Observations of North Atlantic Parameters

Johannes Karstensen

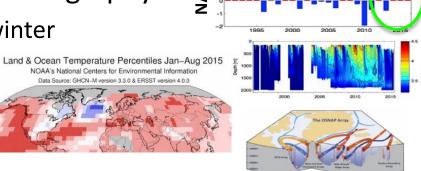
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The Subpolar North Atlantic 2012-2016

- Exciting times for observational oceanography!
 - Since 2011/12: 4 out of 5 NAO high winter
 - Return of deep convection
 - Appearance of the "cold blob"
- Installation OSNAP array
- Beyond SPNA (but closely connected) Arctic melting continues with lowest sea ice records 1st: 2012, 2nd: 2016, ...
 - -> Blue-Action H2020 project





NACLIM

Outline

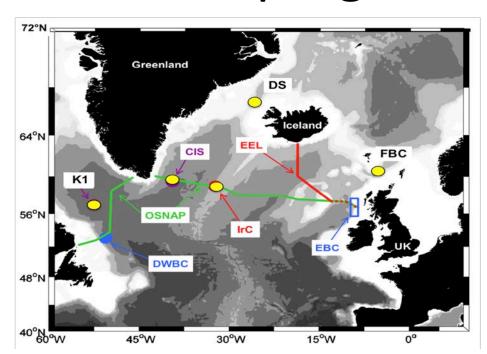
- A brief introduction into the NACLIM observations in the Subpolar North Atlantic
- Sustained Ocean Observing
 - a structured approach: the Framework for Ocean Observing





NACLIM observational program

- Mix of long term moorings (inflow to the Nordic Seas, overflows, deep western boundary current, convection depth)
- Process studies:
 EGC moorings freshwater
 transport & entrainment in
 overflow plume
- Hydrography & Tracer sections



(after NACLIM Deliverable D22.31)



Climate data time series at NACLIM website

Fluxes

- Faroe Bank Channel overflow transport
- Hornbanki section Atlantic inflow volume and heat fluxes
- Labrador Sea western boundary current transport at 53° N
- RAPID transport of MOC components at 26.5° N
- Wyville Thomson Ridge overflow transport
- Faroe Shetland Channel volume, heat and salt fluxes of Atlantic Water, and total fluxes
- Denmark Strait overflow transport
- Iceland-Faroes Atlantic inflow
- Kogur Array freshwater flux

Entrainment

Denmark Strait overflow plume

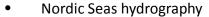
Mooring data

- Angmagssalik array
- Irminger Sea mooring Long-term Ocean Climate
 Observations LOCO2/3

Hydrography data









 Properties of the Atlantic Water Core in the Faroe Current



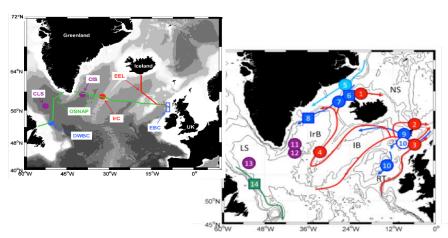




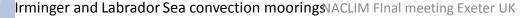












NACLIM data and data access

- Data and Products have been converted in machine-readable format (netCDF)
- Climate & Forecast CF metadata standard used
- Added error estimates & data analysis documentation
- Next steps:
 - Time series data to be implemented into Obs4MIPs initiative
 - Link to Copernicus Climate Service

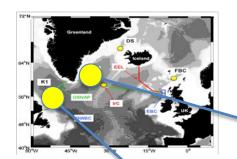
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	geografial training

Data set	Denmark Strait overflow transport
Description	Daily average of overflow transport on Denmark Strait
Period	September 1996 – September 2014
Location	66° N 28° W (map)
Instruments	Moored ADCPs
Variables	Overflow volume transport.
Source	Detlef Quadfasel (UHAM)

Protected area			
Data file	ds_overflow_transports_daily_1996_2015.txt		
Data files	ds_overflow_transports_daily_1996_2015.nc		
Documentation	<u>readme.txt</u>		
References	Jochumsen_etal_2012.pdf		

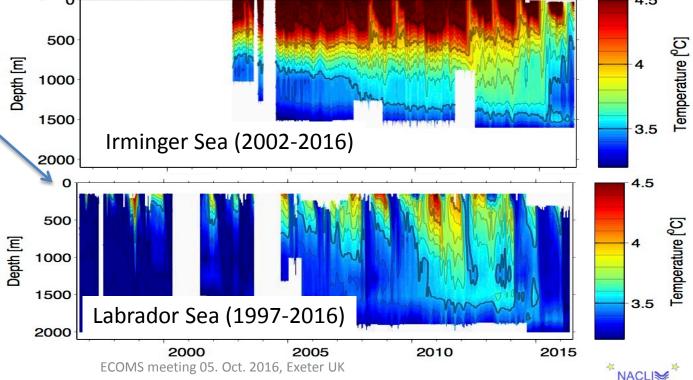
ECOMS meeting 05. Oct. 2016, Exeter UK



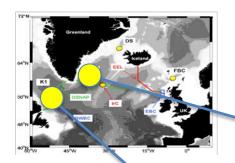


Up to 20-yrs of Deep Convection monitoring at NACLIM time series sites

Since end 1990 – warming!



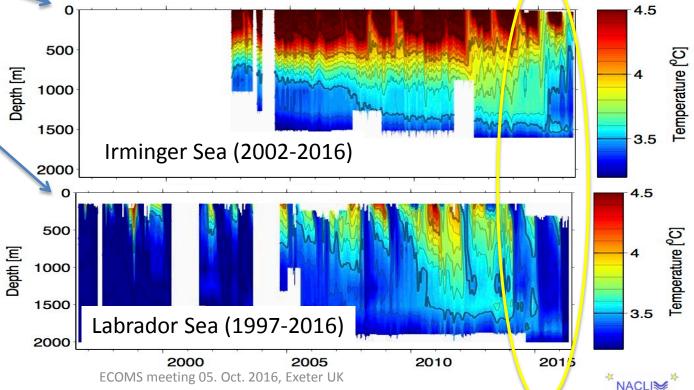




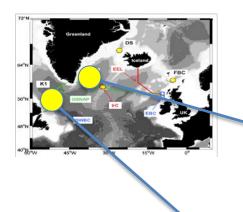
Up to 20-yrs of Deep Convection monitoring at NACLIM time series sites

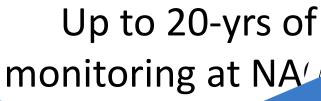
Since end 1990 – j warming!

 Return of the deep convection in NAO high years



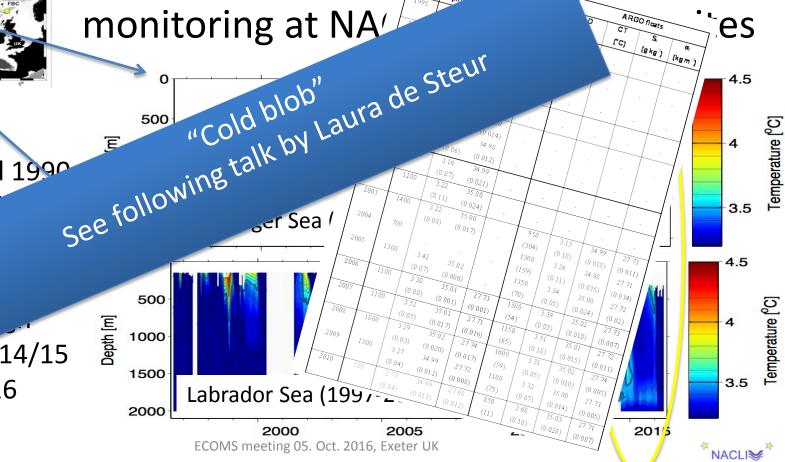






Since end 1999 warmin

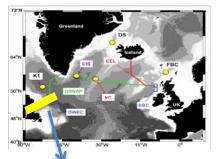
Retu deep in NAO years (2014/15 & 2015/16



vection

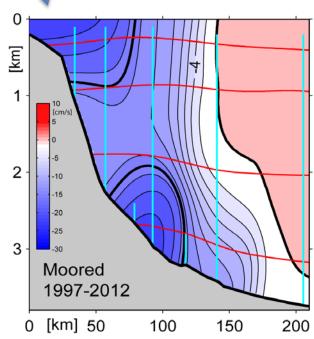
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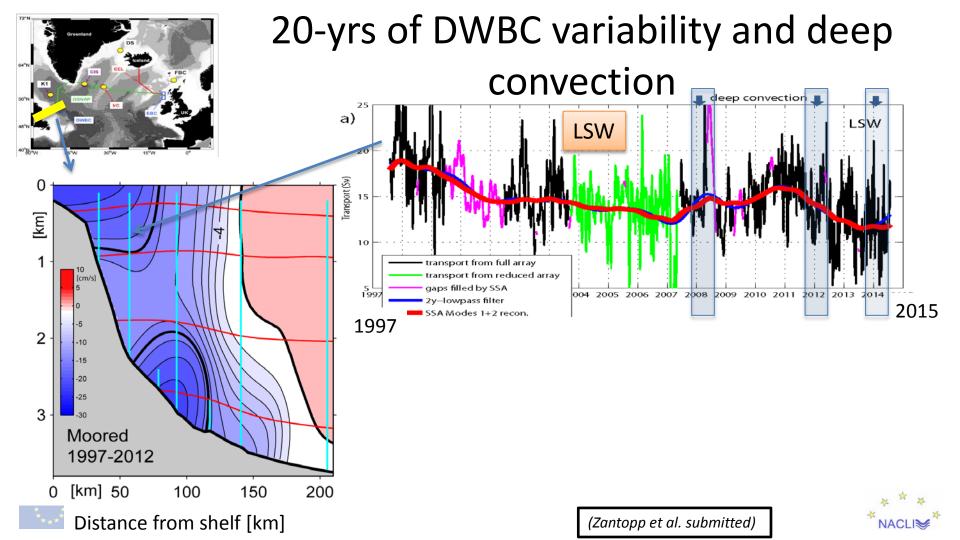


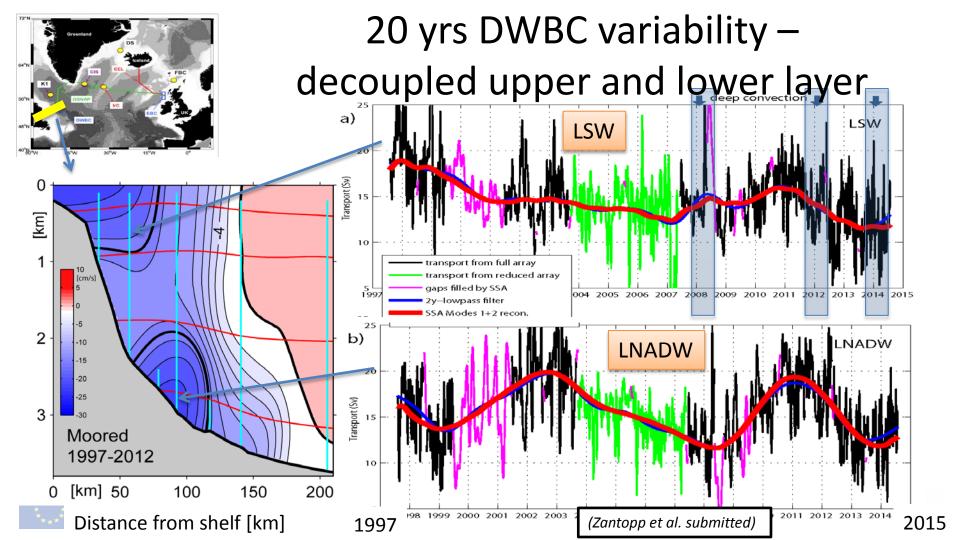
20-yrs of DWBC variability and deep convection

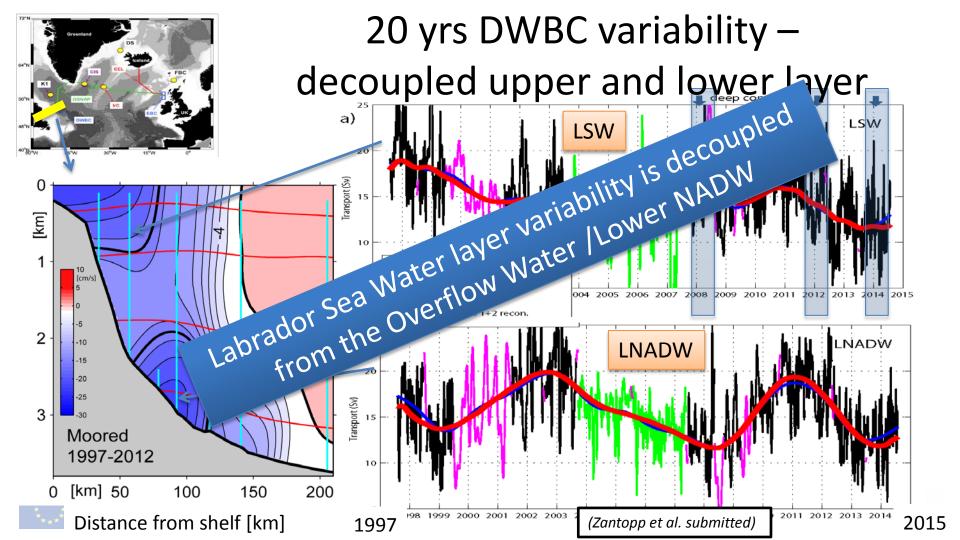
 It has long been suspected that the Labrador Sea convection feeds the upper part of the Deep Western boundary current (DWBC)

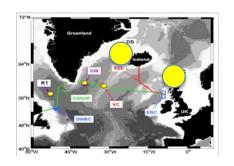






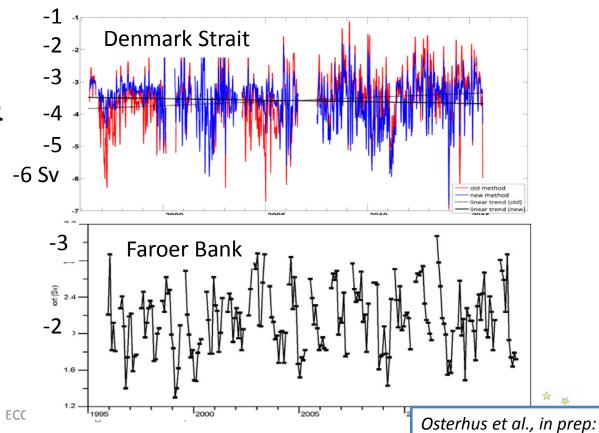




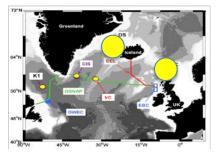


20-years Overflow into SPNA

- Denmark Strait & Faroer Bank Channel
- Overflow transport is constant on >1year

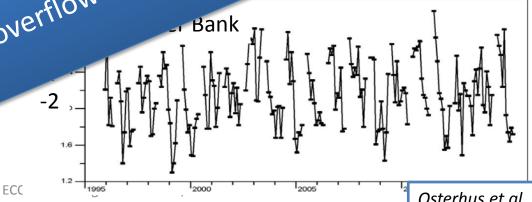






Denmark Strait & Denmark Strait & Significant transport change over
Faroer Bank significant transport change over
Than no statistically significant transport change over The FBC overflow has warmed by about 0.1°C Denmark Strait &

Overf transpl constan >1year





Observational data in the context of climate modelling and climate services

- Observational data is primarily used in two ways:
 - (1) for the initialization of the predictions systems
 - (2) for the validation of the prediction systems





Observational data in the context of climate modelling and climate services

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 - (1) for the initialization of the predictions systems
 - (2) for the validation of the prediction systems
- Relevant Data "groups" (for practical reasons)
 - Satellite data
 - In-situ data
- Key for data-use is accessibility and documentation





Satellite data





space for europe

European Space Agency

- Coordinated on international level
- "Sustained" systems
- Data accessible and well documented
- Provide boundary condition for model initialization and validation



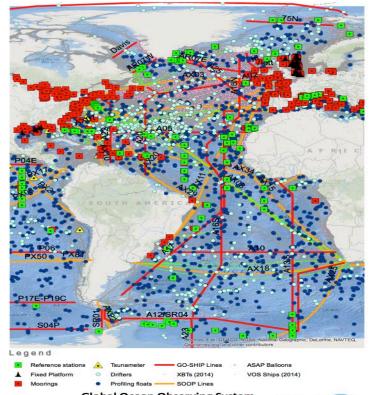




In-situ data

Atlantic in-situ data 2015

- Multiple networks:
 - Drifter/Floats, moorings, ships, gliders, XBT/VOS/SOOP, ...
- Organized the Global Ocean/Climate Observing System (GOOS/GCOS)
- Sustainability: ?
- Financing: individual nations















OceanObs'09

Ocean information for society: sustaining the benefits, realizing the potential



Future of Sustained Observations

- OceanObs'09 identified tremendous opportunities, significant challenges
- Called for a framework for planning and moving forward with an enhanced global sustained ocean observing system over the next decade, integrating new physical, biogeochemical, biological observations while sustaining present observations





























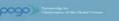






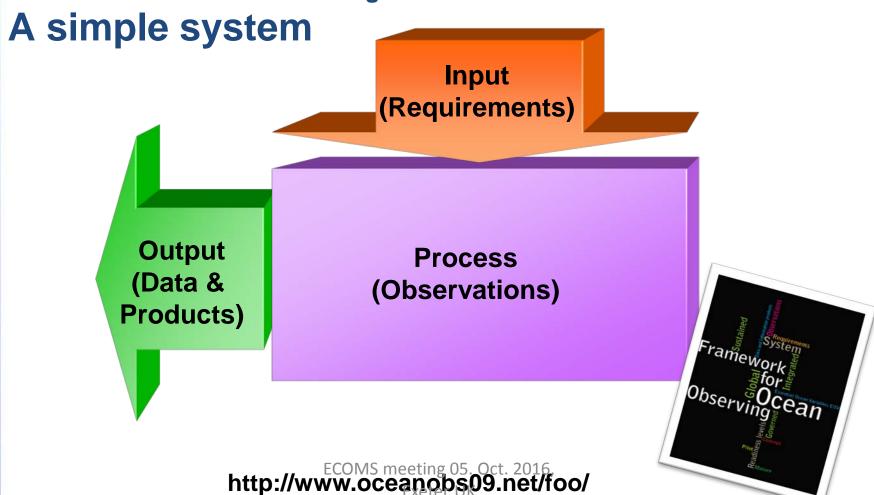








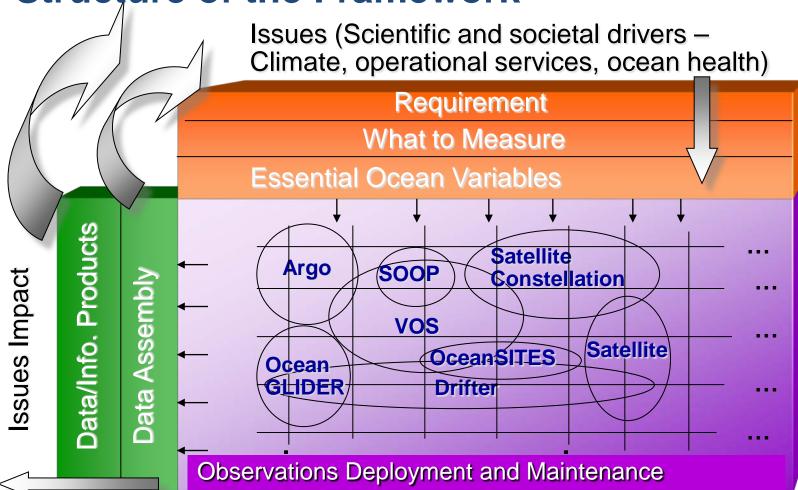
Framework for Ocean Observing









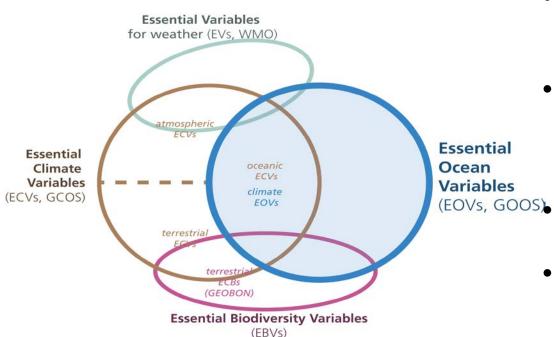




Driven by requirements, negotiated with feasibility in mind

podu usus

Essential Ocean Variables



- We cannot measure everything, nor do we need to
- basis for including new elements of the system, for expressing requirements at a high level
 - Driven by requirements, negotiated with feasibility
- Allows for innovation in the observing system over time





Towards sustained system: requirements, observations, data management

Readiness

Mature

Pilot

Concept

Increasing Readiness Levels

Attributes:

Products of the global ocean observing system are well understood, documented, consistently available, and of societal benefit.

Attributes:

Planning, negotiating, testing, and approval within appropriate local, regional, global arenas.

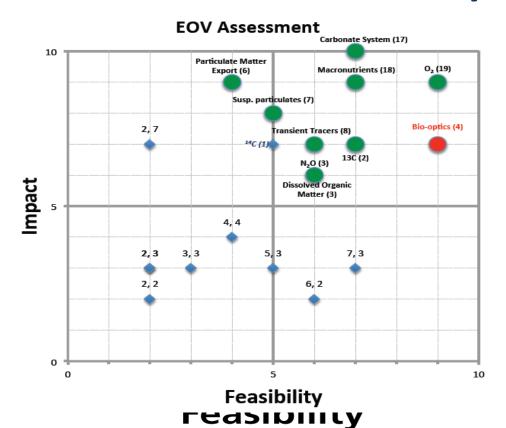
Attributes:

Peer review of ideas and studies at science, engineering, and data management community level.

More Research



Essential Ocean Variables: Feasibility vs. Impact









Phenomena

• EOV shall enable monitoring of physical, biogeochemcial, biological ocean relevant phenomena:

Circulation

Fronts and eddies

Tides

Coastal processes

Air-sea fluxes

Waves (Surface / Internal / Planetary)

Freshwater cycle

Sea level

Upwelling

Riverine

Heat storage

Stratification

Mixed layer

Water mass

Sea ice extent

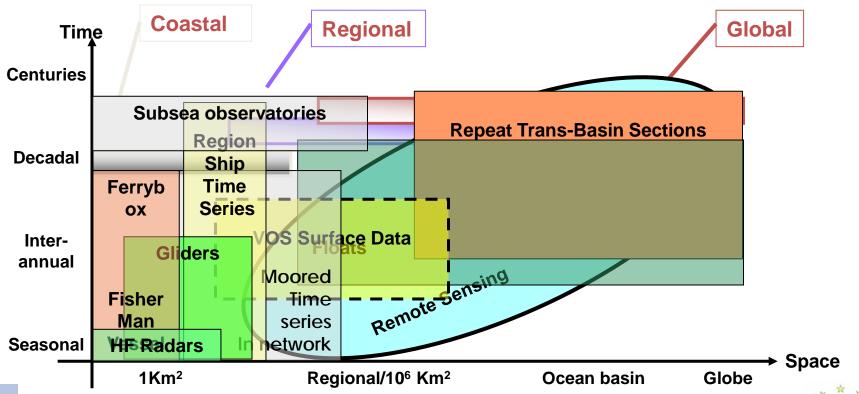
Extreme events





Global to Regional to Coastal







The Current Global Ocean Observing System



Integrated system designed to meet many requirements:

- Climate
- Weather prediction
- Global and coastal ocean prediction
- Marine hazards warning
- Transportation
- Marine environment and ecosystem monitoring
- Naval applications
- 8 of 9 Societal Benefits





- Tide gauge stations
- Drifting Buoys
- Tropical Moored Buoys
- Profiling Floats
- Ships of Opportunity
- Ocean Reference Stations
- Ocean Carbon Networks

- **Dedicated Ship Support**
- Data & Assimilation Subsystems
- Management and Product Delivery
 - Satellites -- SST, Surface Topography, Wind, Color, * Sea Ice

Implementation of the FOO

- International: working groups at OOPC (Physics), IOCCP (Biogeochemistry), GEOBON (Biology)
- Pacific: TOPOS2020 (revision of TOGA array)
- Europe projects (closely linked to Copernicus Marine service):
 - Atlantic: AtlantOS (2014-2019)
 - Arctic: INTAROS (2016-2021)
 - Mediterranean: MedOOS (submitted)





Galway Statement on Atlantic Ocean Cooperation Launching a European Union - Canada - United States of America

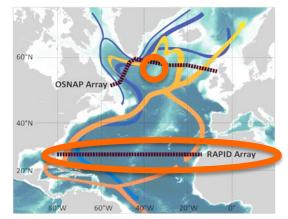
The Signatories of this Statement meeting on the occasion of the high level event

23 and 24 May 2013

The following two topical talks

Ocean Transport estimates (Volume, heat, freshwater, carbon?) are identified as key metrics for model/data comparisons
Analysis related to two AMOC Arrays are presented:

- OSNAP 60°N (2014 present):
 - No full analysis yet (first turn-over cruise ended two weeks ago) and Laura de Steur will present first results from Irminger Sea observations
- RAPID 26.5°N (2004 present):
 - Gerard McCarthy will present latest update on subtropical AMOC time series









The research leading to these results has received funding from European Union 7th Framework Programme (FP7 2007-2013), under grant agreement n.308299 NACLIM (www.naclim.eu)



