

# CANICE Code Development & Current Status

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AIAA Atmospheric & Space Environment Conference  
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# OUTLINE

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- The CANICE Codes: 2 & 3D
- Capability Development Strategies
  - Desired prediction capabilities
  - User friendly interface or GUI
- Current Validation Strategies
  - Droplet impingement characteristics
  - Ice shapes/mass
  - Anti-icing heat requirements
- Future Validation Needs

# The CANICE Code

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- Developers:

- **Ecole Polytechnique de Montreal** under the Bombardier Aeronautical Chair (Prof. I. Paraschivoiu and his team)
- **Bombardier Aerospace**, Advanced Aerodynamics Department (Dr. Fassi Kafyeke and his team)

- CANICE versions

- **1998: CANICE-2D** – multi-element & time step capability + hot-air jet based anti-icing simulation
- **2006: CANICE-3D** – a panel method based full aircraft ice accretion prediction & anti-icing simulation code

# Capability Development Strategies

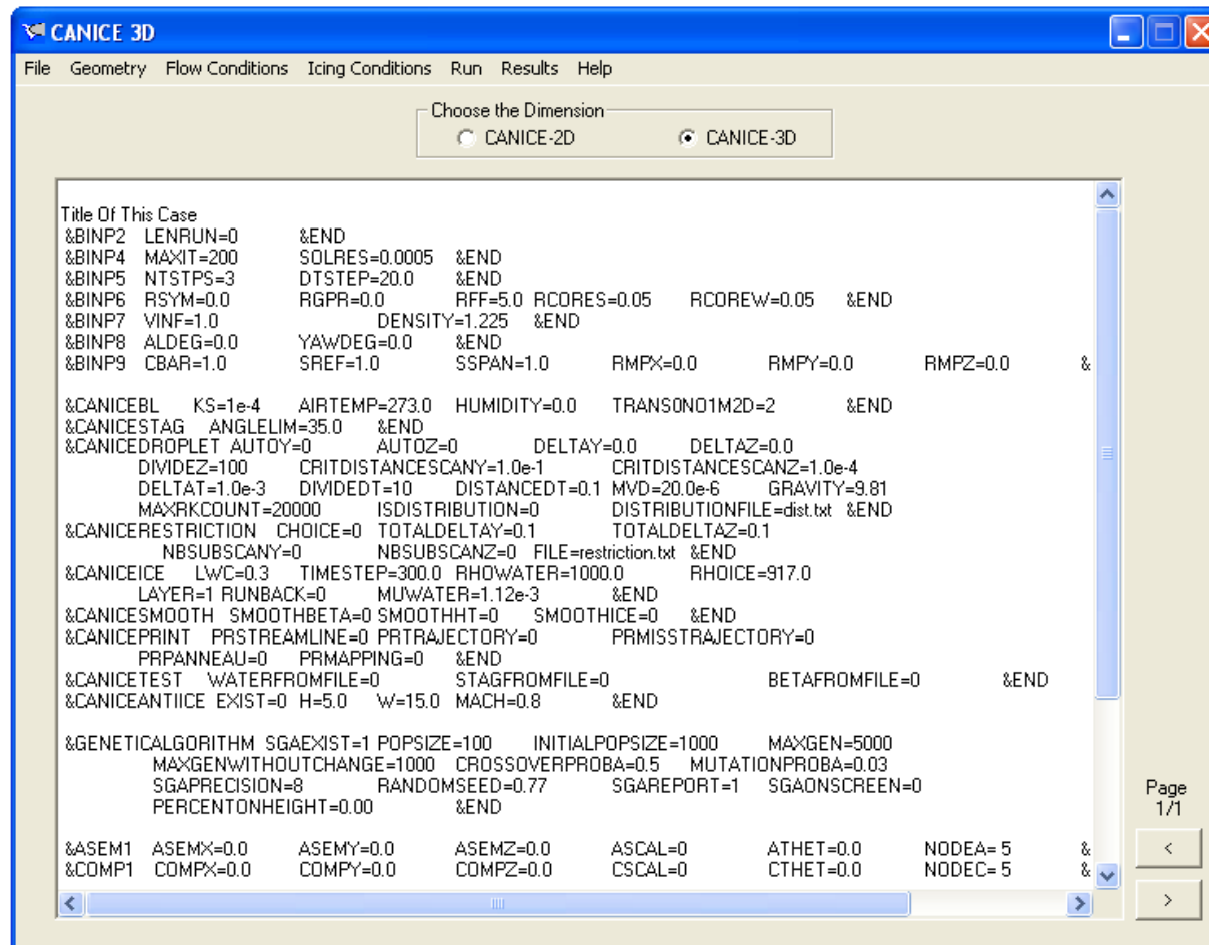
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- Key Development Objectives (**CANICE3D**)
  - **Fast/reliable** – panel method based instead of CFD
  - **Complete aircraft** ice accretion/anti-icing simulation
  - Idea of **numerical correlations** for hot air jet heat transfer to model internal heat distributions using multi-variable/dimensional **Kriging** interpolation
  - User friendly interface or **GUI**
  - Developed for: **Bombardier Aerospace**
  - **Timeline**: 2001-2005

# Capability Development Strategies

- User Friendly GUI



# Current Validation Strategies

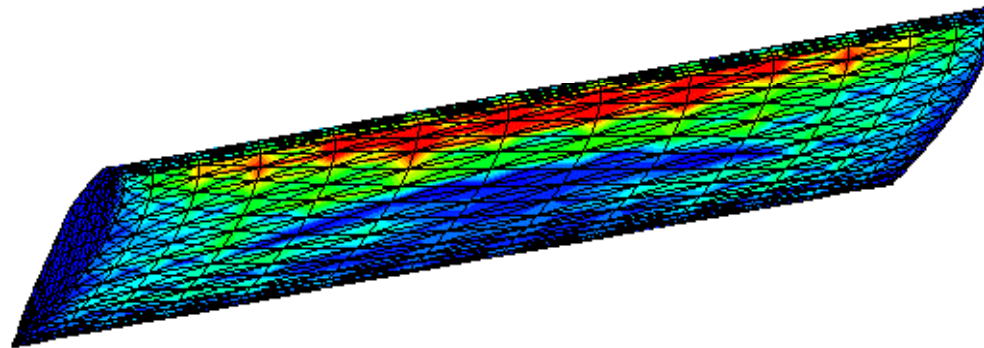
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- Modular approach
- Validation sources
  - NACA reports on impingement characteristics
  - NASA ex-Lewis/Glenn experimental ice shape databases and others found in literature
  - Heat transfer correlations (empirical) for single/multiple slot/hole hot-jet impingement on flat surface
  - Comparison with other icing code predictions
  - NATO RTO, SLD and other validation workshops
  - **Feedback from Bombardier Aerospace**

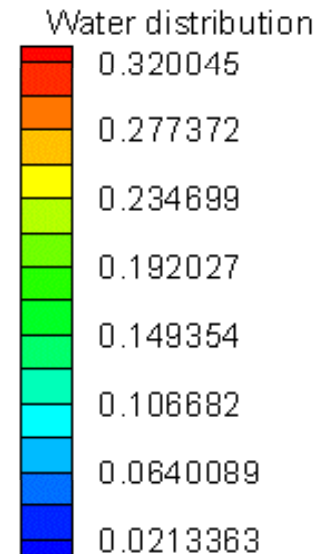
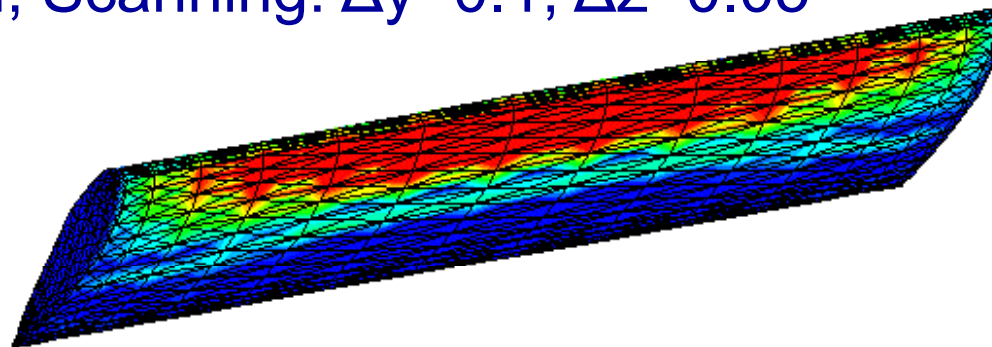
# Current Validation Strategies...

- Droplet Impingement

20  $\mu\text{m}$ , 600 panels,  $\alpha = 8^\circ$ ,  $V_{\text{inf}} = 500 \text{ ft/s}$

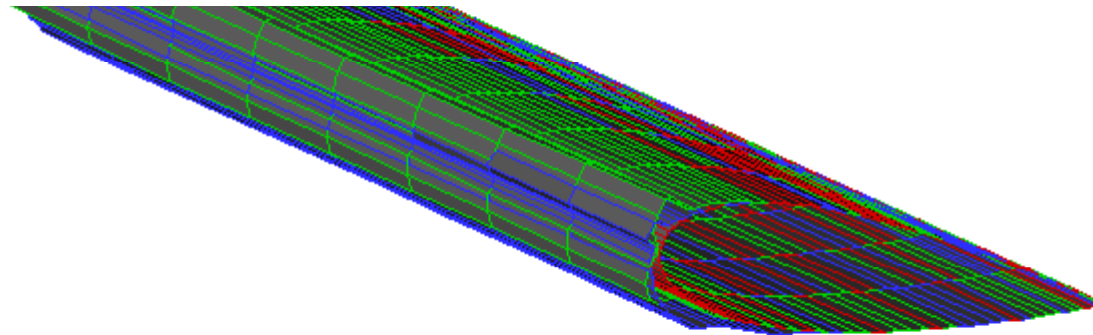
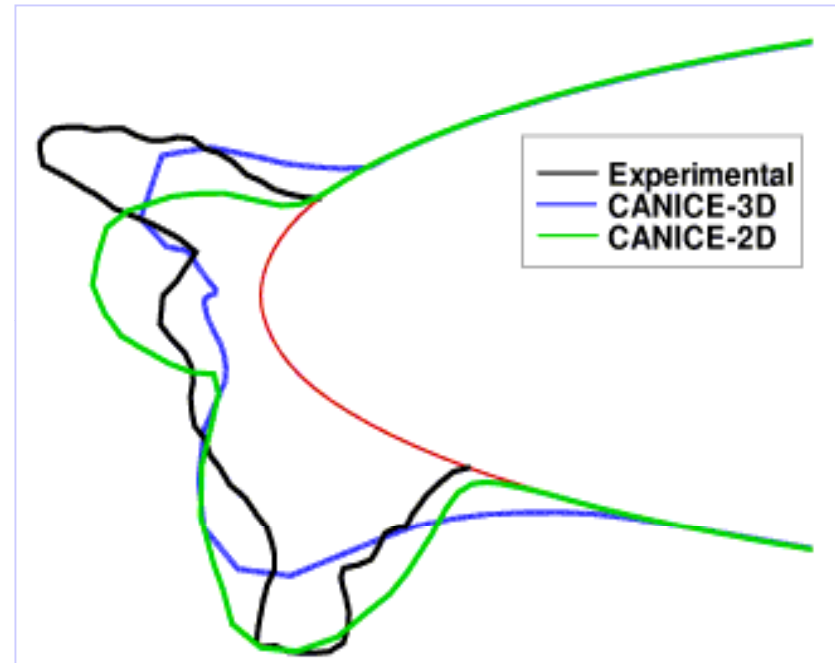
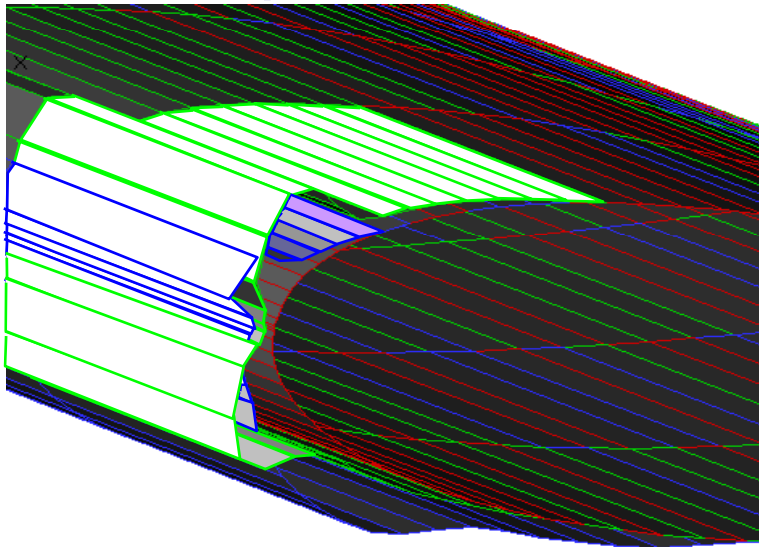


50  $\mu\text{m}$ , Scanning:  $\Delta y=0.1$ ,  $\Delta z=0.05$



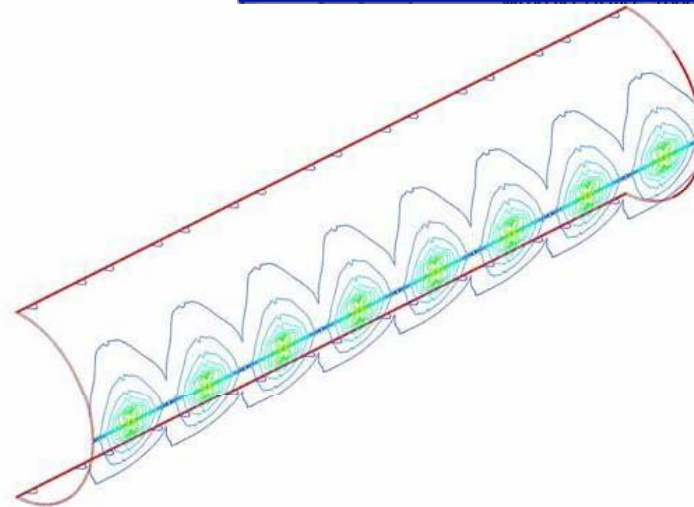
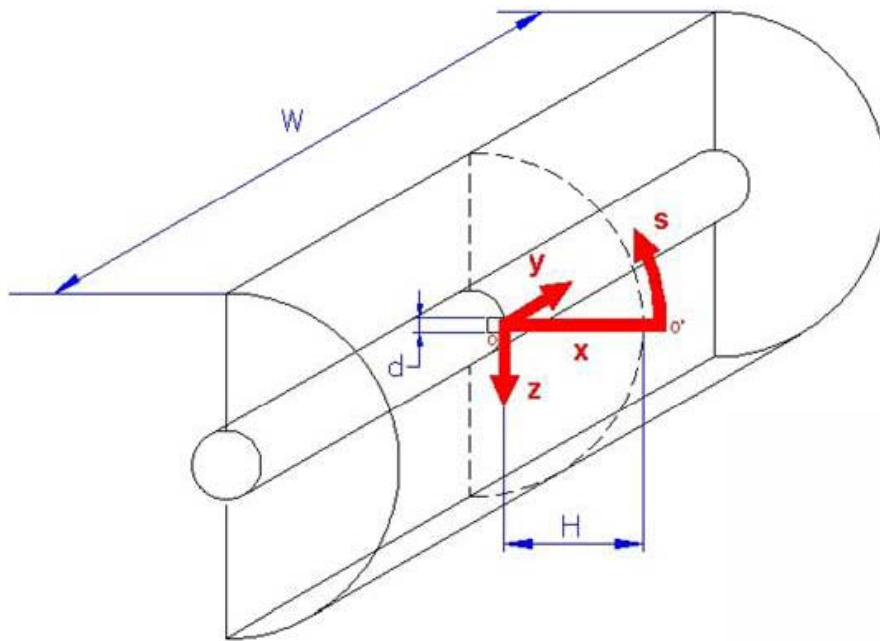
# Current Validation Strategies...

- Ice shapes



# Current Validation Strategies

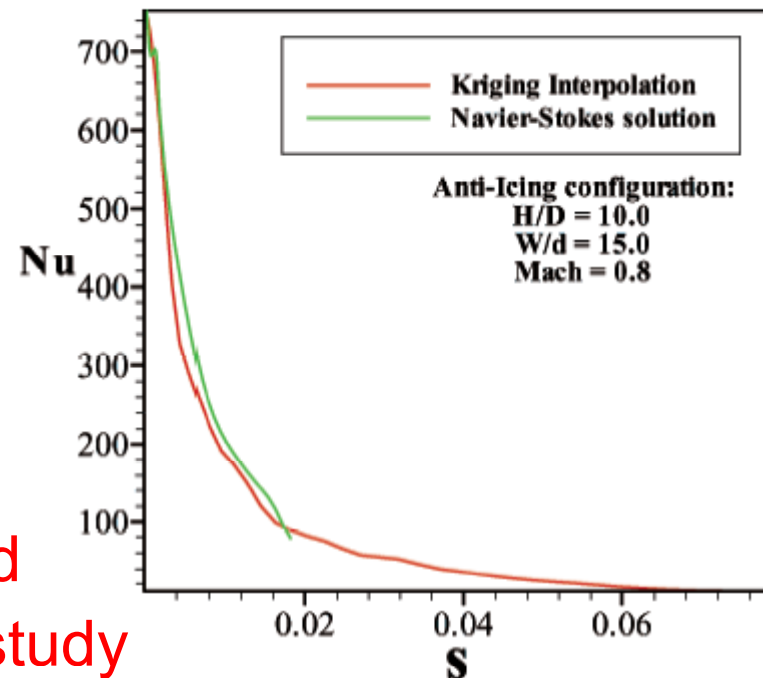
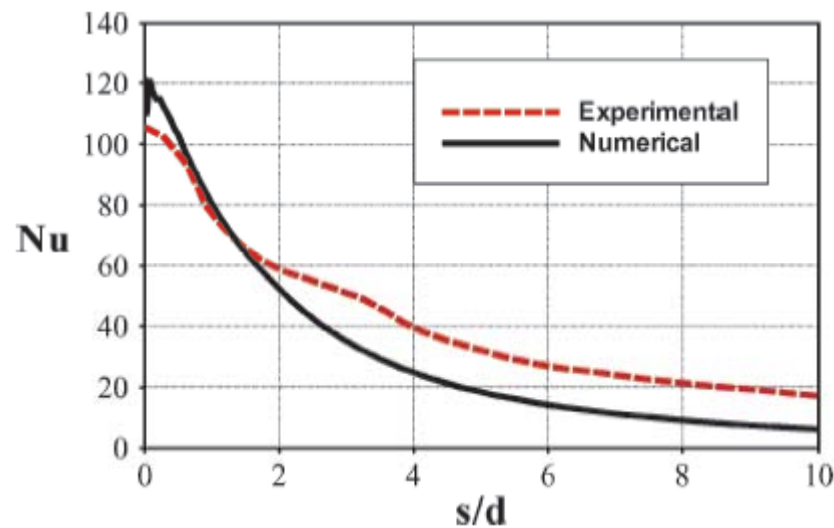
- Hot-Air Jet Heat Transfer



# Current Validation Strategies

- Hot-Air Jet Heat Transfer

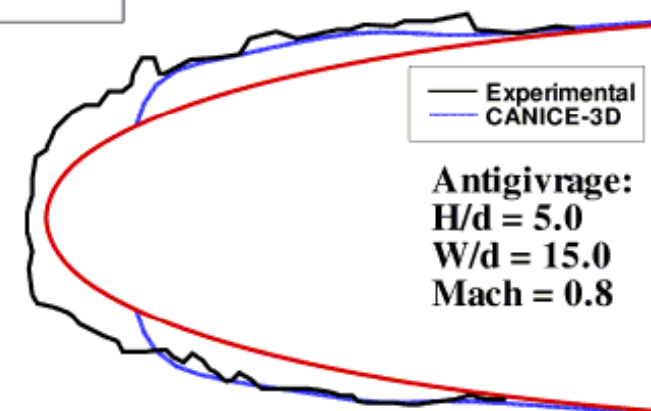
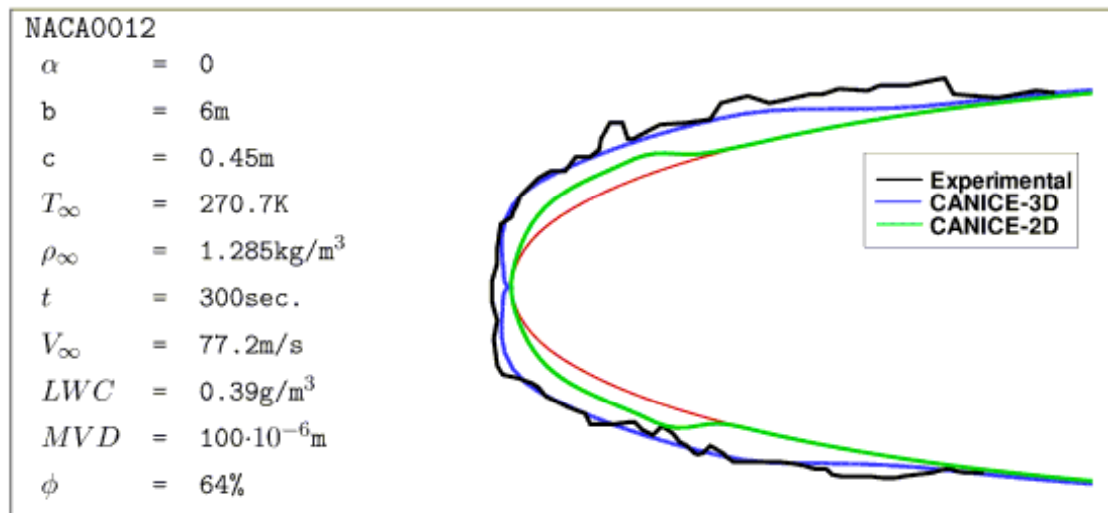
- Correlations – Martin, Advances in HT, 13, 1977
- Kriging – Ecole Polytechnique group, 2003



- Flat plate correlations used to validate in-house CFD study

# Current Validation Strategies...

- Anti-icing simulation



# Future Validation Needs

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- Droplet impingement data and experimental ice shapes on 3D geometries – fuselage, nacelle, wings with sweep, etc.
- To avoid ambiguity, clean surface pressure distribution data be provided along with above
- More accurate models for splashing and shedding phenomena
- Hot-air jet impingement heat transfer (experimental) data on curved surfaces