

Antarctic peninsula aerosol particle composition analyzed with a new HILIC-ESI-TOF-MS method for free and combined amino acid

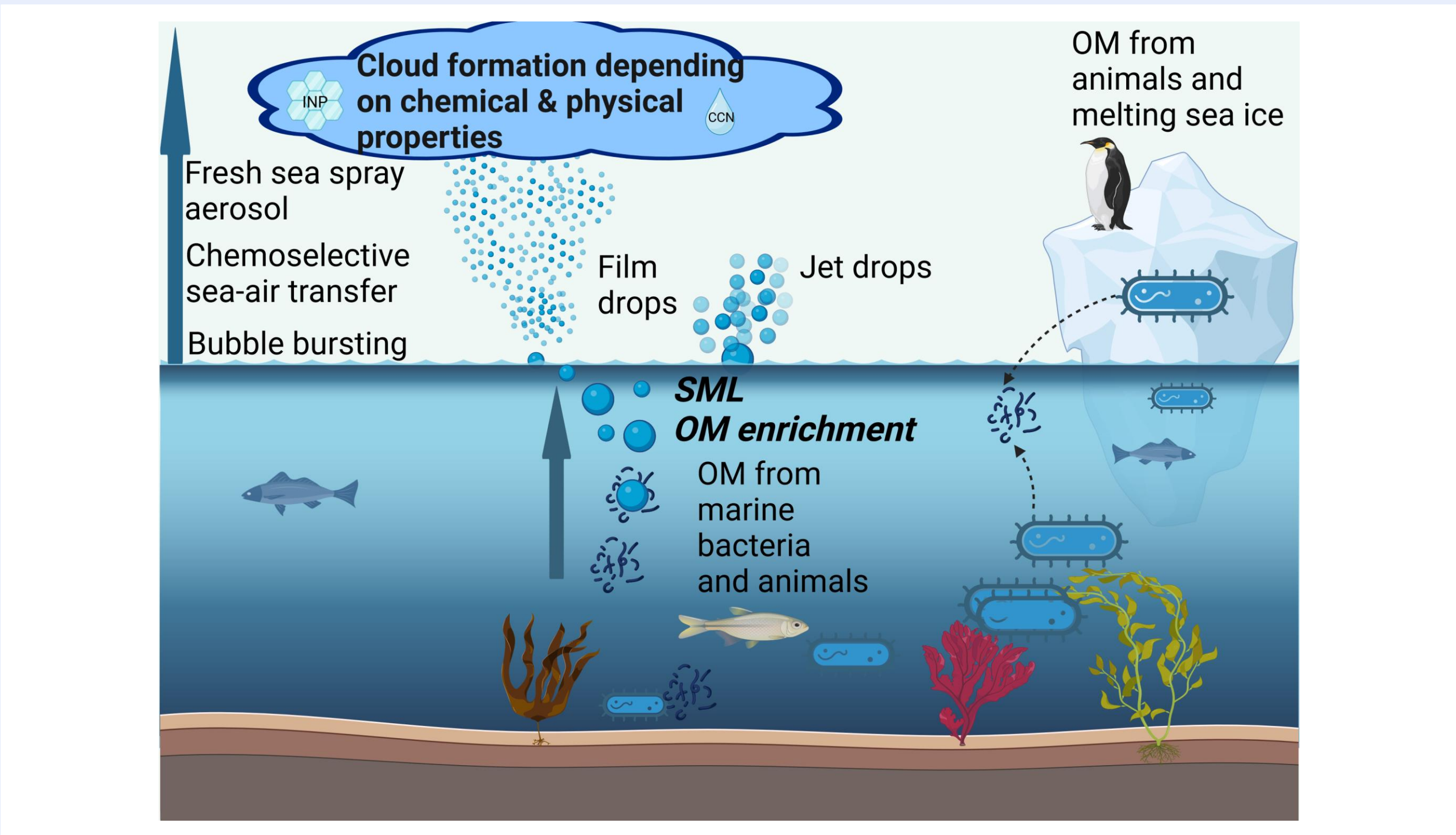
Christina Breitenstein¹, Manuela van Pinxteren¹, Sebastian Zeppenfeld¹, and Hartmut Herrmann¹

¹Leibniz Institute for Tropospheric Research (TROPOS), Atmospheric Chemistry Department (ACD), Permoserstraße 15, 04318, Leipzig, Germany



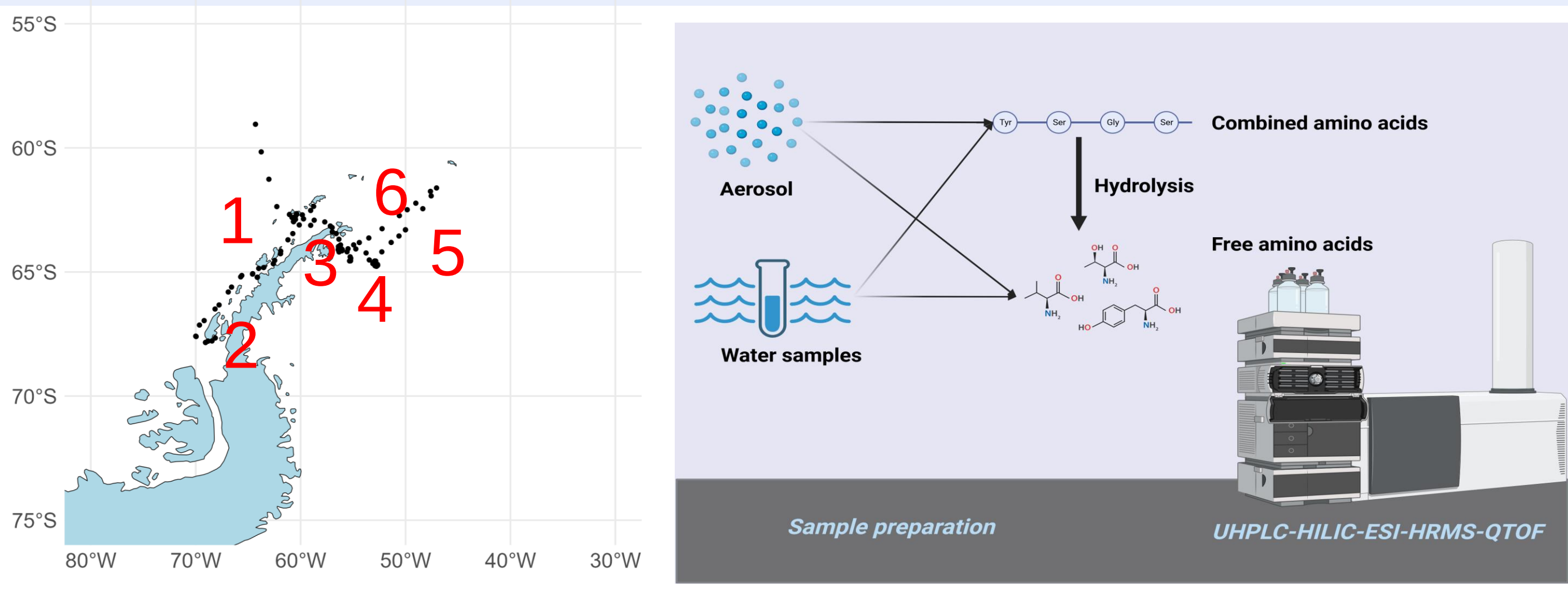
Contact: breitenstein@tropos.de

Motivation



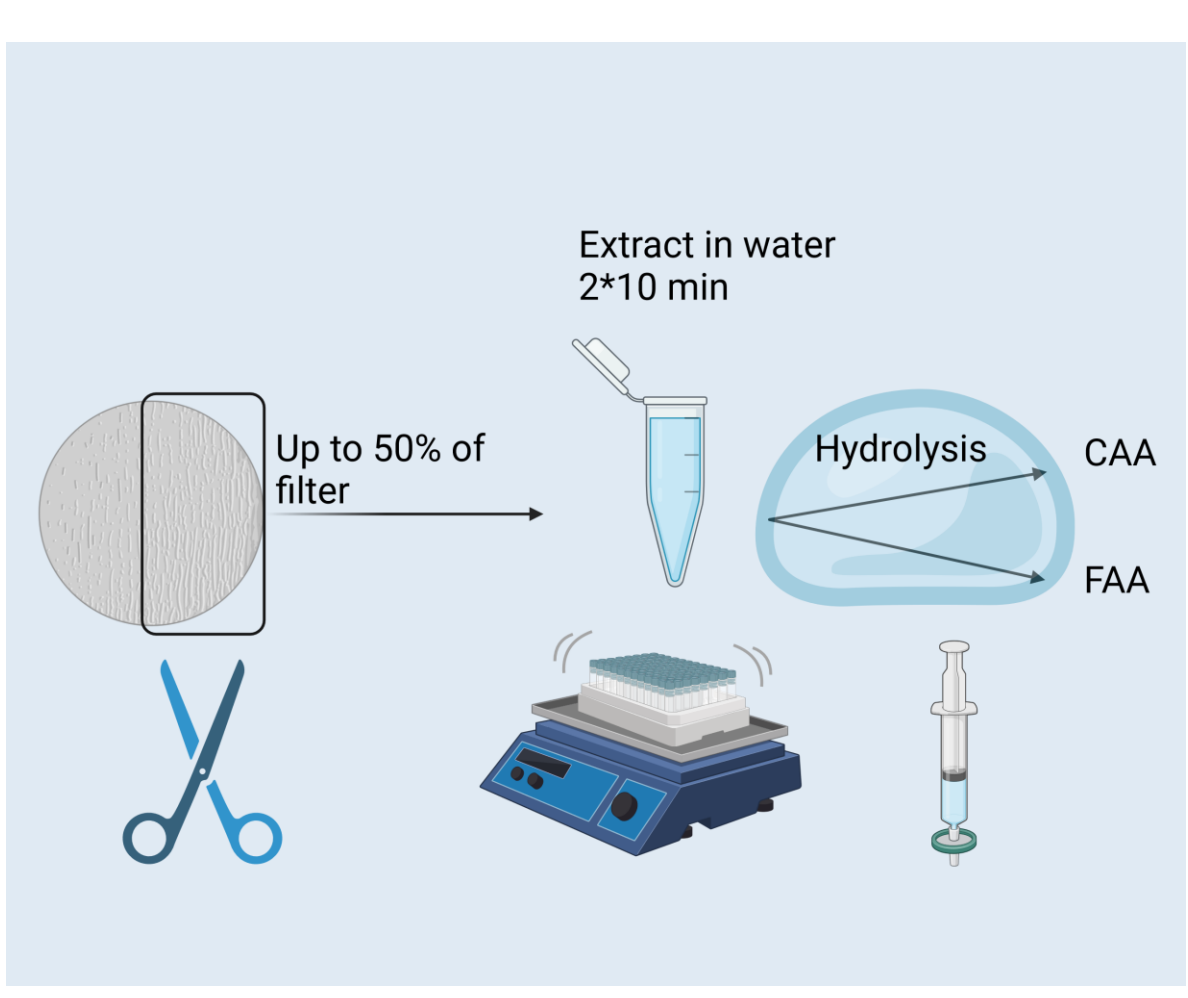
- Remote marine aerosol particle composition is not fully understood. One important factor for cloud formation processes via cloud condensation nucleus (CCN) and ice nucleating particles (INP) is the molecular composition of the aerosol particles.
- Especially organic matter (OM), consisting to a large fraction of amino acids, is not well studied.
- One of the main sources is the sea surface microlayer (SML), through wind and wave driven processes OM is transferred to aerosol particles.

Methods



- A ship-based sampling campaign was conducted in Feb-March 2022 around the Antarctic peninsula, sampling SML and Bulk water.
- Also, particulate matter (PM) samples were collected using a low-pressure collector with a size-resolved inlet in a 36h sampling interval.
- A hydrophilic interaction liquid chromatography (HILIC) coupled to a quadrapole time of flight (QTOF) MS method was developed.

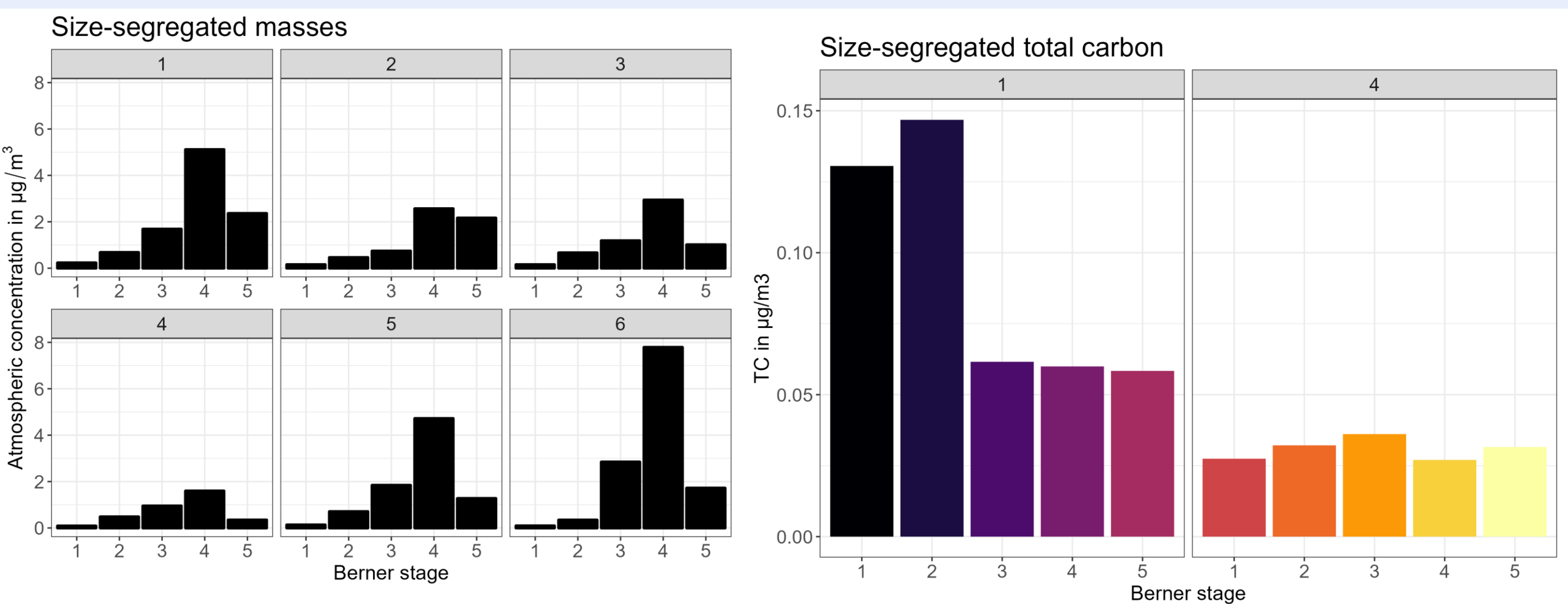
Overview of sampling and sample handling strategy



- Amino acids are ubiquitous, careful handling must be ensured.
- Different validations to assure reliable data, such as Blank control and hydrolyzation influence were done.
- Total amino acids (TAA) consist of free amino acids (FAA) and combined amino acids (CAA). CAA are peptide/proteins, this is needed to understand OM composition.

Results

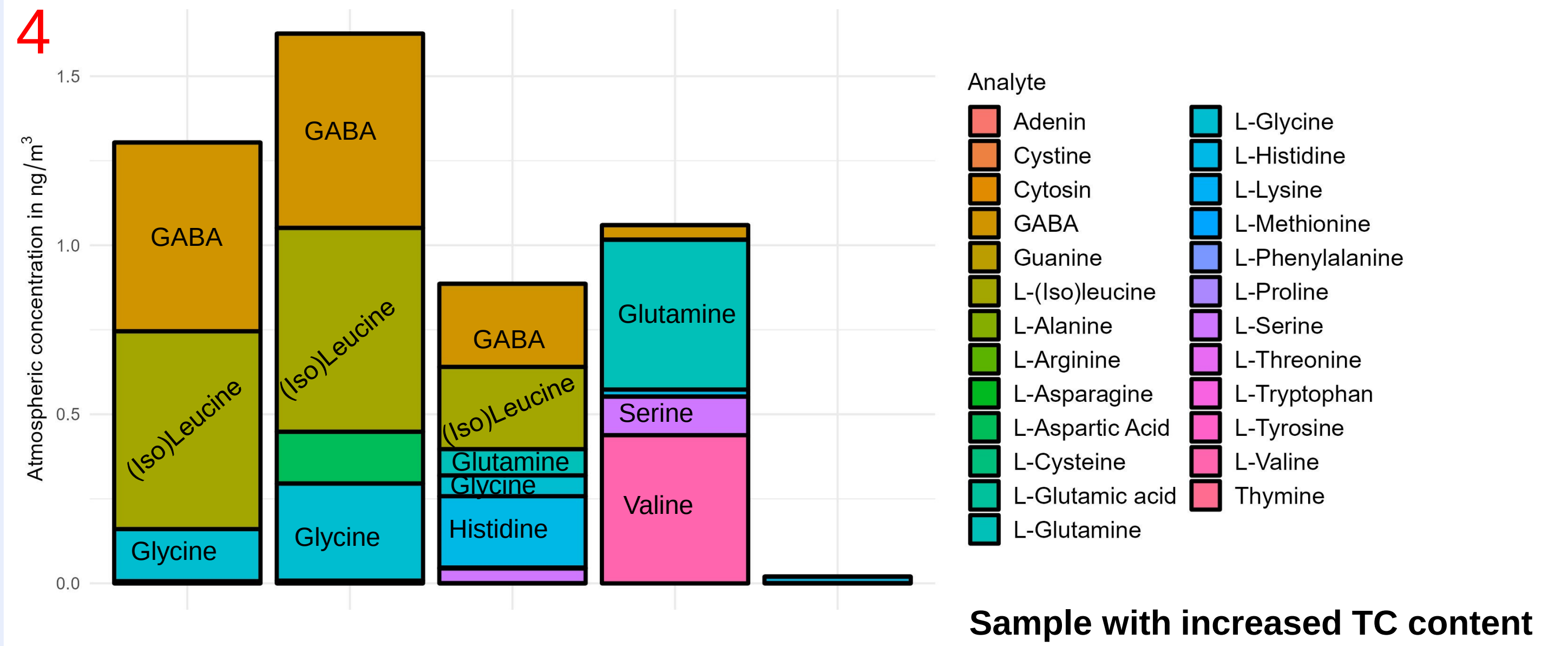
Overview of size-segregated mass and TC content



- Highest aerosol particle masses at 1.2-3.5µm, coarse mode
- Total carbon content higher at fine mode.

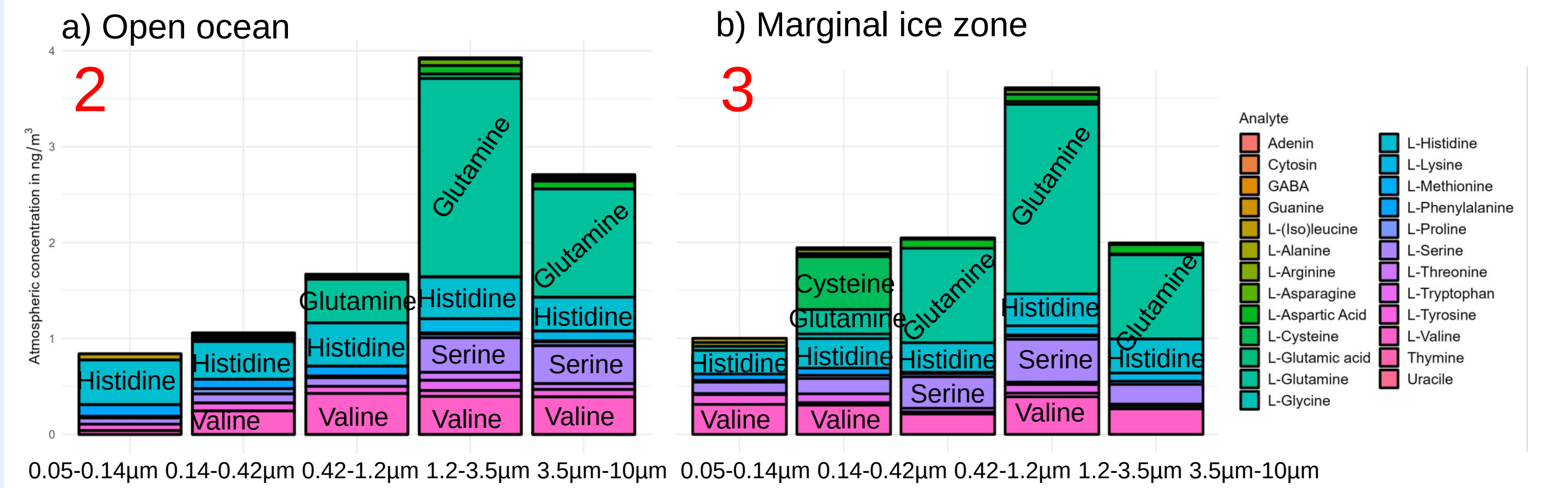
Results -Comparison of FAA composition within field campaign

Sampling at open ocean stationary position



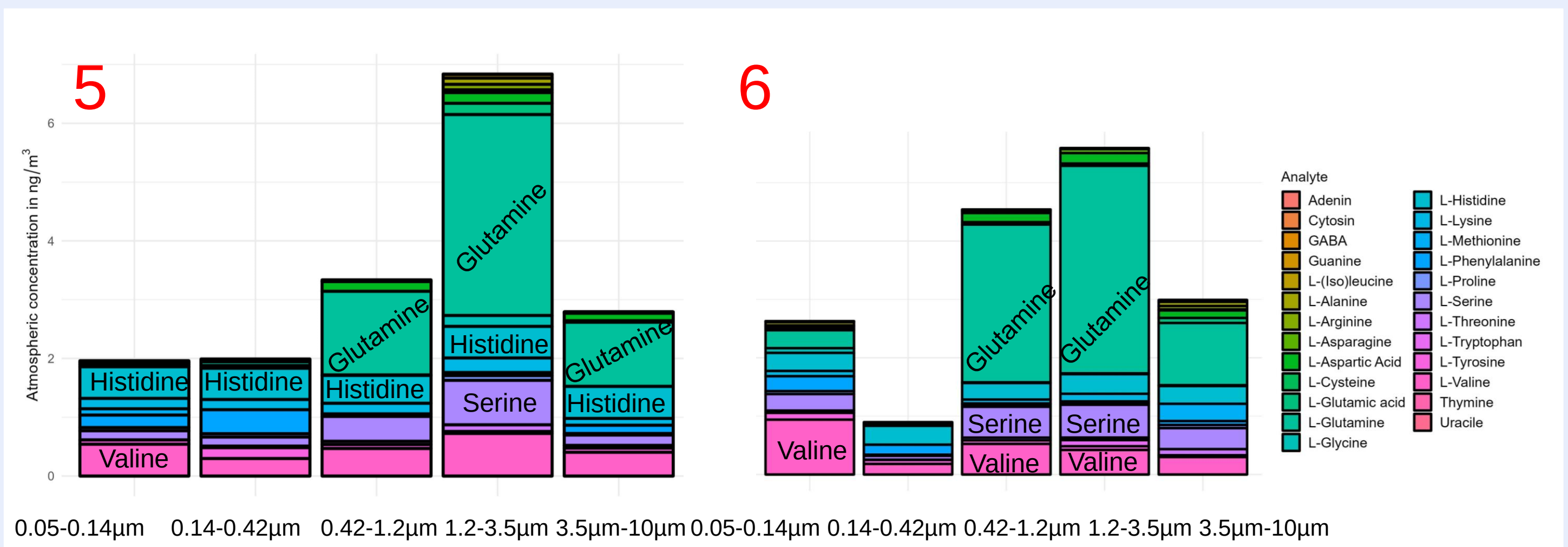
- Heavy snowfall and high wind speed influencing individual FAA concentrations.
 - Long-range transport marker Glycine^[1] highly concentrated in fine mode.
 - High concentrations of bacterial tracer GABA^[2] in fine mode.
 - Phytoplankton bloom tracer Glutamine^[3].

Sea ice influence on FAA concentrations

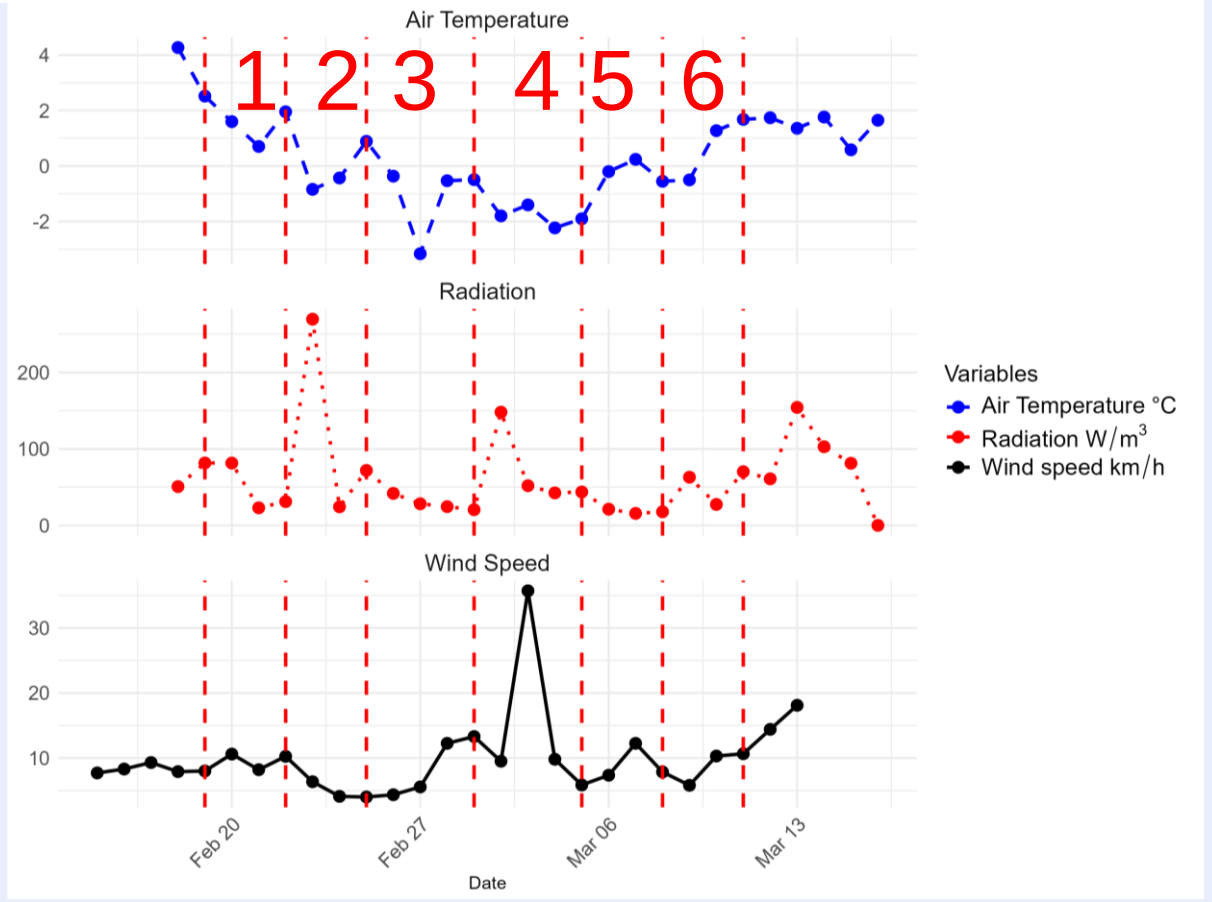


- Higher individual and ΣFAA concentration for coarse mode than fine mode particles.
 - ΣFAA concentration driven by of Glutamine, Histidine, Serine and Valine.
- Higher concentration of Phenylalanine, tracer for algae bloom, while increased radiation (2) and open ocean samples.
- Cysteine only found during coldest sampling period, often oxidized to Cystine.

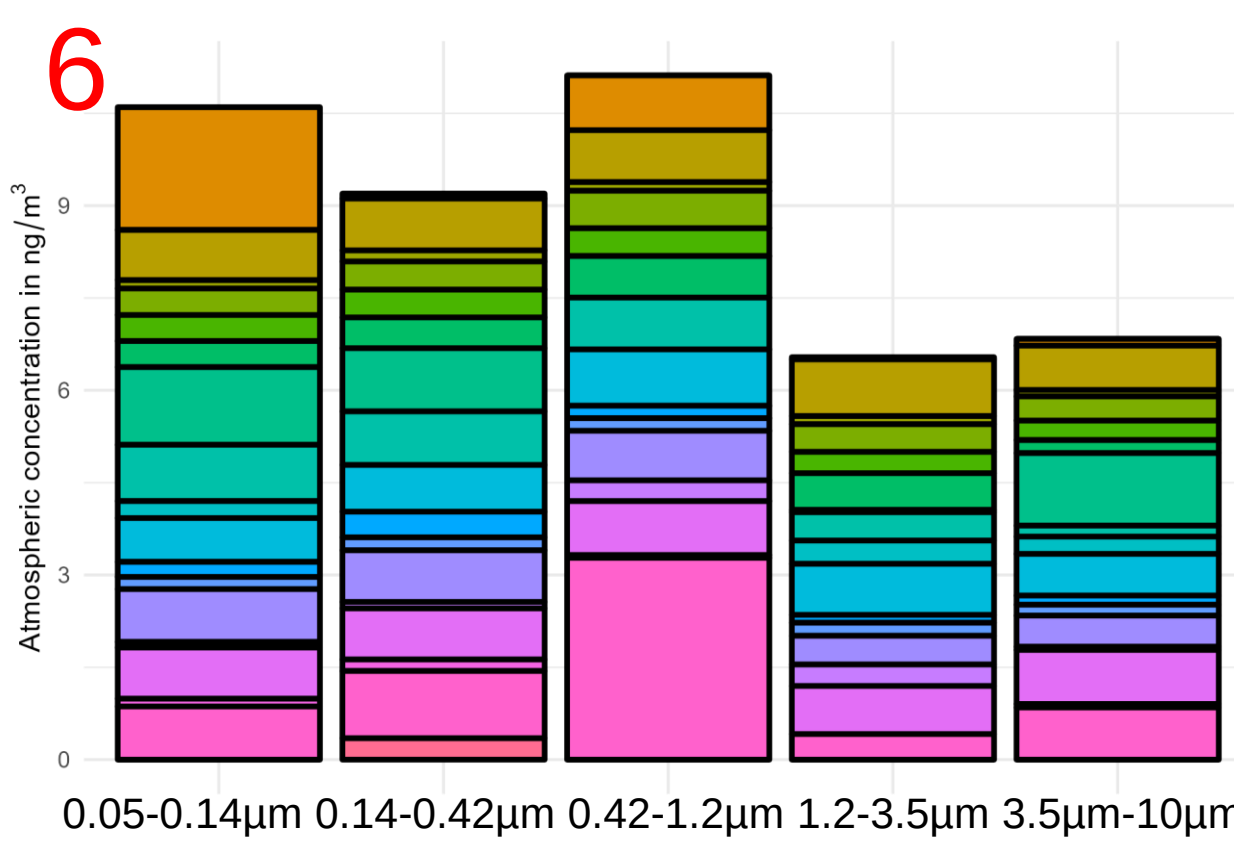
Comparison of FAA concentrations during a transect



- Air temperature and radiation similar.
- Spike in particle mass not driven by FAA.
- High concentrations of stable FAA Glutamine, Histidine, Serine and Valine drive ΣFAA concentrations.
- Long-range transport tracer Glycine not main FAA.
- High influence of wind speed on FAA composition.



Outlook –TAA and water samples



- Analysis of TAA for all samples.
- Relate the TAA concentration and composition to different meteorological and oceanic conditions
- Combination with SML and Bulk water sample results to understand the occurrence, transfer and significance of AA on aerosol particles

Sketches made with BioRender, graphs with RStudio
[1] <https://doi.org/10.5194/acp-15-5457-2015>
[2] <https://doi.org/10.4319/lo.1999.44.7.1809>
[3] <https://doi.org/10.5194/bg-18-1067-2021>