WORLD OCEAN CIRCULATION
USER CONSULTATION MEETING

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Testing Ocean Circulation Products with an Ecosystem Model and Biological and fisheries Data

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An hybrid modeling framework to combine:

- the progress in ecological sciences to describe ocean pelagic ecosystem and species habitats and behaviour;

- The progress in ocean (physical and biogeochemical) modeling;

- the progress achieved in stock assessment models for quantitative estimation of population dynamics parameters models (MLE).
Ocean Circulation for Ecosystem and Fisheries

2D - 3-layer environment:

**INPUT:**
Temperature, Currents, Primary production, Euphotic Depth, Dissolved O2
⇒ Zooplankton, micronekton

habitats + movements
Integrated over day-night conditions in the 3 vertical layers

1 – Modeling of low and mid-trophic levels
2- Modeling of Species Habitat and population dynamics and fisheries

2D – Habitat and population dynamics
(monitoring; Assessment; Indicators)
Ocean Circulation for Ecosystem and Fisheries

Modeling of low and mid-trophic levels

Temperature; currents; Primary production

Available in April in the COPERNICUS-MEMS catalogue
Ocean Circulation for Ecosystem and Fisheries

Applications to Species Habitat and movement Modeling

Management issue: By-catch of (protected) marine turtles in tuna fisheries

Objective: Provide fishermen with realtime maps of risk of turtle bycatch (and avoid fishing closure)

Press Release – Closure of Swordfish Fishery Underscores Sea Turtle Management Success (May 11, 2018)

By wpcouncil

HONOLULU (11 May 2018) The Hawaii shallow-set longline fishery for swordfish has reached 33 of 34 allowed loggerhead sea turtle interactions for 2018 and was closed today by the National Marine Fisheries Service until Jan. 1, 2019, as a settlement agreement approved by the US District Court, District of Hawaii. Hawaii produces half of the US domestic swordfish.
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Applications to Species Habitat and movement Modeling

Displacement during May 2005 -> May 2006 (final position= red dots)

29 turtles released

Loggerhead turtle Habitat modeling (Abecassis et al., 2013)

Predicted Habitat + obs

Simulated density of animals + obs

Operational products (GLORYS U&V;T) and sat. PP of sufficient quality to develop useful applications in open ocean (sub-tropical to temperate area)
Applications to Species Habitat and movement Modeling

Management issue: Prohibits injury or disturbance of marine mammals by US citizen worldwide (U.S. Marine Mammal Protection Act)

Objective: Provide regular updates of Marine mammal species habitats
Applications to Species Habitat and movement Modeling

Density maps are produced by statistical models (e.g., J. Roberts, Duke Univ)

The introduction of deep micronekton as new explanatory variables yielded better fitting density models than lower-trophic covariates (chlorophyll) for 4 of 5 deep-divers groups or species tested (beaked whales, sperm whale, dwarf and pygmy sperm whales, pilot whales, and striped dolphin).

Consistently, models for deeper divers selected deeper SEAPODYM layers.

✓ Also valid in the deep ocean, but...

*All others were not significant and dropped from the model
Ocean Circulation for Ecosystem and Fisheries

Applications to Population Dynamics and Fisheries

Mercator-Ocean: GLORYS2v4 ocean reanalysis

OBS: Climatology
AOML (drifters)

Skipjack density (mt/sq.km)

GLORYS2v1

GLORYS2v4

GLORYS2v4_Free run (no assimilation)

P. Lehodey | ESRIN | 21/02/2019 | Slide 10
Applications to Population Dynamics and Fisheries

SKIPJACK TUNA BIOMASS & FISHERIES with SEAPODYM

Predicted exploitable (30-70 cm FL) skipjack density (t/km²) at resolution ¼° x week (2013-2015) and observed total catch (monthly)

Operational modeling
real time + data
assimilation + high resolution

Currents in the equatorial regions are corrected with the mean state of the free run...
Recommendations

• Reanalyses and realtime products for ocean circulation become used by marine ecologists and fisheries scientists for management and conservation of species

• Realistic mesoscale circulation consistent with satellite derived primary production is needed to work with statistical approaches using biological/fisheries data

• Though there is obvious progress, ocean reanalyses with data assimilation have still problem with the equatorial surface and deep circulation

• as long as the problem is not fully solved in the equatorial circulation a (temporary) solution should be proposed by the providers (with explanations), not the end-users!

• Problems have been also detected in region of complex bathymetry (not shown) at resolution of $\frac{1}{4}^\circ$. 1/12$^\circ$ seems to improve based on preliminary results