9th INTECOL International Wetlands Conference

Wetlands in a Complex World

Relationship between tree growth of *Macrolobium acaciifolium* and climate in central Amazonian floodplain forests

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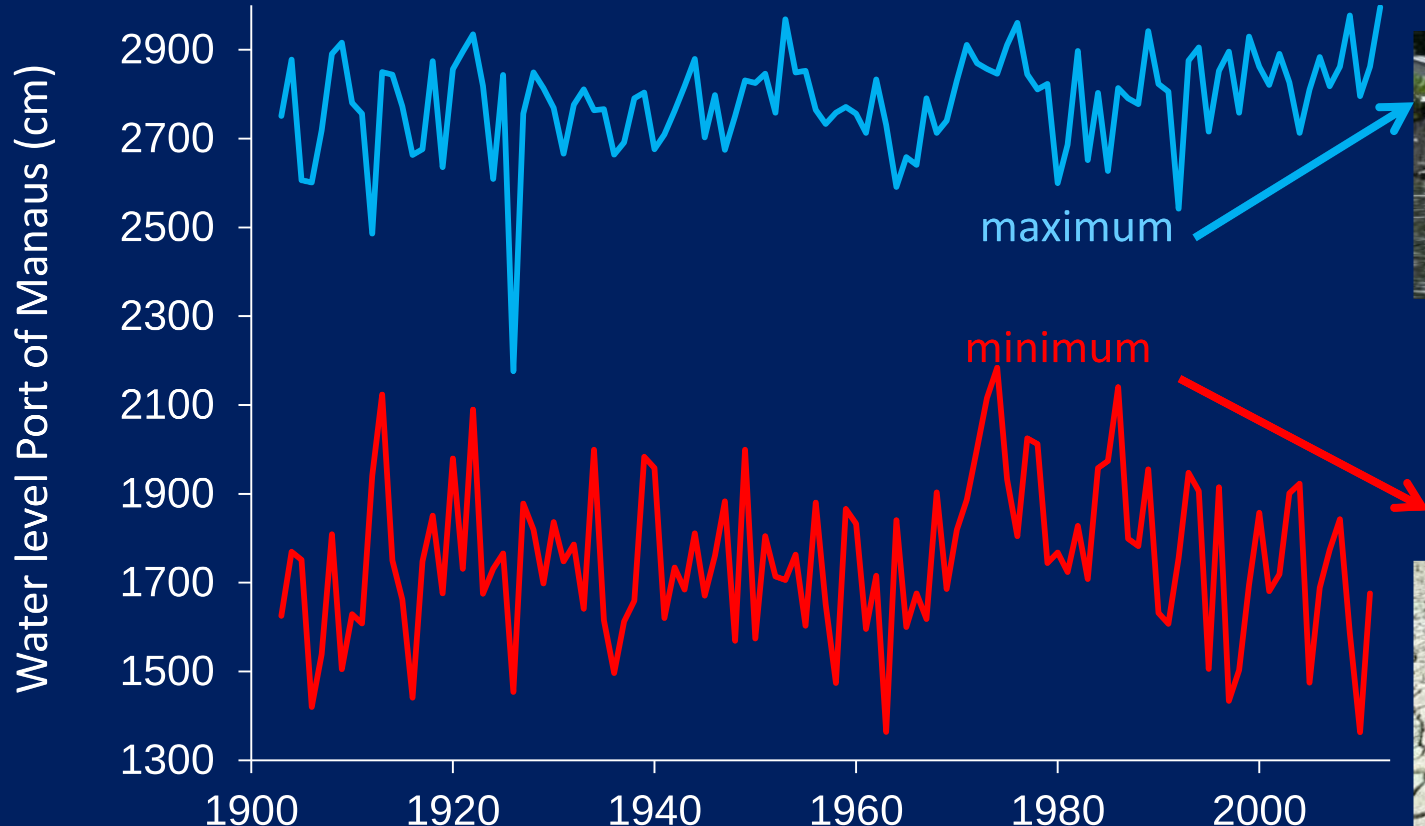
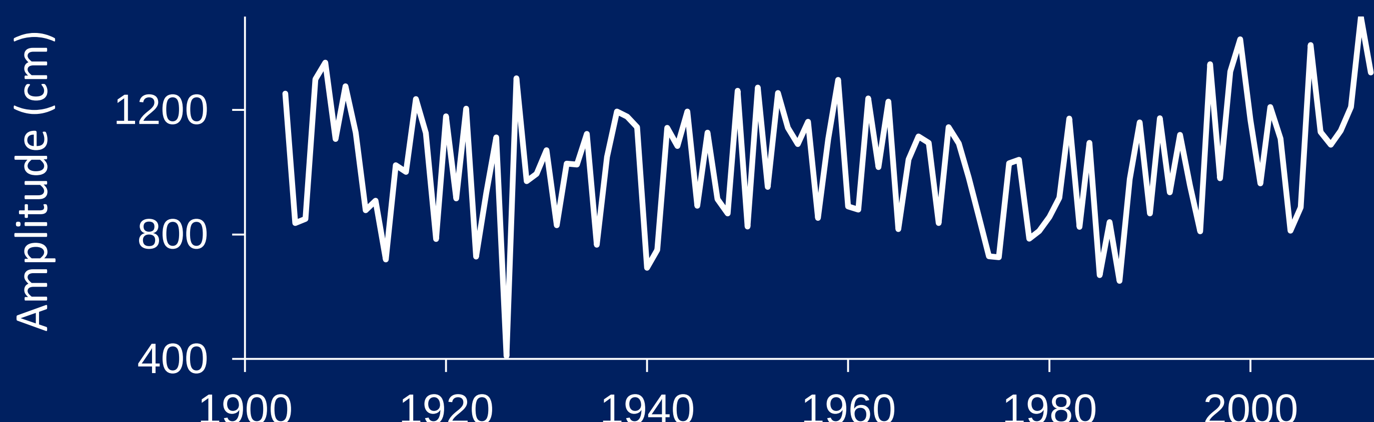
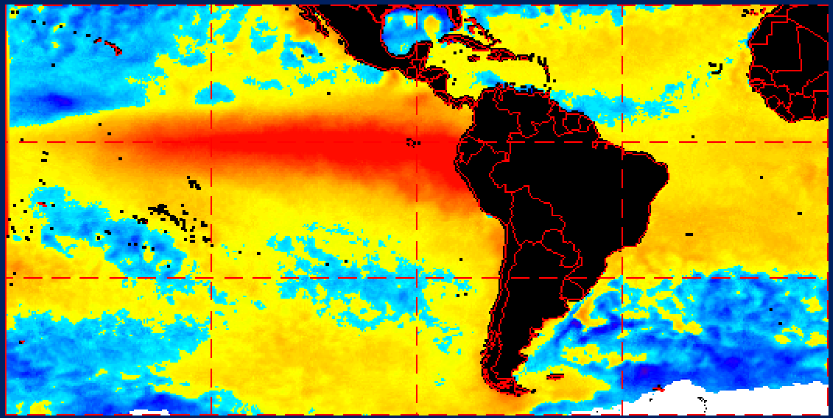
Maximum, minimum water level and amplitude at the Port of Manaus (Central Amazonia) over the last 110 years





The mean amplitude is 10.2 m

Data: ANA



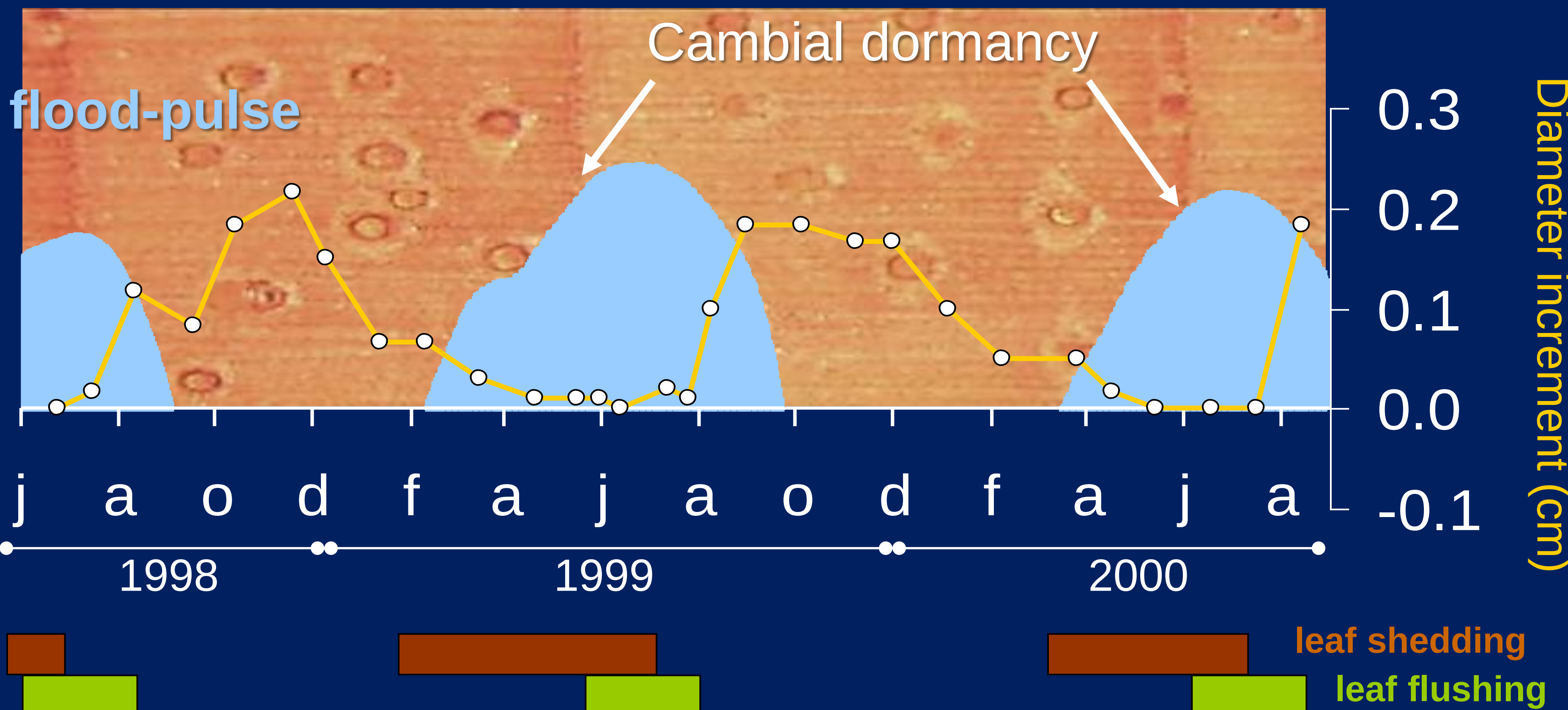
El Niño (warming of surface water in the Equatorial Pacific) and La Niña (cooling of surface water in the Equatorial Pacific) have an impact on maximum water levels of the Amazon River and its tributaries

***T*-Test**	**El Niño**	**Other years**	**T-Value (*p*)**	**La Niña**	**Other years**	**T-Value (*p*)**
Flood pulse	*n* = 33	*n* = 64		*n* = 29	*n* = 68	
Maximum water level (Manaus)	27.05	28.09	-3.97 ($p<0.001$)	28.19	27.54	3.02 ($p<0.01$)

(Schöngart *et al*. 2004; Schöngart & Junk 2007)

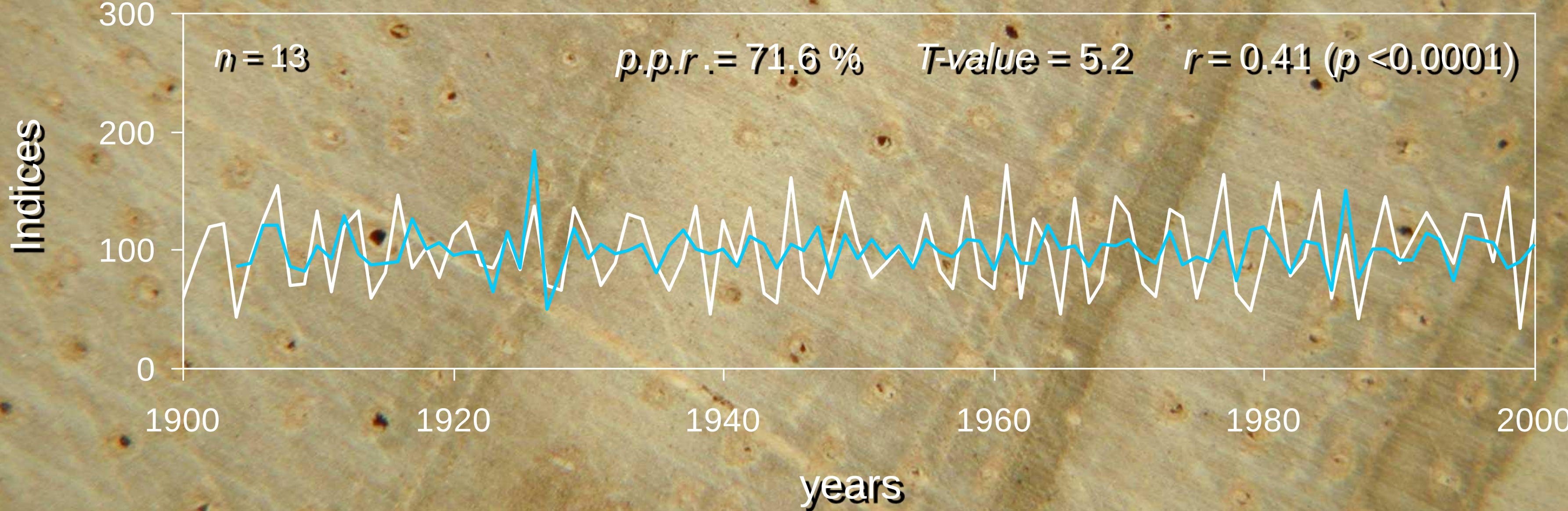
Severe droughts in the Amazon basin, such as in 2005 and 2010, are associated with positive sea surface temperature anomalies of the northern Tropical Atlantic (Marengo *et al.* 2008, 2011)

Seasonal growth of *Macrolobium acaciifolium* in Amazonian floodplain forests



Schöngart *et al*. (2002)

Relationship between tree-ring chronology of *Macrolobium acaciifolium* (white curve) and the lenght of the terrestrial phase (non-flooded period, blue curve) in floodplain forests of Central Amazonia



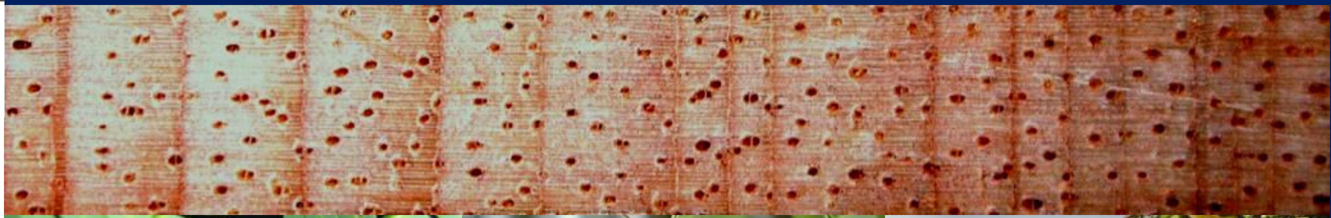
Schöngart *et al.* (2005)

***Macrolobium acaciifolium* (Benth.) Benth. (Fabaceae)**

- Wide geographic distribution in Amazon basin
- Dominant at low topographies in floodplain forests
- Tree height 20-30 m, diameter up to 150 cm
- Tree ages of up to 500 years
- Non-nodulated, semi-deciduous legume tree species
- Distinct annual tree rings with almost no ring anomalies
- Switch to anaerobic metabolism during aquatic phase
- Low wood density (0.39-0.49 g cm^{-3})
- Timber commercially used (furniture, house construction)

(Schlüter 1989; Worbes 1996; Parolin *et al*. 1998; Kreibich 2002; Schöngart *et al.* 2002, 2005; Wittmann *et al.* 2010)

Occurrence of *M. acaciifolium* in the Amazon floodplains

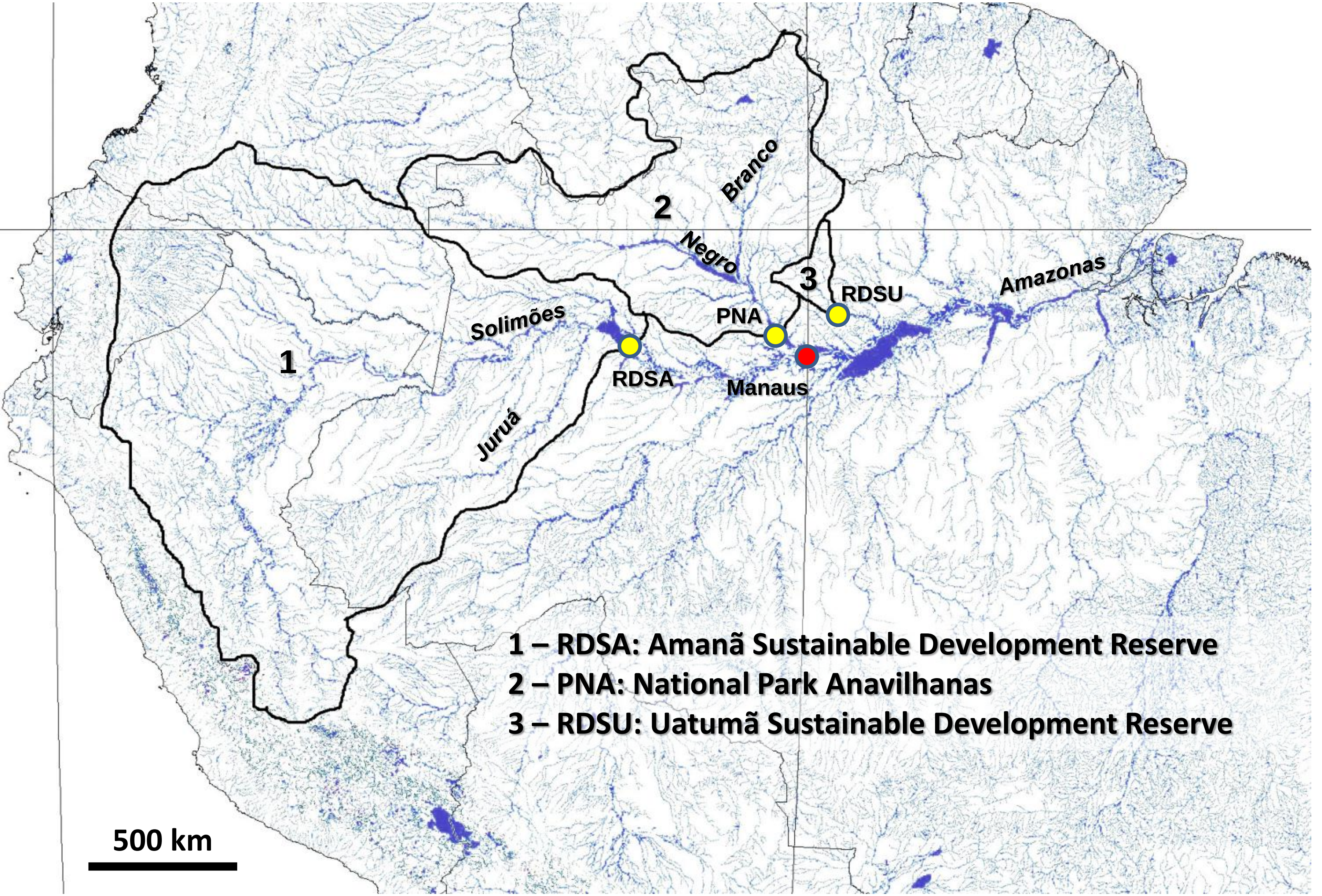


Objective

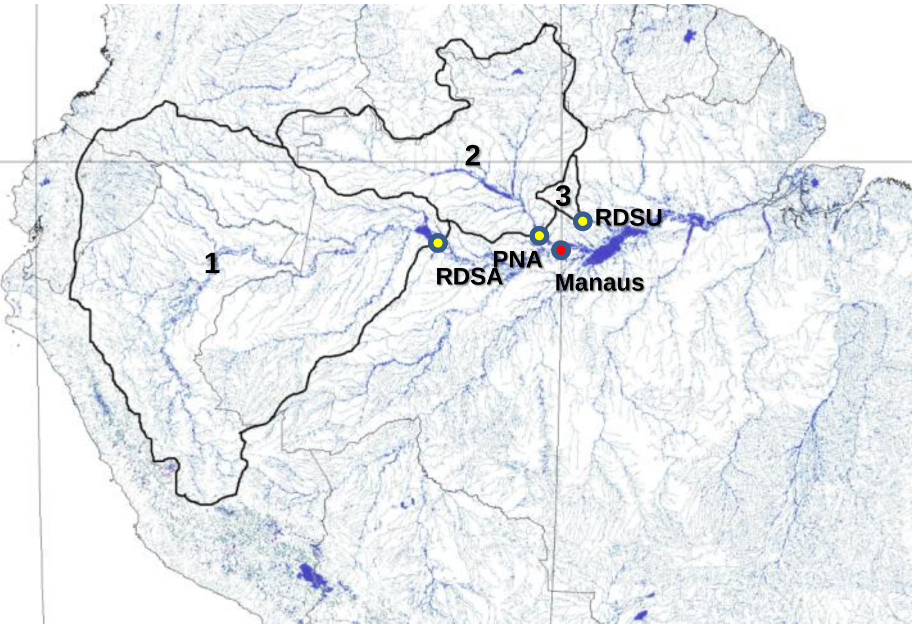
To study the relationship between diameter growth and regional hydrological regime as well as sea surface temperature (SST) anomalies from the Equatorial Pacific and Tropical Atlantic oceans developing tree-ring chronologies of *M. acaciifolium* at three different hydrological basins in the Central Amazon region

- Determination of tree age and radial increment rates of a population at each site
- Construction of tree-ring chronologies for each site
- Climate-growth relationships at each site

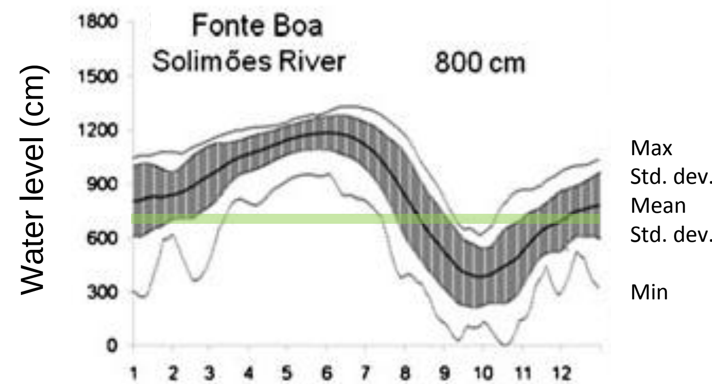
Study regions



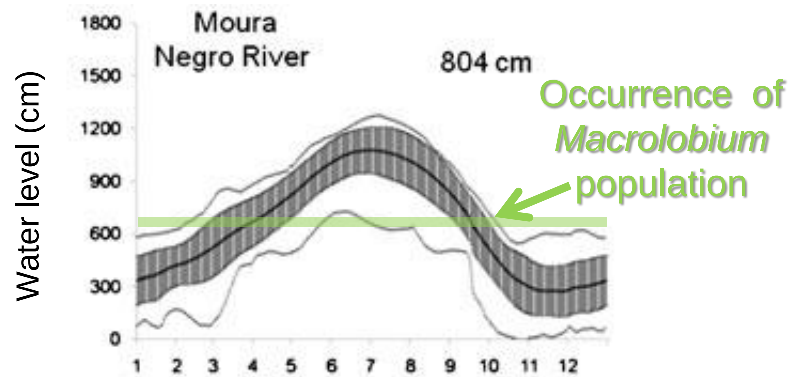
Hydrological regime at study regions



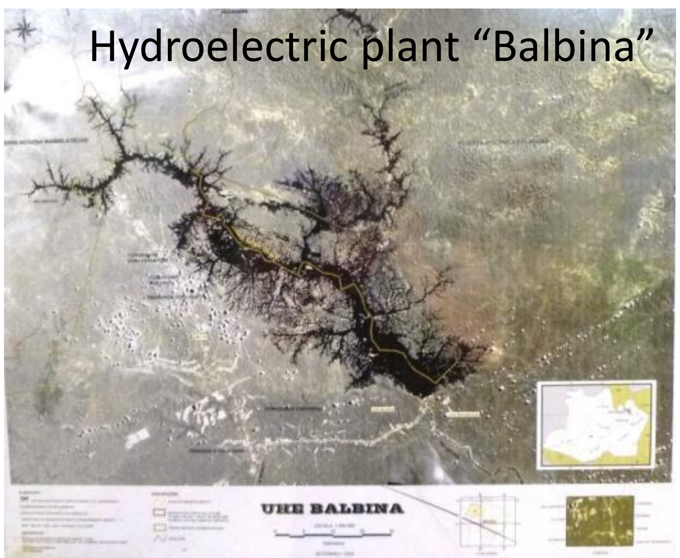
1 - RDSA

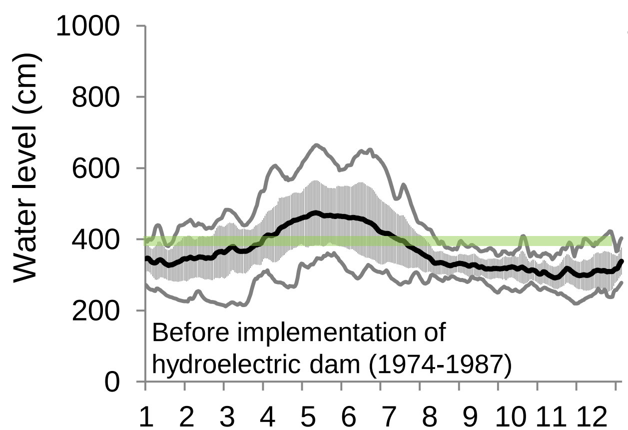


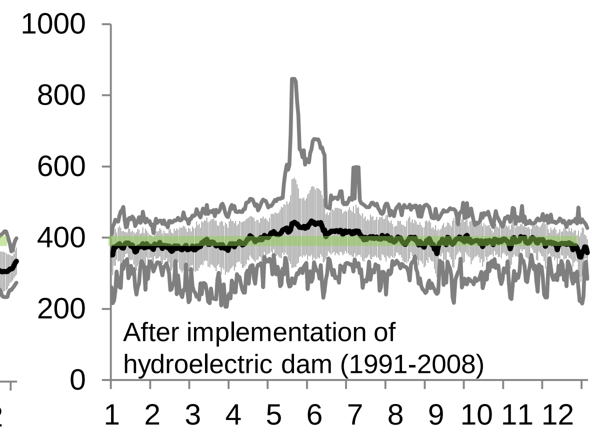
2 - PNA



3 - RDSU







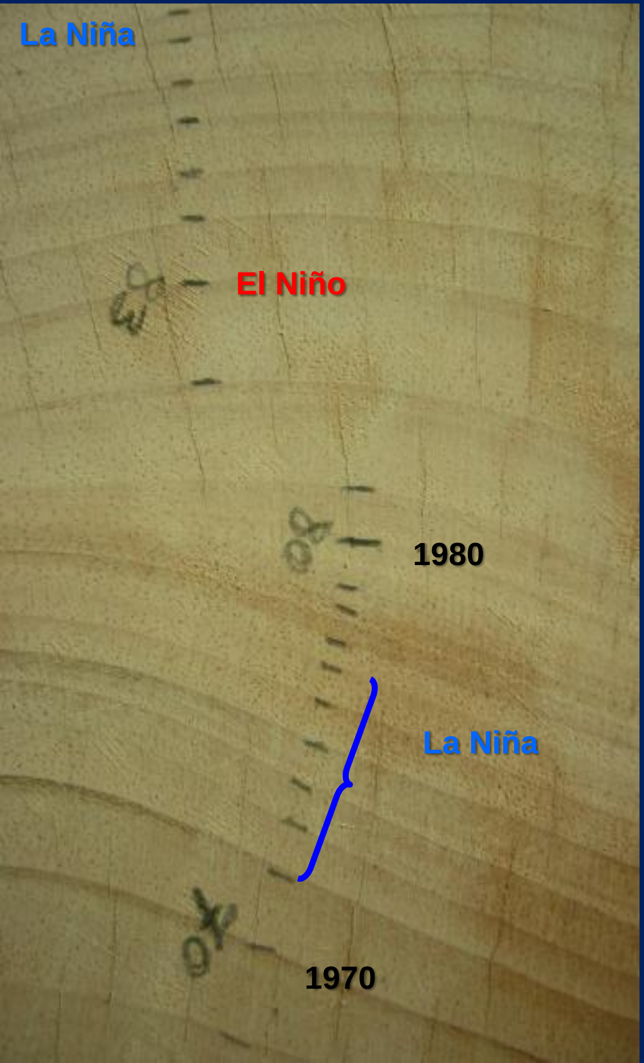
Data: ANA

Material and methods – field work

20 emergent trees in each floodplain forest at low elevations (diameter >40 cm)

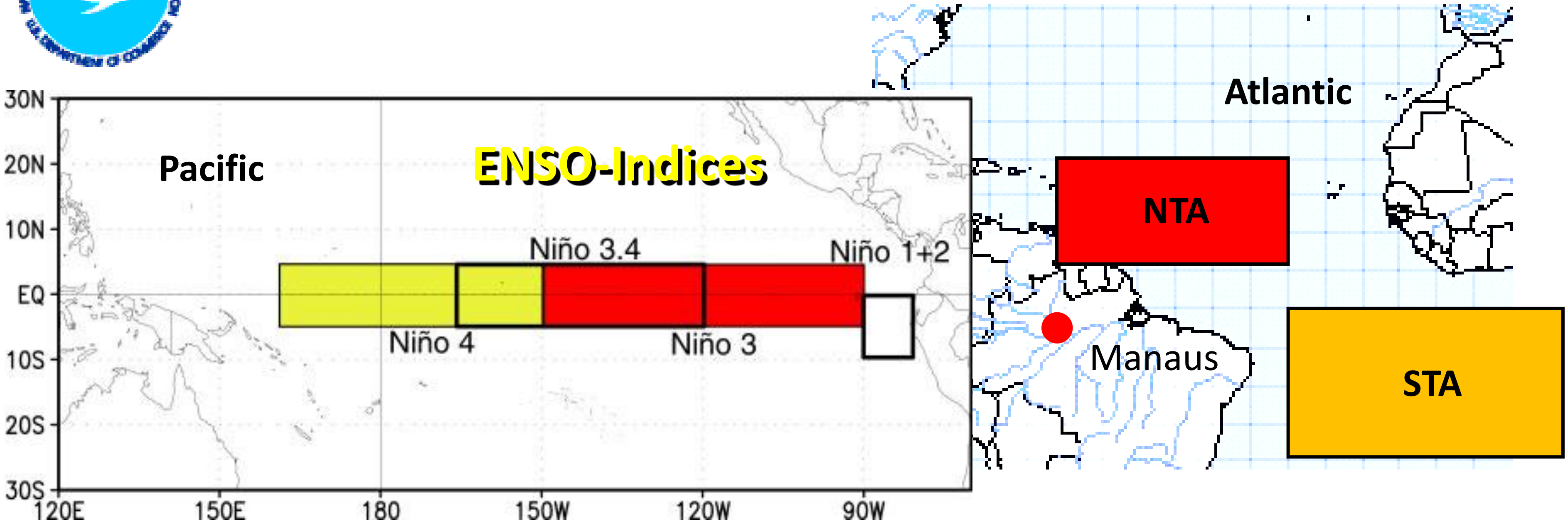
- Measuring of:
  - DBH (diameter at breast height)
  - Flood-height
- Sampling of core at DBH to determine tree age and radial increment

Material and methods – Dendrochronological analyses



- Tree-ring analysis (wood anatomical structure, false tree rings)
- Ring-width measurement (nearest 0.01 mm) with digital measurement device
- Cross-dating (optical and statistical synchronisation of ring-width series)
- Indexation of ring-width curves with of 5-yr running mean (elimination of growth trends)
- Comparison with regional hydrological regime (flood-pulse)
- Relationship with sea surface temperature (SST) anomalies from Equatorial Pacific and Tropical Atlantic oceans for a period of 24 months (current and previous year)

Data - Sea surface temperature (SST) anomalies



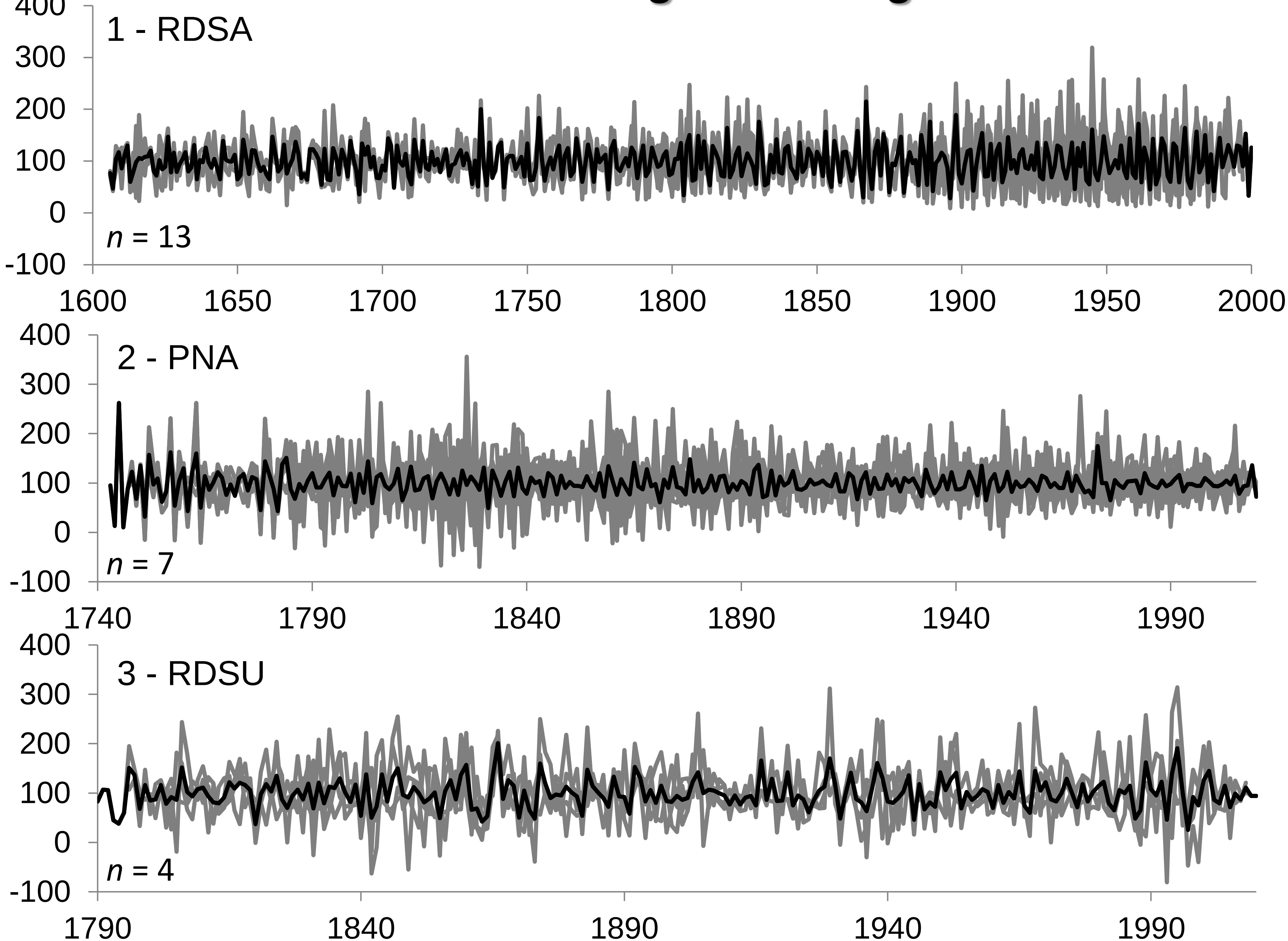
	Latitude	Longitude	Data since
El Niño region 1 + 2	0°-10° S	90°-80° W	1950
El Niño region 3	5°N-5°S	150°W-90°W	1950
El Niño region 3.4	5°N-5°S	170°W-120°W	1950
El Niño region 4	5°-5°S	160°E-150°W	1950
Tropical North Atlantic (NTA)	5°-20°N	60°-30°W	1950
Southern Tropical Atlantic (STA)	0°-20°S	30°W-10°E	1950

Data of monthly SST anomalies are obtained from the Climate Prediction Center of the National Weather Service (NOAA) available on http://www.cpc.ncep.gov/data/indices.

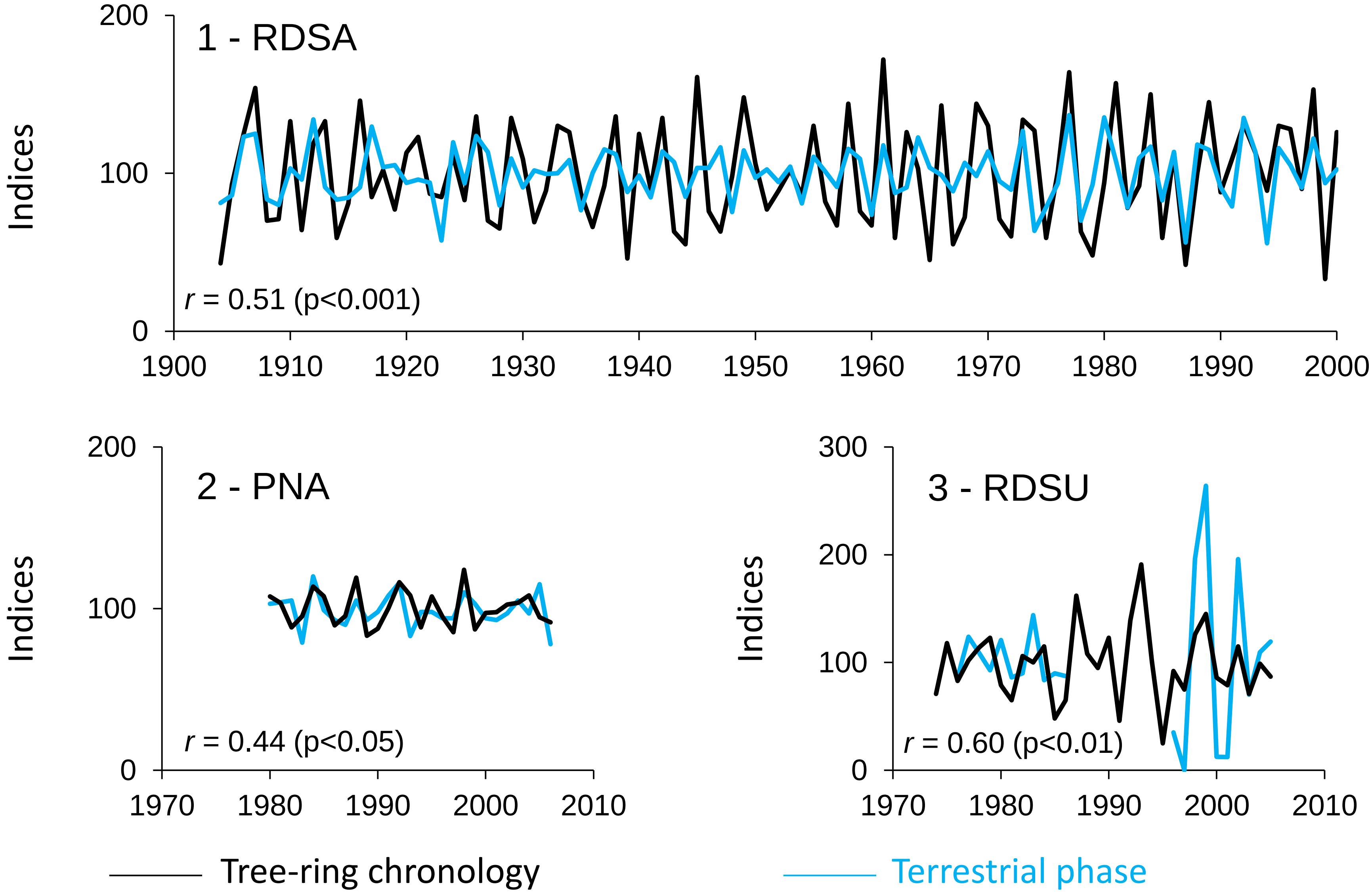
Results – key parameter of analysed populations

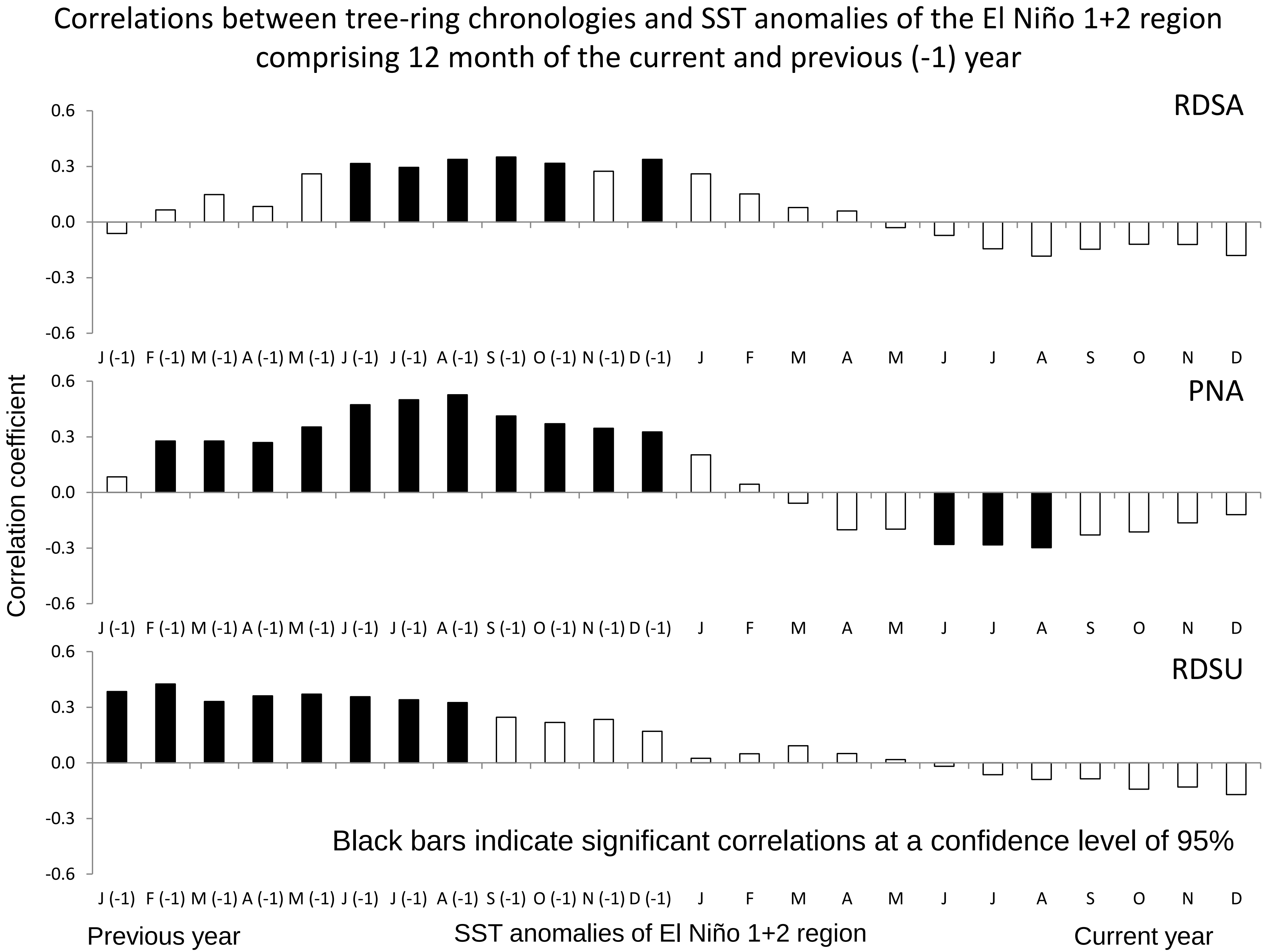
n = 20 at each study site	RDSA	PNA	RDSU
Mean duration of terrestrial phase (days)	183	231	222
Mean diameter (cm)	76 (49-108)	86 (73-106)	97 (74-137)
Mean age (years)	268±118	275±88	268±88
Maximum age (years)	403	418	443
Mean diameter increment (mm)	3.0±0.76	3.1 ± 0.35	3.8 ± 0.41

Results – Tree-ring chronologies

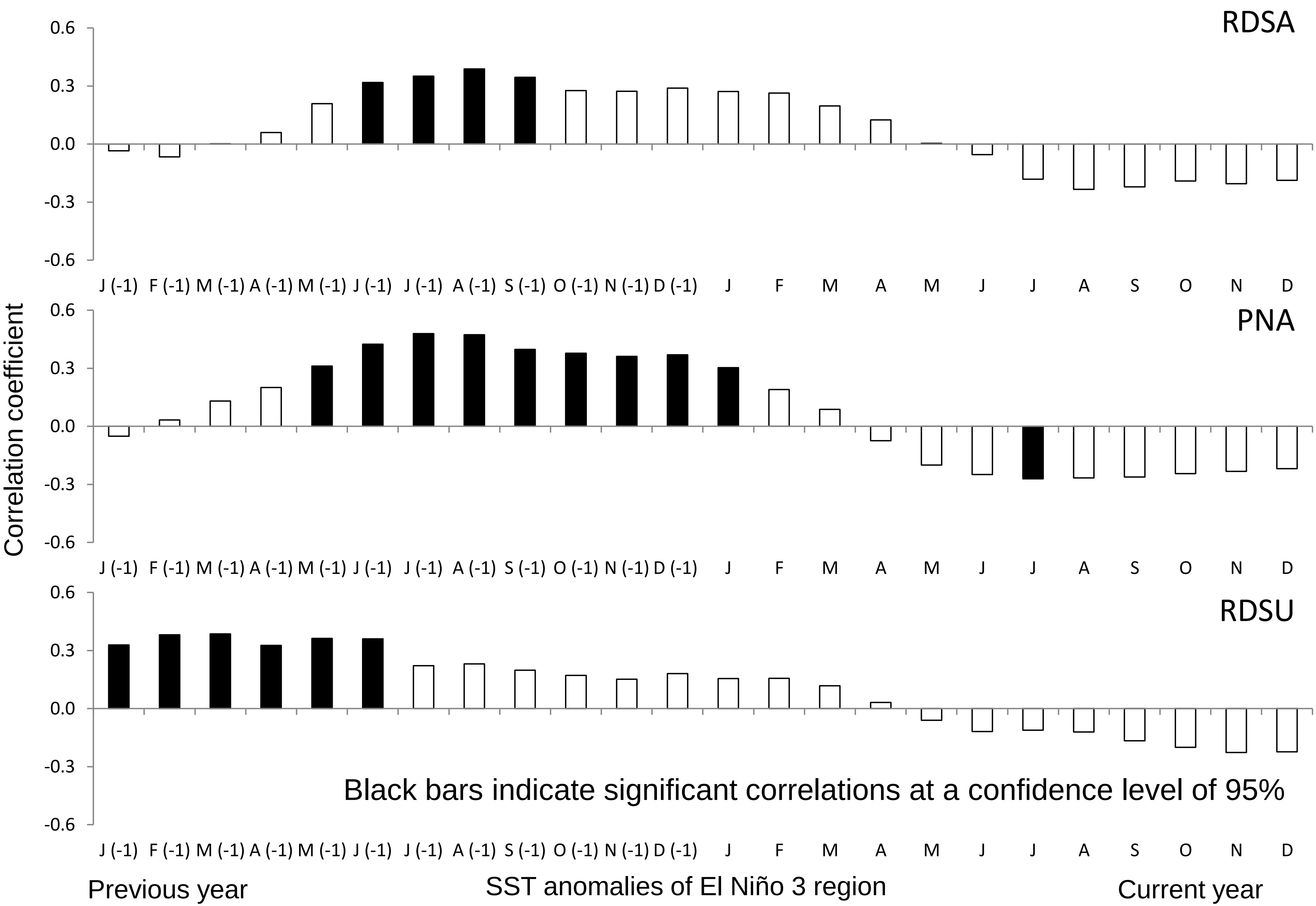


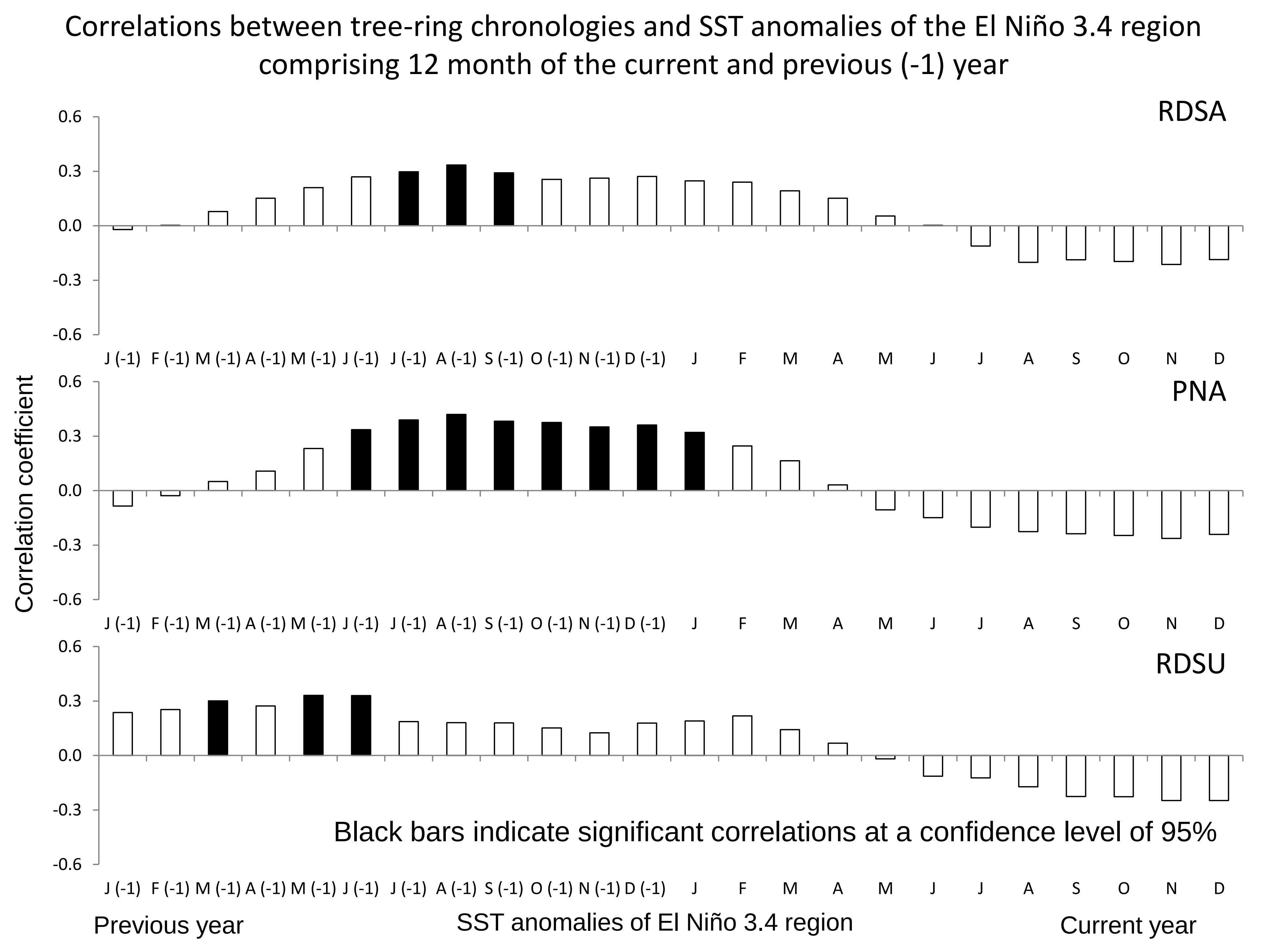
Results – Relationship between tree-ring chronology and length of terrestrial phase



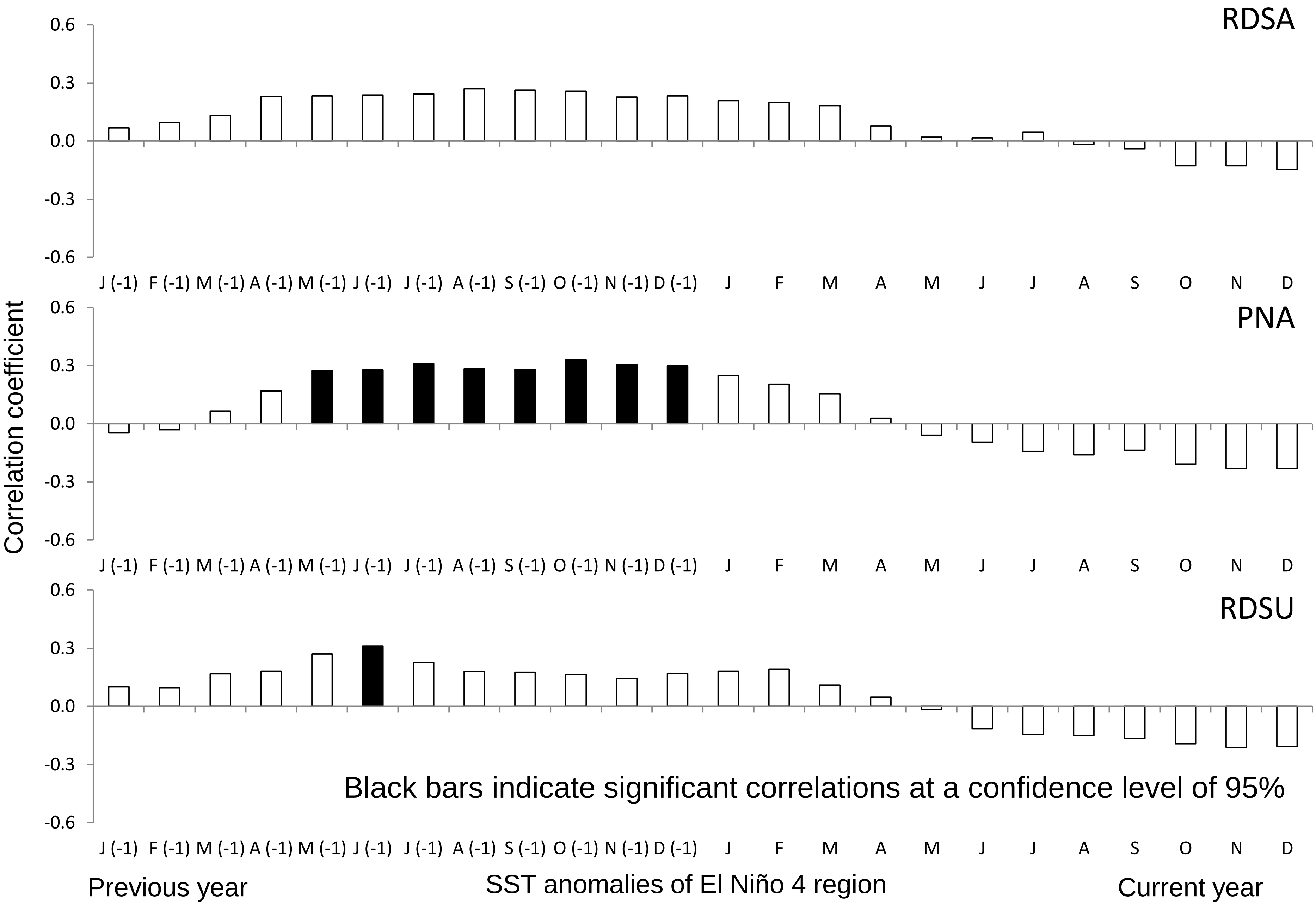

Correlations between tree-ring chronologies and SST anomalies of the El Niño 1+2 region comprising 12 month of the current and previous (-1) year
RDSA
PNA
RDSU
Correlation coefficient
0.6
0.3
0.0
-0.3
-0.6
J (-1) F (-1) M (-1) A (-1) M (-1) J (-1) J (-1) A (-1) S (-1) O (-1) N (-1) D (-1) J F M A M J J A S O N D
Black bars indicate significant correlations at a confidence level of 95%
Previous year
SST anomalies of El Niño 1+2 region
Current year

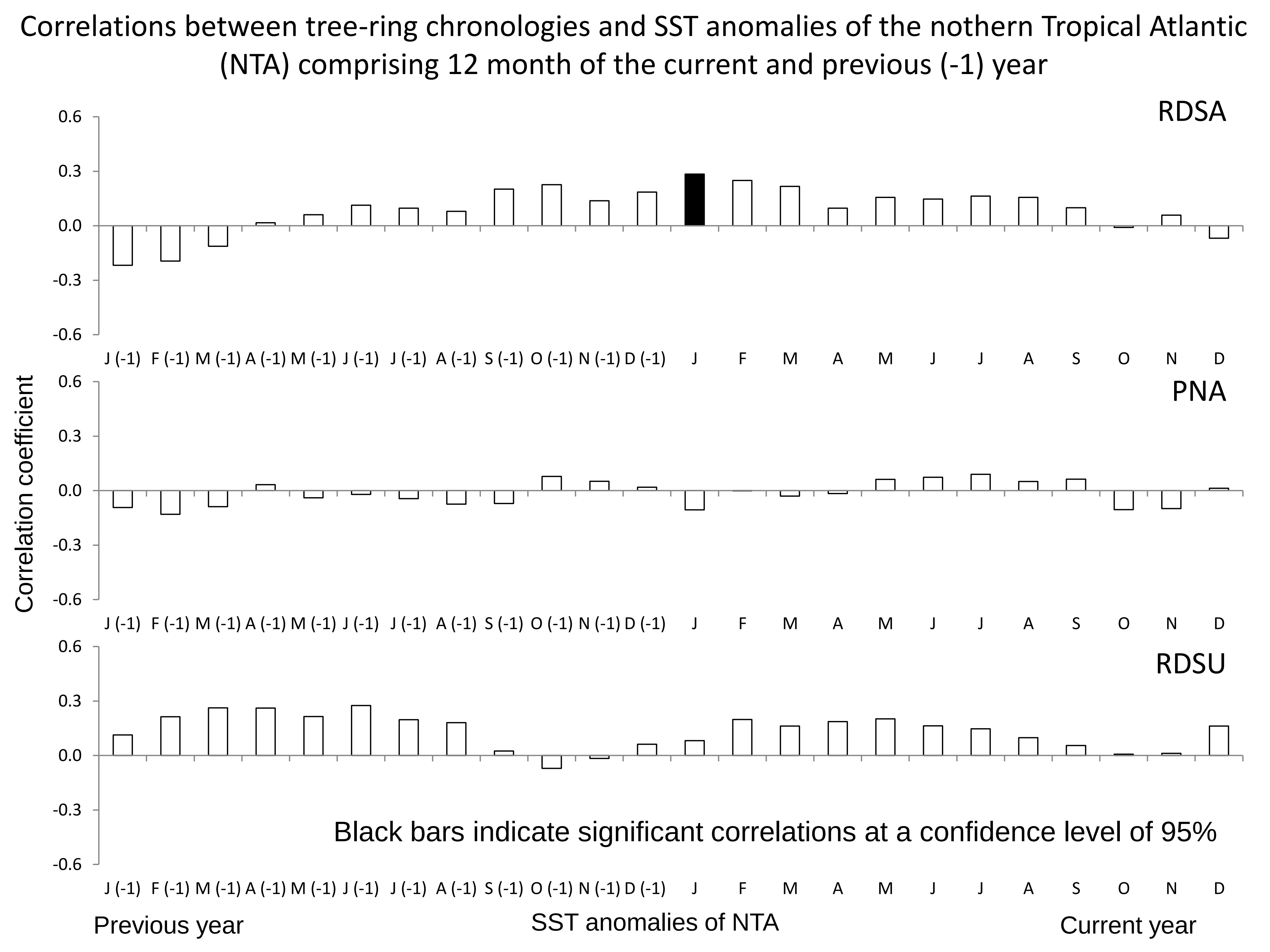
Correlations between tree-ring chronologies and SST anomalies of the El Niño 3 region comprising 12 month of the current and previous (-1) year



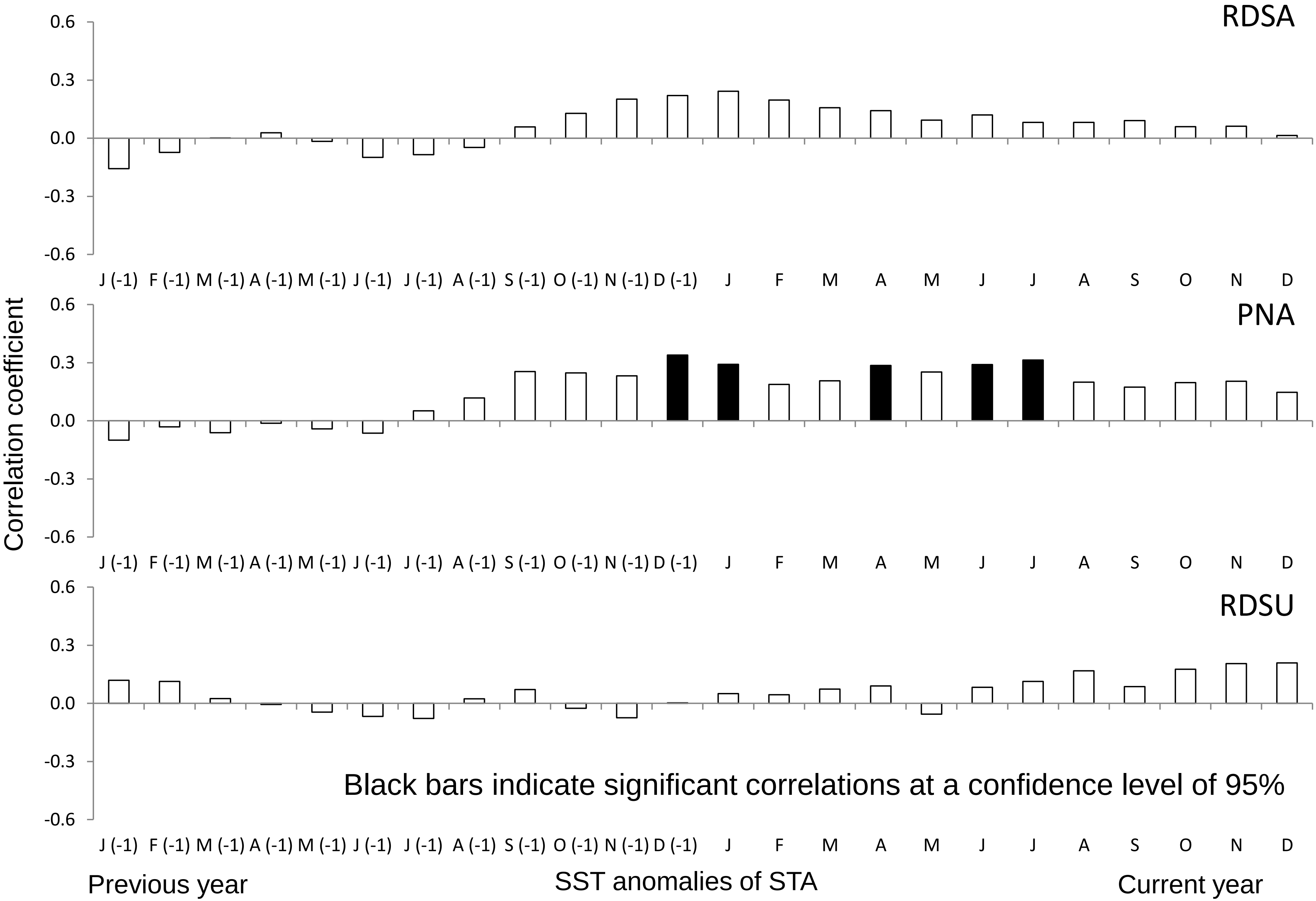

Correlations between tree-ring chronologies and SST anomalies of the El Niño 3.4 region
comprising 12 month of the current and previous (-1) year
RDSA
PNA
RDSU
Correlation coefficient
0.6
0.3
0.0
-0.3
-0.6
J (-1) F (-1) M (-1) A (-1) M (-1) J (-1) J (-1) A (-1) S (-1) O (-1) N (-1) D (-1) J F M A M J J A S O N D
Black bars indicate significant correlations at a confidence level of 95%
Previous year
SST anomalies of El Niño 3.4 region
Current year

Correlations between tree-ring chronologies and SST anomalies of the El Niño 4 region comprising 12 month of the current and previous (-1) year



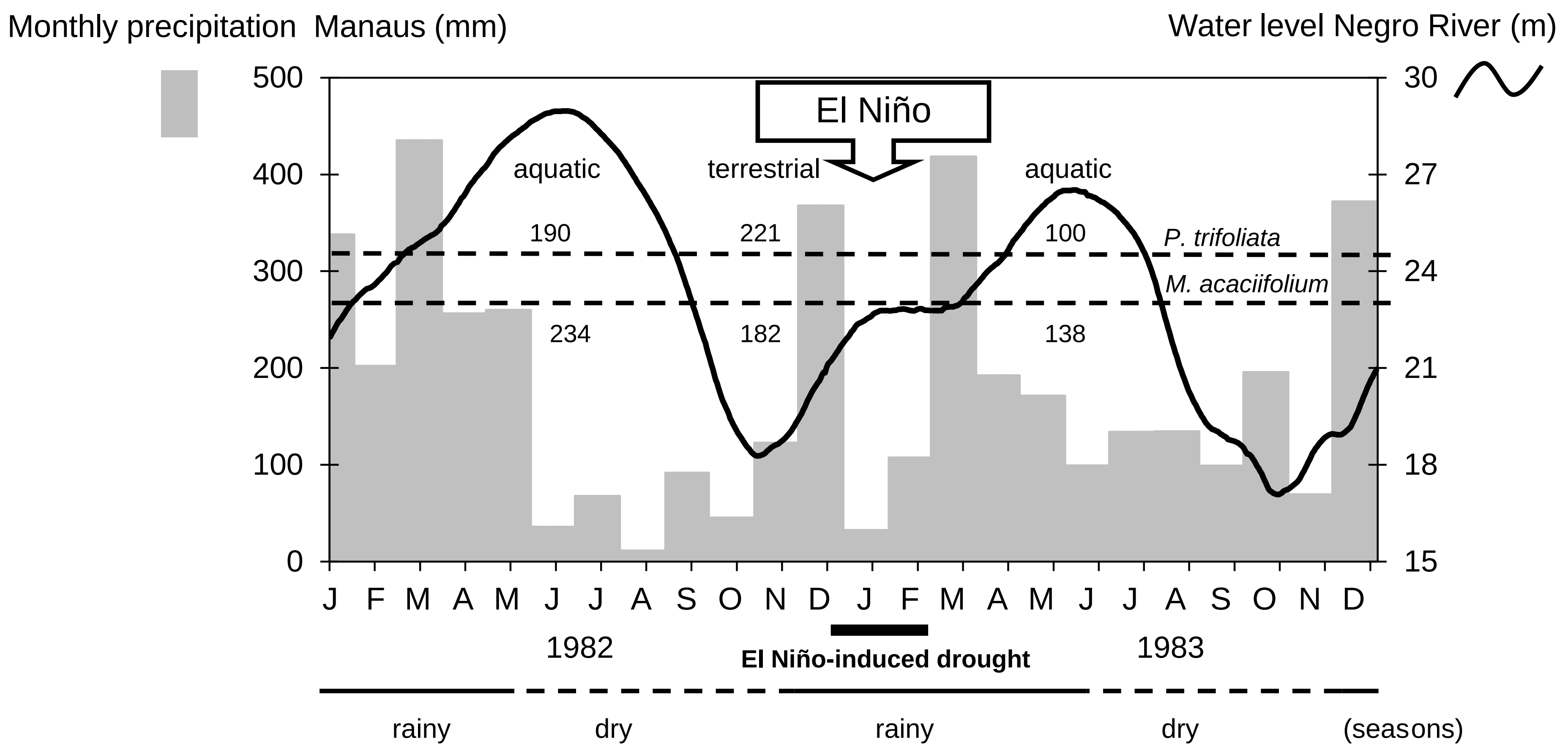

Correlations between tree-ring chronologies and SST anomalies of the nothern Tropical Atlantic (NTA) comprising 12 month of the current and previous (-1) year
RDSA
PNA
RDSU
Correlation coefficient
0.6
0.3
0.0
-0.3
-0.6
J (-1) F (-1) M (-1) A (-1) M (-1) J (-1) J (-1) A (-1) S (-1) O (-1) N (-1) D (-1) J F M A M J J A S O N D
Black bars indicate significant correlations at a confidence level of 95%
Previous year
SST anomalies of NTA
Current year

Correlations between tree-ring chronologies and SST anomalies of the southern Tropical Atlantic (STA) comprising 12 month of the current and previous (-1) year



Comparison of tree ring index between ENSO years (El Niño, La Niña) and other years

Ring-width index	El Niño years	Other years	T-value (p)	La Niña years	Other years	*T*-value (p)	Reference
M. acaciifolium (RDSA)	107.4	96.0	1.81 (<0.05)	93.0	102.9	-1.46 (ns)	Schöngart *et al*. (2005)
M. acaciifolium (PNA)	101.8	96.7	1.17 (ns)	92.8	100.9	-1.78 (ns)	This study
M. acaciifolium (RDSU)	107.1	95.7	1.29 (ns)	95.9	101.3	-0.56 (ns)	This study
Piranhea trifoliata	104.2	97.2	4.26 (<0.01)	94.9	100.6	-1.13 (ns)	Schöngart *et al*. (2004)



Conclusions

- Tree growth of *M. acaciifolium* in the Central Amazonian floodplain forests is triggered by the flood-pulse and also SST anomalies.

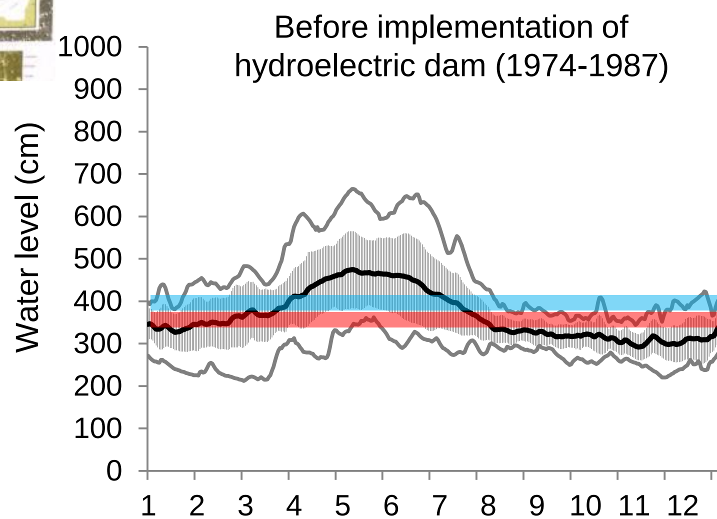
- Depending on the size and geographical location of the sub-basins the tree species in the floodplains present varying relationships with SST anomalies from the Equatorial Pacific and Tropical Atlantic.

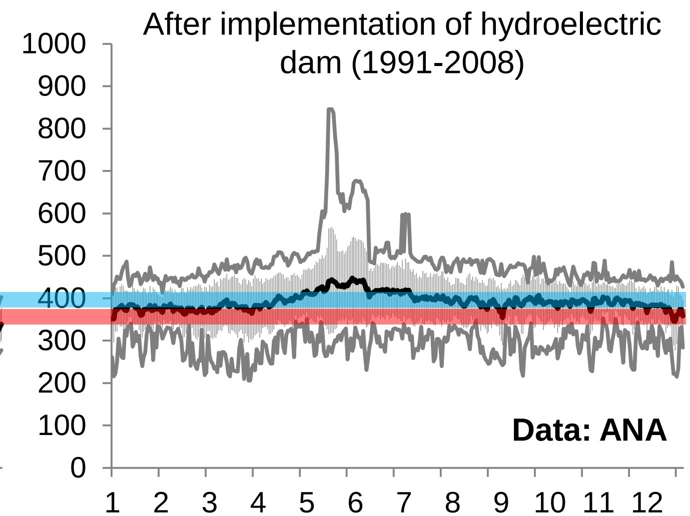
- SST anomalies from the Equatorial Pacific are more evident than those from the Tropical Atlantic. However, no significant difference can be found comparing ENSO years (El Niño, La Niña events) with other years. This can be traced back to the occurrence of this species at low topographies in the floodplains which are already flooded or water-logged when the ENSO signals appear.

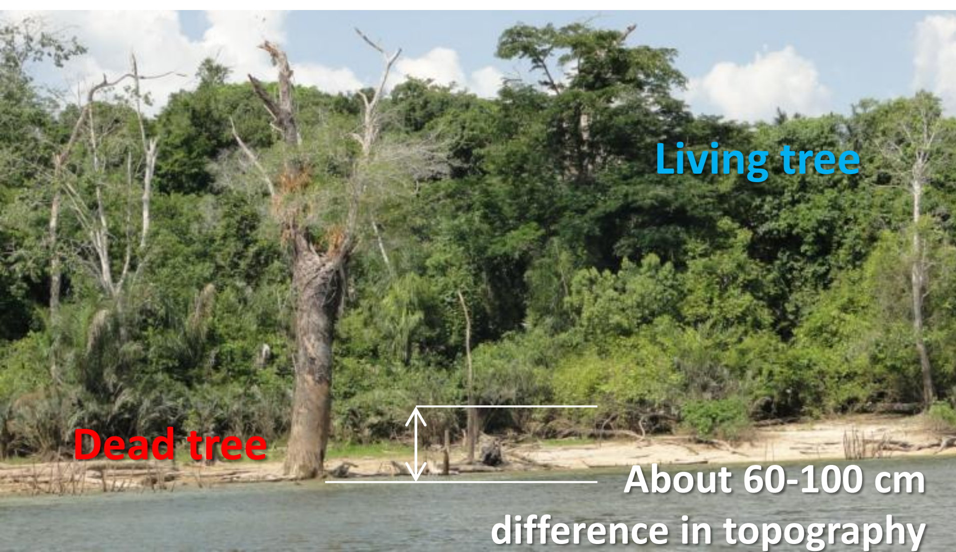
- *Macrolobium* as a huge potential for climate reconstruction in the Amazon basin due to its large geographical distribution, high tree ages, distinct annual tree rings with few anomalies.

Evaluation of changes in the flood pulse caused by the implementation of the hydroelectric plant "Balbina" on tree growth in flood plain forests of the Uatumã River

Dating of dead *Macrolobium* trees by the established tree-ring chronology for the RDSU







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