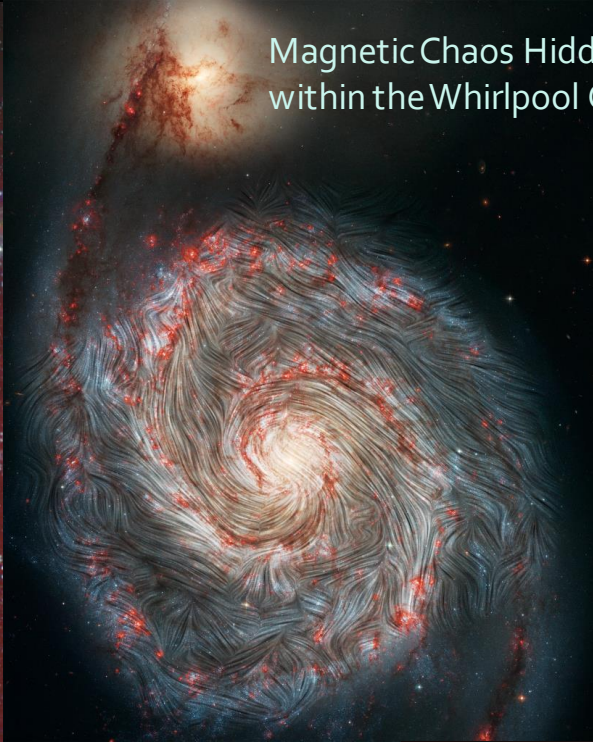


A magnetic collapse

Magnetic Chaos Hidden within the Whirlpool Galaxy



Magnetic 'Highway' Channels Material Out of Starburst Galaxy

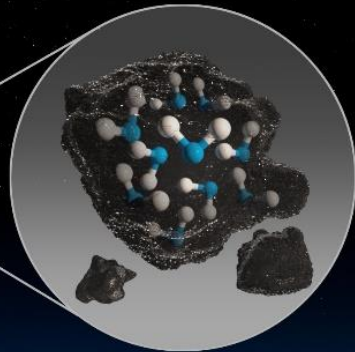


# Project Update

*Presented to:* SOFIA Users Group  
*Presented by:* The SOFIA Project  
Naseem Rangwala  
NASA Project Scientist  
Rob Landis  
NASA Project Manager

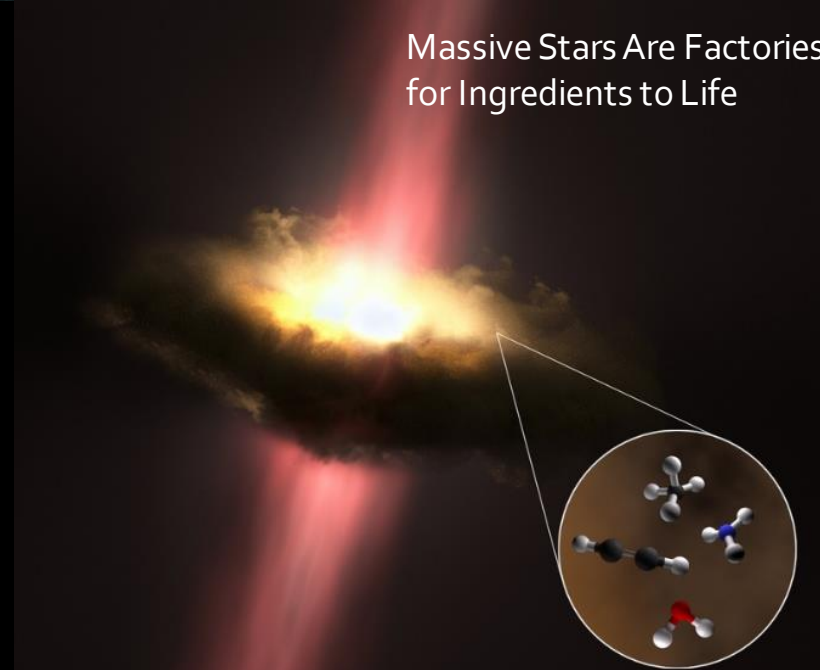
*Date:* 26 January 2021

Water on the Sunlit Surface of the Moon

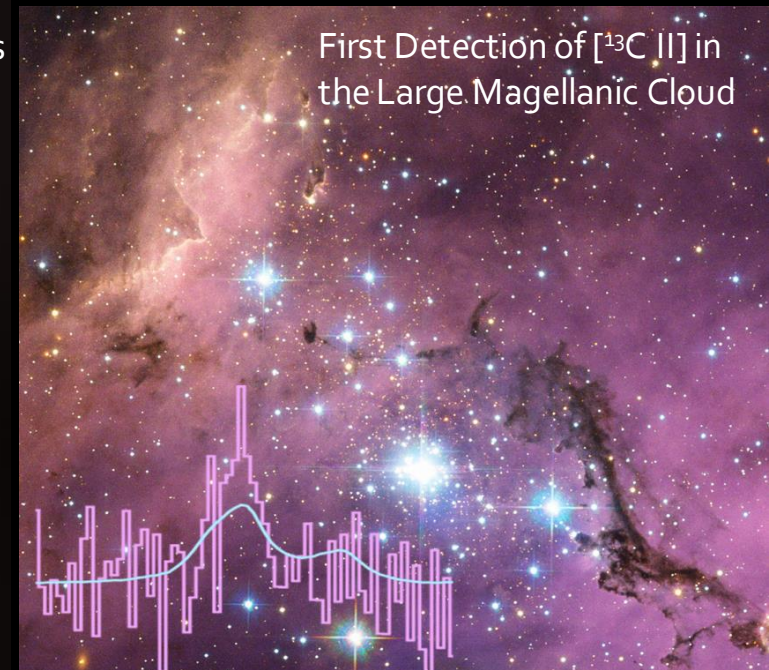


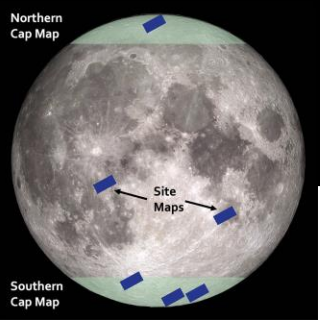
## Exploring the Infrared Universe

Massive Stars Are Factories for Ingredients to Life



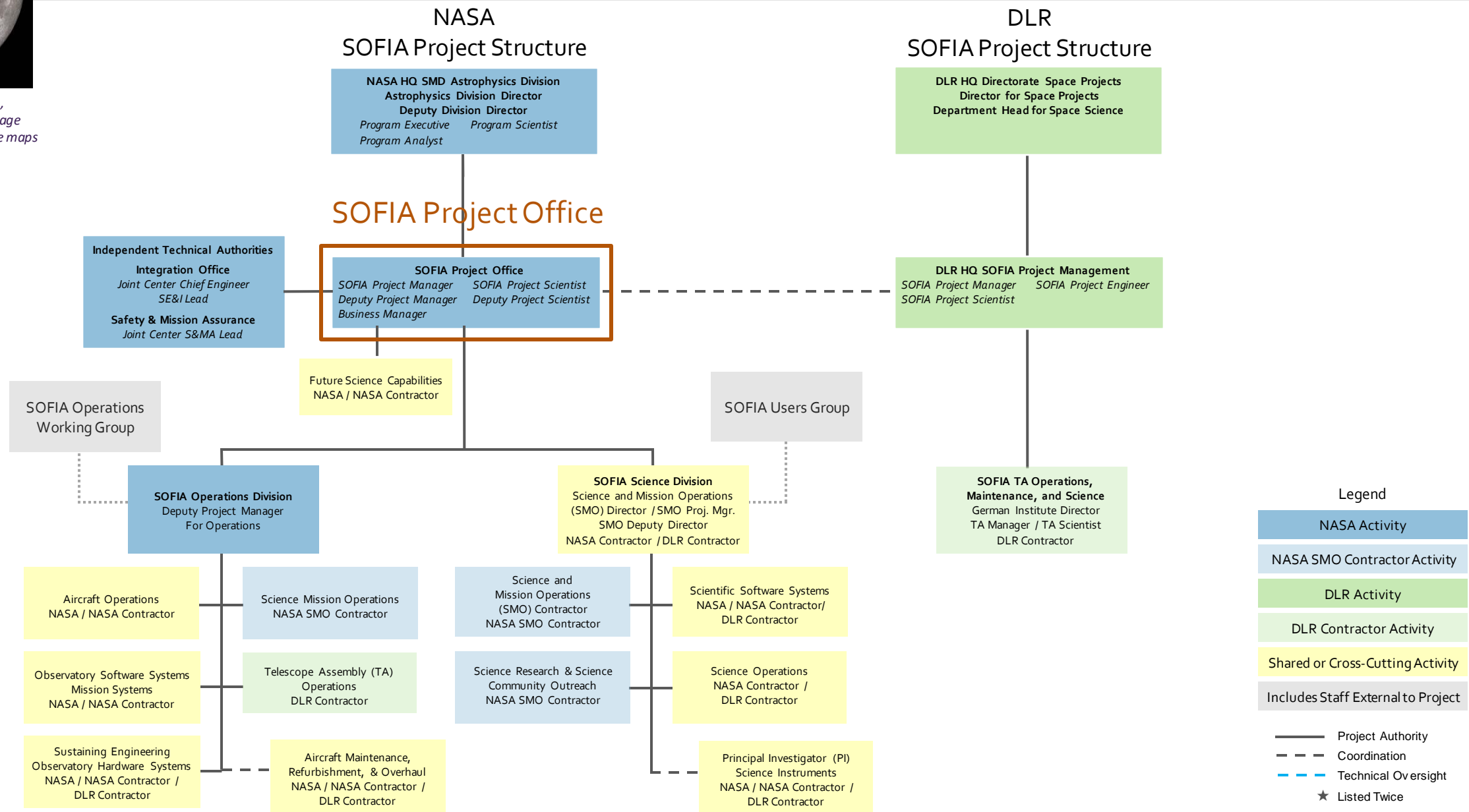
First Detection of [<sup>13</sup>C II] in the Large Magellanic Cloud





Mapping water on the Moon, SOFIA observing program image shows locations of 6.1μm site maps on the lunar surface

# SOFIA Project Organization (high level)



# SOFIA Response to 5-Year Flagship Mission Review



*SOFIA shows magnetic field alignment over an entire galaxy.*

The SOFIA Project's response to the Five-Year Flagship Mission Review (FMR) report submitted in fall 2020 to NASA HQ

- Describes the immediate and strategic initiatives as well as policy changes undertaken by the Project to substantially increase the publications and scientific impact of the observatory by the next Senior Review, expected in 2022.
- The Project's response also describes various studies and strategic planning activities undertaken by the Project following the FMR to address the individual recommendations and top-level advice.



26 January 2021



SOFIA Response to 5-Year Flagship Mission Review

September 30, 2020

<https://www.sofia.usra.edu/science/sofia-overview/steering-documents>



# SOFIA Mission Objectives



**Table 1.2 – SOFIA Mission Objectives\***

**PRIORITIZED MISSION OBJECTIVES FOR THE NEXT 5 YEARS**

- 
- 1 Dedicate at least one-third to one-half of observing hours to Legacy programs

---

  - 2 Maximize observing time in the Southern Hemisphere

---

  - Emphasize high-quality data collection; effort includes, but is not limited to:
    - a. Maximizing observing in low water-vapor conditions
    - 3 b. Increasing observing opportunities during optimal observing months
    - c. Conducting a robust proposal selection and technical evaluation process
    - d. Prioritizing the collection of well-characterized, well-calibrated, large, homogeneous data sets

---

  - 4 Pursue synergies with ground-based observatories and NASA missions via collaborative efforts and joint observing programs

---

  - 5 Build a bigger and a scientifically diverse user community

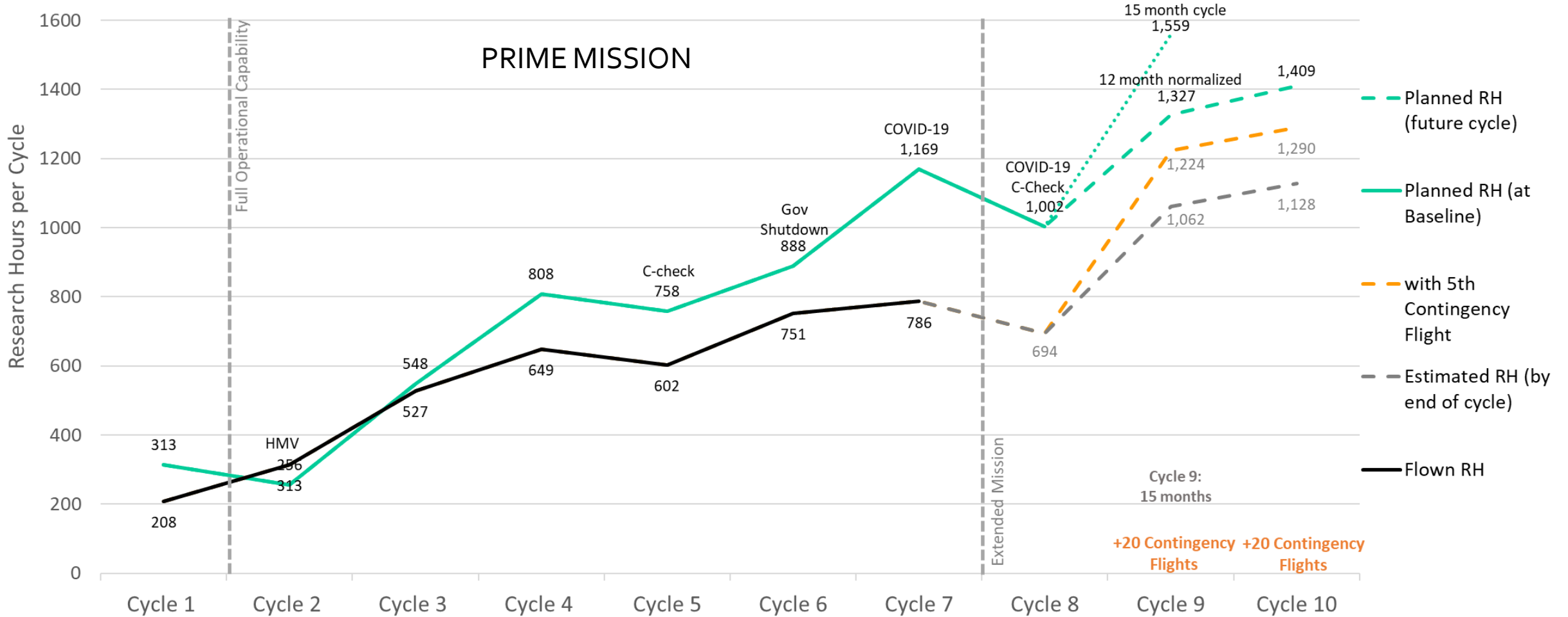
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  - 6 Maintain the capability to upgrade and develop new instrumentation to support new discoveries or new astrophysics priorities
-



# SOFIA Bold Initiative

## Increasing Observing Opportunities for the Community



- Contingency flights will substantially improve program completion rate boosting publications
- Expected to achieve ~1290 research hours annually
- Path to 100 SOFIA publications

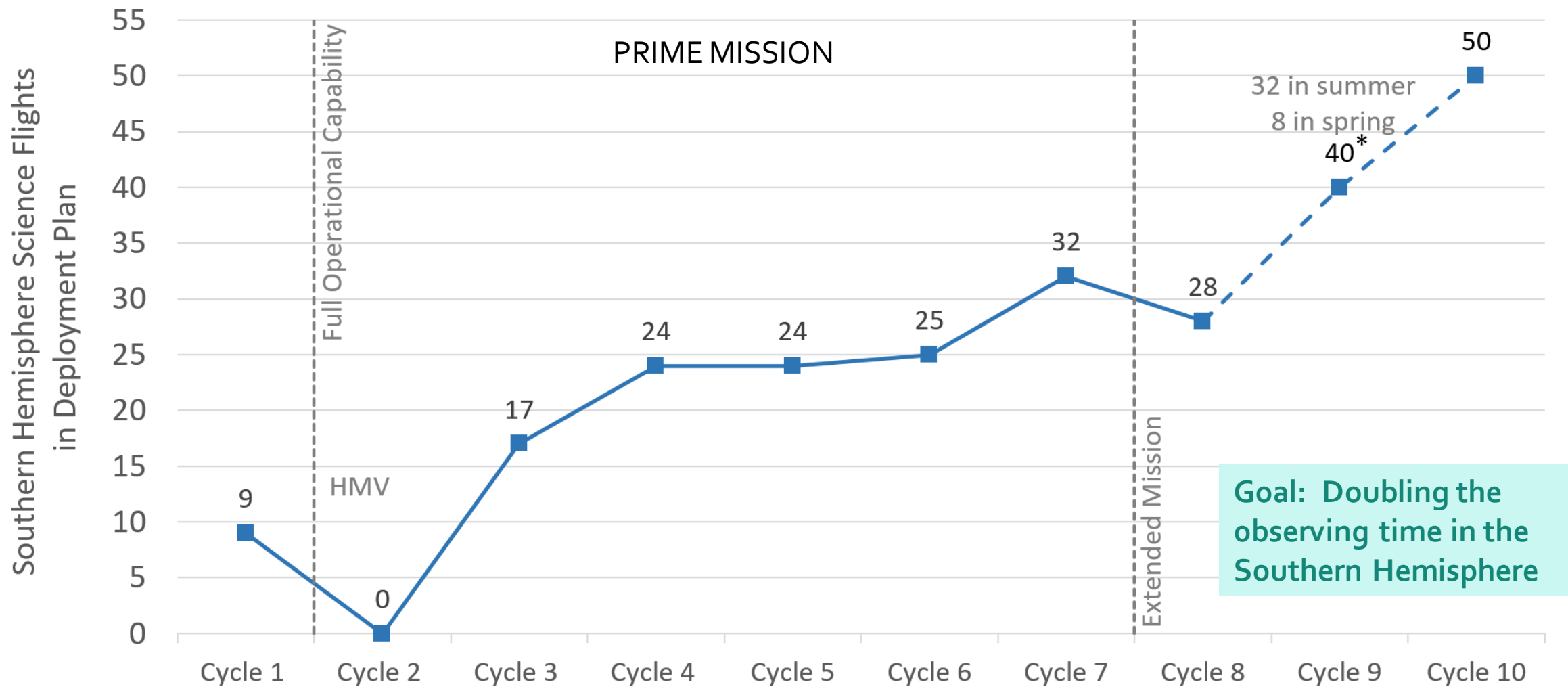
**Goal: ~60% more observing time in the extended mission**





# SOFIA Bold Initiative

## Fly 50 flights in Southern Hemisphere annually



\* COVID-19 led to the cancellation of the Cycle-8 Southern deployment. The new Cycle-9 schedule starts with the Cycle-8 Southern deployment plan (32 flights), additionally includes a short spring deployment (8 flights) and ends with a long summer deployment (32 flights).



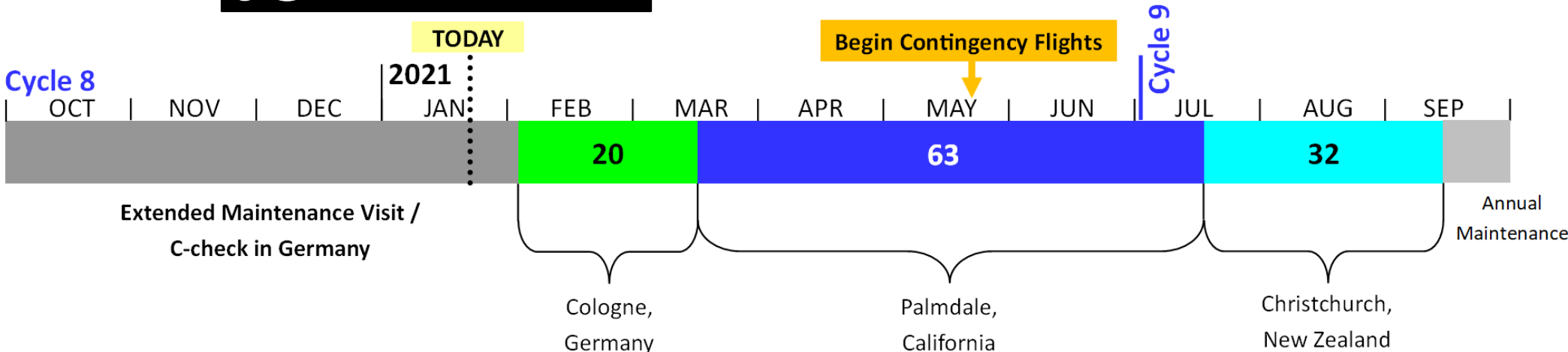
## 50 flights are in the planning schedule for Cycle-10

- ▶ 1 long (~34 flights) plus 2 "suitcase" deployments (~8 flights each) with different science instruments
  - ★ Allows all SOFIA instruments to observe the Southern Hemisphere skies
- ▶ Establishing alternate deployment sites for suitcase deployments
  - French Polynesia/Tahiti done
  - Argentina survey on hold due to COVID-19)
- ▶ Concept of operations is being developed
- ▶ If there are unforeseen budgetary constraints, then Northern Hemisphere flights can be traded with Southern Hemisphere flights
- ▶ **First suitcase deployment for Cycle-9 scheduled for March 2022 (likely Tahiti)**

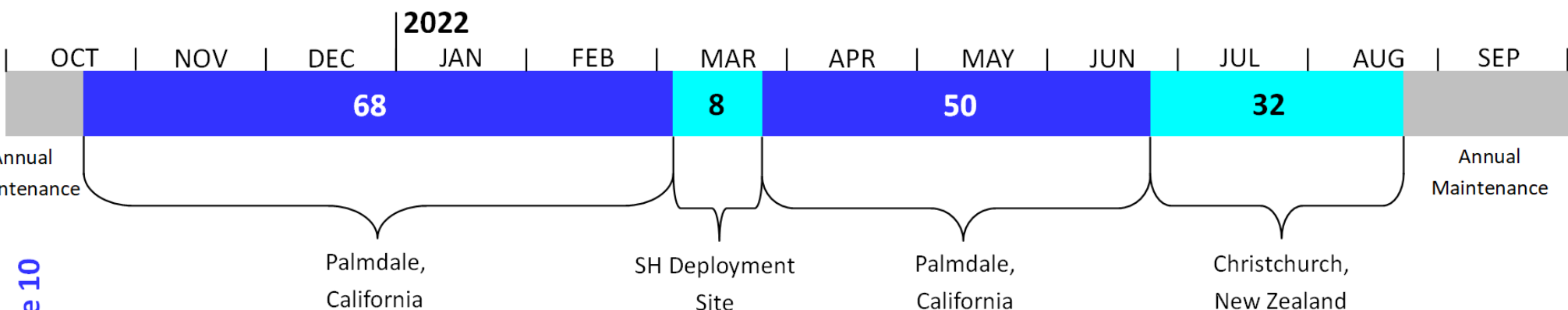
# SOFIA Observing Schedule Plan

Cycle **8** Science Flown Baseline  
 Flights **15** of **93**

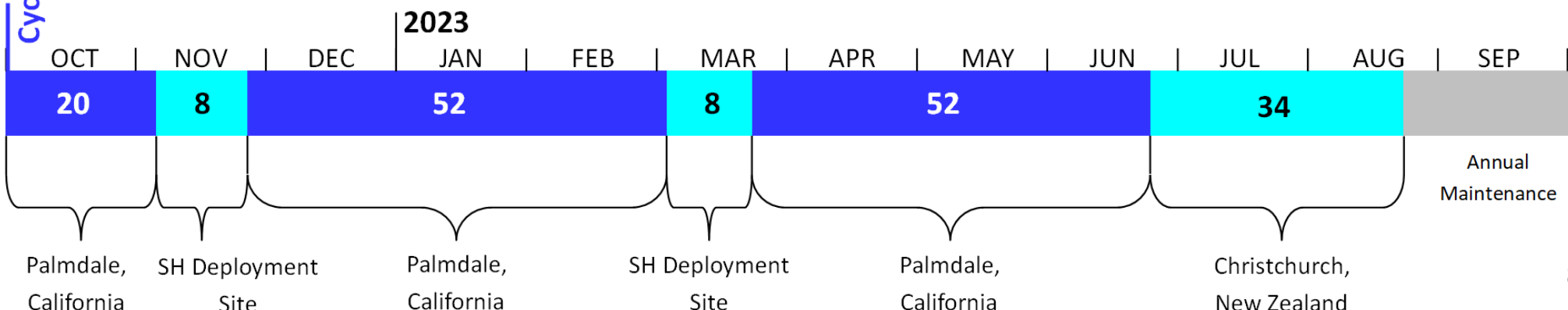
**FY 21**



**FY 22**



**FY 23**







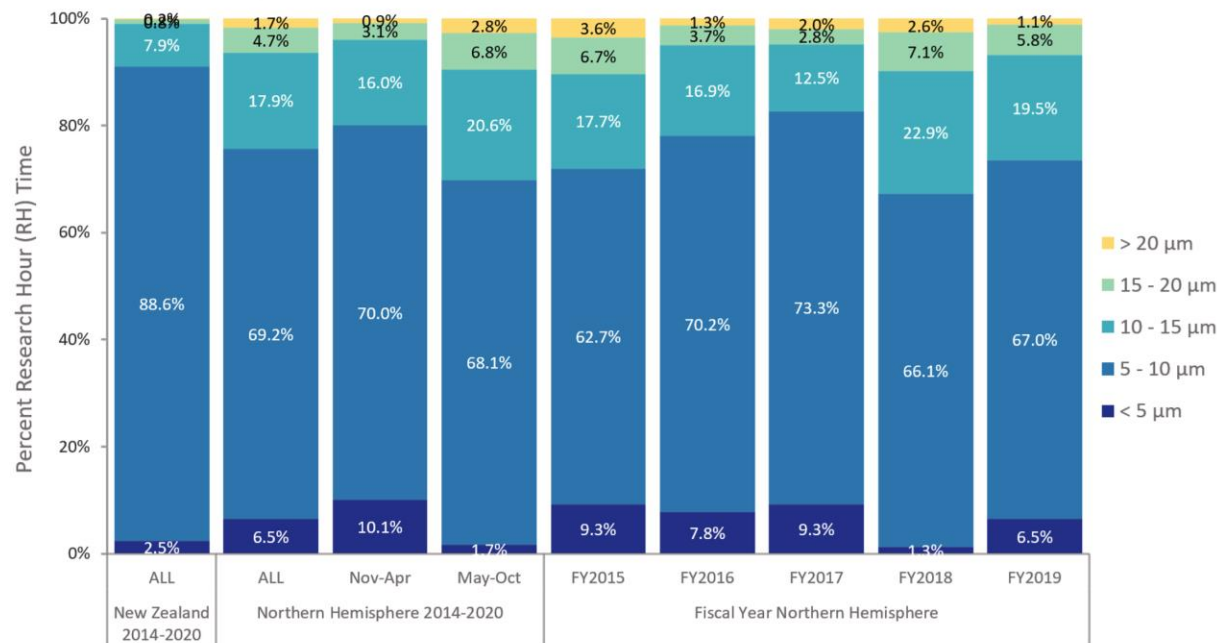
# SOFIA Mission Objective

## Maximize Observing Time in Low Water Vapor Conditions

- The Project led a study to figure out a reliable and consistent method of measuring and tracking high-value observing time, i.e., operationally, is SOFIA providing sufficient high-value observing time?
- NASA GEOS weather database provides reliable measurements of stratospheric height and zenith water vapor.

- For all North American SOFIA flights since 2014, SOFIA spent 76% of the research hours\* in excellent conditions (< 10 μm) and 93% in very good conditions (< 15 μm)
- For all NZ flights since 2014, SOFIA spent 91% of the time observing in excellent conditions (< 10 μm) and 99% in very good conditions (< 15 μm)

Figure 6.3 – Zenith PWV from Satellites (All Flight Levels)



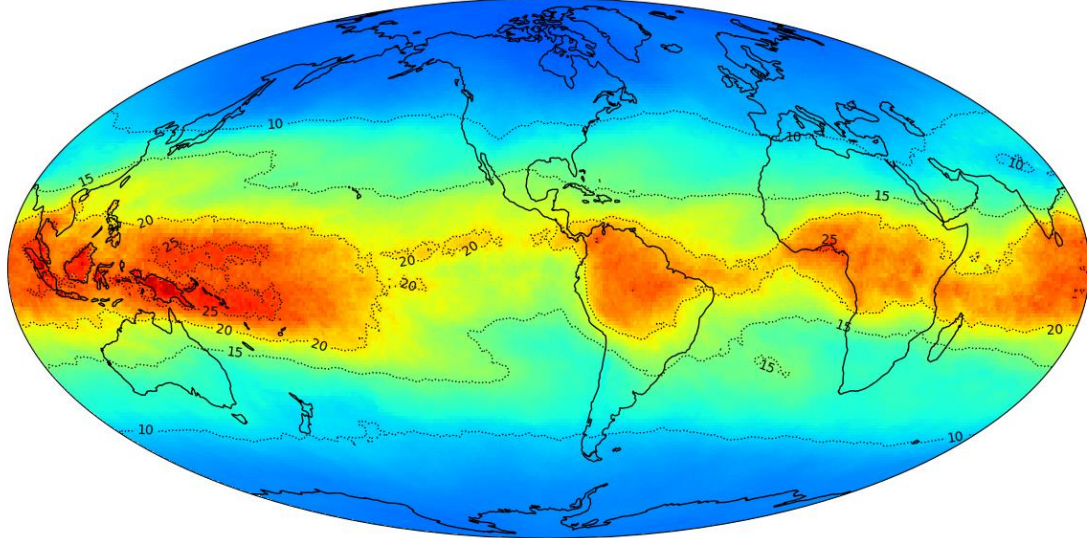
\* May-Oct data are skewed towards lower PWV, because SOFIA typically does not conduct operations between June – August from Palmdale.  
 \* During June, July & August, “very good” water-vapor conditions occur less frequently, and shorter flights are recommended.  
 \* Research hours are defined as hours when the telescope door is open and observatory systems are operational and ready to collect data.



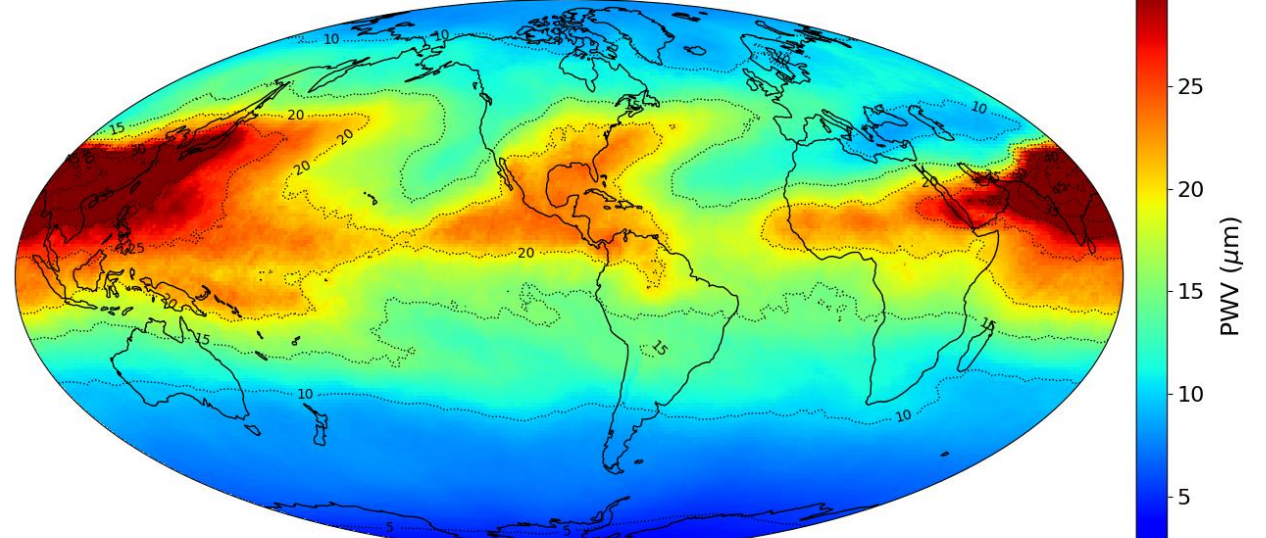
# SOFIA Global Precipitable Water Vapor Maps (all months)



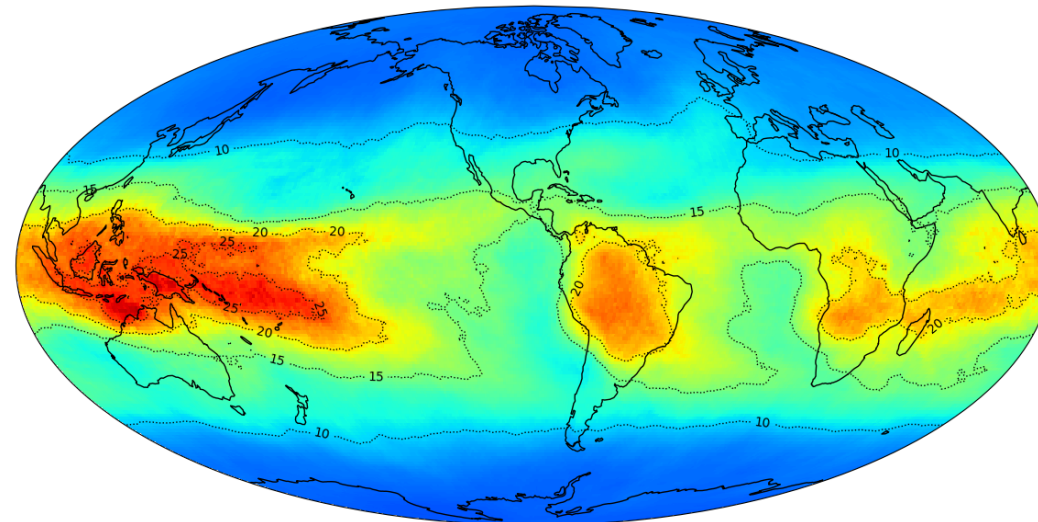
PWV FL390 April



PWV FL390 July



PWV FL390 December





# Water Vapor Forecast Accuracy 24 hours before the mission



### Forecast

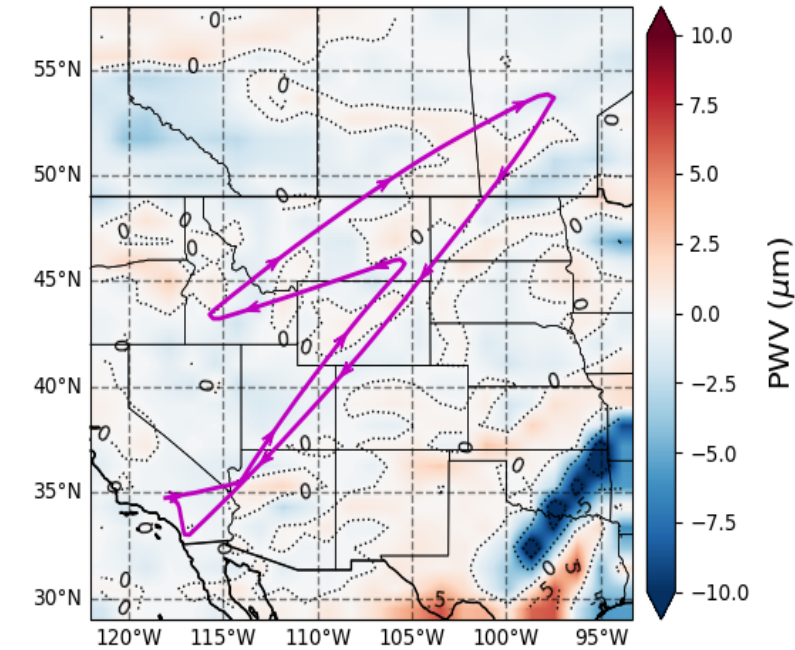
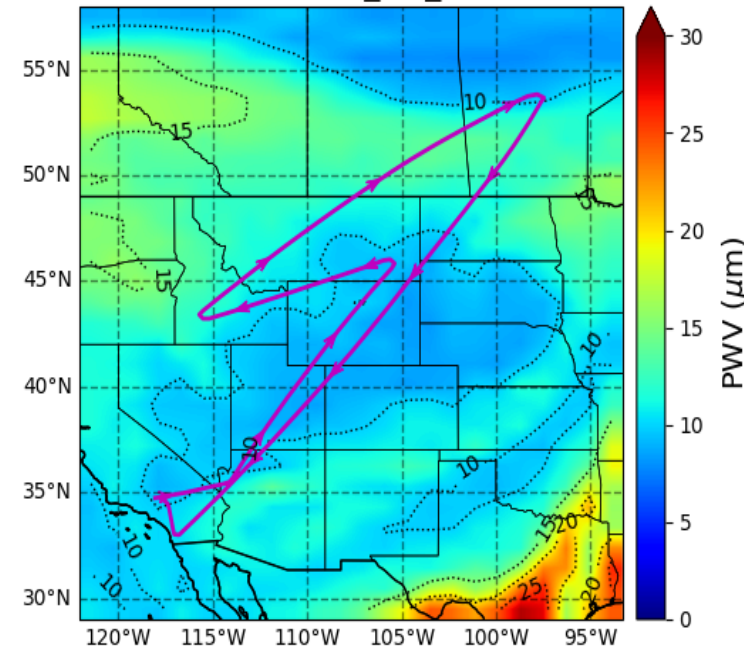
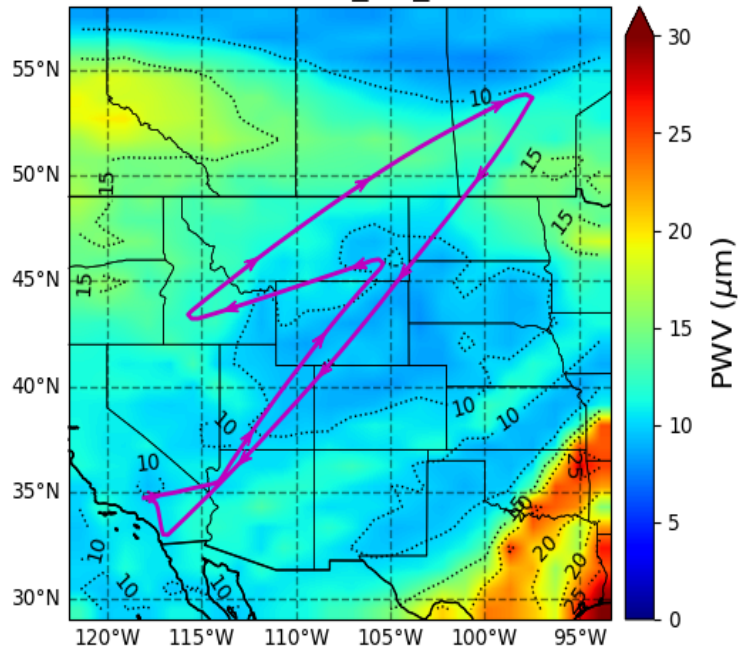
### Actual

### Residuals

FL390 2020-09-12\_HA\_F686 -24hrs

FL390 2020-09-12\_HA\_F686 Actual

FL390 Residuals





# Water Vapor Forecast Accuracy 48 hours before the mission

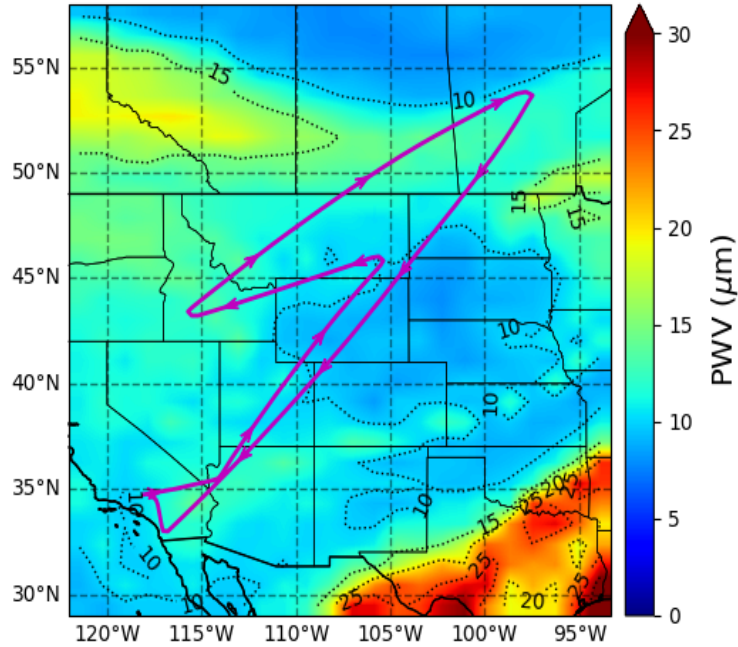


### Forecast

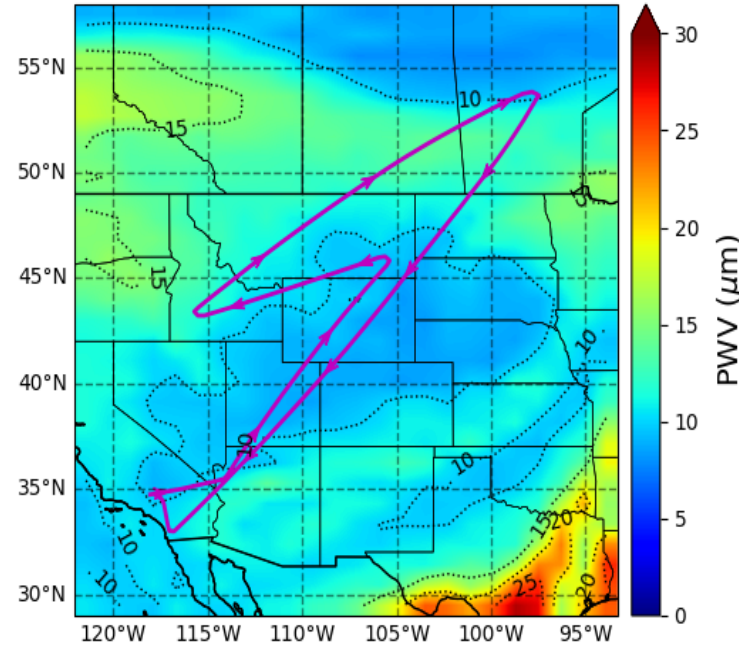
### Actual

### Residuals

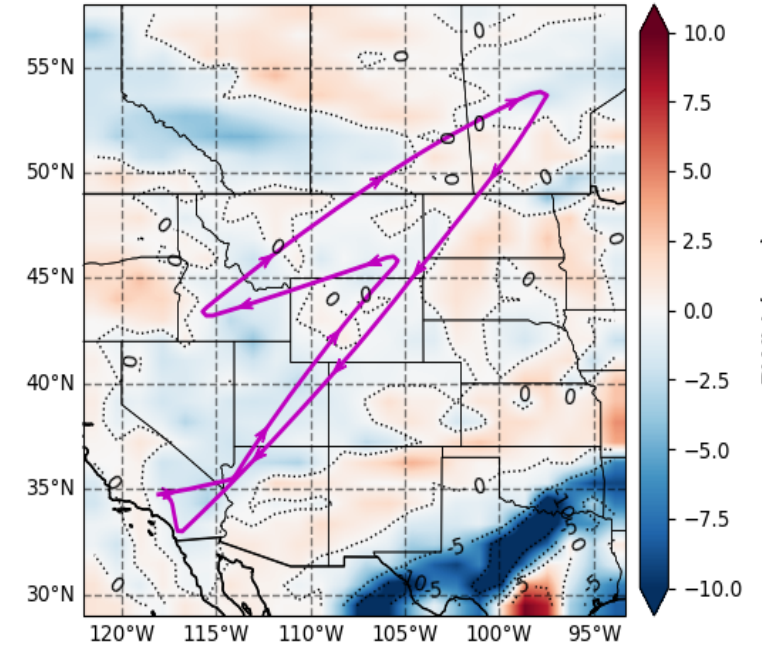
FL390 2020-09-12\_HA\_F686 -48hrs



FL390 2020-09-12\_HA\_F686 Actual



FL390 Residuals





# Water Vapor Forecast Accuracy 120 hours before the mission

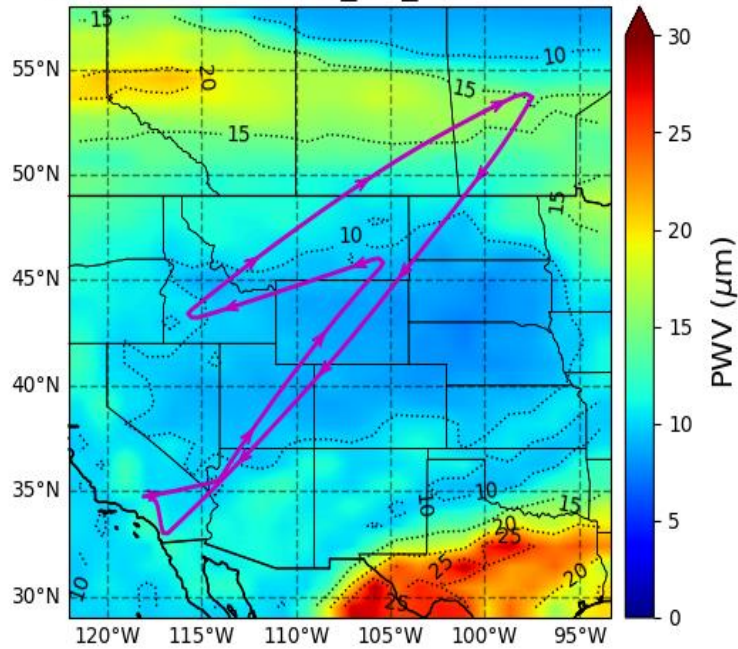


### Forecast

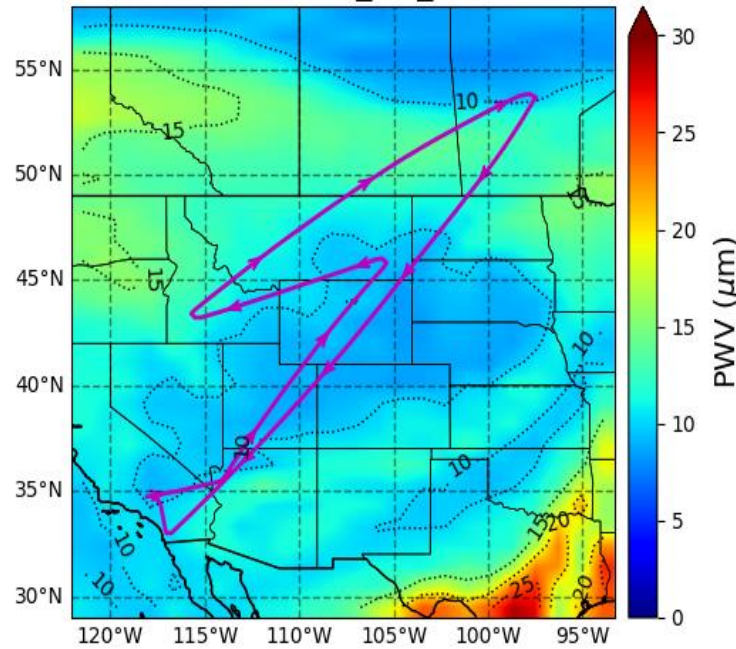
### Actual

### Residuals

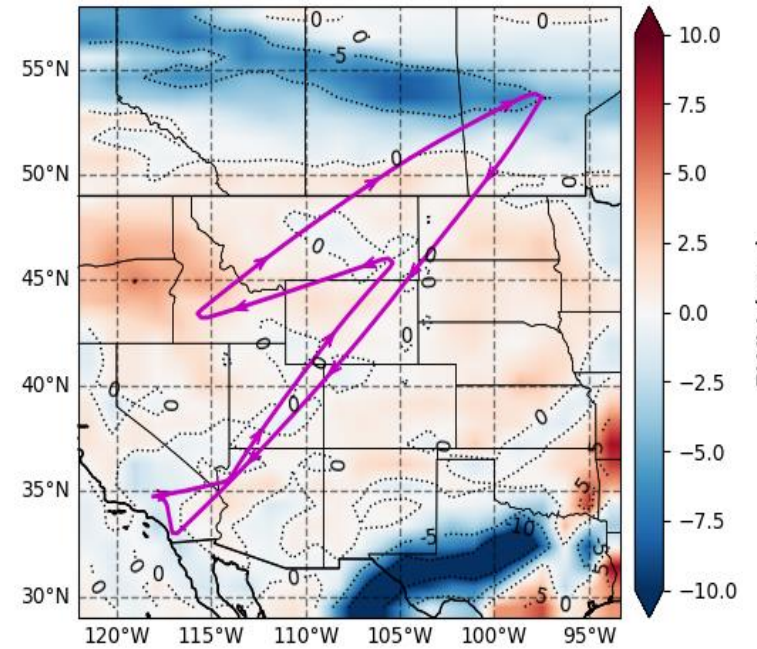
FL390 2020-09-12\_HA\_F686 -120hrs



FL390 2020-09-12\_HA\_F686 Actual



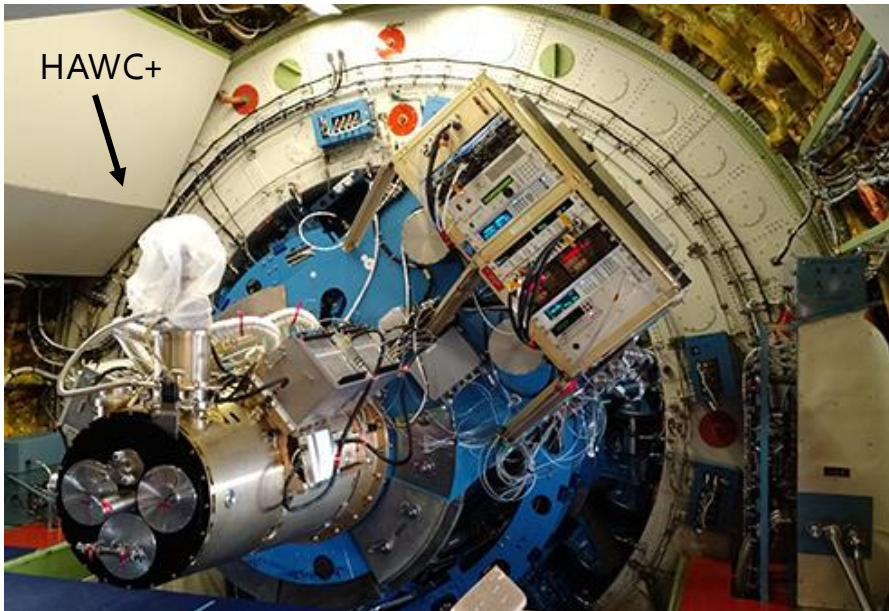
FL390 Residuals



# Instrument Roadmap Update



Project moving forward  
with the HAWC+ upgrade.  
*Stay tuned...*



Magnetized Filamentary Gas  
Flows in Serpens South

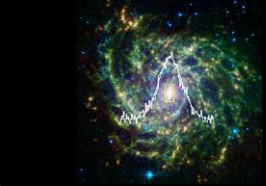




## Substantially increasing SOFIA's Scientific Return

- ▶ 60% more observing time for the community
- ▶ Adding 20 contingency flights per year
- ▶ Doubling observing time in the Southern Hemisphere
- ▶ New archival call (\$1.5M available funds for the community) in 2021
- ▶ Upgrading HAWC+ upgrade
- ▶ Enhanced science community engagement
- ▶ Additional instrument scientists
- ▶ Additional investment in the SOFIA data archive at IRSA
- ▶ SOFIA postdocs to increase to ~6 per year

Budget: SOFIA is fully funded in FY 2021



# SOFIA's Extended Mission - 1 of 2

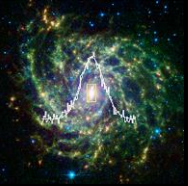


**SOFIA's extended mission started in fall 2019 after the conclusion of the Flagship Mission Review (FMR)**

Expectations include:

- Fully **transition from development to mature operations**, with focus on increasing scientific output and impact
- Divert “development” resources (without impacting sustained operations of 4 flights per week) to:
  - **Increase scientific data collection** by flying more and minimizing downtime (e.g., moving to 1-year maintenance per the SOMER & FMR)
  - **Increase scientific productivity and impact** by (for example) promoting archival research and growing/diversifying SOFIA community
- Operate with **higher mission-assurance risk** to allow SOFIA to fit within a reduced annual planning budget
  - e.g., suitcase (or mini) Southern Hemisphere deployment conducted with a much smaller crew, which increases the risk posture. If something breaks, then we return home.
- Implement **operational efficiencies** to further reduce cost or to reinvest in science enhancing initiatives





# SOFIA's Extended Mission - 2 of 2



Continued...

- Move to **once-a-year annual maintenance** starting 2021
- **Observatory hardware and software development activities will be limited** to tasks required to sustain and maintain Observatory's ability to continue to collect high-quality science data
  - Non-mission-critical development will be deployed once a year
  - **Mission-critical changes or corrective tasks will not be impacted**
  - New science instruments (SI) will be driven by the commissioning schedule and will not be managed under the once-a-year software deployment schedule until the new SI has been accepted as a facility-class SI



# Discoveries are made possible by a multi-disciplinary and talented SOFIA team



Pilots



Mission Director



Safety Technicians



Telescope Operators



Mission Briefing before take-off



Airborne Ambassadors / Teachers



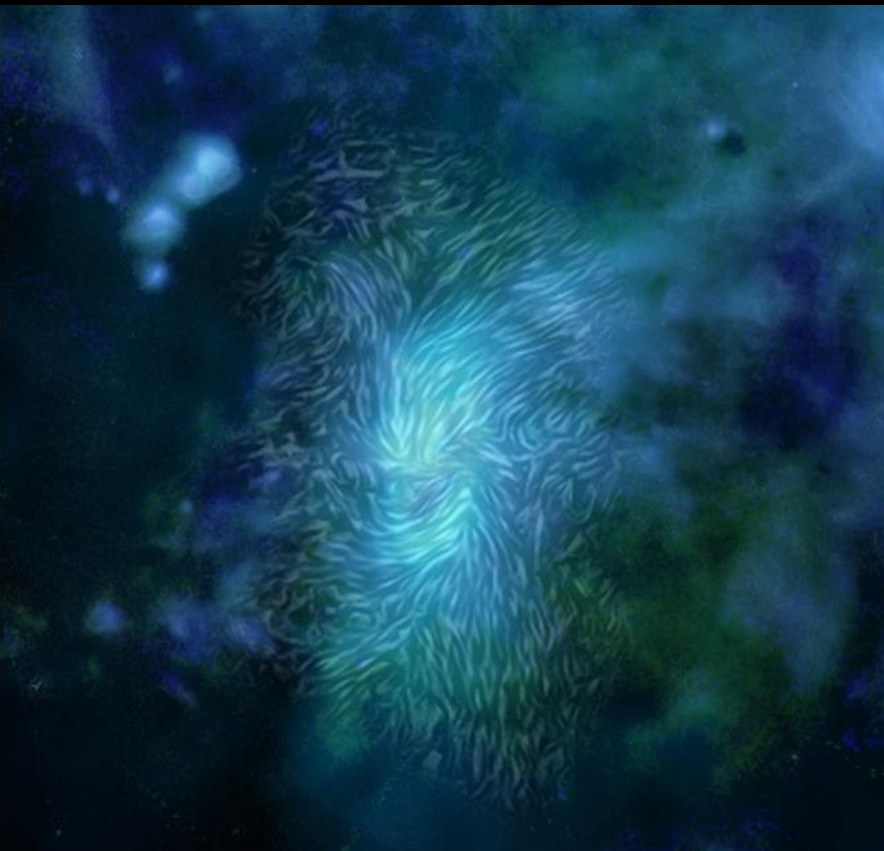
Instrument Scientists/Operators



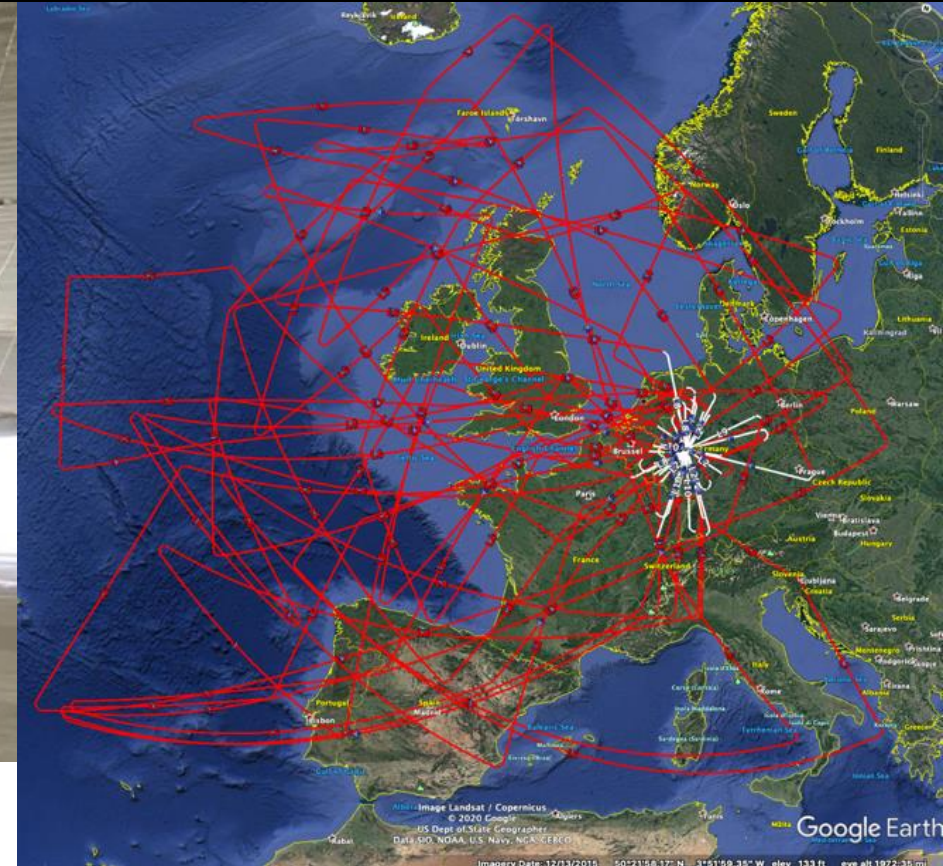
Mission Directors / Guest Observers



# SOFIA Resumed Operations Under COVID-19 Protocols



# SOFIA is in Germany / Maintenance & Deployment Status

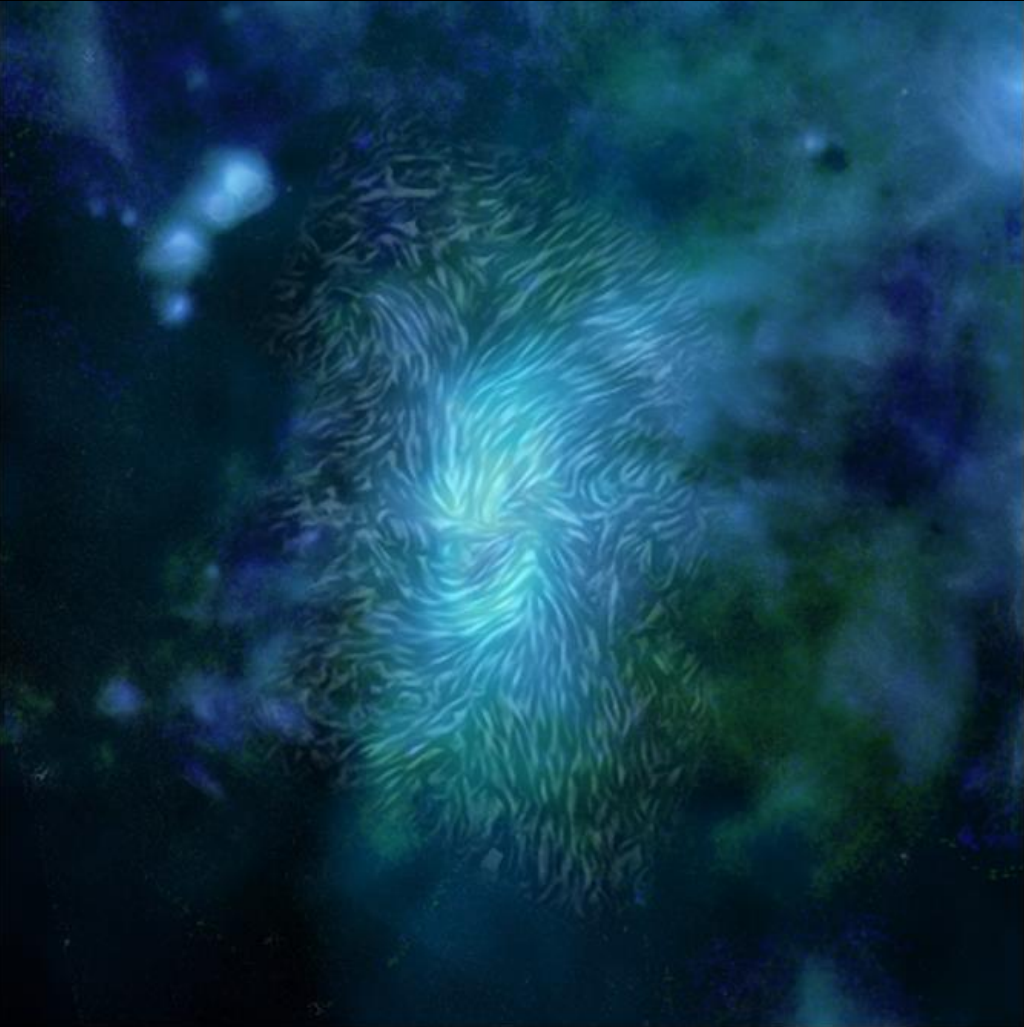


SOFIA chocked in place, for the engine run up test on 13 January 2021 at the Lufthansa Hamburg facility

Overlay of the 20 planned science flights out of Cologne, Germany, starting February 7, 2021



# Acronyms List



FMR – Flagship Mission Review

FY – Fiscal Year

HAWC+ – High-resolution Airborne Wideband Camera

IRSA – Infrared Science Archive

GEOS – Goddard Earth Observing System

NZ – New Zealand

PWV – Precipitable Water Vapor

RH – Research Hours

SI – Science Instrument

SOFIA – Stratospheric Observatory For Infrared Astronomy

SOMER – SOFIA Operations Maintenance Efficiency Review

TA – Telescope Assembly