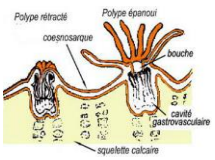
Sen2Coral

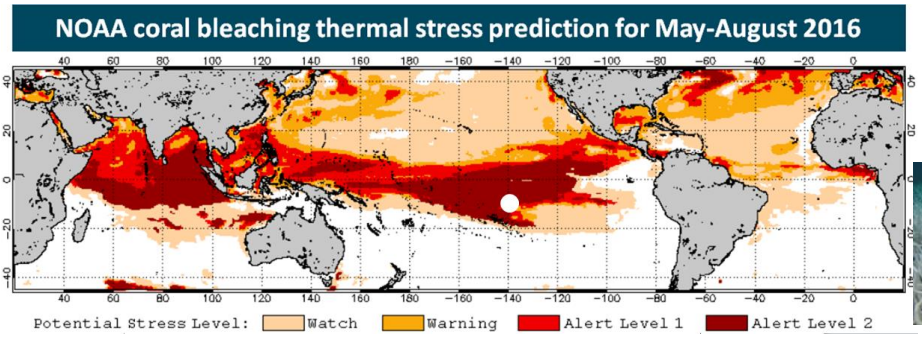
an ESA project for coral reefs health assessment and monitoring

El Nino's Coral Bleaching: the Marquesas demonstration



Polyps live symbiotically with an alga, the zooxanthella, which converts light into carbohydrates. When stressed by photo-inhibitors, corals expel their algae, lose their colour – hence the name of the plague: **Bleaching** - and unless rapidly colonised again, die.

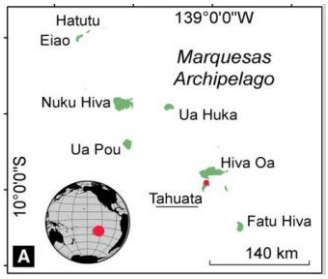
Mass bleaching occurs under thermal stress such as the one induced by the 2016 freak El Nino. The Marquesas have small, deep lagoons, pounded by swells and affected by thermal stress, making their coral reefs highly vulnerable.



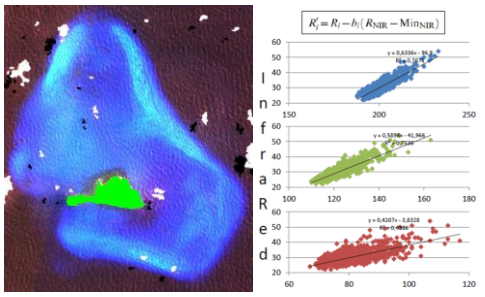
Because they need a higher light absorption rate to synthetize energy, deep corals are more sensitive to thermal stress. The Marquesas mean February temperature anomaly was + 2.5°C.

The uninhabited island of Fatu Huku was selected to conduct a test survey. The object of the exercise was to prove that coral bleaching observed in-situ by divers, and vaguely by subsurface cameras, could also be detected by the Sentinel-2 Multispectral Instruments (MSI), on the assumption that if a demonstrator can work in such a challenging environment, it will work everywhere!

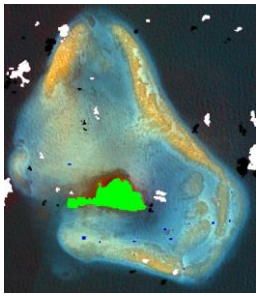
Habitat mapping such as the detection of coral bleaching requires a toolbox dedicated to enhance Sentinel-2 Earth Observation capabilities.



Amongst the algorithms developed for the Sen2Coral project, special mention should be made of spatial registration, cloud masks, atmospheric corrections, surface glint removal, water column correction, radiometric normalisation, depth invariant indices, physics-based radiance inversion, satellite derived bathymetry and, most difficult of all, detection of changes.



Deglint procedure



RGB composite of depth-variant indices

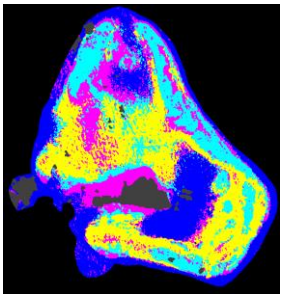
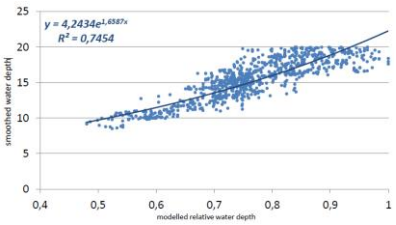
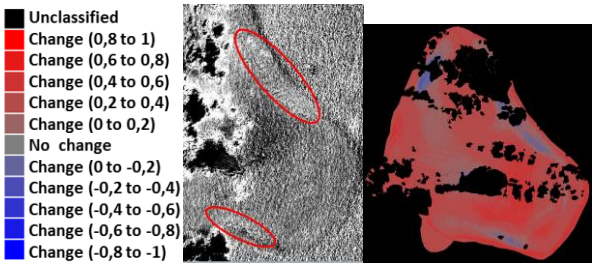


Image classification of habitats



Sonar depths against relative SDB model depths

Changes were detected between two February and April Sentinel-2 images. The changes took the form of very faint variations observed in the relative green/blue ratio in the water column, at the sea/surface interface and in the sea bottom albedo.



Changes in the green/blue ratio:

$$l_w^{(B_3,B_2)}\big|_a(21Apr) - l_w^{(B_3,B_2)}\big|_a(11Feb)$$

CONCLUSION

Whilst negative anomalies are likely to be caused by wind generated turbulence ("sand storms", backscatter, aerosols), positive reflectance anomalies can be ascribed to coral bleaching,

Although very faint, reflectance anomalies affecting Fatu Huku deep coral could be detected from space by Sentinel-2, while the towed subsurface camera could only see blurry images.

Subsurface camera blurry images

https://sen2coral.org