



# The 1960s drought and subsequent transition to a wetter climate in New York City's Catskill Mountains watershed

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Stephanie Jurburg, Jennifer Nakamura*

Lamont Doherty Earth Observatory

Seager et al. J. Climate (2012)

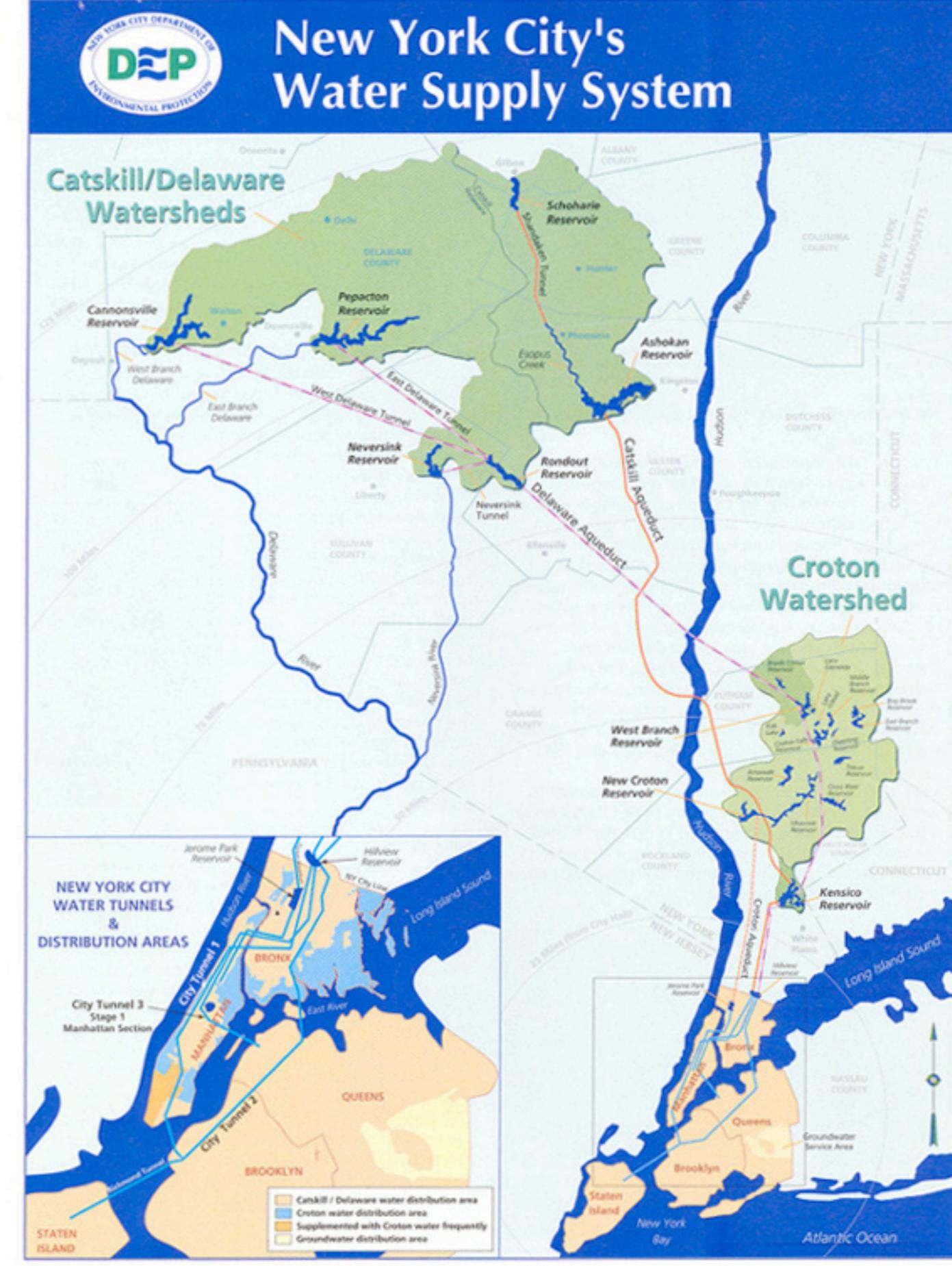


New York City first drew water from the Croton watershed (Old Croton Aqueduct 1842, New Croton Aqueduct 1890).

Then turned to Catskills. Ashokan Reservoir and Catskill Aqueduct 1915.

Capture of Delaware River water began in 1937. Rondout Reservoir 1950, Neversink 1954, Pepacton 1955, Cannonsville 1964. And that was it.

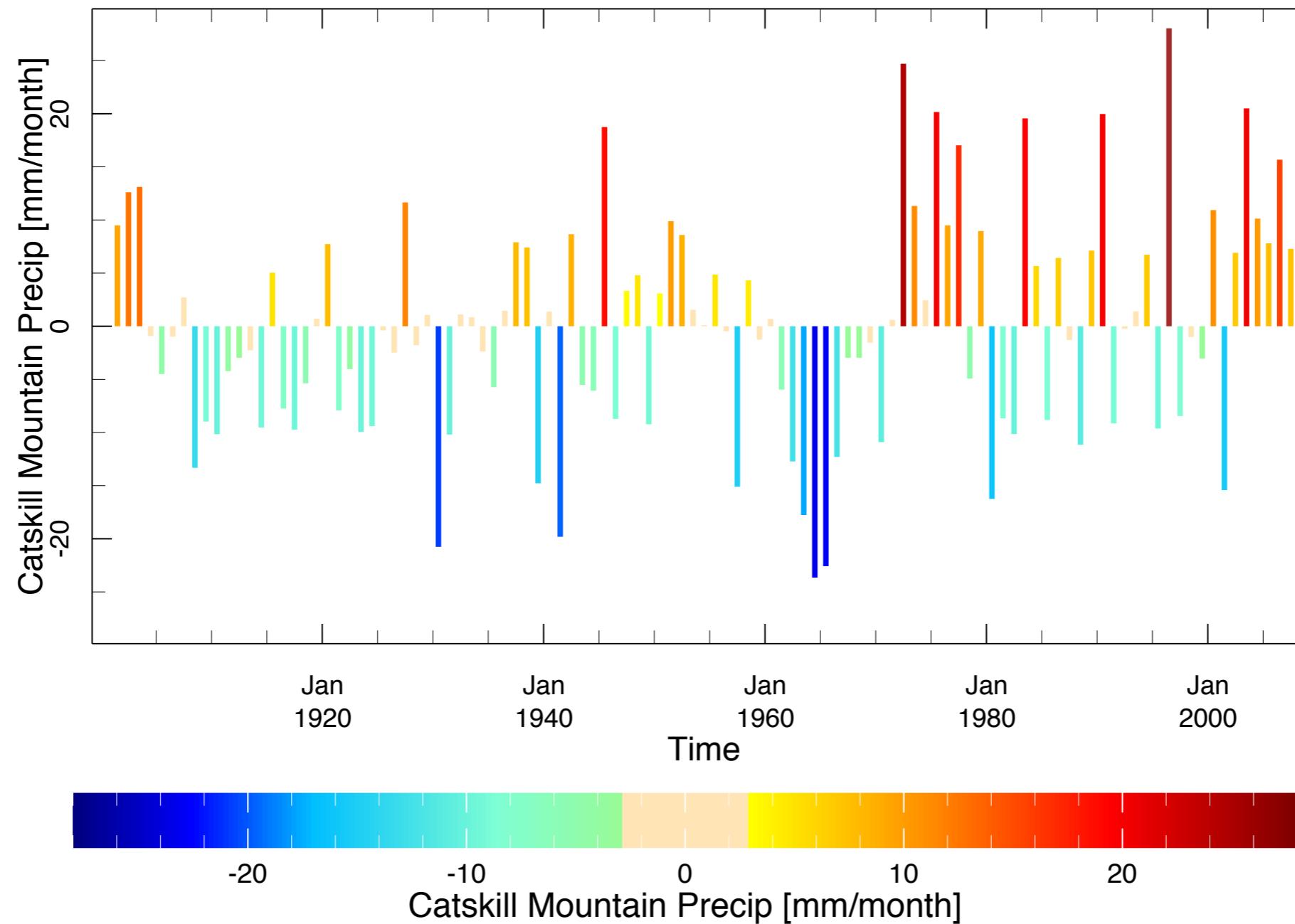
19 reservoirs and 3 regulated lakes. 95% water delivered by gravity. Croton water is filtered but Catskill water is unfiltered. Considered a poster child of ecosystem services!





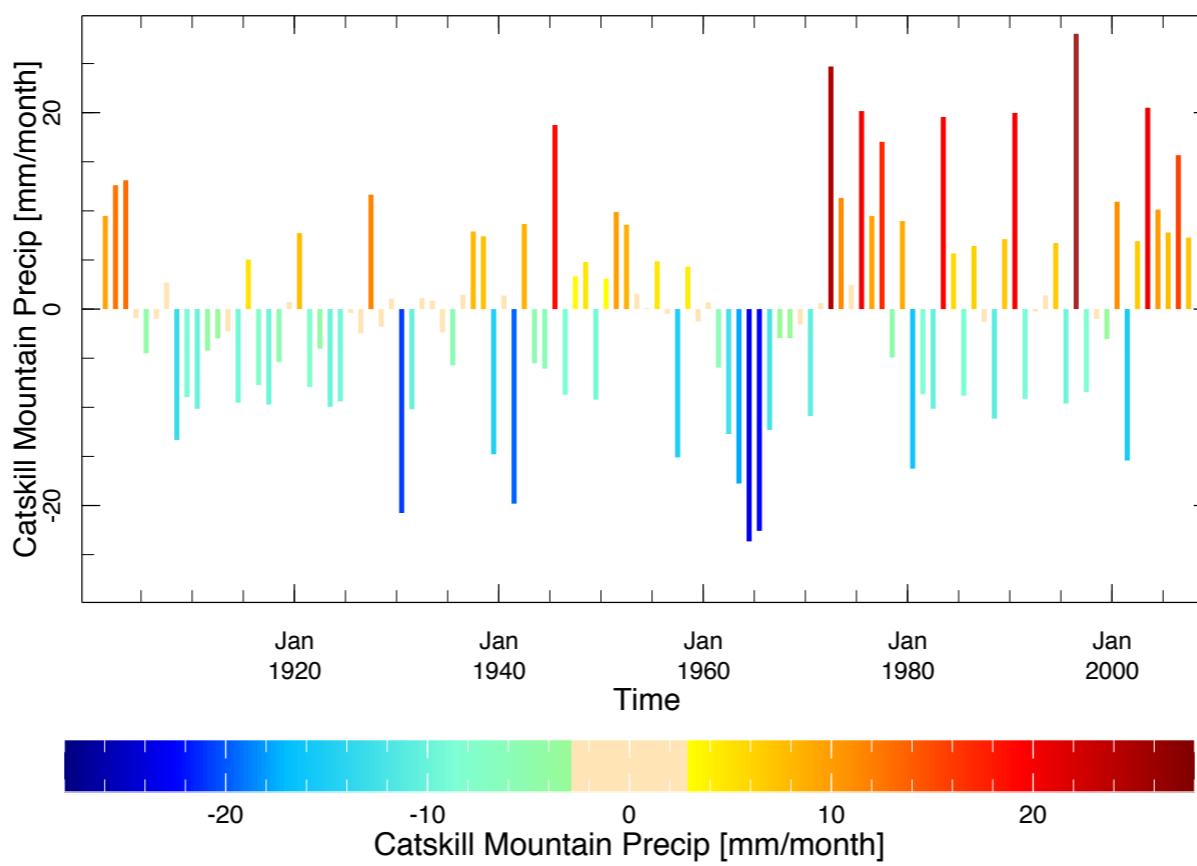
Friday, October 26, 12

# Annual Precipitation over Catskill Mountains

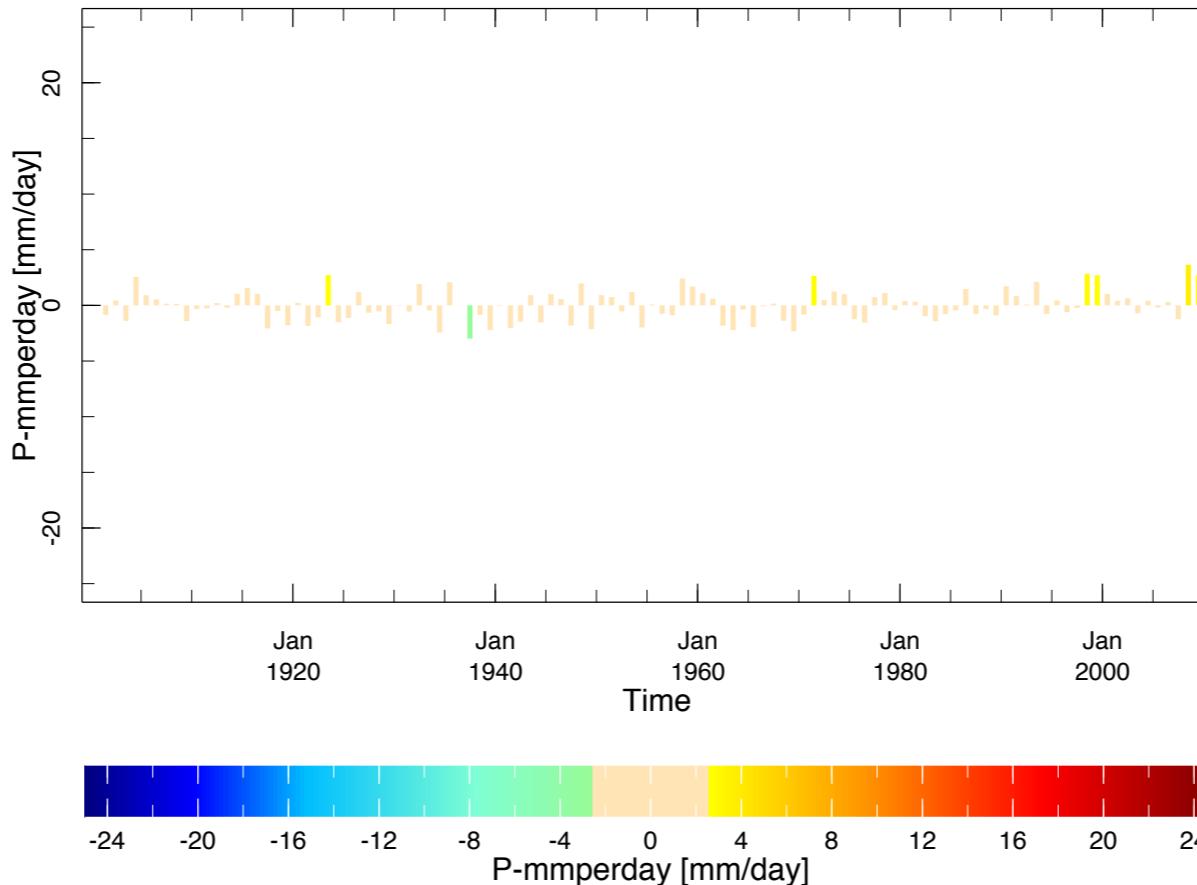


Precipitation data (GPCC gridded) across the Catskills region show the 1960s drought and a remarkable post 1970s pluvial

Observed  
Catskill  
precipitation.  
Trend 8mm/  
month

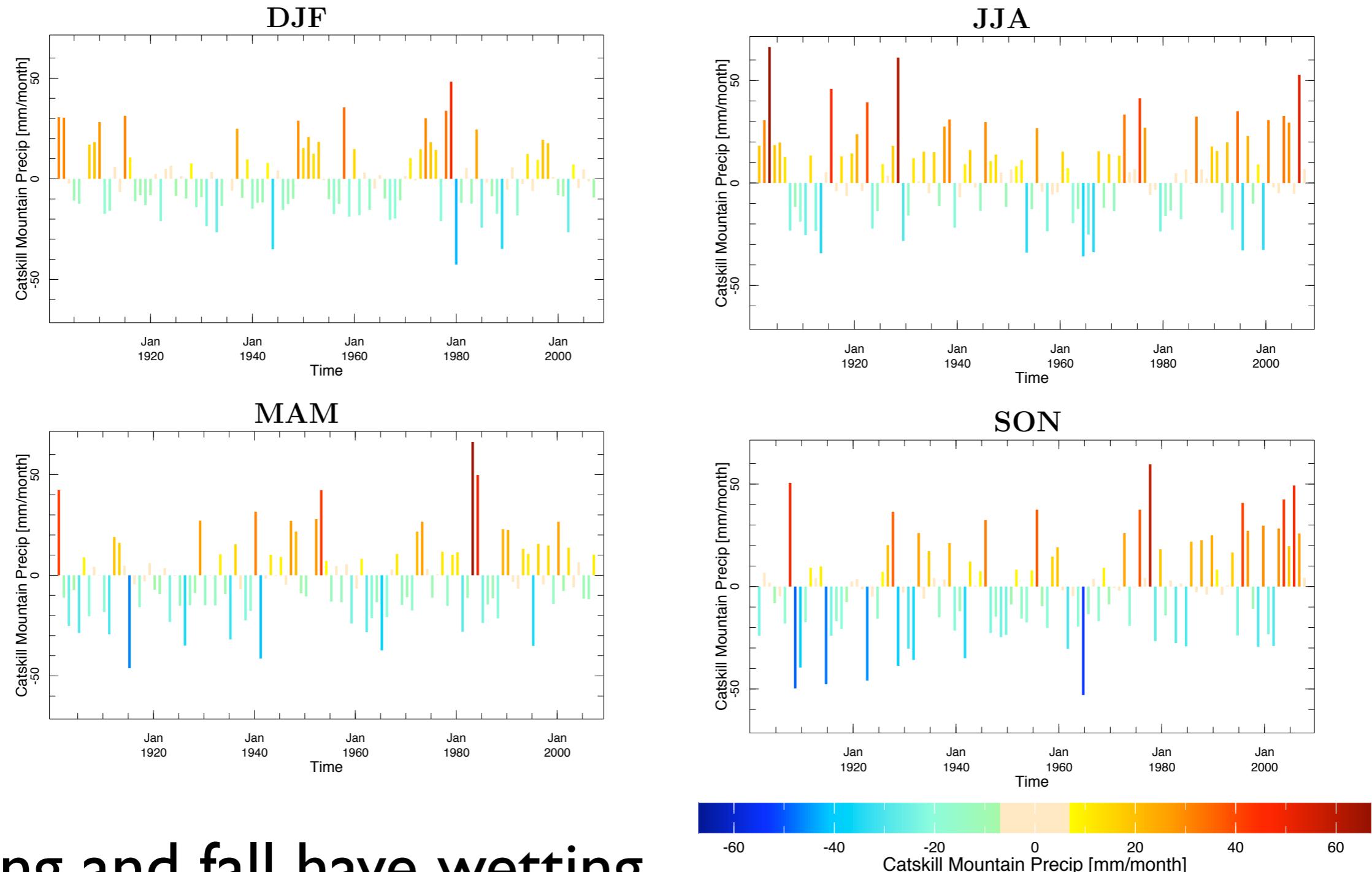


24 IPCC AR4  
model mean  
precipitation.  
Trend 1mm/  
month



Only an insignificant  
part of the wetting is  
consistent with  
modeled climate  
change

# Seasonal Precipitation over Catskill Mountains

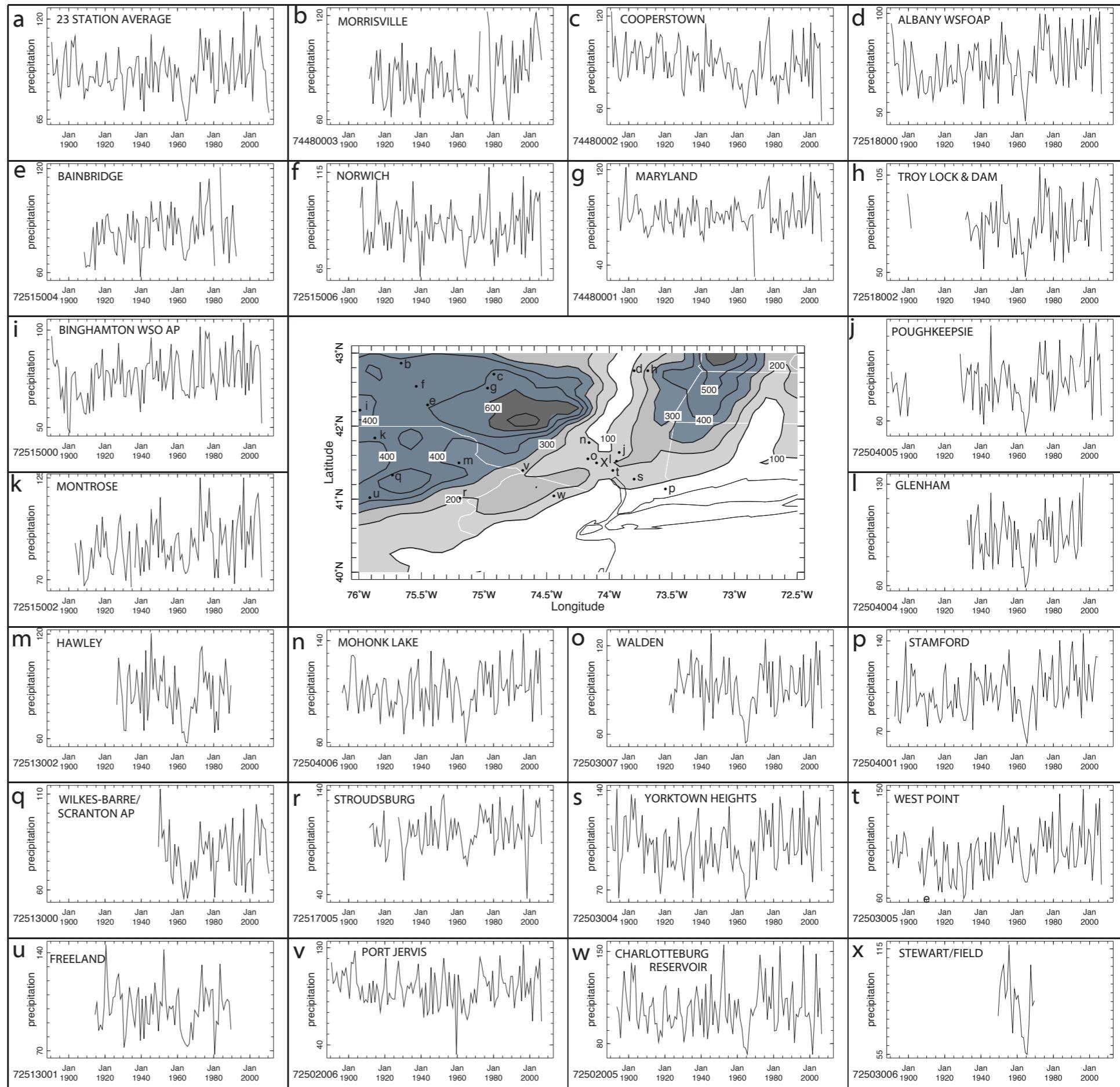


Spring and fall have wetting trends. 1960s drought appears year round.

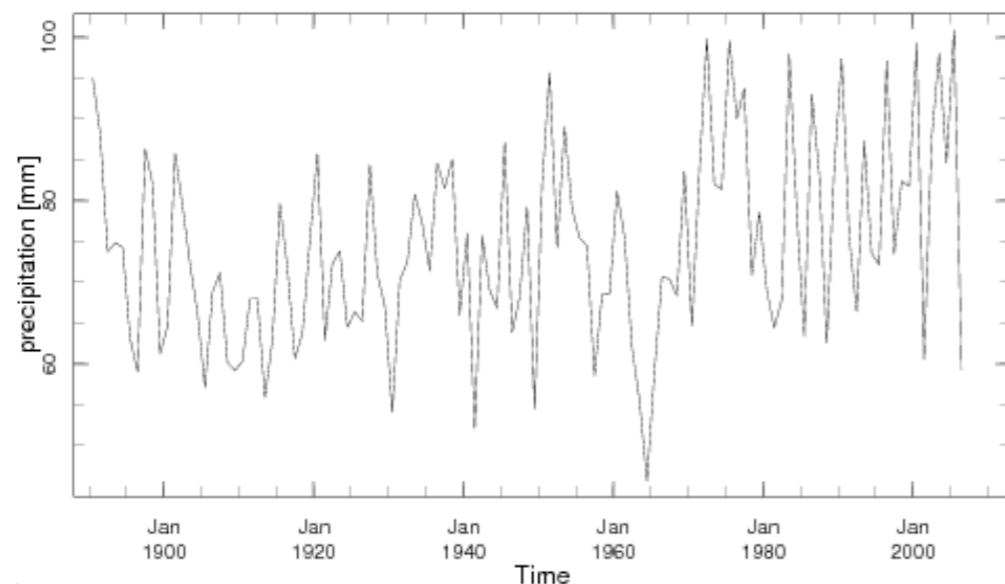
23 station  
average



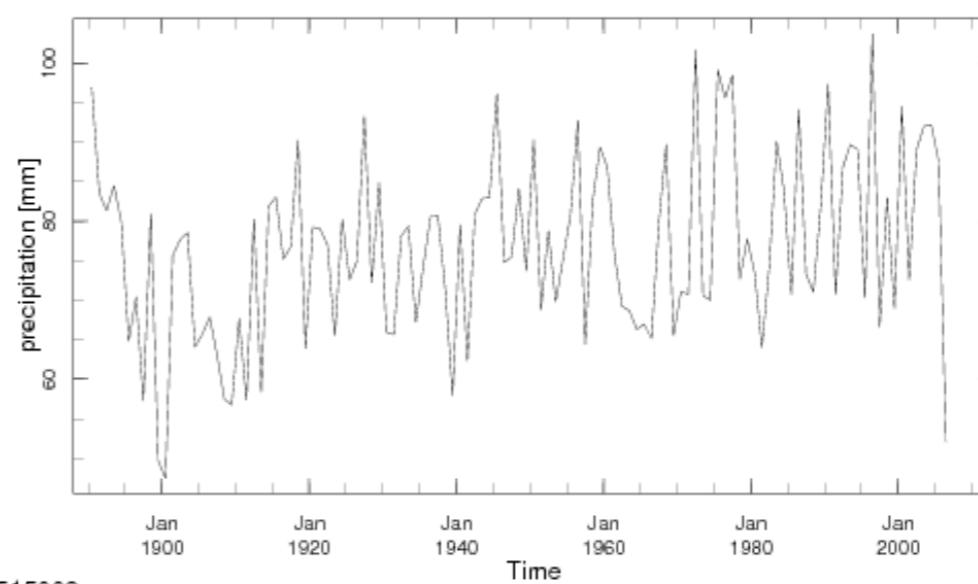
Catskills  
region  
precipitation  
history as  
seen from  
individual  
rain gauges



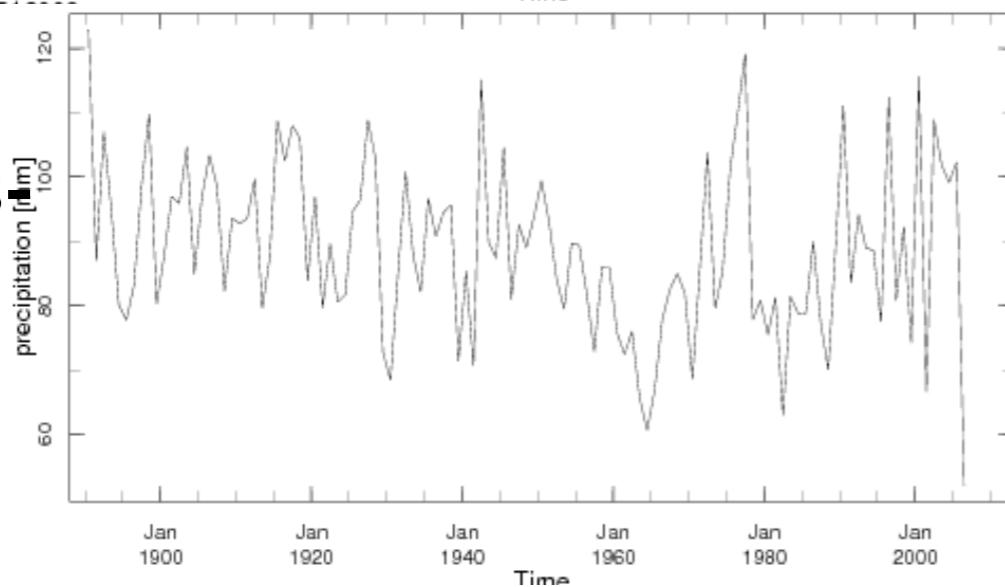
**Albany**



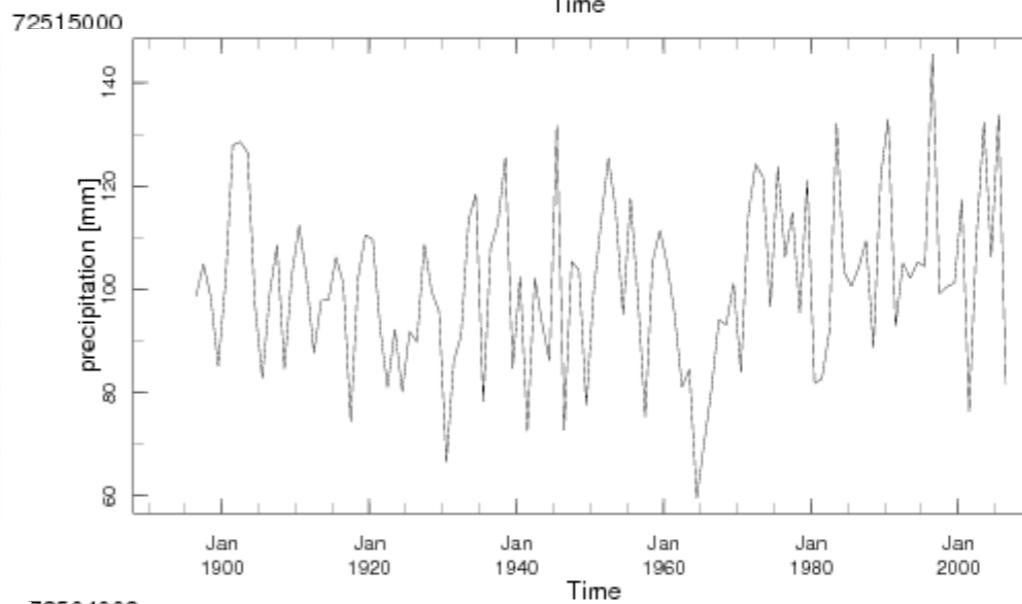
**Bing-  
hampton**



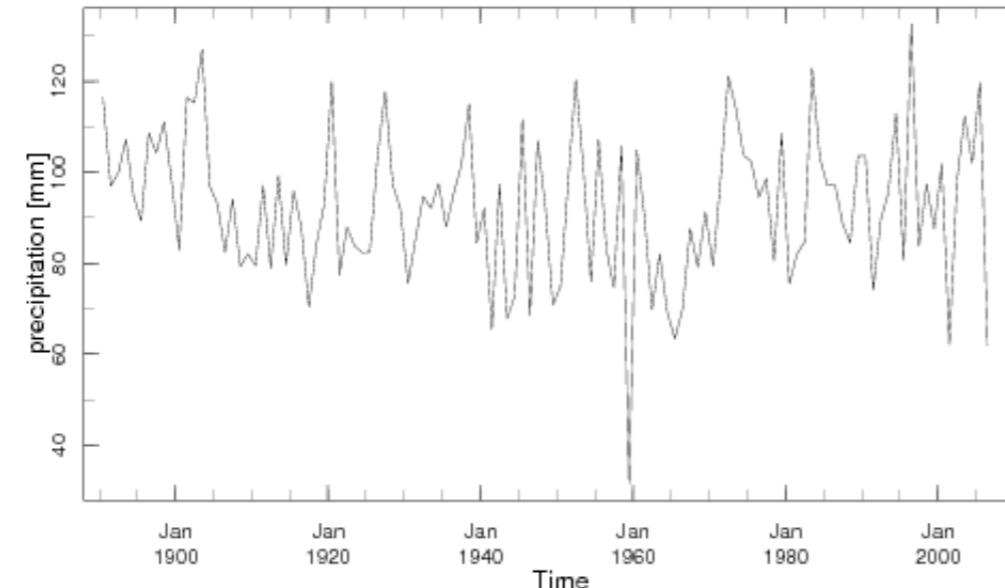
**Coopers-  
town**



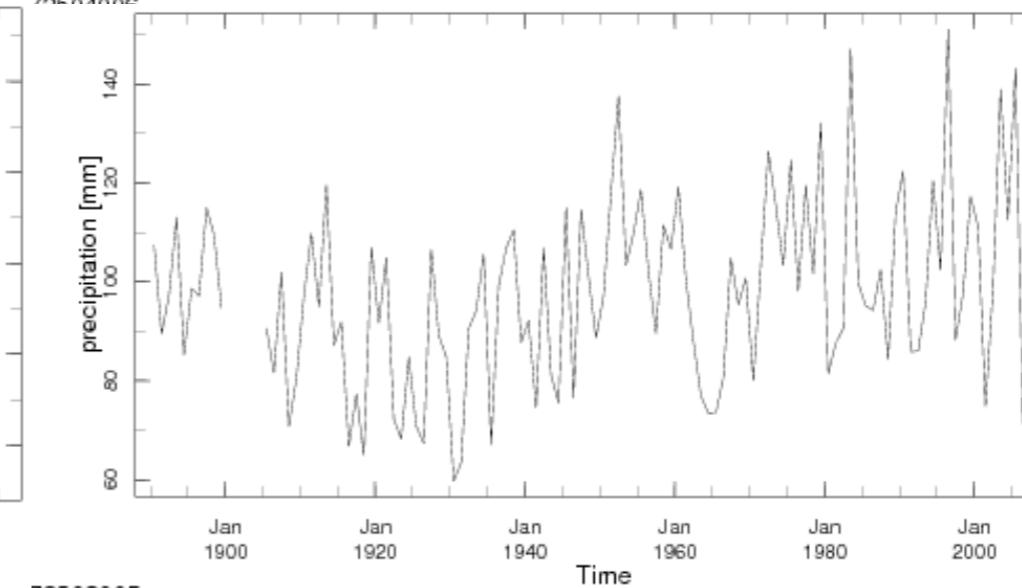
**Mohonk  
Lake**



**Port  
Jervis**



**West  
Point**



72502006

72503005

Literature search turns up:  
Namias (1966)  
and not a lot else ...

**MONTHLY  
WEATHER  
REVIEW**

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**NATURE AND POSSIBLE CAUSES  
OF THE NORTHEASTERN UNITED STATES DROUGHT DURING 1962-65**

JEROME NAMIAS

Extended Forecast Division, Weather Bureau, Environmental Science Services Administration, Washington, D.C.

**ABSTRACT**

During the past 4 years noteworthy weather fluctuations of a persistent kind have occurred over large portions of the United States, the most prominent of which have been the deficiency in precipitation over the Northeast and the excess over the Southwest and the Northern Plains. The nature of these abnormalities is described with the help of seasonal frequency distributions of precipitation determined for 40 climatologically homogeneous areas of the country. From this and other material it is shown that the Northeast drought has been largely a spring and summer phenomenon at the same time when abundant rains occurred over the Northern Plains and Far Southwest.

The large-scale upper-air currents favoring or inhibiting precipitation through interactions with air masses and storms are next described. The most consistent year-to-year feature of these upper winds in the quadrennial has been the persistence of one southward dip in the westerlies just off the eastern seaboard and another over the Far Southwest.

A hypothesis is proposed for the cause of the aberrant upper-wind currents which considers the atmosphere and ocean as a complex coupled system. Abnormalities of sea-surface temperature are created by anomalous surface wind drag and by extraction of heat by anomalous air masses. The ocean thus serves as a reservoir whose heat transfer affects sequences of atmospheric systems. An attempt is made to show that a feedback system of this type has been operating efficiently during the past 4 years so as to produce the observed anomalous weather patterns.

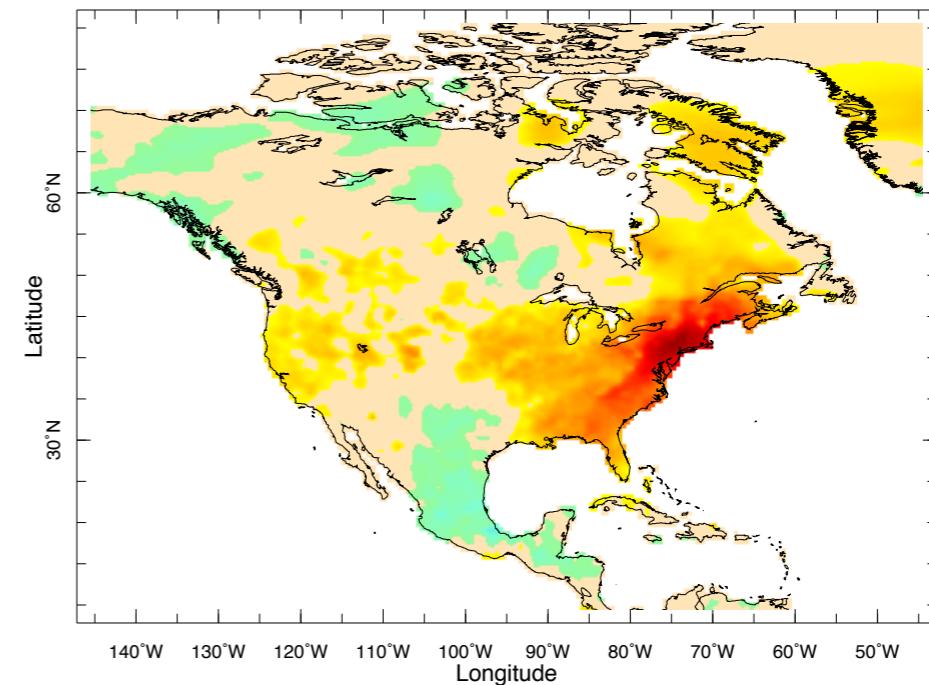
Catskills precipitation  
is only well correlated  
with precipitation in  
east - and northeast  
in summer.



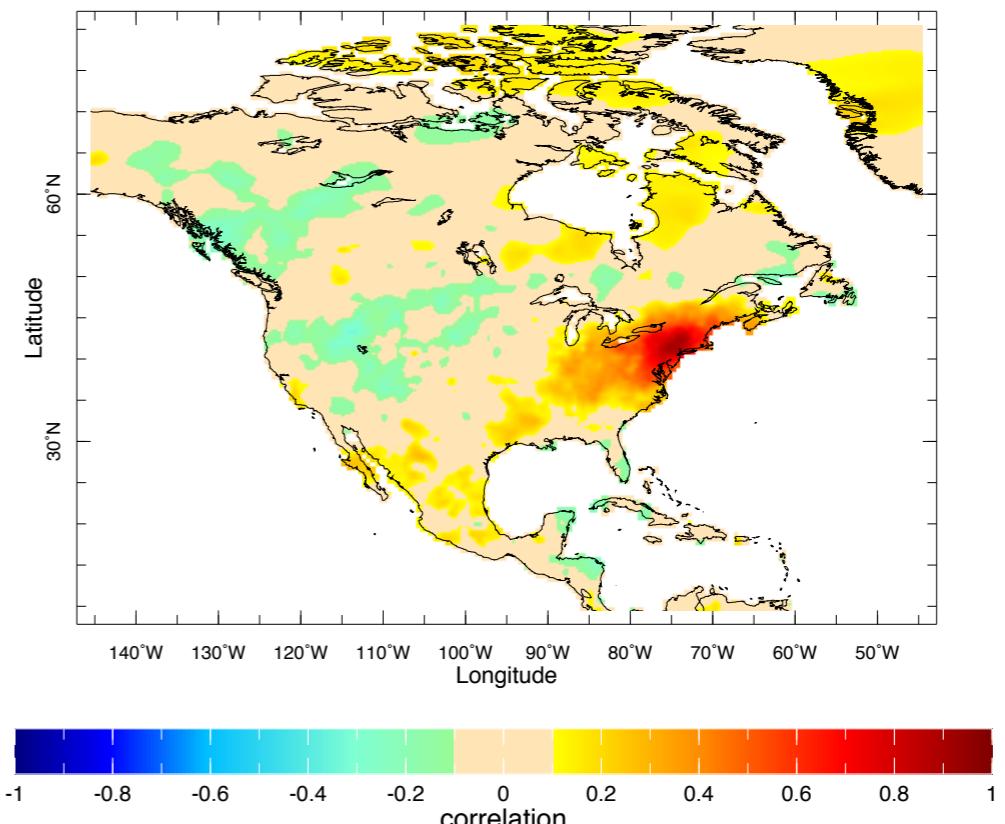
Pepacton reservoir

Correlation of Catskill Mountain Precip on GPCC Precip

(A) Nov-Apr



(B) May-Oct

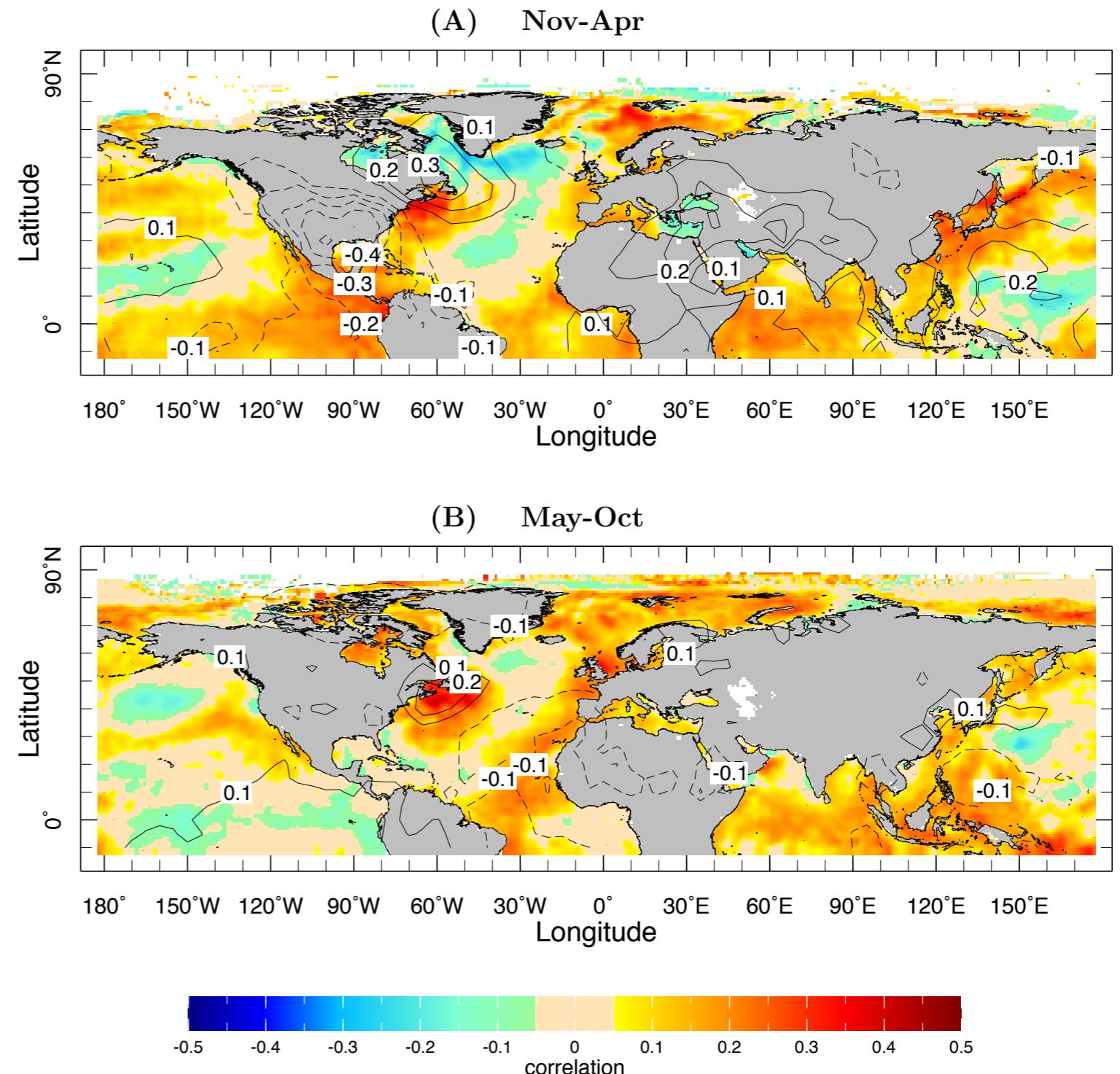


Strongest correlations to SST are in local Atlantic. Overall positive caused by association (coincidence?) between century long wetting and global warming.

High SLP over Atlantic immediately northeast of Catskills associated with wet.

High implies onshore flow. (Looking at storm track anomalies on to-do list.)

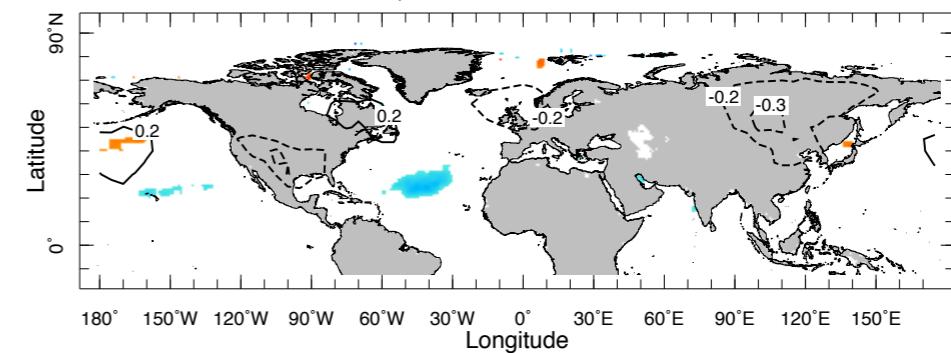
Correlation of Catskill Mountain Precip on Hadley SST (color) and SLP (contours)



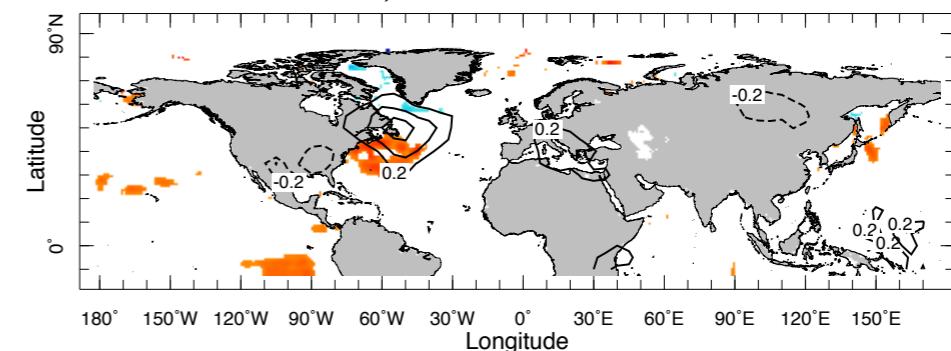
**Correlation with SLP  
and SST by season  
and plotting only  
where statistically  
significant reveals no  
believable  
hemispheric  
teleconnections to  
Catskills precipitation**

Corr Catskill P on SST (color) and SLP (contours)

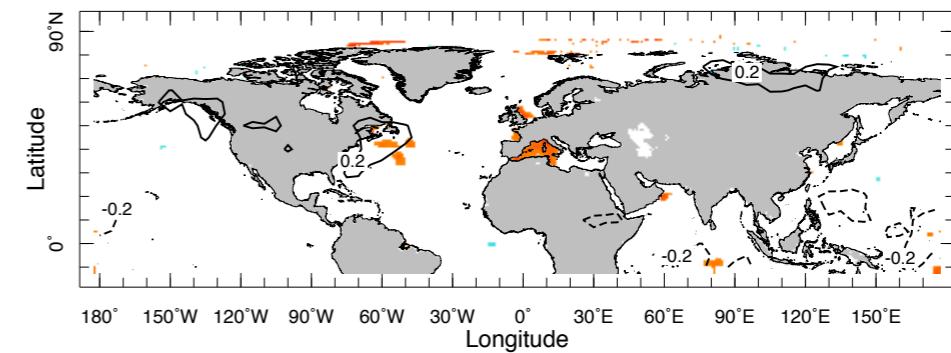
a) DJF



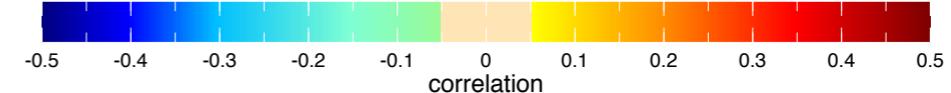
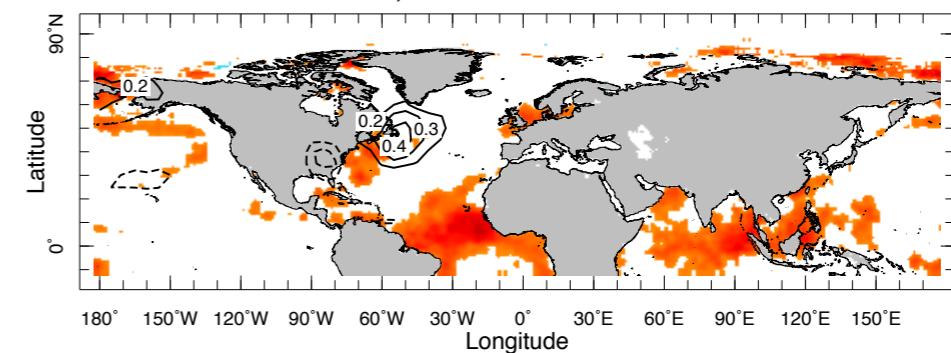
b) MAM



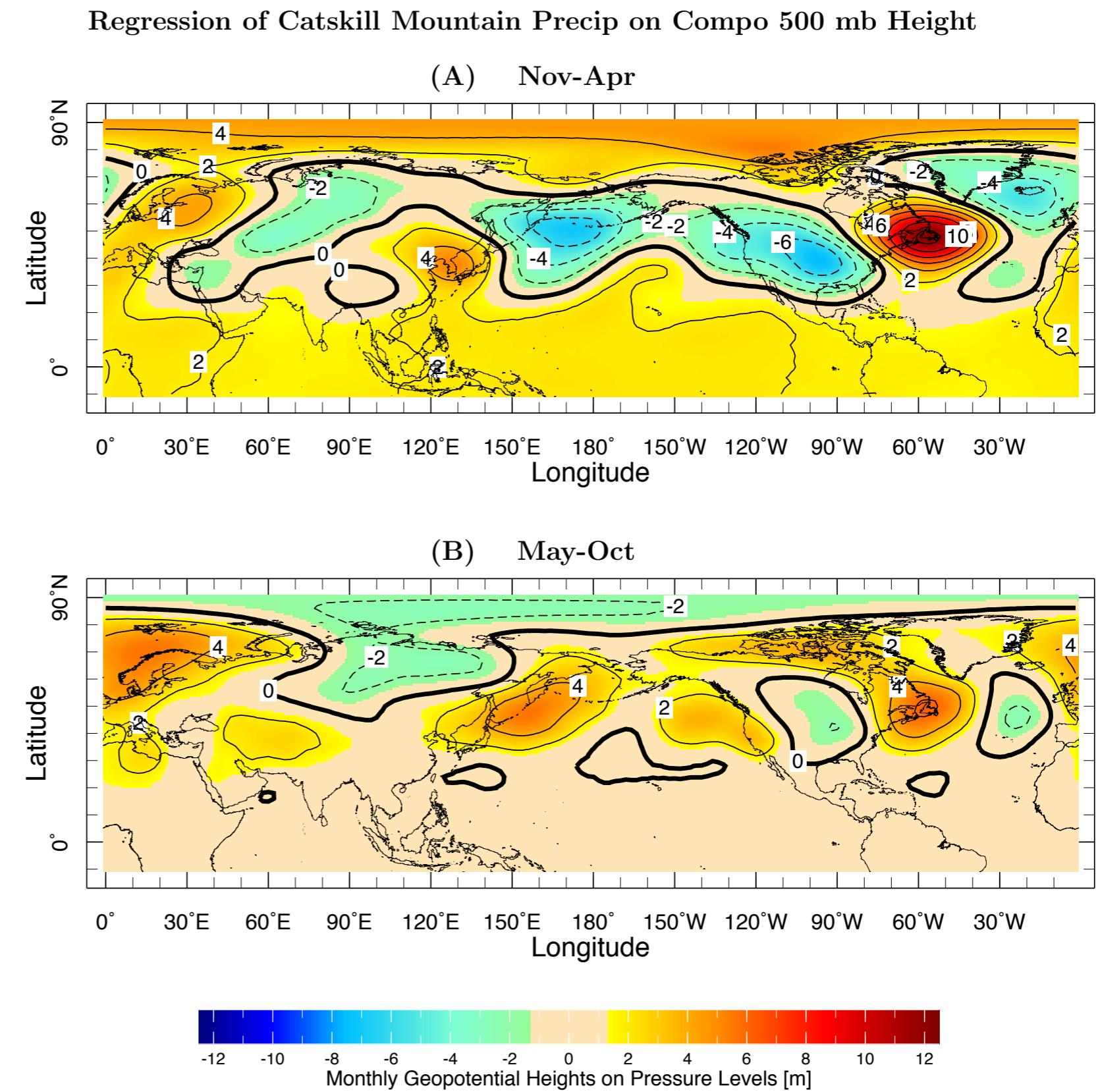
c) JJA



d) SON



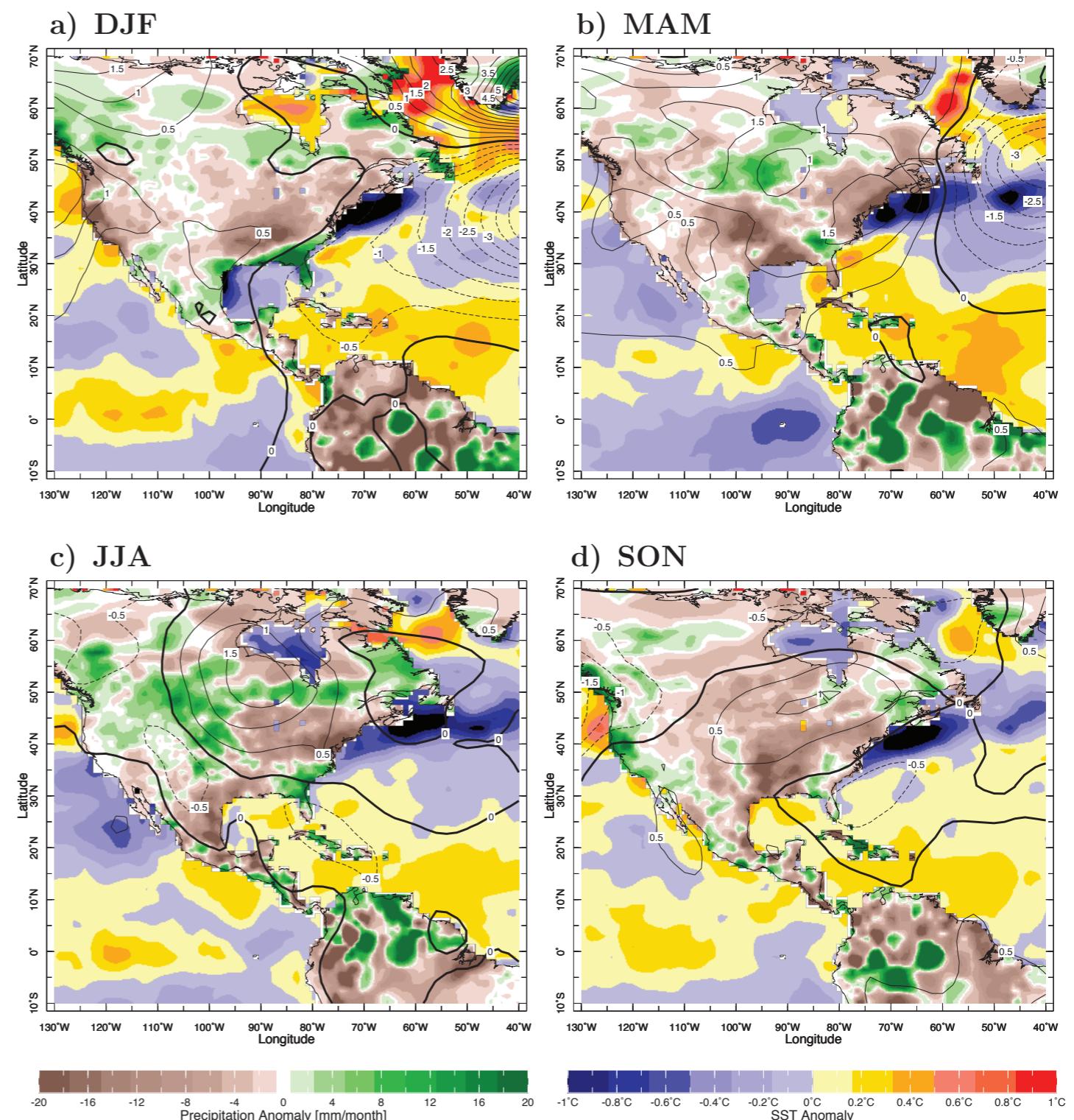
Regression of winter  
500mb height  
anomaly on Catskill  
precipitation shows a  
NA/Atl wave train.



As identified by Namias,  
the 1960s drought was  
characterized by a spring  
low over the Atlantic to  
the NE. Cool SSTs are  
consistent with northerly  
flow, probably not causal.

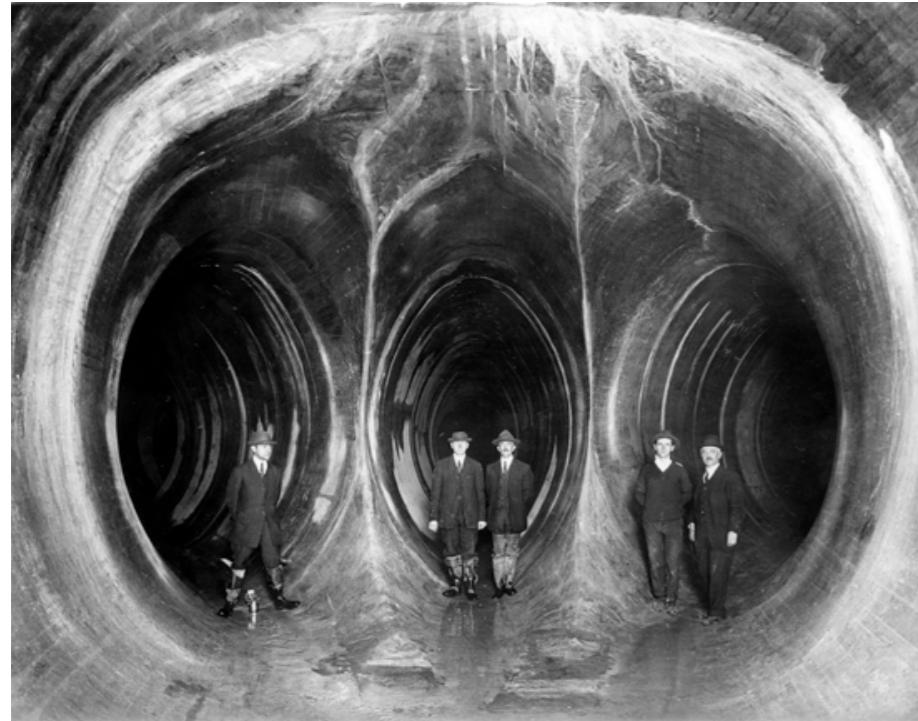


1962-1966 Precip (land), SST (ocean), and SLP (contours)



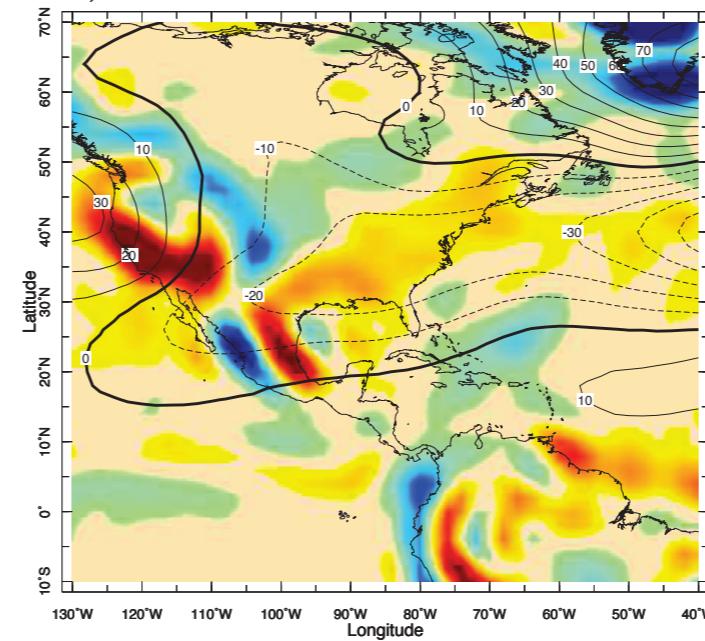
Ashokan  
Reservoir

Consistent with  
northerly flow west  
of the low, the East  
Coast was under  
powerful winter and  
spring subsidence  
during the drought  
causing drying.

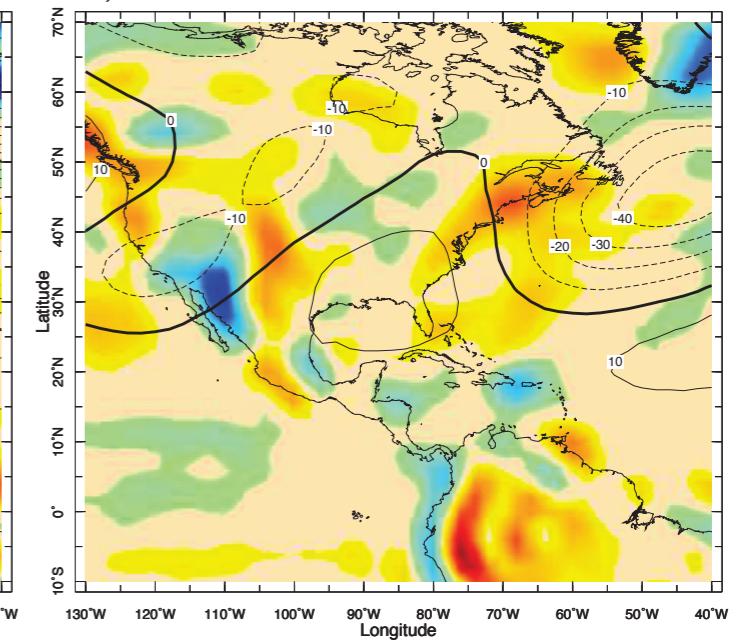


1962-1966 700 mb Vert Vel (color) and 500 mb Height (contours)

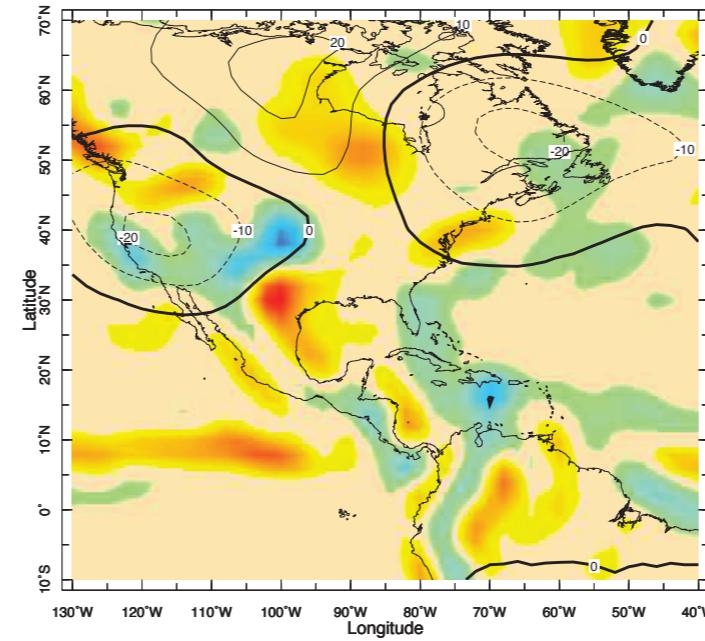
a) DJF



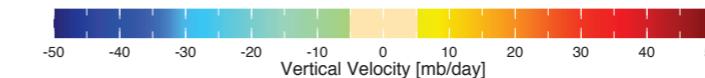
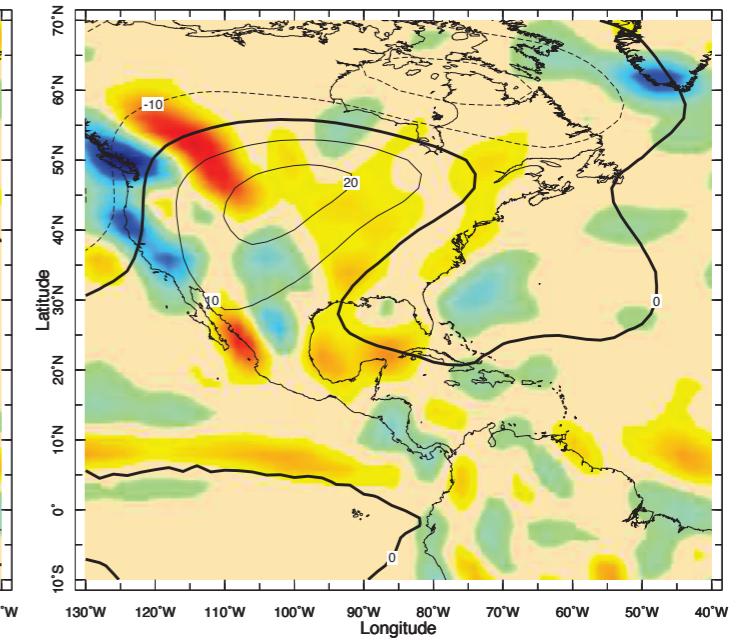
b) MAM



c) JJA



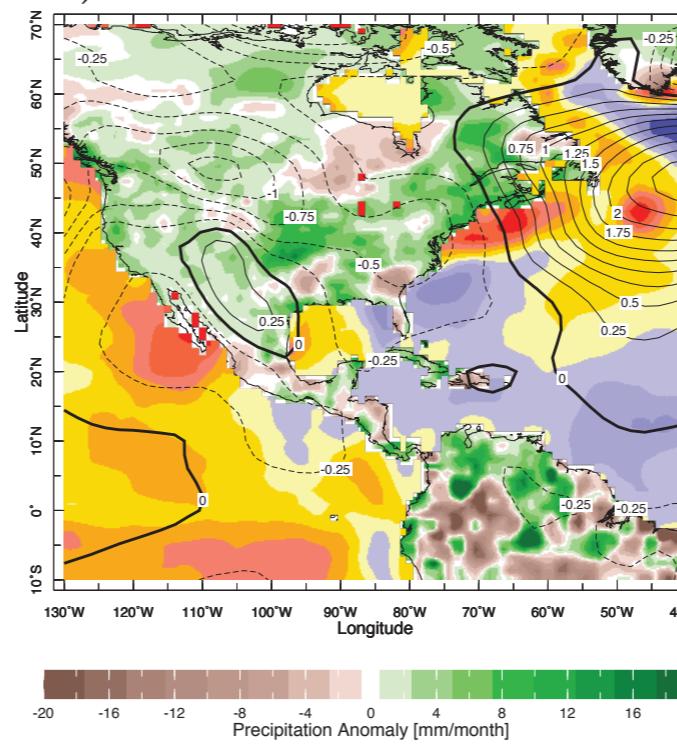
d) SON



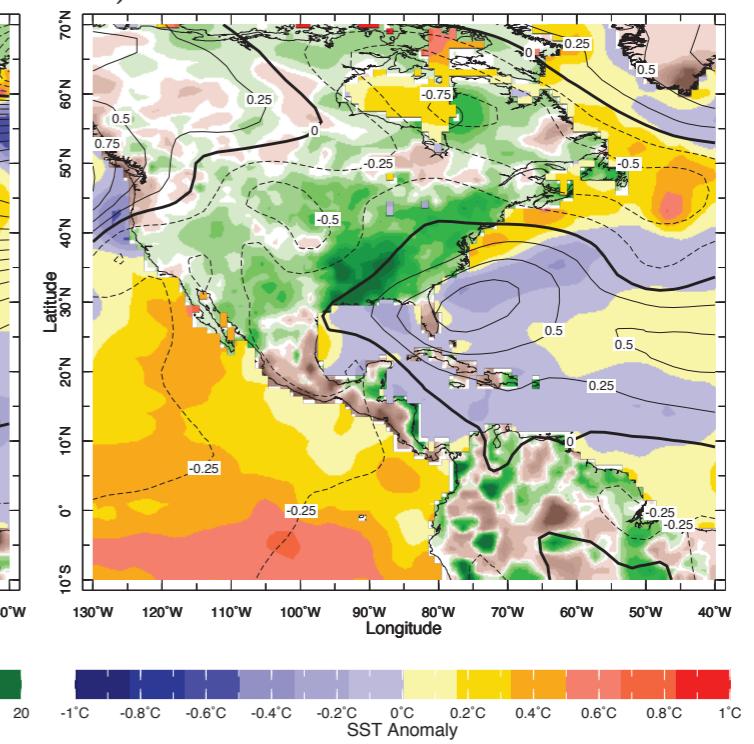
Engineers inside Catskill Aqueduct siphon, 1923

Precip (land), SST (ocean), and SLP (contours)

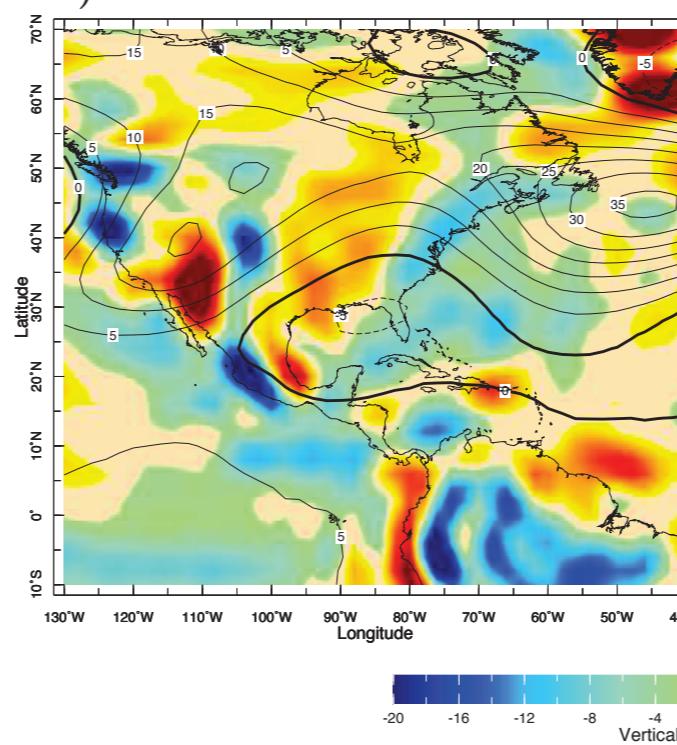
a) MAM



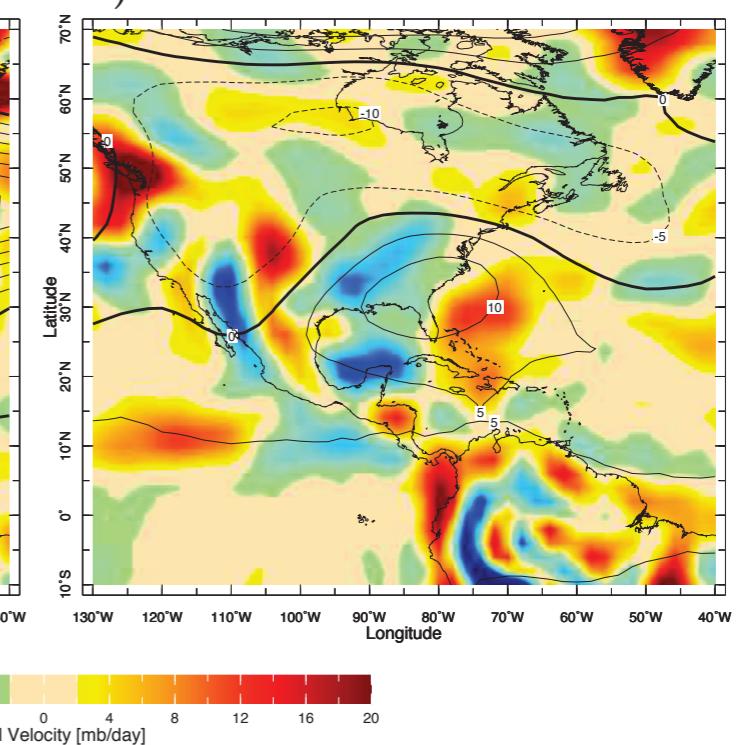
b) SON



c) MAM

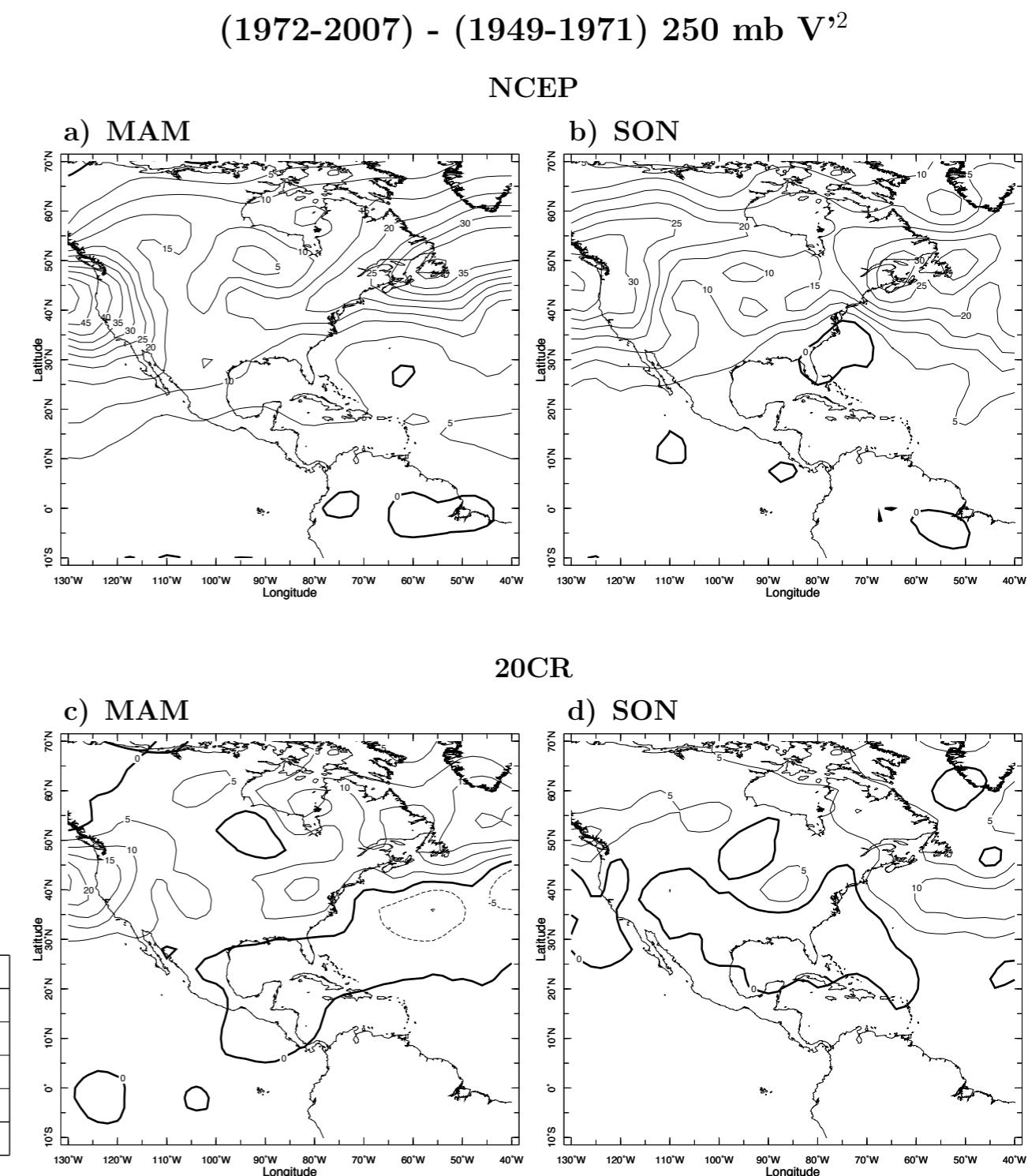
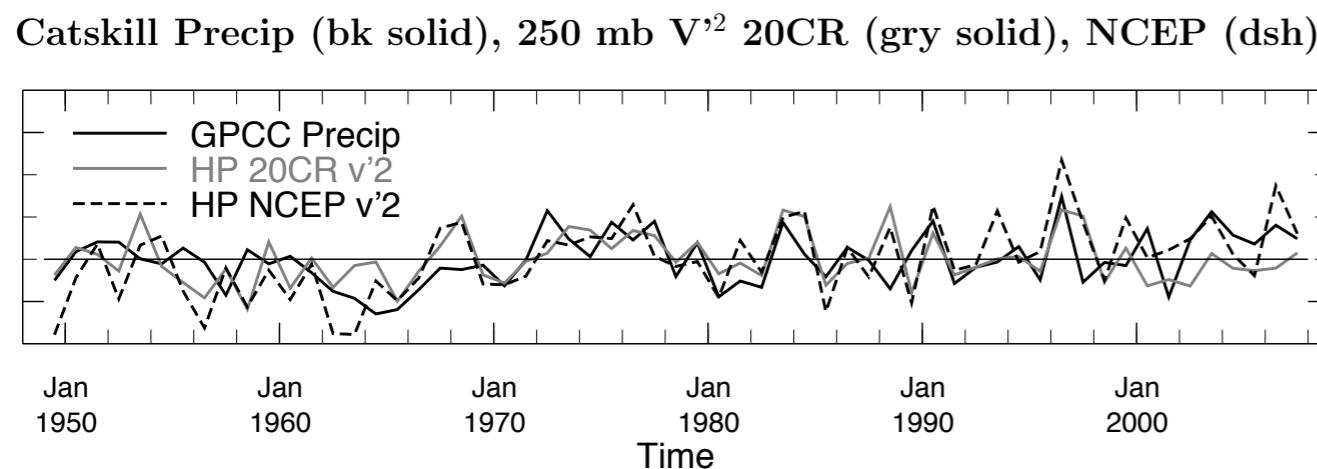


d) SON

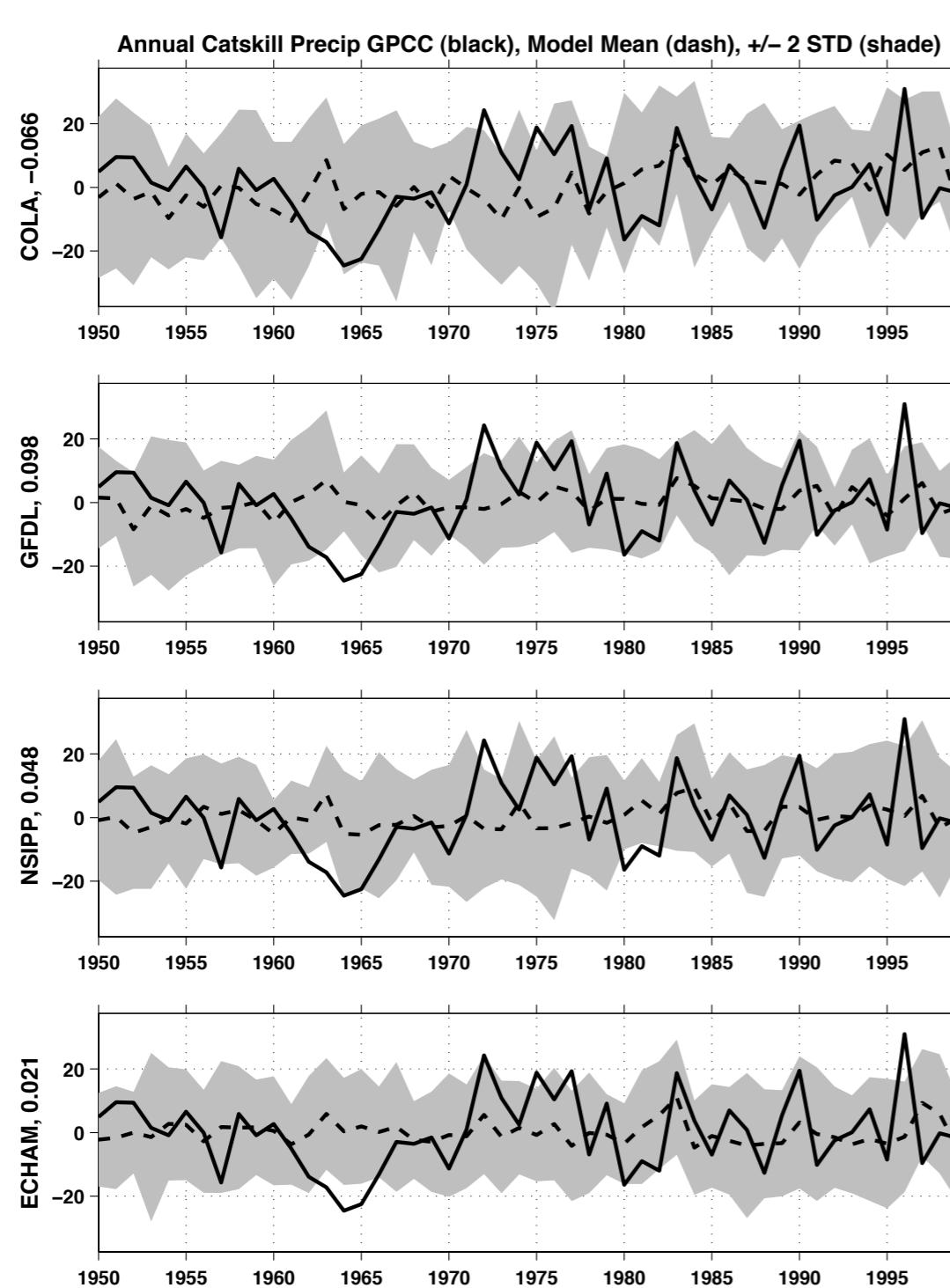


The post drought wetting (hard to attribute from the Reanalysis) is strongest in MAM and SON when flow anomaly had southerly aspect.

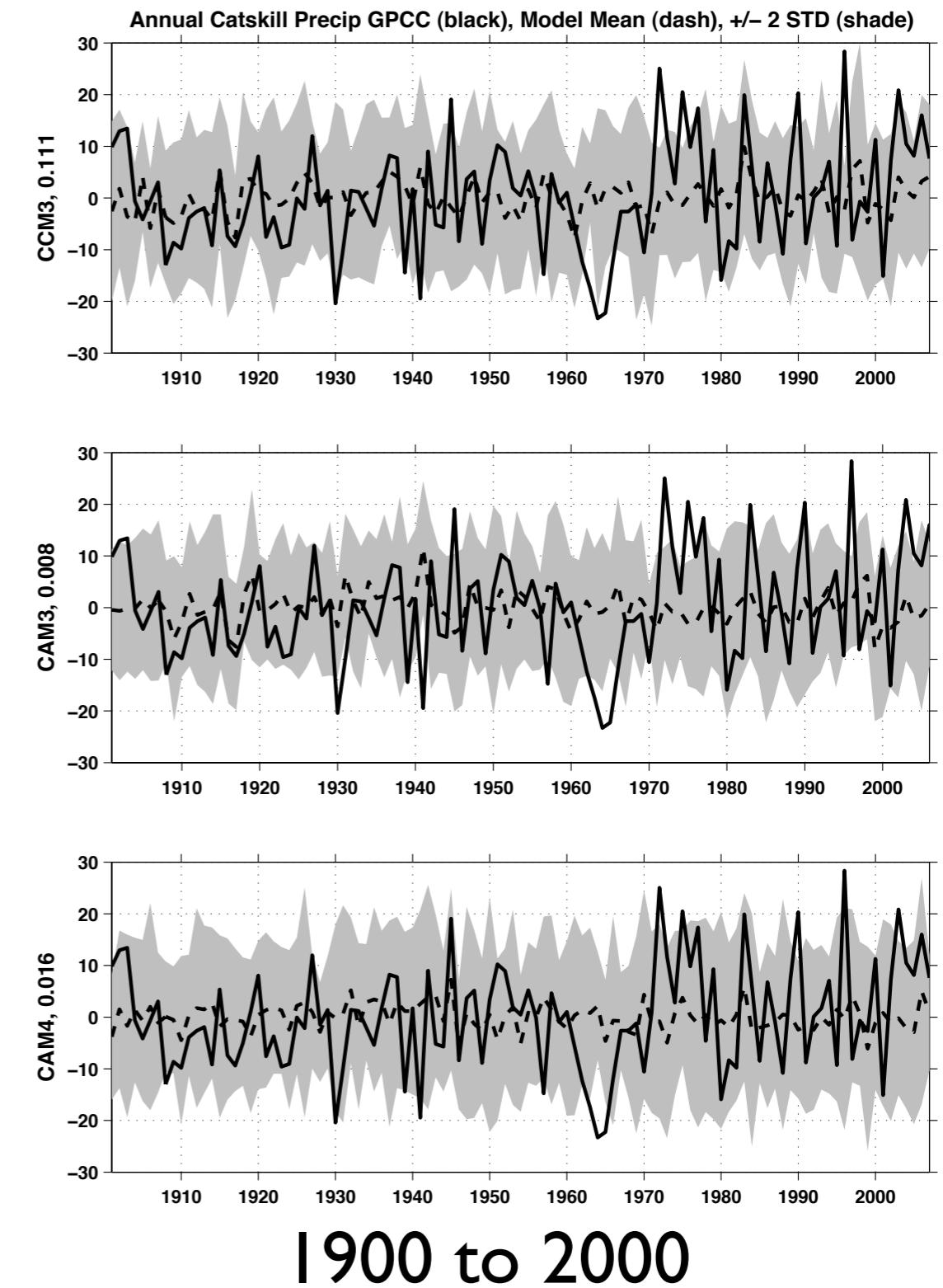
However there is an intriguing link of early 1970s wet shift to strengthening of local and hemispheric storm track  
 (Chang and Fu 2002,  
 Harnik and Chang 2003)  
 seen in Reanalyses,  
 radiosondes and 20CR



# All SST-forced GCMs examined fail to simulate the 1960s drought and subsequent pluvial

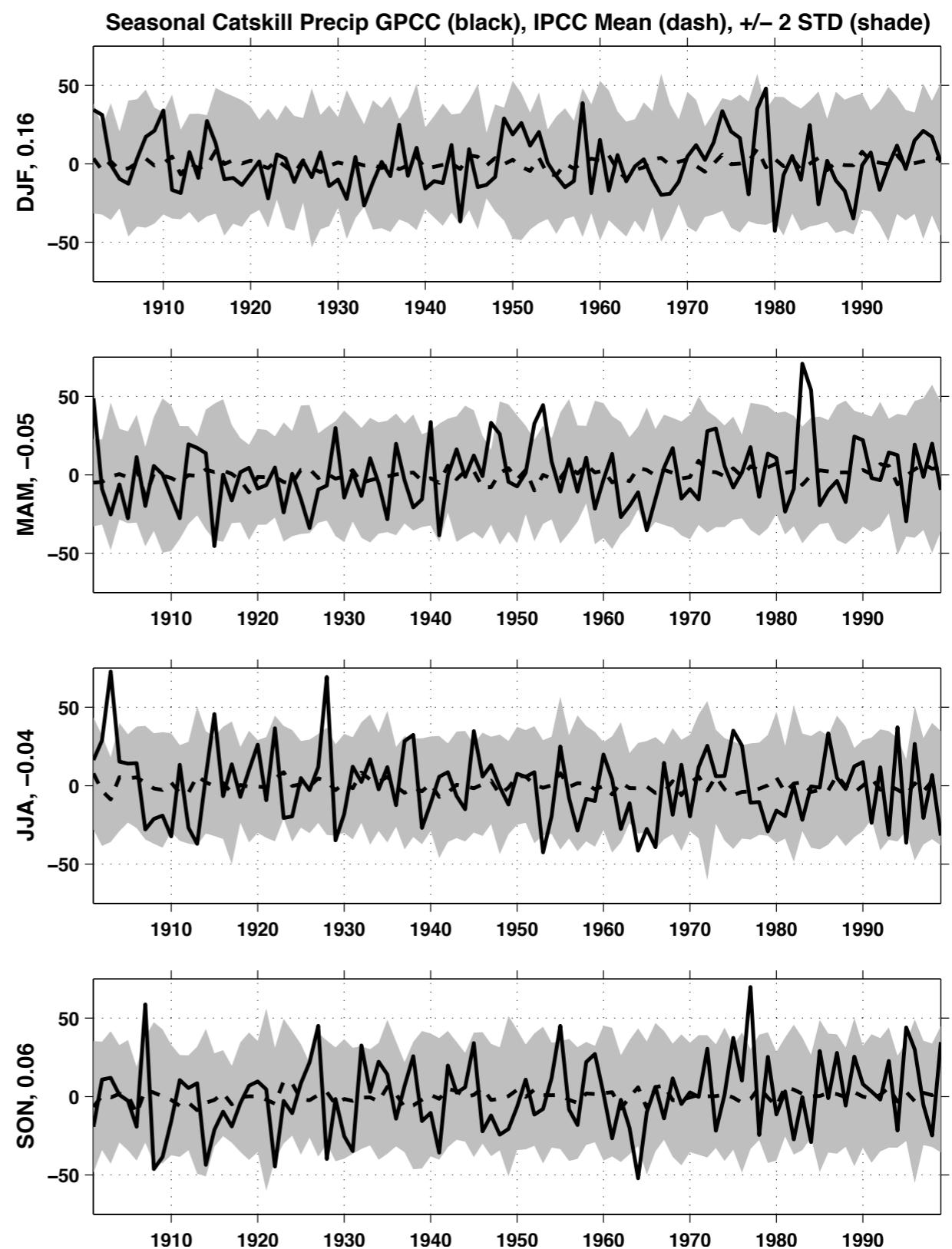


1950 to 2000



1900 to 2000

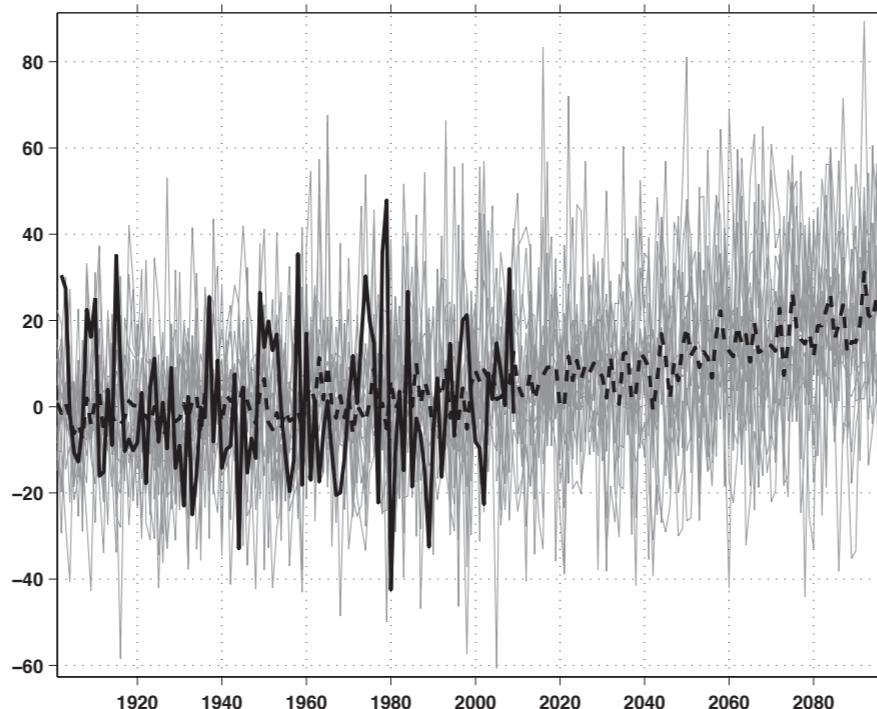
The MAM and SON 20th Century wetting trends are not consistent with IPCC AR4/CMIP3 model estimates of response to radiative forcing.



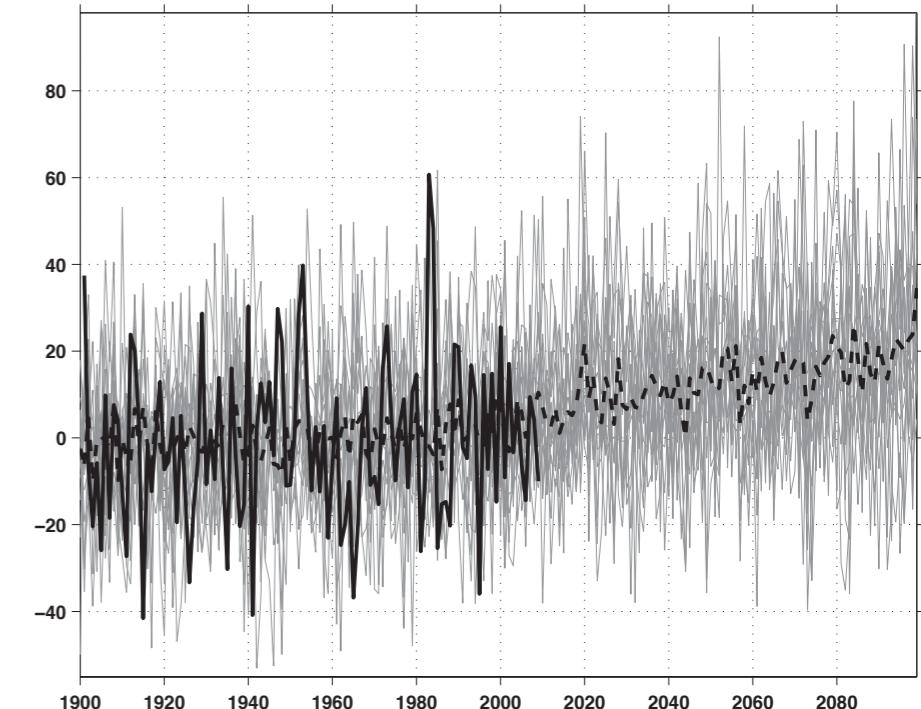
Seasonal Precipitation Anomaly over Catskill Mountains  
Observed (solid), CMIP5 Mean (dash), CMIP5 Ind. (grey)

CMIP5 results  
show 20th  
Century wetting  
trends greater  
than can be  
explained as  
response to  
radiative forcing.  
Models do  
predict DJF and  
strong MAM  
wetting trends in  
21st Century

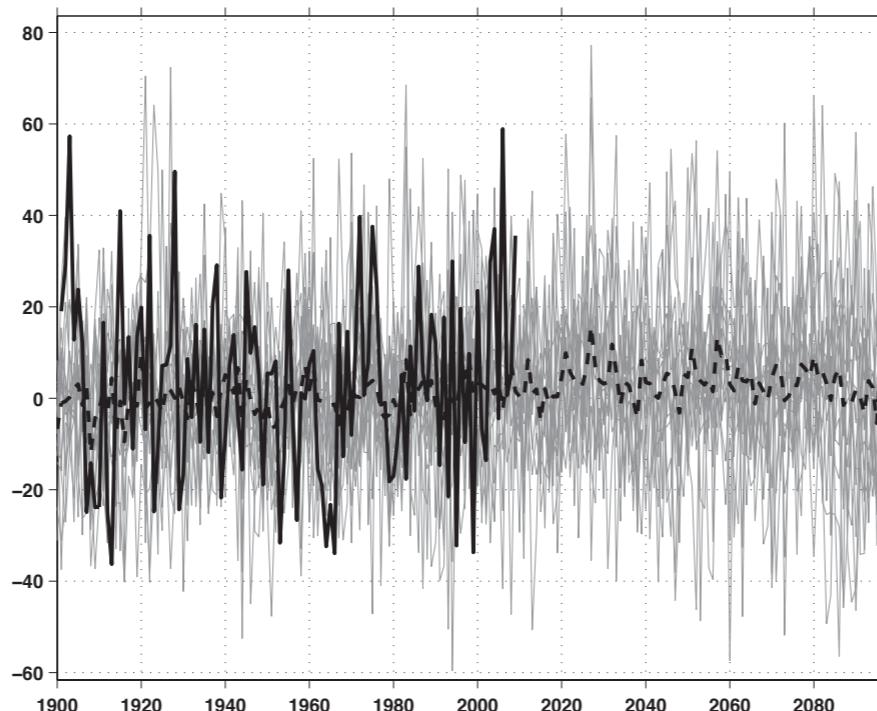
a) DJF



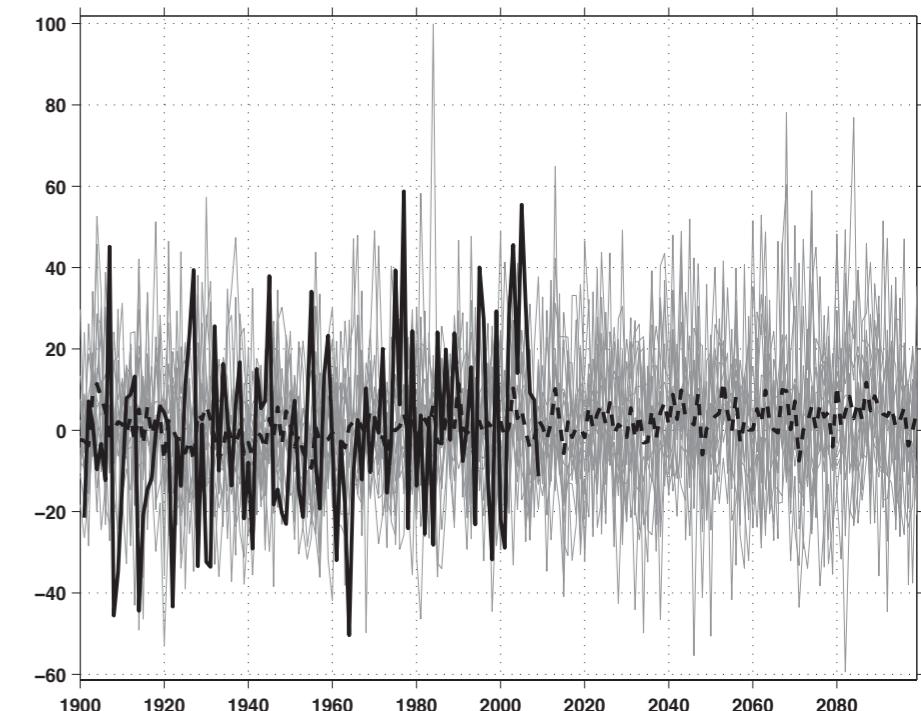
b) MAM



c) JJA

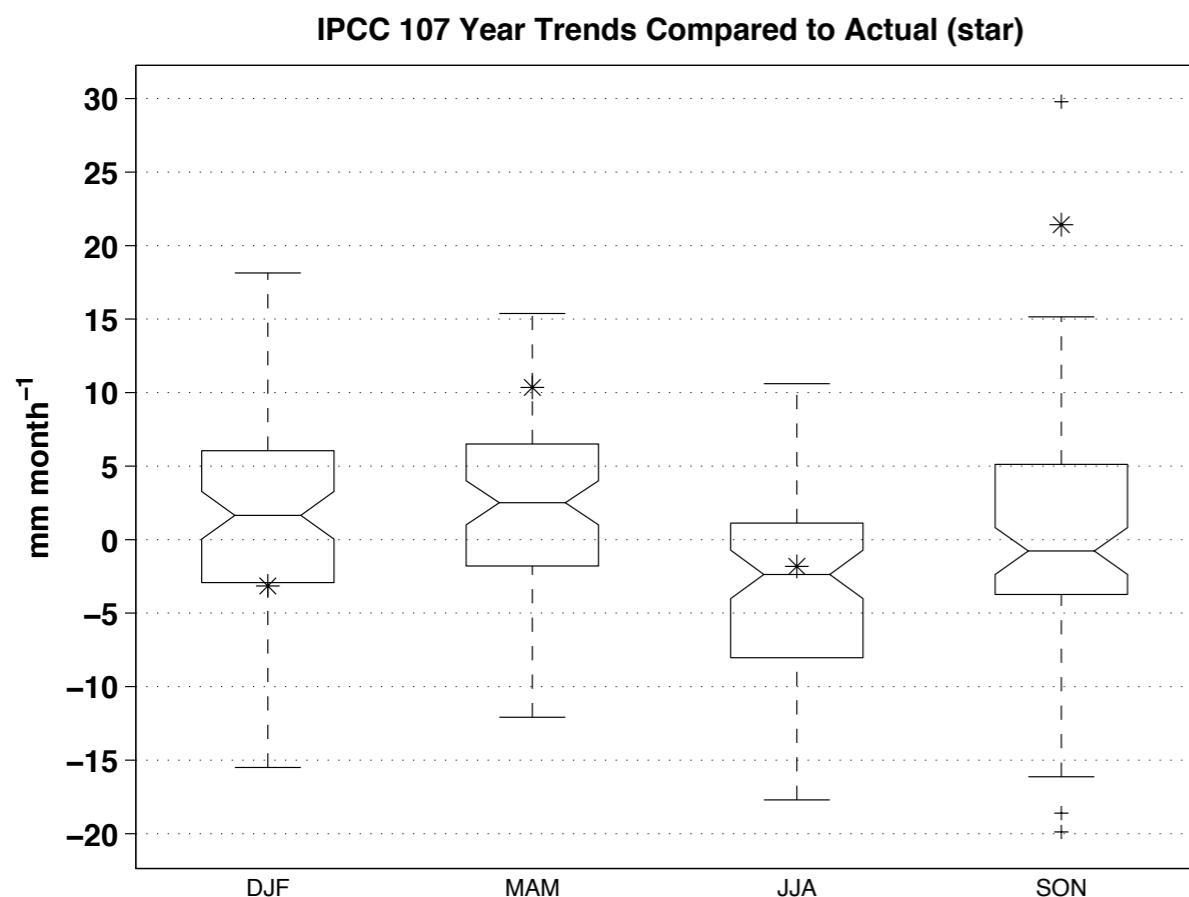


d) SON

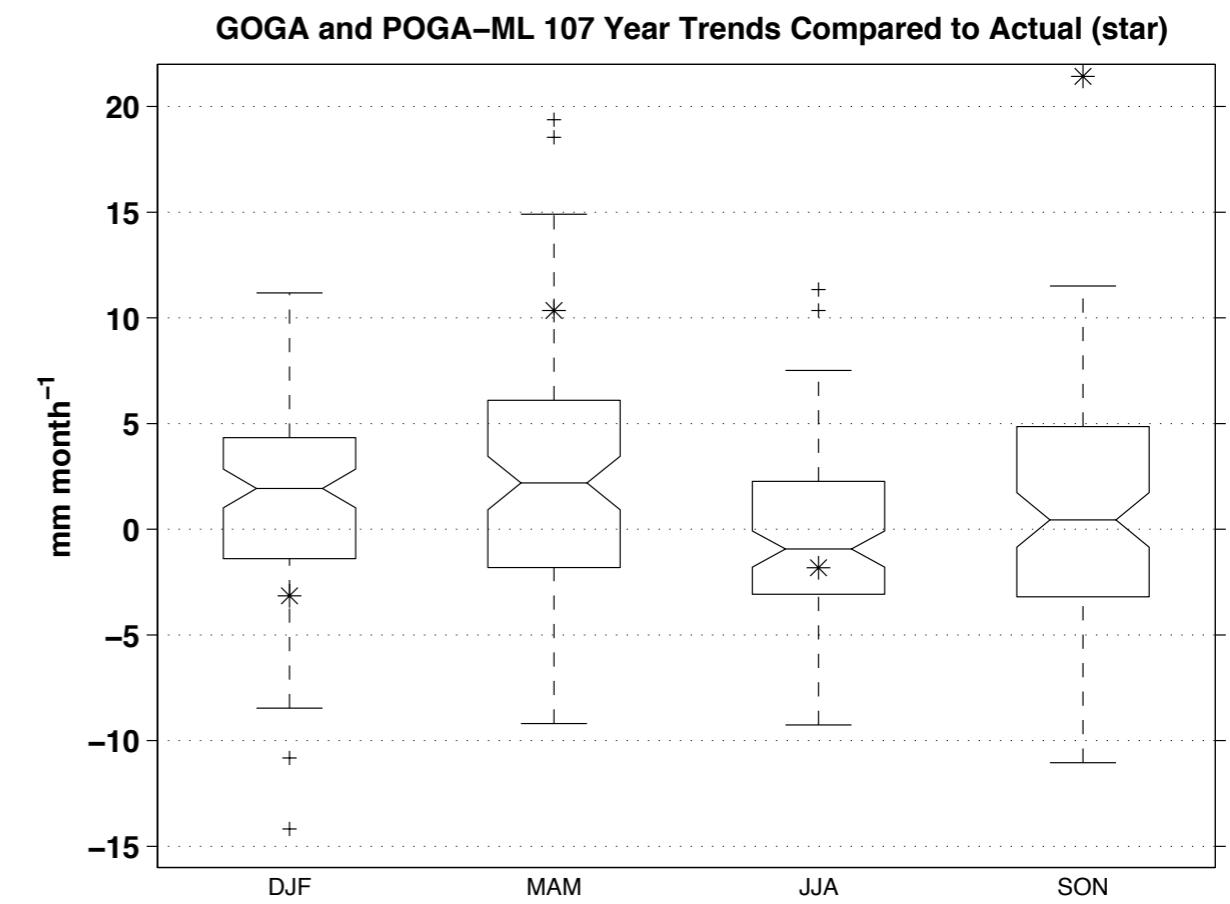


# How unusual is the 107 year wetting trend in the Catskill region?

distribution of all 1900-99 (scaled to 107 year) trends in 76 IPCC AR4/CMIP3 runs



distribution of all 107 year trends (starting in 1856, 1878, 1900) in 96 SST-forced atmosphere GCM runs

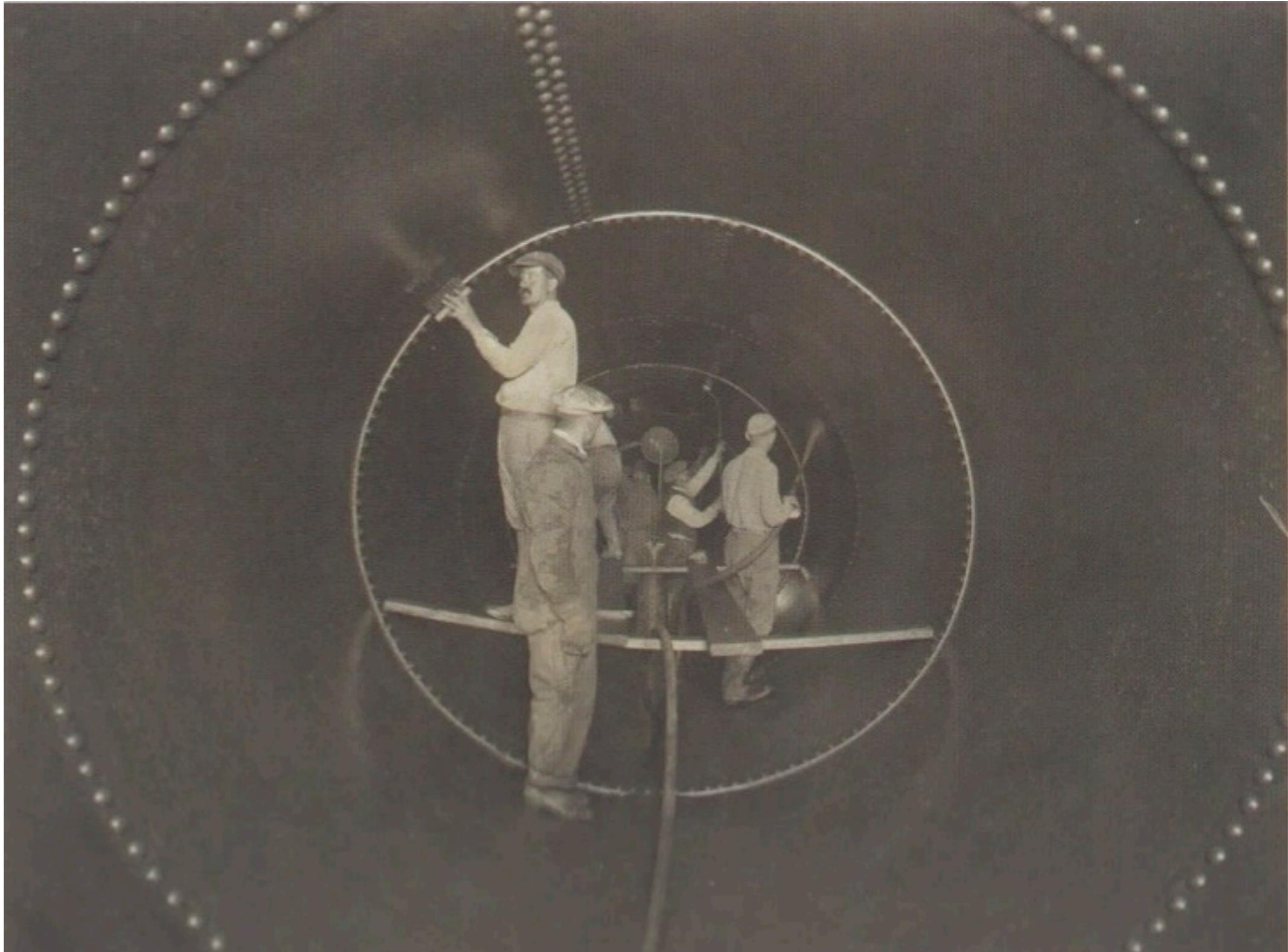


Only SON trend falls outside model range. Why?



Engineers inside  
aqueduct illuminated  
by multiple  
synchronous flashes -  
or are they post-Dada  
artists?

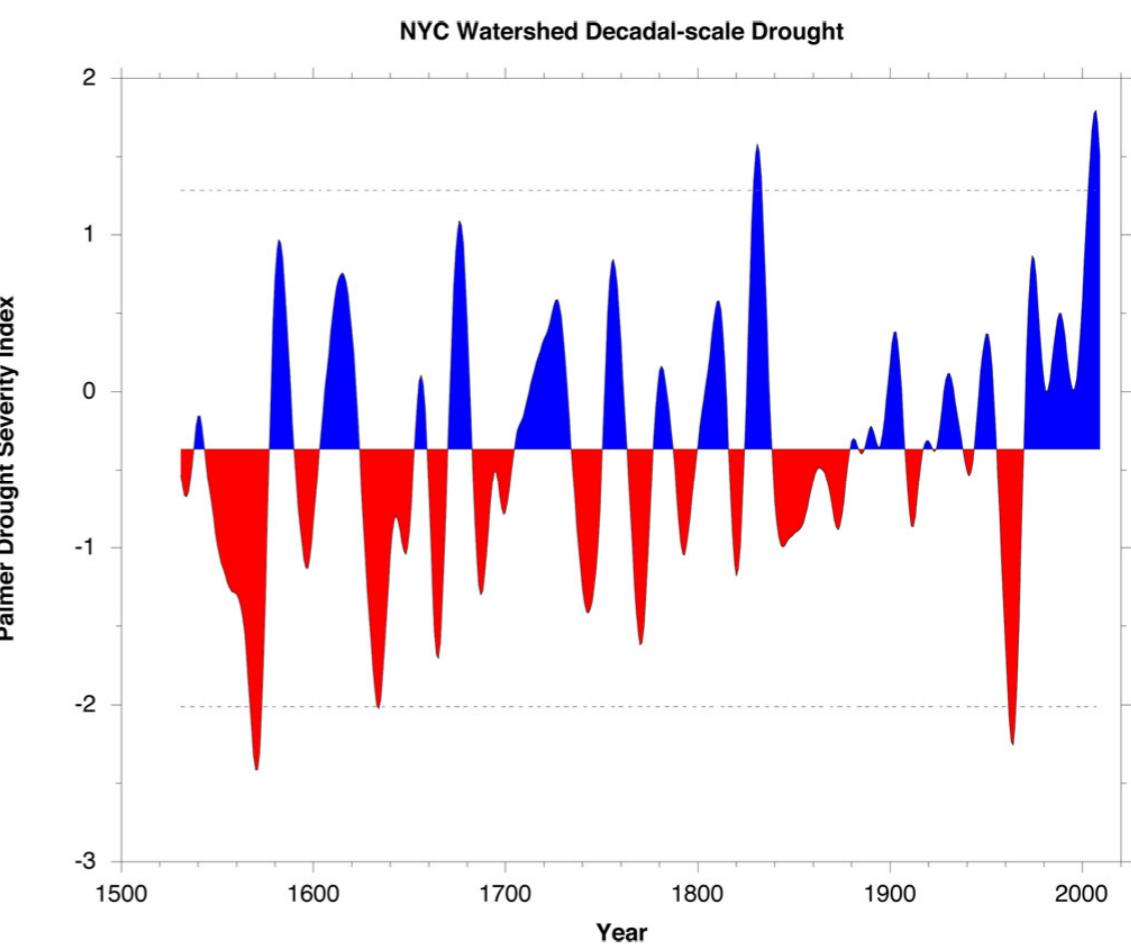
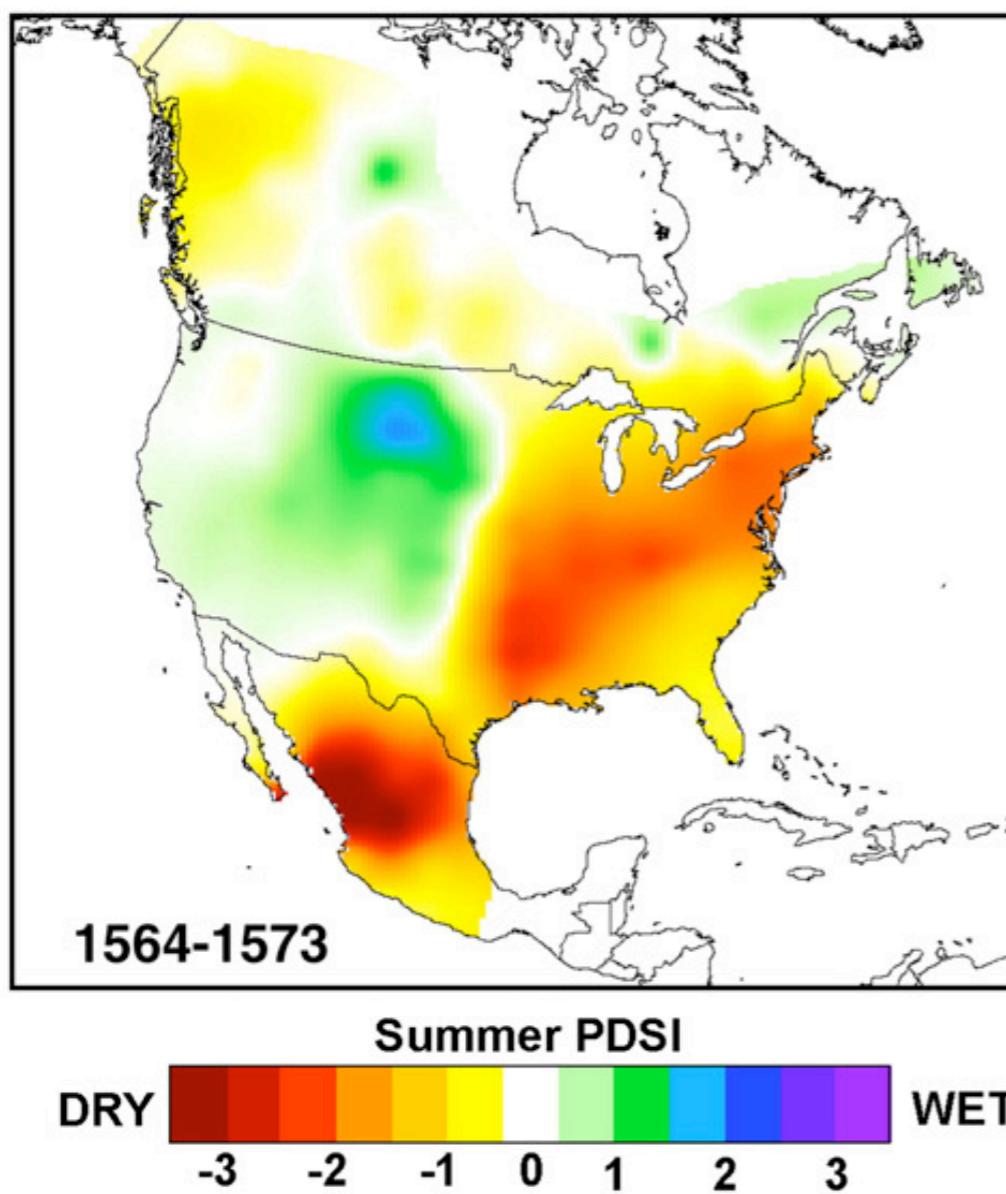
# Finishing touches to the lined aqueduct



Century long instrumental records reveal two climate mysteries in New York City's Catskills watershed: the 1960s drought and the pluvial we are living in.

New multispecies tree ring reconstructions for region by Neil Pederson (Lamont Tree Ring Lab) reveal even more mysteries!

In NYC watershed, the 1960s drought was excelled in earlier centuries ....



Pederson et al. (in press)

... in particular by the mysterious late 15th Century Mexico-Mississippi-Eastern megadrought

... also, multi-century wetting trend

Cook et al. 2007

# Conclusions

The 1960s drought - the drought of record in the northeast - appears to have resulted from a random sequence of atmospheric events ...

To quote Gene Rasmusson, via Chet Ropelewski, 'sometimes it's just one damned thing after another' ...

The Atlantic SSTs look caused by the atmosphere circulation anomaly not vice versa ....

The post drought wetter climate remains a mystery, no evidence of SST or radiative forcing of it. Associated with apparent strengthening of northern hemisphere storm track .... Tree ring records suggest pluvial part of a centuries long trend to a wetter climate ...

A return of the 1960s drought would be a real blow amidst rising temperatures and increased precipitation intensity ...