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## TEMPERATURE PROFILES

Temperature profiles provide information about the environment of the tagged animal during the deployment period. These are reported as Profiles of Depth and Temperature (PDT). On Wildlife Computers tags, a PDT is developed by measuring the external (environmental) temperature as a function of depth. The tag records depth (rounded to the nearest 8 m) and min and max temperature to the nearest 0.2° C observed at each depth. The depth range is from -40 m to 2000 m with a resolution of 8 m (4 m on either side of the recorded depth). The temperature range is from -4° C to 46° C. Any temperatures recorded colder than -4° C will be reported as -4° C. How these temp-depth profiles are collected and summarized may differ between tag types.

### MiniPAT PDT

On a MiniPAT tag, temperature and depth data are collected as part of “Summary Messages” meaning that the data are packaged by summary period (programmed by the user before deployment). The temperature and depth sensor data are recorded at the archival sample interval. “Profiles” are generated based on the depths visited by the tag during each summary period. There are two types of PDT profiles that can be transmitted:

#### Tags Containing This Data Product

MiniPAT

1. Low-Resolution Profiles: these profiles are the default when the tag remains above 400 m during the summary period. The tag creates a “profile” using eight different depths that is transmitted in one Argos message.
2. High-Resolution Profiles: these profiles are the default when the tag ventures deeper than 400 m during the summary period. The tag creates a “profile” using 16 different depths transmitted in TWO Argos messages.

The depths are chosen dynamically to include the minimum (min) and maximum (max) depths detected during the summary period with the remaining depths (6 or 14) arranged equally between the min and max. For each depth in a “profile” the min and max observed temperatures to the nearest 0.2° C are reported. In high-resolution profiles, every other depth-temp pair is transmitted in the first message, and the remaining data are transmitted in the second message. This allows you to see the entire range of the profile even if only one message is received.

### microPAT PDT

microPAT sends Empirical Cumulative Distributions (ECDs) of Depth including the minimum and maximum depths encountered, as well as the depth above which (i.e., shallower than) the animal spends 25, 50, 75, and 100% of its time during fixed, 6-hour summary periods. For each ECD depth, the tag will also provide the maximum temperature encountered at the ECD depths during the summary period, providing a temperature profile of the water column. These are behaviorally-driven temperature profiles. *Note: Due to limited bandwidth, the tag will attempt to send three out of the four, 6-hour summary periods per day at random.*

#### Tags Containing This Data Product

microPAT

### SPLASH10 PDT

PDTs on a SPLASH10 tag are developed similarly to the PAT-style as described but depth and temperature are sampled at the histogram sampling rate.

#### Tags Containing This Data Product

SPLASH10

SPLASH10-F

# TEMPERATURE PROFILES—CONTINUED

## Broken Stick PDT

### Tags Containing This Data Product

SCOUT-Temp

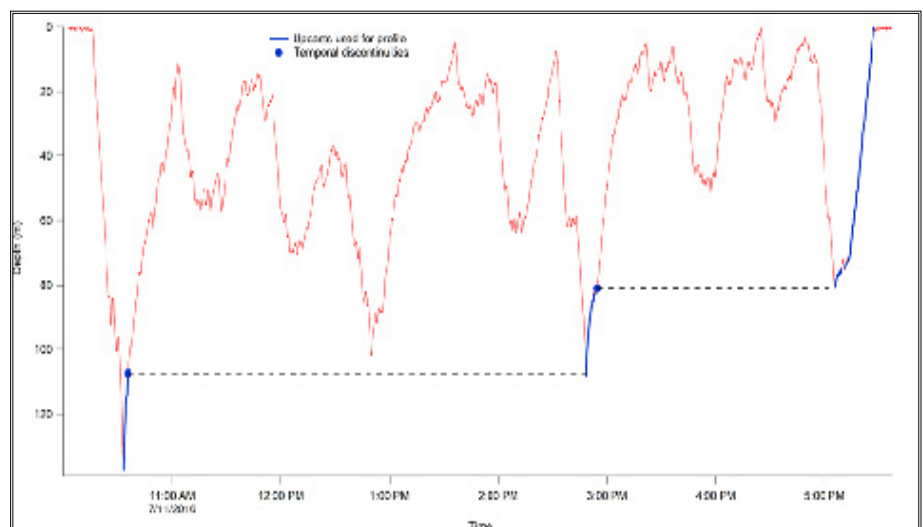
While wet, the SCOUT-Temp tag records external temperature (environment) every second. These readings are stored in a table that is binned by depth with an 8 m resolution. Each depth entry has an accompanying timestamp. As the tag moves through the water, the most recent temperature recorded at a particular depth is retained as part of the “profile.” For example, if an animal moves up and down past 30 m in depth before returning to the surface, the tag records the temperature from the last time it passed 30 m to show in the profile. An expiration time is applied to all data in the table. This time limit is configurable from one minute to 45 days. Any data older than this will be ignored. Once the tag reaches the surface (reads “dry”) after also recording a depth deeper than the user-configurable minimum, the tag will generate a Broken Stick PDT message for transmission via Argos.

The broken stick profile is generated using the most recent data in the depth table that are recorded BEFORE a dry reading; consequently, all profiles are ascents from depth or ‘upcasts’ starting at the deepest depth in the summary period (Figure 1). A broken stick algorithm (piecewise linear regression) is used to choose the break points for the “profile” that will be transmitted. Generally, a broken stick algorithm is an iterative process that selects data points of maximum difference between the “original data” and the “profile.” The data are reconstructed by linear interpolation between the current point, and points selected during the previous iterations. The first and last points are forced to be the minimum and maximum depths, with another breakpoint forced to occur at the bottom of the Mixed Layer (shallowest depth prior to the temperature dropping  $0.5^{\circ}\text{C}$  from the temperature at the surface). The algorithm will then identify eight more break points for the profile using the iterative process described above.

The transmitted message will contain the depth-temperature data from each point in the broken stick profile, and will also include the age of the oldest data point (to the nearest 15 minutes). This is reported in order to detect possible horizontal movement between water bodies. Each entry is also flagged as a discontinuity if the time between consecutive depths in the profile is more than 60 minutes.

Depth is transmitted in units of 8 m and temperature in  $0.1^{\circ}\text{C}$  steps from  $-5^{\circ}\text{C}$  to  $40^{\circ}\text{C}$ .

*Figure 1—The transmitted profile uses the most recent temperature readings at each depth (blue). This means that the deeper depths will be flagged as having a temporal discontinuity since they only occurred earlier in the summary period and the last ascent to the surface did not contain depths deeper than 80 m.*



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# TEMPERATURE PROFILES—CONTINUED

## DIVE PDT

The dive PDT is used to capture a temperature profile representing a vertical slice of the ocean (the end of a dive). Sampling of the depth and temperature pairs begins when the tag goes deeper than the user-configurable minimum dive depth and ends when it returns to the surface. To ensure that each dive eventually ends, there is a three-hour limit on dive duration. The tag will sample the store depth-temperature pairs for the deepest dive during each histogram summary period. The most recent temperature recorded at a particular depth is retained as part of the “profile.” For example, if an animal moves up and down past 30 m in depth during a single dive, then the temperature recorded the last time it passed 30 m during the dive is what will appear in the profile.

The tag captures the deepest dive during the summary period using real-time processing. For each histogram summary period, the tag will select the single deepest dive. If the current dive is deeper than the previous dive, data collected from the current dive will overwrite the data being held in the divePDT buffer from some previous dive. Data are continuously sampled at the histogram sampling rate, the tag will consolidate the depth-temperature pairs from the divePDT buffer into a “profile” for transmission via Argos. The data are reported in the divePDT.csv file. The number of messages created from this data product is a function of dive duration and the number of depth-temperature pairs saved from the dive. It can range from just a few data points up to 2000. Consequently, turning on this data product could result in creating hundreds of Argos messages.

### Tags Containing This Data Product

SPLASH10
SPLASH10-F

## FIXED DEPTH PDT

Fixed depth temperature profiles are available on SPLASH tags and report temperature at predetermined depths corresponding to either the World Ocean Database (2013) or World Ocean Atlas 1994 (WOA94) depth tables. Or, the tag can automatically choose which depth table to use based on a priority order. The first priority would be to minimize the number of messages, and the second priority would be to maximize the number of depths reported. This choice could occur if the number of messages generated by the profile is the same for either WOA94 or WOD13. Similar to the DivePDT, these profiles store temperature-depth pairs from the deepest dive within the histogram summary period. Temperature and depth will be collected every two seconds on selected dive ascents. If a dive descends 10% deeper than any previous dive in the current summary period, then all previous data are cleared and new temperature-depth data are collected every two seconds for the remainder of the current dive. The temperature is saved if the depth of the reading corresponds with one of the WOD13 or WOA94 depth tables. To increase the likelihood of a reading, depths within 10% of the WOD13 or WOA94 depths are also allowed. When the instrument reaches the surface and reads “dry,” data collection is stopped and a Fastloc® GPS snapshot is taken. The Fastloc reading for the deepest dive is NOT set but saved internally until the end of the summary period.

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At the end of a summary period there will be one temperature profile that resulted from a single ascent of the deepest dive. There will also be one Fastloc snapshot associated with that dive. The resulting message includes a minute resolution timestamp and value that indicates the length of the ascent that produced the profile. This later value provides a quantitative measure of profile quality.

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