CONDOR Seamount (SW Faial Island, Azores): Space and Time Ocean Colour and SST variability from 2002 to 2010

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Introduction:

The Condor seamount is located about 18.5 km (10 nautical miles) southwest of the island of Faial, Azores (NE Atlantic). Condor is an elongated, flat-topped seamount, characterized by two major summits along a SE-NW direction. It is about 26 km long and 7.4 km wide at about 800 m depth. Depths range from 180 m to 1000 m (Fig. 1).

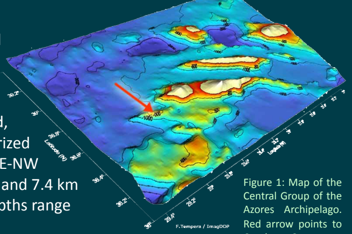

Figure 1: Map of the Central Group of the Azores Archipelago. Red arrow points to Condor Seamount. Graphic: F. Tempera/ ImagDOP

Data Source:

Data was collected from different sources:

- Sea Surface Temperature and Chlorophyll *a* (Chl *a*) in situ measurements (CTD and Fluorometer, respectively);
- Satellite images of Sea Surface Temperature (SST) and Ocean Colour (OC) from MODIS (Aqua);
  - Monthly and seasonal averages were determined for the Condor master (Fig. 2).

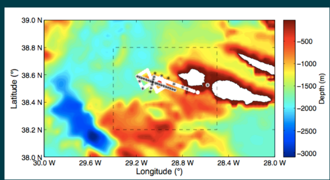

Figure 2: Bathymetry map of the SW of the Central Group of the Azores, showing in the centre the Condor Seamount. July cruise stations in white (•), November cruise stations in black (★) and Condor master for MODIS satellite imagery processing (--).

Monthly Variability:

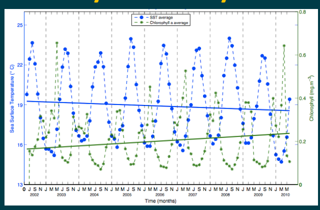

Figure 3: MODIS-derived SST (blue) and Chlorophyll *a* (green) Monthly Average Variation for the CONDOR master. Polyfit with general trend.

MODIS-derived monthly average SST measurements and Chl *a* concentrations clearly show strong OC and SST variability in an almost direct inverse relationship. In general, monthly SST values increase from May to August and decrease onwards. Sea surface temperatures are in general higher during summer months (July to September) while Chl *a* highest values are usually seen during spring months (March to April). Highest (23.99 °C) and lowest (14.71°C) SST values occurred in August 2008 and March 2010, respectively. Chlorophyll *a* maximum (0.66 mg.m^{-3}) and minimum (0.07 mg.m^{-3}) concentrations were measured in May 2003 and September 2004. A general trend of smooth decrease in SST and increase in Chl *a* is observed across the nine-year period of time (Fig. 3).

Seasonal Variability:

Seasonal data show the same relationship as monthly data, i.e., an inverse relationship. However, spikes get smoother. Summer and autumn have higher SST while winter and spring present higher values of Chlorophyll *a*. Monthly and seasonal SST trends are very alike, while seasonal Chl *a* shows a marked decrease in time, contrary to the monthly trend. (Fig. 4).

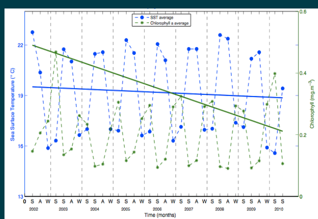

Figure 4: MODIS-derived SST (blue) and Chlorophyll *a* (green) seasonal average variation for the CONDOR master. A polyfit with general trend is presented for both data.

Anomalies:

During the nine-year period, there is a higher incidence of positive SST anomalies, although in the last 12 months, these have turned to be mostly negative (Fig. 5A,B). As for Chl *a*, alternate positive and negative anomalies are observed, with two strong positive phases, observed during march 2003 and 2010 (Fig. 5C; cf. Fig. 3). During years 2004 to 2009, seasonal Chl *a* *anomalies are mostly negative* (Fig. 5D), coinciding with positive SST phases (cf. Fig. 4).

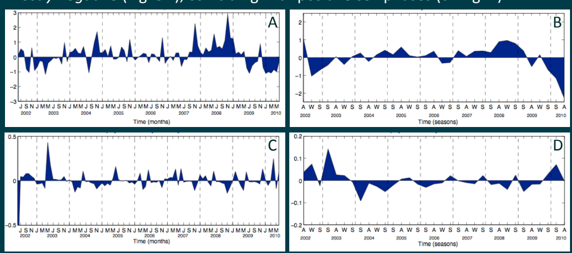

Figure 5: MODIS-derived SST monthly anomalies (A), SST Seasonal anomalies (B), Chlorophyll *a* monthly anomalies (C) and Chlorophyll *a* seasonal anomalies (D) for the CONDOR master.

Satellite Data versus *In Situ* Measurements:

Sea Surface Temperature

In situ surface temperature values versus satellite-derived SST measurements reveal that, in general, MODIS underestimates real values (Fig. 6).

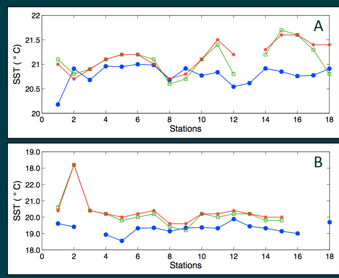

Figure 6: Comparison of SST between stations from satellite MODIS/ Aqua (—●—) and *in situ* measurements: surface (30 cm) (—□—) and 3 m depth (—✱—). A – July Cruise; B – November Cruise.

However, for the summer Cruise (July), there seems to be a nice match between in situ and satellite temperature variations along the stations (Fig. 6A). Note that surface temperatures change more significantly among stations during this time of the year meaning that water is less well mixed among locations (average temperature is about 21.0 °C, almost 1.5 °C higher than in November). In November (Fig. 6B), the match between *in situ* and satellite temperatures is not as clear as it is in July. Note that surface temperatures do not change significantly among stations during this period of the year (with the exception of station 2) meaning that water is well mixed during that season (average temperature is about 19.5 °C). In some stations, 3-m surface values are higher than surface ones.

Chlorophyll *a*

In situ Chl *a* versus satellite-derived OC measurements reveal that MODIS, in most cases, does not capture information at the DCM (Deep Chlorophyll Maximum) layer level. In most stations MODIS OC is overestimated when compared with in situ values (Fig. 7).

Note that in July the DCM layer is mostly observed between 25-50 and 75 m depth (Fig. 7A), while in November it is usually observed between 75 and 100 m depth (Fig. 7B).

Compared to autumn, *in situ* Chl *a* values are lower during summertime with concentrations up to 0.14 mg.m^{-3} versus up to 0.2 mg.m^{-3} in autumn.

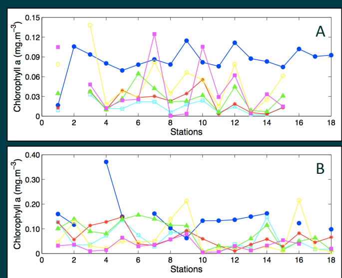

Figure 7: Comparison of Chlorophyll *a* between stations from MODIS/ Aqua (—●—) and in situ fluorometer measurements: 5 m (—□—), 25 m (—✱—); 50 m (—▲—); 75 m (—○—) and 100 m (—■—). A – July Cruise; B – November Cruise.

Conclusions:

- Temporal (monthly and seasonal) variability is evident in SST and OC satellite-derived measurements during a nine-year study period on Condor seamount;
- Average SST´s show some smooth decay with time, along with seasonal OC seasonal concentrations which decay strongly during the same period of time;
- Monthly OC averages increase with time, revealing stronger sensitivity to capture the observed 2010 peak in spring Chl a concentrations;
- During the two cruises, MODIS in general, underestimates average SST *in situ* values, while overestimates Chl *a* real ones;
- Further studies will help to elucidate better CONDOR temporal variability of physical and biological parameters at daily to seasonal time scales.

CONDOR in the Future:

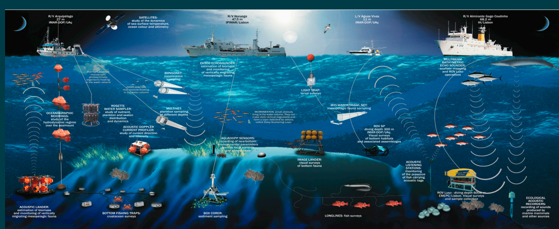

Figure 8: Scheme of the Condor Seamount scientific observatory in the Azores. Equipment and main platforms in use and planned to be used include: several research vessels (1–4), two remotely operated vehicles (5, 6), a manned submersible (7), oceanographic instruments (8–12), biological sampling gear (13–16), fishing gear (17, 18), telemetry instruments (10, 19), acoustic instruments for biomass estimations (20, 21), sediment sampling (22), other imagery nstruments (23), seafloor mapping (24), and animal sounds recording (25).Components of the figure are illustrative and not to scale. Graphics: F. Porteiro and E. Giacomello © ImagDOP

References:

CONDOR project website: http://condor-project.org/

Acknowledgments:

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