

ReefTEMPS, FAIRs access to Reef ecosystem environmental measurements

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ReefTEMPS is a coastal ocean observatory in the South, South West and West Pacific that provides long-term monitoring of climate change and its effects on the status of coral reefs and their resources. The network has been deploying sensors for temperature, pressure, conductivity, fluorescence and/or turbidity at 98 sites throughout the coastal zone of some 20 island states and territories since 1958.

ReefTEMPS (<http://www.reeftemps.science/>), labelled *Service National (for) Observation (SNO)*, is part of the French research infrastructure "coastal ocean and nearshore observations" **IR ILICO**.

The network's platforms have been strategically positioned in relation to the processes observed and the underlying scientific issues, in locations that are sometimes difficult to access and for which very little data exist. Indeed, satellite remote sensing can not yet provide high resolution and accuracy over coastal waters. Autonomous sensors, with acquisition frequencies ranging from 30 minutes to 1 second (high frequency), are immersed for periods ranging from 6 months to 2 years and are then downloaded. The acquired data are then added to the database by the instrumentation engineers. A validation process involving oceanographers qualifies the data and produces long time series or "historical series". The network was deployed throughout the Pacific island region starting in 2010, but has incorporated much older stations, some of which have been in operation since 1958.

ReefTEMPS is used to measure long-term trends, inter-annual changes (i.e. seawater temperature), and rare or extreme events (i.e. tropical storms) and to understand the physical, chemical and biological processes at work in the overall dynamics of the systems (i.e. coral bleaching).

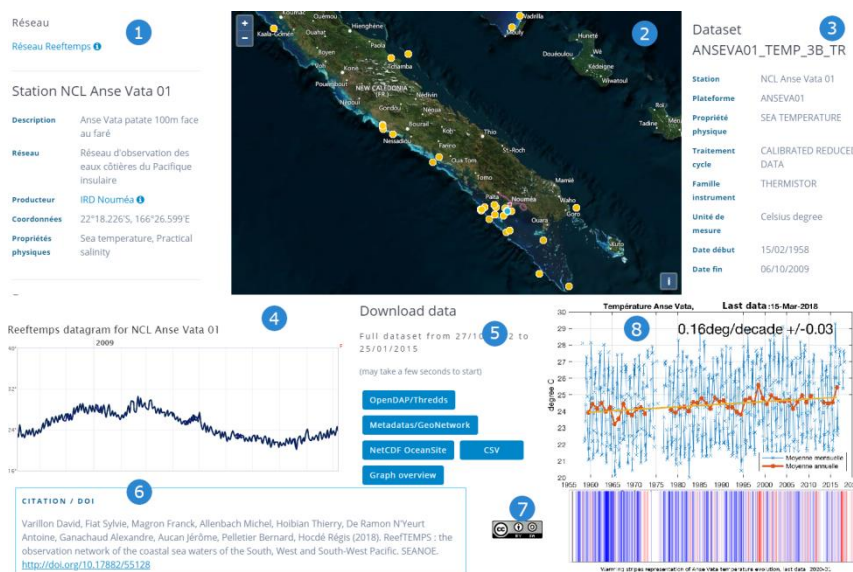


Figure 1:

Getting Anse Vata (New Caledonia) temperature data in ReefTEMPS:

- 1/ station metadata,
- 2/ station location on interactive map (blue spot),
- 3/ Dataset metadata,
- 4/ Interactive datagram to preview data,
- 5/ Download available,
- 6/ DOI reference,
- 7/ Data licence,
- 8/ Data science products as a result.

FAIR, as *Findable, Accessible, Interoperable and Re-usable* (FAIR principles, Wilkinson et al. 2016), in its Data principles

(Findable) The ReefTEMPS data and metadata are openly available thanks to a unique identifier provided by Seanoe, a French data warehouse provided by the [ODATIS ocean cluster](#) of the [Data Terra research infrastructure](#) (see figure 1 case 6)): [doi:10.17882/55128](https://doi.org/10.17882/55128).

Several catalogue web services (CSV, SOS) are delivered directly. ReefTEMPS is also referenced in thematic portals (ILICO, Seanoe). Data searches in generic search engines (datasetsearch.research.google.com, search.datacite.org) with a few simple keywords (i.e. oceanographic data pacific) identify ReefTEMPS in the top10.

(Accessible) The ReefTEMPS information system allows access to metadata and data using web services available under the [http protocol](#) without access restrictions. Opening up the data was a strong initial choice.

(Interoperable) Numerous standards are used to provide the data to as many user communities as possible, including oceanographers, ecologists, and the public interested in wind or marine based sports. Much of this is based on the [Open Geospatial Consortium \(OGC\)](#): with the Catalog Service for the Web (CSW), Web Map Service (WMS), Web Feature Service (WFS) and Sensor Observation Service (SOS). The other part is based on [OpenDAP](#) "Open-source Project for a Network Data Access Protocol" where data are organized using the [Climate and Forecast standard \(CF\)](#) and the [OceanSites data format](#). The vocabularies used in ReefTEMPS are mainly provided by [OceanSites](#) but some more specific ones are the vocabularies defined by Ifremer.

(Reusable) The data are updated six months on the Seanoe archive storage, with incremental versions of the dataset, revised versions always available on request and referenced using unique keys. Exemple of the 2019-09 version of the dataset: [doi:10.17882/55128#66815](https://doi.org/10.17882/55128#66815).

The diversity of data delivery modes, whether by direct download or by archiving, allows ReefTEMPS to optimize data reuse. It is published under Creative Commons.

FAIR, as fair, sustainable development (Data ecosystems for sustainable development, UNDP report, 2015), in its service organization

ReefTEMPS provides data management and delivery for 14 Pacific countries divided into 20 territories, most of which has very little data capacity. The architecture of the information system has been designed so that multiple instances can be deployed very simply in various locations while keeping the entire network interoperable and accessible from a single entry point. Indeed, it is



preferable, from the point of view of the ethics surrounding the intellectual property of the data, that each country be able to host locally its own productions. Although we have not yet had the opportunity to implement this networking functionality, it is something we have been promoting with our partner.

Figure 2: ReefTEMPS multi-instance network organisation.

In our poster, we will present the global architecture of the information system with the open sources tools used to build it according to FAIR concepts. We will specify the standards and norms implemented to publish the metadata and data. A short focus will be devoted to the analysis of the topology and flows of consultations, extractions and use of the data. Finally, we will expose the organizational workflow of data processing with our subnetwork partners from the various countries of the Pacific island region.