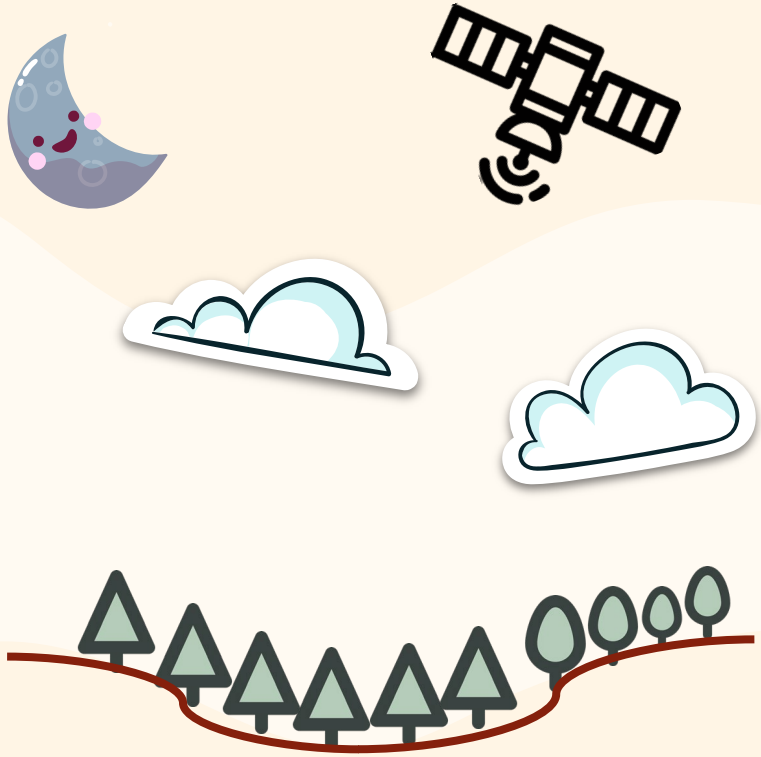
Machine Learning Estimation of Leaf Area Index from GOES -19

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with much needed assistance from

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Background… Do We Care?

what's this "LAI" thing?

- Leaf Area Index measures the leaf area over a given amount of ground
- Total (one sided leaf area) divided by ground surface area

how do we get it?

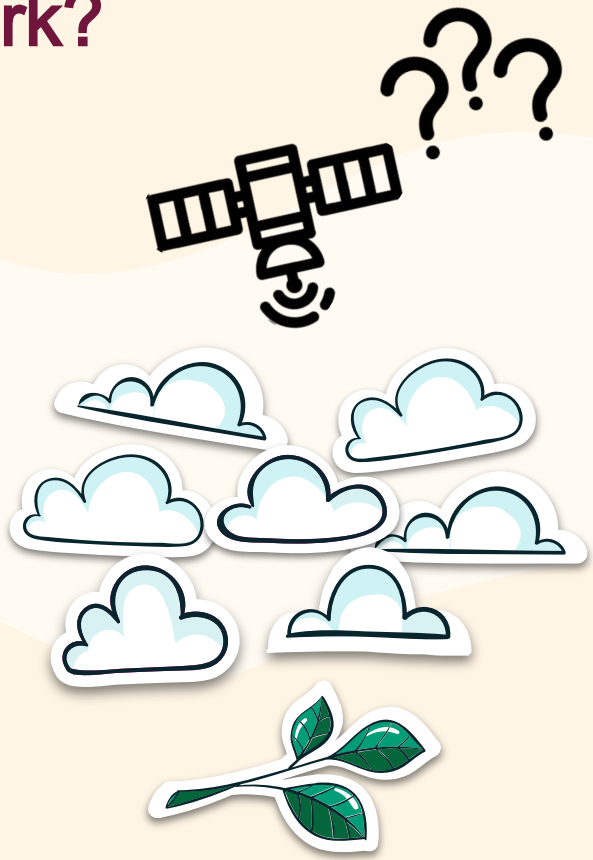
- Cut down every tree you see
- Satellites like MODIS and VIIRS have been used to estimate LAI
- Measure reflected light from vegetation
- Utilize lookup tables, physical models



all aboard the GOES-19…

- Became operational on April 7th, 2025
- The main instrument onboard is ABI (Advanced Baseline Imager)

Dataset + How Does It Work?



The DATASET

- Apr. 7, 2025 → Apr. 6, 2026
- Removing sites outside the useful GOES scan, with unfavorable viewing geometry, and observations with poor quality flags (cloudy) 362,589 →78,940 training sites, 1.21 million usable site-period examples
- GOES-19 ABI:
  - Band 2 — Red, 0.64 µm
  - Band 3 — NIR, 0.86 µm
  - Band 5 — SWIR, 1.61 µm
- Observations near 15, 18 + 21 UTC

BRF= reflected sunlight in a particular viewing direction

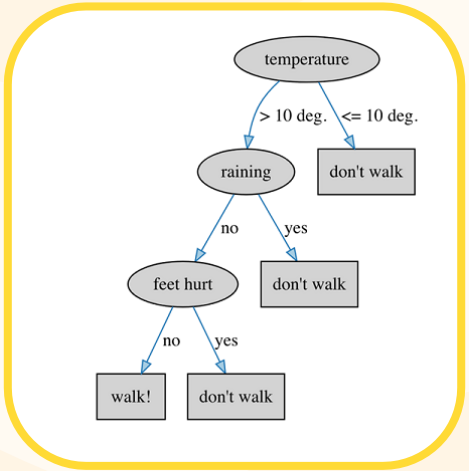
- Changes with Sun + satellite geometry
- 15, 18 + 21 UTC were kept separate

What Model?



Machine Learning:

- Give the model GOES measurements and known LAI values… let it figure it out
- Decision tree: ask a series of questions → LAI prediction
- **Random Forest**
  - many different trees
  - average their predictions
- **XGBoost**
  - builds trees one-by-one
  - each new tree learns from previous errors



- hint: XGBoost is better

Does It Actually Work?

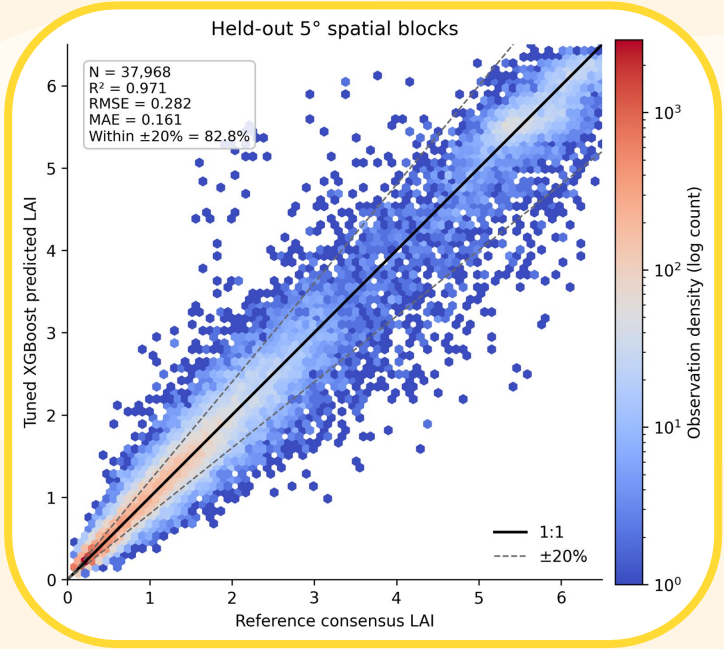


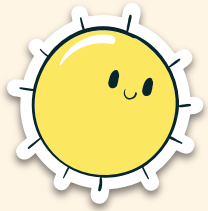
how did we test it?

- Unseen sites: Randomly select train and test sites that do NOT overlap
- Future time: Train on 2025… test on 2026?
- Spatial-block: Group sites into 5° by 5° blocks
    - The model does can’t benefit (cheat) from nearby training locations

metrics:

- **R^2:** how well predictions reproduce variation
- **MAE:** average size of how bad we missed
- **RMSE:** same thing but more weight to larger misses





cool + Future Direction





why ABI?

- Advantages:
  - GOES19 watches the same region throughout the day
  - Much more frequent updates (every 10 minutes)
  - Good for rapid changes?
- Tradeoffs:
  - Coarser spatial resolution
    - ABI 2km, MODIS/VIIRS 500m
  - Saturation
  - Viewing geometry

- Higher frequency observations from GOES?
- Biome specific models?
- Expand domain, maybe other GOES satellites

