What are the advantages of satellite imagery

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What is satellite imagery used for. Pros and cons of satellite imagery.

Daniel Hogan (In-Q-Tel CosmiQ Works) and Jason Brown (Capella Space) with CosmiQ Works and Capella teams. When asked to represent a satellite image, most people imagine something like the left side of the figure above. It is an optical image "a photograph" even if taken by a very powerful camera. But optical images are not the only way to view the Earth's surface from a satellite or an airplane. Synthetic aperture radar, or SAR, is a completely different way of generating an image actively illuminating the ground rather than using sunlight as with optical images. The right side of the image above shows how the SAR images are very different from the optics. These differences pose challenges but also create new capabilities. One of the main advantages of SAR is simple: even the best optical camera mounted on planes or satellites is less useful at night and useless when there are clouds or smoke. The SAR can capture images at night and see through clouds and smoke. It is a 24-hour 24-hour technology for all weather conditions. SAR data will be present in SpaceNet 6. In this two-part blog series, we will address the basics of how SAR works, what makes it unique and what makes it useful. Even if (or above all) you have never heard of SAR, this series is for you! How does Radar work in Synthetic Opening Works? Synthetic aperture radar is a way to create an image using radio waves. The radio waves used in the SAR typically range from about three cm to a few metres of wavelength, which is much longer than the wavelength of visible light used for the production of optical images. These wavelengths belong to the microwave part of the spectrum in the figure below. Figure one. Comparison of wavelength, frequency and energy for the spectrum RADAR is the acronym for Radio Detection and Ranging. Radar is an active system that generates its own radio waves and transmits them from its antenna, antenna, A target. Depending on the target properties and the geometry of the image, the radar antenna will receive all, part or none of the radio wave energy (this is the RADAR detection part). This received signal will travel for a time proportional to the distance of the target from the antenna (this is the RADAR Ranging part). Figure two. Imaging Radar Geometry (NASA) Real Radar Opening (RAR) Side-imaging radar is different from a future-oriented radar, such as weather radar. If a radar antenna, which amplifies the signal transmitted and received, is transported in an airplane or in an orbiting satellite, a radar can be used to obtain an image of the ground below. This radar image is formed by transmitting pulses of radio frequency energy (RF) to the ground and to the side of the plane, measuring the return force (sometimes called "echo") and the time needed to make the return journey to the antenna. In this way, the soil is scanned in two dimensions. One dimension is the range dimension. Objects are positioned along this dimension according to their distance from the radar. The second dimension is the "long track" dimension (or "cross-range" or "azimuth"). In this dimension, the ground is scanned by the beam moving on the ground at a speed equal to the speed of the platform (plane or satellite), and the objects are positioned in this dimension depending on the position of the plane along the runway. One image is constructed from reflected signals in both dimensions. The spatial resolution, i.e. the ability to solve objects on the ground, differs in the direction of the interval (perpendicular to the direction of flight) from the azimuth direction (parallel to the direction of flight). In the "real-aperture radar", the resolution of the range of action is defined by the width of the impulses transmitted by the antenna. The azimuth resolution is determined by Part Part the footprint on the ground, and the width of the beam is inversely proportional to the length of the antenna. A short length of the antenna corresponds to a wide beam width (beam footprint on the ground). Since piloting an antenna large enough to generate a reasonable azimuth resolution in space is prohibitive, this limits the spatial resolution in the azimuth direction. The development of advanced processing algorithms solved the problem, leading to a new generation of imaging radar called Synthetic Aperture Radar. Synthetic Aperture Radar (SAR) To mitigate the undesirable effects of the low azimuth resolution of real aperture radar, the motion of the antenna along the azimuth direction is used to “synthesize” or give the effect of a long antenna as shown in Figure 3. To mitigate the undesirable effects of the low azimuth resolution of real aperture radar, the motion of the antenna along the azimuth direction is used to “synthesize” or to give the effect of a long antenna as shown in Figure 3. Figure 3. Synthetic Aperture Generation (Credit: NASA) This synthesis process is possible because a scatterer (target) on the ground remains within the real aperture radar beam for many radar pulses. By summing up the reflections of all these pulses, a large antenna with a much smaller beam width can be synthesized, resulting in a better spatial resolution in the azimuth direction. This technique is applicable to both aerial and space systems. SAR image interpretation While SAR images can be rendered on a recognizable map, there are important differences between optical and SAR images. The SAR image is considered a non-literal type of image because it does not resemble an optical image that is generally intuitive to humans. These aspects must be included for accurate interpretation of images. ShadowingShadowing is caused for the same reasons that shadows form in the optical image: an object object object the direct radiation path visible light in the case of optical imaging and the radar beam in the case of SAR. However, unlike optical images where shaded objects can be seen due to atmospheric dispersion, there is no information in a SAR shadow because there is no return signal. ForeshorteningSince SAR is a side-looking tool, which goes, the indietroscattered returns will be arranged in the image according to how far the target is from the antenna along the inclined plane (flight plane-radar image.) This causes some interesting geometric distortions in the imagery, such as pre-riding. As shown in Figure 4, the slope A-B is compressed in the inclined plane because the radar signal reaches point B shortly after reaching point A in time. This causes a tall object with a slope, like a mountain, to appear steeper, with a thin, luminous “edge” appearance. Note that the aspect angle of the sensor affects the proehortening; a larger aspect angle will diminish the effect. Figure 4. Precursed geometry (Credit: NASA) Figure 5. Layover Geometry (Credit: NASA) Layover Layover is an extreme example of pre-riding where the object is so high that the radar signal reaches point B before it reaches point A. This causes returns from point B to be placed on the image closer to the sensor (near range) and point A dark, as if the top was superimposed at the foot of the mountain. Figure 6. Examples of geometric effects in SAR Imagery (Image credit: ERS, ESA 2011. Retrieved 20 January 2020. The effects of these phenomena are altered depending on the aspect angle of the sensor. A larger aspect angle increases the effect of shadows (lengthening the shadow,) by minimizing the effect of lying down (less lying down.) A smaller aspect angle has the opposite effect. Examples of these effects on rough terrain are given in Figure 6. The 7, meanwhile, shows an example of how buildings in an urban environment are distorted by the same effects. All tall buildings tall were arranged horizontally because of the rest. Pixel Brightness While a radar image may seem like a monochromatic optical image, this impression is deceptive. The intensity of the pixels in a radar image is not indicative of the color of the object (as in a color photograph). The intensity depends on the amount of energy transmitted by the SAR sensor (such as the brightness of the light source), the material properties of the object, the physical shape of the object and the angle from which the object is displayed. Design Parameter Sensor and operating parameters allow engineers to have control over the reflex return signal (called backcatter). Designers design and model the system and operating parameters to maximise radar yields and therefore information collected against specific targets. During the design, the system~'s wavelength and polarization (discussed below) are chosen and once launched, they cannot be modified. These fixed sensor parameters dictate at a certain level the resulting brightness of a pixel in a particular image. The wavelength affects the azimuth resolution but also has important implications for penetration, see figure 8. In general, radar penetration increases with wavelength. The look angle influences the passage and shadow as described above, but may also have an effect on pixel brightness because it changes the way the radar beam interacts with the object. Polarization on transmission and reception also affects pixel brightness as described in the following section. Figure 8. Radar Penetration by Frequency Implementation of all these improvements, however, required to make difficult choices. ' we delayed the start of the eight-month service to complete and validate Sequoia226; veined design. The satellite also doubled the size,from 48 kg to 100 kg. However, despite these choices, we're excited about the emergence of a world-class SAR satellite that delivers what our customers need and expect. Surface Parameters The surface parameters which which which The luminosity of pixels is the surface roughness of the material, relative to the wavelength of the system and to the material scattering (the dielectric constant of the object). If the surface roughness of the material is smooth compared to the wavelength of the system, the radar beam is reflected (figure 9) according to the law of reflection. It's called speculation. If the surface is rough compared to the wavelength of the system, the radar beam is spread in all directions. This is called diffuse dispersion. Changing the roughness of the surface results in various amounts of diffuse dispersion and variable luminosity of pixels. The dielectric constant of the scattering material is a physical property of a material that determines the reflectivity of that material to electromagnetic waves. Metallic objects and water have a higher dielectric constant and are more reflective, however, as © are smooth compared to the wavelength of the system, and usually flat, the radar beam is mirroringly reflected, away from the sensor. Figure nine. In addition, some superficial features will cause a mirror reflection towards the sensor, bouncing on more surfaces. A double bounce reflection is called a dihedral return and a triple bounce return is called a three-way return. These are caused by smooth surfaces oriented to 90-degree angles of each other, as shown in Figure 10. Figure ten. Dihedral scattering SpeckleSAR is a consistent imaging method because © radio waves in a radar beam are aligned in space and time. This consistency offers many advantages (it is necessary for the process of synthetic opening to work), but leads to a phenomenon called specicles. Speckle is a salt and weight variation of pixel brightness that degrades the quality of SAR images, making the image interpretation more difficult. Speckle is checking why © there are often many individual in a given pixel, which leads to positive (salt) and negative (pepper) (pepper) through pixels with an otherwise constant backscatter return. What's the next post this post described how SAR images are produced. Using intelligent signal processing, SAR creates radar images with higher resolution than otherwise possible. SAR images provide information about what is on the ground, but Distortions and mirrors make these images very different from optical images. In the second part of this two-part series, we look at some of the special data analysis methods used with SAR and explore what makes SAR useful on optical imaging. This will be the subject of our next installment, â¨¬" ÅSAR 201. Thanks to ADAM VAN ETENTE AND RYAN Lewis. Lewis.

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