

Reasons For The Seasons

User's Guide

A Supplemental Document accompanying the paper:

“Exploring the reasons for the seasons using Google Earth, 3D models, and plots”
by Declan De Paor, Mladen Dordovic, Paul Karabinos, Stephen Burgin, Filis Coba,
and Steven Whitmeyer. International Journal of Digital Earth, 2016.

Reasons For The Seasons
A learning resource for students of all ages.

[Download KML](#)

Instructions
To open the KML file, you need the Google Earth desktop app installed on your computer. Get it [here](#). Google Earth for mobile devices is not supported.

Resources for Instructors
To test students' learning outcomes, instructors can download a pre-/post-test and key.
For the password to the key, please contact info@geode.net using your academic email address.

[Download Test »](#) [Download Key »](#)
[User Manual](#)

Part of Project
GEODE
Google Earth for Onsite and Distance Education


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Fig. 1. RFTS home page.

Introduction

Reasons for the seasons (RFTS for short) is an interactive learning resource that leverages the popular Google Earth virtual globe. It is designed to help students and members of the public visualize and understand the multiple factors that influence Earth's seasons. The home page URL is geode.net/rtfs (Fig. 1). A KML file can be downloaded from: <http://geode.net/RFTS/> and opened with the Google Earth desktop application. Google Earth itself can be downloaded from [https:// www.google.com/earth/desktop](https://www.google.com/earth/desktop). Prior to using

RFTS, it is recommended that you practice basic Google Earth navigation, such as zooming and changing the camera angle using shift-click and drag, arrow keys, or the navigation control at top right in the main window.

Once the KML file is loaded, you see the view as in Fig. 3. You should: (1) make the Sidebar visible in the View menu; (2) deselect everything in the layers sidebar; and (3) collapse it and the search box. It is important to ensure that “Grid” is unchecked in the “View” menu, as well as “Atmosphere” and “Sun.” “Toolbar” and “Sidebar” are the only items that should be checked under the “View” menu.

By default, KML files load into “Temporary Places.” The contents can optionally be dragged into “My Places” so that they are preserved when the program is quitted and relaunched. However, any other items in “My Places” must be deselected (Fig. 3).

At launch time, credits are display in a bright red and yellow screen overlay at bottom left (Fig. 3). Deselect it by unchecking the box beside the word “Credits” in the “Places” sidebar.

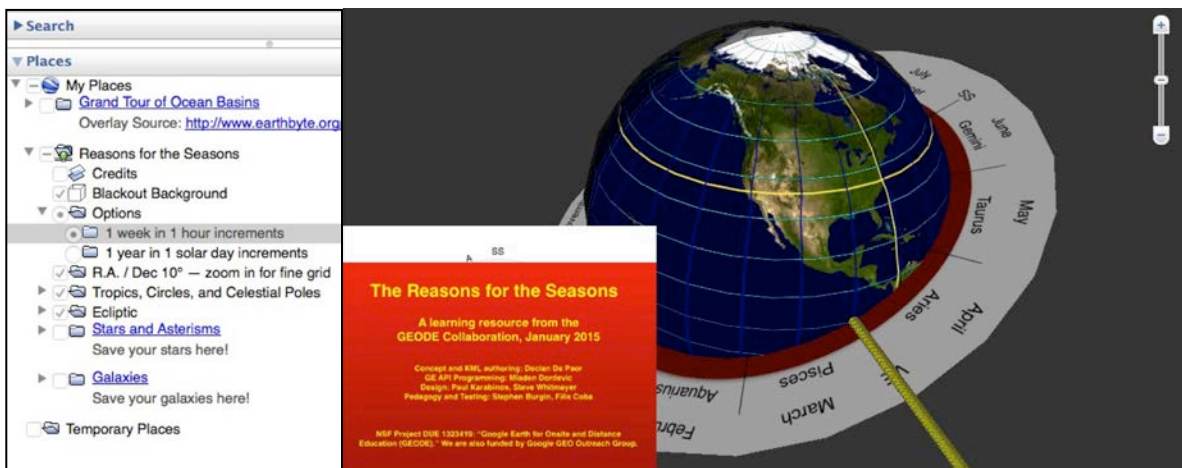


Fig 3. KML file for RFTS opened with the Google Earth desktop application.

Options

Clicking the small triangle next to the “Options” folder reveals its contents (Fig. 3). There are two choices: “1 week in 1 hour increments” and “1 year in 1 solar day increments.” Each causes the time slider control to appear at top left of the main window (Fig. 4). Clicking the Play button starts the animation. Animation speed can be controlled with the wrench tool. Due to a Google Earth bug, the globe flashes white as images are loaded for the first time. You should run the time slider slowly to cache images and get past this initial flashiness.

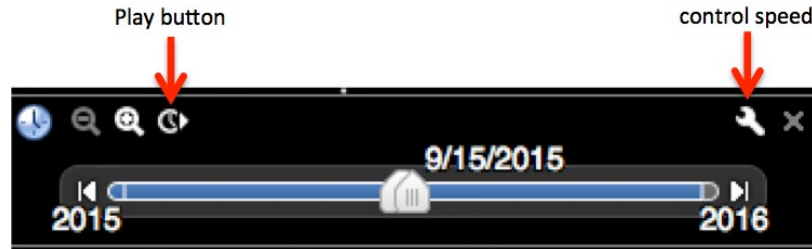


Fig. 4. The Google Earth timeline control.

When “1 week in 1 hour increments” is selected (Fig. 5), the main thing you see is the Earth spinning under the fixed r.a./dec grid. The “Blackout Background” option should be checked to hide the potential confusing Google Earth background sky during animations (unfortunately it cannot be deselected and behaves differently from the API version). The blackout is oriented for a view looking down on North America but can be easily changed for other views by right clicking, selecting Get Info (Mac) or Properties (PC), and editing the object’s lat/lon coordinates.

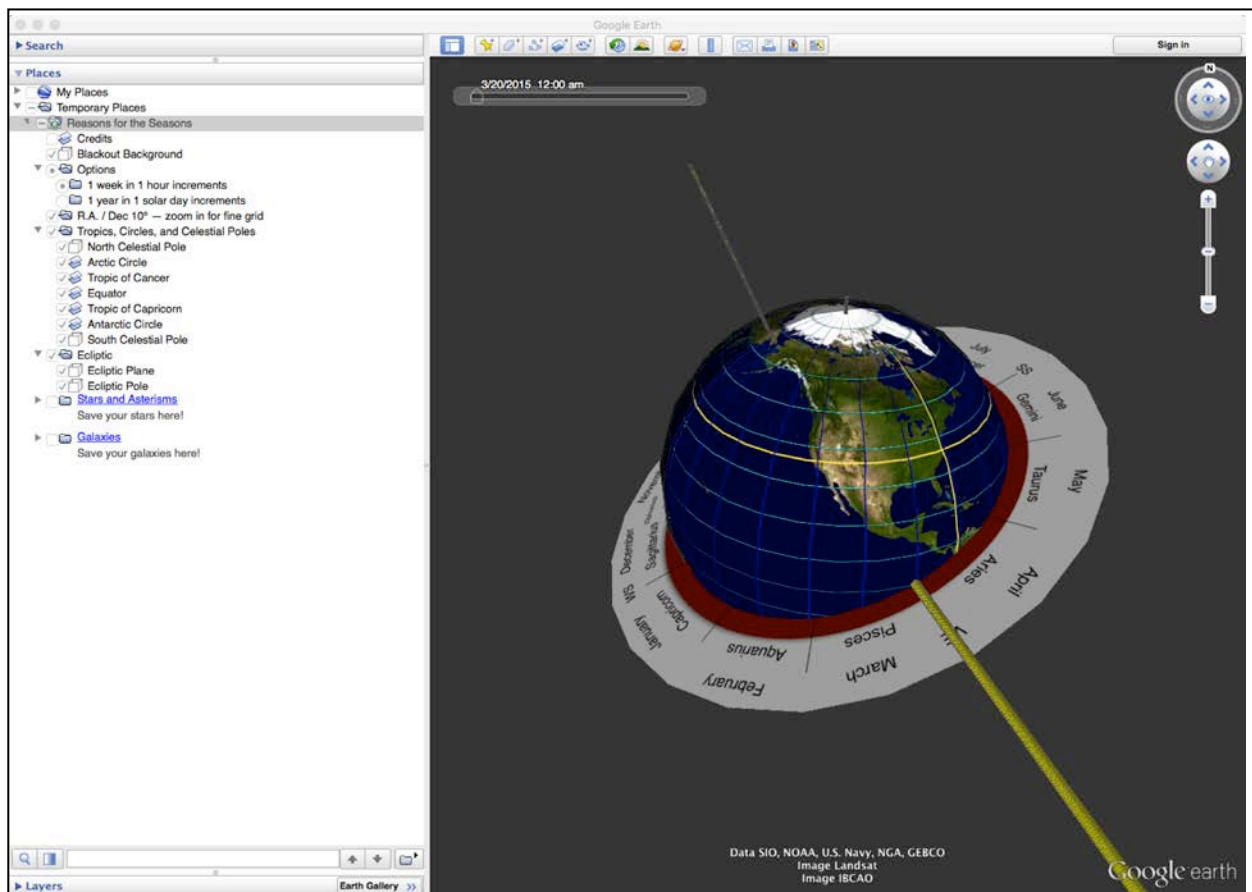


Fig. 5. View when “1 week in 1 hour increments” is selected. Google Earth background sky is hidden.

As explained in the main paper, the blue great circles are lines of right ascension and the cyan small circles are lines of equal declination. After a few days, you should notice that the sunbeam is moving along the ecliptic. It migrates along the ecliptic approximately 1° per day.

When “1 year in 1 solar day increments” is chosen, the Earth appears to rotate slowly. This is due to the fact that it rotates 361° per solar day (24 hours) so somewhat like wagon wheels in cowboy movies, you don’t notice the full circle. It only takes 23:56:04 (or 1 sidereal day) to rotate 360° but it takes the extra few minutes for the Sun to cross one’s meridian.

A white screen overlay (Fig. 6) at bottom left of the main window shows the Earth as a tiny (but still exaggerated) green dot orbiting the yellow Sun as viewed looking down on the ecliptic plane (Fig. 6). A green line through the green dot shows the constant trend of Earth’s axis as it orbits. This heliocentric overlay may help you relate to the geocentric view in Google Earth. Because of its distance from Earth, the Sun cannot be shown in the latter view but a yellow central sunbeam extends out into space. When the animation is run, the screen overlay changes in step with the main window view.

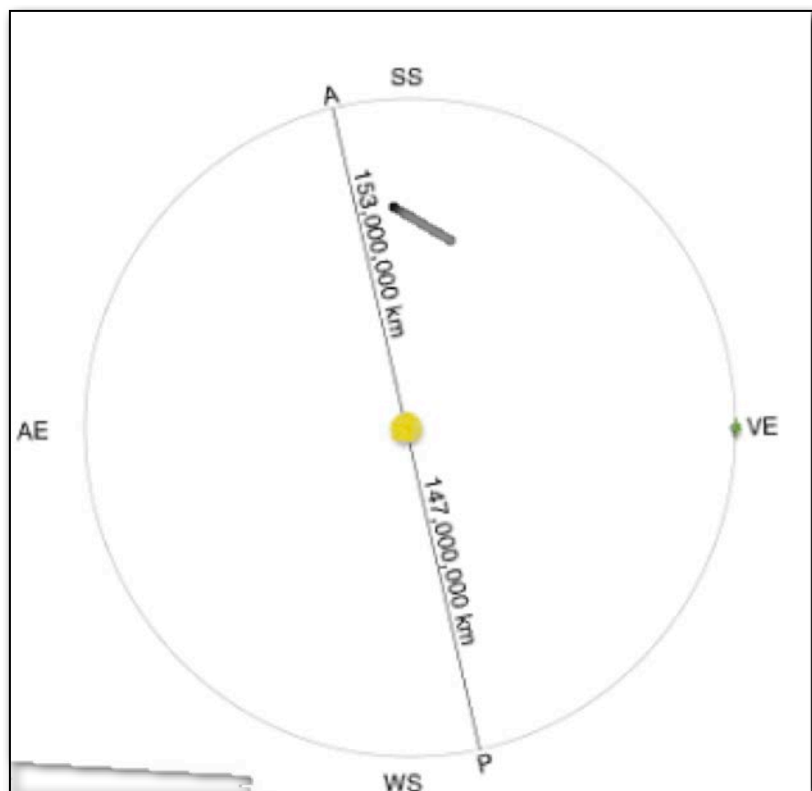


Fig. 6. The screen overlay located at the bottom left corner of the Google Earth when 1 year in 1 solar day increments is chosen. The central yellow sphere is the Sun, and the tiny green dot initially next to vernal equinox (VE) represents the Earth. The Earth orbits the Sun when the animation is run.

If you click the \oplus sign next to “Tropics, Circles, and Celestial Poles” then the folder expands to reveal a list of reference items that you can show on the globe (Fig. 7 a). The next folder allows one to show or hide the ecliptic plane and/or pole (Fig. 7 b).

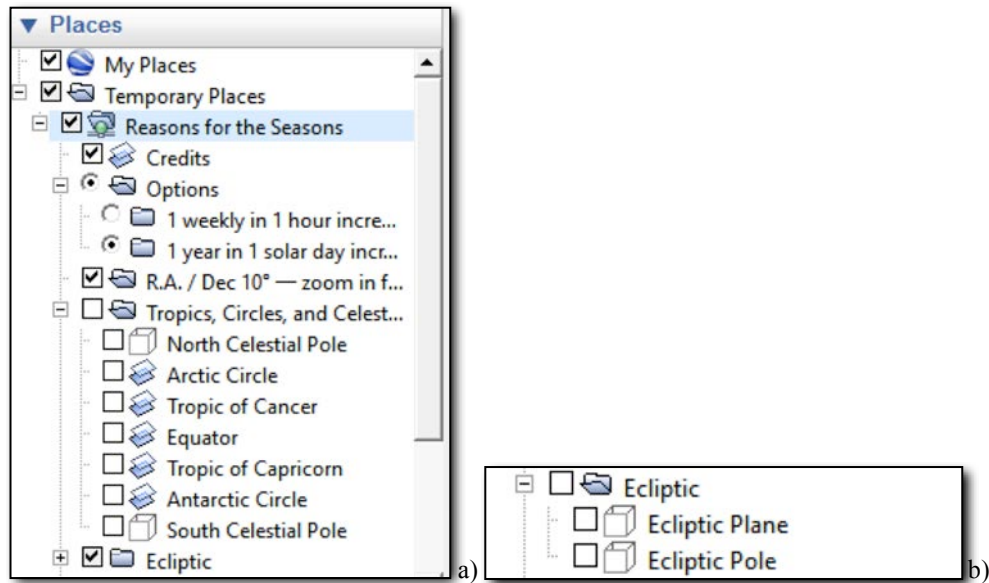


Fig. 7. a) Places toolbar after expanding the “Tropics...” folder. b) The “Ecliptic” folder expanded.

As explained in the main paper, you can use the Google Earth “Ruler” tool set to degrees to measure the azimuth (“Heading”) and zenith angle (“Map Length”) of the Sun (Fig. 8 a). The Sun’s altitude is simply 90° minus the zenith angle. If the time slider thumbs are separated, a series of sunbeams with varying azimuths and altitudes can be created (Fig. 8 b)

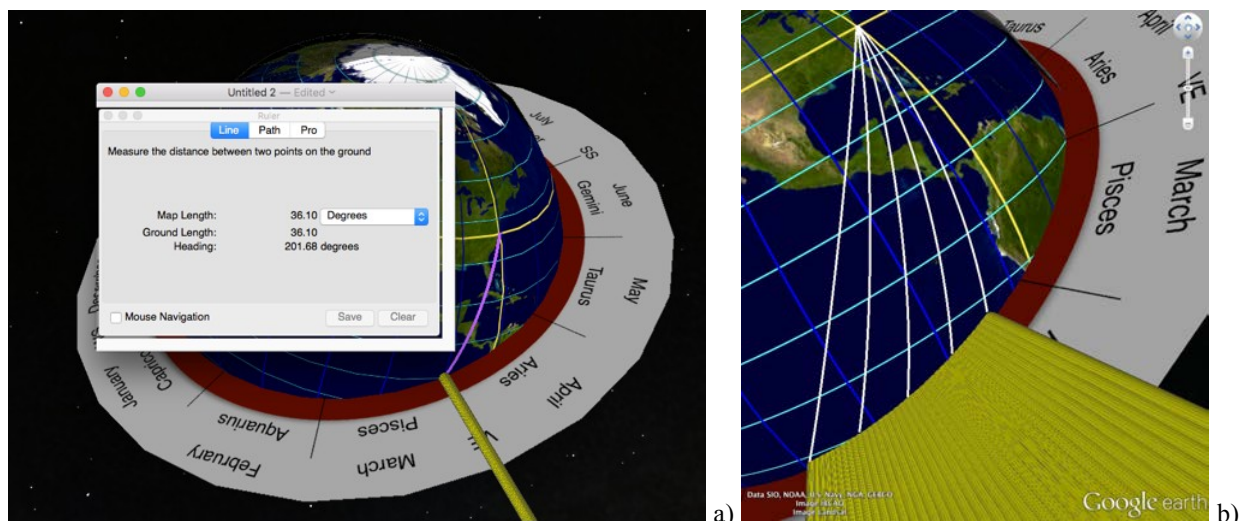


Fig. 8. a) Google Earth “Ruler” tool set to degrees. b) Expanding time slider thumbs.

Beyond Seasons

The KML file can be used for astronomy learning beyond the reasons for the seasons.. The folder “Stars and Asterisms” contains the stars in the Big Dipper asterism, the Big Dipper stick figure, and the celestial sphere—a whiteout that hides the Earth’s terrain, allowing you to concentrate on angular measurement (Fig. 9 a, b, c). This shows that stars in any given constellation need not be near each other, some can be much further from the Earth than others.

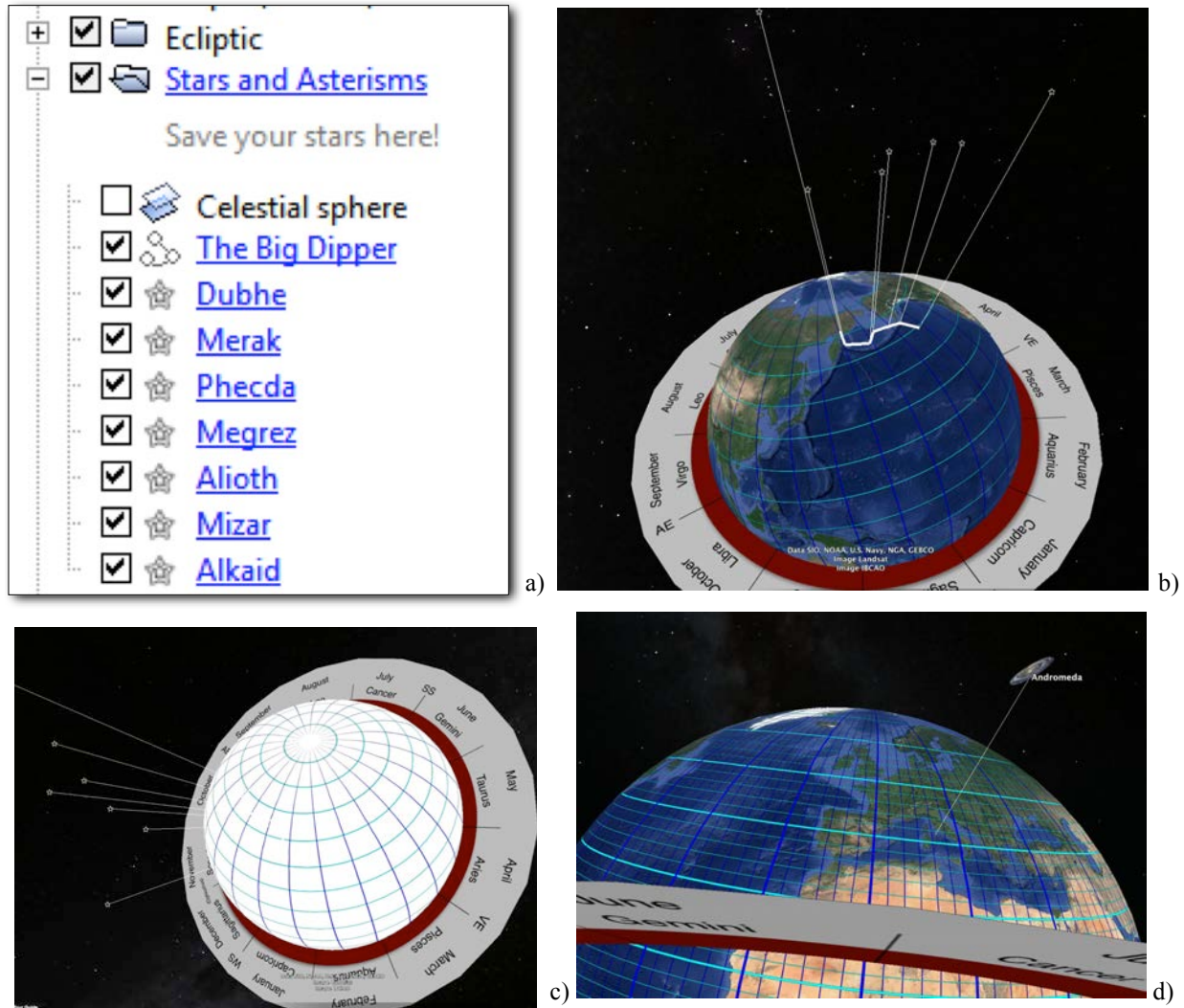


Fig. 9. a) Stars and Asterisms folder expanded. b) Stars with their relative positions away from the Earth scaled. c) The celestial sphere blanks out the Earth’s terrain. The r.a./dec coordinates of stars are fixed. d) Screenshot with Andromeda checked in the Galaxies folder.

The final folder is “Galaxies.” It contains an image of the Andromeda galaxy (Fig. 9 d). Obviously distances are not to scale but r.a./dec coordinates are accurate. You can create your own asterisms and galaxies with the Google Earth “Placemark” tool.

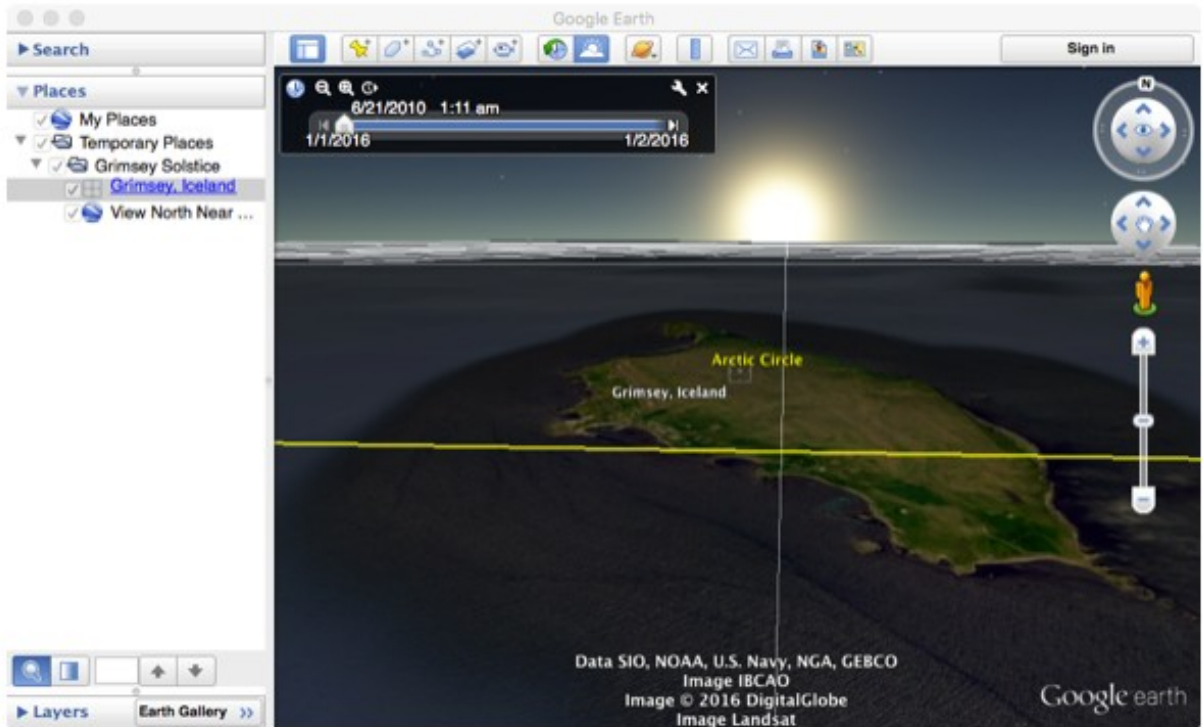


Fig. 10. Midnight Sun, Grimsey Island, Iceland.

Conclusion

In addition to the features in our KML download, you can explore the build-in features of Google Earth to study weather and seasonality. For example, there is weather information in the “Layers” sidebar. Turning on the 3D terrain helps illustrate the relationship between landscape, topography, and seasons. Historical imagery can show changes in weather with time. The main paper discusses how you can view the midnight Sun on the Arctic Circle on the summer solstice.

We hope you find this resource useful. Please send feedback to ddepaor@odu.edu. Enjoy!

Acknowledgment

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