Ocean pathways connecting the subtropical convergence zones : applications to marine plastic litter

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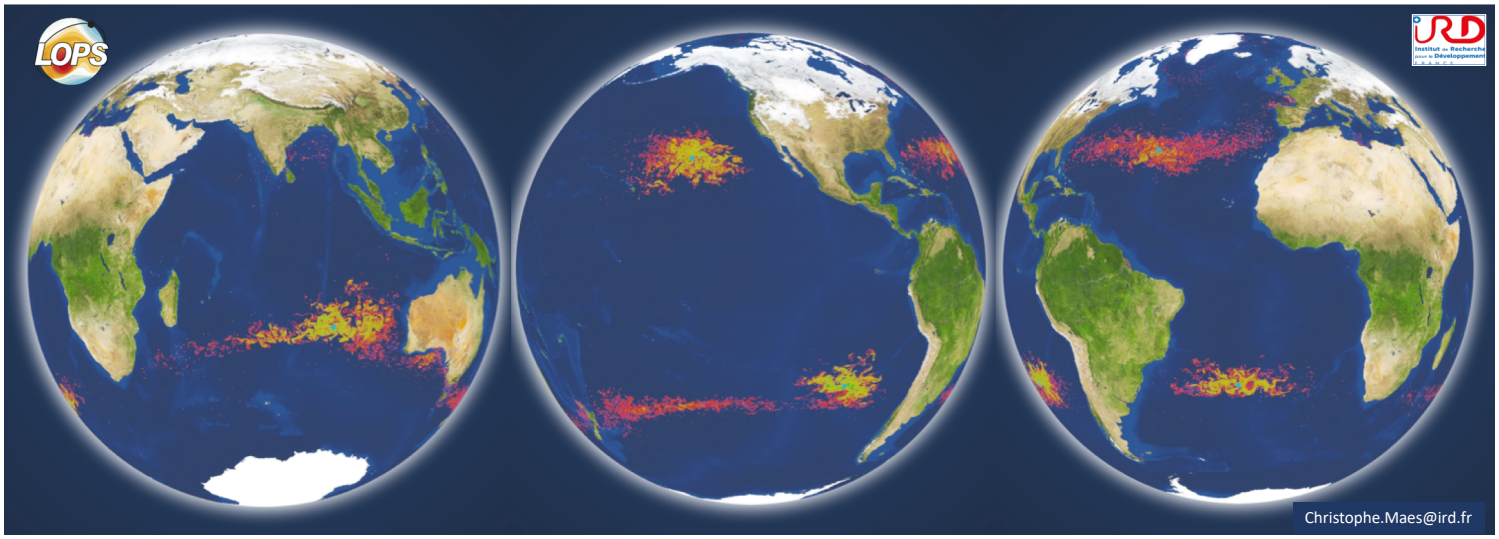
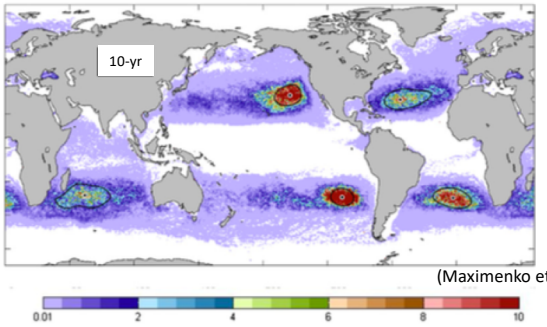


MOTIVATIONS OF THE PRESENT STUDY

I. Convergence in ocean subtropical gyres: A view from a stationary solution

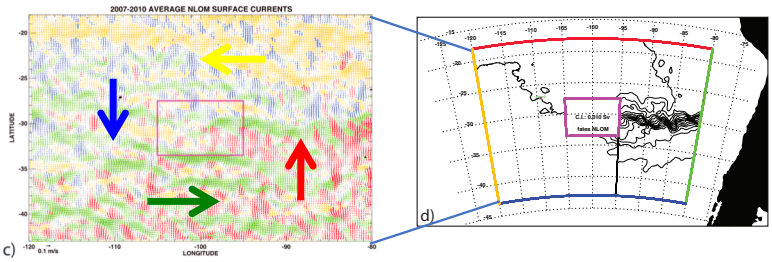
The Maximenko model (Maximenko *et al* 2012) uses a transition matrix approach, based on the probability of particle travel between ½° bins calculated from trajectories of a historical global set of satellite-tracked drifting buoys



(Maximenko et al. 2012)

II. Origin and Fate in the convergence zones of the subtropical Pacific Ocean (Maes et al. 2016)

« The explicit consideration of small-scale eddy-like variability is an advance in our understanding of the connections made between the centers of the convergence zones and the edges of the gyres. »



NLOM (1/32°)

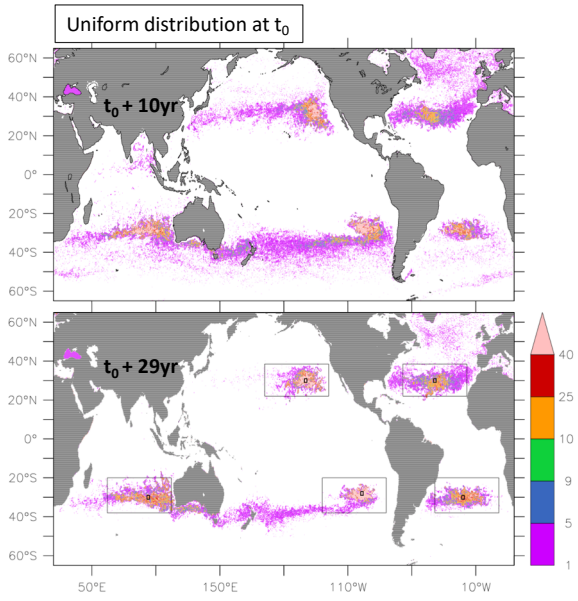
III. Evidence of a Surface "Superconvergence" Pathway Connecting the South Indian Ocean to the Subtropical South Pacific Gyre (Maes et al. 2018 GRL)

« Future progress in tackling the ubiquitous and growing plastic and litter problem in the global ocean should consider … the mesoscale and submesoscale variabilities in the simulation of ocean dynamics. »

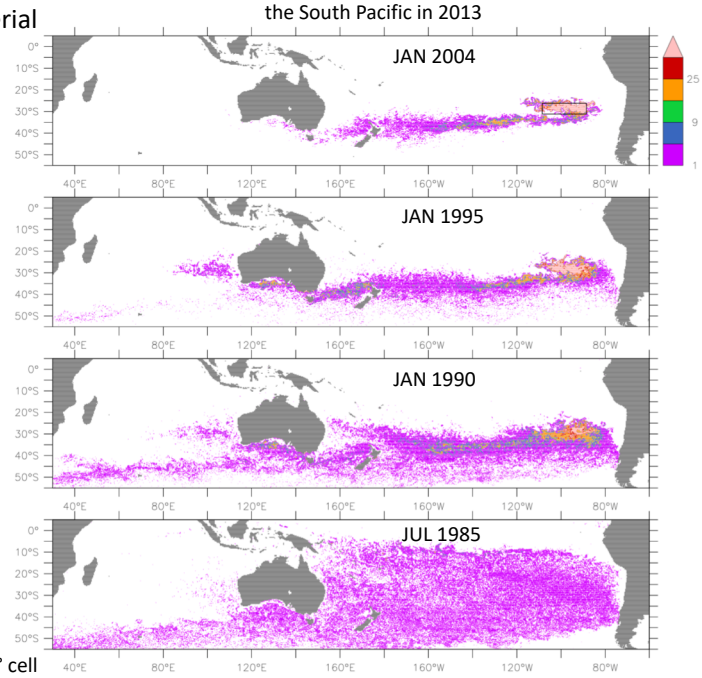
III. Evidence of a Surface “Superconvergence” Pathway Connecting the South Indian Ocean to the Subtropical South Pacific Gyre

(Maes et al. 2018 GRL)

Revealing new « pathways » for the connectivity of floating material

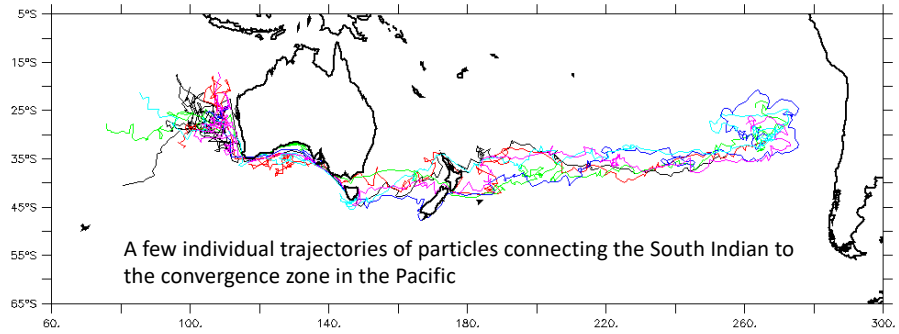


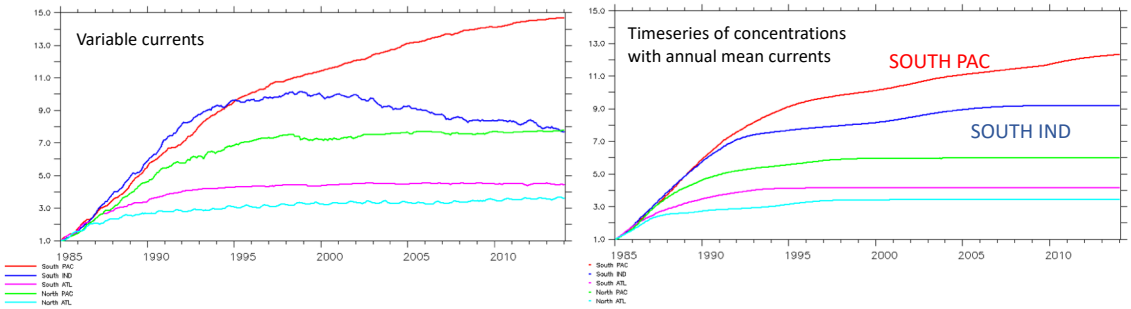
Backward tracking of particles that converged toward the South Pacific in 2013



Number of particles per ¼° cell

One important point : What are the driver mechanisms?





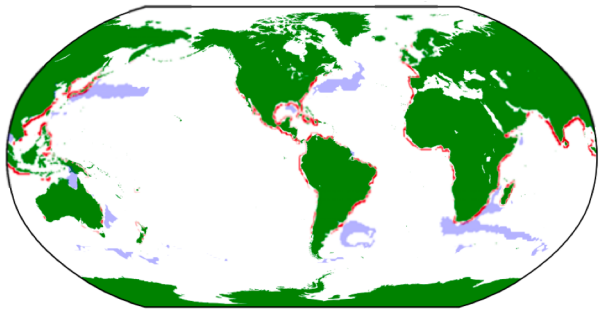
Number of particles per ¼° cell

Current variability is crucial to sustain this pathway

APPLICATION TO PLASTIC MARINE LITTER

- GOAL: Evaluate the « realistic » input scenarios (van Sebille et al. 2015 vs. Lebreton et al. 2017) of marine litter (microplastics or whatever small floating material or debris)

- APPROACH:
    - Consider 1million particles along the coasts
    - Dispersion by surface currents over the 1985-2013 period
    - Release operated over the 1st year (i.e., 1985)
    - No sinks

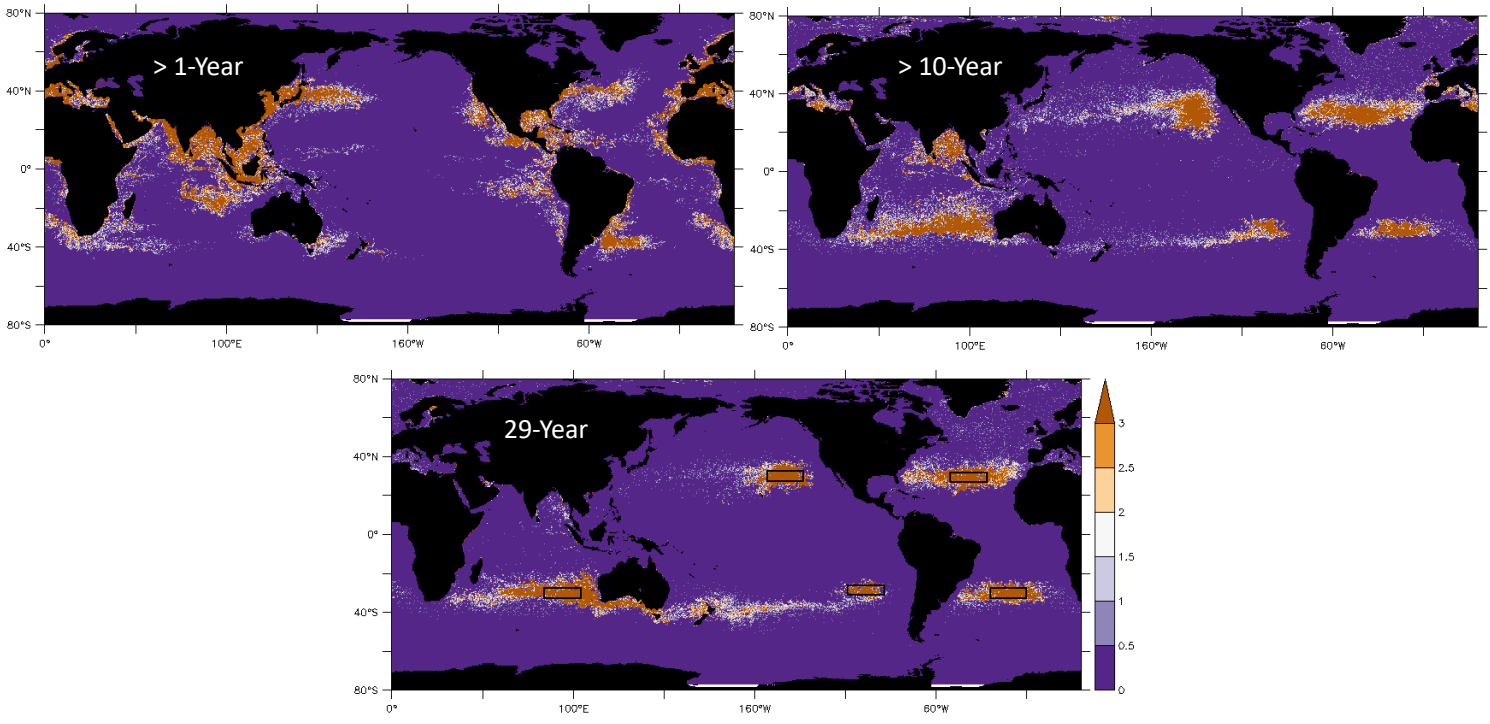


(van Sebille et al. 2015)

- TOOLS:
    - Ocean surface currents : CMCC ¼° re-analyses (Storto and Masina 2016)
    - Lagrangian approach: tracking « fictive particles » with the ARIANE tool (Blanke and Raynaud 1997)

APPLICATION TO PLASTIC MARINE LITTER

Number of particles per ¼° cell



APPLICATION TO PLASTIC MARINE LITTER

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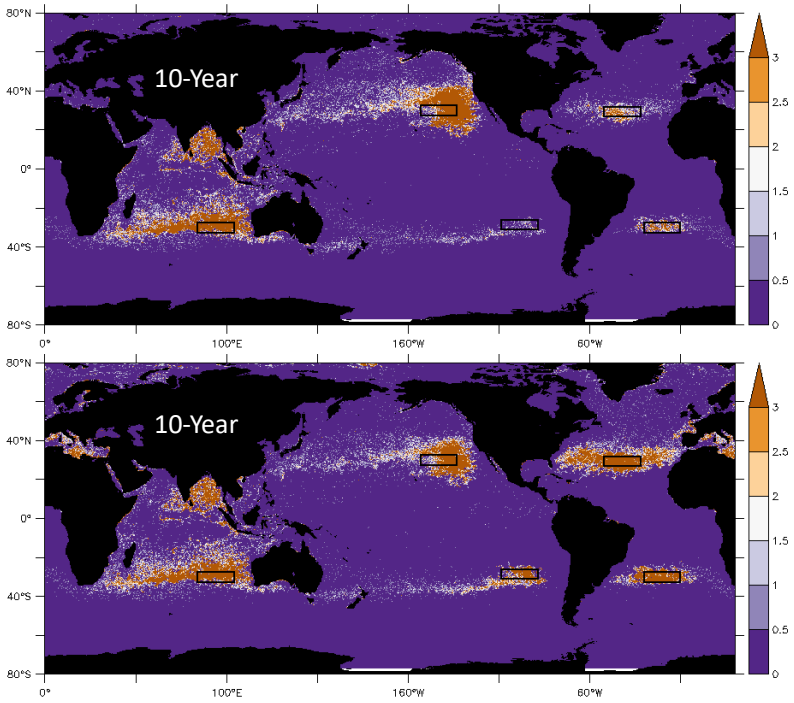
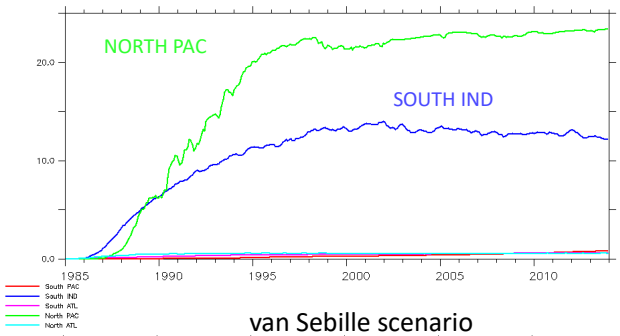
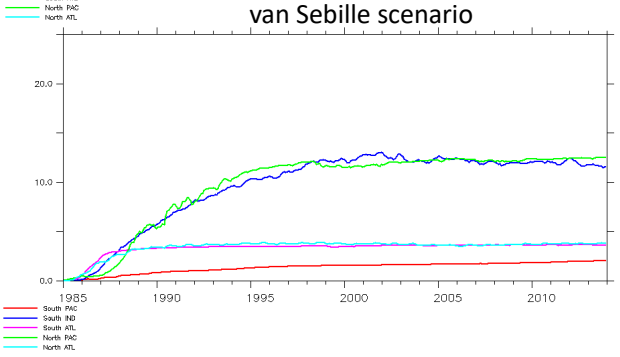


Lebreton scenario

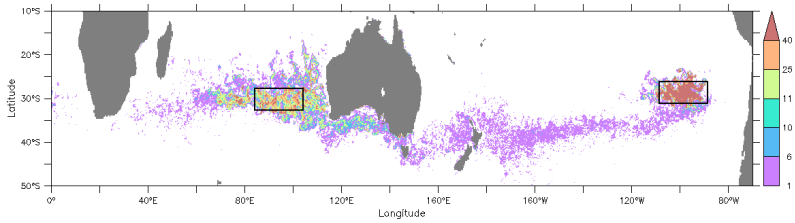


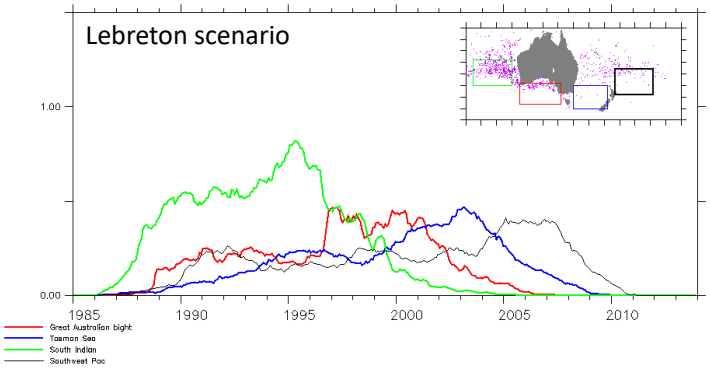
van Sebille scenario

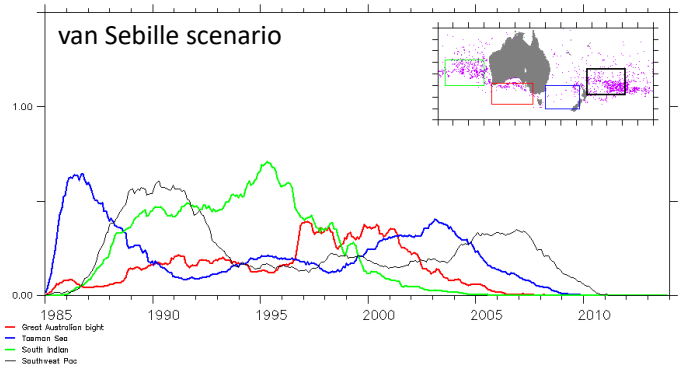


APPLICATION TO PLASTIC MARINE LITTER

Backward tracking of particles that converged toward the South Pacific







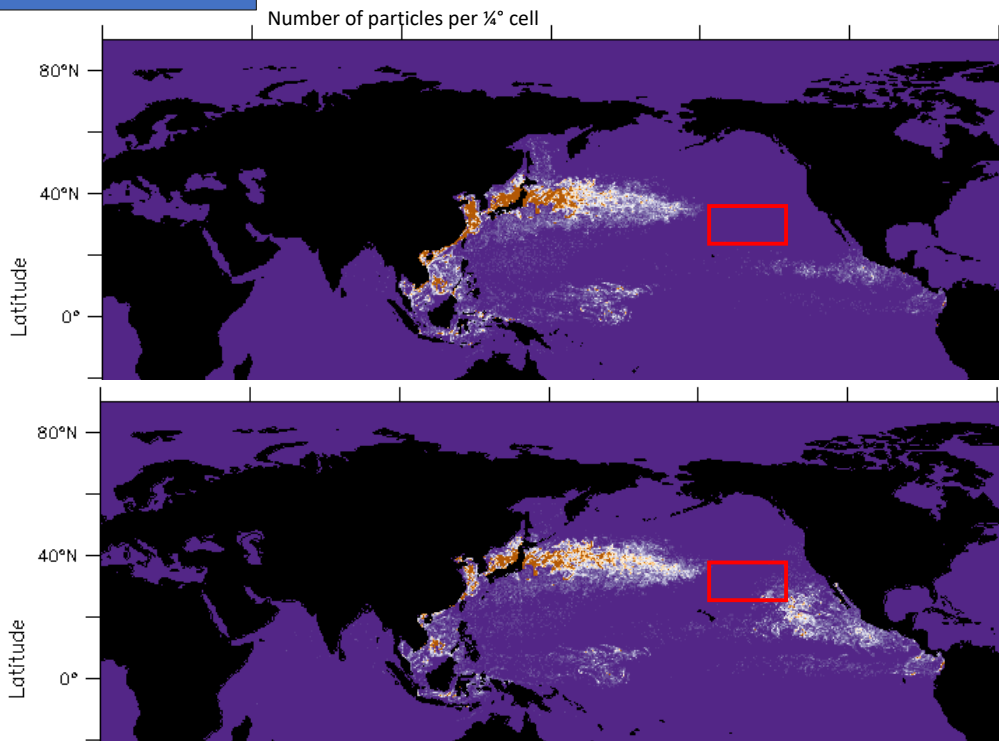
Except the presence of some initial particles in the Tasman Sea and southwest Pacific in the right case, the dynamics of the super-convergent pathway result mainly from the input of the south Indian Ocean (i.e., after 1995)

APPLICATION TO PLASTIC MARINE LITTER

Backward tracking of particles that converged toward the North Pacific

Lebreton scenario

van Sebille scenario



CONCLUSIONS AND OUTLOOK

OCEAN DYNAMICS

Temporal variations in current are crucial for linking certain large-scale regions

MARINE LITTER SCENARIO

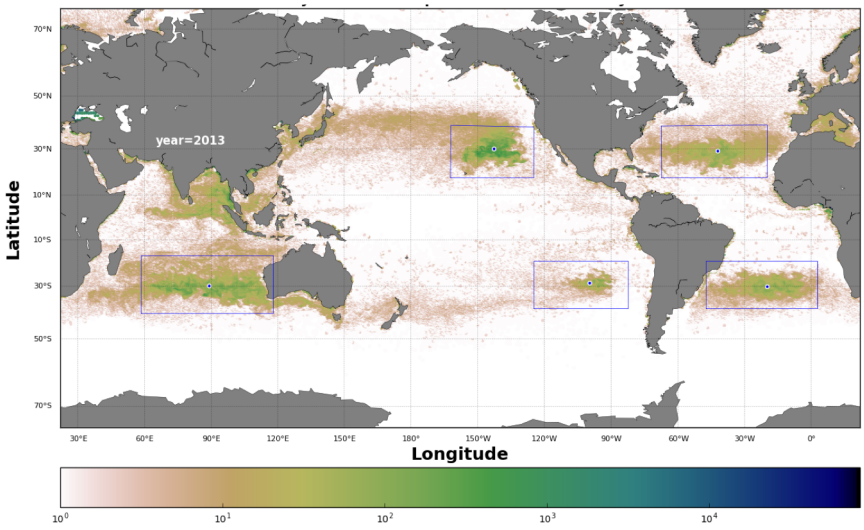
It is also important to reduce the error bars of the source scenario as well as differences in ocean model formulation and dynamics

PERSPECTIVE: TOWARD A REALISTIC SIMULATION

- more physical processes (waves, windage, mixing…)
- dispersion processes (oceanic turbulence, synoptic forcing) including the approach of Coast-Ocean-Coast
- more realistic release scenario
- source to sink approach

Evaluating global dispersion with observations?

Preliminary results with continuous sources (along coasts) and '*conceptual*' sinks (finite life span)



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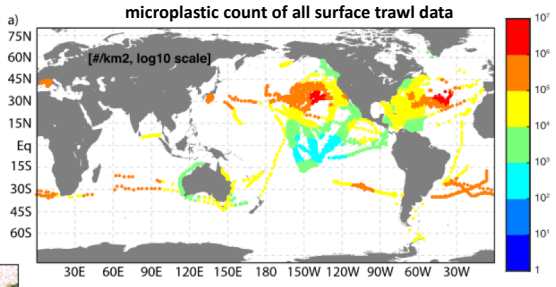

(van Sebille et al. 2015)

Pending Actions:

- Integrated Marine Debris Observing System (IMDOS) – OceanObs19

- SCOR FLOTSAM: http://scor-flotsam.it/

https://micro2018.sciencesconf.org/

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