Groundwater Measurements Using Gravitational Instruments

ECV: Groundwater

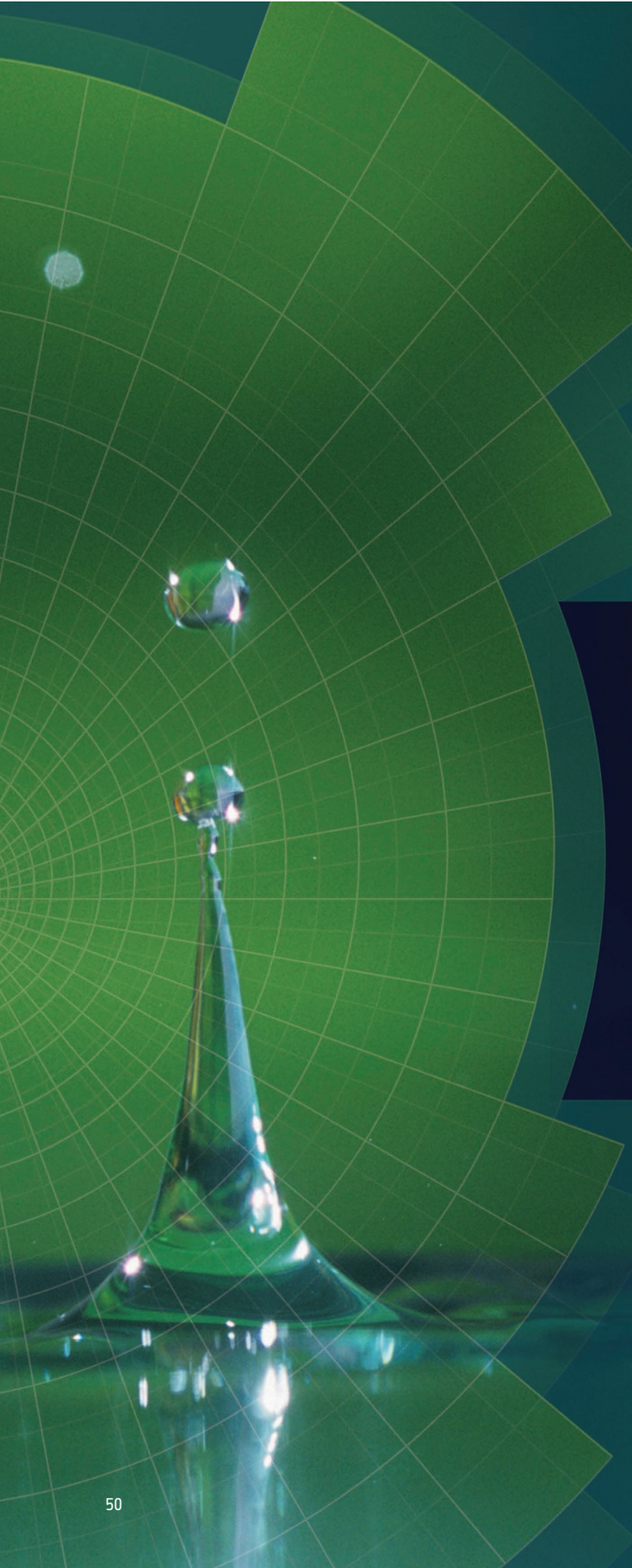
Measuring Groundwater with Gravity

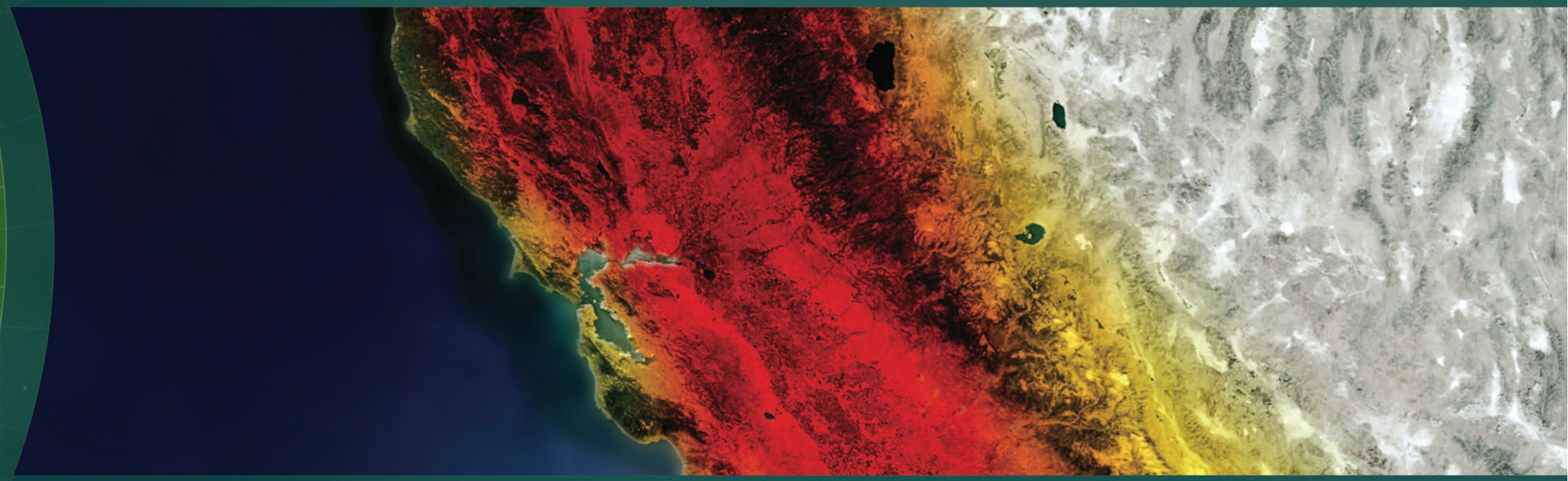
We now measure and monitor almost all aspects of the hydrologic cycle from space. Gravity instruments are used to measure precipitation, ice sheets and glaciers, ocean surface temperature and salinity, soil moisture, surface water and river flows and, importantly, groundwater.

Satellites can map the Earth's gravitational field based on very detailed measurements of tiny changes in spacecraft orbit. In the case of the GRACE mission, the gravity field is measured by taking laser range measurements between two satellites flying together in close formation. The satellites are just over 200km apart and the ranging system is sensitive enough to detect separation changes as small as 10 micrometres, or approximately one-tenth the width of a human hair.

These measurements enable the detection of changes in the mass of sub-surface water over broad areas, effectively weighing the increase or decrease in groundwater. The measurement crosses jurisdictional and national boundaries, providing objective and quantitative environmental information for decision makers.

Groundwater storage, recharge and discharge are important aspects of understanding climate change impacts and assessing the need for adaptation. The UN's International Groundwater Resources Assessment Centre (IGRAC) has established the Global Groundwater Monitoring Information System (GGMIS) to provide an interactive and transparent reference for groundwater-related information. In the coming decade, it is expected that detailed observations from the GRACE mission, and planned follow-on missions, will be incorporated into the GGMIS and become an important part of the basis for long-term groundwater climate data.





Groundwater storage in California as seen by the Gravity Recovery and Climate Experiment (GRACE) mission in June 2014. Colours progressing from green to orange to red represent greater accumulated water loss between April 2002 and June 2014.

Credit: NASA/JPL-Caltech/University of California, Irvine

Managing Extreme Drought

Changes in the climate drive changes in precipitation patterns and these changes have a significant impact on water resources. Water supplies are vital to supporting the health of our communities and to the productivity and prosperity of many sectors of the economy, perhaps most importantly agriculture and food security. It is estimated that nearly 30% of the world's total freshwater resources (including snow/ice) are stored as groundwater.

Observations of groundwater resources are an essential element of any effective water management strategy, as they inform both short-term tactics such as usage restrictions and longer-term adaptation. While groundwater can be measured locally by water resource management authorities, gravity measurements from satellites have enabled unprecedented global observations of groundwater supply. These observations are timely, systematic and independent of local authorities. They also help to support resilience against extreme events like drought.