CL1.2.6 – abstract number EGU22-8090

The Gleissberg (~85 year) and other periodicities in the flood cycles of the Brahmaputra River past present and future; implications for possible global mechanisms

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The Gleissberg (~85 year) and other periodicities in the flood cycles of the Brahmaputra River past present and future; implications for possible global mechanisms

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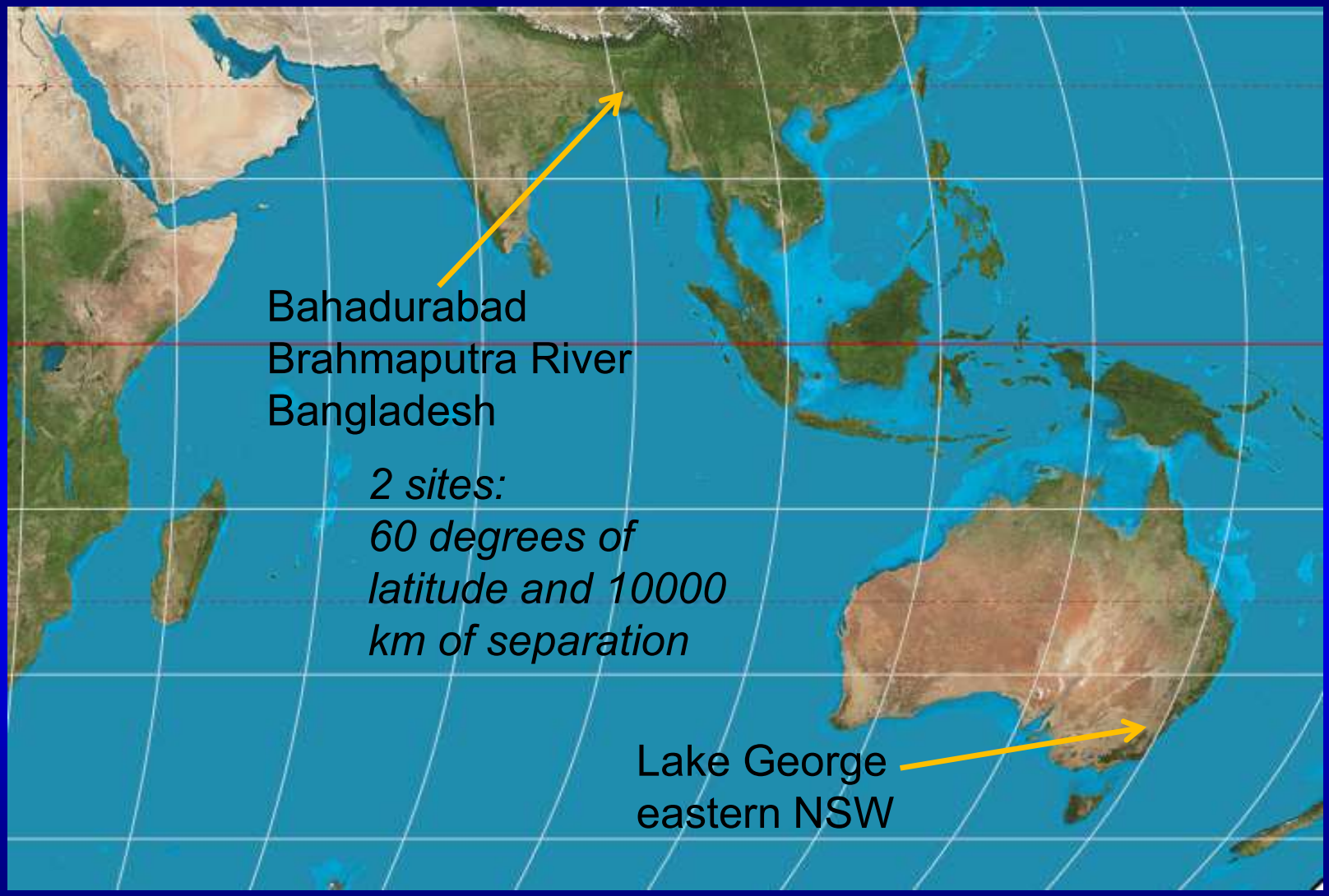
Asten and McCracken (AGU 2021, paper H45Z-12) note strong ~85 and ~50 year periodicities in flood data and lake level data in NSW, south-east Australia. We now compare data sets for the Brahmaputra River (latitude 25ºN) 1800-2000CE with Lake George (latitude 35ºS) levels 1820-2020CE. Both data sets show a pair of dominant spectral maxima at 80 and 50 year periods.

A study by Rao et al (2020) of observed and reconstructed discharge of the Brahmaputra shows only limited correlation of discharge rates with recorded floods. We use a record of Oceanic Nino Index 1870-2021CE (McNoldy, 2021) to compare with floods and find that for time 1875-2010, 14 of 17 observed floods associate with La Nina events. However there were 27 La Nina events in this interval hence as a working hypothesis LaNina events are close to being a necessary condition (~82%) for floods but not a sole determinant. We use spectral analysis to locate multi-decadal natural cycles which also influence discharge levels and flood frequency.

The Brahmaputra discharge rate data extends back to year 1309CE (Rao et al, 2020). The power spectrum shows a series of strong maxima, especially at 242, 132, 90, &75year periods similar to those in ^{14}C and ^{10}Be records for the Holocene. The entire record can be fitted using a model of 8 sinusoids, leaving only a 20% residual variance. The model allows extrapolation of the discharge rate into the future and predicts an above-average discharge for years 1995-2040CE, peaking ~2020. This predicted time-span of above-average discharge is based on natural frequencies embedded in the record and does not include any possible influences from 21st-century global warming. The prediction appears closer to the observed increase post-2000, than does a prediction based on CMIP5 models as provided in the Rao etal (2020) paper.

A further test of the efficacy of the discharge curve fitting method is provided by limiting the observed data to years 1309-1900CE, then projecting the model to 2200. The projected curve from 1900 replicates the observed dry period 1950-1995 and validates the hypothesis that the dry period was not an unusual event but was part of the natural cycles as reconstructed since 1309. The projected curve from 1900 also closely follows the model based on all data to 2010 in predicting the above-average discharge rates 1995-2040.

As noted above both data sets show a pair of dominant spectral maxima at 80 and 50year periods. The similarity between the spectra invites a hypothesis that the long-period natural cycles at both locations have a common origin, possibly solar-related rather than being of local atmospheric/oceanic origin. A key difference is that the phases of the spectral maxima are reversed for the two sites. Physical mechanisms producing these dominant periods for the 19th and 20th centuries, and the phase difference between the northern and southern hemisphere sites are not yet known. They could be related to variations in solar insolation, cosmic-ray ionization of cloud cover, or mode changes in global ocean current systems driven by unknown external forcing.


Bahadurabad
Brahmaputra River
Bangladesh
2 sites:
60 degrees of
latitude and 10000
km of separation
Lake George
eastern NSW


Bahadurabad
TIBET
Chengdu
成都市
Chongqing
重庆
SICHUAN
PUNJAB
UTTARAKHAND
HARYANA
New Delhi
नई दिल्ली
UTTAR PRADESH
Nepal
Kathmandu
काठमाडौं
Bhutan
ARUNACHAL PRADESH
GUIZHOU
Jaipur
जयपुर
Lucknow
लखनऊ
BIHAR
Patna
पटना
NAGALAND
MANIPUR
YUNNAN
Bangladesh
JHARKHAND
MADHYA PRADESH
India
TRIPURA
WEST BENGAL
MIZORAM
Indore
इन्दौर
CHHATTISGARH
Kolkata
কলকাতা
Myanmar (Burma)
Hanoi
Nagpur
नागपूर
ODISHA
Chiang Mai
เทศบาลนคร เชียงใหม่
Naypyidaw
နေပြည်တော်
Laos
MAHARASHTRA
Vientiane
ວຽງຈັນ
TELANGANA
Thailand
Bangkok
ANDHRA PRADESH
Vietnam
Bengaluru
Layers
Google
Map data ©2022 Google
Australia
Terms
Privacy
Send feedback
500 km


WALES
Sydney
Wollongong
NSW (Australia)
Wagga Wagga
Canberra
Lake George
AUSTRALIAN
CAPITAL
TERRITORY
Albury
Layers
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Privacy
Send feedback
100 km

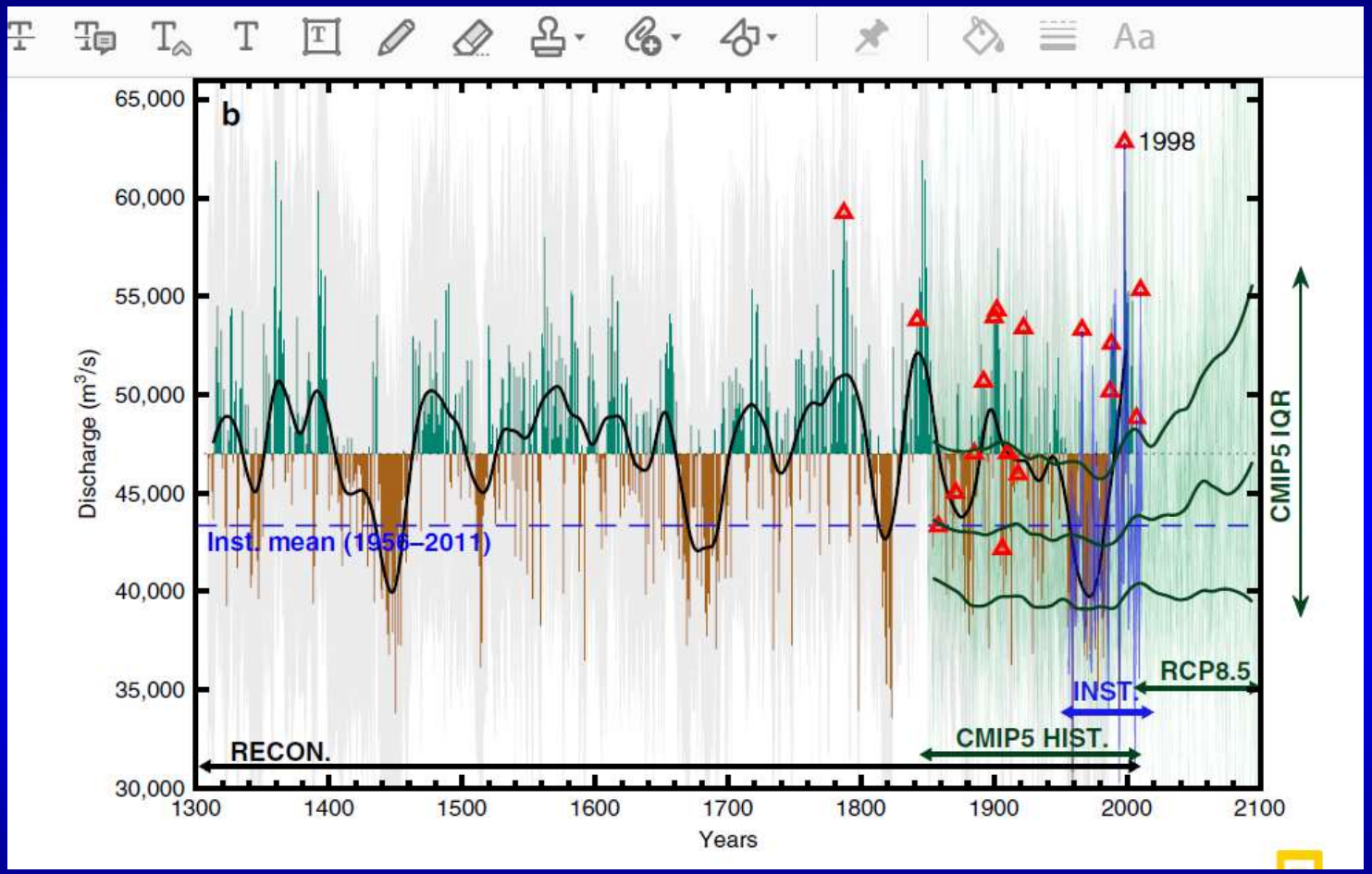


Figure and data from Rao et al (2020)

Summary of Rao conclusions:

Instrumental era records 1956–1986 CE) are time of abnormally low discharge

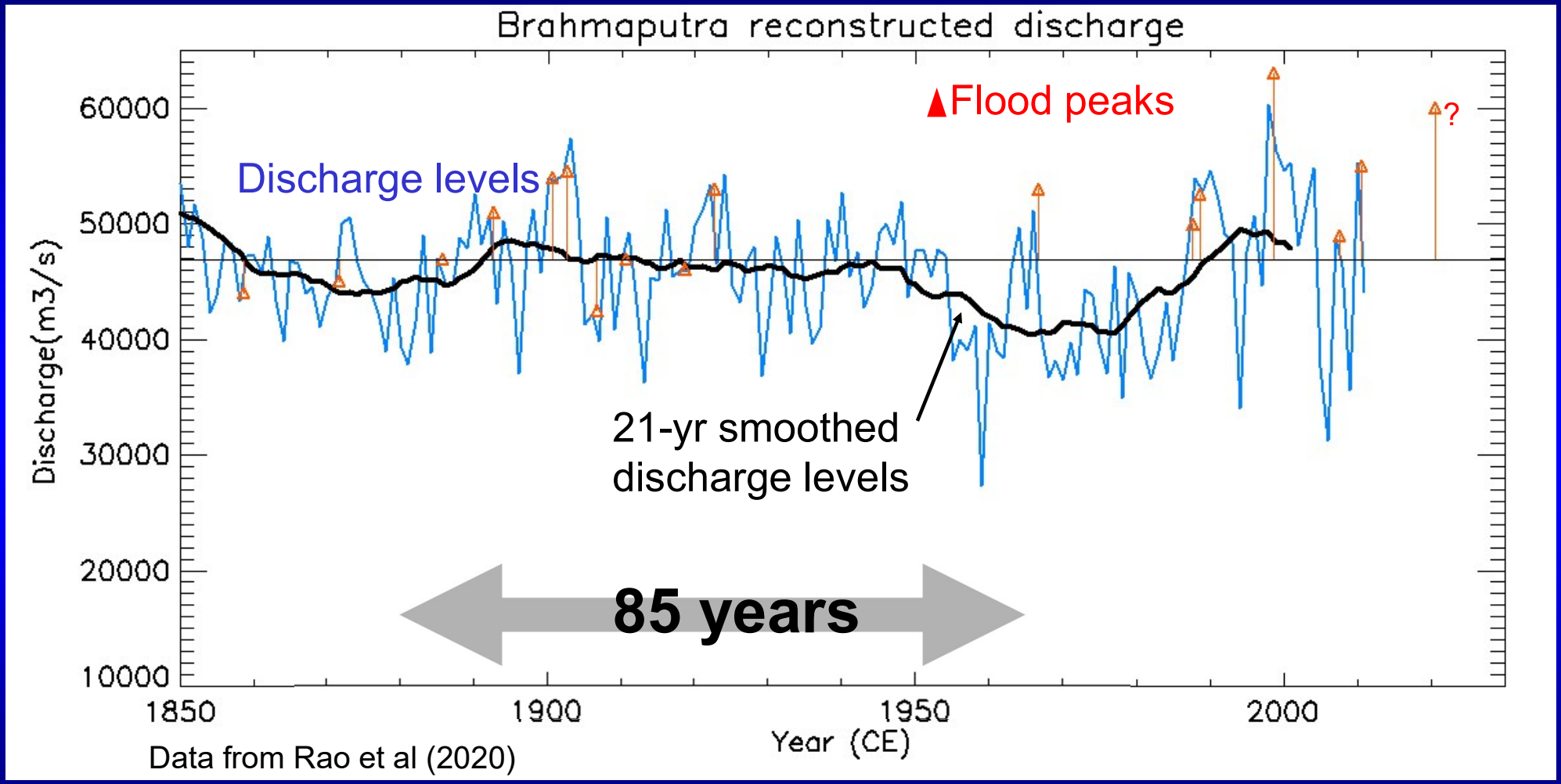
RCP8.5 climate models predict increasing rate discharge to 2100

No correlation of flood frequency with ONI

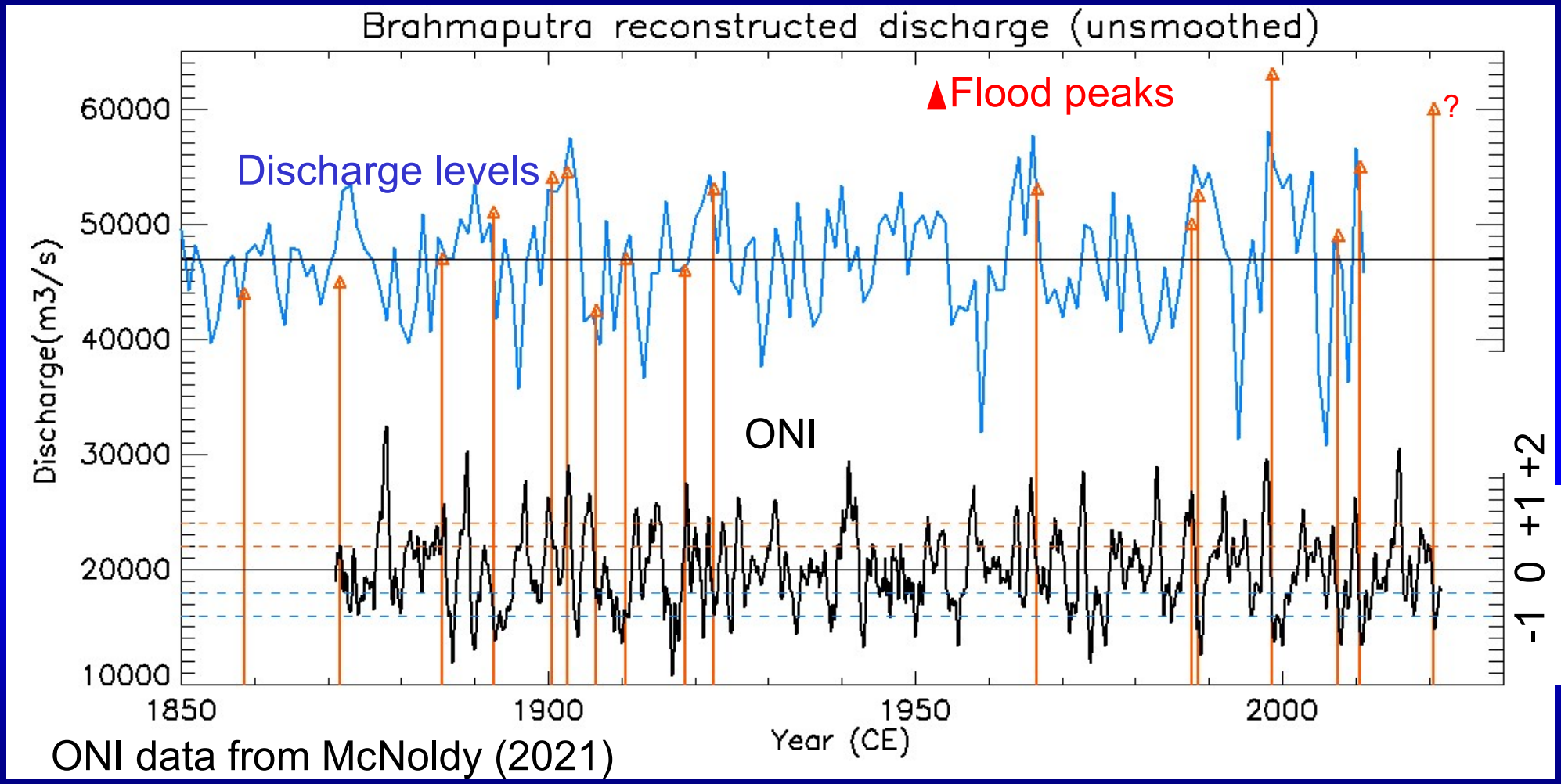
Reminder: ONI = Oceanic Nino Index

ONI <-0.5 = moderate La Nina; < -1 = strong La Nina

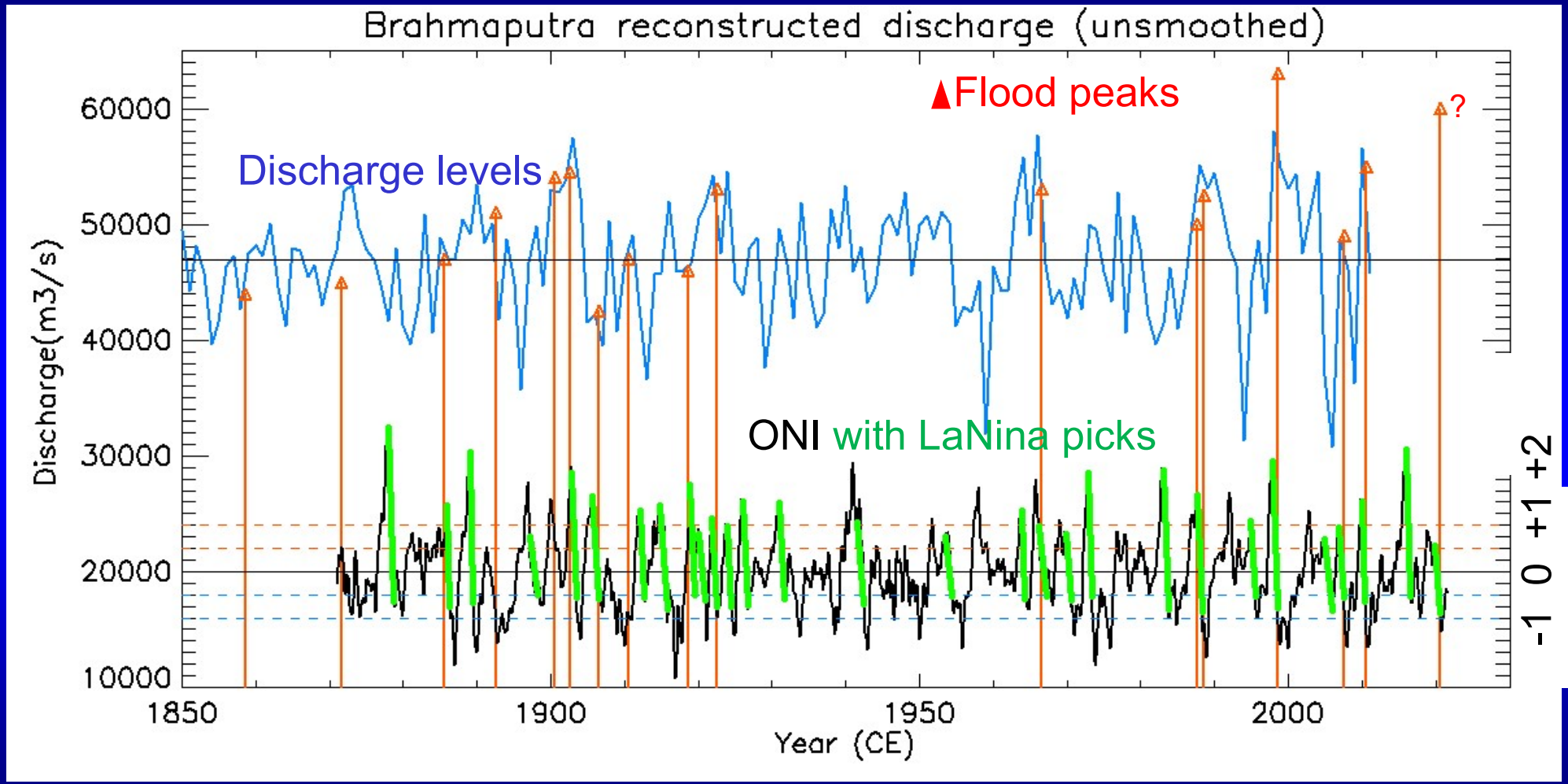
ONI >0.5 = moderate El Nino; > 1 = strong El Nino



Data from Rao et al (2020)



ONI data from McNoldy (2021)



Criterion for La Nina pick: ONI index decreases 1.25 or more

COMMENTS - BRAHMAPUTRA RIVER AND ONI 1875-2010 CE

1. time 1875-2010, 14 of 17 observed floods associate with La Nina events. However there were 27 La Nina events in this interval hence as a working hypothesis LaNina **events** are close to being a necessary condition (~82%) for floods but not a sole determinant.

2. This result assists in flood prediction/probability since La Nina events can be predicted 3-10 years in advance (Leamon et al, 2020, 2021)

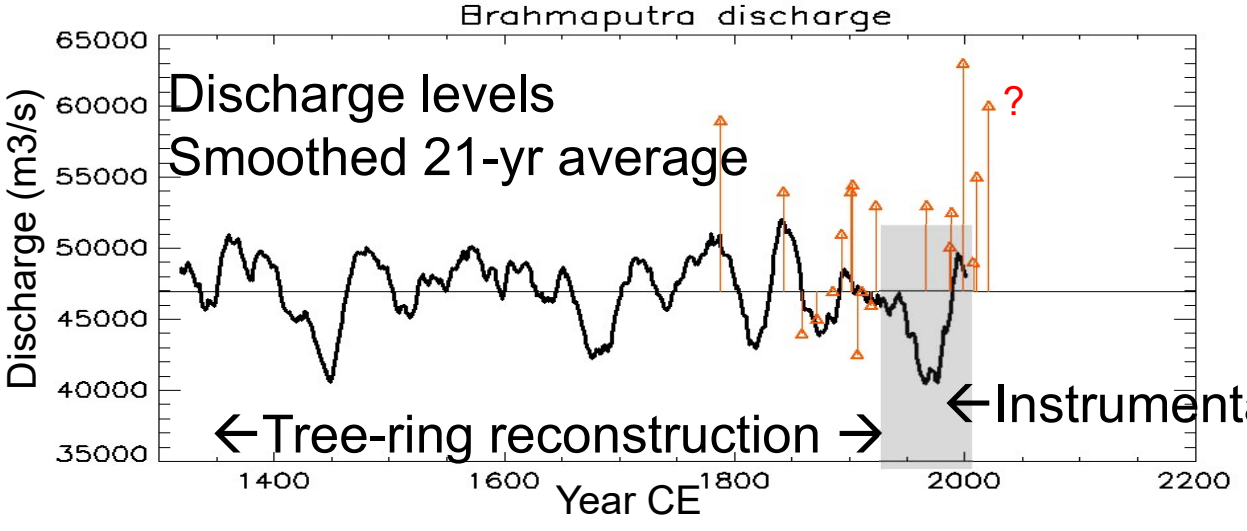
BRAHMAPUTRA RIVER AND ONI 1875-2010 CE

- There were a total of 27 La Nina events
- 14 out of 17 floods were associated with La Nina events

➔La Nina events are necessary but not sufficient for flood events

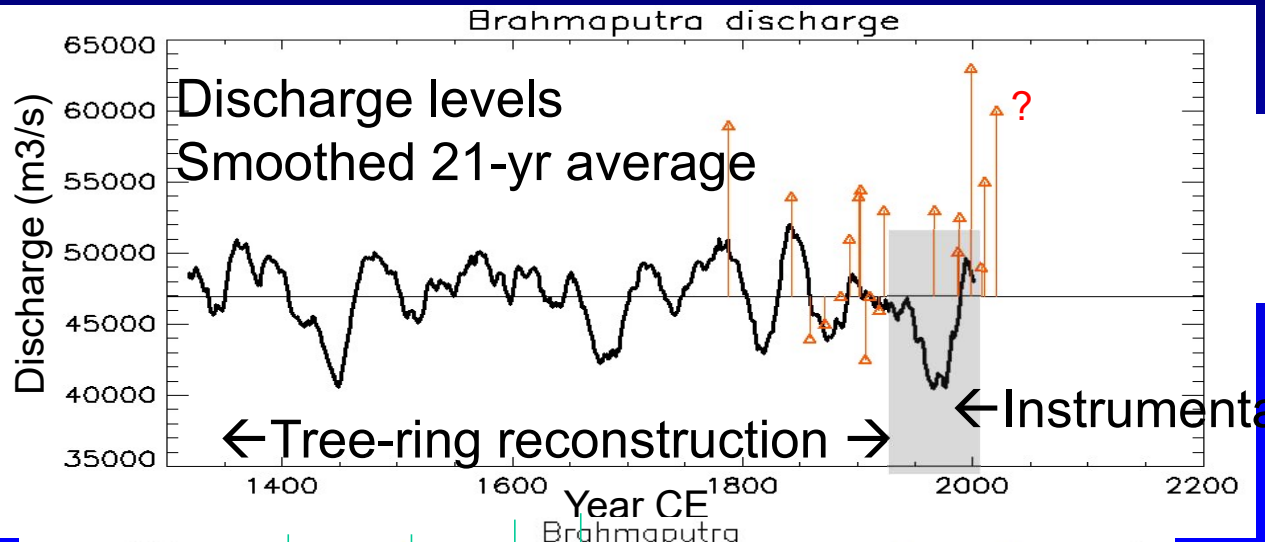
Is there another systematic factor affecting flood occurrence? Hypothesis: Gleissberg period

SPECTRAL PROPERTIES OF BRAHMAPUTRA DISCHARGE DATA 1319-2001 CE

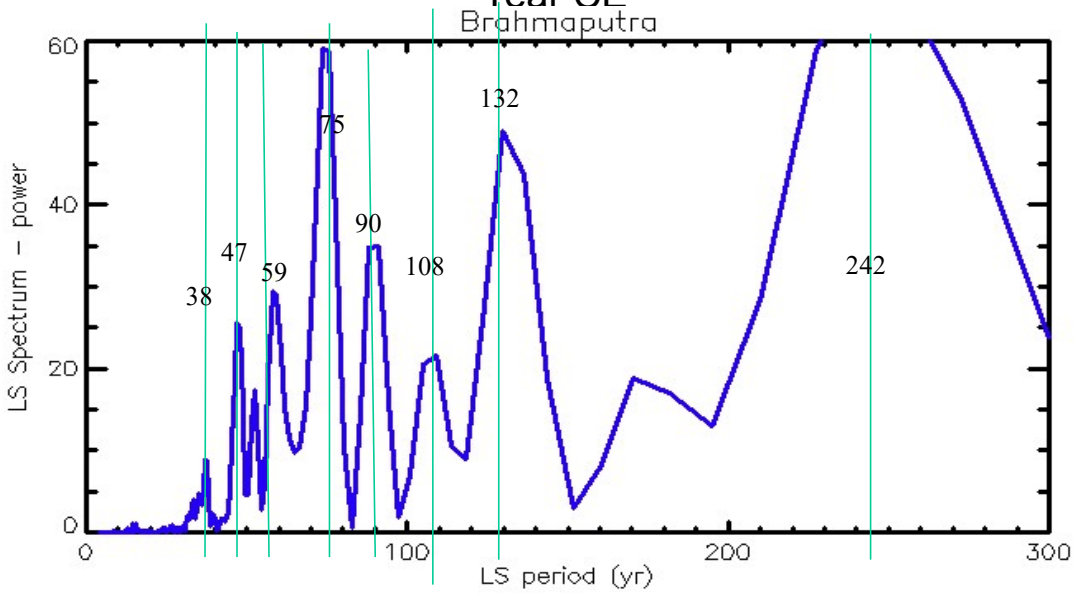


Discharge levels
Smoothed 21-yr average

SPECTRAL PROPERTIES OF BRAHMAPUTRA DISCHARGE DATA 1319-2001 CE

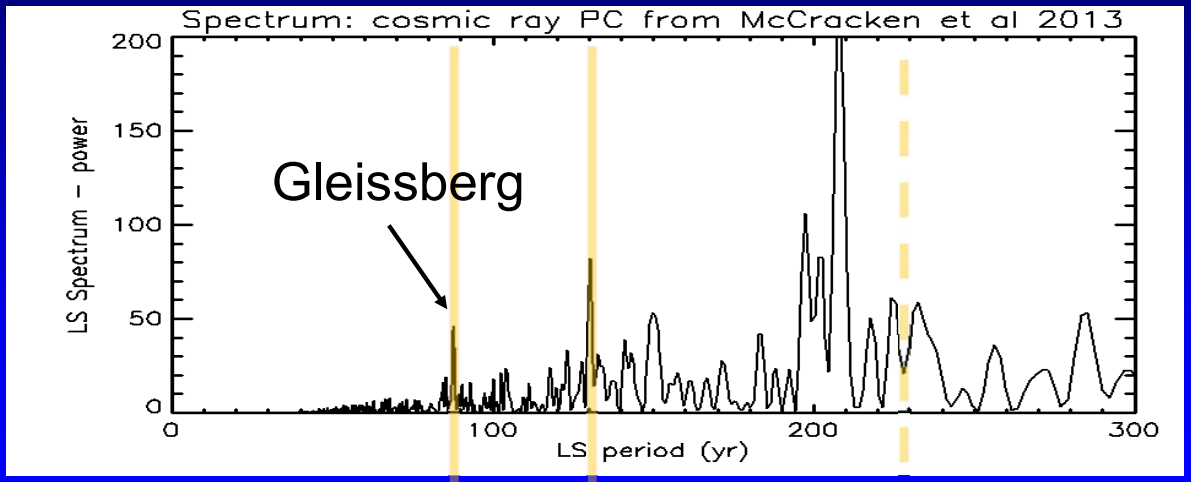


Discharge levels
Smoothed 21-yr average

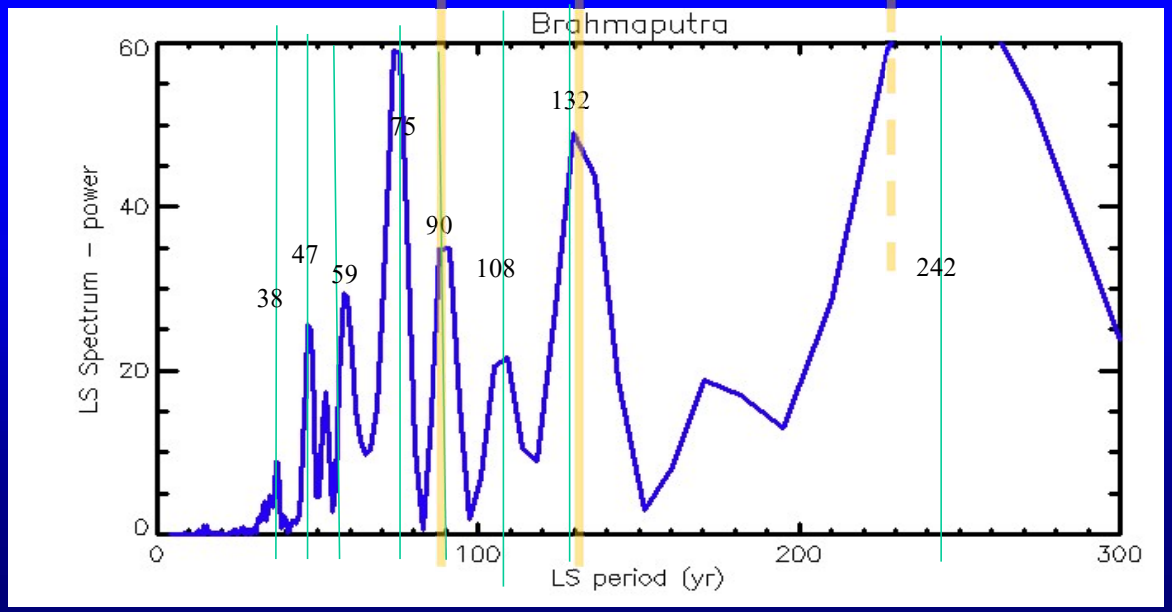


Lomb-Scargle spectrum
shows 8 dominant periods

SPECTRAL PROPERTIES OF BRAHMAPUTRA DISCHARGE COMPARED WITHCOSMIC RAY 1.PC

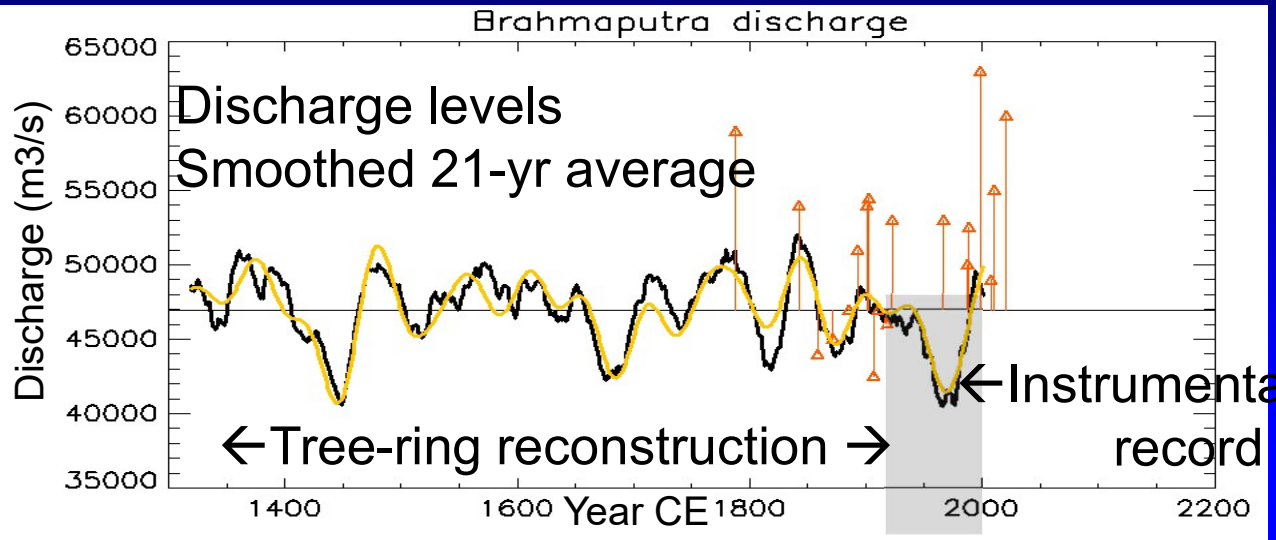


Lomb-Scargle spectrum of 9000-year cosmic ray 1.PC from 10Be and 14C

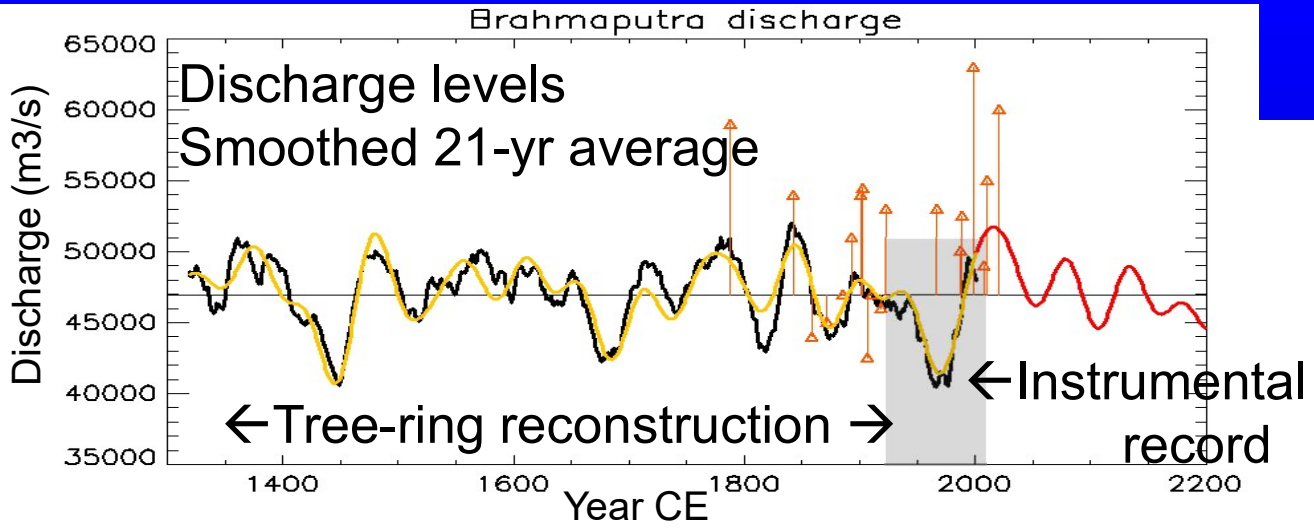


Lomb-Scargle spectrum shows 8 dominant periods

SPECTRAL PROPERTIES OF BRAHMAPUTRA DISCHARGE DATA 1319-2001 CE



Black: Discharge levels Smoothed 21-yr average
Yellow: Discharge synthesized from 8 spectral periods



Red: Discharge extrapolated **from 2001 to year 2200 CE**

COMMENTS – SPECTRUM AND BRAHMAPUTRA EXTRAPOLATION TO 2200 CE

3. The power spectrum shows a series of strong maxima, especially at 242, 132, 90, &75year periods similar to those in ^{14}C and ^{10}Be records for the Holocene (McCracken et al, 2013) Entire record fitted using a model of 8 sinusoids, with 20% residual variance. Peaks at 75, 90, 242 yr periods invite comparison with the Nile river, the 86 yr Gleissberg period, and consideration of a solar link (see eg Ruzmaikin et al, 2006,2015)

4. Extrapolation into the future predicts above-average discharge for years 1995-2035CE, peaking ~2020.

- based on natural frequencies embedded in the record and **does not include** any possible influences from 21st-century global warming.
- prediction based on observed frequencies **appears closer to the observed increase post-2000**, than does a prediction based on CMIP5 models as provided in the Rao etal (2020) paper.

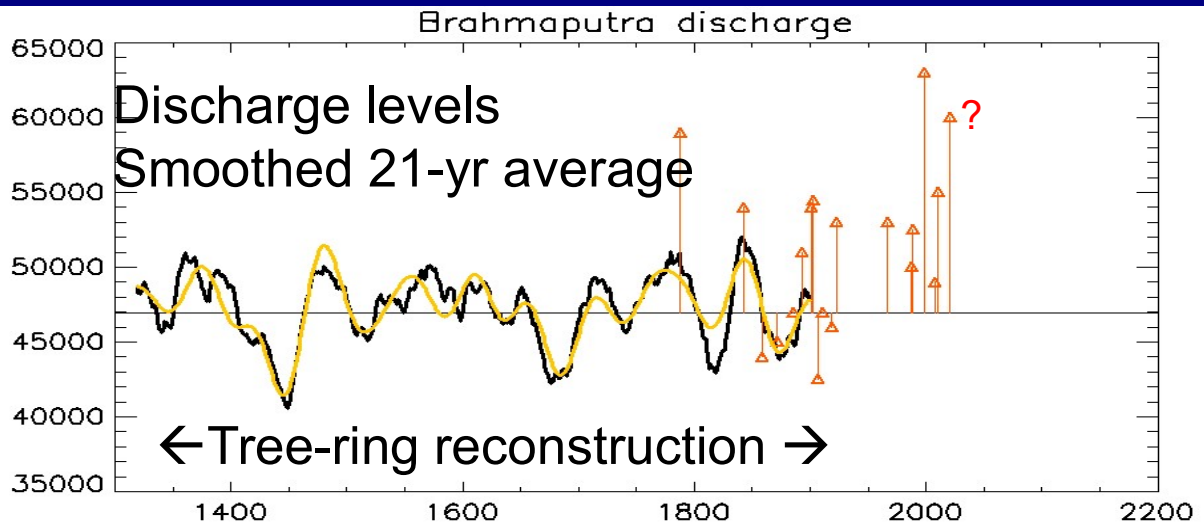
BRAHMAPUTRA RIVER AND ONI 1875-2010 CE

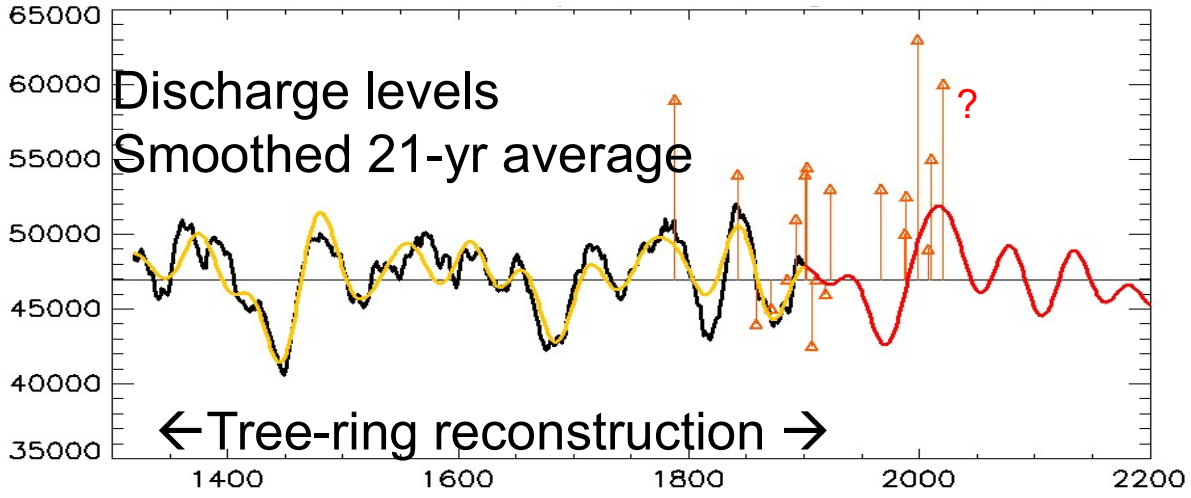
- There were a total of 27 La Nina events
- 14 out of 17 floods were associated with La Nina events

➔La Nina events are necessary but not sufficient for flood events

Is there another systematic factor affecting high-discharge decades? Hypothesis: Gleissberg period

EXTRAPOLATION OF BRAHMAPUTRA DISCHARGE DATA 1319-1900 CE TO 2200



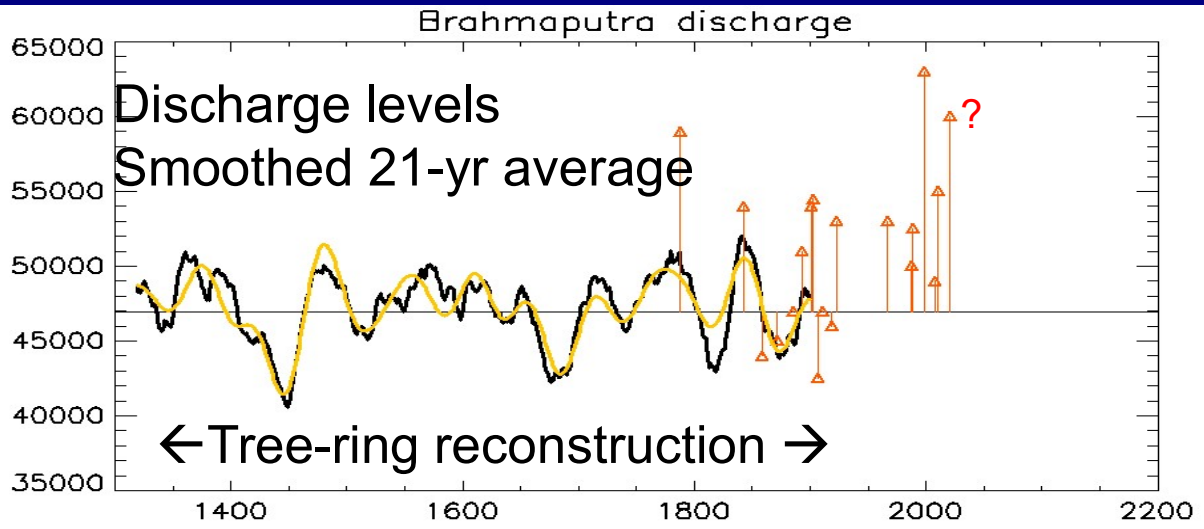


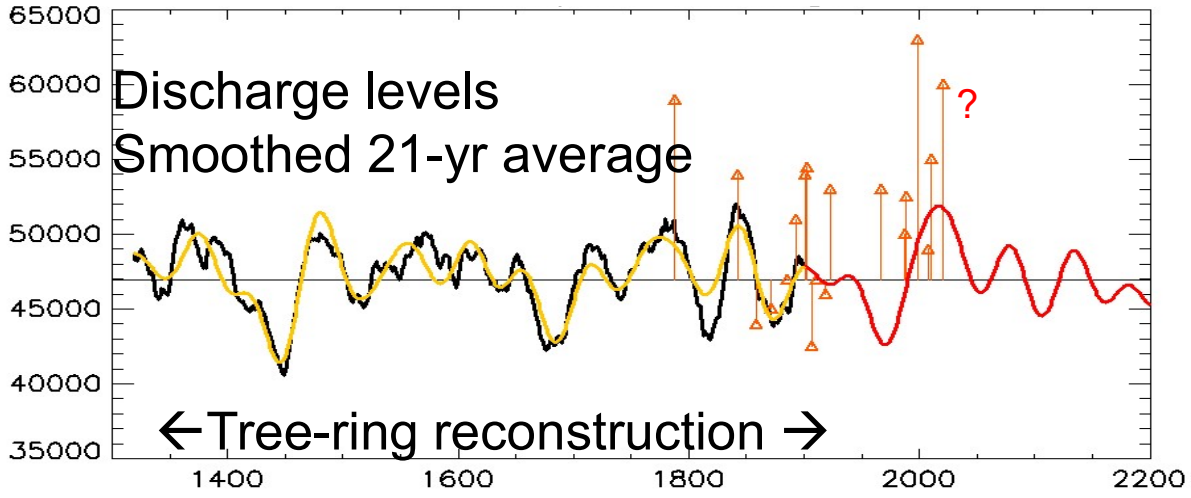
Restrict observation record **1319-1900 CE PRE-INSTRUMENTAL**

Yellow: Discharge synthesized from 8 spectral periods

Red: Discharge extrapolated **from 1900 to year 2200 CE**

EXTRAPOLATION OF BRAHMAPUTRA DISCHARGE DATA 1319-1900 CE TO 2200

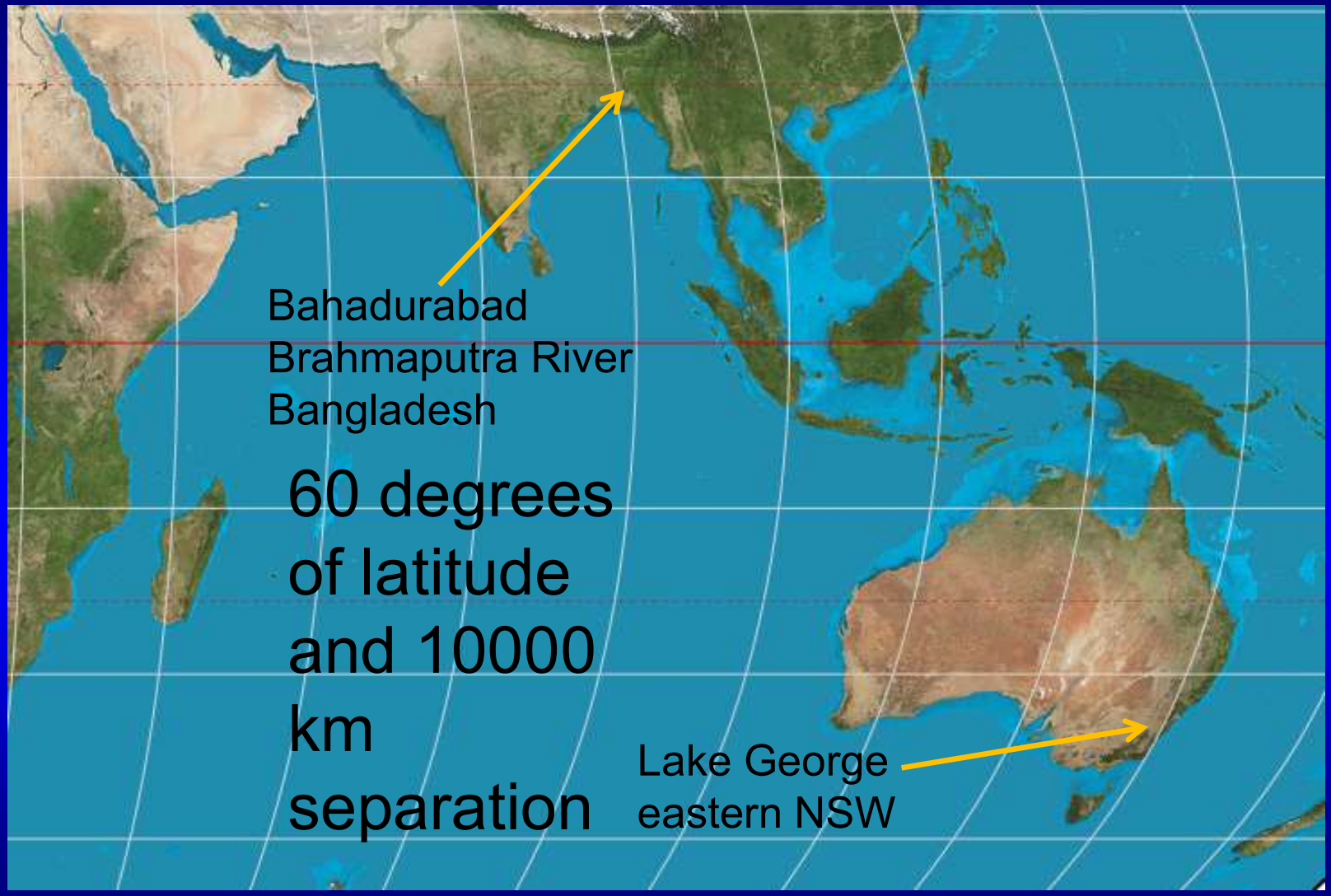




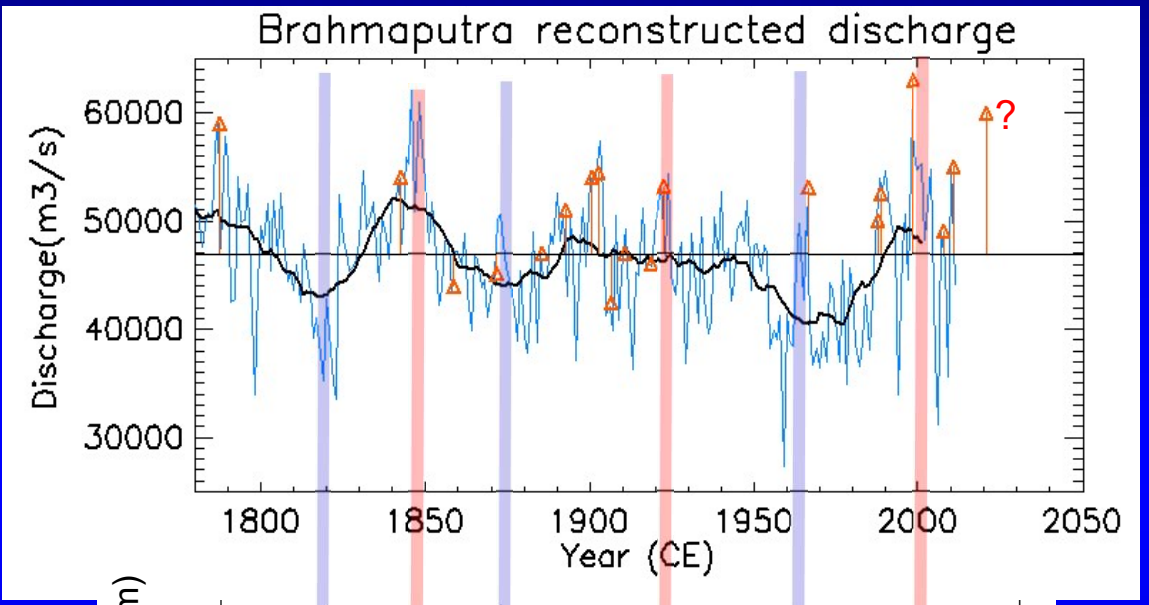
Restrict observation record **1319-1900 CE PRE-INSTRUMENTAL**

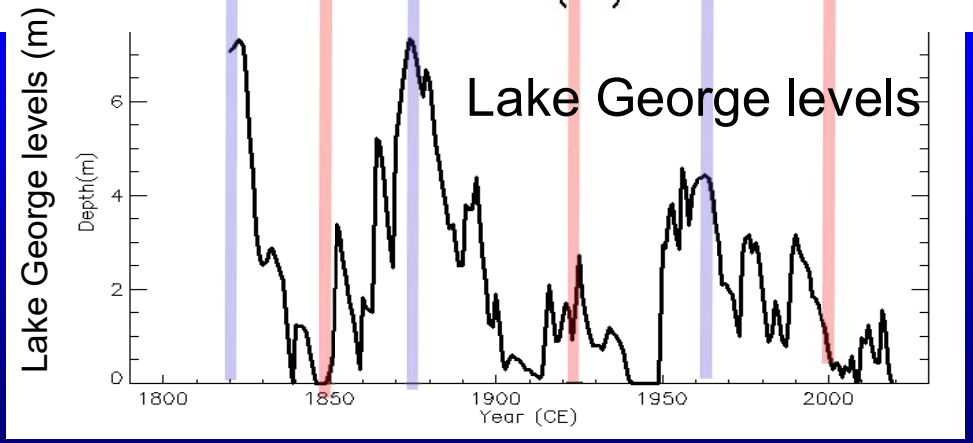
5. A further test of the efficacy of the discharge curve fitting method is provided by limiting the observed data to years 1309-1900CE, then projecting the model to 2200. The projected curve from 1900 replicates the observed dry period 1950-1995 and validates the hypothesis that the **dry period was not an unusual event** but was part of the natural cycles as reconstructed since 1309. The projected curve from 1900 also closely follows the model based on all data to 2010 in predicting the above-average discharge rates 1995-2040.

Now compare spectra of 200-year segment of Bramaputra R discharge
with
Lake George NSW levels

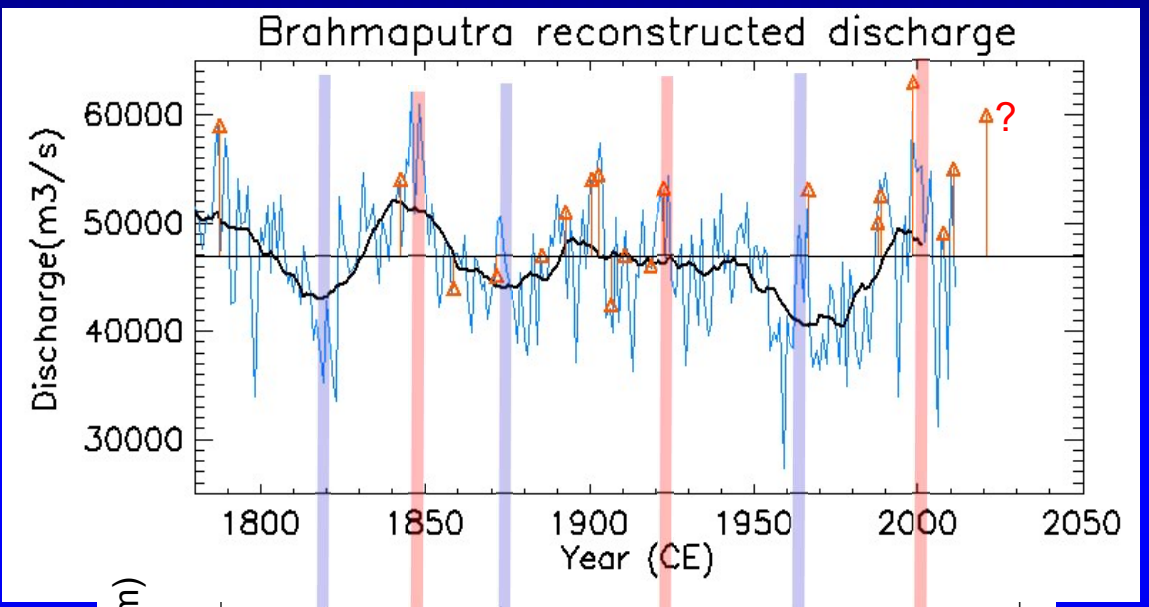

Bahadurabad
Brahmaputra River
Bangladesh
60 degrees
of latitude
and 10000
km
separation
Lake George
eastern NSW

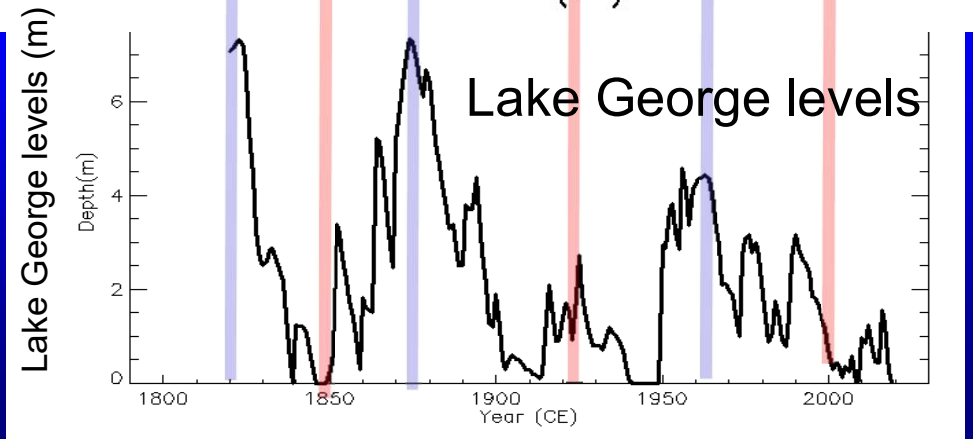
INVERTED PHASE RELATIONSHIP : BRAHMAPUTRA DISCH. & L. GEORGE LEVELS

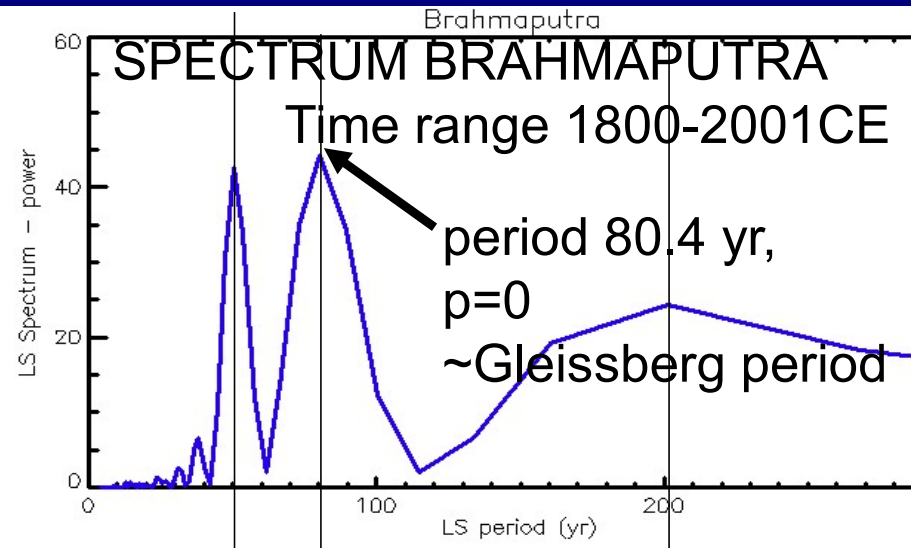


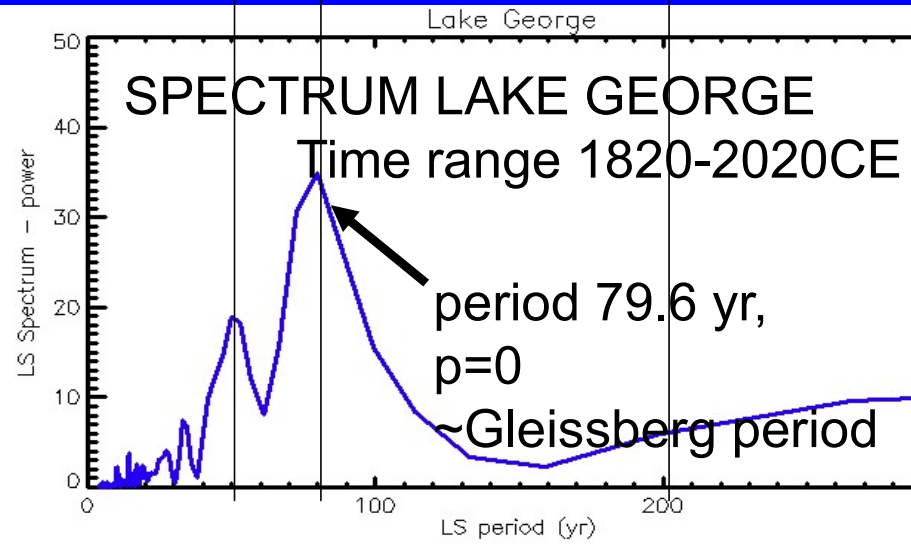


INVERTED PHASE RELATIONSHIP : BRAHMAPUTRA DISCH. & L. GEORGE LEVELS









6. Comparison with Lake George NSW water levels

- Same 80yr (~Gleissberg) and 50 yr periods for 200 yr record
- 1800-2000CE for Brahmaputra
- 1820-2020CE for Lake George

- Both data sets show a pair of dominant spectral maxima at 80 and 50 yr periods. The similarity between the spectra invites a hypothesis that the long-period natural cycles at both locations have a common origin, possibly solar-related rather than being of local atmospheric/oceanic origin.

SUMMARY

Brahmaputra R (Bangladesh) and Lake George (NSW):

Floods on Brahmaputra show La Nina event is a necessary but not sufficient condition (~50%)

Currrent >average peak discharge projected to continue to 2035 CE

Dominant periods in spectra for both locations 1800-2000 CE are closely similar (80 yr and 50 yr).

=> similar external forcing

Dominant period 80 yr is close to Gleissberg period (85 yr)

=> is there a solar/cosmic ray connection in forcing?

Phase reversal N & S Hemisphere

=> implication for forcing mechanism

References

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