

Seasonal Changes in Albedo

1. How does albedo change with the seasons?

Albedo in the polar regions increases in the fall and winter and decreases in the spring and summer. Data are not available in winter, so students may not say winter.

2. What is unique about ice and snow?

Ice and snow have a high albedo and reflect a lot of incoming sunlight.

3. What does the changing albedo in the polar regions tell you about seasonal changes in ice and snow?

The increase in albedo in the fall and winter show more ice and snow. The decrease in spring and summer show a decrease in ice and snow.

Annual Sea Ice Minimum

1. What happens to sea ice in the summer?

Some of the sea ice melts in the summer. It reaches its annual minimum extent in September.

2. What trend did you observe in the video?

The annual sea ice minimum has been decreasing over time.

Changes in Sea Ice over Time

1. What reasons can you think of to explain why the older sea ice is disappearing?

Accept reasonable responses. Possible answers include that seasonal melt is being accelerated by changing albedo leading to the absorption of more solar radiation and speeding up the melt.

Feedbacks

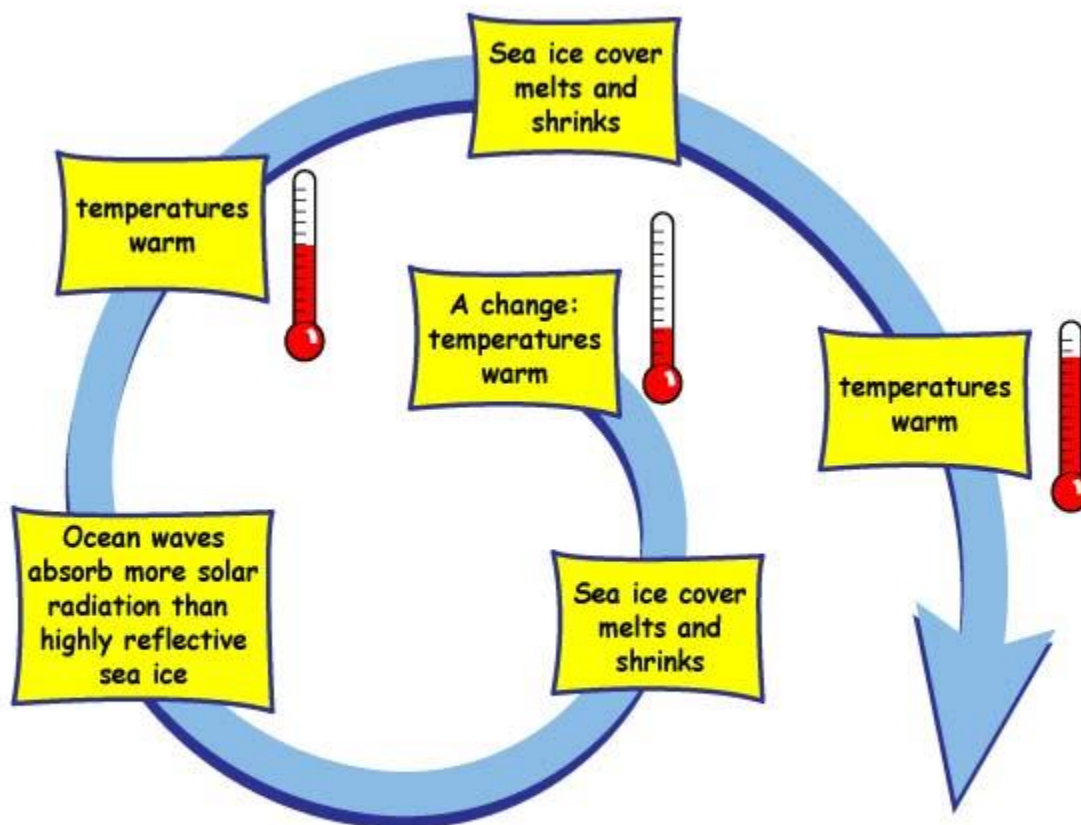
1. What is a negative feedback loop? Explain the example given in the video.

A negative feedback loop is when a change or input to a system causes an output in a system. That output will in turn dampen the effects of the original input. It is sometimes referred to as a self-regulating system.

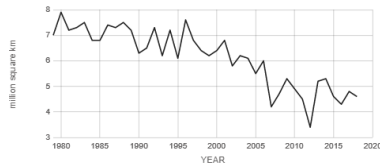
2. What is a positive feedback loop? Explain the example given in the video.

A positive feedback loop is when a change or input to a system causes an amplified change in the system. This tends to move a system out of equilibrium.

3. Complete the graphic organizer of a positive feedback loop for the effects of changing albedo on sea ice.



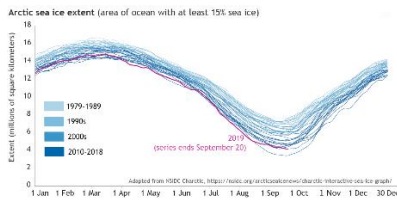
Positive Feedback Loop



Source: climate.nasa.gov

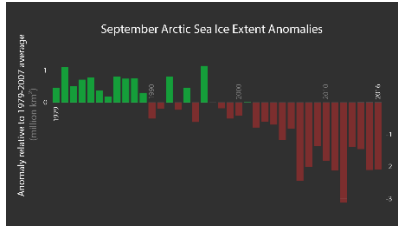
This graph shows the sea ice minimum over time.

1. What was the level of sea ice in 2000?
Approximately 6.4 million square km.
2. What was the level of sea ice in 2005?
Approximately 5.5 million square km.
3. What was the level of sea ice in 2010?
Approximately 4.9 million square km.
4. What was the level of sea ice in 2015?
Approximately 4.6 million square km.
5. What was the highest level and what year was it?
1980. 7.9 Million square km.
6. What was the lowest level and what year was it?
2012. 3.4 million square km.
7. What is the trend over time?
The annual sea ice minimum is decreasing over time. There are fluctuations from year to year, but the overall trend is down.
8. How will albedo change with this trend in the sea ice?
As sea ice decreases, albedo will decrease. The albedo of the ocean is much lower than the albedo of the sea ice.



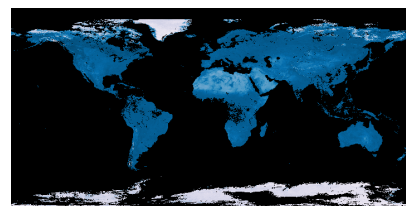
The graph shows the sea ice over the course of the year for many years.

1. What is the pattern of sea ice each year?
Each year, the sea ice increases from January through March. It then decreases through September and increases from October through December.
2. What time of year has the highest level of sea ice?
March
3. Which month has the lowest sea ice each year?
September
4. How has the minimum changed over time?
The minimum has decreased over time.
5. What is the difference between the different time ranges shown on the graph?
The older ranges had more sea ice throughout the year. As the ranges have gotten more recent, they have decreased.
6. How is the time range 2010 – 2018 different from the other time ranges?
It shows the lowest levels of sea ice throughout the year.
7. What is the trend over time?
The sea ice is decreasing throughout the year over time. Even the peak times have less sea ice.
8. How will albedo change with this trend in the sea ice?
As sea ice decreases, albedo will decrease. The albedo of the ocean is much lower than the albedo of the sea ice.

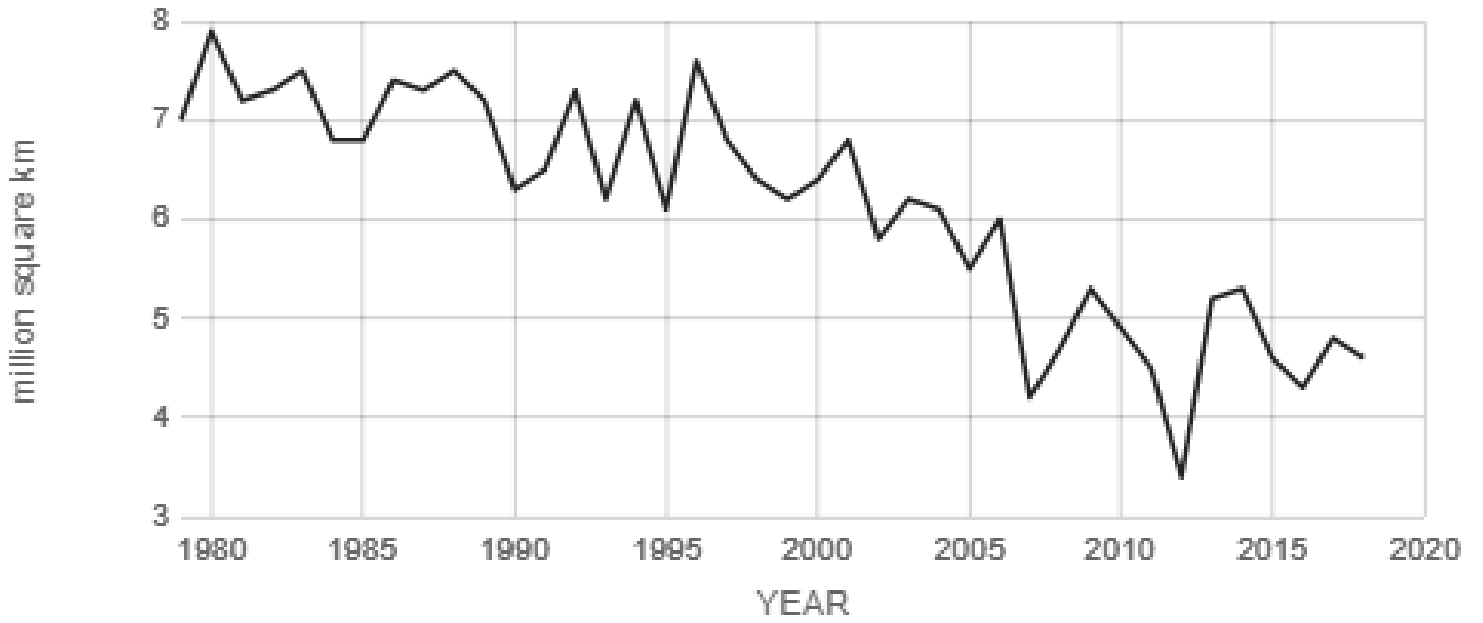


1. What years were used to find the average sea ice extent?
1979-2007
2. How does the year 2000 compare with the average?
It is about 0.5 million square km lower than the average.
3. How does the year 2005 compare with the average?
It is about 1.1 million square km lower than the average.
4. How does the year 2010 compare with the average?
It is about 1.8 million square km lower than the average.
5. How does the year 2015 compare with the average?
It is about 2.1 million square km lower than the average.
6. Which year had the lowest value?
2012
7. What is the trend over time?
The September Arctic sea ice extent is decreasing. The anomalies are getting larger in the negative direction. That means the numbers are more and more below average.
8. How will albedo change with this trend in the sea ice?
As sea ice decreases, albedo will decrease. The albedo of the ocean is much lower than the albedo of the sea ice.

These images show albedo over land only. That means that the albedo in the polar regions in these images is from snow or land ice. Focus on the albedo in the Arctic when answering the questions.

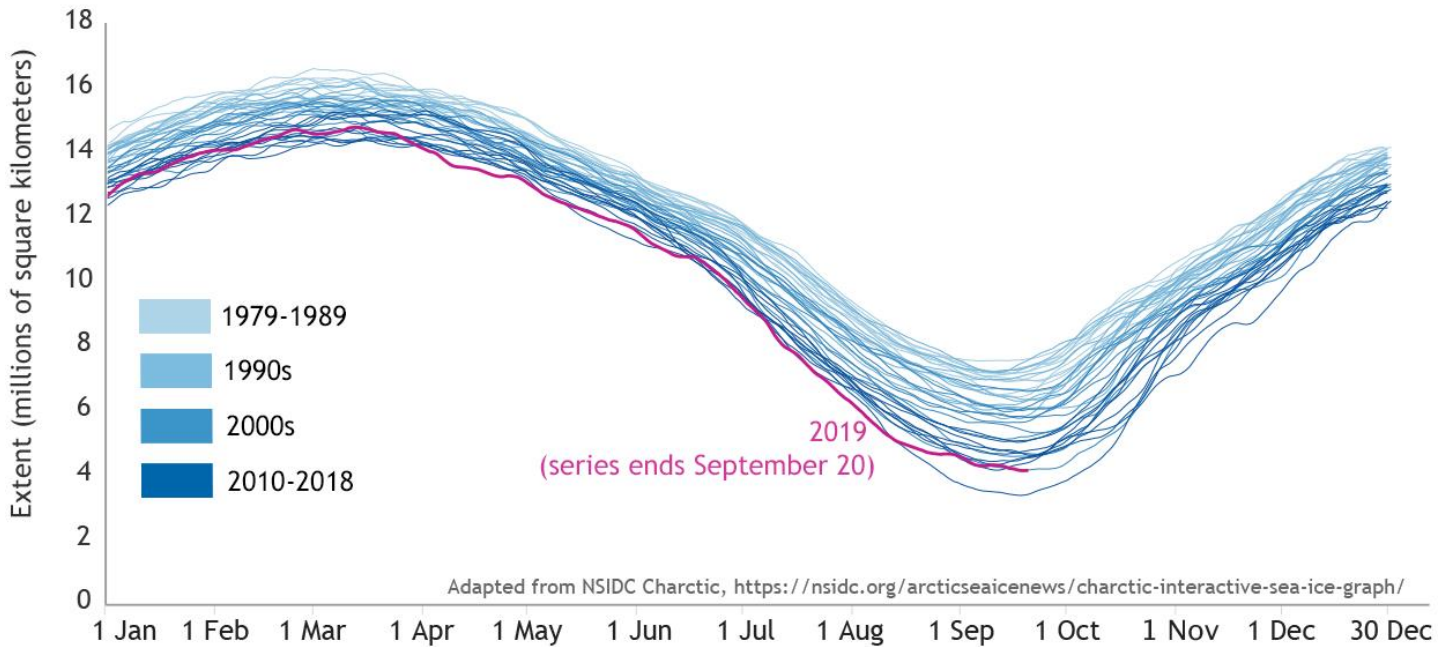


1. What month does each image show?
September
2. What is significant about that month?
It is the month when the annual sea ice reaches the minimum extent in the Arctic.
3. How does the albedo for 2000 compare with 2005?
There is a larger are in 2000 with a high albedo than in 2005.
4. How does the albedo for 2000 compare with 2010?
There is a larger are in 2000 with a high albedo than in 2010.
5. How does the albedo for 2000 compare with 2015?
There is a larger are in 2000 with a high albedo than in 2015.
6. Which year had the lowest albedo?
2010 looks lower for North America. 2005 looks lower for Asia.
7. What is the trend?
The trend is an overall decrease.
8. What relationship might there be between the albedo on land and sea ice?
The lower albedo on land suggests less snow is surviving. That could mean that less sea ice is also surviving.



Source: climate.nasa.gov

Arctic sea ice extent (area of ocean with at least 15% sea ice)



Adapted from NSIDC Charctic, <https://nsidc.org/arcticseaicenews/charctic-interactive-sea-ice-graph/>

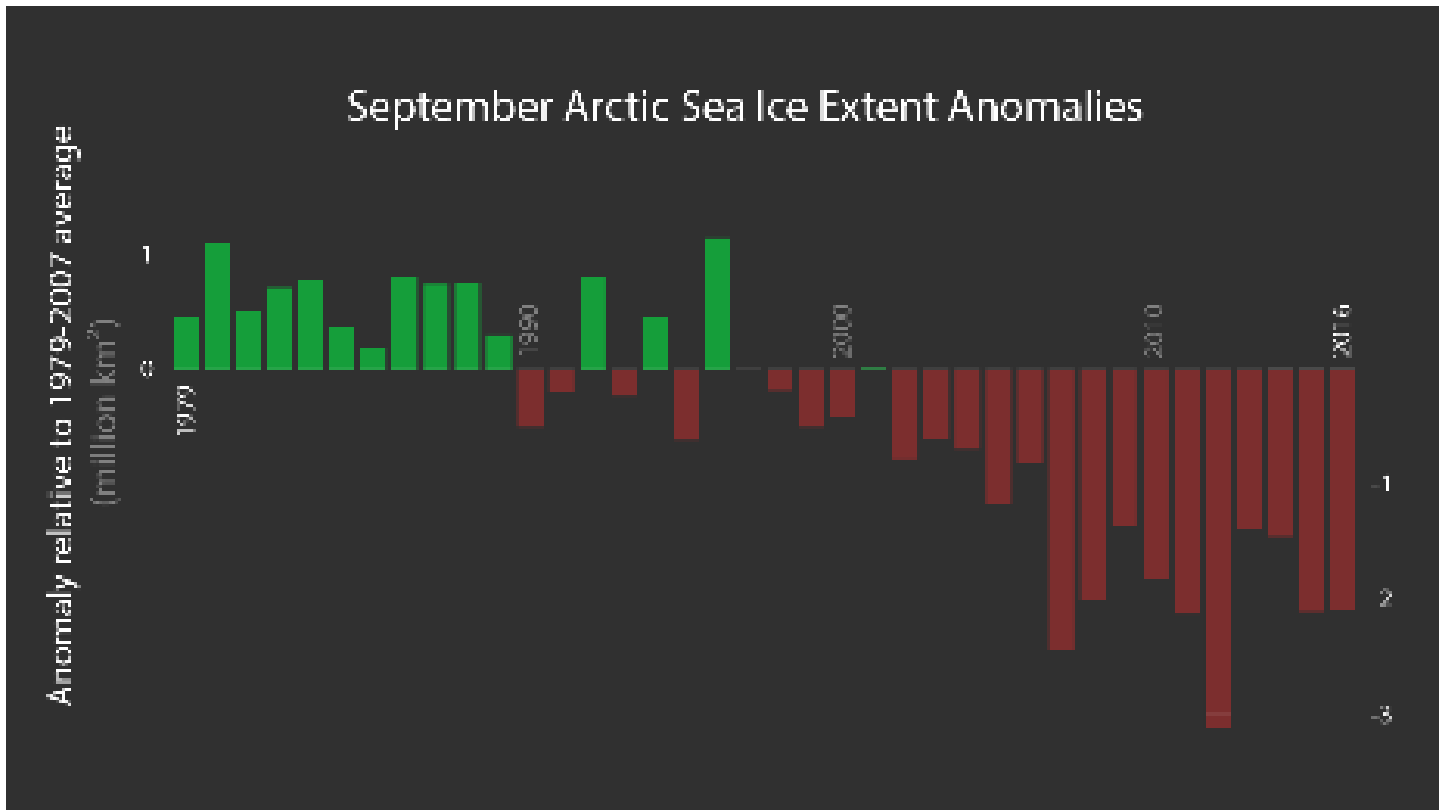
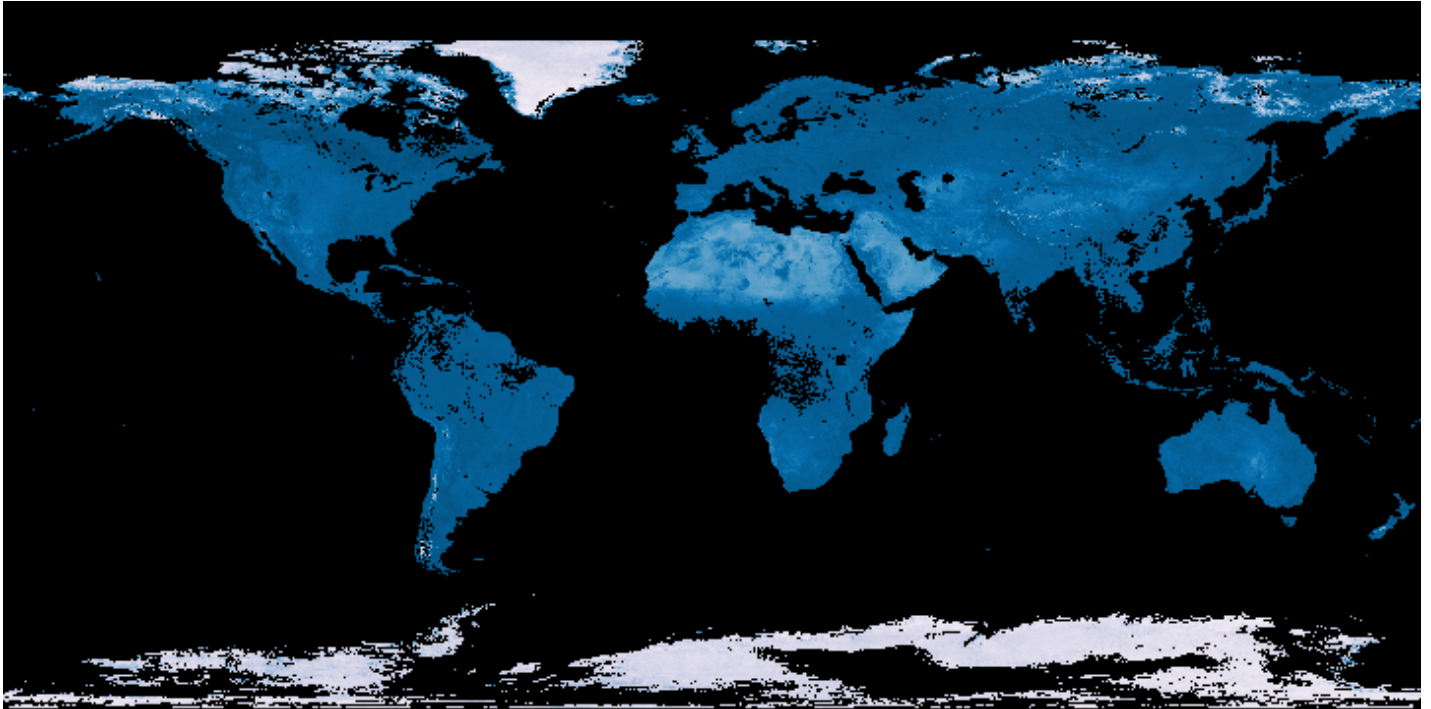
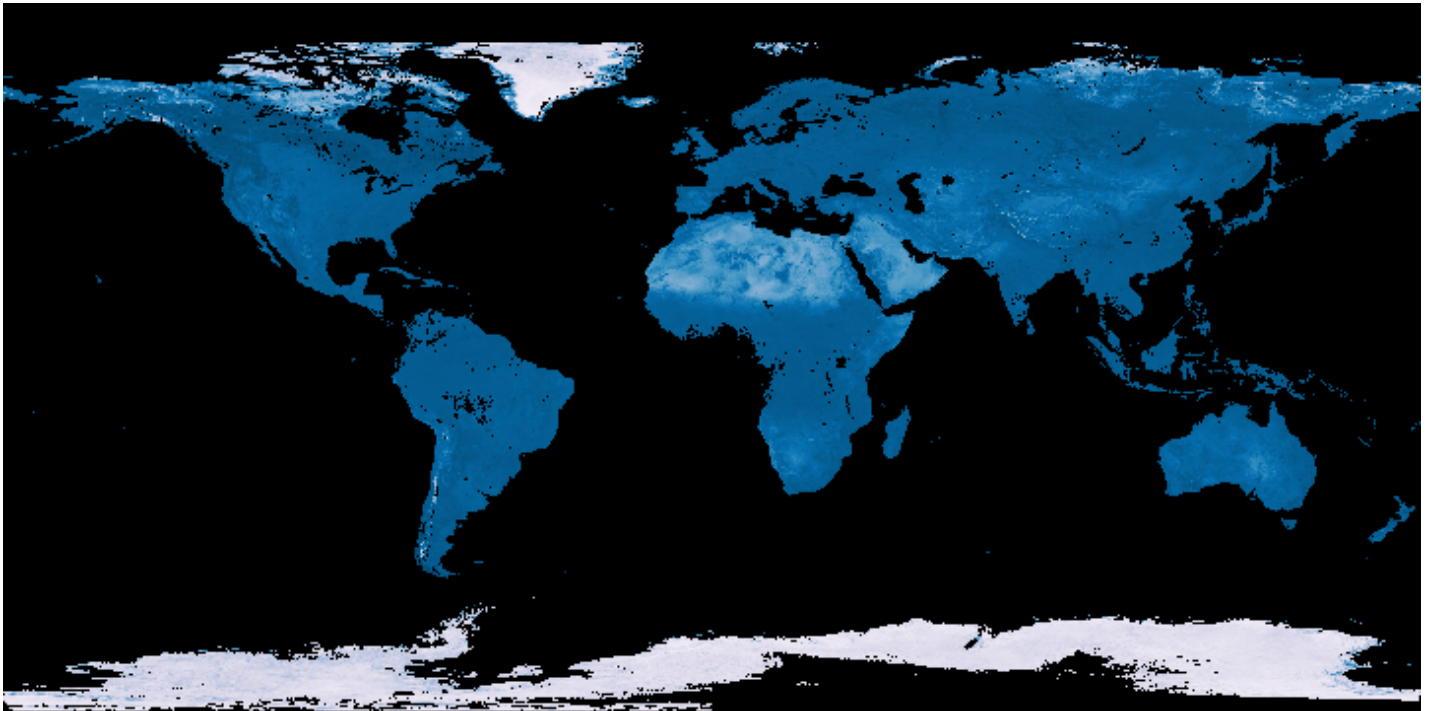


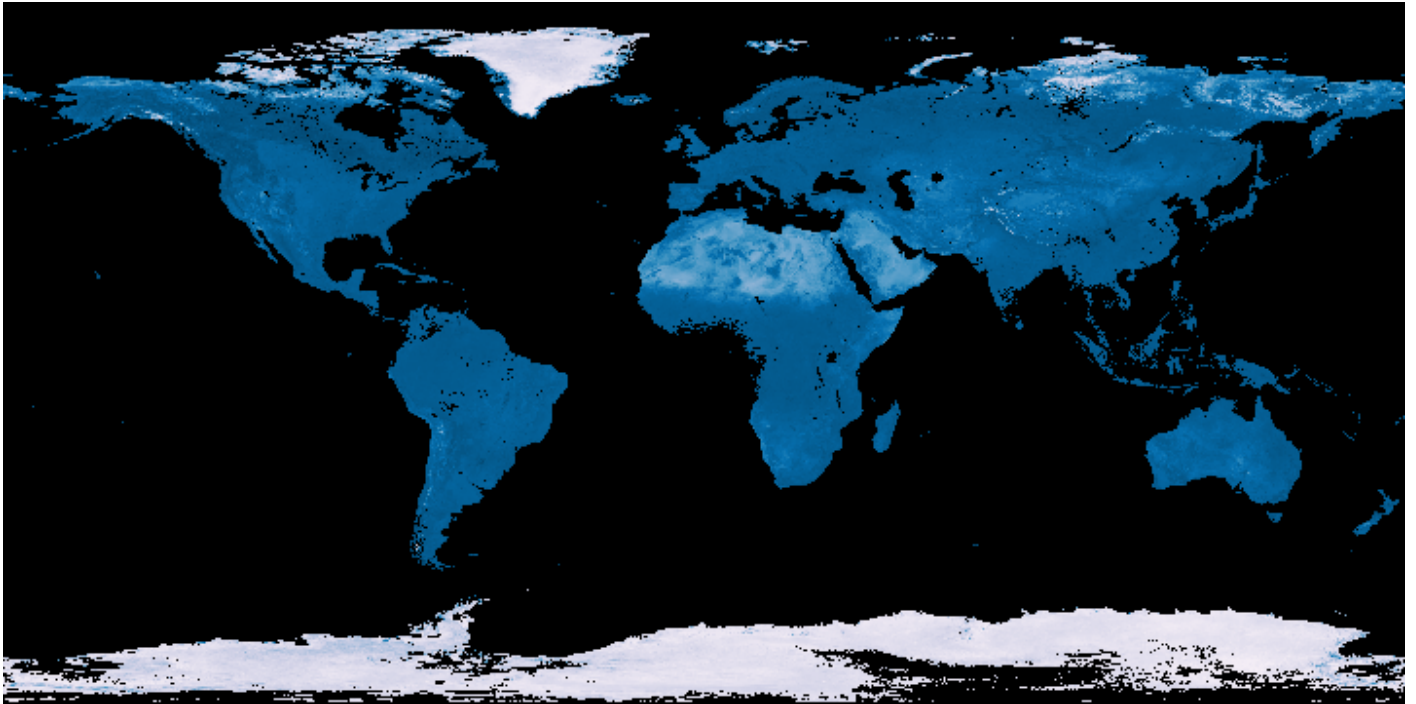
Image Credit: NASA Goddard Space Flight Center



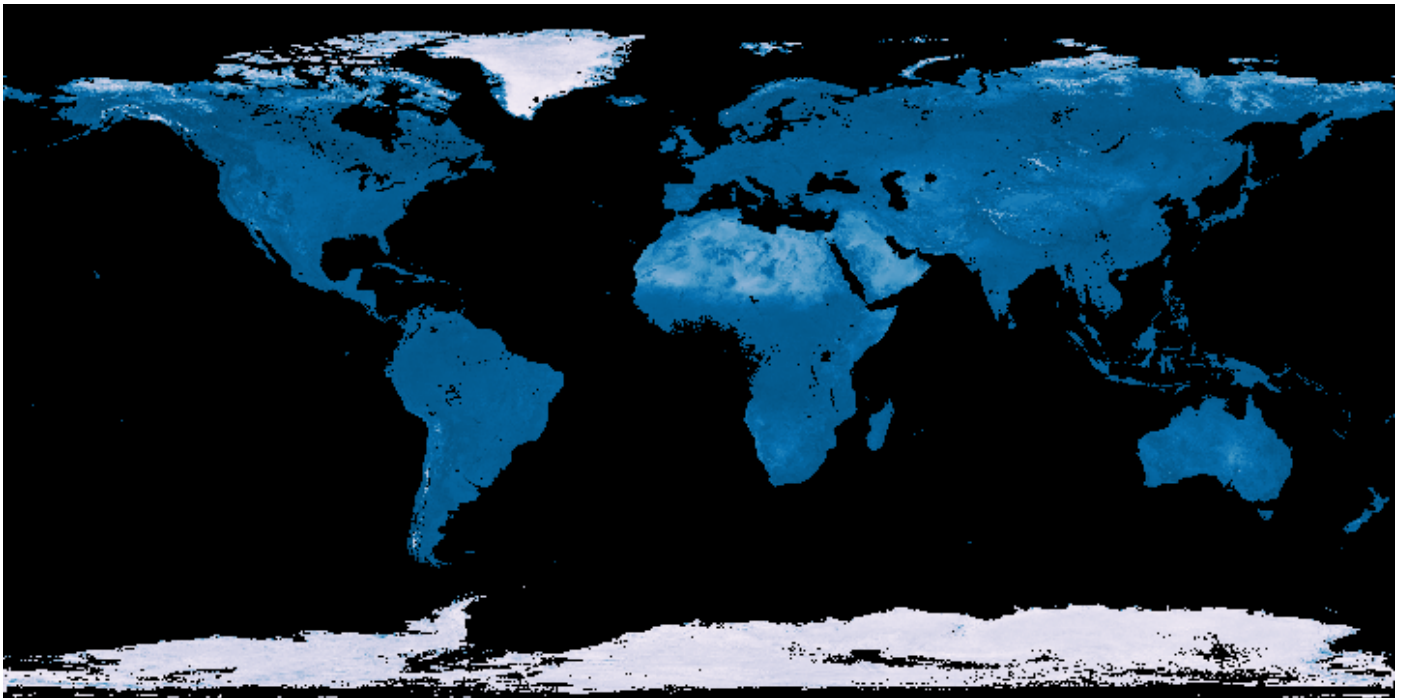
Albedo September 2000 – Image Credit: NASA NEO



Albedo September 2005 – Image Credit: NASA NEO



Albedo September 2010 – Image Credit: NASA NEO



Albedo September 2015 – Image Credit: NASA NEO



Student Name:

Date:

Period:

Claim: Make a claim to answer the question: **What is likely to happen to Arctic sea ice in the next few years?**

Accept reasonable claims.

Evidence: Sufficient, Appropriate, and Observation Driven	Reasoning: (Why is this evidence important?)
<u>Evidence should be appropriate.</u>	<u>Reasoning should be logical and reasonable.</u>