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Imaging the impurity distribution in polar ice cores: future pathways in measurement and analysis

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Polar ice cores are invaluable archives of our climate past but retrieving climate signals from the oldest and highly thinned ice remains a challenge. A breakthrough can come from imaging the impurity distribution in ice using laser-ablation inductively-coupled plasma mass spectrometry (LA-ICP-MS), but dedicated expertise in image analysis is urgently needed.
Here we are illustrating this new inter-disciplinary frontier with some key open questions. To study the ice-impurity interplay in deep ice, we must significantly extend the physical size of the images beyond a few mm2. We show how utilizing inpainting techniques guided by optical data promise upscaling sparse LA-ICP-MS lines to a full comprehensive image. This approach can be extended with a 3D structural model of the ice chemistry. This way we can predict how processes at the crystal scale can affect bulk concentrations measured by melting cm-volumes of ice. Such tools in image analysis with deep learning techniques will also benefit the already wide-spread application of LA-ICP-MS imaging in biogeosciences.

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