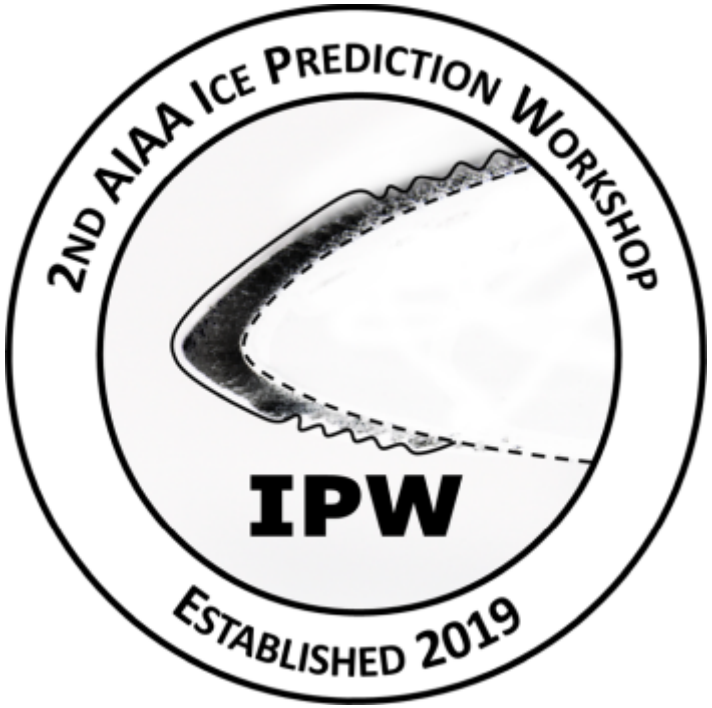


Ice Prediction Workshop 2023

Markus Lindner, NTNU

NTNU
Norwegian University of Science and Technology

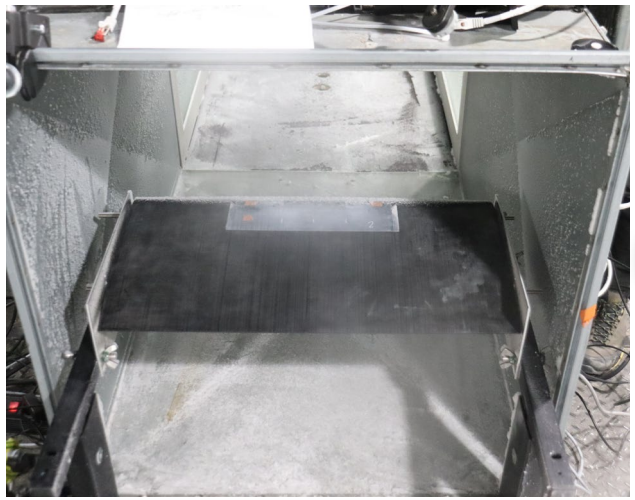
UAV Icing Lab

Norwegian University of Science and Technology
Department of Engineering Cybernetics

Provide the knowledge & solutions for unmanned aircraft in icing conditions.

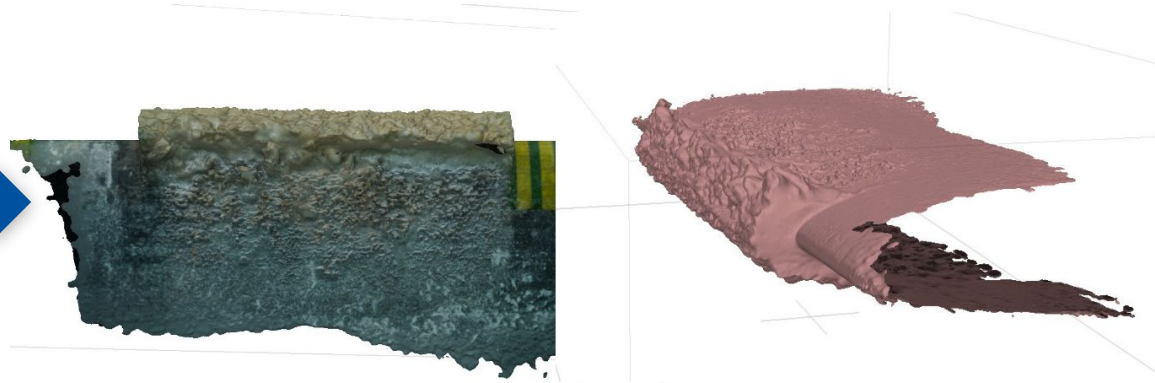
www.uavicinglab.com

Case 3 – Experimental Setup



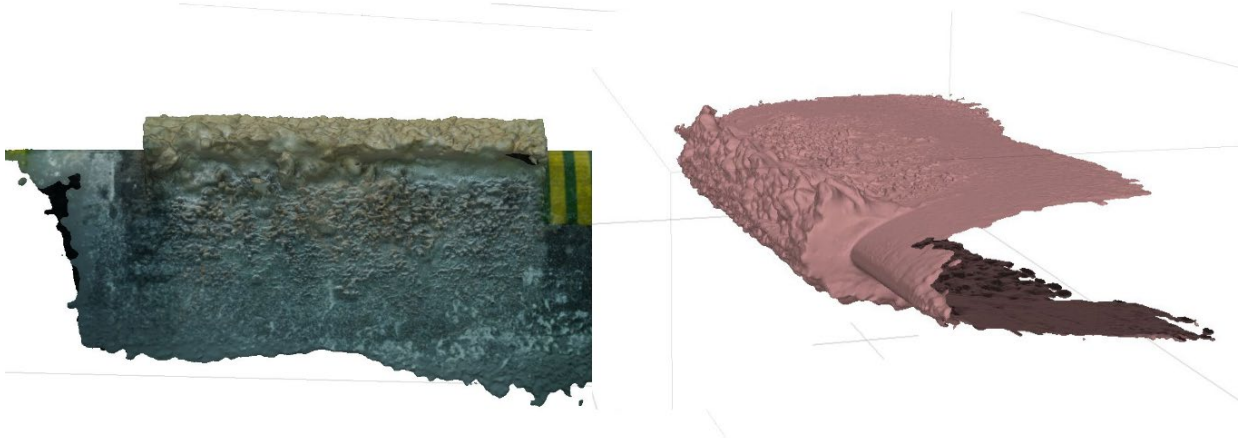
Icing wind tunnel

Photogrammetry setup

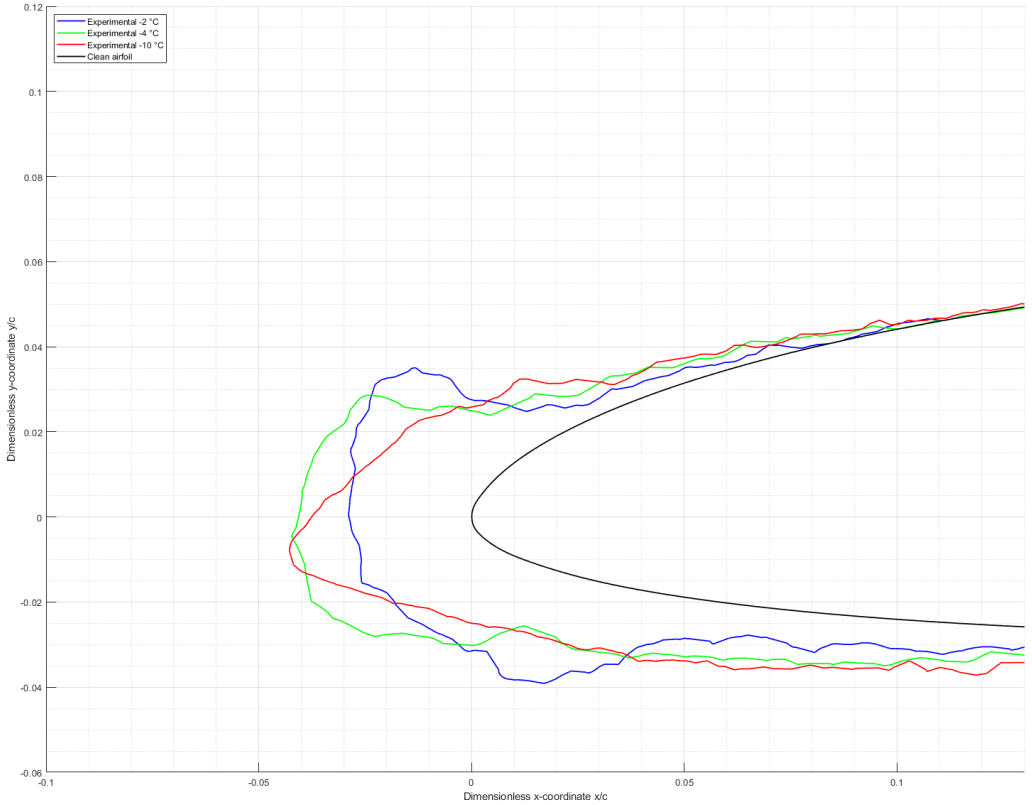


Digital 3D ice shapes

Case 3 – Experimental Setup



Digital 3D ice shapes



MaxCCS

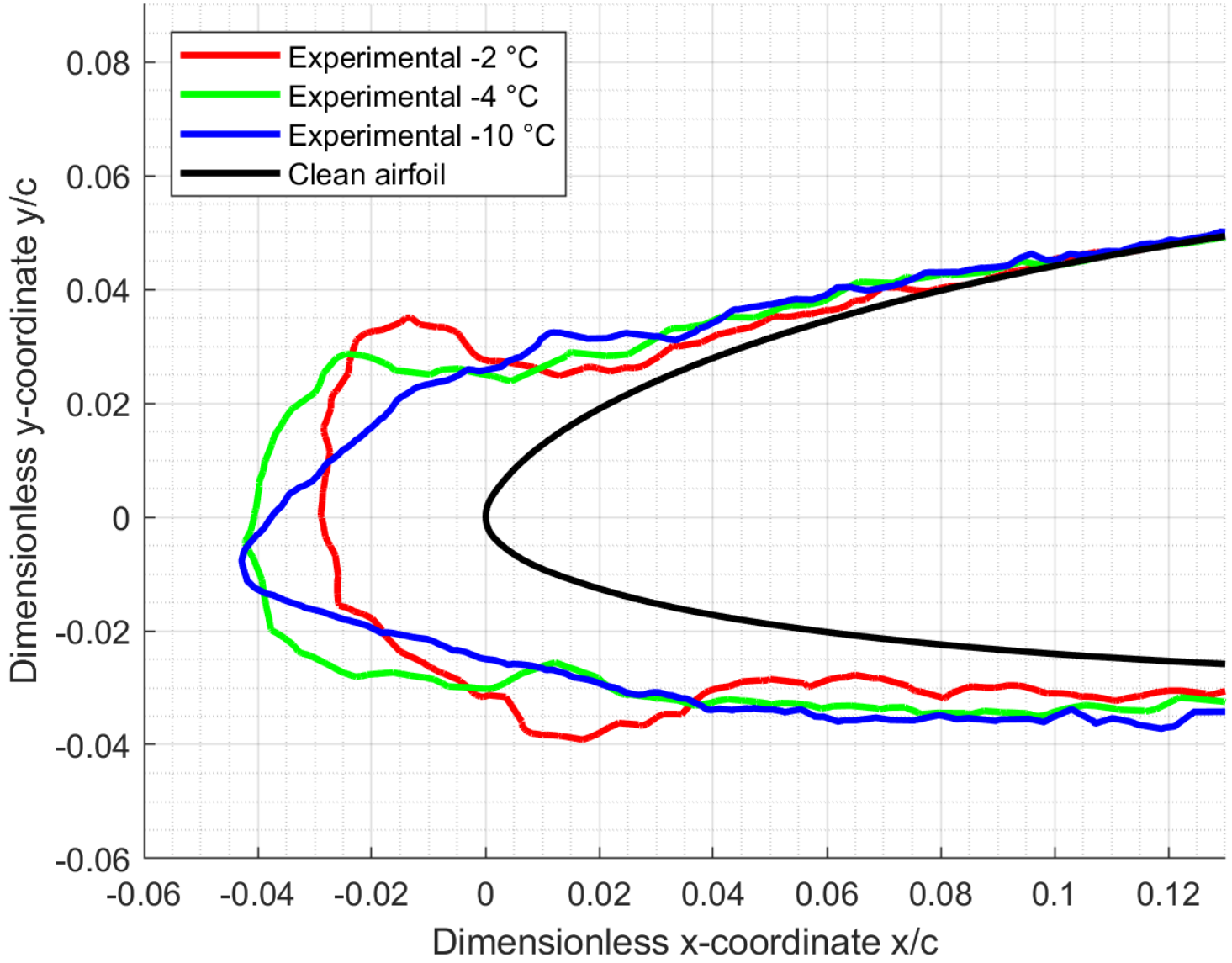
Case 3

RG-15 – Small Wing, Low Speed Icing

BUT maybe:

New Measurements at IWT

~~0.44 g/m^3~~ → 0.51 g/m^3



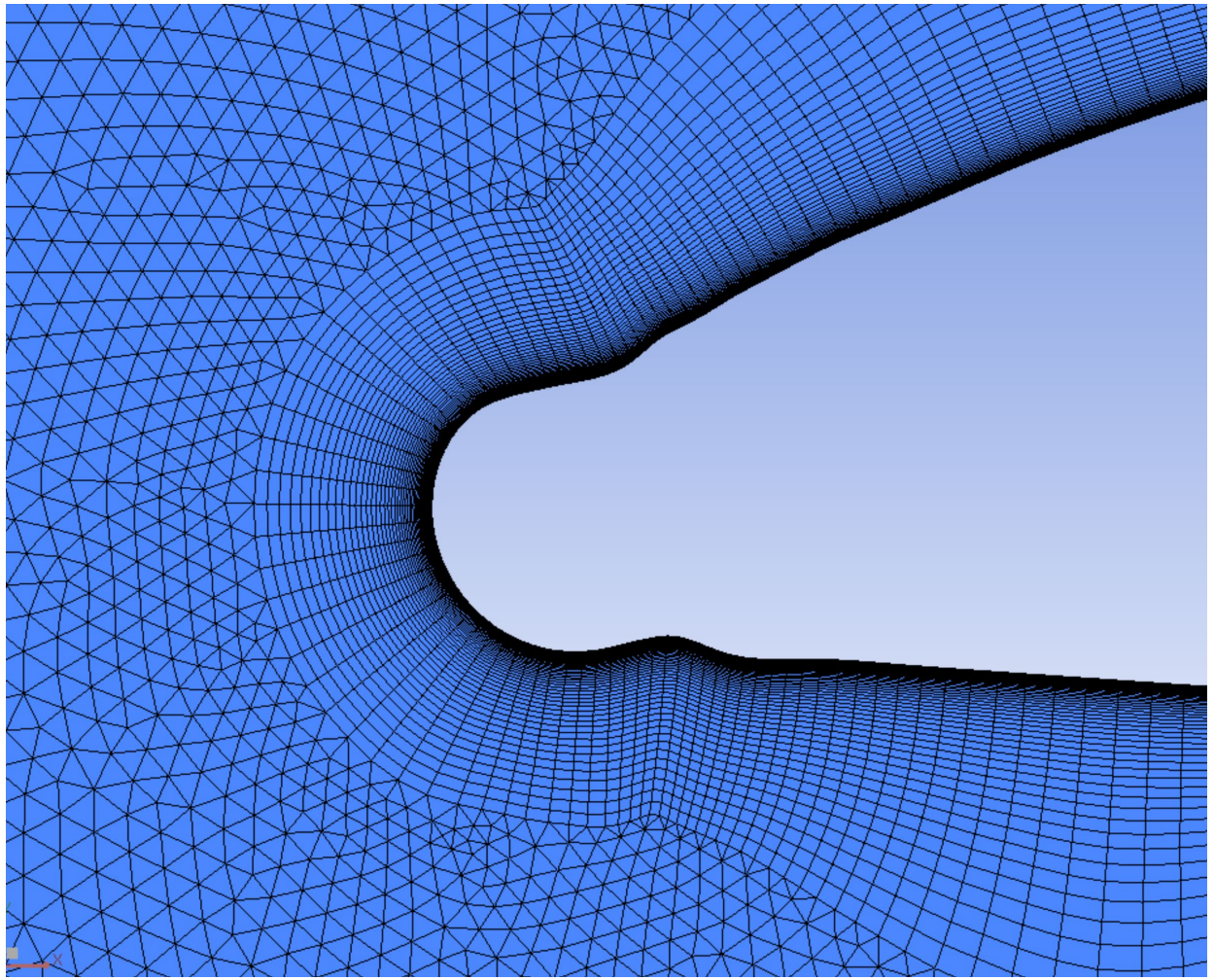
Simulation Approach

- Software: ANSYS FENSAP-ICE v22R2
  - Flow model: RANS, 2nd order
  - Droplet model: Eulerian
  - Thermodynamic model: modified Messinger model
  - constant ice density = 917 kg/m^3
  - Initial roughness = 0.0005 m
  - Remeshing with Fluent Meshing

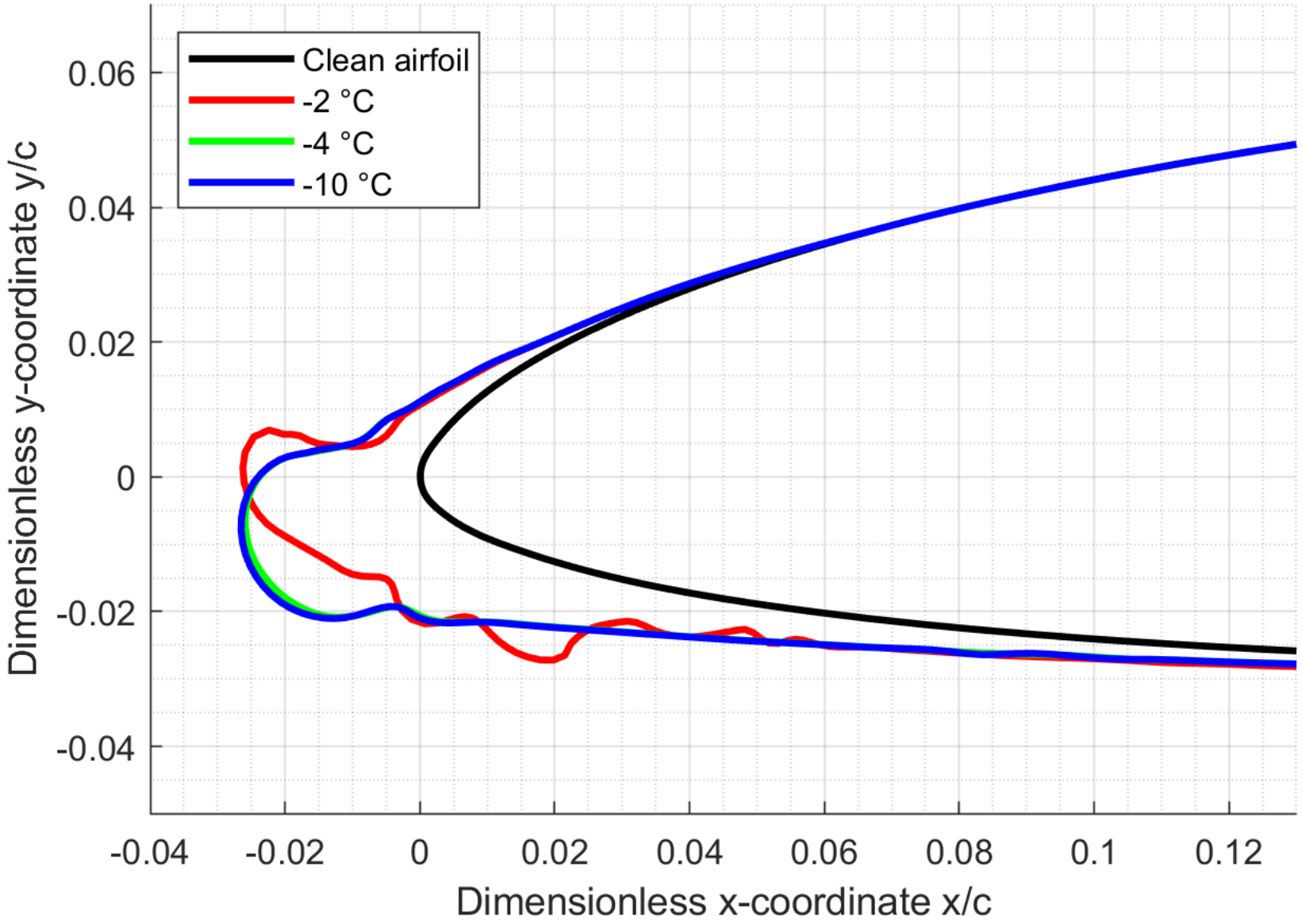
- Turbulence Model: Menter k-ω-SST, fully turbulent

Simulation Approach

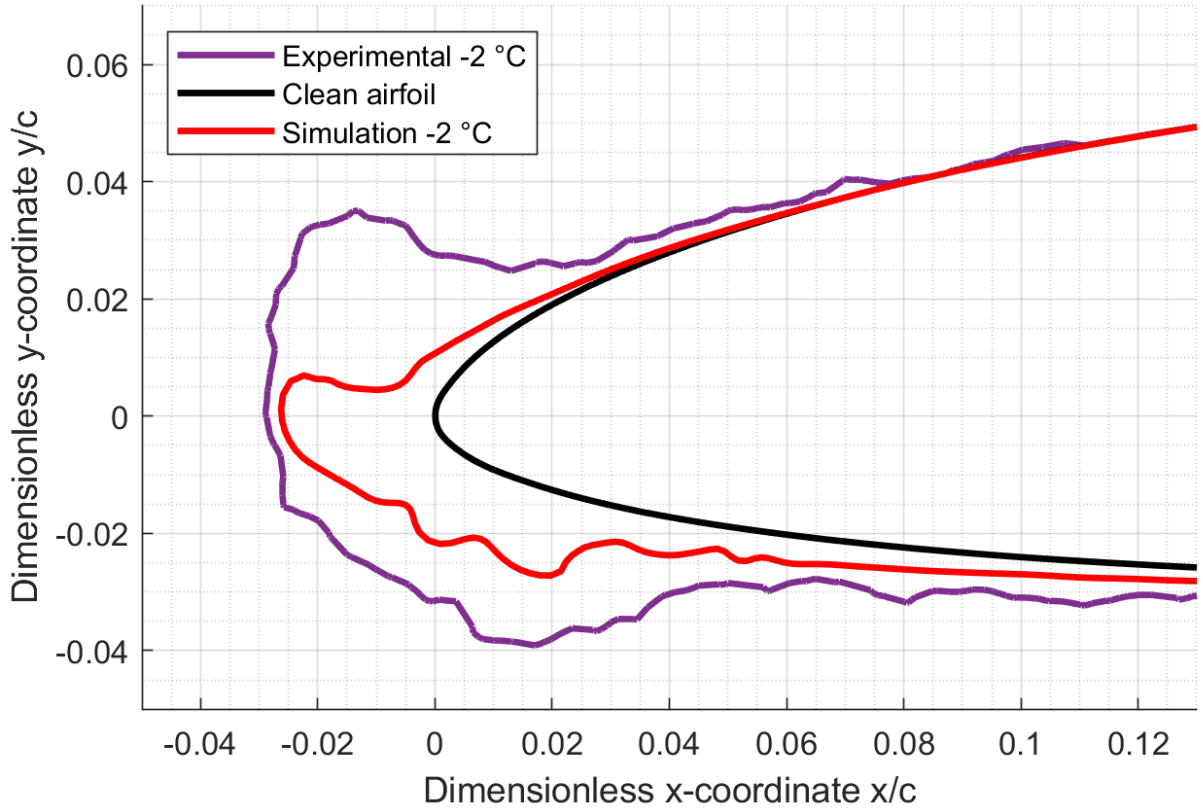
- Initial mesh provided by organization committee
- Multi-shot simulation with 7 shots
  - First shots 30 s
  - Other shots 200 s (except last 170 s)
- Remeshing settings
  - Curvmin: 0.0004
  - Curvmax: 0.001

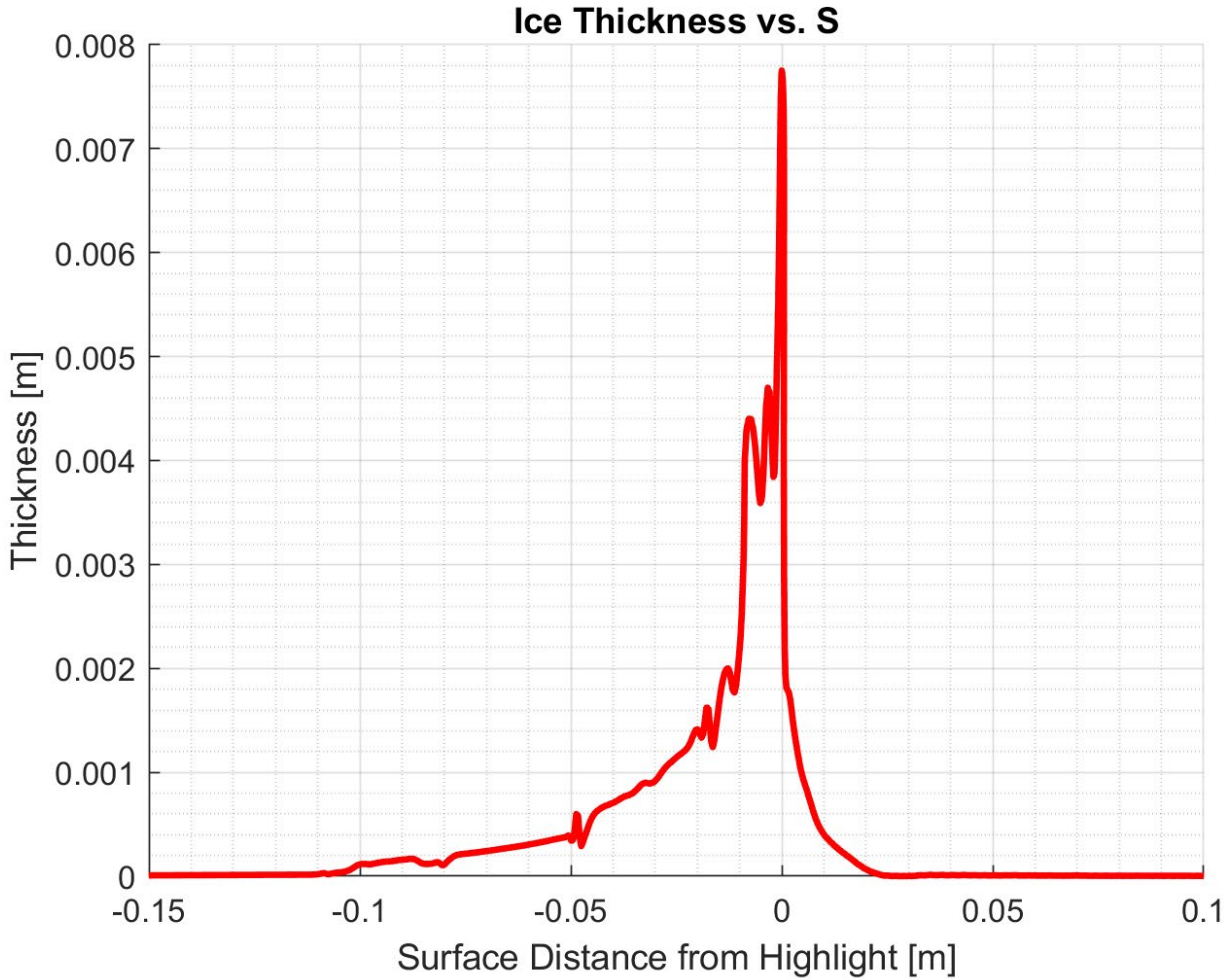


Case 3 - Results

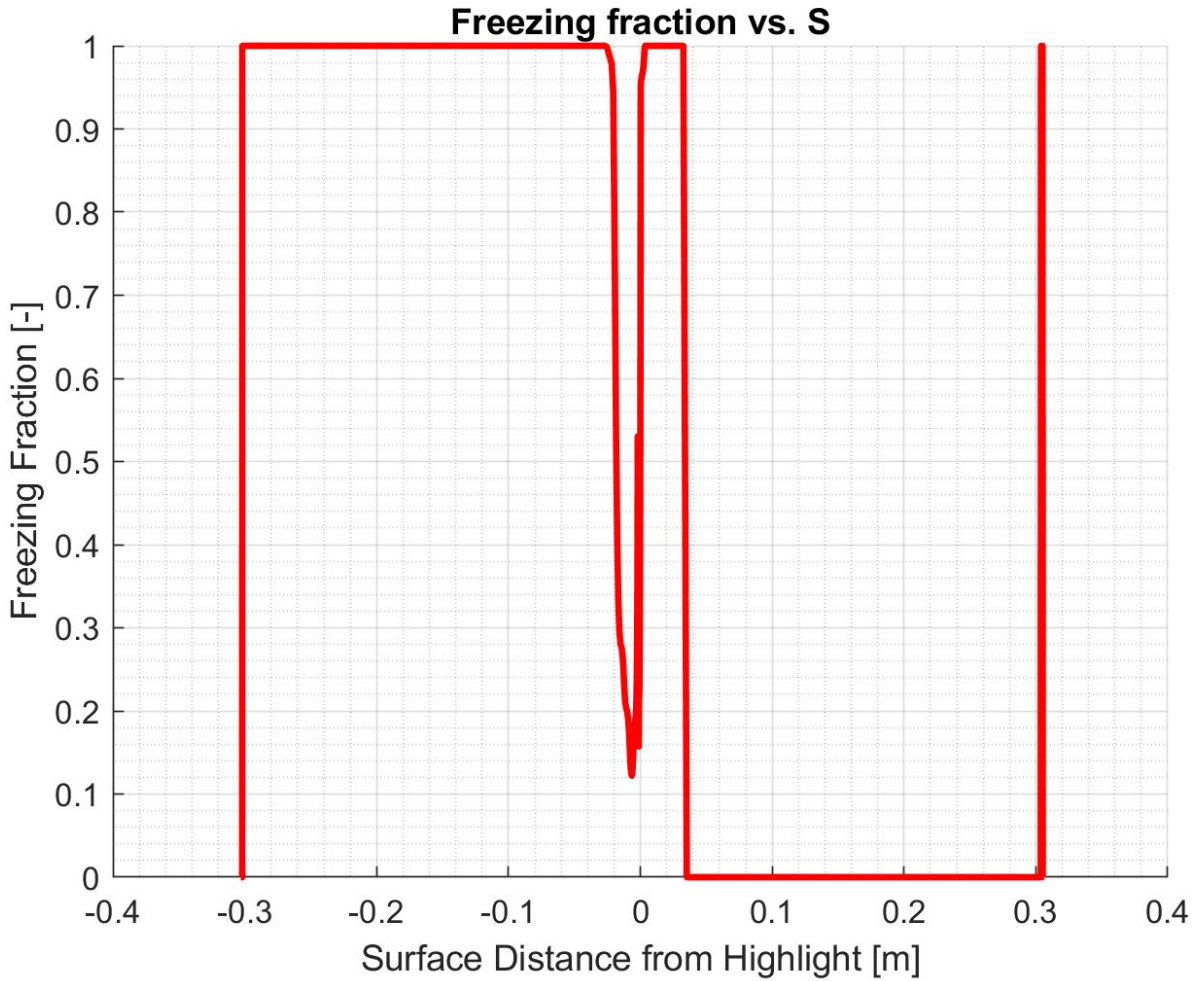


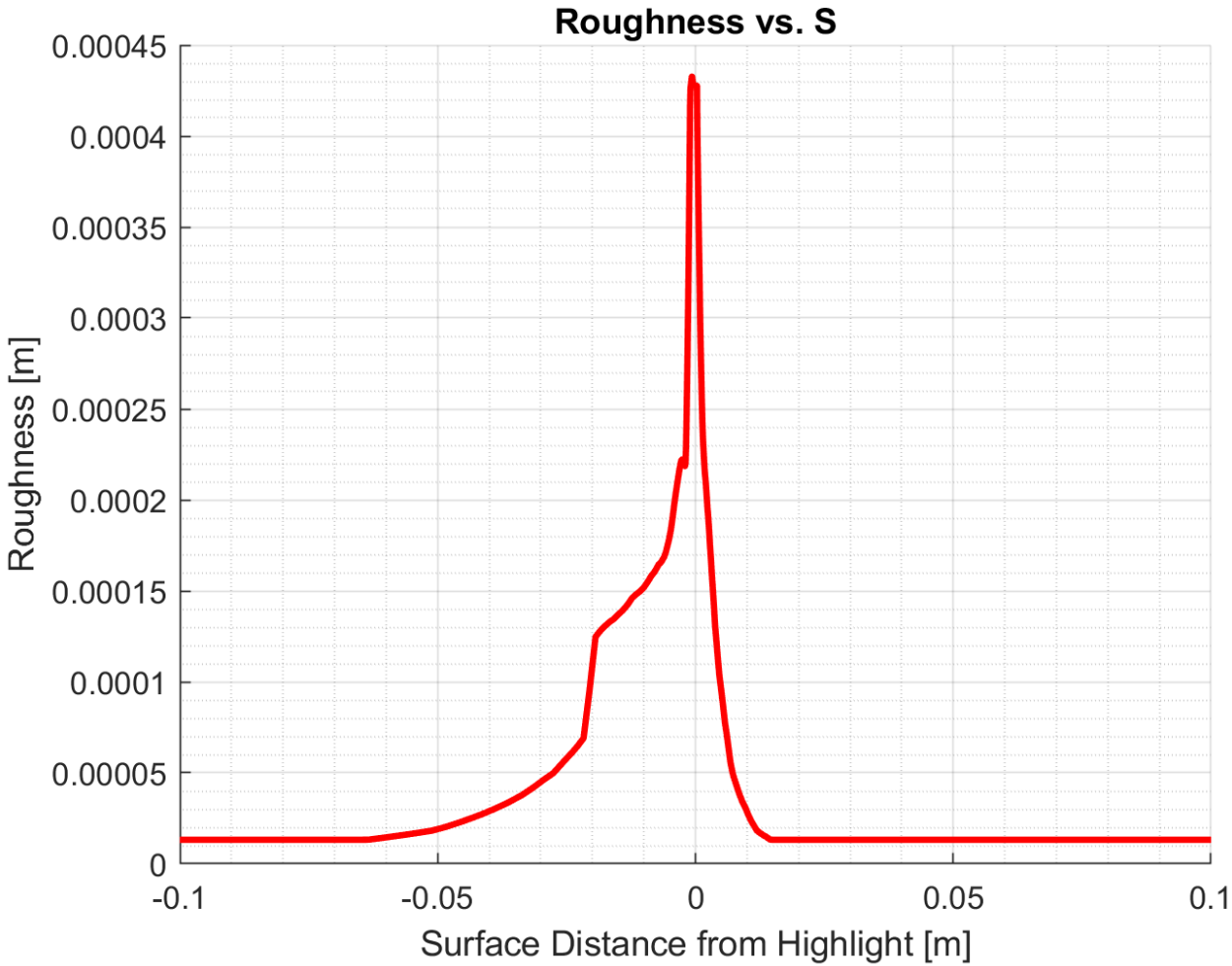
Case 3.1 – Temperature –2 °C



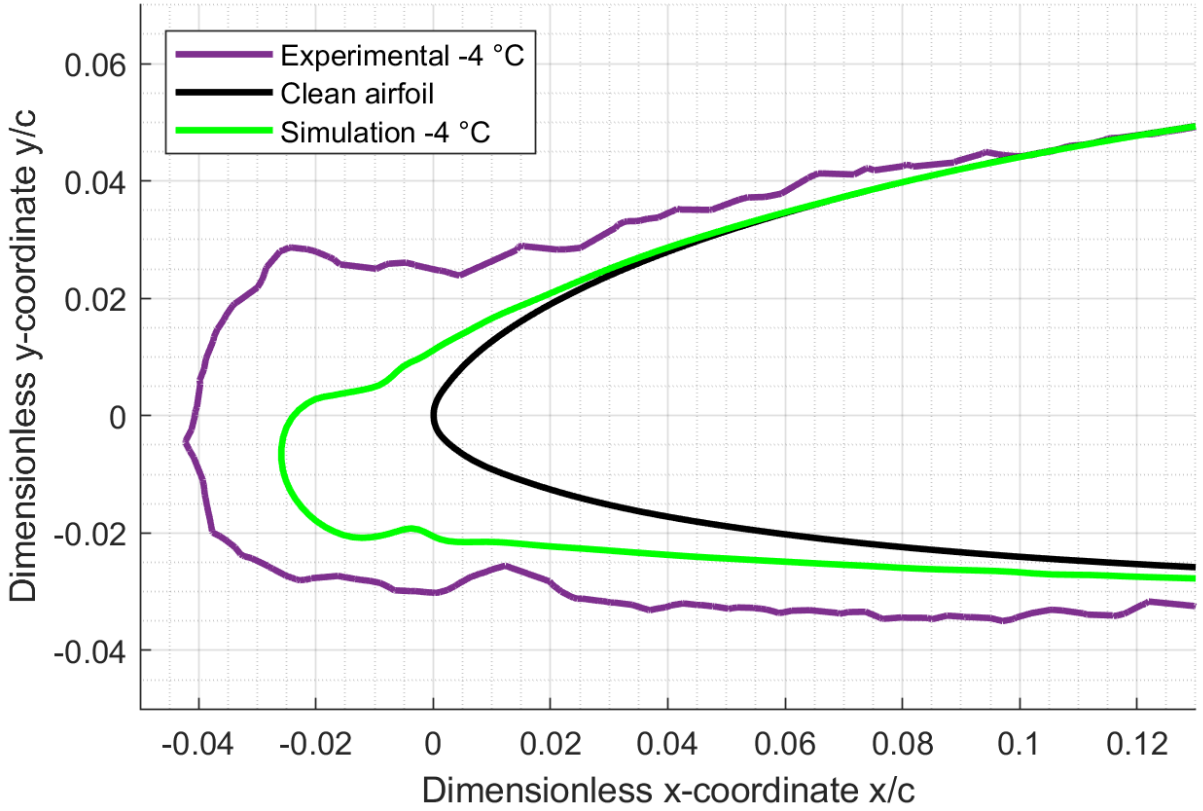


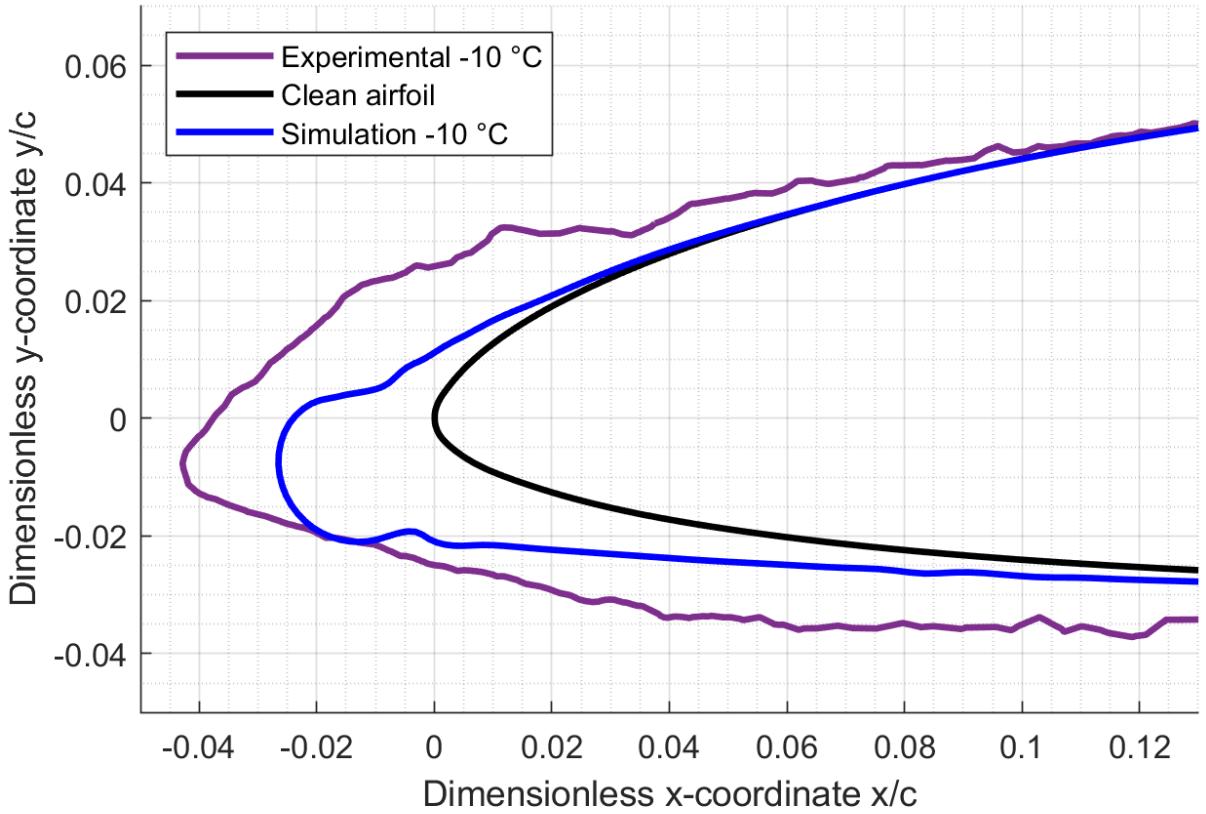
Case 3.1 – Temperature –2 °C



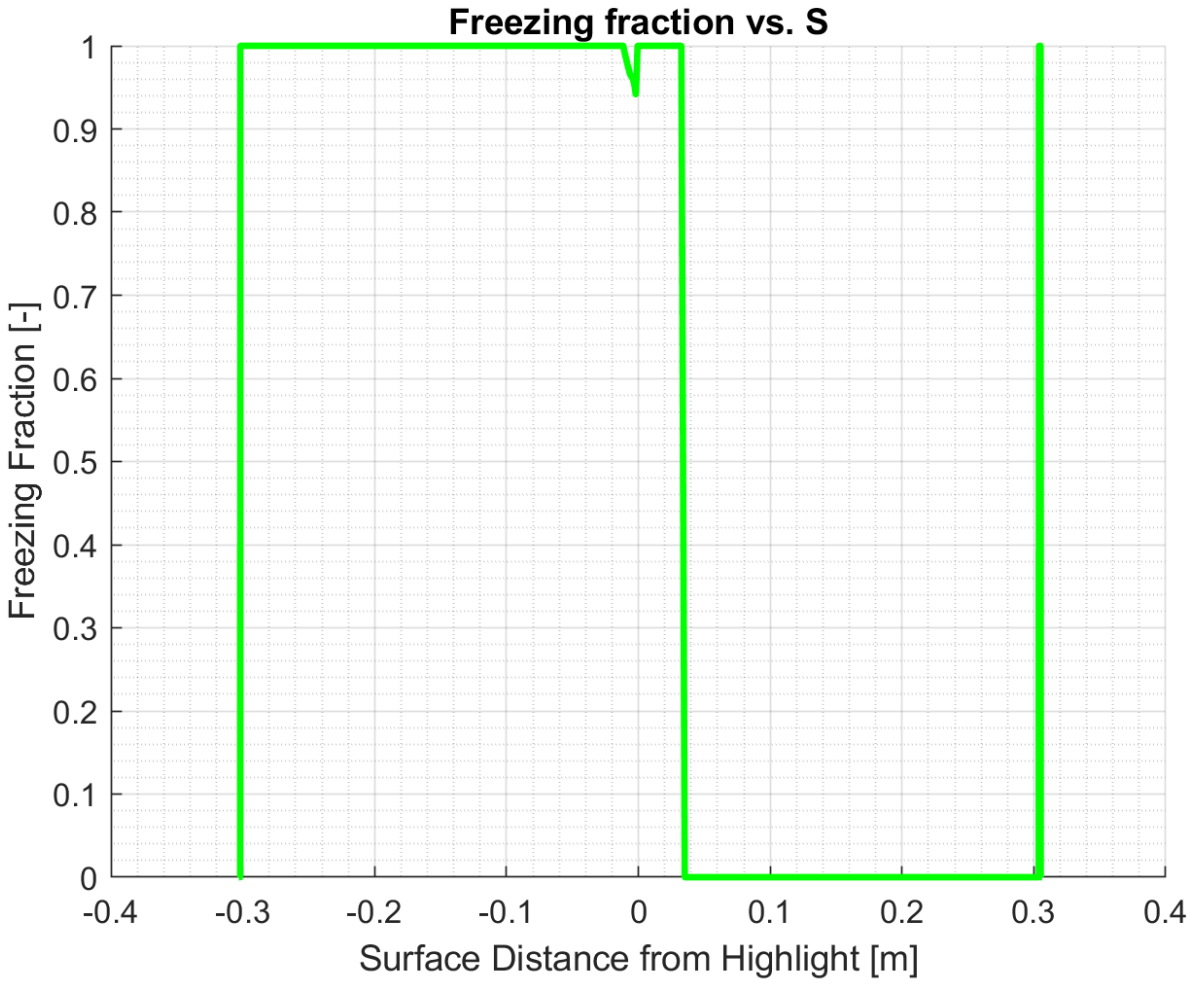


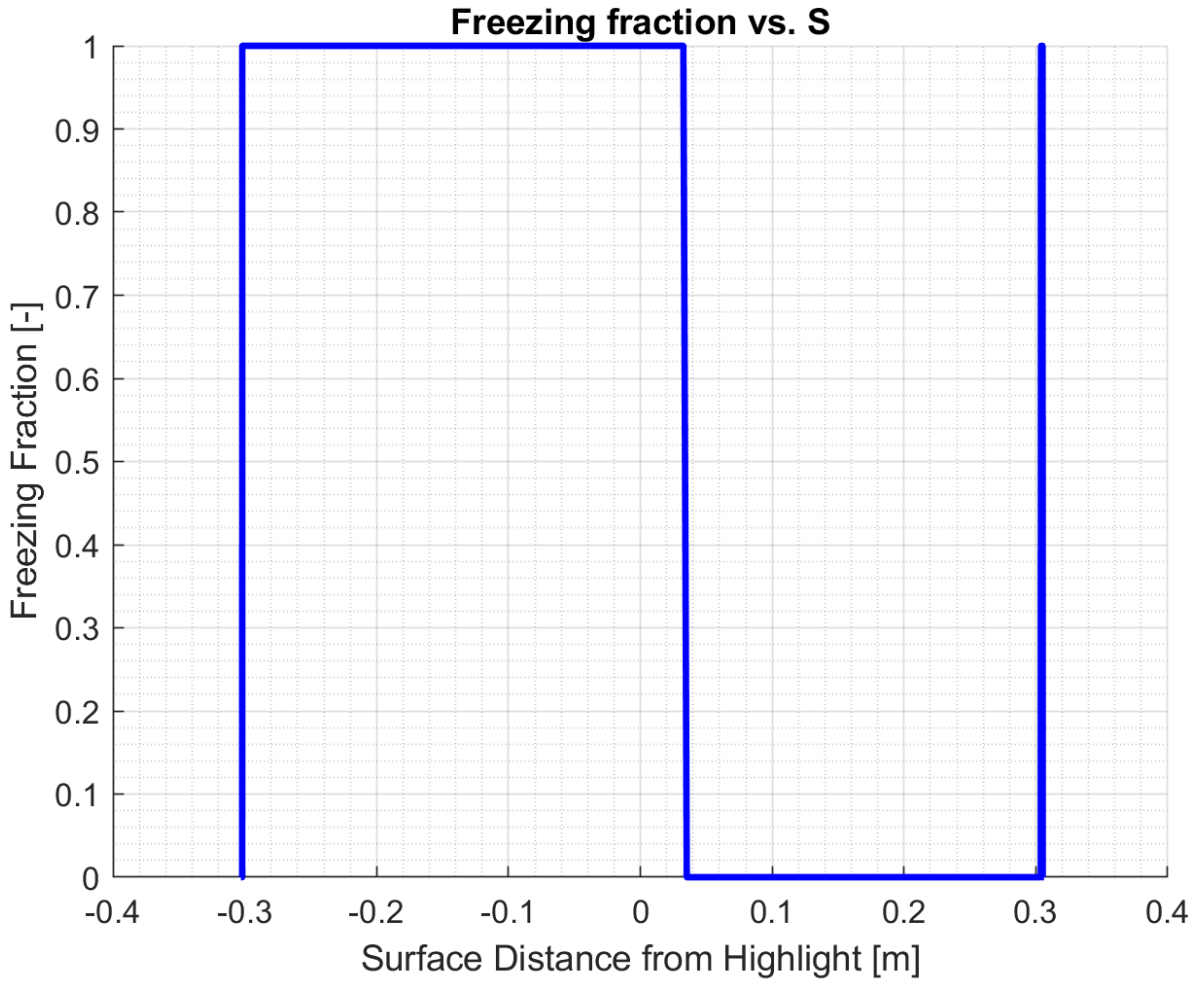
Case 3.2 – Temperature –4 °C and –10 °C



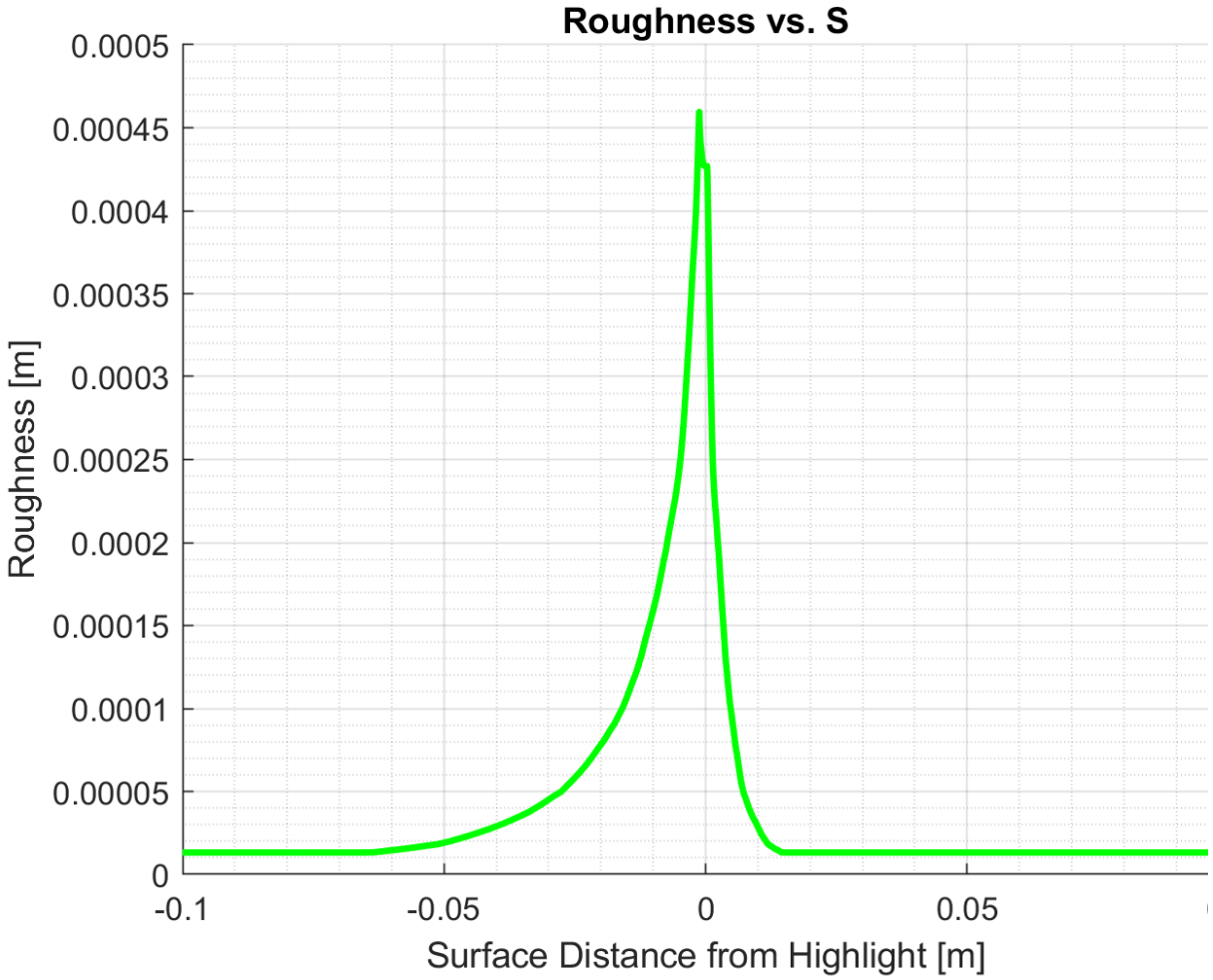


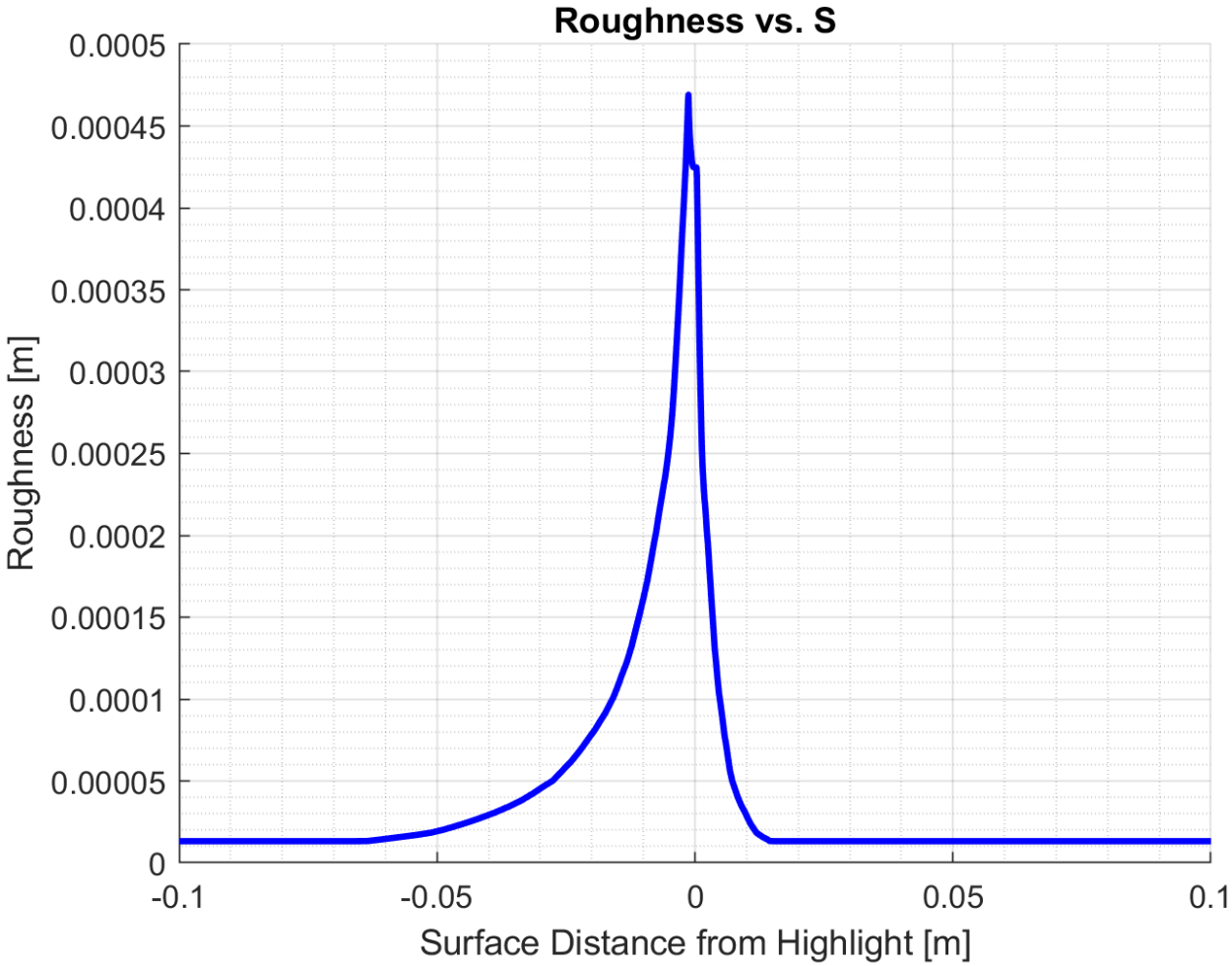
Case 3.2/3.3 – Temperature –4 °C and –10 °C





Case 3.2/3.3 – Temperature –4 °C and –10 °C





Major Findings

- Limited agreement with experimental results
  → potential 20% LWC offset
- Only small deviations between the –4 °C and –10 °C case
  → high freezing fraction at –4 °C

Future Steps

- Review and repeat experimental settings
- Parametric studies

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