Here Comes the Rain Again… or Is It Snow?

39.5°F/4.2°C — The near-surface temperature threshold that determines whether precipitation will be rain or snow near Lake Tahoe in the Sierra Nevada, according to new research published in *Frontiers in Earth Science*. As part of the Tahoe Rain or Snow project, 200 citizen scientists used a cellphone app to take more than 1,000 precipitation phase observations in the Lake Tahoe region in 2020. Using this data, scientists discovered that the rain/snow temperature threshold near the land surface was not 32°F/0°C—the freezing point of water—but significantly warmer. Past studies have indicated that weather forecasts and hydrologic models struggle to accurately predict precipitation type in the region when the temperature is near freezing, and the new research indicates that the conventional threshold causes significant overpredictions of rainfall and underestimates snow accumulation, which could have serious implications. “Scientists use a temperature threshold to determine where and when a storm will transition from rain to snow, but if that threshold is off, it can affect our predictions of flooding, snow accumulation, and even avalanche formation,” explains coauthor Keith Jennings of Lynker Technologies and the Desert Research Institute (DRI). Jennings and coauthors Monica Arienzo and Meghan Collins of DRI established the Tahoe Rain or Snow project in 2019 to improve precipitation prediction through real-time weather observations collected by volunteers. [Source: Desert Research Institute]
QUESTION:
What caused record-breaking levels of aerosols to congregate in the stratosphere over the Southern Hemisphere in the early months of 2020?

ANSWER:
According to research published in *Science* by Ilan Koren of the Weizmann Institute of Science and Eitan Hirsch of the Israel Institute of Biological Research, intense and massive wildfires in southeastern Australia in late 2019 and early 2020 injected smoke particles into the stratosphere—a surprising finding because such particles usually settle in the lower atmosphere before falling back to earth, and generally only reach the stratosphere when they are propelled by a volcanic eruption. The two scientists used satellite data for the years 1981–2020 to determine that the aerosol optical depth (AOD) over the Southern Hemisphere during the studied period exceeded the average by more than three standard deviations and registered some of the highest readings ever obtained—even greater than those measured after the eruption of Mt. Pinatubo in 1991. Normally the tropopause blocks smoke particles from drifting into the stratosphere. Importantly, the tropopause is lower at higher latitudes, making it thinner there than at other locations, creating less atmosphere for smoke particles to traverse and better enabling them to breach the tropopause. But there was another important factor that helped the aerosols reach greater heights: Koren and Hirsch discovered that prevailing midlatitude winds traveling across the southern end of Australia advected smoke from the fires to the Pacific Ocean, with some smoke forming deep convective clouds and then rising into the stratosphere. The large amounts of smoke act as cloud condensation nuclei, allowing clouds to develop deeper and increasing their ability to penetrate the tropopause. Once in the stratosphere, prevailing winds dispersed the smoke particles uniformly throughout the Southern Hemisphere, where they survive much longer than at lower levels of the atmosphere before settling back to earth. “People in Chile were breathing particles from the Australian fires,” Hirsch says.

2nd QUESTION:
The researchers found that the smoke blocked some incoming solar radiation, causing notable cooling over cloud-free portions of the ocean. Did the cooling caused by the smoke have a discernible impact? Koren says “we still do not know how much influence that cooling and dimming may have had on the marine environment or weather patterns.” The smoke also absorbs some solar radiation, which can have a localized warming effect in the atmosphere, but “the effects of smoke warming in the stratosphere are not yet clear,” Koren says. [SOURCES: Weizmann Institute of Science, bryfmonline.com]
The temperature at the top of a thunderstorm cloud over the southwestern Pacific Ocean on December 29, 2018—the coldest known temperature in a storm cloud ever recorded by satellite. Simon Proud (University of Oxford and the National Centre for Earth Observation) and Scott Bachmeier (University of Wisconsin—Madison) identified the record-breaking temperature and attributed it to a combination of warm ocean waters and an occurrence of the Madden-Julian Oscillation, which enhances convection. The researchers also examined other satellite cloud temperature data from the years 2004–20 and found that such extremely cold clouds may be getting more common, with half of all the recorded cloud temperatures below −100°C occurring in the final three years of the studied period. The finding could signal an increase in severe storms since, as Bachmeier explains, “vigorous tropopause-penetrating updrafts...can create a convective storm that is more likely to produce damaging winds, large hail, or tornadoes.” The study was published in Geophysical Research Letters. [Source: University of Wisconsin—Madison]
Afternoon Sunlight is a Delight for Clouds

CAUSE: When winds are weak, sunlight in the afternoon warms tropical oceans more

...As sea surface temperatures increase, turbulence forms

...Warmer water enhances the turbulence

EFFECT: Clouds develop overhead

Scientists utilized Doppler lidar on a research vessel in the tropical Indian Ocean to measure the height and strength of turbulence produced by afternoon warming of the ocean—measurements that in the past had only been made by aircraft. “With lidar, we have the ability to profile the turbulence 24 hours a day, which allowed us to capture how these small shifts in temperature lead to air turbulence,” explains lead author Simon de Szoeke of Oregon State University. “No one has done this kind of measurement over the ocean before.” The research team found that when winds were weak, afternoon sunlight warmed sea surface temperatures by at least 1°C on 24% of days over a 3-month period. The warmer ocean then enhanced the strength and height of convective turbulence in the atmospheric mixed layer, causing water vapor to rise from the ocean surface and spawn clouds. The study found that the warming, which de Szoeke says “is an effect that has largely been ignored,” takes place over about 5% of the world’s tropical oceans. The findings could be used to improve climate models, as de Szoeke notes that “[t]here are a lot of subtle effects that people are trying to get right in climate modeling.” The study was published in Geophysical Research Letters. [SOURCE: Oregon State University]
“Don’t go around the storm, go through.”

—The prevailing attitude of container ship captains, according to Jonathan Ranger of the finance/insurance company American International Group, Inc. This philosophy has contributed to an increasing number of incidents in which containers fall overboard or topple over on deck and are destroyed. More than 3,000 containers fell into the water last year—the most in seven years—and more than 1,000 had suffered the same fate this year as of the end of April. A number of factors are to blame, including larger ships with higher stacks of containers and an e-commerce boom that has increased demand and intensified the urgency for rapid deliveries. But when combined with the aggressive approach of ship captains, more volatile weather has also been an important influence. According to Todd Crawford of The Weather Company, the North Pacific Ocean experienced its strongest winds this past winter since 1948, creating perilous conditions for the many container ships crossing from Asia to North America. The result has been a series of costly mishaps: last November, giant swells and gale-force winds caused the One Apus to lose more than 1,800 containers worth over $90 million of cargo, while early this year, the Maersk Essen and the Maersk Eindhoven combined to lose around 1,000 containers. The mishaps have disrupted the supply chains of hundreds of retailers and manufacturers in the United States. [Source: Bloomberg]
Those findings come from a recent study by Kaitlyn Loftus and Robin Wordsworth. The Harvard University researchers derived the extent of drop sizes by calculating the shape, fall speed, and evaporation speed of raindrops on various planets, and discovered that there is “a fairly small range of stable sizes that these different composition raindrops can have,” Loftus says. “[T]hey’re all fundamentally limited to be around the same maximum size.” Loftus and Wordsworth discovered that depending on the strength of a planet’s gravitational pull, maximum droplet sizes range from about one-half to just six times the size of water rain on Earth, even though they often have much different chemical compositions and are falling through varying types of atmospheres—for example, Venus has sulfuric acid precipitation and Jupiter is pummeled by helium and mushy ammonia hailstones. The researchers project that on rocky planets like Earth, raindrops smaller than about one-tenth of one millimeter in radius would evaporate before reaching the surface, while drops larger than several millimeters in radius would split into smaller drops while falling—a fairly narrow size range, given the considerable growth raindrops undergo from cloud droplets. Loftus theorized that the consistency of drop size across planets could be related to the relationship between a droplet’s surface tension and its density. The study, published in the *Journal of Geophysical Research: Planets*, may help researchers study liquid-shaped valley and crater features of archaic Mars (when it was warm enough for liquid water), among other alien environments, as well as ancient Earth. [SOURCE: American Geophysical Union]
Exhibit at the AMS 102nd Annual Meeting
23–27 January 2022
Houston, TX
AMERICAN METEOROLOGICAL SOCIETY

This year’s theme is
Environmental Security: Weather, Water, and Climate for a More Secure World

Don’t miss this chance for your products, services, and research to grab the attention of scientists, policy-makers, educators, researchers, students, hiring managers, and funding agencies.

ANNUAL.AMETSOC.ORG/2022EXHIBITORS
A member benefit from the AMS

**Participate**
in focused and dedicated discussions relevant to you.

**Network**
with colleagues using the comprehensive Member Directory.

**Earn**
recognition for the contributions you make to the Community.

** AMS Community** is our online platform that will revolutionize the way you communicate, connect, and interact with your fellow Society members! We can’t wait to have you join the conversation!

Activate your account with your existing AMS credentials today at: community.ametsoc.org

Questions? Please contact amscommunity@ametsoc.org.
Visualization is a major part of any scientific work, serving to communicate results in an inclusive way. Whether figures, plots, or graphs, they all play a central role in publications, teaching, and public outreach. Furthermore, visualization is one of the integral parts besides automatic tests of the data that help to ensure the quality of meteorological data from one or more weather stations of measurement networks. This last aspect, in particular, requires the automatic generation of figures and their dynamic presentation.

Our homepage, named “Dolueg” for “here, look” in German dialect/Swiss-German, allows researchers and the public to view relevant and up-to-date data in an easy way that includes further information such as measurement height, device type, and other relevant metadata. Dolueg has proven its value for the detection of malfunctioning devices, showcasing interesting meteorological phenomena, and above all ensuring that the flow of data from our stations into the database can be easily checked and fixed, if need be. Because Dolueg is free, easy to use, and adjustable, it is especially suitable for measurement network operators, that is, when time series are constantly collected and are in need of visual quality control in addition to any automatic checks.
Dolueg consists of two parts: a website created in PHP, a general purpose scripting language mainly used for web servers, and a selection of Python functions that generate a suite of plots. The Python pipeline produces figures frequently which are then dynamically (and in a mobile-friendly way) presented in categories according to the file name of the figure. The grouping reduces the time and effort required to add new figures. Each component can of course be used on its own as well.

The relevant code for these two components is freely available: the website framework (Fig. 1a) and PHP functions can be found at https://github.com/spirrobe/dolueg, and the Python code is hosted at https://github.com/spirrobe/dolueg2figures. Both repositories contain detailed instructions for setup and examples.

Several kinds of figures for time series data are available (Figs. 1b–e): wind roses for one or several stations drawn over a map background, the default line plots, isopleth/contour graphs as time of day versus day of year, and mesh plots of measurement values at several heights. Each type can be further customized in terms of colors, titles, and more.

All figures are by default created as SVG (scalable vector graphics), making them precise, zoomable, usually small in size, and compatible with all common browsers, even without a web server. Figures can be downloaded and, if need be, edited in open-source or commercial vector graphics programs, and they can be directly inserted into documents. The choice of SVG as default makes our figures suitable for reports, lectures, and other applications.

**System requirements and installing Dolueg**

The requirements for Dolueg itself are fairly simple. Even a Raspberry Pi model B should be able to both create and
display plots. Instead of a full web hosting solution, a local computer that runs PHP is also sufficient. The bottleneck for the creation of figures is usually reading the data from storage and thus mandates that enough RAM is available to hold the specified amount of data (e.g., a year of 1-min data).

To set up Dolueg, follow the instructions on the two GitHub repositories above. Each contains detailed instructions for the respective part of the setup (website and the figure pipeline). We further included examples for the creation of some default figures. These files will require minor changes to work with your specific data pipeline.

One adjustment must be done: the Python component of Dolueg requires a way to access data. Figure 2 gives an outline of our data pipeline, where box C represents Dolueg. It is likely that there are differences from our solution in implementation details from box A (measurement) to box B (storage). Regardless of the specific details of data (Excel files, SQL database, or other), when a Python function is available or can be written to get data and metainformation, Dolueg can be implemented and used like our use case (box D and E) and of course can be further extended (e.g., boxes 3, 4, and 5).

Two additional, minor adjustments are recommended but not required: adjusting the CSS (Cascading Style Sheets) files to fit your preferred color scheme in the web component and creating an API Key (Application Programming Interface) for Google Static Maps (if required). Without a valid key, the background of the wind rose/station maps will be from OpenStreetMap instead.

Any feedback, remarks, or requests are welcome and should be provided via the relevant repository to improve code at the source.

**Acknowledgments.** We acknowledge the help, input, and corrections from several generations of student helpers that worked with Dolueg and thus ensured a continuous improvement.

**FOR FURTHER READING**

The Journal of Climate (JCLI) publishes research that advances basic understanding of the dynamics and physics of the climate system on large spatial scales, including variability of the atmosphere, oceans, land surface, and cryosphere; past, present, and projected future changes in the climate system; and climate simulation and prediction.

Open Access option for authors. All papers publicly accessible 12 months after publication.

2019 Impact Factor: 5.707 (2019 Journal Impact Factors by Clarivate Analytics: Meteorology and Atmospheric Science category)

Editorial Board

Timothy DelSole, George Mason University and Center for Ocean-Land-Atmosphere Studies (Co-Chief Editor)
Mingfang Ting, Lamont-Doherty Earth Observatory (Co-Chief Editor)
Mathew Barlow, University of Massachusetts Lowell
Matthew Collins, University of Exeter
Yi Deng, Georgia Institute of Technology
Dietmar Dommenget, Monash University
Jason Evans, University of New South Wales
Michael Neil Evans, University of Maryland, College Park
Isaac Held, Princeton University
Andy Hoell, NOAA/Physical Sciences Laboratory
Xianglei Huang, University of Michigan
Charles Koven, Lawrence Berkeley National Laboratory
Tim Li, University of Hawai’i at Mānoa
Wenhong Li, Duke University
Xin-Zhong Liang, Earth System Science Interdisciplinary Center, University of Maryland
Benjamin R. Lintner, Rutgers, The State University of New Jersey
Shawn Marshall, University of Calgary
Seung-Ki Min, Pohang University of Science and Technology
Hisashi Nakamura, The University of Tokyo
Joel Norris, University of California, San Diego
Yuko Okumura, The University of Texas at Austin
Oleg A. Saenko, Canadian Centre for Climate Modelling and Analysis
Agus Santoso, University of New South Wales
James Screen, University of Exeter
Isla Simpson, University Corporation for Atmospheric Research
Darryn Waugh, The Johns Hopkins University
Baoqiang Xiang, Geophysical Fluid Dynamics Laboratory
Laure Zanna, New York University
Rong Zhang, Geophysical Fluid Dynamics Laboratory

Journal of Climate (JCLI)
ISSN: 0894-8755; eISSN: 1520-0442