

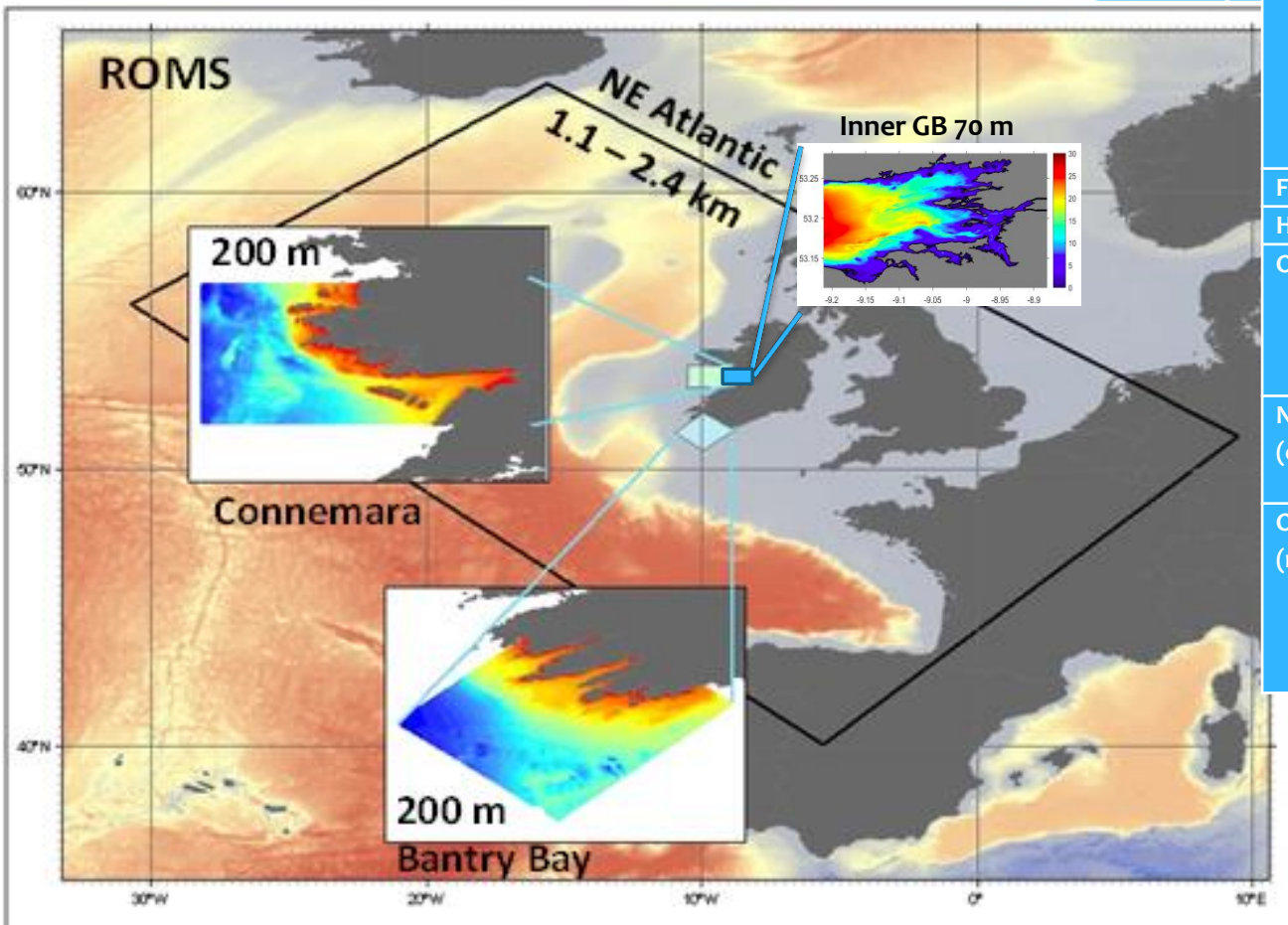
Operational forecasting models for Irish regional and coastal waters and their applications

Tomasz Dabrowski, Kieran Lyons, Diego Pereiro, Hazem
Nagy, Joseph McGovern, Glenn Nolan

Marine Institute, Rinville, Oranmore, Co. Galway, Ireland

COSS-TT meeting Montreal 2-4 May 2023

Marine Institute's operational forecasting models



Bathymetry	GEBCO & INFOMAR
Forcing	<ul style="list-style-type: none"> • 1-Hourly ECMWF 0.1° • Copernicus global ocean $1/12^\circ$ • TPX08 tides $1/30^\circ$ • River climatologies, Corrib operational
Forecast Period	+3 days (daily)
Hindcast Period	-7 days (weekly)
Output	<ul style="list-style-type: none"> • 3D velocities, ssh, stresses @ 1 hourly • T, S @ 3 hrs spatially • 2265 stations @ 10 mins
Nested Domains (operational)	<ul style="list-style-type: none"> • Connemara (200m) • Bantry Bay (200m) • Inner Galway Bay (70 m)
Other Domains (non-op)	Clew Bay (80m), Berthraghboy Bay (50m), Kenmare Bay (120m), Kilmakilloge Harbour (40m), SW Ireland (1 km)

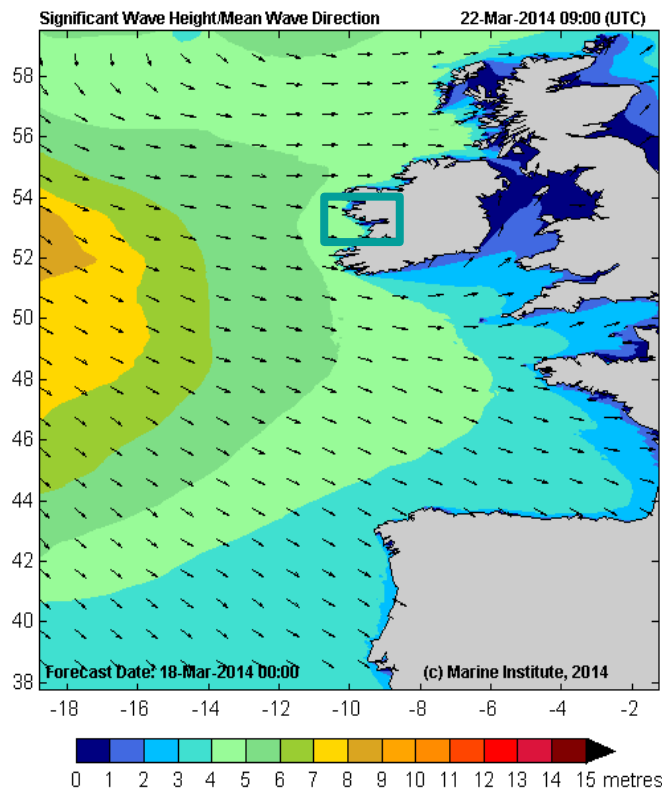
Under dev:

- Celtic Sea

Future:

- Dublin Bay, main fisheries harbours

Marine Institute operational forecasting wave models



Model code	SWAN
Model Grid	Rectangular 0.025° and 200 m
Bathymetry	GEBCO & INFOMAR
Forcing	<ul style="list-style-type: none"> • 1-Hourly ECMWF 0.1° • Copernicus GLO wave model
Forecast Period	+6 days (daily)
Hindcast Period	-7 days (weekly)
Output	<ul style="list-style-type: none"> • significant wave height, wave period, wave spectra • @ 3 hrs spatially • 20 stations @ 0.5hr
Other Domains	West Coast 0.004°

Freshwater inputs

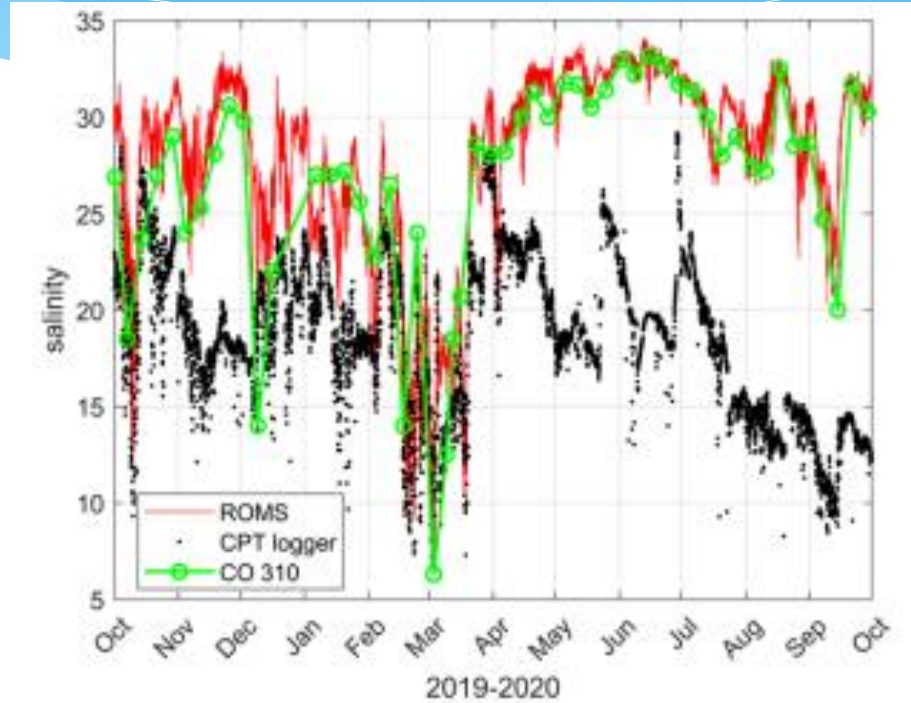
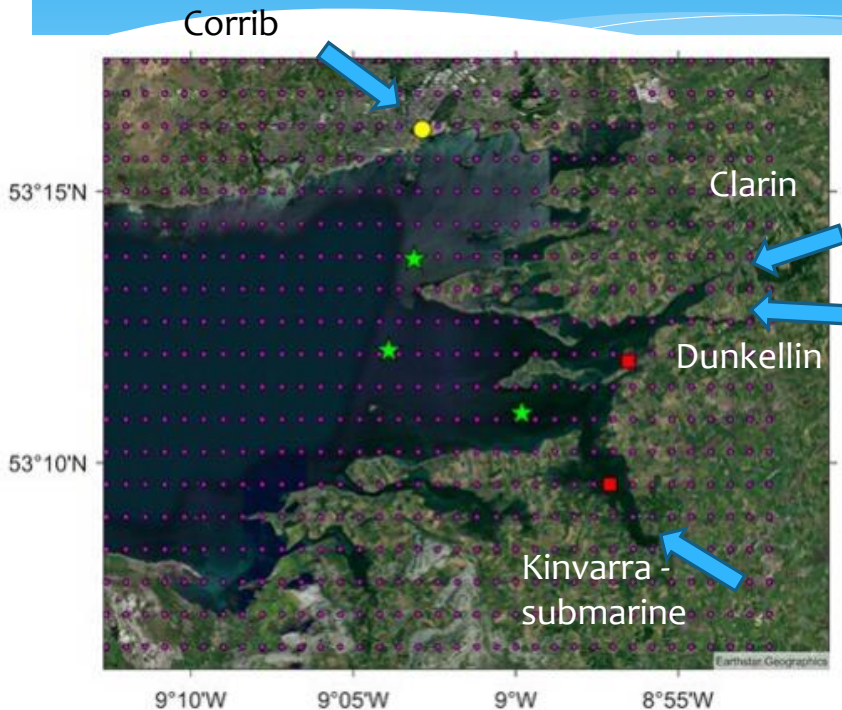
- Daily climatologies were used until recently
- Recent upgrades include specification of near-real-time flows for Irish rivers. Sources:
 - <https://waterlevel.ie/> - flows are published there operationally. For one river we apply a rating curve to convert stage to a flow.
 - Electrical Supply Board (ESB) - provide daily/hourly hydrometric information for each of the hydro schemes managed by ESB. Published in PDF format – we read the flow from PDF

Flows are then fixed for a duration of the forecast and updated next day.



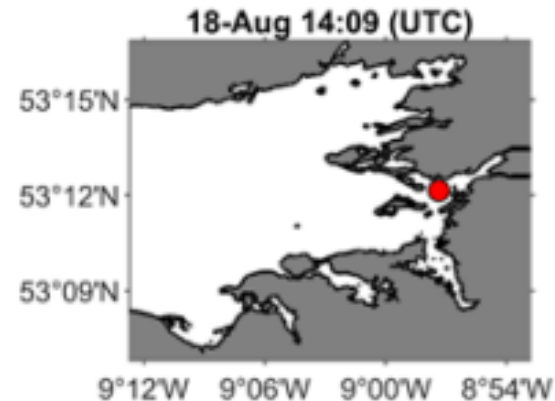
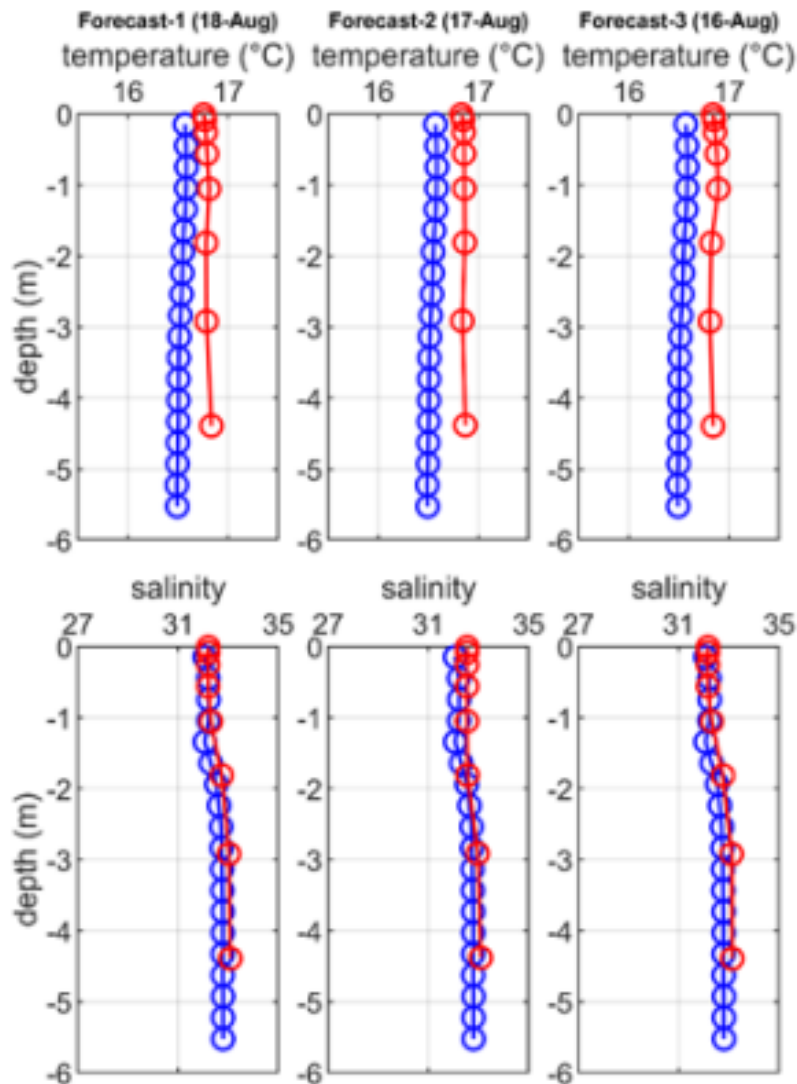
Total LTA discharge
from Irish rivers =
806.9 m³/s

Freshwater inputs – Galway Bay



All inputs are near-real-time from the rating curves.

Freshwater inputs – Galway Bay



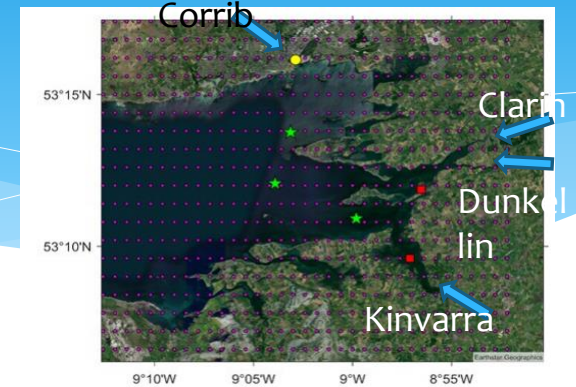
Temp.	F-1	F-2	F-3
MAE	0.25 °C	0.31 °C	0.30 °C
RMSD	0.26 °C	0.31 °C	0.30 °C
CORR	-0.44	0.16	0.78
Max(e)	0.33 °C	0.36 °C	0.34 °C
n	15	15	15

Salt	F-1	F-2	F-3
MAE	0.23	0.26	0.26
RMSD	0.25	0.29	0.29
CORR	0.95	0.92	0.95
Max(e)	0.41	0.48	0.41
n	15	15	15



Wetting-drying & high res

Galway Bay, Clew Bay, Connemara



Context

Inner Galway Bay **subtidal** area **10,352 ha**

Inner Galway Bay **intertidal** area **2,111 ha**

200 m

200 m

70 m

	CONNEMARA OPERATIONAL				CONNEMARA WET & DRY				GALWAY BAY			
	CORR	RMSE	STDN	ARMAE	CORR	RMSE	STDN	ARMAE	CORR	RMSE	STDN	ARMAE
ADCP A (u)	0.955	0.031	1.097	0.182	0.956	0.028	1.027	0.160	0.962	0.026	0.974	0.127
ADCP A (v)	0.757	0.031	2.194	0.973	0.714	0.035	2.328	1.155	0.771	0.027	1.966	0.732
ADCP B (u)	0.951	0.031	1.060	0.186	0.944	0.032	0.924	0.182	0.951	0.030	0.971	0.173
ADCP B (v)	0.066	0.029	0.329	0.583	0.292	0.027	0.218	0.522	0.289	0.027	0.369	0.519
ADCP C (u)	0.930	0.066	1.356	0.443	0.939	0.099	1.707	0.748	0.963	0.036	1.105	0.191
ADCP C (v)	-0.222	0.031	1.537	1.186	-0.036	0.035	1.950	1.340	-0.115	0.026	1.247	0.856



Nesting in Copernicus IBI & NWS

Connemara

Motivation: to avoid having to go through an intermediate step of the NE Atl model when forcing coastal scale models

- 10 min. forcing from NE ATL vs. 1-hourly from IBI and NWS
- A short 6-weeks test carried out.

Basic conclusion: the skill of the Connemara model when forced by IBI or NWS boundary data is similar to that of the operational model (and superior when it comes to tidal heights).

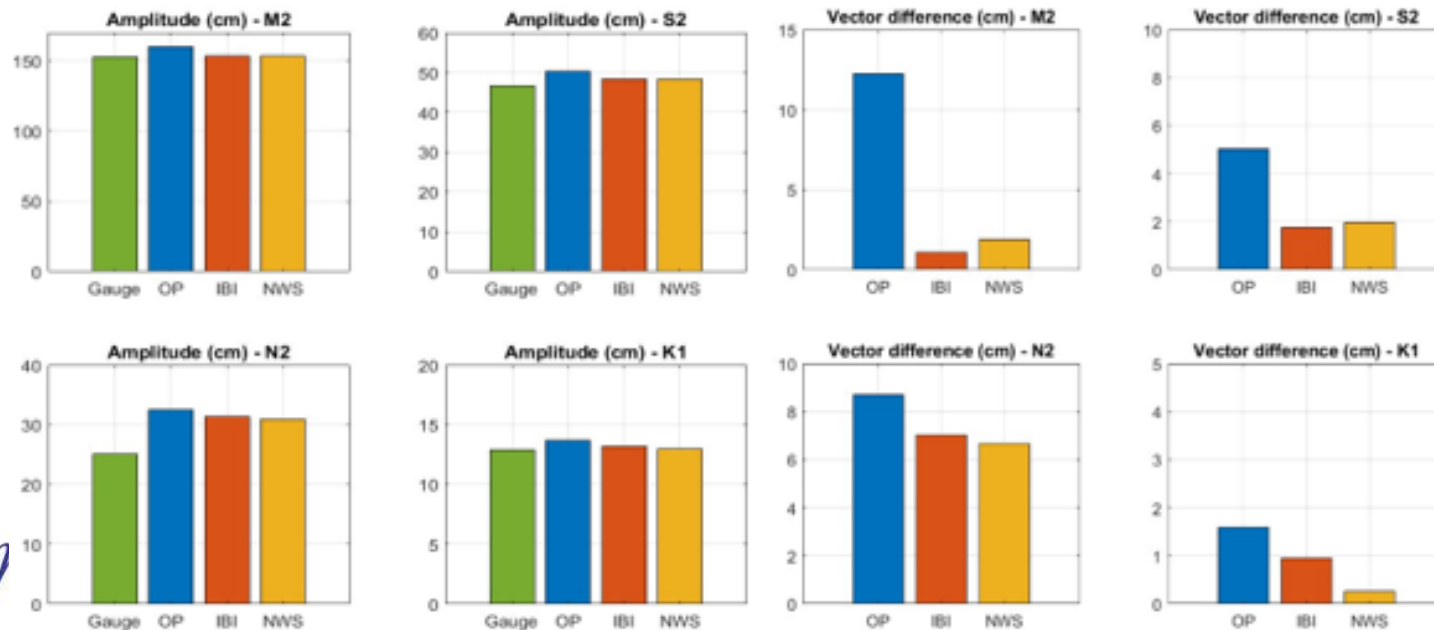
Nesting in Copernicus IBI & NWS

Connemara

Validation of SST at Spiddle Buoy

	BIAS	RMSE	Correlation
Operational	-0.23	0.51	0.54
IBI	-0.09	0.45	0.57
NWS	-0.12	0.45	0.57

Validation of tides at Galway Port



Wave model - SWAN

Upgrades in recent years:

- Transition from GFS to ECMWF wind forcing
- From WaveWatch III to the Copernicus at open boundaries – no significant difference in skill
- Development of an operational Connemara wave model

NE ATL Wave model – from GFS to ECMWF

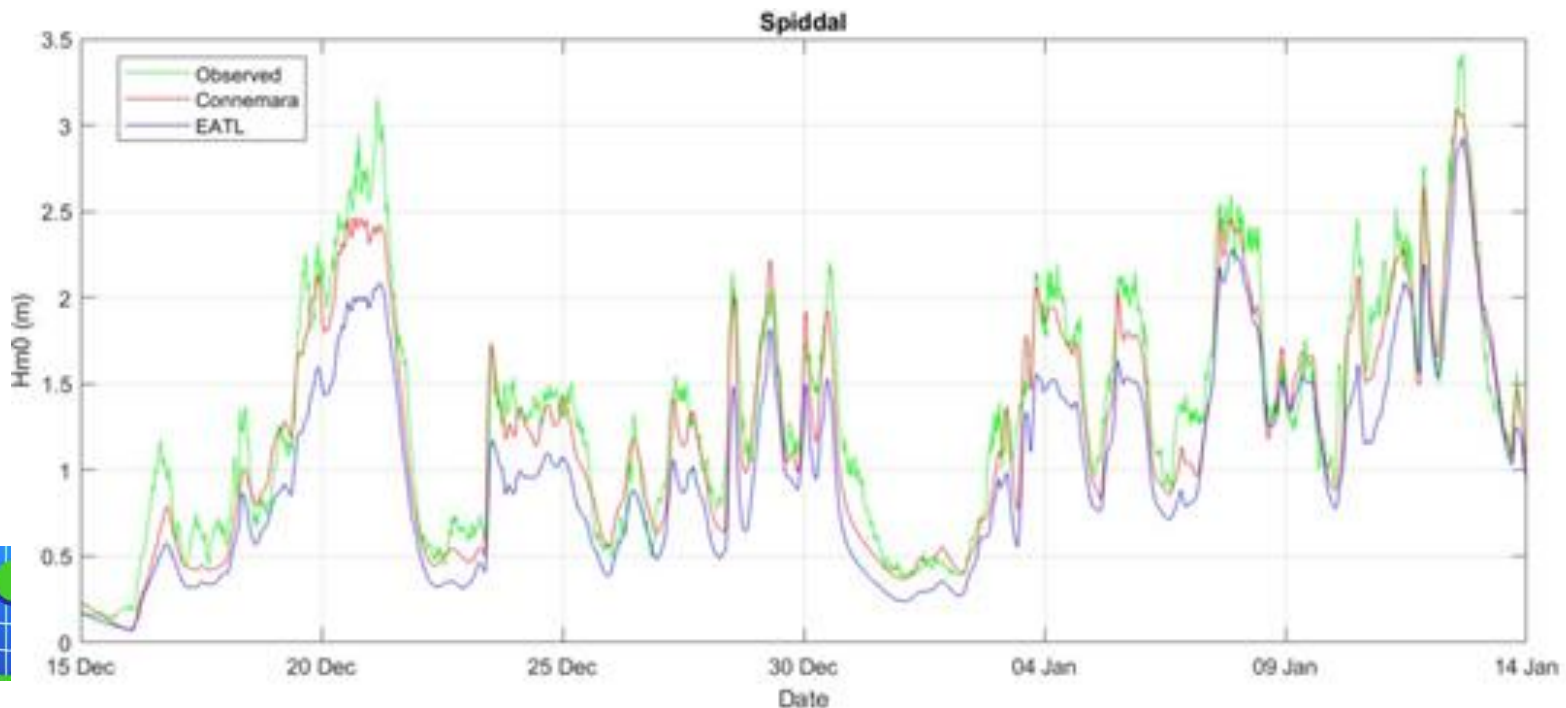
Hm0 skill

	RMSE		BIAS		Correlation Coefficient	
	GFS	ECMWF	GFS	ECMWF	GFS	ECMWF
M2	0.19	0.19	-0.02	-0.04	0.96	0.96
M3	0.50	0.46	0.07	0.02	0.94	0.96
M4	0.52	0.47	-0.11	-0.18	0.92	0.95
M5	0.24	0.24	-0.08	-0.09	0.97	0.97
M6	0.47	0.38	0.17	0.11	0.96	0.97
Spiddal	0.24	0.23	-0.15	-0.14	0.92	0.93
Belmullet Inner	0.45	0.45	-0.18	-0.22	0.92	0.93
Belmullet Outer	0.52	0.50	-0.19	-0.24	0.92	0.94
AVERAGE	0.39	0.36	-0.06	-0.09	0.93	0.95



Connemara vs. NE ATL wave models

Buoy	Hm0 (m)						Tm02 (s)						Tp (s)					
	Bias		RMSE (NRMSE %)		R		Bias		RMSE (NRMSE %)		R		Bias		RMSE (NRMSE %)		R	
	Conn	Eatl	Conn	Eatl	Conn	Eatl	Conn	Eatl	Conn	Eatl	Conn	Eatl	Conn	Eatl	Conn	Eatl	Conn	Eatl
Spiddal	-0.07	-0.18	0.16 (16)	0.27 (27)	0.97	0.95	-0.08	-0.45	0.99 (26)	0.92 (24)	0.57	0.72	1.24	2.80	3.34 (44)	4.64 (61)	0.53	0.42
Finnis	0.11	0.33	0.27 (19)	0.51 (35)	0.95	0.93	0.11	0.68	0.77 (17)	1.20 (27)	0.82	0.84	0.82	1.07	2.91 (28)	3.04 (29)	0.64	0.62



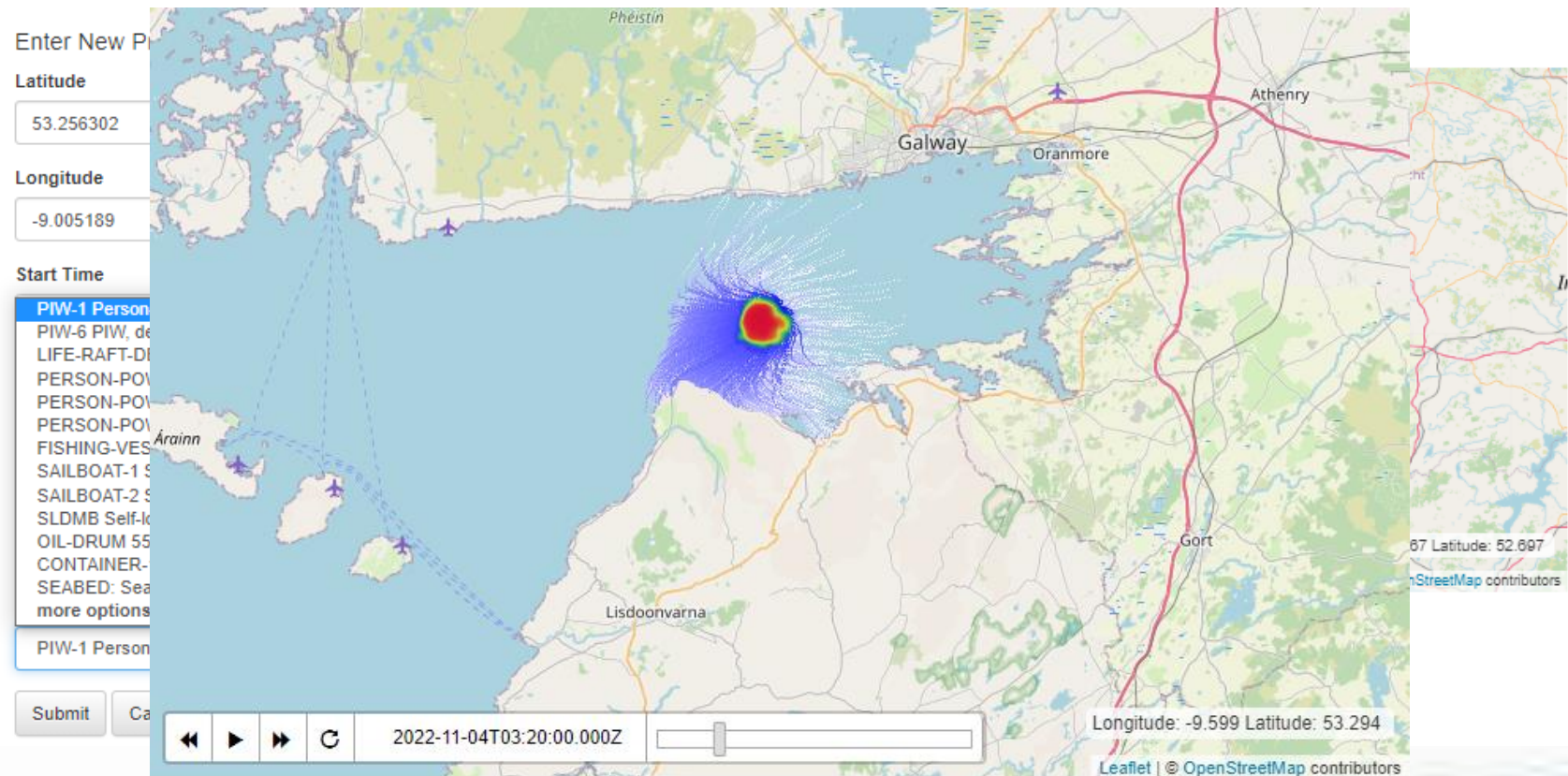
Selected operational services

ADRIFT with OpenDrift

Implemented in Galway Bay, Tamar, Plymouth coast, English Ch.

ADRIFT

Marine Institute predicted sea surface tracking.



Weather window tool

Weather Window



Select a Dataset
MI SWAN East Atlantic

Select a Bay
Killary Harbour

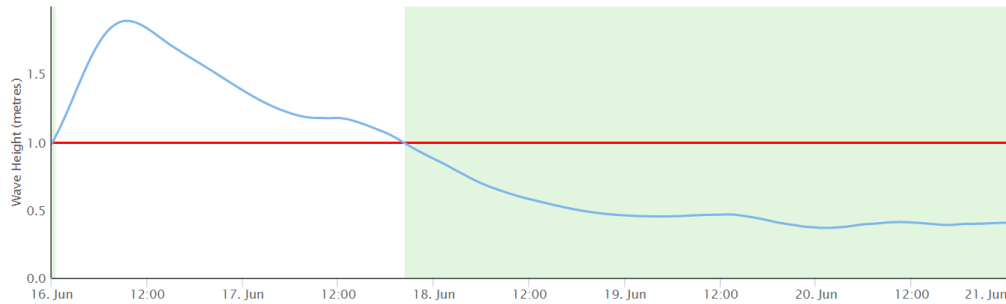
Cut-Off Hei...
1

From:
16-06-202

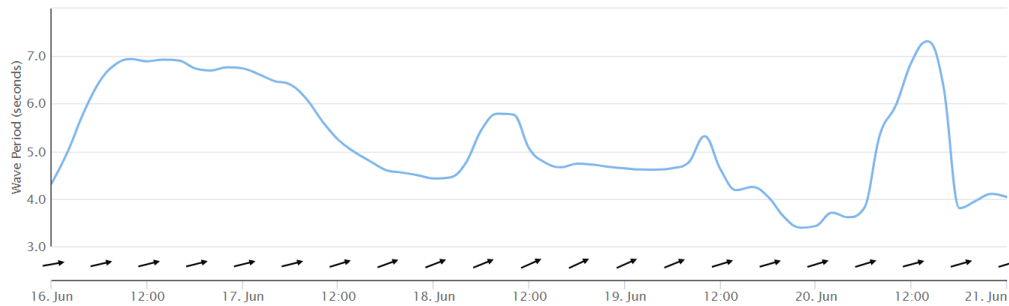
To:
21-06-202

LOAD CHARTS

Significant Wave Height



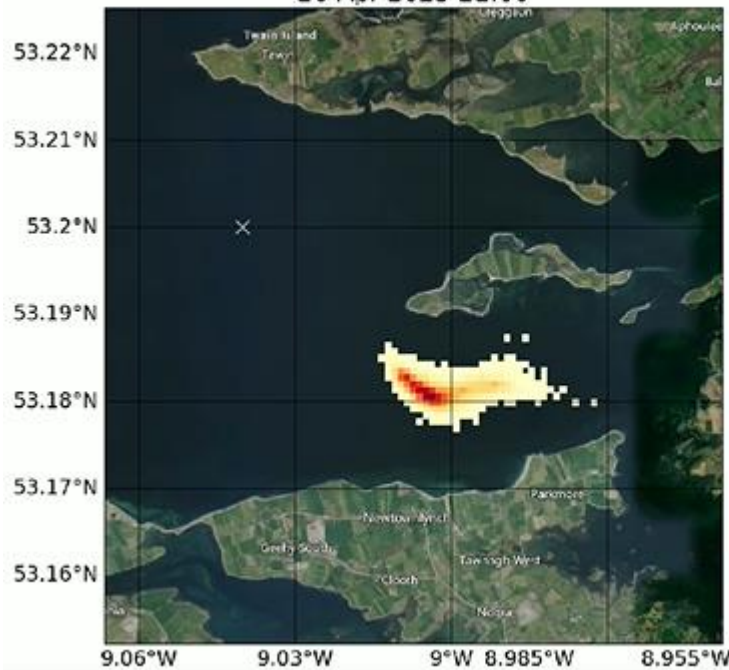
Mean (Average) Wave Period & Direction To



Oyster aquaculture and restoration in Galway Bay

Contamination Source Retrieval

Particle density index:
26-Apr-2023 21:00



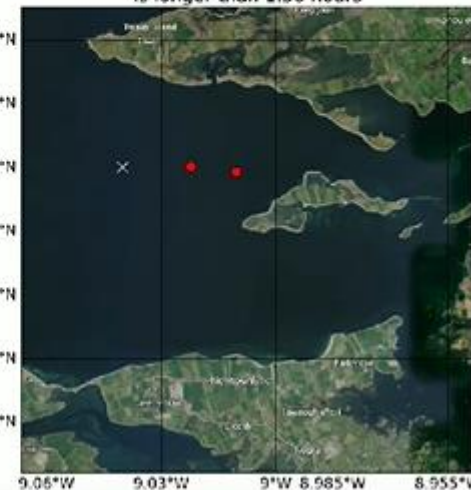
CONTAMINANT SOURCE RETRIEVAL SERVICE

Bulletin generated on: Thu Apr 27 16:51:50 2023
Area: Galway Bay
Your coordinates $x = -9.04^{\circ}$; $y = 53.2^{\circ}$
Simulation length: 0.25 days

Single Particle map:
26-Apr-2023 21:00



Areas where Local Exposure Time
is longer than 1.50 hours



mapbox





© Mapbox © OpenStreetMap Improve this map

Oyster aquaculture and restoration in Galway Bay

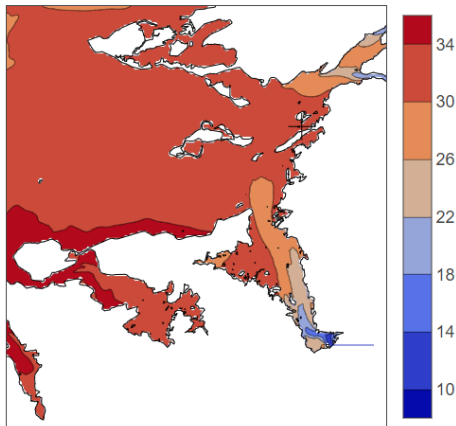
Marine Conditions Mapping Service – particular interest in low salinity events

Killeenaran on 2023-Apr-27 16:00

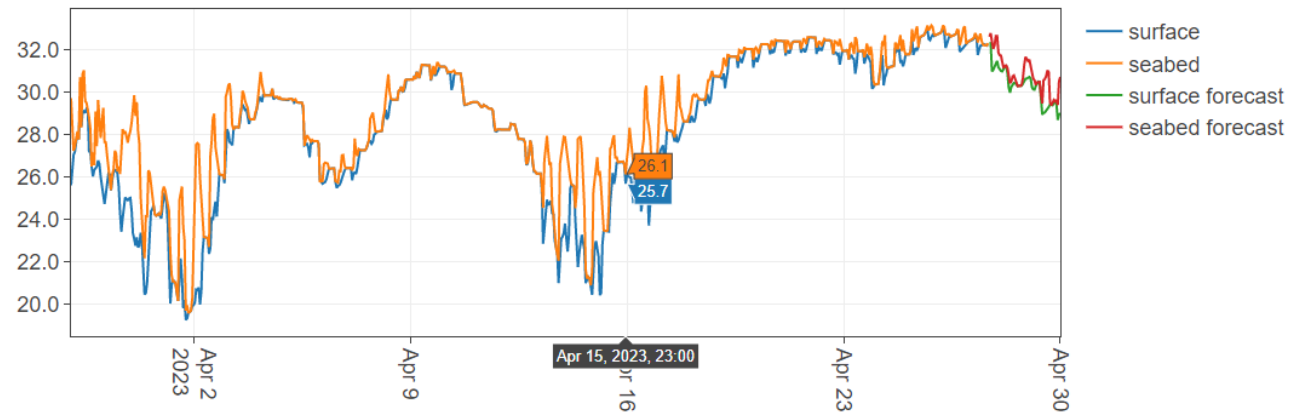
Killeenaran 3-day Forecast

	Surface	12.0 °C	Surface min.	11.2 °C	Surface max.	13.7 °C
	Seabed	12.0 °C	Seabed min.	11.3 °C	Seabed max.	13.8 °C
	Surface	32.2	Surface min.	28.7	Surface max.	32.3
	Seabed	32.3	Seabed min.	29.4	Seabed max.	32.8

Surface salinity on 2023-Apr-27 00:00



Seawater salinity at Killenaran



Thank you

Model outputs:

<http://milas.marine.ie/thredds/catalog.html>

<https://erddap.marine.ie/erddap/index.html>

COSS-TT meeting Montreal 2-4 May 2023



Marine Institute
Foras na Mara