THE HERMANUS MAGNETIC OSERVATORY AS A SPACE PHYSICS FACILITY FOR i-DUST 2010, Apt, France

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ABSTRACT

The Hermanus Magnetic Observatory (HMO) is an Earth and Space national research facility in Southern Africa. It forms part of a worldwide network of observatories and/or data centres. It is also the space weather Regional Warning Centre (RWC) for Africa under the International Space Environment Service (ISES). In this context, the HMO conducts research, makes observations and simulates the variations of the Earth and space environments using a wide network of instruments that are spread around the southern African region and extending as far south as Antarctica. In addition, the HMO offers technological services, mostly to clients in the aerospace and maritime industries. The HMO also runs a Science Outreach programme for the advancement of science amongst learners, educators and the general public.

INTRODUCTION

The Hermanus Magnetic Observatory (HMO) is located close to the Southern tip of Africa, and has been operating continuously as a magnetic observatory at this location since 1941. However, the activities at the HMO entail far more than the average magnetic observatory.

INTERMAGNET MAGNETIC OBSERVATORY

The primary objective of magnetic observatory operations internationally is to make uninterrupted accurate measurements of the Earth's magnetic field over decades at a stable and magnetically clean location. This is required to track the slow variation of the field generated in the Earth's fluid outer core. The HMO as a magnetic observatory is responsible for monitoring and studying variations of the Earth's magnetic field, the derivation of geomagnetic field models and indices, and the distribution of geomagnetic field information. As observatory instruments magnetometers are operated on a continuous basis at the HMO's four *INTERMAGNET* observatories at Hermanus, Hartebeesthoek, Tsumeb (Namibia), and Keetmanshoop (Namibia). At Hermanus 2 FGE three-axis suspended fluxgate magnetometers, a dIdD suspended Overhauser magnetometer, and a standalone scalar Overhauser magnetometer are continuously recording geomagnetic data. At each of the other three observatories a FGE three-axis fluxgate magnetometer as well as a scalar Overhauser magnetometer are in operation. The processed data are distributed to the World Data Centres in Kyoto and Boulder for the computation of geomagnetic indices. Data from 30 secular variation field stations distributed over southern Africa, as well as the Ørsted and CHAMP satellites, are used for the derivation of geomagnetic field models for southern Africa. In this respect the HMO contributes in areas such as safety and security, peacekeeping in Africa through the SANDF, navigation, and mineral exploration.

The four South African observatories are strategically positioned geographically within the world to monitor many important geomagnetic changes, such as the rapid development of a reverse magnetic flux patch at the surface of the earth's core beneath southern Africa (South Atlantic Anomaly). The HMO has particular significance because of its contribution to the DST index, as the Hermanus Observatory is one of only 4 global observatories contributing to the calculation of this index.

The HMO operates a 3 axis induction sensor as well as a 3 axis MAGDAS magnetometer for ULF pulsations on site in Hermanus. The University of Los Angelos (UCLA) have installed a pulsation fluxgate magnetometer in Tsumeb in collaboration with HMO, and the HMO has full access to all the data from pulsation magnetometers operated by UCLA worldwide. The HMO also operates a 12NM64 neutron monitor on site at Hermanus.

SPACE PHYSICS RESEARCH

The current areas of research within the field of space physics undertaken by the HMO include:

- Theoretical studies of waves in dusty plasmas
- Studies of ULF waves using ground-based and satellite data
- Ionospheric characterisation using dual frequency GPS observations
- Bottom side ionospheric modelling
- Pc5 field line resonant pulsation observations using the SuperDARN HF-radars
- Magneto-hydrodynamic modelling of solar-wind/ magnetosphere interactions
- VLF wave characterisation and modelling
- Neutral Atmospheric Dynamics

SPACE WEATHER

The HMO operates as a space weather Regional

Warning Centre (RWC) for Africa under the International Space Environment Service (ISES). ISES's mission is to encourage and facilitate near-real-time international monitoring and the prediction of the space environment as well as to assist users to reduce the impact of space weather on activities of human interest, e. g. the protection of satellite technology and HF communication predictions. A space weather operations facility is currently under construction at the HMO in order to supply space weather forecasts and products to clients and researchers.

The HMO operates a state of the art digital ionospheric radar, model Digisonde DPS-4D on site in Hermanus. The HMO is also responsible for the maintenance, operation, data archiving and distribution of ionospheric data of the other three ionosondes in South Africa located at Grahamstown (Eastern Cape), Madimbo (Limpopo) and Louisvale (Northern Cape).

ANTARCTICA AND SOUTHERN ISLANDS

The HMO is responsible for the technical upkeep and research related to most of the Antarctic projects at the South African Antarctic base SANAE-IV.

The Super Dual Auroral Radar Network (SuperDARN) is an international collaborative network of HF radars that monitor ionospheric plasma convection over the majority of the northern and southern Polar Regions. SuperDARN currently is comprised of 14 radars in the northern hemisphere and 8 radars in the southern hemisphere. The HMO is involved in the Southern Hemisphere Auroral Radar Experiment (SHARE), with British Antarctic Survey (BAS), and manages the SHARE radar at SANAE.

The Space Weather instruments deployed and managed at SANAE, in collaboration with national and international partners, for the study of geomagnetism and ionospheric dynamics are:

- Overhauser absolute geomagnetic field magnetometer;
- Declination-Inclination (DI) observation station;
- FGE three-axis magnetometer;
- Overhauser proton magnetometer;
- GPS Ionospheric Scintillation and Total Electron Content Monitor (GISTM);
- ULTRAMSK and AWESOME narrowband VLF receivers;
- digital broadband VLF recording system, DVRAS;
- Automatic whistler detector (AWD);
- World Wide Lightning Location Network (WWLLN) node;
- Imaging and broad beam riometers;
- 2 low light auroral video cameras.

In addition to the Antarctic instrumentation the HMO operates a GISTM and a ULTRAMSK VLF receiver on Marion Island, and a GISTM receiver on Gough Island.

MAGNETIC TECHNOLOGY SERVICES

The HMO furthermore utilises the unique magnetic field calibration facilities and infrastructure, located in a magnetically clean environment, to provide quality controlled magnetic field and sensor related services to clients in the defence, aerospace and nautical industries on a commercial basis. These services include compass calibrations, geomagnetic surveys and training for the SA Air Force, under-water measurement and signature management, degaussing and deperming of the SA Navy fleet, the placement of magnetic sensors on unmanned airframes, including calibration and navigation algorithms for commercial clients, as well as orientation magnetometers for micro satellites. Equipment and infrastructure used for these services include a non-magnetic climatic chamber, a large Helmholtz coils system (2.5m) for calibration of weapon systems and micro satellites, and a magnetic shielding chamber.

TRAINING AND SCIENCE OUTREACH

The HMO presents space science training in a variety of summer, winter, and Antarctic schools, including space physics, geomagnetism, aeronomy, electromagnetism, MHD waves, signal processing and other courses for graduate and post graduate students at various institutions. A number of MSc and PhD space physics students live on site at the HMO and undertake their studies under supervision at the HMO, utilizing data from the various instruments managed by the HMO.

In terms of science advancement and outreach the HMO strives to create a better understanding and appreciation of science and technology amongst school educators and learners and to promote a public understanding of geomagnetism and space physics, from a dedicated Science Centre on site at the HMO.

CONCLUSION

Through the HMO's geographically wide and multi-functional observational network, the HMO contributes earth and space data to various global networks such as

- The International Real-time Magnetic Obaservatory Network (INTERMAGNET);
- Digital Ionogram DataBase (DIDBase);
- Global Assimilative Ionospheric Model (GAIM);
- Super Dual Auroral Radar Network (SuperDARN);
- World Wide Lightning Location Network (WWLLN); and
- International Polar Year Data and Information Service (IPYDIS).