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GOOS – 222
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Report of the Twentieth Session of the GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC-20)

Woods Hole Oceanographic Institution, USA
14-17 March 2017

The Ocean Observations Panel for Climate is an expert panel of the Global Climate Observing System the Global Ocean Observing System and the World Climate Research Program. OOPC provides scientific advice and guidance on observations to the Joint Commission for Oceanography and Marine Meteorology.



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Opening Session

The twentieth session of the Ocean Observations Panel for Climate was held at Woods Hole Oceanographic Institution (WHOI), in Massachusetts, USA, co-chaired by Bernadette Sloyan and John Wilkin. The panel was welcomed by the Director of WHOI, Mark Abbott. Mark highlighted the importance of maintaining timeseries, and the challenges of doing so in a varying funding climate. He noted particularly that there are exciting developments in new technologies, and the importance of bringing younger scientists, new ideas and new energy into the system for sustaining the ocean observing system into the future.

The Co-Chairs thanked WHOI for their generous support of the meeting including the provision of administrative support to ensure arrangements went smoothly, and the invitation to a Director's hosted reception.

The meeting was attended by OOPC members, 5 of which are new to the panel, plus CLIVAR panel representatives, and representatives of both GCOS and GOOS. To mark the 20th meeting of the panel, the OOPC foundation chair, Neville Smith was in attendance; also representing the Tropical Pacific Observing System, TPOS 2020 project.

Recent OOPC meetings have been held in conjunction with other panels, and the last two meetings have been strongly focused on delivering the GCOS Status Report (2015) and Implementation Plan (2016). OOPC decided to meet in isolation this year, to ensure it could focus discussions on reviewing and reframing its work plan, and particularly identify priorities ahead of OceanObs'19.

Given OOPC is welcoming a 5 new members, OOPC Co-Chair Bernadette Sloyan presented an overview of the role of OOPC, and its terms of reference, as the ocean panel of GCOS and the physics panel of GOOS, providing the connection between the two programmes.

Progress since OOPC-19 was reviewed by running through OOPC-19 actions; It was noted that Essential Ocean Variables (EOV) specifications, and the identification of key ocean phenomena was a big focus of the last meeting. Other ongoing issues include; how we measure the performance of the observing system, the need to connect up developments in deep ocean observations and engagement in the Deep Ocean Observing Strategy, ongoing development of activities focused on boundary currents, and the issues for engagement with the modelling community; were highlighted for inclusion in the relevant work plan area discussion later in the meeting.

All presentations and background documents for the meeting are available at www.goosocean.org/oopc20. Actions are identified throughout the text and also listed in appendix 2.

1. Programmatic Priorities

1.1 Global Climate Observing System (GCOS)

GCOS Secretariat for Terrestrial Observations, Simon Eggleston presented an overview of [GCOS](#) activities and forward plans. He noted that a large focus of the previous year was on the delivery of the [GCOS Implementation Plan \(IP\): the Global Observing System for Climate: Implementation Needs](#), which was presented to the United Nations framework Convention on Climate Change (UNFCCC) Conference of the Parties (COP) in Marrakech at the end of 2016. Drawing on the IP, GCOS is forming a forward strategy which Simon outlined including ideas for performance indicators, and an overview of how GCOS delivers in practice through its assessment and reporting cycle. Simon then provided an overview of the GCOS Implementation Plan, which has a strengthened focus on integration, particularly closing the major climate cycles (including aspirational targets for closing the budgets), data stewardship and the development of a representative set of climate indicators. The Forward plans for GCOS were outlined, including expectations of the panels. A key task of the panels will be to coordinate the review of Essential Climate (ECV) product requirements, set out in Annex of the IP. The Secretariat will also be developing a communications strategy, and a new GCOS Website.

In the discussions, the panel questioned how the climate cycle targets were developed, and their feasibility; considering that throughout the document, actions were costed, and in the oceans chapter, focused on what was really feasible. Bernadette Sloyan (co-author of Ocean Chapter), noted that action items for each observing program were proposed by each network.

It was also not clear how the climate cycle targets related to the ECV requirements. Further development of ECV requirements and observing system development across the domains to meet climate cycle realistic targets will be a topic for future discussion, which will need to be consultation with WCRP.

In the discussion that followed, the panel noted that the candidate Indicators presented did not include Ocean Heat Content; given that over 90% of the excess energy in the climate system has been taken up by the oceans, it was concluded that this was a major omission. The panel acknowledged the challenges in communicating ocean heat content, but suggested calling it Ocean Warming (with units of degrees Celsius) made it easier to convey to a general audience.

DECISION: Recommend to GCOS that Ocean Warming is a GCOS Indicator.

ACTION: OOPC to Propose Ocean Warming as a GCOS Climate Indicator, following the framework in the Indicators report (Bernadette Sloyan to discuss with GCOS next week, Matt Palmer and Bernadette Sloyan to draft justification, By June).

The process for developing the ocean section of the GCOS IP ECV Product Requirements table was discussed; the numbers were drawn from the [EOV Specifications](#), and it was agreed that these numbers could be refined; particularly in terms of the approach taken across the 3 panels of GOOS. The relationship between the GCOS ECV Product requirements and the WMO Rolling Review of Requirements was discussed, particularly the numbers in the [OSCAR Database](#). It was acknowledged that the focus on single global numbers for each product type had long caused headaches for the oceanographic community; as whenever the discussion went to global, there were regional aspects to consider, such as boundary currents. Hence, in the EOVS Specifications, OOPC has identified requirements to capture specific ocean phenomena; these were then summarised as a range of numbers the Ocean ECV product requirements. It was emphasized that the GCOS Secretariat will take responsibility for parsing GCOS ECV Product requirements into the OSCAR Database. Ensuring ocean requirements are accurately represented is an important way of engaging the met services. The numbers in the database are complemented by written [Statements of Guidance](#); it was agreed that these should be reviewed by the panel to ensure they reflect recent developments. It was also noted that for most application areas, a concise 5-15 page guidance document was provided, whereas for climate, only links to all the GCOS reports (300 pages each) were provided; it was agreed that a concise statement of guidance, along the lines of the others would be worthwhile exercise to communicate concisely key messages.

RECOMMENDATION: GCOS to coordinate writing concise statements of guidance for Climate Monitoring, Climate Services (Bernadette Sloyan, Katy Hill, Simon Eggleston to follow up).

- GCOS Secretariat will coordinate input into OSCAR.

ACTION: Review key WMO statements of guidance to ensure ocean observation requirements are all represented.

- Global Numerical Weather Prediction (NWP) (Matt Palmer and Bob Weller)
- High Resolution NWP (Matt Palmer and Bob Weller)
- Nowcasting and Very Short Range Forecasting (Matt Palmer and Bob Weller)
- Subseasonal to longer predictions. (Bernadette Sloyan, Matt Palmer)
- Ocean Applications (Bernadette Sloyan, John Wilkin)

Bernadette Sloyan provided an overview of the Ocean chapter of the GCOS Implementation plan, including key actions which need to be taken forward by the panel. Bernadette noted that a lot of effort went into producing the plan; it is not a plan for the community, but one for justifying investment into the observing system with funders. Bernadette requested that GCOS develop a strategy for communicating IP messages to ensure the effort that went into writing the IP has optimum impact.

RECOMMENDATION: GCOS develop a strategy for communication of GCOS IP messages (Katy Hill, Simon Eggleston, Bernadette Sloyan).

1.2 Global Ocean Observing System (GOOS)

OOPC Secretariat Katy Hill presented an overview of [GOOS](#) on behalf of Albert Fischer. Including an overview of the Intergovernmental Oceanographic Commission and its mandate, the role of GOOS, drivers for sustained ocean observations, and the [Framework for Ocean Observing \(FOO\)](#). The organisation of GOOS was explained, including the role of OOPC, as responsible for the Physics EOVs, while also leading delivery to Climate applications through GCOS; in consultation with the Biogeochemistry and Biology Panels. The Full [list of EOVs](#) were presented, and the main implementation elements: the globally coordinated observing networks which are organised through the [JCOMM Observations Coordination Group](#), and tracked through JCOMMOPS; and the [GOOS Regional Alliances](#).

A diagram showing the GOOS panel structure and application areas is below:

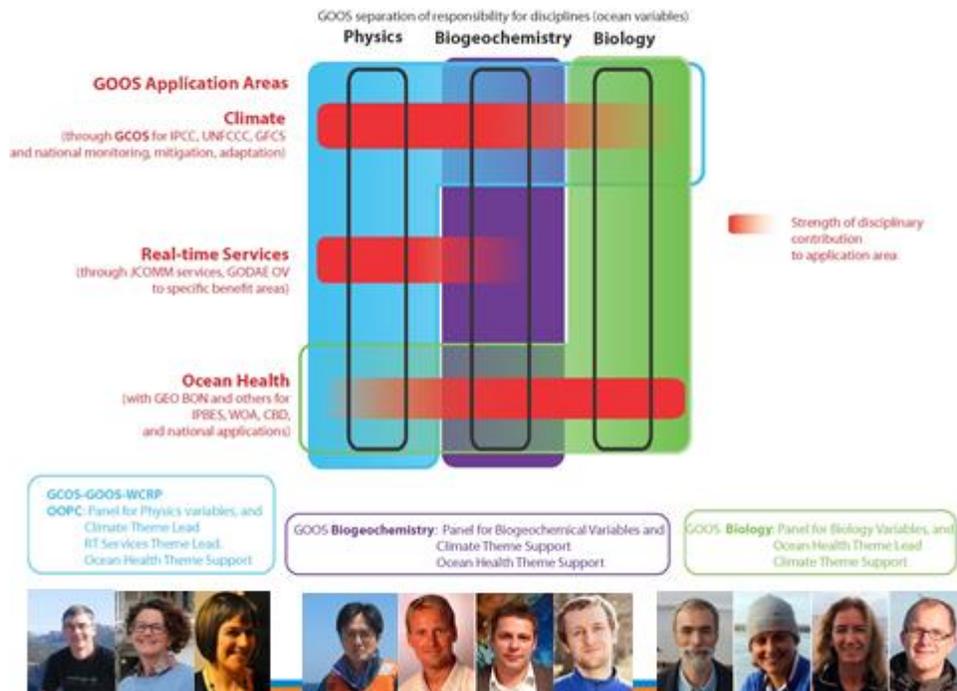


Figure 1. GOOS Panel structure and organisation against main application areas.

As with GCOS, GOOS is also developing a forward strategy, which will help OOPC set its work plan to meet the needs of these two parent programmes. The GOOS Strategy will go to the next GOOS Steering Committee for approval in September 2017. The OOPC Terms of reference were outlined, and particularly the expectations GOOS places on OOPC (which may be different to those from other parent programmes, GCOS and WCRP).

Katy also introduced the [OceanObs'19](#) conference, and outlined the planning to date. The dates have been set for 16-20 September 2019, in Honolulu. It is anticipated that the conference will have around 1200 participants, and NASA is the lead sponsor. The theme is 'Oceans of Opportunity'; connecting observations to users, and a draft structure is shown below.

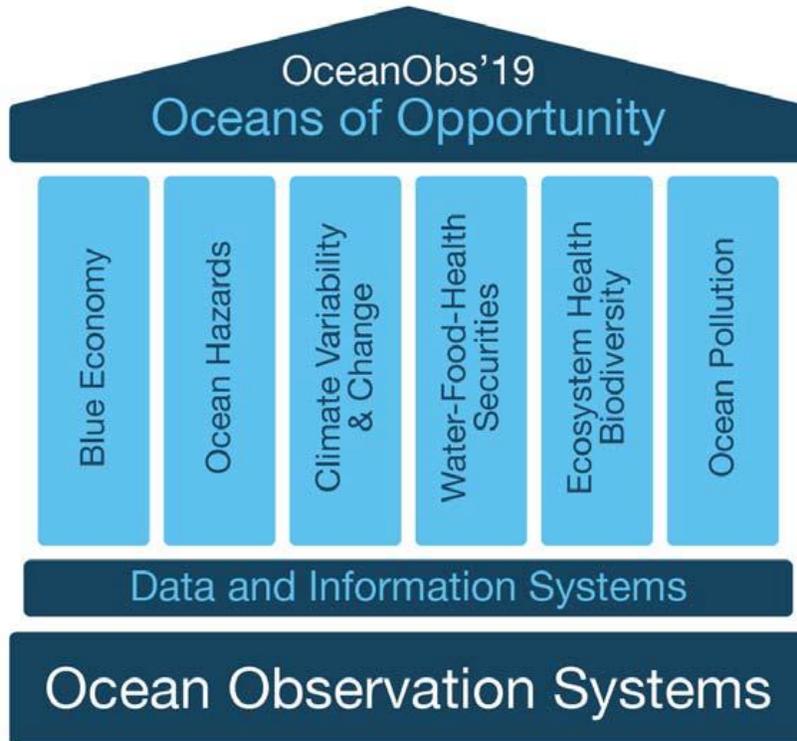


Figure 2. Proposed structure of the OceanObs'19 conference.

The panel discussed how OOPC should contribute to the organisation of OceanObs'19, given it has played a leading role in the organisation of the previous 2 OceanObs conferences. It was agreed that the panel should play an active role in the Programme committee. Members agreed to discuss further on during item 7 at the end of the meeting.

John Wilkin then gave an overview of the development of [EOV Specifications](#) to date, including the motivation, status and ongoing issues. The current version (v. 5.2 is on the GOOS website. The EOV specifications development was motivated by a need to develop a framework for ongoing evaluation of the observing system as part of implementing the FOO; this requires us to have a set of requirements to evaluate the system against. Importantly, the requirements are network agnostic; the focus is on accuracy, frequency and resolution required to capture specific phenomena without particular regard for technology. The documents are also a resource for OOPC to report on requirements through various avenues (e.g. the GCOS Implementation Plan).

John outline the issues which need to be addressed as these specifications are developed into the future; the documents are static, while much of the information is dynamic, e.g. data centres, data streams, information creation contacts/experts; In addition, it is not easy to aggregate requirements across EOV (or phenomena), to inform the make-up of the integrated observing system. John introduced the [Strategic Mapping](#) graphic, and suggested that a more dynamic/database approach would be a more effective way of managing this information. It would also mean we could track interdependencies in the system better. John suggested that the values in the tables do not really align with notions of accuracy, precision and/or bias; and the time and spatial scales were aspirational; and not sustainable for sustained user products. It was noted that the raw information is in the documents, but it hasn't been put to the test to see if it delivers what we want.

He suggested a way forward for discussion

- Specification sheets could be (more) dynamic documents; with key elements of the data organized in a relational format as part of the strategic mapping;
- For major processes and/or impact areas, we should aggregate the data into tables of EOV versus required resolution, accuracy, etc;
- Distinguish goal/breakthrough/threshold observing objectives (as is used by Met Services);

- Based on the above approach, the panel should write a paper presenting the EOVs; illustrating the approach based on a few key applications.

In the discussions that followed, the panel agreed that it was important to publish the EOVs specifications and the thinking behind them, as they are being interpreted in different ways. A high level paper is in process to present all of the EOVs; the Physics EOVs can explain the context for this subset, and the phenomena identified.

ACTION: OOPC to write a peer reviewed paper on Physics EOVs, providing information on the processes undertaken in development of EO specification sheet including identification of phenomena to be observed (led by Johnny Johannesen, Johannes Karstensen, Maria Paz Chidichimo, Marjolaine Krug with Bernadette Sloyan, John Wilkin, Katy Hill to provide comment, advice) OOPC members to review (Submitted by end of this year).

- **Members to consider journal to submit to.**

2. Research and Development.

2.1 World Climate Research Programme

The Chair of the WCRP Data Advisory Council (WDAC), Otis Brown presented an overview of WCRP activities of importance to OOPC. The two overarching objectives of WCRP are a) to determine the predictability of climate, and b) to determine the effect of human activities on climate. Their interests cover interactions amongst the atmosphere, land, ocean and ice to connect the heat, carbon and water cycles across timeframes from weeks to centuries.

The WCRP Structure is organised under a Modelling and Data Advisory Councils, overarching modelling and prediction working groups, five core projects, and seven cross cutting 'grand challenges'.

Otis then focused on the activities of the WDAC, whose role is to serve as a focal point for all observational and data matters across the programme, including:

- **Promote open data policies**, protocols and standards across the programme
- **Coordinate observational needs** and adequacy for WCRP core projects
- **Develop and recognize** the next generation of observing community
- **Ensure long term viability** of the climate observing system for research

Specifically, WDAC has a number of focused activities underway, including:

- **Obs4MIPs:** Collect and publish observational datasets for comparison with CMIPs on the ESGF
- **Ana4MIPs & TIRA:** Earth system, climate, atmospheric and ocean reanalysis activities
- **FLUX:** Coordinate flux research and promote development of associated data sets
- **Meetings:** Coordinate topical meetings, e.g., [5th International Conference on Reanalysis](#)

The ensuing discussion focused on how WCRP and OOPC (and the broader ocean observing community) should interact. For instance; whether WDAC would come to OOPC and advocate the need for missing observations, how OOPC should engage with WCRP and the research and development (R&D) activities across its substantial set of panels and projects; particularly pilots, process studies and analyses, which feedback potential information on the adequacy of the observing system. In response, Otis reiterated that WDAC was really a high level facilitator; however it does not currently have formal linkages to Grand Challenges.

The panel questioned if WDAC is able to provide the connection to all of these activities, given current level of effort; Traditionally, OOPC has engaged the CLIVAR basin panels. Further discussion is needed about how to strengthen the feedback between OOPC and the relevant WCRP activities; particularly the grand challenges on Near Term Prediction and Sea Level. The WCRP/IOC Sea Level conference will be an opportunity to stimulate discussion on observation requirements for evolving decision making needs. For Near Term Prediction, the Grand Challenge does not seem to articulate the needs for sustained observations; on its website, it refers to initialization across the different model approaches, but not the observations required to perform that initialisation. The panel agreed that it should engage in the Near Term Prediction community regarding

requirements for subsurface ocean observations for initialization and validation. These issues were taken up in at the WDAC and the WCRP JSC meetings that followed¹.

WDAC has a strong focus on the packaging of data for models through the East System Grid Federation; and the panel agreed that it would be a great step in this community if we could talk more about the delivery of data by variable, and less about the platforms that deliver them. It was also noted that we need to be clear about the communities we serve and their requirements. The panel also emphasized that interoperability of data; the ability to deliver data into a single environment and associated tool kits (e.g. transfer functions) was more of a priority than spatially complete fields (e.g. Obs/Ana4MIPS), and the panel will work with WDAC to connect to relevant activities to address data interoperability (e.g. the use of [ERDDAP](#) being championed through JCOMM).

ACTION: Define and strengthen OOPC and WCRP interactions (Bernadette Sloyan to raise at WDAC).

ACTION: Advocate for recognition of the requirement for ocean observations in Near-term prediction and forecasting projects in WCRP and CMIP6.

- **Write a review or opinion article on the importance of ocean observations on weather, seasonal to decadal and longer term forecast (predictions) (Bernadette Sloyan, Sabrina Speich, Johannes Karstensen, Matt Palmer).**

3. Systems based reviews and evaluations.

OOPC has identified a number of issues and projects, which will contribute to developing and improving the sustained ocean observing system. Projects and activities reflected here will address GCOS IP Action O6. Technology Development, and O7. Observing System development and evaluation.

3.1 Tropical Pacific Observing System, TPOS 2020

TPOS 2020 Co-Chair Neville Smith gave an overview of the project, progress to date, and key issues for consideration by OOPC. Neville noted that TPOS was set up as a finite lifetime semi-autonomous project, following the OOPC sponsored review in 2014. The major outputs of the project will be in the form of 3 reports (in 2016, 2018, 2020), with 2019 a key year for delivering outputs through key fora; OceanObs'19, WMO Congress and the IOC Assembly. The final report will be focused on the handover of governance, outputs and R&D activities. The First Report was finalized at the end of 2016, and can be downloaded from www.tpos2020.org/first-report, following experts and community reviews. In IPCC 'lite' style assessment approach was used. Design principles, building on GCOS design principles were incorporated, and it was suggested that OOPC might want to consider the development of focused design principles, possible incorporated in planned EOJ journal papers. The plan includes actions (short term), and recommendations; many of which take the long view and fall in OOPC's remit.

Neville noted that to his knowledge, the TPOS 2020 First Report is the first published observing system design which has followed the FOO, with both sustained and experimental elements, incorporated into a single design. The context for TPOS was framed as 'public goods', with analysis of societal benefit areas. Studies of the impact of observations on research and link to societal benefit are actually hard to find. Neville noted that this is a space where the EU Copernicus programme may be able to help.

¹ The issues and questions raised at the OOPC meeting re. how to define and strengthen OOPC interactions with WCRP and the role of WDAC in facilitating connections were taken up at the [6th Session of WDAC](#), 22-23rd March 2017, and the [38th WCRP JSC Session](#) held 3-7 April 2017. The WDAC Co-Chair Otis Brown briefed the WDAC about OOPC concerns on linkages with the WCRP Grand Challenges, as well as the suggestion of an advocacy role for the WDAC (OOPC Co Chair Bernadette Sloyan was a participant). The WDAC strongly supported a request to the WCRP/JSC to establish a mechanism to understand/communicate Grand Challenge science-based observing needs to the WDAC and GCOS. Moreover, the WDAC supported a request to the WCRP/JSC for authority to act as the WCRP advocate for science observing needs with the external community. In the WDAC presentation/report to the WCRP JSC requested establishment of a mechanism to ensure Grand Challenge observing requirements could be effectively communicated to GCOS, and, that the JSC give the WDAC standing to act as the WCRP advocate for science observing needs.

Experience in working the scientists to articulate requirements was discussed. Neville noted that the interpretation of what was meant by 'requirements' was varied. There was significant temptation to go straight to solution space and a need to pause and focus on the requirements analysis. It was also noted that impact verses feasibility needed to be considered through the full loop of the framework.

The actions and recommendations also consider both satellite and in situ as an integrated system, delivering to requirements for variables; Biogeochemistry is also integrated into the design. The report also elaborates on defining the data record verses the climate record; Neville noted that Argo has had a huge impact for a relatively short timescale because it illuminates the historical data record. While defining the need for 30-40 year timeseries as an ultimate aim is not a bad thing, we need to really focus on the timeseries you need to detect a change.

The need for enhanced fluxes information through the regimes of the Tropical Pacific was described, and Neville and Neville noted that the nomination of a new Heat Fluxes ECV was timely, he noted the GCOS IP was optimistic about the capabilities of satellite information. The TPOS report suggests these remain problematic. It was also noted that biases in Numerical Weather Prediction (NWP) remain uncomfortably large; the NWP community has recommended a number of sensitivity experiments, and it is important that we take up this offer considering our community as the user, rather than NWP. However, it makes sense to run these experiments more broadly than the tropical Pacific, and hence there is potential for OOPC to play a coordinating role. Fluxes issues are discussed in more detail in section 4.7.

The key recommendations in the report include:

- Reconfigure the mooring array (more capable moorings, targeting equatorial circulation, mixed layer and its interaction with the atmosphere, and key regimes);
- Double Argo (1.5 – 2.5 varying regionally, Western Pacific a priority for enhanced coverage);
- Initiate pilot and process studies to guide future design (noting that progress in models are not as good as expected: persistent systematic errors need to be addressed, and degraded research investment means scientists and agencies have focused their efforts elsewhere).

The substantial research activities in the Western Pacific were discussed, and through the Western Pacific Task Team, an inventory of ships and mooring data is being developed. Bob Weller and Johannes Karstensen agreed that it would be important to provide support for mooring data archival through OceanSITES. In the Eastern Pacific, it is hoped efforts will focus on the development of a major experiment.

ACTION: OceanSITES agreed to assist in developing an inventory of moorings in Western Pacific. (Neville Smith to contact Johannes Karstensen).

RECOMMENDATION: Improve visibility, searchability of OceanSITES moorings activities. (OCG and JCOMMOPS).

Neville also highlighted some significant uncertainties with Wind Stress; particularly in regions of low winds and strong currents, as satellites measure relative to a moving surface, and in situ observations are relative to a fixed surface. This sampling difference probably represents a systematic error across the whole of the Tropical Pacific. In consistencies in rain flagging and diurnal cycle sampling issues were also raised. It was suggested that it would be good to have a small project on winds. These issues are discussed further in section 4.7.

In reflecting on the process, Neville noted that severe weather and waves are currently gaps. In gathering intelligence, challenges remained largely in the modelling space; models and data assimilation system provide limited guidance, there is a need to innovate approaches taken in Observing System Experiments (OSEs) and Observing System Simulation experiments (OSSEs); and prediction systems still don't have the capability to use TPOS efficiently.

In conclusion, Neville noted that there was significant crossover between issues identified and recommendations from TPOS 2020 and the global agenda of OOPC; he also noted that the community needs to be a strong advocate for Microwave SST. The panel noted that the security of microwave instruments was also of concern to the Sea Ice community, and it might be helpful if OOPC advocated for their continuance with satellite agencies.

In the discussion that followed, the group delved further into issues and developments related to models noting in particular that NWP models have shown phenomenal progress; they are now coupled, so draw increasingly on the ocean observing system (focus also needed on boundary layer processes); however, we haven't seen the same progress in seasonal forecast models. A lot of focus of model development has been on increasing complexity, rather than improving how underlying processes are represented. Aspects of these issues are addressed further in agenda 5. The potential to make progress on the waves issue was also discussed, noting that Sea State is an ECV. Currently we have the capability to capture swell components (400m).

ACTION: Advocate for continuity of Satellites Microwave SST, Sea Ice observations (Johnny Johannesen, Ben Rabe, Tony Lee to draft letter to be sent to space agencies on behalf of OOPC, identify who to it send to)

- **Eitarou Oka, Katsuro Katsumata to identify who to contact at JAXA re. AMSR.**
- **Ben Rabe and Katsuro Katsumata for Arctic and Antarctic, engage with CliC, SCAR, SOOS and Arctic programs**
- **GHRSSST Community. Letter to GOV ST raising concern**
- **Katy explore opportunities to raise at CEOS SIT**

3.2 AtlantOS

OOPC panel member Johannes Karstensen gave an overview of the [AtlantOS](#) project, including progress to date. AtlantOS is also structured according to the FOO, with a strong focus on requirements for EOVs, and systems based design and evaluation. AtlantOS also has a strong focus on delivery to sustainable development. AtlantOS was funded as a 4 year project, and is now half way through. A [briefing paper](#) has been released, and the ultimate output will be a Blueprint for an Integrated Atlantic Observing System.

During the discussion, the connection between the CLIVAR Atlantic Panel in AtlantOS was raised. Given there is an overlap between membership of the Atlantic Panel and those involved in AtlantOS, this connection is managed organically. In addition, while AtlantOS is a European project, it installs the Galway Statement of transatlantic cooperation and hence has partners in US and Canada

The panel also noted that [RAPID-MOC](#) AMOC programme, which is monitoring the Atlantic Meridional Overturning Circulation at 26.5N, is planning a review in 2018 and that the PIRATA community has been promoting the idea of a review of the integrated in situ Tropical Atlantic Ocean observing system in 2018. It was questioned how these various efforts were connected to AtlantOS. Johannes suggested that AtlantOS was a coordinating activity rather than specific science review; and that while the European Commission pays for the AtlantOS project, it is up to the national programmes to contribute; but the panel then questioned how the RAPID-MOC and Tropical Atlantic Observing System Reviews would then feed into the Blueprint. The Enhancing Prediction of Tropical Atlantic Climate and its Impacts ([PREFACE](#)) project finishes in the coming year; it would be timely for this to also be connected to AtlantOS.

ACTION: Follow development of Blueprint of Atlantic Observing (Watching brief) (Johannes, Maria Paz, Sabrina)

3.3 Indian Ocean Observing System Review.

Indian Ocean panel member Mike McPhaden gave an outline of the review of the Indian Ocean Observing System that is being sponsored by OOPC, CLIVAR, and Integrated Marine Biosphere Research ([IMBER](#)) project, and is led by the CLIVAR-GOOS Indian Ocean Panel. The focus of the panel is largely on the in situ observing components, but it will provide some recommendations for satellites. The current observing system was designed in 2004, so the design and progress is ripe for a revisit. The observing system is basin scale in focus, while linking to coastal systems (Agulhas, IMOS), and also provides context for intensive process studies such as CINDY/DYNAMO.

The Review TORs are:

- Make actionable recommendations for priority observing system components going forward, including pilot studies with new technologies;
- Provide justification for these recommendations by:

- Reviewing the current status of IndOOS and its past successes and failures;
- Articulating the scientific and operational drivers of IndOOS and their societal impacts;
- Identifying the essential ocean variables (EOVs) that address these drivers, their spatial coverage and temporal/spatial resolution.

A workshop was held in Perth in January 2017, as part of the Indian Ocean Panel meeting to kick start the review. The meeting was focussed around science and operational drivers, current observing system components and future technologies.

In the discussion that followed it was noted that the 2004 observing system design focused primarily on the tropical Indian Ocean; and the current review will expand the focus to include the southern Indian Ocean subtropics. Mike McPhaden noted that we are not starting from ground zero. The Indian Ocean Panel feels that the current system fundamentally works and is trying to improve it. Hence decided it is not necessary to start from scratch in articulating requirements and EOVs, but rather to update where necessary. The panel discussed the user community for the observing system, which currently includes weather and climate, including biogeochemistry; but tsunamis, fisheries are currently out of scope. However, the Indian Ocean project of IMBER, Sustained Indian Ocean Biogeochemistry and Ecosystem Research (SIBER)), is engaged in the review.

The Panel discussed the 17 research and operational drivers identified by the workshop, and noted that they could be grouped thematically or combined. In the 0 drivers, subseasonal to seasonal prediction and extreme events should also be included. The observing system in the Indian Ocean is relatively young, and it was noted a stronger connection needs to be fostered to societal benefits. The panel also discussed the link to the 2nd International Indian Ocean Experiment (IIOE2); and encouraged the two activities work together to set the forward trajectory for Indian Ocean activities. The connection to coastal issues and activities also needs to be strengthened. OOPC has been invited to nominate representatives to the review panel, and agreed that 2 members of OOPC should be nominated.

Decision: OOPC to recommend 2 representatives to be part of the Indian Ocean Observing System Review Panel (Weidong Yu, Marjolaine Krug).

3.4 The Deep Ocean Observing System, (DOOS).

Bernadette Sloyan presented progress in the development of the DOOS, including the outcomes of the DOOS workshop held in December 2016 at Scripps. The workshop noted that Large-scale ocean circulation plays a key role in the transport of heat from the tropics to high latitudes and from the surface to the deep ocean, heavily influencing global climate. This is reflected in the priority action to develop a full-depth temperature observing system in the GCOS IP (O10). There are gaps, however, in our knowledge of detailed aspects of the global overturning circulation and its variability. Specific to the deep sea are deep and bottom water formation rates and water properties, circulation and deep-ocean mixing, geothermal heating, and the impact of these on the deep ecosystem. Science questions were identified, based on these issues, and Essential Ocean Variables. Most are of the Physics variables identified are already GOOS Physics EOVs, but additional DOOS EOVs include

- Ocean Turbulence;
- Ocean Bottom Pressure;
- Geothermal Fluxes; and
- Ocean Bottom Boundary Fluxes.

More work is required to address the feasibility and readiness of these EOVs. Key observing components, (including those required to address GCOS IP Ocean Action O10) include:

- 1) Continuing North and South Atlantic Meridional Overturning Circulation measurements;
- 2) Broad scale deep Argo for variability in deep properties and circulation;
- 3) Decadal Repeat hydrography for comprehensive high quality snaps shots of deep properties and circulation;
- 4) Regional observing systems in a limited number of boundary currents, constricted flows and choke points;
- 5) Carefully selected bottom pressure measurements.

It was emphasised that DOOS needs to address key challenges for integrated ocean “estimates”. Katsuro Katsumata is now a member of the DOOS committee, and will keep OOPC updated on DOOS development. The panel discussed approaches for measuring bottom pressure, and the relative feasibility of using tsunami moorings, cables, and satellites (GRACE). It was also noted that while climate requirements are quite broadscale, with some regionally enhanced observations; physical measurements to underpin ecosystem and other applications (e.g. mining) may be more focussed on specific locations, i.e. Clarion Clipperton Fracture Zone.

ACTION: Follow development of DOOS (Watching brief) (Katsuro Katsumata).

- **Suggest DOOS communicate with OSTST (Ocean Surface Topography Science Team) to explore possible synergy in DOOS design of pressure measurement to complement satellite altimetry/gravity/geodesy missions (Katsuro Katsumata, John Wilkin)**

3.5 Evaluating Multidisciplinary Observing System Requirements: Outcomes from the IMSOO Workshop

GOOS Biology panel Co-Chair Sam Simmons presented an overview of the Integrated Multidisciplinary Sustained Ocean Observing (IMSOO) Workshop, which was held 8-10 February in Miami, sponsored by GOOS and the US National Science Foundation, Research Collaboration Network (RCN). The aim of the workshop was to

- Build on the established societal and scientific requirements expressed in EOVs, identify the key applications and phenomena that will benefit from co-located multi-disciplinary sustained observations;
- Identify near-term innovation priorities for observing platforms and sensors to enable multi-disciplinary observations; and
- Identify programmatic and professional connections between existing and emerging observing networks that will increase multi-disciplinary observations.

The aims were addressed through 3 demonstration themes: Phytoplankton Blooms, Oxygen Minimum Zones and Boundary Currents and their interactions with the shelf, which were discussed in breakout sessions.

3.5.1 Phytoplankton session and project plan.

Sam then presented an overview of the outcomes of the Phytoplankton break out session, which framed the challenges in terms of gaps, overarching themes, and worked towards 2 and 5 year goals.

For the open ocean, a two year goal was to incorporate phytoplankton sampling in Global Ocean Shipboard Hydrography Investigations Programme (GO-SHIP) cruises. This will require effort in the development of standards and best practices for plankton data, and a proposal for a SCOR working group is underway. Resourcing for data delivery will also need to be considered. On a 5 year timeline, the group proposed that BioArgo targets should be implemented with sustained funding support, and Underwater Vision Profilers (UVPs) incorporated into the observing system.

For the coastal ocean, a two year goal was to conduct a meta-analysis of existing coastal datasets, and to fill gaps focussing on developing nations, utilising frameworks such as the Small Island Developing States (SIDS); the coastal component will be designed with development of coastal observation requirements within GOOS. While this is a multidisciplinary project, the GOOS Biology Panel will keep tabs on its development.

In the discussion, the potential for a backbone set of multidisciplinary moorings could be identified as part of the OceanSITES network of timeseries sites as part of the open ocean activities; OceanSITES are looking for guidance on developing the mission and targets for this type of OceanSITES. The role and limitations of Continuous Plankton Recorders (CPR) was also discussed, and the potential to add UVPs; however, it was noted that CPRs are usually towed behind large vessels, and need to be self-contained; particularly in terms of power requirements. Also, the UVPs are likely not feasible to add due to turbulence. The potential to include Echosounder data on GO-SHIP cruises was also discussed; however, Echosounders and Acoustic Doppler Current Profilers (ADCPs) contaminate each other, and the priority for GO-SHIP are ocean current observations. The importance of measuring light absorption, and the potential for light/optics to become an EOVI was discussed also.

3.5.2 Oxygen Minimum Zone (OMZ) session and project plan.

Johannes Karstensen presented the outcomes of the OMZ breakout. The discussions emphasised the need for truly multidisciplinary observing targets to observe OMZs. An overarching question was identified:

- How do changing OMZs affect the spatio-temporal distribution, productivity and trophic structure of the benthic and pelagic communities?

plus a number of specific questions:

- What are the physical mechanisms controlling/influencing oxygen supply to OMZs?
- What are the biological components controlling/influencing oxygen consumption?
- How does benthic-pelagic coupling affect biogeochemical and ecological feedbacks?
- What is the role of microbial community metabolism on the development of OMZs?
- What is the bottom-up effect of changing OMZs on the trophic structure?
- How does the fish biomass and community structure change in relation to a changing OMZ?

Goals were identified for 2 and 5-10 year time horizons. The two year goal focussed on a demonstration project, leveraging existing observing activities combined with modelling and considering in particular applications to developing projects.

The group plan to develop a project called Variability in the Oxycline and its impacts on the ecosystem (VOICE) , and these activities will be further progressed at the GO2NE workshop in Monterey in September 2017. This project will be overseen by the GOOS Biogeochemistry panel.

In the discussion, it was noted that there was particular interest in the need to focus on OMZs in less developed regions. The Bay of Bengal will be a focus in the 2nd Indian Ocean Expedition (IIOE2).

The OMZ activity will be supported by the GOOS Biogeochemistry Panel and the Plankton by the GOOS Biology Panel. However, OOPC will need to stay connected. The OOPC members who participated in these breakouts will keep tabs on progress.

ACTION: Keep IMSOO Workshop themes Plankton and OMZs on Watching Brief (Bernadette Sloyan, Johannes Karstensen)

3.5.3 Boundary Currents, shelf coastal Interactions: Integrating ocean observations across the coastal shelf boundary.

John Wilkin presented an overview of the Boundary Currents (BC) break out discussions. The session built on previous discussions led by OOPC focussed on open ocean-coastal connections, rationale for boundary current observations, networks to integrate, etc. OOPC is advocating for a comprehensive observation/modelling study in key eastern and western boundary current locations building on existing infrastructure to address:

- Impacts and influences of large-scale remotely driven variability on boundary currents;
- How variability in strength and dynamics of the BC drive shelf-sea/open-ocean exchange, including nutrient forcing, carbon export, and other aspects of productivity of shelf waters;
- Response of coastal and BC dynamics to local and regional wind and buoyancy forcing; impact these have on dynamics at larger scales through teleconnections;
- Quantifying resolution required to represent coastal and BC dynamics in global climate models;
- Obtaining basin-wide estimates of meridional transports through a synthesis of coastal, boundary and open ocean observations;

The IMSOO break out, in which experts from a range of disciplines attended, focussed on 3 questions;

1. How ecosystem structure/dynamics in coastal ocean is affected by external variability, including O₂, acidification...
2. Cross-shore exchange between land, shelf and deep ocean
3. Ecological hotspots. Episodic (e.g. fronts, eddies, upwelling) and persistent (e.g. canyons, headlands, shelf break)

However, John noted the breakout focussed relatively little on:

- Connections to basin scale transport estimation
- Connections to modelling: downscaling, OSSE, seasonal prediction
- Coordination with GODAE OceanView and GOOS Regional Alliances (GRA)
- Land-ocean and ocean-meteorology interactions
- Low latitude boundary currents
- Societal impacts

For each of the questions, the processes/phenomena that needed to be captured were identified, EOVs and time and space scales, and platforms that could contribute to their delivery. The approach taken was considered a potential blueprint for evaluations of boundary current/shelf observing systems.

The next steps were identified by the IMSOO Group, which included

- Test the approach on analysis of requirements and capabilities in well-observed eastern and western boundary current systems
 - California Current (led by Francesco Chavez, IOOS)
 - East Australian Current (led by Tim Moltmann, IMOS)
 - Synthesis: Refined approach to addressing issues, phenomena/EOVs, and feasibility/impact
- Engage with GEO, Future Earth to identify societal drivers in BC locations -> set path toward delivery of useful products and information
- Engage with GODAE task teams to partner in observing system design and evaluation
- Develop concept for a multi-disciplinary backbone observing system (2-3 years)
- Develop concept for multi-disciplinary relocatable observing system pilot for observing finer scales (3-5 years)

Complementary developments which would contribute to a boundary currents activity include the formation of an International OceanGliders programme, which has established task teams to develop sustained observing missions focussed on boundary currents, storms, and convection and mixing. In addition, the Altimetry for regional and coastal ocean modelling (ARCOM) group, a joint activity between the GODAE OceanView Coasts and Shelf Seas Task Team (COSS-TT) and the the Coastal Altimetry Community, have developed a proposal to ESA to task CryoSat to the global coastal ocean for the remainder of its mission. John will be attending the COSS-TT meeting in April to gauge interest in collaborating with OOPC on the boundary currents issue.

John then proposed some next steps for OOPC, which should be coordinated through a task team to:

- Review previous and on-going boundary current observing experiments / Review existing and novel technologies for coordinated shelf-sea/deep-ocean observation, in time for OceanObs'19
- Recommend intensive international pilot process experiments in specific boundary current/shelf-sea regimes that will guide the development of a sustained observation and modelling system
- Improve techniques for downscaling climate models, including adequate representations of higher frequency, smaller scale processes that drive coast and shelf dynamics and ecosystem response.
- Coordinate with GODAE for state estimation and observing network design
- Coordinate with GOOS Regional Alliances for regional coastal observing,
- Make connection to societal impacts in the global coastal ocean

In the discussion, the relative merits of the approach taken at IMSOO was discussed, and the potential to learn from existing well observed systems was noted to have merit. It was noted that we need a clear pathway from a collection of process studies and regional efforts to a sustained observing system: we can't just jump from one to the other, and need to ensure we scale up boundary current activities towards a global pilot experiment which needs to be evaluated, before pushing to sustain the system.

ACTION: Form a Boundary Current - Shelf System Task Team, engaging OOPC members and community experts (John Wilkin, Maria Paz to lead, Marjolaine Krug, Johannes Karstensen, Robert Todd engaging Peter Oke/Andy Moore COSS TT, OSEval TT).

- **Keep watching brief on IMSOO Boundary Current reviews of California Current, East Australia Current (John Wilkin, Katy Hill)**

- **Prompt IMSOO OMZ/Phytoplankton groups to propose metrics of coastal model performance that could underpin Coastal MIPs (John Wilkin to work with Sam Simmons, Johannes Karstensen)**

3.6 Next steps in connecting up observations for climate in the coastal zone from a terrestrial perspective.

Simon Eggleston presented the importance of connecting up observations in the coastal zone from a climate perspective, noting the action in the GCOS IP (T2) to develop joint plans for coastal zones between OOPC and Terrestrial Observation Panel for Climate (TOPC). Simon referred to the climate cycles. To connect up the carbon cycle, the transport of carbon from the land to the ocean through rivers and run off is a major unknown. Carbon accounting will need to be reported under the Paris agreement, and terrestrial accounting includes coastal carbon sinks; Mangroves, Sea Grasses, Salt Marshes (which are GOOS Biology EOVs, and come under the GCOS Ocean ECV 'Marine Habitat Properties); which connects to GCOS Terrestrial ECVs also for Land cover, Above ground Biomass, Soil Carbon. Simon noted further potential to connect up interests in the observations of the cryosphere and water cycle, and summarised key overlaps of immediate interest as Carbon fluxes and stores; Sea Ice, Ice Sheets and Glaciers; River discharge, nutrient flows, water discharge into the ocean.

Simon recommended the development of a joint TOPC-OOPC task force to meet electronically, prepare a workshop, and report back to panels.

During the discussion, observation gaps were explored, and in particular it was noted that developments in satellite products show promise. The future NASA Surface Water SWOT mission for estimates of river discharge, the use of products from soil moisture and salinity missions together to understand river flow/run off, ocean colour in coastal waters, and the ESA Biomass mission. Ocean salinity near river mouths is being used to estimate river discharge. This is an ongoing effort in data assimilation and inverse modelling. Also, there is a good relationship between Coloured Dissolved Organic matter (CDOM) and salinity. Work is needed on use of radiation spectral data across land and ocean observations.

The panel noted that TOPC does not have specification sheets for the terrestrial ECVs which would help in e.g. connecting up the requirements at the coastal interface. It was also agreed that the task force should be a joint TOPC-GOOS team, as the coastal issues are truly cross cutting the GOOS panels.

DECISION: OOPC agrees to participate in TOPC-Cross GOOS task team with representation from TOPC, GOOS Biology, GOOS BGC, OOPC (Telecon Simon Eggleston, Katy Hill, Sam Simmons plus Maciej Telszewski, Patricia Milosavich to frame issue and identify appropriate representation).

3.7 Air Sea Fluxes

Air Sea Heat fluxes have largely been on 'watching brief in the OOPC work plan to date; but as Ocean Surface Stress and Ocean Heat fluxes are now approved ECVs, OOPC now has a renewed focus on the task of developing the requirements and observing system design (actions O17 and O18 of the GCOS Implementation Plan). In addition, issues highlighted in the TPOS 2020 First Report (discussed in section 4.1) also provide motivation for action from OOPC, beyond just the Tropical Pacific.

OOPC Panel member Tony Lee (also TPOS2020 Backbone System Task Team member) and Tom Farrar (TPOS 2020 Steering Committee member and Planetary Boundary Layer Task Team co-chair) presented an outline of the issues related to winds, noting that coverage from available scatterometer winds data remains an issue. There are currently 2 publically available satellites, which provide coverage of only 60% of the global ocean every 6 hours. The gap filling using reanalysis winds for the remaining 40% of the ocean introduced significant errors into synthesized wind products. This is a real issue, and Tony requested that OOPC advocate for data availability.public data availability from at least a third scatterometer (e.g., from one of the scatterometers to be launched by China in the next couple of years). Other wind issues were discussed in the context of TPOS 2020; notably:

- Issues of inadequate sampling the diurnal cycle leading to aliasing satellite winds;
- The causes for the larger differences between satellite and in situ winds in convective/rainy regions than rain-free regions: (1) rain contamination of satellite winds and the consistency of satellite wind rain flags,

and (2) sampling differences between satellites of different footprints and between satellite winds averaged over their footprints and point-wise in-situ wind measurements;

- Surface current effect on wind stress in regions of low winds and strong currents (satellites are measuring stress referenced to a moving surface while in-situ sensors measure absolute winds relative to a stationary frame);
- The need for efforts to test the impacts of in-situ winds in synthesized wind products and reanalysis products.

Tony recommended OOPC engage the International Ocean Vector Wind Science Team to enhance the efforts to address the aforementioned issues. The upcoming Reanalysis conference provides opportunities to address the last issue mentioned above as well. The panel discussed many of the issues above in depth, and decided that the panel OOPC should take a lead in addressing the issues and engaging key parts of the community.

ACTION: Work with modelling and observational communities to address issues related to winds.

- **Estimate the effect of small-scale convective cells on the discrepancy between satellite and in-situ wind measurements in rainy regions (Tony Lee, Bob Weller, engaging Tom Farrar, etc)**
- **Engage IOVWST to improve consistency of rain flagging (Tony Lee)**
- **Encourage NWP centres with coupled assimilation capability (e.g., NCEP) to account for ocean surface current effect on wind stress and test impacts of TMA winds (Tony Lee)**
- **Engage NWP centres (e.g., ECMWF) to test the impacts of in-situ winds on reanalysis (Tony Lee).**
- **Engage CEOS to ensure international data sharing (Chinese scatterometers) (Tony Lee, Weidong Yu)**

OOPC Panel member Bob Weller then gave an overview of the progress made with heat fluxes, noting the GCOS IP O17 action gave renewed impetus to refine observing strategy. Bob referred back to the work of the Ocean Observing System Development Panel (OOSDP), which ran in the mid-1990s, and was the predecessor panel to OOPC. The panel developed whitepapers on key aspects of observation, including one for fluxes. The strategy focused on broad global sampling of state variables, and high temporal resolution sampling at key sites. In the 20 years since, progress has been made with flux reference sites, and the OceanSITES network developed, and a strategy focused on identifying characteristic sites (high amplitude, high uncertainty, characteristic sites, etc). Ships were instrumented with upgraded sensors as part of the Voluntary Observing ship programme, and progress towards identifying errors in model and remote sensing field.

Current issues and challenges include a dependence on ship time to service moored flux sites. Short term mooring deployments don't meet requirements for fluxes, but maintaining moored sites is challenging. OceanSITES is working with other networks to explore synergies and see if the available ship time across networks could be used to support the observing system as a whole. In situ calibration from ships also requires dedicated ships. OceanSITES have also grappled with whether to withhold data from the GTS or not., so that OceanSITES data is used for calibration.

Future evolution includes more capable buoys, integration of direct covariance flux systems, and more diverse sensors. OceanSITES has also initiated conversations with the Data Buoy Cooperation Panel regarding consistency between coastal meteorology and bluewater flux sites.

Given the evolution of models and observations over the last 20 years, the panel agreed it was timely for a revised strategy for air sea fluxes. Further discussion is needed also between in situ, satellite and flux products; it was noted that the WCRP Data Advisory Council has a fluxes working group, which should be engaged in this activity. Further discussion of fluxes in the context of forecasts was included in the item 5.

ACTION: Write up strategy for air sea fluxes observations, working with old WGASF, (Bob Weller, Lisan Yu, Marjolaine Krug).

3.8 Polar Seas

CLIVAR Southern Ocean panel member Katsuro Katsumata (Kats) presented the range of activities in the Southern Ocean noting the key gaps which need to be addressed, including:

- Sea Ice Area and thickness, snow cover
- Air Sea Fluxes
- Under Ice Observation – ice shelf cavity.

In Situ Sea Ice observations were identified as a particular action in the GCOS IP (Action O15)

A number of major initiatives are in place which will feed into the sustained observing system; these include projects [SOCCOM](#), [ORCHESTRA](#), [NECKLACE](#) and the [Year of Polar Prediction](#)

OOPC Panel member Ben Rabe then gave an overview of observations in the Arctic, including a number of process studies and research initiatives (e.g. MOSAiC and FRAM). Many initiatives which will be associated with YOPP. Discussion followed regarding to what Arctic Observations, particularly Arctic drifting buoys (ice-tethered platforms), were on the GTS. The point was raised that there is currently no regional CLIVAR panel for the Arctic. Kats commented that an Arctic panel is in planning. Organisations such as the International Arctic Science Committee (IASC) also play an important role as they coordinate Arctic science across disciplines (atmosphere/ocean/cryosphere/land/social).

OOPC Panel member Johnny Johannesen gave an overview of the European project on Integrated Arctic Observing System, or IntArOS, which is similar in structure and objectives the AtlantOS project; and is part of an Arctic cluster of programmes which also includes modelling and forecasting; though it is different in that it needs to cover Atmospheric, Oceanic and Terrestrial observations. IntArOS aims to develop an integrated Arctic Observing system by extending, improving and unifying existing and evolving systems in the different regions of the Arctic. Enhancements will be in targeted areas and include ice tethered profilers, subsurface moorings, extensions to the Ferrybox system on ships of opportunity and ice capable bio Argo floats.

Discussions focussed on comparing approaches, new technologies and the range of initiatives in the Arctic and Southern Ocean, and the potential to draw on these efforts to develop a strategy for future sustained observing in the future. Given the extent of community activity, at this stage, OOPC agreed that the activities in the community should be kept on watching brief.

ACTION: Engage in Arctic and Antarctic observing programmes (watching brief) (Ben Rabe, Katsuro Katsumata, Johnny, report back to next OOPC)

4. Approaches to assessing observing system performance and evaluation.

4.1 Coordinated approach to using models, products and syntheses to inform observing system design.

CLIVAR GSOP Co-Chair Matt Palmer presented an update on progress since OOPC-19, on developing a position paper on the approaches to observing system design and evaluation, with a particular focus on the role various modelling systems and applications might play in this assessment. A draft was circulated following discussions between Matt and Johannes Karstensen, and Matt is seeking volunteers to contribute.

As an initial focus, Matt recommends exploring ocean heat content across a range of models (Climate models, and high resolution ocean models, extracting synthetic profile data; and using high res model results to improve climate model representation). OOPC discussed this approach and its merits in depth; the panel agreed that such a focus on ocean heat content was timely given the evolution of the observing system, and the importance of tracking heat content to close the global energy budget; the discussion continued in agenda item 6. Further, the panel discussed the potential of including tracking freshwater budget, with a particular focus on the high latitudes where regional freshwater content changes are relevant to the global sea level budget. As well as being highly topical, the review will serve to bring together a number of different regional experts and activities across OOPC and the wider research community.

4.2 Potential to assess observing system performance against requirements to observe phenomena/process identified in EOVS specification sheet.

Given TPOS 2020 has had some in depth discussions about how models can be used constructively to assess the design and performance of the Observing System, some of which may be of interest more broadly.

Tony Lee presented an outline of one approach in particular: the Wyrki Challenge, where the aim is to assess the observational capability to close the volume, heat, and freshwater budgets of the tropical Pacific with the specified observing system design extracted from a model. The panel noted that this experiment should be carried out using a range of models, and a collaborative effort would be beneficial across GODAE OceanView, CLIVAR GSOP and TPOS 2020. It was pointed out that ECCO (Tony Lee), CSIRO (Susan Wijffels), the

University of Tokyo (Yukio Masumoto) and Mercator (Pierre Yves le Traon) are working on this assessment initially, so there will be an opportunity to compare approaches before broader guidelines are developed.

Neville Smith suggested there may be benefit in engaging forecast groups in developing observation impact assessments. Following engagement in the [WMO Workshop on the impact of various observing systems on NWP](#) in May 2016 in Shanghai, Neville was impressed with the sophisticated approaches being used to assess the impact of observations for NWP. Forecast groups are even able to pinpoint the impact on a forecast for every dollar invested in observations. Neville noted that groups are interested in performing similar assessments, with the oceanographic community rather than NWP in mind as the customer. What is the metric we would chose if surface fluxes was what we wanted to explore?

In the discussion, it was noted that impact on a forecast can't be considered in isolation from the other ways in which an observation contributes to a forecast; however, it is part of the intelligence mix that can be used in observing system evaluation. Model sensitivity experiments also need to be considered, especially as such approaches are much cheaper than data assimilation. The OOPC agreed that further collaboration with the NWP community would be important, specifically in understanding the impact additional observations of fluxes would have.

ACTION: Propose a small meeting of flux obs, products and NWP modellers (6-8 people) to frame requirements for sensitivity experiments (Bob Weller, Marjolaine, Lisan Yu, Representatives from NWP community).

- **OOPC to make connection with (Atm) Reanalysis producers re. datastreams in database, being injected, consistently rejected (i.e. OceanSITES data).**
- **Discuss OOPC Flux observations strategy with WDAC Fluxes Task Team (Bob Weller to discuss with Carol Anne Clayson, Bernadette to raise in general terms at WDAC meeting next week).**

5. Supporting Sustained Observations

5.1 JCOMM Observations Coordination Group (OCG).

JCOMM OCG Chair David Legler provided an overview of the OCG membership, terms of reference, and current work plan focus, as well as an update on the status and issues of note for each of the major global observing networks. OCG's work plan is focused around key areas where synergies across the networks can be built on: Requirements, Implementation, Metrics, Standards and Best Practices, Data and Integration, plus oversight of JCOMMOPs. OCG is also engaging new networks working towards global coordination such as OceanGliders and HF Radar. David noted that we need to work towards getting a status update from the GOOS Regional alliances in the future. Complementary to the EOVS Specification sheets developed by the panels, the Network Specification sheets are developing, with improved articulation of missions and targets, enabling JCOMMOPs to report on more effective and comprehensive KPIs. An annual Ocean Observing System report card is under development, which will provide an effective way of communicating the status and importance of the observing system to high level for a (such as WMO and IOC assemblies). While the observing network performance indicators are improving, work is still needed, in collaboration with OOPC, to develop observing system performance metrics against requirements.

OCG is also focusing on working towards the end game of the delivery of observations by variable; this requires work on standards and best practice and data integration. A tool called ERDDAP is being trialed at key data assembly centres, and OCG is working within JCOMM on the development of the JCOMM Data Management Strategy. OCG is also leading the development of an Open GTS node, to enable broader access to GTS datastreams.

It was commented that the Open GTS is potentially of broad interest, including for GOOS regional alliances. It was suggested that perhaps a presentation at the GOOS Regional Forum would be welcome.

ACTION: Present Open GTS proposal at the GOOS Regional Forum (John Wilkin to follow up with US IOOS).

David continued by outlining future challenges for JCOMM OCG; these include expanding the suite of networks, and defining criteria/process for engagement, coordination of logistics across internationally and across networks, particularly optimum use of ship time, working with the OOPC on the strategy for delivering

observations against requirements by EOV, and incorporating developments and changes from regional projects such as TPOS 2020 and AtlantOS.

Key issues for discussion between OOPC and OCG were identified as:

- Updating authoritative requirements. What is the process? How are EOV Specifications reviewed?
- Incorporation of regional project recommendations, what is the role of OOPC and OCG in responding?
- Assessing utility and fitness for purpose of the observing system; how should the observing enterprise be reviewed, and progress evaluated?
- Shifting to the Framework for Ocean Observing and EOV framework, enables us to focus on leveraging the efficiencies of networks. How do we determine the 'best' mix of networks?

David also noted the GCOS IP Actions for which OCG and its members have responsibility; largely the network based actions. Performance tracking against these actions will be made easier by JCOMMOPS enhanced metrics.

In the discussion the group discussed the focus on articulating the phenomena to capture and how this informs the scales, and regional aspects of observations required is a productive approach to take. Historically, OOPC has focused on some thematic and some network reviews. It now focuses more thematically (Boundary Currents), or regionally (TPOS 2020), but there was some discussion as to whether more variable based reviews should be promoted.

It was pointed out that the IPCC 5th Assessment report gives guidance on challenges and observation requirements and hence topics for potential reviews; changes in temperature and heat content, changes in salinity and freshwater content (on seasonal and longer timescales) are clear foci needing renewed attention. This underlined that it would be timely to run a review of the Observing System for capturing changes in heat and freshwater content, led by OOPC. The timeline of OceanObs'19 was discussed as a motivation for such a review. Draft terms of reference of the review were drafted and are included in Appendix II. It was proposed that the previous work towards a position paper on approaches to observing system assessment be folded into this heat / freshwater content review.

ACTION: Develop proposal for Temperature/Heat Content and Salinity/Freshwater Content Review, including shelf seas, deep ocean, ice covered ocean. Consider Connection to WCRP Grand Challenge on Sea Level/ Concept Heat CLIVAR Research Opportunity, GOV, and see IPCC 5AR WG1 Ch3. (Matt Palmer, Sabrina Speich, Eitarou Oka, Johannes Karstensen).

RECOMMENDATION: Discuss possibility of an observing system review for tracking changes in Ocean Carbon content (OOPC Co-Chairs to raise with GOOS Biogeochemistry Panel.)

Bernadette Sloyan then provided an overview of the GCOS IP Actions for which OOPC and OCG joint action is needed, particularly around advocating for sustained observations. The actions underlined the need for OOPC to play a stronger advocacy role, and this is reflected in a number of actions identified on communication and advocacy for the panel.

5.2 G7 Oceans Compact

David Legler gave an overview of the G7 Oceans Compact, and efforts to progress issues on sustained observing. This topic is on watching brief, and members of G7 countries were encouraged to connect to G7 Oceans Compact related discussions in their respective countries.

5.3 WEBINAR: Are we there yet? 20+ years of Looking for the Sustained Ocean Observing System for Climate.

For OOPC's 20th meeting, and in recognition of the contributions of long standing members of OOPC, Neville Smith (foundation OOPC Chair), and Bob Weller (original and existing OOPC member) gave an entertaining public webinar on their perspectives of the progress made to date in sustained ocean observing, and next challenges. The [GOOS Webinar](#) was archived and is available for viewing online.

6. Discussion of future priorities, work plan update and what we want to deliver for OceanObs'19.

The proposed Terms of Reference for agreed projects were presented for discussion, and were approved, on

- Heat and Freshwater Content Review
- Air Sea Fluxes
- Observations for near term prediction.
- Boundary Currents.

The proposed TORs can be found in Appendix II.

Further discussion focused on OOPC's contribution to OceanObs'19, and the panel agreed that OOPC should play a strong role in its organization. A number of members offered to engage in the programme committee, and Sabrina Speich, Weidong Yu and Matt Palmer agreed to consult their institutes about playing a more substantive role.

DECISION: OOPC must have strong representation on OceanObs'19 Programme committee. Communicate, informally to Eric Lindstrom of desire to take leading roll, suggested committee members from OOPC from Weidong Yu, Sabrina Speich, Matt Palmer, and Johannes Karstensen

- Weidong Yu, Sabrina Speich and Matt Palmer to consult their home institutes re support for nomination to OceanObs'19 programme committee.

7. Summary of decisions and actions, timing of next meeting.

The panel reviewed and approved the actions from the meeting (summarized in appendix I). The chairs decided that the existing work plan (2013-2018) would not be updated, but a new one would be developed taking forward the key projects identified. The Chairs underlined the need for the panel to strengthen its communication and advocacy role, and agreed to provide an overview set of slides to panel members, and also communicate the outcomes of the OOPC 20 meeting.

The next meeting (OOPC-21) will be held in either Argentina or Australia, in the week beginning the 12th March 2018.

ACTION: Develop a general presentation to communicate OOPC objectives, aims and role in GOOS and GCOS (Katy Hill, Co-Chairs, OOPC members to review).

ACTION: OOPC-20 meeting highlights captured in the internal meeting summary to be drafted into a short communication for the broader community through e.g. WCRP, CLIVAR, NASA Earth Observer newsletter (Katy Hill).

DECISION: Dates of next meeting, week beginning 12 March 2018. Bernadette to explore Australia, Maria Paz Chidichimo (with Bob Weller) to explore Argentinian options.

Appendix I: Actions

Number	Action	Names	Timeline
Communication and Engagement			
1	ACTION: OOPC to write a peer reviewed paper on Physics EOVs, providing information on the processes undertaken in development of EOVS specification sheet including identification of Phenomena to be observed() OOPC members to review ().	Johnny Johannesen, Johannes Karstensen, Eitarou Oka, Maria Paz Chidichimo, Marjolaine Krug with Bernadette Sloyan, John Wilkin, Katy Hill to provide comment, advice	Submitted by end of 2017
	a. Members to consider journal to submit to.		
2	RECOMMENDATION: GCOS to coordinate writing concise statements of guidance for Climate Monitoring, Climate Services	Bernadette Sloyan, Katy Hill, Simon Eggleston to follow up	Week following OOPC-20, in WMO.
	a. GCOS Secretariat will coordinate input into OSCAR.		
3	ACTION: Review key WMO statements of guidance to ensure ocean observation requirements are all represented.		Timeline?
	a. Global NWP	Matt Palmer and Bob Weller	
	b. High Resolution NWP	Matt Palmer and Bob Weller	
	c. Nowcasting and Very Short Range Forecasting	Matt Palmer and Bob Weller	
	d. Subseasonal to longer predictions.	Bernadette Sloyan, Matt Palmer	
	e. Ocean Applications	Bernadette Sloyan, John Wilkin	
4	RECOMMENDATION: GCOS develop a strategy for communication of GCOS IP messages	Katy Hill, Simon Eggleston, Bernadette Sloyan	Week following OOPC.20
5	ACTION: Advocate for continuity of Satellites Microwave SST, Sea Ice observations (draft letter to be sent to space agencies on behalf of OOPC, identify who to it send to)	Johnny Johannesen, Ben Rabe, Tony Lee	
	a. Identify who to contact at JAXA re. AMSR.	Eitarou Oka, Katsuro Katsumata	
	b. Arctic and Antarctic, engage with CliC, SCAR, SOOS and Arctic programs	Ben Rabe, Katsuro Katsumata	
	c. GHRSSST: Letter to GOV ST raising concern	Johnny Johannesen, Ben Rabe, Tony Lee	
	d. Raise at CEOS SIT	Katy Hill	
6	ACTION: Define and strengthen OOPC and WRCP interactions (to raise at WDAC).	Bernadette Sloyan	Raise at WDAC (week following OOPC-20)
7	ACTION: OOPC-20 meeting highlights captured in the internal meeting summary to be drafted into a short communication for the broader community through e.g. WCRP, CLIVAR, NASA Earth Observer	Katy Hill	

	newsletter (Katy Hill).		
8	DECISION: Recommend to GCOS that Ocean Warming is a GCOS Indicator.		
9	ACTION: OOPC to Propose Ocean Warming as a GCOS Climate Indicator, following the framework in the Indicators report	Matt Palmer and Bernadette Sloyan to draft justification	June 2017
10	DECISION: OOPC must have strong representation on OceanObs'19 Programme committee. Communicate, informally to Eric Lindstrom of desire to take leading roll, suggested committee members from OOPC from Weidong Yu, Sabrina Speich, Matt Palmer, and Johannes Karstensen	Weidong Yu, Sabrina Speich, Matt Palmer, and Johannes Karstensen	
	a. Weidong Yu, Sabrina Speich and Matt Palmer to consult their home institutes re support for nomination to OceanOBS'19 programme committee.		April 2017
11	ACTION: Develop a general presentation to communicate OOPC objectives, aims and role in GOOS and GCOS	Katy Hill, Co-Chairs, OOPC members to review	May 2017
Boundary Currents, shelf-coastal interactions (connection to Ocean forecasting)			
12	ACTION: Form a Boundary Current - Shelf System Task Team, engaging OOPC members and community experts	John Wilkin, Maria Paz to lead, Marjolaine Krug, Johannes Karstensen, Robert Todd engaging Peter Oke/Andy Moore COSS TT, OSEval TT	May 2017
	a. Keep watching brief on IMSOO Boundary Current reviews of California Current, East Australia Current	John Wilkin, Katy Hill	
	b. Prompt IMSOO OMZ/Phytoplankton groups to propose metrics of coastal model performance that could underpin Coastal MIPs	John Wilkin to work with Sam Simmons, Johannes Karstensen	
Other Multidisciplinary Projects			
13	DECISION: OOPC agrees to participate in TOPC-Cross GOOS task team with representation from TOPC, GOOS Biology, GOOS BGC, OOPC	Telecon Simon Eggleston, Katy Hill, Sam Simmons plus Maciej Telszewski, Patricia Milosavich to frame issue and identify appropriate representation	April 2017
14	ACTION: Keep IMSOO Workshop themes Plankton and OMZs on Watching Brief	Bernadette Sloyan, Johannes Karstensen	Ongoing
Ocean Surface Stress			
15	ACTION: Work with modelling and observational communities to address issues related to winds.		
	a. Estimate the effect of small-scale convective cells on the discrepancy between satellite and in-situ wind measurements in rainy regions	Tony Lee, Bob Weller, engaging Tom Farrar, etc	

	b. Engage IOVWST to improve consistency of rain flagging	Tony Lee	
	c. Encourage NWP centres with coupled assimilation capability (e.g., NCEP) to account for ocean surface current effect on wind stress and test impacts of TMA winds	Tony Lee	
	d. Engage NWP centres (e.g., ECMWF) to test the impacts of in-situ winds on reanalysis	Tony Lee	
	e. Engage CEOS to ensure international data sharing (Chinese scatterometers)	Tony Lee, Weidong Yu	
Heat Fluxes			
16	ACTION: Write up strategy for air sea fluxes observations, working with old WGASF	Bob Weller, Lisan Yu, Marjolaine Krug	
17	ACTION: Propose a small meeting of flux obs, products and NWP modellers (6-8 people) to frame requirements for sensitivity experiments	Bob Weller, Marjolaine, Lisan Yu, Representatives from NWP community	
	a. OOPC to make connection with (Atm) Reanalysis producers re. datastreams in database, being injected, consistently rejected (i.e. OceanSITES data).		
	b. Discuss OOPC Flux observations strategy with WDAC Fluxes Task Team	Bob Weller to discuss with Carol Anne Clayson, Bernadette to raise in general terms at WDAC meeting next week	
Ocean Change Detection			
18	ACTION: Develop proposal for Temperature/Heat Content and Salinity/Freshwater Content Review, including shelf seas, deep ocean, ice covered ocean. Consider connection to WCRP Grand Challenge on Sea Level/ Concept Heat CLIVAR Research Opportunity, GOV and see IPCC 5AR WG1 Ch3	Matt Palmer, Ben Rabe, Sabrina Speich, Eitarou Oka, Johannes Karstensen	
	a. Propose coordinated Observing system design studies for requirement of ocean heat and freshwater content, detection. (with GSOP, GODAE Oceanview)	Matt Palmer, Ben Rabe, Eitarou Oka, Johannes Karstensen, Bernadette Sloyan	
19	RECOMMENDATION: Discuss possibility of an observing system review for tracking changes in Ocean Carbon content		
Near-term predictability and forecasting			
20	ACTION: Advocate for recognition of the requirement for ocean observations in Near-term prediction and forecasting projects in WCRP and CMIP6.		
	a. Write a review or opinion article on the	Bernadette Sloyan, Sabrina	

	importance of ocean obs on weather, seasonal to decadal and longer term forecast (predictions)	Speich, Johannes Karstensen, Matt Palmer	
Observing System Tracking			
21	ACTION: Present Open GTS proposal at the GOOS Regional Forum (John Wilkin to follow up with US IOOS).	John Wilkin to follow up with US IOOS	September 2017
22	ACTION: OceanSITES agreed to assist in developing an inventory of moorings in Western Pacific.	Neville Smith to contact Johannes Karstensen	Done.
23	RECOMMENDATION: Improve visibility, searchability of OceanSITES moorings activities.	OCG and JCOMMOPS	
Regional Observing system activities			
24	DECISION: OOPC to recommend 2 representatives to be part of the Indian Ocean Observing System Review Panel	Weidong Yu, Marjolaine Krugg	
25	ACTION: Engage in Artic and Antarctic observing programmes (watching brief)	Ben Rabe, Katsuro Katsumata, Johnny, report back to next OOPC	
26	ACTION: Follow development of DOOS (watching brief)	Katsuro Katsumata	
	a) Suggest DOOS communicate with OSTST (Ocean Surface Topography Science Team) to explore possible synergy in DOOS design of pressure measurement to complement satellite altimetry/gravity/geodesy missions	Katsuro Katsumata, John Wilkin	
27	ACTION: Follow development of Blueprint of Atlantic Observing	Johannes Karstensen, Maria Paz Chidichimo, Sabrina Speich	
28	DECISION: Dates of next meeting, week beginning 15th March 2018.	Bernadette to explore Australia, Maria Paz Chidichimo (with Bob Weller) to explore Argentinian options.	

Appendix II. TORs of proposed projects and reviews.

Heat and Freshwater Content Review

Proposed review of the ocean observation system for quantifying global and regional heat and freshwater changes

WHY?

Ocean heat content change provides our primary means of estimating the absolute magnitude of Earth's Energy Imbalance. The associated global thermal expansion is an important component (30-40%) of global sea level rise. Both systematic changes and variability in ocean heat transports are important factors in determining the ocean climate change response and can give rise to decadal predictability. Regional high-latitude freshwater changes can in principal help constrain the ice-sheet and glacier mass input to the ocean, the other main component of global sea level rise. Accurate quantification of local steric changes (arising from heat and freshwater change and variability) are essential for understanding and attribution of sea level variations measured by satellite altimeters.

WHAT?

Aim #1. To assess/review the potential importance of the following regions for closure of global ocean heat budget on interannual and longer timescales. (1) Deep Ocean (below 2000m), (2) Marginal Seas / Continental Shelves, (3) Ice-covered regions.

Aim #2. To quantify the adequacy of the observing system for constraining ocean heat and freshwater re-distribution and the spatial patterns of variability and change.

Aim #3. Consideration of the freshwater budget with particular focus on polar regions and closure of the ice-sheet mass addition budgets (can we independently verify the mass addition estimates of GRACE etc from consideration of the regional freshwater budgets?)

Aim #4. Assessing/reviewing the adequacy of the global observing system for constraining regional steric sea level changes.

Aim #5. Sensitivity study of ocean sampling on estimates of global and regional heat and freshwater content, and regional steric sea level based on synthetic profile datasets.

Aim #6. To propose a strategy for additional ocean observations that would meet the requirements for Aims #1-5.

HOW?

The work will be carried out in collaboration with the CLIVAR CONCEPT-HEAT research focus and link into the WCRP Grand Challenge on Regional Sea Level Change and Coastal Impacts.

Aims #1-#4 will be using a combination of global ocean reanalysis (Copernicus datasets, GODAE OceanView, CLIVAR GSOP, AtlantOS?), coupled climate model simulation (MetO + others?) and observational-based approaches.

Aims #2 and #5 will be addressed using synthetic profile datasets developed at the Met Office (and AtlantOS? Links to Thierry Penduff's OCCIPUT data sets?) using in-house analysis techniques and drawing on international collaboration through CONCEPT-HEAT.

A science team will be gathered in the first few months of the project, with and a scientific lead assigned for each of the Aims #1-5. All leads will participate in Aim#6 in collaboration with OOPC.

The overall co-leads will report back progress and initial science results at OOPC-21

WHEN?

1. Scoping of work and assembly of writing/analysis team will be carried out over the next 6 months (by September 2017).
2. Analysis of climate model simulations and ocean reanalysis to be carried out during 2018.
3. Pulling together of results to start in late 2018 with write-up aimed for completion for Ocean Obs '19.

WHO?

Matt Palmer, Sabrina Speich, Eitarou Oka, Johannes Karstensen, Ben Rabe, ...

Proposed OOPC/TPOS 2020 Flux Project

Purpose/Aims

1. To understand the sensitivity of flux estimating systems (NWP, OAFlux, Reanalysis) to surface ocean variables (SST, Ta, LW, SW, ...);
2. To understand the sensitivity more generally of NWP and Reanalysis products to different types and sources of ocean data (principally ocean surface variables);
3. To understand the importance of sub-seasonal to interannual analysis and predictions systems to ocean/marine surface data; and
4. To develop an understanding of the predictability (variability) of surface variables and fluxes in (high-resolution) coupled models.

[NB There should be a close relationship with projects that are aiming to bring observational, model (and data assimilation) development and theoretical groups together to understand the processes and mechanisms that contribute to systematic errors and thus guide priority observational needs for parameterisation improvement.]

Specific aims/sub-projects?

1. First and second aims

- Sixth WMO Workshop on the Impact of Various Observing Systems on NWP included the following draft recommendation:
 - *NWP and modelling communities to continue to develop modeling and assimilation approaches relevant to surface flux measurements and subsurface ocean observations and to undertake relevant data sensitivity and impact studies when possible.*
- Design Forecast Sensitivity Observation Impact and/or DFS (Degrees of Freedom Signal) experiments to determine the sensitivity of 24hr forecast error to different ocean data types and/or platform sources
 - Includes a dialogue on the life-cycle of surface marine data in typical NWP systems
 - Could also be done within Reanalysis
 - [I also do not understand how SST sensitivity comes into this; it seems only to be important for atmospheric retrievals cf as a BC]
- As above but with a metric constructed around ocean surface products (wind, flux, ...) to determine the sensitivity of wind/wind stress surface flux products to different data types and sources (e.g., SCAT, microwave atmospheric data, surface data, ...)
 - In effect, this is an elaboration of existing work but with the ocean community acting as a key user of NWP/RA products.
 - the metric may need to be developed from OceanSITE flux reference.
- Empirical systems like OAFlux and CCMP should also be used, but this is likely to work best as a parallel activity
 - The gridded products need to quantify the robustness of the flux estimation to the statistical approach in use.
- Begin with a focused dialogue between OOPC/TPOS 2020 scientists and 1 or 2 NWP/RA /CCMP/OAFlux experts

2. Third aim

- Not yet fleshed out but there are questions around the sensitivity of prediction systems to PBL data; on shorter time scales at least, for strongly coupled processes, it would be logical to expect PBL data to be useful for both initialisation (a memory of the heat and moisture exchange) as well as for testing and perhaps correcting analyses and forecasts.

3. Fourth aim

- Initiate discussion with groups running high-resolution coupled systems (NCAR, ECMWF) to better understand the variability and predictability of surface variables

- This can also help flux observers and product developers to understand the needs of high-resolution modeling for surface flux observations and gridded products and to help modelers to develop a set of metrics (e.g. selected OceanSITE flux reference sites, basin or regional indices) for model validation.
- A question: How would we develop objective guidance on a sample design where the driver is validation rather than initialisation or boundary conditions?

Interested parties?

- Obviously OOPC, GSOP, perhaps AOPC
- TPOS 2020
- CCMP, OAFflux, ICOADS, ...
- IPET-OSDE (Eyres)
- ...

Proposed OOPC Review on ocean observational requirement for near-term Climate Prediction (aka Decadal Prediction)

A dynamical prediction consists of an ensemble of forecasts produced by integrating a climate model forward in time from a set of observation-based initial conditions. As the forecast range increases, processes in the ocean become increasingly important and the sparseness, non-uniformity and secular change in sub-surface ocean observations is a challenge to analysis and prediction. To date, approaches to ocean initialization include: assimilation only of SSTs to initialize the sub-surface ocean indirectly. Studies suggest an expected improvement in skill when sub-surface ocean information was used as part of the initialization. Assimilation of atmospheric data, on the other hand, is expected to have little impact after the first few months.

Long time scale temperature variability in the North Atlantic has received considerable attention together with its possible connection to the variability of the Atlantic Meridional Overturning Circulation (AMOC) in predictability studies. The predictability of the AMOC varies among models and, to some extent, with initial model states, ranging from several to 10 or more years. The predictability values are model-based and the realism of the simulated AMOC in the models cannot be easily judged in the absence of a sufficiently long record of observation-based AMOC values.

Although idealized model experiments show considerable promise for predicting internal variability, realizing this potential is a challenging task. There are three main hurdles: (1) the limited availability of data to initialize and verify predictions, (2) limited progress in initialization techniques for decadal predictions and (3) dynamical model shortcomings that require validating how the simulated variance compares with the observed variance.

Purpose/Aims

5. To understand the sensitivity of near-term climate predictions to the data used to initialise the ocean state.
6. To develop an understanding of the ocean drivers of predictability of near-term climate and where improvement of skill of these forecast is derived.
7. To ensure the ocean observing system provides the data and is used appropriately and in its full potential in the near-term climate prediction studies initialization and verification.

Specific aims/sub-projects?

1. Strengthen engagement of OOPC in the WCRP GC on Near-term prediction
2. Increase the visibility of the ocean observations for initialization, validation and biases correction of prediction models.
3. Outline strategies for use of ocean observations in initialization and validation of climate prediction.

Interested parties?

- WCRP, Decadal prediction research groups, time series observations groups, Recently launched relevant projects: "Blue Action" <http://www.blue-action.eu>.
- ...

Boundary Currents

Proposed Boundary Currents Task Team.

In coastal oceans and marginal seas, ocean processes impact human activities, environmental health, and important ecosystem services.

- Shelf sea are proximate to energetic boundary currents that mediate shelf-sea/open-ocean exchange.
- Boundary current transports are of leading importance in ocean basin budgets of heat, freshwater and biogeochemical.
- Short length and time scales, and difficult operating environments, are a challenge to quantifying these transports.

Workshops / Reviews?

- Agree on set of guiding societal issues
 - e.g. guidance from IMSOO OMZ and Phytoplankton groups
- Review existing and emerging capabilities
 - satellites (SLA, temp., salt, color, sea-state, wind stress)
 - in situ obs. from establish global and regional networks
- Review BC activities/issues within existing programs
 - AtlantOS, TPOS2020 (LLWBC), IndOOS
- Frame set of OSSE
- Prototype multi-disciplinary observing systems for long-term monitoring
- Evaluate against existing data and model results for coastal regions

Actually do some work on reviews, OSSEs ...

The next workshop? ...

Membership?

- OOPC – Maria, Marjolaine, John
- GRAs
- GODAE COSS-TT and OSEval-TT
- Geographic key regions – EAC, CalCurr, Kuroshio, ...
- Basin scale projects – AtlantOS, IndOOS
- *IMSOO projects*
- Emerging technologies
 - OceanGliders (*R. Todd*)
 - HF-radar
 - Modeling: advanced observation impact, DA OSSEs, operational control/planning (*COSS-TT? C. Edwards*)

Notes:

Qingdao BC conference in June

Canadians high latitude BC (observing, dynamics and modeling)

In consultation with

Appendix III: Agenda

Ocean Observations Panel for Climate, 20th Session Tuesday 14-Thursday 17th March 2017, Woods Hole, USA.

General schedule: Registration Tuesday from 8.30am. Day runs from 9.00-17.30 (Coffee breaks at 10.30 and 15.30, Non-hosted lunch at 12.30-1.30 in Canteen). Early Finish on Friday (aim for 13.00).

TUESDAY:

AM:

1. Welcome and Opening (Chair: Bernadette Sloyan)

- 1.1. Opening from Co-Chairs and Welcome from Mark Abbott (WHOI Director)
- 1.2. Discuss/accept Agenda
- 1.3. Progress since OOPC-19 (Actions).

2. Programmatic Priorities. (Chair: John Wilkin)

Aim: Seek guidance from OOPC parent and partner programmes re. upcoming tasks and priorities. Discuss how this should guide OOPC forward Work Plan.

- 2.1. Global Climate Observing System, GCOS
 - 2.1.1. GCOS: Priorities, expectations of OOPC from GCOS, including cross cutting activities (Simon Eggleston)
 - 2.1.2. Overview of The GCOS IP Ocean Section, priority actions to be taken by OOPC (Bernadette Sloyan)
 - 2.1.3. Discuss GCOS Priorities, actions from IP, alignment with work plan.
- 2.2. Global Ocean Observing System, GOOS
 - 2.2.1. Priorities, expectations of OOPC from GOOS (including outcomes from IMSOO cross-GOOS workshop, developments of other panels, plans for OceanObs19) (Katy Hill for Albert Fischer).
 - 2.2.2. Progress in development of the EOVS Specifications, next steps (John Wilkin)
- 2.3. Discussion: priorities for OOPC, goals for OceanObs19 .

PM:

3. Research and Development (Chair: Bernadette Sloyan)

AIM: To identify and prioritise panel activities in ocean observation evaluation and development , with input from WCRP.

- 3.1. World Climate Research Programme, WCRP
 - Request WCRP act on GCOS IP Actions 02. Integration and Data Access, 03. Data Quality, 04. Development of climatologies and reanalysis products*
 - 3.1.1. WDAC activities, priorities. (Otis Brown)
 - 3.1.2. WCRP Grand Challenges. OOPC interactions (discussion).

Stop at 14.45. 15.00: Woods Hole P.O Seminar by OOPC Co-Chair Bernadette, discussions with local colleagues, followed by Woods Hole Hosted Reception.

WEDNESDAY:

4. Systems Based Reviews and Evaluations

AIM: to review progress in thematic observing system design, development and evaluation activities, and prioritise activities and foci for future years, including identifying leads/groups to coordinate.

See GCOS IP Action 06. Technology Development, and 07. Observing System development and evaluation.

This session will be discussion sessions focused around specific workplan topics. The discussion leads are asked to build on work plan for this area, review community developments since OOPC-19, and propose how OOPC should engage in the future, for discussion (e.g. keep topic on watching brief, participate in community activity(ies), lead a community activity such as a workshop or evaluation)

AM: (Chair: John Wilkin)

- 4.1. Tropical Pacific Observing System, TPOS 2020 Project (Neville Smith, engaging Tom Farrar, Xiaopei Lin)
- 4.2. AtlantOS progress, towards an integrated Atlantic observing system (Johannes Karstensen, Maria Paz Chidichimo, Sabrina Speich),
- 4.3. Indian Ocean Review (Mike McPhaden, Bernadette Sloyan, Weidong Yu)
- 4.4. Deep Ocean Observing System, DOOS (Bernadette Sloyan, Eitarou Oka, Sabrina Speich)
GCOS IP Action O10: Full depth Temperature Observing System.

PM: (Chair: Bernadette Sloyan)

- 4.5. Evaluating Multidisciplinary Observing System requirements: Outcomes from the IMSOO Workshop.
 - 4.5.1. Phytoplankton Blooms (Bernadette Sloyan, Sam Simmons)
 - 4.5.2. Oxygen Minimum Zones (Johannes Karstensen)
 - 4.5.3. Boundary Currents, shelf-coastal interactions, (John Wilkin and Robert Todd, engaging Marjolaine Krug, Maria Paz Chidichimo)
GCOS IP Action O1: coordination of enhanced shelf/coastal observations
- 4.6. Next steps connecting up observations for climate in the coastal zone from a terrestrial perspective (Simon Eggleston, with input from John Wilkin, Sam Simmons).
GCOS IP Action T2: Develop joint plans for Coastal Zones.
- 4.7. Air Sea Fluxes (Bob Weller, Tony Lee, engaging Tom Farrar, Lisan Yu)
GCOS IP Action O16: Ocean Surface Stress observations
GCOS IP Action O17: Ocean Surface Heat flux Observations.
- 4.8. Polar Seas (Benjamin Rabe, Katsumata Katsaros)
GCOS IP Action O15: In situ sea ice observations

THURSDAY:

5. Approaches to assessing observing system performance and evaluation. (chair: Bernadette Sloyan)
(Leads: Matt Palmer, Johannes Karstensen)

GCOS IP Action O7: Observing System design and evaluation

AIM: Agree on how to take forward an activity on the design of observing system experiments (modelling and statistical) for optimum benefit.

- 5.1. Coordinated approach to using models, products and syntheses to inform observing system (in partnership with GOV, GSOP)
- 5.2. Potential to assess observing system performance against requirements to observe phenomena/process identified in EOVS specification sheet. What is currently being undertaken by the community (DOOS, Boundary Currents, TPOS 2020)
- 5.3. Discussion.

6. Supporting sustained observing systems. (Chair: John Wilkin)

GCOS IP Action O5: Sustaining support for Ocean Observing

AIM: to discuss and agree on how OOPC and JCOMM OCG can work together to strengthen the sustained ocean observing system.

6.1. JCOMM Observations Coordination Group,

GCOS IP Actions O5: sustained funding support, O48: ancillary observations

Request JCOMM OCG Act on GCOS IP Actions O37-O57 (in situ networks).

6.1.1. Update on observing system status, challenges and work plan of OCG (David Legler, JCOMM OCG)

6.1.2. Development of the Network Specifications, including missions, targets. (David Legler, Katy Hill)

6.1.3. Areas where OCG require input from OOPC (discussion on how the two panels interface) (David Legler, Bernadette Sloyan)

6.1.4. GCOS IP Actions requiring action from OCG. *(in addition to network based actions, discussion on how OOPC/OCG Can address GCOS actions O5: sustained funding support, O48: ancillary observations)* (Bernadette Sloyan)

6.2. G7 Oceans Compact: (David Legler, John Wilkin)

6.3. **WEBINAR: Are we there yet? 20+ years of looking for the Ocean Observing System for Climate.** (Neville Smith, Bob Weller), plus discussion .Scheduled for 4pm local time.

Thursday eve: Non Hosted dinner in Falmouth.

FRIDAY .

7. Discussion: future priorities, work plan update, what we want to deliver to OceanObs19. (Bernadette Sloyan)

AIM: To prioritise OOPC intersessional tasks, and their leads for 2017-2018 with a view to what we hope to showcase at OceanObs19

8. Summary of Decisions, actions. Timing/location of next meeting. (John Wilkin, Katy Hill)

Close: 13.00. Friday.

Appendix IV: List of participants

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