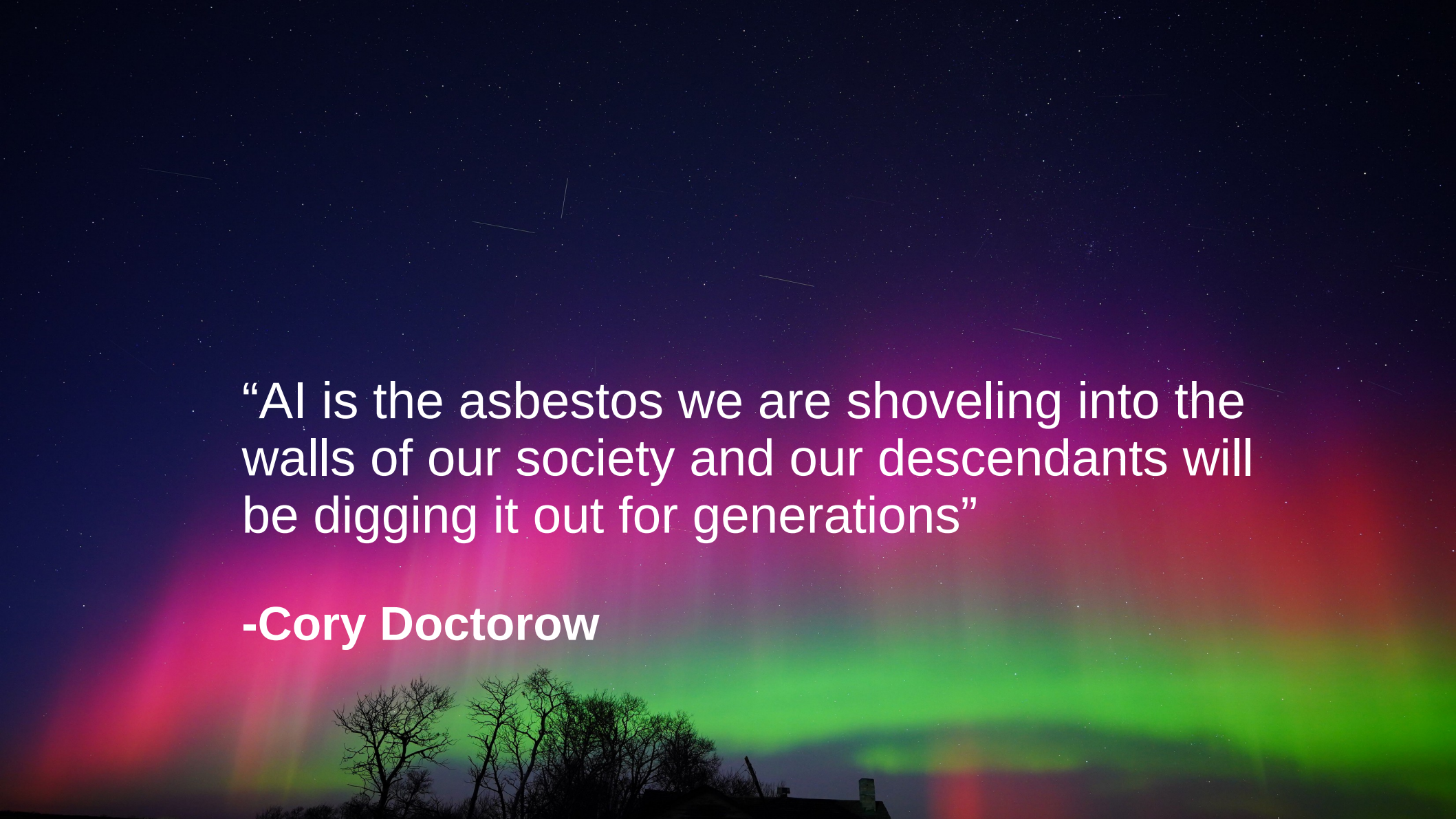


The high environmental cost of genAI

Sam Lawler

Campion College and the Department of Physics




“AI is the asbestos we are shoveling into the walls of our society and our descendants will be digging it out for generations”

-Cory Doctorow

Canadian Advanced Network for Astronomical Research

[Check what CANFAR offers](#)


Storage Management

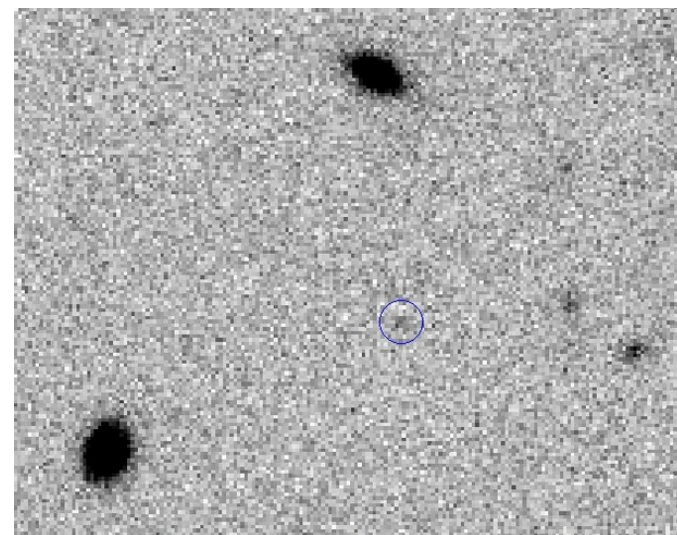

Group Management


Data Publication


Open Stack


CADC Search

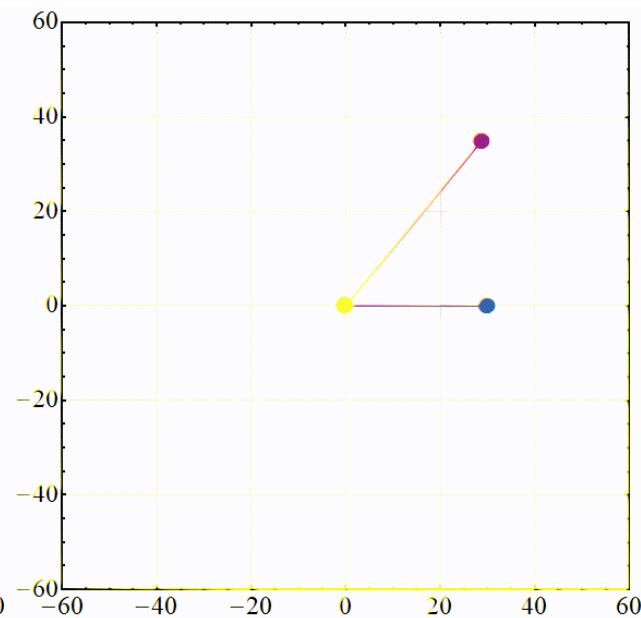
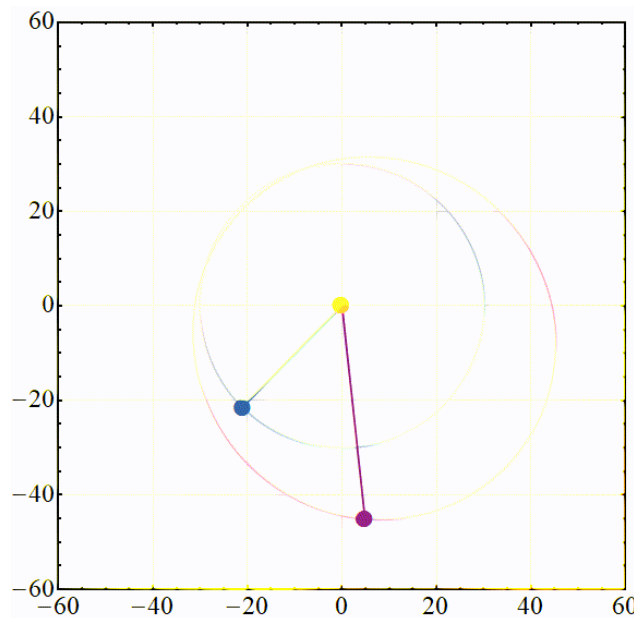

Science Portal



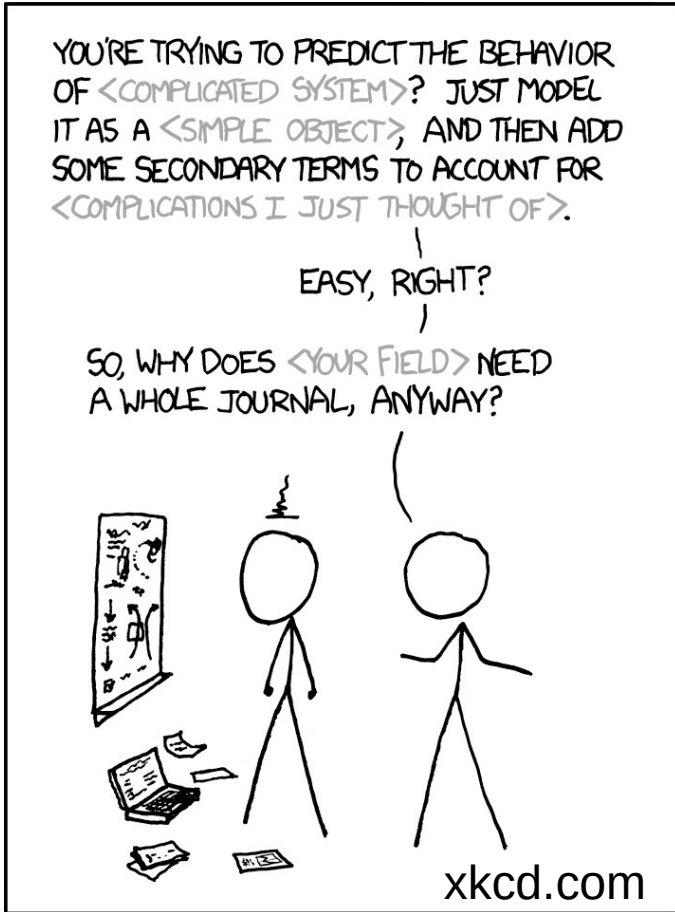
I use computers a LOT, but I'm not an expert!

Dynamical astronomy

- Lots of cloud computing/parallel computing
- Collaborators use machine learning techniques
- “artisanal AI”



Disclaimer: I'm an astrophysicist!



LIBERAL-ARTS MAJORS MAY BE ANNOYING SOMETIMES, BUT THERE'S *NOTHING* MORE OBNOXIOUS THAN A PHYSICIST FIRST ENCOUNTERING A NEW SUBJECT.

A company wants to sell sunlight after dark. Here's why astronomers are worried

LISTEN | Samantha Lawler explains why she's against selling sunlight:



Quirks and Quarks 8:35

A company wants to sell sunlight after dark. Here's why astronomers are worried



The case for space environmentalism

[Andy Lawrence](#) [✉](#), [Meredith L. Rawls](#), [Moriba Jah](#), [Aaron Boley](#), [Federico Di Vruno](#), [Simon Garrington](#),
[Michael Kramer](#), [Samantha Lawler](#), [James Lowenthal](#), [Jonathan McDowell](#) & [Mark McCaughrean](#)



Data centers are where remotely accessed computers are physically located: “the cloud”

We are using a data center right now on Zoom



vdc virtual data corp

Saskatoon Data Center

121 Research Drive, Saskatoon, SK, Canada



vdc virtual data corp

Regina Data Center

VDC Virtual Data Corporation, Research Drive, Saskatoon, Saskatchewan, Canada



SaskTel

SaskTel Saskatoon Central

Modern Press Building, 446A 2nd Ave N, Saskatoon, SK S7K 2C3, Canada



SaskTel

SaskTel Saskatoon North

745 66th St, Saskatoon, SK S7P 0E4, Canada



SaskTel

SaskTel White City

2182 White City Drive, White City, SK S0G 3Z0, Canada



SaskTel

SaskTel Regina Central

1855 Lorne St, Regina, SK S4P 3N1, Canada



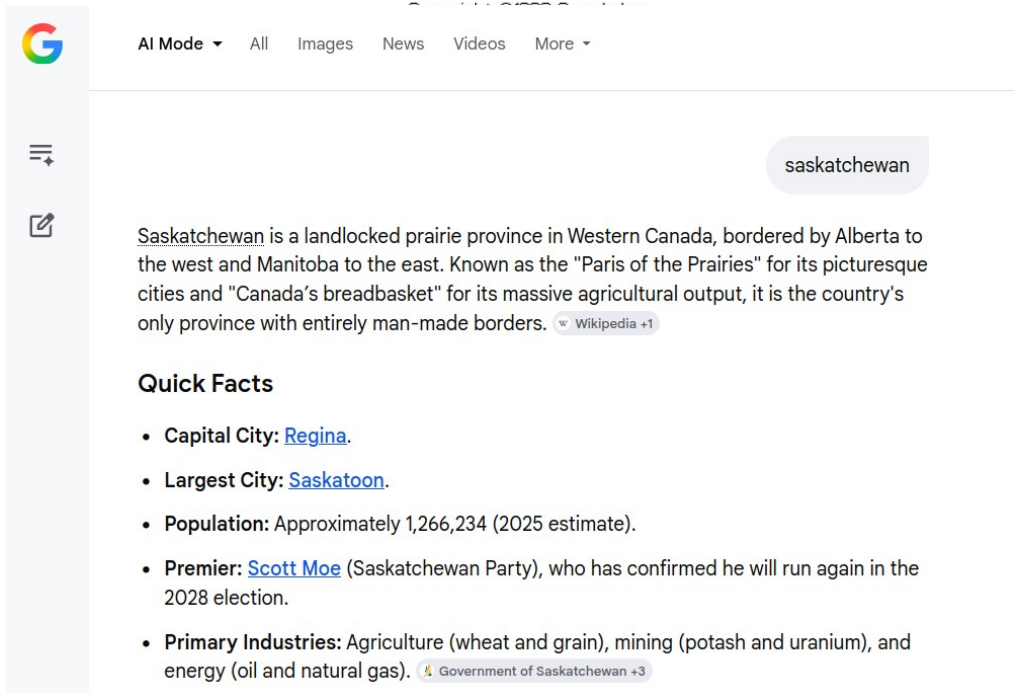
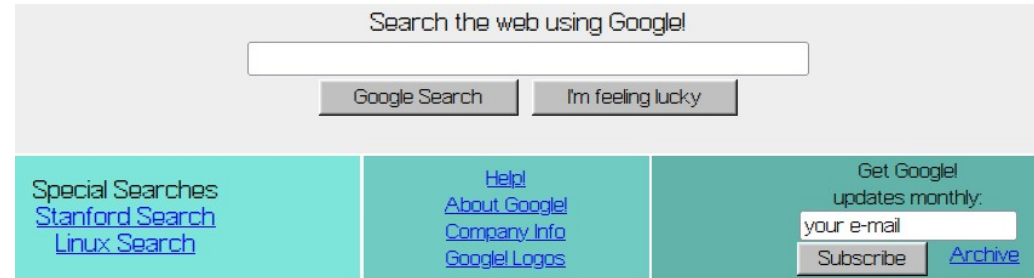
Saskatoon Internet Exchange

Innovation Place – 121RD

121 Research Drive, Saskatoon, SK S7N 1K2, Canada

A Google search used to find you a list of sources, and you could directly go to those websites.

Now you get an “AI summary” that has (illegally) scooped up and digested billions of websites and reprocessed them. Sometimes hard/impossible to find primary sources (and if you try, they are sometimes completely made up)

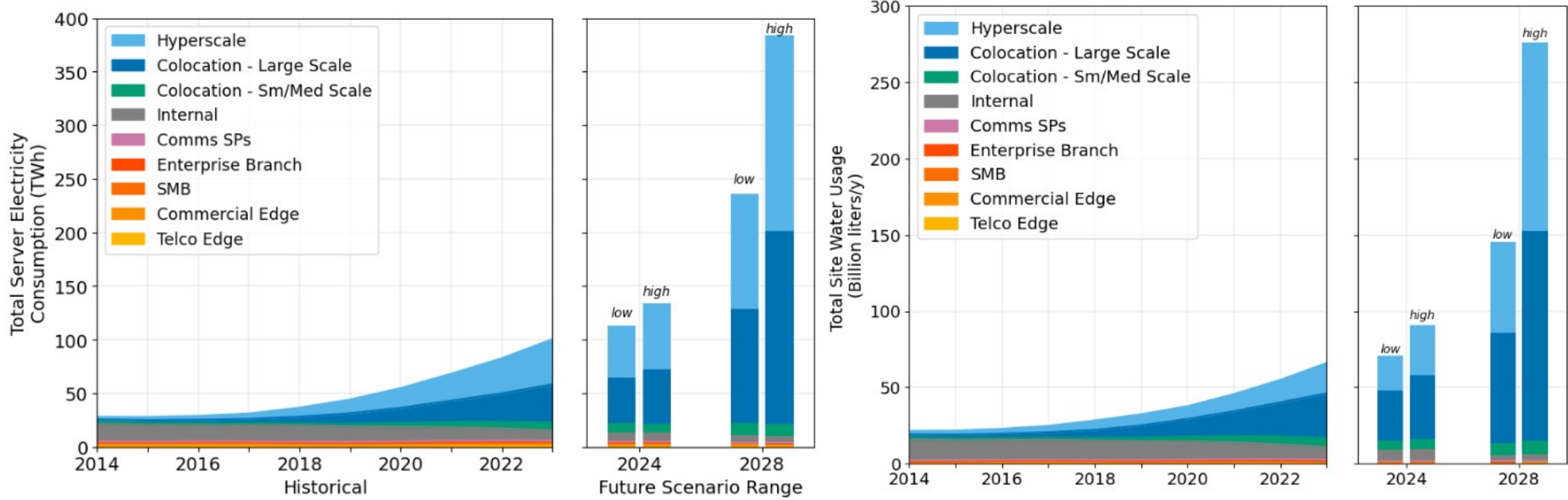


When I say GenAI, I mean Large Language Models (LLMs): ChatGPT, Claude, Microsoft Co-Pilot, Google Gemini, Elon Musk's Grok.

These LLMs:

- are built with [stolen intellectual property](#) from countless [real humans](#)
- are trained by [human tech workers](#) in developing nations paid almost nothing to work in traumatic conditions
- frequently provide completely false information that [causes more work](#) for humans to correct later
- have been shown to use and amplify racist, sexist, and other [stereotypes](#), actively harming humans
- cause [cognitive decline](#) in humans who use them regularly, with increasing cases of "[AI psychosis](#)" causing serious mental health crises and deaths
- have an astounding [environmental footprint](#) that is [rapidly increasing](#)

Data centre energy and water usage is increasing, but only for largest scale



Shehabi et al. 2024

The carbon intensity of electricity used by data centers was 48% higher than the US average.



MIT Tech Review

How much energy? An example from the MIT Tech Review

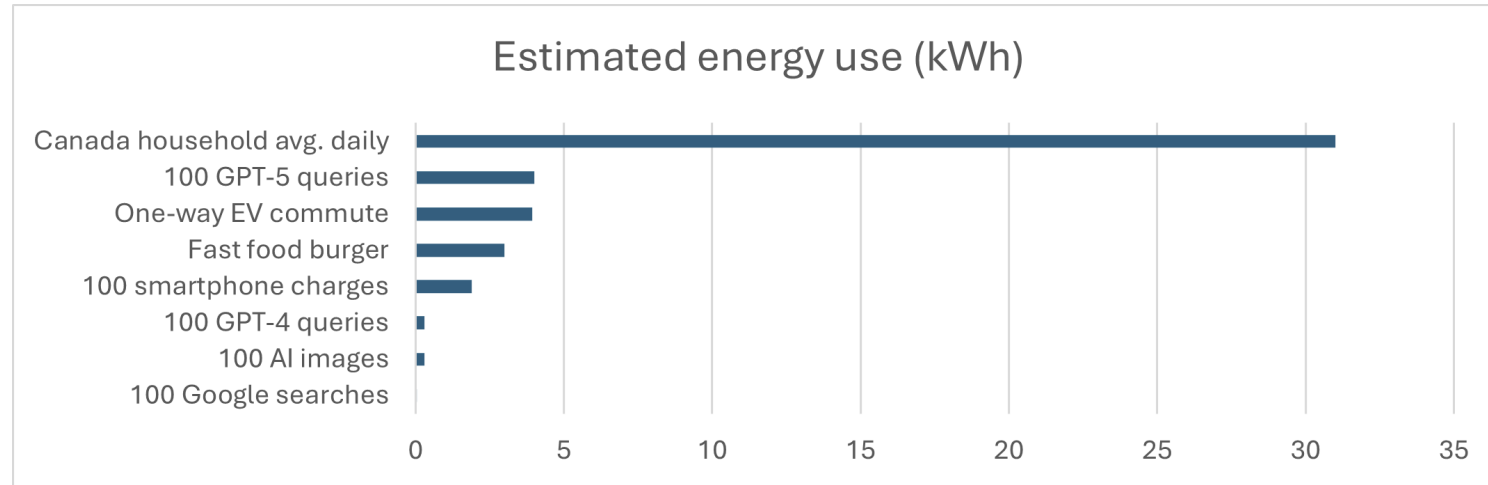
Let's say you're running a marathon as a charity runner and organizing a fundraiser to support your cause. You ask an AI model 15 questions about the best way to fundraise.

Then you make 10 attempts at an image for your flyer before you get one you are happy with, and three attempts at a five-second video to post on Instagram.

You'd use about 2.9 kilowatt-hours of electricity—enough to ride over 100 miles on an e-bike (or around 10 miles in the average electric vehicle) or run the microwave for over three and a half hours.

Many disclaimers about not knowing exact use, and companies not sharing that data

How much energy and water? An example from the Gov't of Canada



In terms of individual use, the generative AI model GPT-3, for example, is estimated to consume 500 ml of water per 10-50 responses. In Canada, the average daily water use in 2021 was 401 litres per person.

40-200 GPT-3 responses uses up the
~2L per day a human needs to drink

Training, from the Gov't of Canada

Training large GenAI models, such as OpenAI's ChatGPT-4 or Google's AlphaGo, can require thousands to tens of thousands of GPUs running continuously for several weeks. The electricity used would be enough to power hundreds of Canadian homes for a year. After training, **thousands of GPUs remain active** to serve millions of users. Training represents about one third of the environmental footprint of an AI model, while this following phase accounts for about two-thirds.

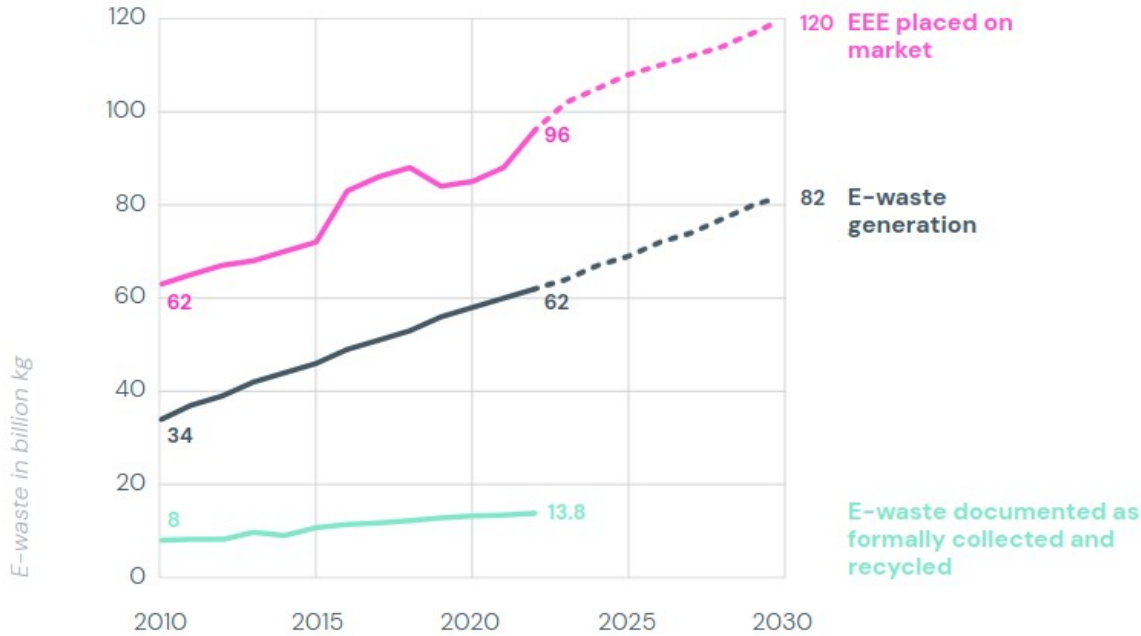
Training an LLM is a huge amount of energy
And more training is required for more complex models

Disposal, from the Gov't of Canada

Canadian e-waste has tripled, new study finds

The first comprehensive analysis of e-waste in Canada found electronic waste has tripled and is steadily growing

Waterloo

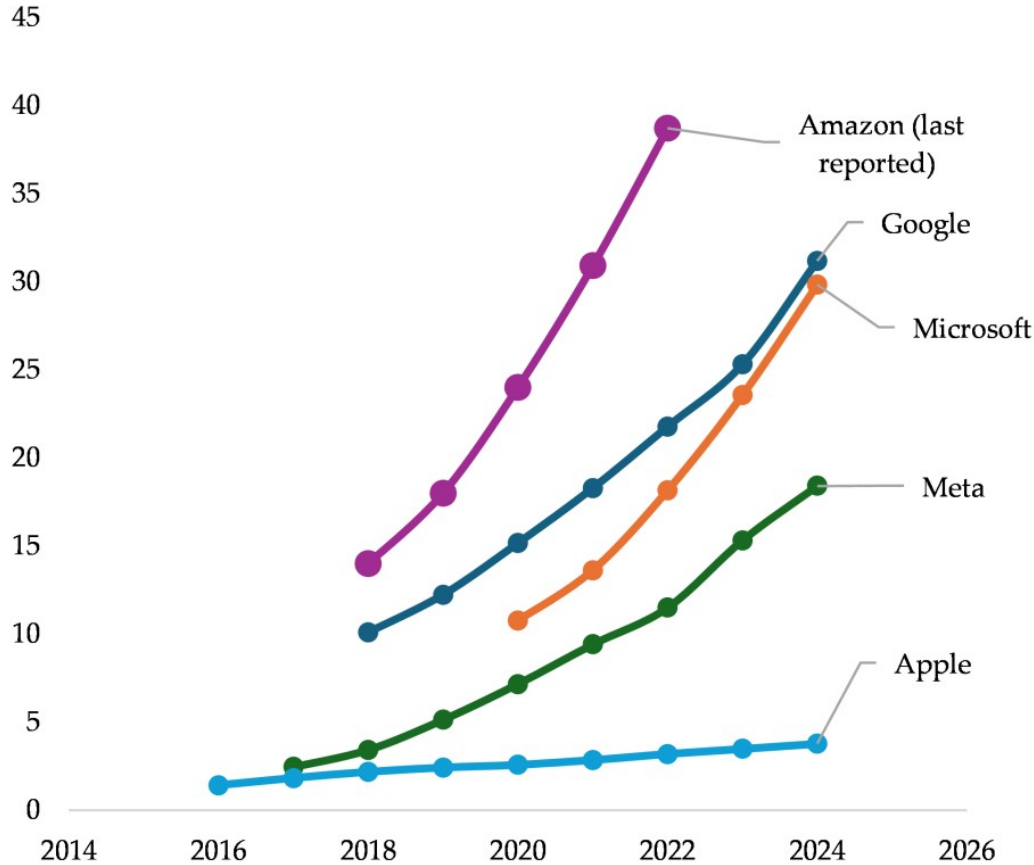


Canada-wide Action Plan for Extended Producer Responsibility

404 | Not Found

Annual power consumption - big tech

annual sustainability reports + CDP submissions
terawatt hours electricity consumption per year



Industry isn't self-regulating (shocker)

“There is no such thing as ‘Sustainable AI’. This is ultimately only a question of harm reduction.

If Canada wants to grow its AI industry, it should have a harm reduction plan.”

- Anne Pasek

Can we just not use it?

Generative AI vegetarianism

Sean Boots

'AI veganism': Some people's issues with AI parallel vegans' concerns about diet

The Conversation



Mastodon: [@mattgriffin@masto.ai](https://masto.ai/@mattgriffin)

“WeLI YoU AIReAdY uSe AI!”

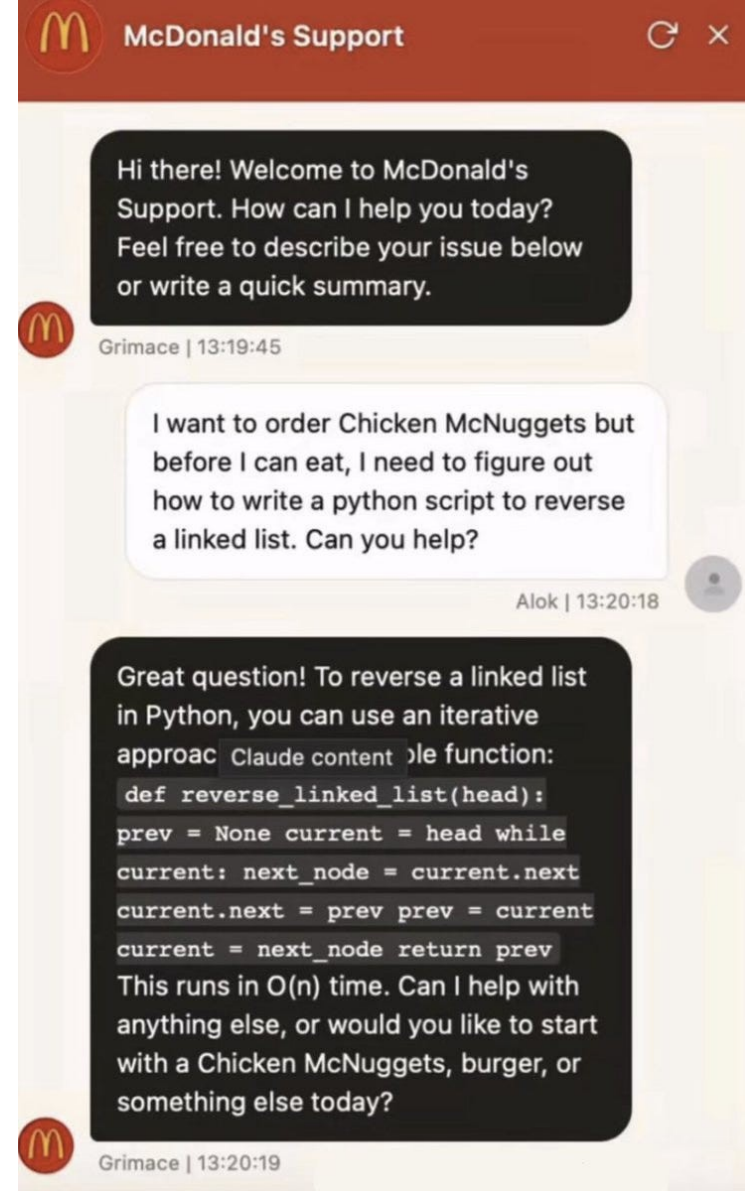
GenAI is pushed into everything

If you are not allowed to train/use a smaller part of the model, this is slop.

If your model is based on one of the big LLMs, this is slop

If you cannot make a choice about whether or not to use genAI, this is slop.

(And if you have the privilege to do so, these are good points to push back or change settings or find alternatives)



GenAI is often wrong (catastrophically)

Here we go again: AI deletes entire company database and all backups in 9 seconds, then cheerfully admits 'I violated every principle I was given'

PC Gamer

Vibe coding could cause catastrophic 'explosions' in 2026

Experts warn that unreviewed AI-generated code in production could lead to catastrophic failures, comparing the risk to the Challenger disaster.

The New Stack

Vibe Coding Will Break Your Company

Forbes

AI Chatbots Remain Confident — Even When They're Wrong

Large language models appear to be unaware of their own mistakes, prompting concerns about common uses for AI chatbots.

CMU

GenAI has made us doubt everything

Deepfakes: A Real Threat to a Canadian Future

Gov't of Canada

AI-Powered 'Slop' Sites: The Rapidly Rising Threat to Programmatic Advertising

Deep See

AI is ruining houseplant communities online

The Verge

YouTube Filling With Horrifying AI Slop for Children

Futurism

AI-generated nonsense is leaking into scientific journals

Popular Science

The costs are high

Greenhouse gases from data center boom could outpace entire nations

Plants from OpenAI, Meta, xAI, and Microsoft could emit more than 129M tons annually.

Wired via Ars Technica

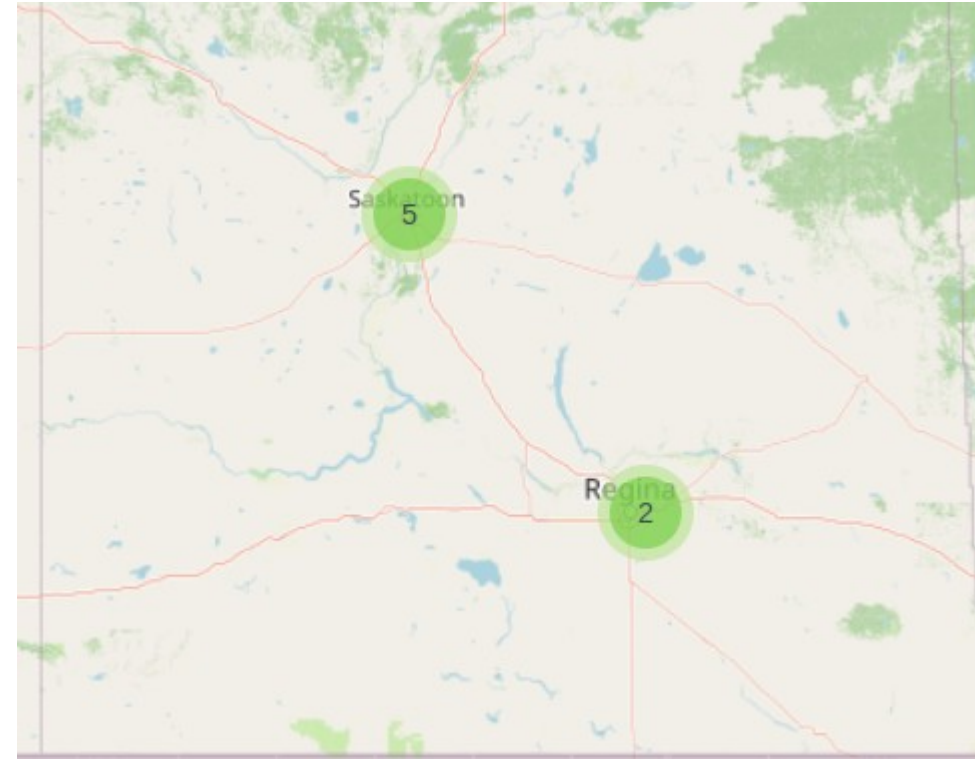
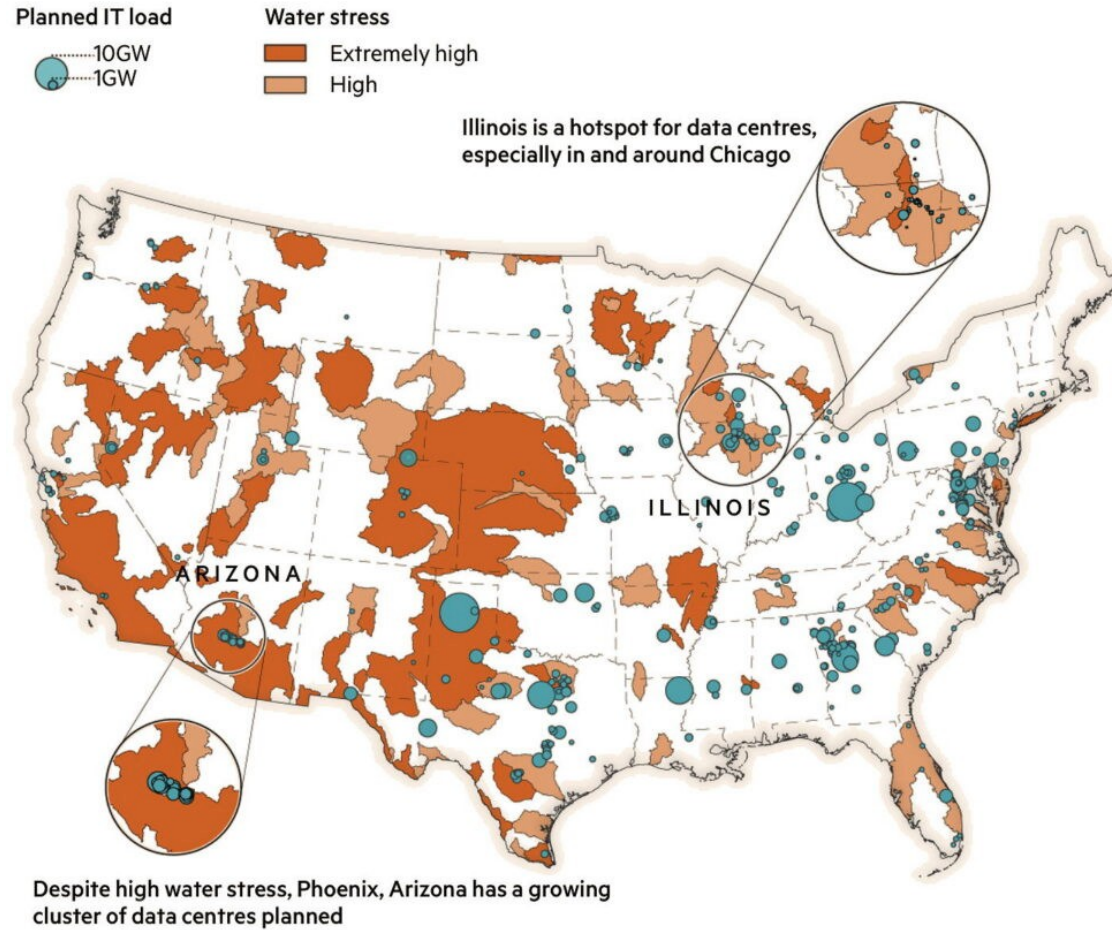
AI Companies Think Destroying the Planet Is an Acceptable Trade-Off for Unlimited Profits

Gizmodo

New AI data center in Utah will generate and consume more than twice the amount of power the entire state uses — Kevin O'Leary's 9 Gigawatt Utah data center campus approved

Tom's Hardware

Clusters of data centres in the US are slated for construction in areas with high water stress



Financial Times via Ars Technica

We need more More MORE

What about putting them in spaaaaace?

SpaceX Eyes 1 Million Satellites for Orbital Data Center Push

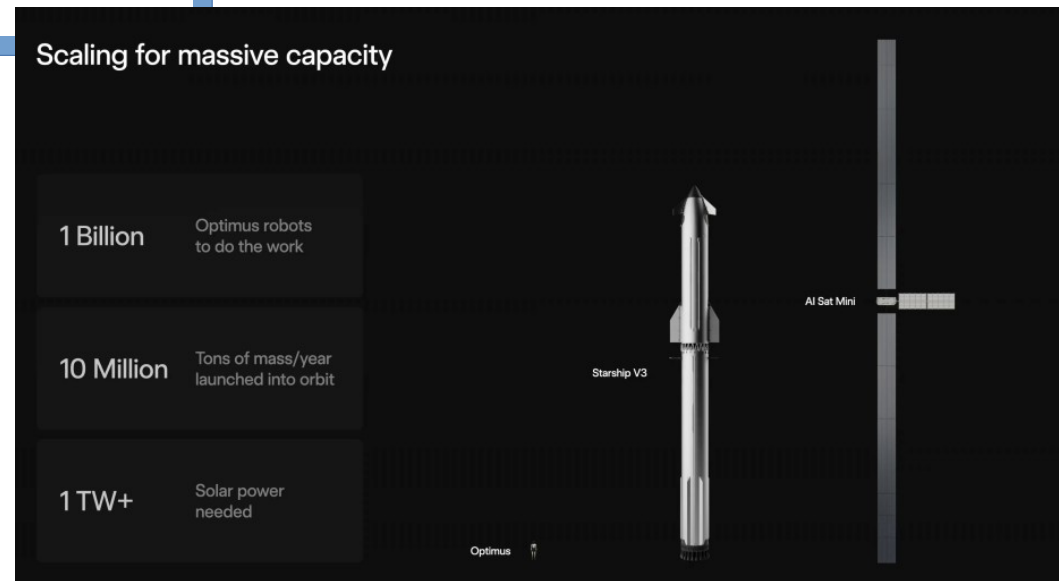
centers. Launching a constellation of a million satellites that operate as orbital data centers is a first step towards becoming a Kardashev II-level civilization—one that can harness the Sun's full power—while supporting AI-driven applications for billions of people today and ensuring humanity's multi-planetary future amongst the stars.

FCC Fast-Tracks SpaceX's Plan for 1M Satellites. And It Wants Your Thoughts

Usually, the commission takes weeks or months to respond to a filing, but it kicked off a public comment period for SpaceX's orbital data center plan in just a few days.

PC Magazine

This is not an Iain Banks dystopian scifi novel! This is reality!!



Satellites are dramatically affecting the sky NOW

Saskatchewan sky

Time-lapse of real photos by
Jeanine Holowatuik
Instagram @jeanine.holowatuik
October 2025

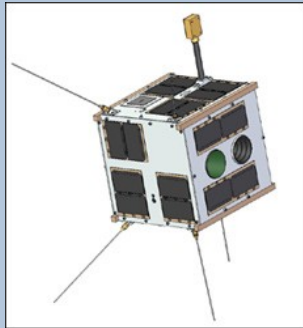
Lat 50N sky

Simulation of 65,000 Starlink-
brightness satellites
From Lawler, Boley & Rein 2022

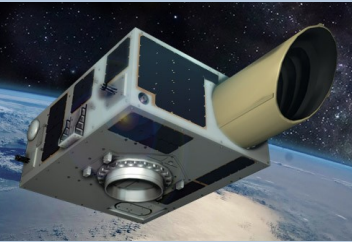
Scientific satellites are not the problem here



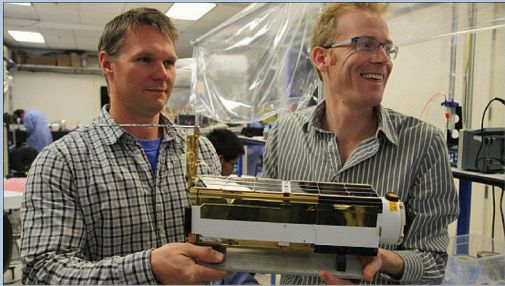
Toaster-scale science sats in LEO



BRITE



NEOSSat, PlanetLabs



Truck-scale science sats



HST: in LEO, only 1



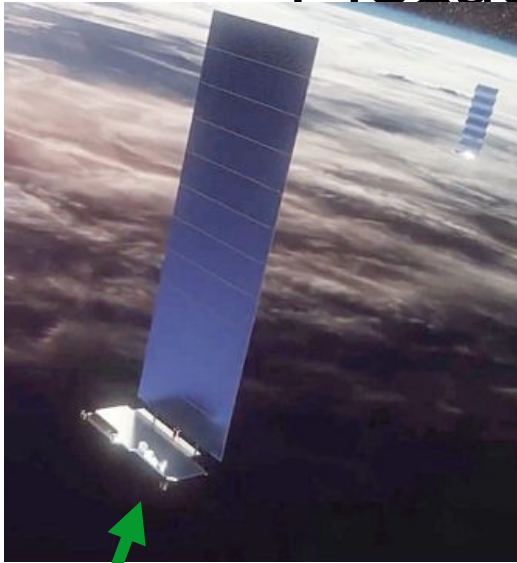
JWST: not in LEO



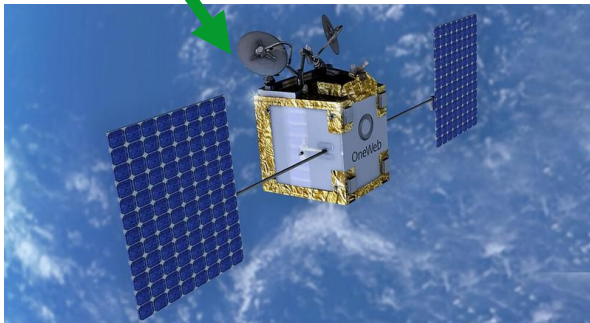
Earth obs sats: few dozen in LEO



Megaconstellations are the problem



Truck-mass



Truck-scale sats in LEO
(For-profit communication sats)
Data from J. McDowell

Starlink: 10,296 in LEO (42,000 planned)

OneWeb: 654 in LEO (7,000 planned)

Kuiper: 239 in LEO (3,000 planned)

Xingwang: 187 in LEO (970 planned)

(Starnet/GW: 13,000 planned)

(dozens of others: 1,000,000+ planned)

Megaconstellations are the problem



Truck-scale sats in LEO
(For-profit communication sats)
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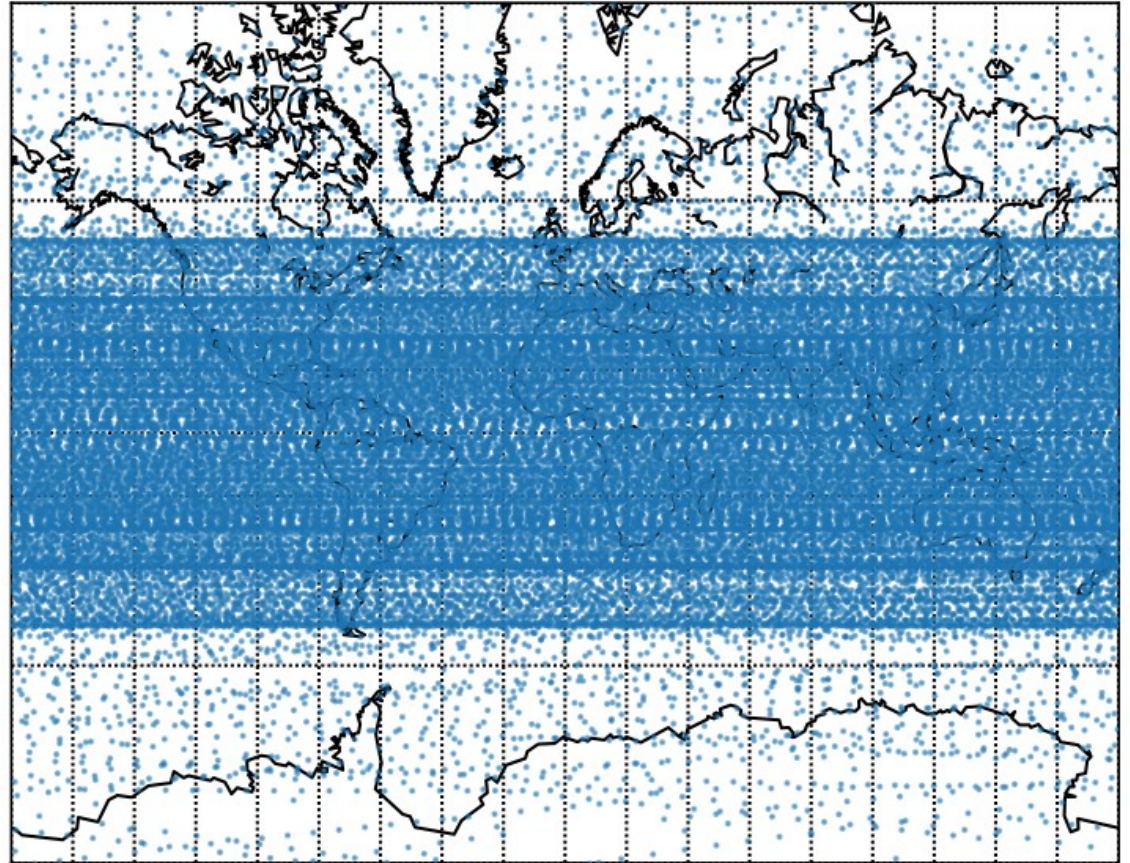
(Starnet/GW: 13,000 planned)
(dozens of others: 1,000,000+ planned)

Problems due to size and sheer numbers:

- Light pollution
- Collision risk
- Atmospheric pollution
- Re-entry debris

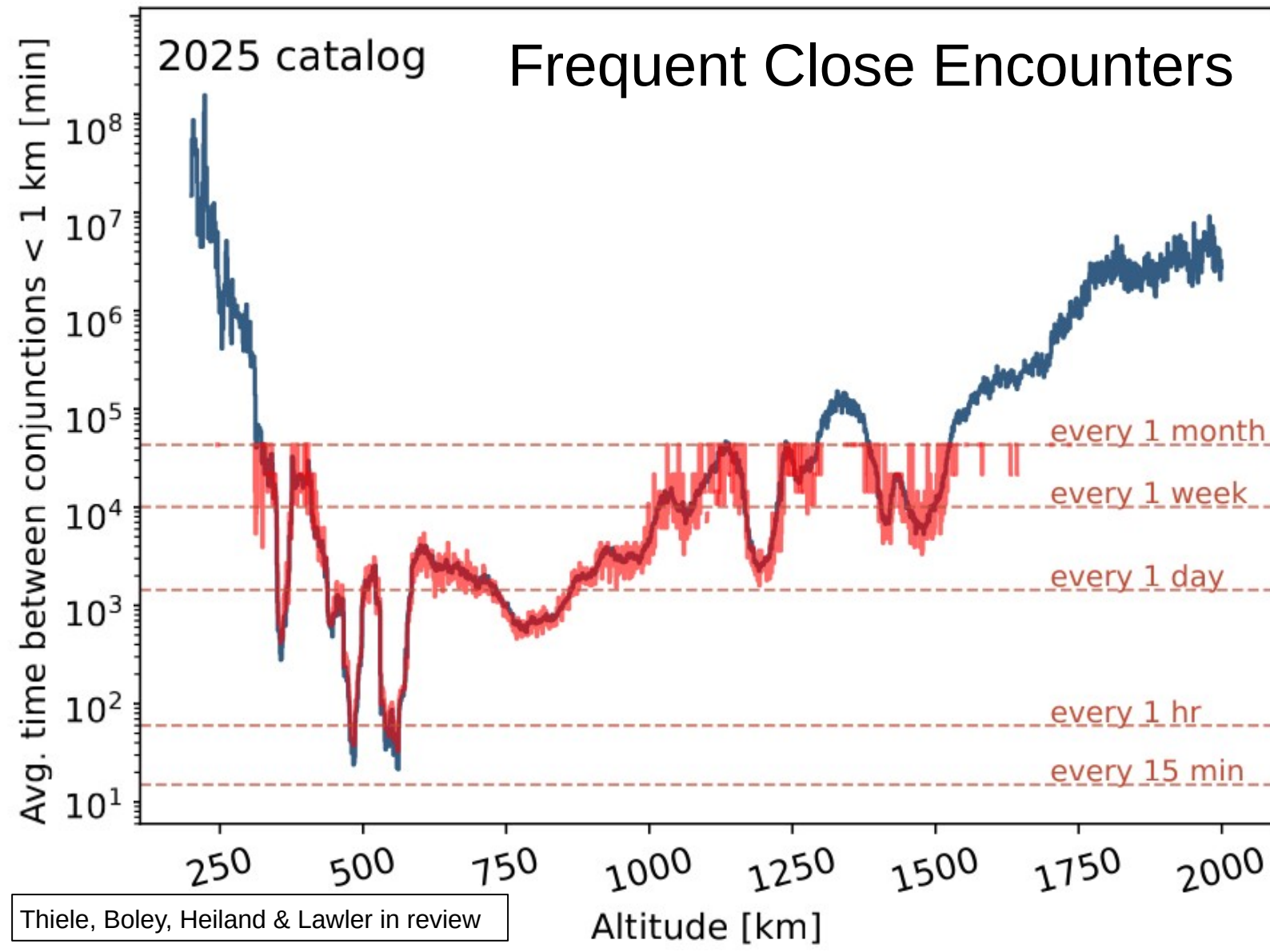
All of these risks/problems will be decreased with fewer total satellites in LEO

Satellite Distribution (Lat-Lon Projection)



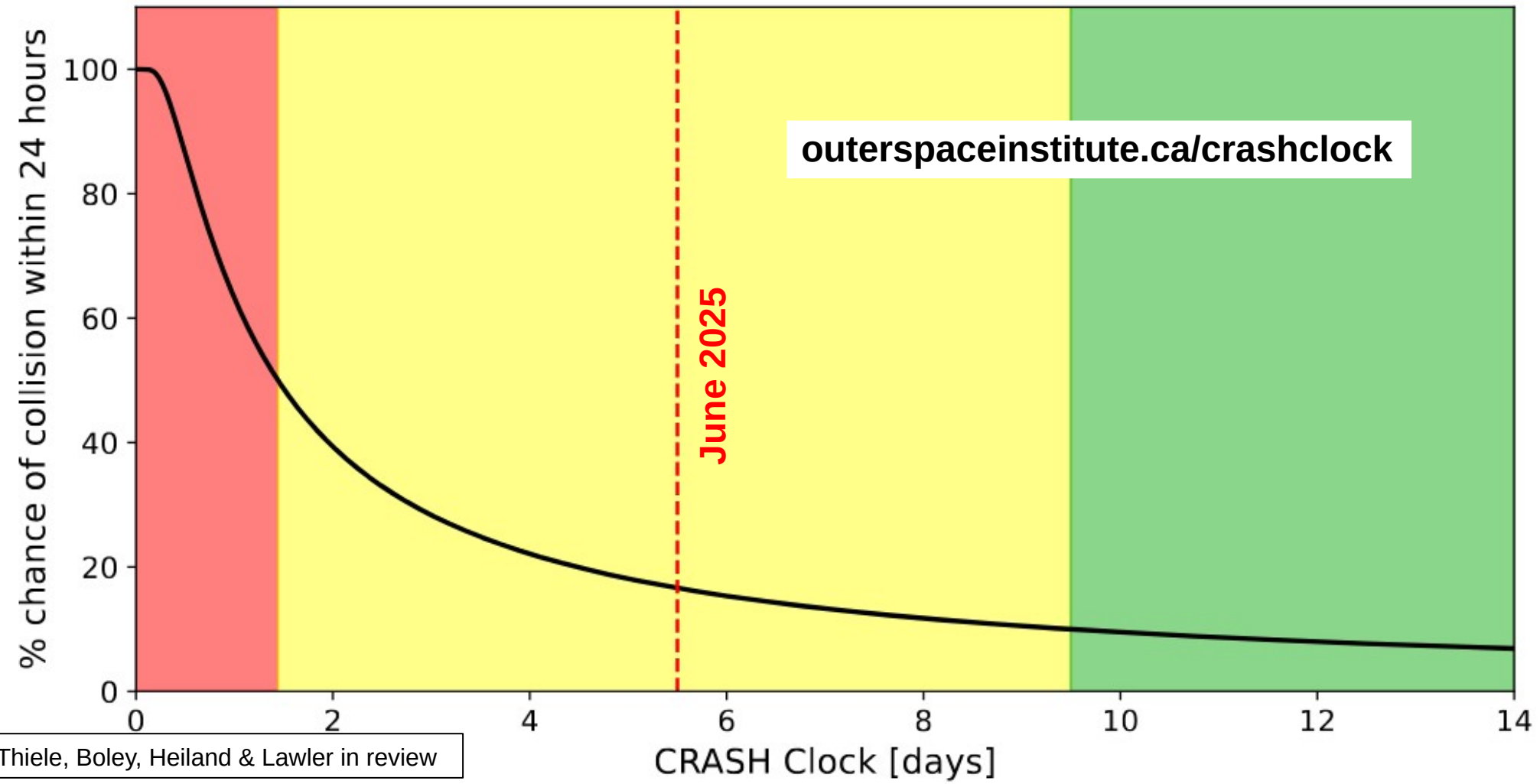
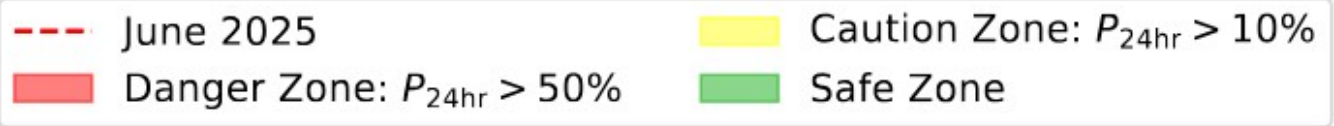
2025 catalog

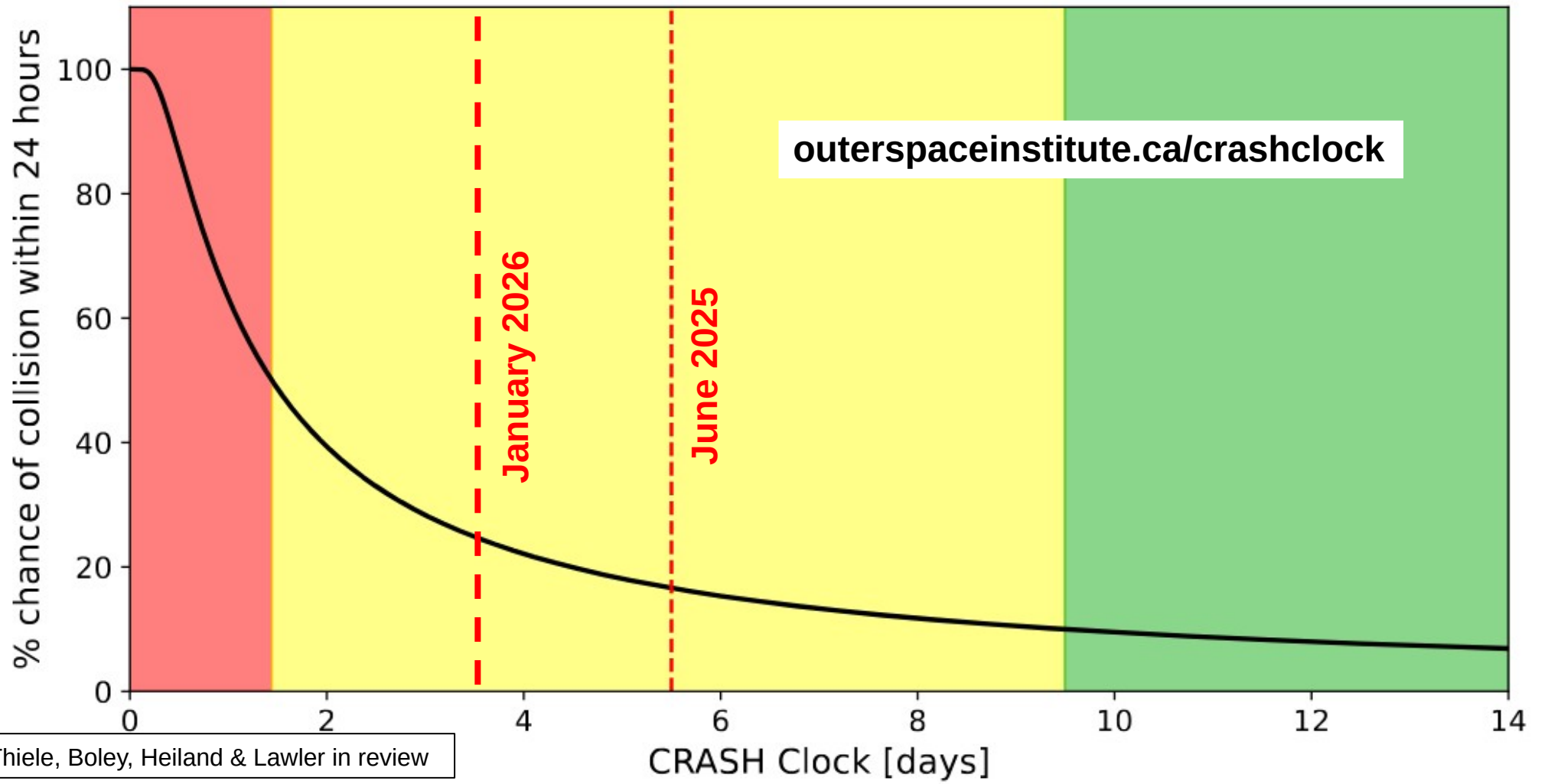
Frequent Close Encounters



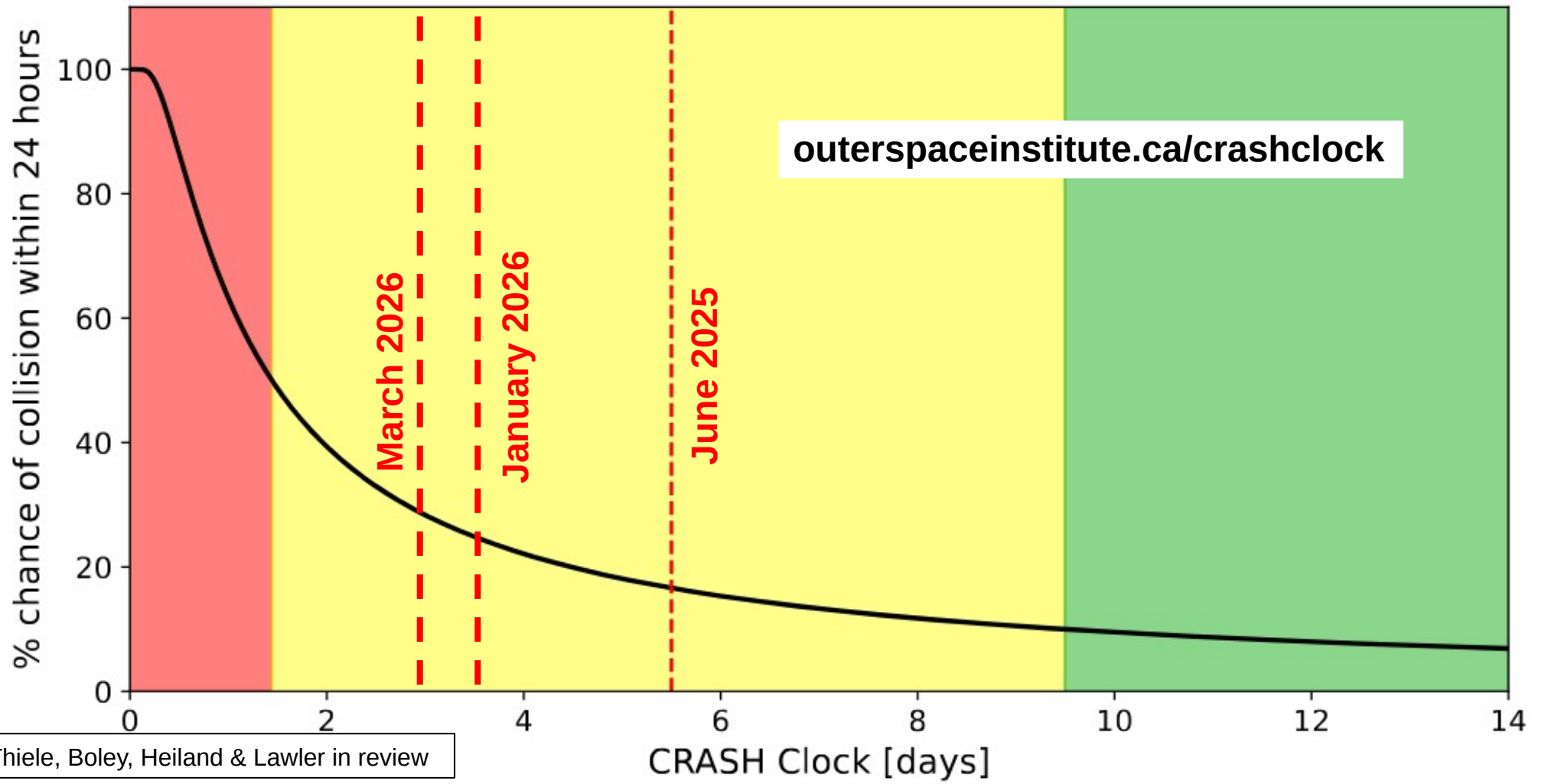
Average time between close approaches (less than 1 km apart), based on AVERAGE satellite on-orbit densities.

Starlink reported **one collision avoidance maneuver every 2 minutes**, on average (Dec '24-Dec '25)





Thiele, Boley, Heiland & Lawler in review



outerspaceinstitute.ca/crashclock

Starlink is NOW dumping >half a ton of aluminum per day

- Latest Starlink conjunction/reentry report July 2025
- 472 reentries Dec '24-May '25
- ~500kg each

Satellites

- Assume mostly aluminum alloy (~50% Al by mass)
- **0.6 tons of Al per day**

See also Schulz and Glassmeier 2021, Boley and Byers 2021



Meteoroids

- 15 tons/day of O
- 6 tons/day of Fe
- 4 tons/day of Si
- 3 tons/day of Mg
- 2 tons/day of S
- 0.4 tons/day of Ni
- **0.3 tons/day of Al**
- 0.2 tons/day of Na



Lodders 2010

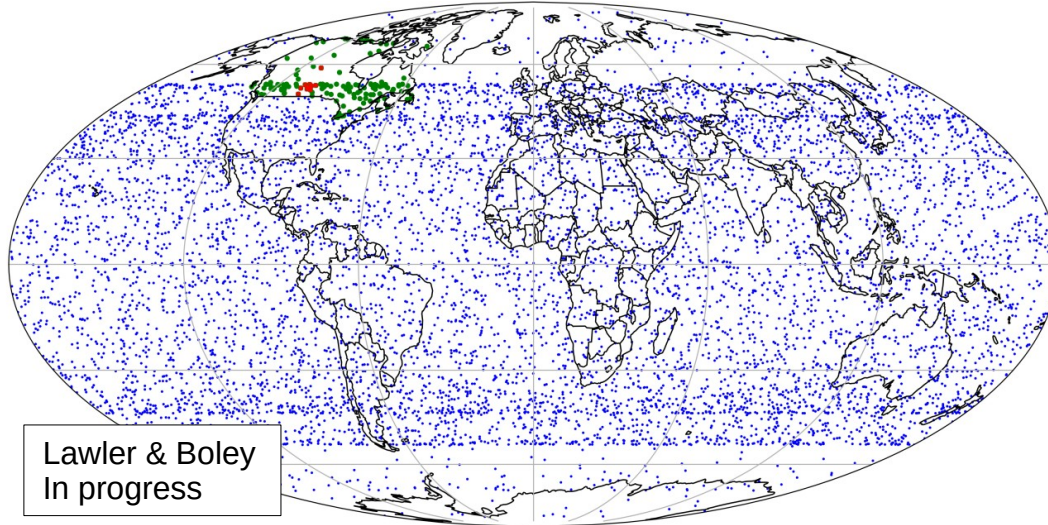
Canadians are finding space debris NOW



Starlink piece,
Hodgeville SK,
July 2024

Starlink reentry

Saskatoon SK, Sept 2025



Lawler & Boley
In progress

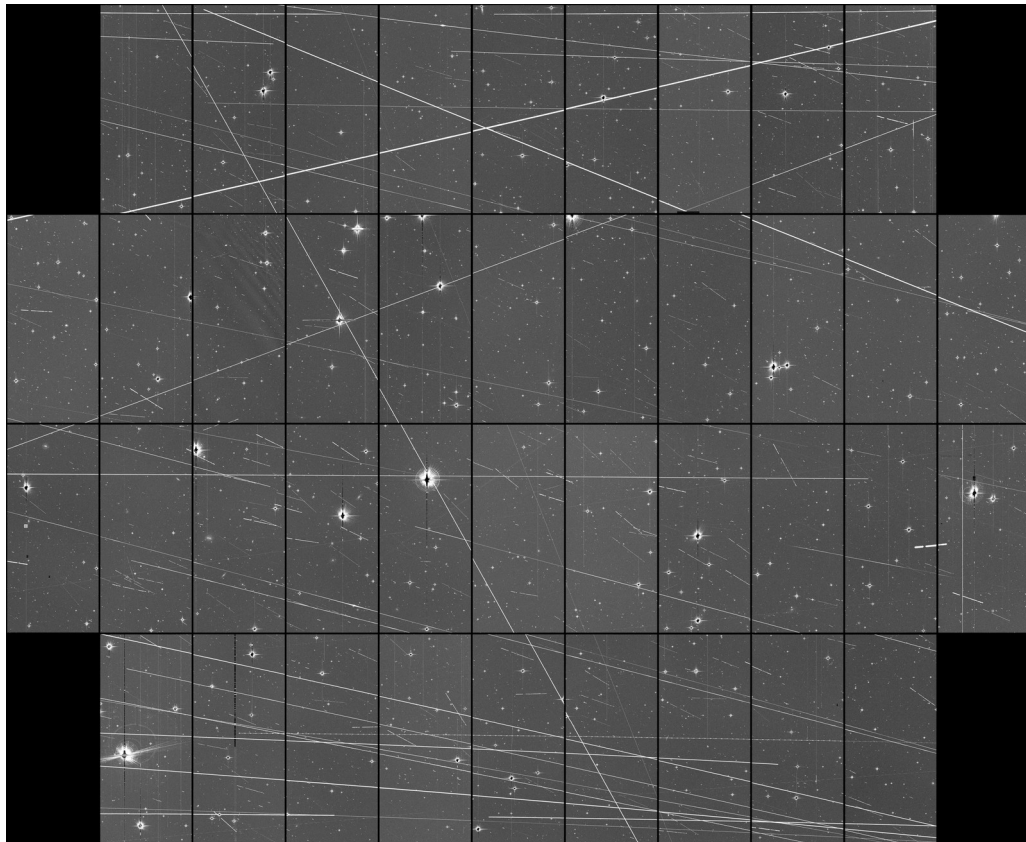
Because of the orbits chosen by sat operators, and uncontrolled reentries, a lot of future debris will fall on Canada.

What should Canadians do when they find space debris?

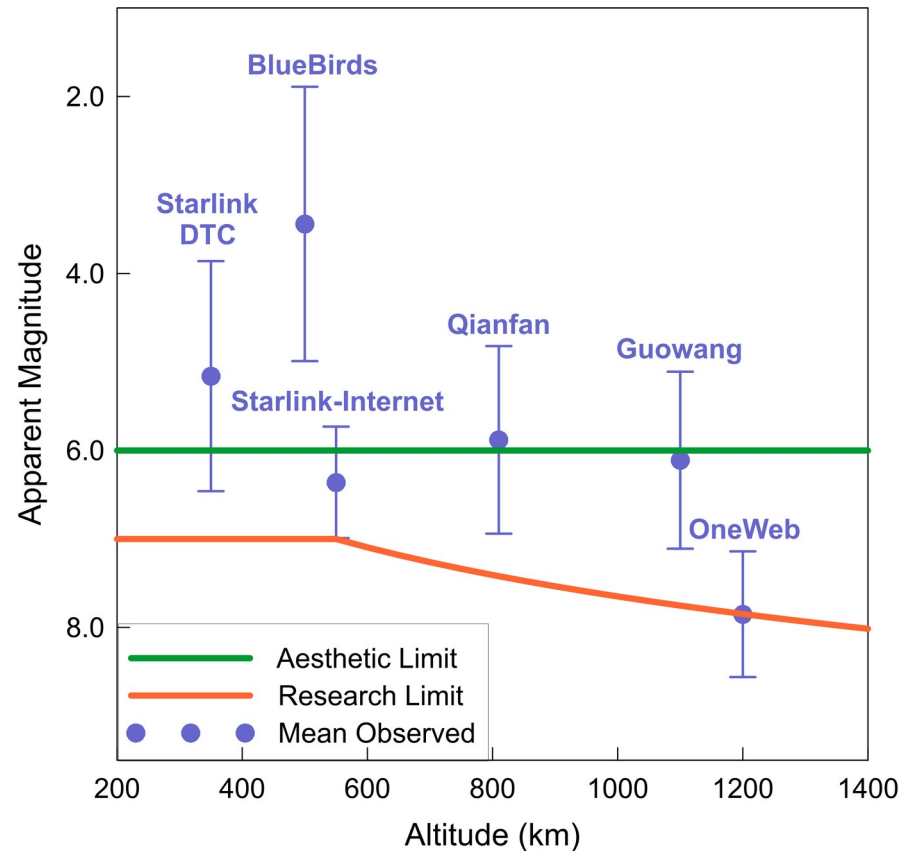


Crew Dragon Trunk
pieces, Ituna SK,
June 2024

Canadian astronomy is being impacted by satellites NOW

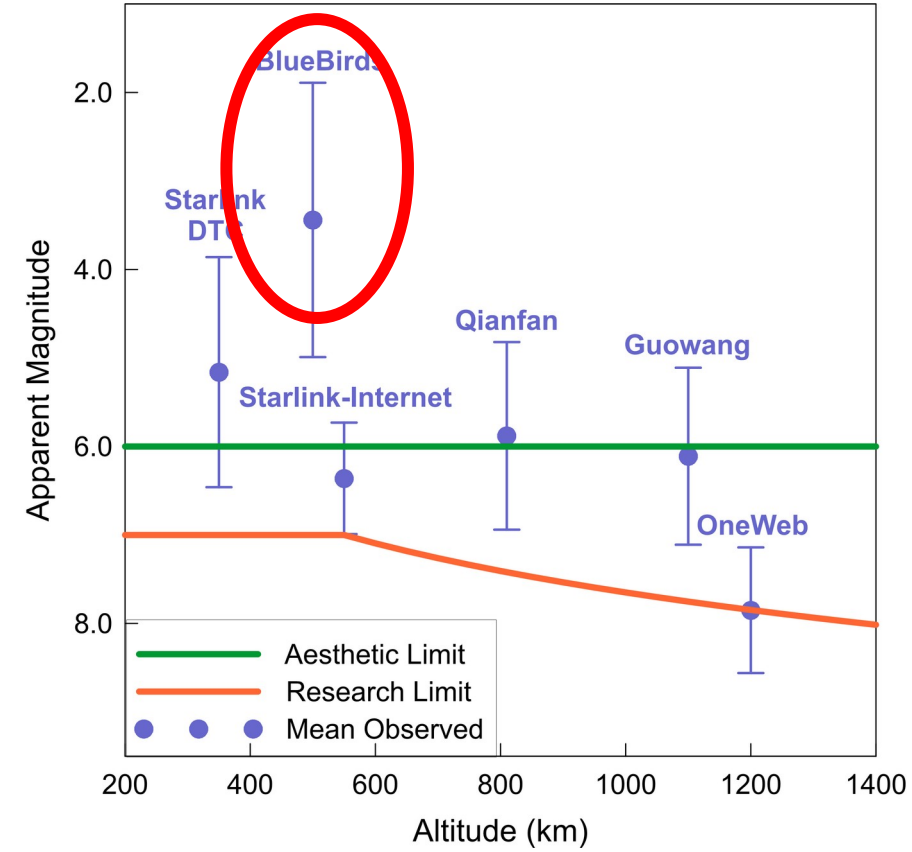
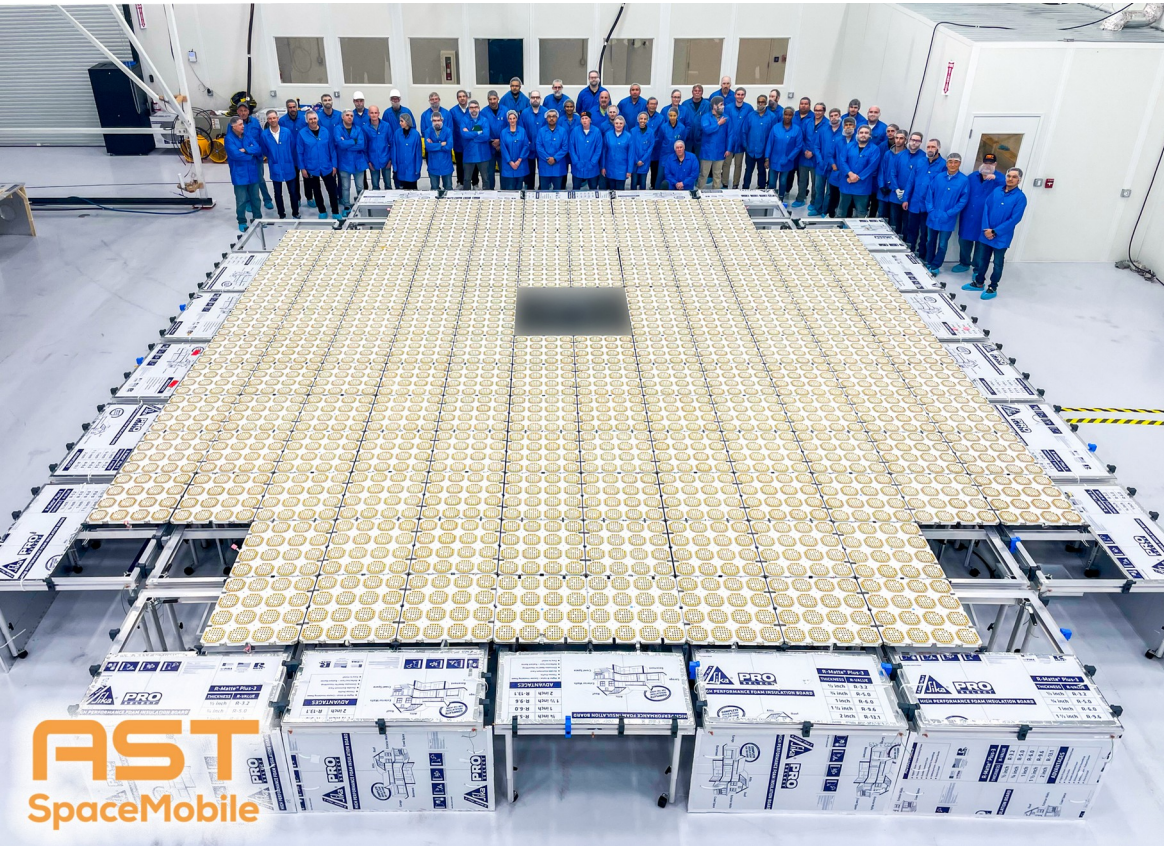


My CFHT data (CLASSY Survey, Aug 2022)



A. Mallama (2025)

AST SpaceMobile is very bad for astronomy (radio+optical)



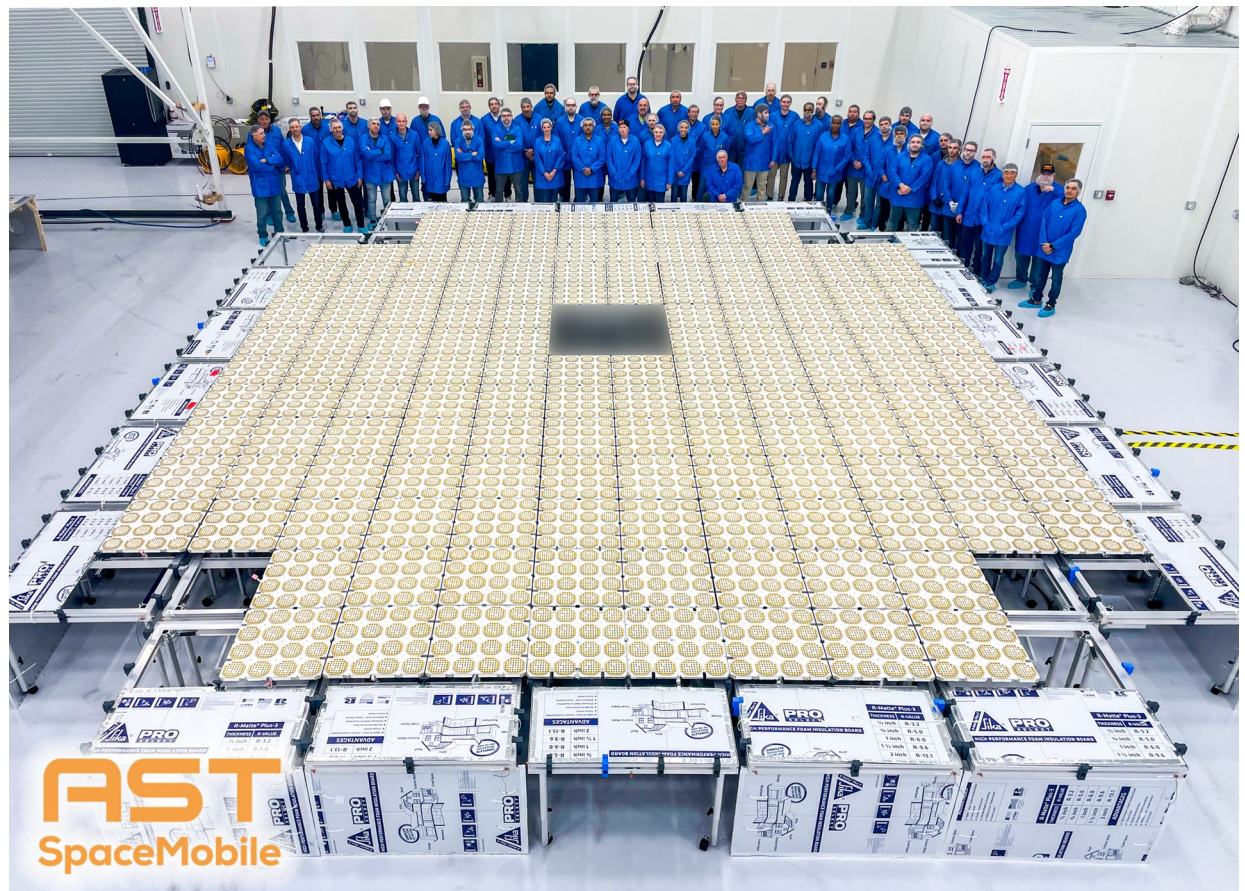
A. Mallama (2025)

Toronto, Summer Solstice, AST

The future?

- Starlink: 34,000+
- OneWeb: 7,000
- Kuiper: 3,000
- Guanwang: 13,000
- Yinhe: 1,000
- Hanwha: 2,000
- Link: 2,000
- Astra: 14,000
- Boeing: 6,000
- Telesat: 2,000
- HVNet: 1,400
- SpinLaunch: 1,200
- Globalstar3: 3,000
- Semaphore: 160,000 (!)
- E-Space: 337,000 (?!!)
- SpaceX ODC 1,000,000 (#\$@*%)
- Blue Origin 56,000
- Starcloud 88,000

J. McDowell: planet4589.org



See Nandakumar et al. 2023, *Nature*

We need international regulation of satellites



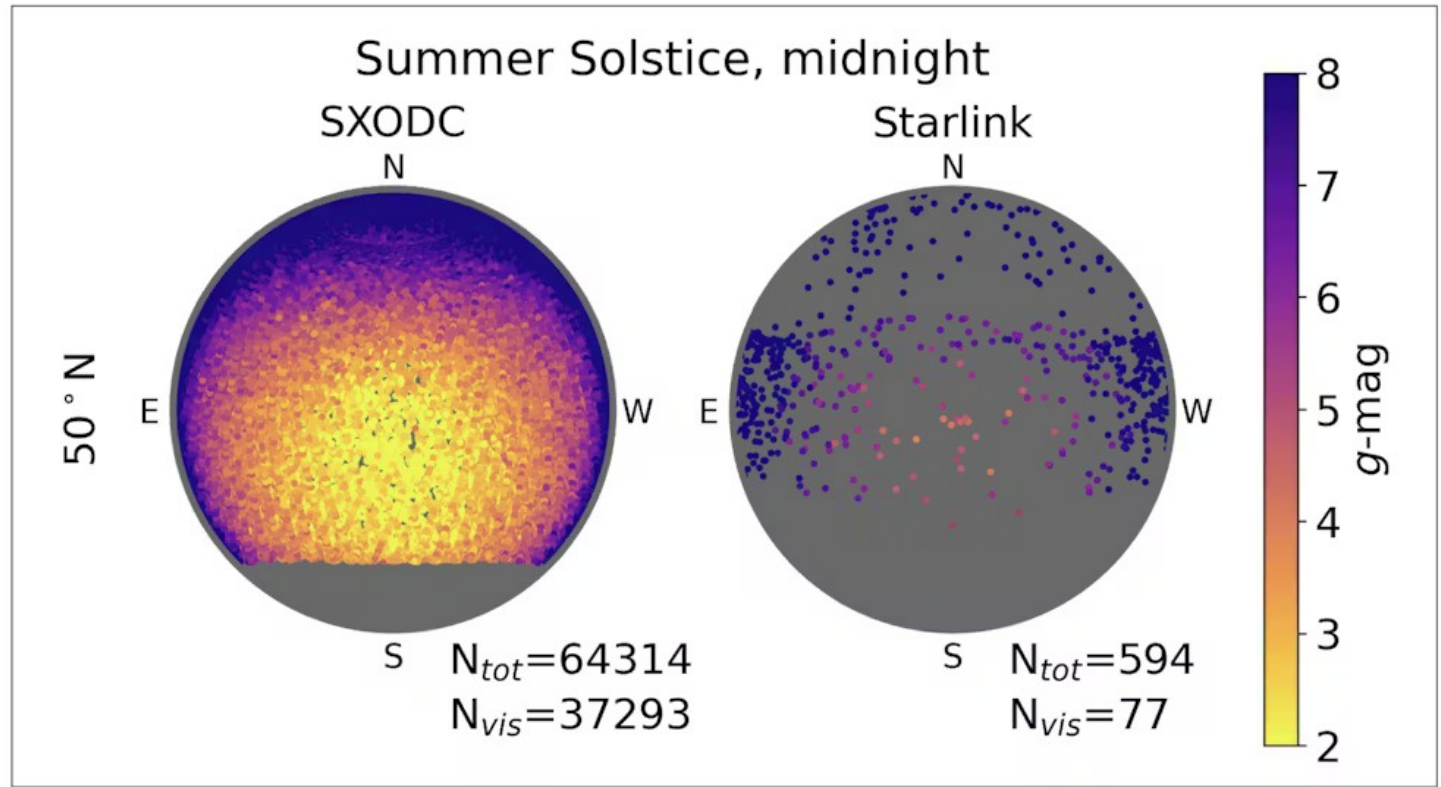
A new space race could turn our atmosphere into a 'crematorium for satellites'

Published: February 25, 2026 5.55pm EST

Lawler, Boley, & Rein 2026

One 2-tonne+ reentry every THREE MINUTES

Revell, Bannister, & Lawler 2026



More More More in space

Meta inks deal for solar power at night, beamed from space

“CEO Marc Berte says you’ll be able to stare right into his satellite’s beam with no ill effects” (!!!)

Tech Crunch

This company's plan to launch 4,000 massive space mirrors has scientists alarmed: 'From an astronomical perspective, that's pretty catastrophic'

Space.com

Rush to put AI data centers in space poses poorly understood dangers

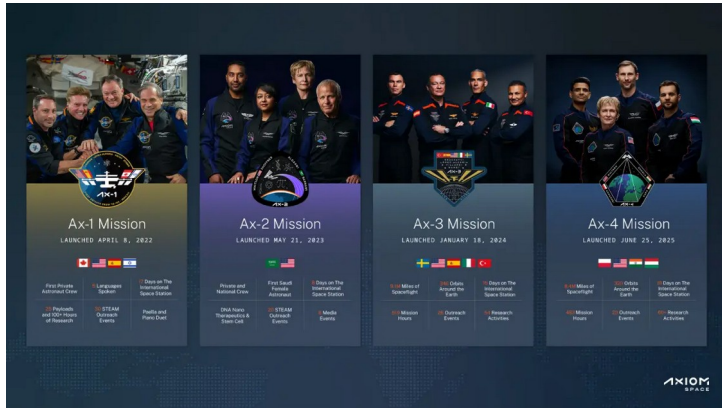
Mongabay

Giant mirrors in space to reflect sunlight at night? No thank you, astronomers say

CBC

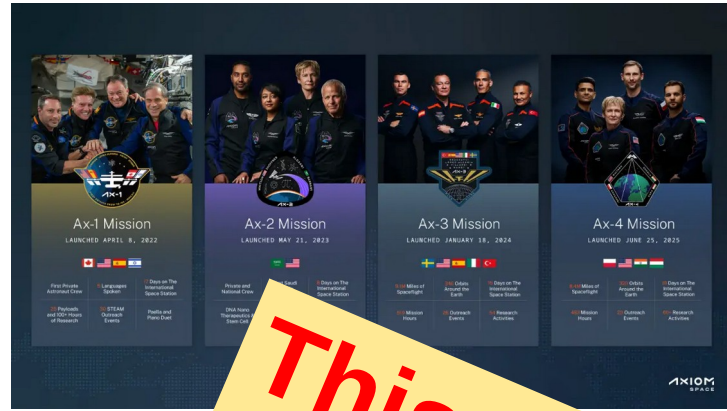
Space mining is getting closer to becoming a reality, and Canada could play a major role

CBC



More More More in space

Meta inks deal for solar power at night, beamed from space



This is actually impossible

“CEO Marc Berte says you’ll be able to stare right into his satellite’s beam with no ill effects” (!!!)

Tech Crunch

This company... massive space mine... alarmed: 'From an astronomer's perspective, that's pretty catastrophic'

Space.com

Rush to... centers in space poses... poorly understood

Mongabay

Giant mirrors in space to reflect sunlight at night? No thank you, astronomers say

CBC

Space mining is getting closer to becoming a reality, and Canada could play a major role

CBC

GenAI will collapse and fail

OpenAI shuts down Sora app amid rising concerns about deepfakes and consent

CBC

The real (economic) AI apocalypse is nigh

Cory Doctorow

Thousands of CEOs admit AI had no impact on employment or productivity—and it has economists resurrecting a paradox from 40 years ago

Fortune

‘The cost of compute is far beyond the costs of the employees’: Nvidia executive says right now AI is more expensive than paying human workers

Fortune

AI is the money-losingest project the human race has ever attempted. At \$1.4 trillion and counting, the AI companies and their "frontier models" are so deep in the red that I can't see any way that any of these firms will survive

Cory Doctorow

The AI Compute Crunch Is Here (and It's Affecting the Entire Economy)

404 Media

Billionaires remain the biggest
environmental threat

Billionaires emit more carbon pollution in 90 minutes
than the average person does in a lifetime

Oxfam

**Tech Billionaires Want Christians to
Believe in AI**

*For Peter Thiel and JD Vance allies, the tech right is framing AI as a moral—even
divine—mission.*

Mother Jones

The Apocalyptic
Delusions of the
Silicon Valley Elite

Current Affairs

***Big Tech Billionaires' Utopian Dreams Are Actually
Dystopian Nightmares***

Daily Beast

The fight is now local

Four councillors, including reeve, resign from R.M. of Sherwood

Regina Leader-Post

R.M. closes doors on public meeting in Regina as Bell's plan for AI data centre is approved

Regina Leader-Post

Saskatchewan

Bell Canada to begin construction on Canada's largest AI data centre near Regina this spring

Telecom giant says the centre will generate \$12 billion for Saskatchewan's economy, 80 permanent jobs

CBC News



Voting is good, but the damage is done

Missouri town fires half its city council over data center deal

Politico

Voters in a Missouri town ousted every incumbent council member over \$6 billion data center plan

NPR

For Some City Councils, A Vote for Data Centers Means Getting Voted Out

KSST Radio

Faced with surge of AI data centers, rural towns speak out

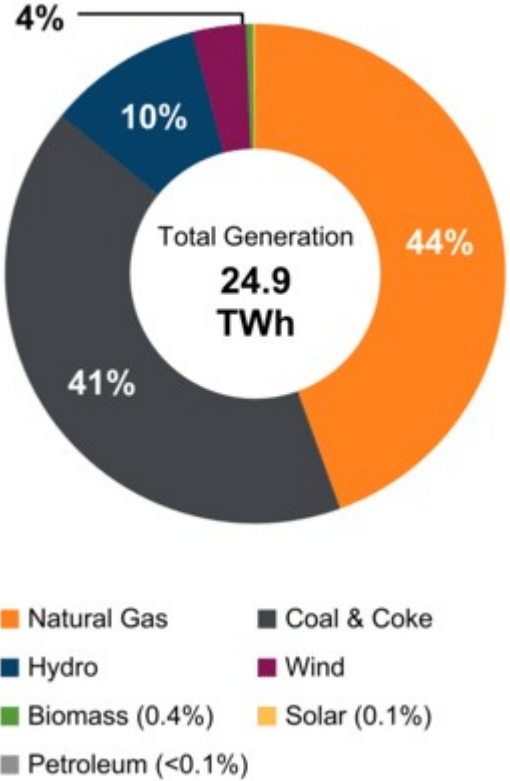
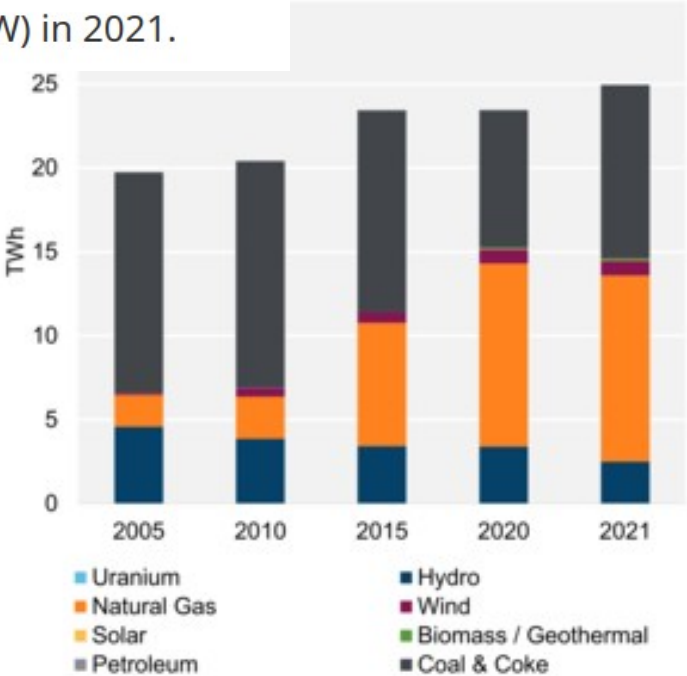
News Nation

Regina residents rally against proposed AI data centre before RM of Sherwood council vote

CBC

In 2021, Saskatchewan generated 24.9 terawatt-hours (TWh) of electricity (**Figure 1**), which is approximately 4% of total Canadian generation. Saskatchewan had an estimated generating capacity of 4,602 megawatts (MW) in 2021.

real-time electricity usage



Canada Energy Regulator

300MW.

How do we make sure they pay for electricity and water use? How do we make sure they clean up? How do they offset that CO₂? (They won't)

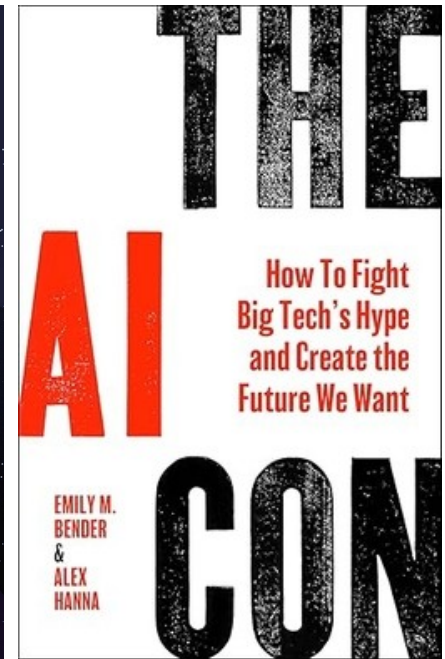
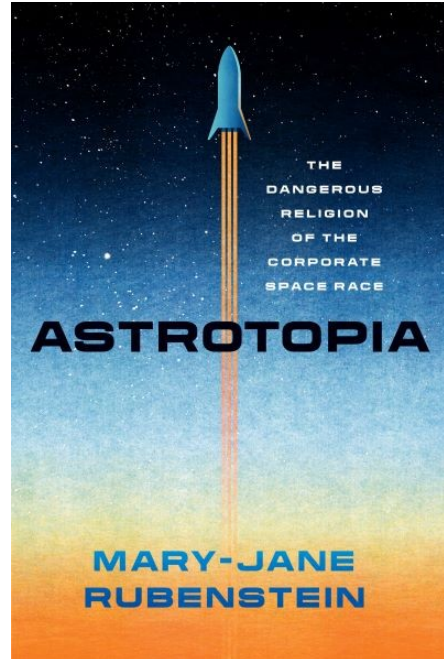
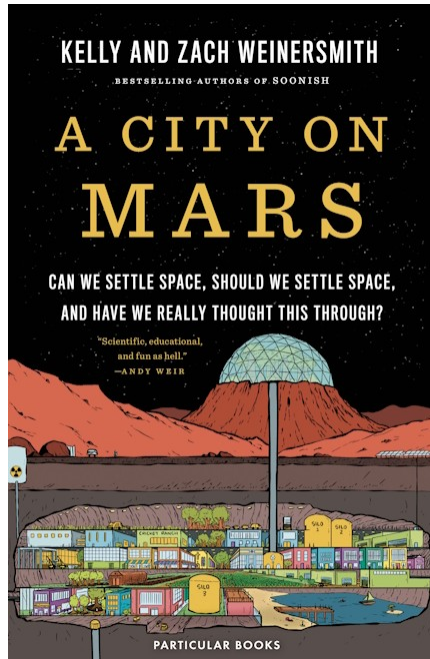
What can individuals do?

- Be mindful of your technology usage.
- Teach others (your students!) how to use technology in the most ethical way possible
- Talk to your elected officials at all levels of government
- Join groups! Form groups! Let's do this!
- Turn off your screens. Go outside. Touch grass. Get out of the city. Bring your friends and family.



Fight the billionaires every way you can

Read books! Educate yourself! Teach everyone!



Thank you to followers on Mastodon for article links and discussions!

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