**Intro:** Our oceans cover about 70 per cent of Earth’s surface, and we’ve long known that they are integral to all known life and govern our weather and climate. In Situ measurements taken in the water provide us with a wealth of information while hundreds of kilometers above the ocean surface, satellites are making their own measurements. Later this year Sentinel 3 will be joining the family of satellites observing the Earth and by combining the information from these with the continued ground-based measurements, we will have an even more accurate global perspective, helping us further understand our oceans.

Oceans and space

**00:10** VO: Our oceans cover about 70 per cent of Earth’s surface, but to what degree do we really understand them? Measurements taken in the water provide us with a wealth of information. Hundreds of kilometers above the ocean surface, satellites are making their own measurements, giving us a broader view of these vast bodies of water, and revolutionizing oceanography.

*Images: Crew of Plymouth marine Laboratory take In-situ measurements from the sea surface to check and calibrate against satellite data - filmed in Plymouth, UK, 30/3/15, Then animation of Sentinell1 satellite, ESA 12/03/2014*.

We know that oceans have a major impact on the weather and the environment, acting as heaters at the poles and air conditioners at the equator. A global conveyer belt of ocean circulation is responsible for the transport of heat, carrying warm water from the equator toward the poles.

*Images:* Images of ocean from ESA 13/3/2013, then satellite image of weather, *followed by Gulf Stream Ocean circulation animation ESA -*19/02/2013, followed by animation of underwater, ESA, 13/3/2013, Then Animation of Globe and Poles from ESA 25/03/2014

**00:48** VO: There is more life in the oceans than anywhere else on Earth. One of the smallest forms of ocean life but one of the most important is Plankton, In addition to being a source of food for other aquatic life, plankton produce oxygen while soaking up huge amounts of carbon dioxide.

*Images of sea life, ESA, 27/1/2010 originaly from Galatee Films 2009.*

**01:05** VO: Increasing sea surface temperatures and sea level rise are becoming an observable reality in our oceans. Understanding them has become one of the most important factors for measuring and predicting environmental change.

Satellites are one of the most effective ways of monitoring these changes in our oceans from different perspectives.

*Image –Animation of globe with sea surface tempretures ESA* 19/02/2013*. Waves breaking on the coast , ESA 2013. Sea ice melt off Greenland ESA 2004,. Animation of Cryosat ESA 2013.*

**01:25 -SOT Shubha Sathyendranath, Senior Scientist, Plymouth Marine Laboratory**

**in the context of climate change, the oceans are the greatest reservoir of the anthropogenic, of the excess heat that our planet is accumulating, and the satellites help us to see how the - at least at the surface - how the temperature is changing. With the melting of the ice and the increasing in the temperature, sea level has been increasing, not everywhere, and not uniformly, but overall the trend is an increasing trend.**

**01:47** VO**:** ESA’s Earth observation satellites have been monitoring oceans for years. On board the Envisat satellite, an infrared radiometer measured sea surface temperature to within a fraction of a degree. CryoSat, ESA’s ice mission, is dedicated to precise monitoring of the changes in the thickness of marine ice floating in the polar oceans. The Soil Moisture and Ocean Salinity satellite – called SMOS and the Gravity and Ocean Circulation mission – called GOCE – are also providing us with information to help us understand ocean dynamics, and their relationship to climate.

*Animation of Envisat taking measurements from ESA 03/04/2012. Animation of Cryosat, SMOS, Goce and animation of Globe showing sea tempreture ESA 25/02/2010.*

02:20 - VO: Oceanography with satellites will take a leap forward with the upcoming Sentinel-3 mission, being developed for Europe’s Copernicus programme. Sentinel-3 is based on a constellation of two identical satellites orbiting 180 degrees apart, and will provide global coverage every 1 to 2 days.

*Images- Animation of Sentinel 3, ESA 2014, then 2 Sentinel1 satellites orbiting earth, ESA 2014.*

**02:38 SOT Jérôme Benveniste, Senior Advisor in Altimetry, ESA**

**When you go across an ocean from north pole to south pole with a satellite it takes 50 minutes, and 50 minutes to complete the circle. Given that it does 14 orbits a day, you have global coverage in practically one day.**

*Covering Images- 2 Sentinel1 satellites orbiting earth, ESA 2014.*

Carrying a suite of state-of-the-art instruments, Sentinel-3 will measure the topography and temperature of the sea-surface

*Animation Sentinel3- ESA 2014*

**03:04 -SOT Jérôme Benveniste, Senior Advisor in Altimetry, ESA**

**The level of the sea, which rises by 3 millimetres a year, we will measure it with a precision that’s a fraction, say 0,4 or 0,3 millimetre a year, So we try to make this set of measurements better and we will try now to prepare for the integration of the new satellite Sentinel 3.**

*Images- Cut-aways of Banveniste, 9 April 2015 ESA ESRIN, Frascati , Italy*

Sentinel-3 will also measure ocean colour, an indicator of the levels of those microscopic phytoplankton - responsible for producing half the oxygen on Earth.

*Images of sea colour and animation of Globe showing Plankton levels-, ESA 03/04/2012*

**03:31 – Shubha Sathyendranath, Senior Scientist, Plymouth Marine Laboratory**

**They will respond very rapidly to any change, so probing the phytoplankton population is one way to understand how the ocean ecosystem, which is at the mercy of the physics of the ocean, how they are responding to climate variability and eventually to climate change**

03:53 VO: We’ve long known that oceans are integral to all known life, and govern our weather and climate. By combining information from an array of satellites with continued ground-based measurements, we get a global perspective to help us further understand our oceans.

*Image of waves and underwater sea life ESA, 27/1/2010 originaly from Galatee Films 2009.Smos taking measurements ESA 2013. In situ sampling and waves ESA, Plymouth, UK, 30/3/15*

04:09 - End of A-Roll

**B-Roll**

**SOT** **Shubha Sathyendranath, Senior Scientist, Plymouth Marine Laboratory,** 30 Mars 2015 Plymouth, UK

04:09 Phytoplankton that I mention, they are microscopic, they are dynamic, they are very active, so you can think of them as the ocean analogue to the canary in the coal mine. They will respond very very rapidly to any change, so probing the phytoplankton population is one way to understand how the ocean ecosystem, which is at the mercy of the physics of the ocean, how they are responding to climate variability and eventually to climate change

We can use satellites to look at sea surface temperature, especially in the context of climate change again, the oceans are the greatest reservoir of the anthropogenic, of the excess heat that our planet is accumulating, and the satellites help us to see how the - at least at the surface - how the temperature is changing.

05:26 The ocean temperatures have been increasing, surface temperatures, but not so much in the last couple of years, and the scientists are again interested in why that is so. And one of the possibilities is that this represents the fact that more heat has gone deeper into the ocean, so scientists are looking at things like that actively. But in general the sea surface temperature has been increasing, as has the sea level

With the melting of the ice and the increasing in the temperature, sea level has been increasing, not everywhere, and not uniformly, but overall the trend is an increasing trend. So that is another factor that we can get at using satellite altimeters, microwave sensors.

More recently ESA has also launched satellite sensors to look at sea surface salinity , so that’s another area of interest. Also ESA has SMOS to measure sea surface salinity

**SOT** **Jérôme Benveniste, Advisor in Altimetry, ESA,** 9 April 2016 ESA ESRIN, Frascati , Italy

06:39 When you cross the north pole to the south pole with a satellite you take 50 minutes from the north pole to the south pole, 50 minutes to go back up again. Knowing that you’ll be doing 14 loops per day, you’ll have global coverage in almost one day, and you’d need a year to do that in a ship. So the satellite is really good for making repeated global measurements.

It helps that we use floaters that we disperse in the ocean to measure the parameters that are on the ground, measurements that help us calibrate measurements taken from a distance.

07:34 From space we measure from a distance physical parameters, such as temperature and salinity, we know how to measure the mass by the variation in the gravity field, and we measure the height of the ocean, which integrates several phenomena, and also the colour of the ocean by looking in visible light. The nutrition, that means the Plankton, which will serves the chain altimeter

08:04 We doing a huge job to bring the altimetric measurements of climatic change that have been made traditionally since 20 years on a climatic level, An enormous team from Europe will work on this, 07:23 What are we doing, With the altimeter we are at about 1000 km away, we will measure to near centimetre accuracy, something that we will follow for 20 years at a millimetre per year, we will measure the level of the sea, which is the 3 millimetre’s a year, that rises at 3 millimetres a year, and we will measure it with a precision that’s a fraction , say 0,4 or 0,3 millimetre par an, we know that we will measure it much better the last 5 years, than the first 5 years of this series of 20 years. So we try to make this set of measurements better and we will try now to prepare for the integration of the new satellite Sentinel 3., JASON ? and later as well Sentinel 6 which is the next of these high resolution altimeter’s

09:04 The ocean circulates because of differences in mass, differences in density, due to the presence of salt and heat. Once we know the density we can combine it with the gravity field. A great change that we have is to have measured the gravity field with precision with the ESA mission GOCE, gravity and ocean circulation experiment, so a real mission dedicated to ocean circulation.

**16:12** **General views of Plymouth port, Crew of Plymouth marine Laboratory take In-situ measurements from the sea surface and check and calibrate against satellite data in the laboratory - filmed in Plymouth, UK, 30/3/15 - x 45**

**16:12 End of B-Roll**