

8 DECEMBER 1999: METEOROLOGY OF THE SUN AND PLANETS

**Dr I James, University of Reading – Factors Determining the Atmospheric Circulations of the Planets**

A planetary atmosphere is set into motion by a thermodynamic imperative, which demands that it be heated at a higher pressure than it is cooled. Its motion is constrained by various dynamical factors, the most important of which is the rotation of the planet. The character and strength of the circulation is the result of an interplay between the intensity and distribution of heat sources and sinks, the rotation rate of the planet and the character of its solid surface, if any. These various factors will be illustrated by results from simple global circulation models which permit a wide range of planetary parameters to be explored. Ideas on the parametrization of atmospheric heat fluxes will be explored briefly.

**Dr O Talagrand, LMD/CNRS, Paris - Modelling the Climate and Meteorology and Mars**

Numerical modelling, based on the adaptation to the Martian conditions of Atmospheric General Circulation Models originally developed for the needs of terrestrial meteorology and climatology, has now become a basic tool of the study of the atmosphere of Mars. Numerical models produce a general circulation which is somewhat similar to the circulation of the Earth's atmosphere, with Hadley-type convection in low latitudes and baroclinic-type waves in winter midlatitudes. A significant difference is a much stronger seasonal modulation, due to the much lower thermal inertia of the Martian fluid envelope. More recent work has borne on the impact of the strongly varying atmospheric dust content, and on the circulation of the high atmosphere (> 30 km).

**Professor C Jones, University of Exeter - Styles of Convection in Rapidly Rotating Spherical Systems – Sun and Major Planets**

The evidence supporting the hypothesis that the zonal flows in the giant planets are caused by planetary scale convection will be reviewed. The nature of large scale convection can be investigated by numerical simulation, but a direct approach is difficult because of the extreme values of the parameters involved: rapid rotation (very low Ekman number) and high Rayleigh number. Indeed, it is only very recently that a complete solution of the linear stability problem has been found. The behaviour at mildly supercritical Rayleigh numbers has, however, been resolved both for very low Ekman number and a range of Prandtl numbers, and the patterns that can occur will be reviewed. Work in progress to investigate the interaction of shearing jet flows with convection will be briefly considered.

## **Professor N Weiss, University of Cambridge – Differential Rotation and the Generation of Magnetic Fields in the Sun**

The rotation rate at the solar surface depends on latitude, with an equatorial acceleration, and we now know from helioseismology that this pattern persists throughout the convection zone (which occupies the outer 30% by radius). At the base of the convection zone there is an abrupt transition to the radiative zone, which rotates uniformly. The differential rotation is itself produced by turbulent convection, with a shear layer (the tachocline) at the interface between the convective and radiative zones. The disordered magnetic fields produced by small-scale dynamo action at the solar photosphere can be contrasted with the systematic fields produced when turbulence is dominated by rotation. Nonlinear development of the fields is typically limited by the action of the Lorentz force on differential rotation. In stars like the Sun, dynamo action leads to cyclic activity (the sunspot cycle) which is apparently chaotic. Moreover, the cycles are modulated on a longer timescale, giving rise to episodes of reduced activity (grand minima) such as the Maunder Minimum in the seventeenth century. This pattern can be understood by reference to low-order models.

## **Dr P Irwin, University of Oxford – The Achievements of the Galileo Mission for Jupiter's Atmosphere**

The Galileo mission arrived at Jupiter in December 1995 and consisted of two parts, an orbiter and an atmospheric entry probe. The probe made the first ever in situ observations of conditions in the Jovian atmosphere including temperature, composition, clouds and winds. The orbiter on the other hand, which itself became the first artificial satellite of Jupiter, has now been operating successfully for nearly 4 years and its remote sensing instruments have returned a wealth of information concerning the state of the Jovian atmosphere. This talk aims to review the impact of these new measurements on our understanding of Jupiter's atmosphere.

## **Dr A Coustenis, Department of Space Research, Paris-Meudon Observatory - The Atmosphere of Titan: the Huygens/Cassini Mission**

Titan, Saturn's largest satellite is at the moment, the object in our Solar System closer to our own planet, in particular with regard to its atmosphere. Host to a multitude of organic products, resulting from the chemical and photochemical reactions between N<sub>2</sub> and CH<sub>4</sub>, Titan's atmosphere is a dense, extended environment, where dynamical and compositional effects combine to produce something similar to what the primitive Earth may have looked like. This is one of the reasons why Titan has attracted the attention of the scientific community for a great number of years, and has been the target of many ground-based observations as well as space observatories (such as ISO in 1997) and space missions such as Voyager (in the 80s). In the future, the ESA/NASA

Cassini/Huygens mission will explore the saturnian system and Titan in particular, for four years, starting in 2004. We expect then to unravel some of the remaining mysteries of the satellite, such - among other - as the nature and composition of the aerosols and other condensates in its atmosphere, the nature of its surface, hidden under a thick cloud deck, and the extent of the dynamical and chemical processes that take place in the lower part of its atmosphere.

### **Dr P Read, University of Oxford - Forthcoming Missions to Study the Atmosphere of Mars**

The past decade has seen a remarkable growth of activity in the exploration of Mars by spacecraft, especially by NASA, with notable recent successes in the Mars Pathfinder lander and Mars Global Surveyor orbiter. During the coming decade, this growth is set to develop into a major international campaign, as NASA pushes ahead with its objective to return rock samples to Earth from the Martian surface by around 2005. Europe, too, is preparing to join this rush to Mars, with ESA's Mars Express mission (including the UK's Beagle 2 lander) and the NetLander mission being pursued by a consortium of space agencies including NASA and CNES. This talk will attempt to give an overview of the current missions relevant to studies of Mars' atmosphere and climate, and those approved and under consideration in the coming 5-10 years. Data assimilation is another technique which is being actively applied to the analysis of this new meteorological data from Mars, in conjunction with the development of powerful GCMs of the atmospheric circulation; the prospects for future use of this technique for Mars will be briefly discussed.