

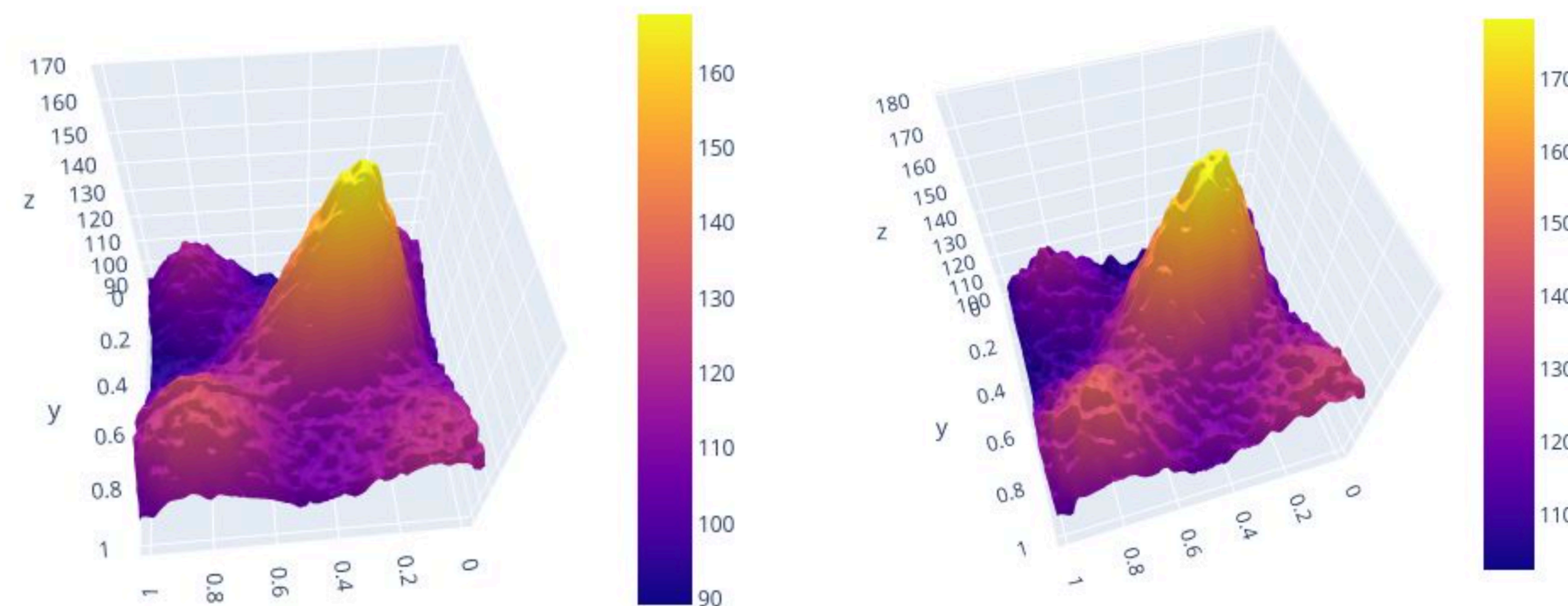
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Challenge

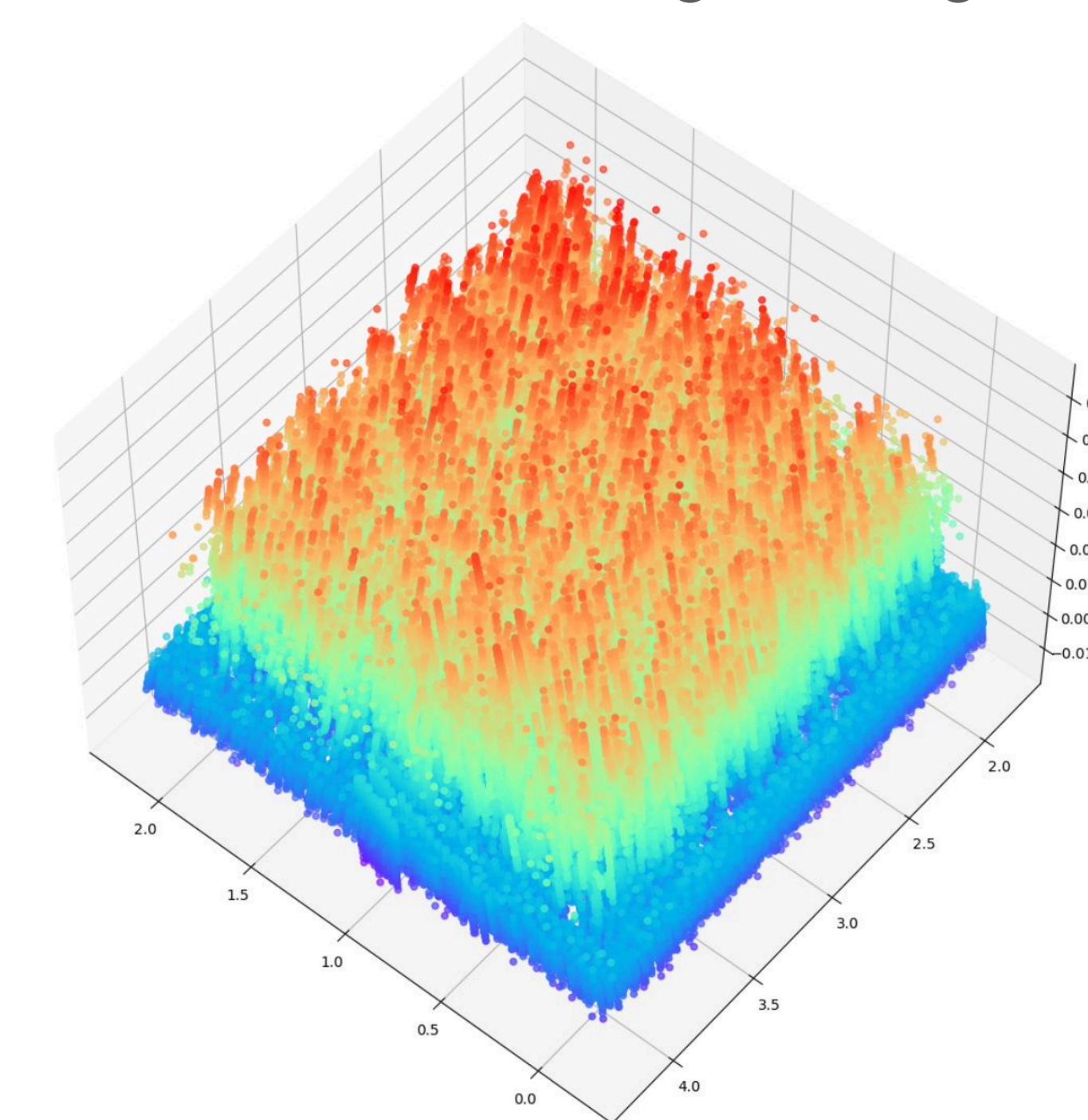
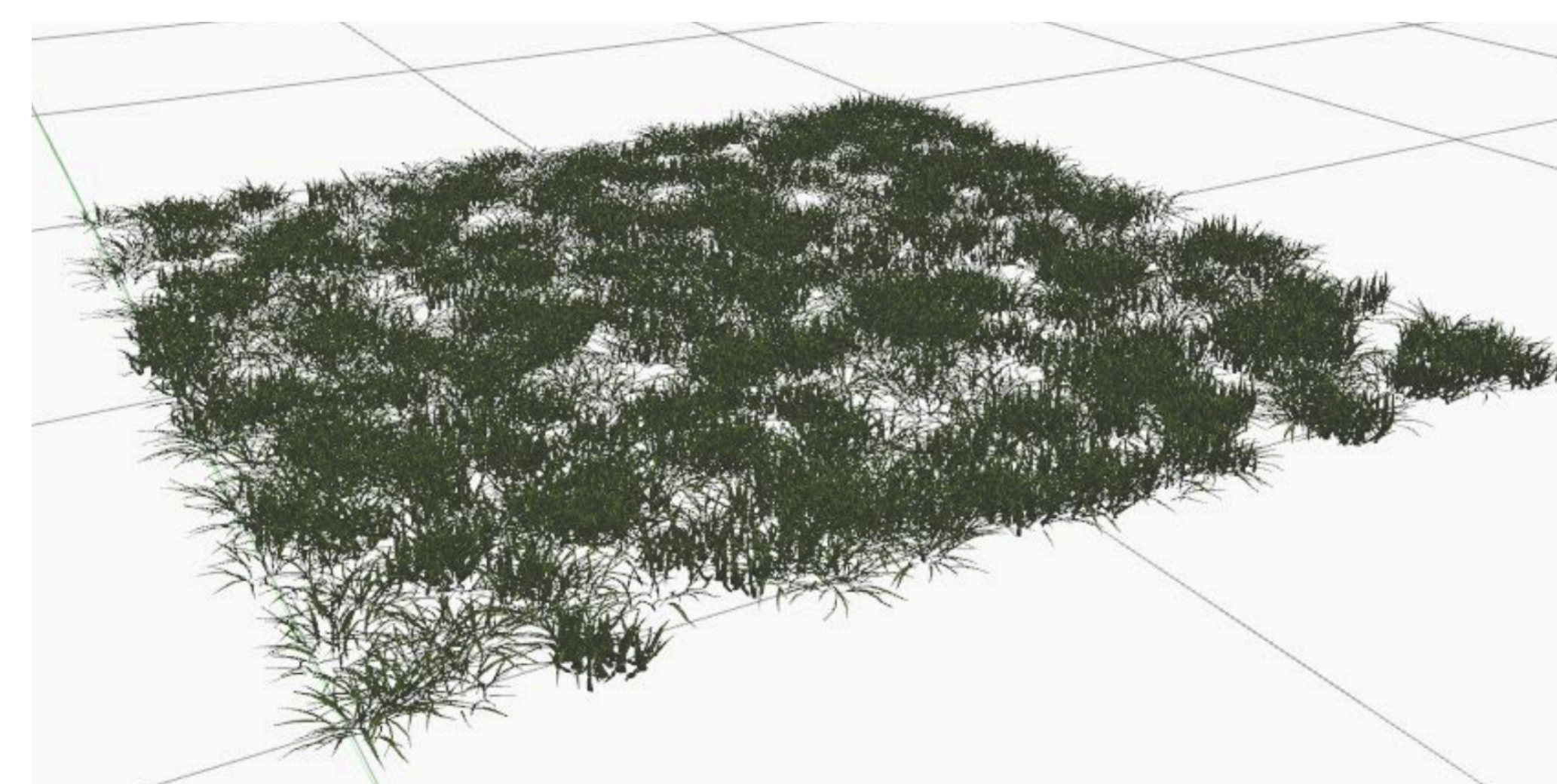
- Autonomous monitoring and active intervention in a new paradigm of **precision grazing** practices.
- Improve land productivity and lessen environmental impacts, while utilizing COTS robotic and sensor platforms.
- Estimate spatiotemporal processes on widely varying timescales and effectively deploy heterogeneous robot teams over long time horizons.

Key Results (Year 2)

- Applied novel Bayesian LSTM architecture to learn and predict complex forage dynamics from training data based on a combination of expert input from a predictive temporal model and robotic data.
- Full simulation environment for forage simulation, UAV monitoring, neural network-based prediction, and UAV temporal planning.



LSTM-based Bayesian forage prediction (predicted- left, target - right)



High-fidelity forage simulation (left) and height perception (right).

Education and Outreach

- K-12 academic experiences for students in collaboration with Virginia Tech's Center for Enhancement of Engineering Diversity.
- Dissemination through the Plant Management Network of the American Phytopathological Society and the Natural Resources Conservation Service of the USDA.

Scientific Impact

- Intersection of novel techniques from decision theory, risk-aware path planning, and combinatorial optimization.
- Order of magnitude improvement in computational complexity for multi-scale robot planning, through a novel hierarchical design.
- Novel modeling and decision resources for broad pastureland management and ecological mitigation practices.

Broader Impact

- Pasturelands are an integral part of agricultural production in the United States, covering 48 million ha.
- Maximizing pastureland use will improve the profitability and ecological sustainability of livestock farming.
- Autonomous operation will further improve profitability, especially for niche farms where manual labor is impractical.