DPA (Dune Parameters Analysis) is presented as a free MATLAB software for analyzing bedform geometry parameters.

Method framework

This is an automated method, combining 2D Fourier analysis, wavelet transform, zero-crossing analysis and a variety of filters.

Firstly, the wavelength of interest can be automatically determined by a series of 2D Fourier analyses. Secondly, the dominant regional orientation of the surfaces is calculated by the 2D DFT (Cazenave et al., 2013). Thirdly, the matrix is rotated, re-gridded, and split into numerous profiles. Target bedform profiles are separated by wavelet transform and spline filters (Gutierrez et al., 2013). Then, dune crests and troughs are extracted by zero-crossing analysis. Finally, the individual geometric parameters such as wavelength, height, asymmetry, lee-slope angle and so on, are calculated.

Dune parameters definition

The wavelength is defined as the distance between subsequent trough locations and height as the perpendicular distance between the crest and the straight line connecting the adjacent troughs. The asymmetry is defined as the difference of the distance between the crest and the trough west of the crest and the distance between the crest and the trough east of the crest divided by the wavelength. The average and maximum lee-slope angles are detected by the derivative of the lee-slope of the dune.

Important

This program is a free software in the hope that it will be useful. And you can redistribute it and/or modify it.

If you use it and want to quote it, here is the paper.

Wang, L.; Yu, Q.; Gao, S.; Zhang, Y., and Flemming BW. Submitted. An automated procedure to calculate the morphological parameters of superimposed two-dimensional dunes.

Instructions

1. Bathymetry data preprocessing

The input data must be a rectangular surface saved in a mat file. It can be a matrix named ‘data’ with three columns of x, y, and depth(z) (inputtype: 1, such as the example data ‘testdata_type_1.mat’) or three meshed matrixes named ‘x’, ‘y’, and ‘z’ (inputtype: 2, such as the example data ‘testdata_type_2.mat’).

2. Measurement of the wavelength of interest

The function **LT** can be used to calculate the wavelength of interest, and display the bathymetry map and a typical bedform profile perpendicular to the dune crest. After the calculation, the results will be displayed.

Here is the example:

```
[LT, T, PHID] = LT('D:\DPA\testdata_type_2.mat',  2);
1
2
.
.
13
There are 2 wavelength(s) of interest, they are 9 m, 208 m.
```

3. Dune geometries analyses

The wavelength of interest calculated by the LT function is the input of the dune parameters calculation. Besides, the surface matrix, inputtype, data resolutions, project storage path, and folder name are also the inputs of the **DPA** function. After the calculation, the results will be saved in the project folder.

There are two wavelengths of interest in the example data, so we need to run it twice. Here is the example:

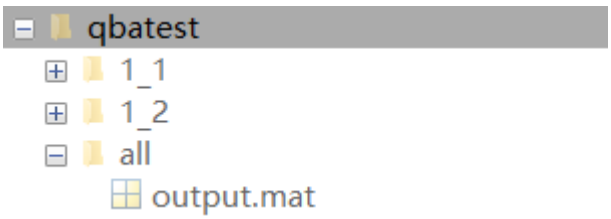
First run: 9 m as the wavelength of interest.

```
DPA('D:\ DPA\', 'test1', 'D:\DPA\testdata_type_2.mat',  2, 9, 1);
The subset 1_1 is finished. (1/55)
.
.
.
The subset 5_11 is finished. (55/55)
```

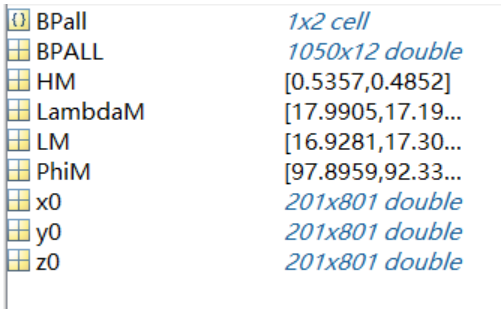
Second run: 208 m as the wavelength of interest.

```
DPA('D:\ DPA\', 'test2', 'D:\DPA\testdata_type_2.mat',  2, 208, 1);
The subset 1_1 is finished. (1/1)
```

4. Outputs



Outputs are saved in the output.mat file.



phiM is the subset dominant dune crest orientation.

BPALL

1050x12 double

	1	2	3	4	5	6	7	8	9	10	11	12
1	25.0920	2.5775	13.5056	9.5115	3.9941	0.2622	0.4085	0.0194	3.7551	4.1698	5.0037	0.4074
2	31.5303	1.6845	10.5123	2.4951	8.0172	0.1615	-0.5253	0.0154	3.7027	3.7027	4.1784	-0.5238
3	26.8525	4.3524	23.0004	9.9960	13.0044	0.7050	-0.1308	0.0307	4.0321	4.0321	5.8354	-0.1304
4	27.6225	6.2648	23.5002	9.9973	13.5029	0.6371	-0.1492	0.0271	3.6442	4.5519	5.5629	-0.1489
5	49.9092	3.1739	14.5013	9.0066	5.4947	0.4384	0.2422	0.0302	4.5578	5.0826	6.9251	0.2414
6	29.3830	8.0398	23.5000	10.0003	13.4997	0.6566	-0.1489	0.0279	3.7536	4.8446	6.1194	-0.1489
7	50.1839	5.1549	13.0003	7.5029	5.4974	0.4087	0.1543	0.0314	4.2479	5.7560	7.3183	0.1538
8	67.5180	2.7509	21.5001	12.0026	9.4975	0.8180	0.1165	0.0380	4.9137	7.4736	8.7196	0.1163
9	30.6483	9.8834	23.0008	10.5066	12.4942	0.7523	-0.0864	0.0327	4.0922	5.1520	6.0309	-0.0870
10	49.9634	7.2046	13.5001	6.9985	6.5016	0.3408	0.0368	0.0252	2.9971	4.5251	5.7982	0.0370
11	67.7928	4.7319	21.5001	11.5029	9.9972	0.8789	0.0700	0.0409	5.0152	5.0152	8.5832	0.0698
12	31.4183	11.7958	24.0018	11.5094	12.4925	0.6877	-0.0410	0.0287	3.4156	3.5777	5.8185	-0.0417
13	49.7429	9.2544	12.5006	5.9983	6.5022	0.2040	-0.0403	0.0163	1.9478	2.3437	2.8237	-0.0400
14	67.5723	6.7816	22.0001	11.5023	10.4978	0.8066	0.0457	0.0367	4.3890	4.3890	6.8849	0.0455
15	90.3542	3.6220	22.0014	12.5080	9.4934	0.6429	0.1370	0.0292	3.8721	3.8721	5.8445	0.1364
16	30.2073	13.9829	22.5021	10.5104	11.9918	0.6777	-0.0658	0.0301	3.6840	3.6840	6.3403	-0.0667
17	49.0271	11.3728	15.5011	6.9959	8.5052	0.3916	-0.0974	0.0253	3.2021	4.7747	5.6625	-0.0968
18	67.8470	8.7627	20.5004	10.5057	9.9947	0.9185	0.0249	0.0448	5.2455	5.2455	7.6819	0.0244

BPALL is the individual dune parameters. They are x of dune crest, y of dune crest, wavelength, left wavelength, right wavelength, wave height, asymmetry, stepness, average lee slope angle, average lee slope angle between knick points, maximum lee slope angle, and depth of dune crest.

Example data

The example data is a 500 m × 1000 m rectangular domain located on a sandbank in the north of the Dover Strait, UK, called South Falls. The bathymetric data was downloaded from a website called UKHO INSPIRE Portal & Bathymetry DAC (http://aws2.caris.com/ukho/mapViewer/map.action), which is provided by the UK Hydrographic Office (www.ukho.gov.uk) under an open government license.

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If you have any questions about code, please send an email to twilight528400@hotmail.com

References

Cazenave PW, Dix JK, Lambkin DO, McNeill LC. 2013. A method for semi-automated objective quantification of linear bedforms from multi-scale digital elevation models. Earth Surface Processes and Landforms 38(3): 221–236.

Gutierrez RR, Abad JD, Parsons DR, Best JL. 2013. Discrimination of bed form scales using robust spline filters and wavelet transforms: Methods and application to synthetic signals and bed forms of the Río Paraná, Argentina. Journal of Geophysical Research: Earth Surface 118(3): 1400–1418.