I would like to congratulate to the authors for this work that contributes with data analsysis for plume analsysis in real time in real scenarios for decision-making support.

The article proposes a sounding methodology to characterize fire plumes during wildfire events. Although it does not provide a detailed protocol, it clearly emphasizes the importance of in-situ data collection using a feasible and affordable approach to better understand and assess plume behavior and atmospheric dynamics during a fire. I find this work highly valuable, as fire analyses are often based solely on forecast data. This study offers a practical method for estimating fire plume dynamics in areas where radar systems are prohibitively expensive. Additionally, the real-time data collection and analysis performed during the fire enhance its value for emergency management, moving beyond the traditional post-event analysis approach.

The article presents very useful information and includes clear application examples. It is well-written and well-structured. However, readers should be familiar with fire and atmospheric terminology, and ideally be up to date with the current state of research on fire plume dynamics and fire typologies.

The article outlines a method for obtaining atmospheric soundings from an ongoing fire, including measurements not only of the ambient atmosphere but also of the head, flank, and rear of the fire. While the work does not go into detail about the balloon sounding launch procedure or the success rate—points also raised by an anonymous reviewer-it focuses on the sounding data collected from different locations and their use for analyzing plume state and potential, which is useful for operational decision-making.

The authors acknowledge the limitations of their approach and provide recommendations for how to work with the data presented.

This article makes an important contribution to operational practices and this research field by characterizing fire plumes and assess transitions between different fire plume behaviors.

I would recommend to the authors to apply at least minor comments when they apply.

> *We would like to thank the reviewer for taking the time to review the paper and for providing valuable comments that have helped us clarify and improve the proposed methodology and its explanation.*

The article focuses on integrating sounding data to characterize fire plumes, as stated in the title, and the content aligns well with this aim. The authors address the inherent uncertainty in the sounding data, particularly due to the balloons moving within the plume's indraft and temperature peaks, which affects the success rate of non-ambient soundings. However, there is no quantitative assessment of the uncertainty for each variable derived from the sounding methodology, nor an analysis of how sensitive the plume top estimation is to those uncertainties—beyond potential temperature and rising speed. I understand this could be the focus of a separate study, which would require a large number of soundings and additional instruments for validation in different contexts with prescibed fires. Still, the article highlights the importance of potential temperature and vertical velocity as key factors in plume-top estimation, with other variables being more relevant when using the parcel method for potential plume-top prediction.

In the revised version, as commented on with the first anonymous review, we have added the following information.

1.-Quantification of the Uncertainty of plume top height. The uncertainty has been estimated using the radar data. It shows that there is an average error of 166.8 m

2. Quantifying the uncertainty of the variables measured under ambient conditions by the descending sondes has been achieved by comparing ascending and descending data. This comparison justifies the use of the descending profile as ambient data, if necessary, to complement the characterization of the thermodynamic profiles.

In section 4.2, we have already discussed the fact that sondes represent a single trajectory inside the plume. Compared with radar readings, the sondes may not penetrate the most active buoyant cores. However, they are definitely transported within the plume. Therefore, they are able to detect and estimate the plume top (compared with radar) and the average rising speed.

To improve the assessment of the uncertainty of the sondes and the trajectory, radar measures will be required to obtain a continuum of the plume. As stated by the reviewer, such a work will be completely new research, not in the scope of this paper. We have a plan to do it in the future.

In the current manuscript, we have focused on providing a methodology to characterize in situ the plume thermodynamic variables. In doing so, we are able to determine the pyroconvection transition potential using easy-to-operate sondes in the fire environment without the need to deploy in the field for special teams. We demonstrate that such measures do provide an increase in awareness and capacity to provide accurate information for decision-making.

Despite the limitations on uncertainties in the plume top and lack of capacity to capture the highest vertical velocities at the plume core, our methodology demonstrates that by accounting for the indraft where the sonde is launched, we obtain data accurate enough to capture the plume top. This information is added to a classification of the pyroconvection prototype and its potential transition during the fire operations. Moreover, it has now been used to constrain and evaluate the results of fire plume models to advance our understanding of the interactions between environmental conditions and the rise of the fire plume.

To include this information on the uncertainty of our observations gathered by the sounding system, we will complement this in the revised version of the paper with supplementary material. In this SI, we analyze the observations of sondes launched simultaneously. In studying several collocate and simultaneous soundings, we are able to compare the accuracy of different trajectories and the robustness of our thermodynamic profiles.

New Complementary material:

S7.-Uncertainty assessment for the radiosonding system

We assessed the uncertainty in our radiosonde data by analyzing measurements taken from radiosondes launched simultaneously from the same location. Our analysis included five ambient soundings and three in-plume sondes. We calculated the mean and standard deviation of these measurements to better understand the potential variations during the ascent of the sondes. This approach allows us to quantify deviations that could impact our results.

For all the variables calculated, the uncertainty observed is low (Table S7.1). The large uncertainties are primarily found at the top of the atmospheric boundary layer (ABL). Here *we find variations that range from 200 to 300 meters (Figures S7.2 and S7.3). This level of uncertainty is typical, as both the ABL and plume top are not constant and tend to fluctuate in the entrainment zone, which can be characterized with air masses with three different thermodynamic characteristics: fire plume, ABL ambient, and free tropospheric air. The uncertainty analysis enables us to contextualize the information obtained, suggesting a buffer of 200-300 meters in the estimation of the plume top when assessing the potential for pyroconvection transitions.*

Table S7.1. *Uncertainty of radiosonde trajectory for ambient and in-plume measures for the variables used in the radiosounding methodology. The variables acronyms are Tpv as virtual potential temperature, RH as relative humidity, WS as wind speed, WD as wind direction and in the case of in-plume sondes we add vertical velocity. Ambient uncertainty has been obtained by ambient sondes on the 9th-08-2025, launching five consecutive sondes between 16:03 and 16:11 UTC, at 46º 03 45.44'' N and 0º 40' 22.54''E (Spain). The in-plume sondes are obtained for three sondes launched during the Casablanca fire the 08-02-2023 in Chile (See Figure 11) between 21:46 and 21:51 UTC from the same spot.*

	T (C) σ	*RH (%) σ*	*WS ($m\cdot s^{-1}$) σ*	*WD (º) σ*	*Vertical velocity ($m\cdot s^{-1}$) σ*
Ambient	*0.204*	*0.818*	*1.08*	*12.16*	
In-plume	*0.379*	*0.425*	*1.119*	*20.924*	*0.416*

1.- Uncertainty in measuring ambient conditions

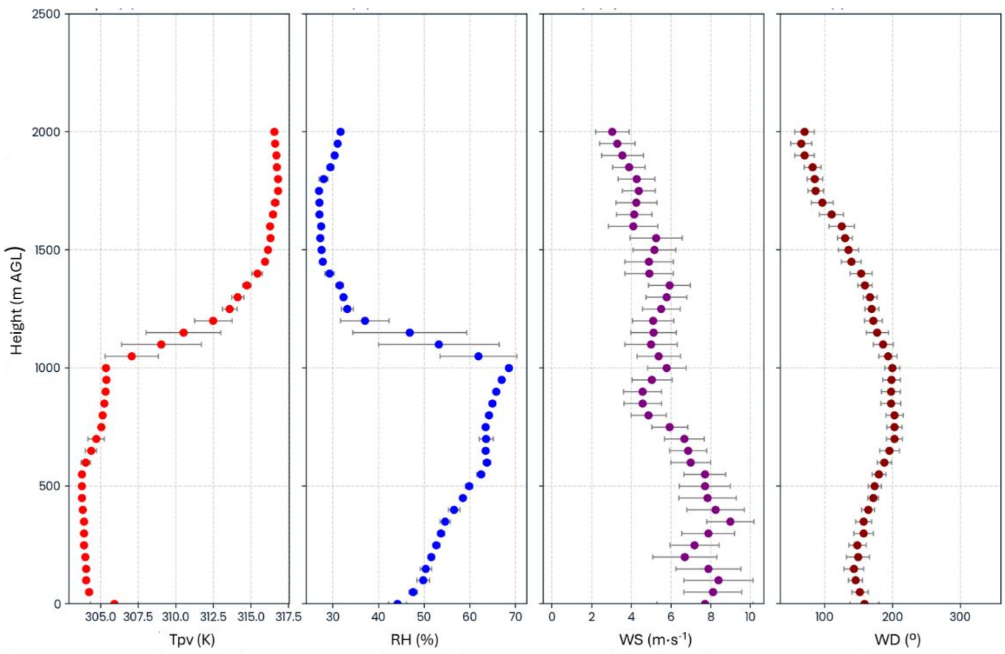

Figure S7.1.- *Profiles of the main variables that characterize the ambient conditions: virtual potential temperature (Tpv), relative humidity (RH), wind speed (WS), and wind direction (WD). The profile shows the mean ensemble average based on five soundings (and the standard deviations). The five soundings were launched between 16:03 and 16:11 UTC. The uncertainty is quantified by the standard deviation of the mean at every 50 m of altitude.*

2.- Uncertainty in measuring in-plume conditions

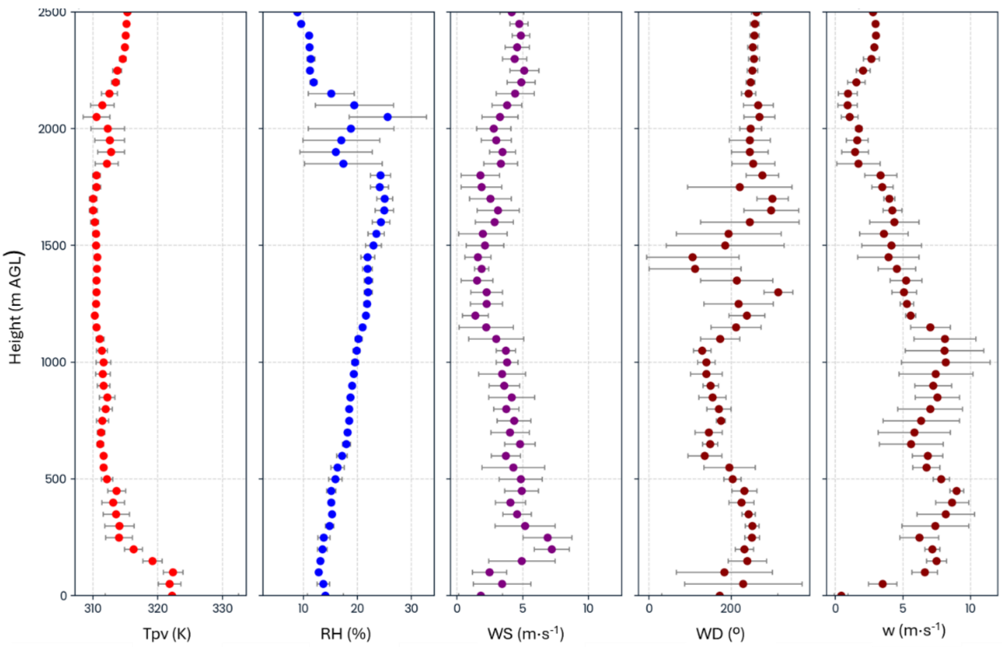

Figure S7.2.- Profiles of the main variables that characterize the in-plume conditions: virtual potential temperature (Tpv), relative humidity (RH), wind speed (WS), and wind direction (WD), and vertical velocity (w). The profile shows the mean ensemble average based on five soundings (and the standard deviations). The three soundings were launched between 21:46 and 21:51 UTC in the Casablanca fire (Chile) (see Figure 11). The uncertainty is quantified by the standard deviation of the mean at every 50 m of altitude.

Minor Comments:

Update model name and cite missing reference: MESO-NH/Forefire – Jean-Baptiste Filippi.

Thanks for detecting it. Done. We added the next cite:

Filippi, J. B., Mari, C., & Bosseur, F. (2013, July). Multi-scale simulation of a very large fire incident. Computation from the combustion to the atmospheric meso-scale. In 4th Fire Behavior and Fuels Conference.

There is no need to justify the balloon radiosounding method beyond its affordability and operational simplicity. Other technologies like high-altitude atmospheric balloons, Doppler radar, UAVs, and helicopter-mounted sensors are capable of real-time data collection as well.

Table 1 may be unnecessary, but I understand that in real-world field campaigns, time constraints, costs, and complexity support the value of the information presented.

We acknowledge that other methods can collect data in real time. However, they have logistical challenges, as highlighted in Table 1, or fail to accurately identify the plume top, such as with helicopter-mounted sensors or UAVs. Among the options, radar and balloons are the most effective systems. Additionally, small balloons are the only ones permitted to operate in a fire environment.

We believe that these issues warrant discussion, as in some campaigns, the use of UAVs or balloons has been prohibited during the daytime due to aerial firefighting operations. While radars are a comprehensive solution for data gathering, they are expensive, challenging for *regular firefighters to operate, and difficult to transport and install near a rapidly advancing fire front, which presents safety challenges.*

Considering everything, we believe it is important to explain why small balloon soundings are preferred over other technologies. This is a fundamental aspect that justifies our methodology.

It would be helpful to use a consistent temperature unit throughout the article.

"S parcel increase by3°C" → should be "S parcel increases by 3°C" (missing space and verb correction).

We addressed the issue.

"estimating the dilution plume height, is adequate" → remove the comma: "estimating the dilution plume height is adequate."

We addressed the issue.

In Section 3.3.3, regarding the Casablanca III fire in Chile: it states the fire grew to 12,073 ha between February 8–10, 2023, but also says it had already blown up on February 2, reaching 363,000 ha. Including fire spread metrics would help readers better understand the relationship between plume dynamics and fire spread behavior.

Sorry, the text was not clear enough. We referred to that after the chaotic situation on the 2nd when fires burn 362.000 ha, then between the 8th and the 10th the Casablanca fire grew up to 12703 ha. We intended to show how, amid extreme and huge extreme wildfire conditions, the proposed methodology can still work properly.

We addressed the issue .

Old text:

'A set of updrafts and ambient pairs of sondes were launched at the Casablanca III fire in Chile (Figures 11 and 12). The fire grew up to 12073 ha between the 8th and 10th of February 2023. The situation in Chile was dramatic after the fires blew-up on February 2, resulting in over 362.000 ha burned'.

New text:

'A series of updrafts and ambient pairs of sondes were launched at the Casablanca III fire in Chile (see Figures 11 and 12). The situation in Chile became dramatic after the fires intensified on February 2, resulting in over 362,000 hectares burned. Additionally, a new fire grew to 12073 hectares between February 8 and February 10, 2023'.

"Fire behavior was initially expected to calm in the early evening, but there was a 60% chance of intensification during the day-to-night transition due to the advection of drier air from the SW" — I assume this is for context, and the 60% probability comes from a weather forecast ensemble.

Thanks for highlighting this not enough clarified issue. The affirmation is based on the forecasted chances of the event for that day. That forecast is managed by the planning section in the Incident Command system and passed down to the units.

New text:

‘Fire behavior was initially expected to become less active in the early evening. However, the combined assessment of various weather forecasts indicated a 60% chance of intensification during the transition from day to night. This potential increase in fire activity is due to the movement of drier air from the southwest into the area.