Current Weather Studies 3B:

SUNLIGHT THROUGHOUT THE YEAR

1. Print this file and associated images. Also answer the Thursday "Concept of the Day" questions in the Daily Summary File.

2. Complete the Investigation by responding to the *Chapter Progress Questions* (*Study Guide* binder) and the introductory portion of Investigation 3B from the *Weather Studies Investigations Manual*.

A suite of weather satellites in geosynchronous (also called geostationary) orbit provides a constant view of the Earth with their visible, infrared and water vapor sensors. Each satellite, revolving eastward at the same rate the Earth rotates, remains over a fixed spot on Earth's equator so its view of Earth remains the same. These satellites are crucial to storm surveillance, particularly over data-sparse areas. They also demonstrate the receipt of sunlight at locations over the Earth during the year. The **Applications** portion of Investigation 3B in the *Weather Studies Investigations Manual* displays visible views from the U.S. Geostationary Operational Environmental Satellite (GOES) East when sunset was occurring on the equator directly under the satellite (subsatellite point) for those astronomically important days of equinox and solstices. These geosynchronous satellites provide monitoring of the Earth with full disk views available online at 6-hour intervals. The U.S. currently has two GOES satellites observing the Earth.

Full disk views of Earth are available online in near real time. Image 1 is the full-disk visible view from the European METEOSAT geosynchronous satellite at 1200Z 8 February 2012. Because the METEOSAT's subsatellite point is over the equator at 0° longitude and Z time (UTC) is the local standard time at 0° longitude (called the Prime Meridian), the time (1200Z) of the image coincides with local noon along the Prime Meridian.

1. At this noon time along the Prime Meridian, the Earth in Image 1 is illuminated **[(*only in the eastern portion of the disk*)(*fully over the whole disk*) (*only in the western portion of the disk*)]**.

To observe the sunlight illumination on the Earth on any day of the year, at any time, go to the U.S. Naval Observatory website listed in the Monday Current Weather Studies (http://aa.usno.navy.mil/data/docs/earthview.php), under **Earth: Cylindrical Projection**, enter the data -Year: *2012*, Month: *February*, Day: *8*, Hour: *12*, and Minute: *00*, then click ***Show Earth Map***. (You may need to reduce the image size to view the full Earth.)

2. As noted in the Naval Observatory display, at this time of year – 8 February, more sunlight is reaching Earth in the **[(*Northern*)(*Southern*)]** Hemisphere. (The Image 1 METEOSAT view appears totally illuminated because the satellite at its orbital distance from Earth can only image about one-third of the planetary surface.)

On that same website, under **Earth: Spherical Views**, select View: *North* with Month: *February*, Day: *8*, Hour: *12*, and Minute: *00*, and then click on ***Show Earth View.*** The North Pole is centered in the circular display. Observe the proportion of the Northern Hemisphere that is illuminated. Then reset the View to *South* with the same date and time, noting again the proportion of the Southern Hemisphere about the South Pole that is illuminated. (You may wish to open two windows to click between hemisphere displays to see this comparison.)

3. Considering the illumination pattern shown in Question 2, the Northern and Southern Hemisphere Spherical Views **[(*are*)(*are not*)]** consistent with that illumination pattern.

Image 2 is a full-disk visible view from U.S. GOES East satellite at essentially the same time as the METEOSAT. Compare the images and note that the sunlit portion of the Image 2 disk is not complete; the result of that portion of Earth's surface has not yet rotated fully into daylight.

On the GOES East Image 2 there are yellow arrows at the top and bottom of the page. Connect these arrows with a line. This line represents the rotation axis of Earth similar to Figure 7 of the Investigation 3B Application section. A light blue line has been drawn to denote the position of the equator. Also, there are two red tic marks along the margin near the poles that represent the extension of the terminator line (recall Image 1 of the Monday Current Weather Studies 3A) approximating sunrise in this case. Connect these tic marks with a straight line to approximate the terminator. [Note: Due to the illumination of a spherical Earth shown on a flat image, the terminator line is not to scale or exact position.]

4. Note the areas near the North and South Poles. The yellow arrow representing the South Pole is located to the daytime side of the terminator. The period of daylight at the South Pole would therefore be **[(*0*)(*12*)(*24*)]** hours.

5. The yellow arrow representing the North Pole is located to the nighttime side of the terminator. The period of daylight at the North Pole would therefore be **[(*0*)(*12*)(*24*)]** hours.

6. Using the lower left corner of a sheet of paper for a right angle, place the left edge of the paper along the terminator line. Slide the paper's left edge along the terminator. The bottom edge of the paper shows the direction of the Sun's incoming rays at this time. These rays show that sunlight at this time of year is received more directly in the **[(*Northern*)(*Southern*)]** Hemisphere.

The amount of solar energy reaching Earth's surface is the result of the length of the daylight period and the directness, angle to the surface, of the Sun's rays. The energy is shown for three latitudes in Figure 1 of Investigation 3B. The changing energy receipts determine the seasons at any location. These sunlight receipts can also be monitored as a by-product of weather satellite imagery.

Full disk visible and infrared satellite images similar to those used in this investigation can be found via the course website **Satellite** section link, "GOES Satellite Server", then GOES Full Disk, METEOSAT, MTSAT (Japanese satellite) or Indian Ocean Images in the left menu list. In this way you can track Earth's rotation through its sunrises and sunsets and keep tabs on storm systems around the world.

Suggestions for further activities: One can calculate the position of the Sun in the sky for your local position. The NOAA Solar Position calculator site (http://www.srrb.noaa.gov/highlights/sunrise/azel.html) provides the solar declination angle as well as the solar elevation and azimuth angles for any time of day and day of the year. In this way, you could check the theoretical astronomical values with your observed Sun paths.

An animation that compares Earth's orbital revolution to its daily illumination from the Sun over the year is http://www.youtube.com/watch?v=000-3JYM0NI&feature=related.

Answer the **Current Weather Studies** activities on the CWS *Answer Form* (provided from the course website on Wednesdays).

Instructions for Communications with Mentor:

Transmit this week's work to your LIT mentor by Monday, 13 February 2012, or as coordinated with your mentor. Include:

- **Chapter Progress Response Form** from the *Study Guide* or the course website.
- **Investigations Answer Form** for 3A and 3B from the *Study Guide* or course website.
- **Investigation 3B** page 3B-3 from the *Weather Studies Investigations Manual*.
- **Current Weather Studies Answer Form** for 3A and 3B from course website.

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