The "Road to 20" International Data Cube Deployments

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In an effort to expand the impact of CEOS satellite data through data cubes, we would like to have many operational international Open Data Cube (ODC) deployments to broaden the user community and achieve a global network of similar data cubes. Therefore, since early 2007, our goal is to deploy operational data cubes in 20 countries by the year 2022. In some cases, these data cubes will cover the entire country, but in other cases they will be smaller cubes for specific regions or applications.

The table below summarizes the status of international data cube development and discussions in specific countries. This list will be updated often to reflect the status of these interactions. It is our hope that the international expansion of data cubes will increase the breadth and depth of user contributions to the open source software and tools so that the impact of CEOS satellite data is increased over time.

Operational Data Cubes = 9
In-Development Data Cubes = 14
Under Review or Expressed Interest in Data Cubes = 33
TOTAL = 56

Status	Country	Stakeholder(s)	Description
Operational	Australia	GA, CSIRO	Original inventor of the Data Cube. Recently approved significant funding for Digital Earth Australia which will use the Open Data Cube (ODC) infrastructure.
Operational	Colombia	IDEAM, Univ of Andes	Functioning full country data cube since Dec 2016. Focus on forests. Working with a team at IDEAM (led by Pilar Rivera) and Andes University (Harold Castro). Investigating how the ODC can be the core data for Colombia operational forest management reporting.
Operational	Switzerland	UNEP-GRID, Univ of Geneva	Project led by Greg Giuliani. Completed the full Landsat archive for Switzerland with approximately 4000 scenes from 1984-2017. Added automated updates for Landsat data. Swiss government has renewed its support for the Swiss Data Cube (SDC) thru 2019. Planning on adding S1 and S2 data in early 2019. Several summer students working on SDC applications. New website: http://www.swissdatacube.org
Operational	Taiwan	National Space Organization, NAR Labs	March 2018: Dr. Chou presented new results in Colombia from the Taiwan Data Cube that demonstrate their cube is operational and producing relevant data products for decision-making. They are producing

			products for forest management and land degradation due to typhoon damage. March 2017: Meeting with Ming-Chih Cheng (NSPO) and Chyi-Rong Chiou (PhD from Taiwan Forestry Research Institute) at GFOI. They have a large HPC available for a Data Cube. Their application needs are forestry and disasters. Step-2 (>2018) is that they (Taiwan) would like to train Honduras (Forest Institute) to build a data cube as a capacity building desire through their Taiwan Aid Agency (ICDF).
Operational	Kenya, Tanzania, Sierra Leone, Ghana, Senegal (5 countries)	Global Partnership for Sustainable Development Data (GPSDD)	May 2018: Release of the Africa Regional Data Cube (ARDC) in Nairobi, Kenya. Remote training conducted in 2018 to cover deforestation, flooding, illegal mining and urbanization.
In Development	United Kingdom (U.K.)	U.K. Catapult	Project led by Daniel Wicks. They have installed a data cube for Wales using their own pre-processed Landsat 5/7/8 and Sentinel-2 data (Sept 2017). They also have an internal UK IPP proposal that would fund a capacity building effort for the Pacific Islands (Solomon Islands, Vanuatu, and Nauru). Also contacted by Trivedi Mandar (Official Development Assistance of U.K.) who showed interest in the Data Cube and is connected to GFOI.
In Development	Georgia, Moldova (2 countries)	UN Environment and GRID-Geneva	The "Mainstreaming biodiversity and ecosystem services in Eastern Europe and Caucasus" project, funded by the Ministry of Climate and Environment and the Ministry of Foreign Affairs of Norway, UN Environment and GRID-Geneva participated in a workshop in Tbilisi (Georgia) and Chisinau (Moldova), respectively 30 October-1 November 2017 and 13-15 November 2017. The project will transfer capacity to each country to use the Open Data Cube technology for biodiversity and ecosystem monitoring. The first step resulted in a single path-row data cube using Landsat data.
In Development	Vietnam, Cambodia, Laos, Thailand (4 countries)	Mekong River Commission (MRC), VNSC, VAST, Asia-Rice	Nov 2018: VNSC (new CEOS Chair) proposed a new Mekong Data Cube (supported by the Mekong River Commission). This cube will include Vietnam. Cambodia, Laos and Thailand and focus on forest and rice applications. It is planned for completion by the end of 2019. August 2018: CSIRO team (Anstee, Paget, Newnham) were in Vietnam (week of 30 July) for technical consultations with VNSC and several end-

			users in VN government/academia. Conducted a Vietnam Data Cube (VDC) workshop on March 9, 2018 to release the first version of the VDC to government and researchers. Working to get a forest mapping application in place in 2018. Rice and water quality applications are planned for 2019. They have completed several test cubes over central (Ho Chi Minh City) and south (Mekong) Vietnam.
In Development	Mongolia	Mongolian Meterological Institute	Nick Walker is leading a consortium called SIBELIUs, which is one of the UK Space Agency's International Partnership Program (IPP) projects. SIBELIUs is focused on providing greater resilience for Mongolia's herding community. At the heart of our project will be an Open Data Cube, which we will develop in collaboration with the Mongolian meteorological institute (NAMEM). Key information required includes: pasture, drought and snow.
In Development	Uganda	Drought and Flood Mitigation Service (DFMS)	Led by the U.K. Rhea Group. They will use Amazon cloud for hosting and all of their work will be open source. Plans for 2017 cube of Northeast Uganda (Karamoja region) and then 2018 for full country (Landsat, S1, S2). They expect to achieve an operational system by March 2019.
In Development	China	CAS-RADI (Chinese Academy of Sciences - Institute of Remote Sensing and Digital Earth)	CAS-RADI is working with Alex Held (CSIRO) and Stuart Minchen (GA) with support from AOGEOSS. Gu Yingfa is developing the cube on an HPC at a regional university. RADI is working with CSIRO on developing ingestion procedures for data from several of Chinese EO satellites. In parallel, a team under Guo Huadong is also developing a large cloud-based/HPC processing system, which is expected to include an implementation of the ODC. This is part of their recently funded "CAS-Earth" project, which aims to establish the necessary underpinning "digital earth"-type database and infrastructure to support a number of very large projects in China, including the national "Belt and Road" program. In July 2018, they want to begin training domestic researchers and some government users on the use of the "RADICube". Their plan is to then also begin, probably in early 2019, to use it for larger, regional projects, and eventually also help train countries in the Asia-Pacific region at a dedicated DataCube training centre.
Under Development	Austria	Univ of Salzberg Earth Observation Data Centre (EODC) for Water	Nov 2018: The "Austrian Data Cube: An EODC service for the Austrian EO user community" project is funded by the Austrian Research Promotion Agency (FFG). Austrian Data Cube (ACube) aims to develop a proof-of-concept for a data cube system for Austria with the goal to

		Resources Monitoring; TU Wien Department of Geodesy and Geoinformation (GEO); University of Natural Resources and Life Sciences, Vienna (BOKU); Federal Ministry Environment and Tourism (BMLT); Federal Ministry of Defence (BMLV)	remove technological barriers for the use of Copernicus data in Austria. The data cube shall consist of a time series of highly standardized and harmonized radiometrically and geometrically corrected Sentinel-1 and Sentinel-2. The data is prepared as to best meet the requirements of a diverse Austrian user community. The test system will be designed so that users can (1) directly access the data cube via a Web Map Service (WMS), offering thereby the potential for a straightforward integration into existing own workflows or (2) the user can use the ACube directly on the EODC cloud infrastructure. The development will be guided by a series of user workshops that will ensure optimum uptake of their requirements during initial conception and test implementation. July 2018: Matt Paget (CSIRO) gave a seminar at University of Salzburg and is supporting them on a ODC implementation. A researcher from Univ. of Salzberg visited CSIRO for 3 months for training. Their project is called Sen2Cube (Sentinel-2 Semantic Cube Austria) and will provide a web-based service for S2 queries.
Under Development	Ireland	ICHEC (the Irish Centre for High-End Computing)	Nov 2018: Contacted thru the ODC website by Jenny Hanafin from ICHEC (the Irish Centre for High-End Computing). They hold the Sentinel data archive for the country. UK-Catapult plans to support the effort.
Under Development	Armenia	Center for Ecological-Noosphere Studies of the National Academy of Science (CENS), Swiss Government	Working with Dr. Shushanik Asmaryan, GIS and Remote Sensing Department of CENS. UNEP-GRID (Greg Giuliani) was approved for a 2-year project to support building a data cube for Armenia. The project will start in Oct 2018. This project may be linked to Google Earth Engine as a demonstration test for "Data Cubes on Demand" and using their ARD products with ODC tools.
Under Development	South Korea	KARI	July 2018: Dr. Kiwan Lee from the Korea Aerospace Research Institute (KARI) is using the ODC to ingest KOMPSAT data. They are using OpenStack for their cloud computing infrastructure and plan to release their ingest config to GitHub.
Under Review	Uruguay	Director Nacional de Medio Ambiente (DINAMA) - similar to EPA in USA	Discussions with Fernando Miralles-Wilhelm (UMD, World Bank) and Dr. Virginia Fernandez (DINAMA Director of Environment Division). Current World Bank project in Uruguay focused on agriculture (corn, wheat) and water quality (chlorophyll, TSM). A telecon was held on July 31 to discuss needs and capacity. Developed a sample cube over the Paso Severino reservoir. Uruguay provided sample water quality validation data

			on 29-Aug-17. NASA GSFC (Nima Pahlevan) provided support for water sampling and satellite data validation approaches.
Under Review	Ukraine	UN Environment and GRID-Geneva	April 2018: Contacted by Professor Nataliia Kussul from Space Research Institute of Ukraine. Nataliia Kussul is also talking with Greg Giuliani (Swiss Data Cube) about their experiences. Possible follow-on capacity building project, supported by the Swiss Data Cube team at UN-GRID Geneva.
Under Review	Mexico	CONABIO	Nov 2018: USGS is preparing 113,000 archive Landsat scenes for all of Mexico. The data will be delivered by the end of 2018 and they will be trained to ingest the data into a cube, connect a UI and run Python notebooks. August 2018: GA has been hosting 5 staff from the Mexico's INEGI to support them in building their capacity to establish and run their own operational Open Data Cube. They are installing a new large computing system that will host the cube. July 2018: GA is preparing to host a delegation of developers for four weeks from INEGI in Mexico to help them establish an operational ODC deployment. This will likely include a workshop with the Australian Bureau of Statistics on approaches to environmental-economic accounting. April 2018: Andrés López Román from the Vice-Presidency of Geographic Information, Environment, Territorial Planning of INEGI in Mexico contacted the IDEAM team (Colombia) for advice regarding the Data Cube. The Mexican government and AMEXCID (their international development agency) sponsored CSIRO and Colombia to visit in Nov 2017 for a workshop on biodiversity and DataCubes at CONABIO in Mexico City. CONABIO is migrating data and much of their mapping programs to AWS platforms for cost-savings reasons, and want to work with us on the AWS implementation of the DataCube. There have also been past discussions with the Mexico regarding the "MadMex" ecosystem and land use mapping efforts.

Under Review	India	ISRO	Contacted by Senthil Kumar (WGCapD) about building capacity in India for a Data Cube. ISRO presented their Data Cube progress at APRSAF (Nov 2017). They have developed ingestors for several datasets (e.g. ResourceSat) and have been testing preliminary products. Discussed status with Dr. Bimal K Bhattacharya at the LSI-VC meeting (Feb 2018). He suggested the primary ISRO data cube contact is Debojyoti Dhar.
Under Review	Albania and Greece (Balkans)	i-BEC	Working with George Zalidis (i-BEC) on several potential funding opportunities for a Balkans Data Cube. The 1st Rountable Meeting was on June 17, 2018 to explore options for a Balkans Data Cube. This followed with a proposal to World Bank for a UNSDG project that uses Data Cubes.
Under Review	Peru	World Bank	Discussing options with Habab Taifour (WB) as she is starting a new water management project in Peru in mid-2017.
Under Review	Guatemala	Research and Outreach Institute on the Environment and Society (IARNA)	May 2019: Contacted by Hector Tuy to begin work on a data cube. Also interested in moving toward a larger regional Mesoamerica or Latin cube. Nov 2018: Contacted by Hector Tuy. He is the former director of the Research and Outreach Institute on the Environment and Society (IARNA) of Universidad Rafael Landívar (URL), and editor of the Environment Profile of Guatemala. He is interested in the environmental and social impact of palm oil expansion in Guatemala (land use change), and in the 4 major lakes and rivers in the country. He proposes to manage a cube at IARNA along with several computer science students. They are interested in deforestation, land change, water and urbanization.
Under Review	Honduras	Honduras Forest Institute, Environmental Ministry of Honduras	Met with Hector Lagos Matute and Gerson Perdomo at the 2017 GFOI meeting in Colombia. They are also involved with the DEVELOP project thru Univ of Georgia. Suggested as a potential capacity building project by Taiwan through their Aid Agency, the International Cooperation and Development Fund (ICDF). Recent connection (Dec 2017) through the Colombia IDEAM team to Romel Sarmiento from the Environmental Ministry of Honduras.
Under Review	Canada	CSA and Agri-Food Canada	Working with Yves Crevier (CSA) and Ian Jarvis (Agri-Food Canada) to investigate approaches for a Canada cube to support JECAM and a CSA project on Climate Change and Ecosystem Resiliance (5 small distributed projects). They would like to use a computing system at Carlton Univ. Lab

			(in Ottowa) to host the cube. They are also working with Mike Holder (Landsat Science Team).
Under Review	Chile	National Fisheries Agency (Servicio Nacional de Pesca y Acuacultura)	Preliminary discussions coordinated by Alex Held (CSIRO)
Under Review	United Arab Emerites (UAE)	Mohamed Bin Rashed Space Centre	Preliminary discussions coordinated by Alex Held (CSIRO). Additional interest expressed at the CEOS Plenary in Nov 2018 as the UAE Space Agency joined CEOS.
Under Review	Vanuatu, Solomon Islands, Fiji (3 countries)	U.K. Catapult. U.K Government, UNOSAT, UNEP-GRID Geneva	Coordinated by Dan Wicks (U.K. Catapult). They are considering a U.K. IPP proposal focused on capacity building for developing countries and believe a Data Cube will be a good approach. The proposed CommonSensing project is to improve resilience towards climate change to start in Q1 2018. UNEP GRID Geneva also involved in the project.
Under Review	Samoa	CSIRO	Contacted by Neil Sims (CSRIO) about creating a Data Cube for Samoa to support SDG Indicator 15.3.1 (Land Degradation). They are currently working with Conservation International and using coarse resolution AVHRR and MODIS datasets (from Google Earth Engine) and the TREND.EARTH tool. A Samoa Cube was created in August 2018 and used for demonstration.
Under Review	Bangladesh	Bangladesh Agricultural Research Institute (BARI)	Jorge Pena and Juan Gerschman (CSIRO) have a 3-year project in Bangladesh around water management for agriculture (rice) in the NW region. Mainuddin Mohammed (Project Leader) and Mahboob Golam (Activity Leader) at the Bangladesh Agricultural Research Institute (BARI) are key contacts. They desire to create classification maps (via Random Forest Classifier) and Evapotransporation (ET) maps to feed their models for agriculture yield. Investigating a local or AWS deployment and also discussing options with SERVIR-Himilaya.
Under Review	Japan	Remote Sensing Technology Center of Japan (RESTEC),	Feb 2018: Meeting at JAXA to discuss plans for a Data Cube and potential support from RESTEC. Dec 2017: Michihiro Koide (RESTEC) contacted GA and CSIRO for support to develop a Data Cube to support rice monitoring and their INAHOR algorithm. They are planning to ingest S1 and ALOS-2 data, write a Jupyter notebook for rice mapping using SAR data, and create a UI to connect to the cube.

Under Review	New Zealand	Centre for Space Science Technology (CSST)	Approached CSIRO (Alex Held and Rob Woodcock) about the Data Cube. They are interested in hosting a system (Kiwi Cube) that is similar to Australia and includes a government element and a commercial element, similar to the CSIRO Industry Hub.
Under Review	Panama	United Nations (Panama External Relations)	Contacted by Juliette Chevalier from the United Nations. She expressed an interest in Data Cubes to support Panama applications.
Under Review	South Africa	SANSA (South African National Space Agency)	April 2018: Contacted by Paida Mangara (Manager: Research and Applications Development; pmangara@sansa.org.za) Nov 2017: Conducted a telecon with Clement Adjorlolo (SANSA). They would like to use Landsat, Sentinel 1/2/3, CBERS and SPOT to run applications (urbanization, human settlements, rangelands, forestry, water, land use change). The Data Cube would be installed on their local SANSA computing system (2 PB storage) and will be supported by a software team. Also contacted by Abel Ramoelo (CSIR Research Scientist) as he is interested in Kruger National Park biomass estimates. Mid 2016: Contacted by Clement Adjorlolo (SANSA) and Francesco Fava (ILRI) about a Data Cube to support rangelands (GEOGLAM RAPP test site).
Under Review	Brazil	INPE	INPE is working with BNDES (Brazil Bank) to use funds from their Amazonia Project (payments for deforestation program) to develop a Data Cube project with CBERS and other datasets to support the Brazil Biome monitoring program.
Under Review	Sri Lanka	Sri Lanka Department of Irrigation, International Water Management Institute (IMWI)	Aug 2018: David Wiberg and Claudia Sadoff (IMWI) have been in contact with GA about using a Data Cube to support water security in Africa and Asia.
Under Review	Philippines	TBD	Contacted by Shin-ichi Sobue (JAXA) about supporting a Data Cube for Philipinnes. JAXA is planning to supply ALOS PALSAR ScanSAR 50m data to them and would prefer to use a Data Cube that is consistent with the Japan and Vietnam methods.

Under Review	Malaysia	TBD	Contacted Alex Held (CSIRO). Interested in the region of Sarawak where the local government is keen to modernise the way the use EO and other geospatial data.
Under Review	Costa Rica	TBD	The FAO representative for Costa Rica (Carla Ramires) Contacted IDEAM about a Data Cube for Land Use and Land Cover
Under Review	Indonesia	LAPAN-National Institute of Aeronautics and Space	July 2018: CSIRO and GA are developing a joint proposal for support of establishment of ODC infrastructure and key coastal monitoring and 'blue carbon' applications with LAPAN and environment ministry. 2017: Connected via Barb Ryan (GEO) to Dr. Yudi Setiawan, Department of Forest Resources Conservation and Ecotourism, Faculty of Forestry, Bogor Agricultural University.
Under Review	Togo, Benin (2 countries)	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH	Contacted by Olga Weigel (GIZ, Germany) about a data cube for Togo and Benin to monitoring of the Mono Biosphere Reserve in Benin/ Togo in the coastal area.
Under Review	Syria	Univ. of Salzberg and Italian Space Agency (ASI)	Paper by Hannah Augustin (Univ of Salzberg) describes plans to use S2 data and the ODC framework for monitoring the Syria-Turkey border. This research was supported by the Austrian Federal Ministry of Transport, Innovation and Technology (BMVIT) under the programme 'ICT of the Future' within the project SemEO.
Under Review	Pakistan	Space and Upper Atmosphere Research Commission of Pakistan (SUPARCO)	July 2018 via CSIRO: New discussions underway with SUPARCO around potential collaboration and training on establishment of an ODC there.
Under Review	Germany	DLR	July 2018: Matt Paget (CSIRO) gave a briefing to the remote sensing group at DLR in Oberpfaffenhofen (near Munich), with discussions ongoing on implementation of a trial ODC.
Under Review	Sweden	Swedish National Space Agency	March 2019: The Swedish National Space Agency will implement an Open Data Cube over Southern Sweden to explore that capacity for EO analysis and Climate Change Adaptation.

Under Review	Argentina	???	Contacted via email by Pedro Luiz.