Global Ocean Modeling And How To Link To National Inventories

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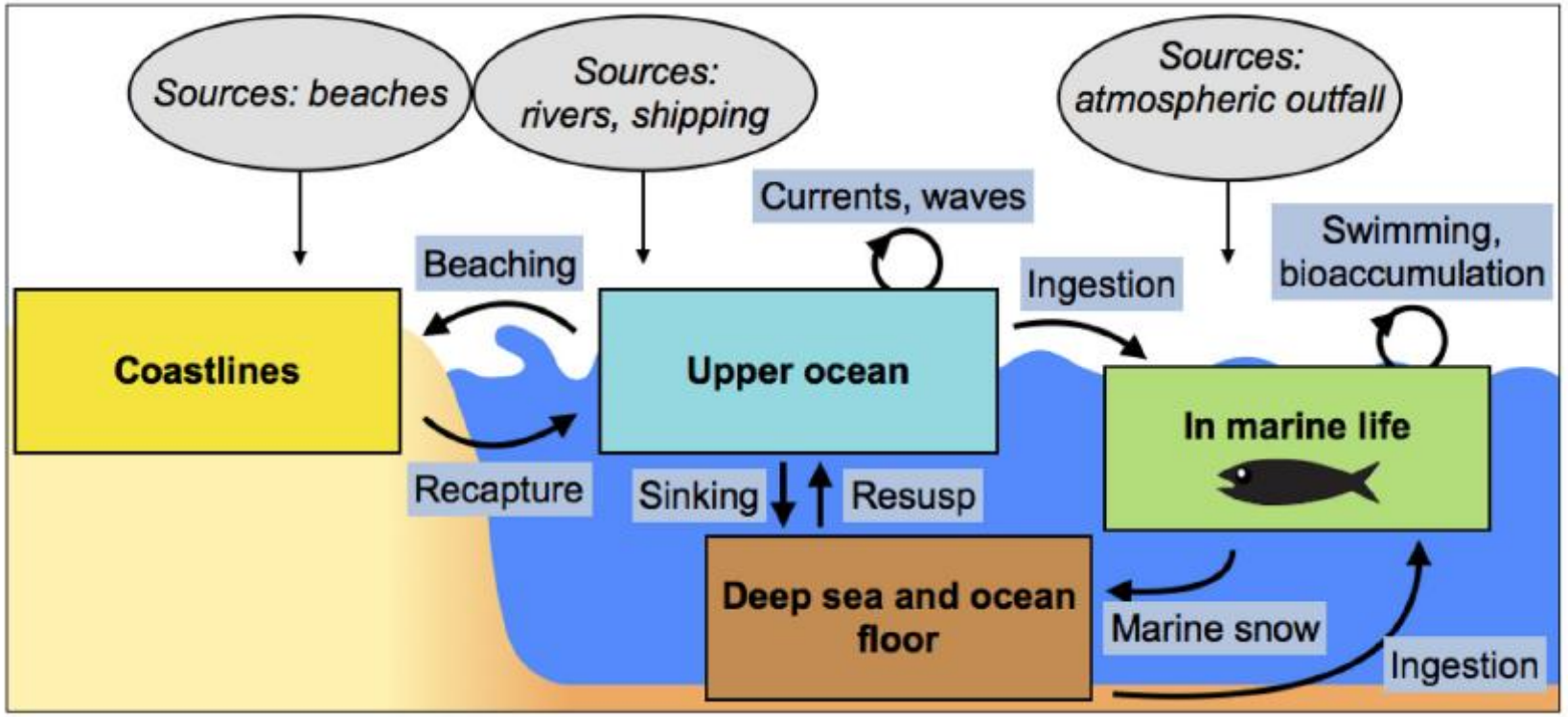
- Marine debris makes its way into the marine environment by way of numerous land-based and at-sea sources.
- Due to the relative immensity of the ocean, observations of marine debris or other floating/drifting objects, and direct measurements of ocean surface currents that move them, are relatively sparse.
- Ocean numerical models can be utilized to simulate the movement of debris for a number of different purposes.
  - Models can be used to “fill in the gaps” where few observations are available. We can also use models to evaluate “what if ” scenarios by varying conditions or parameters one at a time and observing the outcome.
  - Models can be applied to forecast the probable trajectories of debris of known origin, or to identify potential sources of debris by predicting the likely paths taken. They also can be used to assess optimal removal locations.

Uncertainties

→ **What are the main contributing sources of debris in the ocean?**

→ **What is the fate of the debris in the ocean?**

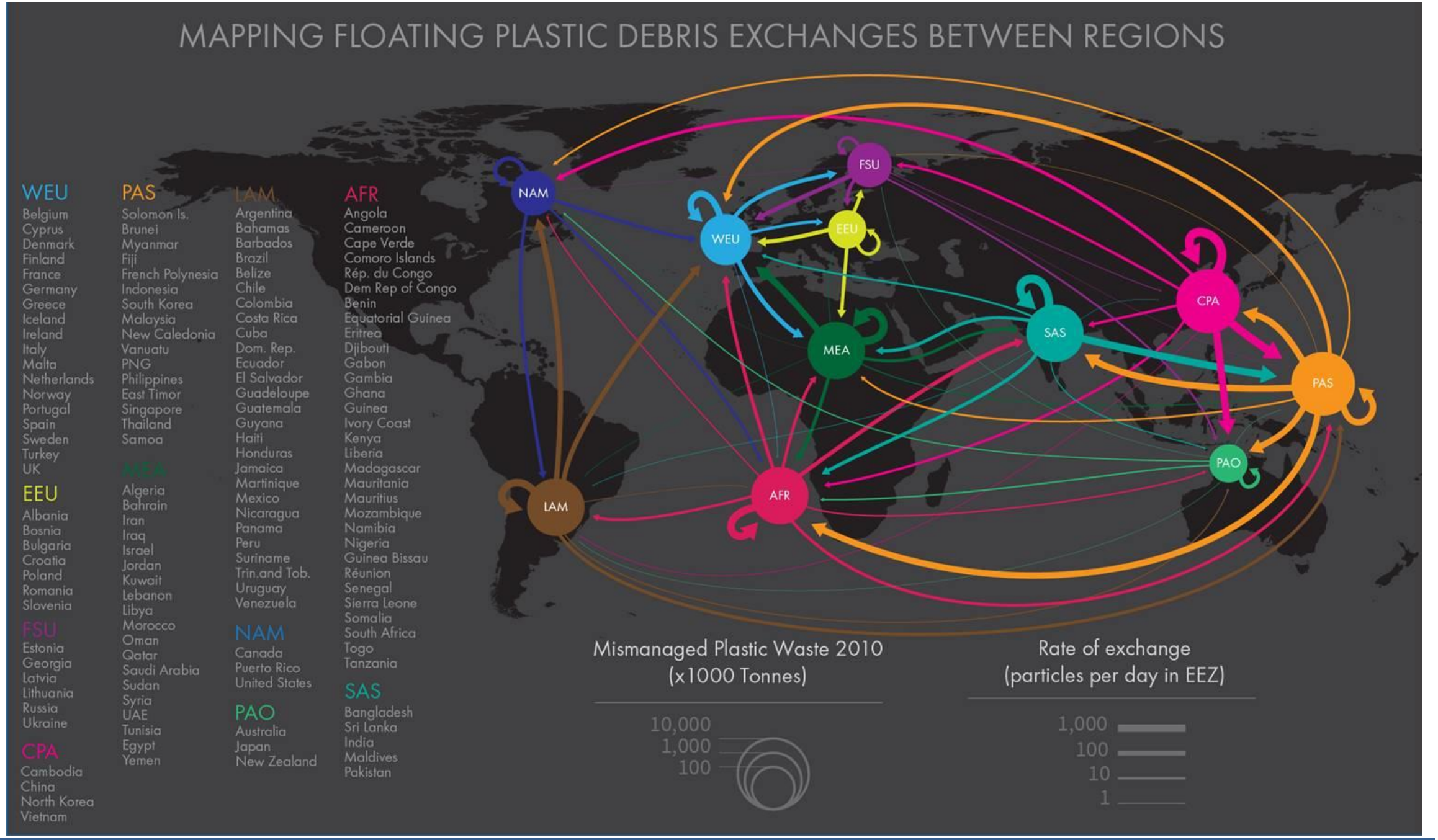
→ **Model errors**

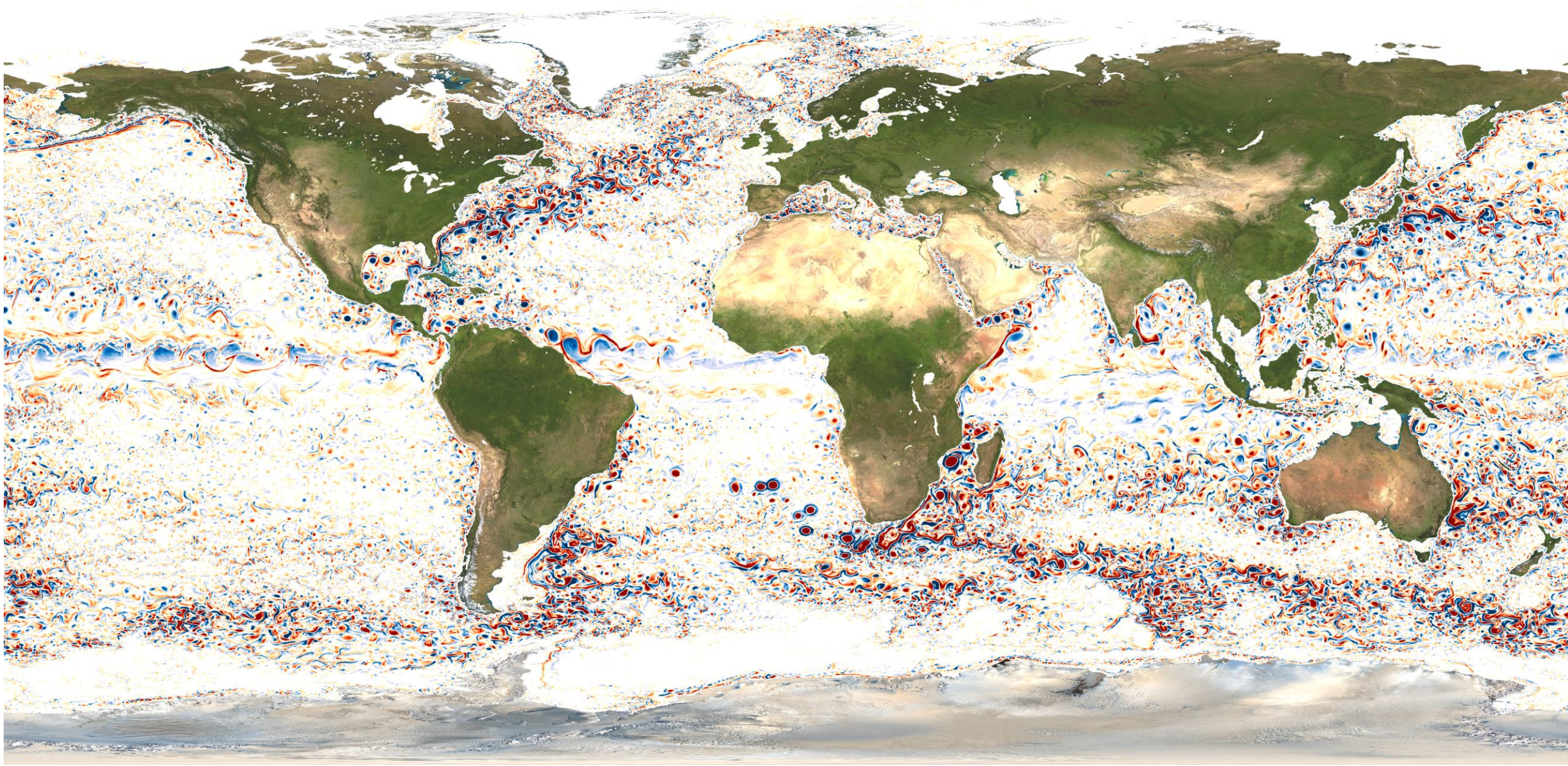


Hardesty et al. (2017)

State-Of–The-Art Global Ocean Modeling

- Horizontal resolution of 1/12° to 1/25° (8 to 4 km grid spacing at the equator, finer at higher latitudes) – requires supercomputers and accurate atmospheric forcing.
- Ocean currents can be constrained via the data assimilation of observations (remote sensing (*i.e.*, sea surface height, temperature), floats (Argo), and in-situ (XBTs, moorings))
- Can the ocean models be used to determine which geographical areas are more prone to contribute to marine litters?

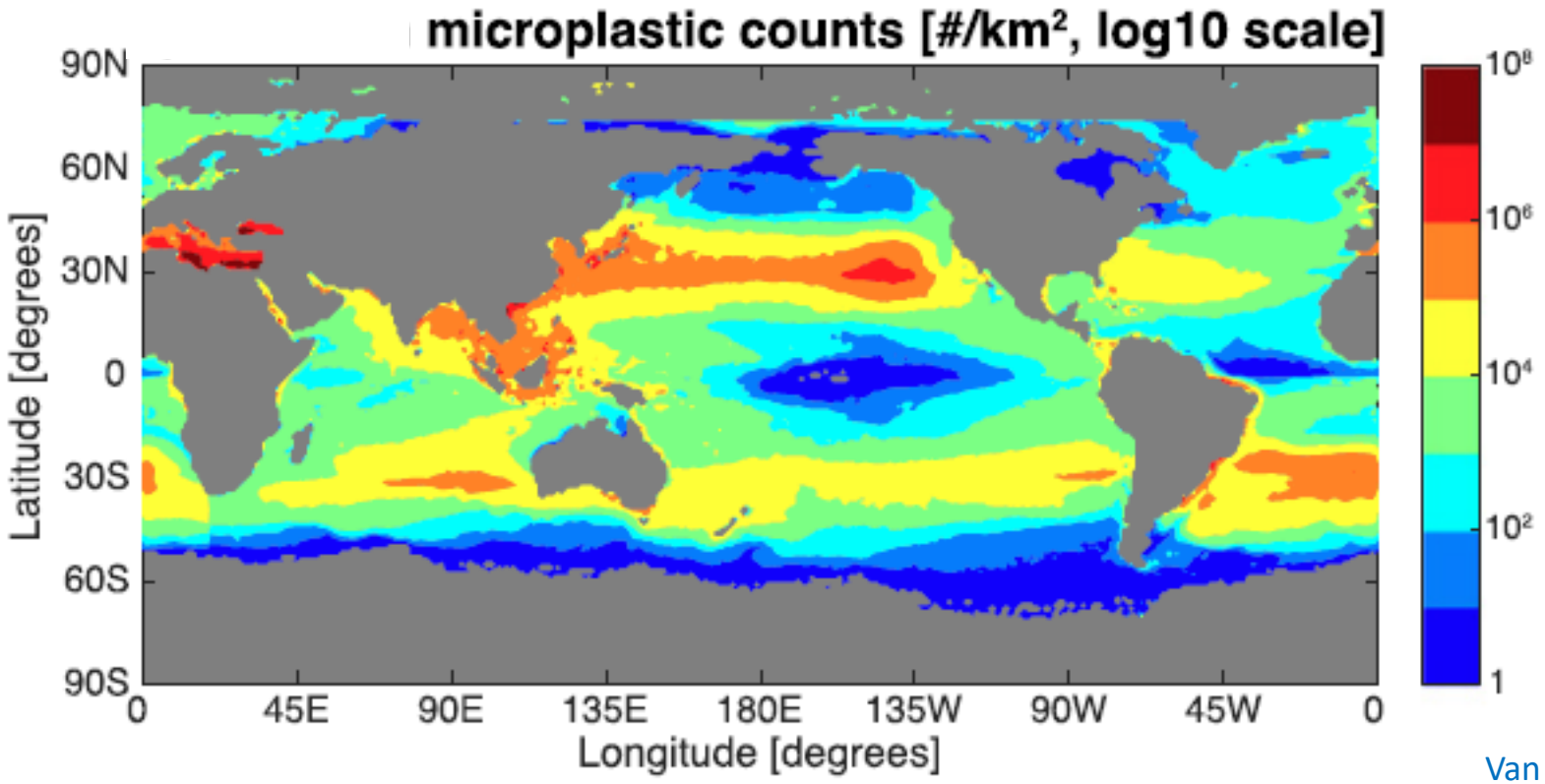

MAPPING FLOATING PLASTIC DEBRIS EXCHANGES BETWEEN REGIONS
WEU
Belgium
Cyprus
Denmark
Finland
France
Germany
Greece
Iceland
Ireland
Italy
Malta
Netherlands
Norway
Portugal
Spain
Sweden
Turkey
UK
EEU
Albania
Bosnia
Bulgaria
Croatia
Poland
Romania
Slovenia
FSU
Estonia
Georgia
Latvia
Lithuania
Russia
Ukraine
CPA
Cambodia
China
North Korea
Vietnam
PAS
Solomon Is.
Brunei
Myanmar
Fiji
French Polynesia
Indonesia
South Korea
Malaysia
New Caledonia
Vanuatu
PNG
Philippines
East Timor
Singapore
Thailand
Samoa
MEA
Algeria
Bahrain
Iran
Iraq
Israel
Jordan
Kuwait
Lebanon
Libya
Morocco
Oman
Qatar
Saudi Arabia
Sudan
Syria
UAE
Tunisia
Egypt
Yemen
LAM
Argentina
Bahamas
Barbados
Brazil
Belize
Chile
Colombia
Costa Rica
Cuba
Dom. Rep.
Ecuador
El Salvador
Guadeloupe
Guatemala
Guyana
Haiti
Honduras
Jamaica
Martinique
Mexico
Nicaragua
Panama
Peru
Suriname
Trin.and Tob.
Uruguay
Venezuela
NAM
Canada
Puerto Rico
United States
PAO
Australia
Japan
New Zealand
AFR
Angola
Cameroon
Cape Verde
Comoro Islands
Rép. du Congo
Dem Rep of Congo
Benin
Equatorial Guinea
Eritrea
Djibouti
Gabon
Gambia
Ghana
Guinea
Ivory Coast
Kenya
Liberia
Madagascar
Mauritania
Mauritius
Mozambique
Namibia
Nigeria
Guinea Bissau
Réunion
Senegal
Sierra Leone
Somalia
South Africa
Togo
Tanzania
SAS
Bangladesh
Sri Lanka
India
Maldives
Pakistan
NAM
WEU
FSU
EEU
MEA
SAS
CPA
PAS
PAO
AFR
LAM
Mismanaged Plastic Waste 2010
(x1000 Tonnes)
10,000
1,000
100
Rate of exchange
(particles per day in EEZ)
1,000
100
10
1



Expert Consultation on Marine Litter National Source Inventories 25-26 March, Nairobi, Kenya

Example: Using numerical models and ocean forecasts to improve our understanding of microplastic distribution

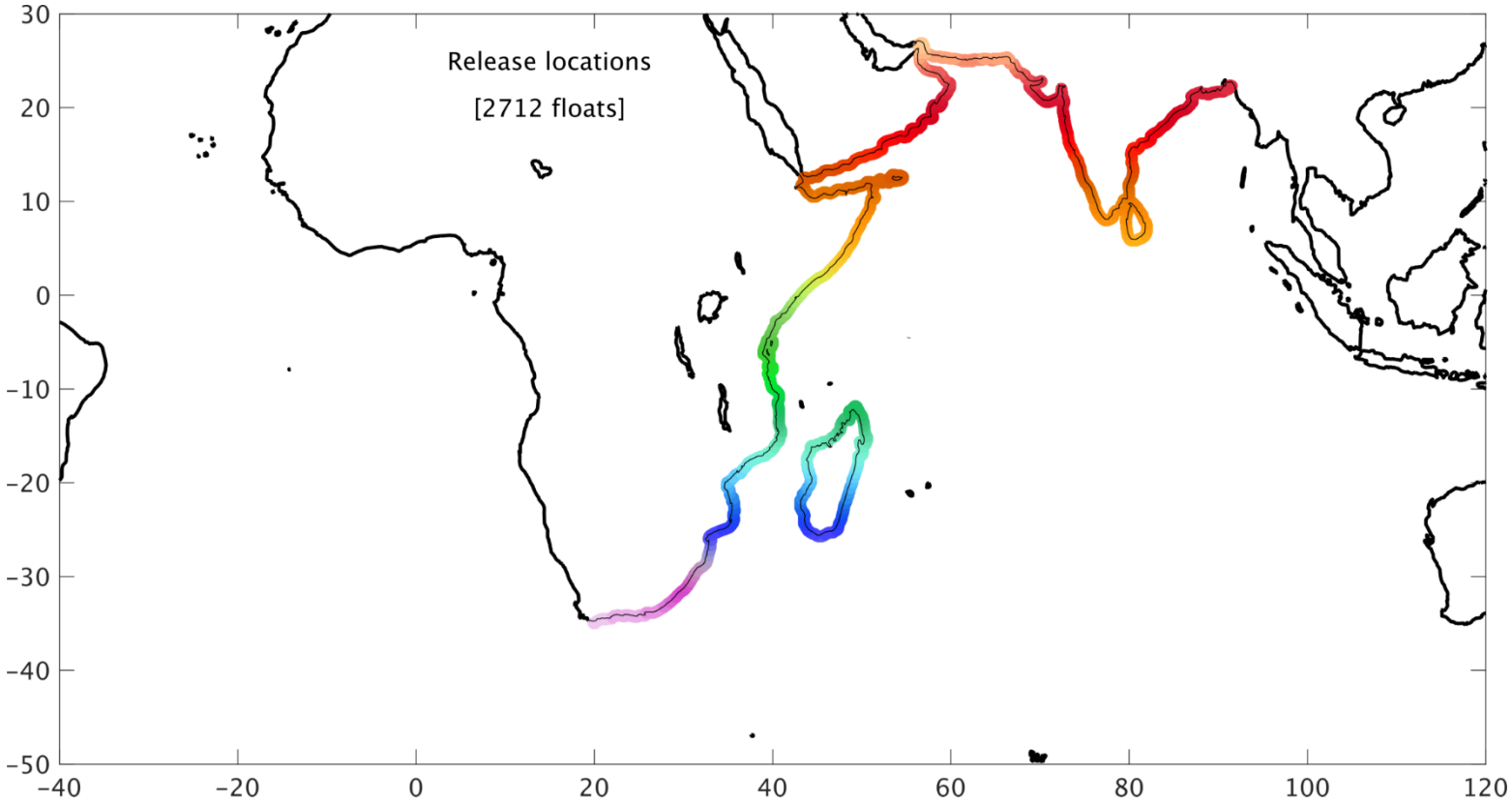
→ **Microplastics can be modeled as a tracer**



Van Sebille et al. (2015)

Example: Using numerical models and ocean forecasts to predict marine debris pathways

→ **Marine debris can be modeled as a particle or float**



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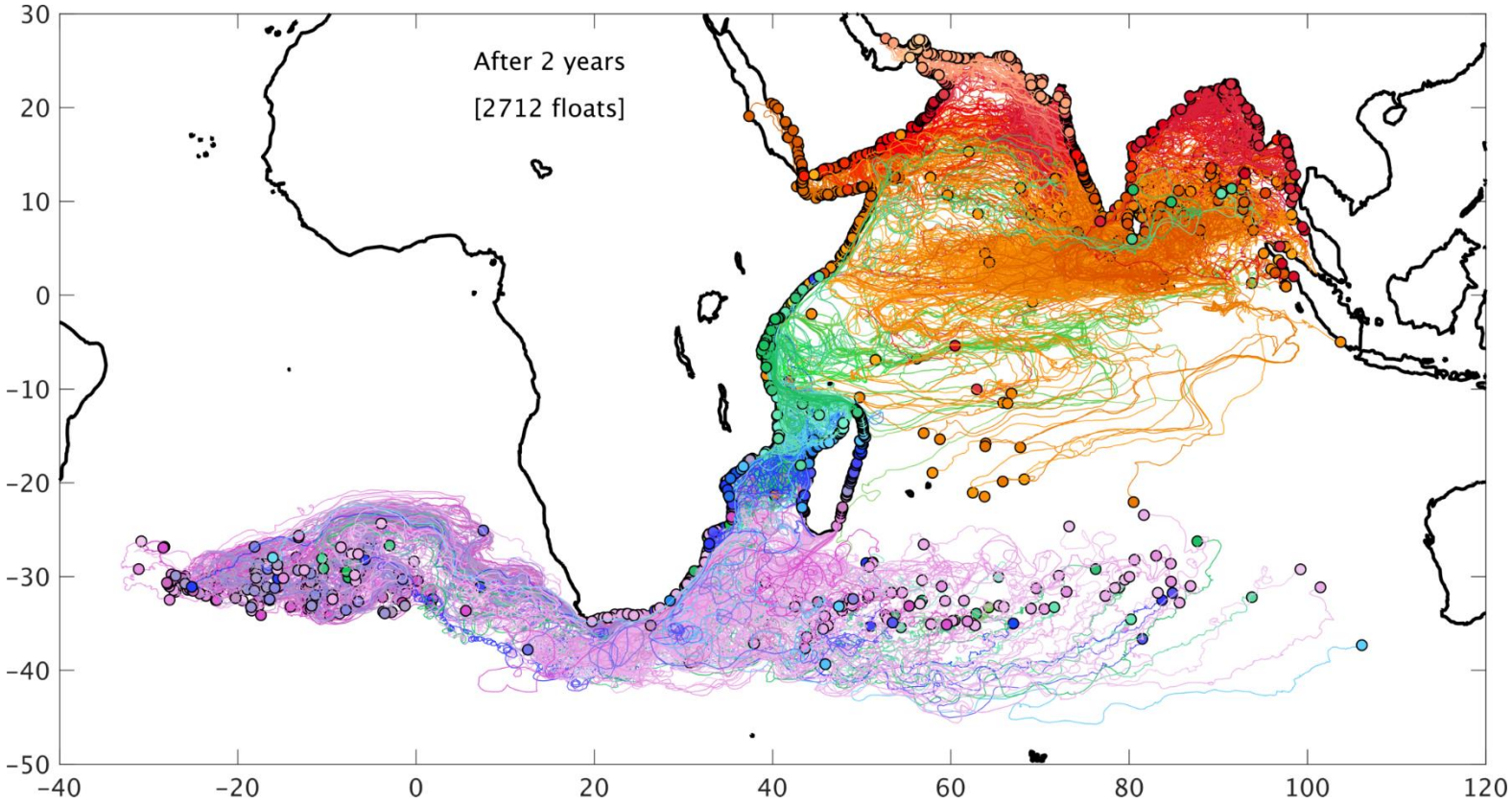
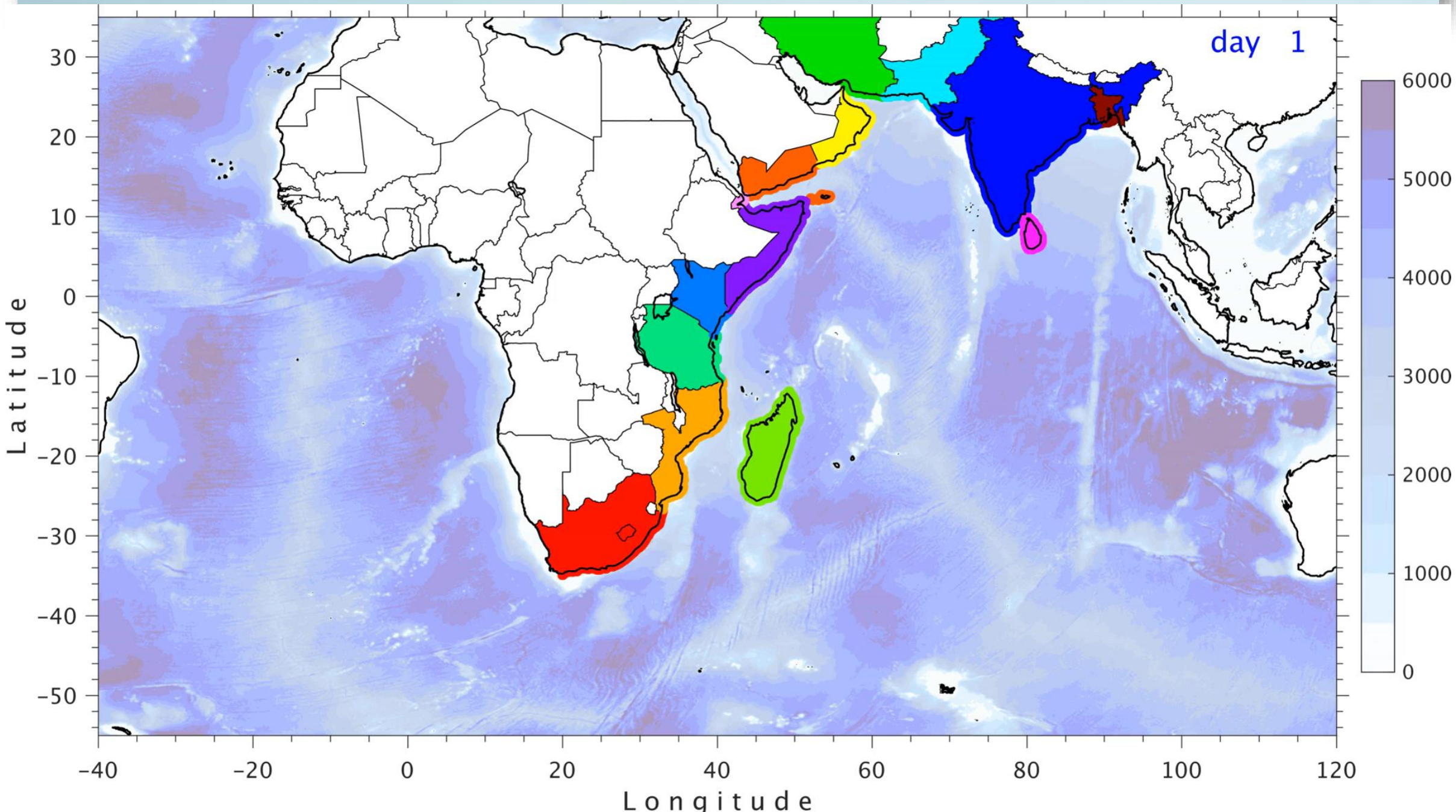


Preliminary attempt to link to national source inventory



Example: Using numerical models and ocean forecasts to predict marine debris pathways

- **Caveats:**
  - **Demonstration, not accurate**
  - **Simple advection of a uniform distribution of litters**
  - **No attempt to ensure accurate initial conditions**
  - **Offshore advection of litter not taken into account => what is the dominant process? 98% remains on land**
  - **No degradation, sinking, wind and wave effects, etc.**

Next steps (1)

→ **Assess and develop the underpinning science and tools to eventually enable full integration of litter in existing global ocean prediction systems. Can be done by leveraging national and international efforts (*e.g.,* TOPIOS (Tracking Of Plastic In Our Seas) funded by a European Research Council Starting Grant) via a white paper and/or a focused workshop.**

→ **Improvement of routine observations of marine debris (national inventories - key to initialize the models – rivers versus beaches versus open ocean)**

Next steps (2)

→ **Modeling of the essential life span of marine litter (*e.g.*, degradation, micro- and nano-plastics, etc.) – 3D modeling.**

→ **Strong analogy with the modeling of phytoplankton and fisheries – similar limitations (*e.g.*, lack of observations and in depth knowledge of NZPD interactions) –another analogy is oil spill modeling**

→ **Define the most pressing questions that can be addressed with the global numerical models regarding national inventories and to which accuracy.**