ROSES20: Summary

All ROSES20 solicitations are now done. Some statistics:

- 1595 proposals were submitted across all programs
- 307 proposals were selected (will go up slightly)
- 19.2% overall selection rate
- Average time to notification was 154 days
  - Improvement over the past 2 years!
  - Two programs (PDART and LARS) exceeded 180 days; five programs were at less than 100 days.
- Very positive reviews of our DAPR experiment – more on that later

For comparison

ROSES19

- 1568
- 242
- 15.4%
- 166 days
Reminders on ROSES 21

• No-Budget experiment with DDAP
• Dual-Anonymous Peer Review for all Data Analysis Programs (DAPs)
• No Due Date (NoDD) programs (open now!)
  • https://science.nasa.gov/researchers/NoDD
• Remember rules on duplicate proposals (see C.1)
• Compliance: We are checking and strictly enforcing compliance rules. Non-compliant proposals may be returned without review or be declined on this basis regardless of intrinsic merit score from the panel.
PMEF in ROSES21 and ROSES22

• Replacing the ROSES21 Planetary Major Equipment & Facilities (PMEF) call with the Planetary Science Enabling Facilities (PSEF) call
  • This is only the stand-alone part of PMEF, no change to "appended" PMEF proposals
  • PSEF is the broader Facilities program that we’ve talked about before; another talk on this topic later in the meeting.

• In ROSES22, PMEF will exist as a funding line but not as an appendix (PSEF will be there). “Appended” requests will be handled a bit differently.
  • Again, wait for Aaron’s talk.
<table>
<thead>
<tr>
<th>Planetary Science Division ROSES 21 Program</th>
<th>Step-1 Due Date</th>
<th>Step-2 Due Date</th>
<th>Panels Held</th>
<th>Selections/Proposals</th>
<th>Selection Dates</th>
<th>Days from Step-2 to Select</th>
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</thead>
<tbody>
<tr>
<td>Planetary Protection Research</td>
<td>04/12/2021</td>
<td>05/13/2021</td>
<td>Yes</td>
<td>5/10 (50%)</td>
<td>10/15/2021</td>
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<tr>
<td>Exoplanets Research Program</td>
<td>04/02/2021</td>
<td>05/27/2021</td>
<td>Yes</td>
<td>22/183 (12%)</td>
<td>10/6/2021</td>
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<tr>
<td>Development and Advancement of Lunar Instrumentation</td>
<td>04/16/2021</td>
<td>06/16/2021</td>
<td>Yes</td>
<td>xx/44</td>
<td>TBD</td>
<td></td>
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<tr>
<td>Yearly Opportunities for Research in Planetary Defense</td>
<td>04/22/2021</td>
<td>06/17/2021</td>
<td>Yes</td>
<td>12/23 (52%)</td>
<td>10/19/2021</td>
<td>124</td>
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<tr>
<td>Cassini Data Analysis Program(^1)</td>
<td>05/07/2021</td>
<td>07/09/2021</td>
<td>Yes</td>
<td>15/38 (39%)</td>
<td>10/8/2021</td>
<td>92</td>
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<tr>
<td>Hot Operating Temperature Technology</td>
<td>06/01/2021</td>
<td>08/03/2021</td>
<td>Yes</td>
<td>7/38 (18%)</td>
<td>11/15/2021</td>
<td>104</td>
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<tr>
<td>Juno Participating Scientist Program</td>
<td>06/14/2021</td>
<td>08/13/2021</td>
<td>Yes</td>
<td>10/27 (37%)</td>
<td>11/12/2021</td>
<td>91</td>
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<tr>
<td>VIPER Mission Co-Investigator Program</td>
<td>07/02/2021</td>
<td>08/31/2021</td>
<td>No</td>
<td>xx/50</td>
<td></td>
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<tr>
<td>Planetary Science and Technology Through Analog Research</td>
<td>07/23/2021</td>
<td>10/07/2021</td>
<td>No</td>
<td>xx/49</td>
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<tr>
<td>New Frontiers Data Analysis Program(^1)</td>
<td>09/03/2021</td>
<td>11/04/2021</td>
<td>No</td>
<td>xx/21</td>
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<tr>
<td>Mars Science Laboratory Participating Scientist Program(^1)</td>
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<td>11/05/2021</td>
<td>No</td>
<td>xx/50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mars Data Analysis(^1)</td>
<td>09/24/2021</td>
<td>11/18/2021</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Discovery Data Analysis(^1)</td>
<td>09/28/2021</td>
<td>11/23/2021</td>
<td>No</td>
<td></td>
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<td></td>
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<tr>
<td>Planetary Science Early Career Award</td>
<td>N/A</td>
<td>12/08/2021</td>
<td>No</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Planetary Major Equipment and Facilities (stand alone proposals)</td>
<td>12/03/2021</td>
<td>02/03/2022</td>
<td>No</td>
<td></td>
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<tr>
<td>Lunar Data Analysis(^1)</td>
<td>12/01/2021</td>
<td>02/24/2022</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Martian Moons eXploration Participating Scientist Program</td>
<td>TBD</td>
<td>TBD</td>
<td>No</td>
<td></td>
<td></td>
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<tr>
<td>Future Investigators in NASA Earth and Space Science and Technology</td>
<td>N/A</td>
<td>TBD</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Highlighted in Yellow = Cross-Divisional
Not solicited this year: MatISSE, ICAR, Habitable Worlds

1: DAPR Program
NoDD programs

We are not yet reporting on individual programs, as we feel that would be premature:

• Several programs just passed their “anniversary date”. One program (SSW) has an anniversary date in January.

• 45% of all proposals received under NoDD have been reviewed as of 11/4/21 (more reviews will be completed by the time you see this).

• Selection rates so far are comparable to those from ROSES20, but we anticipate that they will go up as more reviews are completed.

• Average notification time is currently <120 days (across all programs) and we expect it to go down at least a little. Only one proposal has exceeded the targeted maximum time to notification (235 days).
The FY22 President’s Budget Request includes $11M additional funding for R&A! This funding will be incredibly valuable, allowing us to:

- Establish a Facilities program
- Significantly reduce or eliminate all of the out-year “mortgages” for R&A.
ROSES22: Some changes

- PMEF turning into PSEF (as already mentioned)
- We expect to have several new calls
  - Apollo Next Generation Sample Analysis 2 (ANGSA-2)
  - Desert Research and Technology Studies (D-RATS)
  - Artemis Geology Team
  - OSIRIS-REx Sample Analysis PSP
- PDART: under ROSES22, PDART will not accept any proposals for development or validation of tools
  - Reason: The Planetary Data Ecosystem review highlighted some weaknesses in how tools are developed and supported. We need to change how this is done moving forward.
This is data you’ve seen before: Submitted proposal budgets are increasing at rates well-above inflation.

Why?

Possibilities:

1. Team size (FTEs) is growing
2. Some particular element(s) are growing very fast
Rising Proposal Budgets: Example

Data from SSW – 40% cost growth in 6 years (SSW is not unique in this regard!)

Takeaways:

- Selections are not biased for or against expensive proposals
- Median is lower than mean – we have a "tail" on the high-cost end.
- The trend is effectively linear
Rising Proposal Budgets: Breakdown

Breakdown budget into subcomponents: this is taken from NSPIRES cover page information, and does have uncertainties

- Salary and Indirects are the highest individual cost components
- All components (save one) are growing at around 6%/year
- Subawards are growing a bit faster.
- No obvious culprit!
Rising Proposal Budgets: Team Size

Are teams getting bigger?

- Yes, but not nearly at the same rate. Team size grows at ~2% / year (~10% over the last 6 years)

- Are teams asking for more FTEs?
  - We can’t tell – while information is in the Table of Work Effort for each proposal (as required in ROSES), those tables aren’t easily parsed.
Salaries themselves appear to be growing at a rate in excess of inflation. Mean salary increases are 3.6%/year. Combine this with 2%/year growth in team size, and it’s just about the 6% we see. Is that it?
Excessive Fringe/Inflation

It has been noted that some proposals have excessive fringe rates and/or relatively large inflation factors built into a budget:

1) NSSC notices these things and flags them.
2) These can lead to significant delays in sending out new awards
3) In these instances, budgets will also be reduced per NSSC findings

What is “excessive”? 
- Inflation rates >3%
- Fringe rates
Allowable costs for data archiving

Can a proposal include effort for data archiving?
• Yes
• Of course, any effort included in a proposal will be part of the peer review, so should have an appropriate justification.
Grant funding for Community Service

This came up at the last PAC, and after discussion with grants folks, we have a better answer:

• May proposals include time for community service?
  • Short answer: No
  • Longer answer: Anything charged to the grant has to be “allocable” – i.e., the costs incurred further the funded activity.
    • Review panels were specifically called out as an unallocable cost
  • Service can be covered through overheads on grants, but that is a matter of written institutional policy
High-Risk / High-Impact: Update

After discussion within SMD, the special high-risk / high-impact “blue ribbon” panel will not be done again (at least for now).

- Data so far shows that HR/HI proposals are selected at the same or higher rates than proposals in general.
- The additional effort required from both Principal Investigators and Program Officers was found to be high.

PSD (and SMD) continues to encourage submission of HR/HI proposals!

SMD has established a Research Catalyst Fund (next slide) that will provide some additional support for proposals of broad interest to SMD.
SMD Research Catalyst Fund

- RCF is a small SMD-level funding line designed to act as a focal point and catalyst for programmatic activities that cut across the directorate’s science disciplines.
- RCF co-funds disciplinary research awards based on four priorities. It is not a separate solicitation.
**ISFM Update: ISFMs renewed**

<table>
<thead>
<tr>
<th>Center</th>
<th>ISFM</th>
<th>Lead</th>
<th>FY22</th>
<th>Duration</th>
<th>Last Review</th>
<th>Reproposed</th>
<th>Next Review</th>
<th>Other Divisions</th>
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<tbody>
<tr>
<td>ARC</td>
<td>Mars Climate Modeling Center (MCMC)</td>
<td>Kahre</td>
<td>1,280,000</td>
<td>10/21-9/24</td>
<td>Jun-20</td>
<td>Mar-21</td>
<td>~Mar-23</td>
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<tr>
<td>ARC</td>
<td>Habitable Environments and Biosignatures / Center for Life Detection (HEB/CLD)</td>
<td>Hoehler &amp; Parenteau</td>
<td>1,615,000</td>
<td>10/21-9/24</td>
<td>Jun-20</td>
<td>Mar-21</td>
<td>~Mar-23</td>
<td>BPSD</td>
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<tr>
<td>ARC/NSFC</td>
<td>Evolutionary Processes that Drove the Emergence and Early Distribution of Life (EPDEL)</td>
<td>Ditzler &amp; Pohorille</td>
<td>857,000</td>
<td>10/21-9/24</td>
<td>Jun-20</td>
<td>Mar-21</td>
<td>~Mar-23</td>
<td>BPSD</td>
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<tr>
<td>ARC</td>
<td>Astrobiologically Important Organics during Early Planetary System Formation and Evolution</td>
<td>Sandford</td>
<td>300,000</td>
<td>10/21-9/24</td>
<td>Jun-20</td>
<td>Mar-21</td>
<td>~Mar-23</td>
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<tr>
<td>GSFC</td>
<td>Planetary Geodesy</td>
<td>Mazarico</td>
<td>545,000</td>
<td>10/21-9/26</td>
<td>Jun-20</td>
<td>Mar-21</td>
<td>~Oct-24</td>
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<td>GSFC</td>
<td>Fundamental Laboratory Research (FLaRe)</td>
<td>Elsila &amp; Stern</td>
<td>4,100,000</td>
<td>10/21-9/26</td>
<td>Jun-20</td>
<td>Mar-21</td>
<td>~Oct-24</td>
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<tr>
<td>GSFC/ARC</td>
<td>The Goddard Instrument Field Team (GIFT)</td>
<td>Young &amp; McAdam</td>
<td>778,989</td>
<td>10/21-9/26</td>
<td>Jun-20</td>
<td>Mar-21</td>
<td>~Oct-24</td>
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<tr>
<td>JSC</td>
<td>Coordinated Analysis (CA)</td>
<td>Keller</td>
<td>1,950,000</td>
<td>10/21-9/25</td>
<td>Jun-20</td>
<td>Mar-21</td>
<td>~Oct-23</td>
<td></td>
</tr>
</tbody>
</table>

Total Budget from PSD: $20.9M
Increase in PSD budget comes from moving directed work from SERA to ISFM and by moving a cross-diisional contribution into this portfolio.
ISFM Update: Budgets over time

ISFM Funding (Historical and Planned)

Contributions from other Divisions

Flat funding unless R&A budget changes significantly. Total PSD allocation at $20.9M/year
We are not presenting them today, but we have quad charts for all of the ISFMs to give status updates. Those charts have been sent to the PAC and will be posted with this presentation.

Question for the PAC: (Maybe you can’t answer this yet) Is this a good way to keep you informed of ISFM Status?
It was observed this year while preparing for GPRAMA that the demographic statistics of the science highlights (nuggets) tends to skew towards: more senior; male; Caucasian.

We want the highlights to reflect the diversity of our community, and we’re thinking about how we can improve and communicate our process to get better representation in submissions.

This will be a topic next time.
Recently, we made some small changes to how NASA takes feedback from the AGs. To that end, a few points:

- NASA can only take Advice from a single body (the PAC), and that body operates under FACA rules. There are also laws limiting how many FACA bodies can exist.

- The AGs cannot provide advice or findings that require an official response. But,
  - The POC for each AG can take any “comments” from them and bring them back to PSD for discussion and to get answers
  - The AG can bring comments to the PAC – this is important when a particular topic may need an official response – but the PAC ultimately is responsible for determining how it will treat those comments.
The Future of Data Analysis Programs

Disclaimer: There is no intent to make any major changes to the DAPs any time soon. These are topics that have been raised several times on which we felt that the PAC might have some useful advice.

Over time, many DAPs acquire ever-more eligible missions: what is the right time to “retire” a mission from DAP eligibility?

• N years after end of mission?
• When proposal pressure drops below some threshold?

Would having a single “Planetary DAP” make sense (much like the successful Astrophysics DAP in APD)?
Reviewers: A little bit of data
EXPLORE
SOLAR SYSTEM & BEYOND

Stephen Rinehart, Ph.D.
PSD ISFM End of Year Review, Quad Charts
2021
ARC
OVERARCHING PROJECT GOAL: To develop, maintain, and make available to the community, state-of-the-art Mars Global Climate Models (MGCMs).

MCMC CORE FUNCTIONS:
- Conduct cutting edge scientific research on the atmosphere and climate of Mars
- Develop and maintain state-of-the art models
- Provide access to models and output
- Support NASA missions and the Mars Exploration Program (MEP)
- Engage the community and educate next-generation climate scientists

FY 21 ACCOMPLISHMENTS AND HIGHLIGHTS:

SCIENCE:
- 14 papers submitted, in revision, in press, or published on Mars’ current and past climate
- Presented 12 lead- or co-authored presentations at conferences or workshops.

MODEL DEVELOPMENT:
- New GCM based on NOAA/GFDL cubed-sphere finite volume dynamical core is under development. Basic current Mars physics are included; moving top higher is progressing.

MODEL & OUTPUT ACCESS:
- Released Legacy MGCM on NASA GitHub: https://github.com/nasa/legacy-mars-global-climate-model

MISSION SUPPORT:
- Making GCMs, GCM output, and analysis tools publicly available support the interpretation of observations (e.g., MAVEN/UVS) and mission design studies (e.g., Aeolus).

COMMUNITY ENGAGEMENT AND EDUCATION:
- Convened session on Mars Climate Modeling at Fall AGU (December 2020).
- Held first full meeting with the Independent Working Group (January 2021).
- Mentored students (high school through graduate school) and post-docs.

NEXT STEPS:
- Continue Science Investigations:
  - Several papers in prep will be submitted soon; plans to attend meetings, including AGU.
- Continue Model Development To:
  - Improve aerosol implementation and flexibility.
  - Implement and test physics to move model top to the upper atmosphere.
  - Implement and test Early Mars physics.
  - Test nesting/stretching grid configurations for mesoscale modeling.
- Release NOAA/GFDL Cubed-Sphere Mars GCM:
  - Process has started but won’t finish until near the end of FY 22.
- Continue to Support Current and Future NASA Missions
- Actively Engage the Community:
  - Legacy Mars GCM (Virtual) Tutorial will be held November 2-4, 2021
This ISFM targets major questions about the origin and evolution of planetary systems and exoplanets, maintaining close ties with meteoritics and the JSC ISFM, and focusing on:

1) “The First Million Years” of the nebula, and the first planetesimals that formed there (asteroidal and cometary)
2) Turbulence and fluid dynamics in protoplanetary disks
3) Dynamical evolution of exoplanetary systems
4) Radiative transfer modeling of exoplanetary atmospheres
5) Close collaboration with the JSC cosmochemistry ISFM (including on the highlight at right)

**Progress FY 21**

1. Depletion of moderately volatile elements in chondrites
2. “Pade” 3D CFD code progress/documentation
3. More problems for streaming instability in turbulent nebulae
4. Stability of multiple and trojan exoplanet systems investigated
5. New exoplanet cloud structure model developed
6. Studied cloud structure effect on retrievals of abundances from reflected light data
7. Studied variable irradiation on eccentric giant planets

**If this ISFM were to be funded, we would be working on:**

1. First ever 3D nebula simulations of turbulent concentration of particles, clump survival, and the planetesimal IMF
2. Extension of MVE depletion studies in the first Myr to include isotopes (with JSC) carbon, water, rapid expansion, disk truncation, radial mixing, and infall
3. Release of the Pade’ 3D CFD code to the community
4. AI/ML code for planetesimal formation, intended for release to community
5. Global redistribution of supervolatiles relative to outer planet satellites
6. Dynamical stability of conjoined bodies such as Arrokoth
7. Orbital stability of closely spaced exoplanetary systems
8. Planning and leading focused workshops on the 1st Million yrs

**Depletion of Moderately Volatile Elements (MVEs) in chondrites, as caused by open system processes in a hot early inner nebula**

Outburst-related processes in the “First Million Years” of the solar nebula may have caused the ubiquitous, unexplained volatility-dependent depletion of elements less volatile than silicates, and also what has been interpreted as enriched refractory elements in carbonaceous chondrites.
ISFM purpose and objectives:

- Provide spectral data (experiment + theory) and data analysis tools to interpret observations, maximizing the science return from many NASA missions
- Benefit both Astrophysics and Planetary Applications
- Coordinate synergistic inter-laboratory research efforts leveraging Ames’ unique expertise (lab+theory+observation)
- Expand the content and impact of PAHdb (NASA Ames Polycyclic Aromatic Hydrocarbon Infrared (IR) spectral database)
- Develop sister databases (Raman, Optical Constants)

FY2021 accomplishments + highlights:

- **PAHdb expansion**: → *85 lab spectra* (70 PAH clusters+15 PAHs)
  → *1,030 theoretical spectra* (1,030 PAH clusters)
  → software analysis tools and dedicated online repository
- **Sister databases created**: → Raman database (*Ramdb*) nearly finished, → Optical Constants database (*OCdb*) structure defined
- **Lab expansion and upgrade**: new operating plan+last IR CRDS parts (*COSMiC*), new IR detector + vacuum pumps (*ICEE*), UV lamp part (*MIOCI*)
- **Data analysis** (theory + experiments) and interpretation of observational data using PAHdb resulted in the publication of 9 papers, and in 13 presentations at 11 conferences (virtual)
  - 1 white papers, 8 review panels

Next steps:

- **Laboratory milestones** will be completed (they have been on hold due to labs closing during the COVID-19 pandemic)
  → IR spectra of gaseous PAHs, PAH Raman spectra, optical constants.
- **Theory libraries** will be completed
- **Tools** will be released for quick JWST PAH data analyses
- **PAHdb** will allow the scientific community to interpret astrophysical and planetary IR spectra
  → Team involved in ERS + Cycle 1, awarded Cycle 1 observing time
  → *Ramdb* will be online early FY2022
  → *OCdb infrastructure* will be completed

This year’s accomplishments are summarized in the lower left quadrant.
Evolutionary Processes that Drove the Emergence and Early Distribution of Life (EPDEL)

Objectives:
- Establish plausible continuous paths from abiotic processes to the emergence of life. What cosmo-chemical and planetary processes are likely to provide a path from a habitable environment to an inhabited environment?
- Understanding the emergence of life as an integrated process. How can evolution through natural selection endow simple protocells with the ability to support metabolism, information transfer, and energy transduction?

Accomplishments:
- Advances in computational biophysics, molecular evolution, and organic chemistry through both simulations and the analysis of prior experimental work.
  - 9 publications
  - 6 technical talks
- Service to NASA review panels (9, including external reviews) and to relevant non-NASA review panels (4).
- Additional community service, e.g., Build-A-Cell, AstroCheminar, Festival of Science.

Next steps:
- Bring laboratory experimental spaces and instruments back online. We have been in mandatory telework status for 18 months.
- Resume laboratory experiments.
- Round two tasks for FY22-FY24: i) From abiotic formation of amphiphiles to protocellular function; ii) pyruvate reaction networks and the origin of metabolism; iii) evolution of functional peptides and protocell adaptation.
Microbial Innovation and Ecosystems Research (MEIR)

Purpose and Objectives:

A coordinated study of the evolutionary record, biological interactions, and biogeochemical activities of extant life on Earth to inform understanding of the mechanism, history, formation and distribution of biosignatures. Four tasks:

1) The Microbial Ecology of Intact Photosynthetic Ecosystems
2) Sedimentary Systems Research
3) Diversity and Evolutionary Innovation
4) Community Partnerships including AHED

Accomplishment summary:

Task 1 milestone – Metagenome assembled genomes (MAGs) for nutrient experiments complete – pathway analysis underway.

Task 3 milestone – Genomics analysis pipeline is revealing gene-by-gene evolution into new habitats.

Supported activities:
- 2 symposia presentations
- 5 NASA and 1 external review panels
- 9 publications (including 5 white papers)
- 3 proposals not written

Community functions shift under nutrient manipulations.

Pathway analysis for MAGs from microbial mats incubated under different nutrient conditions

Next steps:

MIER will not be continuing past FY21.

Computational research supported for tasks 1 and 3 will wind down, with publications pending.

COVID-19 NPP extension support will allow for continued research on task 1.
Habitable Environments and Biosignatures (HEB)

Purpose and objectives:

*Developing a science of biosignature detectability*

Develop an intellectual framework in which existing spacecraft observations, informed by an understanding of terrestrial biology in its environmental context, can aid in prioritizing science, technology development, and mission implementation for the life detection endeavor:

- Tailoring to (prioritizing among) diverse targets for life detection
- Target instrument capabilities
- Payload options (for life detection *and* context)
- Instrument development and basic research
- Precursor spacecraft observations

Accomplishments and top highlights:

- Peer-reviewed papers and book chapters: 13
- White papers: 1
- Conference presentations/invited talks: 2
- Panel Service: 11
- Collaborations w/ other Centers: Goddard Center for Astrobiology
- Extensive involvement in Standards of Evidence for Life Detection Workshop and white paper
- Facilitators for Scialog, Search for Life in the Universe

Next steps:

- PY22-24 Renewal combine CLD and HEB
- HEB Task 1: Develop a framework that constrains detectability as a function of spacecraft and/or telescope observables, with applications to Mars, ocean worlds, and exoplanets.
  - Subtask 1.1. Biological potential (Leads: Davila, Hoehler)
  - Subtask 1.2. Biosignature potential (Leads: Des Marais, Parenteau)
  - Subtask 1.3. Biosignature Potential and Diagenesis as Constrained by Mission Data (Lead: Bristow)
- *Subtask 1.1*. New Biological and Physical Sciences Division (BPSD) and Planetary Science Division (PSD) collaboration

The color of plants around other stars from spectral optimization

Center for Life Detection (CLD)

**Purpose:** to support the planning and implementation of missions that will seek evidence of life beyond Earth

**Objectives:**
- Develop tools that organize astrobiology knowledge in a way that facilitates its use in mission planning
- Identify key research and technology development needs to advance LD mission readiness

**Accomplishments**
- “Life Detection Knowledge Base” webtool online
- LDKB workshops (3) & content development groups (5)
- Inception-to-Write-Up involvement in “Standards of Evidence for Life Detection Community Workshop”
- 9 papers, 12 presentations, 16 panel service

**Next steps:** LKDB Content and Functionality
- Expand LDKB content
- Measurement technology module
- Science traceability module
- Risk assessment module

The “Life Detection Knowledge Base” Webtool
Summary

- EIMM Studies Comparative Processes linking planetary atmospheres and surfaces to their plasma and meteoroid environments
- 3 topical focus groups: EIMM/1 Exospheres and Atmospheric Escape, EIMM/2 Meteoroids, EIMM3: Plasma Processs and Magnesosphere

Accomplishments

<table>
<thead>
<tr>
<th>FY21 Metrics:</th>
<th>Exospheres Ionospheres Magnetospheres Modeling Package</th>
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<tbody>
<tr>
<td>Pubs</td>
<td>President IAU Commission (2018 - 2021): Several contributos to Surface Bounded Exospheres Book</td>
</tr>
<tr>
<td>13+ Pubs</td>
<td>Mentorship of over 10 undergrads, grads and postdocs</td>
</tr>
<tr>
<td>30+ conf. pres.</td>
<td>11+ panels with 6 as panel chair</td>
</tr>
</tbody>
</table>

Nugget

EIMM Researcher R. Lolachi is developing tools to understand how dust properties affect sunlight scattering in the lunar exosphere.

Next Steps

- Welcome New EIMM Co-Lead Diego Janches!
- Continue mini-proposal process building continuity between focus areas and ensuring early career scientists are involved in EIMM with routine tag ups
- Maintain emphasis on community service (e.g., mentorship, panel service and making EIMM software tools available Hosting mini-workshops for each EIMM topical focus area with the broader community
Fundamental Lab Research (FLaRe)

Jamie Elsila and Jen Stern

For more information about ISFM at Goddard: https://ssed.gsfc.nasa.gov/MajorRandAThemes/index.html

Summary

In FY21, FLaRe supported ~60 scientists working on 42 planetary science research projects in a variety of areas including extraterrestrial sample analysis, creation and analysis of planetary and primitive analogs, laboratory and observational spectroscopy, and chemistry of solar system environments.

Accomplishments

<table>
<thead>
<tr>
<th>FY21 Metrics: FLaRe</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pubs</td>
<td>27 published 8 submitted</td>
</tr>
<tr>
<td>Presentations</td>
<td>9 invited talks 20 contributed 7 posters</td>
</tr>
<tr>
<td>Outreach</td>
<td>&gt;20 seminars &gt;10 public events</td>
</tr>
<tr>
<td>Panel Service</td>
<td>9 group chiefs 22 panelists &gt;25 externals</td>
</tr>
<tr>
<td>Mentorship</td>
<td>3 students 9 postdocs 9 Science Pls</td>
</tr>
</tbody>
</table>

- 2 decadal survey panelists
- 1 SBAG steering committee member; 2 ExMAG members
- Analog materials provided to enable two successful research proposals with external collaborators
- And more ...

Nugget

FLaRe-funded analysis of GIFT-collected samples of Icelandic lava, river basalt, and volcanic sediment identified organic molecules associated with formation of secondary minerals. This work suggests multiple formation pathways associated with both biologic and chemical processes in each environment.

Next Steps

- Support lab reopening and recovery, along with mitigation of delays to research efforts caused by Covid-19
- Maintain mini-proposal process to create a balanced portfolio that enables continuity in successful research areas and allows for pilot explorations and responses to new opportunities
- Emphasize service to NASA and to the external community
- Maintain and strengthen inter-ISFM collaborations, within GSFC and across Centers
Goddard Instrument Field Team (GIFT)
Kelsey Young and Amy McAdam

For more information about ISFM at Goddard: https://ssed.gsfc.nasa.gov/MajorRandAThemes/index.html

Summary

- FY21 Scope of Work:
- Volcanic Deposit Evolution and Origins (VIDEO): Successful Iceland Campaign Aug 2021
- Field Methods at Analogs of Planetary Sites (FMAPS): Campaign planned to Lava Beds Nat’l Monument delayed to FY22 due to wildfires
- Archiving and Accessibility of GIFT Field Data
- Ames Analog Field Testing, Evaluation and Research (AAFTER): Completed Atacama field data analysis from Sept 2019, delayed Arctic drill test

Accomplishments

<table>
<thead>
<tr>
<th>FY21 Metrics: GIFT</th>
<th>Conference Presentations</th>
<th>Panel Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Publications</td>
<td>5</td>
<td>2 group chiefs</td>
</tr>
<tr>
<td></td>
<td>(e.g., GSA, AGU, LPSC, Lunar Surf. Sci. Wkshp., Terrestrial Analogs Wkshp., NESF/NLS)</td>
<td>10 panelists</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 external rev.</td>
</tr>
</tbody>
</table>

- noteworthy papers: Bower et al., 2021; Voigt et al., 2021; Glass et al., 2021
- notable service: LEAG and MEPAG committees, academic degree committees, workshop/conference organizing committees

Next Steps

- Development of Community Safety Resources & Logistics Plans
- Development of Field Data Management Strategies: Work on field data archiving and Data Management Plan for field data
- Partnerships with NASA ARC and JSC and academic institutions: ARC-funded teams expanded moving into FY22, strong JSC collaboration, students and postdocs funded at multiple academic institutions
- Development of Early Career Scientists: Numerous early career scientists funded through GIFT; GIFT enables them to acquire field experience
- Public Engagement: Input to Agency-recognized NASA Expeditions social media accounts and NASA’s Planetary Analogs website, outreach events

Nugget

GIFT addresses these research areas through field campaigns to planetary analog sites which explore interdisciplinary science questions and incorporate testing of planetary-relevant instrumentation.
Planetary Geodesy
E. Mazarico and M. Barker
For more information about ISFM at Goddard: https://ssed.gsfc.nasa.gov/MajorRandAThemes/index.html

Summary

- **Gravity & Geodesy** obtain geophysical measurement, develop new methodology;
- **Geophysical Analysis** investigate planetary interiors;
- **Topography** produce foundational products;
- **Illumination & Radiometry** science analysis, exploration support

Nugget

Our 2019 detection of an inner core elicited debate about Mercury’s interior structure.
In a follow-up study, we show through rigorous interior structure modeling that our low moment of inertia and higher $k_2$ values are the only consistent set, strengthening our former result.

Accomplishments

<table>
<thead>
<tr>
<th>FY21 Metrics: Planetary Geodesy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pubs</td>
</tr>
<tr>
<td>Pap. 13 Conf. 20</td>
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</table>

- Improvements to the INPOP21a ephemerides (lunar orbit and rotation)
- chair of ROSES panel

Next Steps

- Mini-proposal process with continuity in scope with previous successful scientific efforts, such as radio tracking data processing, geophysical analysis, illumination studies, …
- Continue support of early-careers and their integration within the Planetary Geodesy portfolio
- Maintain emphasis on community service, such as with the production of higher-level products from raw geodetic datasets, and their regular release through our data portal
Sellers Exoplanet Environment Collaboration
Ravi Kopparapu, Avi Mandell, Elisa Quintana

Summary – The Five-Year Mission

• Advancing the coupling of stellar models with atmospheric heating and chemistry models
• Enhancing our flexible chemistry and climate models with new laboratory and experimental data
• Updating multiple independently developed GCMs to predict robust observables
• Expanding tools for simulating, retrieving and interpreting exoplanet observations.

Accomplishments

FY21 Metrics: [work package]

<table>
<thead>
<tr>
<th>Pubs</th>
<th>Panel Service</th>
<th>Leadership Positions</th>
<th>Tool Access</th>
</tr>
</thead>
<tbody>
<tr>
<td>20+</td>
<td>&gt;10 panelists</td>
<td>ExoPAG, NExSS, Conference SOCs</td>
<td>EMAC, PSG, ROC, KE3D, ExoCAM</td>
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</table>

• TRAPPIST Habitable Atmosphere Intercomparison (THAI) workshop report – Fauchez +
• Flares, Rotation, and Planets of the AU Mic System from TESS Observations, Gilbert +

Next Steps

• Mini-proposal process once a year. Currently 32 active projects in FY21. ‘Retreats’ to inspire new cross-divisional project ideas.
• Ensure early-career scientists are integrated with SEEC community by engaging them in workshops, LOC organization etc.
• Maintain emphasis on community service, such as through panel service, workshops, EMAC/PSG access.

Dr. Vincent Kofman’s article in Universe Today

How To Search the Chemical Makeup of Exoplanet Atmospheres for Hints at Their History

Author’s note – this article was written with Dr. Vincent Kofman, a scientist at NASA’s Goddard Space Flight Center (GSFC), working in the Sellers Exoplanet Environments Collaboration (SEEC), and the lead author on the research it discusses.

Thousands of exoplanets have been discovered in the recent decades. Planet hunters like TESS and Kepler, as well as numerous ground-based efforts, have pushed the field and we are starting to get a total number of planets that will allow us to perform effective statistical analysis on some of them.
ISFM Work Package Summary
Research tasks in the Coordinated Analysis Work Package focus on coordinated microstructural, chemical, mineralogical, and isotopic microanalyses of presolar and early solar system solids, the building blocks of the planets, and their subsequent evolution by aqueous, thermal, and regolith processes on their parent bodies. Analyses are performed in a carefully coordinated sequence on the same sample in order to maximize the science return from precious materials.

Overall Accomplishments
# of Peer Reviewed Publications: 33  Selected Papers:
# of Conference Abstracts: 43. Selected Abstracts:
# of NASA Peer Review Panels: 10 (1 group chief, 6 panelists).
Graduate student committees/supervised: 11

Future Work
[4] Space weathering experiments on analogs including hypervelocity impacts and low flux irradiation experiments on carbonaceous chondrites.
Geochemistry and Cosmochemistry Work Package
Astromaterials Research and Exploration Division
NASA Johnson Space Center
Work Package Lead: Justin Simon

ISFM Work Package Summary
Research tasks in the GCWP utilize specialized laboratories and analytical instruments to study the early solar system and origin and evolution of rocky planets. These fundamental measurements complement planetary mission data and astronomical observations of other solar systems and help define the scientific framework for NASA Space Science Missions. The work primarily focuses on compositional measurements of returned samples and meteorites from asteroids, the Moon, and Mars.

Overall Accomplishments
# of Peer Reviewed Publications: n=26 (16 co-authored with other JSC ISFM WP)
# of Conference Abstracts: n=16
Selected abstracts: [1] Deligny et al. (2021) First in-situ nitrogen isotope measurements in Martian meteorites, Goldschmidt
# of NASA Peer Review Panels Served on: 4 panelists incl. 1 Group Chief, 3 appeals, 1 commitment to serve as panelist for future rolling reviews
Other Service Activities of Note: Member of Planetary Science and Astrobiology Decadal Survey, 2023-2032, Chair of the Research and Assessment Team, Women+ of Color Project at Harvard University, JSC NPP Fellowship Coordinator

Science Nugget
Anthony Gargano (student), Zachary Sharp, Charles Shearer, Justin Simon, Alex Halliday, and Wayne Buckley (2020)
Chlorine isotope compositions and halogen contents of Apollo return samples, Proceedings to the National Academy of Sciences

Lunar materials are depleted in fluorine and chlorine 10x relative to Earth (halogens measured by ICP-MS at NASA JSC)

Future Work
P1. Isotopic, chemical, and textural studies of chondrite components to test astrophysical models
P2. Track moderately volatile element isotope compositions and trace element abundances in chondrites to test models for early nebula processes (disk winds, ongoing infall, primary accretion, mixing, and radial condensation and evaporation fronts)
P3. Determine the distribution and evolution of volatile elements in planetary bodies in the Solar System (meteorites and Apollo samples)
P4. Study the geochemistry and timing of planet differentiation leading to ancient crusts on asteroids, the Moon, and Mars
Mission-Enabling Research Work Package
Astromaterials Science and Exploration Division, NASA Johnson Space Center

ISFM Work Package Summary
Research tasks in the Mission-Enabling Research Work Package focus on experiments, measurements, and analog research to interpret data returned from planetary missions and characterize geological processes on planetary bodies. The research in this work package helps identify habitable environments on Mars by constraining environmental conditions, like pH, temperature, and redox, from compositional measurements of the martian surface. Furthermore, efforts to synthesize martian and lunar analog materials feed into human exploration goals by providing the scientific and engineering community with geologic materials to prepare for human missions to the Moon and Mars.

Overall Accomplishments
26 Peer Reviewed Publications (12 from analog work, 14 from analog+mission work – i.e., incorporating mission datasets)
Selected papers:
59 Conference Abstracts (40 from analog work, 19 from analog+mission work)
Served on 8 NASA Peer Review panels
Mission-Enabling scientists serve on 8 Ph.D student committees, mentored 3 undergraduate students, and mentored 14 high school students.
18 public talks to elementary- through undergraduate-level students

Science Nugget: Re-analysis of Mars Phoenix TEGA data indicates organic C, Fe-carbonate, and Ca-carbonate are present in Northern Plains soils (P. Sutter)

Next Steps
- Mars-analog fieldwork in Iceland in summer 2022 with the GIFT WP to study soil organic content and preservation
- Building M2020 SHERLOC UV Raman spectral database with Mars-analog samples
- SAM-like EGA of nitrates and additional Mn phases (crystalline and amorphous) for comparison to MSL-SAM data
- Characterize the mineralogy and geochemistry of Mars- and Moon-analog samples collected from Iceland, Antarctica, and Hawaii via XRD, XRF, IR spectroscopy, electron microscopy, and ICP-OES
- Synthesize Mars-relevant Fe-oxides/oxhydroxides from Fe-silicates
- Synthesize tricatahedral smectite from basaltic glass at a range of pH and pCO2
ISFM Work Package Summary
The two research tasks in the Organic Geo- and Cosmochemistry Work Package focus on the analysis of organic matter in rock and regolith samples to determine how organic molecules are formed, how they evolve over time in different geochemical environments, and the effects of interplay between organics and their inorganic host materials. Analyses are performed on molecules directly isolated from extraterrestrial samples, such as meteorites and returned samples, produced by laboratory reactions simulating prebiotic chemistry, and *in situ* analyses of molecules in astromaterials samples.

Overall Accomplishments
# of Peer Reviewed Publications: 1 published + 2 in review + 2 in preparation
Selected Papers:
- Thomas-Keprta et al. (in press) *Geochimica et Cosmochimica Acta*
- Kaiser et al. (in review) *Meteoritics & Planetary Science*

# of Conference Abstracts: 10
# of NASA Peer Review Panels: 5
Other Service Activities of Note:
- 1 detaillee to HQ for 0.75 FTE
- 1 guest-editorship of *Symmetry* journal special issue
- Assistance to COSPAR working group on Mars returned sample safety
- Panelists on 2 EPO events
- Mentoring Ph. D. student
- MSI fellowship sponsor/mentor for 2 students

Science Nugget
Mineral separates from LON 94101 were hot-water extracted individually for amino acids, after which the solid residues were transferred to SEM mounts for analysis. Below are several BSE images of grains for which amino acid contents were determined individually, and for which correlations between mineralogy and organic composition will be investigated.

Future Work
- Future *ex situ* work will entail analysis of a range of aqueously altered carbonaceous chondrites to determine if aqueous alteration has discernable effects on the distribution of organics amongst mineral phases.
- For *in situ* studies, analyses have focused primarily on CR, CM, CV and CO chondrites; this work will be expanded to investigate mineral/organic associations in CB, CK and relatively primitive ordinary chondrites.
Planetary Process Simulation Work Package
Astromaterials Research and Exploration Division
NASA Johnson Space Center
Work Package Lead: Kevin Righter

ISFM Work Package Summary
Carry out petrologic simulations of planetary interiors and surfaces (experimental petrology lab), and hypervelocity impact to understand formation conditions of astromaterials (rocks, shock history, geologic relations) (experimental impact lab)

Overall Accomplishments (FY21)

# of Peer Reviewed Publications: 13 published + 5 in review + 2 in preparation

Selected Papers:

# of Conference Abstracts: 15
# of NASA Peer Review Panels: 4

Other Service Activities of Note: 3 associate editors, 28 journal reviews, 24 outreach events, 8 society or community panels.

Science Nugget: InSight Mars core size and composition (10-15% S) imply Ag isotopic anomalies in mantle.

Future Work - Labs re-opened and poised to carry out experimentation proposed in ISFM cycle 2; Inter-WP (GCWP, CAWP) and inter-center (GSFC) collaborations

Project 1: Characterizing the strength-to-gravity transition in impact cratering
Project 2: Disruption of ordinary chondrites
Project 3: The effects of target-container size on impact experiments
Project 4: Isotopic tracers and volatile abundance inapatite
Project 5: Low FeO planetary surfaces
Project 6: Metal-silicate partitioning of siderophile elements
Project 7: Spinel as a sensor of redox conditions

Applications to Mercury, Venus, Earth, Mars, Moon, asteroids
Marshall Space Flight Center ISFM Lead: Dr. Michael Zanetti (ST13)
Organization: MSFC Heliophysics & Planetary Science Branch/ST13,
Dr. David McKenzie, manager
michael.r.zanetti@nasa.gov
david.e.mckenzie@nasa.gov

MSFC's planetary scientists conduct impactful research while also providing meaningful scientific and exploration context for our engineering organizations. ISFM support will allow our scientists to excel at their scientific areas of interest and provide continued service to NASA missions and panels, the scientific community, and public engagement.

Technical Objectives:

The Marshall Interdisciplinary Planetary Science (MIPS) program will support 3 primary areas of research:

1. Remote-Sensing and Mission Data Analysis. Interdisciplinary projects combining electromagnetic sounding of space plasma environments, modeling of thermal evolution of the Moon and other rocky planet interiors, and CLPS science data; to support lunar surface processes investigations and Cross-Artemis Site Selection Analysis (CASSA) and Artemis and HLS lunar surface requirements.

2. Comparative Planetology using Mobile LiDAR. Focused around the Kinematic Navigation and Cartography Knapsack (KNaCK), a unique, mobile, velocity-sensing light detection and ranging (LiDAR) instrument being developed in our group.

3. Dusty Plasma Laboratory (DPL). The DPL is used to determine the electrostatic charging, optical, and gas accretion properties of dust and icy dust as a function of size, material, and environmental conditions.

MIPS Team members:

Michael Zanetti, ISFM lead (Research areas 1.1, 1.2) *
Heidi Haviland (Research area 1.1) *
Paul Bremner (Research area 1.1) *
Caleb Fassett (Research area 1.1)
Dennis Gallagher (Research area 1.3)
Alvin Cantrell (Research area 1.3)
Eric Bradley (Research area 1.3) * Early Career scientist

Relationship of ISFM to Service:

The MIPS ISFM projects enable the Agency's exploration initiatives, with focused scientific research about the Moon, Mars, and beyond, and address SMD 2020-2024 Strategies, NASA Decadal Science goals, and Artemis Science Goals. MIPS team members participate in:

- Artemis Science Definition Team
- Cross-Artemis Site Selection and Analysis (CASSA) Technical Assessment Teams
- NASA Decadal Survey
- Precision Landing and Hazard Avoidance for Human Landing System (HLS) and Space Launch System (SLS) programs
- Design Specification for Natural Environments (DSNE) lunar surface, exosphere, and plasma environment sections
- Review panels, journal manuscript reviews, society committees
- Engagement of the public through colloquia and classroom visits