CLIVAR REPORT

Climate and Ocean: Variability, Predictability, and Change

Report on the 10th Session of the CLIVAR Global Synthesis and Observations Panel

Meeting Report

5-6 February 2019, Woods Hole, USA

March 2019
CLIVAR Report No. 2/2019

List of actions:

- Provide comments to the 2nd TPOS2020 Report (Already done)
- Propose a breakout session in OceanObs19 on

  "Ocean observations for climate reconstructions" organized and supported by GSOP. The session will be devoted to the presentation and discussion of observational requirements for producing and assessing ocean-oriented climate reconstructions (ocean reanalyses and model-free objective analyses), including practical aspects (e.g. data dissemination) and methodological challenges that the production of reconstructions is concerned with.

- Endorse and participate to the OSEVal breakout session:

  Title: Advancing collaboration between the model/data assimilation and observational communities through OSE/OSSE activities for ocean and climate monitoring and forecasting
  - **Session leads: Yosuke Fujii, Villy Kourafalou, Arun Kumar, Pierre-Yves Le Traon, Elisabeth Rémy, Yan Xue**
  - **Hosted by: GODAE Ocean View (OceanPredict) Observing System evaluation Task Team**
  - **Supported by: GODAE Ocean View (OceanPredict) /CLIVAR-Global Synthesis and Observation Panel /Copernicus Marine Environment Monitoring Service /Tropical Pacific Observing System (TPOS) 2020**

- Contact CREATE to understand whether the project is alive or not (ongoing)
- Poster or presentation in OceanPredict (submitted by Y. Fujii) to be prepared
- Contact leaders of inter-comparison and other activities mentioned before for endorsement (ongoing)

Meeting Summary

The 10th Session of CLIVAR Global Synthesis and Observations Panel (GSOP) took place at Woods Hole Oceanographic Institution, 5-6 February 2019, and was organized as a series of talks from the Panel members and invited experts, each of them followed by questions and discussions. The second day of the meeting included also a long discussion to summarize the previous discussions, identify activities to be endorsed by GSOP and recommendations from the Panel. Below, the main outcomes are summarized, after a short summary of the talks given during the session. The complete list of participants and talks, together with the Agenda, is available at: http://www.clivar.org/events/10th-session-clivar-global-synthesis-and-observations-panel

Presentations at the meeting

- Andrea Storto presented previous activities conducted under the auspices of GSOP and some suggestions for future plans.
- Nathalie Zilberman presented the initial deep Argo network pilot studies in selected regions, and the planned coordinated deployment at global scale for the next few years.
- Steven Jayne introduced the Argo program, including its extension to i) Biogeochemical (BGC) Argo (and the SOCCOM project), ii) doubling the core Argo network in the Equatorial band and within the western boundary current regions and iii) the deep Argo network plans
- Lijing Cheng presented the current development of ocean synthetic observation activities and their application to assess mapping methods for ocean heat content studies, including possible extensions of the method to assess observational sampling.
- Isabelle Ansorge presented oceanography activities in South Africa, including observational, educational and modeling studies performed at the University of South Africa.
- Francois Counillon provided an overview of observation requirements needed for enhancing the accuracy of reanalyses in polar regions and in the Tropics, with also focus on methodological advantages of the coupled assimilation paradigm (ice-ocean, ocean-BGC and atmosphere-ocean).
- Yosuke Fujii presented the activities conducted by the Global Ocean Data Assimilation Experiment (GODAE) Observing System Evaluation Task Team. He also presented the forthcoming OceanPredict initiative that will replace GODAE, starting from the next OceanPredict conference in Canada.
- Matt Mazloff provided several updates on the BGC Argo program, and on biogeochemical ocean state estimation (in the Southern Ocean) performed at Scripps Institution of Oceanography (SIO).

- Susan Wijffels presented the TPOS2020 2nd report, the rationale behind the choice of the backbone TPOS and the recommended tropical mooring array (TMA) design.
- Yan Xue presented Real-Time Global Ocean Monitoring at NCEP, focusing on the Tropics and the implied observing network monitoring, in order to assist ENSO forecast and monitor the influences of ocean observations on the ocean analysis uncertainty in a multi-system context.
- Carol Anne Clayson introduced the SurFlux Task Team, part of WDAC, including its mission, terms of references and activities, with focus on the "radiation" subgroup.
- Bob Weller introduced the recent re-organization of US CLIVAR, and summarized some achievements from the OceanSITES initiative, including specific comparison of air-sea fluxes measurements with atmospheric reanalyses.

Endorsement of activities

a) Inter-comparison of reanalyses provides a valuable way to assess the reanalyses through consistency estimates, evaluate the advance of accuracy of reanalyses with time, and sketch strengths and weaknesses of them in a fit-to-purpose context. To this end, GSOP endorses this kind of activities. In particular, active inter-comparison activities include:

- Real-time ORA-IP (RT ORA-IP), focusing on the monitoring of anomalies of temperature and salinity in the Tropical Pacific and Atlantic in real-time, led by NOAA and BoM for temperature and salinity, respectively, with emphasis on diagnostics relevant to ENSO prediction.

- Polar ORA-IP (PORA-IP), which focuses on inter-comparison of sea-ice and transports in the Arctic Ocean. Led by P. Uottila (FMI), it produced a paper on the mean state, with the aim of extending the study to the inter-annual variability in the future.

- North Atlantic ORA-IP (NA ORA-IP), which focuses on inter-comparison of hydrography and transports in the North Atlantic Ocean. Led by L. Jackson (UK Met Office) and C. Dubois (Mercator Océan), PORA-IP is expected to report in a summary paper its activity in the next months.

b) Strategic development of **in-situ and satellite observing networks**, with particular focus on the gain of predictability for medium to long range prediction systems, monitoring of low-frequency climate signals and introduction of new observing technology to measure poorly observed regions.

- TPOS2020 vision: with the new tropical mooring design in the context of the newly proposed Backbone TPOS, the introduction of SuperSites with exceptional equipment, and the link with the modeling and reanalysis community for assessing the value of the new Backbone TPOS (see also point c). GSOP has provided comments to the draft TPOS2020 2nd report, with particular attention to the link between observational community and the prediction one, asking for a close connection between the different communities.

- Argo2020 vision: with the combined recommendation for the strengthening of the core Argo network (doubling core Argo network in the Equatorial band and within the western boundary current regions), the deployment of the deep Argo network at global scale in the next 2-3 years and the BGC Argo network development.

c) Observation evaluation studies

- OSEval TT: The GODAE Task Team for Observation Evaluation (OSEval) aims at coordinating Observing System Experiments (OSEs) and Observing System Simulation Experiments (OSSEs) activities between different institutions for the continuous monitoring of the impact of different observation types and the optimization of future observational sampling. GSOP endorses these activities, and in particular stresses the importance of coordinated multi-system OSE and OSSE studies in order to increase the robustness of the observation impact results. A close connection with future OceanPredict activities is desirable.

- Synthetic observation impact studies (supported by National Key R&D Program of China and Institute of Atmospheric Physics, Chinese Academy of Sciences), which can provide an insight into the accuracy of mapping methods (used in objective analyses for e.g. ocean heat content reconstructions) and evaluate the effect of different observation sampling on the resulting accuracy of ocean heat content estimates. This approach proves to be valuable at identifying both the accuracy of current reconstructions and the impact of observational sampling, at relatively low costs.

d) Climate oriented datasets

IQuOD is a state-of-the-art climate oriented data collection of sub-surface temperature measurements with quality flags and accuracy and state-of-the-art calibration and bias-correction procedures. GSOP acknowledges its crucial importance for climate reconstructions and regional studies and endorses its future development (including updating the timeseries and extending the dataset to salinity and additional ocean parameters).

e) Use of **ocean reanalyses for validation**, and in particular the CREATE-IP activity and tools, in the context of the Ana4MIPs developments, which have the two-fold merit of promoting and advertising the use of reanalyses and inter-compare them through their built-in tools (visualization and comparison).

Recommendations

a) It has been extensively discussed that there is **lack of climate data assembly center** capable to integrate different projects (e.g. OceanSites for deep T/S, GO-SHIP, and others, including repeated hydrography data), but also additional datasets such as e.g. current / ADCP measurements, glider and marine mammals for Argo-poor regions. The lack of standard format and common repository emerges as clear weaknesses, preventing these data to be widely utilized in climate monitoring studies and reanalyses, in spite of their high value. Having uncertainty estimates will be a plus for assimilation/validation/analysis applications.

b) Coordinated OSE/OSSE activities (in a multi-system context) should be strengthened. A possible way consists in the creation of a publicly available “nature run” for OSSEs (e.g. from an

eddy-resolving model simulations) from where all participants may extract synthetic observations for specific studies. To this end, the link with OceanPredict and the OSEval TT should be reinforced.

c) Coupled data assimilation paradigm shall be promoted for ocean-sea-ice and ocean-biogeochemistry applications as it proves to be mature enough. With the emergence of reanalyses provided by coupled system, strongly coupled data assimilation of ocean- sea ice – atmosphere may be key for providing the next generation of reanalyses product but the data assimilation formalism is yet not mature enough.

d) Bias in reanalyses is still a major concern. Some actions are recommended by GSOP: i) a stronger link with CLIVAR Ocean Model Development Panel (OMDP) (e.g. inter-comparison of control runs from reanalysis realizations without using a strict protocol as in CORE, and having a joint workshop perhaps); ii) inter-comparison of time-averaged and time-varying analysis increments (as in TPOS), which implies that reanalysis producers need to store analysis increments in real-time and observation innovation/feedback files; iii) promotion of inter-comparison and monitoring tools that mimic NWP standards (e.g. tools for real-time monitoring of ocean observations in prediction systems (this could be checked with Mercator Ocean, UKMO, US Navy HYCOM, and with GODAE Inter-comparison and validation and the OSEval Task Teams); and iv) survey of state-of-the-art methods for bias-correction.

e) Start discussion to **identify best practices** for understanding the sensitivity of reanalyses and reconstructions to assimilation time windows and mapping methods.

f) There have been significant advances in **air-sea flux gridded products**, i.e. their maturity has increased in the recent years (e.g. wind products in TP, etc.). It is recommended to have systematic comparison with atmospheric and oceanic reanalyses, perhaps involving also atmospheric reanalysis community (TIRA Task Team), and foster their use for coupled ocean-atmosphere data assimilation (tuning and validation).

g) Sea-ice thickness data have reached a reasonable maturity in the Arctic Ocean, which is testified by a large number of scientific publications successfully ingesting those data in the past few years. Studies and projects devoted to building **sea-ice thickness datasets in the Antarctic Ocean** shall be initiated and supported. There is still large uncertainty in snow thickness.

h) Climate Indexes from reanalyses, e.g. based on ORA-IP and RT ORA-IP experience should be promoted routinely and formulated to respond to stakeholder's requirements (e.g. fisheries, hurricane, ocean heat waves, etc.). The Copernicus Marine Environment Monitoring Service (CMEMS) is taking already care of some of that, but relying mostly on European products: it is desirable that this approach is extended to include all available real-time global products.

Final Remarks

- Next GSOP session meeting, to be decided later on (to take place around summer 2020) but possibly to merge with other meetings/conferences
- Future Memberships:
  - 1 member can be proposed from Japan to replace Y. Fujii at the end of 2019,
  - Paulo Caolil will be rotating off as well. Possible replacements were identified in:
  - Rym Msadek (Cerfacs): assessment, methods, and long-term predictions
  - Peter Oke or Vincent **????** (ask Susan Wijffels, she mentioned someone but could not remember) (CSIRO) from Australia to provide a membership from Oceania
  - OceanSites: change ex-officio membership (Trull CSIRO or Krustensen GEOMAR)
  - South-America membership will be missing: starting enviagingnvisaging someone.
  - Satellite expert missing (air-sea fluxes or others?)

Participants of the GSOP10 meeting

Annex A: Meeting Agenda

10th Session of CLIVAR Global Synthesis and Observations Panel

Woods Hole Oceanographic Institution (WHOI), Carriage House, Quissett Campus. USA

Tuesday, 05 February 2019

0900–0930: Welcome and Introductions – Co-Chairs
0930–1000: Review of past GSOP activities – Andrea Storto (NATO STO CMRE, Italy)
1000–1020: Argo 2020 – Steve Jayne (WHOI, USA)
1020–1040: Coffee and discussions
1040–1100: Deep Argo – Nathallie Zilberman (Scripps Institution of Oceanography, USA)
1100–1120: TPOS2020 – Susan Wijffels (WHOI, USA)
1120-1200: Discussion
1200–1330: Lunch
1330–1350: Observations needed for enhancing the accuracy of reanalysis in polar regions – François Counillon (NERSC, Norway)
1350–1410: Updates on BGC-Argo and carbon system state estimation – Matt Mazloff (Scripps Institution of Oceanography, USA)
1410–1430: Real-Time Global Ocean Monitoring at NCEP: ENSO, beyond ENSO and Impacts of Ocean Observing Systems – Yan Xue (NOAA/NCEP, USA)
1430–1450: Observing System evaluation studies and OceanPredict – Yosuke Fujii (Meteorological Research Institute, Japan)
1450–1510: Coffee break
1510–1630: Discussion
1630–1800: Reception

Wednesday, 06 February 2019

0900–0930: Thoughts on CLIVAR and GSOP – Bob Weller (WHOI, USA)
0930–0950: Current development of ocean synthetic observations and their application – Lijing Cheng (Institute of Atmospheric Physics, China)
0950–1010: Current research and opportunities in South Africa – Isabelle Ansorge (University of Cape Town, South Africa)
1010–1030: Coffee break
1030–1050: Surflux Task Team – Carol Anne Clayson (WHOI, USA)
1050–1200: Planning of future GSOP activities
1200–1330: Lunch
1330–1500: Discussion wrapup and drafting of planning documents
1500–1600: Tour of Argo float Lab

Annex B: List of Participants

Name	Affiliation	Country	Role
Andrea Storto	NATO STO CMRE	Italy	Co-chair
Steven R. Jayne	Woods Hole Oceanographic Institution (WHOI)	USA	Co-chair
Yan Xue	NOAA/NCEP	USA	Member
Yosuke Fujii	Meteorological Research Institute, JMA	Japan	Member
Matt Mazloff	Scripps Institution of Oceanography	USA	Member
Nathalie Zilberman	Scripps Institution of Oceanography	USA	Member
François Counillon	Nansen Environmental and Remote Sensing Center (NERSC)	Norway	Member
Isabella Ansorg (remote)	University of Cape Town	South Africa	Member
Lijing Cheng (remote)	Institute of Atmospheric Physics, Chinese Academy of Sciences (IAP-CAS)	China	Member
Uwe Send (remote)	Co-chair / OceanSITES	USA	Ex-officio
Jose Santos (remote)	International CLIVAR Project Office (ICPO)	China	Executive Director
Jing Li (remote)	International CLIVAR Project Office (ICPO)	China	Staff Scientist
Susan Wijffels	Woods Hole Oceanographic Institution (WHOI)	USA	Invited
Bob Weller	Woods Hole Oceanographic Institution (WHOI)	USA	Invited
Carol Anne Clayson	Woods Hole Oceanographic Institution (WHOI)	USA	Invited