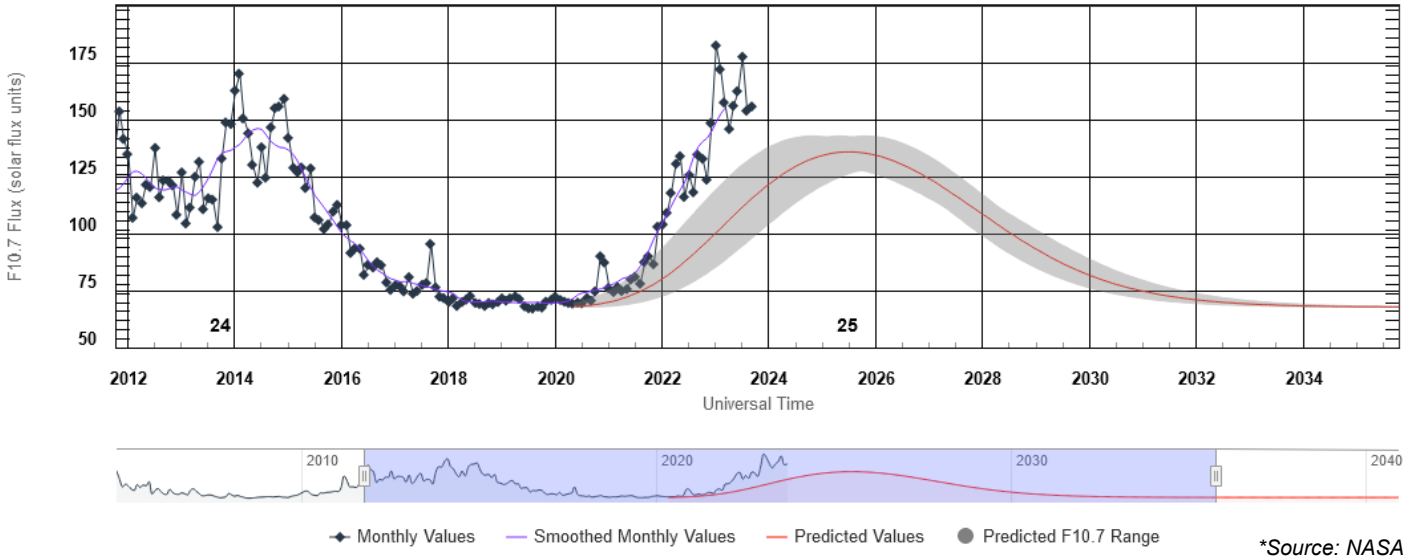
Meeting the Challenge of Increasing Solar Activity with Automated Survey Analysis and Quality Control

Solar Cycle

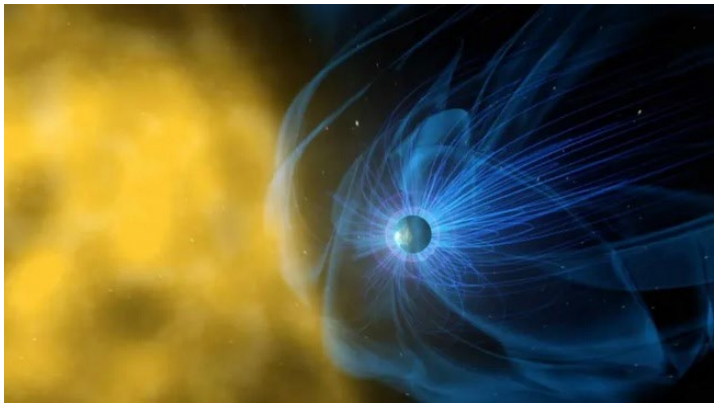
- Geomagnetic activity increasing ↑



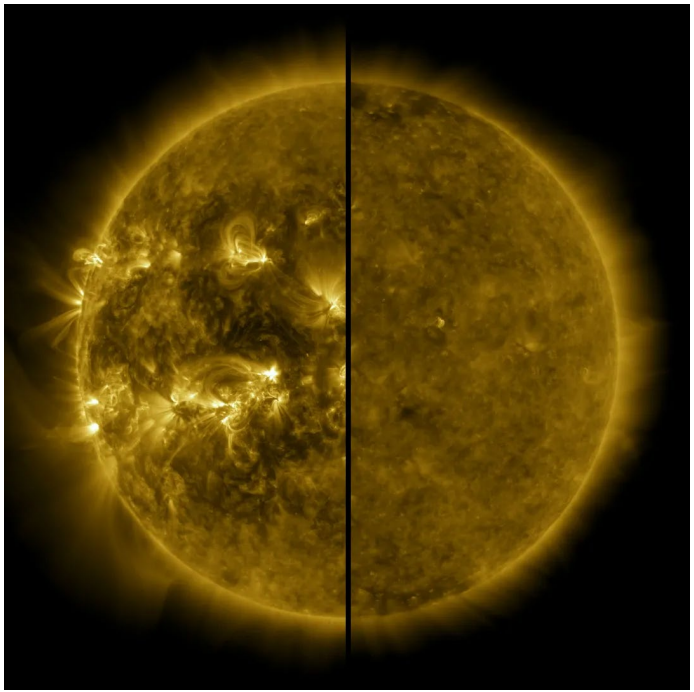
Source: NASA

Magnetospheric Fluctuations

- Short-term fluctuations
- Increase in **magnitude** and **frequency**



*Source: NASA



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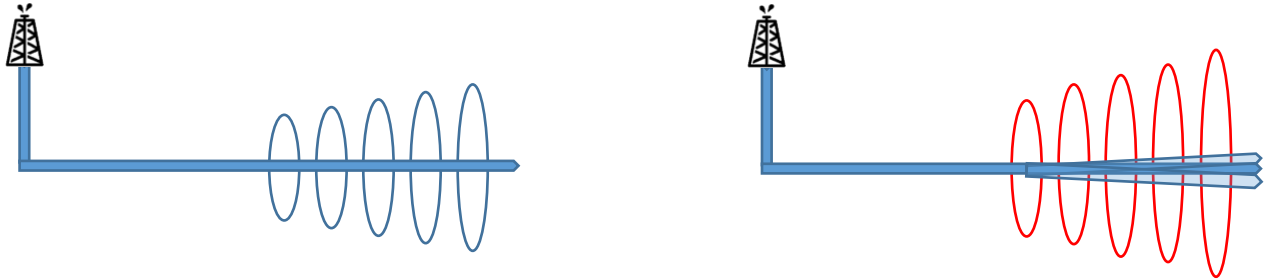
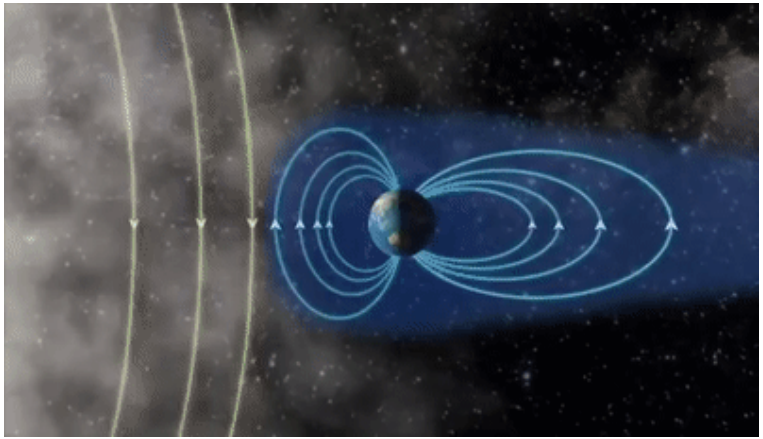
Survey Quality

- Increase in geomagnetic activity ↑
- Decrease in MWD Survey Quality ↓
- Increase in wellbore position uncertainty ↑



Vulnerable Locations

- Latitude ↑
- Magnitude of fluctuations ↑



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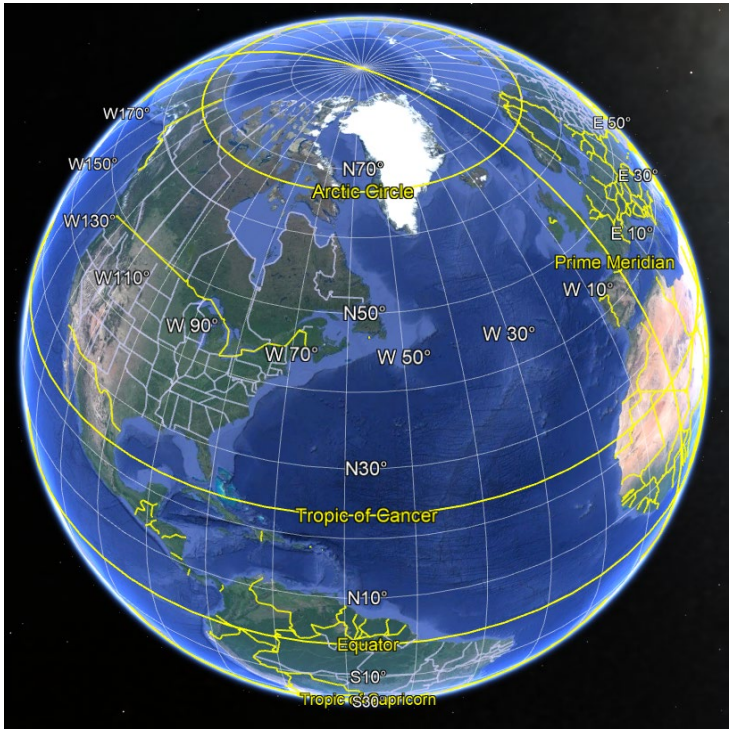

*Source: Google Earth

Automated Platform Readiness

- React efficiently to increased risk from geomagnetic activity
  - Recognize
  - Facilitate plan changes
  - Maintain positional accuracy goals
  - Minimize downtime

Effect on MWD Surveys – Quality Control

- QC measures usually in place to validate accuracy
- Based on *expected* magnetic field strength and dip angle
- Assumed to be *stable* during a run
- Fluctuations in actual field → MWD measurements
- Potentially fail QC and bring survey accuracy into question
- Good stations could appear bad
- Bad stations could appear good

Effect on MWD Surveys – Quality Control

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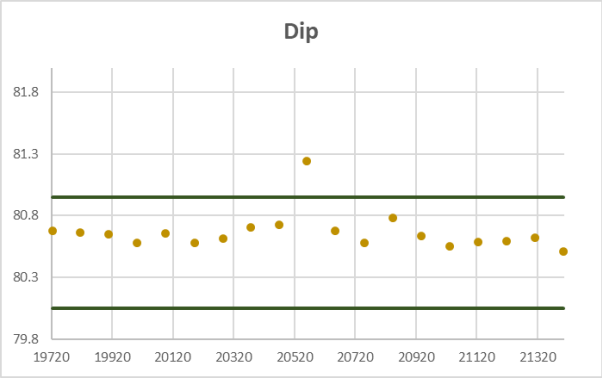

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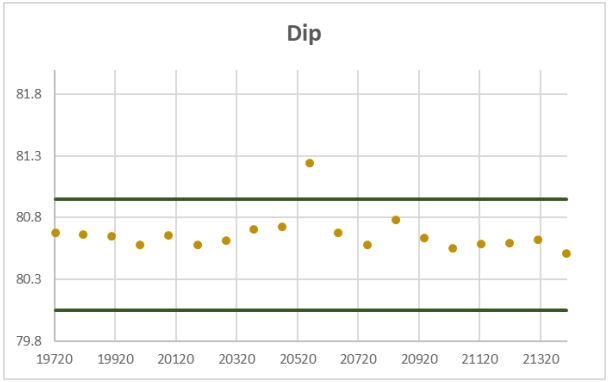
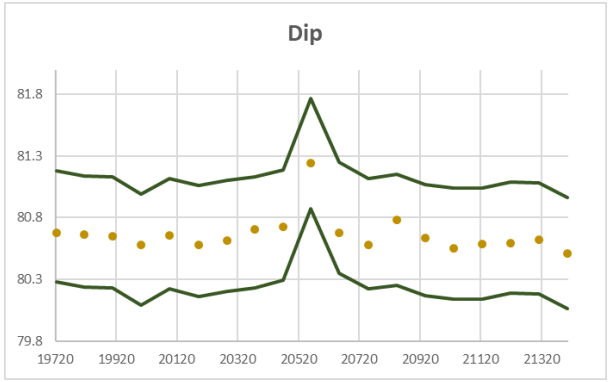




Effect on MWD Surveys – MS Corrections

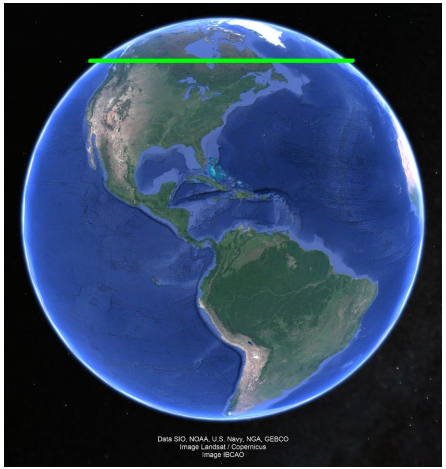
- Multi-station corrections commonly correct for drillstring interference
- Depend on *expected* magnetic Field Strength and Dip angle
- Real short-term changes to these parameters undermine validity of corrections

Effect on MWD Surveys – Declination

- Magnetic Declination likewise fluctuates during solar storms
- → Direct error on survey station azimuth

Case Study

- Anti-collision situation
- Survey program: Standard MWD measurements with high-definition model (HDGM)
- Strong solar activity occurred during drilling of Run 2
- High latitude
- Tight target
- Tight drilling time frame



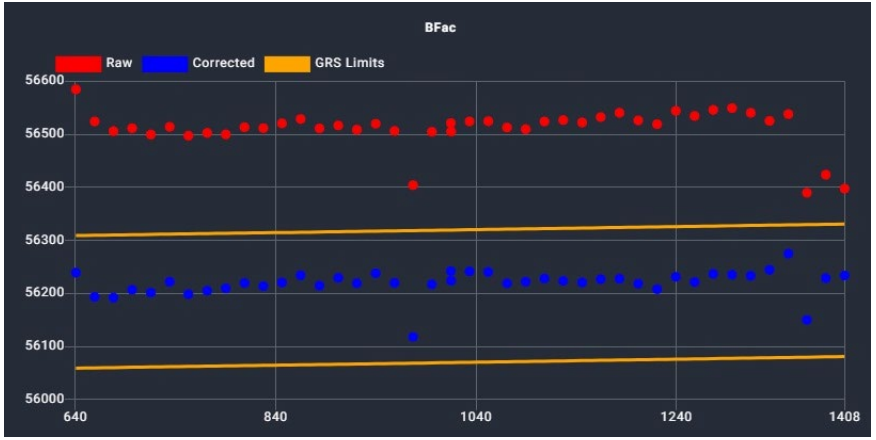
Case Study

- Survey quality deteriorated
- Standard plan called into question
- Risk management
- Replanning partway through drilling run

Case Study

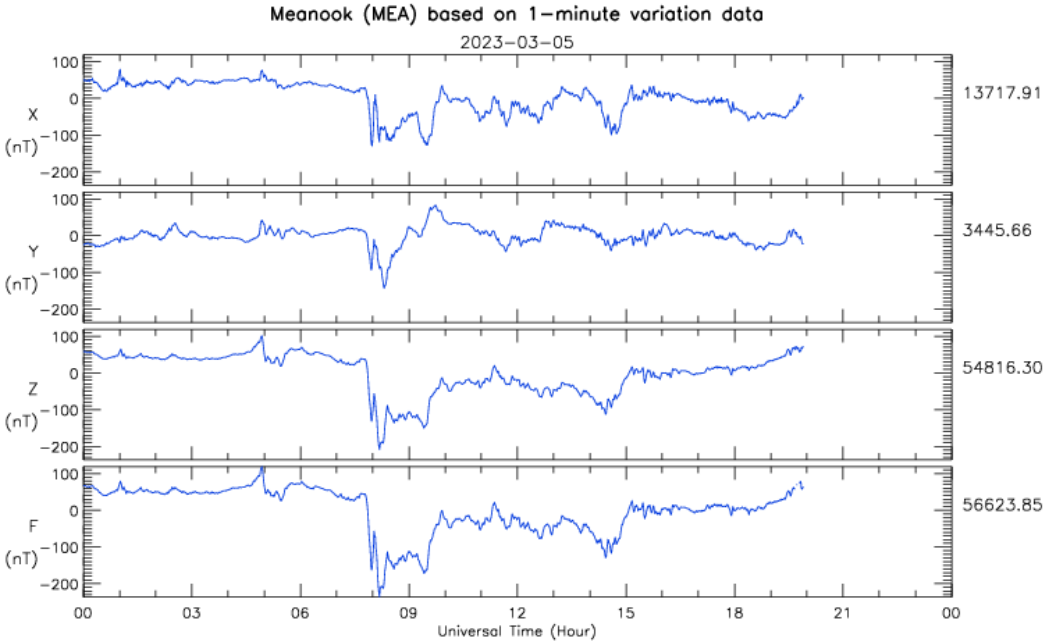
- MS corrections needed (DSI)
- Survey quality deteriorated

✓ External Interference	✓ Entering ZOE	✓ Large Dec Difference
✗ Survey Station Trouble	✓ TF Variety	
✓ Survey Procedure Issues	✓ Field Applied SAG	



Case Study

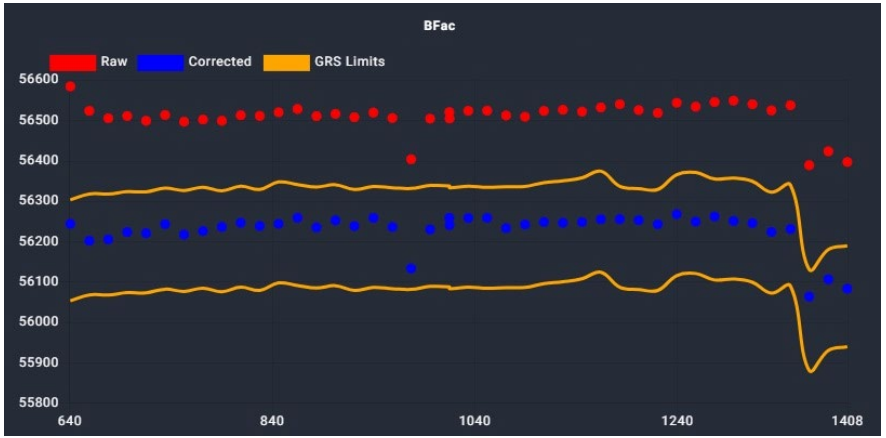
- Data analysis included checking for solar activity
- Expedited if disturbance data is an integral part of the automated platform
- Direct link to nearby magnetic observatory

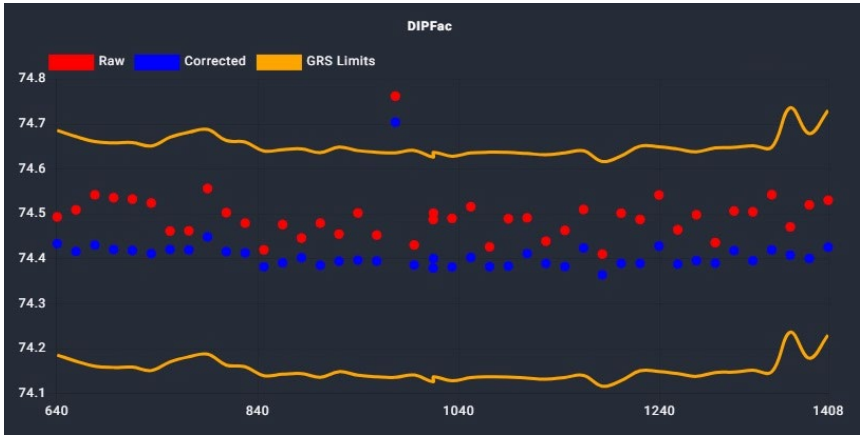


Source: Natural Resources Canada

Case Study

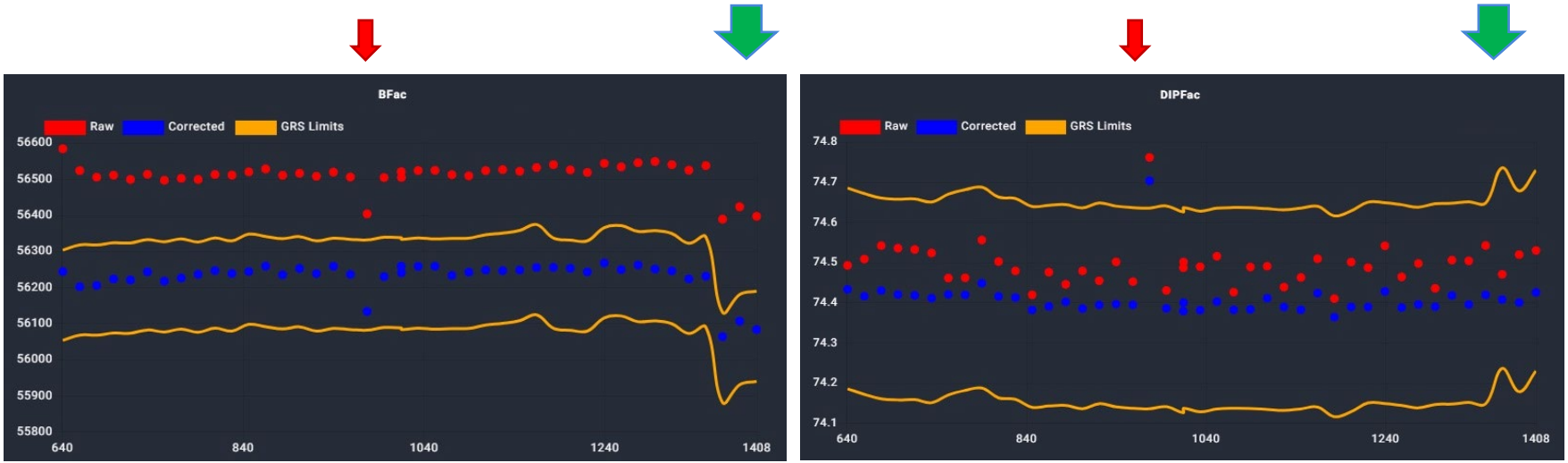
- Reprocessing on the fly reveals that solar activity changed the field





Case Study

- Recent stations are fine, but need new references. One bad station revealed.

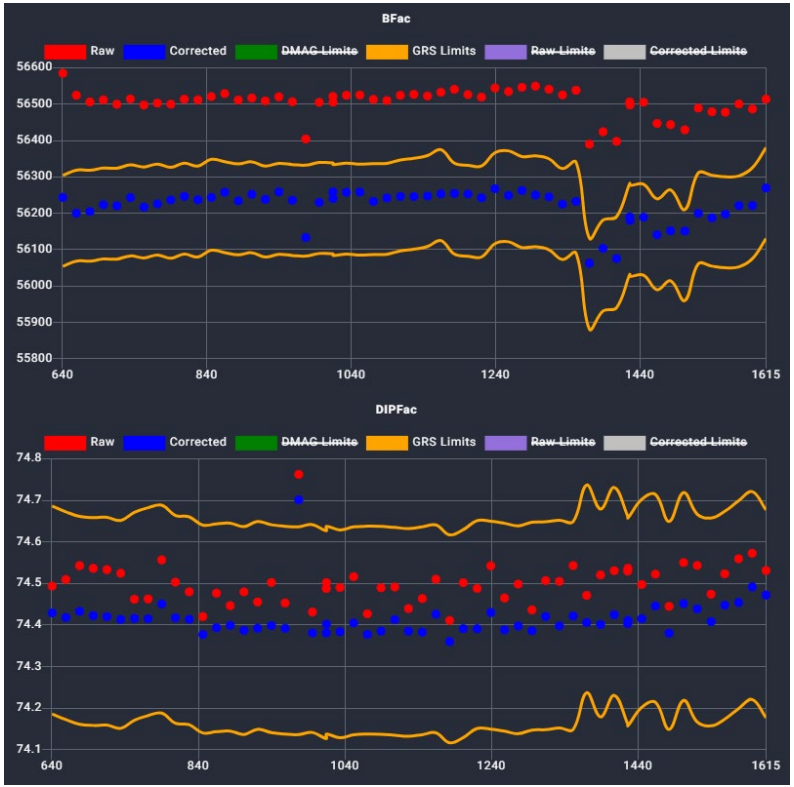


Case Study

- Discussion with Drilling Engineer and management team
- Strong geomagnetic activity may continue
- Risk assessment (AC concerns and tight target)
- Decision to change survey program
- Goals best served by including geomagnetic disturbance corrections (IFR2)
  - Valid MS corrections
  - Declination change in real-time
    - (e.g. The most recent station needed a 0.39 deg declination adjustment)

Case Study

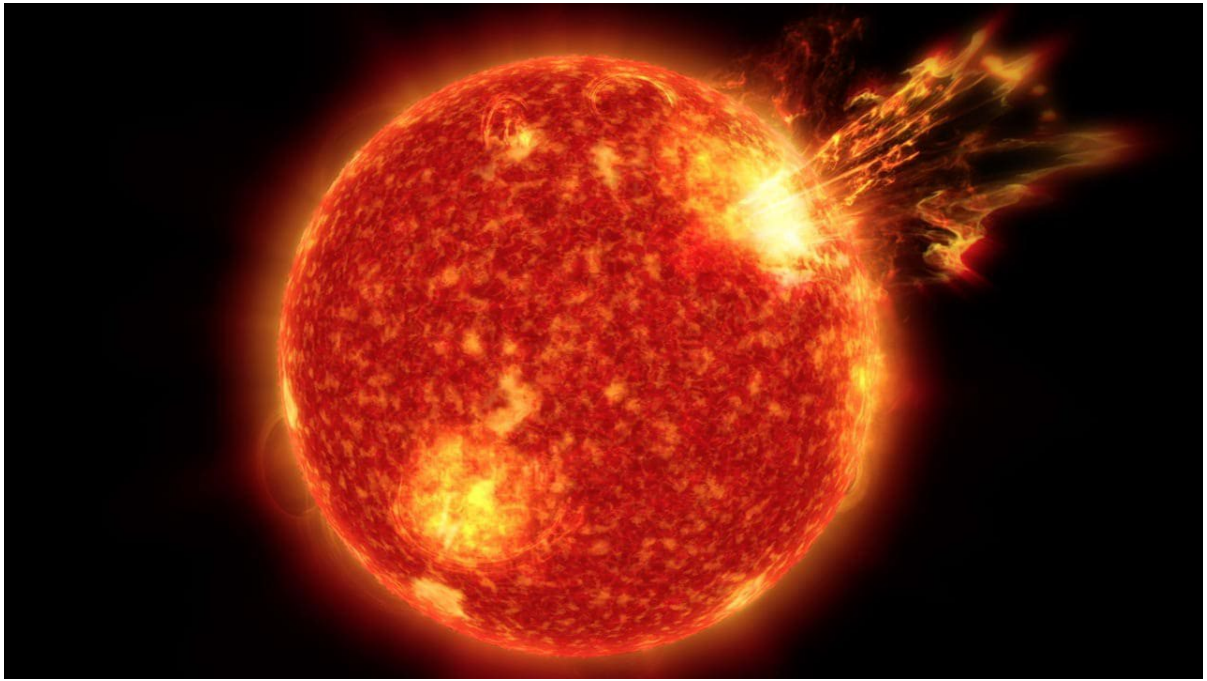
- Run completed with minimal downtime
- Updated references on same raw data
- Crucial features:
  - Robust QC checks to quickly identify survey station issues
  - Independent references, linked to 3D space and time, adjustable on the fly for any data set
  - Active link to obs. data for vulnerable locations



Conclusions

- Flexibility and capability of automated platform proved crucial during the run
  - Early detection of surveying issue
  - Fast Analysis
  - Recommendation within minutes
  - Accommodation of survey program change
  - Real-time mitigation of geomagnetic disturbance
    - Nearby magnetic observatory
    - Real-time link

Questions?



*Source: NASA