Circulation of Earth's Real Atmosphere

Striking evidence of the general circulation of the atmosphere can be seen via animated satellite views of Earth. Go to the following animation of full-disk views of Earth as seen from the European METEOSAT geostationary weather satellite located above the Gulf of Guinea: *http://www.gerhards.net/astro/wolken_200705_en.html*.

12. Scroll down to the global view and click on the play button to the lower left of the image to start the animation. The view is centered on Earth's surface directly under the satellite at the intersection of the equator (0° Latitude) and the Prime Meridian (0°Longitude). This animation shows Earth's cloud circulation during a full month (May 2007) as seen in EUMTSAT infrared imagery. The bright, blotchy clouds in the equatorial region can be seen flowing generally from **[(*west to east*)(*east to west*)]**. (Clouds move with the horizontal wind and so their motions are an indicator of wind direction.)

13. This band of bright clouds in the equatorial region is an indication of **[(*sinking*)(*rising*)]** air. The band generally marks the locations where surface winds in the Northern and Southern Hemispheres blowing towards the equator meet. Called the ITCZ (Intertropical Convergence Zone), the band of cloudiness is characterized by the bright clouds indicating intense thunderstorm activity and by high rainfall rates. It roughly parallels the equator around the globe.

14. The animation shows that to the north and south of the ITCZ are broad expanses of relatively clear skies (e.g., Sahara Desert of northern Africa and the Kalahari Desert of southern Africa). Similar extensive clear sky areas are found around the globe at about the same northern and southern latitudes. The general absence of clouds implies that at these latitudes, the atmosphere exhibits persistent **[(*sinking*)(*rising*)]** air motion.

15. Note the wisps of less bright clouds that are frequently seen spewing towards higher latitudes from the ITCZ cloud complexes. They are high-altitude clouds moving towards the **[(*northwest in the Northern Hemisphere and towards the southwest in the Southern Hemisphere*)(*northeast in the Northern Hemisphere and towards the southeast in the Southern Hemisphere*)]**. Their motions are consistent with global circulation models that depict low-latitude circulations resembling convection currents between the ITCZ and about 30 degrees N and S. These are the **Hadley cells**. The surface components of these cells are the Northeast Trade winds in the Northern Hemisphere and the Southeast Trades in the Southern Hemisphere.

16. Further examination of the animation shows that in the middle latitudes poleward of the relatively clear areas in both the Northern and Southern Hemispheres are swirls of clouds marching generally from **[(*west to east*)(*east to west*)]**. These cloud motions also show a tendency for movement towards higher latitudes.

The satellite images we have been examining in this animation show only about 42% of Earth's surface due to the satellite being positioned in space at an altitude of about 36,000 km

(22,300 mi) above Earth's surface. Geostationary satellites are not positioned far enough from Earth to provide views of Earth's surface and atmosphere at the highest latitudes. Consequently, the animation being examined does not show atmospheric circulations in polar regions. However, it does provide considerable visual evidence of the general circulation of Earth's atmosphere.

[Similar recent full-disc animations of geostationary satellite views from around the world ending with the latest imagery available can be found via: *http://www.ssec.wisc.edu/data/geo/*. At this website, at the left, click on "8 Image Animation" button under "Latest Image/ Animation", and under "Geographic Coverage", click on "Full Disk" button.]

Global Views of Earth's General Circulation: To view the latest ten-day global montage movie which includes cloud-top satellite infrared imagery, go to either:

(AniS Java format) - *http://www.ssec.wisc.edu/data/comp/cmoll/cmoll.html*
(MPEG format) - *http://www.ssec.wisc.edu/data/comp/cmoll/cmoll.mp4*

Updated every six hours, the global montage contains cloud images that are a combination of GMS, GOES-8, and Meteosat imagery. Sea surface and synoptic observation temperatures over land are also presented in the montage. The AniS Java format enables you to set the animation speed bar above the image. In the MPEG format version, you can control animation speed by repeated clicking on the forward button at the lower center of the image.

17. During the period of the global montage animation you are viewing, clouds in Earth's tropical region show a worldwide general motion that trends towards the **[(*east*)(*west*)]**.

18. The swirls of clouds at the middle and higher latitudes show a worldwide general motion that trends towards the **[(*east*)(*west*)]**.

Note the daily changes in temperatures over land surfaces. The temperatures are coded as shown in the "SYNOPTIC OBS" portion of the color bar under the montage. The time is reported in the bottom line of data in Coordinated Universal Time (UTC).

19. Observe daily temperature changes at a particular location by focusing on Ghana in western Africa (located close to the equator and on the Prime Meridian). There, at 0° Longitude, the local time for 00 UTC is midnight, 06 UTC is 6 am (about sunrise), 12 UTC is 12 noon, and 18 UTC is 6 pm (about sunset). Watching several daily cycles, the minimal daily temperatures seen on the sequence of images is at **[(*midnight*)(*6 am*)(*noon*)(*6 pm*)]** local time.

20. Now, over several daily cycles, note the longitudinal change in the temperatures of land surfaces as a day progresses. The locations of highest land-surface temperatures (the regions of deepest red color) migrate from **[(*east to west*)(*west to east*)]**.

Summary: The planetary-scale circulation of Earth arises from the combined effects of Earth's directional receipt of solar energy and Earth's rotation. The daily temperature cycles

observed in Items 19 and 20 result from the combined effects of the receipt of solar energy and Earth's rotation. Being close to the Equator, Ghana experiences nearly equal periods of daylight and darkness that produce a fairly uniform daily temperature range throughout the year. The migration of daily high temperatures observed in Item 20 results from the eastward rotation of Earth. These are aspects of Earth's directional receipt of solar energy and Earth's rotation that are the primary boundary conditions that determine Earth's climate system.