

Satellite Cloud Notes

Satellite Observations

Satellites observe cloudiness by measuring electromagnetic radiation at a variety of wavelengths (e.g., visible, infrared, microwave). Most satellites use *passive* remote sensing (the satellite measures whatever radiation happens to be reflected or emitted by the Earth) but a few current and upcoming satellites (TRMM, Cloudsat) use *active* remote sensing (the satellite measures the return of its own emitted radar or lidar signal). Active remote sensing is costly in power resources and hence not frequently implemented. Two common satellite orbits are *geostationary* and *sun-synchronous* (polar-orbiting). Geostationary satellites are GOES-East (U.S.), GOES-West (U.S.), Meteosat (Europe), and GMS (Japan). Sun-synchronous polar orbiters are typically in “morning” or “afternoon” orbits.

	<u>geostationary</u>	<u>sun-synchronous</u>
orbital inclination	0°	99°
orbital period	1 day	100 minutes
altitude above equator	36000 km	800 km
orientation to surface	above same point on Earth at all local times of day	above different points of Earth all at same local time of day
low- and midlatitude sampling	most of hemisphere and complete diurnal cycle	narrow swaths and limited diurnal cycle
polar sampling	not observable	overlapping swaths can provide nearly complete diurnal cycle
advantages	simultaneous view of large area of Earth at all times of day	close-up view of Earth and good polar sampling
disadvantages	far away and cannot view poles	geographical gaps and poor diurnal sampling at lower latitudes

Satellite Observing Wavelengths

Visible: The source of visible radiation is the Sun. It is primarily transmitted through the clear atmosphere but is partially reflected by clouds. The surface (except snow/ice) primarily absorbs visible radiation. Measurement of reflected visible radiation is used to identify cloudiness at any level of the atmosphere during daylight hours. Clouds may be difficult to identify if they are thin (and thus not very reflective) or if they occur over snow and ice.

Infrared (water vapor window): The surface of the Earth emits infrared radiation (also the Sun in the near infrared). Clouds absorb and re-emit infrared radiation. The clear atmosphere absorbs little and emits little radiation at the wavelength of the water vapor “window”. The amount of emitted radiation increases with increasing temperature of the emitting substance (and is thus related to height above the surface). Measurement of infrared radiation in the water vapor window is used to identify cloudiness and especially the height of cloud top at all hours of the day. Clouds may be difficult to identify if they are very thin (and thus partially transmissive) or if they occur over cold surfaces.

Infrared (water vapor): As for infrared in the water vapor window, except the clear atmosphere absorbs and re-emits infrared radiation at water vapor wavelengths (most of the infrared spectrum). The amount of absorption and re-emission increases with increasing specific humidity. Measurement of infrared radiation at water vapor wavelengths is used to identify moist regions of the atmosphere.

Microwave: Emitted by the surface, water vapor (depending on wavelength), and cloud liquid water. Measurement of microwave radiation is used to estimate total water vapor and liquid water in the atmospheric column over oceans.

