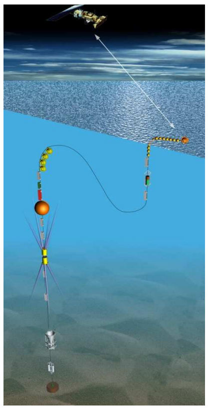
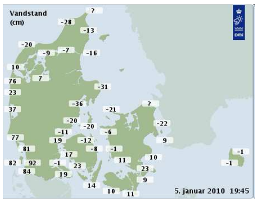
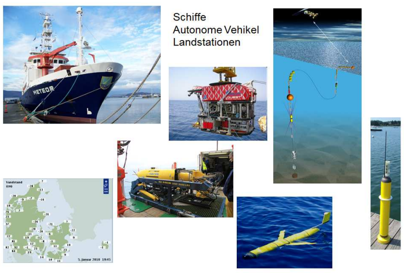
02 - Messplattformen

Landstationen
Schiffe
Autonome Vehikel





Messplattformen



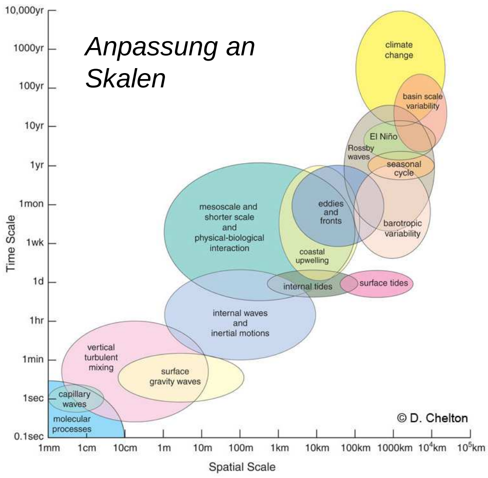
Messplattformen

Satelliten
Schiffe
Bojen – Drifter – Floats
Verankerungen
ROVs – AUVs – Glider
Landstationen

Wozu brauchen wir die Messplattformen und Geräte?

- Forschung
- Umweltüberwachung (z.B. Klima, Verschmutzung)
- Information zum Ozeanwetter (z.B. Schiffsrouten, Tourismus)
- Informationen für das Militär

Messstrategien



Messplattformen

Satelliten
Schiffe
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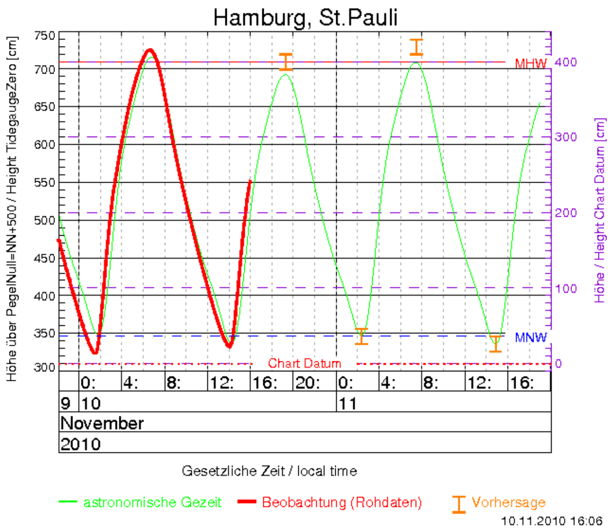
ROVs – AUVs – Glider
Landstationen

4-D Rauminformation x,y,z,t

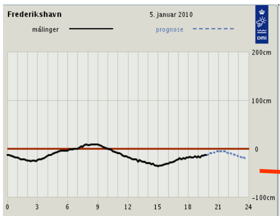
Landstationen - Pegel



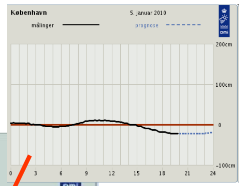
z.B. Wasserstand in cm

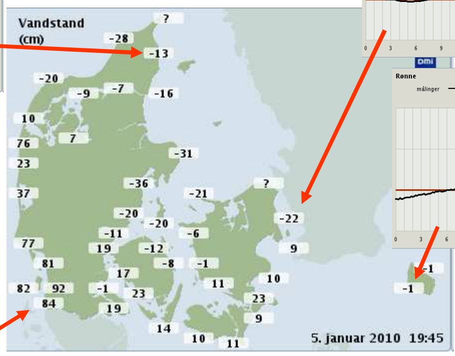
www.wasserstandsdienst.de

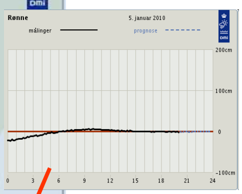
Landstationen

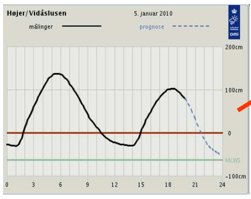


Küstenpegel
Wasserstand in cm



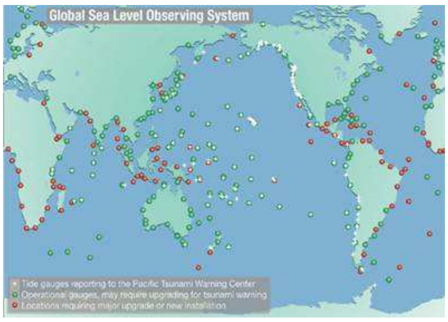




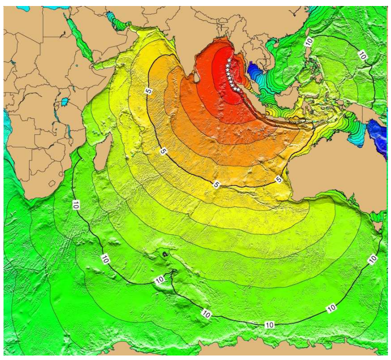


www.dmi.dk

Landstationen



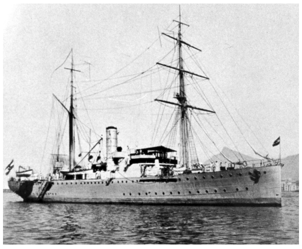
- Tide gauges reporting to the Pacific Tsunami Warning Centre
- Operational gauges, may require upgradeing for tsunami warning
- Locations requiring major upgrade or new installation



26. Dez. 2004 Tsunami

Source: Nature vol. 434 March 3, 2005

Forschungsschiffe – 3 Generationen METEOR



Forschungsschiffe

Einsatzgebiete

Disziplinen

Eigner

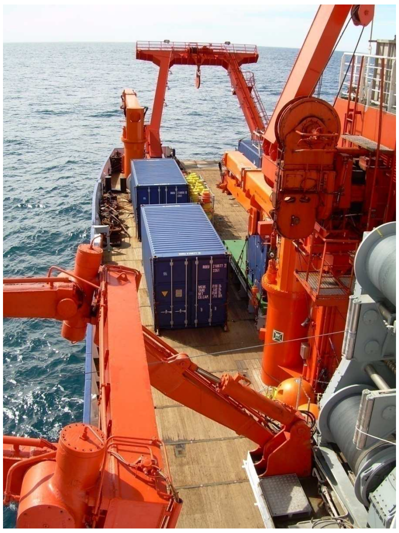
Anforderungen – typische Eigenschaften

Fest installierte Geräte

Organisation von Schiffseinsätzen

Kosten

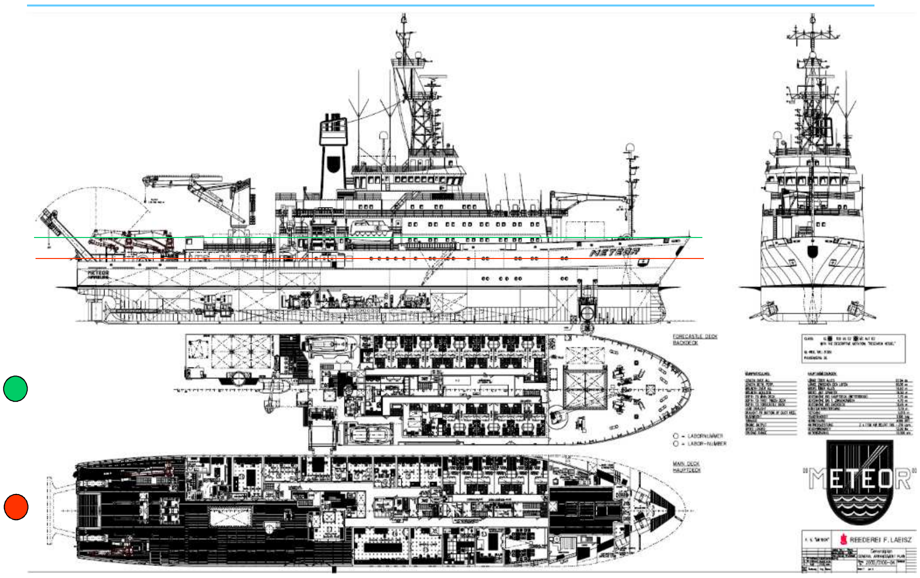
Forschungsschiffe – METEOR



Leben und Wohnen

Hebezeuge
Winden
Stauraum
Labore

FS METEOR



Forschungsschiffe

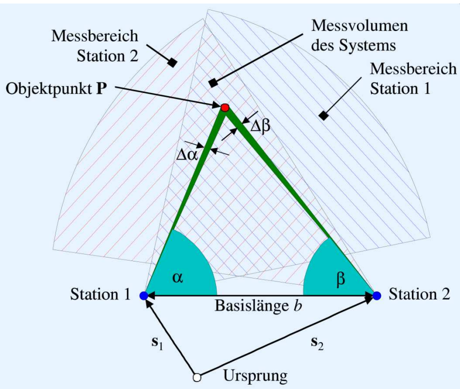
Die meisten Messgeräte werden von den Forschern mitgebracht.

An Bord vorhanden sind Messsysteme für die

- Navigation
- Hydroakustik (Lotung)
- Strömungsprofil-Messung (ADCP)
- Hydrographie (T,S, …)
- Meteorologie

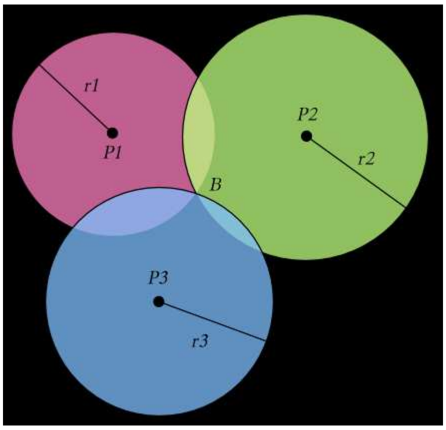
Navigation (x,y,z)

Kreuzpeilung (Triangulation – Winkelmessung)



Navigation (x,y,z)

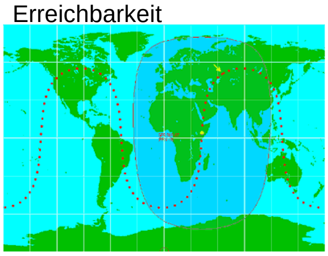
Längenpeilung (Trilateration – Entfernungsmessung)



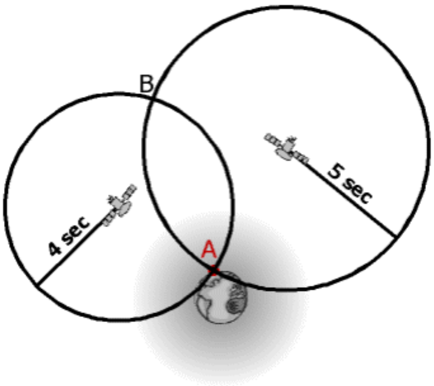
GPS

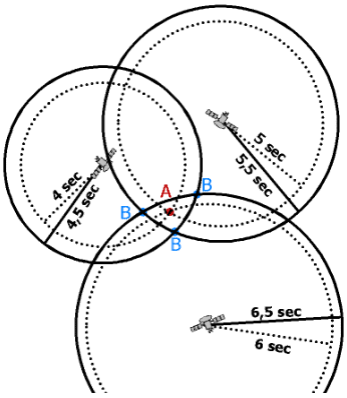
Bodenstationen

Erreichbarkeit



Anwendungen Trilateration





Global Positioning System (GPS)

Position in der Vertikalen

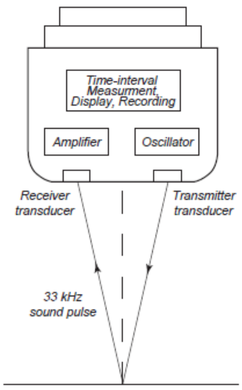
Messung der Tiefe des Ozeans

Echo-Lote

Ein Schallsignal wird mit einer Frequenz von 10-30 kHz ausgesendet. Das Echo vom Meeresboden wird nach einer bestimmten Zeit empfangen.

$$\boxed{z = \frac{1}{2} c t}$$

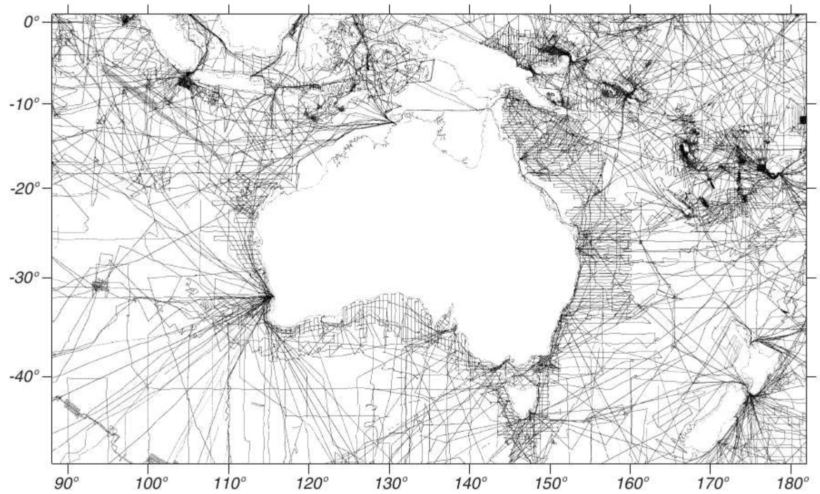
z: Wassertiefe [m]
c: Schallgeschwindigkeit [m/s]
t: Zeit [s]



Stewart (2008)

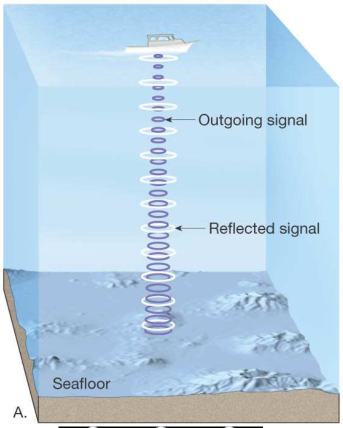
Position in der Vertikalen

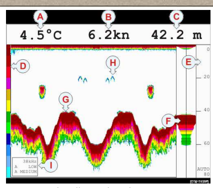
Example: Locations of echo-sounder data used for mapping the ocean floor near Australia



Stewart (2008)

Position in der Vertikalen



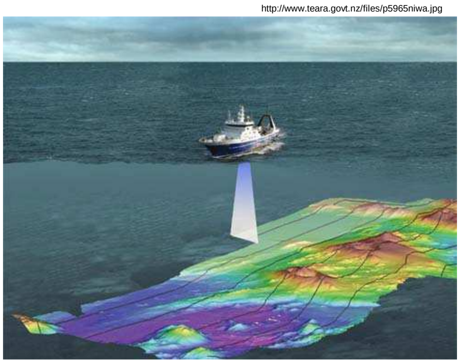


http://www.simrad.com

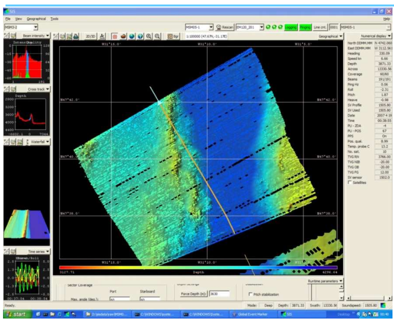
← single beam system

multibeam system

http://www.teara.govt.nz/files/p5965niwa.jpg



Position in der Vertikalen

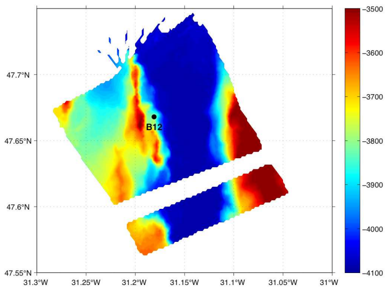


Beispiel: Multibeam survey

R/V Maria S. Merian
Reise MSM-05/1
2007

Breite: 13 km

Rohdaten auf dem Bildschirm



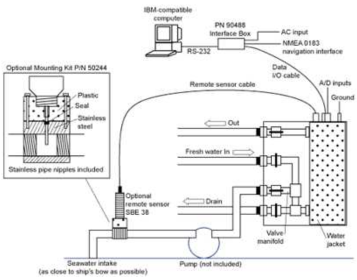
Bearbeitete und geglättete Daten

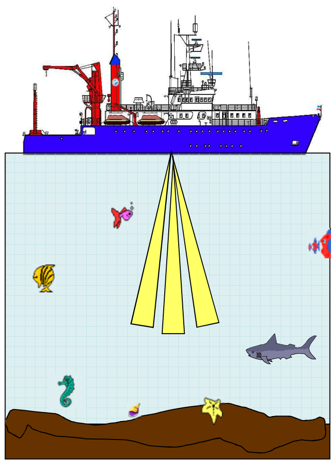
B12: Position eines verankerten Messgeräts

Quelle: IUP- Uni HB (2007)

Schiffseigene Geräte

Thermosalinograph

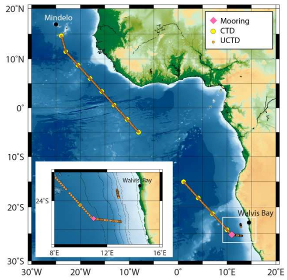


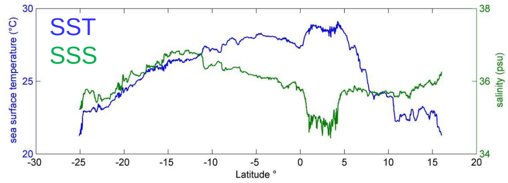


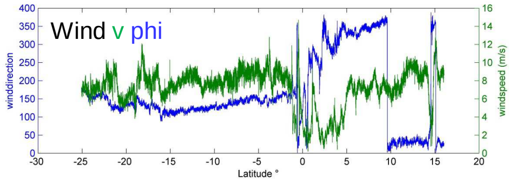
Stromprofilmesser

Thermosalinograph und Profilstrommesser

METEOR Fahrt M104 Transit Walvis Bay – Mindelo Februar/März 2014



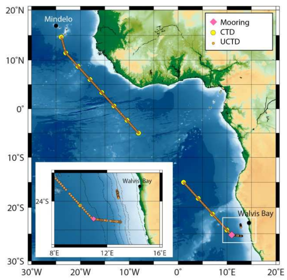


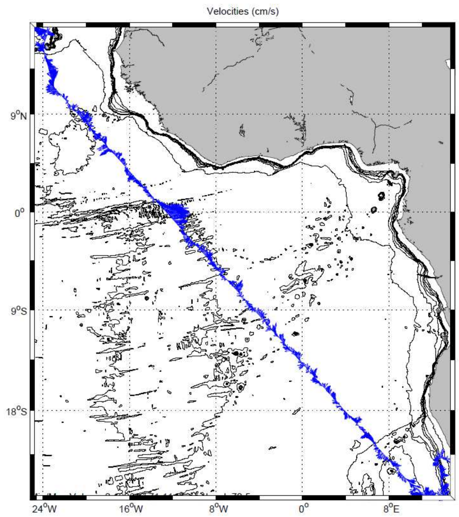


Oberflächentemperaturen und Salzgehalte,
Windgeschwindigkeit und –richtung.

Thermosalinograph und Profilstrommesser

METEOR Fahrt M104 Transit Walvis Bay – Mindelo Februar/März 2014





37.5 kHz ADCP, 70-100m

Einsatz von Großgeräten: Unterwasser Roboter

ROV
Remotely Operated Vehicle

23

http://www.marum.de/Tauchroboter_QUEST.html

Verankerungen

Eulersche Messungen

Selbstregistrierende Messgeräte am Meeresboden verankert

Dauer bis zu 5 Jahren

Auftrieb

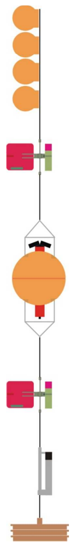
Strommesser

ADCP

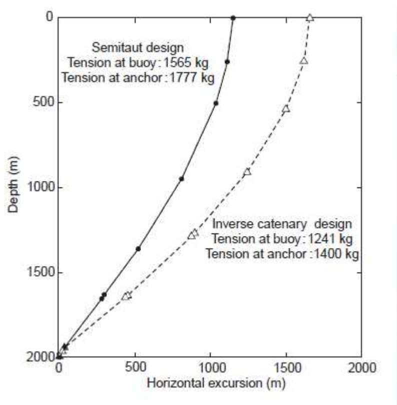
Strommesser

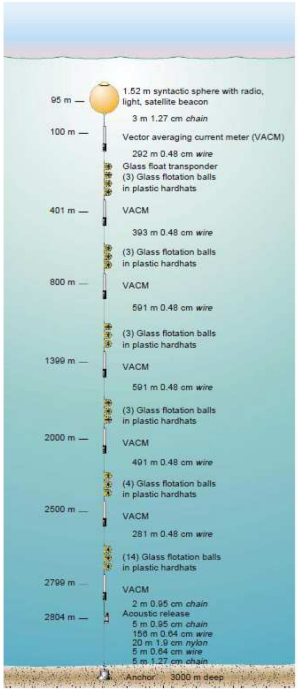
Auslöser

Ankergewicht



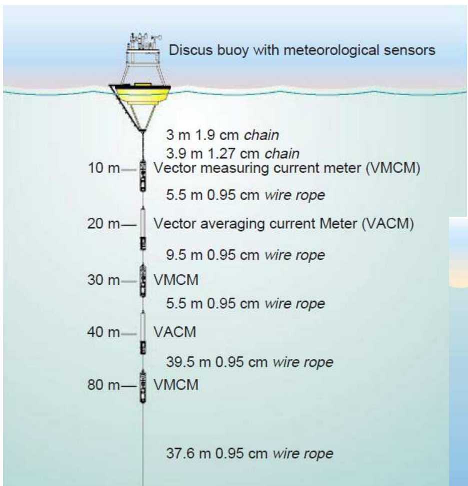
Unterwasser-Verankerung

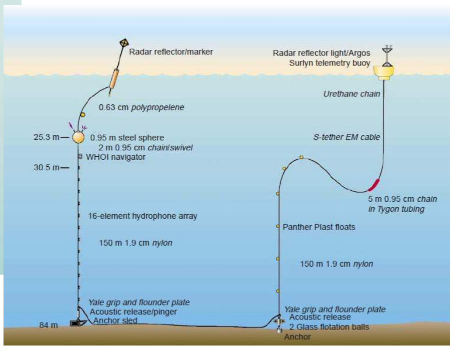




Trask & Weller, 2001

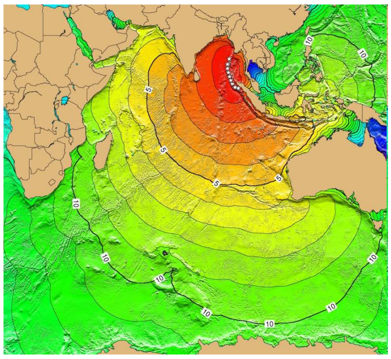
Oberflächen-Verankerungen





Trask & Weller, 2001

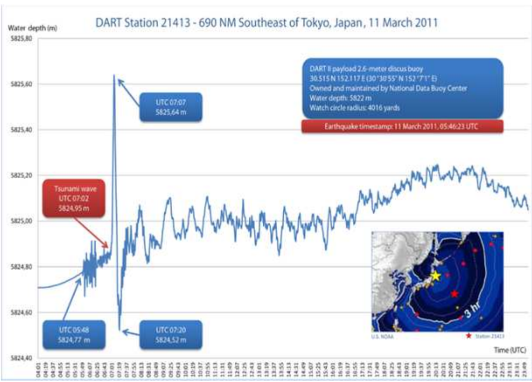
Land- und Seestationen

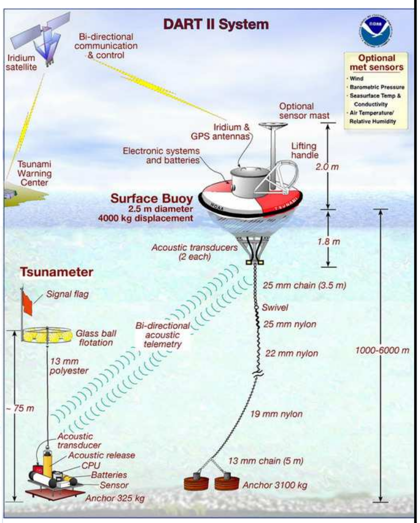


26. Dez. 2004 Tsunami

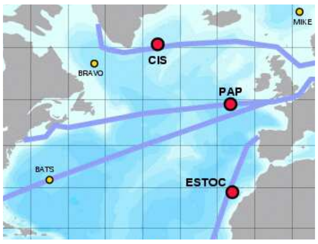
Land- und Seestationen

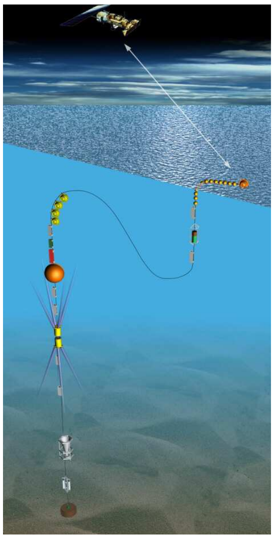
DART: Deep-ocean Assessment and Reporting of Tsunamis

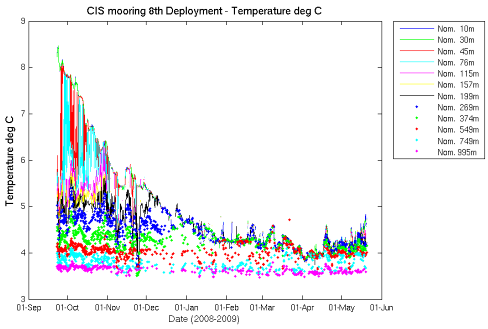




Verankerungszeitserien







Karstensen, Körtzinger, Send

Beispiel: Erwärmung im Randstrom der Labradorsee

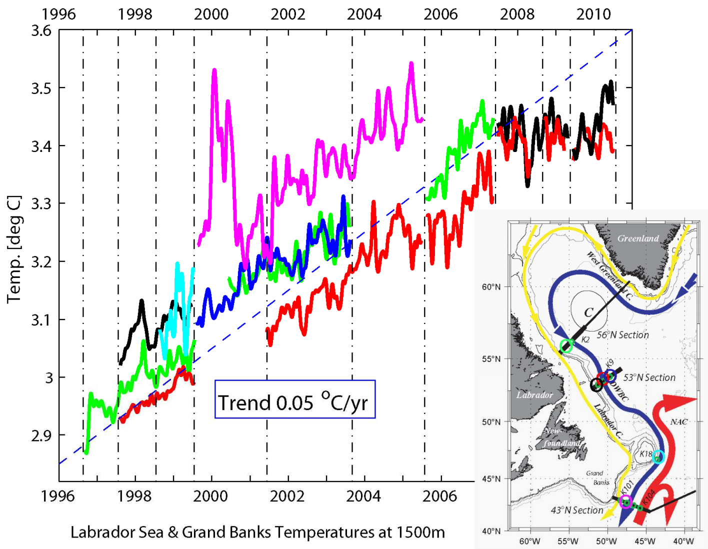
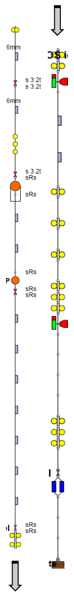
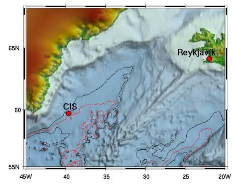
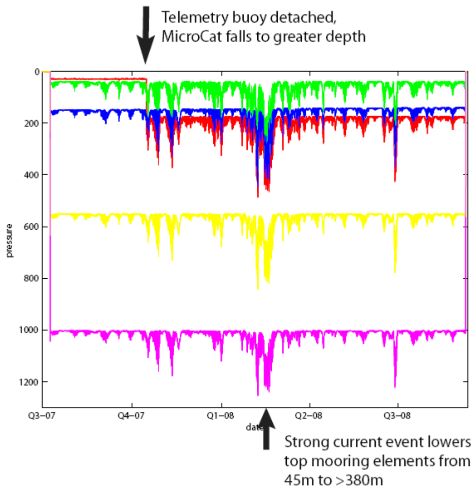


Figure: Fischer et al., 2010

Probleme bei Verankerungen

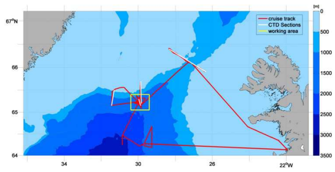


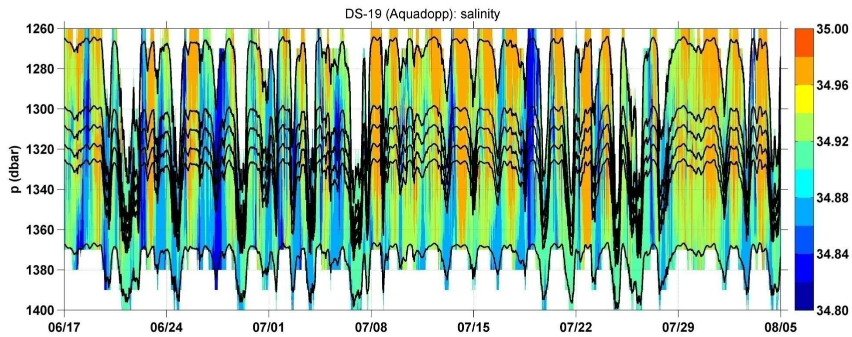




© S. Schmidt, IFM-GEOMAR, Kiel

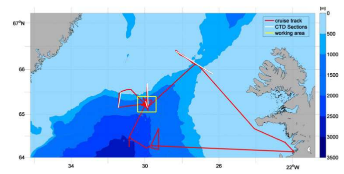
Beispiel: verankerte hydrographische Messgeräte

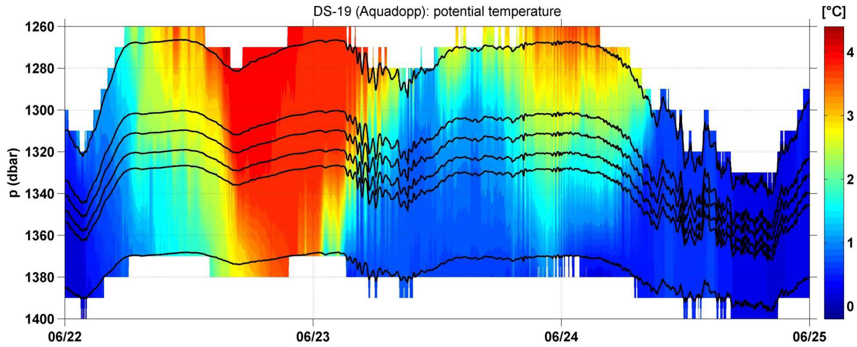




MSM 21 1b Verankerungsarray

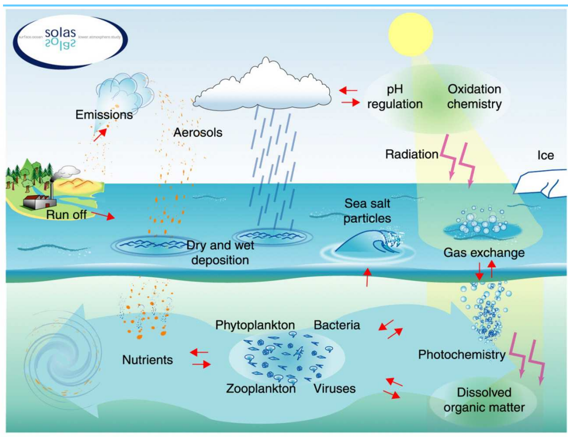
Beispiel: verankerte hydrographische Messgeräte





MSM 21 1b Verankerungsarray

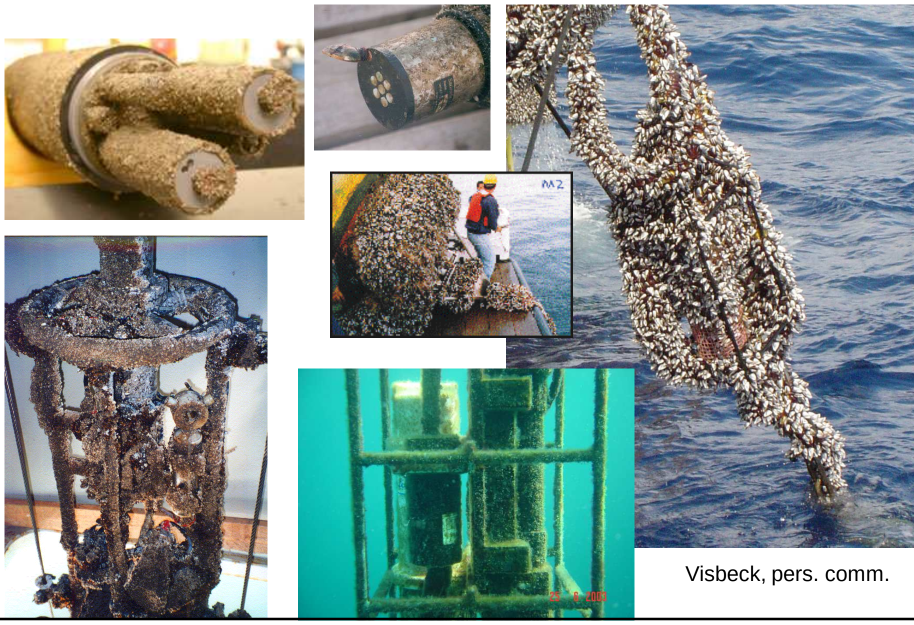
Near surface measurements



Significant Signals of
Climate Variability and Change
occur in the upper 100 m of the Ocean.

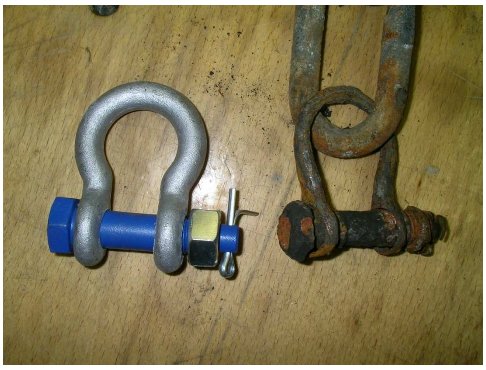
Visbeck, pers. comm.

Problems with biofouling



Visbeck, pers. comm.

Probleme bei Verankerungen



Meerwasser ist chemisch nicht neutral und wirkt als Elektrolyt. Es greift Metalle an.

Der Wasserdruck stellt hohe Anforderungen an die Instrumente, sie dürfen auch bei hohem Druck keine verfälschten Messwerte liefern.

Die Geräte müssen robust sein und mechanische Beanspruchungen überstehen.

Probleme bei Verankerungen

Probleme mit Vandalismus

Several locations of the TAO and PIRATA arrays had to be abandoned because of unmanageable vandalism

Visbeck, pers. comm.

Swallow floats, SOFAR & RAFOS floats

Schallquellen am Drifter, Hydrophone am Schiff x,y

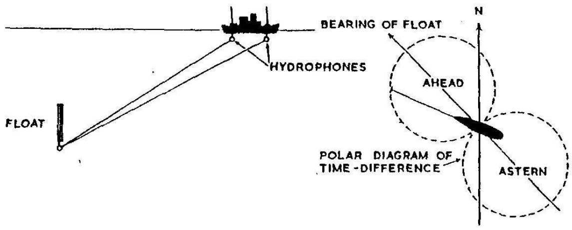
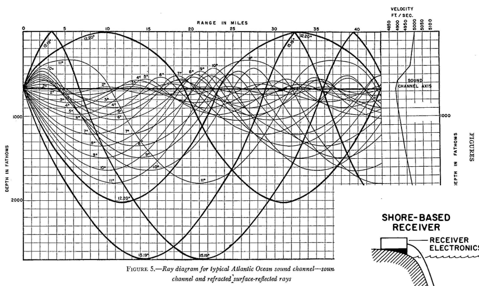


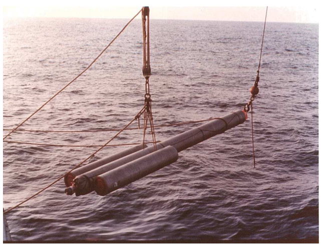
Fig. 3. Method of locating float.

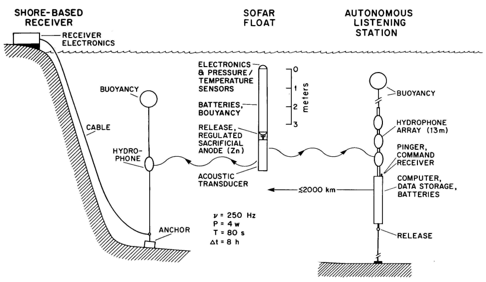
Swallow floats, SOFAR & RAFOS floats

Driftende Schallquellen und verankerte Lauschstationen im Ozean x,y

SOund **F**ixing **A**nd **R**anging

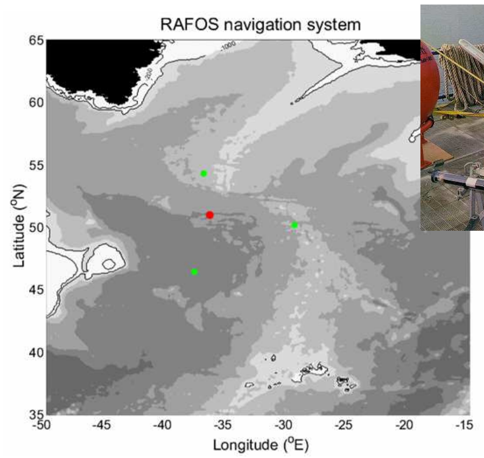


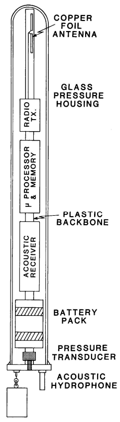




Swallow floats, SOFAR & RAFOS floats

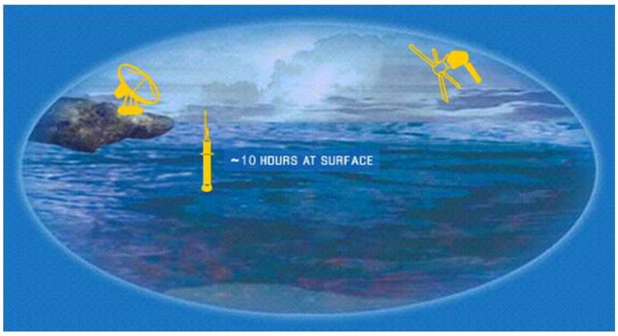
Verankerte Schallquellen und lauschende Drifter im Ozean x,y





Drifter - Floats

Lagrangesche Messungen



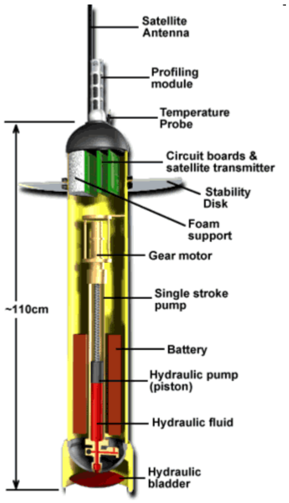
ARGO

Sustain network of 3000 profiling floats

Measure temperature and salinity of the upper 2000 m in all basins

Provide all data free of charge

APEX - Floats



Comprised of three subsystems:

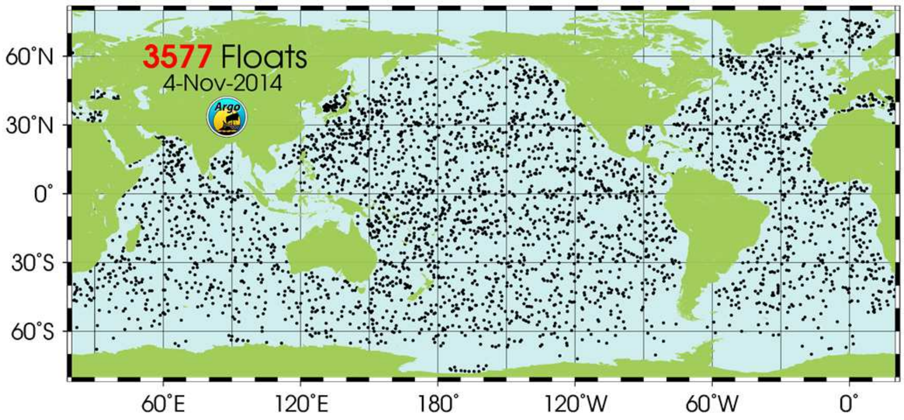
Hydraulics: control buoyancy adjustment via an inflatable external bladder, so the float can surface and dive.

Microprocessors: deal with function control and scheduling.

Data transmission system: controls communication with satellite.

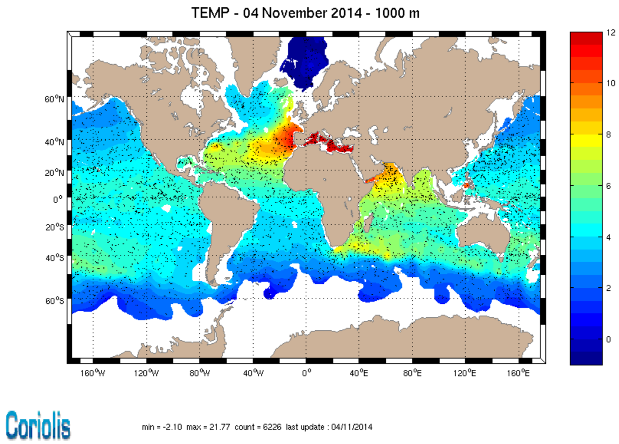
Approx. Weight: 25 Kg
Max. operating depth: 2000m
Crush depth: 2600m

ARGO Netzwerk



http://www.argo.ucsd.edu

Anwendungen



Data is available to everyone

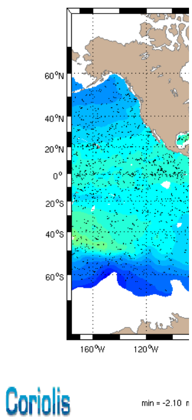
Data centres provide analysis products

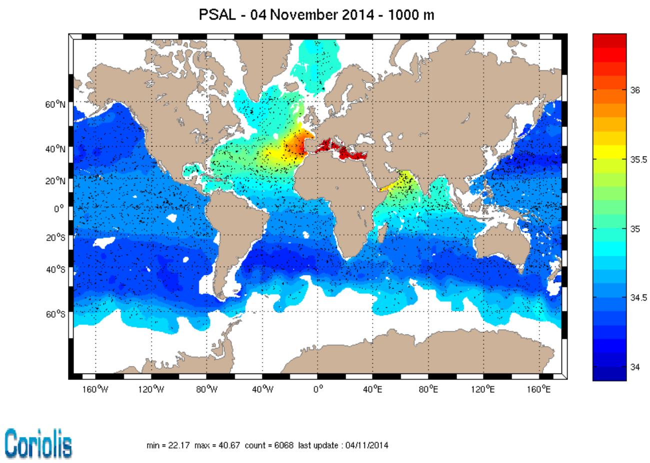
Data is used for assimilation in forecast models

Temperatur in 1000 m Tiefe

http://www.coriolis.eu.org/

Anwendungen





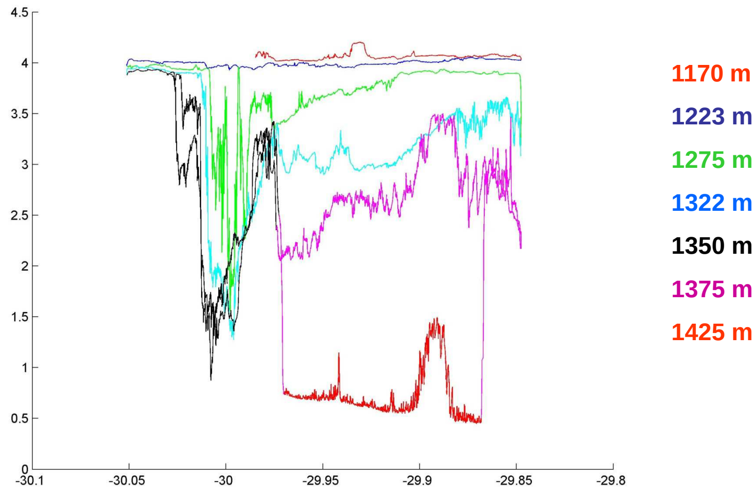
Salzgehalt in 1000 m Tiefe

http://www.coriolis.eu.org/

Beispiel: AUV Einsatz

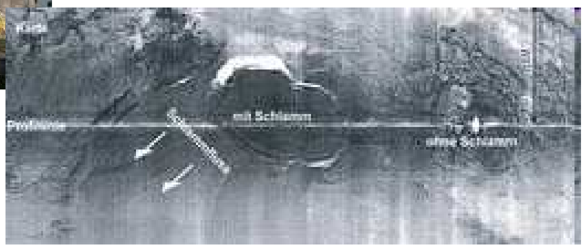
MSM 21 1b AUV Einsatz

Beispiel: AUV Einsatz



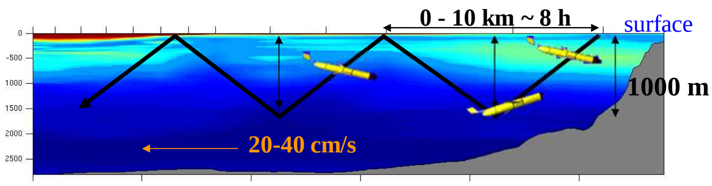
Potential temperature

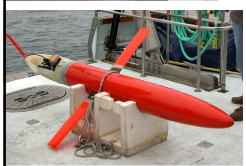
AUV

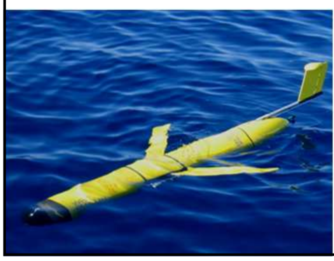


http://www.marum.de/MARUM_Seal.html

Glider







profilieren in den oberen 1000m

kommunizieren in real time

max. 6 Monate durchgehend im Einsatz

können mit verschiedensten elektronischen Sensoren ausgerüstet werden

Visbeck, pers. comm.

Glider

Glider werden durch positiven oder negativen Auftrieb hervorgerufen durch Volumenänderung angetrieben. Kein Propeller ist nötig.

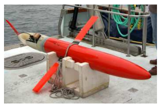
Flügel wandeln vertikale Geschwindigkeit in horizontale um.

Sie gleiten abwärts wenn sie schwerer als die Umgebung sind und aufwärts wenn sie leichter sind. Dies führt zu einem Sägezahn Muster.

Slocum Thermal Webb Research Corp.

Slocum Webb Research Corp.

Spray: Scripps Institution of Oceanography



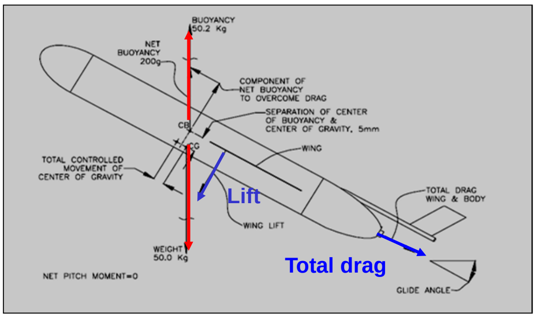
Seaglider University of Washington

Extra buoyancy = +/-200g

Control of buoyancy and internal mass distribution

vertical velocity, roll and pitch

horizontal velocity and direction



Visbeck, pers. comm.

Glide angle ~ 25° +/- 5°

Glider

Reception Station

ftp

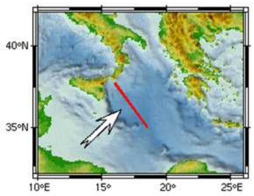
Coriolis Data Center

Operational Model

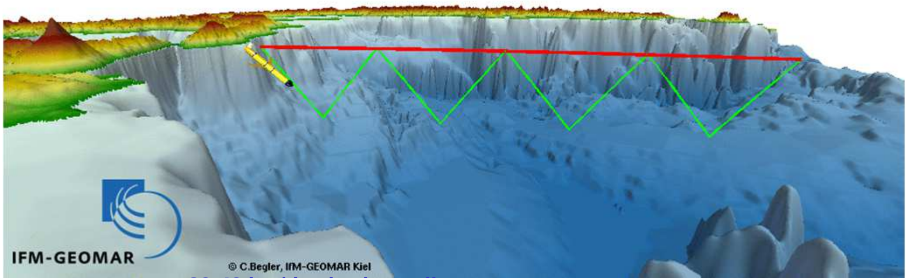
data

missions

GPS + IRIDIUM

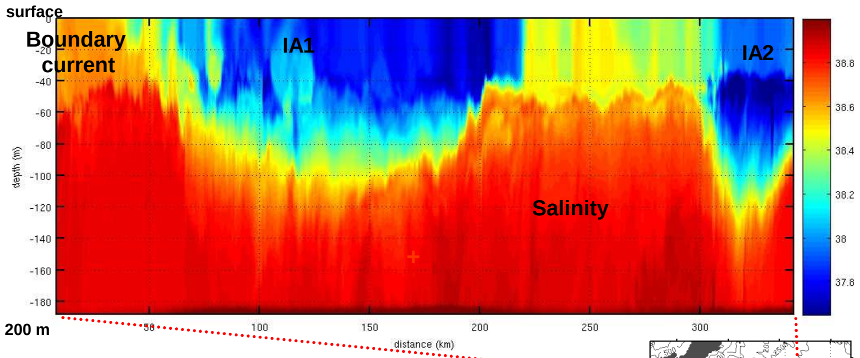


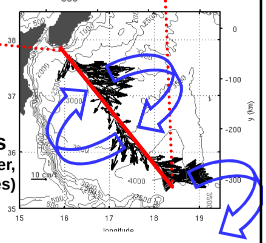
Visbeck, pers. comm.



20-40 km/day horizontally

Glider im Mittelmeer





Mean velocities between surfacings
(dead reckoning underwater, Adjustement with GPS fixes)

Ionian Anticyclones (IAs)

R ~ 80 km	**Ro ~ 0.2**
U ~ 40 cm/s	**Bu $^{1/2}$ ~ 0.2**
H ~ 100 m	**Lifetime > 5 months**

Visbeck, pers. comm.

Moderne Autonome Systeme

Fixed Systems (Euler):

- Mooring technology is advancing to allow for real time data communication.
- The surface layer will soon be within reach for sustained observations by winched sensor and communication platforms.

Passively drifting (Lagrange):

- Autonomous profiling floats have demonstrated to be a useful long endurance (~4 years) platform for global observations.

Actively Propelled (buoyancy engine):

- Gliders are a promising new platform for the study of the upper ocean at high resolution and medium endurance (1-6 months).
- about 1-2 W Power requirement