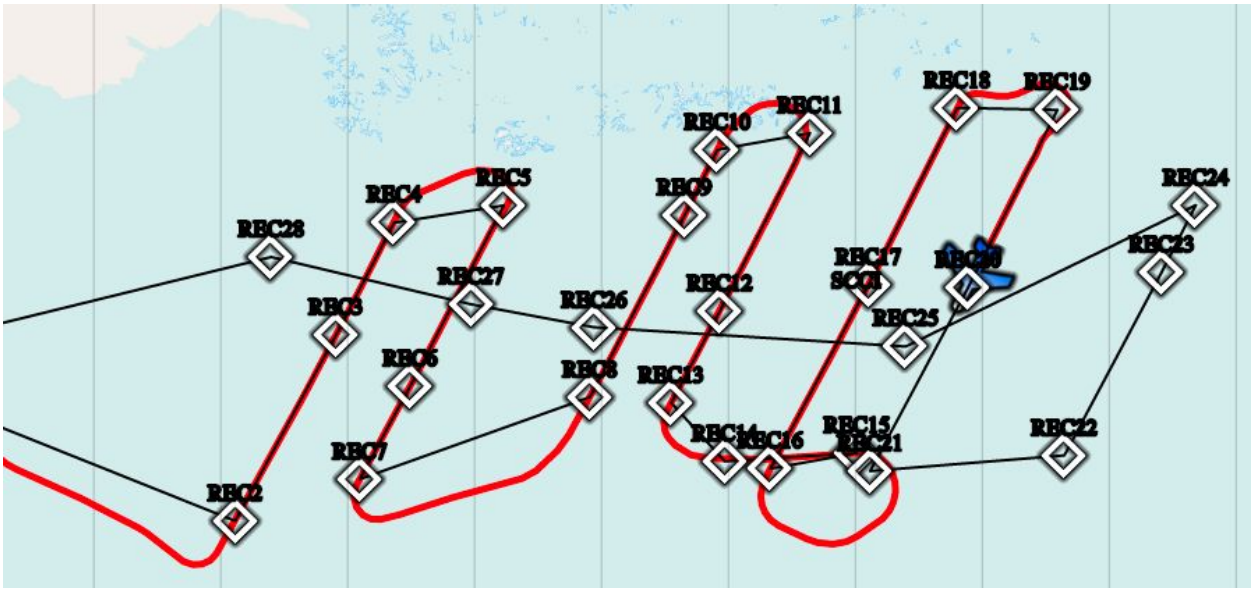
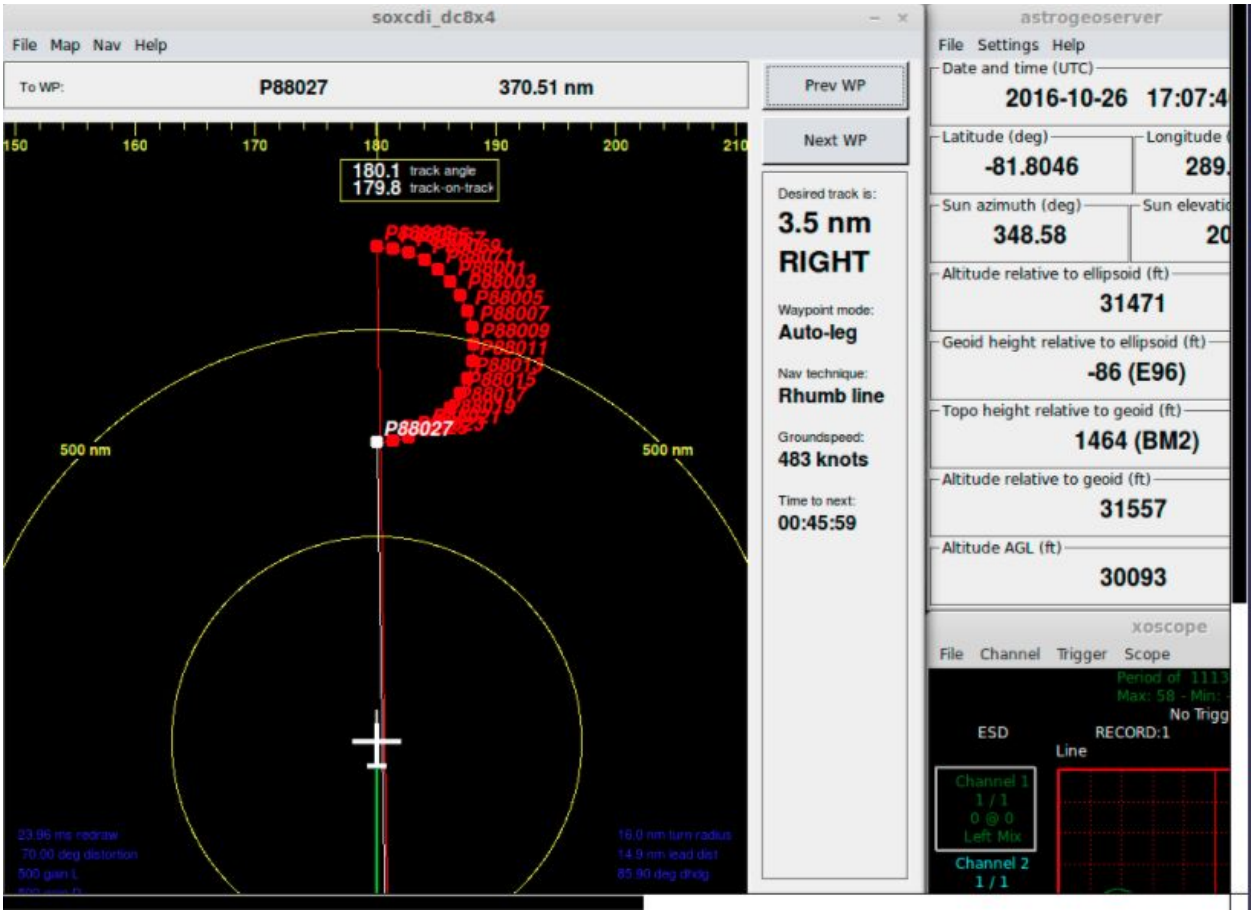
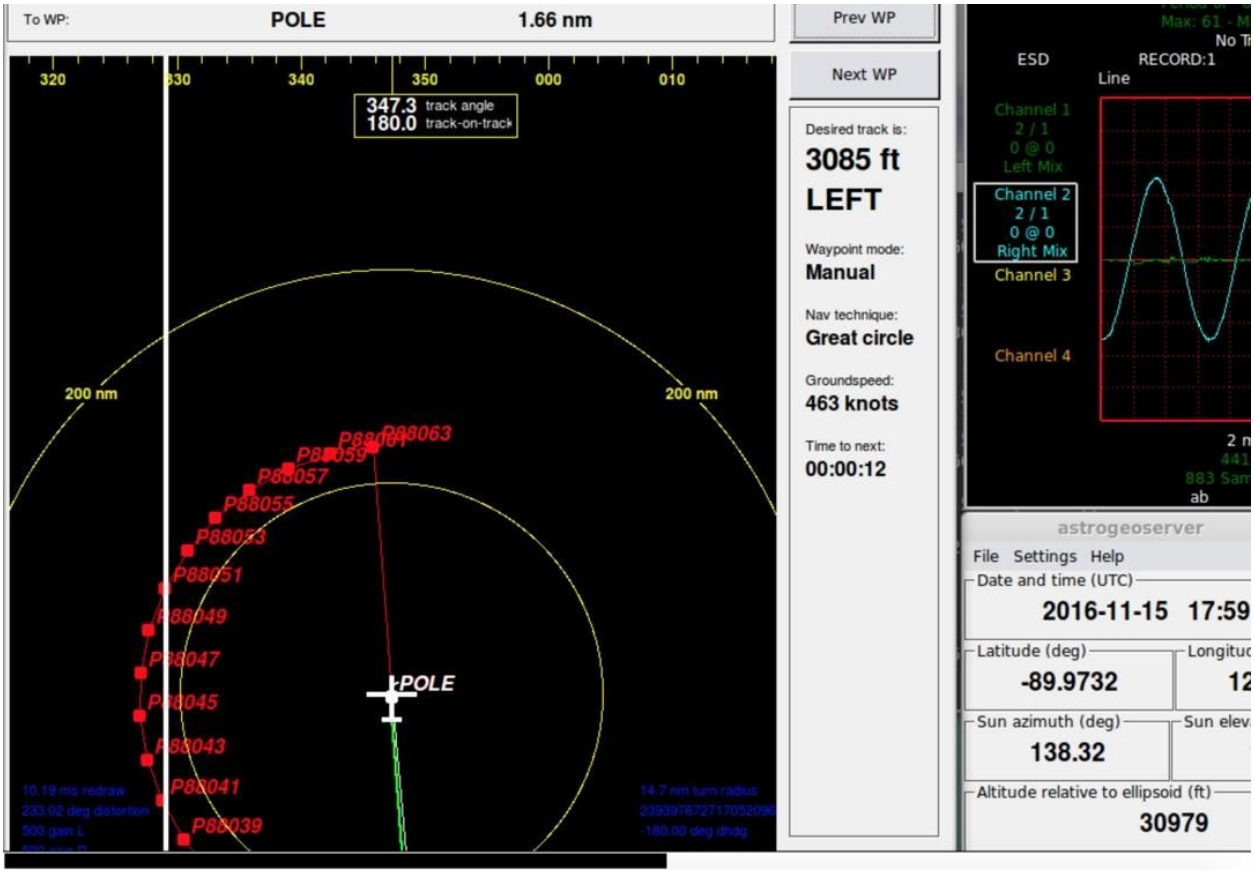
Images of Navigation and Student Note Catcher
Operation IceBridge Antarctica 2016



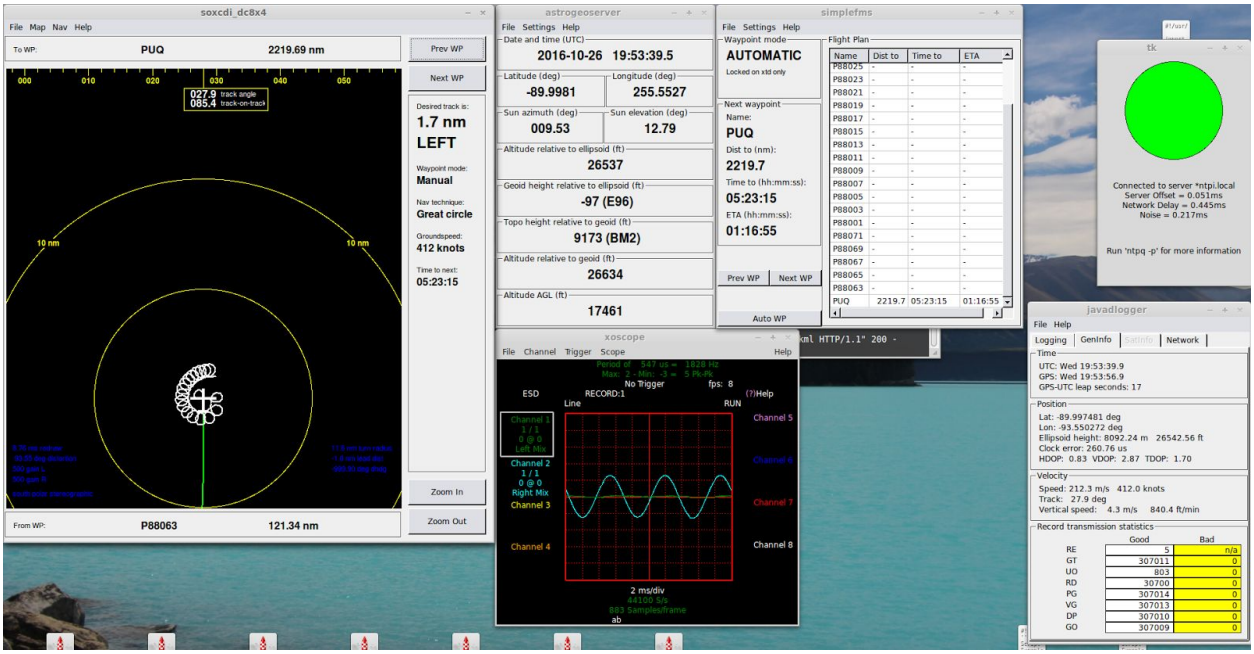
A flight path will follow a route through waypoints set up ahead of time. **(NASA image)**



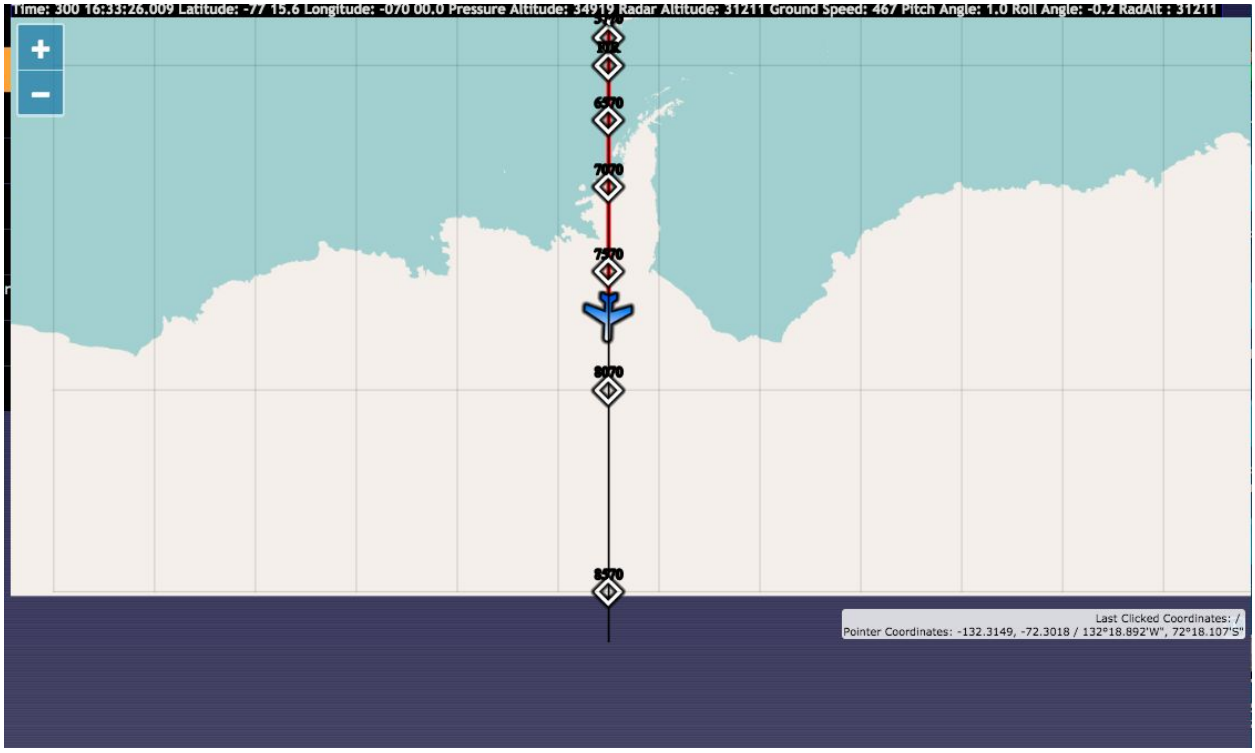
View as flight approaches 85th parallel - note the red waypoints forming a semicircle. (NASA image)



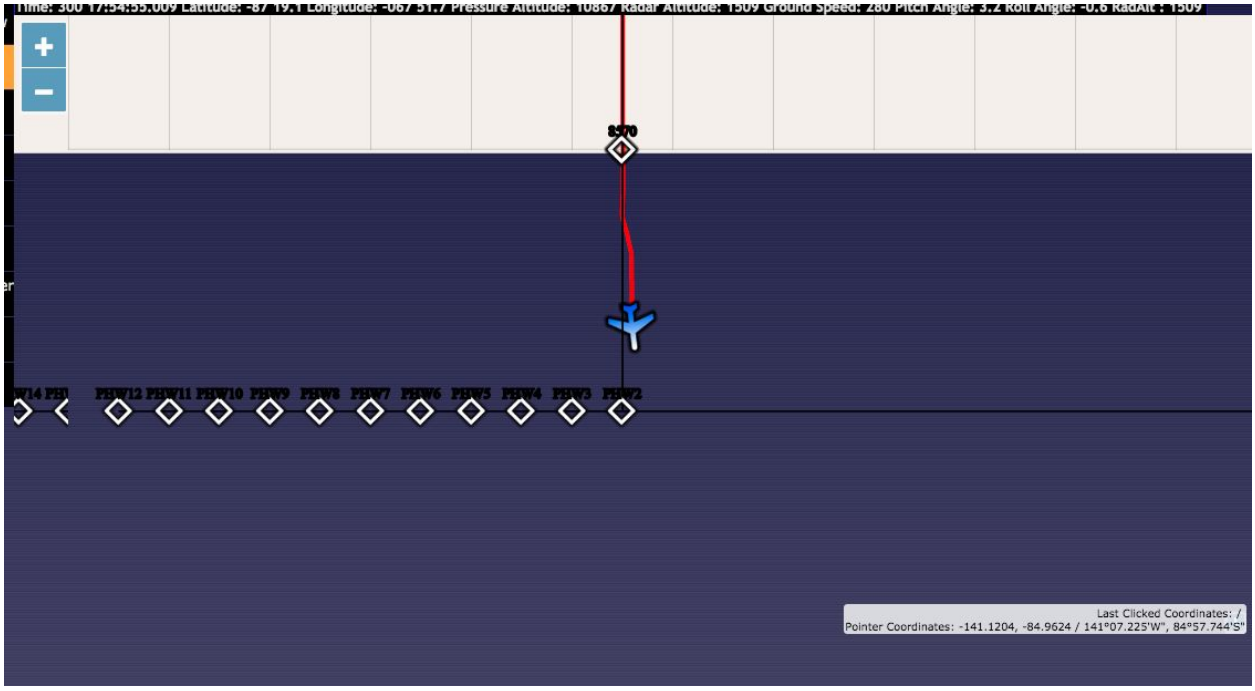
View showing location of plane at South Pole and the waypoints along the 85th parallel (NASA image)



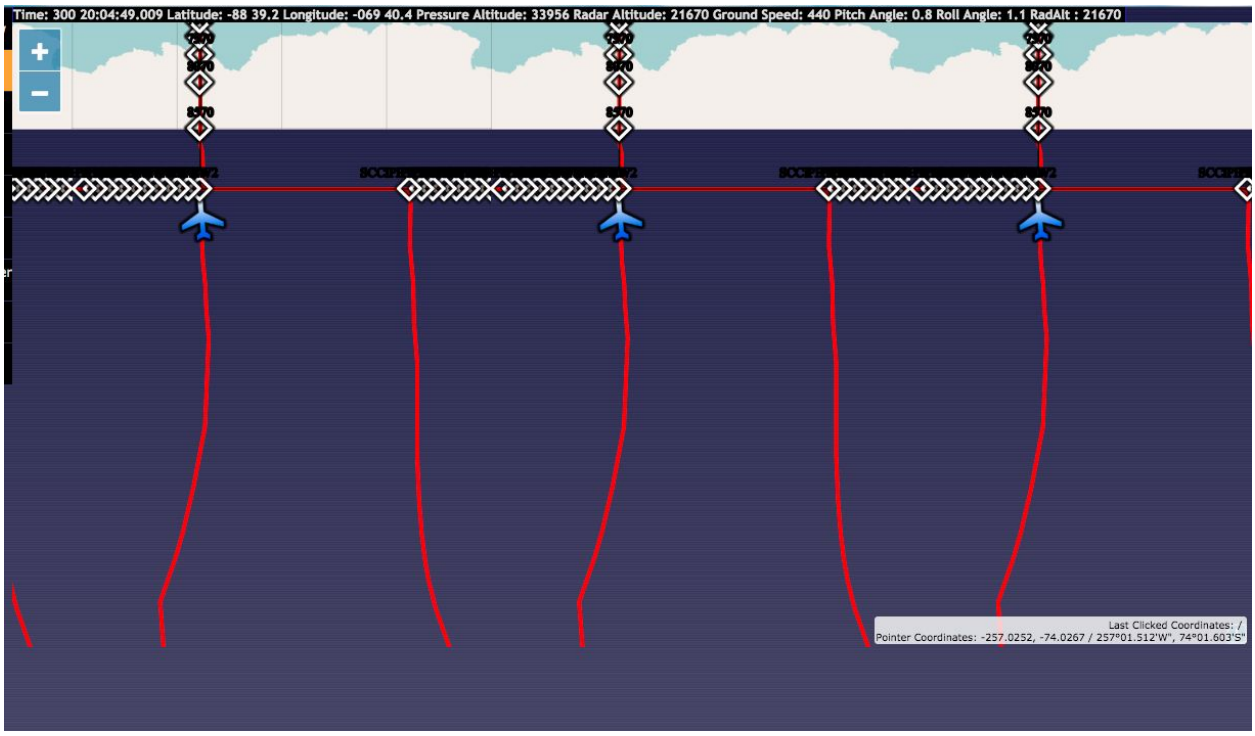
Full view readout of instrument panel while crossing the South Pole. (NASA image)



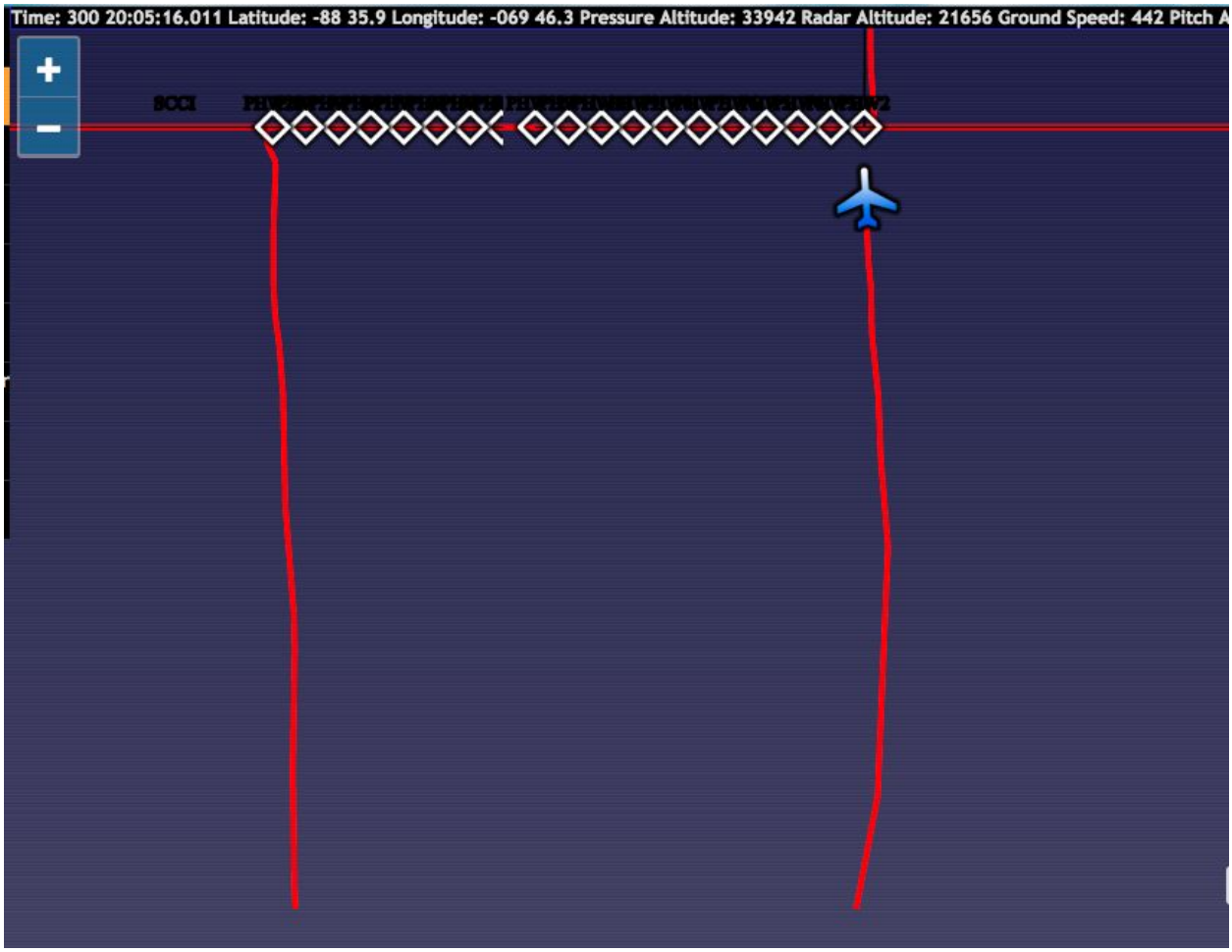
View of flight path approaching the 85th parallel. Note how we will “Fly off the map” at 85° S (NASA image)



The waypoints here appear as a straight line along the 85th parallel. (NASA image)



The computer has difficulty reading how the plane will head south and then north again... what would be a better way to show this? (NASA image)



Where is the South Pole on this image? (at the bottom) Why does it appear this way? (because after crossing the Pole, the plane will be heading North) (NASA image)

Student Note Catcher

Name _____ **Class** _____ **Date** _____

Lesson	**Student Response Area**
Do Now: What are some ways to navigate? Think about navigation on the Earth using the sun, the stars, and also with instruments. Write your thoughts here Write (use the right column), then discuss your ideas with your tablemates.	**Do Now:**

GRAPPLE:

Scenario: You wake up someplace in Antarctica in the southern summer. You are lying on the ice dressed warmly, with a small leather satchel. The satchel contains a GPS with good batteries, a map, a watch, a compass, some nutrition bars, a dozen short metal stakes, a coil of rope and a note from your friend with coordinates of her camp on the ice **88°27'40"S, 108°45'10"W**. The visibility is fair with gentle winds whipping up a bit of snow, but it is spring, so the sun is up for at least 9 hours of the day. There is a pair of skis, poles and boots next to you.

You need to make a plan and travel to your friend's camp. How will you do that?

Your task:

1. Find your Friend's camp!
2. Make a plan to determine where you are and where you need to go.
3. Draw your plan on the maps provided (Antarctic Map 1 and 3) including labels for all lines of latitude, longitude and your route

What you know:

1. You know how to read a map, a watch, a GPS and a compass.
2. The daylight hours in the spring near the poles include some sunlight and some darkness
3. You have heard that some satellites do not cover the area close to the South Pole, beyond 88°.
4. 1° of latitude = 60 nautical miles (approx. 100 km)

What you learn:

1. Once you turn on your GPS, you learn where you are located: **87°22'50"S, 160°38'28"W.**
2. Your watch reads 11:00 AM and the sun is up and the weather is fair.

What you need to do:

Work with your table to figure out your present location on a map and come up with a plan to reach your friends camp.

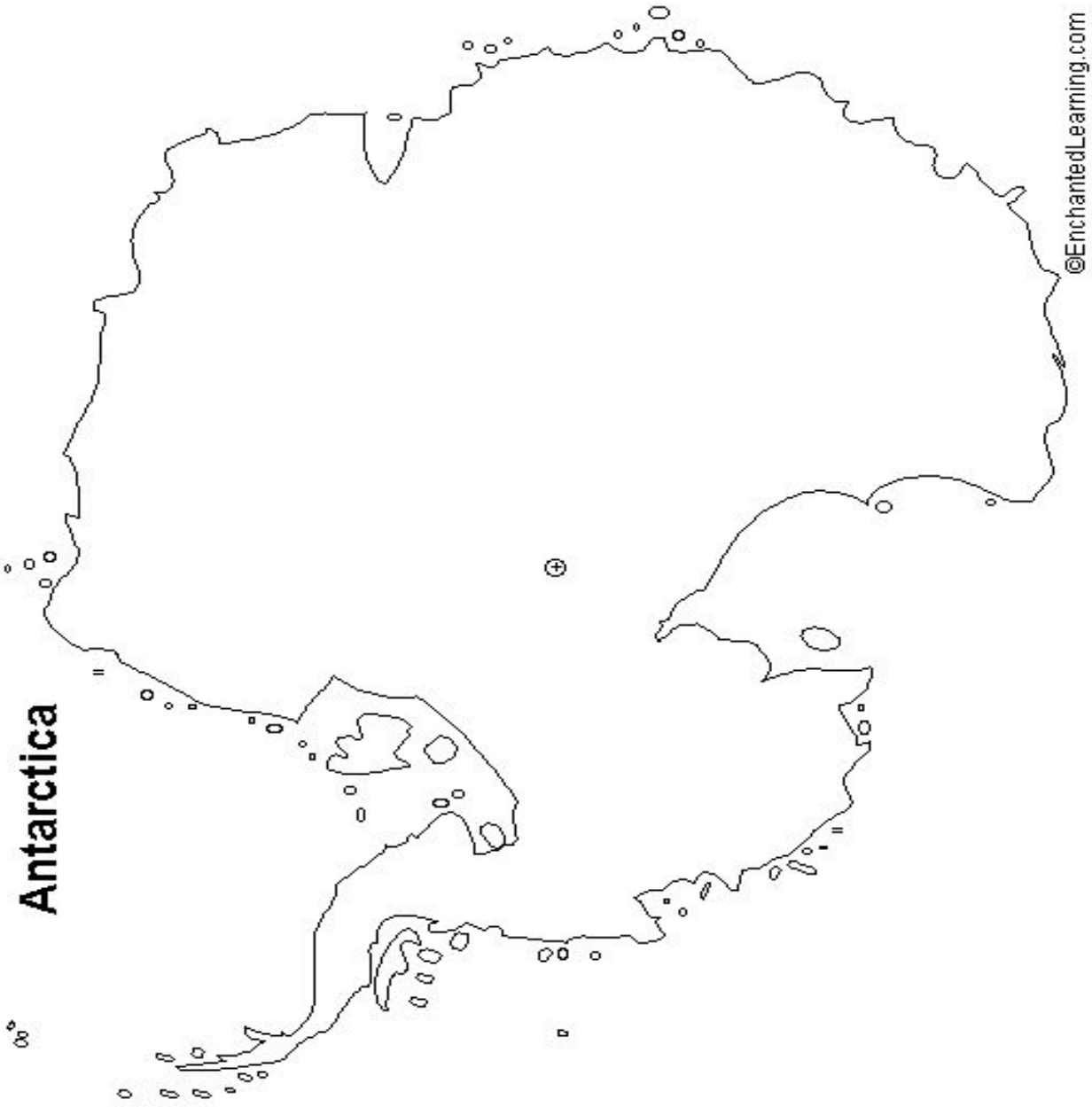
Use this space to take notes, answer questions and make a plan.

Use a detailed map of Antarctica to help you (or use the link to the National Snow and Ice Data Center (NSIDC) Operation IceBridge Portal Map to help you locate yourself here. Once on this map, click S for southern hemisphere and move over the center of Antarctica. As you move your mouse across the map, you will see Longitude, Latitude on the bottom right. Zoom in and out with the + and - buttons.) Did you find yourself? Describe your location: Did you find your friend's camp? Detail what direction you will have to go from where you are: Use Antarctic Map 1 to draw lines of latitude and longitude. Also, draw your route! Use Antarctic Map 2, The NSIDC map, more detailed maps your teacher may have, and online maps for reference.	

FOCUS: Look at the colored screen captures taken as we flew to the South Pole with NASA's Operation IceBridge mission, labeled "Images of Navigation over South Pole - Operation IceBridge 2016" Why do the images look the way they do? See the images showing the plane "flying off the map". Why does it appear this way?	
APPLY: Now lets think about TIME ZONES! Take a look at these links to get your thinking going. https://www.timeanddate.com/worldclock/antarctica http://www.worldtimezone.com/time-antarctica24.php	

1. If it is Noon when you hit the 88th parallel along Greenwich Mean Time (0° Longitude), what time is it on the other side of the Pole, at 180°? ***2. For each 45° that you travel, how many time zones (hours) do you cross?*** ***3. Which direction would you need to travel to go back in time? To go into the future?*** ***Extension: What is "declination" and how does it relate to navigation?*** ***Go to https://maps.ngdc.noaa.gov/viewers/historical_declination/ and explore - you will see that the magnetic South Pole is way west of the geographic South Pole. Explain how this can be!***	
Exit Ticket: ***Choose one point on the map of Antarctica and ask your shoulder partner to figure out the latitude/longitude of that location.*** ***Choose a second point and ask them to set a course between the two points.*** ***Write the locations you picked for your partner and the heading they set to navigate between them.*** ***Turn your note catcher face down if you partner was able to meet the Learning Target.***	Exit Ticket:

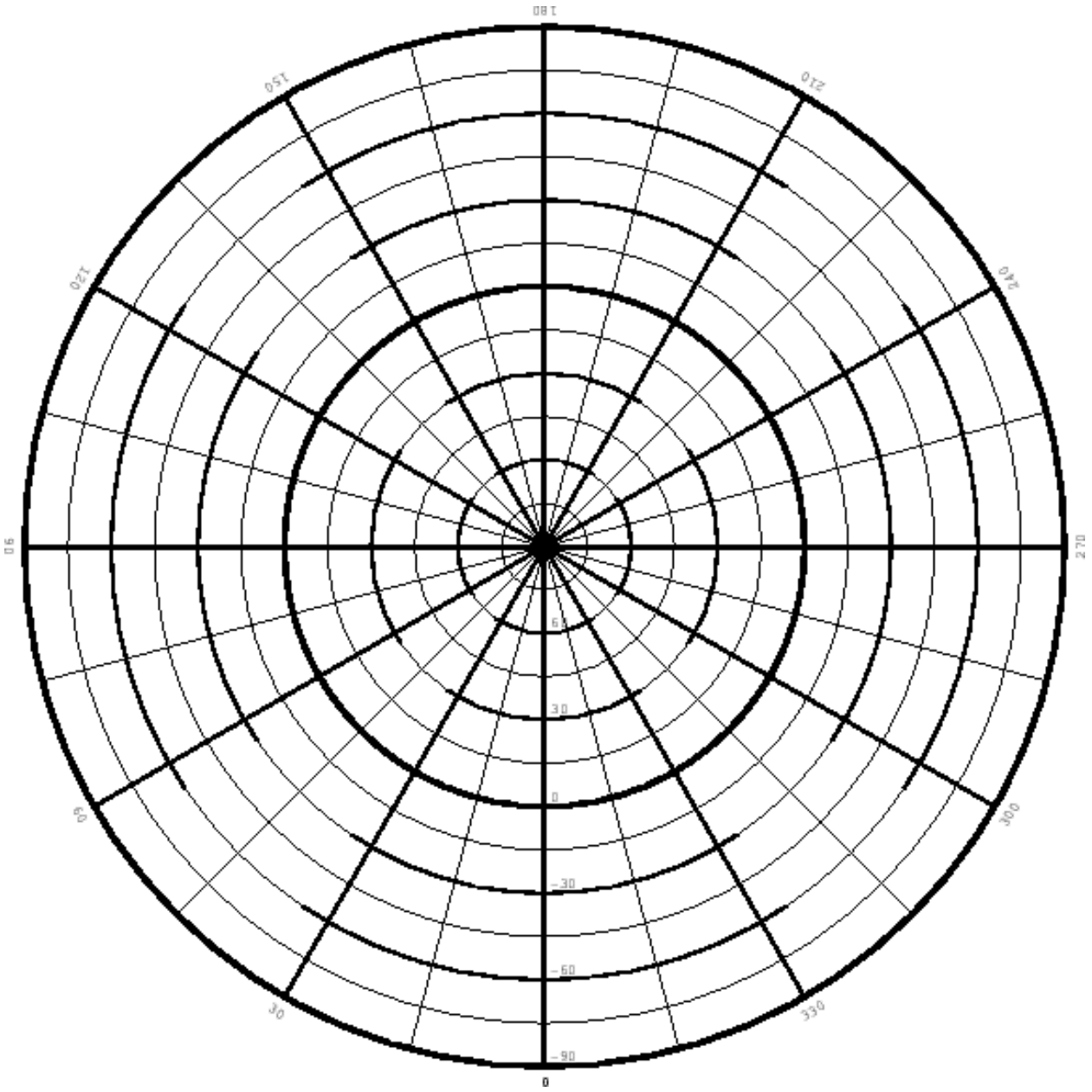
Antarctic Map 1



Antarctic Map 2

Taken from http://geology.com/world/antarctica-map.jpg

Map 3 - Polar Statigraphic Projection



Summative Assessment Questions

1. Why do planes circle along the 88th parallel when flying across the South Pole?

2. What tools might be useful to navigate near the pole?

3. How many time zones do you pass through if you travel 180° around the Pole?

4. What about if you pass through 360°?

5. Choose 3 locations in Antarctica on a map (NSIDC or other map you used in this lesson) and Identify the longitude and latitude. Write them correctly here.

6. Einstein extra credit: Why are the locations of the magnetic and geographic South Pole different?

Navigation Around the Poles! Lesson Scoring Rubric

Student Name _____ Class _____ Date _____

Lesson Learning Target	3 - Meets expected level of proficiency	2 - Beginning level of proficiency	1 - Limited evidence of proficiency
I can use longitude and latitude to find a location and plan a route	Student can differentiate longitude and latitude, use coordinates to find a location, and calculate a heading in planning a route	Student shows proficiency with 2 of these 3 skills	Student shows proficiency with 1 of these 3 skills.
I can use different instruments to establish heading within and beyond satellite coverage	Student can use a compass, map and GPS to establish locations and bearings	Student shows proficiency with 2 of these 3 skills	Student shows proficiency with 1 of these 3 skills
I can navigate between and discuss time zones near the poles	Student shows an understanding of time zones, where they are located, which direction the zones progress, and how longitudinal lines come together at the pole	Student shows proficiency with 2 of these 3 skills	Student shows proficiency with 1 of these 3 skills
I can navigate beyond limitations in some instruments near the poles	Student can score 5-6 correct answers on the summative assessment	Student can score 3-4 correct answers on the summative assessment	Student can score 1-2 correct answers on the summative assessment
Extensions (optional)	Student extended their learning by engaging in the video on timezones and was able to answer the follow up question, and/or student learned about declination on how the geographic and magnetic poles can be in different places. Assign extra points as desired.		