Table 1: Input requirements to detect OPAXs using the algorithm TRACE-X.

Parameter	Description	Type
var	model output name of detection variable	string
var2 *(opt)*	model output name of second detection variable (if compound extremes)	string
thresh	type of threshold used (absolute of relative)	string or int
thresh2 *(opt)*	type of threshold used on second variable	string or int
depth[a]	Depth (in meters) below which extremes are not detected	float
depth_lim_output	Depth (in meters) that need to be reached for extremes to be kept in output.	float
minDuration	Minimum duration (in days) of the detected extremes	float
edges_or_corners	Type of connectivity between grid cells. Set to *1* if connect by edges or corners; *0* if only edges	int
two_threshs	Set to *True* if compound extremes, i.e. detection on two variables; *False* otherwise	bool
moving_baseline	Set to *True* if relative threshold computed on detrended data; *False* otherwise	bool
restart	Set to *True* if script had to be stopped before ending to start from the last processed year.	bool
additional_diags	Set to *True* to have information on additional variables that are not used for the detection itself	bool
additional_properties	Set to *True* to have additional characteristics on the extremes (see table S2)	bool
years	Years span by the detection	1D array
dir_in	Directory where model output is stored	string
dir_in2 *(opt)*	If use_extended_hindcast is *True*: second directory where model output is stored	string
setup	setup for filenames of model output (format "setup_year_avg.nc")	string
outpath	Directory for storing detection output	string
areamask	Mask of the domain to use for detection	2D boolean array
dz	Field of grid cells height in meters	3D array
zlevs_rho	Field of grid cells depth in meters	3D array
area	Field of grid cells area in square meters	2D array
thresh_main	Relative threshold value for each grid cells	3D array
thresh_main2 *(opt)*	Relative threshold value for each grid cells for the second variable used in detection (compound extremes, i.e. if two_threshs is set to *True*)	3D array
slope_main *(opt)*	Linear trend value for each grid cells. Necessary if moving_baseline is set to *True*	3D array
slope_main2 *(opt)*	Linear trend value for each grid cells for the second variable used in detection (compound extremes, i.e. if two_threshs is set to *True*). Necessary if moving_baseline is set to *True*	3D array
thresh_var *(opt)*	Relative threshold value for each grid cells for any additional variable used for diagnostics but not for detection. Used if additional_diags is set to *True*)	3D array
clm_file_output	Temperature daily (365 days) climatology file (netCDF4 file)	string
filename_clm_366j	Temperature daily (366 days) climatology file (numpy array file)	string
flonlat *(opt)*	File gathering longitude and latitude arrays. Used if additional_properties is set to *True*)	string
lon_varname *(opt)*	Longitude variable name in flonlat	string
lat_varname *(opt)*	Latitude variable name in flonlat	string
fdcoast *(opt)*	File with the distance to the coast for each grid cell. Used if additional_properties is set to *True*)	string
dcoast_varname *(opt)*	Distance to the coast variable name in fdcoast	string

[a] Having only one depth limit cuts the extremes at this depth and results in an artefact of large number of small extremes right at the depth limit. Having a two-level selection on the depth suppresses this artefact. Thus give depth>depth_lim_output.

Table 2: Available outputs from algorithm TRACE-X.

Parameter	Description	Unit
n_events	the total number of detected extreme events	-
ev_number	the event ID	-
intensity_max	maximum [Thresh-Value] value (if extremes are defined as below the x percentile)	variable unit
intensityxvolume_detect_var	severity: cumulative intensity in space and time	km^3 d var unit
intensity_mean	time average of volume weighted intensity	variable unit
detect_var_min	minimum value of the variable used for detection reached within the extreme (relevant if extremes are defined as below the x percentile)	variable unit
detect_var_mean	time and volume weighted mean value of the variable used for detection in the event	variable unit
time_I_max	time of maximum intensity	date
time_z_max	time when the event reaches its shallowest depth	date
index_start	ordinal time when the event initiates	-
index_end	ordinal time when the event ends	-
duration	index_end - index_start	days
volume_tot	cumulative volume over time	km^3 d
volume_mean	daily volume	km^3
vertical_extent	difference between shallowest and deepest point over the whole lifetime	m
z_max	shallowest depth reached by the event	m
z_min	deepest depth reached by the event	m
z_min_at_z_max	deepest depth where the event reached the shallowest level	m
loc_z_max_eta	ETA index of the shallowest point	-
loc_z_max_xi	XI index of the shallowest point	-
loc_Imax_eta	ETA index of the maximum intensity point	-
loc_Imax_xi	XI index of the maximum intensity point	-
With additional_diags switched on		
var_min	minimum value of omega aragonite, pH or oxygen	variable unit
var_mean	time and volume weighted mean omega aragonite, pH or oxygen in the event	variable unit
intensityxvolume_var	severity: cumulative intensity for omega aragonite, pH or oxygen in space and time if a threshold is given	km^3 d var unit
var_I_mean	time average of volume weighted intensity in omega aragonite, pH or oxygen if a threshold is given	variable unit
var_I_max	maximum [Thresh-Value] value (if extremes are defined as below the x percentile) if a threshold is given	variable unit
delta_temp_max	maximum temperature anomaly (positive or negative)	°C
intensityxvolume_delta_temp	cumulative excess or deficit of heat carried in the event	km^3 d °C
delta_temp_mean	time and volume weighted mean temperature anomaly in the event	°C
With additional_properties switched on		
depth	time average of volume weighted depth	m
vertOcc	time average of area weighted vertical occupation of an event	m
dcoast	time average of volume weighted distance to the coast	km
lat	time average of volume weighted latitude	°N
lon	time average of volume weighted longitude	°E
horProp	distance between the center of gravity of an extreme at initiation and at ending	km
vertProp	height difference between the center of gravity of an extreme at initiation and at ending: positive value means a deepening; negative value means a shoaling of the events over its lifetime	m
propVel	horizontal propagation divided by duration of an event	km d^{-1}
area_mean	area average in time and depth	km^2

duration_at_cell_mean	average duration at each grid cell involved in the extreme	days
duration_at_cell_max	maximum duration at one grid cell	days
severity_omega_D_I	duration times mean intensity with regard to aragonite saturation state	Ω_A unit.d
severity_pH_D_I	duration times mean intensity with regard to pH	pH unit.d