# GLOBE Data Collection – Accuracy & Precision

**Course Most Applicable: Can be used in any math or science course**

**Timing: 2 Days**

**GLOBE CAP Framework Connection:** Students will increase their capacity to evaluate scientific data using GLOBE protocols. The activity focus is on the scientific practices of data collection and interpretation. Since students must understand these practices to plan and conduct scientific investigations, it is best placed early in the school year. While students consider factors that affect the accuracy and precision of data collected in real-world places, they will develop their capacity for systems thinking and other transferable 21st century skills such as collaborating with others, thinking critically, and making judgments and decisions.

**Investigation and Experimentation:**

1. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop their own questions and perform investigations.
*a. Students will:* Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.

**NGSS Connection:**
**HS-ESS3-5: Analyze geoscience data and the results from global climate models to make an evidence-based forecast of current rate of global or regional climate change and associated future impacts to Earth Systems.**

**Science and Engineering Practices: Analyzing and Interpreting Data**
Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. Analyze data using computational models to make valid and reliable scientific claims (HS-ESS3-5)

**Disciplinary Core Ideas: Weather and Climate**
Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. (secondary to HS-ESS3-6)

**Crosscutting Concepts: Patterns**
Stability and Change: Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS- ESS3-3), (HS-ESS3-5)

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**Student Learning Outcomes:**

- ✓ Be able to operate a portable $CO_2$ meter and a pocket weather meter during data collection
- ✓ Be able to explain the importance of both *accurate* and *precise* data collection
- ✓ Demonstrate the ability to collaborate within a team by collecting data while tasks and roles are distributed across group members

**21st Century Skills:**

- ✓ Critical Thinking
- ✓ Communication

**Background:** Data collection is more complicated than it seems. Errors made while collecting data and recording observations can lead to inaccurate interpretations and conclusions. *Accuracy* and *Precision* are both important components of the investigative process when collecting data. *Accuracy* refers to how close the data collected is to the actual true quantity. *Precision* in measurement describes how well a measurement can be repeated to achieve the same result. Today you will work in groups to practice collecting accurate data and evaluating the precision of your data.

**Anticipatory Set:** Recall the lesson about weather and air quality from the newspapers. By analyzing weather data provided in the newspaper: high/low temperatures, cloud cover, precipitation, humidity, UV index, we can determine the relative air quality of our community. Recall in front of class how to operate $CO_2$ meter and weather meters. Recall the definition with example of *accuracy* and *precision*.

**Materials:**

- 8 Portable $CO_2$ Meters
- 8 Pocket Weather Meters
- GLOBE Cloud Protocols
- Data Collection Sheet (one for each student)
- Pencil
- Calculator
- Clip board

**Procedure:**

Write driving question on the board: Why is scientific data important?

**Part One - Day 1**

1. Divide students into groups of 4.
2. Distribute portable $CO_2$ meter and pocket weather meter to each team
3. Distribute Data Collection Sheet/clip board, calculator to each group
    - ➢ Person 1 – $CO_2$ meter operator
    - ➢ Person 2 – weather meter operator
    - ➢ Person 3 – data recorder/timer/team manager
    - ➢ Person 4 – cloud protocol (Atmospheric Data Sheet) recorder

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4. Have students demonstrate their knowledge on how to operate both pieces of equipment by asking the entire class to collect data from the same outdoor location.
5. Return to classroom
6. Jigsaw groups, have students compare and contrast data across groups, and construct an explanation using evidence about why their data is not identical despite everyone collecting from the same area.

**Part Two - Day 2**

1. Assign 2-3 groups to each site.
2. Designated sites around the campus.
    a. Site A – Baseball field (open area).
    b. Site B – Redwood grove (or well-shaded area).
    c. Site C – Between classroom buildings (concrete area).
3. Distribute Data Collection Sheet/clip board, calculator to each group
4. Each student within a group will record cloud data
5. Each group complete the Atmospheric Data Sheet
6. Students turn on equipment and collect data and record observations every 3 minutes for 9 minutes. Each student within a group will enter data in Table 1 of data sheet.
    a. $CO_2$, relative humidity, temperature ($CO_2$ meter)
    b. Wind speed, temperature, relative humidity, barometric pressure, altitude (weather meter)
7. Return to classroom
8. Calculate averages for each column in Data Table 1.
9. Return to original group and answer analysis questions on data sheet.

**Guided Instruction:** Prior to going outside, demonstrate how to use equipment. Within each team, circulate to ensure students are reading instrumentation correctly. This includes holding devices away from people (high above head for weather meter) and away from breathing ($CO_2$ meter). Make sure students are recording data accurately – the meters will fluctuate – they will need to know what number to right down even though it fluctuates. When returning to class after Day 1 jigsaw, troubleshoot data collection problems and discuss variations in data across class.

**Wrap Up/Independent Study:** Once data has been collected on Day 2 and students have completed analysis questions, generate class discussion as time allows or assign these questions for homework:

1. How easy/difficult was it to collect *accurate* data points?
2. Why did numbers fluctuate (instrument precision leads to uncertainty)
3. Were data points *precise*? Why
4. How might have the data locations affected the data collected?
5. How did the weather data (clouds, temperature, humidity) play a roll in the amount of $CO_2$ recorded?
6. How do the $CO_2$ data collected at all 3 locations compare to the BEACON data?
7. How important is it to record data both *accurately* and *precisely*?

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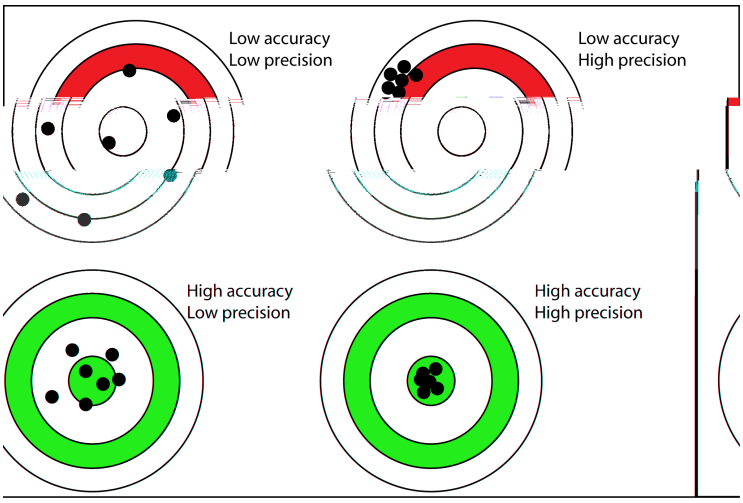
# STUDENT DATA COLLECTION SHEET
## Accuracy & Precision

Name _____ Date _____

**Background:** It is important to collect **ACCURATE** and **PRECISE** data when conducting research. In today's activity, you will collect data, record observations, and then evaluate your data for accuracy and for precision. **Accuracy** is defined as how close the data are *to the accepted value*. **Precision** is defined as how close the data are *to one another*. The graphic below illustrates how accuracy and precision are related.




**Procedure:**

1. Complete the data table below using the $CO_2$ meter and the Weather Meter
2. Calculate the average for both data sets. Consider the average your "accepted value".

**Table 1 – $CO_2$ Meter Data and Weather Meter Data** **SITE**_____

| Time | $CO_2$ on $CO_2$ Meter | R. H. on $CO_2$ Meter | Temperature on $CO_2$ Meter | Wind Speed on Weather Meter | Temperature on Weather Meter | R. H. on Weather Meter | Pressure On Weather Meter | Altitude on Weather Meter |
|---|---|---|---|---|---|---|---|---|
| | Units: | Units: | Units: | Units: | Units: | Units: | Units: | Units: |
| 0 min | | | | | | | | |
| 2 min | | | | | | | | |
| 4 min | | | | | | | | |
| 6 min | | | | | | | | |
| AVG. | | | | | | | | |

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**Analysis Questions:**

1. Look at the $CO_2$ readings from Table 1. If the current accepted $CO_2$ concentration of the air is actually to be 395 ppm, how accurate are your data readings at 0, 2, 4, and 6 minutes?

2. Describe the trend in the $CO_2$ data you collected (Table 1). Using this data as evidence, construct an argument for why your readings at 0, 2, 4, and 6 minutes are either precise or imprecise?

3. While collecting data in the field, identify 2 factors that could affect the *accuracy* of one of your data points:
   1.

   2.

4. While collecting data in the field, identify 2 factors that could affect the *precision* of your set of data:
   1.

   2.

5. Why is it important to record observations and collect data *accurately?* Why is it important to record observations and collect data *precisely*?

6. Self Reflection: State two changes you will make the next time you conduct a scientific investigation. These changes should address how you collect data, in order to improve the accuracy and precision of the data you collect.

   1. a.

   2. b.

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7. Self Reflection: When you talked about the terms *accuracy and precision*, what was your contribution to this discussion? **Use evidence to support your response.**

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