How to Construct a Nugget

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Nuggets

What scientists think they are

What NASA HQ says they are

What we wish they were: a relaxing beverage

(*A variety of hops with a floral, resiny aroma and flavor. Primarily a bittering hop.*)
Newly discovered red arcs on Saturn’s moon Tethys are mystifying because they are not linked to any obvious geologic features. The graffiti-like arcs were found in enhanced-color images taken by Cassini April 11, 2015. Their presence on the hemisphere coated by recent water-ice grains from Saturn’s E ring suggests that the features are young or reddish material is being resupplied. The next opportunity to observe them even closer will be November 11, 2015 during a 8,300 km flyby.

Reddish arcs are illustrated in this magnified, infrared-enhanced color image (above). The origin and composition of the red arcs are currently unknown, but there may be an analogy with reddish-tinted bands observed on Jupiter’s water world, Europa.

Enhanced-color image (left) shows one hemisphere is stained by Saturn’s radiation belts while the other is spray-painted white by water ice particles orbiting the planet.

Press Release - http://go.nasa.gov/1D98l5Y
The Mindset of a Nugget

• Consider the nugget a stand-alone product. This may be the first and only time the reader ever hears of this result.

• Write for a political science major who avoided classes in the physical sciences.
  • NASA’s primary audience is Congress and U.S. taxpayer

• Your reader will be engaged, or not, with one look at the nugget.
  • Catchy title
  • Visually engaging artwork
  • Create an uncluttered look. Allow for “air” in your design.

• Assume the nugget will not be viewed in an online format.
  • Don’t rely on links to a website or a video to explain the results.

• Be prepared to exercise your artistic/stylistic side. Helpful to look at:
  • Infographics
  • TED presentation slides
Nugget Rules of Thumb: Message

• “Why do we care?” “Why is this important?”
  • Often the most difficult part of developing a nugget.
  • With particularly arcane results, use general statements about why the findings matter, such as: “These findings contribute to our understanding of the fundamental processes of planet formation.”

• What is the takeaway message of finding?
  • Use one or two short, easy-to-understand sentences.

• Use analogies to make complex ideas easier to understand

• If multiple conclusions, what is the most important conclusion?
  • Better to convey one or two points well, than more points poorly.

• Is there a human connection?
Nugget Rules of Thumb: Text

• Start with the nugget template, approved by NASA HQ.

• Use the minimum number of words possible.
  • Reduce amount of text on slide, then reduce it again.
  • Eliminate redundancy

• Use 3-4 bullets maximum.

• Avoid!
  • Jargon
  • Acronyms

• Include link to press release (tiny URL preferred) or reference to paper.

Have others (non-scientists) review the final draft for clarity.
Nugget Rules of Thumb: Visuals

- Use visuals that draw the eye. The fewer, the better. Colorful.

- Make pictures as big as possible.
  - Crop and enlarge images. Fill the slide, if possible.
  - Use natural empty space as a place for text.

- If visuals from a paper are not compelling or are very complex, use an image of the topic.
  - For example, an atmospheric chemistry finding can use an atmospheric limb picture as slide background.

- If you must use a graph, simplify it.
  - Crop, remove bars, consider removing technical units

- Include short captions for figures and plots, if needed.
  - Try not to use complex plots if you can state results in words.
Graffiti on Tethys

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Press Release - http://go.nasa.gov/1D98I5Y
Saturn’s moon Enceladus harbors a large, 6-mile deep underground ocean of liquid water, indicated by gravity measurements by the Cassini spacecraft and Deep Space Communications network.

- Radio measurements of Enceladus’ gravity indicate an interior reservoir of liquid water, which may be connected to water jets gushing from fractures near the small moon’s south pole.
- The newly reported finding validates the inclusion of Enceladus among the most likely places in our solar system to potentially host life.

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Bouncing Radio Signals Off Titan Seas

• Three firsts for Cassini Radio Science (RSS)
  • First time bouncing a RSS radio signal off from Titan seas (bistatic experiment)
  • First ever detection of Ka-band echoes off of Titan during a RSS bistatic experiment
  • First radio occultations of Titan’s atmosphere with new “2-way” radio science mode

• Bistatic experiments yield information on a surface’s electrical properties, and in turn composition, and on surface roughness
• Occultations provide information on the thermal structure of the atmosphere

Note that the data presented in this Quick Nugget is minimally processed and is undergoing refinement and analysis.
Hyperion: An electron accelerator

- During a close encounter with Saturn’s moon Hyperion in 2005, data from several instruments (MAG, CAPS, MIMI) indicated that Cassini was briefly magnetically connected to the surface.
- CAPS instrument detected a beam of electrons coming from the surface of Hyperion.
- RPWS instrument detected intense plasma wave activity due to electron beam.

Explanation:
- Hyperion’s surface was electrically charged to around -200 volts by plasma from Saturn’s magnetosphere striking it.
- Low energy electrons were accelerated up to the spacecraft by the large potential difference. Cassini can remotely detect charging conditions on moons.
- Surface charging of a natural body has previously only been observed at the Earth’s Moon - first published detection in the Outer Solar System.

“Detection of a strongly negative surface potential at Saturn’s moon Hyperion” by Tom Nordheim et al.; Geophysical Research Letters.
Cassini Makes a “Shocking” Discovery at Saturn’s Moon Hyperion

- Scientists analyzing plasma spectrometer (CAPS) data from a 2005 flyby were surprised to find that small, sponge-faced Hyperion reached out across 1,200 miles to zap Cassini with a 200-volt electron beam.

- Measurements indicated a strongly negative surface potential (or voltage) on Hyperion and that low-energy electrons were accelerated up to the spacecraft by the large potential difference. There were no signs of damage to the spacecraft from the electron beam.

- Hyperion resides in a highly variable environment between Saturn’s magnetosphere and the solar wind. This active environment is likely the source of Hyperion’s surprising electrical charge.

- This is the first confirmed detection of a charged surface on an object other than our Moon. Such effects are predicted to occur on many other bodies including asteroids and comets. Strong electric charging effects could be a hazard to future robotic and human explorers of solar system objects without atmospheres, including Earth’s moon.

Cassini has provided unprecedented opportunity to track seasonal change in temperature, dynamics and chemistry at Saturn’s poles over a decade of orbital reconnaissance.

- North Pole
  - Troposphere: March 2007
  - Stratosphere: June 2014
  - Tropospheric polar cyclones (hotspots) persistent throughout mission – downwelling in polar hurricane.
  - Hexagon rotated 30° westward over 7 years, not a stationary wave after all.

- South Pole
  - Troposphere: July 2005
  - Stratosphere: October 2013
  - South pole has cooled > 35 K, dissipation of southern stratospheric vortex during autumn/fall.

Stratospheric (1-mbar) temperatures reconstructed from CIRS data. Coldest N. polar temperatures 6-8 years after winter solstice; warmest S. polar temperatures 1-2 years after summer solstice, long seasonal lag time.

Saturn’s polar regions have displayed extreme seasonal changes during Cassini’s decade-long watch:

- Saturn’s polar stratosphere features large warm vortices (a polar hood) during the summer that change substantially over last decade;
- The North Pole warmed by about 20 Kelvin (36 degrees F) during spring. Cassini is still waiting for emergence of a seasonal vortex expected to appear before end of mission;
- The South Pole cooled by about 35 kelvins (63 degrees F) during its fall;
- Shifting temperatures depend not only on sunlight, but also enormous circulation patterns.

Cassini is providing the most comprehensive view ever obtained of seasonal change on a giant planet. Long-term observations are filling significant gaps in our knowledge of fundamental meteorology and chemistry of giant planet atmospheres.

Under normal solar wind conditions Titan is inside Saturn’s magnetopause and bow shock and interacts with the planet’s rotating magnetosphere.

Under extreme solar wind conditions, the bow shock and the magnetopause retreat inside Titan’s orbit and the moon is in the supersonic solar wind.
As a result of the exposure to a supersonic flow, Titan generates a bow shock ahead of its induced magnetosphere. For the first time in 9 years, Cassini observed Titan in the supersonic solar wind and detected a collisionless bow shock.
Titan is nearly always within Saturn's magnetosphere, the vast bubble created by the giant planet's magnetic field. Cassini caught Titan outside that protective magnetic bubble during a flyby on December 1, 2013. A strong surge in solar activity had blown back the sun-facing side of Saturn's magnetosphere, leaving the un-magnetized body of Titan exposed to the raging stream of energetic solar particles.

Cassini scientists have concluded that Titan behaves much like other un-magnetized bodies, including Venus, Mars, and comets, when exposed to the raw power of the solar wind. This leaves Titan unprotected and its atmosphere directly interacts with the undiluted solar wind.

This is not the case at Earth, where the powerful magnetic field acts as a first line of defense against the solar wind, helping to protect our atmosphere from being stripped away.

The finding adds significantly to our understanding of how the sun interacts with magnetized versus un-magnetized solar system bodies.

"Titan's Interaction with the Supersonic Solar Wind,"
Write your Own Nugget!

• Apply the Nugget Rules of Thumb to create your own nugget

• Have another audience member review/edit your nugget

• Be creative! This is part of your advertising effort – make it look attractive so people will actually want to read it!

• Current NASA Template:
  - <insert link to template>

• Cassini Examples:
  - Cassini_Nugget2014.pdf
  - Cassini_Nugget2013.pdf
Cassini/VIMS spectra from the storm head reveal that storm cloud particles are composed of a mixture of at least three materials.

Two alternate models both require ammonia ice and water ice to obtain accurate fits to observations.

The presence of water ice at visible cloud levels requires powerful convection to loft materials from more than 200 km below.

The monster storm that erupted on Saturn in late 2010 has already impressed researchers with its intensity and long-lived turbulence. Now, scientists studying near-infrared data from NASA’s Cassini spacecraft have found that the storm churned up water ice, not normally present in the uppermost clouds, from deep within Saturn’s atmosphere. This finding is the first detection of water ice in Saturn’s atmosphere.

- The visible-light image (left) from Cassini’s imaging camera shows giant storm clouds on Feb. 25, 2011.
- The infrared image (right) and spectrum (middle) was obtained a day earlier by Cassini’s Visual and Infrared Mapping Spectrometer (VIMS). Together, they show water and ammonia ices dredged up from deep within Saturn’s atmosphere.
- The presence of water ice at visible cloud levels requires powerful convection to loft materials from more than 200 km below.

Embedded moonlets ("propellers") puff up ring material

The new model explains why the puffed up "cloud" of ring particles (260m high) is much shorter along the orbit direction than the usual "two-lobe" channel cleared out by the object and others like it. This model also explains a mystery feature seen at the outer edge of the B Ring, as a similar embedded object.

Encke gap (320 km wide)

"Earhart" (1/2mile size) near equinox

A new light scattering model allows for gravitational scattering and collisional damping of ring particles by a "propeller" (P), predicting the shape of its shadow.

Reprojected images of Earhart

Shadow model superposed on two images

Frank: we may not usually give a citation but there may be room for it here
Cassini scientists estimate small, hundred-meter-size moonlets in the millions could be embedded in Saturn’s Rings. Elongated, propeller-shaped features in the rings are actually clearings in the rings created by these moonlets. Now, the geometry of the shadows cast in Saturn’s rings reveals how these unseen moonlets puff up the surrounding ring particles.

A new light-scattering model allows for gravitational scattering and collisional damping of ring particles by a “propeller” (P), predicting the shape of its shadow.

The new model explains why the puffed up, 850 foot-tall “cloud” of ring particles is much shorter along the orbit direction than the usual channel cleared out by the object and others like it.

“The Shadow Knows: Vertical structures induced by embedded moonlets in Saturn’s rings: the gap region,” Holger Hoffmann, Frank Spahn, Martin Seiβ, August 2013; Source: arXiv
New analysis* of Cassini data sheds light on how the heavy, complex hydrocarbon aerosols that make up Titan's haze layers form out of the simpler molecules high in the atmosphere. Now that the chemical lineage of these complex aerosol molecules has been identified, the longevity of Cassini’s mission, through 2017, will make it possible to study their variation with Titan’s seasonal change.

The presence of complex, ringed hydrocarbons known as polycyclic aromatic hydrocarbons (PAHs) explains the origin of the aerosol particles found in the lowest haze layer that blankets Titan's surface.

Sunlight and electrically charged particles in Saturn’s magnetic environment break up nitrogen and methane molecules at about 600 miles (1,000 kilometers) altitude in Titan’s atmosphere. This results in the formation of massive positive ions and electrons, which trigger a chain of chemical reactions. A variety of hydrocarbons are produced this way, many of which have been detected by Cassini instruments in Titan's atmosphere. Eventually, these reactions lead to the production of carbon-based aerosols, large aggregates of atoms and molecules that are found well below 300 miles (about 500 kilometers) altitude in Titan’s haze.

PAHs are thought to have played a role in the formation of life on Earth. The role of PAHs in Titan’s complex atmospheric chemistry one reason why Titan is of interest to astrobiologists.
Cassini Finds Titan’s Smog Begins with Chemical Reactions High in the Atmosphere

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- Sunlight and electrically charged particles in Saturn’s magnetic environment break up nitrogen and methane molecules at about 1,000 km (600 miles) altitude above Titan. Massive positive ions and electrons form, triggering a chain of chemical reactions. A variety of hydrocarbons are produced this way and many have been detected by Cassini’s instruments.

- The reactions lead to the production of carbon-based aerosols, large aggregates of atoms and molecules that are found well below 500 km (300 miles) altitude in Titan’s haze.

- How these aerosols vary with seasonal change on Saturn will be one focus of Cassini’s mission through 2017.


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Is Titan’s Methane Cycle Temporary?

Titan’s fascinating methane chemistry, its lakes, rain and hydrocarbon dunes, may be just a temporary anomaly, geologically speaking.

- A gigantic outburst of methane may have been released eons ago, possibly after a huge impact. This would have led to Titan’s current global smog haze and its continent-size hydrocarbon sand dunes, according to a new model* based on data from NASA’s Cassini mission.
  - A comet impact or global resurfacing by cryovolcanic activity could have caused such a release.
- The new model indicates that methane is not being replaced fast enough to sustain Titan’s methane cycle. In Earth’s water cycle, water continuously migrates from the surface to the atmosphere and back again. But it appears that Titan’s methane rises into the atmosphere on a one-way trip to destruction.
  - Sunlight is destroying Titan’s methane, and the data indicate it’s not being replaced, so Titan’s “methane era” may one day draw to a close.
- Over time, the destruction of methane by sunlight will reduce the overall amount of methane in Titan’s environment while sand, seas and lakes derived from its destruction will continue to accumulate on the surface.

*Observations of Titan’s Northern lakes at 5 microns: Implications for the organic cycle and geology,” C. Sotin et al., Icarus, 2012
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Eye Spied: Saturn’s Behemoth Polar Hurricane

Stunning new views from NASA’s Cassini spacecraft reveal the eye of an enormous hurricane locked in place at Saturn’s north pole.

In this false color image, red indicates deep clouds, while green shows clouds that are higher in altitudes. The Sun is to the right in this image.
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~1250 Km
Cassini’s Composite Infrared Spectrometer (CIRS) Team detected a new molecule, propylene (propene), in Titan’s upper atmosphere.

First definitive identification of propylene gas in a planetary atmosphere outside Earth.

Propylene is an important raw material for our chemical industry used to make polypropylene, a durable plastic that is molded into food storage containers.

Detection of Propene [Propylene] in Titan’s Stratosphere