2018 International Geophysical Calendar (FINAL)

Cooperative programs pertaining to solar activity and the Earth's environment

Go to the ftp site for past calendars.

The International Geophysical Calendar contains information about:

- 2018 Solar Eclipses
- 2018 Meteor Showers

and recommended scientific programs for

- Airglow and Aurora Phenomena
- Atmospheric Electricity
- Geomagnetic Phenomena
- Ionospheric Phenomena
- Vertical Incidence sounding program
- Incoherent Scatter observation program
- Meteorology.
- Global Atmosphere Watch (GAW)
- Solar Phenomena
- Variability of the Sun and Its Terrestrial Impact (VarSITI)
- Space Research, Interplanetary Phenomena, Cosmic Rays, Aeronomy
- Meteor Showers
-

2018 FINAL Calendar -- PDF version

EXPLANATIONS

This Calendar continues the series begun for the IGY years 1957-58, and is issued annually to recommend dates for solar and geophysical observations, which cannot be carried out continuously. Thus, the amount of observational data in existence tends to be larger on Calendar days. The recommendations on data reduction and especially the flow of data to World Data Centers (WDCs) in many instances emphasize Calendar days. The Calendar is prepared by the International Space Environment Service (ISES) with the advice of spokesmen for the various scientific disciplines.

The Calendar provides links to many international programs, giving an opportunity for scientists to become involved with data monitoring and research efforts. International scientists are encouraged to contact key people and to join the worldwide community effort to understand the Sun-Earth environment.

The definitions of the designated days remain as described on previous Calendars. Universal Time (UT) is the standard time for all world days. Regular Geophysical Days (RGD) are each Wednesday. Regular World Days (RWD) are three consecutive days each month (always Tuesday, Wednesday and Thursday). Priority Regular World Days (PRWD) are the RWD which fall on Wednesdays. World Geophysical Intervals (WGI) are 14 consecutive days in each season, beginning on Monday of the selected month, and normally shift from year to year. In 2018 the WGI are March, June, September, and December. Quarterly World Days (QWD) are one day each quarter and are the PRWD which fall in the WGI.

The 2018 FINAL Calendar is available in PDF format.

2018 Solar Eclipses:

a) **15 February 2018**: The 15 February 2018 partial solar eclipse will have a maximum of 60% coverage from Antarctica. Visibility will range on South America from 40% of the solar diameter covered at the southern tip of Tierra del Fuego, Chile, to 35% at Punta Arenas, Argentina; to 28% in Comodoro Rivadavia, Argentina; to 16% in Buenos Aires, Argentina; to 7% in Santiago, Chile; ranging as far north as Asuncion, Argentina.
   - Map of partial solar eclipse 15 February 2018 (by Fred Espenak)
   - Interactive Google map of partial solar eclipse 15 February 2018 (by Xavier Jubier)

b) **13 July 2018**: The 13 July 2018 partial solar eclipse will have a maximum of 34% at the northern tip of Antarctica south of Australia. Visibility will be 10% at Hobart, Tasmania, Australia; 2% at an altitude of 29° at Melbourne and south of Adelaide, Australia.
   - Map of partial solar eclipse 13 July 2018 (by Fred Espenak)
   - Interactive Google map of partial solar eclipse 13 July 2018 (by Xavier Jubier)

c) 11 August 2018: The 11 August 2018 partial solar eclipse will be visible from northern Europe and Asia, Greenland, and northeasternmost Canada. Coverage is 5% at Oslo, Norway; 29% at Tromso, Norway; 4% at Stockholm, Sweden; 9% at St. Petersburg, Russia; 20% at Urumqi, China; 40% at Ulan Bator, Mongolia; and 34% at Beijing, China, just before sunset; as well as 20% at Reykjavik, Iceland; and sunrise in northeastern Quebec, Newfoundland, and Labrador.
   - Map of partial solar eclipse 11 August 2018 (by Fred Espenak)
   - Interactive Google map of partial solar eclipse 11 August 2018 (by Xavier Jubier)

We thank Fred Espenak (Arizona) (http://EclipseWise.com) and Xavier Jubier (Paris) (http://xjubier.free.fr/en/) for their data and maps; see also Michael Zeiler's http://eclipse-maps.com for maps and Jay Anderson's http://eclipsophile.com for weather discussions. Espenak's Thousand Year Canon of Solar Eclipses: 1501 to 2500 is available from www.astropixels.com/pubs, and is the successor to earlier Canons and the NASA website that he ran. It and other work of Espenak, much of it formerly on the NASA website, is now available at http://EclipseWise.com.

Information assembled by Jay M. Pasachoff, Williams College (Williamstown, Massachusetts), Chair, International Astronomical Union's Working Group on Eclipses.

- **Eclipse References:**
    - Pasachoff website linking much eclipse reference material: http://eclipses.info
    - Fred Espenak, Thousand Year Canon of Solar Eclipses 1501 to 2500, 2014 (ISBN-10: 194 1983006); www.astropixels.com/pubs
    - Fred Espenak, Five Millennium Canon of Solar Eclipses: -1999 to +3000, 2006 (NASA/TP-2006-214141) https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20070003587.pdf
    - http://eclipse.gsfc.nasa.gov
    - Leon Golub and Jay M. Pasachoff, The Sun, 2017, UK: Reaktion Press; US: U. Chicago Press, 2017 ISBN: 978-0-8109-7274-2.
    - Leon Golub and Jay M. Pasachoff, The Solar Corona, 2nd ed., Cambridge University Press, 2010 (ISBN-10: 052188201X).
    - Jay M. Pasachoff and Alex Filippenko, The Cosmos: Astronomy in the New Millennium, 4th ed., Cambridge University Press, 2014 (ISBN-10: 049501303X).
    - Leon Golub and Jay M. Pasachoff, Nearest Star: The Surprising Science of Our Sun, 2nd edition, Cambridge University Press, 2014 (ISBN-10: 1107672643).
    - Jay M. Pasachoff, The Complete Idiot's Guide to the Sun, Alpha Books, 2003 (ISBN-10: 1592570747).

2018 Meteor Showers

(Selected from data compiled by Jürgen Rendtel for the International Meteor Organization Shower Calendar):

a. **Annual meteor showers liable to have geophysical effects:** Dates (based on UT in year 2018) are:

Dates	Peak Time (UT)	Name
December 28-January 12	January 03, 22:00	Quadrantids (QUA)
January 31-February 20	February 08, 07:00	α-Centaurids (ACE)
April 14-April 30	April 22, 18:00	Lyrids (LYR)
April 19-May 28	May 06	η-Aquariids (ETA)
May 14-June 24	June 07	Daytime Arietids (ARI) [1]
May 20-July 05	June 09	Daytime ζ-Perseids (ZPE)[1]
June 05-July 17	June 28, 17:00	Daytime β-Taurids (BTA)
July 12-August 23	July 30	Southern δ-Aquariids (SDA)
July 17-August 24	August 12/13, 20:00-08:00	Perseids (PER)[2]

September 09-October 09	September 27	Daytime Sextantids (DSX)[3]
October 02-November 07	October 21/22	Orionids (ORI)
November 06-November 30	November 17, 22:30	Leonids (LEO)[4]
December 01-December 15	December 07[5]	Puppid-Velids (PUP)
December 04-December 17	December 14, 12:30	Geminids (GEM)
December 17-December 26	December 22	Ursids (URS)

[1]Daytime Arietids and Daytime ζ-Perseids tend to blend into one another, producing a strong radio signature for several days in early to mid June. The shower maxima dates are not well established and may occur up to a day later than indicated.

[2]A possible encounter with a Perseid filament is announced for August 12 around 20h UT Peter Jenniskens. The filament is thought to be an accumulation of meteoroids in a mean-motion resonance. Observations are needed to see what is detectable around this position which is right at the start of the given peak period. An additional potential enhancement due to a every old dust trail on August 13 at 01h37m UT, found in computations by Jérémie Vaubaillon, may give only negligible rates anyway, thus could easily pass unnoticed within the normal main maximum period.

[3]Daytime Sextantids (DSX): Shower maxima dates is not well established and there may be additional peaks.

[4] Jérémie Vaubaillon's calculations have yielded four trails the Earth should approach this year, although none of them closely enough to cause high rates. The first encounter happens on November 18 at 23:27 UT and may be one of the more promising trails. Weaker activity may occur on November 19 at 23:59 UT and November 21 at 00:54 UT. A late encounter,with better prospects for recognizable activity, although just after full Moon is reached on November 25 at 23:26 UT. Mikiya Sato reported two dust trails should pass close to the Earth, on November 19 at 22:20 UT and November 20 at 07:04 UT for their respective peak times. However, both trails have been perturbed a lot and should be quite thin, so the rate increase may be less than 10 and thus difficult to detect separately from the general shower rate. Mikhail Maslov adds some additional, probably bright, Leonids may occur on November 20 at 09:30 UT. However, this is expected to be a minor effect and could bedifficult to detect.

[5]Maximum date is a reference for the radiant and is not necessarily a true maximum.

b. **Annual meteor showers which may have geophysical effects:** Dates (based on UT in year 2018) are:

Dates	Peak Time (UT)	Name
April 15-April 28	April 23	π-Puppids(PPU)
June 22-July 02	June 23 or 27	June Boötids (JBO)
August 28-September 05	September 01, 02:00	Aurigids (AUR)
September 05-September 21	September 09, 16:00	September ε-Perseids(SPE)[1]
October 06-October 10	October 09, 00:10	Draconids (DRA)
November 15-November 25	November 21	α-Monocerotids (AMO)

[1]Mikiya Sato's calculations hint at a possible outburst on September 09 at 19:12 UT.

Meteor Shower Websites:

- Shower activity near-real time reports -- International Meteor Organization
- Meteor shower activity forecast from your own location -- Meteor Shower Flux Estimator
- Shower names and data -- IAU Meteor Data Center
- Announcements and reports of meteor outbursts -- IAU Minor Planet Center
- Shower outburst activity forecast -- Institut de Mecanique celeste et de calcul des ephemerides (IMCCE)

Meteor Shower References:

- Handbook for Meteor Observers, edited by Jürgen Rendtel and Rainer Arlt, IMO, 2014.
- Meteor Shower Workbook, edited by Jürgen Rendtel, IMO, 2014.

- A Comprehensive List of Meteor Showers Obtained from 10 Years of Observations with the IMO Video Meteor Network, by Sirko Molau and Jürgen Rendtel (WGN, the Journal of the IMO 37:4, 2009, pp. 98-121).
- Peter Jenniskens, Meteor showers and their parent comets. Cambridge University Press, 2006, 790 pp.

Real Time Space Weather and Earth Effects

The occurrence of **unusual solar or geophysical conditions** is announced or forecast by ISES through various types of geophysical **"Alerts"** (which are widely distributed via the internet on a current schedule). Stratospheric warmings (STRATWARM) were also designated for many years. The meteorological telecommunications network coordinated by the World Meteorological Organization (WMO) carries these worldwide Alerts once daily soon after 0400 UT. For definitions of Alerts see ISES URSIgram Codes.

RECOMMENDED SCIENTIFIC PROGRAMS (FINAL EDITION)

(The following material was reviewed in 2017 by the ISES committee with the advice of representatives from the various scientific disciplines and programs represented as suitable for coordinated geophysical programs in 2018.)

Airglow and Aurora Phenomena.

Airglow and auroral observatories operate with their full capacity around the New Moon periods. However, for progress in understanding the mechanism of many phenomena, such as low latitude aurora, the coordinated use of all available techniques, optical and radio, from the ground and in space is required. Thus, for the airglow and aurora 7-day periods on the Calendar, ionosonde, incoherent scatter, special satellite or balloon observations, etc., are especially encouraged. Periods of approximately one weeks' duration centered on the New Moon are proposed for high resolution of ionospheric, auroral and magnetospheric observations at high latitudes during northern winter.

Atmospheric Electricity.

Non-continuous measurements and data reduction for continuous measurements of atmospheric electric current density, field, conductivities, space charges, ion number densities, ionosphere potentials, condensation nuclei, etc.; both at ground as well as with radiosondes, aircraft, rockets; should be done with first priority on the RGD each Wednesday, beginning on 03 January 2018 at 0000 UT, 10 January at 0600 UT, 17 January at 1200 UT, 24 January at 1800 UT, etc. (beginning hour shifts six hours each week, but is always on Wednesday). Minimum program is at the same time on PRWD beginning with 24 January at 1200 UT. Data reduction for continuous measurements should be extended, if possible, to cover at least the full RGD including, in addition, at least 6 hours prior to the indicated beginning time. Measurements prohibited by bad weather should be done 24 hours later. Results on sferics and ELF are wanted with first priority for the

same hours, short-period measurements centered around minutes 35-50 of the hours indicated. Priority Weeks are the weeks that contain a PRWD; minimum priority weeks are the ones with a QWD. The World Data Centre for Atmospheric Electricity, 7 Karbysheva, St. Petersburg 194018, USSR, is the collection point for data and information on measurements.

Geomagnetic Phenomena.

It has always been a leading principle for geomagnetic observatories that operations should be as continuous as possible and the great majority of stations undertake the same program without regard to the Calendar.

Stations equipped for making magnetic observations, but which cannot carry out such observations and reductions on a continuous schedule are encouraged to carry out such work at least on RWDs (and during times of MAGSTORM Alert).

Ionospheric Phenomena.

Special attention is continuing on particular events that cannot be forecast in advance with reasonable certainty. The importance of obtaining full observational coverage is therefore stressed even if it is only possible to analyze the detailed data for the chosen events. In the case of vertical incidence sounding, the need to obtain quarter-hourly ionograms at as many stations as possible is particularly stressed and takes priority over recommendation (a) below when both are not practical.

For the **vertical incidence (VI) sounding** program, the summary recommendations are:

a. All stations should make soundings on the hour and every quarter hour;
b. On RWDs, ionogram soundings should be made at least every quarter hour and preferably every five minutes or more frequently, particularly at high latitudes;
c. All stations are encouraged to make f-plots on RWDs; f-plots should be made for high latitude stations, and for so-called "representative" stations at lower latitudes for all days (i.e., including RWDs and WGIs) (Continuous records of ionospheric parameters are acceptable in place of f-plots at temperate and low latitude stations);
d. Copies of all ionogram scaled parameters, in digital form if possible, be sent to WDCs;
e. Stations in the eclipse zone and its conjugate area should take continuous observations on solar eclipse days and special observations on adjacent days. See also recommendations under Airglow and Aurora Phenomena.

For the **incoherent scatter observation program**, every effort should be made to obtain measurements at least on the Incoherent Scatter Coordinated Observation Days, and intensive series should be attempted whenever possible in WGIs, on Dark Moon Geophysical Days (DMGD) or the Airglow and Aurora Periods. The need for collateral VI observations with not more than quarter-hourly spacing at least during all observation periods is stressed.

Special programs are described by the 2018 World Day Schedule which lists Incoherent Scatter coordinated observation days. Data collection on such days starts by 1300 UT on the indicated start date and ends no later than 2000 UT the ending day (i.e., a 1 day experiment runs for at least 31 hours).

Month	Start Date	Length	Experiment
January	15-16	2	QB50 Field-Aligned/Vertical
January	10-31	10	StratWarm (see Note 1)
February	14-16	3	Patches
June	12-13	2	QB50 Field-Aligned/Vertical
June	6-20 alert	5	CONGSS (see Note 2)
Special Case	see Note 3	3	CME sudden commencement

Note 1: The decision to start this 10-day run will be based on predictions of Sudden Stratospheric Warming. In the case of no SSW event, the World Day will revert to a 5-day run at the end of the alert period, Jan 29 to Feb 3. There should be five days notice for the alert.
Note 2: The decision to start this alert-based run will be based on predictions of magnetic disturbances. The alert should be announced five days before the start of the run.
Note 3: The decision to start this alert-based run will be based on the prediction of an ICME. The alert window will last the entire year, with a best effort made by operators to respond. The alert should be announced five days before the start of the run. Intention is to catch the sudden commencement in as many radars as possible to look at the global response.

- AO -- Arecibo Observatory
- JRO -- Jicamarca Radio Observatory

Special programs: Contact Dr. Emma Spanswick (elspansw@ucalgary.ca) and Dr. Andrew Kavanagh (andkav@bas.ac.uk) for more information.

For the **ionospheric drift** or wind measurement by the various radio techniques, observations are recommended to be concentrated on the weeks including RWDs.

For **travelling ionosphere disturbances**, propose special periods for coordinated measurements of gravity waves induced by magnetospheric activity, probably on selected PRWDs and RWDs.

For the **ionospheric absorption** program half-hourly observations are made at least on all RWDs and half-hourly tabulations sent to WDCs. Observations should be continuous on solar eclipse days for stations in the eclipse zone and in its conjugate area. Special efforts should be made to obtain daily absorption measurements at temperate latitude stations during the period of the Absorption Winter Anomaly, particularly on days of abnormally high or abnormally low absorption (approximately October-March, Northern Hemisphere; April-September, Southern Hemisphere).

For **back-scatter and forward scatter** programs, observations should be made and analyzed at least on all RWDs.

For synoptic observations of **mesospheric (D region) electron densities**, several groups have agreed on using the RGD for the hours around noon.

For **ELF noise measurements of earth-ionosphere cavity resonances** any special effort should be concentrated during WGIs.

It is recommended that more intensive observations in all programs be considered on days of unusual meteor activity.

Meteorology.

Particular efforts should be made to carry out an intensified program on the RGD -- each Wednesday, UT. A desirable goal would be the scheduling of meteorological rocketsondes, ozone sondes and radiometer sondes on these days, together with maximum-altitude rawinsonde ascents at both 0000 and 1200 UT.

During **WGI and STRATWARM Alert Intervals,** intensified programs are also desirable, preferably by the implementation of RGD-type programs (see above) on Mondays and Fridays, as well as on Wednesdays.

Global Atmosphere Watch (GAW).

The World Meteorological Organization (WMO) Global Atmosphere Watch (GAW) integrates many monitoring and research activities involving measurement of atmospheric composition, and serves as an early warning system to detect further changes in atmospheric concentrations of greenhouse gases, changes in the ozone layer and in the long range transport of pollutants, including acidity and toxicity of rain as well as of atmospheric burden of aerosols (dirt and dust particles). Contact WMO, 7 bis avenue de la Paix, P.O. Box 2300, CH-1211 Geneva 2, Switzerland or wmo@wmo.int.

Solar Phenomena.

Observatories making specialized studies of solar phenomena, particularly using new or complex techniques, such that continuous observation or reporting is impractical, are requested to make special efforts to provide to WDCs data for solar eclipse days, RWDs and during PROTON/FLARE ALERTS. The attention of those recording solar noise spectra, solar magnetic fields and doing specialized optical studies is particularly drawn to this recommendation.

Variability of the Sun and Its Terrestrial Impact (VarSITI).

Program within the SCOSTEP (Scientific Committee on Solar-Terrestrial Physics): 2014-2018. The VarSITI program strives for international collaboration in data analysis, modeling, and theory to understand how the solar variability affects Earth. The VarSITI program has four scientific projects that address solar terrestrial problems keeping the current low solar activity as the common thread: SEE (Solar evolution and Extrema), MiniMax24/ISEST (International Study of Earth-affecting Solar Transients), SPeCIMEN (Specification and Prediction of the Coupled Inner-Magnetospheric Environment), and ROSMIC (Role Of the Sun and the Middle atmosphere/thermosphere/ionosphere In Climate). Contact: Dr. Nat Gopalswamy (nat.gopalswamy@nasa.gov), President of SCOSTEP or Prof. Marianna Shepherd (mshepher@yorku.ca), Scientific Secretary. Co-chairs are Katya Georgieva (SRTI, Bulgaria) and Kazuo Shiokawa (STEL, Japan). Detailed information on the VarSITI program is available at http://www.varsiti.org.

ILWS (International Living With a Star) International effort to stimulate, strengthen, and coordinate space research to understand the governing processes of the connected Sun-Earth System as an integrated entity. Contact info@ilwsonline.org.

ISWI (International Space Weather Initiative) -- a program of international cooperation to advance space weather science by a combination of instrument deployment, analysis and interpretation of space weather data from the deployed instruments in conjunction with space data, and communicate the results to the public and students. The goal of ISWI is to develop the scientific insight necessary to understand the science, and to reconstruct and forecast near-Earth space weather. ISWI runs science workshops, capacity building activities, and space science schools. Contact Dr. N. Gopalswamy, Executive Director at nat.gopalswamy@nasa.gov.

Space Research, Interplanetary Phenomena, Cosmic Rays, Aeronomy.

Experimenters should take into account that observational efforts in other disciplines tend to be intensified on the days marked on the Calendar, and schedule balloon and rocket experiments accordingly if there are no other geophysical reasons for choice. In particular it is desirable to make rocket measurements of ionospheric characteristics on the same day at as many locations as possible; where feasible, experimenters should endeavor to launch rockets to monitor at least normal conditions on the Quarterly World Days (QWDs) or on RWDs, since these are also days when there will be maximum support from ground observations. Also, special efforts should be made to assure recording of telemetry on QWDs and Airglow and Aurora Periods of experiments on satellites and of experiments on spacecraft in orbit around the Sun.

Meteor showers.

Of particular interest are both predicted and unexpected showers from the encounter with recent dust ejecta of comets (meteor outbursts). The period of activity, level of activity, and magnitude distributions need to be determined in order to provide ground truth for comet dust ejection and meteoroid stream dynamics models. Individual orbits of meteoroids can also provide insight into the ejection circumstances. If a new (1-2 hour duration) shower is observed due to the crossing of the 1-revolution dust trail of a (yet unknown) Earth threatening long-period comet, observers should pay particular attention to a correct determination of the radiant and time of peak activity in order to facilitate predictions of future encounters. Observations of meteor outbursts should be reported to the I.A.U. Minor Planet Center (mpc@cfa.harvard.edu) and International Meteor Organization (visual@imo.net). The activity curve, mean orbit, and particle size distribution of minor annual showers need to be characterized in order to understand their relationship to the dormant comets among near-Earth objects. Annual shower observations should be reported to national meteor organizations, or directly to the International Meteor Organization. Meteoroid orbits are collected by the IAU Meteor Data Center.

The International Space Environment Service (ISES) is a space weather service organization currently comprised of globally distributed Regional Warning Centers, Associate Warning Centers, and one Collaborative Expert Center (European Space Agency). ISES is a Network Member of the International Council for Science World Data System (ICSU-WDS) and collaborates with the World Meteorological Organization (WMO) and other international organizations, including the Committee on Space Research (COSPAR), the UN Committee on the Peaceful Uses of Outer Space (COPUOS), the International Union of Radio Science (URSI), and the International Union of Geodesy and Geophysics (IUGG). ISES works in close cooperation with the WMO and other international organizations to benefit from complementary activities that enhance the availability of data, the exchange of information, and the improvement and dissemination of services, recognizing the mutual interest in global data acquisition and information exchange, in common application sectors, and in understanding and predicting the coupled Earth-Sun environment.

The mission of ISES is to deliver, coordinate and improve operational space weather services. This is accomplished through the rapid exchange of space environment information; the sharing of best practices for data analysis and product development; and the open dissemination of products and services. ISES is organized and operated for the benefit of the international space weather user community.

Through its members, ISES shares data and forecasts and provides space weather products and services to users in their regions. Products and services include but are not limited to: forecasts, watches, warnings, and alerts of solar, magnetospheric, geomagnetic and ionospheric conditions; extensive space environment data; customer-focused event analyses; and long-range predictions of the solar cycle.

This Calendar for 2018 has been drawn up by Dr. R. A. D. Fiori of the ISES Steering Committee, in association with spokesmen for the various scientific disciplines in the Scientific Committee on Solar-Terrestrial Physics (SCOSTEP), the International Association of Geomagnetism and Aeronomy (IAGA), URSI and other ICSU organizations. Similar Calendars are issued annually beginning with the IGY, 1957-58, and are published in various widely available scientific publications. PDF versions of the past calendars are available online.

Published for the International Council of Scientific Unions and with financial assistance of UNESCO for many years.

Copies are available upon request to ISES Director, Dr. Terry Onsager, NOAA Space Weather Prediction Center, 325 Broadway, Boulder, CO, 80305, USA, telephone +1-303-497-5713, FAX +1-303-497-3645, e-mail Terry.Onsager@noaa.gov, or ISES Secretary for World Days, Dr. Robyn Fiori, Geomagnetic Laboratory, Natural Resources Canada, 2617 Anderson Road, Ottawa, Ontario, Canada, K1A 0E7, telephone +1-613-837-5137, e-mail robyn.fiori@canada.ca. Beginning with the 2008 Calendar, all calendars are available only in digital form.

The website for the International Geophysical Calendar, including recent versions, can be found here.