The Joy of Solar Physicists in Science Education

Cherilynn A. Morrow

Space Science Institute, Boulder, CO

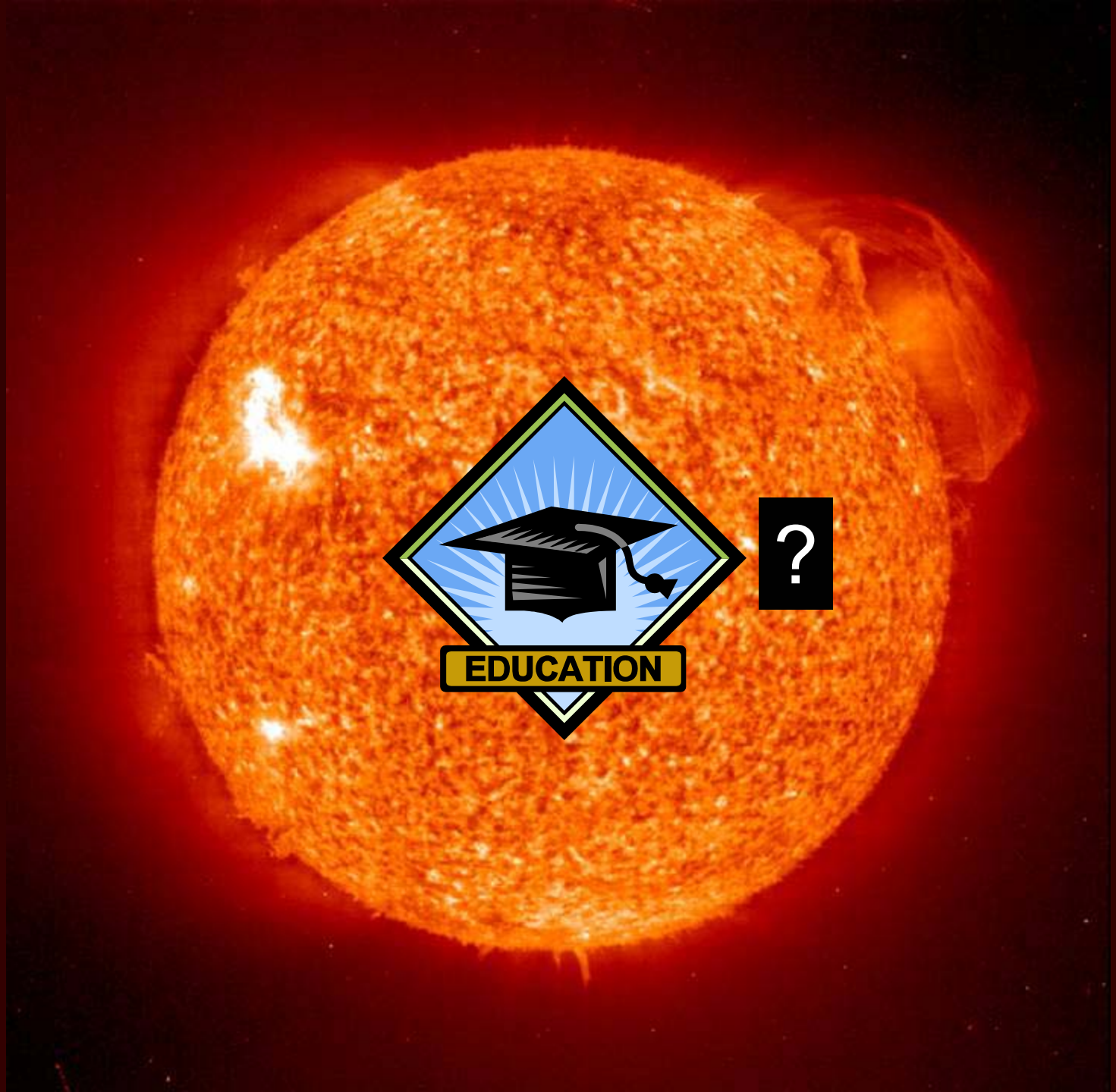
34th Meeting of the Solar Physics Division Laurel, MD June 2003

High-Level Advocacy

"I now view effective science education partnerships between scientists and precollege education science teachers in a completely different light - as the only hope for lasting systemic change in precollege science education and, therefore, as an important national priority for the United States."

- Bruce Alberts, 1993

President, National Academy of Sciences


EDUCATION
?

Modern Science Education Reform

- Students as “scientists” with teachers as facilitators of learning
  - Teacher as “a guide on the side” rather than a “sage on the stage”.
- “Inquiry-based” process of learning
  - “The way scientists *do* science rather than the way they were *taught* science.”

Standards Contain Fundamental Concepts

Systems

Cycles

Energy Transfer

Forces & Motions

Pattern & Scale

Science as Inquiry

Goals of Science Education

- Content Knowledge [fundamental concepts]
- Process Skills [skills of inquiry: observing, measuring, collecting data, analyzing data, reasoning, drawing conclusions from evidence]
- Connections to other disciplines, society, life
- Intellectual confidence, enthusiasm for life-long learning, and curiosity about the world.

Variety of EPO Roles for Scientists

- Presentations in a classroom or a public setting are not the only way to contribute to education and public outreach.

- There are many other roles scientists can play in education and public outreach that are suited to a diversity of talents and interests.

Types of EPO Support from Scientists

- Advocacy for positive change
- Content advisor/reviewer
- Speaking/presenting/teaching
- Access and use of data/resources/facilities
- Content creation (writing, images, web design, etc)
- Curriculum or course development

Gary Rottman
University of Colorado

David Alexander
Lockheed Martin

Phil Scherrer
Stanford University

George “Pinky” Nelson
Western Washington U.

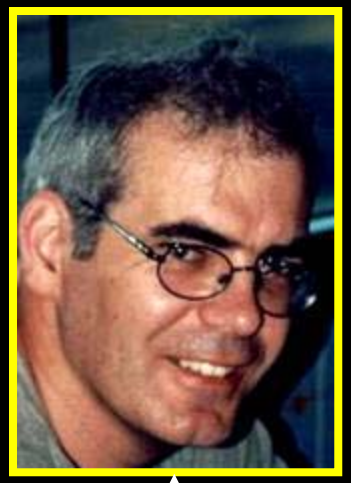
Cheri Morrow
Space Science Institute


http://ssibroker.colorado.edu/broker/PROFILES/1.htm

Gary Rottman

Tithers - practicing research scientists who volunteer some of their time to EPO -- less than 10%

Phil Scherrer



David Alexander

Adapted from "The Diversity of Roles for Scientists in K-14 Education & Public Outreach" by Cheri Morrow
camorrow@colorado.edu

Part-timers – scientists who are paid to do part-time research and part- time EPO

"Pinky" Nelson

Cross-overs - full time EPO professionals who were trained to do scientific research, and now have "crossed over" to EPO

Cheri Morrow

Gary Rottman

Advocates: inspire, encourage, give permission, empower

Resources: help when called upon; make resources available

Phil Scherrer

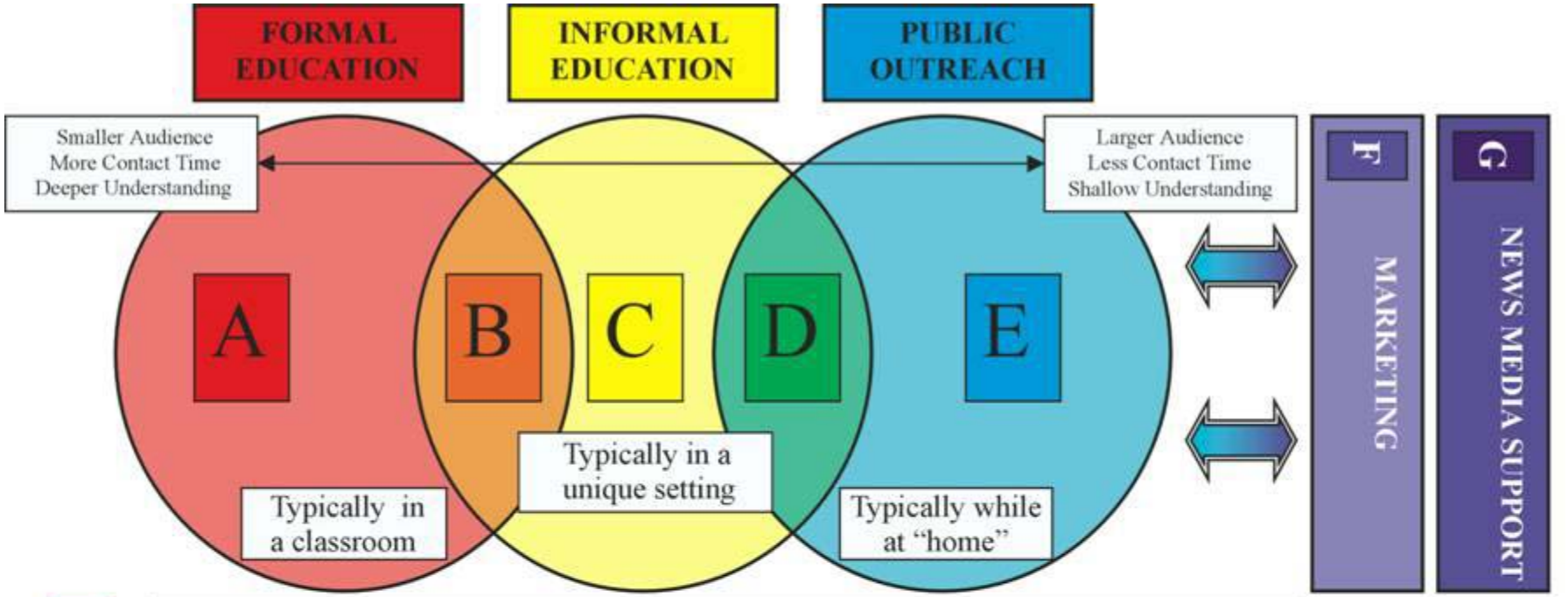
Adapted from "The Diversity of Roles for Scientists in K-14 Education & Public Outreach" by Cheri Morrow
camorrow@colorado.edu

David Alexander

"Pinky" Nelson

Partners: work shoulder-to-shoulder, "in the trenches," with education specialists to create new products or opportunities

Cheri Morrow



A	Curriculum; Textbooks; Teacher workshops; Ugrad intro courses; Systemic reform; Home schooling…
B	Ed. programs at museums/libraries/parks; Elderhostel classes; Scout badges; Science fairs; Internships…
C	Museum exhibits/kiosks; Field trips; Eclipse tours; Star parties; Career workshops; Parks displays…
D	IMAX/Planetarium shows; Public talks; Slide shows/sets; Museum demos; Webcasts; Performing arts...
E	Educational TV/Radio programs; Magazine/Encyclopedia articles; Popular books; Webchats…
F	Display booths; Posters/brochures; Pins/stickers/patches; Hats/T-shirts; Bookmarks/postcards; Mugs…
G	Press releases; Press conferences; Press kits for reporters; Video clips for TV news; Media interviews…

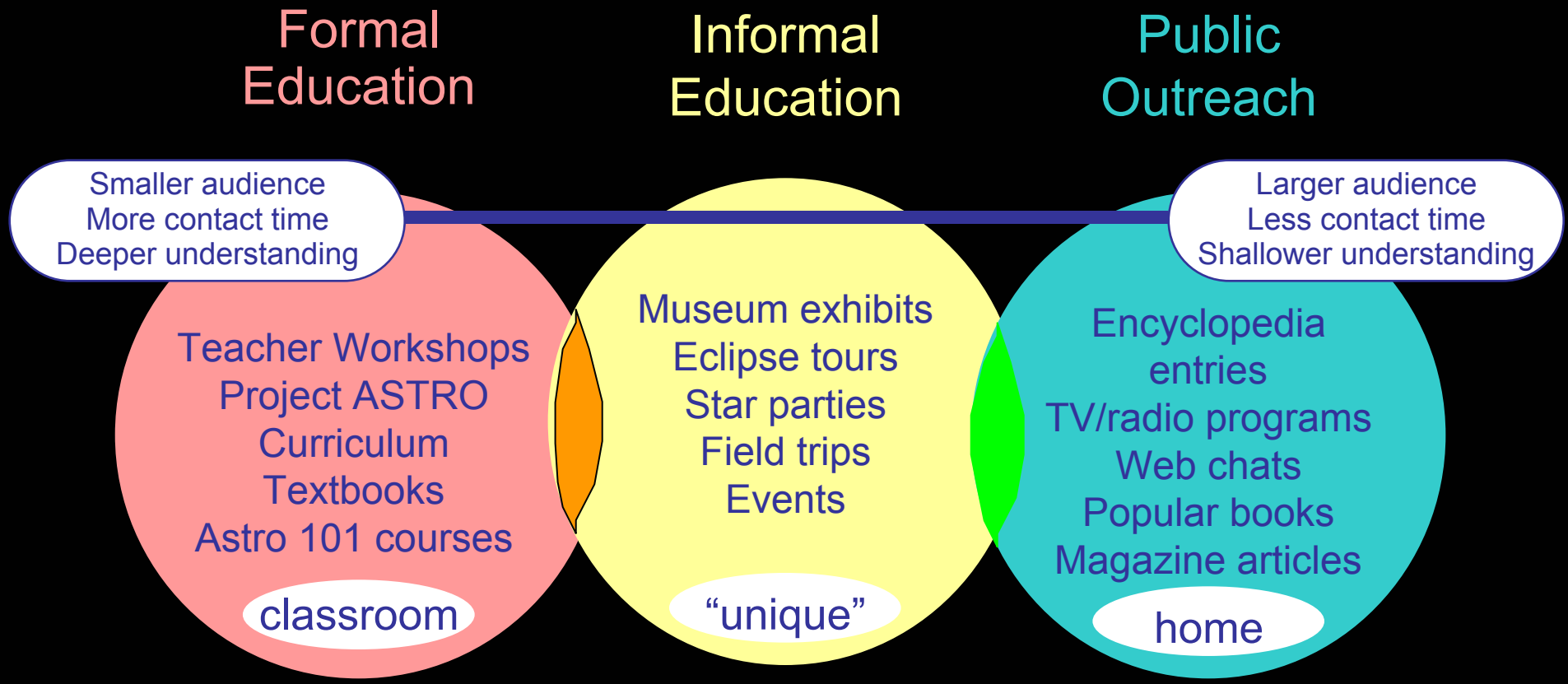
A–E → **EPO**

F → **Marketing**

G → **News Media Support**

Excerpt from "A Framework for Developing Education & Public Outreach Programs Associated with Scientific Research Programs" by Cheri Morrow, June 2000

What IS E/PO?



Ed. Programs at museums, science fairs, scout programs

Public lectures, slide shows, IMAX/planetarium shows, performing arts

Adapted from "A Framework for Developing Education & Public Outreach Programs Associated with Scientific Research Programs" by Cheri Morrow, June 2000

Gary Rottman

Public Outreach: Reaches out to where people may conveniently tune in to hear or see in their everyday lives with information that excites, interest and arouses curiosity (e.g. TV, radio, home computer, magazines).

Phil Scherrer

Informal Education: Engaging opportunities in unique environments (e.g. museums, planetariums, clubs) to motivate life-long interest and learning.

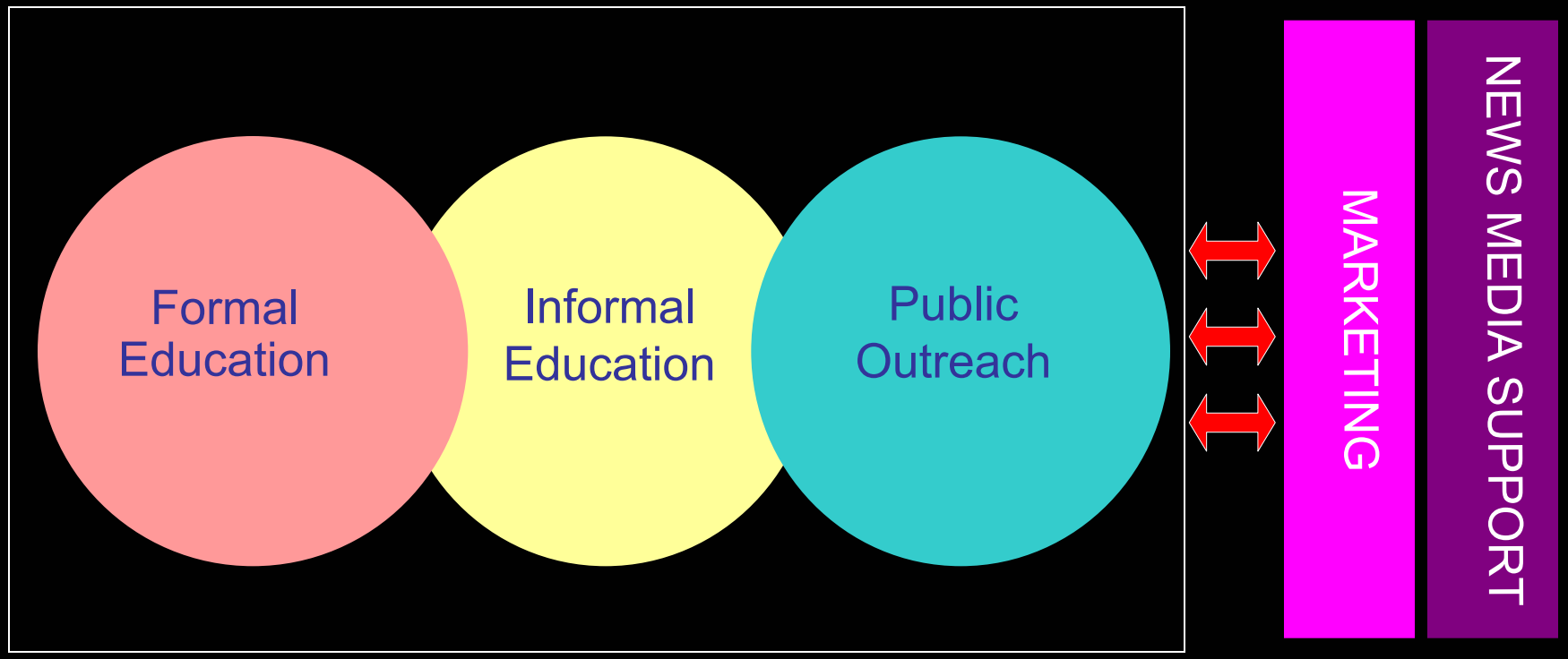
David Alexander

"Pinky" Nelson

Formal Education: Provides a sustained opportunity to deepen knowledge and understanding of fundamental ideas and concepts (e.g. degree and certificate programs)

Cheri Morrow

E/PO Venn Diagram



Display booths, Pins, Stickers, Patches, Mugs, Bookmarks, Postcards, etc...

Press releases, Press conferences, Press kits for reporters, video clips, etc...

Adapted from "A Framework for Developing Education & Public Outreach Programs Associated with Scientific Research Programs" by Cheri Morrow, June 2000

What E/PO is NOT

Coast[illegible]s

[illegible]all paper

[illegible]oor stops

Tchotch[illegible]es

Pres[illegible]releases, press confer[illegible]ces,

or yet [illegible]other … missio[illegible]oster,

sunspot exerci[illegible]ant web site…

Courtesy Heidi Hammel

Sample EPO Roles – Examples from the *Roles Matrix*

	Advocate	**Resource**	**Partner**
K-12 Students	PTA	Science fair judge	Mentor a student
K-12 Teachers	Teacher mtgs	Present in workshop	Project ASTRO
Intro Ugrad Ed	Faculty mtgs	Guest present	Co-create course
Schools of Ed	College admin	Hire ed student	Co-teach methods
Systemic Change	Prof. Societies	Review standards	Co-write standards
Ed Materials	School board	Review materials	Co-create materials
Informal Ed	Board of sci ctr	Review exhibit	Mentor for scouts
Public Outreach	Help PBS/NPR	Public lecture	Write popular book
E/PO Program Management	Ed sessions at science mtgs	EPO scientist for flight mission	Serve as EPO lead: co-design EPO plan

Phil Scherrer

- Stanford University
- Research Professor of Physics:
  - PI for MDI on SOHO spacecraft
  - PI for Magnetic Imager on SDO
  - Director of Wilcox Observatory
- ~ 5 % time devoted to EPO:
  - 1 public lecture per year
  - 1 time per month with 4H club
  - Encouraging staff participation
- QUOTE FROM HIS PROFILE:
  "As the PI of a major project, take EPO not simply as a duty, but embrace it as a key part of your activities. With a larger project you actually have an opportunity to make a big impact."

Adapted from Profiles of Scientists in EPO. This one by Preston Dyches and Cheri Morrow. See **http://ssibroker.colorado.edu/broker/PROFILES .htm**

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Adapted from “The Diversity of Roles for Scientists in K-14 Education & Public Outreach” by C. A. Morrow

The Monotillation of Traxoline

It is very important that you learn about traxoline. Traxoline is a new form of zionter. It is monotilled in Ceristanna. The Ceristannians gristerlate large amounts of fevon and then bracter it to quasel traxoline. Traxoline may well be one of our most lukized snezlaus in the future because of our zionter lescelidge.

Directions: Answer the following questions in complete sentences.

1. What is traxoline?
2. Where is traxoline monotilled?
3. How is traxoline quaselled?
4. Why is it important to know about traxoline?

Attributed to Judy Lanier

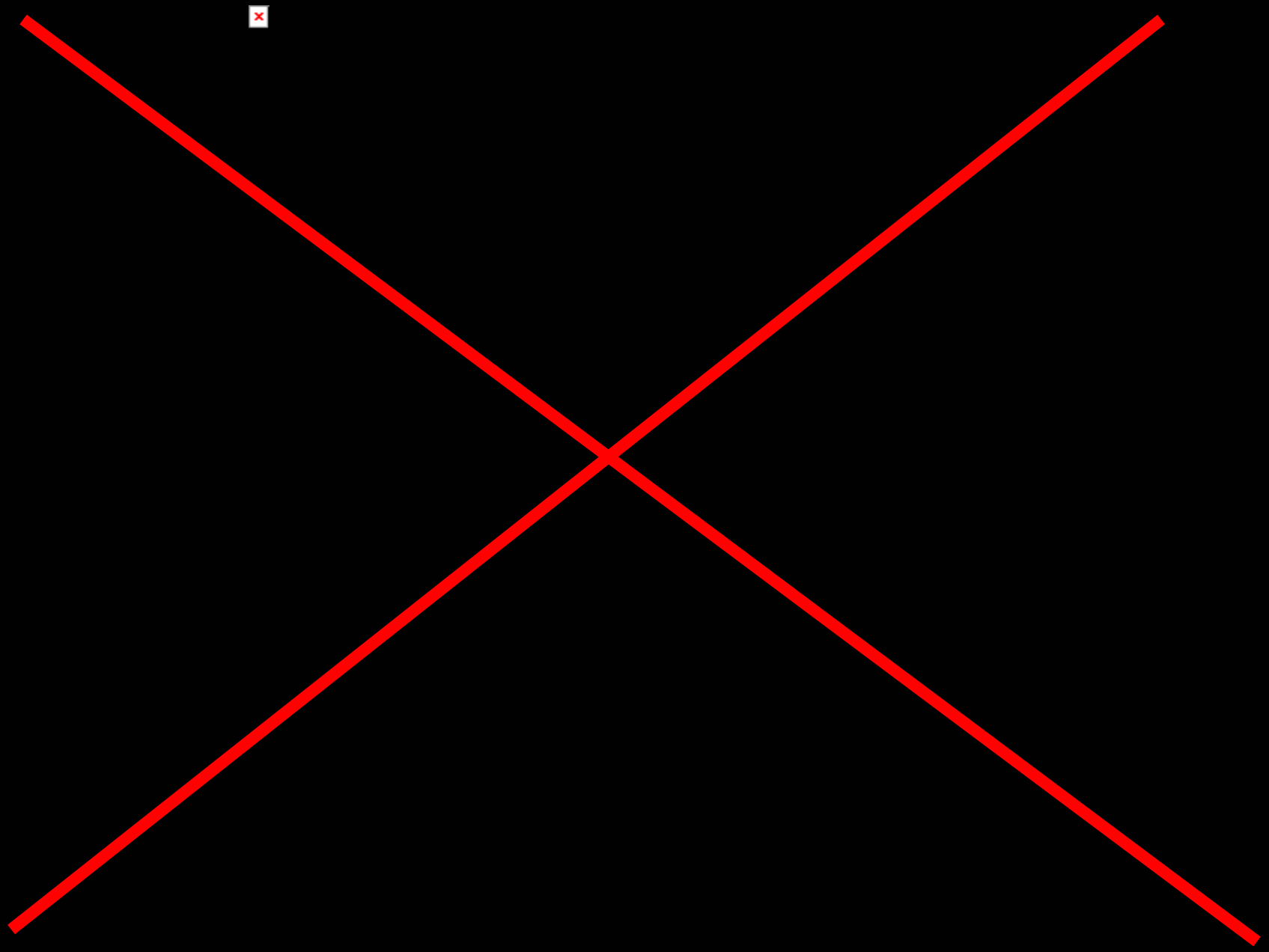
Guidelines for Public Speaking –

devised by C. A. Morrow

ABC: LIVE

- **A = Audience** (Know it, Care about it)
- **B = Big Picture** (Background, Basics, Begin at the Beginning, Relevance, Use Frameworks of Understanding)
- **C = Communication Skills**
  - Language
  - Interactivity
  - Visuals
  - Excitement/Enthusiasm

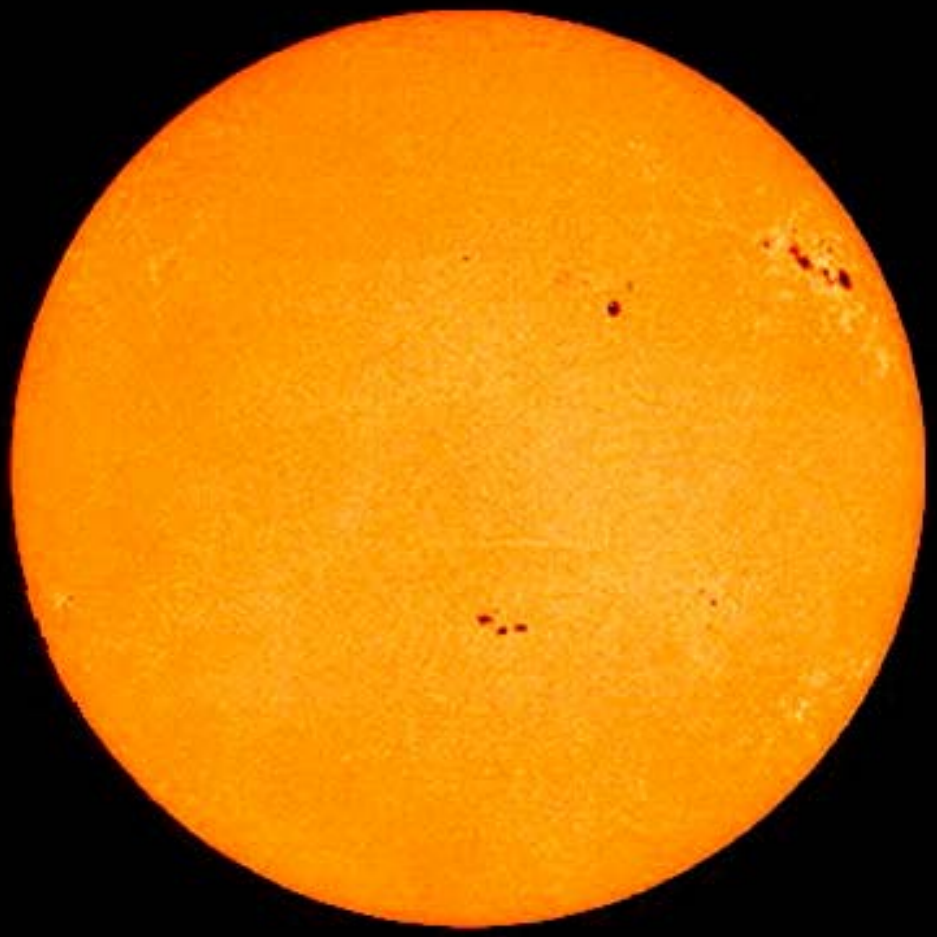
Excerpt from Morrow, Cherilynn A. "How Scientists Can Become Involved in Education and Public Outreach", Abstracts of the NOAA Postdoctoral Program in Climate and Global Change meeting in Steamboat Springs, CO, June 2002. Contact camorrow@colorado.edu for a copy of this page-long abstract.



The Sun in 5 Different Types of Light

1. Visible
2. UV
3. EUV
4. EUV/X-ray
4. X-ray

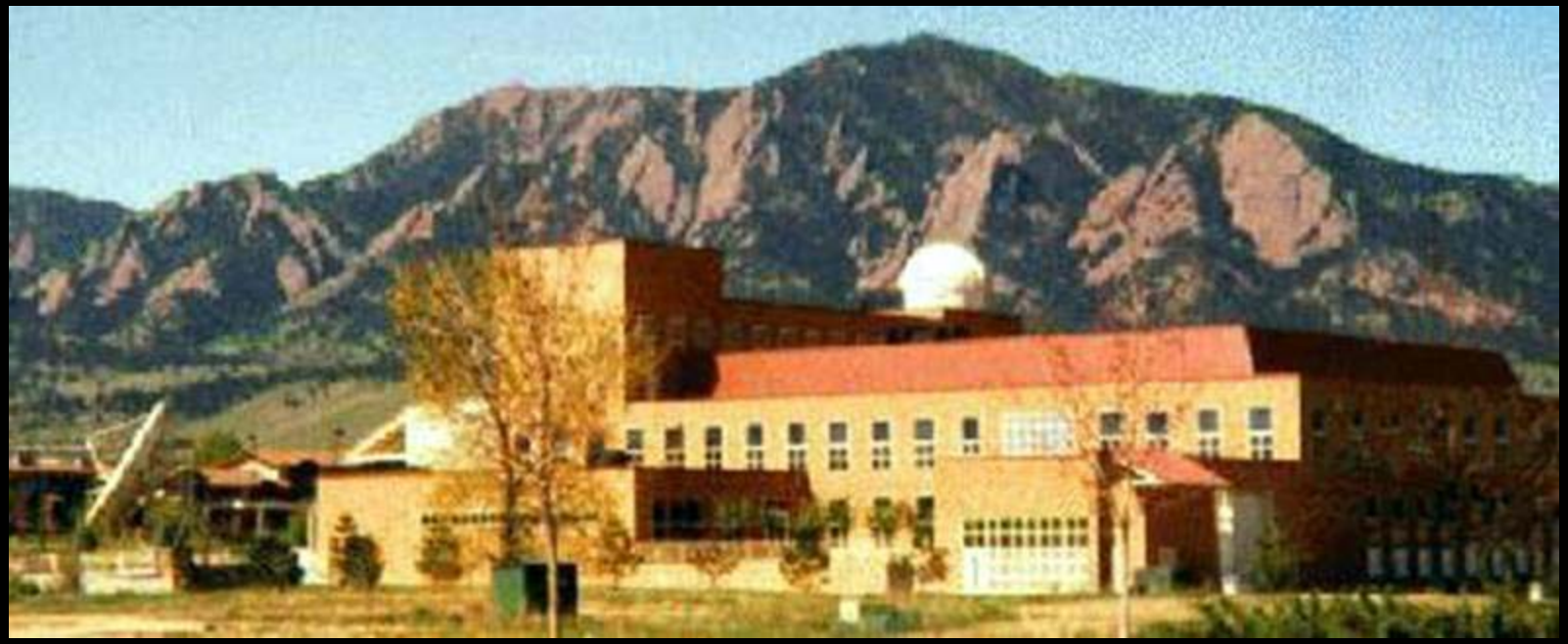
from the SOHO Website



Gary Rottman

- University of Colorado
- Senior Research Scientist:
  - Associate Director of LASP
  - PI for the SORCE mission
  - PI for the SOLSTICE instrument
- No fixed pattern to time on EPO:
  - oversight of EPO partnership to develop school outreach program
  - occasional public lectures/tours
  - writing popular articles
  - advocacy for team doing EPO
- QUOTE FROM HIS PROFILE:
  "EPO is part of the job, and I must say that is it probably one of the more enjoyable pieces of it. When you do it, you find all these people that are bright-eyed, eager and excited about what you do."

Adapted from Profiles of Scientists in EPO. This one by Preston Dyches and Cheri Morrow. See **http://ssibroker.colorado.edu/broker/PROFILES .htm**



The Laboratory for Atmospheric & Space Physics
University of Colorado, Boulder

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Informal Ed	Board of sci ctr	Re bit	Co-d ws
Public Outreach	Help PBS/NPR	Pu e	Write look
E/PO Program Management	Ed sessions at science mtgs	EPO scientist for flight mission	Serv lead: co-design EPO plan

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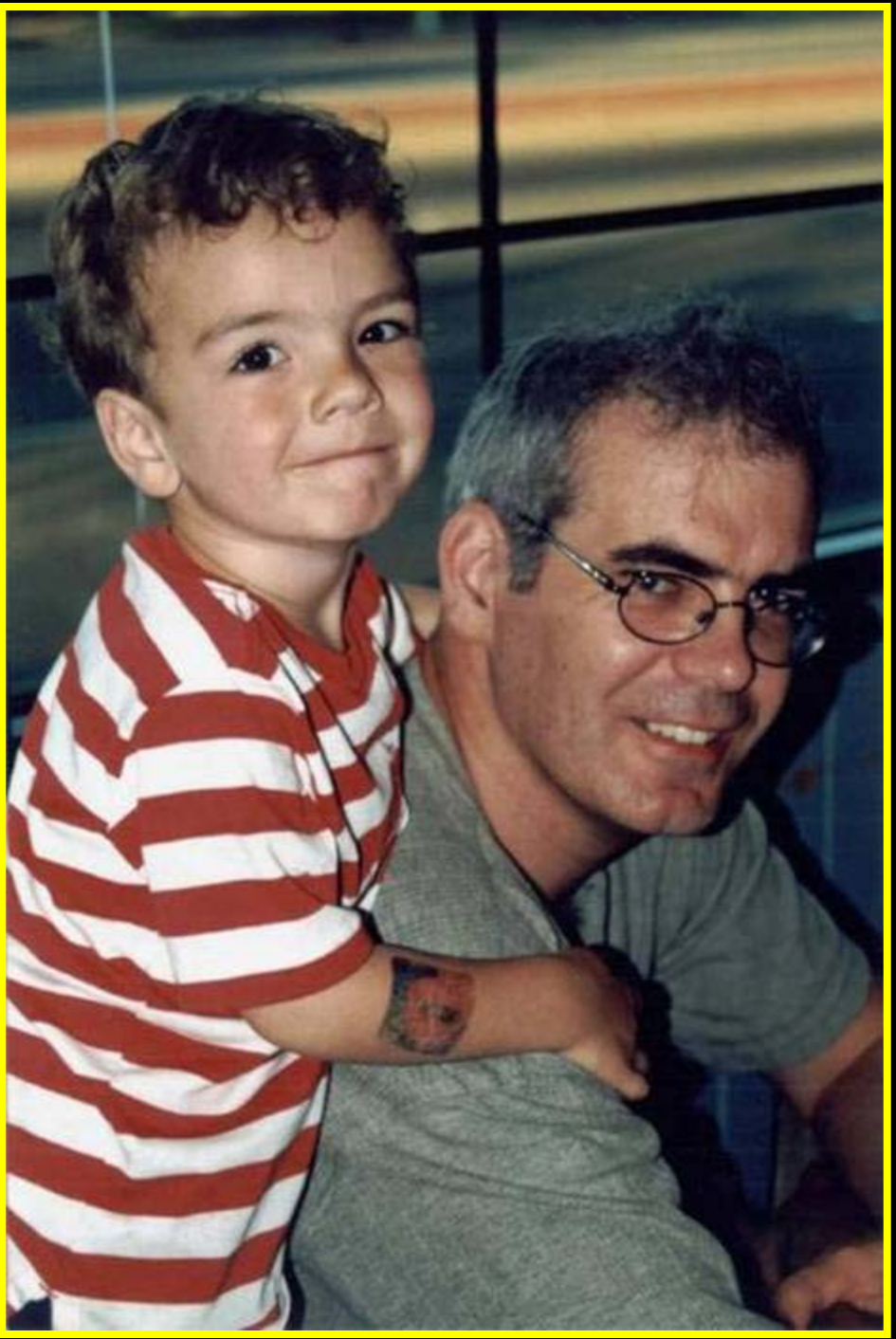


David Alexander

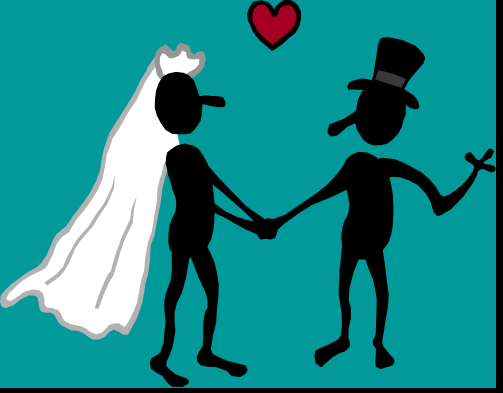
- Lockheed Martin (soon Rice U.)
- Staff Physicist:
  Working on solar flares, coronal mass ejections, coronal heating, and mission concepts.
- EPO time supported by Lockheed:
  - EPO lead for YOHKOH mission
  - Creator/facilitator of Solar Week
- QUOTE FROM HIS PROFILE:
  "Partnering with teachers or other education professionals tends to be mutually rewarding and often fun. Combining your strengths… is a good recipe for an enjoyable and fruitful collaboration that has a better chance of having a meaningful impact."

Adapted from Profiles of Scientists in EPO. This one by Preston Dyches and Cheri Morrow. See **http://ssibroker.colorado.edu/broker/PROFILES .htm**

Common Cultural Differences Between Scientists and Teachers

• Intellectually confident/arrogant	⟷	• Less intellectually confident
• Competitive	⟷	• Collaborative
• Critical	⟷	• Appreciative
• Less socially adept	⟷	• Good social skills
• Confronts problems	⟷	• Works around problems
• Assigns credit carefully for colleagues' ideas	⟷	• Borrows good ideas freely from colleagues

Excerpt from Morrow, Cherilynn A. and Dusenbery, Paul B. "Workshops for Scientists and Engineers on Education and Public Outreach", Preprint: Session Proceedings from the COSPAR Scientific Assembly, Houston, TX, October, 2002. Contact camorrow@colorado.edu for a copy of this paper.



Defining "PARTNER-ship"

devised by C. A. Morrow

- **P** = Personal & Professional Development**
- **A** = Appreciation – express it!
- **R** = Respect – partners' expertise, cultural differences
- **T** = Trust – safety to reveal what you know & don't know
- **N** = Needs –time constraints, meeting education standards
- **E** = Enjoyment – fun and satisfaction
- **R** = Responsibility – to each other and to learners

Excerpt from Morrow, Cherilynn A. "The Role of Scientist-Educator Partnerships in Improving Science Education", Preprint: Proceedings of the Fulbright Symposium 2002, Science Education in Partnership, Hamilton Island, Australia, July 2002. Contact camorrow@colorado.edu for a copy of this paper.

Solar Week

Solar Week is a week-long series of web-based educational activities designed to spark the interest of pre- and early teen girls in science by direct interaction with female scientists at the forefront of solar research.

http://www.lmsal.com/YPOP/solarweek/

LOCKHEED MARTIN

Sample EPO Roles – Examples from the *Roles Matrix*

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Systemic Change	Prof. Societies	Review standards	Co-write standards
Ed Materials	School board	Review materials	Co-[illegible]terials
Informal Ed	Board of sci ctr	Review exhibit	Co-[illegible]ows
Public Outreach	Help PBS/NPR	Pu[illegible]e	Write [illegible]book
E/PO Program Management	Ed sessions at science mtgs	EP[illegible]st for [illegible]sion	Serve as EPO lead: co-design EPO plan

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George “Pinky” Nelson

- Western Washington University
- Director, Sci, Math & Tech Education
  - ex-solar physicist and ex-astronaut
  - ex-Associate Dir. for UW Space Grant
  - ex-director for AAAS Project 2061
- Full time on EPO:
  - coordinating 10 scientists in support of teacher prep program
  - forming an applied research group
  - teaching every quarter
- QUOTE FROM HIS PROFILE:

  “Scientists who get involved in EPO should help people learn the science that they themselves know, and their effort must be tempered by knowledge of educational research…Do your homework…Talk to educators…Read the literature…Forget developing materials for teachers. You don’t have the time or expertise. Neither do teachers. Leave that job to the professionals.”

AAAS: *PROJECT 2061* RESOURCES

Atlas of Science Literacy:

Atlas is an exciting new resource that presents conceptual connections among the ideas and skills that serve as goals for student learning.

They graphically display how students might develop in their understanding of topics such as gravity, natural selection, and statistical reasoning from kindergarten through grade 12.

http://www.aaas.org/project2061/

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Schools of Ed	Co[illegible]in	Hire ed student	Co-[illegible]hods
Systemic Change	Pr[illegible]es	Review standards	Co-write standards
Ed Materials	Sc[illegible]	Review materials	Co-create materials
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Cherilynn Morrow

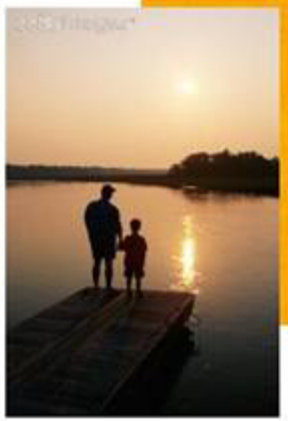
- Space Science Institute, Boulder CO
- Manager for Education & Public Outreach
  - ex-solar physicist [HAO, Cambridge]
  - ex-Associate Dir. for CO Space Grant
  - ex-Visiting Scientist at NASA HQ
- Full time on EPO:
  - EPO workshops/resources for scientists
  - NASA OSS EPO Broker in the West
  - workshops for educators on science
  - development of instructional materials
- QUOTE FROM HER PROFILE:

  "I was looking for a career path that would integrate more of my personal interests in music, movement, poetry, and outdoor adventure…The biggest challenge used to be lack of respect from scientific colleagues who thought less of me for "wasting" my PhD in science on envisioning and managing EPO programs. These days this sentiment seems to be less prevalent, but it's still out there…"

"I have a very strong feeling that science exists to serve human welfare. It's wonderful to have the opportunity given us by society to do basic research, but in return, we have a very important moral responsibility to apply that research to benefiting humanity." – Walter Orr Roberts

Space Science Institute presents

A Family Guide to the Sun



Recommend for kids ages 6-13 (and the adults they play with!)

A collection of informal education activities and resources
for kids ages 6-13 developed by Morrow, Dyches, and Wilkerson

KINESTHETIC ASTRONOMY

For more info about *Kinesthetic Astronomy*, click on “K-12 Curriculum” at http://www.spacescience.org

or contact camorrow@colorado.edu

The Space Weather Center

A 700 sq. ft. traveling exhibit developed in collaboration between the Space Science Institute of Boulder, CO and several Sun-Earth Connection missions based at NASA/GSFC.

Currently at the Challenger Center in Peoria, AZ

Stormy Weather – Solar Style

Modified Lyrics by Cheri Morrow camorrow@colorado.edu

I know why… there's a sun up in the sky…
It's space weather
Since the Sun and Earth been together….
It's solar wind all the time

Sun's a-flare…plumes and prominences everywhere….
Stormy Weather
Sunspots play in pairs, yea together….
And solar wind all the time…the time…Yes, solar wind all the time…

Then a CME (solar storm) burst from the Sun to get me
When it hit the earth magnetic storms, they met me
All I did is pray the lord above will let me
See northern lights once more

Sun shines on… Solar cycles come and gone…It's space weather
Since the Sun and Earth been together…
It's solar wind all the time… Yes, solar wind all the time

Space physicist Robert Hoffman of GSFC participates in a classroom visit as part of the Space Science Institute's annual 4-day education workshop for scientists.

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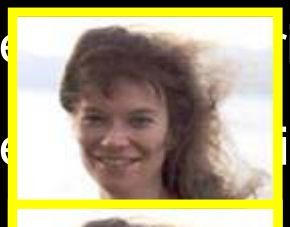
Ed Materials	School board	Re ials	Co- ials
Informal Ed	Board of sci ctr	Re it	Co- s
Public Outreach	H PR	Pu	Write ook
E/PO Program Management	E at s	EF fo on	Serv ead: co-d plan



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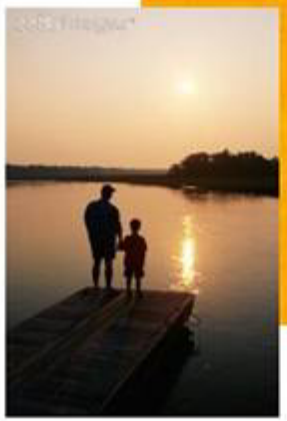
Space Science Institute presents

A Family Guide to the Sun



Recommend for kids ages 6-13 (and the adults they play with!)

We're now looking for a few good reviewers and field testers!

A collection of informal education activities and resources for kids ages 6-13 developed by Morrow, Dyches, and Wilkerson

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Your Image HERE!

Adapted from "The Diversity of Roles for Scientists in K-14 Education & Public Outreach" by C. A. Morrow

Adapted from Profiles of Scientists in Education & Public Outreach.
This profile by Christy Edwards and Cheri Morrow. See
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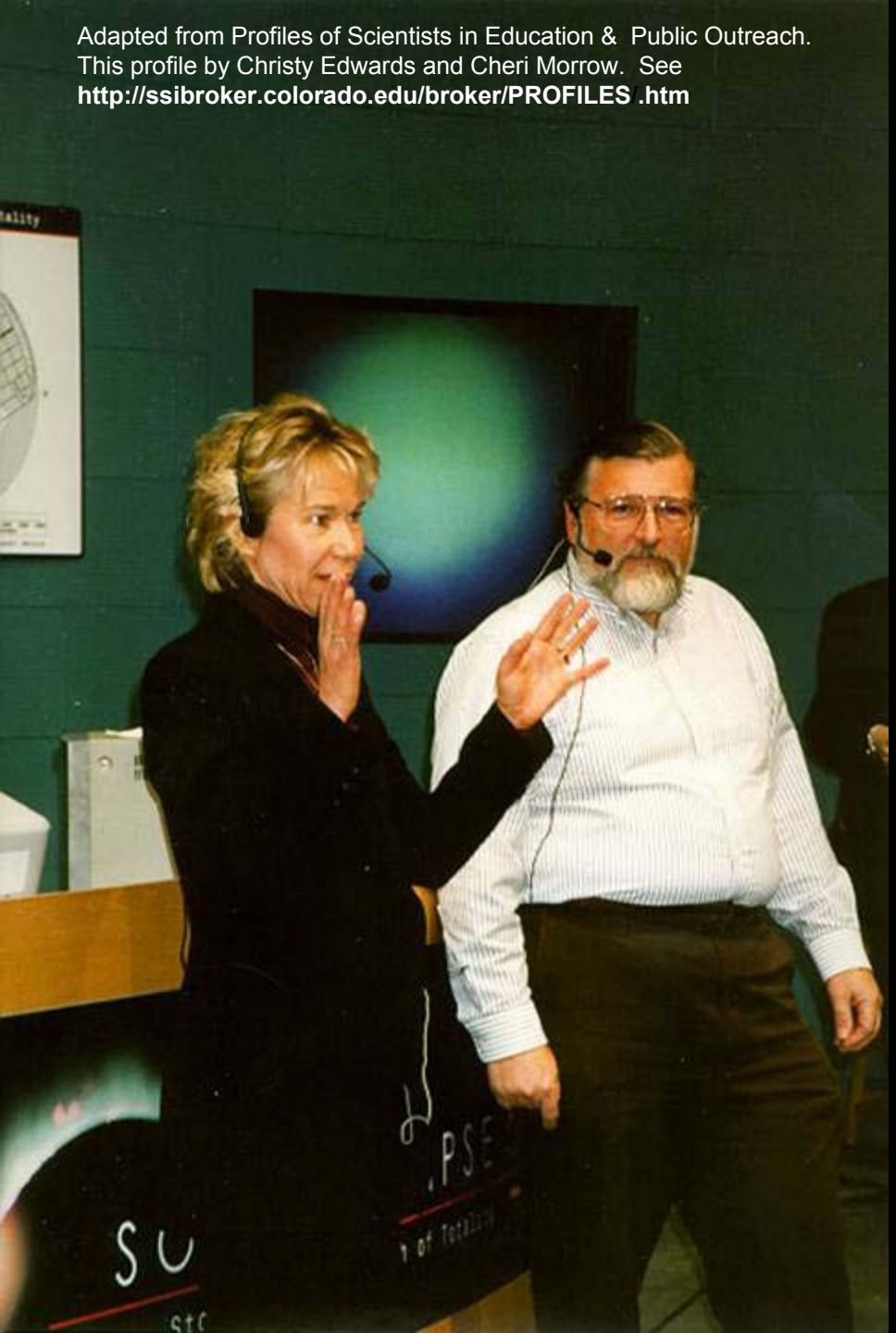


"If scientists make the right connection, they can do something important and valuable without a huge investment of time. With SECEF, we have the contacts and capabilities to make connections with the education world as we've never had before. I find that it's possible to invest 10% of my time and get a lot out of that 10%.

Although we already often feel over-subscribed, and EPO seems like "yet another thing to do," much can be done with good arrangements by those who know the EPO business…I hope more people will look into contacting NASA's EPO organizations to see how they can work together with whatever commitment constraints they have."

Janet Luhman
Space physicist, UC Berkeley

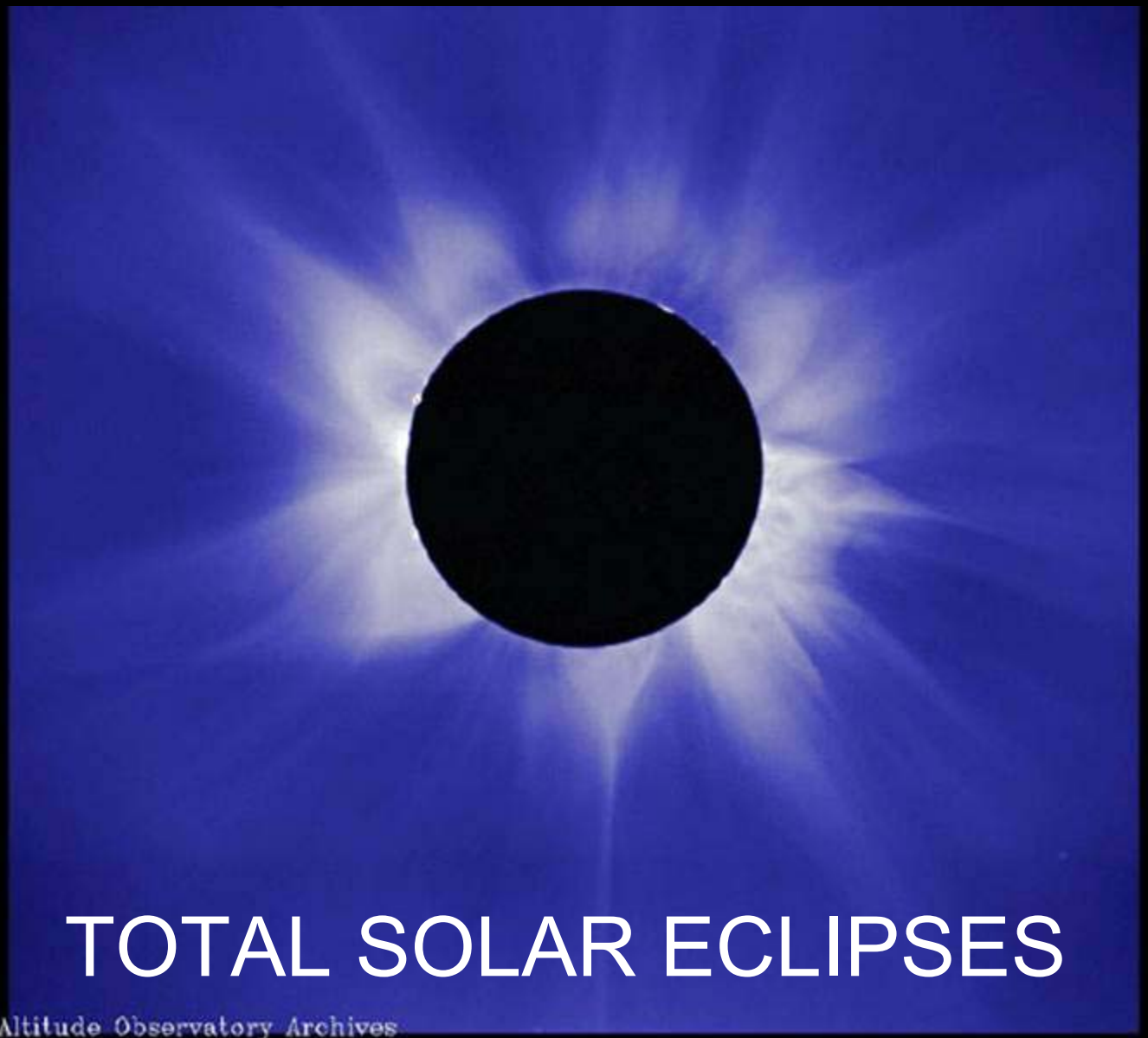
Sun-Earth Connection Education Forum

- The *Sun-Earth Connection Education Forum* (SECEF) is one of four NASA OSS Education Forums that coordinate EPO activities between OSS missions.

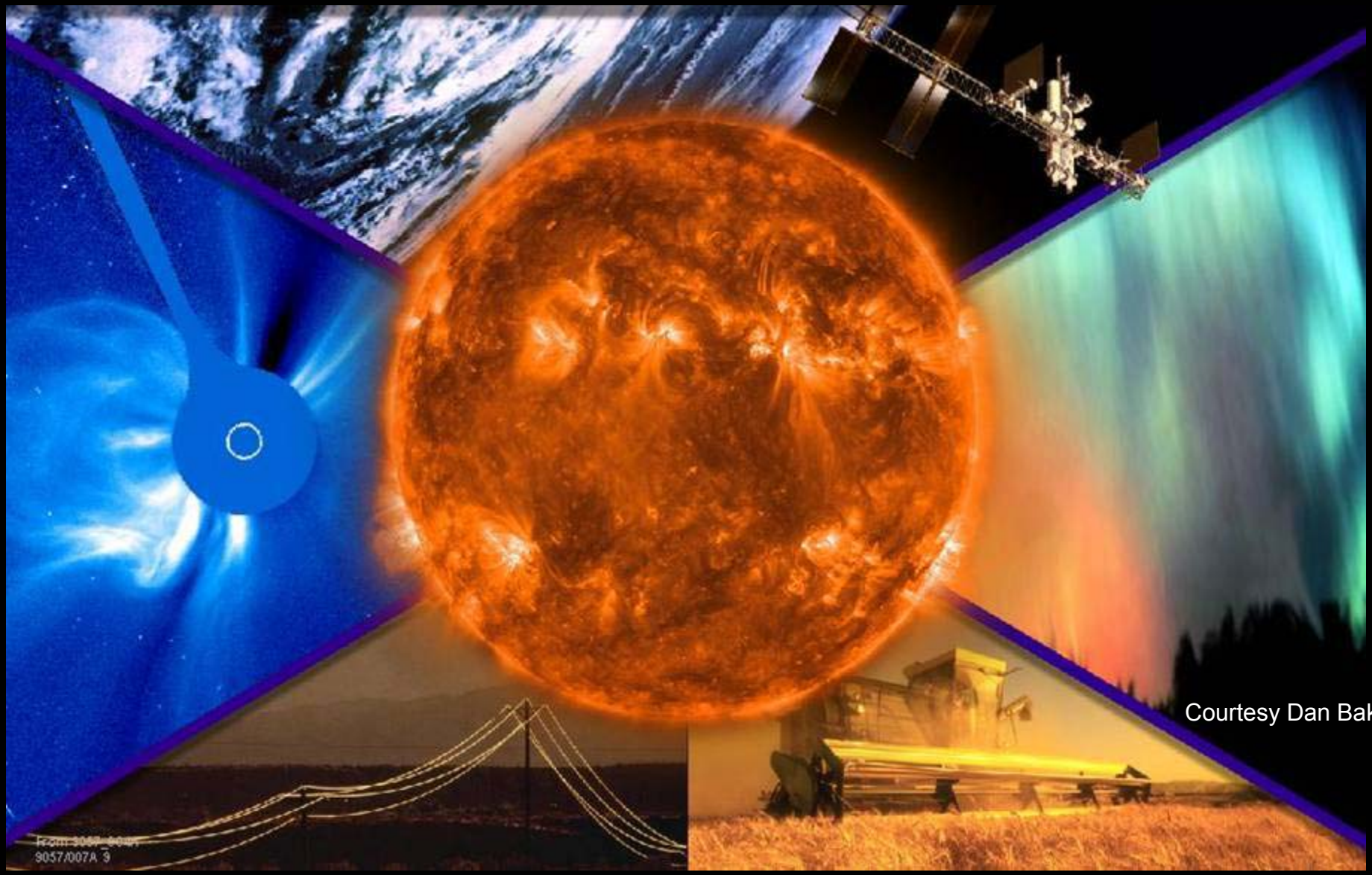
- SECEF is based both at UC Berkeley and GSFC

http://sunearth.gsfc.nasa.gov/

“HOOKS” for LEARNING ABOUT THE SUN



“HOOKS” for LEARNING ABOUT THE SUN



SPACE WEATHER EFFECTS ON EARTH

Sun-Earth Day 2003

Live From the Aurora

NASA Sun-Earth Connection Education Forum

Auroras: Living with a Star
February 11

Live web-cast for museums from Poker Flats
Feb 21-22 & Mar 1-2

Sun-Earth Day
Live From the Aurora
March 18

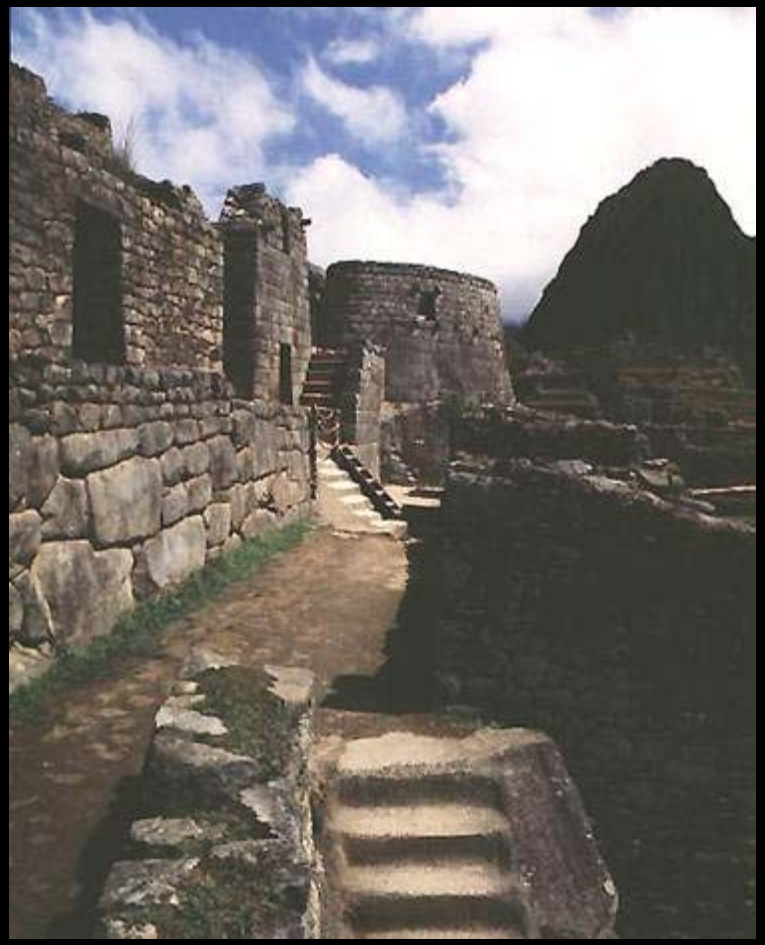
Scientist's Participation and Registration for Sun-Earth Day 2003

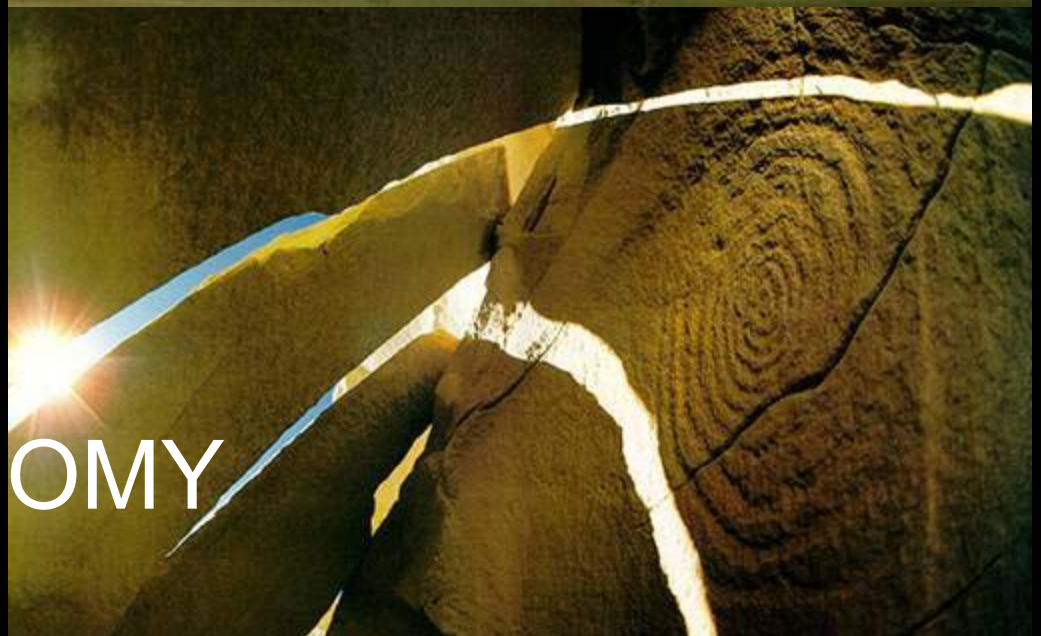
http://sunearth.gsfc.nasa.gov/sunearthday

“HOOKS” for LEARNING ABOUT THE SUN

Courtesy SOHO and the NASA
Sun-Earth Connection Education Forum

“HOOKS” for LEARNING ABOUT THE SUN

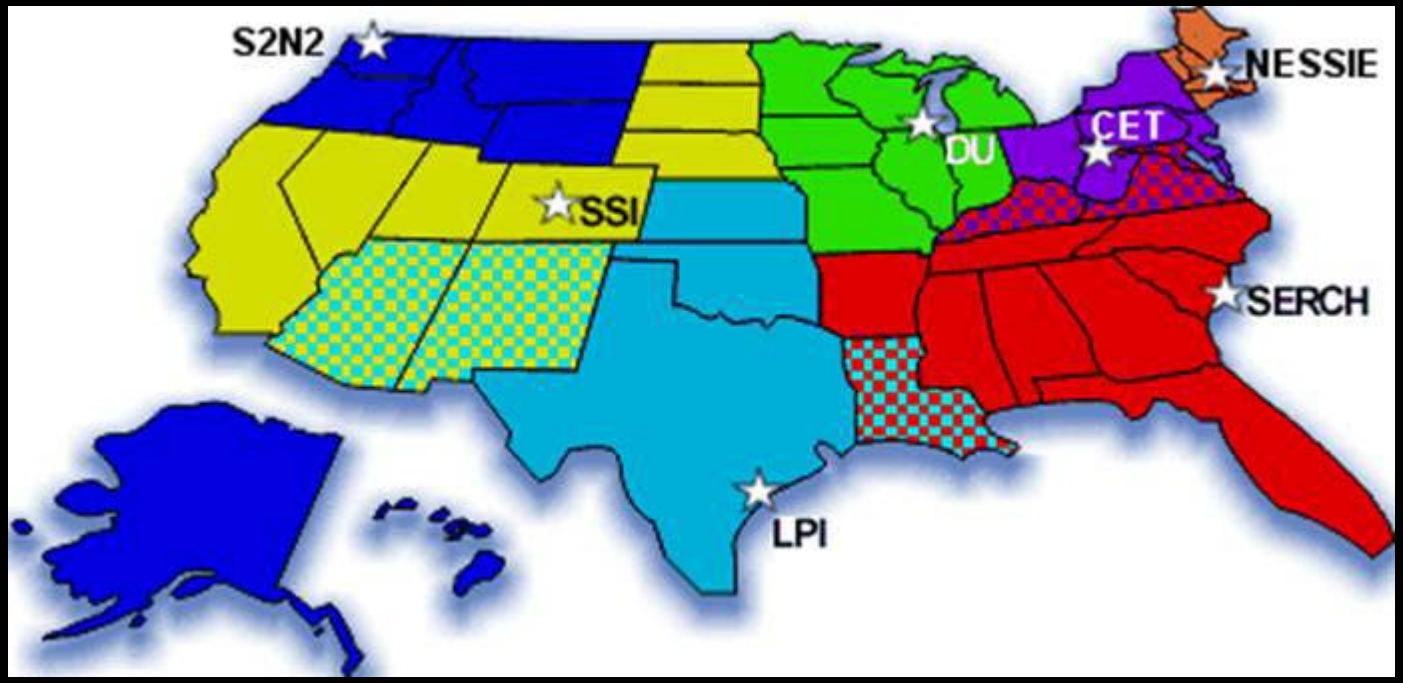




ARCHEO-ASTRONOMY

Courtesy SOHO and the
NASA Sun-Earth Connection Education Forum

NASA OSS EPO Broker/Facilitators



- Northeast – Cary Sneider
- East – Nitin Naik
- Southeast – Cass Runyon
- North – Lynn Narasimhan
- Southwest – Robbie @ LPI
- West – Cheri Morrow
- Northwest – Julie Lutz

http://ssibroker.colorado.edu/Broker/Brokers/

Resources for Scientists in Education

Useful for:

Scientists and science managers doing education

Education managers in scientific research programs

Educators working in partnership with scientists

http://spacescience.org/Education/ResourcesForScientists

White Papers on CD/Web

- A Framework for Planning EPO Programs Associated with Scientific Research Programs
- The Diversity of Roles for Scientists in K-14 Education and Public Outreach
- What are the Similarities Between Scientific Research and Science Education Reform?
- Misconceptions Scientists Often Have about the K-12 National Science Education Standards

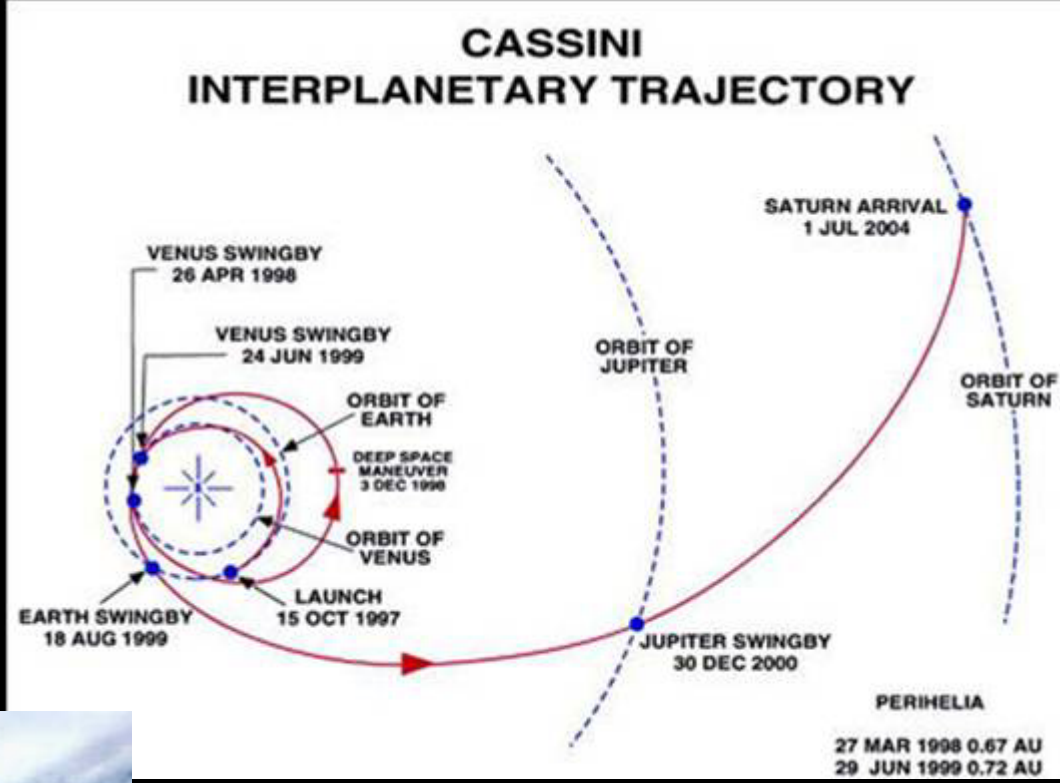
Published in *Astronomy Education Review:*
http://www.aer.noao.edu

See http://www.spacescience.org

[See Quick Links menu at bottom of page; Click on "Papers on EPO"]

LIFE TRAJECTORY*

- Need a good launch
- Assists & influences needed
- Non-linear paths possible
- Multiple paths are possible
- Multiple destinations of interest
- Own impetus also matters



EDUCATION "PIPELINE"

If you don't feed through to a PhD then you "leaked out".

The idea of "life trajectory" vs. "pipeline" was first introduced to C. Morrow by Richard Shope of JPL. This slide represents Morrow's interpretation of Shope's original idea.

The Joy of Solar Physicists in Science Education

Hats off to these and other solar scientists in EPO!

Cherilynn A. Morrow

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