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STATIC AEROELASTIC SCALING WITH NON-SIMILAR FLOW THROUGH MULTIDISCIPLINARY OPTIMIZATION

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Abstract: The use of aeroelastically scaled flying demonstrators is a means of experimentally testing new aircraft concepts while reducing the risks (both economical and operational) of developing, building and testing a full scale aircraft. Traditional aeroelastic scaling of flying models assumes either that flow similarity exists between the two aircraft, or that the difference in the flow conditions has negligible effects. By using this hypothesis, the similarity in the static deflection is achieved by matching the stiffness of the wing while preserving the aerodynamic shape of the wing. However, if this difference is not negligible, the similarity of the static deflection cannot be achieved, in general, only by matching the stiffness, as the pressure distribution changes with the flow conditions. This can be the case, for example, of an airliner flying around Mach 0.85 and its equivalent scaled model flying at a clearly subsonic regime. In this paper, we will focus on the static aeroelastic scaling despite non-negligible differences in the flow compressibility (i.e., Mach number). We will present an approach based on aerostructural analysis and optimization to design both the structure of the wing and its aerodynamic shape to match the static deflection between two aircraft flying at different Mach numbers. The optimization problem consists in minimizing the static deflection of the wing with respect to the structure thicknesses, the wing chord, and the wing twist at several sections along the span. To test this methodology, we will use NASA's CRM wing model flying at Mach 0.85 as the reference aircraft. For that purpose, we use an aeroelastic coupling between a structural solver (an open-source version of Nastran95) and a 3D panel method including compressibility corrections (Panair). All the multidisciplinary analysis and optimizations are assembled using the OpenMDAO framework.