Equipment per set

Thermal IR camera
3 bin bags
water cooler bottle half filled with water
dry ice

Instructions for CO_2 Atmosphere Demo

Introduce the **electromagnetic spectrum** [**see image]**and the concept that we can use different part of the EM spectrum to gather compositional information. Identify the **infrared.** Examples of the NIR include in remote controls, Xbox Kinect etc. In Earth Observation the IR can give us information about the **health of vegetation** and the **presence/structure of clouds**.

Activity 1: Thermal IR

Instructions: Allow participants to view themselves in the thermal IR

What happens: The hotter an object is, the more yellow it will appear on the screen.

How it works: Most surfaces emit or reflects thermal radiation, that we are unable to see. Some materials like glass block thermal IR radiation and will appear black on the screen.

Activity 2: Thermal foot/hand prints

Instructions: Get a volunteer to take of their shoes and stand on the floor for a few mins (or to put their hands on a table/wall for a few mins) get them to take a step back or remove their hands from the surface.

What happens: Hand/foot prints in thermal IR remain behind.

How it works: Thermal IR radiation is absorbed by the surface prolonging the signature.

Activity 3: Thermal reflections

Instructions: Point the camera at a white board or a window.

What happens: The whiteboard or window will act like a mirror, reflections of everything in the room will be seen in the thermal IR.

How it works: Thermal IR can be reflected off surfaces in the same way that visible light reflects off a mirror to give us an image.

Activity 4: IR instrumentation

*Instructions:*Get a volunteer to put their arm in bin bag and hold up a number of fingers. Look at the arm with the Thermal IR camera.

What happens: The bin bag is see-through in the thermal IR.

How it works/context: We can only see in the visible. In the visible we are unable to determine how many fingers the person is holding up as the bin bag is opaque in the visible. In the thermal infrared, the bin bag is transparent, allowing us to determine the number of fingers.

Observing our own planet and others in the IR we can gather compositional information that we can not get from the visible.

An astronomical analogue: the hand in the bag is a bright hot star, the bin bag is a dust cloud around it. In the visible the dust would block observations of the star, but in the IR we can see through the dust and see the star.

Activity 5: The effect of CO_2 in the atmosphere

Instructions: Put a couple of scoops of dry ice into the water filled water-cooler bottle until the "fog" bubbles over. Collect the gas in a bin bag until half full and hold it shut. Fill a second bin bag with air from the room and hold it shut. Get a participant to stand in front of the IR camera and place the bag of air in front of their face. Then place the bag of CO_2 in front of their face.

What happens: The thermal IR signature on the camera will be stronger for no bag, and with the bag of air in front of the participant. When the bag of CO_2 is in front of the participant the signature will be muted.

How it works: We are emitting and reflecting thermal IR radiation detected by the camera. The bag of air does not absorb that much thermal radiation, allowing our signature to reach the detector. CO_2 absorbs some of the thermal radiation emitted from us, stopping it from reaching the detector. This is why the thermal signature is muted. Over a few hours in front of a person, the bag of CO_2 will get warmer.

Context: CO_2 and other greenhouse gases in the atmosphere absorb thermal radiation reflected from the surface, rather than allowing it to be reflected away from the planet. This contributes to global warming.