

## A brief demonstration of a tool for SARAL/AltiKa waveform clustering

Suvajit Dutta<sup>1</sup>, Surajit Ghosh<sup>2,3</sup>, Praveen Kumar Thakur<sup>4</sup>

<sup>1</sup> Vellore Institute of Technology, Vellore, India

<sup>2</sup> National Institute of Technology, Durgapur, India

<sup>3</sup> International Center for Agricultural Research in the Dry Areas, New Delhi, India

<sup>4</sup> Indian Institute of Remote Sensing, Dehradun, India

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### ABSTRACT

This article describes a classification tool to cluster SARAL/AltiKa waveforms. The tool was made using Python scripts. Radar altimetry systems (e.g., SARAL/AltiKa) measures the distance from the satellite centre to a target surface by calculating the satellite-to-surface round-trip time of a radar pulse. An altimeter waveform represents the energy reflected by the earth's surface to the satellite antenna with respect to time. The tool clusters the altimetric waveforms data into desired groups. For the clustering, we used evolutionary minimize indexing function (EMIF) with k-means cluster mechanism. The idea was to develop a simple interface which takes the altimetry waveforms data from a folder as inputs and provides single value (using EMIF algorithm) for each waveform. These values are further used for clustering. This is a simple light weighted tool and user can easily interact with it.

**Keywords:** SARAL/AltiKa Waveforms; Evolutionary Minimize Indexing Function (EMIF); Python

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## 1. Introduction

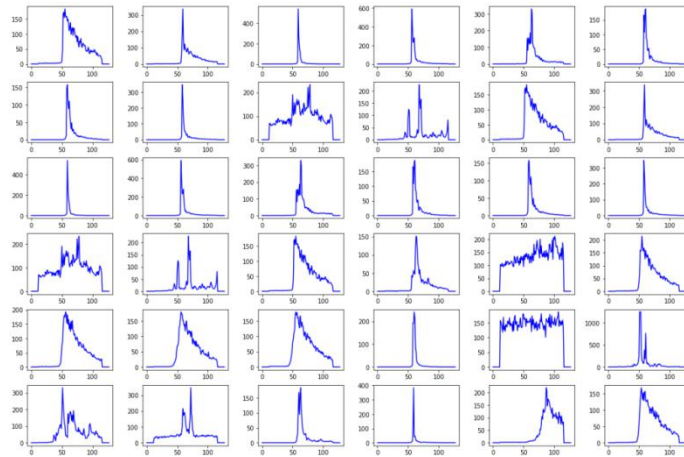
A radar altimetry system emits a radar wave and receives the return signal that bounces off the surface. The surface height is calculated from the difference between range measured by the altimetry sensor and the satellite's centre to a reference surface (reference ellipsoid) and the satellite-to-surface range (Table 1). Along with surface height, by looking at the return signal's amplitude and waveform, wave height and wind speed over the oceans are also can be calculated from altimetry measurement (Chelton 2001). An altimeter waveform represents the energy reflected by the earth's surface to the satellite antenna with respect to time. The altimetry shape depends on the reflection properties of the altimetry signal which is again determined the surface heterogeneity inside the altimetry footprint (Guo et al. 2006; Ghosh et al. 2015). In February 2013, the ISRO (Indian Space Research Organisation) and the CNES (Centre National d'étudesspatiales), jointly, launched Sun-synchronous satellite SARAL with first mono-frequency (Ka-band) altimeter AltiKa and dual frequency radiometer with 35 days' receptivity (Verron et al., 2015). Reactivity of SARAL is 35 days with an inclination of 98.54°. AltiKa is a pulse-limited altimeter (Ghosh et al., 2017). Therefore, it records the average value of the entire footprint below the centre of the satellite. The footprint-based information stored in waveforms. Different types of waveforms are generated due to surface heterogeneity. Even, waveforms change their shapes over high-water and low water levels. However, it has been observed that the changes in waveforms' pattern are not always the same for the similar surface due to surface water dynamics. Appropriate classification method can help to identify those closely related waveform patterns. Ghosh et al. (2016) proposed Evolutionary Minimise Indexing Function (EMIF) for classifying AltiKa waveforms. They used a fitness function to map the AltiKa waveforms into a single valued scalar. Ghosh et al. (2016) identified four waveform groups according to reflection from water land and land-water boundary. They again divided the land-water boundary into two classes viz., land-to-water and water-to-land based on the direction of the AltiKa pass. In the present paper, we briefly demonstrate a window based tool to implement the method proposed by Ghosh et al. (2016).

Sl. No.	Parameters	Description
1.	Range	Distance from the centre of the satellite to the surface of the Earth, that deliberate by the altimeter.
2.	Altitude	Distance of the satellite or altimeter an orientation point. The referenced point used is the reference ellipsoid.
3.	Height	Distance between the water surface and the reference ellipsoid.

**Table 1.** Altimetric parameters

## 2. Data

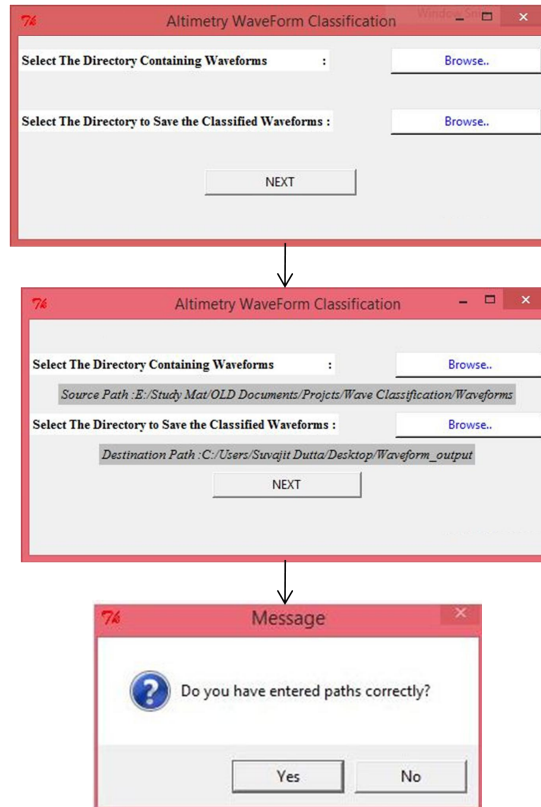
We have selected 40 Hz Sensor Interim Geophysical Data Records (SIGDR) of the SARAL/AltiKa satellite. The SIGDR data comes under Geophysical Data Records (GDR) and it is being useful to the altimetry community after 1-2 days from the date of its acquisition. Waveform data comes in Network Common Data Form (NetCDF) format and the length of each SIGDR waveform data is 128 (**Figure 1**). For details about the SARAL/AltiKa mission, its applications and data characteristics, one can see Verron et al. (2015) and Ghosh et al. (2017).



**Figure 1;** Different shapes of waveforms.

## 3. Tool description

We used Python 2.7 script through Eclipse IDE for the development of the tool. Python 2.7 is the most stable form of Python language till date. Python is a widely used high-level, general-purpose, dynamic programming language. It has several advantages such as code readability, simpler syntax than languages such as C++ or Java, and many more. Therefore, Python is simple, easy to learn syntax emphasises readability and reduces the cost of program maintenance. Python supports various scientific modules and packages, which helps in modularity and code reuse. The major advantage is that libraries are freely available almost for all platforms. The tool (**Figure 2**) presented here is divided into two parts, the first part does the data indexing classification part, and the second part is for developing the interface for ease of interaction with users. We used Tkinter package for interface designing. Tkinter is a Python's de-facto standard GUI package. For algorithm calculation parts numpy-MKL package was used, NumPy is the fundamental package for scientific computing with Python. The tool was made such as way that any user can select the specific folder which contains the waveforms in text format, then another destination folder has to be chosen to store the waveforms after applying the EMIF algorithm on the selected waveforms. Users also can pick multiple waveform files as required. For any computational or functional error, the tool generates a log file for reporting the errors.



**Figure 2;** Altimetry waveform Classification tool.

## 4. Conclusions

The study aimed to make a handy tool for clustering SARAL/AltiKa waveforms using the EMIF algorithm. The tool was designed in such a manner that the user needs to provide waveforms and the tool will give the clustered text files containing indexed waveforms. A Python script was used for running the EMIF function and build the interface. The Python language makes the tool simpler and easily understandable. This tool can be used to clustering other altimetry waveforms data. For future work, multiple algorithms on the waveforms can be applied for better analysis and clustering. The interface also can be improved with some add-on features.

## References

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