

Sustainable measuring strategies for the Ocean


*Environmental monitoring using the OceanPack:
a Robust, Flexible and Cost-Efficient
“Autonomous Underway Measurement System”*



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Chief Project Manager / Scientist

Dipl.-Phys. Stefan Marx
Managing Director



An underwater scene with sunlight rays filtering through the water, creating a blue and white color palette.

Ships equipped
during the last
3 years



Sailing Ships

Sailing systems
in cooperation



OceanoScientific® System:

OceanoScientific

Wind direction

Wind speed

Atmospheric pressure

Air temperature

Air humidity

Radiation

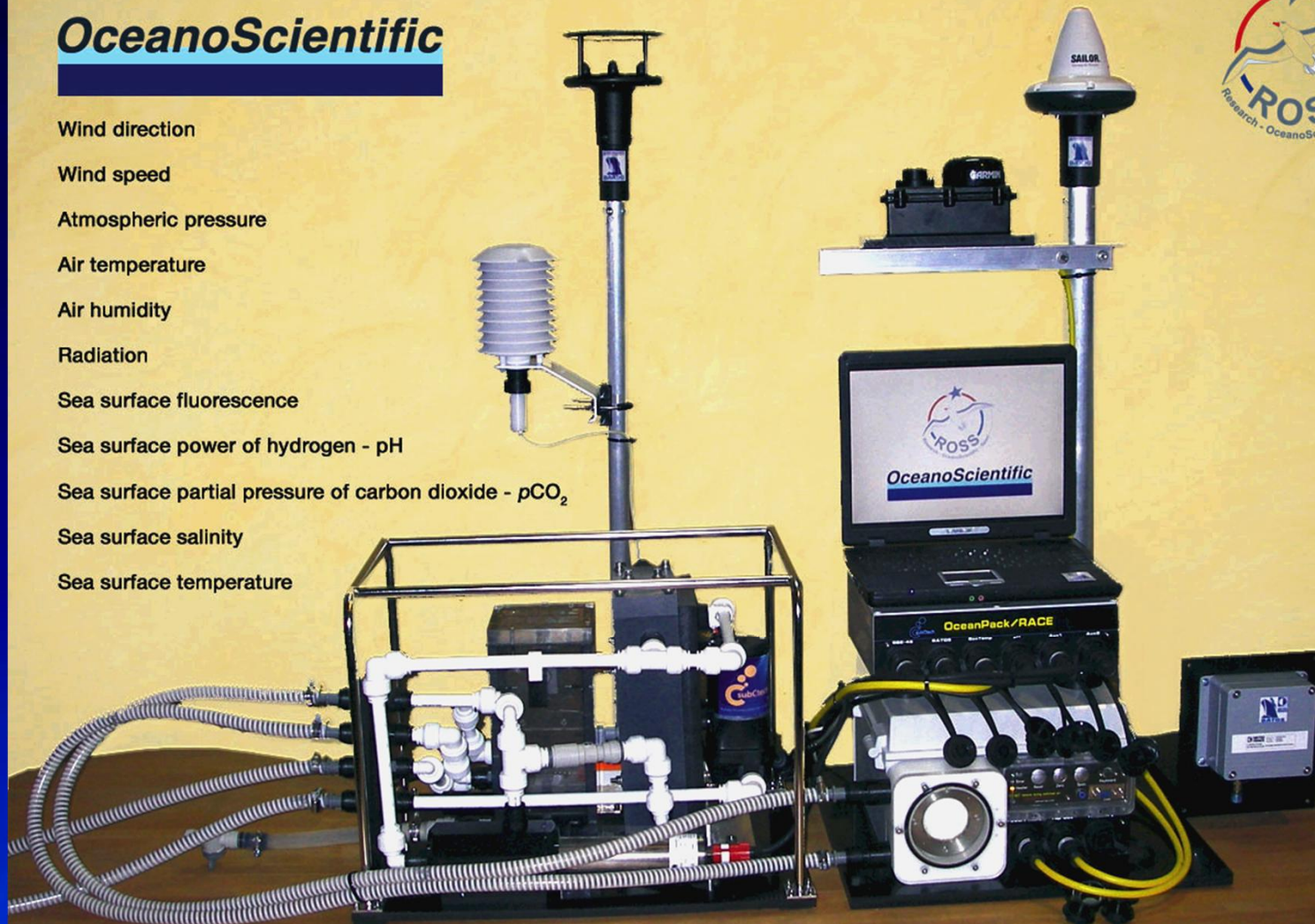
Sea surface fluorescence

Sea surface power of hydrogen - pH

Sea surface partial pressure of carbon dioxide - $p\text{CO}_2$

Sea surface salinity

Sea surface temperature



OceanoScientific® Kit - October 2010

Implementation on small vessels (like SolOceans® OneDesign):

STEP 2
2010 - 2013

OceanoScientific

www.oceanoscientific.org

STEP 1
2006 - 2010

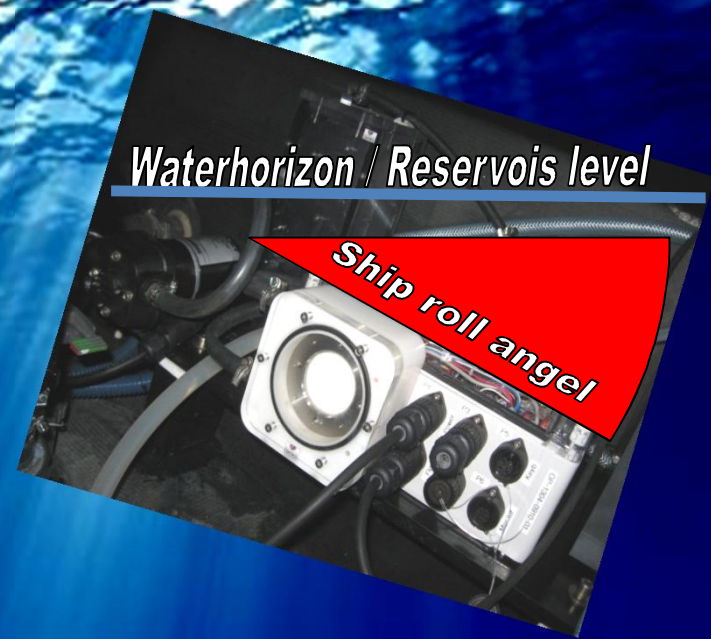
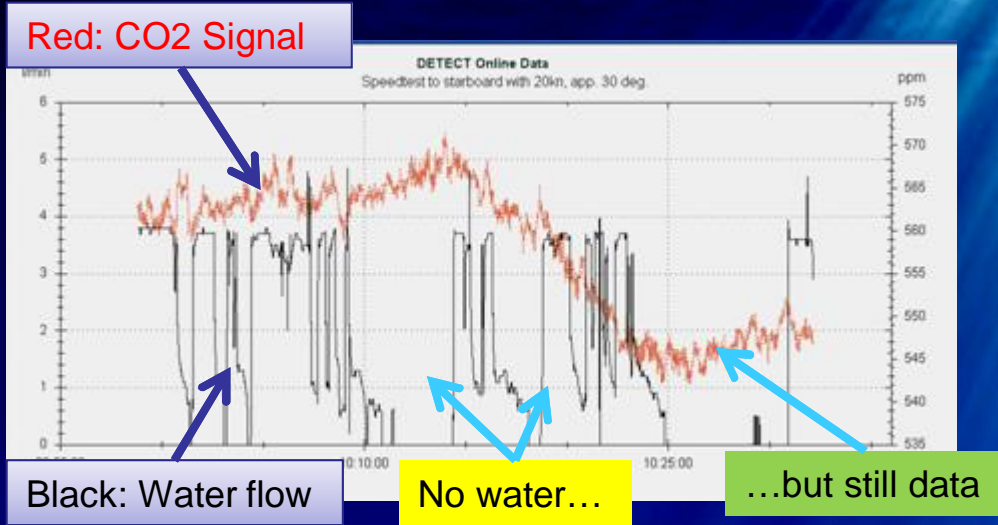
Additional sensors

- › Radiation
- › Sea surface Fluorescence
- › Sea surface pH
- › Sea surface Temperature

www.oceanoscientific.org/en

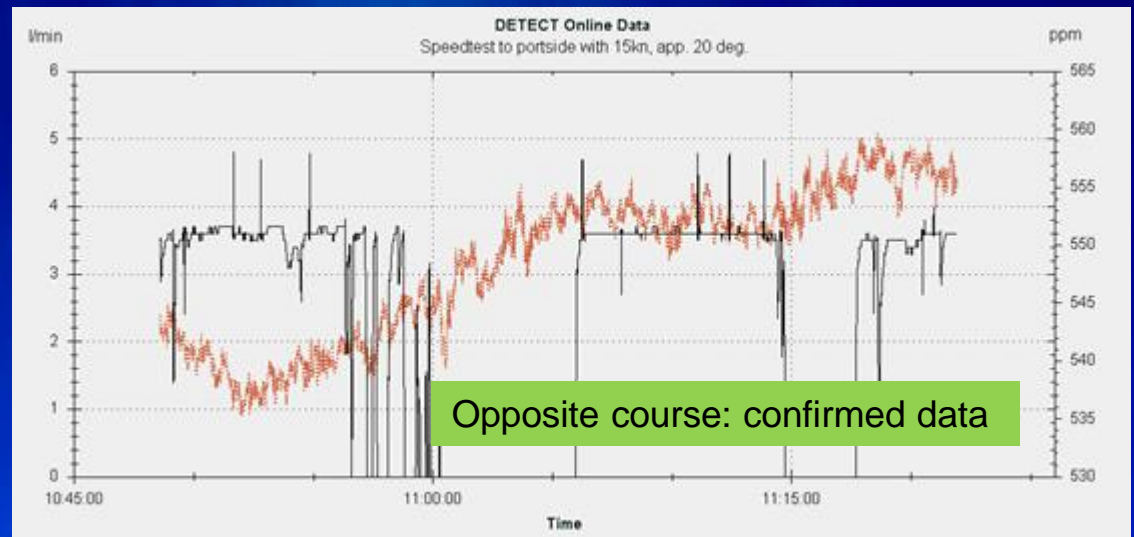
Video: www.youtube.com/watch?v=8CvUdUNcdsl&feature=related

Testing BREST:



Verification at opposite course
Unprocessed raw data at 1 Hz

Worst-case „speed“ test



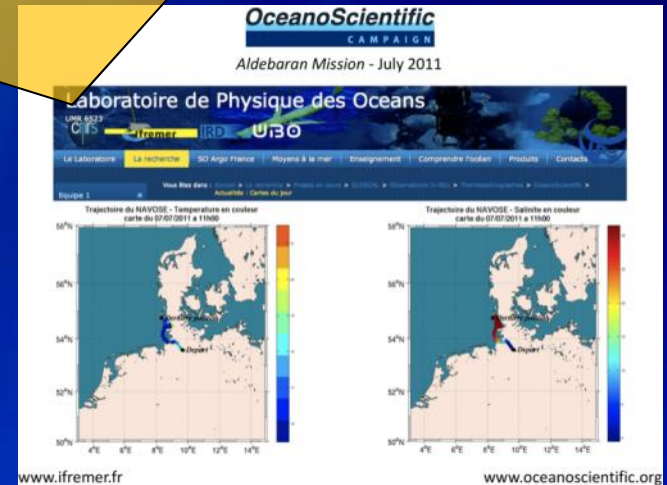
Meereswettbewerb 2011: RV ALDEBARAN



Team of young scientist
Meteorology



www.meereswettbewerb.de
www.aldebaran.org



And in the evening input to
the weather forecast



La Louise

February 2012- September 2012

Greenland/Arctic

Data: Ifremer

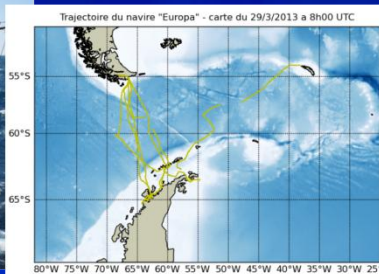


Bark EUROPA

Since January 2013

Antarctica

Data: Ifremer





Research Vessels



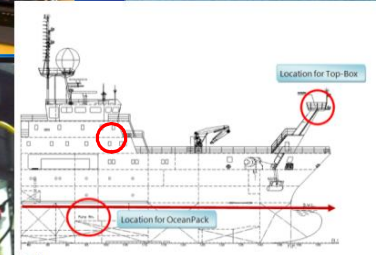
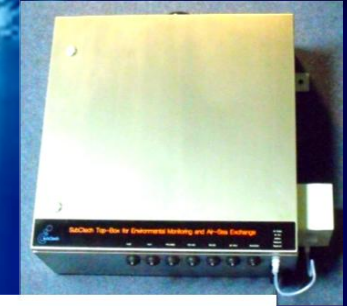
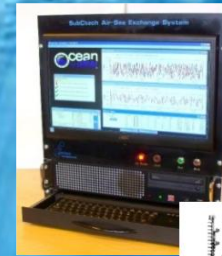


RV XE-XUE

since February 2012

China Sea

Data: Chinese Research Center



RV Belgica

since 2011

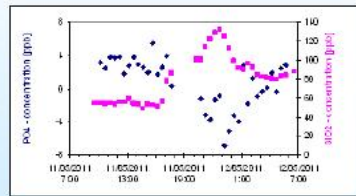
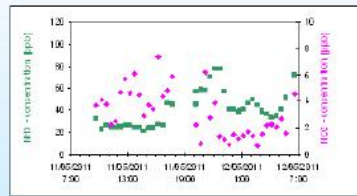
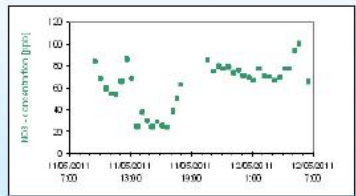
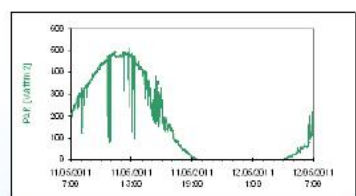
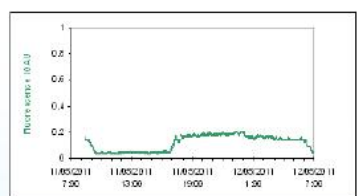
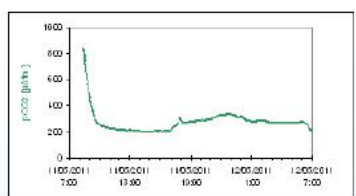
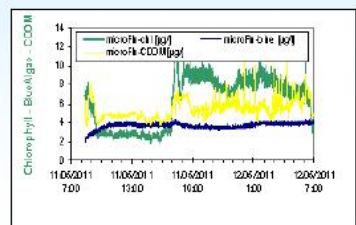
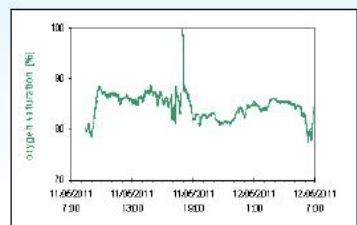
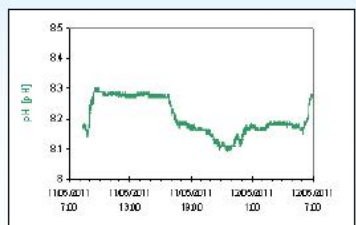
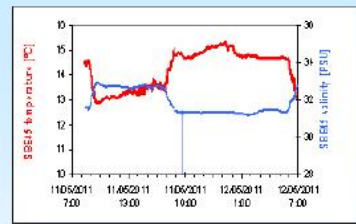
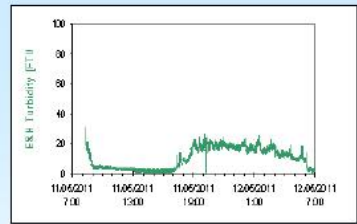
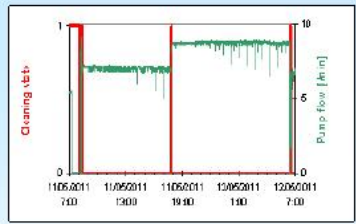
North Sea

Data: MUMM





P dgdjhp hgwx q lwr i#k#h#D ruwk #vhd#P dwkhp dwifdc#P rghov
 P X P P # #P P # #P J P P



AUMS data
 from 11 May 2011 07h00
 till 12 May 07h00.



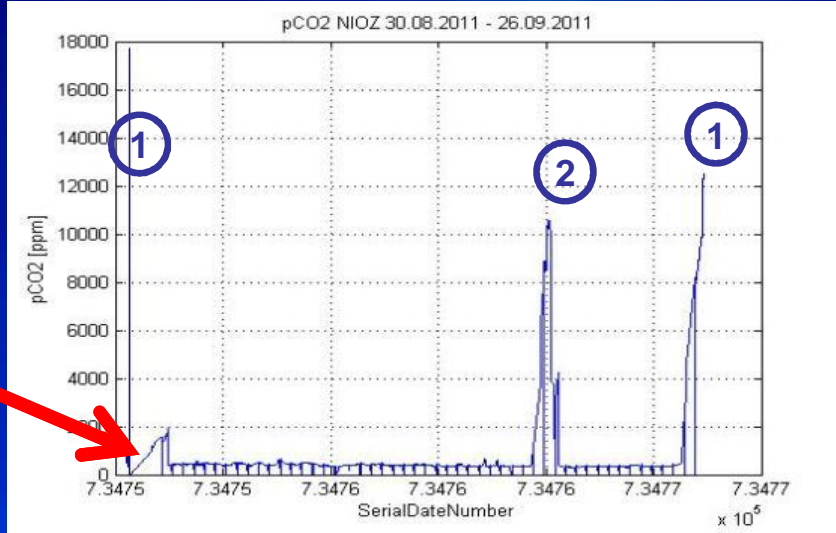
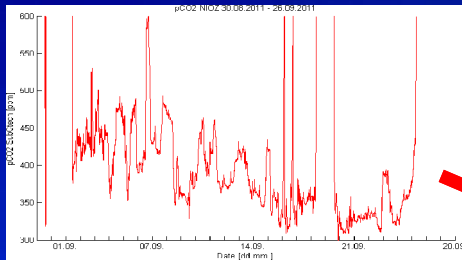
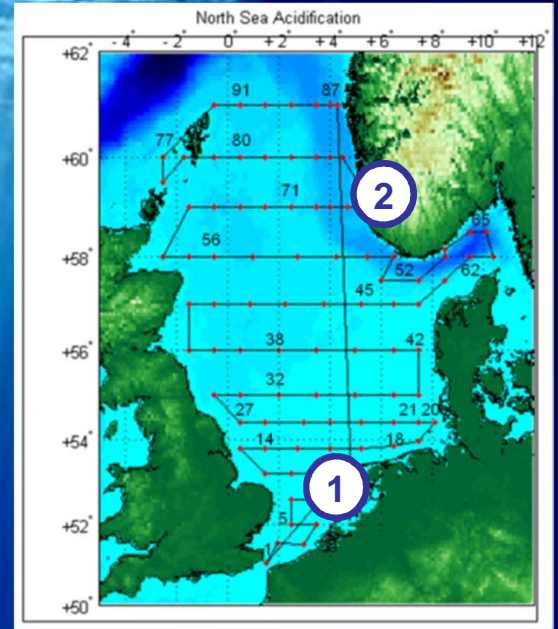
Photo NIOZ

RV Pelagia

30.08.2011-26.08.2011

North Sea

Data: NIOZ



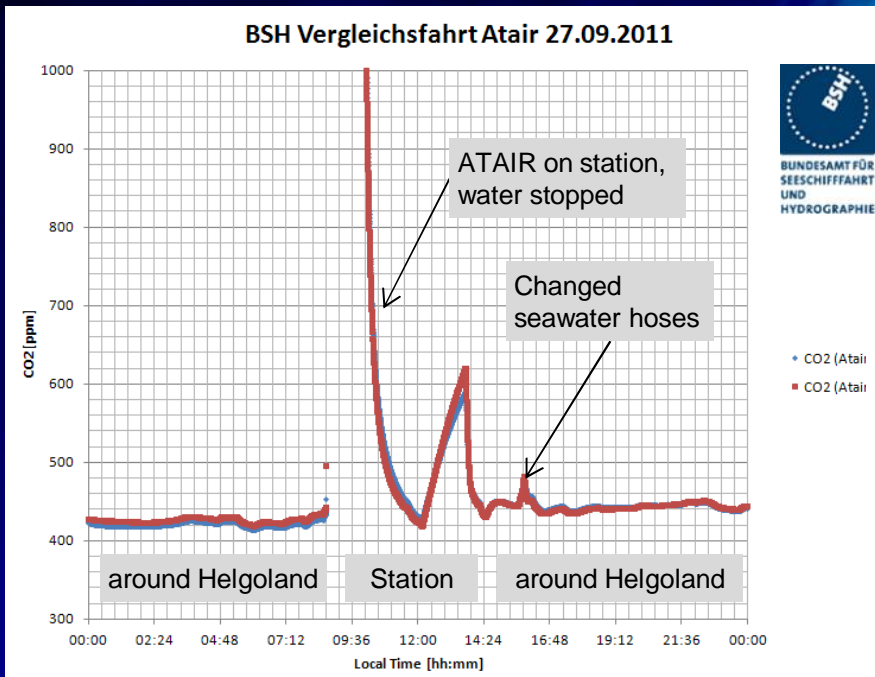
First result: 4 weeks continuously data – 1.5 Mio. Datasets

RV ATAIR

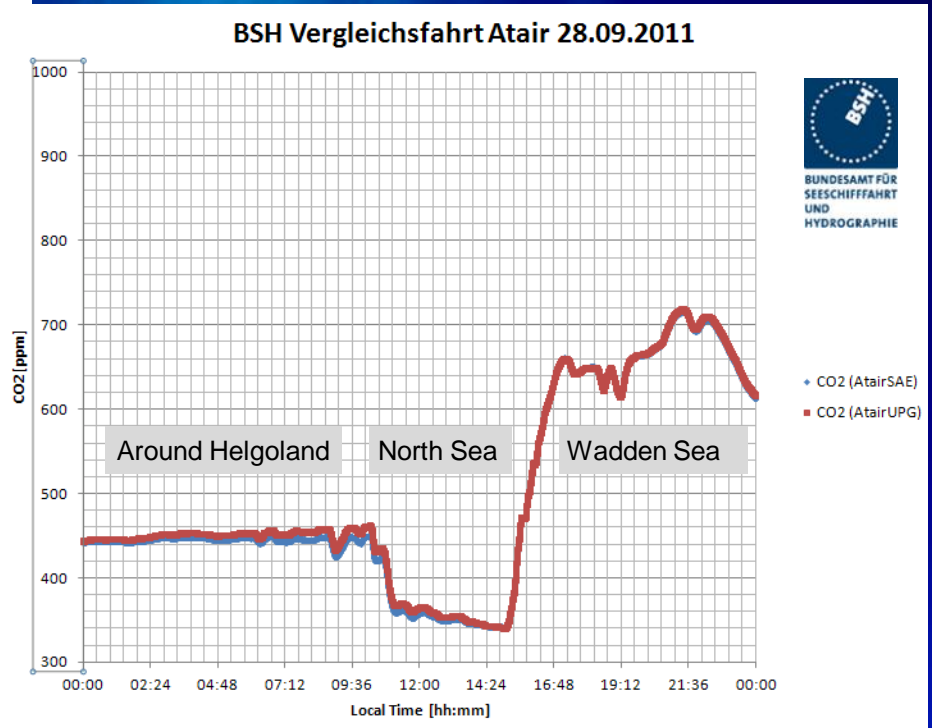
September 2011
 North Sea/Helgoland
 Data: BSH



Photo BSH



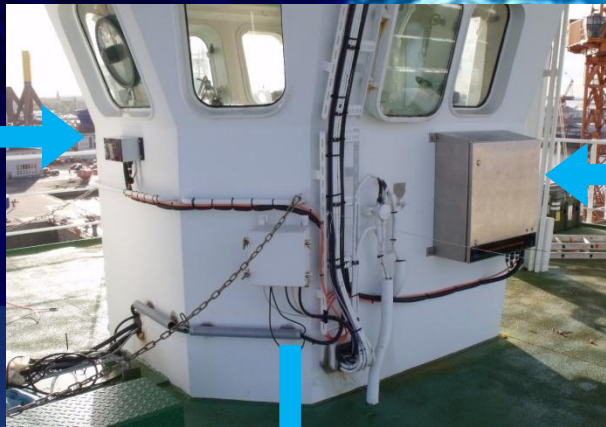
Trip around Helgoland



Helgoland to Weser estuary

Air-Intake

- Air-CO₂
- Arctic Version
- Protection against 30s of flooding



Top-Box

- Air-CO₂
- Meteorological Datalogger
- Arctic Version -40°C
- Fully Autonomous
- Low Maintenance
- Connected by Ethernet

RV Polarstern

Since September 2012
 Antarctica
 Data: NIOZ and Uni Groningen



Water Supply

- Constant Flow & Pressure
- Supply for analyzers
- Gas neutral, e.g. for CO₂
- Fully Autonomous
- Low Maintenance

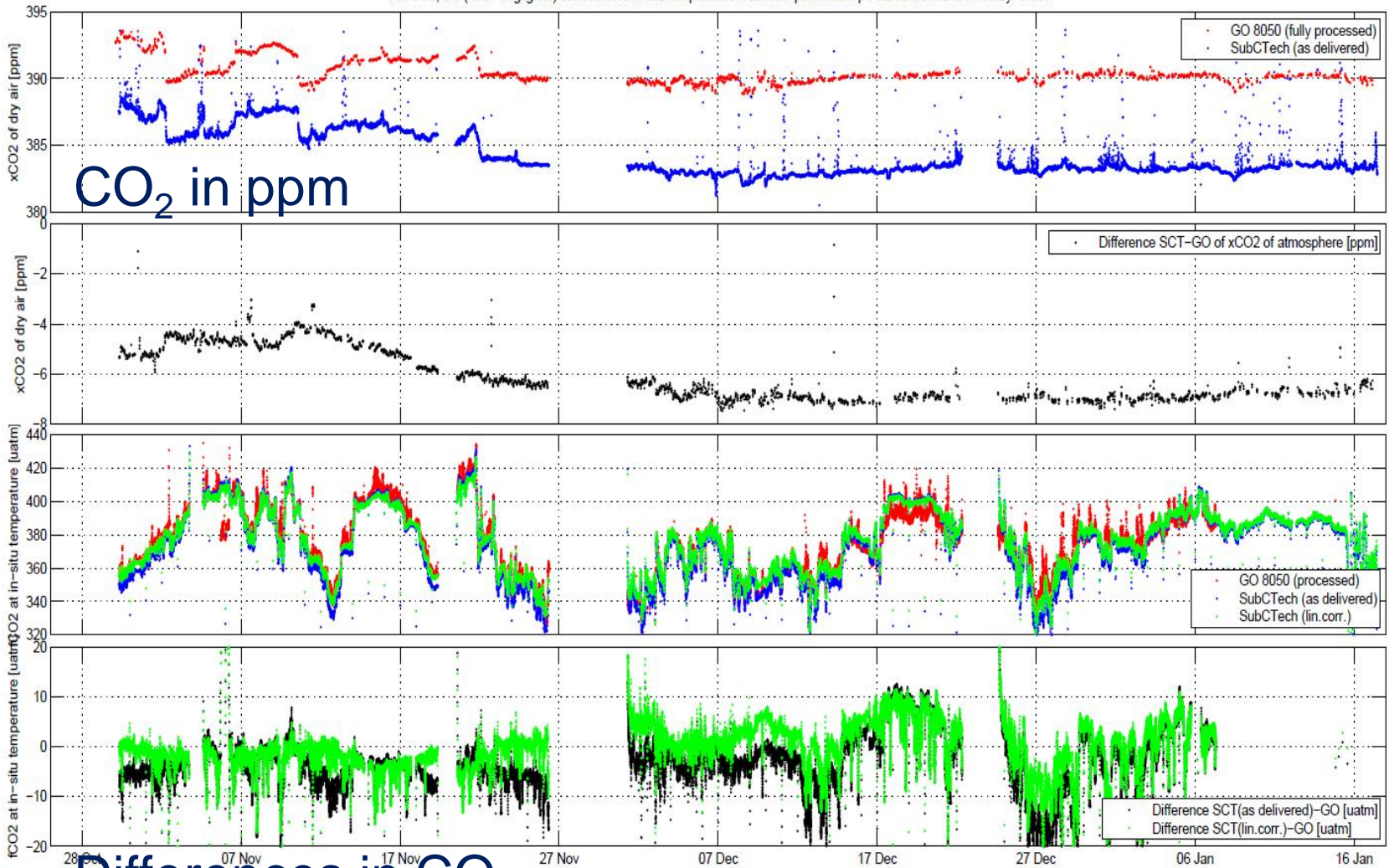


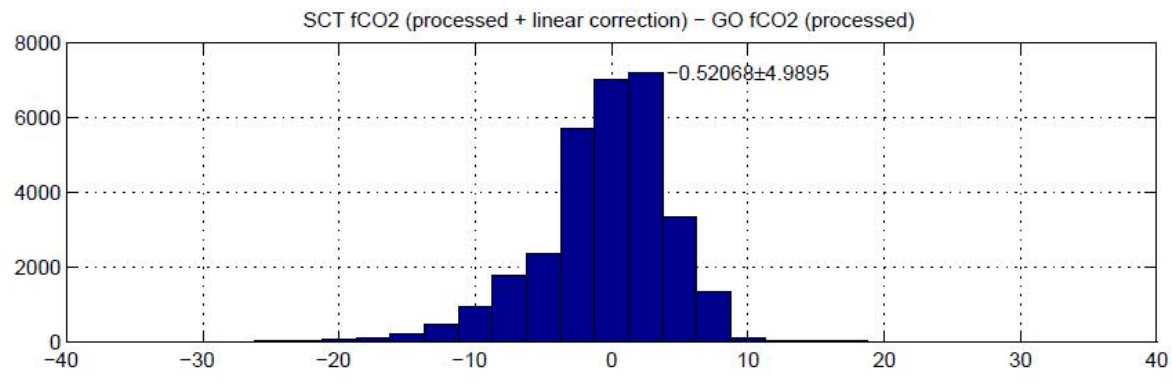
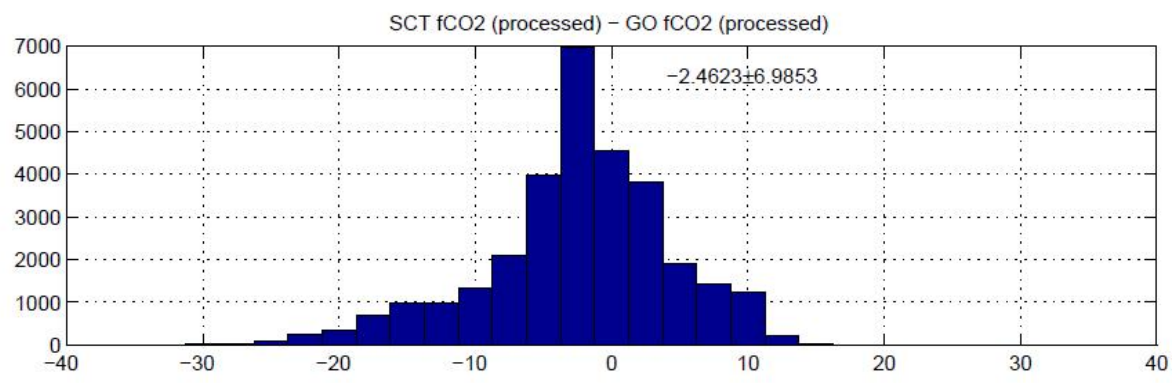
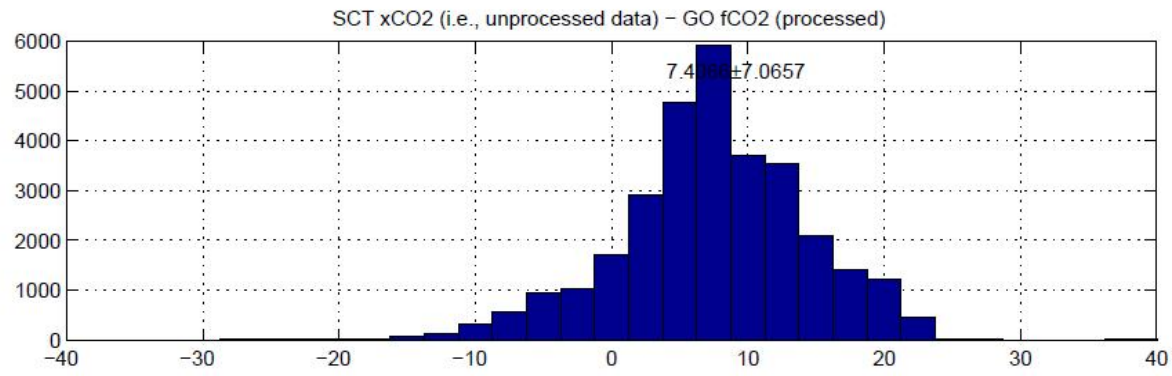
OceanPack

- Water pCO₂ "Underway"
- Oceanographic Datalogger
- Multi-Sensor Support
- Fully Autonomous
- Low Maintenance



A (top): ATM xCO₂ (in dry air). B: Difference. C: EQU fCO₂ (at in situ temperature). D (bottom): Difference (GO signal 20-minute running mean)
 For SCT, the (near-negligible) correction to in situ temperature was NOT performed. pCO₂ converted to fCO₂ by *0.997





What to do next?

- ➔ Calibration unit with calibration and reference gases for the water measurement
- ➔ Including formulas for direct compensation of water temperature
- ➔ Including formulas for direct flux calculation
- ➔ Detailed testing of the Air CO₂ measurement



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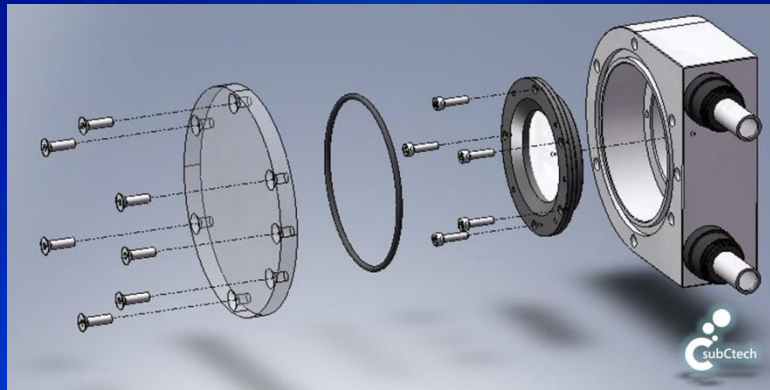


The Technology

OceanPack

Underway Technology:

- Optimized engineering: less leaks → less calibration required
- Optimized components: valves, pumps, membranes are produced specifically
- Best analyzer: developed in cooperation with , already fully integrated
- Integrated automatic zero calibration, results are already processed
- Simply replaceable Flat-Membrane-Equilibrator, patent pending
- Open standard: integrated CF-Card Datalogger speaks  National Marine Electronics Association NMEA-0183 ASCII
- Open system design: flexible interfaces to other sensors, samplers or analyzers
- Marine environmental friendly: little effect of fouling, sedimentation or shocks



OceanPack

Objectives:

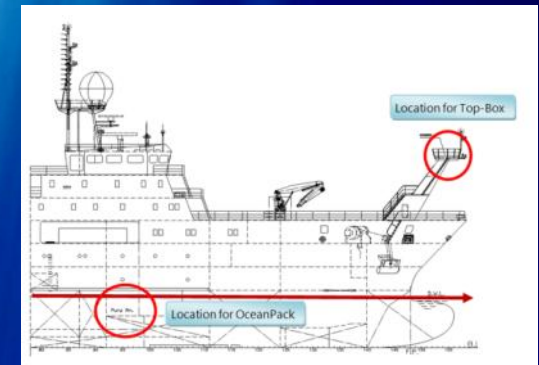
- Highly accurate measurements
- New markets such as small boats
- Applications under extreme conditions
- Small price
- Easy integration - ready to use :
 - Just connect Water in, Water out, Power - and get the Data
- Unattended operation, optionally automatic cleaning
- Very little maintenance for $p\text{CO}_2$:
 - No reference gases are needed while sailing
 - 1-button span calibration
 - Cassette membrane equilibrator
- Flexible and scalable system design

SubCtech GmbH

- ➔ Technology experience for 24 years
- ➔ Marine, scientific and industrial market
- ➔ Development of sustainable technologies
- ➔ System design to system integration
- ➔ Specialized on customized and challenging solutions
- ➔ Benefits:
 - ✓ Ready to use - easy to use
 - ✓ Flexible and modular design
 - ✓ Robust and High reliability
 - ✓ Low Maintenance



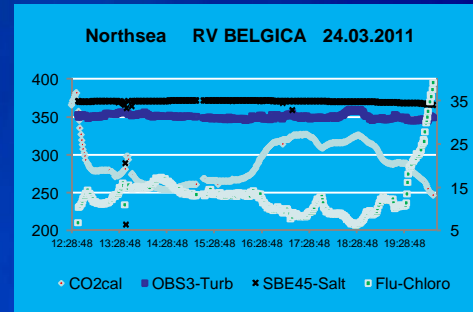
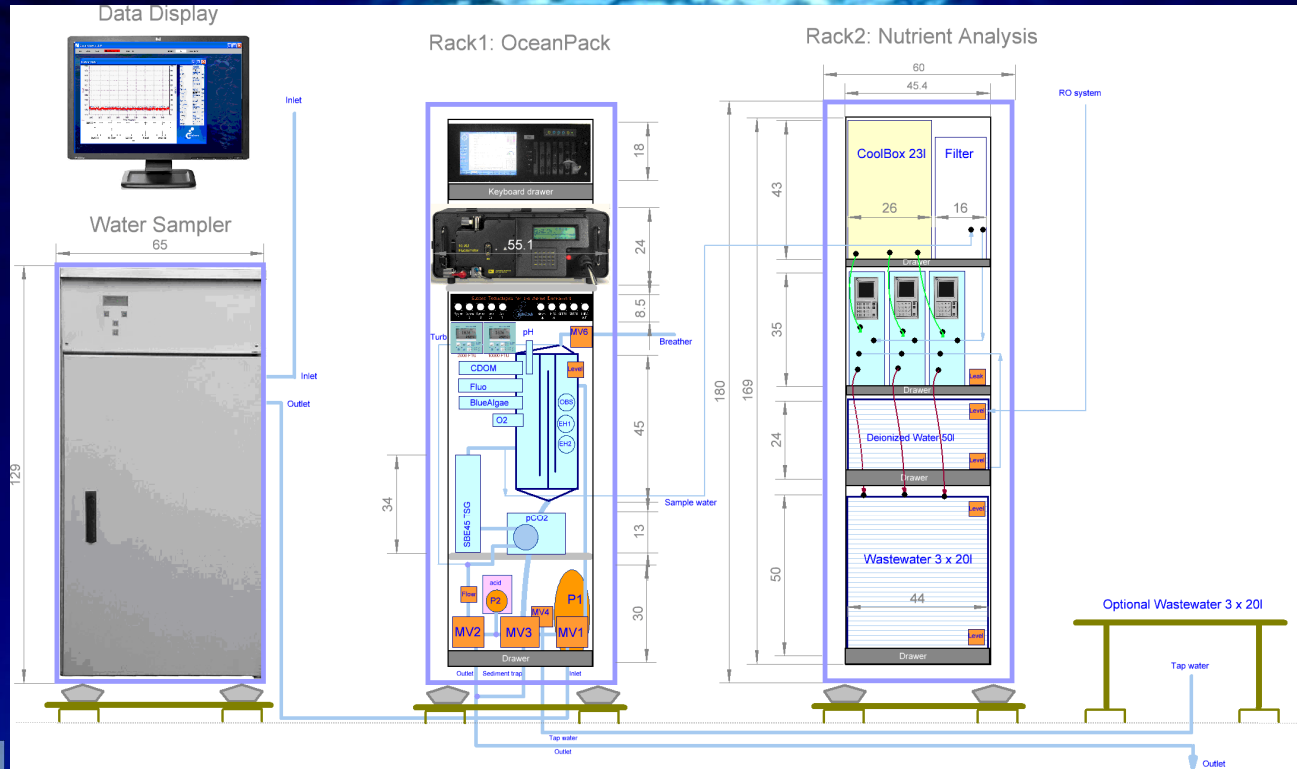
$p\text{CO}_2$ Sea-Air-Exchange Design



- Top-Box consists of:
- CO_2 LI-COR[®] analyzer
 - Air-intake
 - GPS receiver
 - Meteorological sensors
 - Motion sensor (IMU)
 - Power supply

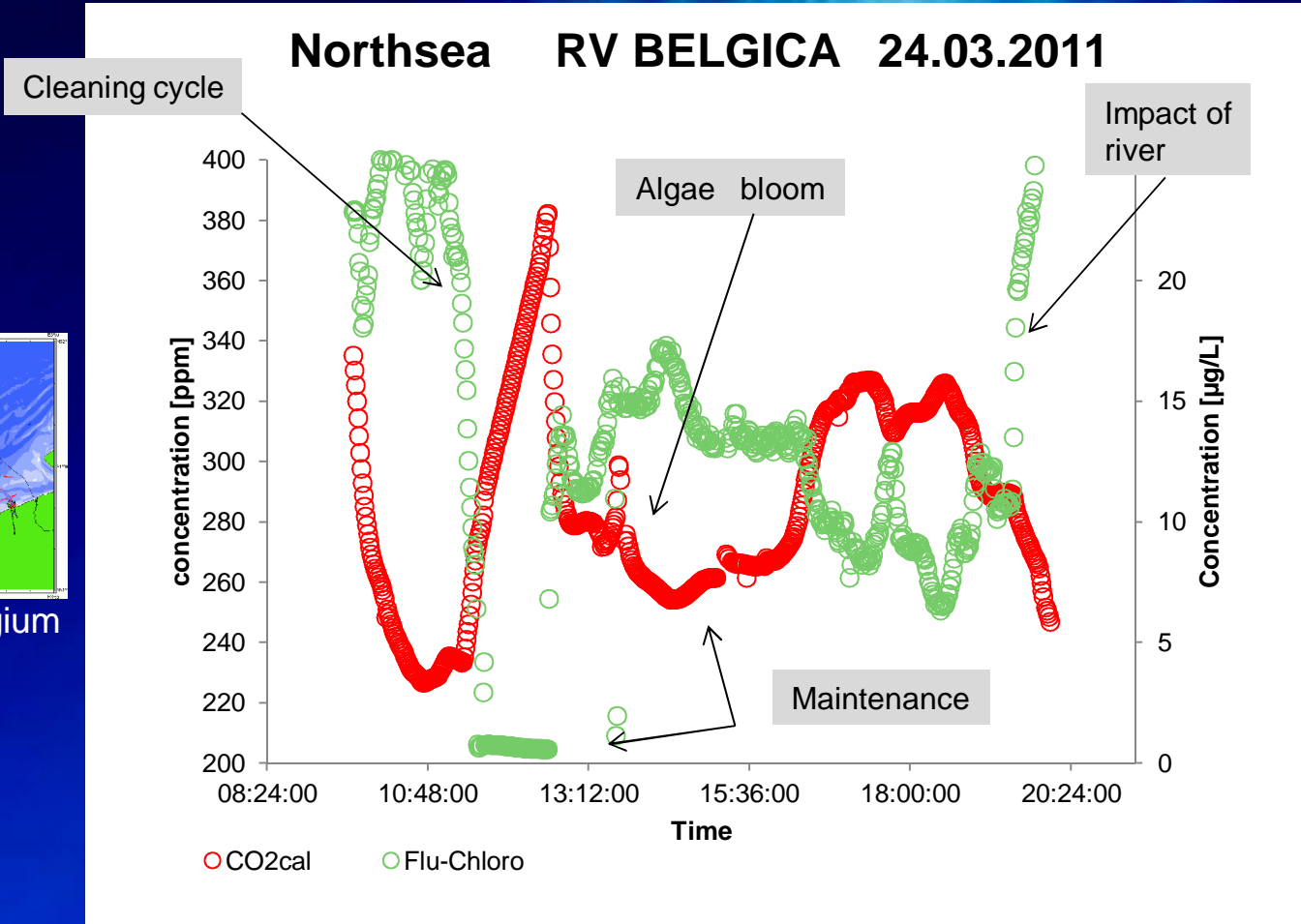
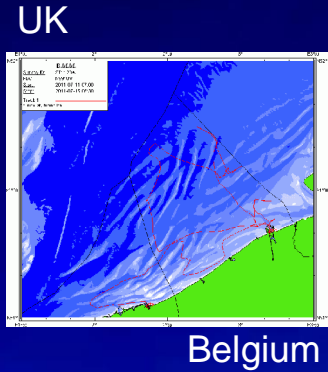
- OceanPack consists of:
- $p\text{CO}_2$ LI-COR[®] water analyzer
 - Water supply, mBubbler[®]
 - Oceanographic sensors
 - SmartDI[®] Datalogger
 - Alarm service
 - Pump, valve control
 - Power supply





Complete water quality monitoring system (3 Years)
(RV BELGICA)

RV Belgica finished the 3 Weeks unsupervised cruise



Data provided by J.Baker,



Gesellschaft für
Marine
Aquakultur
Büsum

CAU

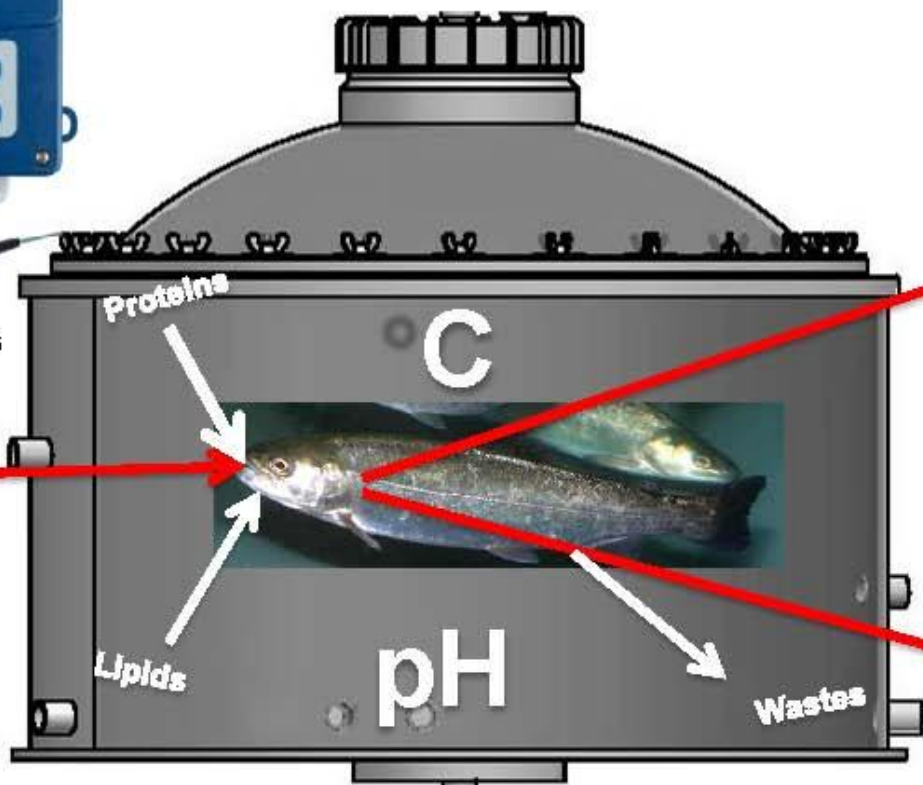
Christian Albrechts
Universität zu Kiel

How to measure the gas metabolism of ammoniotelic aquatic organisms?

Stationary Application



© JUMO GmbH & Co. KG



O₂

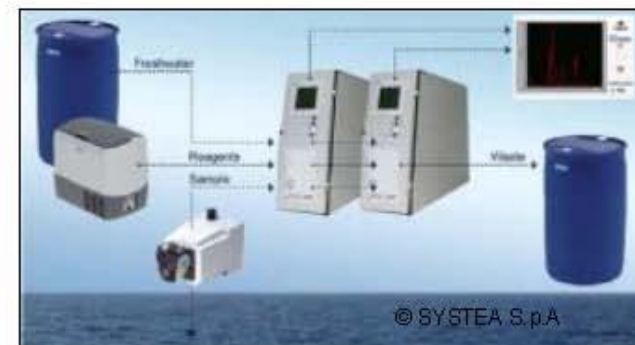
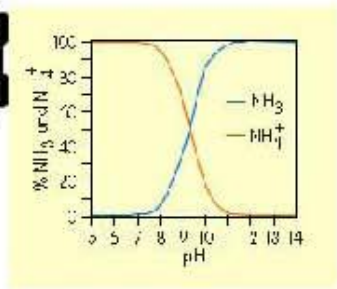
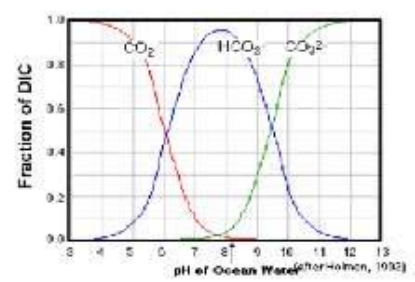
CO₂

NH₃

In cooperation with SubCtech Germany we develop a fast CO₂ meter for aquaculture applications.



Problem!! We need a very accurate pH measurement.



© SYSTEVA S.p.A

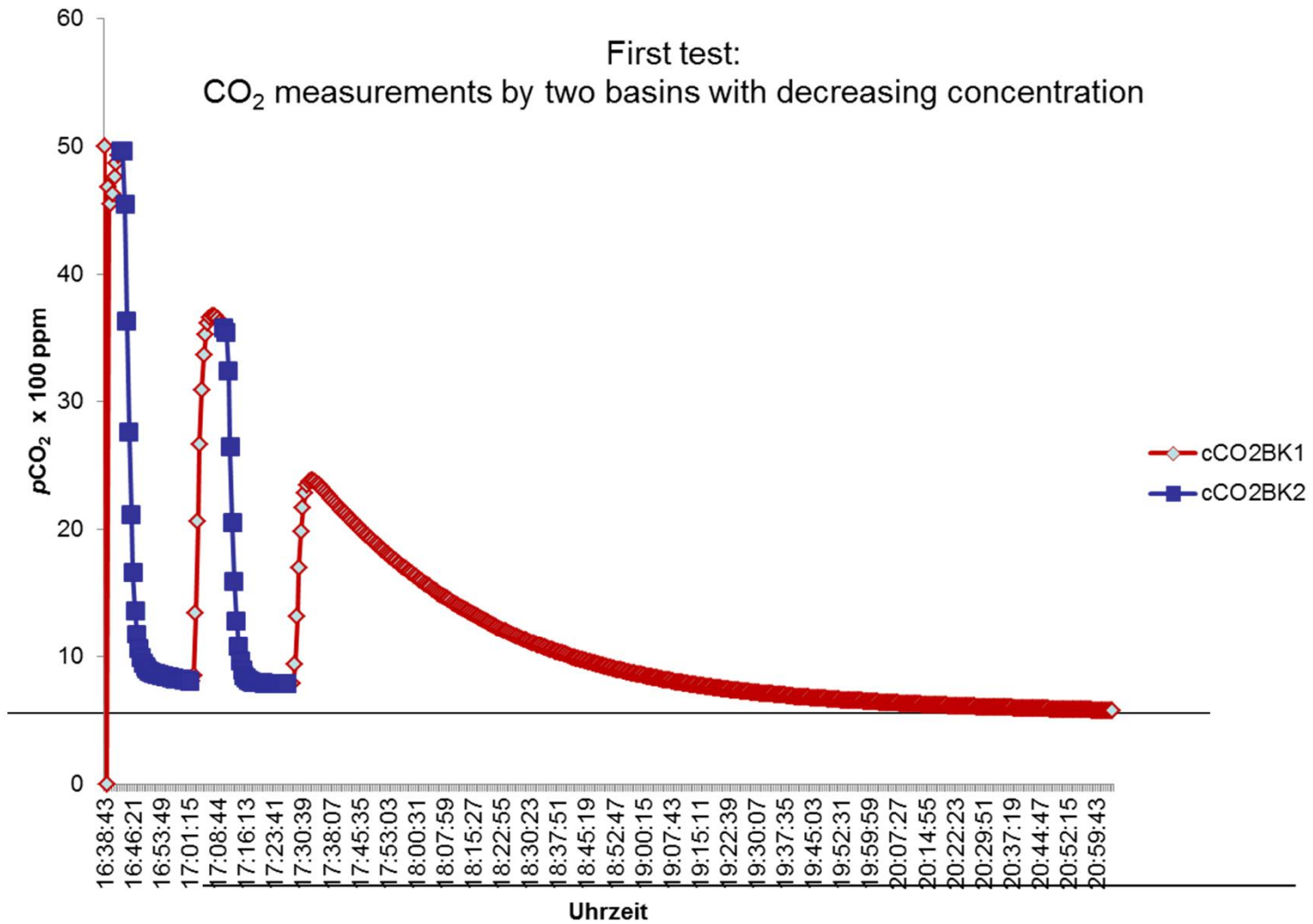


Gesellschaft für
Marine
Aquakultur
Büsum

C | A | U

Christian Albrechts
Universität zu Kiel

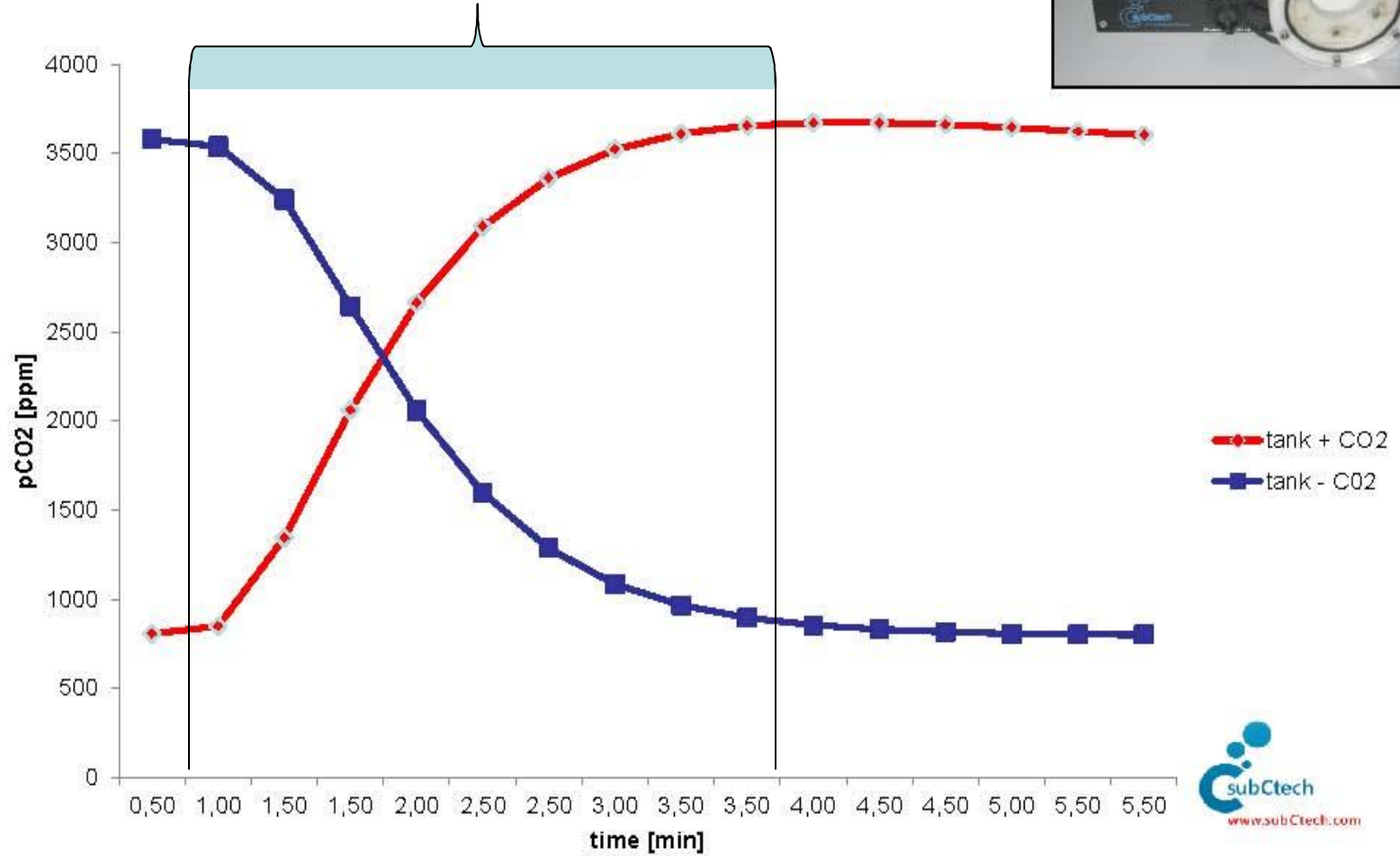
First test: CO₂ measurements by two basins with decreasing concentration



FTZ Westküste der Universität Kiel in Büsum



First results:
New fast CO₂ analyzing method realized
3 Minutes T99 @ $\Delta C = 3000\text{ppm}$



Further development of an online-controlled housing system to detect metabolic activity in fish (WeOStoFi)

