Review of Laly et al. (2024)

The manuscript provides a thorough technical overview of the WaLiNeAs lidar campaign, with particular emphasis on the French team's contributions. The paper successfully covers key aspects of instrumentation, data processing, and the broader scientific implications of water vapor measurements. The methodology for measuring and validating water vapor profiles is clearly laid out, and the detailed calibration procedures add credibility to the data, making the study robust and reliable.

Overall, this paper represents a significant contribution to atmospheric science, particularly in demonstrating the use of lidar data in operational weather forecasting and climate research. I recommend publication after addressing the following minor revisions.

General Areas for Improvement:

- While the technical aspects are thoroughly addressed, a stronger emphasis on the broader implications of the data for climate science and weather forecasting would enrich the paper. Connecting the results more explicitly to their potential impact could enhance the manuscript's significance.
- The detailed discussion of calibration and instrumentation, though important, somewhat overshadows the practical outcomes related to weather events, which are the primary goal of the study. A more balanced focus would improve clarity.

Specific Comments:

Abstract:

- **Line 12**: The two main objectives stated in the abstract have been adressed, however with varying degrees of completition. The first one ("Investigating the water vapor content during heavy precipitation events (HPEs) in the Western Mediterranean coastal regions") has been fully addressed, while the second ("Assessing the impact of high spatio-temporal WVMR data on numerical weather prediction forecasts using assimilation techniques") is partially achieved, with further work on data assimilation still pending. While the paper discusses the potential for these high-resolution datasets to be assimilated into models like AROME to improve weather forecasts (line 79), it does not yet include a completed analysis of this assimilation's impact. The authors emphasize that the lidar data fills critical observational gaps, particularly in the lower troposphere, and mention plans for further assimilation work. However, they don't present results demonstrating the improved prediction accuracy within this paper.

- **Line 15**: The claim of being the first program in Europe to provide network-like, simultaneous, and continuous water vapor profile measurements should be reconsidered. Existing networks like PollyXTNet, EARLINET, and RAMSES have similar capabilities. Please consult these references:
  - *Engelmann, R., Kanitz, T., Baars, H., Heese, B., Althausen, D., Skupin, A., Wandinger, U., Komppula, M., Stachlewska, I. S., Amiridis, V., Marinou, E., Mattis, I., Linné, H., and Ansmann, A.: The automated multiwavelength Raman polarization and water-vapor lidar PollyXT: the neXT generation, Atmos. Meas. Tech., 9, 1767–1784, doi:10.5194/amt-9-1767-2016, 2016.*
  - *Bösenberg, J., Matthias, V. et al. EARLINET: A European Aerosol Research Lidar Network to Establish an Aerosol Climatology. MPI Report No. 348. 2003*
  - *Reichardt, J., Wandinger, U., Klein, V., Mattis, I., Hilber, B., and Begbie, R.: RAMSES: German Meteorological Service autonomous Raman lidar for water vapor, temperature, aerosol, and cloud measurements, Appl. Optics, 51, 8111–8131, doi:10.1364/AO.51.008111, 2012.*

  And other examples from specific campaings and sites:
  - *A. Ansmann et al. Combined Raman elastic-backscatter LIDAR for vertical profiling of moisture, aerosol extinction, backscatter, and LIDAR ratio. Appl. Phys. B Lasers Opt., 55, 18–28, 1992.*
  - *Stachlewska, I.S., Costa-Surós, M. and Althausen, D.: Raman lidar water vapor profiling over Warsaw, Poland. Atmos. Res., 194, 258–267, https://doi.org/10.1016/j.atmosres.2017.05.004, 2017.*
  - *Foth, A., Baars, H., Di Girolamo, P., and Pospichal, B.: Water vapour profiles from Raman lidar automatically calibrated by microwave radiometer data during HOPE, Atmos. Chem. Phys., 15, 7753–7763, doi:10.5194/acp-15-7753-2015, 2015.*
- **Line 18**: Although the paper mentions continuous monitoring for three months, the three lidar instruments did not operate simultaneously during this entire period. Please clarify this aspect.

Introduction:

- **Line 36**: Clarify the sentence regarding “humid air masses from the Saharan regions over the Mediterranean Sea.” It seems the authors intend to convey that air masses become humid as they traverse the Mediterranean Sea, rather than originating as humid over the Sahara.
- **Line 42**: Rephrase to avoid confusion: "leading to an increase in water vapor content up to 5 km in the free troposphere" could be improved by citing Chazette et al. (2016), which suggests the moistening occurs progressively up to 5 km.
- **Line 64**: The lidar calibration at the Météo-France site in Toulouse occurred after the campaign, which raises questions about timing. Was there a reason this validation was not conducted before the campaign, and how did this sequencing affect the results?
- **Line 68**: Harmonize the references to the AERIS database across the manuscript and ensure that the access date is provided for both links.

Section 2. The ground-based experiment:

- **Line 91**: While discussing the Raman lidar sites, mention that they provide continuous, high-resolution water vapor profiles at specific, localized points, and cannot capture broader spatial variations.
- **Figure 2**: Enlarge and change the colors of the labels (“a, b, c, d”) for better visibility.
- **Figure 3**: Including a photo of the WALI instrument would enhance reader comprehension, alongside the existing truck station image.
- **Line 175-176**: Elaborate on how acquiring both N_2-Raman and H_2O-Raman channels for each telescope improves the signal-to-noise ratio, as this is a critical point.
- **Line 178**: Specify if the lidar is operational during precipitation events, and discuss any limitations.
- **Line 179**: Explain how the sky background can affect signal acquisition and potentially degrade measurement quality.
- **Line 194-195**: For better readability, move the sentence "Table 2 provides an overview of the system’s key characteristics for each lidar" to the end of the paragraph.
- **Table 2**: Define the acronym “(AC)” in the last row for clarity.

- **Figure 4**: Include additional explanation in the text about "3ω" and "2ω" and the "seeder input", as well as the implications of WALI's unique configuration with the rotational and vibrational Raman Polychromator.
- **Line 217**: Consider adding "on-site" after "manually" for better clarity.
- **Figure 6**: Several concerns arise:
    - The blank spaces for HORUS-2 from 5/11/22 to 12/01/23 should be marked as "no data" and highlighted in red for consistency.
    - Standardize the timeline format—either daily or monthly—for both periods of the campaign (Oct22-Jan23 and May23-Sept2).
    - If you choose the daily basis, I would make the squares smaller, so the timeline fits in a small space (ideally in one-line timeline) for a better readability (e.g. consider naming the days only with a number instead of the full date to make the squares smaller and in the interest of clarity).
    - In case you choose to show the month name, use abbreviations "Jan." and "Dec." instead of "janv." and "déc".

Section 3. Methodology:

- **Line 243**: There is inconsistency regarding the native time resolution (1 minute (Table2) vs. 50 seconds (line 243). Ensure this is harmonized across the manuscript (also in Fig. 9 it is said "approximately 1 min").
- **Line 244**: Clarify whether the lidar acquires range-corrected Raman signals or if this is done post-processing.
- **Equation 1**: please add the definition for $O_i(z)$ in the text.
- **Equations 4 to 11**: Use consistent nomenclature for the water vapor channel throughout the manuscript, e.g., "H_2O" in Equation 4 vs. "H" in later equations.
- **Equation 6**: Please consider adding more information and development on how you came up with equation 6 from equations 1 and 2.
- **Line 275-288**: Include more information about the refractor telescope used in WALI.
- **Line 300**: Provide more details on ε_m and ε_a to aid reader understanding.

Section 4. Results:

- **Lines 335-336**: Clarify how the calibration between a ground site station and a lidar measurement at 200 m a.g.l. is performed. Why was radiosonde (lines 421-423) data not used for calibration, given the vertical profile data they provide? Is the 45 km distance the limiting factor?
- **Line 346-347**: Please elaborate more the sentence "This shows that therefore, the cross-calibration method is relevant".
- **Fig. 8:** There is no reference in the manuscript to the "Periods used for calibration" mentioned in Fig. 8.
- **Figure 8**: The phrase "correspond to each other" is unclear. Please rephrase to clarify the meaning.
- **Fig. 8 caption**: In the text it is used the acronym "RMSD" instead of "RMS deviation".
- **Line 366**: I guess the authors mean to refer to Figs. 10a and 10b instead of 11a and 11b.
- **Line 396**: typo in the word "conside" should read "consider".
- **Lines 426-428 and line 434**: please clarify if you are describing "mean differences" or mean "RMSD".
- **Line 428**: Soften the statement "This can be explained by..." to "This could be explained by..." since this has not been definitively proven.
- **Line 433**: what was the effect of the radiosounding drifting in these measurements?
- **Table 4**: is there a typo in the flollowing WALI ranges?
    - 2nd and 3rd row: Nightime – Short noise ~ 0.1- 0.3 g/kg (5-10 km) → the upper level from 2-5km is 0.05 g/kg
    - 5th row: Nightime – Total ~ 0.05 g/ kg (2-5km) → Is the upper limit "0.1 g/kg" missing?

Section 5. Data format and quality flag:

- **Table 5**: Provide more information regarding the "file_version" in the dataset name format.