Atlantic Regional Panel

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Panel overview

The CLIVAR Atlantic Regional Panel (ARP) is a part of the CLIVAR organization. The panel is in charge of implementing the CLIVAR science plan in the Atlantic sector. During the last 13 years, the primary function of the panel has been to promote, recommend and oversee the implementation of observational systems in the Atlantic Ocean sector and major research initiatives on Atlantic climate variability and predictability. The ARP works in close collaborations with other CLIVAR panels, regional and global programs. Important achievements have been made over the last three years in the development of an integrated Atlantic observing, ocean and climate modeling systems and interdisciplinary multinational climate research programs. In the following we highlight some of the major scientific and implementation accomplishments made by the CLIVAR international community within the Atlantic Ocean.

Achievements for 2018-19

- **The Tropical Atlantic Observing System (TAOS) Review** *(Speich & Rodriguez)*

The tropical Atlantic observing system was last reviewed in 2006 by CLIVAR and GCOS-GOOS-WCRP through the OOPC with a primary focus on PIRATA (*Prediction and Research Moored Array in the Tropical Atlantic*). Since then, the CLIVAR *Tropical Atlantic Climate Experiment* (TACE) has been completed and more recently the EU program *Enhancing Prediction of Tropical Atlantic Climate and its Impacts* (PREFACE) and the EU H2020 *Optimising and Enhancing the Integrated Atlantic Ocean Observing Systems* (AtlantOS) have been very recently completed. Meanwhile, the European Union pursued the implementation of activities under the *All Atlantic Ocean Research Alliance* (https://www.atlanticresource.org/aora) with the signing of two major international statements, the EU-USA-Canada *Galway Statement on Atlantic Ocean Cooperation in 2013*(http://ec.europa.eu/research/iscp/pdf/galway_statement_atlantic_ocean_cooperation.pdf#view=fit&pagemode=none) and the EU-Brazil-South Africa *Belém Statement on Atlantic Ocean Cooperation* in 2017 (https://ec.europa.eu/research/iscp/pdf/belem_statement_2017_en.pdf). There are also wide-ranging cooperation agreements with other countries (Argentina, Cabo Verde among others). Under these agreements, there are now over 500 international research teams working together on research, innovation and transfer to operational systems on the Atlantic Ocean.

Moreover, scientific priorities and observational technologies have evolved since 2006 and in parallel the observing system has evolved. For example, Argo is now fully developed and has been operating successfully for almost 15 years. PIRATA has also expanded to new sites and has enhanced its measurement suite with higher vertical resolution in the mixed layer, and new CO_2 and O_2 measurements. In the meantime, scientific exchanges are increasing between open-

ocean research programs and coastal states scientists and users, and this under an increased anthropogenic and climate change pressure affecting in multiple way regional marine ecosystems and the human society bordering the tropical Atlantic Ocean.

It is therefore timely to systematically review the requirements for sustained observations in this region , and to critically review the design of the sustained observing system in order to take advantage of what has been learned to date, to collectively identify new opportunities to build on past accomplishments, and to explore the possibility for expanded interdisciplinary initiatives with other communities, e.g. in biogeochemistry.

To that end, a Tropical Atlantic Observing System (TAOS) review was proposed by the CLIVAR Atlantic Region Panel (ARP) and has been organized by the CLIVAR ARP in close cooperation with the PIRATA consortium. CLIVAR ARP has taken the lead and coordinate the review, evaluate scientific progress since the last review, and recommend actions to advance sustained observing efforts in the tropical Atlantic. The TAOS review is intended to complement other reviews focusing on different elements of the Atlantic observing system to take place in the next several years (for example, RAPID-AMOC and OSNAP) and that from parallel efforts being carried out in the Pacific and Indian Oceans (TPOS 2020 and IndOOS). Results of the TAOS review are also expected to feed into the AtlantOS the Program design strategy that is currently being formulated (http://www.atlantos-ocean.org).

The review is guided by the framework for ocean observing and makes recommendations toward an adequate governing mechanism for the future TAOS. The review attempts to be comprehensive across all relevant observing system networks, including satellite observations, but has its focus primarily on the in situ observing system. In addition to ocean physical variables, the review considers atmospheric parameters (e.g. winds, surface fluxes) as well as biogeochemistry and biology within the framework of a single integrated observing system.

The TAOS review was conducted by a Review Committee composed of members of the tropical Atlantic observing community and representatives from GOOS/GCOS, with oversight by the CLIVAR ARP, several of whose members will also serve on the committee. Bill Johns (U. Miami) and Sabrina Speich (LMD/ENS, and ARP member) served as co-chairs of the review committee.

Two workshops were held in association with this review:

1. A "kickoff" workshop held on February 8 and 9, 2018, adjacent to the 2018 Ocean Sciences meeting in Portland, Oregon. A total of 30 participants (See Appendix A.4) attended the workshop. The main goals of this 1st workshop were to define the requirements for the Tropical Atlantic Observing System and to review the present status of the TAOS observing networks. A full report of the workshop is available at http://www.clivar.org/sites/default/files/documents/1st%20TAOS%20Review%20Workshop%20Report_final.pdf and the workshop agenda and presentations can be viewed at http://www.clivar.org/events/tropical-atlantic-observing-system-review-workshop.
2. A 2nd TAOS Review workshop held in Marseille, France October 2018 immediately following the annual PIRATA meeting, attended by 35 participants. The main goals of this workshop were to finalize recommendations for the future TAOS and to make recommendations for the future governance of the TAOS. The agenda and presentations from the 2nd workshop are available at http://www.clivar.org/2nd-tropical-atlantic-observing-system-taos-review-workshop.

The TAOS report has been built from the outcomes of the two workshops and subsequent discussions among the review committee, including inputs from other members of the tropical Atlantic observing and modeling communities.

The TAOS community also contributed to the OceanObs'19 Community White Papers (and in particular one paper already has put forward some of the TAOS recommendations, Foltz et al., 2019), to the conference and it is actually working with the Program Committee to provide input for the Conference outcomes.

The TAOS draft report is now being finalized. It will be distributed mid-November 2019 for a first internal review to ARP CLIVAR members. Thereafter, it will seek public comment and assessment by an expert review board appointed by CLIVAR, OOPC, IO-GOOS, the IOC, and IMBER in early 2020.

- **Planning for EUREC^{4}A/ATOMIC** *(Speich & Zuidema)*

The Atlantic Tradewind Ocean-Atmosphere Mesoscale Interaction Campaign (**ATOMIC, US**) and Elucidating the Role of Clouds-Circulation Coupling in Climate (**EUREC^{4}A , Europe**) initiatives will take place during six weeks in January-February 2020 to address the Northwest Tropical Atlantic ocean-atmosphere interactions at the mesoscale and their relation to the regional oceanic boundary layer and atmospheric shallow-convection. The field work will involve 4 research vessels, 4 research aircrafts, land-based observations from Barbados, and a unique panoply of robotic platforms combined with a comprehensive modeling program (see Fig. 1 below and www.eurec4a.eu).

EUREC^{4}A is an international initiative in support of the World Climate Research Programme's Grand Challenge on Clouds, Circulation and Climate Sensitivity. EUREC^{4}A aims at advancing understanding of the interplay between clouds, convection, the ocean and atmosphere circulation and their role in climate change. A particular emphasis is given to the interaction between shallow convection and the ocean's surface layers, especially in the context of small (100m–10km) scale ocean SST fronts and Oceanic Barrier Layers (OBL).

ATOMIC is a NOAA initiative designed to complement EUREC^{4}A with additional observations focused on the mesoscale oceanic and atmospheric boundary layers. ATOMIC will contribute the NOAA P-3 research aircraft and the Research Vessel the Ronald H. Brown. NOAA's Climate Program Office-Climate Variability and Predictability Program is funding ten research groups to participate. CLIVAR's endorsement of the ATOMIC/EUREC^{4}A-OA activity (http://www.clivar.org/news/atomic-and-eurec4a-oa-have-been-endorsed-clivar) was important for promoting the visibility and significance of these projects.

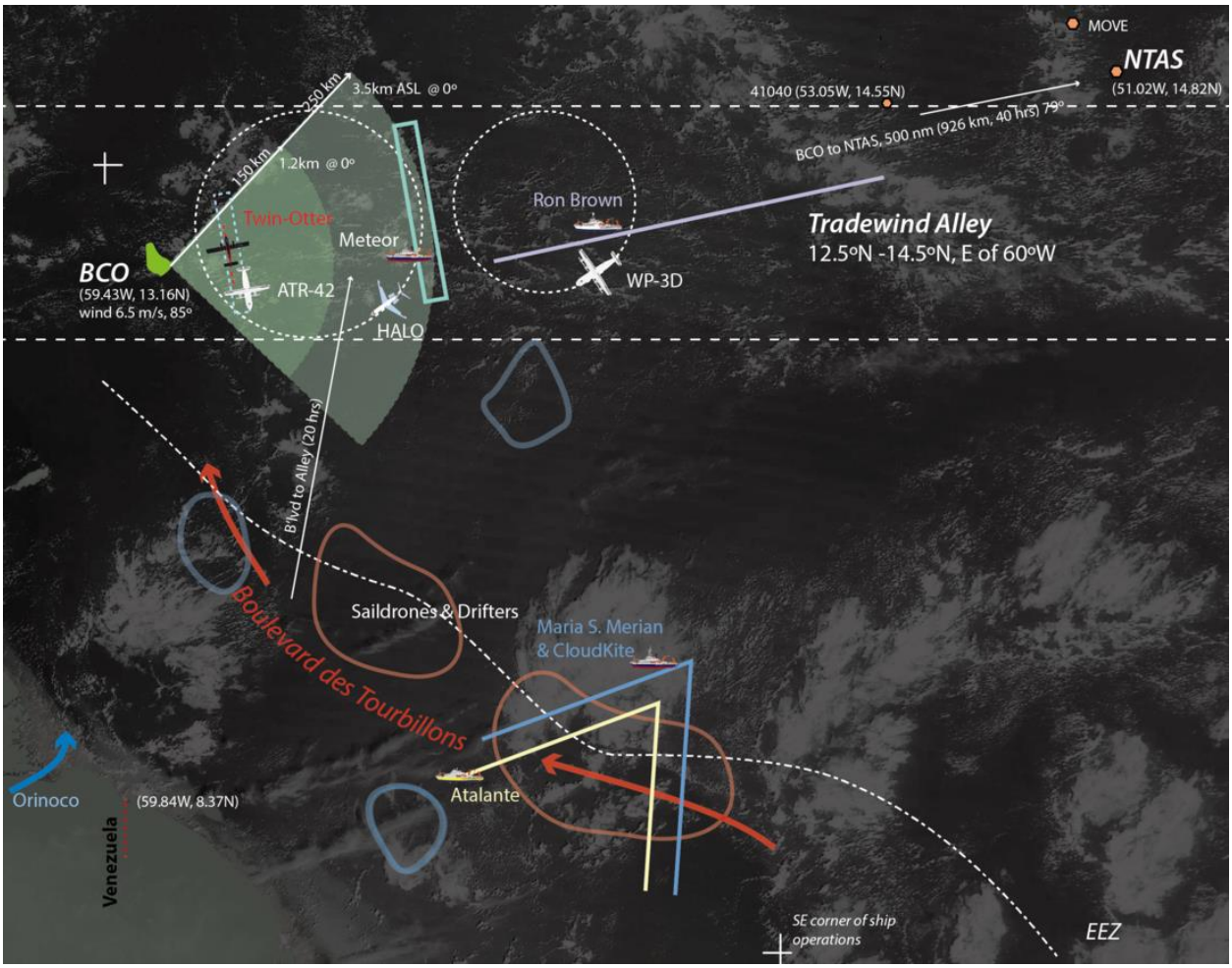


Figure 1: The EUREC^{4}A-ATOMIC working area and observing platforms deployment

- **OceanObs'19 Conference** *(CLIVAR ARP panel members)*

The OceanObs conferences are held once every ten years for the scientific, technical, and operational communities involved in the planning, implementation, and use of ocean observing systems. The goal of the conferences is to communicate progress, promote plans, and to define advances to ocean observing system in response to societies' needs. Each conference provides a forum for the community to review the state of the ocean observing science and operations, and to define goals and plans to achieve over the next decade.

To prepare the conference we sought the views and recommendations of the global ocean and climate communities. To do so, we solicited Community White Papers (CWPs) from the ocean observing and end user communities. The overarching vision of the final CWPs focus on: (1) being forward-looking to the next decade, (2) addressing end-user engagement, (3) addressing opportunities for integration, and (4) connecting to conference themes.

The organizers of OceanObs'19 received over 430 abstracts, which were consolidated to 142 open-access manuscripts published in Frontiers in Marine Science (https://www.frontiersin.org/research-topics/8224/oceanobs19-an-ocean-of-opportunity) from

over 2500 authors from 79 countries. CWPs have always been an integral part of the OceanObs conference series. These papers promote international collaboration, describe the status of a truly large-scale sustained ocean observing effort, and collectively help shape a vision for the future. They garner the collective knowledge of the community to evaluate and enhance the efficacy of our global and regional ocean observing networks.

They provided a forum for community recommendations to inform the outcome of OceanObs'19 conference and to guide post-conference actions.

The OceanObs'19 conference took place on 16-20 September 2019 in Honolulu, Hawaii (www.oceanobs19.org). It gathered over 1,500 scientists, practitioners, and stakeholders from around the world to plan the future of ocean observing science and technology. Organized in plenary, special and breakout sessions, it created momentum of dialogue where exchanges were based on the CWPs outcomes as well as additional inputs provided by the speakers, panels and collective discussions. These created actionable recommendations based on their discussions that informed the final conference statement which collects and condense the most important issues facing the ocean observing community today and how the community plans to address them. From how to codesign observing systems with stakeholders, across regions and disciplines, and with multisectoral input to implementing Findable, Accessible, Interoperable, and Reusable (FAIR) data practices, each session contributed an important dimension to the final statement.

These recommendations are now gathered in a "Living Action Plan" to help fully realize these goals, as well as allow them to adjust and adapt as societal needs change. Such a Living Action Plan is meant to organize outcomes in a way that they can best capture input from the conference attendees and the whole community. It will inform governance of GOOS, mobilize communities of practice, and strengthen partnerships for enhanced ocean science and technology moving forward.

The CLIVAR community has been instrumental in providing inputs to the CWPs and to the OceanObs'19 Conference sessions. In particular, CLIVAR ARP members were among the organizing committee of the conference, led or contributed to key CWPs , and were among those who acted as editors and reviewers. The CLIVAR community, and in particular ARP, should continue to engage in the Living Action Plan and in the proactive building of appropriate actions serving GOOS, GCOS, the climate community, the SDGs and end-users information to be able to tackle the multiple challenges our society is facing.

- **The Atlantic Meridional Overturning – Activities update** *(Frajka-Williams & Chidichimo)*

  - ***Recent results and international coordination***

The current AMOC observing efforts and future observing requirements have been outlined in an AMOC contribution to Ocean Obs'19 (Frajka-Williams et al., 2019). These included an overview of the methods employed by observing arrays (RAPID 26°N, OSNAP, MOVE 16°N, SAMBA 34.5°S), efforts using satellites and/or hydrography, inverse methods and state estimates. For each of the observing arrays, an overview of the methodology applied and the latest updates to the time series were included (See Fig. 2). The publication of all 4 time series in a single figure highlights an apparent lack of meridional coherence, an area where international coordination of analysis efforts may be useful.

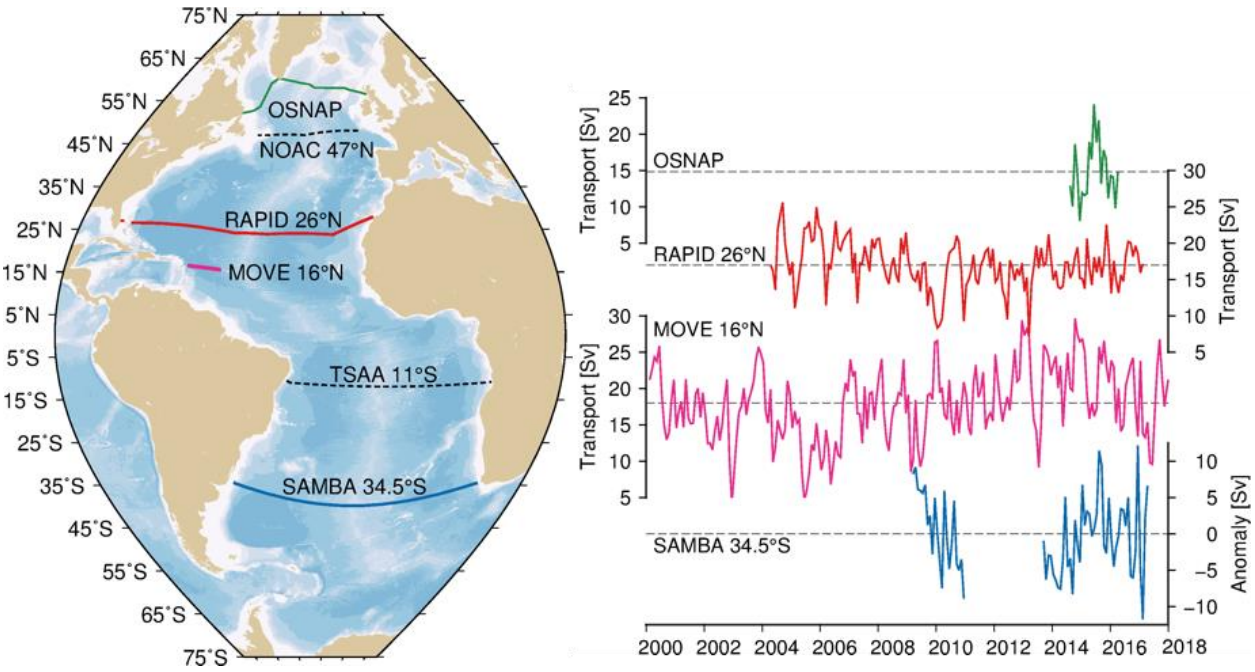


Figure 2. (left) Locations of the 4 arrays designed to estimate the AMOC strength (solid lines) and 2 arrays will the intention to estimate the AMOC, but results still pending (black dashed). (right) Latest results from the 4 arrays in transports (OSNAP, RAPID 26°N, MOVE 16°N) and transport anomaly (SAMBA 34.5°S).

Several members of the CLIVAR ARP (Chidichimo, de Young, Frajka-Williams) attended an AMOC Metrics workshop, led by the US AMOC Team prior to the OceanObs'19 meeting in Hawaii. This workshop brought together members of the different AMOC observing groups to discuss best practices in observing methodology, and also highlighted areas where the groups could learn from each other -- e.g., in protocols for calibrating instruments, application of and choice of wind stress product to calculate meridional Ekman transport, and dealing with the choice of geostrophic reference level / level-of-known motion.

Sunsetting of the US AMOC Science Team: Future coordination role for CLIVAR ARP. US CLIVAR has had an interagency program, the 'US AMOC program', to bring together researchers studying the AMOC and build partnerships between the modeling and observational groups studying the AMOC. It has convened science meetings and coordinated conference sessions, and evaluated and revised priorities for AMOC research as a whole. It was established in 2008, and will officially sunset on December 31, 2020. The CLIVAR ARP has expressed a willingness to step into some of the coordination gap that will be left when the US AMOC team sunsets, though the details of the effort have not been determined. Activities could include coordinating conference sessions at international meetings, facilitating communication between programs, and coordinating an annual report from individual AMOC projects. These will be discussed between the CLIVAR ARP AMOC Task team and the US AMOC Science Team in 2020.

Frajka-Williams E, Ansorge IJ, Baehr J, Bryden HL, **Chidichimo MP**, Cunningham SA, Danabasoglu G, Dong S, Donohue KA, Elipot S, Heimbach P, Holliday NP, Hummels R, Jackson

LC, Karstensen J, Lankhorst M, Le Bras IA, Lozier MS, McDonagh EL, Meinen CS, Mercier H, Moat BI, Perez RC, Piecuch CG, Rhein M, Srokosz MA, Trenberth KE, Bacon S, Forget G, Goni G, Kieke D, Koelling J, Lamont T, McCarthy GD, Mertens C, Send U, Smeed DA, **Speich S**, van den Berg M, Volkov D and Wilson C (2019) Atlantic Meridional Overturning Circulation: Observed Transport and Variability. Front. Mar. Sci. 6:260. doi: 10.3389/fmars.2019.00260

- **Planning of Joint CLIVAR/FIO 2020 Summer School** *(Robinson)*

A joint CLIVAR/FIO Summer School, *Ocean Macroturbulence and Its Role in Earth's Climate*, will take place 6-11 July, 2020 at the First Institute of Oceanography, in Qingdao, China. Planning, including developing the schedule and inviting instructors, is under way. The overview of this course is as follows:

Ocean macroturbulence comprises fronts, eddies, and currents on the ocean meso- submeso-scales (1-300 km). These features are ubiquitous in the world ocean, as revealed by observations and models now available at ever greater spatial resolutions. At the same time, there is mounting evidence that motions on these scales play fundamental roles in Earth's climate system: by transporting heat, momentum, and nutrients within the ocean, by influencing air-sea fluxes of heat, fresh water, and carbon, and by shaping marine ecosystems.

Leading experts in ocean macroturbulence will address the following topics:

- **Observations:** How are remote and in situ observations made on these scales, what new technologies (e.g. autonomous vehicles) are becoming available, and what are the challenges in analyzing and interpreting these data?
- **Dynamics:** What are the dynamical mechanisms that produce meso- and sub-mesoscale motions? How do they interact with larger-scale circulations?
- **Modeling:** How are meso- and submeso-scale motions represented in numerical models? What are the computational challenges to simulating these scales?
- **Role in climate:** How do meso- and submeso-scale motions influence air-sea interactions and fluxes of energy and nutrients between the near-surface and deeper ocean? How do they shape marine ecosystems? What is the importance of ocean macroturbulence for simulating and projecting climate change?

Activities will comprise lectures, problem solving, and discussions of recent journal articles; instructors will provide observational and model data sets for groups of participants to analyze. Groups of students will develop and present proposals for new research.

- **Two proposals for CLIVAR Research Foci (one approved, one declined)** *(Keenlyside & Robinson)*

    - *Tropical Basin Interaction (approved)*

    The Research Focus on Tropical Basin Interactions has proceeded to full bid stage. Its main goal is to elucidate the complex two-way interaction between the tropical basins and to quantify the benefit to climate prediction. It will focus on seasonal to multi-annual variability and predictability, and involve observations (present and paleo) and multi-model experiments. The RF proposal originated mainly from the ARP and is led by Keenlyside and Ingo Richter; and involves panel members Susan Bates and Regina Rodrigues.

    - *The Ocean Submesoscale and Climate (OSMAC - declined)*

The submesoscale is an active and growing area of research in oceanographic theory, observations, and modeling. This submesoscale Research Focus – Ocean Submesoscale and Climate (OSMAC) – was proposed to develop and enhance connections between this oceanographic research on the submesoscale and CLIVAR's foci on climate variability, climate prediction, and climate change, and to build on the outcomes of recent CLIVAR-sponsored activities that address the ocean mesoscale and its interactions with the atmosphere.

Workshops in 2018/2019 as part of panel activities

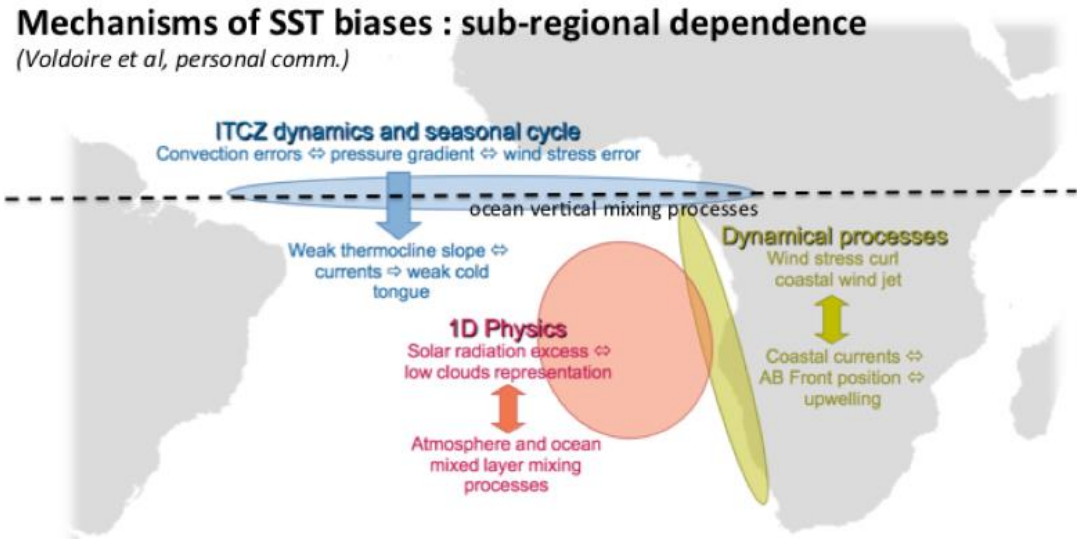
- Keenlyside co-organized a workshop on Climate Prediction in the Arctic and North Atlantic sector, 5-7th June 2019, Bergen, Norway. It was jointly organized by the Bjerknes Climate Prediction Unit and the EU Modelling. There were 50+ participants from the Europe, America, and Asia. This activity is also related to the Climate Dynamics Panel.

- AMOC : With panel CLIVAR ARP members involved in the organization:
    - "PO5: The Meridional Overturning Circulation: Mean State and variability", IUGG/IAPSO Joint Assembly 2019, July 2019, Montreal, Canada.
    - The Eighth SAMOC Workshop (SAMOC VIII) was held back to back-to-back with the IAPSO Joint Assembly meeting in Montreal, Canada. July 2019.
    - Session "Advances in our understanding of the Meridional Overturning Circulation in the South Atlantic", AGU/ASLO Ocean Sciences Meeting, Portland, Oregon, USA. Feb. 2018.

- AMOC but organized outside ARP CLIVAR::
    - 2018 International AMOC Science Meeting, Miami, USA. 24 – 27 July 2018. Attendance from CLIVAR ARP: Frajka-Williams.
    - "US CLIVAR AMOC Metrics: Coordination Observations and Models Workshop", Honolulu, Hawaii, 14–15 Sept 2019. Attendance from CLIVAR ARP: Chidichimo, de Young, Frajka-Williams.

International projects (achieved and ongoing) involving the Atlantic Ocean in which the ARP community is involved

- **The H2020 PREFACE** (which involved Noel Keenlyside and Peter Brandt, ARP members) project who was completed in 2018 delivered significant amount of research on tropical Atlantic climate variability and predictability, and its impacts. The project lead directly to more than 120 peer-reviewed publications. The schematic below provided by Aurore Voldoire highlights the progress made towards understanding the nature of the model biases in the tropical Atlantic. Multi-model prediction experiments were key to achieving this level of understanding (e.g., Voldoire et al. 2019).



Voldoire, A., E. Exarchou, E. Sanchez-Gomez, T. Demissie, A.-L. Deppenmeier, C. Frauen, K. Goubanova, W. Hazeleger, N. Keenlyside, S. Koseki, C. Prodhomme, J. Shonk, T. Toniazzo, A.-K. Traoré. 2019: Role of wind stress in driving SST biases in the Tropical Atlantic. Clim. Dyn. published online

The PREFACE project contributed greatly to scientific capacity building. Thirty-two percent of the PREFACE publications have a female first author and 31% have North-South collaboration in authorship, of which 78% have a first author from the south. The The project also helped to train a new generation of researchers, including those from the region. In total there were of 21 PhD theses (15 from African students) and 21 Master theses (18 from Africa students). Its summer schools (two in Africa), targeted workshops, and interdisciplinary meetings have provided education to continue important research on the tropical Atlantic climate and its impacts. The joint organisation of two project meetings with annual tropical Atlantic variability conferences helped integrate young researchers into the international research community. Lastly, we have helped to ensure the long-term sustainability of the tropical Atlantic observing system, by increasing awareness and developing required competence among regional players.

- **AtlantOS** – An Integrated All-Atlantic Ocean Observing System in 2030 *(Brad deYoung)*

  A team within the H2020 AtlantOS project (which involved S. Speich, MP Chidichimo, B. de Young, ARP members), funded by the European Union, has worked on plans to enhance ocean observing at the basin-scale in the Atlantic. The international team, with representation from around the Atlantic Basin, worked for several years to define the goals for a basin-scale system and to engage the community in consideration of how to develop such a system. Many meetings were held associated with the AtlantOS project (in New York, Lisbon, Las Palmas and Paris) and briefings with key interested international funding partners (in Washington, Brussels and Buenos Aires). A White Paper summarizing the vision for the Atlantic was published as a contribution to the OceanObs'19 meeting (deYoung et al. 2019) and several meetings, side-events and special sessions were held at the OceanObs'19 meeting. The goal of AtlantOS the Program is to implement the vision enunciated in the White Paper.

  The vision for an Atlantic basin-scale ocean observing system is driven by the recognition that until now basin-scale ocean observation has been conducted through loosely-aligned

arrangements of national and international efforts. The All-Atlantic Ocean Observing System (AtlantOS) is an integrated concept for a forward-looking framework and basin-scale partnership to establish a comprehensive ocean observing system for the Atlantic Ocean as a whole. The system will be sustainable, multi-disciplinary, multi-thematic, efficient, and fit-for-purpose. Platforms, networks, and systems do already exist that operate at various maturity levels. AtlantOS seeks to go beyond the status quo by bringing together the observing communities and countries of the Atlantic basin, providing the opportunity to join and support the system. AtlantOS will build upon the coordinated work of the Global Ocean Observing System (GOOS) and the Group on Earth Observations (GEO), two international bodies that support and coordinate global ocean observing. AtlantOS will complement those efforts and offers a new approach to organizing ocean observing at the basin-scale. AtlantOS will focus not only on the physics but also the biology, ecology and biogeochemistry of the ocean and seafloor and will enhance new partnerships among governments, science, civil society and the private sector.

Several of the present steering committee for the AtlantOS program (B. deYoung, M. Visbeck, I. Sousa-Pinto, T. Lamont and G. Canonico) were present at OceanObs'19 and organized and contributed to several meetings including an open town-hall discussion on Sunday before the meeting, a side event on the All-Atlantic Ocean Observing System and a Special Session on A sustainable fit-for purpose ocean observing system – responding to user needs. Each of these events attracted from 50-150 people.

The plan for the development of the AtlantOS program is to work through case studies. The goal of this approach is to showcase the transformation of observing data into information. Key challenges will be addressed to demonstrate the value of the basin-scale approach around the Atlantic and to work on the links between ocean observing and society. These case studies will include coastal and open ocean considerations, will be less about designing and deploying new observing systems than about how to get value from existing ocean observations. The case studies will demonstrate how to add value to ocean observation to better meet societal needs.

The five case studies that are being developed at present are:

1. Providing basin-scale services – Atlantic Meridional Ocean Circulation (AMOC) and biogeochemistry
2. Mitigating Impacts of Sargassum on Coastal Communities in the Tropical Atlantic
3. Networks (science-to-citizen) to predict and explain animal movements in a changing environment
4. Supporting Ecosystems Based Management for Fisheries in Atlantic upwelling regions
5. Carbon Uptake – Identifying sources and sinks of carbon around the basin

Many different meetings have been held to advance these case studies. An open invitation has been released for engagement in each of the case studies. It is expected that further discussion of the Program will be held at meetings planned for the Winter of 2019 with a Town Hall to be held at the Ocean Sciences meeting in February 2020 to be held in San Diego. Further information will be made available on the program web site www.atlantos-ocean.org.

Reference

deYoung, Brad, Martin Visbeck, Moacyr Cunha de Araujo Filho, Molly O'Neil Baringer, CarolAnne Black, Erik Buch, Gabrielle Canonico et al. "An Integrated all-Atlantic Ocean Observing System in 2030." Frontiers in Marine Science 6 (2019):

- The **H2020 project Tropical and South Atlantic - climate-based marine ecosystem prediction for sustainable management** (**TRIATLAS;** TRIATLAS is coordinated by Noel Keenlyside and to which participate S. Speich, R. Rodriguez, M. Araujo, P. Brand, ARP members and ex-officio) officially started June 1st, 2019. The four-year project has 34 partners from 13 countries in Europe, Africa, and Brazil. TRIATLAS builds on the FP7 PREFACE and H2020 AtlantOS projects and its main goal is to use improved climate predictions to deliver marine-ecosystem predictions for the region. The project contributes to enhance ocean observations and to improve (climate and ecosystem) modelling and prediction capabilities. The project has initiated the Cross-Atlantic Network of Excellence in Marine Science (CANEMS) to enhance scientific capacity. See the project website for more information: https://triatlas.w.uib.no; project abstract below.

  TRIATLAS project is linked to the H2020 Coordinated Support Action: All AtlaNtic Cooperation for Ocean Research and innovation (AANChOR). The main ambition of AANChOR is to promote the implementation of the South Atlantic Research and Innovation Flagship initiative and the Belém Statement. The project runs from 2018-2022. (https://cordis.europa.eu/project/rcn/218514/factsheet/en)

- The **iAtlantic-Integrated Assessment of Atlantic ecosystems in space and time project** (http://www.iatlantic.eu/; MP Chidichimo, ARP member, participates to the project) has been funded by a €10.6M grant from the European Union's Horizon 2020 programme. iAtlantic launched in June 2019 and will run for 4 years. The multidisciplinary consortium of 33 partners is led by Prof. Murray Roberts at University of Edinburgh. Work will span the full scale of the Atlantic basin with partners from the US, Europe, Brazil, Argentina and Africa. In particular, iAtlantic will notably augment observing capacities in the South Atlantic including enhancements at the western and eastern side of the "South Atlantic MOC Basin-wide Array (SAMBA)" along 34.5°S.

  Abstract: iAtlantic will assess the risks and vulnerabilities of Atlantic deep-sea and open ocean ecosystems to climate change and multiple stressors in order to identify where and when improved management measures are needed most for healthy Atlantic ecosystems and socioeconomies. To work at this vast scale, iAtlantic capitalises on existing ocean-scale monitoring programmes and enhances these with new sensors to better align North-South capacity for observations, yielding unprecedented ocean-scale climate-based predictions of areas under greatest change. 3D-mapping of the biodiversity and functioning in ecosystems in the water column to the deep seafloor using acoustics, environmental DNA, and trait-based approaches will be enhanced by empirical studies on drivers of ecosystem change at 12 areas in the Atlantic and both in situ and ex situ experimental studies to ground-truth the concept of ecosystem tipping points and critical threshold values. With EMODnet, iAtlantic will develop FAIR, open-access GIS tools to develop management and protection plans considering both biodiversity and socioeconomic factors for the whole Atlantic and to inform the rapidly evolving international, regional and national policies for the Atlantic. Joint North-South scientific initiatives extending from the Arctic to the Southern Ocean will study and highlight priority areas for policy and governance interventions to ensure sustainability of crucial basin resources. By bridging observational systems, exchanging data, researchers and equipment across South to North and East to West axes a new era of all-Atlantic collaboration will emerge.

Articles published in 2018/19 as part of panel activities (if any)

- **OceanObs'19 community white papers**

Benveniste et al. (2019) Requirements for a Coastal Hazards Observing System. Front. Mar. Sci. 6:348. doi: 10.3389/fmars.2019.00348

D'Ovidio et al. (2019) Frontiers in Fine-Scale in situ Studies: Opportunities During the SWOT Fast Sampling Phase. *Front. Mar. Sci.* 6:168. doi: 10.3389/fmars.2019.00168

Davidson et al. 2019) Synergies in Operational Oceanography: The Intrinsic Need for Sustained Ocean Observations. Front. Mar. Sci. 6:450. doi: 10.3389/fmars.2019.00450

deYoung et al. 2019) An Integrated All-Atlantic Ocean Observing System in 2030. Front. Mar. Sci. 6:428. doi: 10.3389/fmars.2019.00428

Foltz et al., 2019: The Tropical Atlantic Observing System. *Front. Mar. Sci.,* **6**, doi:10.2289/fmars.2019.00206

Fox-Kempoer et al. (2019) (2019) Challenges and Prospects in Ocean Circulation Models. *Front. Mar. Sci.* 6:65. doi: 10.3389/fmars.2019.00065

Frajka-Williams et al. (2019) Atlantic Meridional Overturning Circulation: Observed Transport and Variability. Front. Mar. Sci. 6:260. doi: 10.3389/fmars.2019.00260

Meyssignac et al. (2019) Measuring Global Ocean Heat Content to Estimate the Earth Energy Imbalance. Front. Mar. Sci. 6:432. doi: 10.3389/fmars.2019.00432

Palmer et al., 2019) Adequacy of the Ocean Observation System for Quantifying Regional Heat and Freshwater Storage and Change. Front. Mar. Sci. 6:416. doi: 10.3389/fmars.2019.00416

Schmidt et al. (2019) (2019) Future Ocean Observations to Connect Climate, Fisheries and Marine Ecosystems. Front. Mar. Sci. 6:550. doi: 10.3389/fmars.2019.00550

Sloyan et al. (2019) Evolving the Physical Global Ocean Observing System for Research and Application Services Through International Coordination. Front. Mar. Sci. 6:449. doi: 10.3389/fmars.2019.00449

Speich et al. (2019) Editorial: Oceanobs'19: An Ocean of Opportunity. Front. Mar. Sci. 6:570. doi: 10.3389/fmars.2019.00570

Stammer et al. (2019) Ocean Climate Observing Requirements in Support of Climate Research and Climate Information. Front. Mar. Sci. 6:444. doi: 10.3389/fmars.2019.00444

Stewart et al. 2019) The Development of a Canadian Integrated Ocean Observing System (CIOOS). Front. Mar. Sci. 6:431. doi: 10.3389/fmars.2019.00431

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- **Other papers**

Cai et al., 2019 Pantropical climate interactions. Science, Vol. 363, Issue 6430, DOI: 10.1126/science.aav4236 (Keenlyside contributed from the CLIVAR ARP and CDP)

Report on February 2018 Workshop on Ocean Mesoscale Eddy Interactions with The Atmosphere (*checking on this*)

Plans for 2020 and beyond

- Completion/dissemination of TAOS review: We aims to provide the ARP CLIVAR panel for examination the draft Review Report for TAOS by the end of November 2019. After the review by the panel we will seek comments from the larger community (OOPC and GOOS more in general).

- Participation in EUREC^{4}A/ATOMIC: The EUREC^{4}A/ATOMIC will take place in early 2020. A preliminary set of data acquired will serve as basis of numerous studies, both in terms of observation analyses, ocean, atmosphere and coupled numerical experiments to understand processes, improve parametrizations and ocean and atmosphere (weather to climate) predictions.

- Joint CLIVAR/FIO 2020 Summer School: Ocean Macroturbulence and Its Role in Earth's Climate

- Entraining activities of former US AMOC program

  During 2020, the CLIVAR ARP will consolidate plans for an AMOC task team, and work together with the US AMOC Science Team to identify an effective approach for future international coordination of AMOC science efforts.

- *Workshops/Conference sessions:*

  - There will be several AMOC related sessions during Ocean Sciences 2020 in San Diego, US.

    - "Atlantic Meridional Overturning Circulation: An on-going challenge"

    - "Advances in understanding of the meridional overturning circulation in the South Atlantic: Variability, Mechanisms, and Impacts"

    - "Long-term Changes of the Deep Ocean Overturning Circulation: Past and Future"

    - "Atlantic Ocean Variability in a Changing Climate: Observations, Modeling, and Theories"

  - And during the EGU General Assembly 2020 in Vienna, Austria:

- OS1.1 Open Session on Ocean Circulation and Climate (convener from ARP: Chidichimo)
- OS1.3 Ocean circulation, heat uptake, and redistribution
- OS1.6 Sustained Ocean Observing and Paths Toward Improved Understanding and Modelling of Climate
- OS1.7 The North Atlantic: natural variability and global change
- OS1.8 South-to-North: Variability and connectivity along the oceanic current systems from the South Atlantic to the North Atlantic and Arctic Ocean

- An additional workshop on best practices for moored CTD calibration is being proposed to IAPSO by Frajka-Williams and other participants of the AMOC Metrics meeting.

Budget and other needs for 2020

Please keep in mind that the overall budget of CLIVAR is limited and this needs to be distributed between all activities and the SSG meeting.

5,000 CHF, Joint CLIVAR-FIO Summer School: Ocean Macroturbulence and It's Role in Earth's Climate, Qingdao, China, 6 -11 July 2020.

4,000 CHF, 18th Session of CLIVAR Atlantic Region Panel Meeting, Qingdao, China, 12 July 2020.

Aim for a total length of ~2 pages, more is fine, but not necessary

Annex A

Proforma for CLIVAR Panel requests for SSG approval for meetings

1. **Panel name:** Atlantic Regional Panel
2. **Title of meeting or workshop:** Joint CLIVAR-FIO Summer School: Ocean Macroturbulence and It's Role in Earth's Climate
3. **Proposed venue:** First Institute of Oceanography, Qingdao, China
4. **Proposed dates:** 6-11 July, 2020
5. **Proposed attendees, including likely number:** Organizer; 7-8 instructors, 40 trainees
6. **Rationale, motivation and justification, including: relevance to CLIVAR science & WCRP Grand Challenges, and any cross-panel/research foci links and interactions involved:** This will be the 2nd Joint CLIVAR/FIO Summer School, and has been approved by the CLIVAR SSG. Ocean macroturbulence comprises fronts, eddies, and currents on the ocean meso- submeso-scales. Participants will learn about the current observational, modeling, and Earth-system science relating to motions on these scales and their interactions with the broader climate system. This is of direct relevance to CLIVAR-wide goals and to the activities of all regional panels.
7. **Specific objectives and key agenda items:**
   - **Observations:** How are remote and in situ observations made on these scales, what new technologies (e.g. autonomous vehicles) are becoming available, and what are the challenges in analyzing and interpreting these data?
   - **Dynamics:** What are the dynamical mechanisms that produce meso- and sub-mesoscale motions? How do they interact with larger-scale circulations?
   - **Modeling:** How are meso- and submeso-scale motions represented in numerical models? What are the computational challenges to simulating these scales?
   - **Role in climate:** How do meso- and submeso-scale motions influence air-sea interactions and fluxes of energy and nutrients between the near-surface and deeper ocean? How do they shape marine ecosystems? What is the importance of ocean macroturbulence for simulating and projecting climate change?
8. **Anticipated outcomes (deliverables):** Participants will learn about the science, including current research, of how ocean eddies, fronts, and submesoscale motions, participate in the climate system; they will be prepared to identify key problems relating to these topics and to develop research plans to address them. Student groups will prepare research proposals and present them on the final morning of the School. Some of these may be developed into fundable research proposals. A summary report and article for CLIVAR Exchanges or other scientific journals will be

delivered shortly after the school.

9. **Format:** A mix of lectures and participatory activities, with evening social activities and local visits

10. **Science Organizing Committee (if relevant):** The School is being organized by the ARP

11. **Local Organizing Committee (if relevant):** Representatives of the ICPO and FIO

12. **Proposed funding sources and anticipated funding requested from WCRP:**

    ~ 5,000 CHF from WCRP,

    ~ 400,000 RMB from FIO, China

1. **Panel name:** Atlantic Regional Panel
2. **Title of meeting or workshop:** 18th Session of CLIVAR Atlantic Region Panel Meeting
3. **Proposed venue:** First Institute of Oceanography, Qingdao, Chine
4. **Proposed dates:** 11-12 July, 2020
5. **Proposed attendees, including likely number:** 14 ARP members
6. **Rationale, motivation and justification, including: relevance to CLIVAR science & WCRP Grand Challenges, and any cross-panel/research foci links and interactions involved:** This ARP meeting will come well over a year since ARP 17. Piggybacking on the Joint CLIVAR/FIO Summer School will mitigate costs, as several people will participate in both. This is an important meeting for planning future ARP activities, as several major activities – Tropical Atlantic Observing System (TAOS) review, EUREC^{4}A/ATOMIC, the Summer School – will have concluded.
7. **Specific objectives and key agenda items:**
8. **Anticipated outcomes (deliverables):** Plans for ARP activities over the coming 2 years
9. **Format:** 1-day panel discussion
10. **Science Organizing Committee (if relevant):** n/a
11. **Local Organizing Committee (if relevant):** n/a
12. **Proposed funding sources and anticipated funding requested from WCRP:**

    ~ 4,000 CHF from WCRP

    ~ 20,000 US$ from US CLIVAR to support the travel of US members in the panel

Annex B

H2020 TRIATLAS project abstract

Sustainable management of human activities affecting Atlantic marine ecosystems is critical to maintain its health and to support the blue economy of the bordering countries. TRIATLAS will contribute to this by delivering knowledge of the current state and future changes of the Atlantic marine ecosystems. We achieve this through a basin-wide approach that integrates research from the North and South, and that closes critical knowledge gaps in the Tropical and South Atlantic that impede an understanding of the entire basin. We bring together an interdisciplinary team of marine ecologists, physical oceanographers, climate researchers, and social scientists from 35 different institutions in Europe, Africa, and South America, together with industrial and regional stakeholders. We will enhance knowledge of the marine ecosystems in key areas of the Atlantic using existing and pivotal new (physical, biological, societal) observations. Earth system, ecological, and socio-economic models and observations will be used to assess the cumulative impacts of (climatic, pollution, and fishing) pressures driving fluctuations in the marine ecosystem, and the potential for tipping point behavior and regime shifts. We will develop the first predictions of the marine-ecosystem for the next 40 years for the whole Atlantic, by combining state- of-the-art climate prediction and ecosystem models, with Shared Socioeconomic Pathways, and by conducting socio- economic vulnerability assessments services, with stakeholder engagement. TRIATLAS will enhance capacity in marine ecosystems, oceanography, and climate research in countries bordering the South and Tropical Atlantic Ocean. There will be close cooperation and alignment with relevant European Commission services and the South-South Framework for Scientific and Technical Cooperation, as well as other relevant initiatives in the field. We will contribute to upscale cooperation around the Atlantic.