



# Usefulness of the Recent Reanalyses to Provide Indicators of Climate Change

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# Stratospheric Climate Change

- Radiative effects of ozone-depleting substances and greenhouse gases have driven marked cooling at stratospheric levels
  - Lower strat from ozone loss
  - Upper strat from GHG increases

# Stratospheric Observations

- Lower Stratosphere:
  - Radiosonde
    - Long time record
    - Issues: instrument changes, radiation effects
  - MSU Channel 4 & AMSU Channel 9
    - Peaks ~ 70 hPa
    - Several institutes (UAH, RSS, NESDIS) examining long term record
  - GPSRO
    - Global coverage
    - Very Short time record
    - Issues above 10 hPa

# Stratospheric Observations

- Upper Stratosphere

- SSU

- 3 channels peaking at 15, 5, 2 hPa
    - Broad weighting functions
    - Issues: No overlap for early satellites
    - Until recently only one person produced a long term data set
      - Not well documented – unreproducible
    - NOAA/NESDIS recently produced a long term data set

- AMSU

- 6 Channels peaking at 70, 40, 25, 11, 5, 2.5
    - Narrower weighting functions
    - 6+ years overlap with SSU

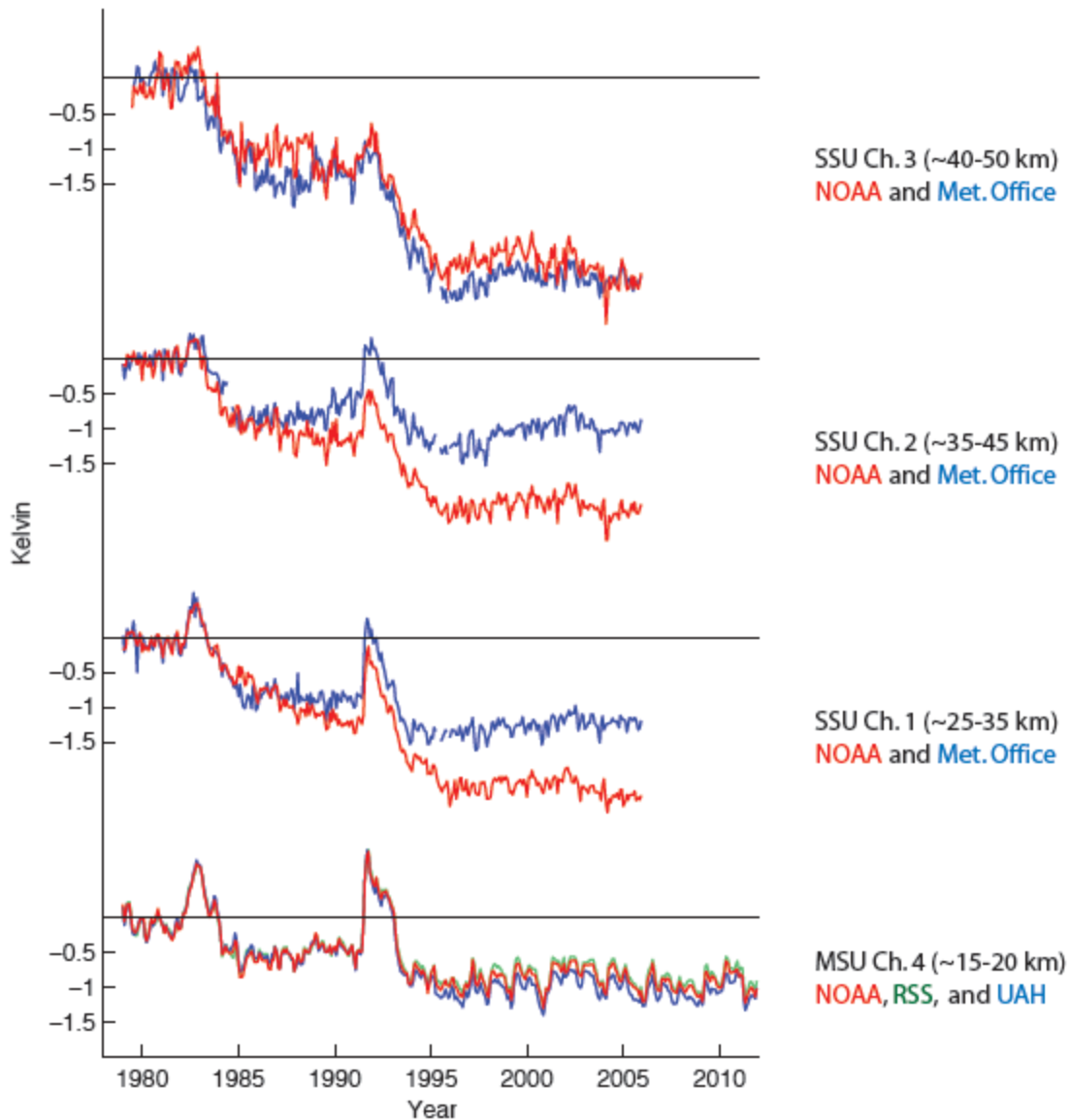
- Lidar & Microwave

- Few sites
    - Short time record

- Rocketsondes

- Few sites
    - Record extends from 60's to early 80's
    - Peak in 70's

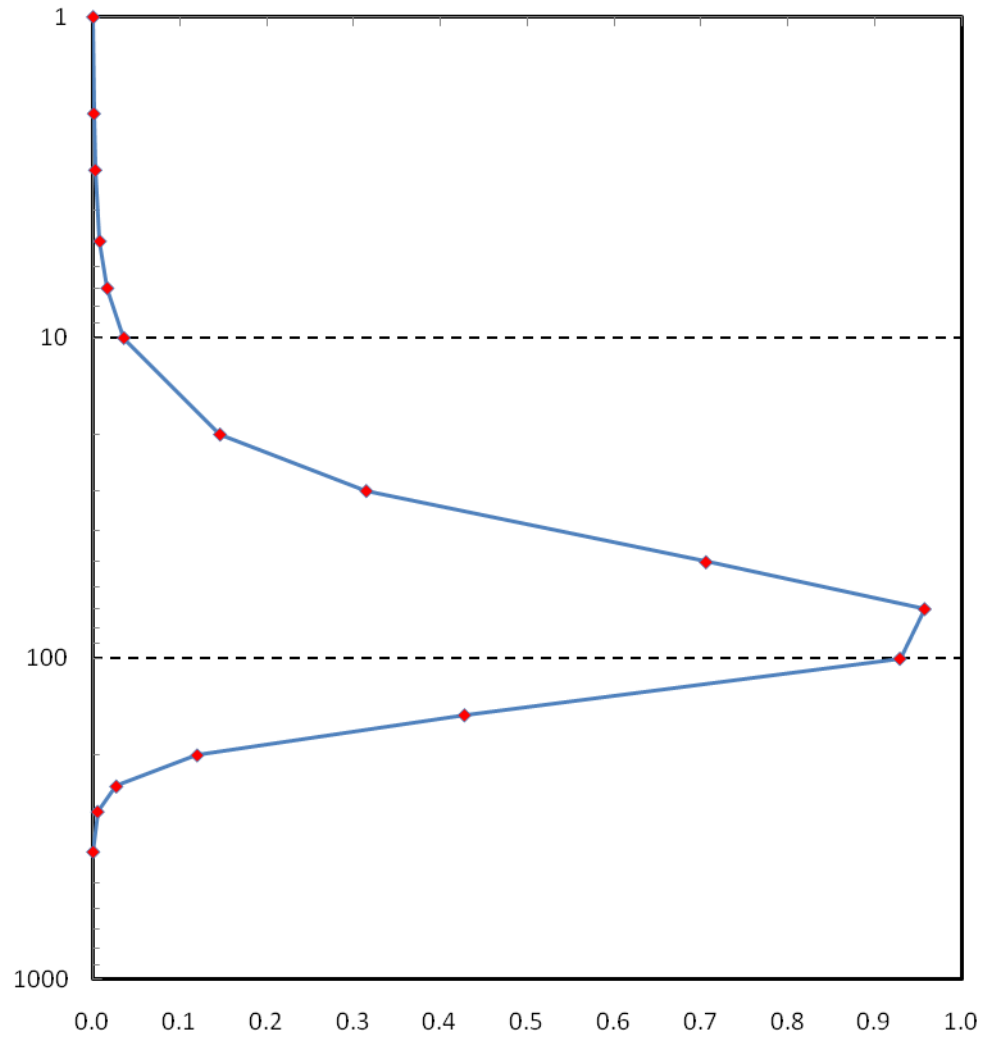
# Global mean temperature anomalies



# Reanalyses

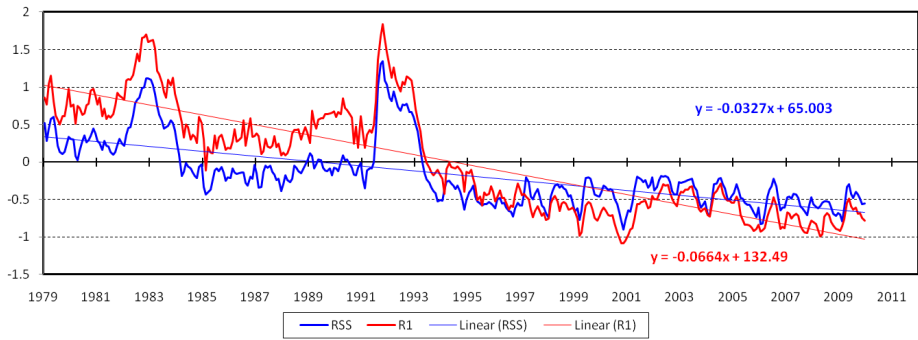
- Can Reanalyses replicate these satellite records?
  - What goes in the same as what comes out?
- If not – why not?
- Assimilate practically every observation every made.
- Different obs get different weights
- Obs get “thinned”
  - More obs in high gradient areas
- Forecast models have inherent bias
  - Assimilation scheme constantly adjusting bias with obs (“truth”)

# MSU CH 4/ AMSU CH 9 WEIGHTS

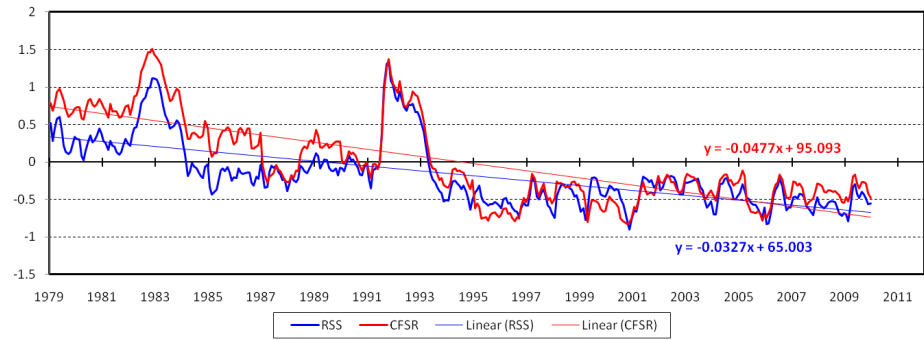


# TLS (MSU 4) Anomalies from Reanalyses vs RSS

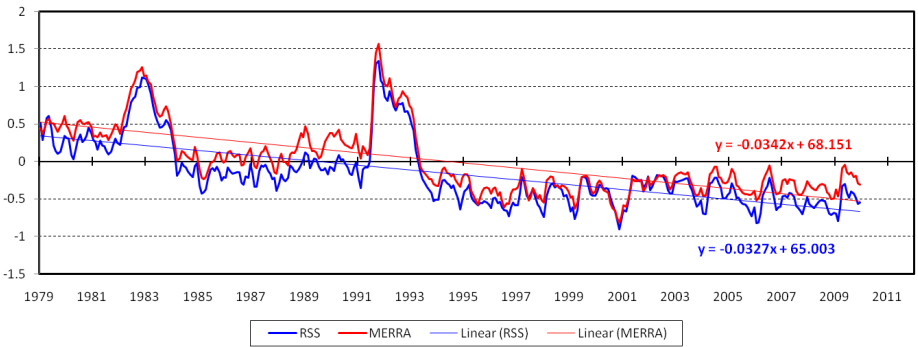
### R1 TLS Anomalies



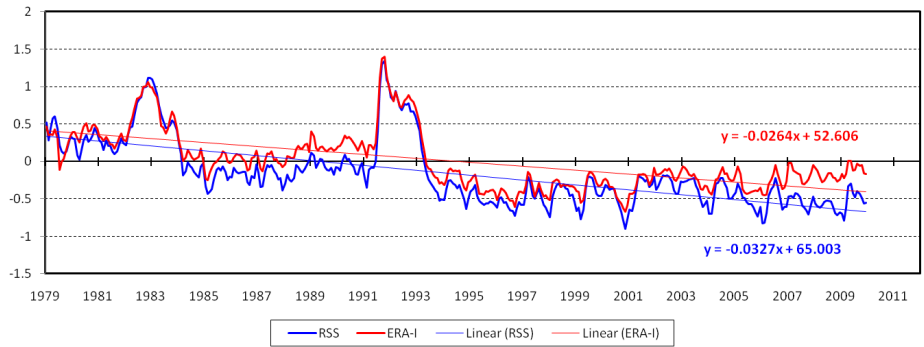
### CFSR TLS Anomalies



### MERRA TLS Anomalies

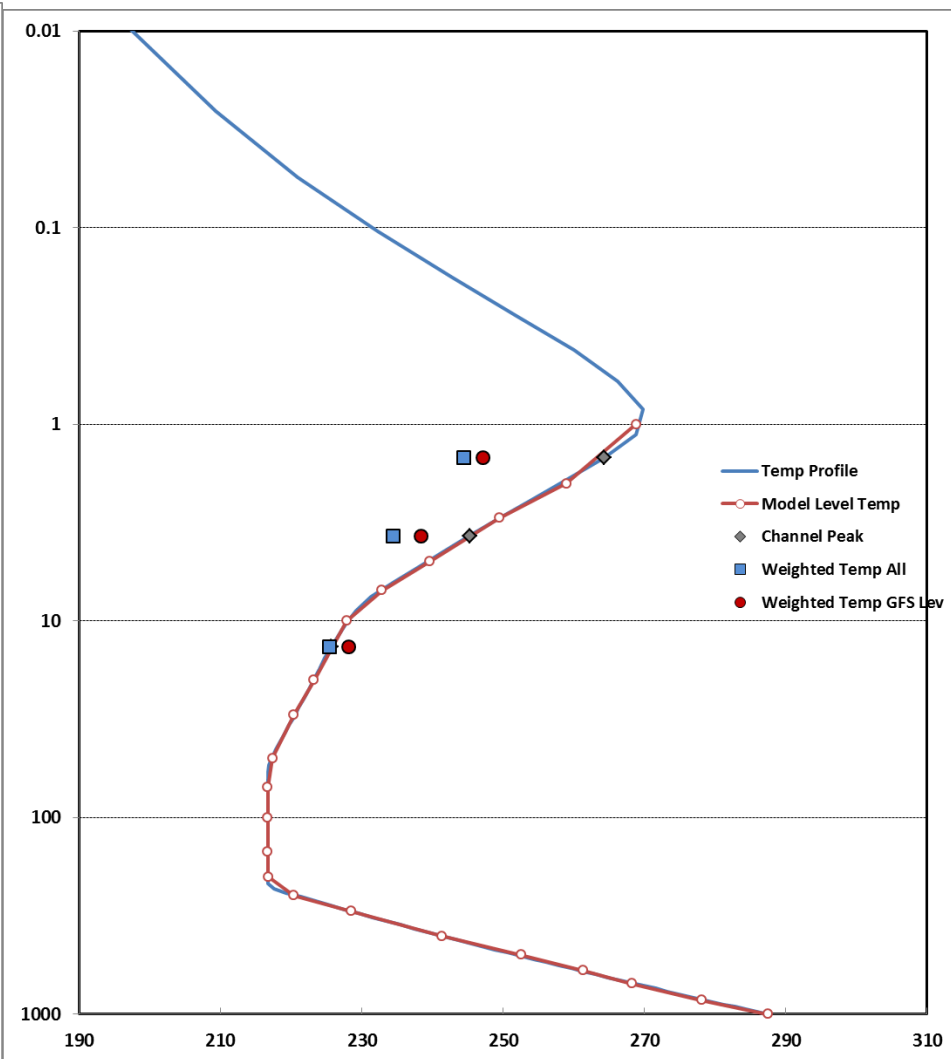
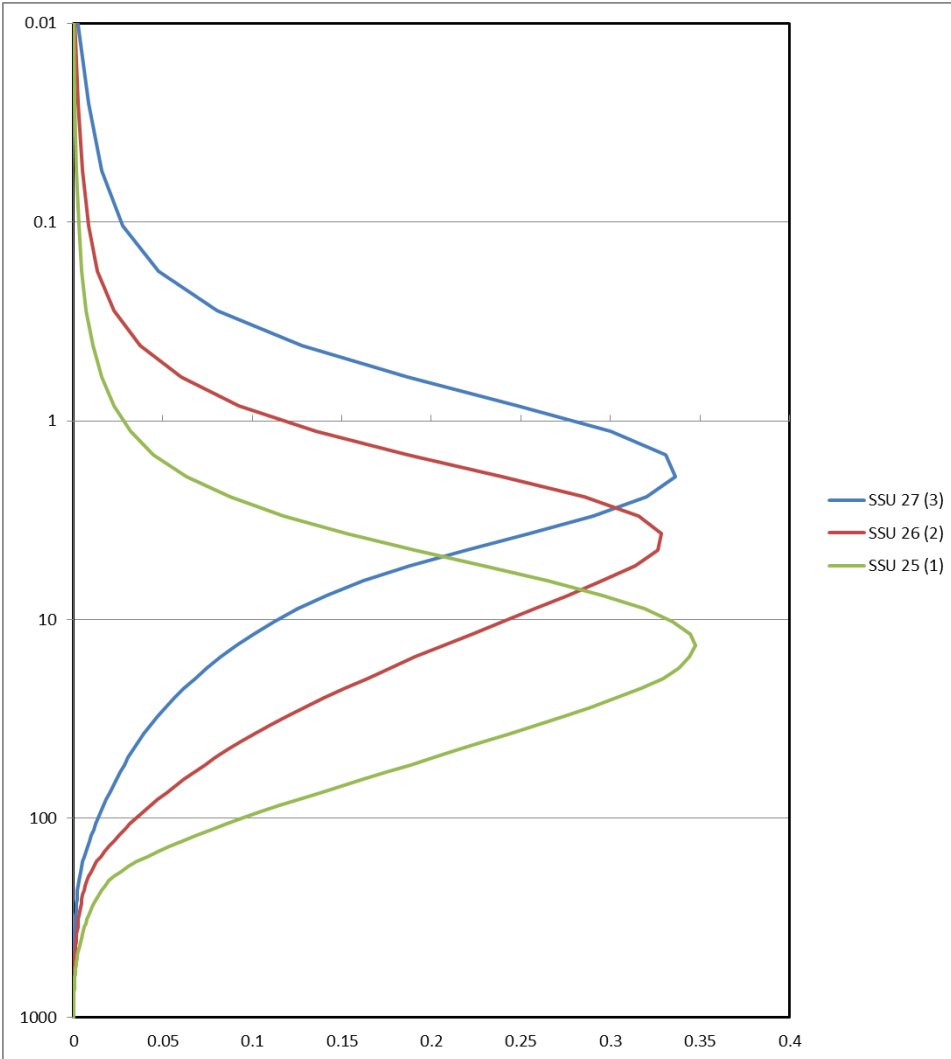


### ERA-I TLS Anomalies



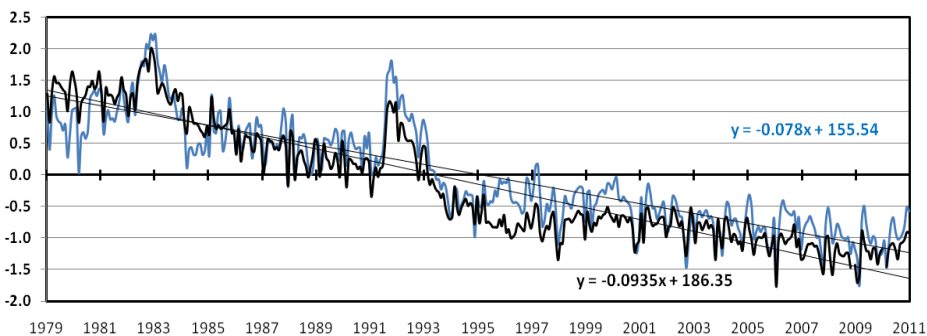


# SSU Weighting Functions – limitation using Model output to replicate

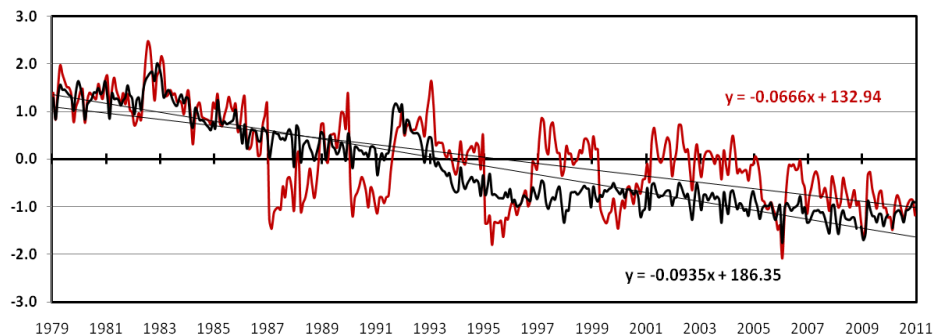


# SSU Ch 1 Anomalies from Reanalyses vs NESDIS/STAR

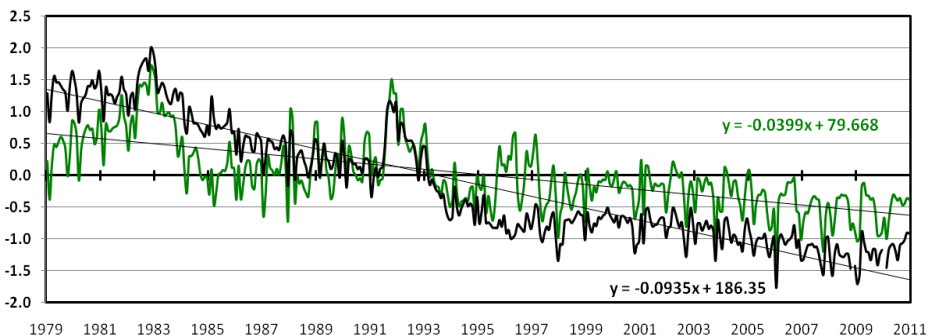
## R1 : T Anomalies SSU Channel 25 Time Series



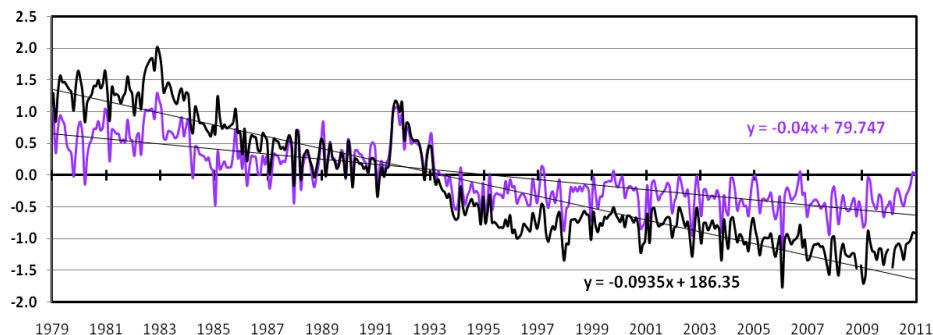
## CFSR : T Anomalies SSU Channel 25 Time Series



## MERRA : T Anomalies SSU Channel 25 Time Series

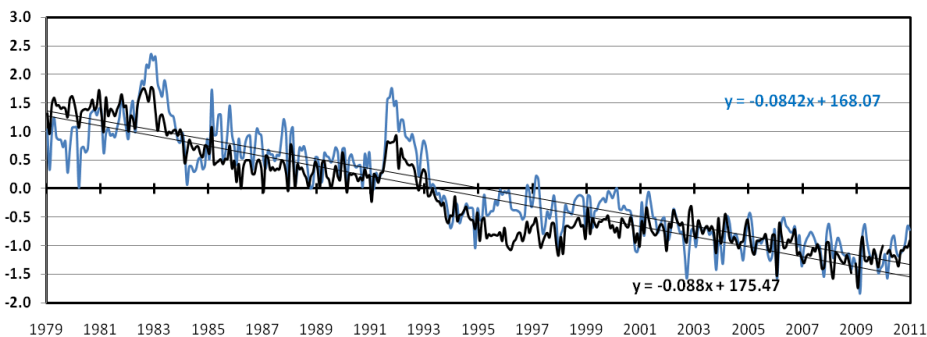


## ERA-I: T Anomalies SSU Channel 25 Time Series

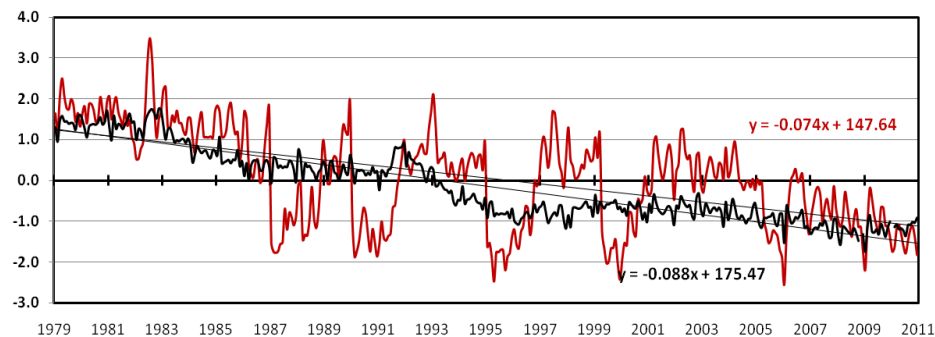


# SSU Ch 2 Anomalies from Reanalyses vs NESDIS/STAR

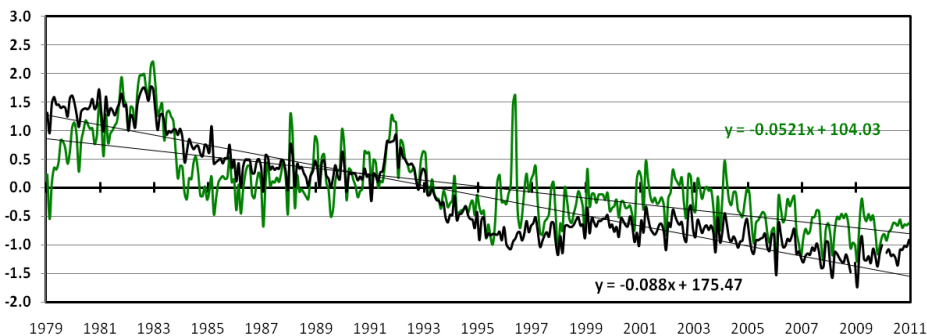
## R1 : T Anomalies SSU Channel 26 Time Series



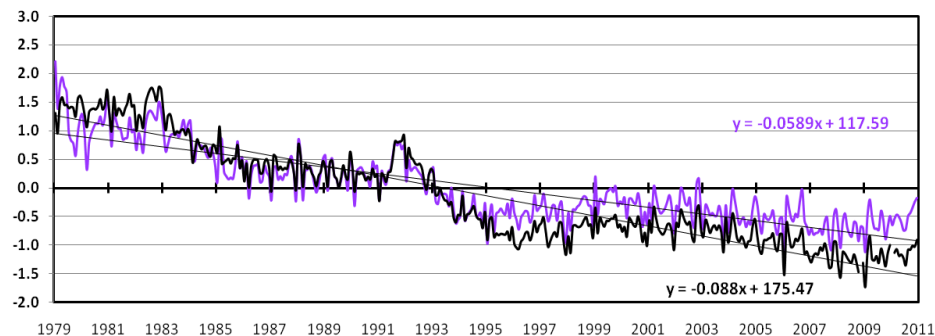
## CFSR : T Anomalies SSU Channel 26 Time Series



## MERRA : T Anomalies SSU Channel 26 Time Series

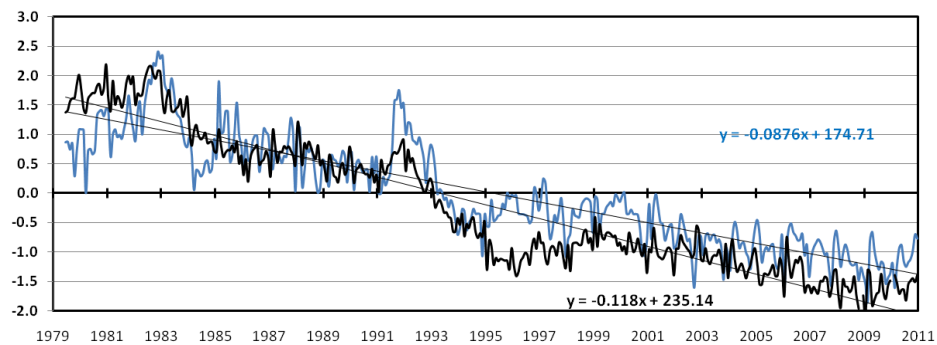


## ERA-I: T Anomalies SSU Channel 26 Time Series

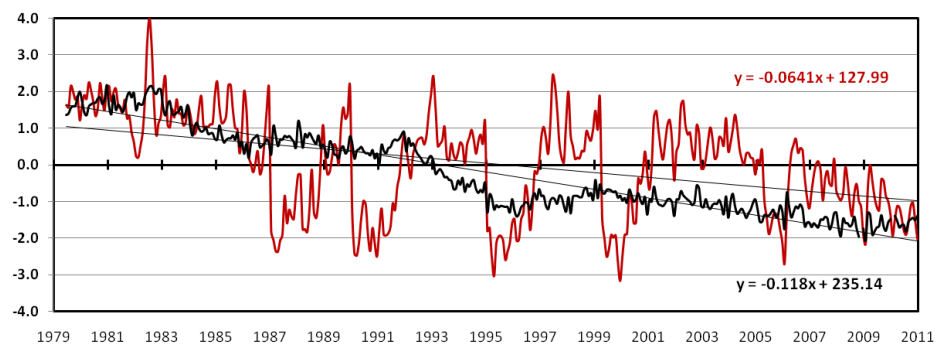


# SSU Ch 3 Anomalies from Reanalyses vs NESDIS/STAR

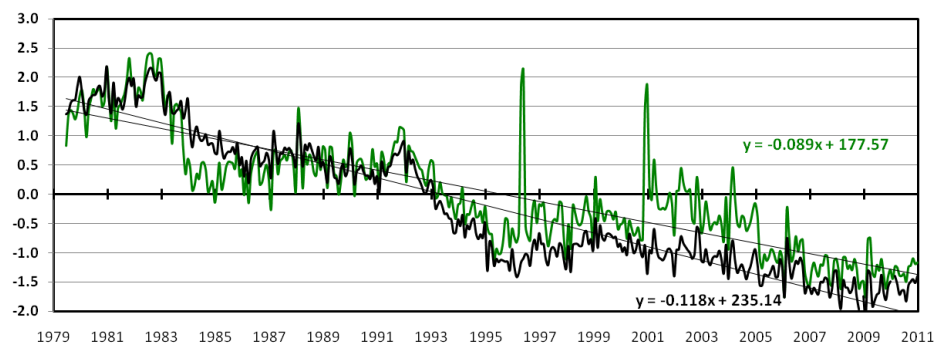
### R1 : T Anomalies SSU Channel 27 Time Series



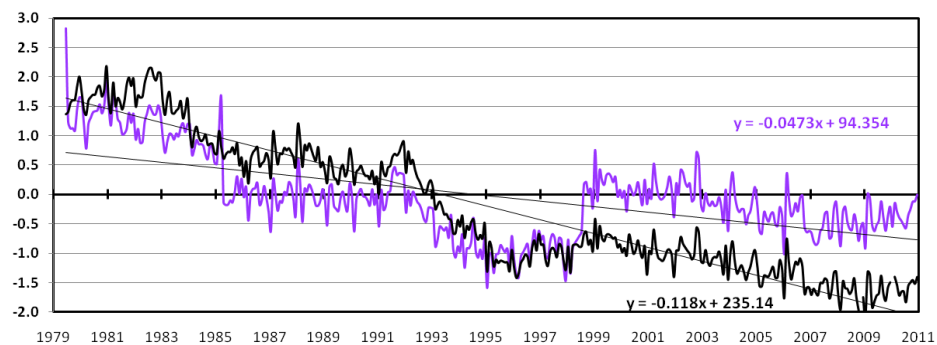
### CFSR : T Anomalies SSU Channel 27 Time Series



### MERRA : T Anomalies SSU Channel 27 Time Series



### ERA-I: T Anomalies SSU Channel 27 Time Series



# Summary

- Stratospheric cooling is indicator of climate change.
- In lower stratosphere there are multiple data sets to detect temperature trend.
- In middle and upper stratosphere only satellite data provides global coverage
- Other data have poor geographic or temporal coverage
- Reanalyses have discrepancies with satellite data trends.
- Reanalyses not ready to use for climate trends in stratosphere.
- Was going to look at ozone trends but...