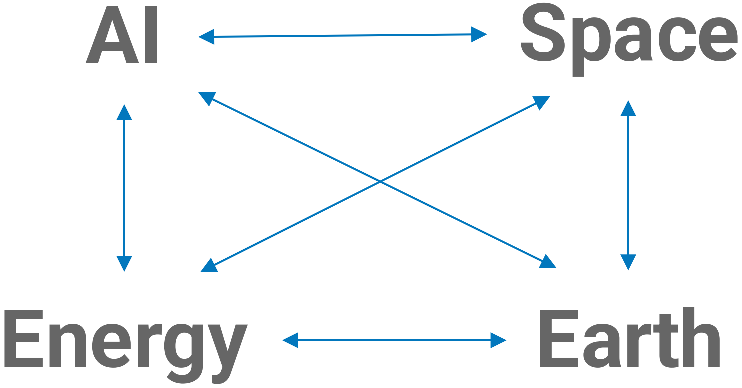
AI + Space + Energy + Earth

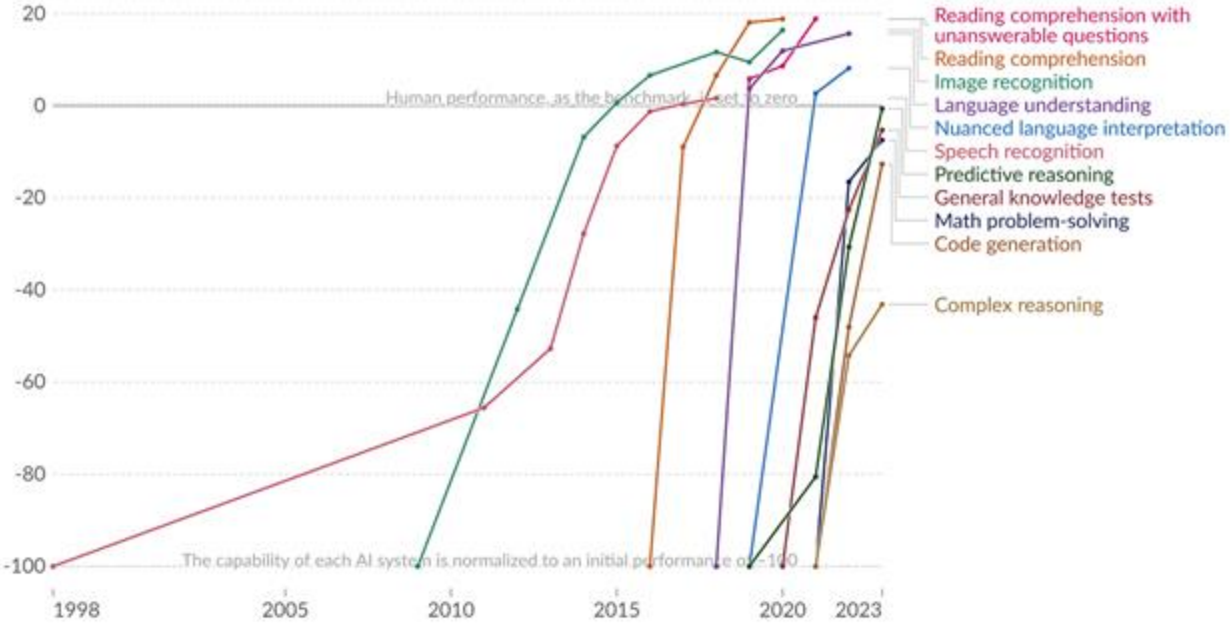
John Platt, Google Fellow
March 27, 2025


AI
Space
Energy
Earth

AI scaling

Test scores of AI systems on various capabilities relative to human performance

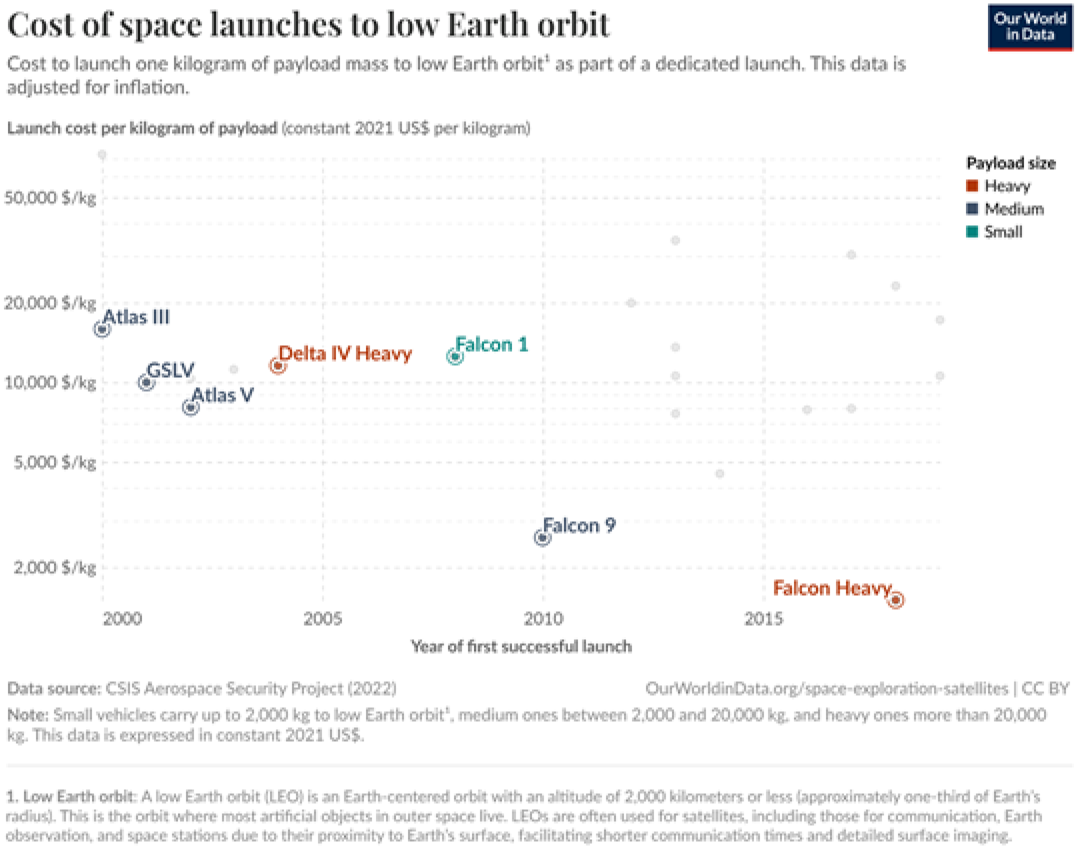
Within each domain, the initial performance of the AI is set to –100. Human performance is used as a baseline, set to zero. When the AI's performance crosses the zero line, it scored more points than humans.



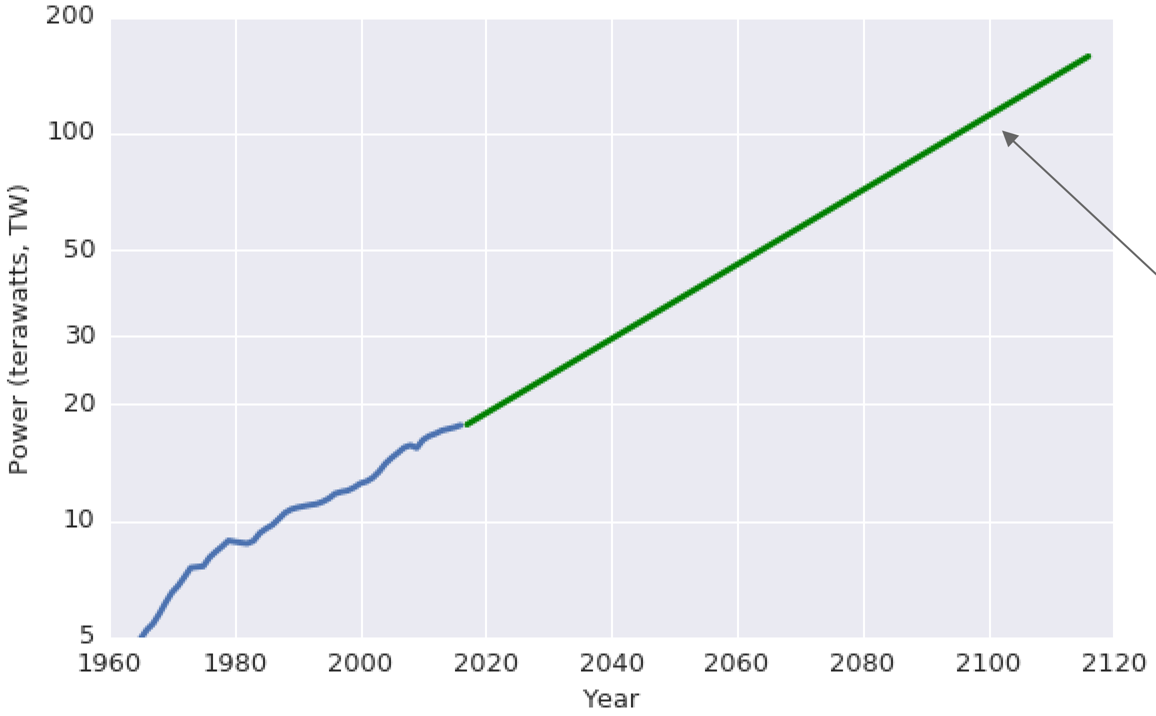
Data source: Kiela et al. (2023)

Note: For each capability, the first year always shows a baseline of –100, even if better performance was recorded later that year.

Space learning curve



Energy use increases



2100 = 113 TW ≈ US power rate for 11.2 billion people

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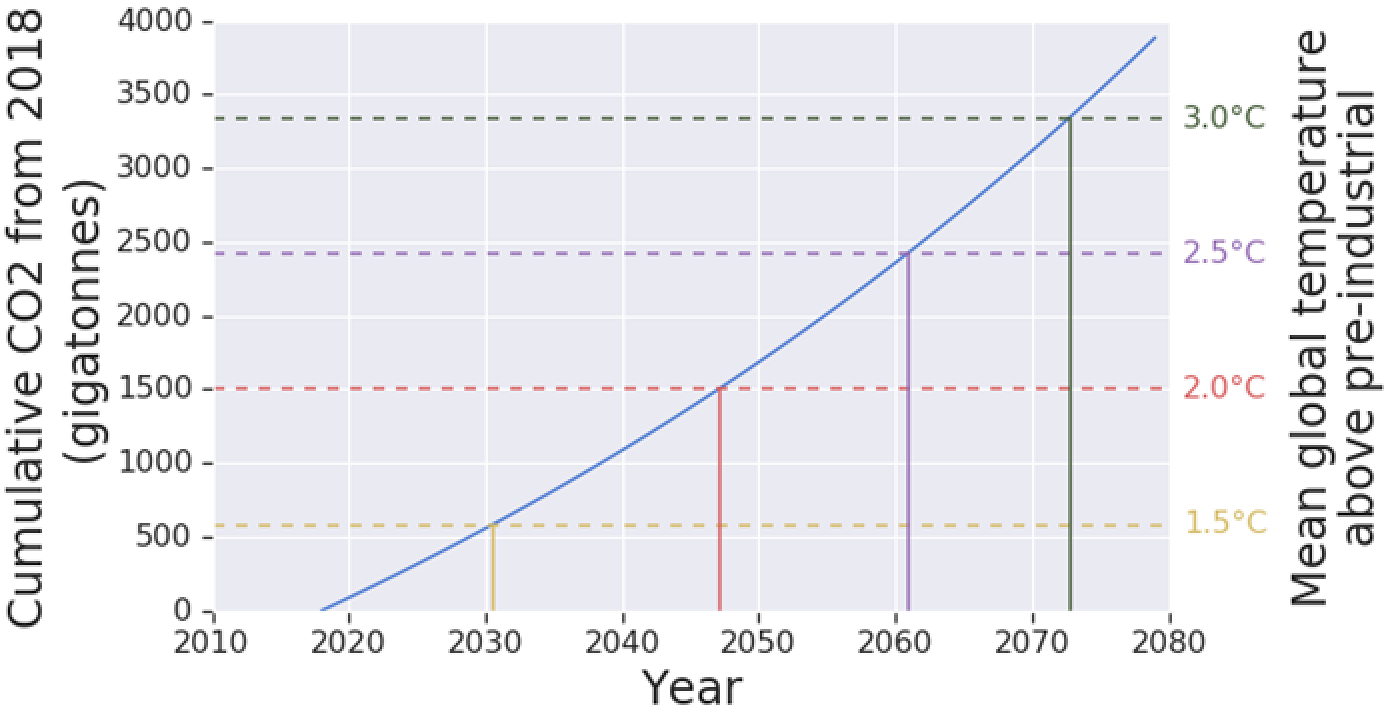
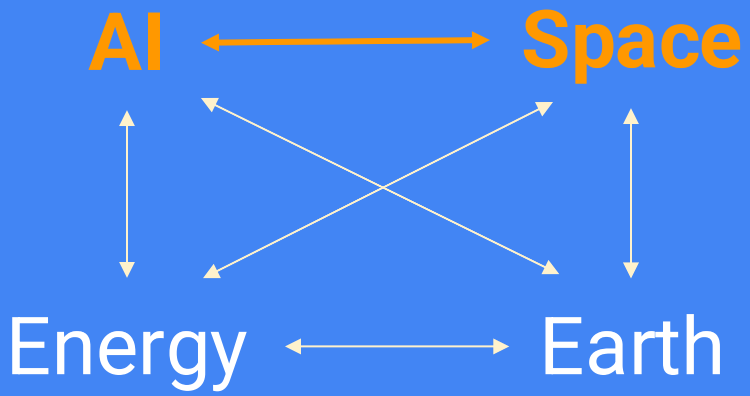
Limitations of climate system



In this talk

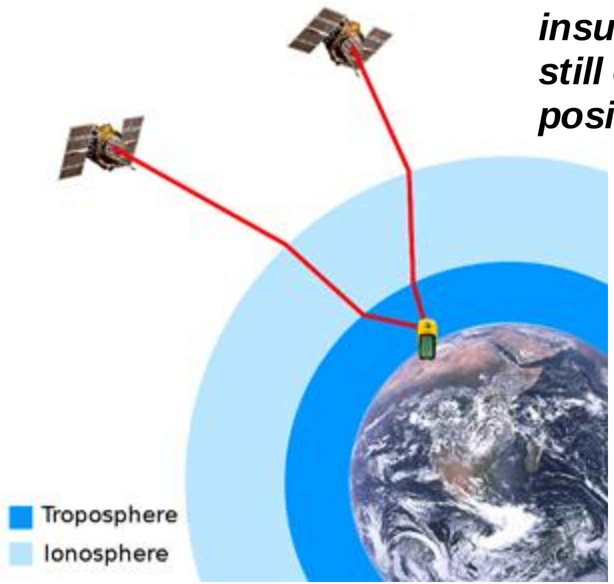
- Measuring ionosphere from phones
- Assessing solar potential of residences
- FireSat
- Some thoughts about large language models

Mapping the Ionosphere from phones



The Ionosphere problem

The existing Klobuchar model is insufficient. Ionospheric distortion is still one of the largest sources of position error.



Satellite signals are refracted by electron density in the ionosphere.

This distorts the perceived location of the satellite and degrades GPS accuracy.

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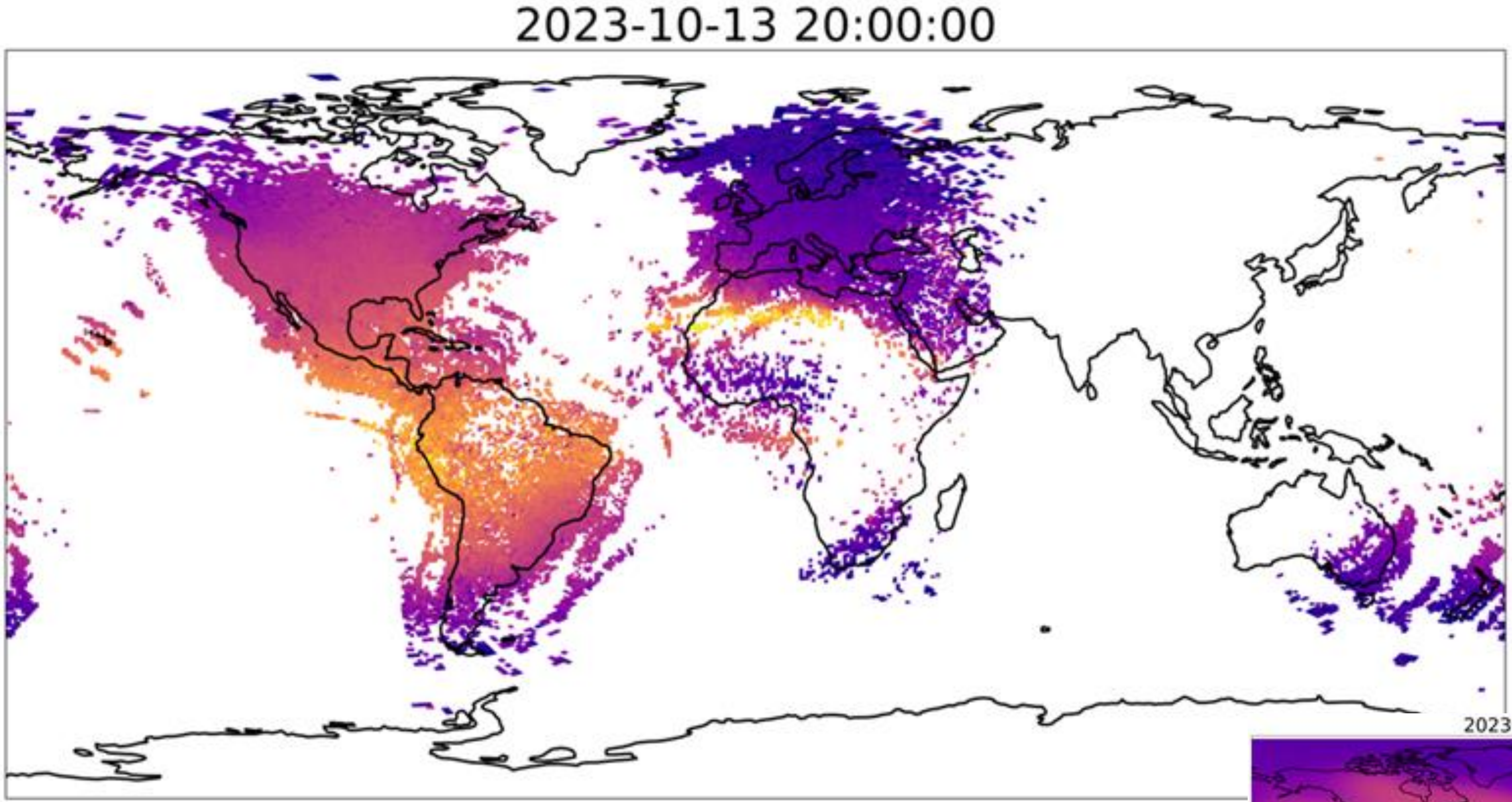
Monitoring Stations have many advantages over Phones… apart from their number.

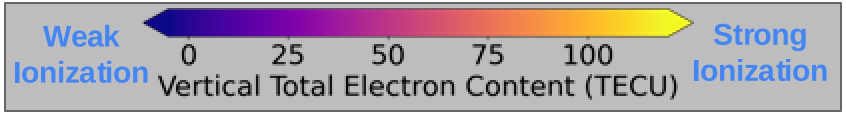
Calibrated scientific instrument

Big expensive antenna

Clear view of the sky

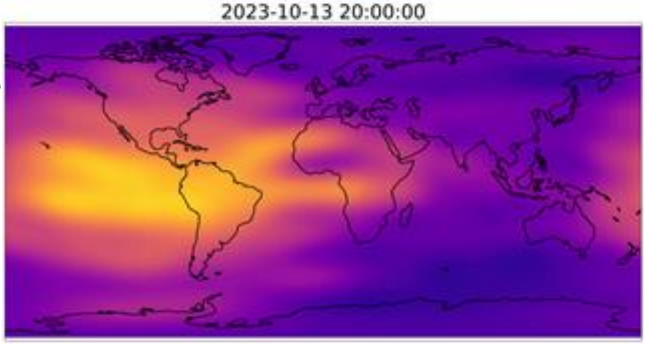
Ubiquitous





Using Phones

Using Monitoring Stations



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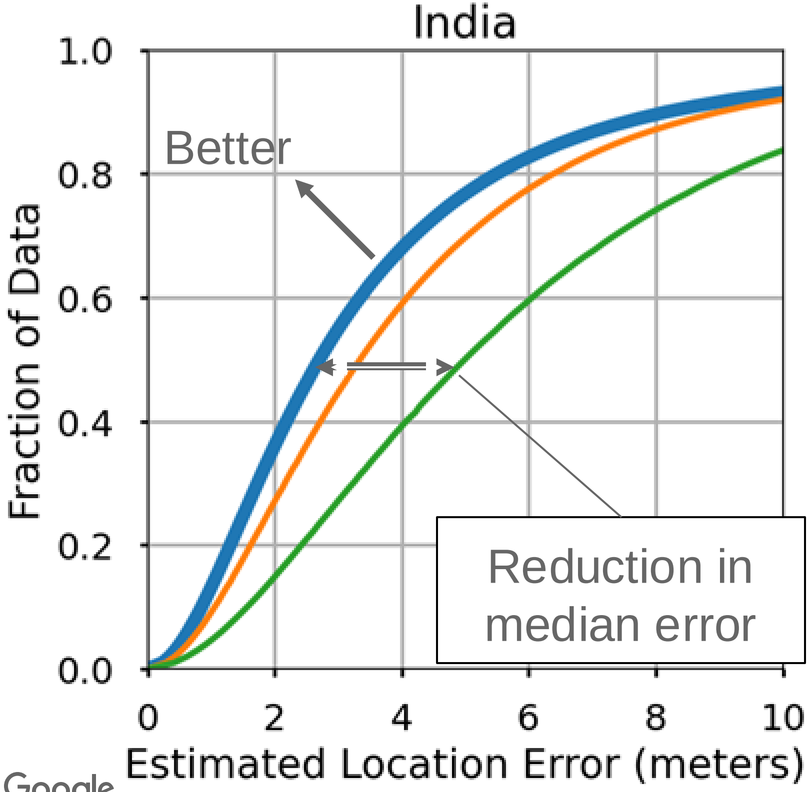
In places like India, with few Monitoring Stations, using Phones provides better performance.

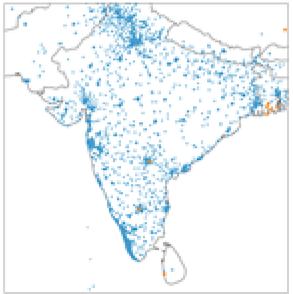


Ionosphere Map

From Phones

From Monitoring Stations

Klobuchar Model - Used for phone navigation today



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Mapping the ionosphere with millions of phones

Jamie Smith, Anton Kast, Anton Geraschenko, Y. Jade Morton, Michael P. Brenner, Frank van Diggelen & Brian P. Williams

Nature **635**, 365–369 (2024) | Cite this article

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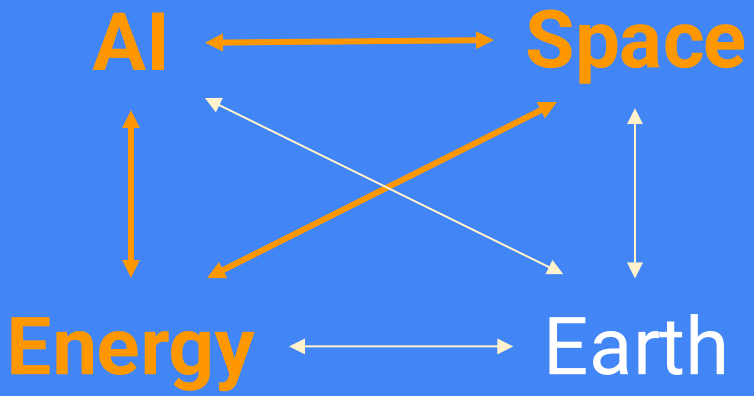
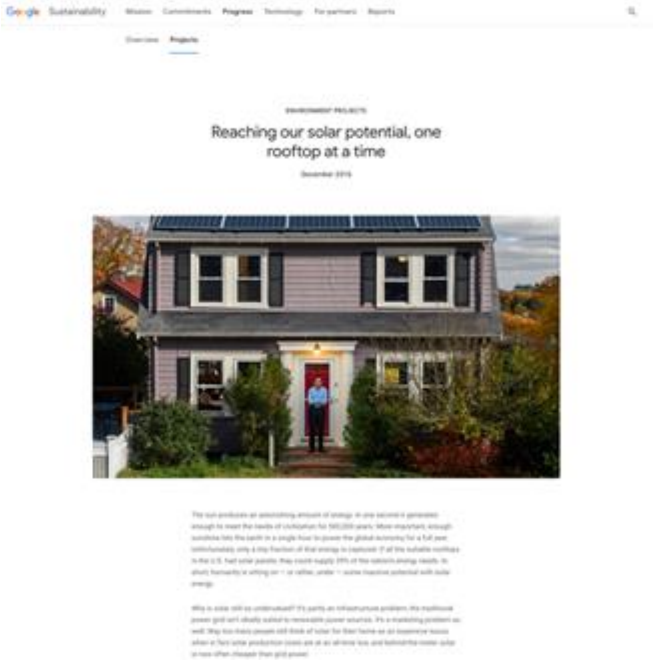
Solar potential of residences



Project Sunroof



Initially launched in 2016, Google's Project Sunroof estimates the solar potential of individual buildings.

Estimating Solar Potential

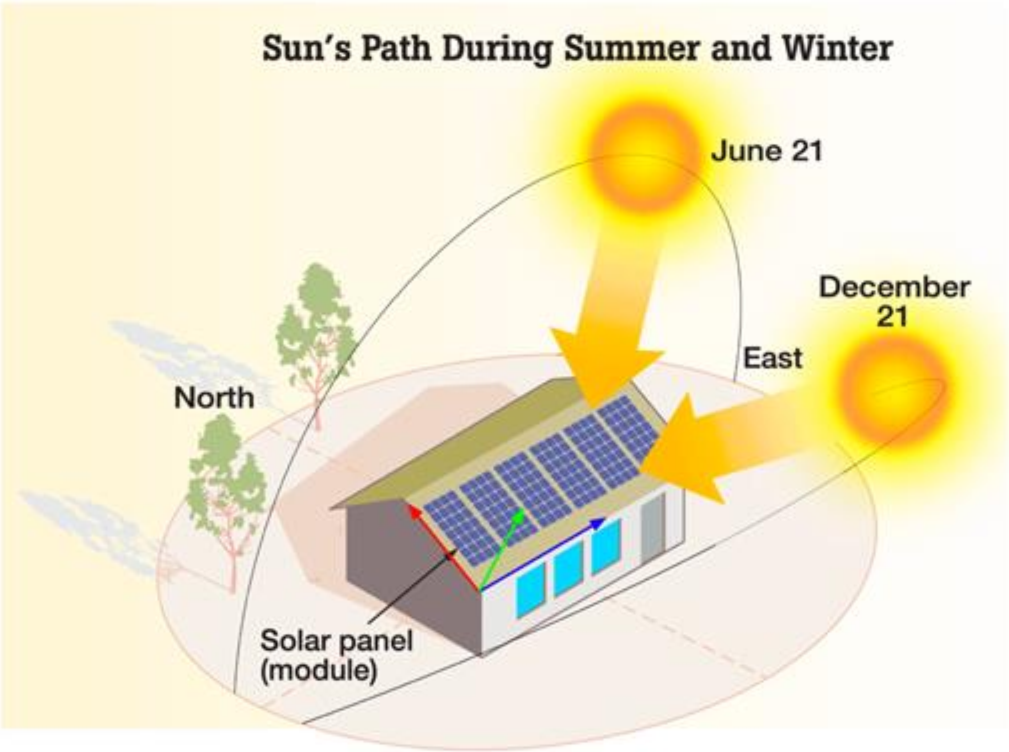
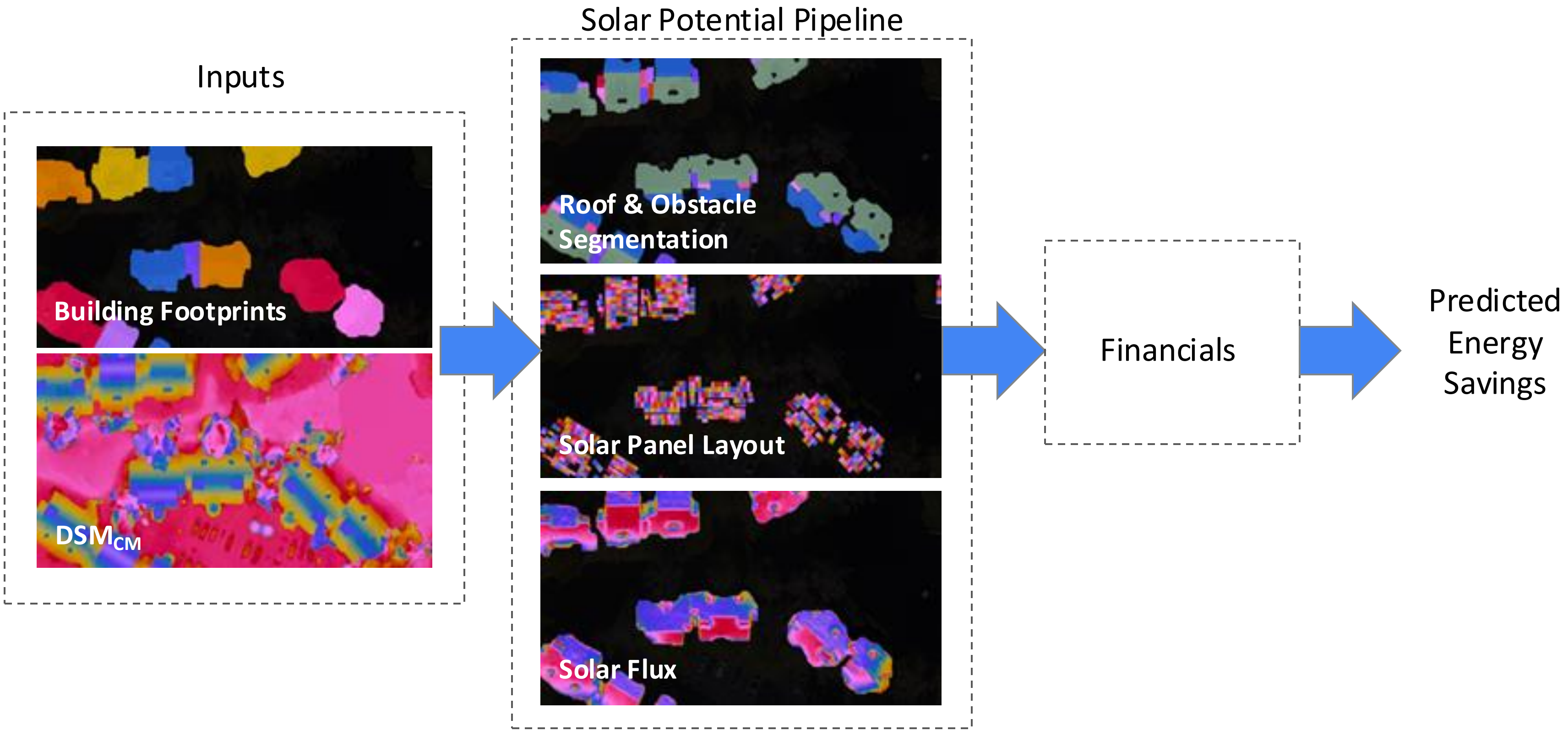
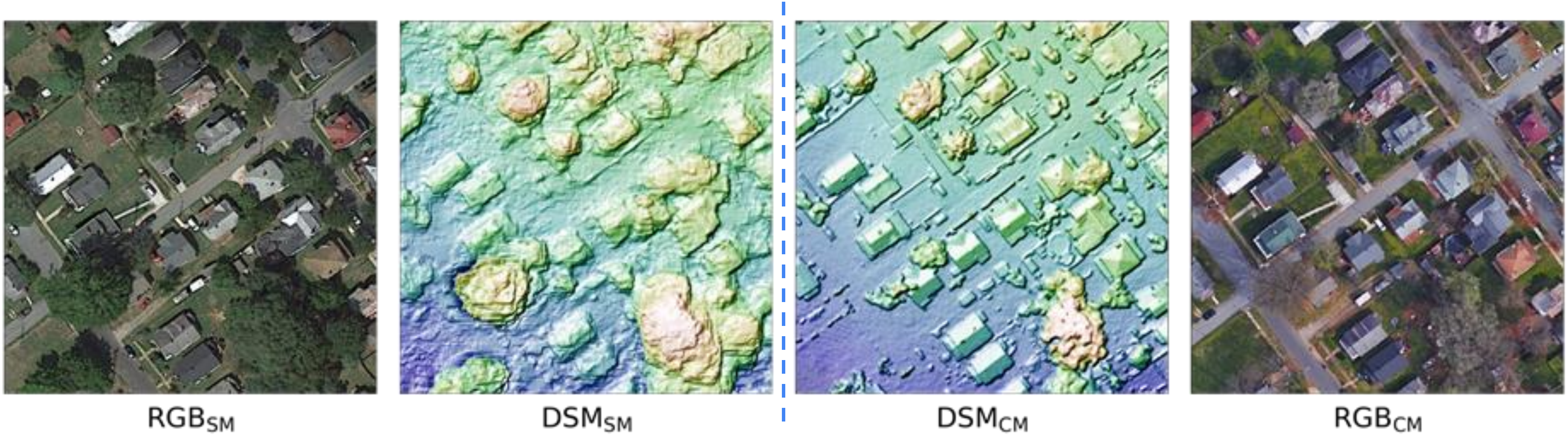


Image credit: US Department of Energy

Sunroof Pipeline



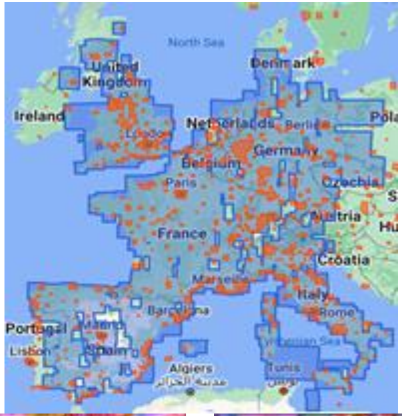
Available Data and its Coverage



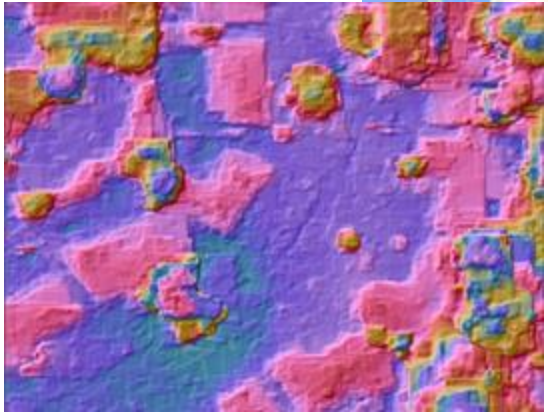
Centimeter scale (CM) data covers only 1/10th the area covered by sub-meter scale (SM) data. Unfortunately, Sunroof cannot operate on SM scale data directly.

Generating high quality Digital Surface Maps

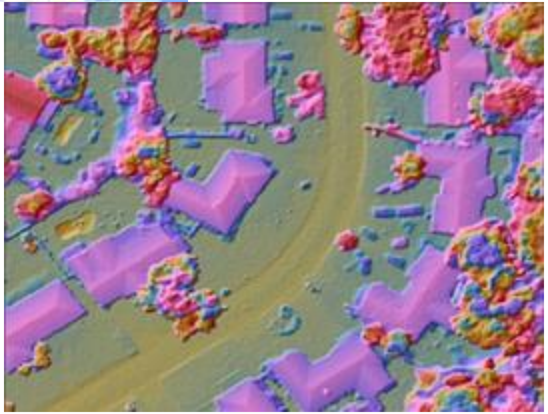
High quality maps have limited availability



Blue: Low quality coverage
Orange: High quality coverage

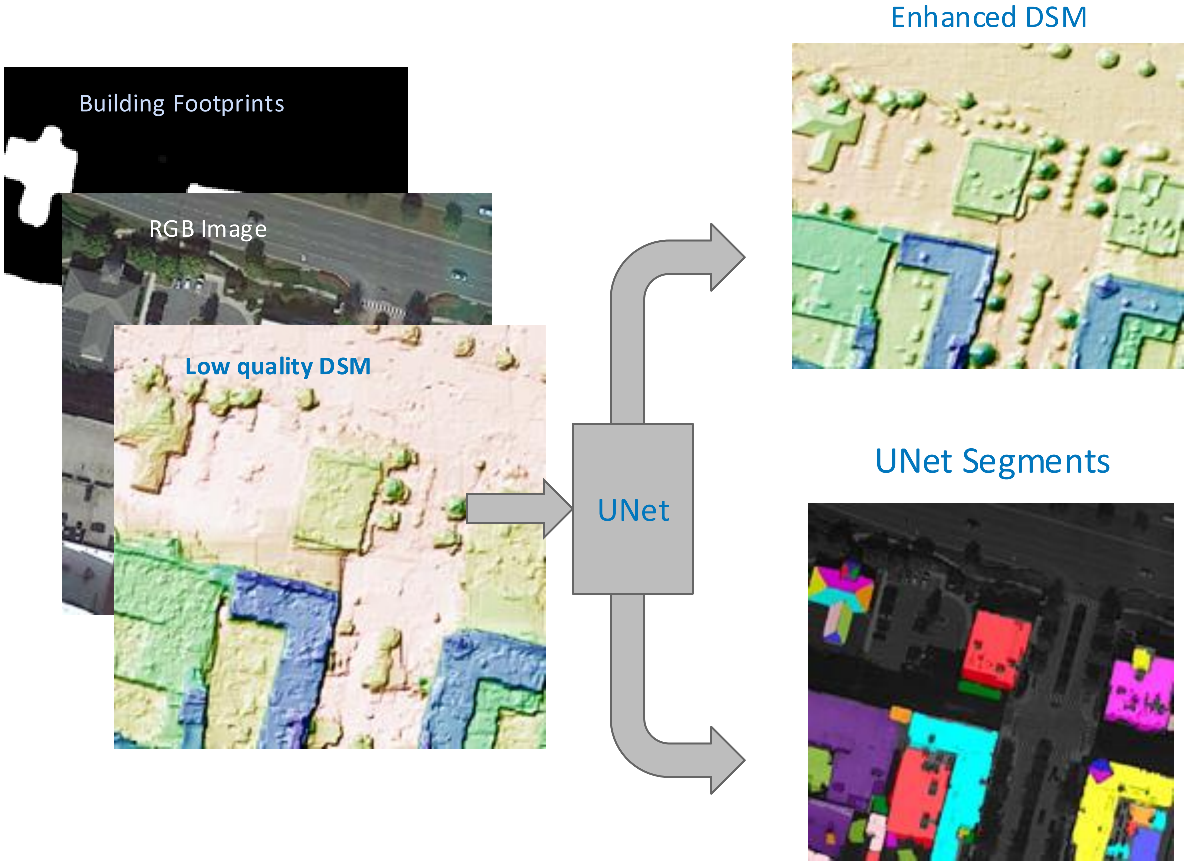


Low quality (DSM)



High quality DSM

Superresolution for DSM and roof segmentation



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Google Maps Platform - Solar API

Before

After

https://arxiv.org/abs/2408.14400

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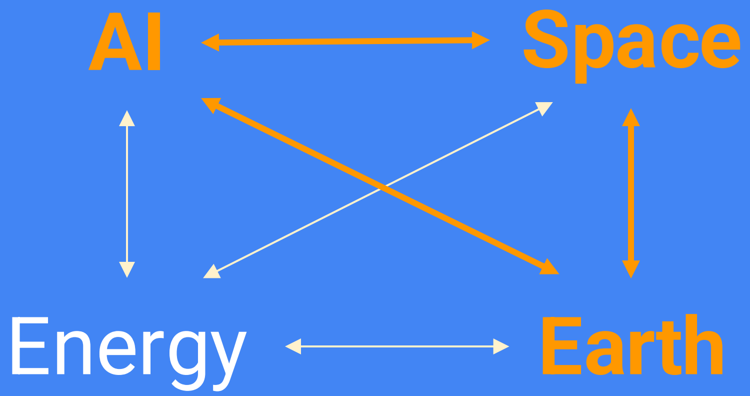
FireSat: quickly detecting wildfires from space



Global trend towards more wildfires

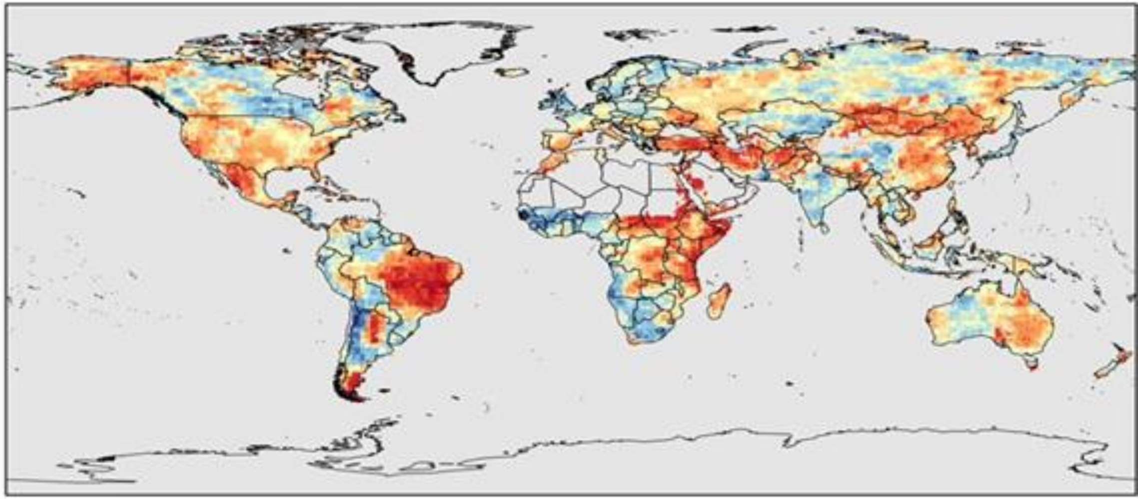
We expect a 15-50% increase for US fires from 2020 levels

Global

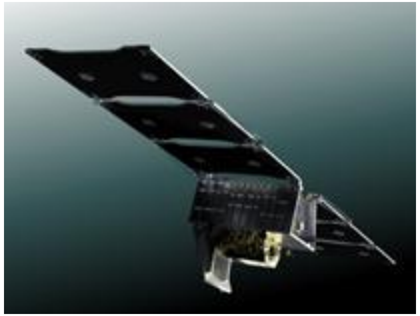
- 330,000 deaths/year (smoke)
- $100B/year in direct loss
- $300B/year in indirect damage
- $15B/year today for suppression

US:

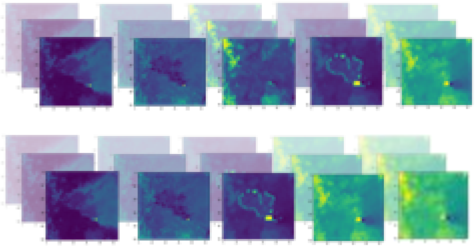
- About 20% of above numbers
- Growing ~15-50% this century.



Idea: Wildfire Ignition Detection



Real-time Satellite imagery



Ignition detection using machine learning

Realtime data sharing with fire agencies

Google

What the US has now

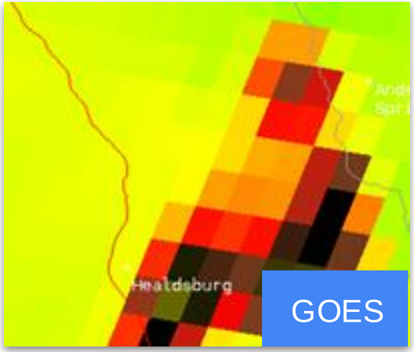
Weekly, 30m resolution
includes IR band

Can see small hot fires (~20m^2)

12 hours, ~500m resolution
includes IR band

Can see medium fires (~5k m^2)

10 minutes, 2km resolution
includes IR band

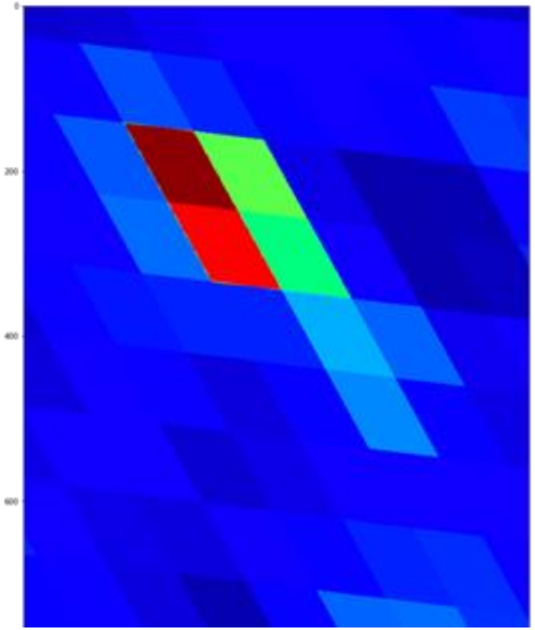


Can see large fires (~1 hectare)

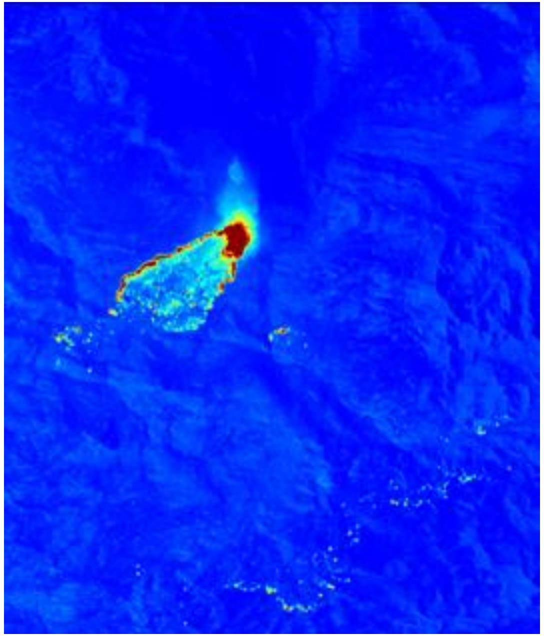
Daily, 3-5m resolution
No IR band

Can see fires *sometimes*

Today vs FireSat (Real Imagery)



GOES (2km by 2km)



Aerial (50m by 50m)

Google

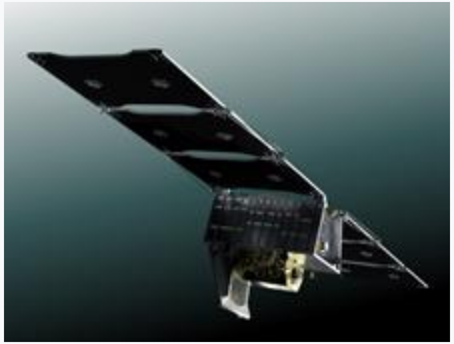
FireSAT: Specs

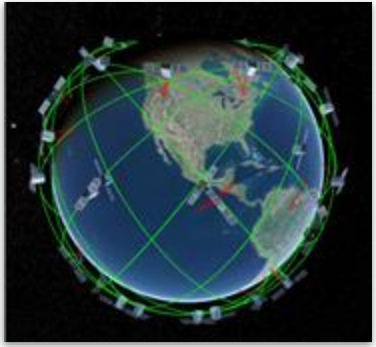
Goal: Take 50m res. image of the earth every 20 minutes to detect/track small fires.

Constellation costs have come down significantly over the last 15 years, this opens up a lot of potential opportunity.

50+ satellites in full constellation	**20 min** avg revisit time for anywhere on Earth	**50m** resolution compared to 2km today	**6** Band channels covering red through infrared

Source: Muon





Using AI-based superresolution

Google

Launched first satellite: 14 March 2025

Photo courtesy of SpaceX

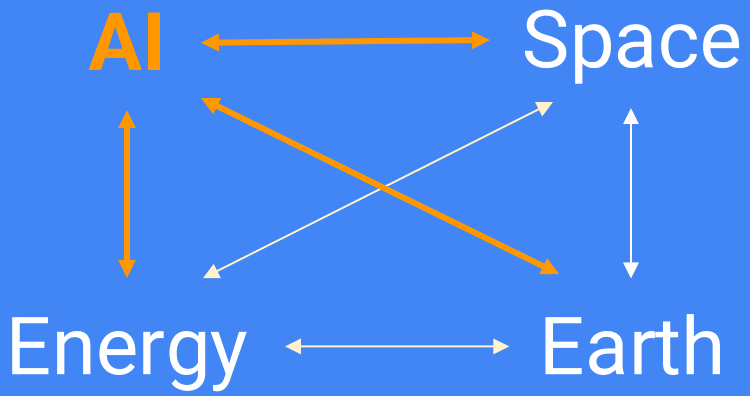
Partnerships with

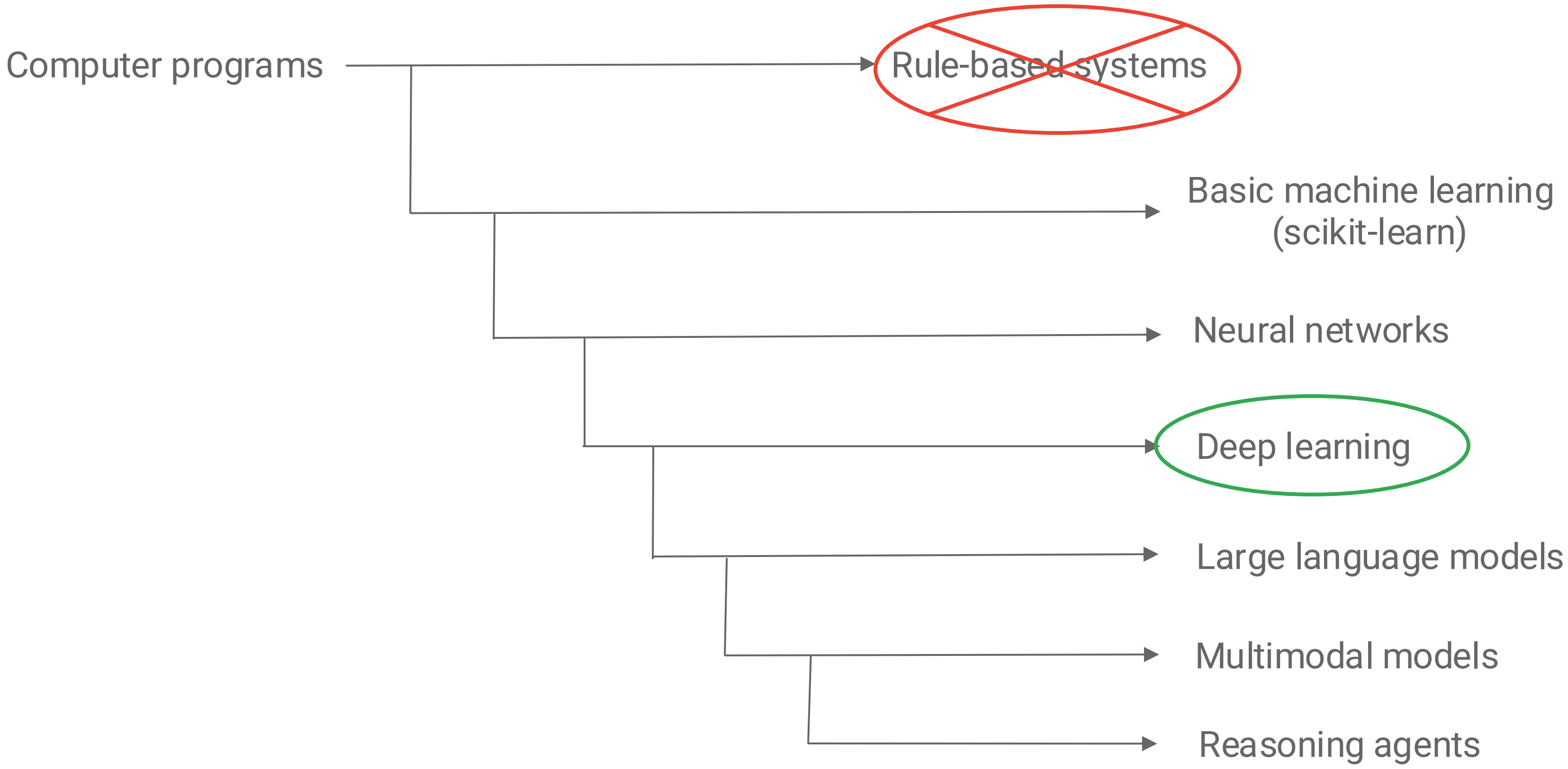
Muon Space

Earth Fire Alliance

- Image calibration will take between 1-12 weeks
- Build AI analysis pipeline using data from first satellite
- Operational pipeline planned for trio launched in 2026

Reflections on use of AI




Computer programs
Rule-based systems
Basic machine learning
(scikit-learn)
Neural networks
Deep learning
Large language models
Multimodal models
Reasoning agents

Google

Deep learning for space/aeronautics/Earth systems

- Prediction of complex systems
- Super-resolution
- Fill-in missing data
- Solving inverse problems

How can reasoning agents help space / aeronautics / Earth?

Dramatically speed up building software systems

Future of LLMs and agents for space is wide open