Earth radiation budget radiometers

Instrument catalogue

- ACRIM III
- CERES
- ERBE
- ERBS
- GERB
- ISP
- KGI-4C
- NISTAR
- PREMOS
- RTER
- ScaRaB/MV2
- SIM
- SODISM
- SOLSTICE
- SOVAP
- SUSIM (UARS)
- TIM
- TSIS

Description

The Earth's radiation budget is the balance between the incoming radiation from the sun and the outgoing reflected and scattered solar radiation plus the thermal infrared emission to space. A number of instruments contribute to measurements of these parameters; the discussion here focuses on those instruments specifically designed to study radiation budget as their sole or primary mission.

In general, different instruments are used to measure the different components of the radiation budget:

– broadband radiometers: to cover the full range of incoming solar radiation (0.2 – 4.0μm) and to monitor the long-wave emitted Earth radiation (3 – 50μm);

– short-wave radiometers: to measure the reflected short-wave radiation from the Earth.

The instruments offer high radiometric accuracy to provide accurate absolute measurements (~ 1 Wm^{-2} is needed). Most radiometers have a narrow field of view and are used to measure the radiance in a particular direction. Using this, together with information on the angular properties of the radiation, the radiation flux may be obtained. Advanced instruments have a directional capability and channels which allow study of the anisotropy and polarisation characteristics of the radiation fluxes.

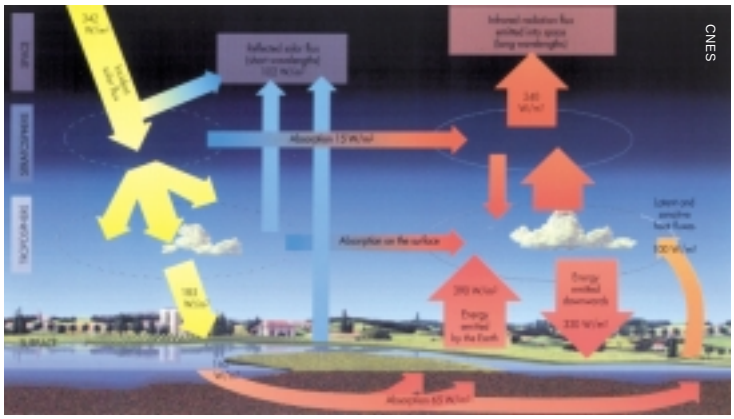
NISTAR, which will be placed in orbit at the Lagrange point L1 (the point between the Earth and the Sun at which the gravitational pull of each is cancelled out), will be the first instrument capable of providing continual observations over the key measurement angle range for the entire Earth and will supplement low Earth orbit and geosynchronous orbit observations.

Future geostationary satellites will measure the shortwave and longwave radiation from the Earth every 15 minutes, and will provide much needed improvements in temporal sampling.

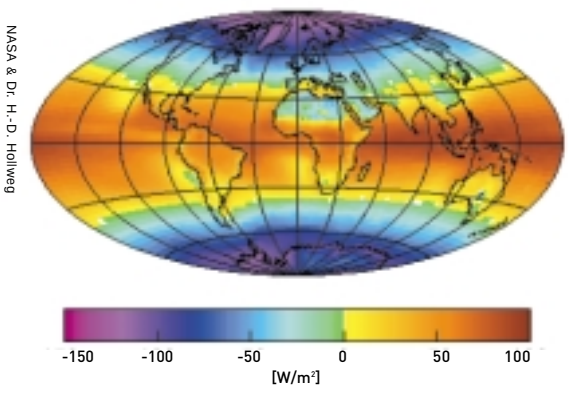
Applications

Solar radiant energy is a major driver of the Earth's climate. The reflection, absorption, and re-emission of that energy is done through a complex system of clouds, aerosols, atmospheric constituents, oceans, ice and land surfaces. Variations in this complex system are the source of changes in the Earth's radiation balance. While the input of energy from the sun is well understood, the amount of radiation leaving the Earth through this complex system is not. Thus, the models that assimilate all of the known characteristics of the Earth, its atmosphere, and the best measurements of the net radiation energy budget, have different predictions. It is theorised that as much as 25% of the anticipated global warming of the earth may be solar in origin. In addition, seemingly small (0.5%) changes in the total solar irradiance (TSI) output of the sun over a century or more may cause significant climatological changes on earth.

Earth radiation budget radiometers offer a unique contribution to understanding of the budget, together with its relationship to global warming such as that resulting from the greenhouse effect. In addition, information from these instruments is of interest in studies of clouds (to investigate cloud radiation forcing, for example) and albedo. Planned measurements will have unprecedented accuracy (0.1%) and precision (relative changes of 0.03%) – which is necessary for detecting the small changes in Earth's radiances that correspond to the incremental changes in our climate system that could be of major importance for humankind far into the future.



The Earth energy budget – the numbers indicate the average energy fluxes over one year, at a global scale.



Sensors such as ERBE have measured the Earth's Net Radiation Budget over long periods (1985-1989 in this sample data).

NISTAR: triana.gsfc.nasa.gov/instruments/nistar.htm

Radiation budget science: triana.gsfc.nasa.gov/instruments/radiation.htm

TIM/SIM/SOLTICE: lasp.colorado.edu/sorce/

GERB: www.sstd.rl.ac.uk/gerb/

ACRIM: acrim.jpl.nasa.gov/