

Earth from Space — 50 Years of Seeing and Understanding a Changing Planet

ICES Biennial Workshop VIII

29 September 2026

Geneva, Switzerland

Michael Rast

Director Earth Sciences, ISSI, Bern, CH

The Space 4.0 Era



Space 1.0

Astronomy

Since millennia



Space 2.0

Space Race

Since 1958



Space 3.0

Int. Cooperation

Since Fall of the Wall



Space 4.0

Space for
Society

Now



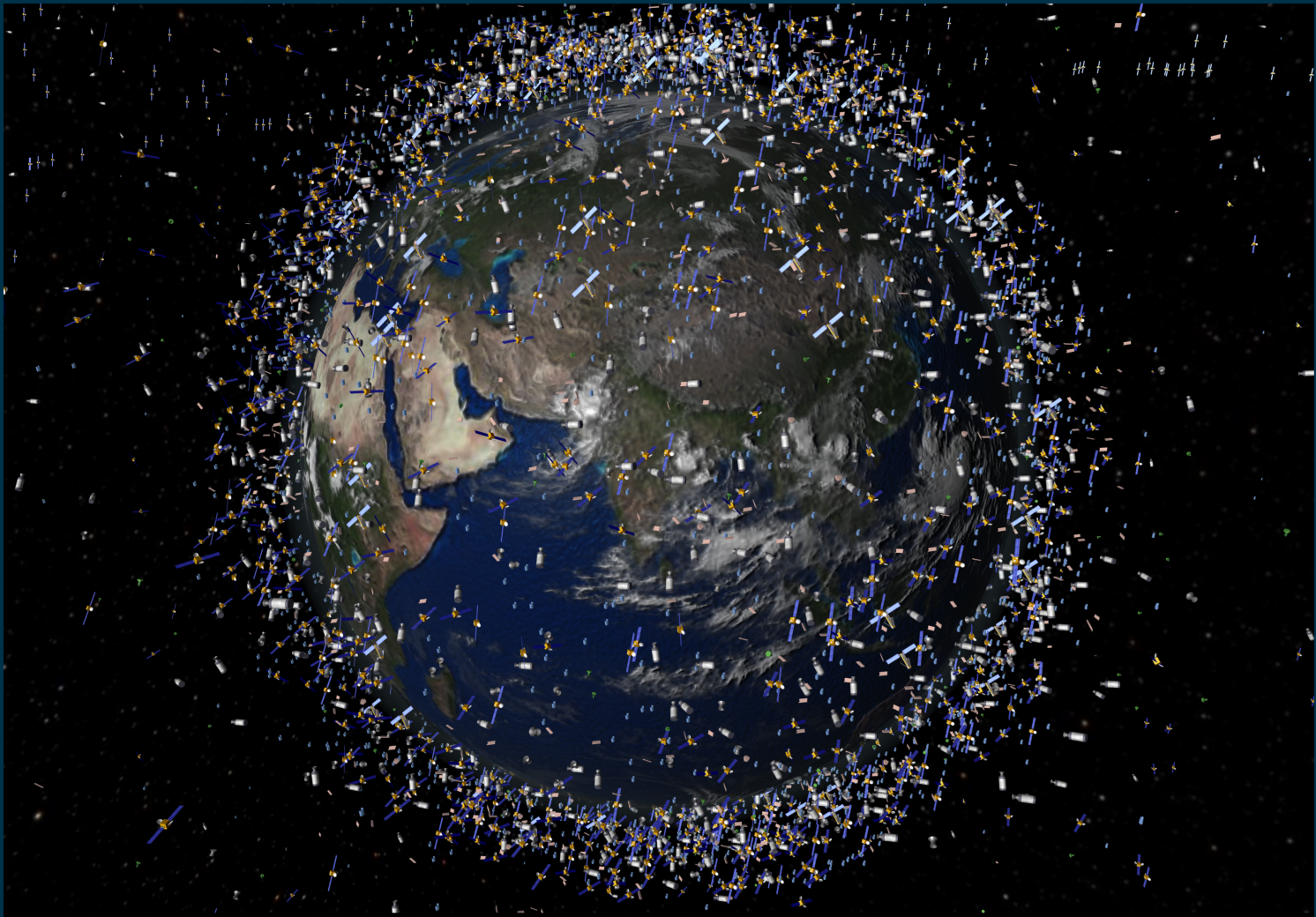
European Space Agency

First Earth observation image from Space

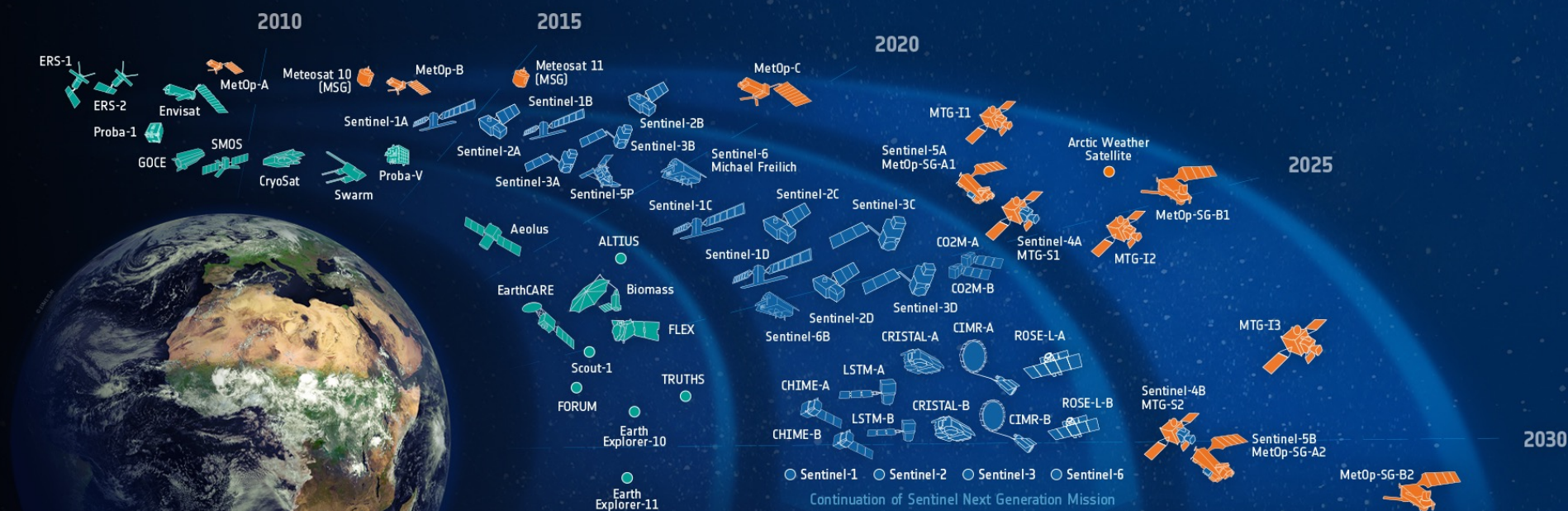
FIRST TELEVISION PICTURE FROM SPACE
TIROS I SATELLITE APRIL 1, 1960



**About
16.000
Satellites
currently,
over 600
Earth
Observation**



ESA-Developed Earth Observation Satellites



Courtesy ESA

Science



Copernicus



Meteorology

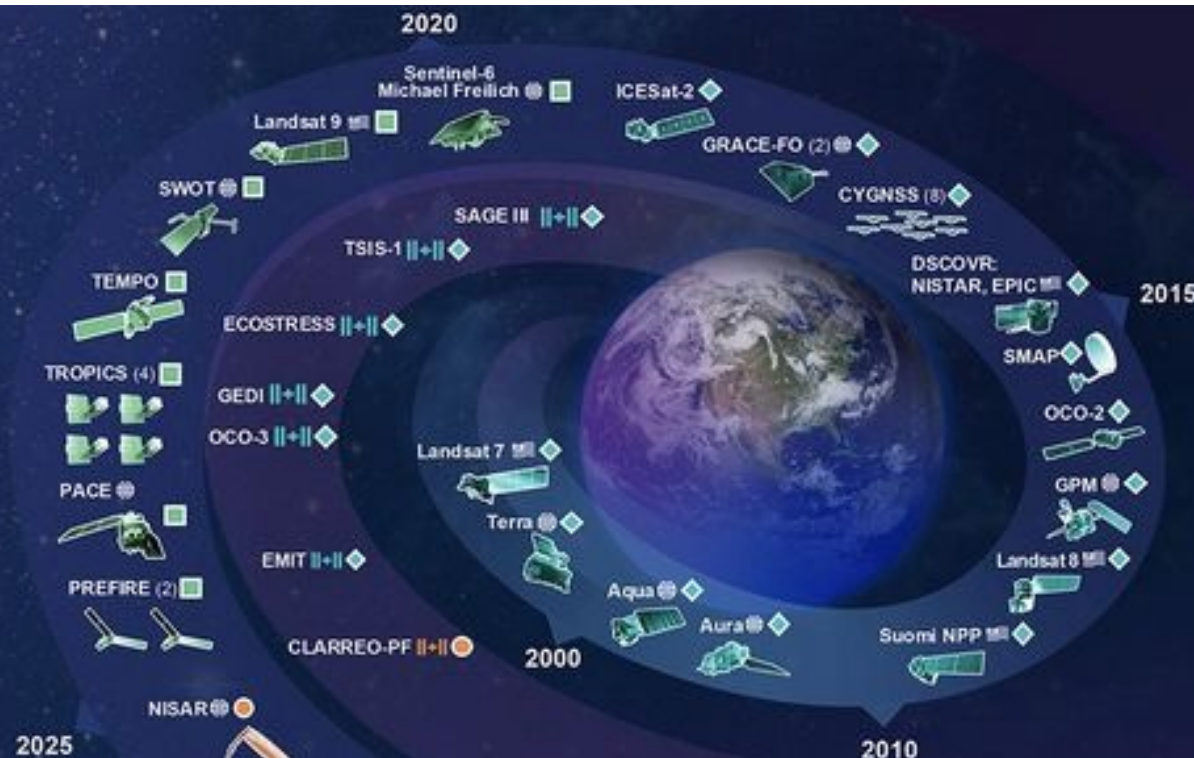


→ THE EUROPEAN SPACE AGENCY

National Aeronautics and
Space Administration



EARTH FLEET



Key

- International Partners
- U.S. Partner
- ISS Instrument
- JPSS Instrument
- Cubesat
- Launch Date TBD
- Earth System
- Observatory Mission
- (Pre) Formulation
- Implementation
- Operating
- Extended

Invest/CubeSats

- MURI-FD 2023
- SNOOPI 2024
- ARGOS* 2024
- ARCSTONE* 2025
- GRITSS* 2025
- GRATTIS* 2026

JPSS Instruments

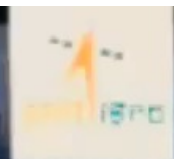
- OMPS-LIMB 2022
- LIBERA 2027
- OMPS-LIMB 2027
- OMPS-LIMB 2032

ISS INSTRUMENTS

2030

NASA
earth

10.31.2024



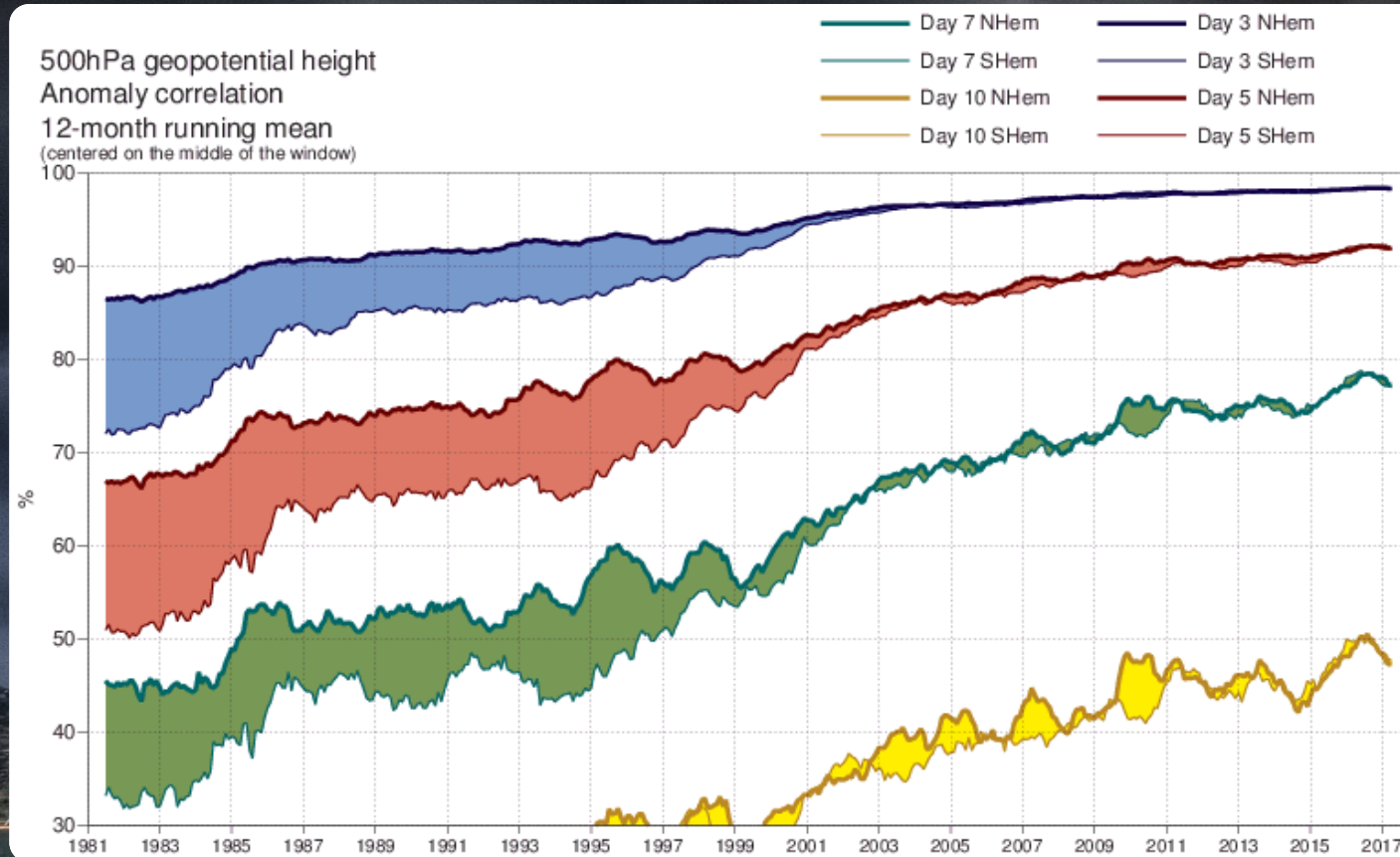
PSLV-C37 CARTOSAT 2 S MISSION

ONBOARD CAMERA

NANO SATELLITES P- SIDE SEPARATION



Increasing Forecasting Accuracy

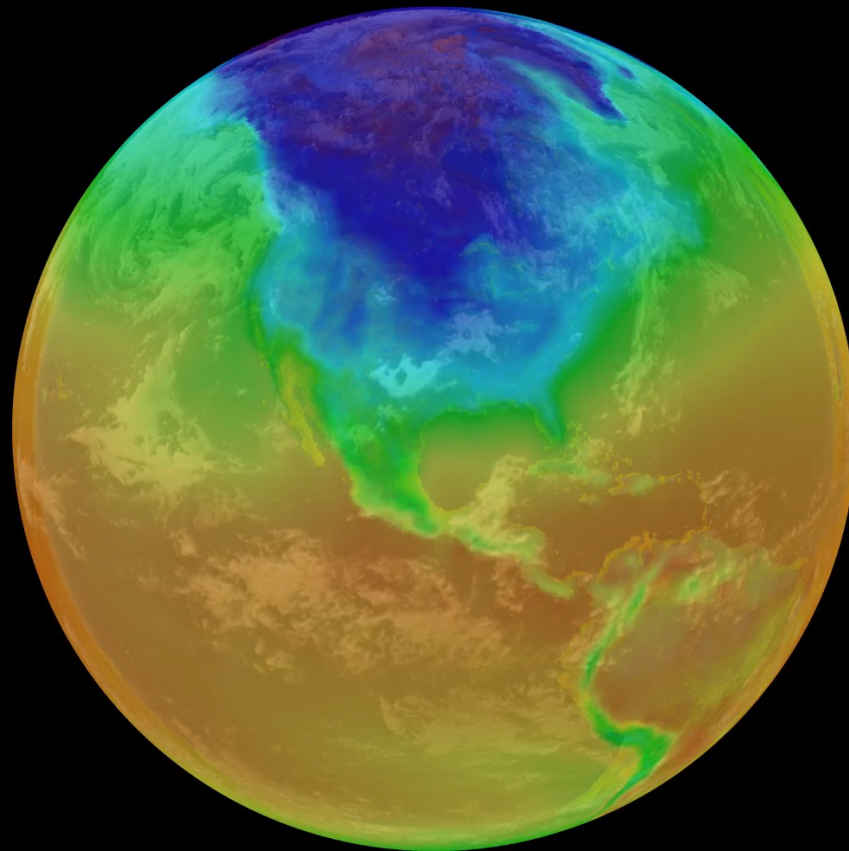


Courtesy ECMWF



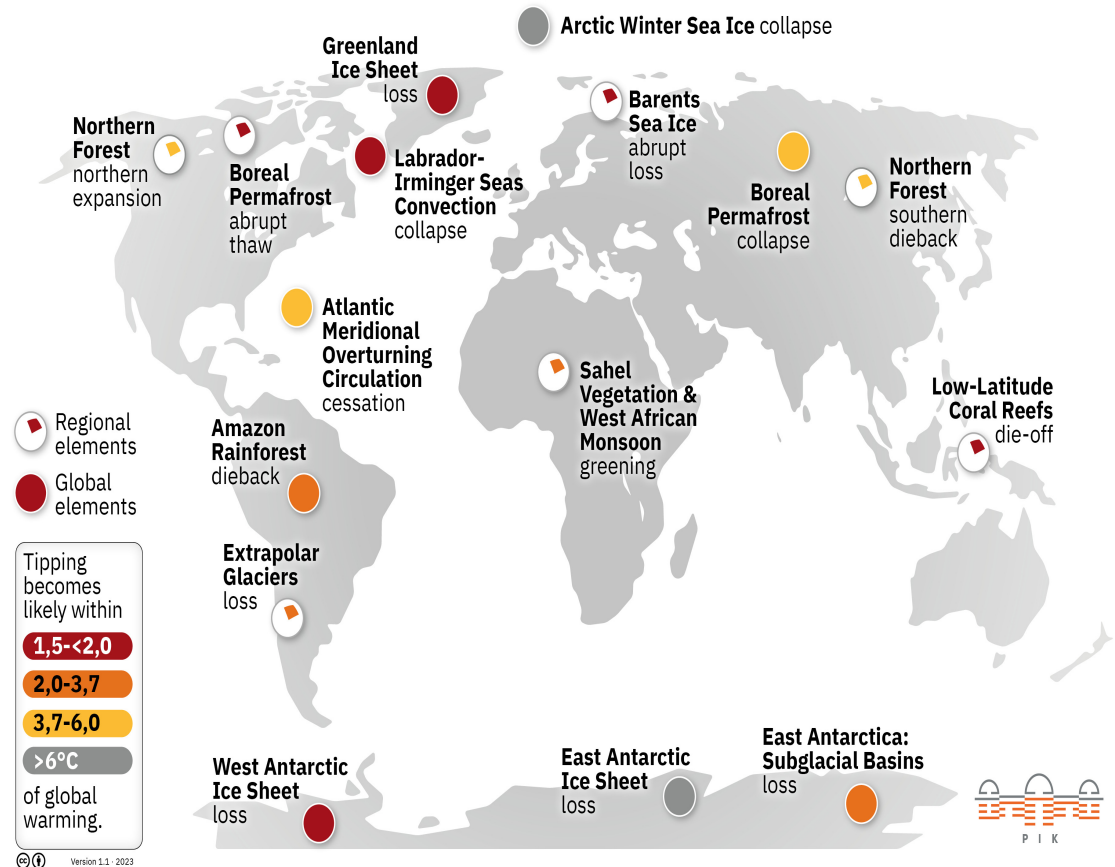
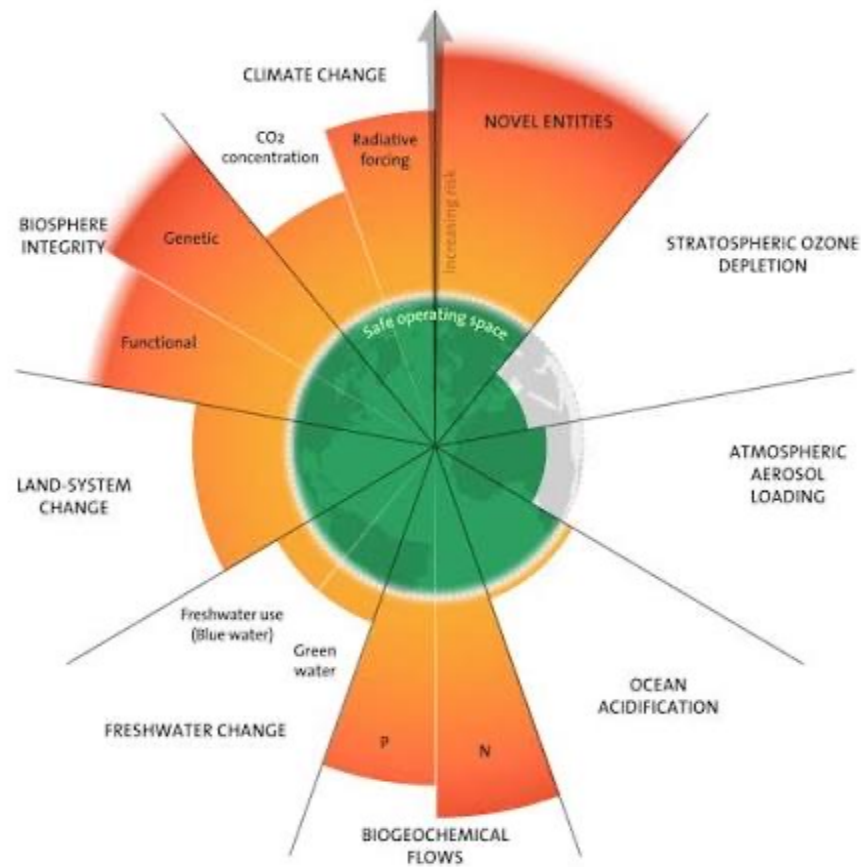
→ THE EUROPEAN SPACE AGENCY

Monitoring the Health of our Planet and ECV's



Courtesy ESA CCI

Planetary boundaries and Global Tipping Points



Rainforest Clearing

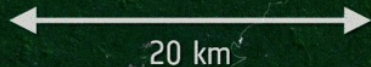
Rondonia, Brazil

Landsat 5

8 July 1989

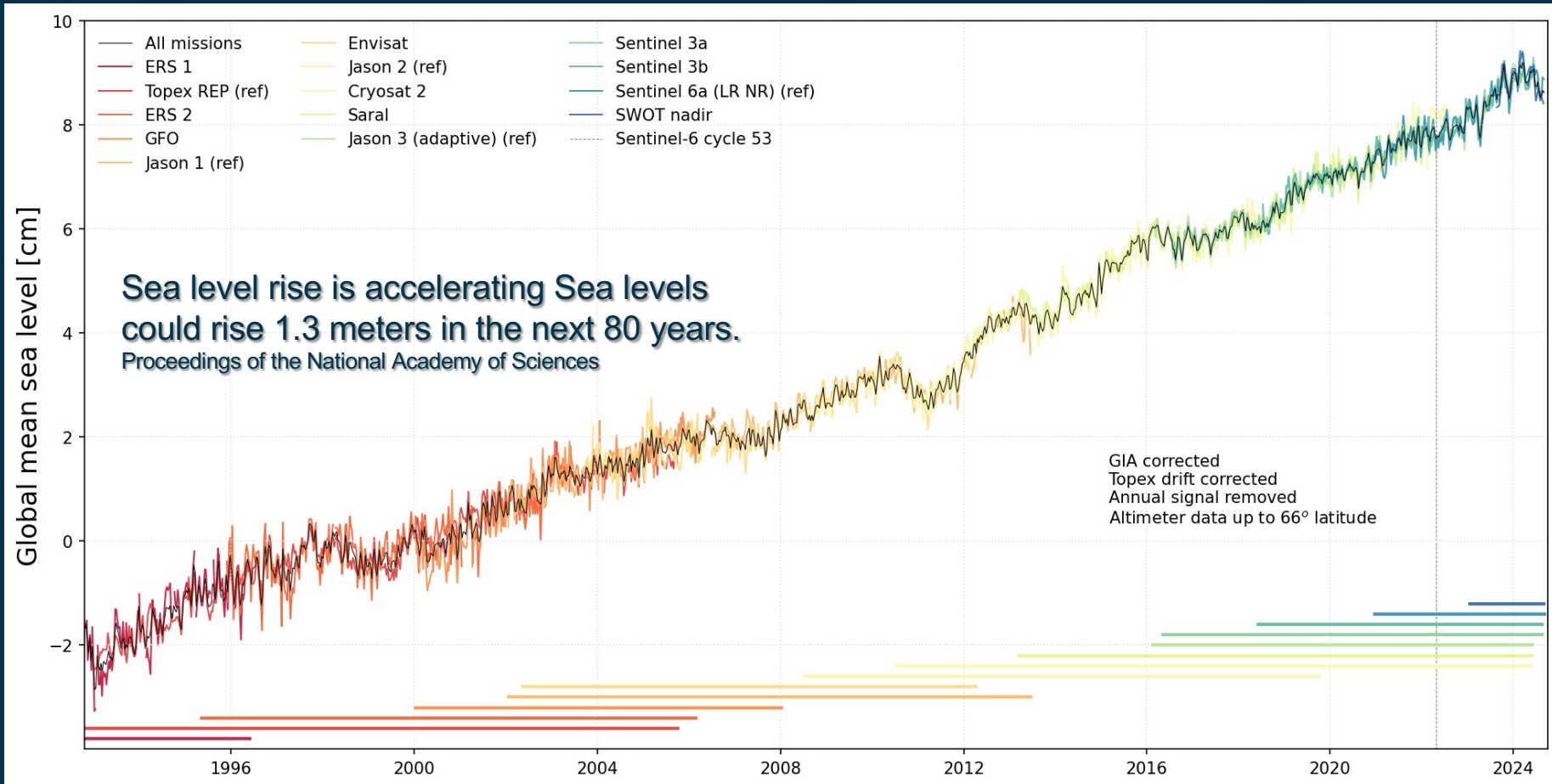


Courtesy ESA



European Space Agency

Rising Sea Levels measured by Radar Altimetry

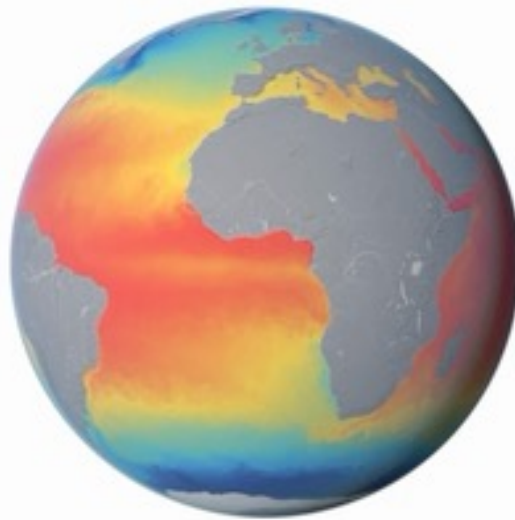
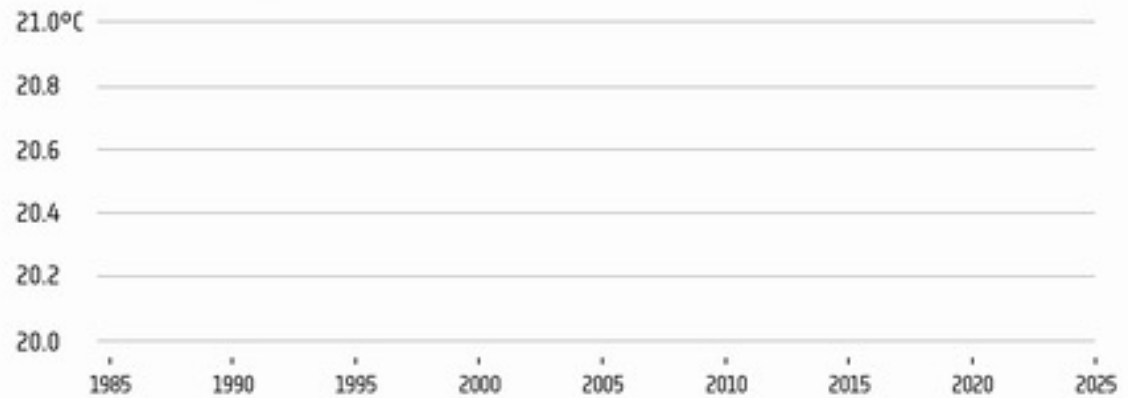




Ocean Warming Acceleration

Global Mean Sea-Surface Temperature

From ESA CCI SST v3



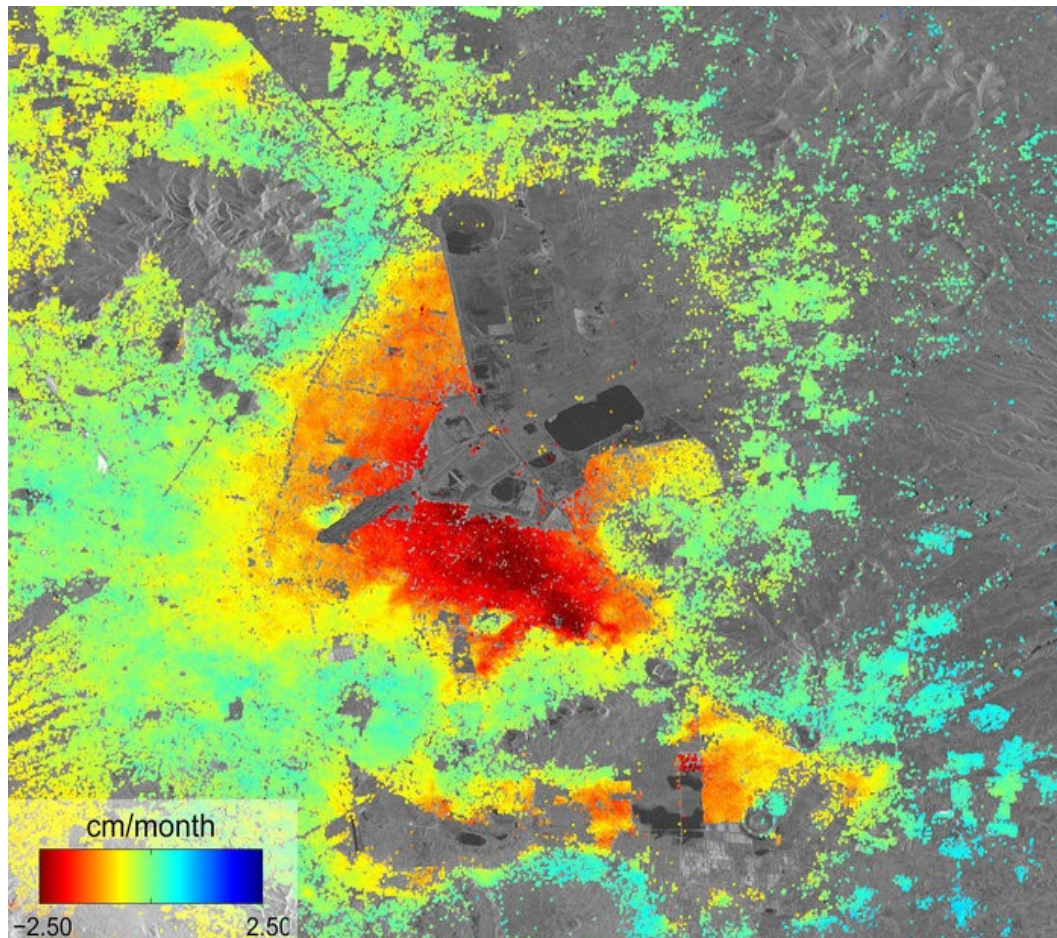
Sea-Surface Temperature
from ESA's Climate Change Initiative

-5 15 35°C

Courtesy ESA

Merchant, Allan and Embury, Environmental Research Letters (2025)

Impacts of ground water extraction



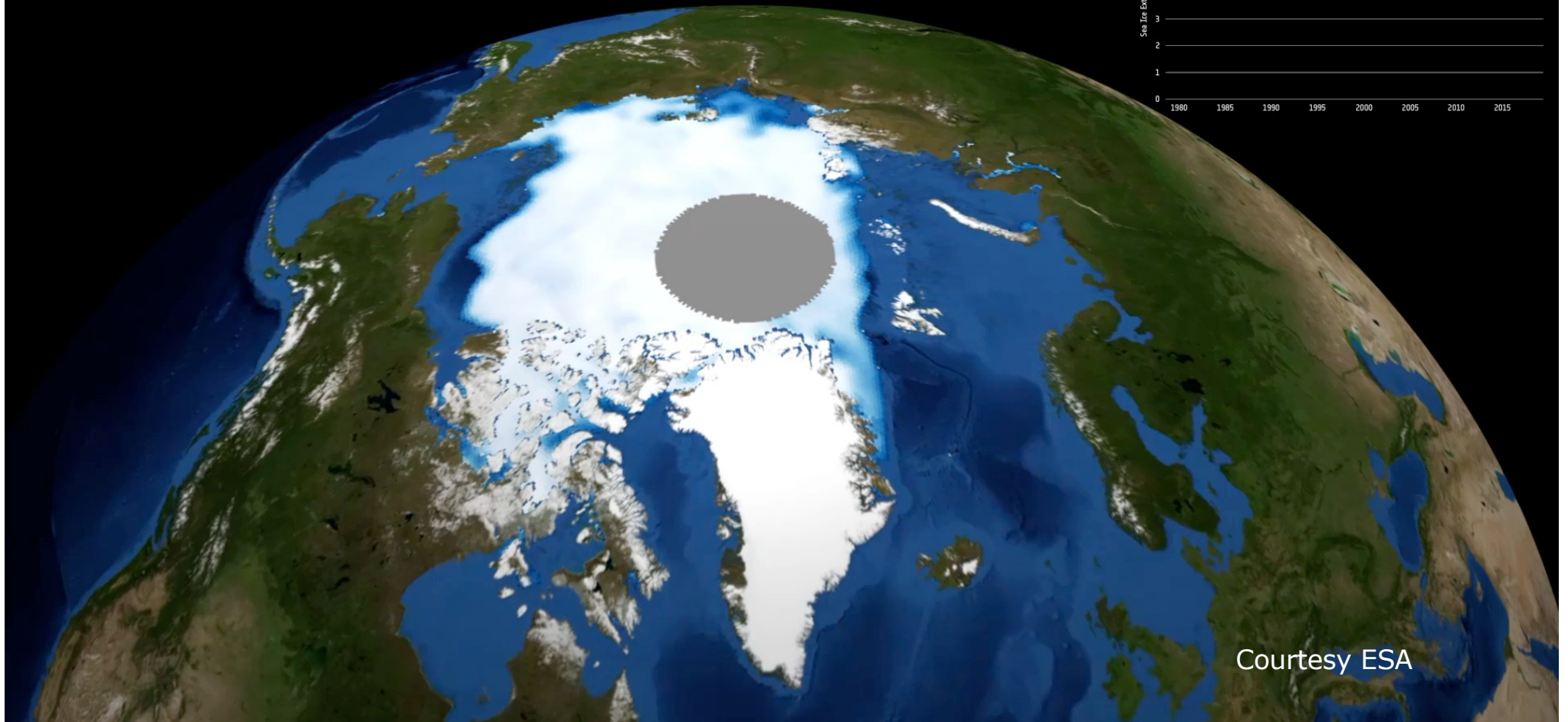
Measuring **Ground Deformation in Mexico City**

from an instrument 800 km out in space

Combining five Sentinel-1 radar scans between 3 October and 2 December 2014

Courtesy ESA

Arctic Ice Cover 1980 - 2020



Glacier Decline

Cryosat



Courtesy ESA CCI



Courtesy ESA CCI

Antarctic Ice Sheet Changes Synergy: => Sentinel-1 / Cryosat

Impact of Covid-19 Lockdown on Air Pollution

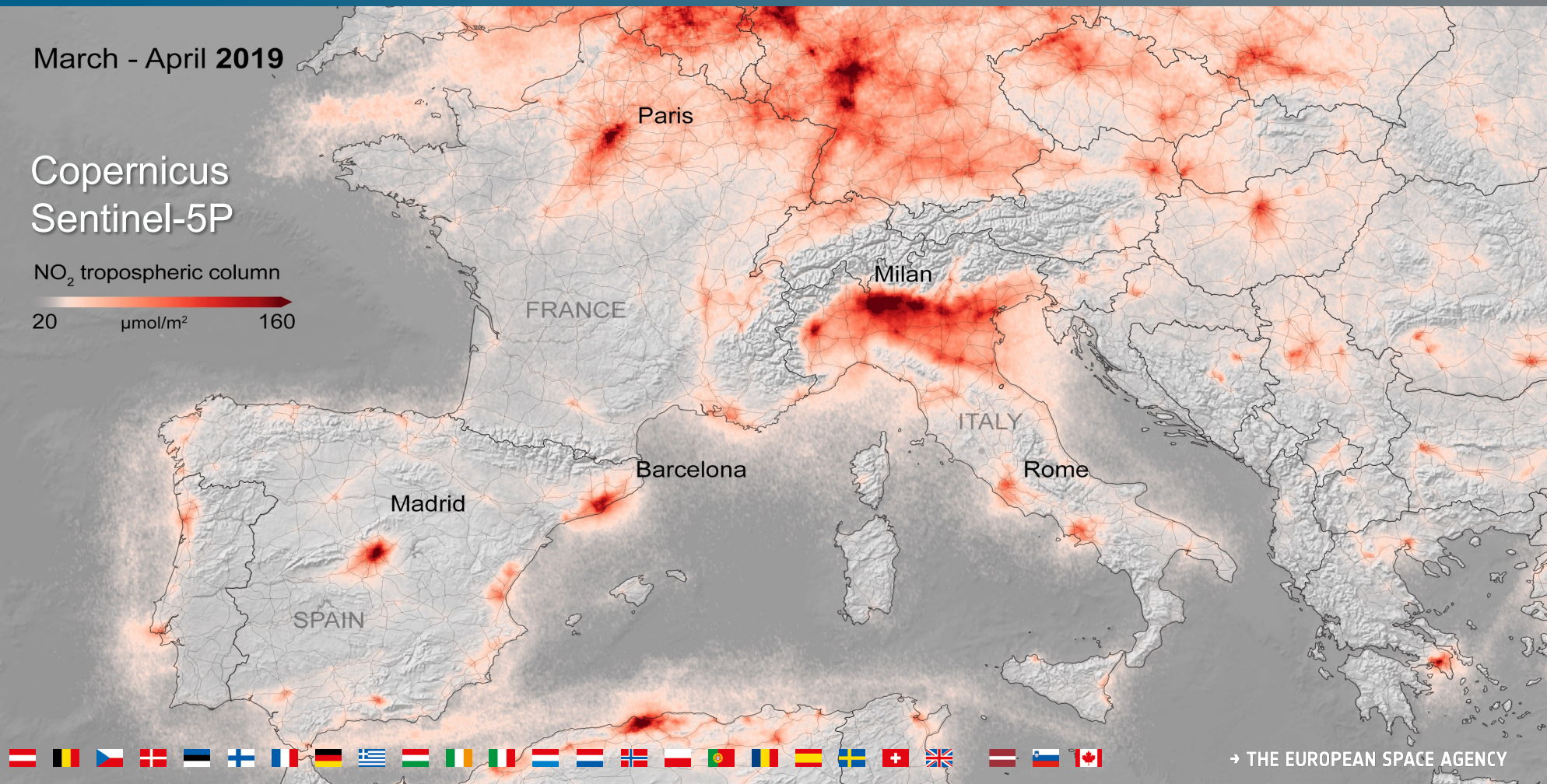


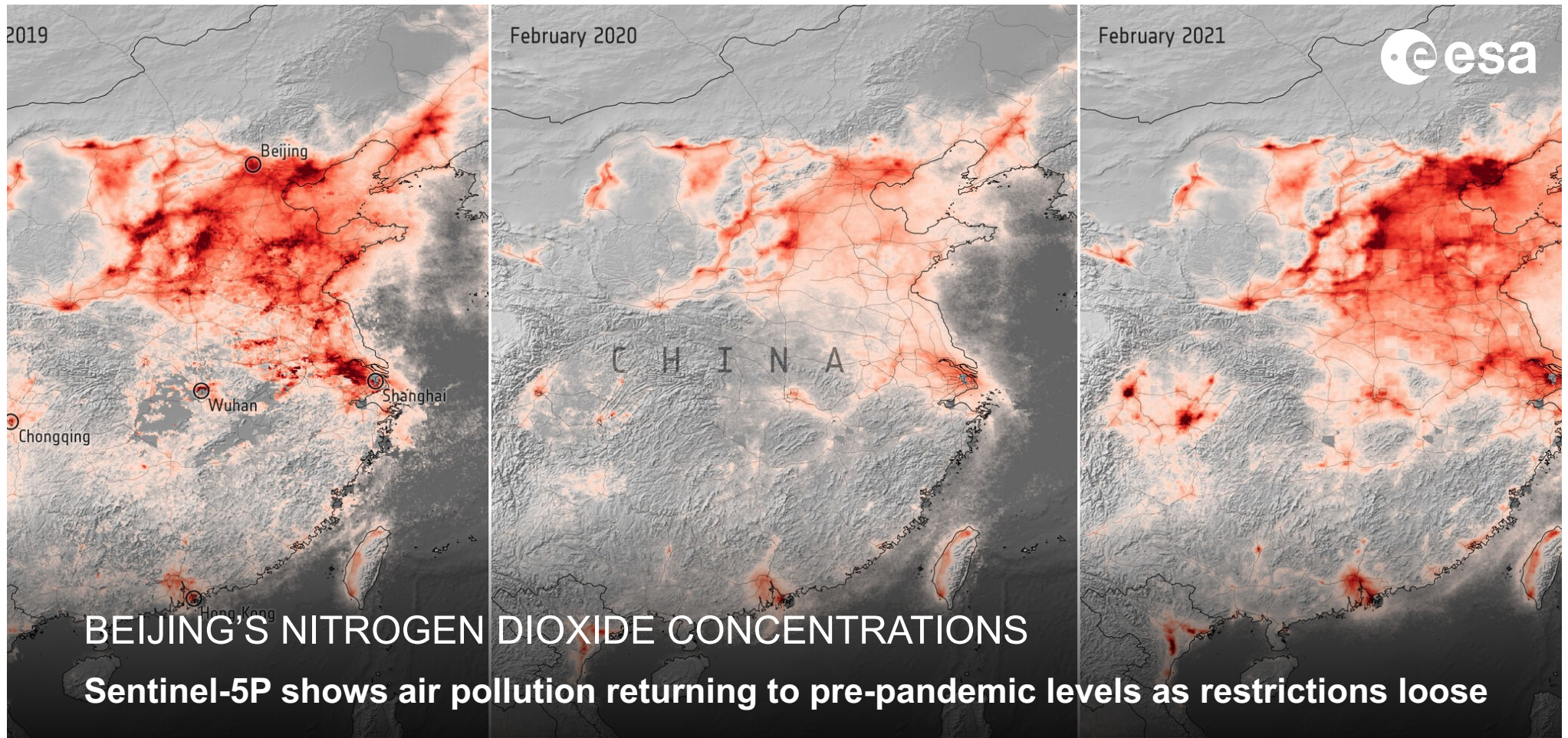
March - April 2019

Copernicus
Sentinel-5P

NO₂ tropospheric column

20 $\mu\text{mol/m}^2$ 160





Nitrogen dioxide tropospheric column

20 $\mu\text{mol}/\text{m}^2$ 250



March 16, 2021

Digital Twin Earth a science area for engagement

Observations

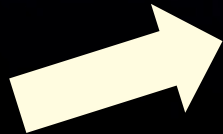
- Public
- Commercial
- NewSpace



AI



Earth System
Science



Scientific knowledge

Predictions

Simulations

Intelligent solutions



Courtesy ESA

Extreme Events



transport

precipitation

runoff

evaporation

groundwater



ESA UNCLASSIFIED – For Official Use



Source: WACMOS-MED, Estellus

European Space Agency

A possible future focus Vision for Earth Observations - integration

Exploratory Missions

Meteo Sats

Sentinels

Small Sat Constellations

HAPS

Drones

HAPS

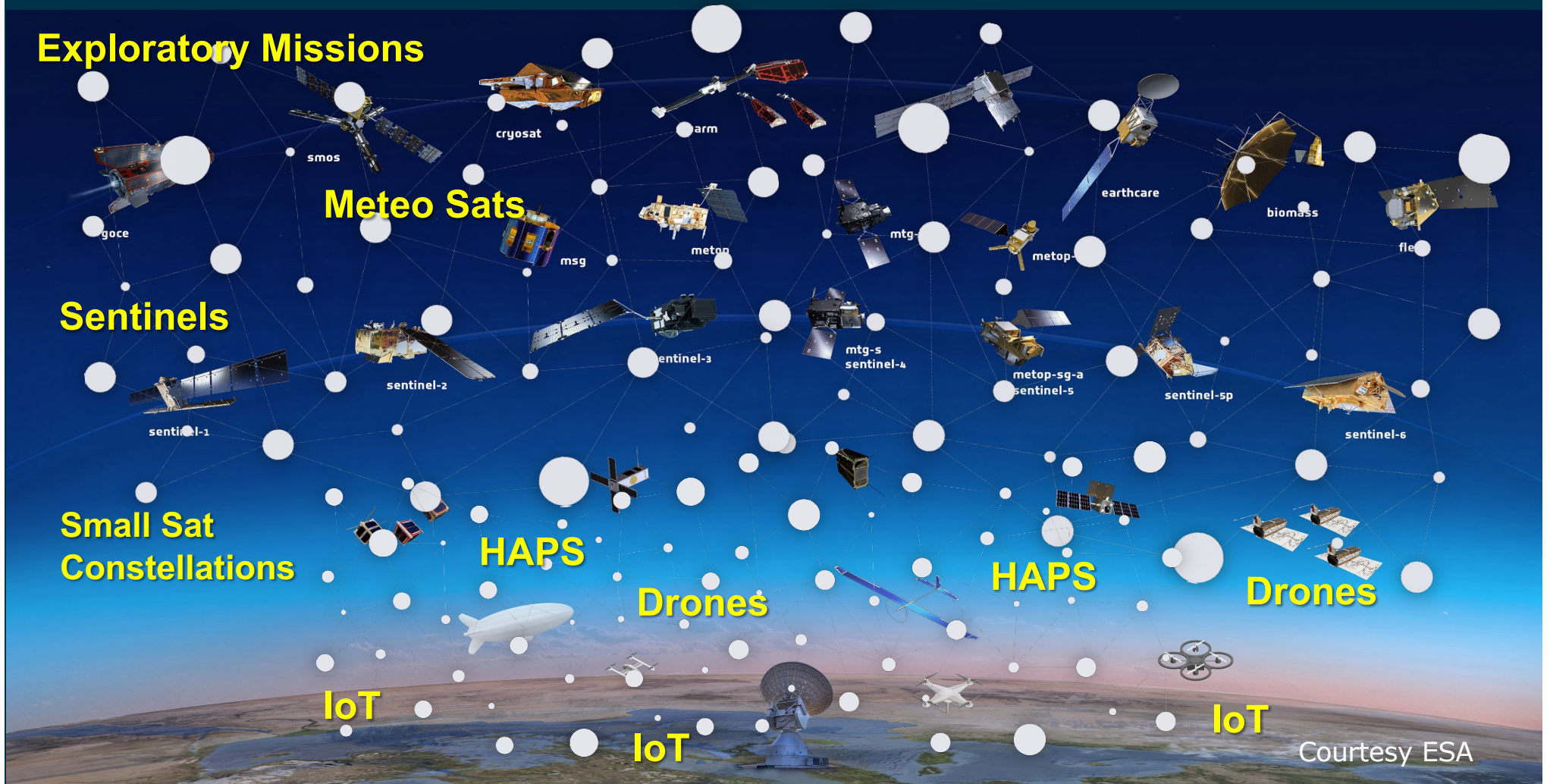
Drones

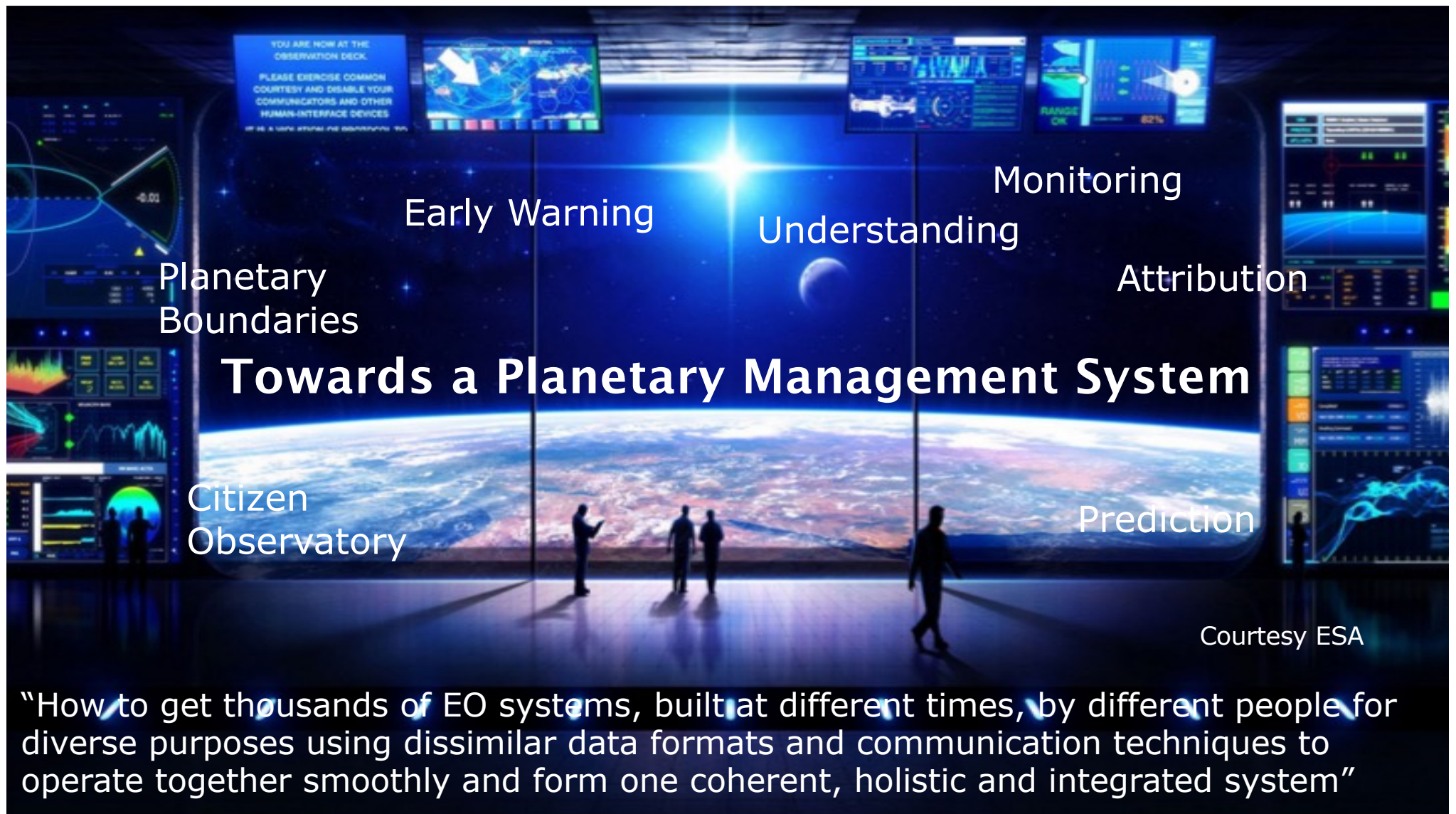
IoT

IoT

IoT

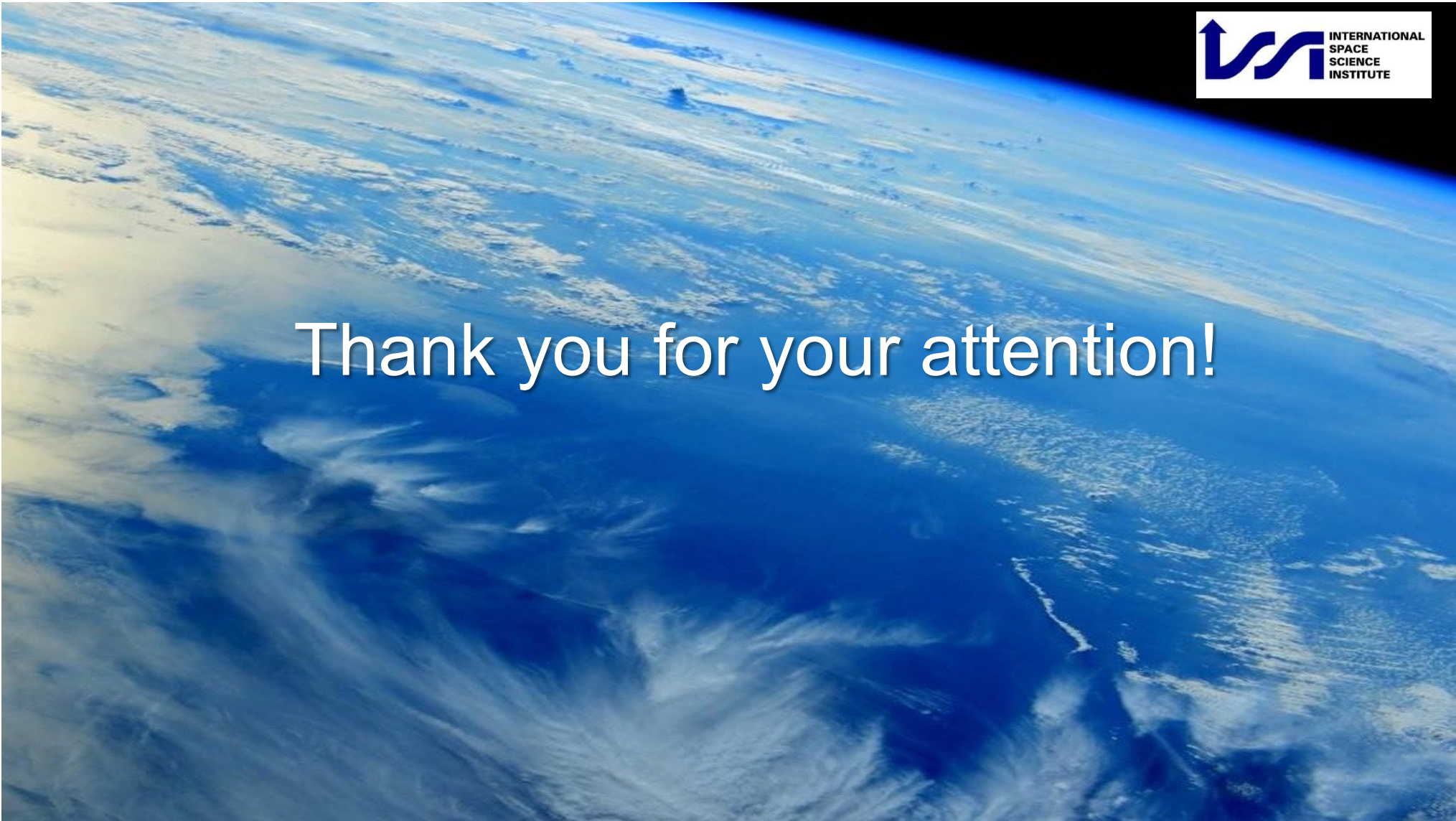
Courtesy ESA





Courtesy ESA

"How to get thousands of EO systems, built at different times, by different people for diverse purposes using dissimilar data formats and communication techniques to operate together smoothly and form one coherent, holistic and integrated system"

The background of the slide is a high-resolution photograph of Earth from space. It shows a vast expanse of blue oceans, white clouds, and a thin, dark blue line representing the Earth's atmosphere against the blackness of space. The perspective is from a high altitude, looking down at the planet's surface.

Thank you for your attention!