Dataset and Analysis Software for Agate Pass Paper

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Overview

The following document describes the datasets and software used in the creation of the manuscript, *Multiplatform Characterization of Currents in Agate Pass, WA*. Paths are referential to the top-level archive folder.

Software

Version: MATLAB 2021b

Dependencies:

- *Mapping Toolbox:* `distance, geodetic2ecef, ecef2geodetic, geodetic2ned, referenceEllipsoid, utmzone`
- *Curve Fitting Toolbox:* `smooth`

Third-party Packages:

- `cmocean`: Thyng, K.M., C.A. Greene, R.D. Hetland, H.M. Zimmerle, and S.F. DiMarco. 2016. *True colors of oceanography: Guidelines for effective and accurate colormap selection.* Oceanography 29(3):9–13. http://dx.doi.org/10.5670/oceanog.2016.66
- `m_map`: Pawlowicz, R., 2020. *M_Map: A mapping package for MATLAB*, version 1.4m, [Computer software]. Available online at available online at www.eoas.ubc.ca/~rich/map.html..

To Use:

Update `launchAgatePassToolbox` with location of `cmocean` and `m_map` packages.
Run `launchAgatePassToolbox` from software folder (all paths relative from here). This will add all the needed paths to your MATLAB path library. All scripts should subsequently be able to run.

Paper Figures and Corresponding Scripts		
Graphic	**Short Description**	**Source Software**
Figure 1	Map of Survey	`plotSiteLayout`
Figure 2	Instruments	N/A - created in Powerpoint
Figure 3	Water level, pred. currents, survey windows	`plotDeploymentTimes`
Figure 4	Time evolution of water properties.	`AP_PaperFigures`
Figure 5	Current speed profiles.	
Figure 6	Ebb deployment sample distribution	
Figure 7	Flood deployment sample distribution	
Figure 8	Horizontal distributions of velocity	
Figure 9	Eddies	
Figure 10	Temperature profiles	
Figure 11	Horizontal temp distributions	
Table 1	Horizontal velocity measurement differences	
Table 2	Sampling statistics for µFloats and SWIFTs	

Supporting Scripts:

The software listed in the above table utilizes compiled data (as described below) to generate all the products included in the manuscript, as well as some other supporting QA/QC figures for data investigation. They rely on the following functions.

- `importStationKeepingData` – loads pre-processed station-keeping ADCP data into SK data structure
- `importSWIFTdata` – loads pre-processed SWIFT ADCP data into SWIFT data structure
- `utm2ll, ll2utm`, `ll2xy` – Coordinate conversion helper functions
- `buildAxes`, `axDim2figDim`, `plotboxpos` – plotting helper functions

We have chosen not to archive the raw data as it is both large (in memory) and redundantly included in the compiled .mat files. For SWIFT data, functions to import and compile raw data are located in a public GitHub repository. µFloats and SLBs import and pre-processing functions are included in this archive for completeness. They are organized according to the scripts they support. View the function files for more information.

`AP2_compileData`

- Imports raw float data and saves compiled data in .mat format
- Imports raw SLB data and saves compiled data in .mat format. Note that DAISY is an old naming convention for the SLB.
- Generates survey metadata structure
- Supporting scripts:

```
import_uFloat                   importDAISY_Upper
importDeploymentSchedule        importEM7180
importADC                       importNanomodem
importBME                       importDeployCtrl
importPiston                    importDeploySched
importTSYS01                    cleanFile
importGPS                       cleanNanomodemData
importLTC4151
```

`AP2_processFloats2Field`

- For each survey, processes the compiled raw float and SLB data into the processed data structure `FS`. Steps include performing QA/QC on relevant data channels and computing float trajectories and velocities from acoustic modem data.
- Supporting Scripts:

```
cleanTimeTruncationErrors       locateSuspectGPS_surfacing
cleanPressure                   locateGPSoutliers
parseFloatSched                 smoothGPS
evalFloatActions                trilateration
evalStepStat                    checkInSite
checkAction4Grounding           central_diff (from elsewhere)
getUnderwaterTimes              trim2time
addUnderwaterBit                tfind
bitOnBoat
```

Data

Data is organized into three folders:

- `./data/sensors`: includes data from primary instruments used in field experiment.
- `./data/lib`: supporting data used in data processing and figure creation.
- `./data/figures`: output figures generated by processing scripts.

Sensors

Station-Keeping Data

Instrument: RDI Workhorse Mariner (1200 kHz) four-beam ADCP
Compiled Data Path: `./data/sensors/ADCP_StationKeeping/compiled`
Compiled Filename: `Sounder_ADCP_20Aug2020[SURVEY NAME]_revised_cleaned`
Imported using `importStationKeepingData` into structure `SK`, as displayed below.

`SK` – structure containing compiled station-keeping ADCP data as loaded in `AP_PaperFigures`

Field	Description	Data Type	Size
`geoRef`	Geographical reference location [lat, lon] for sample position	Double	[1 x 2]
`geoRefDesc`	Description of geographic reference	String	
`D`	Water depth at (constant over nDepthBins)	Double	[nProfiles x nDepthBins]
`X, Y, Z`	Position (Easting, Northing, Down) meters relative to `geoRef`	Double	[nProfiles x nDepthBins]
`[UX, UY, UZ]`	Velocity (East, North, Down) – m/s	Double	[nProfiles x nDepthBins]
`testID`	Numeric ID (1-9) for which survey the profile was taken during	Double	[nProfiles x nDepthBins]
`TS`	Time window used when smoothing velocity data (pre-process step)	Double	[nProfiles x nDepthBins]
`varDesc`	Description of variable structure	String	

Notes:

- For all processing, Station Keeping location 3 was used as the reference location for site-relative coordinates.

SWIFT Data

Instrument: Nortek Signature1000 five-beam ADCP

Compiled Data Path: `./data/sensors/ADCP_SWIFT/compiled`

Compiled Filename: `SWIFT[ID#]_Aug2020_highres_dt30s`

Raw data are .sbd files

Pertinent data are: SWIFT##_Aug2020_highres_dt30s

How are these created? Do we need to include the raw data and preprocessing code in archive?

Imported using `importSWIFTData` into structure `SWIFT`, as displayed below.

`SWIFT` – structure containing compiled SWIFT ADCP data as loaded into `AP_PaperFigures`

Field	Description	Data Type	Size
`geoRef`	Refence location [lat, lon] for relative sample positions	Double	[1 x 2]
`geoRefDesc`	Description of geographic reference (Station keeping location 3)	String	
`D`	Water depth at (constant over nDepthBins)	Double	[nProfiles x nDepthBins]
`X, Y, Z`	Position (Easting, Northing, Down) meters relative to `geoRef`	Double	[nProfiles x nDepthBins]
`[UX, UY, UZ]`	Velocity (East, North, Down) – m/s	Double	[nProfiles x nDepthBins]
`testID`	Numeric ID (1-9) for which survey the profile was taken during	Double	[nProfiles x 1]
`devID`	Numeric ID (22-25) of SWIFT that took the profile	Double	[nProfiles x 1]
`Time`	Time window used when smoothing velocity data (a pre-process step)	Double	[nProfiles x nDepthBins]
`varDesc`	Description of variable structure	String	

microFloat Data

Instrument: microFloat

Compiled Data Location: `./data/sensors/FloatSwarm/compiled`

Compiled Filename: `FloatFieldData_Test[SURVEY#]`

`FS` – All compiled survey data are loaded into single 1x9 structure array with fields as indicated below. Each of the 9 structures are for each of the nine surveys.

Field	Description	Data Type	Size
`tRef`	Reference time for time series	Datetime	[1 x 1]
`tTestSet`	Elapsed time (seconds) since tRef	Double	[1 x number of timesteps]
`addrAllDev`	Array of device IDs	Double	[1 x number of devices deployed]
`smoothSpan`	Time window used when smoothing velocity data (a pre-process step)	Double	[1 x number of devices deployed]
`[xSS, ySS, zSS]`	Position coordinates [Easting, Northing, Depth] relative to reference location `geoRef` and water surface (for depth) for pre-processed float and SLB paths	Double	[length(tTestSet) x length(addrAllDev)]
`[UXS, UYS]`	Smoothed velocity in [East, North] directions (m/s)	Double	[length(tTestSet) x length(addrAllDev)]
`TEMP`	Water temperature along float path	Double	[length(tTestSet) x length(addrAllDev)]

CTD Data

Instrument: CastawayCTD

Compiled Data Location: `./data/sensors/CTD/compiled`

Compiled Filename: `CC2022012_20200820_[CAST_TIME]`

`CTD` – All profiles are loaded but down-selected into 1x9 structure array (one profile for each survey). Data are self-explanatory, excepting units which are as follows:

`Pressure`	dBar
`Depth`	m
`Temperature`	°C
`Conductivity`	µS/cm
`Specific_conductance`	µS/cm
`Salinity`	PSU
`Sound_Velocity`	m/s
`Density`	Kg/m^3

Commented [TWH1]:

lib

AP2_metadata.mat

Contains structure **meta** describing survey properties. Created by **AP2_compileData**.

tsTestTimes	start and end of test day	Datetime	[1 x 2]
tTests	start time of each survey (aligned to when floats programmed to dive)	Datetime	[1 x 9]
locSK	representative coordinates [lat, lon] of each of the three station-keeping location	Double	[3x2]
testNames	list of survey IDs (E1-E4, F1-F5)	String array	[1x9]
validFLT	list of valid float IDs deployed during each survey	Cell array of int	{1x9}
controlType	control type (constant depth or profiling) for each survey	String array	[1x9]

Agate_Tide.mat

Contains structure **tide** describing survey properties.
Retrieved from: https://tidesandcurrents.noaa.gov/noaatidepredictions.html?id=9445753

ts	time	Datetime	
zeta	water level (meters relative to MLLW)	double	

Agate_Current_Pred.mat

Contains structure **pred** describing survey properties.
Retrieved from:
https://tidesandcurrents.noaa.gov/noaacurrents/Predictions?id=PUG1501_6 (9 feet depth)
https://tidesandcurrents.noaa.gov/noaacurrents/Predictions?id=PUG1501_1 (25 feet depth)

Ts_u	timestamp of current prediction	Datetime	
zeta	timestamp of current prediction	double	
depth	depth of 2 water predictions	double	
u_dir	water current direction (compass deg)	double	
u_mag	water current magnitude (m/s)	double	
gep	[Lat, Lon] location of prediction	double	

AgatePass_SiteBoundary.mat

These were created manually by defining a path along the coastline in GoogleEarth, generating a .kml file and converting that to a .mat file.

CLeast	[Lat, Lon] coordinates defining eastern coastline along site	array	[147 x 2]
CLwest	[Lat, Lon] coordinates defining western coastline along site	array	[128 x 2]
siteBounds	[Lat, Lon] coordinates defining “in-water” boundary	array	[276 x 2]

AgatePassBathy.mat

Bathymetry data for Agate Pass.

Retrieved from https://www.ngdc.noaa.gov/nos/H12001-H14000/H12216.html

bathyData	Bathymetry data for site	structure	
bathyMeta	Description of bathymetry content.	char	

AgatePass_SiteMap.mat

Satellite imagery of Agate Pass, used in creation of Figure 1 (Site Layout).

AP2_deployTemplate.mat

Nominal deployment layout: locations for station keeping sampling, and SWIFTS, µFloats, and SLBs releases during ebb and flood surveys. The table was built manually based on a .kml file from Google Earth.

deployTemplate	location information used to generate Figure 1	table	

AP2_boatGPS.mat

Data from the two support vessels. Two tables (**inferno** and **sounder**) for each of the two vessels. Each table has columns: **[ts, lon, lat, heading, altitude, speed]** with row for each timestep. Data is from a QSartz self-logging GPS sensor, assembled into MATLAB table format with no cleaning. Data is used in **AP2_processFloats2Field** to determine when floats, SLBs, and SWIFTs have been deployed and recovered.

FloatProperties.mat

Database of float properties with following data. Used in **AP2_processFloats2Field.**

floatProperties	piston length for each float (one row per float)	table	[30 x 2]
nomFloatArea	nominal float cross-sectional area (sliced along horizontal plane) (cm^2)	Double	[1 x 1]
nomFloatVol	nominal float volume (cc)	Double	[1 x 1]
pistArea	cross-section of piston area (cm^2)	Double	[1 x 1]

NanomodemCalibration.mat

Contains structure **nmDelay** with software delays [seconds] associated with nanomodem signal processing time, used to correct the acoustic travel times between devices. Delays were derived from a specific calibration test. Note DAISY is old name for SLB (and reason for "dsy" in variable names). Used in **AP2_processFloats2Field** processing of µFloat data.

flt	delay between given float [row] and SLB [column]	Double	[30 x 5]
nomFltDelay	mean delay across floats with given SLB [column]	Double	[1 x 5]
nomDsyDelay	average delay across all devices	Double	[1 x 1]
dsy	delay between given SLB and SLB	Double	[5 x 5]
calDate	Time of calibration test	Datetime	[1 x 1]
about	Description of data	Char	