MERRA-2 Data Cube Model

The Modern-Era Retrospective Analysis for Research and Applications, Version 2 (MERRA-2) is the latest atmospheric reanalysis of the modern satellite era produced by NASA’s Global Modeling and Assimilation Office (GMAO). MERRA-2 incorporates observation types not available to its predecessor, MERRA, and includes updates to the Goddard Earth Observing System (GEOS) model and analysis scheme to provide an advanced product suite suitable for weather and climate applications. The six square data images shown on this card illustrate the cubed sphere grid used in the GEOS model that helps improve the representation of the polar regions compared to traditional latitude-longitude grids. On the back of this card are overviews of the six different data sets shown here.

Making the Cube

Using the dotted lines on the other side of this card as a guide, carefully cut out the cube, including the tabs. Fold each square along the scored edges, taping the tabs in place as best you can, forming a cube. Once the cube is closed up, tape the outside edges. Check out the information on the other side of this card before it gets hidden inside the cube!
**Definitions:**

**Assimilation:** The integration of actual observations (such as existing weather data) into a numerical model.

**Hectopascal (hPa):** A metric measurement unit of pressure.

**Microwave Sensing:** Because of their nature, microwaves do not readily scatter and can be used to measure surface temperatures, soil moisture, and sea ice extent.

**Modeling:** Mathematical representations of Earth science phenomena that can be used to make predictions or to understand the Earth's system.

**Hyperspectral Radiance:** The amount of electromagnetic radiation from across the electromagnetic spectrum leaving or arriving at a point on a surface.

**Retrospective Analysis:** A research method that merges observed and modeled data to produce a consistent, long-term record of the Earth system.

**Topography:** The diverse north polar region includes an ice-covered ocean, surrounding land regions characterized by a mix of tundra and boreal forests that are seasonally snow-covered, and glaciers ranging in size from small ice caps to the massive Greenland Ice Sheet. The extent of Northern Hemisphere sea ice varies seasonally from an average of 6 million square miles in March to 2.4 million square miles in September. Over the satellite observing period dating to 1979, the September sea ice extent has declined by about 1.3 million square miles.

**Antarctic:** Total column ozone for August 24, 2002—on early stage in the development of the 2002 ozone hole. Blues indicate very low column-integrated ozone, while warmer colors indicate larger values. The ozone hole is a seasonal loss of the stratospheric ozone layer over Antarctica, which has occurred annually in the austral spring since the late 1970s. The stratospheric ozone layer protects the Earth's surface from harmful, cancer-causing ultraviolet radiation. Since 2000, the ozone hole area has averaged almost 10 million square miles, or about two and a half times the size of the United States.

**Atlantic:** Topography and fraction of area covered by sea ice, snow, and mid-level clouds for October 31, 2016. The Pacific Ocean has a surface area of over 60 million square miles. Year-to-year changes in cloud cover affect the Earth's energy budget—the balance of shortwave radiation arriving from the sun and longwave radiation emitted by the Earth. Such variations are accompanied by changes in temperature, atmospheric circulation, and rainfall that extend far outside the Pacific.

**Asia:** Convective precipitation and 850 hPa (hPa) winds for July 2010. Warmer colors indicate more convective precipitation associated with the south Asian summer monsoon season. The size of the arrows indicates wind strength. The windfield highlights the low-level Somali jet, which pushes moist air toward southwestern India.

**Africa:** Aerosol optical depth for July 21, 2012. Yellows and greens indicate a lower aerosol optical depth, while blues and reds indicate larger values. Aerosols are minute particles suspended in the atmosphere. Aerosol particles can come from large fires, desert winds, industrial sources. Sahara Desert dust can be carried aloft across the Atlantic Ocean to the Americas and can even influence the formation and structure of storms.

**America:** Topography and total precipitation for August 28, 2005. Very high precipitation amounts (shown in red) can be seen in Hurricane Katrina located in the Gulf of Mexico. Katrina was responsible for the deaths of over 1,500 people, with damage estimates exceeding 100 billion dollars. North America experiences the world’s most extreme weather with a combination of conditions that can include hurricanes, tornadoes, droughts, floods, wildfires, blizzards, heat waves, and severe storms. Modern reanalyses have improved the ability to represent the impact of such extremes, allowing their collective impact to be better understood.