ID19- A PYTHON TOOL FOR AUV-BORNE ADCP CURRENT DATA PROCESSING

S. Cusí[32], P. Rodríguez[31], N. Pujol[30], D. Roque[21]

Abstract – Most Autonomous Underwater Vehicles (AUVs) mount Doppler sensors to navigate precisely underwater, where the Global Positioning System (GPS) is unavailable. These sensors -aside of providing accurate AUV velocity with respect to the ground-, can perform currents profiling, measuring currents along the water column. It has been shown that currents measurements taken by AUVs are very close to those taken by bottom-mounted ADCPs and that a 3D approach can yield differences between both instruments of about 0.07 ms-1, averaging AUV data in 90 second time windows. In this paper we present an OceanServer Iver2 AUV 3D water currents processing tool, developed in Python 2.7. The tool outputs .csv files for further data processing/representation as well as plots of the main variables, along with water currents plots.

Keywords –Autonomous Underwater Vehicle, Acoustic Doppler Current Profiler, OceanServer Iver2, SonTek ADCP, Python 2.7

Autonomous Underwater Vehicles (AUVs) can run for several hours (~6 h) and kilometers (~30 km) collecting biogeochemical/physical data of water masses, exploring the seafloor with acoustic or optical technologies, or executing specific tasks with other commercial or custom sensors. One sensor most AUVs mount is the Doppler Velocity Log (DVL) -which provides valuable data on platform velocity with respect to the bottom (bottom-tracking, BT)-, used to accurately navigate underwater, where the Global Positioning System (GPS) becomes useless. In many occasions, the DVL can perform as an Acoustic Doppler Current Profiler (ADCP), turning the AUV into a potential currents measurement tool. This capability, however, has seldom been exploited, judging by the amount of studies one can find in which oceanographers use AUV currents data to characterize water circulation. Some studies have compared currents data measured by AUVs to those measured by moored ADCPs [Dhanak et al., 2001] [Fong and Jones, 2006] [Brown et al., 2011], in order to explore the AUVs' capabilities as reliable current meters. Results show promising differences of about 0.1 ms-1 in horizontal velocity values. A comparison study evaluating the OceanServer Iver2 AUV versus a bottom-mounted Nortek AWAC [Cusí et al., to be presented at OCEANS'15 MTS/IEEE Genova], shows that 3D AUV-Borne ADCP data processing yields differences of about 0.07 ms-1 with respect to the AWAC, using data averaging time windows of 90 seconds.

OceanServer Iver2 AUVs are one of the most commercialized AUV models due to their relatively low cost and ease of operation. These platforms mount SonTek ADCPs, with two possible configurations: 6 and 10 beams. The former setup allows for downward water profiling up to 40 meters and BT, while the latter provides water currents measures below and above the vehicle, covering up to 80 meters, as well as BT. Currents measures are provided at 1 Hz and can be represented by 3D vectors in a platform-based coordinate system. Each of these vectors represents the currents' value at one cell (cells are placed along the vertical axis of the sensor), the number and size of which can be set before the mission starts. Removing AUV's velocity from the measured values is needed to obtain absolute platform-referenced water currents, which then need to be rotated, by using AUV's attitude (pitch, roll and heading), to match the Earth's reference system (i.e. North-East-Up). This process is done every second as currents measures, BT velocities and attitude values are updated at this rate. The 3D approach could be simplified to a 2D one, considering navigation underwater is steady, with pitch and roll values close to zero, but would make surface (unsteady pitch and roll) and yoyo (~ ±15º pitch) navigation measures useless. In addition, the 3D approach places the Earth-referenced currents vectors according to AUV's attitude; which means, for example, that the most distant cells of a 10-beam ADCP (one 40 m below and one 40 m above) mounted on an AUV navigating at 15º pitch and neutral roll, are separated 21.4 m (instead of coincident) in the horizontal plane and 77.3 m (instead of 80 m) in depth.

The tool presented here processes AUV-Borne ADCP data applying a full 3D approach, described above, allowing for multi-purpose sampling and, therefore, avoiding the need of currents mapping devoted missions. This way, currents data can be a by-product of a mission where yoyo and/or surface navigation play an important role. The script takes Iver2 AUV output files and outputs one file containing processed currents values at 1 Hz and, from this file, it generates another file with binned, time averaged currents. Both files adopt CSV format in order to be compatible with widespread tools such as Ocean Data View (Fig. 1, left) or Microsoft Excel. The first file, aside of currents data, includes data describing AUV navigation (attitude, velocity, position) as well as data on ADCP configuration and performance (cell size, number of cells, BT quality, noise). Currents data can be discarded by filtering by any of the mentioned parameters. The script generates plots of the first file's variables over time and currents vector plots of the binned currents; among others, such as depth profiles (Fig. 1, right). The tool is developed in Python 2.7, with the intention to be platform independent and free, and is available for anyone to modify and distribute.

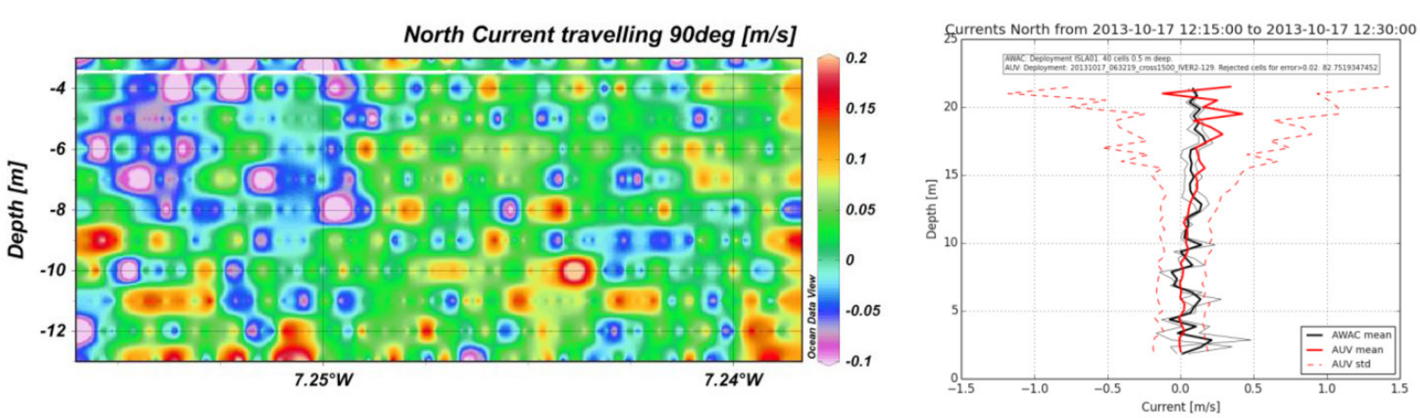

Fig. 1. The tool generates CSV files with all data and binned data. On the left, binned data represented by Ocean Data View software. On the right, 15 minute averaged currents along depth.