

5.4 The Earth Explorer Missions

The Earth Explorer missions are basically research/demonstration missions specifically intended to address requirements for:

- advances in our understanding of Earth system processes and hence to the improvement of numerical models used to predict its evolution;
- the provision of data that can be used to further the development and improvement of retrieval algorithms for geophysical parameters;
- the demonstration of the potential of instrumental techniques that may find operational/commercial application.

They form part of the Agency's future Earth observation programme. The first of these missions is intended to be launched in 2003.

As a result of an extensive consultation with the research community, four Earth Explorer missions have been identified as candidates for the first of these missions. All four have been selected for Phase A studies due to begin in 1998. The candidates are described in the following sections (not in order of priority).

Earth Radiation Mission

The Earth Radiation Mission (ERM) aims to improve the understanding of the role of radiation in maintaining the present climate and in governing the evolution and amplitude of the large-scale climate anomalies. Although, the observed patterns of tropospheric and surface temperatures and the receding glaciers provide some indications of global warming, it is still uncertain whether these short-term trends

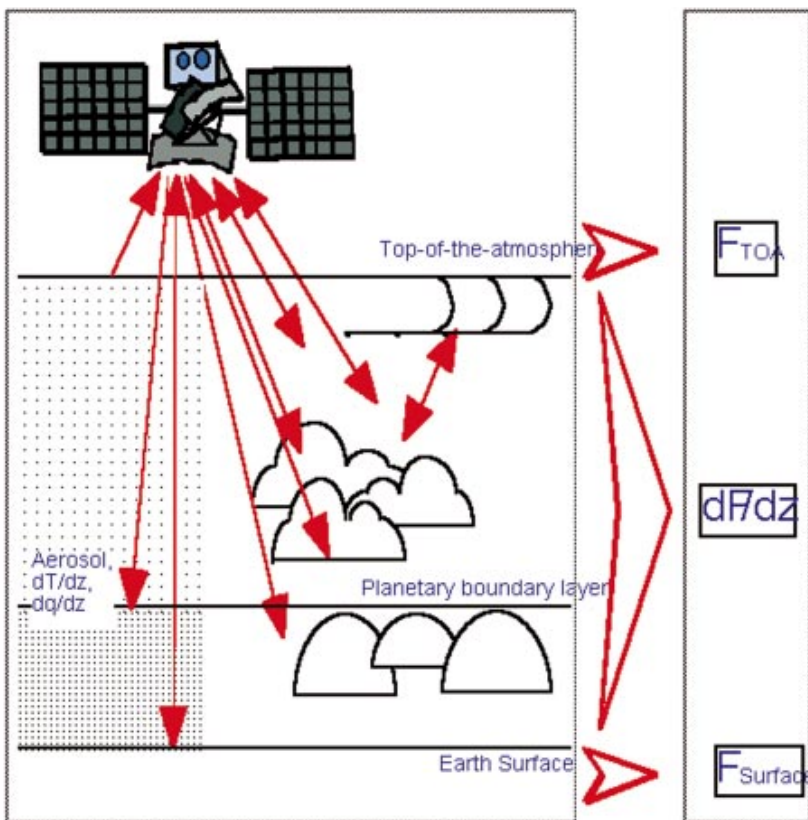


Figure 5.4.1. Observational principles of the Earth Radiation Mission (ERM).

Figure 5.4.2. A satellite concept for the Earth Radiation Mission.

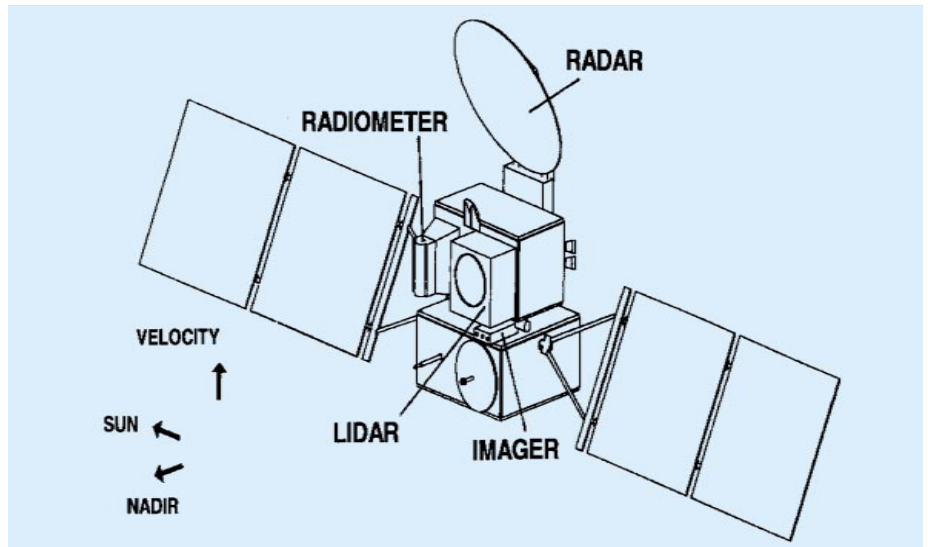


Figure 5.4.3. Geophysical processes relevant to the Gravity Field and Steady-State Ocean Circulation Mission (GOCE).

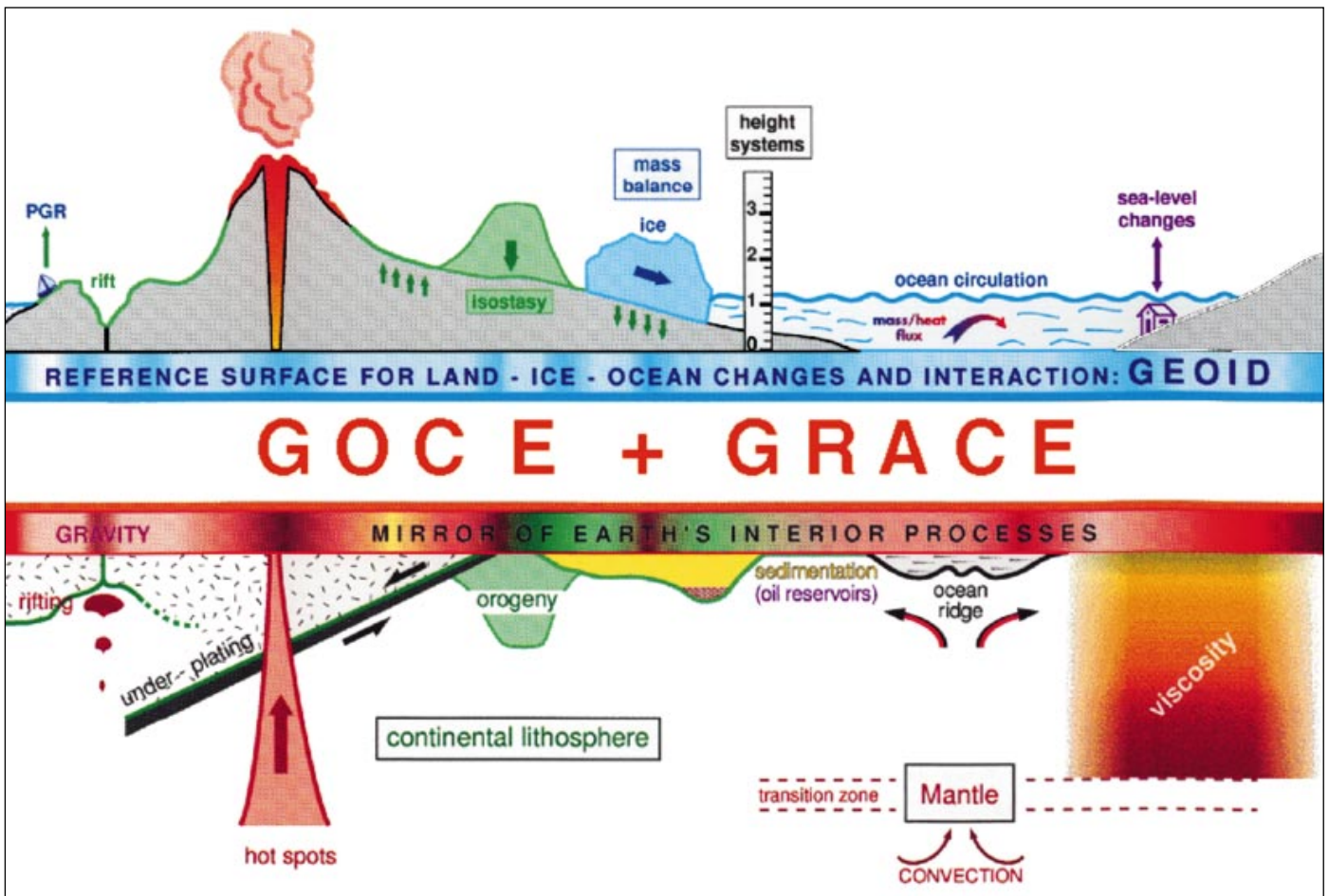
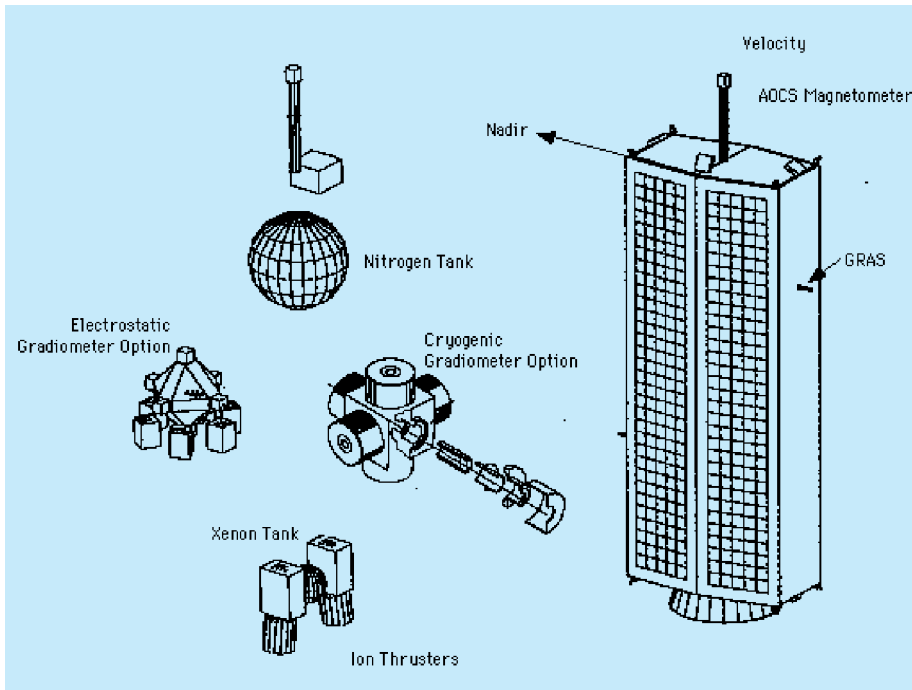


Figure 5.4.4. The GOCE satellite concept.



reflect natural or anthropogenic variations and therefore indication of climate change in the near future. A full understanding of the role of radiation is a key to prediction of climate response and of the increasing perturbation of the radiation balance by anthropogenic emissions.

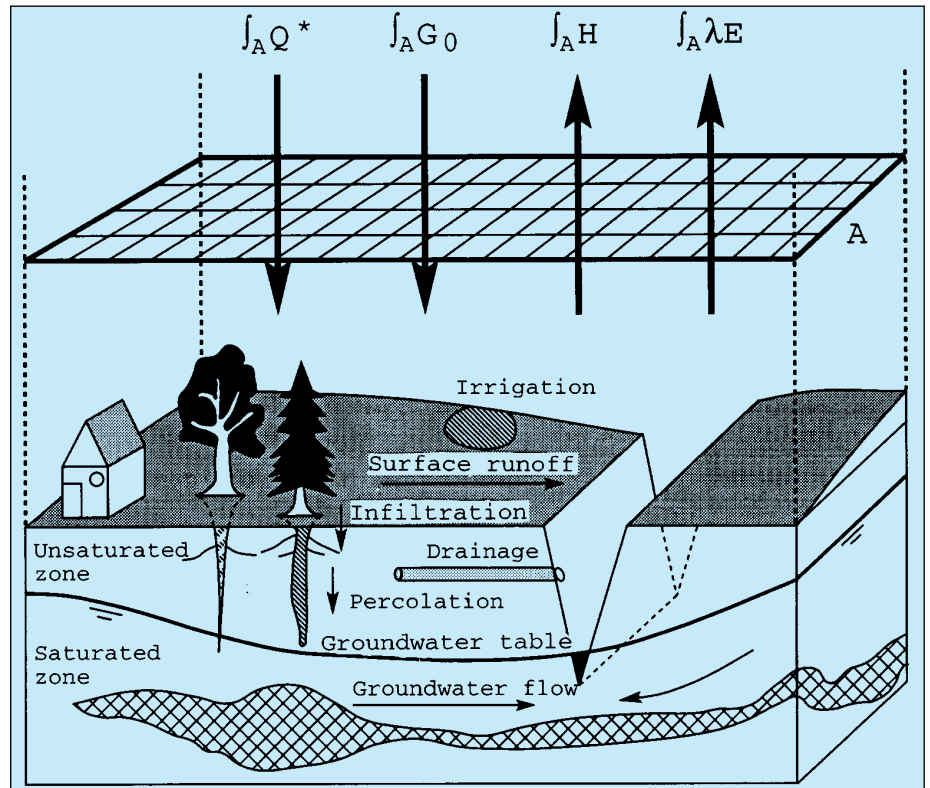
The major thrust for this mission arises from this need to improve our understanding of climate variability and change, recognising the key role played by radiative processes in determining the Earth's climate and in reflecting climate changes. The uncertainties in model predictions of climate change need to be significantly reduced, in particular in response to the observed anthropogenic modifications of atmospheric gases and particle compounds. To make progress in this area, measurements are required of the vertical structure of clouds, and aerosols, coupled with profiles of temperature and water vapour. This is depicted in Figure 5.4.1. The space element is quite extensive, comprising a backscatter lidar and a cloud radar, as well as an imager and a broadband radiometer. A potential ERM satellite is shown in Figure 5.4.2.

Gravity Field and Steady-State Ocean Circulation Mission

The Gravity Field and Steady-State Ocean Circulation Mission (GOCE) would provide data essential for ensuring the development of global and regional models of the Earth's gravity field and of its geoid (the reference equipotential surface) to the resolution and accuracy required for use in a wide range of research and application areas, including global ocean circulation, physics of the interior of the Earth and datum connection. In oceanography, this mission would be the first to provide a precise reference surface for the determination of the absolute ocean topography from the data delivered by satellite altimetry.

The need for this has been highlighted by recent international scientific programmes, including the World Ocean Circulation Experiment (WOCE), the Climate

Figure 5.4.5. Schematic of the hydrological cycle on land.



Variability Programme (CLIVAR) and the Global Ocean Observing System (GOOS). A major deficit in these studies results from the present lack of an accurate description of the total ocean dynamic topography and, thereby, the absolute ocean circulation. The latter is needed to determine the lateral oceanic transport of heat and fresh water and its regional and temporal variations, which are closely coupled to climate variability. A gradiometer supported by a navigation system forms the core of this mission. A schematic overview of the mission is depicted in Figure 5.4.3 and the GOCE satellite concept is shown in Figure 5.4.4.

Land Surface Processes and Interactions Mission

The Land Surface Processes and Interactions Mission (LSPIM) would be dedicated to the study of land-surface processes and their interactions with the atmosphere. It would foster studies on the effect of increased carbon dioxide, loss of bio-diversity, hydrological cycle (Figure 5.4.5), pollution and the pressure of mankind on natural resources, which together form the anthropogenic component of possible global changes. Since man-made processes may enhance natural climate variability and affect eco- and production systems in a complex manner, they must be sufficiently well-known to provide scientifically reliable information on man-made environmental changes.

By advancing the understanding and characterisation of these processes at smaller scales, the mission would enhance their realistic representation in models. This improvement would immediately result in major advances in environmental monitoring and management. The mainstay of the spaceborne element would be an imaging spectrometer (Figure 5.4.6) operating in the visible/near-IR/short wave-IR

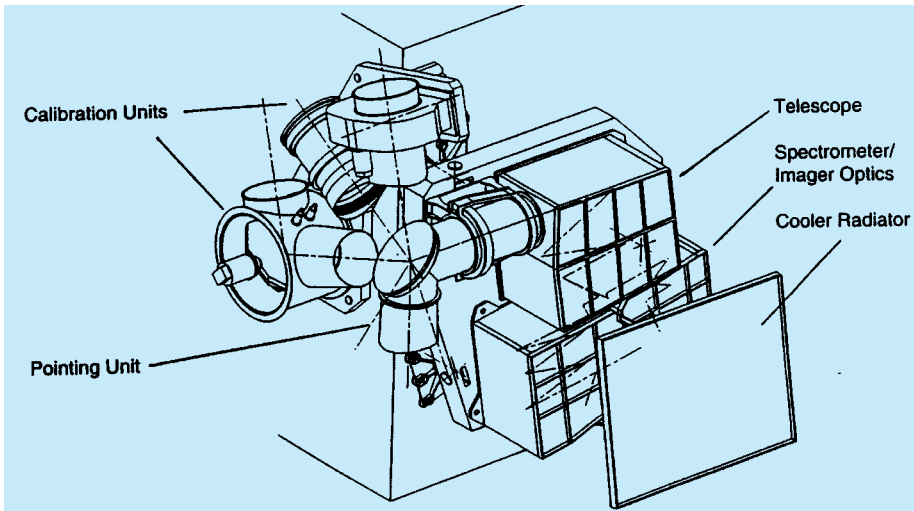


Figure 5.4.6. The Land Surface Processes and Interactions Mission (LSPIM) instrument concept.

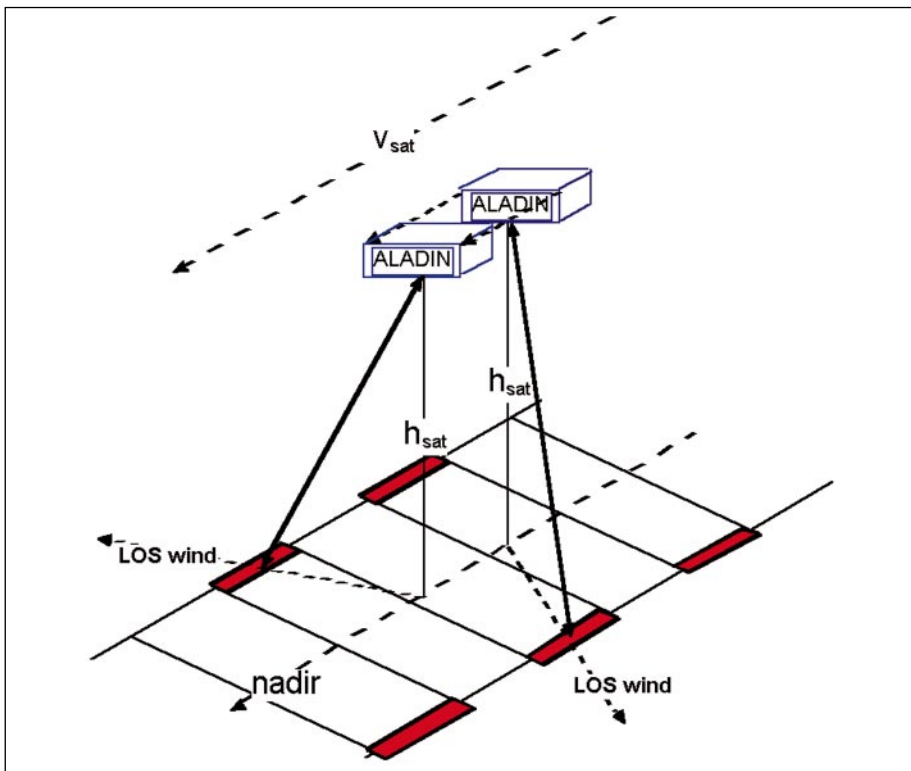


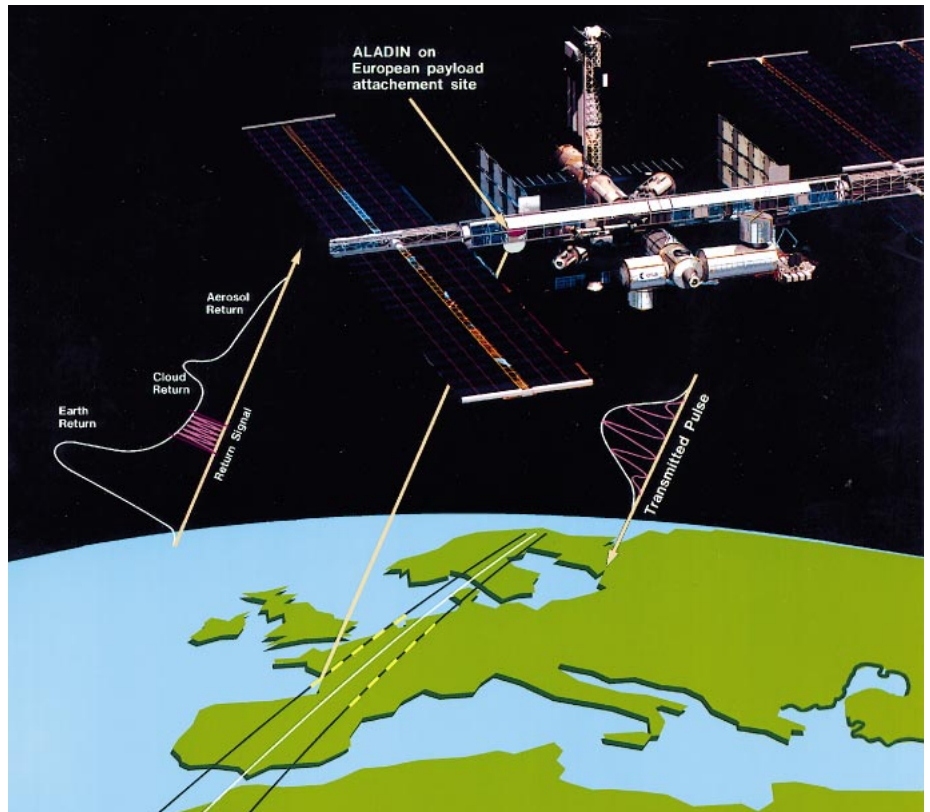
Figure 5.4.7. The observational principle of measuring 3-dimensional winds, for the Atmospheric Dynamics Mission.

supported by a radiometer operating in the thermal-IR. Measurements from space would be closely linked to observations made from a series of well-instrumented surface sites.

Atmospheric Dynamics Mission

The Atmospheric Dynamics Mission would provide observations of 3-dimensional wind fields in clear air, thereby addressing a serious gap in the current

Figure 5.4.8. The implementation of the Atmospheric Dynamics Mission on the International Space Station.



(meteorological) operational observing network. These data would be assimilated into numerical forecasting models and provide the opportunity for assessing their utility in an operational context. The key element of this mission would be the provision of a Doppler wind lidar capable of measuring 3-dimensional winds in clear air. The potential wind observation concept is shown in Figure 5.4.7. Its data would be supported by those from other systems, including sea surface wind data from spaceborne scatterometers.

The mission would also provide data required by the World Climate Research Programme (WCRP) to improve and validate climate models and process studies relevant to climate change. This would be achieved by: a) contributing directly to the study of the Earth's global energy budget by measuring 3-dimensional wind fields in clear air, and b) providing the data relevant to the study global circulation and specific features such as precipitation systems and the El Niño effect. These data are also an essential element for the Global Climate Observing System (GCOS). A potential implementation of the mission on the International Space Station is shown in Figure 5.4.8.