Teaching Activity: How might global warming affect Australia?

Introduction: To predict effects from global warming, climatologists use computers to model the Earth's climate system. The goal is to create a model that is accurate enough to predict future climate given changes in specific conditions, such as a doubling of CO_2 in the atmosphere. However, environmental systems are very complex and models have to simplify them. For that reason, even the most powerful computers have limitations. If the processes that make up a system are not completely understood or represented, the model won't be accurate and the predictions less certain.

To predict the effects from global warming, models first simulate current conditions and then double the amount of atmospheric CO_2. The computer runs until new atmospheric conditions stabilize and no further changes occur. The model then creates a map of the expected changes in temperature and precipitation under the simulated conditions.

Objectives:
- To analyze the effects of global warming on Australia as predicted by climate models;
- To understand why computer models of global warming show a wide range of predicted effects for Australia;
- To analyze the difficulties in planning for the possible effects;
- To recognize that not all of the effects would be harmful;

Important Terms: CO_2, CFCs, climate, climate models, environmental system, global warming, greenhouse effect, CH_4, N_2O;

Materials: Student Activity Sheets, attached maps of Australia, paper/pencil;

Procedure:

Part I: Comparing Models

Climatologists at three different research centers of climate modeling created models predicting global average temperatures and precipitation. Two of the models agree somewhat in the precipitation increases; none agree on the temperature increase. This is because each modeler used a slightly different mathematical equation to model Earth's present atmosphere.

Model	Temp. Increase (*C)	Precipitation Increase (% of Present)
* NCAR	3.5	+7.1
**OSU	2.8	+7.8
***UKMO	5.2	+15.0

*NCAR- National Center for Atmospheric Research

**OSU- Oregon State University, Corvallis, Oregon

***UKMO- United Kingdom Meteorological Office

1. Read through the **Introduction** and **Part I**.
   - Emphasize that these are global average;
   - Emphasize how different the predictions are;
   - Ask students which model they would chose if they wanted to support the argument that global warming would/would not be a severe problem.

2. Discuss the questions # 1-4 in the **Analysis and Comprehension** section.
   - Students should then write out written answers these questions on their own.

Part II: What do the models predict for Australia?
   The three models presented in **Part I** have each produced maps of how precipitation and temperature might change in a warmer Australia. The maps are predicting summertime conditions of soil moisture, which depends upon both temperature and rainfall, both of which are expected to increase. More rain means more water will enter the soil, increasing soil moisture. However, increased temperatures mean more soil moisture will evaporate, causing soil moisture to decrease. Trying to predict soil moisture in any one place is complicated by these opposite effects.

1. Split the class into groups of 3-4.
   - Have each group work with physical relief maps of Australia to see what variables affect climate there.
   - The key here is for students to see how the narrow precipitation belts in the real Australia differ from the models' treatment of the situation as a set of average changes.

2. Tell each group that they will be representing the Ministry of Agriculture for one of the states or territories of Australia.
   - Their task is to design a plan for agriculture in their state, using the predictions for soil moisture.

3. Hand out copies of the **Guide Questions** to each group.
   - Their first job is to familiarize themselves with the existing land uses of their regions of the country.
   - They should be able to pick out a close relationship between soil moisture levels and land use types.
   - Point out that urban areas affect the position of croplands.

4. Each group should summarize the types of land use that are found in their state today and how these are related to the variables of soil moisture and urban areas.

5. Each group should then attempt to reach consensus about what changes the models predict for summertime soil moisture in their state.

- They need to decide if the models predict and increase or decrease.

6. When consensus is reached they need to determine what the forecast mean in relation to the conditions today.
   Examples:
   - a) Greater soil moisture in a desert might not mean much;
   - b) Greater moisture in a well watered area could mean increased agricultural productivity.
   - c) Less water could devastate marginal areas or make croplands less productive.

7. Reconvene the class.
   - Put up large pieces of butcher paper (1 for each state).
   - Have each group put a summary of the model's predictions for soil moisture for their state.
   - Each group should explain what the predictions mean in terms of agricultural land use and describe what kinds of problems or opportunities the changes would present.
     Examples:
       - a) More/less irrigation;
       - b) Difficulty planning because of variability of predictions;

8. Put a list of possible ramifications of global warming on the board.
   - Have students classify each events as either "Good" or "Bad".
   - Initiate discussion toward a tentative consensus on the question:
     "Will global warming help or harm Australia?"

9. Either as a group or individually, have students write 3 paragraphs explaining what they believe the impact of global warming will be on Australia.
   - One goal here is to have them understand how really complicated this issue is. Regions with opposing interests might have very different reactions to the prospect of a warmer climate.

Answers to GUIDE QUESTIONS:

1. [Deserts and some range land]   2. [Mainly range land]

3. [Croplands and forest]   4. [Increase- All states]
   [Decrease - None]

5. [Increase - Westernmost western Australia; Victoria; Tasmania; parts of New South Wales and South Australia;]
   [Decrease - Northern Territory Queensland; most of New South Wales and South Australia; easternmost Western Australia;]

6. [Increase - Northern Territory, South Australia, Tasmania, Victoria, nearly all of Queensland, New South Wales and Western Australia]   [Decrease -Westernmost Western Australia, parts of Queensland and New South Wales]

Students Activity Sheet # 1

Analysis and Comprehension

1. What is the range (high to low) of predicted temperature and precipitation increases? _____ _____ _____

2. Which of the models tend to agree in their predictions? Explain. _____ _____ _____ _____

3. Which of the models is probably dependent upon a very different mathematical equation from the other two models? Explain. _____ _____ _____ _____

4. Think about how precipitation forms. Why would an increase in global temperatures cause an increase in global precipitation? _____ _____ _____ _____

5. How do the model's predictions illustrate this relationship? _____ _____ _____ _____

6. Consider the idea of global average precipitation and temperature. Do you think that knowing the expected global changes helps people make plans for their own community or region?" Explain your answer. _____ _____ _____ _____

GUIDE QUESTIONS

Use these questions to evaluate the maps and climate models predictions of Australia.

1. What kinds of land use are most commonly associated with areas of *low* soil moisture?

_____

_____

_____

2. What kinds of land use are most commonly associated with areas of *medium* soil moisture? _____

_____

_____

3. What kinds of land use are most commonly associated with areas of high or very high soil moisture?_____
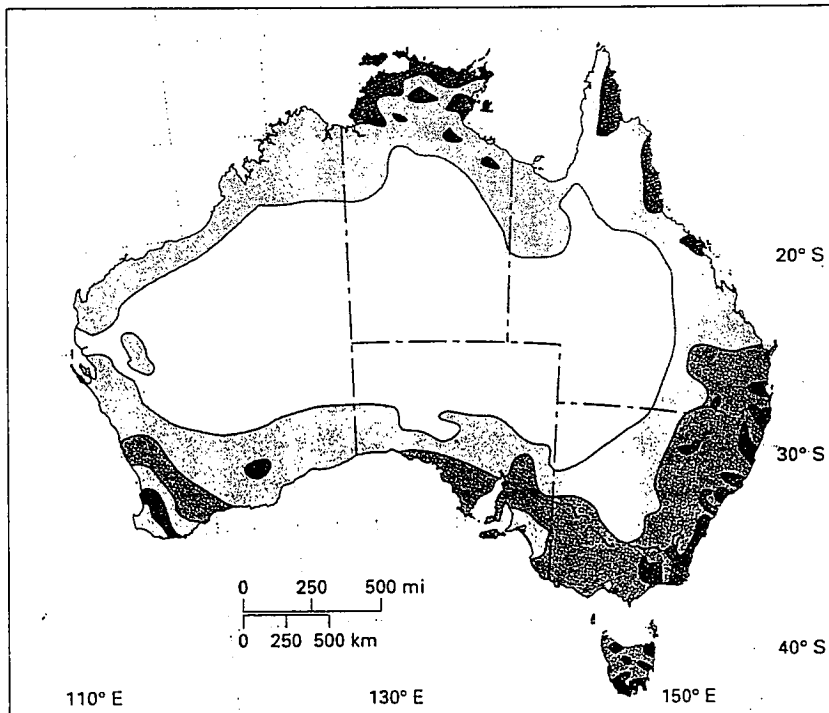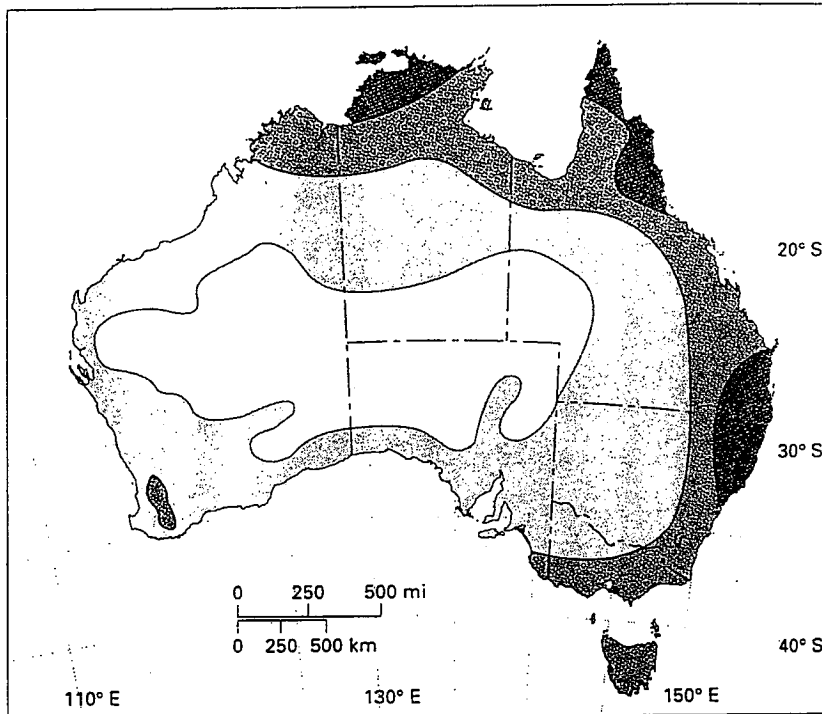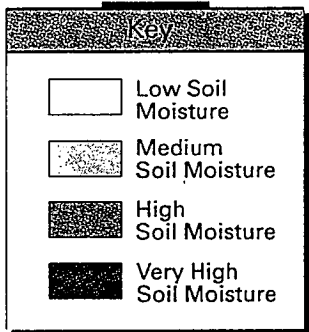
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4. According to the OSU climate model, what states of Australia will experience an increase in soil moisture if global warming occurs? What states will have a decrease?

_____

_____

_____

5. According to the NCAR climate model, what states of Australia will experience an increase in soil moisture if global warming occurs? What states will have a decrease?
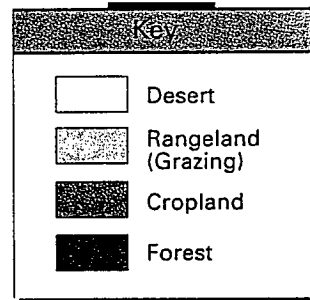
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6. According to the UKMO climate model, what states of Australia will experience an increase in soil moisture if global warming occurs? What states will have a decrease?

_____

_____

_____

Map #1

Soil Moisture in Australia

Key

- Low Soil Moisture
- Medium Soil Moisture
- High Soil Moisture
- Very High Soil Moisture

20° S

30° S

40° S

0   250   500 mi

0   250 500 km

110° E   130° E   150° E

Land Uses in Australia

Key

- Desert
- Rangeland (Grazing)
- Cropland
- Forest

20° S

30° S

40° S

0   250   500 mi

0   250 500 km

110° E   130° E   150° E

Australia: (a) distribution of present soil moisture and
(b) distribution of present land uses.

Map #2

OSU
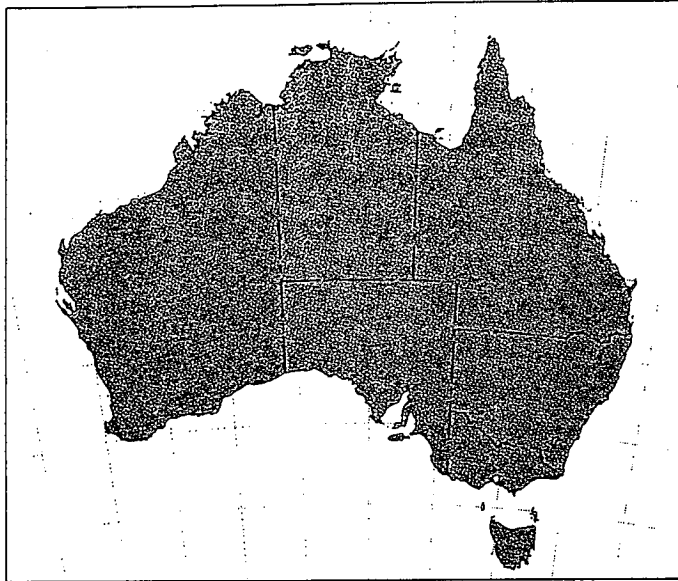
THREE PREDICTIONS OF FUTURE SUMMERTIME SOIL MOISTURE IN AUSTRALIA

NCAR

UKMO

Key

Increase in soil moisture

Decrease in soil moisture

Australian state boundaries

0   450   900 mi

0   450   900 km
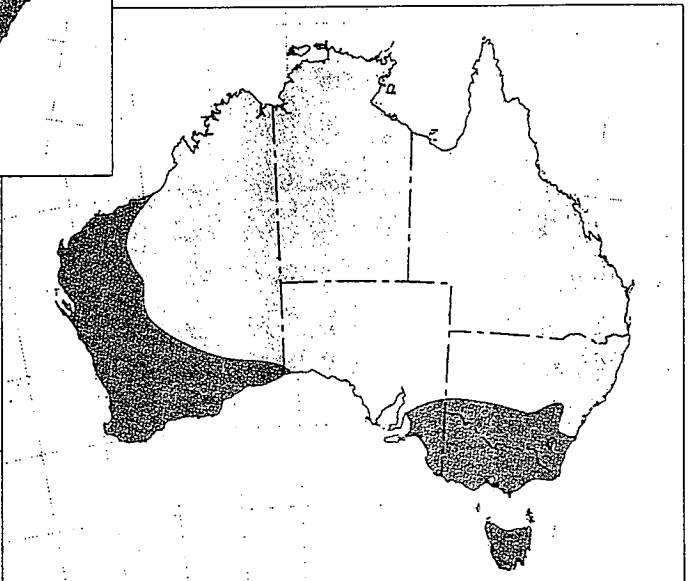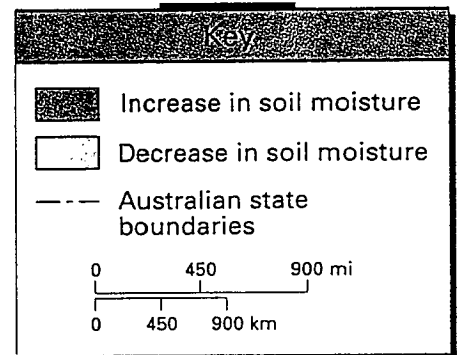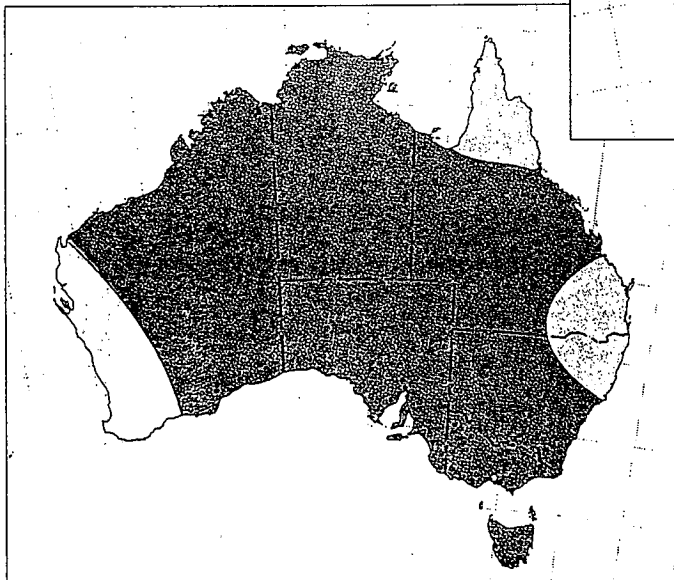
Three predictions of changes in soil moisture for summertime in Australia. Each model increases or decreases in soil moisture from the present to the future, assuming a future atmosphere with doubled CO_2.