From Evangel to NASA

Kevin Grimes — October 4, 2024

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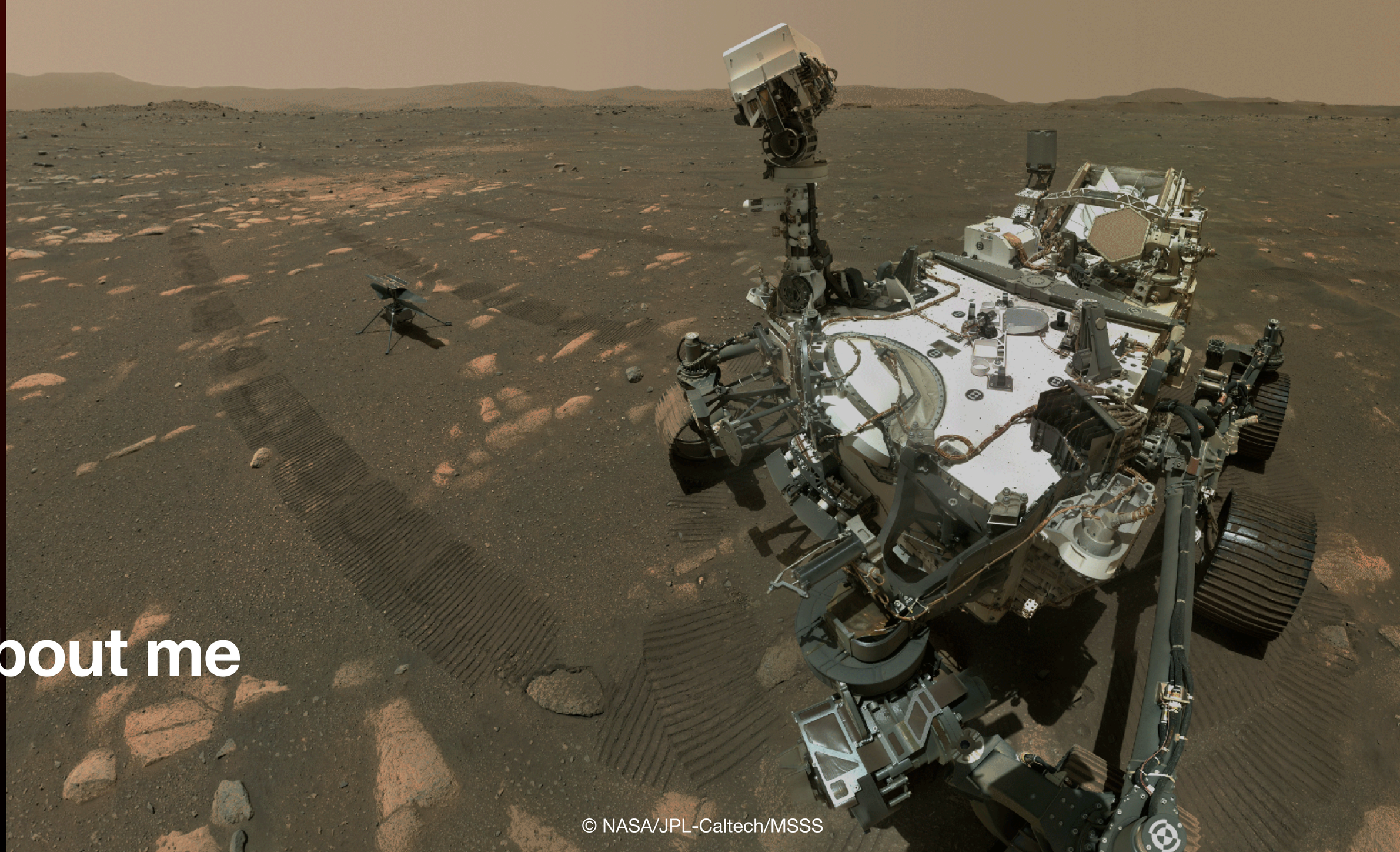
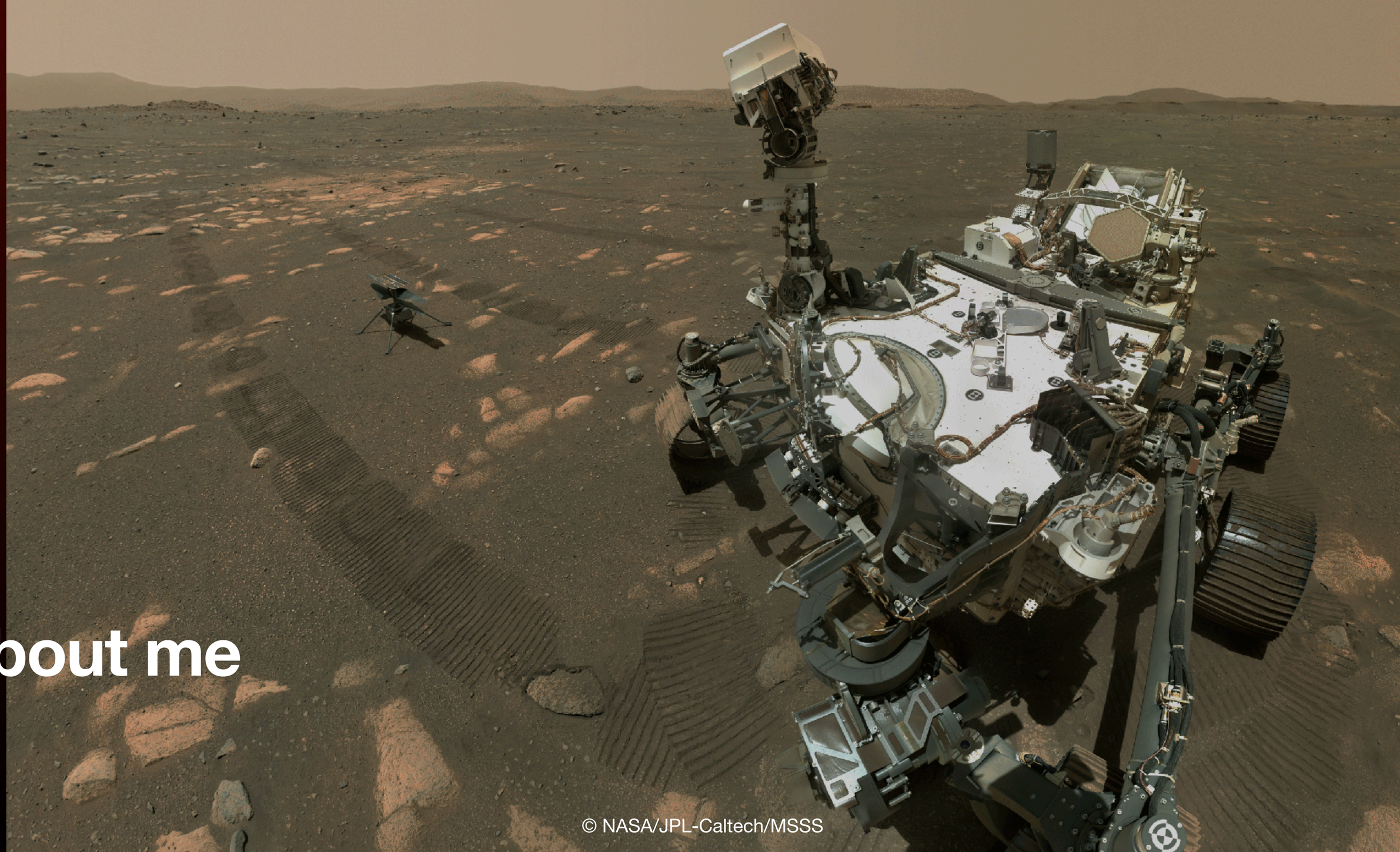
About me



About me



Graduation from Evangel
2017

Graduation from USC
2020

Mars 2020 Landing Celebration – 2021

JPL

- Leader in robotic space exploration, sending
  - Rovers to Mars,
  - Probes into the farthest reaches of the solar system, and
  - Satellites to advance understanding of our home planet
- JPL also operates the NASA Deep Space Network, enabling navigation and data return throughout the solar system.

Managed by the California Institute of Technology and based in Pasadena, JPL is NASA's only federally-funded research and development center.

https://www.nasa.gov/jpl/jet-propulsion-laboratory-history/

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High bay clean room

Space Flight Operations Facility

High bay clean room

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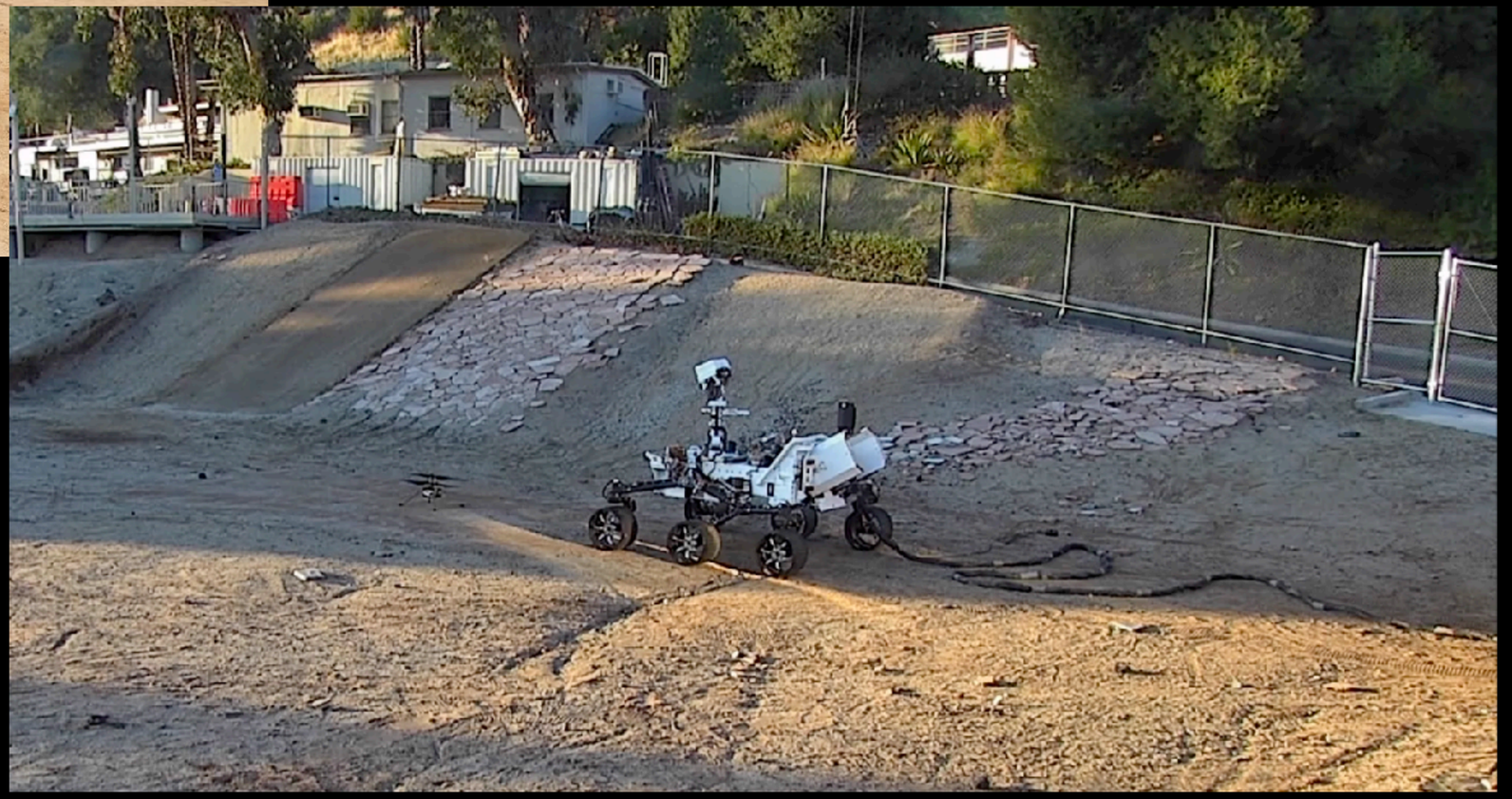
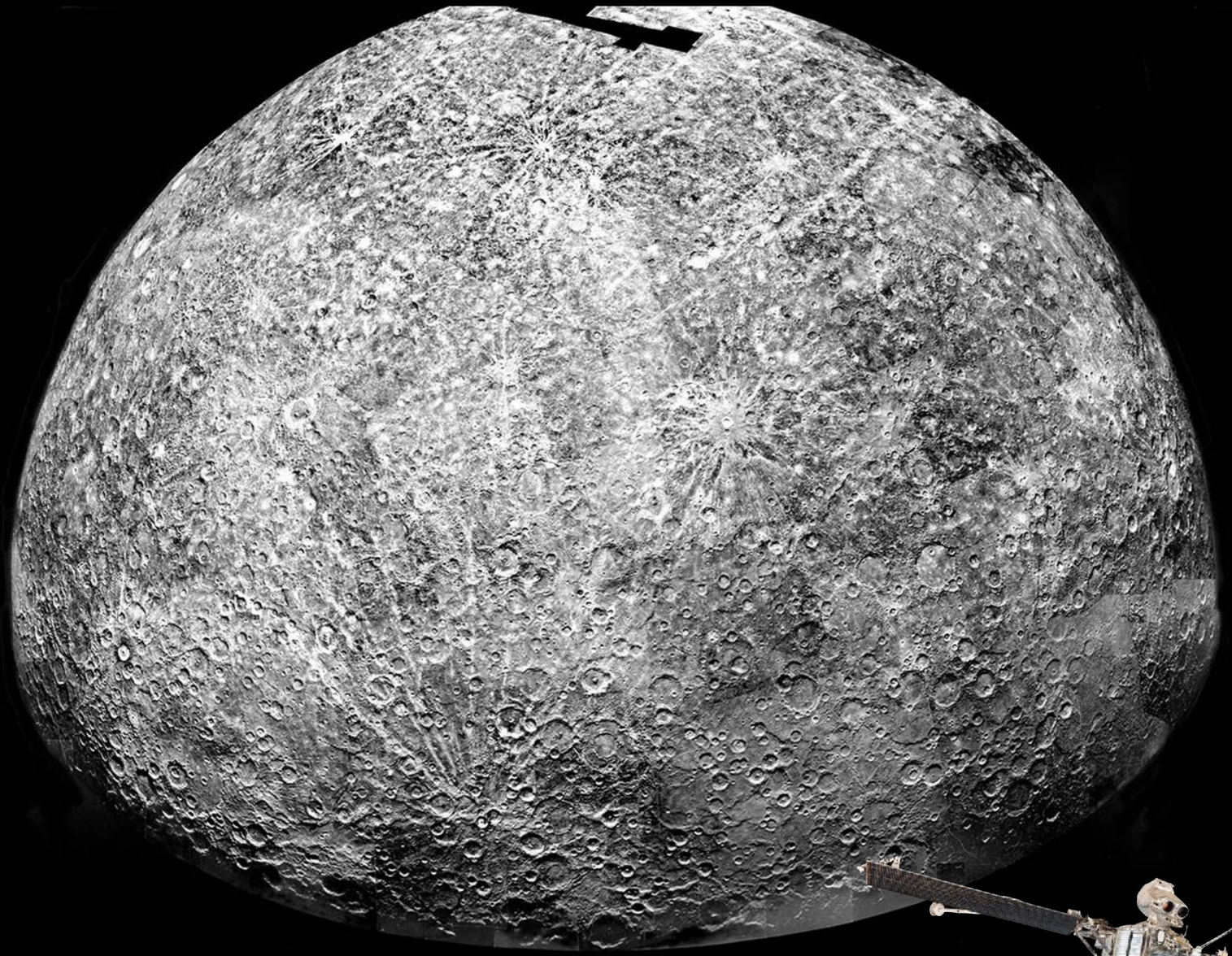
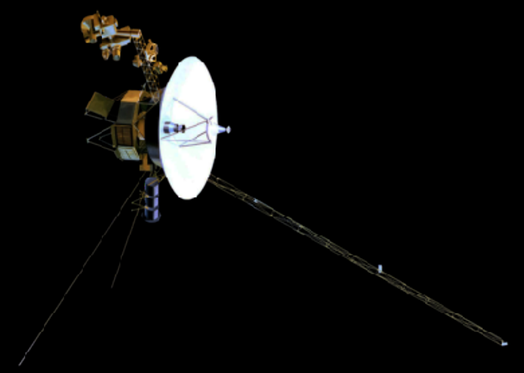
Space Flight Operations Facility

Mars Yard

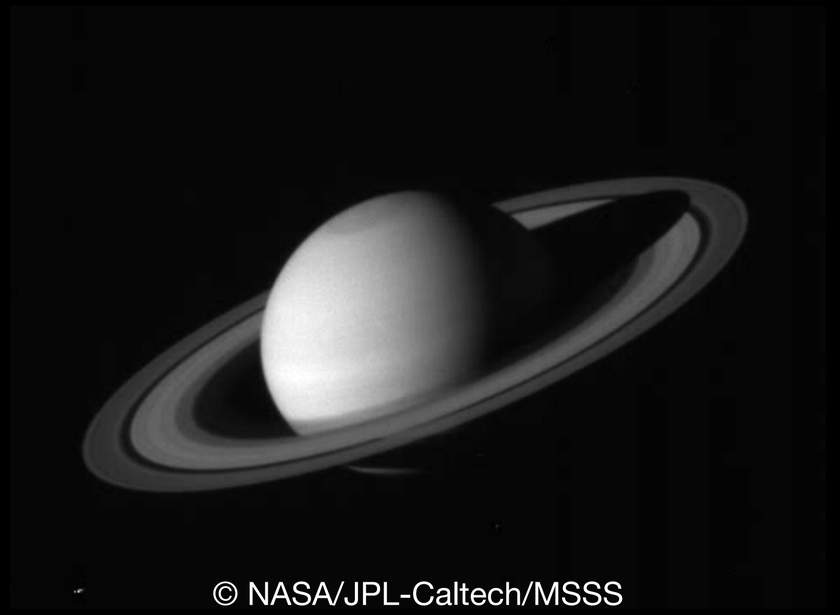




Mariner 10 mission to Mercury



“Pale Blue Dot” captured by Voyager I



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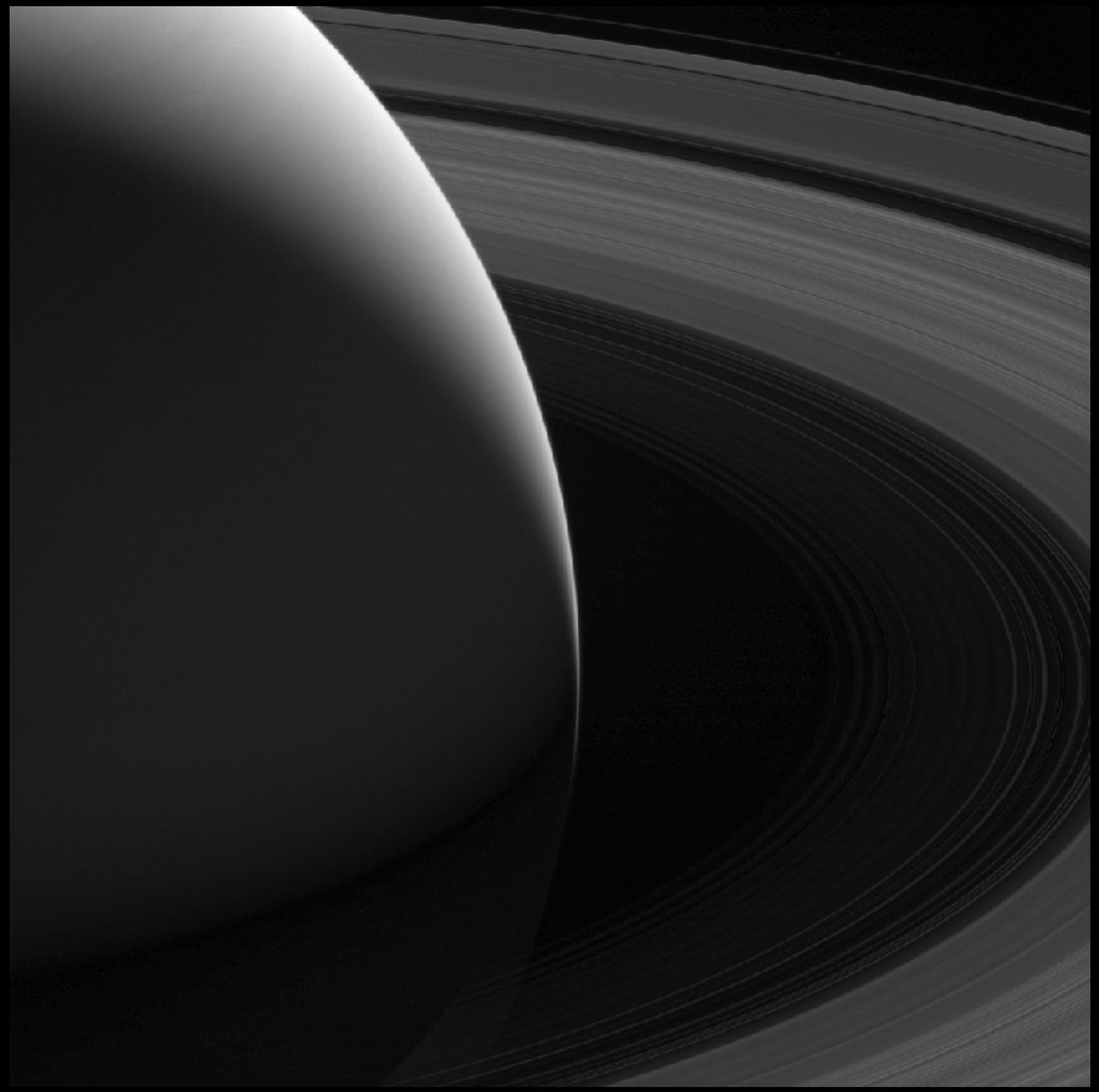
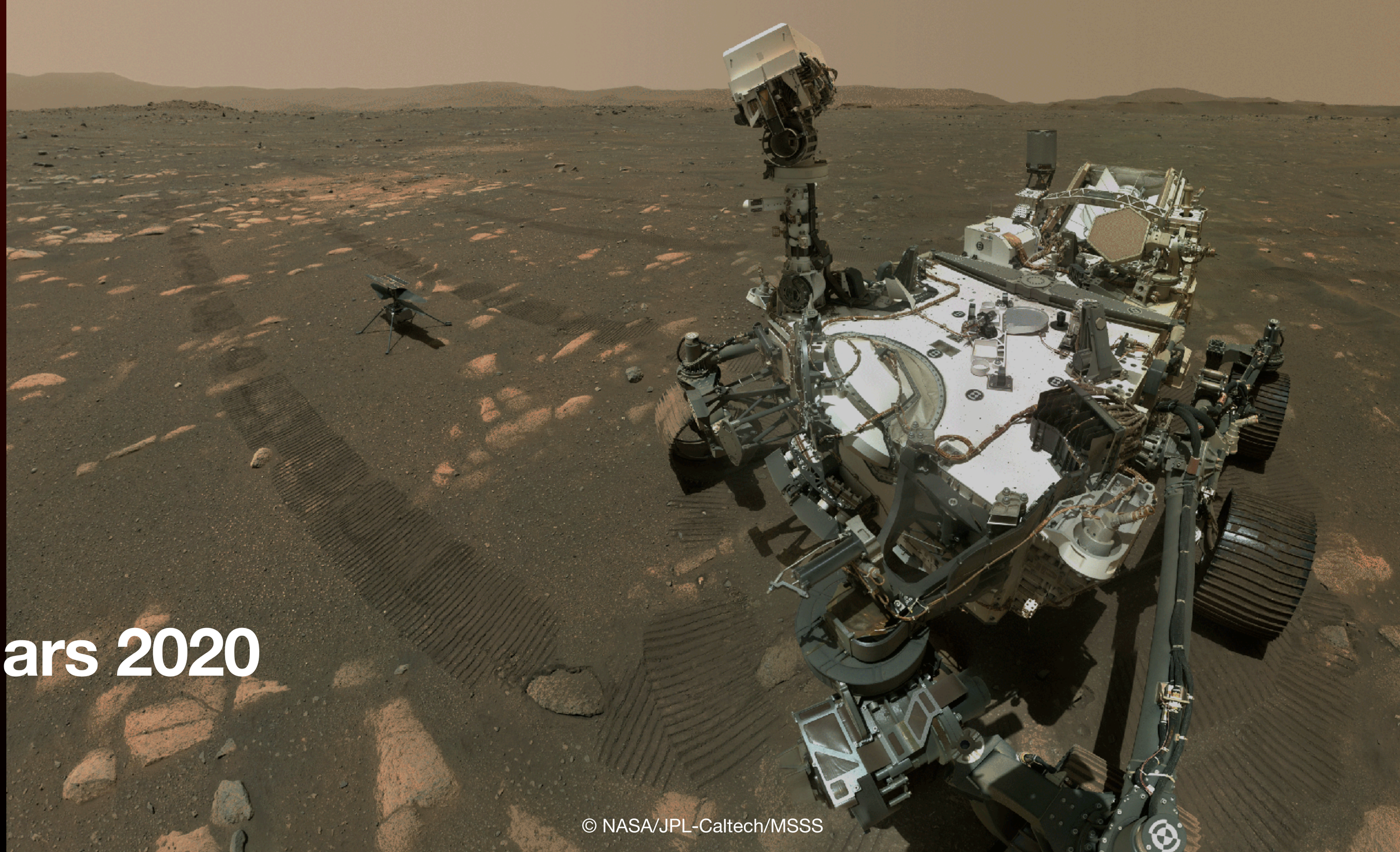
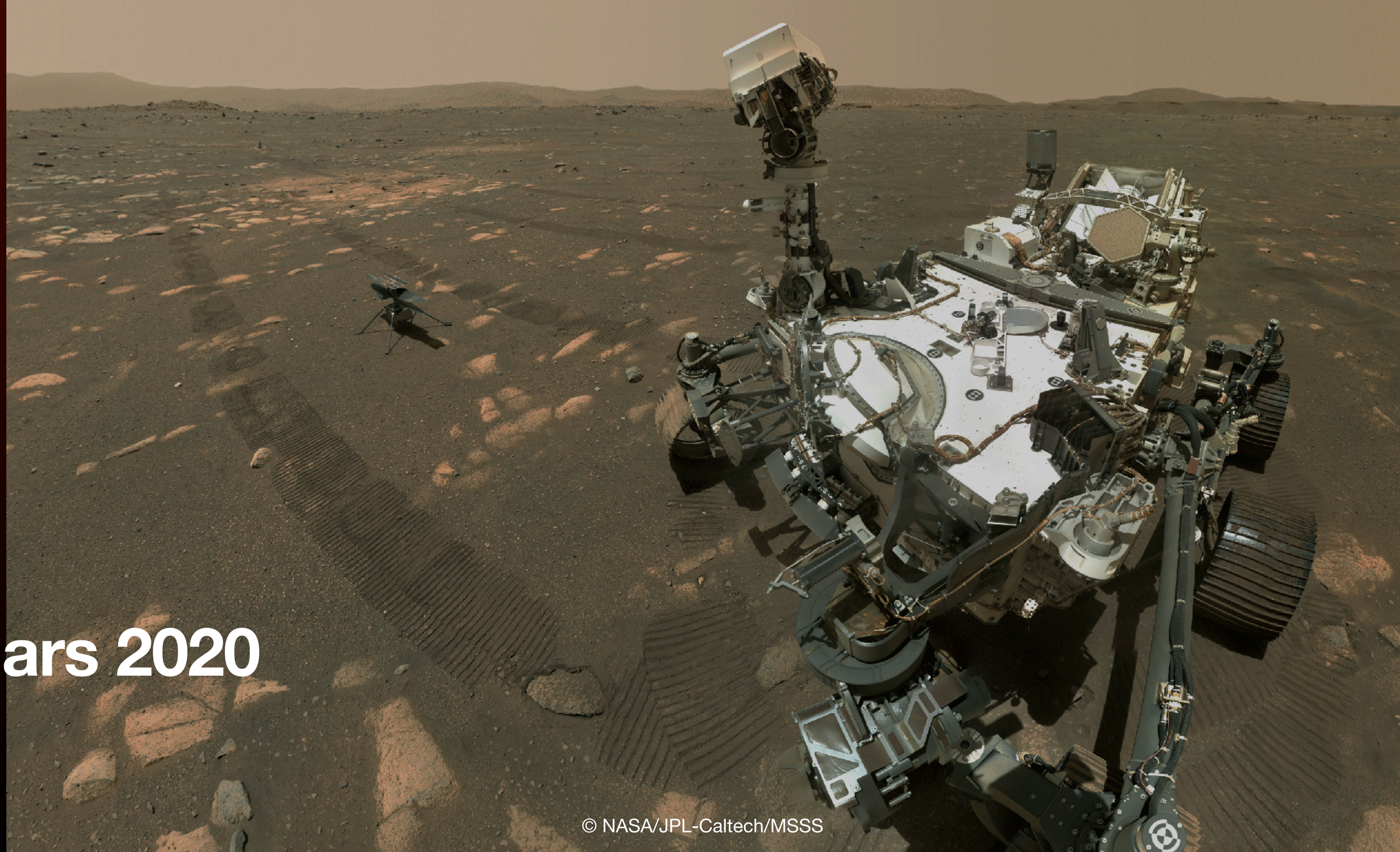
Cassini-Huygens mission to Saturn and Titan



Cassini-Huygens mission to Saturn and Titan

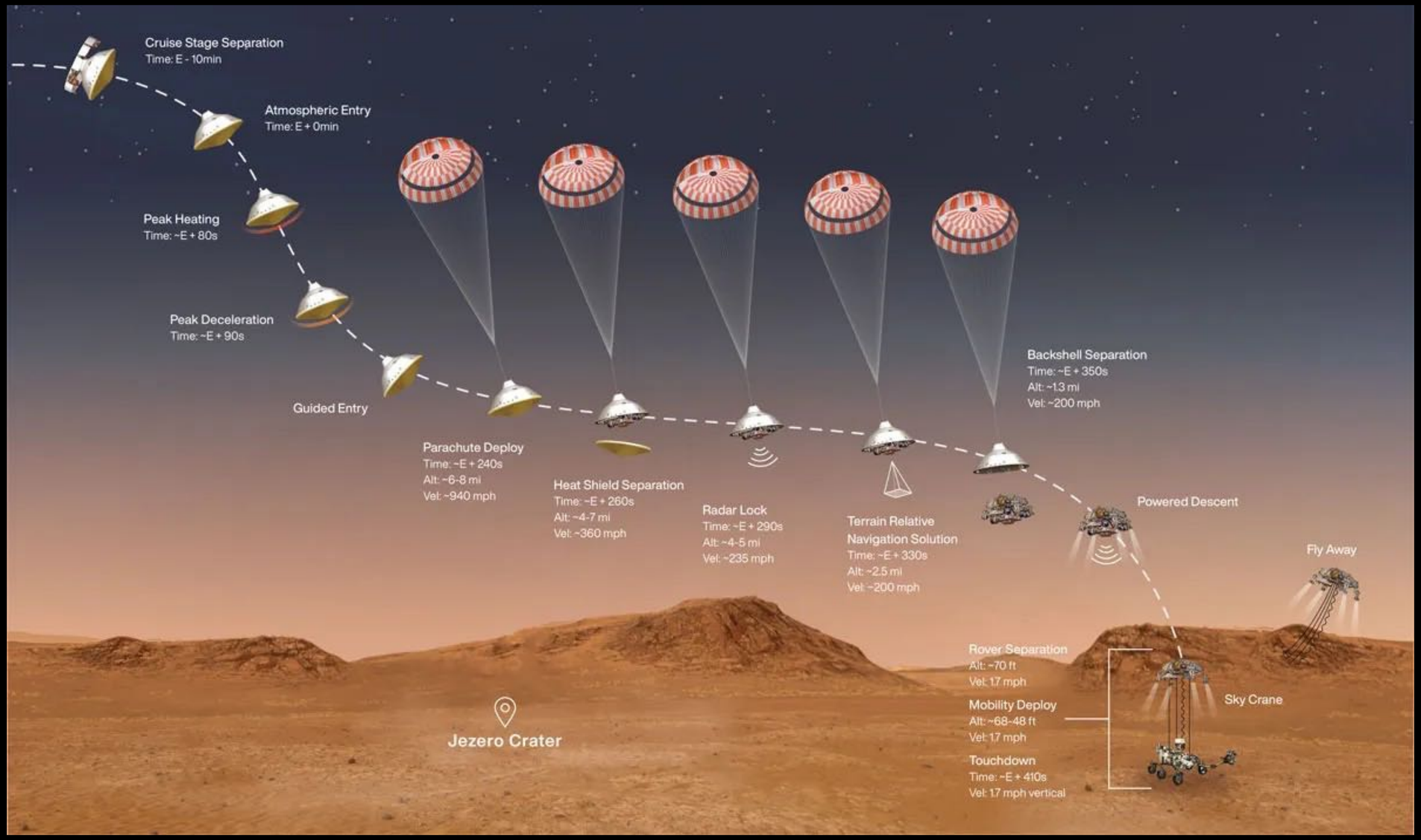


Mars 2020



Mars 2020

Perseverance EDL

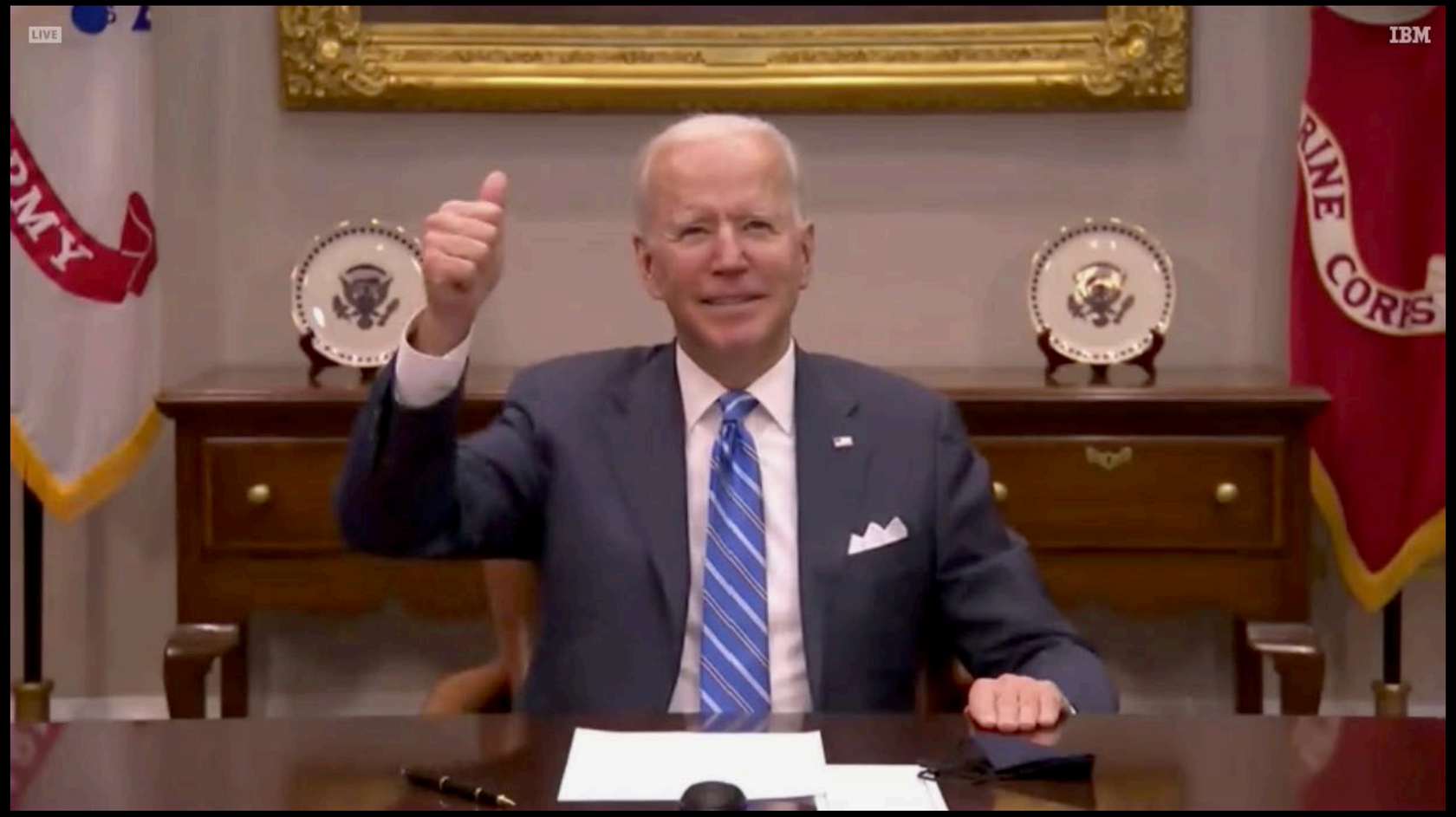


Perseverance EDL

Perseverance EDL

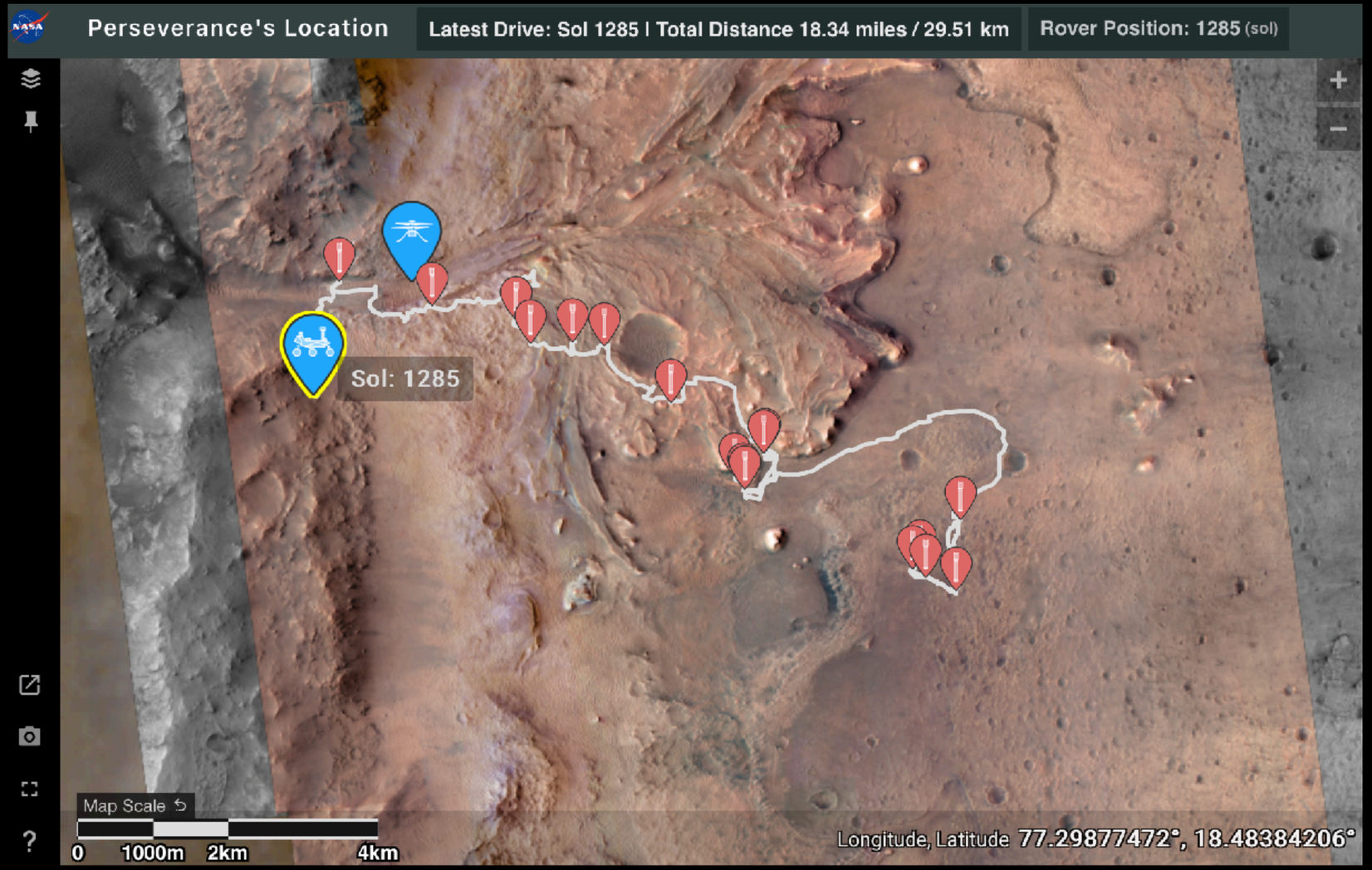

Kevin Grimes (Me)
Robert Deen
Justin Maki
Hallie Abarca... (Cohost)
Stirling Algermissen
Galen
Alice
Eamon Ford
Francois Ayoub
Hyun Lee
Jeffrey Hall
Nicholas Arena
Oleg Pariser
Sidney Fernandez (Sh...
Stephanie Oij
Stepheny Perez

The WFH team

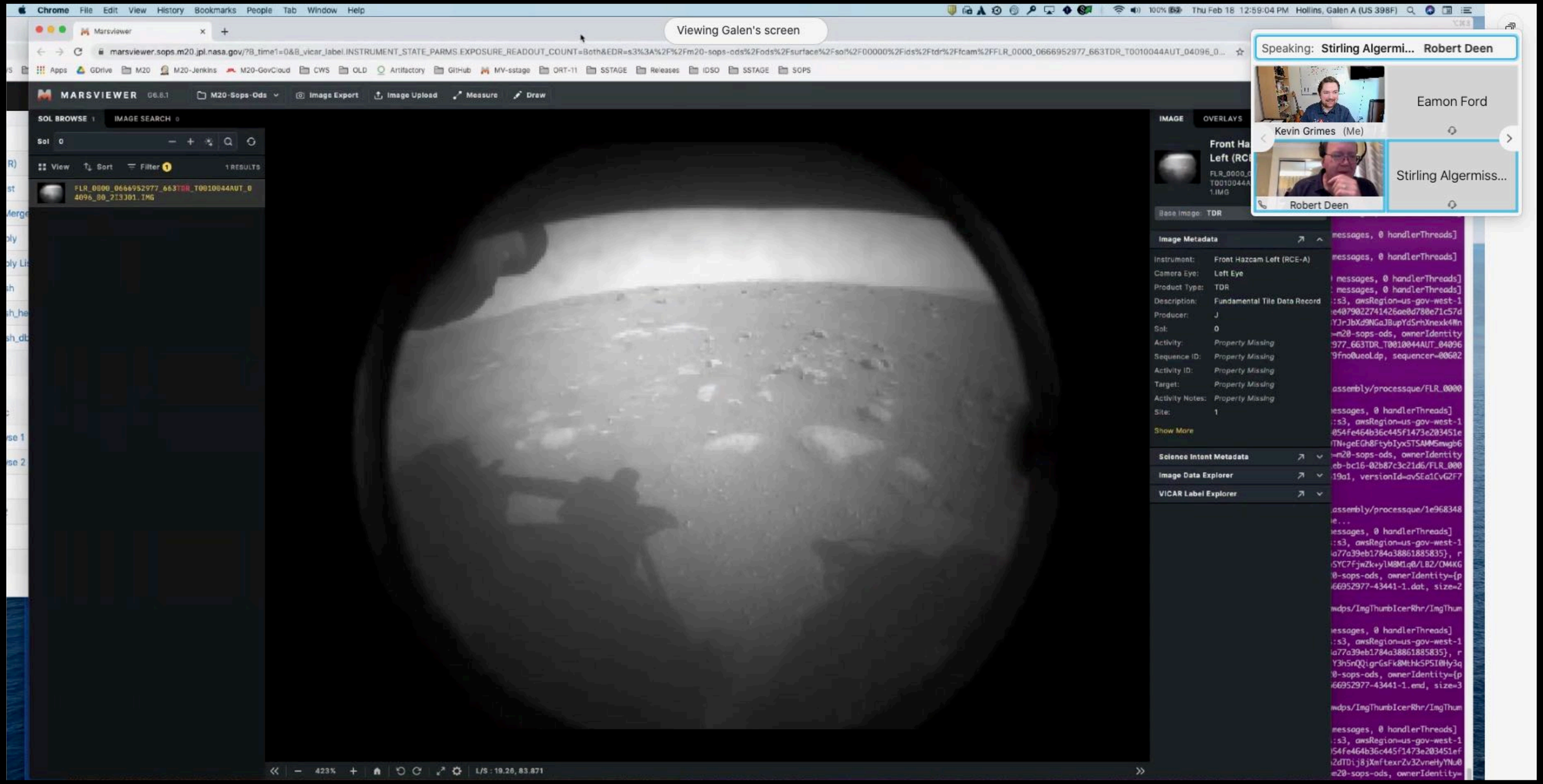


Telecon with the President

Perseverance’s journey to date



https://science.nasa.gov/mission/mars-2020-perseverance/location-map/



Perseverance's first photo

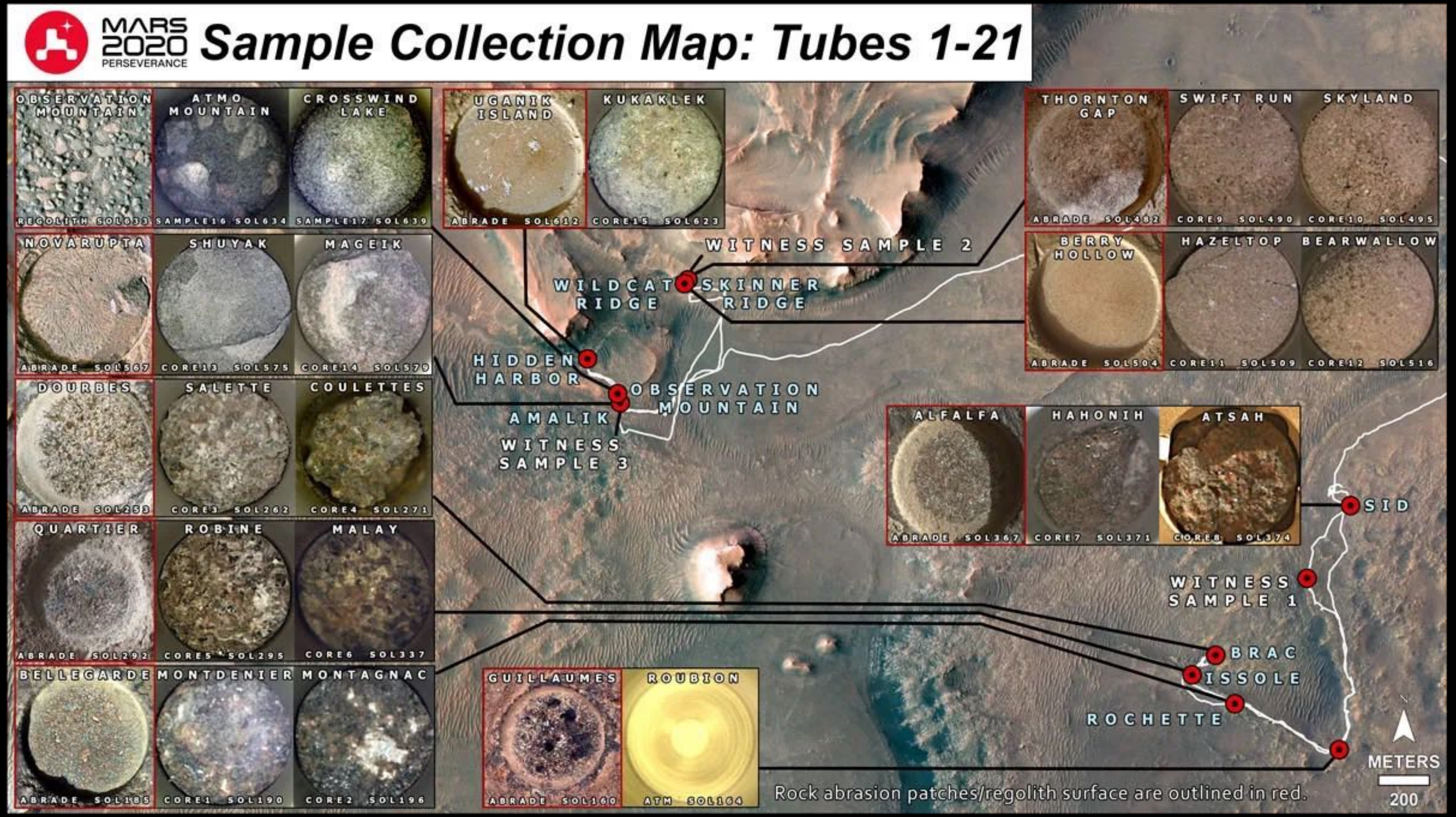
Deploying Ingenuity

Deploying Ingenuity

Ingenuity’s first flight

Ingenuity’s first flight

MOXIE generates oxygen on Mars

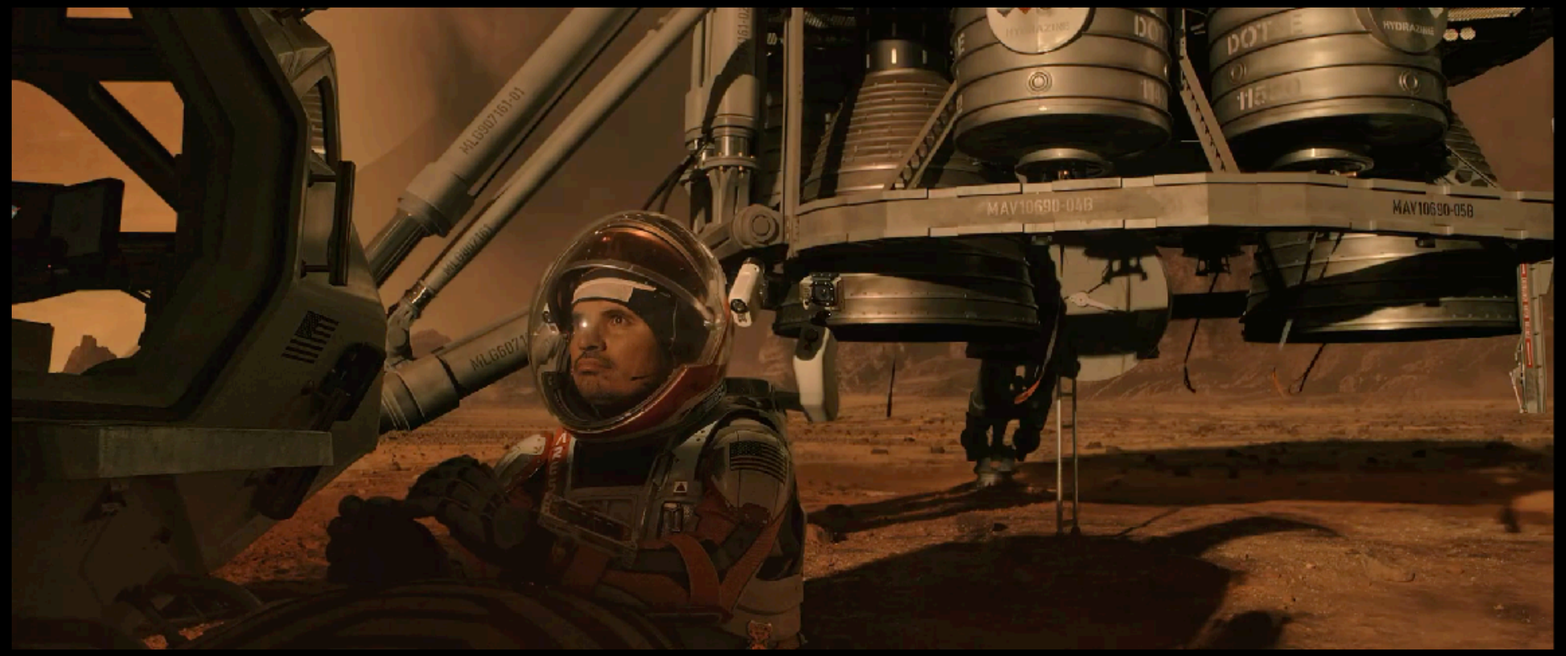


“Three Forks” sample depot

Ingenuity end-of-mission

“Sign of life” – Leopard-spotted rock

Offense #1



Wildly inaccurate sandstorm characterization

Martian dust devil

Sped up 20x

~12 mph

Martian dust devil

Sped up 20x

~12 mph

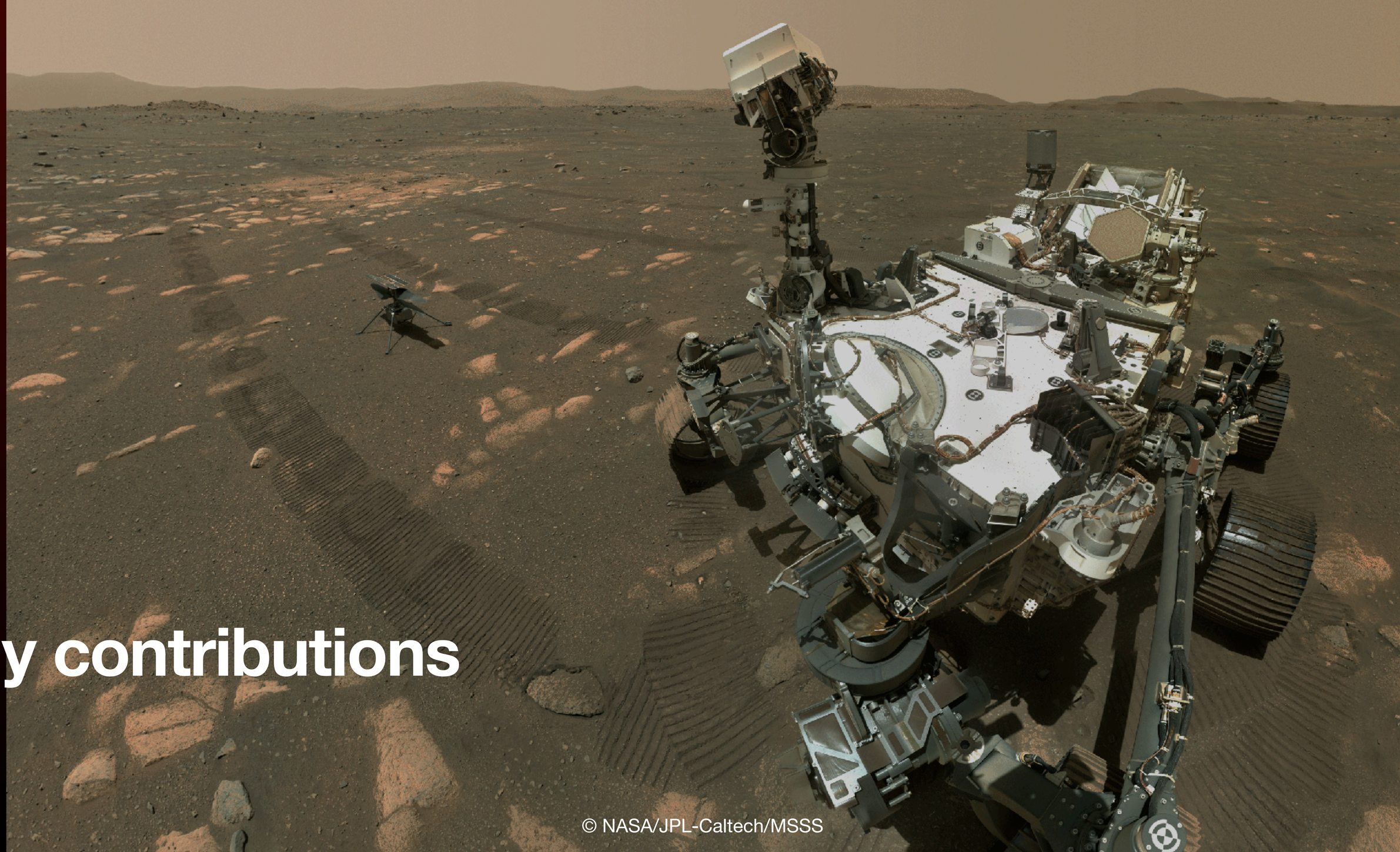
Offense #2

Offense #2

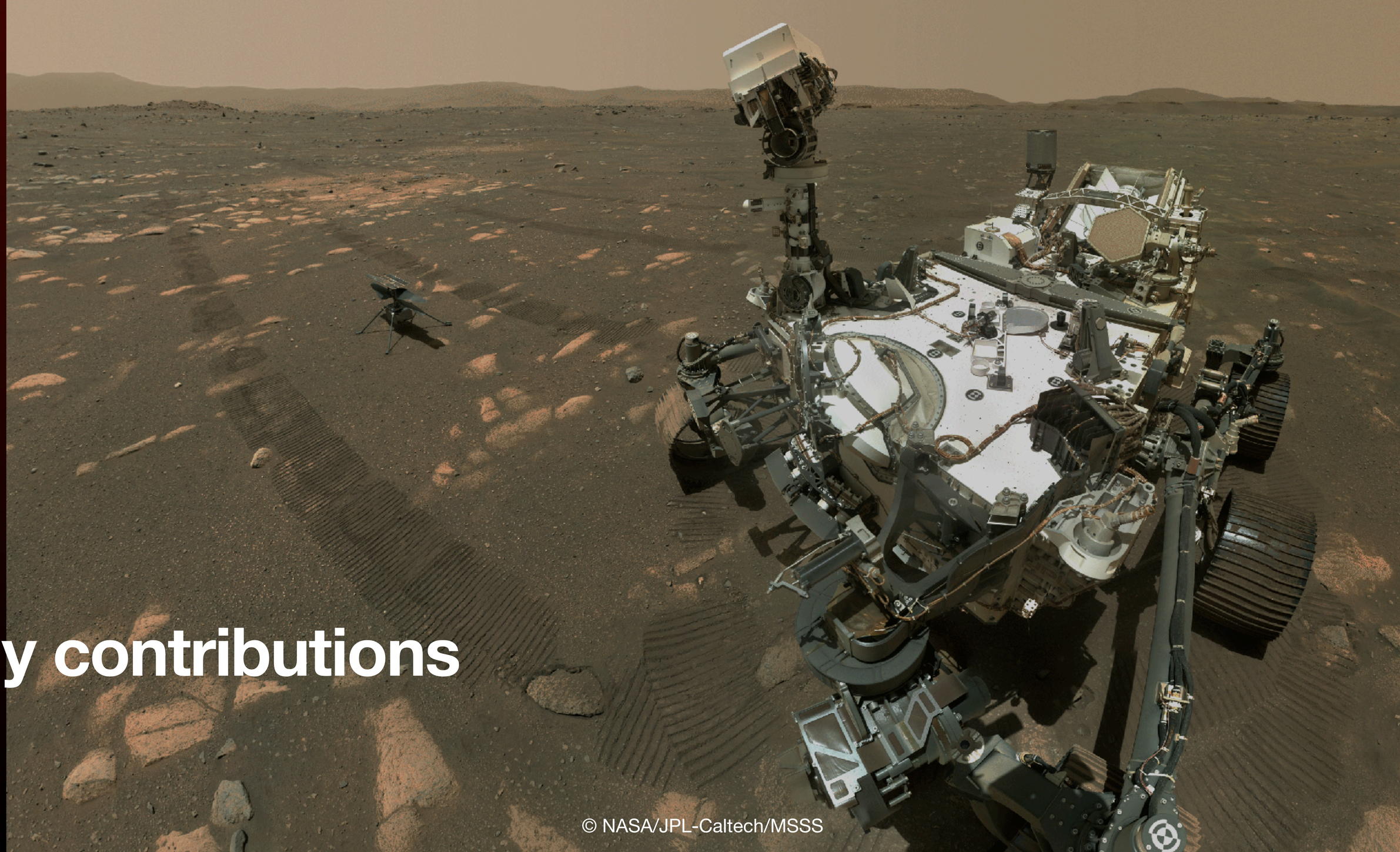
Made JPL look *way* sexier than it is

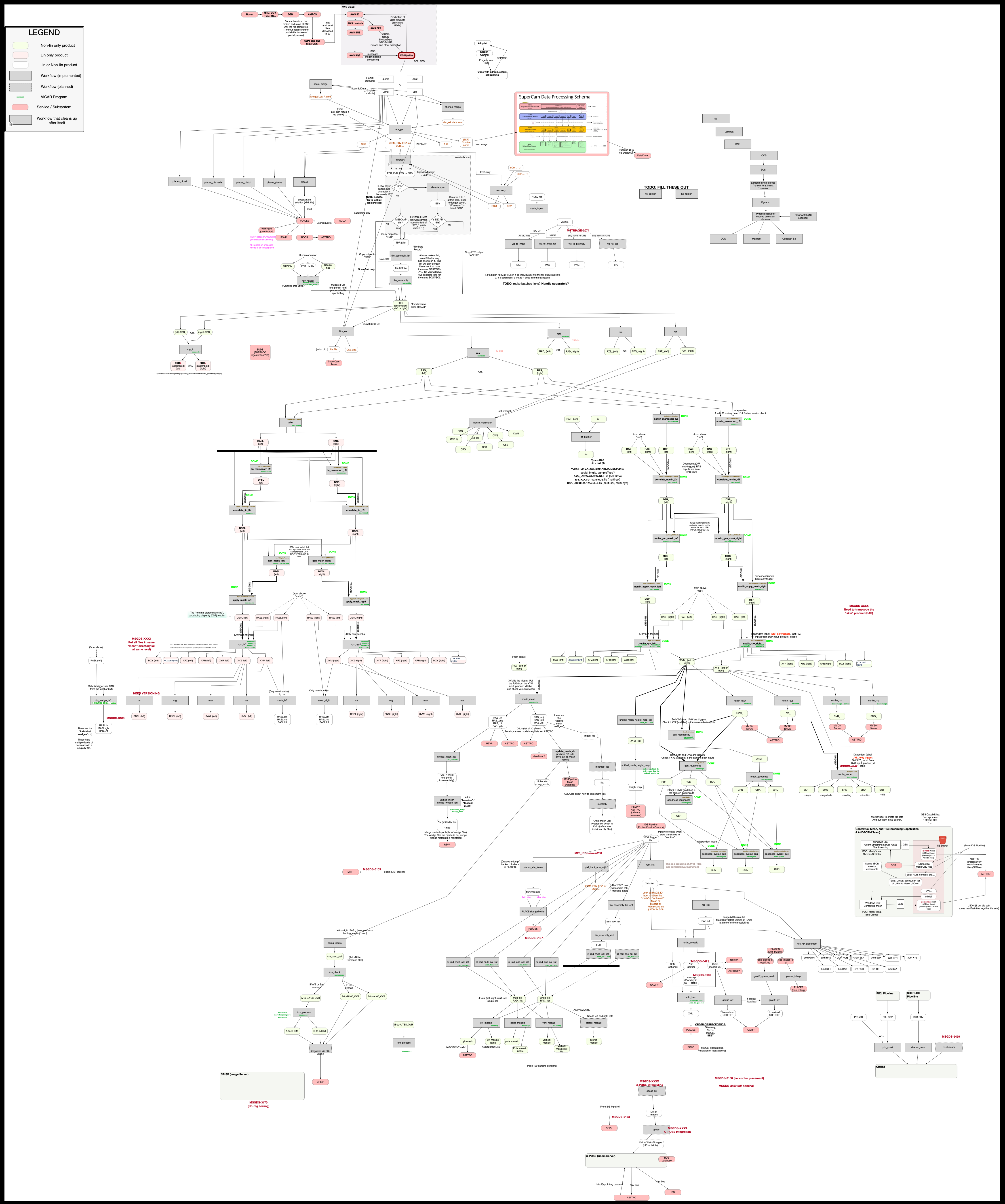
More like

My contributions



My contributions





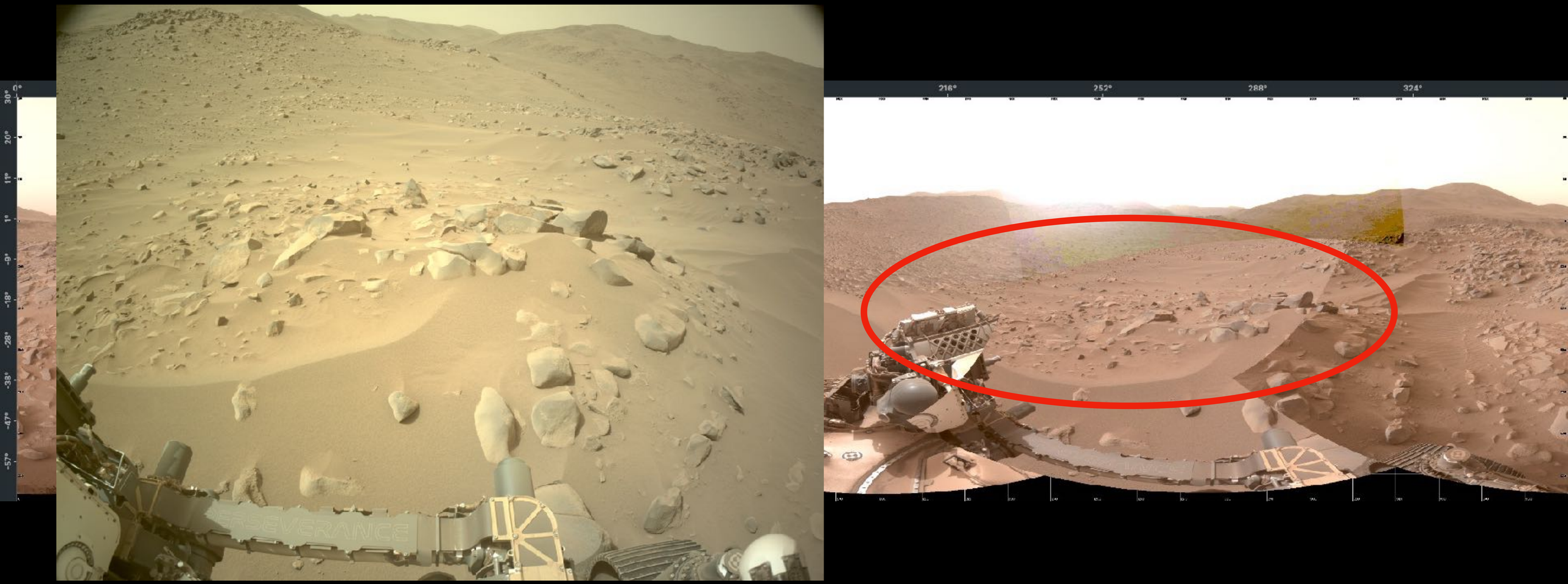
LEGEND
Non-lin only product
Lin only product
Lin or Non-lin product
Workflow (implemented)
Workflow (planned)
marsrad
VICAR Program
Service / Subsystem
Workflow that cleans up after itself
SuperCam Data Processing Schema
TODO: FILL THESE OUT


gen_mask_left
gen_mask_right
DONE
MDSL (left)
MDSL (right)
TRIGGER
apply_mask_left
apply_mask_right
(from above "cahv")
The "nominal stereo matching", producing disparity (DSP) results
DSPL (left)
RASL (right)
RASL (left)
DSPL (right)
(Only non-thumbs)
xyz_left
xyz_right
MSGDS-XXXX
Put all files in same "mesh" directory (all at same level)
(From above)
RASL (left)
MXY (left)
XYX.xmlf (left)
XRZ (left)
XRR (left)
XYR (left)
XYZ (left)
XYM (left)
XYM (right)
XYZ (right)
XYR (right)
XRZ (right)
XRR (right)
MXY (right)
XYX.xmlf (right)
XYM is trigger, use RASL from the label of XYM
NEED VERSIONING!
do_wedge_left
rnr
rng
uvw
uvs
mesh_left
mesh_right
RNRL (left)
RNGL (left)
UVWL (left)
UVSL (left)
RASL.obj
RASL.mtl
RASL.lbl
RNRL (right)
RNGL (right)
UVWL (right)
UVSL (right)
MSGDS-3186
RASL.iv
RASL.rgb
RASL.ht
These are the "individual wedges" (.iv)
These have multiple levels of decimation in a single IV file.
MDS_ (left)
MDS_ (right)
nonlin_apply_mask_left
nonlin_apply_mask_right
Dependent (label) MDS only trigger
(from above "ras")
DSP_ (left)
DSP_ (right)
RAS_ (right)
RAS_ (left)
nonlin_xyz_left
nonlin_xyz_right
Dependent (label) DSP only trigger. Get RAS inputs from DSP input_product_id label
MSGDS-XXXX
Need to transcode the "skin" product (RAS)
XYM_ (left or right)
XYZ_ (left or right)
(From above)
RAS_ (left or right)
XYM is the trigger. Pull the RAS from the XYM input_product_id label, and check version (3char)
nonlin_mesh
RAS_.iv
RAS_.png
RAS_.ht
RAS_.glb
RAS_.obj
RAS_.mtl
RAS_.lbl
these are the "tactical mesh wedges"
OBJs (list of 3D points)
Terrain, camera model metadata --> ASTTRO
RSVP
ASTTRO
ViewPoint?
update_mesh_db
(updates DB (site, drive, az, el, mesh name))
IDS Pipeline Mesh Database
Trigger file
meshlab_list
list
ASK Oleg about how to implement this
meshlab
*.mlp (Mesh Lab Project file, which is XML) (references individual obj files)
unified_mesh_list
RAS_N iv list (one per iv, incrementally)
unified_mesh (unified_wedge_list)
(a.k.a. "baseline" / "tactical mesh")
*.iv (unified iv file)
*.mod
Merge mesh (input is list of wedge files). The wedge files are create in do_wedge. Wedge metadata is registered.
RSVP
Schedule coreg_inputs
unified_mesh_height_map_list
XYM_list
unified_mesh_height_map
Height map
RSVP ? ASTTRO (primary consumer)
Both XYM and UVW are triggers. Check if XYZ (via label) is the same in both inputs.
gen_reachability
gen_roughness
nonlin_uvw
nonlin_uvs
nonlin_rnr
nonlin_rng
UVW_
UVS_
RNR_
RNG_
MV DN Server
ASTTRO
ARM_
reach_goodness
RUF_
RUS_
RUC_
GRN
GRA
GRC
Check if UVW (via label) is the same in both inputs
goodness_roughness
GSR
Dependent (label) UVS_only trigger. Get XYZ_ input from UVS input_product_id label
MSGDS-4242
nonlin_slope
SLP_
SMG_
SHD_
SRD_
SNT_
-slope
-magnitude
-heading
-direction
-ntilt
IDS Pipeline (EopNotificationDaemon)
EOP Trigger file
Pipeline creates when state transitions to "inactive"
Independent inputs
goodness_overall_gun
goodness_overall_gua
goodness_overall_guc
GUN
GUA
GUC
M20_IDS/issues/260
(Creates a dump/ backup of what's in PLACES)
places_site_frame
pixl_track_arm_add
(ECM, ECV, ECZ, or ECR)
The "EDR" now with added PIXL tracking labels
xym_list
This is a grouping of XYM_ files per sol/site/drive/instrument
XYM list
Min/max site
Min site
Max site
PLACE site frame file
PLACES
MSGDS-3187
tile_assembly_list_ebt
EBT TDR list
tile_assembly_ebt
FDR
zl_rad_multi_sol_list
zl_rad_one_sol_list
Look at IMAGE_ID label to determine "mesh" or "not mesh"
Mesh bit
Mosaic bit
Mosaic 2nd bit
(LOOK IN SIS)
ras_list
RAS list
Image (VIC skins) list
Most likely latest version of RADs at time of ortho mosaicking
ortho_mosaic
heli_rdr_placement
MTTT
MSGDS-3153
(From IDS Pipeline)
left or right RAS_ (uses products, but triggered by them)
coreg_inputs
icm_cand_pair
(A-to-B file *.icmcand files)
icm_check
IF A/B or B/A overlaps
IF NO overlap
A-to-B.YES_OVR
A-to-B.NO_OVR
B-to-A.NO_OVR
icm_process
A-to-B ICM
B-to-A ICM
(triggered via S3->SQS)
B-to-A.YES_OVR
icm_process
CRISP
CRISP (Image Server)
nr_rad_multi_sol_list
nl_rad_multi_sol_list
nl_rad_one_sol_list
nr_rad_one_sol_list
4 total (left, right, multi-sol, single-sol)
Multi-sol RAD_ list
Single-sol RAD_ list
ONLY NAVCAM
Needs left and right lists
cyl_mosaic
polar_mosaic
vert_mosaic
stereo_mosaic
cyl mosaic
cyl mosaic list file
polar mosaic
Polar mosaic list file
vertical mosaic
Vertical mosaic list file
Stereo mosaic
ABC1234CYL.VIC
ABC1234CYL.lis
ASTTRO
Page 120 camera sis format
DEM (optional)
*.tif (geotiff)
MSGDS-6421
Ortho mosaic VIC
rsketch
ASTTRO ?
CAMP?
basemap (Probably in S3 -- static)
MSGDS-3169
auto_loco
XML
PLACES
ROLO
ORDER OF PRECEDENCE:
Telemetry, AUTO, manual, BEST
(Manual localizations, validation of localizations)
PLACES (best_tactical)
sqs_places_geotiff_loc
sqs_places_sol
geotiff_queue_work
places_interp
PLACES (best_interp)
geotiff_orr
If already localized
Telemetered ORR TIFF
Localized ORR TIFF
CAMP
MSGDS-3160 (helicopter placement)
MSGDS-XXXX
30m GUH
30m RAS
30m RUH
30m SLH
30m SLP
30m TFH
30m XYZ
5m GUH
5m RAS
5m RUH
5m TFH
5m XYZ
Worker pool to create tile sets And put them in S3 bucket.
GSS Capabilities: * accept mesh * stream tiles
Contextual Mesh, and Tile Streaming Capabilities (LANDFORM Team)
Windows EC2 Geom Streaming Server (GSS) Tile Streaming
GSS
POC: Marty Vona, Thomas Schibler
S3 Bucket
Tactical mesh 3DTiles tileset
SQS
IDS tactical Mesh OBJ files
Scene JSON creator executable
color RDR, normals, etc...
SITE_DRIVE_scene.json list of URLs to tileset JSONs
XYZs
orbital
Windows EC2 Contextual Mesh
Contextual mesh 3DTiles tileset
POC: Marty Vona, Bob Crocco
ASTTRO progressively loads/streams tiles (3DTiles)
PIXL Pipeline
SHERLOC Pipeline
PC*.VIC
RXL CSV
RLS CSV
pixl_crust
sherloc_crust
crust-scam
MSGDS-5459
CRUST

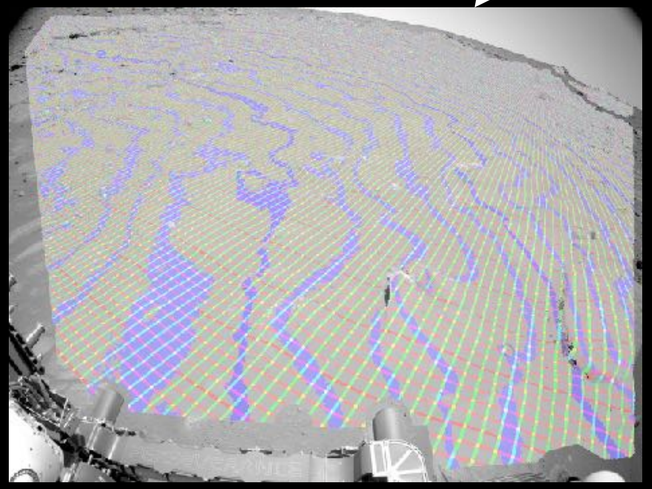
Sol 999 Navcam cylindrical mosaic

Sol 999 Navcam cylindrical mosaic

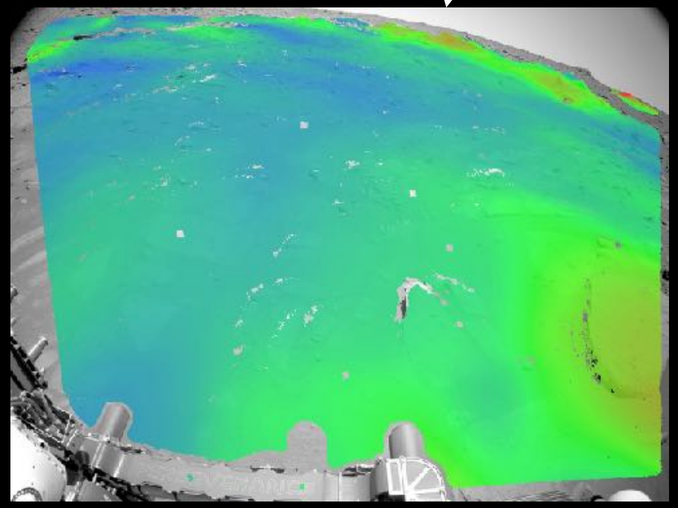
Sol 999 Navcam cylindrical mosaic



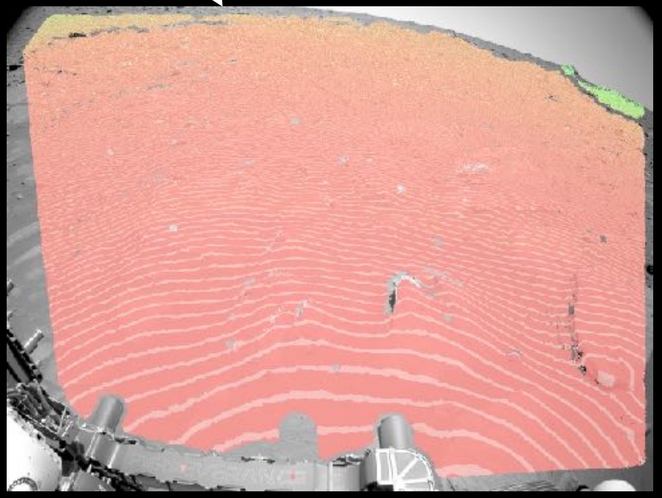
Sol 999 Navcam VCE FDR



XYZ

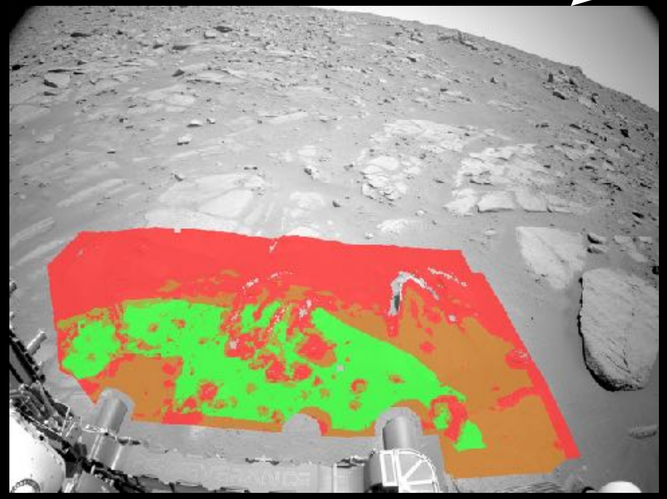


Slope map



Range map

Sol 999 Navcam VCE FDR



Goodness for abrading

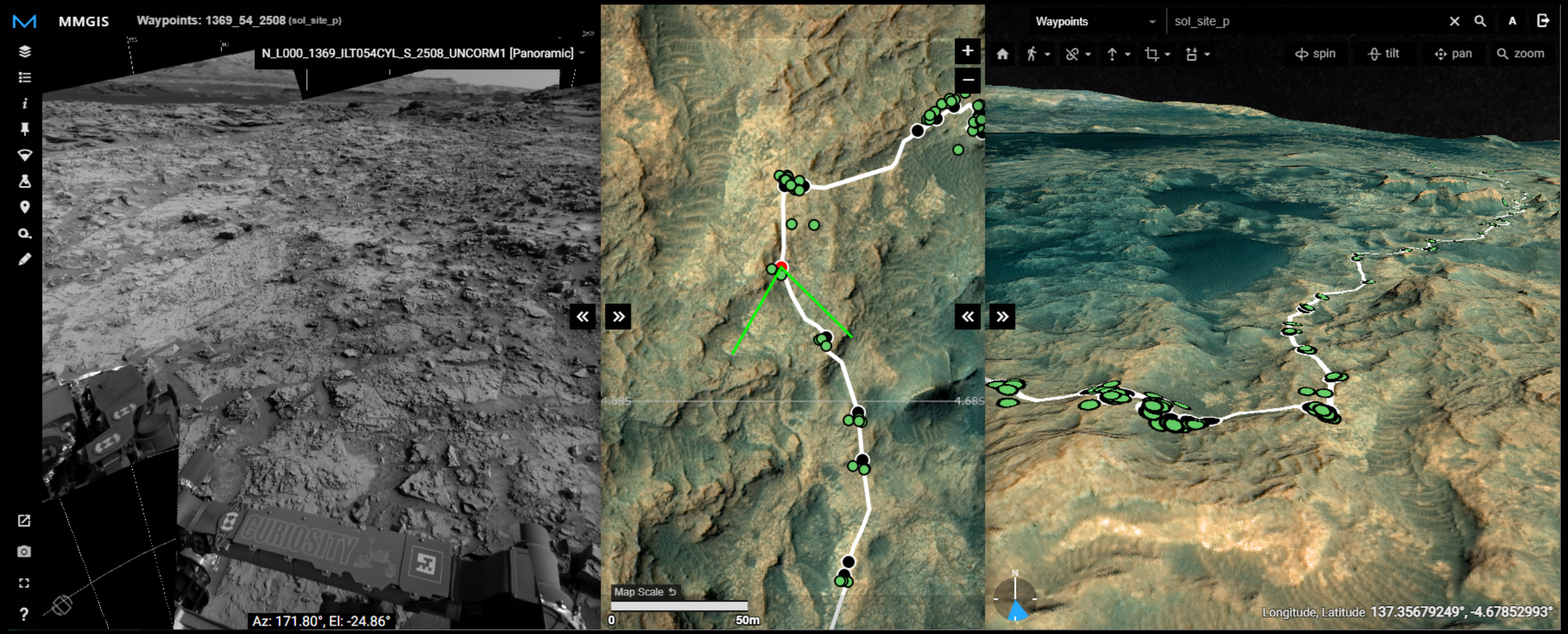
And 30+ more!

Arm reachability

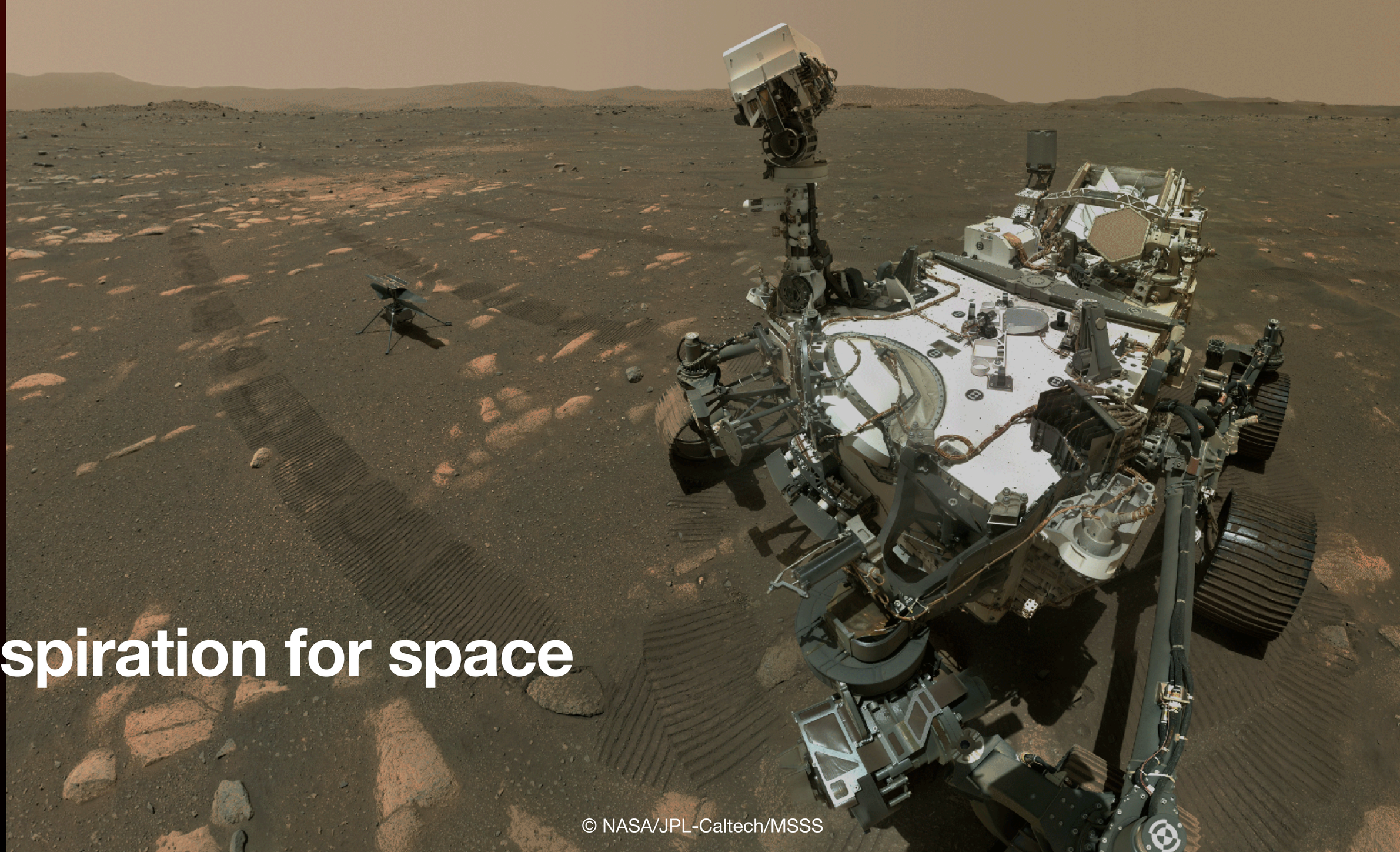
Meshes & 3D tools

Meshes & 3D tools

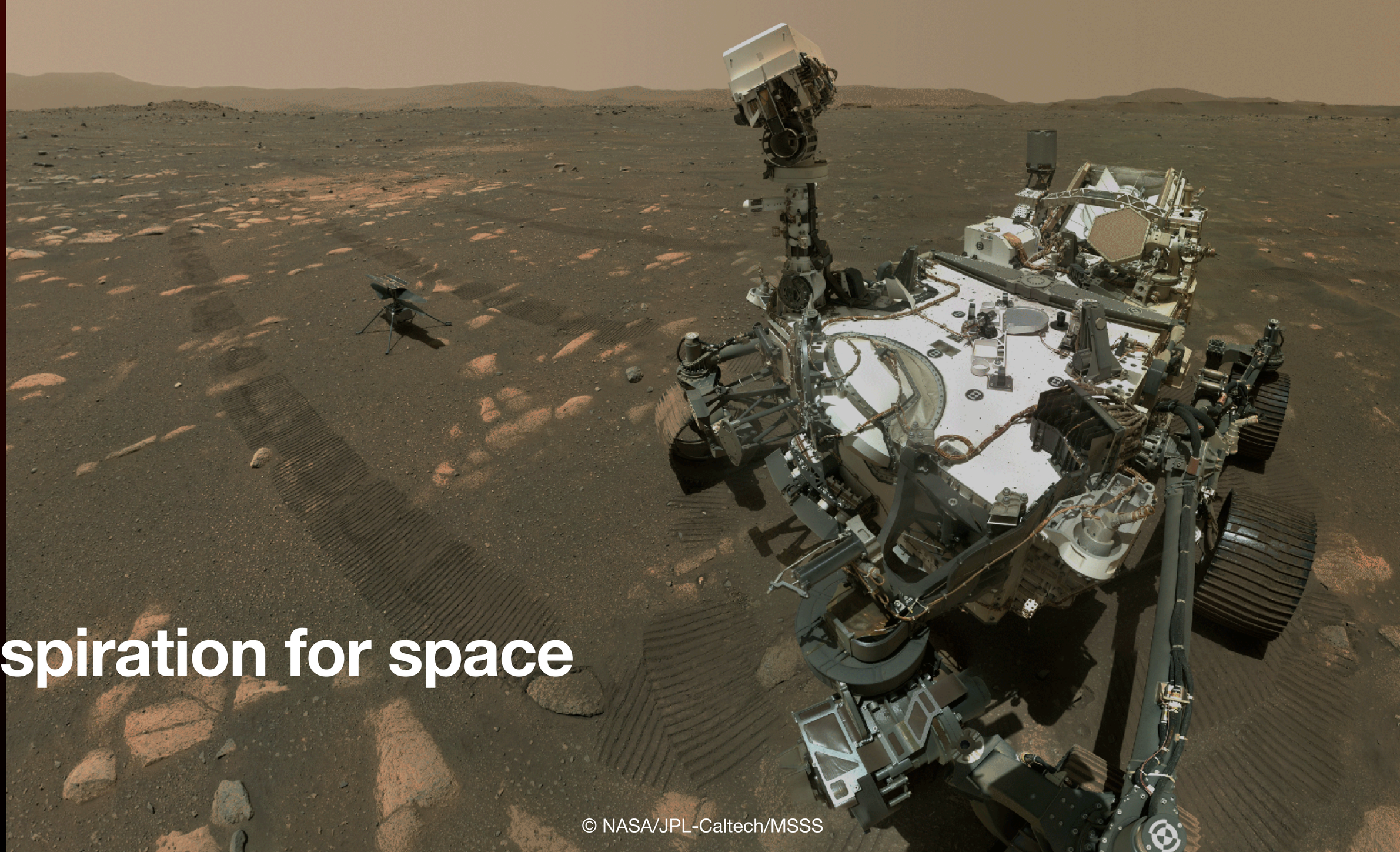
Cartography & localization



Visualization



Inspiration for space

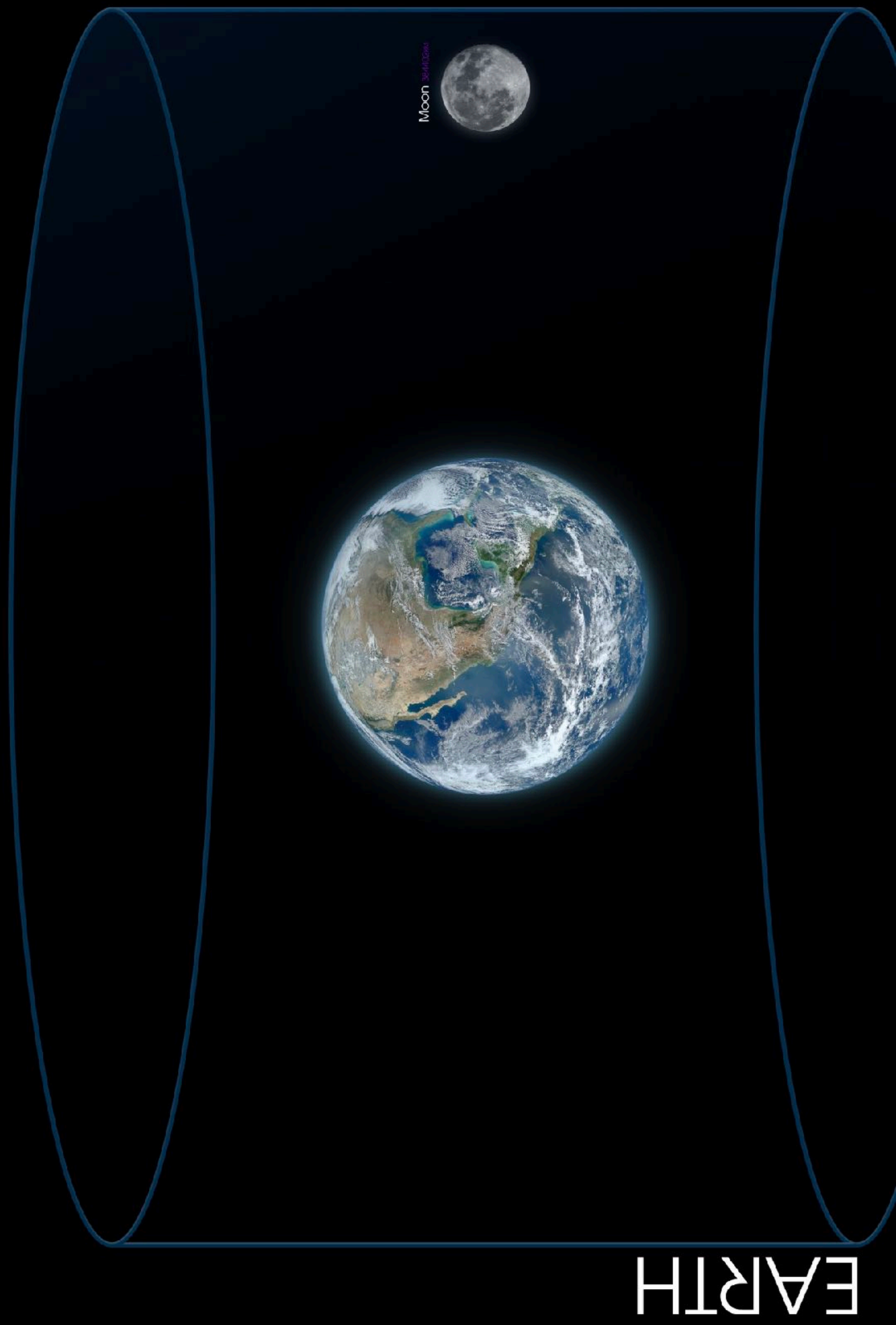


Inspiration for space

Church of the Valley, Highland, California

It started with a sermon on the immensity of the universe…

https://commons.wikimedia.org/wiki/File:Location_of_Earth_(9x1-English_Annot).jpg



INNER SOLAR SYSTEM

https://commons.wikimedia.org/wiki/File:Location_of_Earth_(9x1-English_Annot).jpg

OUTER SOLAR SYSTEM

https://commons.wikimedia.org/wiki/File:Location_of_Earth_(9x1-English_Annot).jpg

CLOSEST STARS

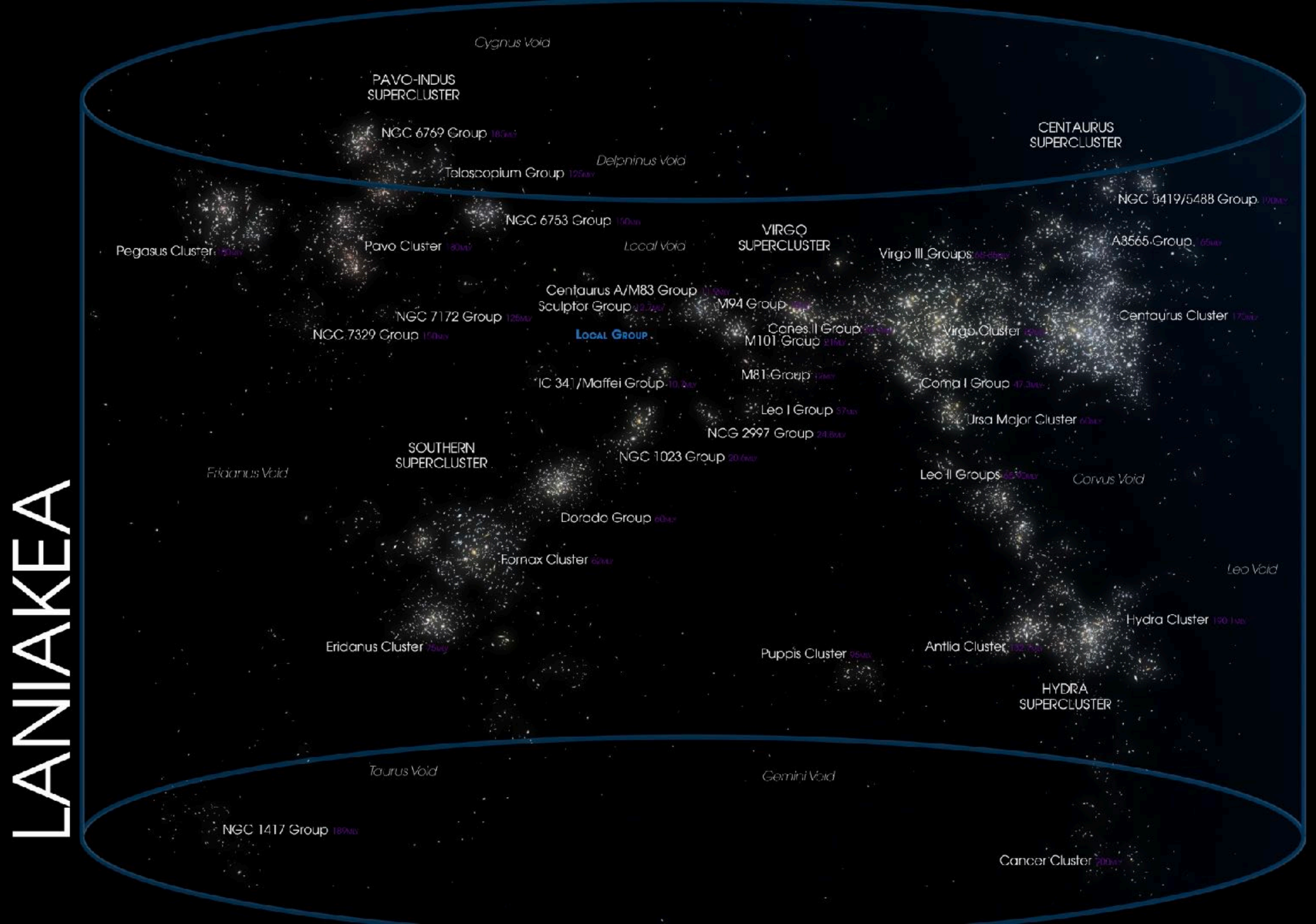
https://commons.wikimedia.org/wiki/File:Location_of_Earth_(9x1-English_Annot).jpg

MILKY WAY GALAXY

https://commons.wikimedia.org/wiki/File:Location_of_Earth_(9x1-English_Annot).jpg

LOCAL GROUP

https://commons.wikimedia.org/wiki/File:Location_of_Earth_(9x1-English_Annot).jpg



https://commons.wikimedia.org/wiki/File:Location_of_Earth_(9x1-English_Annot).jpg

LOCAL SUPERCLUSTERS

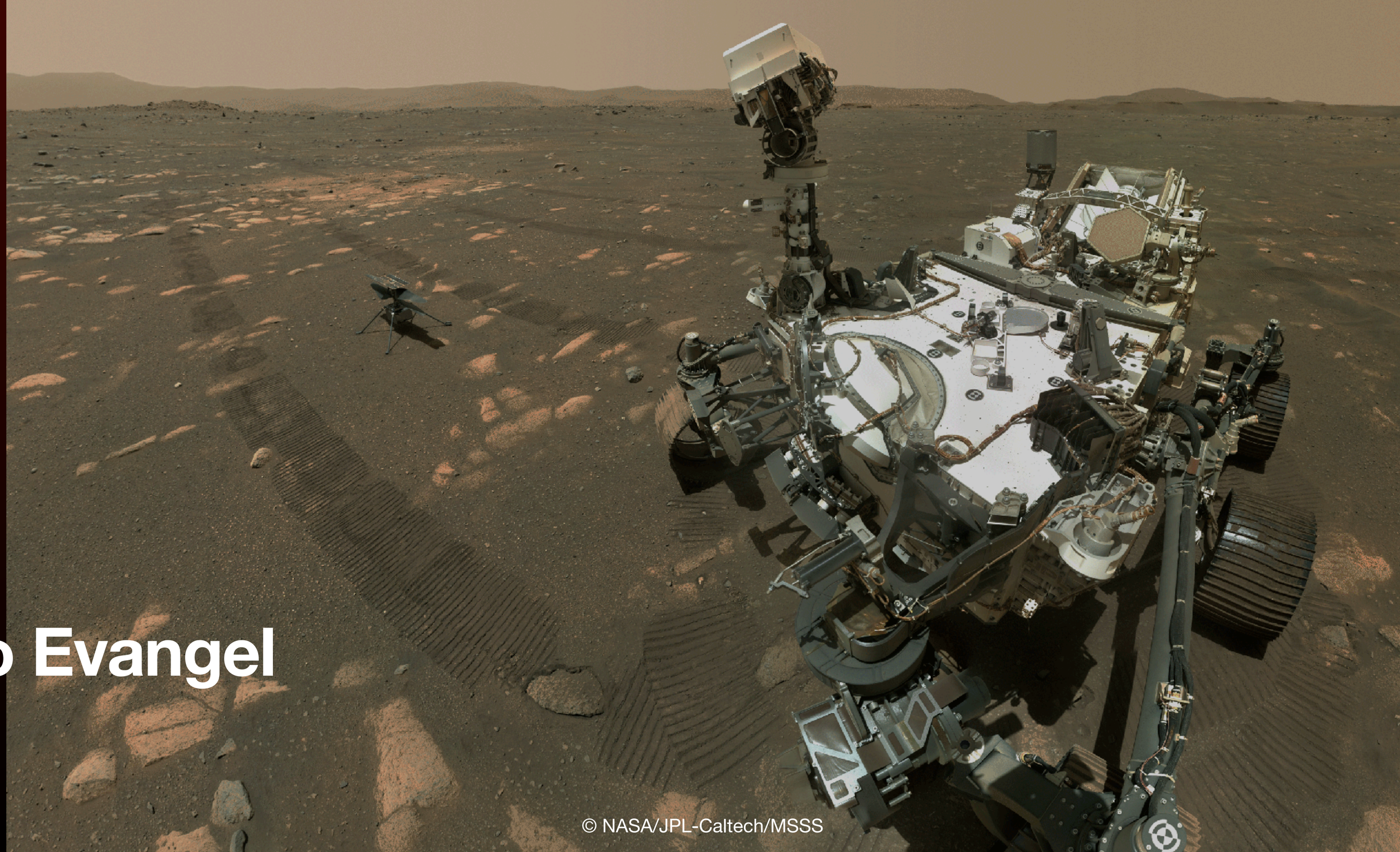
https://commons.wikimedia.org/wiki/File:Location_of_Earth_(9x1-English_Annot).jpg

OBSERVABLE UNIVERSE

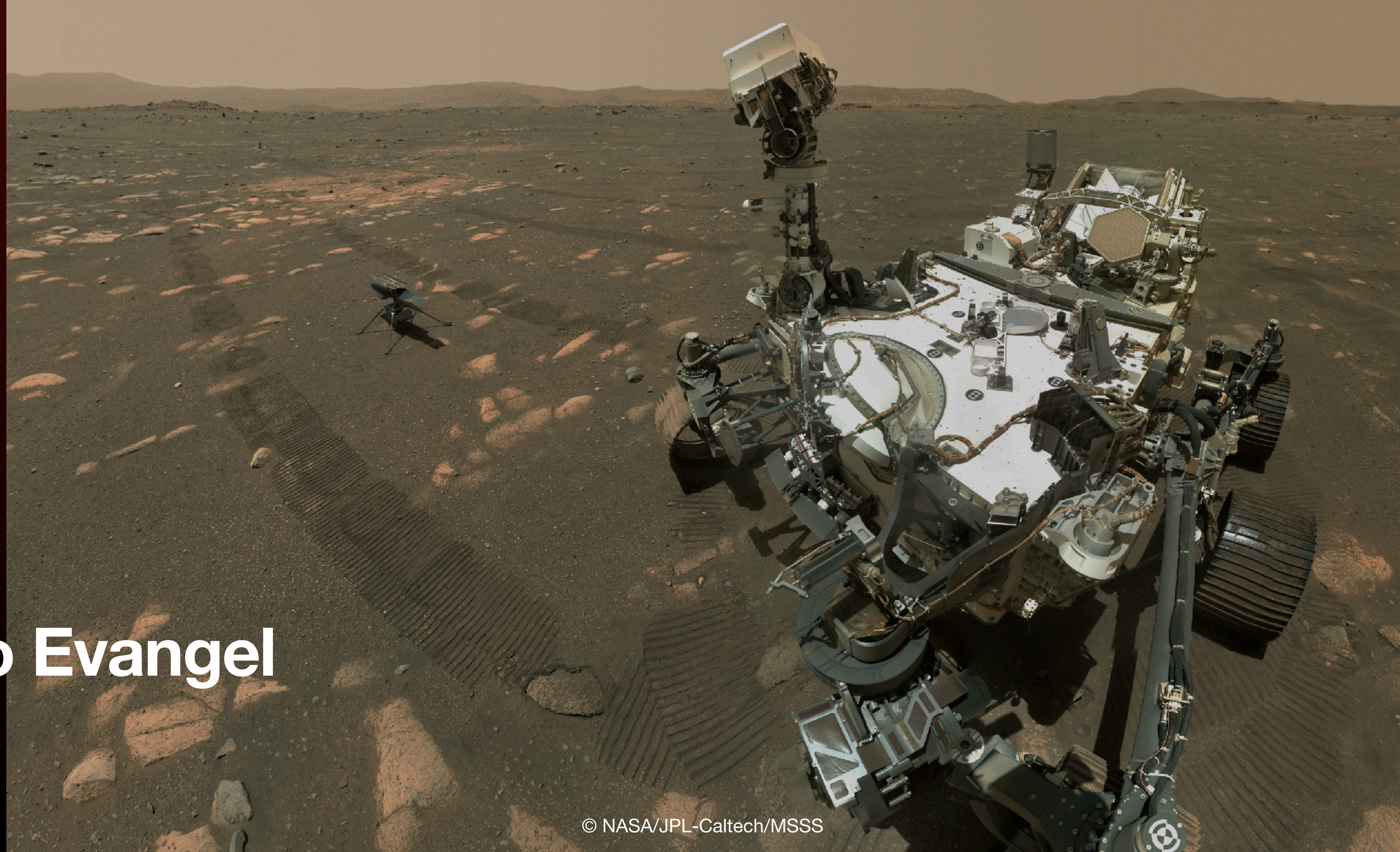
https://commons.wikimedia.org/wiki/File:Location_of_Earth_(9x1-English_Annot).jpg

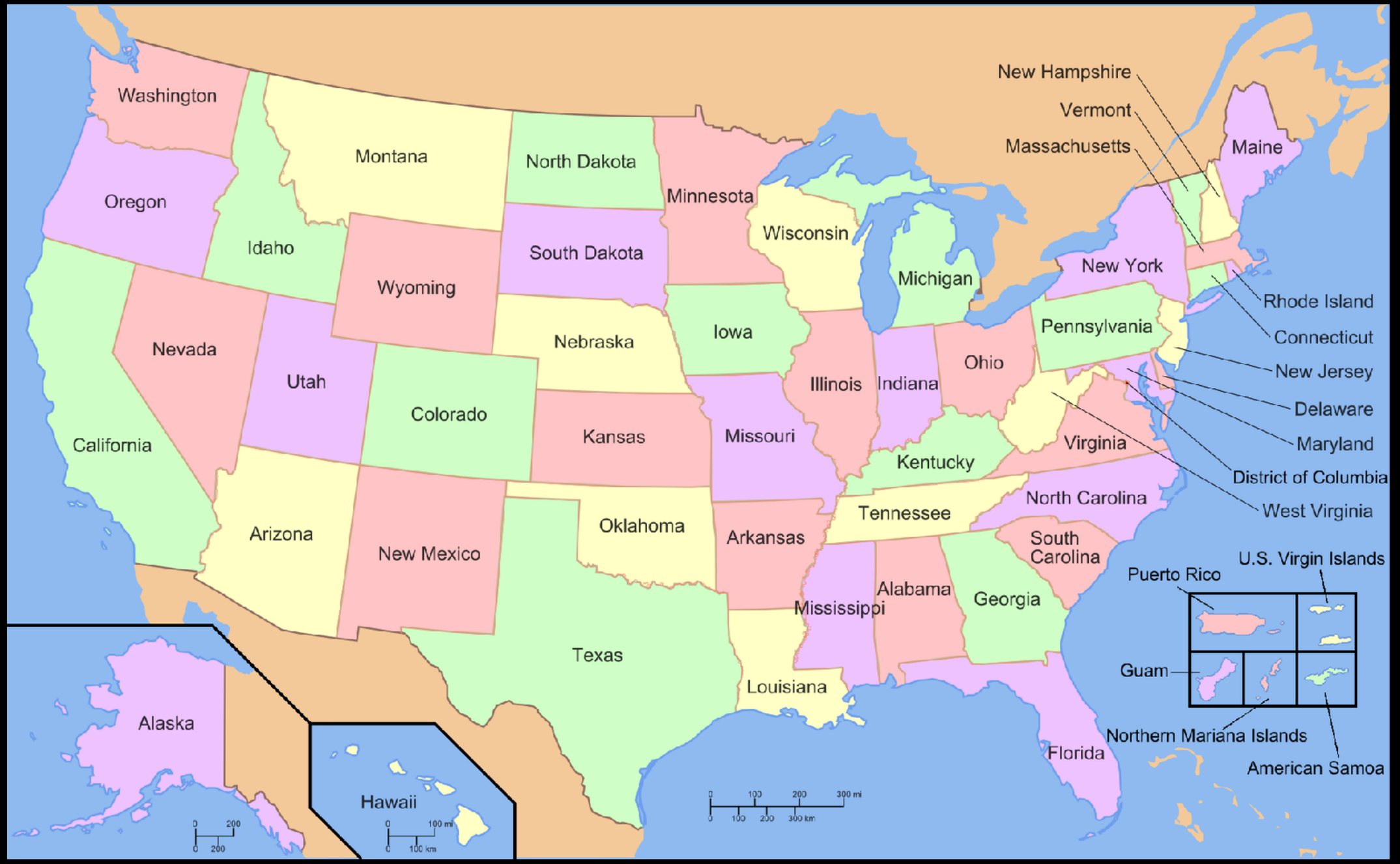
The takeaway: the universe is massive, God controls it all, and *yet* he still loves little old you!

To Evangel



To Evangel




Washington
Oregon
California
Idaho
Nevada
Montana
Wyoming
Utah
Arizona
Colorado
New Mexico
North Dakota
South Dakota
Nebraska
Kansas
Oklahoma
Texas
Minnesota
Iowa
Missouri
Arkansas
Louisiana
Wisconsin
Illinois
Michigan
Indiana
Ohio
Kentucky
Tennessee
Mississippi
Alabama
Georgia
Florida
South Carolina
North Carolina
Virginia
West Virginia
Pennsylvania
New York
Maryland
Delaware
New Jersey
Connecticut
Rhode Island
Massachusetts
Vermont
New Hampshire
Maine
District of Columbia
Alaska
Hawaii
Puerto Rico
U.S. Virgin Islands
Guam
Northern Mariana Islands
American Samoa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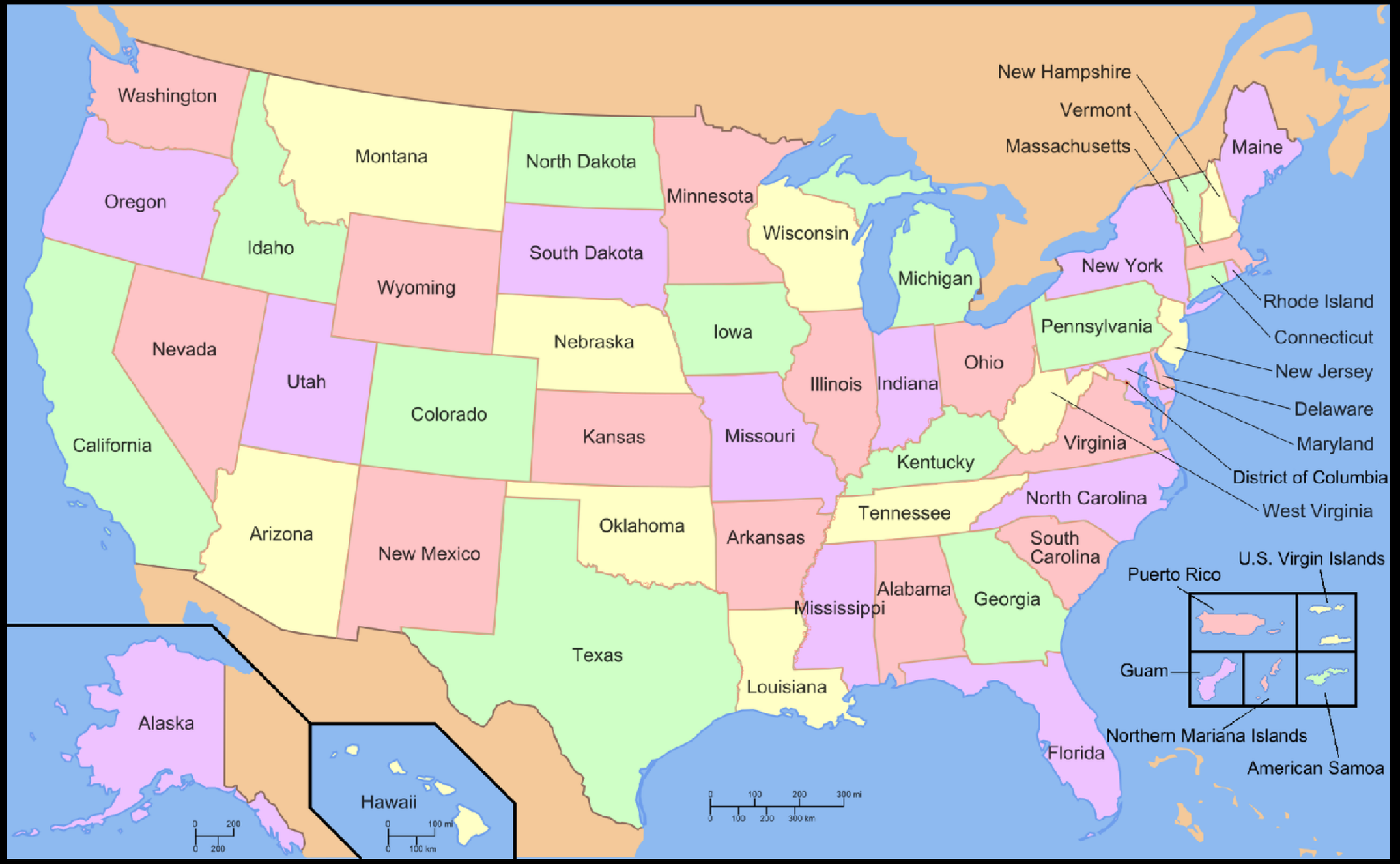
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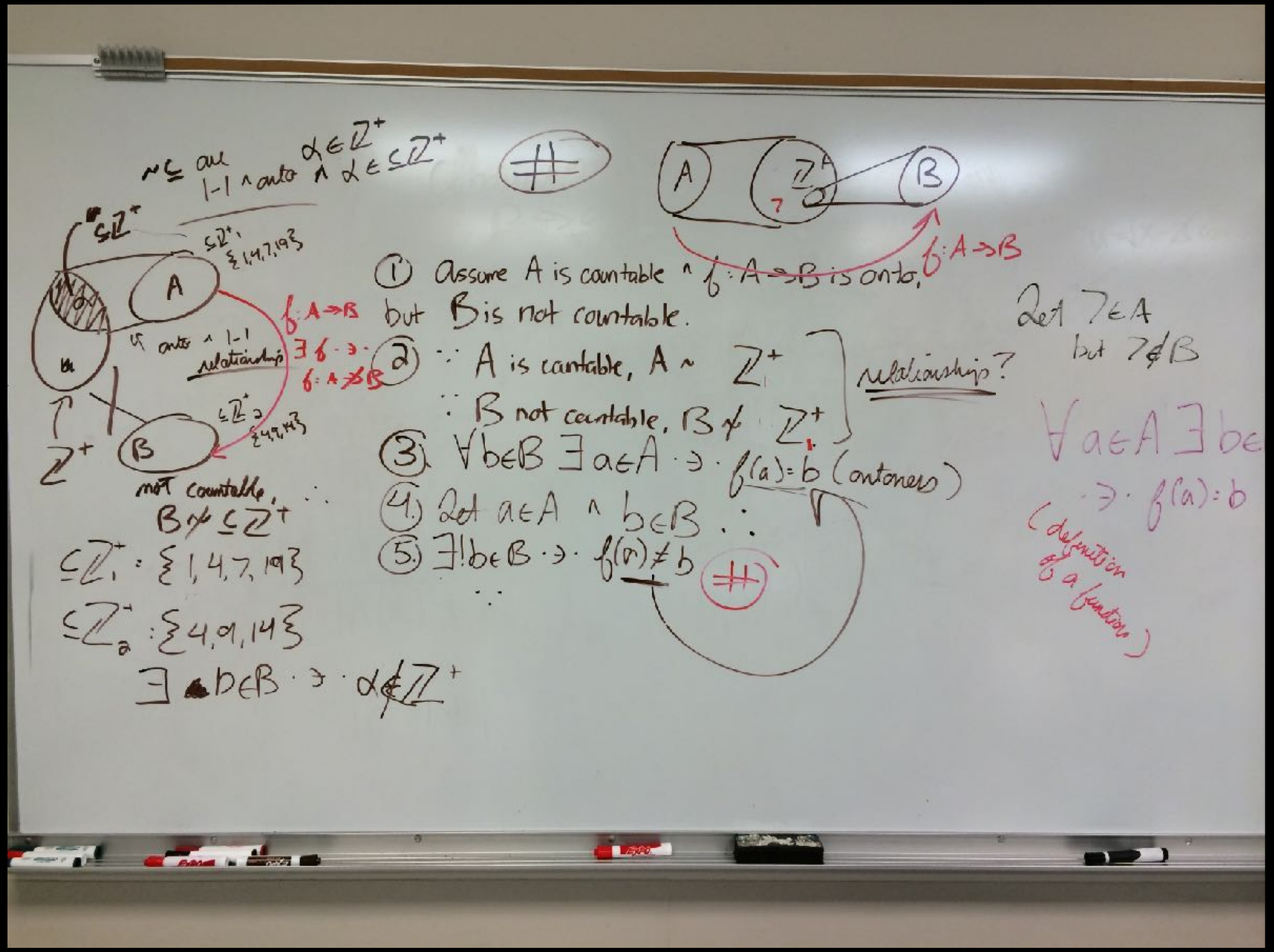
Department of Natural and Applied Sciences

My life quickly devolved into:



Kappa Mu Epsilon

(Math club; not a fraternity)

Until…


vecteezy.com
CPSC 111
Introduction to C++ Programming


vecteezy.com
CPSC 111
Introduction to C++ Programming

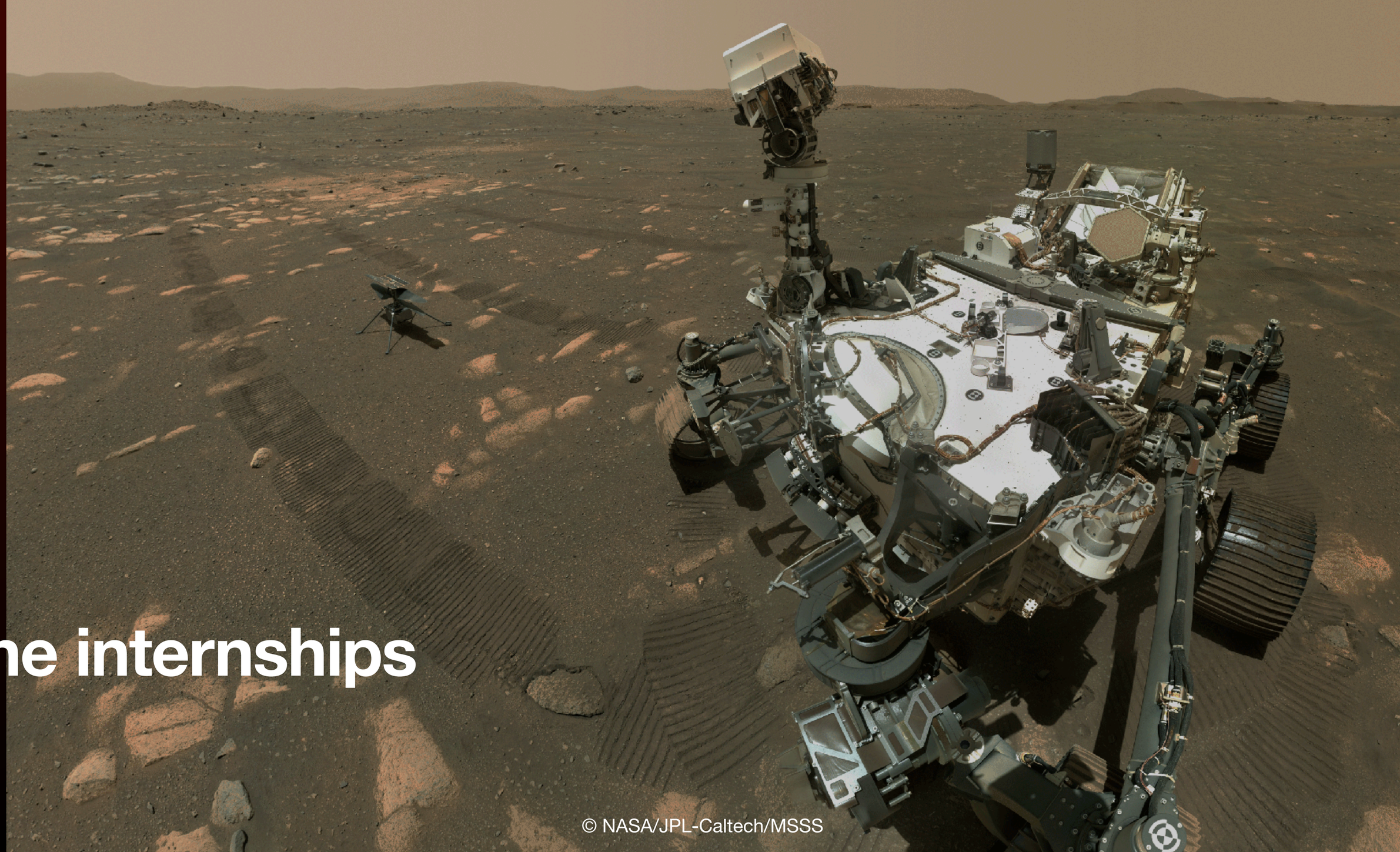
✨ Automation ✨

Take classes you think you'll hate!

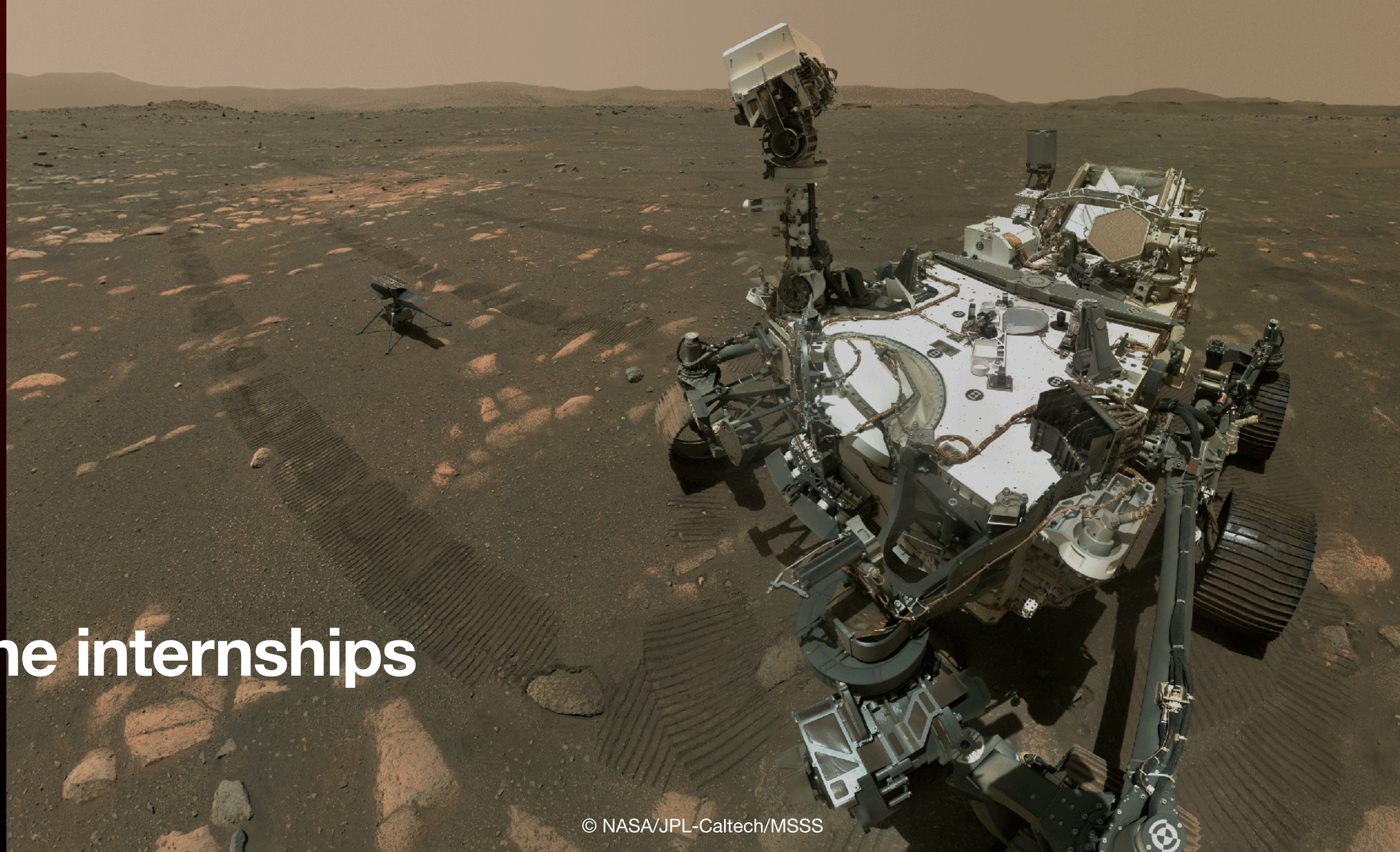
Evangel taught me to…

- …develop the analytical part of my brain
- …work tirelessly on problems until it clicked
- …not be afraid to ask questions
- …not attempt complete everything on my own

The internships



The internships



JPL PROGRAMS

Summer Internship Program

The JPL Summer Internship Program offers 10-week, full-time, summer internship opportunities at JPL to undergraduate and graduate students pursuing degrees in science, technology, engineering or mathematics.

As part of their internships, students are partnered with JPL scientists or engineers, who serve as the students' mentors. Students complete designated projects outlined by their mentors, gaining educational experience in their fields of study while also contributing to NASA and JPL missions and science. Students will also have the opportunity to participate in a number of enrichment activities, including tours, lectures and career advisement, arranged by the JPL Education Office.

Requirements:

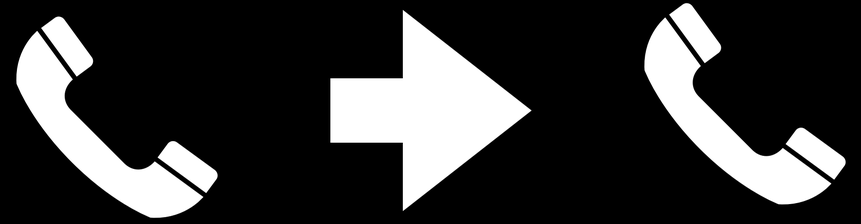
- Currently enrolled undergraduate and graduate students pursuing degrees in science, technology, engineering or mathematics disciplines from accredited U.S. universities.
- Minimum cumulative 3.00 GPA. The cumulative GPA must originate from the institution where the student has a current active status.
- Open to U.S. citizens and lawful permanent residents (LPRs).
- Students must be available full time (40 hours per week) for at least 10-weeks in the summer.

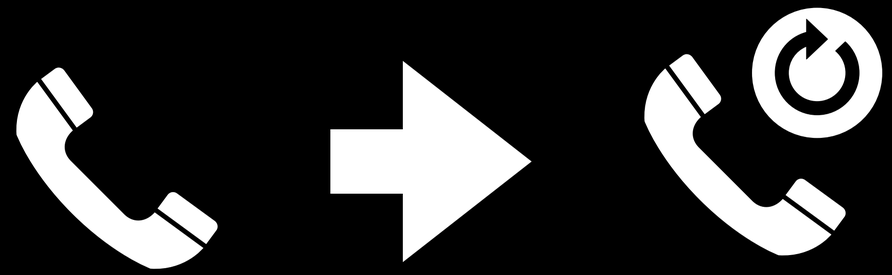
About JPL Internships

NASA's Jet Propulsion Laboratory is a federally funded research and development center managed by Caltech and a leading center for robotic exploration of the solar system. The JPL Education Office works closely with NASA and Caltech, as well as educational organizations and institutions to offer internship opportunities at the laboratory to students from diverse backgrounds and in various stages of their education.

› Learn more about JPL internships and how to apply

Call #1


Call #1
Call #2



Call #1

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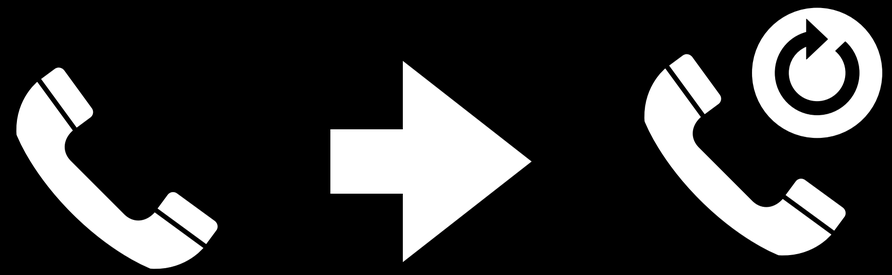
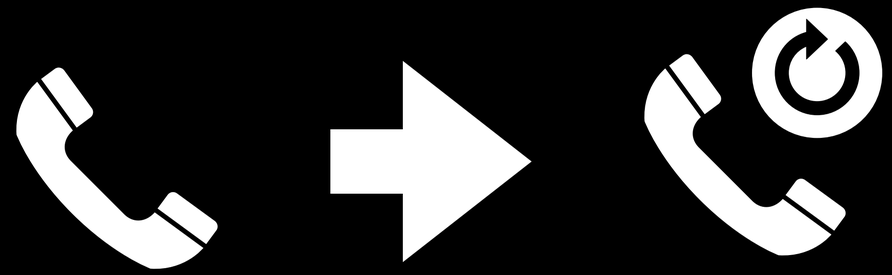


Call #1 Call #4



Call #1

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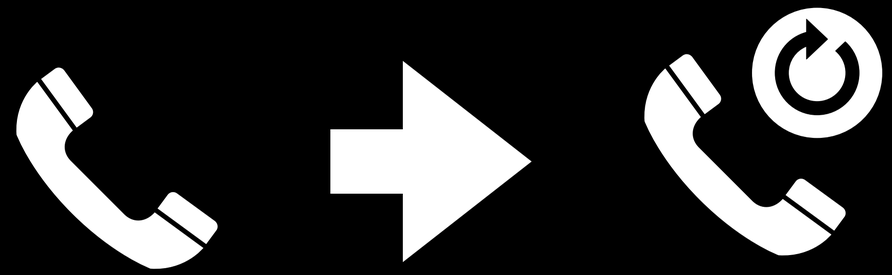
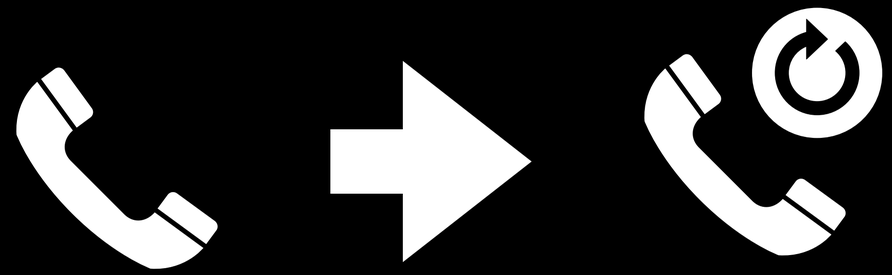
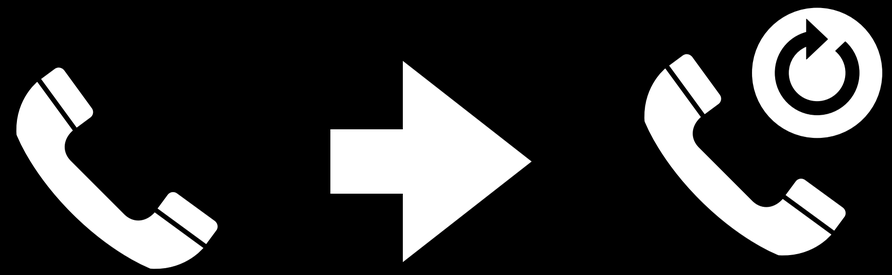


Call #1

Call #6

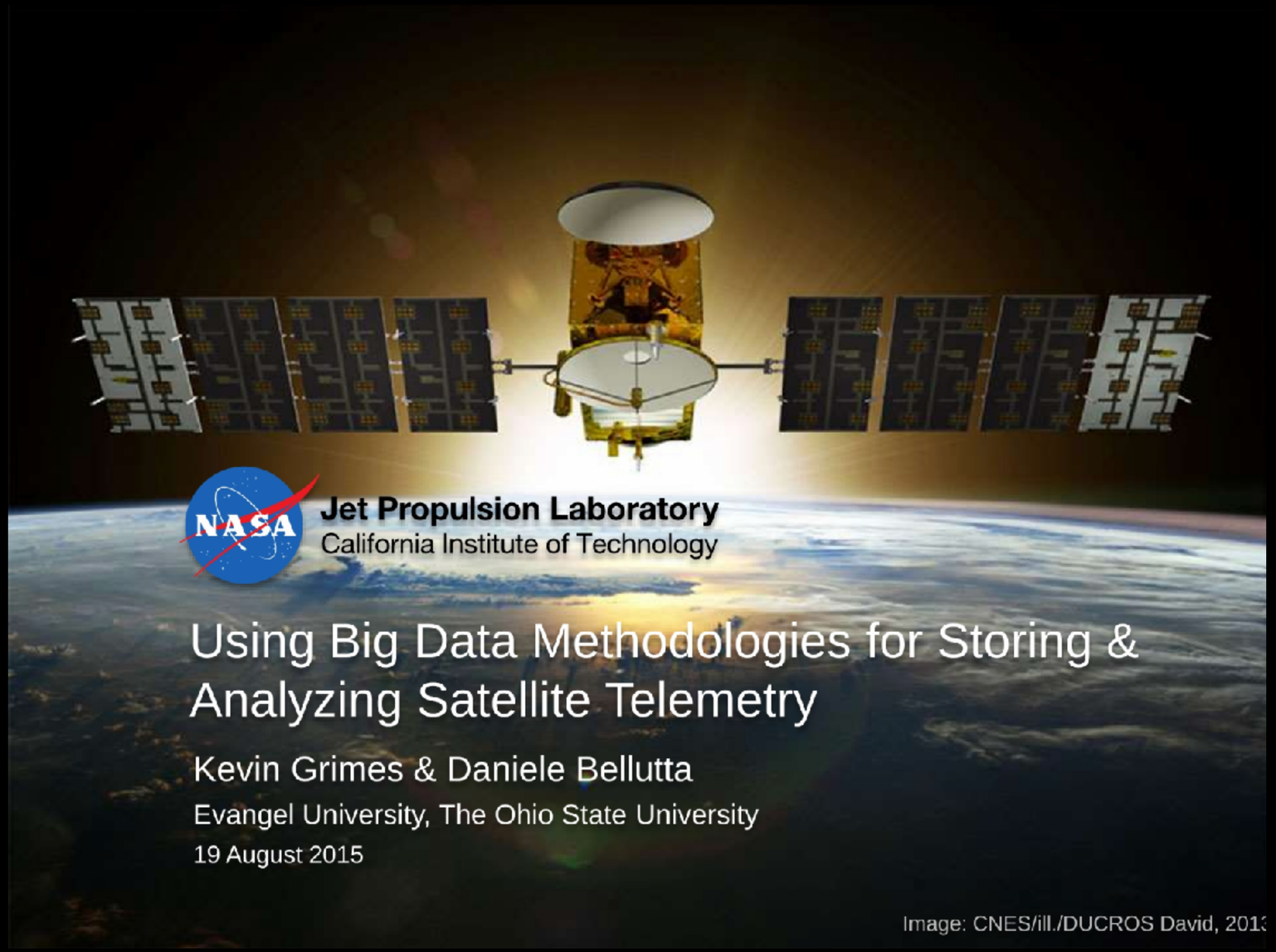


Call #1 Call #7

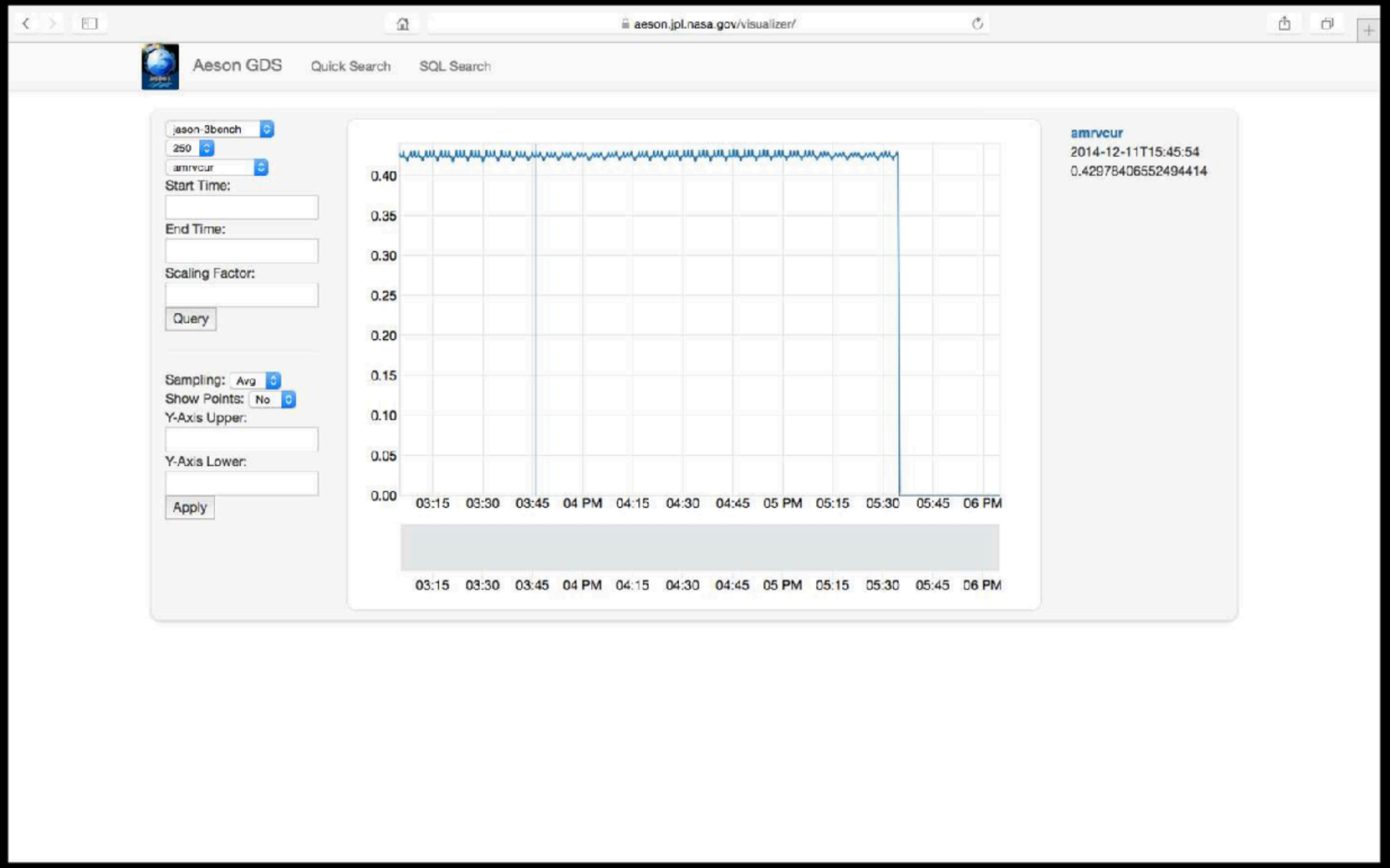


Call #1 Call #8

Internship #1 - Summer 2015



Internship #1 - Summer 2015

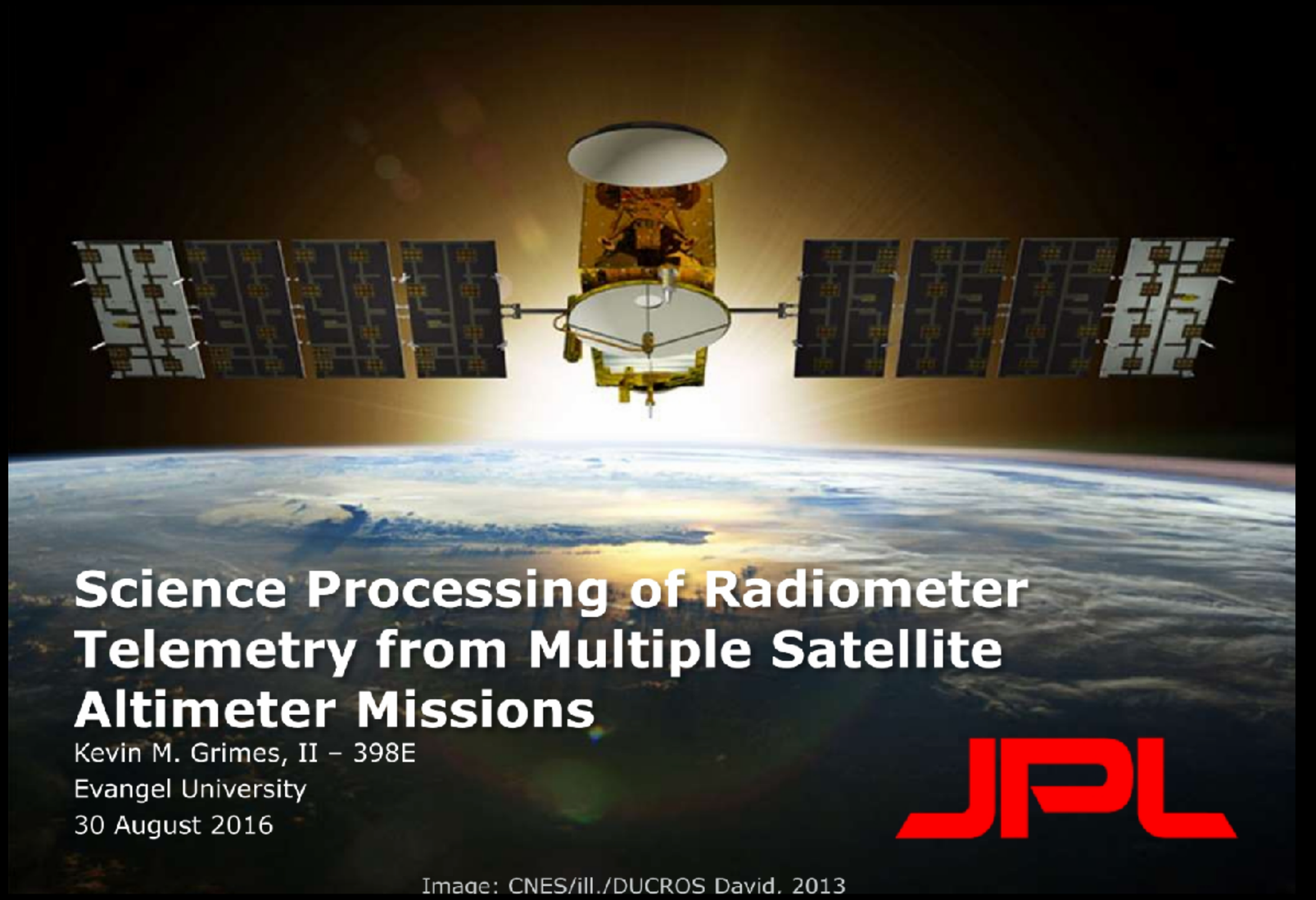


Internship #1 - Summer 2015

```
data-dumper.pl
Copyright 2015, Jet Propulsion Laboratory
Property of California Institute of Technology.
Current APID: 250

---------------------------------
1. Query using the SQL plug-in
2. Query using the normal script
---------------------------------

Your choice: 2

Query all ("yes" to query entire ES source, "no" to enter custom dates)? yes

WARNING! Are you sure? Querying all of the data (from 1980-01-06T00:00:39.000Z to 2014-12-11T18:05:09.000Z) may take a very long time!

Enter a non-zero scaling factor (1 for none):
A scaling factor of 1 has been assumed.

Please type "list" to see all of the fields to choose from, "all" to output all of them, or hit enter if you already know the fields you want: all

Your selected fields:

        dor1cur
        swk2cur
        pos2cur
        gpsacur
        dor2cur
        carmcur
        qamrhcur
        gpsbcur
        apid
        swk1cur
        dhubnrVoltage
        uu15cur
        computed_id
        unused3cur
        type
        uu11cur
        host
        amrvcur
        debug
        @version
        dt
        @timestamp
        usec
        lptecur
        path
        uu12cur

How would you like your output?
(1) Tab-separated format (for GNUPlot & others),
(2) Comma-separated format, or
(3) Encapsulated comma-separated format
Your choice: 2

Progress: 99%

Success.
Time spent querying & printing: 00:02:15

kgrimes@Aeson:~/Documents/Jason-3-Data-Dumper$
```

Internship #2 - Summer 2016

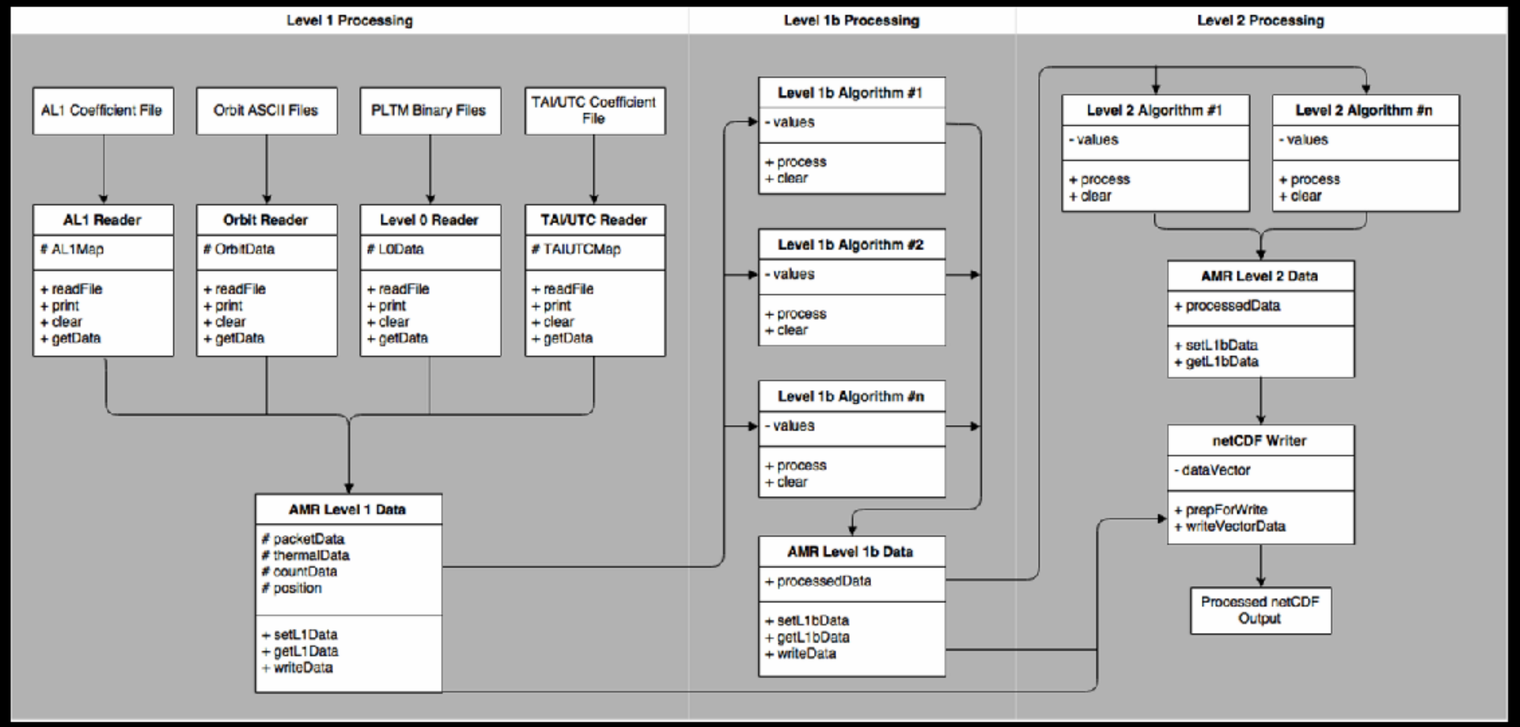
ALTIMOS-Presentation.pptx • 17 pages



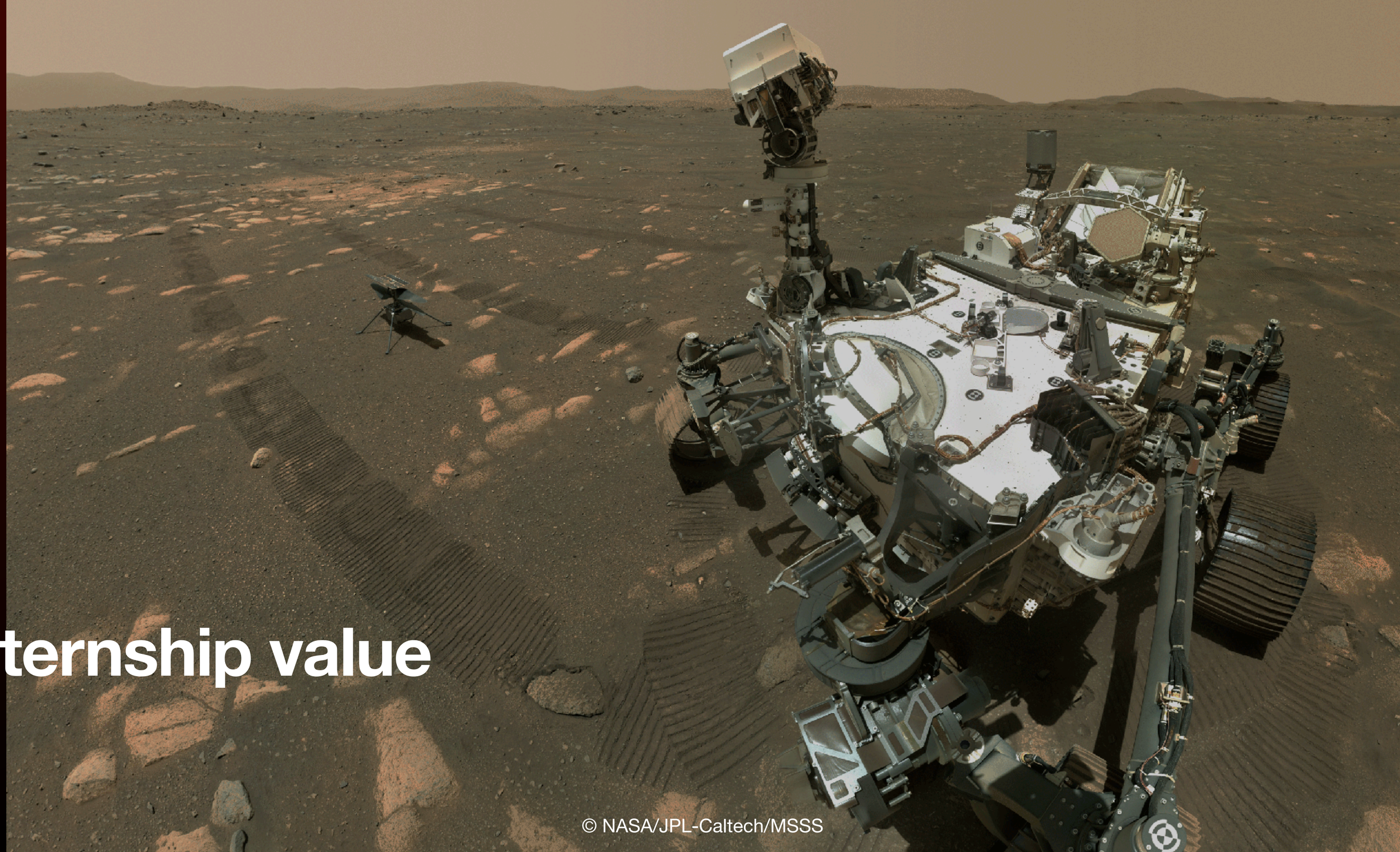
Internship #2 - Summer 2016

Generated by: draw.io

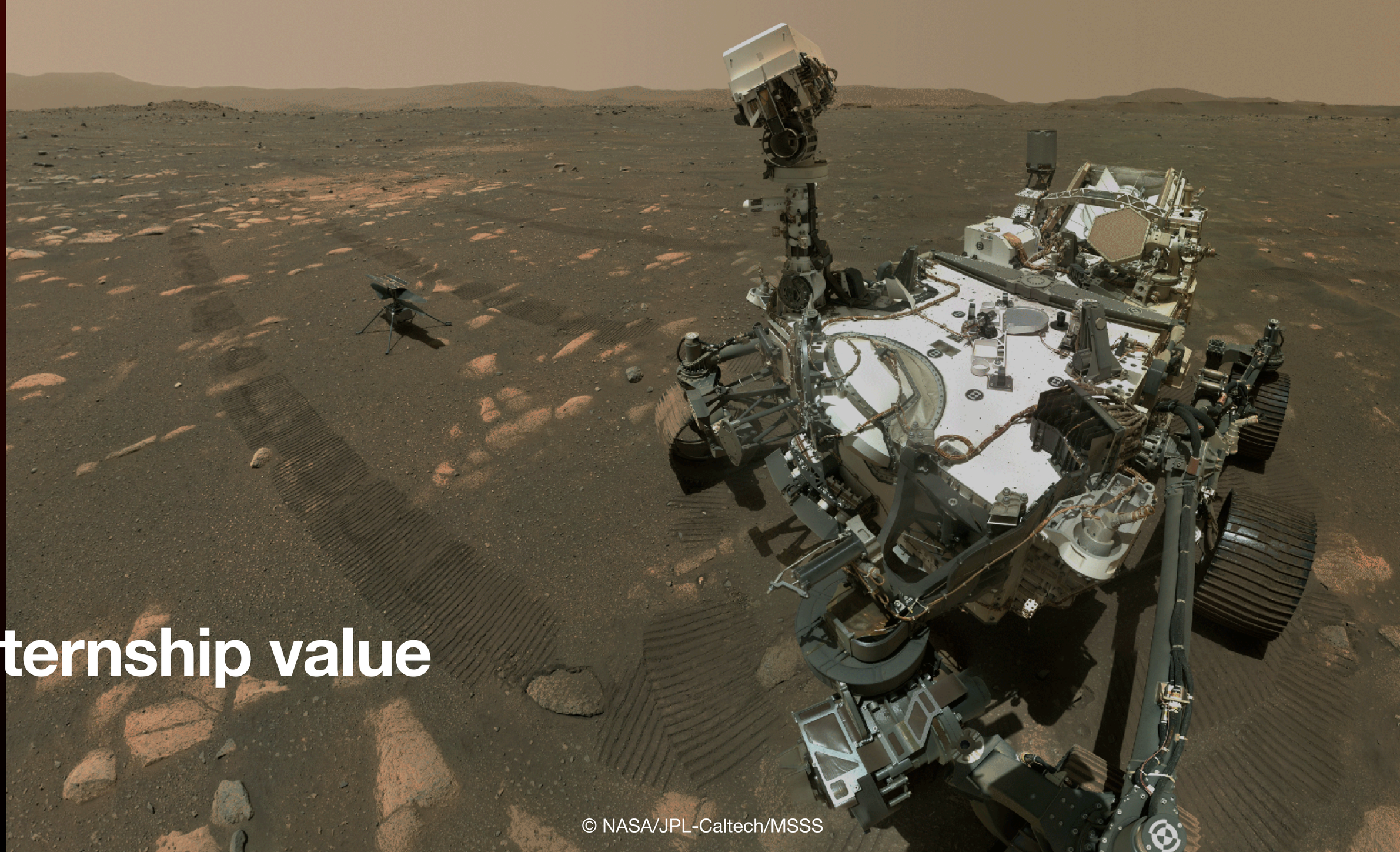
AMR Full Processing



Internship value



Internship value



Internship value

“Soft skills”

- Make progress on my own
- Ask questions
- Collaborate with co-workers
- Present ideas in meetings to people much smarter than me
- Exist in enterprise structure
- Develop relationships with staff
- Make a name for myself at the company I dreamed of working at

Internship value

Technical skills

- Collaborate with GitHub
- “Big data” tools (Apache Spark)
- New programming languages
  - Bash
  - Perl
  - Python
  - JavaScript
- Enterprise search (Elasticsearch & Logstash)

Internship value

Technical skills, cont’d.

- Coding outside of an IDE like Visual Studio
- Interacting with Linux servers
- Science data formats (netCDF)
- Binary data parsing
- Containerization with Docker
- Working with APIs

Internship value

Technical skills, cont’d.

- Enterprise C++ development
  - Doxygen documentation generator
  - Boost library
  - Object-oriented architecture
  - Built using Autotools
- JSON
- Science data structure (L0, L1A, L1B, L2)

Relevance to today

Relevance to today

Advice for graduates

- Experience is more important than where you went to school
- Soft skills
- Software engineers: get a mentor, work on projects, contribute to open source
- Get an internship somewhere, don’t let summers go to waste
- Don’t be afraid to try a course you don’t think you’ll like
- Persistence can be necessary. Keep pushing until the opportunity shuts

Thanks to Evangel

- Forcing me to take a computer science class
- Allowing me opportunities to force myself to grow
- Mentorship
- Safe space to debate ideas
- Loving culture