Behind the Scenes — and Science — of the Earth Observatory

A look into the NASA Earth Observatory approach to science communication

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EarthObservatory.nasa.gov
NASA Earth Observatory
earthobservatory.nasa.gov

- Founded in 1999
- Daily publication of data-driven, scientific imagery
- More than 12,000 stories published

"The Earth Observatory’s mission is to share with the public the images, stories, and discoveries about the environment, Earth systems, and climate that emerge from NASA research, including its satellite missions, in-the-field research, and models."
Ice Age Carolinas

During the last ice age, the Atlantic coastal plain of the southeastern U.S. was a cold, dry, and windy place. With patches of permafrost stretching as far south as Georgia, the seasonal freezing and thawing of sandy soils left landscapes littered with thermokarst sinks and scattered sand dunes and ridges—much like those now found in parts of Alaska and the Arctic.
Airborne Nitrogen Dioxide Plummets Over China

NO₂ amounts have dropped with the coronavirus quarantine, Chinese New Year, and a related economic slowdown.

Image of the Day for March 2, 2020

Instrument:

Sentinel-5P

NASA and European Space Agency (ESA) pollution monitoring satellites have detected significant decreases in nitrogen dioxide (NO₂) over China. There is evidence that this change is at least partly related to the economic slowdown following the outbreak of coronavirus.
In mid-January 2021, the Pacific Northwest of North America was soaked by several episodes of heavy rainfall, leading to widespread flooding and landslides. The culprit was a phenomenon known as an atmospheric river. And this event was about as extreme as they get.

Atmospheric rivers are long, narrow bands of moisture that move like a river in the sky, carrying water vapor from the equator toward the poles. The events occur around the world, usually during the autumn and winter. The U.S. West Coast is most often affected by rivers of warm, moist air originating around Hawaii.

The animation above shows the signature of atmospheric rivers, including a particularly potent one.
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- Inspire readers: show our home planet as NASA sees it
- Satellite imagery, maps, data visualization, and storytelling for science news/results, natural hazards, and the beauty of Earth
- Target audience: Science-literate, interested public, with an eye toward those who overlook science
- Also: educators, media, etc
Earth at Night: Flat Maps

Global Map Downloads - 2015 Color

To download a file to your hard drive, right-click on the file link and select “Save As….”

5600x4900 0.5 degrees 484 MB
5000x4380 0.5 degrees 36 MB
4000x3500 0.5 degrees 3.1 MB
3500x3050 0.5 degrees PNG 8.7 MB
1500x1362 World GSHHS 64.4 MB
Earth at Night: Flat Maps

Global Map Downloads - 2015 Color

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This is incredible to see: b-gat.es/2pOK3Br
@TheAtlantic

NASA's Nighttime Maps Trace Humanity’s Impact on Earth
Advances in how satellites image the planet’s artificial lights are helping scientists estimate global patterns of energy use.

1,156 Retweets 71 Quote Tweets 3,798 Likes
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Thank you @NASAEarth Observatory for featuring our work on marine debris detection in this piece!

Great story out today by @NASAEarth about our work ( @Cryospheric) mapping marine-terminating glaciers. So many glaciers are retreating very quickly.

This @NASAEarth piece by @avoiland shows alarming images of the Pantanal fires and features @icvcentrodevida study based on data from @inpe_mct and #GFED, a great database produced by @NASA_Doug et al. Couldn’t be more proud of our work, this quotation is like an award, thanks!

Drought-parched wetlands in South America have been burning for weeks. earthobservatory.nasa.gov/images/147269/... #Pantanal
SSAI's talented staff supporting the NASA Earth Observatory team have an eye for finding and presenting imagery and data that give the big picture.

Check out this recent article featuring time series imagery of the rapid collapse of an Antarctic ice shelf in March, reshaping a landscape where coastal glacial ice was once thought to be stable: https://lnkd.in/eRSHr5RP

Congrats to the whole EO team (Kevin Ward, Michael Carlowicz, Adam Voiland, Kathryn Hansen, Sara Pratt, Joshua Stevens, Paul Przyborski, Lauren Dauphin) on your ongoing excellence in communicating important topics in Earth science!

Special kudos to SSAI’s Kathryn Hansen who authored the above article and Lauren Dauphin who assembled the images using #landsat data from the U.S. Geological Survey (USGS) and MODIS data from NASA EOSDIS LANCE and GIBS/Worldview.

#earthscience #earthobservation #SSAI
This happens because:

- EO annual web traffic regularly in the top-10 for all NASA.gov URLs
- We cover all Earth sciences funded or enabled by NASA
- Our content is easy to use by others (journals, books, videos, museums, Google Earth, etc)
- Constant stream of fresh, new, well-explained visuals
NASA Earth Observatory
earthobservatory.nasa.gov

- Who we are: small, diverse team with many decades experience in
  - Earth science / geography / geology / climate
  - Journalism / communication / writing
  - Library and information science
  - GIS / cartography / data analysis
  - Web development / programming
How we do so much with so little?

People
- Background
- Experience
- Connections
- Ideas

Processes
- Structured meetings
- Story identification
- Science-driven design
- Editing/review

Programs
- Workflows
- Applications/scripts
- Reusable assets
• Story selection
  • Natural events, disasters, processes
  • New publications, data products
  • Story tips from the community… **that means you**!

• **BYOD**: Bring your own data!
  • We will collaborate with you to share your science - no cost!
Interning at 40,000 Feet: The NASA Student Airborne Research Program Experience

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Design Matters: the Science of Seeing

Color

Light
What does it mean for a thing to be “designed?”

“Well-designed objects are easy to interpret and understand. They contain visible clues to their operation. Poorly designed objects can be difficult or frustrating to use.

They provide no clues—or sometimes false clues. They trap the user and thwart the normal process of interpretation and understanding.”

— Don Norman, *The Design of Everyday Things*
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First TV Image of Mars, by Richard Grumm (1965)

http://www.directedplay.com/first-tv-image-of-mars
Design Matters: the Science of Seeing

- We begin to acquire info from—and make judgements about—graphics before even thinking about it (pre-attentive processing)
- Color choices can aid or inhibit this process, and reinforce thoughtful, accurate interpretation later
  - Is this area hot or cold?
  - Is this relationship good or bad?
  - Can I trust this image?
- Readers first see “what” then later understand “how much” and “why”
Design Matters: the Science of Seeing

Linear Grayscale

Typical Rainbow

https://earthobservatory.nasa.gov/blogs/elegantfigures/2013/08/05/subtleties-of-color-part-1-of-6/
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Linear Grayscale

Typical Rainbow
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Linear Grayscale

A B C D E F

Typical Rainbow

A B C D E F

https://earthobservatory.nasa.gov/blogs/elegantfigures/2013/08/05/subtleties-of-color-part-1-of-6/
~1 in 10 men have a form of red-green colorblindness, ~1 in 200 women

*Millions of readers across the NASA.gov system!*
Figure 2: The term **rainbow color map** can refer to a variety of spectral schemes that do not necessarily suffer from the same problems to the same extent. Notable examples include: (a) the traditional rainbow color map (truncated at blue), (b) Gersh’s perceptually linearized rainbow, (c) the jet color map popularized by MATLAB, (d) the traditional rainbow color map (cycling to magenta), (e) the rainbow color map specified by matplotlib, (f) Kindlmann’s isoluminant rainbow, and (g) the Kindlmann color map.
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Our eyes and brains are easily fooled

https://earthobservatory.nasa.gov/blogs/elegantfigures/2013/08/05/subtleties-of-color-part-1-of-6/
Our eyes and brains are easily fooled
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Our eyes and brains are easily fooled
Luminosity (lightness) curves.

Color is an axis. Steps between values must be linear!
Luminosity (lightness) curves.
Figure 1 from this paper. The fronts were drawn as lines in the original paper – red for an Arctic front, yellow for a mid-latitude front and blue for a sub-tropical front.
Accuracy identifying “Endothelial Shear Stress (ESS)”

“It was surprising to find that different color mapping can render the task less ambivalent.

One can only wonder in just how many other instances we make our task more difficult than it needs to be simply by maintaining the status quo.”

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“But isn’t the colorful rainbow more attention-grabbing?”

“Experimental results showed that brightness and saturation levels are more important than the hue component in attracting attention.”

The human eye has 120 million rods (light sensing) and just 7 million cones (color sensing).
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- Scientific color maps should:
  - Not distort data or introduce false gradients. Show quantitative data with perceptually linear changes in luminosity, not hue.
  - Use a small amount of hue to convey an intuitive context (hot vs cold, wet vs dry, etc.)
  - Be accessible to those with colorblindness
  - Consider the readers of today, not the computational simplicity of yesterday’s engineers
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Tools and resources

ColorBrewer: https://colorbrewer2.org/

Color Palette Helper: https://gka.github.io/palettes/
Lava flows measured by aerial lidar
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Lava flows measured by aerial lidar

Mount St. Helens
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Tom Patterson (2014)
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Guillaume-Henri Dufour (1854)
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Light source
Man writes and draws with his right hand. Right-handedness expresses itself in the characters of western writing and in certain graphic elements. Upstrokes, produced by turning movements of the hand are thin, weak and unshaded. Downstrokes, however, drawn (centripetally) against the hand, are strong or shaded. Zig-zag and wavy lines, running horizontally when given this interplay of thin and thick strokes give an impression of three dimensions illuminated from the left.

A preference for general room lighting from above and from the left, is yet another outcome of right-handed writing, where progress is from left to right. Without this incidence of the light, the point of the pen and the line it produces would be obscured by the shadow of the hand and of the writing implement. Hence, every writer and draftsman orientates his work table so that the light from window and lamp comes from the left or above left. (Left handed people would logically require the light direction from the right as they write from right to left.) Every object, every body, every model in a studio is normally illuminated from the top left.


Untenable theory - not supported by any research!
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Relief inversion effect in terrain representations: Where should we place the light source?

Best - Almost everybody perceives landforms correctly

Cartographic convention

Worst - Very poor landform detection

Methods & Results

We have shown 128 stimuli (64 per condition) to 12 participants in a counterbalanced design. The light source was placed at one of the 16 positions (in 5° increments) on a circle. Participants were asked to determine the correct and incorrect positions.

References

To sum it up:

- Communication must consider the audience—and how their brains work
- General public does not know what you know, does not read same journals, is not used to the same software defaults, or the same unchallenged conventions of your field
- Prioritize audience psychology over technology or irrelevant physics
- If we want people to accept unfamiliar science, we need to be willing to do the same and adjust our approach accordingly
Thank you!

Questions or comments?
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