



Operational Systems Working Group (OPOS-WG)

Outline

- Background
- Terms of reference
- Systems report format and utility for Task Teams
- Ocean Best Practices
- System updates
- Potential impact on Decade and collaborations

Background

- Operational systems are represented on OPST, but never had a specific forum for collaboration
- As discussed at OPST-5, new working group formed to meet this need
- Co-chaired by Fraser Davidson and David Ford
- Meetings so far:
 - #0: 27 Jan & 4 Feb
 - #1: 20 April
 - #2: 20 May

TERMS OF REFERENCE

Terms of Reference

Purpose: Working together to define common challenges in operational oceanography and drive solutions

Vision: Better ocean forecasts for those who need them.

Mission: Improve ocean prediction systems by sharing expertise, engaging external partners, and better understanding user needs.

Terms of Reference

Membership: Membership comes from operational prediction centers

- 2 co-chairs
- 1 representative per country/forecasting center on OPST
- Additional members as needed/desired with expertise to cover specific projects/subjects
- One voice per system regardless of participation number
- Systems represented can be global, basin, coastal, for physics and/or biogeochemistry. Individual forecasting systems would be represented by the forecasting country or consortium.

OPST Participation

- WG as a whole can coordinate presentations at OPST from forecast centers. Presentations can be by WG as a whole, or by individual systems
- WG itself decides how best to present things at OPST.
 - NOTE: OSWG meetings enable all forecasting centers to present on system status, progress, and updates

WG Culture

- Respectful of differences: different schedules, capacities, staffing levels and focus.
- The WG will be enabling/empowering and focused on group needs
- Informal consensus building

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SYSTEMS REPORT FORMAT

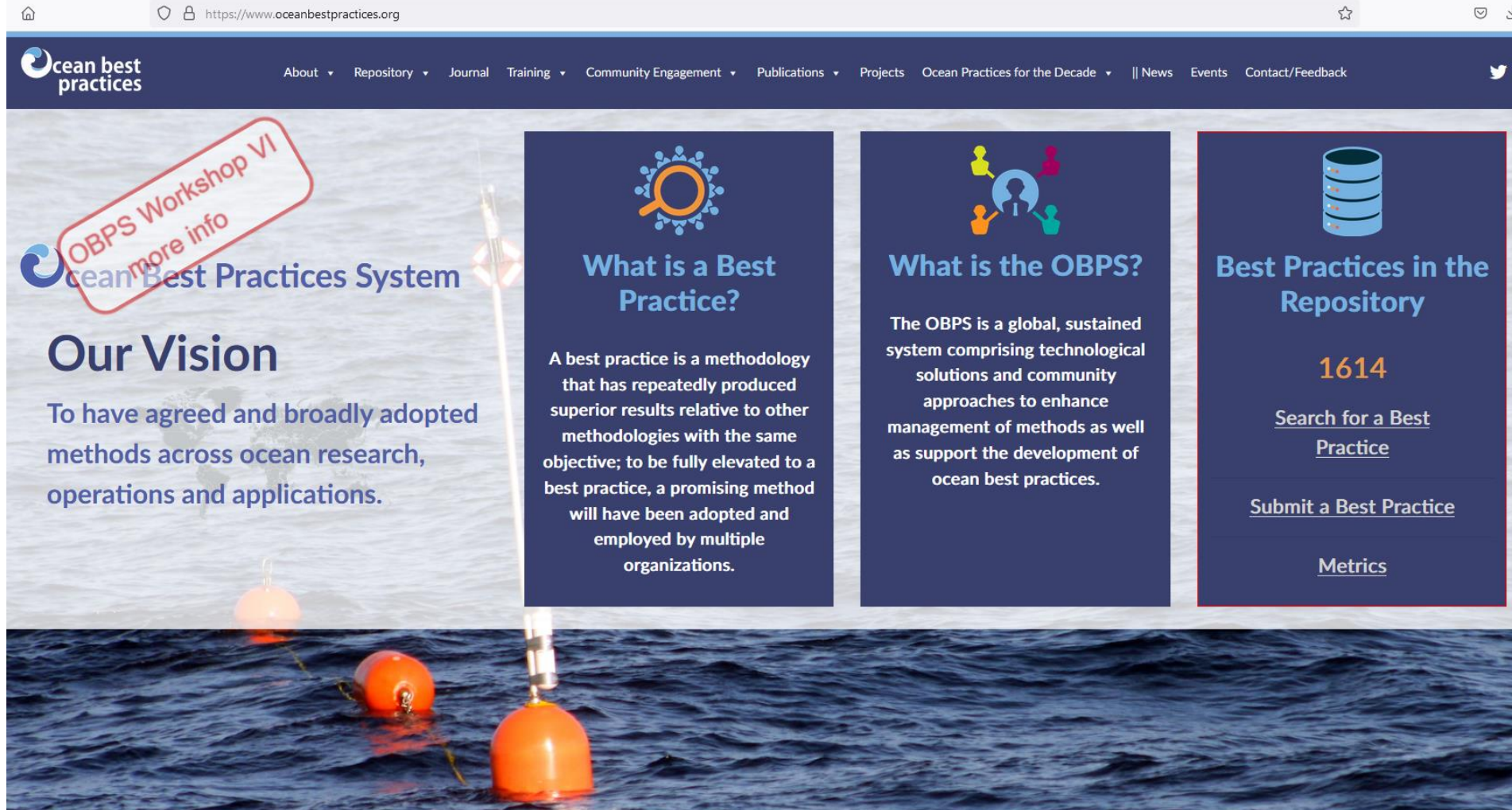
Current Reporting approach

- Each system writes an annual report
 - <https://oceanpredict.org/science/operational-ocean-forecasting-systems/system-reports/>
- Some headline information on website
 - <https://oceanpredict.org/science/operational-ocean-forecasting-systems/ocean-models>
- General agreement is that process could be improved and more useful

Suggestions

- More common report format (while allowing for unique information) with clear suggested lengths for each section
- Tables of information for easy intercomparison
- Summary report combining information across systems
- Dashboard on website with links to systems
- Add section on best practices
- Greater contribution from developing nations
- Separately clearly different systems from same nation
- Update reports when systems change rather than annually
- Enable report to be used to aggregate information in many different ways for a variety of web pages/purposes.

OCEAN BEST PRACTICES



The screenshot shows the Ocean Best Practices System website. The header includes the Ocean Best Practices logo and a navigation menu with links: About, Repository, Journal, Training, Community Engagement, Publications, Projects, Ocean Practices for the Decade, News, Events, and Contact/Feedback. The main content area features a large banner with the text 'Ocean Best Practices System' and 'Our Vision' (To have agreed and broadly adopted methods across ocean research, operations and applications). A red stamp in the top left corner reads 'OBPS Workshop VI more info'. Below the banner are three dark blue boxes with white text and icons. The first box, titled 'What is a Best Practice?', defines a best practice as a methodology that has repeatedly produced superior results. The second box, titled 'What is the OBPS?', describes it as a global system for technological solutions and community approaches. The third box, titled 'Best Practices in the Repository', displays the number '1614' and includes links for 'Search for a Best Practice', 'Submit a Best Practice', and 'Metrics'. The background of the website is a photograph of orange buoys in the ocean.

[OBPS Workshop VI more info](#)

Ocean Best Practices System

Our Vision

To have agreed and broadly adopted methods across ocean research, operations and applications.

What is a Best Practice?

A best practice is a methodology that has repeatedly produced superior results relative to other methodologies with the same objective; to be fully elevated to a best practice, a promising method will have been adopted and employed by multiple organizations.

What is the OBPS?

The OBPS is a global, sustained system comprising technological solutions and community approaches to enhance management of methods as well as support the development of ocean best practices.

Best Practices in the Repository

1614

[Search for a Best Practice](#)

[Submit a Best Practice](#)

[Metrics](#)

<https://www.oceanbestpractices.org/>

Need for best practices in ocean forecasting

- **Share expertise and benefit from it**
- **Help those setting up new forecasting systems and teams**
- **User confidence and information**
- **Become better integrated component of operational value chain**
- **And many other reasons...**

Areas for best practices in ocean forecasting

- Use of observations

- Which repositories to use? How to handle quality control? Do some data need handling differently (e.g. daytime v night-time SST/chlorophyll)? Are observed quantities directly equivalent to modelled quantities? What scales are represented by observations? Etc.

- System monitoring

- Internal quality checks, community intercomparisons, metrics for users, etc

- Research to operations

- Pull-through of model/assimilation developments, pre-operational trials, update/tech-transfer procedures, etc

- Operational resilience

- Backup systems, contingencies, user notifications, 24/7 support, etc

- Outputs

- Delivery methods, product types, formats, postprocessing, documentation, etc
- Compatibility for DITTO (Digital Twin of the Ocean)

BEST PRACTICE OP-OS-WG Theme #1 System Reporting

- Presented to Ocean Best Practices Program
 - Determine needs of Best Practices for reporting (who will use it)
 - Aim for report utility for a variety of groups: OPST, ETOOFS, DCC, OP-OS-WG, OP-TT's, Observing Groups, End user Groups
 - Enable report to provide information for Operational Readiness Level Index (DCC proposed by Enrique)
 - ORL index is 3 or 4 digits with each digit corresponding to a certain characteristic such as (Level of Operations, Level of Validation, Level of output/products/access, Level of coupling ?)
- Timeline:
 - Look at developing a best practice document on system reporting by end of September 2022. Best Practice to be used by all in submitting a report
 - Reports and Best Practice document to be reviewed
 - New reports based on updated best practices by end of March 2023

SYSTEM UPDATES

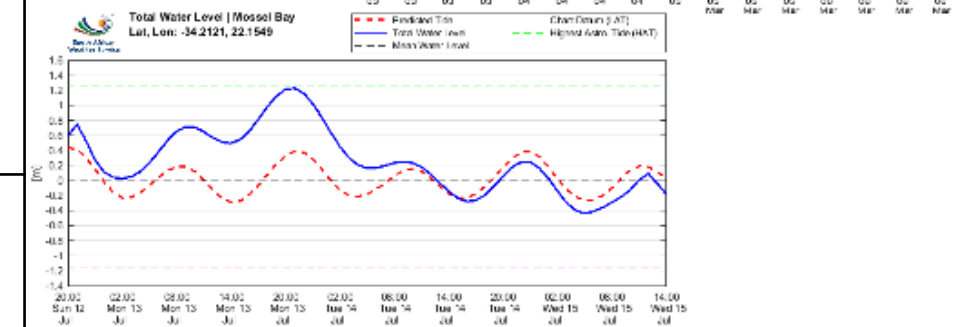
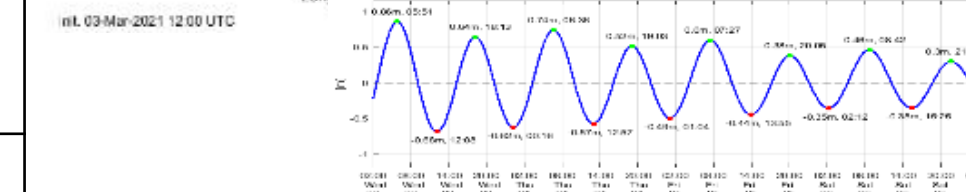
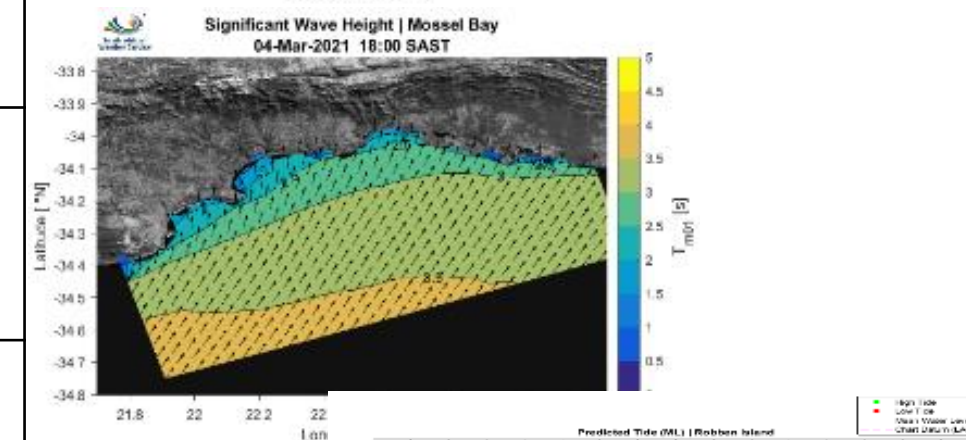
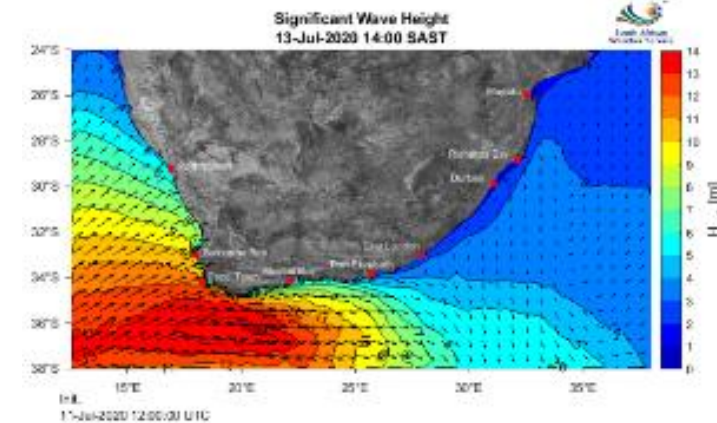
Operational Systems – South Africa



The South African Weather Service (SAWS)

Contact: Marc deVos, marc.devos@weathersa.co.za

Forecast product	Model details	Operational status	Future plans
Waves	SWAN non-assimilative 6 km regional to ~1.5/2 km near key areas	Operational output disseminated here: https://marine.weathersa.co.za	Ensemble wave forecasts (ensemble parameter wave boundary conditions)
Tides	Delft3D Flow Non-assimilative ~ 6km regional	Operational output disseminated here: https://marine.weathersa.co.za	-
Sea-Ice Edge	SAWS-FDF (empirically derived algorithm) for Antarctic areas in METAREA VII	Operational output disseminated here: https://marine.weathersa.co.za	-
Ocean currents, temp and salt	Delft 3D Flow Non-assimilative ~ 700m resolution For limited domain spanning the Cape Peninsula region	Not operational	Operationalize
Rip-current & coastal overtopping	Empirically-derived algorithm Probabilistic point forecast for specific beaches	Not operational	Operationallize



Operational Systems – South Africa



The South African Environmental Observation Network

Contact: Jennifer Veitch, ja.veitch@saeon.nrf.ac.za

} Modelling developments

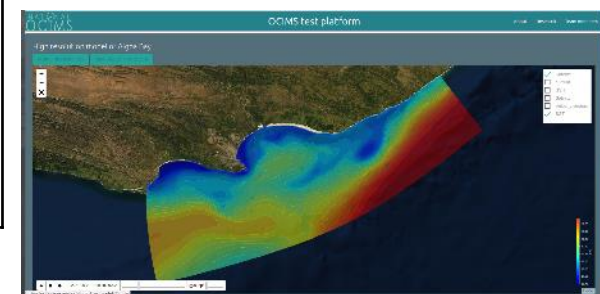
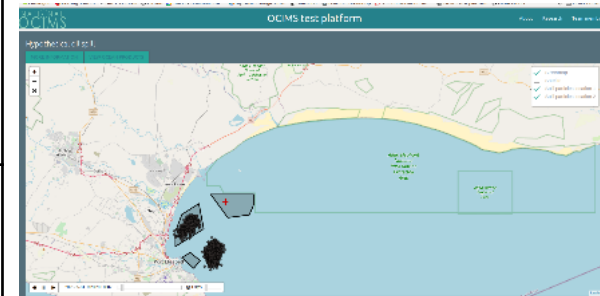
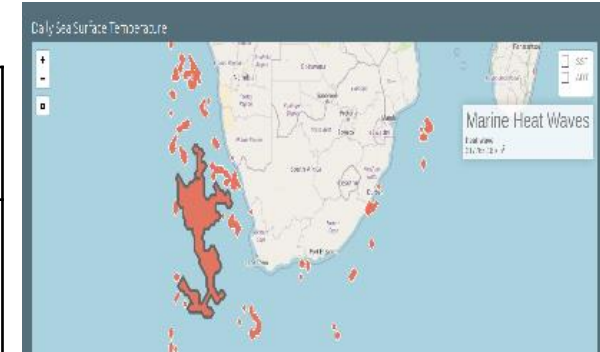


The Department of Forestry, Fisheries and the Environment

Contact: Marjolaine Krug, mkrug.deff@gmail.com

} OCIMS*

Product	Model details	Operational status	Future plans
Various satellite- and global model-derived products for southern Africa's oceans (e.g. position of Agulhas, Marine heatwaves, eddy-tracking)	Algorithms produced to add value to existing operational satellite and GLORYS ocean forecasts for southern Africa's oceans.	Operational output disseminated here: ocimstest.ocean.gov.za	Integrate operational outputs with the National Oceans and Coastal Information Management System as decision support tools.
High resolution, limited domain ocean forecasts (temp, salt and currents) with particle tracker to mimic oil spill.	Delft3D grid, increasing resolution from edges (~3km) to the inside (~500m) of Algoa Bay. CROCO model with GLORYS forecasts at the boundaries Non-assimilative.	Operational output disseminated here: ocimstest.ocean.gov.za (server temporarily down)	- Improve wind forcing - QA/QC procedure - Data assimilation - Run with various boundary forcings. - Implement similar systems for various high-use areas of coastline.



* OCIMS = National Oceans and Coastal Information Management System

<https://ocims-dev.dhcp.meraka.csir.co.za/>

Summary and plans for current ECMWF operational systems 2

- **Plans for the next ocean model upgrade (2023 target)**
 - Upgrade to NEMO V4. Biggest change is the LIM2 (mono-cat) to SI3 (multi-cat) sea ice model
 - Lots of improvement to the NEMOVAR data assimilation system and use of observations
 - Resolution will stay the around 0.25 degree for the ocean
 - New long (1979 onwards, but maybe earlier) uncoupled ocean reanalysis
- **Explorative work on increasing both atmosphere and ocean resolutions are underway**
 - 1/12 degree ocean
 - Could become operational in a not too distant future.
 - Down to 1.4 km global atmospheric resolution are being tested
 - Not a likely operational model anytime soon

INDIAN OCEAN HIGH RES OPERATIONAL OCEAN FORECAST (IO-HOOFS) Contd

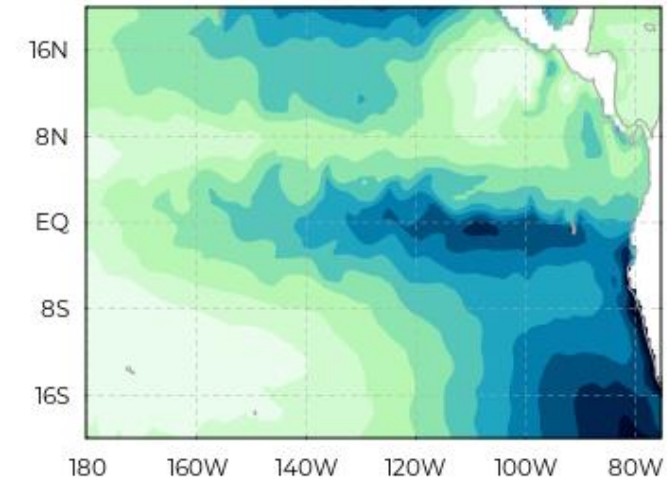
Characteristic	Description	Remarks
System name (version) and domain	IO-HOOFS; Indian Ocean ROMS	INCOIS is shifting to regional MOM6-LETKF for Indian Ocean and FVCOM for coastal waters.
Data Assimilation scheme	LETKF	
Observations being assimilated	Vertical profiles of Temperature and salinity from Argo and other ocean observation platforms, SST from GHR SST. SSS is relaxed at a monthly scale.	ADT assimilation from satellite track data is ready to be operationalized.
Forecast length	3-hourly forecast for 5 days	
Do you provide analysis ? If yes, details	Indian Ocean high resolution analysis of temperature, salinity and currents.	Available since Aug 2016.
Any changes from last report	ADT assimilation is ready	

Overview of status and advances for current JMA operational systems



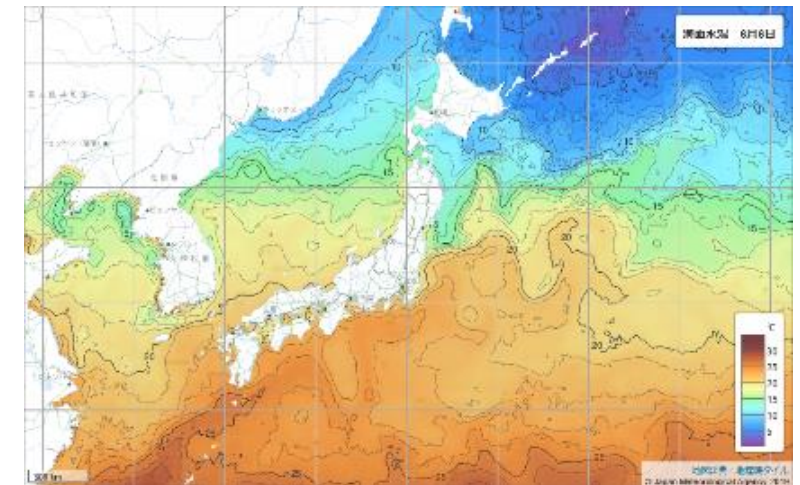
Global system - MOVE/MRI.COM-G3

- Analysis model (**G3A**)
 - Resolution: $1^\circ \times 0.3-0.5^\circ$
 - 4DVAR for T/S, 3DVAR for sea-ice
- Forecast model (**G3F**)
 - Resolution: $0.25^\circ \times 0.25^\circ$
 - Initialized with G3A through IAU downscaling



Regional system

- Analysis model - **MOVE/MRI.COM-NP**
 - Domain: North Pacific ($15^\circ\text{S}-65^\circ\text{N}$, $100^\circ\text{E}-75^\circ\text{W}$)
 - Resolution: 10km ($1/9^\circ \times 1/11^\circ$)
 - 4DVAR for T/S, 3DVAR for sea-ice
- Forecast model - **MOVE/MRI.COM-JPN**
 - Domain: Japan Area ($20-52^\circ\text{N}$, $117-160^\circ\text{E}$)
 - Resolution: 2km ($1/50^\circ \times 1/33^\circ$)
 - Initialized with MOVE-NP through IAU downscaling



Advances in the ocean model (2022)

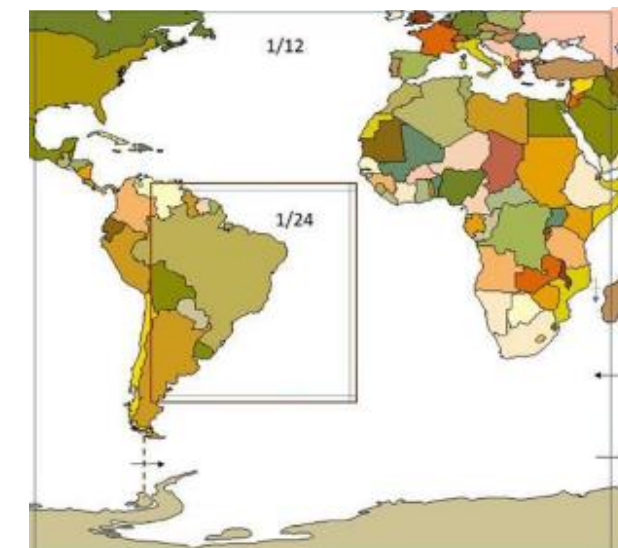
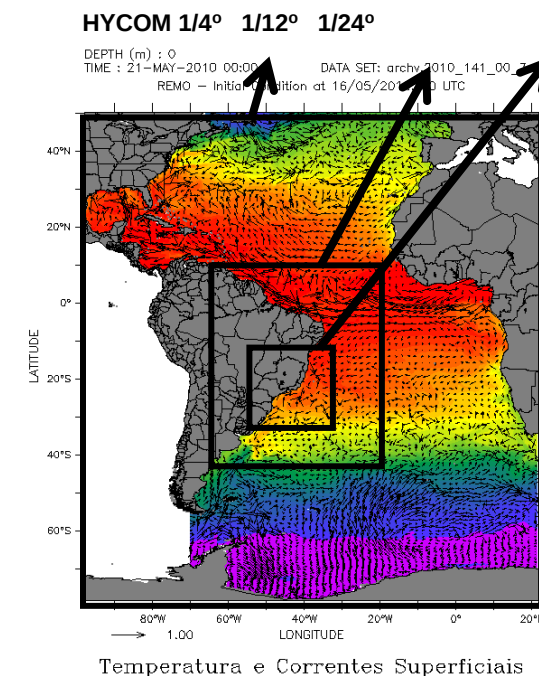
- Upgrade to MRI.COM v5
 - Introduction of new time integration scheme: a third-order predictor-corrector scheme (LFAM3)

Latest system upgrades and achievements in last 6 months

- No major updates implemented in the Brazilian Navy Hydrography Center (CHM)
- operational system composed by HYCOM and the REMO Ocean Data Assimilation System (RODAS) (HYCOM+RODAS) based on EnOI with 126 members
 - HYCOM+RODAS is running in 2 different nested grid systems: one with $1/4^\circ - 1/12^\circ - 1/24^\circ$ L21 available in the CHM site, and another with $1/12^\circ - 1/24^\circ$ L32 not available in the internet
 - Daily 5-day forecasts forced by GFS NCEP/NOAA in the large domain and COSMO/CHM in Metarea V ($34^\circ\text{S}-7^\circ\text{N}$, west of 20°W) with 10 km resolution
 - RODAS assimilates SST analyses from OSTIA, along track SLA and Argo and Deep Argo T/S profiles twice a week. In the other weekdays, 24 h forecasts are used as initial condition

What are the plans for the next 6 months?

- Continue working in collaboration with universities to develop a detection/forecasting system of trajectories of oil in the sea for Metarea V. Detection will be automatic with satellite images and AI technique. MOHID and CMOP models. First versions to be ready by the end of 2023.
- Continue working on the EnKF and OSSEs with SWOT.



REMO – Oceanographic Modeling and Observation Network

WW3

■ Wave Watch 3

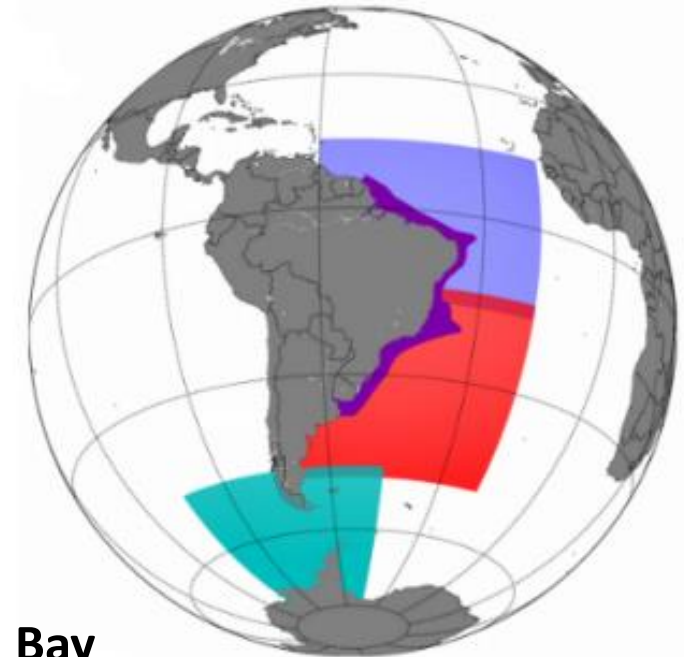
- Two runs per day (00Z and 12Z) forced by GFS/NCEP/NOAA
- Global: $1/3^\circ$; Antarctica: 0.1° ; METAREA V South: 0.1° ; METAREA V North: 0.15°

■ ADCIRC – SWAM (00Z)

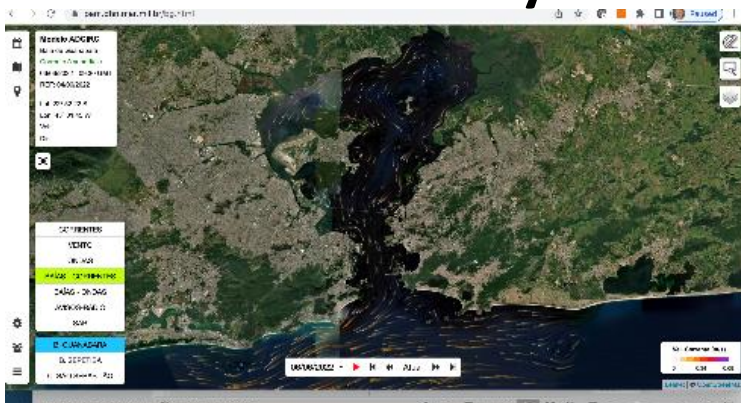
- Guanabara Bay; São Sebastião Cape; Sepetiba Bay currents, winds and waves
- Santos Port and Paranagua Port under development
- Products available for visualization at <https://pam.dhn.mar.mil.br>

■ Coupled Model for Oil Spill Prediction (CMOP) - Under Development

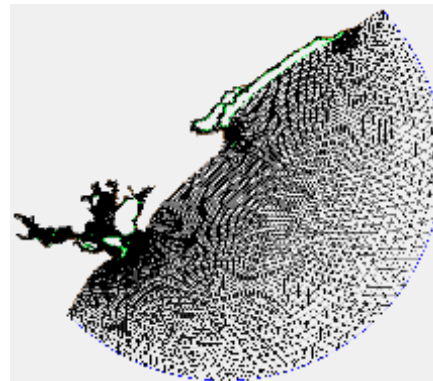
- 3D Lagrangian particle oil spill, transport and fate model



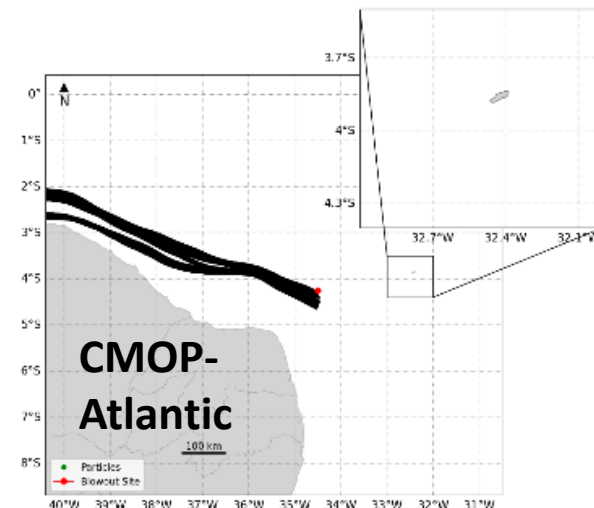
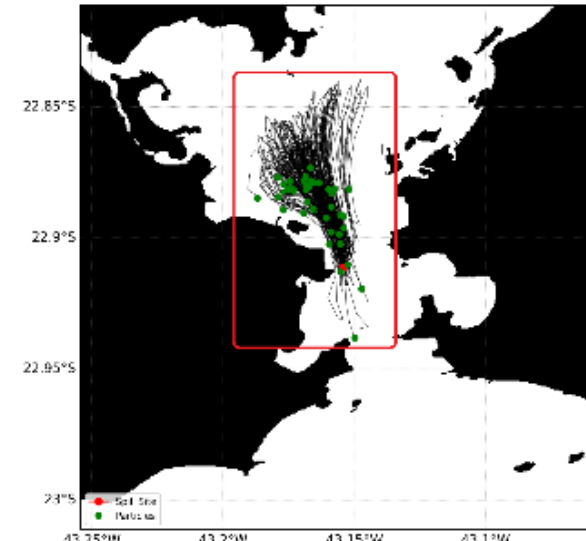
ADCIRC – SWAM Guanabara Bay



Sepetiba Bay

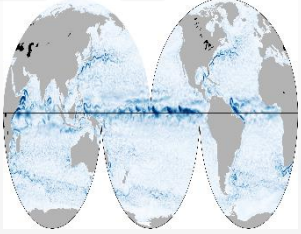


CMOP- Guabanbara Bay



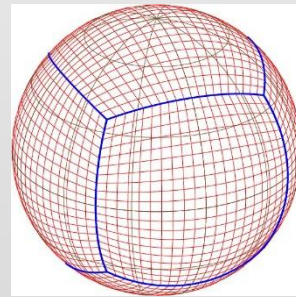
updates of NMEFC China

Mass Conservation Ocean Model

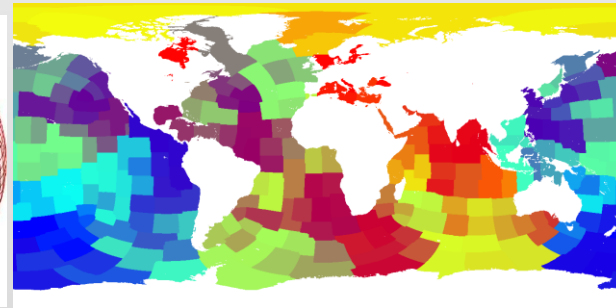


MaCOM

- ◆ A new pressure coordinate Ocean Model
- ◆ Multi-grid included tripole, cubic with global and regional
- ◆ High quality partition for parallel computing and load balancing
- ◆ GPU Acceleration



Spherical cube grid



high quality partitioning for parallel computing

Mass Conservation

$$\rho_1 h u_1 \delta t = \rho_2 h u_2 \delta t$$

$\Downarrow$

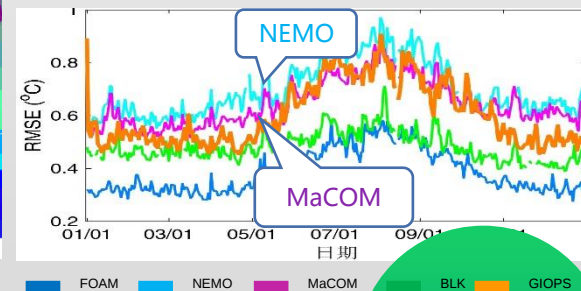
$$h = \frac{P}{\rho g} \quad \text{static equilibrium}$$

$\Downarrow$

$$\rho_1 \frac{P}{\rho_1 g} u_1 \delta t = \rho_2 \frac{P}{\rho_2 g} u_2 \delta t \quad \Rightarrow \quad \nabla_P \cdot (u) = 0$$

no assumptions with $\rho_1 = \rho_2 = \rho_0$

RMS errors for SST by IVTT data



Future

May 2022 operational upgrade

- Global weather forecasts now come from coupled ocean-atmosphere system with $1/4^\circ$ ocean and 6-hourly cycling
- UK weather forecasts use forecast SST from 1.5 km regional model
- Updated mean dynamic topography and observation processing for global and regional models
- Wave models upgraded to WAVEWATCH III v7.12

Italy CMCC GLOBAL OCEAN EDDYING FORECASTING SYSTEM AT 1/16 (GOF516)

▪ Latest system upgrades and achievements in last 6 months

- ✓ The system entered the OceanPredict ensemble in 2021 for the comparison of T,S,SLA.
- ✓ Minor updates concern
 - Bug resolved: the global constant bias of SLA (~2cm) was reduced. The bias was due to a wrong treatment of the global mdt average value (not properly removed).

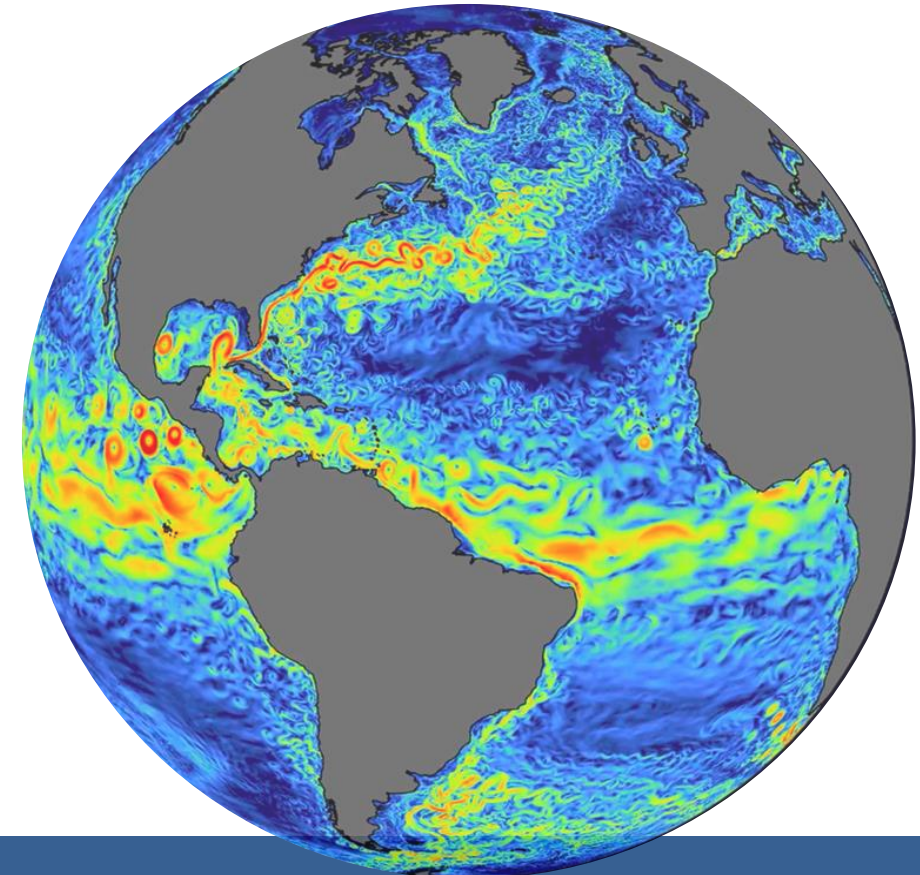


▪ Are the tables for your system on OceanPredict.org up to date

- Oceanpredict webpage is updated for GOF516

▪ What are the plans for the next 6 months?

- The inclusion of new physical schemes from NEMO4.2 :
 - New vertically varying coordinates and mixing scheme will be tested together with high-resolution atmospheric forcing
 - Sea-ice categories will be tested within the new sea-ice model SI³
- The assimilation of new SLA data from Sentinel6 will be included in OceanVar



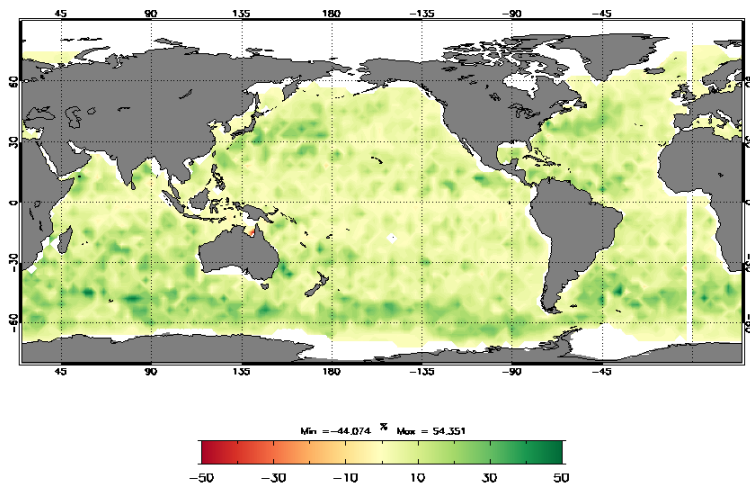
A major release is planned for the end of 2022. The objective is to improve, among others, the analysis and forecast skills, the representation of mesoscale activity, the mass/steric distribution (loss of mass and too much steric in the current system), the equatorial dynamics and interaction with biogeochemistry. This release will include:

- A new version of NEMO (more coherent bulk formulation, more advanced sea ice model with the possibility to represent the ice in different categories).
- The use of high resolution spatial and temporal atmospheric forcing.
- The assimilation of L3 ODYSSEA SST product instead of L4 OSTIA.
- The use of a refined Mean Dynamic Topography allowing, among others, to better represent the equatorial dynamics.
- The use of a new anomalies base from GLORYS12 Mercator reanalysis.
- The use of a 4D approach with the data assimilation scheme, allowing an improvement in the spatiotemporal continuity of mesoscale structures.
- The use of assimilated “super-observations” to filter out scales that the model does not resolve.
- An improvement of mass/steric separation during data assimilation with the inclusion of monthly corrections of GMSL instead of a trend.
- An improvement of the parameterizations of the temperature and salinity bias correction method.

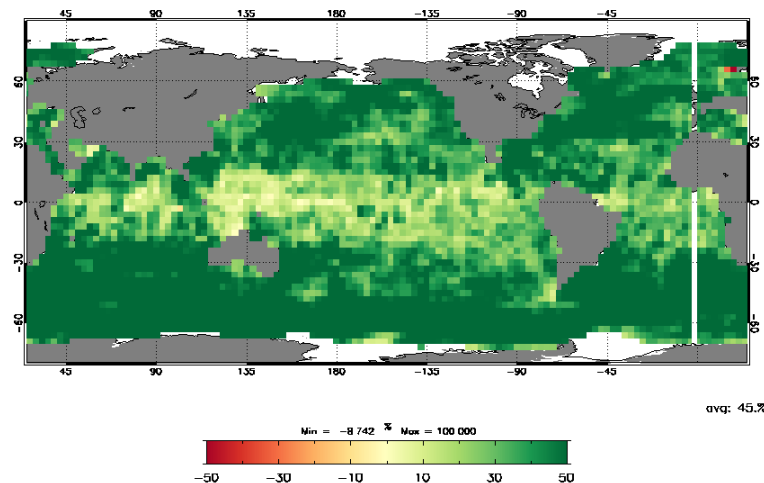
Performances of the system

The influence of SLA and SST L3S on the multivariate analysis, which is the slope between increment and innovation, is strong in the new system (a slope > 40% is ideal)

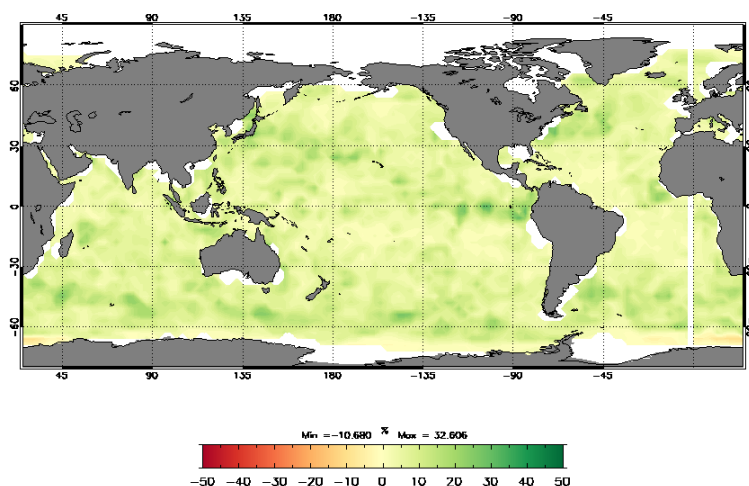
Influence of SLA (old system PSY4)



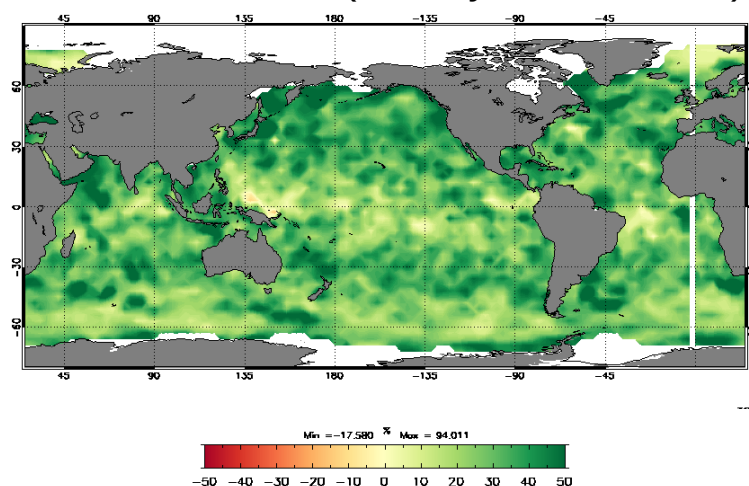
Influence of SLA (new system GLO12)



Influence of SST (old system PSY4)

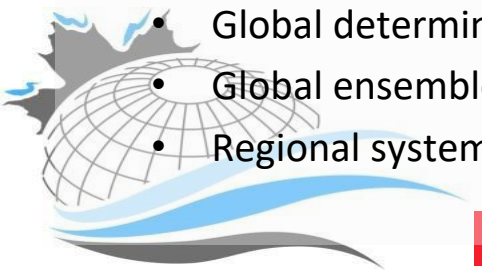
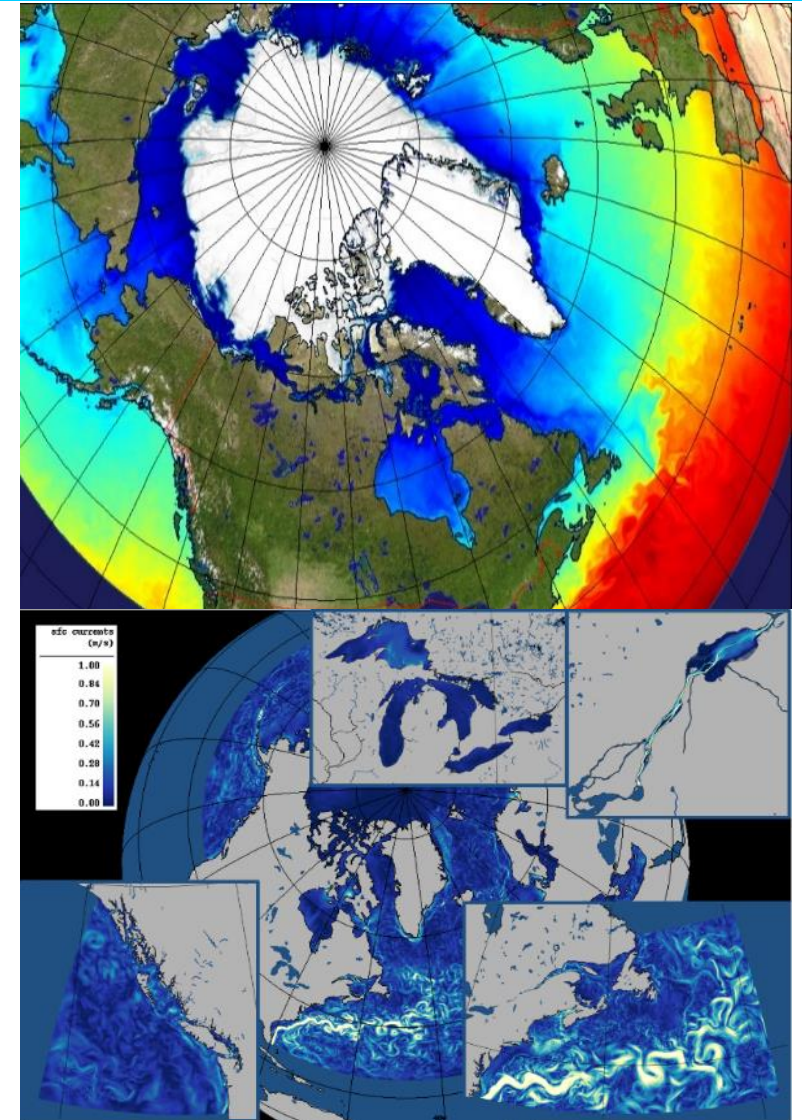


Influence of SST (new system GLO12)



CONCEPTS Prediction Systems

- **Global**
 - Coupled Global Deterministic Prediction System (GDPS; 10d)
 - Coupled Ensemble Prediction System (GEPS; 16d and 32d)
 - Seasonal to Interannual (CanSIPS)
- **Regional**
 - 1/12 ° Pan-Canadian (RIOPS; 84hr)
 - 1/36° East and West Coast (CIOPS; 48hr)
 - 1km Great Lakes (WCPS; 48hr coupled with atm and hydrology)
 - Finite element St. Lawrence River (SHOP)
- **Port Models**
 - St. John Harbour, Canso, St. Lawrence Estuary, Vancouver, Kitimat, Fraser River
- **Storm Surge (NEMO)**
 - Global 1/12 ° (GDSPS)
 - Regional ensemble (RESPS East Coast)
- **Wave model (WW3)**
 - Global deterministic 1/4 ° (GDWPS)
 - Global ensemble (GEWPS)
 - Regional systems (East and west coast and Great Lakes)



Fisheries and Oceans
Canada

Pêches et Océans
Canada



Environment
Canada

Environnement
Canada



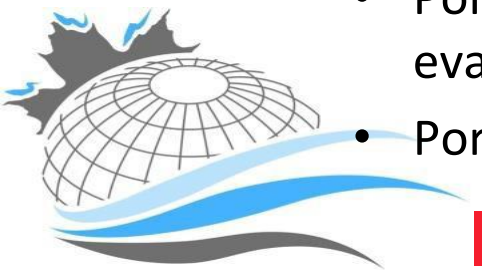
National
Defence

29
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Update on CONCEPTS Prediction Systems

Report of Work Achieved in 2021-22

- **Improvements to all operational systems implemented for Innovation Cycle 3 (Dec. 2021)**
 - Large improvement to water mass properties in RIOPS
 - CLOPS east has significant improvement in tides, water masses and surface properties
 - CLOPS west has embedded Salish Seas 500m config (MEOPAR collaboration)
 - WCPS extended to include CLOPS-E domain and **GSL coupled model discontinued**.
 - **New** west coast wave model using unstructured grids: 5 km offshore to 1 km in coastal waters
 - WW3 for East coast: Large improvement of significant wave height over WAM model
 - **New** NEMO Global storm surge system (GDSPS), compares well to RDSPS and other global surge systems
- **OPP Port Models**
 - Port models for all 6 ports have now been setup in Maestro sequencer and hindcast and forecast evaluations are nearly complete.
 - Port models transferred to CHS for operational development





Search and rescue

United States coast guard have provided feedback of positive outcomes in SAR events in the Pacific Ocean using OceanMAPS currents within their SAROPS system.

Feb 2021 – Two fisherman in a Panga located at the **Ngitak atoll**

Jul 2021 – Three people in 18 ft aluminium boat located **Tarawa, Kiribati**

Aug 2 – Three sailors located on **Puluwat atoll**



Australian Defence Force

Decade and Collaborations

- Looking to propose Decade Project
 - Best Practices for Ocean Prediction System Reporting (2-3 year project)
- Interact with other programmes (DITTO, ForeSea, CoastPredict, etc)
- Interact with Task Teams

QUESTIONS?

Full National Reports PPT available at

<https://drive.google.com/drive/folders/1dlbyAP2lAtyjdKLVgVh3n5d3LiHJpMf-?usp=sharing>