Weather, Climate, Space

**COSMIC**: Low-cost data on Earth's environment from space

Summer 2013

---

### I. Description

In April 2006, a constellation of six microsatellites, each carrying an advanced Global Positioning System (GPS) receiver, was launched into low-Earth orbit in space, beginning a new era in atmospheric remote sensing. The COSMIC mission (Constellation Observing System for Meteorology, Ionosphere, and Climate) is a collaborative project between Taiwan and the United States to demonstrate the use of the radio occultation (RO) technique for weather prediction, climate monitoring, and space weather forecasting. The radio waves transmitted by GPS satellites are slowed and bent as they travel through Earth’s atmosphere, due to the change in atmospheric density with height. These effects are most prominent when a GPS satellite “rises” or “sets” behind Earth. By tracking transmission of GPS radio signals as a COSMIC satellite is occulted, or hidden, by Earth, the satellite can acquire hundreds of measurements of these bent signals, which can be converted to vertical profiles of electron density in the ionosphere and temperature and water vapor in the lower atmosphere.

### II. Stage of Research

Since launch, COSMIC has provided more than 3.5 million radio occultation soundings to the operational and research communities. All global operational weather prediction centers are making use of COSMIC data, and significant positive impacts on forecasts have been demonstrated.

Even though COSMIC has a five-year mission life, five out of six COSMIC satellites are still operating after nearly seven years, and continue to provide valuable data to serve operational and research communities.

COSMIC-2 is a follow-on mission to COSMIC, with a continued partnership between the U.S. and Taiwan. Two constellations, each with six satellites, will be launched in 2016 and 2018, respectively. The first constellation will be in an equatorial orbit, which will provide increased observations over the tropics. The second constellation will be in a polar orbit, similar to that of the original COSMIC constellation, and will provide data with global coverage.
III. Advantages

COSMIC
- Conceived as a demonstration project, the system has proved its value, providing global data with an impact on forecasting at low cost.
- Established as the world’s most accurate, precise, and stable thermometer from space.

COSMIC-2 will have several important advances, including
- The latest-generation receiver, known as TriG, developed by the Jet Propulsion Laboratory, which can track radio signals from three global satellite navigation systems, including GPS (U.S.), GALILEO (Europe), and GLONASS (Russia).
- An advanced antenna design that will considerably boost performance of radio signal tracking, resulting in considerably improved quality of radio occultation soundings.
- Through both tropical and polar constellations, COSMIC-2 will collectively produce more than 10,000 radio occultation soundings per day.

IV. Applications

Weather
- Improve global weather analyses, particularly over data-void areas (such as oceans and polar regions)
- Improve skill of global and regional weather prediction models
- Improve understanding of tropical, midlatitude, and polar weather systems and their interactions

Ionosphere & Space Weather
- Observe global electron density distribution
- Improve the analysis and prediction of space weather
- Improve monitoring/prediction of scintillation and related phenomena (e.g., equatorial plasma bubbles, sporadic E clouds)

Climate
- Monitor climate change and variability with unprecedented accuracy and precision.
- Evaluate global climate models and analyses
- Calibrate infrared and microwave sensors

V. Funding and IP Status

National Science Foundation, NASA, National Oceanic and Atmospheric Administration, U.S. Department of Defense (Air Force and Navy), and the National Space Organization in Taiwan

Now seeking additional funding for COSMIC-2

Contacts

Bill Kuo, COSMIC Program Director
303-497-8910, kuo@ucar.edu

Scott Rayder, UCAR Senior Advisor for Development and Partnerships
303-497-1673, rayder@ucar.edu