

Aeronautics

# Inflight Global Nonlinear Aerodynamics Modeling and Simulation

Highly accurate and efficient system for developing full  
envelope aerodynamic models for aircraft

NASA Langley Research Center has developed an inflight global nonlinear aerodynamics modeling and simulation system. The technology replaces the normal labor-intensive iterative process of repeated flight tests and combining locally-valid models with a single flight and automatically developed globally-valid model. The technology is highly accurate and efficient for developing global aerodynamic and thrust models for aircraft.

## BENEFITS

- ➔ Provides high accuracy, speed, and efficiency in developing global aerodynamic and thrust models for aircraft. Smooth derivatives can be computed analytically for accurate local linear models for characterizing vehicle stability and control or for control system design.
- ➔ Reduces the normal iterative process of repeated flight tests and labor-intensive analysis on the ground to a single flight and automatically developed global model.
- ➔ Ability to form and update the model in-flight allows application to autonomous flight, as well as pilot notification, providing alerts in real time in dangerous situations, when aircraft response falls outside normal ranges.
- ➔ Full envelope nonlinear simulations can be developed very efficiently and accurately from flight data alone.
- ➔ Numerous test flights have been conducted to develop and validate the method.

technology solution



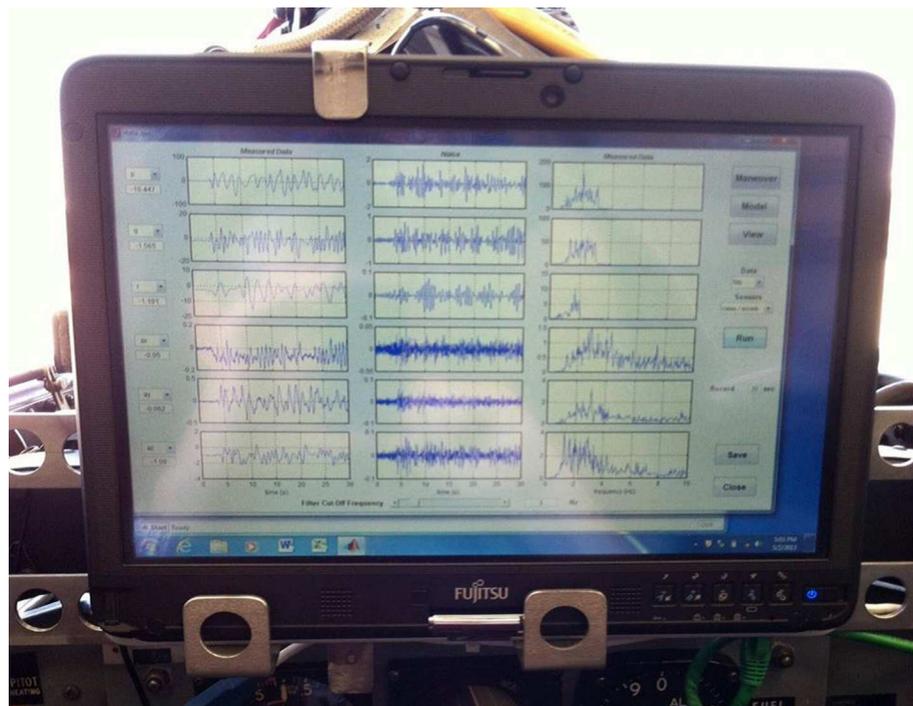
# NASA Technology Transfer Program

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## THE TECHNOLOGY

This technology, the first phase in a suite of technologies designed to control autonomous (unmanned) vehicles, is a method of developing a model that characterizes the aerodynamics and/or thrust of an airplane or spacecraft. The model can be developed and flight validated in as little as a single flight by tracking data relevant to the aircraft response to controls and external forces acting on the vehicle. Current state of the art requires that repeated test flights be made to gather data from different flight conditions, followed by evaluation and analysis on the ground, and repeated over a number of flights, to eventually yield a combined linear, approximate model. This technology, however, can accomplish the development of a validated high-fidelity, global, nonlinear model in as little as a single flight.

The technology is part of the Learn to Fly project to develop real-time models and controllers for autonomous aircraft and spacecraft. For application in piloted aircraft, the system can provide alerts in dangerous conditions, such as tail icing, through detecting abnormal aircraft responses. Potential applications include not only aircraft but also spacecraft or even marine craft, and self-driving cars and trucks.



Real-time analysis computer mounted in test aircraft

## APPLICATIONS

The technology has several potential applications:

- Autonomous aircraft and spacecraft
- Piloted aircraft and spacecraft
- Self-driving cars, trucks, and marine craft

## PUBLICATIONS

Patent Pending

National Aeronautics and Space Administration

### The Technology Gateway

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NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

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