Readme_2017.txt

SPURS-2 2017 Sea Surface Infrared Imagery Dataset

The science goals of the infrared (IR) imagery is described in Asher et al. (2019, Estimating Rain-Generated Turbulence at the Ocean Surface Using the Active Controlled Flux Technique. Oceanography, 32(2):108–115, https://doi.org/10.5670/oceanog.2019.218). The imager was deployed when the Surface Salinity Profiler (SSP) was deployed and the ship underway at 2 m/s. The imager was mounted 10 m above the ocean surface looking out at an incidence angle of 35 degrees with a field-of-view of 20 degrees. When rectified to the ocean surface, images represent a trapezoidal patch of ocean surface approximately 5 m high and 4 m across at the bottom and 5 m across at the top.

In 2017, a Viento-G longwave uncooled longwave bolometer infrared imager with a pixel resolution of 640x480 was used. The AIM had an acquisition rate of 25 Hz and a noise-equivalent temperature level of 50 mK and responded to IR photons in the 8 μm to 14 μm wavelength spectral region. It was operated with an integration time of 1 mS and data were collected using Streams 7 to a custom data acquisition system. Non-uniformity correction (NUC) for the imager was performed internally using a mechanical shutter at 5-min intervals. The images here are provided after the NUC has been applied. See discussion below for more information concerning NUC for the Viento images.

One camera position was used during the 2017 SPURS-2 CFT measurements and it corresponds to Position B from the 2016 SPURS-2 CFT measurements (see Asher et al., 2019, ibid.).

As for the 2016 data, the brightness value of the pixels in an image scale linearly with temperature but the images are provided as uncalibrated in terms of absolute temperature. If absolute temperatures are required they can be estimated using a two-point calibration scheme where the upper temperature bound is given by the measured bulk water temperature (see meteorological dataset from the 2017 SPURS2 cruise) and a lower temperature given by a model that predicts the cool-skin temperature or one of the surface-following temperature records (e.g, salinity snake, SSP, or temperature snake). Other methods for calibrating the images that rely on the fixed gain of IR cameras could also be used. However, calibrating the images into absolute temperature records is best seen as a research topic with no best method suggested here.

A 125 W CO2 laser generated a small heated patch of water on the ocean surface. The laser provided a 105 ms long pulse of 10.6 micron IR light at a 0.5 Hz repetition rate. The decay rate of temperature in the heated patch correlates with relative levels of turbulence at the ocean surface. In general, the heated patch is visible in the upper right quadrant of the video images. Discussion of analysis of the imagery for this application is provided by Haussecker et al. (Haußecker, H., B. Jähne, and S. Reinelt (1995), Heat as a proxy tracer for gas exchange measurements in the field: principles and technical realization, in *Air-Water Gas Transfer*, edited by B. Jähne and E. C. Monahan, pp. 405-413, Aeon-Verlag, Hanau), Asher et al. (Asher, W. E., A. T. Jessup, and M. A. Atmane (2004), Oceanic application of the active controlled flux technique for measuring air-sea transfer velocities of heat and gases, *J. Geophys. Res.*, *109*(C08S12), doi: 10.1029/2003JC001862), and Atmane et al. (Atmane, M. A., W. E. Asher, and A. T. Jessup (2004), On the use of the active infrared technique to infer heat and gas transfer velocities at the air-water free surface, *J. Geophys. Res.*, *109*(C08S14), doi:10.1029/2003JC001805).

The data are presented as a library of 30 minute-long IR videos of the sea surface taken with a longwave IR imager. Data are stored in the video record as raw digital images with a resolution of 480 pixels in the vertical and 640 pixels in the horizontal and a 16-bit depth. Images were acquired at a frame rate of 25 Hz. This gives 45,000 images per .raw file for a total file size of 27.6 GB. There is a header at the beginning of each .raw file that consists of:

Number of Frames (nf), 'length: one int64'
Bits per Pixel (image_depth), 'length: one int32'
Image Width (horizontal pixels), 'length: one int32'
Image Height (vertical pixels), 'length: one int32'
Header Size (offset from start of file to start of images), 'length: one int64'
Timestamps (acquisition time of each image), 'length: nf*int64'

A Matlab m-file function (readRawIR_17.m) is provided that can be used to read the header information and images from a .raw file. Note that the 2017 IR imagery cannot be read using readRawIR_16.m (nor can the 2016 data files be read with readRawIR_17.m).

The frame timestamps are given in terms of number of 100-nanosecond clock ticks from 1/1/1601. They can be converted to Matlab Posixtime using the supplied m-file streams2epoch.m.

The video library filenames for 2017 are in the format:

xxx_cft_2017_MM_DD_RR_Scene##_AIMimg_01.raw

where the following codes are used:

xxx: three letter designation of the primary platform being used as the CFT data were collected. For the 2017 dataset, there are three possible codes: "ssp" for the Surface Salinity Profiler; "eco" for data collected when the WHOI Ecomapper AUV was deployed, and "xxx" for no other correlating measurements (i.e., CFT only)

cft: denotes the data were collected for CFT with the CO2 laser active and creating heated patches

MM: Month (01-12)

DD: Day of month (01 – 31)

RR: Run number (01, 02) denoting the run on that MM/DD

Scene##: Scene number (01-12), see explanation below

The final _01 denotes that Viento-G Imager 01 was used for the 2017 SPURS2 dataset.

Scene number in the filename is terminology used by the video acquisition software used, Streams7. Streams7 stores the video data as "scenes" in a library. The .raw files provided here are the individual scenes extracted from a Streams7 video library and stored as uncompressed binary images.

The number of frames per scene is variable, but generally around 45,000. This is because Streams7 determines file size by run time, not number of frames. Latency in the system sometimes causes a few extra frames in a scene. Some scenes contain fewer than 45,000 images at times due to operator intervention due to camera failure or cessation of SSP run.

There is an issue in the 2017 imagery in that the internal NUC feature of the Viento-G imagers was malfunctioning. This causes a pronounced brightness gradient in the image. This gradient can be removed by averaging. Additionally, the initial datasets from 2017 were acquired using an incorrect imager setting and have pronounced fix-pattern noise.