# Climatology and interannual variations of Arctic Ocean's winter lead fields in Era ICESat-2

ICE, CLOUD, AND LAND ELEVATION SATELLITE-2

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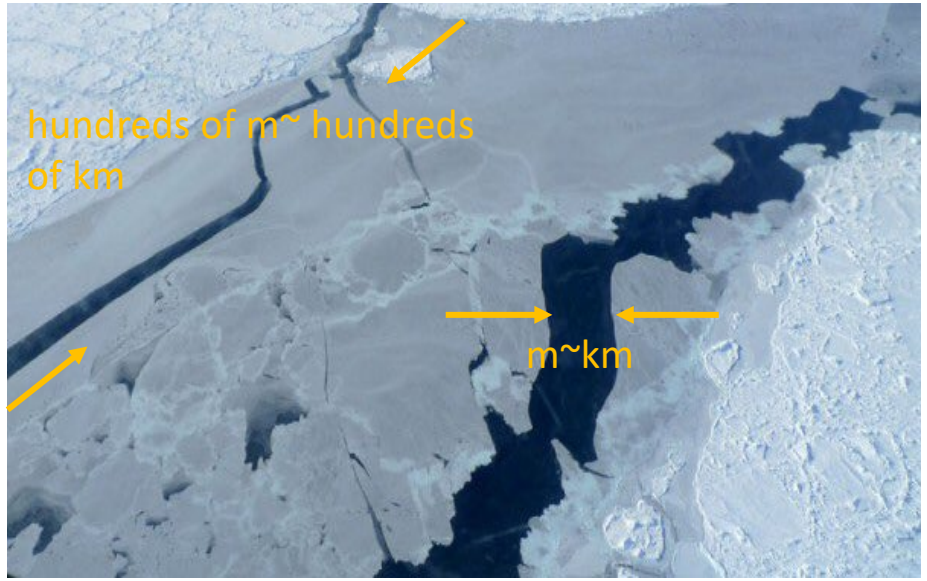


CAMAS 04/09/2026

# ICESat-2 ATL07 vs ATL10

- collects elevation data of individual photons from different surfaces

| | ATL07 | ATL10 |
|---|---|---|
| **Name** | Surface types and heights | Freeboard |
| **Lead detection** | Radiometric (surface photon rate, etc.) | Height retrievals (fb<3 cm) |
| **Lead type** | Specular (dark) | Open water / newly closed leads |

- ATL07 specular leads: 7 m
- ATL10 leads: 7 m ~ 20 m.
- Ice:12~14 m.
- **unprecedented high-resolution, near pan-Arctic**

- **This work: lead fraction and size,** 1° ×4° bin, 2018-2024, November-April

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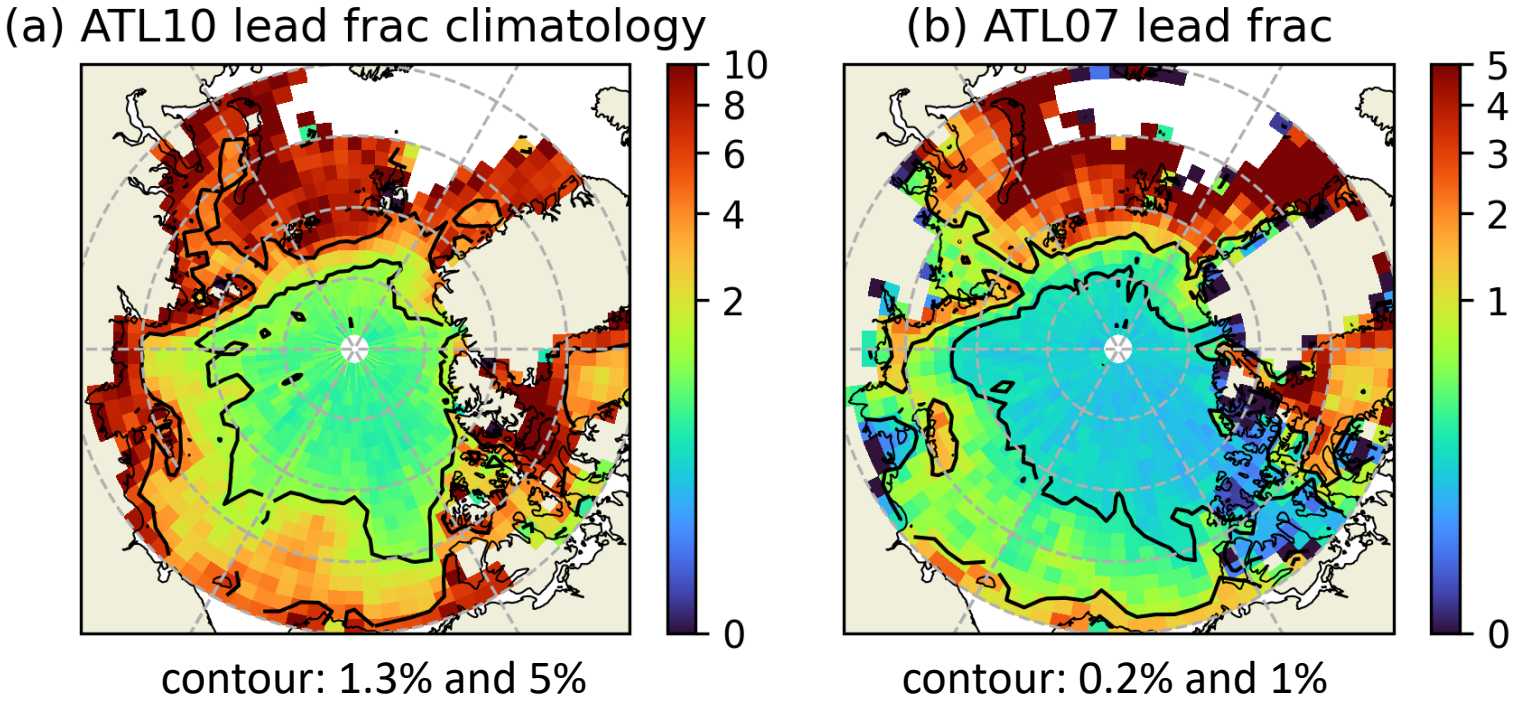
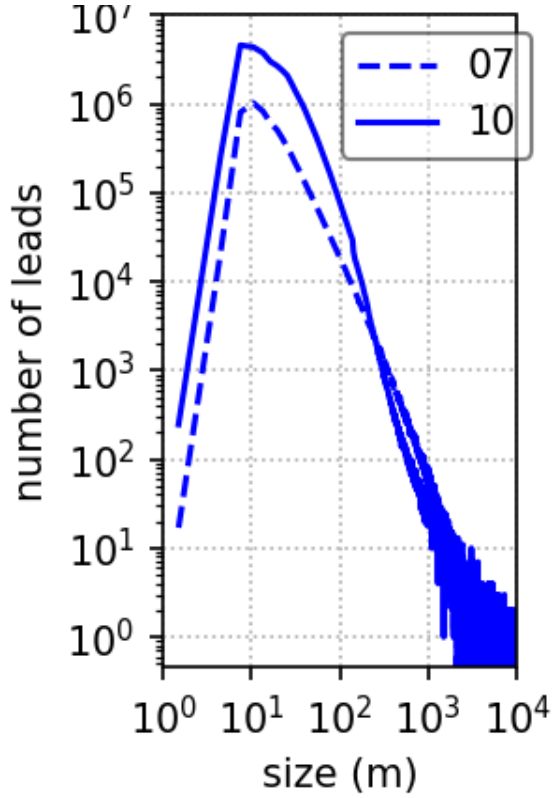
# Climatology – lead fraction




# lead size




- Robust spatial distribution from both products: decrease toward central Arctic.
- Regions of big disagreement: CAA and south of New Siberian Islands

- Power-law distribution
- The exponent flattens towards smaller leads.

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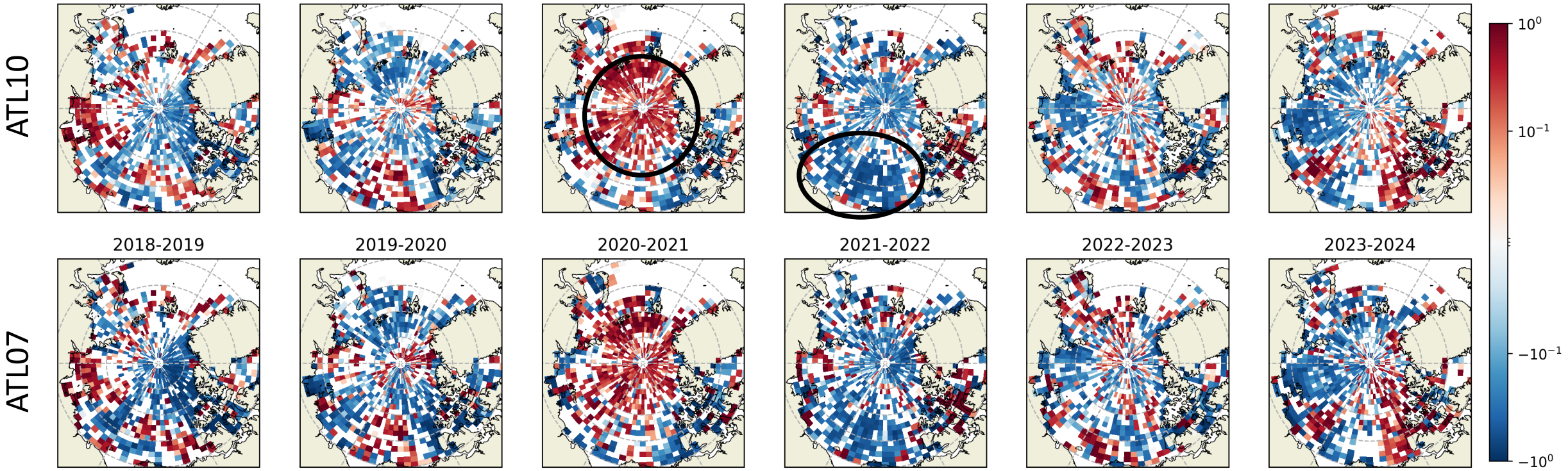
# Interannual variations – lead fraction




- Signature pattern:
- 1) Maximum lead fraction in the central Arctic in 20-21;
- 2) Minimum lead fraction in Chukchi/Beaufort Sea in 21-22;

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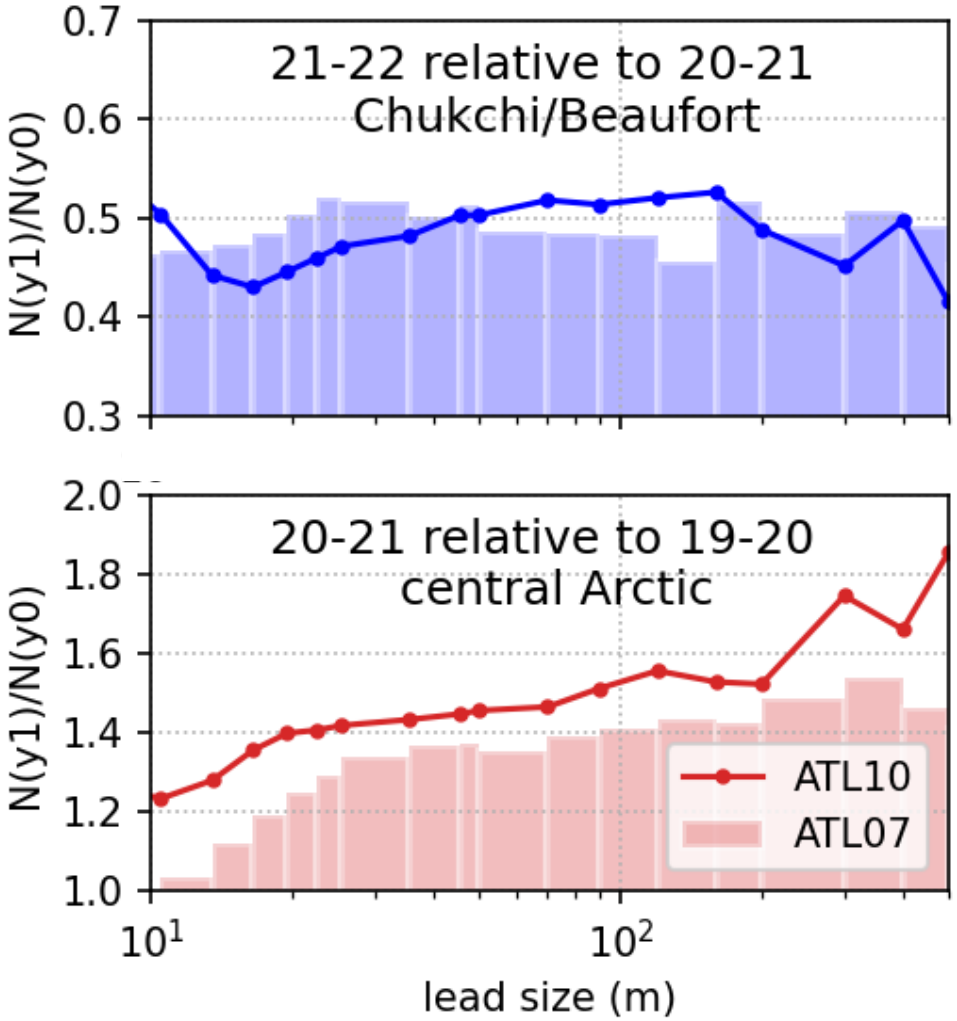
# Interannual variations – contribution from varies sizes

number of leads in a year relative to a selected year

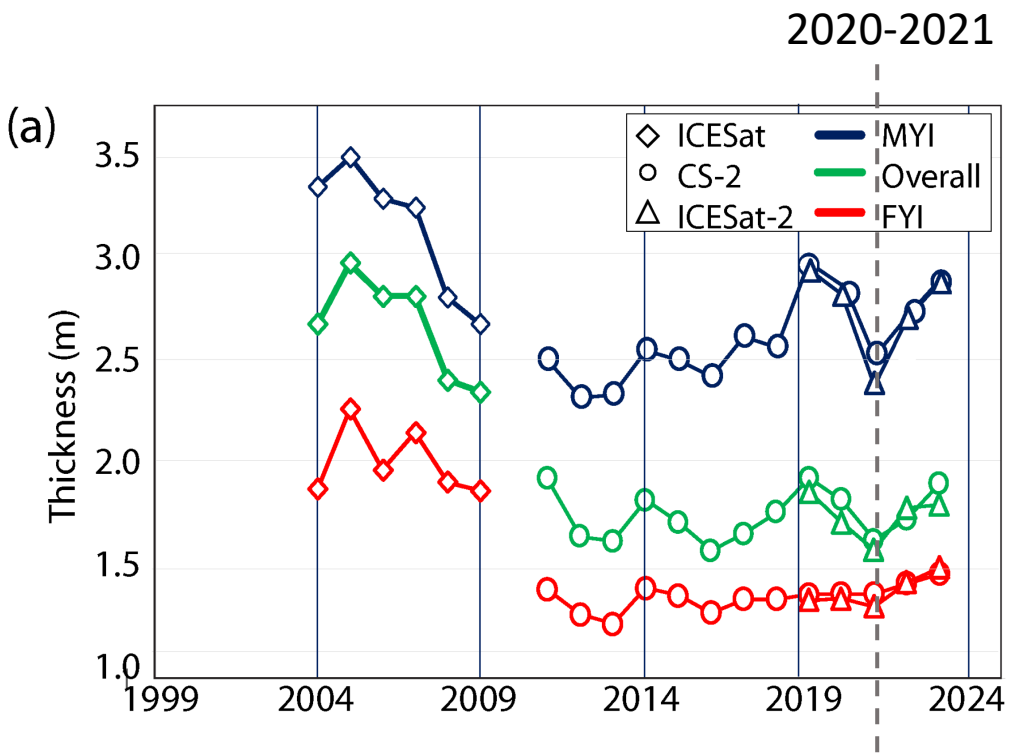



- minimum event in Chukchi/Beaufort Sea 2021-2022: similar contribution from lead of varying sizes

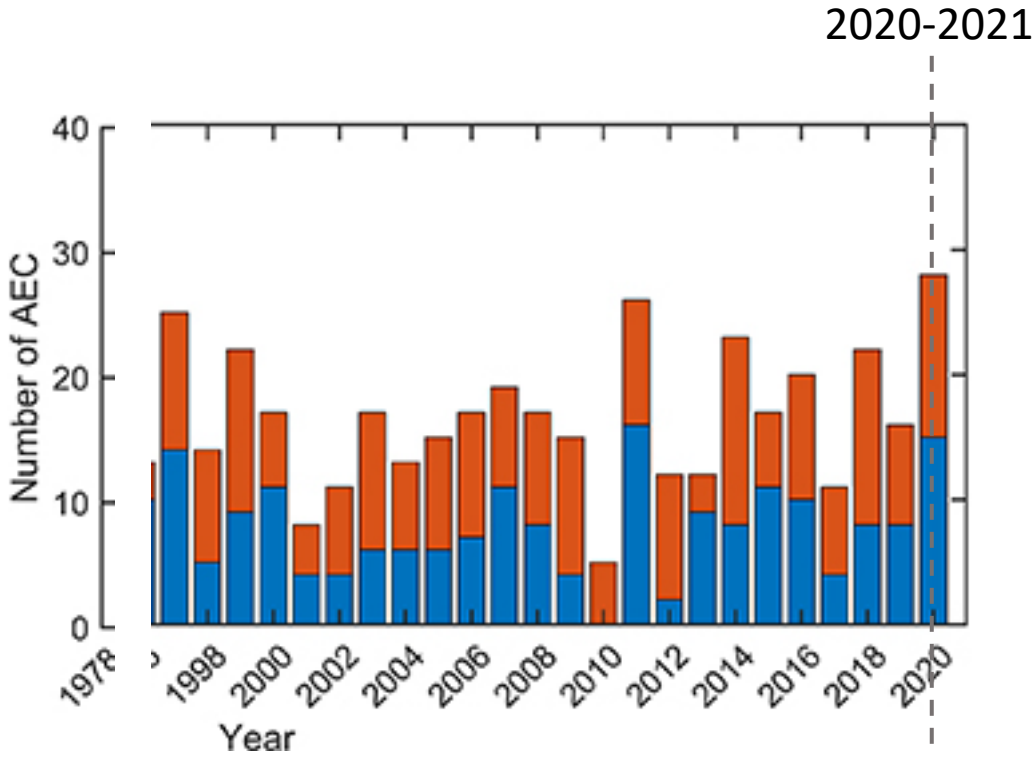
- maximum event in central Arctic 2020-2021: more increase in bigger leads

# Interannual variations – lead fraction

- Lead fraction maximum in central Arctic in 2020-2021 is likely associated with anomalously thin ice cover and active cyclones.




[Kacimi and Kwok, 2024]




[Liu and He, 2023]

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# Products

- Leads information from ATL07 and ATL10 will be made available.

Preprint

Preprints / Preprint egusphere-2025-6155

https://doi.org/10.5194/egusphere-2025-6155
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19 Dec 2025

## Climatology and Interannual Variations in Arctic Winter Sea Ice Leads in the ICESat-2 Era

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**Abstract.** Sea ice leads play a key role in polar air-sea heat, moisture, and gas exchanges, ocean heat and salinity variations, and ecosystem processes. However, their small-scale nature challenges efforts to assess spatiotemporal variability on a pan-Arctic basis. Here, we use six years of high spatial resolution surface type (ATL07) and freeboard (ATL10) products from Ice, Cloud, and Land Elevation Satellite-2 (ICESat-2) to characterize Arctic winter sea ice leads. Both products reveal consistent climatological spatial patterns, with lead fractions generally higher near the ice edge and coastal regions, and lower over the central abyssal plains. Lead sizes follow a power-law distribution, with the exponent increasing with size. We identify four distinct features in the temporal evolution of lead fraction over the ICESat-2 era, including a maximum in winter 2020–2021; increases in lead fraction are primarily driven by changes in the number of larger (>100 m) leads. Our findings show that ICESat-2 measurements provide robust regional-scale characterization of spatiotemporal variability in winter ice leads, which will in turn better inform their underlying response to, and influence on, Arctic climate.

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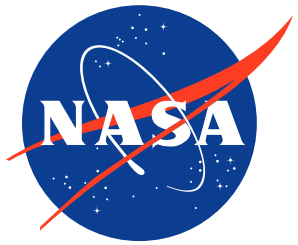
# Acknowledgement


- NASA ICESat-2 science team funding: 80NSSC23K0943
- ICESat-2 science team telecon and sea ice working group
- My coauthors Christopher Little, Nathan Kurtz, Rachel Tilling, Jesse Wimert
- Alek Petty for helpful discussions

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