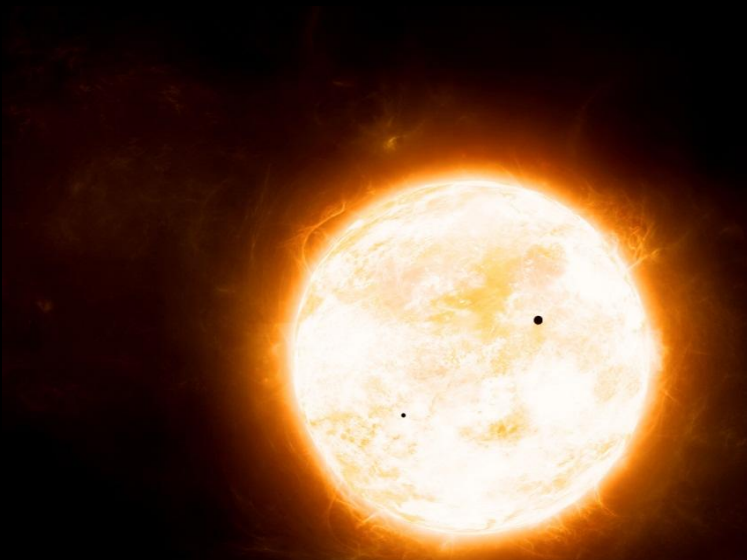

Observation implementation lessons learned and the effect of the global pandemic on future strategies.

Focus on Achieving TSSI Measurements from Space

This will be a Science talk,
but not a Physical Sciences or Engineering talk,
it will be a Social Sciences and Political Sciences talk.

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The pros and cons of the many past strategies used for solar irradiance measurement capture and the evolution history to insure data continuity.

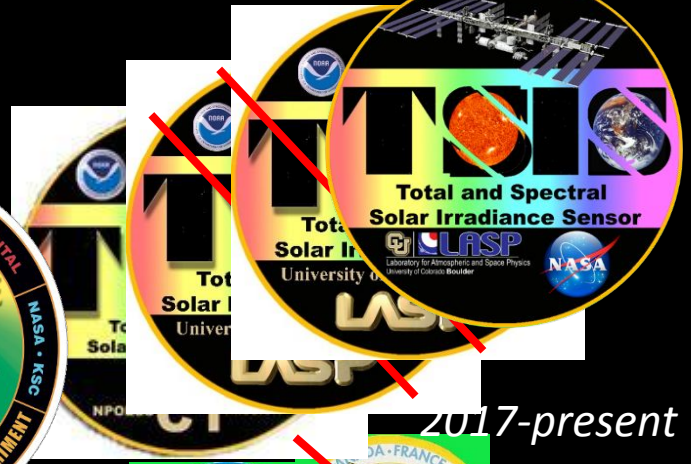
LASP Sun/Earth Climate Monitoring Mission History

Over 4 decades of LASP/GSFC solar irradiance measurement continuity…

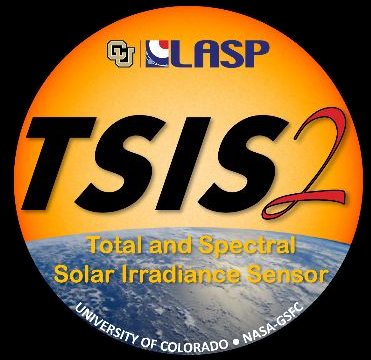
37 studies completed

1991-2005

2003-2020



2017-present



2024-

Long-term strategy

2028-

1998-2017

2018-2022

2010-2013

Launch failed

2013-2017 (TSI)

2022 -

New Tech Demos (ESTO)

1981-1989

One activity ranks above all others for determining solar influence on global change: Monitor the total and spectral irradiance from an uninterrupted series of spacecraft radiometers employed in flight sensitivity tracking"
"Solar Influence on Global Change"
(1994 National Academy of Science Report Reaffirmed in 2007 by NAS))

Scramble to keep continuity

46 years of overlapping measurements

Sustainable solution

How did the SORCE/TSIS evolution to multiple copies come about?

- Transition of responsibility was transferred from NASA to NOAA for the continuation of the Data Records for solar irradiance.
  - NOAA bases its measurement acquisition on Weather Model
    - (like a news paper, need data more quickly than accurately)
  - Climate Data acquisition takes commitment and high accuracy
    - (like a journal, well reviewed and takes time to compose, highly accurate)
- This created a scramble to insure overlapping measurements with a push for large platform implementation despite observational target being the sun not the earth
- 37 studies done by NOAA, NASA and industry, 32 concluded that a free-flyer, follow on to SORCE was optimal implementation.

Misperception that building a copy is easer/cheaper

- We have been able to do a direct comparison between the GOES EXIS instruments (4 identical copies flying on identical platform) and 4 TIM instruments and 3 SIM instruments (built years apart and accommodated on extremely different platforms).
- Because the accommodation considerations are so critical in instrument design, dramatically changing accommodation has a great impact on implementation.
  - TIM & SIM designed to fly on SORCE spacecraft with Pegasus launch
  - To keep the SORCE TIM/SIM designs NPOESS allocated $141M to the S/C for accommodation (3x the cost of the instruments)
  - NPOESS did not go forward (3 years lost in this pursuit)

Rebuild of the instruments

- GOES EXIS built 4 instruments at the same time and stored them for distribution onto the GOES R,S,T,U platforms
  - Cost savings greater than 30% by parallel build to identical spacecraft interfaces.
- 4 TIM & 3 SIM instruments built years apart each to a different spacecraft interface.
  - Parts obsolescence
  - Facilities obsolescence
  - Re-learning of the fabrication skills and jigging and fixturing each time. (+ pandemic implications on personnel availability)
- No cost savings realized

Complex integration required to existing assets

- During this time the Space Shuttle stopped flying to the International Space Station which reduced the contamination environment.
- Therefor TSIS could be supported on the ISS. A complex pointing platform to allow for the find solar pointing and create an interface environment that matched the instruments was constructed $60M
- ISS was disciplined and well documented so we could proceed optimally maintaining the instrument interface to match SORCE.
- We were driving for a long term solution and started work with ESTO in developing technologies to reduce cost and improve performance for the TSIS measurements.
- In parallel we achieved the Compact versions of TIM and SIM

Evaluation and lessons learned from the global pandemic on current and future implementation of space systems data acquisition with emphasis on the TSI and SSI data records.

How hybrid working took hold in science
https://www.nature.com/articles/d41586-022-00729-9

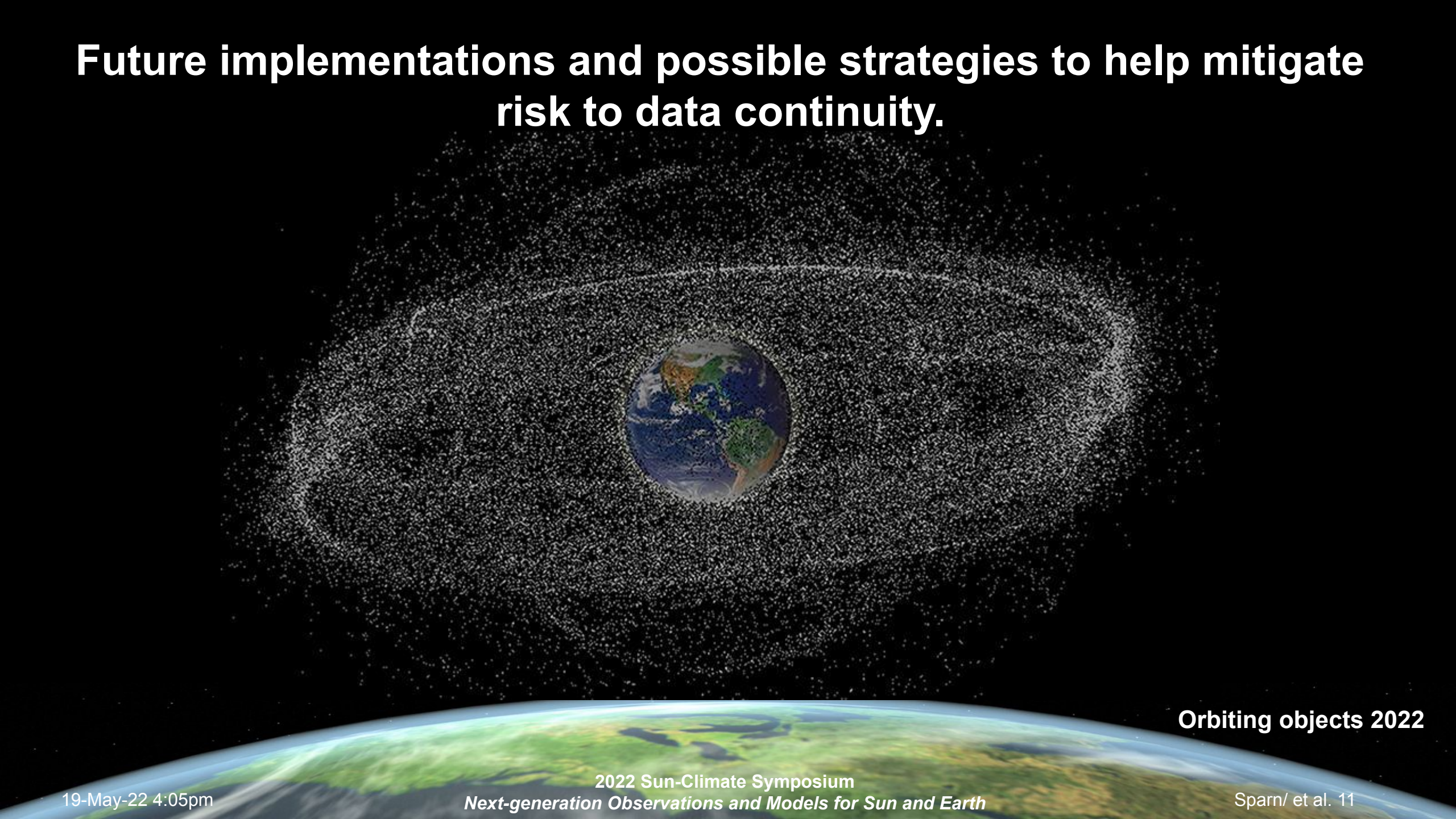
The Pandemic has been extremely challenging so what have we learned?

- Productivity has been greatly reduced and the return toward "normal" is resulting in a new way of doing business.
  - We kept carful tabs on engineering/production productivity throughout the Pandemic. 80% productivity from pre-pandemic is what has been achieved to-date.
  - The workforce has been altered and diminished. People entering the Aerospace/NASA work force were inspired but that has greatly faded. Attitudes are more "self centered".
  - A universal shortage of skilled trained engineers is a driving factor due to many retirements and fewer people inspired to commit to Scientific programs with limited bonus or financial incentive structures.

Tremendous Social impacts had great affects throughout industry

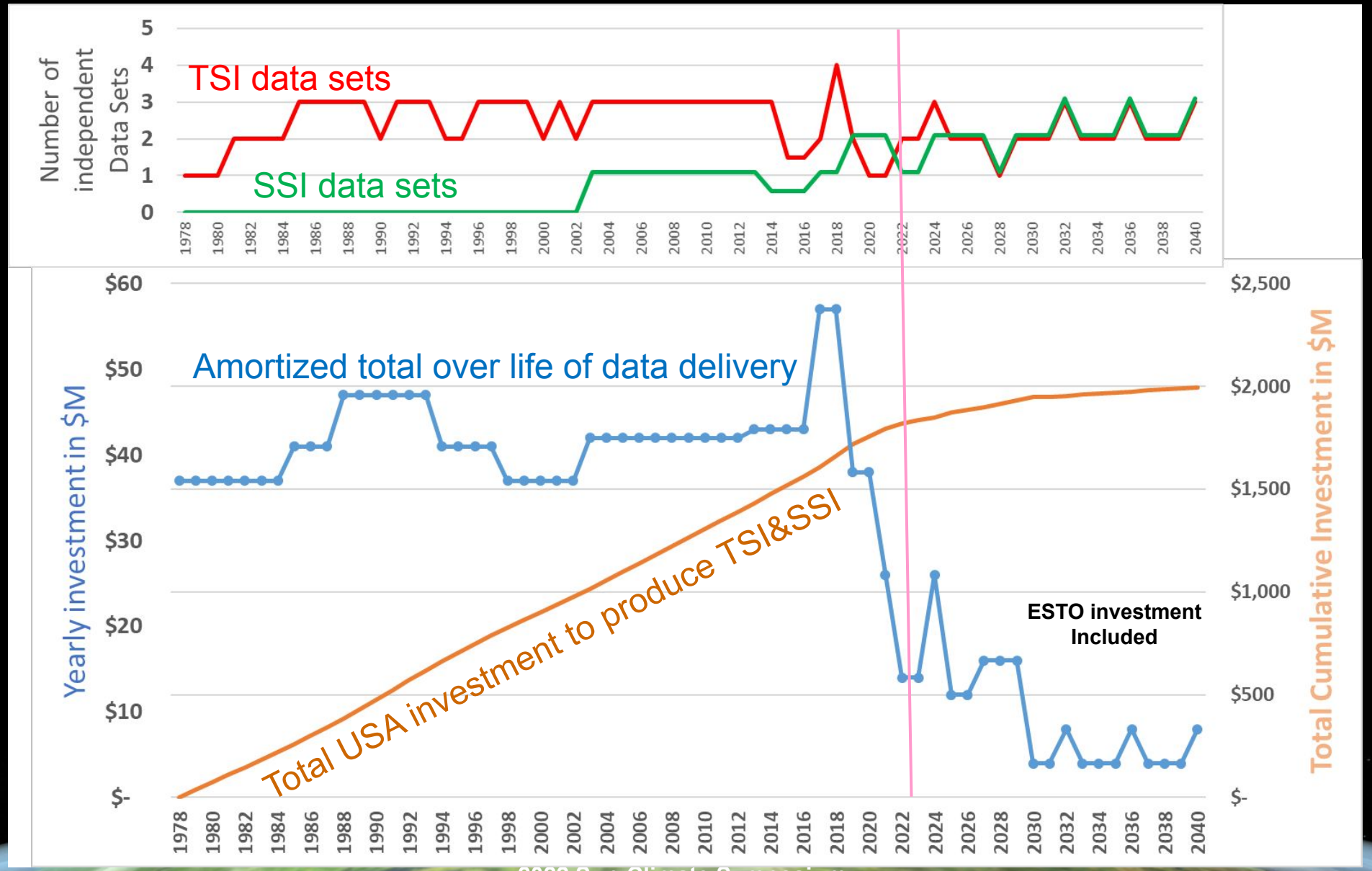
- Partnership
  - It is always important to establish and maintain good working relationships among the team and especially between organizations.
  - During the pandemic, with travel limited or flat-out eliminated the face-to-face meetings we normally enjoy, our working relationships suffered at every level.
  - Instruments are not COTS items and require a partnership to achieve the Science return for which they were selected. Distancing due to C19 created an environment where it was easier to look at complex instruments as COTS and much is lost by this approach.
- Communication
  - Not only have we all become Zoom adepts (or is it Zoom abhorrers?) during the pandemic, but, sadly, many of us have become more reclusive—either as a result of our medical needs or by the simple fact that the world was shut down around us.
  - At LASP, this hit especially hard, because we've come to rely on informal hallway or "water cooler" style conversations to facilitate key information transfer—things like design information, production coordination, testing logistics, or even simple, but important, personal matters like how the family or the pets are doing.

Future implementations and possible strategies to help mitigate risk to data continuity.

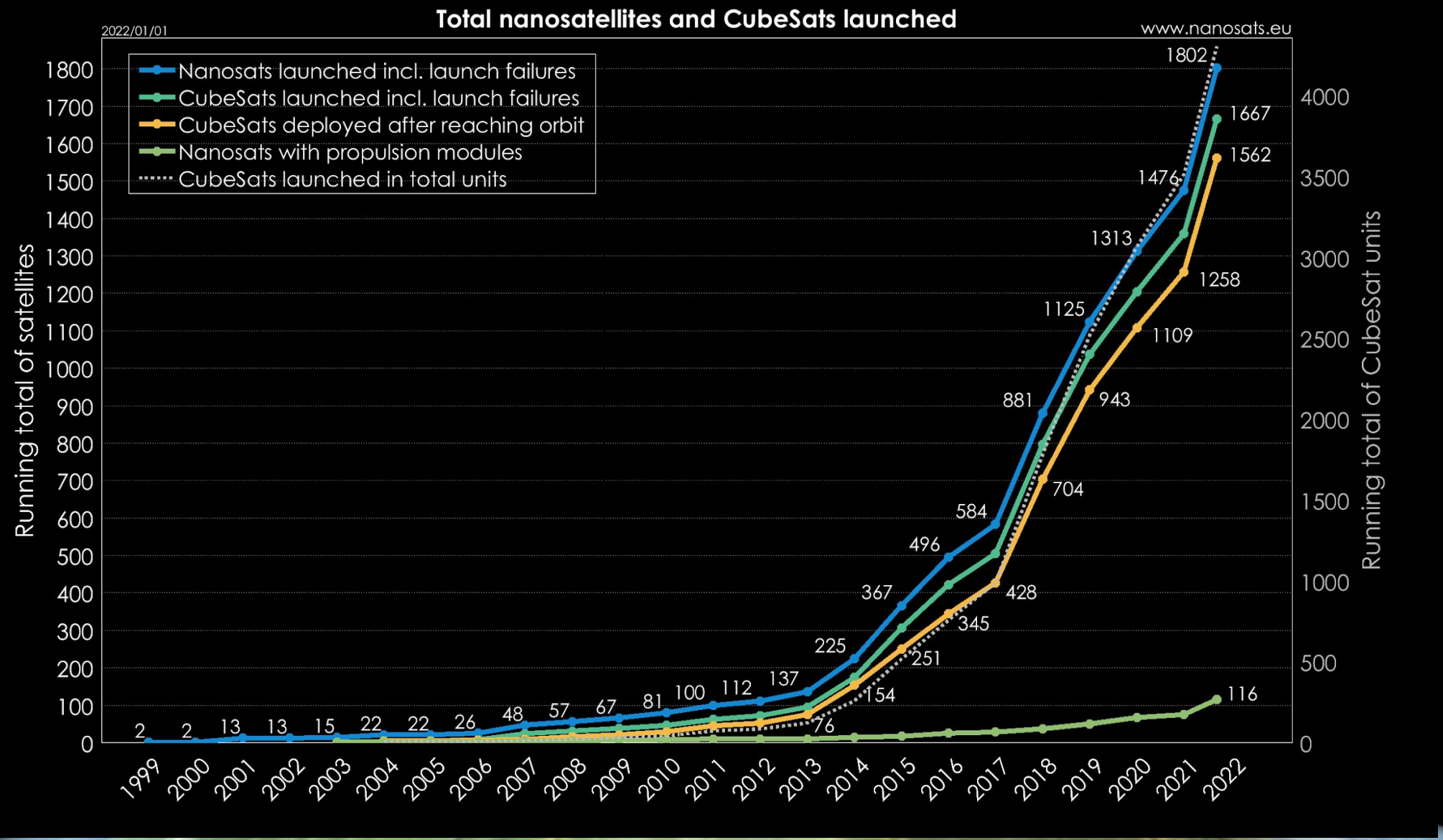


Orbiting objects 2022

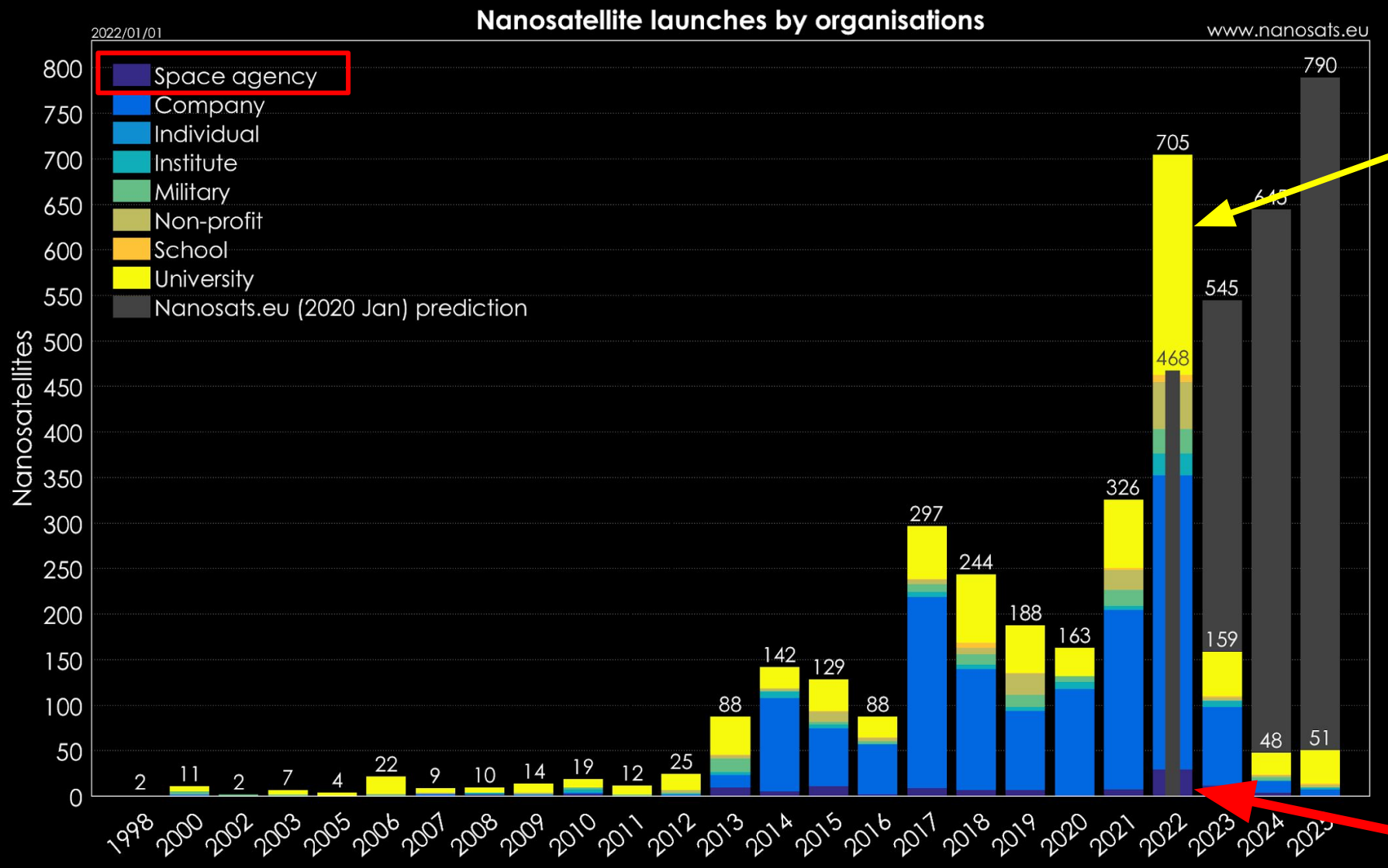
Climate takes commitment (USA investment History)



CubeSats in the future (Too Much of a good thing?)



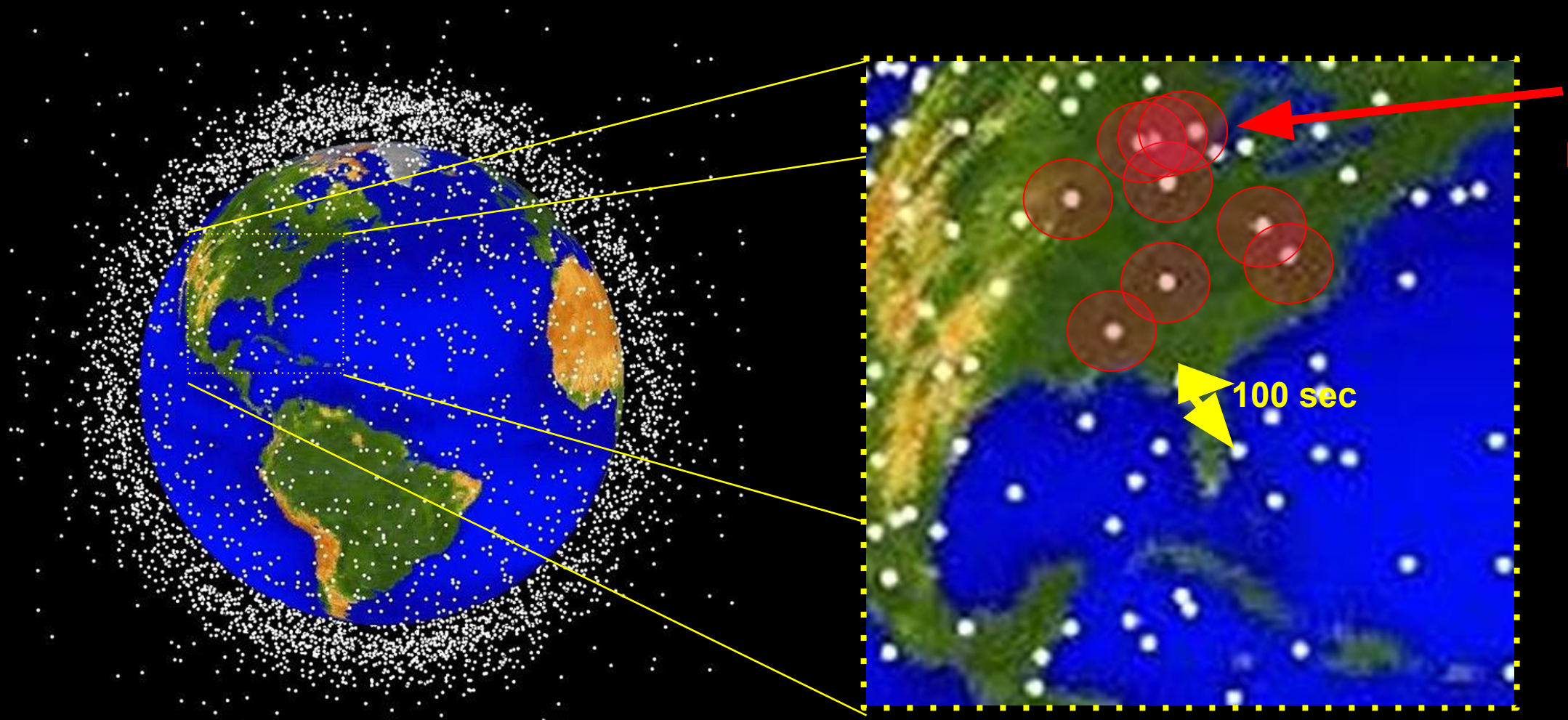
CubeSat launches by organization



Many University launch's include Scientific research

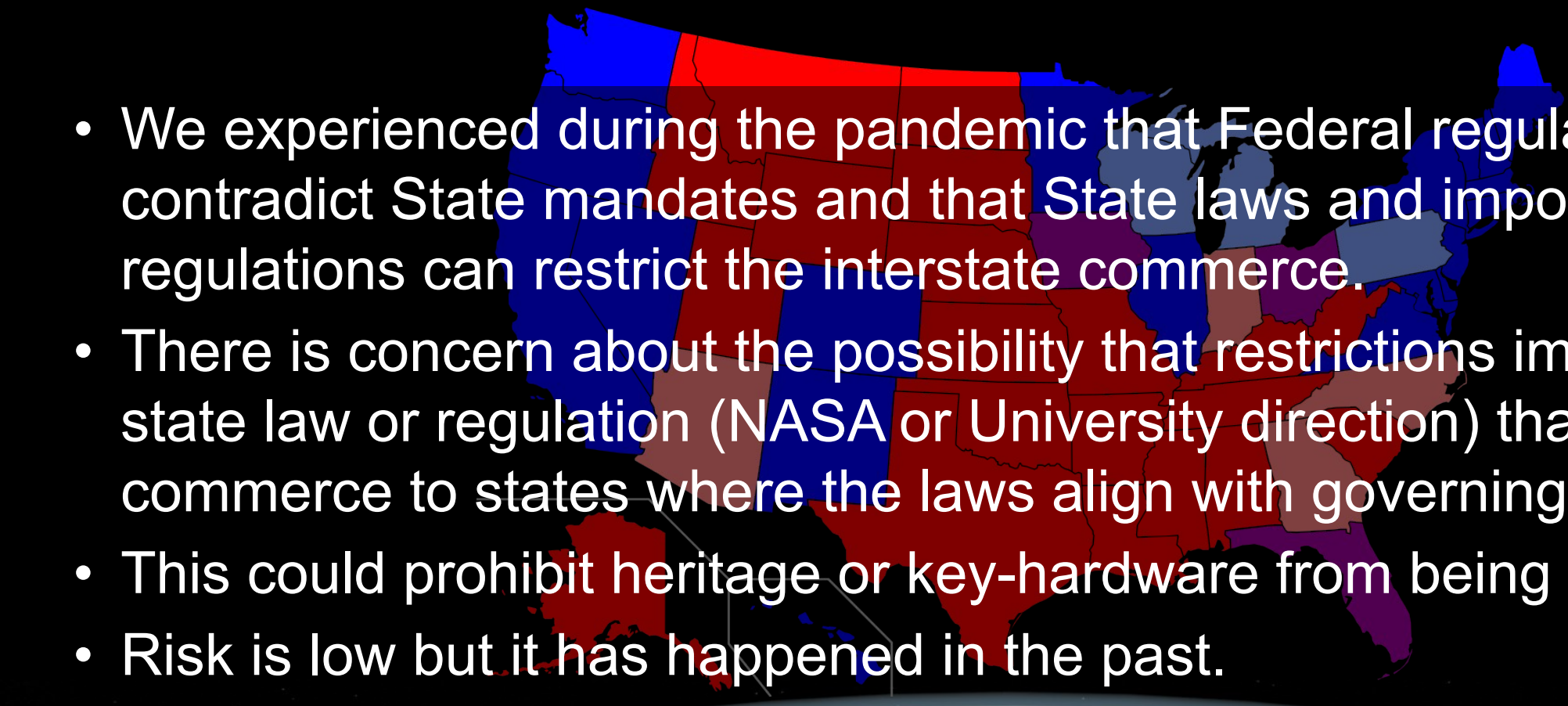
NASA is a very small percent of launches

Future concern regarding Scientific observations via CubeSats



Dots are not to scale. They are 60,000 times larger than a cubesat would appear.

The growing polarization of the United States political environment may impact future implementations and possible strategies to help mitigate risk to data continuity.



- We experienced during the pandemic that Federal regulations can contradict State mandates and that State laws and imposed regulations can restrict the interstate commerce.
- There is concern about the possibility that restrictions imposed by state law or regulation (NASA or University direction) that restrict commerce to states where the laws align with governing state.
- This could prohibit heritage or key-hardware from being used.
- Risk is low but it has happened in the past.