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Deep Learning in the Woods: what can we learn about canopy height from optical remote sensing?

Master Thesis by Emilio Sánchez
18.07.2025 | ILÖK Graduate Conference

Prof. Dr. Hanna Meyer, Dr. Jakub Nowosad

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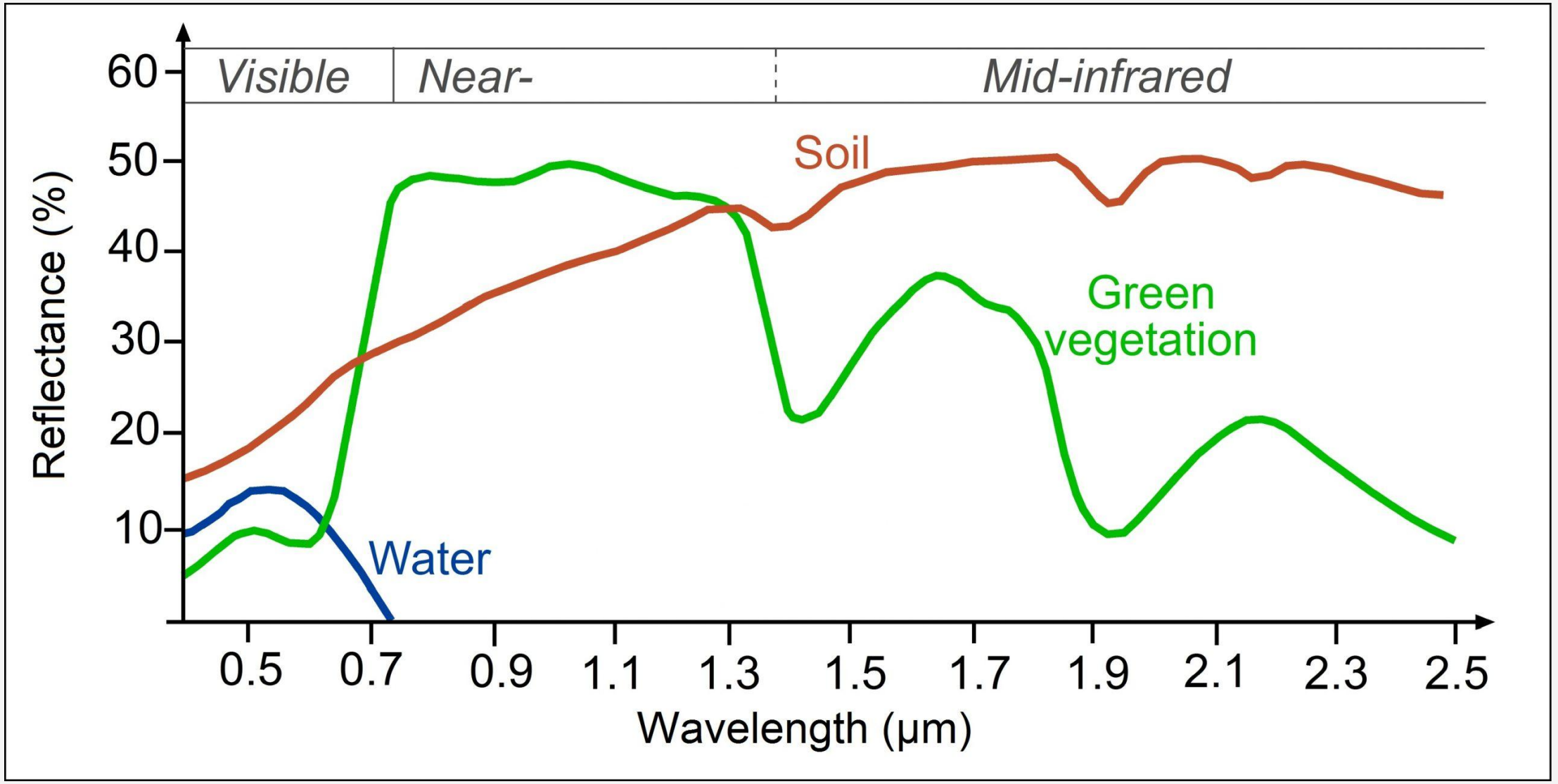
ILÖK
Institute of Landscape Ecology



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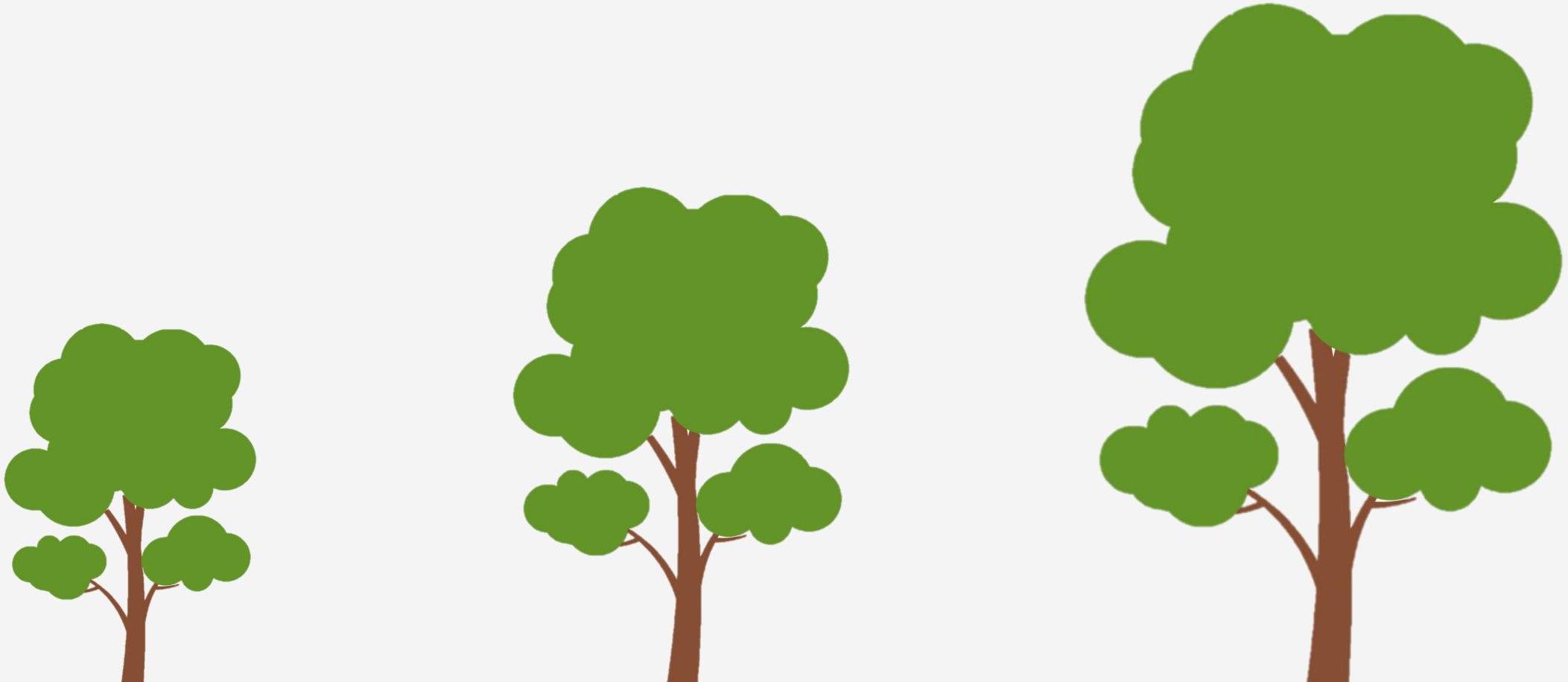
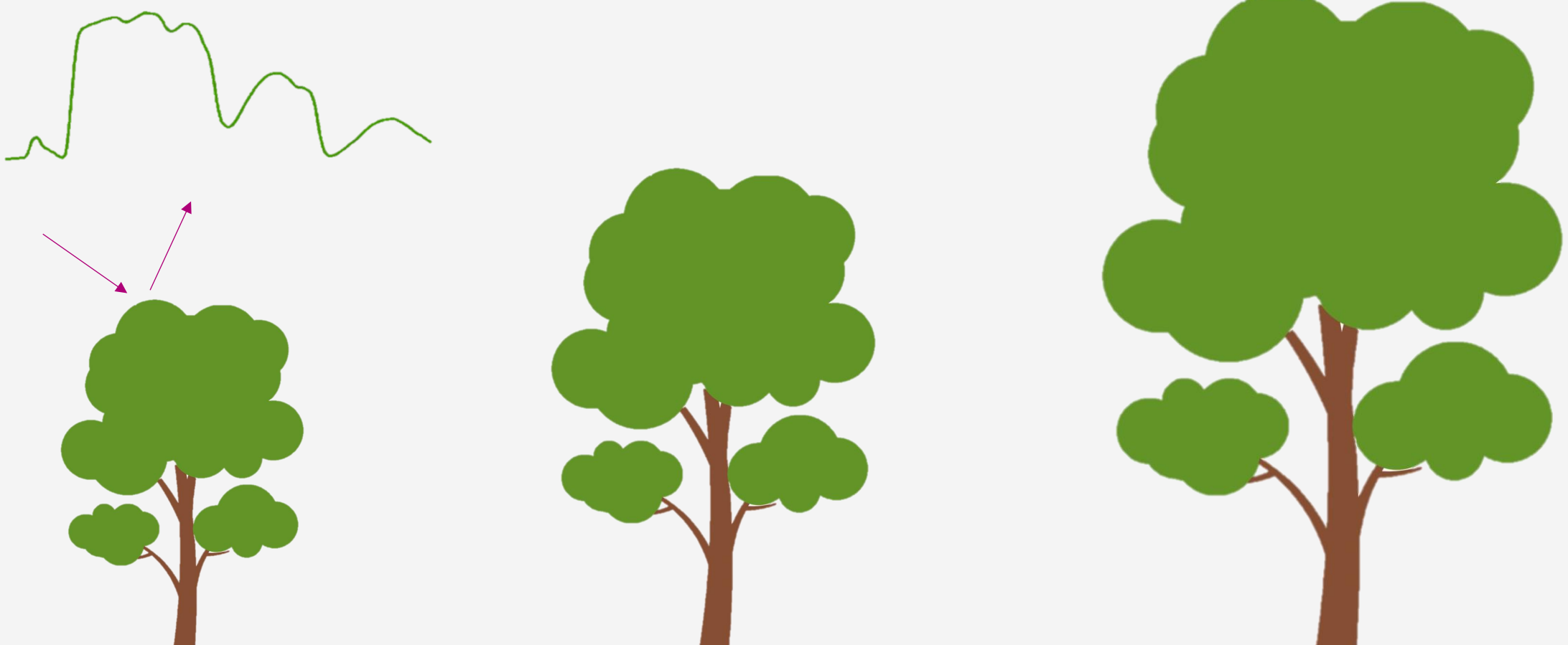
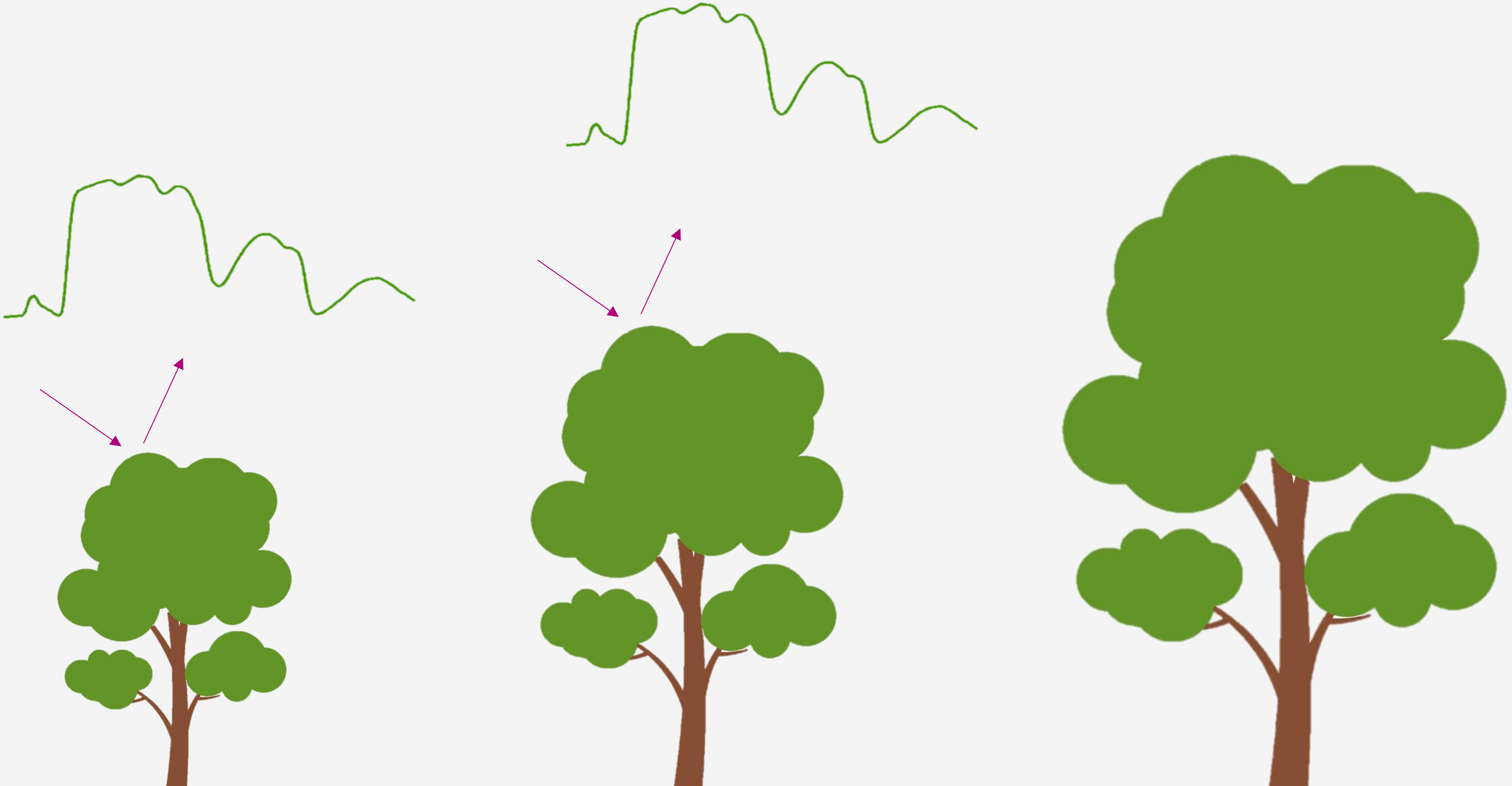






nature ecology & evolution

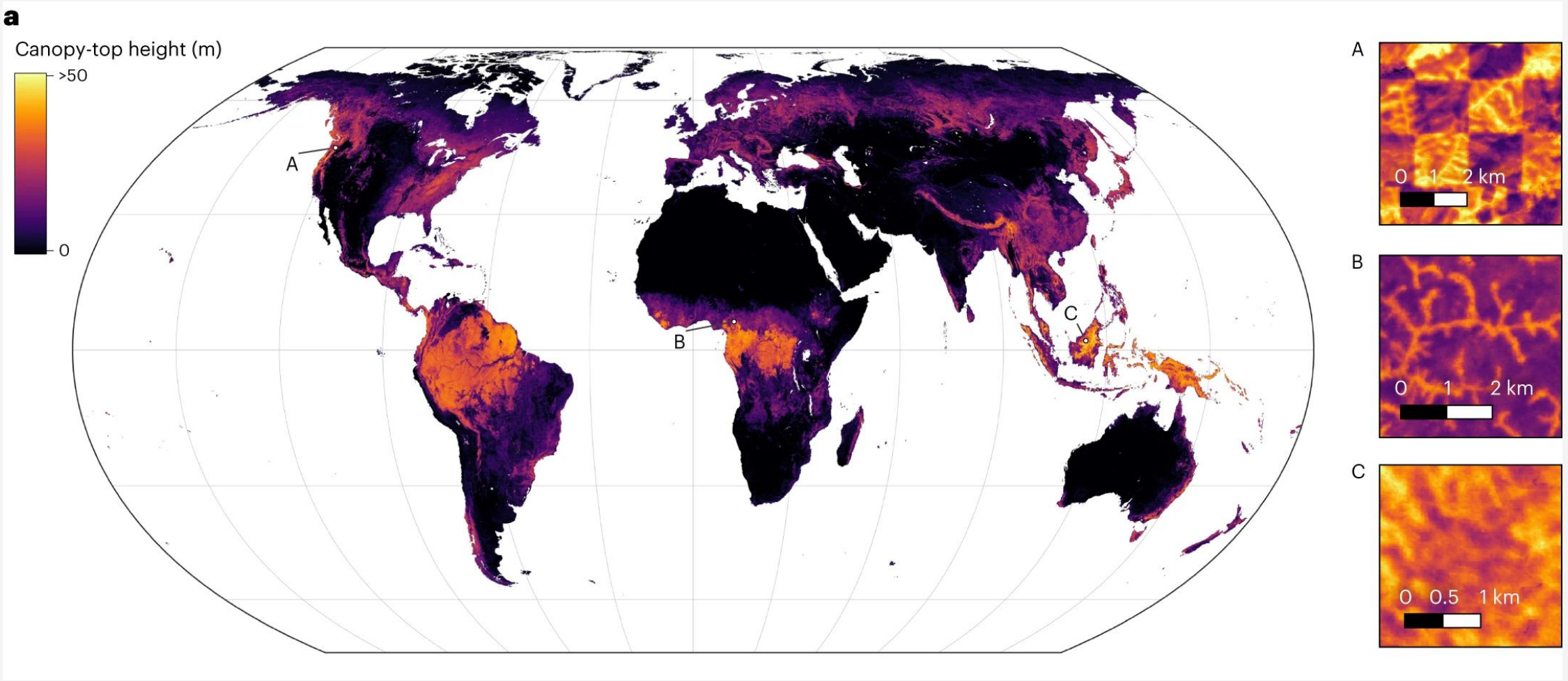
Article

https://doi.org/10.1038/s41559-023-02206-6

A high-resolution canopy height model of the Earth

Received: 9 June 2023

Nico Lang [1,2] ✉, Walter Jetz [3], Konrad Schindler [1] & Jan Dirk Wegner [1,4] ✉



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GOALS

- Proof that spectral data has no explanatory value on the canopy height
- Improve future prediction products

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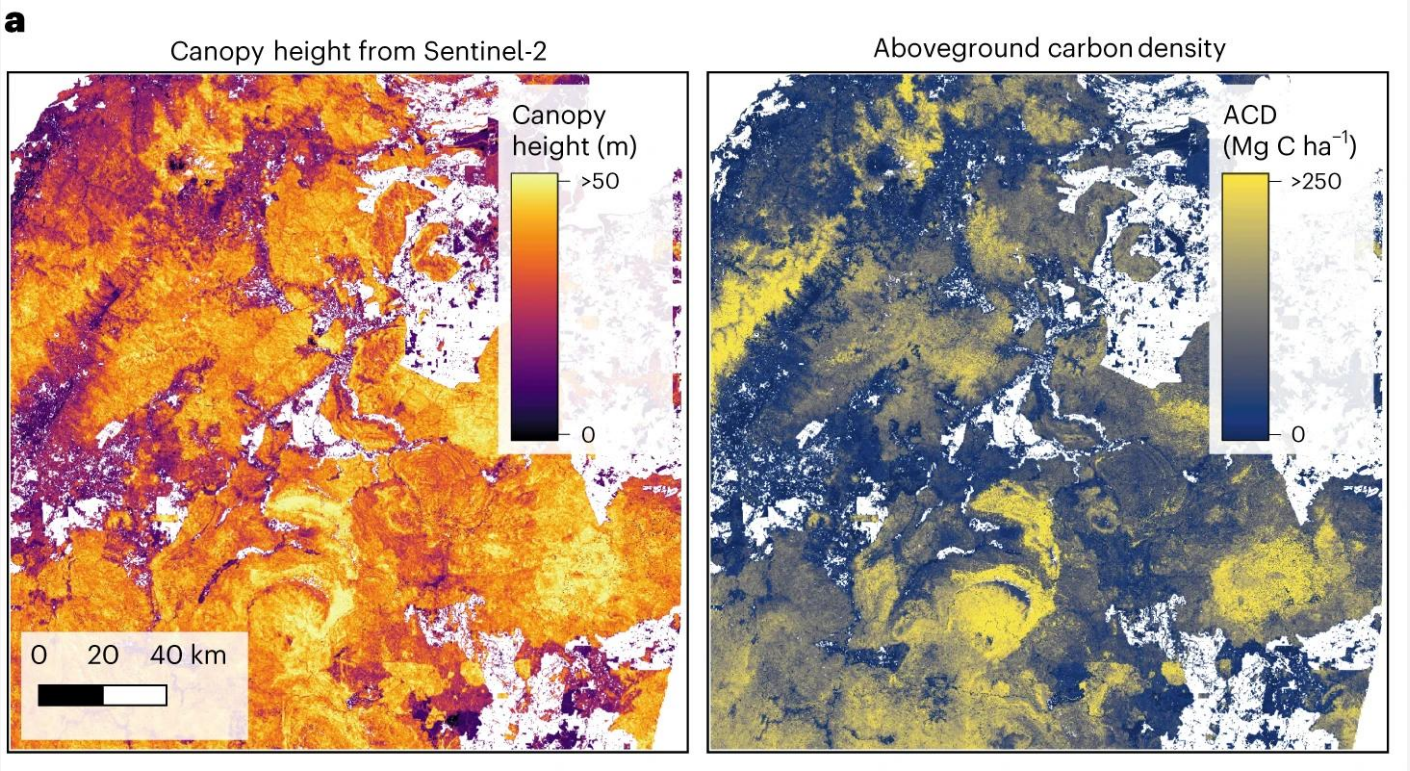
WHY IS THIS IMPORTANT?

Relevance

- Carbon stock mapping
  - Growth and loss



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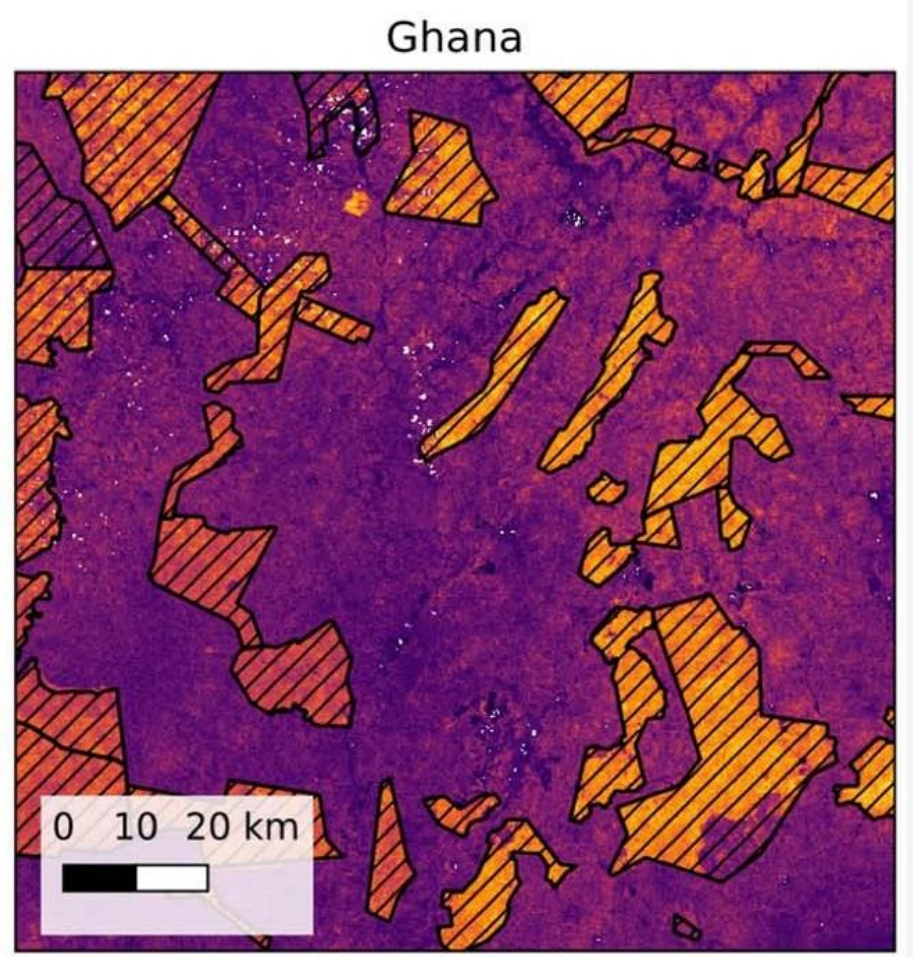
Relevance

- Carbon stock mapping
  - Growth and loss
- Monitoring
  - Environmental damages
  - Protected area analysis



Relevance

- Carbon stock mapping
  - Growth and loss
- Monitoring
  - Environmental damages
  - Protected area analysis
- Habitat analysis

https://live.staticflickr.com/65535/49607202383_dcbcb589b8_b.jpg

Relevance

- Carbon stock mapping
  - Growth and loss
- Monitoring
  - Environmental damages
  - Protected area analysis
- Habitat analysis
- Policy making

https://hsat.space/wp-content/uploads/2020/08/tropical_forest-0d8037c4.jpeg

Global Ecology and Biogeography
A Journal of Macroecology

RESEARCH PAPER | Full Access

Forest canopy height co-determines taxonomic and functional richness, but not functional dispersion of mammals and birds globally

Gang Feng, Jian Zhang ✉, Marco Girardello, Vincent Pellissier, Jens-Christian Svenning

First published: 07 May 2020 | https://doi.org/10.1111/geb.13110 | Citations: 41

Feng & Zhang 2020

Plant Ecology

Exploring the relationship between canopy height and terrestrial plant diversity

Roberto Cazzolla Gatti · Arianna Di Paola · Antonio Bombelli · Sergio Noce · Riccardo Valentini

RC Gatti 2017

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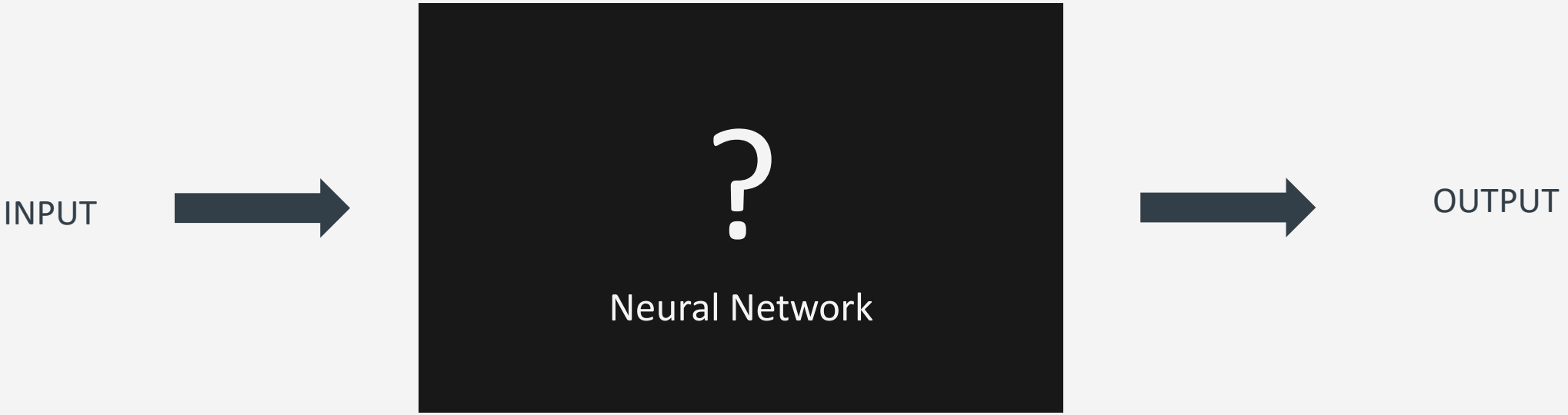
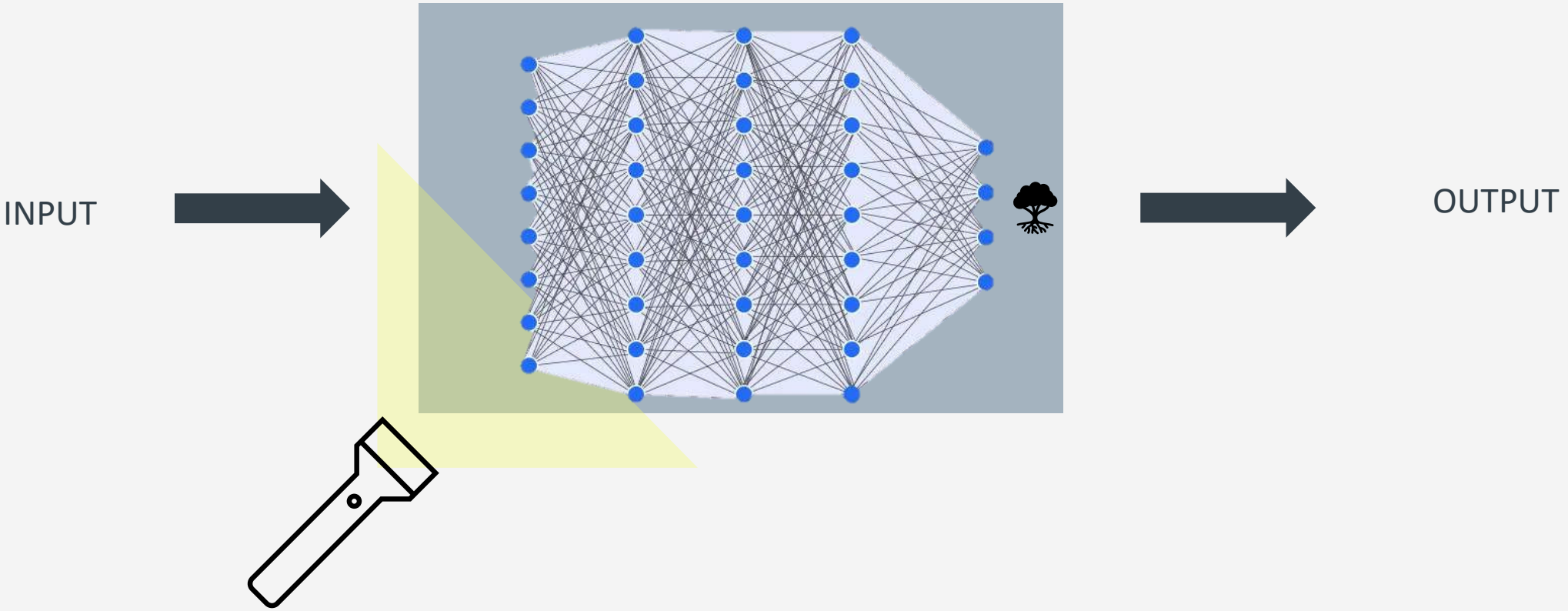
HOW DOES THE MODEL WORK?

AND HOW I TRIED TO FIND OUT


INPUT
?
Neural Network
OUTPUT



https://ik.imagekit.io/botpenguin/assets/website/Deep_Neural_Network_2b9d9075e9.webp

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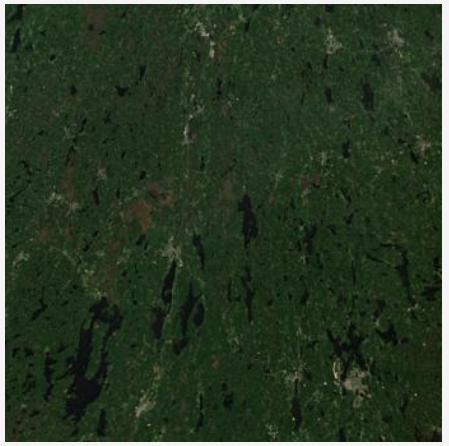
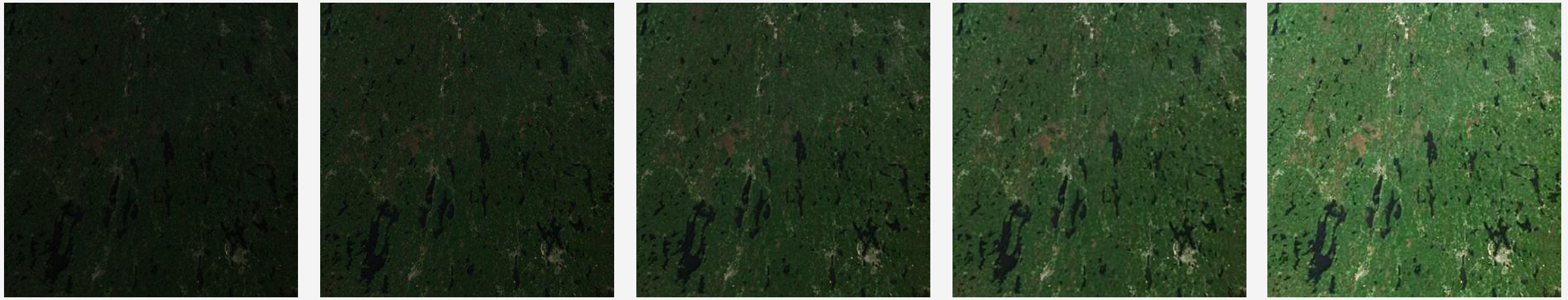
Methods

ORIGINAL



Input manipulation

- 20% - 10% ORIGINAL + 10% + 20%



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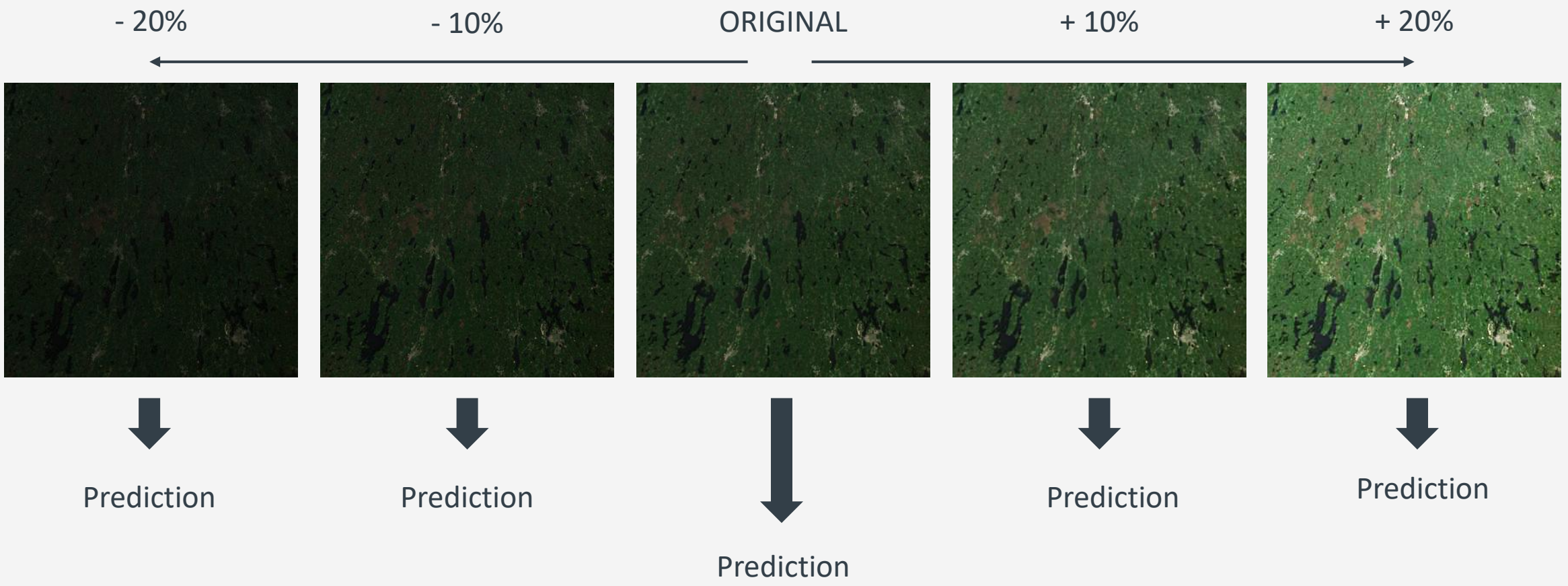
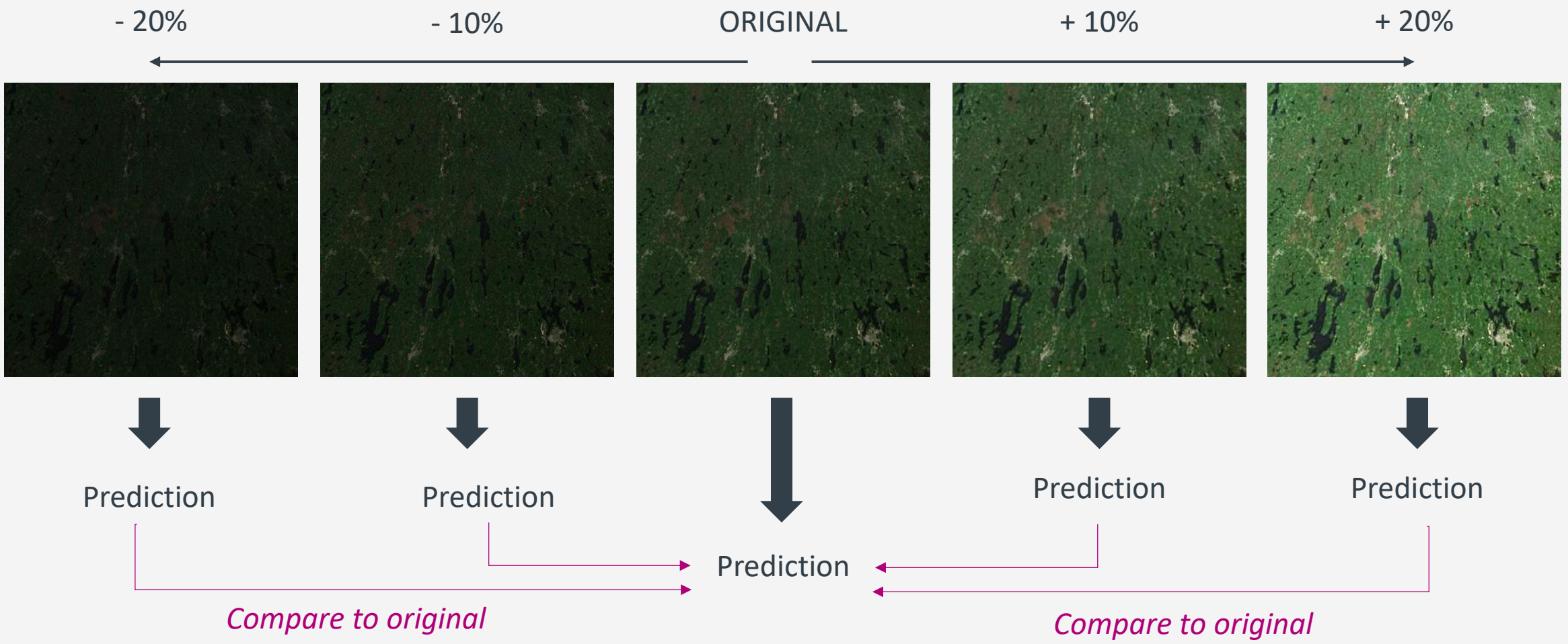
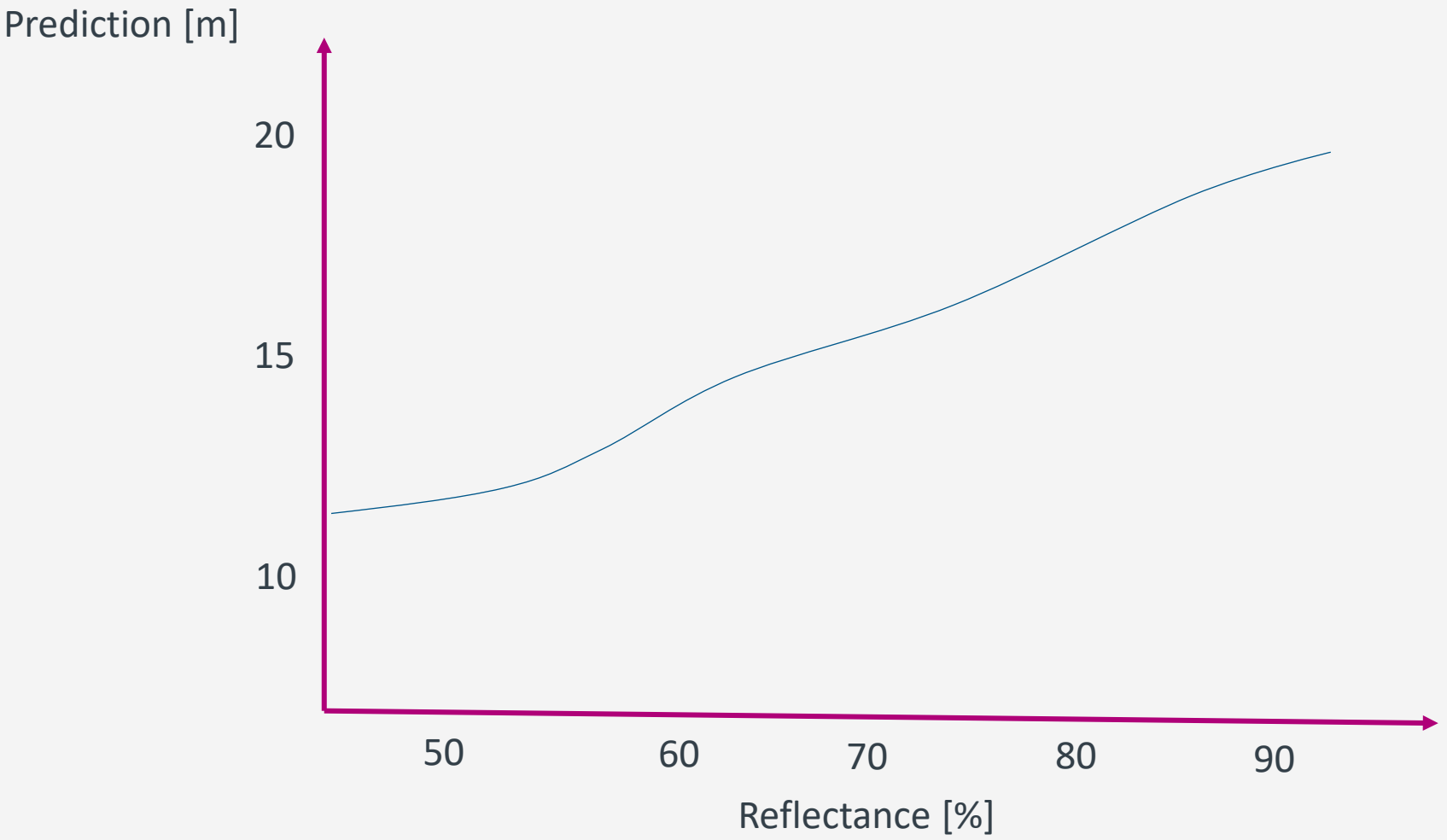
Input manipulation

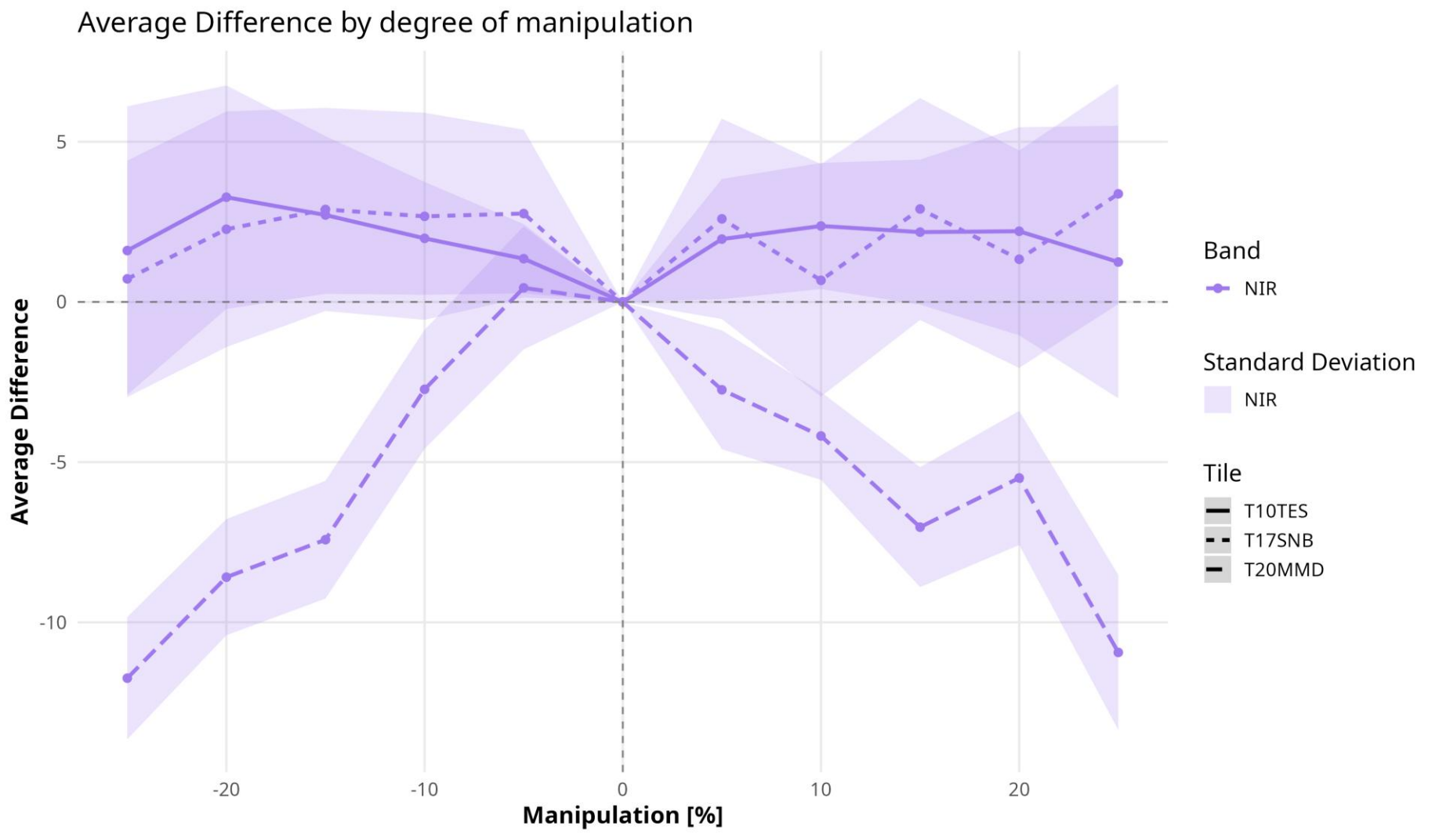


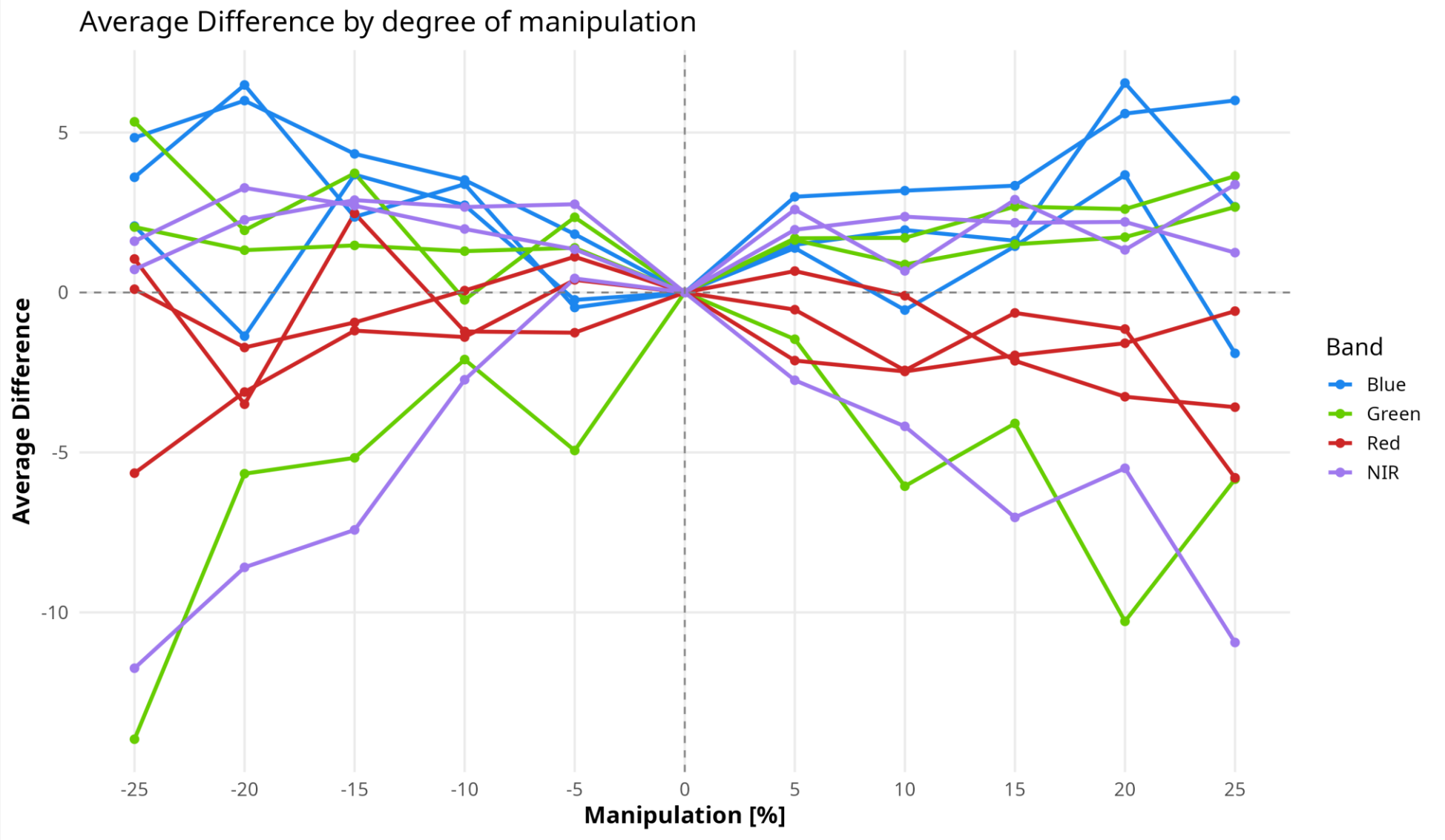
Input manipulation



Expectation if model works




Average Difference by degree of manipulation
Average Difference
5
0
-5
-10
-20
-10
0
10
20
Manipulation [%]
Band
NIR
Standard Deviation
NIR
Tile
T10TES
T17SNB
T20MMD


Average Difference by degree of manipulation
Average Difference
5
0
-5
-10
-25
-20
-15
-10
-5
0
5
10
15
20
25
Manipulation [%]
Band
Blue
Green
Red
NIR


35VML
34UFD
32UQU
32TMT
10TES
17SNB
50TPT
33NTG
20MMD
49NHC
55HEV

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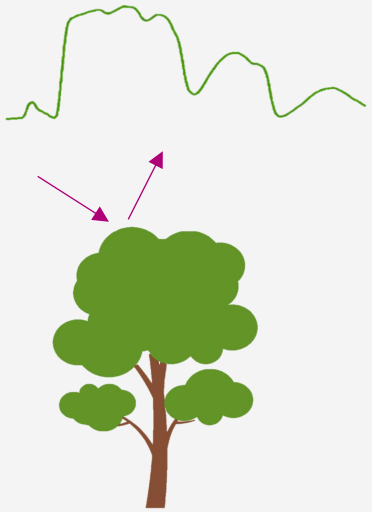

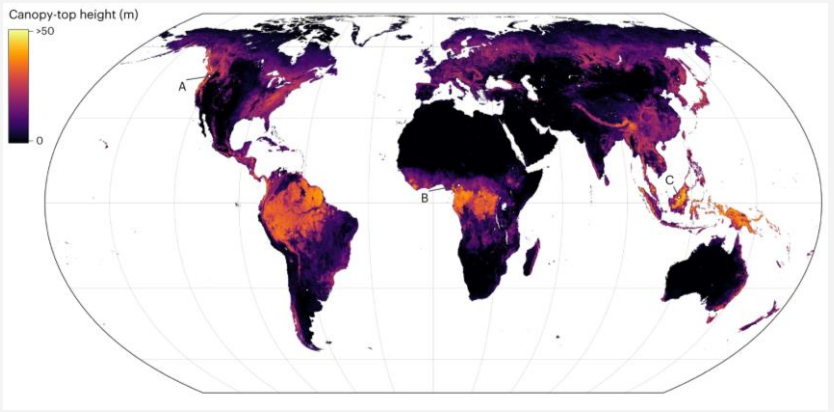

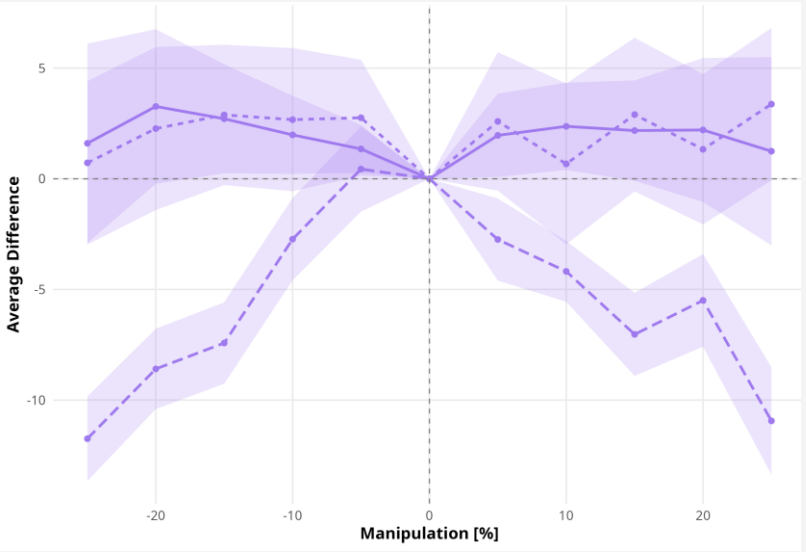

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RECAP

Key Takeaways

- Spectral data does not contain information about canopy height
- The model primarily learned contextual patterns like location
- Critical assessment of AI-based ecological products is crucial

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Thank you for your interest!

More information, updates on the progress, these slides and all sources are available on my GitHub.

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