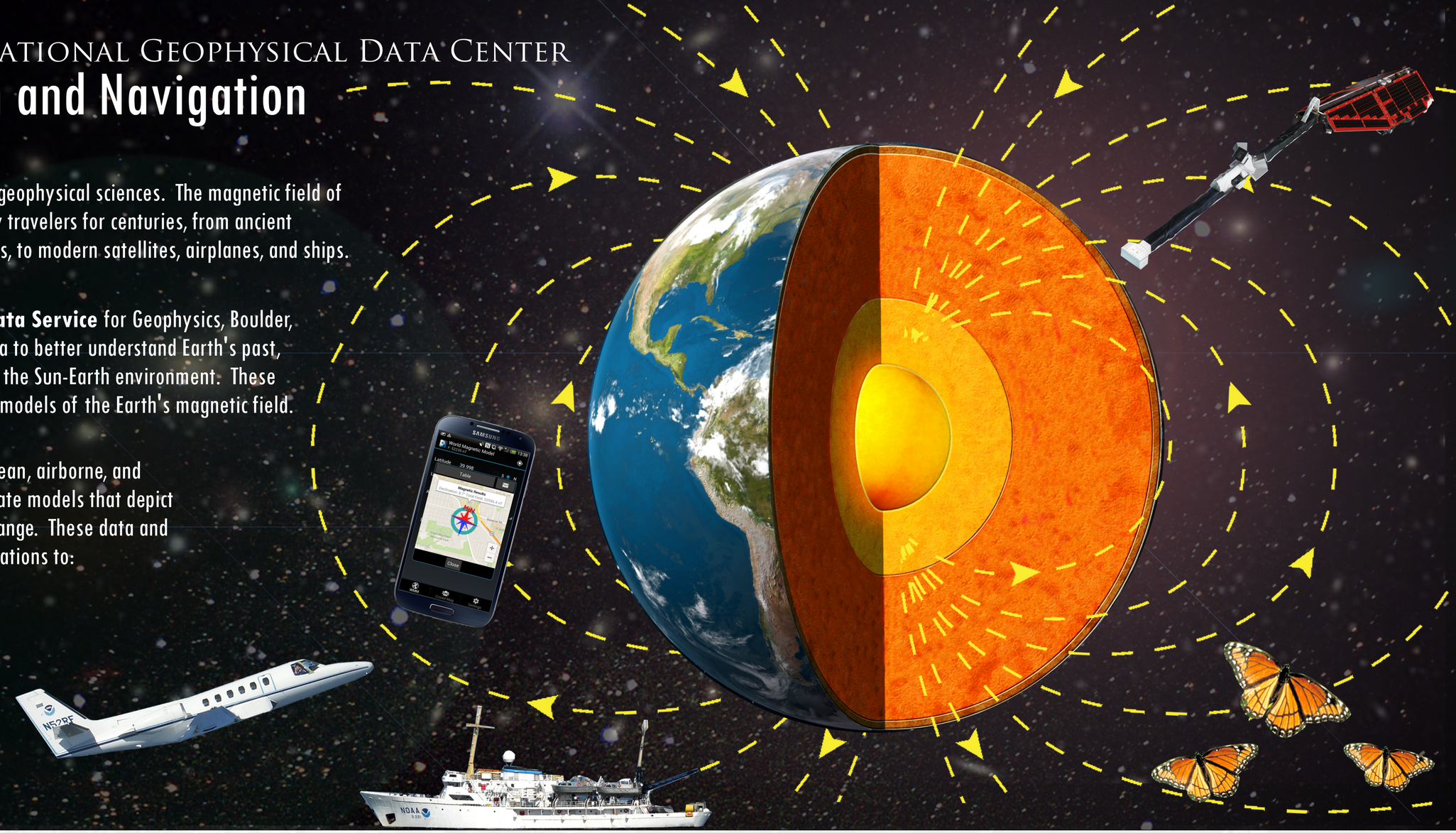
The NOAA National Geophysical Data Center
Magnetism and Navigation

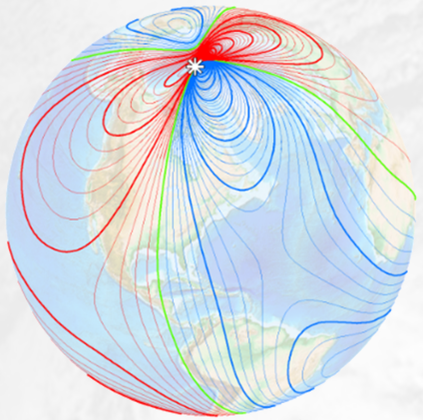
Geomagnetics is the oldest of the geophysical sciences. The magnetic field of the Earth has been mapped and used by travelers for centuries, from ancient mariners to butterflies, birds and whales, to modern satellites, airplanes, and ships.

NGDC and the collocated World Data Service for Geophysics, Boulder, archive digital and analog magnetic data to better understand Earth's past, present, and future magnetic fields and the Sun-Earth environment. These data include descriptions, imagery, and models of the Earth's magnetic field.

Integrated databases of surface, ocean, airborne, and satellite measurements are used to create models that depict Earth's magnetic field and its annual change. These data and models are used in many diverse applications to:

- Navigate on land, sea, and air
- Explore natural resources
- Properly orient satellites in space
- Orient antennas and solar panels
- Survey property boundaries
- Conduct basic research



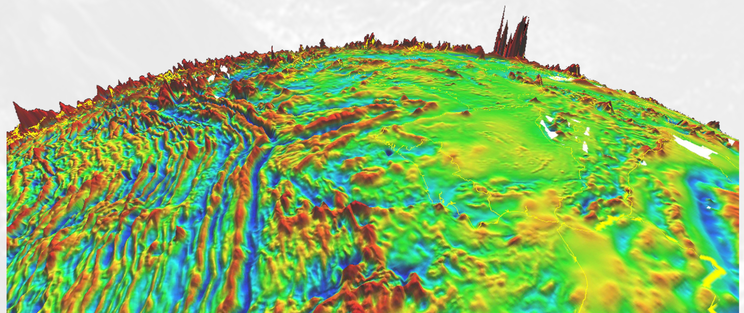


Above: WMM2010, the World Magnetic Model is a model of the Earth's magnetic core field. Positive declination degrees are in red. White star indicates current location of the North magnetic pole.
DOI: 10.7289/V5CR5R8P

Center, Right: EMAG2, A 2-arc-minute resolution map of the Earth's crustal magnetic field.
DOI: 10.7289/V5MW2F2P

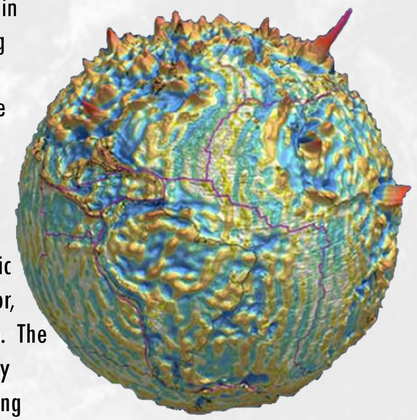
The Earth's magnetic field slowly changes strength and direction, and has been throughout its existence. Observations of the magnetic field have been noted by humans since the 18th century, and recorded by volcanic rocks for millions of years. When tectonic plates that form along oceanic ridges cool to below 700°C, the volcanic rocks record the ambient magnetic field. The slowly moving plates create a kind of "tape" recording, storing information about the strength and direction of past magnetic fields.

Many migratory animals are thought to use the geomagnetic field as an important aspect of orienting themselves and navigating to their seasonal homes. Experiments suggest that migratory birds, whales, lobsters, dolphins, and butterflies can sense the subtle changes in the local geomagnetic field and use that to know the direction they are travelling.



Geomagnetic models are used in aircraft, ship, and car navigation systems, as well as in most of the estimated 1 Billion "smartphones" sold each year. They are used in everything from building models of past climate and tectonic structures over millions of years,to tracking annual animal migration patterns. The World Magnetic Model (WMM) is used by the United States Department of Defense (DOD), NOAA, the FAA, NATO, as well as many mobile phone companies.

NGDC hosts a variety of online calculators that accurately provide real-time geomagnetic values. Applications include a Declination calculator, Magnetic Field calculator, the U.S. Historic Declination calculator, and CrowdMag (a cell phone app developed at NGDC). The High Definition Geomagnetic Model (HDGM) is used by directional drilling companies for location and steering while kilometers underground.



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