

## ADJOINT WALL FUNCTIONS: VALIDATION AND APPLICATION TO VEHICLE AERODYNAMICS

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This paper presents the continuous adjoint method for computing the sensitivity derivatives of integral functions used in incompressible aerodynamics; the formulation includes the full differentiation of the Spalart-Allmaras turbulence model, based on wall functions. The development of the continuous adjoint method for this turbulence model with wall functions is presented for the first time; the only previous work on adjoint wall functions was presented by the same group for the  $k-\varepsilon$  model, [1]. Isolated airfoil cases are initially studied, in order to assess the accuracy of the adjoint method which differentiates the turbulence model equations and the law of the wall. Then, the developed method is used to compute drag sensitivity maps of a passenger car.

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### REFERENCES

[1] A.S. ZYMARIS, D.I. PAPADIMITRIOU, K.C. GIANNAKOGLU, C. OTHMER: 'Adjoint Wall Functions: A New Concept for Use in Aerodynamic Shape Optimization', Journal of Computational Physics, Vol. 229, pp. 5228-5245, 2010.