

Manaus

Belém

São Luís

Fortaleza

Teresina

**BRAZIL**

Salvador

**BOLIVIA**

Brasília

Goiânia

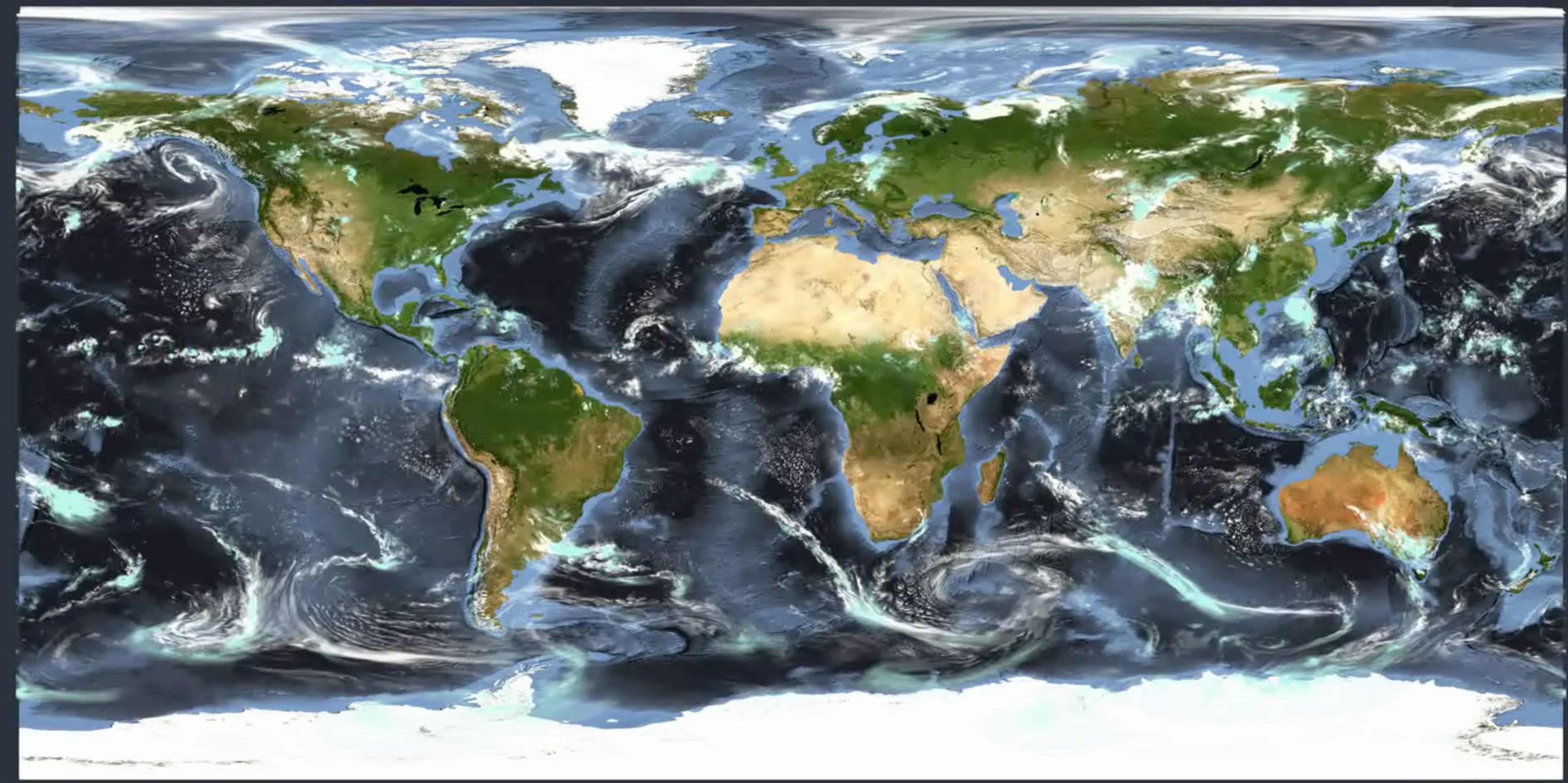
Belo Horizonte

Vitória

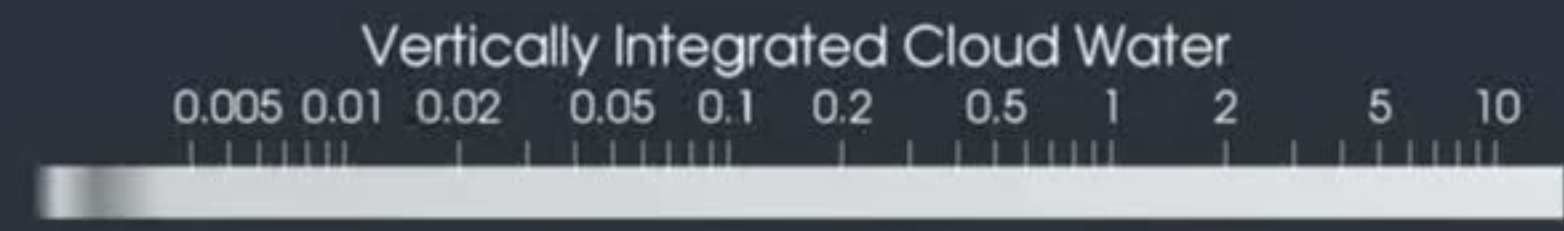
Campo Grande

Cochabamba

Sucre



ICON DYAMOND R2B10 2.5km Resolution  
01.08.2016 at 00:00

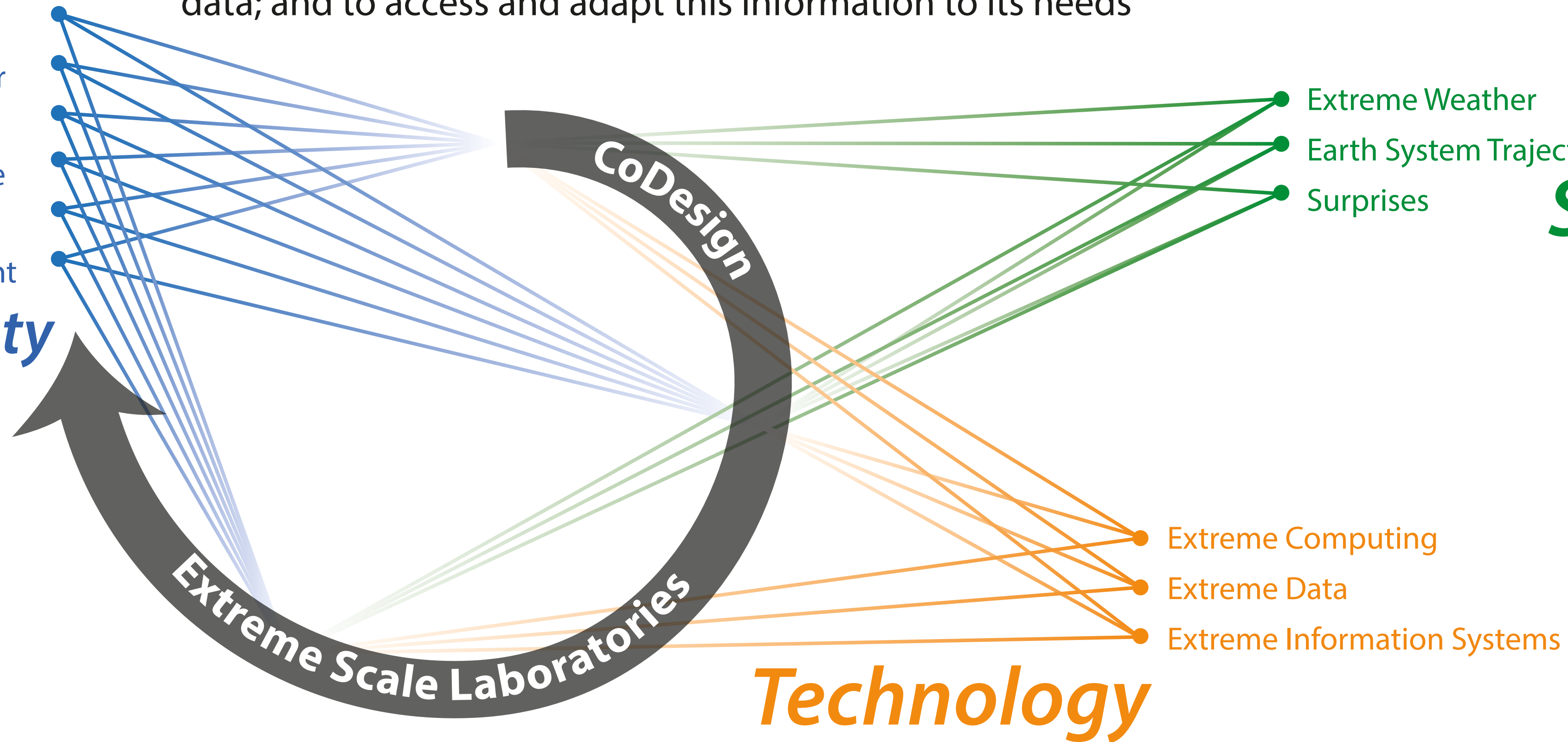


# Extreme Earth

**ExtremeEarth:** Co-designing the technological transformation necessary for step changes in the ability of European society to anticipate weather and climate extremes,, to collect and integrate Earth system data; and to access and adapt this information to its needs

- Critical Infrastructure
- Hydrology and Water
- Energy
- Food and Agriculture
- Health
- Disaster Management

**Society**



- Extreme Weather
- Earth System Trajectories
- Surprises

**Science**

- Extreme Computing
- Extreme Data
- Extreme Information Systems

**Technology**

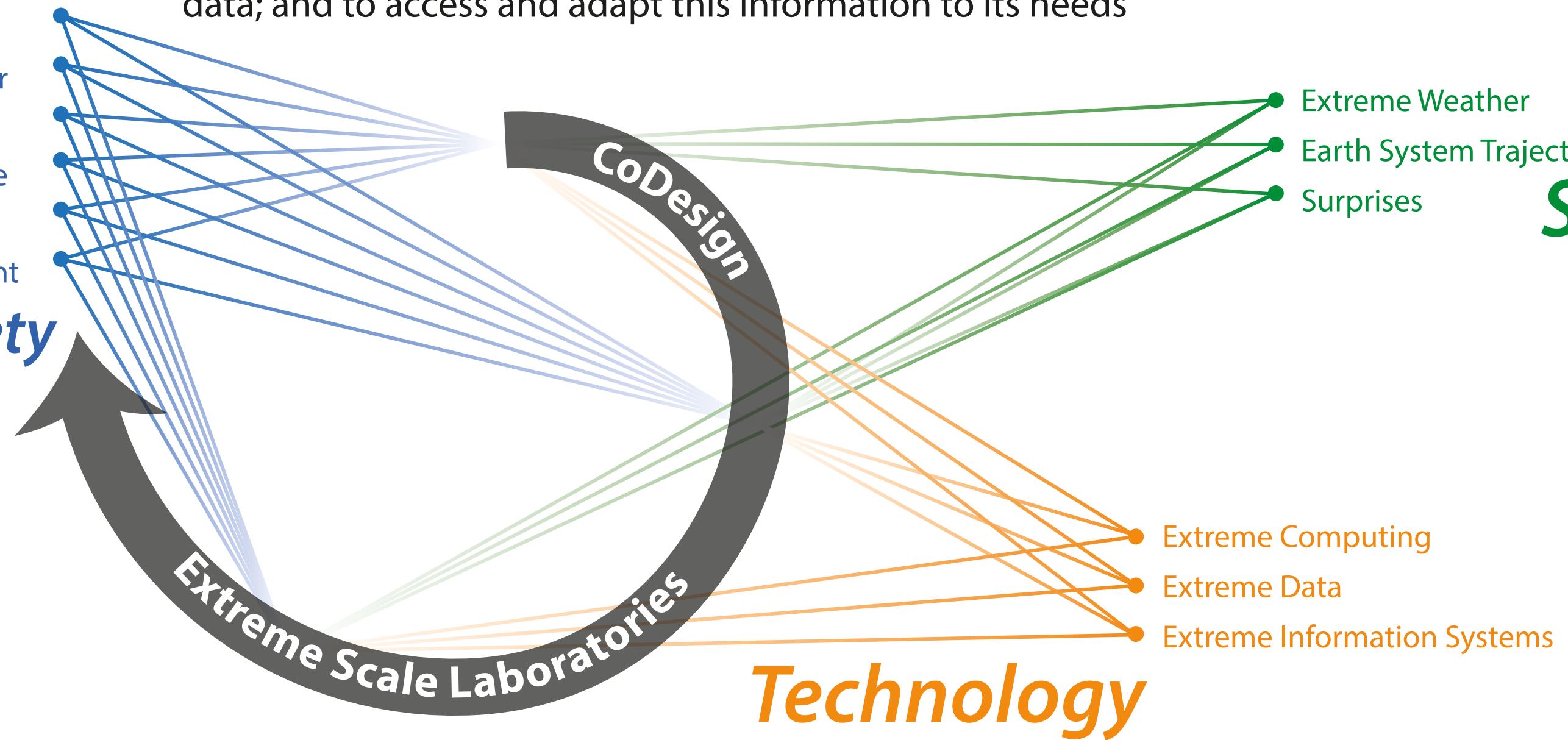
# Extreme Earth

**Key Objective 1:** Step-change in our ability to simulate and predict climate trajectories

**ExtremeEarth:** Co-designing the technological transformation necessary for step changes in the ability of European society to anticipate weather and climate extremes,, to collect and integrate Earth system data; and to access and adapt this information to its needs

Critical Infrastructure  
Hydrology and Water  
Energy  
Food and Agriculture  
Health  
Disaster Management

**Society**



**Science**

**Key Objective 3:** Step change in our ability to link fundamentally new capabilities for simulating and predicting extremes along with their impacts across value chains and render such services accessible to all communities.

**Key Objective 2:** Step-change in our ability to fuse observational information with models for a wholly new view on the Earth system.

# From Extreme Earth to Digital Twins

## Digital twin

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From Wikipedia, the free encyclopedia

A **digital twin** is a digital replica of a living or non-living physical entity.<sup>[1]</sup> Digital twin refers to a digital replica of potential and actual physical assets ([physical twin](#)), processes, people, places, systems and devices that can be used for various purposes.<sup>[2]</sup> The digital representation provides both the elements and the dynamics of how an [Internet of things](#) device operates and lives throughout its life cycle.<sup>[3]</sup> Definitions of digital twin technology used in prior research emphasize two important characteristics. Firstly, each definition emphasizes the connection between the physical model and the corresponding virtual model or virtual counterpart.<sup>[4]</sup> Secondly, this connection is established by generating real time data using sensors.<sup>[5]</sup> The concept of the digital twin can be compared to other concepts such as cross-reality environments or co-spaces and mirror models, which aim to, by and large, synchronise part of the physical world (e.g., an object or place) with its cyber representation (which can be an abstraction of some aspects of the physical world).<sup>[6][7]</sup>

Digital twins integrate [internet of things](#), [artificial intelligence](#), [machine learning](#) and [software analytics](#) with [spatial network](#) graphs<sup>[8]</sup> to create living digital [simulation](#) models that update and change as their physical counterparts change. A digital twin continuously learns and updates itself from multiple sources to represent its near real-time status, working condition or position. This learning system, learns from itself, using [sensor](#) data that conveys various aspects of its operating condition; from human experts, such as engineers with deep and relevant industry [domain knowledge](#); from other similar machines; from other similar fleets of machines; and from the larger systems and environment of which it may be a part. A digital twin also integrates historical data from past machine usage to factor into its digital model.

In various industrial sectors, twins are being used to optimize the operation and maintenance of physical assets, systems and manufacturing processes.<sup>[9]</sup> They are a formative technology for the Industrial Internet of things, where physical objects can live and interact with other machines and people virtually.<sup>[10]</sup> In the context of the Internet of things, they are also referred to as "cyberobjects", or "digital avatars".<sup>[11]</sup> The digital twin is also a component of [cyber-physical systems](#).

# The Digital Continuum will be essential for Destination Earth

## Communications 19/02/2020:



Brussels, 19.2.2020  
COM(2020) 67 final

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN  
PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL  
COMMITTEE AND THE COMMITTEE OF THE REGIONS

Shaping Europe's digital future

Brussels, 19.2.2020  
COM(2020) 66 final

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN  
PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL  
COMMITTEE AND THE COMMITTEE OF THE REGIONS

A European strategy for data

## Strategy:

- A Common European Green Deal data space, to use the major potential of data in support of the Green Deal priority actions on climate change, circular economy, zero-pollution, biodiversity, deforestation and compliance assurance. The “GreenData4All” and ‘Destination Earth’ (digital twin of the Earth) initiatives will cover concrete actions.

## Action:

- Launch the ‘Destination Earth’ initiative

*The ‘Destination Earth’ initiative will bring together European scientific and industrial excellence to develop a very high precision digital model of the Earth. This ground-breaking initiative will offer a digital modelling platform to visualize, monitor and forecast natural and human activity on the planet in support of sustainable development thus supporting Europe’s efforts for a better environment as set out in the Green Deal. The digital twin of the Earth will be constructed progressively, starting in 2021.*

## **WCRP: Digital Twins of the Earth System**

A handful of multinational (continental scale) centers designed to co-develop digital twins of the Earth systems capable of and applied to a quantification of Earth system trajectories.

Focusing efforts in such centers will be necessary for them to benefit from and stimulate technological developments (in computing, information systems, sensing and assimilation), and it will allow them to advance and expand links to applications and concentrate the critical mass necessary to address questions related to the fate of the Earth system.

Different centers, should share common elements (concept of a digital twin), but emphasize specific knowledge gaps, using the narrative of surprises and their regional context, e.g.,

- Collapse of tropical-terrestrial eco-systems (South/Central America)
- Land Ice, including permafrost and links to carbon cycle. (Europe)
- Marine eco-systems (Asia/Pacific)
- Aridity and links to human habitability (Asia/Africa)