Examining Differences in Ice Growth Processes for Different Modes of Storm Formation

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ENVIRONMENT ANALYTICS

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Motivation

Even for summer storms, much of the precipitation that falls to the ground starts as ice high in clouds. Processes of ice growth are generally better understood within summer thunderstorms, which have relatively strong vertical air motions, than for winter snowstorms with relatively weak vertical air motions. We analyzed the environments for ice growth observed in different field projects that sampled winter and summer storms. Improved understanding these environments will enable better prediction of heavy precipitation at the ground.

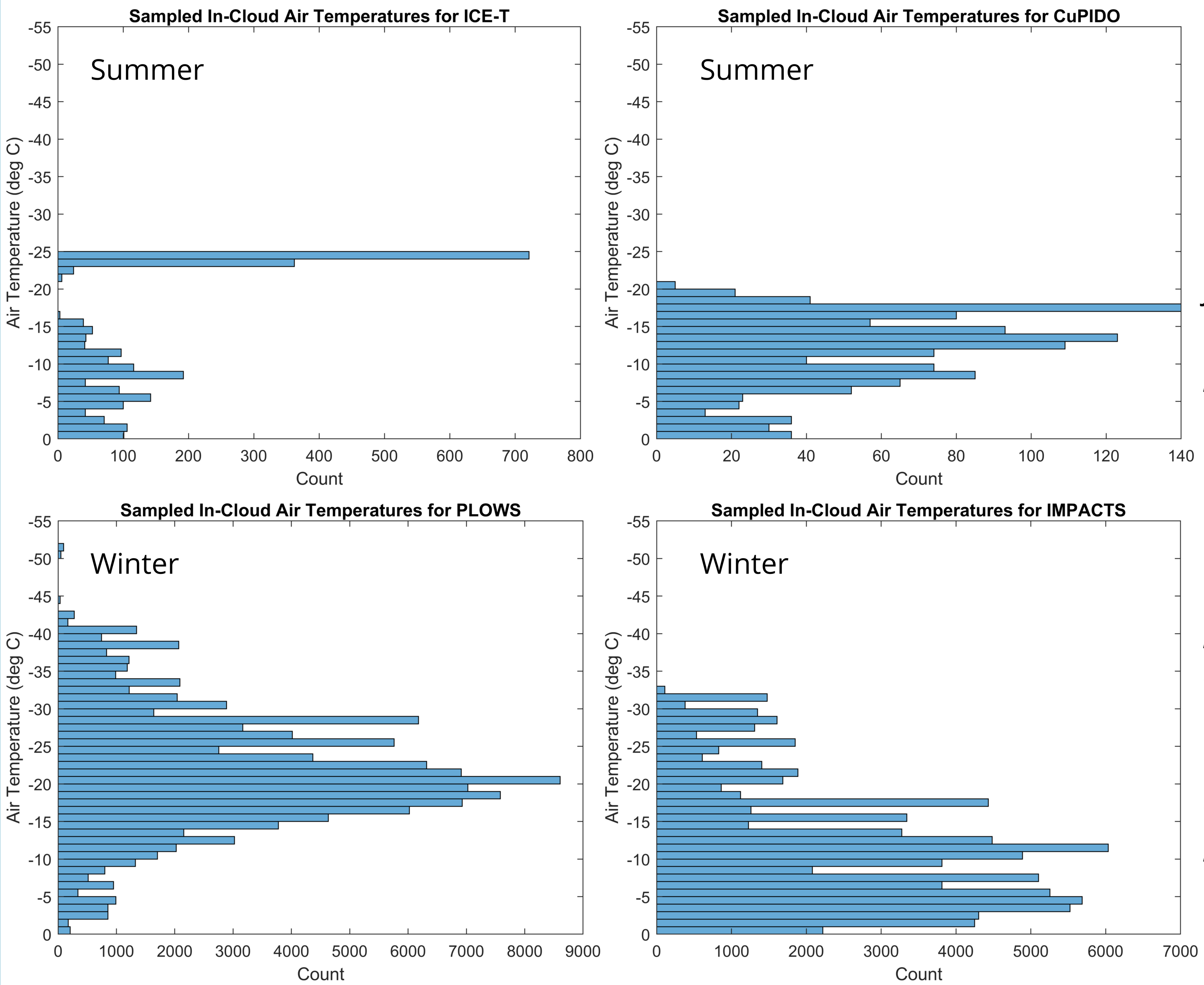
Methods

We used data from field projects which flew research aircraft through clouds to sample their thermodynamic and microphysical properties. Only points that have cloud particle concentrations greater than zero (i.e., "in-cloud" points) are used. We examine the air temperature distributions, as well as relative humidity with respect to ice (RHice), and vertical velocity to compare winter storms with summer storms. Ice growth occurs where RHice exceeds 100%, and ice shrinkage occurs where RHice is less than 100%.

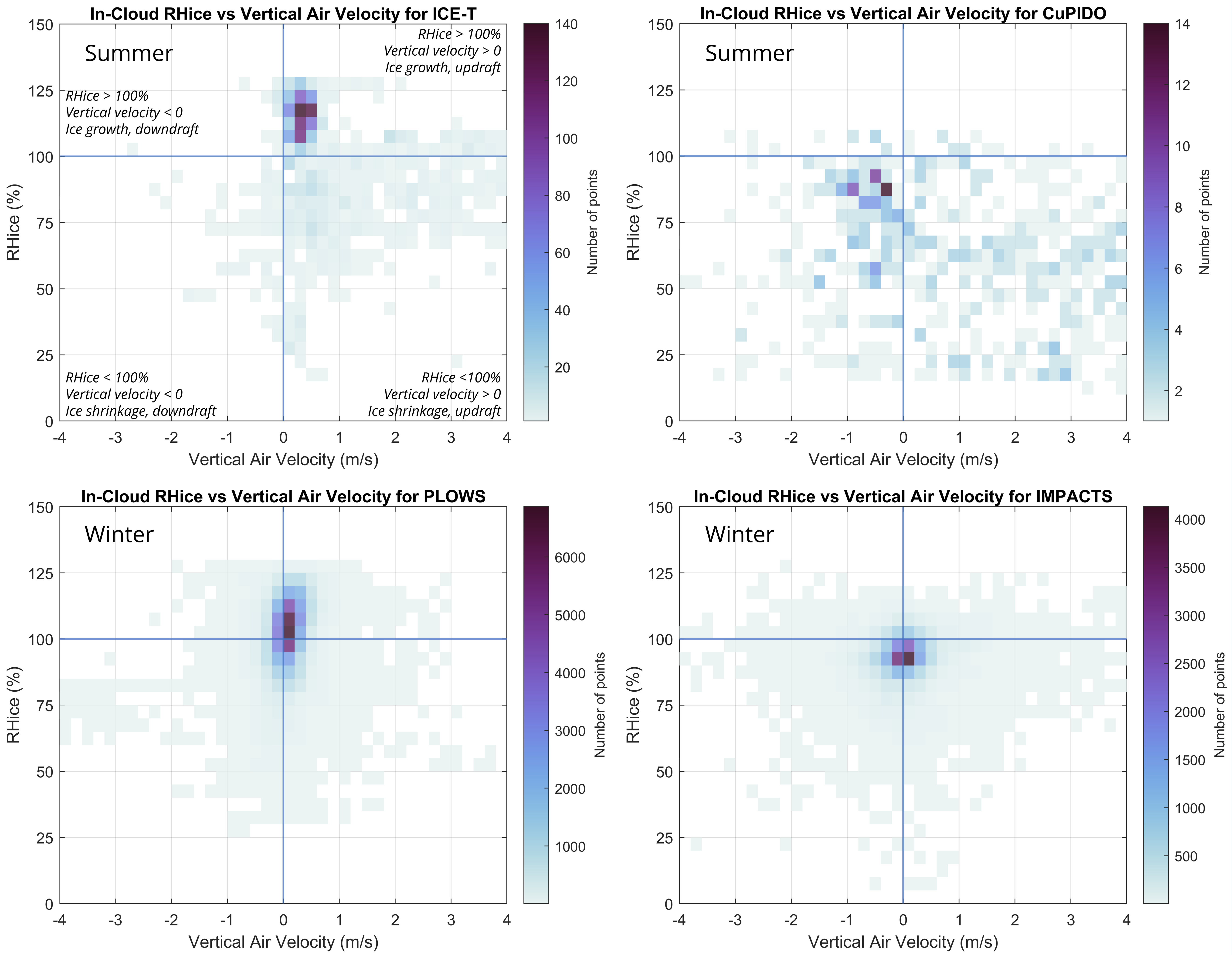
Project	Weather/ Cloud types sampled	Instrument for cloud sensing	Diameter range of sampled particles (μm)
ICE-T	Subtropical marine cumulus	2D-C	75 – 1450
CuPIDO	Orographic (mountain) cumulus	2D-C	75 – 1200
PLOWS	Midwest US winter storms	2D-C	75 – 1200
IMPACTS	Northeast coast and Midwest US winter storms	2D-S	30 – 1900

Left: *Photo from ICE-T field experiment, showing marine cumulus clouds.*

Right: *Photo from IMPACTS field experiment, showing aircraft flying through a US winter storm.*



Histograms of sampled air temperature for points where cloud particle concentration is greater than zero (in-cloud). The winter field projects sampled more points than the summer field projects.



Joint distribution plots of RHice versus vertical air velocity in which cloud particle concentration is greater than zero (in-cloud) and temperature is between -5 and -25 °C.

Summary

- In all the storms, the most common vertical air motions are weaker than +/- 1 m/s
- As expected, saturated updrafts (vertical velocity > 0 m/s and RHice > 100%) which are prime environments for ice growth, occur with higher relative frequency in summer cumulus than the other cloud types.
- In comparison to the Midwest winter storm sample, the Northeast coast winter storms have more in-cloud volume between -5 and -25°C with environments where ice and snow shrink (lose mass).
- Future work will further examine and compare storm structures in Midwest and Northeast coast winter storms.

Acknowledgements

This work is supported by NSF AGS-1905736 and NASA 80NSSC19K0354. Special thanks to Jordan Fritz, Logan McLaurin, McKenzie Peters, Laura Tomkins, and Kevin Burris for their feedback during this project and on this poster.

References

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