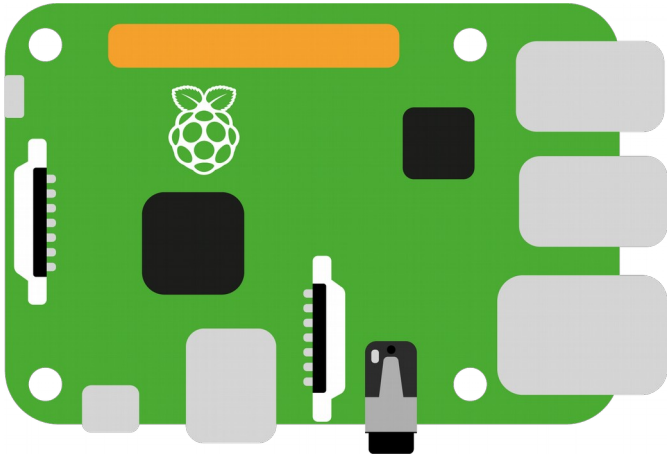


Astro Pi: Python on the International Space Station

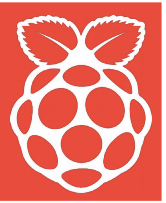
Ben Nuttall

Raspberry Pi Foundation

UK Charity 1129409

Raspberry Pi

Slides, links, feedback and interest



rpf.io/ep19

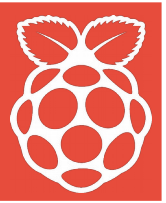
@ben_nuttall

Ben Nuttall

- Technical Programme Manager at Raspberry Pi Foundation
- Based in Cambridge, UK
- Creator of GPIO Zero and piwheels
- Columnist on opensource.com
- github.com/bennuttall
- twitter.com/ben_nuttall
- ben@raspberrypi.org

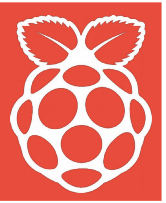
@ben_nuttall

Astro Pi



- There are two Raspberry Pis on the International Space Station
- Kids write Python code that runs in space
- How
- Why
- Cool photos from space, and a time-lapse
- How you can get involved

Raspberry Pi Foundation



- UK charity founded in 2008
- Make and sell Raspberry Pi computers since 2012
- Sold 27M+ units to mix of hobbyists, education and industry
- Sales fund educational mission
- 100+ employees, offices in Cambridge, London, Dublin, California & India
- Youth programmes (clubs, competitions, etc) e.g. Code Club, CoderDojo, Astro Pi
- 2018 – awarded contract to create National Centre for Computing Education for UK government Department for Education

Astro Pi - 2014

- ESA do education programmes
- RPF do education programmes
- RPF/ESA decide to collaborate on an education programme
- Tim Peake, first British astronaut in many years, about to go to ISS
- Tim is an incredible STEM education advocate
- Maybe Tim could take a Raspberry Pi with him?

esa
European Space Agency

Raspberry Pi - 2014

- Raspberry Pi 1 B+
- 700MHz Armv6 CPU
- VideoCoreIV GPU
- 512MB RAM

Sense HAT

- Temperature
- Humidity
- Pressure
- Gyroscope
- Magnetometer
- Accelerometer
- 8x8 RGB LED display
- Mini joystick
- Python library - sense_hat

Camera module

- 5Mpx
- 1080p30, 720p60 and 640 × 480p60/90
- 2592 × 1944 pixels
- Visible light and infra-red versions available
- Python library - picamera

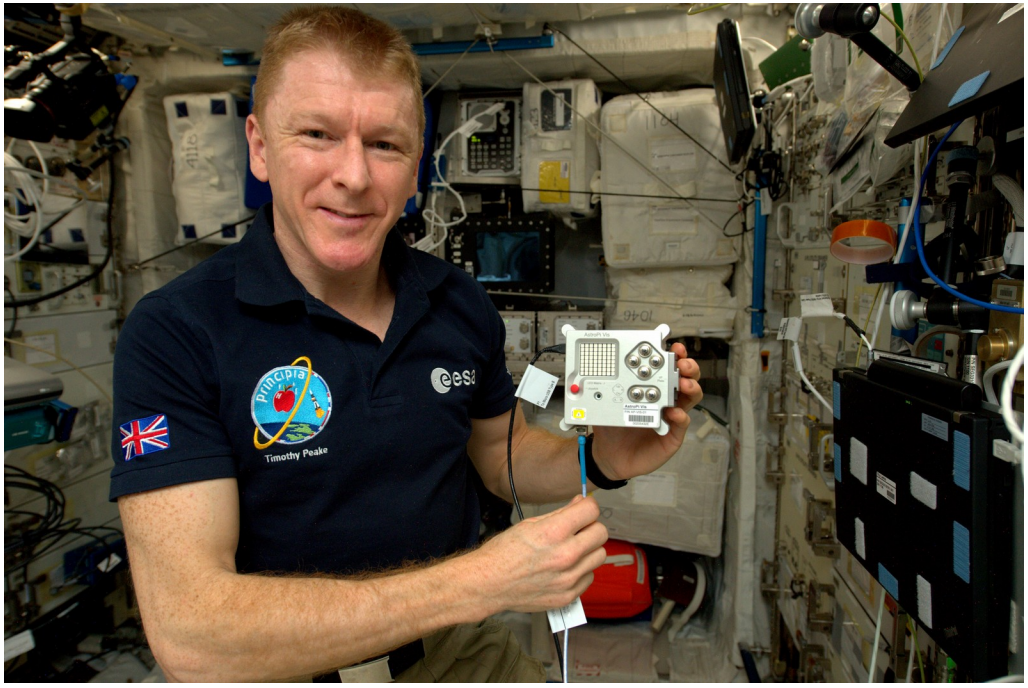
Put it in a case

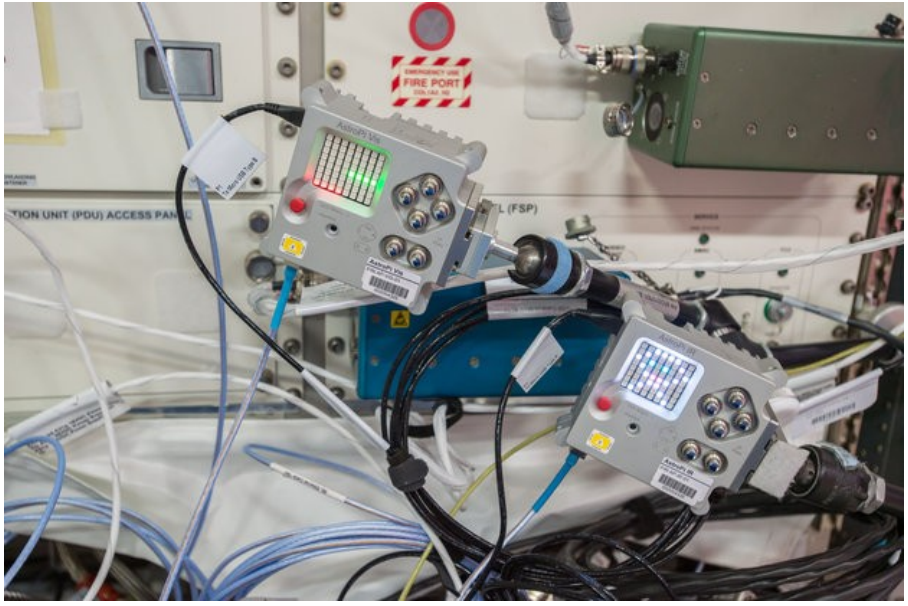
Put it in a case v2

2015 – how do we send it to space?

@ben_nuttall

We (both) made it!





@ben_nuttall

Astro Pi competition

- Competitions for young people in ESA member states (most of EU, plus Canada)
- "Your code in space"
- Mission Zero / Mission Space Lab
- Running since 2015

Astro Pi astronauts

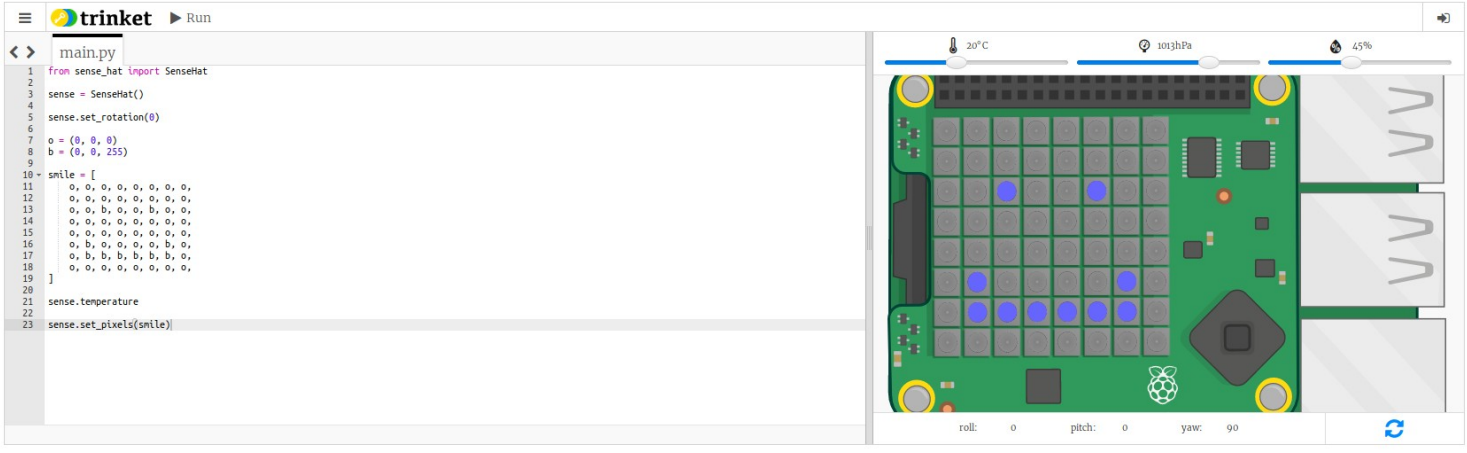
@ben_nuttall

Mission Zero

Mission Zero offers students and young people the chance to have their computer programs run in space on the ISS as part of the European Astro Pi Challenge! Teams write a simple program to display a message to the astronauts onboard. Every participant will receive a certificate with the time and date their code was executed. **Submissions are closed.** Sign up for Astro Pi's mailing list for updates about this and future missions!

Astro Pi

Mission Zero



Mission Zero submissions each met the following requirements:

- read the temperature from the sensor,
- use the LED matrix,
- and run your program without any errors.

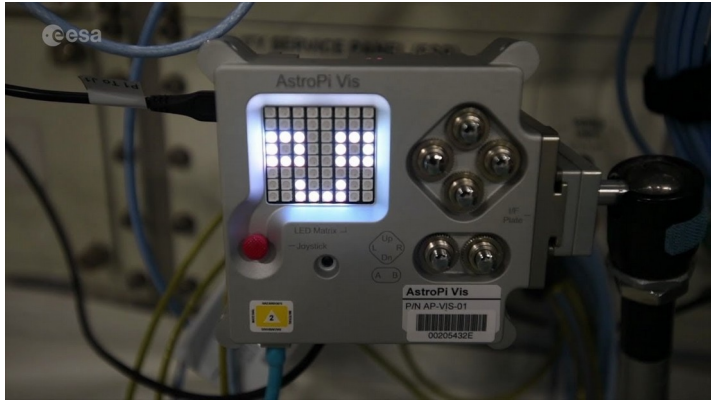
Qualified submissions will run for 30 seconds on the International Space Station.

00:00

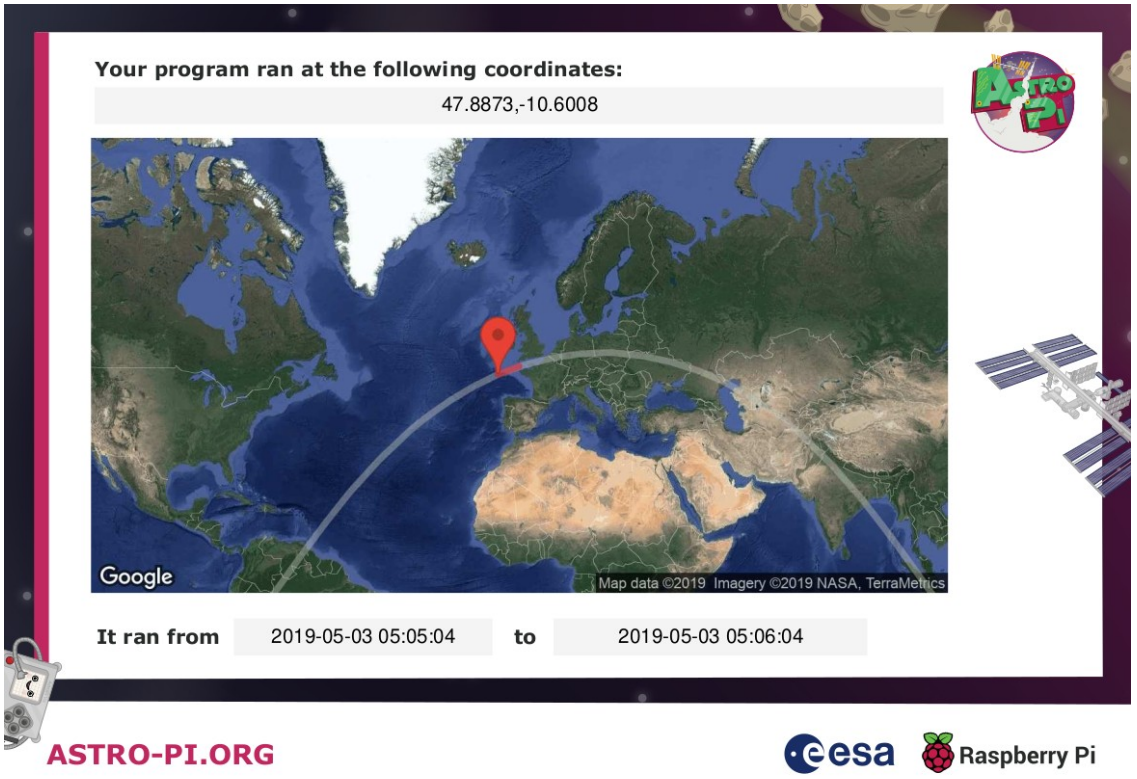
@ben_nuttall

Mission Zero

- 30 seconds runtime on the ISS
- "Hello world" in space – pixel art and messages, with conditionals
- Access to sensors but not camera
- No data logging
- Submit through web emulator on trinket.io



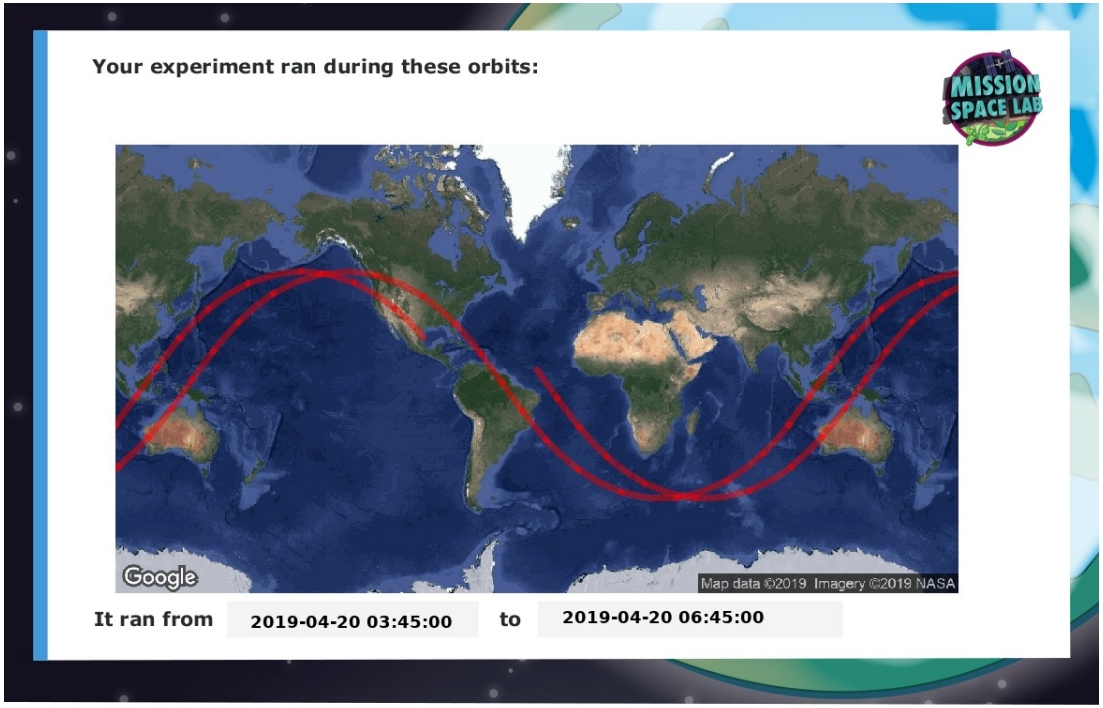
Mission Zero



Mission Space Lab

- 3 hour runtime on ISS
- Science experiment
- Idea phase; code phase; experiment run phase; analysis and report phase
- Two themes: Life on Earth / Life in Space

Mission Space Lab

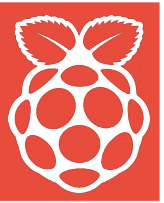


ASTRO-PI.ORG

esa Raspberry Pi

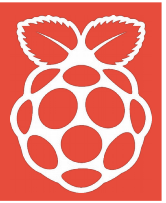
@ben_nuttall

Mission Space Lab ideas



- Detect crew presence with sensors
- Log data to see what happens
- Environmental - check ISS conditions
- Time-lapse
- Global issues e.g. climate change
  - Wildfires
  - Forest depletion
  - Greenery
  - Shrinkage of lakes

Mission Space Lab - libraries



- picamera, sense_hat, pisense
- pyephem, reverse_geocoder
- GDAL (Geospatial Data Abstraction Library)
- numpy, scipy, pandas
- Tensorflow, opencv, scikit-learn, scikit-image

Mission Space Lab - process

- Send custom Raspbian image to ESA
- Test Astro Pi in flight, resolve any issues
- Upload student code
- Student code runs
- Transfer output and logs to ISS dropbox server
- Downlink files to Earth
- Check syslog, re-run some entries (top tip: don't divide by g-force, kids!)
- Distribute files to teams

Mission Space Lab winners – Firewatchers (Portugal)

- Detecting evidence of wildfires
- Use of open image databases from NASA
- Analysing vegetation and plant life from NIR data

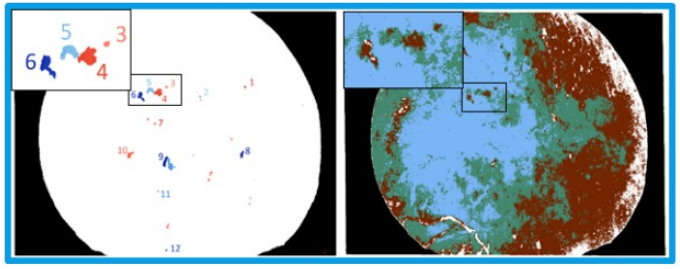


Figure 4 – As in Fig. 3, but showing results from K-mean analysis (Right).

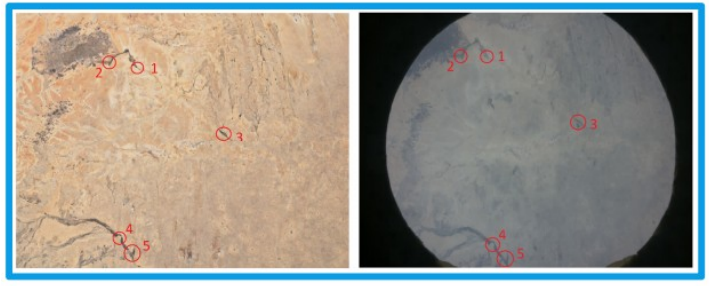
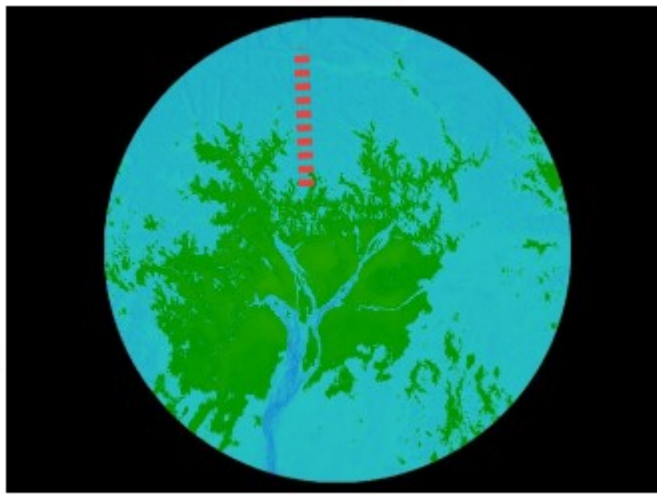


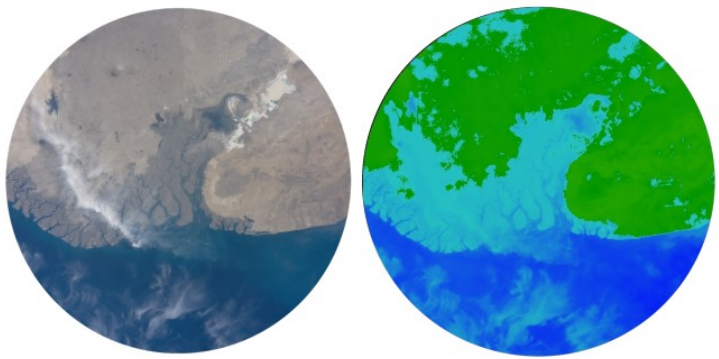
Figure 1 – An example of image georeferencing. Google Maps image of Mellit, Sudan (Left) and photo taken aboard the ISS (Right). Numbers identify some points used for georeferencing.

Mission Space Lab winners – The Happy Pi (Poland)

- Analysing photosynthesis
- Analysing observability of underwater life

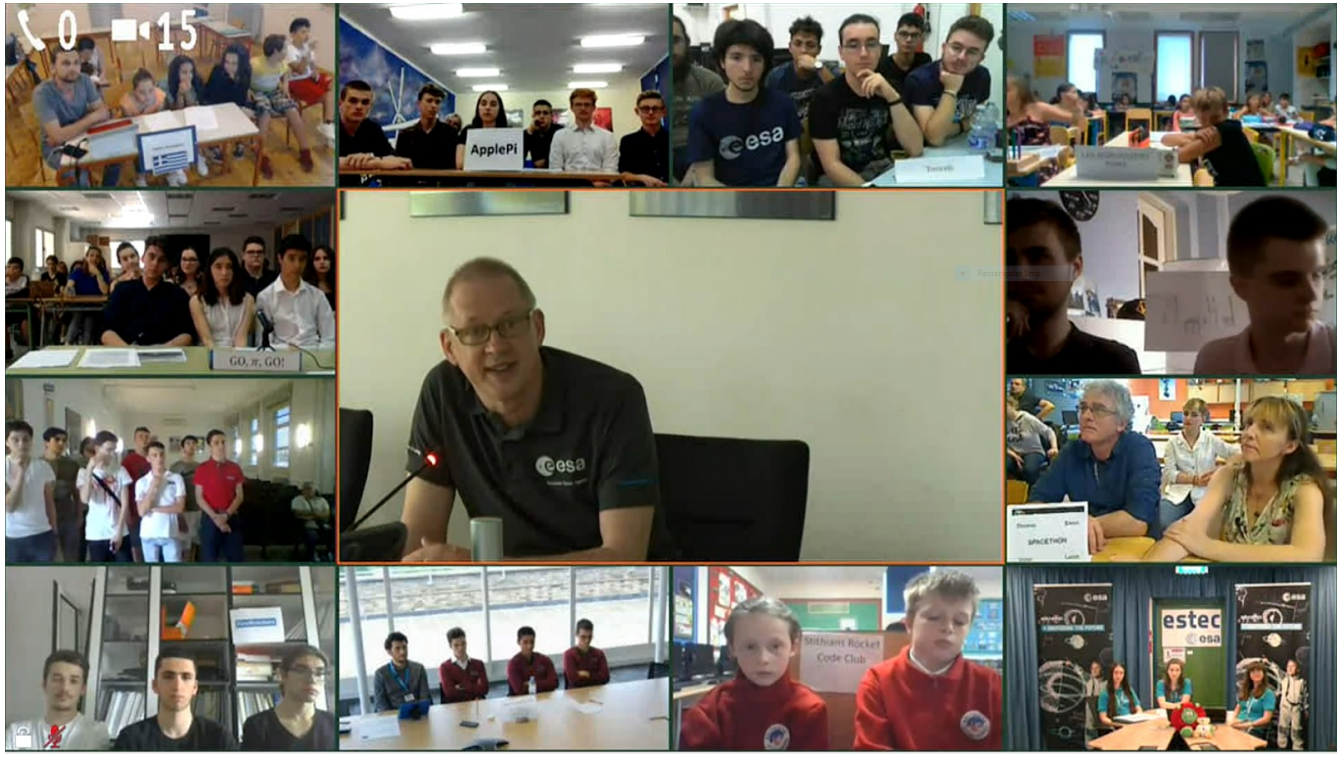


F 1: river Brahmaputra, eastern India



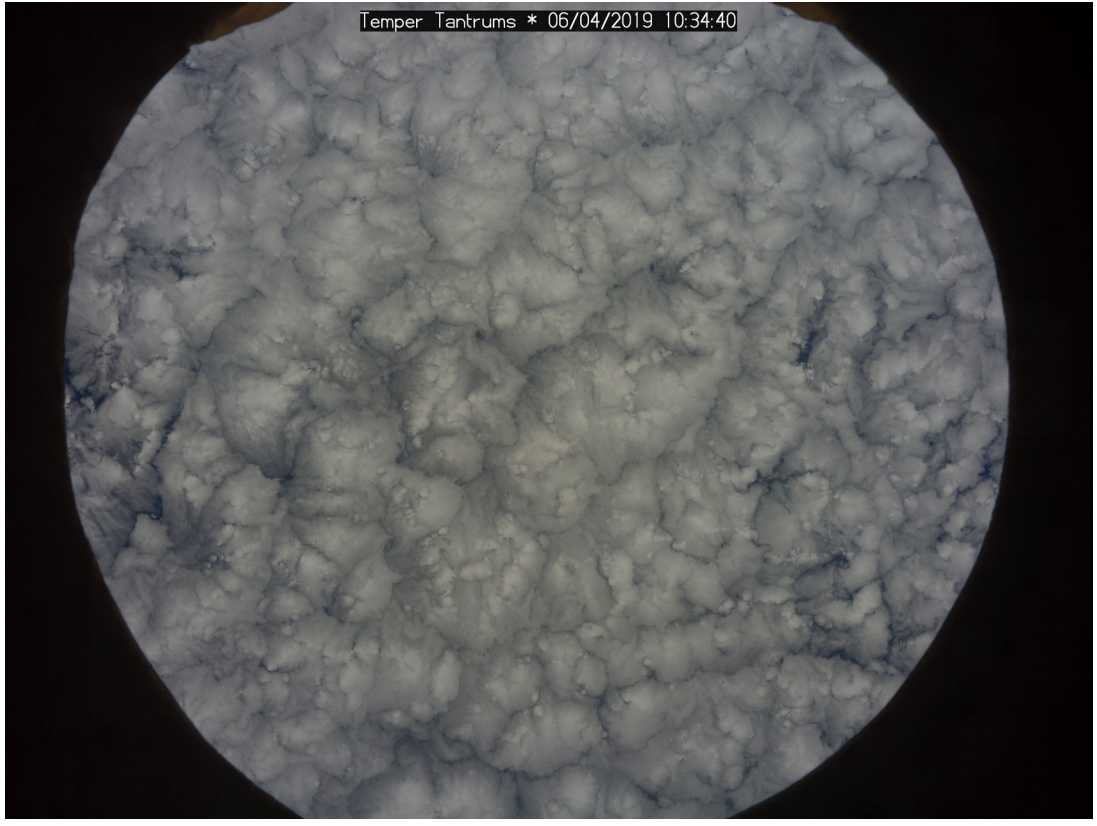
F 5: delta of river Indus, before and after

Astronaut webinar



@ben_nuttall

Photos



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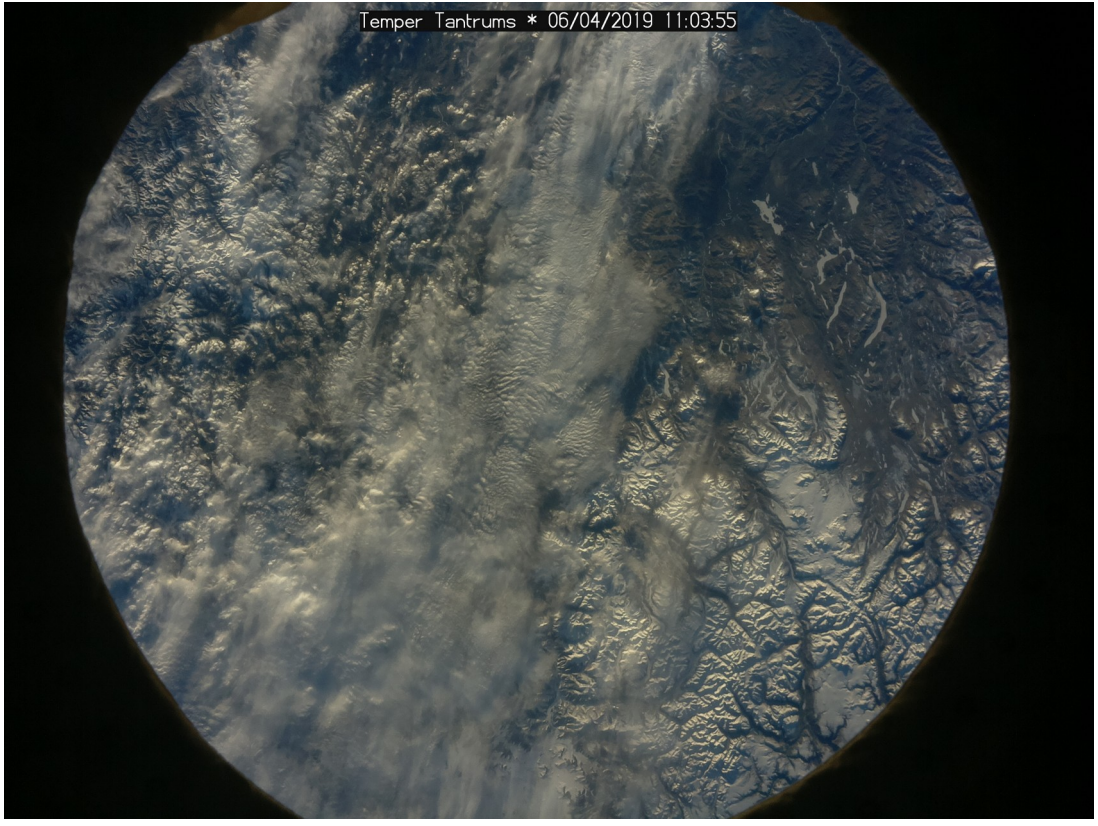

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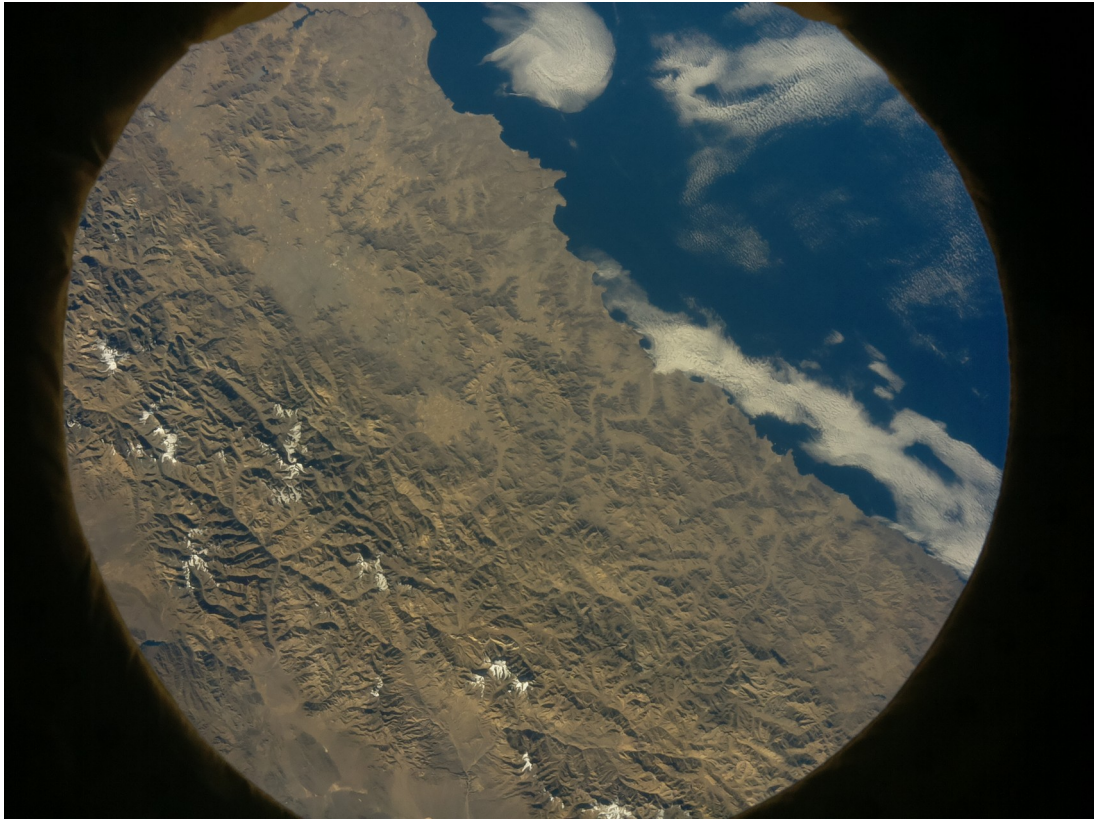

Photos

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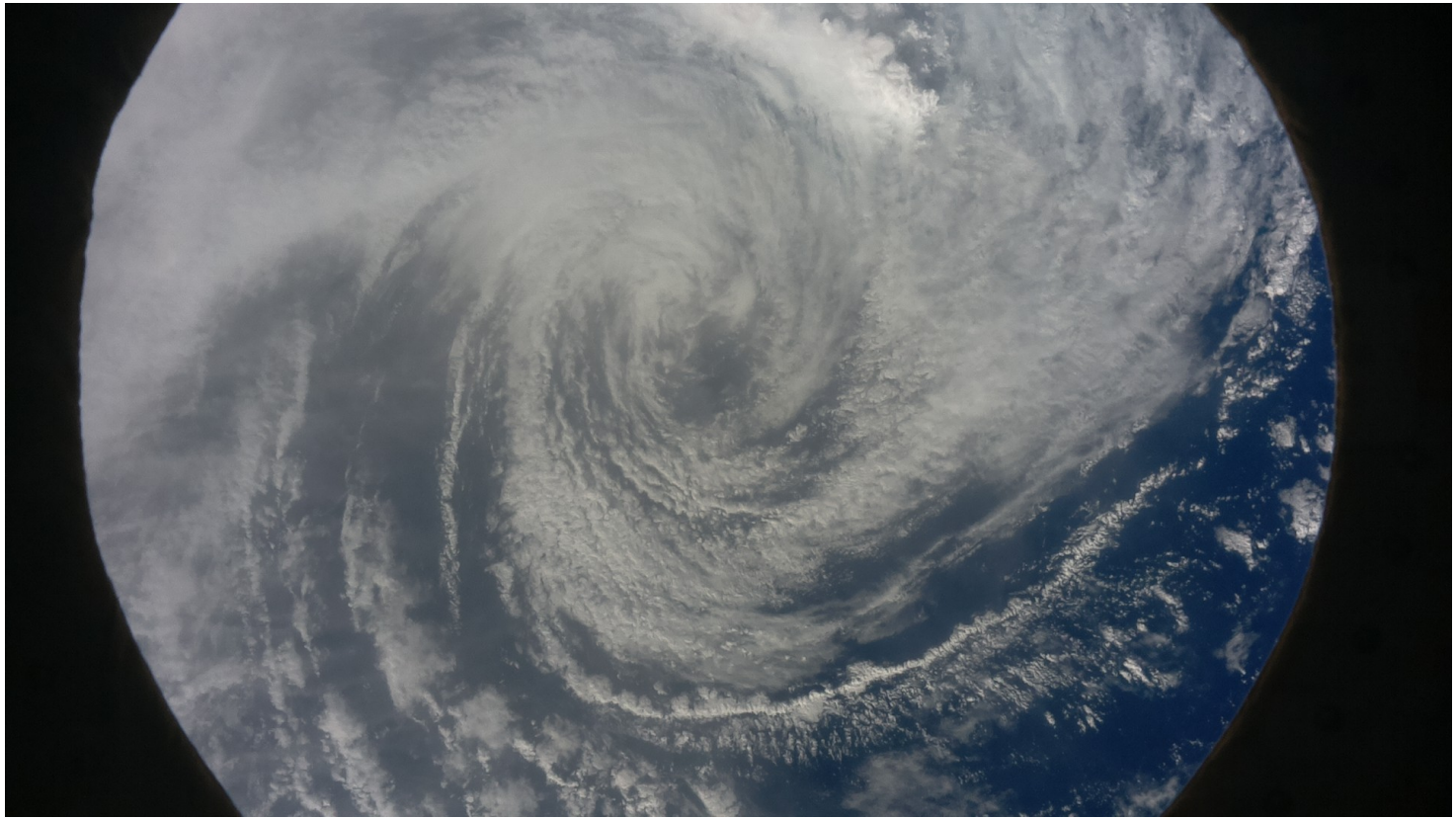

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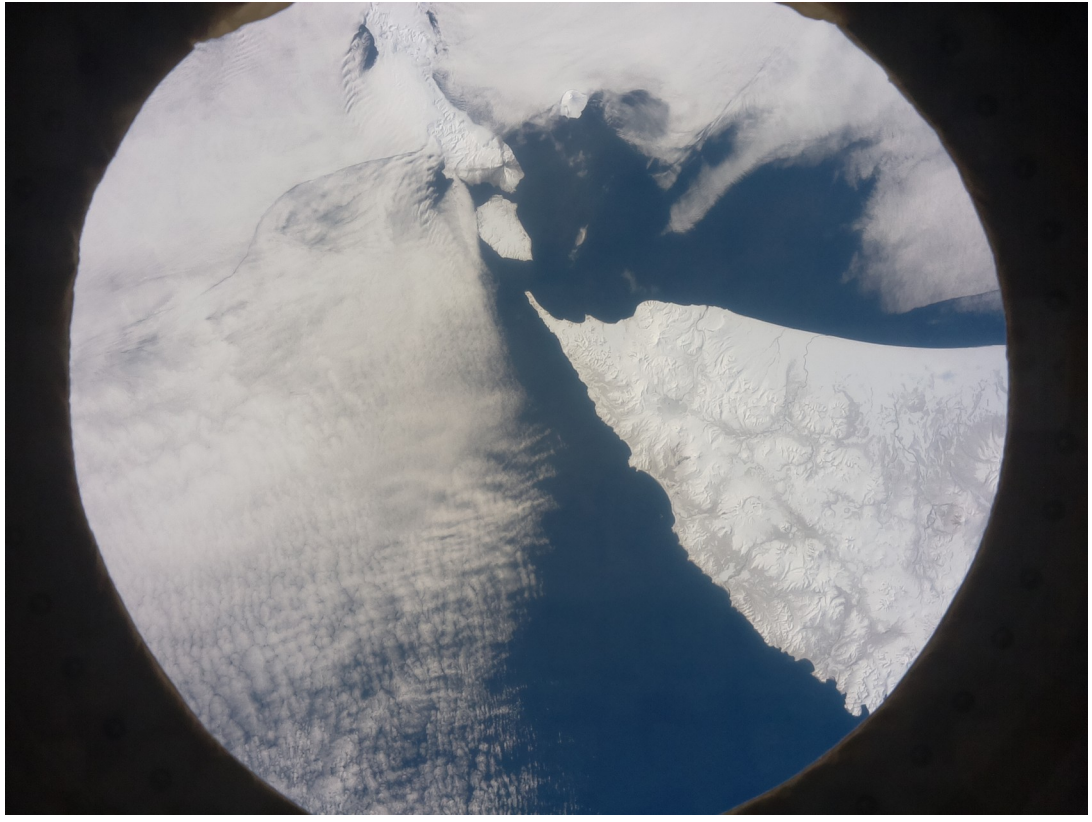
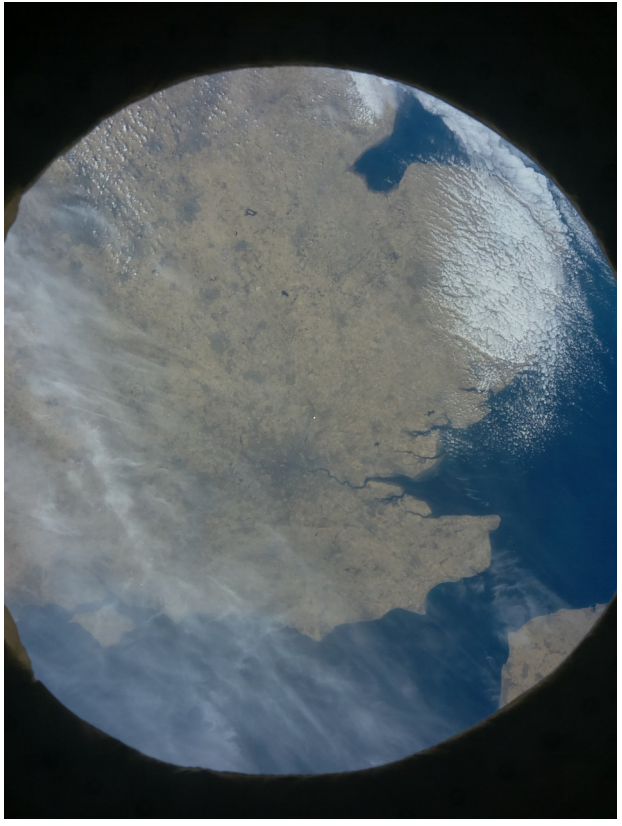


Selfie



Photos

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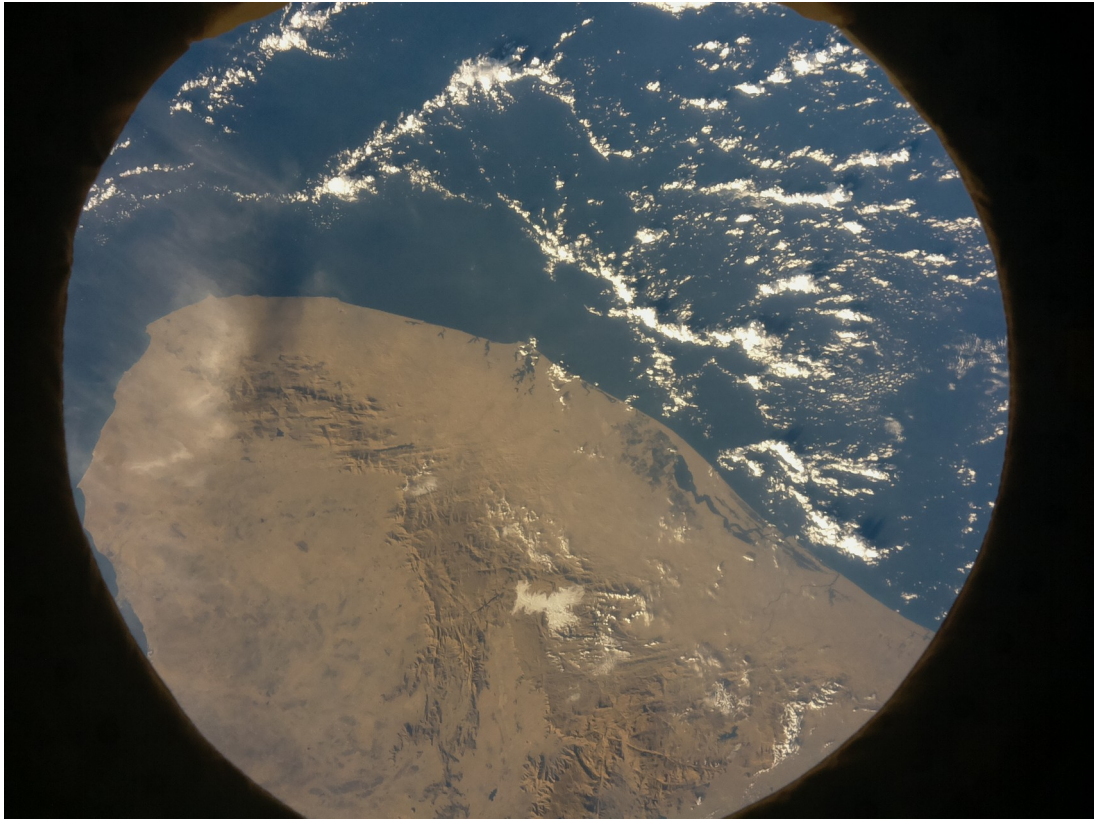

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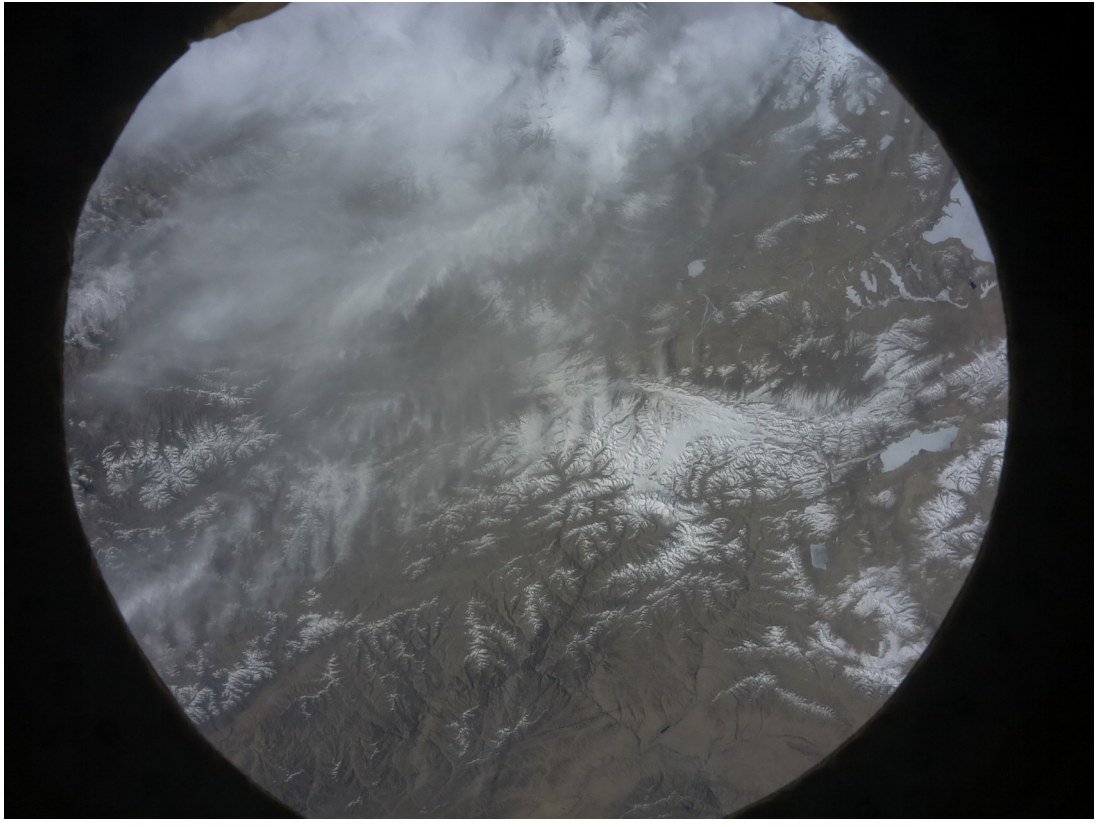
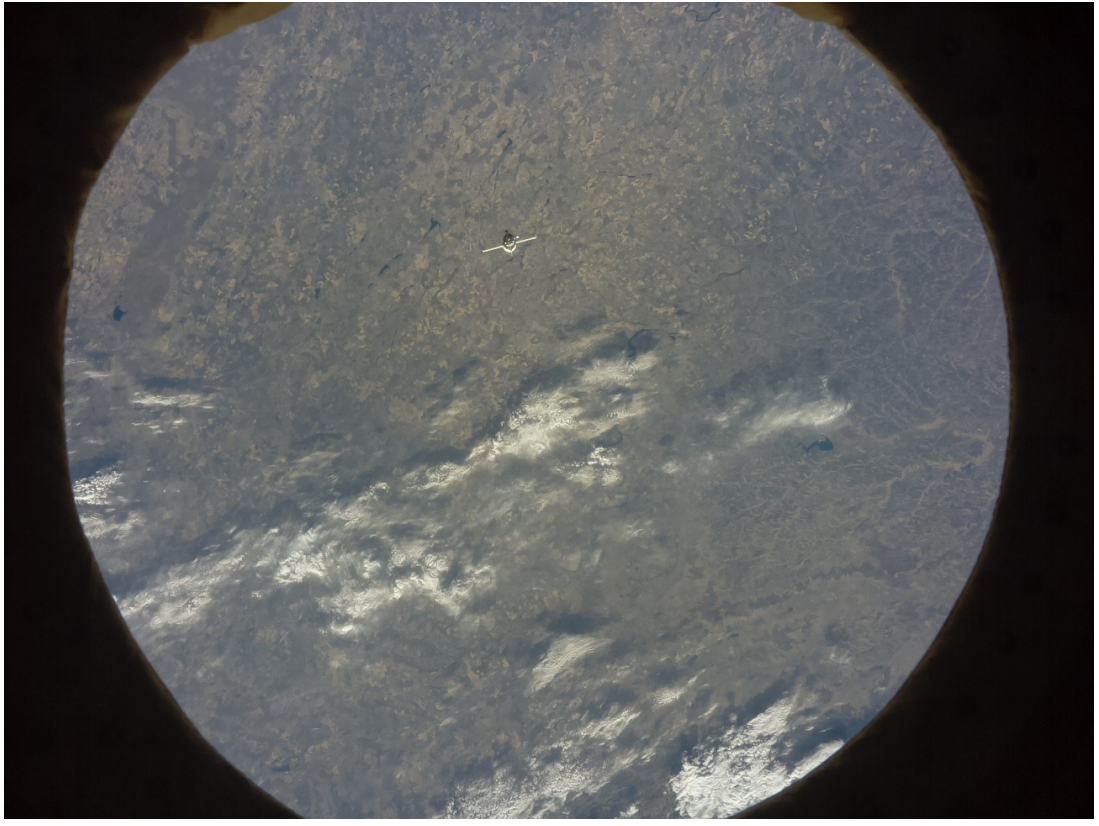


UFO?



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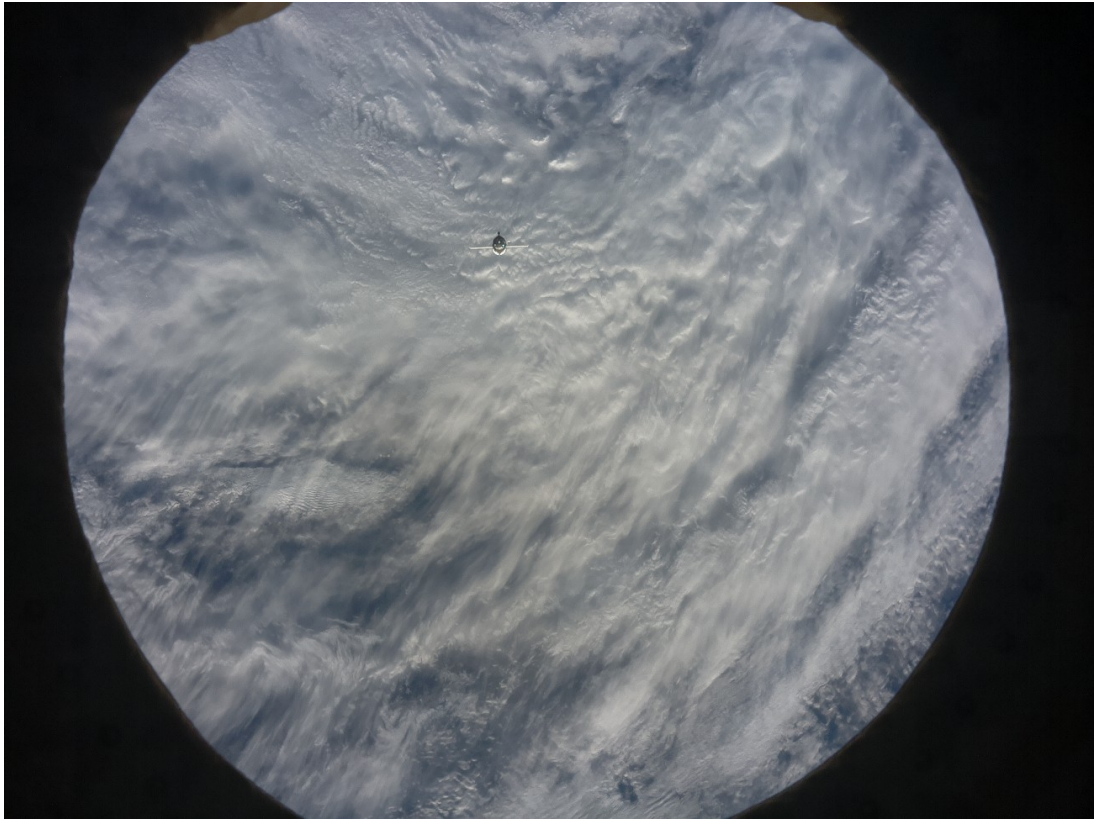

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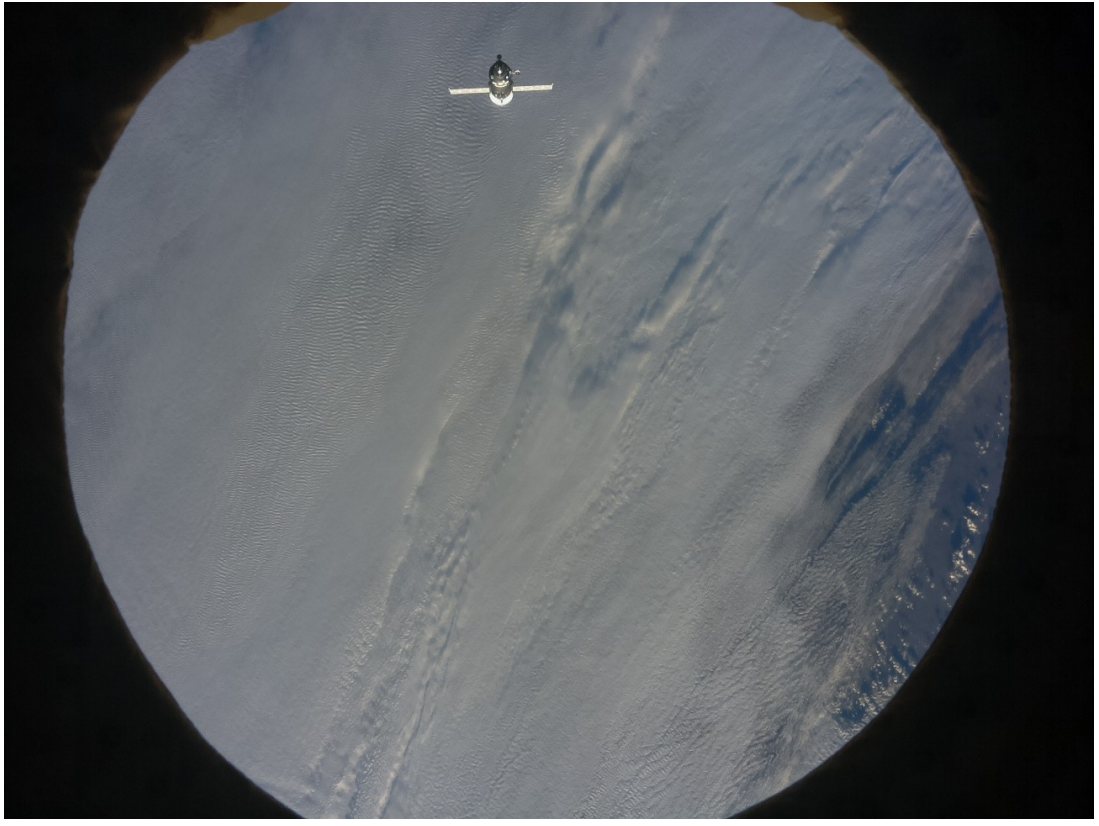
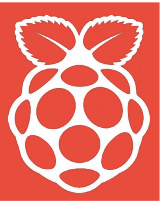


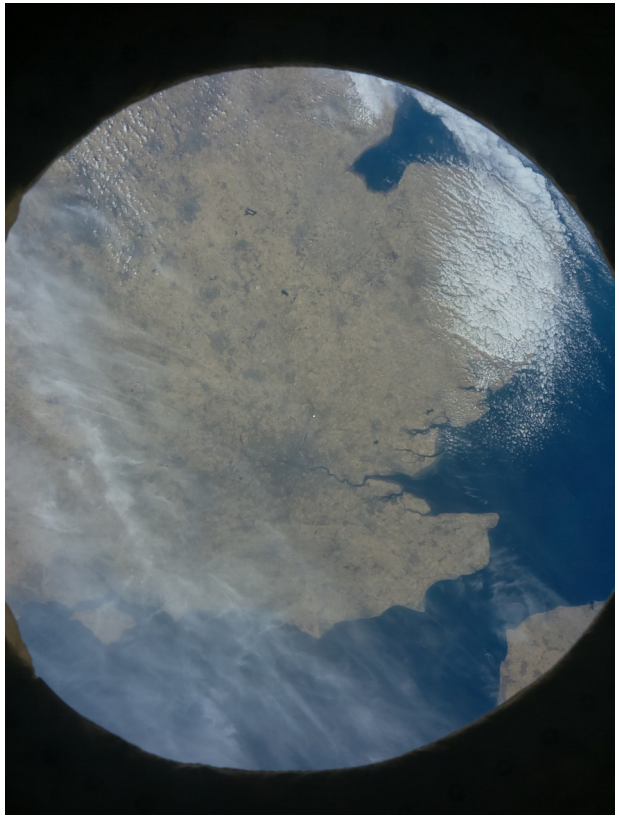
Third mission?



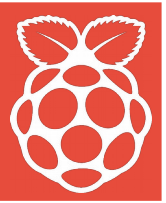
- **In-between Mission Zero and Mission Space Lab**
  - Time commitment
  - Difficulty
- **No ISS involvement**
  - Quicker, less work, no paperwork
- **Using existing data and photos**
- **Small periodic challenges, drop in and out**

Data captured

- CSV of all sensors for 24 hours (8 batches of 3-hour runs) plus ISS location
- Time-lapse of photos

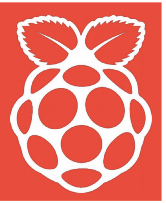


How can you help?



- Talk to me today
- Share your ideas and interest
- Mentor a young person or group when the challenges launch in September
- Volunteer at a Code Club or CoderDojo
- If you have kids in school, tell their teachers about Astro Pi
- Watch astro-pi.org and @Raspberry_Pi / @astro_pi on Twitter for updates

Slides, links, feedback and interest



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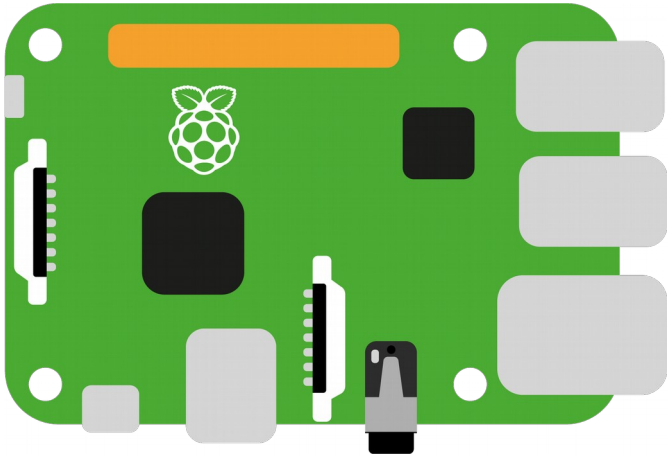

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