



Ultra Large Terrestrial International Magnetometer Array (ULTIMA): A Global Magnetometer Network for Heliophysics Research

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Abstract

The Ultra Large Terrestrial International Magnetometer Array (ULTIMA) is an international consortium that aims at promoting collaborative research on the magnetosphere, ionosphere, and upper atmosphere through the use of ground-based magnetic field observatories. ULTIMA is composed of individual magnetometer arrays distributed around the world, and it provides a platform for each of them to efficiently collaborate with other arrays in order to expand observational coverage. ULTIMA also helps identify the importance and need of individual arrays to continue operation or establish new stations in their host countries. In this poster we introduce the ULTIMA's organization and its observational coverage. We also describe the plans for data exchange and distribution through individual data servers and virtual observatories (such as NASA's Virtual Magnetospheric Observatory), providing opportunities for the scientific community to access an unprecedented amount of integrated ground-based magnetometer observations for heliophysics research.

1. Why ULTIMA?

Observations of geomagnetic perturbations in the geomagnetic field laid the foundation of the early understanding of Sun-Earth Connection. A noteworthy example is Balfour Stewart's observation of the magnetic perturbations in the Ultra-Low-Frequency (ULF) band that led to the discovery of the ionosphere. Today ground-based magnetic observations are used in a wide range of heliophysics research, including monitoring the magnetospheric and ionospheric currents and their responses to solar storms, generation of magnetic indices (such as *Dst*, *AE*, *Kp*), studying magnetospheric processes through the associated ULF waves.

There are hundreds of ground magnetometers sampling data at ~1-sec cadence, and most of them belong to small- or intermediate-sized arrays, each of them may include as many as 50 stations or only one single station. These government-funded arrays have made significant contributions to heliophysics research, but each individual project has funding and management limitations. In today's research environment where joint studies with satellite observations and global simulations are imperative, it is difficult for an individual array to satisfy the demand of wide spatial coverage, densely distributed ground observations.

2. The ULTIMA Consortium

In response to the above realistic demands, the principal investigators of several active ground magnetometer arrays gathered at UCLA on November 17, 2006 and established a consortium "Ultra Large Terrestrial International Magnetometer Array (ULTIMA)." ULTIMA aims at promoting international collaboration among different magnetometer arrays through:

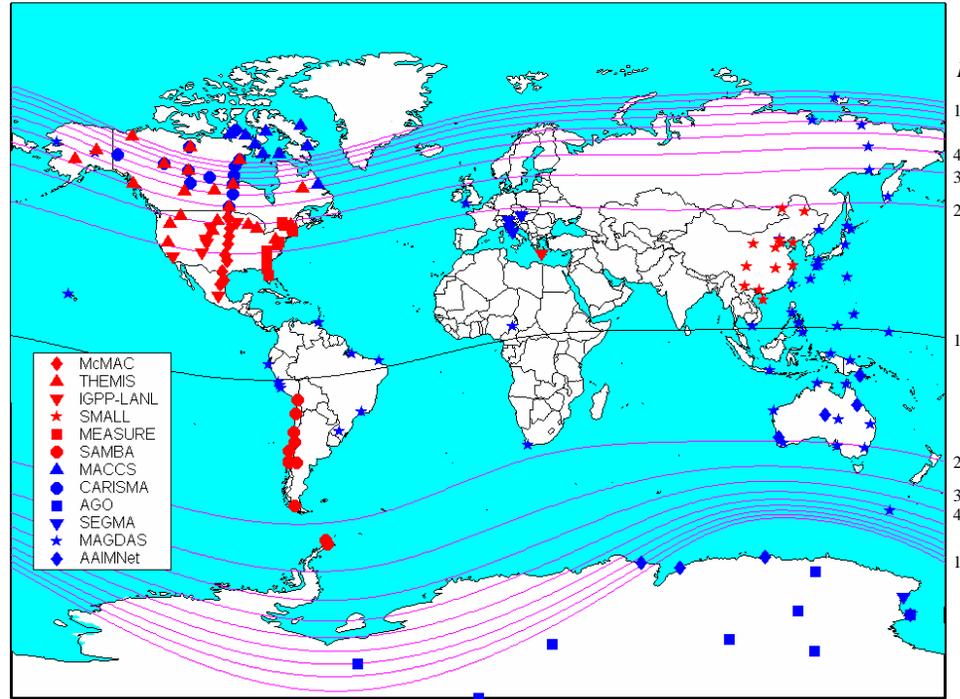


Figure 1. Map of ULTIMA-affiliated magnetometer stations.

Table 1. ULTIMA Members

Array	# of Stations / Regions	Data cadence	Contact
AAIMNet (Australian)	8 / Australia, Antarctica	0.2-sec to 1-sec	Brian Fraser
CARISMA	18 / Canada, USA	1-sec	Ian Mann
IGPP-LANL, SMALL	21 / USA, Mexico, China, etc.	1-sec	Chris Russell
MACCS, AGOs	17 / Canada, Antarctica	1-sec	Mark Engebretson
MAGDAS	38 / six continents	1-sec	Kiyohumi Yumoto ¹
McMAC	9 / USA, Mexico	0.5-sec	Peter Chi ²
MEASURE	10 / USA, Canada	0.5-sec to 1-sec	Mark Moldwin
SAMBA	11 / South America, Antarctica	1-sec	Efthya Zesta
SEGMA	5 / Italy, Hungary	1-sec	Massimo Vellante
THEMIS	22 / Canada, USA	0.5-sec	Vassilis Angelopoulos

1. The present Chair; 2. The present Secretary

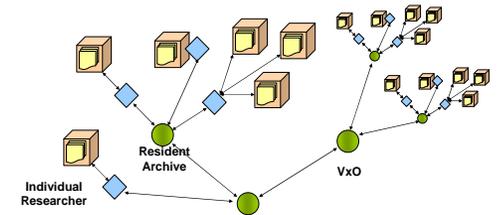


Figure 2. Structure of Virtual Observatories' (VxOs, including VMO) web connections

3. Examples of the Use of ULTIMA Data

- (1) Ionospheric Equivalent Current/Convection (Figure 3)
- (2) Magnetospheric Sounding (Figure 4)

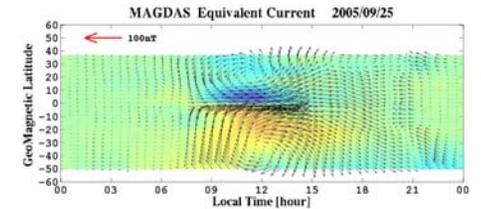


Figure 3. Ionospheric equivalent currents induced by ground magnetic field perturbations

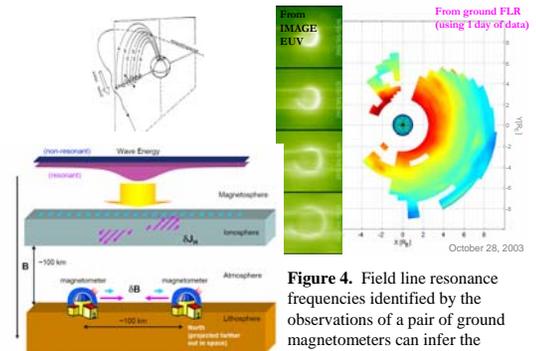


Figure 4. Field line resonance frequencies identified by the observations of a pair of ground magnetometers can infer the equatorial plasma densities in the magnetosphere.

Facilitating data exchange and sharing by setting up standard procedures

- Enabling analysis using data from the global magnetometer network
- Enhancing communications in the ground magnetometer community

The ULTIMA web site (<http://www.serc.kyushu-u.ac.jp/ultima/ultima.html>) provides the consortium's bylaws, which describe ULTIMA's objectives, membership, activities, and data exchange and usage.

Table 1 lists the current ULTIMA members, and Figure 1 shows the map of all associated magnetometer stations.

ULTIMA is a collaborator of NASA's Virtual Magnetospheric Observatory (VMO: <http://vmo.igpp.ucla.edu>) that assists data exchange among the members and data distribution to the public. Each ULTIMA member has a web server that contains the data files, and the VMO server that connects to all individual web servers only needs the metadata to allow data queries. The VMO assists ULTIMA-affiliated arrays with generating the metadata that comply with the Space Physics Archive Search and Extract (SPASE) format.

4. Summary

The establishment of ULTIMA marks a new era of ground magnetometer observations for space weather research. In addition to creating synergy through collaboration, ULTIMA can facilitate joint studies with satellite observations and numerical simulations. The joint efforts between VMO and ULTIMA can also revolutionize the way how ground magnetometer data are used by the scientist community.

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