

AIAA 1st Ice Prediction Workshop

Results post-processing for code-to-code comparison
Final Version

Data Comparison Task Force

July 26, 2021

Participant Identification

Participant	ID
Boeing	01
NASA	03
ONERA	04
GeorgiaTech/NASA	05
Politecnico Di Milano	06
Textron	07
CIRA	08
Oxford	09
AIT	10
NTNU	11
NRC	12

Participant (cont'd)	ID
ANSYS-Bombardier	13
Embraer	14
Polytechnique Montreal	15
FAA	16
Honeywell	17
AeroTex GmbH	18
Siemens – Lockheed	19
Universität Braunschweig	20
ATS	21

Participant Information Summary

ID	Participant	Code	Dataset option
01.1	Boeing	LEWICE	
01.2	Boeing	LEWICE3D	
03.1	NASA	GlennICE	
03.2	NASA	LEWICE	No splashing
03.3	NASA	LEWICE	With splashing
04.1	ONERA	IGLOO3D	
04.2	ONERA	IGLOO2D	
05.1	GeorgiaTech	ANSYS Fluent/GTDROP-Uns/GT-ICE	
06.1	PolitecnicoDiMilano	SU2/PoliDrop/PoliIce	
07.1	Textron	USM3D/LEWICE/LEWICE3D	
08.1	CIRA	SIMBA	
08.2	CIRA	Multilce	
08.3	CIRA	ZEN-IMP3D	
08.4	CIRA	Open-Foam	
09.1	OxfordUniversity	Fluent/ICICLE-2D	No Particle Rotation
09.2	OxfordUniversity	Fluent/ICICLE-2D	With Particle Rotation
10.1	AIT	CFX/ICEAC2D	Experimental Tinf and LWC
10.2	AIT	CFX/ICEAC2D	Experimental Tinf-1 deg.
10.3	AIT	CFX/ICEAC2D	Tinf=266.05, LWC= 0.8

Participant Information Summary (cont'd)

ID	Participant	Code	Dataset option
10.4	AIT	CFX/ICEAC2D	Experimental Tinf-2 deg.
10.5	AIT	Fluent/FENSAP-ICE	Single size droplets
10.6	AIT	Fluent/FENSAP-ICE	7-bins droplet distribution
10.7	AIT	Fluent/FENSAP-ICE	Void density
11.1	NTNU	FENSAP-ICE	Single size droplets
11.2	NTNU	FENSAP-ICE	Droplet size distribution
12.1	NRC	Cobalt	
13.1	Ansys-Bombardier	FENSAP-ICE	Constant Ice Density
13.2	Ansys-Bombardier	FENSAP-ICE	Variable Ice Density
14.1	Embraer	CFD++/AIPAC	
15.1	PolyMtl	CHAMPS	2D/3D
15.2	PolyMtl	CHAMPS	2.5D
16.1	FAA Tech Center	LEWICE / LEWICE3D	
17.1	Honeywell	FENSAP-ICE	
19.1	Siemens – Lockheed	Simcenter STAR-CCM+	
20.1	Universitat Braunschweig	DICEPS-V3.0/FLUENT	Single size droplets
20.2	Universitat Braunschweig	DICEPS-V3.0/FLUENT	Droplet size distribution
21.1	ATS	Metacomp CFD++	

Participant Codes Information

ID	Flow model	Turbulence	Droplet	Thermodynamic	Surface deformation
01.1	Potential		Lagrangian	Modified Messinger	Lagrangian
01.2	RANS	SA	Lagrangian	Modified Messinger	Lagrangian
03.1	RANS	SA	Lagrangian	Revised Messinger	Lagrangian
03.2/.3	Potential	IBL	Lagrangian	Revised Messinger	?
04.1	RANS	k-omega sst	Eulerian	Messinger	Lagrangian
04.2	Viscous-Inviscid coupling		Lagrangian	Messinger	Lagrangian
05.1	RANS	k-omega sst	Eulerian	Extended Messinger	?
06.1	RANS	SA	Lagrangian	Extended Messinger	RBF
07.1	RANS	SA	Lagrangian	Modified Messinger	Lagrangian
08.1	IB RANS	k-omega tnt	Eulerian	Messinger	Dynamic IB
08.2	2D Potential / 3D RANS	k-omega tnt	Lagrangian	Messinger	?
08.3	RANS	k-omega tnt	Eulerian		
08.4	RANS (SIMPLE)	k-omega sst	Lagrangian		
09.1	RANS	k-omega sst	Lagrangian		
09.2	RANS	k-omega sst	Lagrangian		
10.1	Favre-averaged NS	k-omega sst	Lagrangian	Modified Messinger	?
10.2	Favre-averaged NS	k-omega sst	Lagrangian	Modified Messinger	?
10.3	Favre-averaged NS	k-omega sst	Lagrangian	Modified Messinger	?

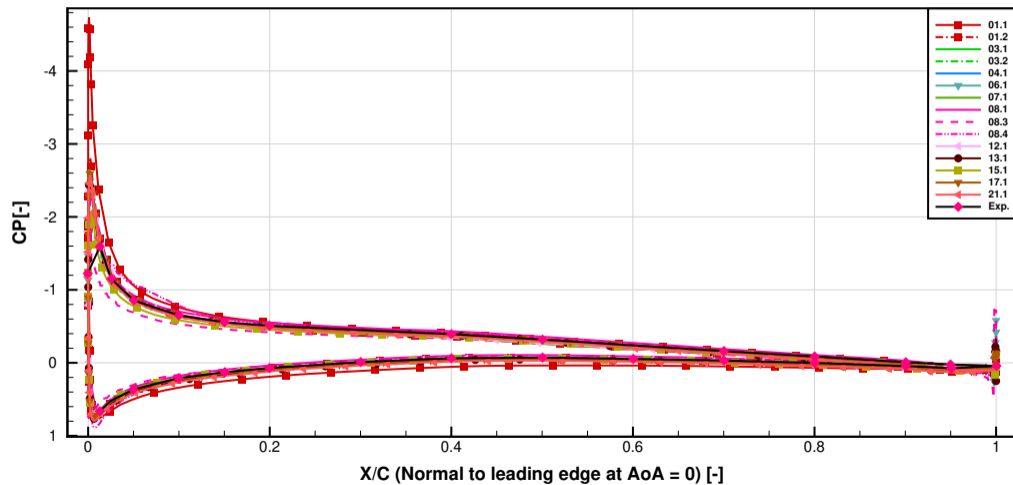
Participant Codes Information (cont'd)

ID	Flow model	Turbulence	Droplet	Thermodynamic	Surface deformation
10.4	Favre-averaged NS	k-omega sst	Lagrangian	Modified Messinger	?
10.5	Favre-averaged NS	k-omega sst	Eulerian	–	–
10.6	Favre-averaged NS	k-omega sst	Eulerian	–	–
10.7	Favre-averaged NS	k-omega sst	Eulerian	Modified Messinger	?
11.1	RANS	SA	Eulerian	Modified Messinger	?
11.2	RANS	SA	Eulerian	Modified Messinger	?
12.1	RANS	k-omega sst	Lagrangian	Morphogenetic	?
13.1	RANS	SA	Eulerian	Modified Messinger	?
13.2	RANS	SA	Eulerian	Modified Messinger	?
14.1	RANS	k-omega sst	Eulerian	Modified Messinger	Lagrangian
15.1	RANS 2D/3D	SA	Eulerian	Iterative Messinger	Lagrangian
15.2	RANS 2.5D	SA	Eulerian	Iterative Messinger	Lagrangian
16.1	RANS	k-omega sst	Lagrangian	Messinger	?
17.1	RANS	?	Eulerian	SWIM	?
19.1	RANS (SIMPLE)	k-omega sst	Eulerian	Segregated Temp.	Multiquadratic RBS
20.1	RANS	k-omega sst	Eulerian	Messinger	Lagrangian
20.2	RANS	k-omega sst	Eulerian	Messinger	Lagrangian
21.1	RANS	SA	Eulerian		

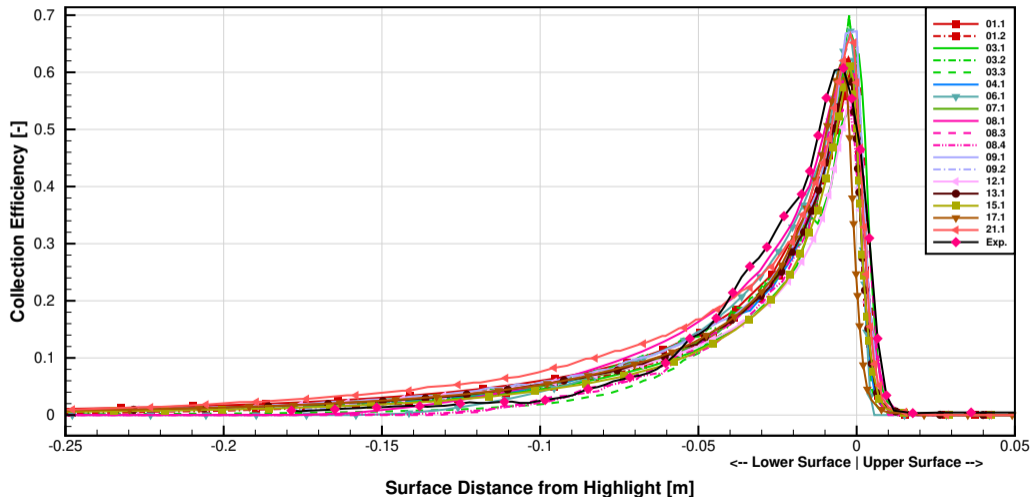
Submitted Data Summary

ID	Impingement						Cases 2D ice				3D ice					
	111	112	121	122	131	132	241	242	251	252	361	362	363	364	371	372
01	2		2				2	2			2	2			2	2
03	3	3	3	3	1	1	2	2	2	2	2	2	2	2	2	2
04	1		2				2	2			1	1			1	1
05							1	1			1	1			1	1
06	1	1	1	1			1	1			1	1			1	1
07	1	1	1	1			1	1								
08	3	3	4	4			2	2	1	1	1					
09	2	2	2	2												
10					1	1	1	4			1					
11							2	2								
12							1				1				1	
13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14							1	1								
15	1	1	1	1			1	1	1	1	2	1	1	1		
16			1	1			1	1	1	1	1	1	1	1	1	1
17	1		1				1	1			1	1			1	1
18																
19							1	1								
20			2	2			1									
21	1		1													
Total	15	11	20	14	3	3	23	23	6	5	13	10	4	4	11	10

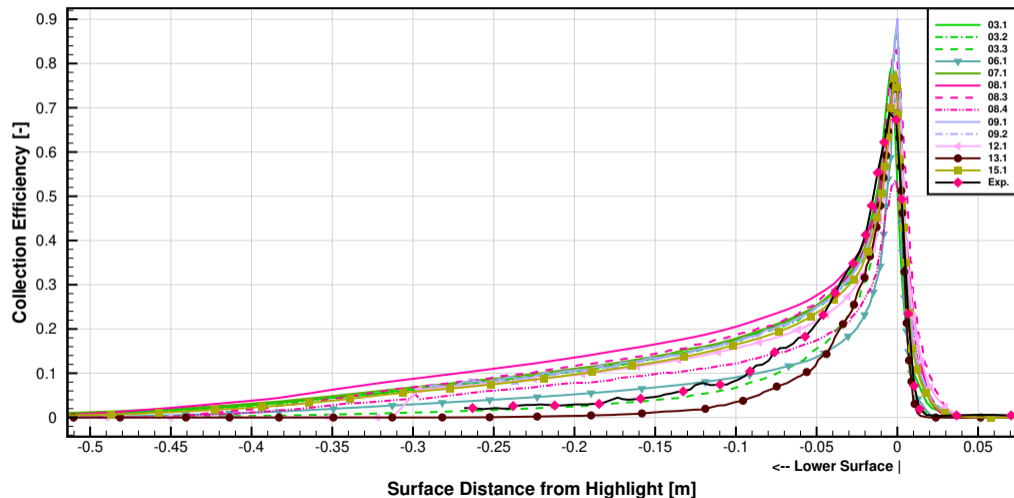
Cases 111/112 – Ma 0.23, Re 5M – CP



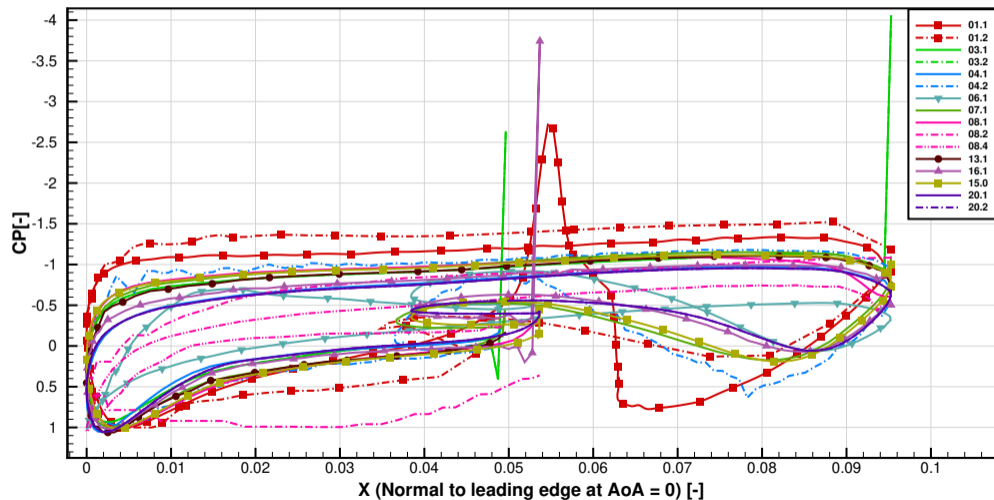
Case 111 – MVD 21 – Collection Efficiency



Case 112 – MVD 92 – Collection Efficiency

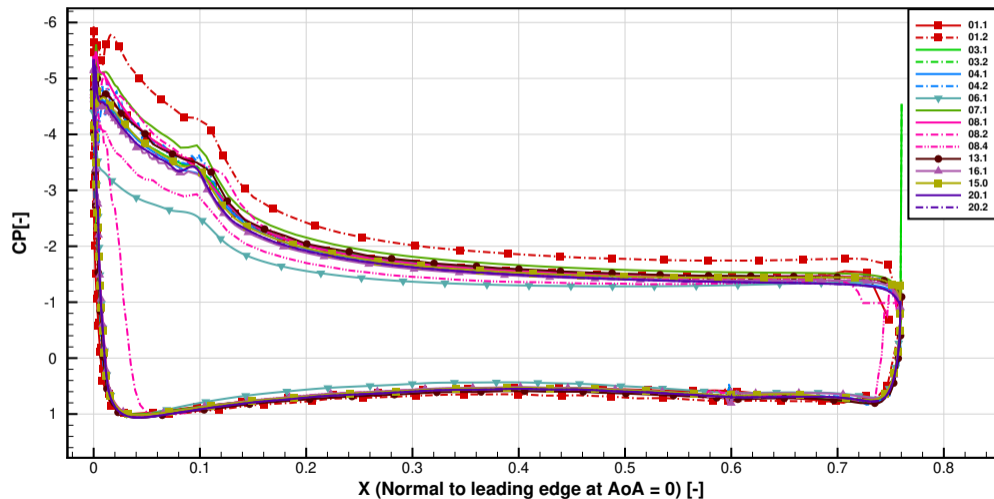


Cases 121/122 – Ma 0.23, Re 4.9M – CP – Slat

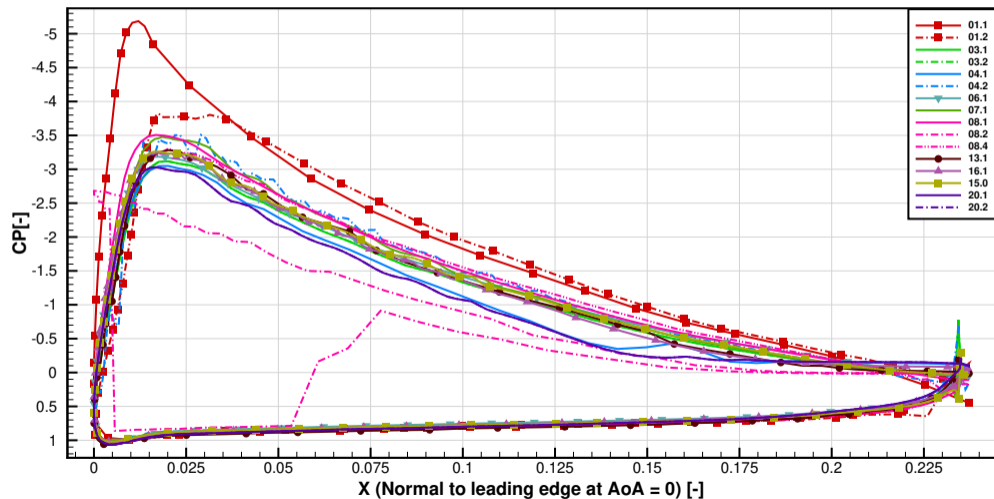


No experimental data of CP for these cases

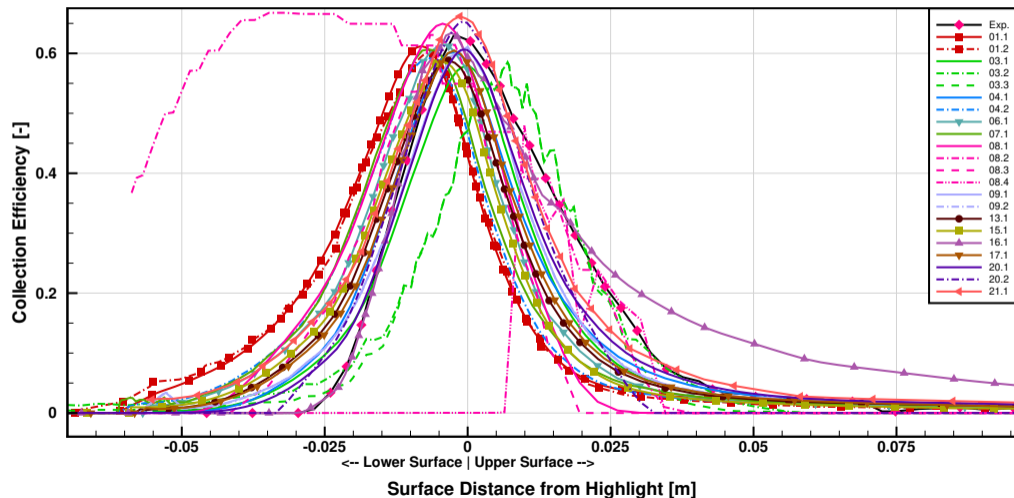
Cases 121/122 – Ma 0.23, Re 4.9M – CP – Main



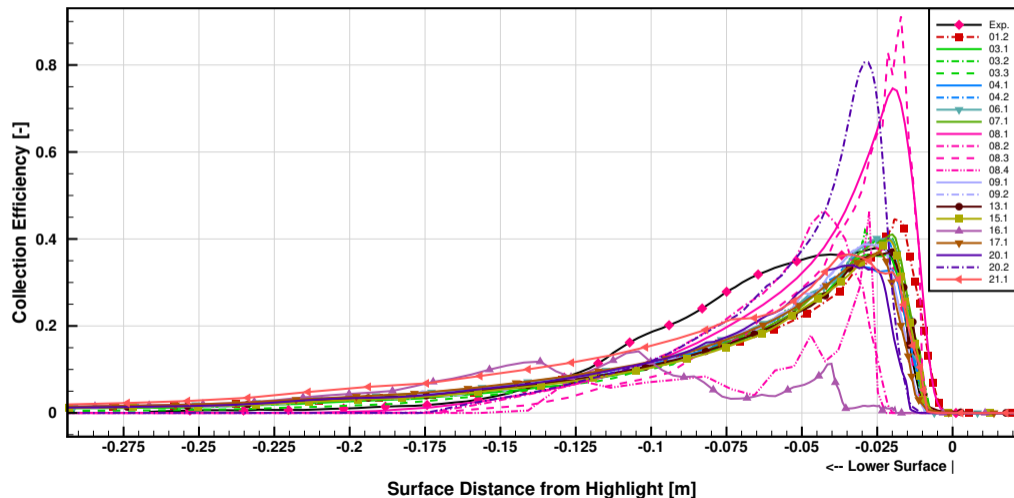
Cases 121/122 – Ma 0.23, Re 4.9M – CP – Flap



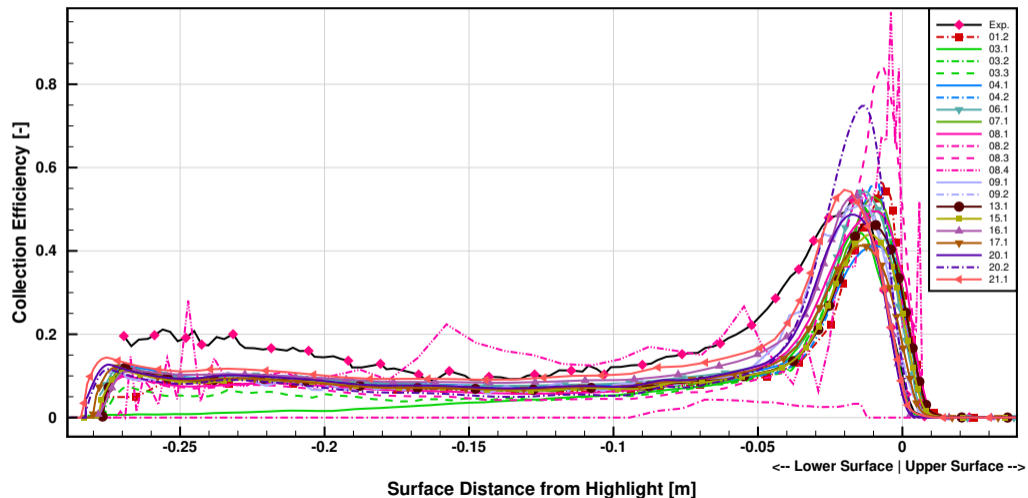
Case 121 – MVD 21 – Collection Efficiency – Slat



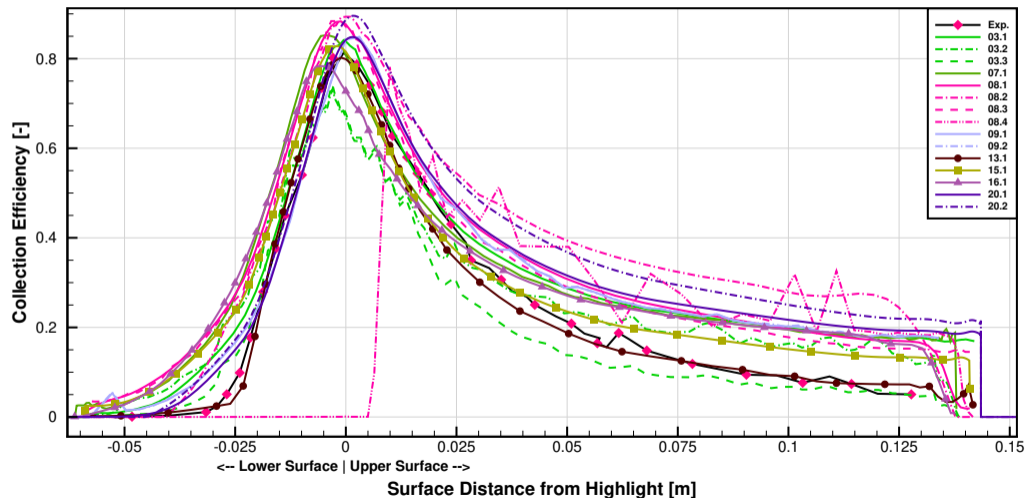
Case 121 – MVD 21 – Collection Efficiency – Main



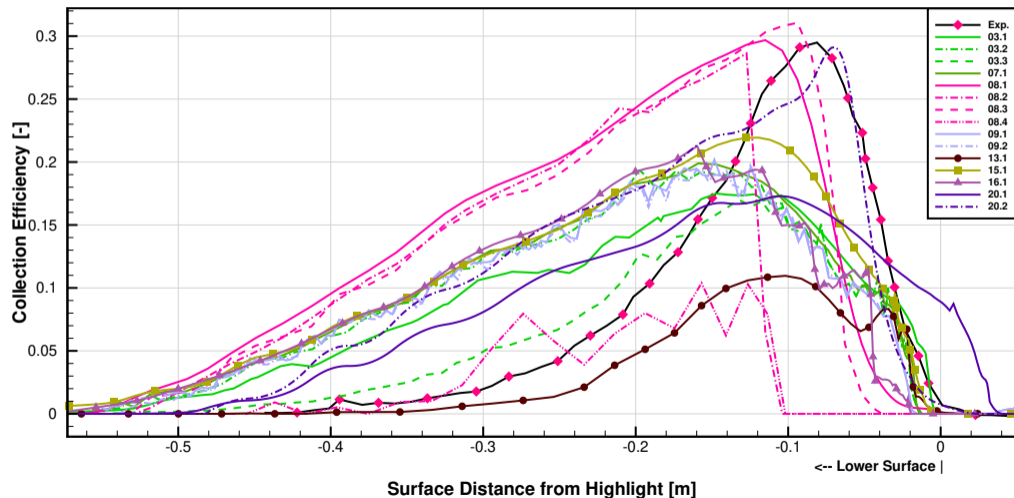
Case 121 – MVD 21 – Collection Efficiency – Flap



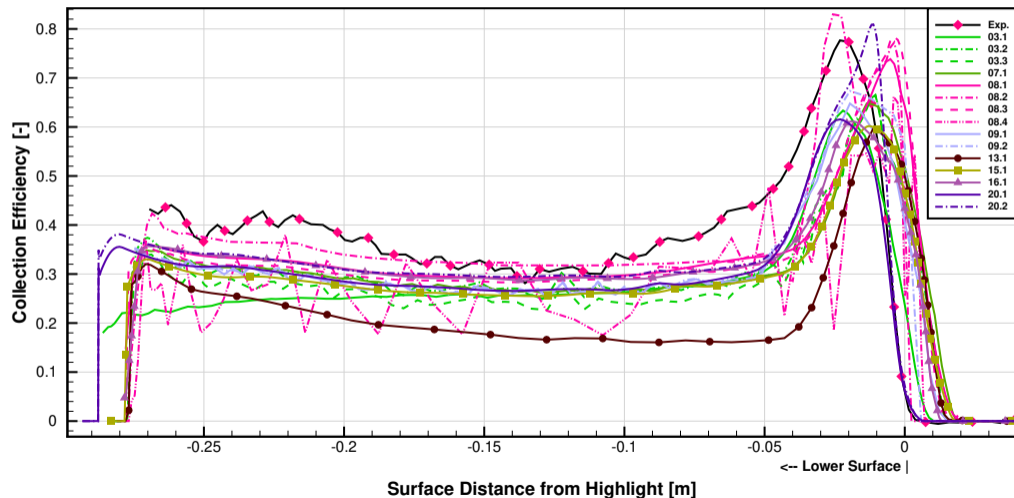
Case 122 – MVD 92 – Collection Efficiency – Slat



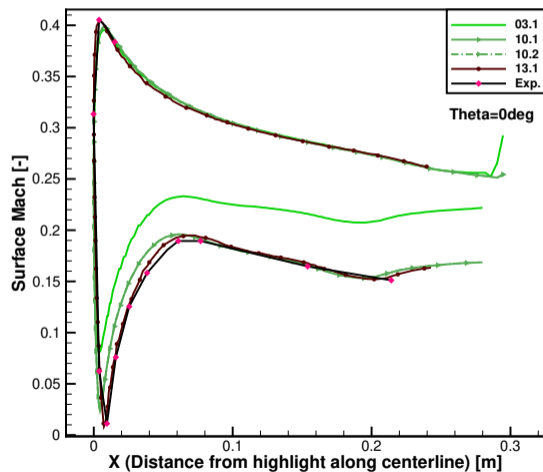
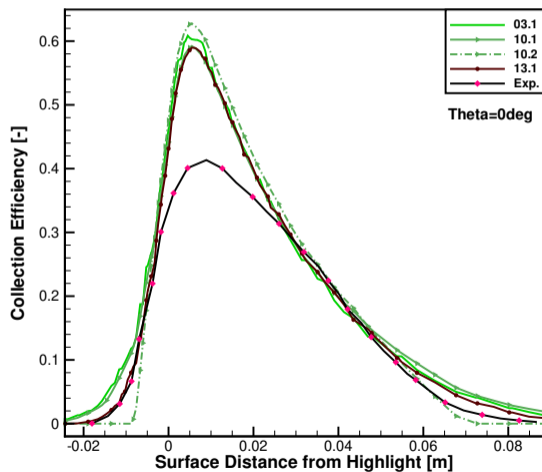
Case 122 – MVD 92 – Collection Efficiency – Main



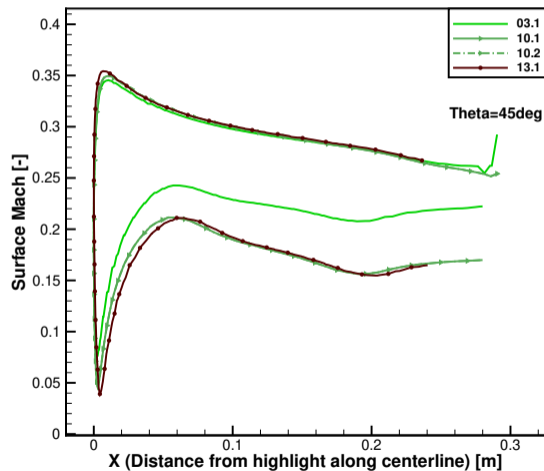
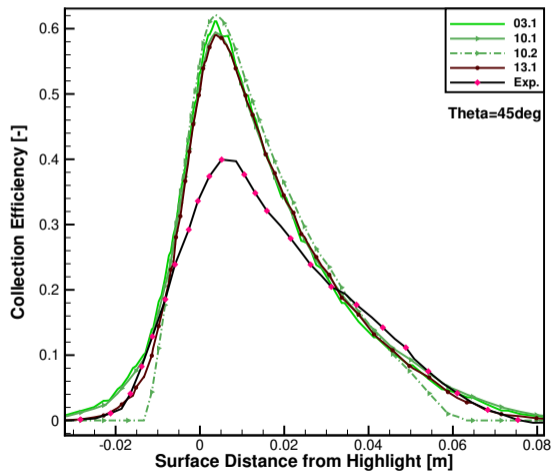
Case 122 – MVD 92 – Collection Efficiency – Flap



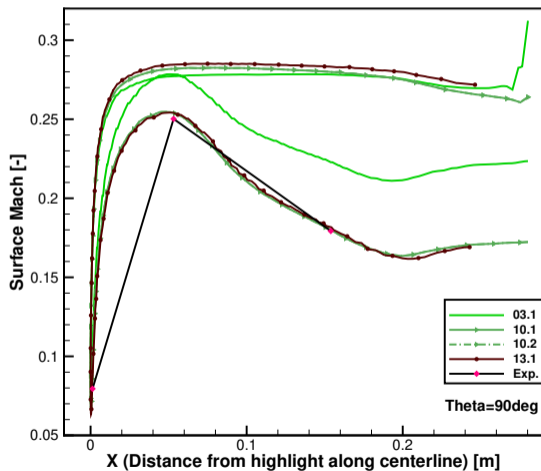
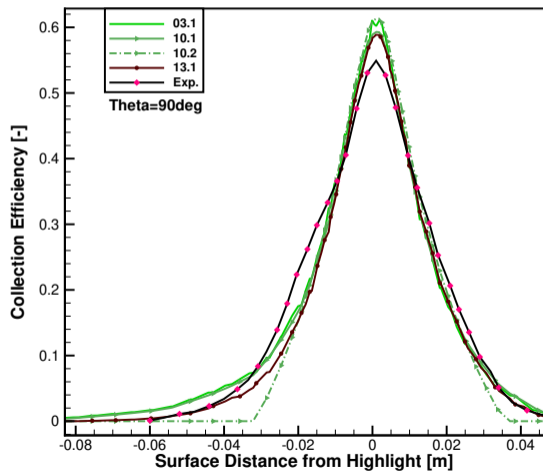
Case 131 – Low mass flow – Theta 0deg



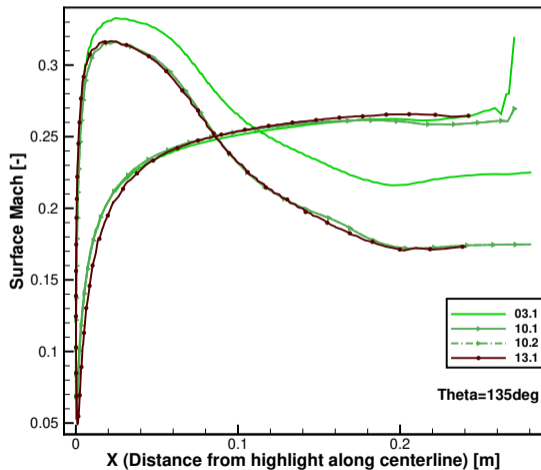
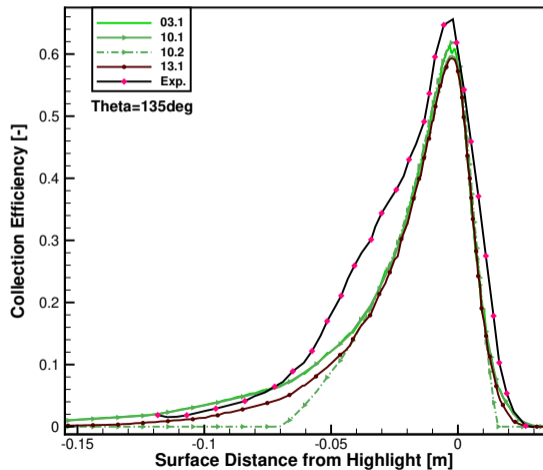
Case 131 – Low mass flow – Theta 45deg



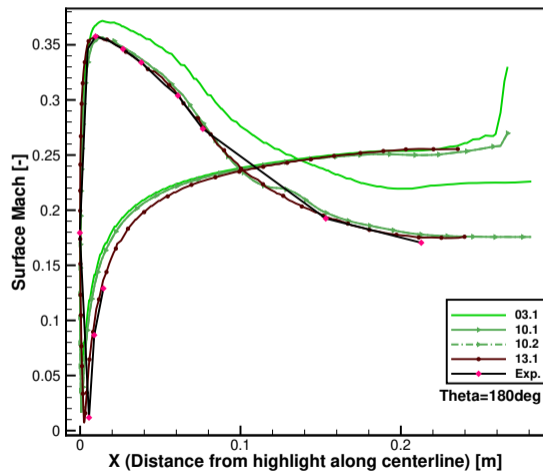
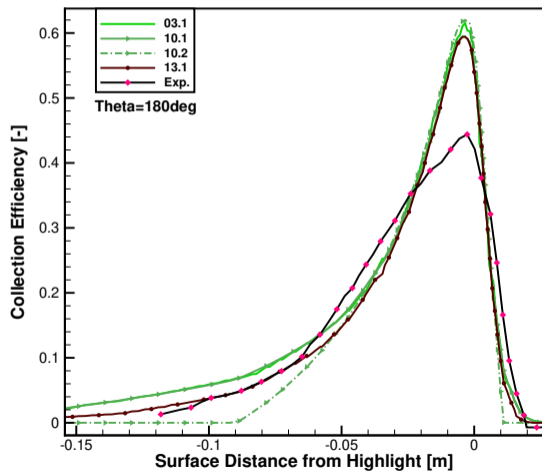
Case 131 – Low mass flow – Theta 90deg



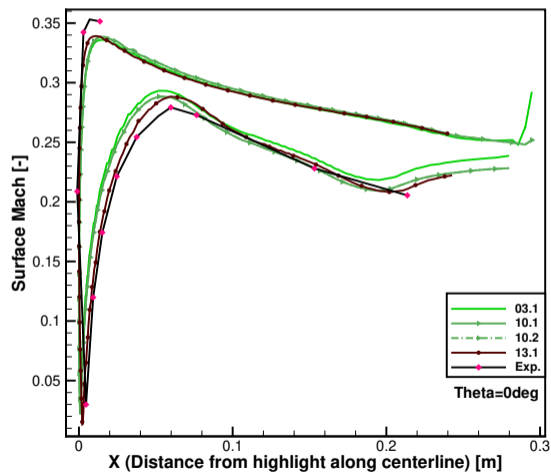
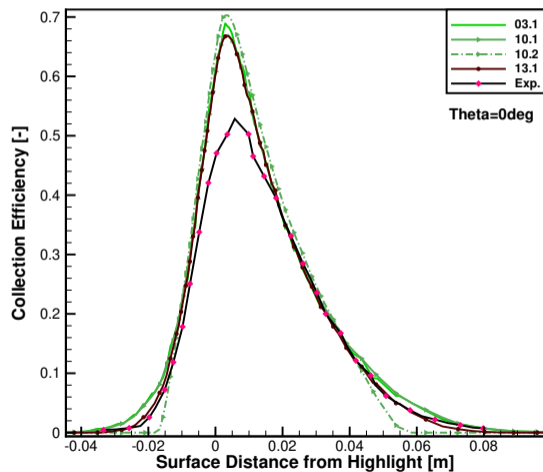
Case 131 – Low mass flow – Theta 135deg



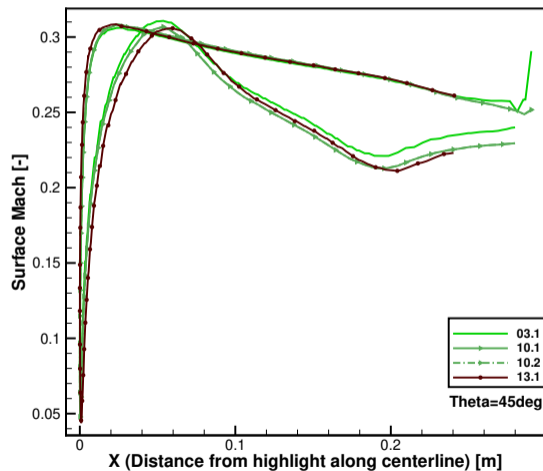
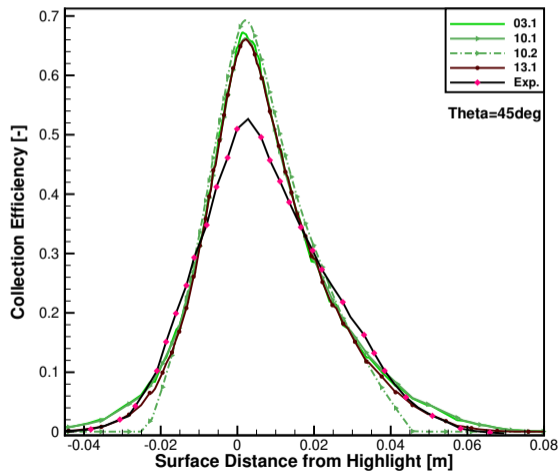
Case 131 – Low mass flow – Theta 180deg



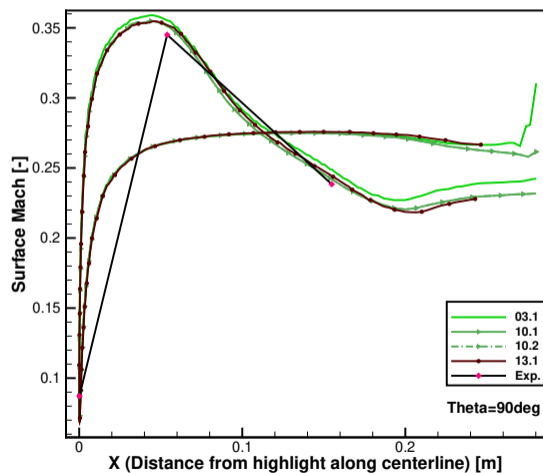
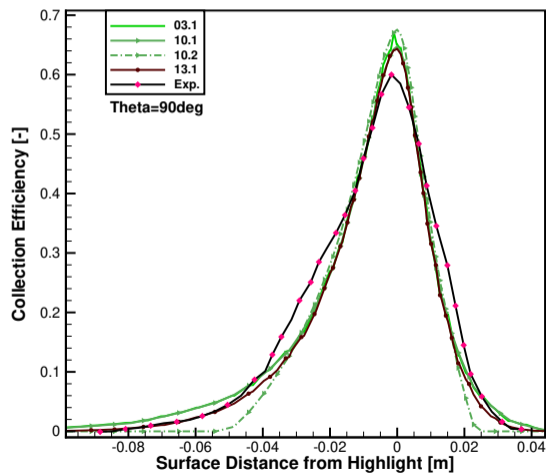
Case 132 – High mass flow – Theta 0deg



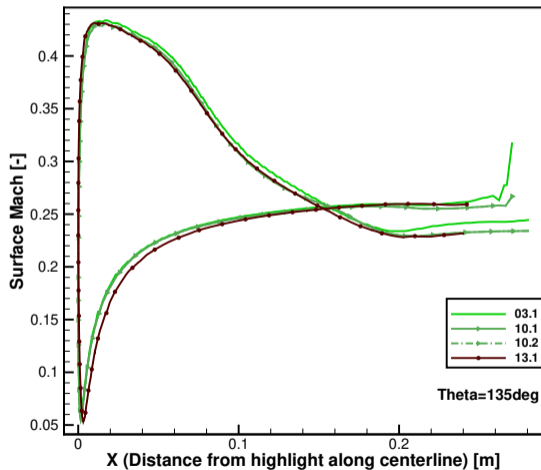
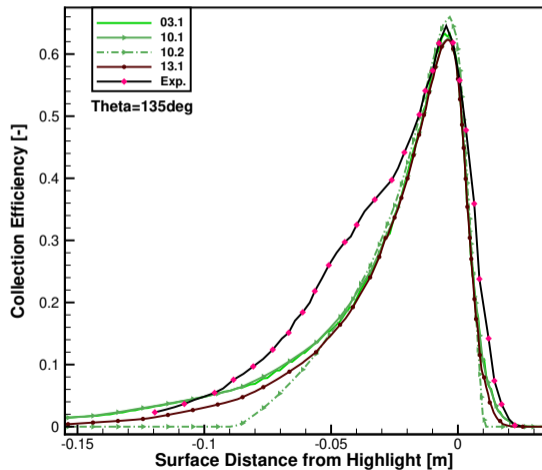
Case 132 – High mass flow – Theta 45deg



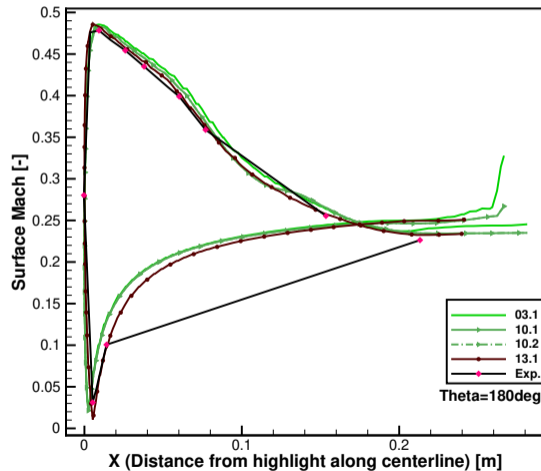
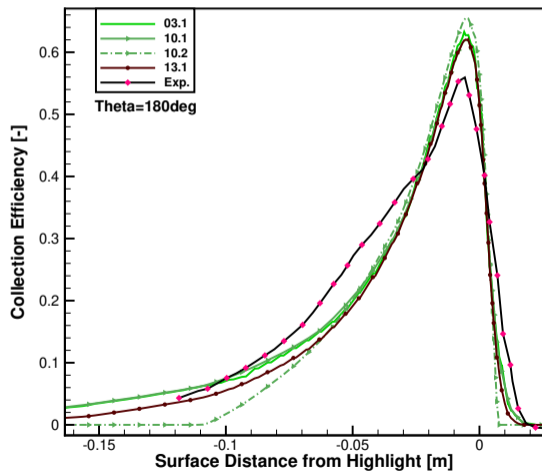
Case 132 – High mass flow – Theta 90deg



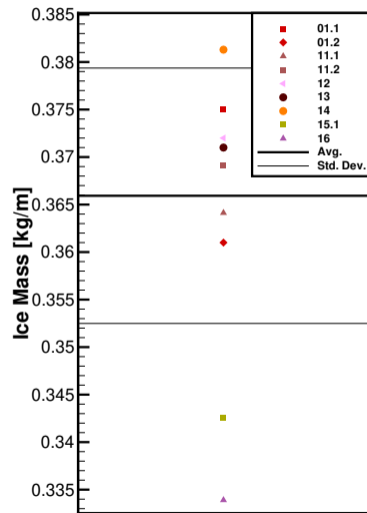
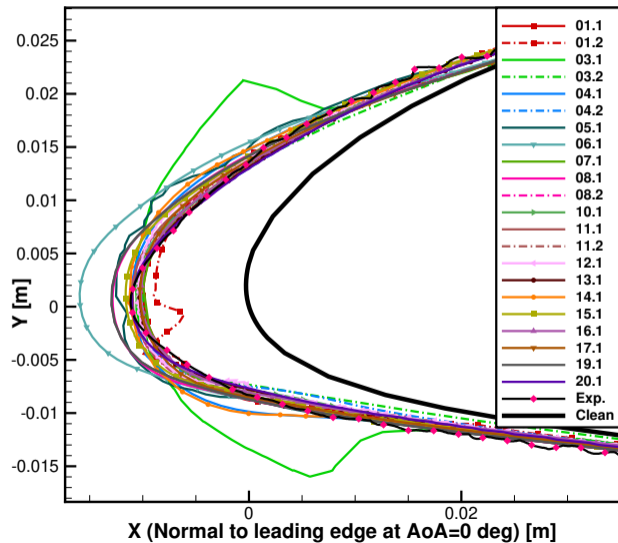
Case 132 – High mass flow – Theta 135deg



Case 132 – High mass flow – Theta 180deg

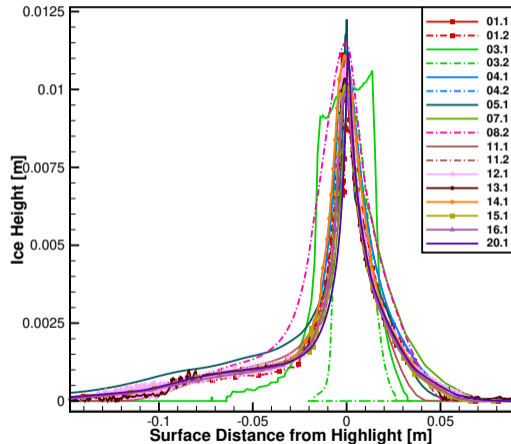
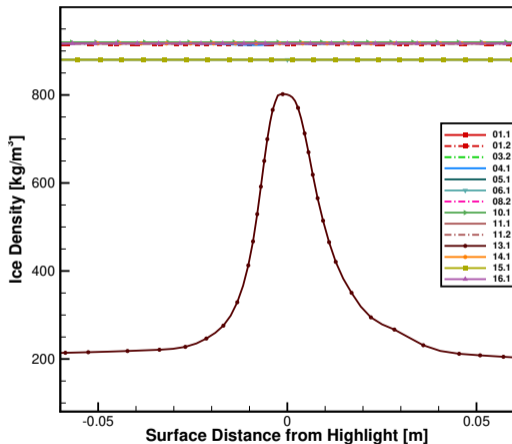


Case 241 – Rime, small chord – Ice Shape

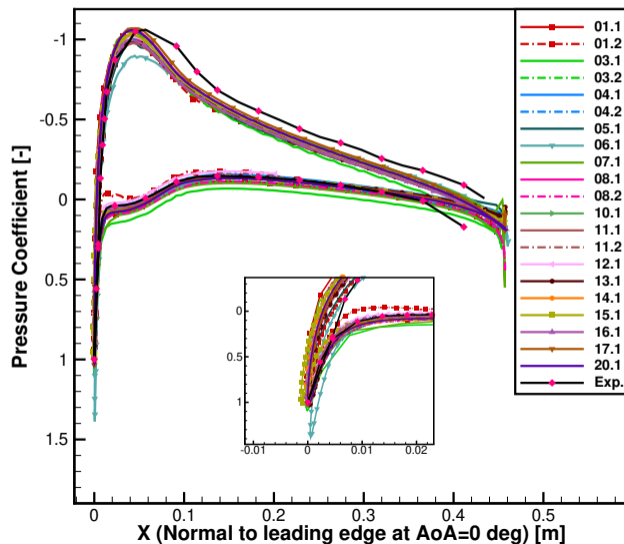


Case 241

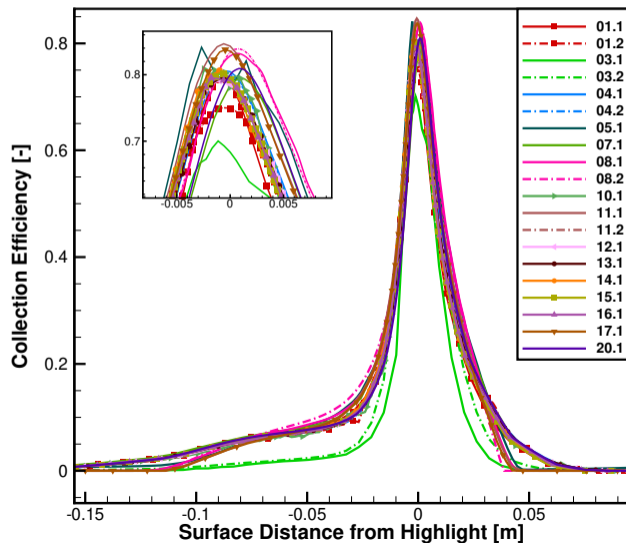
Case 241 – Rime, small chord – Ice Density and Height



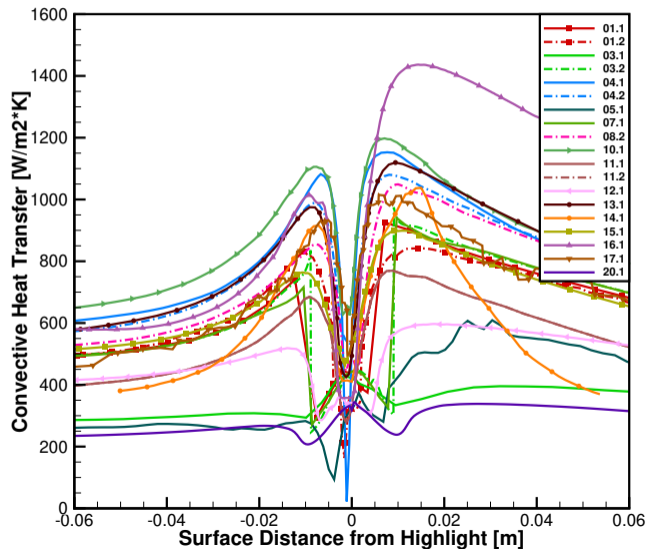
Case 241 – Rime, small chord – Pressure Coefficient



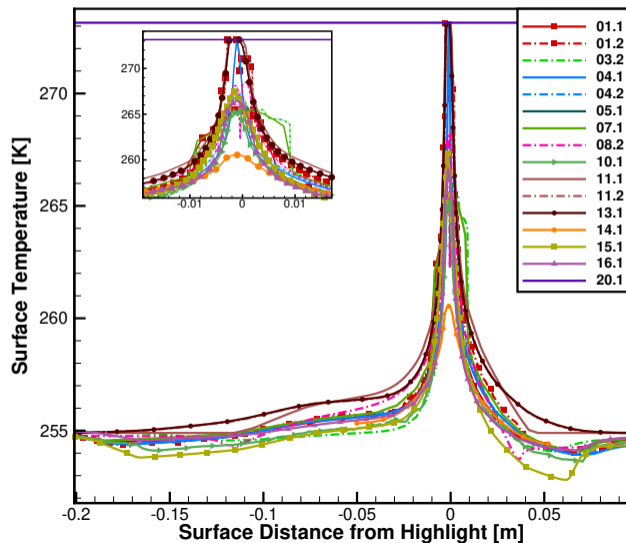
Case 241 – Rime, small chord – Collection Efficiency



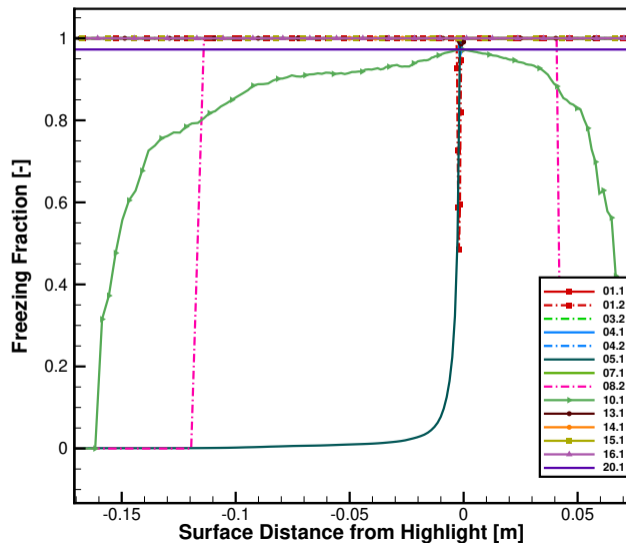
Case 241 – Rime, small chord – HTC



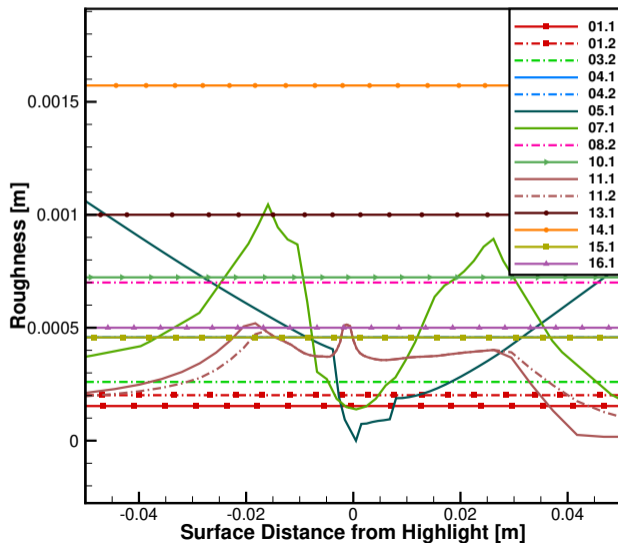
Case 241 – Rime, small chord – Surface Temperature



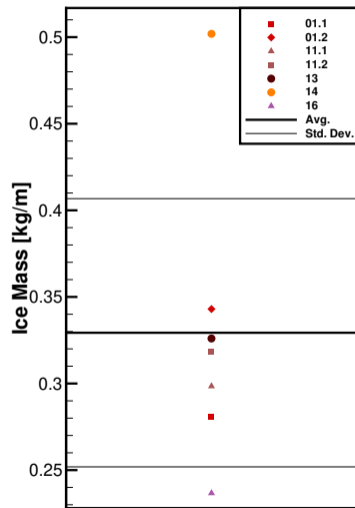
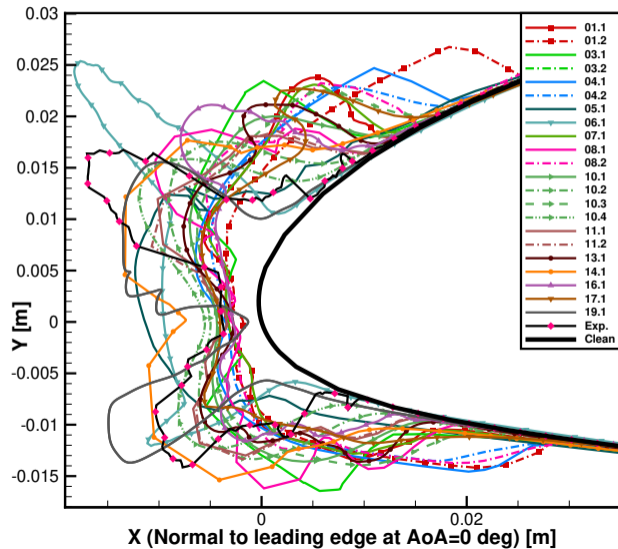
Case 241 – Rime, small chord – Freezing Fraction



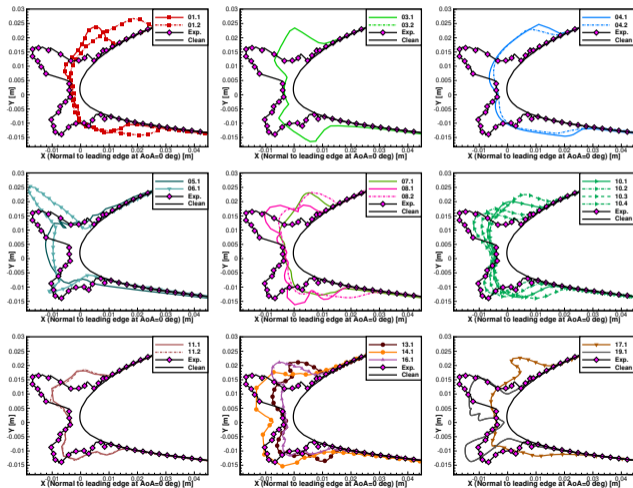
Case 241 – Rime, small chord – Roughness



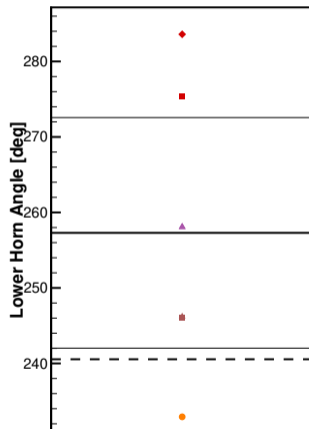
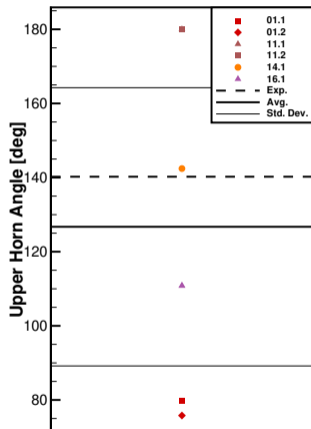
Case 242 – Glaze, small chord – Ice Shape



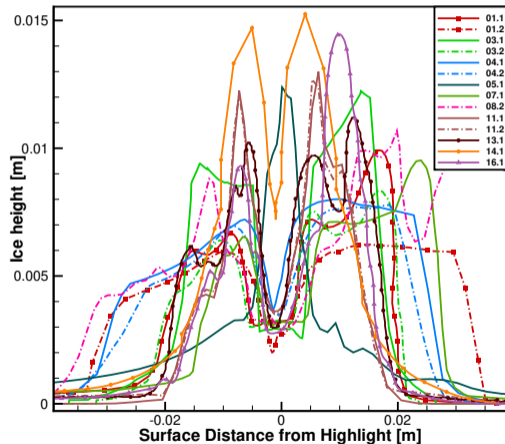
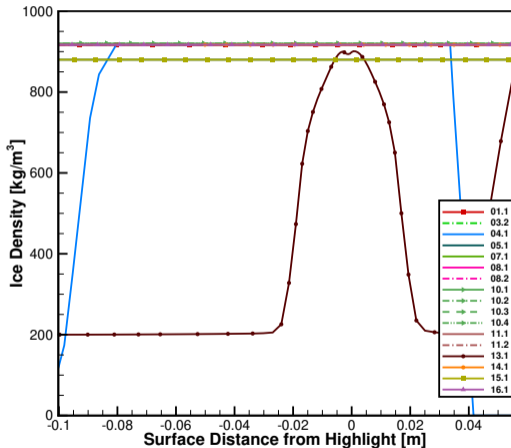
Case 242 – Glaze, small chord – Ice Shape



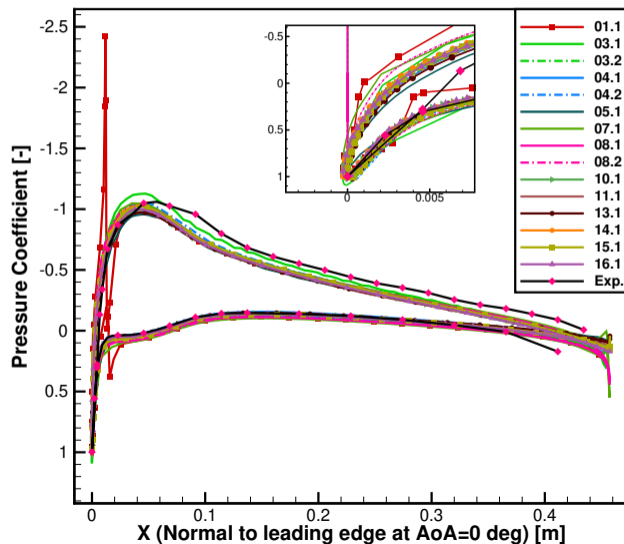
Case 242 – Glaze, small chord – Horns Angle



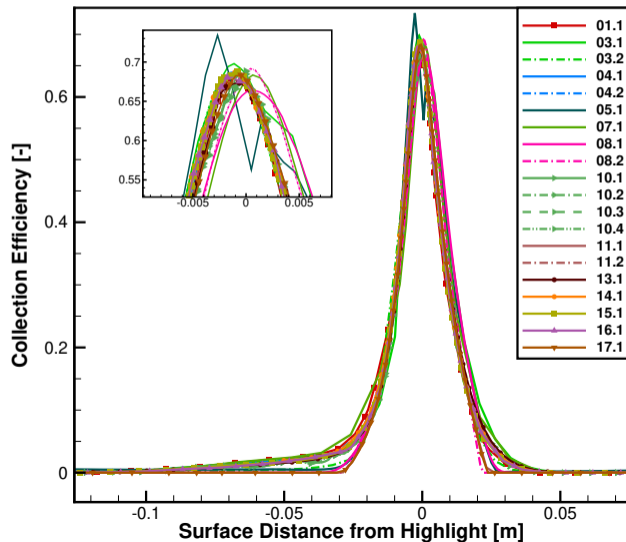
Case 242 – Glaze, small chord – Ice Density and Height



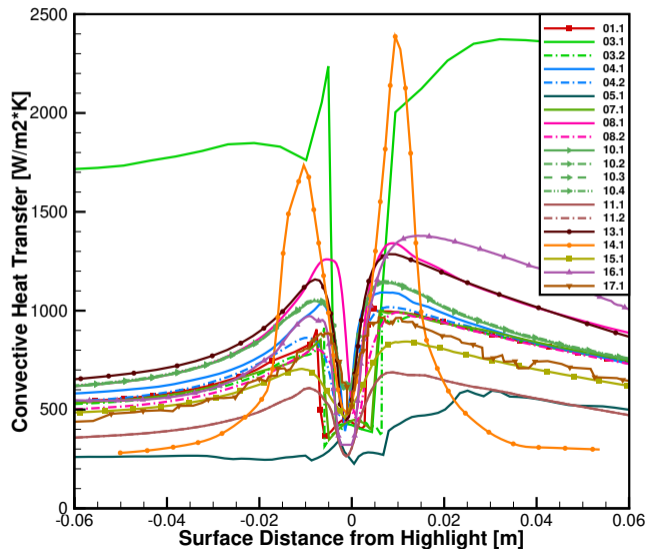
Case 242 – Glaze, small chord – Pressure Coefficient



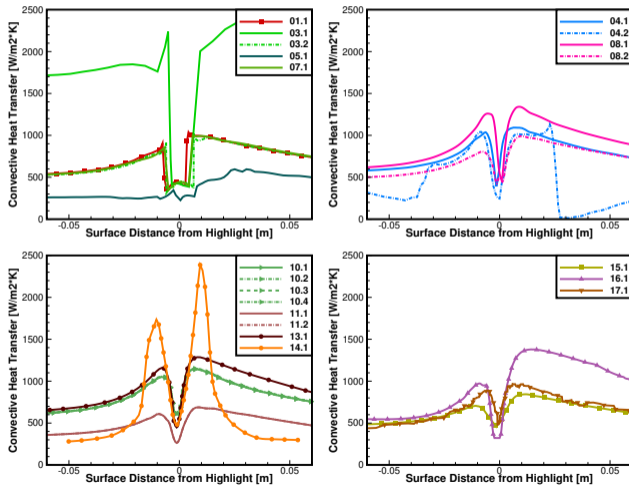
Case 242 – Glaze, small chord – Collection Efficiency



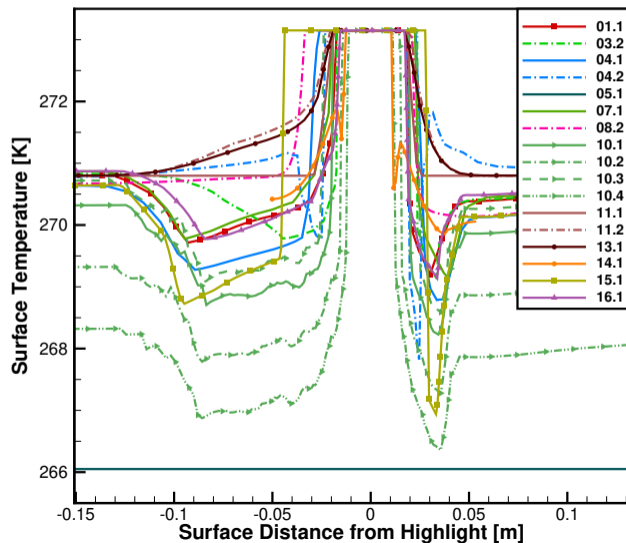
Case 242 – Glaze, small chord – HTC



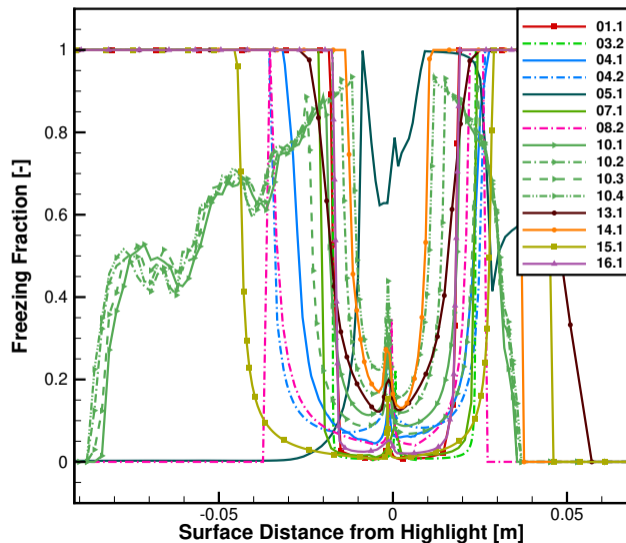
Case 242 – Glaze, small chord – HTC



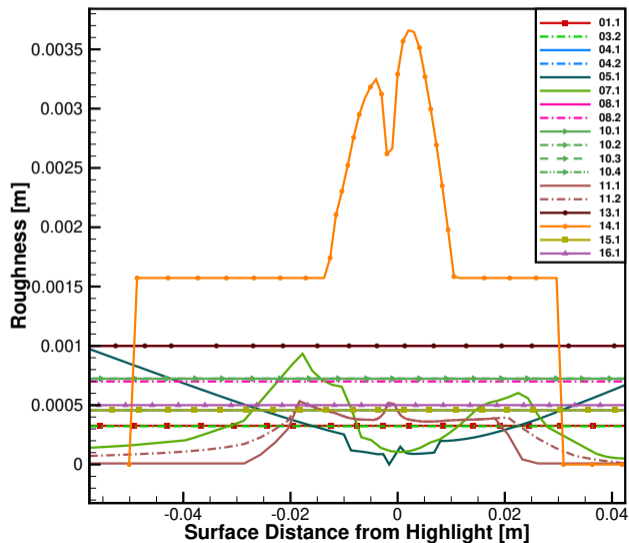
Case 242 – Surface Temperature



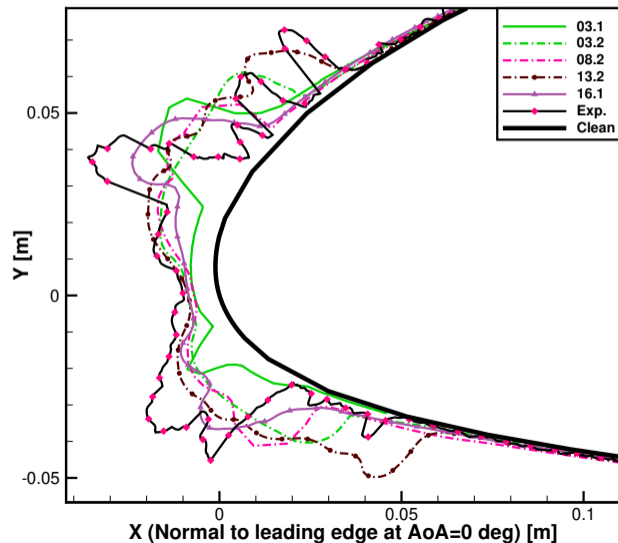
Case 242 – Glaze, small chord – Freezing Fraction



Case 242 – Glaze, small chord – Roughness

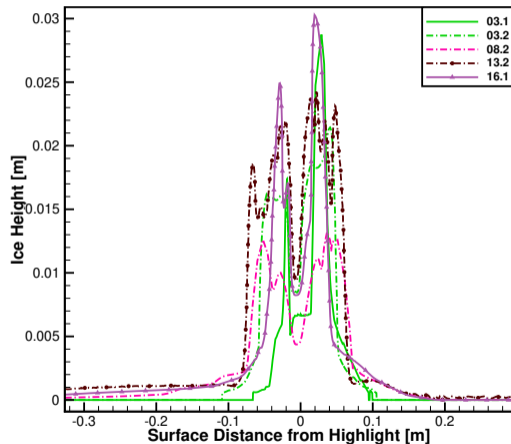
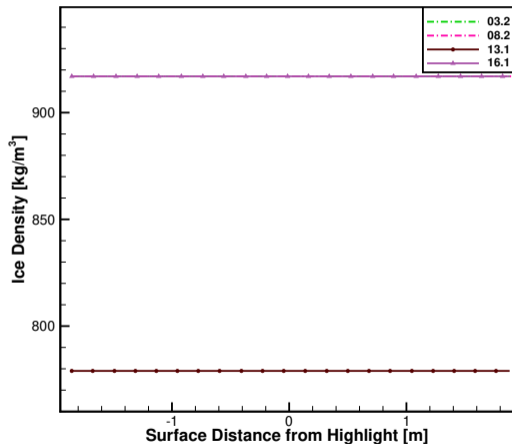


Case 251 – Monomodal SLD, big chord – Ice Shape

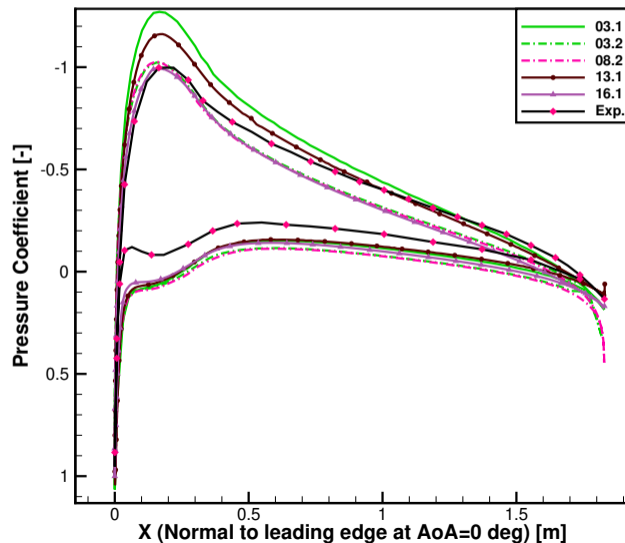


Participant	Ice Mass [kg/m]
13.1	2.57
16.1	1.58
Exp.	1.80

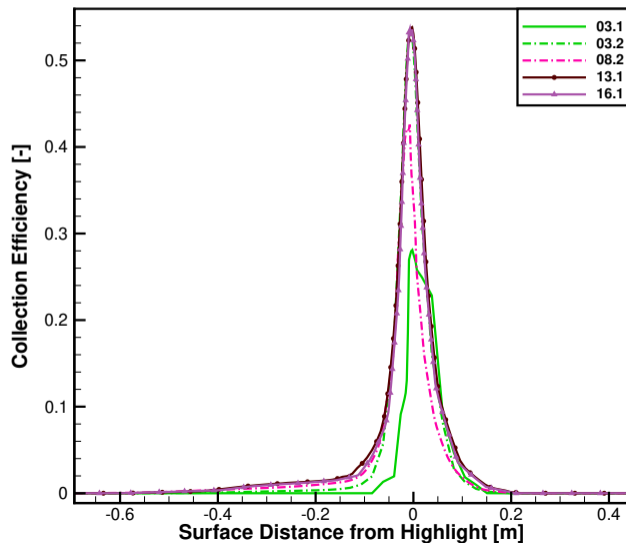
Case 251 – Monomodal SLD, big chord – Ice Density and Height



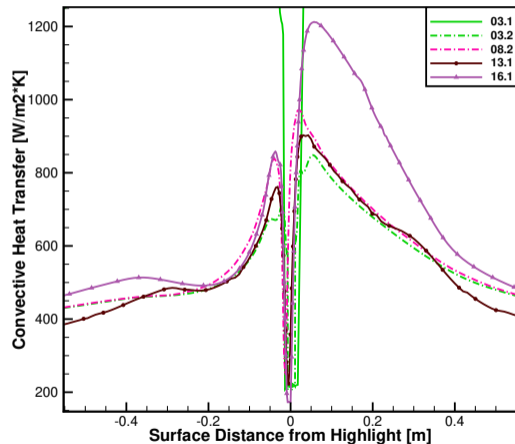
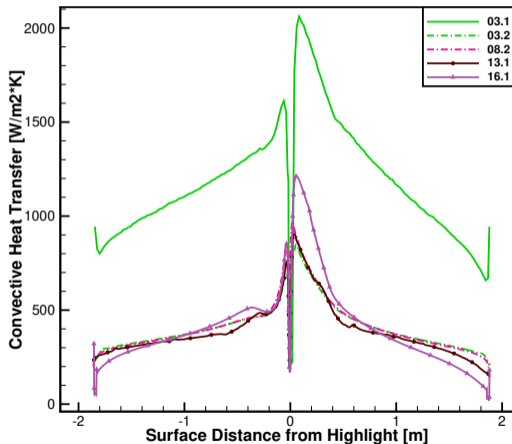
Case 251 – Monomodal SLD, big chord – Pressure Coefficient



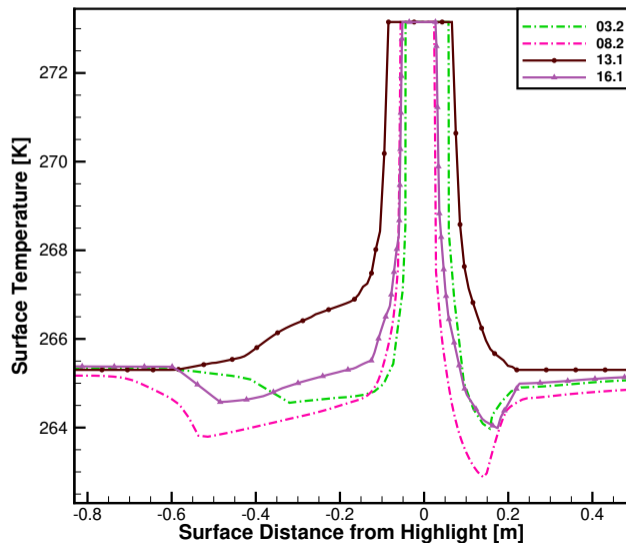
Case 251 – Monomodal SLD, big chord – Collection Efficiency



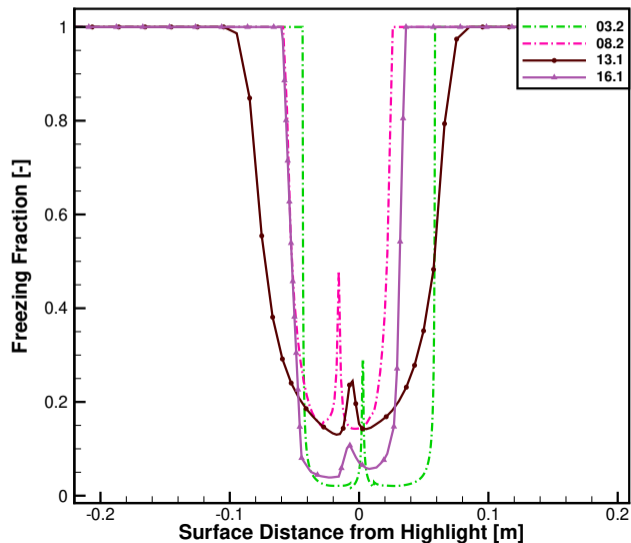
Case 251 – Monomodal SLD, big chord – HTC



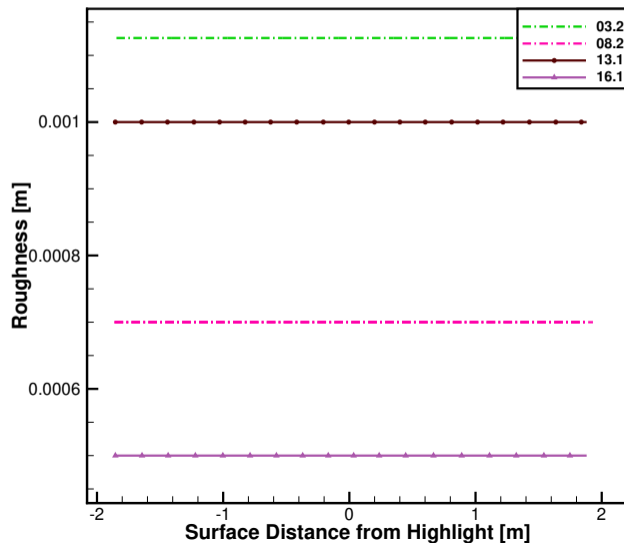
Case 251 – Monomodal SLD, big chord – Surface Temperature



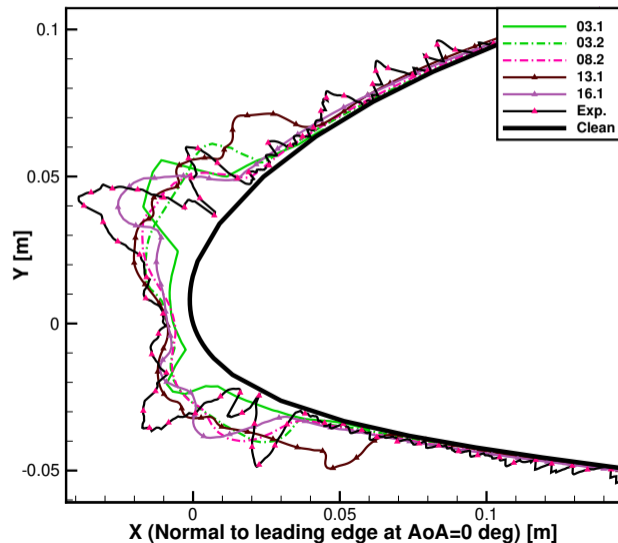
Case 251 – Monomodal SLD, big chord – Freezing Fraction



Case 251 – Monomodal SLD, big chord – Roughness

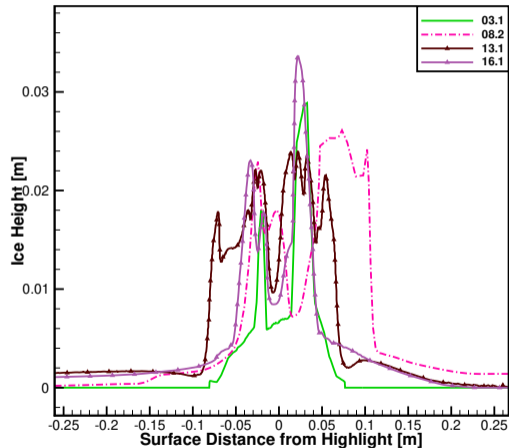
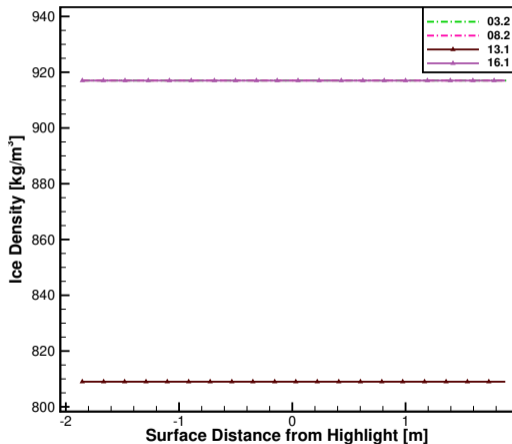


Case 252 – Bimodal SLD, big chord – Ice Shape

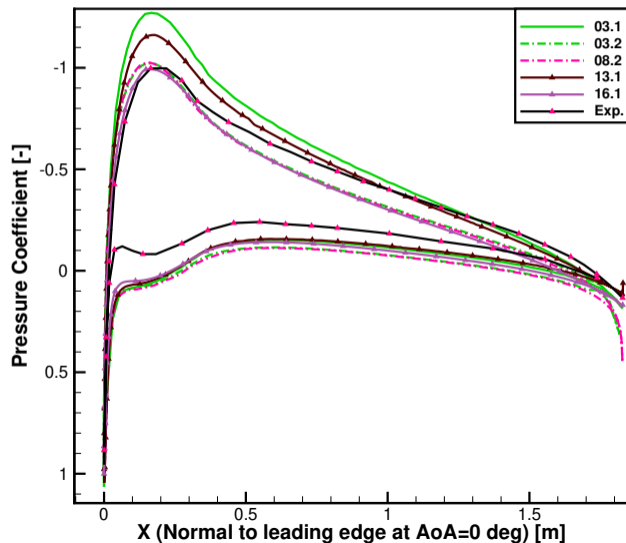


Participant	Ice Mass [kg/m]
13.1	2.94
16.1	1.92
Exp.	2.19

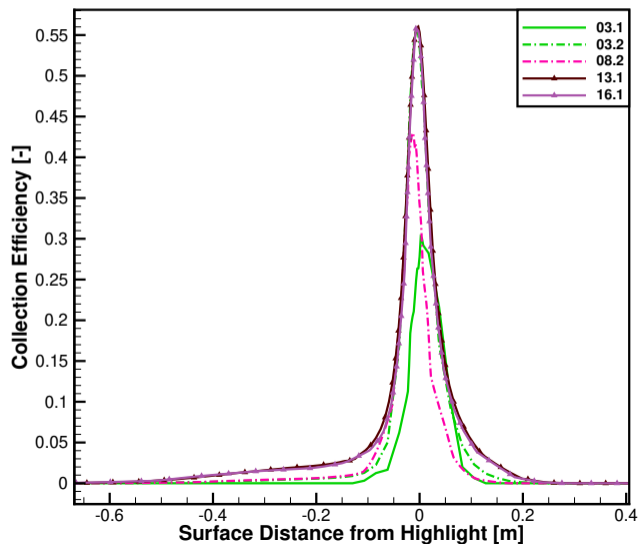
Case 252 – Bimodal SLD, big chord – Ice Density and Height



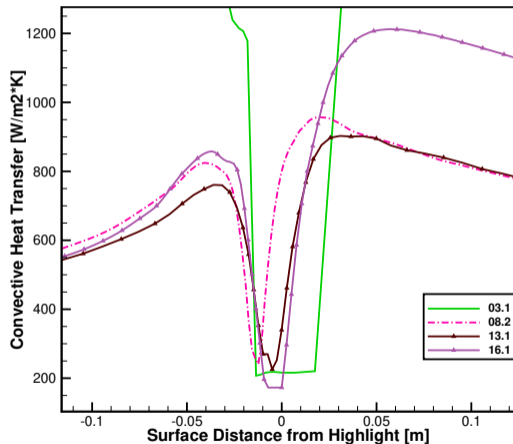
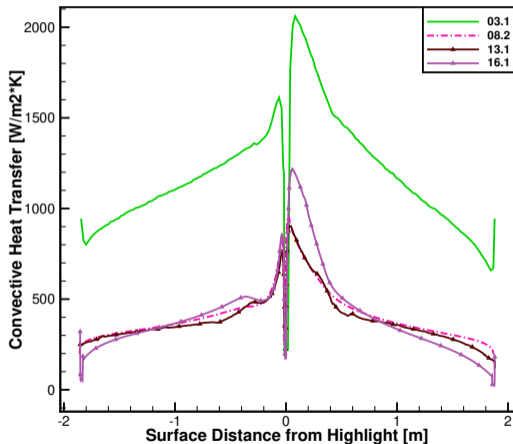
Case 252 – Bimodal SLD, big chord – Pressure Coefficient



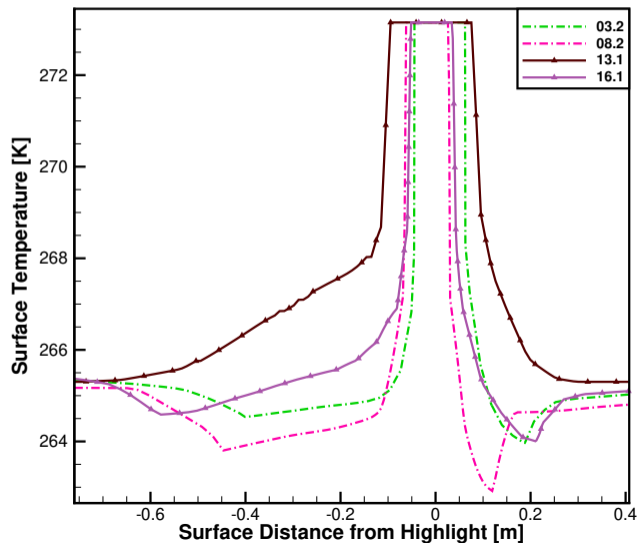
Case 252 – Bimodal SLD, big chord – Collection Efficiency



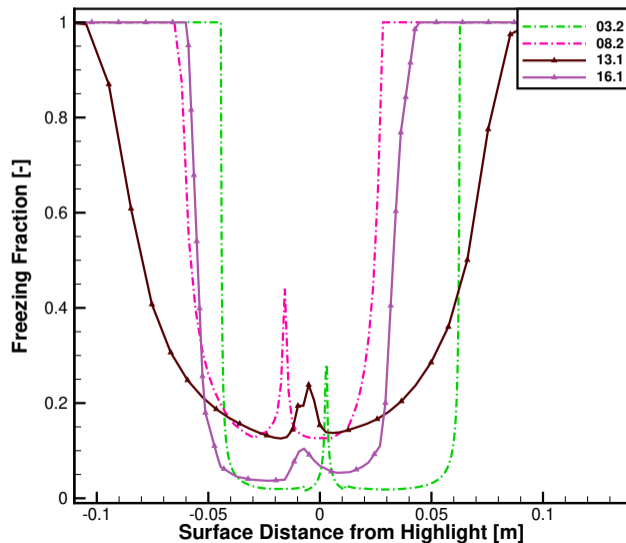
Case 252 – Bimodal SLD, big chord – HTC



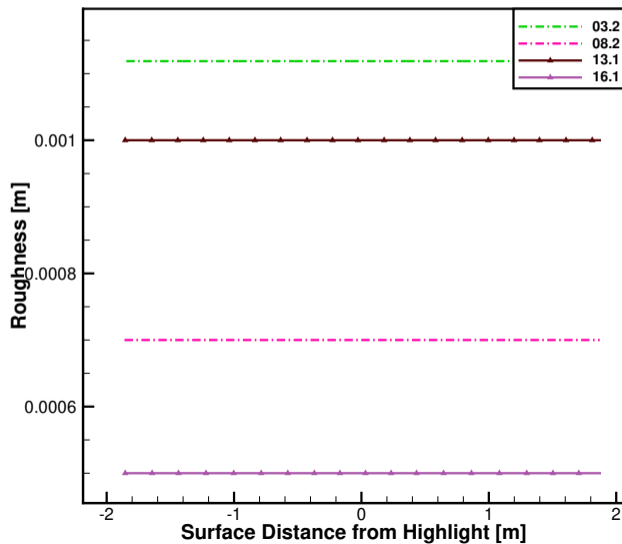
Case 252 – Bimodal SLD, big chord – Surface Temperature



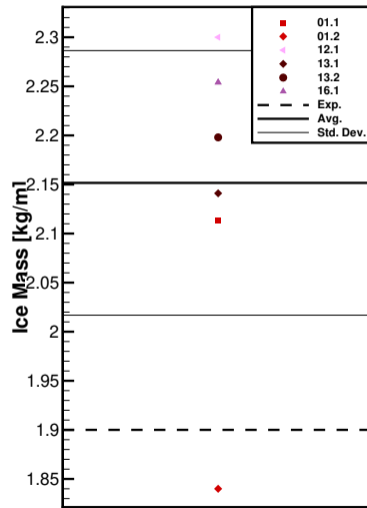
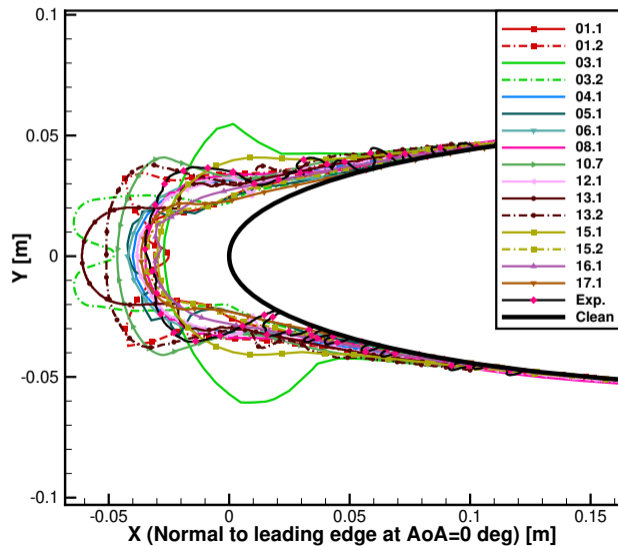
Case 252 – Bimodal SLD, big chord – Freezing Fraction



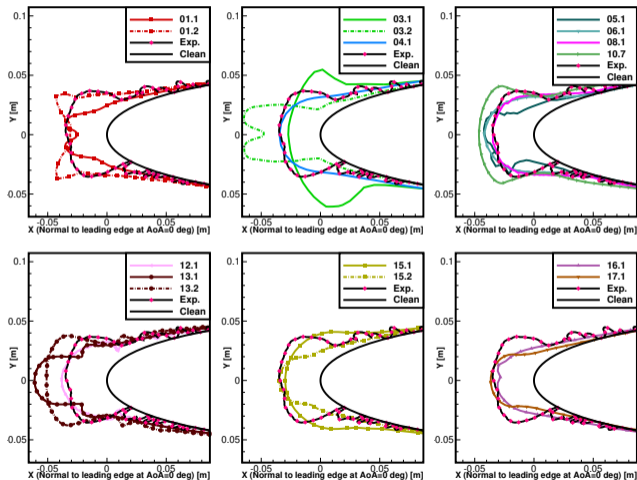
Case 252 – Bimodal SLD, big chord – Roughness



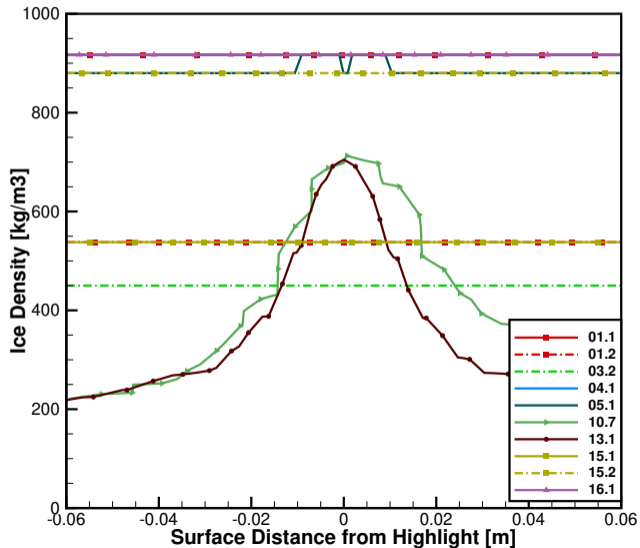
Case 361 Inboard – Rime, sweep 30deg – Ice Shape



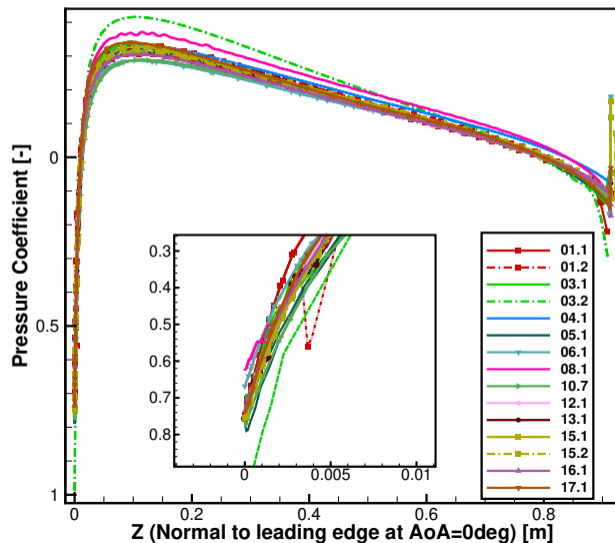
Case 361 Inboard – Rime, sweep 30deg – Ice Shape



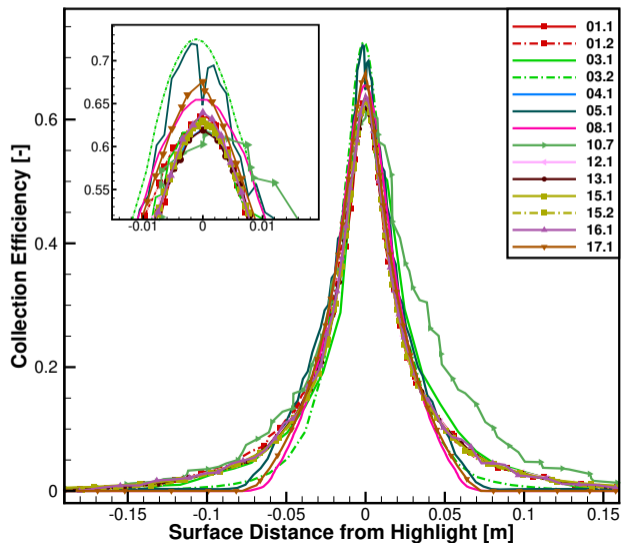
Case 361 – Rime, sweep 30deg – Ice Density



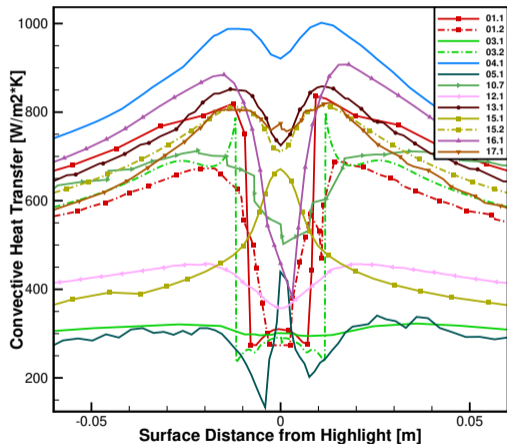
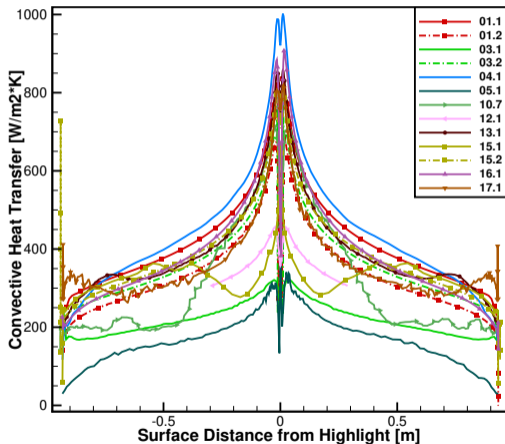
Case 361 Inboard – Rime, sweep 30deg – Pressure Coefficient



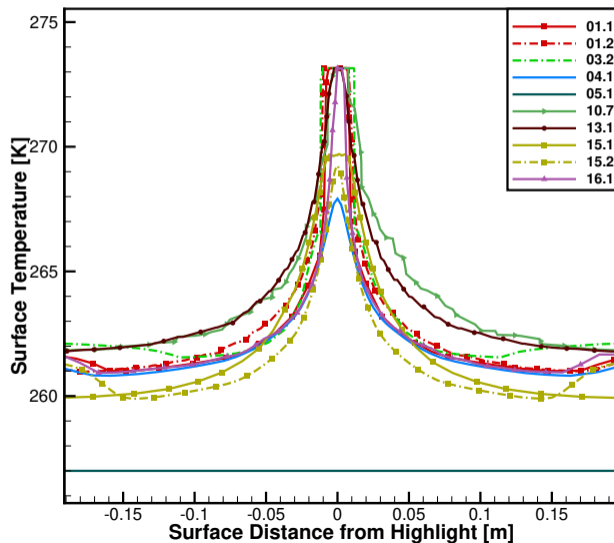
Case 361 Inboard – Rime, sweep 30deg – Collection Efficiency



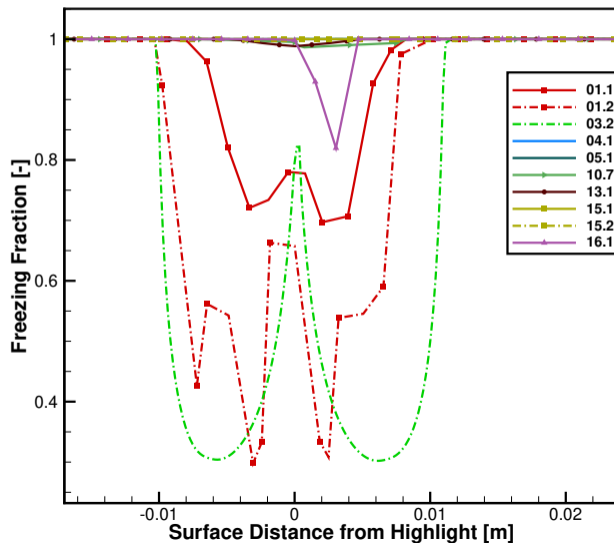
Case 361 Inboard – Rime, sweep 30deg – HTC



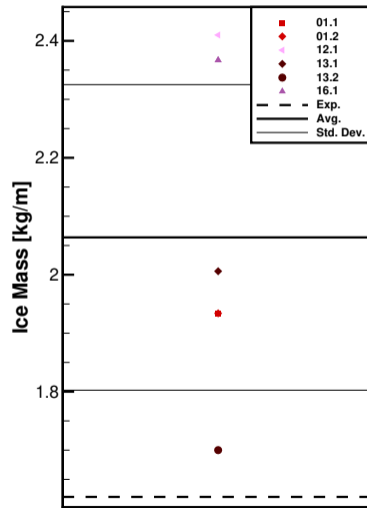
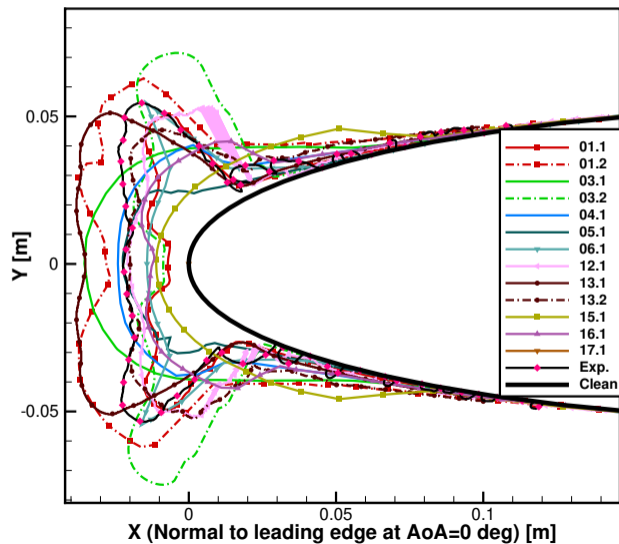
Case 361 Inboard – Rime, sweep 30deg – Surface Temperature



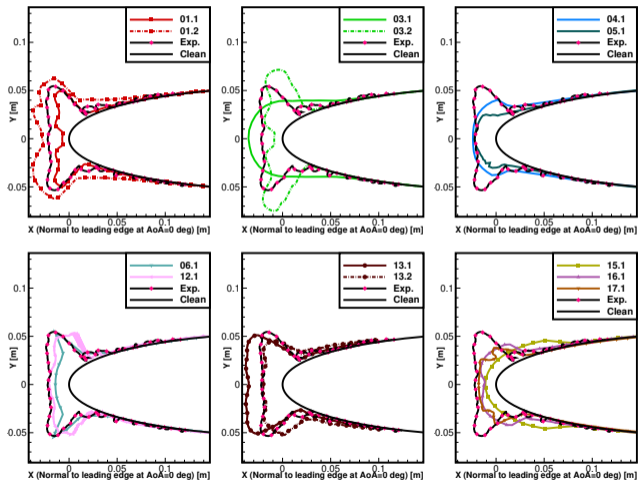
Case 361 Inboard – Rime, sweep 30deg – Freezing Fraction



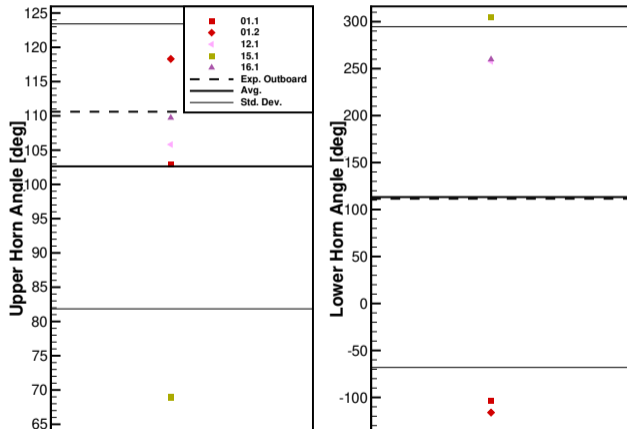
Case 362 Inboard – Glaze, sweep 30deg – Ice Shape



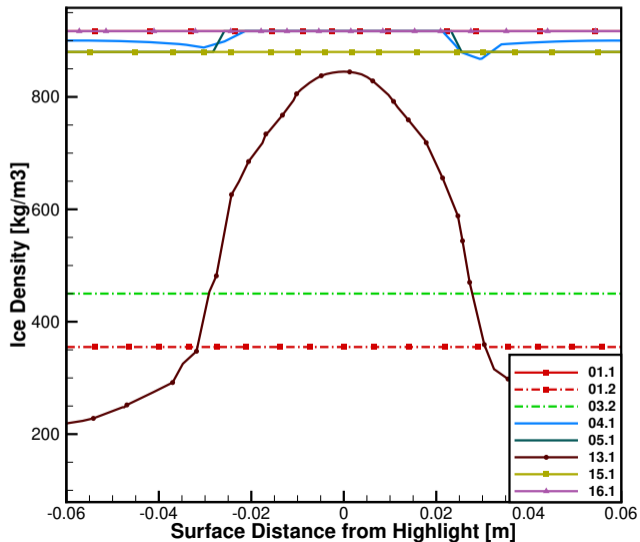
Case 362 Inboard – Glaze, sweep 30deg – Ice Shape



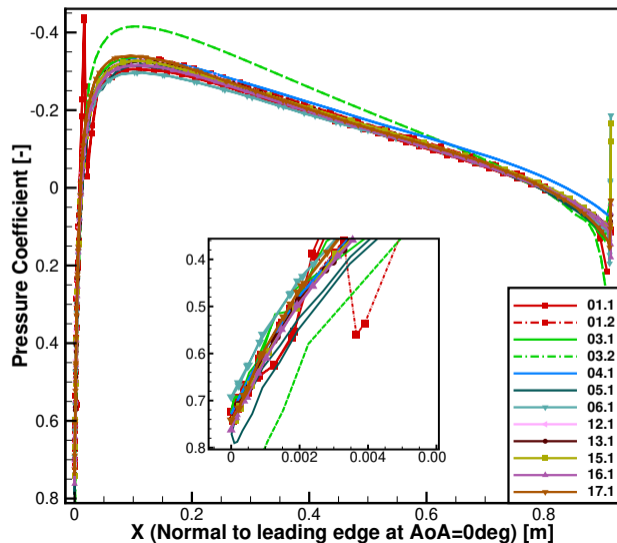
Case 362 Inboard – Glaze, sweep 30deg – Hornes Angle



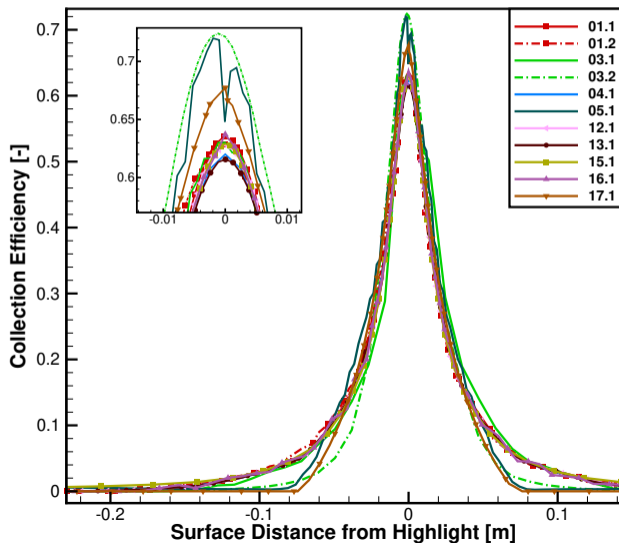
Case 362 – Glaze, sweep 30deg – Ice Density



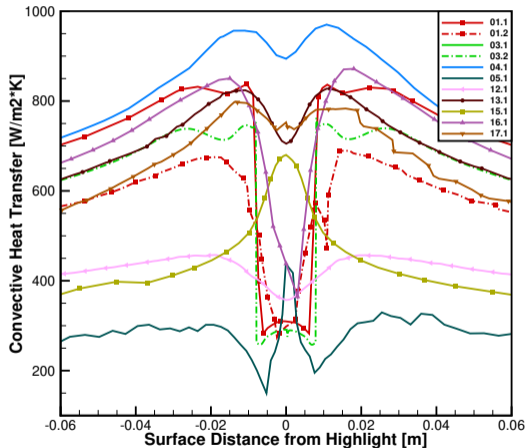
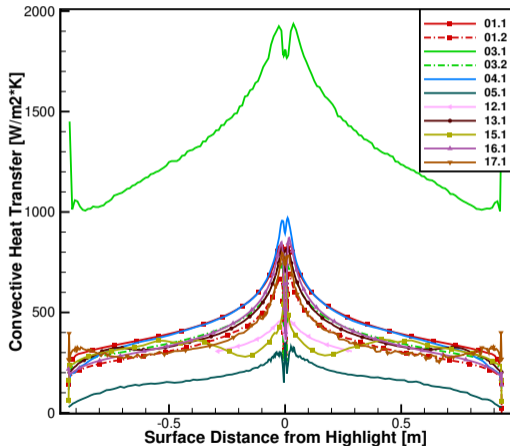
Case 362 Inboard – Glaze, sweep 30deg – Pressure Coefficient



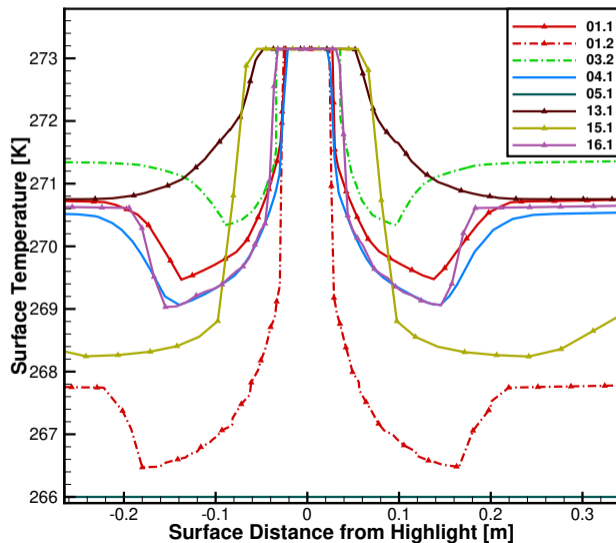
Case 362 Inboard – Glaze, sweep 30deg – Collection Efficiency



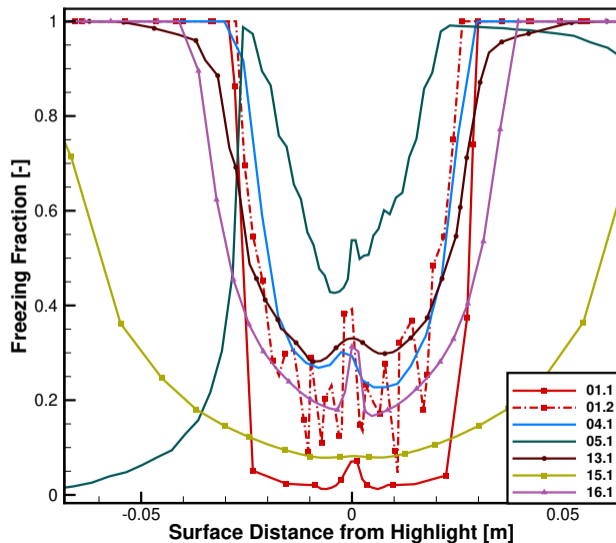
Case 362 Inboard – Glaze, sweep 30deg – HTC



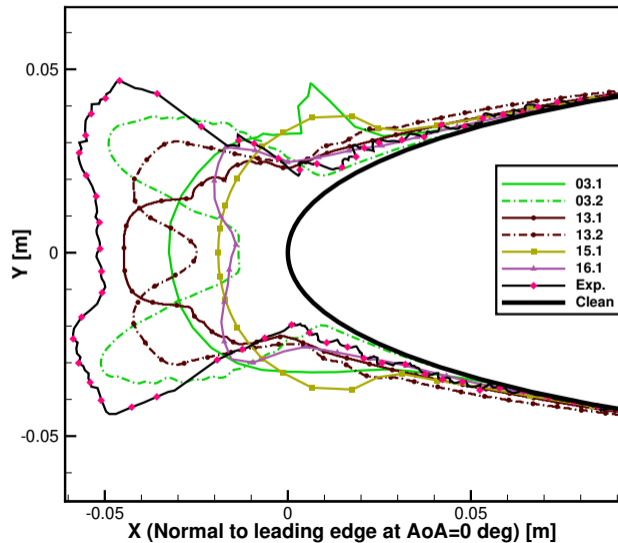
Case 362 Inboard – Glaze, sweep 30deg – Surface Temperature



Case 362 Inboard – Glaze, sweep 30deg – Freezing Fraction

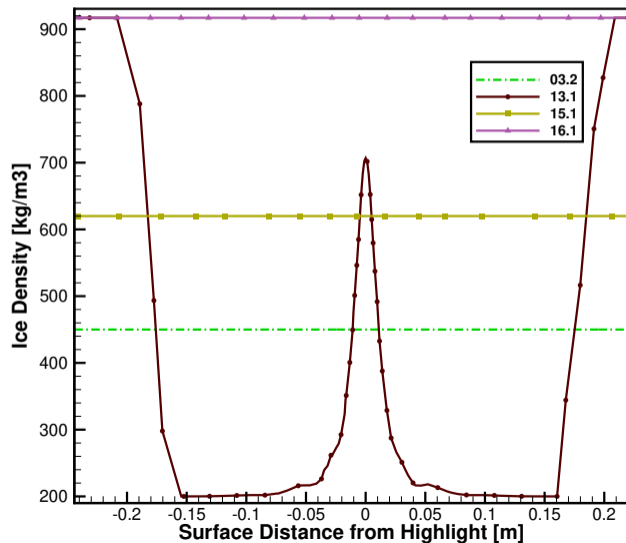


Case 363 Inboard – T 263K, sweep 30deg – Ice Shape

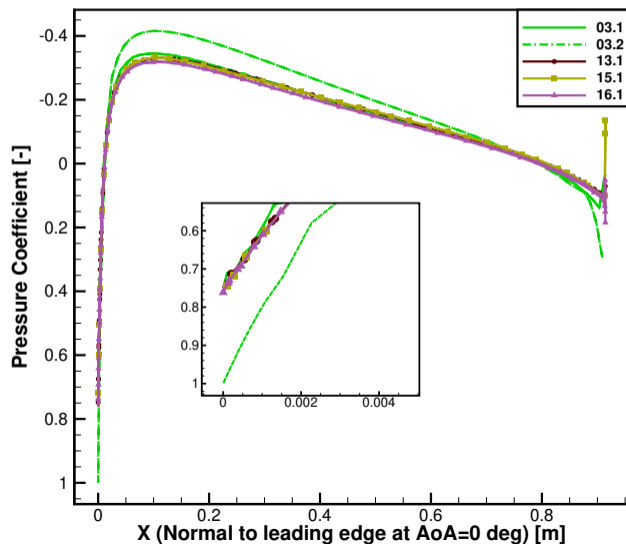


Participant	Ice Mass [kg/m]
13.1	1.417
13.2	1.415
16.1	1.518
Exp.	1.560

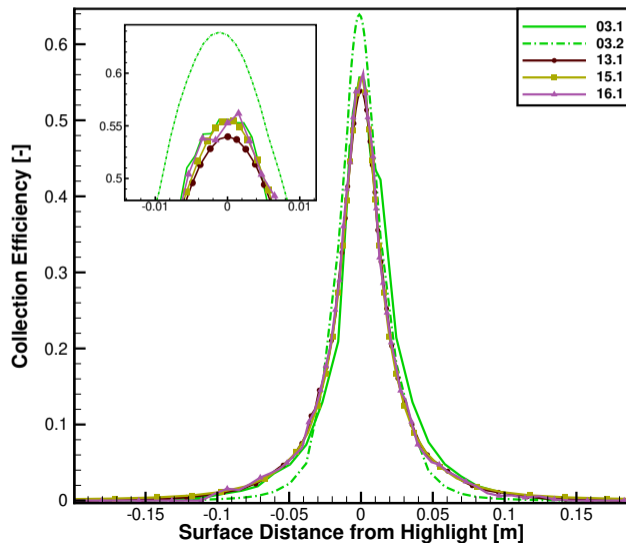
Case 363 – T 263K, sweep 30deg – Ice Density



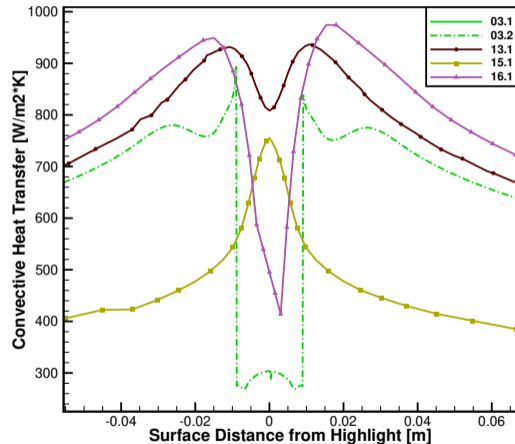
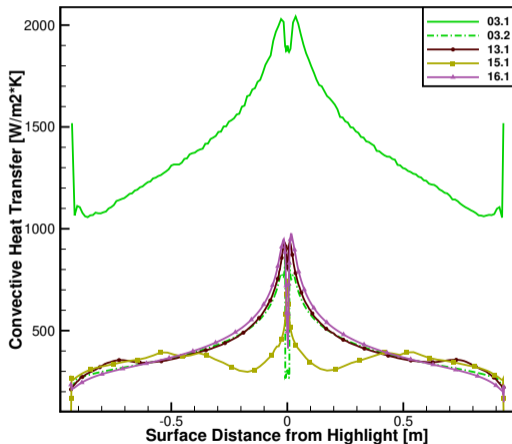
Case 363 Inboard – T 263K, sweep 30deg – Pressure Coefficient



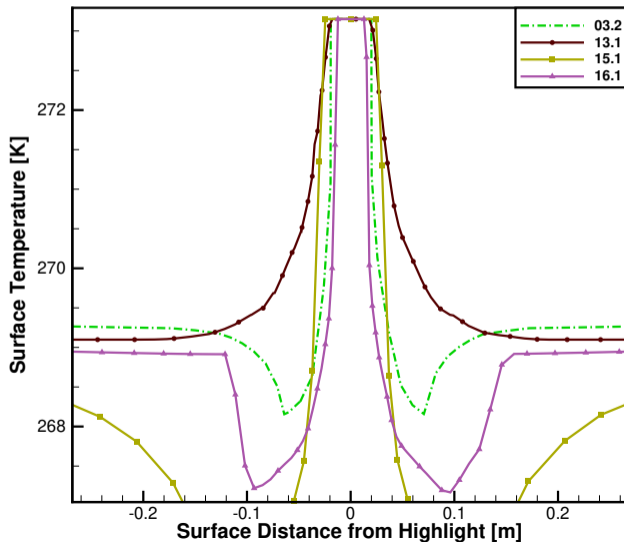
Case 363 Inboard – T 263K, sweep 30deg – Collection Efficiency



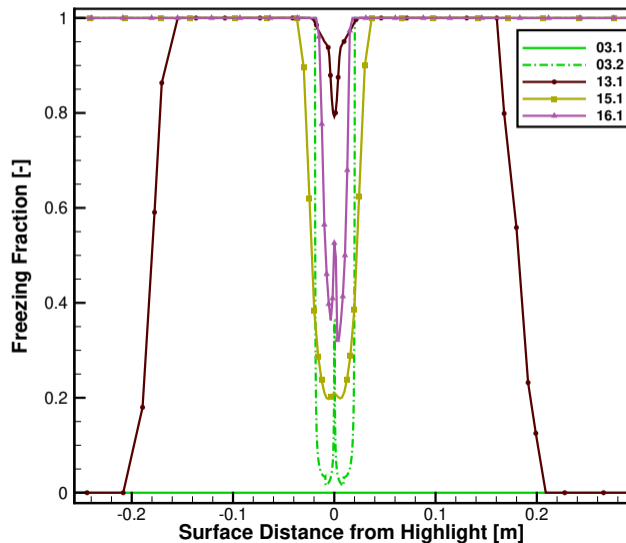
Case 363 Inboard – T 263K, sweep 30deg – HTC



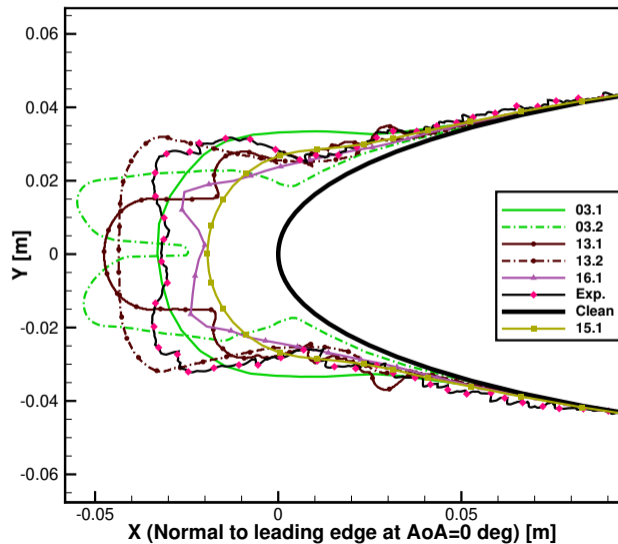
Case 363 Inboard – T 263K, sweep 30deg – Surface Temperature



Case 363 Inboard – T 263K, sweep 30deg – Freezing Fraction

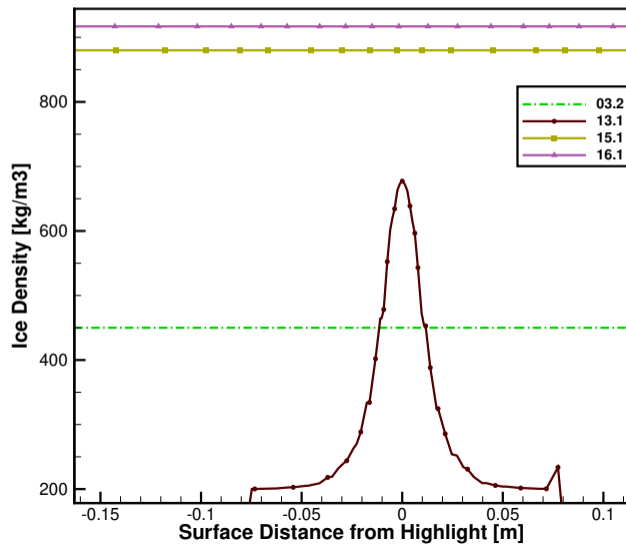


Case 364 Inboard – T 260K, sweep 30deg – Ice Shape

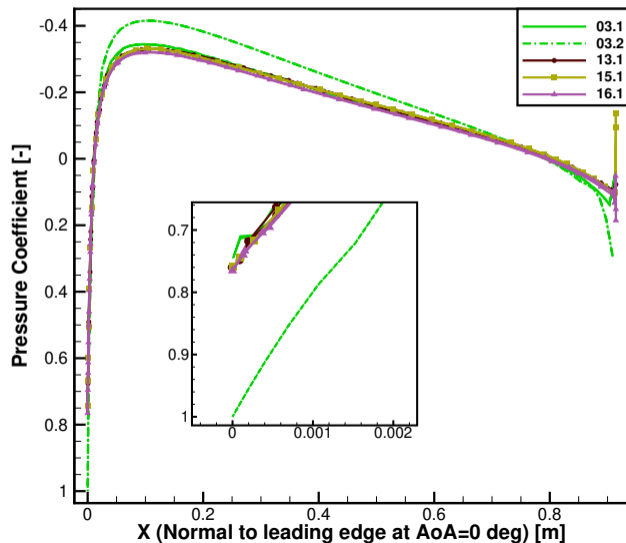


Participant	Ice Mass [kg/m]
13.1	1.444
13.2	1.442
16.1	1.492
Exp.	1.38

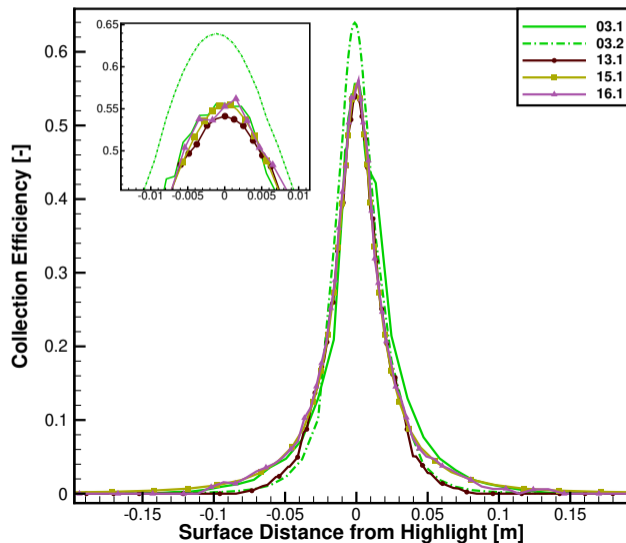
Case 364 – T 260K, sweep 30deg – Ice Density



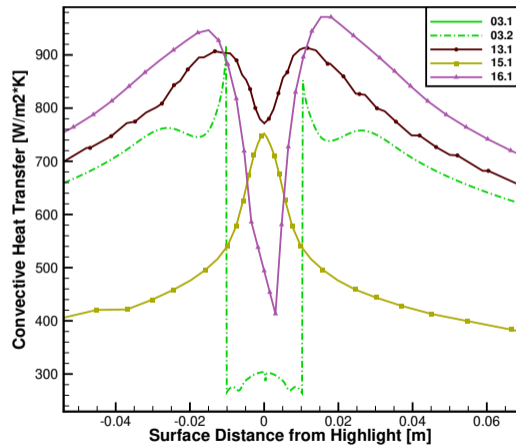
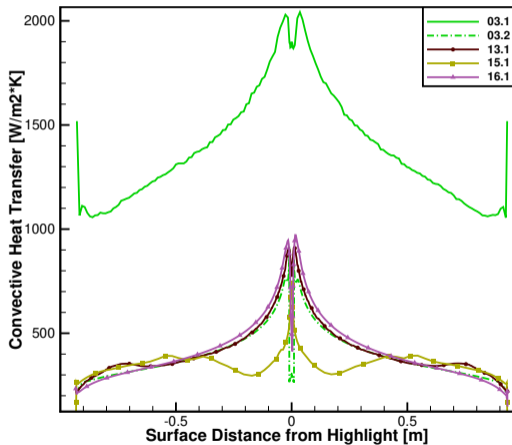
Case 364 Inboard – T 260K, sweep 30deg – Pressure Coefficient



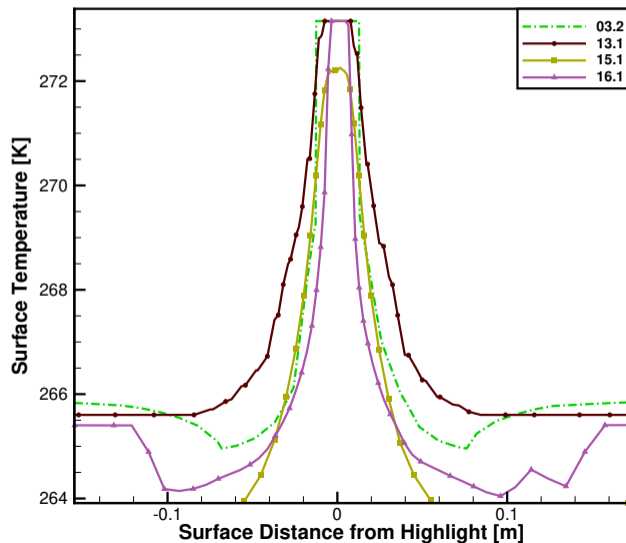
Case 364 Inboard – T 260K, sweep 30deg – Collection Efficiency



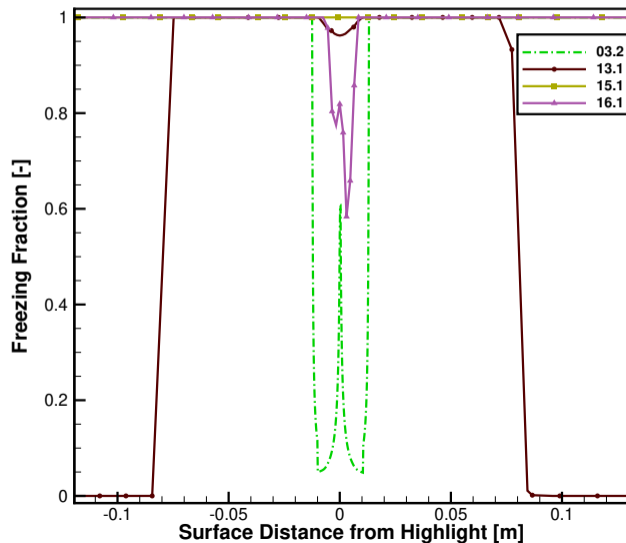
Case 364 Inboard – T 260K, sweep 30deg – HTC



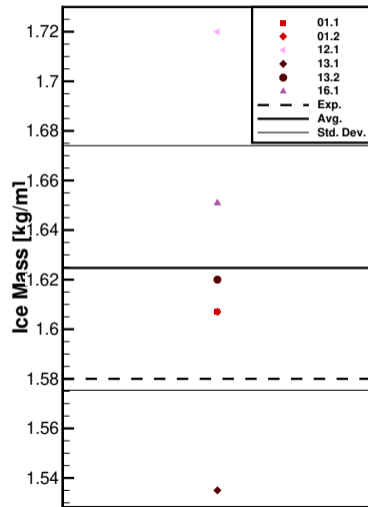
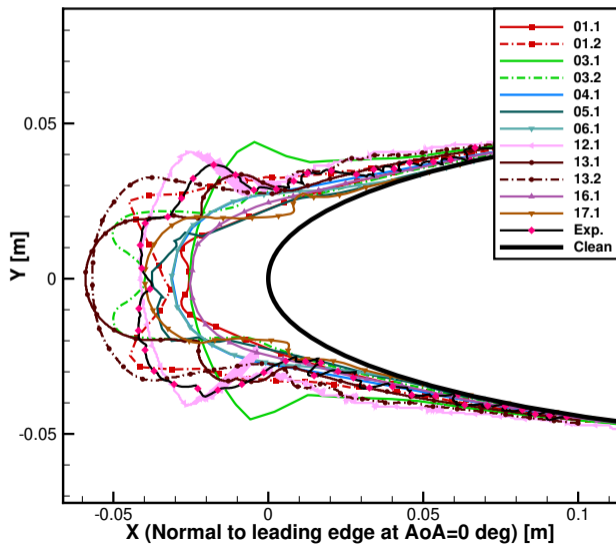
Case 364 Inboard – T 260K, sweep 30deg – Surface Temperature



Case 364 Inboard – T 260K, sweep 30deg – Freezing Fraction

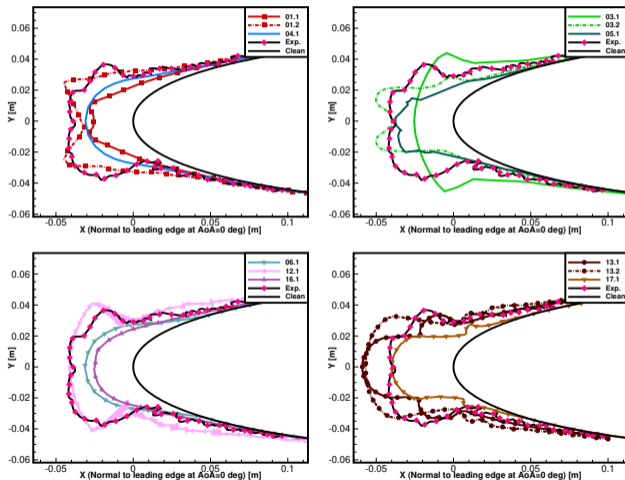


Case 371 Inboard – Rime, sweep 45deg – Ice Shape

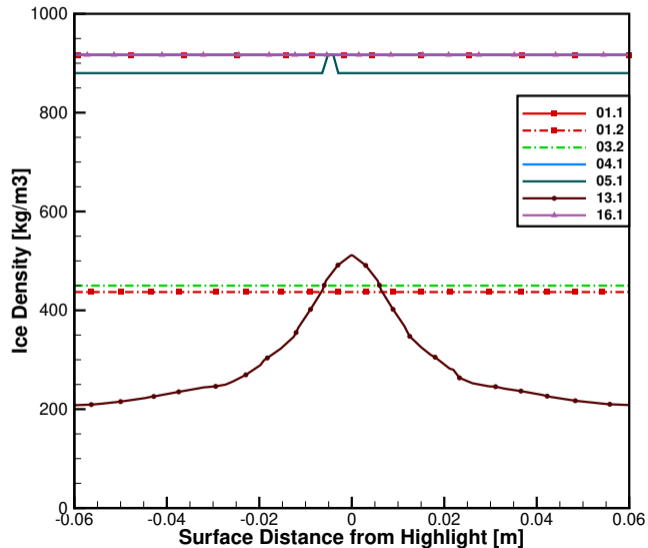


Case 371

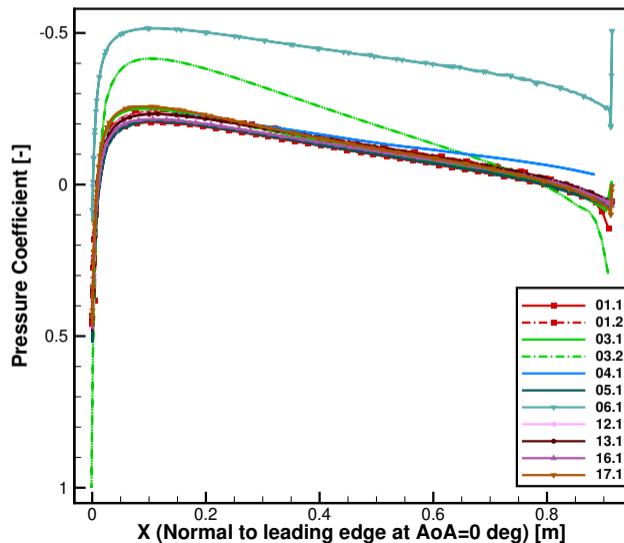
Case 371 Inboard – Rime, sweep 45deg – Ice Shape



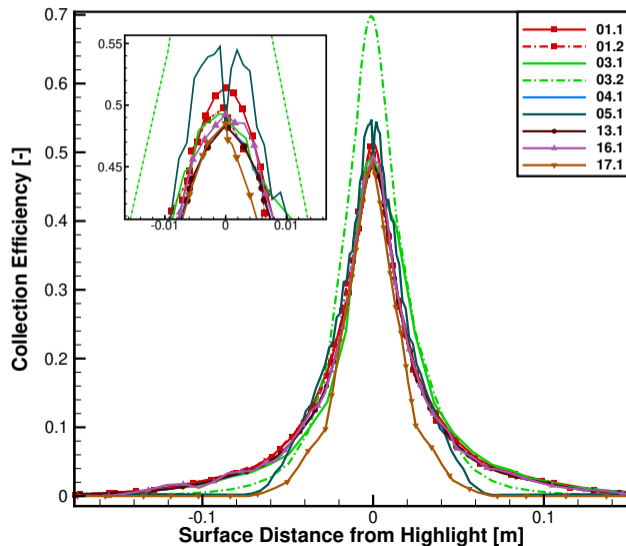
Case 371 – Rime, sweep 45deg – Ice Density



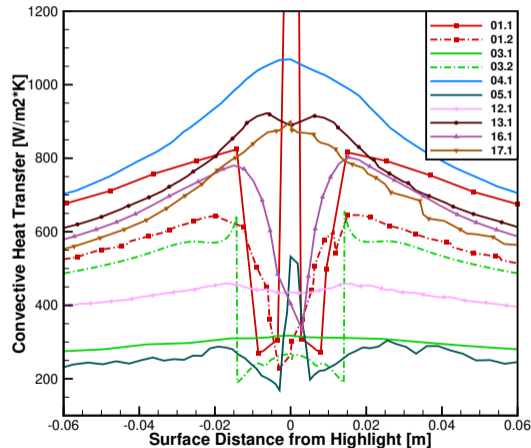
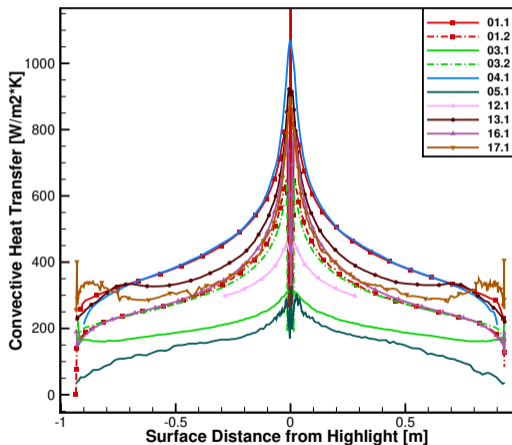
Case 371 Inboard – Rime, sweep 45deg – Pressure Coefficient



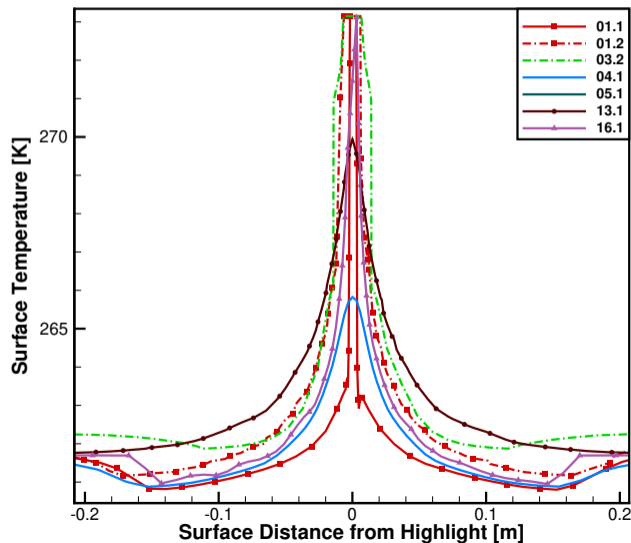
Case 371 Inboard – Rime, sweep 45deg – Collection Efficiency



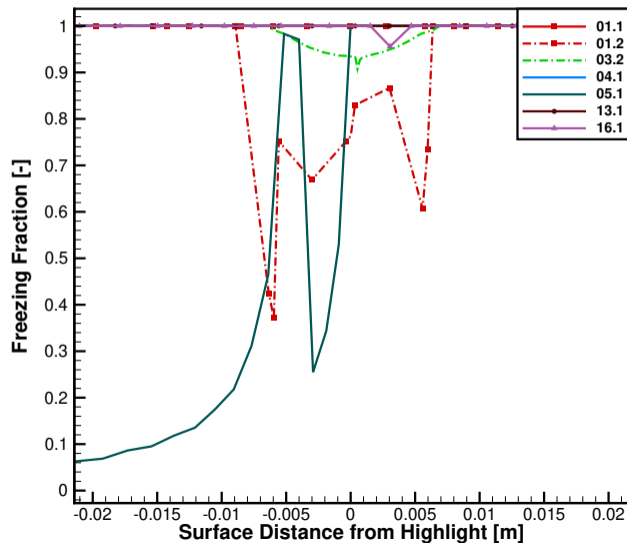
Case 371 Inboard – Rime, sweep 45deg – HTC



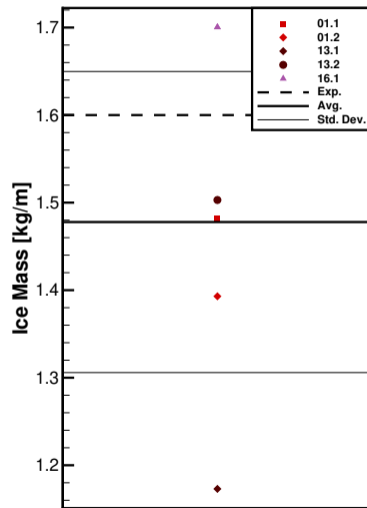
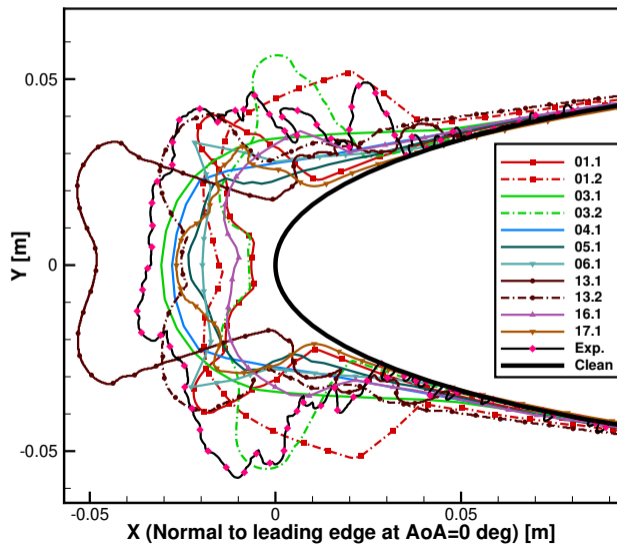
Case 371 Inboard – Rime, sweep 45deg – Surface Temperature



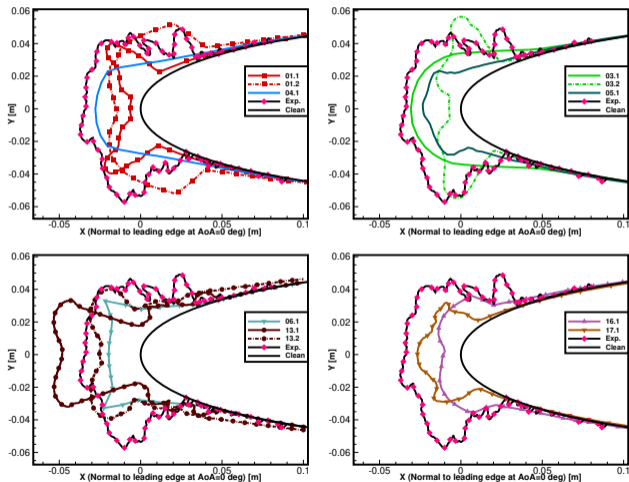
Case 371 Inboard – Rime, sweep 45deg – Freezing Fraction



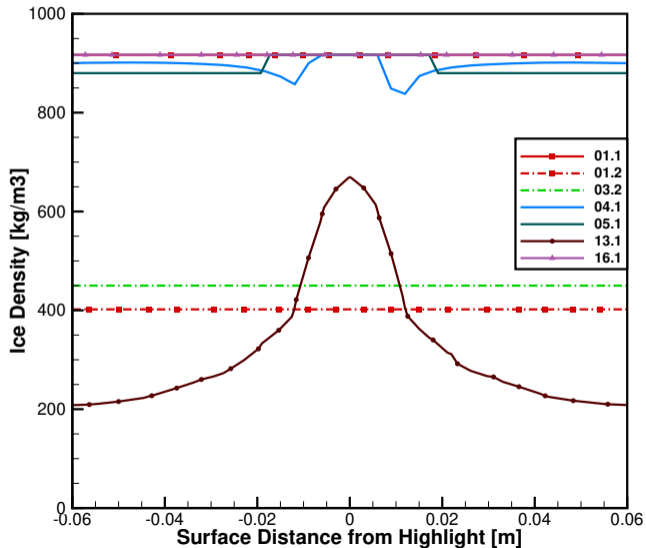
Case 372 Inboard – Glaze, sweep 45deg – Ice Shape



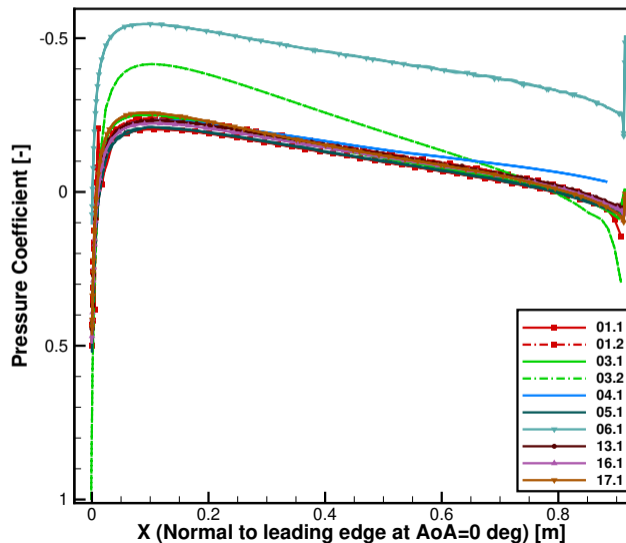
Case 372 Inboard – Glaze, sweep 45deg – Ice Shape



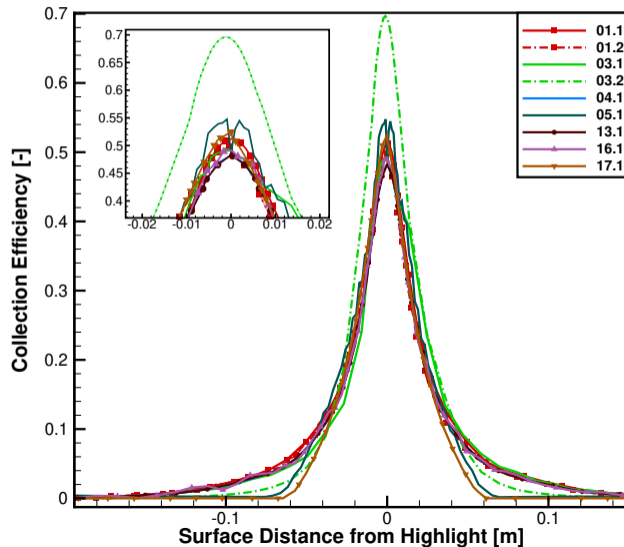
Case 372 – Glaze, sweep 45deg – Ice Density



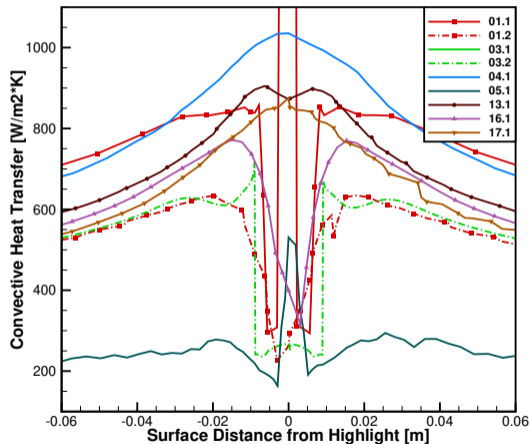
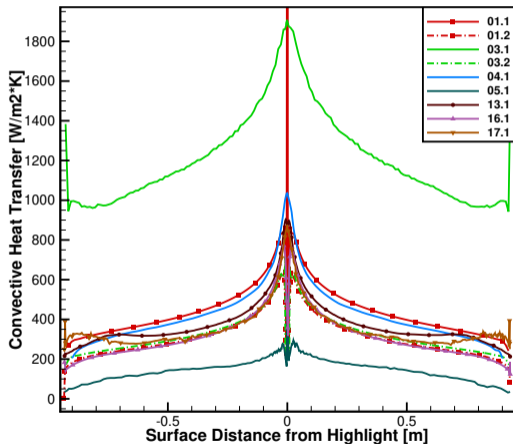
Case 372 Inboard – Glaze, sweep 45deg – Pressure Coefficient



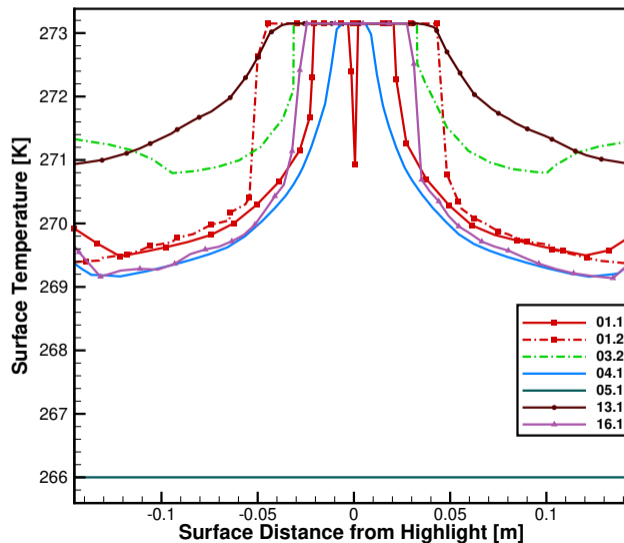
Case 372 Inboard – Glaze, sweep 45deg – Collection Efficiency



Case 372 Inboard – Glaze, sweep 45deg – HTC



Case 372 Inboard – Glaze, sweep 45deg – Surface Temperature



Case 372 Inboard – Glaze, sweep 45deg – Freezing Fraction

