AELO Web Tool User Guide

V1.5 2026-01-13

NOTE: This document describes the AELO Web Tool delivered as the final product for Year 4 (https://year4.aelo.openquake.org/, version 2.0). It updates previous versions by adding the requirements of ASCE 7-22 and ASCE 41-23 and incorporating modifications based on user feedback.

The AELO Web Tool provides a means for users to obtain building-code ground motion parameter values for a single site. The ground-motion parameters are for use with the ASCE 7-16, 41-17, 7-22, and 41-23 Standards. The web tool can be used programmatically via a REST API, or via a minimal web user interface.

Contents

Obtaining an Account

Accounts are assigned by the GEM IT team on an invitation only basis. If you do not have an account and feel that you should have one, please contact Paul.Henshaw@globalquakemodel.org

When an account is created for you, you will receive an email with a link to set up a password.

Using the Web User Interface

In this section we briefly describe how to use the AELO web user interface (WebUI). The AELO WebUI has been tested with Firefox and Chrome, although it is possible that other modern browsers will work correctly.

Logging in

Open a browser and navigate to https://year4.aelo.openquake.org/; you should be presented with a page as shown below:

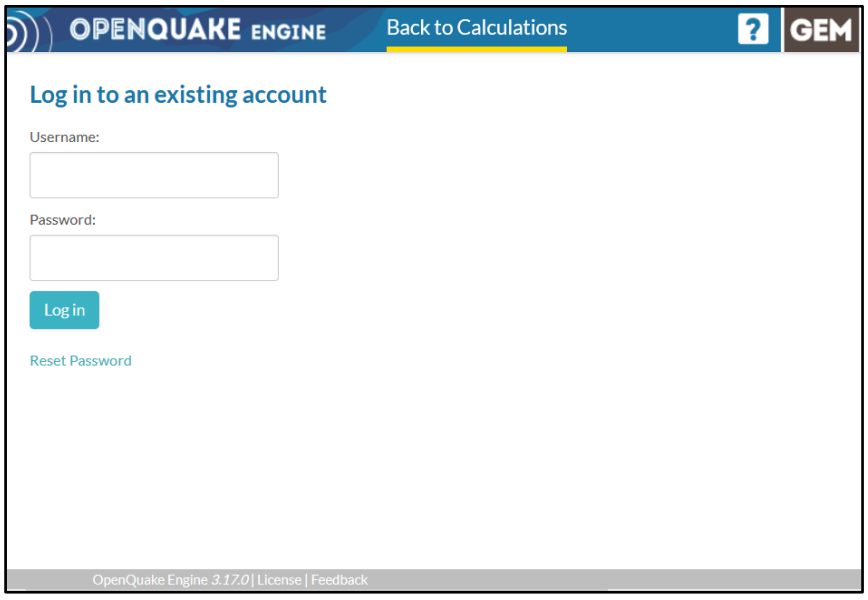


Figure 1: AELO Login page

Enter your username and password; you should now see a page with a short form for AELO calculation inputs and an initially empty list of calculations:

Figure 2: AELO calculation input form.

Running a calculation

In order to start an AELO calculation, the user must provide the following input values:

Calculation Inputs

- Latitude: the latitude of the site (a floating point number in the interval [-90.0, +90.0], max. 5 decimal places)
- Longitude: the longitude of the site (a floating point number in the interval [-180, +180], max. 5 decimal places)
- Site name: a description to assign to the site (max. 256 characters)
- ASCE standards: choice between ASCE 7-16 & 41-17 and ASCE 7-22 & 41-23
- Site class: For ASCE 7-22 & 41-23, the form permits selection of a site class between A and E consistent with the definition of soil site class in Table 20.2-1 of ASCE 7-22. In these cases, a corresponding Vs30 value is automatically assigned for the calculations. The user can also choose to “Specify Vs30” and enter a value within the admissible range 150-1525 m/s. An additional “Default” option can be chosen which follows Section 11.4.2.1 in ASCE 7-22 to compute results for site classes C, CD, and D (pre-defined Vs30 values of (530m/s, 365m/s and 260m/s) and then selects the final results using the envelope of these. For ASCE 7-16 & 41-17, the site class selector is disabled and the site class B-C boundary is automatically selected with a corresponding Vs30 of 760m/s, consistent with the mapped spectral response accelerations in ASCE 7-16.
- Vs30: the time-averaged shear-wave velocity from the surface to a depth of 30 meters (a floating point number in the interval [150, 1525]). The Vs30 field is automatically populated when a site class other than “Specify Vs30” is chosen. For more information about Vs30 please see https://earthquake.usgs.gov/data/vs30/

All input parameters are required in order to perform an AELO calculation. Once the input values have been inserted, press the “Submit” button.

Instant error messages

In some cases, the WebUI will give an error message rather than starting a calculation. These are sometimes due to user errors, while other times the cause is WebUI limitations. Table 1 lists the

known error messages that a user may encounter and their causes. For other error messages, please contact: **aelosupport@openquake.org**

Error message	Cause and action (if applicable)

`Invalid input value`
`Latitude: "latitude XXX[1] > 90"`
 	
`Or`
 	
`Invalid input value`
`Latitude: "latitude XXX[1] < -90"`
	The user entered an incorrect site latitude; check the coordinates and try again

`Invalid input value`
`Longitude: "longitude XXX[1] > 180"`
 	
`Or`
 	
`Invalid input value`
`Longitude: "longitude XXX[1] < -180"`
	The user entered an incorrect site longitude; check the coordinates and try again

`Invalid input value`
 	
`Site name: "site name can not be longer than 256 characters"`
	The user provided a 'Site name' that is too long. Shorten this to <256 characters and try again.

`Invalid input value`
 	
`Vs30: "vs30 100.0 is smaller than the minimum (150)"`
 	
`Or`
 	
`Invalid input value`
 	
`Vs30: "vs30 3500.0 is bigger than the maximum (1525)"`
	The user provided a 'Vs30' that is too small or too large. Replace it with a float within the range 150 - 1525 and try again

`Site at lon=38.0 lat=-41.0 is not covered by any model!`	The requested site coordinates are not covered by any hazard model and so the calculation cannot be run. This includes sites in the USA.

Table 1: Known error messages that a WebUI user may encounter, including the cause and - if applicable - the action the user should take. [1]XXX is the coordinate entered by the user.

Monitoring Calculation Progress

Once a calculation has been submitted, it will appear in the list of calculations. In the example below, we can see a calculation in the process of being executed:

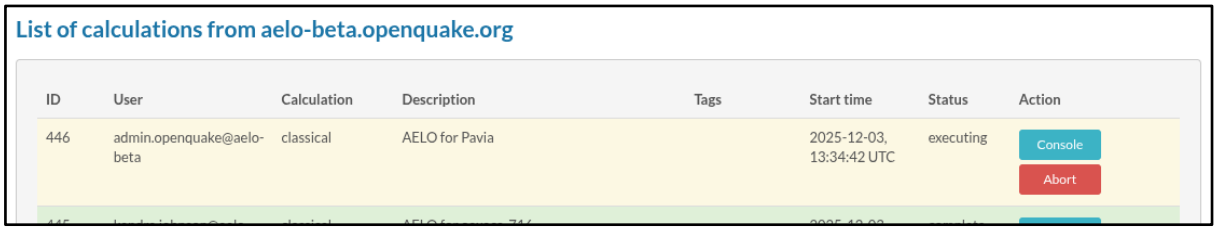


Figure 3: AELO calculation in execution

Please note that the AELO system can run one calculation at a time. In case a new calculation is submitted while a previous one is still running, the new calculation is enqueued and it is displayed in the list as pending. The current user can see only his/her own jobs in the list, so it can be that a previous job launched by a different user (and therefore invisible in the list) will need to complete before the newly submitted job starts execution. Depending on the location of the site, the calculation may take several minutes to execute. The AELO system will send you an email message when the calculation completes, and the calculation will continue execution even if the browser tab is closed. The email notification will report relevant information about the calculation, as demonstrated in Figure 4. The subject will indicate the job identifier and will state if the calculation finished correctly or not. The body will first report the input values specified by the user in the form, also indicating which version of the AELO service was used to run the calculation. Then, in case of an error, it will give an explanation of the problem that occurred; otherwise it will provide a link to open the web page displaying the outputs of the calculation. The same page can be accessed by clicking on the “Outputs” button that appears in the web interface.

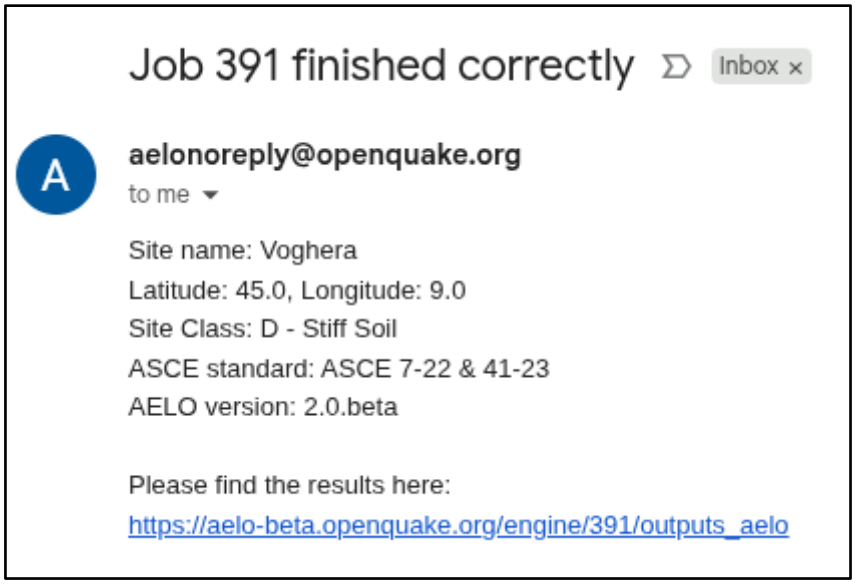


Figure 4: Email announcing completed job with link to outputs

Calculation Outputs

AELO calculations produce a number of different outputs which are documented in detail in the Description of Calculation and Outputs section. Note that the outputs provided will differ depending on the site class and ASCE 7 and 41 versions.

The outputs are divided into two categories: the most widely used outputs are featured on the landing page of the "Outputs" button/link called "Simplified outputs page" (see example in Figure 5), while other outputs that may be interesting or useful to advanced users are accessible by clicking the button "View advanced outputs page" on the bottom left of the Simplified outputs page. An example of the Advanced outputs page is provided in Figure 6.

In the simplified page, the primary results are printed within the outputs table, and are also downloadable in *.csv* format by clicking the "Download csv" buttons on the right (see Figure 5); these include the ASCE 7 and ASCE 41 parameters and ground motions.

Table 1 below summarizes all possible calculation outputs, indicating where each output appears (simplified vs. advanced outputs page) and under which conditions certain results are not provided. For example, outputs are omitted when the probabilistic calculations result in zero hazard ("Zero or Very Low hazard") or when the probabilistic MCE (MCEr or MCEg) falls below the deterministic lower limit defined by ASCE 7 ("Only Prob."). In all other cases ("Others"), the full set of outputs is provided.

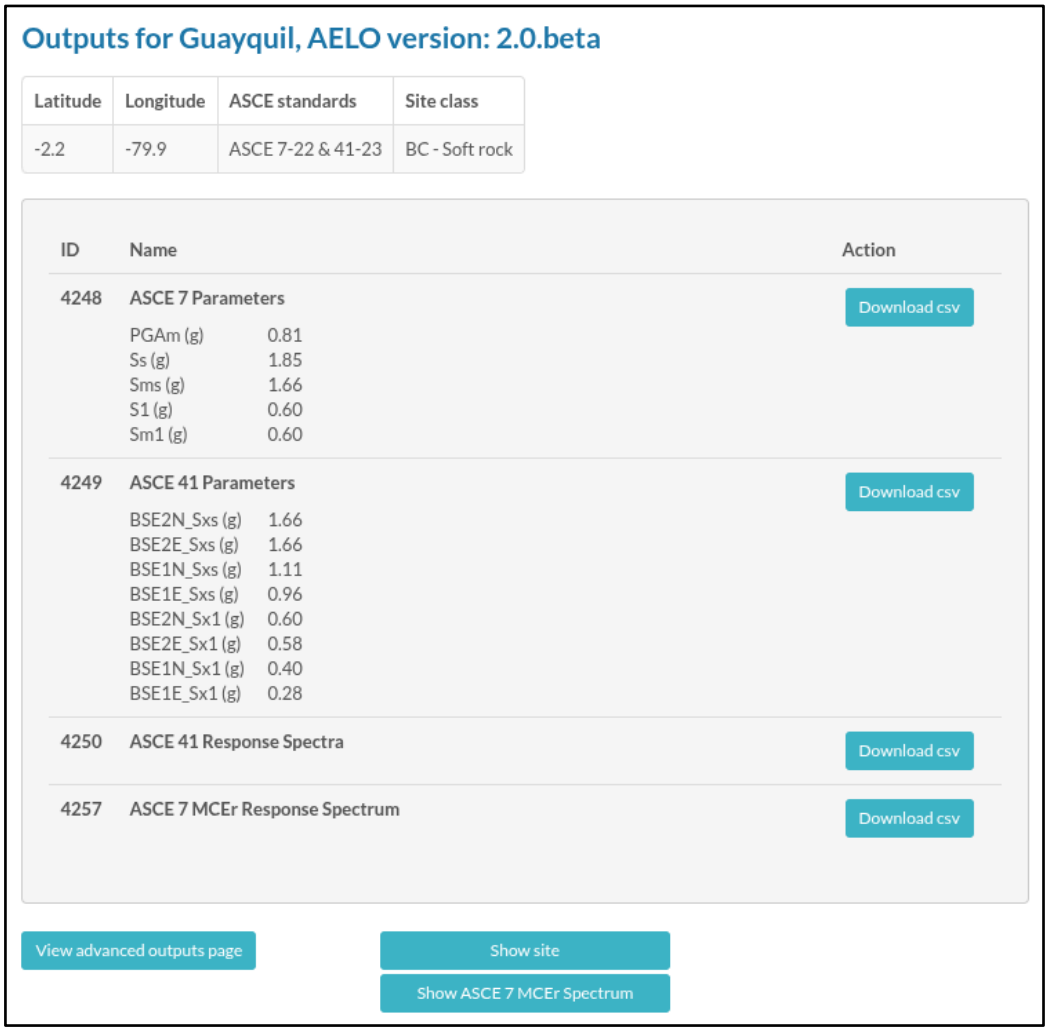


Figure 5: Example of calculation Outputs landing page.

		Where to find these outputs		Expected outputs for site with:		
Type of output	**Output type**	**Simplified page**	**Advanced page**	**Zero or Very Low hazard**	**Only Prob.**	**Others**
ASCE 7	ASCE 7 Parameters	x	x	x	x	x
	ASCE7 MCEr Response Spectrum	x	x	x	x	x
	MCE Calculations		x	x	x	x
ASCE 41	ASCE 41 Parameters	x	x	x	x	x
	ASCE 41 Response Spectra	x	x	x	x	x
	ASCE41 Calculations		x	x	x	x
Deterministic analyses	Mag-Dist-Eps Disaggregation per Source		x			x
	Hazard Curves per Source		x	x	x	x
	Deterministic Earthquake Scenarios		x			x
Classical PSHA	Full Report		x	x	x	x
	Site Model		x	x	x	x
	Uniform Hazard Spectra		x	x	x	x
	Hazard Curves		x	x	x	x
Figures	Show site	x		x	x	x
	Show ASCE 7 MCEr Spectrum	x			x	x
	Show ASCE 7 MCEr details		x		x	x
	Show hazard curves		x		x	x
	Show hazard curves per source		x		x	x

Table 1. Summary of calculation outputs.

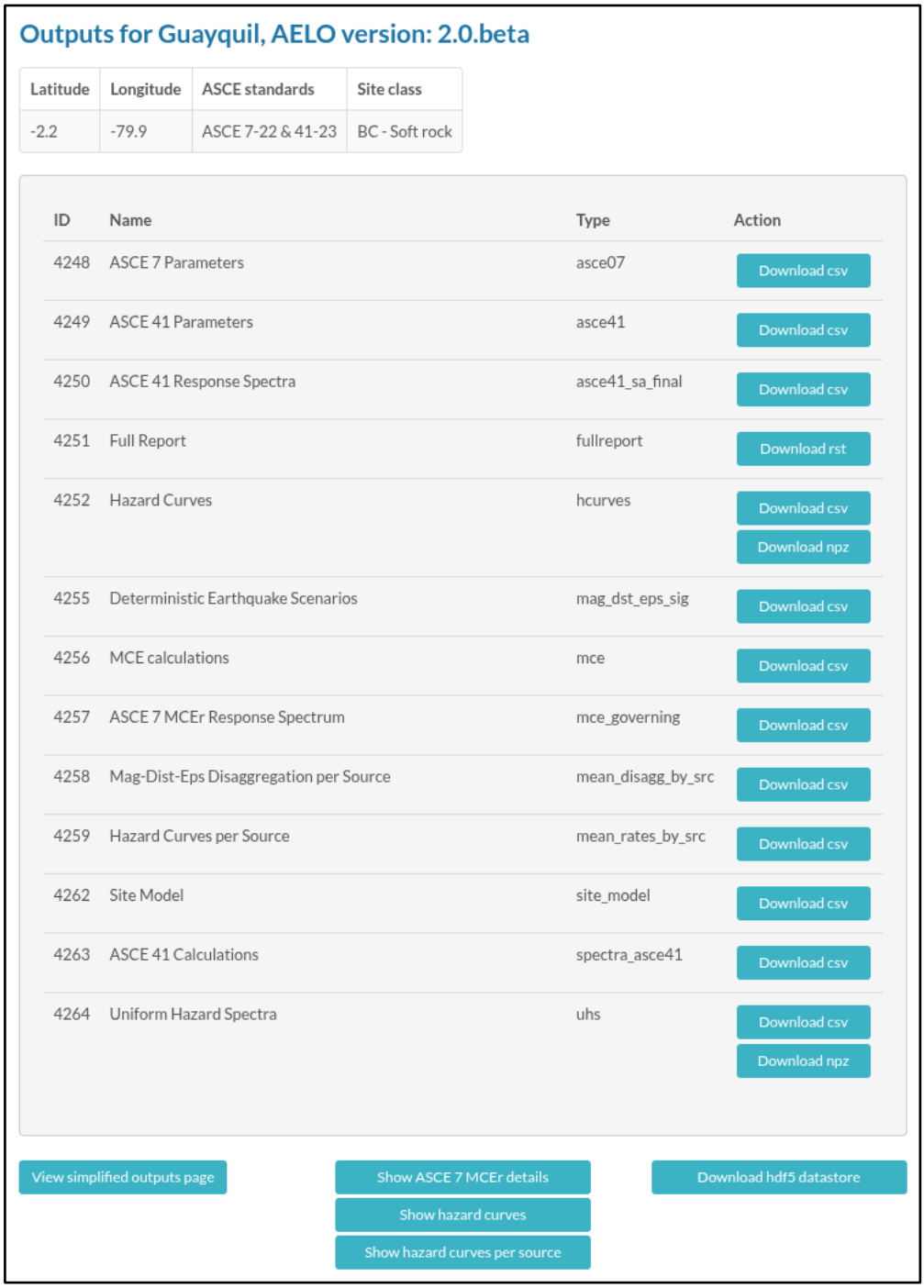


Figure 6: Example of Advanced outputs page. Some outputs will be missing for those cases in which the deterministic calculation is not required (see Table 1)

Output Exceptions

For some sites, the web tool cannot currently provide results, or we do not recommend using them. The reasons and the corresponding responses from the web interface are described here.

1. *The site is not covered by the AELO project*: a pop-up window will indicate that the site is uncovered, and no calculation will begin. This includes latitude/longitude pairs that are inside of the U.S. and its territories, which the AELO web tool does not cover, as well as offshore areas for which our models have not been tested. **If you encounter a site that you believe returns this error incorrectly, please contact aelosupport@openquake.org**.
2. *The calculated hazard is very low*: the calculation completes correctly, but the hazard was too low to compute the ASCE parameters; this occurs when the most frequent ground motion level has a rate below 1/2475 yrs:
   "WARNING: Very low hazard: ASCE 7 and ASCE 41 parameters cannot be computed. For further information, please refer to the user manual."
3. *The site is covered by a hazard model, but the model does not include sources within the maximum considered distance of the site*: the calculation completes, but the hazard is zero because no ruptures occurred nearby, and therefore ASCE parameters are not computed:
   "WARNING: Zero hazard: there are no ruptures close to the site. ASCE 7 and ASCE 41 parameters are not computed. For further information, please refer to the user manual."
4. *The MCE calculated at the site is very low (but >0g):* the calculation completes and provides a complete set of ASCE 7 and ASCE 41 parameters, but some or all of the results are lower than commonly adopted default minimum values; users may need to increase the parameter values to their specified minimums, as they may in cases 2 and 3 above. Given the expectation of different policies for these minimums among users, the web tool does not assign any specific values to these parameters:
   "WARNING: The ASCE 7 and/or ASCE 41 parameter values at the site are very low. User may need to increase the values to user-specified minimums. For further information, please refer to the user manual."

5. Another output response appears when the results correctly exclude outputs specific to the deterministic analysis. Calculations that result in this note have a final MCE derived solely from the Probabilistic MCE, since it is below the DLLs. In this case, the following note is displayed:
   "NOTE: The final MCE is derived solely from the Probabilistic MCE, since it is below the DLLs. Outputs specific to the deterministic analysis are not included. For further information, please refer to the user manual."

Description of Calculation and Outputs

The methodology used for the calculation is described in the ASCE standards and the report summarizing the activities completed within the first three years of the AELO project. A shorter description of the method implemented can be found in Villani et al. (2023). The main steps of the workflow consist of the following:

- Calculation of hazard curves from a probabilistic seismic hazard analysis
- Calculation of probabilistic Risk-targeted Maximum Considered Earthquake (MCE_R or MCEr) and Geometric Mean Maximum Considered Earthquake (MCE_G or MCEg) ground motions
- For cases where the Probabilistic MCE (MCE_R or MCE_G) does not exceed the deterministic lower limit, the governing MCE is the one obtained from the probabilistic analysis. Otherwise, we perform the following, with details in the ASCE 7-22 Standard and the AELO Year 3 final report:
    - Identification of the earthquake sources controlling the hazard at the site, via hazard disaggregation
    - Disaggregation for each individual source by the controlling parameters: magnitude, distance, and epsilon. Then, a deterministic scenario is defined for each source based on the mean of each controlling parameter for the respective source.Calculation of deterministic MCE_R and MCE_G using the scenarios obtained at the previous points, subject to the deterministic lower limits, taking the maximum scenario result as the deterministic MCE.
    - Calculation of the governing MCE as the minimum between the deterministic and probabilistic MCE.

All outputs provided by the web interface are described below. The main results are the *ASCE 7 and ASCE 41 parameters and spectra*, and are featured on the outputs landing page ("Simplified outputs"). **Most users are likely to use only these**. Several additional outputs are available with results from intermediate steps that can be accessed by clicking "View advanced outputs page" at the bottom left. A description of the outputs is provided below for both the Simplified outputs page and the Advanced outputs page.

Simplified outputs page

Note1: * indicates that the field is printed on the simplified outputs page.
Note2: download file names correspond to the "type" field on the advanced outputs page

ASCE 7-16 parameters (.csv)

Parameter	Description
PGA*	Maximum Considered Earthquake Geometric Mean (MCE_G) peak ground acceleration. This is computed as the minimum between the probabilistic and the deterministic MCE_G for 0 s, i.e., PGA (ProbMCE and DetMCE in the file "MCE calculations").
Ss*	MCE_R, 5%-damped, spectral response acceleration for 0.2 s This is computed as the minimum between the probabilistic and the deterministic MCE_R for 0.2s (ProbMCE and DetMCE in the file "MCE calculations").
Ss_seismicity	FEMA P-154 (2015) seismicity region from Ss alone
S1*	MCE_R, 5%-damped, spectral response acceleration for 1 s. This is computed as the minimum between the probabilistic and the deterministic MCE_R for 1s (ProbMCE and DetMCE in the file "MCE calculations").
S1_seismicity	FEMA P-154 (2015) seismic region from S1 alone

ASCE 41-17 parameters (.csv)

Parameter	Description
BSE2N_Ss*	Same as Ss above
BSE2E_Ss*	Min(Ss_5_50 , BSE2N_Ss), where Ss_5_50 is the uniform-hazard SA at 0.2s with a 5% probability of being exceeded in 50 years
BSE1N_Ss*	2/3 * BSE2N_Ss
BSE1E_Ss*	Min(Ss_20_50 , BSE1N_Ss), where Ss_20_50 is the uniform-hazard SA at 0.2s with a 20% probability of being exceeded in 50 years
BSE2N_S1*	Same as S1 above
BSE2E_S1*	Min(S1_5_50 , BSE2N_S1), where S1_5_50 is the uniform-hazard SA at 1.0s with a 5% probability of being exceeded in 50 years
BSE1N_S1*	2/3 * BSE2N_S1
BSE1E_S1*	Min(S1_20_50 , BSE1N_S1), where S1_20_50 is the uniform-hazard SA at 1.0s with a 20% probability of being exceeded in 50 years

ASCE 7-22 parameters (.csv)

Parameter	Description
PGAm*	Maximum Considered Earthquake Geometric Mean (MCE_G) peak ground acceleration. This is computed as the minimum between the probabilistic and the deterministic MCE_G for 0s, PGA (ProbMCE and DetMCE in the file "MCE calculations").
Ss*	Only for site class BC. MCE_R, 5%-damped, spectral response acceleration for 0.2 s. This is computed as the minimum between the probabilistic and the deterministic MCE_R for 0.2s (ProbMCE and DetMCE in the file "MCE calculations").
Sms*	Risk-targeted Maximum Considered Earthquake (MCE_R) spectral response acceleration parameter at short periods. This is computed according to Section 21.4 in ASCE7-22 as: 0.9 × max(MCE_R) for MCE_R spectrum in the period (T) range [0.2 - 5.0] s
Sds	⅔ x Sms
Ss_seismicity	Only for site class BC. FEMA P-154 (2015) seismicity region from Ss alone
S1*	Only for site class BC. MCE_R, 5%-damped, spectral response acceleration for 1 s. This is computed as the minimum between the probabilistic and the deterministic MCE_R for 1s (ProbMCE and DetMCE in the file "MCE calculations").
Sm1*	Risk-targeted Maximum Considered Earthquake (MCE_R) spectral response acceleration parameter at long periods. This is computed according to Section 21.4 in ASCE7-22 as: max{0.9 × max(T × MCE_R), MCE_R(T=1s)}, for MCE_R spectrum in the period (T) range [1.0 - Tmax] Where $\begin{cases} T_{max} = 2s \; for \; V_{s30} > 442 \; m/s \\ T_{max} = 5s \; for \; V_{s30} \leq 442 \; m/s \end{cases}$
Sd1	⅔ x *Sm1*
S1_seismicity	Only for site class BC. FEMA P=154 (2015) seismic region from S1 alone

ASCE 41-22 parameters (.csv)

Parameter	Description
BSE2N_Sxs*	Same as Sms above
BSE2E_Sxs*	Short-period ground motion parameter. This is computed like Sms is from an MCE_R spectrum, but from a BSE-2E spectrum instead (see the ASCE 41-17 parameter descriptions above).
BSE1N_Sxs*	2/3 * BSE2N_Sxs
BSE1E_Sxs*	Short-period ground motion parameter. This is computed like Sms is from an MCE_R spectrum, but from a BSE-1E spectrum instead (see the ASCE 41-17 parameter descriptions above).
BSE2N_Sx1*	Same as Sm1 above
BSE2E_Sx1*	Long-period ground motion parameter. This is computed like Sm1 is from an MCE_R spectrum, but from a BSE-2E spectrum instead (see the ASCE 41-17 parameter descriptions above).
BSE1N_Sx1*	2/3 * BSE2N_Sx1
BSE1E_Sx1*	Long-period ground motion parameter. This is computed like Sm1 is from an MCE_R spectrum, but from a BSE-1E spectrum instead (see the ASCE 41-17 parameter descriptions above).

ASCE 41 Response Spectra (.csv)
This file contains the ASCE 41 spectra as defined in Section 2.3 of the ASCE 41-23 Standard.

ASCE 7 MCEr Response Spectrum (.csv)
This file contains the SaM, i.e., the Risk-targeted MCE spectral response accelerations defined in Section 21.2 of the ASCE 7-22 Standard.

Advanced outputs

All outputs included in the “Simplified outputs” are also available on the “Advanced outputs” page. Some results are available in multiple formats, which may not be readily accessible to all users; however, they are included on this page for use by the most advanced users or developers.

Full Report (.rst)
This file lists information about the calculation itself, including details about computation times and memory use. Please note that this output can sometimes contain very wide tables leading to very long lines. In order to view these files effectively, we recommend using a graphical viewer that can be opened in text editors such as Vim, Apple TextEdit, or Microsoft Notepad which allow the user to disable automatic word wrapping.

Hazard curves (.csv, .npz)

A hazard curve represents the most fundamental result computed for a site from a probabilistic seismic hazard analysis. It provides, for various values of a selected intensity measure type (IMT, e.g., spectral acceleration at a certain period or peak ground acceleration), the corresponding probability of exceedance in the investigation time (in most of the cases, one year). Typical users should use the *.csv* rather than *.npz* format file.

Deterministic Earthquake Scenarios (.csv)
Representative scenario parameters per source and IMT derived from the single-source disaggregation results and used to compute the deterministic MCE.

MCE calculations (.csv)
This file summarises the values computed at different steps used to define the governing maximum considered earthquake (MCE) ground motion levels. For each IMT, the following are provided: deterministic lower limit (DLL), probabilistic MCE (ProbMCE), deterministic MCE (DetMCE is "*nan*" if the ProbMCE < DLL), and MCE. The site id (sid) is always 0 for calculations run for a single site (e.g. from the web tool).

Mag-Dist-Eps Disaggregation per Source (.csv)
This file provides the results of disaggregation by magnitude, distance, and epsilon (the coefficient of sigma in the ground motion aleatory uncertainty) for each of the sources that contribute significantly to the hazard at the spectral acceleration corresponding to the probabilistic MCE for each IMT (the MCEs are specified in the header). For each row the columns represent: the ID of the source; the center value of the disaggregation bin for magnitude, distance, and epsilon; the intensity measure type; and the rate of exceedance of the MCE for the given bin. Only bins with non-zero rate contributions are included.

Hazard curves per Source (.csv)
This file provides values of the rate of exceedance in the investigation time (i.e. the hazard curves) obtained using the individual seismic sources contributing to the probabilistic seismic hazard. The file contains several rows where each row provides the ID of the source, a label specifying the IMT, a value of ground motion, and the corresponding value of the rate of exceedance. A hazard curve for a single source and IMT can be extracted from this file by selecting the rows with fixed values of the source ID and IMT.

Site Model (.csv)
This file lists all the information about the site that was used for the calculation: the position information of longitude (lon) and latitude (lat) and depth (always 0.0 km); and the site conditions Vs30, depth to shear-wave velocity of 1.0 km/s (z1pt0, units of m), and depth to shear-wave velocity of 2.5 km/s (z2pt5, units of km). The values z1pt0 and z2pt5 are calculated inside the workflow based on the given Vs30 or site class.

ASCE41 Calculation

This file contains the ASCE 41 spectra (BSE1N, BSE2N, BSE1E, and BSE2E) for each Vs30 value used in the calculations. Except for the default site class, the spectra coincide with those provided in the file ASCE 41 Response spectra.

Uniform-Hazard Spectra (.csv, .npz)

A spectrum where each ordinate has the same probability/rate of being exceeded in the investigation time. This file contains values for the same intensity measure types listed in the description of hazard curves with certain values of the probability of exceedance in the investigation period. Here, the values of probability correspond to 50%, 20%, 10%, 5% and 2% probability of exceedance in 50 years. Typical users should use the *.csv* rather than .npz format file.

hdf5 datastore

This is a large file containing large volumes of data about the calculation and results, accessible by clicking the bottom right button. Viewing and understanding the contents takes high knowledge of the software underlying the AELO web tool; typical users do not need this file. We do not recommend downloading this file for most users since it can be rather large and requires programming skills to interrogate effectively.

Figures

Figures can be saved by right-clicking each button and choosing "Save link as…". The full set of outputs and figures are included only when the deterministic part of the calculation is completed (see Table 1).

The **Simplified output page** displays two figures, described below.

Location of the site

The "Show site" button at the bottom center of the page displays a basic map with an "x" marker placed at the input coordinates (e.g., see Figure 7). Each country shown in the map is filled with a random color. The main purpose of this map is to provide an easy way to check if the given input coordinates are correct and in the right order.

ASCE7 MCE_r Spectrum

1) The "Show ASCE 7 MCEr Spectrum" button displays the MCEr multi-period response spectrum, as shown in the example in Figure 8. This output is not included in the case of ASCE7-16 and ASCE41-17 calculations and in the case of sites with zero hazard.

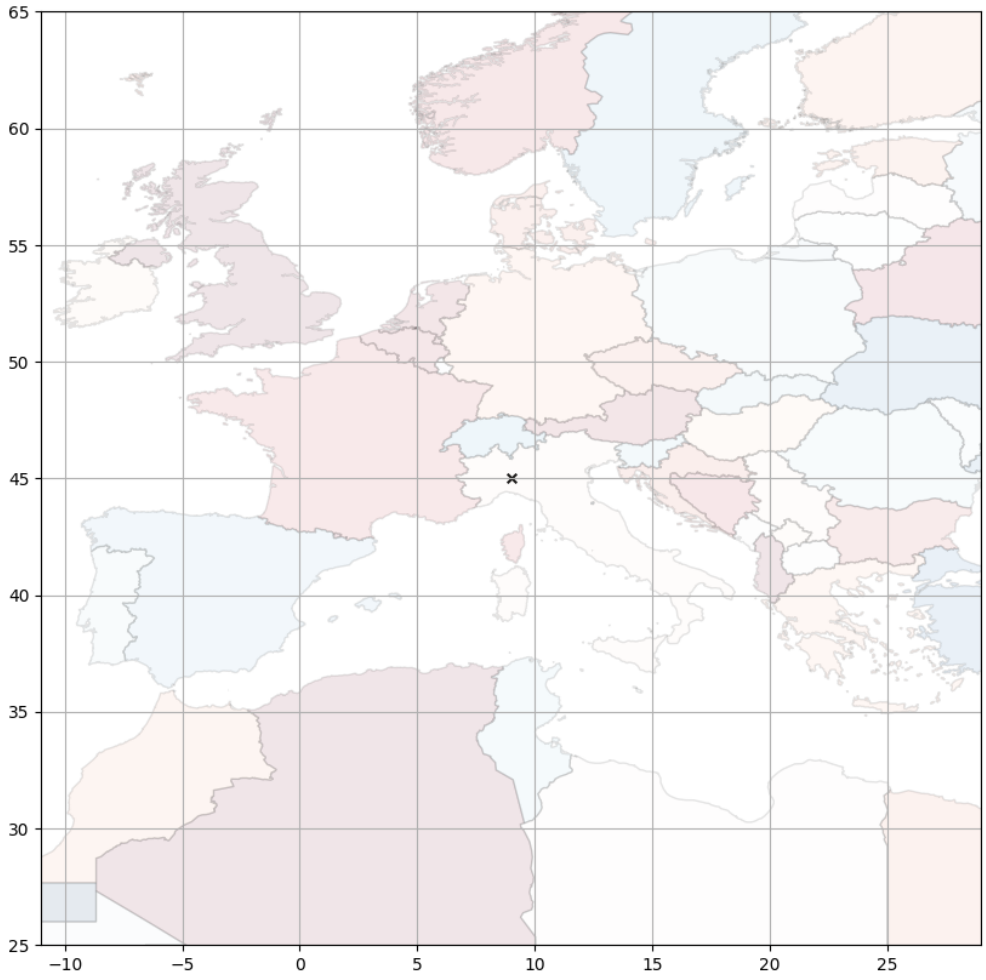


Figure 7: Map showing the location of the input coordinates

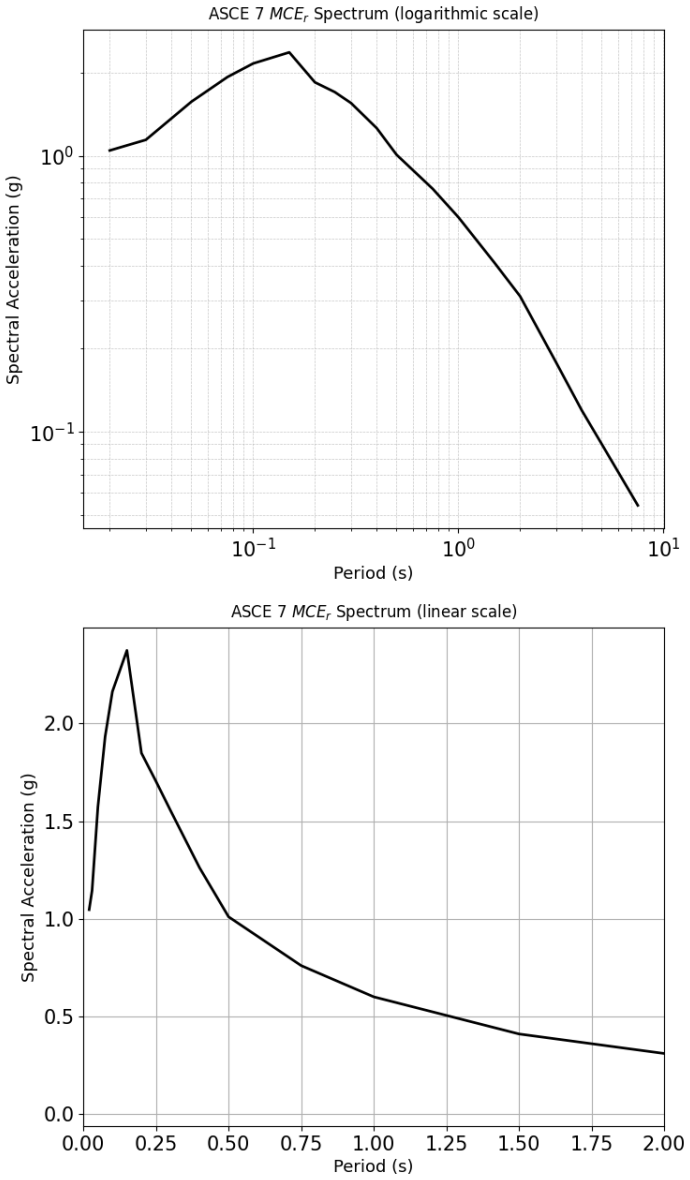


Figure 8: Example of "Show ASCE 7 MCEr Response Spectrum" figure, with logarithmic (upper) and linear (lower) scales

The **"Advanced outputs page "** page provides three figures, described below.

Hazard curves

When the user clicks the **"Show hazard curves"** button, a subset of the hazard curves are displayed. In the plots, the y-axis represents the annual frequency of exceedance while the x-axis corresponds to the intensity measure "acceleration" (g). The same plot shows the hazard curves for:

- PGA (yellow solid line) in terms of the horizontal geometric mean;
- Spectral accelerations in terms of the maximum horizontal component, converted from the geometric mean using the ASCE 7-16 or 7-22 scale factors.

In the case in which the calculation is run using ASCE 7-22 and the "Default" site class, the figure displays three subplots, one for each VS30 used in the calculations (see example In Figure 9).

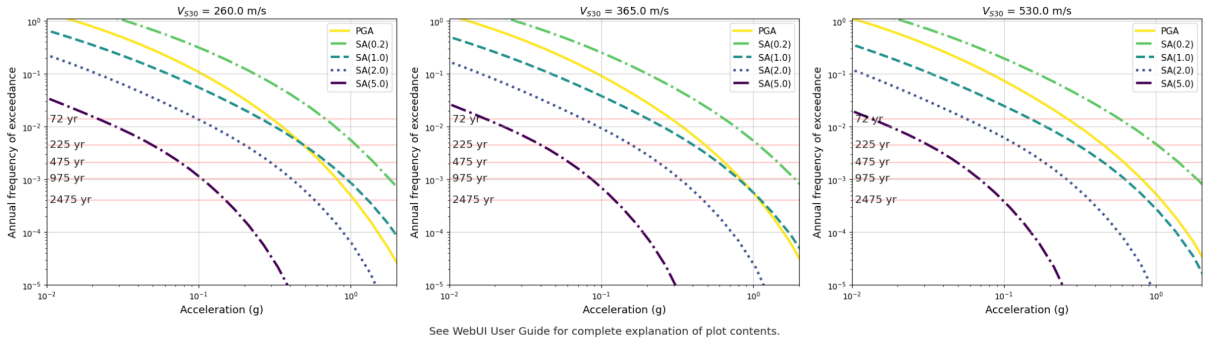


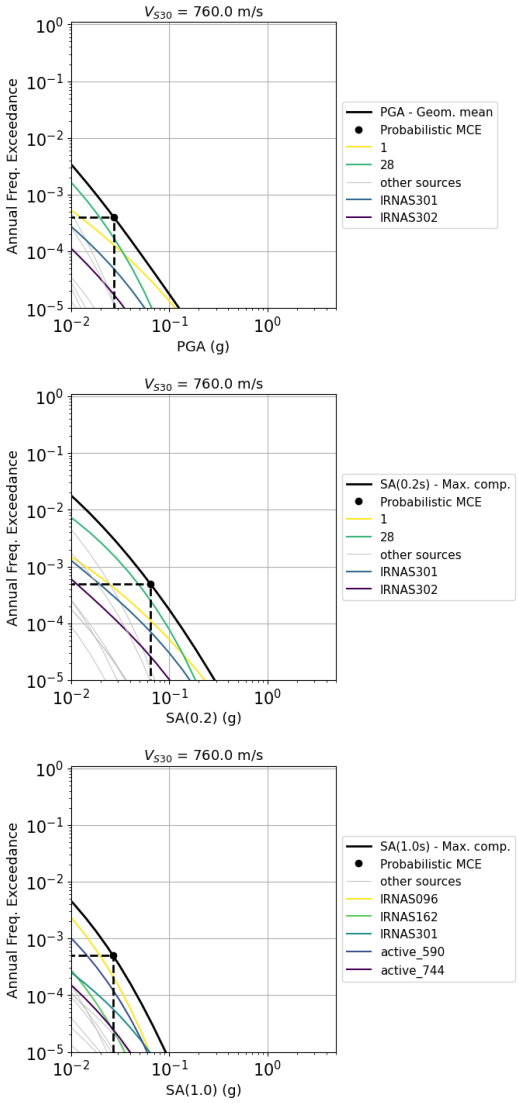
Figure 9: Hazard curves obtained selecting the "Default" site class, which envelopes three V_{s30} values

Hazard curves per source

These figures are displayed when the user clicks the **"Show hazard curves per source".** Figure 10 shows an example: the figure includes three subplots, one for PGA (in terms of horizontal geometric mean) and the other two for spectral accelerations at 0.2 s and 1 s (in terms of maximum horizontal component). Each subplot includes:

- The total mean hazard curve from the probabilistic calculation
- The probabilistic MCE that is disaggregated in the deterministic part of the workflow
- The hazard curve for each seismic source considered. The hazard curves for sources with significant contribution at the probabilistic MCE (i.e., those with annual frequency of exceedance, AFE, at the probabilistic MCE at least 10% of the AFE for the source contributing most) are colored and identified by their source ID (an OpenQuake source property) in the legend, while the other hazard curves are colored in gray.

In the case in which the calculation is run using ASCE 7-22 and the "Default" site class, the three subplots are shown for each of the three Vs30 values used in the calculations (indicated in the titles) and a total of nine plots will be included in the figure, as shown in Figure 11.



See WebUI User Guide for complete explanation of plot contents.

Figure 10: Example of hazard curves per source.

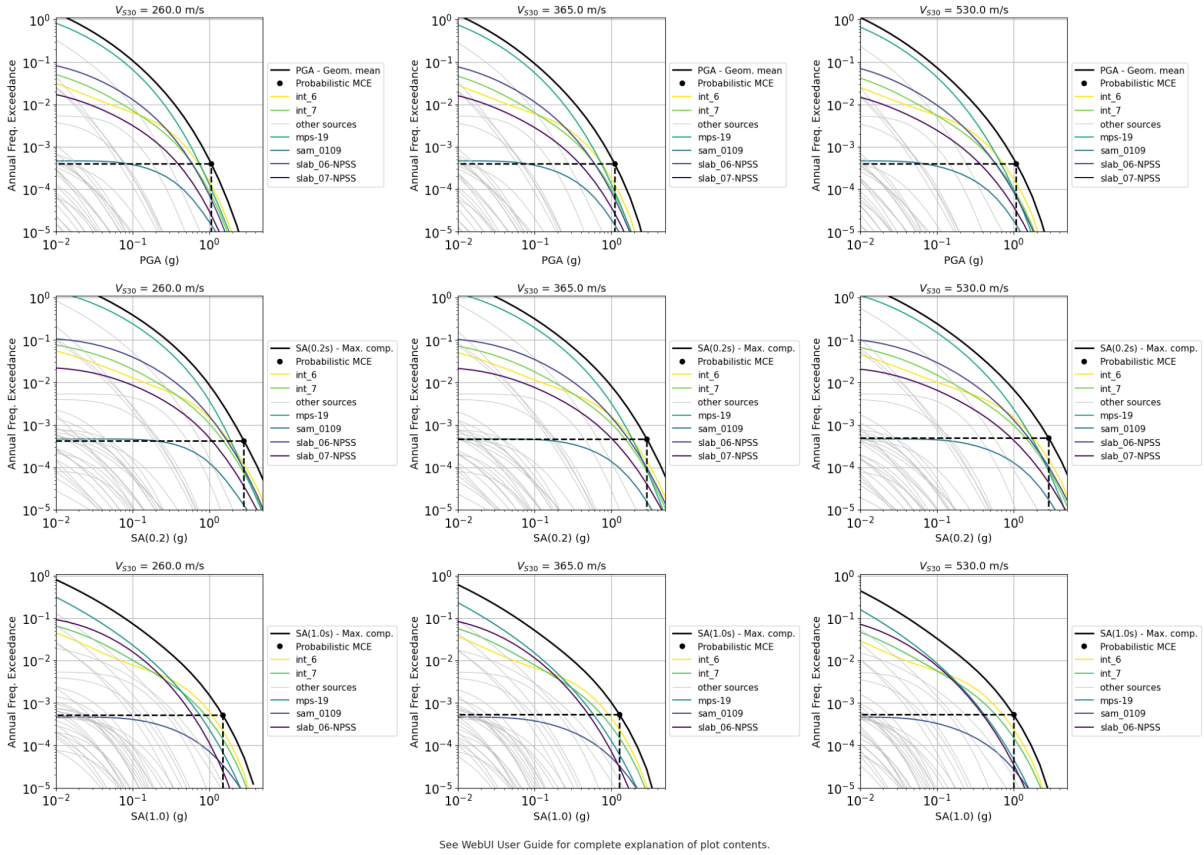
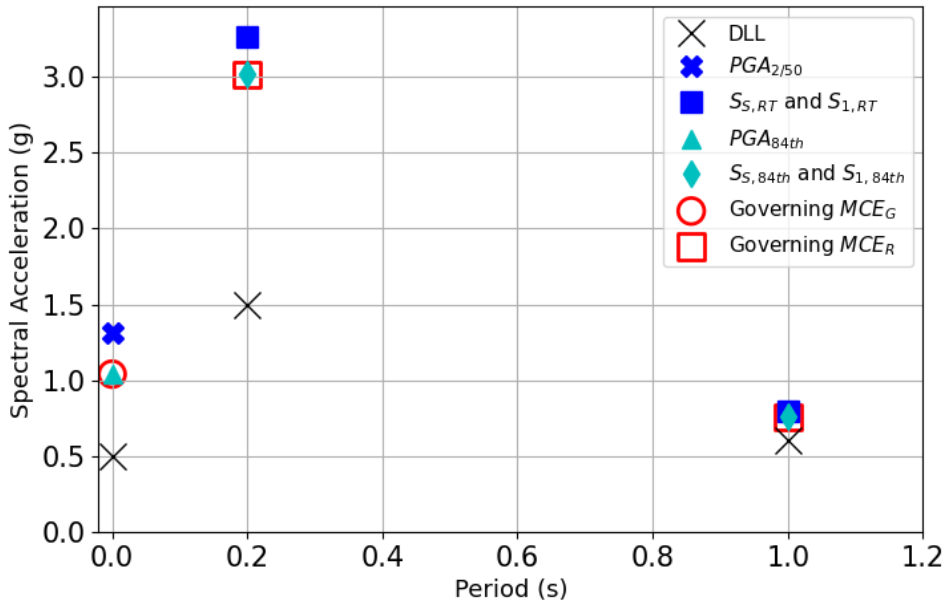


Figure 11: Example of hazard curves per source obtained selecting the "Default" site class, in which case the plots are shown for three V_{s30} values.

Probabilistic, Deterministic and Governing MCE

The button "Show ASCE 7 MCEr details" provides details about the calculations leading to the final governing MCEr. The figure shows the results of the probabilistic MCEr, the deterministic MCEr, the deterministic lower limit (DLL) defined in ASCE 7, and the final governing MCE.

- In the case of ASCE7-16, the plot shows both the MCEg and MCEr details, i.e., PGA_{84th}, $S_{S,84th}$, $S_{1,84th}$, $S_{S,RT}$, $S_{1,RT}$, and $PGA_{2/50}$, where RT stands for risk-targeted, 84th indicates the result of the deterministic analysis, and 2/50 indicates a uniform-hazard value with 2% probability of exceedance in 50 years. An example is shown in Figure 12. All terms are explained in AELO Year 1 Final report.
- In the case of ASCE 7-22, the figure displays the multi-period spectra, as shown in the example in Figure 13.



See WebUI User Guide for complete explanation of plot contents.

Figure 12: Example of probabilistic, deterministic and final governing MCE ground motions for ASCE 7-16.

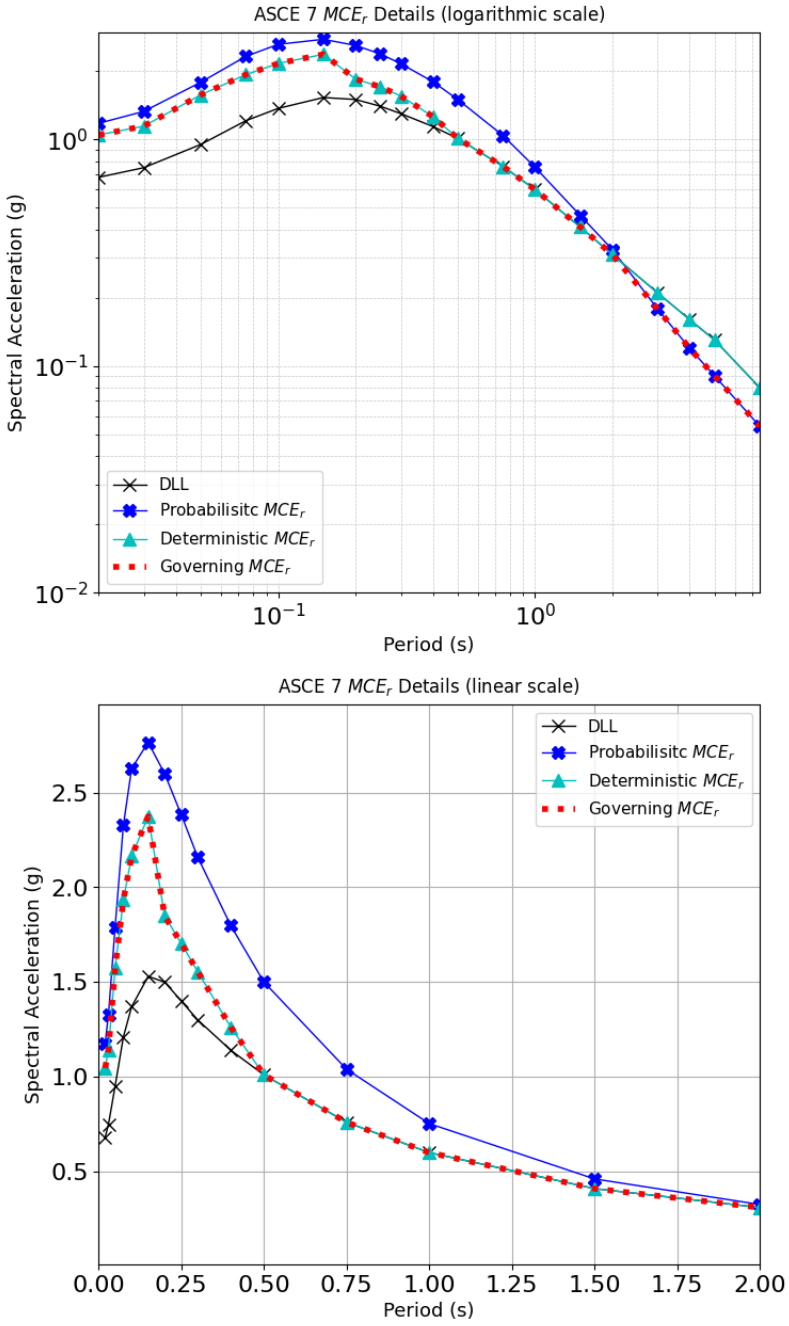


Figure 13: Example of probabilistic, deterministic, and final governing MCEr ground motions for ASCE 7-22.

Nightly Quality Checks

The web tool calculations use the OpenQuake (OQ) Engine, which is constantly undergoing development. To ensure that changes to the OQ Engine do not affect the results given by the web tool, nightly tests are completed to confirm that new values do not deviate substantially from the ones calculated in Year 1 (for ASCE 7-16 & 41-17) and Year 3 (for ASCE 7-22 & 41-23) of the AELO project. If values do deviate, the development team investigates whether a new software bug has been introduced or, instead, if the new values correct an old bug.

QGIS Plugin

It is also possible to view and download AELO outputs using GEM's open-source Integrated Risk Modelling Toolkit (IRTM) plugin for the desktop GIS tool, QGIS, as explained in the subsections below.

Please see the following web page for installation instructions: https://docs.openquake.org/oq-irmt-qgis/latest/00_installation.html

Connect to AELO Web Service

Once the plugin has been installed, open the settings as shown in the figure below:

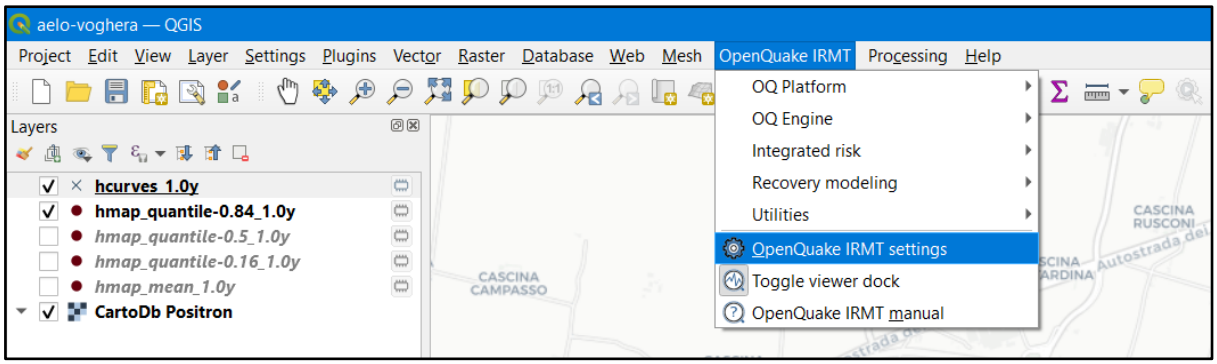


Figure 14: IRMT settings in QGIS

Click on the "New" button in the "OpenQuake Engine connection profile".

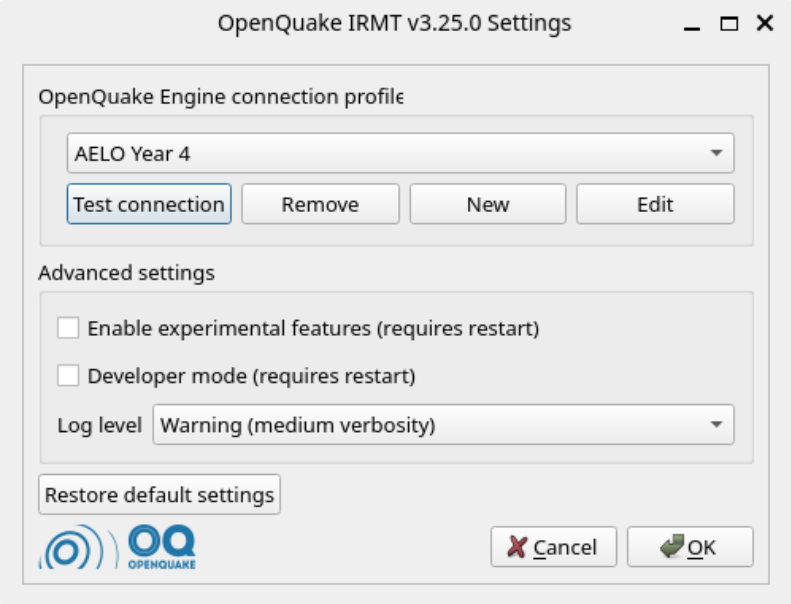


Figure 15: QGIS Plugin: New engine connection profile

Then fill in the form as shown in the figure below, obviously inserting your own username and password. Please note that multiple profiles can be created, for example one to connect to the "year2" service and the other to connect to the "year4" service. The profile name can be any string chosen by the user arbitrarily.

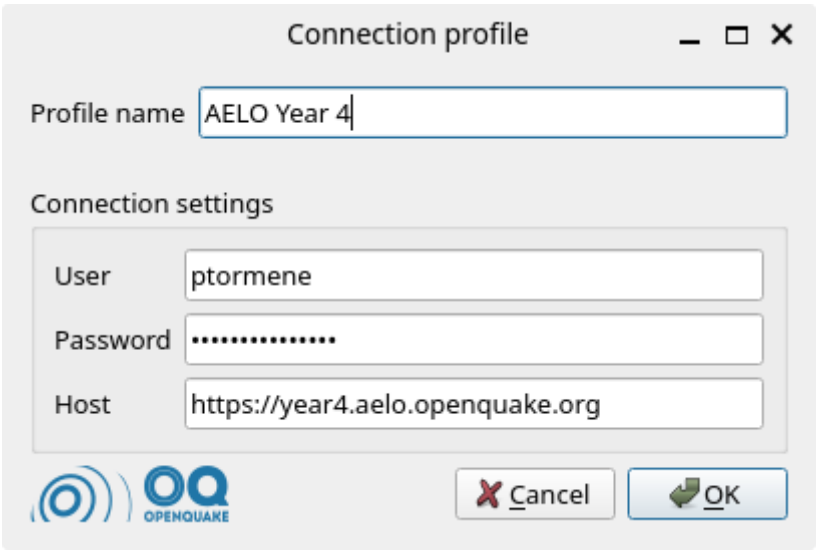


Figure 16: QGIS Plugin: AELO Connection settings

Test the connection with the "Test Connection" button. Assuming all is well, you can now connect to the AELO web service using the "Drive the OpenQuake Engine" menu item/icon, as shown in the figure below:

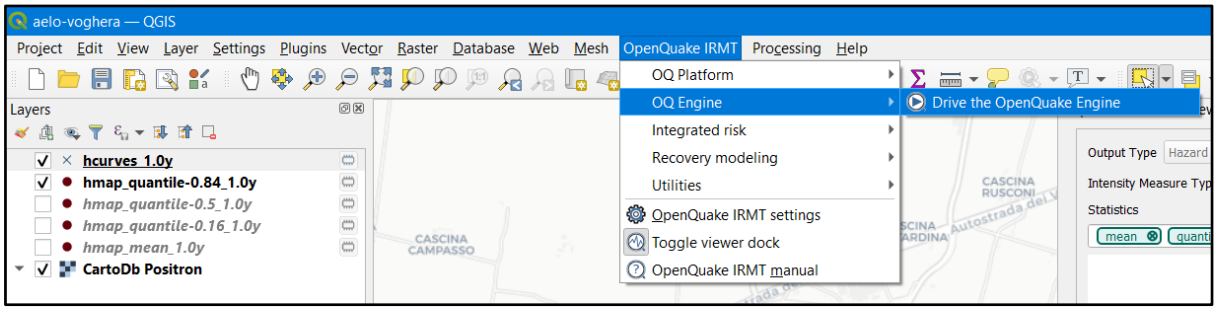


Figure 17: QGIS Plugin: Drive the OpenQuake Engine

Visualize calculation results

The list of available calculations will be shown in a window similar to the one shown in the figure below:

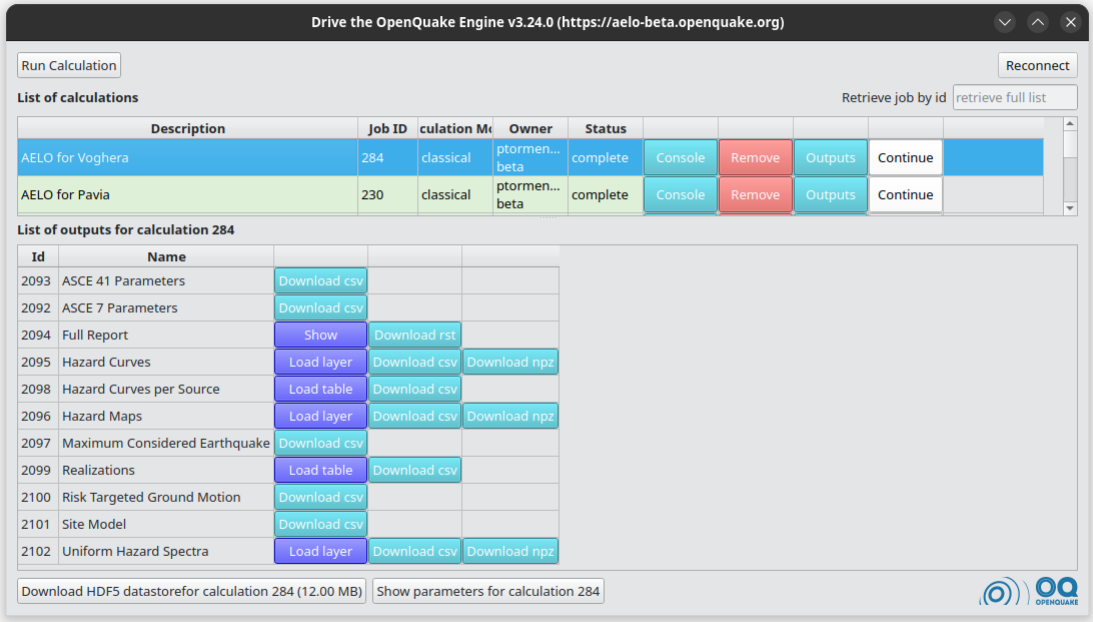


Figure 18: QGIS Plugin: Drive the OpenQuake Engine

In addition to the download options available via the web interface, for some output types we also have a “Load Layer” option. For instance, if we click on the Load layer button for the Hazard Curve or Uniform-Hazard Spectra outputs, we can view the curves in the graph viewer.

For AELO calculations, the default options for loading hazard curves are generally fine:

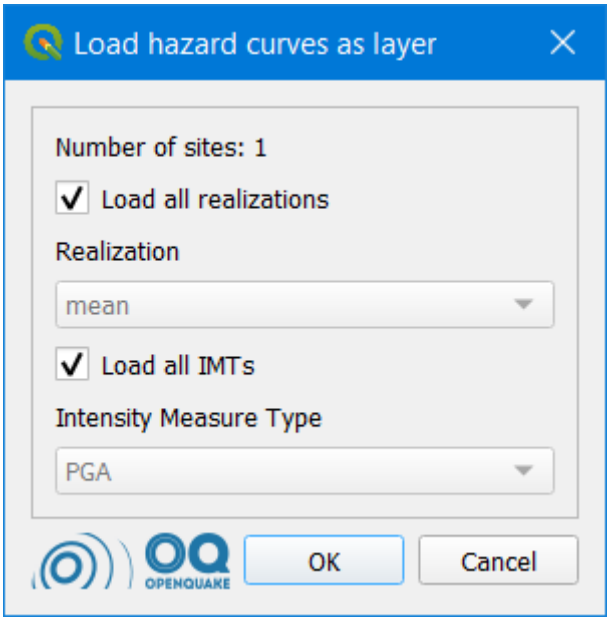


Figure 19: QGIS Plugin: default hazard curve options

After pressing OK, a layer will be loaded with a single cross icon identifying the site. Use "Select Features by Area" to select the site:

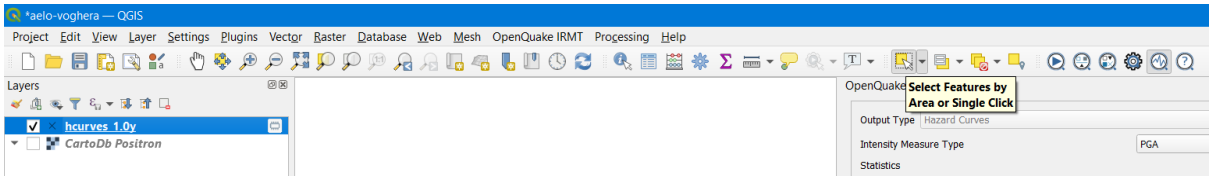


Figure 20: QGIS Select Feature by Area

The graph area will be updated to show hazard curves for the selected site:

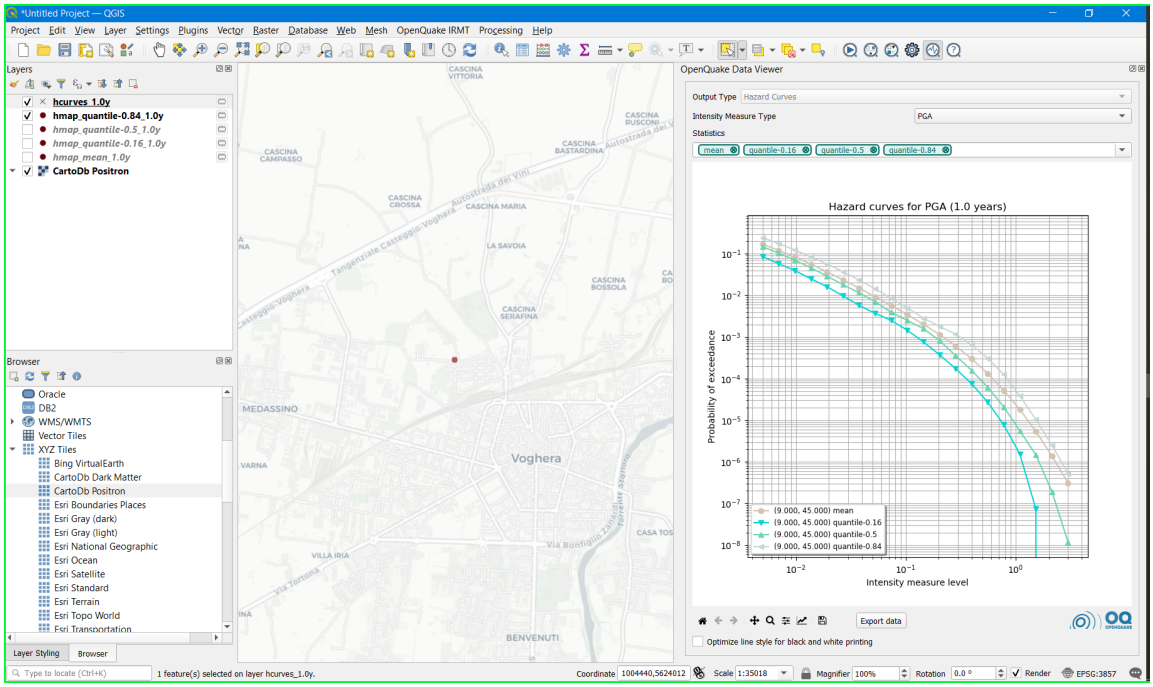


Figure 21: QGIS Plugin presenting hazard curves

Using the drop-down menus in the QGIS Plugin Data Viewer area, it is possible to change Intensity Measure Type and (de)select mean and quantile curves:

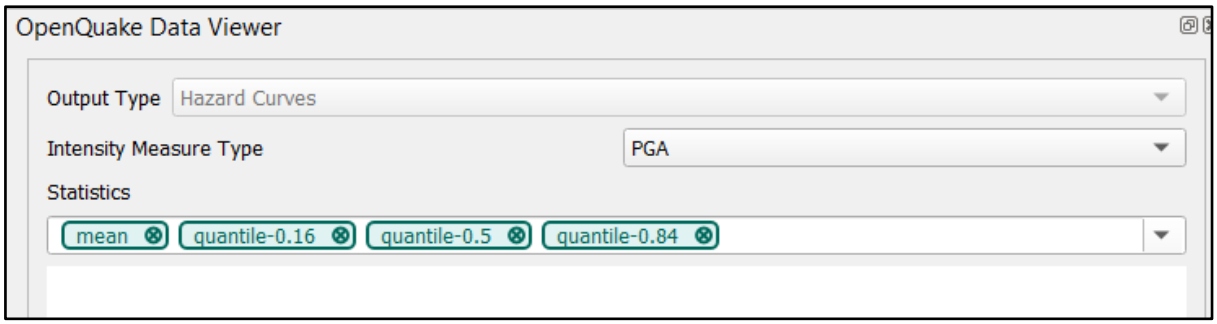


Figure 22: QGIS Plugin Data Viewer controls

For further information regarding the IRMT plugin please refer to the user manual https://docs.openquake.org/oq-irmt-qgis/latest/.

Using the REST API

The AELO web tool can also be accessed programmatically via a REST (REpresentational State Transfer) API (Application Programming Interface). This is useful for integrating AELO with existing systems and/or for automated, non-interactive workflows.

This section briefly describes the REST API endpoints used for the most common operations. Please see https://github.com/gem/oq-engine/blob/master/doc/web-api.md for additional information regarding the OpenQuake engine REST API.

Authentication, login/logout

POST /accounts/ajax_login/

Attempt to login, given the parameters `username` and `password`

POST /accounts/ajax_logout/

Logout

Running a calculation

POST /v1/calc/aelo_run

Run a new AELO calculation for a site with the specified parameters.

Parameters:

```
* lon: the longitude of the site (a float in the interval [-180, +180])
* lat: the latitude of the site (a float in the interval [-90.0, +90.0])
* siteid: a description to assign to the site (<256 characters)
* asce_version (optional, default 'ASCE7-16'): valid values are 'ASCE7-16'
(i.e. ASCE 7-16 & 41-17) or 'ASCE7-22' (i.e. 'ASCE 7-22 & 41-23')
* site_class (optional for 'ASCE7-16', default None): valid values for
'ASCE 7-22' are 'A' (Hard rock, vs30=1500m/s), 'B' (Medium hard rock,
vs30=1080m/s), 'BC' (Soft rock, vs30=760m/s), 'C' (Very dense sand or hard
clay, vs30=530m/s), 'CD' (Dense sand or very stiff clay, vs30=365m/s), 'D'
(Medium dense sand or stiff clay, vs30=260m/s), 'DE' (Loose sand or medium
stiff clay, vs30=185m/s), 'E' (Very loose sand or soft clay, vs30=150m/s),
'default' (Default, vs30=[260m/s, 365m/s, 530m/s]), 'custom' (the vs30
value has to be specified by the user)
* vs30 (optional): the time-averaged shear-wave velocity from the surface
to a depth of 30 meters (a float in the interval [150.0, 1525.0])
```

Response:

```
The input values are validated and a `400 Bad Request` response is returned
if any invalid input is found, specifying the reason for the failure.
If inputs are valid, the engine will first attempt to identify a Mosaic
model that covers the given site, returning a `400 Bad Request` response in
case the site does not belong to any of the Mosaic models. Otherwise, a new
job is created and a `200 OK` response is returned, like:

{"status": "created",
 "job_id": 1,
 "outputs_uri": "https://year4.aelo.openquake.org/v1/calc/1/results",
 "log_uri": "https://year4.aelo.openquake.org/v1/calc/1/log/0:",
 "traceback_uri": "https://year4.aelo.openquake.org/v1/calc/1/traceback"}

`outputs_uri` can be used later to retrieve calculation results, after the
job is complete.
`log_uri` can be called to get the log of the calculation, either while it
is still running or after its completion.
`traceback_uri` can be called in case of job failure (and only after it
occurs), to retrieve a full traceback of the error.
```

As soon as the job is complete, a notification is automatically sent via email to the user who launched it. In case of success, the message will contain a link to the web page showing the outputs of the calculation; otherwise, it will describe the error that occurred.

There are several API endpoints. They can be used, e.g., to list the available jobs, to get a list of available outputs for a job (or to download one of them), and to get the corresponding log or traceback. There are also endpoints to abort or to remove a job. You can also download the AELO changelog. See https://docs.openquake.org/oq-engine/master/manual/api-reference/rest-api.html.