

## Plant Temperatures, Artificial Intelligence and Super-Caffeinated Coffee!

These three items are all relevant to the SpaceX Falcon 9 rocket which took off last Friday, 29<sup>th</sup> June, from Florida's Cape Canaveral Air Force Station at 5.42am EDT. The launch was bound for the International Space Station (ISS), you can watch a replay of the take-off [here](#), and the key scientific mission was NASA's [ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station](#) (ECOSTRESS) mission.

ECOSTRESS is pathfinder mission, which hopes to improve our understanding of how much water different plants and crops require to stay healthy. Plants regulate their temperature by releasing the water they absorb through their roots through their leaves as water vapour. A plant that has absorbed insufficient water cannot maintain this process and therefore its temperature rises. ECOSTRESS aims to measure this temperature change.

It uses the [Prototype HypsIRI Thermal Infrared Radiometer \(PHyTIR\)](#) to take these measurements. This radiometer has six spectral bands, with five in the 8-12.5  $\mu$ m waveband range and an additional band at 1.6  $\mu$ m for geolocation and cloud detection. It's predicted it will measure surface temperature to within 0.1 Kelvin, and will collect data on a 38 m by 69 m cross-track spatial resolution. The mission is expected to last around a year and is the forerunner of the future Hyperspectral Infrared Imager (HypsIRI) mission.

The key product from ECOSTRESS will be the Evaporative Stress Index (ESI), which is used as a drought indicator. Current satellites measure plant stress by seeing the change in plant colour, by measuring the temperature it should enable the stress to be picked up earlier and action could be taken to protect the plants. Given the changes in climate the world is experiencing, understanding how plants cope with different conditions and knowing when they need additional water could be vital for future yields. A recent research [paper](#) by Zarco-Tejada et al also showed the importance of temperature for spotting disease in olive trees.

An interesting element of this mission is that rather than being attached to a satellite, it will be fixed to the outside of the Space Station. The low earth orbit of the ISS offers advantages over other satellites in terms of both its track and temporal resolution, which will allow ECOSTRESS to identify how plants react at different times of the day. This means it will acquire the most detailed temperature maps of the Earth ever acquired from space. In addition, the spatial resolution should allow for measurement at the individual field level. It will also use other satellite data and ground truthing to assess the accuracy of measurements. This is particularly exciting for us at Pixalytics, as we already produce a number of vegetation and land surface products and this mission can offer new scientific information for this area of research.

The ECOSTRESS thermal radiometer can also offer data to support the monitoring of:

- Fires, in particular small wildfires which are something that the UK has experienced this week in our unusually hot weather.
- Volcano's as its radiometer can observe both heat and sulphur dioxide plumes, similar to the existing ASTER satellite.
- Urban heat islands
- Cold water upwellings in coastal and inland waters to help understand how nutrient rich water columns move.

As the blog titled hinted, ECOSTRESS was not the only thing aboard the Falcon 9 payload. It also carried:

- Shipments of food and water for the astronauts, including a batch of super-caffeinated Death Wish Coffee, blueberries and ice cream bars.
- The first artificial intelligent (AI) robot "crew member" to live on the station. The Crew Interactive Mobile Companion, known as CIMON, will interact with the astronauts to assess how humans and robots co-operate in space. With 14 internal fans, CIMON will be able to move throughout the ISS responding to any astronaut that calls its name.
- Multiple scientific experiments for the microgravity environment.

ECOSTRESS is an exciting new mission which we'll be keeping a close on eye. The output it produces could have a significant influence on the way in which vegetation health and growth is monitored from space. We can't wait to see the data!!

