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温室环境分析中冬季室外气温日变化及数学表达

Daily change and math-expression method of outside temperature in winter for greenhouse environmental analysis

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中文摘要：

在温室热环境准确的动态分析中室外逐时气象数据是不可缺少的，但系统完整的室外逐时气温气象观测资料相对较少，为此，该文研究了2009－2011年冬季1月份室外气温的日变化规律。根据连续2 a的观测数据，分析了华北5省区2009－2011年1月份室外气温的逐时变化情况，并归纳出根据日最高气温和日最低气温采用温度逐时变化系数计算逐时气温的方法。结果表明，该方法所得的室外逐时气温模拟结果与实测温度较为吻合。在此基础上，采用傅立叶级数展开的方法，给出了推算冬季任意时刻室外气温的数学表达式。该文为温室环境的精确模拟分析提供详尽的室外温度数据。

英文摘要：

Abstract: Hourly, outdoor meteorological data are essential for the accurate dynamic simulation and analysis of the greenhouse thermal environment. Most meteorological stations have only published the four times (six/eight times) observation results, but hourly data have always been considered as classified files and not published. Also not published is the continuous observation temperature data in research or production, which should be included in the change principle and in greenhouse environment analysis. In this paper, we examined the daily change rule of outside air temperature in January for greenhouse environment analysis. According to observation data from 2009 to 2011, measured and recorded by the thermal recorder RS-12, we acquired the temperature data of each 10 min interval from 14 stations in North China. For each station, we adjusted the data to reflect true solar time, and using the hourly temperature at the true solar hourly time, we calculated the hourly temperature changing coefficient β. We then analyzed the hourly change of outside temperature in five provinces of North China for the month of January, and summarized a mathematical method for hourly air temperature by using β when the daily maximum and minimum temperature were known.The results showed: In the same province, although the measured temperature is quite different in various years, β is always on the similar change trend and value at the same hour, so the outside temperature daily change can be described by the same coefficient in each province. By comparing β of the five provinces in North China, we found that β are similar, and R2 reached 0.9704, so we can also show the hourly change of outside temperature by the same β. Based on the results above, we summed the hourly changing coefficient (1-24h) of outside temperature in January in North China. When we contrasted β with heating ventilation and air conditioning (HVAC), the two curves were different in minimum value time and rise/fall speed, which is related to seasons. The values of the outside air temperature hourly were changing coefficient β from 1 to 24h is -0.35, -0.37, -0.40, -0.44, -0.46, -0.48, -0.50, -0.39, -0.09, 0.12, 0.28, 0.39, 0.46, 0.50, 0.49, 0.41, 0.20, 0.02, -0.08, -0.15, -0.19, -0.24, -0.27, -0.31, respectively. The winter coefficient was examined by Xinkaikou Town in Tianjin in January of 2011, and Tongzhou District in Beijing in January of 2012. The simulation results of hourly air temperature outside by this method were similar to the actual measurements, the R2 all reached 0.98, and average error were all 0.3℃. On this basis, using the Fourier series expansion, we stated a mathematical expression for calculating outside temperature at any time. According to the daily maximum and minimum temperature outside, we could determine the outside temperature at any time and provide full outdoor temperature data for greenhouse environment simulations accurately.