

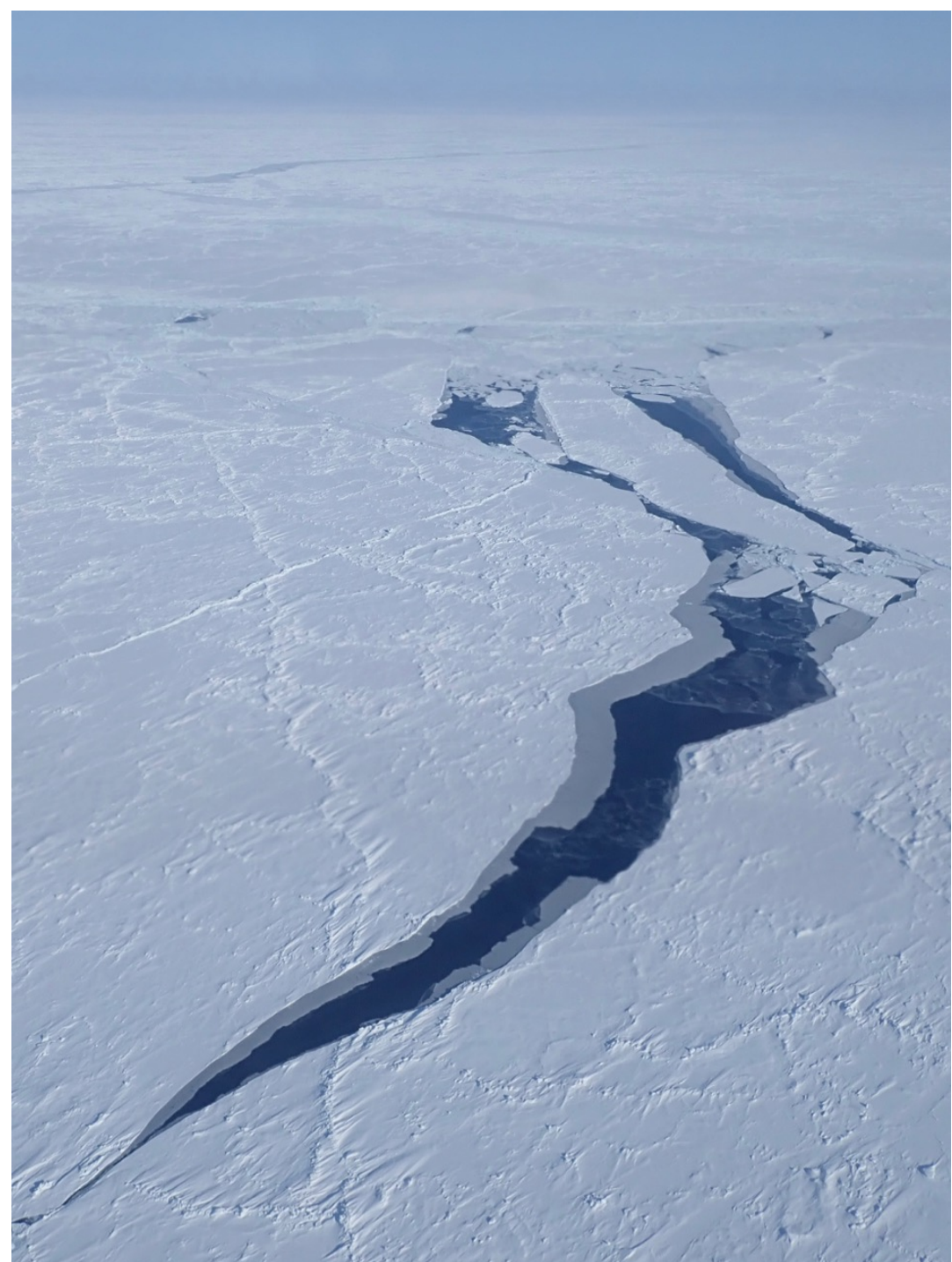
Why?

Why Analyzing Ice Leads?

- Understand dynamics of ice leads & interaction with changing climate conditions
- Important for analysis of Arctic tipping points

Why Using Network Science Methods?

- Provide ice lead prediction (branch forecasting and tracking)
- Faster alternative physical sea ice models
- Transferring success of recent network science tools to cryospheric applications



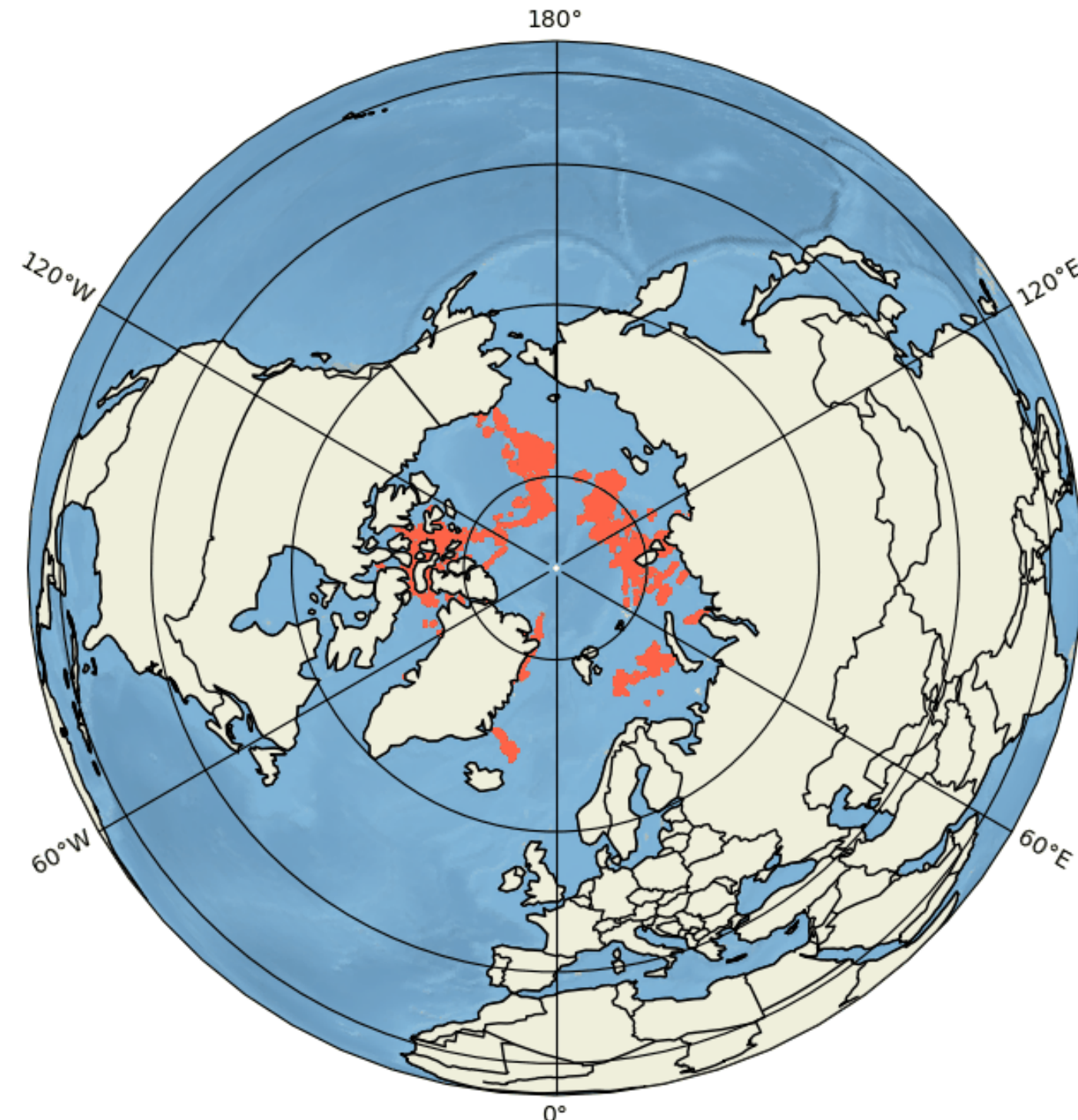
Airborne ice lead photograph. [2]

Data

Ice Leads from daily **MODIS** observations in 2002 - 2020 [1].
Sparse data in summer months.

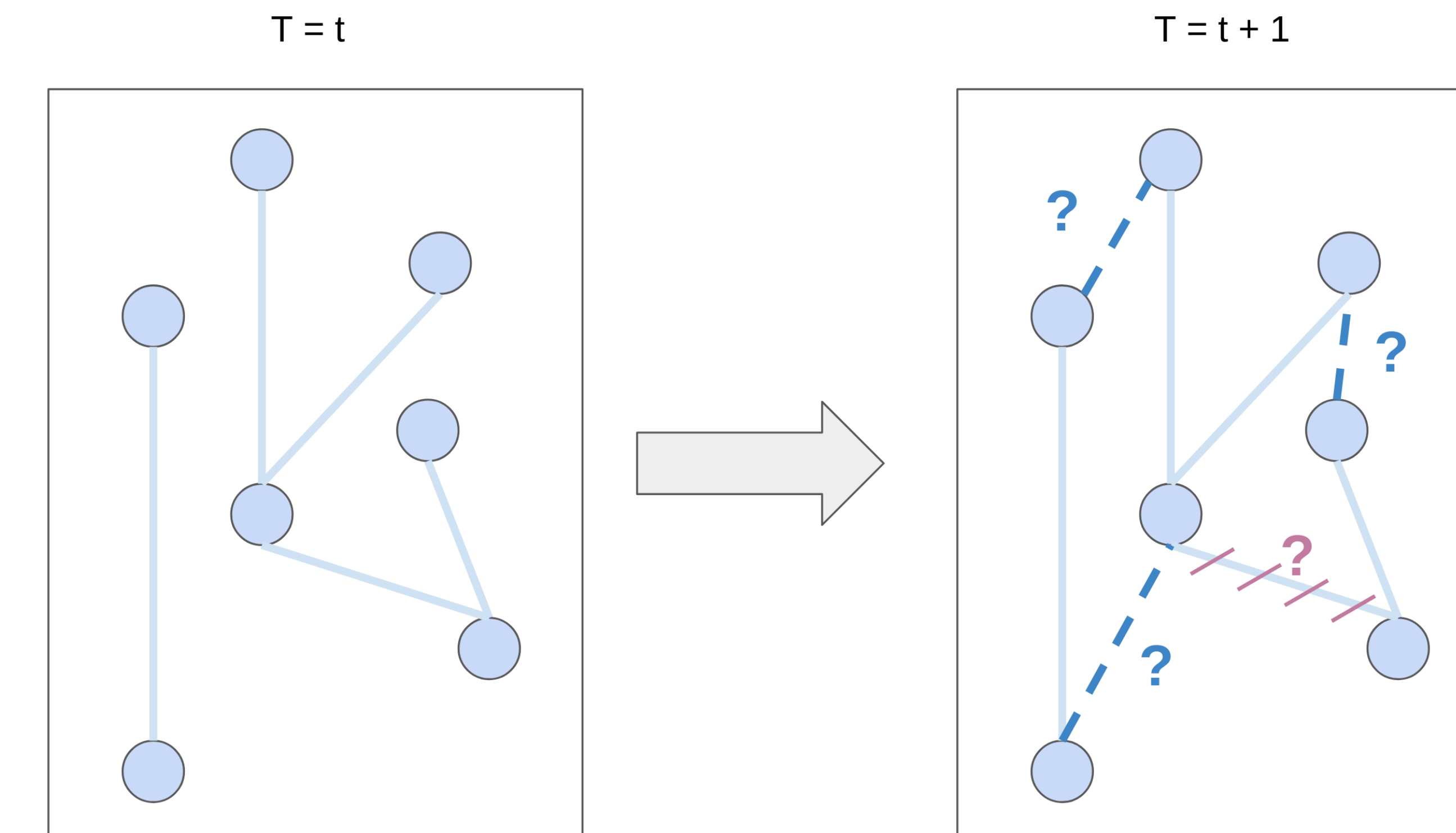
Data includes:

- Start and end point of ice leads
- Length of ice leads
- Width of ice leads



Methods & Results

Link Prediction:



Experimental Setting:

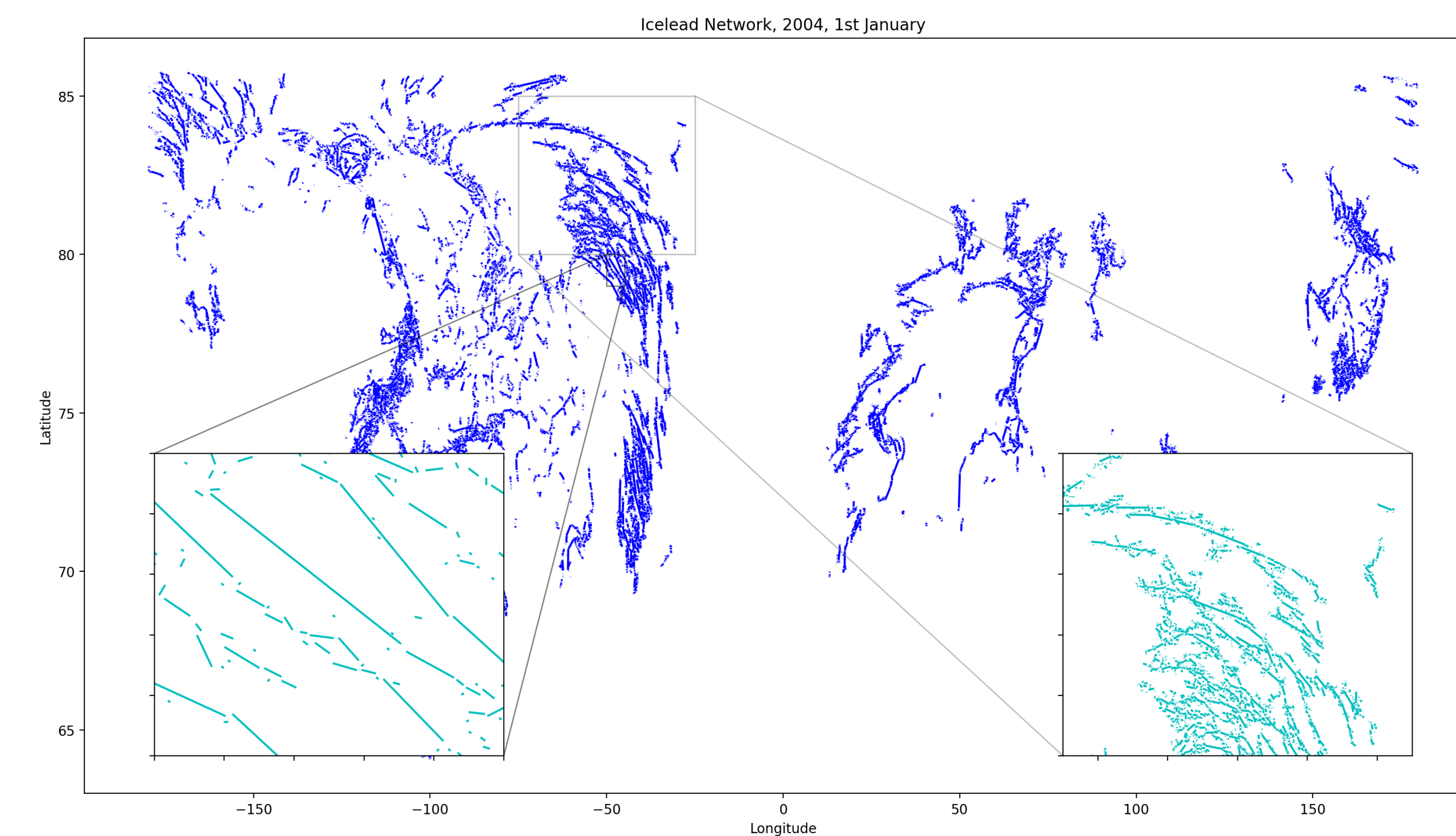
1. Construct temporal and static ice lead networks
2. Drop 5%, 10% or 20% of edges
3. Predict those edges

Result:

Common Link Prediction methods fail

Reason:

Ice Lead Networks are a new type of network family!



References

- [1] Jay P Hoffman et al. "The detection and characterization of Arctic sea ice leads with satellite imagers". In: *Remote Sensing* 11.5 (2019), p. 521.
- [2] Joseph MacGregor. *A smaller lead in sea ice*. Accessed 23 May 2022. https://airbornescience.nasa.gov/image/A_smaller_lead_in_sea_ice, 2018.
- [3] EOS Project Science Office The Earth Observatory. *Extensive Ice Fractures in the Beaufort Sea*. Accessed 12 November 2021. https://eoimages.gsfc.nasa.gov/images/imagerecords/80000/80752/beaufort_vir_2013054_lrg.jpg, 2013.

Take Home Message

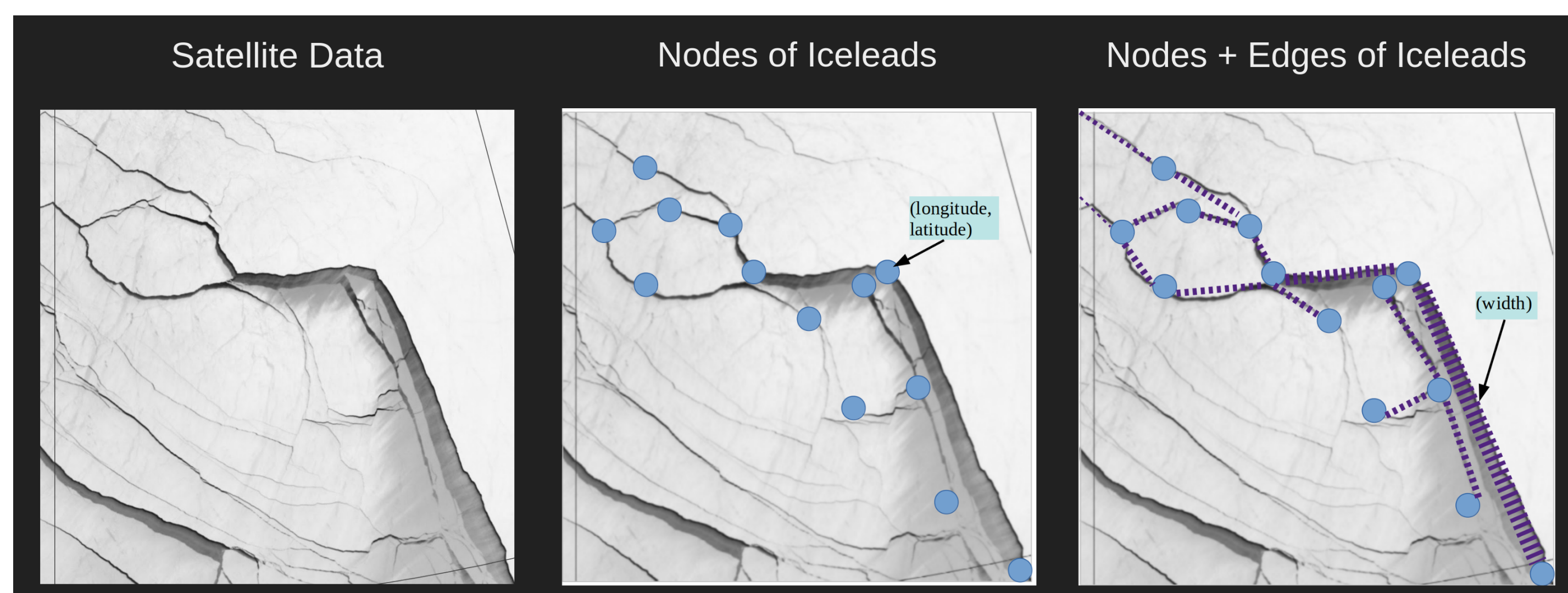
1. Ice leads can be interpreted as **networks**.
2. **Temporal** ice lead network **analysis** is possible and revealing.
3. This new type of real-world graph needs **new link prediction methods**.

Contributions

1. Code to construct "networkx" graphs from ice lead observations:
[www.github.com/liellnima/iceagle](https://github.com/liellnima/iceagle)
2. Discovery of new type of network
3. Temporal and spatial analysis of ice leads

"Ice Leads to Network" Translation

Intuition for interpreting ice leads as network. Satellite image: [3].



Nodes of the network: Start & end points of ice leads. **Node attributes:** Long & Lat.

Edges of the network: Ice leads themselves. **Edge attributes:** Width and length of ice leads.

Appendix: Network's Properties

- Planar, Euclidean, no motifs
- Disconnected, short paths
- Uncommon clusters or communities
- No small-world phenomenon
- Diameter follows seasonal trends
- Linear degree distribution on a log scale (and not log-log scale as common)

Contact

✉ julia.kaltenborn@mail.mcgill.ca