Propagation Prediction Cases

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Introduction

- Two required test cases, each with four different atmosphere profiles, are analyzed.
- Boom carpet cutoff, ground signatures and loudness calculated.
- PCBOOM 6.6 used for all calculations

Test Cases

- Test Case 1:
  - LM1021 at Mach 1.6, Alt 16764 m (55000 ft)
  - Atmosphere profiles:
    - Atmosphere profile 1 (with wind)
    - Atmosphere profile 2 (with wind)
    - Standard atmosphere profile (no wind)
    - Standard atmosphere profile (no wind), with 70% relative humidity at all altitudes
- Test Case 2:
  - Shaped axi-symmetric body at Mach 1.6, Alt 15849.6 m (52000 ft)
  - Atmosphere profiles:
    - Atmosphere profile 3 (with wind)
    - Atmosphere profile 4 (with wind)
    - Standard atmosphere profile (no wind)
    - Standard atmosphere profile (no wind), with 70% relative humidity at all altitudes

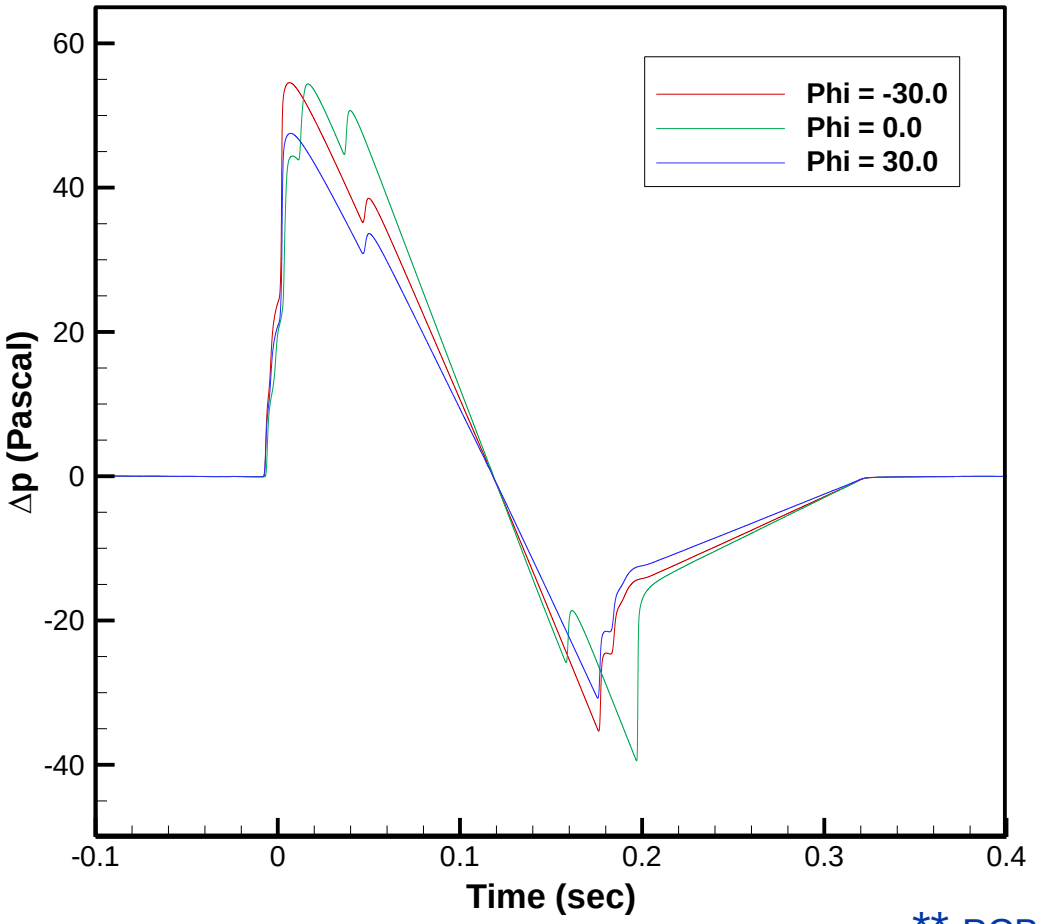
Propagation Prediction Code

- PCBOOM 6.6:
  - FOBoom module performs full carpet ray tracing and provides cutoff positions on both edges.
  - PCBurg module propagates initial pressure signatures along the ray path. Geometric attenuation, nonlinearity, thermoviscous dissipation and molecular relaxation are included in the propagation model.
  - Ground reflection factor is applied at the end of the propagation.
  - Atmospheric pressure is calculated based on hydrostatic equation, input temperature profile and ground atmosphere pressure.
- Computing platform:
  - Windows workstation
- Code Parameters:
  - Sample frequency 102400 Hz
  - Step size factor: 0.05 (default)
  - Anti-Gibbs filter is off

Case One (1)

LM1021 with atmosphere profile 1: Wind, High Humidity

Ground Signatures



Loudness

Phi	PL	CSEL	ASEL
-30.0	92.01	99.03	78.32
0.0	92.08	98.48	78.43
30.0	89.74	97.68	75.92

Cut-off & Ground interception

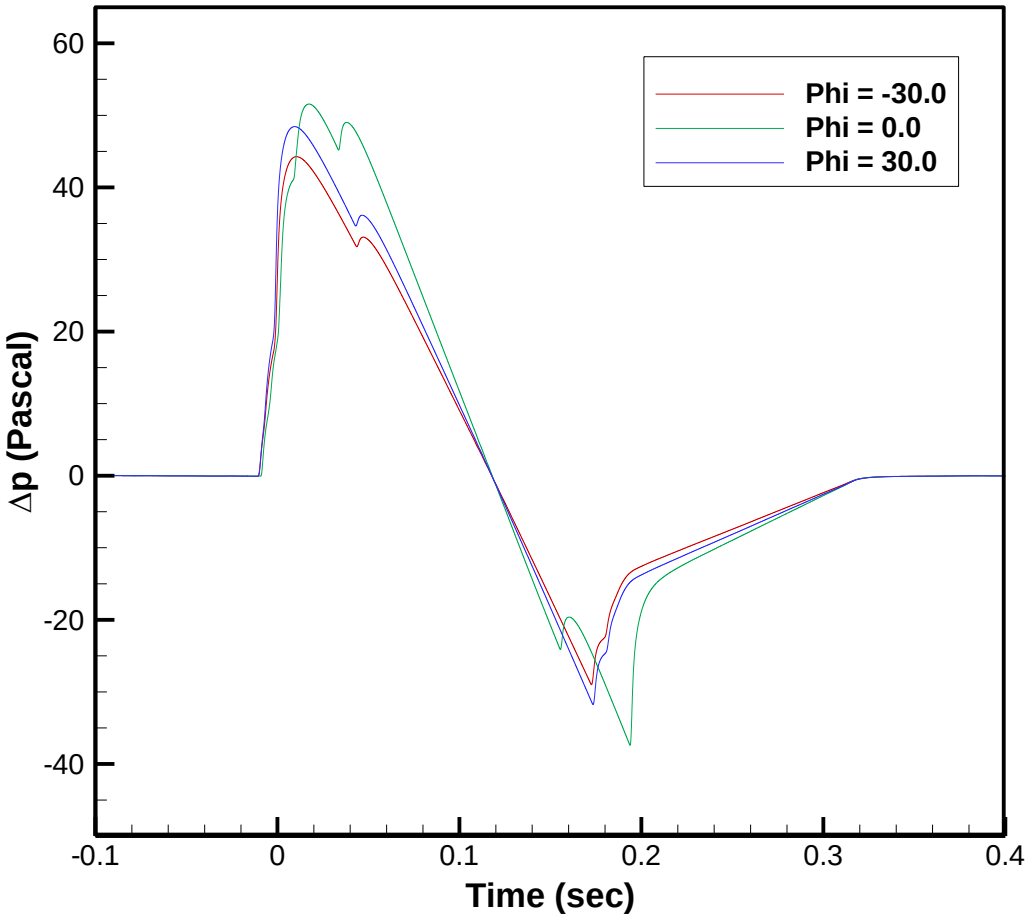
Phi	X (m)	Y (m)
NA**	NA	NA
0.0	13924.61	445.19
56.91	39590.11	41810.24

** PCBOOM failed to capture one side of the cut-off

Case One (2)

LM1021 with atmosphere profile 2: Wind, Low Humidity

Ground Signatures



Loudness

Phi	PL	CSEL	ASEL
-30.0	83.15	96.21	68.42
0.0	85.63	96.92	70.67
30.0	84.98	97.27	70.12

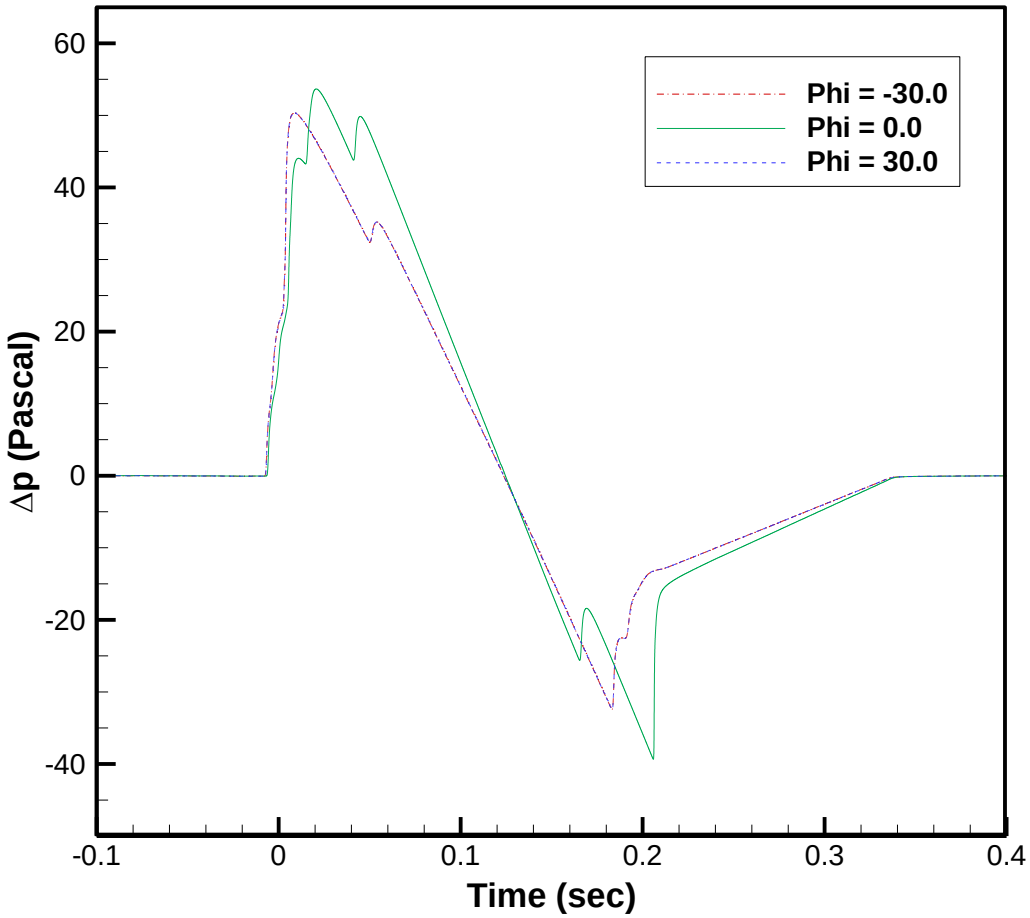
Cut-off & Ground interception

Phi	X (m)	Y (m)
-58.83	56536.62	-58679.85
0.0	15538.46	-1170.49
64.55	42774.08	41347.19

Case One (3)

LM1021 with standard atmosphere: No Wind, Standard humidity profile

Ground Signatures



Loudness

Phi	PL	CSEL	ASEL
-30.0	89.31	97.69	74.63
0.0	91.89	97.92	77.55
30.0	89.31	97.69	74.63

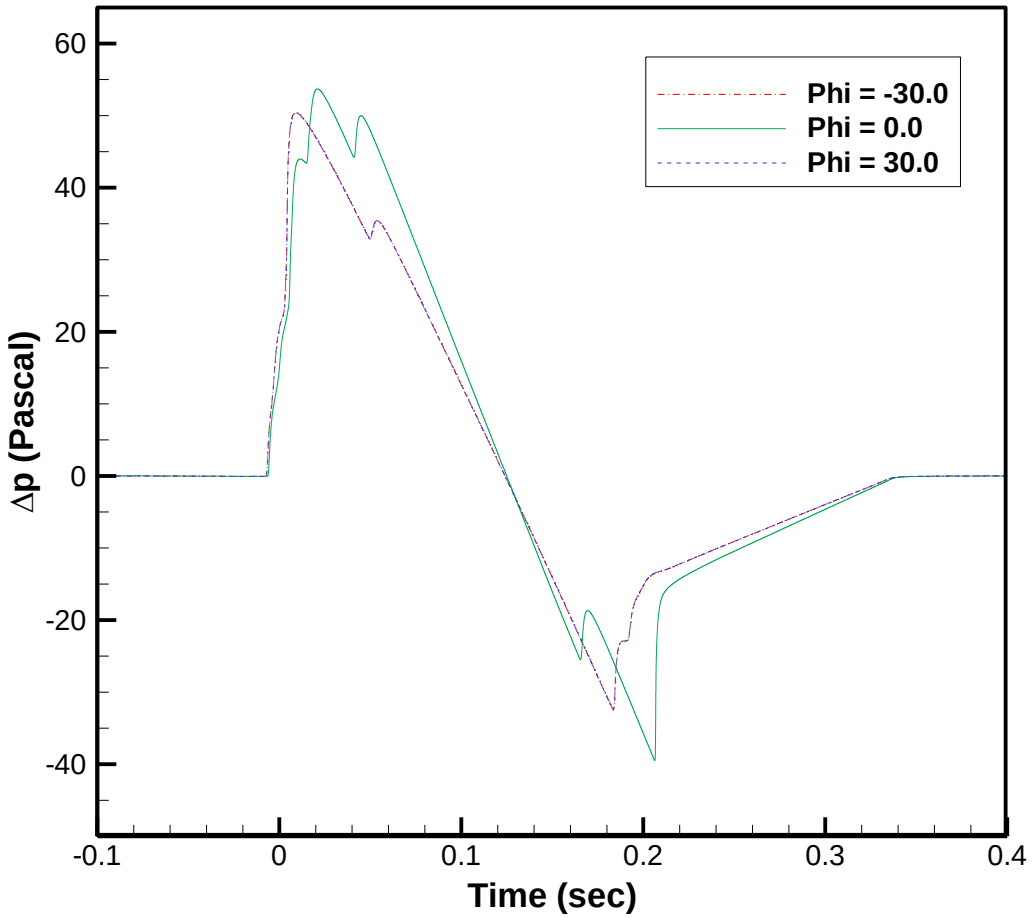
Cut-off & Ground interception

Phi	X (m)	Y (m)
-49.84	32677.91	-31192.47
0.0	14684.29	0.00
49.84	32677.91	31192.47

Case One (4)

LM1021 with standard atmosphere: No Wind, Constant 70% relative humidity

Ground Signatures



Loudness

Phi	PL	CSEL	ASEL
-30.0	88.98	97.64	74.13
0.0	91.39	97.82	76.95
30.0	88.98	97.64	74.13

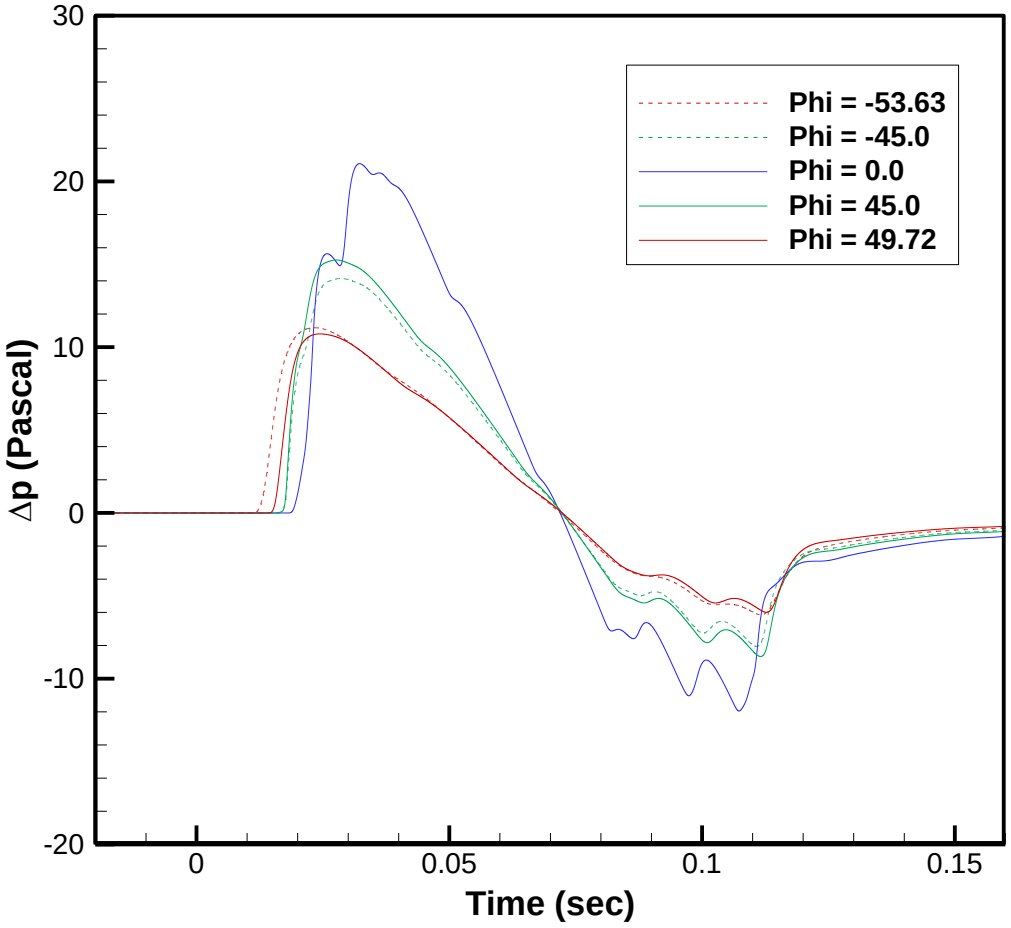
Cut-off & Ground interception

Phi	X (m)	Y (m)
-49.84	32677.91	-31192.47
0.0	14684.29	0.00
49.84	32677.91	31192.47

Case Two (1)

Shaped axi-symmetric body with atmosphere profile 3: Wind, High humidity

Ground Signatures



Loudness

Phi	PL	CSEL	ASEL
-53.63	71.30	86.98	57.59
-45.00	77.18	89.16	62.78
0.00	81.44	92.29	67.11
45.00	78.57	89.99	63.91
49.72	73.74	87.14	59.54

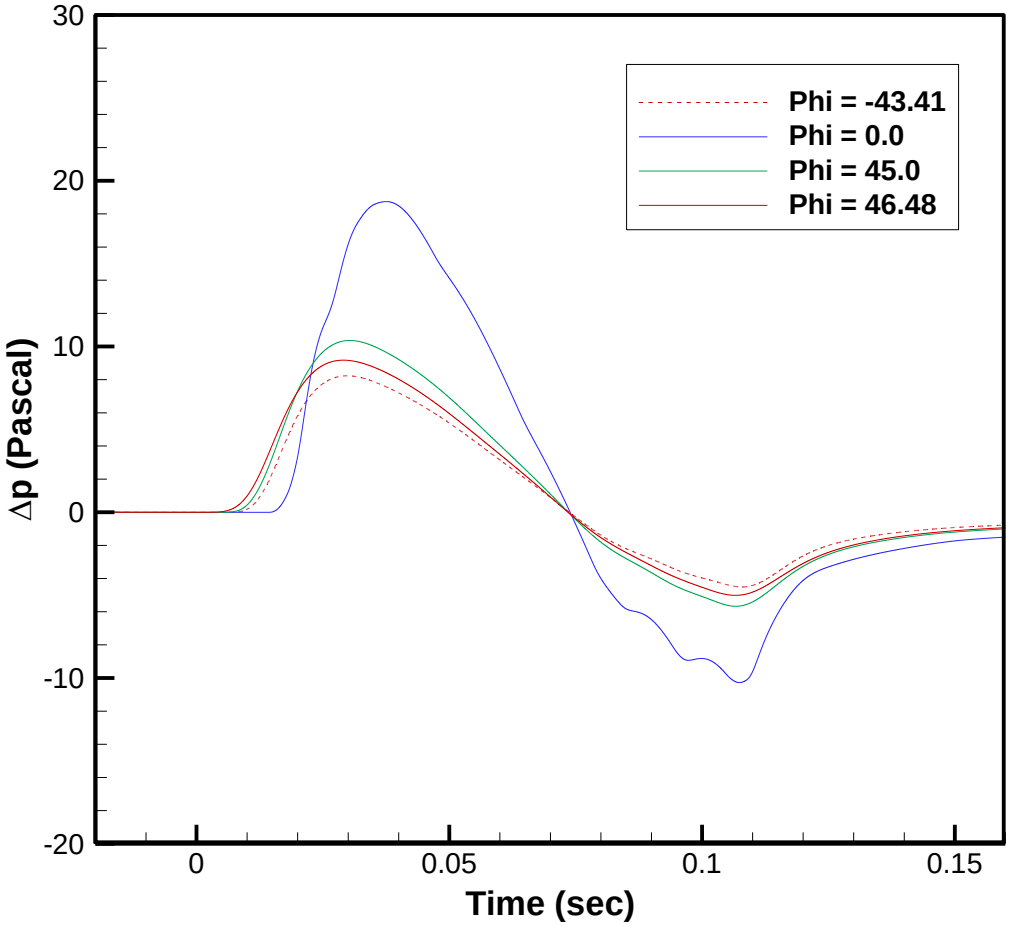
Cut-off & Ground interception

Phi	X (m)	Y (m)
-53.63	52664.41	-50483.93
0.00	15791.69	-450.01
49.72	37546.00	32769.14

Case Two (2)

Shaped axi-symmetric body with atmosphere profile 4: Wind, Low humidity

Ground Signatures



Loudness

Phi	PL	CSEL	ASEL
-43.41	50.23	82.39	43.63
0.00	69.57	89.93	55.44
45.00	50.31	84.13	44.20
46.48	48.28	82.89	42.54

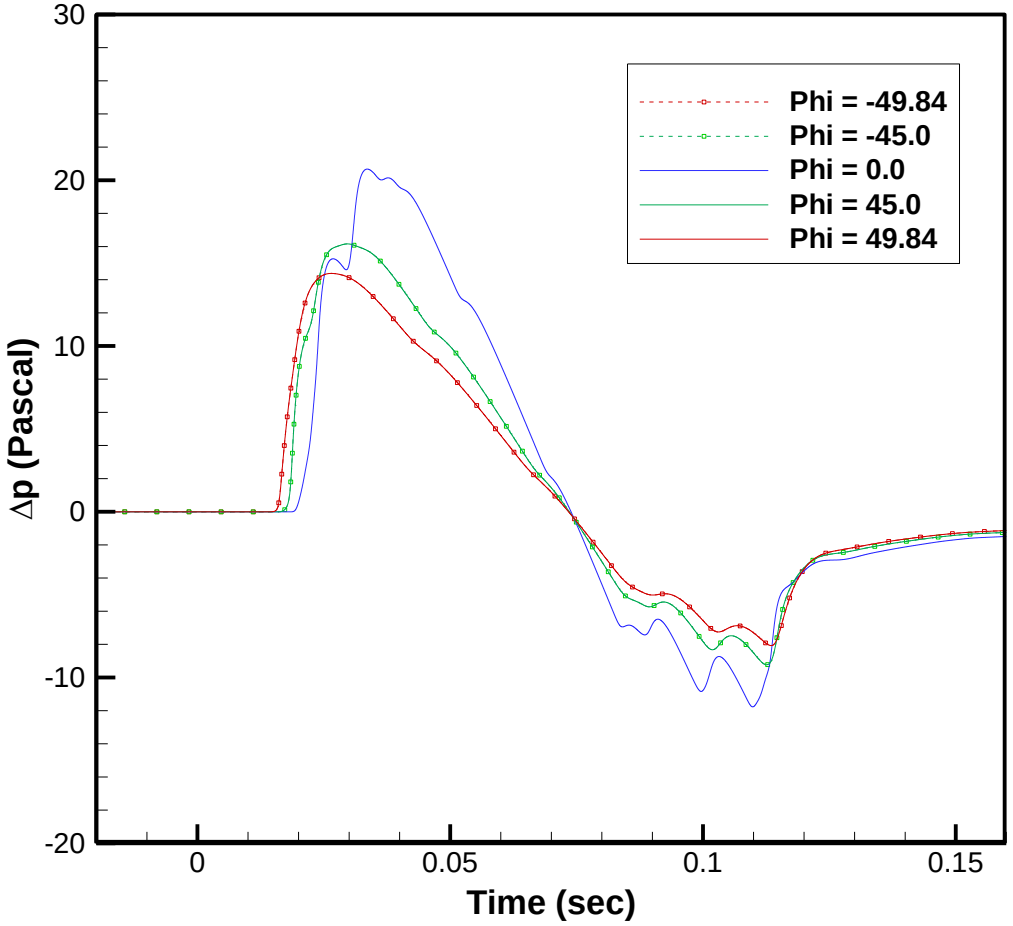
Cut-off & Ground interception

Phi	X (m)	Y (m)
-43.41	32956.87	-25959.24
0.00	15172.91	754.08
46.48	42262.11	38345.91

Case Two (3)

Shaped axi-symmetric body with standard atmosphere: No wind, Standard humidity profile

Ground Signatures



Loudness

Phi	PL	CSEL	ASEL
-49.84	76.16	89.30	61.01
-45.00	78.70	90.21	64.41
0.00	80.58	91.92	66.26
45.00	78.70	90.21	64.41
49.84	76.16	89.30	61.01

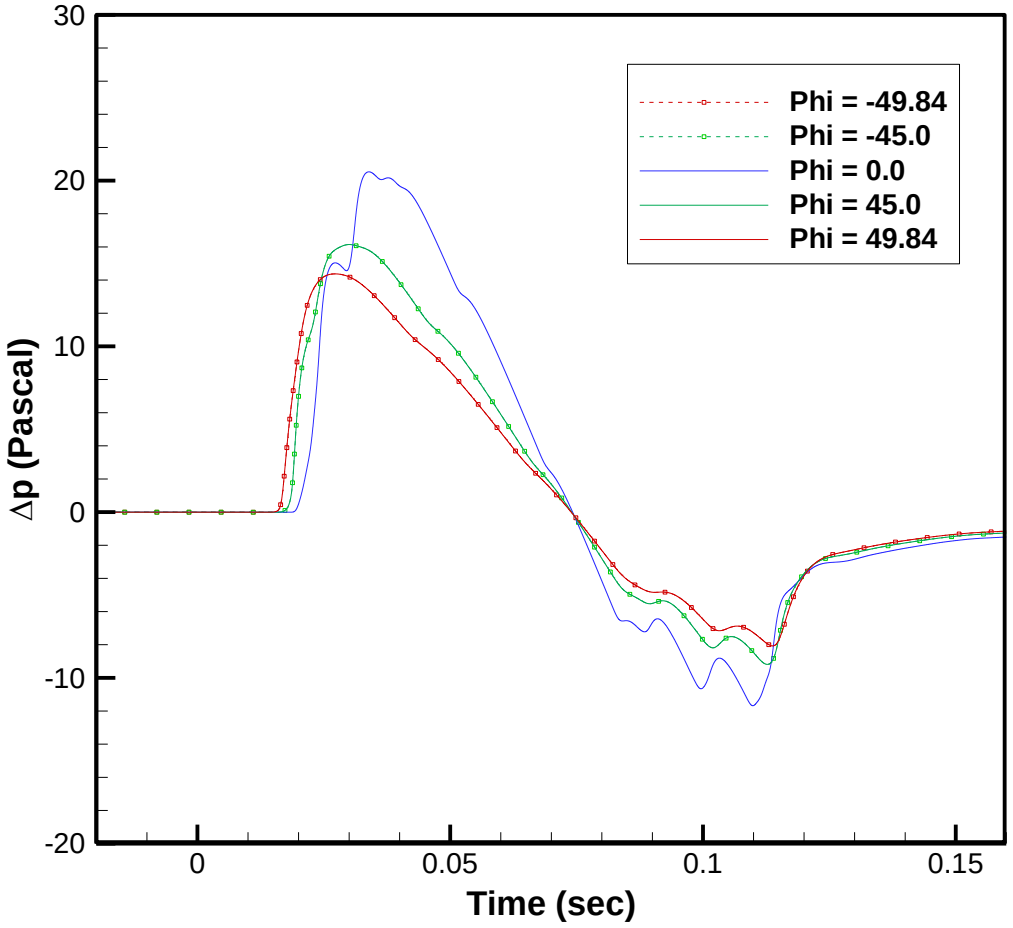
Cut-off & Ground interception

Phi	X (m)	Y (m)
-49.84	31542.72	-30108.91
0.00	13952.16	0.0
49.84	31542.72	30108.91

Case Two (4)

Shaped axi-symmetric body with standard atmosphere: No wind, Constant 70% relative humidity

Ground Signatures



Loudness

Phi	PL	CSEL	ASEL
-49.84	75.70	89.25	60.58
-45.00	77.80	90.10	63.36
0.00	79.76	91.77	65.47
45.00	77.80	90.10	63.36
49.84	75.70	89.25	60.58

Cut-off & Ground interception

Phi	X (m)	Y (m)
-49.84	31542.72	-30108.91
0.00	13952.16	0.0
49.84	31542.72	30108.91

Summary

- Side wind caused un-symmetry in cut-off positions and off-track ground signature in both case one and case two
- Standard atmosphere profile with a standard humidity profile produced very similar ground signatures and loudness as the standard atmosphere profile with a constant 70% relative humidity
- Low humidity in the atmosphere profile leads to more attenuations in the ground signature compared with high humidity in the atmosphere