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Controlled interferometric analysis of glaciomarine interactions and ice-loss processes at European ice coasts

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In the European Arctic Sector, ice coasts formed by glaciers extending into the sea stretch for ca. 3,600 km and represent the most varied elements of the arctic coastline, which grow shorter under current environmental settings. The most retreat of European ice coasts amounting to several hundred meters across the shore each year was detected at fronts of calving tidewater glaciers. This retreat is presumably related with the dominance of ice-loss processes at glacier fronts including melting, marine abrasion and calving over the influx of glacier ice to calving faces. Mass-balance estimates are available only for few arctic glaciers, ice discharge through maritime glacier fronts remains largely uncertain, and we still do not know whether the increased ablation mainly effects the current retreat of most European tidewater glaciers or the decelerated ice flow has a guiding influence on their retreat.

The present paper is devoted to detailed topokinetic studies and enhanced morphological and rheological modelling along European ice coasts using satellite interferometry, altimetry and field surveys with the aim to improve the representation of glaciomarine interactions in regional climate models. Special emphasis is placed on the interferometric analysis of periglacial processes and fast-ice deformation along calving fronts demonstrating different modes and rates of motion. The underlying concept of the study is to compensate the lack of reliable basic control and accurate reference models, which are needed for precise interferometric modelling of glacierized coastlines,

with spaceborne altimetry and apply an original transferential approach to determining frontal velocities of calving glaciers by measuring the fast sea ice translation away from the shore due to the glacier flow. Major attention is paid to the following topics:

- appraising interactions between glacier and fast sea ice and assessing other periglacial processes as additional indicators of coastal changes;
- detecting, measuring and interpreting changes of European ice coasts both in volumetric and fluxometric terms;
- determining the total ice discharge through maritime glacier fronts and estimating glacier mass balance characteristics at both regional (Barents Sea region) and local (specific test sites) scale;
- visualization and full-value mapping of ice-coast dynamics, glacier regime and mass balance and related processes in the form of satellite image maps, value-added interferometric products and controlled composites, scalable animated graphics, and basic layers for dynamic GIS;
- arguing an advanced observation technology for the long-term satellite monitoring of large European maritime glacial complexes, assessing and forecasting main tendencies in the state of land-ice resources and related socio-economic impacts in response to climate change.

Basic test sites exemplifying different types of glaciomarine interactions comprise the largest European ice caps and outlet glaciers in the Svalbard, Franz Josef Land and Novaya Zemlya archipelagos, and at Jan Mayen Island. The experimental data set includes tide-coordinated interferometric and altimetric data obtained from the European ERS and American ICESat satellites in 1995-96 and 2003 respectively as well as large-scale topographic maps, hydrographic charts and 3-D coordinates of control points from D-GPS surveys in key sites.

A conjectural hypothesis of general thinning and accelerating of maritime glacier margins in the Barents Sea region will be verified, a new inventory of European ice coasts will be described, and the evidence of coastal changes or stability will be used for detailed comprehensive classification of ice coasts. The integral estimation of the present state and spatial changes of ice coasts at pan-European scale will be done for the first time in the history of their explorations.