Experiential Learning Modules
Site visit to
National Weather Service
Brookhaven National Laboratory
Upton, NY
July 25, 2014

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1 What is National Weather Service (NWS)?

The National Weather Service (http://www.weather.gov), once known as the Weather Bureau, is a part of the National Oceanic and Atmospheric Administration (NOAA) of the United States government. It is headquartered in Silver Spring, Maryland. The NWS is tasked with providing forecasts, public warnings, and other products to organizations and the public for the purposes of protection, safety, and general information. This is done through a collection of national and regional centers, and 122 local weather forecast offices (WFOs). As the NWS is a government agency, most of its products are in the public domain and available free of charge.

NWS Mission: Provide weather, water, and climate data, forecasts and warnings for the protection of life and property and enhancement of the national economy.

NWS Organization: The headquarters of the National Weather Service is located in Silver Spring, MD with regional headquarters located in Kansas City, Mo.; Bohemia, N.Y.; Fort Worth, Texas; Salt Lake City, Utah; Anchorage, Alaska; and Honolulu, Hawaii. With some 5,000 employees in 122 weather forecast offices, 13 river forecast centers, 9 national centers, and other support offices around the country, NWS provides a national infrastructure to gather and process data worldwide. Each year, NWS collects some 76 billion observations and issues approximately 1.5 million forecasts and 50,000 warnings.

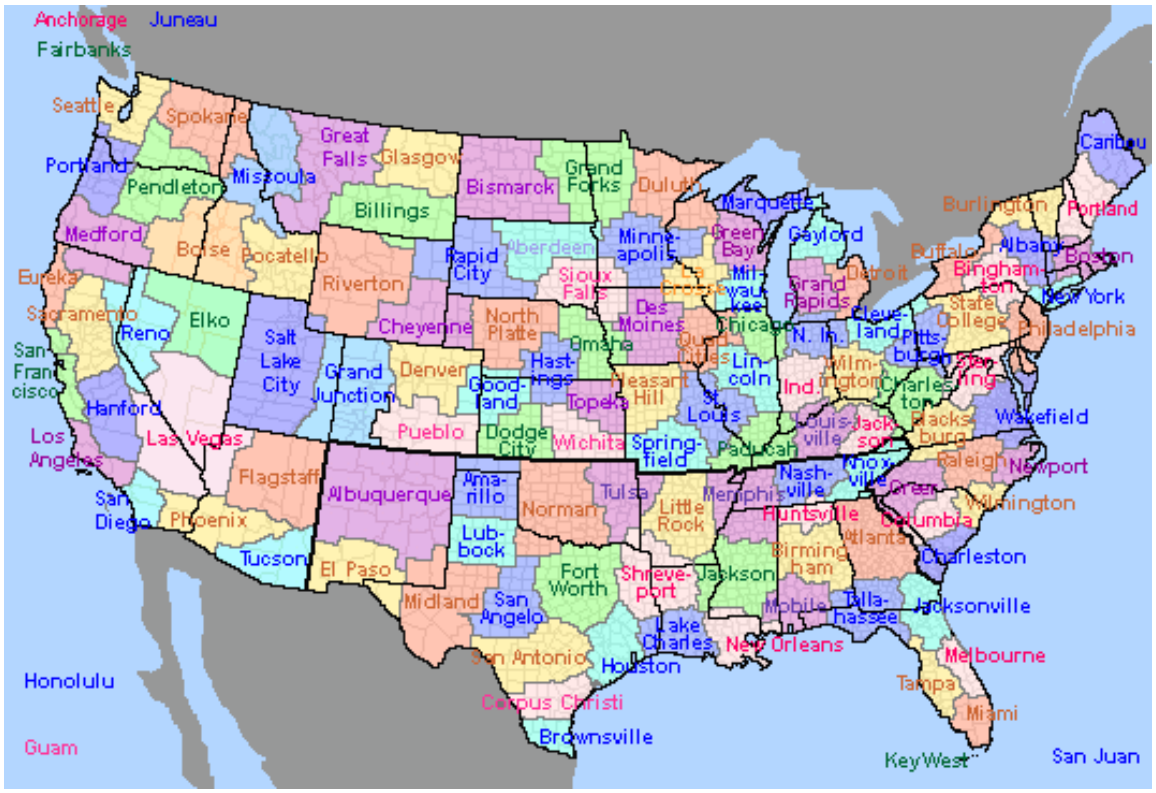


Figure 1: Map of regions covered by the 122 Weather Forecast Offices. Each Weather Forecast Office has a geographic area of responsibility, also known as a County Warning Area, for issuing local public, marine, aviation, fire, and hydrology forecasts

2 Brookhaven National Laboratory (BNL)

Brookhaven National Laboratory is a multipurpose research institution funded primarily by the U.S. Department of Energy's Office of Science. Located on the center of Long Island, New York, Brookhaven Lab brings world-class facilities and expertise to the most exciting and important questions in basic and applied science—from the birth of our universe to the sustainable energy technology of tomorrow.

BNL operate cutting-edge large-scale facilities for studies in physics, chemistry, biology, medicine, applied science, and a wide range of advanced technologies. The Laboratory's almost 3,000 scientists, engineers, and support staff are joined each year by more than 4,000 visiting researchers from around the world.

The Lab offers extensive research and education opportunities for elementary school students through post-doctoral fellows, as well as professional development programs for teachers.

Research Themes

Energy Security: Blazing innovative trails toward a sustainable future powered by solar, wind, hydrogen, and other renewable sources

Photon Sciences: Focusing ultra-bright light to reveal the structures of materials critically important to biology, technology, and more

QCD Matter: Colliding subatomic particles to recreate matter from the dawn of time, and study the force that gives shape to visible matter in the universe today

Physics of the Universe: Exploring cosmic mysteries across the smallest and largest scales imaginable, from neutrinos to dark energy

Climate, Environment, & Biosciences: Mapping climate change, greenhouse gas emissions, and plant biology to protect our planet's future

Figure 2: An aerial view of BNL. The prominent ring is the National Synchrotron Light Source 2 (NSLS-II).

3 Weather Balloon

A weather or sounding balloon is a balloon (specifically a type of high altitude balloon) which carries instruments aloft to send back information on atmospheric pressure, temperature, humidity and wind speed by means of a small, expendable measuring device called a radiosonde. Everyday, NOAA's National Weather Service launches weather balloons from 102 sites throughout the United States, the Caribbean and the Pacific to help with weather forecasting. To obtain wind data, they can be tracked by radar, radio direction finding, or navigation systems (such as the satellite-based Global Positioning System, GPS). Balloons meant to stay at a constant altitude for long periods of time are known as transosondes. But as the saying goes, what goes up must come down, eventually.

Weather balloons are launched around the world for observations used to diagnose current conditions as well as by human forecasters and computer models for weather forecasting. About 800 locations around the globe do routine releases, twice daily, usually at 0000 UTC and 1200 UTC.

The balloon is usually filled with hydrogen due to lower cost, though helium can also be used. The ascent rate can be controlled by the amount of gas with which the balloon is filled. Weather balloons may reach altitudes of 40 km (25 miles) or more, limited by diminishing pressures causing the balloon to expand to such a degree (typically by a 100:1 factor) that it disintegrates.

Figure 3: Weather balloon launch

4 Solar Bag Experiment

Witness the power of solar energy by learning to float a solar bag. A Solar Bag is a long plastic bag made from a very thin plastic and colored black to absorb solar energy. The heated air inside the bag provides buoyancy and causes the bag to float. Over the years, it's become a very popular science demo for teachers to share with their students as they explore the properties of air. It truly is a sight to behold as a giant, black "solar sausage" lifts off of the ground using nothing but sunshine!

Using a Solar Bag is easy. Start by tying off one end of the bag, then filling it with air by running with the open end. Now just tie off the other end and watch as the heat from the sun causes the air inside to expand. Within minutes, the enormous Solar Bag rises into the sky and floats like a giant tube of solar science. Just be careful! The material that Solar Bags are made of has to be thin to enable the sun-powered flight. If you do wind up with tears, packing or masking tape will fix it right up to be used again! It's important to remember that it may take as long as ten minutes for the air inside to heat up enough to cause the bag to float.

What Does It Teach?

The energy harnessed in the Solar Bag comes straight from the sun, but we can't see it! Using the Solar Bag offers a multitude of scientific applications, beginning with how energy from the sun causes air to heat and expand, especially when amplified by the black surface of the Solar Bag. From there, teachers and students can engage in discussions of density, air pressure, buoyancy, convection, and more!

Figure 4: Solar Bag Experiment (The amazing 50 ft long floating bag)

5 Soil Temperature Measurement

Knowing the temperature of the soil is important for many activities including agriculture, horticulture, construction, and even grave digging. It is also important for hydrologists because in many situations a frozen soil limits infiltration of water thereby generating more runoff from rain and snowmelt than soil that is not frozen. Air temperatures and soil temperatures are linked, but soils warm up much more slowly than the air and show little variation over time, while air temperatures can easily vary by 30 degrees or more in a single day. Complex non-linear relationships exist between air and soil temperature responses to climate change. Despite its influence on hydrological and biogeochemical processes, soil temperature has received less attention in climate impact studies.

Despite their importance in controlling watershed biogeochemical and hydrological processes, soil temperature data are generally less available than air temperature measurements. Soil temperature controls biogeochemical processes such as dissolved organic carbon export, length of growing season, rates of mineralization, or decomposition of soil organic matter and nutrient assimilation by plants, weathering of base cations as well as forest productivity

Many factors influence how quickly soils warm in the spring. Dry, sandier, more exposed soil will warm more quickly than wet, clayey and shaded soils. Mulches and turf grass shade the soil and keep it cooler longer into the spring. This can be beneficial in keeping some plants dormant a little later into the spring to avoid spring freeze damage to tender shoots.

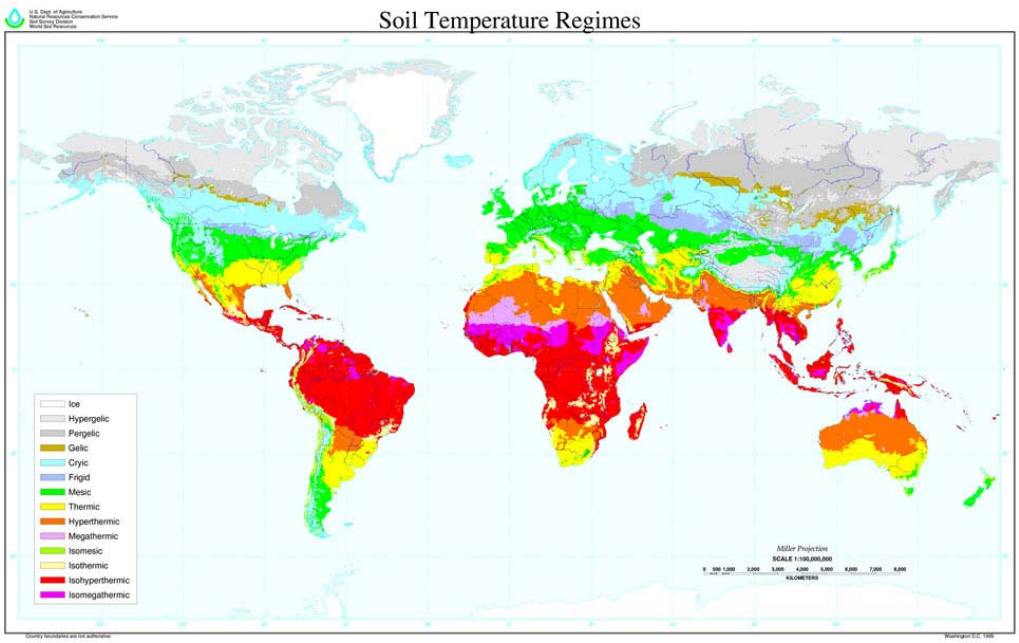


Figure 5: Global Distribution of Soil Temperature Regimes map is based on an interpolation of over 20,000 climatic stations that were input into a soil water balance model to estimate soil temperature regimes.

6 Experiment Quiz

1. What do weather balloons actually do?

2. You find a weather balloon in your backyard. There's some kind of device attached to it. What is it?

3. Most severe weather is generated in areas that are _____.

4. Devices that convert sunlight directly into electricity are called _____ ?

5. The country with the most installed solar power is _____:

6. The Doppler radar can tell you many things about the weather, like _____.
   a) wind direction
   b) wind speed
   c) intensity of precipitation
   d) location of precipitation

7. Which one of these clouds can produce moderate to heavy precipitation?
   a) Cumulonimbus
   b) Nimbostratus
   c) Stratocumulus
   d) Altostratus

8. The original name for the National Weather Service was…
   a) The Weather Bureau
   b) The Weather Channel
   c) The Weather Corp
   d) The Bureau for Weather

9. The office that provides tornado and severe weather watches for the United States is called…
   a) Environmental Modeling Center
   b) NCEP Central Operations
   c) Storm Prediction Center
   d) National Severe Warning Center

7 Activity Sheet for Field Experiment

Temperature Measurement

Location	Air Temperature	Ground Temperature
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Stay out of the High Grass – Ticks!!

Temperature Measurement

The Earth is heated by the Sun.

Temperature is a measure of how effectively the Earth is being heated.

Objective: Collect temperature data to discover how the earth is heated by the sun.

Procedure: In groups of 2-3, use the temperature measuring equipment, proceed to each area to collect temperature data.

- Avoid breathing onto or holding the sensors.
- Allow approximately 1-2 minutes for the sensor to adjust to the location before recording the temperature.
- If possible, place the sensor approximately 1 inch into the soil/dirt to collect the ground temperature. In case of solid surface, place the sensor on to the surface.

Location Notes:

- #3 is the Cement Roadway
- #4 is the Blacktop patches on the Cement Roadway.
- #6 is the gravel road under the trees.
- #7 is the Pine Straw under the trees.
- #10 is next to the dumpster

Stay out of the High Grass – Ticks!!

8 Balloon Activity

Gravity keeps the air from escaping to space!

The Sun Heats the Earth.

Objective: Use data from the weather balloon to explore and learn the structure of our lower atmosphere – in terms of pressure and temperature.

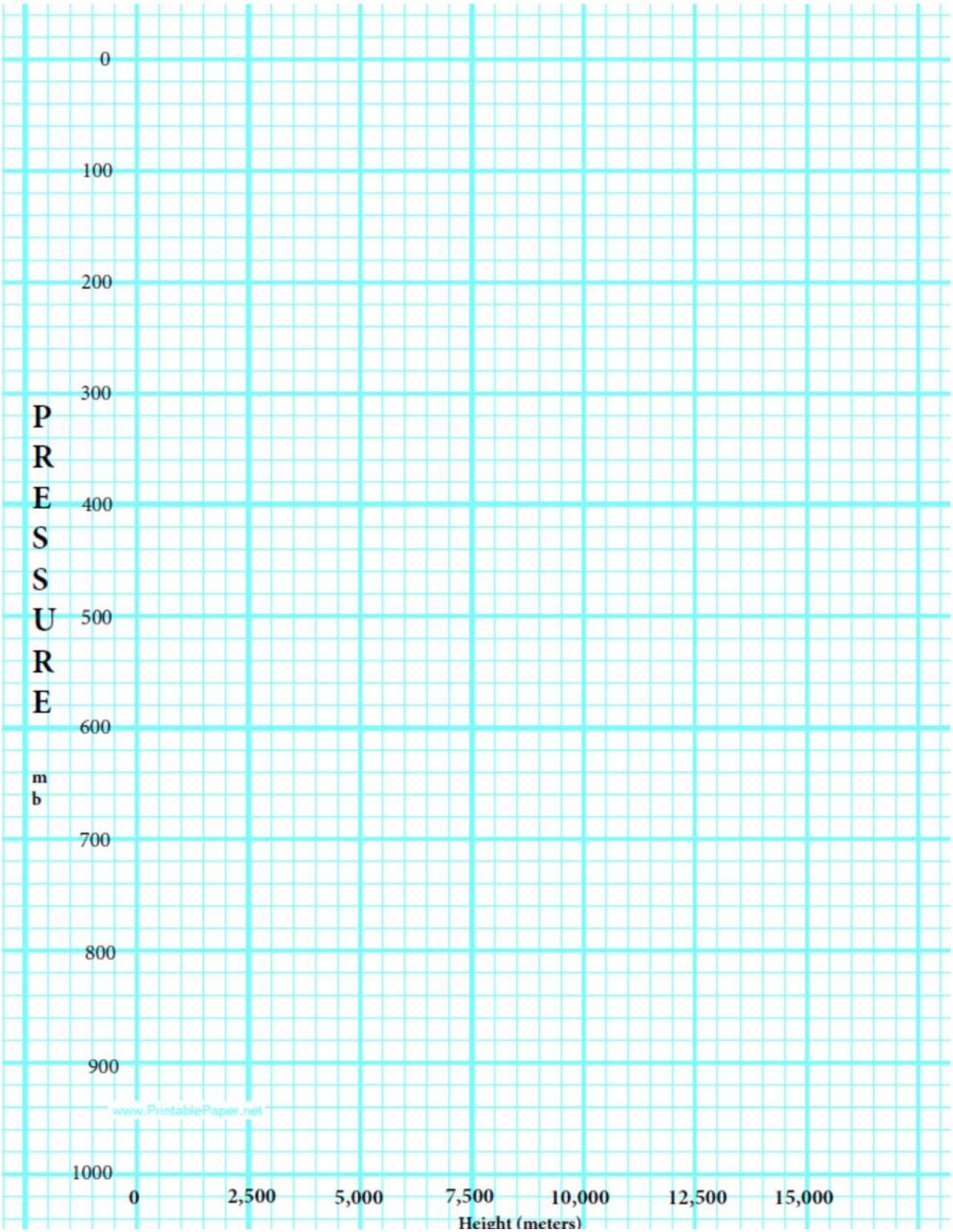
Procedure: In groups of 2-3, graph pressure vs height and temperature.

1. Plot the pressure vs height on the graph paper using the data from the balloon.
    - How does the height change the same between each pressure level?
        - As you go up from the surface the pressure (Increase or decreases).
        - As height increase the rate of pressure change (Increases or decreases).
    - Thus, the relationship in the atmosphere between height and pressure is _____.

2. Plot the pressure vs temperature on the graph paper using the data from the balloon.
    - Between the 1000 and 200 millibars (mb), temperature (increases or decreases) with height.
    - The rate of decrease in temperature is (increasing, decreasing, or constant).
    - Why is the temperature rate of change between 200 and 100 millibars (mb) different?

Data from July 24, 2014 noon weather balloon:

Pressure (mb)	Height (m)	Temperature (C)
1000	187	22.0
900	1042	18.1
800	2064	11.7
700	3198	6.8
600	4362	2.9
500	5900	-7.5
400	7600	-18.9
300	9680	-34.1
200	12370	-58.1
100	16670	-62.7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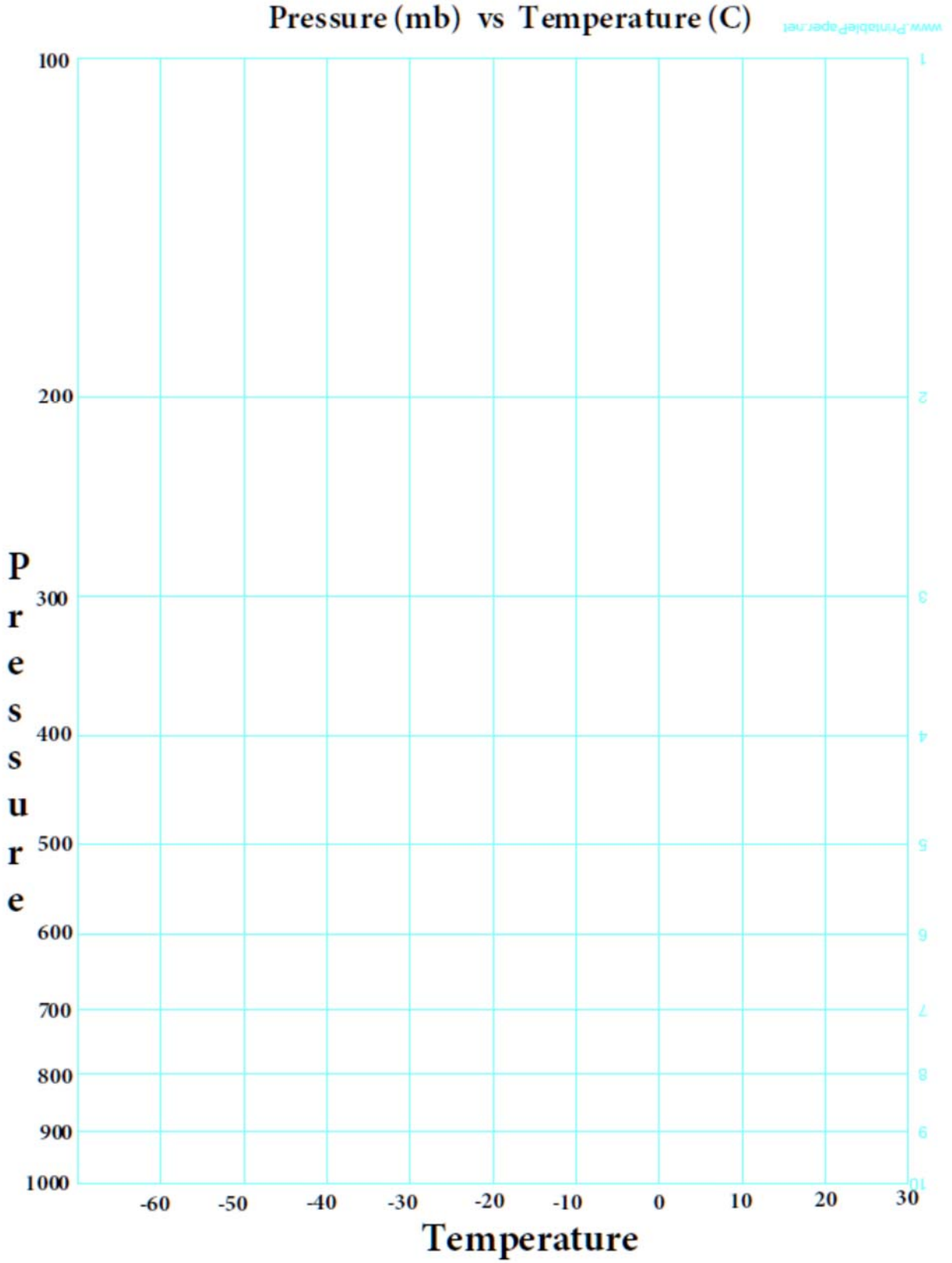
Pressure (mb) vs Temperature (C)
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-40
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-20
-10
0
10
20
30
Temperature