Use of an Uninhabited Aircraft System (UAS) for Atmospheric Observations During an Acoustic Flight Test

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Jennifer Fowler, NASA Langley Research Center

Devin Boyle, NASA Glenn Research Center

Jacob Revesz, NASA Langley Research Center

Jordan Cluts, NASA Glenn Research Center

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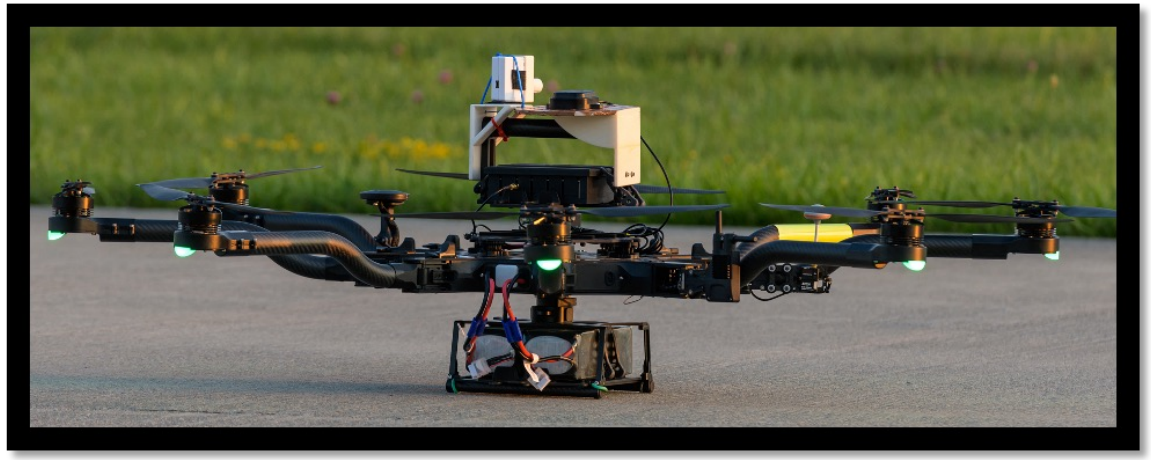
Background – The Learjet Acoustic Flight Test

- Calspan Learjet 25D
- CJ610-8A Turbojet-Powered
- Niagara Falls International Airport
- Full-scale jet noise flyover test for comparison with scaled nozzles in rig
- Acoustics data relies on corrections using atmospheric conditions

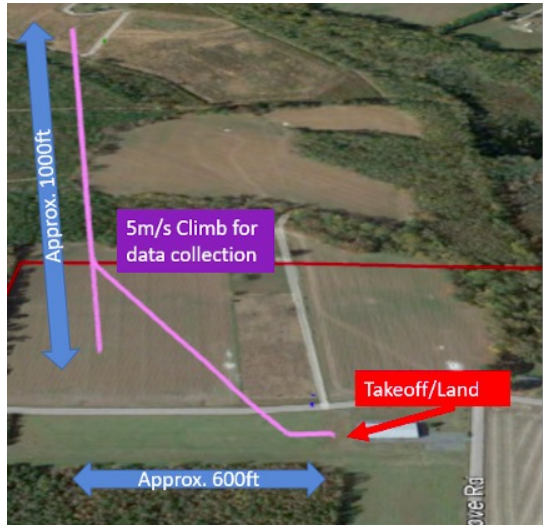
The Measurement Platform

- Small Uninhabited Aircraft System
- Freefly Alta 8 Pro
- 1.27 m (4.17 ft) Diameter
- Payload – 20 lb
- Endurance – 0.0015 Fortnights (30 min)
- Vertical Speed >1,000 fpm

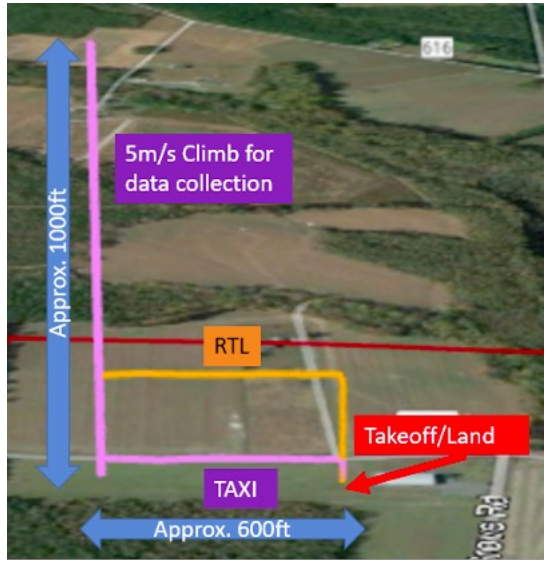


sUAS Platform - Continued

- Flight profile considerations
  - Pilot visibility
  - Total sortie duration
  - Sensor ventilation
  - Airspace/airport limitations



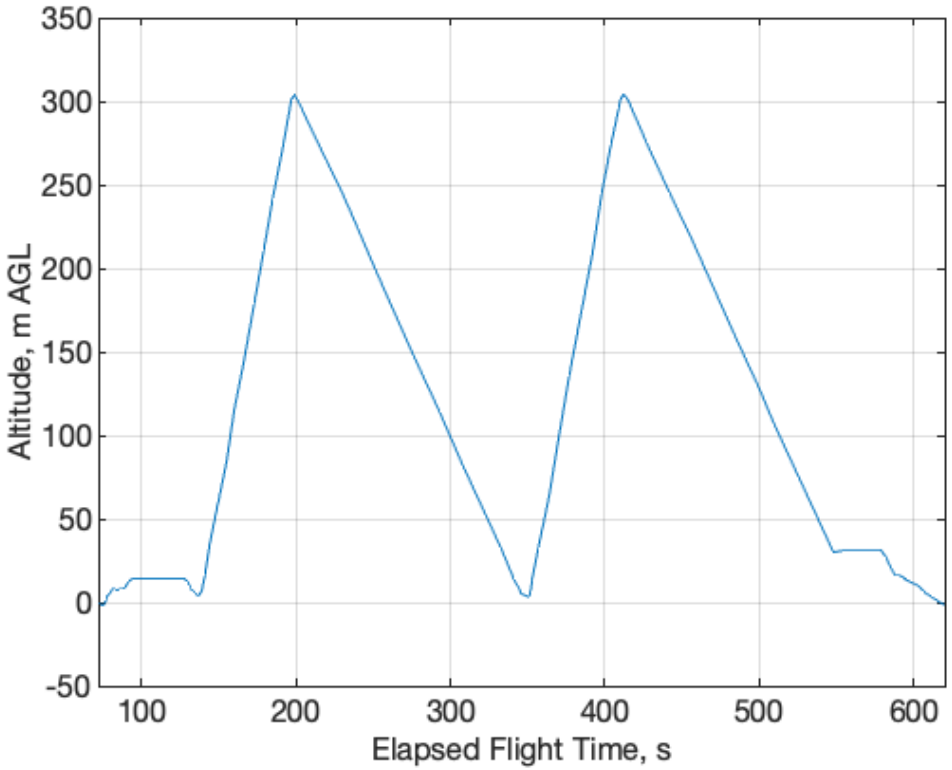
Profile #1



Profile #2

Profile #2 As Flown

- First ascent flown to ventilate iMet-XQ2's thermistor
- Second ascent used for data acquisition

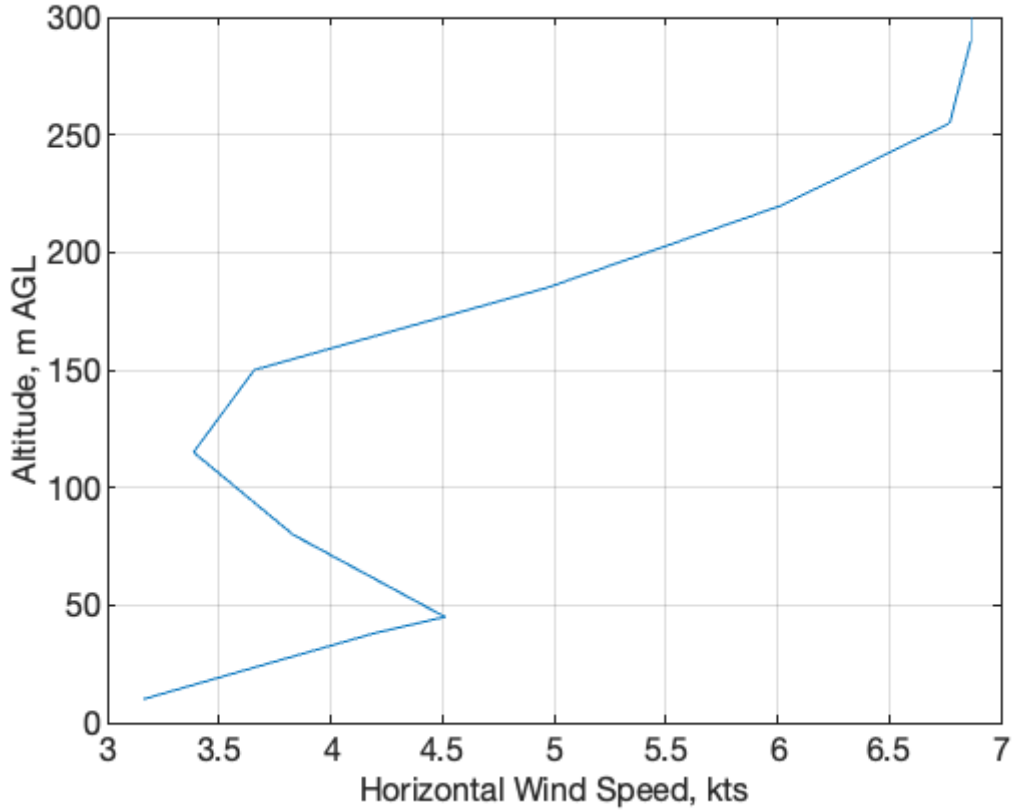


iMet-XQ2 Meteorological Instrumentation

- Temperature, T: thermistor (±0.3°C accuracy)
- Relative humidity, RH: capacitive (±5% RH)
- Pressure, P: piezoresistive (±1.5 mbar)
- Altitude determination:
  - On-board GPS receiver (12 m)
  - Reference ground-based receiver
  - Post-Processed Kinematics (PPK)
  - Precise Positioning
- Wind…no

Light Detection and Ranging (LiDAR)

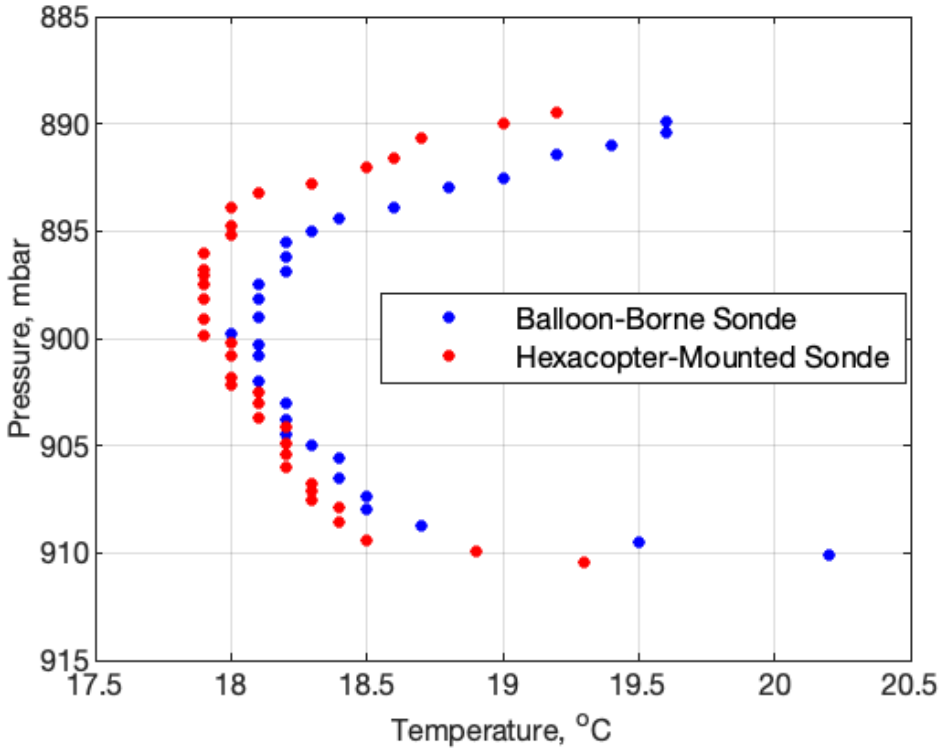
- ZX Lidars ZX-300
- Wind direction and magnitude
- Vertical profile up to 300 m at 10 discrete altitudes above unit
- Near-real-time wind vector observations enabled go/no-go decisions during testing

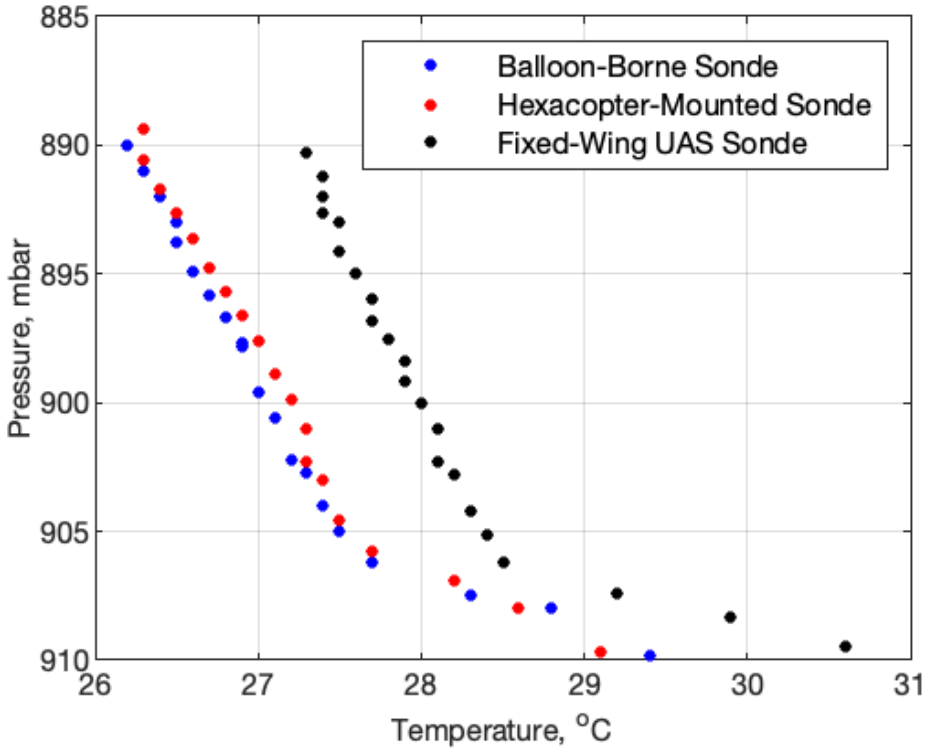


Comparison of Meteorological Instruments

- Radiosonde is current state-of-the-art
  - Attached to balloon in free ascent
  - Enables wind vector in addition to T, RH, P
  - Most expensive and prohibitive (cost, airspace/surface, frequency)
- Radiosonde tethered to anchored balloon often used
  - Recoverable, but disables wind vector observations
- iMet-XQ2 instrumentation similar to radiosonde

Temperature Performance Comparison

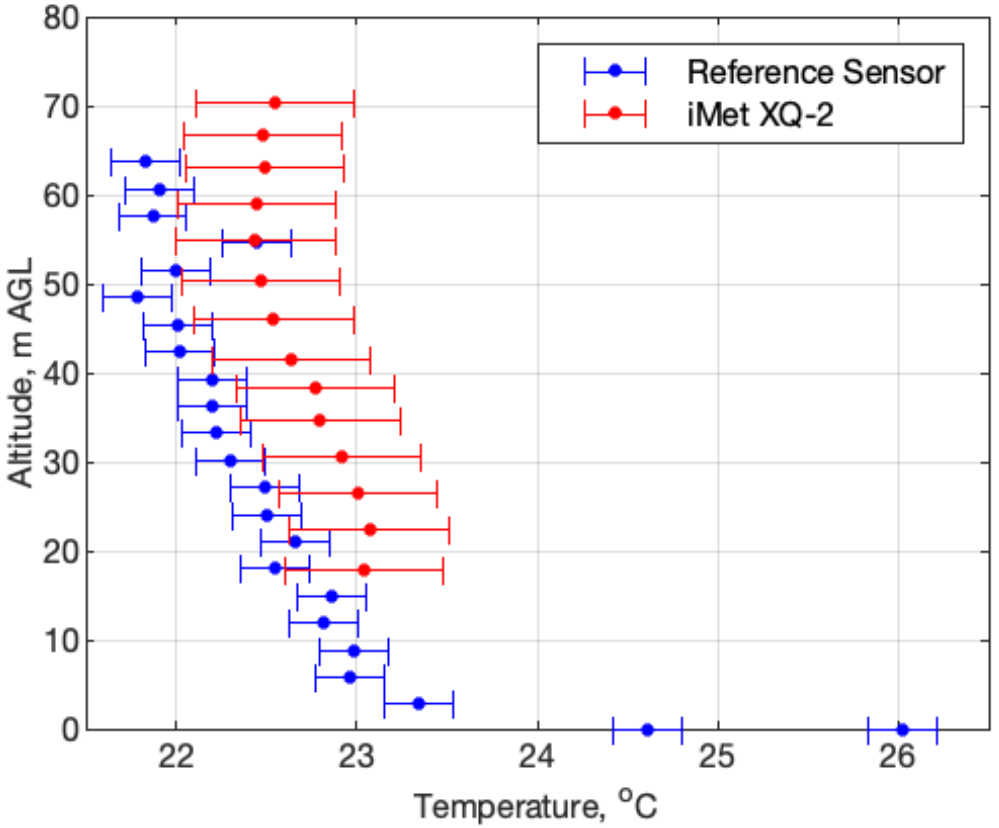




- Balloon-borne instrument (sonde)
- iMet flown with rotary-wing sUAS platform
- iMet flown on fixed-wing UAS

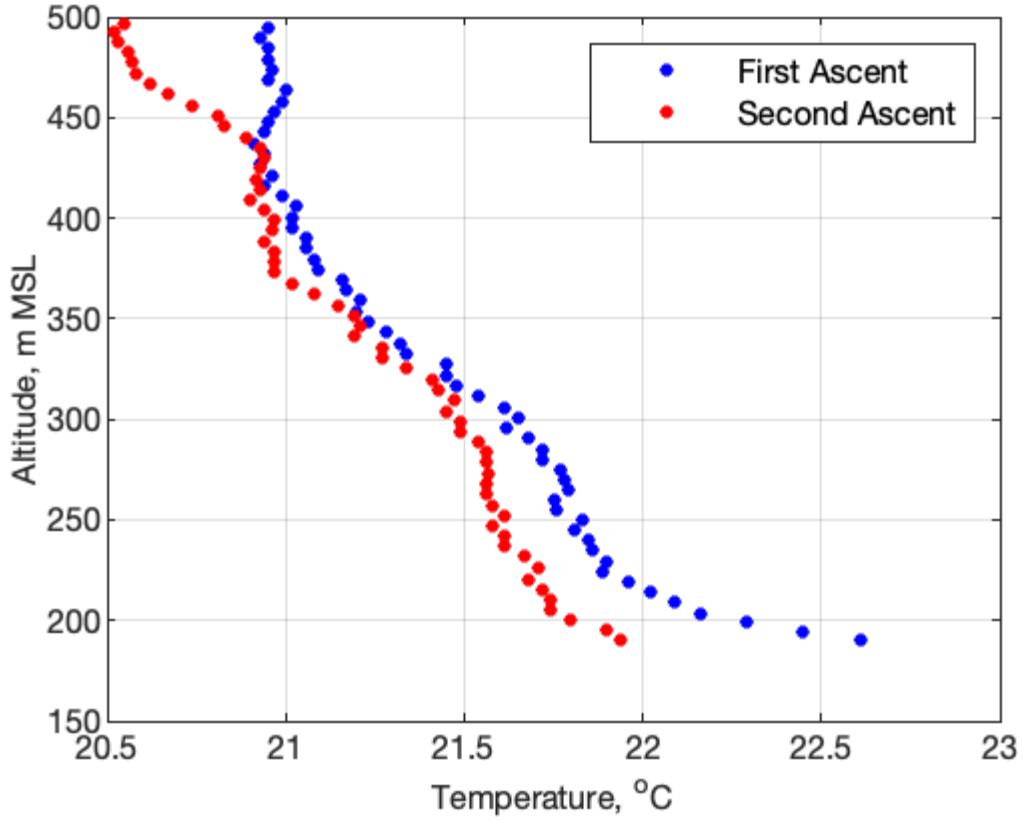
iMet Comparison with Fixed Ref Temp Profile

- Reference thermocouples on fixed string
- Alta 8 flown with iMet-XQ2 on board
  - Single flight (not plotted)
  - Multiple consecutive flights for sensor ventilation
  - XQ2 performed within manufacturer's specifications



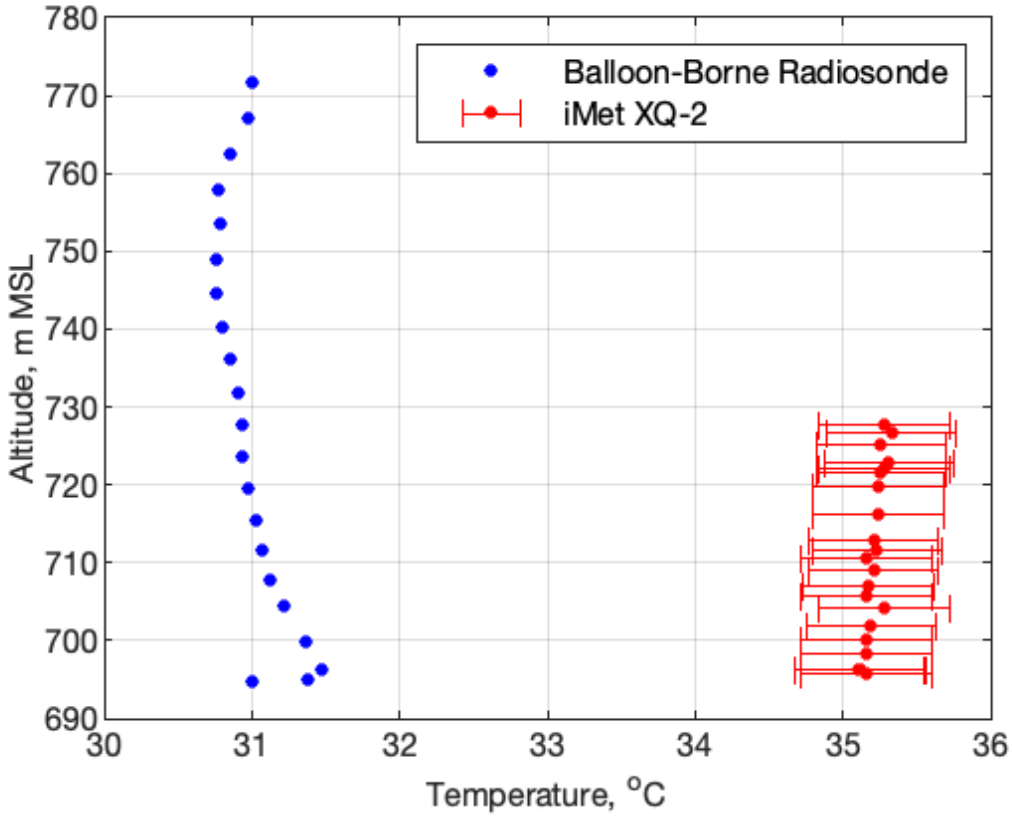
iMet Flight Data During Learjet Test

- Example profile flown during Learjet test
- Modest differences in temperature due in part to the ventilation of XQ2's thermistor on first ascent
- Radiosonde typically starts recording data at 50 m (164 ft)



Further Comparisons – sUAS and Balloon

- Additional comparison flight with balloon-borne radiosonde (Vaisala RS41-SGP)
- Alta 8 flown with iMet-XQ2 on board



Summary

- Atmospheric observations made in the vertical column up to 304.8 m (1,000 ft) AGL
- Performance of UAS-mounted instrumentation comparable to that of balloon-borne radiosonde
- Configuration enabled operation in restrictive environment
- Enabled atmospheric corrections of acoustic data
- Use of UAS-borne meteorological instrumentation ongoing research topic

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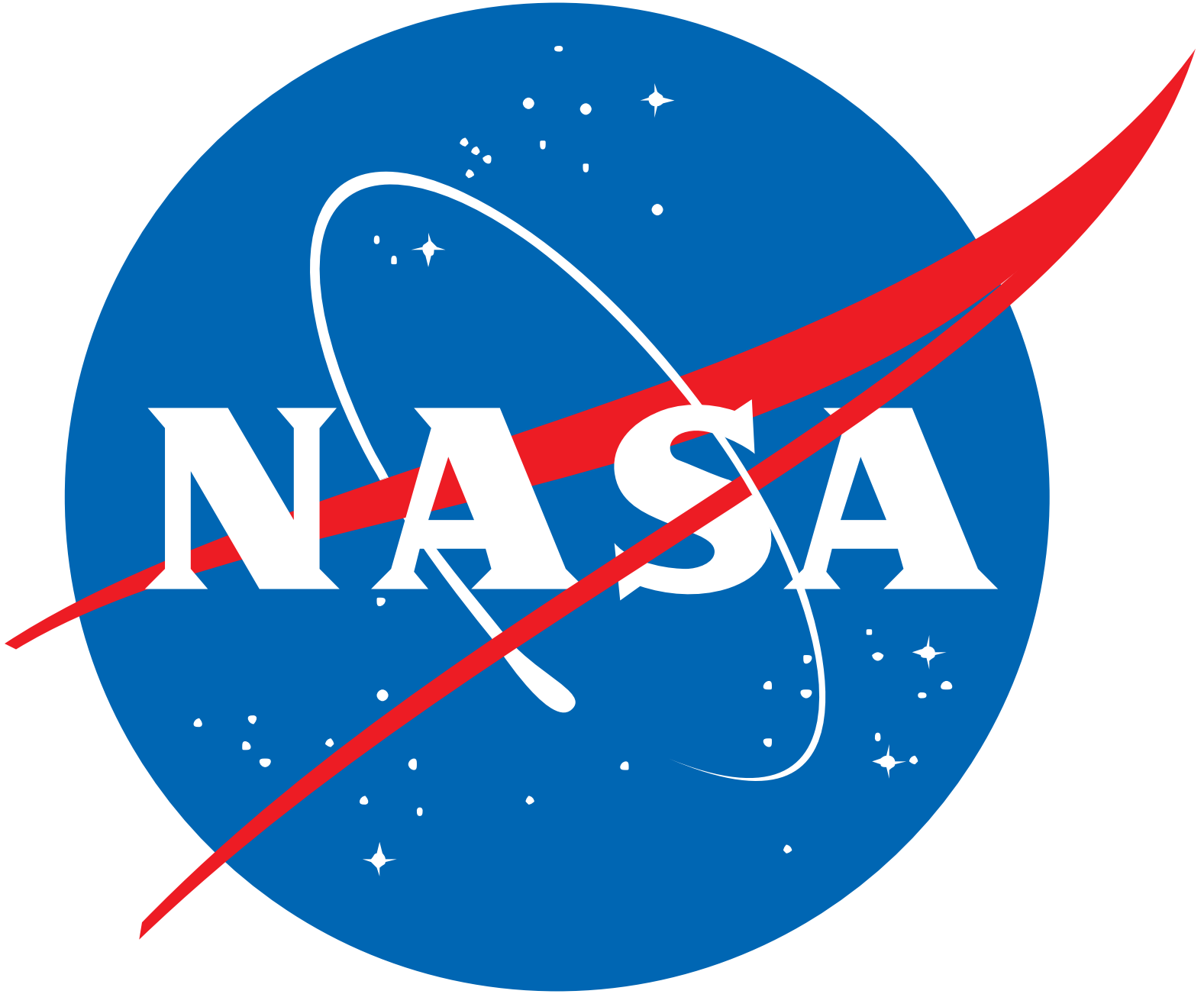
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