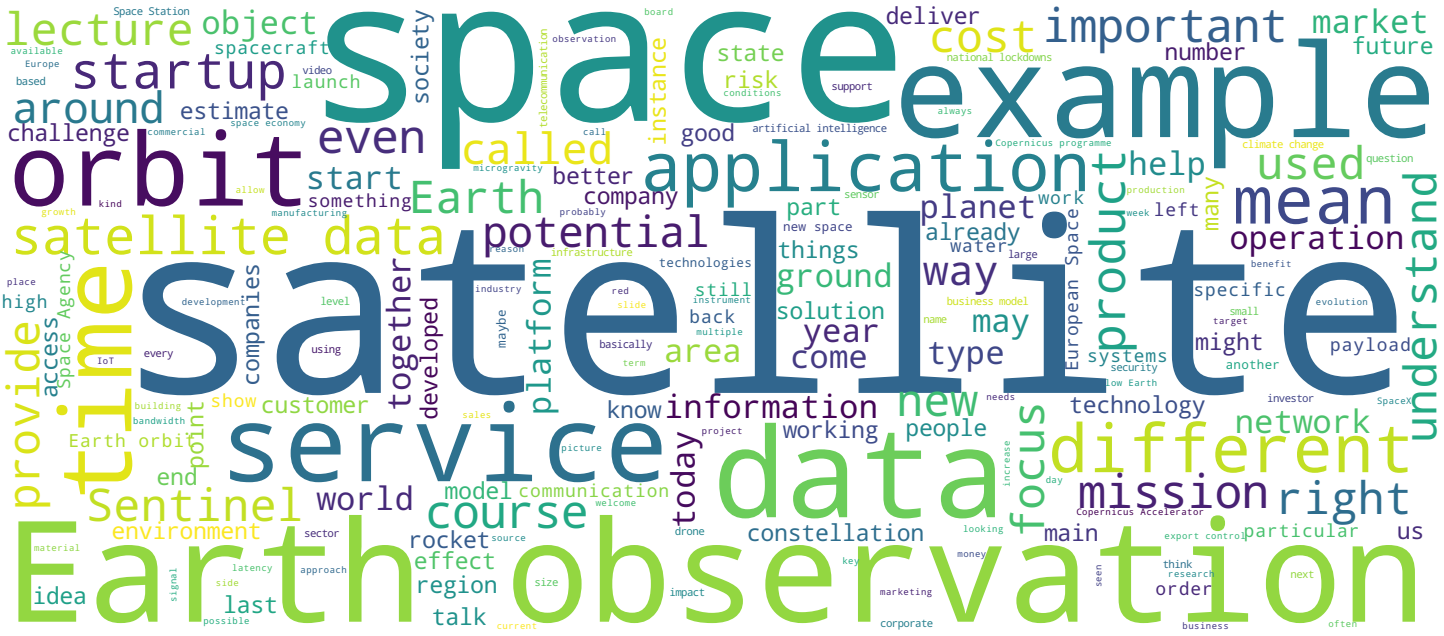

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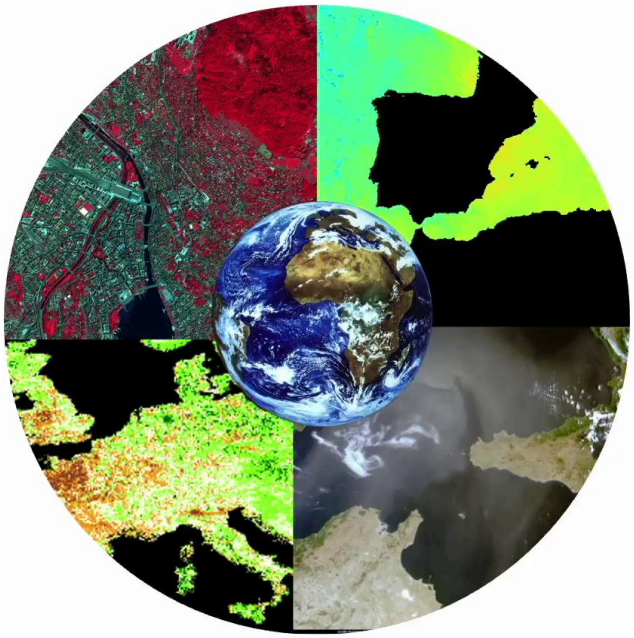
EPFL

Earth Observations for Society



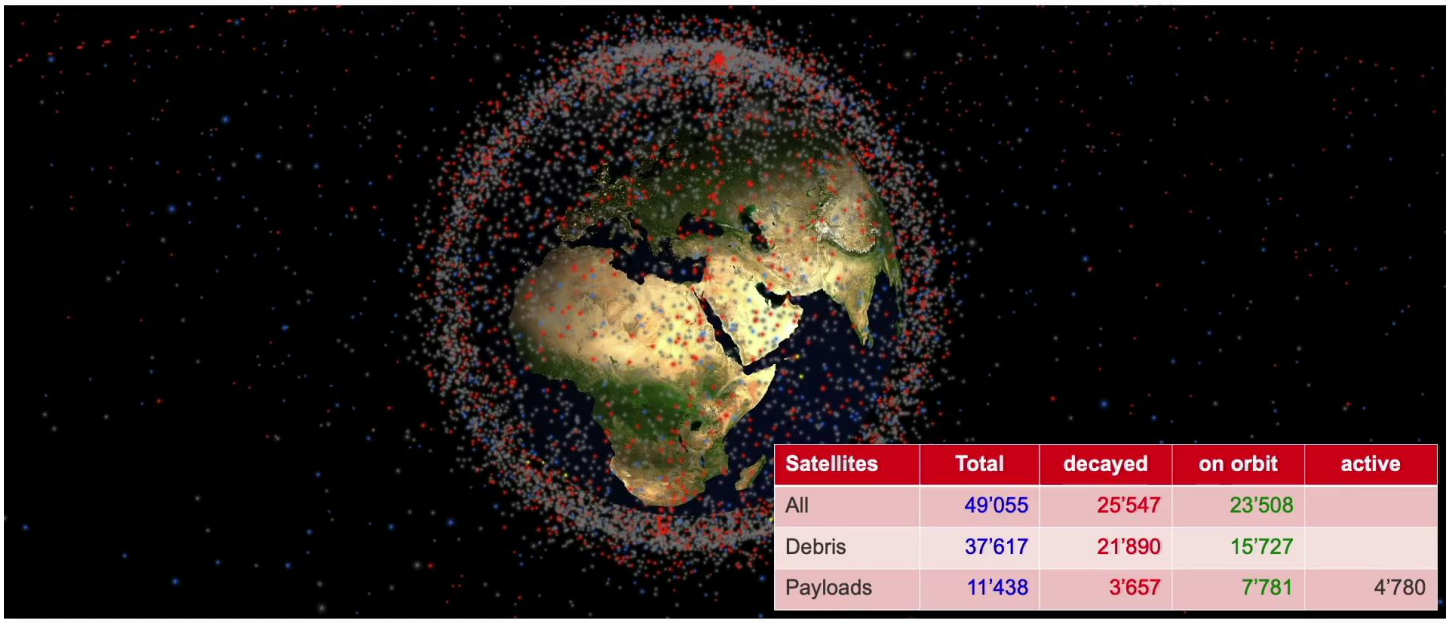
Hello, everyone and welcome to this lecture. I'm Valentina, and I will guide you through the use of Earth observation for the benefit of society. Before we start, let me clarify what I mean with Earth observation. There are in fact, several definitions, but in this lecture we are going to focus on observation of any physical, chemical, or biological processes that we can perform with the help of satellites. These observations are based on remote sensing technique, meaning that we are observing without touching and this instrumentation can in general be assembled on satellites but also on airborne and ground-based platforms.

Notes

Summary

0m 05s

Today's Satellites



Satellites	Total	decayed	on orbit	active
All	49'055	25'547	23'508	
Debris	37'617	21'890	15'727	
Payloads	11'438	3'657	7'781	4'780

Image: real time 3D map of objects in Earth orbit, http://stuffin.space/
Data: http://celestrak.com/satcat/boxscore.asp

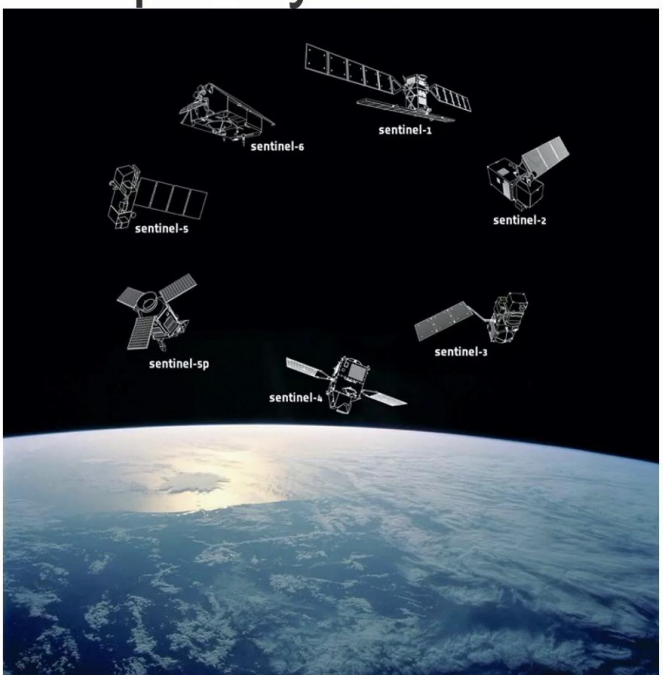
Our planet is continuously under observation by satellites which orbit Earth with different speeds and instruments on board. As of August 2021, there is a huge number of objects orbiting our planet. The majority are debris coming from nonworking satellites or rocket stages, but there are also more than 4000 active satellites and some of them will be the focus of this lecture.

Notes

Summary

0m 45s

Copernicus: Europe's eyes on Earth



In particular, we will focus on the satellite of Copernicus, which is the European Union Earth Observation Programme. This provides a space component but also In-situ data and a service component. The core of the Copernicus space component is the Sentinel family, which currently consists of eight satellites in orbit. These satellites have been developed by the European Space Agency and provide now in operation more than 250 terabytes of data per day, making Copernicus the largest Earth observation data provider in the world.

Notes

Summary

1m 13s

The reason we focus on the Sentinel satellites is that the provided data is available with a completely free and open access policy. This means that there is a huge volume of free data which can indirectly produce social, economical, and environmental benefits. The highest market potential, in fact, lies in the downstream industry, since we can use the satellite data to develop commercial application which can improve internal life on Earth.

Notes

Summary

1m 53s

What can EO do for Society?

What can Earth observation do for our society? Well, satellite data can help us in monitoring the state and health of our planet, which is currently changing because of many problems such as climate change, biodiversity loss, overpopulation, overconsumption, or even the depletion of natural resources. Satellite data can help institution and policy makers in taking data driven decisions while they are working on the sustainable development goals. In particular, the Copernicus programme provides also several services which are categorised into six areas of interest. Atmosphere, marine, land, climate change, security and emergency. However, there is a huge amount of available data, which leaves room to many business opportunities. Let's see together some application of the Earth observation to the society.

Notes

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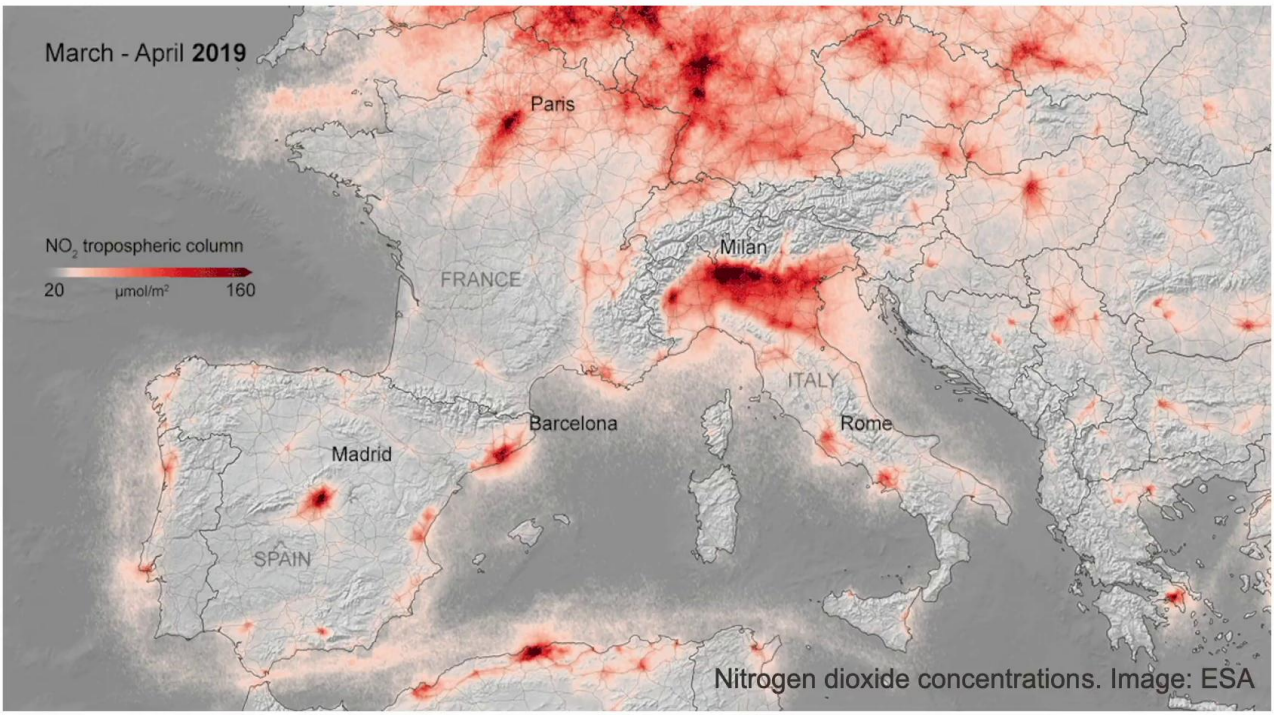
2m 25s

Lockdown’s effects on air-pollution



2020, we will probably all remember as the pandemic year with national lockdowns all around the world to prevent the spread of the coronavirus. This national lockdowns had also an effect on air pollution that it was well visible from satellites. In this case, you can see a comparison of the nitrogen dioxide concentration in Europe in March 2019 and in March to April 2020. The study conducted by the scientist of the Royal Netherlands Meteorological Institute has been possible thanks to an instrument on board of the Copernicus Sentinel five P satellites. With a complete view over Europe. We can see the strong reduction of this air pollutant in 2020 and we can see that it coincides with the reduction of traffic and industrial activities due to the national lockdowns. And it's clearly visible over the major cities across Europe, specifically Milan, Paris and Madrid.

Notes

Summary

3m 24s

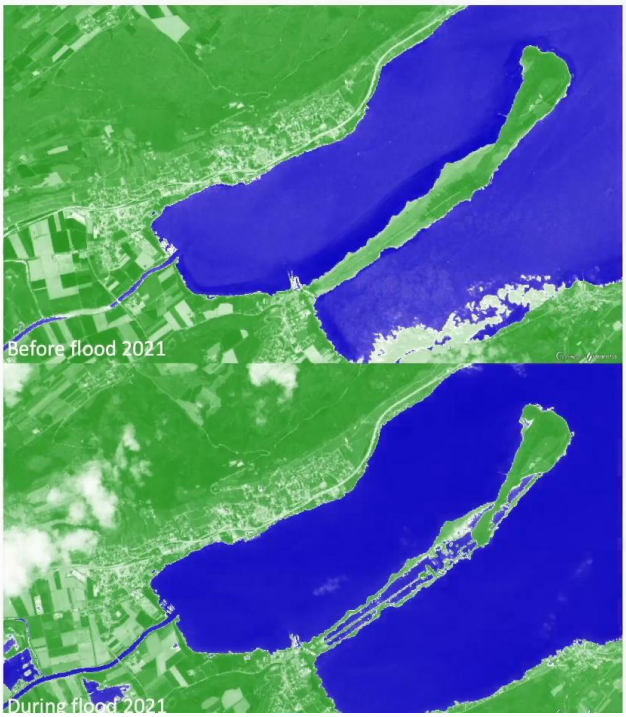
Now let's move to another example. Earth observation can also be used to estimate the effect of global warming. For example, glacier retreat. In this first color picture we can see the Rhône Glacier in Switzerland visualised using the near infrared the red and the green bands of Sentinel Two. If we Zoom in and look at the evolution of the glacier tongue starting from 2015. We can see a strong retreat of the glacier tongue and the growth of a glacier lake. As you can see. Thanks to the Earth observation, we can easily estimate the recession in only 60 years and see that it's off almost 200 metres. This example shows you how powerful Earth observation can be while monitoring events happening on a long time scales.

Notes

Summary

4m 24s

Climate Change & Flooding Events



Now let's stay with climate change and focus on extreme weather events. A higher global surface temperature causes a higher probability of droughts and more intense rainfall which can in turn cause floods. This is what happened in Switzerland in summer 2021. In the upper panels we can see on the left an RGB image of the region of St Peters Peninsula in the Bielersee before the storm and on the right we can see the normalised difference water index the NDWI. This is an indicator for the water content of the region. In the lower panels. Instead, we can see the same region, but during the flood. The comparison shows that the breaching dam is completely covered by water. As you can see here, and also the agricultural fields around have been flooded too. Often. In this case, Earth observation can be really useful to visualise the effect of the area and estimate the size of damages.

Notes

Summary

5m 19s

Urban Expansion

Finally, I would like to show you also how we can monitor urban expansion from satellites. On the left, we can see two LGB images of the region around Zurich Airport. One is from 2015 and the other one from 2021. The round here that you can see here is called Circle and it's a new area which started to be developed in 2015. On the right. Instead, we can look at its development with again false-color images with the near, the red and the green bands. In the central part, you can recognise a park with the vegetation emitting in the near infrared and all around the different building phases.

Notes

Summary

6m 28s

All the application I showed you so far come from two out of the six types of sensor available Sentinel Two and Sentinel Five P. However, even using only these satellite data, you got a feeling about what Earth observation can do for our society and the large potential that is up there. In the last years, many companies started using satellite data, which is an extremely powerful tool in particular to monitor global events and look at the evolution over long period of time, as we saw in the previous examples. At the same time, many startups started using Earth observation. And they're developing with the support of initiatives such as the European Space Agency Business Incubation Centres or the Copernicus Accelerator. However, only member States can access the Copernicus Accelerator programme. For example, Switzerland is not a full member of the Copernicus Programme, and the Swiss startup can rely, for instance, only on the European Space Agency Business Incubation Centre. As an example, we can see Picterra and Rio 20, which are two startups in the ESA BIC Switzerland programme. Pictera offers a special cloud-based platform with integrated deep learning based detectors to help users identify objects and patterns in satellite and aerial images without coding on their own.

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Summary

7m 16s

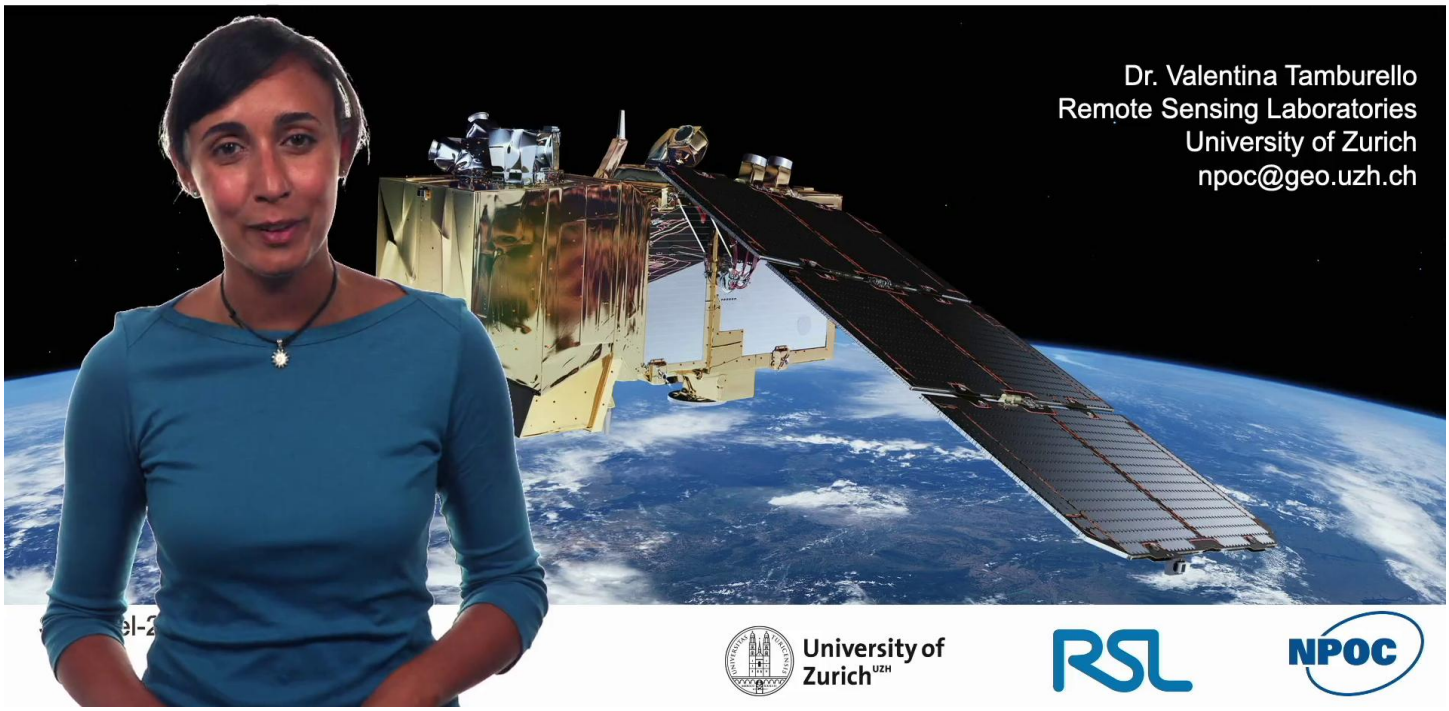
Rio 20 instead, uses artificial intelligence and Earth observation to analyse and estimate the risk for natural and man-made disasters. Among the startups supported by the Copernicus Accelerator, we can see other examples. For example, the Green City Watch, a startup which apply artificial intelligence techniques to satellites and drones data to drive urban green space management 20tree, instead uses satellite imagery and artificial intelligence to monitor forest health to mitigate wildfires and power outages. Marmoris takes advantage of Earth observation to map coral reefs in the world and their environments, and to provide a data driven early warning system which can influence policy restoration and management decisions. Finally, SoilViews use Copernicus Sentinel One, Sentinel Two and Sentinel Three satellite data in combination with deep learning classification models to provide soil analysis and crop suitability recommendation, which help farmers in their daily work.

Notes

Summary

8m 47s

Thank you!



With these last examples, I hope you have now an idea about the potential of Earth observation from satellites and can start thinking about your whole business based on satellite data. Thank you a lot.

Notes

Summary

9m 59s