

Climate Change and Storm Track Change

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Climate Change and Storm Track Change

Outline

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2. Hypothesis
3. Methodology & Data
4. Results
5. Conclusion
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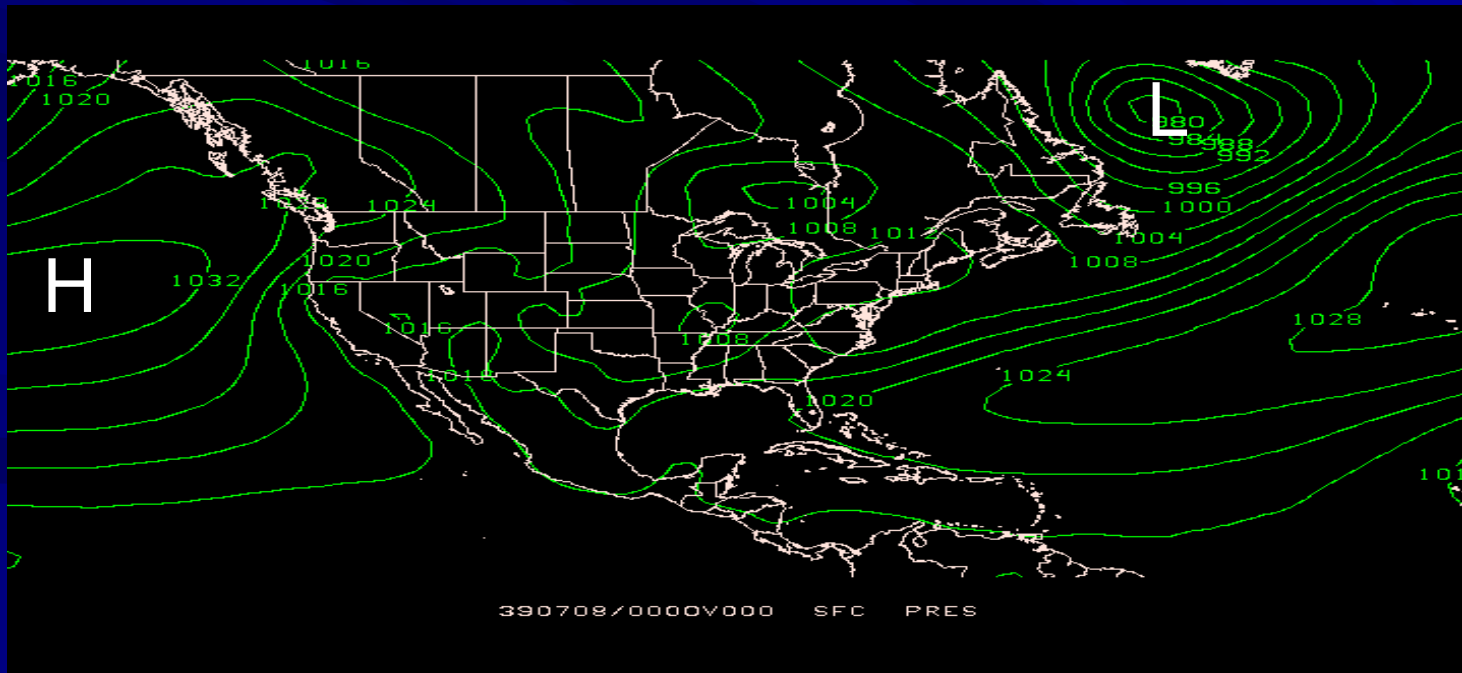
1. Motivation

Why is this important?

- “Climate change is a significant and emerging threat to public health, and changes the way we must look at protecting vulnerable populations.” ~WHO
- “A shift in geographical location or the level of storm track activity can lead to substantial precipitation anomalies with consequential impacts on regional climates” ~Chang et al. 2002

Definitions

- Storm Track: “...regions of maximum high-frequency standard deviation of geopotential heights at 500mb...” or sea level pressure. ~Christoph et al. 1997
- Standard Deviation (SD): a measure of the dispersion of a specific set of values



2. Hypothesis

Geographical pattern of surface warming

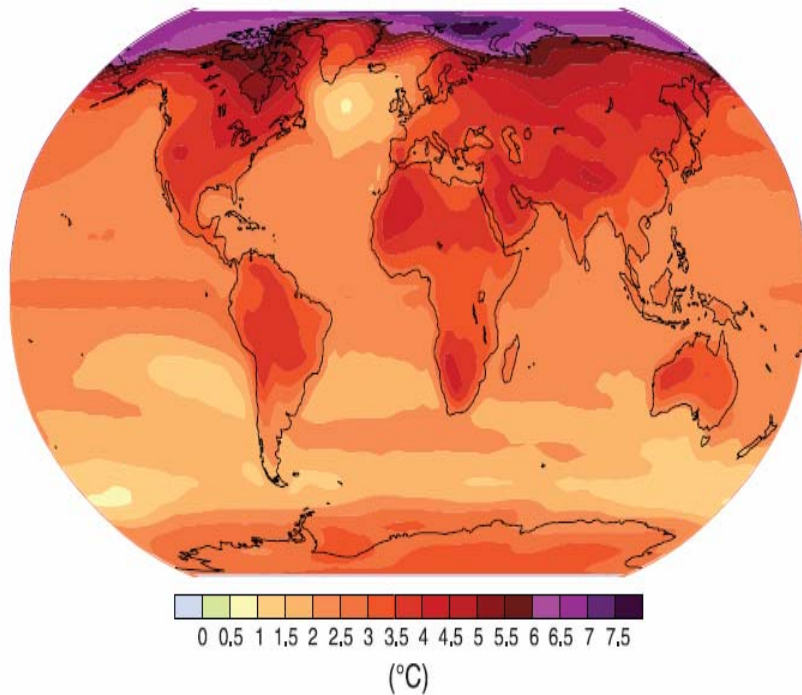


Figure: Projected temperature change in the last 21st century using the A1B scenario.

- Large arctic warming, Temperature gradient weakens
 - Weaker storm track?
- Melting arctic sea ice enhances land-sea contrast in winter
 - Storm track intensity would increase in high latitudes
 - Shifts northward?

3. Methodology & Data

- IPCC 4th Assessment Report (2007)
- NCAR-CCSM3 (Community Climate System Model) – 4 model runs
- Scenario SRESA1B: “A future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and rapid introduction of new and more efficient technologies, with the development balanced across energy sources.” ~*IPCC/UNEP/WMO*

SRESA1B

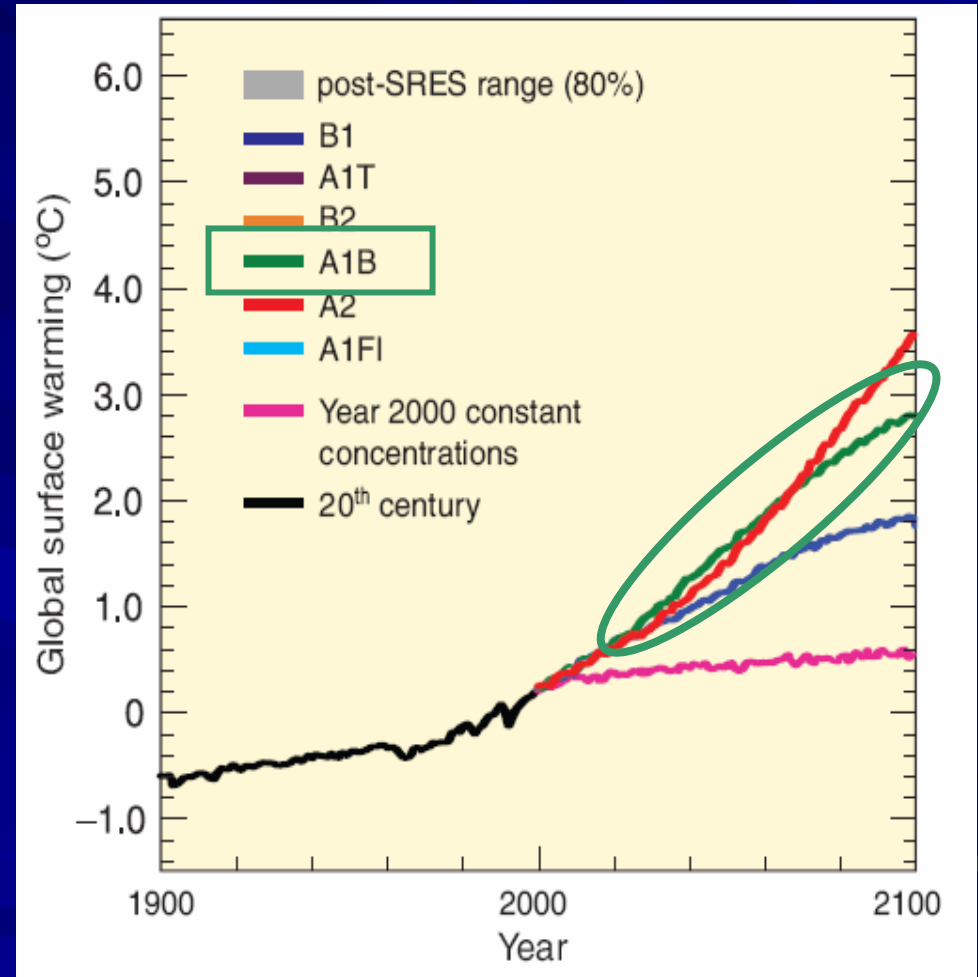
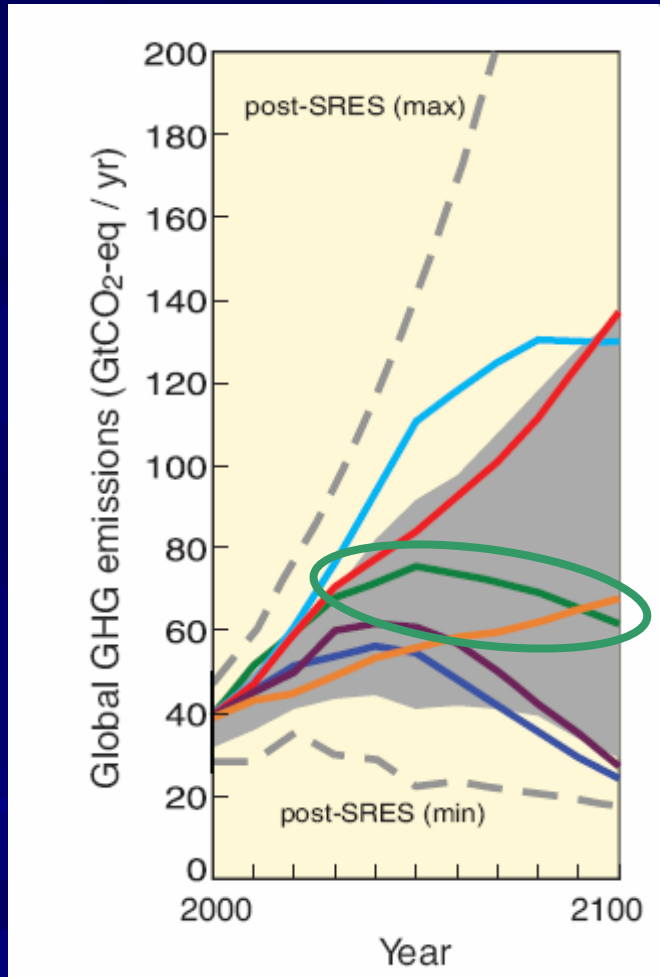


Figure. CO₂ emissions (*left panel*) and surface warming (*right panel*) based on different scenarios during the 21st century.

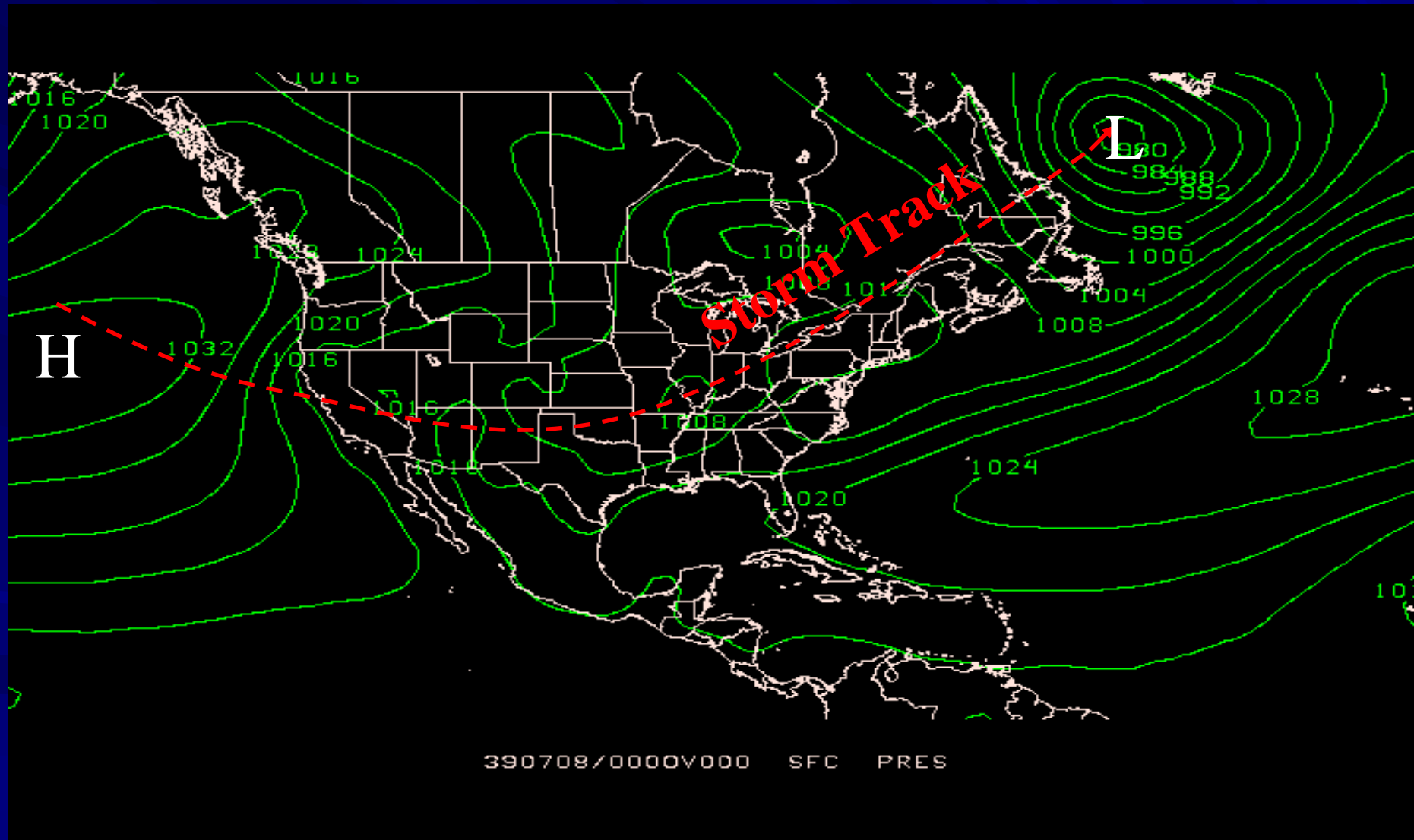
3. Methodology & Data

- Air Pressure at Sea Level
- Years 2000-2100 (October thru March)
- NetCDF files
- NCAR-CCSM3: Run 2, Run 3, Run 5, Run 7

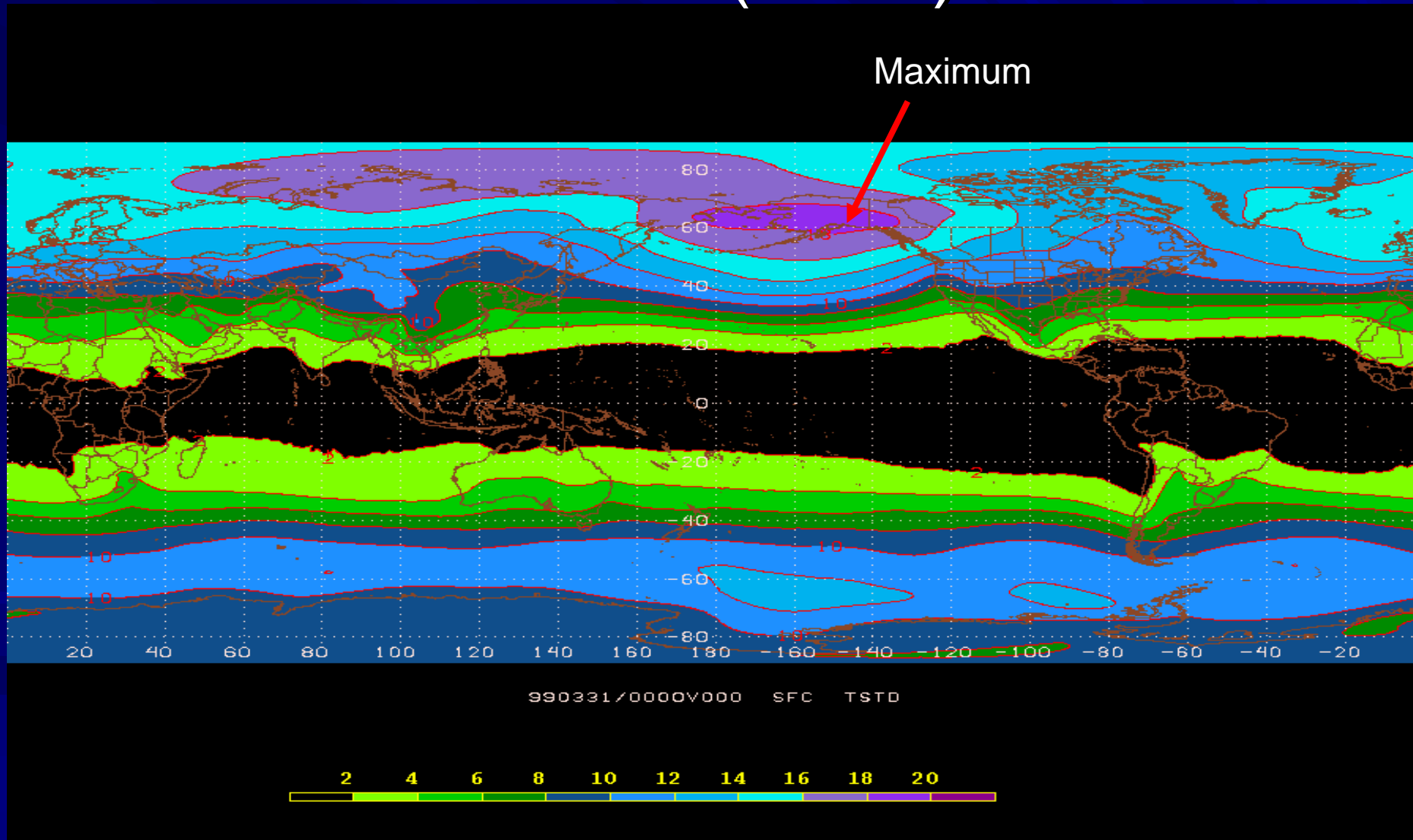
What is the difference between the runs?

- All the runs start at different periods in the pre-industrial models...Basically...they have different initial conditions.
- e.g. Run 2 starts in 1870 while Run 3 starts in 1910

Sea Level Pressure for each Day



Example: SD for one northern Winter (2009)

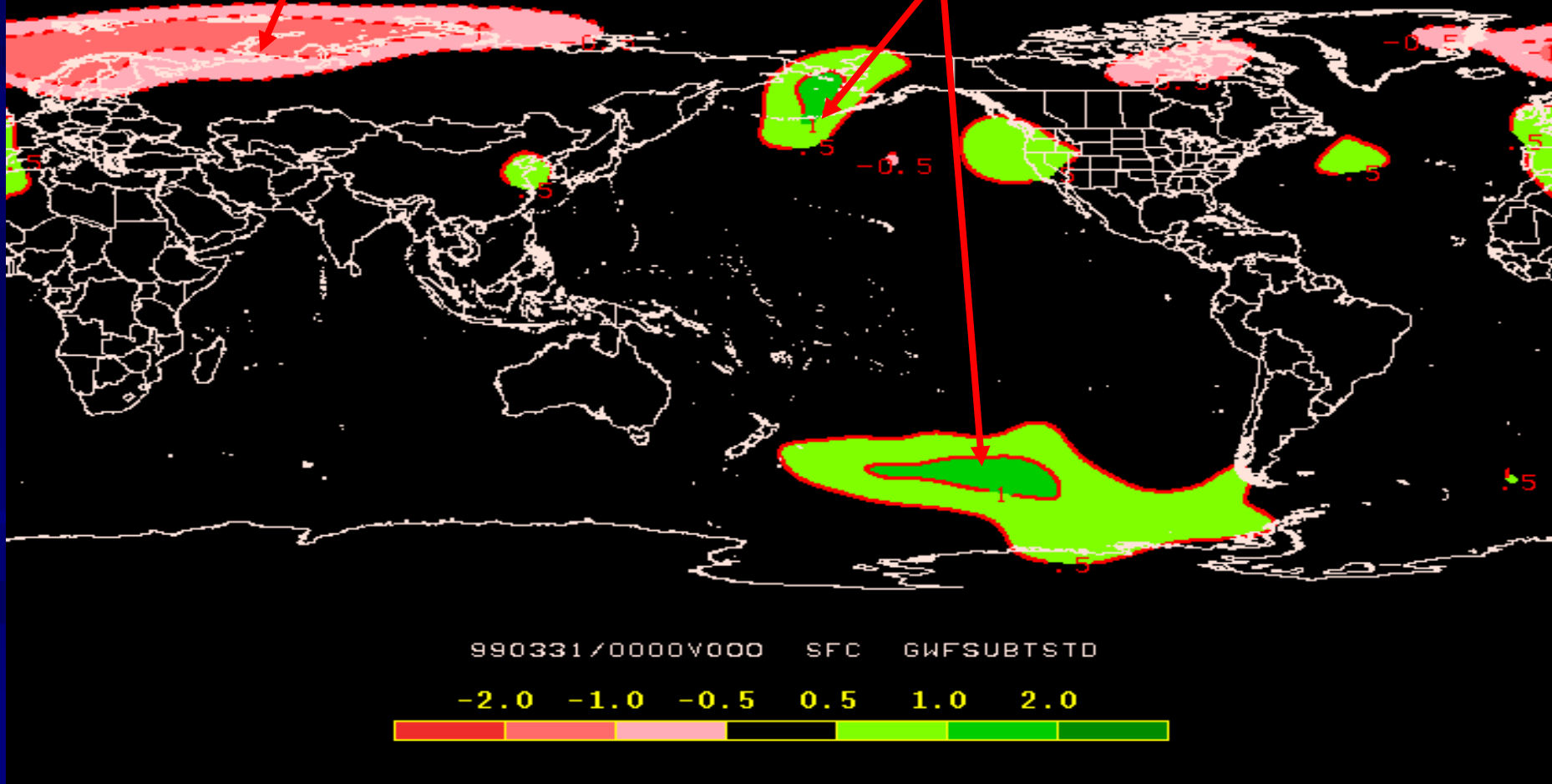


Example: SD Anomaly for 10 years (2089-2099)

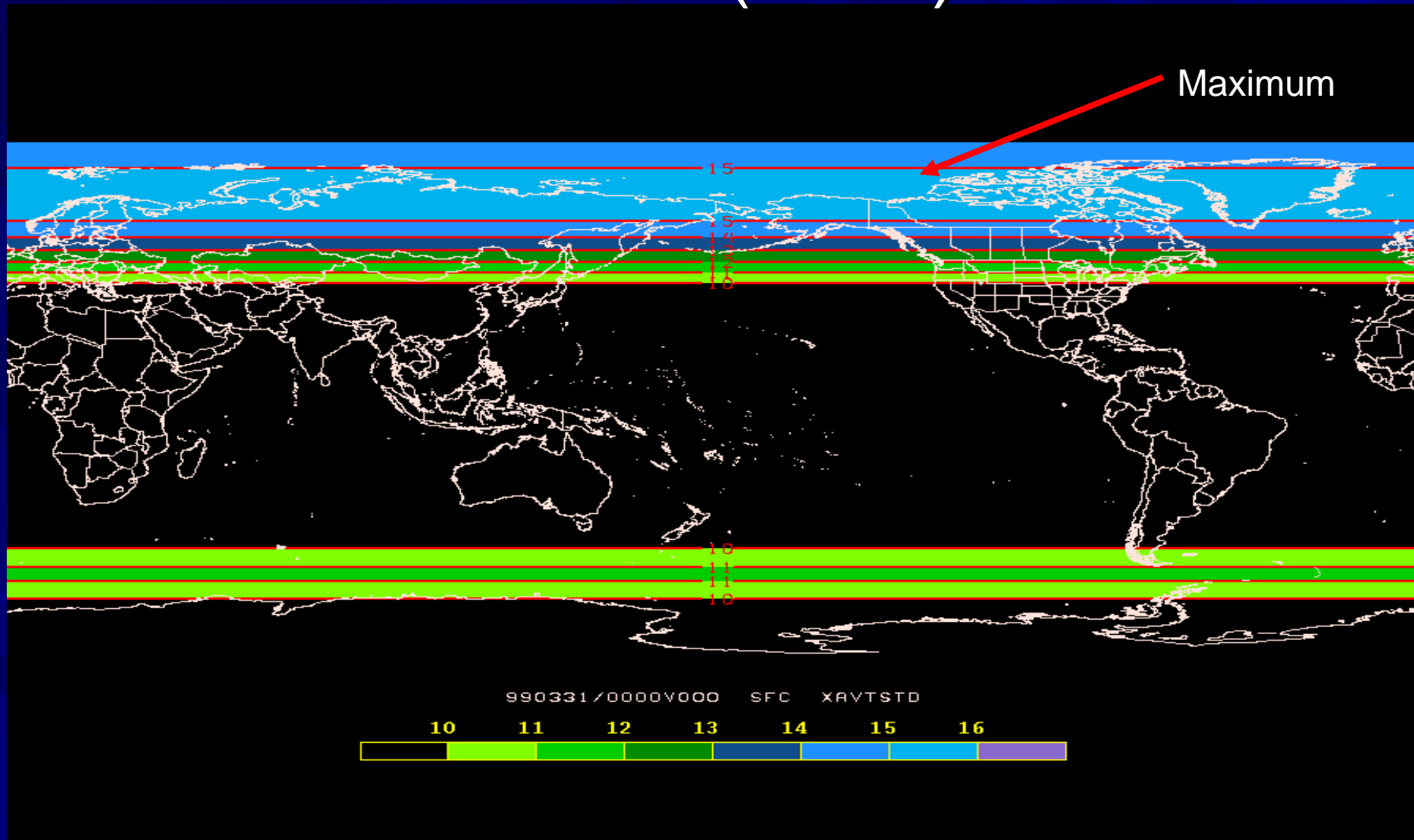
Running Average SD – Century Average SD
Changes in Storm Track Intensity or Location

Minimum: Weaker SD than average

Maximum: Larger SD than average



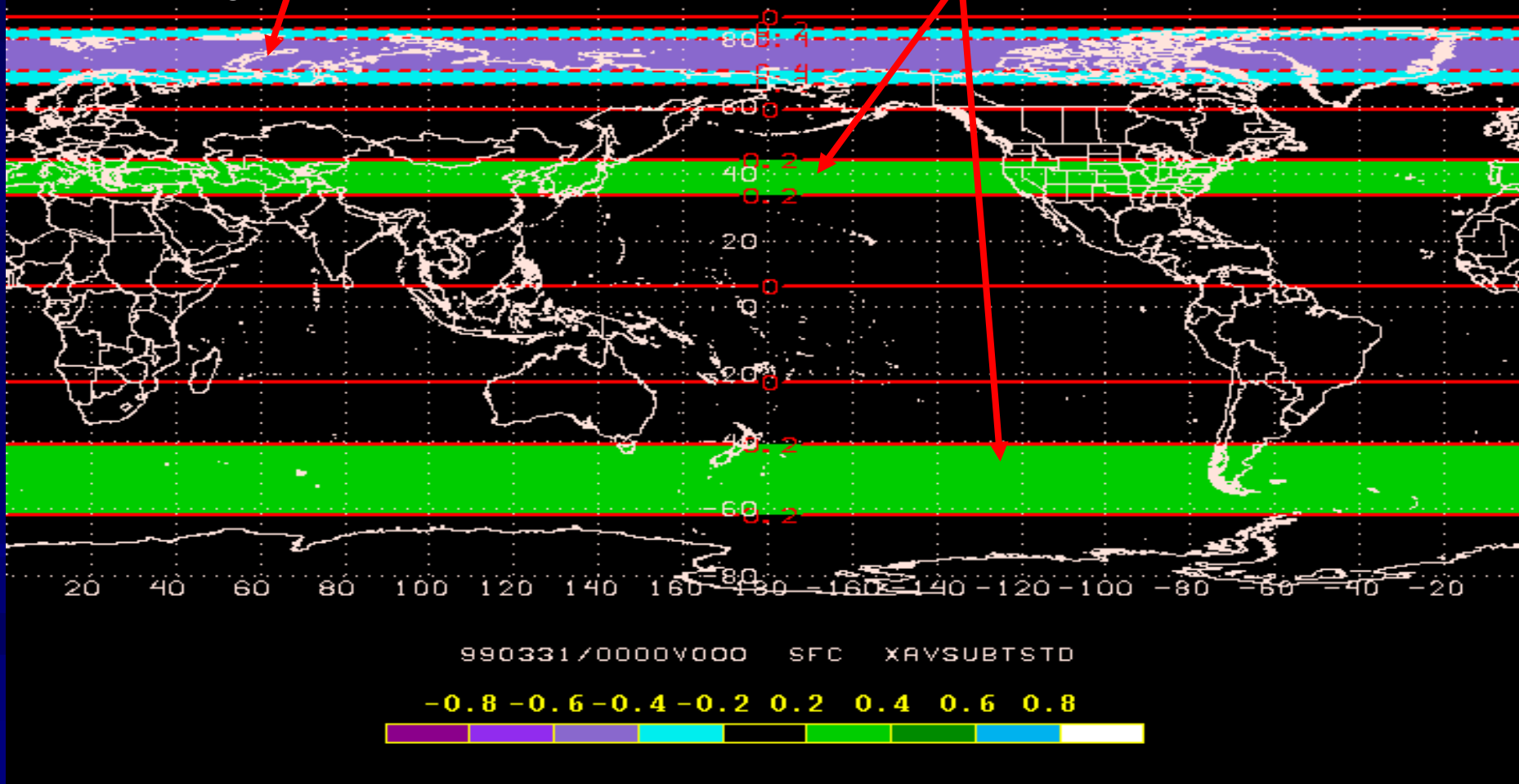
Example: Zonal SD for one northern Winter (2099)



Example: Zonal SD Anomaly for 10 years (2089-2099)
Zonal Running Average SD – Century Zonal Average SD
Storm track Shift

Minimum: Lower SD than long-term average

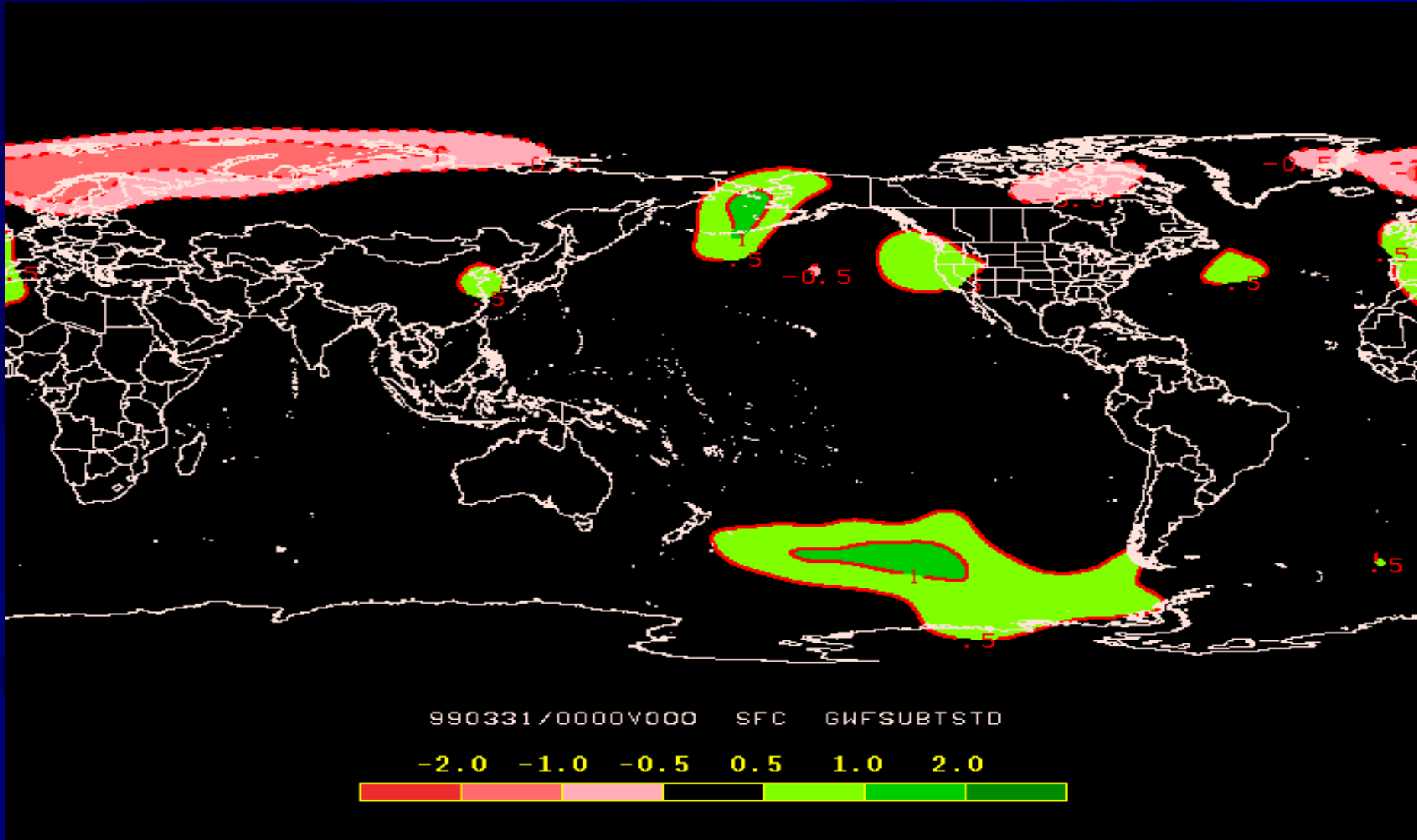
Maximum: Larger SD than average



4. Results

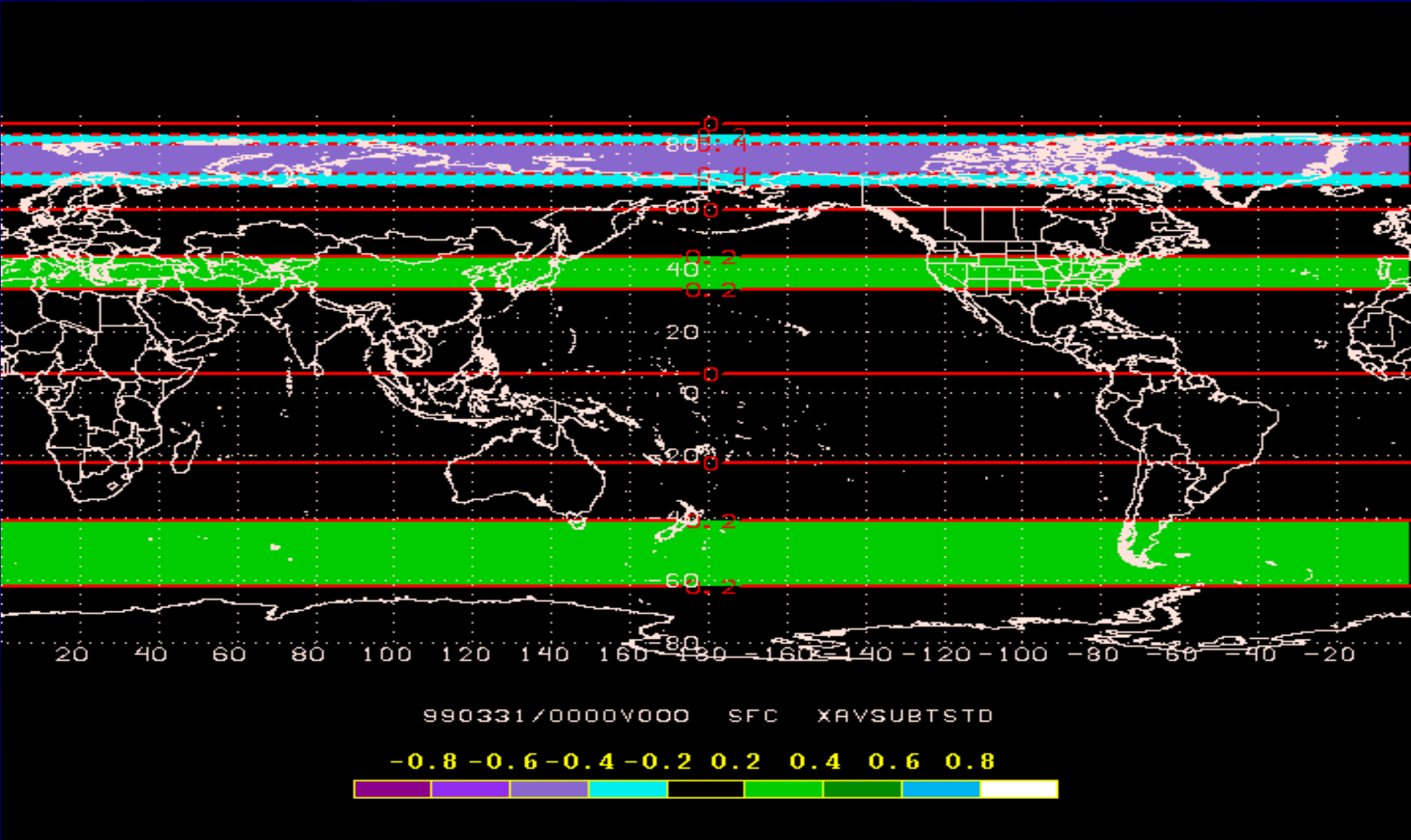
Run 2 (Init 1870)

Running 10 year Average Anomaly



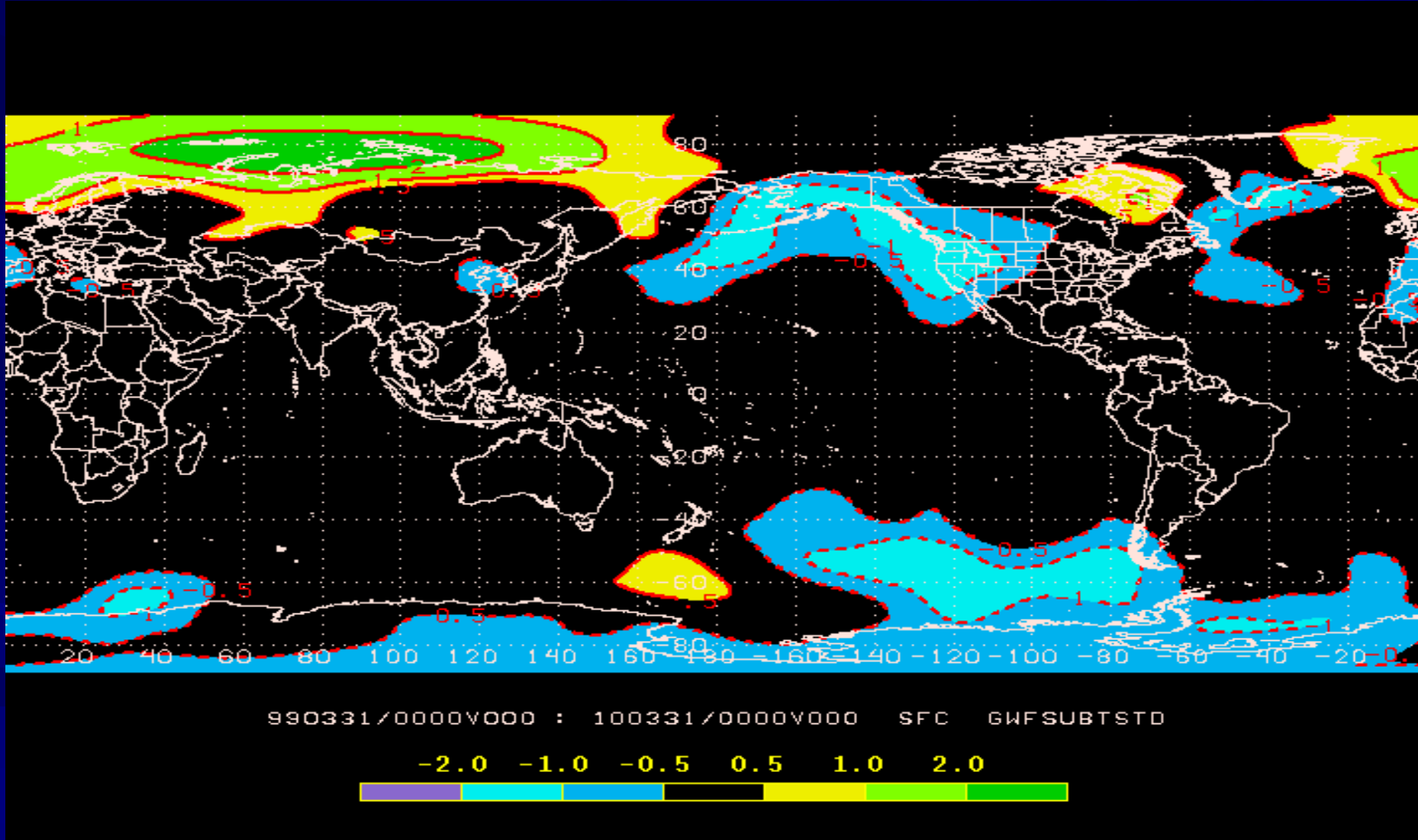
Run2

Zonal Running 10 year Average Anomaly

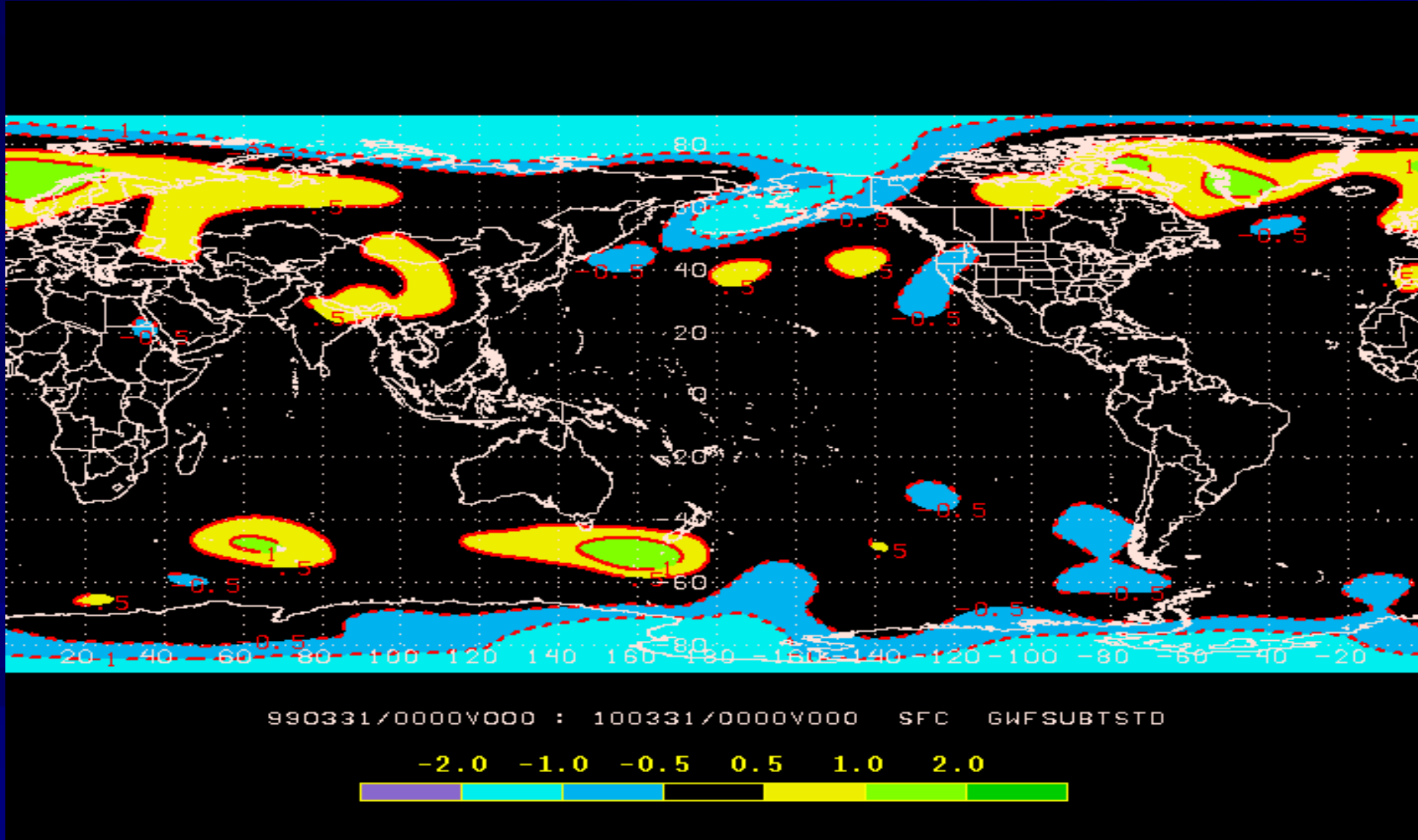


Late 21st Century – Early 21st Century
Running SD
(for each of 4 model runs)

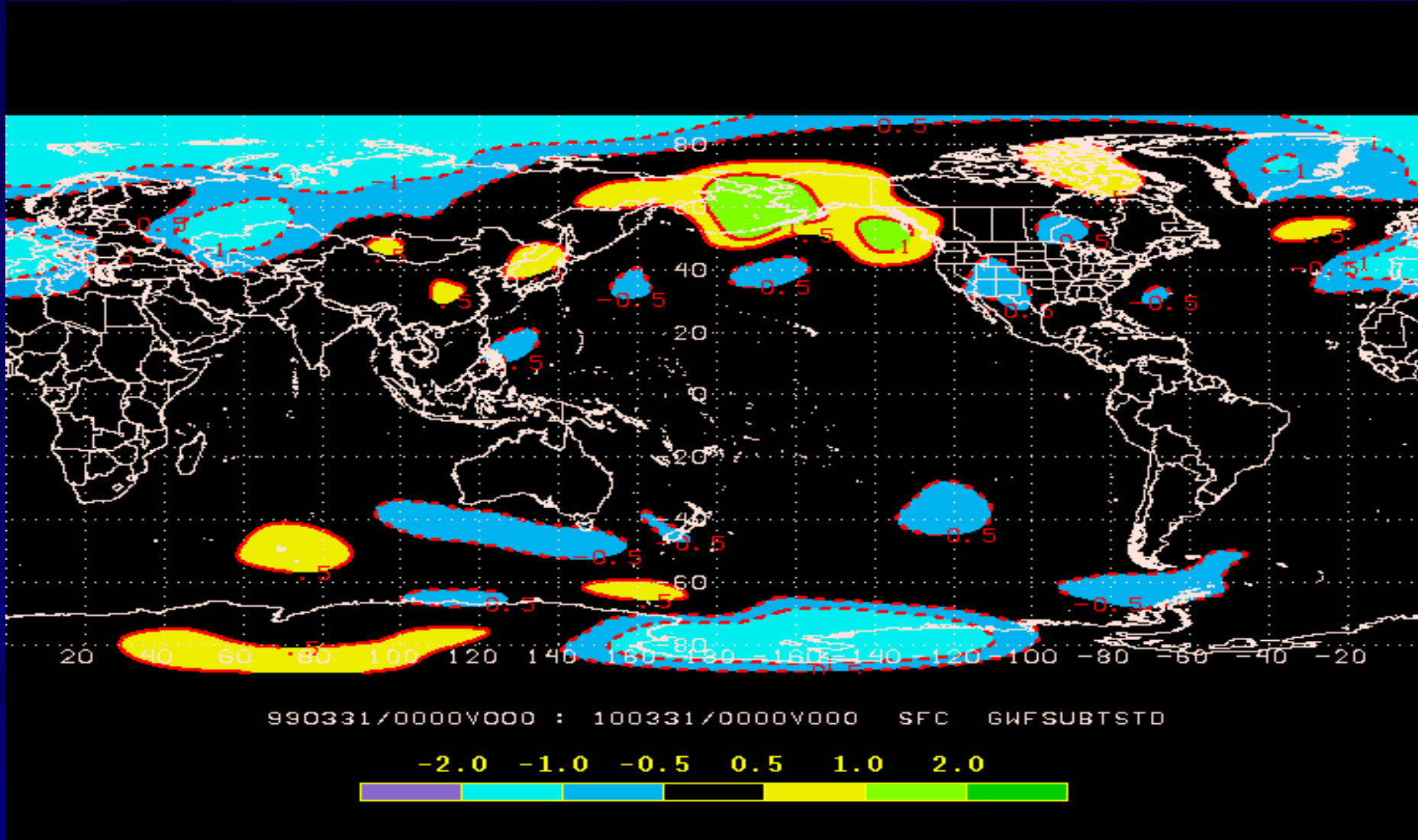
Run 2
Late 21st Century – Early 21st Century
Running Average
Last 10 years minus first 10 years



Run 3
Late 21st Century – Early 21st Century
Running Average
Last 10 years minus first 10 years



Run 5
Late 21st Century – Early 21st Century
Running Average
Last 10 years minus first 10 years

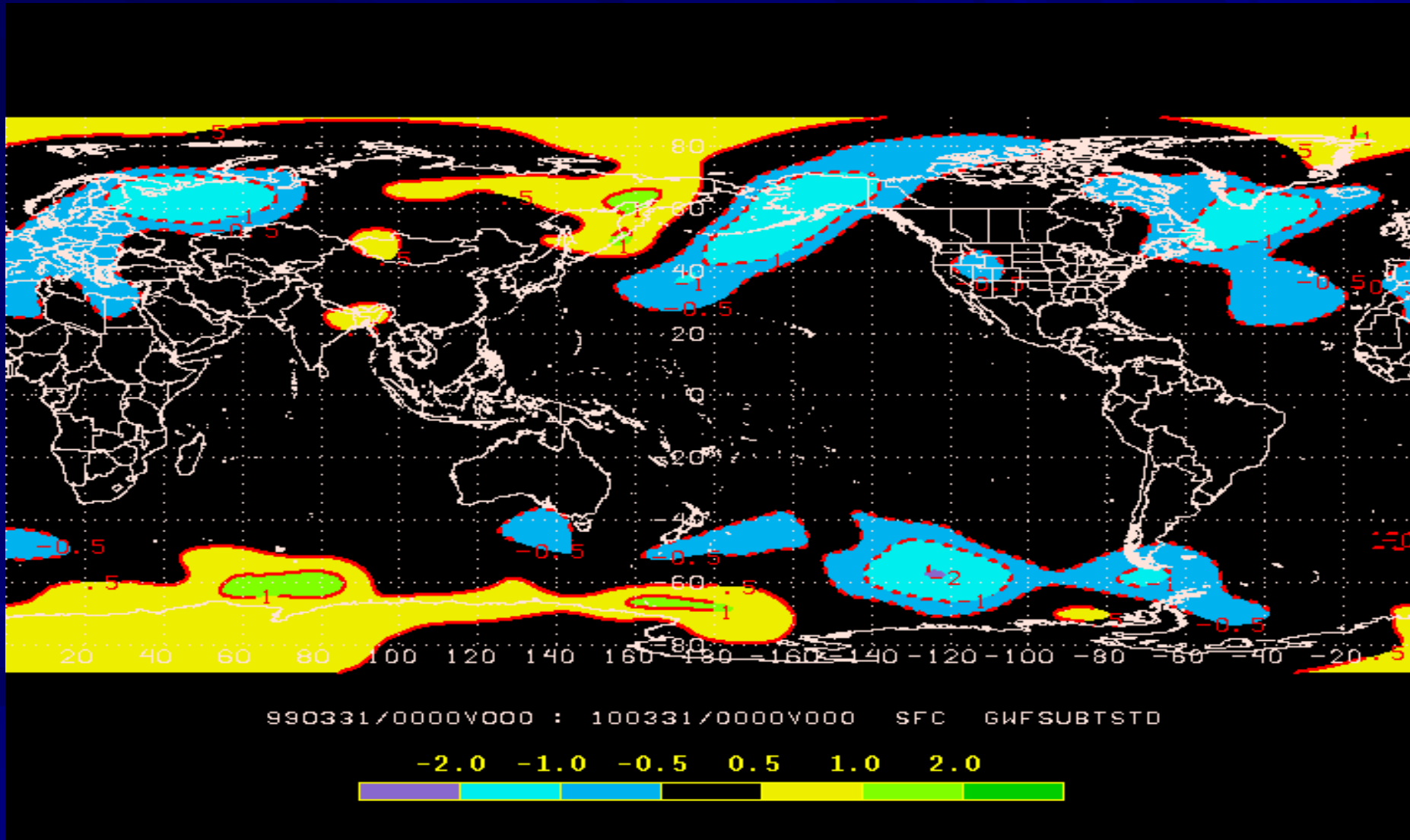


Run 7

Late 21st Century – Early 21st Century

Running Average STD

Last 10 years minus first 10 years



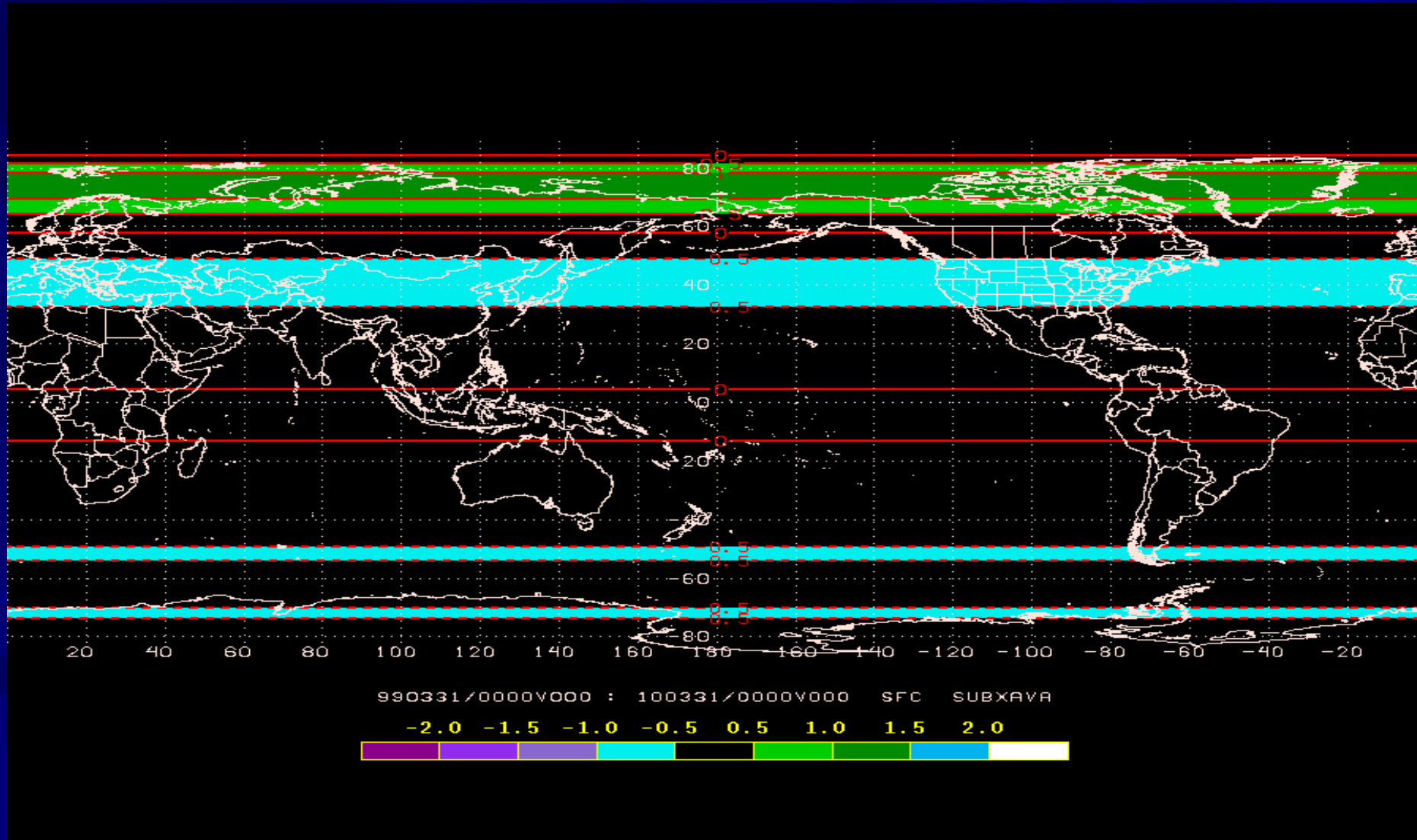
Late 21st Century – Early 21st Century
Zonal SD
(for each of 4 model runs)

Run 2

Late 21st Century – Early 21st Century

Zonal Running Average STD

Last 10 years minus first 10 years

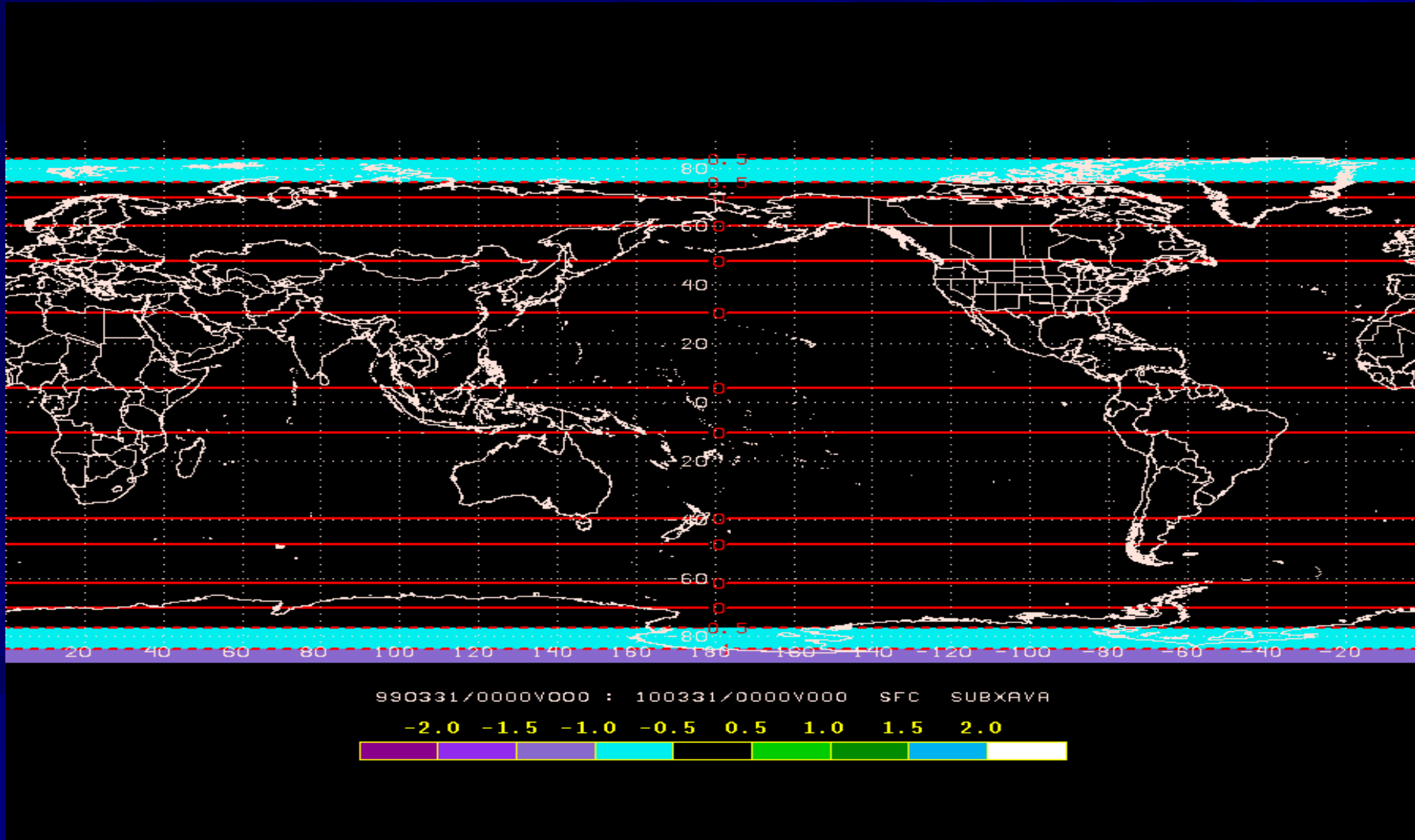


Run 3

Late 21st Century – Early 21st Century

Zonal Running Average STD

Last 10 years minus first 10 years

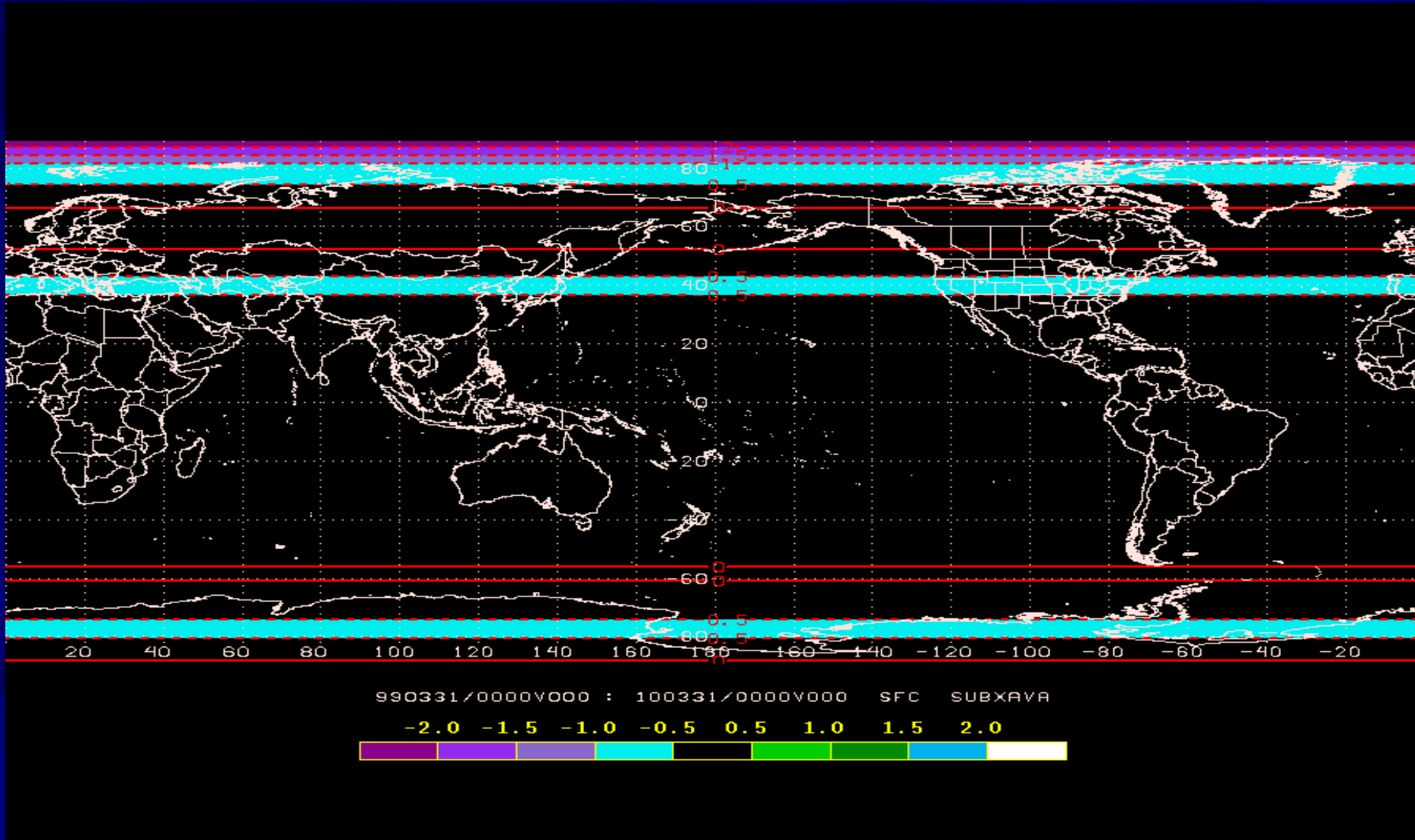


Run 5

Late 21st Century – Early 21st Century

Zonal Running Average STD

Last 10 years minus first 10 years

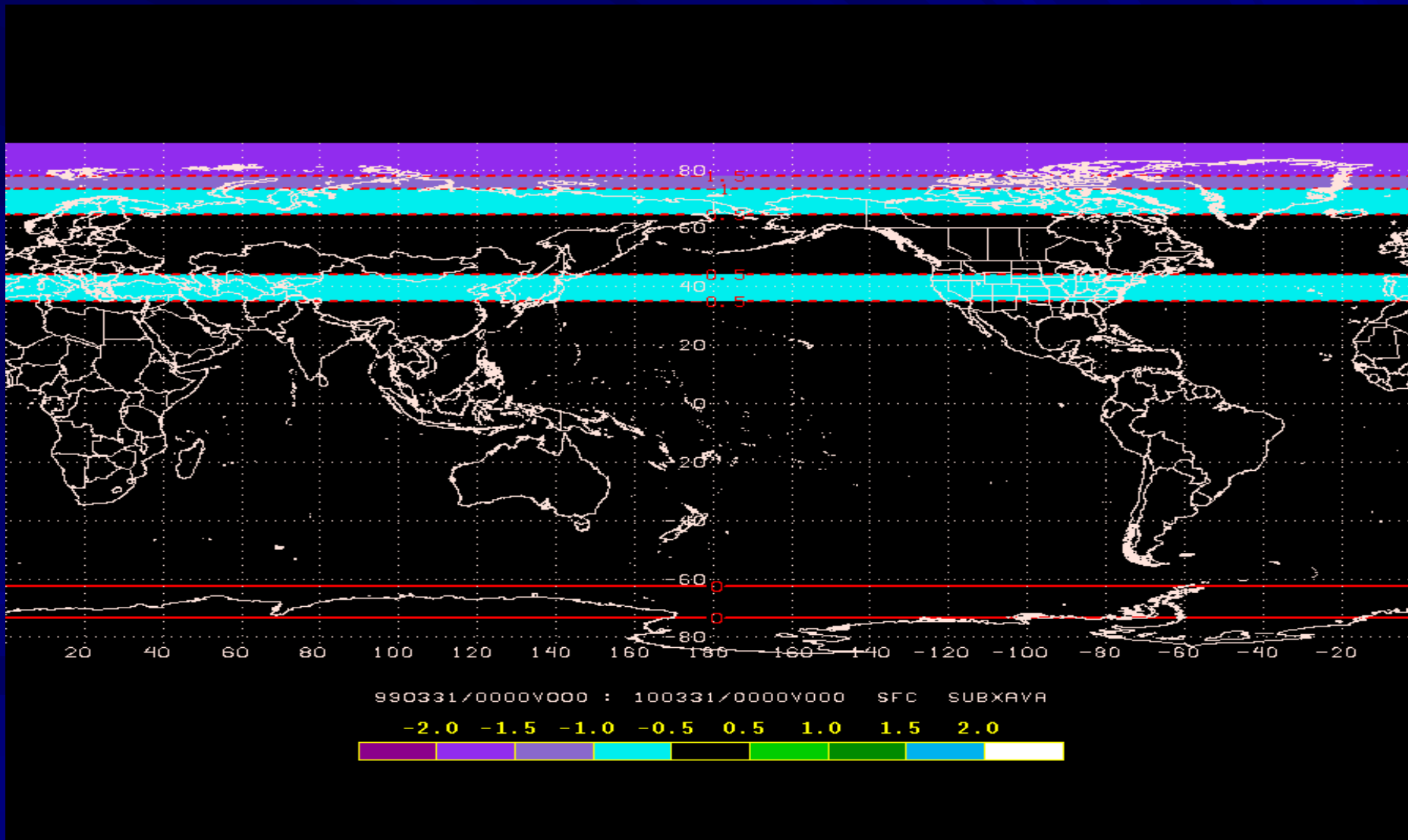


Run 7

Late 21st Century – Early 21st Century

Zonal Running Average STD

Last 10 years minus first 10 years



5. Conclusion

- Biggest changes in the Northern Hemisphere
- No obvious, consistent, systematic storm track changes over 100 year period (!)
- Run 5 and 7...both show a decrease in storm track activity across the higher mid-latitudes
- There is no consistent shift in track or intensity between these 4 model runs

6. Future Research

- Examine temperature fields, sea ice, deep-layer baroclinicity
- Expand to additional model runs
- Examine jet-stream level parameters
- Do an ensemble average for all IPCC model runs
- Examine other IPCC scenarios
- Examine precipitation forecasts

I would like to thank...

- DOE GCEP Program
- Advisor: Dr. Gary Lackmann, NC State Univ.
- Dr. Aiyyer, NC State Univ.
- Intergovernmental Panel on Climate Change (IPCC)
- The Program for Climate Model Diagnosis and Intercomparison (PCDMI)
- Grad Students at NCSU
- IPCC Statement: System Model project (www.cesm.ucar.edu), supported by the, Directorate for Geosciences of the National Science Foundation and the Office of Biological and Environmental Research the U.S. Department of Energy. In addition, the words 'Community Climate System Model and CCSM should be included as metadata for webpages referencing work using CCSM data or as keywords provided to journal or book publishers of your manuscripts. Users of CCSM data accept the responsibility of emailing citations of publications of research using CCSM data to ccsm@ucar.edu.

Questions?