Sundials

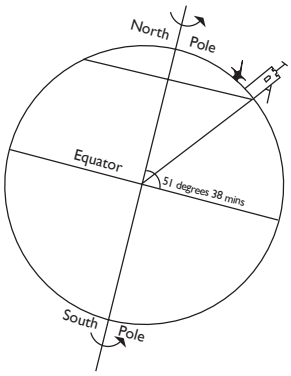
Advanced Composition Explorer (ACE) satellite

The CCLRC Rutherford Appleton Laboratory (RAL) Ground Station receives data from the ACE satellite, which is 1.5 million kilometres above the Earth in the direction of the Sun. The satellite measures the particles and magnetic fields in the solar wind, enabling scientists to predict electromagnetic events that could disrupt satellite or ground-based communications systems. The data gathered at RAL are sent to the Space Environment Center in the USA for processing, and the results can be viewed on the World Wide Web.

http://sec.noaa.gov/ace/

How a sundial works

You might think that a satisfactory sundial can be made by mounting a vertical rod on a horizontal surface or a south-pointing rod on a south-facing vertical surface. However this will only tell you when it is noon, ie the time when the Sun is in the south. For a full set of hour marks the gnomon (the straight marker which makes the shadow on the dial plate) of the sundial must be aligned parallel with the axis of rotation of the Earth.



A horizontal garden sundial needs a gnomon pointing due north inclined at an angle equal to the latitude of the place. With a sundial on an approximately south facing wall, the gnomon must point due south dipping down by the same angle. The time shown on the sundial is the local apparent solar time ie the time in the place according to the Sun. Readings are taken using the upper edge of the gnomon. Correct positions of the hour marks on the dial plate can be calculated. If the sundial is on a wall facing due south the hour marks are symmetrically marked. The asymmetry on the sundial illustrated is because the wall faces 12° east of south rather than due south.

The Earth's orbit about the Sun is not circular. It is elliptical with an angle of 23.5° to the equator. Therefore the Earth's apparent motion is not uniform. 24 hours is only the average (mean) solar day. The length of the apparent solar day varies with the time of year. Sundials run alternately slow and fast during the year: slow from Christmas to mid-April, fast until mid-June, slow until early September and then fast until Christmas. These variations are quite predictable and cancel each other out over the year. For clock-setting purposes (yes, sundials were used to set early clocks which were unreliable and needed frequent re-setting) you need to read the apparent solar time from the sundial, and adjust it by up to 16 minutes. This gives a local 'mean' time which can then be adjusted to take account of longitude. Every four minutes, the Earth turns through 1° of longitude, so in a place 2° west of Greenwich you need to add 8 minutes to the local mean time to give Greenwich Mean Time (GMT). It was only with the coming of the railways in the mid 19th century that standardised time became necessary; before then people happily worked on local time.

Images of sundials

This sundial is on the south wall of St. Mary's church in Long Wittenham, Oxfordshire. At midday it will show 12 noon local solar time. Corrections have to be made to turn this time into GMT, but when these are made the sundial is accurate to 5 or 10 minutes.