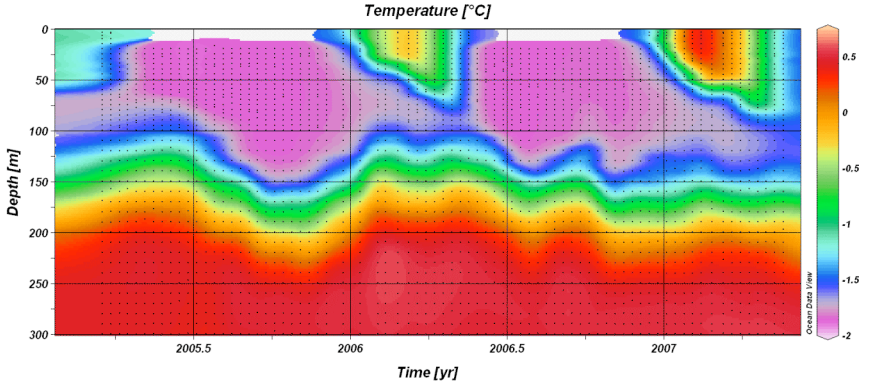
AWI floats winter

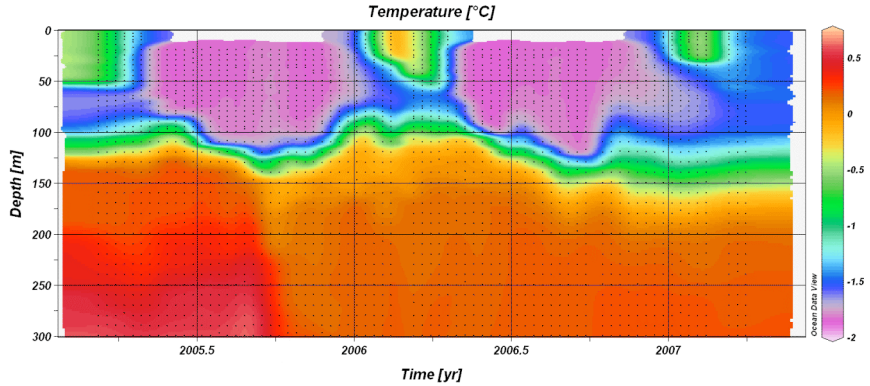


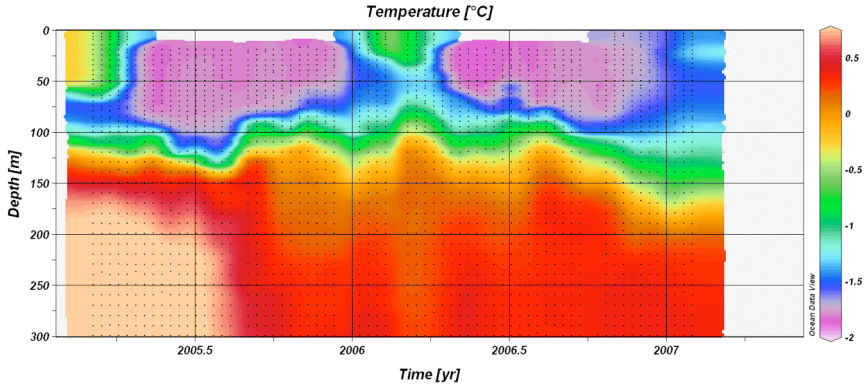
2500 float profiles

AWI

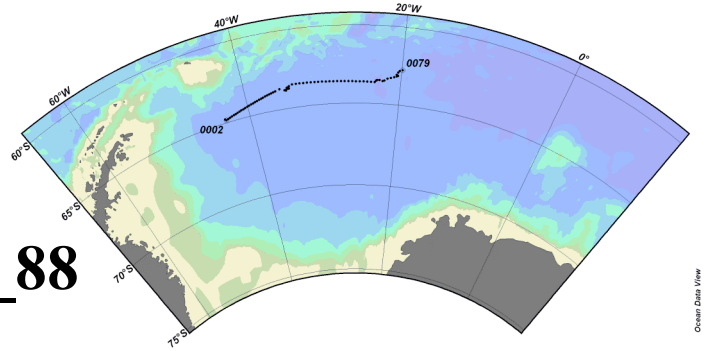
All-season data: Temperature



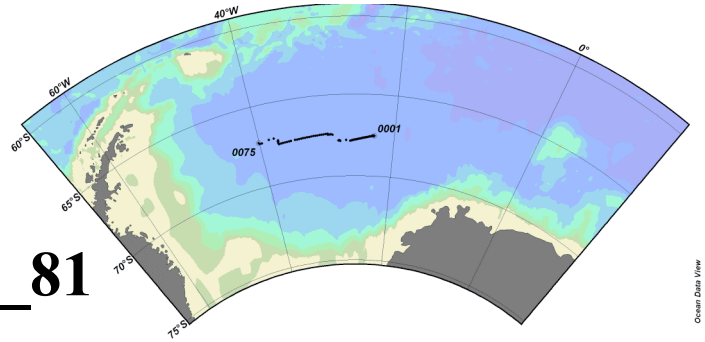




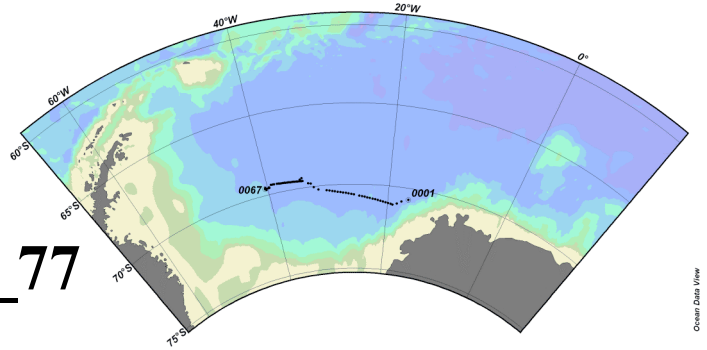
AWI_88



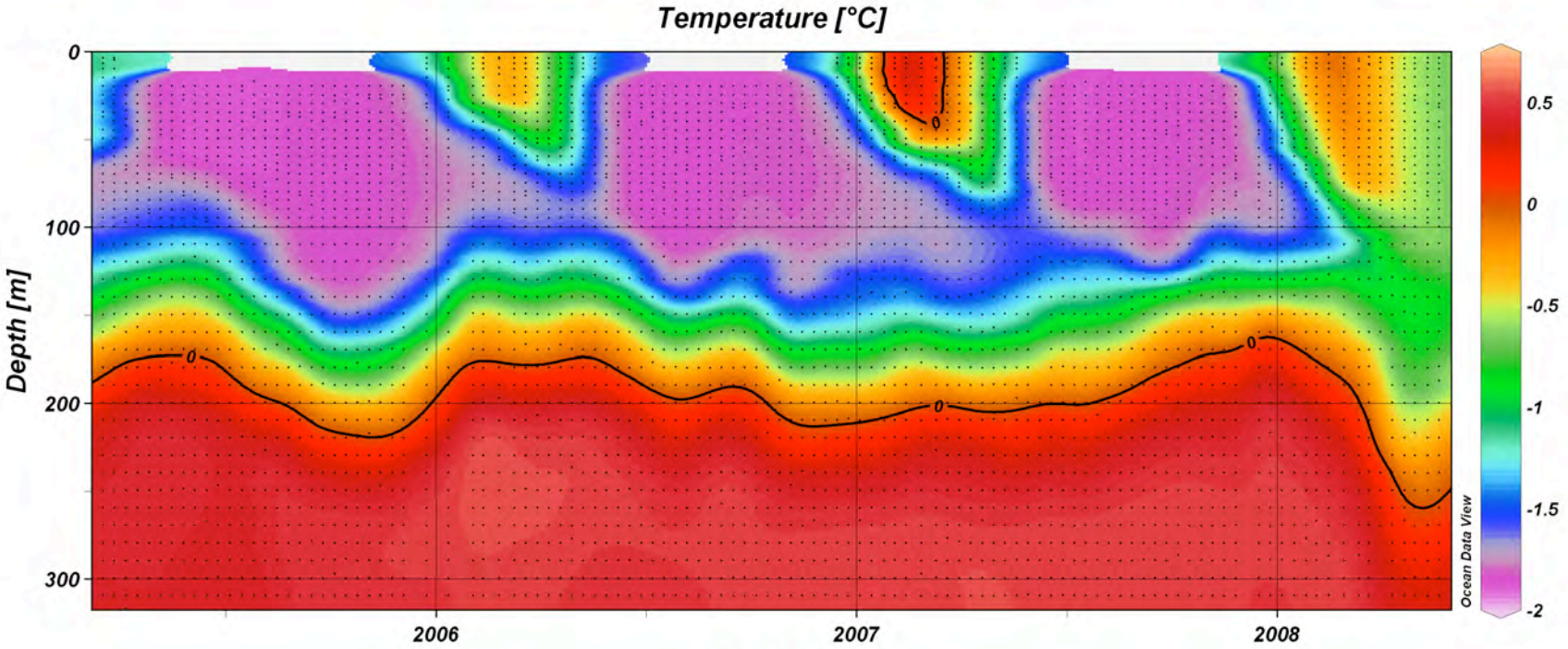
AWI_81

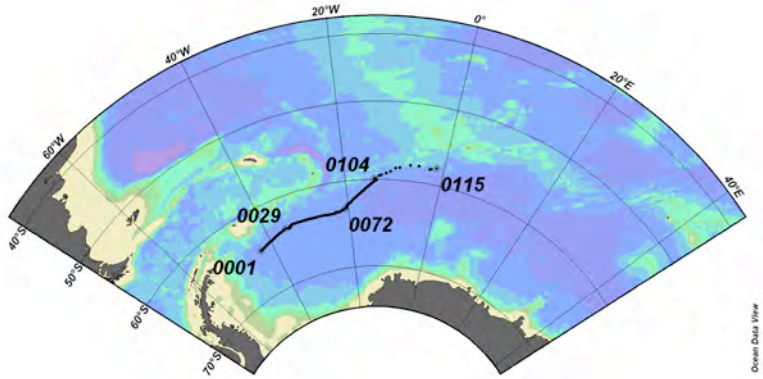


AWI_77



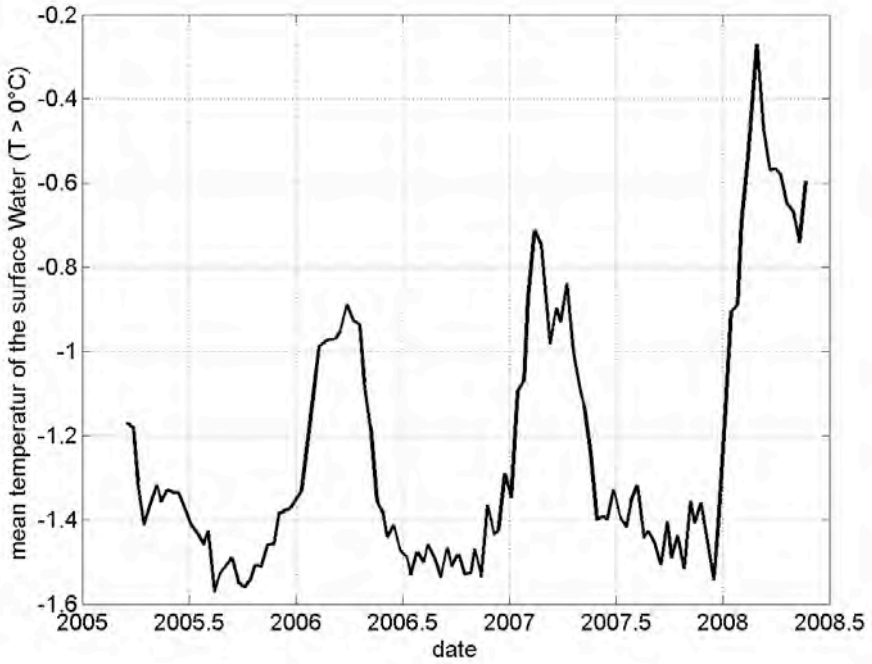
All-season data: Temperature

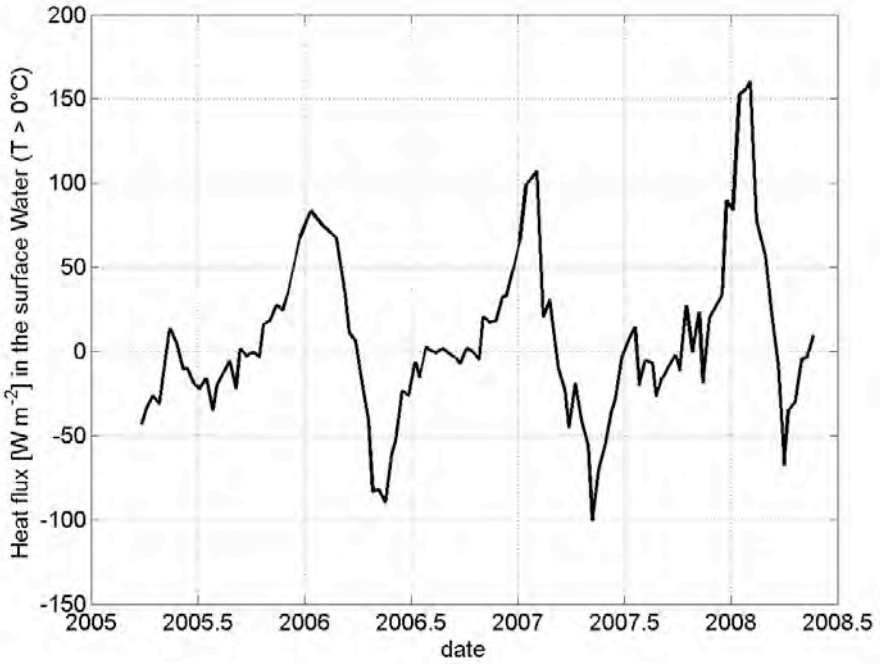


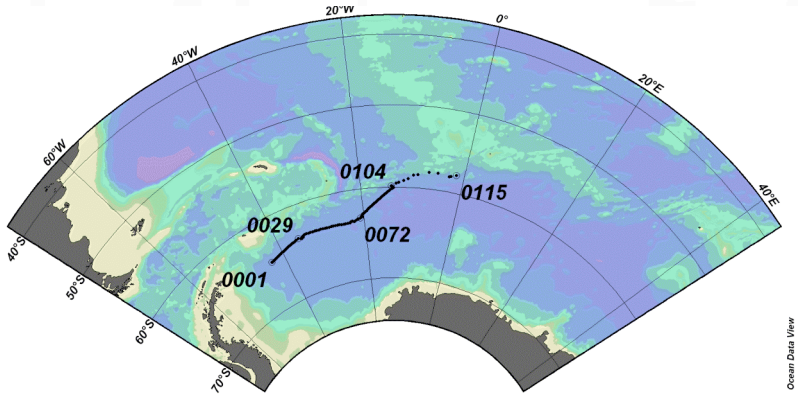


AWI_088
wmo number: 7900086

All-season data: Temperature

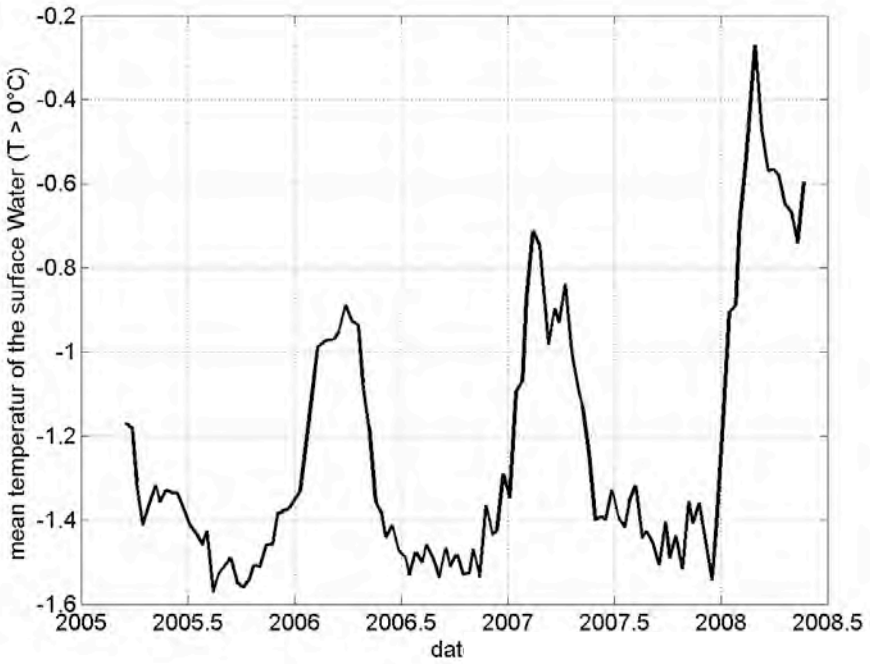


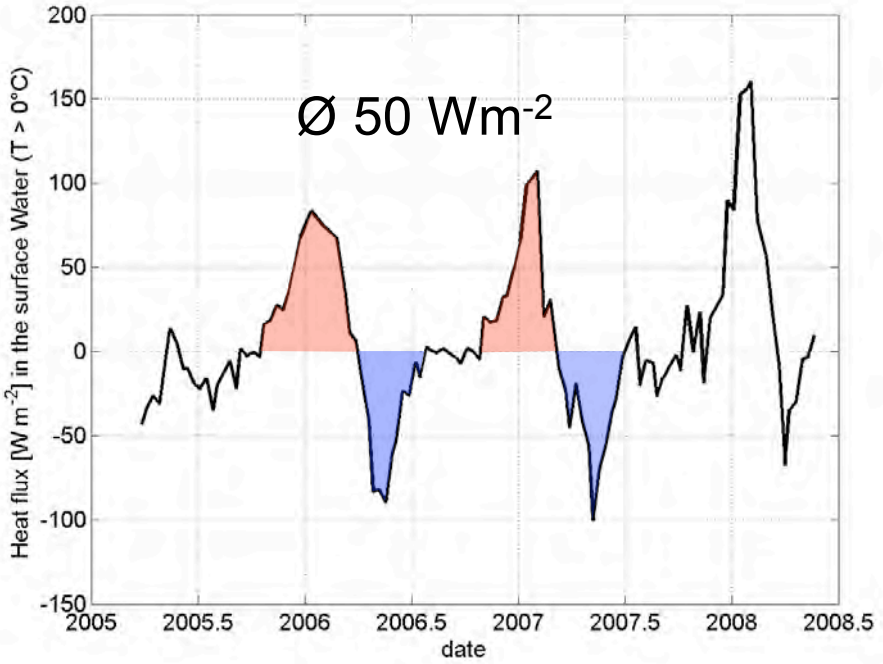


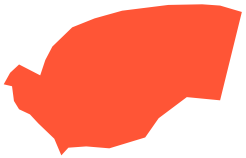


AWI_088
wmo number: 7900086

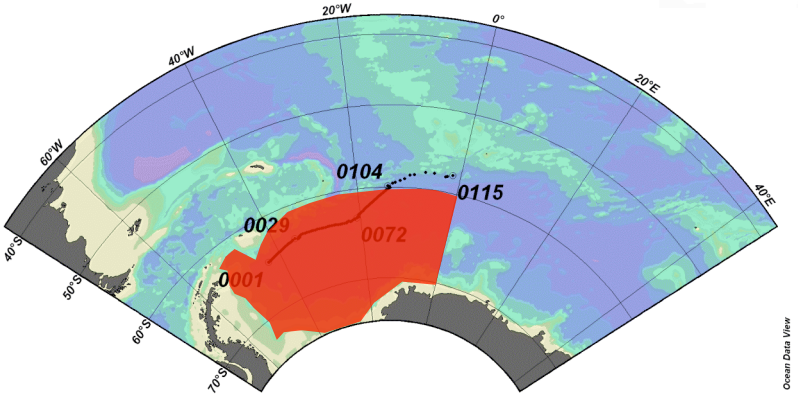
All-season data: Temperature

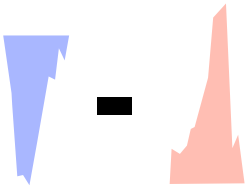






≈ 4 · 10⁶ km²
→ 200TW
seasonal heat flux



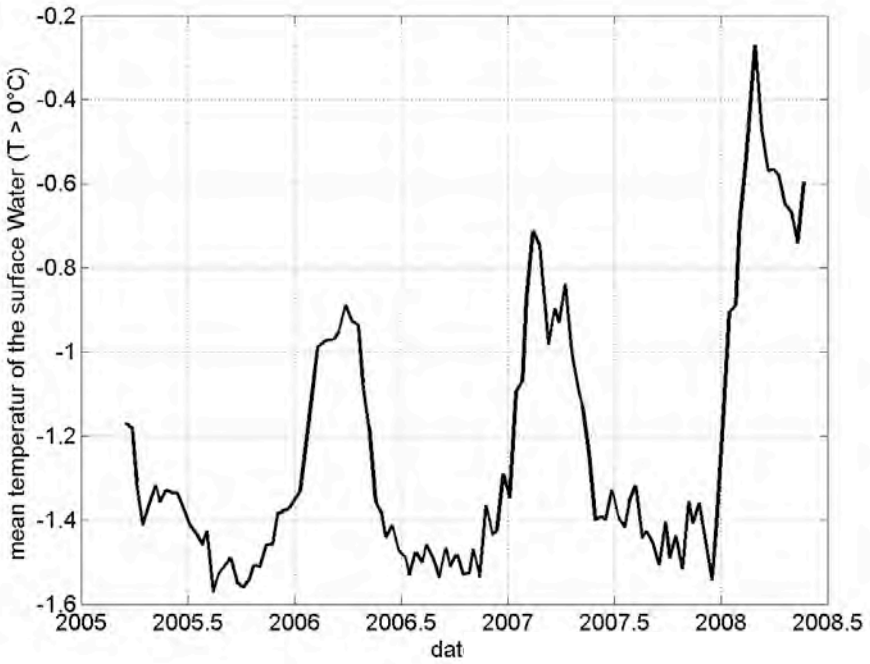


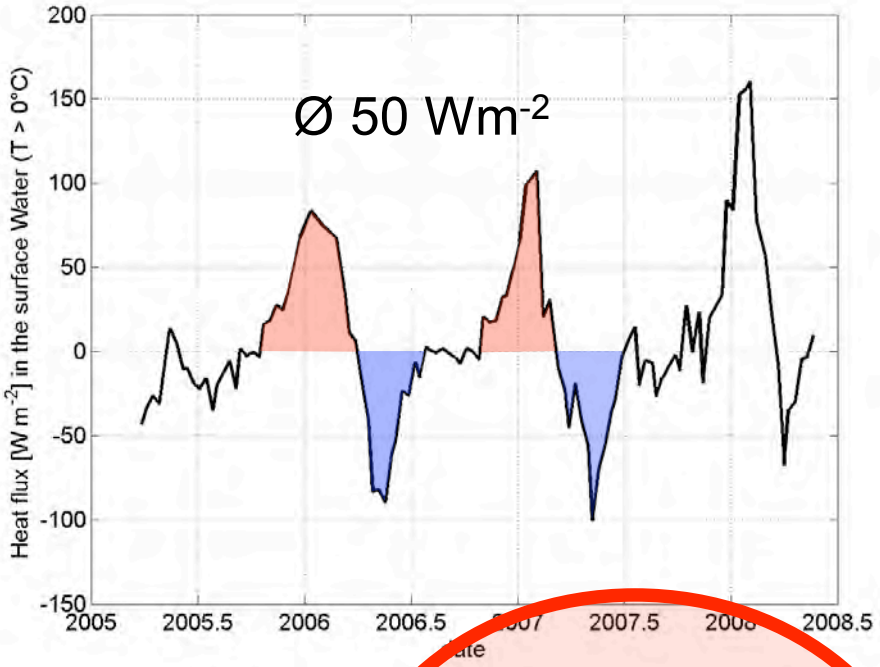
-

?

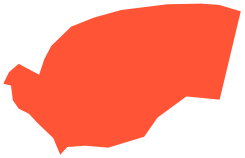
AWI

All-season data: Temperature

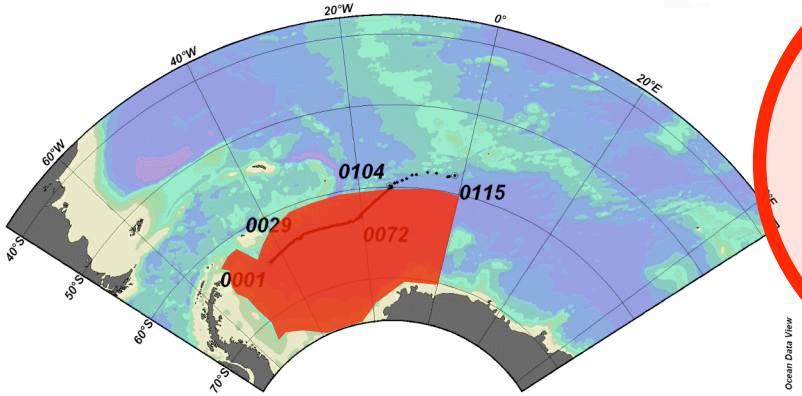


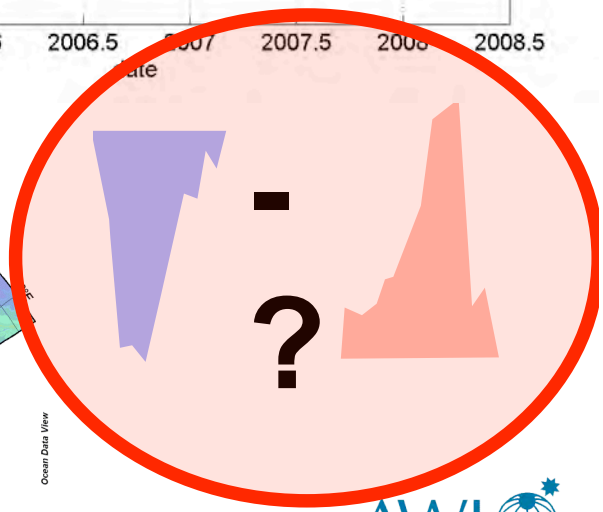


Ø 50 Wm^{-2}



≈ 4 · 10^6 km^2





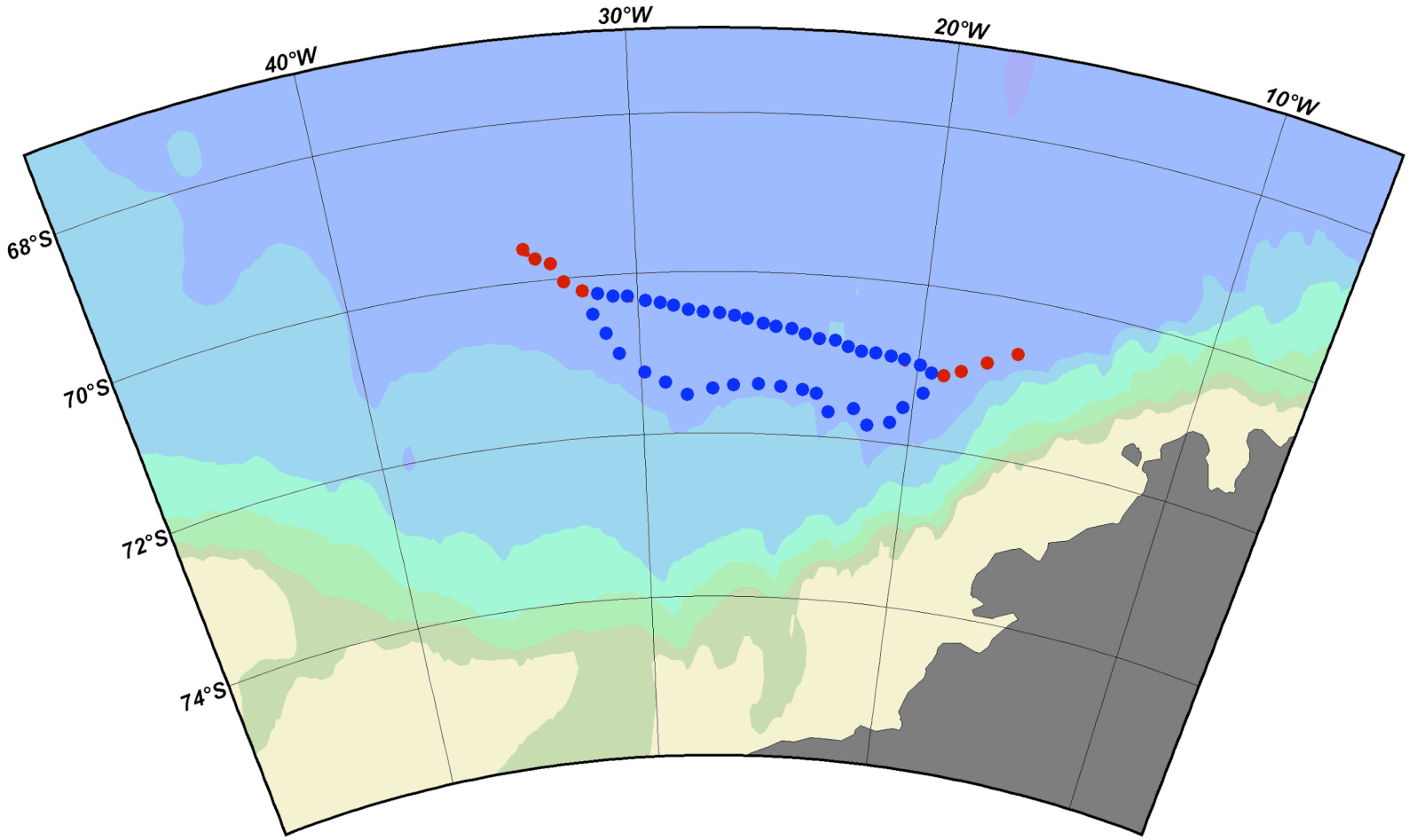
AWI

Ice compatibility of Argo floats: a 3 step process

Ice sensing algorithm2 (ISA2) 2007	**Interim storage (iStore) 2005**	RAFOS 2004
Aborts ascent when sea –ice is expected at the surface +Retarded response	**Provides delayed mode profile when surfacing impossible**	Provides subsurface profile position when surfacing impossible
Successful Update under test	**Successful**	

AWI

Need of RAFOSs

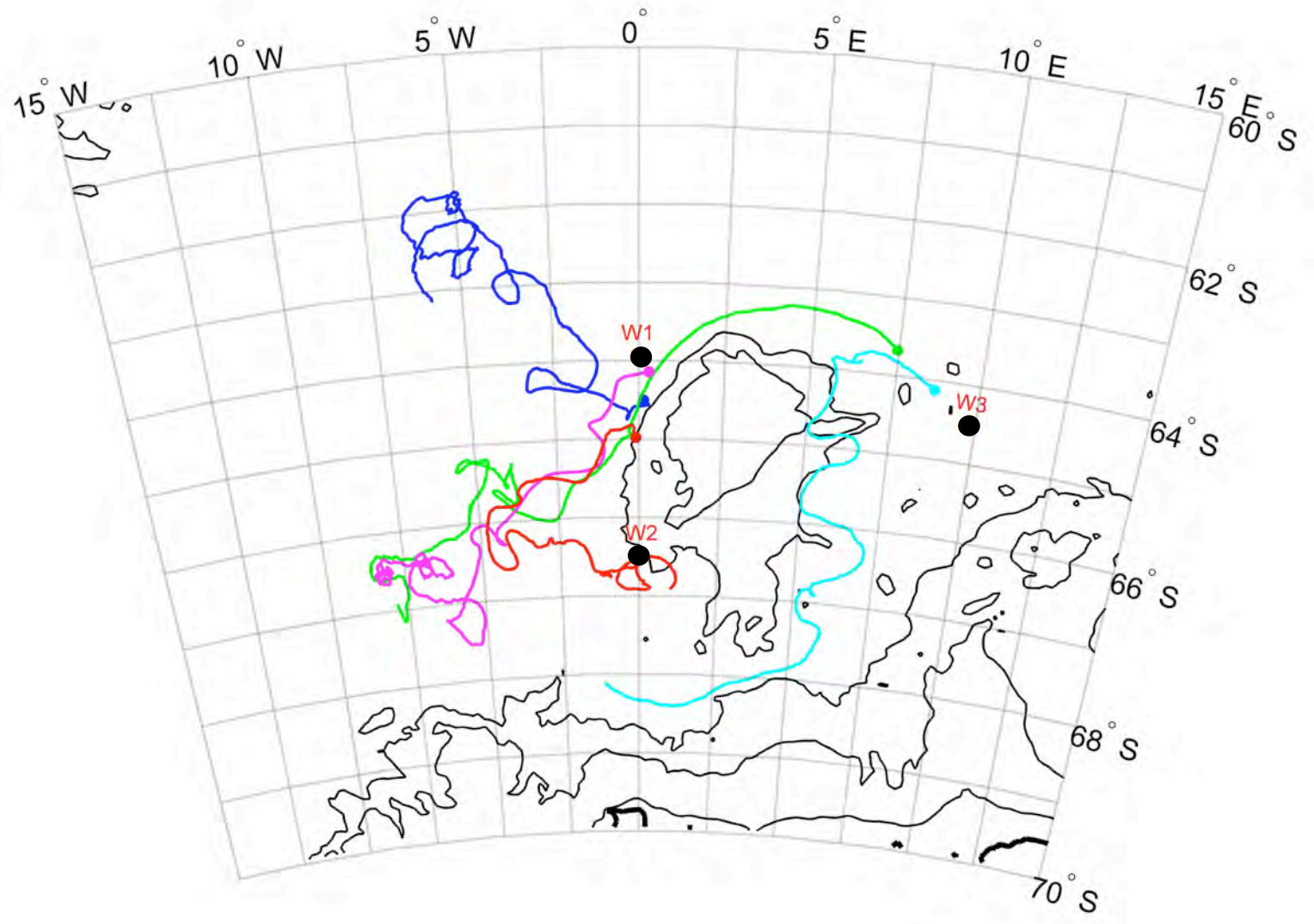


AWI

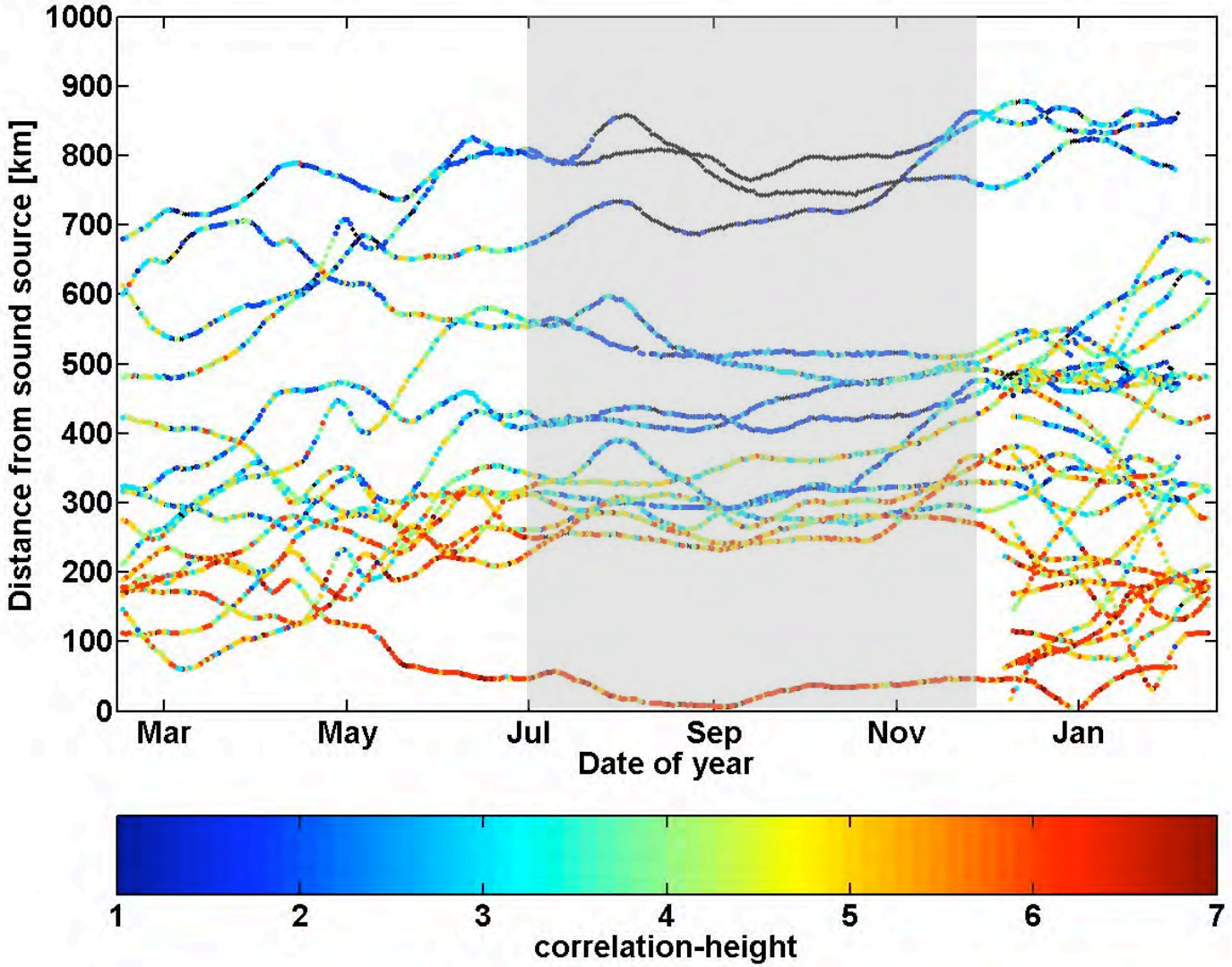
Ice compatibility of Argo floats: a 3 step process

Ice sensing algorithm2 (ISA2) 2007	Interim storage (iStore) 2005	RAFOS 2004
Aborts ascent when sea –ice is expected at the surface +Retarded response	Provides delayed mode profile when surfacing impossible	Provides subsurface profile position when surfacing impossible
Successful Update under test	Successful	

RAFOS subsurface tracking

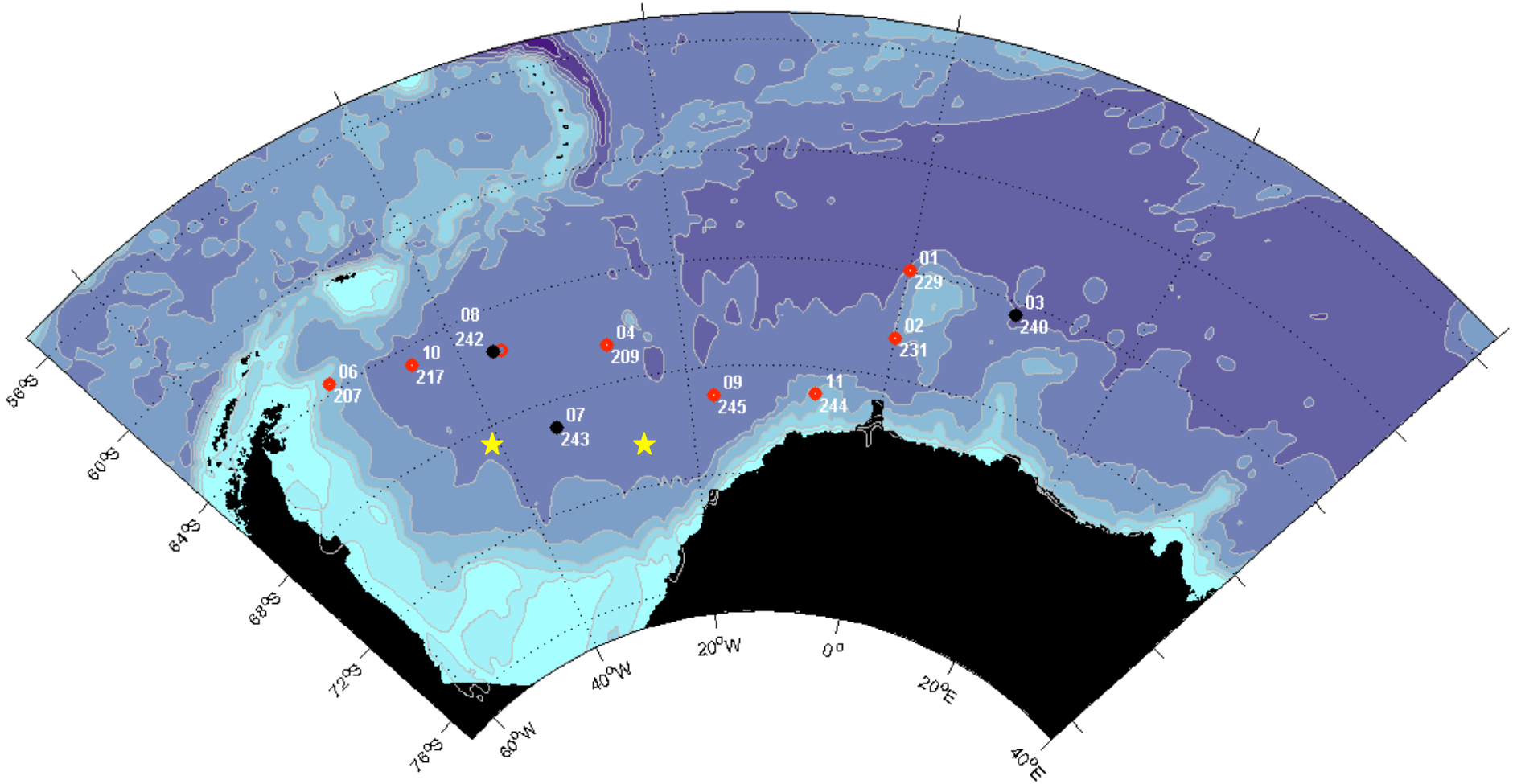


Range of RAFOS-signals in the Weddell Sea



Ice compatibility of Argo floats:

2008: array of 10 Sound Sources installed



AVVI

Ice compatibility of Argo floats: a 3 step process

Ice sensing algorithm2 (ISA2) 2007	Interim storage (iStore) 2005	RAFOS 2008
Aborts ascent when sea –ice is expected at the surface +Retarded response	Provides delayed mode profile when surfacing impossible	Provides subsurface profile position when surfacing impossible
Successful Update under test	Successful	**Successful** **An array of sound sources is installed**

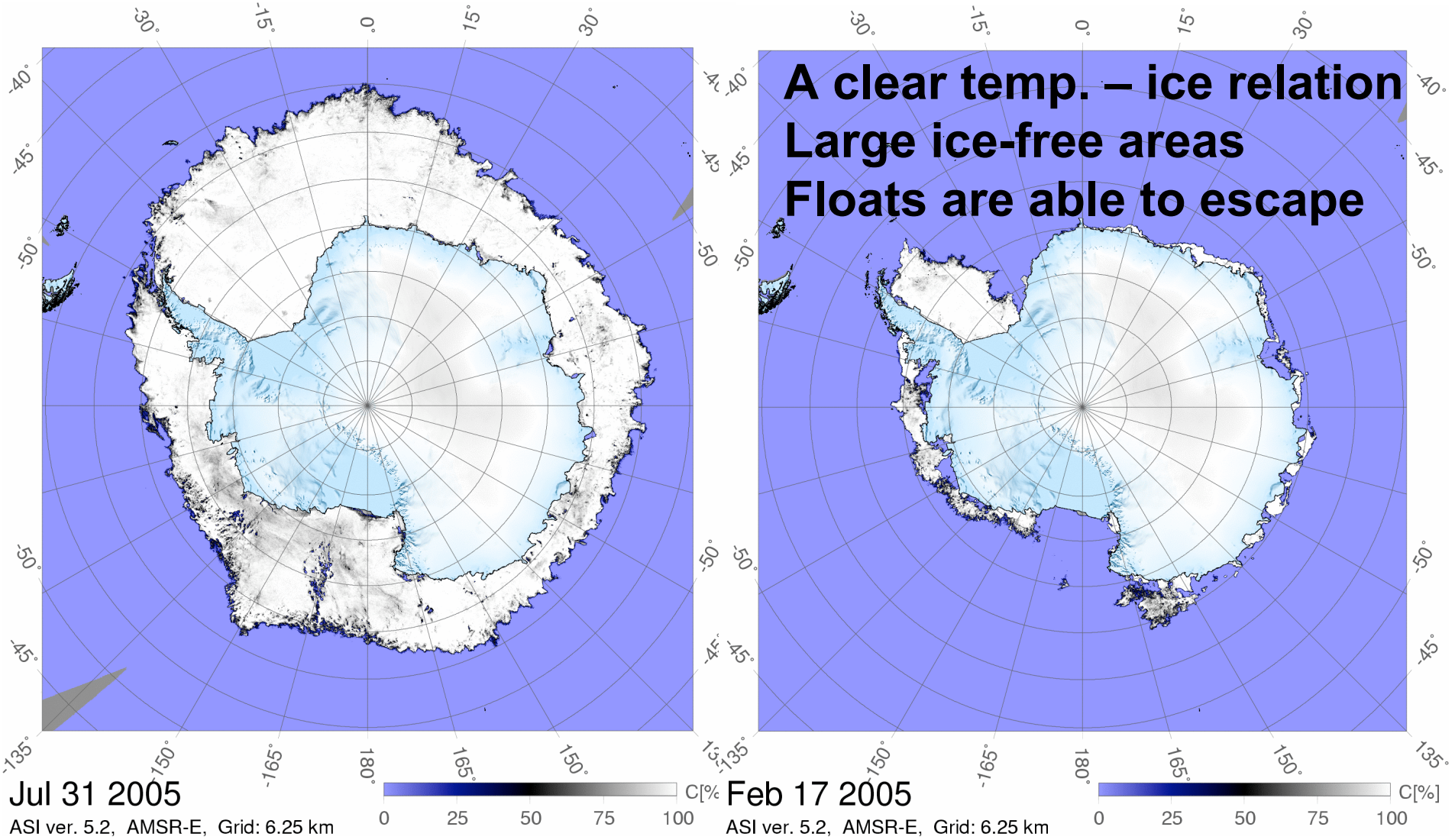
AWI

Arctic

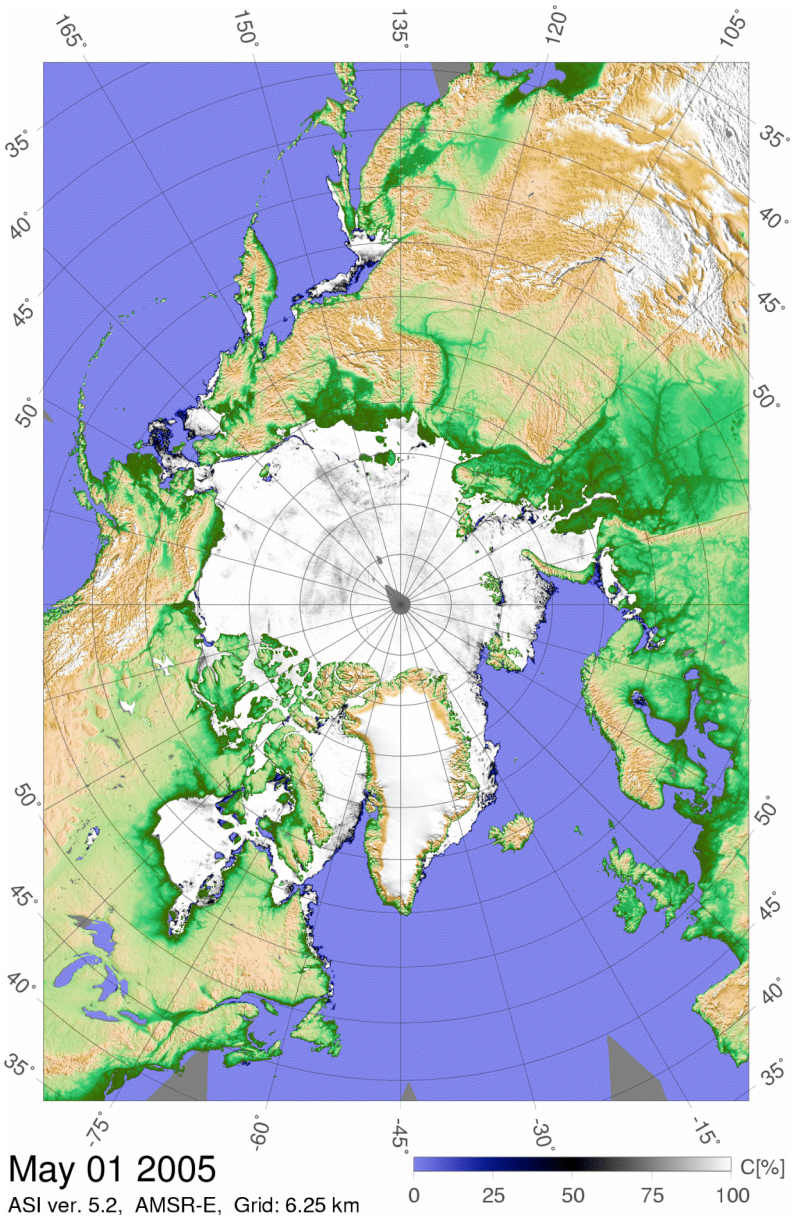
- Adaptation of ISA2 for the arctic
  → Arctic ISA

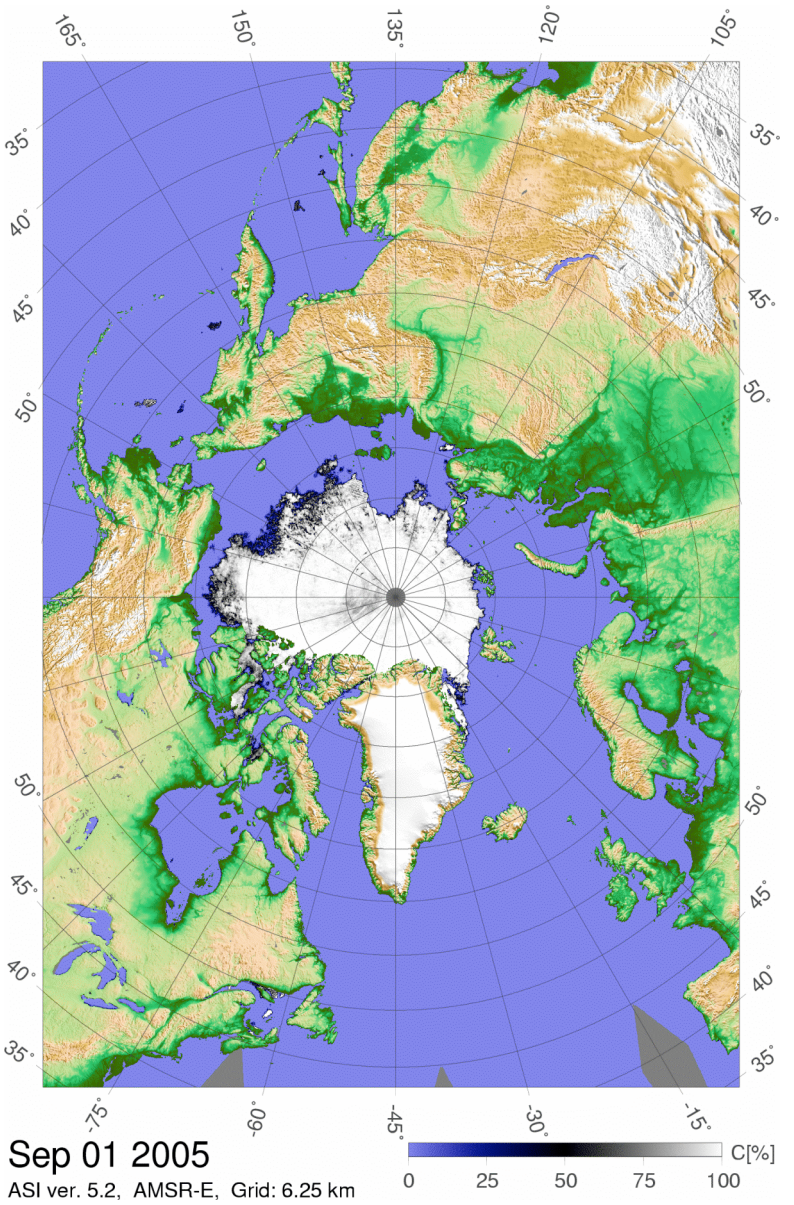
- Determine the range of RAFOS

Antarctic ISA

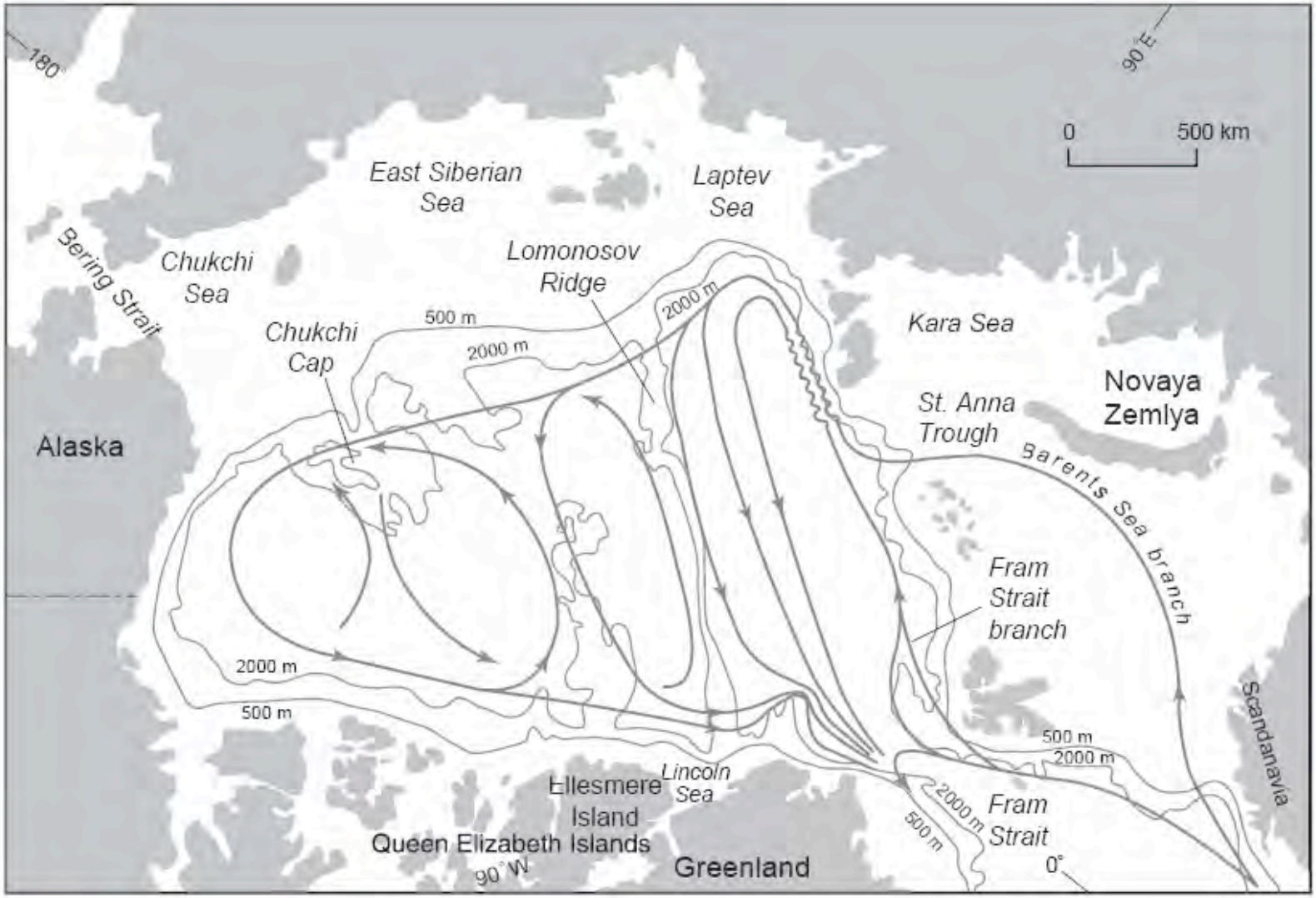


Arctic ISA


May 01 2005
ASI ver. 5.2, AMSR-E, Grid: 6.25 km
C[%]
0 25 50 75 100

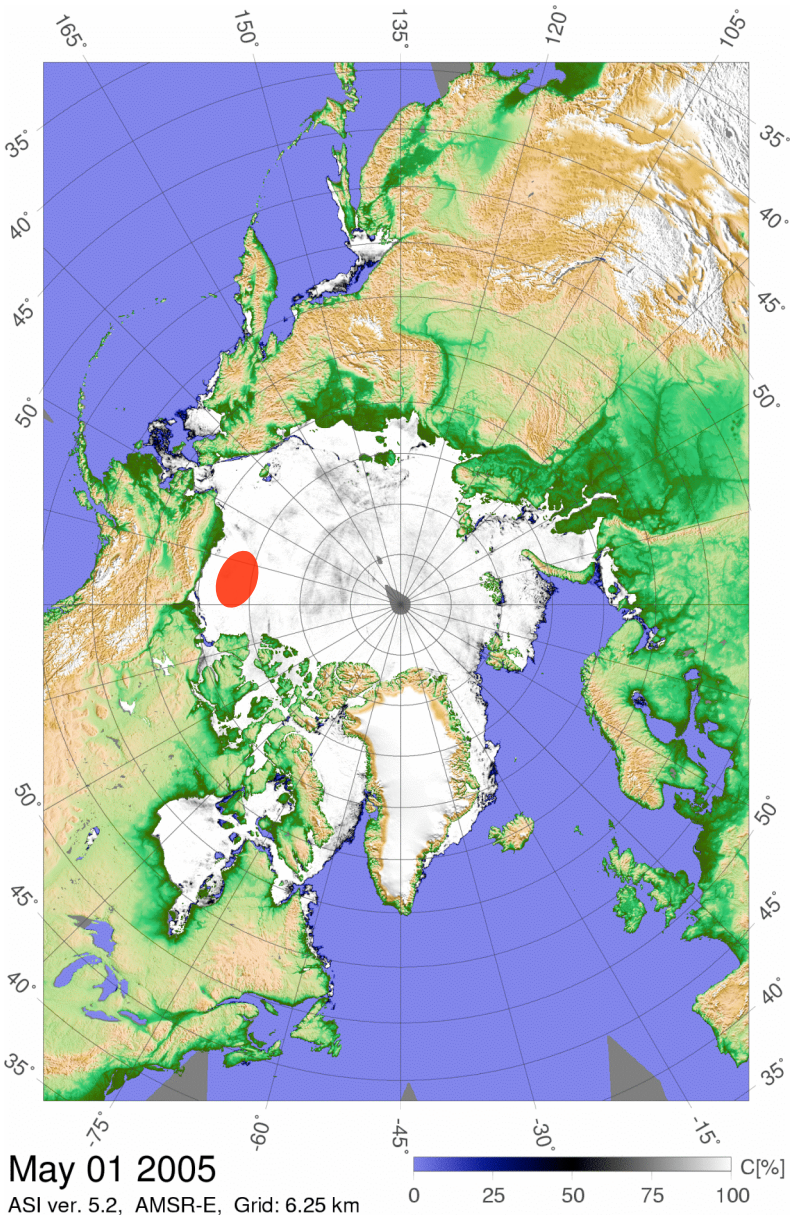

Sep 01 2005
ASI ver. 5.2, AMSR-E, Grid: 6.25 km
C[%]
0 25 50 75 100

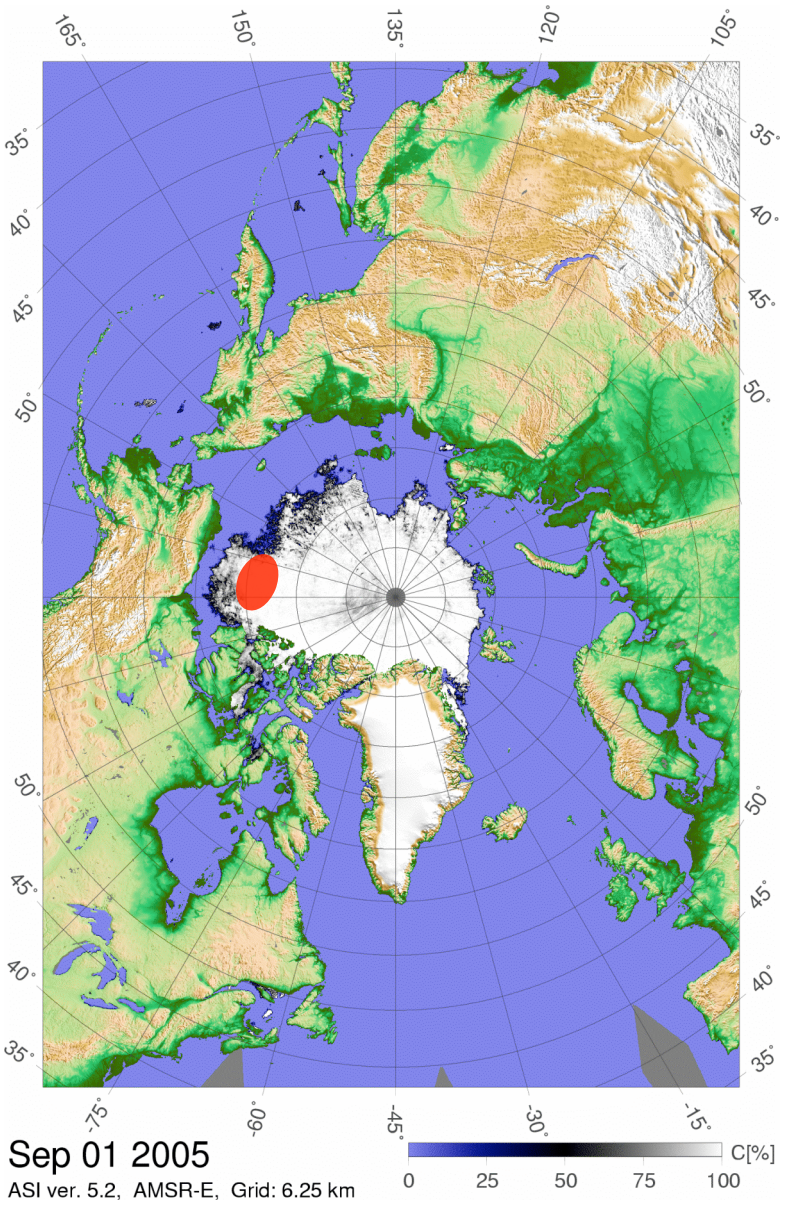
Schematic Circulation of Atlantic waters



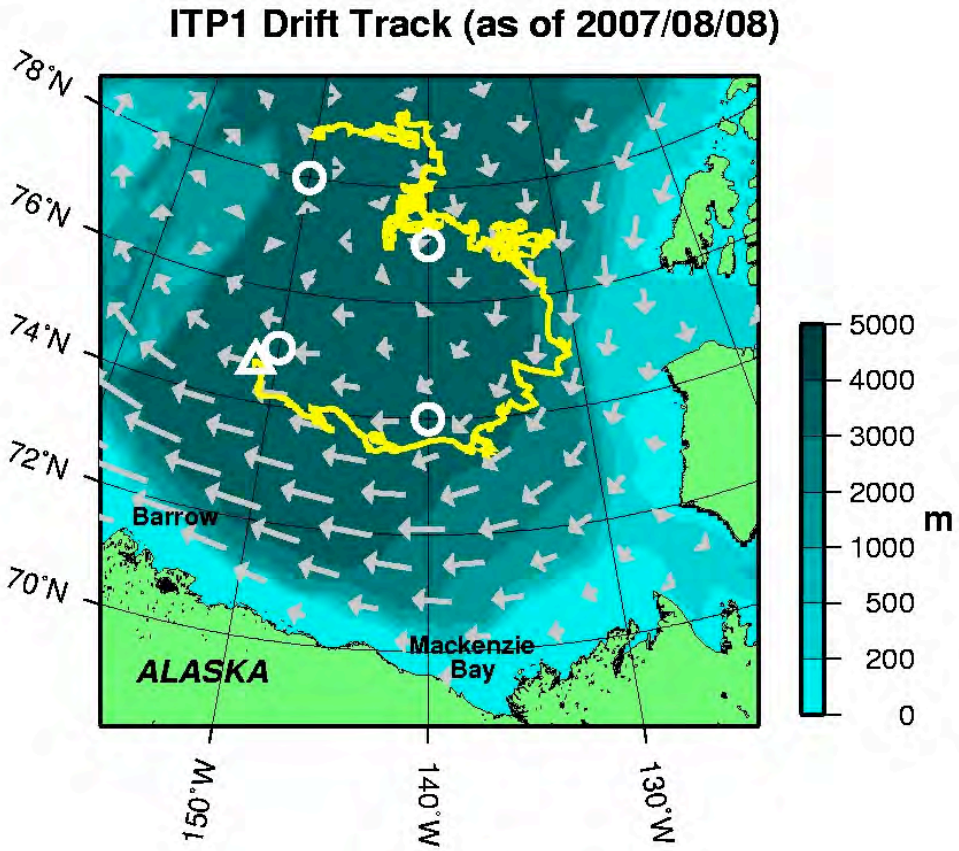
Rudels, 2001

Arctic ISA

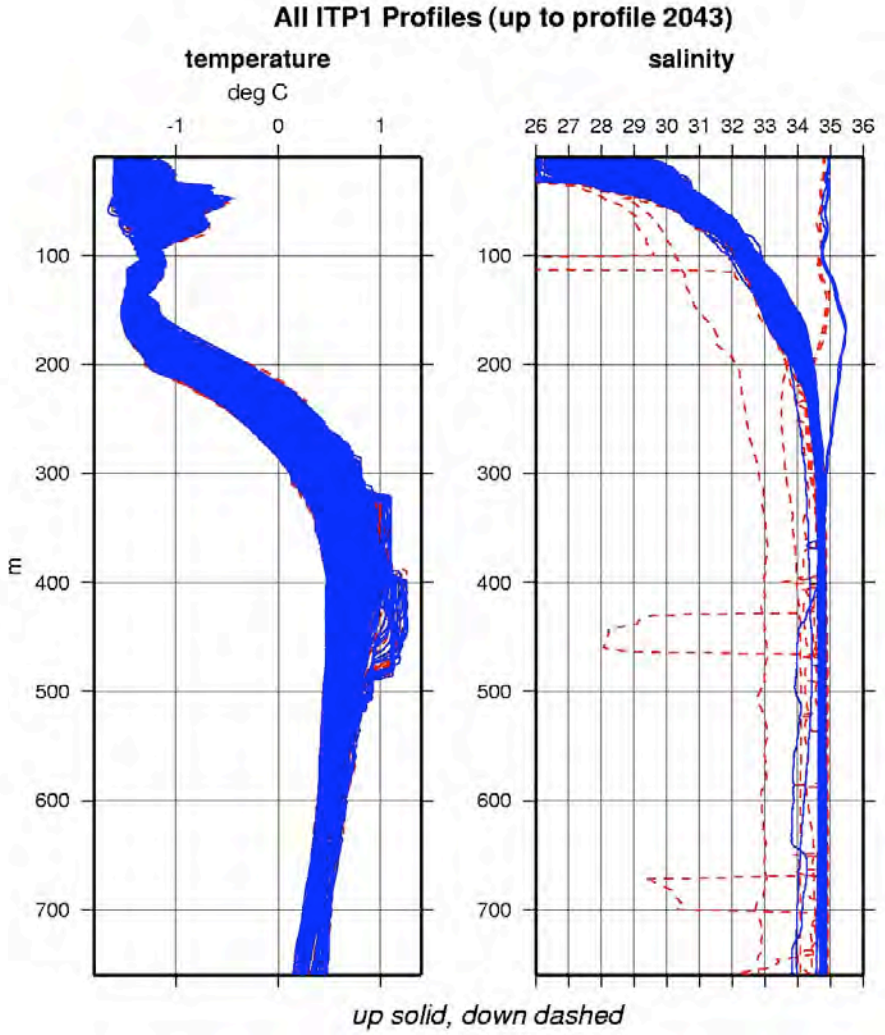

May 01 2005
ASI ver. 5.2, AMSR-E, Grid: 6.25 km
C[%]
0 25 50 75 100


Sep 01 2005
ASI ver. 5.2, AMSR-E, Grid: 6.25 km
C[%]
0 25 50 75 100

Ice-Tethered Profilers



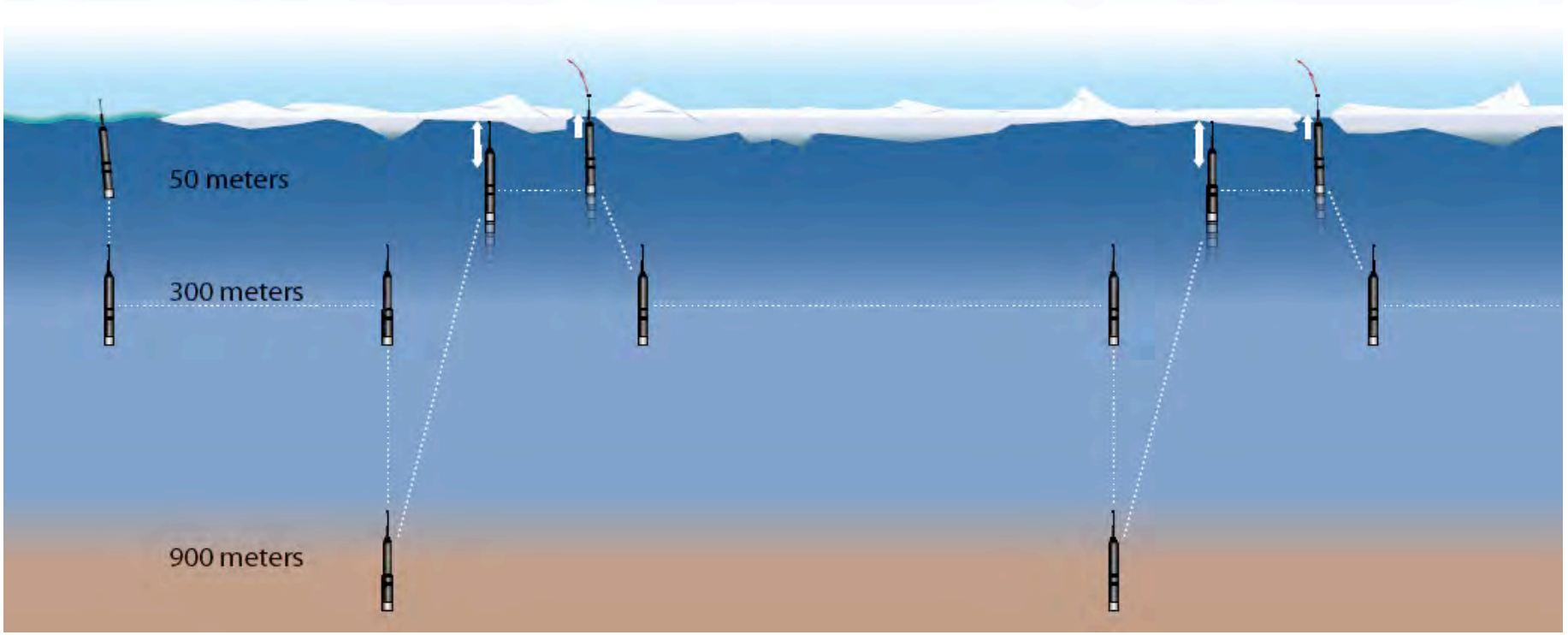
ITP drift (yellow line) and latest location (triangle), BGOS moorings (white circles) and annual ice drift from IABP (grey vectors) on IBCAO bathymetry (shading).



http://www.whoi.edu/page.do?pid=23100

AWI

Polar Profiling Floats (WHOI)



http://www.whoi.edu/ppf/

AWI

Outlook

- Compilation of hydrographic data, in particular seasonal variability

  → Arctic ISA
- Test of the range of RAFOS in the FramStrait

  (August 2008)

  → design of the sound source array
- Integration of iridium

  (first tests are planed in December 2008 Antarctic and in August 2009 Arctic, Polarstern ARK XXIV-2)

AWI

Ice compatibility of Argo floats: a 3 step process

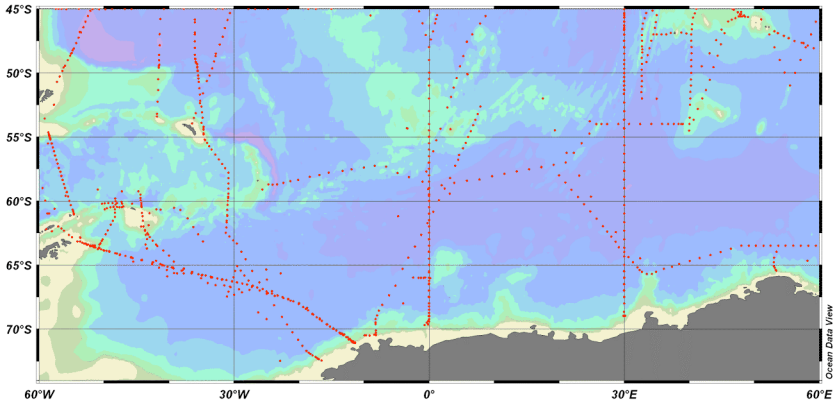
Ice sensing algorithm2 (ISA2) 2007	Interim storage (iStore) 2005	RAFOS 2008
Aborts ascent when sea –ice is expected at the surface +Retarded response	Provides delayed mode profile when surfacing impossible	Provides subsurface profile position when surfacing impossible
Successful Update under test	Successful	Successful An array of sound sources is installed

→ISA/iSore/RAFOS – Float = fully ice compatible 2006/07

AWI

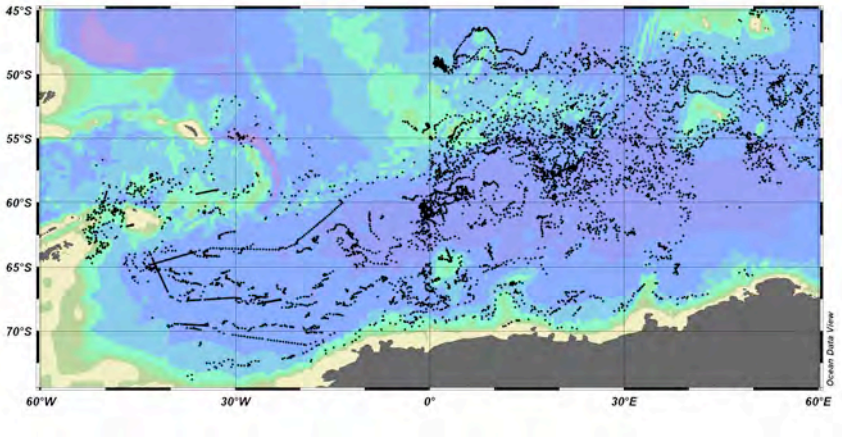
Weddell Sea data

WOCE: CTD-stations



1100 CTD casts

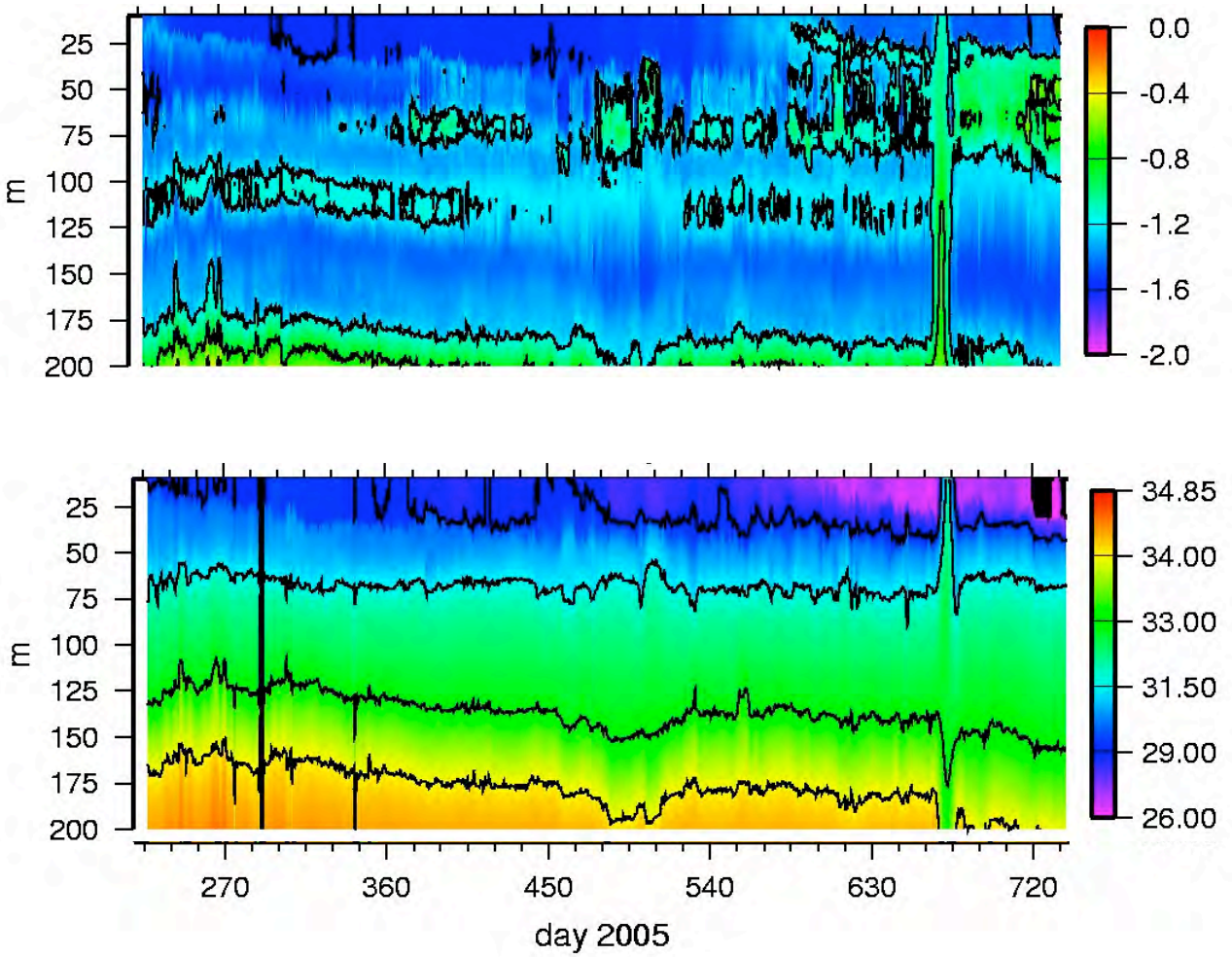
AWI floats



5800 float profiles

AWI

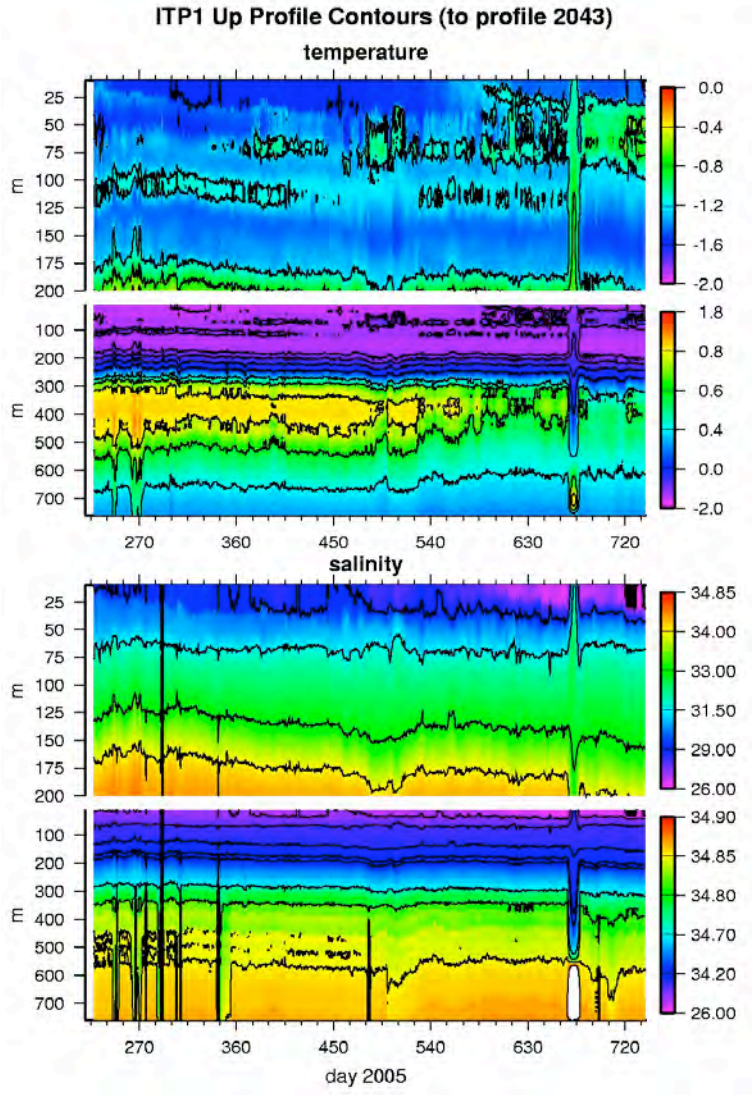
Ice-Tethered Profilers (2)



http://www.whoi.edu/page.do?pid=23100

AWI

Ice-Tethered Profilers (2)



http://www.whoi.edu/page.do?pid=23100