



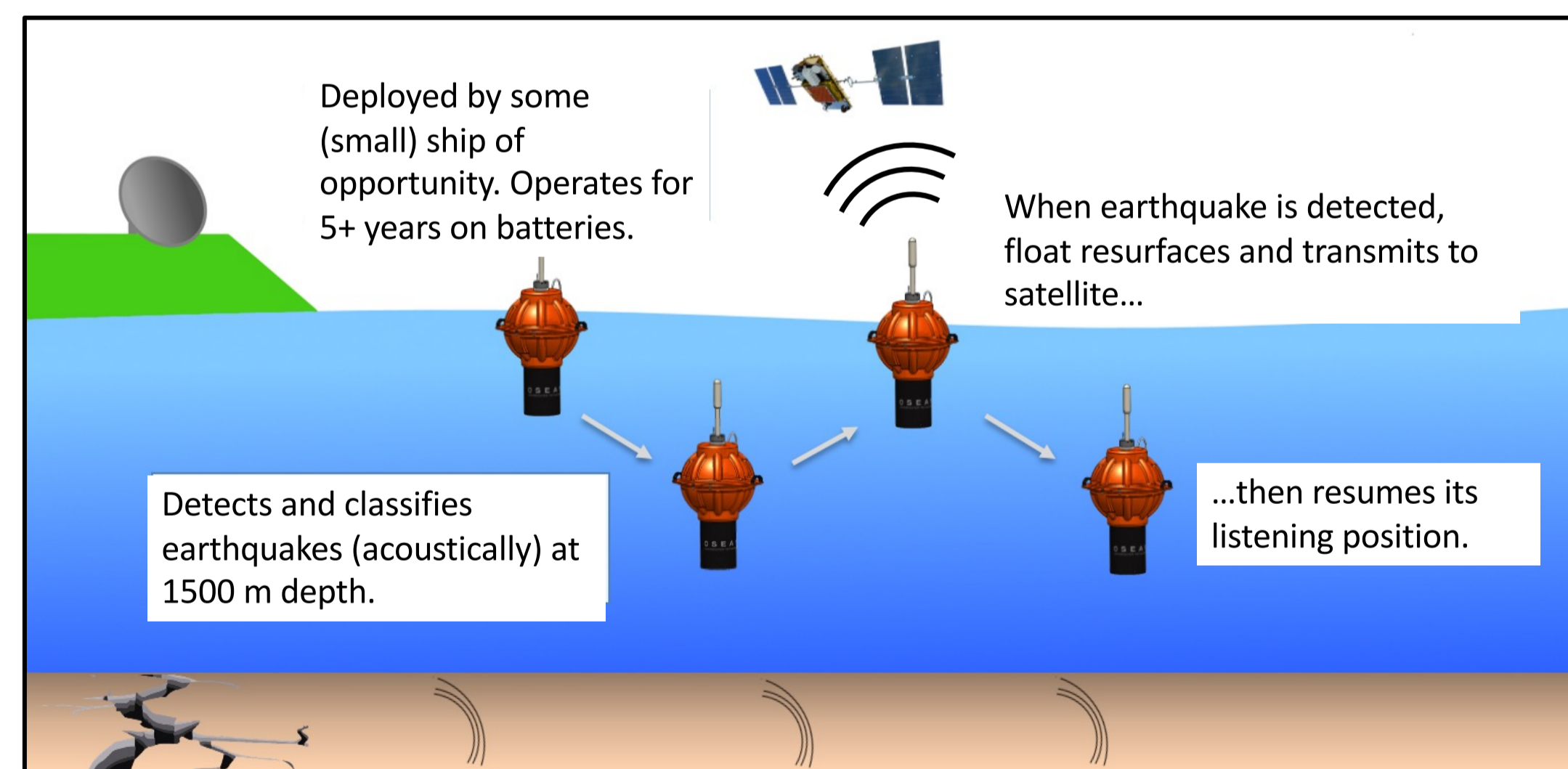
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Re-location and integration into the ISC Bulletin of earthquakes recorded by hydro-acoustic MERMAID instruments freely floating in the South Pacific Ocean

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Abstract Our fleet of 50 autonomous seismo-acoustic floats ("MERMAID") are drifting passively in the South Pacific Ocean at 1500 m water depth. It has recorded ~10,000 earthquake traveltimes over >5 years, running an embedded detection algorithm. By how much can these oceanic "stations" improve earthquake locations? We added our MERMAID data to the International Seismological Centre's holdings of picks from land and island stations and ran the ISC's routine relocation procedures. We present the data quality of MERMAID traveltimes and the improvements obtained for event relocation.

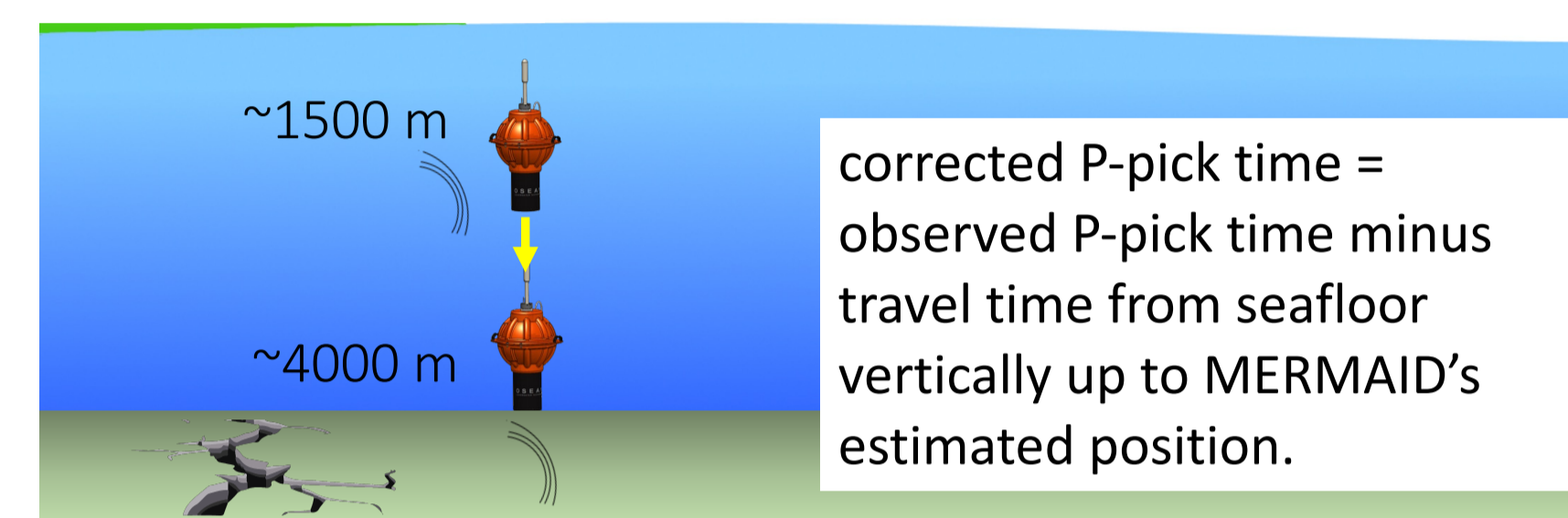
The seismo-acoustic floats ("MERMAID")



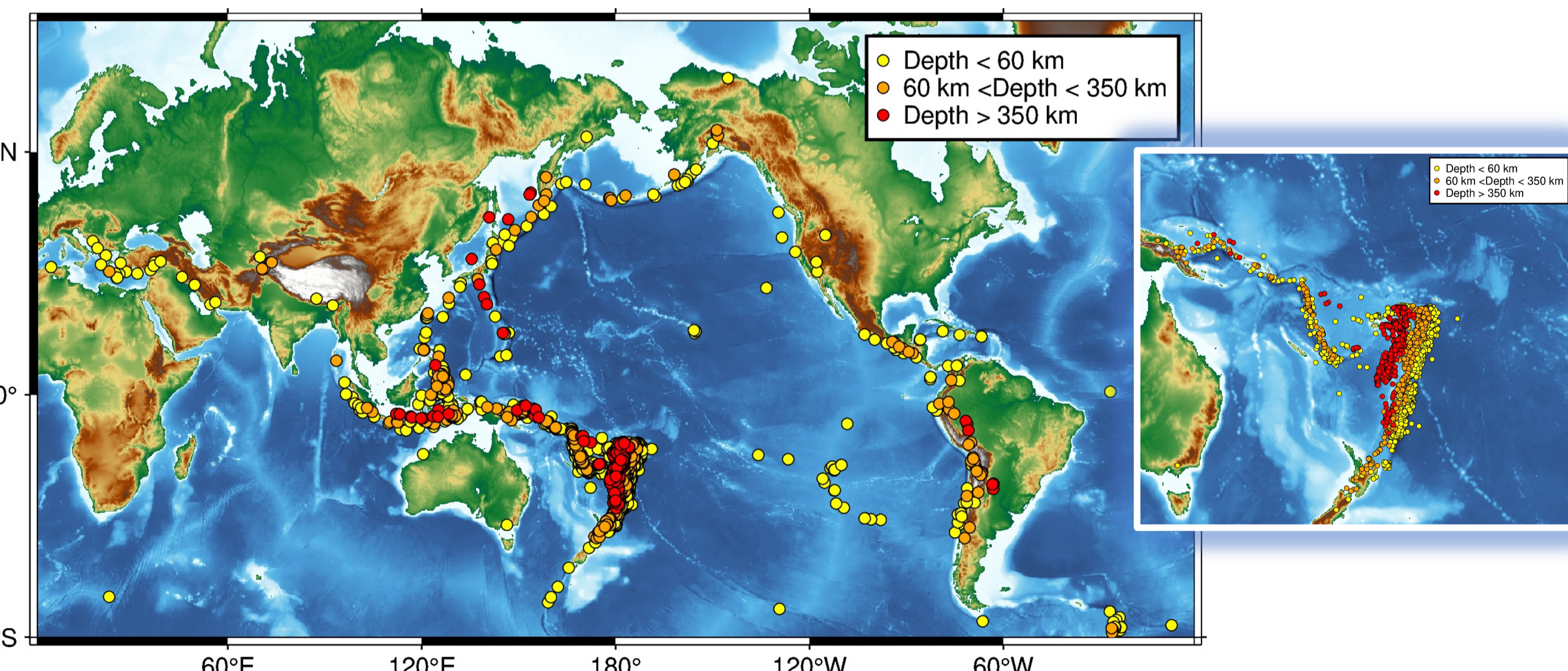
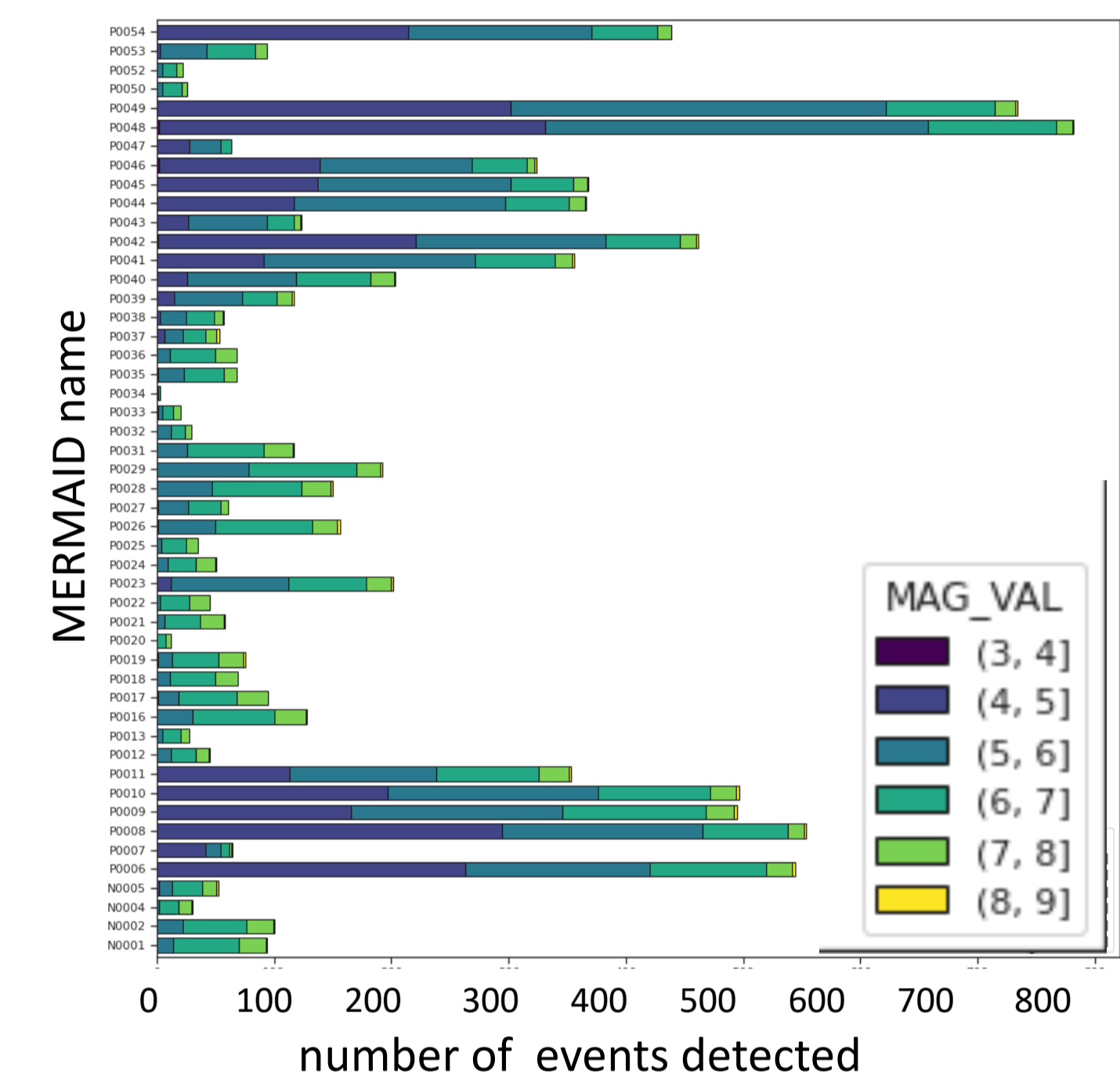
Left: MERMAID are hydrophones that drift in the deep ocean currents, listening for seismic waves that have converted to acoustic waves upon hitting the seafloor from below. **Bottom right:** Snapshot (in 11/2023) of the 50 MERMAID that constitute SPIIM, the South Pacific Plume Imaging experiment. **Bottom left:** a MERMAID (120cm high, 50cm wide, 60 kg heavy) is surfacing near Nice and our lab "Géoazur", where it was developed.



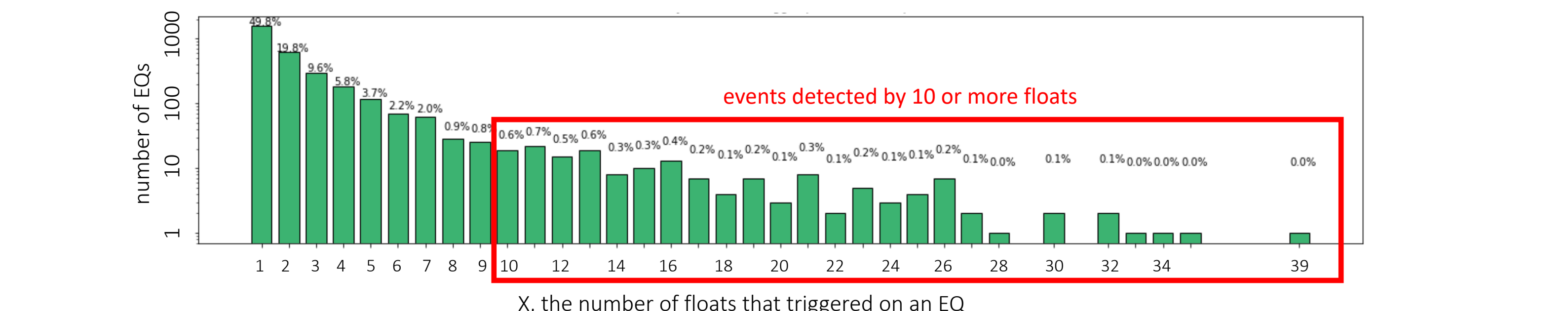
Method and data set



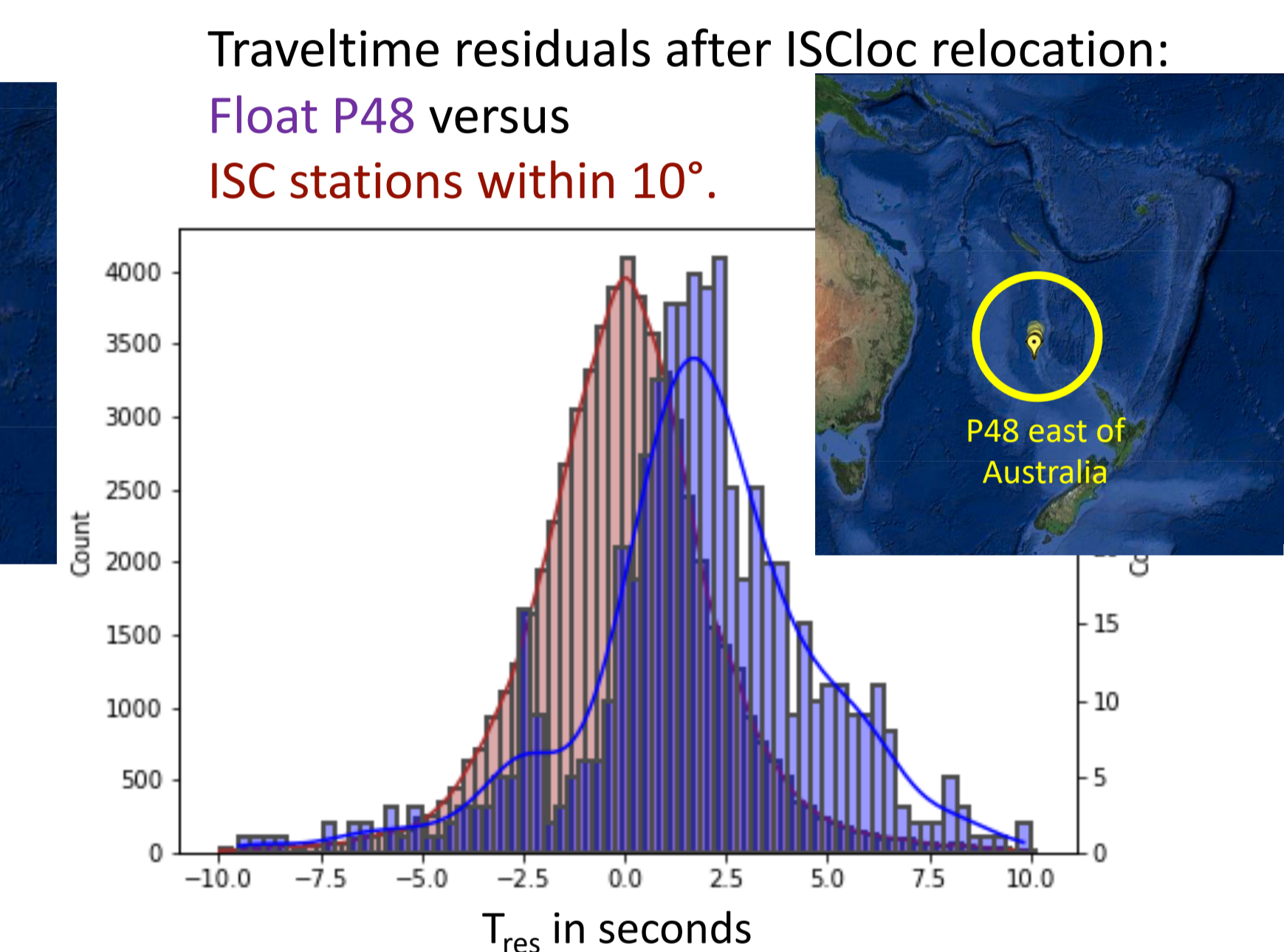
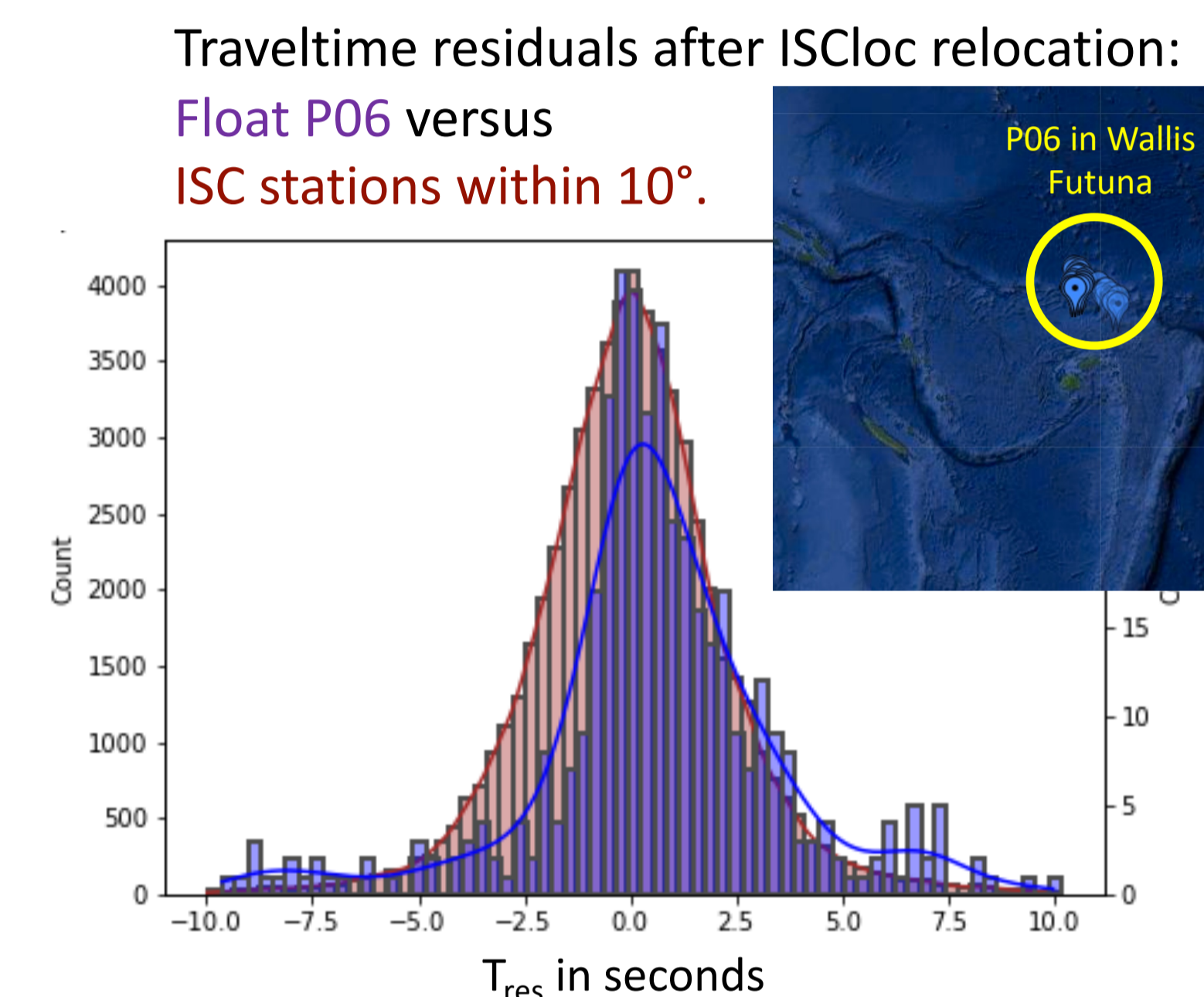
Above: Bathymetry corrections are necessary because all other ISC data are given relative to continental reference model AK135. We chose to correct to the solid seafloor (GEBCO bathymetry), rather than to the (sea) surface. **Right:** The data set consists of ~10,000 usable traveltimes from 3138 earthquakes. Bar graph shows the number of EQs detected by each float. Colour denotes EQ magnitude.



Above: The 3138 events detected by the 50 floats of the SPPIM experiment over >5 years. A handful of MERMAID near the Tonga subduction zone detected thousands of small events, for which the ISC tends to receive very few picks from land stations. **Below:** Histogram of the number of EQs that were detected by X floats. Over 50% of EQs – usually small Tonga-Kermadec events – were detected by only one MERMAID.



Results: Data quality and relocation improvements



Above: "Good" data quality means that after EQ relocation using ISC routines, the traveltime residuals of MERMAID "stations" should not be significantly larger than those of ISC (land/island) stations. Shown are the histograms of traveltime residuals for two MERMAID with abundant data (P06 in top left, P48 in top right), in each case comparing to the histograms of all ISC stations in the area (at <10° distance from the float). MERMAID data quality are seen to be comparable to ISC data: their bell-shaped distributions scatter no more widely than those of their neighbouring land stations. Systematic time offsets likely reflect differing (oceanic = slow) mantle structure beneath the floats. **Below:** Relocation of an mb=4.8 Tonga event at 66 km depth. Left: Three MERMAID recorded it at distances of 3-15°. Among the ISC's >300 useable picks, only two were within the same close range. Middle: EQ location solution without and with the 3 MERMAID picks included in the ISCloc relocation. Right: Error ellipses for the solution without and with the 3 MERMAID picks included. A few nearby MERMAID can make a big difference in this sparsely instrumented ocean area! (Whereas teleseismic events rarely see a significant improvement in the error ellipse.)

ISC Bulletin EventID= 620845244, Tonga Islands 2021/07/23, mb 4.8. ISCloc location results without and with 3 MERMAID picks.

