

The International Space Station: A Unique Platform for Remote Sensing of Natural Disasters

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Assembly of the International Space Station (ISS) was completed in 2012, and the station is now fully operational as a platform for remote sensing instruments tasked with collecting scientific data about the Earth system. Remote sensing systems are mounted inside the ISS, primarily in the U.S. Destiny Module's Window Observational Research Facility (WORF), or are located on the outside of the ISS on any of several attachment points.

While NASA and other space agencies have had remote sensing systems orbiting Earth and collecting publicly available data since the early 1970s, these sensors are carried onboard free-flying, unmanned satellites. These satellites are traditionally placed into Sun-synchronous polar orbits that allow imaging of the entire surface of the Earth to be repeated with approximately the same Sun illumination (typically local solar noon) over specific areas, with set revisit times that allow uniform data to be taken over long time periods and enable straightforward analysis of change over time.

In contrast, the ISS has an inclined, Sun-asynchronous orbit (the solar illumination for data collections over any location changes as the orbit precesses) that carries it over locations on the Earth between approximately 52° north and 52° south latitudes (figure 1). The ISS is also unique among NASA orbital platforms in that it has a human crew. The presence of a crew provides options not available to robotic sensors and platforms, such as the ability to collect unscheduled data of an unfolding event using handheld digital cameras as part of the Crew Earth Observations (CEO) facility and on-the-fly assessment of environmental conditions, such as cloud cover, to determine whether conditions are favorable for data collection. The crew can also swap out internal sensor systems installed in the WORF as needed.

The ISS orbit covers more than 90 percent of the inhabited surface of the Earth, allowing the ISS to pass over the same ground locations at different times of the day and night. This is important for two reasons: 1) certain surface processes (*i.e.*, development of coastal fog banks) occur at times other than local solar noon, making it difficult to collect relevant data from traditional satellite platforms, and 2) it provides opportunities for the ISS to collect data for short-duration events, such as natural disasters, that polar-orbiting satellites may miss due to their orbital dynamics – in essence, the ISS can be “in the right place at the right time” to collect data.

An immediate application of ISS remote sensing data collection is that the data can be used to provide information for humanitarian aid after a natural disaster. This activity contributes directly to the station's Benefits to Humanity mission.

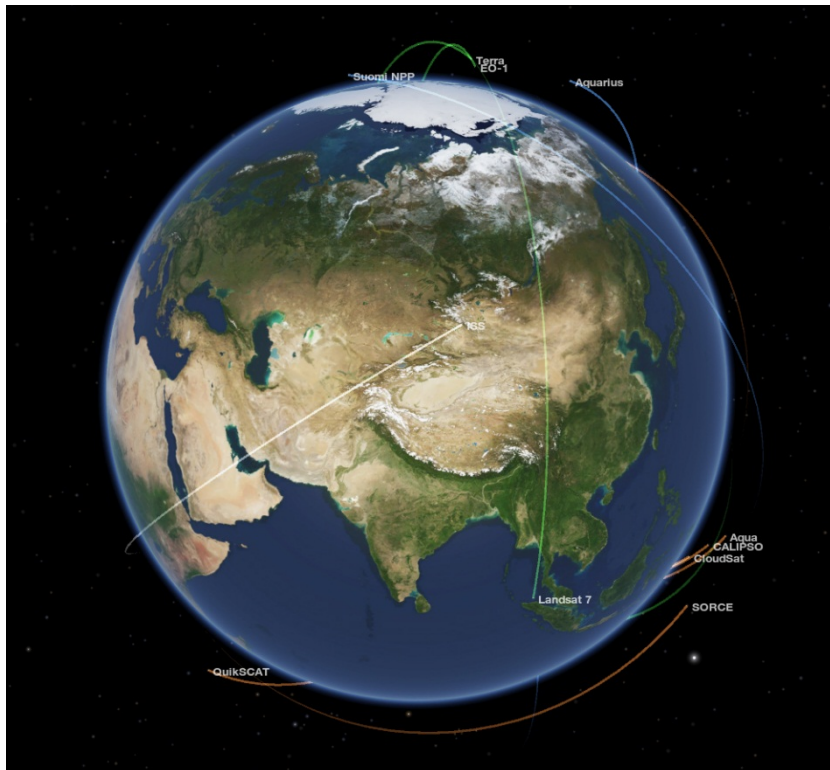
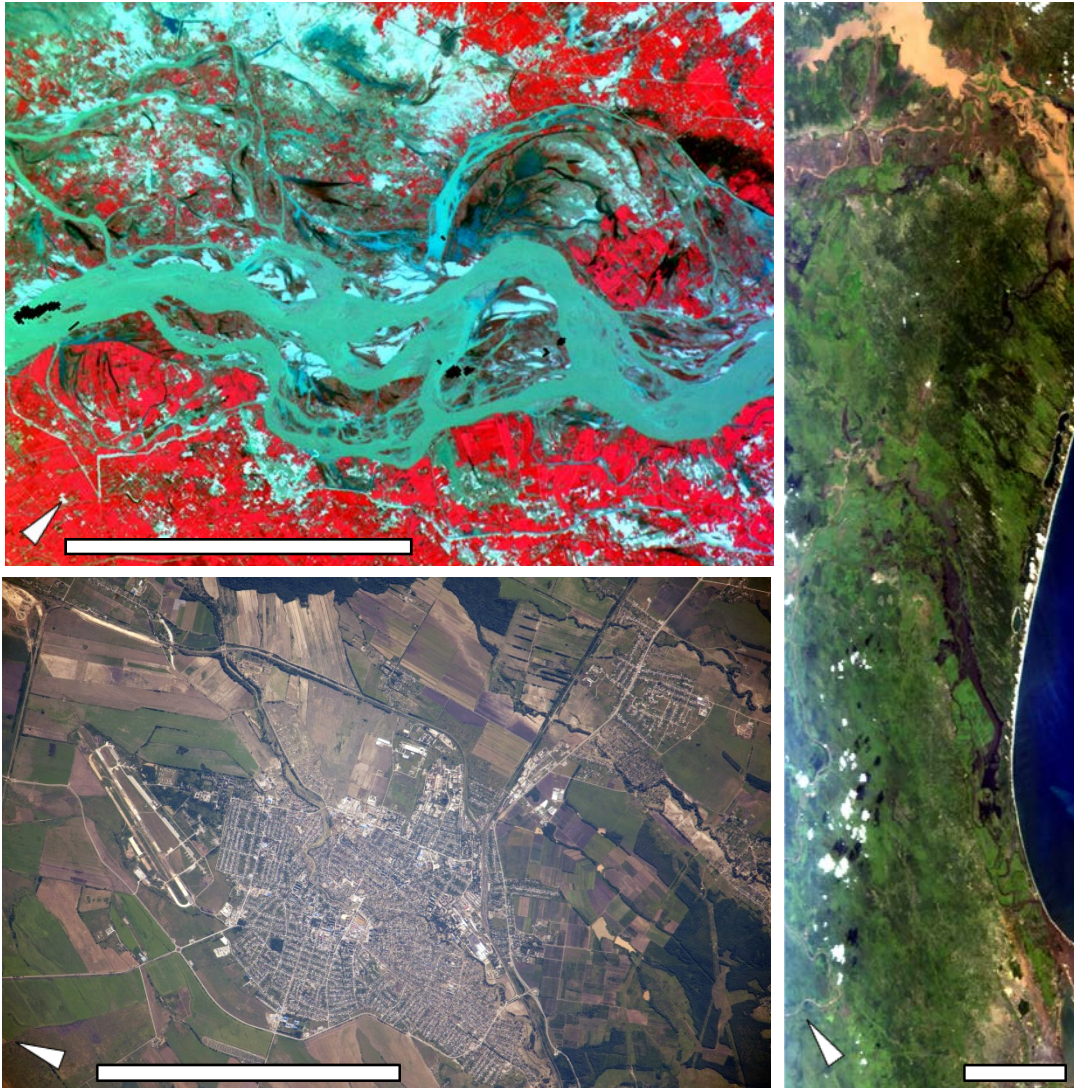


Figure 1.– Representation of polar, Sun-synchronous orbits (e.g., Landsat 7) and the inclined equatorial, Sun-asynchronous orbit of the ISS (image center).

The International Charter, Space and Major Disasters (also known as the International Disaster Charter, or IDC) is an agreement between agencies of several countries to provide – on a best-effort basis – remotely sensed data related to natural disasters to requesting countries in support of disaster response. In the United States, the lead agency for interaction with the IDC is the United States Geological Survey (USGS); when an IDC request, or activation, is received, the USGS notifies the science teams for NASA instruments with targeting information for data collection. In the case of the ISS, Earth scientists in the JSC ARES Directorate, in association with the ISS Program Science Office, coordinate targeting and data collection with the USGS. If data is collected, it is passed back to the USGS for posting on its Hazards Data Distribution System and made available for download.

The ISS was added to the USGS’s list of NASA remote sensing assets that could respond to IDC activations in May 2012. Initially, the NASA ISS sensor systems available to respond to IDC activations included the ISS Agricultural Camera (ISSAC), an internal multispectral visible-near infrared wavelength system mounted in the WORF; CEO, a project that collects imagery through the ISS windows using off-the-shelf handheld digital visible-wavelength cameras; and the Hyperspectral Imager for the Coastal Oceans (HICO), a visible to near-infrared system mounted externally on the Japanese Experiment Module – Exposed Facility. Since May 2012, there have been 37 IDC activations; ISS sensor systems have collected data for 10 of these events (figure 2).



*Figure 2.— Three IDC flooding events as seen from sensors on the ISS.
 Top left: ISSAC, flooding in Pakistan acquired September 9, 2012, scale bar is 10 km.
 Lower left: CEO, flooding in Krymsk, Russia, acquired July 10, 2012, scale bar is 5 km.
 Right: HICO, flooding in Mozambique acquired February 3, 2013, scale bar is 20 km.
 Pointers indicate north for each image.*

The ISSAC completed its prime mission at the end of 2012 and has been replaced in the WOLF with the automated ISS SERVIR Environmental Research and Visualization System, or ISERV, Pathfinder. The ISERV Pathfinder is a pointable, high spatial resolution (~3 m/pixel) camera and telescope system designed primarily as a technology demonstration. Its primary mission is to provide imagery to developing nations as part of the NASA and U.S. Agency for International Development SERVIR (Spanish for “to serve”) program, but it can also respond to IDC activations.

The ISS is intended to be a test bed for multiple users over its lifetime, which means that no single remote sensing system has a permanent internal or external berth. This scheduled turnover provides

for development of new remote sensing capabilities relevant to both research and applied science – including disaster response – and represents a significant contribution to continuance and enhancement of the NASA mission to investigate changes on our home planet.

Clearance Analysis of Node 3 Aft CBM to the Stowed FGB Solar Array

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In early 2011, the ISS Vehicle Configuration Office began considering the relocation of the Permanent Multipurpose Module (PMM) to the aft facing Common Berthing Mechanism (CBM) on Node 3 to open a berthing location for visiting vehicles on the Node 1 nadir CBM. In this position, computer-aided design (CAD) models indicated that the aft end of the PMM would be only a few inches from the stowed Functional Cargo Block (FGB) port solar array (see figure 1).

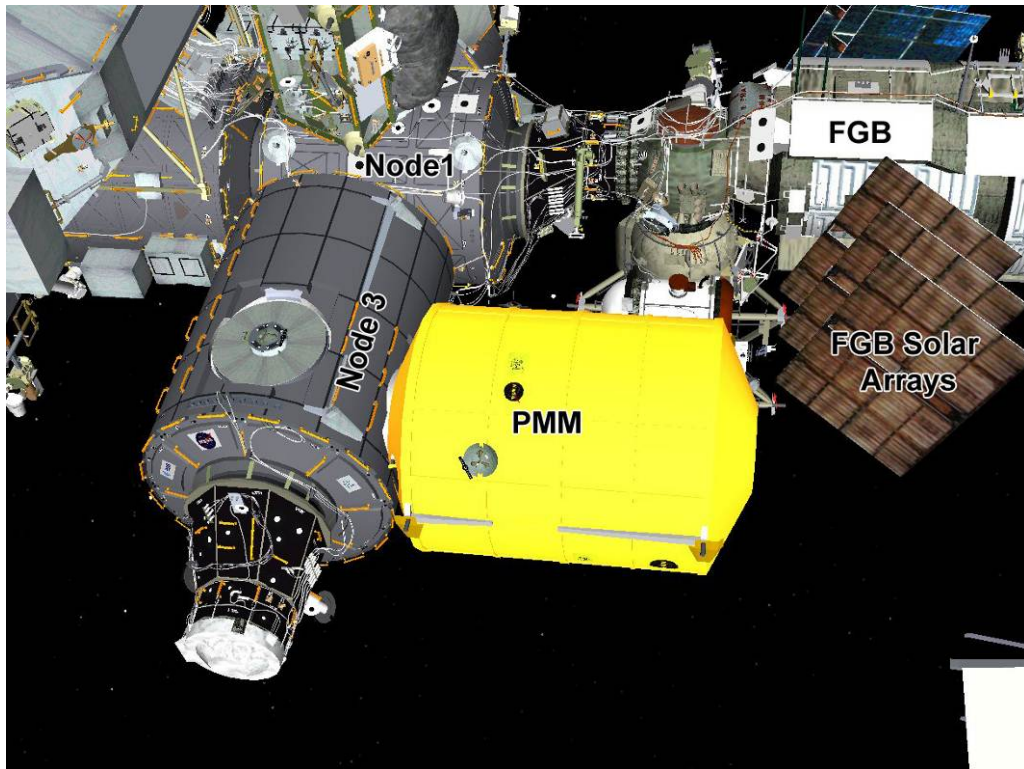


Figure 1.– Proposed relocation site for PMM with minimum clearance to FGB solar arrays.

To validate the CAD model clearance analysis, in the late summer of 2011 the Image Science and Analysis Group (ISAG) was asked to determine the true geometric relationship between the on-orbit aft facing Node 3 CBM and the FGB port solar array (see figure 2).