From: From <evag@ifor.krasnoyarsk.su>
To: k.briffa@uea.ac.uk
Subject: No Subject
Date: Sat, 17 Oct 1998 10:09:48 +0400 (MSD)

trwcrn.rwm
Tree-ring widths (TRW) chronology:

Ident., No.	Trees, No.	Inent. N (trees)
1)	118	all living and dead 2209-years chronology
2)*	4	MAY,925,927,928, CHA044
3)*	1	CHA-H1
4)*	1	MAY702
5)*	1	NOV001
6)*	1	CHA-H6
7)*	1	NOV078
8)*	1	NOV-A02
9)*	1	CHA005
10)*	1	NOV029
11)*	5	CHA060,012,009,017,001

* - calibrated radiocarbon age

1) all living and dead 2209-years chronology
2209=N -212=I 1) 118 samples -5(13F6.0)~

23000 24000 42000 14000 27000 21000 13000 28000 20000 30000 38000 65000 58000
54000 66000 65000 16000 55000 46000 56000 53000 68000 29000 21000 48000 15000
29000 25000 32000 22000 31000 29000 18000 27000 53000 41000 35000 47000 66000
89000 52000 28000 34000 39000 33000 25000 28000 36000 32000 43000 47000 63000
49000 49000 50000 56000 40000 42000 46500 65000 28000 30500 55000 40500 44500
24500 24500 50500 6500 22500 39000 37000 54000 30000 47500 41000 23000 52000
56000 46000 35000 44000 71000 53000 73000 87000 64000 53000 44000 52000 48500
41000 45000 50000 61500 42000 48000 58500 44000 50000 78500 62500 46000 73500
45000 90500 64000 99000 64000 53500 90000 80000 45000 64000 87500 37000 55500
74500 88500 61500 58500 66000 88500 76500116500 84500 88500 44500 70500 26000
46000 51000 15000 42000 55000 81000 76000 67000 61000 34000 28000 24000 54000
34000 46000 27000 37000 33000 53000 56000 51000 52000 52000 64000 58000 39000
48000 35000 51000 49000 37000 43000 55000 32000 39000 57000 34000 29000 45000
49000 11000 33000 45000 36000 36000 32000 32000 41000 43000 30000 15000 43000
16000 23000 50000 46000 30000 23000 10000 38000 26000 28000 26000 19000 21000
27000 27000 18000 11000 20000 12000 16000 12000 24000 16000 20000 22000 11000
28000 22017 28065 21856 12882 14098 22014 25112 35140 14161 1219 19996 13315
13517 10704 15207 19702 19134 16446 3039 17992 25257 15901 23191 23203 1000
27479 15919 11296 19473 10860 19530 15335 26299 9411 5291 31041 12069 4539
27818 7493 10411 7919 10605 9945 17887 14974 13111 12423 8397 3226 22759
13618 10784 12556 15426 18972 22968 16454 17000 19389 10860 16583 17472 16410
29186 14931 19302 13833 21143 7466 21325 6210 18981 19848 12337 19850 26400
18285 20246 31337 23294 13450 17941 34285 38733 27586 32435 25338 21392 32594
28435 35517 40156 18777 23268 28298 30149 19095 25926 42906 39255 34173 22065
29118 17902 27172 38119 37347 25090 6500 34301 26855 5941 38507 35826 14832
22651 22197 36162 32763 24581 31479 25689 34191 36718 42915 26990 26878 43824
34625 32174 57385 51360 55039 55054 37906 18168 34882 34761 41604 12657 13161
16197 31916 24132 21855 30630 36385 30745 24153 40741 30006 33620 26577 33367
26186 38229 29349 52789 47438 35978 47997 17548 51853 46033 28743 12085 27608
34020 17925 32088 34944 33101 4081 30879 17446 15978 28435 18335 35868 22251
21528 34309 2773 6384 9014 19779 23547 26701 11470 22866 13911 18834 21164
20124 10157 23354 23804 25057 14675 20483 14798 8351 21108 8335 10598 17069
23246 30087 13235 14254 15864 2164 9347 19932 7031 20000 12181 12757 3687
20469 14247 10620 8746 28494 27058 13708 17022 20529 15788 28236 10115 19326
18135 23963 15390 7162 17279 32849 31069 16989 24420 13018 25653 14928 27235
23283 18571 29915 27266 33951 24041 47844 47675 44769 46163 46952 19771 23019
38639 34723 33079 33469 21124 29181 20774 26725 29081 34518 17204 28940 37208
32775 58976 10594 42606 48863 36946 32213 41849 27432 39733 16259 35834 34341
62407 42028 44445 35859 29798 36765 23502 18434 20274 45121 21526 24560 31877
34800 38334 20428 8781 37238 19716 7604 19439 30829 32487 20464 29784 31750
31928 23184 25438 32931 32310 39233 32585 27749 35201 28107 26776 28485 12709

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15027 33760 11325 31204 31662 30223 36039 40012 25509  8772 19157 35361 17630
29531 29212 31187 24300  4562 21532 31632 10503 29400 31222 25730 28030 26917
 4688 12078 26173 26710  9482 10246 28444 24912 24827 28289 17974 20492  7018
21514 34516 33310 36256 44727 45114 28650 23419 33516 11778 43465 20220 25175
23955 21139 26410 28461 35890 14156 38692  4772 28678 23572 30616 34457 38619
34856 26276 23577 22361 19873 37267 34284 15317 24184 48975 37987 31429 35273
18054 43859 16763 36500 38608 21093 31207 32854 30413 13416 33594 19433 30082
19389 15758 27999 39612 44671 37417 39594 37086 28268 12974 30605 29249 37753
33663 11363 36143 21306 46288 16113 30107 18372 38803 28205 29546 14434 46587
26678 41108 43586 37374 30224 28331 31544 30825 32838 26578 33066 20678 36675
25315 28839 26035 37685 30226 24501 28528 33510 51162 13581 21995 29417 32967
23924 14920 20805 20512 25141 25598 25703 18462 17040 21751 16046 21996 18069
20342 35014 28332 35165 35442 33871 33850 27816 23579 31256 28535 12889 22552
32800 23463 18168 23192 13514 12918 18007  9645 12635 13072 21150 14148 23932
 9018 12498 18710 16600 21805  7213 22851 15759 15814 15200 23895 13963 25953
17684 20987 27162 17110 30437 32360 29106 16759 32655 33595 19709 33258  6052
26222 17722 34334 39148 11789 42244 36821  1797  4814 13594 26070 12939  6916
23229  4446 10246  7540 13714 22299 20476 19088 13476 18404  3900 19064 32509
18843 22990 28820 26310 43229 39537 31840 28824 37437 49123 36642 26598 35534
22271 52498 57130 24689 41995 27017 30140 37749 57837 25520 46108 54090 49658
45089 24465 57550 46258 47711 57767 40029 55404 32947 54873 46590 58746 34993
54879 61748 27910 32067 31872  7046 36295 37264 37901 26789 30777 43434 37700
29501 43272 44470 25658 40156 29332 20015 29524 36727 36948 31928 29953 19737
41447 12328 39805 22439 26927 23239 39549  7098 15840 20929 23772 15353 28007
22955 21463 24290  8873 17708 27278 21769 28332 18403 23837 14195 28935 20013
26065 23293 17814 25742 24984 18238 28932 31088  8914 36008 13544 29850 32271
43589 40051 23543 16407 22265 30511 16002 27839 32794 22413 10217 39905 27802
20776 26814 33852 34807 22456 20637  4815 21855 37894 25930  1818  6596 23364
29193 17672 24675 23853  5993  1193 29426 28114 14413 24810 26160 25576 11685
23679 28930 27702 26763 11733 36410 22337 39023 39591  5069 35118 21200 20396
 8735 31218 18536 17272 31415  7196 22859 27298 25531 19425 10399 23570 12696
 8352 15032 18992 14626 15444 18765 19280 16423 13234 21223 18692 21367 30821
15418 19031 27041 18009 33393 21949  9369 17344 27753 26670 14494 37218 36654
23904 16576 15594 29869  8638 29094 10394 19081 16729 39305 24061 16216 18959
35626 30247 34454 27558 23983 33922 24609 29676 30460 18236 15331 13953 11694
24988 14321 19124 20936  4785 26340 29808 33539 20732 42390 43144 48471 35663
44234 58963 18491 38119 42704 34253 30509 45563 28242 40627 26959 19787 30831
17054 29454 14203 11907 23517 12541 22802 33360 23233 45317 36219 25209 18721
16921 19920 27720 26663 34059 49228 40157 24209 39570 35193 26808  7585 20873
18554 23309 30212 16812 20517 23079 11592 18401 30493 24638 26735 13995 36813
48920 40278 28927 47026 31865 20986 39037 34740 33252 38718 22690 19176 35577
 2580 11231 25408 24867 15897 22064 19354 25936 36895 19666 28904 37001 44624
50833 37233 36536 10932 23639 22069 37132 32183 18924 14646 39770 48286 41257
61823 38685 48732 17881 14121 42920 48009 43173 31532 31883 41708 27496 35394
21644 60068 59735 39445 37137 52625 62747 31373 22840 37017  4124 18122 16422
23362 11732 27172 29596 28005 12863 26527 33936 40401 25001 19088 35345 14541
41458 29285 35867 35215 41416 40820 28276 29922 54348 48932 45189 27202 40680
22536 12274 11911 15438 31847 15518 32623 16994  6958 28295 12391 20124 15200
 3872 19066  6154 16046 21994  9883 13803 18203  7738 24826 25802 41665 39420
10082 23138 36672 23293 15780 30997 32336 56083 52873 12327 57182 35586 39138
25576 20923 11457 19626 15096 25439 32855 38655 44821 46423 37342 52026 68594
56632 41091 56548 10213 47772 55599 47835 50947 38083 45772 33426 42712 34339
15275 23257 18921 15782 25821 22725 11567 21104 29535 19800 39800 27438 11278
22770 28603 19851 33342 52927 32471 27769 46087 43229 17067 37574 15950 24974
27458 24971 20471 11634 36141 41870 25253 34853 36198 40878 37941 32716 14577
17551 29037 15527 27155 30336 16565 13659 17427 17985 15333 28674 31912 33061
21280 39694 16494 20841 27794 13885  2565 19240 20764 14003 15234 17235 32861
32447 37592 43724 40821 49210 38946 15957 19545 27864 13492 27344 42029 37682
27146 11498 40925 31045 29398 27439 38022 32927 49087 49043 49449 35359 36962
24378 36666 31602 50729 24814 62188 46992 57665  8994 31133 41369 49188 49729
34232 51923 44904 33188 44207 52862 39145 33680 38792 39171 26952 39862 49060
53489 47236 46363 57434 40117 62997 50508 35887 11315 40273 26840 11259 22813
29683 23477  9655 45503 48217 39129 57846 36584 54067 27905 34950 53044 49242
 6346 26682 60001 42356 39453 38095 28854 32367 43999 43182 76475  9980 26734
37163 32521 56584 52948 47244 45685 57133 54086 22626 57892 25345 31469 14592
13839 30265 43116 32693 39278 17673 47578 16717 40561 32427 46271 70501 45415
38845 32493 52634 28619 43829 41729 49462 16162 21579 36292 22750 23572 28727
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 28574 14242 17157 26778 36497 29876 10106 36171 30465 36840 30557 36331 47945
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 24451  7718 29199 25351 12890 36031 18695 18575 27989 21409 22320 26659 23255
  6836 11240 14685 10076 20696 16281  8961 25734 18756 22537  6889 12456 22313
 13306 15308 15505 17235 10645 30885  6203 18640 26682 10589 16431 28376 17826
  6304 17627 27904 30156 32025 27955 46022 22728 14528 20370 26056 21896 28926
 34096 22612 41428 48536 56094 40957 53286 50459 32060 44338 44482 41154 13807
 11326  3297 11426  7576 26075 16469 17875 40687 38680 42653  4189 15048 13883
 31267 30324  8534 19704 27760 28691 32492 52563 38623 37560 27673 33206 25809
 42342 53294 36139 40726 48492 45376 34414 24610 35000 20567 34436 15964 36710
 32282 31438 38330 35359 34186 40505 38729 11085 23307 29585 45856 30278 35038
 28031 61066 71654 75101 44821 39539  5015 23301 32435 16773 42902 38394 35250
 38140 50031 34522 47063 39538 37625 44671 19419 26965 49777 39253 37798 39380
 60435 32630 31485 47937 32777 43802 30784 47142 37691 30497 28847 43470 41648
 37101 40726 16574 33858 35558 42346 32535 35480 39239 19817 17962 40171 19816
 37158 48680 26345 38391 56809 20909 43281 26427 28300 10520 11234 37255 28329
 33247 37494 15393 17142 30050 24568 30868 25822 26042 29408  8962 34690 23488
 22172 23157 30993 11397 34005 23622 34032 29107 33019 39124 10729 45917 29799
 21484 11154 19750 10963 25793 29698 16148 30739 40478 28837 11405 28409 42056
 28589 36331 30851 14922 29795 35541 30907 29046 30087 31996 24960 10172 22222
 47286 32457 29091 29240 24873 14528 23808 17266 29730 13252 16810 11011 21315
 17198 20894 28959 19943 11296 13434  9382 17430 13696 25412 27865 23093  7885
 13852 25494 22304  5032 21311 21766 32202 24233 32537 34665 21149  4541 17197
 21595 10014 17248 23052  9932 26619 24058 31319 24079 32681 26048 23140 12880
 14733 33067 20015 18721 29651 26843 21754 30090 35288 33385 22382 30894 14728
 26071 25792 23771 32227 27265 24298 26117 10108 33626 11545 13202 32819 20454
 20939 12584 32712 11446 29923 24529 21244  2000 29325 10270 18780 14979 29992
 17247 22835 19369 36933 31079 14026 18997 22716 11568 16741 26364 20229 24592
 20948 24879 29982 19867 19478 31888 17419 22989 28106 21737  4936 12040 15016
 18961  5235 18167 24849 18367 27222 23919 14306 20386 33748 14910 22044 19999
 22210 27410 29148 38037 12635 33100 44025 36026  9169 22049 10997 26327 23360
 15028 14360 25476 19163 18067 32330 14489 31136 28690 24305 13269 27592 35264
 13291 29446 26123 19894 18688 21564 28586 40368 33895 36981 22843 28835 25897
 31387 15225 17297 21077 21867 12440 14398 19166 13061 11008 20385 14993  7768
 23283 20160 17045 26833 22701 26387 23256 27723 21111 32775  7176 14600  6560
  4525 15770 14353  9099 15162 24470 36183 31308 31823 19556 30681 26487 20038
 29204 35066 17925 36458 32013 32462  8064 28601 25226 27308 24907 17930 24206
 28880 26326 46087 11387 42678 40037 31112 25112 32453 36598 19521 23389 36012
 27063 36490 35092 22232  9785 37702 38043 30604 35077 43926 47220 41646 34102
 26212 39082 25302 17634 23170 24958 41060 25989 17794  6167 29321 25024 31646
 23853 40694 40252 44804 27458 47022 24027 27829 24725  8566 25765 37958 26832
 44567 34530 16105 27248 26055 34928 27453 39903 34871 26434 37469 24709 39487
 30218 22976 28462 41952 49108 25851 32901 22448 18331 29066 10315 28571 29070
 32664 32870 28318 40625 10357 35280 25849 23649 19720  8395 12389 17508 13577
 16774 11858 18736  6479 12156 19628 23655 22221 18061  6689 17556 20901 29764
 30796  7261 32870 14236  5948 23671 27600 21503 20273 15348 15678 27342 22366
 27979 21643 19756 20343 27883 18753 21325  9415 21976 11436 37690 27274 28101
 25355 33940 30386 34422 25320 52582 45733 36687 35368 37902 42693 22233 16666
 45695  7105 21338 22127 26892 13168 12589 29874 19946 38389 42508 38118 44281
 34808 34262 42548 20033 17134 18463 34504 32362 18734 22133 37281 30119 18316
 28807 26584 45163 45681 23834 13205 14869 29485 27289 22233 23254 13266 19679
 17399 43549 17745 22862 19067 10631 18321 26515 32895 29419 28948 38780 37180
 30926 21697 33762 31089 41763 25857 40686 14920 39838 35513 36599 27497 43523
 38081 35011 32143 40349 36135 43614 51856 50396 67195 57225 61241 41440 65260
 48097 28219 48738 24261 40273 29658 36309 51236 32544 40954 36983 33193 27788
 32247 29070 28358 30658 23016 35060 22024 25796 37168 21417 28881 28177 23317
 24240 15012 13238 22566 26812 17797 23989 38457 13285 22011 26412 25138 40011
 18164 32288 21720 33763  9829 29992 21171 21000 10000 24000 12000 19000

2) MAY,925,927,928, CHA044
     296=N    -670=I 2) 4 samples (MAY925,927,928, CHA044)        -5(13F6.0)~
 42000 76000 35000 37000 35000 27000 47000 24000 95000105000128000 94000102000
 51000 37000 26000 38000 30000 35000 20000 37000 19000 16000 39000 50000 44000
 78000 44000 69000 79000 66000 31000 55000 32000 34000 17000 51000 22750 26000
 55000 55250 43500 37750 28250 61250 33750 55500 28750 51750 38500 42000 22250
 39250 46750 41750 32500 39250 23000 34000 15000 22750  3250  9250 21000 24250
 15250 26500 13250 15500 33750 50750 27500  9750 48000 67500 71500 70500 54500
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 59000 54500 44750 31000 23250 42250 26250 44750 54750 56000 44750105500 44000
 33250 43250 30750 47250 40750 34000 33750 50750 59250 43500 72000 42000 35250
 42500 37500 47750 51000 84750 47000 73000 28500 59000 56750 46000 58000 28000
 23500 16000 13500 25500 27000 49500 31500 58000 80000 83000 73000 35500 74750
 43750 16750 12000 43000 27750 24750 26250 45250 43250 35250 38000 49500 35000
 14250 41000 44000 36500 39000 16750 54750 60250 65500 54250 36750 57250 63778
 58250 88583 83250 72250 97563117313 75875 75750 76250 38000 85563 82938 92500
 77313 98125 28250 33313 51688 42063 73438 49938 92375 32563 65125 48188 55125
 51688 63250 48125 82688 57188 99813 74313 63750 85625 39063 58563 87750 77438
 19063 79563 58750 35063 47750 36188 56750 63125 65938 49917 91833 41833 60833
 55917 94083 58083 66417 84167 84250115167102750103417 52583 72333 52000 86917
 92167 58167 37750 41583 43000 40333 65417 43750 58667 18667 34250 52667 77583
 46917 48417 37583 54500 45833 64417 41000 28167 44417 39000 33500 23111  7167
 27667 40000 14500 13833 34500 20667 28833 35333 36000 16167 29667 32667 28500
 23167 32833 33667 21167 29500 18167 23500 29333 23167 19167 18750 14750 12750
 27250 19500 19000 12250  8250 21000 24000  7000 21000 26000 28500 24000 18000
 10500 21000  9000 10000  7000  8000 16000  3000 13000  8000

 3) CHA-H1
     306=N   -1398=I 3) 1 sample (CHA-H1)                        -3(20F4.0)~
 710 520 595 790 500 760 775 425 640 410 295 115 295 405 335 305 245 575 465 365
11701070 710 630 430 315 615 640 625 540 365 310 755 295 665 550 460  90 565 735
 905 310 755 425 660 590 690 640 765 770 640 405 645 475 595 490 705 480 760 840
 375 415 675 650 650 390 770 935 815 465 660 705 980 645 595 920 715 280 490 400
 925 7501015 890 740 9201085 595 685 755 440 260 450 160 215 430 235 515 695 505
 300 605 395 530 120  60 420 500 480 260 510 485 420 515 765 475 395 675 265 475
 455 465 740 690 280 705 670 795 480 465 455 940 5551210 855 805 740 790  85 465
 405 340 615 735 280 115 510 685 610 165 280 500 765 760 960 685 715 385 300 555
 325 365 235 305  55 215 410 415 600  65 415 315 130  35 200 135 500 295 360 330
 510 415 755 765 490 305 185 145  45 225 315 215 335 325 200 165 270 255 305 280
 315 160 410 345 415 340 325 385 340 185 405 100 365 250 315 320 415 355 125 410
 425 235 270 540 415 340 470 295 525 375 385 235 320 320 125 175 140  80 155 225
 265 255  50  30 170 150  80  50 135  80  65 230 285 430 295 195 245 340 245 255
 285 405 290 395 390 450 250 400 225 250 385 325 285 400 325 315 475 170  85  55
  95 235 180 290 235 400 495 585 640 465 280 510 350 740 5601100 930 380 400 580
 350 650 500 540 510 580

 4) MAY702
     270=N   -2456=I 4) 1 sample (MAY702)                         -2(26F3.0)~
 83 71101 76 62 66 89124144164 11 95 99 74 70 78 85122 551782021611021301531 09
123128153124147152 68173 97131147134111 94 80106 55 72 98 22 58 28 66 76 36 73
  2 65 27 32 48 43 56 39 18 43 33 17 33 36 30 31 15 39 28 37 33 27 23 32 30 16
 29 21 17 25 29 18 35 35 36 15 28 25 26 23 21 26 25 16 14 16 21 31 26  2 20 16
 30 32 26 23 25 40  9 20 35 41 17 12 20 17 13 26 18 25 13 29 20 12 23 15 14 10
 10 19 11 15 12 17 12 10 16  9 10  2 18 14 10 16  5 13  5  4  9  7 12 10 19 21
 13 16 14 32  6 16 27 18 14  9 18  7 11 21 17 11 13  5 16 14 21 17 14 12 14 19
 16 18 15 21 22 17 13 26  4 21  7  9 14  7 23 26 29  8 15 17 13 18 13 12 12 12
 13 16 16 16  7 21  6  7  4 16 18  5 10 11  9 24  9 18 13 10 11  7  3 12  5  9
 11  7 11 10 12 40 34  9 16  2 10 13 13  2  8  5  2  6  3  9  2  8  4  6  8 10
  6  3 14  6 13  9  6  2  5  9

 5) NOV001
     246=N   -2923=I 5) 1 sample (NOV001)                         -2(26F3.0)~
  2 24  4 46 49 46 31 20125114115 71 33115148130 81 58 75107104 57119179106182
1691171271601871621431701021 74 60112 93 34 17 72 76 86100 94109125137 62104133
139 89 99 61 92 40 94 67 16 93 86136 90 60 60 40 78 79 79133 74 81120159 82103
 70 52 72 36 83 65 39108 68 79142127 56 83116138133 62 71 51 77 49113128103158
106 51 54 71 88 70149 60 14 26 43 23 89 35 64100 84 67108 78 48 52 44 22 52 52
 57 13 64 29 43 22109 71 47 37 89 74 93 82 29 52 50 34 64 53 16  8 32 19 38 18
 20 46 40 36 49 15 17 47 43 15 19 31 49 26 29 36 19 25 53  8 36 35 52 46 22 29
 26 43 31 42 22 14 46 48 17 30 49 17 60 51 48 43 32 42 33 21 21 13 28 24 20 38
 40 73 37 36 41 48 47 13 73 28 45 24 46 18 34 33 13 59 21 38 51 22 28 24 31 28
 25 17 10 10 16 23 14 26 14 20 11 18

 6) CHA-H6
     345=N   -3178=I 6) 1 sample (CHA-H6)                         -2(26F3.0)~
 71 90 55 99 41 94 87138157143113 981881841681441471 36 66 91 65 26 95 87 62 58
 93 21 50106 79 61 68 50 85 21101 68 96 73 94 84 65 71 78 46 91 81 79 64 73 33
 49 39 71 42 82102 67 23 26 49 11 55 60 71103 91 65 61 68 38 42 47 42 50 33 37
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 63 50 62 90104 87 26 58 72 52 17  9 32 22 18 44 67 78 40 76 29 62 63 57 29  4
 20 31 30 16 31 51 55 52 42 28 15 50 72 58 73 59 71 67 34 29 48 29 51 41 61 20
 31 11 34 43 40 31 45 19 44 39 48 56 29 41 11 40 44 30 40 27 32 58  5 81 18 16
 31  6 38  6 44 67 15 52105 63 97 67 33 29 43 47 87 70 39 76 63 79 54 83 33 43
 57  4 24 55 85 68 72 75 40 44 27 42 29 54 67 43 47 31 33 19  4 20 26 34 38 47
 13 17 30 24 38  5 20 19 15 12 29 19 43 25 24 31  4 20 19 20  3 34  2 52 26 42
 28 46 31 42 36 17 31  6 28 34 64 35 33 34  7 22 14 31  7 22  5 20  7 15  4 15
 13  2 37 24  8 22 34 32 19 27 31 56 27  2 28 10 21 37 18 20  9 27 18 27  9  7
  1 11  5 27 26 36 52 40 50 42 14 23  4 25 10 38 26 40 56 35 72 38 74 80 32 42
 39 20 14 28 25  8 23 28 23 44 29 54 79 28 29 36 39 45 86 94 11 51  8  3 28  5
 13 15 11  6 18  1 26

 7) NOV078
     299=N   -3358=I 7) 1 sample (NOV078)                      -2(26F3.0)~
 55 86139 68 20 401361421521151531611541 70 95134136113106101 83119184 81166118
 92 18 78160117118 84 90132114 43112123 60 52 34 30 30  8 52  9 21 30 13 49  3
 58 52 18 25 22 33 24 60 27 44 32 39 18 33 43 60 72 81 75 67116 87 25 81 38 41
 41 71 80 93 53 34 78 67 75 82 48 66 18 49 36 41 21  6 10 44 90 53 23 63 98 33
 68 83 50104 88 70 66 60 82 65 41 80 88111 41 45 48 60 29 47 46 50 58 73 50 90
 39 73 46 68 27 68 93 55 51 83 80 40 43 72 23 40 77 86 91 60 67 47 20 20 32 50
 32 37 41 30 31 30 23 19 40 12 27 46 56 58 31 30 20 16 33 30 48 25 22 36 41 50
 24 42 28 20 46 44 19 18 25 23 22  8 37 42 25  6 22 10 20 18 25 29 20 22 23 13
 17 18 36 20 33 32  6 25 26 37 37 33 16 27 38 18 45 41 29 44 42 57 27 53 17 16
 32 17  7 20 22 20 17 22  7 14  7 18 16  6 18 25 24 19 34 14 14 17 15 10 29 24
 40 53 10 47 29 15 35 27 39 32 22 63 28 49 50 64 47 21 34  9 29 27 12 21 34 20
 43 31 34 31 32 14 41 59 42 34 25 33 24

 8) NOV-A02
     286=N   -3457=I 8) 1 sample (NOV-A02)                       -5(13F6.0)~
 83000 84500 67500 62000 50500 64500106500 96500 75500 82500 83000 83000 84500
 94000 73000 73000 64500 72000 75500 94000 93000 52667 66667 56333 53000 57000
 35333 46000  8000  5500 24000 32500 30000 19000 22000 37000 27500 37500 22500
 29500 33000 32500 54500 70500 42000 61000 69000 84000 68000 73500 52000 70500
 77000 91000112500 59000 14500 80000 47000 74500 64000116500 56500 88000 89500
 54500 56000 83000 58000 21000 67500 86500 85500 97000 86000 94500109000 70500
 65500 52000 82500 50500 39500 48500 49500 55000 54500 57000 47500 45000 66000
 77000 78000 76000 54000 68000 58500 21000 28000 14500 46500 29000 48500 37000
 41500 19000 28000 29500 31000 38500 22000 11500 28500 25500 28000 27500 34000
 22000 30000 62500 49500 38500 38000 47000 43000 46500 39500 39000 44000 40500
 45500 38500 74500 38500 42000 22500 30000 46000 41000 22500 37000 31500 19500
  4000 12500 26000 32000 43000 37500 43000 53000 72500 62500 46000 58500  7000
 25500 40500 51000 64000 89000 70000 81000 47500 77500 20500 70000 84000 71000
 76000 56000 54500 76500 59500 35000 51000 62500 39500 41500 28500 48000 23000
 25500 28500 36000  4000 21000 20000 13500  6500 12500  5500 21000 14500 21500
 14000  5000 12500  2000 32500 28000 26500 29000  9000 29000 37500 22500 14000
 41000 22000  1500  5000 23000 11500 19000 20000 26000 24000 29000 15000 11500
 28000 21500 26500 42000 22000 22000  8500 22000 18000  8500  7500 16500 20500
 30500 18500 39500 22000 17000 28500 21000 30000 49500 35500 54000 34500 65500
 53000 55500 44500 43500 75000 76000 56000 63500 39500 37000 10500 38000 48000
 53000 67500 82000 71000 89500103500 85500 83000107000 67000105500117500 78000
123000139500 97500122000 99500 78500 60000 69000 76000 66500 67500 44500 11000

 9) CHA005
     198=N   -3513=I 9) 1 sample (CHA005)                      -2(26F3.0)~
 28 66 47 28 20 50 50 36 44 38 29 38 25 22 19 17 10 18  9 16  9 10 16 19 18 19
 13 14 16 12 10 22 17 17 23 34 38 40 37 67 92 56 41 52 60 47 57 52 77100 90103
 80 49 50 56 38 47 34 44 25 31 47 65 94 91 39 29 62 40 60 44 34 33 43 41 49 34
 63 56 38 43 44 41 33 38 37 38 48 30 46 31 15 13 16 30 41 43 51 50 43 56 69 67
 30 37 52 59 43 44 53 43 64 52 40 47 17 34 35 35 52 26 32 52 43 44 16 10 37 44
 28 39 33 39 38 56 27 58 33 58 79 67 38 24 38 30 38 39 44 19 34 32 28 25 29 27
 25 30 57 55 40 34 47 49 51 37 34 35 24 17 28 35 43 38 56 62 88 79 81 69 85 38
 60 73 78 52 73 38 53 81109121 93 85124116145141

 10) NOV029
     306=N   -3634=I 10) 1 sample (NOV029)                       -2(26F3.0)~
1291592352642012021382131321 54 98111136129125115106 62100126101107108104175111
 43 15 47 53 54108 83119 57 64 81 71 74 44 30 72 82 43 38 82 43 41117 98 98102
 68 74 88 57 47 78 61 94124168 58 41 32 51 45 44 33 37 35 33 19 62 51 65 78132
 77 90 94 79 60 60 21 16  8 21 57 61 45 67 47 64 21 53 58 59 86 50 62 60 52 27
```

```
 74 73 76 61 52 67 45 30 27 25 17 12 11  2 12  9 29 12 23 17  9 18  2 35 17 31
 58 41 67 50 52 22 60 40 13 42 28 31 46 60 34 37 23 31 55 32 59 53 27 37 18 36
 23 27 27 13  8 34 35 24 23 27 20 13 28 33 17 42 31 37 32 35 38 35 35 52 42 54
 33 35 36 45 19 20 20 18 32 33 26 46 30 53 24 55 25 46 57 39 35 69 55 37 42 41
 22 34 59 51 49 53 67 46 19 26 47 45 45 60 46 25 39 47 38 24 47 21 30 46 34 57
 30 18 21 18 39 28 34 21 26 26 15 32 16 29 25 13 33 28 29 17 25 14 31 14 39 37
 33  3 23  5 25 13 19 25 14 26 31 13  7  8 36 15 22 21  3 20 19 24 24 23 13 17
 35 18 26 24 13 31 30 37 17 23 17 10 16 12  7 21 13 12  9  9

11) CHA060,012,009,017,001
     685=N   -3964=I 11) 5 samples (CHA060,012,009,017,001)       -5(13F6.0)~
29500 20500 15000 24000 33000 36500 10000 11000 12500 13500 10500  5500  7000
 7000 10000  4500  3000  6500  9500 16000 13000 16000  5500  7000  9000 11000
13500 22000 15000 15500 13500 12500  4500  6000  7000  9000 21000 23000 42000
14000 17000  5000  5000 14000 22000 21000 17000 15000 12000 15000 17000 16000
10500 10000 15000  6000 22000  8500 17500 15000 34000 27000 12500  9500 14000
14000 13500  9500 15500 17000  9000  5000  8000  8000  8000  9000  7500  4500
 7500 12500 15000 26500 19000 20500 32000 39500 23500 35000 29000 27000 19000
21000 20500 22500 24500 26500 23500 41500 32500 43000 56000 33000 44000 77000
45500 59000 29000 55500 35500 24000 41500 51500 48000 44500 42500 48500 33000
26500 22000 30500 30500 32000 50500 40000 29000 11000 19000 21000 13500 25500
25500 30000  5000  5500 18500  6500 31000 14000 35000 32500 15000 42000 50500
57000 22500 50000 57000 53000 64099 21470  9631 18304 35842 46483 57075 55743
62066 81774 72528 56319 37556 34971 50015 39598 21283 53422 56443 68633 77002
39117 41629 35335 29859 38102 46170 39393 53294 51532 57480 43041 48908 45052
22796 30368 71920 47418 38804 16721 18342 30597 39246 54877 44497 63724 47343
56569 41014 35417 57015 38640 55746 40256 38815 28450 28771 35747 40459 40367
43102 37881 33733 53481 52421 41144 57534 49544 62108 48135 32065 49386 40716
19883 31000 43000 54000 65000 30000 19000 53000 34000 31000 51000 38000 30000
39000 54000 31000 41000 24000  5000 26000 30000 37000 28000 27000 36000 52000
51000 83000 94000 57000 27000 28000 40000 34000 53000 47000 35000 30000 51000
60000 53000 45000 26000 22000 15000 47000 40000 41000 36000 29000 41000 32000
30000 46000 28000 21000 44000 47000 61000 26000 39000 31000 23000 27000 34000
17000 17000 14000 22000 26000 27000 42000 39000 37143 36479 34282 15973 46985
41586 45817 35541 34462 33297 57851 38141 39830 58005 52402 64245 61268 95274
77879 79103 44527 73461 67818 51382 66915 48836 58044 48542 60188 50493 34297
21814 30343 27318 19330 31028 37674 22448 25890 20938 27414 34284 36175 22814
22155 18932 34119 28429 46027 39944 28606 37674 58716 57737 33924 59131 47706
67784 57924 47264 56184 23589 35398 50320 59990 41211 56298 48331 56917 46614
60352 73078100871 72100100826 46340 71674 67785 70748 65034 57059 83787 82437
97654102262 97603 96917110019 72257 67592 83499 86173107194 53370 83050 71618
72105 62601 70925 75670 71983 92814 83718 69543 58714 54920 59474 43291 66602
48121 79532 69034 25023 50577 63493 77587 77307 56182 45723 67844 49108 75721
46890 84507 77881 70337 46438 52629 60915 50684 57532 58031 43993 32527 61223
52640 49079 42544 53483 61960 79030 66823 73806 32689 35046 18242 62750 55673
61686 52388 77760 33551 53130 63936 65666 51292 68383 50993 61192 60891 43838
56876 51626 58651 36797 26491 52839 38990 52762 33637 22651 49848 53290 66765
72486 53265 79909 30593 34434 40624 45162 24607 27409 45092 66972 71704 67281
33133 53007 43198 57953 62357 38773 42726 57282 60859 38621 38300 31630 48192
51651 34748 43513 36436 50128 54668 29234 31987 36751 31569 37721 13337 42200
40125 59482 44299 19273 30587 26770 18675 28352 53830 37686 33647 20975 22003
24719 35767 26587 26669 18037 25899 19415 22622 31868 31603 11966 28692 25282
11026 24117 27808 12843 15031 12381 21029 14078 17673 24989 21396 13818 36290
32305 30660 18314 40216 43074 55488 30400 52655 48880 80052 64740 40598 78201
38192 61936 43419 22177 17147 17388  5300 24236 32535 13552 16430 13265 21525
11911 36666 10407 31224 29079 21922 39323 27000 26000 45000 41000 55000 41000
57893 51388 45397 21782 37218 35585 31277 19650 31069  5221 17963 30678 39867
11885 34455 16000 12500 12500 31000 47500 19000 33500 24500 13000 42000 29000
17000 44000 37000 34500 31500 55500 28500 32500 32000 25500 17000 26000 29000
10500 27000 34000 32000 14000 11000 24000 27000  8000 14000 10000 16000 24000
18000 26000 20500 26000 35500 48500 42500 38000 43500 29500 32500 44000 47000
56000 55000 74500 66000 67000 80000 31000 52000 64000 81000 34000 39000 17000
43000 29000 61000 60000 47000 65000 79000114000 22000 68000 59000113000 54000
103000106000110000 58000 82000107000133000180000178000

tem-rcs.rwm
Temperature reconstructed:
1) Early summer temperature reconstructed, RCS-RES chronology
2) Early summer temperature reconstructed, RCS-RES chronology (5-years moving average)
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3) Annual temperature reconstructed, RCS-chronology (5-years moving average)

1) Early summer temperature reconstructed, RCS-RES chronology
2072=N -77=I TJJ -4(13F6.0)~

150043131332106186 94108 55646 60349 66041119600 86633105443 73367 90395 86782
11717511722410277010186 98365116284103958 74753 94355 75545106681103513 82673
95246111730 74902 91385117818 77971 77228104255107077 48370 92672109750 93019
95197 84505 85990103166104602 81089 59210111680 63814 83614128906111334 82673
70942 52181110096 87623 92177 87623 73565 82475 94058 92969 76634 66437 86039
72971 84208 77228 99058 81683 88564 90890 68665103562 92771104008 87970 67279
74753 93910 99701117719 67031 44410 91930 77575 83911 78119 85594 95345 91138
83564 55795 92128105196 82426 97919 92524 45944109750 79654 73268 93712 71041
93316 82921104057 66338 61735117719 72377 62576112423 62972 76931 72724 78367
80693 95741 86782 81188 79505 71437 64358107324 83218 77872 81485 84950 93118
98662 81634 82624 87277 70348 86089 87227 84257110047 75100 86485 74951 91583
64804 96830 63913 94108 94108 75595 92672101335 82030 87227106928 86287 68566
80792113017117521 89851 95147 79010 75446101137 90742104849109205 64556 79505
90742 95296 76486 90544120244104503 93068 69308 85940 69259 92029110789103909
80050 48469105592 90148 55894119551103958 66190 85346 81386109057100097 81931
100048 85198102919105097107423 75991 79010111631 92029 89851132965111581115442
110245 75842 49112 89851 93167108611 55993 62032 73714104057 90395 84752 97721
103414 91435 80000108364 86138 94058 81733 93761 82574104701 86831126778109700
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45004101236 74555 77278103463 78515113858 82129 81485106730 43816 63022 72823
95939103166102968 68714 92326 73417 86485 91979 87524 68962 97226 95246 96286
74060 86386 75743 66437 97177 68368 77674 91930100988112076 70744 75298 80495
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95395 77674 95840101830111136 69209 95147111581 98959155240 36490120095127718
94702 90544107819 75347110591 57131108463103859162071104552105245 84901 74506
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77525 57923 89702110740112126 81832100394100147 99652 80891 86435103661100345
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88366108413 65150107720103067 89009 95197 86534 47083 71635101533100394 66982
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70051 99157 98315 93662 60745108562 75595103265 79307 72476103810124204128461
102028102473 94504 77822 52379 97375 95147114155101533 51488109997 76139131728
63913 95890 72625116977 93316 93860 63418133658 85396117422114205 94405 83218
81040 92375 93959 99602 85940101384 74060112621 85099 94256 89059113611 94949
77971 89405 99652135292 51488 77426 94900102424 86386 67328 82525 84158 96434
96187 93316 77723 76931 89554 78218 93415 83812 88811118759 97127109552104305
97573 94652 82277 77575 97919 96385 62675 90940112175 90643 79753 86188 66734
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63071 99602 81436 82376 82624103315 78020105641 81782 88960102374 76040107374
105889 94652 68764104156102869 73565104948 45845 96880 79555113215118066 56092
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101335 93118 87425 74753 84851 59111 92474114106 82228 90643 96286 88861119254
104453 87029 82327 98068117719 91682 74110 92078 70249128263127916 64853100493
70843 83812101830131480 701001088591168781043549796960596124550100741103909
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100196 73219 99107104354 80990 61240121531 91336 79703 92672102127103364 77476
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115987 82673118412113066 37430111581 77179 81683 62923110690 82129 81683111383
54409 96484102622 95098 83267 63022 96533 72773 68615 86683 95147 84703 86188
91781 90940 84059 76931 96335 88564 96137114848 72179 84604102919 79208119056
85891 57181 83960108067100196 71882122620112175 81238 68318 69754108265 59755
112373 64408 88168 84554131530 90197 71486 80347115591102523108859 88069 79406

104255 82079 96484 96583 69704 70199 71783 72229103909 78317 88118 89900 56983
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91187 81733121729109255 54508108364 57329 88960 98117 89603 83218 63962122917
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71585 71090 81089 86188 82673111977111581108017 77674121283 63022 80495 98959
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117620 64952 66982 96979 85148 98018101335 73120 82723 57824 97622 90544 70447
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63616 78515 86633 68120 84554102424 86732 95989 85099 92524101978 78713 80594
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85198 98810117620 98860101285 72278 86980 84257 96583 67328 75793 85495 87871
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94553 51785 93761 87970 93118 89356 74258 88861 96731 90593124699 54607117472
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73862 89801 70051 69209 97177 60893101929 99206102622100840 87128110542 50746
106285 85396 83069 79753 58567 74654 87326 80594 88118 76684 90395 66190 79802
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54706 65645103166 99652 87574 88465 66932 86089 82822137222 73912 86881 78614
62428 88465104354114502101285 95543114007105592 90395 71932102226 96286119452
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114155127421116779148261115442121679 77228134054 95098 58171114700 59656108463
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2) Early summer temperature reconstructed (5-years moving average)

2068=N -75=I TJJ5 -4(13F6.0)~

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93573

3) Annual temperature reconstructed, RCS-chronology (5-years moving average)

2068=N -75=I TYY5 -3(13F6.0)~

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VARIABILITY OF LARCH RADIAL GROWTH IN THE EAST OF TAYMIR AND PUTORAN FOR THE LAST 2000 YEARS

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Abstract

Regional tree-ring chronology with extension 2209 years (since 212 B.C. till 1996 A.D.) was built for the east of Taymir according to wood of living trees, well preserved residues of dead trees and semi-fossil wood from alluvial bank deposits by the cross-dating method. In addition the "floading" tree-ring width chronology for the period of Holocene Optimum (3300-2600 B.C.) was built with extention 685 years and supported by several rdiocarbon dates. High values of synchrony and correlation of individual tree-ring series show a prevailing effect of one external factor on radial tree growth change in the studied region of Siberian subarctic. It was established that the main factor of growth variability the early summer and annual temperature is which explains up to 70% of tree growth rate variability. Cyclic components stable for two millennia were revealed at analysis of the tree-ring chronology: double secular (about 180 years), secular (78-90) and intrasecular (44, 28, 11 and 6,7-6,9 years) variations. Models for reconstruction of the early summer and annual air temperature were obtained according to tree growth variability. Temperature dynamics in the eastern part of Taymir for the last two millenia agrees well with temperature variations in the northern hemisphere obtained according to other indirect sources. The warming of the middle of the 20-th century is not extraordinary. The more long in time, and close in amplitude the warming at the border of the first and the second millennia was.

Key words: radial growth, tree-ring chronologies, temperature change, dendrochronology, climate, growth cyclicity, temperature reconstruction, response functions.

Introduction

The leading dendrochronological groups began their work in some key regions of circumpolar zone of the northern hemisphere on building the superlong (several millennia, and for the whole Holocene period if to use subfossil wood) tree-ring chronologies for the quantitative reconstruction of natural temperature variations [6,8,19,20,35,36]. The high latitudinal regions in the northern hemisphere are of greatest interest for assessing natural and anthropogenic variations of air temperature, forest-tundra ecosystem growth and productivity, regeneration regime as well as of polar timberline dynamics because the ecosystems of high latitudes have the highest sensibility to the expected global climate warming [4,15,18,19,22,43]. Owing to accessibility and great amount of well-preserved wood of dead trees as well as of subfossil wood from alluvial river deposits and wood buried in bogs several regions in high latitudes of Russia turned to be promising for building millennial chronologies: the Polar Urals [15,31], Yamal peninsula [32], the east of Taymir and Putoran [7,8,14] and the lower Indigirka river[34]. The following problems were solved in the given paper: 1) obtaining of the absolutely dated 2000 year tree-ring chronology suitable for quantitative reconstruction of climate changes; 2) revealing of the main climatic factor responsible for the year-to-year and long -term growth variability; 3) building of models of climate change

reconstruction for the whole period of long tree-ring chronology.

Material and methods

Dendrochronological material was collected in Kheta-Khatanga plain as well as in Moyero-Kotuy plateau regions of the Middle-Siberian forest zone within the northern stripe of the northern taiga subzone [1] (Fig.1). The wood samples were taken with the help of a borer or chainsaw from the living trees, from the well preserved residues of a dead and subfossil wood. The whole sampled material is from trees from three types of conditions: 1) from the contemporary northern timberline of larch in the stow (urotchishche) Ary-Mas of the Taymir biospheric reservation (latitude of 72 28' N.); 2) from contemporary upper timberline with absolute marks 200-300 m above sea level in the Kotuy river valley (latitude of 70 30'-71 00' N.); 3) from alluvial deposits of flood-land and over-flood-land terraces of large tributaries of the Khatanga river (latitude of 70 30'- 73 00'N.). Measuring of the tree-ring width was made with the help of automatized devices with resolution up to 0.001 mm, and later the measured individual tree-ring chronologies were treated in the standard software package for dendrochronological and dendroclimatological analysis [26,33]. Owing to the high year-to-year variability, high synchrony of individual series between each other the results of the cross dating gave a chance to build the continuous chronology since the year 212 B.C. till 1996 A.D., it means the total length 2209 years. Besides, according to the well-cross-dated discs of subfossil wood for which the series of radiocarbon dates was made at the University of Bern (Switzerland) and at the Joint Institute of Geology, Geophysics and Mineralogy SB RAS (Novosibirsk) the "floading" chronology of 685 years long was obtained which according to the dates agreed with climatic optimum of the Holocene (3300-2600 years B.C.).

Standartization method is used to treat individual series for the best revealing of climatic signal. This method is intended to remove the changes caused by age or by factors of the non-climatic nature (for example, effect of phytocoenotic factors) from tree-ring width variability. For standartization two approaches were used: 1) an approximating curve of age variations is tried for every individual series [15,26]; 2) an age curve is used which is built according to the entire totality of analysed individual curves of growth [3,11,21,23]. As the special studies showed, the long climatic changes (or super-secular variations) remain more reliably at the second standartization method [21]. Therefore, it was chosen for standartization of individual series and obtaining of the long chronology of tree-ring indexes. Obtaining of regional tree-ring chronology (C1) and of the so-called "residual" series (C2), from which autocorrelation was removed [26,40], was as a result of individual series standartization. The main statistic characteristics were calculated for the obtained chronologies: inter-series coefficient of correlation (as an index of synchrony of individual series), sensitivity coefficient, standard deviation,1-st order autocorrelation etc.[30,41].

Analysis of the frequency-temporal structure of obtained chronologies at the entire period and at the 500-year intervals was carried out by Fourie method of direct transforming (Blackman-Tyuki method) and Fourie method of "fast or inverse transforming" (Kuli-Tyuki method) [10]. The methods of graphical assessment of smoothed curves [15,16], analysis of autocorrelational function [2,15], a narrow-striped filtering of series [12] were used at the revealing of long (super-secular) cycles in growth variability. Revealing of the main climatic factors of growth variability was based on response function assessing and interpreting [30,42]. The quantitative reconstruction of climatic factors according to variability of growth indexes was made on the base of calculated regression model at which building one part of climatic series was used for calibration, another part - for verification [6,7,41]. Adequacy of reconstruction model was assessed by standard statistic indexes: correlation coefficient, Fisher's criterion, autocorrelation of

residues - criterion of Darbin-Watson [17].

Results

In the result of the cross dating (its quality was checked by statistic estimates according to the COFECHA program [26,33]) of Larix gmelini living trees and trees dead long ago from the upper timberline as well as of subfossil wood from alluvial deposits the reginal tree-ring chronology since the year 212 B.C. till 1996 A.D. was built for the eastern part of Taymir and Putoran. The total number of wood samples being dated was 118, including 27 living and 91 dead trees. The average age of the used trees made 300 years, the maximum age was 798 years. The percentage of the missing rings is not very large - only 0,5% because the discs were analysed, mainly, but not wood cores [44]. The tree number in the regional chronology is not homogeneous in calendar scale and has a tendency to decrease when moving to the past: 3 and more models since the year 135 B.C., 5 and more models since the year 81 B.C. Dating of dead trees showed that in the upper timberline under continental climate the dead tree residues can remain on the day surface during more than 1900 years. Inter-series correlation coefficient for the whole time period is rather higher than the threshold value (0,62- 0,75, $p < 0,01$). It confirms a stable and strong external influence which synchronizes growth variability of individual trees.

The main statistic C1 chronology for the whole period and in 500- year intervals are given in the Table 1. The high and close coefficient values of sensitivity and standard deviation for the different time intervals show that tree growth variability under these conditions is controlled by one and the same factor during two millennia. Autocorrelation of the first order which shows the growth effect of the previous year on the growth in the next year is of great importance as well. Autocorrelation is not significant after treating it by autoregression model in C2. The average tree-ring width for two thousand years is at the level 0,28 mm but it greatly varies in time, the average tree-ring width is more high (0,40 mm) for the Holocene optimum period (Fig.3). Radiocarbon datings agree well with absolute dendrochronological data.

Analysis of spectral density allowed to show the frequency stripes important by their contribution to the total growth variability and to assess their amplitude (Table 2). The contribution of millennial cyclic component makes about 4%. The large contribution is brought by double secular cycle (in frequency stripe of 120-220 years) up to 20,6% and secular cycle (in frequency stripe of 60-120 years) - up to 13,3%. The cross-spectral analysis of the 500 year old fragments of chronology showed that during two millennia the double secular (180 years), secular (78-90 years) and several intrasecular (44,28,11 6,7- 6,9 years) cycles are steadily present. Hereat, re-distribution in the capacity of separate cyclic components is observed. Such a re-distribution was already noted in the papers on dendroclimatic data from boreal taiga forests and forest-tundra regions [2,12,15]. Positive anomalies of growth, the most strong in amplitude and long in time, fall on the 4-th century, the border of the 6-th and 7-th centuries, the border of the 1-st and 2-nd millennia, the middle of the 20-th century. However, the negative anomalies fall on the 1-st century, the border of the 13-th and 14-th centuries and the first half of the 19-th century. These anomalies can be explained by superposition of cycles of different length. So, growth increase in the middle of the 20-th century agreed with positive periods of the double secular, secular, and several intrasecular cycles (44, 11, and 6,7 years).

Since at the polar timberline the summer temperature is the main factor of growth limiting [6, 15,35,43], then the dendroclimatic analysis of relation of growth variability was carried out, first of all, with air temperature data for summer period. However, some changes were brought to the traditional searching scheme of correlation with average monthly temperature data.In order to reveal the key interval of the season when

temperature mainly affected on radial tree growth the value of correlation coefficient between C2 growth indexes and air temperature for every five days beginning from the 8-th of May was calculated. Everyday data of the Khatanga meteorological station since 1933 to 1989 were used. All the calculations are given in the Fig.4. As we see, the significant positive connection ($p<0,01$) between air temperature for every five days and growth indexes is observed for the period since June 17 to July 11 and it falls on the interval of stable temperature rise in the season. The temperature of the more late intervals of the season does not show large connection with growth variations. The temperature for the period June 17 -July 11 we called as an early summer temperature. Temperature sum for this time period shows the most correlation with C2 tree-ring indices ($R=0,77$). Thus, variability of C2 tree-ring indexes is determined by the early summer temperature variability in the east of Taymir and Putoran by 60%. The smoothed (the 5-year moving average) C1 tree-ring indexes and instrumental values of average annual air temperature show high agreement too ($R=0,72$). At the same time the smoothed annual temperature shows the significant relationship with the concordance coefficient calculated for the same period of 5 years based on all wood samples available. This relationship is positive ($R=0.44, p<0.01$) and shows that in cool periods the synchrony in tree-ring variations among all trees measured becames lower, in warm periods it becomes higher, but has a non-significant relation to tree-ring width variations. Therefore, at seaching of quantitative models of reconstruction of leading climatic variables using tree-ring chronologies it was conventionally taken to use C2 for the early summer temperature reconstruction, and C1 - for the annual temperature reconstruction.

The results of calibration and verification of obtained models of the early summer and average annual temperature reconstruction according to 2000-year chronologies data are given in the Table 3 and in the Fig.5. As we can see, the early summer temperature variability is well explained by tree-ring indexes variability in C2 ($R^2 =0,59 - 0,72$), the average annual temperature variability is described by the model with two variables: by smoothed values of tree-ring indexes in C1 and by concordance coefficient values between individual series ($R^2 =0,67$) (Fig.5). Comparison of calculated values of the early summer and average annual temperatures with the real ones for the period of instrumental observations shows (Fig.5) that the calculated values of the early summer temperature agree well with the year-to-year variability of real values repeating the most large positive (1940-41, 1953, 1967,1979, 1984) and negative (1947, 1949, 1980, 1989) extremes. Hereat, in the curves of the early summer temperature variability the long fluctuations are not expressed. To the contrary, the periods of large temperature rise (1938-1956,1983-1989) and temperature fall (the end of (19)50s and (19)70s clearly agree in reconstructed and real values of average annual temperature.

Based on the obtained models according to two chronologies the reconstruction of the early summer and average annual air temperature was made for the east of Taymir and Putoran for the period since the year 81 B.C. to the present time (it means, for the period provided by 5 and more samples). The curves of variability of the reconstructed early summer temperature (smoothed by the 5-year and 57-year moving average) are given in the Fig.6. The average value of the early summer temperature equals to 9,6 C for the instrumental observation period. The most large fall of the early summer temperature is marked in the 1-st century (T=8,4 C), and in the end of the 13-th century (8,4 C). The most warm periods with the raised average early summer temperature are the end of the 3-rd century (T=9,7 C), the border of two millennia (9,6 C), the middle of the 20-th century (9,9 C). The middle of the 20-th century is characterized by the most rise of the early summer temperature, but the 11-th and 12-th centuries are characterized by the long period with high early summer temperatures.

Long variations of the average annual temperature range from minus 14 C to minus 12,5 C. It was of great interest for average annual temperature to compare the reconstruction data with other indirect data on dynamics of average annual air temperature of the northern hemisphere in order to make clear whether temperature variations in the east of Taymir and Putoran reflect global temperature changes in the northern hemisphere. As such the data on reconstruction of temperature variation in high latitudes according to ratio of oxygen isotopes in ice cores of Greenland were used [25,29]. In the Fig.7 both reconstructions are matched in the calendar scale since the late of the 12-th century. Their good agreement is well seen, especially in positive (the 14-th and 15-th centuries, the end of the 18-th and the middle of the 20-th centuries) and in negative (the late of the 13-th and of the 17-th centuries, and the first half of the 19-th) extremes. It means, the long fluctuations of average annual temperature in the east of Taymir and Putoran agree well with global air temperature variations of the northern hemisphere for the last millennium, and hence the tree-ring chrnology of this region can be used to analyse both regional peculiarities and global temperature variations in the northern hemisphere.

Discussion and conclusions

The results of analysis of the super-long tree-ring chronology of the Taymir and Putoran east show that the information on the main climate changes in the northern hemisphere for the last 2000 years is reliably fixed in it: fall of temperature in the first century, climate warming in the 3-rd and 4-th centuries, warming in the Medival Warm Period (?) or "the small climatic optimum" at the border of two millennia, the long fall of temperature in the 17-th and 19-th centuries ("the small glacial period") and the present climate warming in the middle of the 20-th century [27]. Since the obtained regional chronology has good correlations with other chronologies of subarctic zone within 500- 600 km [6,43], then we can believe that similar regularities of the early summer and average annual temperature variability are typical of large sector of Siberian subarctic. It was shown earlier that the long growth variations agree well for the entire Siberian subarctic [8,24]. The studied region (and this is shown by subfossil wood samples and by obtained "floating" chronology) has a high potential to build the tree-ring chronology for the whole Holocene period and to study in details temperature variations for this period of the Earth history.

Two important consequenses from reconstruction analysis should be noted especially. First, the analysis of frequency structure of series and of their separate fragments illustrates a constancy of the main environmental factors limiting growth. It is confirmed also by comparing reconstructions with other indirect evidences. Second, the warming in the middle of the 20-th century, marked as extraordinary [22], has the analogs in the past. So, the warming at the border of millennia shows a close amplitude and was more long [27,38]. Historical evidences on climate of this Medival Warm period say about the more large climate warming than the present one [13]. The obtained data demonstrate that temperature variations in high latitudes for the instrumental period (1850- 1990) do not go far beyond limits of natural variations revealed during two millennia.

Ratio of natural and anthropogenic components in the present and future climate changes is especially discussed. It is proved in some papers based on the long tree-ring chronologies of North America that the influence of anthropogenic component becomes large and can be separated and assessed quantitatively [39]. Hereat, the trees growing above the upper or polar timberline reflect stable temperature rise in the northern hemisphere [28,35,37]. However, a direct correlation between temperature and growth is marked only for trees from growth regime especially chosen [36,37]. The stable trend of summer and especially winter temperatures for the last decades is connected with the increase of anthropogenic component share, mainly, at the expense of atmospheric green-house

gases [4]. At the same time, on large areas of high latitudes (mainly, in subarctic zone) tree growth, correlating well with temperature rise till (19)60s, begins to stunt after this period from the rise of temperature [24]. We can believe that the direct temperature effect is combined with other factors which influence growth rate of trees in polar latitudes. For instance, increase of winter precipitation can shift the dates of snow cover melting to the more late time even at summer temperature rise [9]. In polar latitudes the conditions of the first season half play the leading role in radial tree growth and tree-ring forming [5,6]. Therefore, tree growth response at the polar timberline will be more complex than we can expect only from summer temperature variations.

Conclusions

1. The long 2209-year (since the year 212 B.C. till 1996 A.D) regional tree-ring chronology was obtained for the east of Taymir and Putoran, suitable for quantitative dendroclimatic analysis and climate change reconstruction. Numerous radiocarbon data of sub-fossil wood and several built "floating" chronologies show a high potential of dendrochronological material of the given region for the building of absolute tree-ring chronology for the main Holocene period (more than 6000 years).
2. The main factors were established which determined the year-to-year variability as well as long-term variability of larch growth in the study region. They are the early summer and average annual air temperature and they determine up to 70% of the total growth variability.
3. In long-term growth variability during two millennia the millennial, the double secular and secular cycles as well as some intrasecular cycles which are met the most often in tree growth variability in polar latitudes of the northern hemisphere are steadily seen. The most large warmings and falls of temperature can be explained by matching particular cycles.
4. Reconstruction of the early summer and average annual temperature variations in the east of Taymir and Putoran showed good agreement of temperature variations in the given region with temperature variations in the northern hemisphere obtained in other indirect sources. The warming in the middle of the 20-th century is not extraordinary. The warming at the border of the 1-st and 2-nd millennia was more long in time and similar in amplitude.

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Tabl.1.The main statistical characteristics of C1 chronology

Period	Years	Statistical parameters				
		Mean index	Sensit.	St.dev.	1-st autocorr.	Coef.var.
212 BC-1996 AD	2209	1.016	0.421	0.443	0.41	43.6
212BC-287AD	500	1.014	0.411	0.482	0.53	47.5
0-499AD	500	0.963	0.426	0.421	0.38	43.7
500-999AD	500	0.982	0.457	0.441	0.38	44.9
1000-1499AD	500	1.015	0.427	0.433	0.37	43.6
1497-1996AD	500	1.039	0.339	0.441	0.44	42.4

Tabl.2. The relative power of different cyclic components in C1 chronology (in % to common variation)

Period	Spectral window			
	<600 years	220-600 years	120-220 years	60-120 years
81 BC-1996 AD	4.0	6.1	11.3	6.7
0-499 AD		2.8	20.6	2.6
500-999 AD		3.7	6.9	11.0
1000-1499 AD		12.0	2.3	4.9
1497-1996 AD		5.9	8.8	13.3

Tabl.3. Statistical evaluations of model for reconstruction early summer temperature based on C2 chronology and annual temperature based on C1 chronology

Calibration			Verification			
Period	R^2	F value	D-W statistics	Period	R^2	F value	D-W statistics
early summer temperature							
1933-1989	0.59	79.6 (p<0.00001)	1.914				
1960-1989	0.72	72.7 (p<0.00001)	1.907	1933-1959	0.45	20.5 (p<0.001)	1.877
annual temperature (average)							
1933-							

1993 0.67 46.0 2.51
(p<0.000001)

FIGURES

Fig.1.The map of territory where wood samples were collected: 1- sites of living old trees; 2- sites where wood remains of dead trees and subfossil wood were collected; 3-recent polar timberline.
Fig.2.The variability of average tree-ring width (smoothed) in absolutely dated (upper) and "floating"(below) Taymir chronology. The according radiocarbon dates shown at right column.
Fig.3.Correlation of C2 index chronology with pentad temperatures (asterisk shows the significant value of correlation coefficient). The many years average temperature curve also shown as wide line.
Fig.4.Comparison between observed and calculated early summer (1) and annual (2) temperature for Taymir. Empty columns indicate the residuals.
Fig.5.Reconstructed early summer temperature from C2 chronology: 1- 5-year smoothing, 2- 57-year smoothing.
Fig.6.Comparison of long-term changes in annual temperature reconstructed from Taymir C1 chronology (2) with oxygen isotopic ratio in Greenland ice cores (2)(according to Burroughs,1992).