TEACHERS AND RESEARCHERS EXPLORING AND COLLABORATING

PolarTREC Lesson Resource

Getting MAD about Magnetics

Mark Buesing

Airborne Survey of Polar Ice 2013

PolarTREC Expedition Page
https://www.polartrec.com/expeditions/airborne-survey-of-polar-ice-2013

This program is supported by the National Science Foundation under award 1918637. Any opinions, findings, and conclusions or recommendations expressed by this program are those of the PIs and coordinating team and do not necessarily reflect the views of the National Science Foundation.

Janet Warburton and Judy Fahnestock
Education Project Managers
Arctic Research Consortium of the US (ARCUS)
3535 College Rd. Suite 101
Fairbanks, AK 99709
(907) 474-1600
info@polartrec.com
www.polartrec.com

Overview

NASA's Operation IceBridge images Earth's polar ice in unprecedented detail to better understand processes that connect the Polar Regions with the global climate system. IceBridge uses a specialized fleet of aircraft and the most sophisticated suite of science instruments ever assembled to gather data on sea ice, glaciers, and ice sheets. The data gathered today will allow future scientists to better understand and model climate change. It is no exaggeration to say that teachers, those who work in support of teachers, and parents are literally raising the next generation of scientists for whom this data will be critical. More information about the project can be found here:
http://www.nasa.gov/mission_pages/icebridge/index.html

One of the instruments Operation IceBridge uses is a magnetometer which gathers data on the magnetic properties of the bedrock beneath the ice. Measuring the magnetic field strength helps scientists identify the type of rock present and knowing the type of rock helps scientists understand how the rock and ice interact.

The P-3 Orion aircraft is ideally suited for measuring magnetic fields as the Orion was originally designed as a submarine hunter and has a magnetic anomaly detector or MAD boom – sometimes called the "stinger". Once used to detect Soviet submarines, it’s now used to help determine what is under the ice.

Objectives

- Learn how to use data acquisition software and hardware (Hall effect magnetic field sensor, Verier LoggerPro, and Microsoft Excel)
- Understand the nature of magnetic fields
- Construct a surface plot and interpret the plot

Procedure

Follow the procedure in the attached worksheet

Credits

Mark Buesing, PolarTREC Teacher 2013
Libertyville High School
Libertyville, IL
mark.buesing [at] d128.org

Resource Details

Region

Arctic

Completion Time

About 1 period

Grade

High school and Up

Permission

Download, Share, and Remix

Expeditions

Airborne Survey of Polar Ice 2013

Author(s)

Mark Buesing

Related Members

Mark Buesing

Materials

Several magnets (more interesting plots are made with magnets of varying strength)

Shoe box (any box will work)

Graph paper (attached in Materials)

Tape

Smartphone

Topic

Earth Science

General Earth Science

Tim Spuck (PolarTREC Teacher 2012) first came up with the idea of items in a box to simulate what Operation IceBridge's radar and lidar systems do. Tim's excellent activity can be found here: http://www.polartrec.com/resources/lesson/seeing-what-you-cant-see

Tools and Methods

Snow and Ice Science

Physical Science

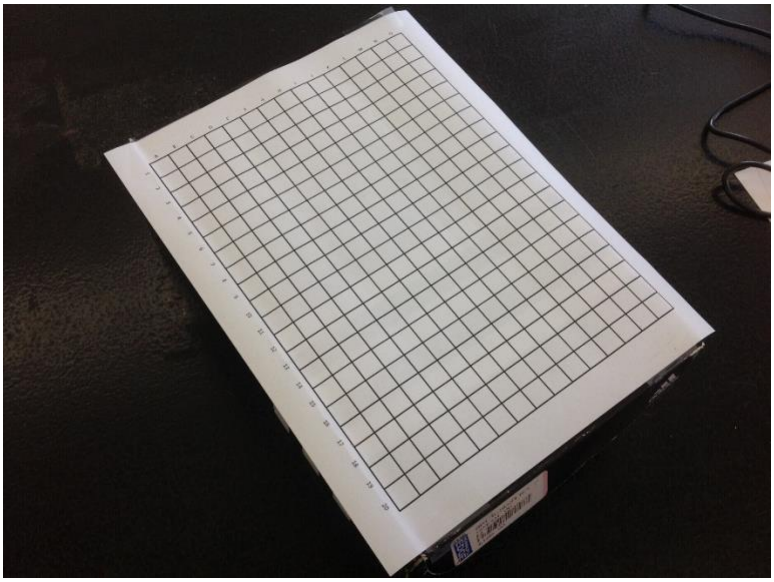
General Physical Science

Motion and Forces

Getting MAD about Magnetics

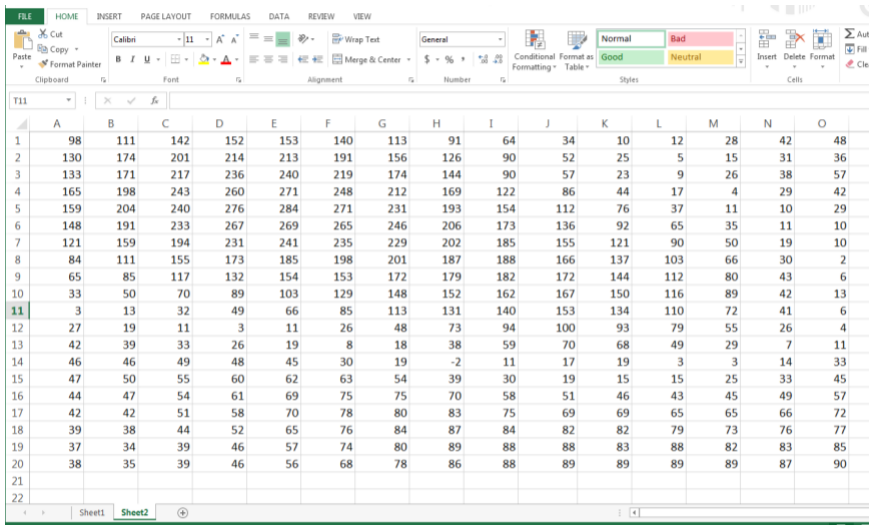
- Tape the magnets onto the bottom of the shoe box and close the lid

- Tape the graph paper onto the top of the shoe box



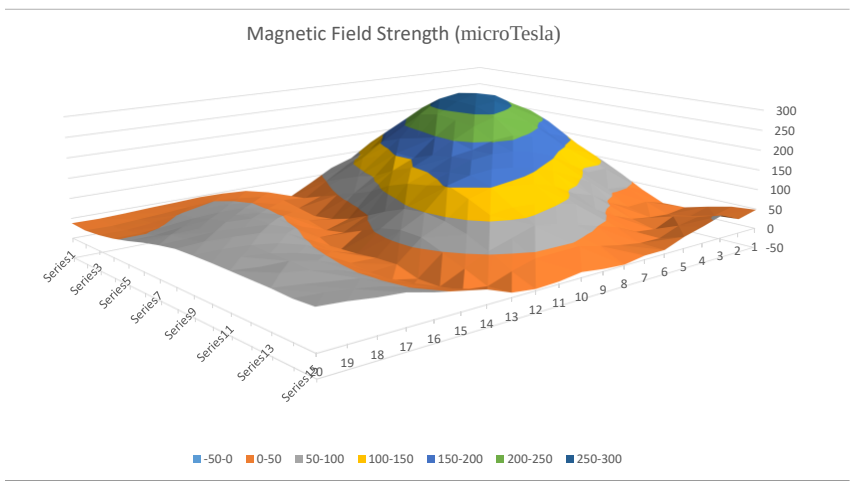
- Download PhyPhox from the App Store or Play Store to your smartphone
- Open the PhyPhox app and under Raw Sensors select *Magnetometer*
- Select ABSOLUTE at the top and click play button to begin measuring
- Magnetic sensor position varies from smartphone to smartphone so for consistency place the top left corner of the phone in each square and record the value in that square.
- Enter the data into an Excel spreadsheet

Example:



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	98	111	142	152	153	140	113	91	64	34	10	12	28	42	48
2	130	174	201	214	213	191	156	126	90	52	25	5	15	31	36
3	133	171	217	236	240	219	174	144	90	57	23	9	26	38	57
4	165	198	243	260	271	248	212	169	122	86	44	17	4	29	42
5	159	204	240	276	284	271	231	193	154	112	76	37	11	10	29
6	148	191	233	267	269	265	246	206	173	136	92	65	35	11	10
7	121	159	194	231	241	235	229	202	185	155	121	90	50	19	10
8	84	111	155	173	185	198	201	187	188	166	137	103	66	30	2
9	65	85	117	132	154	153	172	179	182	172	144	112	80	43	6
10	33	50	70	89	103	129	148	152	162	167	150	116	89	42	13
11	3	13	32	49	66	85	113	131	140	153	134	110	72	41	6
12	27	19	11	3	11	26	48	73	94	100	93	79	55	26	4
13	42	39	33	26	19	8	18	38	59	70	68	49	29	7	11
14	46	46	49	48	45	30	19	-2	11	17	19	3	3	14	33
15	47	50	55	60	62	63	54	39	30	19	15	15	25	33	45
16	44	47	54	61	69	75	75	70	58	51	46	43	45	49	57
17	42	42	51	58	70	78	80	83	75	69	69	65	65	66	72
18	39	38	44	52	65	76	84	87	84	82	82	79	73	76	77
19	37	34	39	46	57	74	80	89	88	88	83	88	82	83	85
20	38	35	39	46	56	68	78	86	88	89	89	89	89	87	90

- From the Insert menu select a 3D surface plot
- Right click on the chart to bring up various formatting and viewing options



Notes:

- Be sure to gather data away from any sources of electromagnetic interference
- One, two, three, or more magnets can be used
- Instead of magnets of varying strength, identical magnets can be used – a much more predictable/regular plot is generated
- Recording 300 values is time consuming – use only part of the graph paper for a shorter activity
- For a much shorter activity, use either dataset here: https://docs.google.com/spreadsheet/ccc?key=0AgePBM0TJqRSdFl0cGVoU21oZnZyU0xRY3otSXJtV2c&usp=sharing

Questions: (Do not open the box … yet.)

1. Where is the magnetic field the strongest on your plot?
2. Where is the magnetic field the weakest on your plot?
3. Sketch where you think magnets are located inside the box.

Open the box and see if your sketch matches.

4. A magnetic field twice as strong would produce a "hill" how many times as tall?
5. Can magnetic field values be negative? If so, what does this mean?
6. Do magnetic fields add, subtract, multiply or divide? Give a reason for your answer.
7. Besides Tesla another unit for magnetic field strength is Gauss. 10,000 Gauss = 1 Tesla. Is a Gauss larger or smaller than a Tesla?
8. 500 microTesla = _____ Gauss.

Acknowledgements:
PolarTREC (Teachers and Researchers Exploring and Collaborating)
http://www.polartrec.com/

Arctic Research Consortium of the U.S. (ARCUS)
http://www.arcus.org/arcus/index.html

National Science Foundation
http://www.nsf.gov/

NASA's Operation IceBridge
http://www.nasa.gov/mission_pages/icebridge/index.html

Libertyville High School
http://lhswildcats.org/

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