National Aeronautics and Space Administration

CLIMATE CHANGE FROM SPACE

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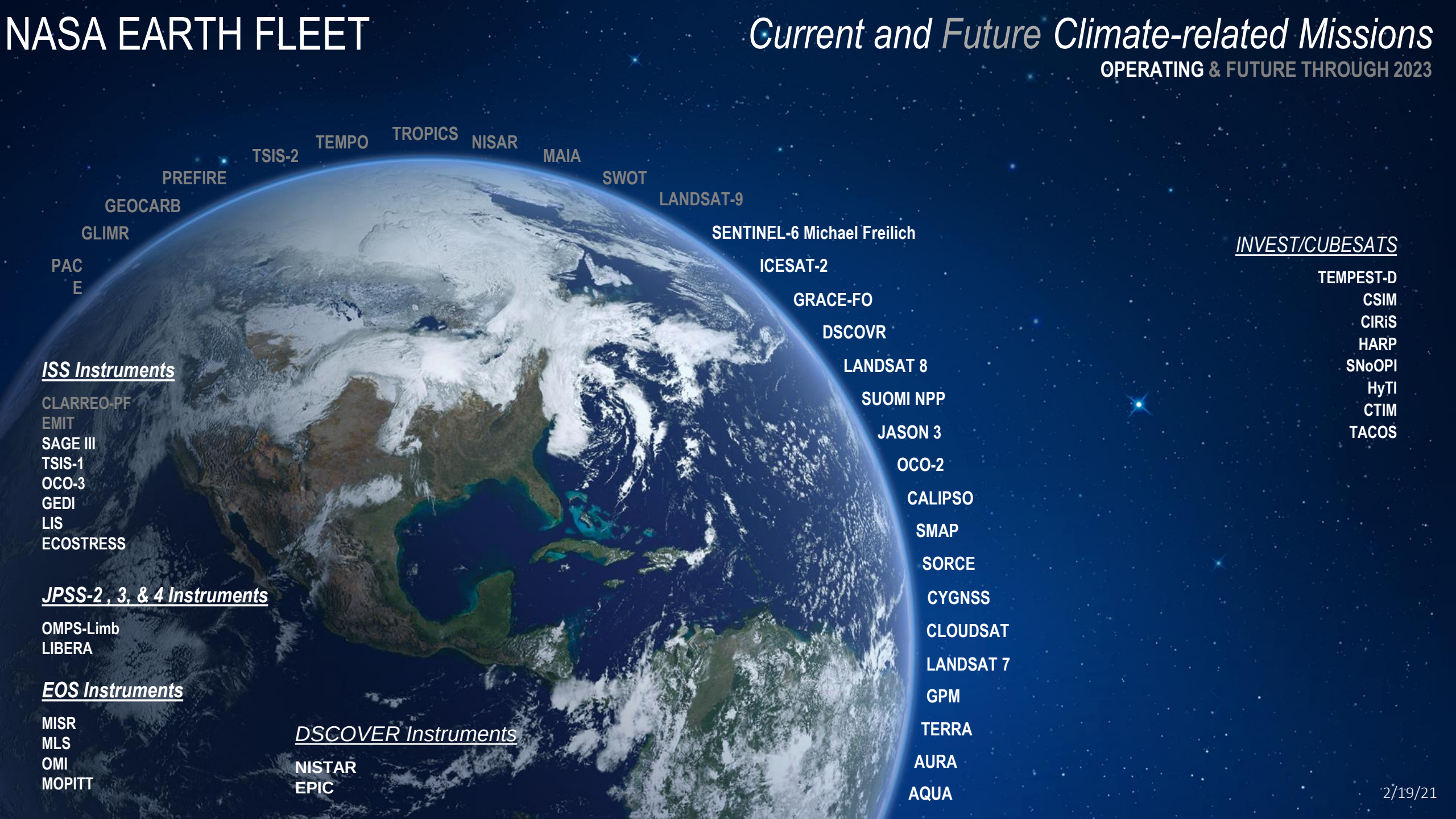
NASA EARTH FLEET

Current and Future Climate-related Missions

OPERATING & FUTURE THROUGH 2023



PAC E
GLIMR
GEOCARB
PREFIRE
TSIS-2
TEMPO
TROPICS
NISAR
MAIA
SWOT
LANDSAT-9
SENTINEL-6 Michael Freilich
ICESAT-2
GRACE-FO
DSCOVR
LANDSAT 8
SUOMI NPP
JASON 3
OCO-2
CALIPSO
SMAP
SORCE
CYGNSS
CLOUDSAT
LANDSAT 7
GPM
TERRA
AURA
AQUA

ISS Instruments

CLARREO-PF
EMIT
SAGE III
TSIS-1
OCO-3
GEDI
LIS
ECOSTRESS

JPSS-2 , 3, & 4 Instruments

OMPS-Limb
LIBERA

EOS Instruments

MISR
MLS
OMI
MOPITT

DSCOVER Instruments

NISTAR
EPIC

INVEST/CUBESATS

TEMPEST-D
CSIM
CIRiS
HARP
SNoOPI
HyTI
CTIM
TACOS

2/19/21

Climate Change: Observations

Mountain Glaciers

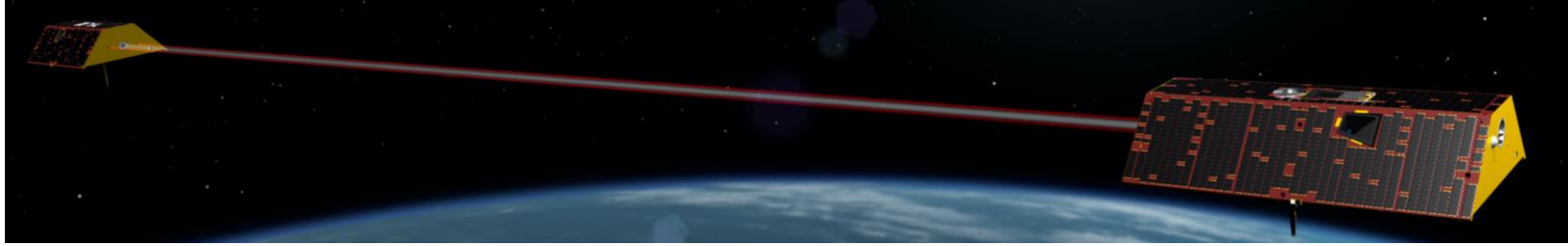
- Landsat (since 1982)
- LandSat 4/5/7/8

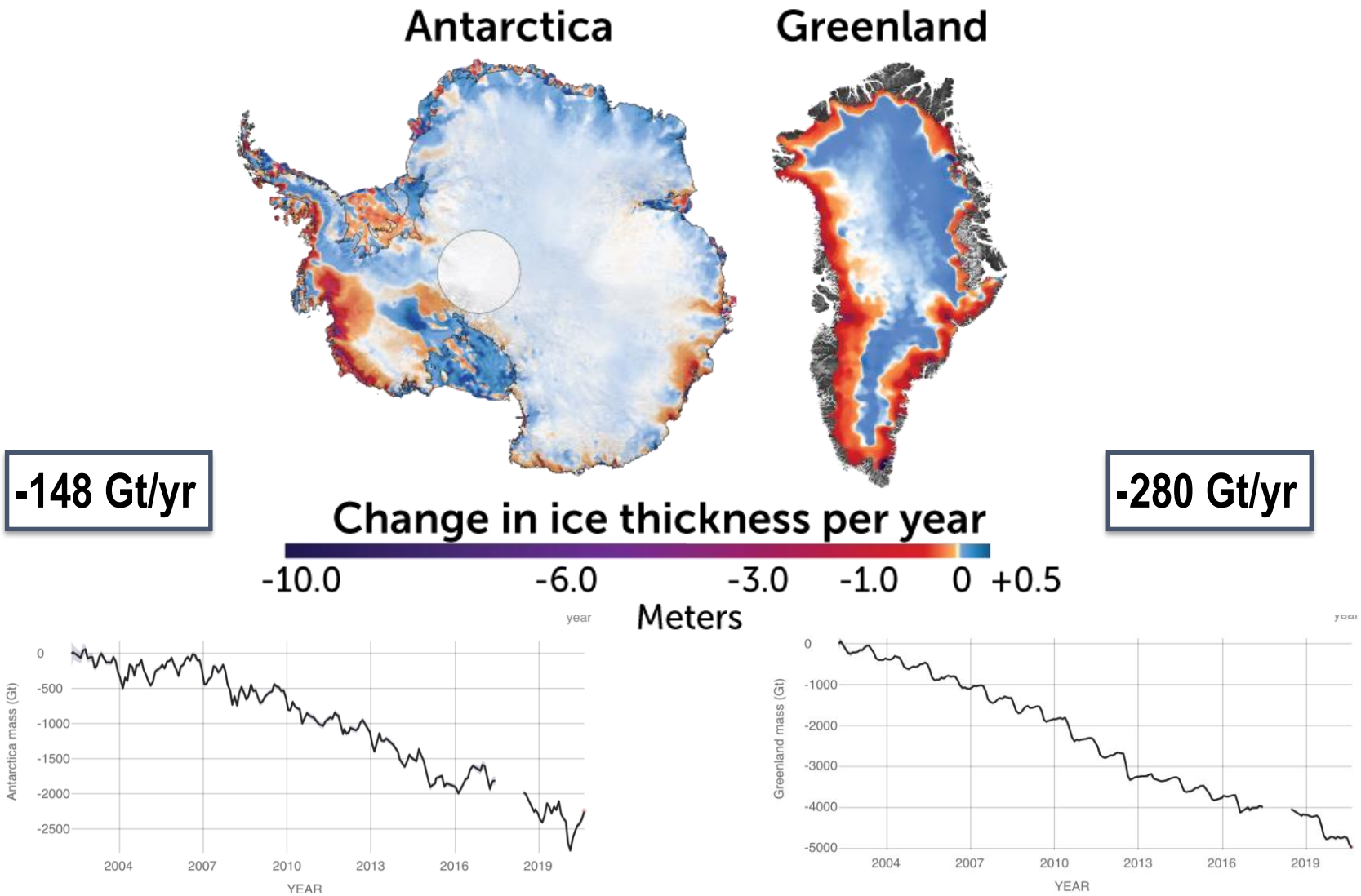
- Columbia Glacier, AK

Ice Sheet Mass

- GRACE (2002-2017)
- GRACE-FO (since 2018)

- Trends April 2002-Dec 2020

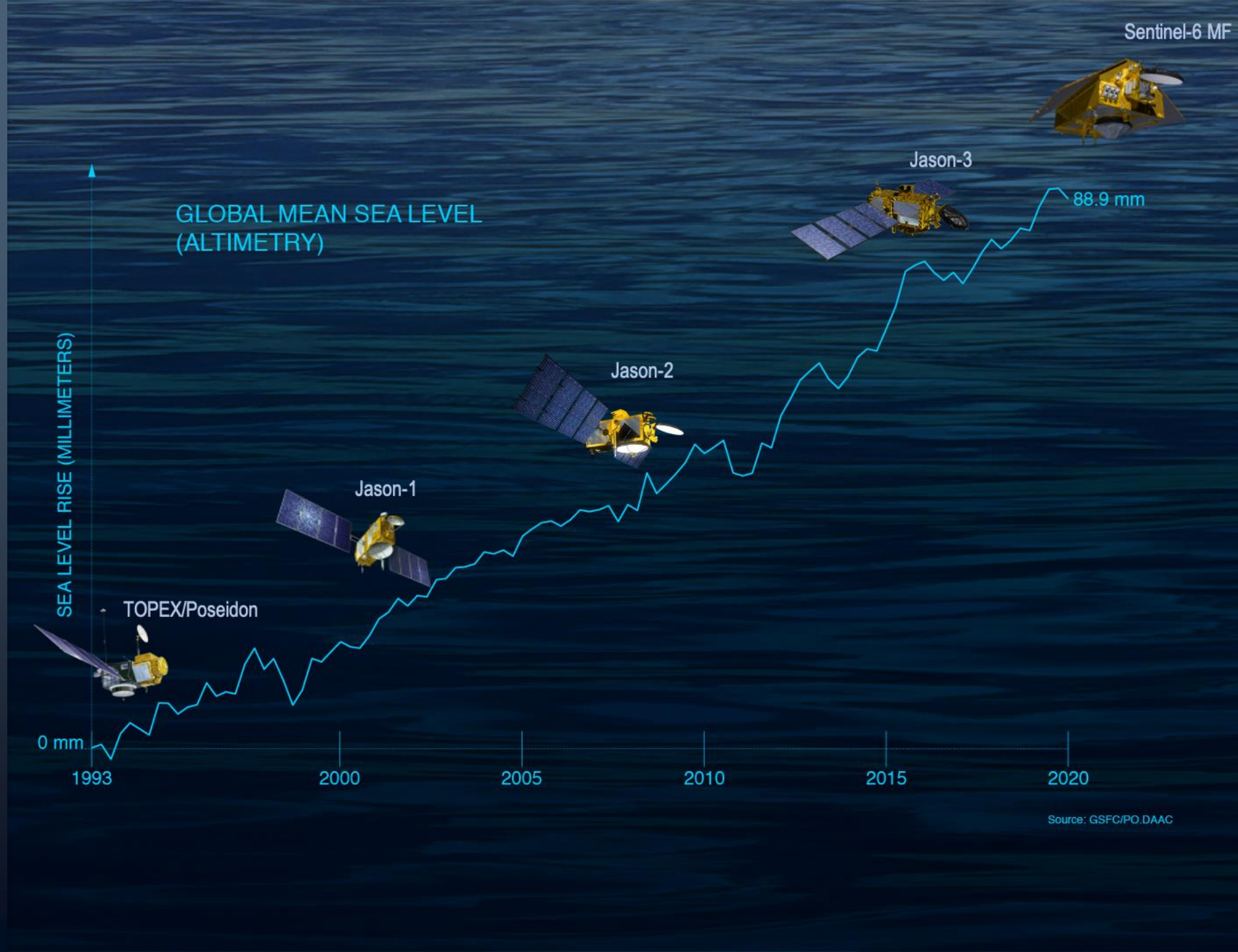




Sea Level Rise

- Since 1993

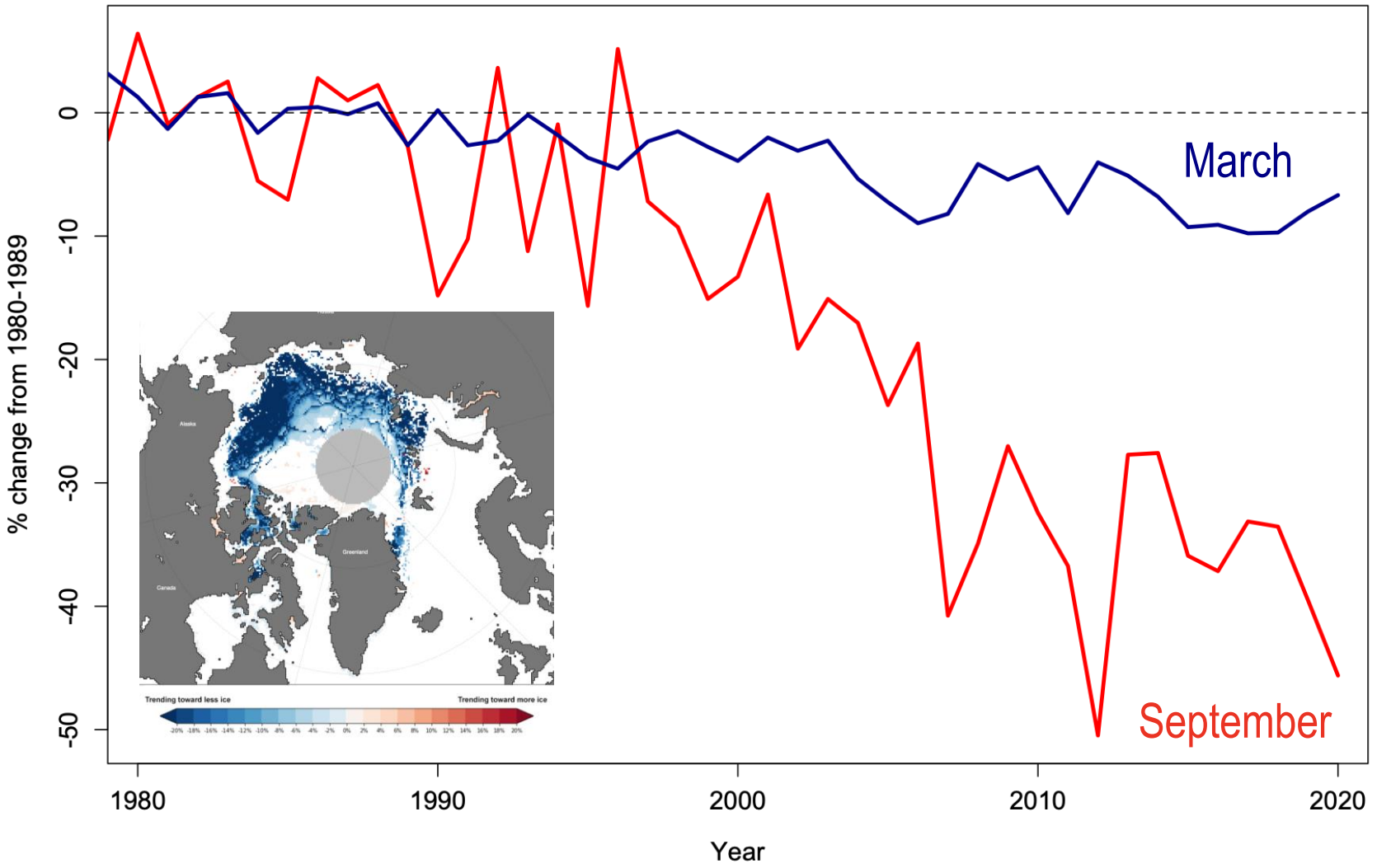
- TOPEX/POSEIDON
- JASON-1
- JASON-2
- JASON-3
- Sentinel-6 Mike Frielich



Arctic Sea Ice Extent

- NSIDC (since 1978)

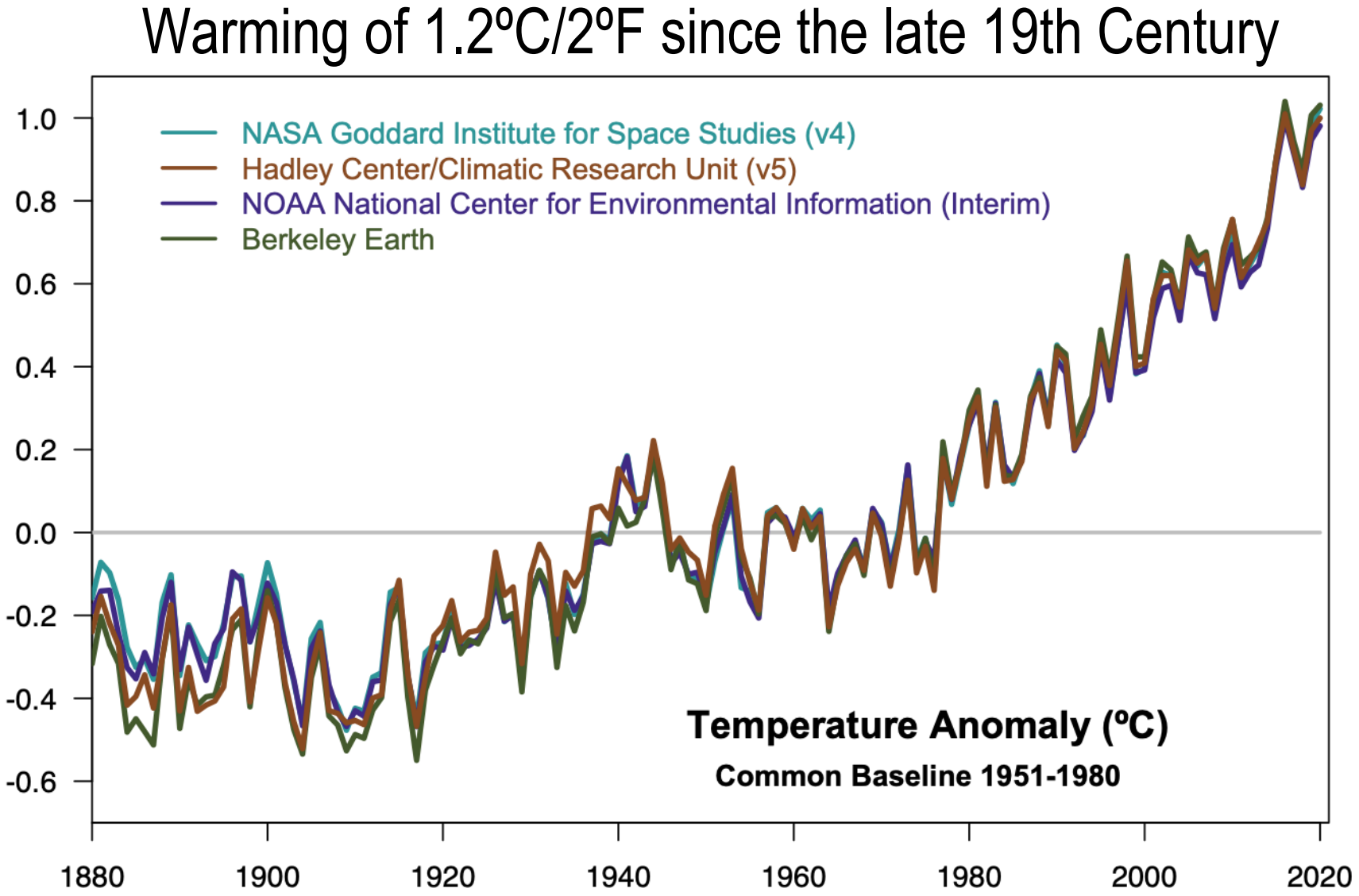
- DMSP, DMSP 5D-3/F17, DMSP 5D-3/F18,
- Nimbus-7



Surface Temperature

- GISTEMP (since 1981)
- Data from 1880

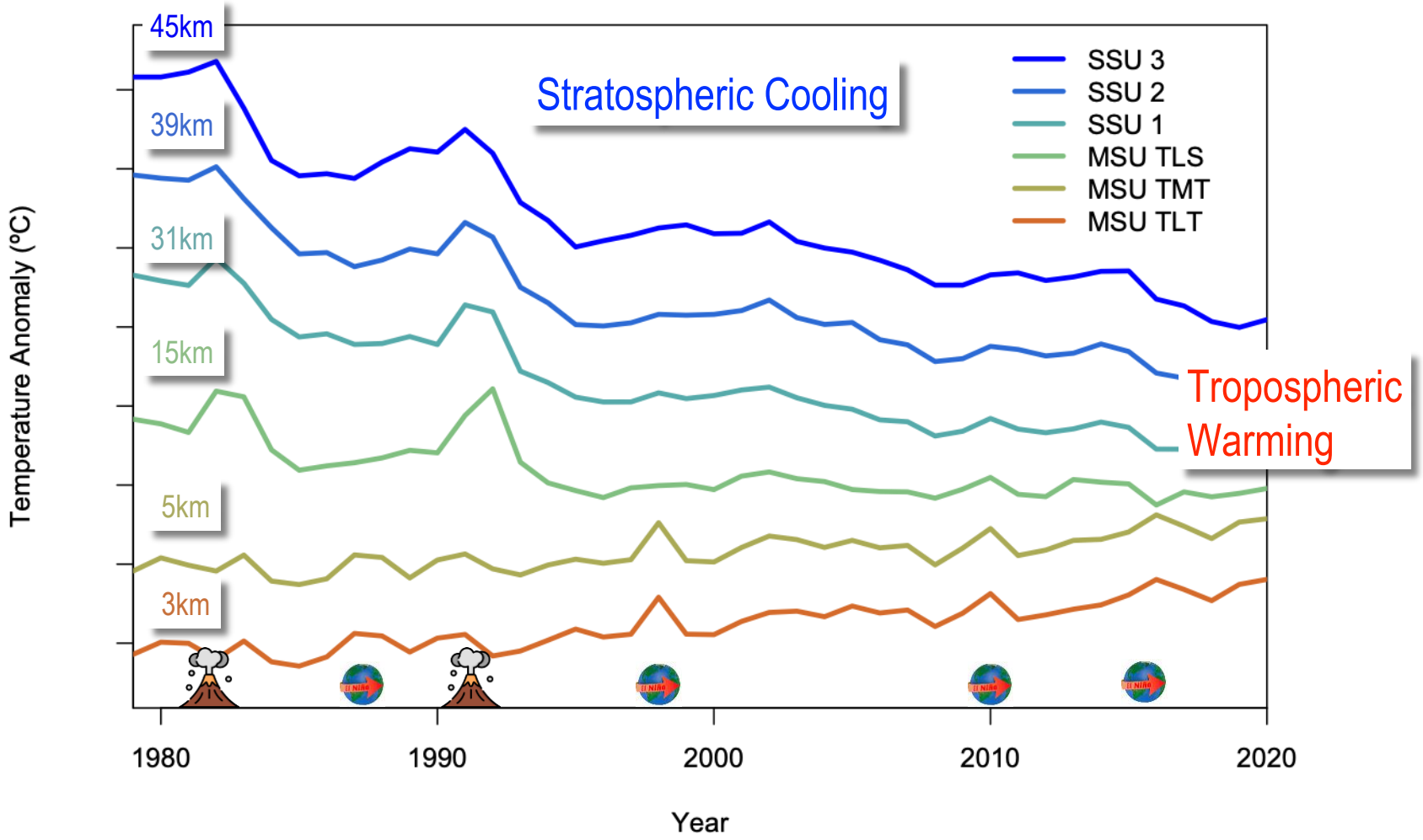
- Weather stations (GHCNv4)
- Ocean buoys/ship data (ERSSTv5)



Atmospheric Temperature

- MSU/SSU/AMSU (since 1979)

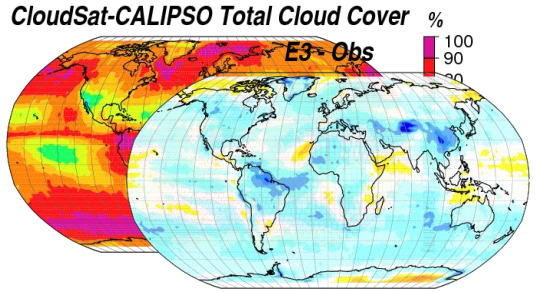
- TIROS-N
- NOAA-6/7/8/9/10/11/12/ 14/15/16/18/19
- METOP-A/B
- AQUA



Climate Change: Processes and Attribution

Climate Models

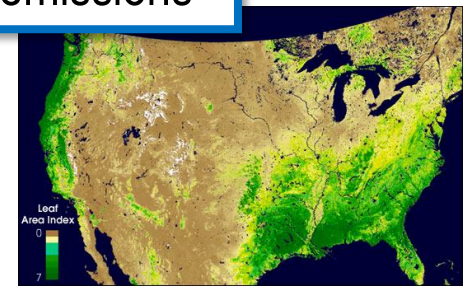
- Need *process*-level information, boundary conditions, drivers.
- e.g. GISS ModelE, NCAR CESM, GFDL CM, etc.
- Tuning/Calibration best done without looking at trends.



Global and regional evaluation across multiple variables & teleconnections

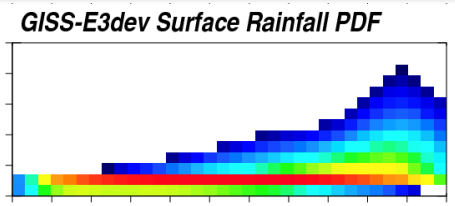
Model inputs

Land surface properties topography, emissions

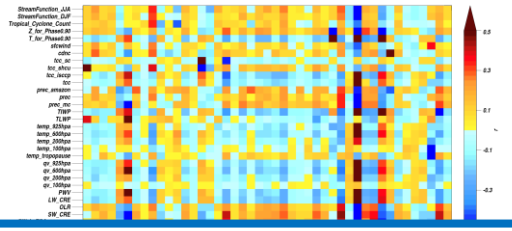


Parameterization development

Process-related diagnostics from low earth orbit and flight campaigns



Global tuning



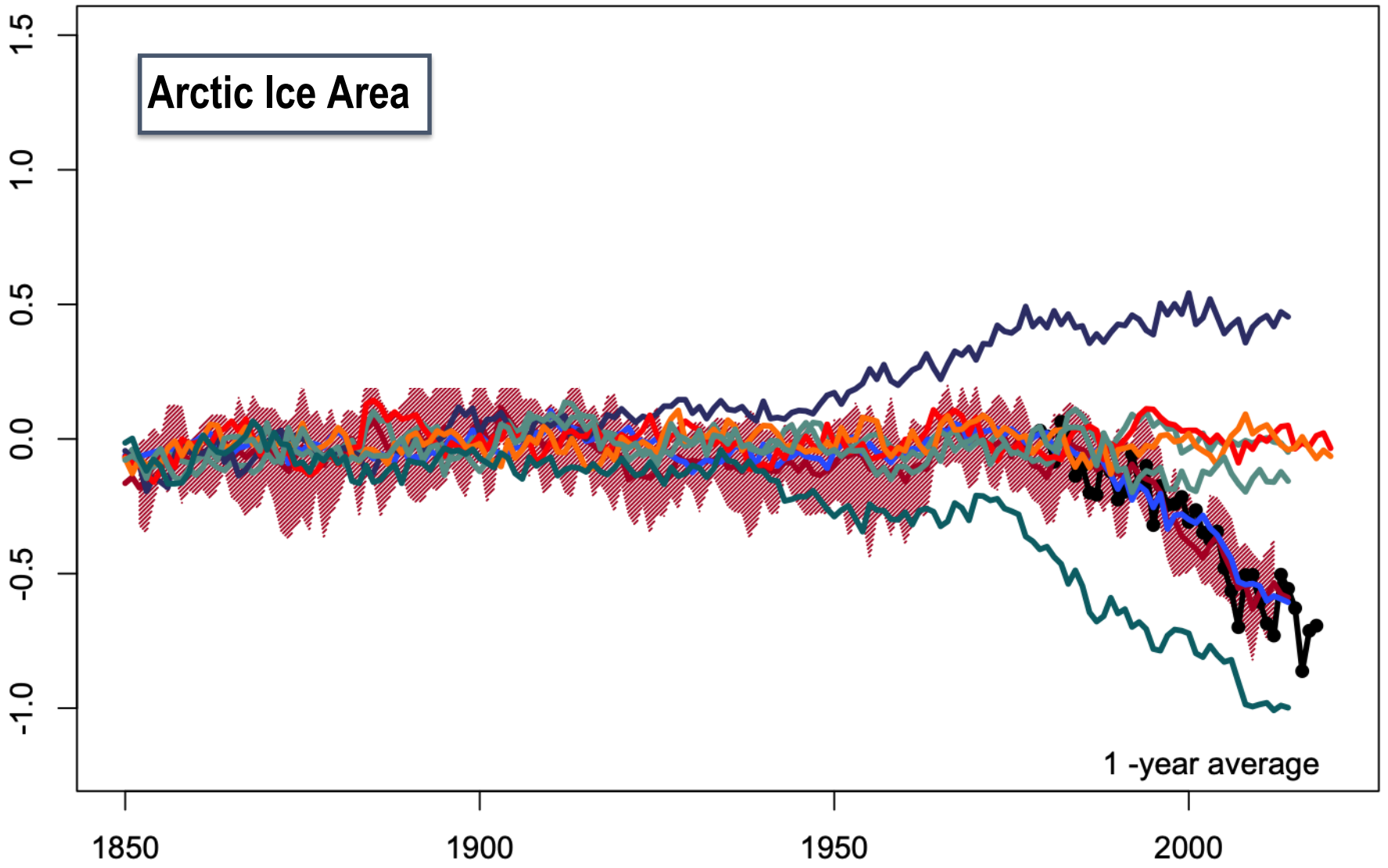
Perturbed physics ensembles plus Machine Learning to match satellite metrics (with uncertainties) across 40+ model parameters

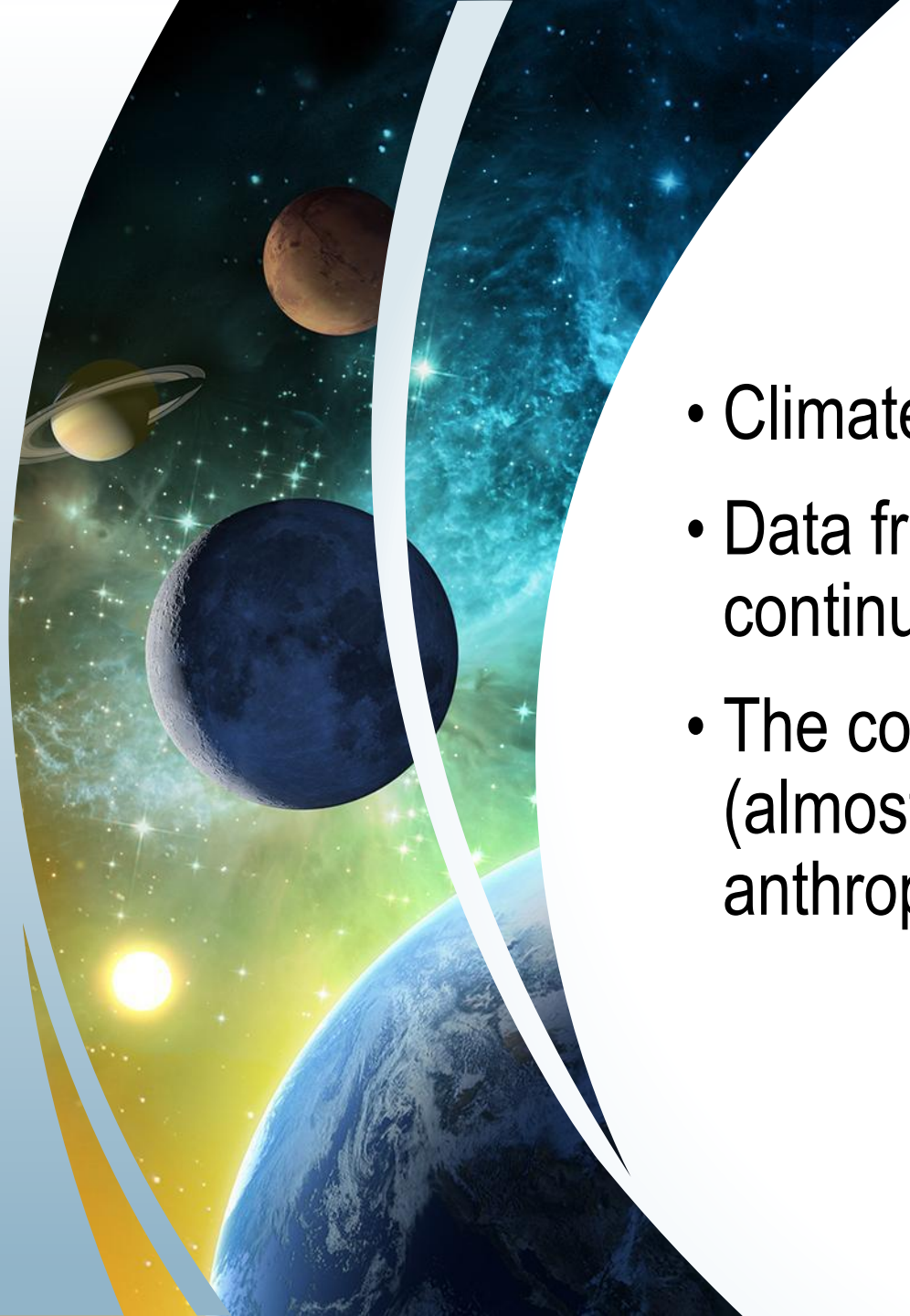
Model evaluation

Attribution

- GISS ModelE2.1 Ensemble simulations with individual drivers, natural-only, anthropogenic-only etc.

- Multi-variate comparisons to observed trends





- Climate change is clearly visible from space
- Data from NASA and other agencies is essential for continuing to monitor and assess efforts to mitigate
- The combination of models & observations imply (almost) *all* current long-term trends are anthropogenic

Thank you!