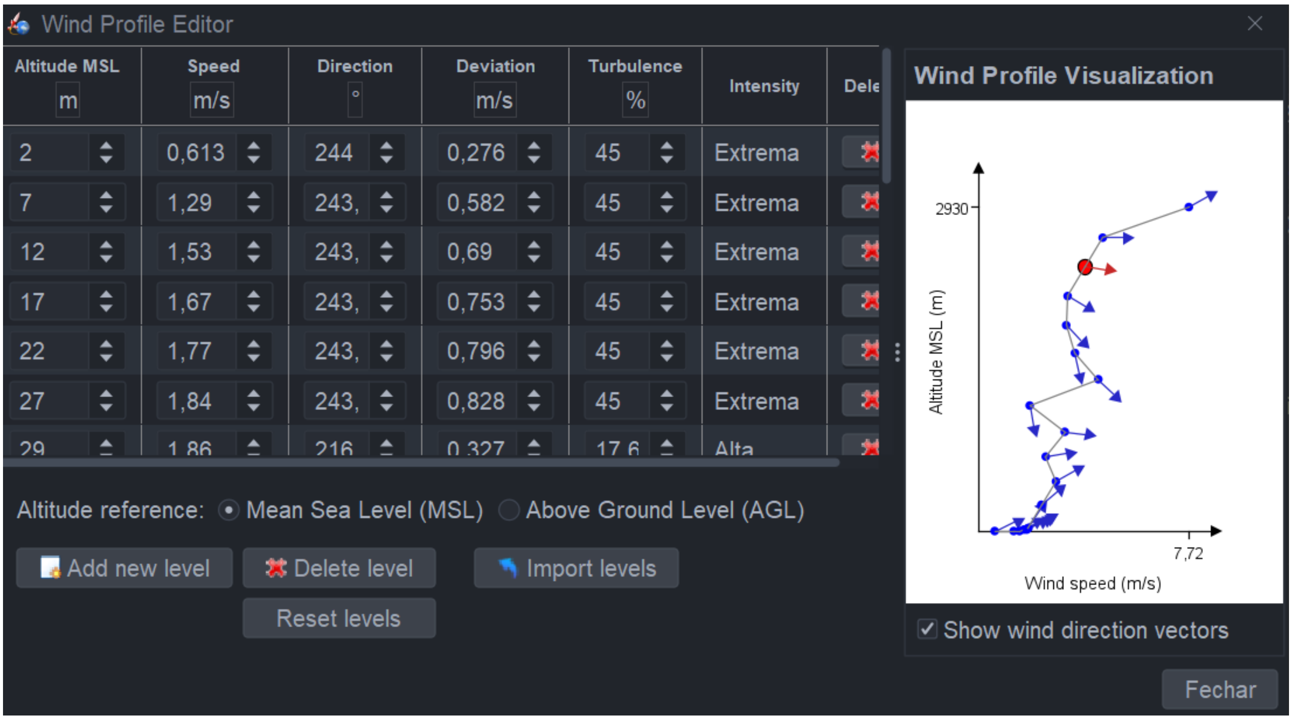

OpenWind

Tool Operation Tutorial

OpenWind

Real Atmospheric Wind Profiles for OpenRocket Simulation

GFS · NOAA   Open-Meteo   OpenRocket-Ready   MOST + Ekman

Introduction — Why Simulate Wind?

Simulating a rocket with careful geometry, a calibrated motor, and verified stability is only half the work. The **atmospheric environment** in which the rocket will fly is equally decisive — and ignoring it is one of the most common sources of error in simulations.

The **wind** is the primary factor of **lateral drift** during flight — especially in the first seconds, when the rocket's speed is still low and the restoring angular momentum is small. A simplified or invented wind profile can completely distort the prediction of the landing point, the effective stability margin, and the launch safety ellipse.

In practice, **wind at 10 m above ground can be 3× lower** than at 500 m — and the **direction can rotate 20° to 40°** between the surface and apogee. This happens because the atmospheric boundary layer is highly stratified: terrain roughness, temperature, solar radiation, and Earth's rotation create vertical gradients that no single value can capture.

How OpenRocket configures wind by default:

- **Average speed**: a single constant value for all altitudes — unrealistic
- **Turbulence / Standard deviation**: single parameter — does not vary with altitude
- **Direction**: fixed for the entire flight — ignores the Ekman spiral and baroclinic turning
- **Temperature and Pressure**: ISA standard values (15°C, 1013 hPa) — may differ by up to 20 hPa from the actual site

OpenWind solves all these problems at once. It queries real global numerical weather prediction (NWP) data — the same data used by professional meteorological services — and automatically generates a CSV file with the complete wind profile, layer by layer, ready to be imported into OpenRocket. With just a few clicks, users replace generic assumptions with real physical data for their launch site and time.

What Do You Gain by Using OpenWind?

Landing accuracy: the real profile reduces the prediction error of the impact zone.

Stability margin: gusts and shear affect the angle of attack — critical for rockets with a low CP-CG margin

Range safety: simulating with a realistic profile defines the impact ellipse with much greater confidence for perimeter delimitation

Real Temperature and Pressure: OpenWind provides these values for configuring the atmosphere in OpenRocket, improving speed and altitude prediction

How to Access OpenWind

OpenWind is available for free at osifog.com.br. Follow the steps:

1. Go to osifog.com.br
2. Click **"Simulators"** in the navigation menu
3. In the **"BIRST Simulators"** section, click the card or button **"Open simulator"** below OpenWind
4. On the simulators page, click the **"OpenWind"** tab (Simulator 02) at the top of the page
5. OpenWind interface will be displayed with the tabs: **📖 About · ⚙ Configure · 📄 CSV · 🌡 Atmosphere · 🚀 OpenRocket**

Before You Start — Get Coordinates in Google Earth

To generate a wind profile with OpenWind, you will need to provide the **latitude, longitude, and altitude of the launch site**. The most accurate and reliable place to get this information is **Google Earth Web**.

Accessing and Creating a Project on Google Earth Web

Go to earth.google.com in your browser.

- Click the ☰ **Menu** icon (three lines, top-left corner) → **"Projects"**
- **Click "New project"** → **"Create project in Google Drive"** or **"Create local project"**
- Name the project: for example, **"Launch Field 2025"**

Adding a Marker at the Launch Site

- With the project open, click **"New element"** → **"Add marker"**
- Click on the map at the exact launch point
- Give it a name, such as **"Launch Pad"**, and click **"Save"**

Getting Latitude and Longitude

- Right-**click** on the exact point on the map
- **Click "What's here?"**
- A panel will appear at the bottom of the screen with the coordinates in **decimal format**
- Example: **-21.783000, -46.566000**. Copy carefully (use a period as the decimal separator)

> 📌 **Coordinate Format**
> **Latitude:** positive = North, negative = South | Example: -21.783000
> **Longitude:** positive = East, negative = West | Example: -46.566000

Getting Absolute Altitude

The altitude used by OpenWind is the **MSL altitude — above mean sea level**, not relative to the ground. To get it accurately:

- Right-click on the saved placemark → "Properties"
- In the **"Altitude"** tab, select the mode **"Absolute"** (instead of 'Relative to ground')
- The value shown in meters is the MSL altitude of the site. Note it down

> ⚠ **Why Absolute Altitude?**
>
> OpenWind uses the MSL altitude (above mean sea level) to query the correct atmospheric data for the corresponding troposphere layer at the site. If you use altitude relative to the ground (always 0 m at the launch point), pressure and temperature data will be incorrect.

How OpenWind Works — Data Pipeline

OpenWind combines two global numerical weather prediction (NWP) sources with its own atmospheric boundary layer model. Understanding this pipeline helps you use the tool with more confidence.

Atmospheric Data Sources

Source	Coverage	Characteristics
GFS — NOAA	Today + up to 15 days	Global spectral model, ~13 km grid, 127 vertical levels, updated 4×/day. For future forecasts.
Historical Forecast	From 2022 to present	GFS/ECMWF-ERA5 reanalysis, 1-hour temporal resolution. For past dates.
Boundary Layer Synthesis (OpenWind)	0 – 500 m AGL	Custom model: MOST + Power Law + Ekman Spiral. Fills low-altitude levels with real physics.

The Boundary Layer Model — Why It Matters

Global NWP models (such as GFS and ERA5) provide relatively coarse vertical resolution in the atmospheric layer where wind shear is often strongest, namely between 0 and 500 m AGL. The lowest available level is typically around 10 m above ground level or higher, and the vertical spacing between levels is irregular and comparatively large.

OpenWind fills this gap with three chained physical models:

- **MOST — Monin-Obukhov Similarity Theory**: calculates the wind speed profile in the surface layer (0–200 m AGL) accounting for atmospheric stability, terrain roughness, and Obukhov length
- **Power Law**: extends the profile above the surface layer, with an exponent dependent on the stability class
- **Ekman Spiral:** Models the gradual rotation of wind direction with increasing altitude, caused by the Coriolis force. Near the surface, wind direction can differ by as much as **40°** from the geostrophic wind direction.

Pasquill-Gifford Stability Classification

Boundary layer stability determines how wind changes with altitude. OpenWind calculates it automatically from the local solar time and reference wind speed:

Cl.	Condition	Obukhov Length (m)	Typical Turbulence
A	Day, < 2 m/s — very unstable	−10	High (strong convection)
B	Day, 2–3 m/s — unstable	−25	High–Medium
C	Day, 3–5 m/s — slightly unstable	−80	Medium
D	Strong wind — neutral	±∞	Low (neutral)
E	Night, 2–4 m/s — slightly stable	+100	Low
F	Night, < 2 m/s — very stable	+30	Very low

Practical Interpretation

A daytime launch with light wind (< 2 m/s) will be Class A: very steep wind gradient and intense turbulence. A launch with moderate wind (3–5 m/s) will be Class C: smoothed gradient. This directly affects how much the rocket will drift in the first 100 m of flight.

Structure of the Generated CSV File

OpenWind generates a file called OpenWind_File.csv with the following structure:

Column	Unit	Description
altitude	m AGL	Altitude above ground. AGL (Above Ground Level) reference
speed	m/s	Wind speed at that level
direction	°	Direction de onde o wind vem (0° = Norte, 90° = Leste)
stddev	m/s	Standard deviation of speed (estimated turbulence)

[SYNTHESIZED] Lines in the CSV

Lines marked with [SYNTHESIZED PG:X] are generated by the OpenWind boundary layer model (MOST + power law + Ekman), not directly from NWP data. They represent the low-altitude levels where global models have insufficient resolution. For recreational rockets (< 3 km apogee) they are physically and statistically realistic.

Step 1 ⚙ Access OpenWind and Configure the Parameters

On the OpenWind page at osifog.com.br/simulador-osifog.html, click the ⚙ **Configure**.

Configuration Parameters

Fill in the following fields:

Field	Example	Notes
Latitude (°)	-21.783000	South = negative. Obtained from Google Earth
Longitude (°)	-46.566000	West = negative. Obtained from Google Earth
Terrain altitude (m MSL)	1180	Absolute altitude. Obtained from Google Earth ('Absolute' mode)
Launch date	2025-11-15	Planned launch date
UTC Time	15:00	Time in UTC — subtract 3h from Brasília time (BRT)
Terrain type	Open Field	Affects the roughness (z_0) used in the MOST model
Maximum altitude AGL (m)	3000	Upper limit of the profile. The height at which OpenWind stops processing data. Use the expected apogee altitude.

Converting BRT to UTC

Brasília (BRT) = UTC − 3. If the launch is at 12:00 BRT, enter 15:00 UTC.

Terrain Types Available

The terrain type defines the roughness length (z_0) used in the MOST model. Choose the one closest to the actual site conditions:

Type	z_0 (m)	Examples de uso
Sea / Open water	0.0002	Launches near lakes, reservoirs, or coastline
Open Field	0.03	Pastures, grasslands, open launch fields
Terrain with trees	0.10	Forest edges, fields with sparse tree cover
Low urban area	0.50	Suburbs, areas with houses and small buildings

Automatically Selected Source

OpenWind automatically selects the data source (GFS forecast or Historical Forecast reanalysis) based on the entered date. For future or present dates it uses the GFS (forecast). For past dates since 2022 it uses Historical Forecast (reanalysis). The selected source is shown in the interface before generating the CSV.

Step 2 📄 Generate the Wind Profile CSV File

With all fields filled in the ⚙ **Configure** tab, click the **"Generate csv file"**. OpenWind will:

- Query the Open-Meteo API with the provided parameters
- Download the NWP data (GFS or Historical Forecast) for the specified site and time
- Apply the boundary layer model (MOST, power law, Ekman) for low-altitude levels
- Assemble and make available for downloading the file **OpenWind_File.csv**

📋 Checking the CSV — 📄 CSV Tab

Click the 📄 **CSV** tab to see a preview of the generated file before downloading.
Check: **number of observed levels** (NWP) and **synthesized levels** (boundary layer).
Typical: 10–15 obs + 15–25 synth.

Checking Atmosphere Data — 🌡 Atmosphere Tab

Click the 🌡 **Atmosphere** tab. This tab displays the temperature, pressure, humidity, and air density data calculated for the launch site. **These values do NOT go into the CSV file** — they are used separately to configure the atmosphere in OpenRocket.

Data	Unit	Where to configure in OpenRocket
Temperature (2 m)	°C	Edit › Simulation options › Launch conditions › Atmosphere → Temperature
Base pressure	hPa	Edit › Simulation options › Launch conditions › Atmosphere → Pressure
Relative humidity	%	Informational — not separately configurable in OpenRocket
Air density (ρ)	kg/m³	Calculated automatically from T and P — use as a reference

📥 Downloading the file

After reviewing the preview, click **"Generate csv file"** (available in the ⚙ Configure tab or in the 📄 CSV tab preview) to download the file **OpenWind_File.csv** to your computer.

Step 3 🚀 Import the Wind Profile into OpenRocket

With the **OpenWind_File.csv** file on your computer, open OpenRocket and follow the steps in the 🚀 **OpenRocket** tab in OpenWind for reference:

Step 3.1 — Open the Simulation Edit Window

- No OpenRocket window, click the **"Simulations"** (or **"Flight Simulations"**)
- Select the desired simulation and click **"Edit Simulation"** (or **"Edit Simulation"**)
- The edit window will open with the tabs: **Launch conditions · Simulation options**

Step 3.2 — Configure the Custom Wind Profile

- In the edit window, click the **"Simulation options"**
- Locate the **"Wind"**
- In the wind mode selector, switch from "Average Wind" to "Custom Wind" (or "Multilevel Wind").
- Click **"Import CSV"**
- Select the file **OpenWind_File.csv** that you downloaded

Step 3.3 — Configure the CSV Import Dialog

A CSV configuration dialog will appear. Configure it EXACTLY as follows:

⚙ CSV Import Dialog Configuration in OpenRocket

- **CSV file has a header row: ✓ CHECKED**
- **Field Separator: , (comma)**
- **Altitude → Column: "altitude" | Unit: m**
- **Speed → Column: "speed" | Unit: m/s**
- **Direction → Column: "direction" | Unit: ° (degrees)**
- **Std Dev → Column: "stddev" | Unit: m/s**

⚠ CRITICAL — Altitude Reference: ABOVE GROUND LEVEL (AGL) ← DO NOT USE MSL HERE.

⚠ Why AGL for the altitude reference?

The OpenWind CSV file uses altitudes in meters AGL (above ground level), not MSL. If you leave the reference as MSL (above mean sea level), OpenRocket will interpret the data incorrectly and the wind profile will be applied at the wrong flight altitudes.

Step 3.4 — Confirm and Verify

- After configuring the dialog, click **"OK"** or **"Confirm"**
- OpenRocket will display the loaded wind levels in a table or chart in the Wind section
- Check that the speed and direction values make sense for the launch site and time
- The levels should range from 0 m to the maximum altitude defined in OpenWind

Step 4 🌡 Configure the Atmosphere in OpenRocket

In addition to the wind profile, OpenWind provides in the 🌡 **Atmosphere** tab the values of **temperature** and **pressure** for the launch site. These values must be manually entered in OpenRocket to complete the real atmospheric configuration.

Still in the **"Edit Simulation"** window, click the **"Launch conditions"**:

Configuring Latitude, Longitude, and Site Altitude

- Under **"Launch site"**, fill in the fields:
  - **Latitude:** decimal value of the launch site (e.g., -21.783000)
  - **Longitude:** decimal value of the launch site (e.g., -46.566000)
  - **Altitude:** MSL altitude of the site in meters (e.g., 1180 m)

Configuring Temperature and Pressure — Atmosphere Section

- Locate the **"Atmosphere"** (or **"Atmospheric conditions"**)
- Click **"Custom atmosphere"** or enable manual editing of the fields
- **Temperature:** Enter the temperature from the **Atmosphere** tab in OpenWind (in **°C**).
- **Pressure:** Enter the pressure from the **Atmosphere** tab in OpenWind (in **hPa** or **mbar**).

> 💡 **ISA vs. Real — Why Does It Matter?**
>
> **ISA Standard:** 15°C and 1013.25 hPa at sea level. OpenRocket automatically adjusts these values to the launch site's altitude, but it does so using the ISA atmospheric model, which may differ from the actual atmospheric pressure by as much as 20 hPa.
>
> **With OpenWind:** you enter the real pressure measured by the NWP model for that site, altitude, and time. This improves the calculated air density, directly affecting local sonic speed and drag.

Configuring Launch Direction and Angle

- Still under **"Launch conditions"**, configure:
  - Uncheck **"Always launch directly upward"** to unlock the direction and angle fields
  - **"Launch rod direction"**: launch direction in degrees (0° = North, 90° = East)
  - **"Launch rod angle"**: rod angle in degrees from vertical (0° = vertical)

> 🧭 **Launch Direction × Wind Direction**
>
> **Remember that in OpenRocket, 0° = North and 90° = East—the same convention used by OpenWind for wind direction. Wind direction values in the CSV indicate the direction from which the wind originates. For example, if the wind direction is 270° (West), the wind is blowing toward the East.**

Step 5 ▶ Run the Simulation and Check the Results

With the wind profile and atmosphere configured, run the simulation:

- Click **"Simulate & Plot"**
- Wait for the simulation to complete
- Observe the altitude vs. time chart and compare it with previous simulations without a real wind profile

What to Check in the Results

- The **apogee** should not change drastically — wind affects lateral drift, not maximum altitude significantly
- The **landing point** (position East/North of launch) will differ from versions with constant wind, especially on days with wind shear
- Check the peak wind speed: the actual wind profile may reveal strong wind layers or gusts at specific altitudes that a constant wind value would not capture.
- •Export the data including "Position East of Launch" and "Position North of Launch" to calculate the landing dispersion ellipse (impact ellipse).

> **Use Together with OpenEarth**
> After running the simulation with OpenWind's real wind profile, export the CSV with the four variables (Time, Altitude, Position East, Position North) and generate the KML file in OpenEarth. This way you will see the 3D trajectory in Google Earth already accounting for the drift caused by real wind.

Done!

Following these steps, your OpenRocket simulation will use real atmospheric and wind data, layer by layer, for your launch site and time. The simulation stops being generic and starts reflecting the real physical environment — making predictions of landing point, stability margin, and safety ellipse much more reliable.

Questions: osifog.com.br · Instagram: @osifog.oficial