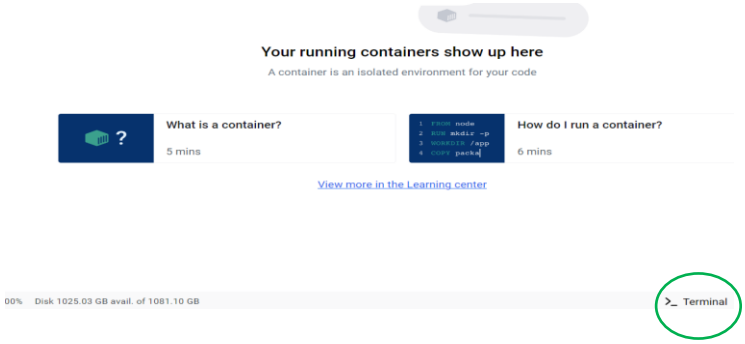
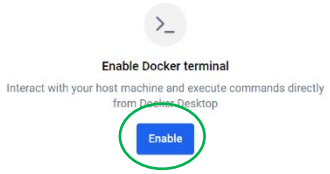
To use EaSiCroM on your PC, follow the procedure outlined below:

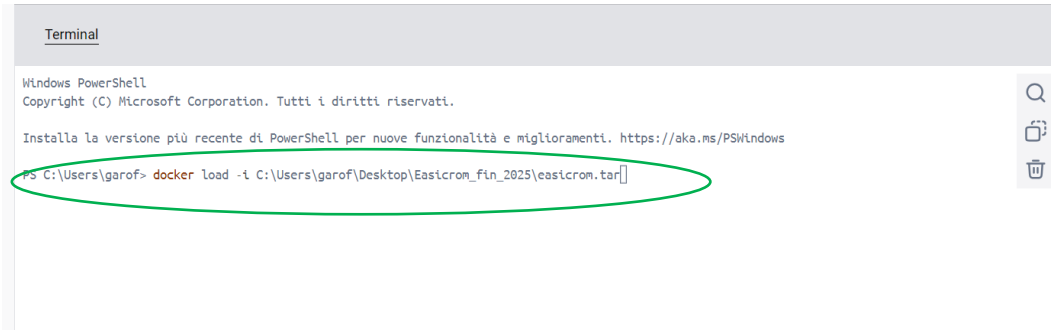
- Download the Docker platform from the following website: https://www.docker.com/products/docker-desktop/ and select the appropriate version from the dropdown menu;
- Download EasiCroM (easicrom.tar) from: https://drive.google.com/drive/folders/1E0Fq5Hk_4u0xaCV1ilXixGHEfSvWL4aK?usp=sharing
- Open Docker Desktop;
- Open the terminal as in Figure (green circle)



- Select enable



- Run the command: "docker load -i <container_path>" replacing <container_path> with the path where EasiCroM was downloaded.



- Press Enter;
- Go to the sidebar in the top left and click "Images";
- Click the "Run" button under "Actions";
- Expand "Optional settings";
- Choose the container name (e.g., EasiCroM);
- Set "5000" as the Host Port;
- Click "Run";
- To run the application, click the Start button in Containers page and then 5000:5000 button under Port(s) once Docker Desktop is open. Alternatively, open a browser tab and enter the address localhost:5000. However, it is recommended to open it via Docker Desktop to speed up the execution of simulations.

- EasiCroM is now ready to run!

Table 1. List of acronyms and their meanings

Acronyms	Meaning of acronyms	Units	*note*
Wat_depl	Lower threshold of plant-available water in the soil to trigger irrigation.	Dimensionless	It is used when the irrigation strategy is based on the soil water content available to the crop (at Root_dph)
Wil_pt	Soil wilting point	Vol (%)	
FC	Soil field capacity	Vol (%)	
Soil_dph	Soil depth	m	
REW	Soil readily evaporable water	mm	
n	Parameter used to control soil evaporation	Dimensionless	A lower value corresponds to reduced soil water loss through evaporation
fk	Evaporation decline factor	Dimensionless	The higher this value, the lower the water loss through evaporation as the soil moisture content decreases.
kc	Crop coefficient for evapotranspiration	Dimensionless	
WP	Water Productivity	kg of dry biomass per mm of water transpired	
f(cover)	Solar radiation extinction coefficient	Dimensionless	
Base_temp	Base temperature of the crop	°C	
Opt_temp	Optimal temperature for crop growth	°C	
Max_crit_Temp	Maximum temperature for crop growth	°C	
LAI_MAX	Maximum Leaf Area Index	$m^2\ m^{-2}$	
Time_LAI_MAX	Time to reach LAI_Max	Growing degree days (GDD; °C)	
Time_End_LAI	Time required to complete the canopy development	Growing degree days (GDD; °C)	
Root_dph	Maximum root depth	m	
Root_win	Initial soil water content at Root_dph	Vol (%)	
Harvest index	Ratio of yield to total biomass	Dimensionless	
Yield_WC	Water content of the yield	%	
Wat_stress_coeff	Coefficient modulating the crop's resistance to water stress	Dimensionless	The higher this value, the greater the impact of water stress on the crop.
RUE	Radiation use efficiency	g of dry biomass per MJ of intercepted solar radiation per m^2	
Wat_consumption_thrs	Threshold for crop water consumption above which irrigation is triggered	mm	It is used when the irrigation strategy is based on the crop's water consumption
V_CO2_max	Maximum rate of CO_2 assimilation by the crop	$\mu mol\ CO_2\ m^{-2}\ s^{-1}$	

KM_const	Michaelis-Menten constant	ppm	
CO2_ref	Reference CO_2 concentration	ppm	
CO2_Cli_change	Climate change CO_2 concentration	ppm	
T_Crit_Yield	Temperature for daily yield reduction	°C	
T_Extr_Yield	Temperature for no yield daily production	°C	
T_yield_imp	Impact factor of high temperatures	Dimensionless	
OUTPUT			
f(Tlim)	Temperature stress on crop growth	Dimensionless	The higher the value, the lower the impact of temperature stress
GDD_cum	Cumulative Growing Degree Days (GDD) for the crop	°C	
f(Wat_str)	Water stress on crop growth	Dimensionless	The higher the value, the lower the impact of water stress
CC_act	Actual canopy cover	Dimensionless	
TDM_cum_CO2	Cumulated total dry biomass adjusted by CO_2 concentration	kg ha^{-1}	
Dry_yield_cum	Cumulated dry yield adjusted by temperature	kg ha^{-1}	
f(Tlim_yield)	Temperature stress on crop growth	Dimensionless	The higher the value, the lower the impact of water stress
Drainage	Water loss by drainage	mm	
Available Water Content	Soil available water at Root_dph	mm	
Water_dem (mm)	Water requirement to reach FC at Root_dph with irrigation	mm	
Tr_act	Actual transpiration	mm	
Ev_act	Actual evaporation	mm	
Etc_act	Actual evapotranspiration	mm	

EaSiCroM functionality

EaSiCroM allows for the simulation of one or more crops simultaneously by selecting either the "Single crop simulation" or "Multiple simulations" option from the main menu ***(The calendar data must be in the yyyy-mm-dd format. Otherwise, the simulations will not be executed)***.

Note! *The input values should fall within a range specified by EaSiCrom in case the user enters values considered out of scale. However, the user can still "force" the simulation by keeping the values they deem most appropriate, even if they fall outside the recommended range.*

In the first case (use the folder **Single_run** as example), it is possible to calibrate a specific crop based on the user's requirements. The user must then set the various parameters (by clicking on the

question mark, the meaning and unit of measurement of each parameter will be displayed) related to soil, crop, and any parameters related to climate change (by setting equal reference atmospheric CO_2 values and actual/forecasted values, there will be no effect on crop behavior due to variations in CO_2). Three types of irrigation strategies can be chosen, as well as the start and end dates of the simulation (if the end date is not set, EaSiCroM will terminate the simulation at physiological maturity).

The user must upload the weather file (in .csv format) following this priority: Date; Tmin (°); Tmax (°C); Precipitation (mm); Wind (m/s); Rg (Global radiation; MJ/m2); RHmin (Relative Humidity; %); RHmax (%); ET0 (mm). The date must be set in the following format yyyy-mm-dd (see sample files provided). The user may also not have ET0 or other meteorological variables. In this case, EaSiCroM will automatically calculate ET0 based on the provided meteorological data (Blaney-Criddle; Pristley-Taylor; Penman–Monteith). If the crop season spans two years, a single weather file containing data for both agricultural years should be uploaded.

For irrigation, the user can choose to trigger water application (through irrigation) whenever the soil water content reaches a specific threshold, which the user specifies in the soil parameters under "Wat_depl"; the higher the value, the more frequent the irrigation events will be triggered, but with smaller volumes, and vice versa (for example, with a value of 0.9, EasiCroM will trigger irrigation when the available soil water content drops to 90%).

Alternatively, the "Water consumption" option can be selected, based on a threshold of water lost from the crop system (in mm), which the user must indicate in the crop parameters under "Wat_consumption_thrs". Alternatively, by selecting the "By user" option, the user must upload a .csv file, specifying the dates and the amount of irrigation water (Date; Irrigation) provided to the crop (see sample file). In the case of a rainfed crop, the user only needs to create an irrigation file with a single date and an irrigation value of 0.

If the user has measured values for vegetation cover (fraction 0-1), Leaf Area Index (LAI, m^2/m^2), or Total Available Water (TAW, mm), they can upload a .csv file under the "Insert CSV for forcing (optional)" section with the values they have for vegetation cover (FC), LAI, and TAW (see sample file). In this case, EaSiCroM will modify the simulation in real-time based on the data provided by the user.

Note! *During the canopy decline phase (defined by the user based on the parameter LAI_MAX and Time_LAI_MAX), if an "excessively" higher value of CC than the simulated data is set (forcing of CC), EaSiCroM may return a CC value for the following day that is inconsistent with the provided forcing data. In this case, it is preferable to use LAI data as forcing or alternatively a slightly lower CC value and verify whether the CC simulation is consistent. Alternatively, the active growth phase of the crop can be extended by acting on LAI_MAX and Time_LAI_MAX (therefore forcing CC) for better consistency between what is observed in the field and what is simulated by EaSiCoM.*

Multiple simulations.

Through the "Multiple simulation runs" screen (use the folder **Multiple run**) as example, it is possible to simulate monocultures, rotations, and multiple simulations on different fields simultaneously. To do this, you need to use a file to be entered under the "Soil parameters" section, which includes, in addition to the soil characteristics, identifying IDs (e.g., 1, 2, 3, etc.). In the case of identical soils, always assign different IDs, but keep the characteristics unchanged. For the files to be inserted under the "Crop parameters" section, the same ID used for the fields should be entered. For monocultures, assign different IDs (corresponding to the fields), but keep the crop parameters unchanged.

For weather variables, load the entire folder containing the weather files under the "weather files" section. The weather files must be named with the same ID as those for the soil and crops. In the case of monoculture, each weather ID corresponds to the agricultural year.

For irrigation, it is selected based on what is indicated in the "irrigation_strategy" column of the crops file. When selecting "Water consumption," irrigation will start whenever the water consumed by the cropping system reaches the threshold in mm indicated in the "Wat_consumption_thrs" column of the crop file. Alternatively, when selecting "Water depletion," irrigation will start when the soil water content threshold indicated in the "Wat_depl" column of the soils file reaches that value.

Even in the case of multiple simulations, the user can force the LAI, fC, and TAW with observed values by specifying the ID used for the soils, crops, and weather (e.g., 1, 2, 3) in the ID column of the forcing file, along with the dates to which these values refer.

! *Note**: The harvest date and thus the crop cycle length in the seasonal outputs of the multiple runs refer to the last day provided in the weather file. In the daily output file, however, it is possible to identify the actual length of the crop cycle, which ends with yield maturity (i.e., grain or fruit).***

Real time simulation.

The real-time simulation (use the folder **Real time simulations** as example) enables precision irrigation based on the differential crop response within the same cultivated plot and is included under the "Insert forcing file (optional)" section. Specifically, the user must upload a crop file (representing a single crop), select an irrigation strategy, and provide an ID file that identifies the hypothetical number of heterogeneous subplots within the field (even though the soil characteristics correspond to a single soil type).

This ID file links to the forcing file, which includes dates and observed values for that specific ID. For instance, the user may have a uniform soil but experience differing crop growth between two

hypothetical subplots. In this case, the user uploads an ID file with entries for IDs 1 and 2, and for each ID, dates and observations for parameters such as LAI, fC, or TAW.

Since these are real-time simulations, the user must upload daily updated weather data (or even longer-term forecasts). In this way, EaSiCroM provides irrigation recommendations based on the weather file for the specific day, or the user can download a file via the "download results" option, which provides irrigation recommendations for past days.

Additionally, the user has the option to set a threshold (threshold for daily irrigation intervention in mm), below which EaSiCroM will not trigger irrigation. This is particularly useful when irrigation is applied via a pivot system, where the user may prefer not to irrigate just one plot but instead waits for both plots to require irrigation simultaneously.

Furthermore, if the irrigation recommendation coincides with the last day in the weather file, EaSiCroM will prompt in the next simulation to confirm whether irrigation was carried out. If the answer is no, the irrigation amount that was not applied on that day will be added to the irrigation requirement for the following day.

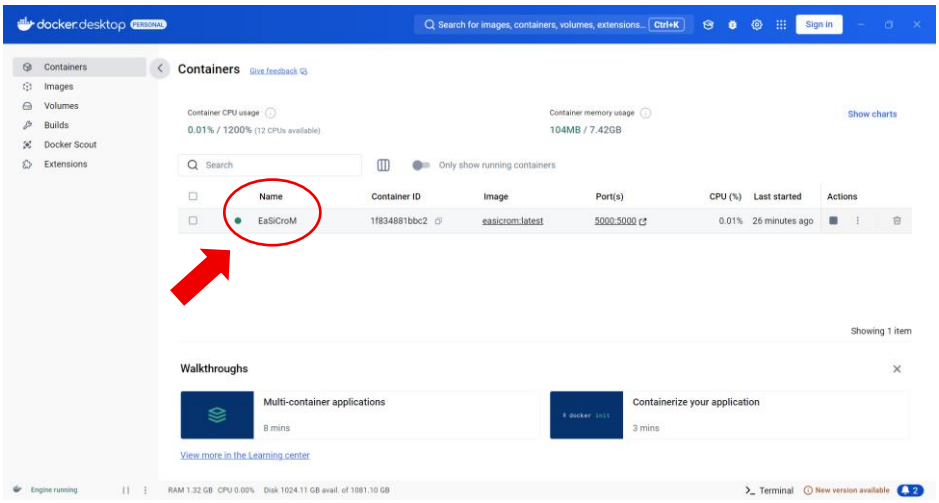
In practice, the user starts the simulation today using the weather data for tomorrow. If EaSiCroM predicts irrigation, after the simulation, a window will appear indicating the volume to be applied to each plot (if it exceeds the minimum threshold previously set). Then, the user uploads a new weather file with the forecast data for the following day to repeat the same simulation procedure.

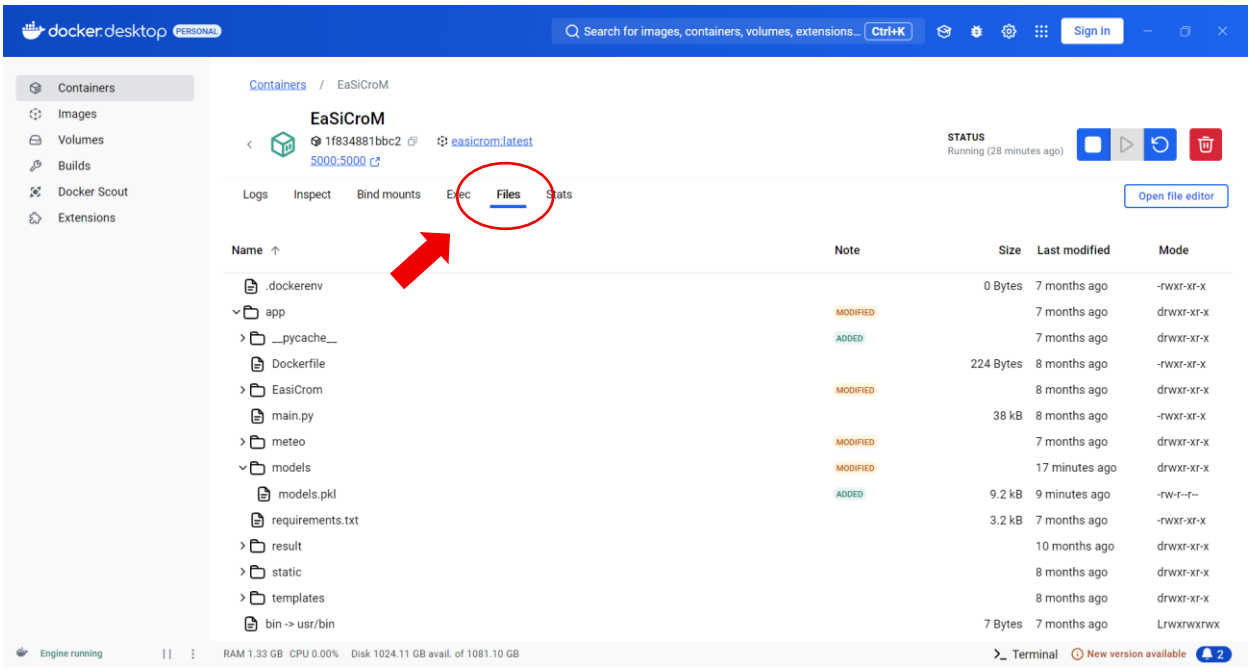
If the simulation extends beyond a specific day in which one or more subplots require irrigation, EaSiCroM assumes that the irrigation for that day has been carried out by the user.

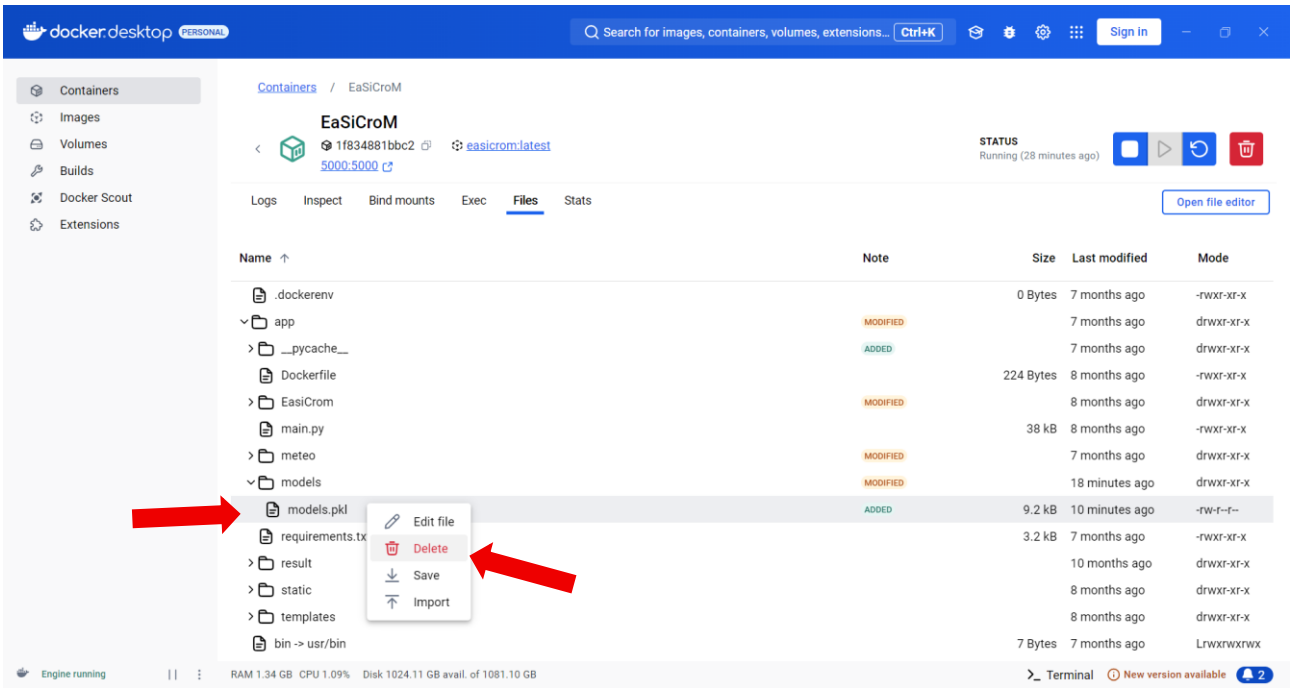
The results of EaSiCroM, both for individual IDs and summarized, can be downloaded via the "Download results" option.

Users can refer to example files, such as those found in the "real-time simulations" folder, to better understand how this feature works.

! Important note. *It may happen that the real-time simulation generates corrupted, non-functional files causing the inability to properly execute the simulations (after the progress, no information about irrigation appears). In this case, open the Docker containers, click on Easicrom, then files, and finally delete the file models.pkl and restart everything (see below).*


docker desktop PERSONAL
Search for images, containers, volumes, extensions... Ctrl+K
Sign in
Containers
Images
Volumes
Builds
Docker Scout
Extensions
Containers
Give feedback
Container CPU usage
0.01% / 1200% (12 CPUs available)
Container memory usage
104MB / 7.42GB
Show charts
Search
Only show running containers
Name
Container ID
Image
Port(s)
CPU (%)
Last started
Actions
EaSiCroM
1f834881bbc2
easicrom:latest
5000:5000
0.01%
26 minutes ago
Showing 1 item
Walkthroughs
Multi-container applications
8 mins
Containerize your application
3 mins
View more in the Learning center
Engine running
RAM 1.32 GB CPU 0.00% Disk 1024.11 GB avail. of 1081.10 GB
Terminal
New version available
2


docker desktop PERSONAL
Search for images, containers, volumes, extensions... Ctrl+K
Sign in
Containers
Images
Volumes
Builds
Docker Scout
Extensions
Containers / EaSiCroM
EaSiCroM
1f834881bbc2
easicrom:latest
5000:5000
STATUS
Running (28 minutes ago)
Logs
Inspect
Bind mounts
Exec
Files
Stats
Open file editor
Name
Note
Size
Last modified
Mode
.dockerenv 0 Bytes 7 months ago -rwxr-xr-x
app MODIFIED 7 months ago drwxr-xr-x
__pycache__ ADDED 7 months ago drwxr-xr-x
Dockerfile 224 Bytes 8 months ago -rwxr-xr-x
EasiCrom MODIFIED 8 months ago drwxr-xr-x
main.py 38 kB 8 months ago -rwxr-xr-x
meteo MODIFIED 7 months ago drwxr-xr-x
models MODIFIED 17 minutes ago drwxr-xr-x
models.pkl ADDED 9.2 kB 9 minutes ago -rw-r--r--
requirements.txt 3.2 kB 7 months ago -rwxr-xr-x
result 10 months ago drwxr-xr-x
static 8 months ago drwxr-xr-x
templates 8 months ago drwxr-xr-x
bin -> usr/bin 7 Bytes 7 months ago Lrwxrwxrwx
Engine running
RAM 1.33 GB CPU 0.00% Disk 1024.11 GB avail. of 1081.10 GB
Terminal
New version available
2



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