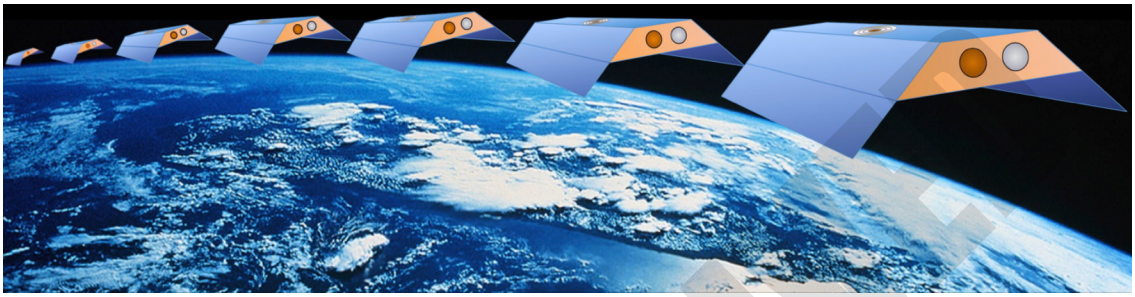
National Aeronautics and Space Administration

NASAfacts

Space Technology
Game Changing Development
Nanosats for Advanced Gravity Mapping and Crosslink Occultation



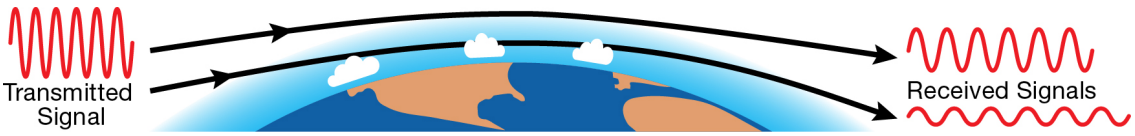
Earth Gravity Observatory—Crosslink Occultation (EGO-XO).

A string of small, low-cost satellites could provide key data sets that allow scientists to track how water and ice are transported around the globe and provide global scale atmospheric measurements to improve weather forecasting and climate modeling.

NASA and a small company called GeoOptics have entered into an innovative cost sharing partnership to design a constellation of small satellites called the EGO-XO that will provide gravity and atmospheric measurements with much higher accuracies at a fraction of the cost of current systems.

First, the system will provide highly accurate data to map Earth's gravity field. The data will identify features on or near the surface such as mountains or ice sheets that have significant mass. By identifying small changes in the gravity map over time scientists can track changes in ice sheets, snow pack, and ground water levels. This would help planners and policy makers make informed decisions that impact our daily activities.

Second, by measuring the propagation delays in the signals between satellites as those signals pass through different layers of the atmosphere, we can measure atmospheric pressures, temperatures, water vapor, and trace gas concentrations at a global scale. If distributed in near real time, this data can be incorporated into existing weather models to greatly improve their accuracies. Also, by tracking this data over long periods of time, scientists will be better able to detect small climate trends buried within the noise of seasonal and annual variability.



Unlike GPS sounding, which relies only on signal bending, XO observes amplitude changes caused by signal absorption to sense moisture and trace gas concentrations.

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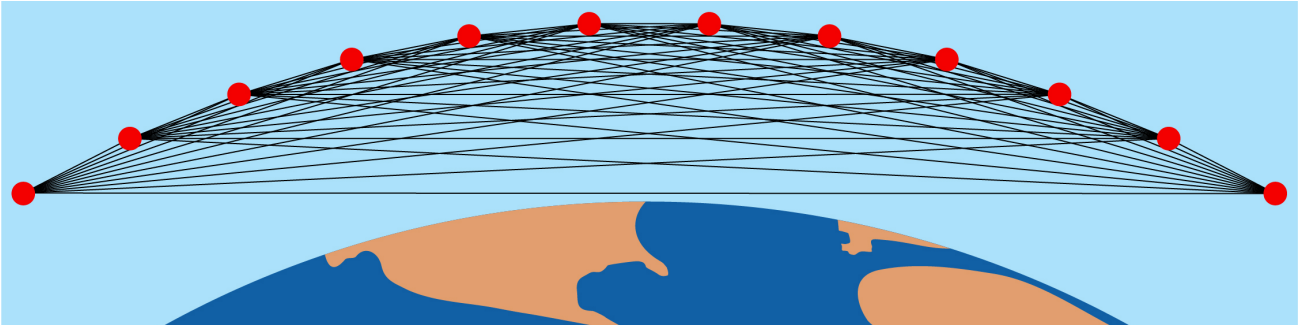

Drawing showing the multiple signal propagation paths available for atmospheric sounding with a string of small satellites.

Currently, the NASA GRACE mission has two large satellites that perform gravity mapping by measuring slight changes in distance between them as they are pushed and pulled by mass features on Earth as they fly by. Through a NASA Tipping Point solicitation, GeoOptics has proposed a system with several small, low-cost satellites traveling in an arc that would greatly improve both global gravity mapping and atmospheric sounding capabilities.

The new technologies could greatly improve the accuracy of the measurements allowing smaller mass features and variations to be detected on Earth. This would provide finer spatial resolutions of changing water and other mass concentrations around the globe.

One of the key technical challenges of this effort is to reduce signal noise throughout the system. Because the position knowledge of the satellites relative to one another must be within a micron (millionth of a meter) when they are hundreds of kilometers apart, the design must be exceptionally precise. If not treated carefully, things like thermal expansion of the spacecraft bus will introduce errors that are substantially larger than the accuracy needed for the measurements.

Modelling the EGO-XO system to ensure all system noise sources have been identified and reduced to acquire the measurement accuracies needed will be a significant task during the design phase of the project, work being led by scientists at the University of Texas and the University of Colorado.

Commercial markets for weather data are booming, and precise gravity maps are increasingly used by private industry for such applications as mineral and oil exploration and resource management. It is expected that an operational EGO-XO system deployed in the early 2020s will be entirely supported by commercial data sales to public and private users around the world.

GRACE has proven to be an exceptionally productive climate and Earth monitoring mission, a breakthrough in its time. It completed 15 years of invaluable service in March 2017. But technology has moved forward and the 20th century model of massive, costly platforms in small numbers is being quietly replaced by the modern concept of agile fleets of nanosatellites offering greater versatility, resolution, and performance at dramatically lower costs.

The Game Changing Development (GCD) Program investigates ideas and approaches that could solve significant technological problems and revolutionize future space endeavors. GCD projects develop technologies through component and subsystem testing on Earth to prepare them for future use in space. GCD is part of NASA's Space Technology Mission Directorate.

For more information about GCD, please visit http://gameon.nasa.gov/

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