JPL Scout's Imminent Impactor Warning Performance:

2022 EB5 and 2022 WJ1 (and 2023 CX1)

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The Imminent Impact Warning Problem

Different from the long-term warning problem

- Rapid response is crucial at every stage of the process
- Requires monitoring of MPC's NEO Confirmation Page
- JPL's Scout monitoring system
  - Deployed in 2017
  - Uses Systematic Ranging (Farnocchia et al. 2015)
  - Run times typically 5-10 minutes
  - ***Scout Impact Rating posted to WWW immediately***
- NEOScan, deployed by SpaceDys in 2018, uses similar algorithm

Scout Impact Ratings

	Description	I.P.	Frequency	
1	small	>0.01%	~1/day	"Low-level"
2	modest	>0.1%	~2/week	
3	moderate	>1%	~2/month	"High-level"
4	elevated	>10%	~1/month	

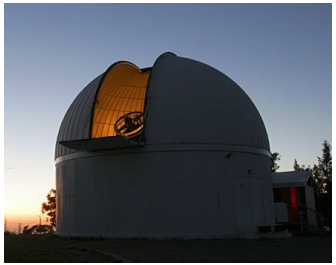
Actual predicted impacts: ~1/year (five-year mean)

Imminent Impact Warning

What could possibly go wrong?

OBS

- Telescope
  - ↳ Image Processing
    - ↳ MPC Submission



Imminent Impact Warning

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MPC
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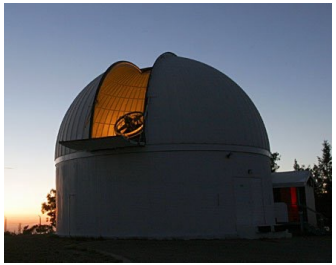

Imminent Impact Warning

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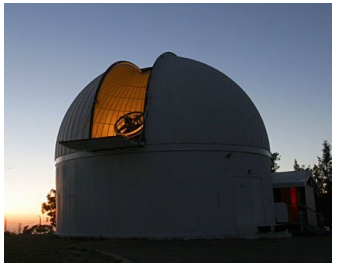

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JPL
- ↳ JPL Scout Analysis
  - ↳ Scout Alert Issued

IAU Minor Planet Center

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CNEOS

Imminent Impact Warning

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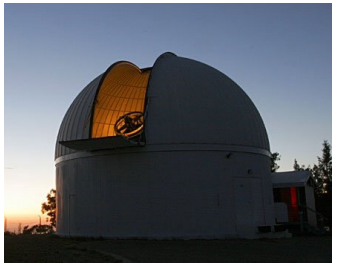

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Back to Telescope ↵

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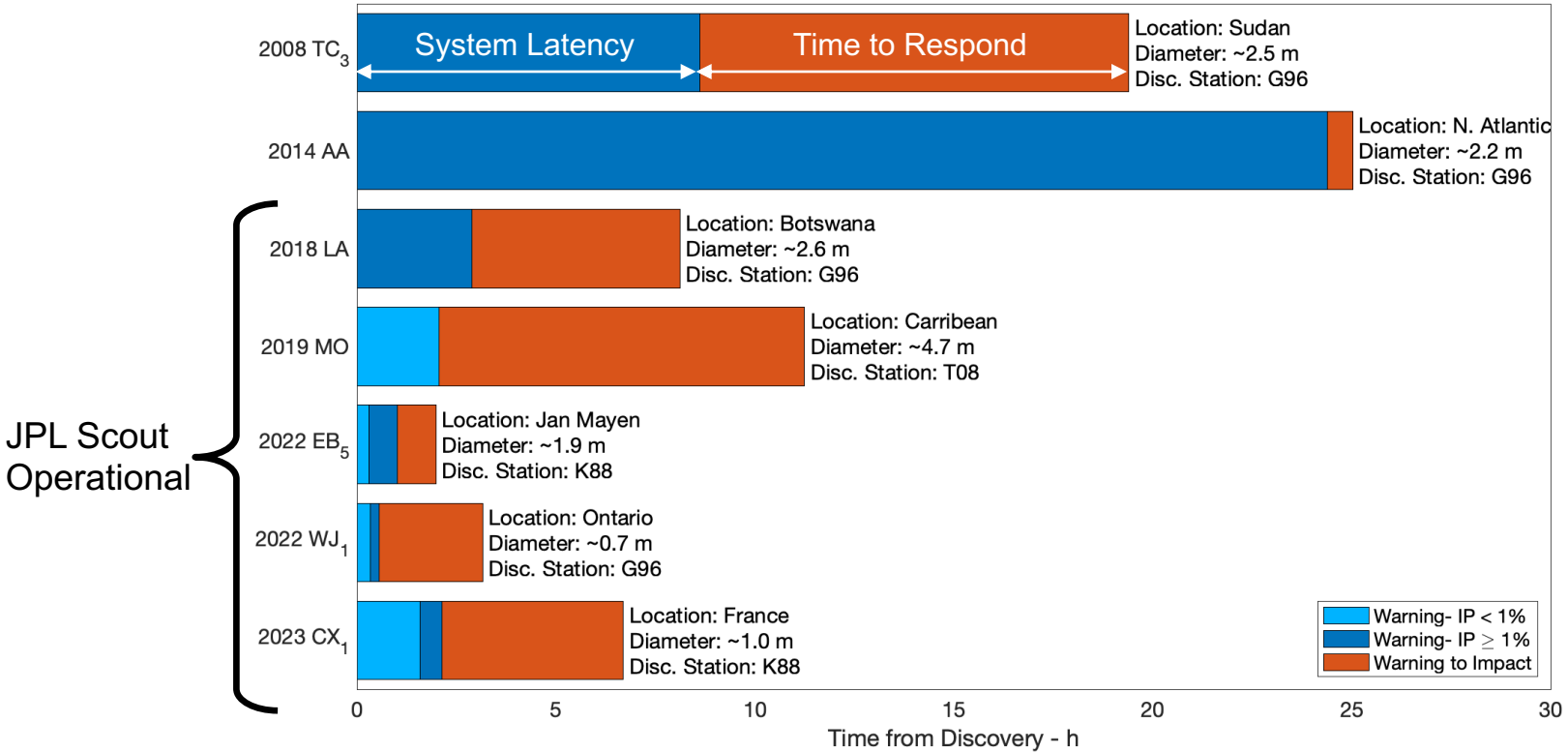
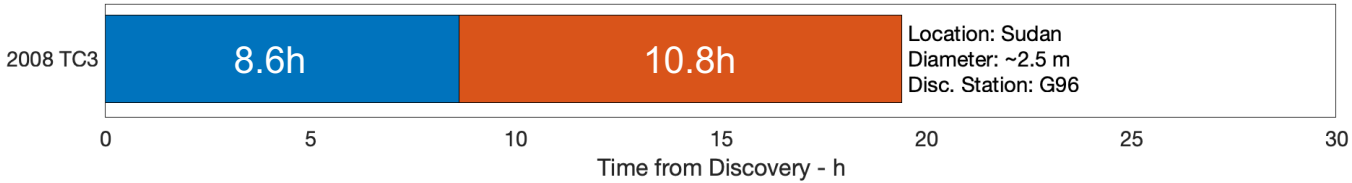
CNEOS

How has the system been working over the years?



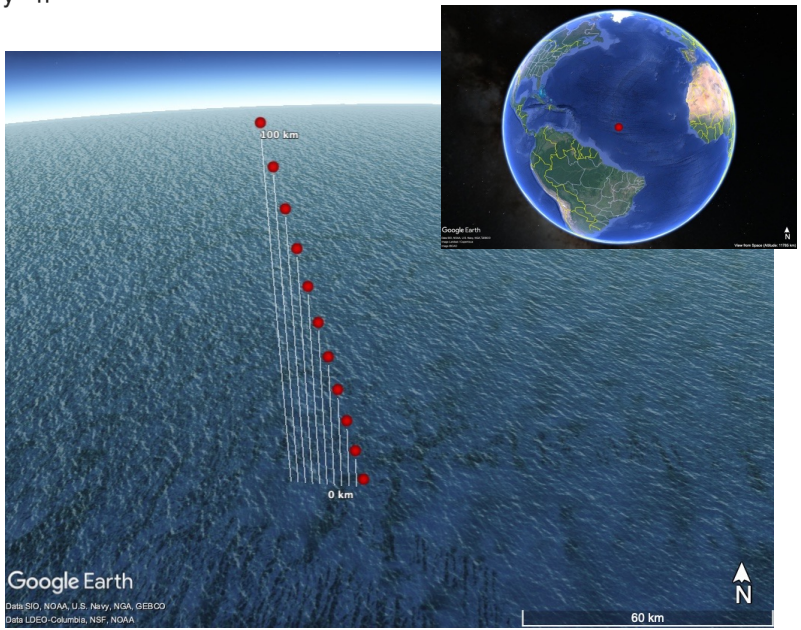
2008 TC_3 – CSS, Mt. Lemmon 1.5m



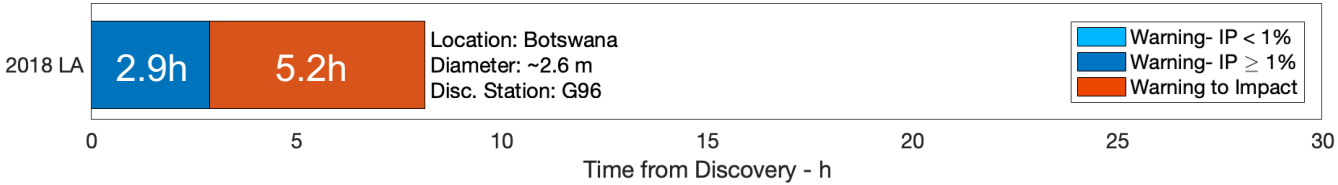
- No automated systems in place
- Warning to JPL came in the form of a morning phone call from the MPC
- First public notice came as an MPEC issued by the MPC
- ~11 hours of time for tracking and characterization
- Meteorites recovered

2014 AA – CSS, Mt. Lemmon 1.5m

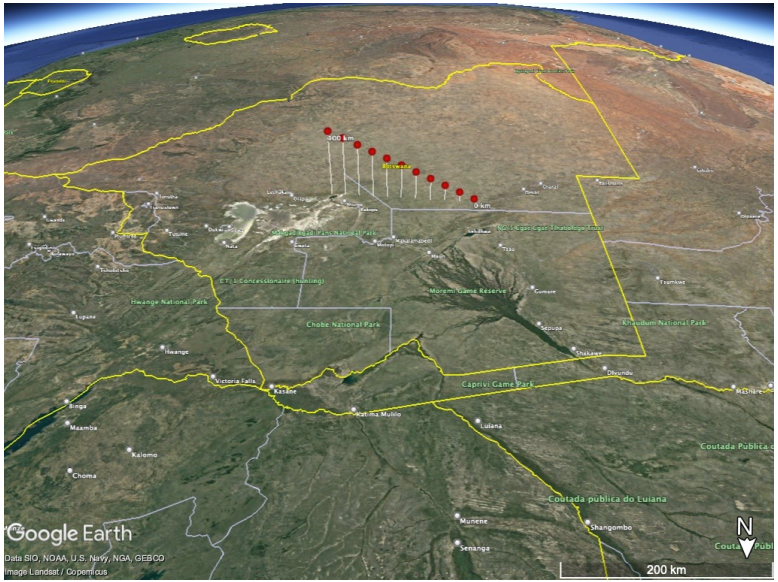
- No automated systems in place
- For full discussion see Farnocchia et al. 2016



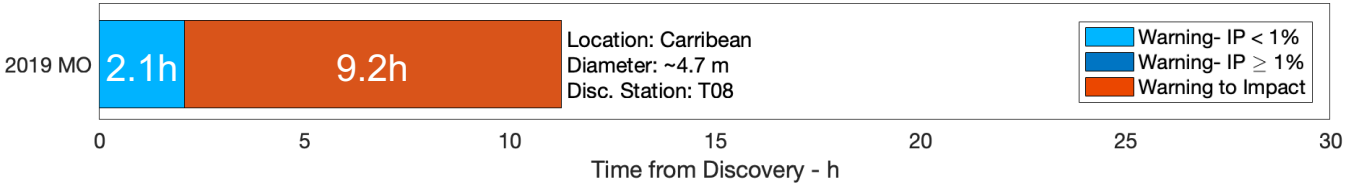
2018 LA – CSS, Mt. Lemmon 1.5m



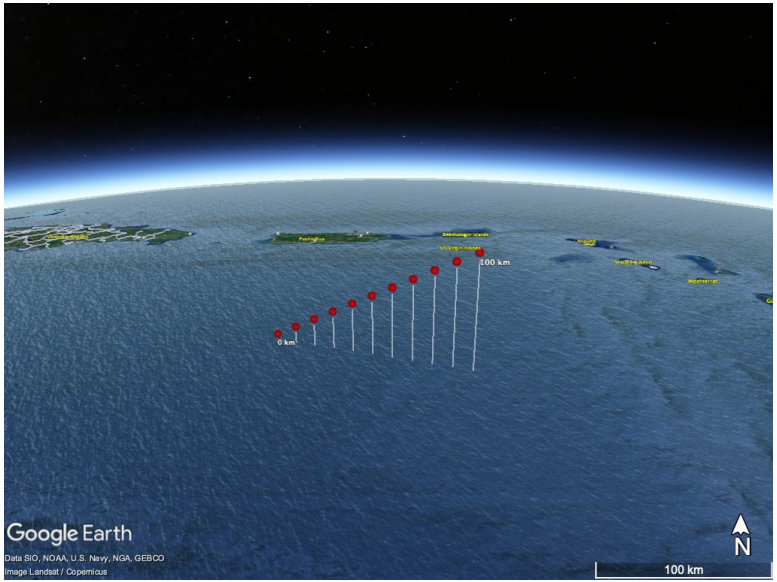
- First case after Scout was operational
- Meteorites recovered



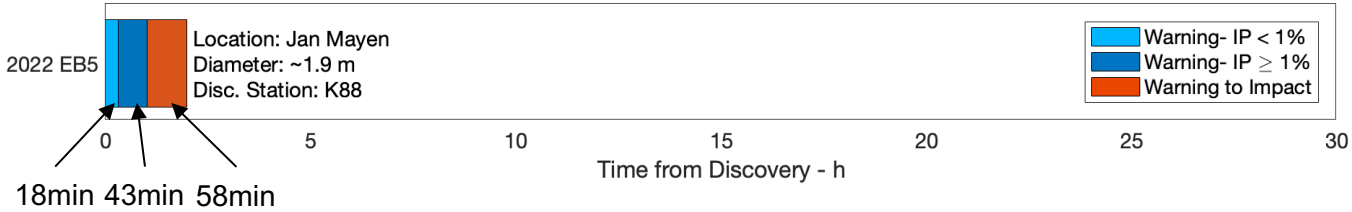
2019 MO – ATLAS Mauna Loa 0.5m



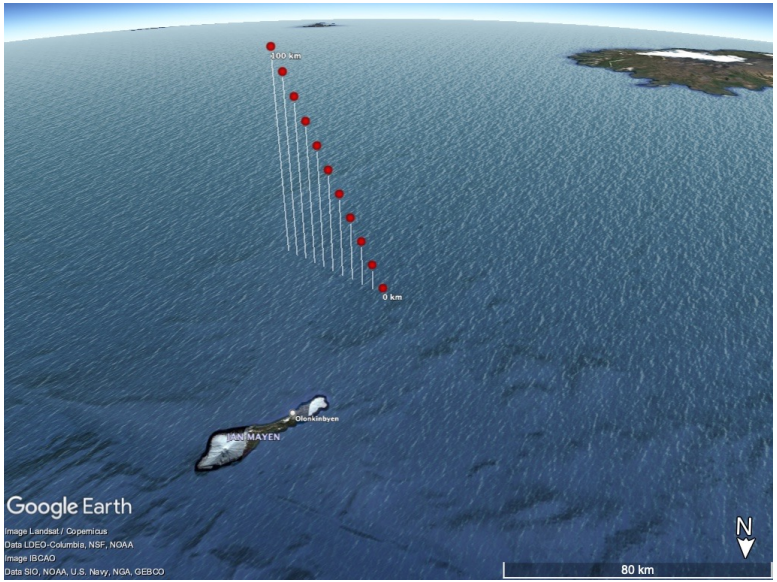
- Only low-level warning from Scout
  - 0.4% imp. prob.
- No follow up prior to impact
  - Precovery reported later



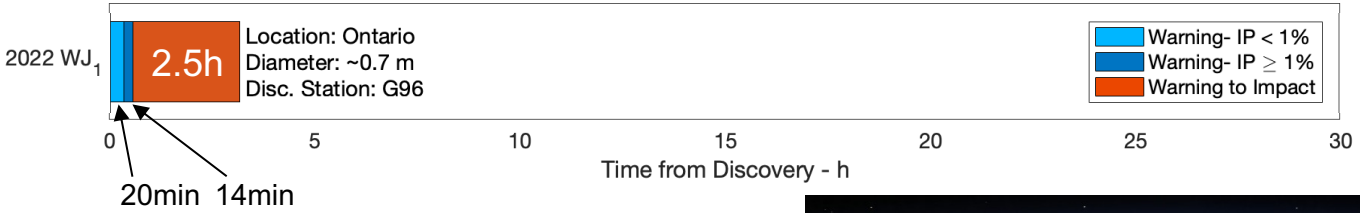
2022 EB_5 – GINOP-KHK 0.6m, Hungary



- Discovered by K. Sarneczky only ~2 h before impact
- Low-level Scout alert issued only 18 min after discovery (0.5% imp. prob.)
- High-level alert issued ~1h after discovery
  - ~1 h before impact



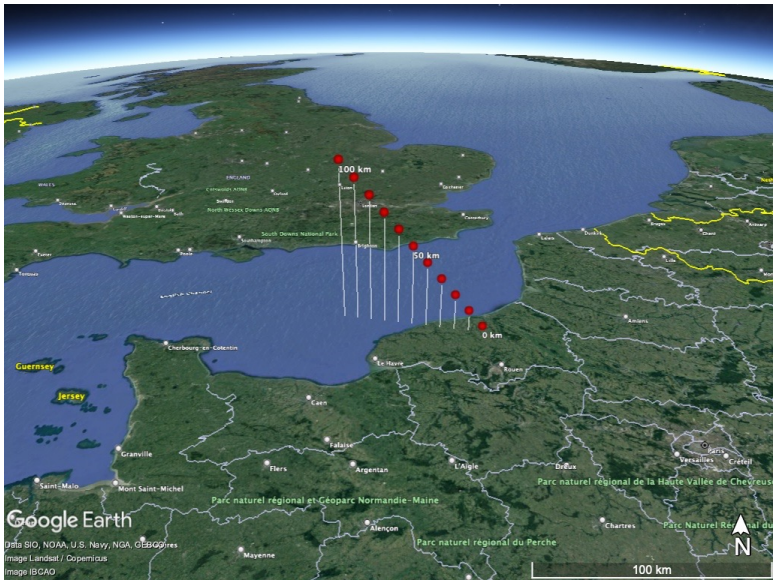
2022 WJ_1 – CSS, Mt. Lemmon 1.5m



- Scout low-level warning in 20 min
  - High-level warning in 34 min
- ~2.5 h of time for characterization

2023 CX_1 – GINOP-KHK 0.6m, Hungary

- Scout low-level warning in 1.6h
  - High-level warning in 33 min later
- ~4.5 h of time for characterization
- Meteorites recovered



Summary

- Impactor discoveries made 2-25 h before impact
- In the Scout era, warning times have ranged from 18 min to ~3h (mean ~1.3 h)
- Diameters in range 0.7-2.6 m
  - Except for 2019 MO (4.7m)
- 4 of 7 impacts over land
  - 3 of 7 yielded meteorites
- Discovery counts
  - Catalina Sky Survey – 4
  - Sarneczky – 2
  - ATLAS – 1

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