Hyperspectral imaging of Península Valdés, Argentina with HICO

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Abstract/project summary
The Península Valdés (PV) region of Argentina (Figure 1) is an important calving ground for southern right whales (*Eubalaena australis*). Annually mothers give birth and raise their calves in its two gulfs, Golfo San José and Golfo Nuevo. The whales begin to appear on the nursery ground in May and most have departed the area by December. They feed sporadically on spring zooplankton patches in September and October. Since 2005 there has been a significant increase in right whale mortality at PV, with most of the deaths (89% between 2002-2011) being calves less than 3 months old [*Rowntree et al.*, 2013]. Nearly synoptic with the sharp rise in whale mortality has been a five-fold increase in the magnitude of the spring phytoplankton blooms in the region [*Wilson et al.*, 2014]. There is clear evidence that the whales are being exposed to biotoxins from harmful algal blooms (HABs) in the PV region, however no definitive statement of causality can be made about the role of biotoxins in the deaths of right whale in the PV calving area region [*Wilson et al.*, 2014]. While the abundance of HAB phytoplankton, both of *Pseudo-nitzschia* spp. and *Alexandrium tamarense*, in the PV area have increased in the past decade, the observed abundances are not high enough to account for the observed increase in chlorophyll. We propose to use HICO data to characterize the properties associated with the high levels of chlorophyll that develop in the austral spring (Sept-Nov).

Project description

Study Area and Data Request
Península Valdés (PV) is an important calving ground for the population of southern right whales (*Eubalaena australis*) that live in the western South Atlantic Ocean. PV is located on the northern Patagonian coast of Argentina, south of Golfo San Matías (GSM) and situated between two gulfs, Golfo San José (GSJ) which opens to the north, and Golfo Nuevo (GN) which opens to the south (Figure 1). The density of whales in this area during the calving season is so great that it was used as a test area for a recent paper counting whales from space using data from the WorldView2 satellite [*Fretwell et al.*, 2014].

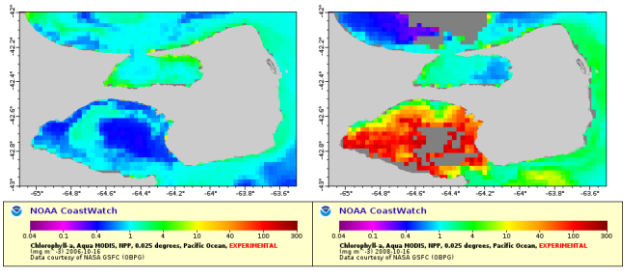

Figure 1. Daily MODIS chlorophyll data of Golfo San José (north) and Golfo Nuevo (south) in Península Valdés Argentina for Oct 16 2006 (left) and Oct 16 2008 (right), showing the large increase in the magnitude of the spring (SON) phytoplankton bloom in this region, particularly in Golfo Nuevo.

Since 2005 there has been a significant increase in right whale mortality at PV, with most of the deaths (89%) being calves less than 3 months old [*Rowntree et al.*, 2013]. So far the cause of this increase in calf mortality has not been determined. Nearly synoptic with the sharp rise in whale mortality has been a five-fold increase in the magnitude of the spring phytoplankton blooms in the region [*Wilson et al.*, 2014]. No definitive statement of causality can be made about the role of biotoxins in the deaths of right whale in the PV calving area region, although there is clear evidence that the whales are being exposed to biotoxins from harmful algal

blooms (HABs) in the PV region [*Wilson et al.*, 2014]. For the past ten years the local shellfisheries have been closed in the latter half of the calving season because of STX levels above the regulatory threshold. These closures occur at the time when the adults whales are starting to feed at PV. Elevated levels of *Pseudo-nitzschia* spp. and *Alexandrium tamarense*, producers of Domoic acid (DA) and saxitoxin (STX), respectively, often occur at PV during the calving season. Traces of STX and DA have been found in samples from a few dead whales, albeit at very low concentrations. Frustules of *Pseudo-nitzschia* spp. have been found in fecal samples from whales in the region, indicating there is local direct foraging or trophic transfer of these toxin producing species [*D'Agostino*, 2013]. However, while the abundance of HAB phytoplankton, both of *Pseudo-nitzschia* spp. and *Alexandrium tamarense*, in the PV area have increased in the past decade, their abundances are not high enough to account for the observed increase in chlorophyll.

We propose to use HICO data to try to characterize the properties associated with the high levels of chlorophyll that develop in the austral spring (Sept-Nov). The primary focus is on the southern bay, GN, (Figure 1) as strong blooms develop there more frequently than in GSJ [*Wilson et al.*, 2014]. The target region for imaging is bounded between 42.45°S-43°S and 64.15°-65.05°W, an area of 61 km x 73 km, most of which would fit into the 42 km x 192 km scene size of HICO. Imaging is requested during Sept-Nov, as that is the period when historically the blooms develop [*Wilson et al.*, 2014]. We request the data in a hyperspectral image cube of land and ocean remote sensing reflections, ie the image cube after atmospheric correction. We would also like the suite of standard products based on simulated MODIS data: chlorophyll, suspended sediments, CDOM, etc.

In situ data

Drs. Viviana Sastre, Norma H. Santinelli and Mónica Hoffmeyer have been involved with monitoring of phytoplankton and zooplankton in the PV region for many years. Dr. Sastre and Dr Santinelli will collect in-situ data from several sites in GN to characterize phytoplankton classes, ie diatoms, dinoflagellates, silicoflagellates, other flagellates, etc.. Dr. Hoffmeyer's group will sample and analyze for chlorophyll-a and zooplankton. This sampling is currently conducted bi-weekly. We will coordinate the timing of the sampling to get synoptic sampling once the HICO imaging dates have been scheduled. In addition to the regular coastal sampling carried out by the the Ministry of Fisheries, sampling will be conducted using whale watching boats, and research ships from CENPAT and ships from the Prefectura Naval Argentina. Additionally Drs Hoffmeyer and Sastre are collaborating with a group from AWI (Alfred Wegener Institute for Polar and Marine Research) in Bremerhaven, Germany which will be deploying a Solid Phase Adsorption Toxin Tracking (SPATT) in PN for toxin monitoring [*MacKenzie et al.*, 2004], and these data will be available for use in the study.

Biographical sketch and available facilities

Dr. Wilson has been actively using ocean color data since 2000 [*Wilson and Adamec*, 2001; 2002]. Since 2003 her research has focuses on understanding the biological and physical mechanisms behind the late summer chlorophyll blooms that develop in the

oligotrophic North Pacific [*Villareal et al.*, 2011; *Villareal et al.*, 2012; *Wilson*, 2003; 2011a; *Wilson and Qiu*, 2008; *Wilson et al.*, 2008b]. In January 2003 she was asked to do the satellite analysis for a research project examining the potential role of harmful algal blooms (HABS) in the increase in right whale mortality at PV, which lead to the *Wilson et al.* [2014] paper. Many of the same collaborators on that project will be involved with the proposed HICO work. Dr. Wilson is also actively involved in outreach to increase the usage of satellite data, especially for ocean color data, and especially within the field of fisheries science [*Hernandez and Wilson*, 2013; *Wilson*, 2011b; *Wilson et al.*, 2008a]

Dr. Wilson will analysis the HICO data using SEADAS software. This study will do analyses similar to those done on data from the Monterey Bay [*Ryan et al.*, 2014], although the suite of in-situ data will be different, and MERIS data is no longer available to use for comparisons.

Output and deliverables

Ideally the HICO data will help us to characterize the properties associated with the high levels of chlorophyll that have recently started to develop in the PV region in austral spring (Sept-Nov). The unexplained recurring high mortality of southern right whales in this region makes understanding the marine environment conditions a high priority. The hyperspectral data from HICO will give us more insights into the constituents of the high chlorophyll water that is present during periods of high calf mortality.

Dr. Wilson will attend the annual HICO meeting and present the results from the PV study area.

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