15th UNESCO/IOC-ODC Training Course/Summer School
on Ocean Dynamics and Ocean Models
First Institute of Oceanography, Qingdao

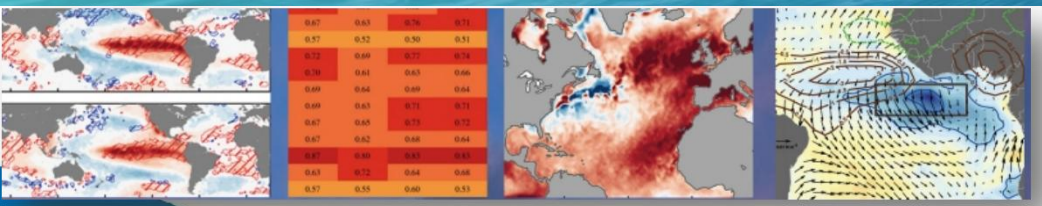
CLIVAR

30TH Anniversary

Climate and Ocean: Variability, Predictability, and Change

- through the lens of my personal career

John Huai-Min Zhang, CLIVAR ICPO Director john@clivar.org



Acknowledgement: CLIVAR ICPO Team, esp. Yang Zhao

WCRP World Climate Research Programme

03 September 2026

www.clivar.org

WORLD METEOROLOGICAL ORGANIZATION

unesco Intergovernmental Oceanographic Commission

International Science Council

World Climate Research Programme (WCRP): Co-sponsored by UN WMO, IOC of UNESCO, and NGO ISC, established in 1980.
Mission Goal: coordinates and facilitates international climate research to develop, share, and apply the climate knowledge that contributes to societal well-being

WCRP Structure

Joint Scientific Committee (JSC)

WCRP Secretariat

Lighthouse Activities

International Offices

Core Projects and Research Communities

- Climate and Cryosphere (CliC)
- Global Energy and Water Exchanges (GEWEX)
- Climate and Ocean Variability, Predictability and Change (CLIVAR)
- Stratosphere-troposphere Processes And their Role in Climate (SPARC)
- Earth System Modelling and Observations (ESMO)
- Regional Information for Society (RIfS)

Ongoing Activities and Fora

- Fixed-term projects
- Reference datasets, evaluations and benchmarking
- Rapid updates, syntheses, assessments, gap analysis
- Conferences and workshops
- Diversity and capacity building: ECRs, regions
- Communications and outreach

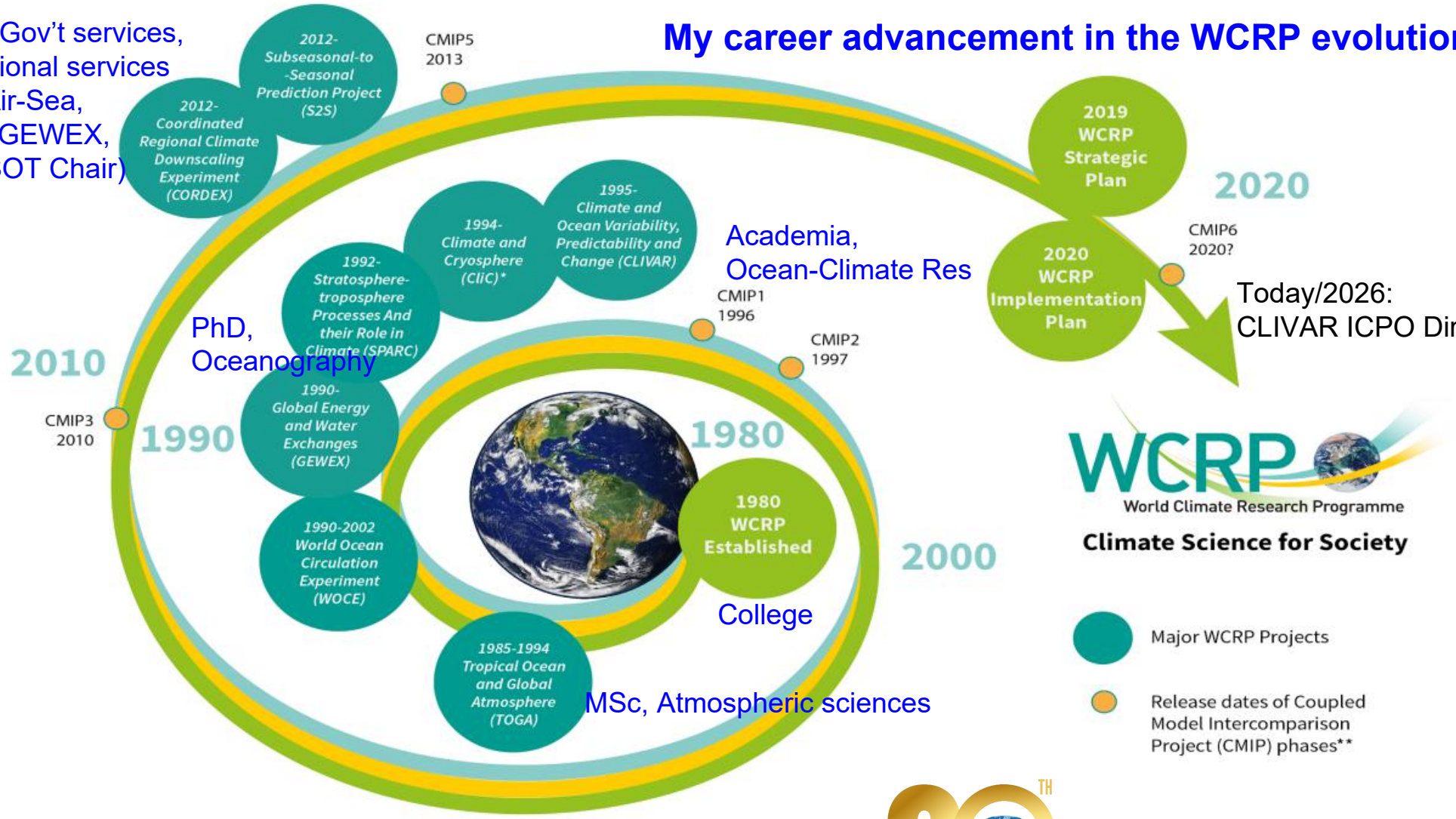
Two new Lighthouse Activities:

- Global Precipitation Experiment (GPEX)
- Climate Intervention

World Meteorological Organization | International Science Council | unesco | WCRP World Climate Research Programme

My career advancement in the WCRP evolution

NOAA: Gov't services, Professional services (AMS Air-Sea, WCRP GEWEX, WMO SOT Chair)



PhD, Oceanography

Academia, Ocean-Climate Res

College

MSc, Atmospheric sciences

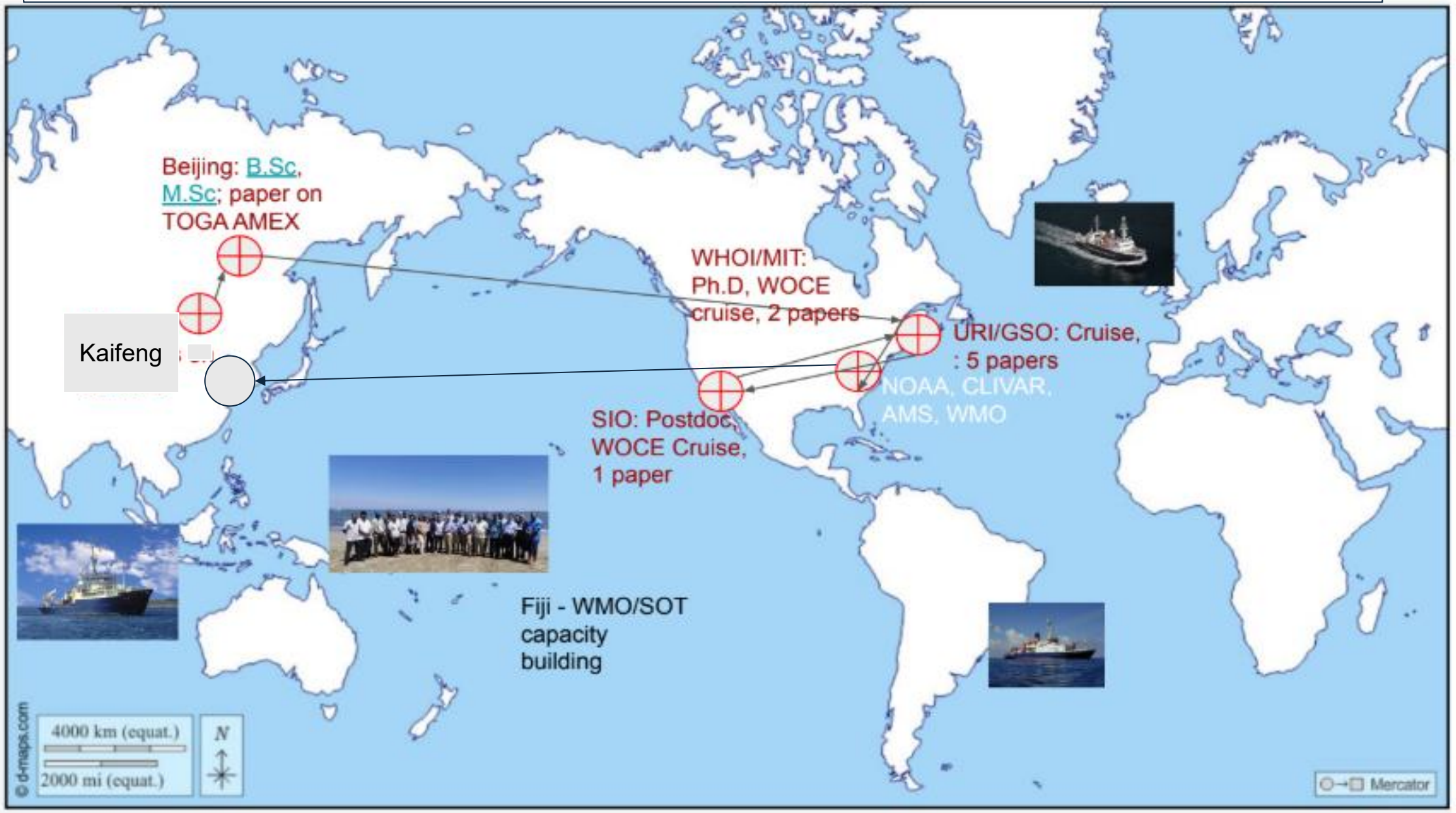
Today/2026: CLIVAR ICPO Director

WCRP World Climate Research Programme

Climate Science for Society

30TH Anniversary CLIVAR

My Career Track: From TOGA to WOCE and to CLIVAR



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http://www.hyxbocean.cn/article/id/19890204.

Tropical Ocean-Global Atmosphere (TOGA) program (1985–1994): AMEX (Australian Monsoon Experiment):

第11卷 第2期 海 洋 学 报 Vol.11, No.2
1989年3月 ACTA OCEANOLOGICA SINICA March, 1989

夜间海面上空大气边界层结构的研究

张 怀 民 周 明 煜
（中国科学院大气物理研究所，北京） （国家海洋局海洋环境预报中心，北京）

摘 要

本文建立一个一维数值边界层模式，以模拟海面上夜间大气边界层结构的基本特征及其变化规律. 用Wangara资料进行的数值试验表明，，该模式模拟的结果与实测结果吻合较好. 又以在西太平洋上进行的AMEX探测资料(1987)为初始场，对海面上大气边界层进行数值模拟，并比较夜间海、陆上空大气边界层结构的差异.

式中，t是以小时为单位的当地时间. 地面湿度$q_s(t)$以线性变化表示.

地转风值由地面地转风$\vec{v}_{g0}$和热成风值以二次曲线来拟合. 对$u_g(z,t)$有

$$u_g(z,t)=a+bz+cz^2 \quad (19)$$

由地面地转风$u_{g0}(t)$及0—1km及1—2km的热成风$\Delta u_{g1}(t)$、$\Delta u_{g2}(t)$得到a、b、c的表达式. 式(19)中z以km为单位.

$$\left.\begin{aligned} a&=u_{g0}(t) \\ b&=[3\cdot\Delta u_{g1}(t)-\Delta u_{g2}(t)]/2, \\ c&=[\Delta u(t)-\Delta u_{g1}(t)]/2 \end{aligned}\right\} \quad (20)$$

同理可得$v_g(z,t)$的表达式.

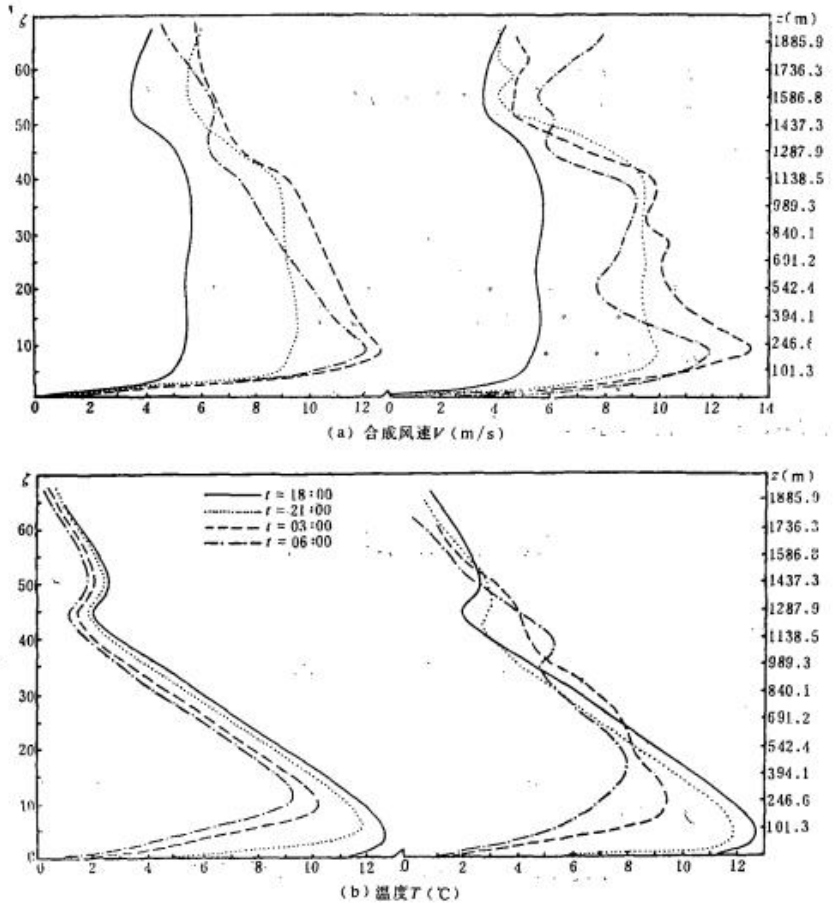
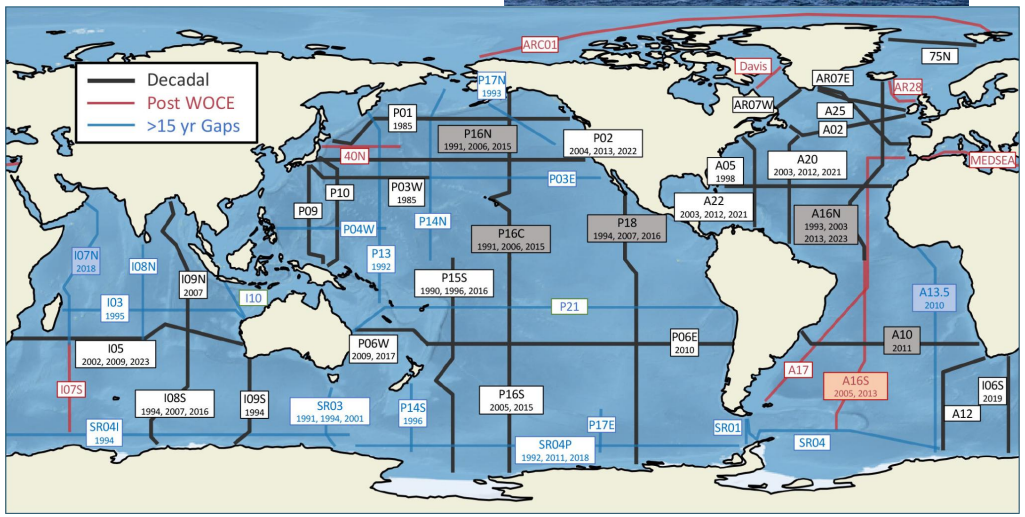


图1 Wangara资料的数值模拟（左）与实测结果（右）的比较

World Ocean Circulation Experiment (WOCE): Observations (RV Meteor - S. Atlantic, 22 days, 1992; RV Knorr - Indian Ocean, 35 days, 1995; RV Haakon Mosby, 11 days, N. Atlantic); and Inverse Modeling to study ocean circulation and diffusion , and air-sea interaction and watermass formation



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Zhang, H.-M., and N. G. Hogg, 1996: Deducing dynamic properties from simulated hydrographic data: Part I. Results from a non-eddy-resolving model. *Journal of Marine Research* 54, (4). https://elischolar.library.yale.edu/journal_of_marine_research/2197

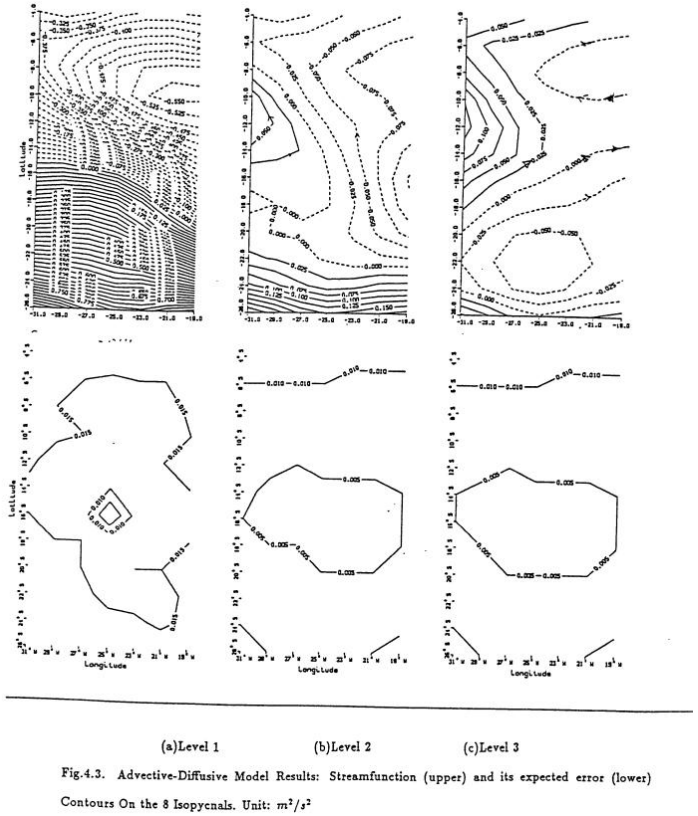
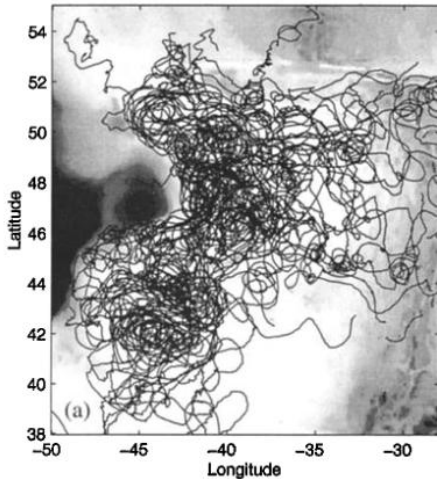
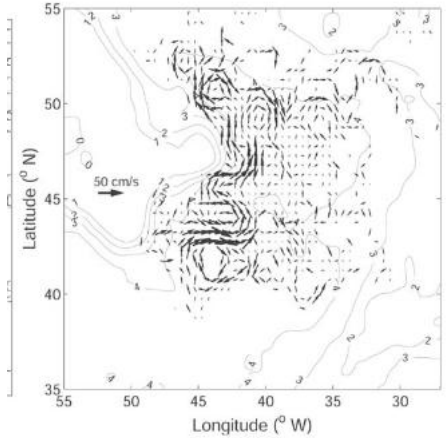
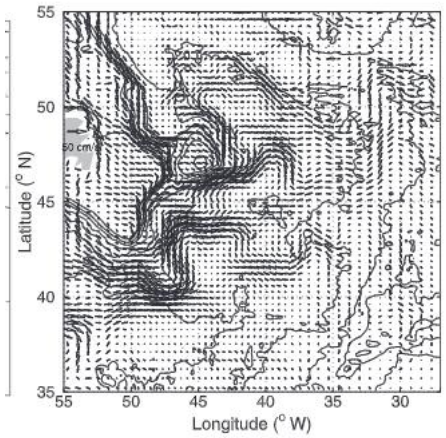


Fig.4.3. Advective-Diffusive Model Results: Streamfunction (upper) and its expected error (lower) Contours On the 8 Isopycnals. Unit: m^2/s^2

Lagrangian Float Observations to study N. Atlantic circulation and diffusion processes; Repeated MV Ship lines to mean changes in the Gulf Stream; Numerical modeling to study air-sea interactions







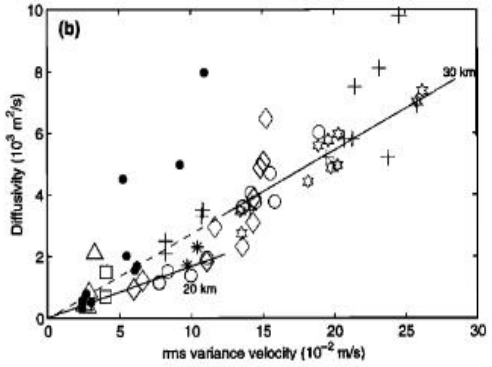
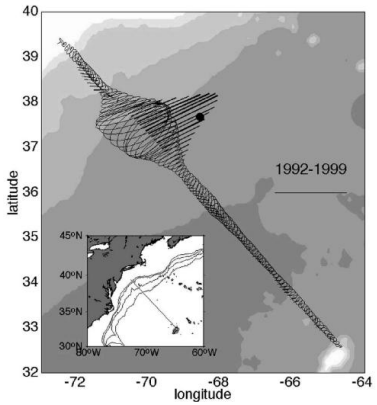


Figure 18. Eddy diffusivity (a) versus velocity variance and

Rossby & Zhang: Velocity and vorticity structure of the Gulf Stream



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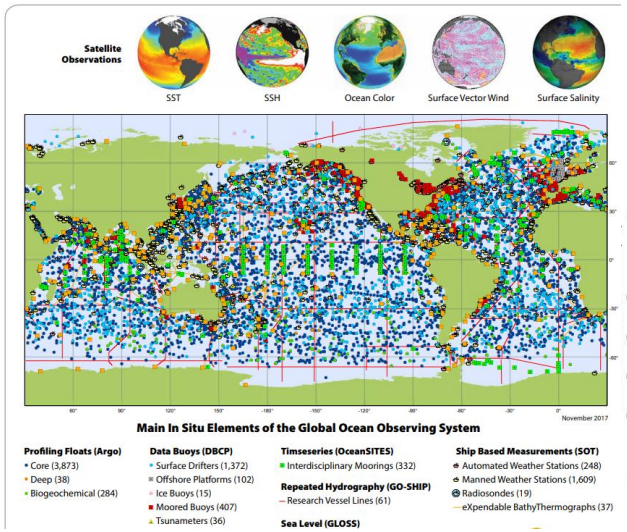
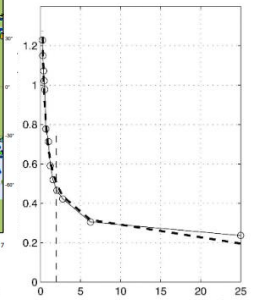
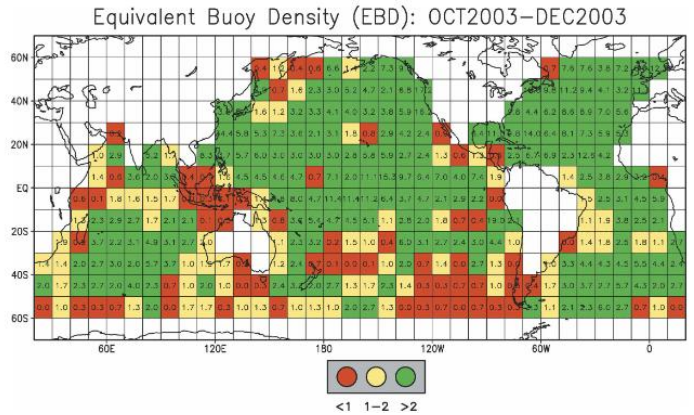
NOAA National Climatic Data Center (2002-2015):

– satellite data analysis & products (SST, SSW), **integrated sat & in-situ use**, AMS Air-Sea Comm.







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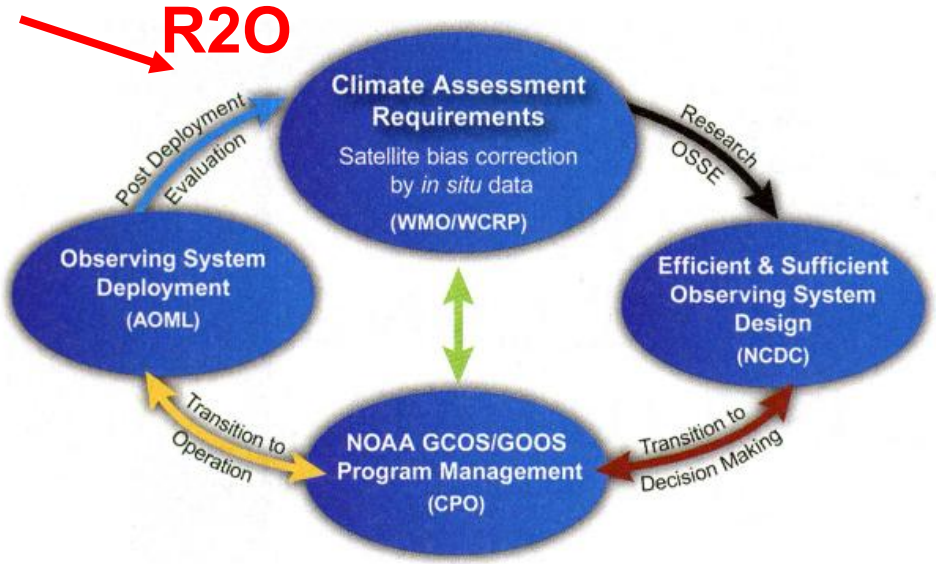
An Integrated Global Observing System For Sea Surface Temperature Using Satellites and in Situ Data: Research to Operations

H.-M. Zhang, R. W. Reynolds, R. Lumpkin, R. Molinari, K. Arzayus, M. Johnson, and T. M. Smith



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Geophys. Res. Lett.. **33** (17), L17714. http://dx.doi.org/10.1029/2006GL027086

L17714 ZHANG ET AL.: GLOBAL HIGH RESOLUTION SEA WINDS L17714

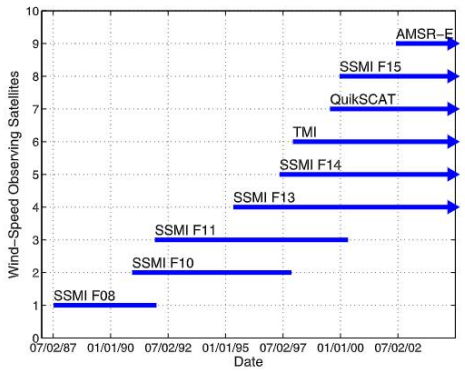


Figure 1. Timeline of the long-term US sea surface wind speed satellites used in this study.

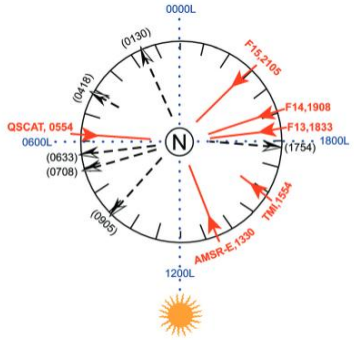


Figure 2. A simplified view looking down at the North Pole of the satellite observations in Local Solar Time (LST) of January 2005. Solid lines and arrows indicate ascending tracks and dashed lines and open arrows indicate descending tracks.

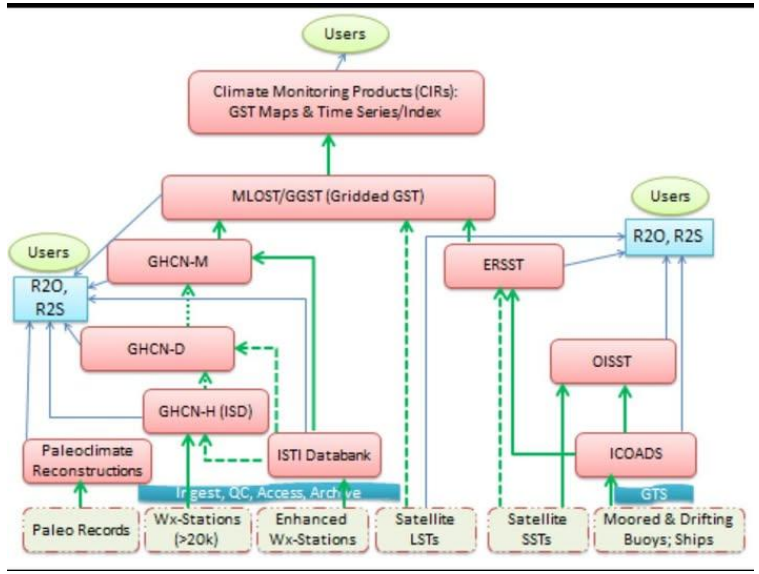
Cited by ESA design team

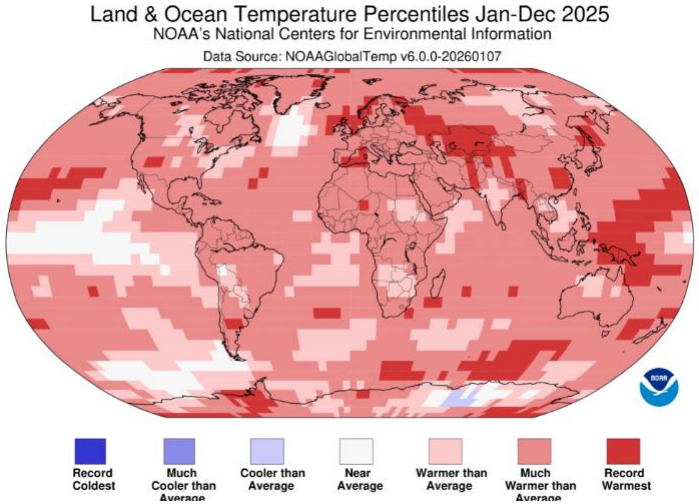
- WCRP GEWEX WG
- "WMO Guide to Climatological Practice
- Ocean Obs'09 Whitepaper
- AMS Air Sea Interaction Committee; Co

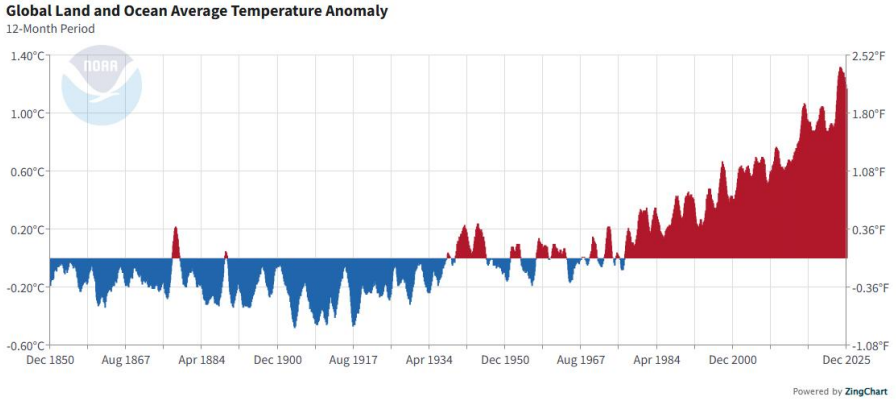
NOAA National Centers for Environmental Information (2016-2025): Supervisory Oceanographer

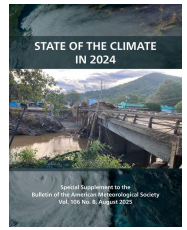
– GST Portfolio Manager, Air-Sea/Ocean Surface Section Chief, Climate Trends & Extremes, WMO/SOT Chair

Global Surface Temperature/GST Portfolio









- WMO/SOT Chair:
  - Capacity Building training in Fiji
  - WMO/IMP Symposium on extreme weather
- Whitepaper - Ocean Obs'19
  - A Global Ocean Observing System (GOOS), Delivered Through Enhanced Collaboration Across Regions, Communities, and New Technologies. Moltmann, T., J. Turton, H.-M. Zhang, and coauthors
- Building star-performance teams (DOC medals)
- US/NOAA-China/CMA senior leadership summit

Extreme Marine Heatwaves in the Global Oceans during the Past Decade

Boyin Huang,[a] Xungang Yin,[a] James A. Carton,[b] Ligang Chen,[b] Garrett Graham,[c] Keneshia Hibbert,[d] Seonju Lee,[e] Thomas Smith,[f] and Huai-Min Zhang[a]

A new gridded offshore wind profile product for US coasts using machine learning and satellite observations

James Frech[1,2], Korak Saha[1,2], Paige D. Lavin[1,3], Huai-Min Zhang[4], James Reagan[2], and Brandon Fung[1]

Present Day: ICPO Director

CLIVAR Mission and Scientific Priorities

CLIVAR is one of the 6 Core Projects of the World Climate Research Program (WCRP)

CLIVAR's **mission** is to understand the dynamics, interaction, and predictability of the climate system with emphasis on ocean-atmosphere interactions.

Some Scientific priorities of CLIVAR:

1. Mechanisms of climate variability and change that require further investigation with the ultimate goal of better constraining the fluxes of energy and carbon in the climate system;
2. Ocean processes that modulate climate variability and change for which open questions remain;
3. Climate predictability challenges over a broad range of space and time scales.

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CLIVAR

Climate and Ocean Variability, Predictability and Change

Objective:

To facilitate observations, analysis, predictions and projections of variability and changes in the Earth's climate system, with emphasis on ocean-atmosphere interactions, to the benefit of society and the environment in which we live.

CLIVAR legacy includes:

- **implementation and development of major multinational observing networks** in all ocean basins;
- development of **ocean and climate re-analyses**, to bridge observations and modeling through data assimilation;
- development of **ocean-climate models, initialized decadal climate predictions building on ocean-climate reanalyses.**

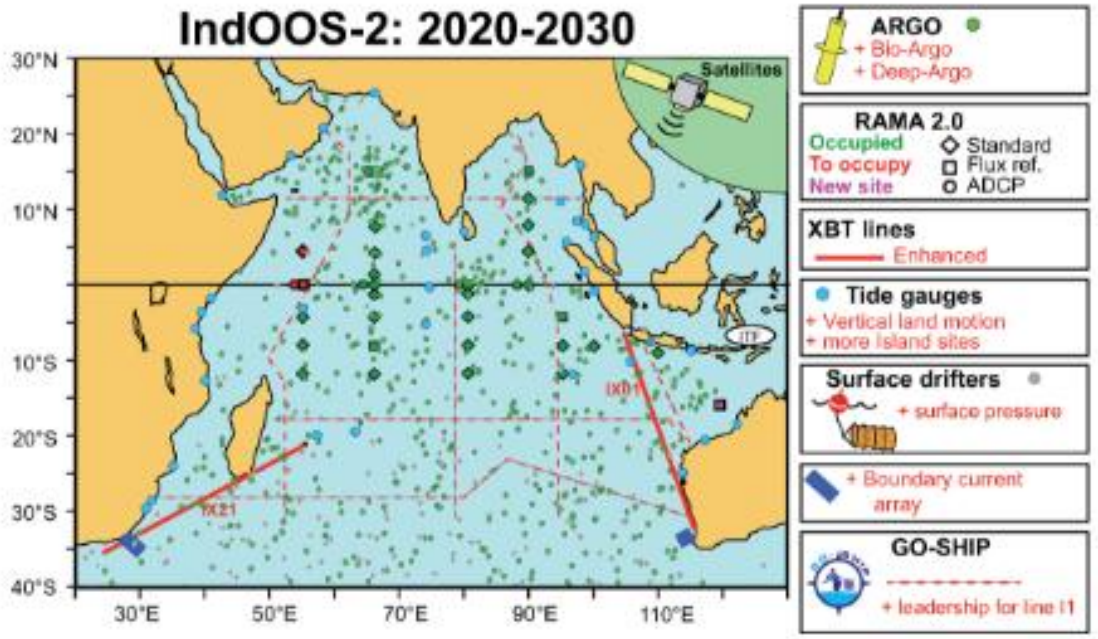
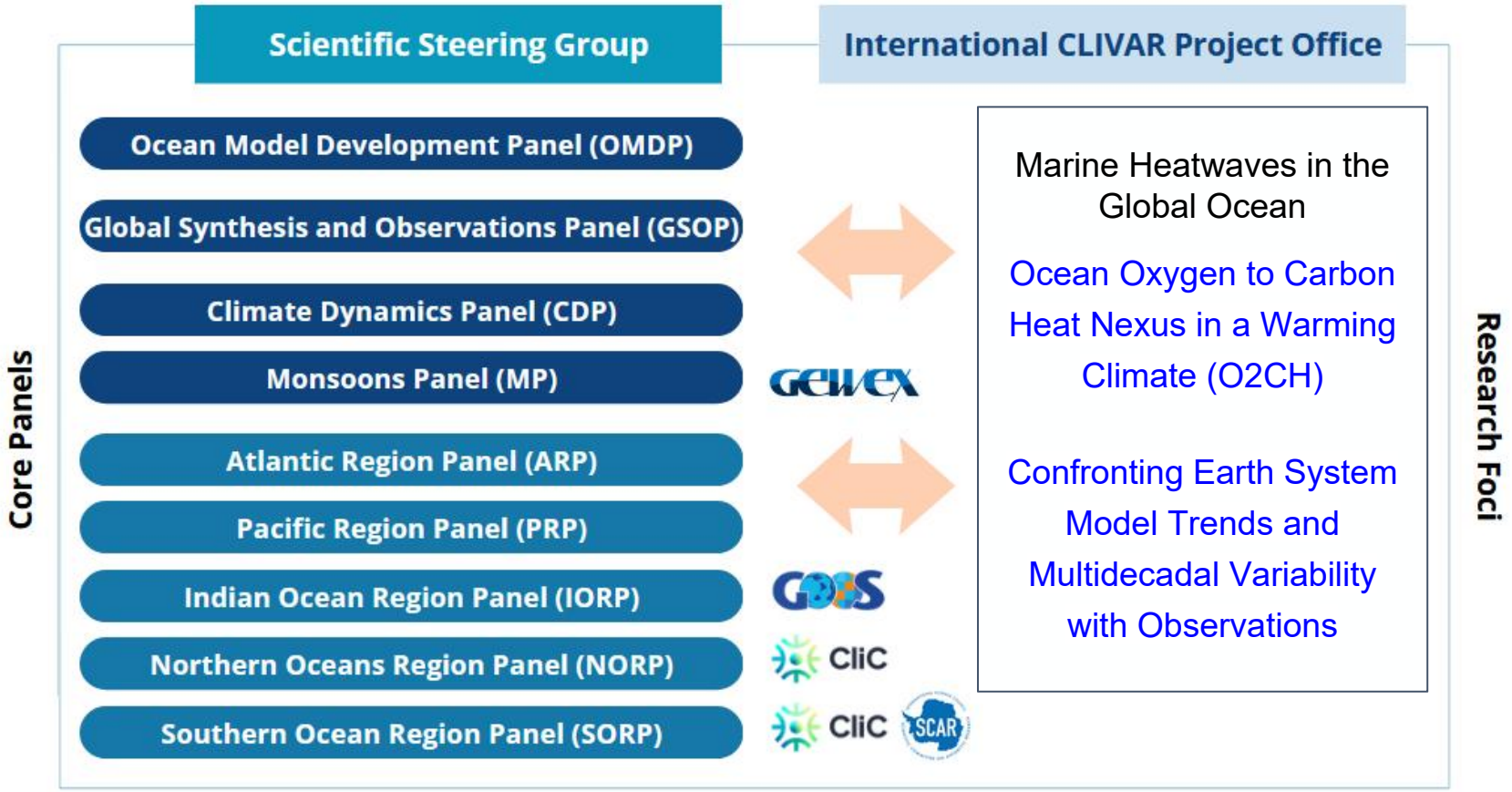


Figure: IndOOS-2: A Roadmap to Sustained Observations of the Indian Ocean for 2020-2030

CLIVAR consists of 4 ‘Global’ Panels, 5 Regional Panels, and Research Focus



The CLIVAR SSG provides overall guidance for CLIVAR activities, in concert with WCRP objectives, and establishes CLIVAR Panels and Working Groups (+Task Teams) and their terms of reference.

Research Foci address urgent and actionable research challenges. RFs have a limited life-time (3-5 yrs)

Cross-WCRP Joint Working Groups

WCRP World Climate Research Programme

CLIVAR Climate and Ocean Variability, Predictability and Change

GEWEX

Monsoons Panel

Panel structure: Monsoon Panel (MP) & 3 regional Working Groups (WG)

- Regional WGs tasked with identifying priority areas for targeting advances
- Regional WGs relatively flexible to organize themselves under the guidance of MP

CLIVAR/GEWEX Monsoons Panel (MP)
14 Members

WG on Asian-Australian Monsoons (WG-AAM)

WG on AMerican Monsoons (WG-AMM)

WG on AFrican Monsoons (WG-AFM)

WMO WWRP WCRP World Climate Research Programme International Science Council

INTERNATIONAL MONSOONS PROJECT OFFICE • IITM • MoES • PUNE • INDIA

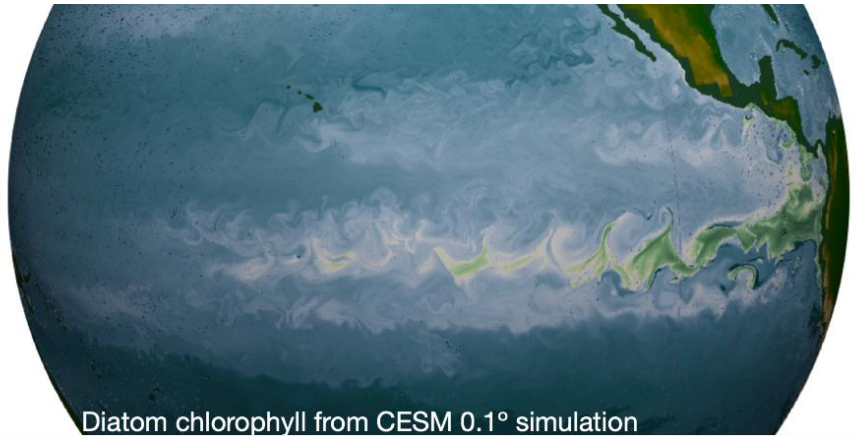
सत्यमेव जयते Ministry of Earth Sciences Government of India

INDIAN INSTITUTE OF TROPICAL METEOROLOGY PUNE

INTERNATIONAL MONSOONS PROJECT OFFICE (IMPO)

New Efforts

PRP Working Group on **Tropical Pacific BGC-Physical Interactions** to bring together the community across physical and biogeochemical disciplines to identify and advance research questions and observing and modeling needs for understanding ocean biogeochemical (BGC) cycles and their interactions with climate and ocean dynamics in the tropical Pacific (TP).


Diatom chlorophyll from CESM 0.1° simulation

GSOP is involved in Marine Environment Reanalyses Evaluation Project (MER-EP) as part of the panel's *Ocean Reanalyses Intercomparison* activities.

Frontiers in Marine Science > Ocean Observation > Research Topics

Demonstrating Observation Impacts for the Ocean and Coupled Prediction

37.7K views | 94 authors | 18 articles

frontiers

Peter R. Oke, Yosuke Fujii and Elizabeth Remy

IORP is forming new Task Teams:

- Marine Paleo
- Coastal Observations
- Indonesian Seas

World Cl
Research

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International Science Council

CLIVAR OMDP New Working Groups:

New Efforts

Ocean Model Intercomparison Project (OMIP) – a core component of CMIP, a framework for evaluating and improving performance of global ocean and sea-ice models.

Geosci. Model Dev., 9, 3231–3296, 2016
www.geosci-model-dev.net/9/3231/2016/
doi:10.5194/gmd-9-3231-2016

OMIP contribution to CMIP6: experimental and diagnostic protocol for the physical component of the Ocean Model Intercomparison Project

Stephen M. Griffies[1], Gokhan Danabasoglu[2], Paul J. Durack[3], Alistair J. Adcroft[1], V. Balaji[1], Claus W. Böning[4], Eric P. Chassignet[5], Enrique Curchitser[6], Julie Deshayes[7], Helge Drange[8], Baylor Fox-Kemper[9], Peter J. Gleckler[3], Jonathan M. Gregory[10], Helmuth Haak[11], Robert W. Hallberg[1], Patrick Heimbach[12], Helene T. Hewitt[13], David M. Holland[14], Tatiana Ilyina[11], Johann H. Jungclaus[11], Yoshiki Komuro[15], John P. Krasting[1], William G. Large[2], Simon J. Marsland[16], Simona Masina[17], Trevor J. McDougall[18], A. J. George Nurser[19], James C. Orr[20], Anna Pirani[21], Fangli Qiao[22], Ronald J. Stouffer[1], Karl E. Taylor[3], Anne Marie Treguier[23], Hiroyuki Tsujino[24], Petteri Uotila[25], Maria Valdivieso[26], Qiang Wang[27], Michael Winton[1], and Stephen G. Yeager[2]

Regional Ocean-Climate Projections

OMDP & RIfS CORDEX Task Team to develop coordinated simulation protocols and deliver standardised datasets towards coordinated regional ocean-climate projections.

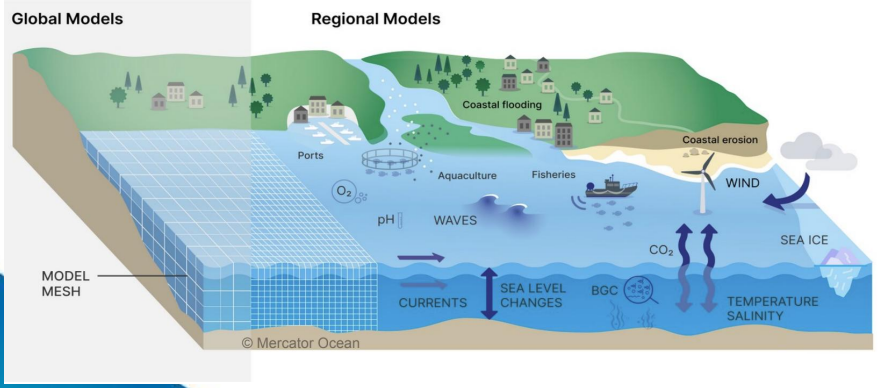
Membership	
Angélique Melet (Coordinator)	Mercator Ocean, France
Samuel Somot (Coordinator)	CNRM, Météo-France, France
Dorotea Iovino	CMCC Foundation, Italy
Shogo Urakawa	Meteorological Research Institute/ Japan Meteorological Agency, Japan
Marine Herrmann	LEGOS, France and USTH, Hanoi, Vietnam/ Chulalongkorn University, Bangkok, Thailand
Sheila Estrada	CICESE, Mexico
Markus Meier	Leibniz Institute for Baltic Sea Research Warnemünde (IOW), Germany
Andrew Orr	British Antarctic Survey (BAS), UK
Marcus Thatcher	CSIRO, Australia
Jason Holt	National Oceanography Centre (NOC), UK
Xuebin Zhang	CSIRO, Australia
Elizabeth Drenkard	GFDL, USA

New Efforts

CLIVAR OMDP/RIfS CORDEX Task Team on Regional Ocean Modeling and Climate Projections

Motivation:

- Need to provide refined regional information relevant for societal services and adaptation measures;
- Need for dynamical downscaling approaches as most coupled global climate models will not be able to run with high-resolution ocean models; and
- Lack of international coordination of regional ocean modelling and climate projections.



Objectives:

- Develop coordinated simulation protocols and deliver standardized datasets towards coordinated regional ocean-climate projections;
- Explore the potential of data-driven machine-learning approaches to simulate oceanic regions and their future evolution;
- Advance the science of regional ocean climate modelling and projections, through multi-model assessments, identification of biases, and underlying processes;
- Provide a forum for regional ocean modelers and model users to share knowledge and experience;
- Serve climate impact and adaptation needs by engaging with users/stakeholders and providing data and expertise to ocean climate services; and
- Contribute to international and regional expert assessment reports.

Capacity Building, Education, and Training

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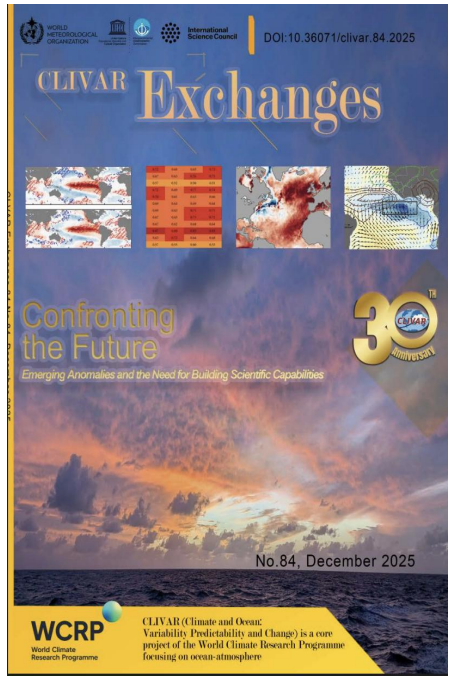
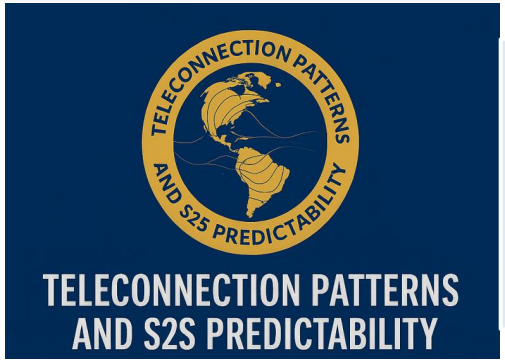


An Early Career Session with mentoring (WCRP, CLIVAR SSG) was held as a Side Event at Pan-CLIVAR 2025



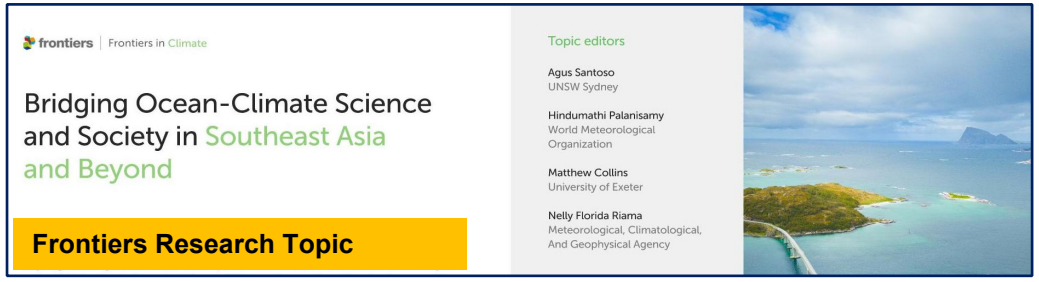
Online university course co-organized by GEWEX-CLIVAR Working group on American Monsoons and Universidade Federal de Itajuba (all materials available online)

Co-organized by NORP, SORP, OMDP, and ARP, the workshop brought together ~80 in person and ~ 50 online participants; ECRs participation >50%

BRIN · frontiers · IPSL · Institut Teknologi Bandung · Laoshan Laboratory · Ocean University of China · US CLIVAR · WCRP World Climate Research Programme

The 2025 Pan-CLIVAR Meeting brought together CLIVAR members from all panels, research foci, and SSG, as well as invited representatives from WCRP core-projects and external partners to:

- **Develop ideas and input for the next CLIVAR science and implementation plans;**
- Foster interactions across panels, WCRP core projects, and partners;
- Evaluate progress, formulate future priorities, and enhance members cohesion; and
- Engage scientists and stakeholders in southeast Asia.



Emerging topics for the new CLIVAR Science Plan

- AI/ML applications and coordination while not losing the traditional process-based focus;
- Strategy for continued observations in the absence of substantial reductions of institutional / government support / funding which cannot wait until the outcomes of OceanObs'29;
- Regime shifts and tipping points;
- Extremes pertaining to CLIVAR;
- Sea level changes;
- Research related to biogeochemistry and carbon which can tie into marine carbon dioxide removal;
- Improving joint use of model and observational products in a coherent and synergistic way;
- Review of past accomplishments and identify gaps; and
- Enhance societally relevant science and applications, including early engagements with stakeholders, policy makers, etc.

CLIVAR Publications
1) Monthly News Bulletin; 2) Periodical Research Articles - CLIVAR Exchanges

August 2026 Bulletin

WCRP World Climate Research Programme

CLIVAR Climate and Ocean Variability, Predictability and Change

A Message From the ICPO Director

"Among the initial tasks as the new ICPO Director since mid June, I had the opportunity to attend the biennial open science conference and committee meeting of the Scientific Committee on Antarctic Research (SCAR2026) in mid August, from which I was so reenergized. SCAR2026 was one of the most energetic meetings I have attended, evidenced by the 1000+ capacity ballroom that was fully crowded including standing attendees at the doors, at both the opening and closing events of Day 1 and Day 5, and with specialized workshops two days before and two days after the Conference. I am glad to see that our CLIVAR scientists, particularly the Southern Ocean Regional Panel (SORP) members, are actively participating in SCAR activities (more below), and I was able to meet some of them at a lunch break and "side bars". One major theme of SCAR2026 was the planning for the Fifth International Polar Year (IPY-5) in 2032-2033, which is a geopolitically popular theme supported by many national funding agencies; national proposal calls may come out soon. Some of our CLIVAR members (e.g. SORP) have already been engaged in the IPY-5 planning, but I call for the wider CLIVAR community's involvement to contribute on the ocean dynamics and climate aspects. As a major week-long SCAR poster said, what happens in the poles affects everyone. A great example is the melting ice/freshwater impact to the general ocean circulation and ENSO cycles. CLIVAR can also more closely collaborate with the SCAR's existing AntClim21 and AntClimNow to a newly proposed SCAR Research Program at SCAR2026: the Antarctic Climate Extremes - Drivers, Predictability and Cascading Impacts (ACES). We hope your participation under the WCRP CLIVAR umbrella/brand can carry you further down the road, and please feel free to contact icpo@clivar.org, if ICPO can assist you." -John Huai-Min Zhang

CLIVAR News and Announcements

CLIVAR at the 2026 SCAR Open Science Conference, Oslo, Norway, 8-19 August 2026

The 12th SCAR Open Science Conference (SCAR OSC) brought together the Antarctic research community in Oslo, Norway, earlier this month. Several CLIVAR members from the polar

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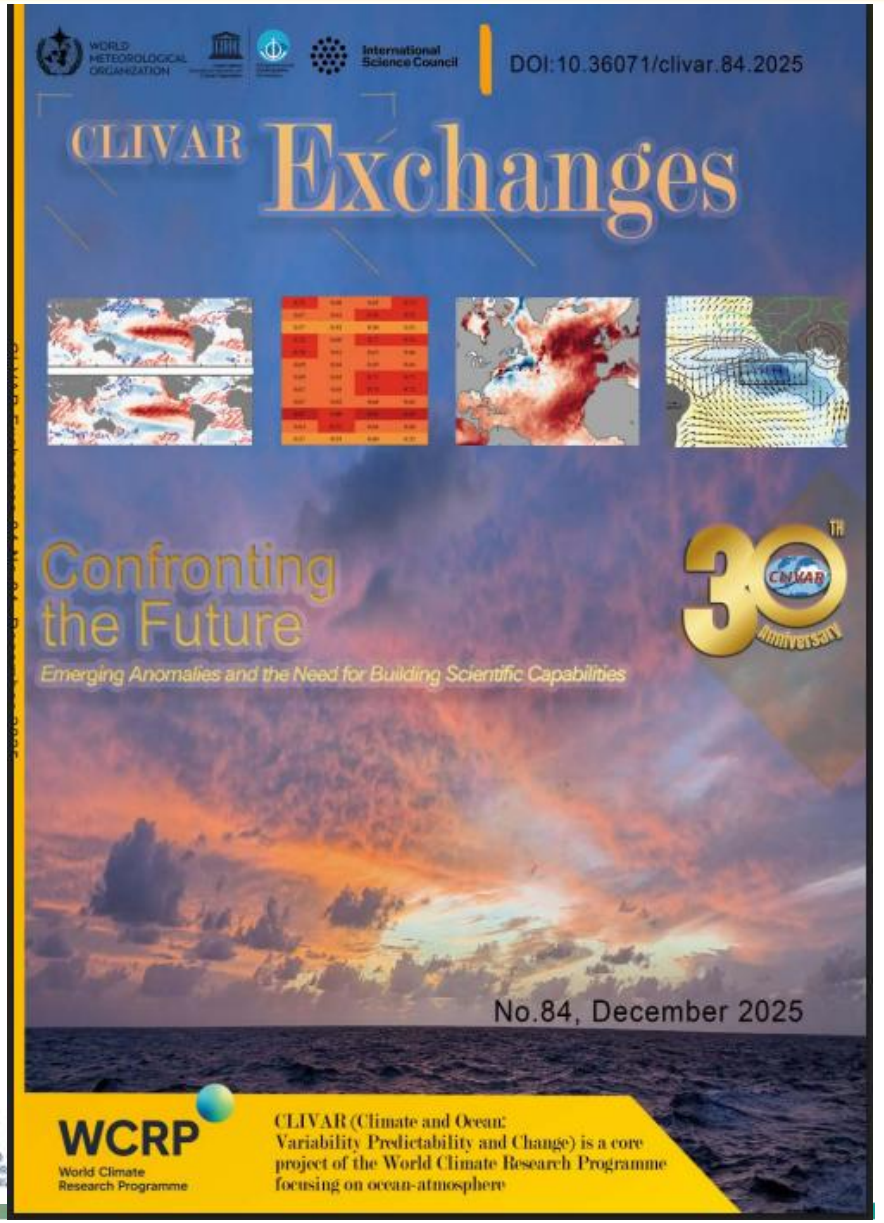
More contact info later …



How to get involved with us?

- Communications

Monthly Bulletin

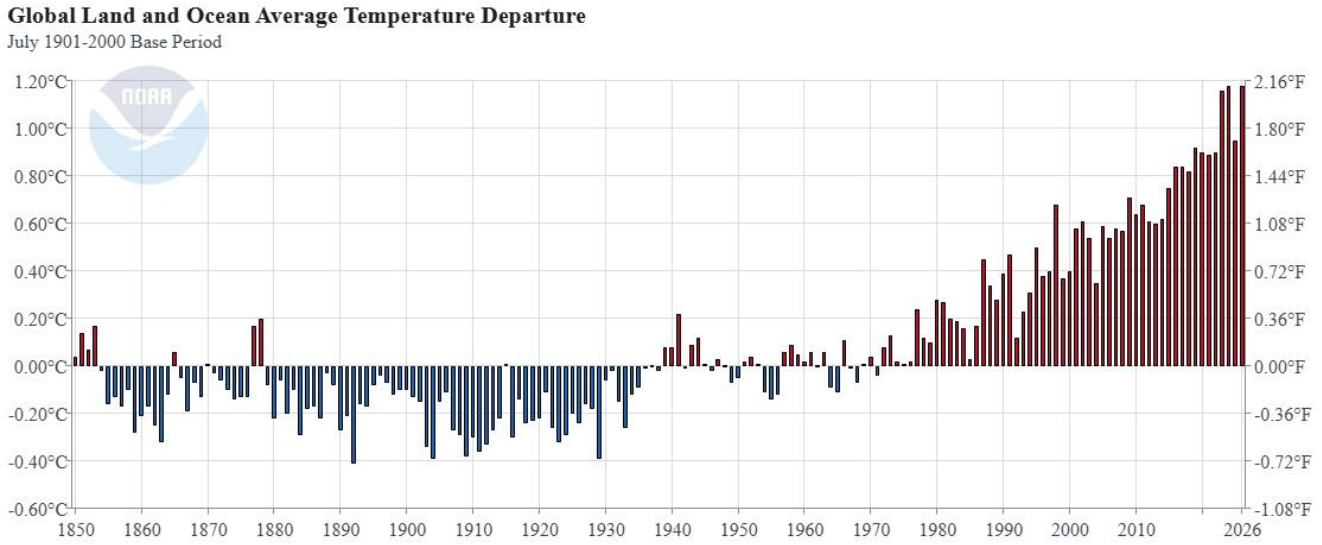
@WCRP Climate and Ocean Variability, Predictability and Change (CLIVAR)

@wcrp-clivar.bsky.social

https://www.youtube.com/@wcrp_clivar

https://www.facebook.com/clivar/

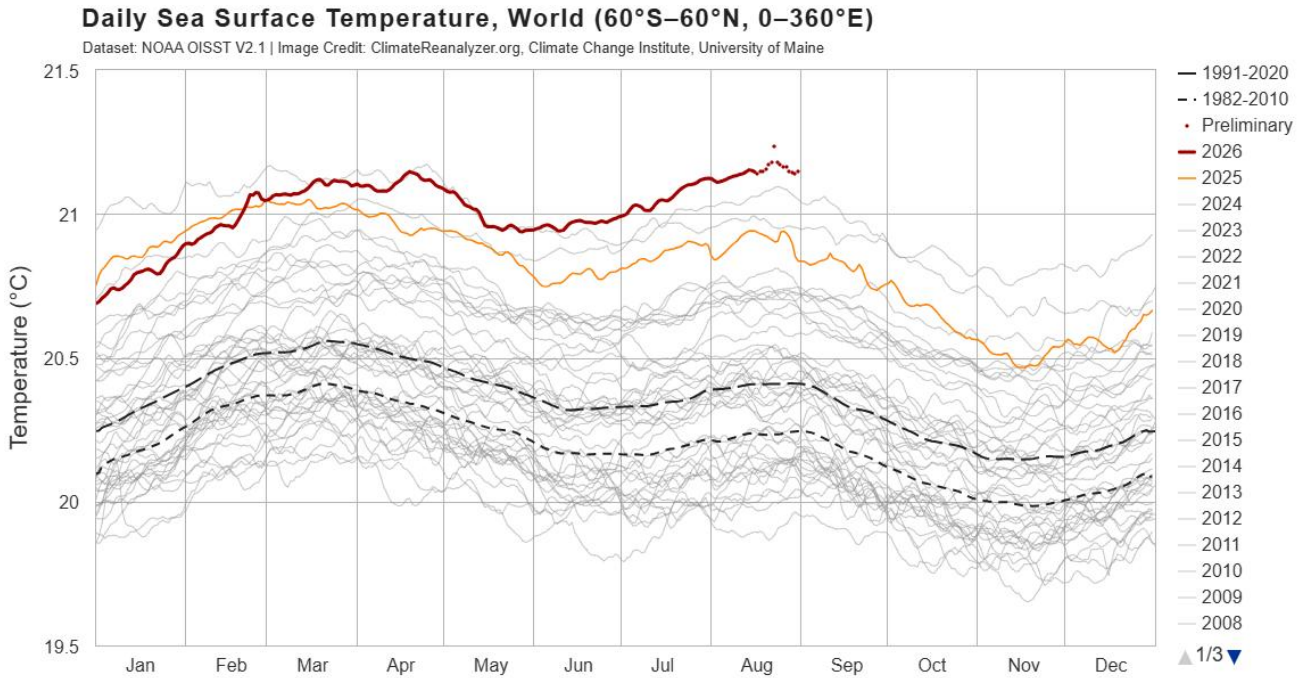
Slides for thoughts: From knowns … To unknows

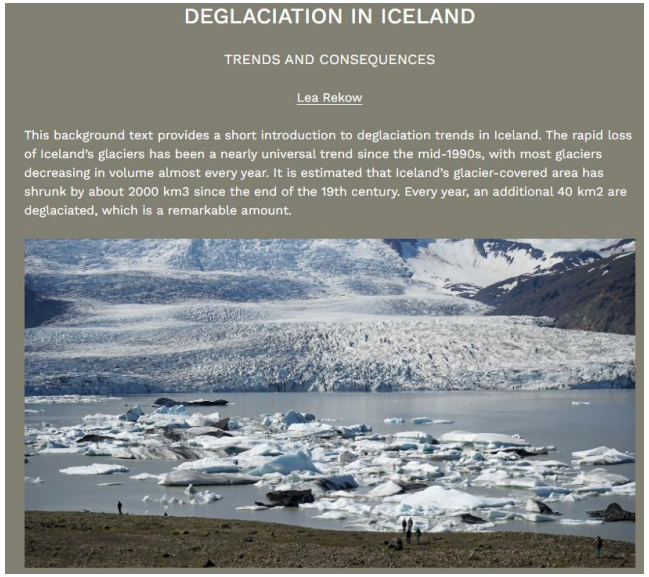


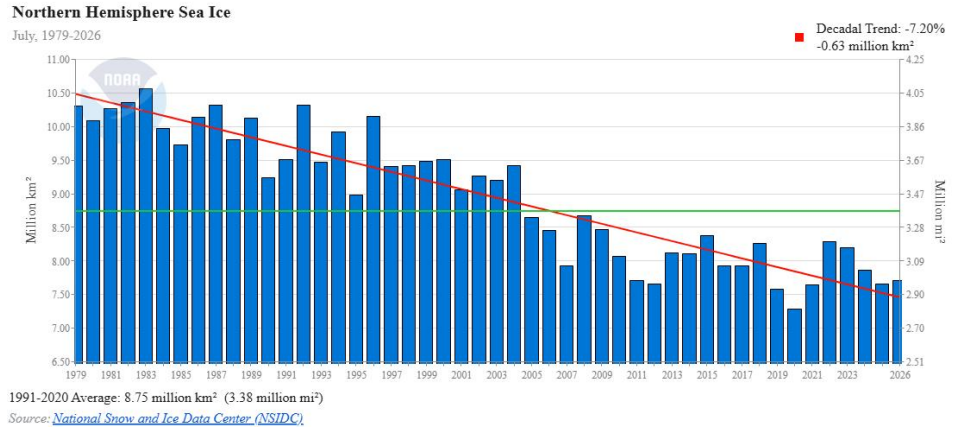
kxan.com

Record warm Gulf of Mexico partially responsible for Texas heat wave

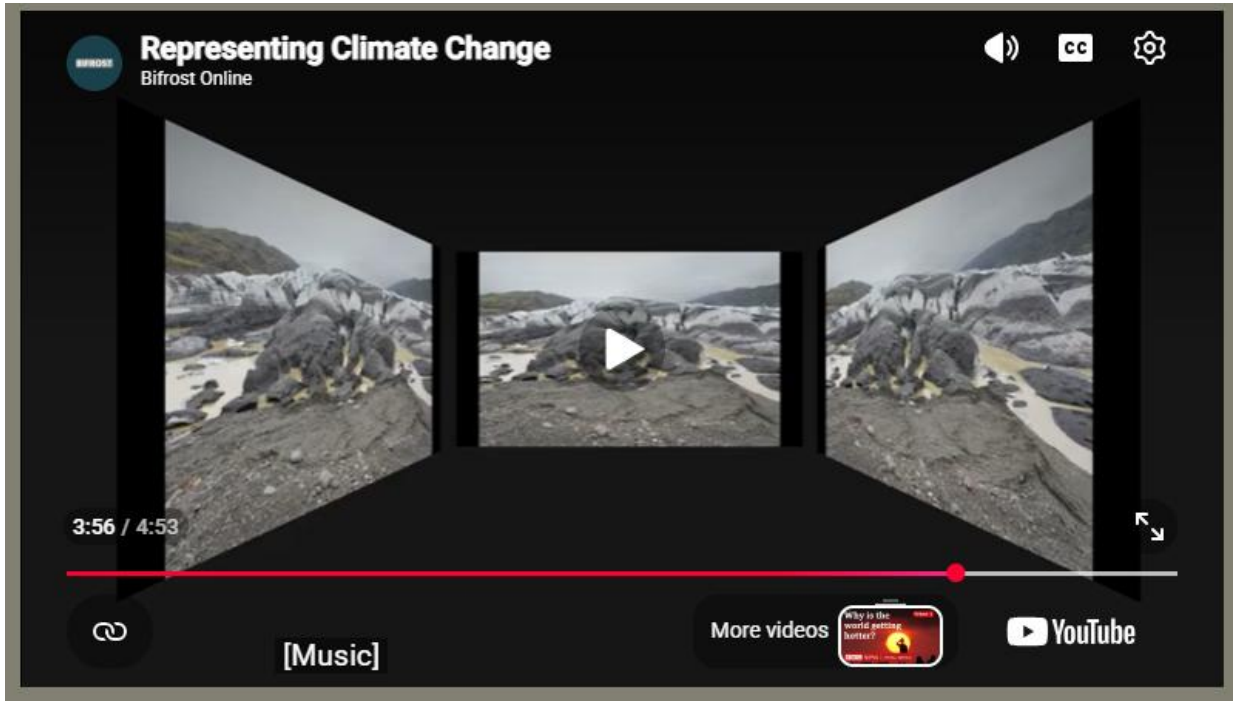
David Yeomans 2 hours ago







[Deglaciation in Iceland: Trends and Consequences - Wright-Ingraham Institute](https://wright-ingraham.org/deglaciation-in-iceland-trends-and-consequences/)
https://wright-ingraham.org/deglaciation-in-iceland-trends-and-consequences/



… to uncertainty and unknowns

Tropical/subtropical storm example

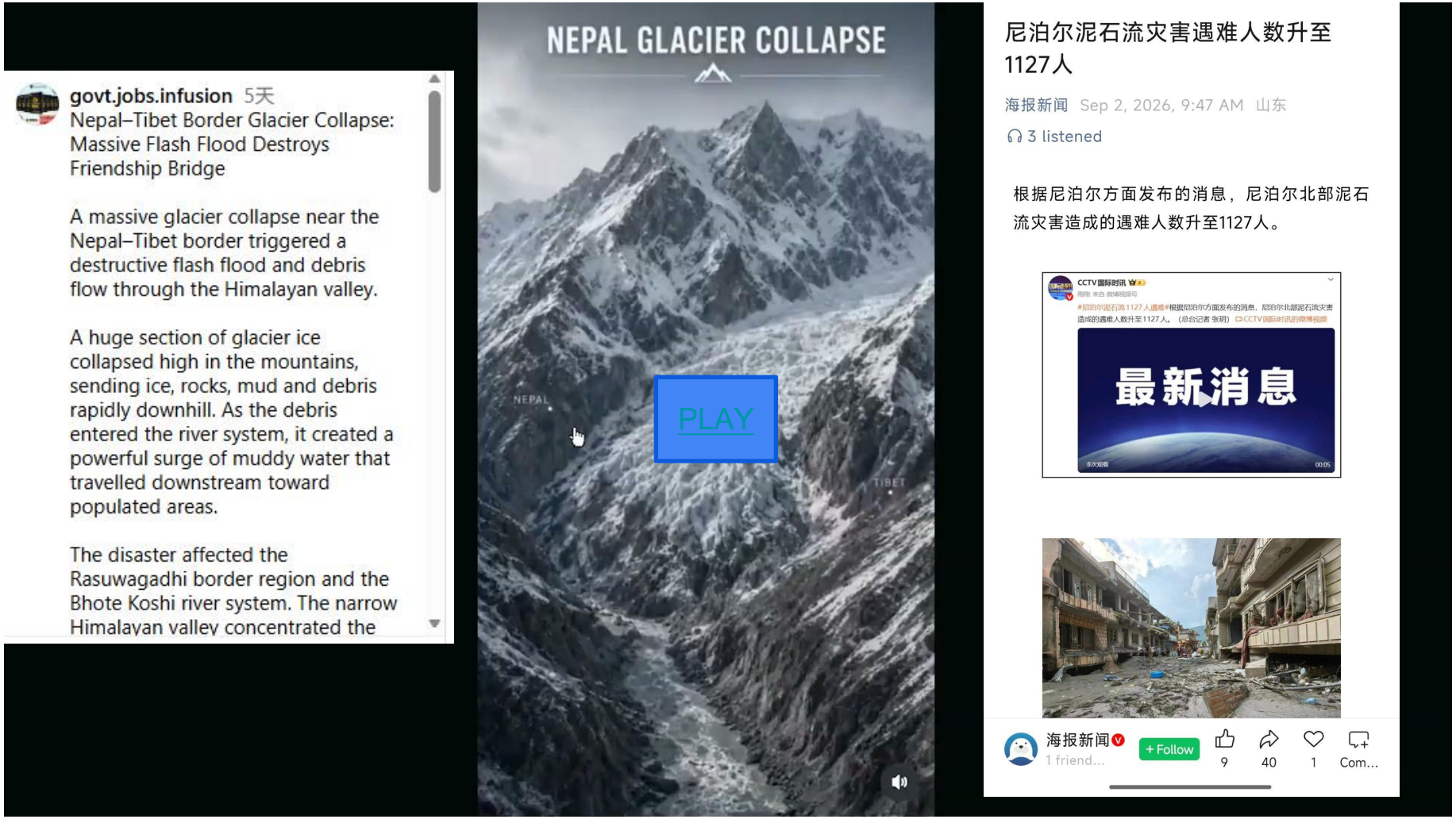
Scars on the Mountain documentary movie
https://www.angel.com/watch/scars-on-the-mountain

Hurricane Helene was a catastrophic Category 4 major hurricane that struck the Southeastern United States in late September 2024. It stands as the strongest hurricane on record to hit Florida's Big Bend region, the costliest storm in North Carolina's history, and the deadliest contiguous U.S. hurricane since Hurricane Katrina in 2005. Fueled by historically warm waters in the Gulf of Mexico, the storm underwent rapid intensification before making landfall. W Wikipedia +1

High Mountain example

Glacier ice/snow melts over the world: can tricker catastrophic damages

- Himalaya; August 2026



Hope and Progress - Climate Change Planning & Mitigations:

Science-based and informed decisions can save lives and reduce property damages

- The Switzerland Blatten case

On **May 28, 2025**, a catastrophic cascading rock-ice avalanche and landslide devastated the mountain village of Blatten (often misspelled as "Blanken" or "Blankenburg") in the Lötschental valley of Valais, Switzerland. Wikipedia

The disaster occurred when roughly 10 million tons of rock broke off the *Kleines Nesthorn* peak due to climate change-induced thawing permafrost. This massive debris load collapsed onto the **Birch Glacier**, causing the glacier to detach and trigger a violent landslide that rushed down the mountain at speeds up to 200 km/h. EGU Blogs +2

Key Details of the Disaster

- **The Impact:** The landslide unleashed over 3 to 9 million cubic meters of mud, rock, and ice, burying **90% to 95% of Blatten**. The debris deposit stretched 2.3 kilometers across the valley floor. Antarctic Glaciers +3
- **Seismic Activity:** The force of the glacial collapse and landslide triggered a local **3.1 magnitude earthquake**. UNESCO Chair on Water-r...
- **Damming & Flooding:** The massive flow obstructed the *Lonza River*, forming a natural dam and creating a lake that submerged the few buildings that weren't directly buried by debris. eu-space.europa.eu +1
- **Casualties:** Fortunately, local authorities had detected early slope deformations and ordered a **preventative evacuation** of the village's 300 residents on May 19, nine days before the collapse. However, one 64-year-old shepherd who was outside the official evacuation zone tragically lost his life. Wikipedia +1

Financial Loss: Total economic damages from the disaster are estimated to exceed 320 million Swiss Francs.