Extreme Wildfire Events Data Hub for Improved Decision Making

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Editor	Chiel van Heerwaarden (WU)
Contributors	Marc Castellnou (CFRS), Pau Guarque (PCF)

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List of Acronyms

CLASS	Chemistry-Land-Atmosphere-Soil-Slab
EWED	Extreme Wildfire Events Data Hub for Improved Decision Making

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Executive Summary

This deliverable is the development and first initial release of a web-based version of the existing Chemistry-Land-Atmosphere-Soil-Slab (CLASS) model and an inclusion of an entraining (fire) plume model to determine the potential rise of a wildfire plume under a given weather condition. The software is accessible via https://classmodel.github.io/class-web, and its latest v0.3.0 version has been released under DOI: https://doi.org/10.5281/zenodo.15609037

1. Introduction

One of the key properties of a wildfire plume is its depth and the sensitivity of that depth to changes in the local weather or the fire size and intensity. To understand these changes better, it is very helpful to have a tool that quickly allows for quick exploration of the development of the weather and the wildfire.

In this deliverable of the EWED-project, we have developed this tool. We have taken the Chemistry-Land-Atmosphere-Soil-Slab (CLASS) model, [1][2] developed and maintained at Wageningen University as the starting point. The CLASS model is a conceptual model of the daytime atmosphere in which the evolution of temperature, humidity and wind throughout the day can be modelled in the order of seconds. Its fast run time makes it extremely suitable for fast exploration of cases and parameter studies. Therefore, it is ideal for quickly learning more about the conditions under which wildfires develop.

The aim of this deliverable was to port the main atmospheric model from a C++/Qt based version to an easy to access web-based version, and to enhance it with a fire plume model to test the height a plume can reach. This enables access from anywhere and from mobile devices without having to install software and will ultimately enable users to load cases and soundings from the EWED data portal (Deliverable 3.3) for further study.

2. Implementation

With the Netherlands eScience Center as the subcontractor to develop the software, we have completed an initial version of the web-based CLASS, as promised in this deliverable. This implementation has been made in JavaScript, making the model run entirely client side, thereby preventing the need for having to run any CLASS model simulations on a server. The source code is hosted on Github at the address https://github.com/classmodel/class-web and the latest v0.3.0 release of the model can be accessed via GitHub Pages on https://classmodel.github.io/class-web.

3. A brief overview of the workflow

Here, we will give a brief overview of how the user will be working with the code. First, the user needs to select an experiment to run (Figure 1). This can be the default case (the case that is in the original CLASS model and the basis case for the exercises in the widely used textbook *Atmospheric Boundary Layer* from Cambridge University Press [2]) or a case from the EWED data portal. In the report here, we show the Varnavas example case. At completion of Deliverable 3.3, it will be possible to launch cases based on data saved on the EWED data portal.

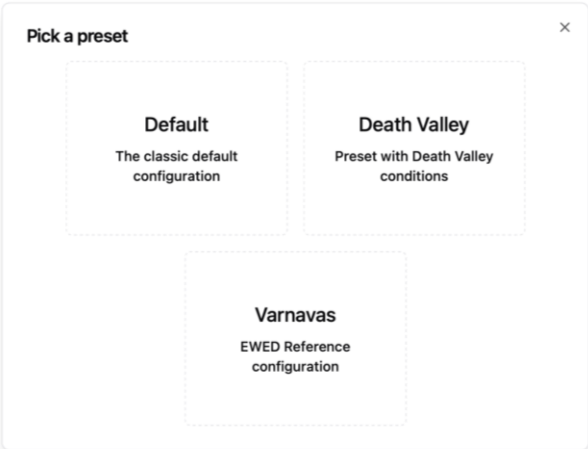

Figure 1. Selecting an experiment.

Then, once the case is loaded, the user gets the experiment configuration screen, combined with some initial plots (Figure 2). Here, we have selected the Varnavas case, created from the conditions of the 11th of August, 2024 fires near Athens, Greece. In preparing the Varnavas case, we have created initial profiles from ERA5 using the (LS)^{2}D tool [3] (https://github.com/ls2d/ls2d), and compared and manually finetuned it against the available radio sounding for that case. Manual finetuning is needed, as often soundings have too high variability to automatically determine the necessary vertical profiles of temperature, humidity, and wind from it.

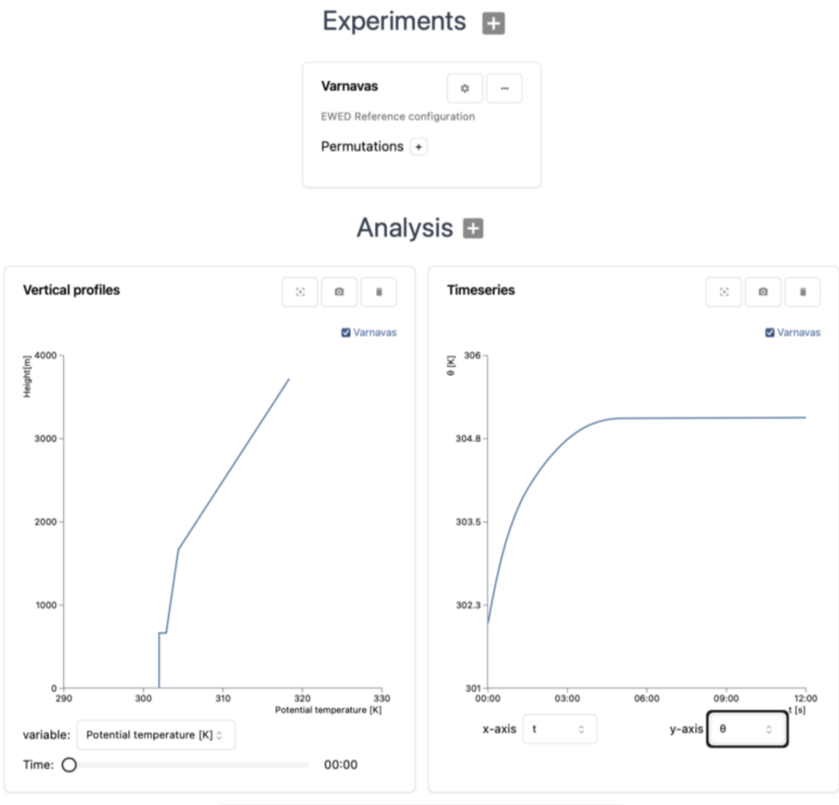

Figure 2. Main window with experiment and initial plots. This example shows a vertical profile of potential temperature (left) and a time series of the mixed-layer potential temperature theta. In preparation for the training event, we will include additional explanation to the variables in the time series.

The user can now make permutations to the experiment (add a fire or change environmental conditions) and see the impact, by clicking the + next to permutations and adjusting the settings via the configuration window (Figure 3). To aid the novice user, each option is clickable to get a brief description of the variable name.

Figure 3. Screenshot of the configuration window.

In the window shown below (Figure 4), we have added an additional simulation with a more unstable air aloft and have added a wildfire plume to rise in the profile.

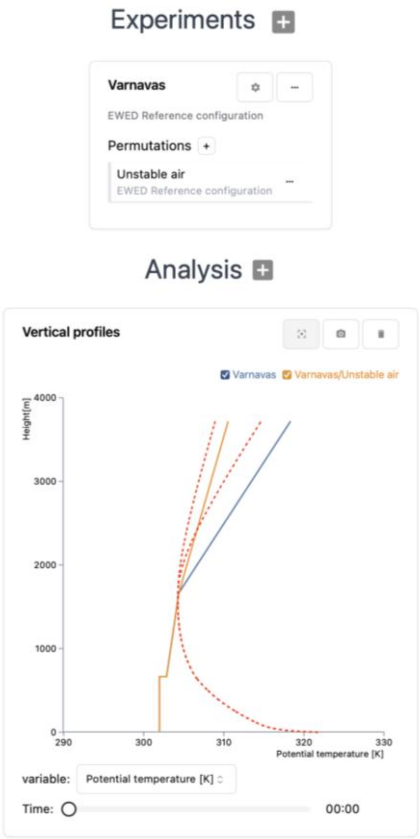

Figure 4. A variation on the run and the addition of a wildfire plume

The figure shows two cases, the original Varnavas fire case (blue line), and an additional case in which the atmosphere is made more unstable. More unstable means that the potential temperature of the atmosphere is increasing less fast with height, allowing a buoyant parcel to rise to greater depth. In this simulation, the model was run with a rather intense fire, and therefore for both simulations the fire plume (dashed red) hits the model top.

In the final stage of the project, the integration of the EWED Data Portal and the modelling tool will be fully completed, to enable plotting of soundings from the portal on top of the model output. The infrastructure is already in place for the plotting (Figure 5), but the coupling to the data portal is ongoing while observational fire plume data is being added to the data portal. At completion of Deliverable 3.3, the user will be able to launch cases directly from the data portal.

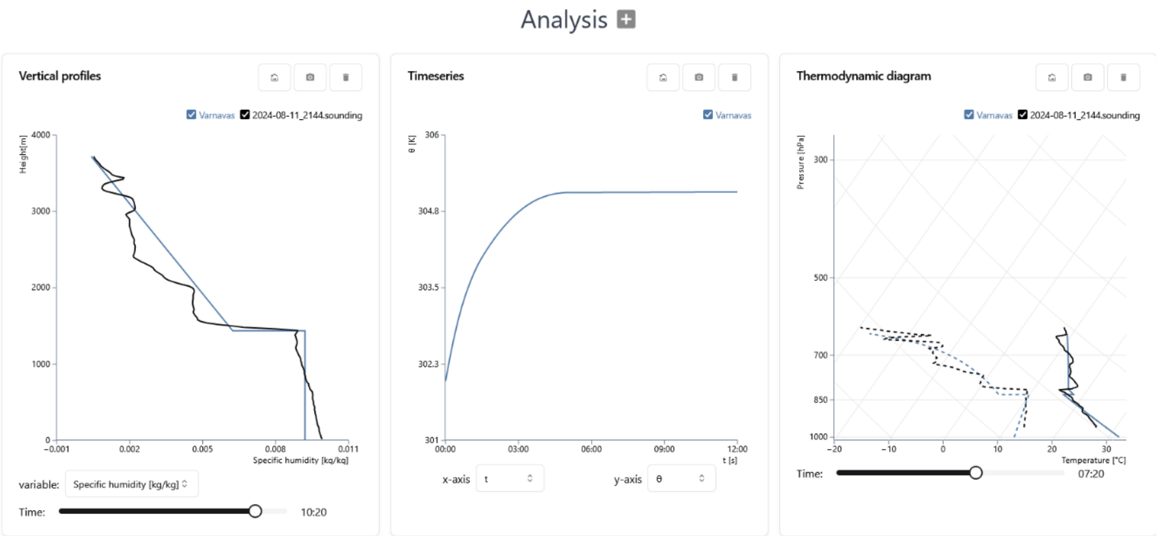

Figure 5. Plotting model output and soundings from the EWED data portal together.

4. Conclusions

The explanation above has shown that we have achieved the goals of the deliverable: a web-based version of CLASS with the extension of a wildfire plume model. This version will be continuously updated until the end of the project based on user experiences, with the focus of optimizing the use for fire analysts.

5. References

[1] Van Heerwaarden, C.C., Vilà-Guerau de Arellano, J., Gounou, A., Guichard, F. and Couvreux, F., 2010. Understanding the daily cycle of evapotranspiration: A method to quantify the influence of forcings and feedbacks. *Journal of Hydrometeorology*, *11*(6), pp.1405-1422REF 2

[2] Vilà-Guerau de Arellano, J., van Heerwaarden, C.C., van Stratum, B.J. and van den Dries, K., 2015. *Atmospheric boundary layer: Integrating air chemistry and land interactions*. Cambridge University Press.

[3] van Stratum, B.J.H., van Heerwaarden, C.C. and Vilà-Guerau de Arellano, J., 2023. The Benefits and Challenges of Downscaling a Global Reanalysis With Doubly-Periodic Large-Eddy Simulations. *Journal of Advances in Modeling Earth Systems*, *15*(10), p.e2023MS003750.