

OceanGliders

Boundary Ocean Observing Network

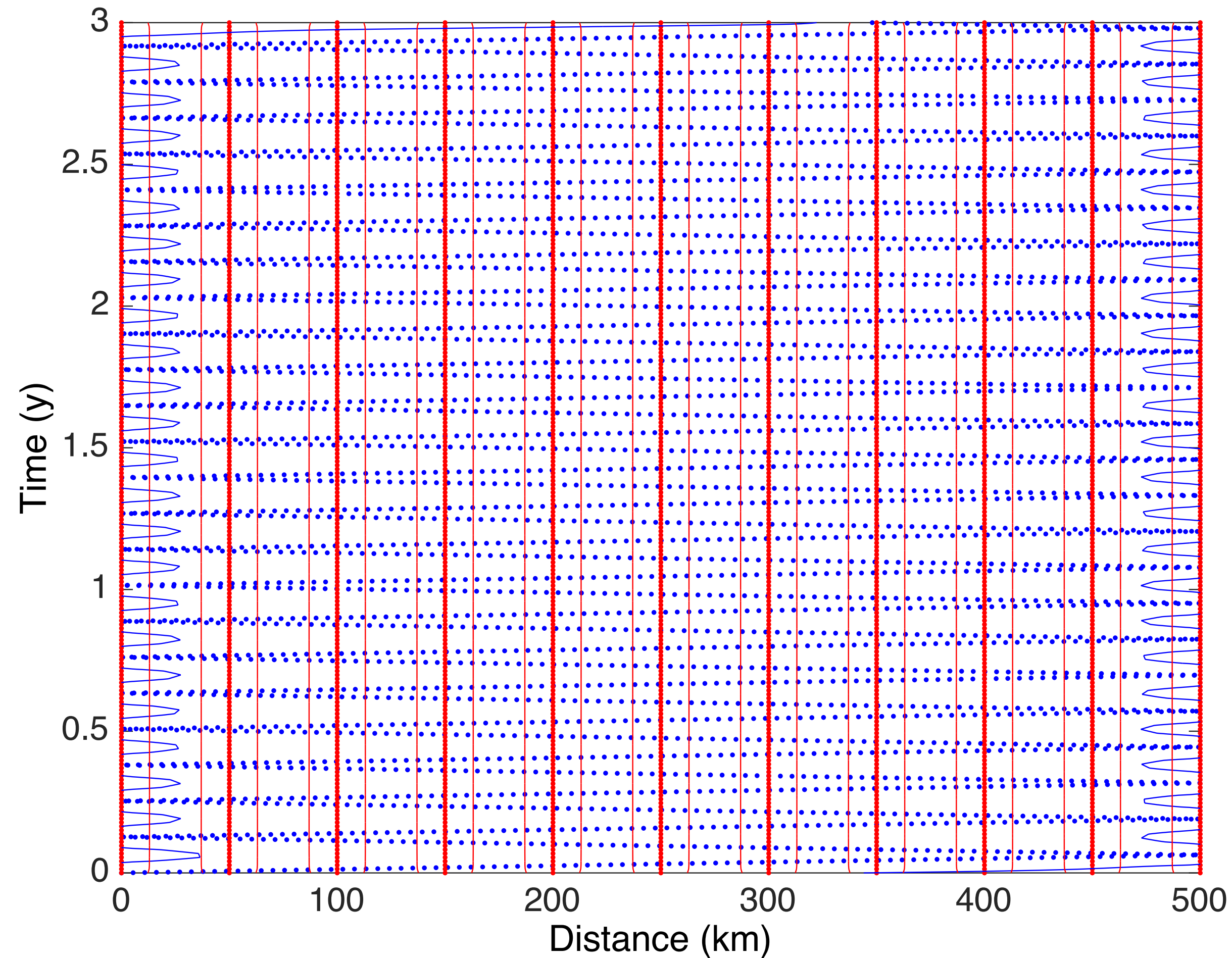
Dan Rudnick and 34 members of BOON



Rationale

- Society experiences changes in the global ocean through effects on the boundaries
- Fisheries, transportation, weather, recreation, etc.
- Western boundary currents dominate the meridional transport of heat, and are major drivers of climate variability
- Eastern boundary currents are often upwelling systems that comprise some of the most biologically productive regions in the world
- Boundary currents in marginal seas provide the major means of exchange with the open ocean and impact regional ecosystems
- Communication between the coast and open ocean is regulated by the boundary currents that flow along the continental slopes
- A global network of underwater gliders to uniquely address this need within a multi-platform observing system

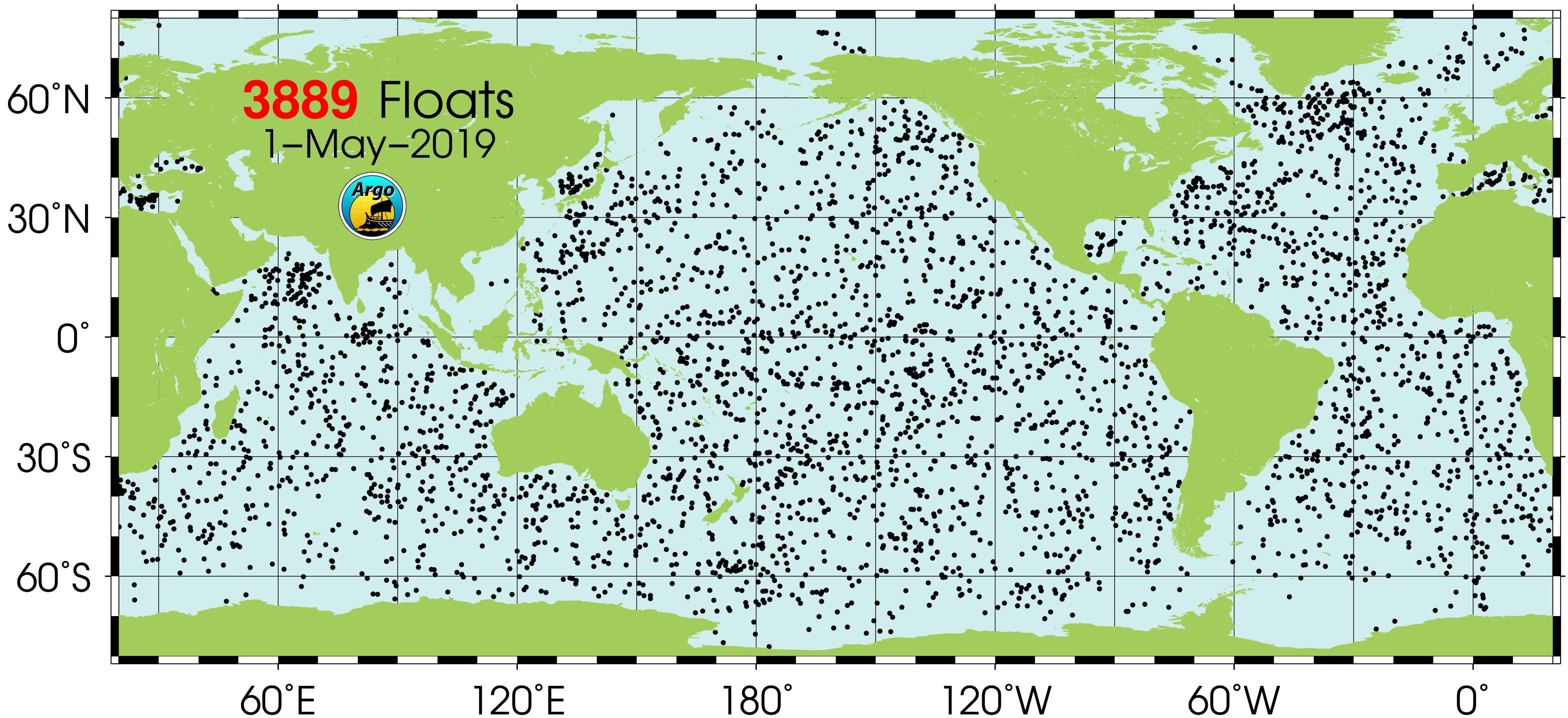
Why gliders in the boundary currents?

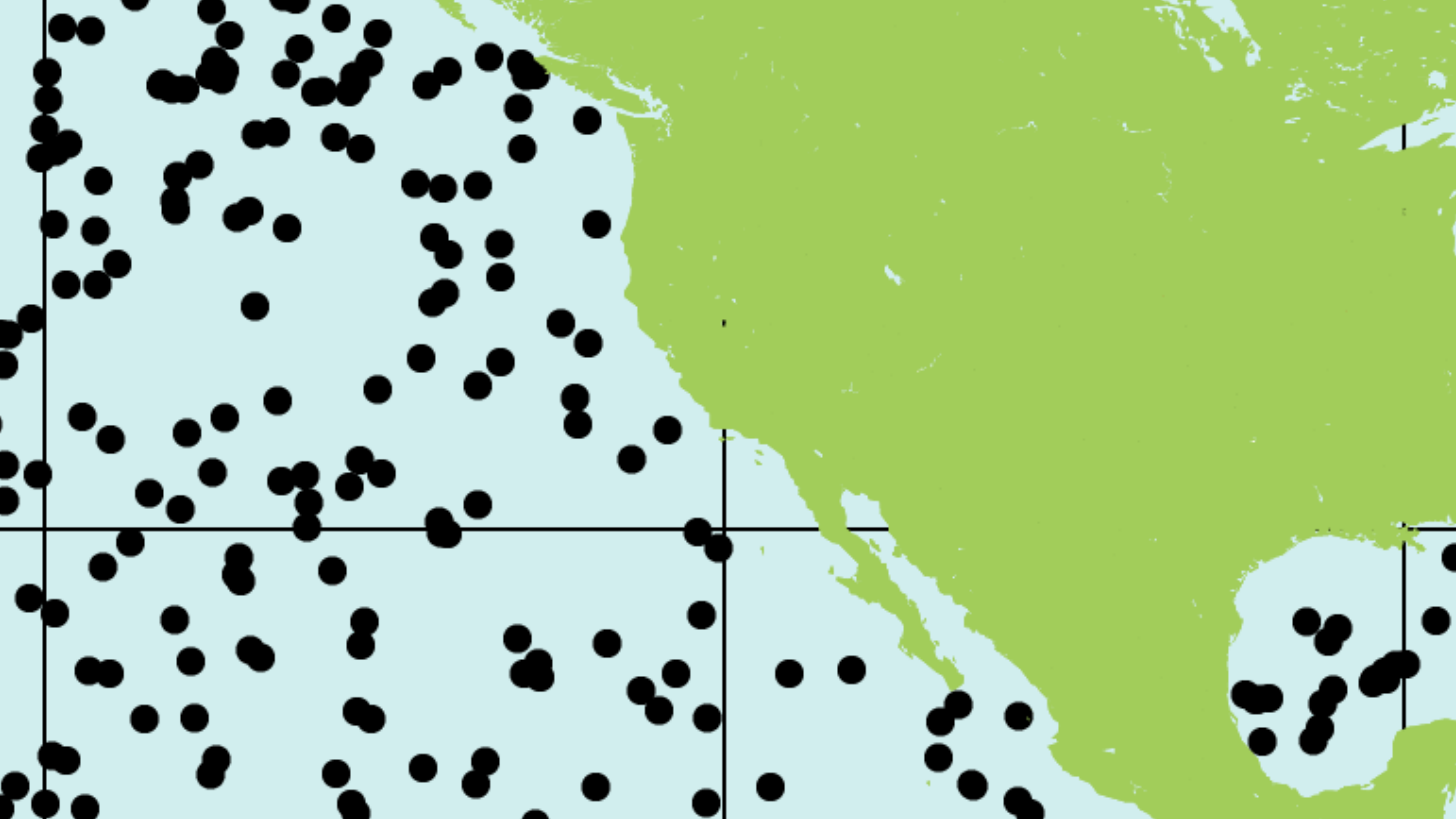


Objective map, $L=30$ km, $T=30$ d

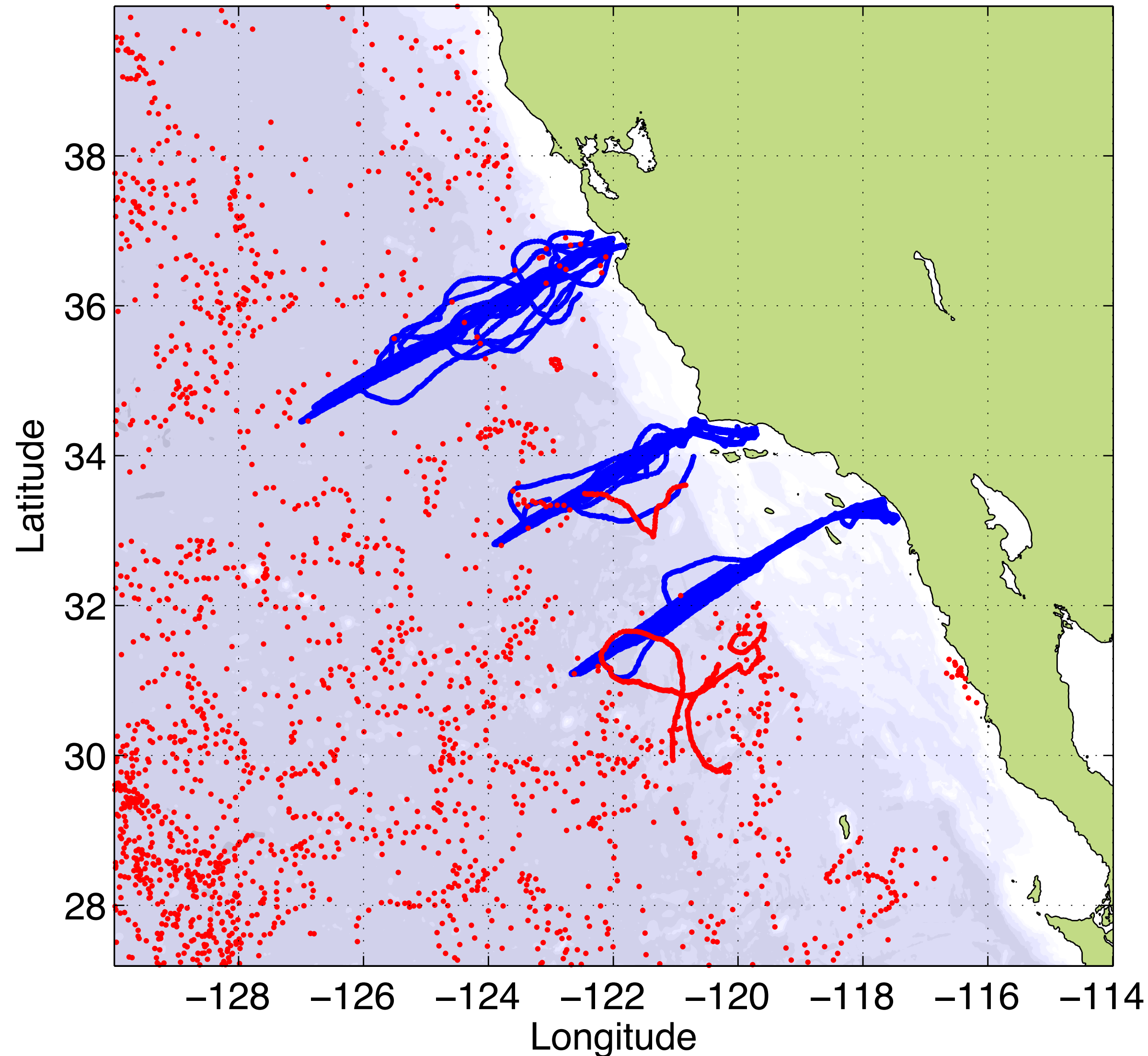
- Gliders are efficient near boundaries, as they rely only on small boats
- Gliders connect the coast and open ocean
- Gliders missions can be sustained indefinitely
- Glider sampling is a good match to the resolution needed in boundary currents

Argo



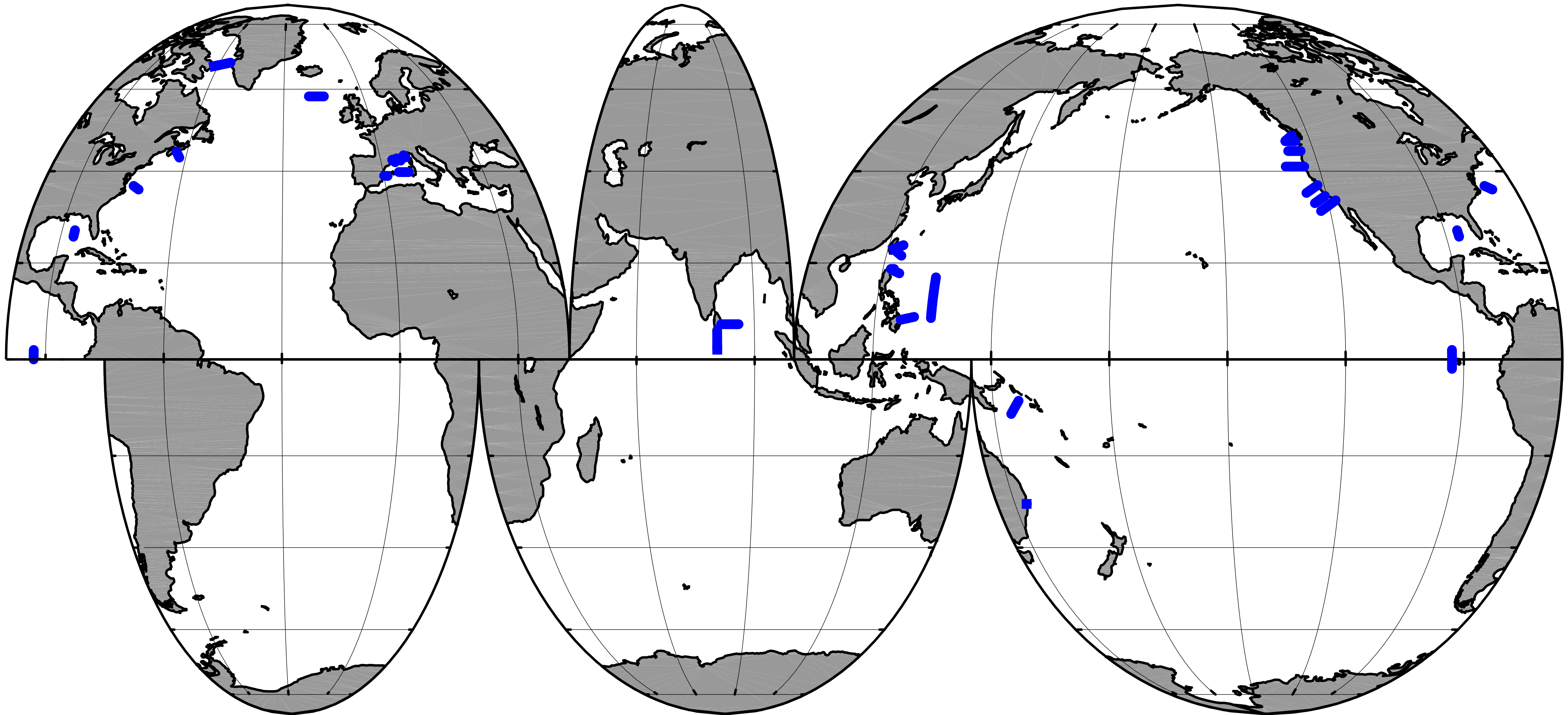


Sampling: gliders vs. Argo



- Area defined by regional model
- 28893 glider profiles
- 2482 Argo profiles
- 12 times as many profiles from gliders as from Argo
- Gliders connect coast to open ocean

Sustained boundary current observations



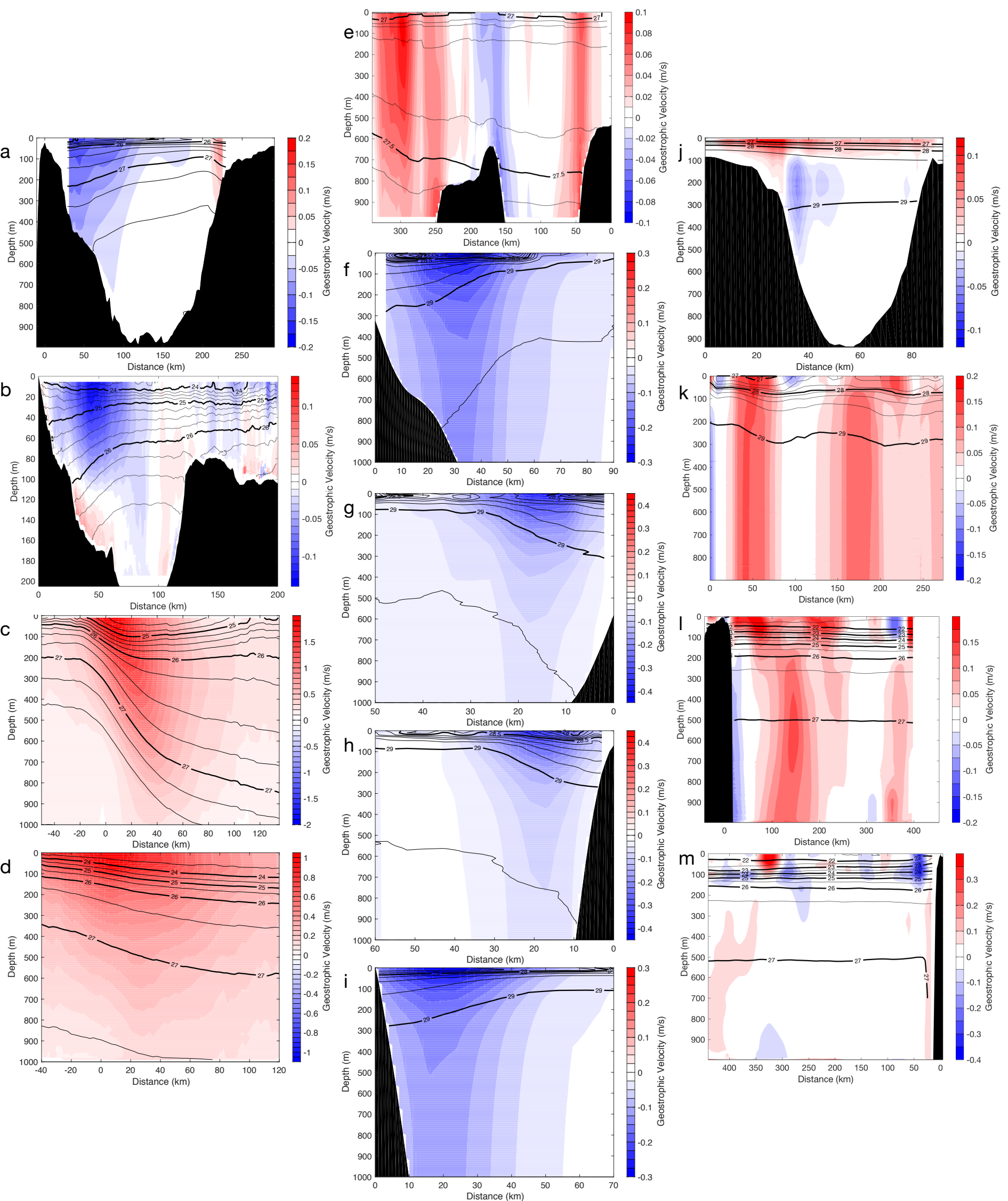
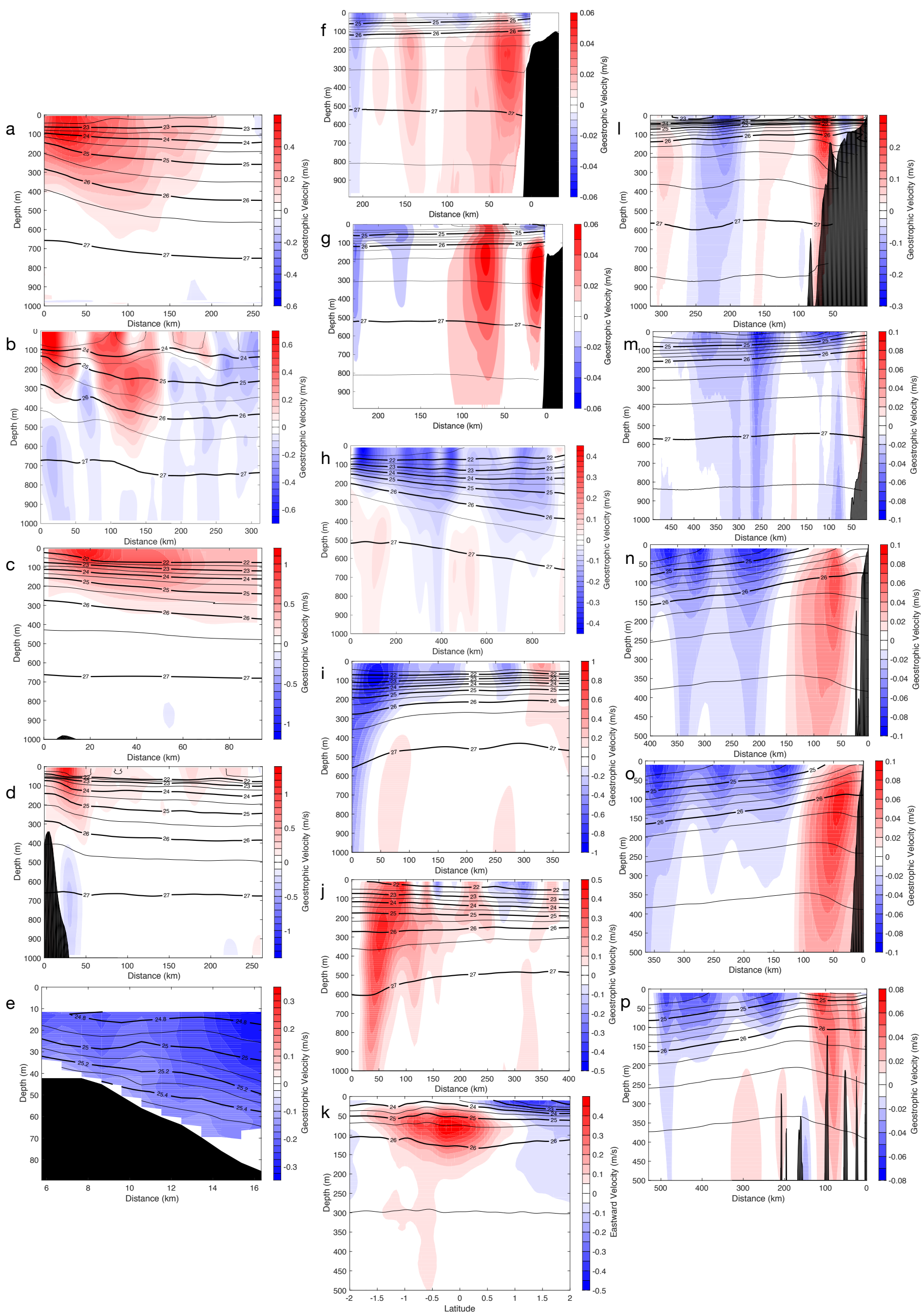
Absolute geostrophic velocity

- Depth-dependent across-section velocity $v'(z)$ from along-section gradient of density
- Depth-average velocity V from glider dead reckoning
- These are combined to produce absolute across-section geostrophic velocity, a unique product of gliders

$$v'(z) = \frac{g}{f\rho_0} \int_z^0 \frac{\partial \rho}{\partial x} dz$$

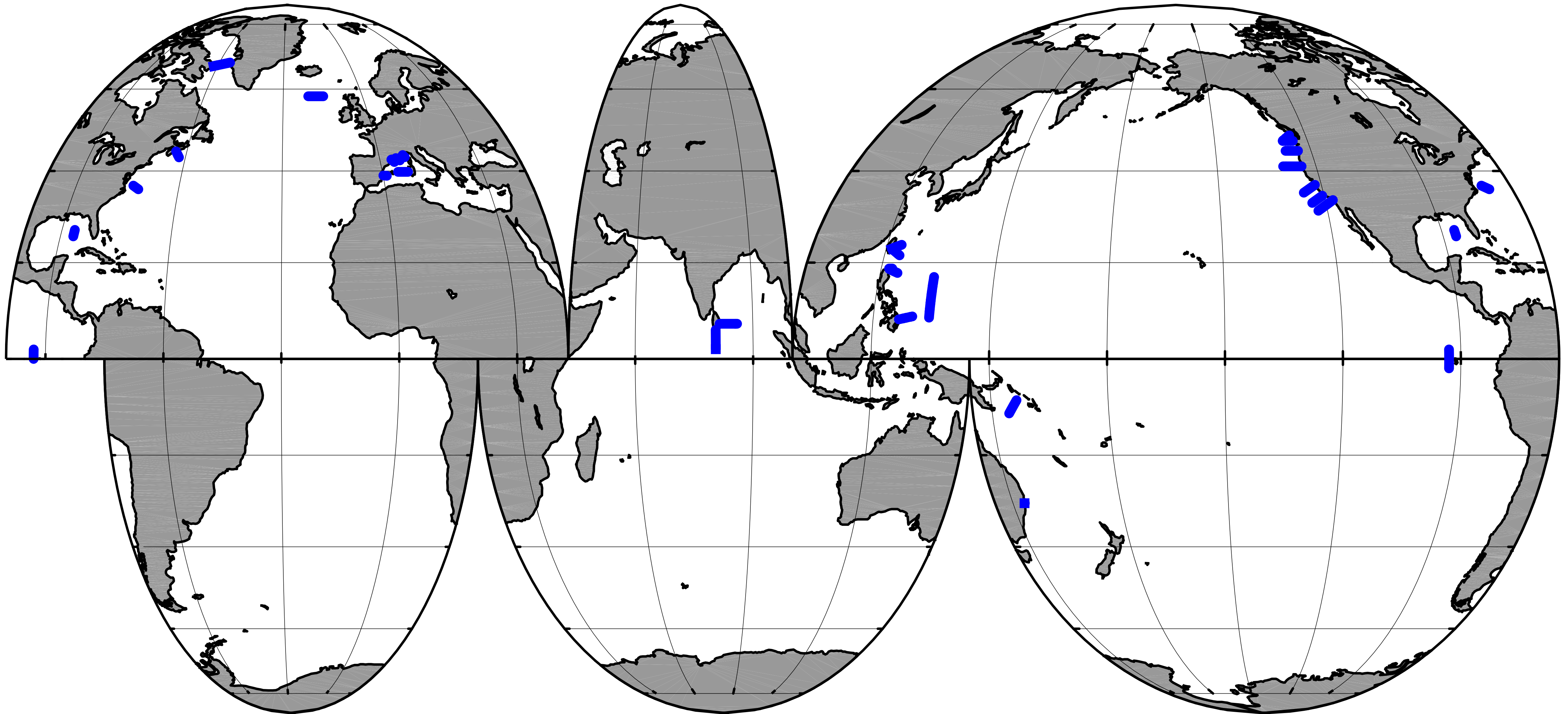
$$v(z) = v'(z) - \frac{1}{h} \int_{-h}^0 v'(z) dz + V$$

Sustained sections of velocity

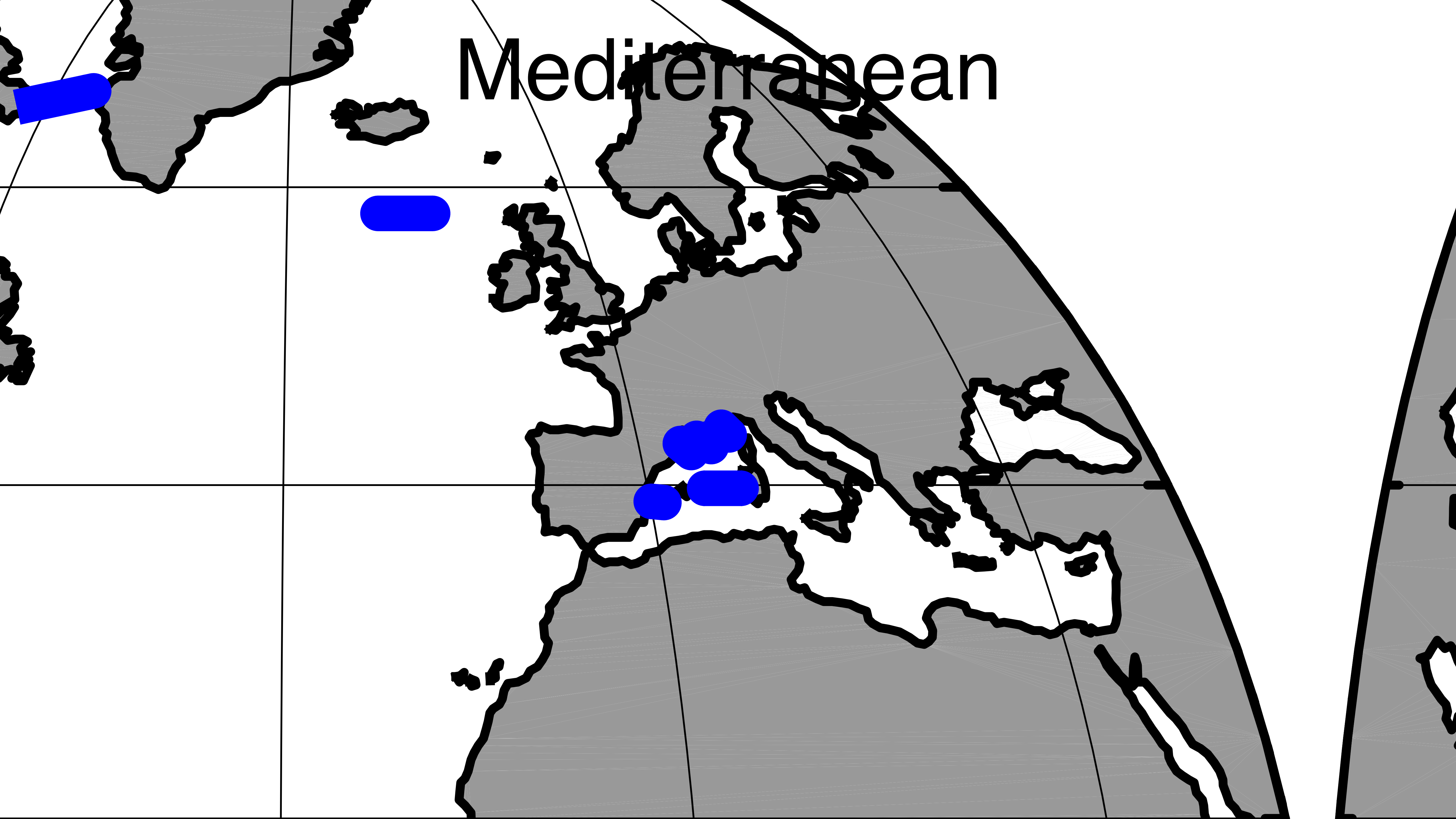


- 29 sections
- Sustained for at least one year
- Pacific, Atlantic, Indian, Mediterranean

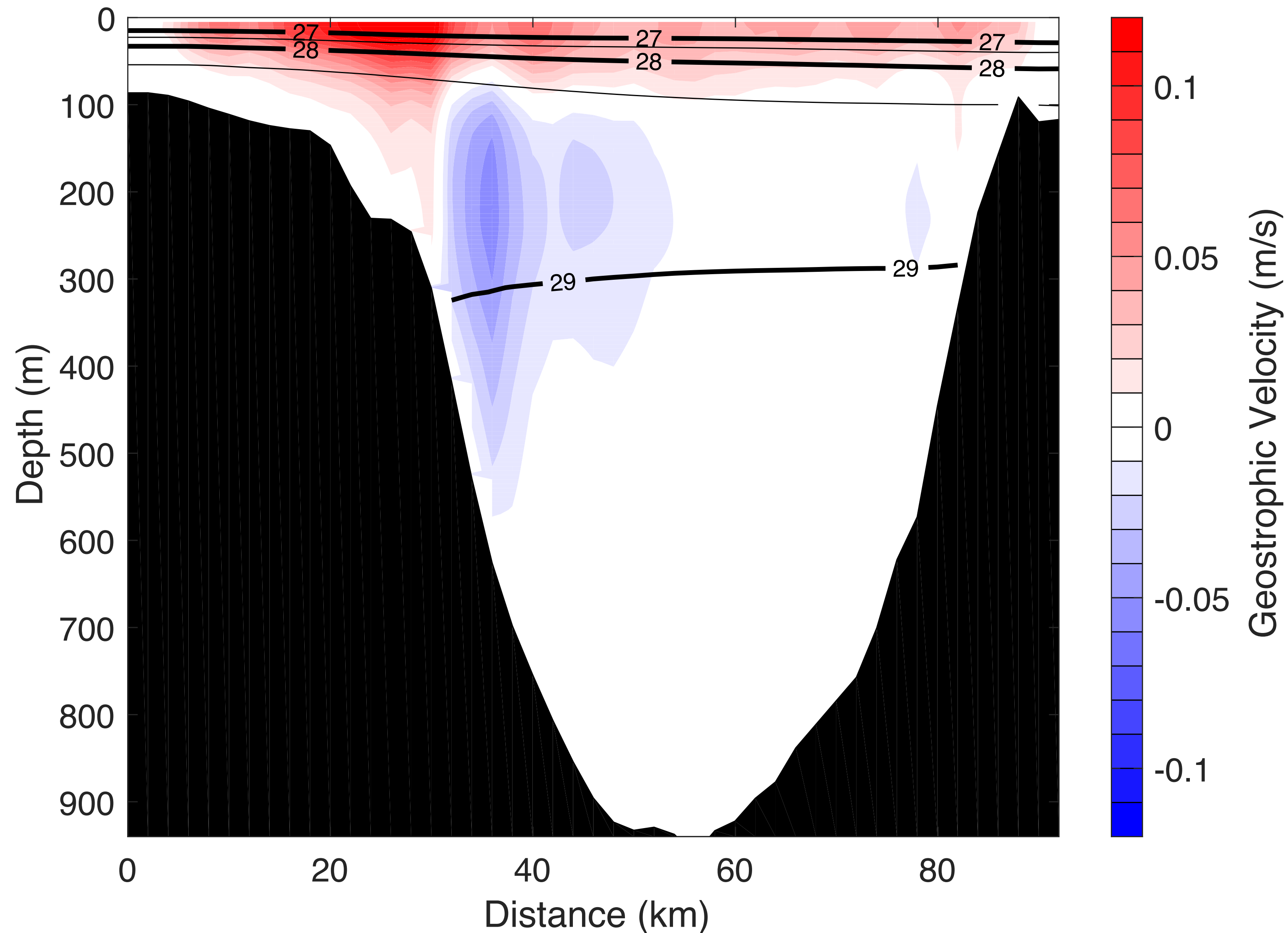
Mediterranean



Mediterranean

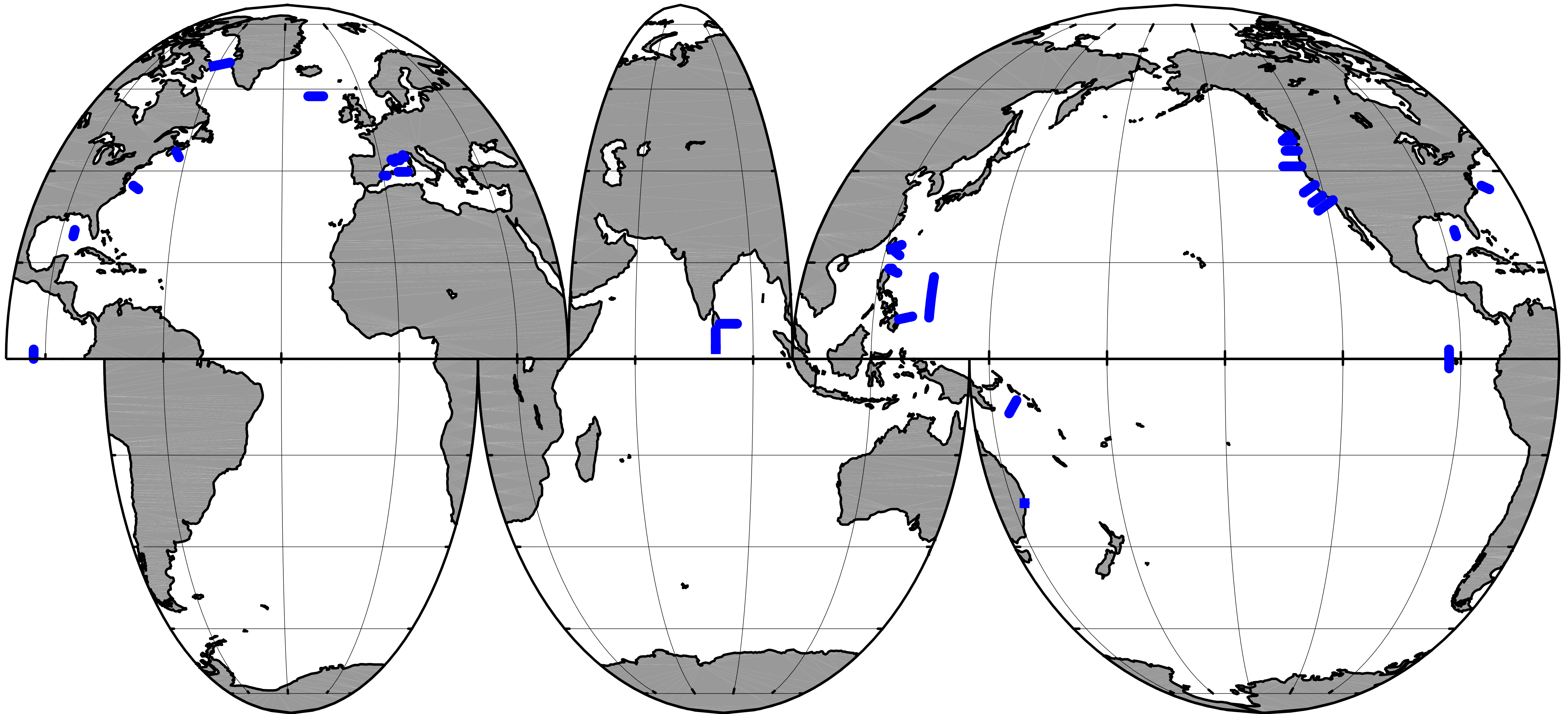


Mediterranean

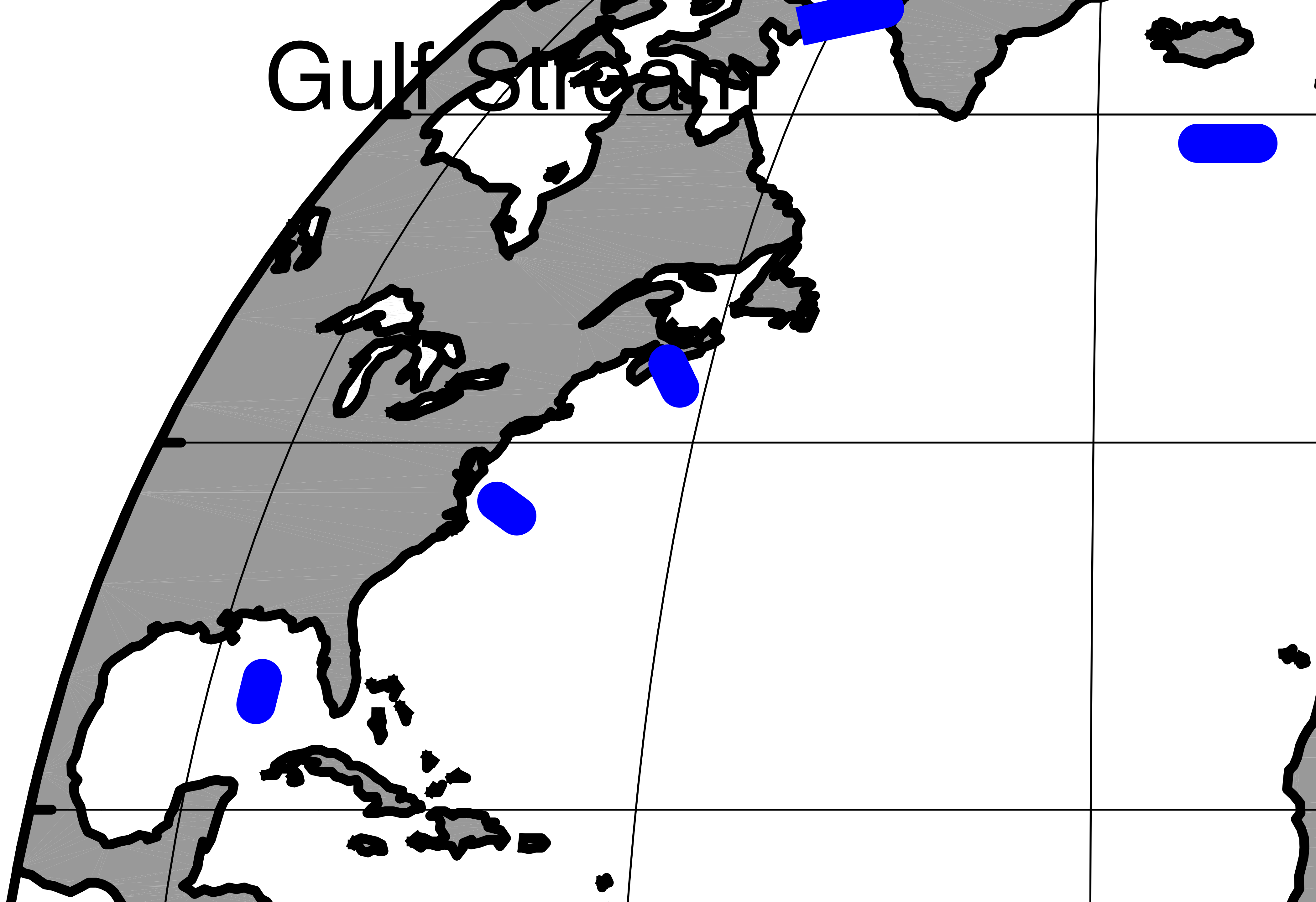


- Ibiza Channel (Heslop et al. 2012)
- Several additional sections including in the Northern Current System (Testor et al., 2018), and in the Mallorca Channel (Barcelo-Llull et al., 2019)
- Gliders may be especially useful in marginal seas

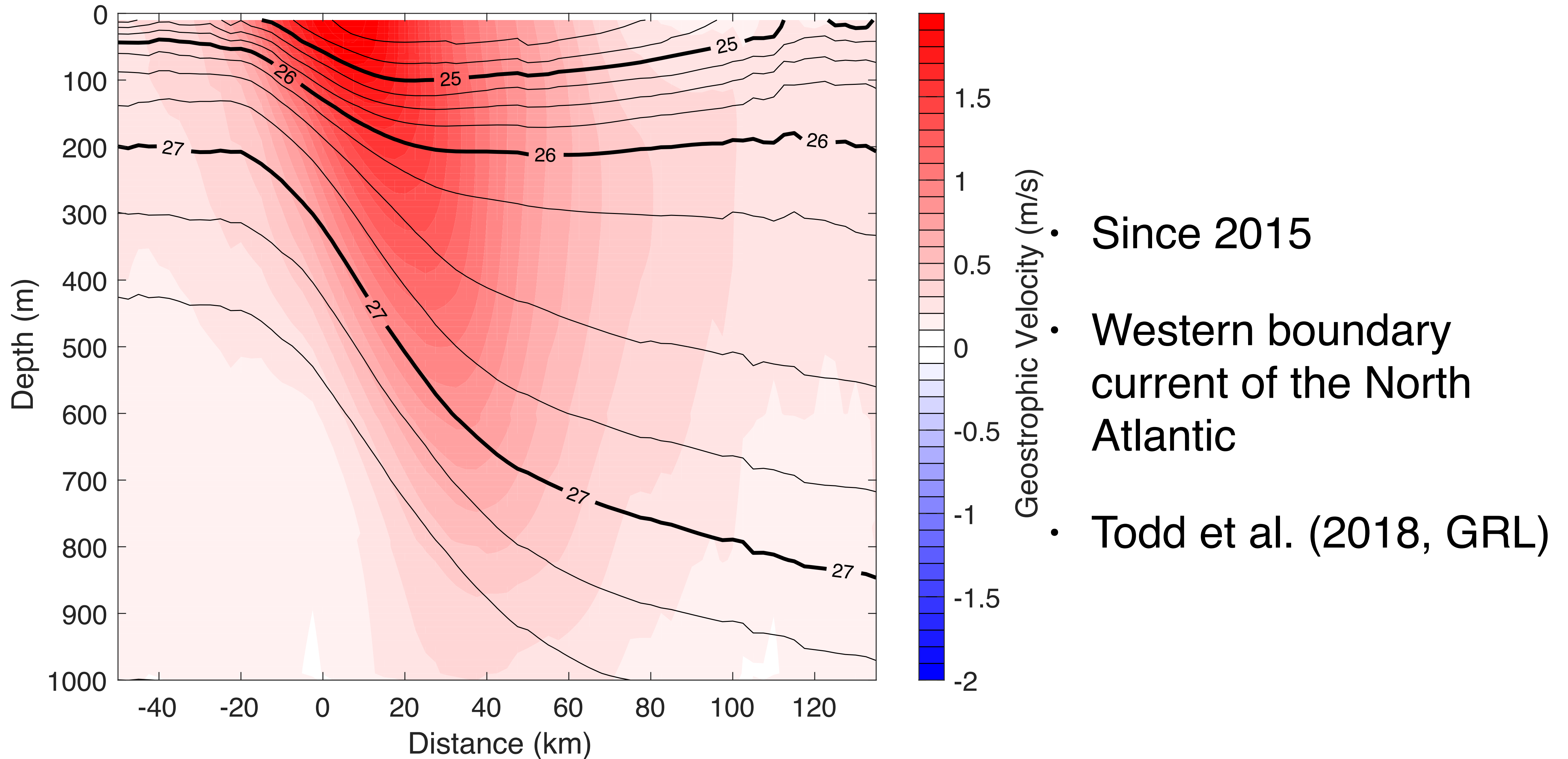
Gulf Stream



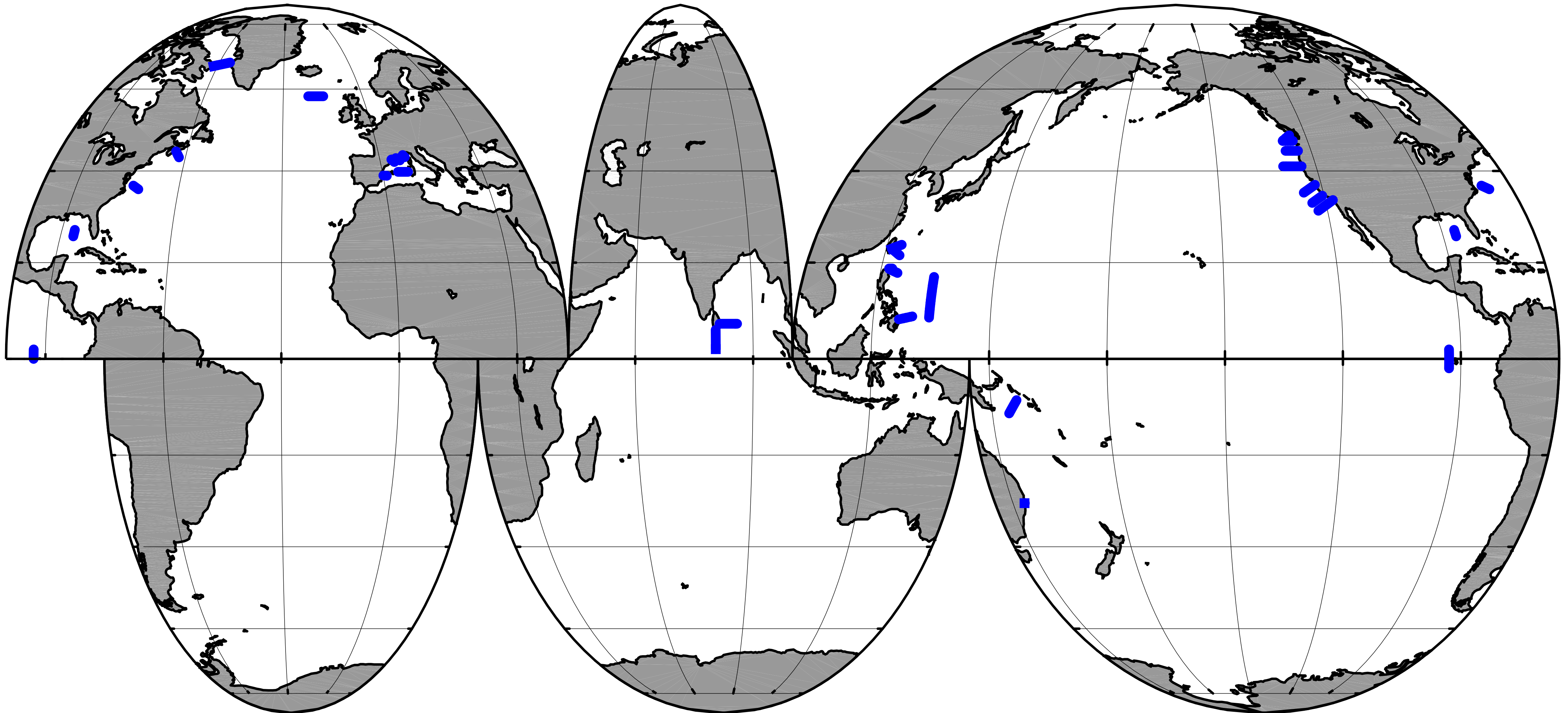
Gulf Stream



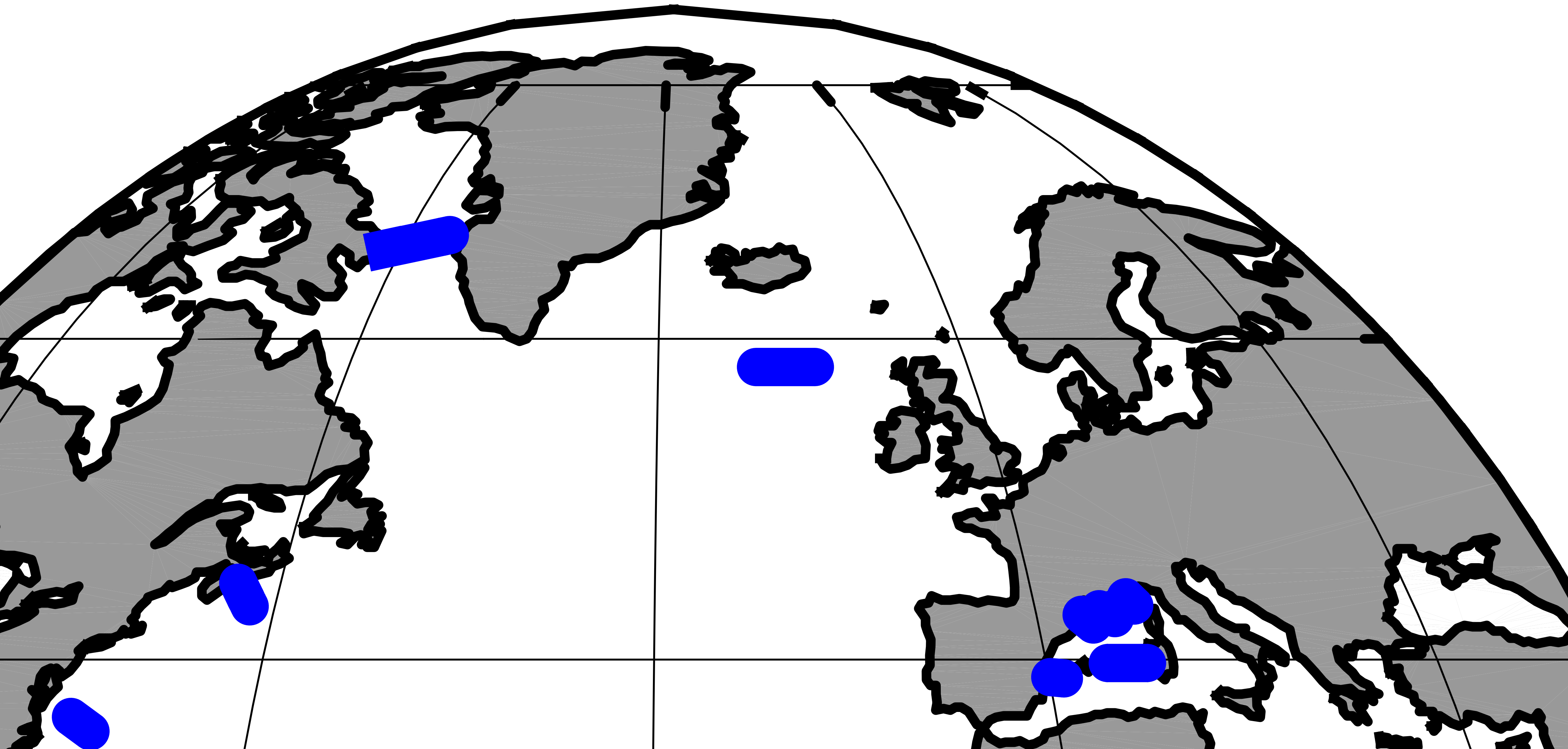
Gulf Stream



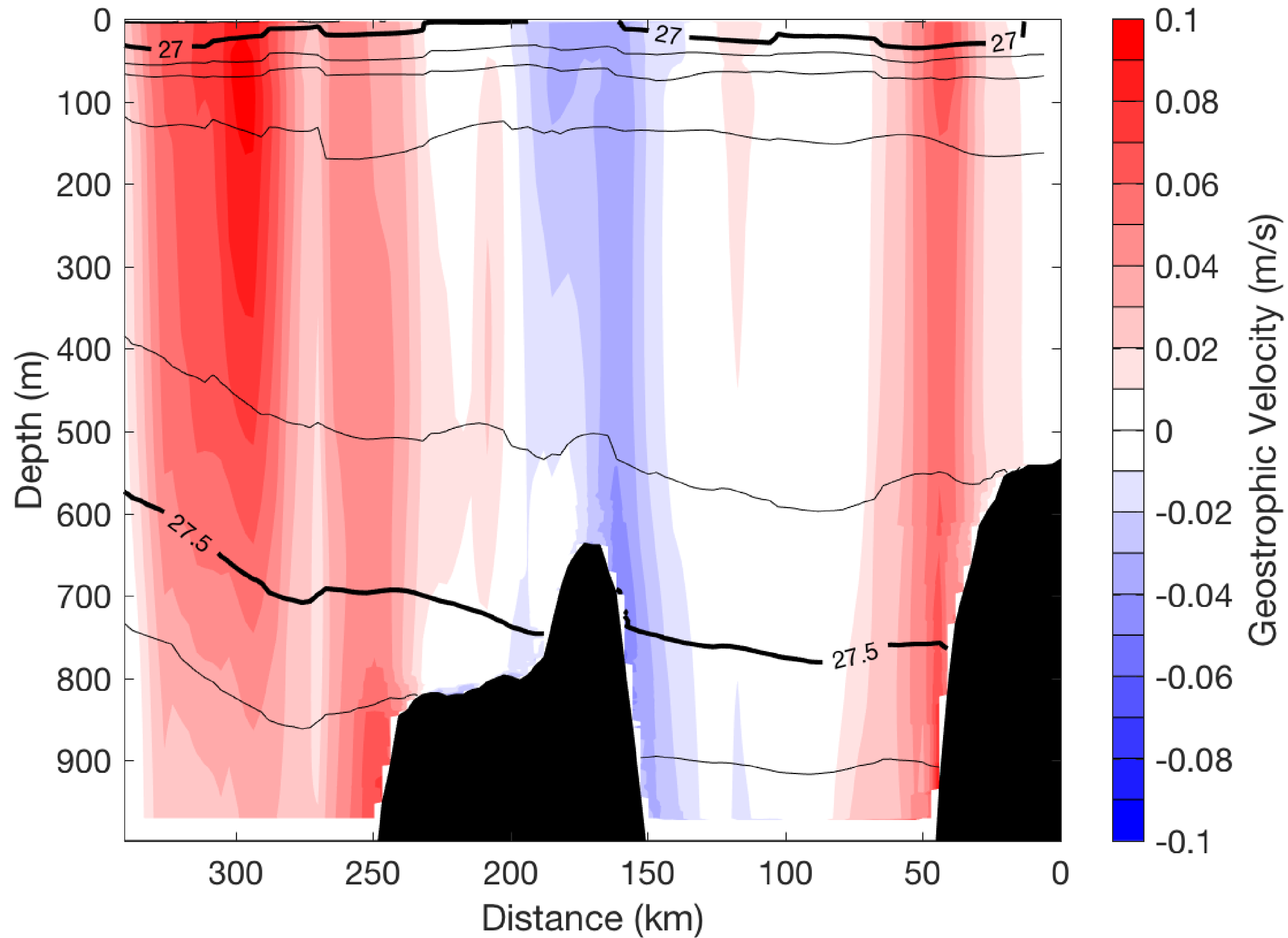
North Atlantic Current



North Atlantic Current

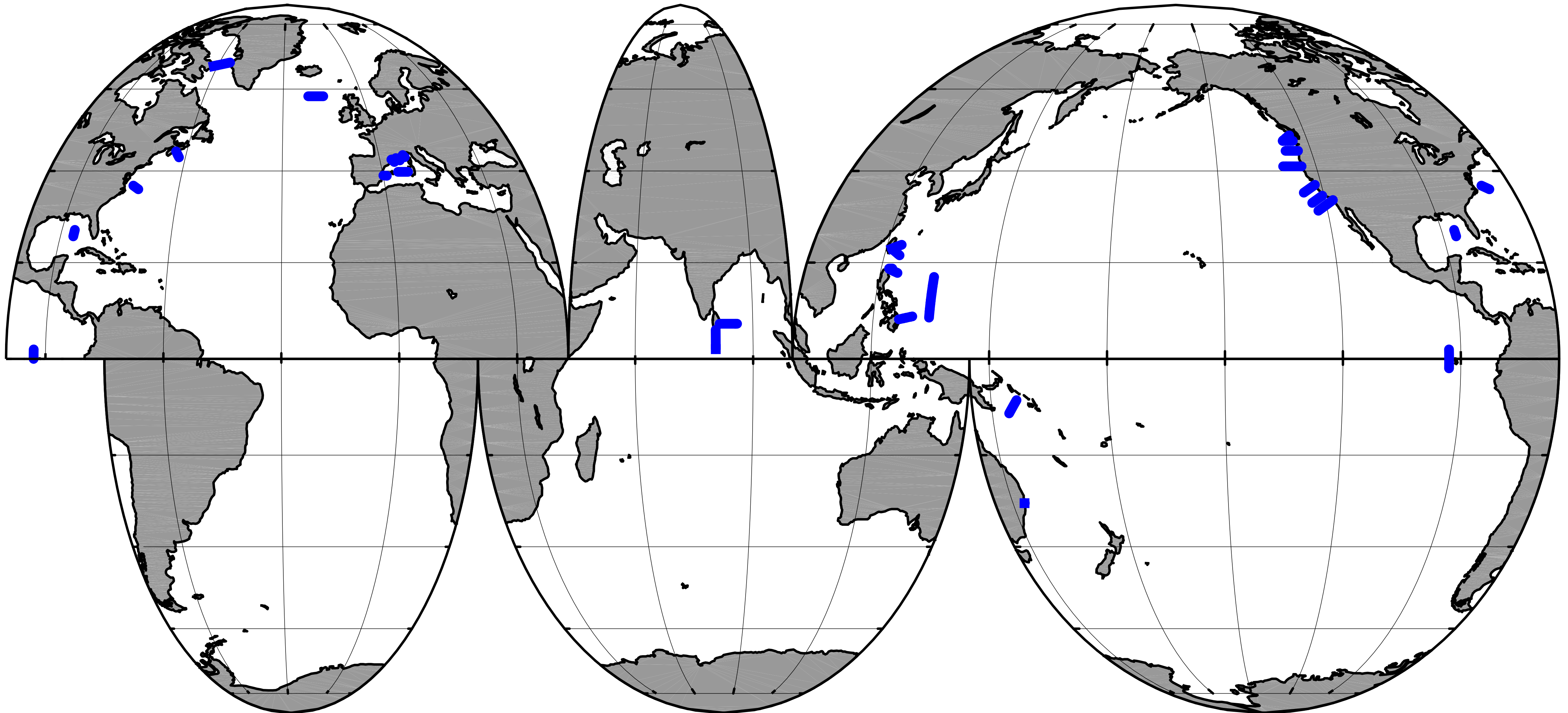


North Atlantic Current

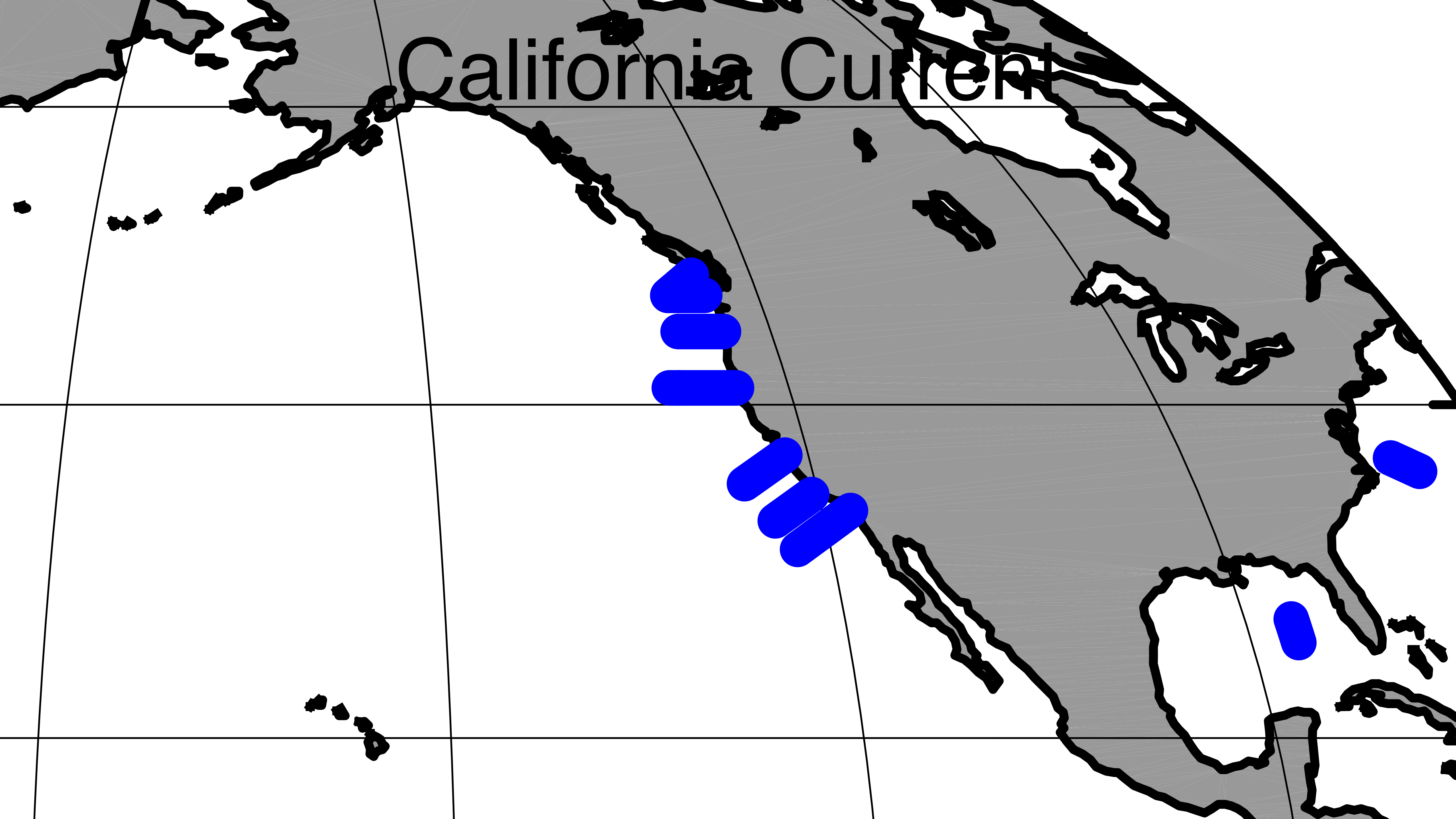


- Since 2014
- Major component of the North Atlantic Meridional Overturning Circulation
- Houpert et al. (2018, JGR)

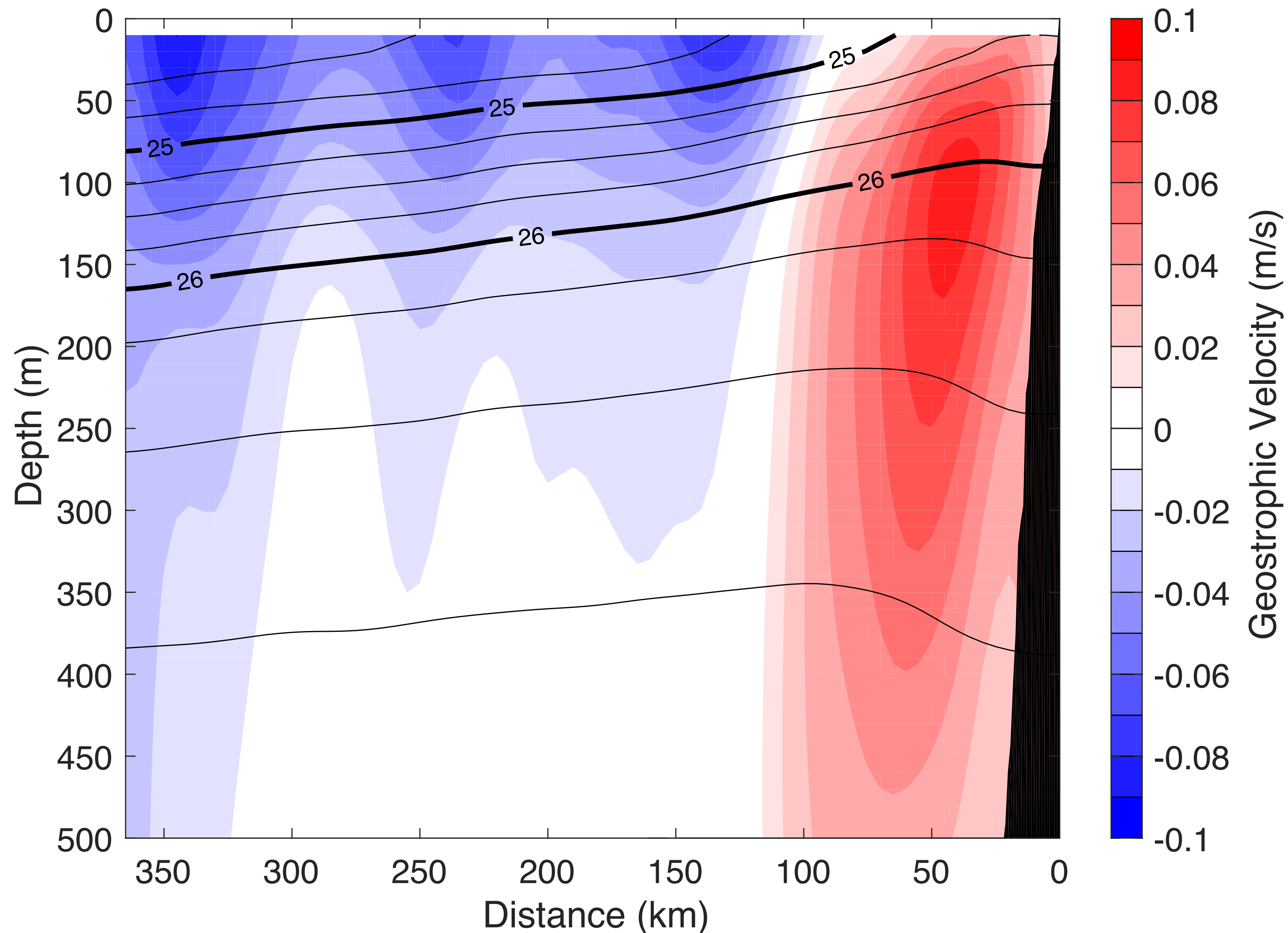
California Current



California Current

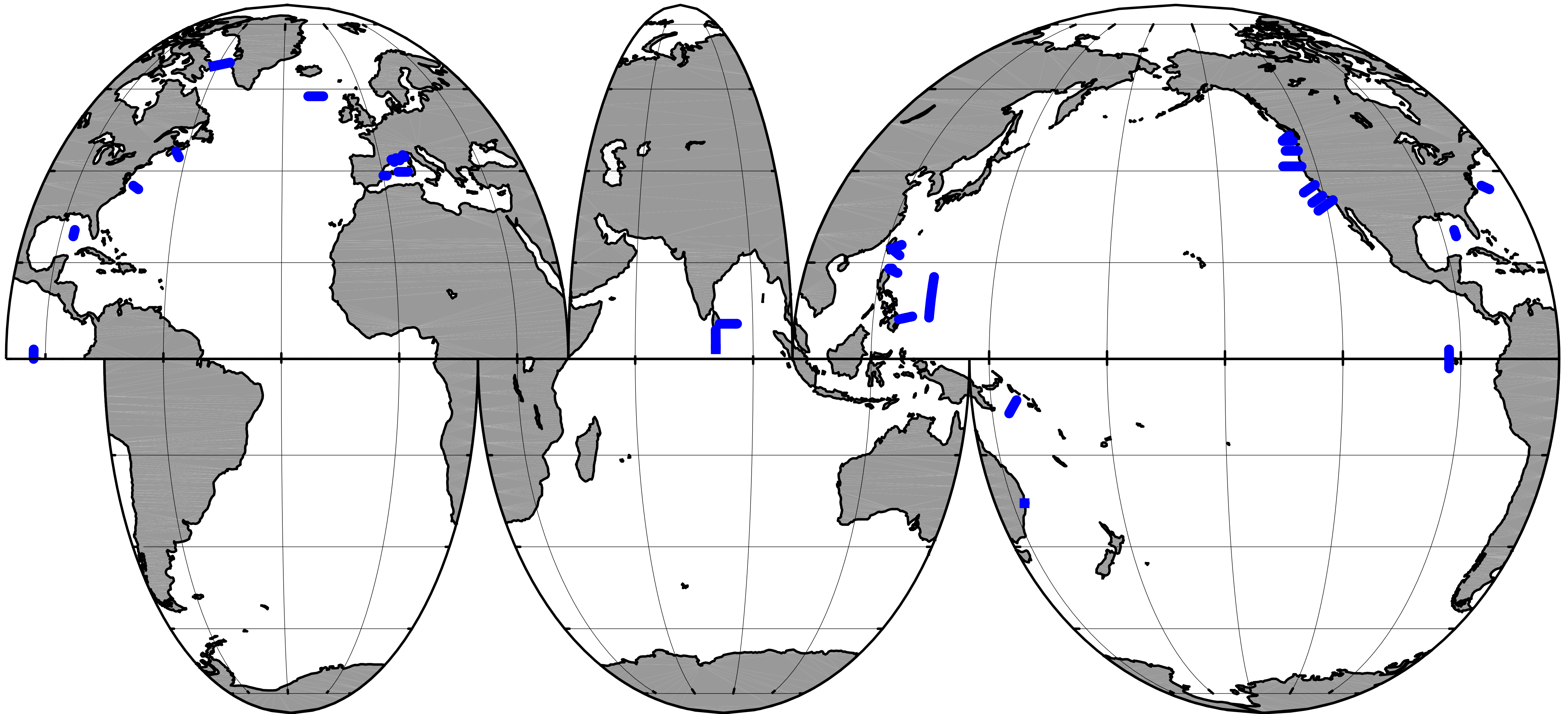


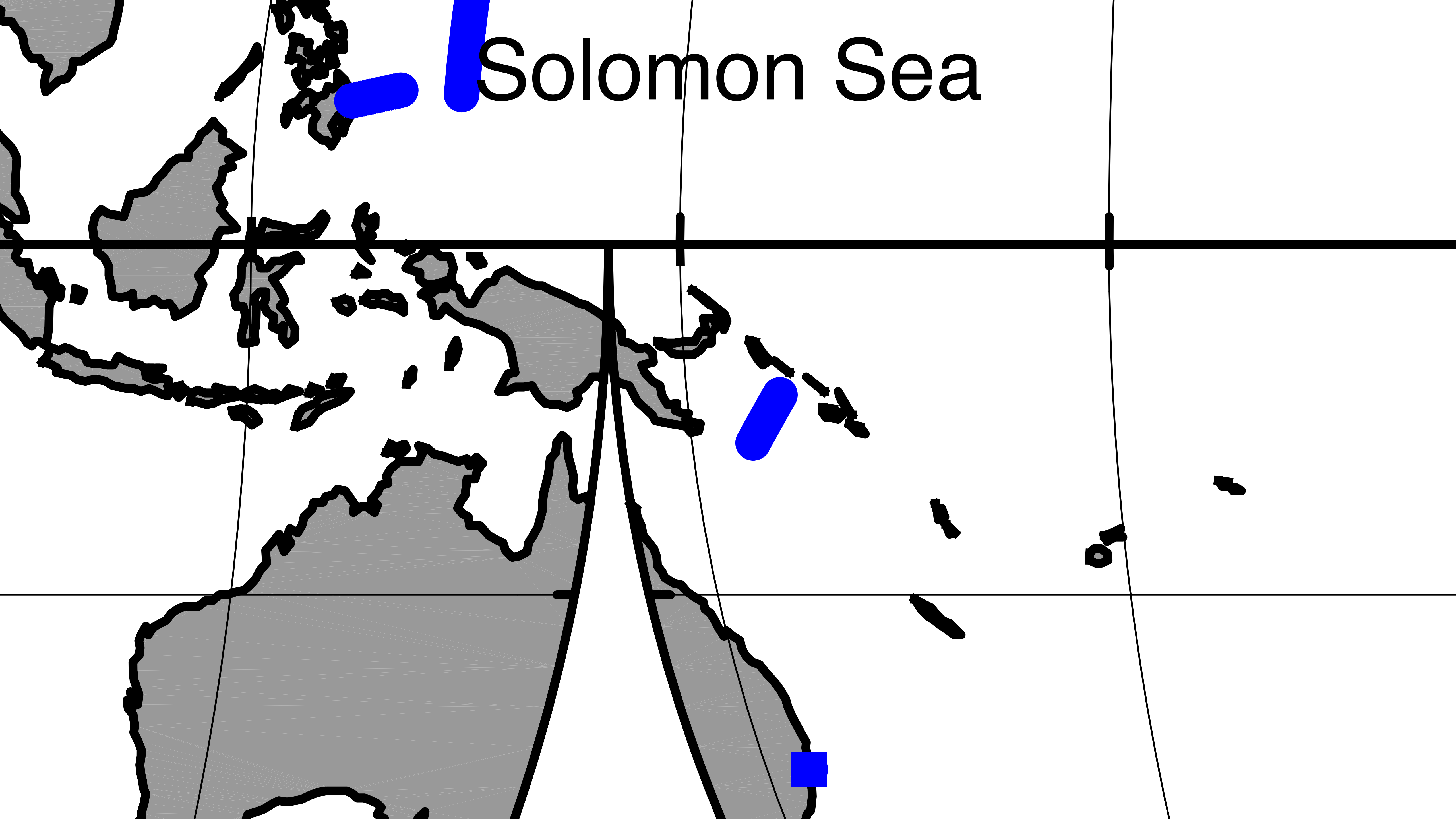
California Underwater Glider Network



- 12 years on three traditional CalCOFI lines
- Regional effects of climate variability as by El Niño
- California Current and Undercurrent
- Rudnick et al. (2017, Prog. Oceanogr.)

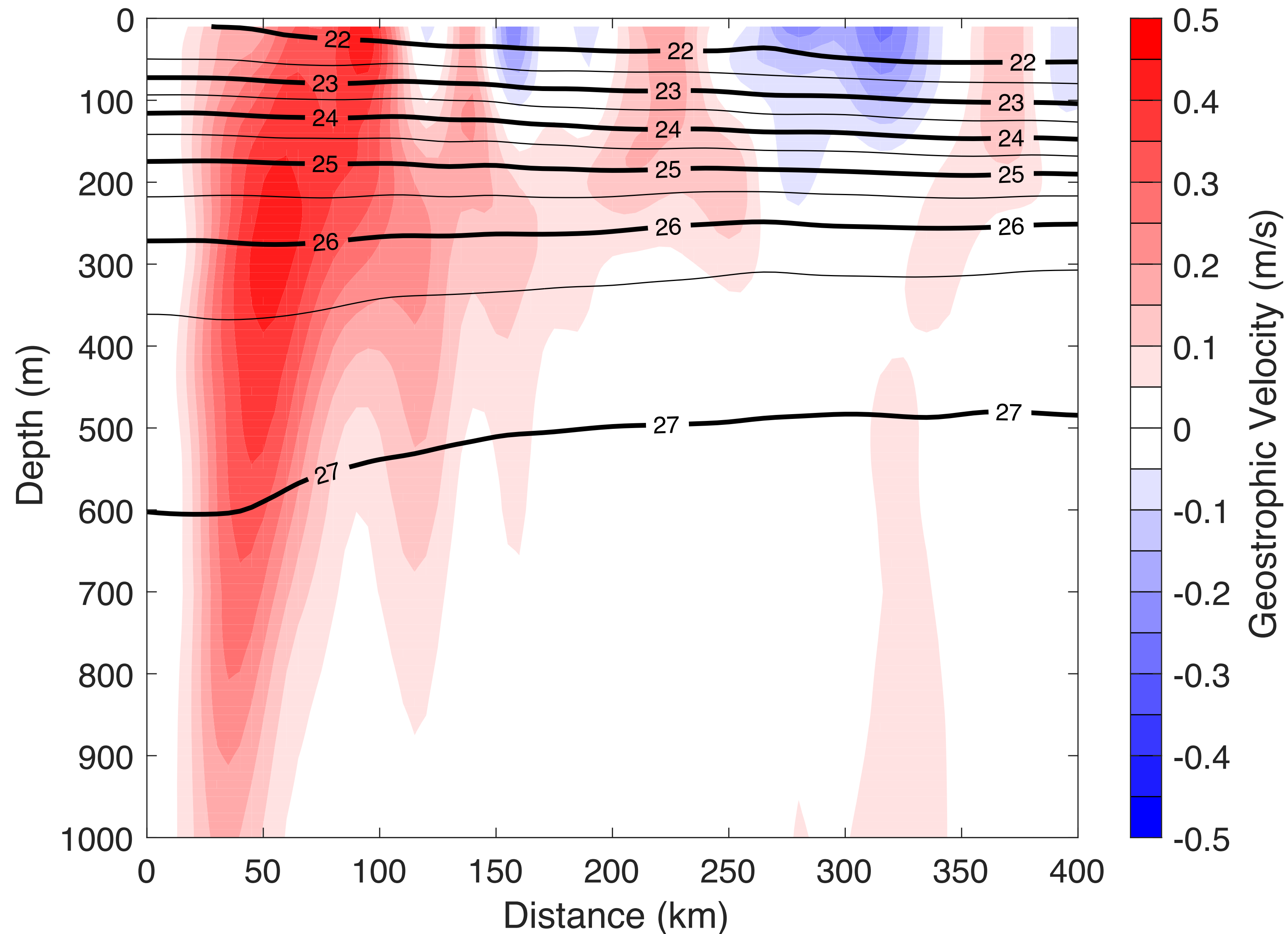
Solomon Sea





Solomon Sea

Solomon Sea



- 10 years across the Solomon Sea
- Low latitude boundary current that feeds the Pacific Equatorial Current System
- New Guinea Coastal Undercurrent
- Davis et al. (2012, JPO)

Gliders and models

- The data provided by underwater gliders are a natural match for regional models of coastal ocean circulation
- These regional (as contrasted with global) models are necessary, as the currents and water properties in the coastal ocean vary on the relatively small scales set by topography
- Accurate forecasting depends on initialization on these small scales, which can be satisfied by a network of gliders
- From their earliest conception, underwater gliders were viewed as components of observing/modeling systems, and progress over the past decade has proven the efficacy of this approach.

Purpose of BOON, a network of networks

- Provide coordination and linkage for a global observing program
- Support regional efforts respectful of the coastal countries
- Encourage sustained, year-round operation
- Help to publish data in near-real time on the GTS and in CF compliant formats to a central data assembly center
- Improved and sustained quality control of glider data
- The ultimate realization will be a global network of regional networks that monitor boundary current variability across international borders to the world's benefit
- Proposal: 100 gliders sustained in boundary regions