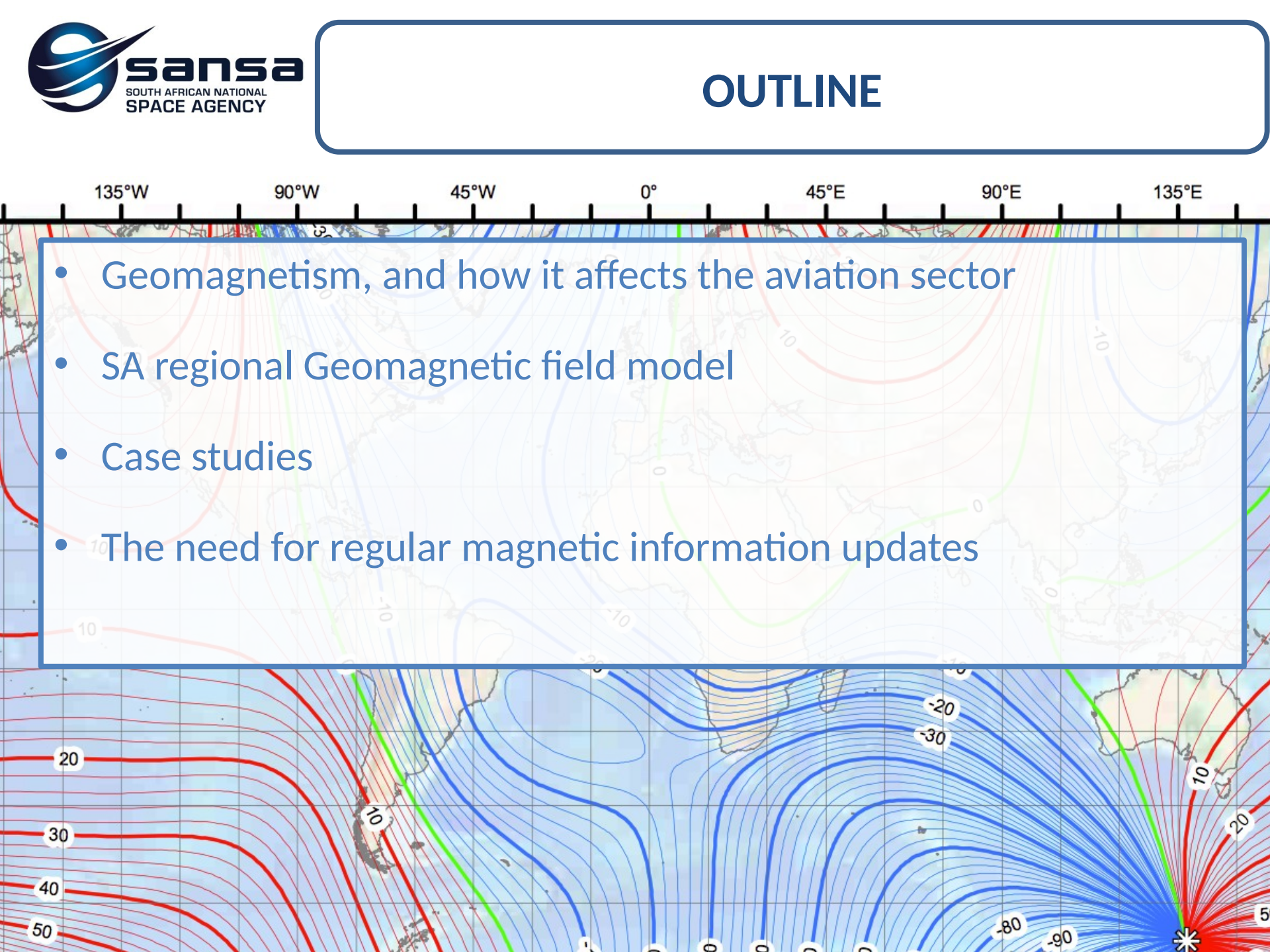




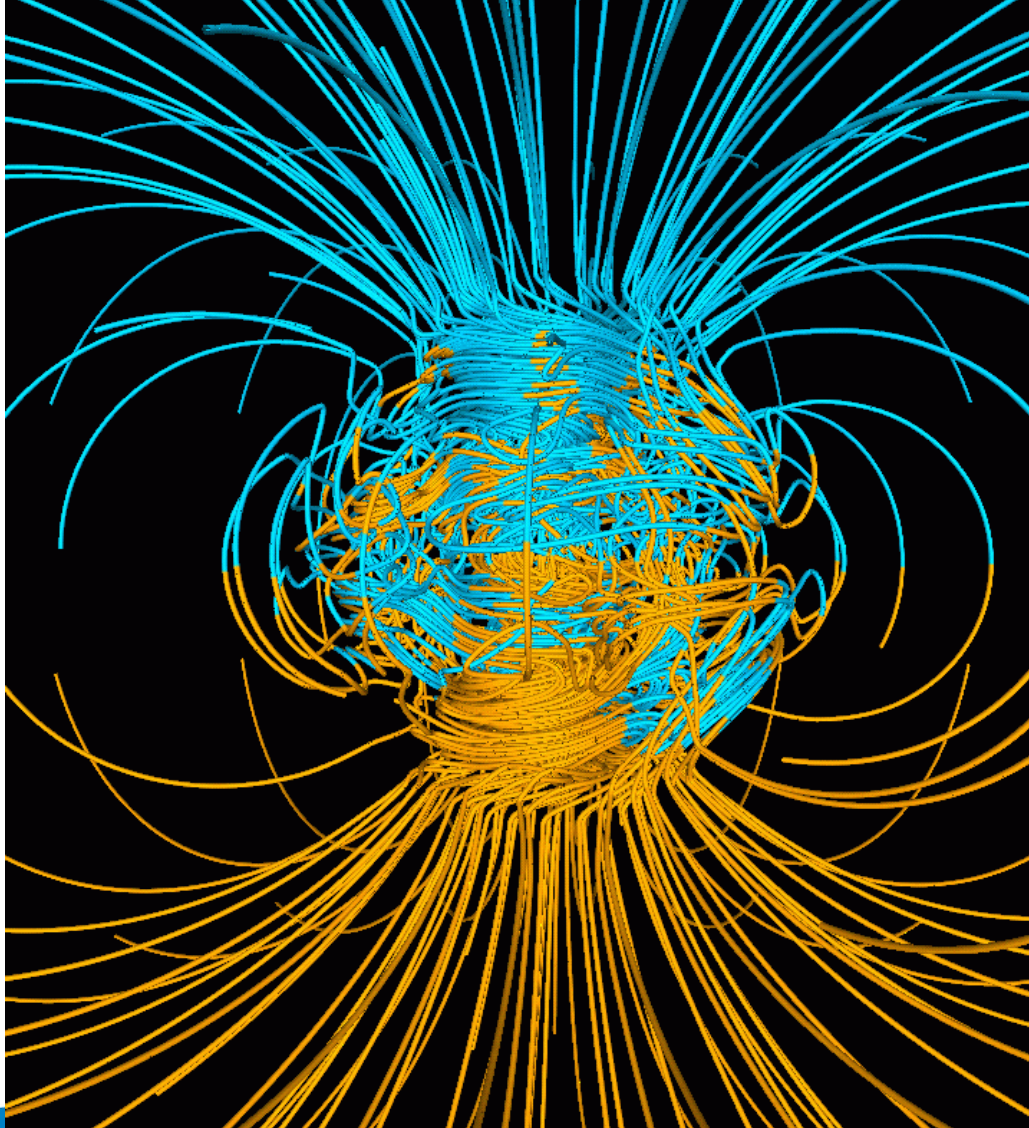
Magnetic Variations and Geomagnetic Modelling

Dr. Amoré Nel

The South African National Space Agency

- 
- Geomagnetism, and how it affects the aviation sector
 - SA regional Geomagnetic field model
 - Case studies
 - The need for regular magnetic information updates

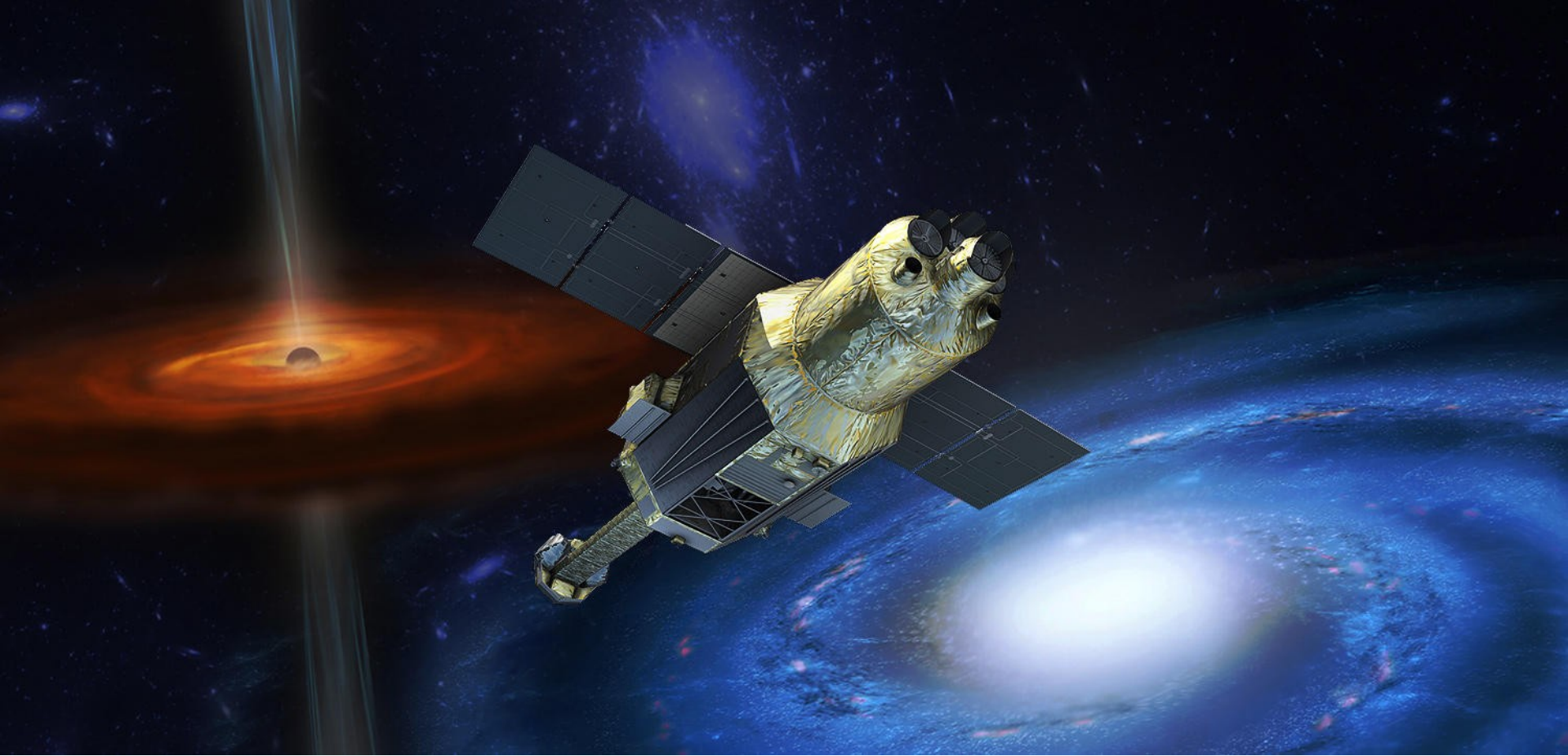
GEOMAGNETISM



Earth is surrounded by an invisible force field known as the geomagnetic field

Protects us from the harmful effects of space weather.

The geomagnetic field also plays a role in navigation and mapping applications as well as having an effect on technological systems.



LEO February 2016. March 26 lost contact, break up in five pieces, \$ 270 million loss.



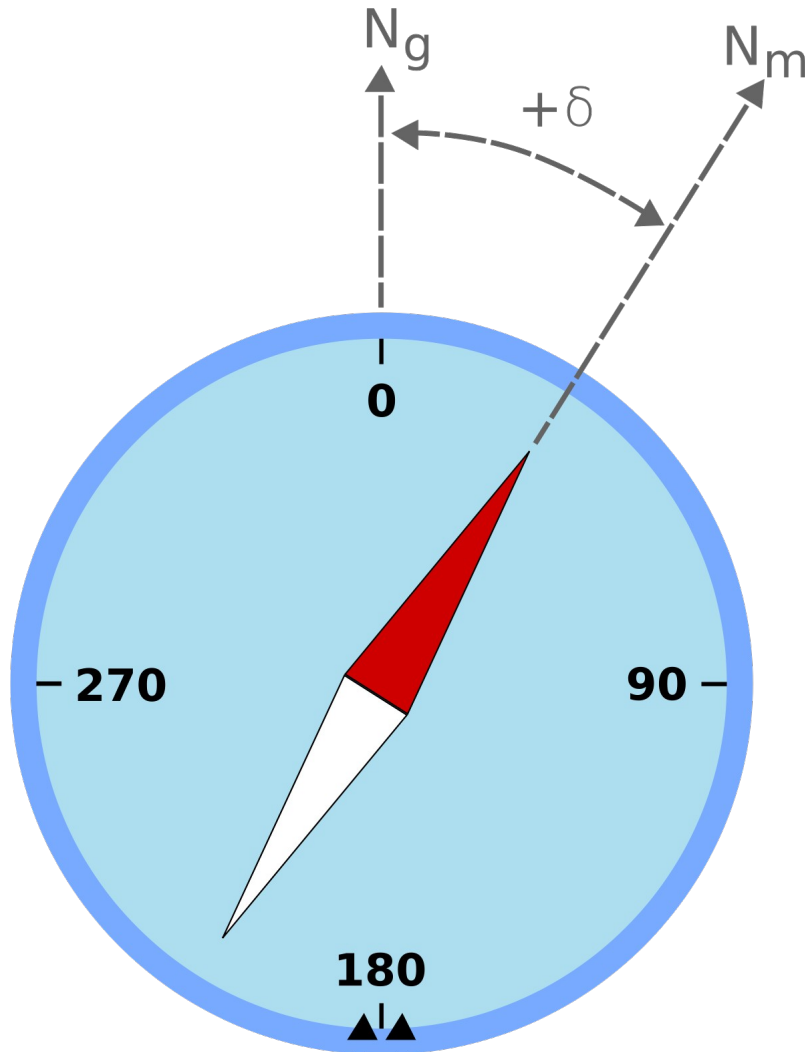
40 of 49 Starlink satellites reentered the atmosphere during a moderate storm in 2022
\$ 50 million.

GEOMAGNETISM AND AVIATION

Declination is an important component when considering the topic of aircraft navigation. In aviation, Earth's changing magnetic field affects airport operations, approach procedures, and could compel runway names to be updated to more accurately reflect its magnetic directions.

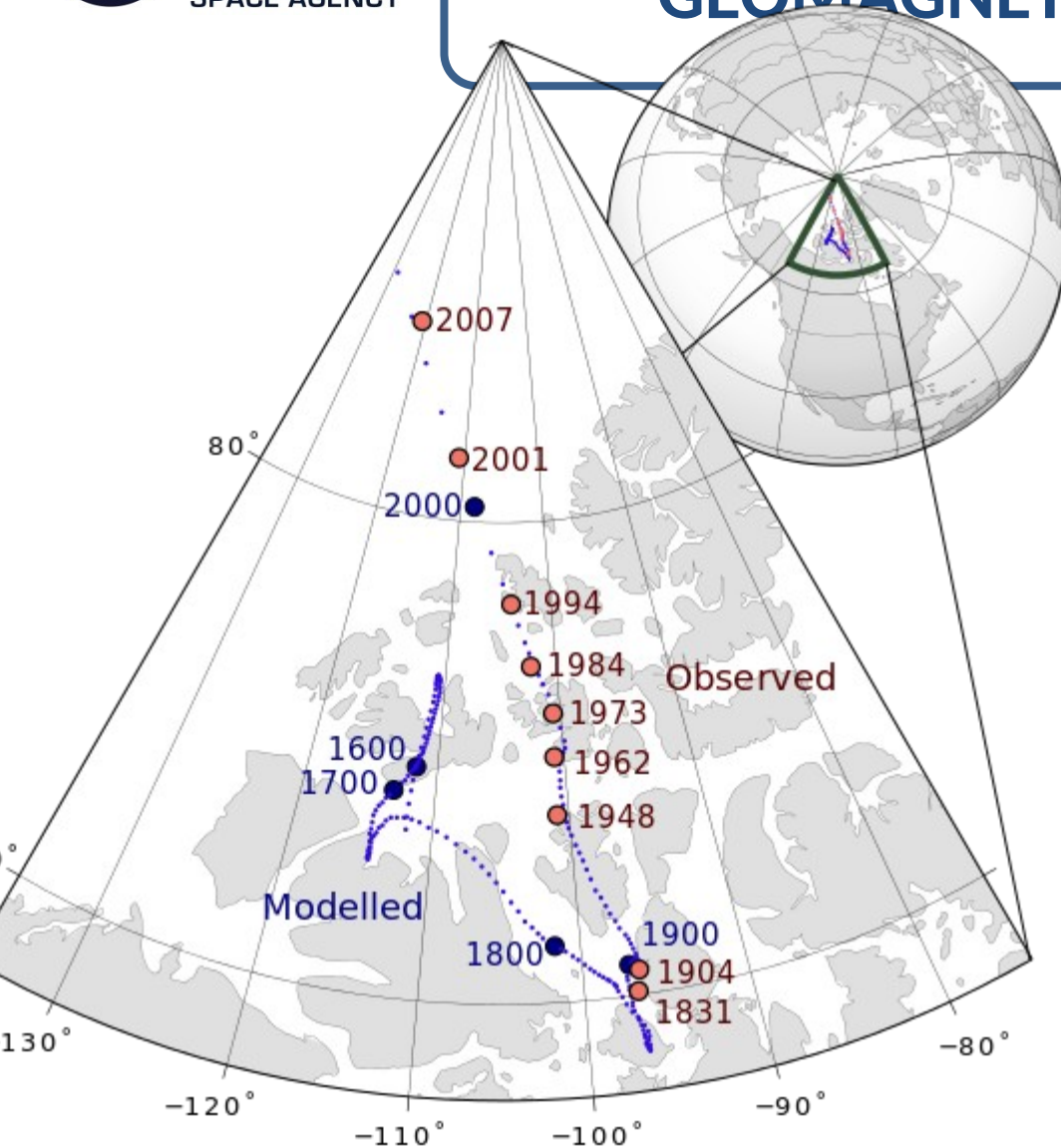


GEOMAGNETISM



- Magnetic declination (referred to as magnetic variation in the aviation sector) is the angle between true and magnetic North.
- This angle varies with position, and due to the temporal variability of Earth's magnetic field and movement of the magnetic north pole, changes over time at varying rates in different locations.

GEOMAGNETISM AND AVIATION

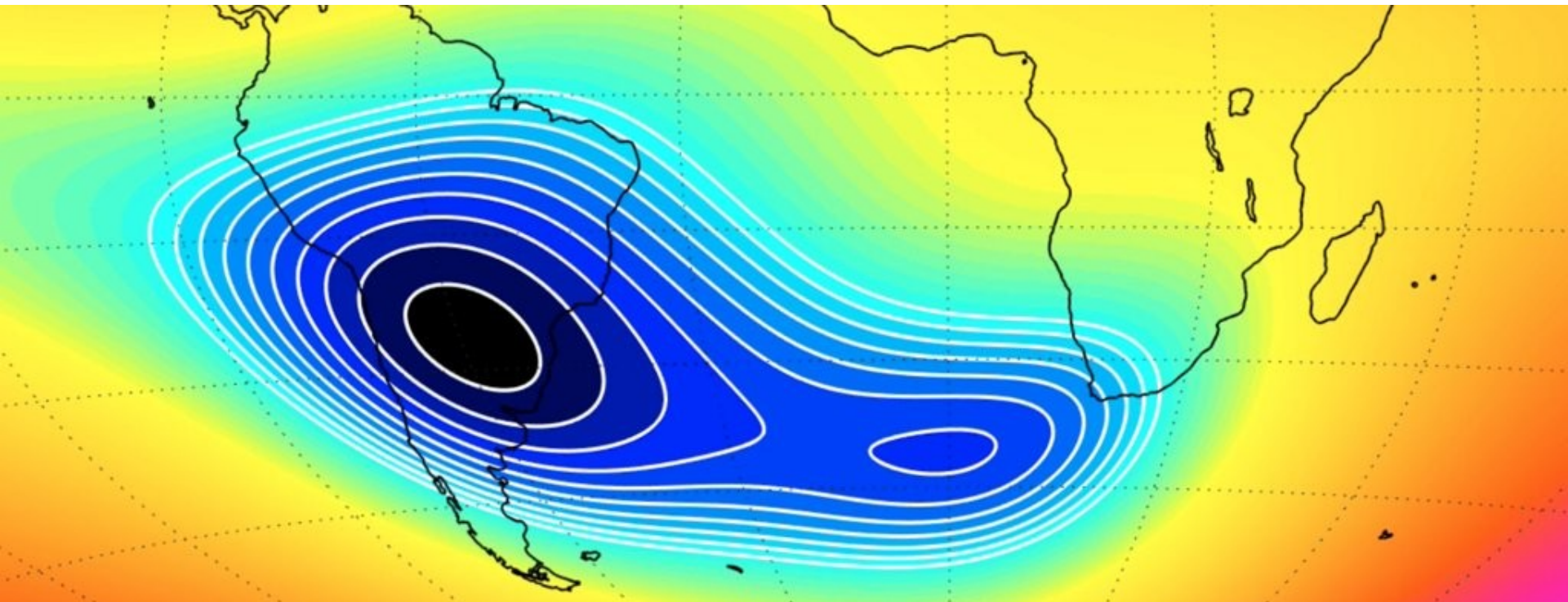


Earth's magnetic field is changing: Magnetic north was drifting at a rate of up to about 9 miles (15 km) a year. Since the 1990s, however, the drift of Earth's magnetic north pole has turned into "more of a sprint," scientists say. Its present speed is about 30 to nearly 40 miles a year (50-60 km a year) toward Siberia.

*~EarthSky, 19 May 2020
Image: Wikimedia Commons*

The South Atlantic Anomaly

- The Atlantic sector is home to an anomaly, the SAA, that is gradually drifting westwards and evolving in shape due to changes in the Earth's core.
- This alters the regional intensity and orientation even more over this region, compared to more 'stable' regions on the globe.



One of the practical consequences of this is that Geomagnetic Models have to be updated periodically with the pole's current location. Models are vital for many navigation systems used by ships, Google maps and smartphones, for example.

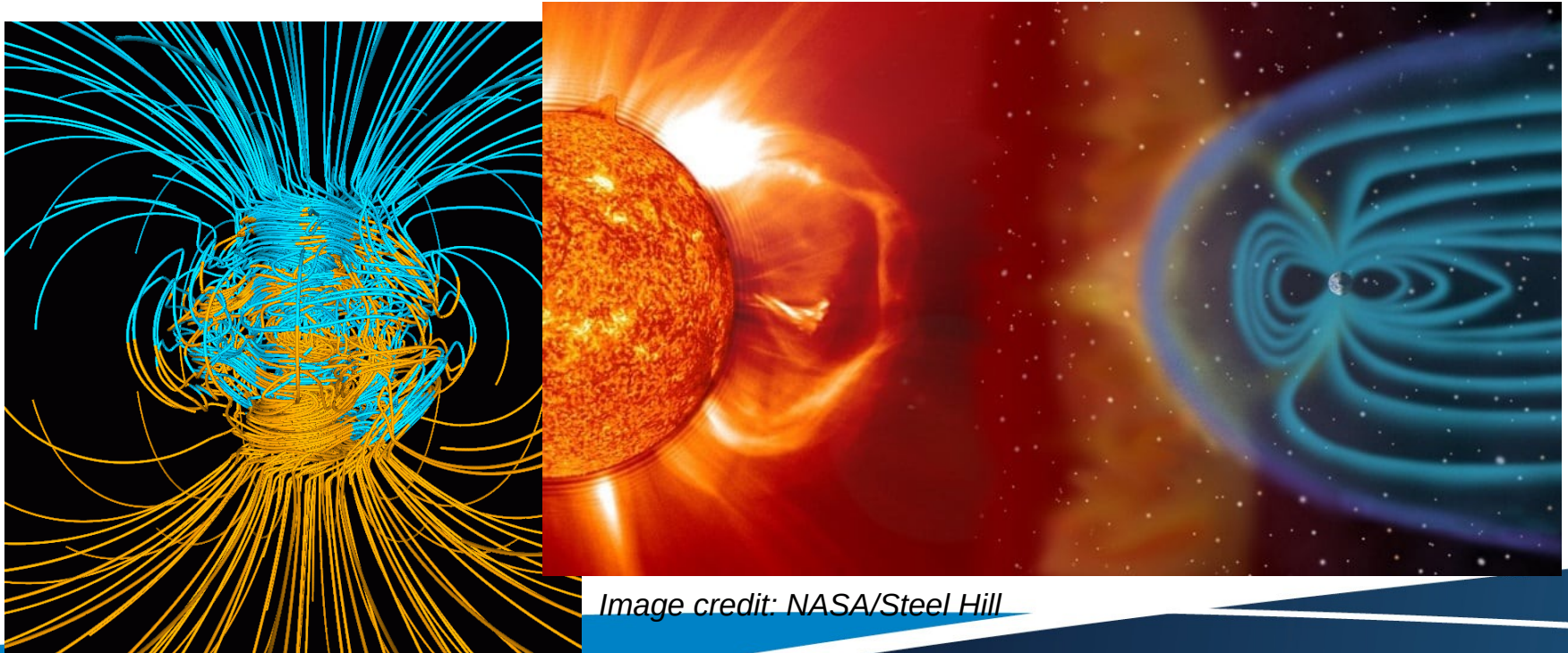
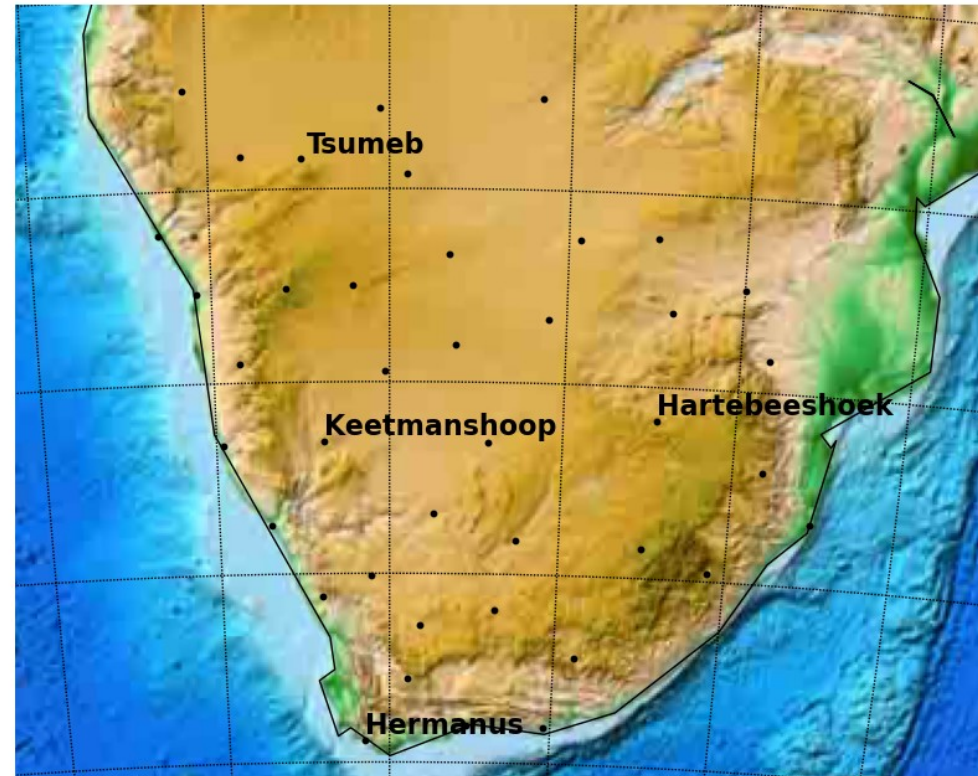


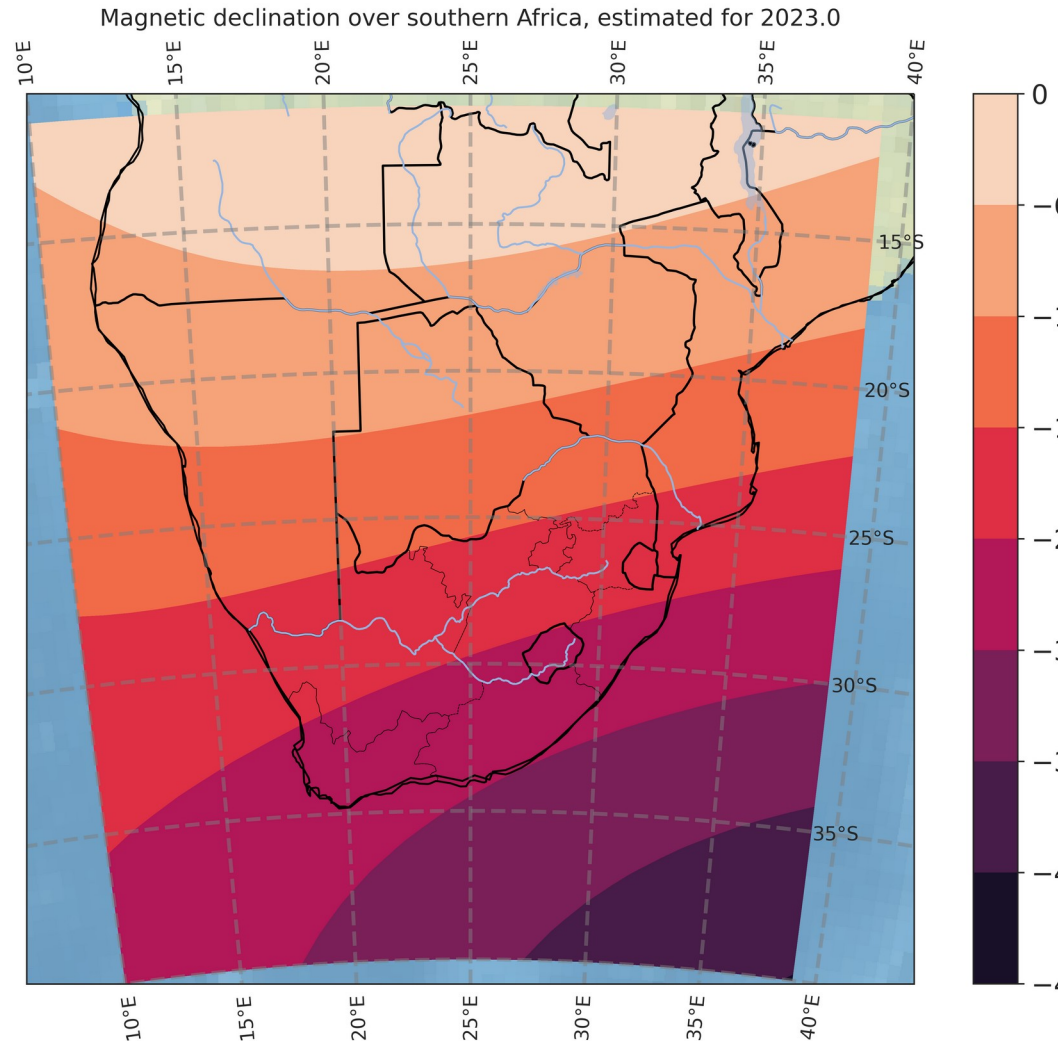
Image credit: NASA/Steel Hill

SANSA GEOMAGNETIC FIELD MODEL

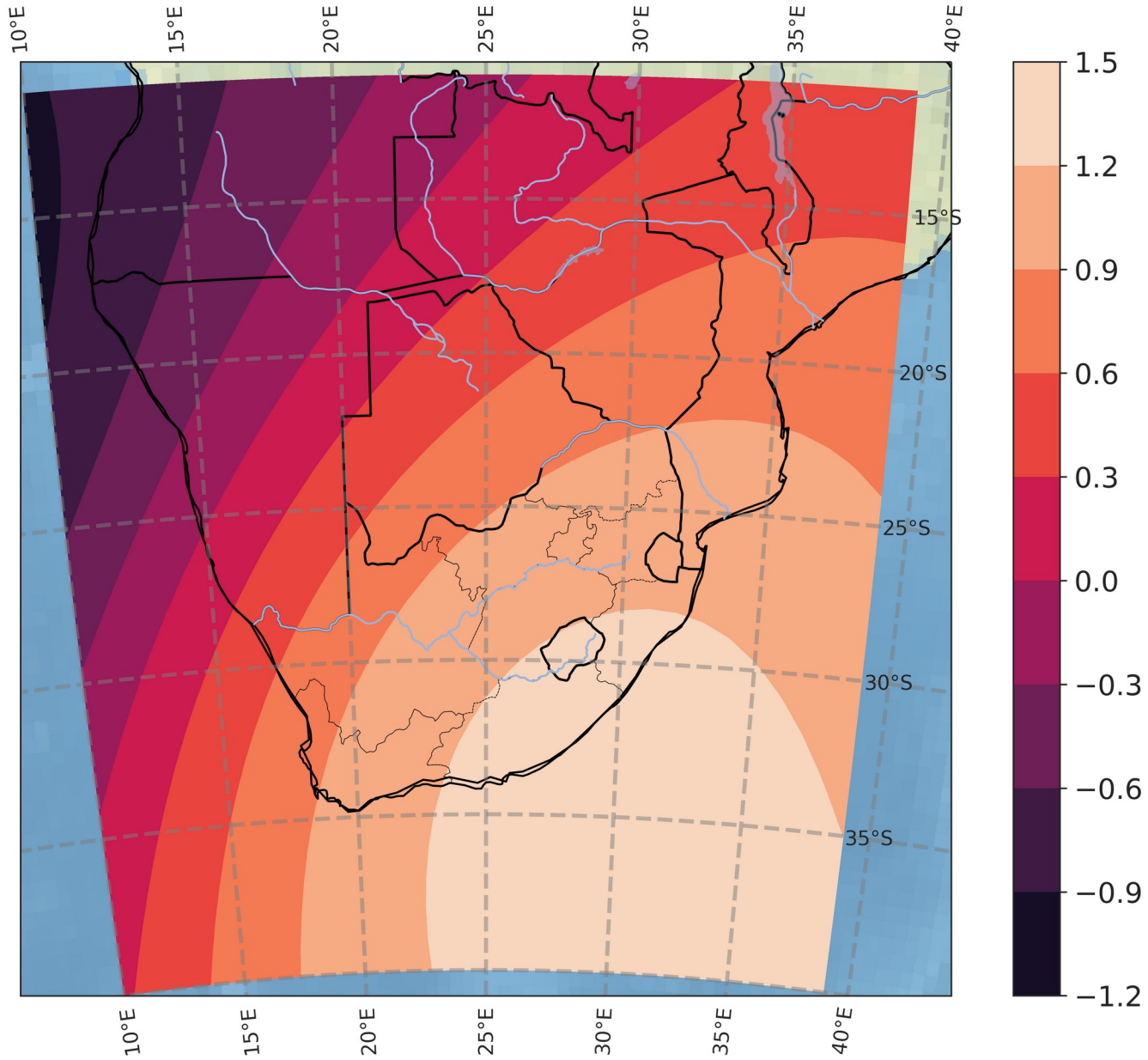
- The SANSA Southern African Regional Field model is a data-based, mathematical representation of Earth's magnetic field used to determine the magnetic declination for navigation, orientation, and heading references.
- This model plays a critical role in assisting our clients with accurate navigation measurements.



It is the only high-resolution regional magnetic field model of southern Africa, and is updated annually using field survey data and data from dedicated magnetic observatories managed by SANSA. Most global field models are updated once every 5 years and do not incorporate magnetic field survey data from southern Africa.



Difference in magnetic declination over southern Africa, estimated for 2023.0/2017.0



WHY ARE UPDATES IMPORTANT: CASE STUDY: TAMPA

- Tampa International Airport (TPA) shut down its primary runway in 2011 to repaint the numeric designators at each end, and change the taxiway signage
- As a result of the movement of the magnetic north pole, runway 18R/36L no longer aligned along the 180-degree/0-degree north-south axis. When the runway reopened, it had been repainted 19R/1L to more accurately reflect its magnetic directions.
- More than 140 signs and panels had to be changed, as well as the painted numerals on the runways.
- Cost: \$ 1.5 million

• *National Business Aviation Association, 14 March 2011.*

WHY ARE UPDATES IMPORTANT CASE STUDY: FAIRBANKS

Fairbanks International Airport in Alaska renamed runway 1L-19R to 2L-20R in 2009 when magnetic north shifted enough to mandate a change. And the airport operators know—from NCEI's World Magnetic Model (WMM) and other sources—that they'll likely need to update the name again in 2033.

National Oceanic and Atmospheric Administration, 20 November 2017.



WHY ARE UPDATES IMPORTANT CASE STUDIES: WICHITA, GENEVA

- The North Magnetic Pole wanders constantly, by around 60 kilometres per year. If the compass bearing will, at a certain point, round off to another degree, the runway must be renamed based on international aviation regulations.
- In 2018, this was done at Geneva Airport. Around 100 sign panels were replaced, and 150 kilograms of paint was used for repainting the numbers on the runway.
- The Dwight D. Eisenhower National Airport in Wichita, USA, renamed its three runways in 2019 due to shifts in Earth's magnetic field, which necessitated updating the numerical designations on the runways. The cost associated with renaming runways generally includes expenses for changing signage, repainting runway numbers, updating charts and publications, and labor costs.

CONCLUSIONS

Research and Development within the field of magnetic technology and geomagnetic field modelling is required in order to identify future safety and security solutions, and to provide a foundation on which challenges in the aviation sector can be addressed.



Thank you

<http://www.sansa.org.za>

anel@sansa.org.za