# TEMPERATURE VARIABILITY ASSESSMENT AT VINEYARD SCALE: CONTROL OF DATA ACCURACY AND DATA PROCESSING PROTOCOL

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**Abstract:**

**Context and purpose of the study -** Climatic variability studies at fine scale have been developed in recent years with the reduction of material cost and the development of competitive miniaturized sensors. This work is forming part the LIFE-ADVICLIM project, of which one of the objectives is to model spatial temperature variability at vineyard scale. In the Bordeaux pilot site, a large network of data loggers has been set up to record temperature close to the vine canopy. The reduced distance between plant foliage and measurement equipment raises specific issues and leads to an increased rate of outliers compared to data retrieved from classical weather stations. Some of these were detected during data analysis, but others could not be easily identified. The present study aims to address the issue of data quality control and provide recommendations for data processing in climatic studies at fine scale.

**Material and methods -** Temperature variability at vineyard scale was assessed from a network of 90 temperature stations set up in Saint-Emilion, Pomerol, and their satellite appellations. In order to test the accuracy of the measurement, 2 temperature sensors T1 and T2 (Tinytag talk 2, Gemini UK) have been connected to each temperature station and programmed to record hourly minimum and maximum temperature. The accuracy given by the constructor for this material is 0.4°C. The difference between the 2 sensors for each temperature station was analyzed during the 2017 campaign and compared. A classical meteorological station installed in Saint-Emilion (Meteo France) provided the information on climatic condition in the pilot site. A temperature station was also set up next to this meteorological station to assess both the impact of canopy and the type of material on temperature. Raw temperature data and bioclimatic indices like Winkler index were analyzed.

**Results -** Differences exceeding material accuracy have been detected over the whole network for several locations and dates. Average of differences is higher for maximum temperature than minimum when the whole year is taken into account. Differences can change Winkler index up to 106 degree.days for the same temperature station. Seasonal effect was observed for minimum and maximum temperature with higher differences between T1 and T2 during the winter.

Significant difference on maximum temperature was observed between data from the classical meteorological station and temperature recorded by the neighboring data logger installed in the canopy. Temperature recorded by temperature station is 1 to 4 °C warmer because the solar shield is less ventilated. A seasonal effect was observed, with higher difference recorded during the summer, which induced significant differences between calculated degree days. To eliminate confusion between degree days recorded by these 2 systems, a "Canopy Winkler Index" was created for the Winkler Index constructed with the temperature station, located inside the canopy.

Careful data processing is needed to obtain accurate temperatures from miniaturized temperature station located inside the canopy. Installation of 2 sensors for each temperature station is recommended to control and detect outliers. An automatic data processing system is under development to detect and replace outliers.

**Keywords**: Fine scale – Temperature variability – Temperature stations – Data accuracy - Data processing – Vineyards

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## 1. Introduction

# Temperature variability assessment at vineyard scale: control of data accuracy and data processing protocol

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## Introduction and objectives

This work is part the LIFE-ADVICLIM project, of which one of the objectives is to model spatial temperature variability at vineyard scale (Quénol & al, 2014). In the Bordeaux pilot site, a large network of miniaturized temperature stations has been set up close to the vine canopy. The reduced distance between plant foliage and measurement equipment lead to an increased rate of outliers compared to data retrieved from classical weather stations. Some of these were detected during data processing, but others could not be easily identified. The present study aims to address the issue of data quality control and provide recommendations for data processing in climatic studies at fine scale.

## Materials and methods

**90 temperature stations** were set up in Saint-Emilion, Pomerol, and their satellites appellations (Figure 1).
2 sensors were connected to each temperature station and placed in solar radiation shield to record daily **minimum (Tn) and maximum (Tx) temperature.**

The accuracy of the temperature sensors **(Tinytag talk 2, Gemini UK)** given by the constructor is **0.4°C by sensor** (Figure 2).

**For each of 90 miniaturized temperature station:**  **2 temperature sensors:** S1 S2 → **There is a problem with at least one of the sensors if S1 – S2 > 0.8°C (absolute value)**

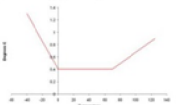

Figure 2: Temperature sensors accuracy (Source: Data sheet Tinytag Talk 2)

Differences (S1 –S2) in each temperature station were analyzed during the **2017 campaign.**

Impacts of the type of material and location inside the canopy on temperature were also assessed by comparing a temperature station installed next to a classical **weather station** installed in Saint-Emilion (Meteo-France).

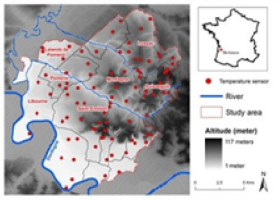


Figure 1: Localization of temperature sensors in Pomerol/St-Emilion pilote site

## Temperature data accuracy at fine scale

**1** **Raw database was processed by deleting detected outliers (Figure 3 and 4).**

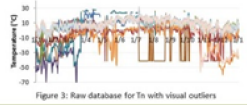

Figure 3: Raw database for Tn with visual outliers

**Data processing (delete visual outliers)** → **7% of data were deleted** on Tx and on Tn.

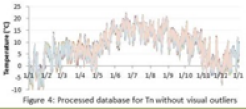

Figure 4: Processed database for Tn without visual outliers

**2** **Non detected outliers were then analysed from the remaining database by analysing differences between temperature sensors S1 and S2 for each temperature stations (Figure 5):**

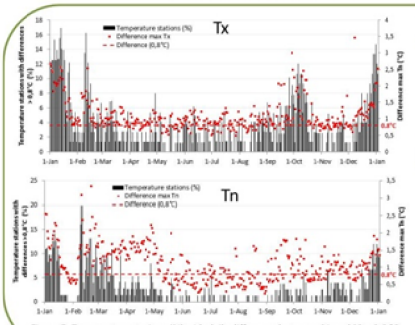


Figure 5: Temperature stations (%) with daily difference between S1 and S2 > 0.8 °C and maximal difference (°C) in 2017

**Differences (> 0.8°C between S1 and S2) in 2017:**

Temperature stations recording at least one day with difference: **70% (Tx and Tn)**
Maximum of non detected difference: **3.5°C (Tx), 3.3°C (Tn)**
Average of temperature station with difference per days: **4 % (Tx), 2% (Tn)**
Maximum temperature stations during one day with difference: **17 % (Tx), 20% (Tn)**

→ **Differences have been detected, up to 3.5°C. Tx record more differences than Tn**

**Seasonnal effect:**

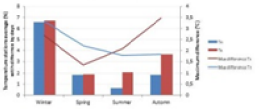

Figure 6: Seasonality differences

→ **Differences are more frequent and higher during winter**

**Impact on Canopy Winkler index:**

Average difference: **25 degree.days**
Maximum difference: **106 degree.days**
Temperature stations recording differences **higher than 50 degree.days: 12%**

→ **Differences did not impact significantly Canopy Winkler index**

## Comparison between temperature data recorded by miniaturized temperature station and classical weather station

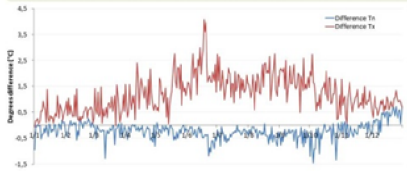

Figure 7: Temperature difference between temperature station in canopy and classical meteorological station (°C) in 2018

Maximum temperature recorded by Tinytag is **1 to 4 °C warmer** because the solar shield is less ventilated (de Resseguier, 2018).

A seasonal effect was observed, with **greater difference recorded during the summer** (Figure 7).

Winkler Index recorded by Tinytag is **100 degree.days warmer** (Figure 8).

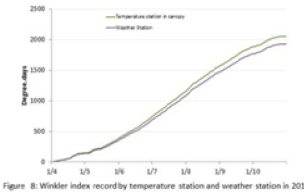

Figure 8: Winkler index record by temperature station and weather station in 2018

→ To eliminate confusion between degree.days recorded by these 2 systems, the Winkler Index constructed with miniaturized temperature stations will be called **"Canopy Winkler index"**

## Conclusion

- **Outliers have been detected** in processed database
- Relatively minor effect on bioclimatic indices
- **Duplicating sensors** for each temperature station improves data accuracy
- **Precautions** must be taken to interpret these data compared to classical weather station
- When Winkler index is constructed with data from miniaturized temperature stations, it is referred to **"Canopy Winkler index"**

## References

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