# SkyWAAtch

*The Newsletter of Westchester Amateur Astronomers*

## *January 2019*


### *Comet 46P/Wirtanen by Mauri Rosenthal*

*Mauri writes:* On December 10th the weather was good enough to image Comet 46P/Wirtanen. While this comet returns roughly every 5 years, the 2018 visit included a relatively close approach and hopes were high for naked eye viewing. So far, though, the comet has shown no tail and was difficult to spot, even with binoculars. I imaged the comet as it coursed through Cetus. I used a Borg 55FL astrograph, an IDAS LPS-V4 filter, and ZWO ASI1600MC camera on an iOptron CubePro 8200 mount. This image uses 1.25 hours of data during which the comet moved through the center of the frame. PixInsight processing was used to create this composite image with the comet and background stars frozen in place. As with other comets, the green color shows the presence of carbonaceous gases sublimating from the frozen core. I made a video that you can see at https://www.flickr.com/photos/124244349@N07/46296721871/in/dateposted/.

## WAA January 2019 Lecture

**Friday, January 11th, 7:30pm**

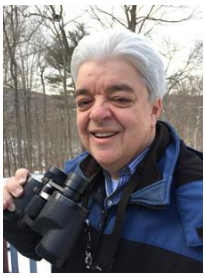
**Lienhard Hall, 3rd floor**
**Pace University, Pleasantville, NY**

### Head-Turning Celestial Sights, 2019-2022

### Joe Rao

In the aftermath of the "Great American Solar Eclipse of 2017," many were led to believe that there would be no more "astronomical spectaculars" until the next total solar eclipse over the US in 2024. In this talk, however, Joe Rao will explain that there are several celestial occurrences that are coming our way between now and 2022 that more than qualify as "head-turning" events. In fact, a couple of cases are literally once-in-a-lifetime sky shows. And the best thing of all is that you won't need to make any arduous (or expensive) journeys to remote parts of the world: all of these events are accessible from our own backyards.

Now if he can only guarantee good weather...



Speaking of weather, Joe Rao is an 8-time Emmy nominated broadcast meteorologist. Last June he celebrated his 40th anniversary in broadcasting, having started out in radio and later (in 1995) going full time on television as Chief Meteorologist at News 12 Westchester. At the end of 2016, Joe made the switch to Verizon Fios1 News where he is based today. Joe is also an assiduous amateur astronomer, having been actively involved in astronomy for over 50 years. Since 1986 he has served as an Associate at the Hayden Planetarium and is currently a Contributing Editor for Sky & Telescope. He also writes about astronomy and space for the online news service Space.com, as well as for Natural History magazine and The Farmers' Almanac. In 2008, Joe was the recipient of the Solar Physics Division Popular Writing Award of the American Astronomical Society and in 2009 received the prestigious Walter Scott Houston Award from the Northeast Region of the Astronomical League.

**Pre-lecture socializing with fellow WAA members and guests begins at 7:00 pm!**

## WAA February 2019 Lecture

**Friday, February 1st**
**7:30 pm, Pace**

### What's New on Mars?

### Br. Robert Novak
### Iona College

**Call: 1-877-456-5778 (toll free)** for announcements, weather cancellations, or questions. Also, don't forget to visit the WAA website.

## Starway to Heaven

### Ward Pound Ridge Reservation, Cross River, NY

There are no scheduled Starway to Heaven observing events for December, January or February. Our monthly star parties will resume at Ward Pound Ridge Reservation in March 2019.

## Renewing Members

| | |
|---|---|
| Robin Stuart | Valhalla |
| John Higbee | Alexandria, VA |
| Byron Collie | Croton on Hudson |
| Winston Archer | Yonkers |
| Warren Lindholm | Cortlandt Manor |
| Steve Miller | Waccabuc |
| Kevin Doherty | White Plains |
| Mayan Moudgill | Chappaqua |

Westchester Amateur Astronomers

### Also In This Issue

# ALMANAC For January 2019

## Bob Kelly, WAA VP for Field Events


Jan 5


Jan 14


Jan 21


Jan 27

In January, Venus draws attention to Jupiter and Mercury in the morning sky. Watch the Midnight Supermoon Total Lunar Eclipse during the night of January 20-21. Mars stands out in the southwestern sky in the evening.

The Midnight Supermoon Total Lunar Eclipse is deepest at 12:12 am EST on the night of January 20-21 and lunar perigee occurs at 3 pm. See the next page for more details. Some people have a Monday holiday to recover some sleeping time. Beware of higher than normal tides from the 20th through 23rd, especially if a nor'easter passes by. The largest full moon for 2019 will be in February.

Happy Gregorian Calendar New Year! Near Midnight on New Years' Day, New Horizons will pass a tiny denizen of the Kuiper Belt, originally named 2014 $MU_{69}$ but now called Ultima Thule. Information from New Horizons takes six hours to travel back to Earth at the speed of light. The spacecraft can't talk and take photos at the same time, so around 10:30am EST, an "I'm OK" tone will be the first word that the craft survived the encounter. First data may arrive mid-afternoon. It may take as long as 20 months for all the data from the encounter to get to Earth.

Venus holds its brilliance in the pre-sunrise sky and plays traffic cop for the other planets. The Morning Star reaches its furthest elongation from the Sun on the 6th. From the 20th to the 25th, Jupiter passes Venus – look for several days of a striking paring of the brightest planets in our morning sky. Our Moon joins the scene on the 30th and 31st. Venus will appear to drift lower each week, but will hang on, low but bright, into May. The planet will be half-lit in the first week of January, becoming gibbous with time, but appearing smaller in a telescope. A photo now and again will make a nice set of comparison shots as Venus' phase changes.

Mercury starts out January halfway between Jupiter and the Sun in the morning sky, only 10 degrees above the horizon at sunrise. The innermost planet is tiny but almost fully lit at magnitude minus 0.5.

It would be a good year for the Quadrantids meteor shower, with no moon to dazzle our eyes and a hundred meteors an hour possible at the peak. However, the shower peaks at 9pm on the 3rd for the USA and tapers off quickly. There may not be many left by the time we plow face-forward into the meteor stream after midnight.

Mars is small and bright, like a leftover holiday ornament hanging up in the southwestern sky after sunset. It's the brightest object in that neighborhood of the sky. In a telescope, Mars shows little detail, but is noticeably out of round at 88 percent sunlit. The moon passes by to point it out on the 9th.

Uranus is hiding in the evening sky to the upper left of Mars in the dim stars of Pisces. If you can hop to it, it's worth a look. In a telescope, it's definitely a disc, unlike the surrounding point-like stars. Neptune has lost its Martian red laser pointer star. It's in Aquarius to the lower right of Mars halfway to horizon.

Saturn is in conjunction with our Sun on the 2nd. It drifts through the SOHO C3 field of view during the first week of January. Mercury zips by at the end of the month, at superior conjunction on the far side of the Sun on the 29th.

Latest sunrise is January 4th. [Why not December 21st? Can you figure it out?] By then, sunset is already 10 minutes later than in early December, giving hope to evening commuters. We are closest to the Sun for 2019 on January 4th. At 91.4 million miles away, we're 3 percent closer than at our apogee on July 4th. For the record, there is a partial solar eclipse for the North Pacific on January 6th.

The International Space Station has three souls on board, with more expected in February. It is visible in the morning sky through the 14th and in the evening sky after the 19th. Check your favorite satellite-finding app for updated times and to look for photo ops with our moon and bright planets. ■

**WAA Members: Contribute to the Newsletter!**
Send articles, photos, or observations to
waa-newsletter@westchesterastronomers.org

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Editor: Larry Faltz
Assistant Editor: Scott Levine
Editor Emeritus: Tom Boustead

# Supermoon Total Lunar Eclipse Sunday-Monday January 20-21 2019

## Bob Kelly

The full Moon on the night of January 20th will be sliding through the northern part of the Earth's shadow, our Moon's cratered southern edge never quite getting to the center of the Earth's shadow. There may be a large difference in color from reddish on the southern part of the moon to a bright northern edge that almost seems to be outside the shadow. As a preteen in the late 1960s, I cried when my parents made me come in half-way through an eclipse just like this one. I thought (wrongly) that the moon hadn't reached totality; so don't be disappointed if it the moon never seems to appear totally dark.

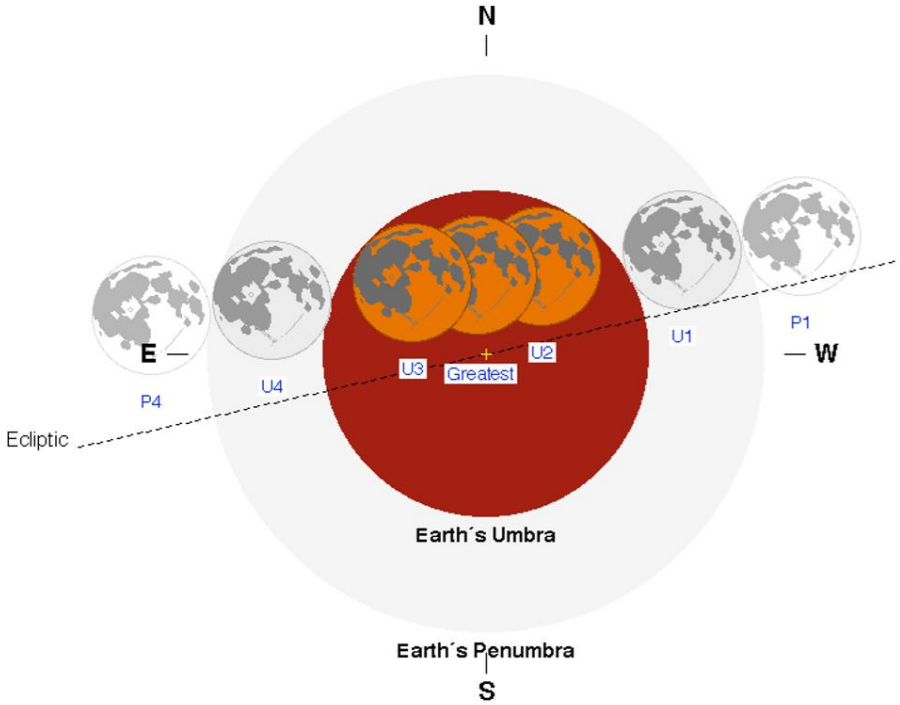
The eclipse is maximum just 15 hours before the moon is closest to Earth for January. High in the southern sky, the Moon will not look noticeably larger than usual. In fact, the optical illusion of the moon looming over the horizon dissipates when we crane our necks to see the moon stuck like a piece of gum high on the celestial sphere. That night, we'll follow it from the start of the partial lunar eclipse at 10:34 pm EST at 61 degrees above the southeastern horizon to the deepest eclipse at 12:12 am 69 degrees high in the south.

This won't be a look-out-your-window eclipse unless you have a skylight in the direction of the Moon or a car with a Moon roof (Will a sun roof work as well?). This is a get dressed, get out in the middle of the night, find the Moon, lay back and watch as your eyes pick up fainter stars while the moonlight turns down like on a rheostat to a reddish glow. Around 10 pm, the Earth's shadow will be a light gray shading on the southeastern quadrant of the moon. After 10:30 pm darkness descends on the edge of the moon and engulfs the disc through midnight and edges off the moon just before 2 am.

Use a lounge chair to aim yourself at the moon and a sleeping bag to keep warm as the dew condenses on you. No optical aid is needed, but a pair of binoculars can give an even better view.

The rest of North and South America will see the eclipse at the same time – just adjust the times for the other time zones.

The next total lunar eclipse visible from the eastern United States won't be until May 15/16, 2022. ■




Eclipse durations

| | |
|---|---|
| Penumbral | 05h 11m 30s |
| Umbral | 03h 16m 45s |
| Total | 01h 01m 59s |

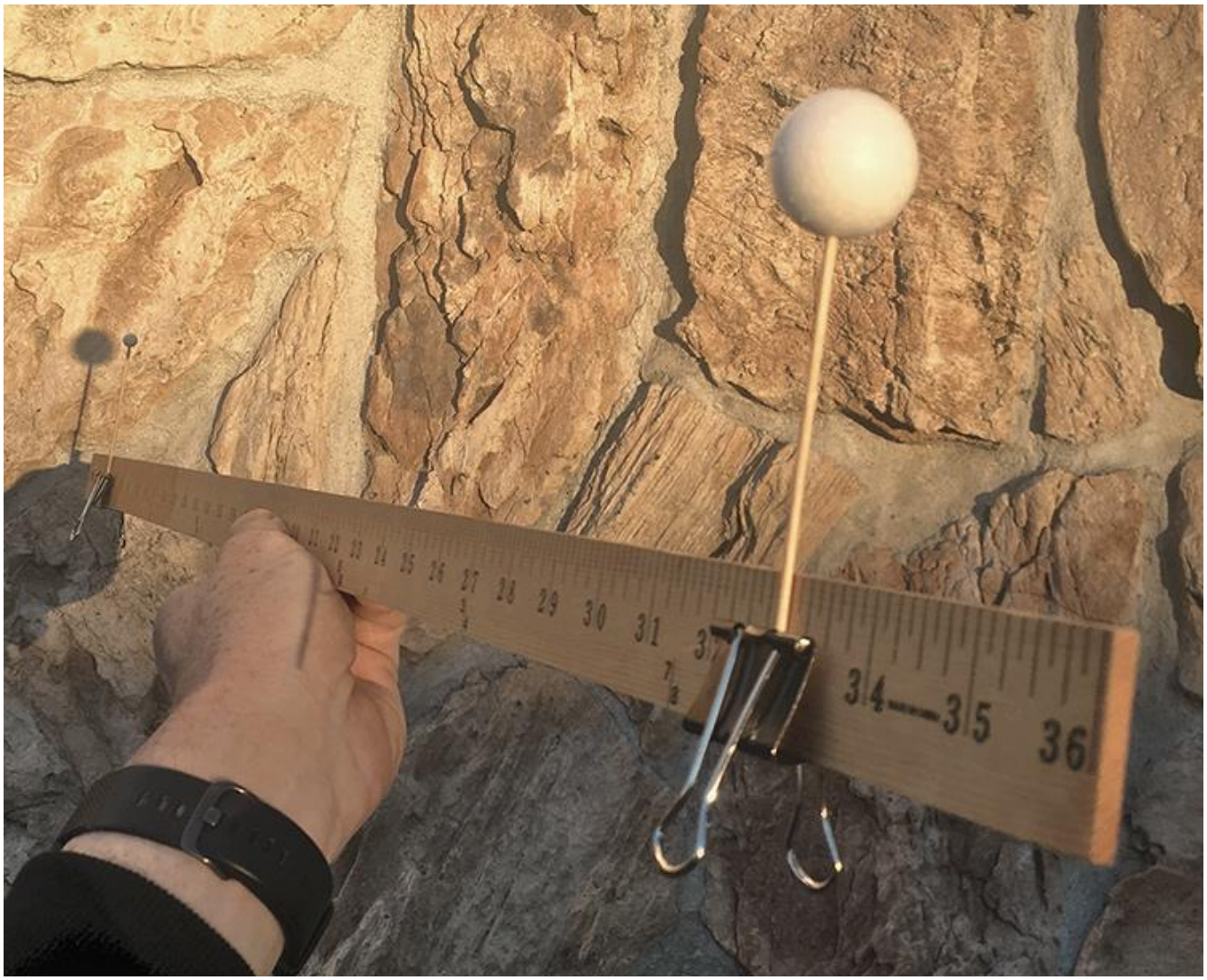
Eclipse contacts (EST)

| | |
|---|---|
| P1 | 09:36:30 pm |
| U1 | 10:33:54 pm |
| U2 | 11:41:17 pm |
| U3 | 00:43:16 am |
| U4 | 01:50:39 am |
| P4 | 02:48:00 am |

Eclipse Predictions by Fred Espenak, NASA's GSFC

## From the NASA Night Sky Network

**Make your own Lunar Eclipse!**




Have you ever wondered how eclipses occur? You can model the Earth-Moon system using just a couple of small balls and a measuring stick to find out! The "**yardstick eclipse**" model shown here is set up to demonstrate a lunar eclipse. The "Earth" ball (front, right) casts its shadow on the smaller "Moon" ball (rear, left). You can also simulate a solar eclipse just by flipping this model around. You can even use the Sun as your light source! Find more details on this simple eclipse model at **bit.ly/yardstickeclipse**.

Philosophy is written in this grand book—I mean the universe—which stands continually open to our gaze, but it cannot be understood unless one first learns to comprehend the language and interpret the characters in which it is written. It is written in the language of mathematics, and its characters are triangles, circles, and other geometrical figures, without which it is humanly impossible to understand a single word of it; without these, one is wandering about in a dark labyrinth.

Galileo Galilei, *Il Saggiatore* (*The Assayer*, 1623)

## WAA Annual Meeting, December 7th

WAA held its Annual Meeting (a requirement of its not-for-profit corporate status) on December 7th, electing officers for 2019. The new officers are:

| | |
|---|---|
| President | Paul Alimena |
| Sr. Vice President | Charlie Gibson |
| Secretary | Rich Steeves |
| Treasurer | Doug Baum |
| VP Programs | Pat Mahon |
| VP Field Events | Bob Kelly |
| VP Membership | Eva Andersen |
| VP Communications | Frank Jones |
| VP Newsletter | Larry Faltz |
| Nominating Committee | Bill Newell, Larry Faltz |
| Audit Committee | Darryl Ciucci, Joe Geller |

At the meeting, outgoing President Larry Faltz reflected on the current state of the club. WAA has become financially secure with several years' operating expenses in reserve while holding dues at just $25 (for several decades!). We've been able to do this by growing membership, with the number of members increasing from 120 to 200 in the past 5 years, coupled with frugal management, as well as the wonderful generosity of Pace University and Matt Ganis, who provide our meeting space, and the Westchester County Parks Department and Ward Pound Ridge Reservation for hosting our viewing events. We attract members through our regular programs and outreach events around the county. We've also recruited new members by simply being responsive to the public at our events and to individuals who contact us to request help with new telescopes, or even just for information about astronomy. What ties it all together is effective communication through emails, the newsletter, our telephone hot line, occasional items in the local press, word of mouth, and most of all the enthusiastic participation of our members.

The importance of communications was recognized by amending our Bylaws to create a Vice President for Communications. Long-time WAA member Frank Jones will take on this important responsibility to ensure that we continue to keep members informed and that we respond promptly to requests for information or assistance from members and the public.

In addition to our elected officers, we have an Advisory Board whose members are invited to Board meetings to discuss issues and help carry out the functions of the club. Our thanks to Karen Seiter, Jeffrey Jacobs, Olivier Prache, Dede Raver, Satya Nitta, Darryl Ciucci, Mike Lomsky, Robert Novak, Tim Holden, Hans Minnich, Mike Cefola, Bill Newell, Eva Andersen, Richard Steeves, Matt Leone and Dan Cummings for their support and wise counsel.

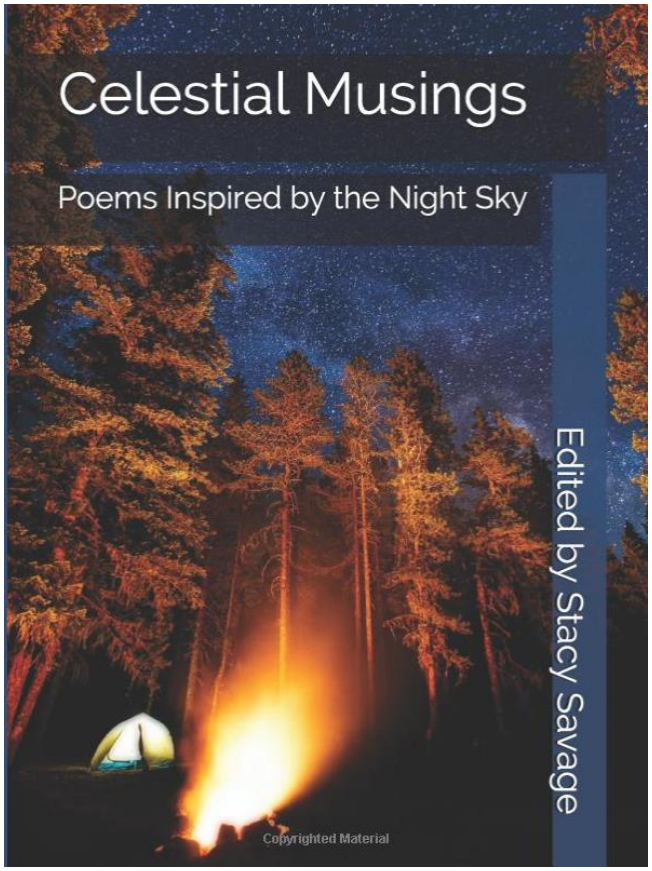
Our lecture series in 2018 featured some remarkable speakers, among them David Mestre from the Discovery Museum on the remarkable Greek computing device the Antikythera Mechanism, Brother Novak updating us on Mars, Carter Emmart from the American Museum of Natural History/Hayden Planetarium driving us around the surface of the moon and Mars, Alex Teachey from Columbia on his discovery of the first exomoons, WAA's own Satya Nitta on artificial intelligence and astronomy, Jon Morse, CEO of BoldlyGo and former NASA scientist on prospects for lunar telescopes, and Andrew MacFadyen from NYU on gravitational waves. We had some great star parties even though we had to cancel more events than we would have liked (which would be true if we had to cancel only 1!). Our booth at NEAF was staffed by almost 20 members. We held outreach events at Nevis Labs, Somers Library, Harrison Library, Our Lady of Mt. Carmel Church in Elmsford and Draper Park in Hastings-on-Hudson. Members observed and imaged at Ward Pound on non-star party nights through the special use permit with the park that was negotiated in 2017 (advance notice and club ID required). We published our newsletter monthly thanks to the contributors and especially Tom Boustead, who has so ably edited the journal for 12 years and now deserves honored status as Editor Emeritus. Get set for another great year in 2019. ■

**2019 Calendar**

| Lectures (Fridays) | Star Parties (Saturdays) (Make-up date is the following week) |
|---|---|
| January 11 | March 2 |
| February 1 | March 30 |
| March 1 | April 27 |
| April 5 | June 1 |
| May 3 | June 29 |
| (No meeting June, July, August) | July 27 |
| September 13 (Members' Night) | August 24 |
| October 4 | September21 |
| November 1 | October 19 |
| December 6 (Annual Meeting) | November 23 |

NEAF (Northeast Astronomy Forum): April 6-7 (Rockland Community College)

## Poetry of the Night Sky




The night sky has always been an inspiration to artists, writers, poets and composers. Among the inspired is WAA member Ann Cefola, whose poetry often muses on the natural world. Ann recently contributed three poems to a new anthology, *Celestial Musings: Poems Inspired by the Night Sky*.

Ann is the author of *Face Painting in the Dark* (Dos Madres Press, 2014), St. Agnes, *Pink-Slipped* (Kattywompus Press, 2011) and *Sugaring* (Dancing Girl Press, 2007) and translator of Hélène Sanguinetti's *Hence this Cradle* (Seismicity Editions, 2007). She received a Witter Bynner Poetry Translation Residency at the Santa Fe Art Institute and the Robert Penn Warren Award judged by John Ashbery. Her work has appeared in journals such as *Feminist Studies* and *Sugar Mule*, and her translations in journals such as *Eleven-Eleven*, *Exchanges* and *Inventory*.

Blue Moon

Light deflected: The snow's
mirror angles over trees
like low-flying egret.
It creeps through blinds
saying, Don't sleep.

For you, I abandon
my translucent calluses
and nails painted nude-pink.
I leave the soft porcelain girl,
breathing evenly, behind.

Homeless solar ray, I want
to peer in windows and rattle the insane,
my pale gaze turn icicle to flame,
draw long shadows in snow,
freeze random glass panes.

Sticking like dry ice,
my touch's blue powder.
Best avoid my aluminum glance:
see how I burn white-hot,
I spiral outward.

Anne Cefola

*Celestial Musings: Poems Inspired by the Night Sky* is now in print. The proceeds from the book will benefit the Charles W. Brown Planetarium at Ball State University. The book is $12 per copy if you order through Amazon. To order through Amazon, click on the link below.

https://www.amazon.com/dp/1791345964/ref=sr_1_2?s=books&ie=UTF8&qid=1545077252&sr=1-2&keywords=celestial+musings ■

## *In the Naked Eye Sky*

# January 2019: On Triangles, and Hexagons, and Flying Space Robots

### Scott Levine

Once the holidays move out, winter can seem endless and bleak. We deserve a long stretch of petering-out, a gradual transition out of merriment and time to slow down; extra soup, please.

The skies, help, though. This time of year, our nights face a stretch of the galaxy with a bunch of the sky's brightest stars. Thankfully, astronomers make things easy and cordon stars off into easy-to-find geometric shapes: The various seasonal triangles; the Great Square of Pegasus; the Winter Hexagon.

The great thing about these asterisms – these loose and unofficial, but recognizable groups of stars – is we can make up our own, all we want. I like to look for triangles, too. One of my favorites is within the Winter Hexagon, on its northern and eastern side; to the left as we face it. Let's skip all the stars in Orion, and give the attention to some other, off-brand stars.

On the Hexagon's edge, near the big-name, yellow Capella (α Aur) is **Menkalinan** (**β Aur**), a second-magnitude star about 80 light years away. Its name comes from Arabic word for shoulder, and it represents Auriga the charioteer's arm. Like so many others, what we see as one star is two. In this case, it's an eclipsing binary pair. They orbit each other invisibly other than a slight dimming and brightening about every three days.

From there, it's a fun hop to second-magnitude **Alhena (ν Gem)**, about 105 light years away. Alhena is an interesting one to spot. In Westchester's often exhausted-looking skies, it seems to sit almost in the middle of nowhere, quite a way from the next nearest bright star. It's Gemini's third brightest and forms the foot or knee of Pollux.

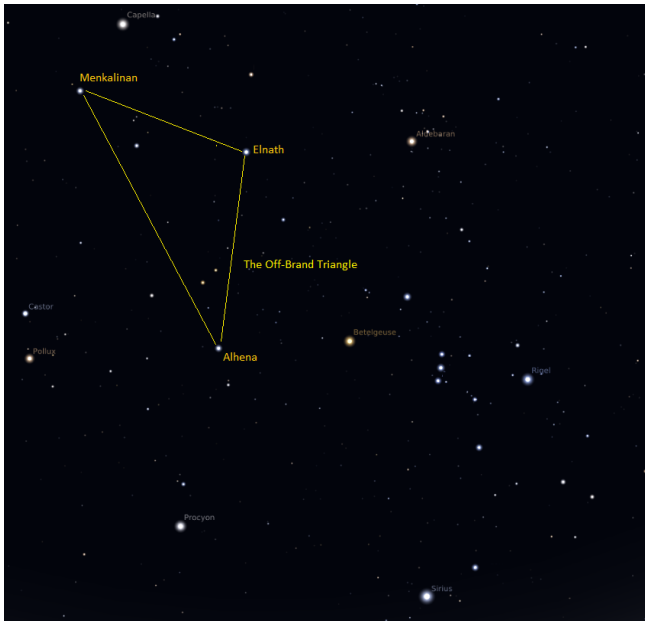
Finally, let's head back up to **Elnath** (**β Tau**), the bull's horn, about 130 light years away. For much of its history it was considered part of Auriga and Taurus, and you might see it listed in both. If you have a pair of binoculars or a telescope, there are quite a few deep sky clusters and nebulas in that part of the sky.

Elnath is one of my favorites because that spot is almost directly opposite the direction toward the center of our galaxy. If you turn around and face the other way, you'd be looking in toward the middle of the Milky Way.

With that one small act, that one turn, you can see the stars of winter and autumn speed across the sky in front of you. Six months of life rush by — Halloween, Thanksgiving, meteor showers, hot dogs, cannonballs, fireworks — before you stop and look toward Sagittarius, the archer. Out that way, tiny New Horizons is speeding away, going somewhere out toward the icy fringes of the solar system beyond Pluto and 2014 MU69.

Take it slow and enjoy watching the story unfold. When you get to the other side, Sagittarius will be below the horizon, but you'll see **Deneb** (**α Cyg**), the last of the Summer Triangle's stars; the brightest in Cygnus. It's still there, just above the horizon, reminding you of where you've been and where you're going.

What other asterisms can you sketch out? I hope you'll take a look. ■




Scott Levine's astronomy blog, *Scott's Skywatch*, can be found at
https://scottastronomy.wordpress.com/author/scottlevine13/

# Geoengineering: Good for the Earth? Bad for Astronomy?

## Larry Faltz

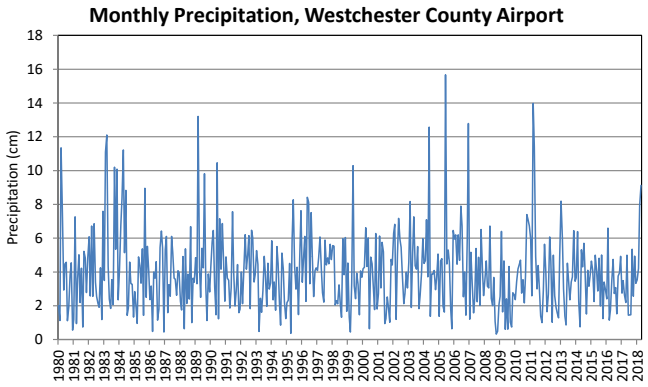
Being an amateur observer seems to be getting more difficult by the year, and I'm not just talking about my aging eyes. Old-timers in WAA talk wistfully of the darker skies of the early 1990's at our star party site at the Ward Pound Ridge Reservation. The darkness inevitably gave way to development in northern Westchester with its inevitable increase in lighting for safety and business activities. The switch from sodium vapor street lights to broad-spectrum LEDs means astronomers can't use "light pollution reduction" filters to eliminate the sodium and mercury lines that are of little astrophysical interest to preserve the valuable parts of the spectrum, primarily hydrogen-alpha and oxygen III. Most new fixtures use continuous-spectrum LEDs that have a lot of longer blue wavelengths. Blue light is scattered more efficiently by nitrogen and oxygen molecules in the atmosphere because scattering is inversely proportional to the $4^{th}$ power of the wavelength. Reducing light pollution is best addressed through advocacy by joining the International Dark-Sky Association and addressing issues in an organized way with local government and businesses. While light pollution is annoying, it's not fatal for the enjoyment of the night sky even though it reduces contrast and makes faint objects harder to see. It may be an inconvenience, but you can plan ahead and travel to darker sites.

We don't cancel events because of light pollution, of course, but because of bad weather. Almost always, that's due to clouds (with or without rain) and on rare occasions because of extremely cold weather at the margins of the viewing season. Both of our Saturday star party dates in November had clear skies but steady winds above 10 miles per hour with gusts over 20. In these conditions, telescopes of every design shake beyond anyone's ability to get a satisfactory view. That resulted in a rare wind-related cancellation. Even without the wind, we seem to have had to cancel more star parties and outreach events than in previous years. Don't worry: we're going to keep trying!

It's a fact that climate change is real, the Earth is warming,[1] and it's the result of human activity. It's a conclusion based on hard science and a vast number of consistent, objective findings. Disbelievers are fantasists, or worse. The Earth is round, the Apollo astronauts really did walk on the moon, vaccines protect public health and they have lower risks to vaccinated individuals than the diseases they prevent. As Neil deGrasse Tyson once said, "The good thing about science is that it's true whether or not you believe in it."

A warmer atmosphere has a higher water vapor capacity, and if it does we should expect more clouds. I searched for information about whether our area is becoming cloudier. There's a huge amount of climate information on the web site of the National Centers for Environmental Information.[2] There are many searchable data sets, as well as summary data describing trends over the last 100 years. They don't collect information on how many astronomy club star parties are cancelled,[3] but there's a lot of data on temperatures, precipitation, winds and snow cover. Some weather stations do measure cloudiness over 24-hour periods.

I found monthly rainfall amounts at Westchester County Airport for the period January 1980 to October 2018, perhaps an indirect measure of cloudiness, but it didn't seem to show a trend.



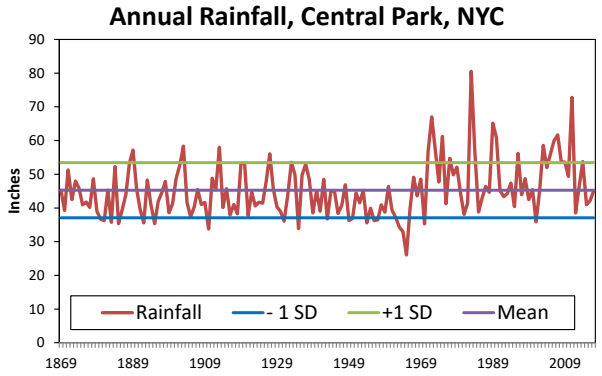

Maybe the timeline wasn't long enough. There's a difference between weather and climate, something many people don't seem to or want to understand.

[1] Read the 2018 Intergovernmental Panel on Climate Change report "Global Warming of 1.5° C" at https://www.ipcc.ch/sr15/

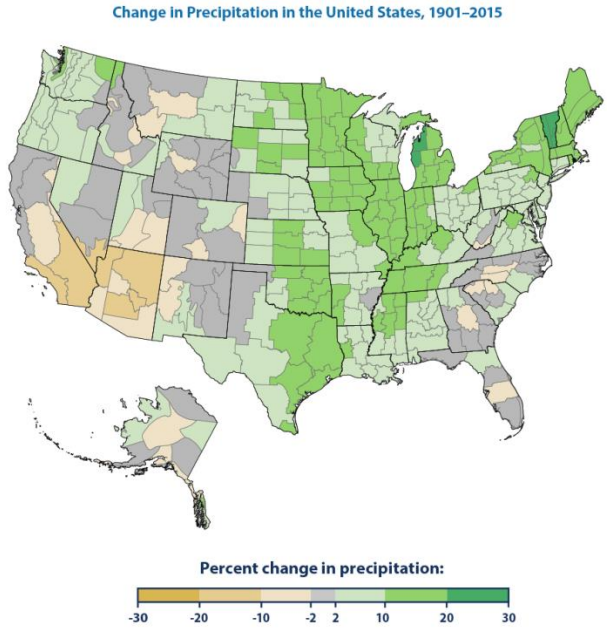
[2] https://www.ncdc.noaa.gov/

[3] WAA isn't the only club thinking about this problem. As an example of the buzz among amateurs, see this thread on CloudyNights: https://www.cloudynights.com/topic/630921-is-2018s-weather-bad-all-over/

I downloaded and plotted annual rainfall amounts in Central Park from 1869 to 2017, and there does seem be a recent trend towards more precipitation.



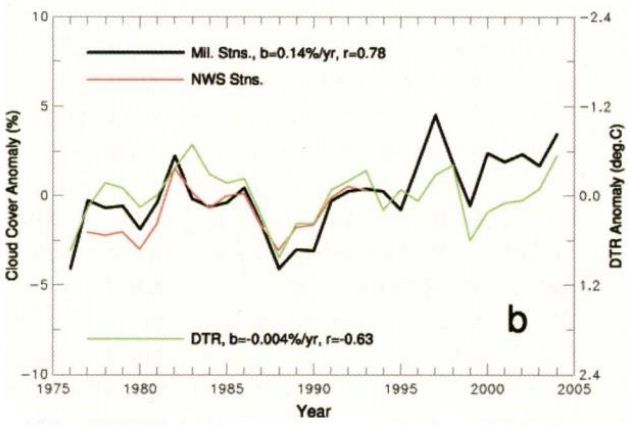

This is consistent with data that shows that over the last century, the Northeast and Midwest have seen an increase in precipitation while Southwest has seen a decrease.




So, if it rains more, there are probably more cloudy days (and nights). This is still indirect evidence. A measure of actual cloudiness would be more helpful.

In 2017, a Swedish amateur astronomer gathered cloud cover data for Stockholm from 1961-2016.[4] He was able to show a trend towards increased cloudiness over that interval, although the data might not pass rigorous tests for statistical significance.

In a 2006 study of cloud cover data from military weather facilities published by the American Meteorological Society,[5] Dai et. al stated that "Upward trends of total cloud cover from the late 1970s to 2004 are seen at many of the 124 military stations within the contiguous United States that have continuous human observations." A representative graph from the paper, showing a clearly rising trend, illustrates this point.




Beginning in the 1960's, reducing air pollution was the goal of energy policy. American cities and industrial areas were bathed in "smog," visible air pollution composed of nitrogen oxides, sulfur oxides, ozone, smoke and other particulates. It became evident that air pollution had serious health consequences including asthma and lung cancer. Reducing lead, sulfur and particulate emissions from automobiles was expensive: unleaded gas cost more, auto emission controls added hundreds of dollars to manufacturing and maintenance costs. Devices like exhaust gas recirculators and catalytic converters often made the cars run poorly. People wanted "muscle cars", not small, fuel-efficient (mostly foreign) vehicles. Reducing emissions from power plants and building furnaces was very expensive and cut into profits. There was substantial opposition from both business and government. Back around 1967, as the first serious attempts were made to combat the problem, I recall NYC Mayor John Lindsay being asked on a TV interview program what the city was going to do about it, which was fundamentally nothing for lack of funds. He tried to dismiss the problem with a cynical New York wisecrack, saying "I don't trust air I can't see." With the advent of the Environmental Protections Agency 1970 effective pollution controls were finally implemented. There's no question that the amount of air pollution in

4 https://epistulaeastronomicae.wordpress.com/2017/03/26/the-curse-of-cloudiness-and-climate-change/

5 https://journals.ametsoc.org/doi/pdf/10.1175/BAMS-87-5-597

US cities has been vastly reduced. Formerly smog-bound metropolises like Los Angeles now only have choking haze when there are forest fires in the region. However, reducing particulate pollution didn't have any effect on the production of carbon dioxide, and as world energy usage from coal and oil increased, atmospheric $CO_2$ levels rose, amplifying the greenhouse effect. Solar energy comes in, but it can't be reflected out as efficiently as before. Temperatures rise and the climate changes, not for the better.

Sunlight heats the atmosphere and the Earth. Atmospheric $CO_2$ traps heat. As polar sea ice melts, the Earth's surface becomes darker and less solar radiation is reflected back to space. More heat is retained. On a hot day, do you want to wear a dark shirt or a white one? As temperatures rise, arctic permafrost thaws, releasing methane ($CH_4$), another powerful greenhouse gas. The cycle is repeated.

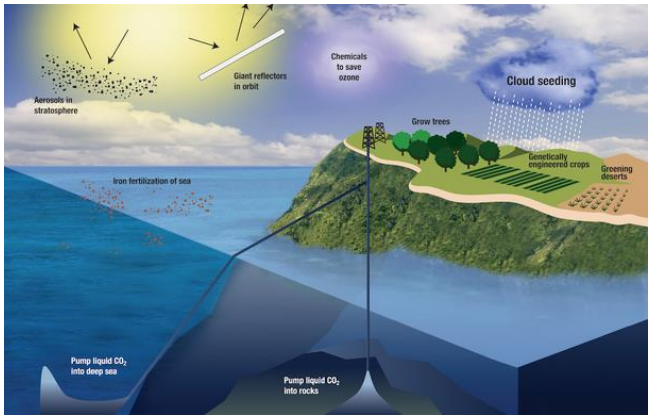
The Fourth National Climate Assessment,[6] released on the Friday after Thanksgiving 2018, paints a sad picture of the near future. It predicts vastly disruptive economic, biologic and societal impacts from unrestrained global warming as soon as 2040. It's terrifying reading, it can't be dismissed and it should be a call to action. The report describes a wide variety of adaptive responses that need to be taken to reduce the disruption (for example: the sea level is rising, so raise the roadways in Miami) but doesn't identify efforts to reduce the emission of carbon dioxide, the major cause of the problem, since that was not its purpose. The Paris Agreement (and its predecessor the Kyoto Protocol) addressed $CO_2$ reduction, but it's not clear that their targets are achievable or affordable.

Climate change is going to be very hard to stop because of the natural human tendency to not want to give up our comforts, which depend on ample, easily available, portable, low-cost energy, and that means coal and oil. Reducing $CO_2$ emissions by switching from oil and coal to renewable forms of energy (wind, geothermal, and solar) is technically difficult and can be expensive, at least at first. Nuclear energy is "clean" as far as the atmosphere is concerned, but the problems of nuclear waste and diversion of nuclear materials by terrorists remain. The economic impacts of making these changes are vast; governments are reluctant or in downright denial. Committing funds of the magnitude required means not paying for something else (Social Security, Medicare, the military?) so it seems unlikely that we'll make much progress.

[6] https://nca2018.globalchange.gov/

There are two other general strategies besides reducing $CO_2$ emissions that night mitigate the effects of climate change caused by human activity.

1. Remove atmospheric $CO_2$ in sufficient quantities and store it on or in the Earth or in the oceans. Although the easiest way to do this would be to reforest much of the Earth, deforestation is continuing unabated as the world's population grows. New technology, implemented on a massive scale, would be needed to extract $CO_2$ from the atmosphere and deposit it underground in the form of carbonates, or to increase its uptake by marine organisms.
2. Reduce the amount of sunlight hitting the Earth's surface. This could take the form of orbiting occulting devices or seeding the stratosphere with particles that would block sunlight. This is called "solar radiation management" (SRM).




Potential geoengineering strategies (Kathleen Smith/Lawrence Livermore National Laboratories)

*Geoengineering* (also known as climate engineering) is the catch-all term used for these two groups of strategies. Although there are known chemical ways to sequester carbon dioxide, none of them seem scalable on global level, they'd be very expensive and they seem unlikely to be tried. The possibility of injecting sunlight-blocking substances into the atmosphere, on the other hand, has a long and interesting natural history, because Mother Nature herself has done some experiments. Just ask a dinosaur.

Periodically, natural events inject large amounts of particulate material and sulfur dioxide into the upper atmosphere, reducing the amount of sunlight reaching the Earth's surface. Most of these events are volcanic, although we are fairly sure the Chicxulub asteroid impact in the Yucatan 66 million years ago had devastating world-wide consequences of a similar nature. It is

estimated that the dust cloud from the impact, high in sulfuric acid aerosols, would have circulated for at least 10 years and might have reduced sunlight by 10-20% and global temperatures by as much as 7.5° C. Reductions in global temperatures can have significant effects on the biosphere. with major extinctions not only of the cold-blooded dinosaurs, but of other flora and fauna. Volcanic events have identical consequences. Some of the earlier extinctions, including the "Great Dying," the Permian–Triassic extinction event 251 million years ago in which 96% of marine species and 70% of land species died off, appear to have had volcanism as their major component.

A recent article in *Science*[7] suggested that 536 AD was "the worst year to be alive" because of a major volcanic eruption in Iceland (which was then unpopulated, so there were no eye witnesses). Atmospheric ash resulted in decreased sunlight, global temperature reductions of 1.5-2.5° C, global crop failures and economic disruption, the latter determined from the amount of lead in ice cores. Lead is a byproduct of silver smelting and levels correlate with economic activity. Populations were thinned. Recovery took decades.

More recent volcanic eruptions are experimental resources for scientists studying the impact of atmospheric aerosols on climate. The most recent very large-scale eruption was Mount Pinatubo in the Philippines, which exploded on June 15, 1991. Nearly 20 million tons of sulfur dioxide were injected into the stratosphere. Global temperatures dropped by about 1° F (0.5° C) from 1991 through 1993. The even larger Krakatoa explosion on August 27, 1883 lowered average global temperatures by 1.2° C in the year following the eruption. Temperatures did not return to baseline until 1888.

Should we inject particles into the upper atmosphere to block enough solar radiation to cool the earth and counterbalance the greenhouse effect?

In a 2006 editorial "Albedo Enhancement By Stratospheric Sulfur Injections: A Contribution To Resolve A Policy Dilemma?" in the journal *Climate Change*,[8] Dutch climatologist Paul J. Crutzen, winner of the 1995 Nobel Prize in Chemistry for his work on the ozone hole, noted that the effect of greenhouse gas emission on global warming has been some extent counteracted by the sulfur-containing soot particulates from automobiles and industrial activity.

> Recent research has shown that the warming of earth by the increasing concentrations of $CO_2$ and other greenhouse gases is partially countered by some backscattering to space of solar radiation by the sulfate particles, which act as cloud condensation nuclei and thereby influence the microphysical and optical properties of clouds, affecting regional precipitation patterns, and increasing cloud albedo. Anthropogenically enhanced sulfate particle concentrations thus cool the planet, offsetting an uncertain fraction of the anthropogenic increase in greenhouse gas warming. However, this fortunate coincidence is "bought" at a substantial price. According to the World Health Organization, the pollution particles affect health and lead to more than 500,000 premature deaths per year worldwide. Through acid precipitation and deposition, $SO_2$ and sulfates also cause various kinds of ecological damage.

Crutzen notes that after controls were put in place to reduce sulfur emissions, they declined at 2.7% per year, but this resulted in an increase of incident solar radiation of 0.10% percent per year from 1983 to 2001. Calculations made by other researchers suggested that completely "clean" air (zero sulfur and particulate emissions) could lead to a rise in global surface temperatures of 0.8° C per decade and as much as 4° C in the Arctic. In other words, cleaning up the atmosphere helped raise global temperatures! As the old saying goes, "no good deed goes unpunished."

The optimal location for particulate aerosols would be in the stratosphere, high enough to avoid direct ingestion by humans and animals. Cruzen writes,

> Although climate cooling by sulfate aerosols also occurs in the troposphere, the great advantage of placing reflective particles in the stratosphere is their long residence time of about 1–2 years, compared to a week in the troposphere. Thus, much less sulfur, only a few percent, would be required in the stratosphere to achieve similar cooling as the tropospheric sulfate aerosol. This would make it possible to reduce air pollution near the ground, improve ecological conditions and reduce the concomitant climate warming. The main issue with the albedo modification method is whether it is environmentally safe, without significant side effects.

There is no direct way to evaluate this last statement. We don't have a laboratory that closely mirrors the

[7] https://www.sciencemag.org/news/2018/11/why-536-was-worst-year-be-alive

[8] Available on line at http://faculty.washington.edu/stevehar/Geoengineering_packet.pdf

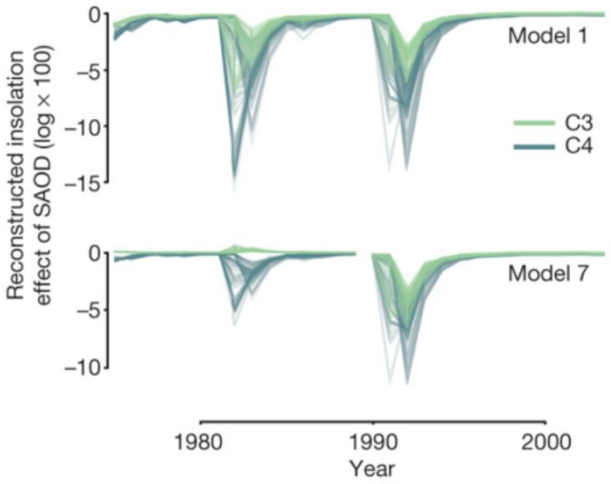
whole planet: the whole planet *is* the laboratory, and we can't have a control. Do we take a chance and live with the consequences? The atmosphere will cool, but what about the growth of sunlight-dependent plants, particularly important food crops? Would we put ourselves back to the year 536, or even worse, 66 million or 251 million years ago?

A paper[9] in *Nature* in August 2018 written by climatologists from the University of California, Stanford and Columbia examined this issue by trying to calculate the impact of solar radiation on plant growth. They correlated atmospheric and agricultural data from periods surrounding the Pinatubo eruption as well as the 1982 El Chichón eruption in Mexico, which, although less cataclysmic than the Pinatubo event, injected a fairly similar amount of sulfur dioxide into the atmosphere. There was little global cooling from the El Chichón event, however, because of the simultaneous occurrence of an El Niño event that raised ocean temperatures in the Pacific.

The authors noted that for both explosions, the opacity of the atmosphere was increased by "more than an order of magnitude" for months after the events. They calculated that the Pinatubo eruption reduced the stratospheric optical depth by 0.15, with direct sunlight reduced by 21%, diffuse sunlight increased by 20% (due to scattering) and total sunlight reduced by 2.5%.

The differential effect of direct and scattered sunlight on photosynthesis in ecosystems is difficult to evaluate. Diffuse sunlight might penetrate forest canopies better than direct sunlight, improving the photosynthetic efficiency in plants nearer the ground. The paper says "It is unknown whether damages from decreasing total light or benefits from increasing diffuse light dominate in crop production." They also note that "Previous studies of unmanaged ecosystems have tended to find that scattering increases biomass growth—although not always—and, importantly, that edible yield production may not directly correlate with biomass growth." The plants that grow may not be the ones that we want to eat.

Based on quantitative crop yields before and after the two eruptions, and running the data though a variety of models, the authors calculated that changes in sunlight from stratospheric sulfate aerosols after the two volcanic events appeared to have reduced maize yields by 48% and soy, rice and wheat yields by 28% per "stratospheric aerosol optical depth," an objective measure of atmospheric light attenuation. This translates into absolute decreases of 9.3% for maize and 4.8% for the other crops mentioned.




From Proctor, et. al.: Fig. 3: panels B and C, showing 2 modeling of crop yields after the 1982 and 1991 volcanic eruptions. C3=maize, C4= soy, rice and wheat.

Given the inability of the world's largest countries to give up coal and oil,[10] not to mention dogmatic climate-change denial on the part of some governments, $CO_2$ levels will continue to rise, permafrost melting will continue to add $CH_4$ and melting of the polar caps will reduce the Earth's albedo, meaning its surface will retain more solar energy in the form of heat. So it's almost inevitable that some form of geoengineering will be tried, regardless of the risks. Compared with other forms of mitigation, SRM using sulfur injection into the stratosphere is very cheap. We're not going to build sunshades thousands of square miles in extent and place them in orbit, but one estimate suggests that a small fleet of aircraft could deposit enough sulfur aerosols to counteract 1.5° C of warming at a cost of less than $10 billion per year. Compared to the cost of eliminating $CO_2$ emissions that lead to that level of warming, it's a pittance.

The first experimental steps towards SRM are coming soon. A team from Harvard is planning the Stratospheric Controlled Perturbation Experiment (SCoPEx). The goal is to release a small amount of

[9] Proctor, J., et. al., Estimating global agricultural effects of geoengineering using volcanic eruptions, *Nature* 2018; 560:480-483

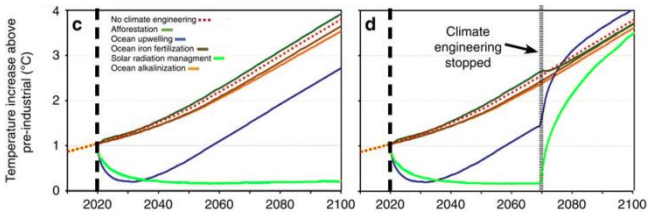
[10] https://www.nytimes.com/2018/11/24/climate/coal-global-warming.html, https://www.nytimes.com/2018/12/05/climate/greenhouse-gas-emissions-2018.html

calcium carbonate, on the order of just 100 grams, from a steerable balloon 20 kilometers above the southwest US, and observe the dispersal of the particles. While $CaCO_3$ is less effective as a sun-blocker than sulfur aerosols, it causes less ozone destruction. The cost of the experiment is $3 million. Solar attenuation won't be measured. It's a baby step, but it's still a step. I was gratified to see that the SCoPEx scientists and other SRM proponents do have an understanding that the technology could have serious downsides. Implementation of SRM would have global consequences and would presumably need a global consensus to decide whether it should ever be employed. We know how well global cooperation has worked lately.

Stratospheric aerosols pose inevitable problems for astronomy, both amateur and professional.

If, say, 2.5% of sunlight is blocked, 2.5% of the light of any celestial object will be blocked. The reach of research telescopes, including the next generation of very large instruments, will be blunted, slowing or stopping inquiry into a wide variety of astronomical questions. Amateur viewing is similarly at risk. Injecting particles into the stratosphere could increase sky brightness by as much as 25% according to some studies. Dark nights won't be very dark. Faint objects would be more difficult to resolve as contrast decreases, a problem for both visual observing and imaging. The quality of solar images will decrease. There will be many fewer, if any, "bluebird" days, when the crisp Hα images of activity on the solar and limb prominences are so impressive. The daytime sky will be a faded greyish-blue on its best days.

The other problem with geoengineering is that it probably won't work as long as human activity continues to generate $CO_2$. In a modelling study published in 2014,[11] climate scientists from the GEOMAR Helmholtz Centre for Ocean Research Kiel in Germany found that all of the proposed geoengineering strategies failed to stop rising global temperatures under current rates of greenhouse gas emissions. At best, the models suggest aerosol SRM might blunt rising temperatures by just 8%. The other strategies were basically complete failures and all these options have their own detrimental effects on weather, long-term climate and Earth biology. Seeding the atmosphere with sulfur aerosols has another long-term risk: you can't ever stop doing it. If the process is discontinued, according to the models, the Earth's temperature would rise several degrees within a few decades, a rate even higher than the current rate of climate change.




2 frames from Fig 2 of Keller et. al. (L) Global temperatures with various geoengineering strategies assuming continued $CO_2$ production. (R) Impact of discontinuation in 2070.

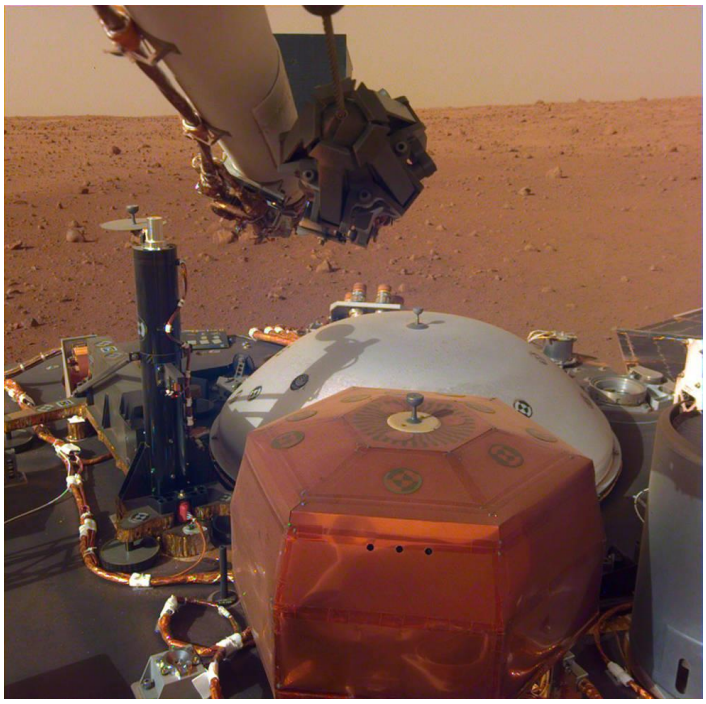
"Fixing global warming is more important than astronomy," said David Grinspoon, an astrobiologist at the Planetary Science Institute and a well-known science writer, at the American Astronomical Society meeting in January 2017. "There's no question to my mind that saving our civilization and many other species is more important than our ability to do ground-based astronomy for a few decades." True, but once the genie gets out of the bottle, he won't go back in if the GEOMAR data is correct. And hoping we might also rein in our production of $CO_2$ after cooling the Earth with aerosols (or frankly any form of post-hoc $CO_2$ reduction) reminds me of a study published in the *American Journal of Public Health* in 2014 that showed that on average, an obese adult who drinks diet soda eats nearly 200 more calories per day than an obese adult who drinks regular soda. I'm having a Diet Coke, so I guess it's OK to have the Double Whopper with Cheese and the supersize fries! We're seeding the atmosphere, so who cares about $CO_2$ reduction? Problem solved, right? Wrong.

It seems very likely to me that Earth-based astronomy, professional or amateur, would be given a near-fatal blow if SRM by aerosol injection becomes our only strategy for dealing with climate change. I worry that its low cost and ease of implementation make it inevitable. And even if it works, food plants flourish and weather patterns aren't scrambled, we'll be hooked on it forever. Conversion of $CO_2$ into solid carbonates seems much safer and obviously better for the sky, but it would cost far more than SRM.

The sky is a precious natural resource. The Earth's surface isn't the only thing that is endangered. We must act responsibly to solve one mess we've made with Mother Nature without making another. ■

[11] Keller, DO, Feng, EY, Oschlies, A, Potential climate engineering effectiveness and side effects during a high carbon dioxide-emission scenario, Nature Communications 2014: available at http://dx.doi.org/10.1038/ncomms4304

## Images



### InSight on Mars

The InSight spacecraft landed flawlessly on Mars on November 26th. It was another triumph for NASA and the Jet Propulsion Laboratory. The non-mobile probe will examine Mars' internal structure and seismology.

This image from InSight's robotic-arm mounted Instrument Deployment Camera shows the instruments on the spacecraft's deck, with the Martian surface of Elysium Planitia in the background. The image was received on Dec. 4, 2018 (Sol 8).

Credits: NASA/JPL-Caltech
Full image and caption at
https://www.jpl.nasa.gov/spaceimages/details.php?id=PIA22871.

The InSight web site is
https://mars.nasa.gov/insight/.

### Memories of a spring night: May 23, 2018

WAA Outreach, Nevis Labs Girls Scouts, Irvington

*I just wanted to thank you and all of the wonderful WAA volunteers who generously came to Nevis with their telescopes on Wednesday night. Finally the weather held out and it turned out to be a spectacular evening. The whole experience was really something special and the girls (and their families) had a great time. -- Amy Garwood*

### Need astronomy gear in Tokyo?

During a trip to Japan in October, Larry & Elyse Faltz stopped by Kyoei, an astronomy shop in the high-tech Akihabara district, also known as "Electric City." The small shop was packed with high quality Japanese Takahashi, Vixen and Borg instruments, and carries a complete range of other astronomy equipment. Kyoei does a large Internet business (http://www.kyoei-tokyo.jp/). Larry chatted with Hideo Okamura (pictured), who, as it turned out, was at NEAF last year. There are a large number of small astronomy clubs throughout Japan. Observing is a challenge: light pollution is intense throughout the small, densely populated country and getting to a dark sky site is difficult.

***Comet 46P/Wirtanen image by Gary Miller***

It's not surprising that more than one WAA'er imaged this relatively bright comet, which sadly never made it to naked-eye brightness in our area. 46P/Wirtanen was discovered in 1948 at Lick Observatory. Estimated to be 1.2 kilometers in diameter, it orbits between the Earth and Jupiter with a period of 5.4 years. It passed closest to Earth on December 16th making it the 10th closest comet in modern times. The comet was the original target of the Rosetta spacecraft, but launch delays required redirection of the probe to 67P/Churyumov–Gerasimenko. Gary made this image on December 5th at Ward Pound Ridge when the comet was in Eridanus at magnitude 10. Explore Scientific 127 ED refractor, Canon T7i, 10x60 sec exposures, sacked with Deep Sky Stacker comet subroutine.

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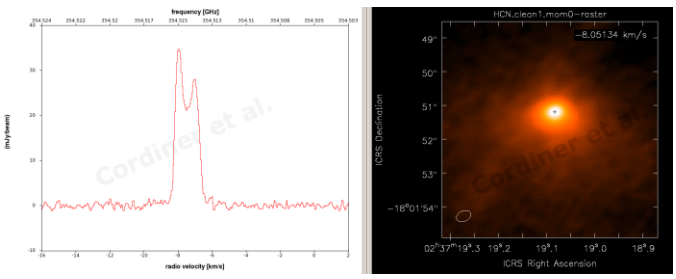
**Information posted on the University of Maryland Comet Wirtanen Observing Campaign web site**
http://wirtanen.astro.umd.edu/ (accessed 12/18/18)




Cordiner et al. obtained interferometric observations of comet 46P/Wirtanen using the Atacama Large Millimeter/submillimeter Array (ALMA) on 2018-12-02.… The HCN spatial distribution (right panel) is strongly centrally-peaked, at a position consistent (within 0.2 arcsec) of the latest Horizons orbital solution (K181/6). The HCN spectral line profile (left panel) is double-peaked, with an enhanced blue lobe, indicative of preferential outgassing from the Earth-facing side of the nucleus. The HCN line FWHM of 1.4 km/s implies a coma outflow velocity of around 0.7 km/s.

## Research Highlight of the Month

As related to WAA by December speaker Andrew MacFadyen of NYU, the LIGO and VIRGO gravitational wave collaboration has so far detected ten black hole mergers and one neutron star merger. The positions of these events on the sky is shown in a map in the paper "GWTC-1: A Gravitational-Wave Transient Catalog of Compact Binary Mergers Observed by LIGO and Virgo during the First and Second Observing Runs" that was posted on the arXiv physics pre-print server on November 30th (https://arxiv.org/pdf/1811.12907.pdf). Some of the black hole mergers were reported for the first time in this paper.

The map shows the relatively large areas of space in which each event might be located. The area in which a source might be found is triangulated from the exact time the signal reaches each of the three detectors. The LIGO detectors are in Hanford, Washington and Livingston, Louisiana, and the VIRGO detector is near Pisa, Italy. GW170817 is the neutron-star merger that was also seen by gamma-ray instruments, resulting in a very small sky location area. It was further narrowed by visual detection of the object itself in the galaxy NGC 4993. See the November 2017 SkyWAAtch for an in-depth report on this event. ■

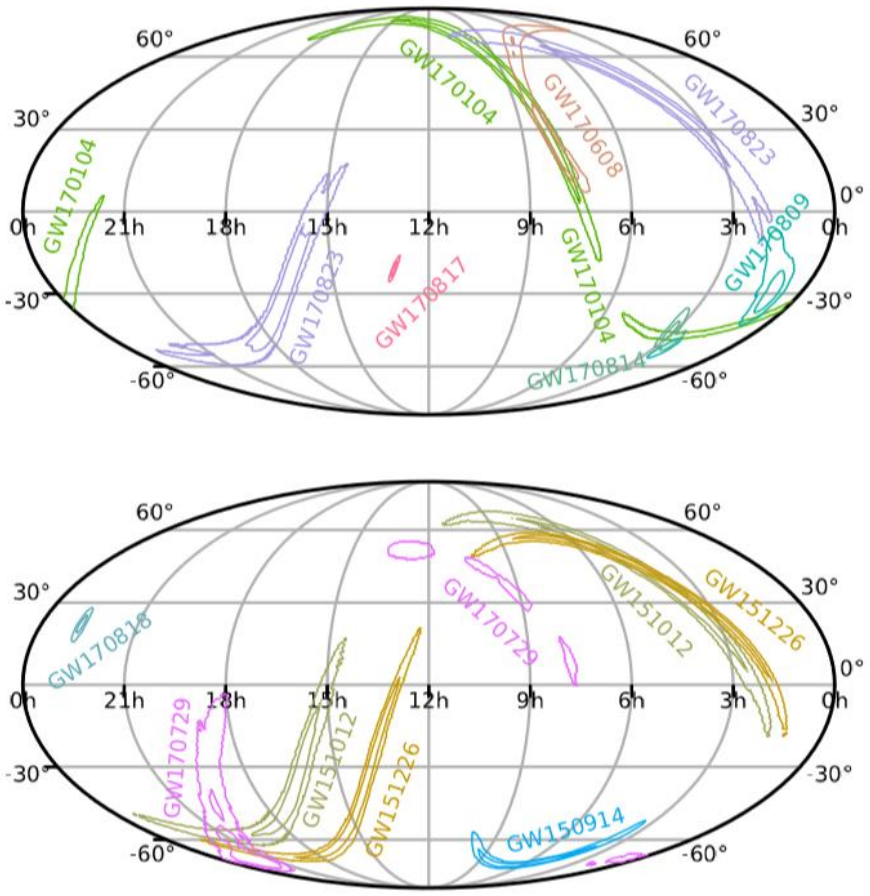



FIG. 8. Parameter estimation summary plots V. The contours show 90% and 50% credible regions for the sky locations of all GW events in a Mollweide projection. The probable position of the source is shown in equatorial coordinates (right ascension is measured in hours, and declination is measured in degrees). 50% and 90% credible regions of posterior probability sky areas for the GW events. *Top panel:* Confidently detected O2 GW events [21] (GW170817, GW170104, GW170823, GW170608, GW170809, GW170814) for which alerts were sent to EM observers. *Bottom panel:* O1 events (GW150914, GW151226, GW151012), along with O2 events (GW170729, GW170818) not previously released to EM observers.

## Member & Club Equipment for Sale

January 2019

| Item | Description | Asking price | Name/Email |
|---|---|---|---|
| Celestron 8" SCT on Advanced VX mount | Purchased in 2016. Equatorial mount, portable power supply, polar scope, AC adaptor, manual, new condition. | $1450 | Santian Vataj spvataj@hotmail.com |
| Celestron CPC800 8" SCT (alt-az mount) | Like new condition, perfect optics. Starizona Hyperstar-ready secondary (allows interchangeable conversion to 8" f/2 astrograph if you get a Hyperstar and wedge). Additional accessories: see August newsletter for details. Donated to WAA. | $1100 | WAA ads@westchesterastronomers.org |
| Celestron StarSense autoalign | New condition. Accurate auto-alignment. Works with all recent Celestron telescopes (single or dual fork mount or GEM). See info on Celestron web site. Complete with hand control, cable, 2 mounts, original packaging, documentation. List $359. Donated to WAA. | $225 | WAA ads@westchesterastronomers.org |
| Meade 395 90 mm achromatic refractor | Long-tube refractor, f/11 (focal length 1000 mm). Straight-through finder. Rings but no dovetail. 1.25" rack-and-pinion focuser. No eyepiece. Excellent condition. A "planet killer." Donated to WAA. | $100 | WAA ads@westchesterastronomers.org |
| Televue 55mm 2-inch Plossl. | Very lightly used. Excellent condition. Original box. | $175 | Eugene Lewis genelew1@gmail.com |
| Orion 150 Mak-Cassegrain telescope | Excellent condition. Will include heated dew-shield. | $300 | Tom Boustead bousteadtom@gmail.com |

Want to list something for sale in the next issue of the WAA newsletter? Send the description and asking price to ads@westchesterastronomers.org. Member submissions only. Please only submit serious and useful astronomy equipment. WAA reserves the right not to list items we think are not of value to members.

Buying and selling items is at your own risk. WAA is not responsible for the satisfaction of the buyer or seller. Commercial listings are not accepted. Items must be the property of the member or WAA. WAA takes no responsibility for the condition or value of the item or accuracy of any description. We expect, but cannot guarantee, that descriptions are accurate. Items are subject to prior sale. WAA is not a party to any sale unless the equipment belongs to WAA (and will be so identified). Sales of WAA equipment are final. *Caveat emptor*!