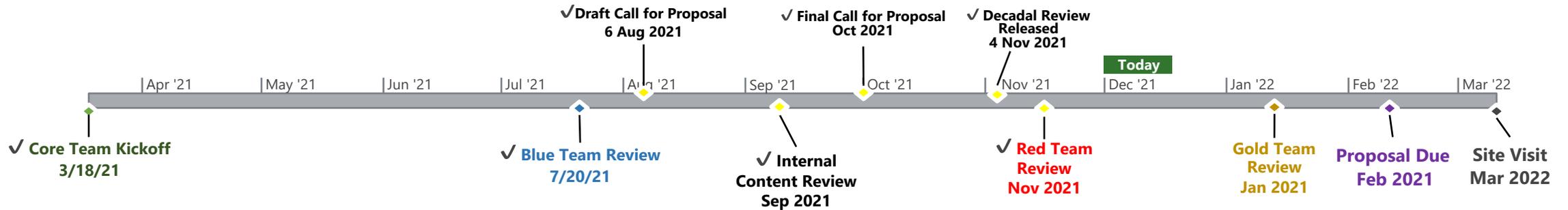


Senior Review Proposal

Margaret Meixner

December 6, 2021

Senior Review – Timeline



Important dates:

1 Oct 2021	Senior Review 2022 Call for Proposals Released
4-Nov 2021	Decadal Review Released
15-Nov 2021	Red Team Review
Dec 2021	Potential flying of panel members
Dec & Jan	Revision of proposal
11 Feb 2022	Proposal Due
Feb 2021	Potential flying of panel members
21-25 Mar 2022	Panel site visit to Ames

Senior Review Status

Present status

- Incorporating feedback from November Red Team Review which was positive
- Tuning messaging of the proposal in response to the Decadal Survey

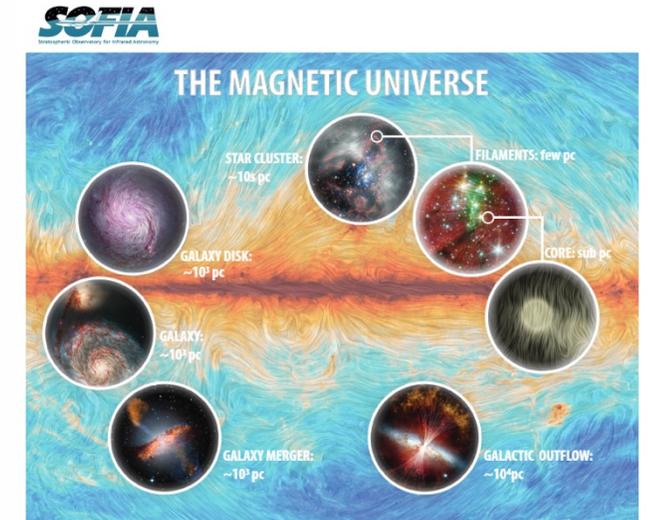


Figure 2.1-1. SOFIA HAWC+ observations of cores, galactic filaments, and galaxies are revealing the mysterious nature of magnetic fields in the Universe from sub-pc to kpc scales. The background Planck image provides the context over a much larger scale. SOFIA's finer resolution is finding that the contribution of magnetic fields could be critical for the formation of stars, shaping the galactic structures and the intergalactic medium. From the top right going clockwise SOFIA HAWC+ measurements of 30 Doradus super star cluster, Serpens South filament, IRAS 15398-3359 low mass protostar, galaxies M82, Centaurus A, M51, and NGC 1068.

turbulence, and gravity in the star formation process remains uncertain. While turbulence is easily measured by spectral line broadening, measurements of magnetic fields, especially in dense, dusty star-forming regions, remain difficult. Consequently, magnetic fields are by far the least explored and least understood of the key ingredients for star formation.

In star-forming filaments, magnetic fields in the diffuse outer regions are oriented parallel to the filament, but in the dense inner regions they lie perpendicular to the filament [Planck XXXV 2016]. However, SOFIA/HAWC+

About the SOFIA HAWC+ images:

"Both combine beauty and physical content... looking at them it makes me wonder if SOFIA/HAWC+ is the van Gogh of the 21st century."

Quote from Prof. Bernhard Brandl, Leiden University, 2020 Conference on Ground-based Thermal Infrared - Past, Present, and Future

measurements of the Serpens South star-forming regions [Pillai et al. 2020] found a new twist: at the highest column densities ($A_V > 21$ mag) the field direction once again turns parallel to the filament, confirming a theoretical prediction that in the densest part of the filament, gravity dominates over magnetic pressure [e.g., Chen & Ostriker 2014].

The study of magnetic fields in dense filaments at pc scales is in its infancy, with only a handful of robust measurements [Pillai et al. 2017], and many more filaments must be measured to ascertain the importance of magnetic

Senior Review – Key Review Criteria



◆ Senior Review is forward-looking, but current & past performance matters.

Scientific Merit

- ❖ Overall scientific strength & Impact of the mission 50%
- ❖ Expected scientific output and return on investment
- ❖ Incremental and synergistic benefit to the Astrophysics Division Mission Portfolio
- ❖ Quality of data collection, archiving, distribution, and usability

Relevance & Past Performance

- ❖ Progress since the last review 25%
- ❖ Mission's responsiveness to the last review
- ❖ Mission's relevance to the SMD science plan
- ❖ Mission's relevance to the 2020 Astrophysics Decadal Survey

Operations and Cost

- ❖ Suitability of mission's operating model
- ❖ Health of the observatory and its instruments
- ❖ Operating cost & cost efficiency

Leadership/Impact:

Training, mentoring and leadership opportunities that will expand the skills of its staff & foster the next generation of mission leaders

25%



Science case: 50% of grade

- The Magnetic Universe
- The Chemical Universe
- Star Formation and Feedback
- Time Domain Studies
- Solar System

SOFIA Science Cases

The Magnetic Universe

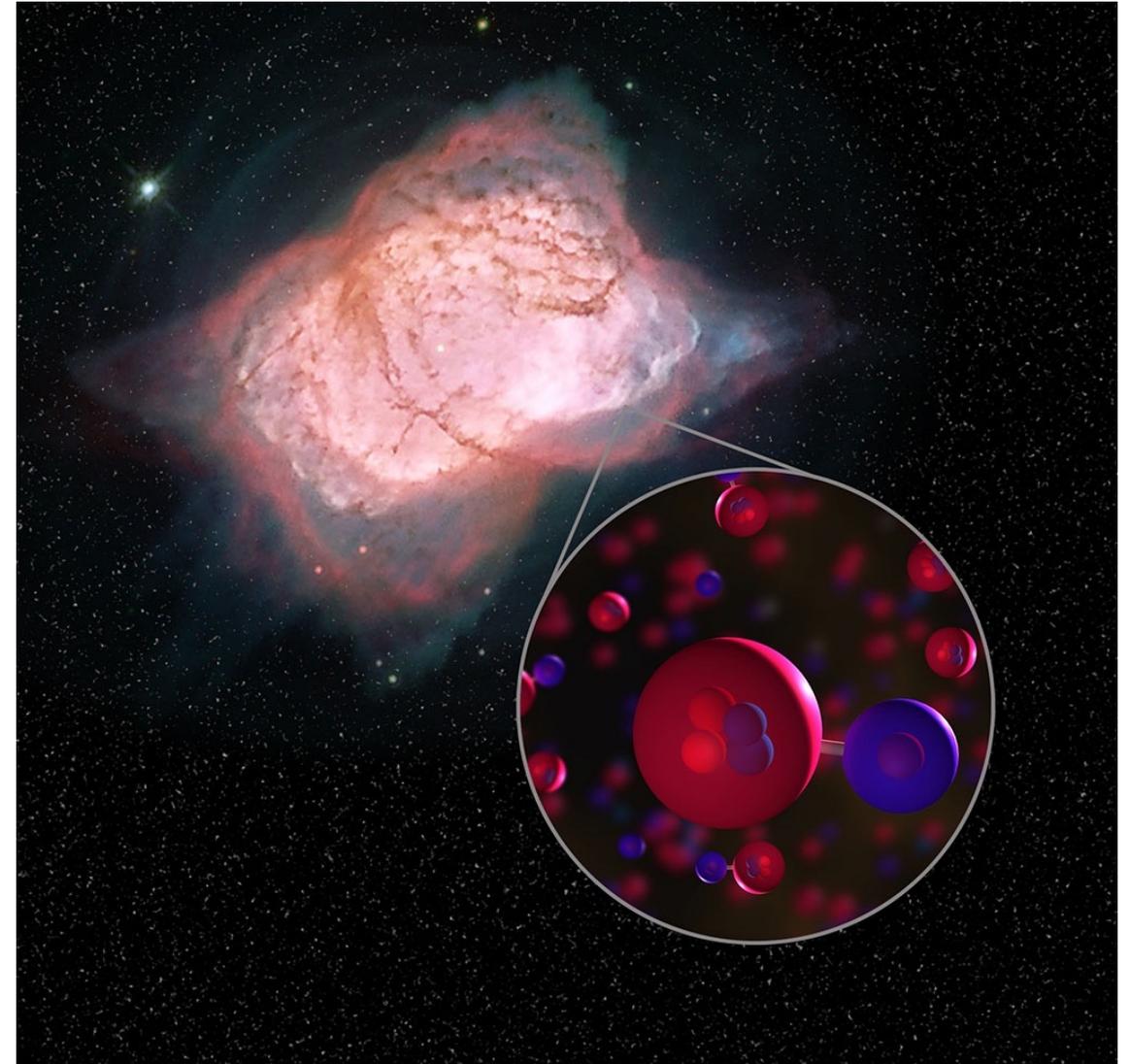
- What is the role of magnetic fields in forming stars?
- How do magnetic fields help shape galactic spiral structure and galactic superwinds?



SOFIA Science Cases

The Chemical Universe

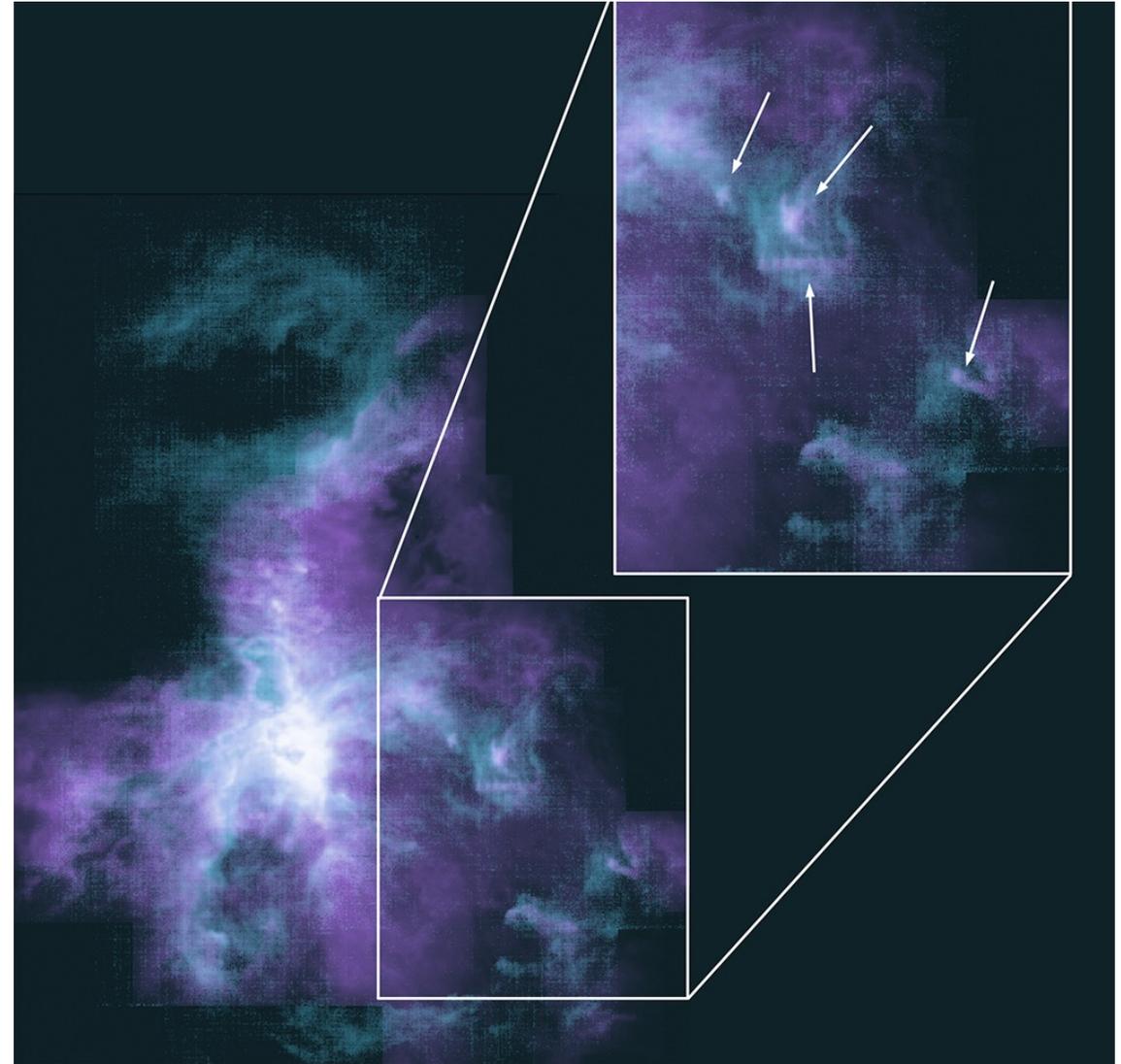
- What is the fraction of H₂ in CO-dark clouds?
- What are the abundances of prebiotic molecules and water in protostar environments?



SOFIA Science Cases

Star Formation and Feedback

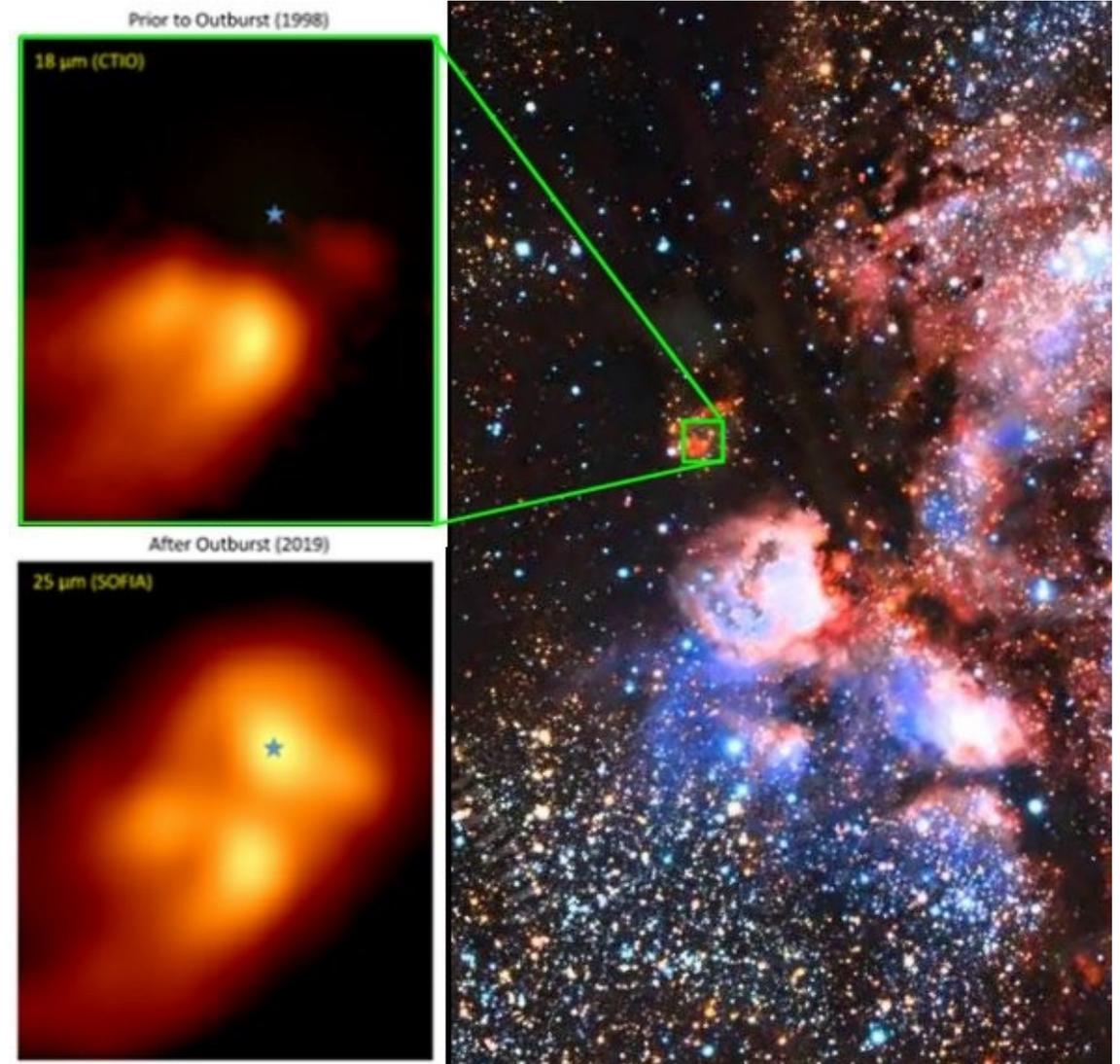
- Is [C II] a universal tracer of star formation?
- How does stellar feedback affect the surrounding medium?



SOFIA Science Cases

Time Domain Studies

- Accretion Bursts in High-Mass Protostars
- Temporal Variations on Multi-Cycle Timescales



SOFIA Science Cases

Solar System

- What are the compositions of the surfaces of moons, asteroids, and comets?
- What are the compositions of the atmospheres of planets and moons?

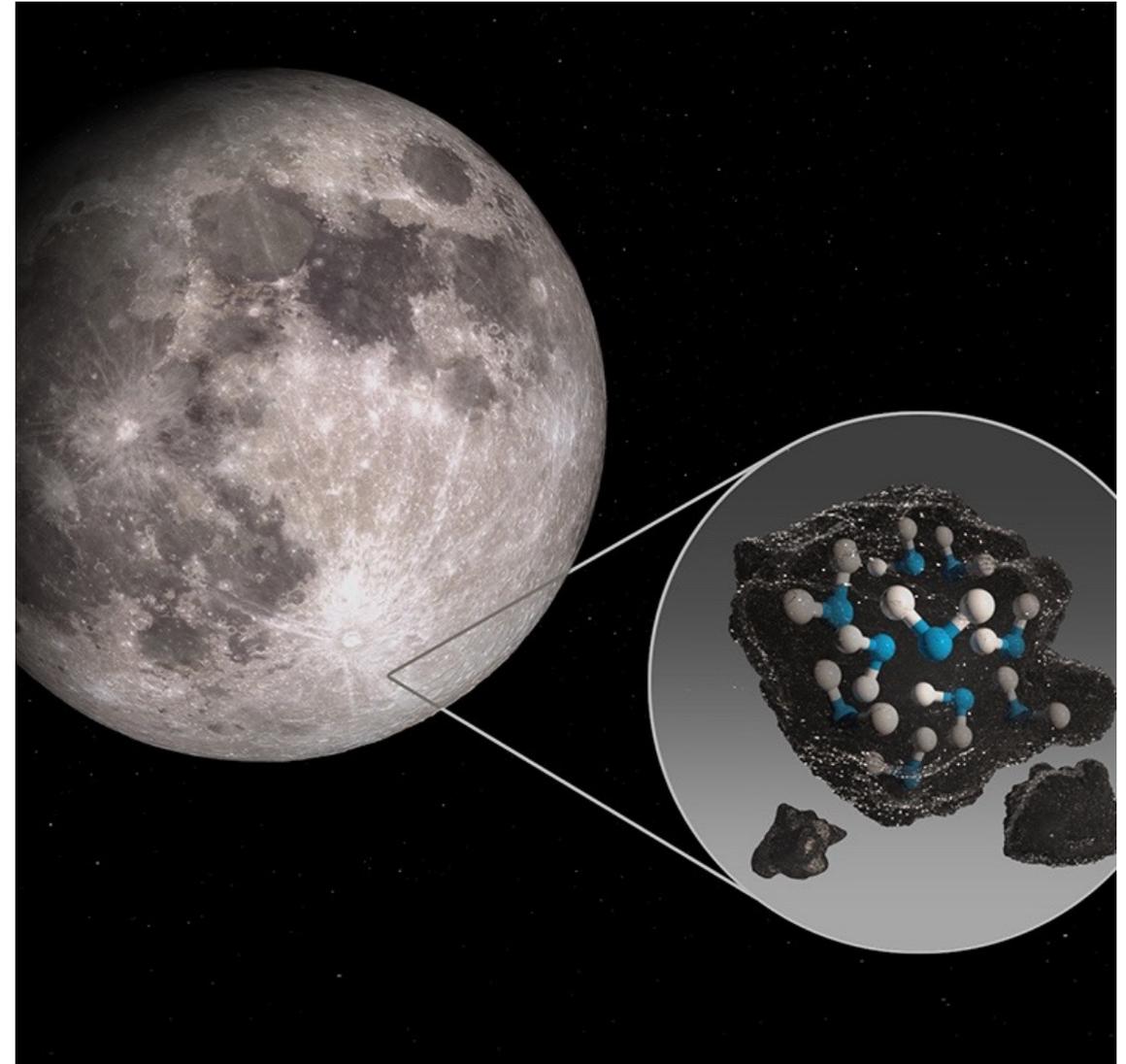


Table 4-1. Response to the Flagship Mission Review Recommendations

Recommendation Number	Proposal Sections	Specific FMR Recommendations	Plan in place	In Progress	Completed	Implementation Details
1 2	5.2 5.3 6.1	Nurture a science-driven culture within the mission Embrace change in operational approaches	Y		Y	Hired additional science and outreach staff, automated multiple processes, cross-trained staff, shortened instrument swap times, implemented aggressive community outreach focused on SOFIA science
3	3.2 5.1	Emphasize completion of high-priority science programs	Y		Y	Addition of contingency flights, more thorough technical review of proposals, automatic rollover of incomplete programs to next cycle
4 5	3.3 3.6 5.1 6.7	Emphasize the collection of high-quality data Maximize observing time at stratospheric altitudes	Y	Y		Scheduling of yearly aircraft maintenance when observing conditions are poorest, use water vapor instead of altitude, using water vapor forecasts to fine tune which flights to fly, flying more southern hemisphere flights in humid northern summer
6	5.1 6.7	Fly more Southern Hemisphere flights	Y	Y		Doubling the annual number of Southern Hemisphere flights
7	3.6	Transfer data products into the archive quickly	Y		Y	Flight-by-flight processing rather than series-by-series; more staff cross-trained to perform data processing
8 9	7.3 5.5	Split aircraft operations from telescope/science operations Invoke HIRMES cost and schedule control	N N			NASA/Project decided against fully implementing this recommendation after exhaustive study HIRMES was terminated in 2021 by NASA SMD, citing significant technical, cost, and schedule risks
10	3.1 5.5	Focus on current science operations rather than future science instrument development	Y	Y		EXES transitioned to a facility instrument to be more productive, planning begun for a HAWC+ upgrade, increasing southern access to more instruments

Response to last review, 25% of grade

SOFIA has addressed all recommendations from Flagship Mission Review



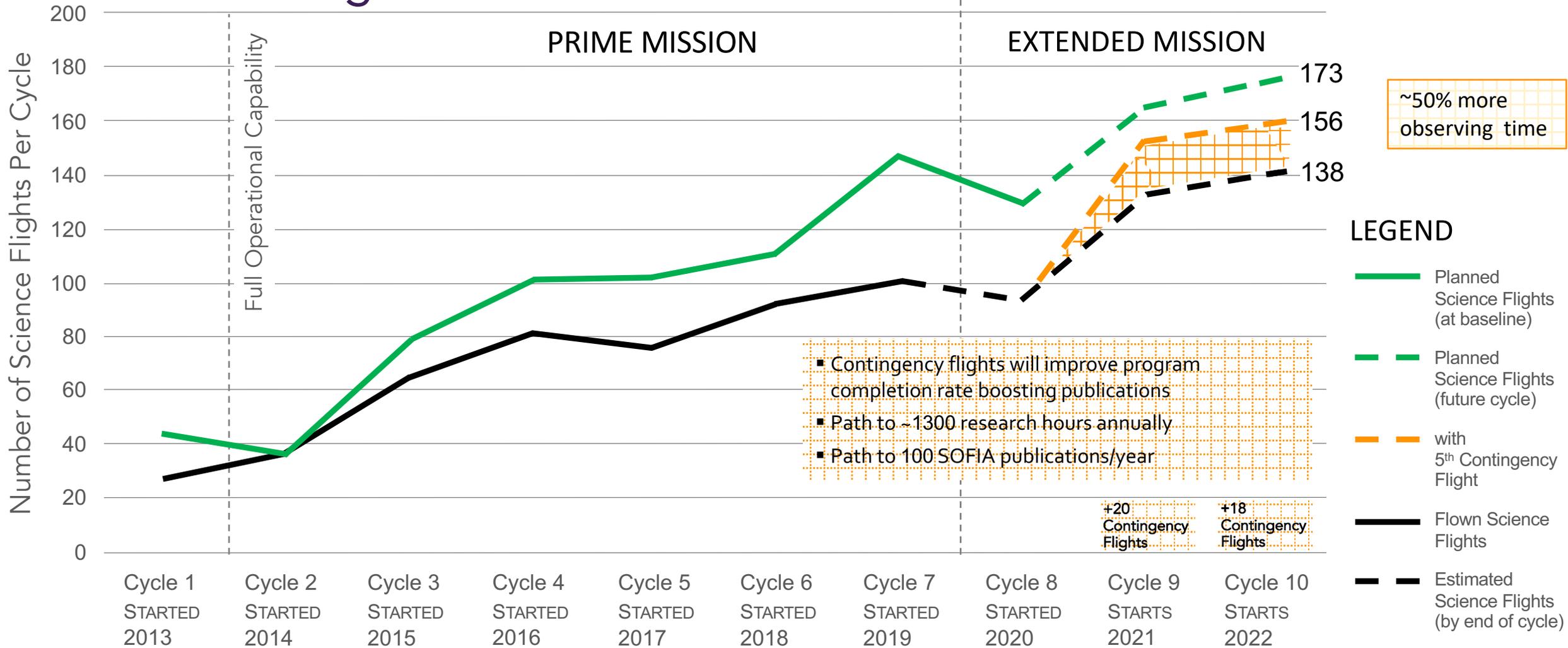
Future initiatives

1. Implement new observing opportunities for Northern and Southern hemispheres.
2. Grow SOFIA community and make it more scientifically diverse. **Outreach talk, Metrics**
3. Increase Science Return by 10% with innovative improvements to science operations.
4. Prioritize legacy programs to enhance SOFIA archival value.
5. Increase SOFIA science discovery space with upgraded or new instrumentation. **Instrument Roadmap**

Increasing Observing Time



Science Flights



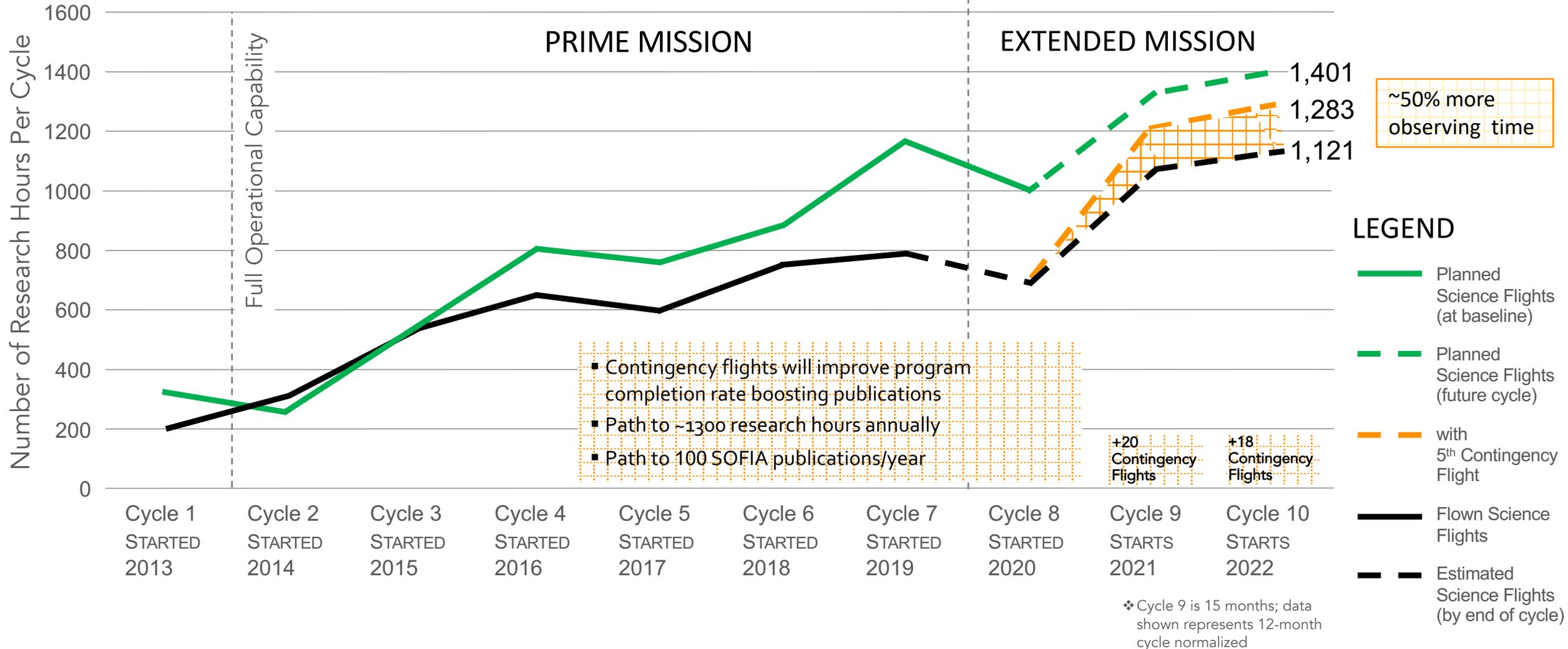
❖ Cycle 9 is 15 months; data shown represents 12-m cycle normalized



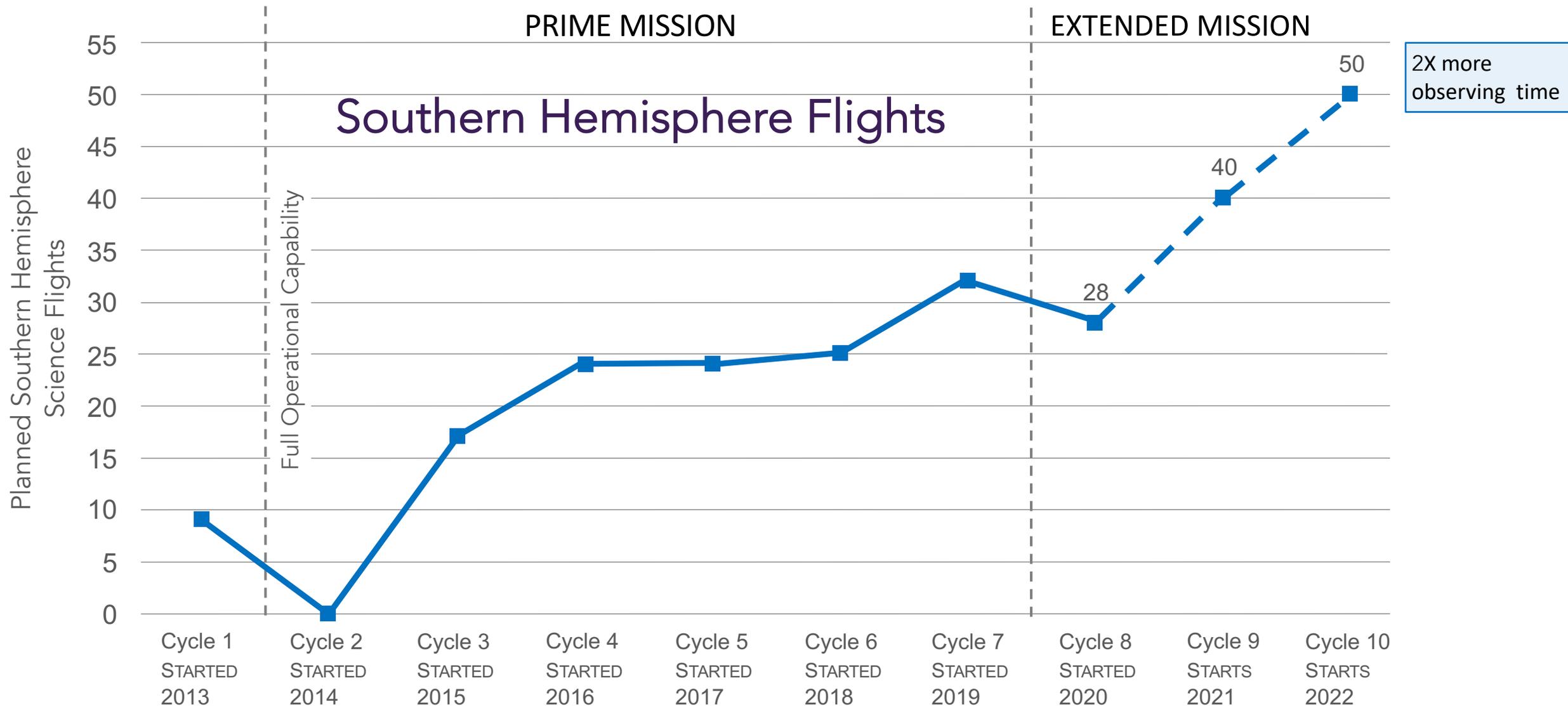
Increasing Observing Time



Research Hours



Fly 50 Flights in Southern Hemisphere Annually



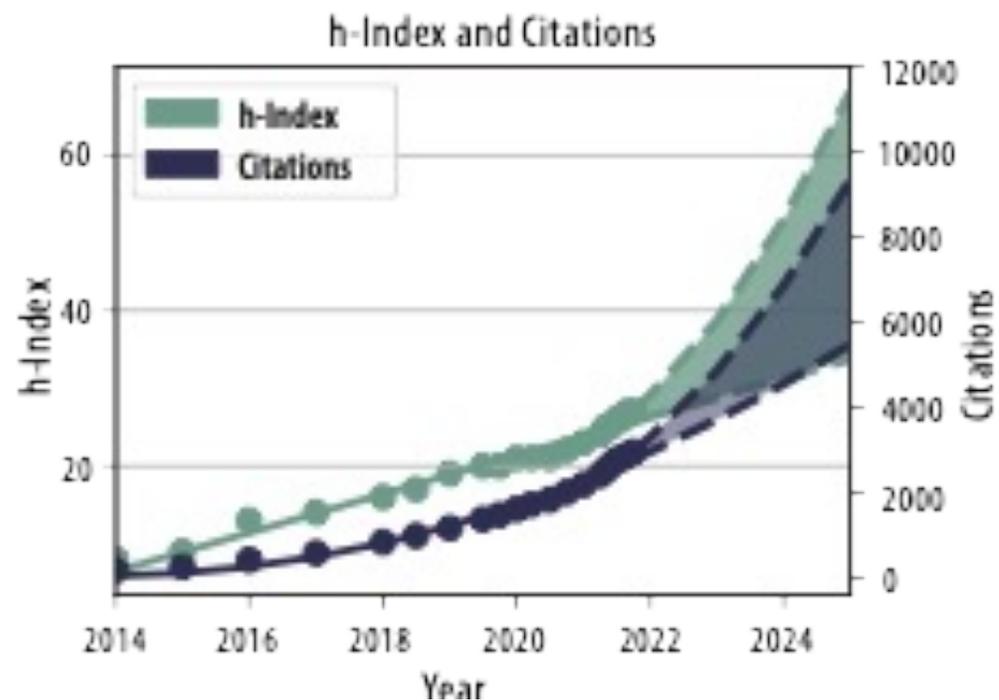
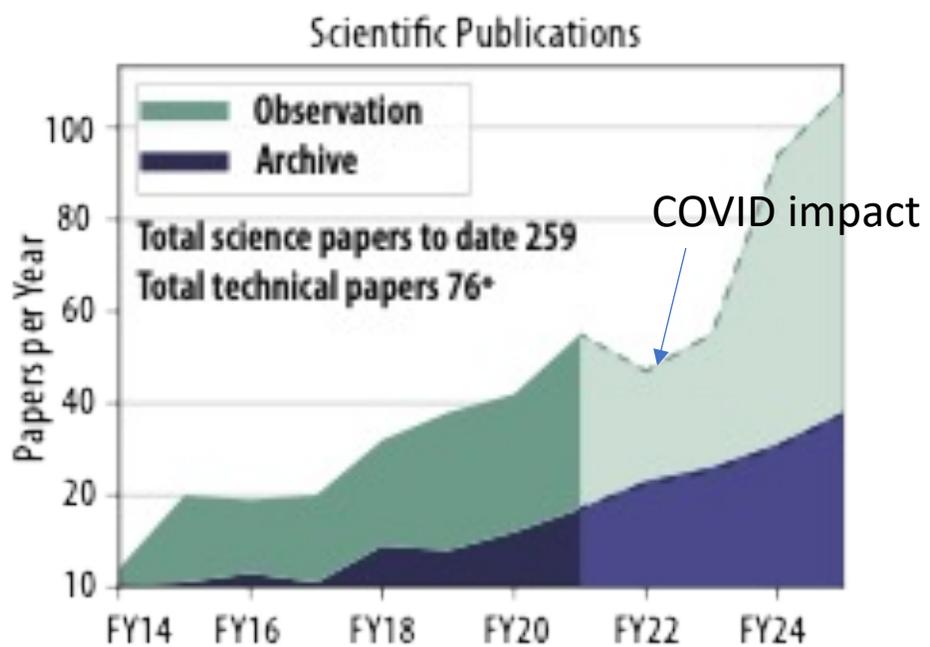
❖ Cycle 9 is 15 months; Data shown represents 12-month cycle normalized



Increasing Science Per Flight

- Efficient Scheduling using Weather Prediction
- More efficient instrument modes
 - HAWC+ scanning polarization mode
 - FIFI-LS on-the-fly mapping mode
- New Software automation
 - Tool to streamline grants process under discussion
 - Increased interoperability between integration time calculator and observation request software

Publication Predictions



Post Decadal Review Proposal messaging:

- SOFIA has undergone a recent major transformation in response to the FMR review
- The “new” SOFIA is the only far-infrared facility now and for years to come
- SOFIA has unique and compelling science, highlighted by the legacy programs
- SOFIA has a strong, dedicated team – this will be the first human crewed mission to go through senior review
- Plans for future ensure increasing scientific productivity
- The development of new instruments is a key feature of SOFIA

Post Decadal Review Proposal Re-organization:

- The decadal review emphasizes mid-to-far-IR studies in multiple research areas where SOFIA can uniquely contribute
- The Senior Review proposal will now be organized so that the SMD and Astro2020 priorities and their link to SOFIA will be immediately clear