

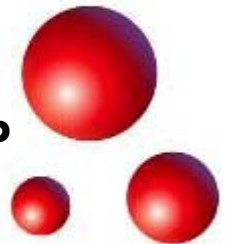
# 3D Icing Codes – A code developer's view

Richard Moser, Roger Gent  
AeroTex UK

Presentation to AIRA 3D Ice Accretion Code  
Workshop, 4<sup>th</sup> August, 2010, Toronto, Canada

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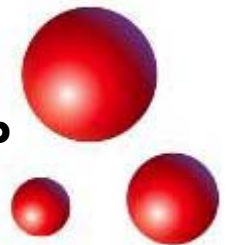
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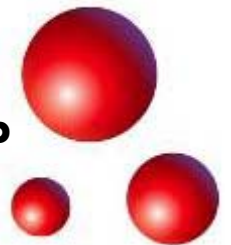
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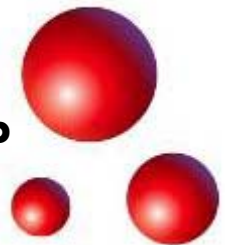
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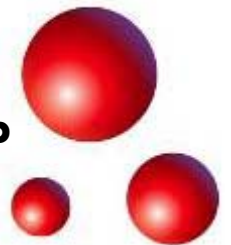
# 3D Code Verification

- **Choose ‘Verification’ rather than ‘Validation’**
  - **Code may not work on another application / flow regime**
- **Verification mainly performed against 2D data sets**
- **2D slice, or 2.5D method**
  - **Partly due to lack of available 3D data**
  - **Partly due to high computational overhead**



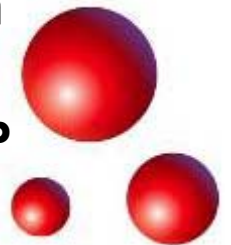
# Sources of Verification Data

- **Open source**
  - **Very limited**
  - **Mostly from NASA / NASA Contractors**
    - **Plenty of catch data available (e.g. Papadakis)**
    - **Ice shape data is more limited**
    - **Wing ice shape data tend to show 2D profiles!**
    - **No improvement over 2D methods!**
    - **High sweep / lobster tail → cannot predict!**
    - **Shortage of ice shape data for air intakes and complex 3D geometries**
      - **Precisely the components most 3D codes are currently being applied to**
      - **Usually heated/IPS so no ice!**



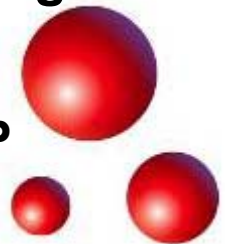
# Sources of Verification Data

- **Proprietary Data Sources**
  - Reasonable amount of data around
  - Cannot publish / or use by another developer!
  - **AeroTex to acquire 3D ECS scoop air inlet data**
    - late 2010, via EU grant funded project
    - Proprietary, so no external release expected
    - Normally heated / IPS installed
      - Perform a few unheated runs to check tunnel calibration and for design method validation



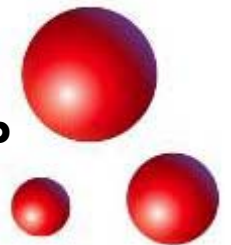
# Sources of Verification Data

- **Proprietary Data Sources**
  - **Some sources of data now probably 'lost'**
    - Custodians changed employment, data deleted
    - e.g. UK MOD data
      - UAV Airframe (Phoenix)
      - Merlin Helicopter engine bay cooling inlet
  - **Other sources sometimes possible**
    - Many Aerospace companies have data which they occasionally supply to developers to 'prove' their 3D code works (prior to licence)
    - Possible additional source – but no use during code 'development' phase



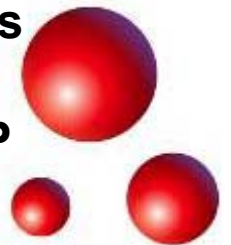
# Issues with Verification Data

- **Need high fidelity data**
  - **Issues often arise with questions over tunnel results**
  - **Incompleteness of published test conditions and results**
    - e.g. Tunnel corrections applied
  - **Priority for test is often NOT ice shape**
    - **If it is an IPS evaluation test**
    - **Limited number of ice shape test points**



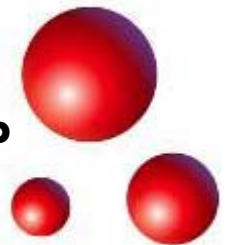
# Code Comparison Exercise

- **An excellent idea!**
  - **Natural extension from RTO 2000 exercise on 2D codes**
  - **Will allow**
    - **‘Minimum functionality’ to be established**
    - **‘Best practice’ to be identified**
  - **AeroTex keen to support inter-code comparison exercise**
  - **However, depends on timing/schedule**
    - **ATX Code may only be early development standard!**
      - **Hence, only able to perform ‘sub-set’ of cases**



# Code Comparison Exercise

- **Main Issue is likely to be lack of cases**
  - **Blind test unlikely for many codes?**
    - **Due to lack of a large database to select from?**
    - **Some codes may already be 'tuned' to that data**
      - **Issue noted in 2D comparison exercise**
      - **FAA encourage validation against a 'wide' data base of cases**
- **Ideally, cases need to be selected to cover**
  - **Catch, catch limits and concentration factor**
  - **Ice profile**
  - **Thermal IPS (Anti-iced surface)**
    - **Hot-Air and/or Electrothermal**
  - **Wing, inlet, external mounted component**

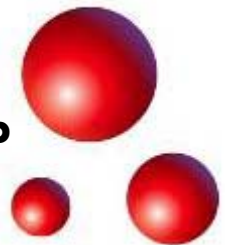


# Code Comparison Exercise

- **AeroTex is willing to support AIRA in establishing a workshop (and in taking part!)**

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Thank You

Questions?

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