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Visual and fluorescence characterisation of particulate aerosols in ice cores with imaging flow cytometry

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Current efforts to examine and quantify so-called 'biomarkers' present in polar ice samples offer exciting potential as biological and biochemical proxies for past climate and ocean dynamics. Here we present a new rapid and easily replicable method to provide measurements of the microscopic particulate content of ice samples from polar environments. Using an Amnis® Imagestream® Imaging Flow Cytometer, melted snow and ice samples from Patriot Hills in the Ellsworth Mountains, Antarctica were analysed for their particulate (biological and non-biological) content. Selective use of a nucleic acid stain pre-treatment allows for a straightforward gating strategy that resolves both autofluorescent and non-autofluorescent biological material in sample replicates. In the Patriot Hills samples this method clearly identifies marine picoplankton, along with non-biological particulates such as tephra and minerogenic material. Crucially, the 60x Brightfield images provided by the Imagestream offer a significant additional capability above standard flow cytometry systems; each object identified by the machine can be visually differentiated (automatically or manually) from particulates with similar fluorescence properties. Back-trajectory analysis with the NOAA Hybrid Single-Particle Lagrangian Integrated Trajectory (HySPLIT) model indicates that these ice-bound marine organisms originate from the Weddell and Amundsen-Bellingshausen Seas. This technique, when paired with established chemical and biochemical methods, shows considerable potential in providing valuable information about the nature and origin of aerosols and biomarker signals trapped in past ice layers.