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Ocean Surface Circulation with Implication for Marine Debris Distribution

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Modern, multi-instrumental Global Ocean Observing System (GOOS) includes satellites and in situ observations, monitoring the ocean state at the highest accuracy and resolution ever. By combining data of satellite altimetry, surface drifters, wind and gravity, ocean currents can be assessed globally and at research quality. The map of the mean surface currents shows a complex pattern of oceanic fronts and gyres. Distinct are the convergences of Ekman currents in subtropical gyres that, through the Sverdrup mechanism, are feeding anticyclonic circulation in the gyres.

Drifter trajectories can also be utilized to simulate the evolution of the marine debris. Main problem is the inhomogeneous drifter data density, both due to convergence/divergence of the ocean currents and due to the drifter deployment scheme. A model constructed from statistics of the drifters exchange between small bins corrects this bias and was run from the uniform initial condition to study the fate of debris in the ocean. In addition to such actively studied debris accumulation areas as the Great Garbage Patch in the North Pacific, a new so far unrecognized, the world-strongest convergence is discovered in the South Pacific from the model solution.

The same model reveals a complex pattern of convergence/divergence on the cold/warm flanks of major oceanic fronts. This pattern is studied in the framework of nonlinear interaction between Ekman drift and geostrophic baroclinic fronts outcropping at the sea surface. Results are generalized to assess the dynamics of internal Ekman layer distributed along the thermocline and controlling the secondary circulation at the fronts.