Ocean acidification observation and research – latest advancements and new technologies

Kirsten Isensee[1], Katherina Schoo[1], Helen Findlay[2], Janet Newton[3] and Stephen Widdicombe[2]
[1] Intergovernmental Oceanographic Commission of UNESCO
[2] Plymouth Marine Laboratory, UK
[3] University of Washington, USA

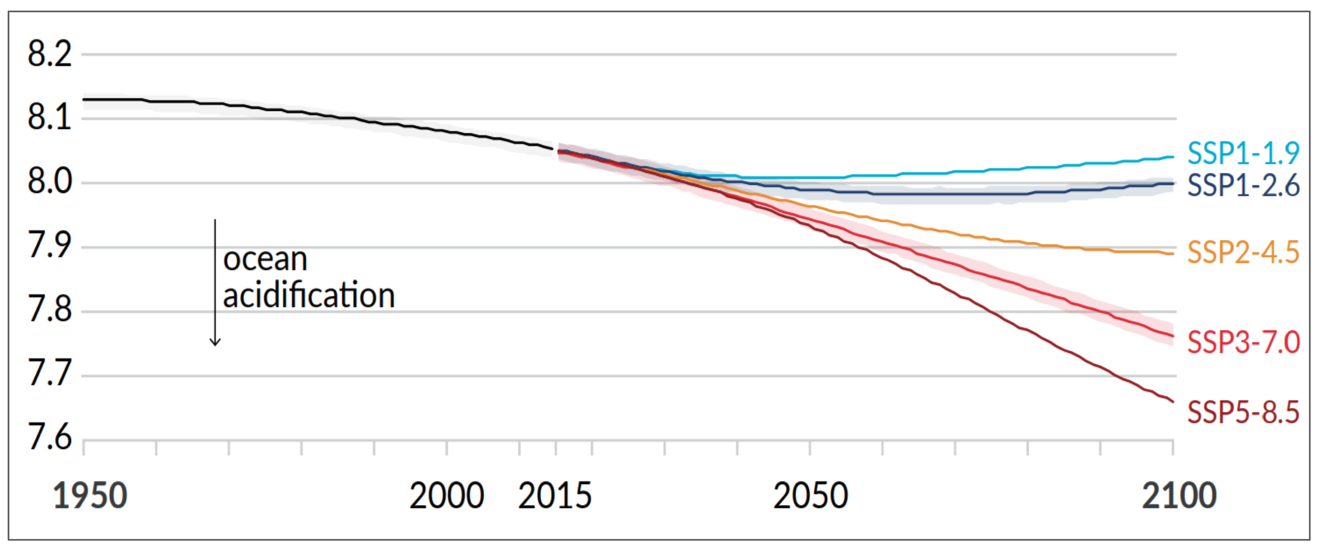
unesco Intergovernmental Oceanographic Commission

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

OARS Ocean Acidification Research for Sustainability

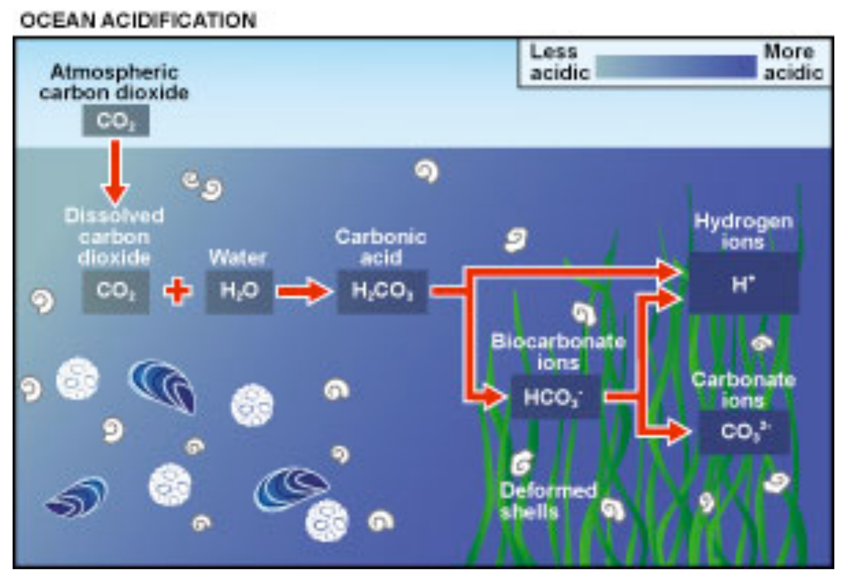
Facts to Remember

1. 25 % of the annual emissions of anthropogenic CO_2 to the atmosphere (WMO, 2021) are absorbed by the ocean, thereby helping to alleviate the impacts of climate change on the planet (Friedlingstein et al., 2020).
2. The CO_2 reacts with seawater, changes its carbonate chemistry of the ocean, reduces the seawater pH - therefore the process is referred to as 'ocean acidification'. Since preindustrial times ocean acidification increased between 37-43 %.



Global ocean surface pH (IPCC, 2022). The black curve represents a historical simulation of pH; colored curves indicate five possible future scenarios with high, intermediate, and low greenhouse gas emissions.

3. Ocean acidification threatens organisms and ecosystem services, including food security, by reducing biodiversity, degrading habitats, and endangering fisheries and aquaculture.
4. Ocean acidification will continue to increase – open-ocean surface pH is projected to decrease by around 0.3 pH units by 2081–2100, relative to 2006–2015, under RCP8.5 (virtually certain), with consequences for the global climate (IPCC, 2019).
5. As acidity and temperature of the ocean increase, its capacity to absorb CO_2 from the atmosphere decreases, impeding the ocean's role in moderating climate change.



Chemical reactions in seawater related to ocean acidification. Source: University of Maryland.

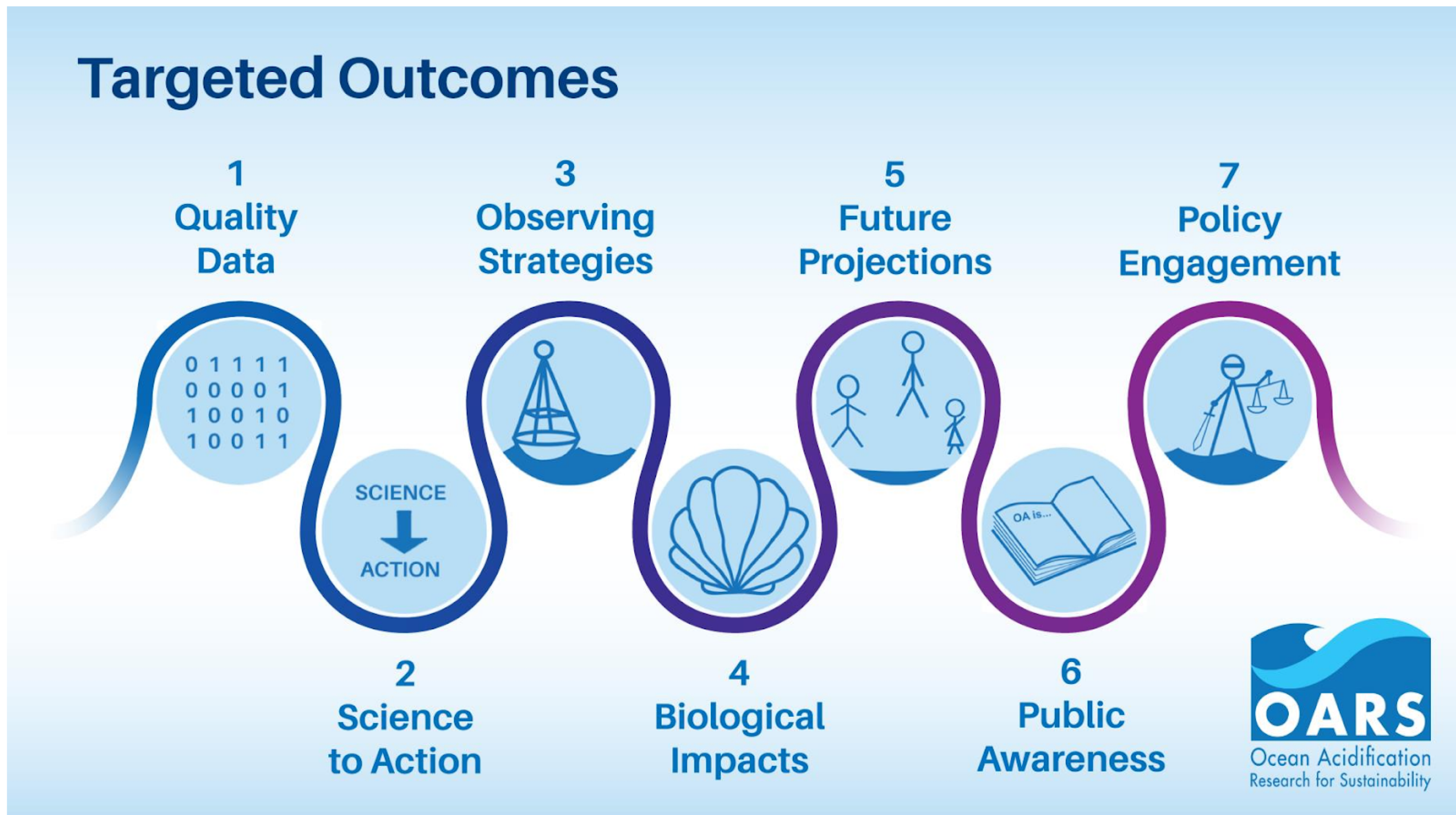
Ocean Acidification Research for Sustainability

A road map to deliver the ocean acidification science we need for the ocean we want

The UN Ocean Decade Ocean Acidification Research for Sustainability (OARS) programme fosters the co-development of ocean acidification science, including the impacts on marine life and sustainability of marine ecosystems in estuarine-coastal-open ocean environments around 7 outcomes (Figure on the right). Its activities deliver against the SDG target 14.3 'Minimize and address the impacts of Ocean Acidification, including through enhanced scientific cooperation at all levels' and to improve observations of inorganic carbon, an Essential Climate Variable, supporting the work of the UNFCCC and IPCC.

The spirit of OARS embraces **4 C's**:

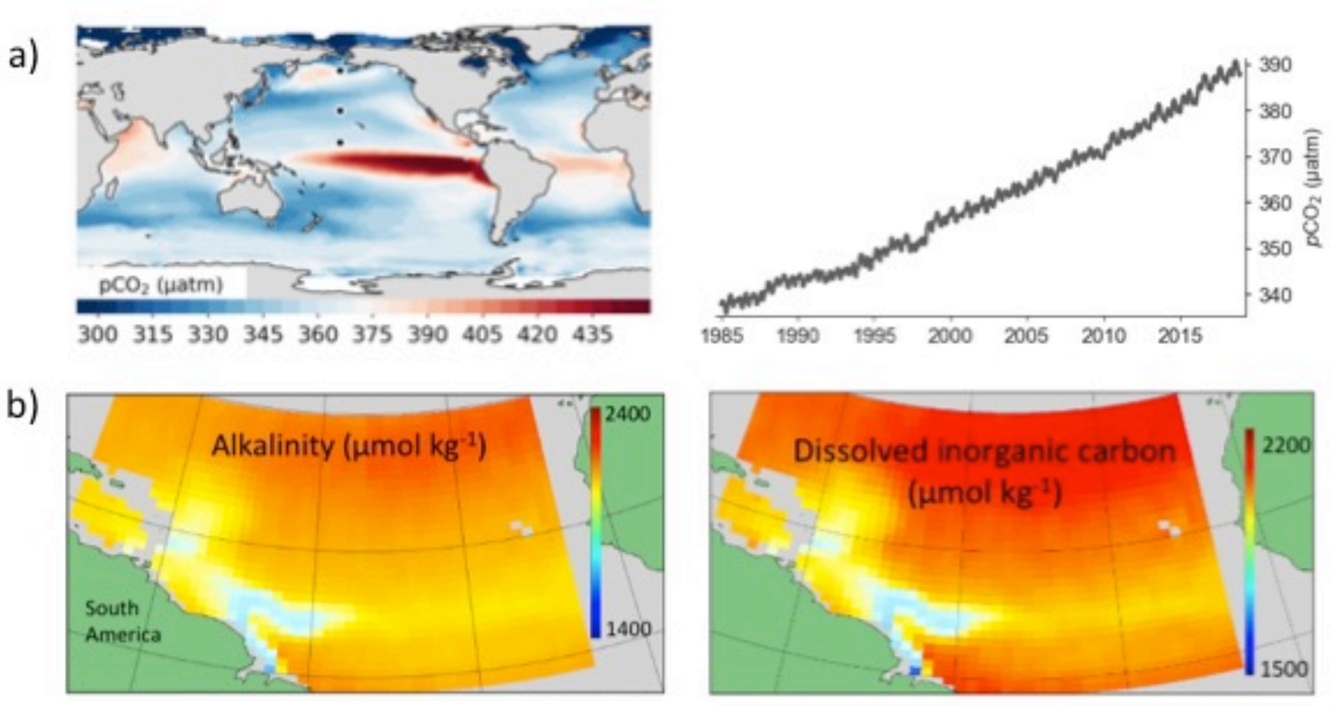
- **Collaboration** across all levels and all players
- **Capacity** building across science and impact
- **Co-design** and implement observation and research to address the threat of ocean acidification though actions and solutions
- **Communication** between all involved in generating impact and change.



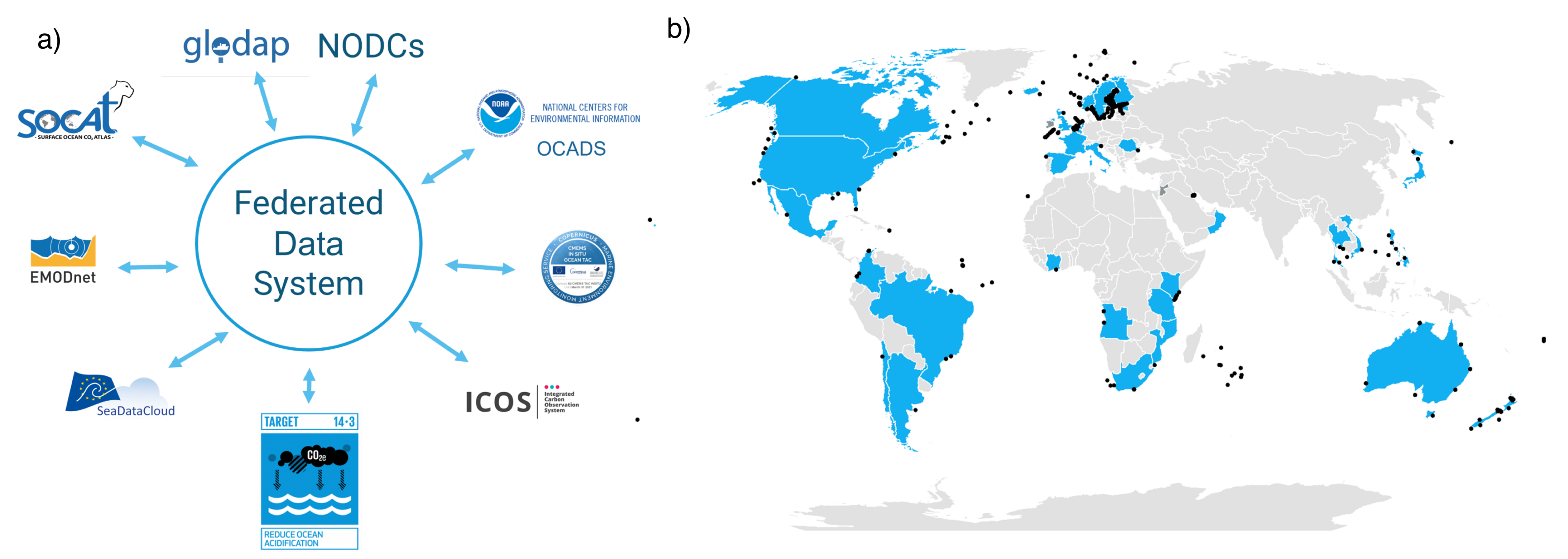
Innovation of Ocean Acidification Observations

Advancement in satellite remote sensing

Satellite remote sensing now allows synoptic scale observations that fill the gaps of traditional ocean acidification observations in both space and time. Ocean carbon and the carbonate system can be monitored as a result of their innate relationships to variables that are now routinely observed from space, including temperature and wind speed, global ocean colour and global salinity observations from. Today it is possible to measure the atmosphere-ocean exchange of CO_2 with satellite observations of sea surface temperature and wind speed (Shutler et al., 2020); temperature and salinity are important diagnostic variables of the processes that control the carbonate system variability (i.e. solubility, mixing, transport, etc.) and have strong co-variance with nutrients so directly influence growth. The relationships between the different carbonate system parameters are fundamentally driven by thermodynamics; and salinity also affects the coefficients within the carbonate system equations.



Recent advances in satellite observation-based data for studying the surface water marine carbonate system (Shutler et al., in review). a) Global assessments of the amount of gaseous CO_2 (pCO_2) can be mapped using satellite observations in conjunction with in situ databases to provide decadal-scale monthly data inputs to annual carbon assessments (i.e. Friedlingstein et al., 2021) (data from Gregor and Gruber, 2021); b) Regional assessments using satellite observation-based methods can quantify alkalinity and dissolved carbon flowing from the Amazon into the Atlantic (data from Land et al., 2019)



Ocean acidification data collection in the framework of the SDG 14.3.1 a) Vision of the integrated data system to facilitate data submission and sharing; b) locations of measurements included in the SDG 14.3.1 data reporting February 2022 (black dots) and corresponding countries.

New ways to collect and access ocean acidification data

The methodology for SDG Indicator 14.3.1, which calls for the "Average marine acidity (pH) measured at agreed suite of representative sampling stations", provides the necessary guidance on how to conduct ocean acidification observations, what to measure and how, including standard operating procedures and methods approved by the ocean acidification community. It further includes guidance on the type of metadata and data to collect and how to submit it towards the Indicator. To facilitate this data submission, the SDG 14.3.1 Data Portal was developed: an online tool for the submission, collection, validation, storage and sharing of ocean acidification data and metadata. Together with the ocean acidification community, IOC is working on an integrated data system that will permit the exchange of ocean acidification data between relevant databases, minimizing the need for multiple data submissions and reformatting.