Real-Time, In-Situ Detection of Dust Devils using Pressure Sensors

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Dust Devils

As seen by Spirit's Navcam, 8/21/05

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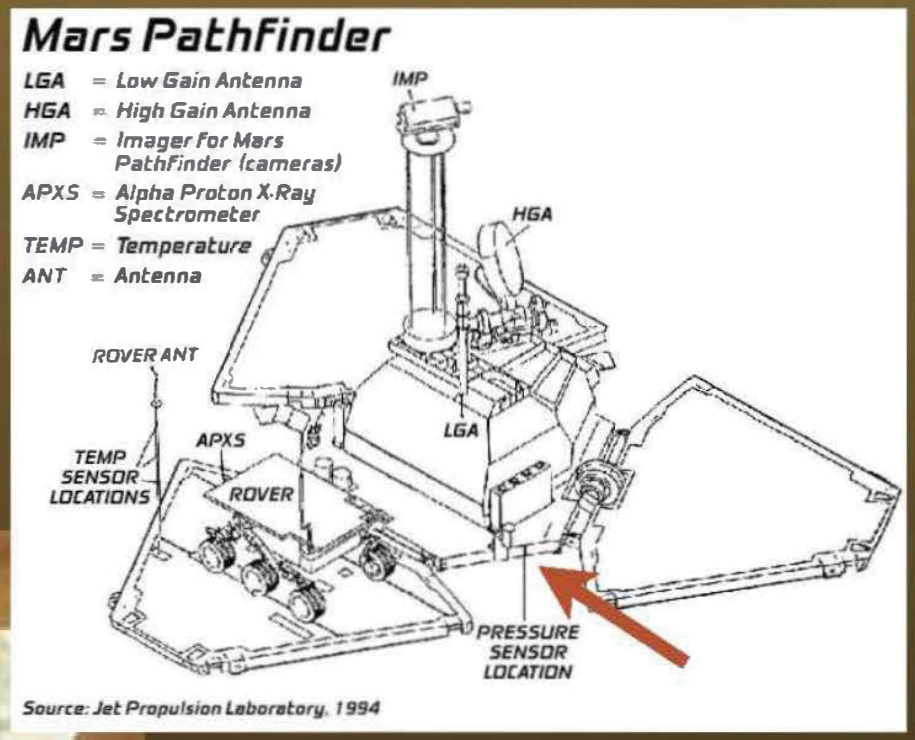
Another way to capture dust devils:

Detect the pressure drop as they pass over the rover or lander.

The Mars Pathfinder Lander had an atmospheric pressure sensor as part of its meteorology package.

Pressure Sensor on MPF

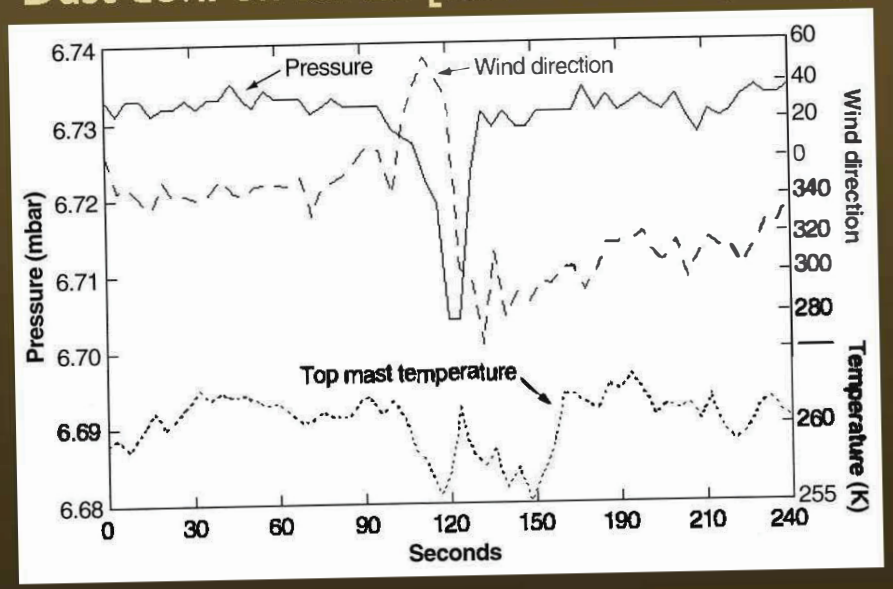
- 1-m inlet tube mounted on base petal
- Max sensitivity of 0.25 μbar



MPF Pressure Data Collection

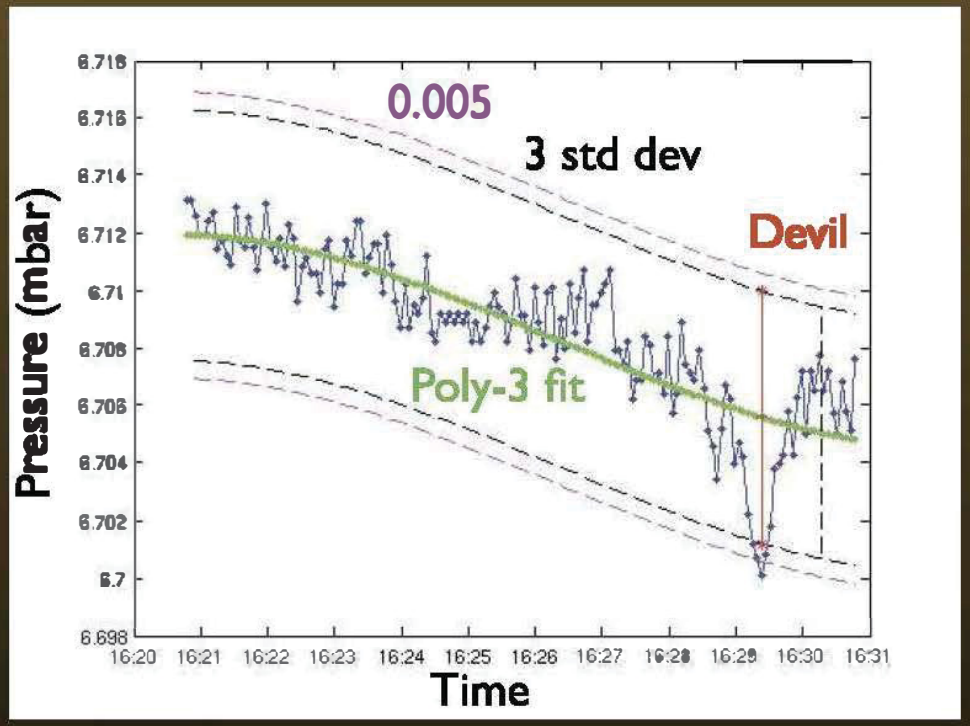
- 30-sol primary mission:
  - Each sol: ~150 minutes (0.25 Hz; some 1-Hz)
  - Sol 25: 0.25-Hz all day ("presidential MET")
- Extended mission (sols 31-83):
  - Four more presidential METs
- Dust devil:
  - Local, short-duration drop in pressure
  - Change in wind direction
  - Sol 62: temporary 1.5% drop in solar power

Dust devil on sol 25 [Schofield et al., 1997]



Ground-Based (Offline) Detection

- [Murphy and Nelli, 2002]
  1. Divide observations into 15-minute windows
  2. Fit 3rd-degree polynomal to data
  3. Identify deviations from mean signal
     - >3 standard deviations and >= 0.005 mbar drop



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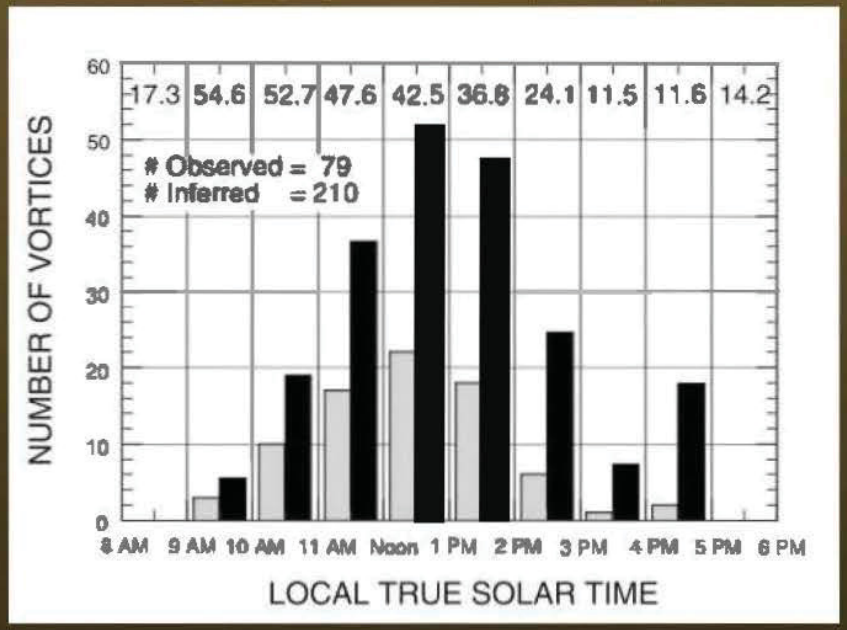
Ground-Based (Offline) Detection

- Found 125 events
  - 79 dust devils (37% false detections)
  - Others mostly caused by data gaps, etc.
- 210 expected...
  - 131 unobserved

Observed (grey) and inferred (black) dust devils [Murphy and Nelli, 2002]



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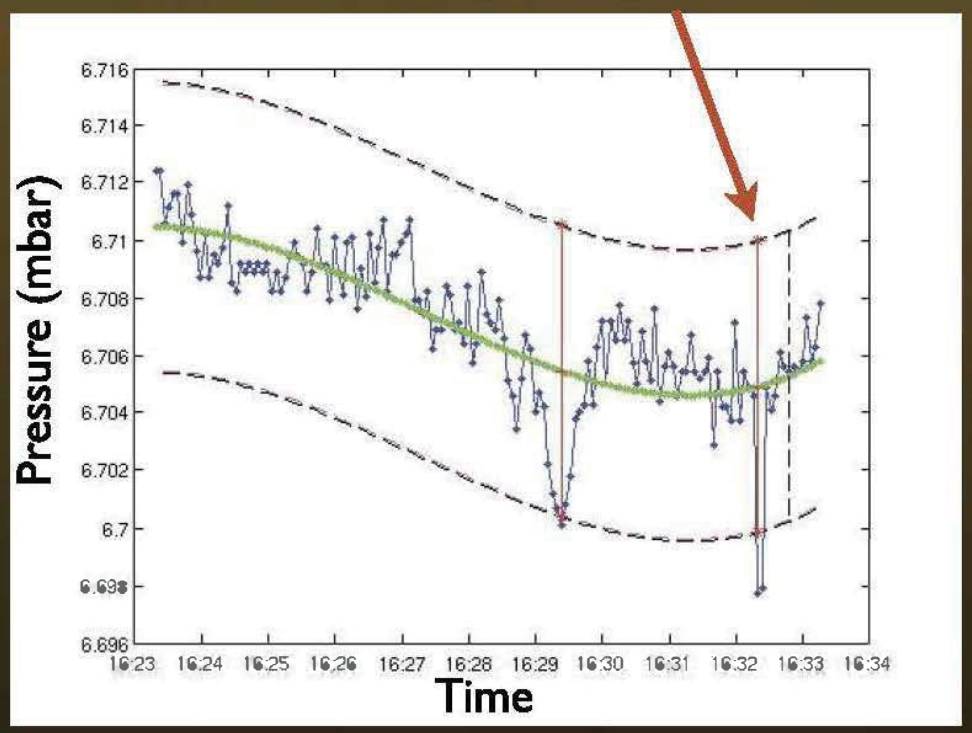
In-Situ (Online) Detection

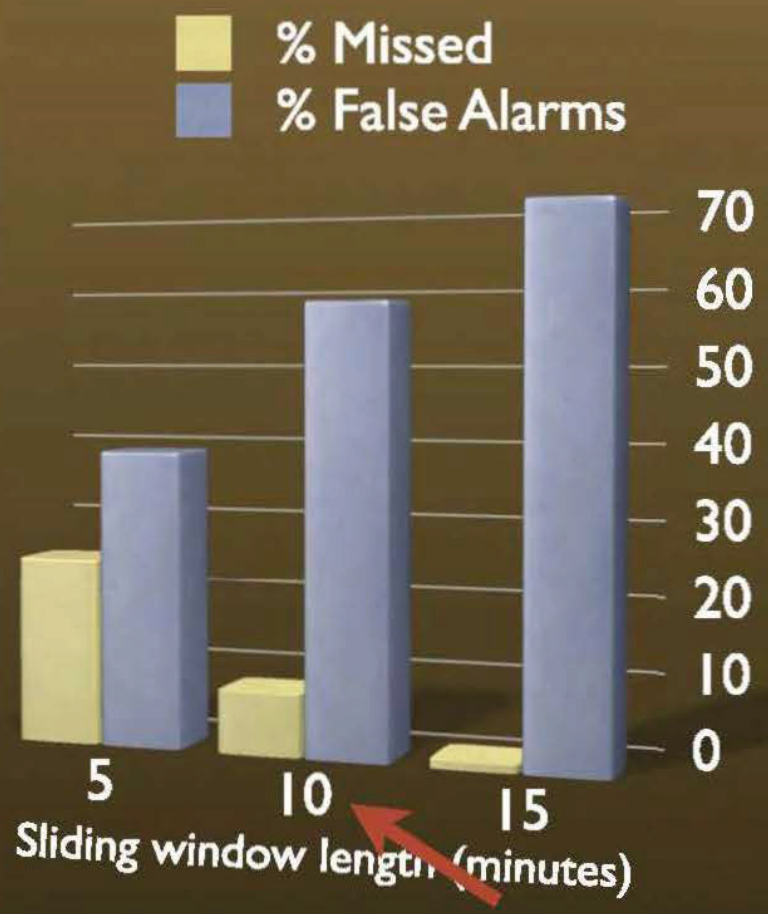
- 15-minute <u>sliding</u> window (jump by 30 seconds)
- Detect devils as they happen

Second Dust Devil at 25:10:35:26.7



Performance

- Variables
  - Length of sliding window
  - Linear, poly-2, poly-3 fit
- Best results: poly-3
  - 8% missed, 57% false alarms
  - M&N: 37% false alarms
    - No continuity between windows
- Longer window = fewer missed
- Longer window = more spurious



Significance

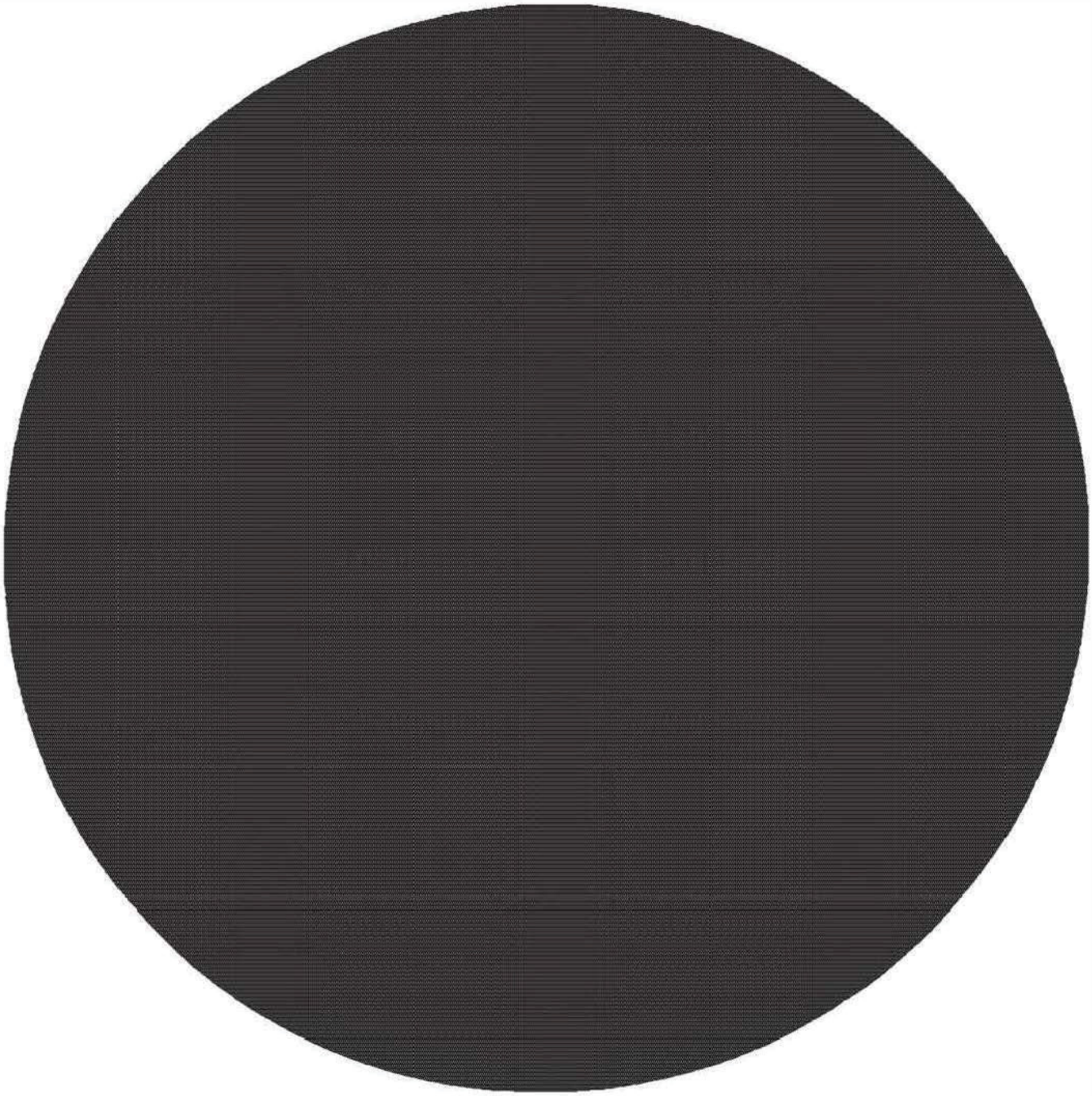
- 79 MPF events, with a 15-minute context window, only took 12% of bandwidth that was used
  - M&N: 131 unobserved dust devils (210 total)

- Same bandwidth: up to 600 dust devil detections
  - Given accuracy results, our method would return appx. 450-500 detections

- Feasible: constant monitoring, save and downlink only the dust devil detections

Conclusions

- What does this mean for the future?
  - Onboard monitoring of dust devils is feasible
  - Detections could be used to trigger image collection for confirmation
    - No simultaneous pressure and camera observations on MPF

- Thank you: Interplanetary Network Directorate, Mars Technology Program
- Questions?

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