IAU Division C Inter-Commission C1-C2-C3-C4
Working Group for Astronomy in Culture (WGAC)
Annual Report for 2021

Steven Gullberg (Chair, USA)

Javier Mejuto (Co-chair, Honduras)

Organizing Committee

Beatriz Garcia (Argentina), Steven Gullberg (USA), Duane Hamacher (Australia), Jarita Holbrook (South Africa), Alejandro Martin Lopez (Argentina), Javier Mejuto (Honduras), Rosa M. Ros (Spain)

Membership

The WGAC presently has 97 members - 62 Working Group Members and 35 Working Group Associates. *Astronomy in Culture* is interdisciplinary and our Associates, many with backgrounds in fields other than astronomy, make valuable contributions.

Working Group Members

Alan Alves-Brito (Brazil), Elio Antonello (Italy), Megan Argo (UK), G.S.D. Babu (India), Ennio Badolati (Italy), Juan Antonio Belmonte (Spain), Kelly Blumenthal (USA), Kai Cai (USA), John Carlson (USA), Brenda Corbin (USA), Milan Dimitrijevic (Rep. Serbia), Steve Durst (USA), Marta Folgueira (Spain), Jesus Galindo-Trejo (Mexico), Alejandro Gangui (Argentina), Beatriz García (Argentina), Rita Gautschy (Switzerland), César González-García (Spain), Steven Gullberg (USA), Duane Hamacher (Australia), Saeko Hayashi (Japan), Abraham Hayli (France), Bambang Hidayat (Indonesia), Thomas Hockey (USA), Susanne Hoffmann (Germany), Jarita Holbrook (South Africa), Andrew Hopkins (Australia), Matthaios Katsanikas (Greece), E. C. Krupp (USA), Mary Beth Laychak (USA), Annette Lee (USA), Ioannis Liritzis (Greece), Alejandro Lopez (Argentina), Claudio Mallamaci (Argentina), J. McKim Malville (USA), Javier Mejuto (Honduras), Areg Mickaelian (Armenia), Steve Miller (UK), Eugene Milone (Canada), Simon Mitton (UK), Andrew Munro (USA), Raymond Norris (Australia), Wayne Orchiston (Australia), Robert Preston (USA), Michael Rappenglück (Germany), Rosa Ros (Spain), Clive Ruggles (UK), Sara Schechner (USA), Irakli Simonia (Rep. Georgia), Magda Stavinschi (Romania), Christiaan Sterken (Belgium), Linda Strubbe (USA), Woodruff Sullivan (USA), Virginia Trimble (USA), Ana Ulla (Spain), Johnson Urama (Nigeria), David Valls-Gabaud (France), Iryna Vavilova (Ukraine), Tiziana Venturi (Italy), Murli Verma (India), Gudrun Wolfschmidt (Germany), Georg Zotti (Austria).

Working Group Associates

Danielle Adams (USA), Bryan Bates (USA), David Begay (USA), Suresh Bhattarai (Nepal), Patricio Bustamante (Chile), Nicholas Campion (UK), Brian Davis (USA), Margaret Davis (USA), Sona Farmanyan (Armenia), Roslyn Frank (USA), Robert Fuller (Australia), Cecilia Gomez (Argentina), Akira Goto (Japan), Liz Henty (UK), Stanislaw Iwaniszewski (Mexico), Olaf Kretzer (Germany), Olanrewaju Lasisi (Nigeria), Trevor Leaman (Australia), Flavia Pedroza Lima (Brazil), Monica Martinez-Borravo (Mexico), Nancy Maryboy (USA), Armando Mudrik (Argentina), Gregory Munson (USA), Cristina Negru (Romania), David Pankenier (USA), Fabio Silva (UK), Emilia Pasztor (Hungary), Manuel Pérez-Gutiérrez (Spain), Eduardo Rodas (Honduras), William Romain (USA), John Saul (France), Ivan Šprajc (Rep. Slovenia), Doris Vickers (Austria), Alexander Wolf (Russian Fed.), Mariusz Ziółkowski (Poland).

Objectives

The IAU *Working Group for Astronomy in Culture* (WGAC) is a leading organization for the advancement of all aspects of this growing field. The WG is in part a discussion and collaboration group for researchers in archaeoastronomy and *Astronomy in Culture*, and as well for others with interest in these areas. A primary motivation is to facilitate interactions between researchers, but the WG also has significant interest in promoting education regarding *Astronomy in Culture* in all respects. It is the focal point within the IAU for both research in the field of *Astronomy in Culture* and in educating the public regarding examples of how astronomy has been used in culture throughout world history. The WGAC works to further the following objectives:

- Advance the field of *Astronomy in Culture*
- Promote research and publication
- Promote strong initiatives and give support for educators on different levels regarding their use of multiple aspects of cultural astronomy in the classroom
- Pursue exploration of astronomy in contemporary literature, poetry, music, films, etc.
- Promote public outreach to educate regarding *Astronomy in Culture*
- Use the fascination with *Astronomy in Culture* to inspire youth interest in pursuing any aspect of astronomy in their futures
- Increase the understanding of how astronomy was used in cultures within developing nations where such has not yet been fully explored
- Facilitate interactions between researchers in the field
- Promote the inclusion of archaeoastronomical research in other fields such as archaeology, anthropology, Indigenous studies, and Native American studies that also includes increased collaboration with these fields

Activity in 2021

In 2021 the Working Group changed its name to *Working Group for Astronomy in Culture (WGAC)* to better reflect the wide scope of activity of the WG. We also added

affiliation with Commission C2 Communicating Astronomy with the Public to strengthen our outreach interests. As a result, the WGAC is now affiliated with all four of Division C's commissions: C1, C2, C3, and C4. Our collaboration with each greatly enhances what the WG is able to contribute. We also enjoy collaboration with other WGs in the Division.

The WGAC presently works with, but does not limit itself to, advancement in eight principal areas: culturally sensitive sites, education, public outreach, contemporary cultural astronomy, developing nations, interdisciplinary collaboration with relevant fields, indigenous astronomy, and WG publications. The many members of the WGAC also actively perform rigorous research and publication of *Astronomy in Culture*.

Some selected examples of our work in 2021:

Culturally Sensitive Sites

The Culturally Sensitive Sites committee is a joint initiative led by the WGAC that includes the Royal Astronomical Society and the American Astronomical Society. The committee has over 20 members located around the world and meets frequently via Zoom. Our primary mandate is to provide astronomers with insight as to Indigenous concerns regarding observatories that have been or are to be built upon culturally sacred lands. We also will endeavor to provide outreach to the public and to establish best practices to be considered when new observatory/facility projects are proposed in the future. In 2021 we shared our message at four conferences – IAU Communicating Astronomy with the Public CAP 2021 in May, American Astronomical Society 238 in June, Royal Astronomical Society National Astronomy Meeting (NAM) in July, and European Society of Astronomy in Culture in September. The NAM presentation was a full workshop that began with role playing about a fictitious very large radio telescope proposed to be built immediately adjacent to Stonehenge. This proved to be a very relevant way of captivating and engaging the audience for the rest of the workshop discussions. Members making presentations in 2021 were Megan Argo, Steven Gullberg, Jarita Holbrook, Annette Lee, Alejandro Lopez, Javier Mejuto, and Steve Miller. Saeko Hayashi joined other presenters in a video produced by Jarita Holbrook that is similar to the workshop presentation to be used for additional activities. Several presentations are being given in 2022 and will continue into the future.

Education

Georg Zotti is developing a significant education capability in Stellarium that visually demonstrates light and shadow effects of cultural astronomy. He showcased this great learning tool in a presentation with an example called "Evaluation of Light and Shadow Interaction of an Inca Sanctuary in Stellarium." For this he created an accurate visual demonstration of an actual solar effect created by the Incas at Ollantaytambo, Peru that takes place at the time of the December solstice.

Astronomy artist Jessica Gullberg, Steven Gullberg's wife, painted the many Babylonian constellation images that were superimposed with the stars in Stellarium. Susanne Hoffmann directed the project and Steven was a technical advisor for this significant contribution to *Astronomy in Culture*. The new paintings were first published in a Stellarium software release in September 2021 and were later updated. They serve to give great insight into Babylonian astronomy, both for those viewing the site and also for those enjoying Babylonian presentations at planetariums. Stellarium is a significant tool for astronomy education and research.

The WGAC worked with the WG for Key Initiatives in Education, Outreach, and Development (WGKI, formerly NASE) to aid their efforts in showing teachers throughout the world how to use *Astronomy in Culture* in their classrooms to captivate the interest of students for astronomy.

WGAC members continue to develop and offer university courses and programs of study in cultural astronomy. This is very important for the field as it continues to develop.

Outreach

In 2021 most outreach was virtual due to the pandemic. In addition to conference presentations, members of WGAC also spoke to the general public, astronomical groups, and historical societies. WGAC is increasing its interaction with certain activities in Commissions C1 and C2 to further mutual goals. The WGAC seeks to excite the public with cultural astronomy in an effort that includes inspiring youth for STEM, both in astronomy and in other fields. Many contributions were made during the year to further this most important endeavor.

Contemporary Cultural Astronomy

Georg Zotti assisted an Italian e-musician to drive acoustic effects in a live performance with Stellarium. He also worked with an artist regarding a possible astro-inspired component for her exhibition.

Virginia Trimble related an example of relative astronomical ignorance of average college-educated Americans since the 1930s. Students in a Physics of Music course were shown a cartoon with a classic error. The cartoon from 1934 showed Cinderella and the prince dancing minutes before midnight with a crescent Moon not very high in the sky and pointing in the wrong direction. The students were asked on a quiz to recognize something physically impossible in the cartoon and none of them saw anything wrong.

Armando Mudrik worked to develop planetarium functions related to cultural astronomy at the Scientific Interpretation Center "Plaza Cielo Tierra" of the National University of Cordoba in Argentina.

Alan Alves Brito published about Astro-anthropologics and poetry of invisible matters. The first publication is in Portuguese with English forthcoming.

Developing Nations and Indigenous Astronomy

Alan Alves Brito has been working with maroon and black communities in Brazil. He is publishing three related papers and reports that there will be more, including books, in the year to come. His goal is to highlight and use cultural astronomy as a main aspect in the curricula in an effort to promote decolonized science communication and education. He is delivering talks in Brazil and overseas.

Robert Fuller is working with Australian Aboriginal culture related to cultural astronomy. He is beginning a post-doc project to examine a songline uncovered during his Ph.D. research which he thinks may connect to a distant story in Northern Australia through a very long songline, all of which is connected to their astronomy.

Annette Lee created, produced, and hosted eight virtual presentations for the Native Skywatchers "Two Eyed Seeing: NASA and Indigenous Astronomy for the Benefit of All" series that was sponsored by NASA. Many prominent Indigenous speakers joined her in sharing the astronomy of their cultures.

Interdisciplinary Collaboration

Armando Mudrik assisted archaeologists with cultural astronomy in two projects – one at the National University of Cordoba and the other at the University of Buenos Aires.

Rita Gautschy taught an archaeoastronomy course in the fall of 2021 that was tailored for archaeologists.

Robert Fuller worked to build more collaborative relationships with anthropologists, especially with regard to the cultural astronomy of Australian Aboriginal songlines and another project will collaborate with archaeologists as well. This research has spread to Aboriginal rock art, mainly petroglyphs. Robert and colleagues are beginning the photogrammetric mapping of a major petroglyph site with a goal of trying to determine if there are astronomical connections with these petroglyphs.

Andrew Munro, in collaboration with a prominent archaeologist, gave a very well received cultural astronomy presentation at the annual meeting of the Society for American Archaeology.

Georg Zotti gave a very well received cultural astronomy presentation at the annual meeting of the European Association of Archaeologists. The EAA has established a community for Archaeology & Astronomy in Culture.

Fabio Silva and Liz Henty continue their work to forge closer understanding and collaboration between cultural astronomy and archaeology in the United Kingdom.

Steven Gullberg, Roslyn Frank, Andrew Munro, Javier Mejuto, and Annette Lee gave a very well received cultural astronomy presentation at the annual meeting of the Native American and Indigenous Studies Association.

WG Publications

Advancements were made with publications intended to be both internal and external. These involve material for WG members and material designed to educate others. A significant project is to educate the public about cultural astronomy and another from the Culturally Sensitive Sites committee endeavors not only to relate Indigenous insight to astronomers but also to better educate the public. Best practices are being recorded to be published for future use.

Member Publications in 2021

The editors of the journals that focus on or otherwise frequently publish articles of *Astronomy in Culture* are members of the WGAC. Their efforts contribute greatly to the advancement of the field.

WGAC members continue to further our cultural astronomy activity areas with research and publication. Many significant publications (as authors/co-authors/editors/co-editors) were reported for 2021 and are listed here; they give good example of our contributions to *Astronomy in Culture*. Many more are forthcoming and will be recounted in our next report. Given are author names and titles only for considerations of length in this report.

Danielle Adams – Early Islamic Encounters with the Rain Stars of pre-Islamic Arabian Astronomy; Arabian Indigenous Astronomy & The Stardust Project; The significance of indigenous Arabian astronomy in seasonal forecasting within pre-Islamic and early Islamic Arabia as well as its cultural heritage that remains in many of the modern star names that are used today by the astronomical community worldwide

David Begay – Two Eyed Seeing: Navajo (Diné) Astronomy & NASA Moon to Mars; Diné-Navajo Winter Constellations – The Milky Way

Alan Alves Brito - Educação escolar quilombola: desafios para o ensino de Física e Astronomia; Referencial curricular gaúcho para o Ensino Médio de 2021: contexto de produção, ciências da natureza e questões étnico-raciais; Educação para as relações étnico-raciais no ensino de física e astronomia no Brasil: mapeamento da produção em mestrados profissionais (2003-2019)

Juan Antonio Belmonte - Ad orientem: Las iglesias románicas del Camino Francés bajo la perspectiva de la Astronomía Cultural: El Occidente del Camino; East or Easter? keys to the orientation of Romanesque churches along the way of Saint James; The river and the sky: astronomy and topography in Caral society, America's

first urban centers; Atrapando el Solsticio? Un Análisis Crítico de la Orientación de los Templos de Deir el Bahari; Archaeoastronomy / Cultural Astronomy; El Paisaje Cultural de Risco caido y las montañas sagradas de Gran Canaria: un territorio conectado con el Cielo; Beyond paradigms in cultural astronomy; Las Escrituras del Pueblo Majo: claves para el poblamiento de Canarias, Risco Caído et les Montagnes Sacrées de Gran Canaria: valeur, authenticité et politique de préservation d'un refugee de montagne Amazigh; What Equinox?

Patricio Bustamante - Launch of the Andean Cosmo-Amazonian Science Book, Conversation: Who Were We Before the Spaniards?; 2021 PAH in the Origin and Development of Astronomy; Solar eclipses in the Mapuche – Tehuelche worldview; Cultural Astronomy in Hispanic-Indigenous Contexts of Central Chile; Summary of 3 Papers. Pleistocene coalition news; Project "From heaven to your hands. Andean constellations for Stellarium in Atacama". Beckuntur Micro funds for sustainable tourism

Milan Dimitrijević - Archeoastronomical Research in Felix Romuliana (The Palace, Neither on Heaven nor on the Earth); Shield of Heracles and the Temple of Apollo Pagasaeus: An Archaeoastronomical Perspective, Archaeoastronomy and Examples of Research in Serbia; A Possible Astronomical Interpretation, Interesting Samples from the Collection of Roman Coins of Sergije Dimitrijević III

Roslyn Frank – Beyond Paradigms in Cultural Astronomy

Robert Fuller - Linking the Pleiades to a Reawakened Black Duck Songline in Southeastern Australia

Beatriz Garcia - Education and Heritage in the Era of Big Data in Astronomy

Rita Gautschy - Celestial Aspects of Hittite Religion, Part 2: Cosmic Symbolism at Yazılıkaya, Astronomical Data and Their Usefulness for Dating Ancient Societies, Common features of megalithic stone rows in western Switzerland, The Hittite Rock Sanctuary of Yazılıkaya: A Time-Keeping Device from c. 1230 B.C.

A. Cesar Gonzalez-Garcia - Beyond Paradigms in Cultural Astronomy; Ad orientem: Las iglesias románicas del Camino Francés bajo la perspectiva de la Astronomía Cultural: El Occidente del Camino; East or Easter? keys to the orientation of Romanesque churches along the way of Saint James; The river and the sky: astronomy and topography in Caral society; America's first urban centers; Beyond paradigms in cultural astronomy

Steven Gullberg - The Milky Way's Dark Constellations; Listening to Other Voices: Culturally Sensitive Sites Group; Cultural Astronomy for Inspiration; Education and Heritage in the Era of Big Data in Astronomy; Cultural astronomy; Review of the Skyscape Archaeology Keynote Lectures, Spring 2020; Astronomy of the Inca Empire; Astronomy at Teotihuacan and Tenochtitlan; Inka's Cosmovision, space,

time, and Cosmos: A Western perspective; Special Volume, Preface – 9th International Workshop on Astronomy and Relativistic Astrophysics: from Quarks to Cosmos; Complementary Duality of the Inca's Cosmovision: An Astrophysics Perspective

Liz Henty - Exploring Archaeoastronomy: A History of its Relationship with Archaeology and Esotericism; Review of Efrosyni Boutsikas, Stephen C. McCluskey and John Steele (eds), Advancing Cultural Astronomy: Studies in Honour of Clive Ruggles

Thomas Hockey - A paper sky - Planispheric celestial volvelles

Susanne Hoffmann - Wie der Löwe an den Himmel kam – Auf den Spuren der Sternbilder; Applied and Computational Historical Astronomy, Historical Constellations in the Planetarium; Star of Bethlehem – How to tell the astronomy correctly; Reconstruction of ancient constellations in the planetarium dome; The simulated sky: Stellarium for cultural astronomy research; Astrologie – Der Ursprung der Horoskope

Jarita Holbrook - Listening to Other Voices: Culturally Sensitive Sites Group; Two Eyed Seeing: African Indigenous Astronomy & NASA Moon to Mars; Starry, Starry Night

E. C. Krupp – Celestial Aspects of Hittite Religion, Part 2: Cosmic Symbolism at Yazılıkaya

Annette Lee - Listening to Other Voices: Culturally Sensitive Sites Group; Two Eyed Seeing: Navajo (Diné) Astronomy & NASA Moon to Mars; Milky Way Circles Around Us; Two Eyed Seeing: Hawaiian Indigenous Astronomy & NASA Moon to Mars; Kula Amakihi Students' Presentation; Two Eyed Seeing: Art, Indigenous Astronomy & NASA Science – Making Spirit, Making Art; Carl Gawboy Presents … Mishi Bizhiw, The Great Panther; Bebaamaadizid Anung, The Traveler Through the Stars; The Ojibwe and Madoodiswan (the Sweat Lodge) Constellation; Janix=ce Bad Moccasin Presents …; Ida Downwind Presents …; Ramona Kitto Stately Presents … Canasa-Ozuha-Wetu-Spring; Ojibwe Night Sky; D(L)akota Night Sky – Wetu; South African Night Sky; Arabian Indigenous Astronomy & The Stardust Project (Annette created, produced, and hosted the Two Eyed Seeing series sponsored by NASA. Three of its episodes took place in the last part of 2020 and the ones included here were presented in 2021)

Alejandro Lopez – Listening to Other Voices: Culturally Sensitive Sites Group

Nancy Maryboy – Two Eyed Seeing: Navajo (Diné) Astronomy & NASA Moon to Mars; Diné Winter Stars

Javier Mejuto - Listening to Other Voices: Culturally Sensitive Sites Group; Situación de los Sistemas de Numeración Indígenas Hondureños: Una aproximación bibliográfica

Armando Mudrik - Luna e identidad entre migrantes europeos y sus descendientes en el sur de la región chaqueña Argentina

Andrew Munro – Bonito Phase architectural syntax and social change

Flavia Pedroza Lima - From Astroarchaeology to Astronomy in Cultures; What Physics Says – Ale Pacini; Casa da Tia Ciata; When the Scorpio meets ema: Europeans and indigenous people cross their eyes in the skies of Brazil

Michael Rappenglück – Beyond Paradigms in Cultural Astronomy

Eduardo Rodas Quito - Situación de los Sistemas de Numeración Indígenas Hondureños: Una aproximación bibliográfica

Rosa Ros - Education and Heritage in the Era of Big Data in Astronomy

John Saul – "Archaeoastronomy": were attempts to project the "undying" heavens into the ways of Earthbound mortals an initial condition of our humanity?

Ivan Šprajc - Astronomical aspects of Group E-type complexes and implications for understanding ancient Maya architecture and urban planning; Equinoctial Sun and astronomical alignments in Mesoamerican architecture: Fiction and fact; Significado astronómico de los grupos E en la arquitectura maya: Una reevaluación; Beyond Paradigms in Cultural Astronomy

Christiaan Sterken - Bronze Age Rock Art and 20th-Century Oil-On-Canvas Impressions of Constellation Crux, the Southern Cross

Alexander Wolf – The simulated sky: Stellarium for cultural astronomy research; Some Thoughts on the Skycultures in Stellarium

Gudrun Wolfschmidt - Applied and Computational Historical Astronomy

Georg Zotti - The simulated sky: Stellarium for cultural astronomy research; Simulation for Research and Outreach; A Virtual Park of Astronomical Instruments; Virtual Archaeoastronomy with Stellarium: An Overview; Some Thoughts on the Skycultures in Stellarium; Exploring skies remote in time and culture with Stellarium; Stonehenge und Astronomie; Beyond Paradigms in Cultural Astronomy; Astronomischer Almanach für Österreich 2021; Astronomischer Almanach für Österreich 2022

Future

The WGAC has embarked upon a busy and productive triennium. An overriding objective is to continue our world effort to represent and advance the field of *Astronomy in Culture*. Our many activities serve to do just that.

We will seek to elevate our collaboration with Commission C1 Astronomy Education and Development and Commission C2 Communicating Astronomy with the Public for our increasing efforts with education and outreach. Our collaboration with Commission C3 History of Astronomy and Commission C4 World Heritage and Astronomy will continue to be robust, as will our interactions with the Working Group for Star Names (WGSN), the Working Group for Key Initiatives in Education, Outreach and Development (WGKI), Working Group for Astronomical History in Danger (WGAHD), and Working Group for Ethnoastronomy and Intangible Astronomical Heritage (WGEIAH). We continue to develop and provide cultural astronomy material, guidance, and insight in support of related efforts in these and other areas.

We will continue to gather examples of astronomy found in contemporary culture.

We also will further strengthen our collaborative ties with archaeoastronomy organizations and other professional organizations in related research fields.

We will continue robust efforts to enlighten astronomers throughout the world as to Indigenous sensitivities at astronomical sites on sacred grounds. This includes suggestions as how astronomers can best interact with those expressing these concerns.

We seek to expand our efforts in further research and publication of Native American and other Indigenous astronomy. We also continue to compile material regarding archaeoastronomy in developing nations.

Our members will continue robust research and publication regarding topics in *Astronomy in Culture*.

We look forward to meeting for WGAC business, sharing of research, discussing future collaborations and activities, and general collegial interactions while at the 2022 General Assembly in Busan and also at the General Assembly in Cape Town in 2024. Many of us will as well further cultural astronomy at other astronomy, archaeoastronomy, archaeology, anthropology, and Indigenous events during the triennium.

We look forward to continuing to increase our membership and to the contributions that all of our members will make!