

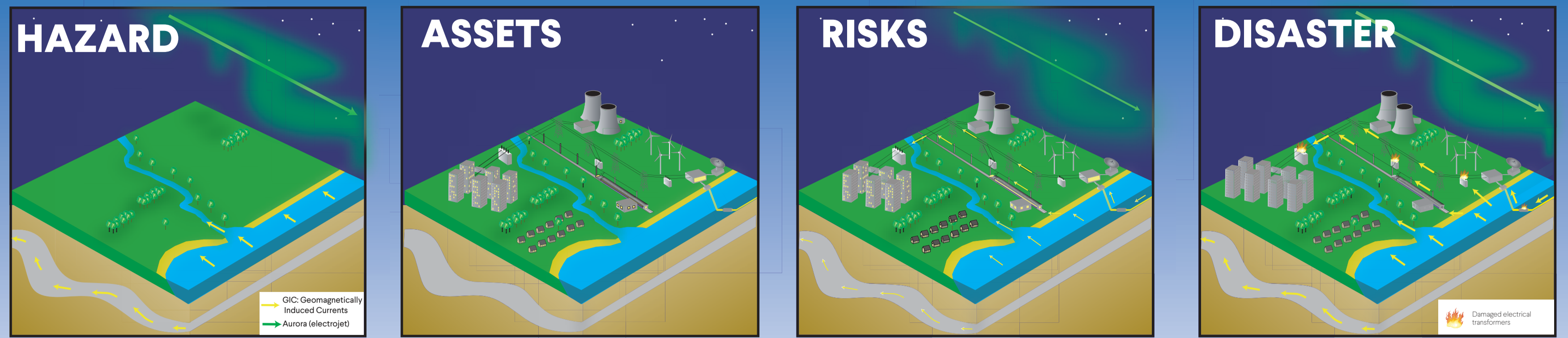
Space Weather and the Culture of Risk in Europe

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Abstract

Since its massive electrification, Europe has never faced a major geomagnetic storm at its mid-latitudes, unlike Northern America which has been affected three times (1921, 1946 and 1989). Hence, many European countries have little risk culture when it comes to this hazard; as it is often observed in major hazards, the absence of a memorable disaster does not help much in fostering prevention or reduction measures. A good example is that the ESA space weather website, which features myriads of observations and forecasts does not provide any content popularization or translation, confining the area to experts only. Many industries, including the rail industry, have not developed any standardized framework or action plan. Mid-latitude public hazard and emergency managers are little informed about the risks. Their ability to protect people and infrastructure are limited. Populations are hardly aware of this kind of hazard and are not in a position to build resilience against it. It is therefore essential to set forth the rational foundations of this risk culture - as may also be the case for other types of hazards- for the citizen to understand these issues and to support the relevant emergency measures. This poster presents the notion of major hazard in space weather by illustrating hazard materialization (ground or near-shore GIC-inducing auroral electrojet) and its impact on assets (a coastal plain crossed by high-voltage lines, an electric railroad, submarine cables, satellite captors...). Elementary Physics principles such as electromagnetic induction are popularized, but also the steps leading to geomagnetic storms. Technological systems are described in two phases: their operation during calm space weather, their potential disruption during extreme space weather conditions. A graphic design shows a home network likely to be affected, to explain that in exceptional circumstances, service providers will manage technical networks by decreasing operating power which will lead to slowdown or interruptions. A new format of official surveillance and alert notices is suggested including a pre-alert phase when an extreme geomagnetic storm is likely and an alert phase when it is confirmed as it is already done for hurricanes. Lastly, this poster suggests some needed forecasts for the return of hazards to European mid-latitudes to rationally reshape the culture of risk

Define the major risk



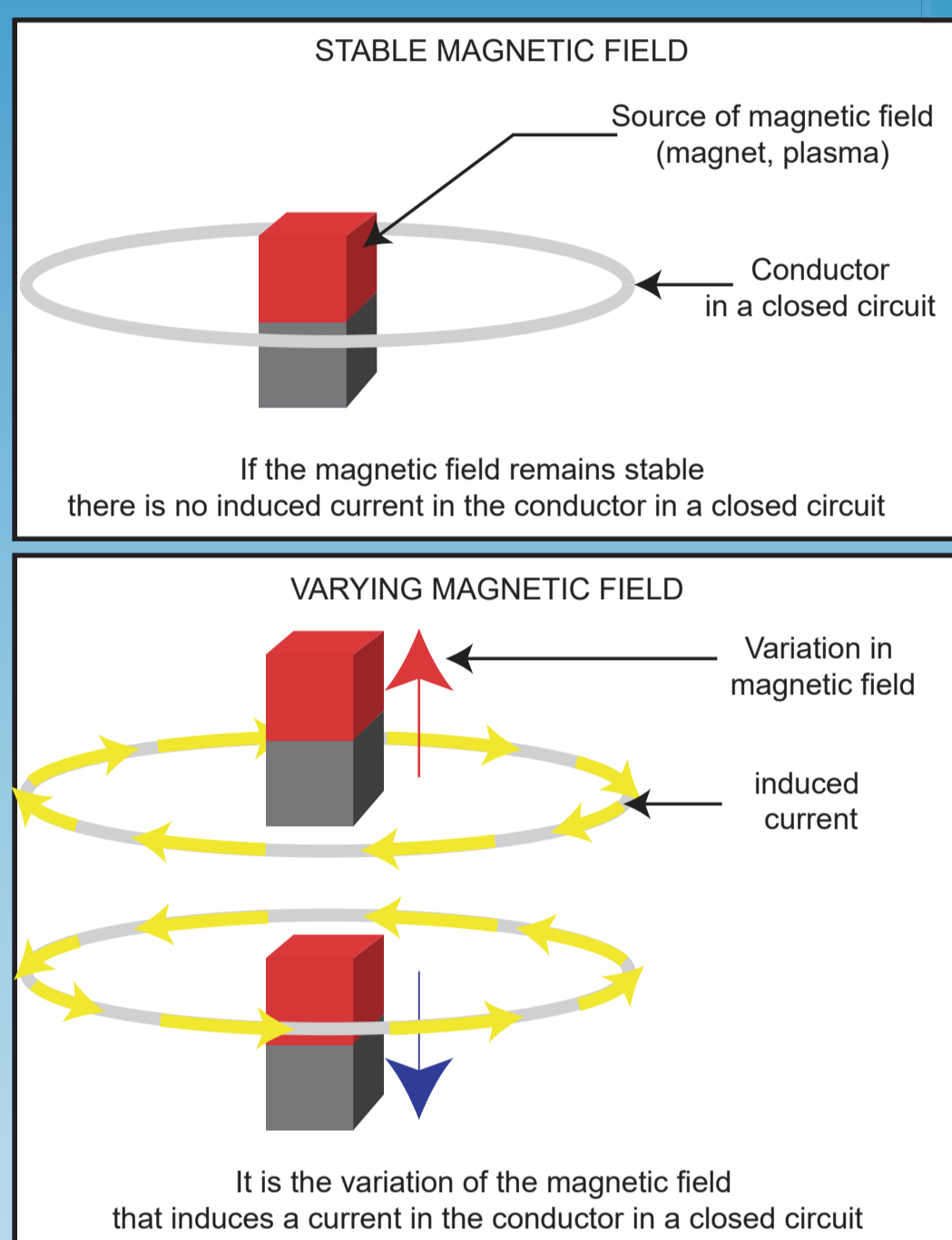
When a random natural phenomenon (hazard) has the potential to cause damage to people and property, and disrupt economic activities (assets), it becomes a risk. The scale of the disaster depends on the vulnerability of the exposed assets, in other words, their robustness or resilience in the face of a given event. Extreme events, when they occur in an area with many assets, generate major disasters. Obviously, major risks are characterized by infrequency but even more by their extreme impacts on assets.

For geomagnetic storms, the hazard here is represented by Geomagnetically Induced Currents (GIC), which can damage electrical infrastructure and consequently harm citizens and their economic activities (assets). This, therefore, constitutes a risk. It is a major risk because essential and vital infrastructure, including energy; communication and transportation systems, can be affected on a large scale.

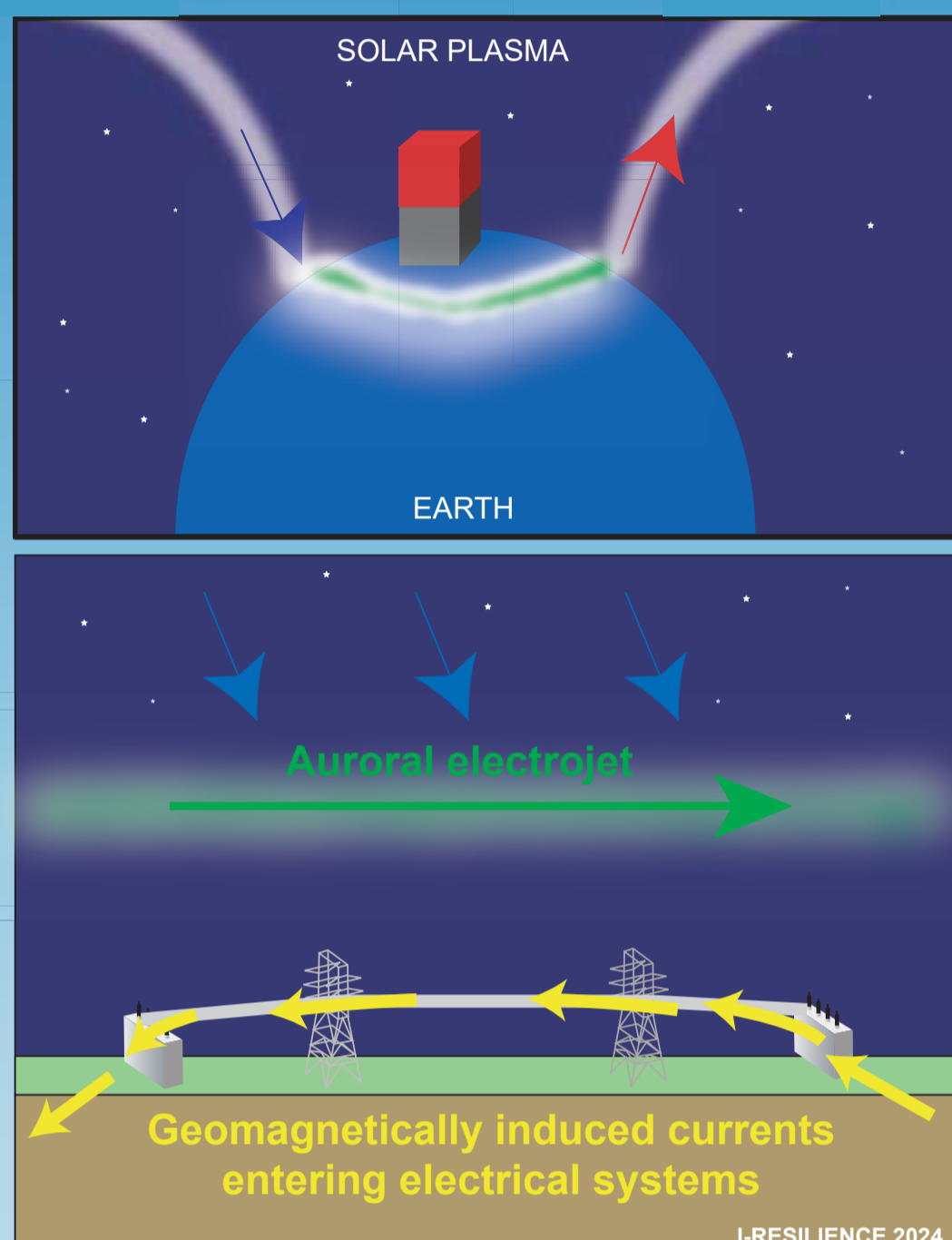
Communicate simply on the hazard

When addressing the general public, the explanation of physical phenomena, although complex in reality, needs to be simplified to middle school level. The aim is for the public to get a basic understanding of the hazard so that they can quickly take ownership of the risk and adhere more easily to the implementation of resilience strategies.

Electromagnetic induction



Geomagnetic storm

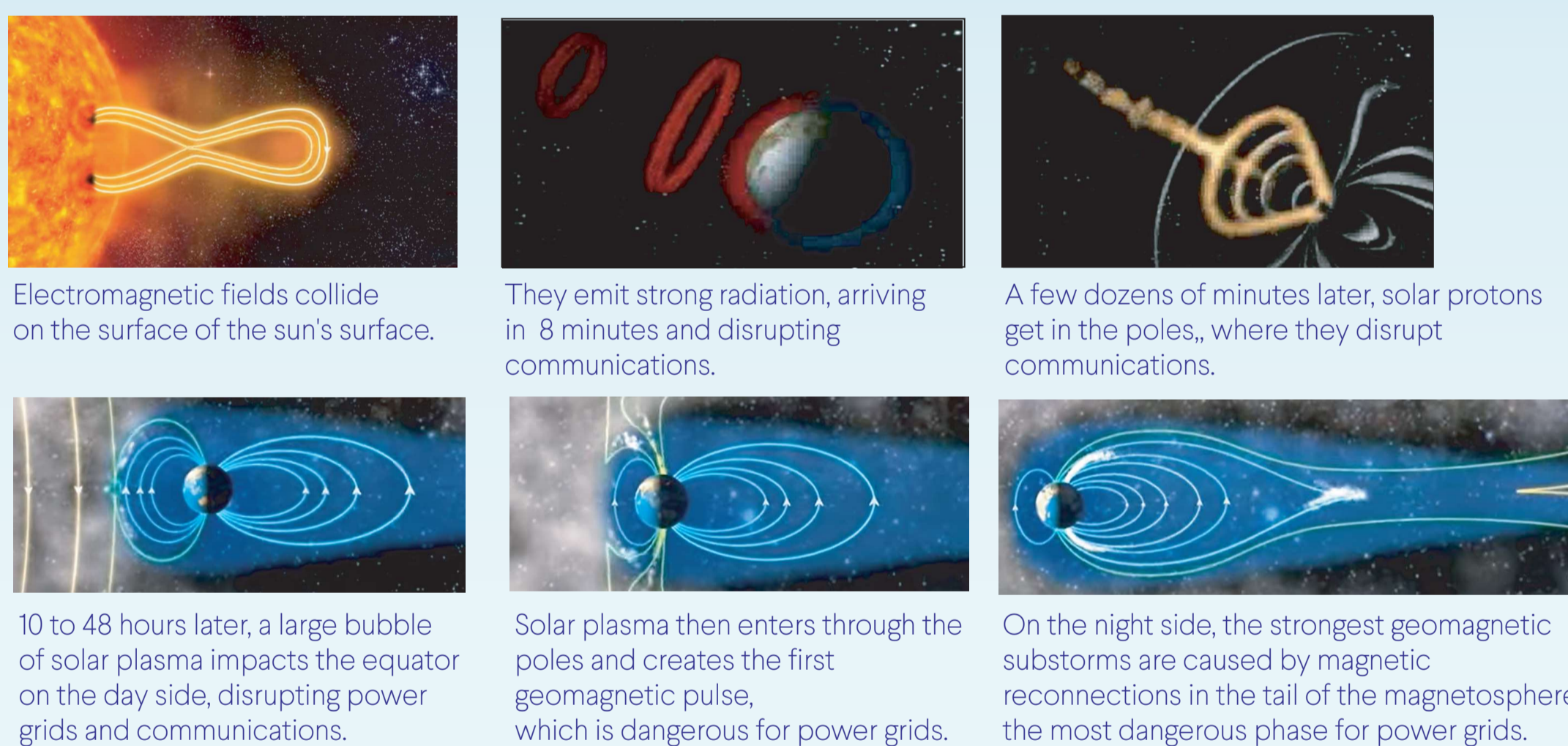


Foucault currents can also be popularised, but for a more scientific audience.

Illustrate the aurora

In order to make the hazard tangible, the aurora will be highlighted, even though areas without aurora may be affected by geomagnetic storms. Both the media and the general public will share images of the aurora during the geomagnetic event, making this reality tangible even if it cannot be directly observed by the exposed citizen. This representation of the hazard via the aurora is to be preferred to the more physical representation of a moving magnetic field which is more suitable to address science students.

Popularise the phases of a major solar event



Foster resilience

During weather warnings

Doctrine: Reducing power consumption

Prevention measures

Doctrine: Increasing autonomy in the face of long power cuts

Geomagnetic storms' surveillance and alert in Europe

Autonomy and lower power consumption

	Phases	Trigger	Advice to the public	Pictograms
Before the storm	Storm Watch	From 48h to 24h before the arrival of strong solar winds	- Follow the space weather, - Make sure you and your family know the instructions.	[Info icon]
Before the storm	Pre-alert	From 24h to 10h before the major storm hit	- Follow the space weather regularly, - Recharge your battery-powered devices, - Start switching off your non-essential appliances.	[Battery icon], [Power icon]
Before the storm	Alert	From 2h to 30 min before the major storm hit	- Follow the space weather continuously, - Finish charging your batteries, - Switch off all non-essential appliances.	[Battery icon], [Power icon]
During the storm	Power reduction, Blackouts	During the major storm (from 6h to 2 days or more)	- Stay on low power to save your batteries and relieve the networks (electricity, water, internet...).	[Power icon]
After the storm	Power reduction, Blackouts	As soon as the storm has ceased	- Priority to emergency services in use of the networks, - Stay on low power.	[First aid icon], [Power icon]
After the storm	End of alert phase	Possibility of persistent power cuts	- Help people who are weakened by the length of the cuts, - Follow the instructions of the authorities.	[Help icon]

Individual actions:

- ◆ Consider the car as an emergency source of energy,
- ◆ Family plans and helping neighbours when the grids are unavailable.

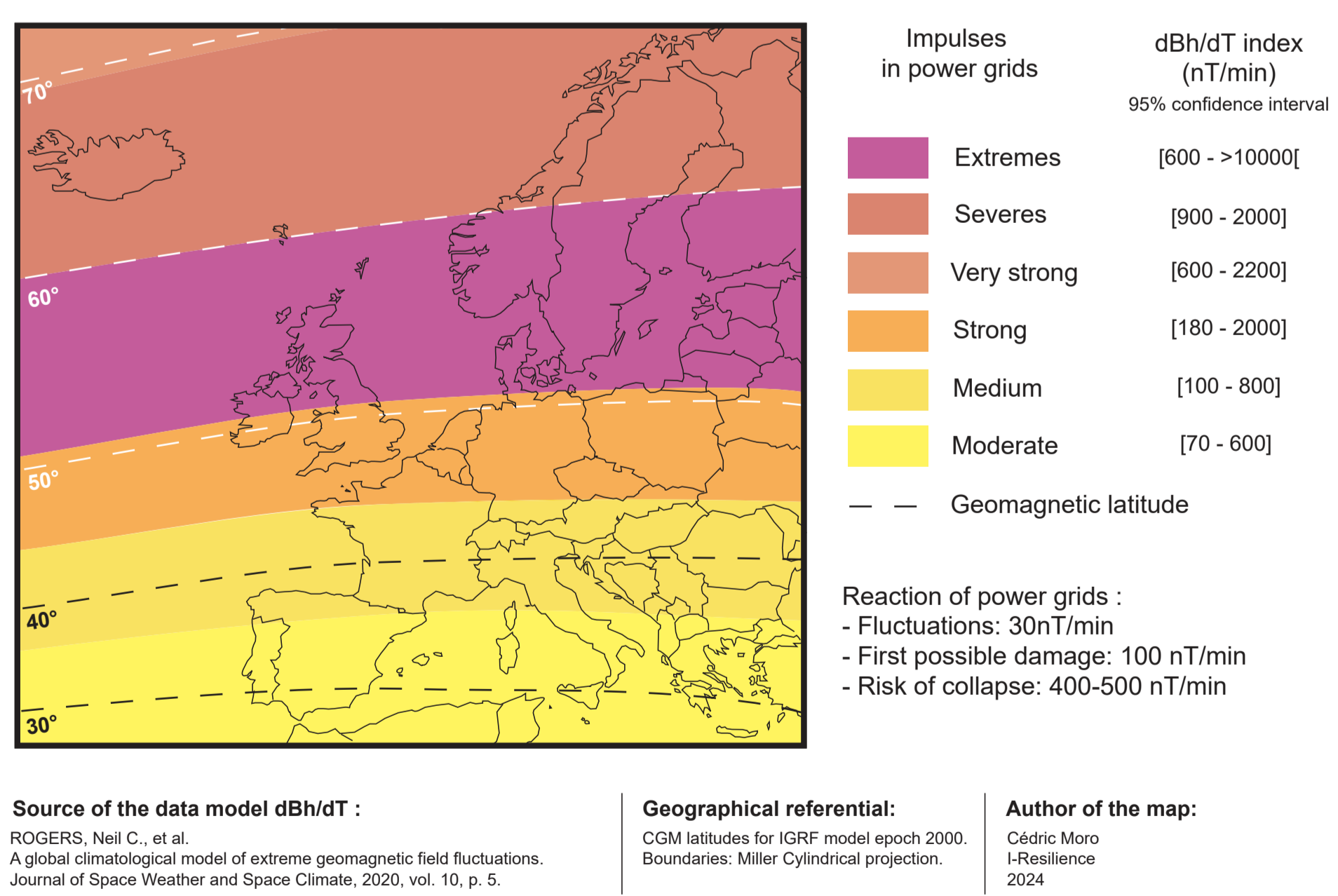
Public actions:

Space weather must now incorporate all emergency and prevention plans.

Don't forget to adapt these suggestions to your local context (translations, cultural elements, maps, etc.).

Map the risks

100-year geomagnetic pulses in Europe



Source of the data model dBh/dT : ROGERS, Neil C., et al. A global climatological model of extreme geomagnetic field fluctuations. Journal of Space Weather and Space Climate, 2020, vol. 10, p. 5. Geographical referential: CGM latitudes for IGRF model epoch 2000. Boundaries: Miller Cylindrical projection. Author of the map: Cédric Moro i-resilience 2024

The whole of Europe is affected by risk. It needs a much more detailed risk map than this one.

Awaken the memory of risk

Date	DST (nT)	Auroras or techno impacts
17 sep 1770	-900 à -1300	Mid-lat Eur, East Asia
2 sep 1859	-800 à -1200	Mid-lat Eur, North Am
15 may 1921	-775 à -1039	North Am.
4 feb 1872	-830	Mid-lat Eur, Everywhere in the world
25 sep 1909	-595	Mid-lat Eur, North Am.,
13 mar 1989	-589	North Am., North Eur, UK
31 oct 1903	-513	Mid-lat Eur, North Am., Central Asia
28 mar 1946	-512	North Eur, North America

The era of mass electrification and major HV networks European mid-latitudes

Since its massive electrification, mid-latitude Europe has never been hit by a major geomagnetic storm.

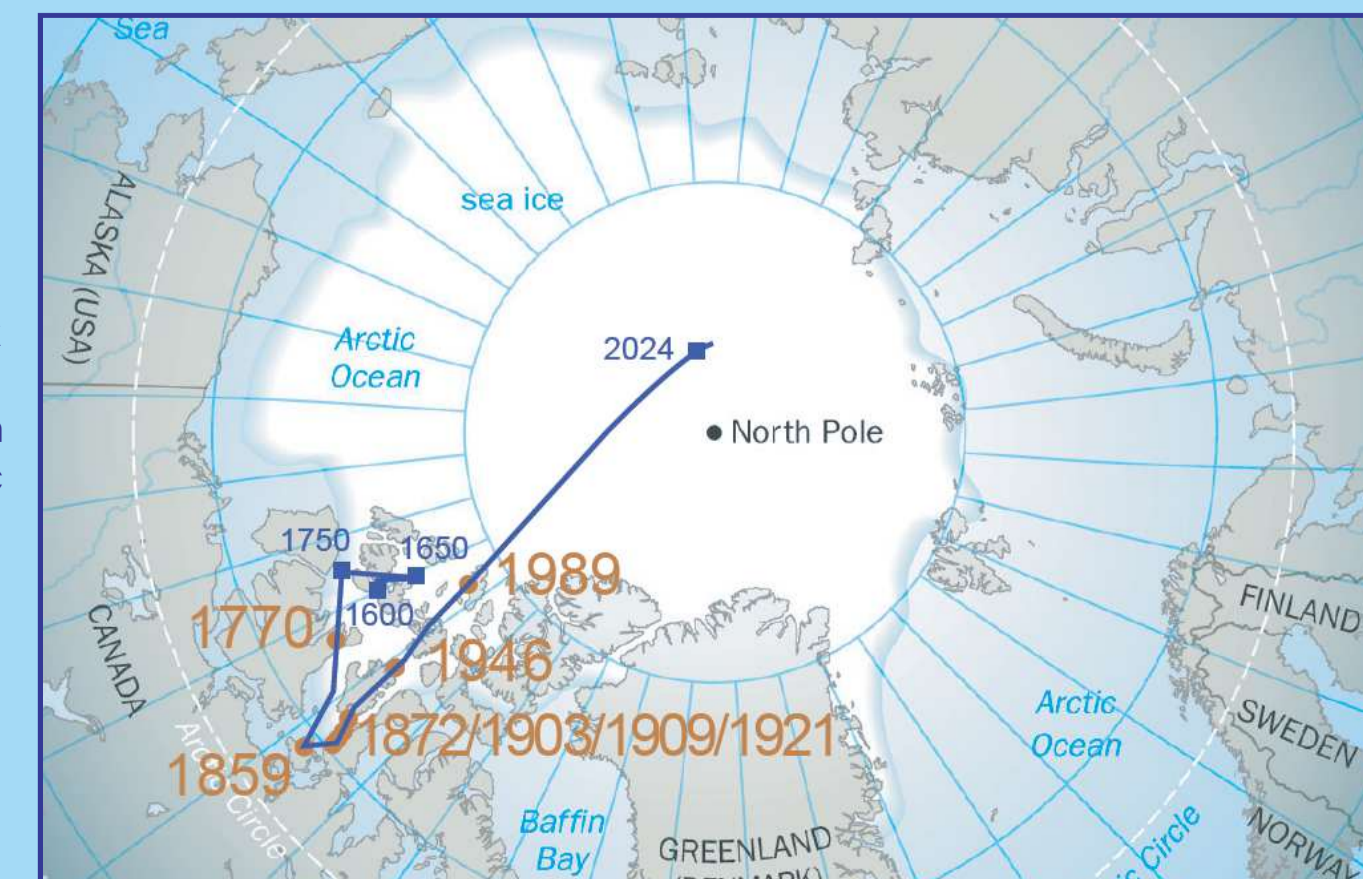
In national and local press archives, identify the impacts of major geomagnetic storms (auroras, disrupted power lines, Telegraph, telephone, railway lines, etc).

Discussion

The North Magnetic Pole was located over North America. America is almost always affected by major storms, unlike other continents

Since 1989, 35 years have passed, there has been no major geomagnetic storm (DST index below -500nT), despite fairly active solar cycles. This relatively calm period began with the very rapid migration of the North Magnetic Pole over the Arctic Ocean in 1990.

The Continental zone that will host the relatively stabilized North Magnetic Pole could therefore be the most exposed, all the more so if it is positioned low in latitude, as was the case in 1859 during the Carrington event.



Conclusion

Since the emergence of monotheistic religions, the crucial role of the sun has been repressed in the collective unconscious. Hence, megalithic sites have declined to the benefit of revealed religions and further, to the benefit of science, which carries the promise of a humanity in control of its future. The lights of the sun eventually gave way to mankind's enlightenment. In this immaterial path, many astrophysicists are over-reassuringly insisting on the protective role of the magnetosphere while consciously knowing how our technological societies are exposed to major solar hazards. So, is claiming the power of the sun in our societies unconsciously deemed to be a regression? Could we not escape existential anxiety entrapment and argue in favor of an acceptance of the relative and slight vulnerability of the magnetosphere, to which our societies will survive but to which they could be better prepared?