College of Arts and Sciences, Atmospheric Sciences Program

Analysis of Ambient Air Temperature Differences Between Artificial Turf and Grass Fields in the Context of Athletics

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INTRODUCTION

Many schools are choosing to install artificial turf fields over typical natural grass fields for their sports facilities. Some of the benefits artificial turf fields provide include:

- Less maintenance required
- More cost-efficient
- Better durability

However, recent studies have found that athletes are more injury-prone when playing on artificial surfaces.

Microclimate of Artificial Turf

Many studies have investigated the microclimate of artificial turf grass. From these studies, there are a few common findings:

- The surface temperature of artificial turf is much higher than the ambient air above it
- The surface temperature of artificial turf is much higher than the surface temperature of natural grass

These studies have not compared the ambient air temperature above artificial turf versus natural grass turf.

Context of Athletics

Higher ambient air temperatures can lead to an increased risk of heat-related health impacts especially when performing physical activity. The differences in temperature above both surface materials can result in one leading to more heat-related health impacts than the other.

METHODS

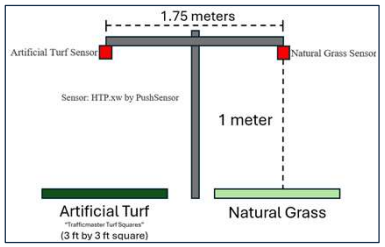


Figure 1: Diagram of tripod setup for study

- Collected temperature and humidity data for two and a half weeks
- Tripod was placed at Waterman Agricultural and Natural Resources Laboratory
- Data analytics were performed using Python scripts
- Pearson Correlation Method was used

RESULTS

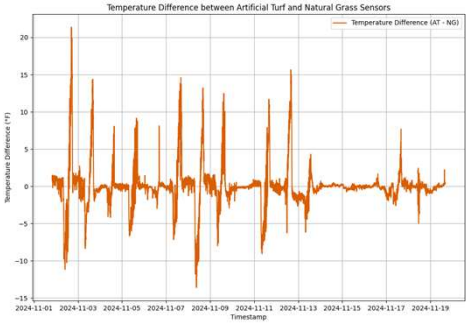


Figure 2: Difference in one-meter ambient temperatures between artificial turf and natural grass

The difference in temperature graph fluctuates consistently over time. Negative values indicate natural grass was warmer during that time while positive values indicate that artificial turf was warmer. On average air temperatures over Artificial turf were 0.05 °F warmer than over natural grass.

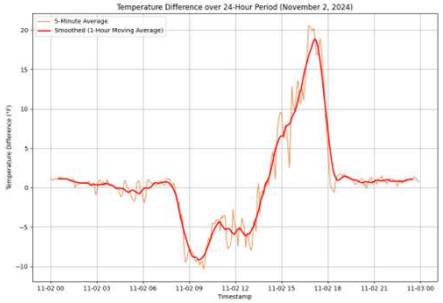


Figure 3: Difference in one-meter ambient temperatures between artificial turf and natural grass on warmest day of study

November 2nd was the warmest day of the study. Natural grass temperatures were initially higher, peaking at 10°F above artificial turf. Later in the day, artificial turf became warmer, reaching a peak difference of 20°F. During the night, temperatures above both surfaces were similar.

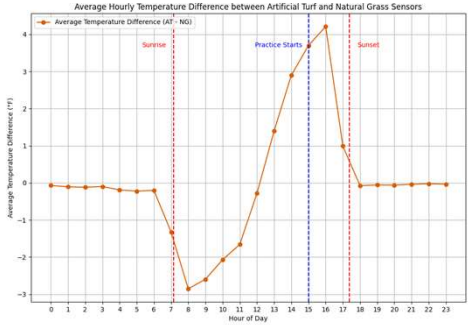


Figure 4: Average hourly temperature difference between artificial turf and natural grass

A common trend can be seen across all days of the study:

- After sunrise natural grass is warmer
- Around noon artificial turf begins warming more
- As the sunsets temperatures drop and temperature of both surfaces become similar
- This remains throughout the night

It is important to note that many high school athletes typically begin practicing around 3 pm. During this time the temperature of artificial turf is much warmer than natural grass

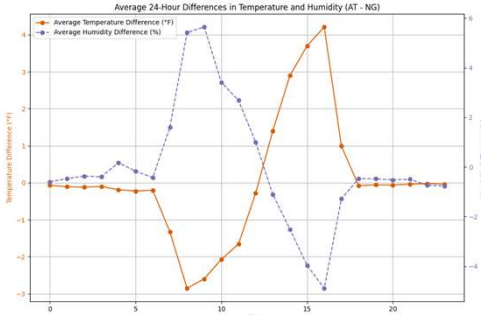


Figure 5: Average hourly temperature differences compared to humidity differences between artificial turf and natural grass

A negative correlation is identified between air temperatures and humidity. This is backed up by a Pearson correlation coefficient value of -0.94 indicating a strong negative correlation. This is likely since since natural grass is alive and it undergoes the process of evapotranspiration. This leads to consistently slower evaporative cooling throughout the entire day. Artificial turf evaporates all water much faster.

CONCLUSIONS

This study found there is a correlation between artificial turf versus natural grass in the context of ambient air temperature.

- On average artificial turf temperatures were negligibly warmer than natural grass
- Natural grass is initially warmer due to the slower evaporation process caused by transpiration, which cools the air above through the evaporation.
- After all the water evaporates from the artificial turf it becomes considerably warmer than natural grass
- Artificial turf is warmest during the time that athletes typically practice in the late afternoon into the evening

These results indicate that using artificial turf could lead to an increase in heat-related health impacts.

Limitations

This study was conducted in November when solar radiation rates were diminishing. The difference in temperatures would likely be greater if conducted during the heat of the summer with peak hours of daylight.

BIBLIOGRAPHY

1 Bergeron, M. F., C. DiLaura Devore, S. G. Rice, and Council On Sports Medicine and Fitness and Council on School Health, 2011: Climatic Heat Stress and Exercising Children and Adolescents. *Pediatrics*, **128**, e741–e747, https://doi.org/10.1542/peds.2011-1664.

2 Buskirk, E. R., E. R. McLaughlin, and J. L. Loomis, 1971: Microclimate over Artificial Turf. Journal of Health, Physical Education, Recreation, 42, 29–30, https://doi.org/10.1080/00221473.1971.10617177.

3 Kanaan, A., E. Sevostianova, B. Leinauer, and I. Sevostianov, 2020: Water Requirements for Cooling Artificial Turf. Journal of Irrigation and Drainage Engineering, 146, 05020004, https://doi.org/10.1061/(ASCE)IR.1943-4774.0001506.

4 Liu, Z., and C. Y. Jim, 2021: Playing on natural or artificial turf sports field? Assessing heat stress of children, young athletes, and adults in Hong Kong. Sustainable Cities and Society, 75, 103271, https://doi.org/10.1016/j.scs.2021.103271.

5 Petrass, L. A., D. M. Twomey, J. T. Harvey, L. Otago, and P. LeRossignol, 2015: Comparison of surface temperatures of different synthetic turf systems and natural grass: Have advances in synthetic turf technology made a difference. Proceedings of the Institution of Mechanical Engineers, Part P: Journal of Sports Engineering and Technology, 229, 10–16, https://doi.org/10.1177/1754337114553692.

ACKNOWLEDGEMENTS

Special thanks to the Atmospheric Sciences Program for supplying equipment for the study. Additional thanks to Jackie Beck for helping guide me through my first research project.