The article, “Landsat-5 Thematic Mapper Outgassing Effects” from IEEE Transactions on Geoscience and Remote Sensing takes a look at Landsat-5 Thematic Mapper and discusses its periodic variation in detector response from probable outgassing build-up. Landsat 5 uses two InSb detector arrays for infrared sensing in two specific bands, 1550-1750nm and 2080-2350 nm. It also has one HgCdTe detector array to sense infrared in the 1040-1250 nm. These sensors are in a radiative cooler assembly maintained at ~-181 degrees C. There is a ZnSe window that allows the optical energy to reach the detectors, and this is where the problem lies. The responses observed from the InSb detectors were noted to vary approximately 3 to 5% over the lifetime of the payload. This variation is believed to be because of a film buildup on the window, similar to frost on a window.

Luckily, the Landsat-5 team developed a procedure to remove any contaminants by heating the payload to 23 degrees C and then cooling it back to -181 degrees C. Landsat-4 also had degradation because of contaminants but it wasn’t until later that a characterization of the detectors was developed in order to prove the contamination, this happened to be before the launch of Landsat-5. They even went on to use equations to determine the thickness of the film on the window.
This Landsat-5 really shows and uses outgassing in two fold. First is that over the life of the satellite the thickness of the film seemed to decrease overtime time which told them that something inside the assembly was outgassed but then overtime the contaminants either escaped or were absorbed onto other parts of the payload. Unfortunately they are unsure exactly what it was. As the temperature inside the payload had to be very cold the outgassed material was absorbed onto the window forming an ice like layer. By heating the payload up to a much higher temperature the absorbed ‘film’ evaporated. Then once cooled again the particulates would begin to coat the window until the next temperature cycle was performed.

The article goes into great depth of how they used the ‘degradation’ of the sensors between each temperature cycle to build a dataset to help build an outgassing model which was used to determine future times when the temperature cycle will need to be performed and eventually used for payload calibration. Below is an image from the article which shows data points where the sensor variation can be seen. The lower the data points the more contamination on the window. When it rises back up that is when a temperature cycle was performed.
There was a lot of difficulty working out this information to ensure it didn’t include effects from thermal variation, known lifetime degradation of the sensors, etc.

The benefit of this article’s work was to provide not only a method to help resolve the lens outgassed contamination issue, but to also work to provide corrected measurements for the payload during its life between the temperature cycles. This correction helps keep the payload more accurate.

Article 1:

Article 2:

(Artached)

Article 3:

(Artached)