



*Exploring the World of Science*

# Inaugural University of Michigan Science Olympiad Tournament

The test may be taken apart. Ties will be broken based on predetermined questions and quality of response.

## Remote Sensing

Test length: 50 Minutes

Team number: \_\_\_\_\_

School name: \_\_\_\_\_

Student names: \_\_\_\_\_

(3) Match the equation to its name.

\_\_\_ Planck function

a) 
$$B_{\lambda}(T) = \frac{2hc^2/\lambda^5}{e^{hc/\lambda kT} - 1}$$

\_\_\_ Wien's law

b) 
$$j^* = \sigma T^4$$

\_\_\_ Stefan-Boltzmann Law

c) 
$$\lambda_{\max} = b/T$$

(2) What is the key difference between active and passive sensors?

(1) What is the most common source of radiation detected by passive sensors?

- a) Infrared
- b) Reflected sunlight
- c) Sunlight
- d) Radio waves

(1) A radiometer is....

- a) A device which measures detects and analyzes spectral content of incident radiation
- b) A device that emits EM radiation and measures backscatter
- c) An instrument which measures EM intensity in a band of wavelengths
- d) None of the above

(1) LiDAR stands for....?

- a) Light Detection and Ranging
- b) Light Deflection and Ranging
- c) Light Detection and Reception
- d) Light Deflection and Receiving

(2) How does LiDAR work?

(4) Label each type of sensing with active (A) or passive (P)

\_\_\_ Radar altimetry

\_\_\_ LiDAR

\_\_\_ Precipitation radar

\_\_\_ Radiometer

(2) What is beam attenuation?

(6) Why are the blackbody radiation curves for the Earth and the Sun so different? Draw a graph of the two curves.

(1) What scattering mechanism is responsible for the sky's blue color?

- a) Brillouin
- b) Debye
- c) Raman
- d) Thompson
- e) None of the above

(6) Is the scattering elastic or inelastic?

\_\_\_ Brillouin

I) inelastic

E) elastic

\_\_\_ Debye

\_\_\_ Raman

\_\_\_ Thompson

\_\_\_ Compton

\_\_\_ Rayleigh

(4) Match the scattering to the phenomenon/application.

\_\_\_ Rayleigh

a) x-ray photographs

\_\_\_ Raman

b) spectroscopy

\_\_\_ Debye

c) blue sky

\_\_\_ Compton

d) white clouds

(1) Where is the atmospheric refraction for a star the lowest?

(8) List and define the four types of optical remote sensing systems.

(1) What range of EM waves do optical sensors detect?

- a) Visible light spectrum
- b) Infrared
- c) Microwaves
- d) A & B
- e) B & C
- f) None of the above

(5) Assuming a constant atmospheric refractive index of  $n=1.003$ , for a ray of light incident perpendicular to the atmosphere/vacuum interface, what is the angle of refraction?

Fill in the blank (1 pt each)

A surface with a high albedo absorbs \_\_\_\_\_ light than a surface with low albedo.

Nitrous oxide has a \_\_\_\_\_ global warming potential than carbon dioxide.

(5) Are these carbon sinks part of the long-term (L), short-term (S) carbon cycle or both (B)?

\_\_\_ Plants

\_\_\_ Fossil fuels

\_\_\_ Oceans

\_\_\_ Animals

\_\_\_ Limestone

(1) Which of these is not a greenhouse gas?

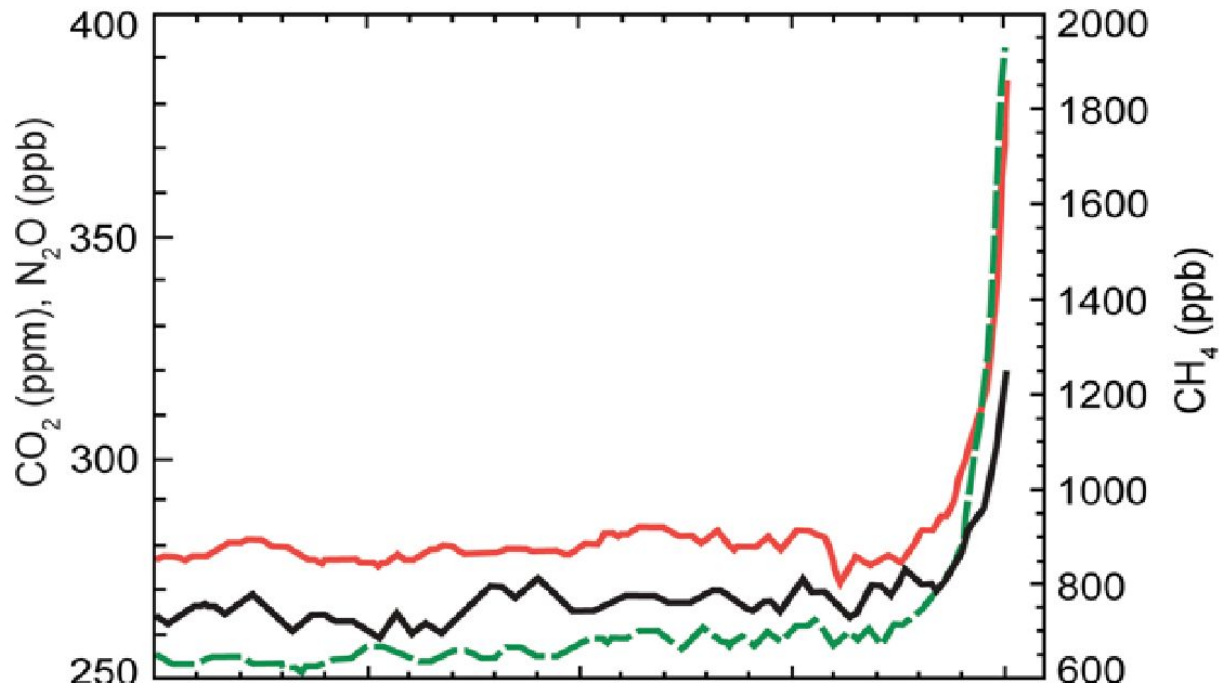
- a) Ozone
- b) Carbon dioxide
- c) Molecular nitrogen
- d) Nitrogen oxides
- e) None of the above

(7) Order the following greenhouse gases from least to greatest abundance in the atmosphere: carbon dioxide, ozone, methane, nitrous oxide, chlorofluorocarbons, hydrofluorocarbons, and water vapor.

(1) What is the most abundant trace gas in the atmosphere?

- a) Carbon dioxide
- b) Water vapor
- c) Argon
- d) Nitrogen
- e) None of the above

(6) Label the chart with the correct greenhouse gas for each data plot.



(1) Which greenhouse gas has the most variable spatial distribution?

- a) Nitrous oxide
- b) Carbon dioxide
- c) Water vapor
- d) CFCs
- e) None of the above

(1) What type of cloud is most likely to cool the earth's surface via interaction with solar radiation?

- a) Cirrus
- b) Stratus
- c) Cumulonimbus
- d) Stratocumulus
- e) None of the above



(1) Which is the most significant natural source of aerosols?

- a) The ocean
- b) Volcanoes
- c) Wind
- d) Wildfire
- e) None of the above

(1) What would be the overall climate impact of a large volcanic explosion?

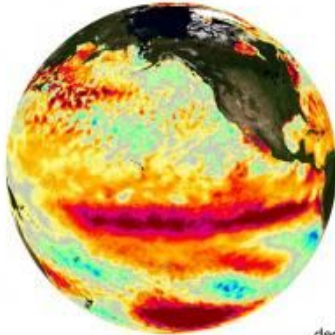
- a) Short period of warming (a few years)
- b) Long period of warming (20-50 years)
- c) Short period of cooling (a few years)
- d) Long period of cooling (20-50 years)
- e) None of the above

(1) Is the impact of aerosols uniform across the planet?

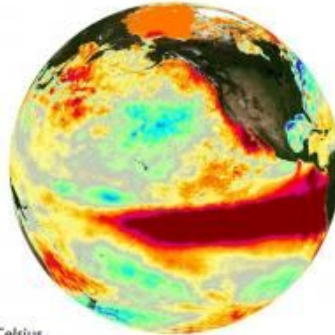
(3) What is the theorized impact of increased aerosols on clouds and heat transfer?

## Monthly Averaged Sea Surface Temperature and Height Relative to Normal

December 2009  
Blended AMSR-E and MODIS SSTA

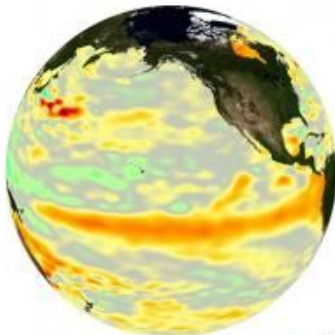


December 1997  
Pathfinder AVHRR SSTA

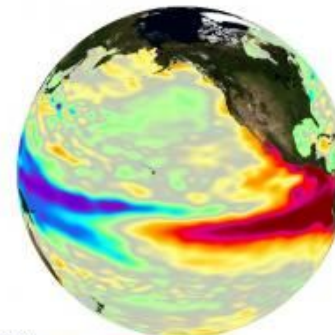


degrees Celsius  
-2.5 0.0 2.5

December 2009  
Jason-1 SSHA



December 1997  
TOPEX/Poseidon



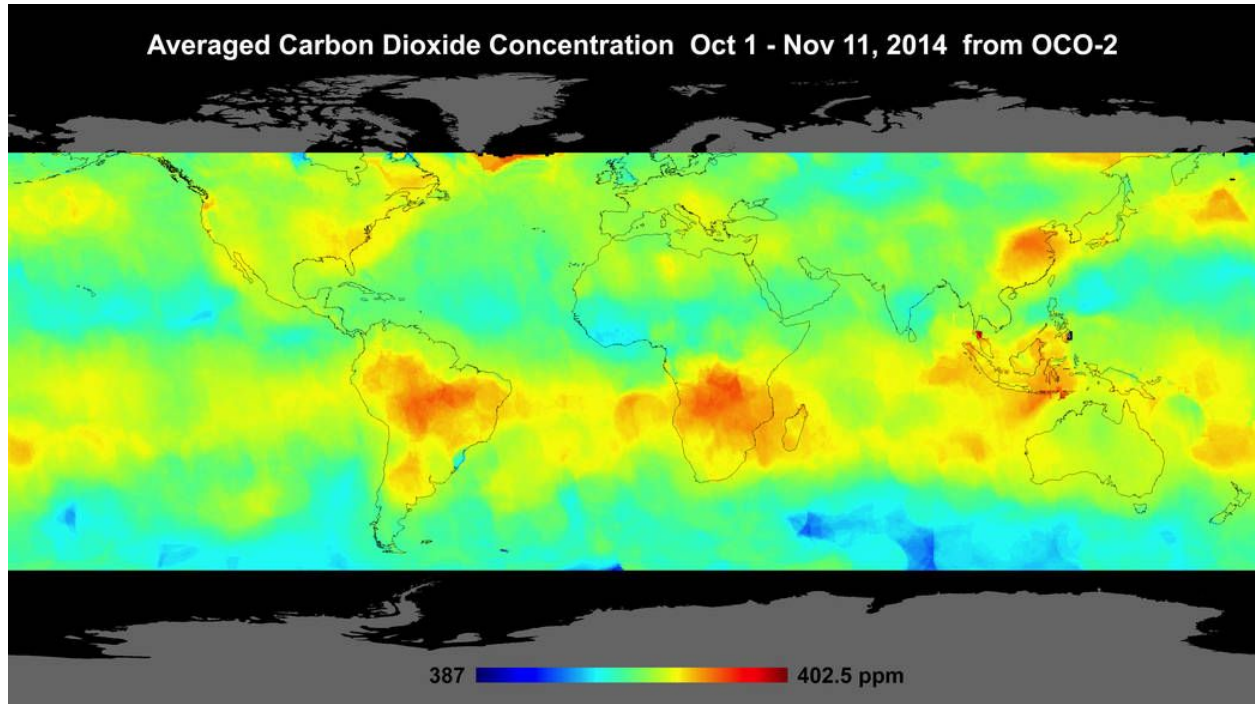
millimeters  
-300.0 0.0 300.0

(2) What phenomenon does the above series of images depict?

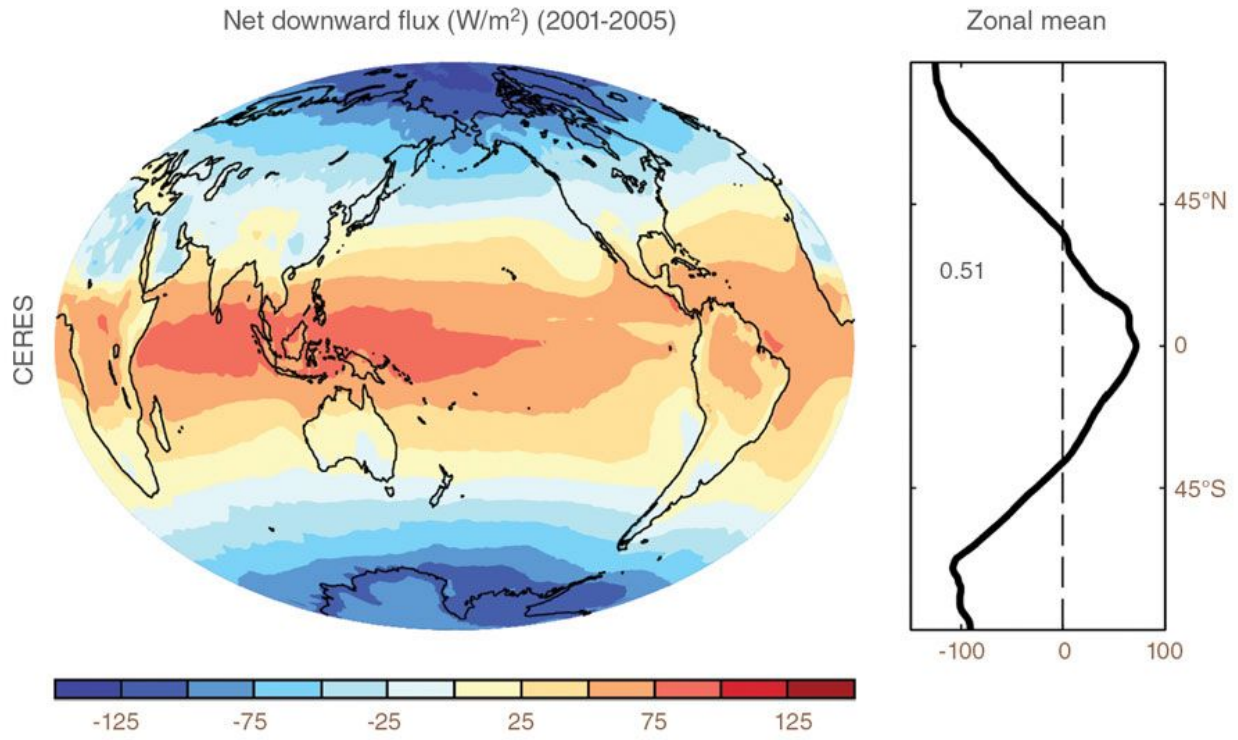


(2) What do the colors in this image represent?

(tiebreaker) Why is Lake Erie unclouded, but not the other Great Lakes?

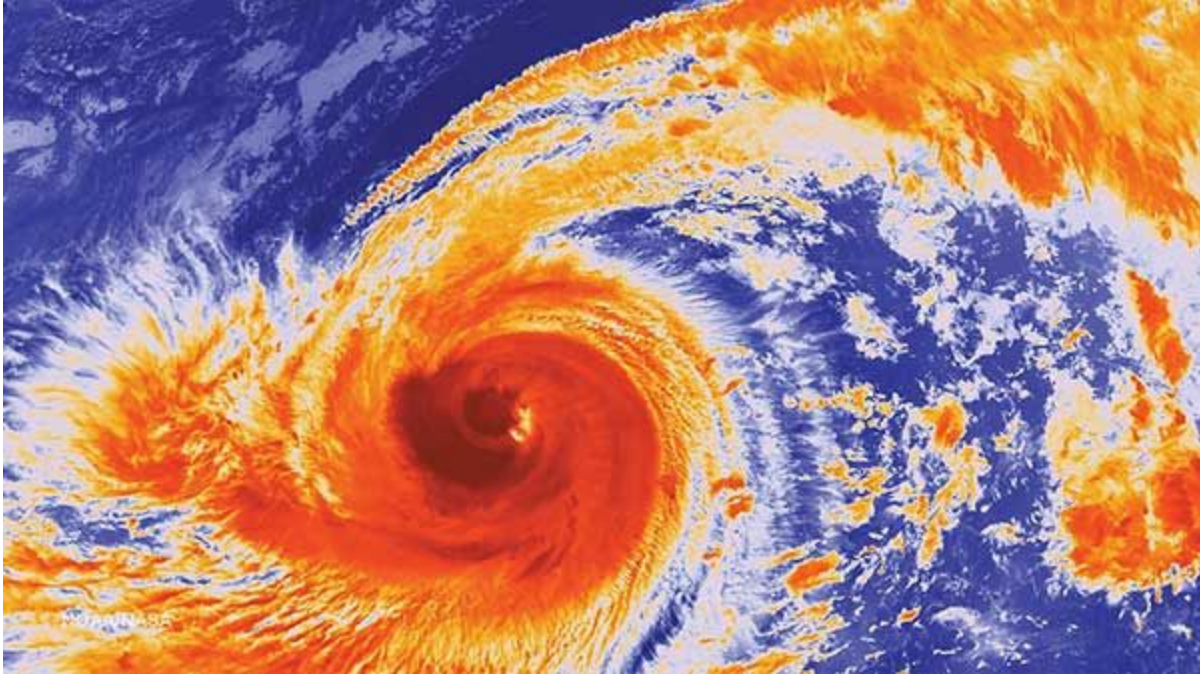


(2) Explain the elevated carbon dioxide levels in China.

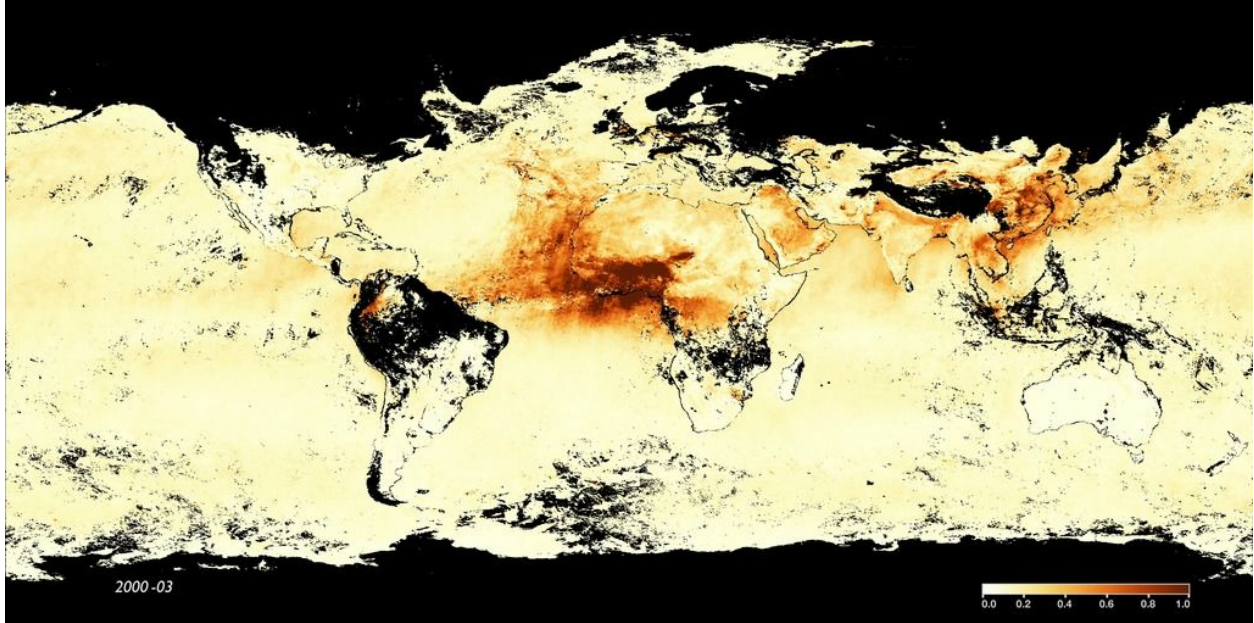


(6) Interpret the information in the image and explain its impact on Earth's climate.

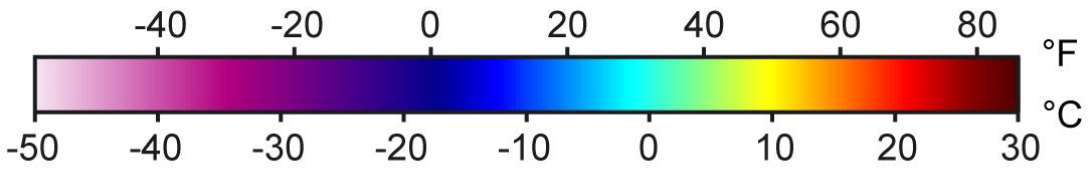
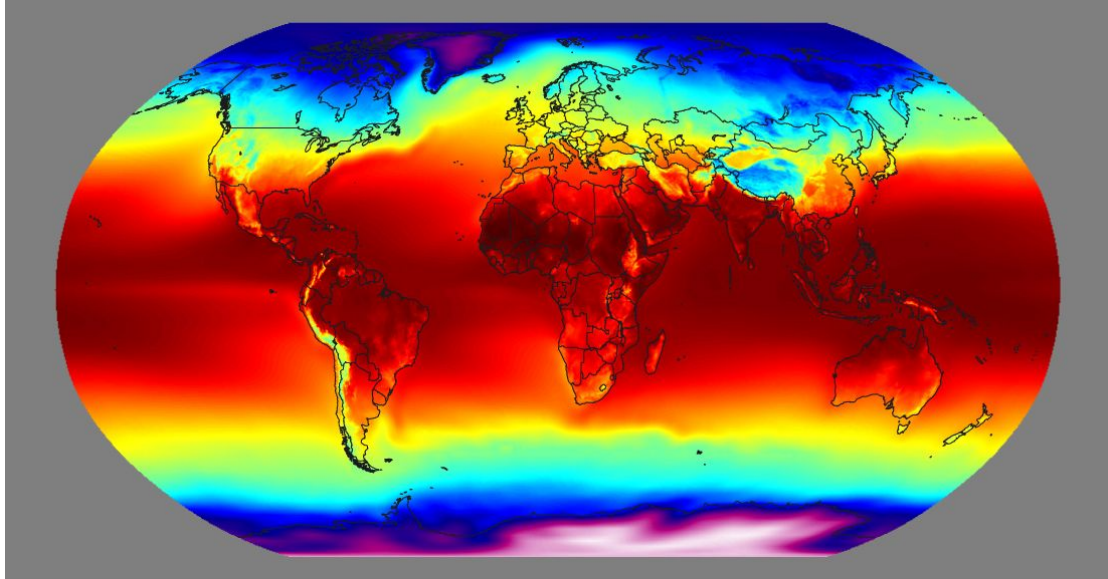




(tiebreaker) The above image, created from CrIS, shows what event off the coast of Japan?



(3) MODIS image of aerosol optical depth. Which regions will see the greatest health effects? What is indicated by the black pixels?



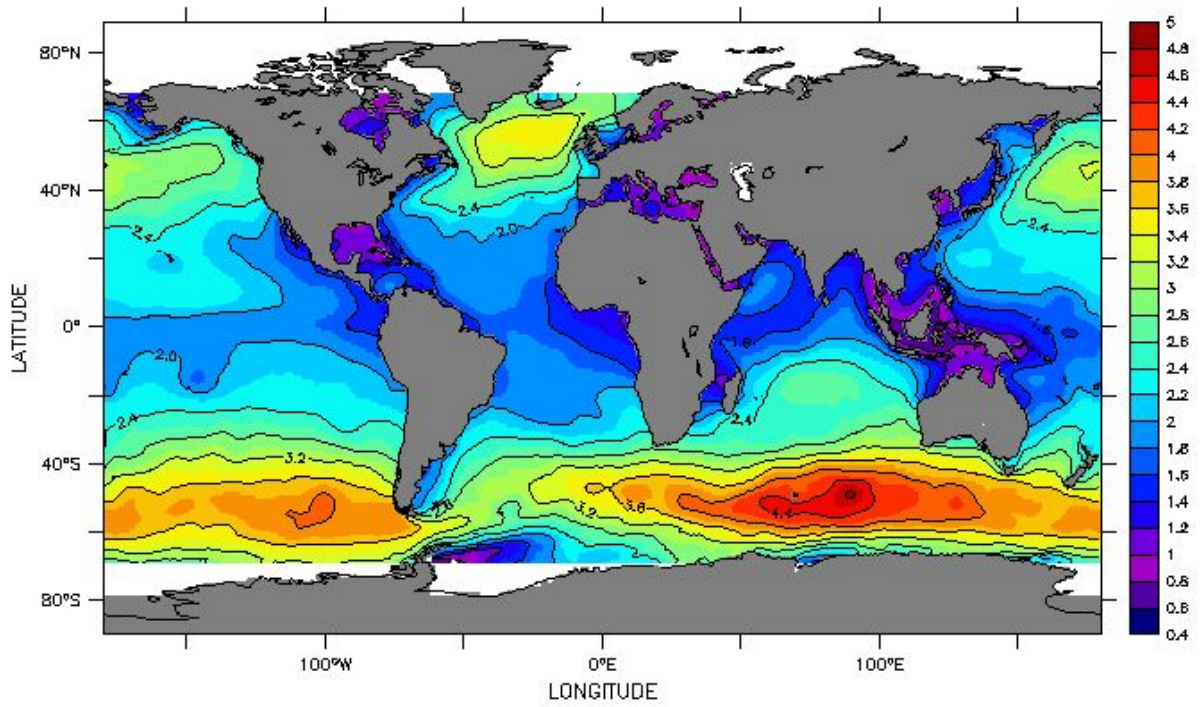
## Annual Mean Temperature

(tiebreaker) Why is Antarctica's average temperature colder than the Arctic?



AVISO

TIME : 12-FEB-2004 00 to 12-FEB-2005 00



Mean Significant wave height Jason-1 (m)

(4) Which regions have the highest waves? What is the reason for this?