

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

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Lamont Doherty Earth Observatory

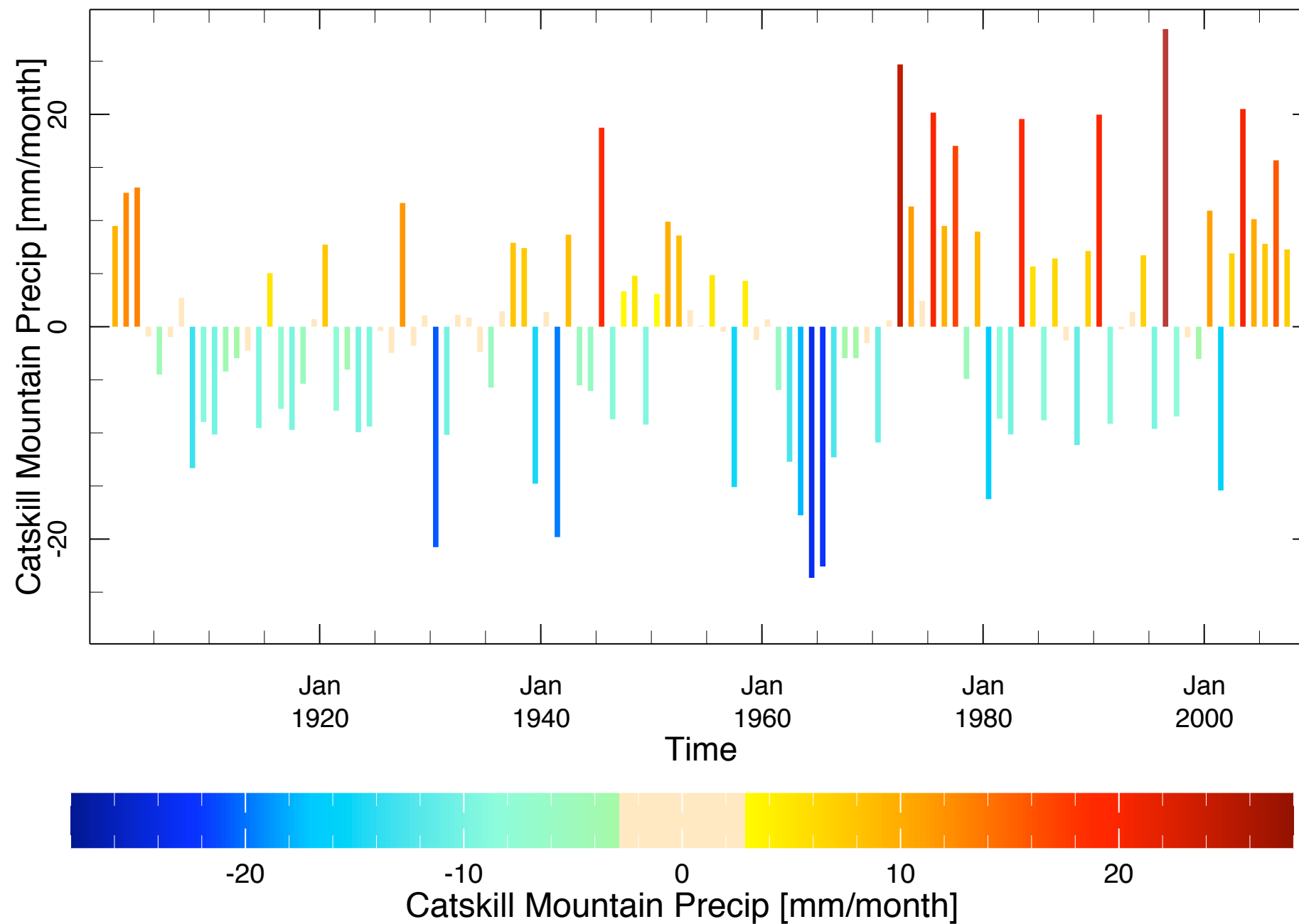
19 reservoirs and 3 regulated lakes. 95% water delivered by gravity. Croton water is filtered but Catskill water is unfiltered. *Considered a poster child of ecosystem services!*







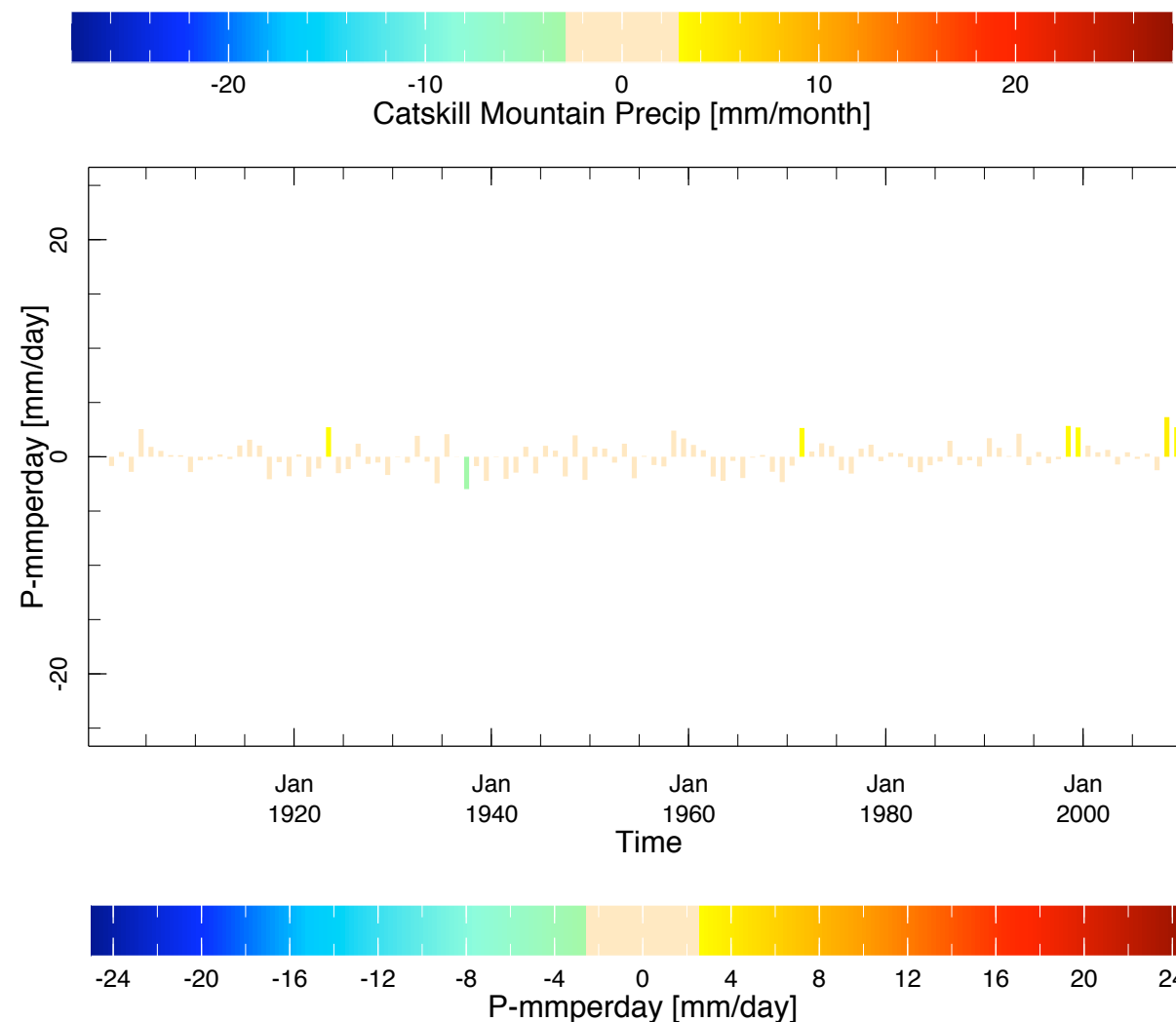
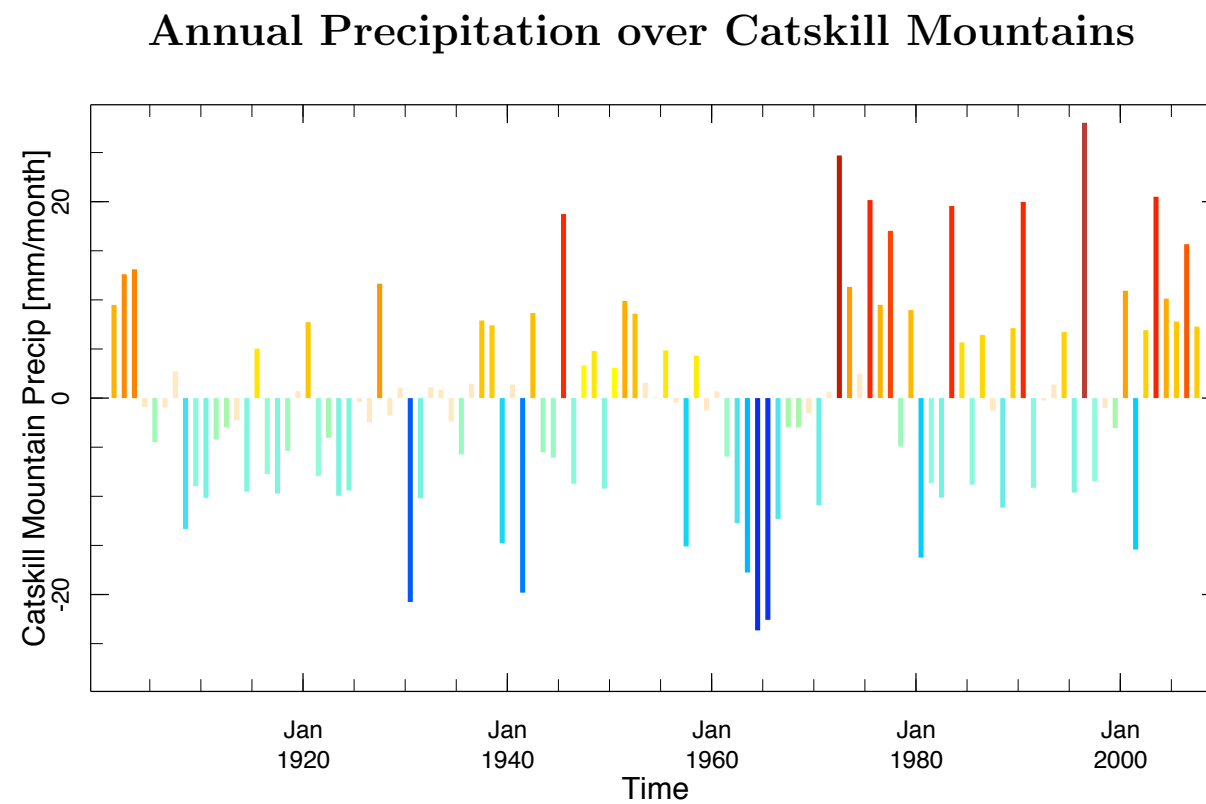
Annual Precipitation over Catskill Mountains



Rain gauges across the Catskills region show the 1960s drought and a remarkable post 1970s pluvial

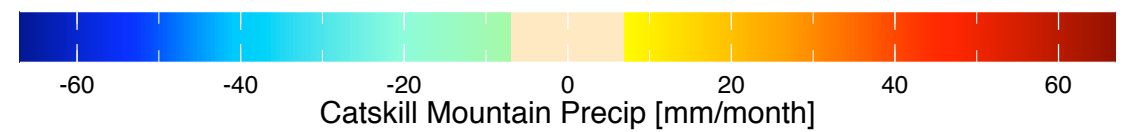
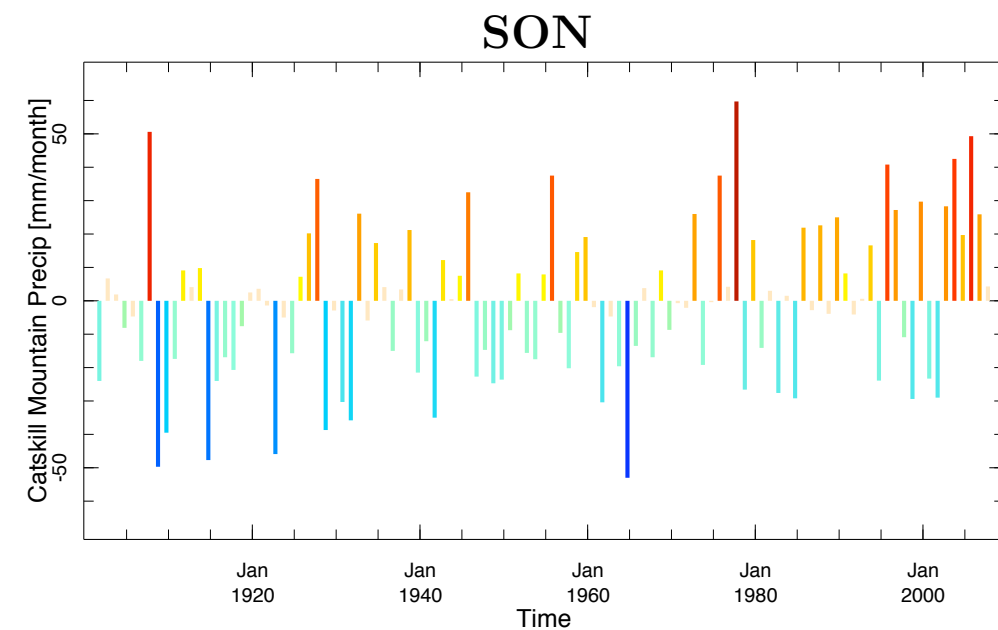
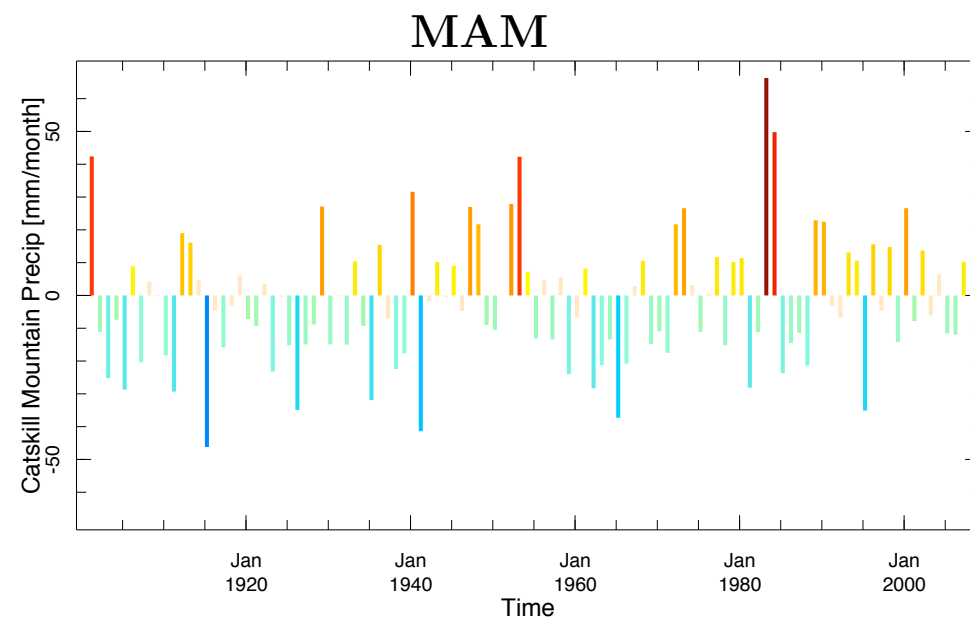
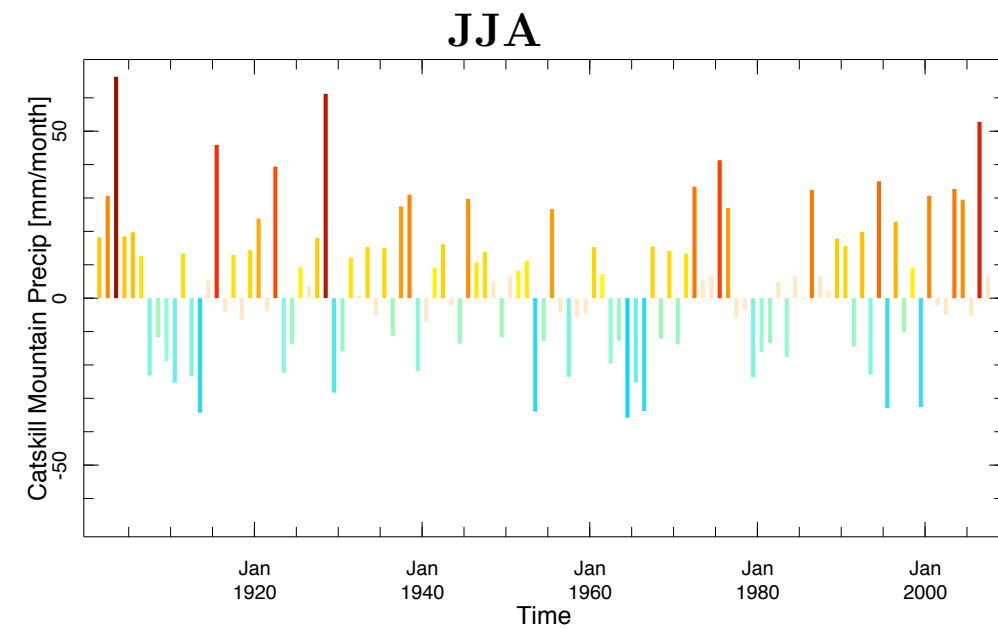
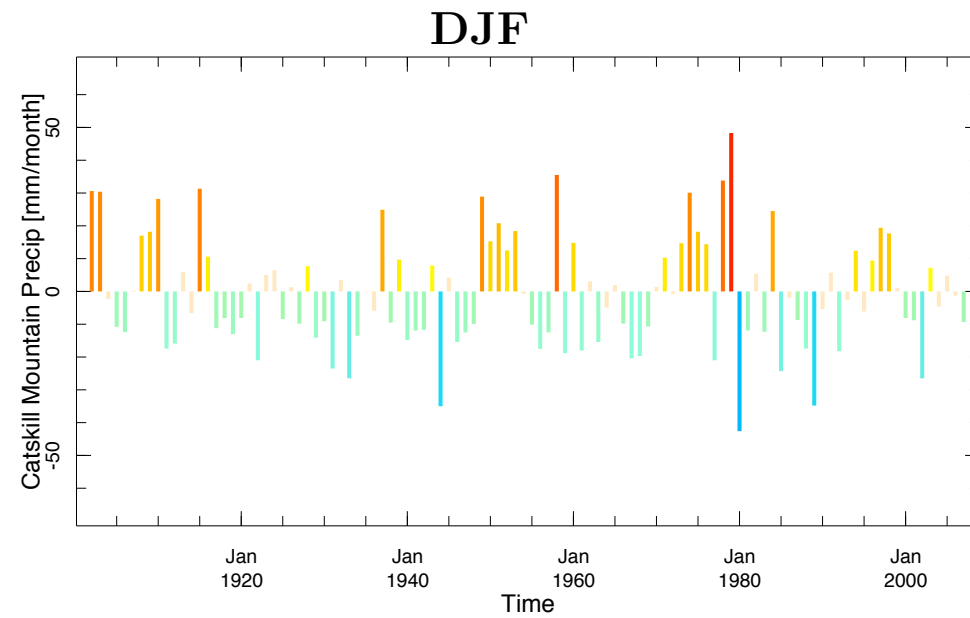
Observed
Catskill
precipitation.
Trend 8mm/
month

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

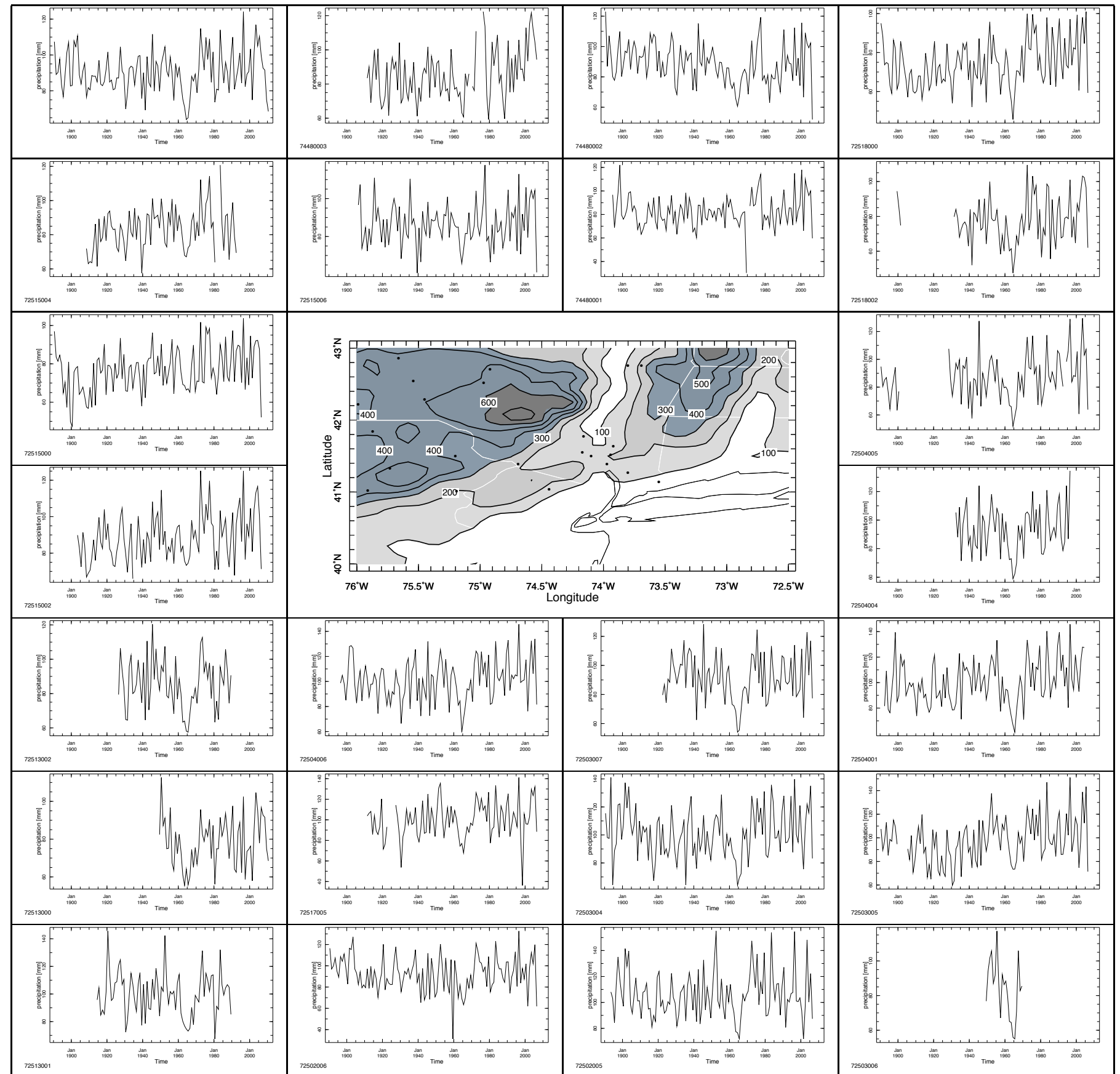


Spring and fall have wetting trends. 1960s drought appears year round.

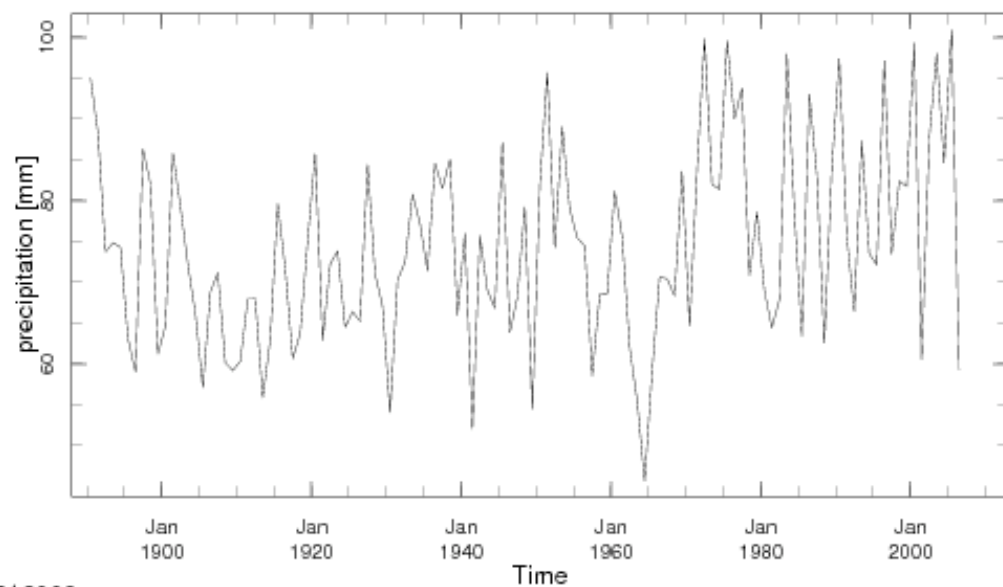
23 station
average



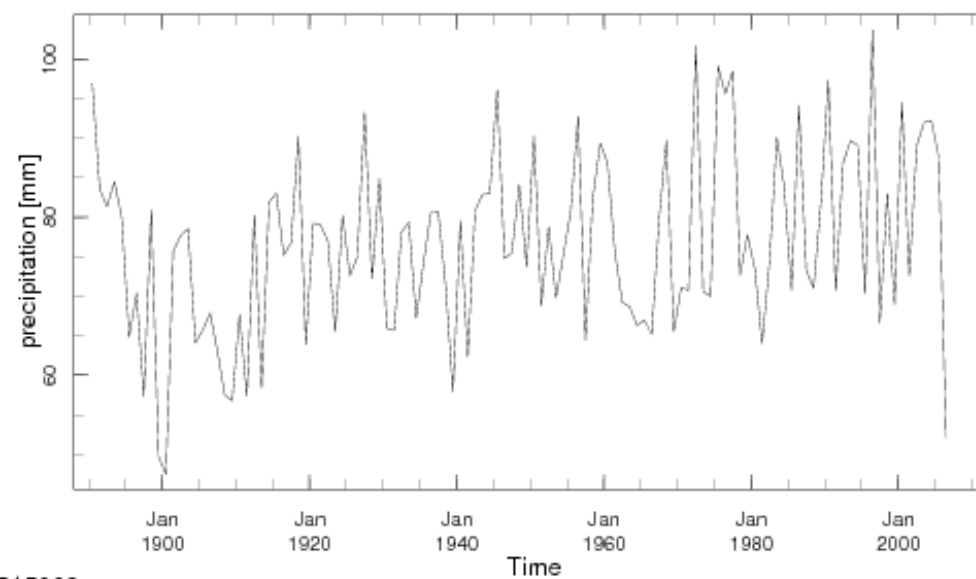
Catskills
region
precipitation
history as
seen from
individual
rain gauges



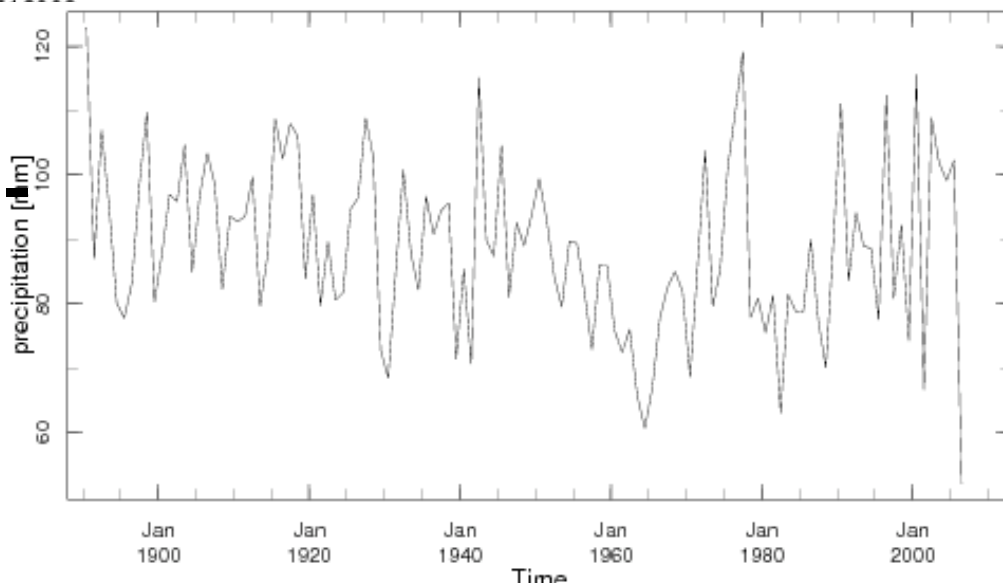
Albany



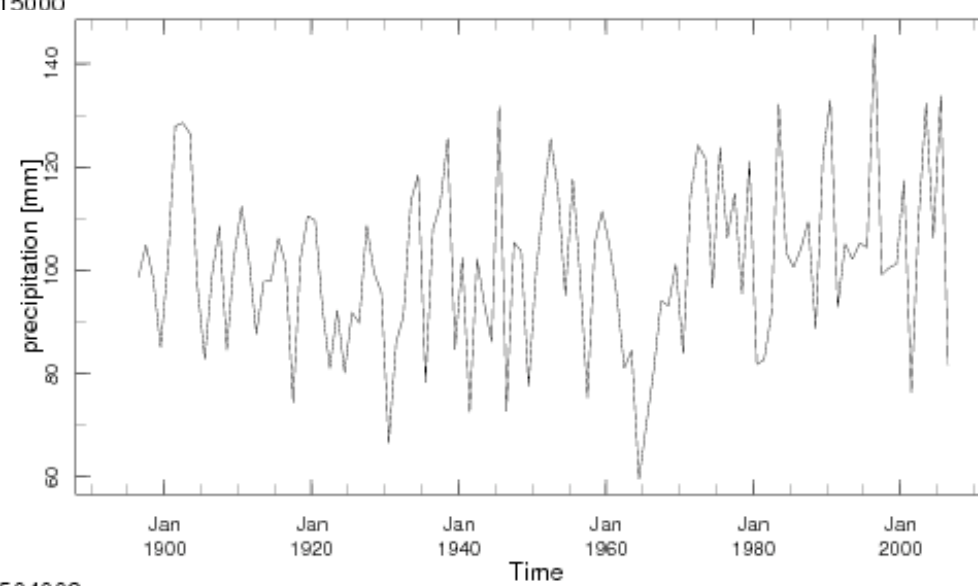
Bing-
hampton



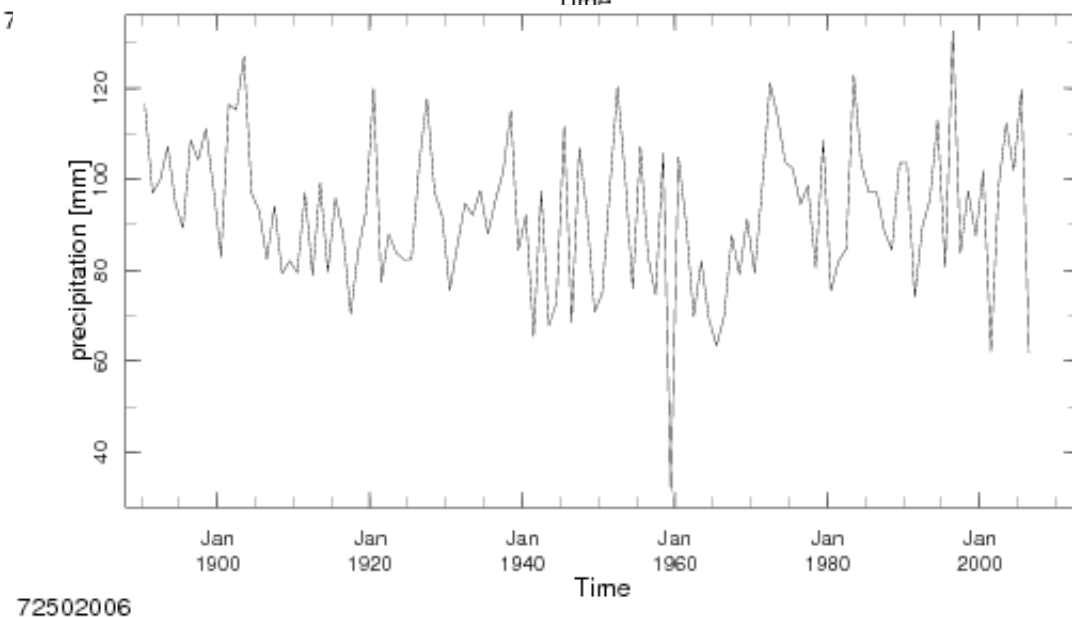
Coopers-
town



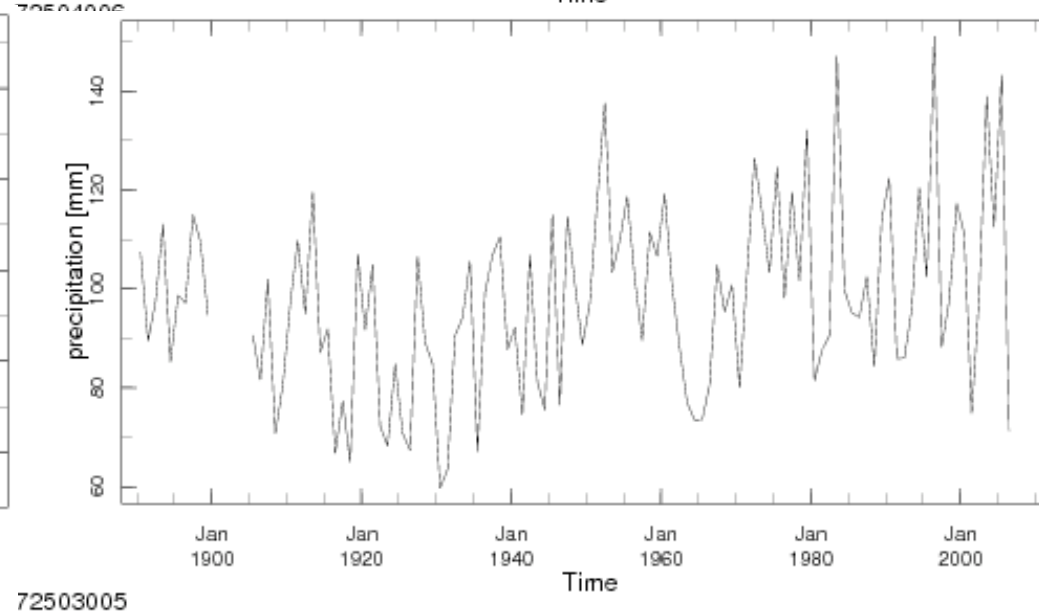
Mohonk
Lake



Port
Jervis



West
Point



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

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

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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.

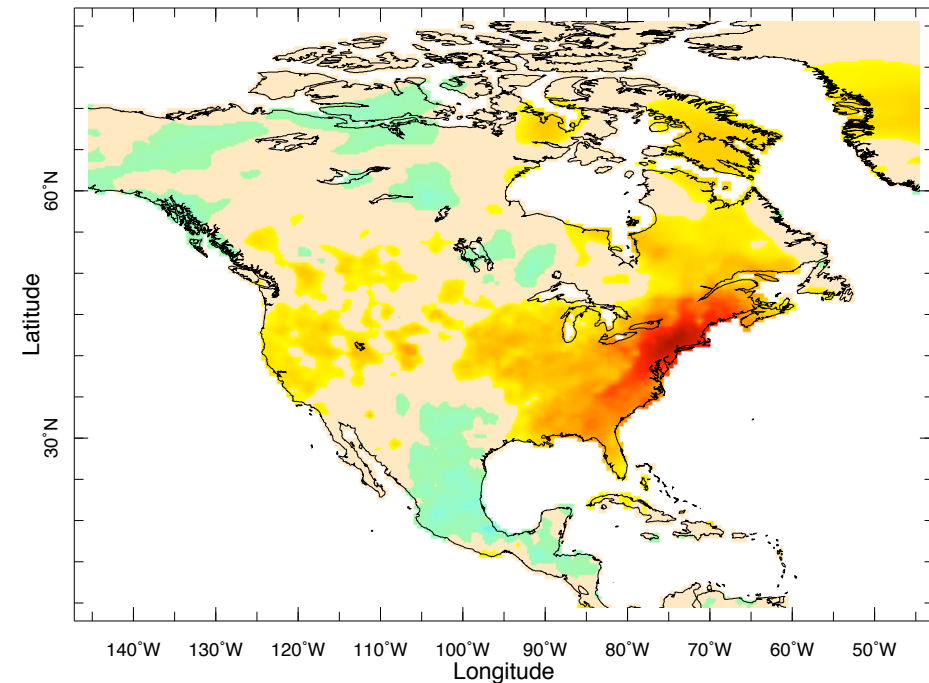
A hypothesis is proposed for the cause of the aberrant upper-wind currents which considers the atmosphere and ocean as a complex coupled system. Abnormalities of sea-surface temperature are created by anomalous surface wind drag and by extraction of heat by anomalous air masses. The ocean thus serves 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.

Namias identified the
cause of the drought as
springtime low off east
coast and cold water
which caused early
occlusion and/or stability
and reduced precip and
persisted via positive air-
sea interaction

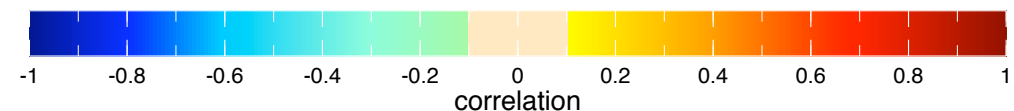
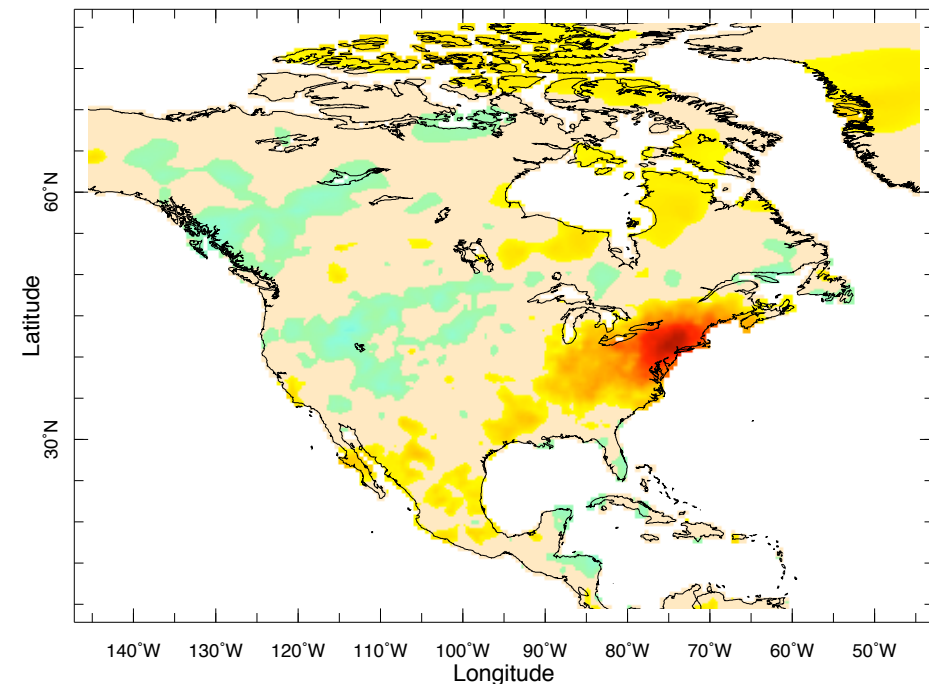
Catskills precipitation
is only well correlated
with precipitation in
east - and northeast
in summer.

Correlation of Catskill Mountain Precip on GPCC Precip

(A) Nov-Apr



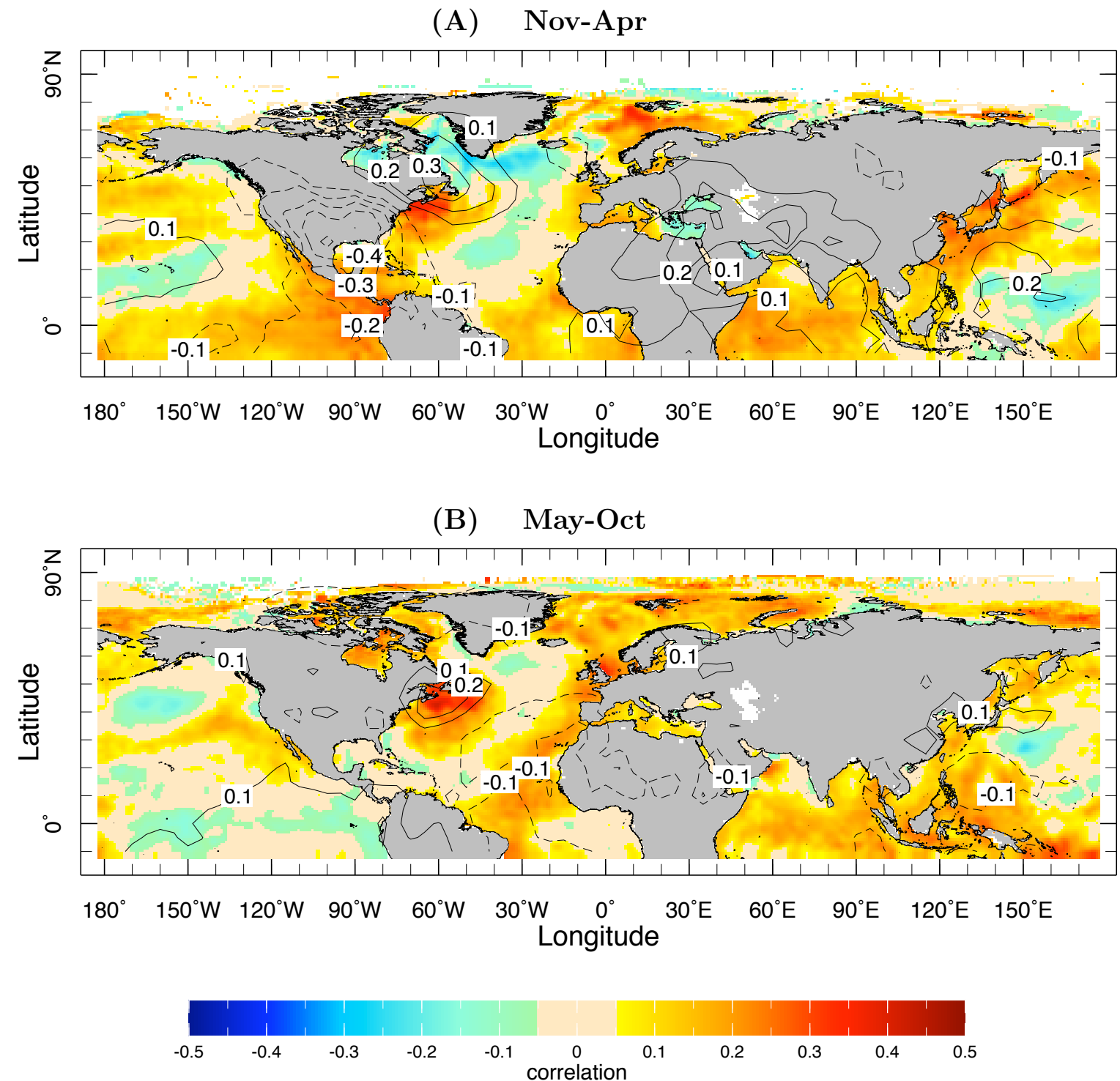
(B) May-Oct



Pepacton reservoir

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.)

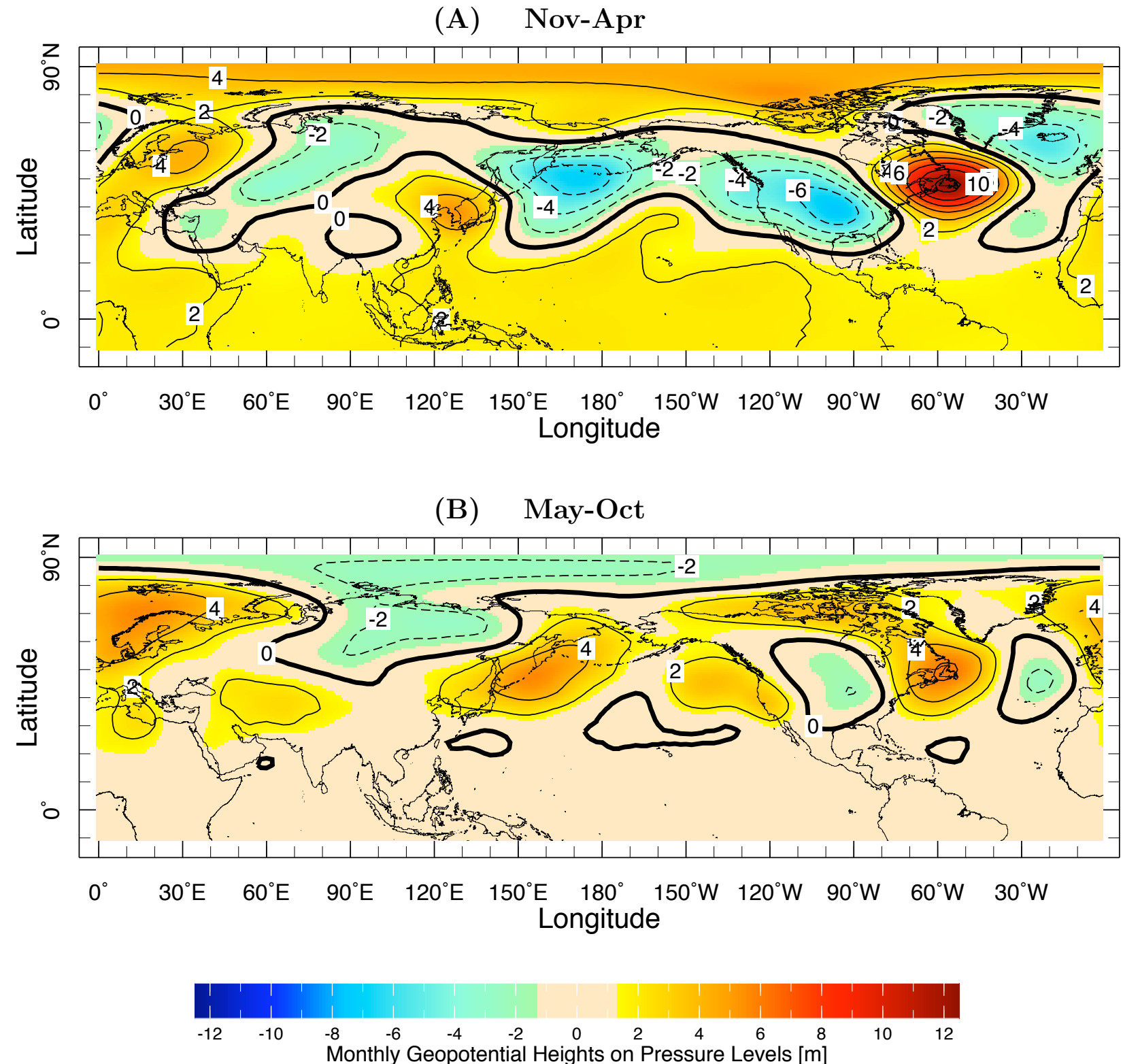
Correlation of Catskill Mountain Precip on Hadley SST (color) and SLP (contours)



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

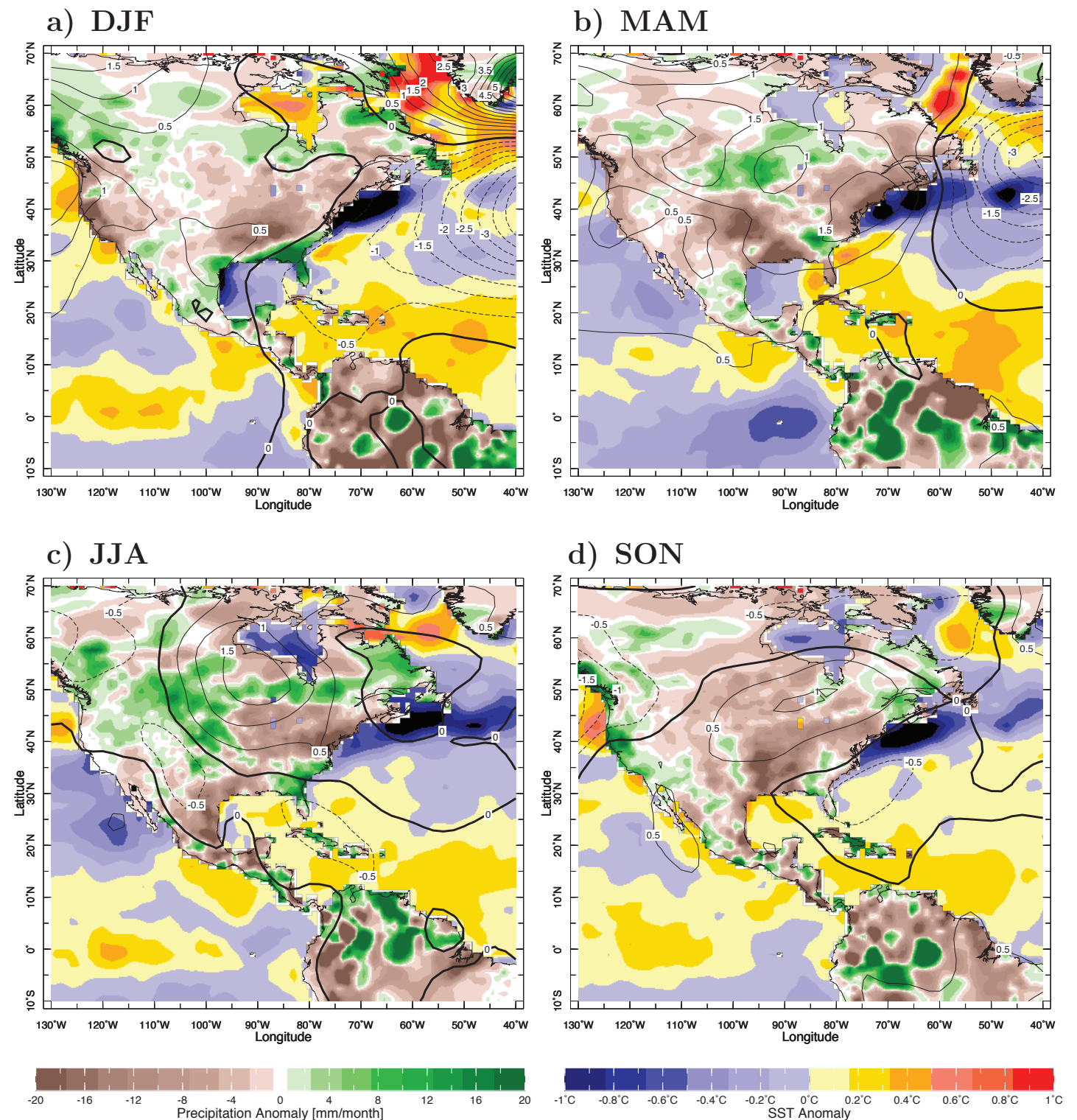
Summer association is a purely mid-latitude Rossby wave train

Regression of Catskill Mountain Precip on Compo 500 mb Height



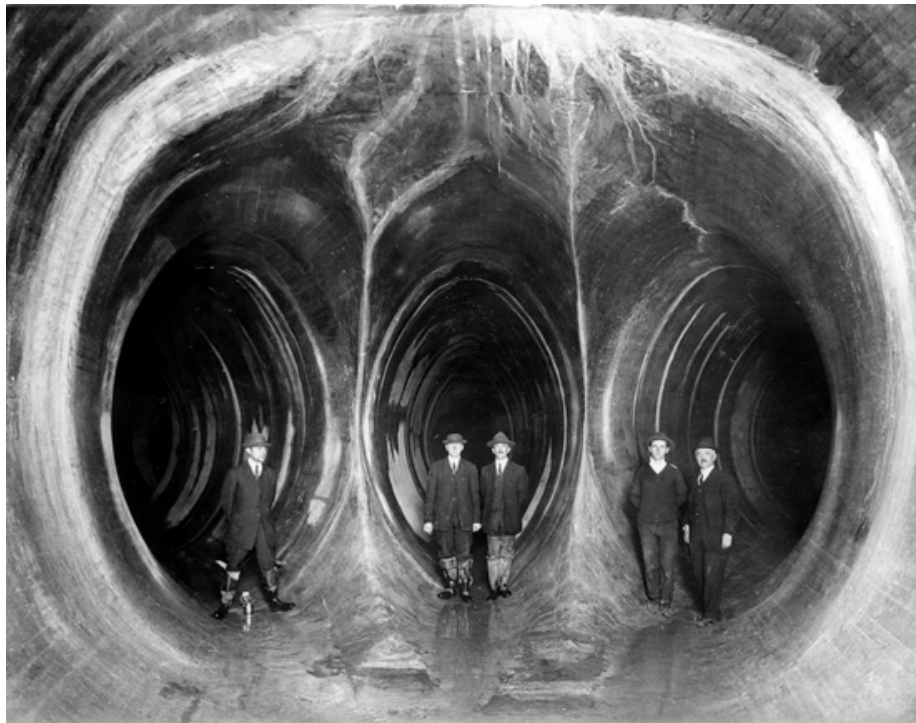
As identified by Namias, the 1960s drought was characterized by a spring low over the Atlantic to the NE. Cool SSTs are consistent with northerly flow, probably not causal.

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



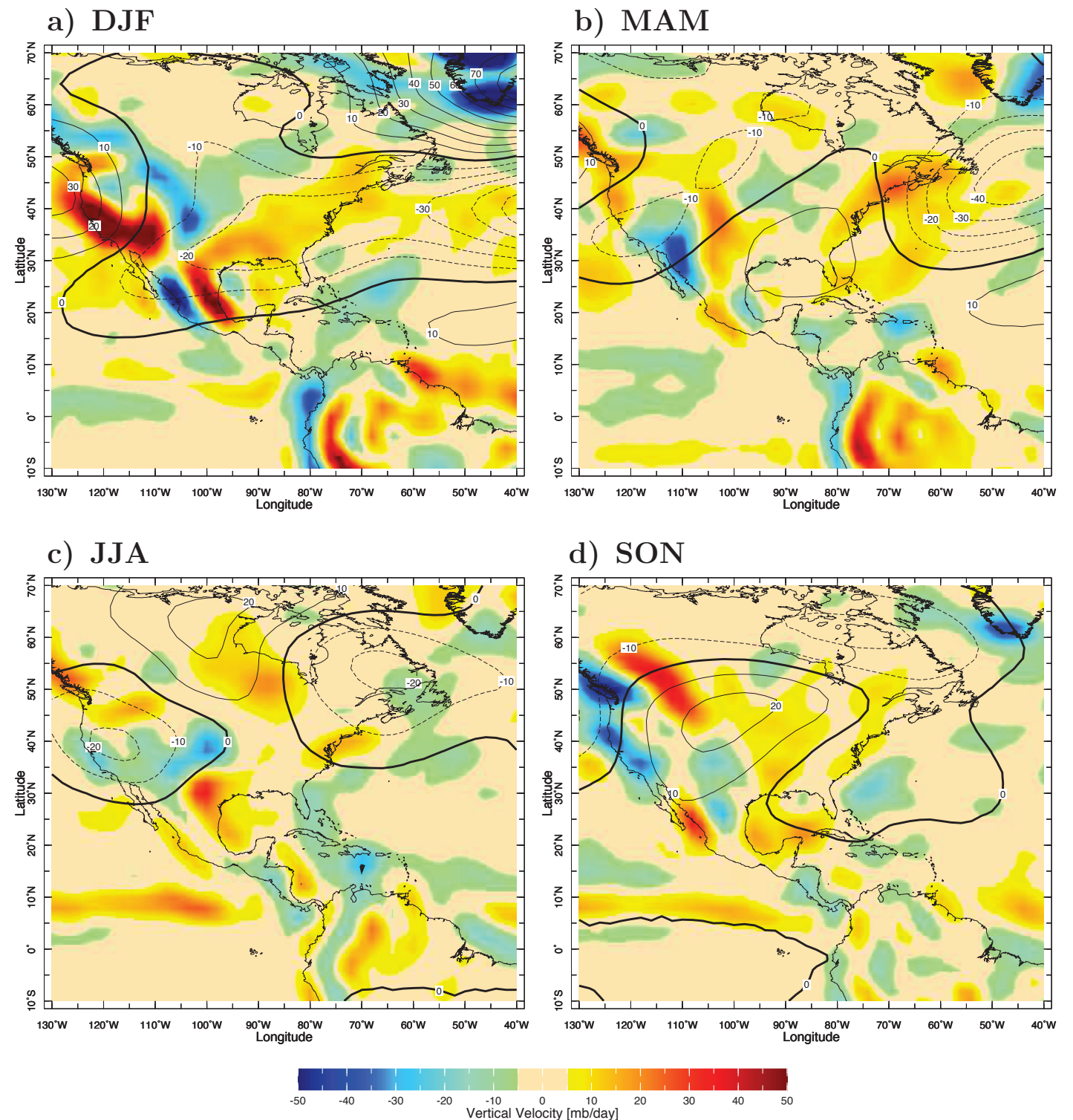
Ashokan Reservoir

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



Engineers inside Catskill Aqueduct siphon, 1923

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



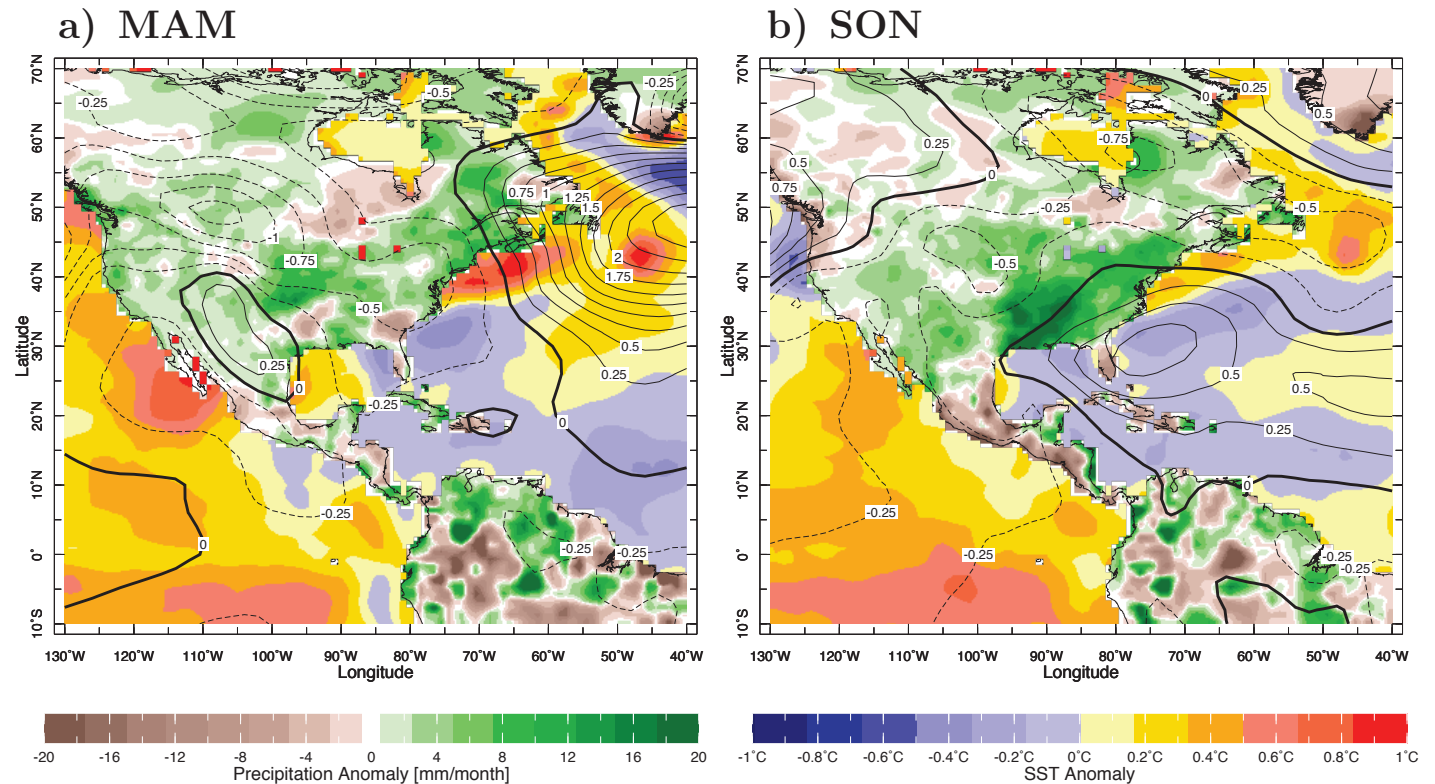


Aqueduct, Washington Square Park

(1972-2007) - (1949-1971) GPCC Precip and 20CR

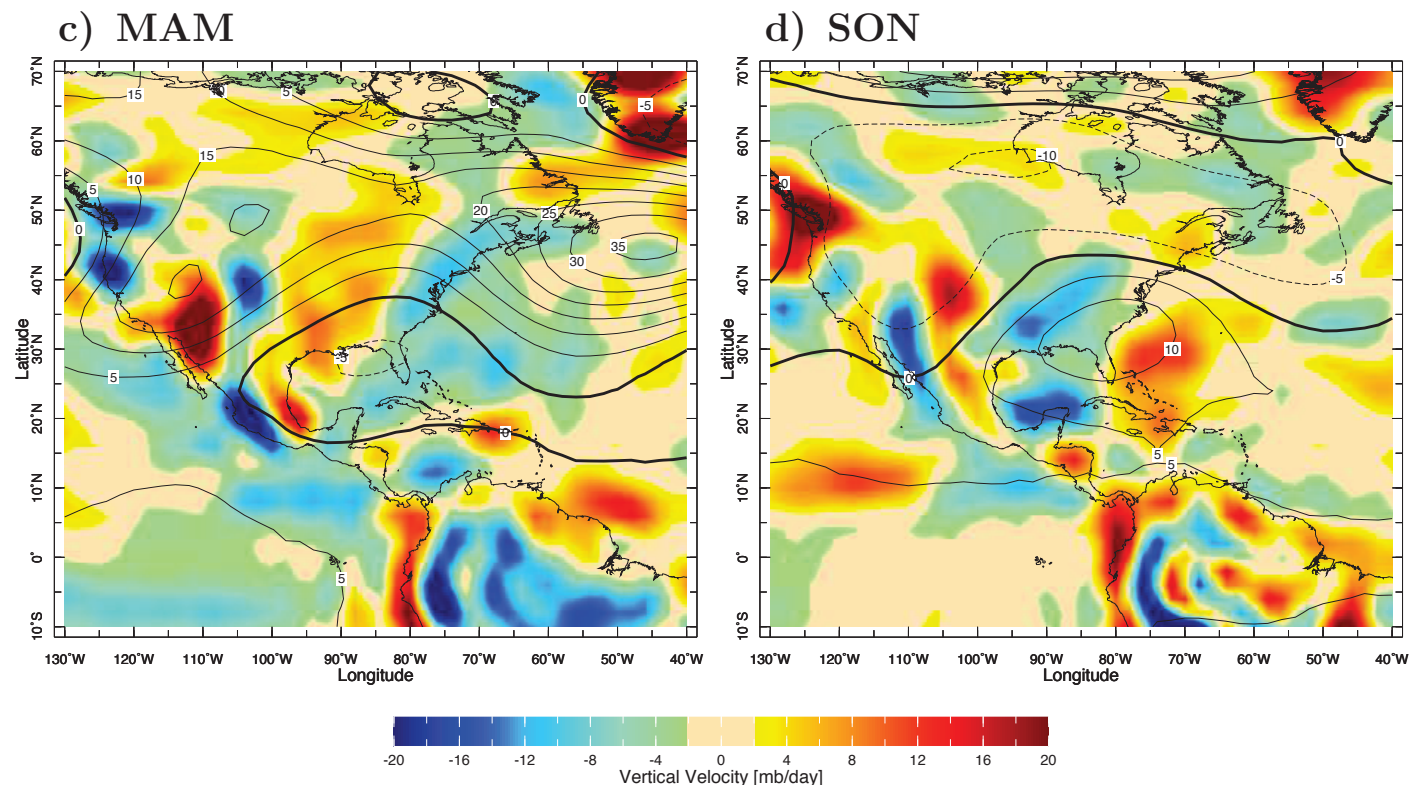
Precip (land), SST (ocean), and SLP (contours)

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



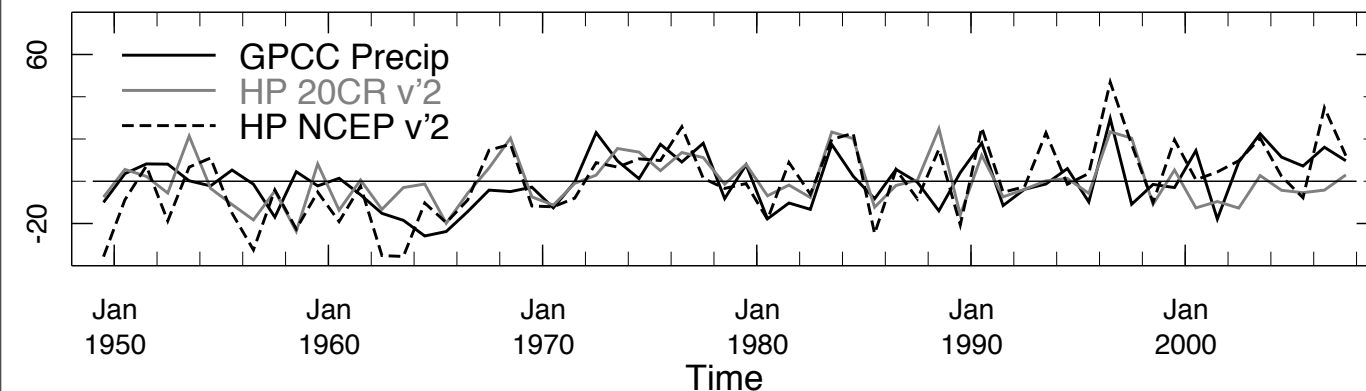
700 mb Omega (colors) and 500 mb Heights (contours)

For both 1960s drought and the following pluvial it is probably expecting too much to get a consistent Reanalysis moisture budget



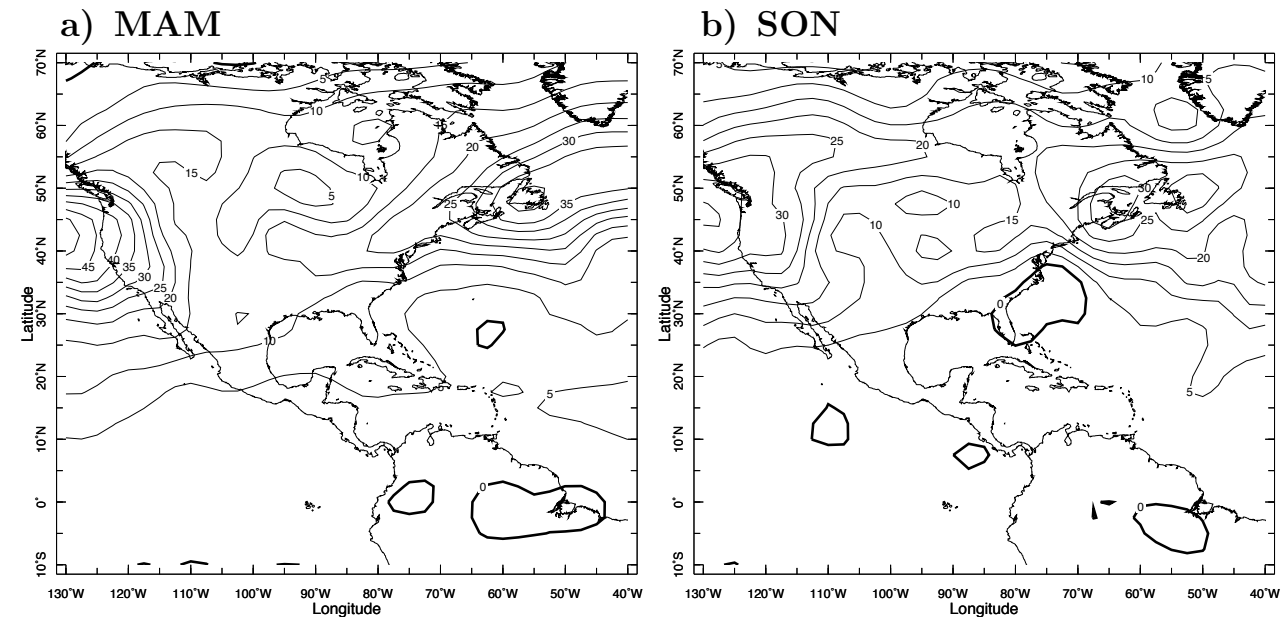
However there is an intriguing link of early 1970s wet shift to strengthening of local and hemispheric storm track (Chang and Fu 2002, Harnik and Chang 2003) seen in Reanalyses, radiosondes and 20CR

Catskill Precip (bk solid), 250 mb V'^2 20CR (gry solid), NCEP (dsh)

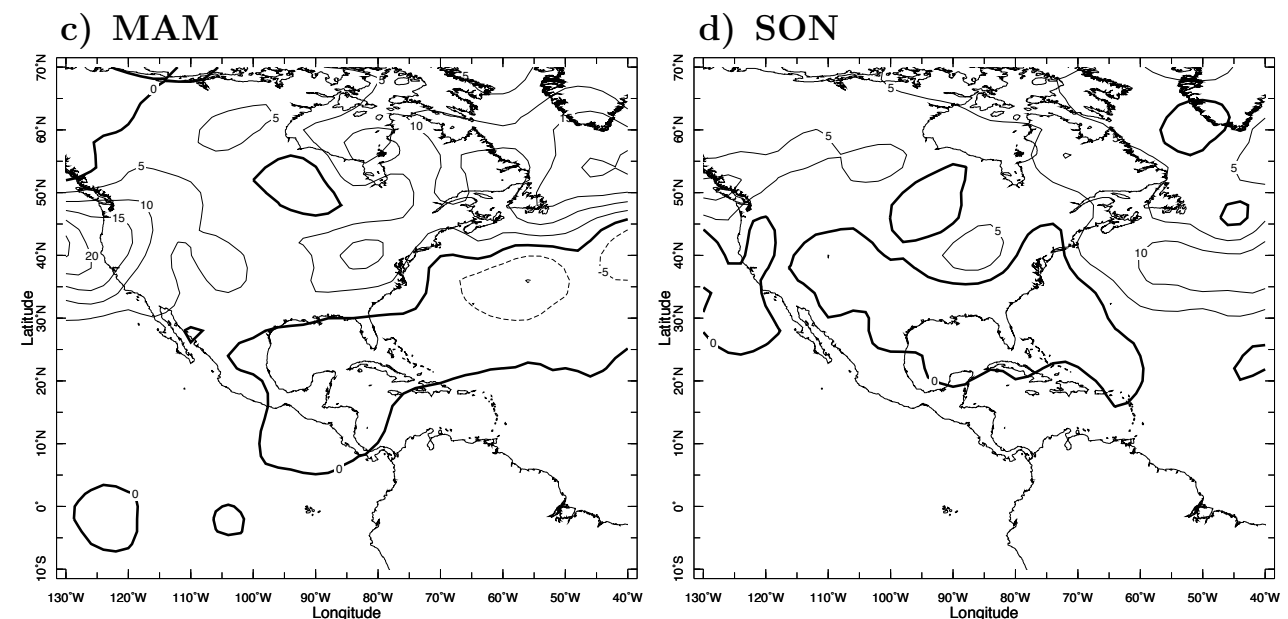


(1972-2007) - (1949-1971) 250 mb V'^2

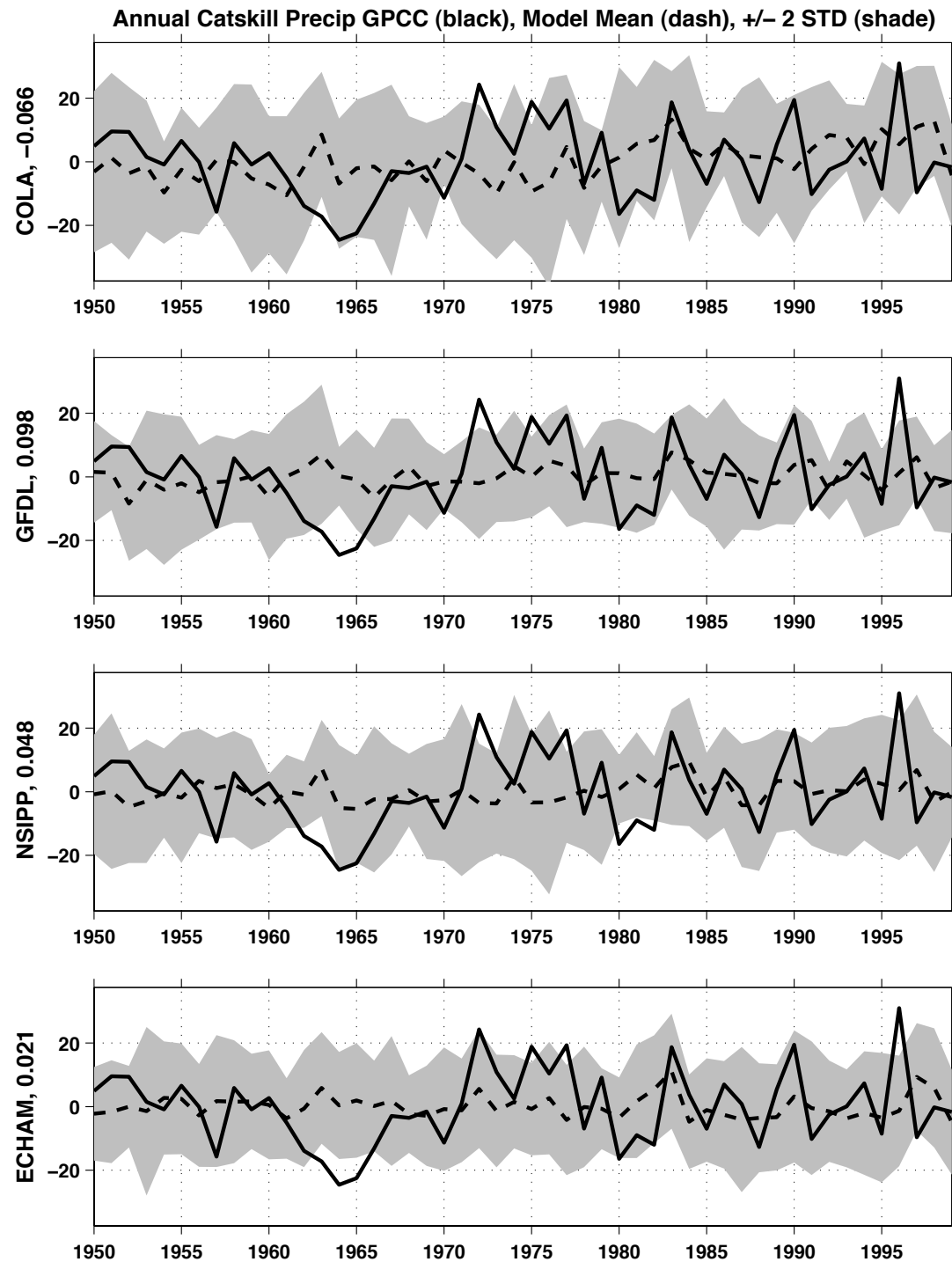
NCEP



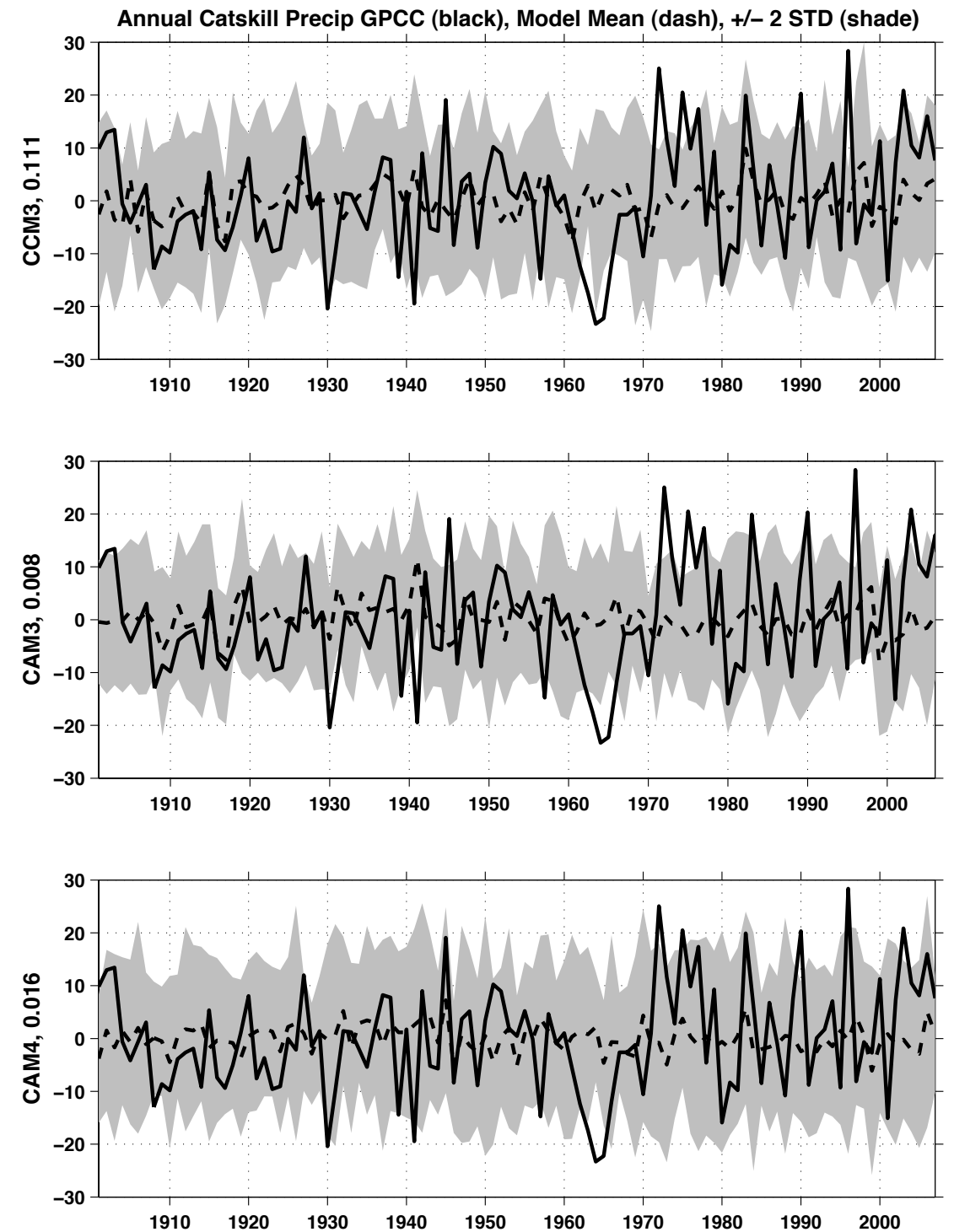
20CR



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



1950 to 2000

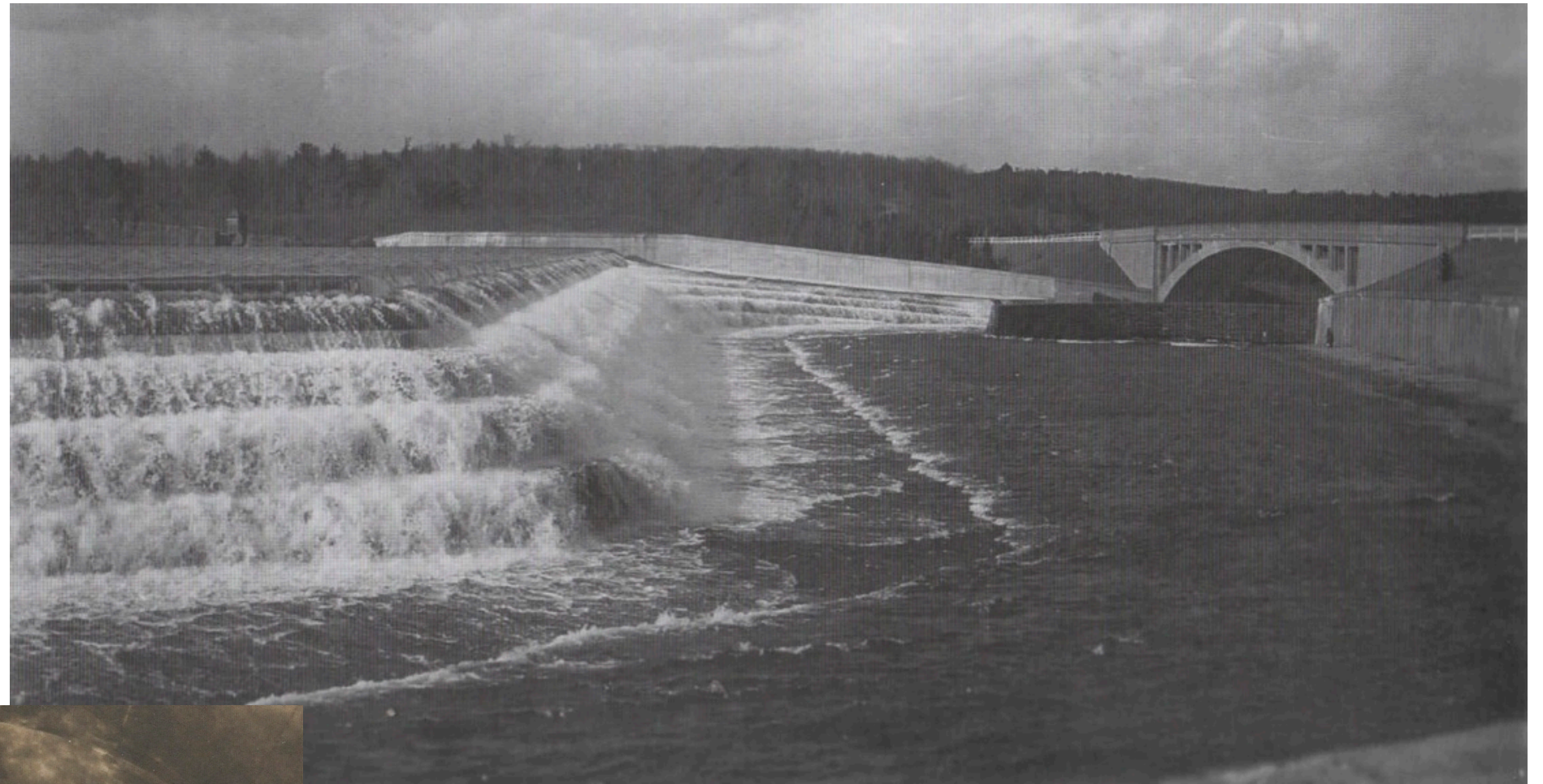


1900 to 2000



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

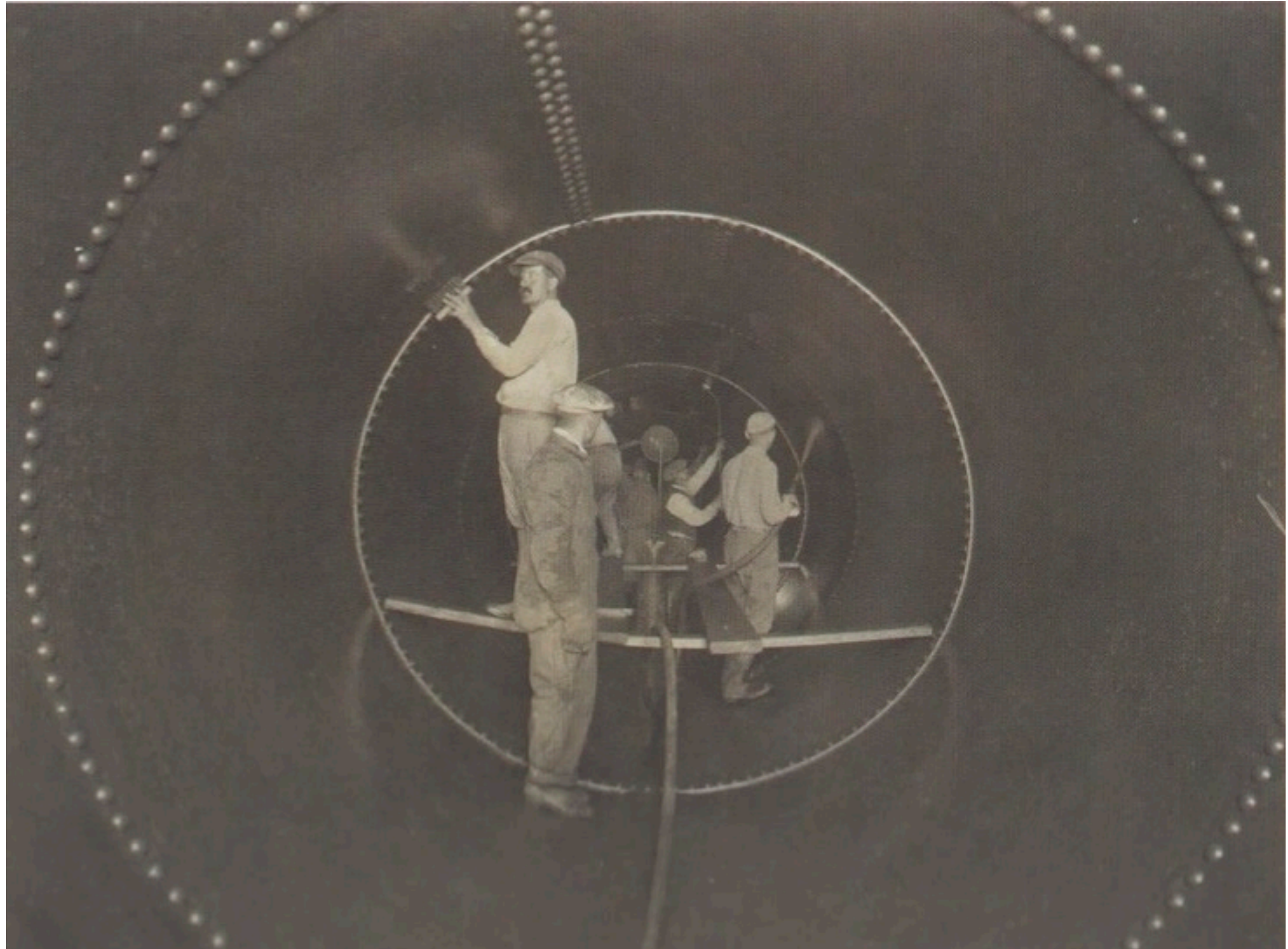
Ashokan reservoir



Lining Catskill aqueduct



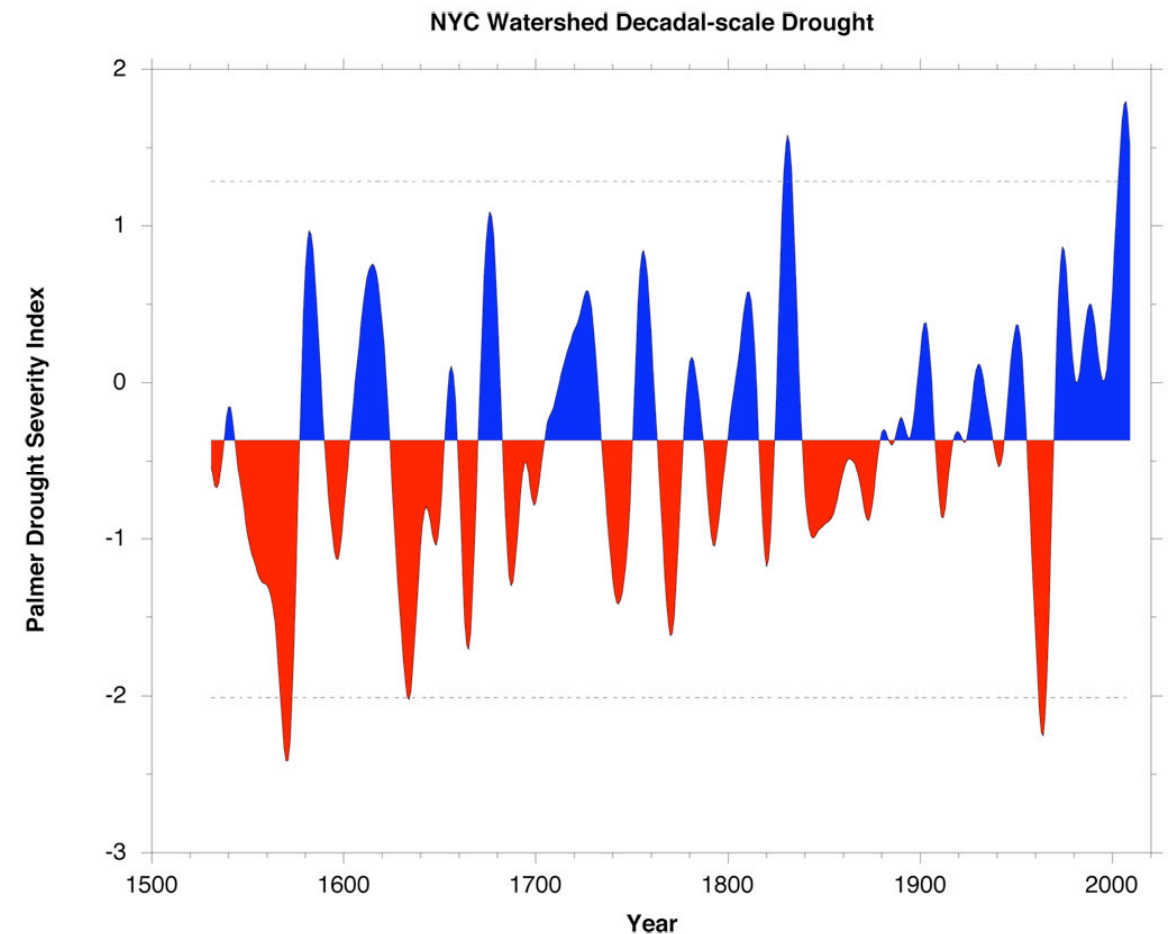
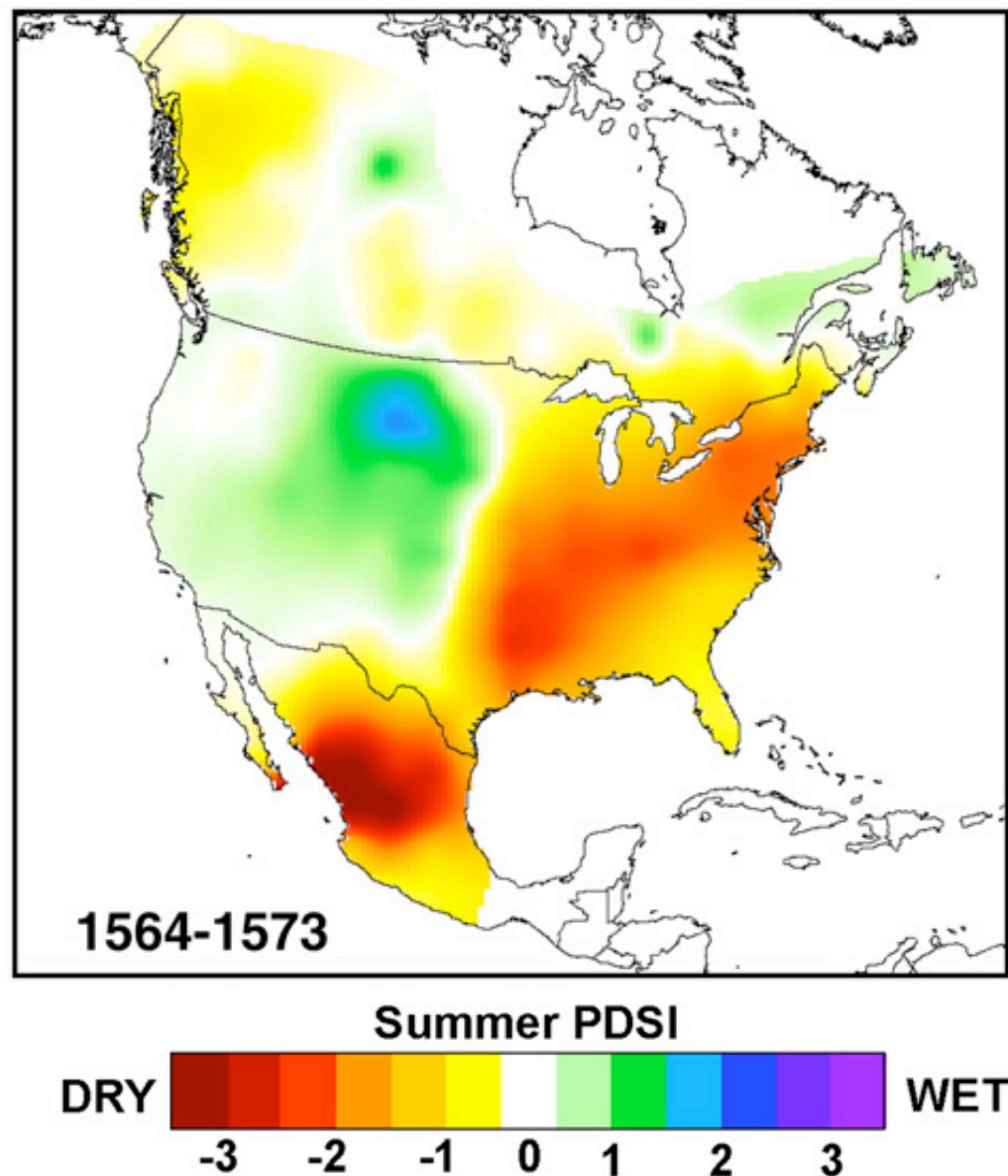
Finishing touches to the lined aqueduct



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 (in prep.)

... 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 ...