



TABLE of CONTENTS [NOTE: This file includes Section 1 only. The full Table is provided for reference.]

1.	SUMMARY OVERVIEW	3
1.1	Logic Model and Guiding Principles	3
1.3	Outreach Partnerships (POCC & POCA)	5
	PUNCH Outreach Core Consortium (POCC)	5
	PUNCH Outreach & Communications Alliance (POCA)	6
1.4	Summary of Outreach Products & Events.....	7
1.5	Outreach Goal and Five Objectives.....	8
1.6	From Inputs to Outcomes	9
	Phase B Accomplishments	9
2.	MOTIVATIONS and ASSETS	10
2.1	Synergy: Outreach, Communications, and STEM Education	10
2.2	The PUNCH Mission and Data.....	11
2.3	Enthusiasm of PUNCH Scientists.....	12
2.4	The Eclipses.....	12
2.5	Leveraging Chaco	13
	The “Eclipse” Petroglyph Site	14
2.6	Participants We Intend to Benefit (and Learn From).....	16
2.7	Leveraging Partnerships – Stone Soup Model	16
2.8	Evaluation Strategy for PUNCH Outreach.....	19
	Integrating Evaluative Processes	19
3.	OUTREACH IMPLEMENTATION.....	20
3.1	PUNCH Outreach Products and Events	21
	Row 1: Native & Hispanic/Latinx Learners	21
	Row 1: Embodied Learning: Kinesthetic Astronomy	22
	Row 2: Choosing Planetarium Shows	23
	Row 2: Tactile Objects and Graphics	25
	Row 3: Girl Scout Patches and Events	26
	Row 4: Chaco Interpretation with Heliophysics	27
3.2	Outreach Activities for Each Objective	28
	Objective 1: Support for SME Engagement in Outreach	28
	Objective 2: Support for Partnerships of Mutual Benefit	30
	Objective 3: Enduring, High-Impact Products	31
	Objective 4: Replicable Events on the Ancient & Modern Sun Watching Theme	33
	Objective 5: Broad and Strategic Dissemination	35

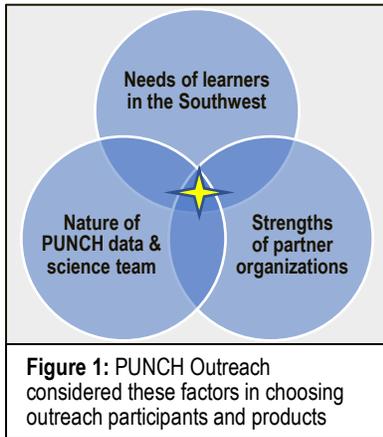


3.3 Management Plan.....	37
POCC Leadership	37
PUNCH Outreach Organization	38
POCC Advisory Board.....	41
POCC Institutions and their Experience.....	43
Project Management Processes and Communications	45
Plan of Work.....	46
Schedule.....	47
4. BUDGET.....	50
4.1 Baseline Budget.....	50
Summary of Funded Activities by Institute:.....	50
4.2 De-Scope Budget.....	51
4.3 Threshold Budgets	52
4.4 Summary of Deliverables	53
APPENDICES	55
APPENDIX A: SUMMARY of PHASE B ACTIVITY for PUNCH Outreach.....	56
APPENDIX B: Report on Outreach Experience and Interests of the PUNCH Science Team	59
APPENDIX C: Letters of Support and Commitment	64
APPENDIX D: Curriculum Vitae	116
APPENDIX E: References.....	152



1. SUMMARY OVERVIEW

We propose to leverage the NASA PUNCH Small Explorer mission to extend outreach of the fundamental science of heliophysics to underrepresented and underserved learners in the American Southwest and to the broader public in that region. We are well poised for national impact if funded at the baseline level. The populations we have chosen to emphasize are: Native American and Hispanic/Latinx youth and families, Girls in STEM, and the Blind and Visually Impaired (B/VI). These choices are motivated by the three considerations in the Venn diagram of **Figure 1**. **Attuning to the needs and opportunities of these historically marginalized populations has led to a multi-cultural, multi-sensory, arts-integrated outreach plan for PUNCH that is enriching for all people in all communities.** Our products and events are designed to “**Shine a Light on Diverse Views of the Sun,**” be they scientific, cultural, historic, or the result of first-person observations.



1.1 Logic Model and Guiding Principles

Figure 3 is the detailed Logic Model for the PUNCH Outreach Project (hereafter simply “PUNCH Outreach”) that the rest of this proposal will address. The model demonstrates how the Inputs and Activities of our planned work result in Outputs and Outcomes that contribute to longer-term benefits to NASA and to broader society. Inputs include the **8 Principles (Figure 2)** of our overall strategy, which have guided the development of the PUNCH outreach plan (this document) during Phase B and will continue to guide its implementation. Also in the *inputs* column are PUNCH scientists and eventually their data and discoveries, the curation of existing resources from NASA and other sources, and the body of outreach institutions, collaborators, consultants, and advisors we have assembled during Phase B (organized as the POCC and POCA described below).

8 GUIDING PRINCIPLES for the PUNCH OUTREACH PLAN
1. Engaging outreach expertise in collaboration with mission leadership
2. Synergizing the Science, Outreach, and Communication Teams.
3. Coordinating & synergizing with allied NASA groups & missions
4. Enacting a thematic outreach approach to broaden participation
5. Aligning mission attributes with outreach participants & partners
6. Leveraging strengths & partnerships among multiple institutions
7. Learning from those we intend to benefit from the start
8. Using evidence-based practices & integrating evaluative processes

Figure 2: The eight Guiding Principles for the PUNCH Outreach Plan

The *activities* column of the logic model summarizes the actions leading to the Outputs and Outcomes that indicate our success. The *outputs* column includes measurable metrics that our evaluator will help us account. The *outcomes* column requires qualitative inquiry on the part of our evaluator with the variety of stakeholders we intend to benefit. We are already collaborating with these stakeholders to learn about their needs, interests, and ideas. The rightmost column is a collection of longer-term NASA and societal benefits. These are visionary statements that the PUNCH outreach team’s efforts intend to help realize.

PUNCH Outreach Logic Model

Enhancing Diverse Public Engagement in NASA Heliophysics

PUNCH Outreach: Shining a Light on Diverse Views of the Sun with an Ancient & Modern Sun Watching Theme

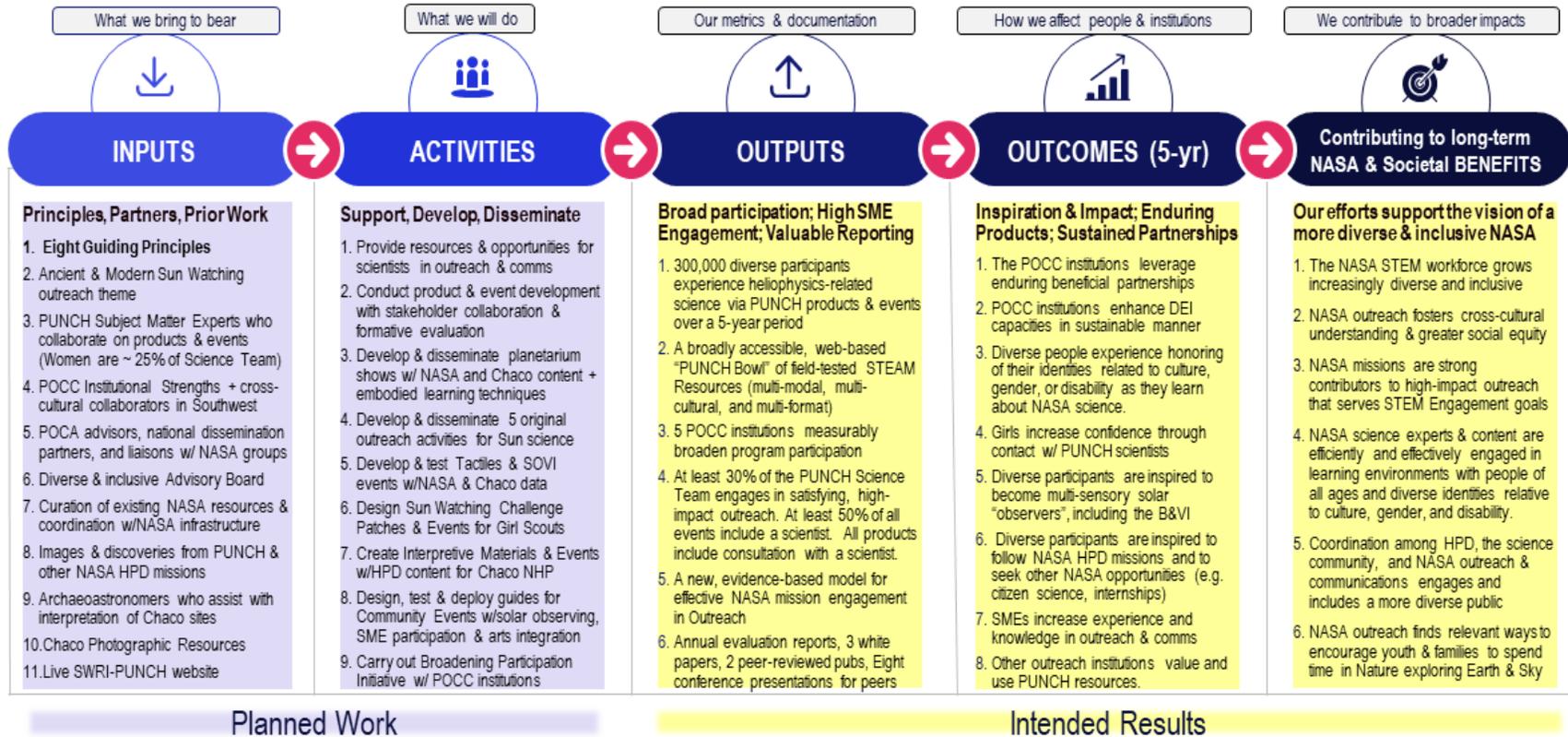
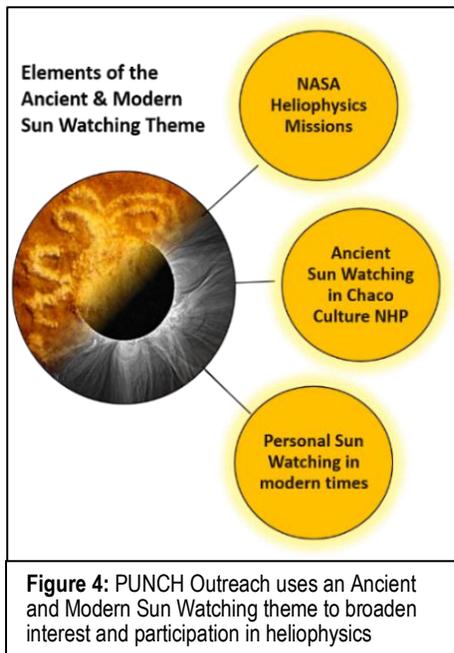


Figure 3: The detailed logic model for the PUNCH Outreach Plan

1.2 Ancient & Modern Sun Watching Theme

Our 5-year, \$3M plan interweaves science, art, history, and culture via the theme of ***Ancient and Modern Sun Watching*** that combines: 1) PUNCH (and other NASA Heliophysics missions); 2) selected ancient solar observatories of Chaco Culture National Historical Park – a World



Heritage site and International Dark Sky Park in the remote, high-desert of northwestern New Mexico; and 3) culturally appropriate invitations to personal observation of the Sun. Science learning in cultural and personal contexts is vitally important to minority learners, and our theme ensures cultural relevance throughout the Southwest. **The theme represents NASA exploration of the Sun as an extension of humanity’s long-lived dedication to observing the star at the center of our solar system.**

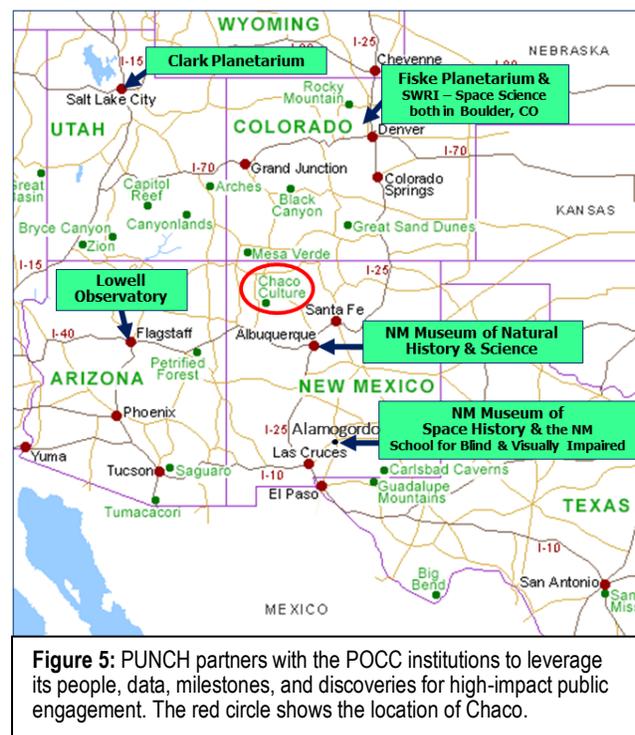
The Ancient and Modern Sun-watching theme is also of broader interest in a decade that features a solar maximum of activity, two solar eclipses visible from the US, and a host of exciting milestones for NASA missions like PUNCH, Parker Solar Probe, and Solar Orbiter that will make contemporaneous observations of the Sun’s corona. Moreover, there is worldwide evidence that every human being is descended from a Sun watching culture. Thus, our theme also has a universal quality while being rooted in the evidence and the people of the Southwest.

1.3 Outreach Partnerships (POCC & POCA)

PUNCH Outreach is integrated with existing regional resources and closely coordinated with NASA outreach and communications efforts on the national level to help ensure complementarity of effort, alignment with NASA goals, and the potential for broader impact beyond the Southwest.

PUNCH Outreach Core Consortium (POCC)

We have formed the PUNCH Outreach Core Consortium (POCC), comprising the Southwest Research Institute (SwRI), five planetariums and science centers in four states (CO, NM, UT, AZ), and key collaborators and consultants in the populations we intend to benefit. The POCC institutions have a combined annual visitorship of about 750,000. Of these, over 225,000 participate in a full-dome planetarium experience during their visit. The visual nature of the PUNCH science data combined with the visual drama of a sunrise rolling up the side of a pyramid-shaped rock from an “eclipse” petroglyph site in Chaco Canyon have motivated our emphasis on



planetarium partners. POCC institutions have worked together on designing and organizing the PUNCH Outreach Plan since May 2020 with central coordination provided by the PUNCH Outreach & Communication Lead (OCL), Dr. Cherilynn Morrow, and Fiske Director, Dr. John Keller. As a result, there is already a strong foundation for communication and resource-sharing across the Consortium. Dr. Morrow will serve as POCC Director for the plan’s implementation, and Dr. Keller as Co-Director.

POCC institution professionals are expert in delivering science content for youth and families, experienced with convening large public events, located in or near places with populations of those we intend to benefit, and willing to continue growing their capacity to broaden participation in their programming. The POCC amplifies the PUNCH outreach investment. POCC institutions collaborate directly with the PUNCH mission and invite PUNCH scientists to engage in the high-impact outreach opportunities they create, including collaboration on product development and presentations at events.

PUNCH Outreach & Communications Alliance (POCA)

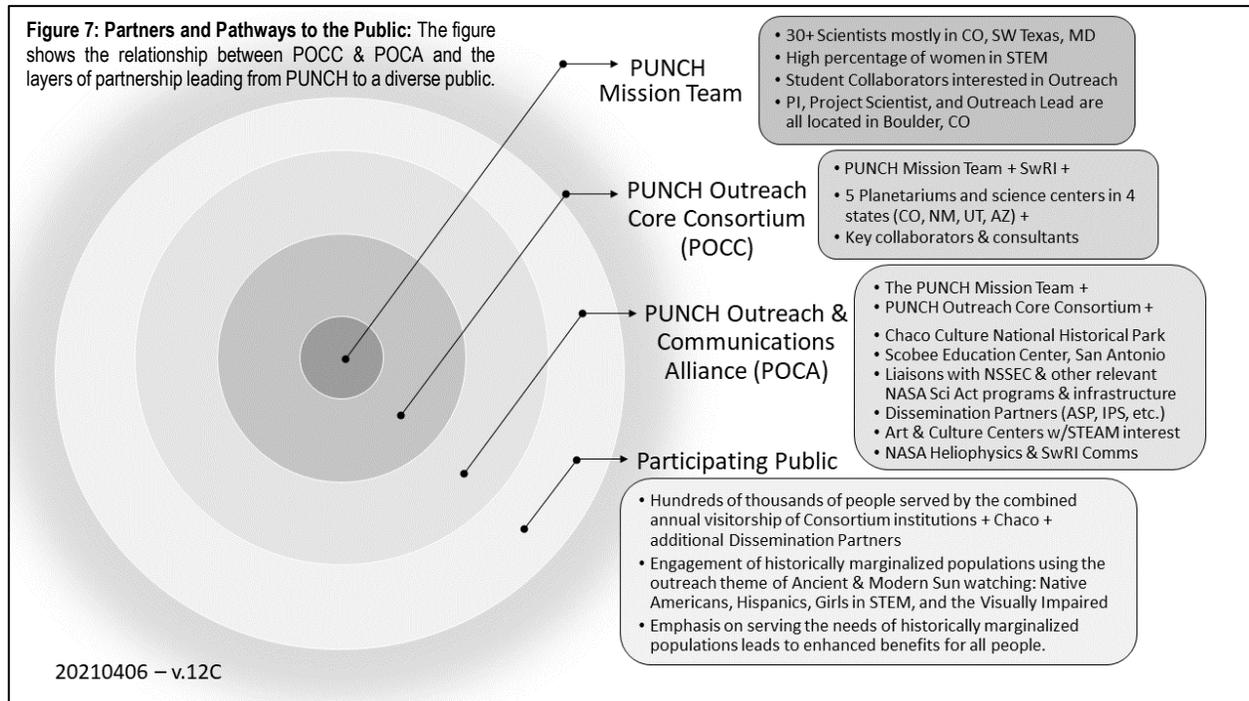
To ensure maximum benefit, we have also formed a broader collaborative alliance. The “PUNCH Outreach & Communications Alliance” (POCA) includes the funded core consortium (POCC) and adds a set of advisors, dissemination partners, and liaisons to represent NASA and other relevant organizations on a no-exchange-of-funds basis. The layer added to the POCC to make the POCA contains three new types of colleagues for the overall PUNCH Outreach team, including:

- 1) Colleagues doing complementary work in heliophysics communications at SwRI and at NASA GSFC with whom we continue to coordinate and explore synergies of effort.
- 2) A PI-designated liaison from the heliophysics education group (NSSEC), and connections to six other NASA-sponsored programs that are relevant to PUNCH outreach domains (see the Table in **Figure 6** below).
- 3) Dissemination partners who assist national and strategic local dissemination (e.g., the International Planetarium Society, the Astronomical Society of the Pacific, the San Juan College Planetarium – the nearest one to Chaco Canyon and a large Navajo population; Owens Planetarium – the nearest one to NASA GSFC with several PUNCH scientists)

The POCC executes the core mission of regional outreach in the US Southwest. The POCA helps to radiate the impact of PUNCH outreach to the nation. **Figure 7** depicts these layers of partnership leading from the PUNCH mission to a diverse public.

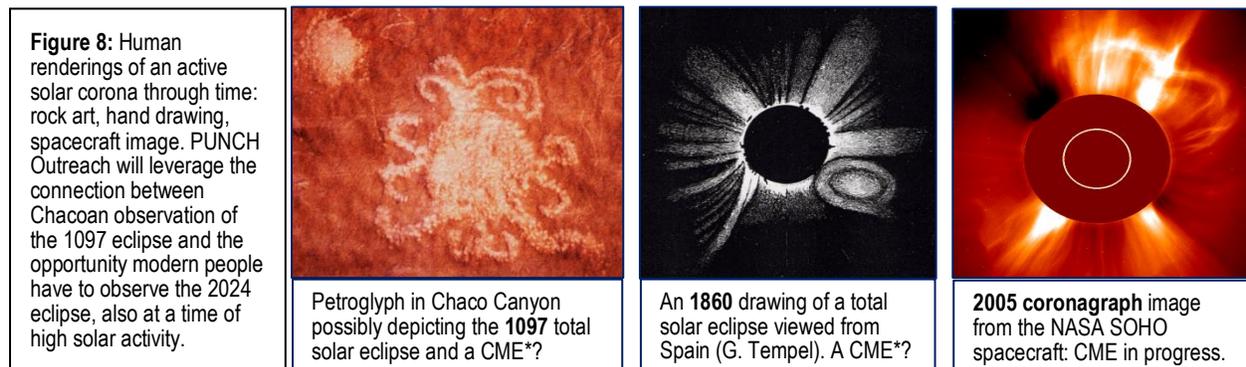
Name of NASA program	NASA connection	Points of Contact	Role in PUNCH Outreach
NSSEC at Goddard	NASA & Heliophysics	Carolyn Ng	Liaison
Reach for the Stars	NASA & Girl Scouts	Pamela Harman	Advisory Board
PLANETS	NASA & Out-of-School time	Dr. Joelle Clark	Advisory Board
Earth to Sky	NASA & National Parks	Anita Davis & Genevieve deMessieres	Informal Advisors
Infiniscope	NASA & Digital Interactives	Geoffrey Bruce	Informal Advisor
Eclipse Soundscapes: Citizen Science Project	NASA & Accessibility for Visually Impaired	Trae Winter and Mary Kay Severino	Dissemination partner
MAIANSE	NASA & Native America	Bonnie Murray	Dissemination partner

Figure 6: The Table lists the NASA-sponsored Science Activation groups (Sci-Acts) and the STEM Engagement group (MAIANSE) with whom we have consulted and explored relationships of mutual benefit during the proposal development process.



1.4 Summary of Outreach Products & Events

PUNCH outreach products and event planning guides (which document what we learn about best practices for implementing events with each of the populations we intend to benefit) will be of enduring value and make a unique and complementary contribution to the body of existing resources. The volume of products and events created by our collaborative model for the POCC far exceeds what any single institution could do on its own for the same investment of dollars in the same time period. The POCC institutions pool and leverage their strengths to develop, test, and disseminate products and event planning guides, *all* expressing the Ancient and Modern Sun Watching theme as a coherent, cross-project tool for establishing more diverse STEM engagement. Key POCC products include: 1) three full-dome planetarium shows (two short films and a feature film highlighting both eclipse and PUNCH data) all explicitly integrated with supplemental techniques and tools for audience-centered interaction; 2) a set of activity options that define a new Girl Scout Challenge Patch; 3) self-directed training materials for new interpreters of a Chaco Sun-watching site with a **unique petroglyph that is possibly humanity’s first recording of an active solar corona in an enduring medium**; and 4) a multi-cultural, multi-modal, multi-sensory collection of curated and newly created STEAM resources



*CME = Coronal Mass Ejection = a type of solar storm that disrupts the solar corona and surrounding heliosphere.

that includes embodied learning activities, tactile resources, and audio-visual interactives. Specific types of community events for Girl Scouts, B/VI learners, Native American and/or Hispanic/Latinx youth and families make use of some or all these versatile resources.

POCC institutions have committed to our Broadening Participation in Planetarium (BPiP) initiative to ensure that POCC events enhance opportunities for historically marginalized youth to become interested in science and more confident about considering STEM-related careers. Part of BPiP is to consult with Native and Hispanic youth about the specific design of the events intended to engage them and their families. As currently envisioned, PUNCH Outreach Events provide pathways for 1) following the stories of new discoveries made by PUNCH and allied heliophysics missions; 2) exploring ancient Sun watching sites with modern technology; 3) becoming a first-person Sun-watcher in modern times; and 4) seeking further engagement with NASA. POCC (regionally) and POCA (nationally) increase awareness, appreciation, curiosity, and knowledge about: 1) humanity’s relationship to the Sun; 2) NASA Heliophysics; 3) ancient Sun-watching; 4) options for personal solar observation; and 5) how art & science are valuable allies. In all events we intend that diverse people experience honoring of their identities related to culture, gender, or disability as they learn about NASA science.

1.5 Outreach Goal and Five Objectives

The yellow box (**Figure 9**) expresses the overarching goal of PUNCH outreach efforts. The turquoise box below (**Figure 10**) contains the five objectives supporting this overarching goal.

Figure 9: OVERARCHING GOAL for PUNCH OUTREACH:

To leverage the PUNCH mission to inspire historically marginalized youth in the Southwestern US to learn about NASA heliophysics in ways that honor their identities related to culture, gender, and disability, and thereby increase their confidence and consideration for pursuing STEM career pathways

Figure 10: OBJECTIVES in SUPPORT of the OVERARCHING PUNCH OUTREACH GOAL:

Objective 1: SUPPORT for MISSION TEAM ENGAGEMENT

To support the PUNCH mission team in contributing its expertise, data, and discoveries to high-impact opportunities in heliophysics outreach and communications.

Objective 2: SUPPORT for OUTREACH PARTNERSHIPS of MUTUAL BENEFIT

To leverage the strengths and enhance the capacities of planetariums and science centers to share NASA heliophysics with underserved & underrepresented populations, including Native American and Hispanic/Latinx youth & families, Girls in STEM, and the Blind & Visually Impaired, as well as the broader population.

Objective 3: OUTREACH PRODUCTS of HIGH IMPACT and ENDURING VALUE

To develop, test, and deliver a multi-sensory, multi-modal, multi-cultural suite of enduring outreach **PRODUCTS** on the theme of *Ancient & Modern Sun Watching* with emphasis on NASA heliophysics missions, ancient Sun watching sites in Chaco Culture National Historical Park, and personal observation of the Sun.

Objective 4: REPLICABLE OUTREACH EVENTS

To design, develop, test, and deploy a suite of outreach **EVENTS** that use PUNCH Outreach products, SME participation, arts-integration, and opportunities for both direct and indirect solar observation to engage diverse participants in the Ancient & Modern Sun Watching theme and to provide pathways to other NASA-sponsored opportunities related to heliophysics.

Objective 5: BROAD and STRATEGIC DISSEMINATION

To ensure that all resources, products, and event planning guides are accessible and usable by outreach organizations both within and outside the PUNCH Outreach sphere of partnerships, and in particular are useful to institutions who have access to the underserved & underrepresented populations on which PUNCH outreach efforts are focused.

Objectives 1 and 2 support collaborative relationships and develop new capacities among PUNCH scientists and POCC outreach partners so that our work together may be more effective and valuable to diverse learners. Objectives 3, 4, and 5 focus on the products and events related to the Ancient & Modern Sun Watching theme, and their broad and strategic dissemination.

1.6 From Inputs to Outcomes

Figure 11 offers a reduced view the detailed logic model presented above (Figure 3). The turquoise ovals contain the five Objectives that organize PUNCH outreach activity to achieve intended results (detailed in the *outputs* and *outcomes* columns of Figure 3). Our project evaluator assesses the Outputs & Outcomes to determine the quality of PUNCH Outreach contributions to *NASA & Societal Benefits* which are detailed in the rightmost column of Figure 3 and represented by the “star” in Figure 11 below.

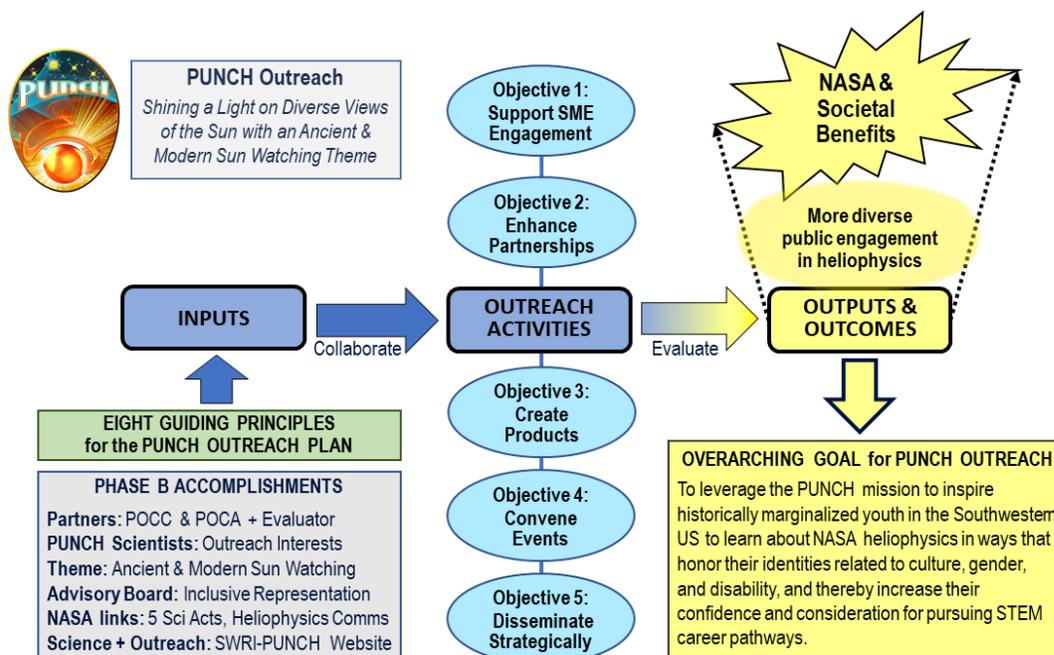


Figure 11: A reduced view of the PUNCH Outreach Logic Model detailed in Figure 3

Phase B Accomplishments

The gray box at lower left of Figure 11 summarizes the results of our Phase B work that has built the foundation for PUNCH outreach activities to succeed (**Appendix A**). This work and our Eight Guiding Principles from Figure 2 are *inputs*. Phase B accomplishments include the...

- 1) formation of the POCC and POCA (including links to 6 NASA-sponsored Science Activation programs and rhythmic communication with the NASA Heliophysics Communication group);
- 2) identification of a highly qualified evaluator who has been working with the outreach team throughout the proposal development process;
- 3) assessment of the outreach experience and interests of the PUNCH science team just before their first team meeting in June 2020 (**Appendix B**);
- 4) identification of the Ancient & Modern Sun Watching theme;
- 5) counsel and commitment of a 6-member Advisory board representing Latinx and Native American cultures as well as expertise in Planetarium, Girl Scout, and Out-of-School time programming; and
- 6) close collaboration among Dr. Morrow, the PI, and Project Scientist to develop a NASA-reviewed website for PUNCH with a placeholder for our outreach resources.

This groundwork allows our outreach activities to result in the outputs and outcomes that support our overarching goal (shown in the yellow box at lower right of Figure 11). In turn, the outputs and outcomes result in more diverse public engagement in heliophysics and thereby support the broader collective vision of a more diverse and inclusive NASA.

The PUNCH Outreach Project unites PUNCH scientists with regional and culturally relevant outreach expertise in a coherent framework of high-impact activity to enhance diverse heliophysics engagement the US Southwest. The Project realizes its potential for national impact via dissemination partners and other allies associated with existing NASA efforts.

Diverse participants in our community outreach events and live interaction planetarium programs (both at POCC institutions and in the regional communities surrounding them) have opportunities to “see” the Sun in multiple ways, whether through the eyes of an ancient Sun watcher in Chaco, or through the “eyes” of a NASA spacecraft like PUNCH, or through their very own eyes with gnomons, pinhole cameras, filters, eclipse glasses, and solar telescopes. Both sighted and B/VI learners are invited to “observe” the Sun in other sensory modalities including tactile and sound. PUNCH Outreach *shines a light on diverse views of the Sun*. The needs and opportunities of marginalized learners have led us to propose a suite of multi-cultural, multi-sensory (audio, visual, tactile, kinesthetic), arts-integrated products for versatile use in a collection of PUNCH-sponsored community events that stand to be enjoyable and beneficial to all people in all communities, even as they serve the more focused, overarching goal of PUNCH Outreach.

PUNCH Outreach will positively affect hundreds of thousands of people in the 5-year period of PUNCH funding, and vastly more people as our sustainably designed products and event planning guides are used for many years afterward. The proposed work will also leave a legacy of interconnection and new institutional capacities of ongoing benefit to NASA’s public engagement goals, even after the PUNCH mission is complete.

ADDENDUM:



The cultural site that is home to the “eclipse” petroglyph (Figure 8) is labeled 29SJ514 in the archives of Chaco Culture National Historical Park. This 20-cm wide petroglyph is located on the southern facet of a rock complex about the size of a small house. On the eastern facet of 29SJ514 (around the corner from the “eclipse” petroglyph), there is a larger, spiral-shaped petroglyph. Looking northeastward from the center of this spiral about half-a-month prior to the summer (June) solstice, the sunrise appears to roll up the north side of a pyramid-shaped rock on the horizon (depicted in sequence above).

On the actual solstice, the Sun appears to rise in a small notch further northward (leftward) on the horizon. This means the site could have been used by Ancestral Puebloan Sun watchers to help predict and confirm the time of summer solstice ceremonies. The same dramatic “roll” up the side of the pyramid-shaped rock also occurs at sunrise about half-a-month *after* the summer solstice (early July). This is near the time of year when the total solar eclipse of 1097 occurred (11 July). The predictive and confirmatory sunrises at 29SJ514 help to strengthen the interpretation of the “eclipse” petroglyph on its southern facet as a solar phenomenon.

The photo sequence above was obtained on 5 June 2008 by Park Ranger GB Cornucopia using a hand-held filter. The actual time between the first appearance of the Sun in the notch (leftmost image above) and the Sun arriving at the top (rightmost image above) is approximately 11 minutes. These photos were presented to the participants of the NASA-sponsored Chaco Educator Institute for Astronomy convened in 2008 and directed by the PUNCH Outreach & Communications Lead. In collaboration with the descendants of Ancestral Puebloan people and a leading cultural astronomer, PUNCH Outreach will obtain professional, time-lapse photography of this sunrise phenomenon which is not otherwise accessible to the public.