The old Philippine Sea Plate is subducting beneath the Eurasian Plate at a relatively high convergence rate, implying that the Ryukyu trench is rather a highly coupled subduction (*Ado et al. 2009)*. However, the few of earthquakes of M8+ in the arc over the last 350 years (*Watanabe, 1985*) brought up the question of how the megathrust releases strains. Although a part of the research puzzle was elucidated with the finding of silent earthquakes (e.g *Nakamura and Sunagawa 2015*), an accurate estimation of the subduction coupling, which seems to highly vary along the trench (according to the distribution of paleotsunamis, *Goto et al. 2013*), is still required.
As in an ocean-ocean subduction, geodetic tools are often limited in space and in time, they give a short-term estimation of the megathrust coupling, which can be in disagreement with observations made over a larger time scale. An enlargement of the rather short time window of instrumental records is hence crucial for a better understanding of megathrust processes at multiple time scales. Toward this goal and taking advantage of the ubiquitous corals in tropical areas, we started a project in February 2016 focused on the use of coral microatolls along the Ryukyu arc. Coral microatolls are massive coral colonies, living in shallow reef flats that act as natural tide gauges by accurately recording relative sea-level changes (*Meltzner and Woodroffe 2015)*. We use them to retrieve the history of strain accumulation and relief over the megathrust interface through the whole seismic cycle (e.g *Zacchariasen et al. 1999*). Additionally to tectonic investigations, as the coral record consists of a significant climatic component, we also get informations on the climate in the region (the regional sea-level trend and short-term oceanographic events).

We performed a first fieldwork in March 2016 dedicated to the finding of corals microatolls in the northeastern part of the arc between north of Okinoerabu and Okinawa. The microatolls ubiquity we observed will permit to work along transect perpendicular and parallel to the trench, which is highly needed to an accurate understanding of the megathrust behavior (size of the seismogenic segment, segmentation of the arc…). Moreover we observed a large variability in shape, from cup-shaped corals indicating submergence at Ie-jima to hat-shaped corals indicating emergence at Yoron. This morphology variability means that a signal is probably superimposed on the homogeneous regional sea-level rise estimated with satellite altimetry to be of 3mm/yr since at least 1992 (probably since 1950 according to sea-level reconstruction from *Meyssignac and Cazenave, 2012*).

Based on the geomorphologic environment of the microatolls, we decided on a first sampling fieldwork in Itoman and Onna (south and west part of Okinawa, respectively) and in the northeastern lagoon of Yoron. We mainly checked the good connexion between the coral's area and the open ocean to avoid any moating effect that would give unreliable relative sea-level history. We also performed a detailed survey of the area, with a total station, to check that all microatolls from the site are recording the same modern history. We sampled two living corals for the three sites analysed and one large fossil microatoll of 8 m of diameter in Yoron. We only found microatolls from Porites specie, with variable color from purple to brown-yellow, that could be linked to the growth rate.

After a thin cutting of the coral slabs at the marble mason (equipped with stable diamond wire) and the x-ray of the thin coral slices at the hospital, we are able to count the growth bands on the coral x-ray. We then infer a stratigraphic drawing of the coral and reconstruct the corresponding HLS curve for each microatoll.

We thus reconstructed the relative sea-level changes over the last century with living microatolls and inferred more than three centuries of record from the fossil microatoll of Yoron.
In Onna, we inferred an emergence trend of about 1mm/yr over the last 55 years interrupted by few die downs around 1986, 1995, 2004, 2016. Over the same period, the microatolls from Itoman also recorded slight emergence but with lower rate close to zero and synchronous die downs. Thanks to the longest record of the coral Ito 2 that began to grow in 1868, we identified a major submergence trend of about 7mm/yr (sudden, gradual or a combination of both) that started around 1906. The first part of the Ito 2 record between 1868 and 1906 is unreliable. At that time the coral was growing in a moated pool protected from the open ocean by an emerged reef. This means that the coral was rather recorded the level changes of the pool than the relative sea-level changes in open ocean. The connexion to the open ocean was established in 1907 during a channel opening (City Office of Okinawa). Finally in Yoron, the coral record consists of an

alternation between periods of stable relative sea-level to emergence and periods of submergence (sudden or gradual) since 1928.
Regarding the fossil microatoll of Yoron, the inner part of the coral is unfortunately very smoothed due to erosion and we did not find residual die downs. We however infer a slow submergence of at best 1mm/yr over about 270 years with possible changes in rate. The external younger rim, which is higher than the inner part imply a major change in submergence rate (from 1mm/yr to more than 5mm/yr). Since the remaining cup shape of the fossil microatoll was also observed on at least one other large fossil microatoll, we assume that the cup shape is not due to erosion but to the relative sea-level changes. Thus, even though the inner part of the fossil coral is difficult to interpret, it is clear that the microatoll recorded a major change in submergence rate (sudden or gradual) over the last decades before it died. U-Th dating of the fossil microatoll of Yoron are ongoing and will help to understand the coral signal.

For the last century, we looked to other relative sea-level records available in the Ryukyu area. From the six longest available tide gauges in the Ryukyu arc, we inferred that over the last 40-50 years the submergence trend varies between tide gauges (from 0.5±0.7 mm/yr at Nase to 4.4±1.5 mm/yr at Nakanosima) and with the absolute regional sea-level rise of 3mm/yr. The two closest tide gauges of Naha and Okinawa record submergence rate is of 1mm/yr for the last 40 years, which is again lower than the regional trend, similarly to the signal inferred from coral microatolls. This could mean that at the scale of the arc, a signal is superimposed on the homogeneous regional trend, and could generate subsidence or uplift. Since volcanoes are far from the studied areas and actives faults of the upper plate usually generate a local signal, the only structure able to generate deformations at a regional scale, and with amplitude compatible with our observations is the megathrust. Even though the GPS studies imply no coupling for the Ryukyu trench, we still do not know what happened over longer timescale. The 1911 Kikai-jima earthquake of M8 is the only one that occurred during the coral record. However the epicentral location is about 300 km far from the studied areas, which makes unlikely that the earthquake was recorded by the coral microatolls we sampled. Regarding the silent earthquakes that occurred along the arc, we do not know if the deformation generated in surface during such events is large enough to be recorded by microatolls (as the slow events recorded with GPS in Mexico and New Zealand with centimetric vertical amplitude reaching, *Larson et al. 2007, Wallace and Beavan 2006*).
While we would need more data and an accurate map of the active structures along the arc to go further in the interpretation of the coral signal, we can bring some assumptions of how the megathrust could explain the relative sea-level changes deduced from corals. For the signal of Okinawa, the last 55 years of emergence could be due to some interseismic loading on the megathrust interface that would generate in surface an uplift of few millimeters per year. The fast submergence trend recorded by Ito 2 between 1906 and about 1960 could imply a major coupling change on the megathrust. For the record of Yoron, we could propose that the corals are recording some interseismic uplift (like in Okinawa) interrupted by possibly sudden centimetric submergence events (between 5 cm and 10 cm) that could be due to slow earthquakes.
Finally, the inconsistency between records of Okinawa and Yoron could be due to the several structures that enter in subduction and that could generate a segmentation of the arc. Thus, Yoron and the south part of Okinawa might belong to two separate segments of the megathrust and have different tectonic history.
We identified synchronous die downs between corals and in the closest tide gauges of Naha and Okinawa, which is a good indication of the reliability of the coral microatolls as natural tide gauges. These temporary emergence events are probably due to oceanographic effects and will deserve a deeper study in the future (through SST analysis for example).

This first study on the coral microatolls in the Ryukyu islands need to be extended along the arc and also in time by still looking for fossil microatolls and for other markers as reef plateau and marine terraces. We have also begun to work at that millenary scale with the sampling of the emerged reefs in March 2016. U-Th dating of those samples are ongoing.
A study of the actives faults of the arc will highly help to go further and decipher between signal related to the megathrust and local signal due to actives faults of the upper plate.