

L'espace au service du climat

Vers une Planète Sous Surveillance : Le Rôle Émergent des Nano-Satellites



Introduction

□ Space for Climate Action

- **A Global Challenge:**
The climate crisis requires innovative tools to monitor, understand, and mitigate its effects.
- **The Role of Satellites:**
Satellites enable continuous, global observation of Earth, providing critical data for:
 - Monitoring greenhouse gases (CO₂, CH₄, etc.).
 - Predicting extreme weather events.
 - Analyzing changes in ecosystems and oceans.
- **The Small Satellite Revolution:**
With reduced costs and increased flexibility, nanosatellites and microsatellites make these observations more frequent and accessible.

Introduction

□ Nano-Satellites: A New Era for Earth Monitoring

▪ **Why Nano-Satellites?**

- Lower costs and rapid deployment.
- Adaptability for specific scientific missions.
- Capability to operate in constellations, enabling near real-time global coverage.

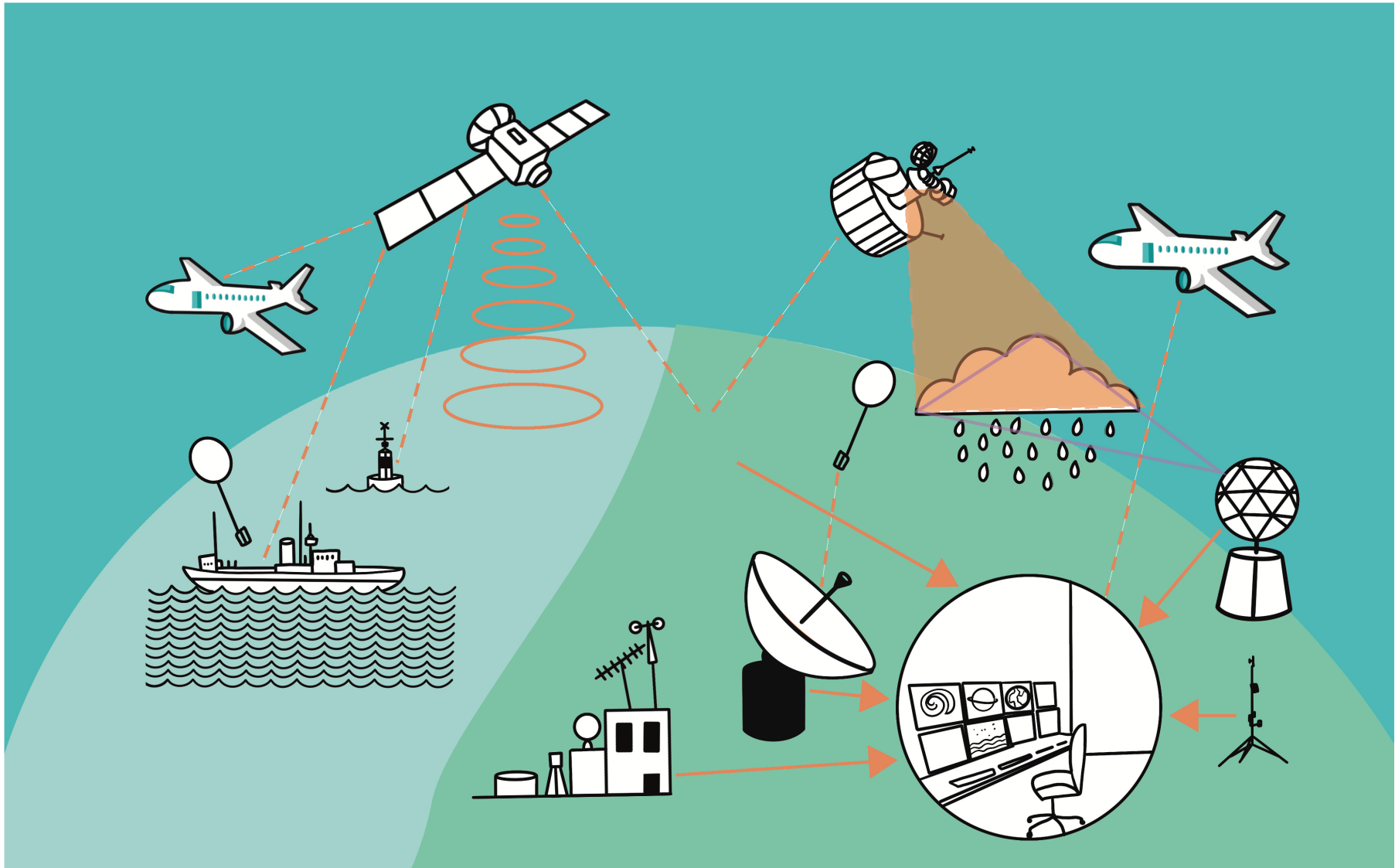
▪ **Practical Applications:**

- Measuring industrial and agricultural emissions.
- Tracking wildfires, polar ice, and rising sea levels.
- Enhancing climate models with high-precision data.

▪ **A Promising Future:**

Nano-satellites play a key role in the transition to a well-monitored planet, enabling climate policies to be based on reliable and accessible data.

Introduction



Introduction



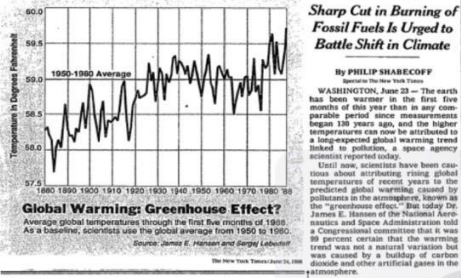
Introduction



The New York Times

VOL. CXXVII... No. 47,546... WASHINGTON, FRIDAY, JUNE 24, 1988... 30 CENTS

Global Warming Has Begun, Expert Tells Senate



Immigration Law Is Failing to Cut Flow From Mexico



High Court Getting Unusual Plea Not to Reverse Key Rights Ruling

WASHINGTON, June 23 — In an unusual plea for a strong argument from the Reagan Administration for overruling the 1973 decision to affirm the constitutionality of the abortion law, the Supreme Court today received a major 1973 decision that conservatives have called for Mr. Justice's removal from office.

The case involves a Reconstruction era law providing that all people have the same right "to make and enforce contracts" as "enjoyed by white citizens." The Court's 1973 decision rendered the law unconstitutional, permitting its use by private plaintiffs to sue discriminatory private schools and to seek damages for racial discrimination in private business dealings generally.

The current activity is the result of the Court's unexpected 5-4 vote on April 25 to invite arguments in a pending case over whether that interpretation of the law should be reconsidered in an issue that none of the parties to the case had raised.

The brief on behalf of 67 members of the Senate and 119 members of the House will be filed Friday, as well as about 18 other briefs filed as friends of the cause by those who support the precedent set in the 1973 case. Among them is the Justice Department, which is also a party to the case.

The briefs were filed in support of the law, which the Justice Department says is "one of the most important and highly visible laws that the Court will face in its next term. His decision attracted criticism from some people on both sides, but especially angered conservatives. They had

Drought Raising Food Prices; Inflation Effect Seem Minor

WASHINGTON, June 23 — The severe drought gripping the farm belt has begun to raise the retail price of food, but the effect on inflation is expected to be minor. Two major unknown factors are what extent food processors will raise prices in anticipatory buying of raw materials and to what extent consumers will stock up on certain products. But factors could be higher demand.

"It's apprehensive," said Harold Bryner, professor emeritus of agricultural economics at the University of Missouri, citing industry reports of relatively few companies. He said "they can't do much about the drought, but they can raise prices." The Kolliga Company in St. Louis, Mo., said prices of wheat, corn and soybeans are up 10 to 15 percent, even though the raw materials are down.

"I'm apprehensive," said Harold Bryner, professor emeritus of agricultural economics at the University of Missouri, citing industry reports of relatively few companies. He said "they can't do much about the drought, but they can raise prices." The Kolliga Company in St. Louis, Mo., said prices of wheat, corn and soybeans are up 10 to 15 percent, even though the raw materials are down.

Against Drug Tide, Only a Holding Action

By MICHAEL WINES

Less than three years after crack crackled in New York streets, the city's police have not succeeded the fight to abolish trafficking in the drug, saying its traditional law-enforcement tactics are intractable in the problem, they say, that they have begun to focus instead on keeping some neighborhoods from descending into lawlessness.

The city's difficulty in suppressing the crack trade and its accompanying violence is similar to what other cities like Detroit, Miami and Los Angeles, are experiencing, according to drug experts.

In New York, as elsewhere, officials struck at dealers by flooding streets with narcotics police, tripping drug arrests and seeking to cut off the drug's supply. But even the side effects of those tactics — a police presence that intimidates, sometimes simply fighting drugs and clogged courts — may be enough to weigh the benefits.

With more money and officers, the police say, they could easily arrest four or five times as many crack dealers as they are now. Without vastly larger prisons, better Federal efforts to stop cocaine smugglers and a basic change in the demand for the drug, the fight against the crack trade will be only a holding action.

Soviet Offers to Adjust Imbalance Of Conventional Forces in Europe

By PAUL LEWIS

UNITED NATIONS, June 23 — The Warsaw Pact is prepared to make greater reductions than NATO in conventional forces in Europe to remove imbalances and enhance the prospects for a more comprehensive arms reduction, a senior Soviet army official said today.

The Soviet offer is significant, army control experts say, because Moscow appears to be acknowledging for the first time that its forces in Europe exceed those of the North Atlantic Treaty Organization, and it seems ready to eliminate this advantage by accepting unilateral cuts.

A Three-Stage Plan

The official who spoke today, Lt. Gen. Konstantin F. Mishustin, Deputy Chief of the Government Directorate of the Soviet Foreign Ministry, said the Soviet Union was willing to adjust imbalances "between the two sides' conventional forces" in Europe in three stages. He said the plan would be announced to a 23-nation arms control conference that is expected to open in Vienna this month.

This first step would involve an exchange of "sufficial" data about the size of each side's forces in Europe, which would enable negotiators to identify "imbalances and asymmetries," he said.

The General Mishustin also made clear that if the West was found to have an advantage over the Warsaw Pact in particular categories of armaments, it would be expected to make similar unilateral cuts.

The Soviet proposals have been emerging over several months, and are seen as a significant step toward reducing the imbalance between the two sides' conventional forces in Europe.

Interim District Attorney Drops Out of Bronx Race

By FRANK LYNN

A political struggle that has ensnared Governor Cuomo and United States Attorney Rudolph W. Giuliani and embarrassed Bronx politicians took an unexpected turn yesterday when the Bronx District Attorney, Paul T. Gentile, announced that he would not be a candidate for election this fall. But Mr. Gentile declined to yield pressure from the Governor and Mr. Giuliani to resign an interim term that runs until the end of this year.

Mr. Gentile, who acknowledged that he was "a terrible politician," picked an unusual forum for making his announcement, the tail end of a news conference held on the steps of the Bronx courthouse by Robert T. Johnson, who resigned as a Criminal Court judge Wednesday and was announcing his candidacy for district attorney. Mr. Johnson had the backing of the Democratic, Republican and Liberal Party leadership.

Martin Out Again

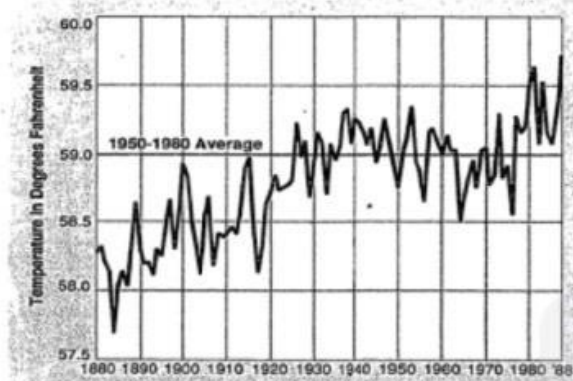
Billy Martin's fifth term as Yankee manager ended in dismal yesterday. He was replaced by Lou Piniella, Page D19.

News Summary, Page A2

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24 June 1988

Global Warming Has Begun, Expert Tells Senate



Sharp Cut in Burning of Fossil Fuels Is Urged to Battle Shift in Climate

By PHILIP SHABECOFF
Special to The New York Times

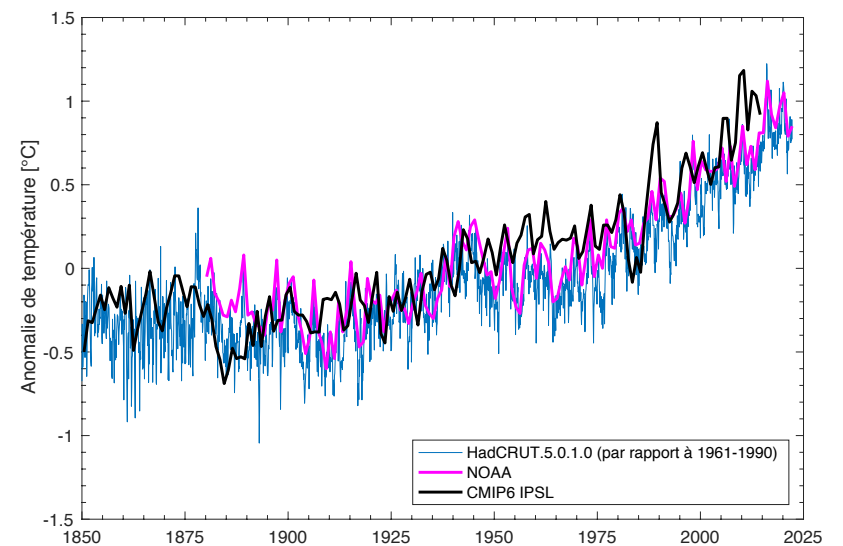
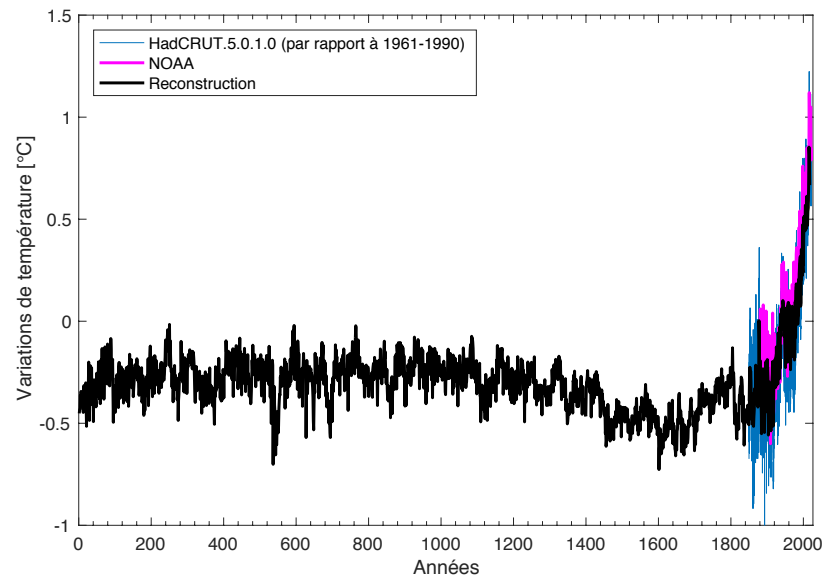
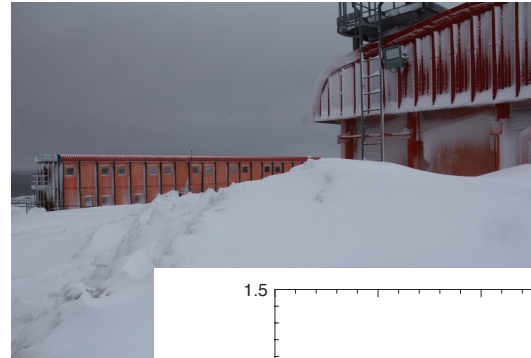
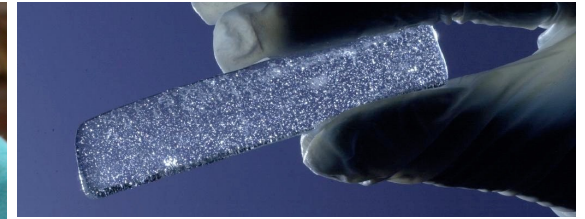
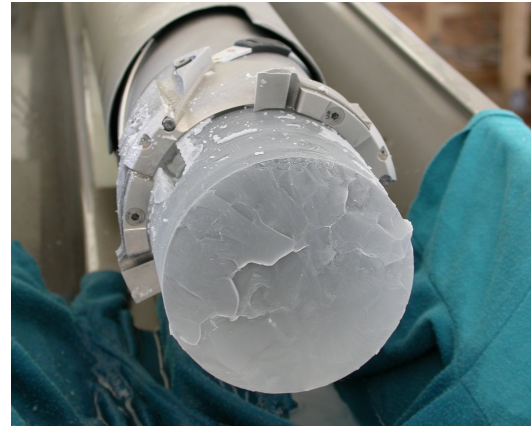
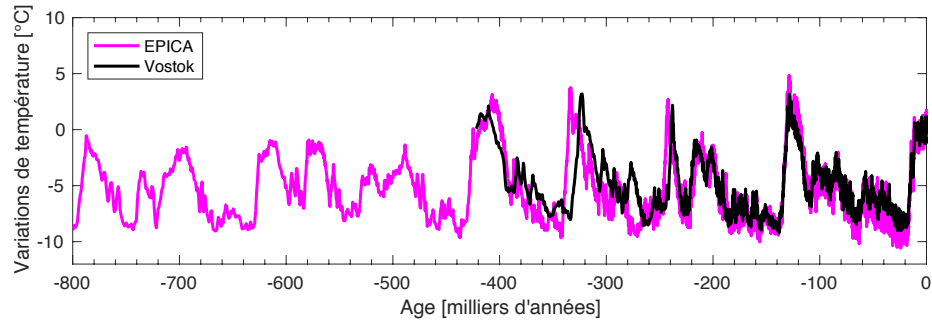
WASHINGTON, June 23 — The earth has been warmer in the first five months of this year than in any comparable period since measurements began 130 years ago, and the higher temperatures can now be attributed to a long-expected global warming trend linked to pollution, a space agency scientist reported today.

Until now, scientists have been cautious about attributing rising global temperatures of recent years to the predicted global warming caused by pollutants in the atmosphere, known as the "greenhouse effect." But today Dr. James E. Hansen of the National Aeronautics and Space Administration told a Congressional committee that it was 99 percent certain that the warming trend was not a natural variation but was caused by a buildup of carbon dioxide and other artificial gases in the atmosphere.

This is an issue that has been known for a long time.

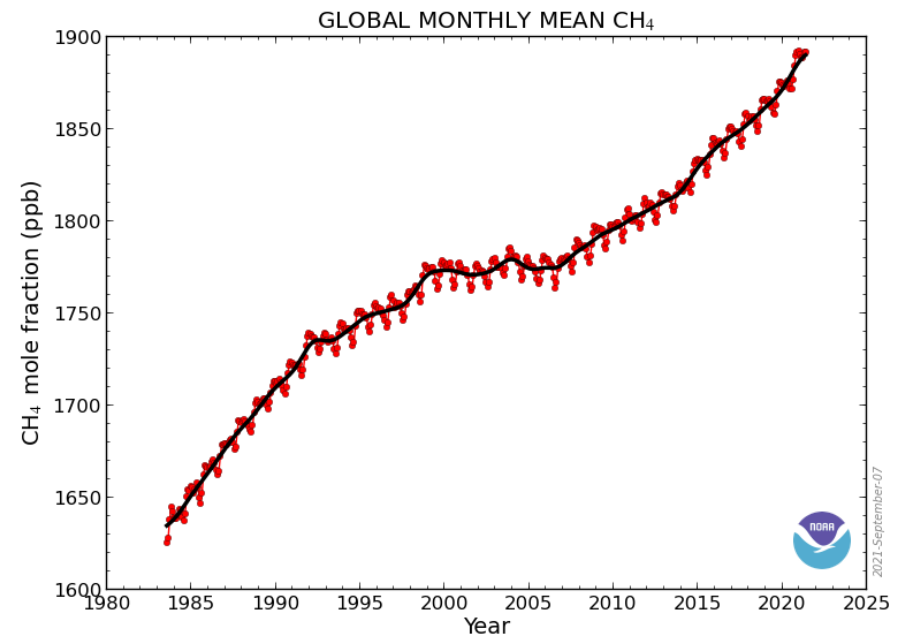
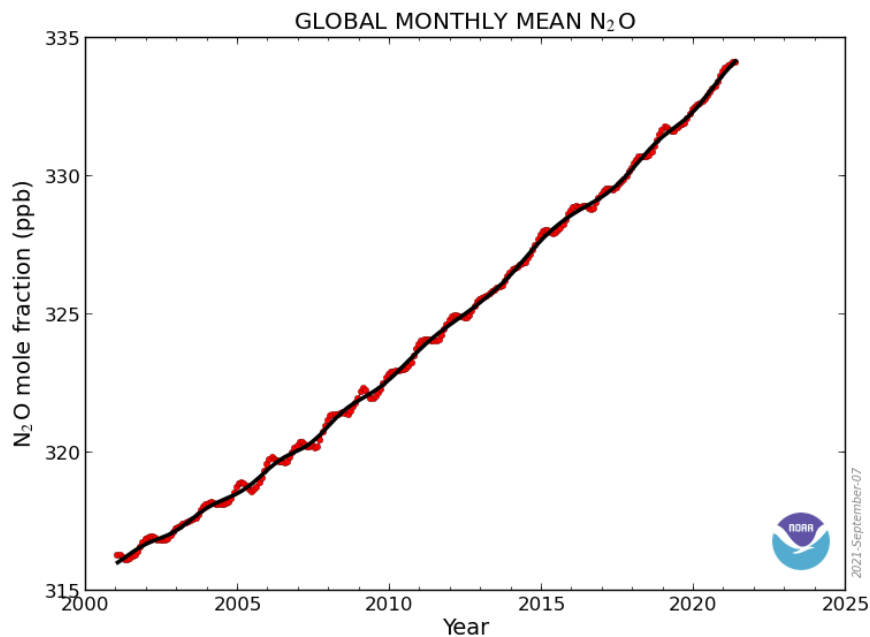
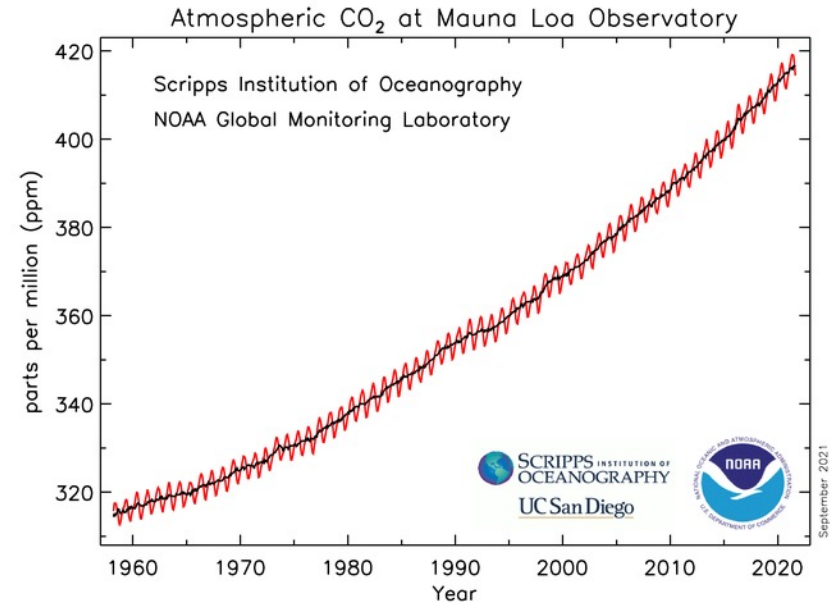
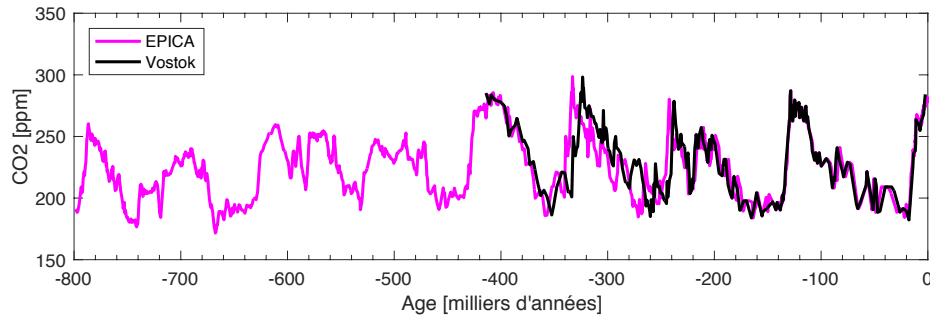
Some effects of climate change

Temperatures



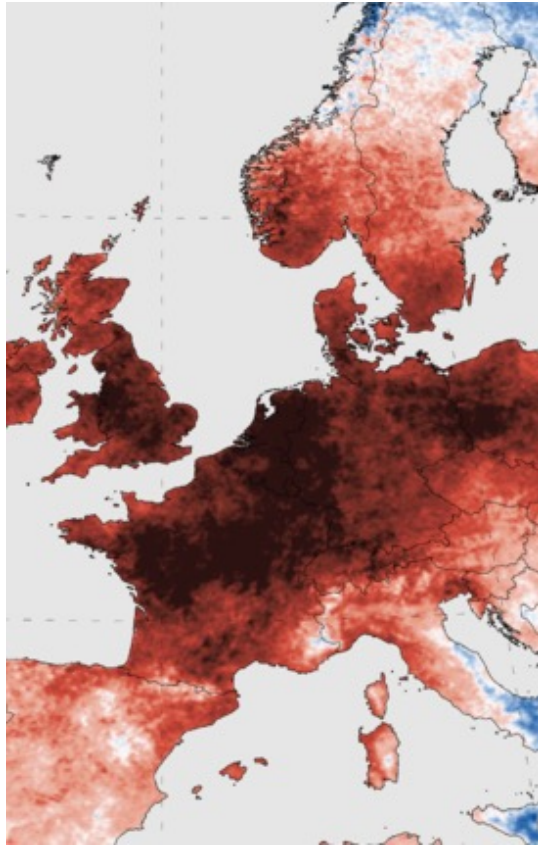
Some effects of climate change

GHG



Some effects of climate change

Heat waves



*European Heat Wave
EU 2006
(70'000 dead, €13 billion in
damages)*



*Black Saturday bushfires
Australia 2009
(173 dead, > €2 billion in
damages)*



*Californian Camp Fire
US 2018
(85 dead, > €6 billion in
damages)*

There is also the summer of 2021 when Algeria experienced devastating wildfires, exacerbated by an intense heatwave. The fires, particularly concentrated in the Kabylie region in northern Algeria, led to the tragic loss of numerous lives, including both civilians and soldiers who were trying to combat the flames.

Some effects of climate change

Drought and Floods

Untold Human Suffering in Pictures

Drought



Floods

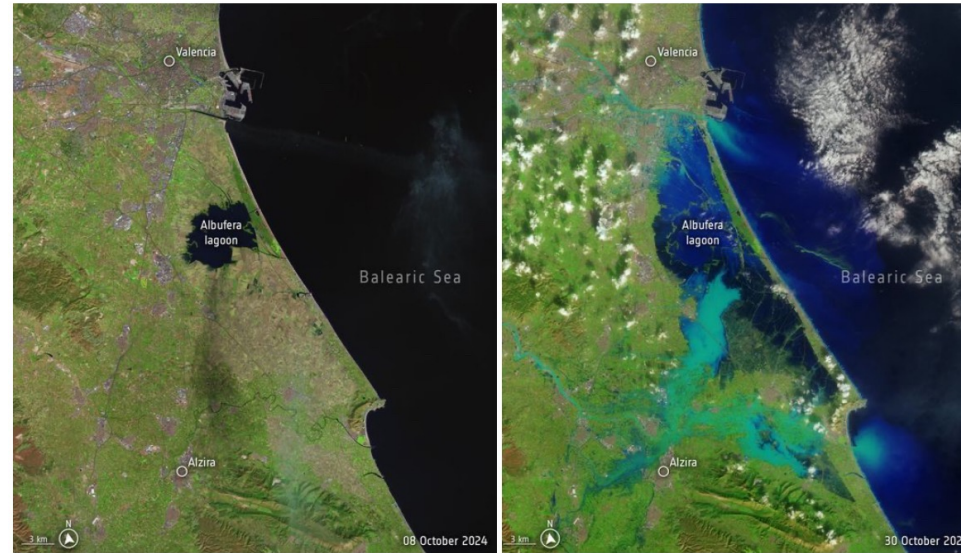


Figure 1. The impacts of climate-related droughts (left column) and floods (right column). Left column (top to bottom): “Children in dust storm” (Ethiopia, 2016; photograph: Anouk Delafortrie/EU/ECHO), a water hole that may have become empty because of drought (Mozambique, 2016; photograph: Aurélie Marrier d’Unienville/IFRC), drought-affected corn field in Paulding County, Ohio (United States, 2012; photograph: US Department of Agriculture/Christina Reed), “Drought in Kenya’s Ewaso Ngiro river basin” (Kenya, 2017; photograph: Denis Onyodi/Denis Onyodi/KRCS). Right column (top to bottom): houses are nearly submerged by flooding (Bangladesh, 2020; photograph: Moniruzzaman Szal/Climate Visuals Countdown), “A girl, duck in hand wades through the water in Rwangara” (Uganda, 2020; photograph: Climate Centre), “two children a boy and a girl on a flooded riverbank” (Bangladesh, 2018; photograph: Moniruzzaman Szal/Climate Visuals Countdown), “Residents wade through flooded streets to escape flood waters” (United Kingdom, 2008; John Dal). All photos are licensed under Creative Commons and all quotes are from the Climate Visuals project (<https://climatevisuals.org>). See supplemental file S1 for details and more pictures.

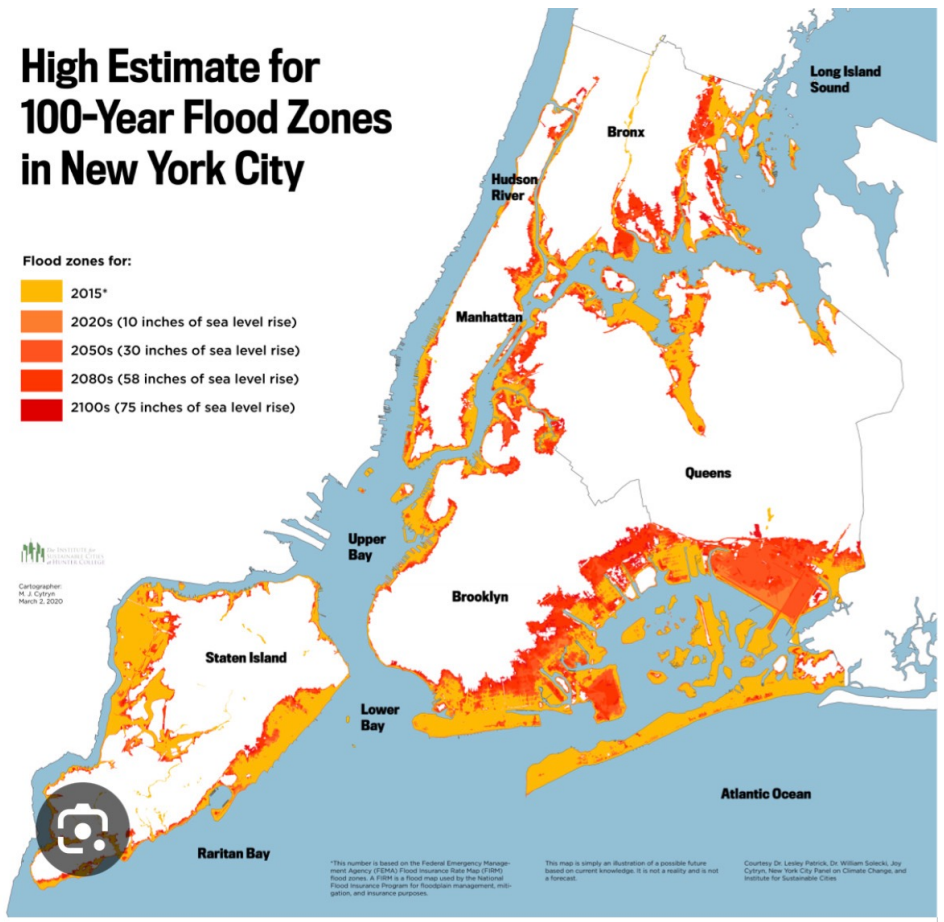
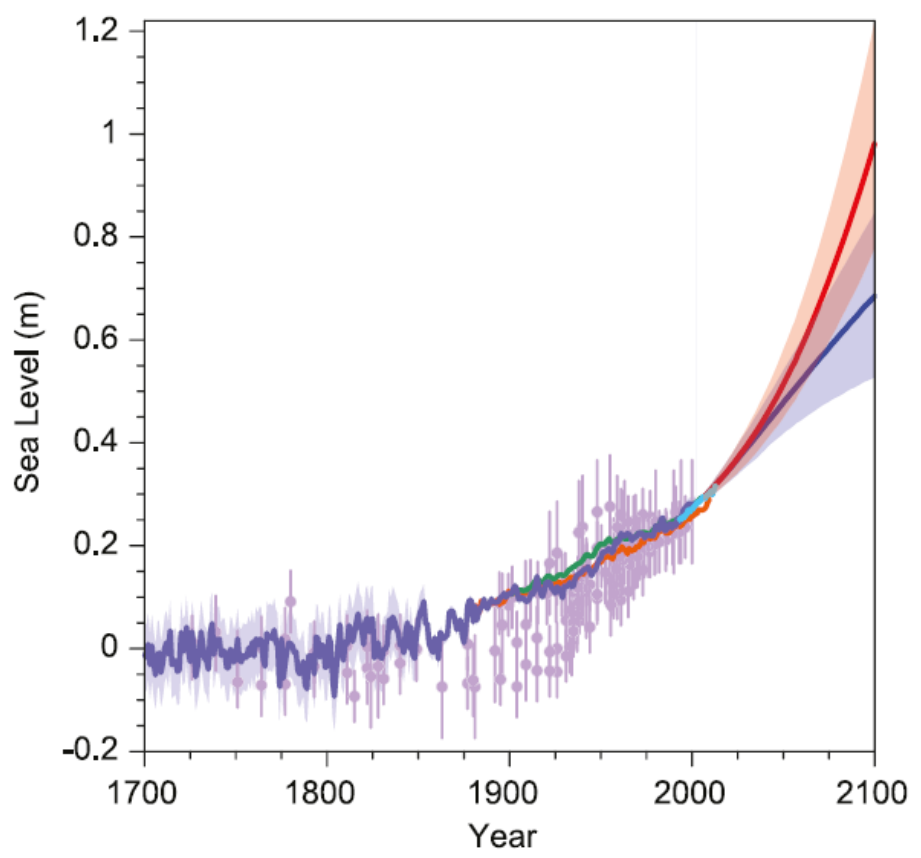


John Deere fait appel à SpaceX pour connecter ses tracteurs en toutes circonstances



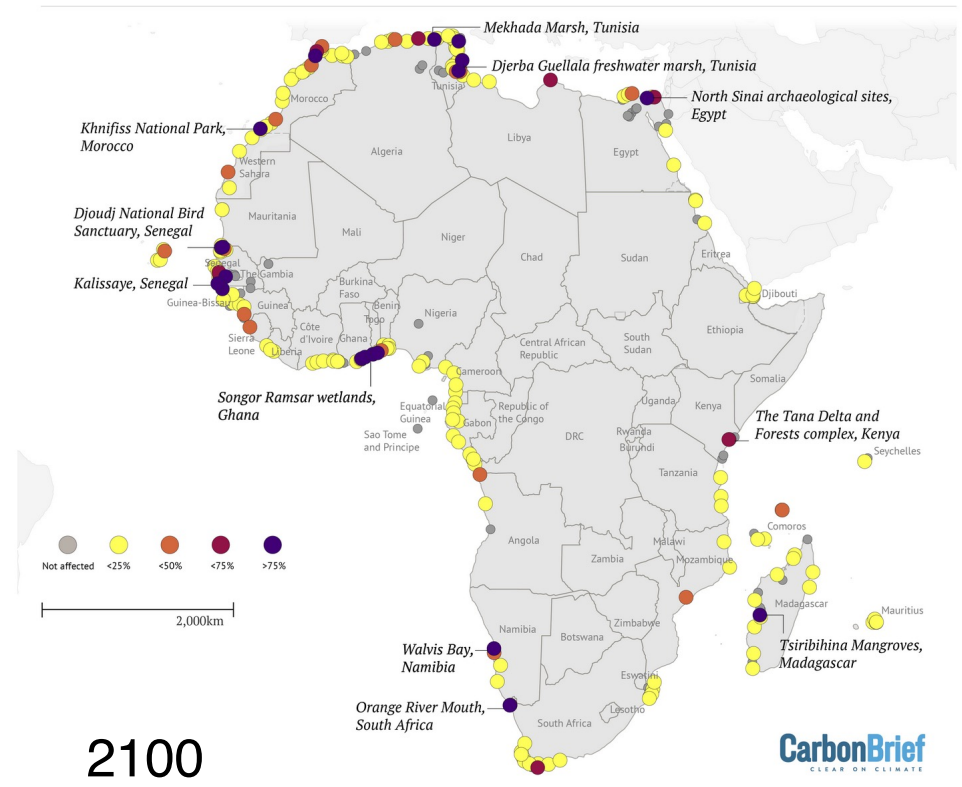
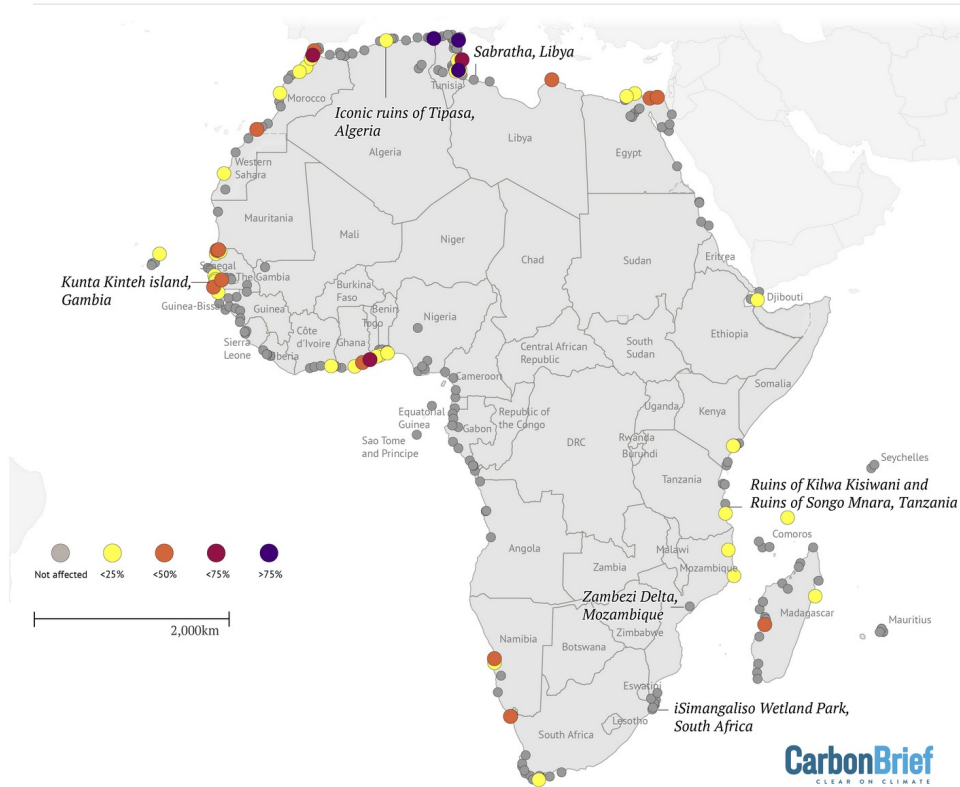
Some effects of climate change

Rising sea levels



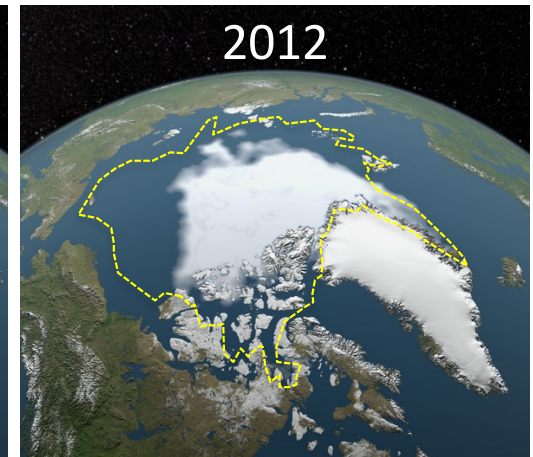
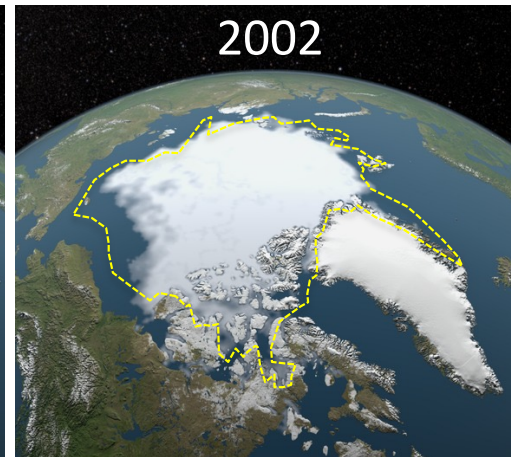
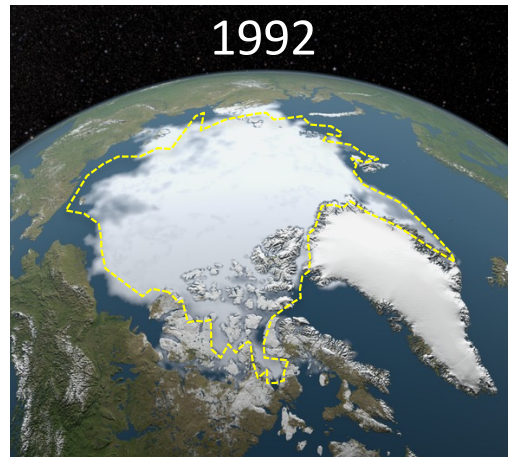
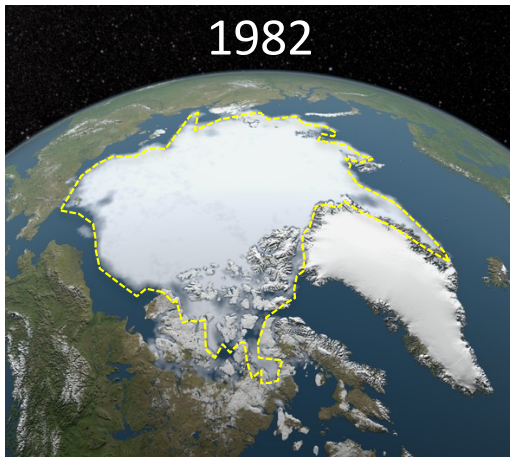
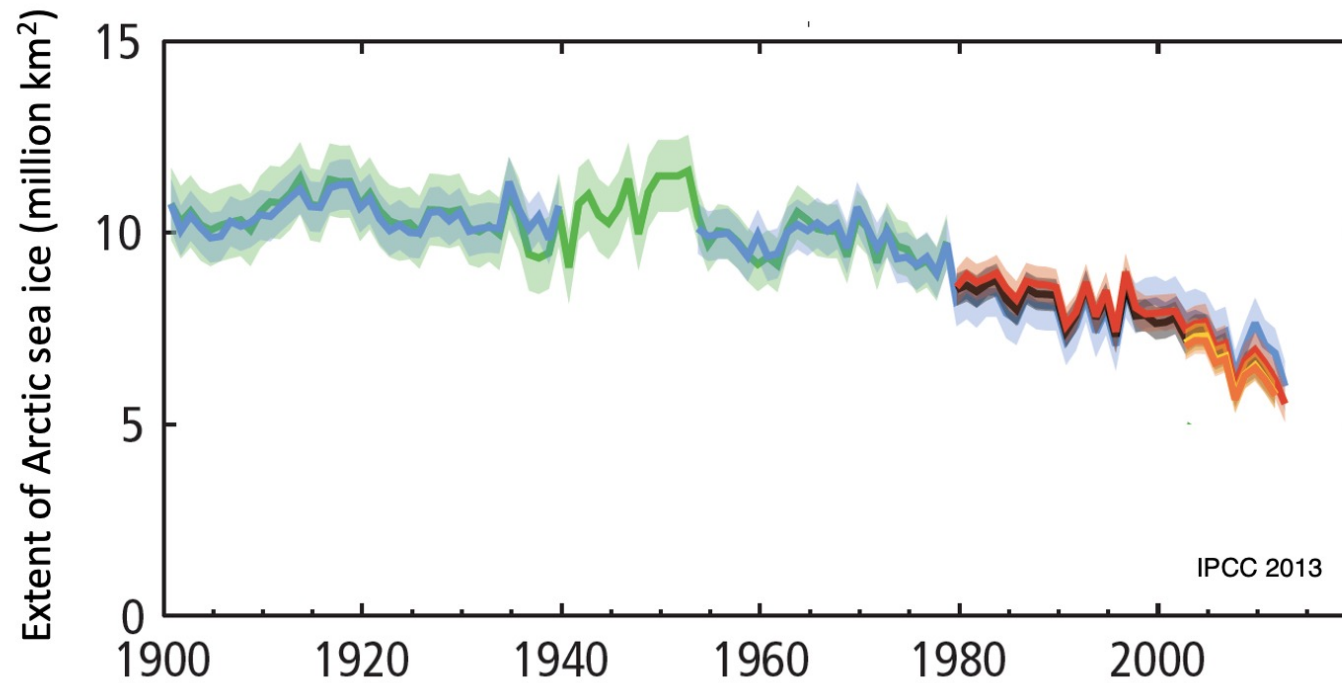
Some effects of climate change

Rising sea levels



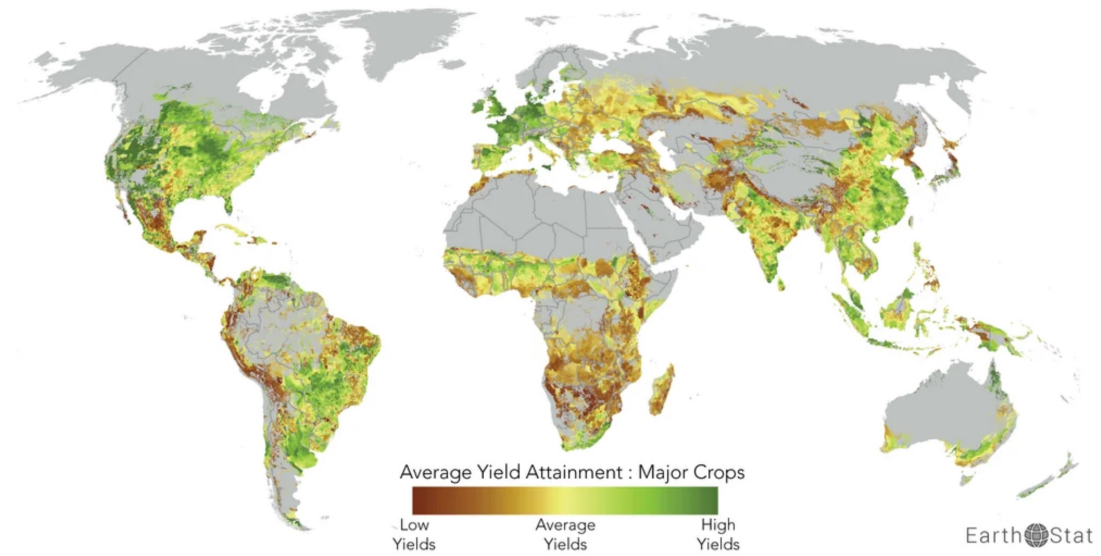
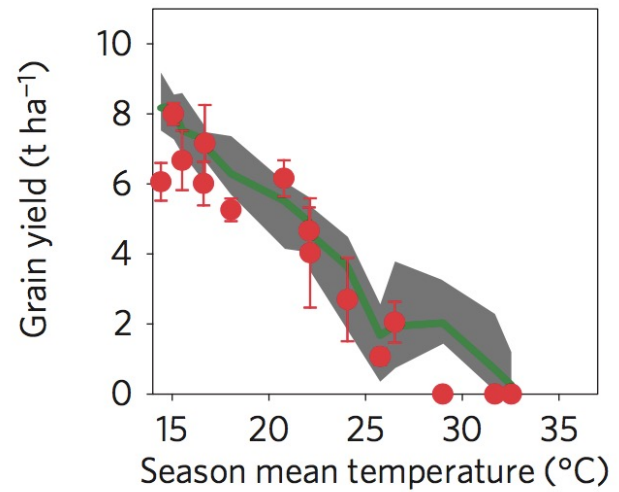
Some effects of climate change

Sea ice

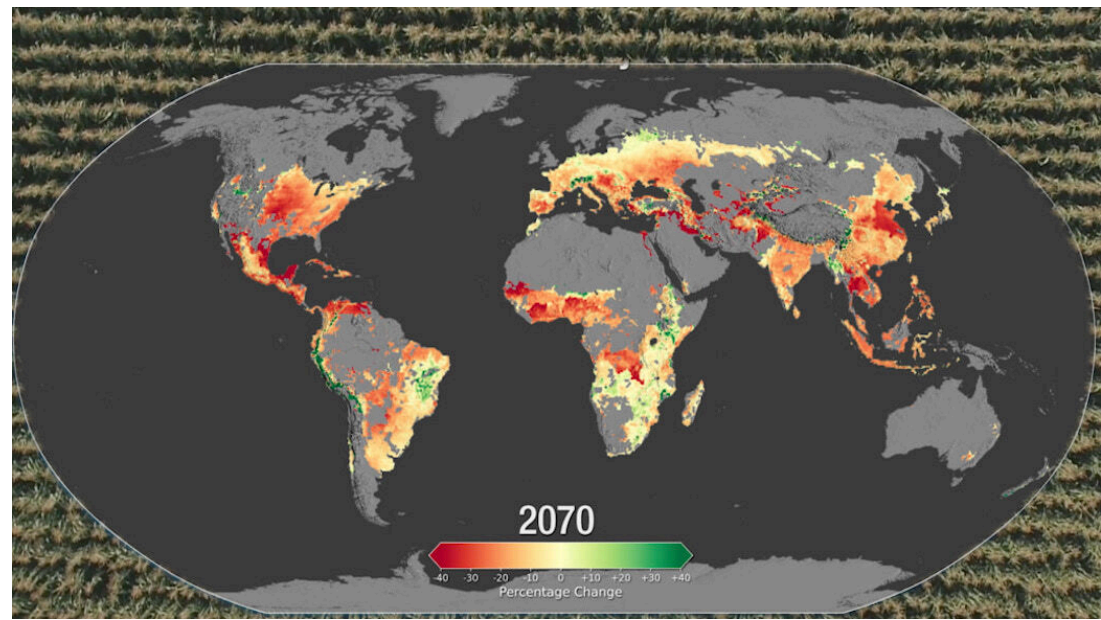
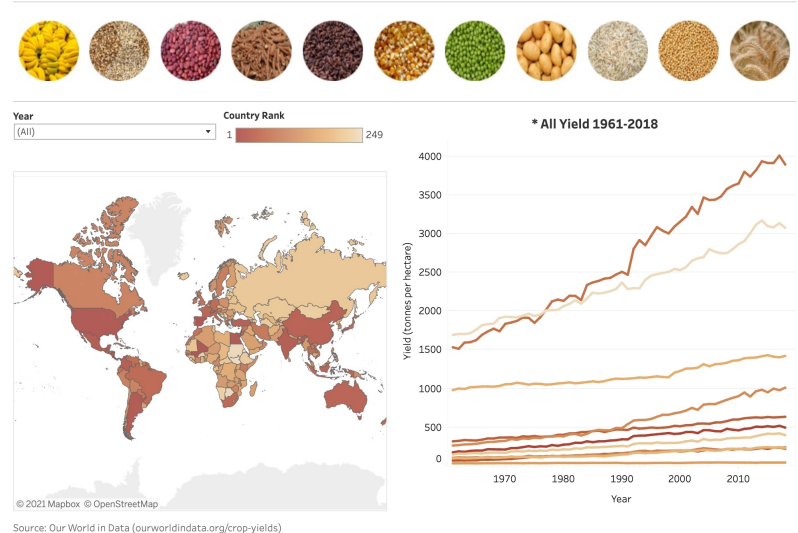


Some effects of climate change

Crops yields



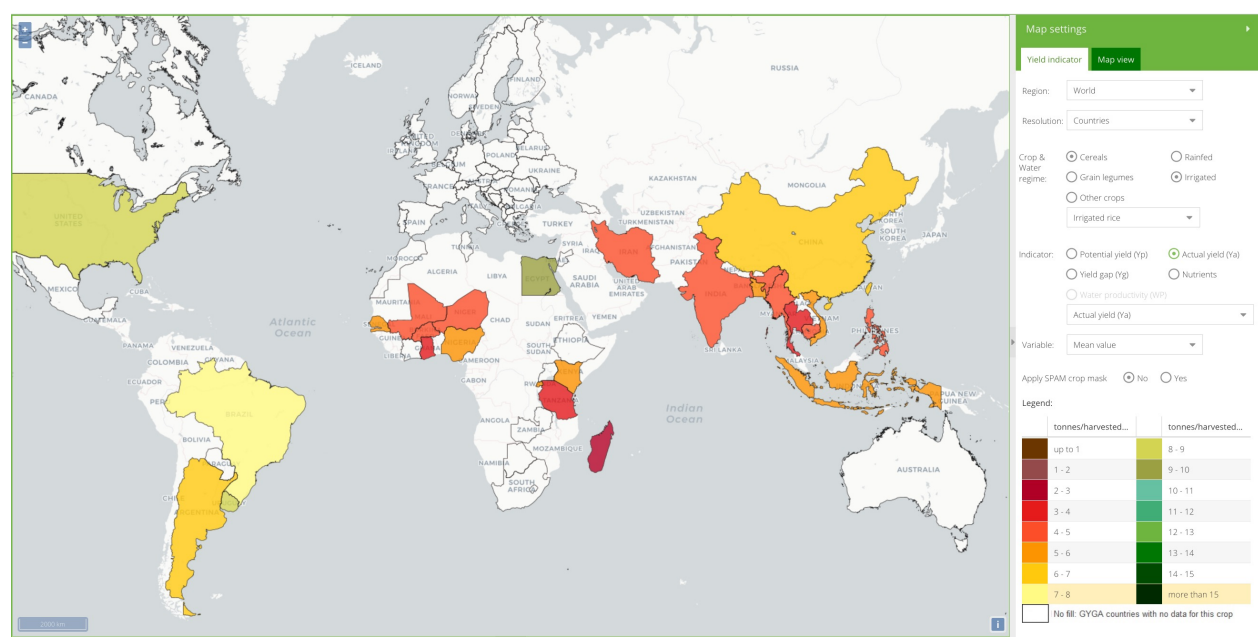
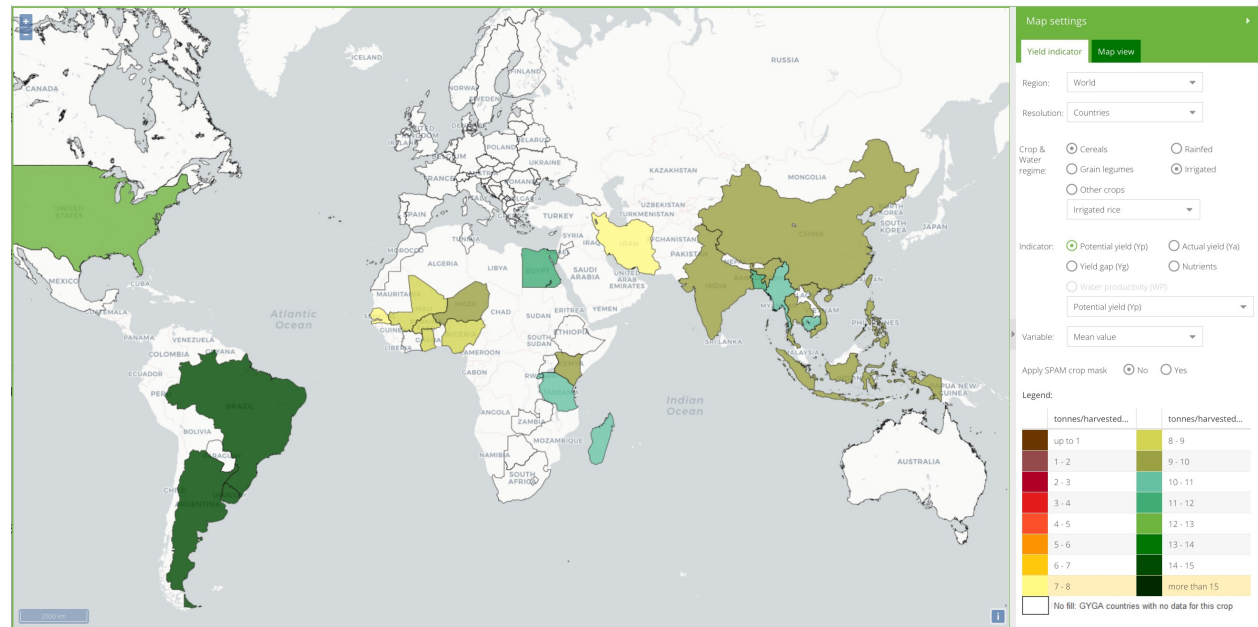
Global Crop Yields 1961-2018
Use images to filter by crop and map to filter by country



Flat map of the world showing in red where decreases in corn yields are projected to occur in 2071: parts of North America, South America, West Africa, Central Europe, India, China. Credit: NASA/Katy Mersmann

Some effects of climate change

Rice production



Some effects of climate change

Reducing biodiversity

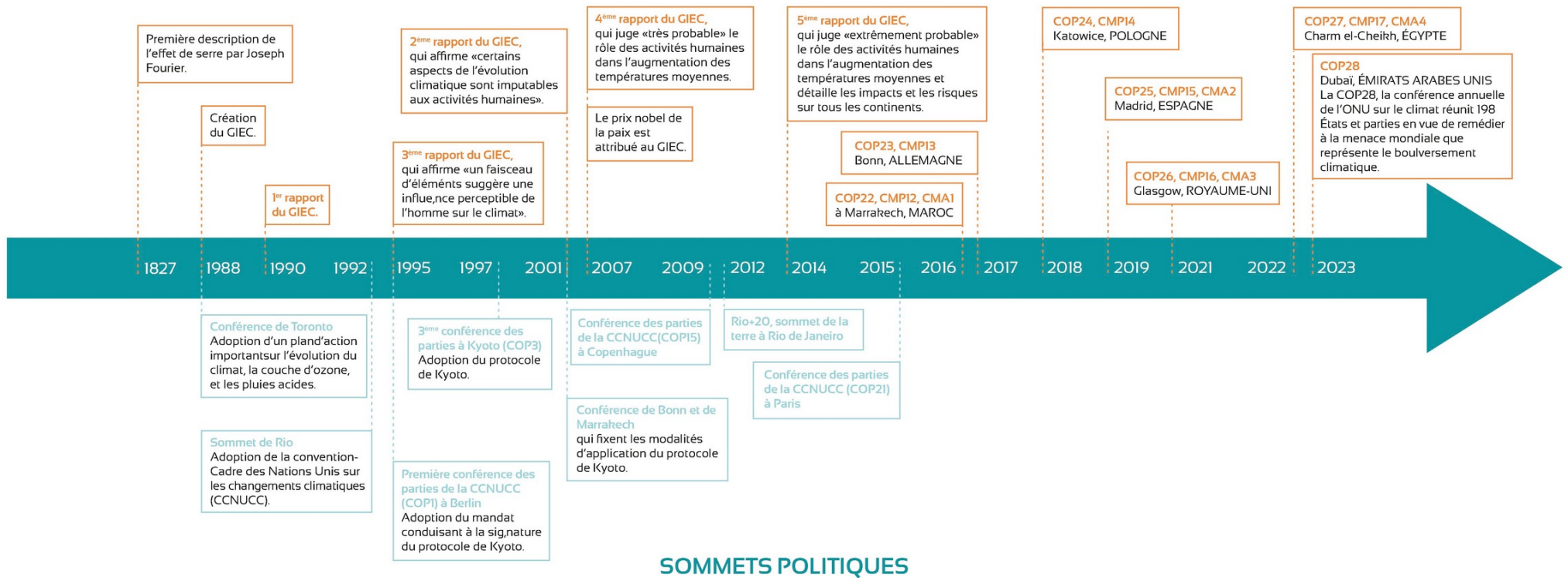
Least concern	Vulnerable	Endangered	Extinct
Happy	Soon endangered?	70% dead in 3 generations (habitat < 5000 km ²) (population < 2500)	Dead
Example: pigeon, brown rat, pavement ant	Example: Koala, African elephant, panda, ...	Example: Gorilla, black rhinoceros, blue whale...	Example: Dinosaurs, dodo...



Some effects of climate change

Forums

AVANCÉES ET FORUMS SCIENTIFIQUES



Models



INSTITUT PIERRE SIMON LAPLACE

LABORATOIRE DES SCIENCES
DU CLIMAT ET DE L'ENVIRONNEMENT

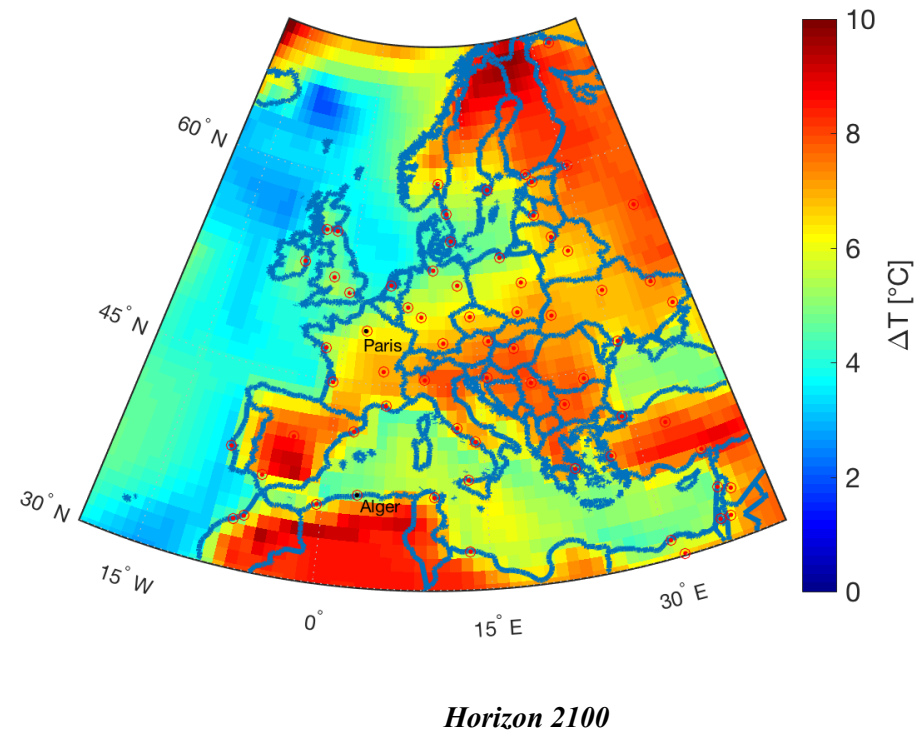
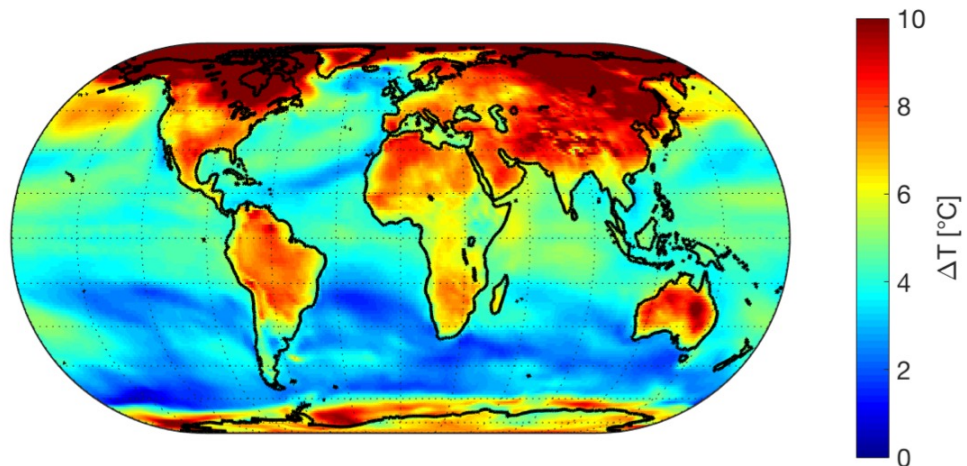
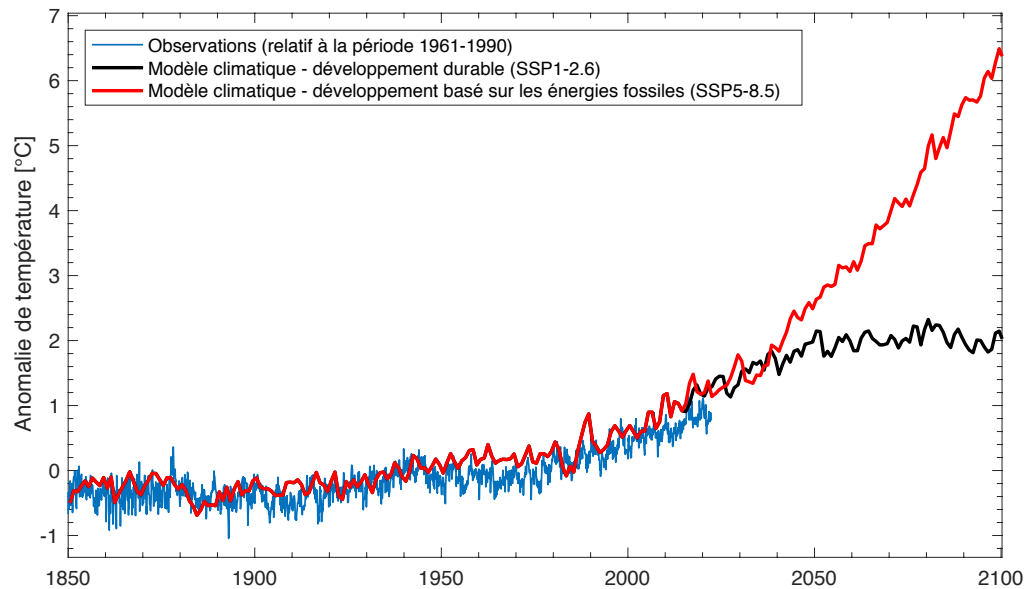
LABORATOIRE DE MÉTÉOROLOGIE DYNAMIQUE

LABORATOIRE D'OCÉANOGRAPHIE ET DU CLIMAT:
EXPÉRIMENTATION ET APPROCHES NUMÉRIQUES

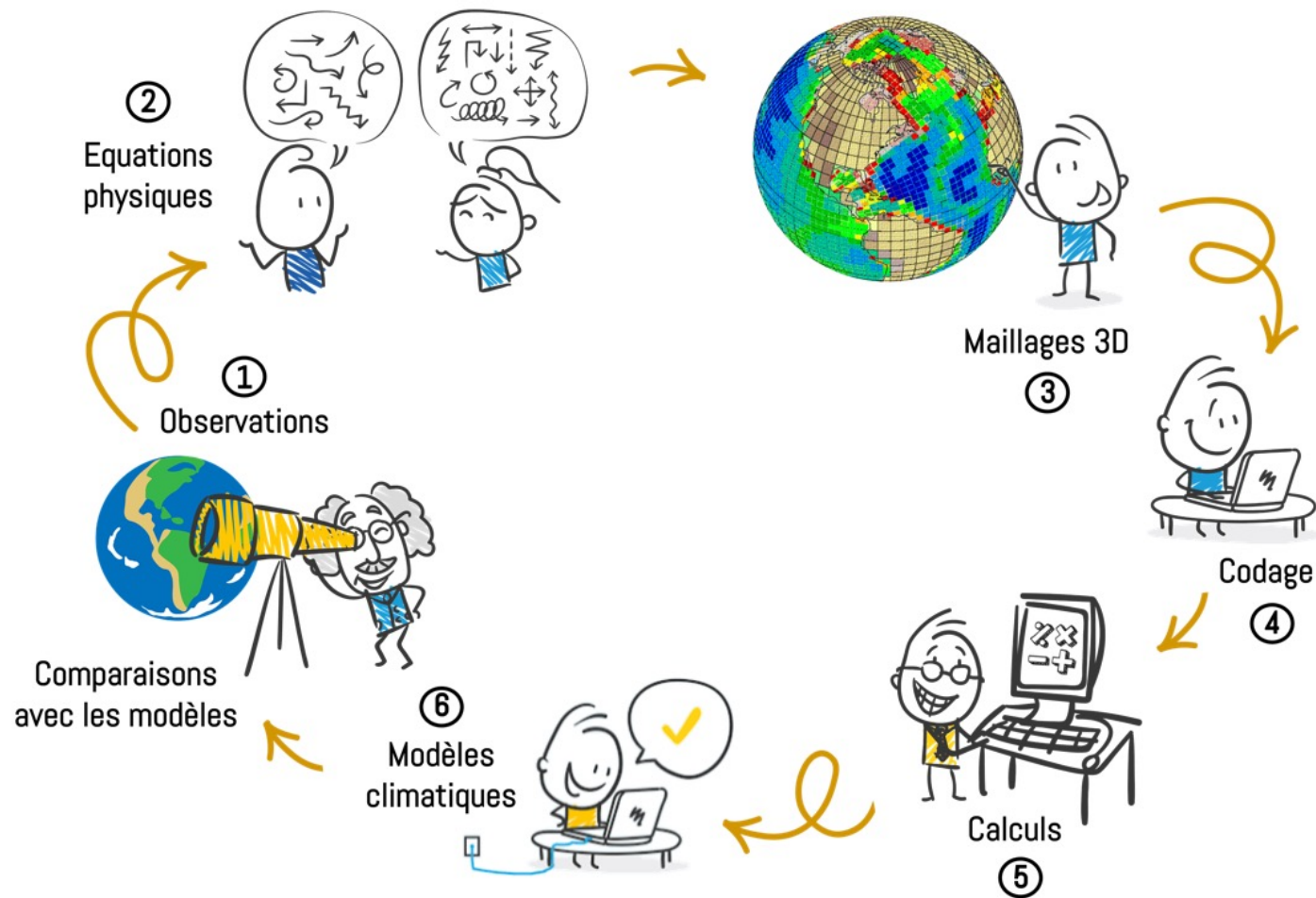


DIRECTION DES SCIENCES DE LA MATIÈRE

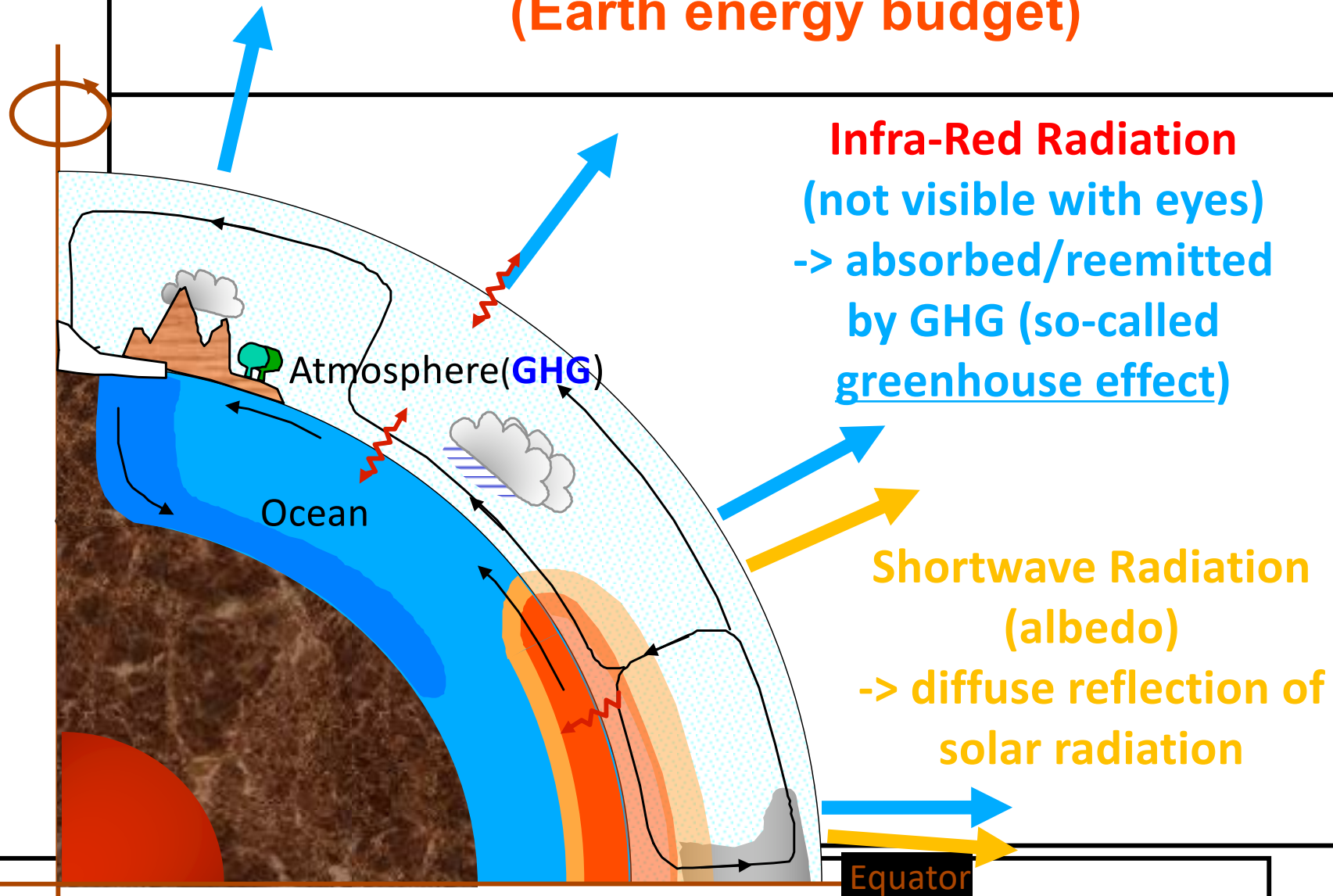
Models



Models and satellites observations



Climate: thermal machine (Earth energy budget)



Infra-Red Radiation
(not visible with eyes)
-> absorbed/reemitted
by GHG (so-called
greenhouse effect)

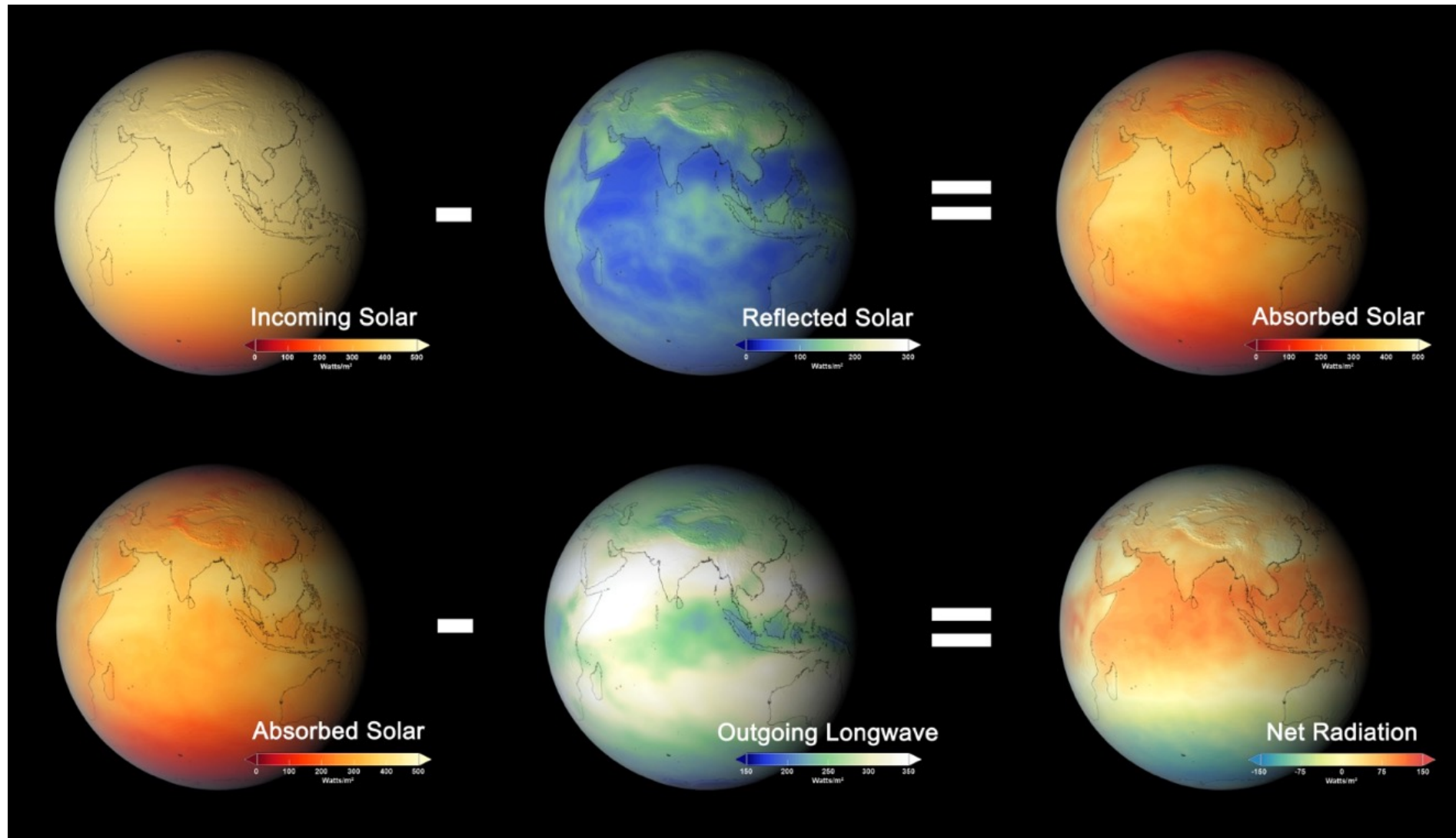
Shortwave Radiation
(albedo)
-> diffuse reflection of
solar radiation

Equator

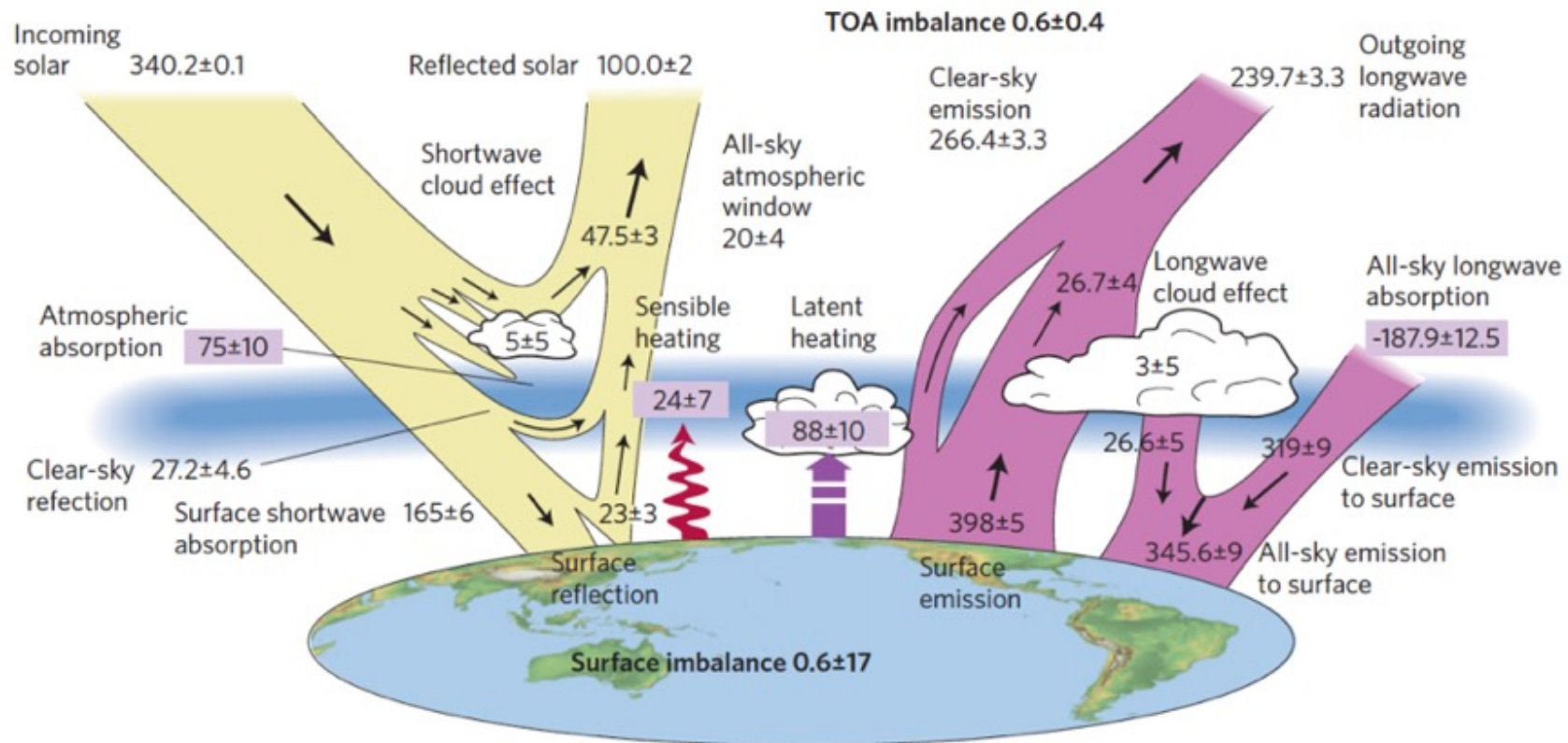
$$\text{Energy balance} = + \text{Solar Visible} - \text{Terrestrial Infra-Red}$$

Difference between incoming solar radiation and outgoing radiation

Importance of the key components of the Earth energy budget

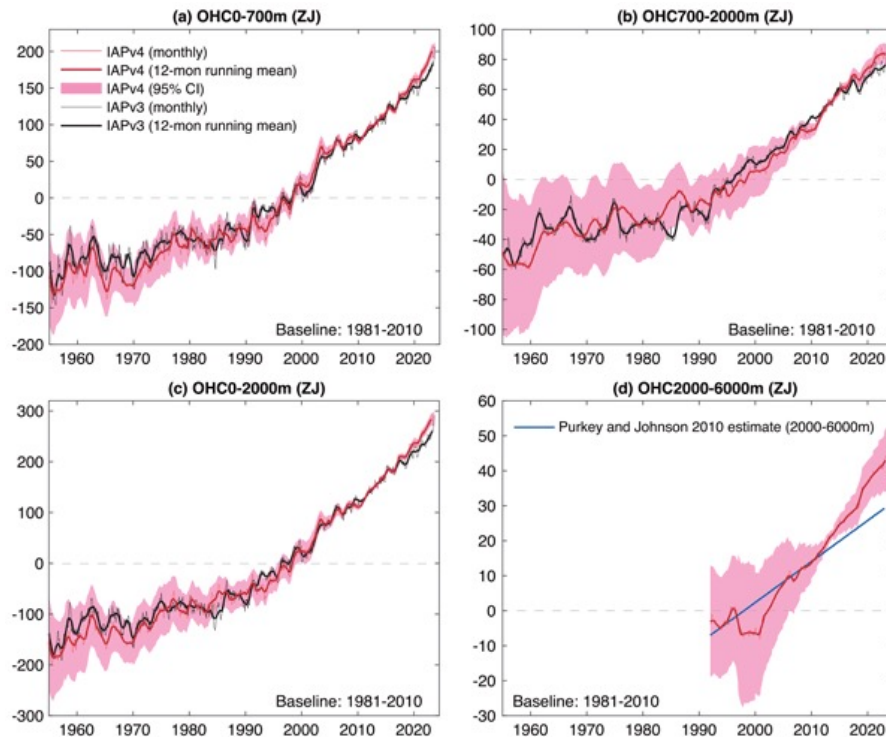


Importance of the key components of the Earth energy budget

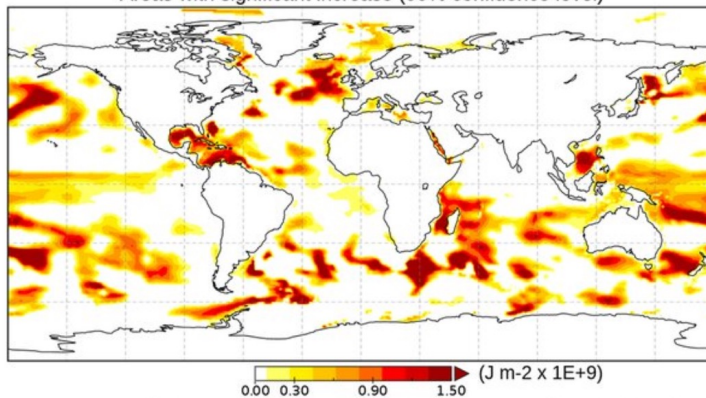


Earth Energy Imbalance = Incoming solar – [Reflected solar (OSR) + Outgoing longwave radiation (OLR)]

Importance of the key components of the Earth energy budget



Ocean Heat Content Increase (2022 vs 2021)
Areas with significant increase (99% confidence level)



To estimate the temperature increase due to an energy imbalance of 0.6 W/m^2 over a decade, we need to account for the distribution of this energy within the climate system, particularly in the oceans, which absorb about 90% of the excess heat. Here's how to proceed:

Calculation Steps

- Total Accumulated Energy:** An energy imbalance of 0.6 W/m^2 sustained over a decade (10 years) results in an accumulation of energy.

$$\text{Total Energy} = 0.6 \text{ W/m}^2 \times 10 \text{ years} \times 3.15 \times 10^7 \text{ s/year} \approx 1.89 \times 10^9 \text{ J/m}^2$$

- Surface Area of Earth:** The total surface area of Earth is approximately $5.1 \times 10^{14} \text{ m}^2$, so the total accumulated energy is:

$$\text{Total Energy} = 1.89 \times 10^9 \text{ J/m}^2 \times 5.1 \times 10^{14} \text{ m}^2 = 9.64 \times 10^{23} \text{ J}$$

Converting this to zettajoules ($1 \text{ ZJ} = 10^{21} \text{ J}$):

$$\text{Total Energy} = 9.64 \times 10^{23} \text{ J} = 964 \text{ ZJ}$$

- Distribution of Energy (90% in the Oceans):** Since the oceans absorb about 90% of this energy, we have:

$$\text{Ocean Energy} = 0.9 \times 9.64 \times 10^{23} \text{ J} \approx 8.68 \times 10^{23} \text{ J} = 868 \text{ ZJ}$$

- Temperature Increase of the Oceans:**

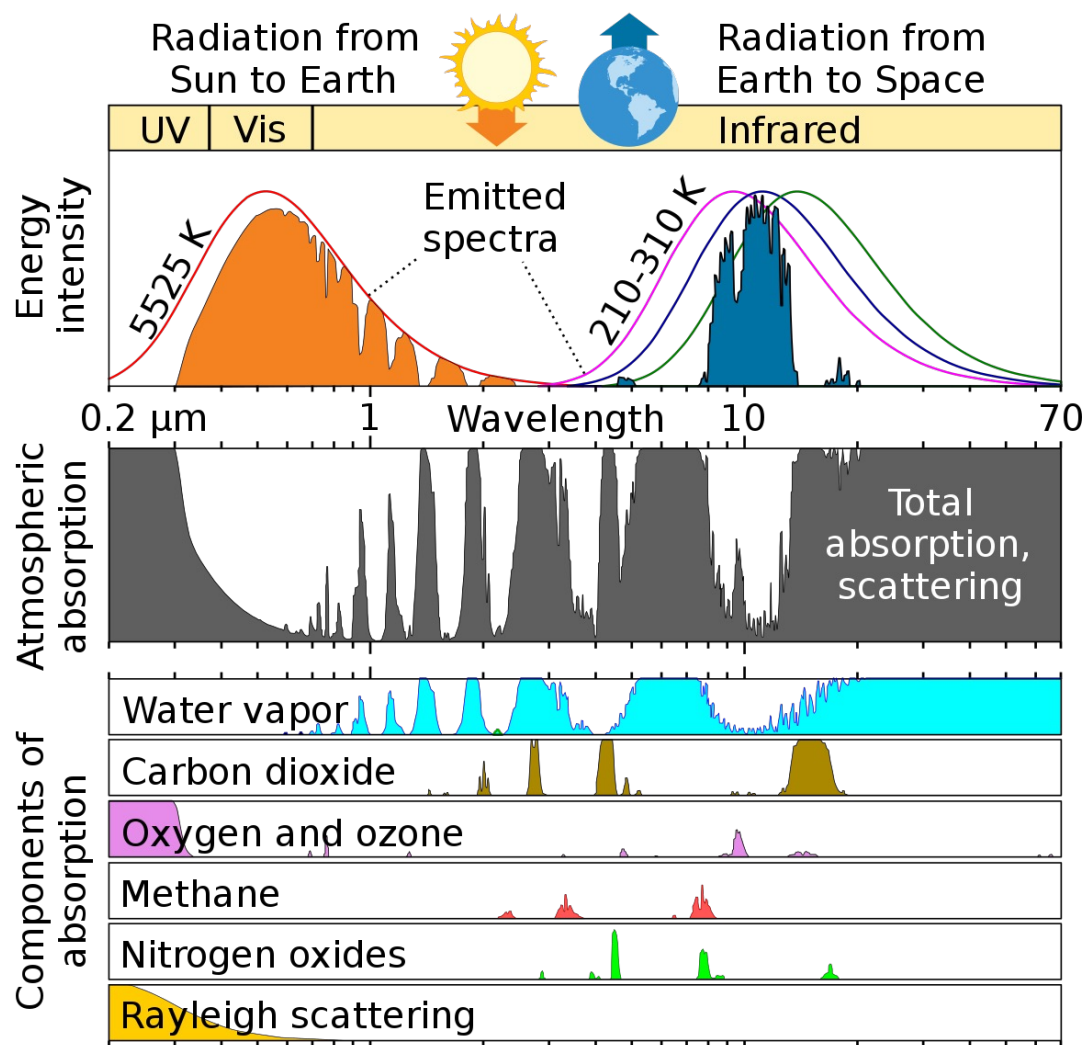
- The volume of the upper 700 meters of the ocean, which responds most quickly to climate changes, is approximately $3.6 \times 10^{17} \text{ m}^3$.
- The specific heat capacity of seawater is about $4.18 \times 10^3 \text{ J}/(\text{kg K})$.
- The density of seawater is around 1025 kg/m^3 .

Using these values, we calculate the average temperature increase in the upper 700 meters of the ocean:

$$\Delta T = \frac{8.68 \times 10^{23} \text{ J}}{3.6 \times 10^{17} \text{ m}^3 \times 1025 \text{ kg/m}^3 \times 4180 \text{ J}/(\text{kg K})}$$

$$\Delta T \approx 0.55 \text{ }^\circ\text{C}$$

Importance of GHG and role in Earth energy budget



At $\sim 1.6 \mu\text{m}$, the entire CO_2 column is measured. Whereas at $\sim 15 \mu\text{m}$, it's sensitive to the temperature of the stratosphere.

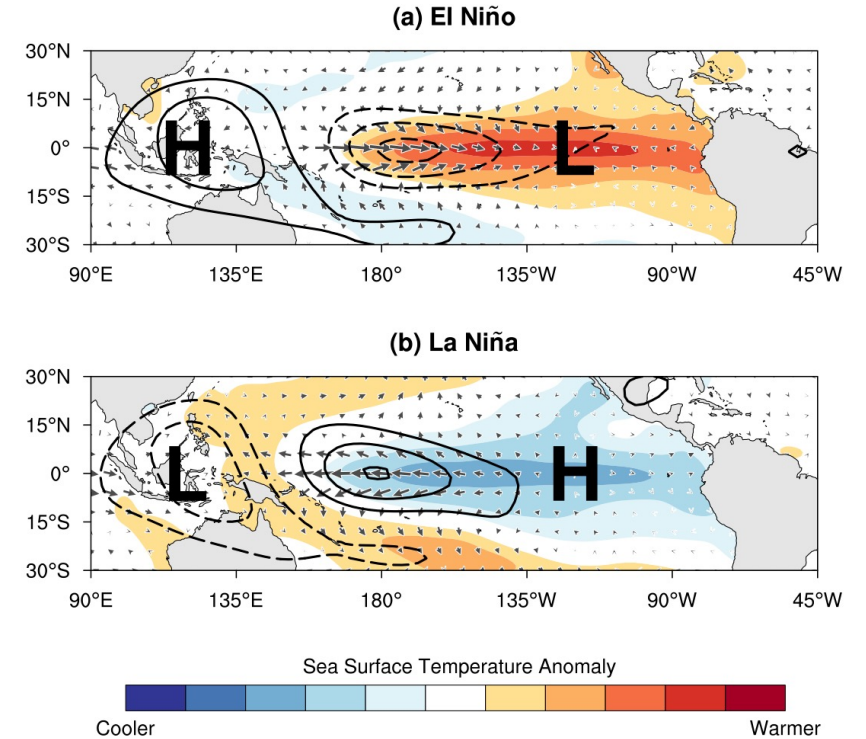
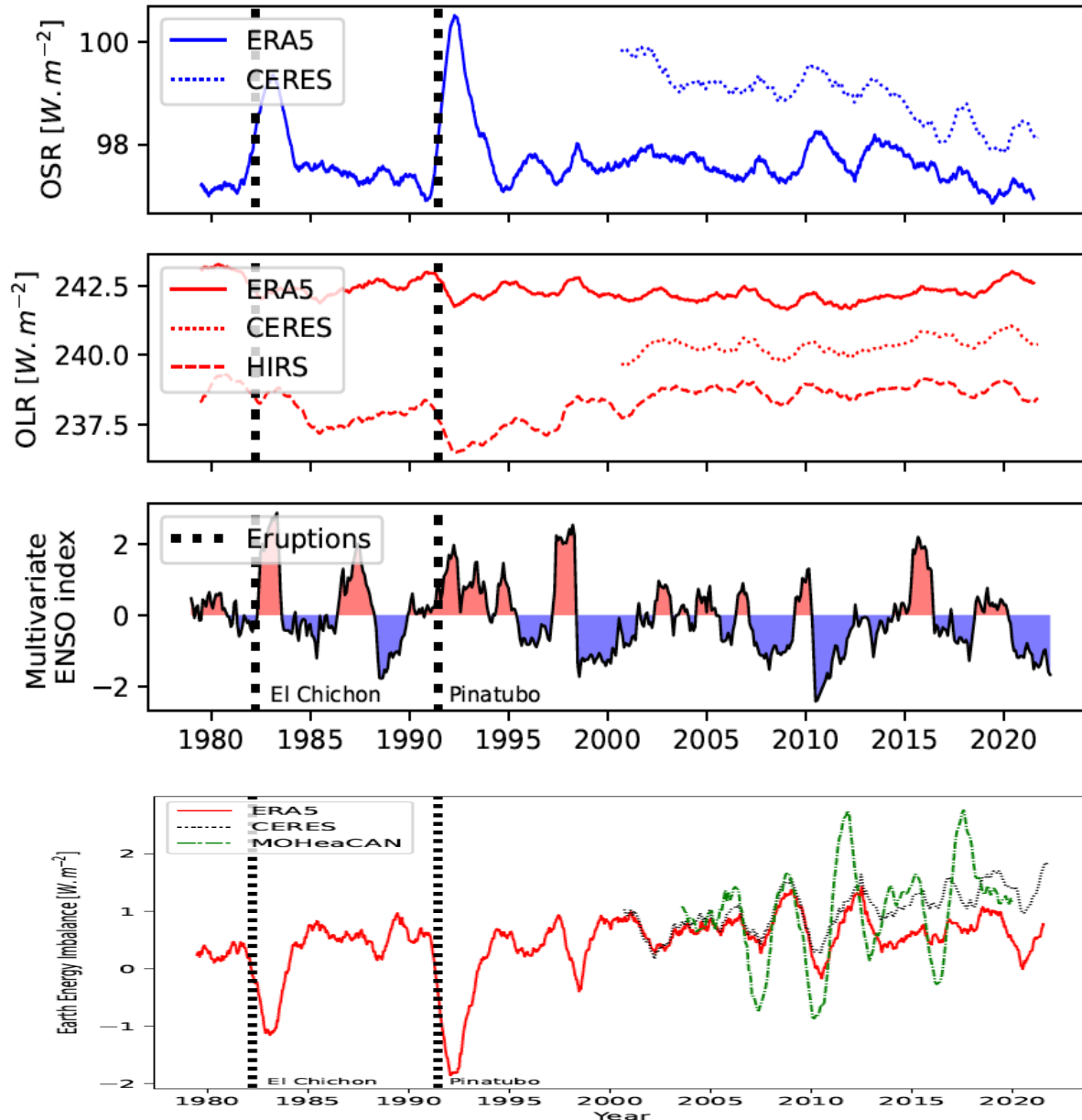
The $\sim 8 \mu\text{m}$ band is sensitive to silicates (deserts).

The $\sim 10 \mu\text{m}$ band is sensitive first to the surface temperature and then to emissivity.

At $\sim 19.2 \mu\text{m}$, it's sensitive to the presence and characteristics of high cirrus clouds.

At $\sim 40 \mu\text{m}$, it depends on stratospheric water vapor.

Importance of OLR and OSR observations



The El Niño–Southern Oscillation (ENSO) recurring climate pattern causes fluctuations in heat storage in the ocean, leading to temporary global warming during El Niño phases (recent major events: 1982–1983, 1997–1998, and 2014–2016) when the ocean surface warms up in the central and eastern tropical Pacific Ocean, removing heat by radiating it back to space. Since May 2023, negative OLR anomaly values indicate the return of El Niño to the tropical Pacific after seven years.

Satellites constellation

□ Importance of satellite observations.

- **Satellite observations are useful for:**
 - **Understanding how clouds and aerosols influence Earth's energy balance from the top of the atmosphere to the surface.**
 - **Better determining atmospheric and oceanic circulations.**
 - **Better understanding the processes related to large tropical convective systems and their life cycle.**
 - **Understanding trends and patterns of change associated with sea ice and snow cover in polar regions.**
 - **Improving seasonal to interannual forecasts, ...**
- **To improve our understanding of Earth's energy balance, observations are needed over several time scale ranges (multi-decadal variations, annual, seasonal, monthly, and the diurnal cycle of these different systems).**
- **This information/observations are important for refining models.**

Satellites constellation

□ Importance of Earth radiative budget at the top of the atmosphere

- The first challenge comes from the studies by Lindzen in 1994 and 1998. These studies argue that the response time of surface temperature isn't just influenced by λ (the climate feedback parameter that accounts for individual feedback processes) and the ocean's mixed layer heat capacity. The diffusion coefficient k , found at the base of the mixing layer, also plays a crucial role. This coefficient, however, is not well-understood. The deep ocean and the oceanic mixing layer are pivotal in determining how surface temperature reacts over time. The climate feedback parameter measures how Earth's climate reacts to energy changes entering and exiting the planet. **To accurately determine λ , another separate observation is essential.**
- **The second challenge involves the unpredictability in historical measurements of radiative forcing, particularly from aerosols, which counterbalance some of the radiative forcings from CO₂.** The accurate values for k and λ remain elusive. To address these uncertainties, Hansen et al. in their 2005 and 2011 studies suggest utilizing precise ocean heat content measurements. This approach offers a way to tackle the uncertainties in assessing historical radiative forcing and the vertical heat diffusion in the ocean over past periods.

Satellites constellation

□ Requirements

Produit	Fréquence	Résolution	Incertitude de mesure requise	Stabilité par décennie
Tableau de synthèse – Bilan radiatif de la Terre				
Rayonnement à ondes longues sortant (OLR)	Mensuel (résolution du cycle diurne), 3 heures	10-100 km / NA* * Non applicable	Exigences en moyenne globale : 1,0 W/m ²	0,1 W/m ² par décade
Rayonnement à ondes courtes sortant (OSR)	Mensuel (résolution du cycle diurne)	10-100 km / NA	Exigences en moyenne globale : 1,0 W/m ²	0,1 W/m ² par décade
Irradiance solaire totale (TSI)	Journalier	NA / NA	0,54 W/m ²	0,1 W/m ² par décade
Irradiance solaire spectrale	Journalier	1 nm < 290 nm ; 2 nm 290-1000 nm ; 5 nm 1000-1600 nm ; 10 nm 1600-3200 nm	0,3 %	1 % par décade

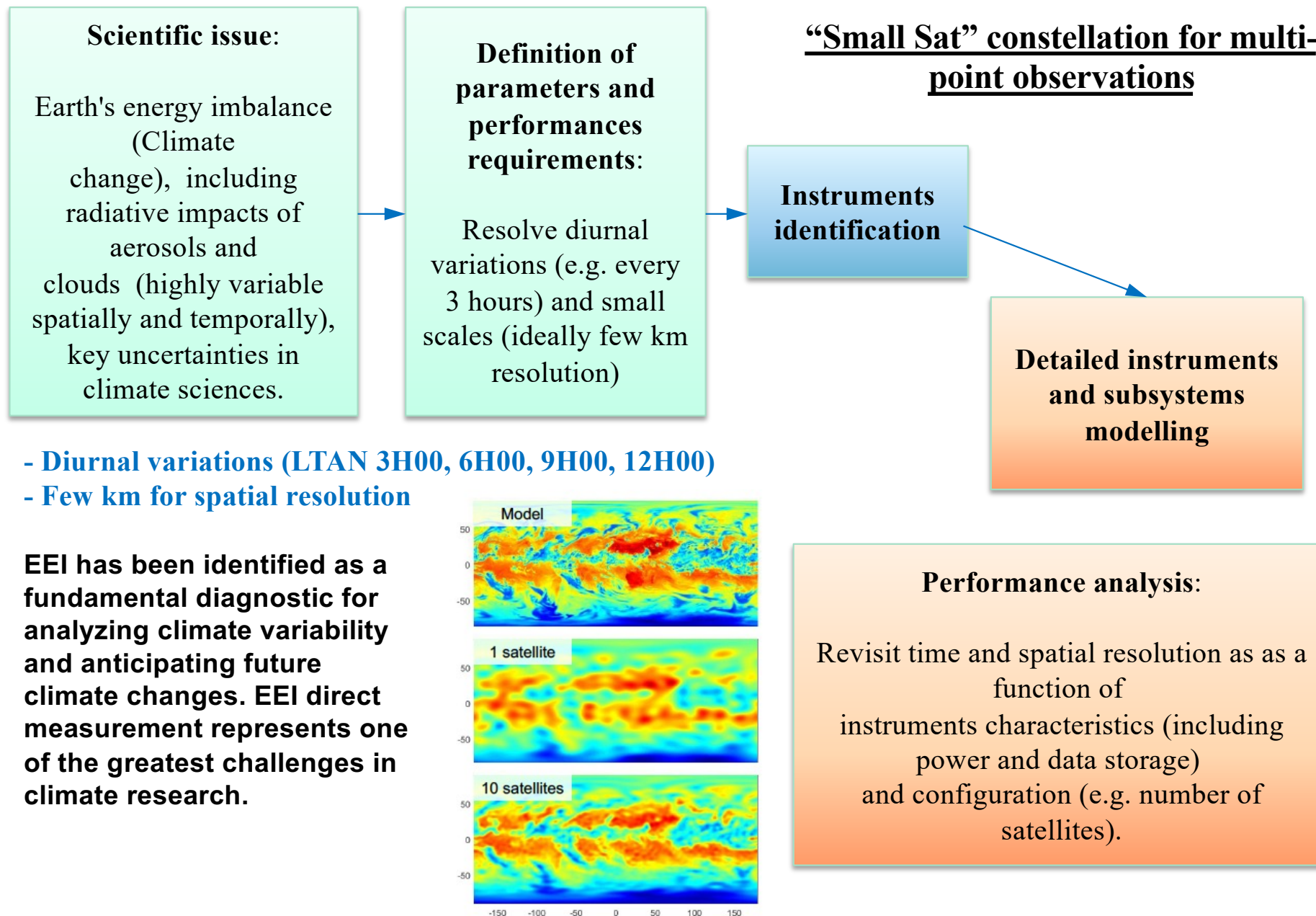
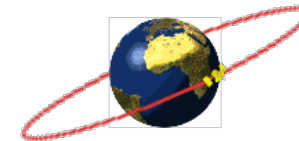
M. Meftah, 2023.

Livre : L'espace et le NewSpace au service du climat.

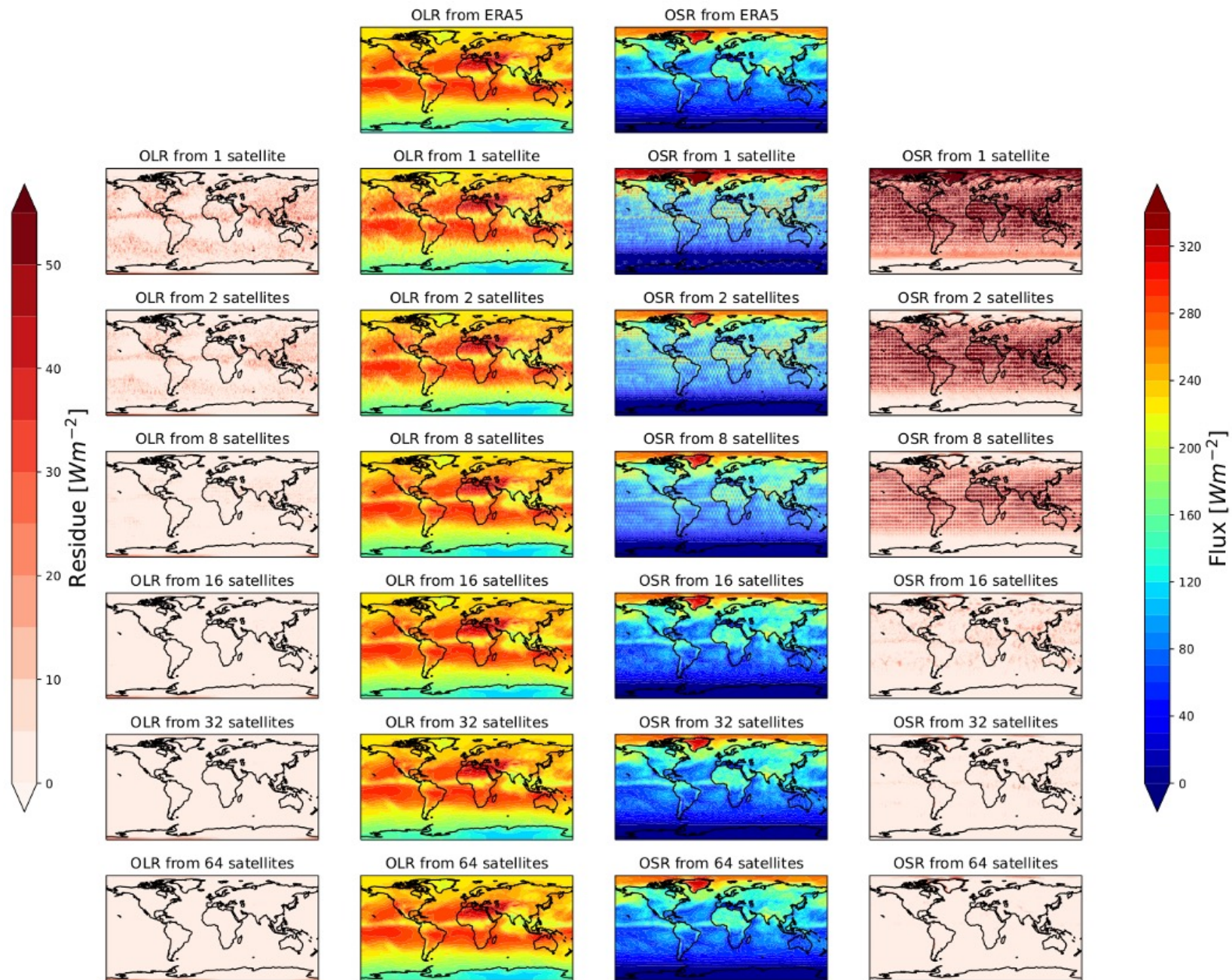
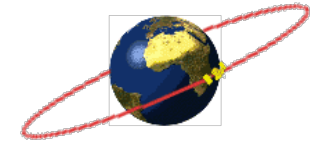
Produit	Fréquence	Résolution	Incertitude de mesure requise	Stabilité par décennie
Tableau de synthèse – Atmosphère				
Profil de température troposphérique	3 heures	25 km / 1 km	0,5 °C	0,05 °C
Profil de température stratosphérique	3 heures	100 km / 2 km	0,5 °C	0,05 °C
Tableau de synthèse – Composition atmosphérique				
CO ₂	3 heures	2-10 km / NA	1 ppm 0,2 ppm biais interrégional	0,2 ppm par décade
Colonne de CO ₂ troposphérique	3 heures	2-10 km / NA	1 ppm	1,5 ppm par décade
CO ₂ troposphérique	3 heures	2-10 km / 5 km	1 ppm	1,5 ppm
Colonne de Méthane troposphérique	3 heures	2-10 km / NA	10 ppb	7 ppb
Méthane troposphérique	3 heures	2-10 km / 5 km	0,5 ppb	0,7 ppb
Méthane stratosphérique	Journalier	100-200 km / 2 km	5 %	0,30 %

- To achieve these performance levels (time criteria), it is necessary to implement satellite constellations.
- Spatial resolution (< 30 km for Earth radiative budget, <10 km for convective cells and water vapor, etc.) and temporal resolution (3 hours).

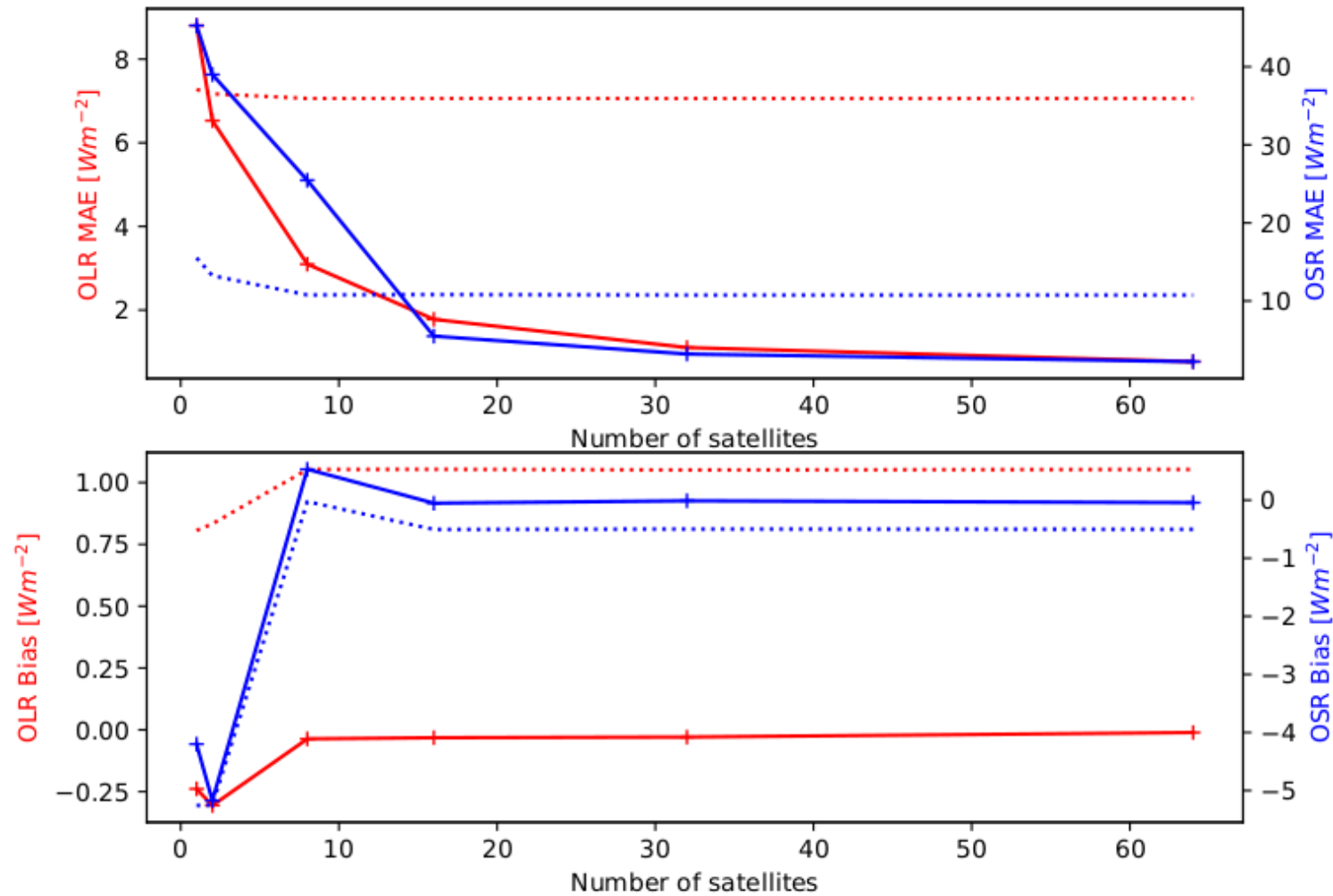
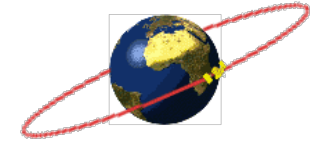
Satellites constellation



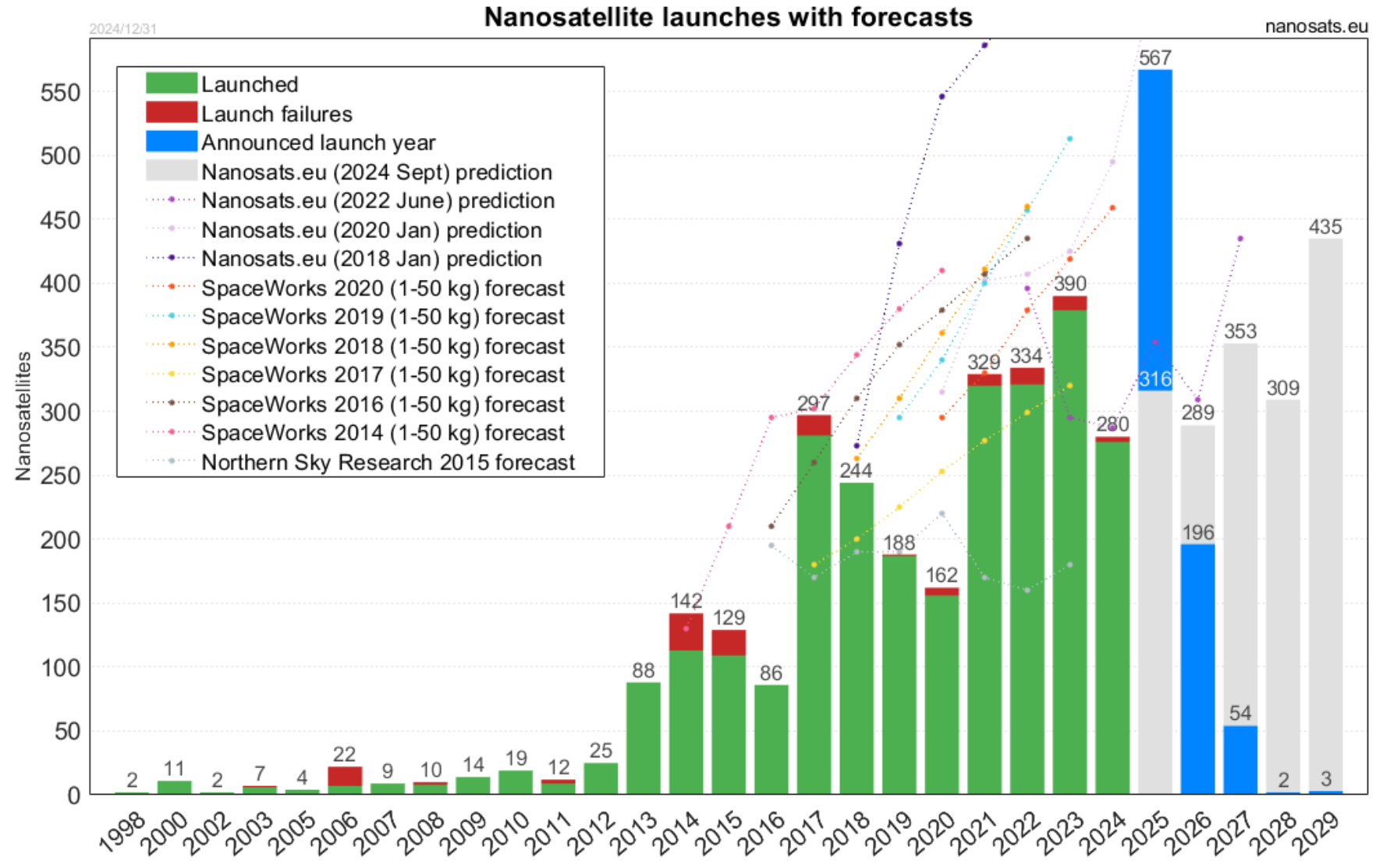
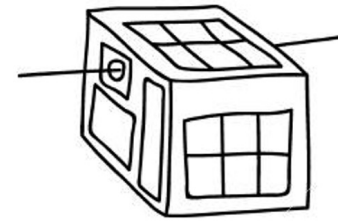
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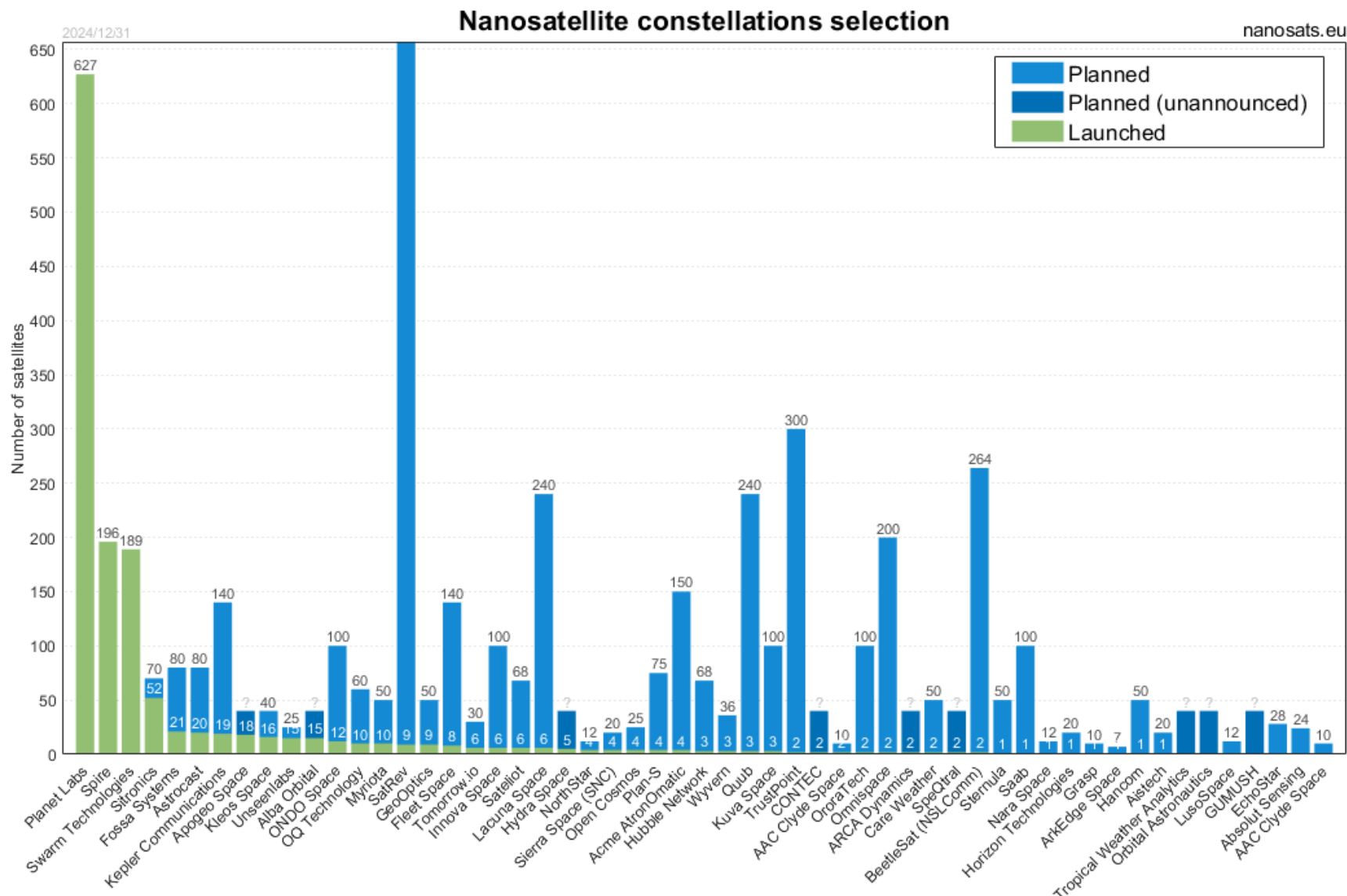
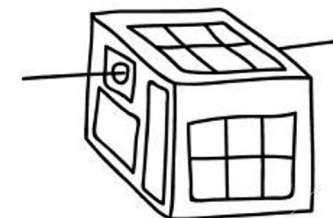
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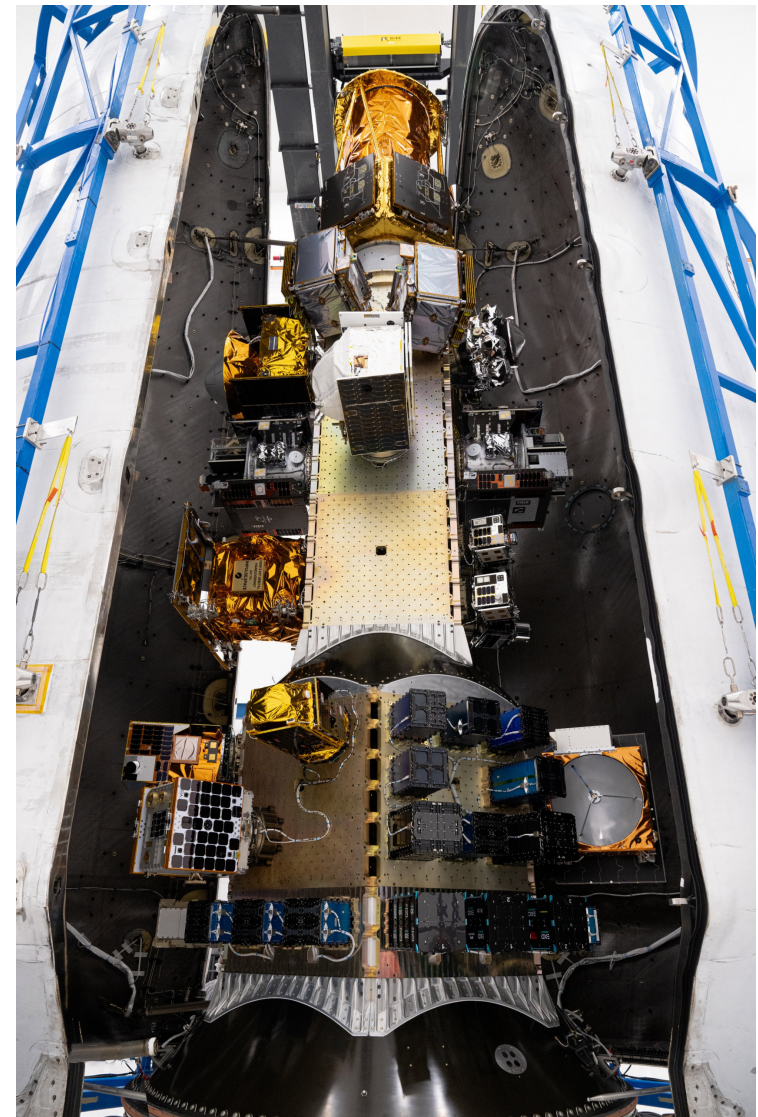
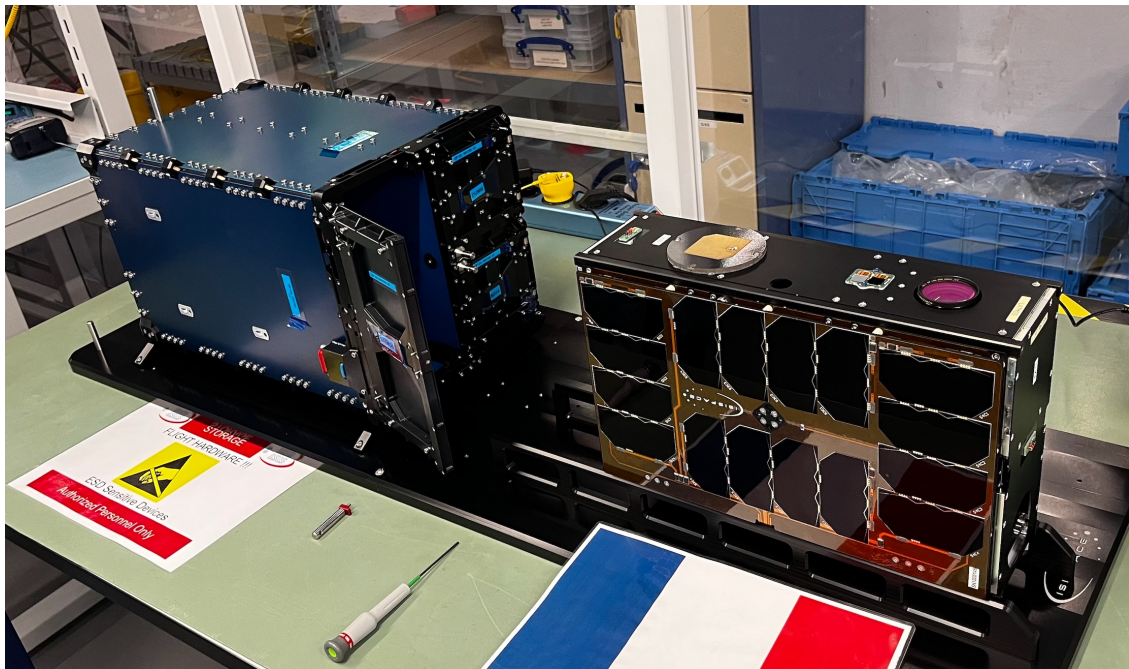
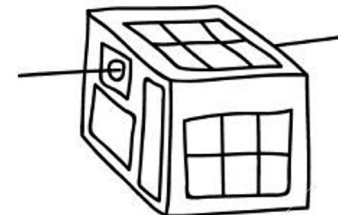
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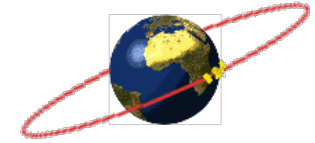
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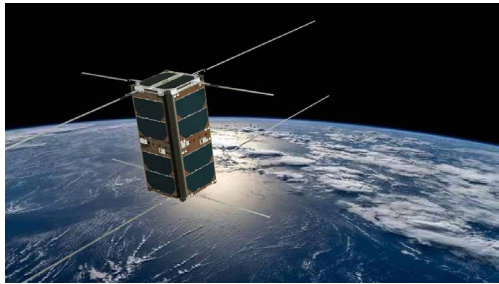
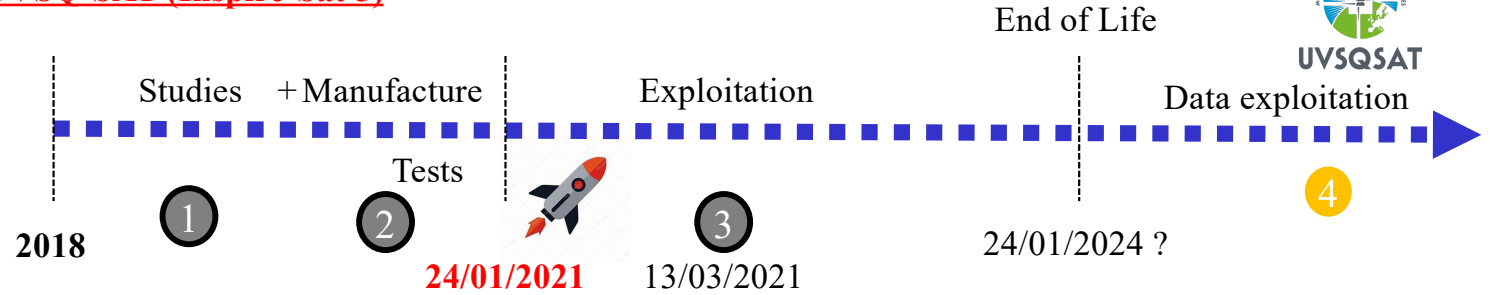
Satellites constellation



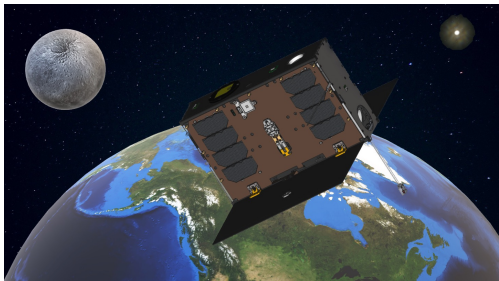
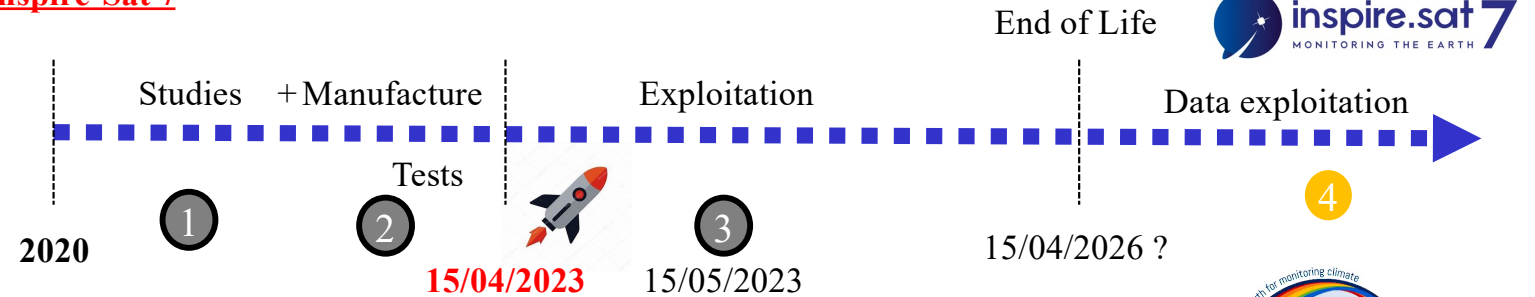
Satellites constellation



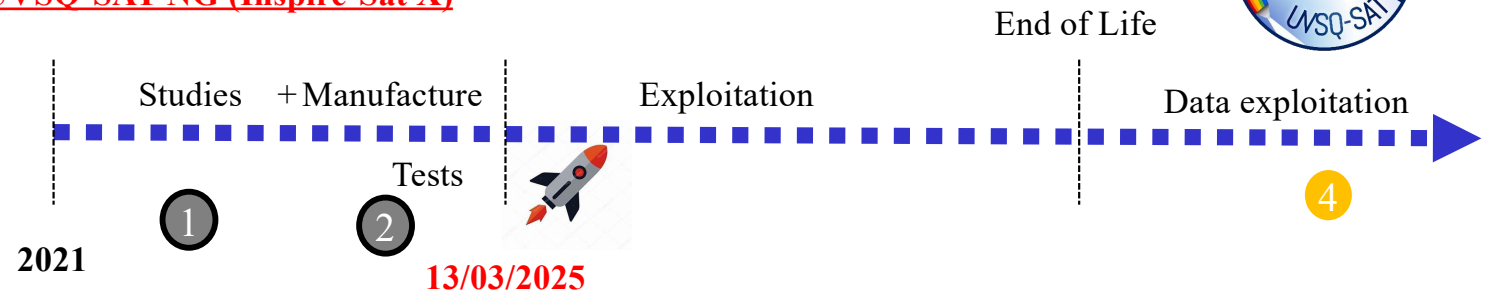
UVSQ-SAT (Inspire-Sat 5)



Inspire-Sat 7



UVSQ-SAT NG (Inspire-Sat X)



Phases 0/A, B, C, D

Phase E

Phase F

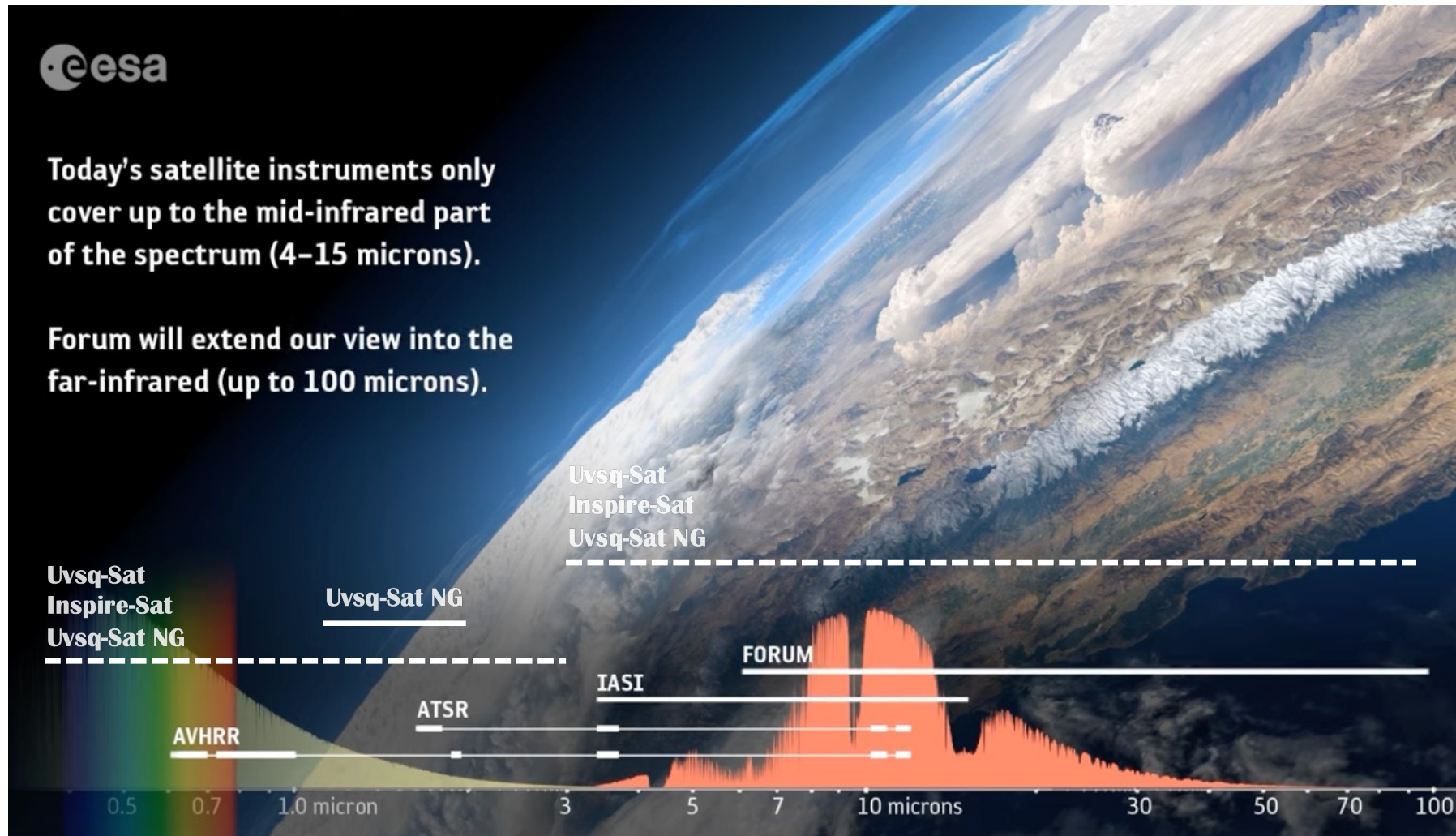
Satellites constellation

□ Requirements

Requirements for Uvsq-Sat—Launched on 24 January 2021 from Cape Canaveral, Florida, USA				
ECV	Absolute accuracy	Stability per year	Spatial resolution	Temporal resolution (global map)
OSR	$\pm 10.00 \text{ Wm}^{-2}$	$\pm 5.00 \text{ Wm}^{-2}$	2500 km per element	30 days with one CubeSat
OLR	$\pm 10.00 \text{ Wm}^{-2}$	$\pm 1.00 \text{ Wm}^{-2}$	2500 km per element	30 days with one CubeSat
Requirements for Inspire-Sat 7—Launched on 15 April 2023 from Vandenberg, California, USA				
ECV	Absolute accuracy	Stability per year	Spatial resolution	Temporal resolution (global map)
OSR	$\pm 5.00 \text{ Wm}^{-2}$	$\pm 1.00 \text{ Wm}^{-2}$	2500 km per element	10 days with two CubeSats
OLR	$\pm 5.00 \text{ Wm}^{-2}$	$\pm 1.00 \text{ Wm}^{-2}$	2500 km per element	10 days with two CubeSats
Requirements for Uvsq-Sat NG—Launch Date in 2025 or in 2026				
ECV	Absolute accuracy	Stability per year	Spatial resolution	Temporal resolution (global map)
OSR	$\pm 3.00 \text{ Wm}^{-2}$	$\pm 1.00 \text{ Wm}^{-2}$	2500 km per element	5 days with three CubeSats
OLR	$\pm 3.00 \text{ Wm}^{-2}$	$\pm 1.00 \text{ Wm}^{-2}$	2500 km per element	5 days with three CubeSats
CO ₂	$\pm 4.0 \text{ ppm}$	$\pm 1.0 \text{ ppm}$	2–10 km per pixel	> 30 days
CH ₄	$\pm 25.0 \text{ ppb}$	$\pm 10.0 \text{ ppb}$	2–10 km per pixel	> 30 days
Requirements for a Hypothetical Satellite Constellation Named Terra-F—Horizon 2035				
ECV	Absolute accuracy	Stability per decade	Spatial resolution	Revisit time
TSI	$\pm 0.54 \text{ Wm}^{-2}$	$\pm 0.14 \text{ Wm}^{-2}$	–	24 h
OSR	$\pm 1.00 \text{ Wm}^{-2}$	$\pm 0.10 \text{ Wm}^{-2}$	10–100 km per pixel	3 h
OLR	$\pm 1.00 \text{ Wm}^{-2}$	$\pm 0.10 \text{ Wm}^{-2}$	10–100 km per pixel	3 h
EEI	$\pm 1.00 \text{ Wm}^{-2}$	$\pm 0.10 \text{ Wm}^{-2}$	–	24 h
CO ₂	$\pm 1.0 \text{ ppm}$	$\pm 1.5 \text{ ppm}$	1–5 km per pixel	3 h
CH ₄	$\pm 10.0 \text{ ppb}$	$\pm 7.0 \text{ ppb}$	1–5 km per pixel	3 h

Satellites constellation

□ Synergy with other space-based missions



Synergy



Conclusions

Our main scientific goal is:

- **To observe essential climate variables with a constellation of small satellites.**

The INSPIRE goals are:

- To initiate a Space Program, and to teach courses related to Space.
- To have Laboratory facilities for hardware development and specialized personnel for teaching.
- To have facilities for building and testing CubeSat/small Instruments.
- To have ground stations for satellite operations.

Our positions are:

- To Design for simplicity and robustness:
 - Assume designs will fail and then prove they will work.
 - Design the satellite for easy assembly and disassembly.
 - Have respectable margins, robust safe modes, few deployables, graceful performance. degradation, and frequent preventative satellite resets.
- To Build an experienced team—it matters:
 - A successful team has veteran member(s) and frequent informal peer reviews (discussions) with proven subject matter experts.