Office of Institutional Research and Social Responsibility, NTU
International Degree Program in Climate Change and Sustainable Development, NTU
Research Center for Future Earth, NTU

NEWSLETTER
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SC+NTU

Shiuh-Shen, Chien. Jen-Ping, Chen. Ling-Jyh, Chen. Jehn-Yih, Juang. Ming-Kung, Chung.Yi-Huan, Hsieh. Po-Hsiung, Lin.
SC+NTU Work Team

The comfort level of classrooms has always been a concern for the SC+ team. Factors such as temperature, humidity, and CO2 levels in learning spaces can affect the comfort of both teachers and students, which in turn may impact teaching quality and learning performance. Through the use of the team's MAPS6 indoor sensors for actual measurements and continuous evolution in data analysis, the overarching goal is to improve classroom comfort and provide a conducive environment for teaching and learning.

This issue of the newsletter will cover the development process of automating the analysis of indoor comfort and a temperature measurement project in the newly established Classroom 102. By integrating questionnaire data and indoor sensor data through an automated workflow, the analysis speed is accelerated. In the Comfort+Common Sense section, we will review a contemporary article on the impact of weather on retailers.

Monthly Activities Summary

04/06

Taipei City Environmental Education Group Activity I

Led by the Taipei City Environmental Education Group, the team ventured into the Maokong Hiking Trail in the suburban area of Taipei City. Carrying the portable version of MAPS, they started monitoring PM2.5 levels along the route from the Taipei Zoo Station. Dr. Zhong Ming-guang and the SC+ team carefully explained the implementation and measurement methods of the MAPS sensor, and the participants had the opportunity to operate the portable monitoring device themselves. It was also observed that the air quality in the Maokong area was excellent, making it a suitable environment for people to be outdoors and enjoying nature.

04/13

Taipei City Environmental Education Group Activity II

For the second week of the Environmental Education Co-learning Group, the team ventured into the suburban area of Taipei City to explore the Zhangshan Temple Trail. In addition to measuring PM2.5 levels along the route, the team went a step further and calculated the carbon footprint of their journey together with the group members. With a focus on individual calculations, the carbon footprint of transportation and travel throughout the journey was assessed. The participants quickly realized that taking public transportation can effectively reduce their personal carbon footprint.

04/18

Patent Approval Received

The Environmental Comfort Sensing Management System has gone through a long process of handling and review, and finally, we have received good news. The Patent Office has officially issued a notification that the patent has been approved. We hope that this patent can further advance environmental research and development.

Achievements and Announcements

Automated Indoor Comfort Analysis

SC+ Work Team and Department of Geography Tzu-Ya, Wang

Explanation of the current progress of automated indoor comfort analysis: Figure 1 illustrates the development process of automation. We have completed the integration of data, data organization, and webpage design. The following sections will provide a detailed description of the development process.

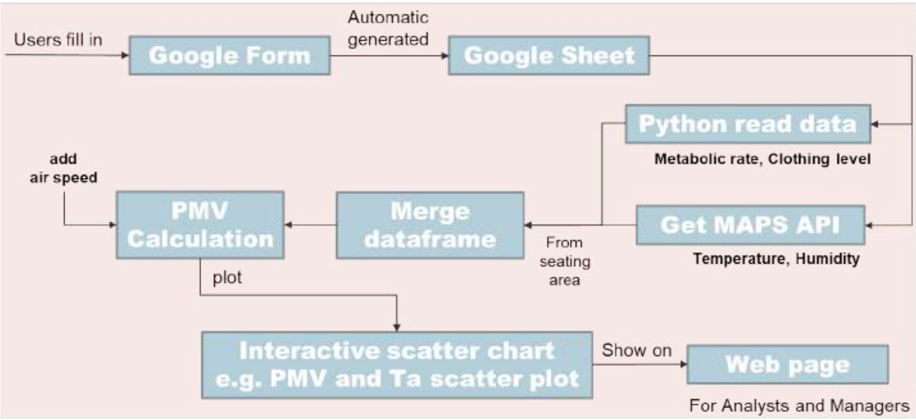

Figure 1: Automated Development Process for Indoor Comfort

The automation process starts with obtaining the questionnaire responses collected via a Google Form. When using Google Forms, the responses automatically generate a corresponding Google Sheet. The primary goal is to access the data from the Google Sheet using the Google Sheets API. After obtaining the questionnaire responses, data from the MAPS (indoor sensors) is also required. Currently, the connection is established for three specific dates when the questionnaires were distributed: 3/25, 4/1, and 4/26. The ultimate purpose of data processing is to obtain the necessary parameters, which include individual clothing and activity levels, as well as area temperature and relative humidity. These parameters are used to calculate the Personalized Thermal Comfort (PMV) index. However, this process involves several steps, such as standardizing time format (averaging over 5 minutes), converting clothing and activity levels, and temperature calibration, among others. Finally, the data from both sources are merged based on seat number and timestamp. The pythermalcomfort library is utilized to calculate the PMV. This describes the automated process for analyzing comfort data.

Next, the web page is primarily designed for researchers, aiming to help them browse and observe data in real time. The entire web page is built using the Streamlit package in Python. Streamlit is a package that enables fast creation of web pages in Python. It eliminates the need to write HTML, CSS, JavaScript, and other front-end components. With Streamlit, web scraping, data science, machine learning, and other data can be easily presented and shared using simple Python syntax. It is a convenient tool for web development.

The current design of the web page consists of the following sections (Figure 2):

1. Title
2. Dropdown menu (for switching the x-axis parameter of the scatter plot)
3. Average PMV and temperature in the classroom
4. Left: Scatter plot of PMV and other environmental parameters; Right: Average values of parameters in different zones (including PMV) - This section provides the most relevant information for researchers and is the focus of attention.
5. List of all data (highlighted in yellow are the maximum values) - The purpose of this section is to allow users to directly refer to detailed information when observing specific data points of interest or anomalies in the scatter plot.

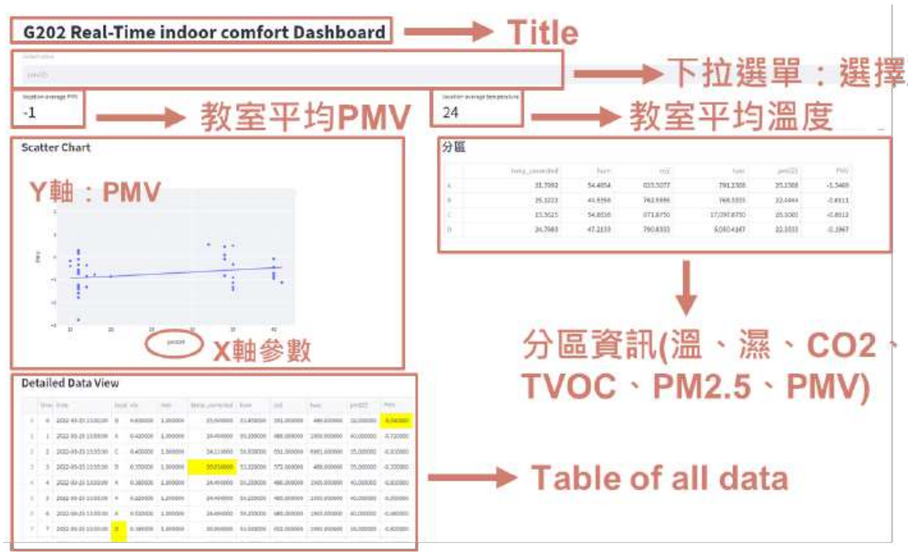

Figure 2: Introduction to the Comfort Dashboard Interface Area

The following are the areas that need improvement and completion in the future:

1. Transitioning web data from static to dynamic: Currently, the data displayed on the web page is imported from CSV files and is static. It is not directly linked to the Python file that consolidates the data. There are still technical issues to be resolved in this aspect.
2. Enhancing interactive charts: Besides obtaining real-time results, the goal of creating this automated analysis web page is to provide more interactivity during browsing. For example, when a particular data point on the scatter plot stands out, it would be desirable to have a functionality where clicking on that point corresponds to the detailed data in the table, allowing instant viewing of more detailed information. There are still many technical challenges to overcome in achieving this, including handling subjective feedback.
3. Determining web content and layout: Ensuring whether the web page requires additional content and how to optimize the UI layout for better user readability.
4. Adding a notes field: Including a notes column in the detailed data table on the web page to provide additional remarks, such as noting any issues with a specific instrument or indicating the utilization of data from a particular device.
5. Addressing minor issues with web page text: Since the current modifications to the web page are based on the examples provided by Streamlit and familiarity with the tool is still being developed, adjustments to the UI aspects will be made in the future.

United Nations Sustainable Development Goals and Campus Implementation - Temperature Measurement in Classroom 102

Meng-Chen Li, Tzu-Chiang Huang, Mei-Hui Chao, Hsuan-Ting Kao

In the context of the United Nations Sustainable Development Goals and campus implementation, an opportunity was taken to carry out a campus comfort project. An experiment was conducted to measure the temperature in Classroom 102 of the New Student Building. The objective was to compare the classroom temperature with the existing standards. Several factors were considered when choosing the measurement location, and ultimately Classroom 102 was selected. One reason was the unique layout of the classroom, with a longer width and shorter depth, and with only a window at the back of the classroom. Another reason was the passive attitude of the administrators. Finally, it was noted that the teaching faculty often felt hot but were unable to turn on the air conditioning.

For this classroom temperature measurement, the MAPS6 was used as the measurement tool. The data collected included temperature and CO2 concentration. Five MAPS6 devices were placed in the classroom: one in each corner and one in the center. Prior to data collection, all five MAPS6 devices were simultaneously placed in a designated calibration area located in the front right of the classroom for calibration. Then, each device was moved to its designated observation point, and this process was repeated three times. The data obtained from the devices placed together in the calibration area were used to establish a regression model for temperature calibration.

The experiment was conducted from November 29th to December 9th. The team members were scheduled to record the classroom occupancy and the status of door and window openings once in the morning and once in the afternoon on class days. However, during data collection, it was discovered that the device located in the front left of the classroom was malfunctioning, so its data was not used for analysis. Additionally, the initially planned temperature data from Drunken Moon Lake could not be obtained due to unfavorable weather conditions. As a result, data from the grass field was used as the outdoor temperature reference. The MAPS6 device in New Student Hall 102 had a previous malfunction and, although it was repaired, it couldn't be disassembled for a unified calibration. Therefore, the data from that device was not used for analysis in this study.

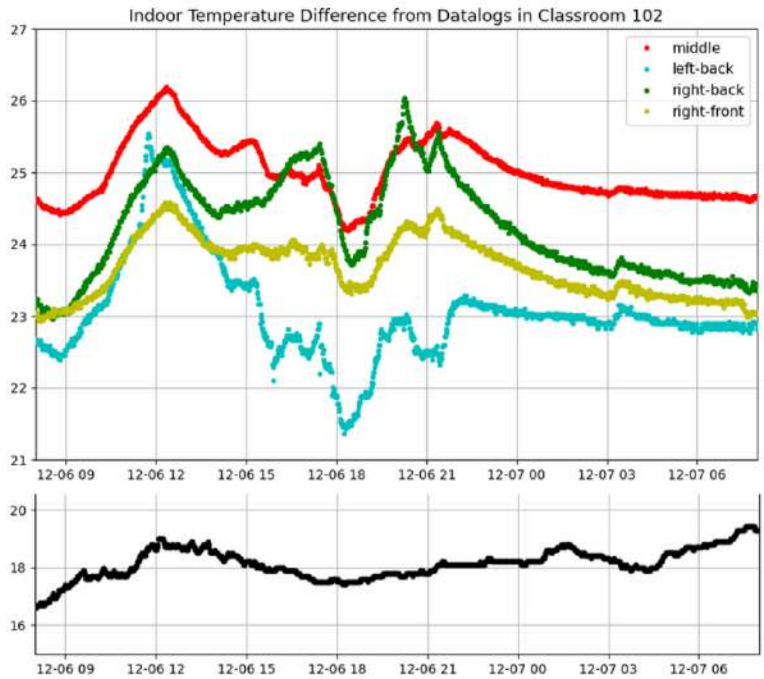

Figure 1: Indoor and Outdoor Temperatures

We also take the center of the classroom as a benchmark, and compare the temperature around the classroom with it (Figure 2), and we can find that the temperature at the corner is slightly lower than the central temperature most of the time.

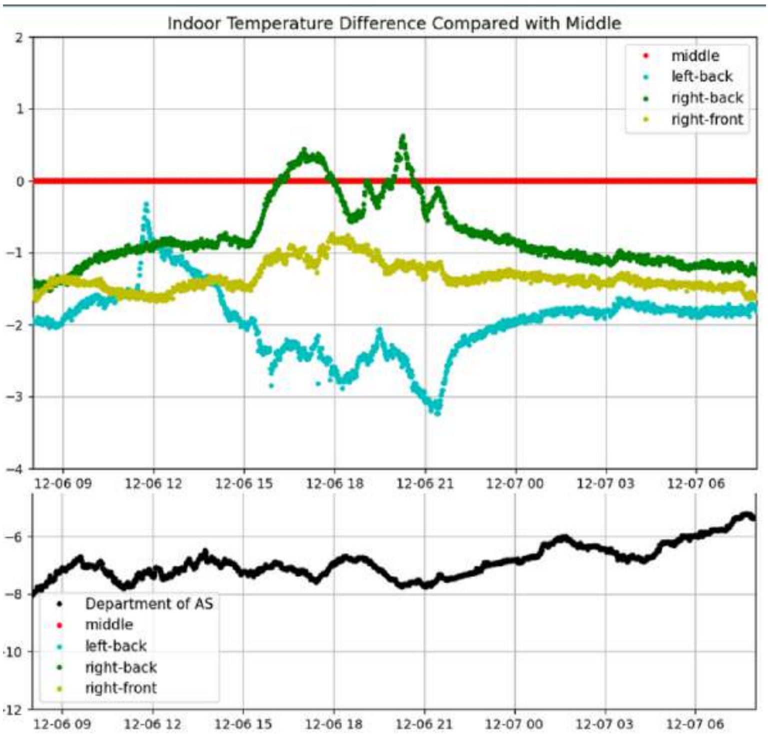

Figure 2: Comparison of Temperatures between the Center and Surroundings of the Classroom

In Figure 3, the CO2 concentration inside the classroom is observed as an indicator of human activity. It can be seen that the concentration gradually increases from the morning until around noon, reaching its peak. However, in the afternoon, despite having a higher number of people in the classroom compared to the morning, the CO2 concentration is lower. This can be attributed to the effect of opening the doors, which effectively reduces the indoor CO2 concentration.

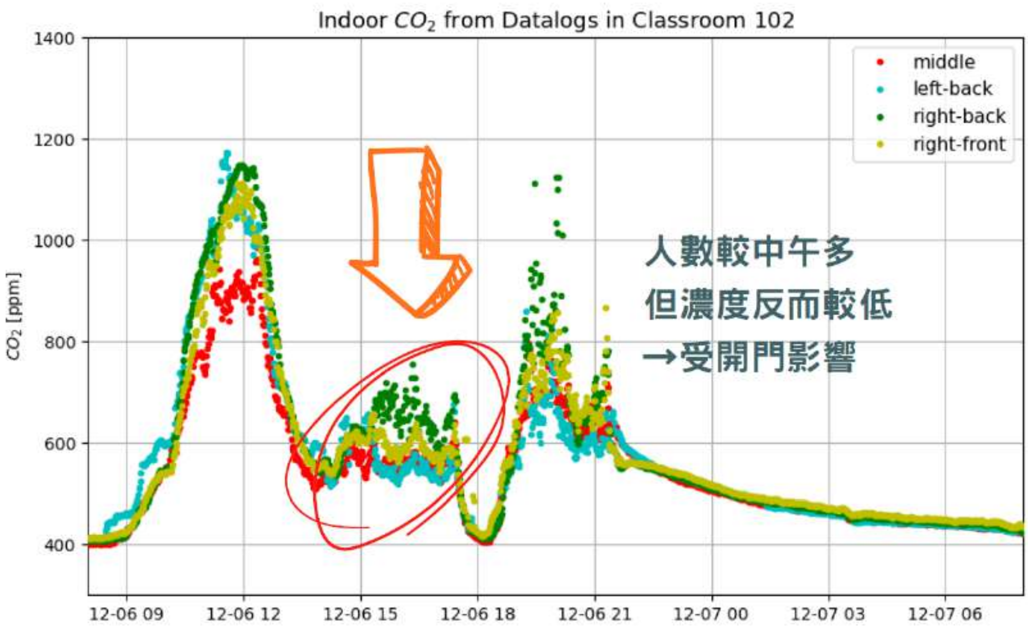

Figure 3: Indoor CO2 Concentration

Science Tips

Weather impact on retail sales: How can weather derivatives help with adverse weather deviations?

IPCS Yu-Hsin Yeh

This paper focuses on the impact of weather on retailers and explains how weather derivatives can be used to mitigate the adverse effects of weather deviations. Weather derivatives are a new type of tool designed to incorporate weather factors into a company's risk management. The most common weather-related product is insurance against weather disasters, such as typhoons and earthquakes, which compensates companies for losses caused by major natural disasters. In addition, there are also products that provide insurance for non-catastrophic weather events, such as temperature and rainfall variations. While these weather changes may not cause significant losses, they pose various risks to businesses, potentially resulting in revenue decline or unmet sales expectations, thereby incurring additional costs. Therefore, the application of weather derivatives involves businesses insuring their products during months when they are highly sensitive to weather conditions in order to stabilize income, cover excess costs, or stimulate sales.

Weather can indeed influence consumer buying behavior, including what to buy, where to buy, when to buy, and how much to buy. These individual purchasing behaviors indirectly affect product sales volume. For example, manufacturers of winter clothing are impacted by a warm winter in terms of their sales. These general effects are already familiar to businesses. However, to address or mitigate the operational impact of weather more comprehensively, more detailed information is needed to formulate strategies or make significant decisions.

This study focuses on the region of Croatia and analyzes the daily sales of non-alcoholic beverages in 60 stores within the research area. The results indicate that beverage sales have significant peaks in April and December. Even when excluding these two months, it is evident that beverage sales gradually increase during the summer. When examining the relationship between daily average temperature and sales throughout the year, there is a moderate correlation. However, when analyzing the data by individual months, noticeable variations between months become apparent. This suggests that non-alcoholic beverage sales have different sensitivities to temperature across different months, particularly during the summer, which is a critical period for sales.

In addition to analyzing the sensitivity of products to temperature, this study also examines the characteristics of products based on lagged and leading temperature indicators. It analyzes the correlation between sales and temperatures of the previous six days and the subsequent six days, aiming to determine whether past and future temperatures influence consumer purchasing behavior. The results show that, for the majority of months, the highest correlation between temperature and sales is observed with the temperature of the same day. This can be interpreted as impulsive purchasing behavior for non-alcoholic beverages, where consumers are primarily influenced by the current ambient temperature to make their purchasing decisions.

When conducting analysis on the relationship between products and environmental factors, it is not possible to apply the same model universally. This is because different geographical climates, business characteristics, and product features all have an impact. For example, cultural festivals in each country can influence consumer purchasing behavior, and the sensitivity of products to climate may vary. Additionally, consumer consumption habits should also be considered in such analysis.

Reference

Štulec, Petljak, & Naletina (2019). Weather impact on retail sales: How can weather derivatives help with adverse weather deviations?. Journal of Retailing and Consumer Services, Volume 49, July 2019, 1-10. https://doi.org/10.1016/j.jretconser.2019.02.025

ABOUT OUR TEAM

SC+NTU Work Team

Principal Investigator: Shiuh-Shen Chien

Executive Consultant: Ming-Kung Chung; Yi-Huan Hsieh

R&D and Calibration Consultant: Jen-Ping Chen; Ling-Jyh Chen; Jehn-Yih Juang; Po-Hsiung Lin

Taipei Field Consultant: Jen-Ping Chen; Jehn-Yih Juang; Po-Hsiung Lin; Chih-Hao Hsieh; Chin-Lin Wei

THOD Consultant: Jen-Ping Chen; Sheng-Lin Chang; Horng-Huei Liou

Work Team: Miao-Jung Chien; Wei-Jhe Chen; Cheng-En Lin; Xin Yang; Tzu-Chun Chang; Rong-Cih, Chang; Tzu-Ya, Wang; Chieh-Hsiang, Fan

International Degree Program in Climate Change and Sustainable Development (IPCS)

The International Degree Program in Climate Change and Sustainable Development, as its name suggests, is an interdisciplinary degree program that encompasses a global perspective. Established by the College of Science, the program is a joint effort among NTU faculty members from both scientific research and humanities backgrounds. In dealing with climate change and sustainable development, we instrument in-depth teaching in a wide range of topics. Students are required to bring their knowledge and skills to the table and approach environmental issues from a multi-angled perspective. They are encouraged to break free from traditional views on sustainability and think outside the box. Students are expected to be motivated learners, thinkers, analysts, and most important of all, practitioners. Our ultimate goal is to cultivate students' ability in interdisciplinary problem-solving in dealing with the complexity of climate change issues.

ABOUT OUR TEAM

Location Aware Sensing System (LASS)

The Location Aware Sensing System (LASS) is an important maker community in Taiwan, and it is also the creator of air boxes, water boxes, and other micro-sensing devices. LASS focuses on the integration of citizen technology and spatial information, aiming to design and implement an environmental sensing system with local characteristics through the integration of hardware and software. The community strives to promote open source and public welfare as the main axis, and to create customers instilled with a 'self-creator' spirit, develop low-cost environmental monitoring equipment with an open software and hardware architecture so that the public may build a set of sensing systems that meet their specific needs through a self-made process. At the same time, LASS also adopts and open attitude towards sensing data and allows volunteers to use environmental monitoring data uploaded to the cloud system by other partners in the community in order to build a real-time monitoring network.

PARTNERS ➤

Wenshan Community College. Daxue Village, Taipei City.

Jianguo Village, Yingge Distrint New Taipei City. Taiwan Mobile Co., Ltd

Transit-Hospital-Oriented Development(THOD) Work Team

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