Extreme_SeaState_Contour_v1

QuickSheet

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Contents

1 Installation and Running

The following list details the installation and running instructions for the Extreme_SeaState_Contour_v1 code:

1. Unzip the file Extreme_SeaState_Contour_v1.zip in a separate folder.
2. Open Extreme_SeaState_Contour_v1.m in MATLAB.
3. Prepare a MATLAB .mat file with a timeseries of wave height and period for the code to use. See requirements for this dataset on line 27 in the main code file.
4. Adjust the .mat filename and other user options in the code as described in Section 3.
5. Run the code using the 'Run' button.

2 Required toolboxes, functions, and scripts

The following list details the MATLAB toolboxes, functions, and scripts that are required for running the Extreme_SeaState_Contour_v1:

- Curve Fitting Toolbox (MATLAB Toolbox)
- Statistics Toolbox (MATLAB Toolbox)
- princomp_rotation (Function)
- dataorg (Function)
- Comp2_bins (Function)
- sigma_fits (Function)
- mu_fits (Function)
- iform (Function)
- princomp_inv (Function)
- steepness (Function)
- dispersion_solver_NR_method (Function)
- density_calc (Function)
- Extreme_SeaState_Plots (Script)

3 User Options

User options are found on the following lines in the Extreme_SeaState_Contour_v1 code:

- **Line 131**: Change version number to reflect version written in code name.
- **Line 132**: Change run date to the current date.
- **Line 134**: Copy dataset name into brackets. Dataset must be in .mat format and must include three vectors of input values: DateNum, H_s and T_e or T_p.
- **Line 135**: Change water depth for related dataset.
- **Line 137**: Choose the bin size that will be used to create bins of Component 2 values based on corresponding sorted Component 1 values. This value should be greater than 100 to ensure that each bin contains enough values to create an appropriate distribution fit (default value: 250).
- **Line 138**: Choose the number of steps that will be used to discretize the circle in the normal space in order to complete the inverse FORM calculation (default value: 1000).
- **Line 140**: Choose the sea state duration corresponding to the data in hours (default value: 1 hour).
- **Line 141**: Choose the return period of interest in years (default value: 100 years). This entry can be a scalar or a row vector.
- **Line 143 (Optional)**: Enter estimate of breaking steepness; comment this line to skip this step.

4 Key Calculation Sections

The following list details the code's key calculation sections and the lines at which they occur.

- **Line 125**: Calculation setup and user options.
- **Line 148**: Removing NaN data, assigning T label depending on input (T_e or T_p).
- **Line 172**: Principal component application.
- **Line 183**: Data organization and processing.
- **Line 192**: Fitting Component 1 distribution for whole data set.
- **Line 213**: Splitting Component 2 into bins of size 'size_bins' according to sorted Component 1 values.
- **Line 226**: Fitting each bin of Component 2 with a normal distribution.
- **Line 251**: Fitting mu and sigma as functions of mean Component 1 value for each bin.
- **Line 267**: Performing the inverse FORM calculation.
- **Line 280**: Return to original orientation.
- **Line 293**: Calculation of steepness curve (if input provided by user).
- **Line 325**: Creation of density plots.
- **Line 344**: Plotting and saving results.

5 Output

The final output of the Extreme_SeaState_Contour_v1 code includes the items detailed below:

1. A file named after the concatenation of the dataset name, code version and run date is created. In this file, the following information is saved in a data structure named ExtremeSeaState_results:

    - **Hs**: Significant wave height observations with NaN data removed.
    - **T**: Peak period or energy period observations with NaN data removed.
    - **DateNum**: Vector of timestamps for each measurement in the input.
    - **Rank_Comp1_Comp2**: Matrix with the rank (based on Component 1 value), Component 1, and corresponding Component 2 and DateNum measurements.
    - **Comp1_ecdf**: CDF of Component 1 data.
    - **Comp1_pd**: Probability distribution object containing the fitted Component 1 CDF.
    - **Comp1_freq**: Matrix in which each column corresponds to a single bin and contains the values of Component 1 in each bin.
    - **Comp2_freq**: Matrix in which each column corresponds to a single bin and contains the values of Component 2 in each bin.
    - **Comp2_bins_pds**: Structure containing the probability distribution objects created by fitting the CDFs for Component 2 for each bin.
    - **histnum1**: Vector with number of values in each bin.
    - **edges1**: Vector with the index of the edges of each bin of size_bin up to the last bin.
    - **Comp1_mean**: Vector of mean values of Component 1 for each bin.
    - **mu_vals**: Mean of Component 2 for each bin based on fitted distribution.
    - **sigma_vals**: Standard deviation of Component 2 for each bin based on fitted distribution.
    - **mu_fit**: Fitted value of mu calculated at each mean value of Component 1 for each bin.
    - **sigma_fit**: Fitted value of sigma calculated at each mean value of Component 1 for each bin.
    - **mu_param**: Parameters of the function used to fit mu as a function of the mean value of Component 1 for each bin.
    - **sigma_param**: Parameters of the function used to fit sigma as a function of the mean value of Component 1 for each bin.
    - **Comp1_R**: Calculated Component 1 values along the contour boundary.

- **Comp2_R**: Calculated Component 2 values along the contour boundary.
- **Hs_R**: Calculated H_s values along the contour boundary following return to original input orientation.
- **Hs_R_2**: Values of H_s along the contour boundary and along the wave breaking steepness curve at values where the H_s value is greater than the breaking steepness.
- **T_R**: Calculated T values along the contour boundary following return to original input orientation.
- **SteepH**: Wave height values calculated along the wave breaking curve.
- **depth**: Water depth at buoy under analysis.
- **coeff**: Principal component coefficients.
- **shift**: Shift applied to Component 2 to ensure that there aren't any negative values.
- **Time_r**: Return period(s) chosen by the user to calculate environmental contour(s).

2. A folder named after the concatenation of the dataset name, code version and run date is created. In it, the following 13 figures are saved:

   - **Figure 1**: Plotting the Component 1 distribution fit with original CDF.
   - **Figure 2**: Plotting the Component 1 distribution fit with original CDF zoomed in to the top of the distribution.
   - **Figure 3**: Plotting the Component 1 distribution fit with original CDF zoomed in to the bottom of the distribution.
   - **Figure 4**: Plotting the Component 2 CDF for each bin.
   - **Figure 5**: Plotting the Component 2 CDF for each bin with distribution fitting for five selected bins.
   - **Figure 6**: Display mu and sigma fits.
   - **Figure 7**: Plot the Component1 and Component 2 data and corresponding extreme event boundary.
   - **Figure 8**: Plot the H_s and T data and corresponding contour boundary.
   - **Figure 9**: Plot steepness curve with extreme sea state contour.
   - **Figure 10**: Plot data and contour with steepness included in contour.
   - **Figure 11**: Plot of data density with extreme sea state contour.
   - **Figure 12**: Plot of data density.
   - **Figure 13**: Plot of data density with extreme sea state contour and steepness curve.