# Eechnical Note <br> No. 5 

TABLES OF MEDIAN HOURLY VALUES OF THE COSINE OF THE SOLAR ZENITH ANGLE ( $\chi$ ) FOR THIRTY-FIVE LOCATIONS

by R. E. McDuffie
U. S. DEPARTMENT OF COMMERCE NATIONAL BUREAU OF STANDARDS

## NATIONAL BUREAU OF STANDARDS

## Eechnical Note

No. 5

TABLES OF MEDIAN HOURLY VALUES OF THE COSINE OF THE
SOLAR ZENITH ANGLE (X) FOR THIRTY-FIVE LOCATIONS
by
R.E. McDuffie

February 1959

NBS Technical Notes are designed to supplement the Bureau's regular publications program. They provide a means for making available scientific data that are of transient or limited interest. Technical Notes may be listed or referred to in the open literature. They are for sale by the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.

DISTRIBUTED BY
UNITED STATES DEPARTMENT OF COMMERCE
OFFICE OF TECHNICAL SERVICES
WASHINGTON 25, D. C.
Price $\$ 1.25$

Many parameters of the lower ionosphere, notably D and E region maximum electron densities and $D$ region absorption, vary as a simple function of the cosine of the zenith angle ( $x$ ) of the sun. It is convenient, therefore, to have tabulations of cosine $X$ for the locations at which ionospheric vertical soundings are being made. This report consists of tables of hourly values of cosine $X$ from sunrise to sunset for the 15 th day of each month appropriate to thirty-five vertical incidence ionospheric stations associated with the National Bureau of Standards, including fourteen new stations established for IGY (see Table 1). The tables were prepared in response to the recommendation by the U.R.S.I. Mixed Commission on the Ionosphere (see Proc. Mixed Comm. on the Ionosphere, p. 77 Resolution 2, Brussels, 1954).

The calculations were made in compliance with the suggestions of W. J. G. Beynon and G. M. Brown, expressed in a paper entitled "On the calculation of solar zenith angle" published in U.R.S.I. Information Bulletin, No. 97. In addition to a comprehensive discussion of the merits and accuracy of their method of computation they list a table of values of solar declination $\delta$ and equation of time $\epsilon$ for the l5th day of each month that are considered to be the best compromise values which allow for the year-to-year variations. Since the period of the International Geophysical Year (1957-1958) falls midway between the times of extreme variations of $\delta$ and $\epsilon$, i.e., midway between consecutive leap years, the values given will be quite adequate for the determination of $\cos X$ at all stations.

The basic equation is:
$\cos x=\sin \varphi \cdot \sin \delta+\cos \varphi \cdot \cos \delta \cdot \cos \left(h_{m}+\epsilon+\beta\right)$ where
$\varphi$ is latitude
$\delta$ is solar declination
$h_{m}$ is the hour angle of the mean sun from noon, reckoned positive westwards
$\epsilon$ is the correction applied to $h_{m}$ due to the Equation of Time, reckoned positive when the true sun is ahead of the mean sun
$\beta$ is the local time correcticn, reckoned positive when the time meridian is west of the station.

Since the values of $\delta$ and $\epsilon$ for the 15 th day of a month are close to the monthly median values, it is legitimate to employ the resulting $\cos X$ values in conjunction with monthly median ionospheric parameters. Interpolation between stations is not correct because of the time correction for distance from the standard meridians.

TABLE 1
Location Geographic Time Page
Iat. Iong.

| Adak, Alaska | N51 ${ }^{\circ}$ | $54^{\prime}$ | W $176^{\circ}$ | $36^{\prime}$ | $180^{\circ} \mathrm{W}$ | 4 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Amundsen-Scott (Pole) Antarctica | S90 | 00 |  | -- | GCT | 5 |
| Anchorage, Alaska | N61 | 14 | W149 | 53 | 150 W | 6 |
| Baguio, Philippines | N16 | 25 | E120 | 35 | 120 E | 7 |
| Barrow, Alaska | N71 | 20 | W1. 56 | 46 | 150 W | 8 |
| Belvoir, Virginia | N38 | 44 | W 77 | 08 | 75 W | 9 |
| Bogota, Colombia | N 4 | 32 | W 74 | 15 | 75 W | 10 |
| Byrd Base, Antarctica | S80 | 00 | W120 | 00 | 120 W | 11 |
| Cape Canaveral, Florida | N28 | 24 | W 80 | 36 | 75 W | 12 |
| Cape Hallett(Adare), Antarctica | 572 | 25 | El70 | 55 | 165 E | 13 |
| Chiclayo, Peru | S 6 | 48 | W 79 | 49 | 75 W | 14 |
| Chimbote, Peru | S 9 | 04 | W 78 | 35 | 75 W | 15 |
| College-Fairbanks, Alaska | N64 | 54 | W147 | 48 | 150 W | 16 |
| Concepcion, Chile | S36 | 35 | W 72 | 59 | 75 W | 17 |
| Ellsworth, Antarctica | 577 | 43 | W 41 | 07 | 45 W | 18 |
| Ft. Monmouth, New Jersey | N40 | 18 | W 74 | 12 | 75 W | 19 |
| Godhavn, Greenland | N69 | 15 | W 53 | 33 | 45 W | 20 |
| Grand Bahama Island | N26 | 36 | W 78 | 15 | 75 W | 21 |
| Guam, Mariana Islands | N13 | 27 | E144 | 45 | 150 E | 22 |
| Huancayo, Peru | Sl2 | 03 | W 75 | 20 | 75 W | 23 |
| La Paz, Bolivia | S16 | 29 | W 68 | 03 | 75 W | 24 |
| Iittle America, Antarctica | S78 | 17 | W162 | 15 | 165 W | 25 |
| Maui, T. of Hawaii | N2O | 48 | W156 | 30 | 150 W | 26 |
| Narsarssuak, Greenland | N61 | 09 | W 45 | 22 | 45 W | 27 |
| Okinawa, Ryukyu Islands | N26 | 19 | E127 | 47 | 135 E | 28 |
| Panama, Canal Zone | -N 9 | 24 | W 79 | 54 | 75 W | 29 |
| Puerto Rico, W. Indies | N18 | 30 | W 67 | 10 | 60 W | 30 |
| Reykjavik, Iceland | N64 | 08 | W 21 | 47 | 15 W | 31 |
| San Francisco, California | N37 | 24 | W122 | 10 | 120 W | 32 |
| San Salvador, Bahama Islands | N24 | 05 | W 74 | 30 | 75 W | 33 |
| St. John's, Newfoundland | N47 | 37 | W 52 | 42 | 60 W | 34 |
| Talara, Peru | S 4 | 38 | W 81 | 18 | 75 W | 35 |
| Thule, Greenland | N76 | 33 | W 68 | 50 | 75 W | 36 |
| White Sands, New Mexico | N32 | 18 | W106 | 30 | 105 W | 37 |
| Wilkes, Antarctica | S66 | 15 | Ell 10 | 35 | 105 E | 38 |

## Adak, Alaska (51.90N, $176.6^{\circ} \mathrm{W}$ ) Time: $180^{\circ} \mathrm{W}$

 Hourly values of $\cos X$ for 15 th day of each monthLST Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec 00

01
02
03
04 .000 .057 .020
05 .009 .148 .197 .160 .061
06
$07 \quad .140 \quad .323 \quad .447 \quad .490 \quad .457 \quad .370 \quad .250 \quad .113$
$08 \quad .012 \quad .124 \quad .278 \quad .466 \quad .583$. 623 . 593 . $512 \quad .384 \quad .252 \quad .108 \quad .012$
$09.129 \quad .249 \quad .414 \quad .587 \quad .688 \quad .735 \quad .709 \quad .632 \quad .512 \quad .365 \quad .217 \quad .122$
$10.219 \quad .329 .510 \quad .676 \quad .780 \quad .818 \quad .796 \quad .722 \quad .599 \quad .446 \quad .294 \quad .202$
$\begin{array}{llllllllllllll}11 & .274 & .406 & .568 & .728 & .828 & .866 & .848 & .776 & .649 & .489 & .335 & .247\end{array}$
$\begin{array}{llllllllllllll}12 & .291 & .427 & .586 & .740 & .840 & .877 & .863 & .790 & .657 & .490 & .336 & .254\end{array}$
$\begin{array}{lllllllllllll} & 13 & .269 & .407 & .563 & .710 & .805 & .849 & .838 & .763 & .623 & .450 & .297\end{array} .223$
$\begin{array}{lllllllllllll}14 & .209 & .348 & .498 & .641 & .736 & .785 & .776 & .697 & .549 & .372 & .221 & .156\end{array}$
$15 . .115 \quad .252 \quad .398 \quad .537$. 645 . 688 . 681 . 597 . 441 . $260 \quad .113 \quad .056$
16 . 128 . 268 . 406 . 507 . 566 . 559 . $469 \quad .306 \quad .122$
$17 \quad .119 \quad .256 \quad .363 \quad .426 \quad .418 \quad .323 \quad .156$
18
19
20
.000
21
22

Amundsen-Scott. (Pole Station), Antarctica (90.0号, -- ) Time: GCT
Hourly values of $\cos X$ for 15 th day of each month
GCT Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

| 00 | .363 | .225 | .042 | .144 | .315 | .394 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| 01 | .363 | .224 | .041 | .144 | .314 | .394 |
| 02 | .363 | .224 | .041 | .145 | .314 | .394 |
| 03 | .363 | .224 | .041 | .145 | .314 | .394 |
| 04 | .362 | .224 | .040 | .145 | .314 | .394 |
| 05 | .362 | .224 | .040 | .146 | .314 | .395 |
| 06 | .362 | .223 | .040 | .146 | .313 | .395 |
| 07 | .362 | .223 | .040 | .146 | .313 | .395 |
| 08 | .362 | .223 | .039 | .146 | .313 | .395 |
| 09 | .362 | .223 | .039 | .146 | .313 | .395 |

10 . 362 . 222.039
11 . 362 . 222.038
$12 \quad .362 \quad .222 \quad .038$
13.361 .222 .038
$14 \quad .361 .221 .037$
$\begin{array}{llll}15 & .361 & .221 & .037\end{array}$
$\begin{array}{llll}16 & .361 & .221 & .037\end{array}$
17.361 . 221 . 036
18.361 .220 .036

19 . 361 . 220.036
$20 \quad .361 \quad .220 \quad .036$
$21 \quad .360 \quad .220 \quad .035$
$22.360 \quad .220 \quad .035$
$23 \quad .360 \quad .219 \quad .035$
$.147 \quad .313 \quad .395$
$.147 \quad .313 \quad .395$
$.147 \quad .312 \quad .395$
$.148 \quad .312 \quad .395$
.148 . 312.395
$.148 \quad .312 .395$
.148 . 312.395
$.149 \quad .312 \quad .395$
.149 .312 .395
.149 . 311.395
.149 .311 .395
.150 . 311 . 395
.150 .311 .395
.150 . 311.396

Anchorage, Alaska ( $61.2^{\circ} \mathrm{H}, 149.9^{\circ} \mathrm{W}$ ) Time: $150{ }^{\circ} \mathrm{W}$ Hourly values of $\cos X$ for 15 th day of each month

LST Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec 00

01
02
03
04
05
06
07
08
$\begin{array}{lllllllll}. & .195 & .190 & .385 & .518 & .568 & .537 & .441 & .298\end{array}$
09 $\begin{array}{lllllllll}.116 & .293 & .483 & .611 & .660 & .631 & .538 & .395 & .229\end{array}$

$11 \quad .112 \quad .250 \quad .426 \quad .606 \quad .725 \quad .774 \quad .759 \quad .662 \quad .514 \quad .338 \quad .175 \quad .084$
$\begin{array}{lllllllllllll}12 & .131 & .274 & .447 & .622 & .738 & .789 & .769 & .680 & .528 & .346 & .182 & .096\end{array}$


15 . $013 \quad .157 \quad .320 \quad .483 \quad .599 \quad .659 \quad .650 \quad .549 \quad .379 \quad .185 \quad .027$
$16 \quad .065 \quad .223 \quad .385 \quad .504 \quad .568 \quad .554 \quad .453 \quad .277$. 081
17 . 110 . 271 . 393 . 461 . 448 . 341 . 163
18
.148 . 275 . 347 . 332 . 221 . 035
19
20
21
.026 . 158 . 232 . 216 . 099
.049 .126 .107
.034 .012
22

Baguio, Philippines $\left(16.4^{\circ} \mathrm{N}, 120.6^{\circ} \mathrm{E}\right)$ Time: $120^{\circ} \mathrm{E}$
Hourly values of $\cos X$ for 15 th day of each month
LST Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec 00

01
02
03
04
05
06 .056 . 115 .120 .090 .060 .045 .026
07 . 103 . 132 . 209 . 301 . 349 . 347 . 322 . 302 . 291 . 269 . 214 . 144 $08 \quad .321 .362 \quad .443 \quad .528 \quad .466 \quad .559 \quad .538 \quad .527 \quad .519 \quad .491 \quad .427 \quad .354$ $09 \quad .510 \quad .563 \quad .647 \quad .722 \quad .750 \quad .740 \quad .725 \quad .721 \quad .713 \quad .676 \quad .604 \quad .531$
$\begin{array}{lllllllllllll}10 & .658 & .722 & .805 & .871 & .889 & .879 & .869 & .870 & .859 & .812 & .733 & .666\end{array}$
$11 \begin{array}{lllllllllllll} & .754 & .827 & .907 & .963 & .974 & .965 & .962 & .965 & .948 & .890 & .807 & .747\end{array}$
$\begin{array}{llllllllllllll}12 & .792 & .871 & .947 & .993 & .999 & .993 & .996 & .999 & .973 & .905 & .820 & .769\end{array}$
$\left.\begin{array}{lllllllllllll} & 13 & .769 & .852 & .922 & .958 & .962 & .961 & .969 & .970 & .932 & .855 & .771\end{array}\right) .732$
$\begin{array}{llllllllllllll} & 14 & .686 & .771 & .833 & .862 & .865 & .871 & .883 & .879 & .829 & .744 & .663 & .637\end{array}$
$\begin{array}{llllllllllllll} & 15 & .550 & .632 & .687 & .710 & .716 & .729 & .744 & .733 & .671 & .591 & .505 & .491\end{array}$
$\begin{array}{llllllllllllll}16 & .369 & .447 & .493 & .512 & .524 & .546 & .562 & .541 & .468 & .372 & .305 & .305\end{array}$
$\begin{array}{lllllllllllll} & 17 & .156 & .226 & .265 & .283 & .303 & .332 & .348 & .318 & .235 & .137 & .079\end{array} .089$
18 . 018 . 038 . 067 . 104 . 117 . 077
19
20
21
22
23

Barrow, Alaska (71.30 ${ }^{\circ} \mathrm{N}, 156.8 \mathrm{~W}_{\mathrm{N}}$ ) Time: $150 \mathrm{O}_{\mathrm{N}}$
Hourly values of $\cos X$ for 15 th day of each month
Lst Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

00

01
02
03
04
05
06
07
08
09
10
11

14 15
$.002 \quad .083 \quad .055$ $.005 \quad .083 \quad .054$ .028 . 104 . 073 .070 .143 . 111 .127 . 198 . 165 . 042
.041 . 197 . 266 . 231 . 112 $\begin{array}{llllll}.121 & .274 & .340 & .306 & .189 & .021\end{array}$ $\begin{array}{llllll}.204 & .353 & .417 & .384 & .270 & .104\end{array}$
$\begin{array}{llllllll}.077 & .283 & .429 & .490 & .459 & .349 & .184 & .004\end{array}$ $\begin{array}{llllllll}.151 & . & 354 & .497 & .556 & .526 & .419 & .255\end{array}$
.027 . 212 . 412 . 551 . 610 . 582 . 476 . 311 . 126
$.072 \quad .256 \quad .453 \quad .589 \quad .648 \quad .622 \quad .517 \quad .350$. 161
$\begin{array}{llllllllll}.097 & .280 & .473 & .607 & .667 & .643 & .538 & .369 & .177 & .008\end{array}$
$.101 \quad .282 \quad .472 \quad .605$. 666 . $644 \quad .539 \quad .366 \quad .170 \quad .001$
$\begin{array}{lllllllll}.084 & .263 & .450 & .582 & .645 & .624 & .518 & .342 & .143\end{array}$
$\begin{array}{lllllllll}.047 & .224 & .408 & .541 & .606 & .586 & .478 & .297 & .096\end{array}$
$.166 \quad .350 \quad .484 \quad .551 \quad .532 \quad .421 \quad .236 \quad .033$
$\begin{array}{lllllll}.095 & .259 & .414 & .485 & .465 & .351 & .166\end{array}$
$.016 \quad .198 \quad .337 \quad .410 \quad .390 \quad .272$. 080
$.116 \quad .289 \quad .334 \quad .312 \quad .191$
.183 . 260 . 237 . 112
.116 . 194 . 169 . 041
.062 .140 . 113
.024 . 103 . 073

## Belvoir, Virginia (38.7 ${ }^{\circ} \mathrm{N}, 77.1^{\mathrm{W}}$ ) Time: $75 \mathrm{O}_{\mathrm{W}}$

Hourly values of $\cos X$ for 15 th day of each month
LisT Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec 00

01
02
03
04
05
.036
06 . 075 . 186 . 220 . 185 . 110 . 021
07
$08 \quad .087 \quad .174 \quad .312 \quad .464 \quad .558 \quad .582 \quad .553 \quad .494 \quad .412 \quad .310 \quad .194 \quad .102$

$\begin{array}{lllllllllllll}10 & .373 & .478 & .619 & .756 & .834 & .854 & .834 & .785 & .702 & .587 & .457 & .368\end{array}$

$\begin{array}{lllllllllllll}12 & .499 & .618 & .753 & .874 & .940 & .964 & .954 & .908 & .813 & .679 & .545 & .469\end{array}$
$\begin{array}{lllllllllllll}13 & .489 & .612 & .743 & .855 & .919 & .946 & .941 & .893 & .789 & .648 & .514 & .448\end{array}$
$14 \quad .430 \quad .555 \quad .680 \quad .786$
$\begin{array}{lllllllllllll}15 & .327 & .450 & .568 & .670 & .735 & .773 & .774 & .717 & .593 & .439 & .313 & .267\end{array}$
$\begin{array}{llllllllllll} & .166 & . & .306 & .417 & .515 & .585 & .629 & .631 & .567 & .434 & .276\end{array} .156 \quad .121$
$\begin{array}{lllllllllll}17 & .017 & .131 & .236 & .333 & .408 & .460 & .461 & .389 & .250 & .088\end{array}$
18
.037 . 135 . 218 . 255 . 275 . 194 . 046
.026 .089 . 086
20
21
22
23

## Bogota, Colombia ( $4.50 \mathrm{~N}, 74.2 \mathrm{~W}$ ) Time: $75^{\circ} \mathrm{W}$

Hourly values of $\cos X$ for 15 th day of each month
LisT Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec 00

01
02
03
04
05
06 . 025 . 053 . 043 . 018 . 013 .037 .062 .051 . 001 $\begin{array}{lllllllllllll} & 07 & .187 & .187 & .229 & .279 & .297 & .279 & .258 & .264 & .294 & .314 & .293\end{array}$ $08 \quad .413 \quad .426 \quad .472 \quad .515 \quad .521 \quad .499 \quad .483 \quad .497 \quad .530 \quad .544 \quad .513 \quad .454$ $09 \quad .602 \quad .635 \quad .682 \quad .717 \quad .712 \quad .687 \quad .677 \quad .698 \quad .731 \quad .736 \quad .696 \quad .639$ $\begin{array}{llllllllllllll}10 & .763 & .799 & .846 & .870 & .856 & .830 & .826 & .853 & .882 & .877 & .829 & .778\end{array}$ $\begin{array}{llllllllllllll}11 & .862 & .908 & .952 & .966 & .944 & .918 & .922 & .951 & .974 & .957 & .907 & .861\end{array}$ $\begin{array}{lllllllllllll}12 & .900 & .953 & .993 & .996 & .969 & .947 & .956 & .986 & .999 & .972 & .919 & .884\end{array}$ $\begin{array}{lllllllllllll}13 & .876 & .933 & .966 & .959 & .929 & .913 & .928 & .955 & .957 & .919 & .867 & .845\end{array}$ $\begin{array}{llllllllllllll}14 & .789 & .847 & .873 & .858 & .828 & .818 & .838 & .860 & .849 & .803 & .755 & .746\end{array}$ $\begin{array}{llllllllllllll}15 & .647 & .703 & .720 & .699 & .672 & .671 & .693 & .707 & .684 & .633 & .589 & .594\end{array}$ $\begin{array}{lllllllllllll}16 & .459 & .509 & .518 & .494 & .473 & .480 & .503 & .508 & .473 & .416 & .382 & .399\end{array}$ $\begin{array}{lllllllllllll}17 & .237 & .280 & .280 & .255 & .243 & .258 & .280 & .275 & .230 & .172 & .147 & .175\end{array}$ 18 . 030.023 .001 . 020 . 041 . 025

19
20
21

Byrd Base, Antarctica $\left(80.0^{\circ} \mathrm{S}, 120.0^{\circ} \mathrm{W}\right)$ Time: $120^{\circ} \mathrm{W}$
Hourly values of $\cos X$ for 15 th day of each month
LST Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
$00 \quad .196 \quad .052$ .145 .229 $.154 \quad .235$ $.173 \quad .252$
.029 .201 .278 .066 .237 . 312
.109 . 277 . 351
$.154 \quad .320 \quad .392$
$.198 \quad .362 .433$
$.036 \quad .239 \quad .400 \quad .472$
$.071 \quad .273 \quad .432 \quad .504$
$.098 \quad .298 \quad .456 \quad .529$
$.115 \quad .313 \quad .470 \quad .544$
$.120 \quad .316 \quad .472 \quad .549$
$.114 \quad .308 \quad .464 \quad .542$
$.096 \quad .289 \quad .444 \quad .525$
$.068 \quad .260 \quad .416 \quad .499$
$.031 \quad .223 \quad .380 \quad .466$
.181 .339 .427
$.136 \quad .296 \quad .386$
.092 .253 .345
.052 . 215 . 307
.019 .182 .274
.158 .250
23 . 200.055

Cape Canaveral, Florida $\left(28.4^{\circ} \mathrm{N}, 80.6^{\circ} \mathrm{W}\right)$ THe: $75^{\circ} \mathrm{W}$ Hourly values of $\cos X$ for 15 th day of each month

LST Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec 00

01
02
03
04
05

| 06 |  |  |  | .086 | .109 | .075 | .017 |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| 07 |  |  | .090 | .221 | .303 | .320 | .288 | .240 | .187 | .125 | .042 |  |
| 08 | .136 | .213 | .312 | .438 | .510 | .522 | .494 | .454 | .405 | .338 | .234 | .162 |
| 09 | .322 | .396 | .512 | .630 | .693 | .701 | .678 | .645 | .597 | .523 | .423 | .339 |
| 10 | .474 | .559 | .672 | .785 | .838 | .845 | .828 | .800 | .750 | .667 | .554 | .479 |
| 11 | .583 | .677 | .791 | .892 | .938 | .944 | .933 | .909 | .854 | .762 | .651 | .574 |
| 12 | .640 | .741 | .852 | .943 | .983 | .992 | .987 | .963 | .901 | .799 | .686 | .617 |
| 13 | .642 | .748 | .854 | .935 | .973 | .985 | .985 | .960 | .889 | .777 | .664 | .606 |
| 14 | .588 | .696 | .796 | .870 | .906 | .924 | .928 | .893 | .817 | .698 | .587 | .540 |
| 15 | .483 | .590 | .683 | .750 | .788 | .812 | .820 | .785 | .692 | .566 | .460 | .425 |
| 16 | .332 | .436 | .521 | .585 | .627 | .659 | .668 | .625 | .521 | .391 | .291 | .268 |
| 17 | .148 | .246 | .324 | .386 | .434 | .473 | .482 | .431 | .319 | .184 | .093 | .080 |
| 18 |  | .031 | .102 | .165 | .221 | .268 | .275 | .215 | .092 |  |  |  |

## Cape Mallet (Adare), Antarctica ( $72.4^{\circ} \mathrm{S}, 170.9^{\circ} \mathrm{E}$ ) THe: $165^{\circ} \mathrm{E}$

 Hourly values of $\cos X$ for 15 th day of each monthI.ST Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
00.065 . 017 . 101
01 . 079 . 039 . 119
02 . 111 . 079 . 155

| 03 | .160 | .014 |  | .134 | .206 |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| 04 | .220 | .077 | .033 | .200 | .268 |  |
| 05 | .290 | .149 | .110 | .273 | .339 |  |
| 06 | .363 | .225 | .057 | .188 | .348 | .411 |

$\begin{array}{llll} & 07 & .435 & .300\end{array} .134$
$08 \quad .501$. 370 . 205 . 011
09 . 556 . 429 . 264 . 071
$\begin{array}{lllll}10 & .597 & .473 & . & 307\end{array}$
$\begin{array}{lllll}11 & .621 & .499 & .333 & .133\end{array}$
$\begin{array}{lllll}12 & .626 & .506 & .338 & .136\end{array}$
13 . 612 . 492 . 322 . 117
$\begin{array}{lllll}14 & .579 & .460 & .287 & .080\end{array}$
$.009 \quad .190 \quad .372 \quad .518 \quad .598$
$15 \quad .531$. 410 . 235 . 026
$\begin{array}{llll}16 & .470 & .347 & .169\end{array}$
$\begin{array}{llll}17 & .400 & .276 & .094\end{array}$
18 . 327 . 198 . 03. 5
$.093 \quad .248 \quad .342$
19 . 254 . 122
$.018 \quad .177$. 272
.113 .209
21.132
.062 .158
22.091
.027 . 121
23.067

Chiclayo, Peru $\left(6.8^{\circ} \mathrm{S}, 79.8^{\circ} \mathrm{W}\right)$ Time: $75^{\circ} \mathrm{W}$ Hourly values of $\cos X$ for 15 th day of each month

LST Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec 00

01
02
03
04
05
06

| 07 | .169 | .138 | .141 | .153 | .143 | .114 | .097 | .123 | .188 | .250 | .266 | .228 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| 08 | .402 | .383 | .391 | .396 | .376 | .341 | .328 | .364 | .433 | .489 | .495 | .453 |
| 09 | .611 | .604 | .614 | .611 | .580 | .541 | .534 | .578 | .649 | .696 | .693 | .651 |
| 10 | .781 | .785 | .796 | .783 | .742 | .701 | .701 | .751 | .819 | .857 | .846 | .807 |
| 11 | .900 | .915 | .924 | .901 | .851 | .811 | .817 | .871 | .933 | .960 | .944 | .912 |
| 12 | .961 | .984 | .989 | .955 | .899 | .862 | .875 | .929 | .983 | .999 | .980 | .957 |
| 13 | .960 | .988 | .987 | .943 | .884 | .851 | .869 | .922 | .966 | .972 | .952 | .941 |
| 14 | .896 | .926 | .918 | .866 | .805 | .779 | .802 | .851 | .882 | .879 | .862 | .864 |
| 15 | .774 | .803 | .787 | .728 | .669 | .650 | .677 | .719 | .738 | .727 | .715 | .731 |
| 16 | .602 | .610 | .602 | .539 | .485 | .475 | .503 | .537 | .543 | .527 | .523 | .551 |
| 17 | .392 | .410 | .377 | .312 | .265 | .263 | .292 | .315 | .310 | .293 | .297 | .337 |
| 18 | .159 | .167 | .126 | .062 | .025 | .031 | .058 | .071 | .057 | .040 | .053 | .104 |

19
20
21
22

Chimbote, Peru $\left(9.1^{\circ} \mathrm{S} 78.6^{\circ} \mathrm{W}\right)$ Time: $75^{\circ} \mathrm{W}$
Hourly values of $\cos X$ for 15 th day of each month

LST 00
01 02 03 04 05

| 06 |  |  |  |  |  |  |  | .022 | .054 | .026 |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| 07 | .202 | .167 | .163 | .166 | .149 | .117 | .101 | .133 | .206 | .275 | .296 | .261 |
| 08 | .432 | .409 | .410 | .406 | .379 | .341 | .330 | .371 | .448 | .510 | .522 | .484 |
| 09 | .637 | .626 | .629 | .617 | .579 | .537 | .532 | .581 | .659 | .713 | .716 | .677 |
| 10 | .802 | .802 | .806 | .784 | .736 | .693 | .694 | .749 | .824 | .868 | .864 | .829 |
| 11 | .917 | .927 | .928 | .896 | .840 | .797 | .805 | .863 | .932 | .966 | .956 | .928 |
| 12 | .973 | .990 | .988 | .945 | .883 | .843 | .857 | .916 | .977 | 1.000 | .987 | .969 |
| 13 | .966 | .989 | .980 | .928 | .862 | .827 | .847 | .904 | .954 | .967 | .954 | .947 |
| 14 | .898 | .922 | .906 | .845 | .779 | .750 | .775 | .828 | .865 | .870 | .859 | .866 |
| 15 | .772 | .795 | .771 | .703 | .639 | .618 | .646 | .692 | .717 | .714 | .710 | .730 |
| 16 | .598 | .616 | .584 | .512 | .453 | .440 | .470 | .507 | .520 | .520 | .515 | .548 |
| 17 | .386 | .398 | .357 | .284 | .232 | .227 | .257 | .285 | .286 | .277 | .288 | .333 |
| 18 | .153 | .154 | .106 | .034 |  |  | .023 | .040 | .033 | .024 | .045 | .100 | 19 20

21
22
23

College - Fairbanks, Alaska $\left(64.9^{\circ} \mathrm{N}, 147.8^{\circ} \mathrm{W}\right)$ Time: $150^{\circ} \mathrm{W}$
Hourly values of $\cos X$ for 15 th day of each month
IST Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec 00

01
02.028

03
04

05
06
07
08
09
10
$11 \begin{array}{lllllllllllll} & .054 & .196 & .375 & .560 & .685 & .738 & .715 & .620 & .464 & .281 & .115 & .024\end{array}$
$12.068 \quad .212 \quad .389 \quad .570 \quad .693 \quad .748 \quad .727 \quad .632 \quad .472 \quad .284 \quad .118 \quad .031$
13 . 055 . 201 . 375 . 552 . 674 . 731 . 712 . 616 . 451 . 259 . 093 . 012
$14 \quad .016 \quad .163 \quad .333 \quad .507 \quad .629 \quad .688 \quad .672 \quad .573 \quad .402 \quad .207 \quad .043$
$15 \quad .099 \quad .266 \quad .438 \quad .561 \quad .623 \quad .608 \quad .506 \quad .330 \quad .131$
$16 \quad .015 \quad .179 \quad .349 \quad .474 \quad .541 \quad .525 \quad .419 \quad .238 \quad .038$
17
18
19
20
21
22

Concepcion, Chile $\left(36.6^{\circ} \mathrm{S}, 73.0^{\circ} \mathrm{W}\right)$ Time: $75^{\circ} \mathrm{W}$
Hourly values of $\cos X$ for 15 th day of each month
LST Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec 00

01
02
03
04

| 05 | . 018 |  |  |  |  |  |  |  |  |  | . 066 | . 086 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 06 | . 212 | . 112 | . 020 |  |  |  |  |  | . 011 | . 163 | . 265 | .278 |
| 07 | . 406 | . 315 | . 228 | . 132 | . 043 |  |  | . 067 | . 217 | .366 | . 458 | . 467 |
| 08 | . 586 | . 506 | . 421 | . 319 | . 222 | . 155 | . 160 | .254 | . 406 | . 549 | . 633 | . 640 |
| 09 | . 742 | .671 | . 588 | . 4 '79 | . 372 | . 303 | . 314 | . 413 | . 565 | . 700 | .778 | .786 |
| 10 | . 862 | . 800 | . 716 | . 599 | . 485 | . 415 | . 431 | . 535 | . 683 | . 810 | . 882 | . 894 |
| 11 | . 938 | . 883 | . 797 | .671 | . 551 | . 483 | . 504 | .610 | . 753 | . 871 | . 939 | . 958 |
| 12 | . 964 | . 915 | . 825 | . 691 | . 567 | . 501 | . 528 | . 634 | . 768 | . 878 | .945 | . 972 |
| 13 | .940 | . 894 | . 799 | . 656 | . 530 | . 469 | . 501 | . 604 | . 730 | . 832 | . 899 | . 936 |
| 14 | . 866 | . 820 | . 719 | . 570 | . 445 | . 390 | . 425 | . 523 | . 639 | .734 | . 804 | . 852 |
| 15 | . 748 | .700 | . 592 | . 439 | . 316 | . 267 | . 304 | . 397 | . 503 | . 593 | . 668 | .727 |
| 16 | . 594 | .541 | . 426 | .270 | . 153 | . 111 | . 149 | .234 | . 330 | . 417 | . 498 | . 567 |
| 17 | . 413 | .354 | . 232 | . 077 |  |  |  | . 045 | . 130 | . 219 | . 307 | .386 |
| 18 | . 220 | .152 | . 024 |  |  |  |  |  |  | . 012 | . 108 | . 194 |
| 19 | . 026 |  |  |  |  |  |  |  |  |  |  | . 005 |

20
21
22
23

Ellsworth, Antarctica $\left(77.7^{\circ} \mathrm{S}, 41.1^{\circ} \mathrm{W}\right)$ Time: $45^{\circ} \mathrm{W}$ Hourly values of cos $X$ for 15 th day of each month

IST Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

| 00 | . 157 | . 012 |  |  |  |  | . 107 | . 191 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 01 | . 165 | . 019 |  |  |  |  | . 120 | . 202 |
| 02 | . 185 | . 040 |  |  |  |  | .147 | . 226 |
| 03 | . 218 | . 073 |  |  |  | . 013 | . 185 | .260 |
| 04 | . 260 | . 116 |  |  |  | . 061 | . 230 | . 303 |
| 05 | . 308 | .166 |  |  |  | .114 | . 281 | . 352 |
| 06 | . 359 | . 219 | . 045 |  |  | . 170 | .334 | . 403 |
| 07 | . 410 | .273 | . 099 |  | . 019 | . 223 | .384 | . 453 |
| 08 | . 457 | . 322 | .150 |  | . 068 | . 271 | .430 | . 498 |
| 09 | .498 | .365 | . 193 |  | . 109 | .310 | .467 | . 536 |
| 10 | . 528 | . 398 | . 225 | .024 | . 139 | . 338 | . 493 | . 563 |
| 11 | .546 | .418 | .244 | . 041 | .156 | . 352 | . 506 | . 578 |
| 12 | . 552 | .424 | . 250 | . 045 | .159 | . 353 | . 505 | . 581 |
| 13 | .543 | .417 | .241 | . 034 | .147 | . 339 | . 492 | . 569 |
| 14 | . 522 | . 395 | . 218 | . 009 | . 122 | . 312 | . 465 | .546 |
| 15 | . 489 | .362 | . 182 |  | . 084 | .273 | .427 | . 511 |
| 16 | . 447 | . 319 | .137 |  | . 038 | . 226 | .381 | . 468 |
| 17 | . 399 | .268 | . 085 |  |  | .173 | . 330 | . 420 |
| 18 | .347 | .214 | . 029 |  |  | . 118 | .277 | .369 |
| 19 | .296 | .160 |  |  |  | . 065 | .226 | . 319 |
| 20 | .249 | .110 |  |  |  | . 018 | .180 | .274 |
| 21 | . 208 | . 067 |  |  |  |  | .143 | .236 |
| 22 | .178 | . 034 |  |  |  |  | . 116 | . 209 |
| 23 | . 159 | . 013 |  |  |  |  | . 103 | . 193 |

Ft. Monmouth, New Jersey $\left(40.3^{\circ} \mathrm{N}, 74.1 \mathrm{~W}\right)$ Time: 75 W
Hourly values of $\cos X$ for 15 th day of each month
LST Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec 00

01
02
03
04
05 .043 .084 .047
06 . 120 .231 . 266 . 231 . 156 . 064
$07 \quad .017 \quad .156 \quad .315 \quad .418 \quad .448 \quad .415 \quad .348 \quad .261 \quad .159 \quad .046$ 08 . 110 . 201 . 343 . 496 . 591 . 616 . 588 . 527 . 442 . 336 . 214 . 122 $09.260 \quad .361 \quad .504 \quad .651 \quad .737 \quad .760 \quad .736 \quad .681 \quad .596 \quad .482 \quad .355 \quad .263$ $\begin{array}{llllllllllllll}10 & .377 & .486 & .629 & .768 & .847 & .869 & .850 & .800 & .711 & .590 & .457 & .369\end{array}$ $\begin{array}{llllllllllllll} & 11 & .453 & .569 & .710 & .841 & .914 & .937 & .923 & .874 & .781 & .651 & .515 & .433\end{array}$ $\begin{array}{lllllllllllll}12 & .482 & .604 & .741 & .863 & .932 & .958 & .949 & .900 & .799 & .661 & .524 & .449\end{array}$ $\begin{array}{llllllllllllll}13 & .462 & .587 & .719 & .856 & .901 & .931 & .926 & .875 & .765 & .619 & .484 & .418\end{array}$ $\begin{array}{lllllllllllll}14 & .395 & .521 & .647 & .756 & .823 & .858 & .856 & .801 & .682 & .529 & .397 & .341\end{array}$ $\begin{array}{llllllllllll} & 15 & .285 & .409 & .529 & .633 & .703 & .744 & .744 & .683 & .554 & .396\end{array} .269 \quad .224$ $\begin{array}{lllllllllllll}16 & .140 & .260 & .373 & .475 & .549 & .596 & .597 & .529 & .391 & .230 & .109 & .074\end{array}$ $17 \quad .083 \quad .191 \quad .292$. 372 . 426 . 426 . 350 . 206 . 042

Godhavn, Greenland $\left(69.2^{\circ} \mathrm{NT}, 53.5^{\circ} \mathrm{W}\right)$ Time: $45{ }^{\circ} \mathrm{W}$ Hourly values of $\cos X$ for 15 th day of each month

LST Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

00 02 03 04 05 06
.048 .020
.046 .017
.067 .035
$.034 .108 \quad .075$
$.096 \quad .167 \quad .133 \quad .010$
$.016 \quad .172 \quad .240 \quad .205 \quad .086$
$\begin{array}{llllll}.104 & .256 & .321 & .285 & .171 & .006\end{array}$
$\begin{array}{llllll}.196 & .344 & .406 & .373 & .261 & .098\end{array}$
$.080 \quad .284 \quad .429 \quad .489 \quad .457 \quad .348 \quad .187$. 011
$\begin{array}{lllllll}.162 & .364 & .505 & .563 & .533 & .427 & .267\end{array}$
$\begin{array}{llllllll}. & .48 & .232 & .430 & .567 & .624 & .596 & .493\end{array} .332 \quad .150$
$\begin{array}{llllllllll}. & .280 & .478 & .611 & .668 & .642 & .540 & .378 & .192 & .024\end{array}$
$.130 \quad .312 \quad .503 \quad .634 \quad .692 \quad .668 \quad .567$. 401 . 211 . 043
$\begin{array}{lllllllll}. & 138 & .318 & .505 & .635 & .693 & .672 & .570 & .401\end{array} .207 \quad .039$
$\begin{array}{llllllll}.122 & .299 & .483 & .612 & .673 & .653 & .550 & .377\end{array} .179 \quad .012$
$\begin{array}{lllllllll}. & .253 & .258 & .439 & .569 & .632 & .613 & .508 & .330\end{array}$
$\begin{array}{lllllllll}.025 & .197 & .376 & .507 & .573 & .555 & .446 & .264 & .062\end{array}$
.120 . 298 . 431 . 501 . 482 . 370 . 188
$.032 .211 \quad .347$. 419 . 400 . 284.094
$\begin{array}{lllll}.120 & .260 & .334 & .314 & .194\end{array}$
$\begin{array}{llll}.032 & .175 & .252 & .230\end{array}$
$.100 \quad .177 \quad .154 \quad .027$
.038 .116 .090
.073 .043

## Grand Bahama $\left(26.6{ }^{\circ} \mathrm{N}, 78.2{ }^{\circ} \mathrm{W}\right)$ Time: $75^{\circ} \mathrm{W}$

Hourly values of $\cos X$ for 15 th day of each month
LST Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec 00

01
02
03
04
05

| 06 |  |  |  | .024 | .110 | .130 | .097 | .043 |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| 07 |  | .024 | .129 | .254 | .330 | .344 | .313 | .270 | .224 | .168 | .088 | .008 |
| 08 | .182 | .243 | .352 | .471 | .538 | .546 | .520 | .485 | .442 | .380 | .292 | .209 |
| 09 | .367 | .439 | .551 | .662 | .718 | .723 | .702 | .674 | .632 | .563 | .467 | .384 |
| 10 | .516 | .598 | .710 | .812 | .860 | .864 | .848 | .825 | .781 | .702 | .600 | .520 |
| 11 | .618 | .710 | .820 | .912 | .953 | .957 | .947 | .927 | .878 | .790 | .683 | .613 |
| 12 | .668 | .766 | .872 | .955 | .990 | .997 | .993 | .974 | .916 | .818 | .710 | .644 |
| 13 | .661 | .764 | .864 | .938 | .970 | .981 | .983 | .961 | .894 | .787 | .678 | .624 |
| 14 | .598 | .702 | .796 | .863 | .894 | .911 | .916 | .891 | .813 | .698 | .591 | .549 |
| 15 | .483 | .586 | .673 | .733 | .767 | .790 | .799 | .767 | .678 | .556 | .455 | .424 |
| 16 | .324 | .423 | .502 | .559 | .597 | .628 | .638 | .598 | .498 | .372 | .278 | .259 |
| 17 | .132 | .225 | .297 | .353 | .396 | .435 | .445 | .396 | .287 | .158 | .072 | .064 |
| 18 |  | .005 | .069 | .126 | .179 | .224 | .233 | .174 | .056 |  |  |  |

20
21
22
23

Guam, Mariana Islands $\left(13.6^{\circ} \mathrm{TV}, 144.9^{\circ} \mathrm{E}\right)$ Time: $150^{\circ} \mathrm{E}$
Hourly values of cos $X$ for 15 th day of each month
LST Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec 00 01 02

03
04
05
06 . 006 . 010
07 . 033 . 050 . 117 . 201 . 246 . 243 . 216 . 198 . 196 . 187 . 144 . 079 $\begin{array}{lllllllllllll} & 08 & .261 & .291 & .362 & .440 & .474 & .465 & .443 & .435 & .437 & .422 & .369\end{array} .300$ $09 \quad .467 \quad .508 \quad .582 \quad .652 \quad .675 \quad .663$. $646 \quad .646 \quad .649$. $625 \quad .564 \quad .468$
 $\begin{array}{lllllllllllll}11 & .753 & .816 & .889 & .939 & .944 & .930 & .926 & .935 & .930 & .887 & .813 & .753\end{array}$ $\begin{array}{lllllllllllll}12 & .815 & .886 & .955 & .994 & .993 & .981 & .984 & .994 & .981 & .927 & .851 & .799\end{array}$ $\begin{array}{lllllllllllll}13 & .815 & .891 & .955 & .984 & .980 & .972 & .981 & .989 & .966 & .902 & .825 & .785\end{array}$ $\begin{array}{lllllllllllll}14 & .754 & .833 & .889 & .910 & .905 & .903 & .916 & .921 & .886 & .813 & .739 & .704\end{array}$ $\begin{array}{lllllllllllll}15 & .637 & .714 & .762 & .777 & .773 & .779 & .796 & .793 & .746 & .666 & .597 & .572\end{array}$ $\begin{array}{lllllllllllll}16 & .470 & .543 & .583 & .593 & .594 & .608 & .626 & .616 & .556 & .471 & .409 & .395\end{array}$ $\begin{array}{lllllllllllll}17 & .265 & .331 & .363 & .371 & .379 & .402 & .420 & .400 & .330 & .242 & .189 & .184\end{array}$ 18 . 037 . 094 . 118 . 127 . 144 . 175 . 191 . 161 . 081 19

# Huancayo, Peru $\left(12.0^{\circ} \mathrm{S}, 75.39 \mathrm{~W}\right)$ Time: $75^{\circ} \mathrm{W}$ Hourly values of $\cos X$ for 15 th day of each month 

LST Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec 00

01
02
03
04
05
$06.033 \quad .002$.084 . 123 .097
$\left.\begin{array}{lllllllllllll} & 07 & .270 & .230 & .218 & .209 & .182 & .144 & .131 & .171 & .255 & .332 & .360\end{array}\right) .329$
$\begin{array}{llllllllllllll} & 08 & .494 & .466 & .458 & .442 & .404 & .361 & .353 & .402 & .489 & .560 & .578 & .544\end{array}$

$\begin{array}{lllllllllllll}10 & .843 & .838 & .831 & .797 & .739 & .692 & .696 & .758 & .841 & .894 & .897 & .868\end{array}$
$\begin{array}{lllllllllllll}11 & .944 & .949 & .940 & .894 & .829 & .783 & .794 & .859 & .936 & .978 & .976 & .954\end{array}$
$\begin{array}{lllllllllllll}12 & .986 & .998 & .984 & .929 & .858 & .815 & .832 & .897 & .965 & .997 & .992 & .981\end{array}$
$\begin{array}{llllllllllllll}13 & .966 & .982 & .962 & .897 & .824 & .786 & .809 & .871 & .928 & .950 & .946 & .946\end{array}$ $\begin{array}{lllllllllllll}14 & .886 & .903 & .875 & .802 & .729 & .698 & .725 & .782 & .827 & .840 & .841 & .853\end{array}$ $\begin{array}{lllllllllllll} & 15 & .750 & .765 & .729 & .650 & .580 & .557 & .586 & .637 & .669 & .676 & .681\end{array}$
$\begin{array}{lllllllllllll}16 & .568 & .578 & .534 & .452 & .390 & .371 & .403 & .444 & .465 & .467 & .480 & .519\end{array}$
$\begin{array}{llllllllllllll}17 & .353 & .355 & .303 & .219 & .162 & .156 & .186 & .218 & .227 & .229 & .250 & .301\end{array}$
18 . 119 . 111 . 052
.008 .069
19
20
21
22

La Par, Bolivia ( $16.5^{\circ} \mathrm{S}, 68.0^{\circ} \mathrm{W}$ ) Time: $75^{\circ} \mathrm{W}$
Hourly values of $\cos X$ for 15 th day of each month
LST Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec 00

01
02
03
04
05 . 023 .008
$06 \quad .175 \quad .119 \quad .089 \quad .066$. 034 . 025 . 119 . 213 . 260 . 238
$\begin{array}{lllllllllllll} & . & .403 & .358 & .334 & .305 & .262 & .216 & .208 & .261 & .360 & .449 & .489\end{array} .459$
$\begin{array}{lllllllllllll} & 08 & .610 & .578 & .556 & .520 & .466 & .416 & .413 & .475 & .575 & .657 & .684\end{array}$
 $\begin{array}{lllllllllllll}10 & .910 & .899 & .877 & .822 & .749 & .698 & .707 & .779 & .873 & .936 & .949 & .930\end{array}$
$\begin{array}{lllllllllllll}11 & .982 & .979 & .954 & .888 & .809 & .759 & .775 & .849 & .935 & .987 & .997 & .987\end{array}$
$\begin{array}{lllllllllllll}12 & .994 & .996 & .966 & .890 & .807 & .762 & .784 & .856 & .933 & .974 & .983 & .984\end{array}$
$\begin{array}{lllllllllllll}13 & .945 & .950 & .913 & .829 & .744 & .705 & .731 & .800 & .865 & .898 & .909 & .922\end{array}$
$\begin{array}{lllllllllllll}14 & .839 & .843 & .799 & .707 & .624 & .592 & .622 & .685 & .738 & .763 & .778 & .805\end{array}$
15 . $682.684 \quad .630 \quad .535 \quad .456 \quad .431 \quad .463 \quad .518 \quad .559 \quad .579$. 601 . 640
$\begin{array}{lllllllllllll}16 & .486 & .481 & .420 & .322 & .250 & .233 & .266 & .312 & .342 & .359 & .388 & .439\end{array}$
17 . 264 . 251 . 182 . 084 . 020 . 012 . 043 . 079 . 098 . 117 . 155 . 217 18 . 031 . 007

19
20
21
22

Little America, Antarctica $\left(78.3^{\circ} \mathrm{S}, 162.2^{\circ} \mathrm{W}\right)$ Time: $165^{\circ} \mathrm{W}$
Hourly values of $\cos X$ for 15 th day of each month
LST Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

| 00 | . 165 | . 021 |  |  |  |  | . 115 | . 199 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 01 | . 172 | . 026 |  |  |  |  | . 127 | . 209 |
| 02 | . 191 | . 045 |  |  |  |  | . 152 | . 230 |
| 03 | . 221 | . 076 |  |  |  | . 015 | .187 | . 263 |
| 04 | .261 | . 117 |  |  |  | . 061 | . 230 | . 304 |
| 05 | .307 | .165 |  |  |  | . 112 | .279 | . 351 |
| 06 | . 356 | . 216 | . 041 |  |  | . 165 | . 329 | . 400 |
| 07 | . 405 | .267 | . 093 |  | . 012 | . 216 | .378 | .448 |
| 08 | . 451 | . 315 | . 142 |  | . 060 | . 263 | . 422 | . 492 |
| 09 | .490 | . 357 | .184 |  | .100 | . 301 | .458 | . 528 |
| 10 | . 520 | .389 | .216 | . 015 | . 130 | . 328 | .485 | . 555 |
| 11 | . 539 | . 409 | . 235 | . 032 | .147 | .344 | .498 | . 571 |
| 12 | .545 | . 417 | .242 | . 036 | . 151 | .345 | . 499 | .574 |
| 13 | . 538 | .410 | .234 | . 027 | . 140 | . 333 | . 486 | . 564 |
| 14 | . 518 | . 391 | . 213 | . 004 | .117 | . 307 | . 461 | .542 |
| 15 | . 487 | .360 | . 180 |  | . 082 | . 271 | .426 | . 510 |
| 16 | . 448 | . 318 | . 137 |  | . 038 | . 227 | . 382 | . 469 |
| 17 | .401 | .270 | . 087 |  |  | .176 | . 333 | . 423 |
| 18 | . 352 | .219 | . 034 |  |  | . 124 | . 283 | . 374 |
| 19 | . 302 | .167 |  |  |  | . 072 | . 233 | . 326 |
| 20 | .256 | . 118 |  |  |  | .026 | . 189 | . 282 |
| 21 | .216 | . 076 |  |  |  |  | . 152 | .245 |
| 22 | . 189 | . 044 |  |  |  |  | . 126 | . 218 |
| 23 | . 168 | . 023 |  |  |  |  | . 112 | . 203 |

Maui, Territory of Hawaii $\left(20.8^{\circ} \mathrm{N}, 156.5 \%\right)$ Time: 150 W Hourly values of $\cos X$ for 15 th day of each month

LST Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec 00

01
02

03
04
05
06 .029 .043 .010
$07 \quad .087 \quad .195 \quad .260 \quad .267$. 237 . 203 . 176 . 141 . 079 . 006 $\begin{array}{lllllllllllll} & 08 & .186 & .232 & .324 & .427 & .481 & .482 & .457 & .432 & .412 & .368 & .297\end{array} .220$ $09.386 \quad .443 \quad .538 \quad .633 \quad .677 \quad .674 \quad .654 \quad .637 \quad .615 \quad .567 \quad .487 \quad .409$
$\begin{array}{llllllllllllll}10 & .550 & .619 & .715 & .800 & .834 & .830 & .816 & .805 & .781 & .724 & .636 & .561\end{array}$
$\begin{array}{lllllllllllll}11 & .669 & .747 & .841 & .917 & .943 & .939 & .931 & .923 & .894 & .827 & .735 & .666\end{array}$
$\begin{array}{lllllllllllll} & 12 & .733 & .819 & .910 & .975 & .995 & .993 & .992 & .985 & .949 & .871 & .776\end{array}$
$\begin{array}{lllllllllllll}13 & .738 & .830 & .916 & .971 & .987 & .990 & .993 & .986 & .939 & .852 & .757 & .706\end{array}$
$14.685 \quad .778 \quad .857 \quad .905 \quad .920 \quad .928 \quad .936$. 925 . 867 . 771 . $678 \quad .640$ $\begin{array}{lllllllllllll} & 15 & .576 & .669 & .740 & .781 & .798 & .813 & .825 & .807 & .737 & .634 & .546\end{array} .520$ $\begin{array}{llllllllllllll} & 16 & .419 & .508 & .572 & .608 & .629 & .652 & .665 & .640 & .558 & .450 & .369 & .356\end{array}$
$\begin{array}{lllllllllllll}17 & .225 & .308 & .363 & .398 & .425 & .456 & .470 & .435 & .344 & .232 & .159 & .157\end{array}$
18 . 007 . 081 . $129 \quad .165$. $200 \quad .239$. 251 . $206 \quad .105$
19 . 015 . 024
20

21

Narsarssuak, Greenlanā ( $61.2^{\circ} \mathrm{N}, 45.4 \mathrm{~W}$ ) Time: 45 W
Hourly values of $\cos X$ for 15 th day of each month
LST Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec 00

01
02

03
04 05

06
07 08 09
 $\begin{array}{lllllllllllll}11 & .112 & .250 & .426 & .606 & .725 & .774 & .751 & .662 & .514 & .338 & .175 & .084\end{array}$
 $\left.\begin{array}{lllllllllllll} & 13 & .123 & .268 & .438 & .608 & .723 & .776 & .759 & .668 & .511 & .324 & .161\end{array}\right) .080$ $\begin{array}{lllllllllllll} & 14 & .083 & .229 & .395 & .562 & .676 & .732 & .717 & .624 & .461 & .270 & .109\end{array} .035$ $\begin{array}{llllllllllll}15 & .017 & .161 & .324 & .487 & .603 & .662 & .649 & .552 & .382 & .189 & .031\end{array}$ $.069 \quad .228 \quad .389 \quad .508 \quad .571 \quad .558 \quad .457 \quad .281 \quad .085$

17
18
19
$\begin{array}{lllllll}.114 & .275 & .397 & .465 & .451 & .345 & .168\end{array}$
$\begin{array}{llllll}. & 152 & .279 & .350 & .335 & .224\end{array}$
. 029 . 161 . 235 . 219 . 103
.052 .128 . 109
.036 .014

Okinawa, Ryukyu ( $26.3^{\circ} \mathrm{IV}, 127.8 \mathrm{O}_{\mathrm{E}}$ ) Time: $135^{\circ} \mathrm{E}$
Hourly values of $\cos X$ for 15 th day of each month
LST Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec 00

01
02
03
04
05
06 . 050 . 071 . 037
$07 \quad .068 \quad .193 \quad .272 \quad .286 \quad .255 \quad .209 \quad .163 \quad .109 \quad .033$
$08 \quad .131 \quad .189 \quad .296 \quad .416 \quad .484 \quad .494 \quad .466 \quad .429 \quad .387 \quad .328 \quad .243 \quad .161$
$09.324 \quad .393 \quad .503 \quad .615 \quad .674 \quad .679 \quad .657 \quad .627 \quad .587 \quad .520 \quad .427 \quad .344$
$\begin{array}{llllllllllllll}10 & .484 & .563 & .674 & .778 & .827 & .831 & .814 & .790 & .748 & .673 & .572 & .492\end{array}$
$\begin{array}{lllllllllllll}11 & .600 & .688 & .798 & .893 & .934 & .937 & .926 & .906 & .859 & .775 & .669 & .594\end{array}$
$\begin{array}{lllllllllllll}12 & .664 & .760 & .867 & .951 & .986 & .992 & .987 & .968 & .914 & .819 & .712 & .644\end{array}$
$\begin{array}{llllllllllllll}13 & .672 & .773 & .875 & .950 & .982 & .991 & .991 & .971 & .908 & .804 & .696 & .638\end{array}$
$\begin{array}{llllllllllllll}14 & .623 & .727 & .822 & .890 & .920 & .935 & .939 & .916 & .842 & .729 & .623 & .577\end{array}$
$\begin{array}{lllllllllllll}15 & .521 & .645 & .712 & .773 & .805 & .827 & .835 & .805 & .720 & .600 & .498 & .465\end{array}$
$\begin{array}{lllllllllllllll}16 & .373 & .473 & .553 & .610 & .645 & .674 & .684 & .647 & .550 & .426 & .330 & .309\end{array}$
$\begin{array}{lllllllllllllll} & . & . & .288 & .355 & .409 & .451 & .488 & .498 & .452 & .346 & .218 & .131 & .120\end{array}$
$18 \quad .066 \quad .131 \quad .186 \quad .236 \quad .280 \quad .288 \quad .233 \quad .117$
19
.015 .065 .071 .006
20

21
22

Panama, Canal Zone (9.40 $10.9{ }^{\circ} \mathrm{W}$ ) Time: 75 W
Hourly values of $\cos X$ for 15 th day of each month
LST Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec 00

01
02
03
04
05
06
07 . 065 . 073 . 128 . 197 . 232 . 223 . 198 . 189 . 201 . 206 . 175 . 114
$\begin{array}{llllllllllllll} & 08 & .297 & .317 & .376 & .439 & .463 & .448 & .428 & .429 & .445 & .444 & .402 & .338\end{array}$
$09.504 \quad .536 \quad .598 \quad .653 \quad .666 \quad .648 \quad .633 \quad .642 \quad .659 \quad .649 \quad .599 \quad .535$
$\begin{array}{lllllllllllll}10 & .673 & .717 & .779 & .825 & .827 & .807 & .799 & .814 & .828 & .809 & .752 & .690\end{array}$
$\begin{array}{lllllllllllll}11 & .792 & .846 & .907 & .942 & .936 & .916 & .915 & .933 & .942 & .912 & .850 & .794\end{array}$
$\left.\begin{array}{lllllllllllll} & 12 & .853 & .915 & .972 & .996 & .984 & .967 & .972 & .991 & .992 & .951 & .886\end{array}\right) .840$
$\begin{array}{lllllllllllll}13 & .853 & .920 & .971 & .985 & .969 & .957 & .967 & .985 & .975 & .924 & .859 & .824\end{array}$
$\begin{array}{lllllllllllll}14 & .789 & .859 & .902 & .908 & .892 & .885 & .901 & .914 & .892 & .832 & .769 & .748\end{array}$
$\begin{array}{lllllllllllllll}15 & .669 & .737 & .772 & .772 & .757 & .758 & .777 & .784 & .749 & .682 & .624 & .616\end{array}$
$\begin{array}{lllllllllllll}16 & .498 & .562 & .589 & .584 & .574 & .584 & .604 & .602 & .556 & .484 & .433 & .438\end{array}$
$\begin{array}{lllllllllllll}17 & .290 & .347 & .366 & .359 & .356 & .374 & .394 & .383 & .325 & .251 & .209 & .226\end{array}$
$18 \quad .058 \quad .105$. 117 . 111 . 117 . 143 . 162 . 140 . 072
19
20
21
22
23

Puerto Rico, West Indies $\left(18.5^{\circ} \mathrm{N}, 67.29 \mathrm{~N}\right)$ Time: $60^{\circ} \mathrm{W}$ Hourly values of $\cos X$ for 15 th day of each month

LST Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec 00

01
02
03
04
05
06 .005 . 016
$07 \quad .079 \quad .180 \quad .239 \quad .243 \quad .215 \quad .185$. 165 . 138 . 083 . 013
$\begin{array}{llllllllllllll} & 08 & .195 & .234 & .320 & .415 & .464 & .463 & .438 & .418 & .402 & .370 & .305 & .231\end{array}$
$09.398 \quad .450 \quad .539 \quad .626 \quad .665 \quad .659 \quad .640 \quad .627 \quad .613 \quad .573 \quad .500 \quad .424$
$\begin{array}{lllllllllllll}10 & .570 & .630 & .720 & .798 & .827 & .819 & .806 & .799 & .783 & .734 & .653 & .581\end{array}$
$\begin{array}{lllllllllllll}11 & .690 & .762 & .851 & .919 & .939 & .932 & .925 & .922 & .901 & .842 & .755 & .689\end{array}$
$\begin{array}{llllllllllllll}12 & .757 & .838 & .923 & .981 & .995 & .990 & .989 & .987 & .959 & .889 & .800 & .741\end{array}$
$\begin{array}{llllllllllllll} & 13 & .766 & .852 & .931 & .980 & .989 & .988 & .993 & .991 & .952 & .873 & .783 & .735\end{array}$
$\begin{array}{lllllllllllll}14 & .714 & .803 & .875 & .915 & .924 & .929 & .938 & .932 & .882 & .794 & .706 & .670\end{array}$
$\begin{array}{llllllllllllll}15 & .606 & .694 & .759 & .792 & .802 & .814 & .827 & .815 & .753 & .657 & .574 & .551\end{array}$
$\begin{array}{lllllllllllll}16 & .448 & .533 & .590 & .619 & .633 & .653 & .667 & .647 & .573 & .472 & .396 & .386\end{array}$
$\begin{array}{lllllllllllllll} & 17 & .253 & .331 & .380 & .407 & .427 & .455 & .470 & .440 & .357 & .252 & .185 & .186\end{array}$
$\begin{array}{llllllllll} & .032 & .102 & .144 & .171 & .200 & .235 & .249 & .209 & .115\end{array}$
19 .008 . 018
20
21
22
23

Reykjavik, Iceland (64.7 ${ }^{\circ} \mathrm{N}, 21.39 \mathrm{~W}$ ) Time: $15^{\circ} \mathrm{W}$
Hourly values of cos $\chi$ for 15 th day of each month LST Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec 00

01
02

03
04

05
06
07
08
09
10
$\begin{array}{lllllllllllllll}11 & .046 & .185 & .364 & .551 & .676 & .728 & .703 & .609 & .456 & .278 & .113 & .020\end{array}$
$\begin{array}{llllllllllllll}12 & .076 & .219 & .396 & .579 & .701 & .754 & .732 & .638 & .482 & .298 & .133 & .044\end{array}$
$\begin{array}{lllllllllllll} & 13 & .080 & .225 & .400 & .578 & .698 & .753 & .734 & .639 & .478 & .290 & .124\end{array} .040$
$\begin{array}{llllllllllllll} & .055 & .202 & .373 & .547 & .667 & .724 & .707 & .611 & .445 & .252 & .088 & .009\end{array}$
15.005 . 151 . 319 . 490 . 611 . 671 . 655 . 556 . 385 . 189.027

16
17
18
19
20
21
22
$\begin{array}{lllllll}. & 145 & .312 & .438 & .505 & .490 & .383\end{array} .204 \quad .001$
$.036 \quad .204 \quad .333 \quad .404 \quad .388 \quad .276 \quad .090$
.093 . 226 . 300 . 282.165
.123 . 199.179 .053
.031 .103 .087
.036 .011

San Francisco, California $\left(37.4{ }^{\circ} \mathrm{N}, 122.2 \mathrm{O}^{\mathrm{W}}\right)$ Time: $120^{\circ} \mathrm{W}$ Hourly values of $\cos X$ for 15 th day of each month

LST Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec 00

01
02
03
04
05 . 025
06 .071 . 179 . 212 . 177 . 104 . 020
07
$\begin{array}{lllllllll}.121 & .275 & .375 & .402 & .369 & .305 & .225 & .133 & .026\end{array}$
$08 \quad .099 \quad .183 \quad .319 \quad .467 \quad .558 \quad .580 \quad .552 \quad .495 \quad .418 \quad .320 \quad .206 \quad .115$

$\begin{array}{lllllllllllll}10 & .391 & .494 & .631 & .765 & .839 & .858 & .838 & .792 & .713 & .601 & .474 & .387\end{array}$
$11 \begin{array}{llllllllllll} & .478 & .590 & .725 & .850 & .918 & .937 & .923 & .880 & .795 & .674 & .544\end{array} .462$
$\begin{array}{lllllllllllll}12 & .519 & .636 & .768 & .885 & .948 & .969 & .960 & .917 & .826 & .696 & .565 & .490\end{array}$
$\begin{array}{lllllllllllll} & 13 & .509 & .630 & .757 & .866 & .926 & .952 & .947 & .902 & .802 & .664 & .533\end{array} .468$
$\begin{array}{lllllllllllll}14 & . & .449 & .572 & .693 & .795 & .855 & .886 & .885 & .836 & .726 & .581 & .453\end{array} .398$
$\begin{array}{lllllllllllll}15 & .344 & .465 & .580 & .677 & .739 & .776 & .778 & .723 & .603 & .452 & .328 & .284\end{array}$
$16.201 .318 \quad .426 \quad .520 .586$. 630 . 632 . 570 . 441 . 286 . $169 \quad .135$
$\begin{array}{llllllllll} & .029 & .140 & .252 & .334 & .406 & .457 & .459 & .389 & .253\end{array}$
$18 \quad .039 \quad .133$. 213 . 269 . 269 . 191 . 045
19.018 .079 .077

20
21
22
23
$\underline{\text { San Salvador, Bahama Is. }\left(24.1^{\circ} \mathrm{N}, 74.5^{\circ} \mathrm{W}\right) \text { Time: } 75^{\circ} \mathrm{W}, ~}$ Hourly values of $\cos X$ for 15 th day of each month

List Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec 00

01
02
03
04
05
06
$08 \quad .254 \quad .312 \quad .415 \quad .525 \quad .582 \quad .586 \quad .562 \quad .534 \quad .501 \quad .446 \quad .361 \quad .281$
$09 \quad .434 \quad .504 \quad .609 \quad .710 \quad .759 \quad .759 \quad .740 \quad .719 \quad .685 \quad .622 \quad .530 \quad .450$

| 10 | .575 | .655 | .760 | .852 | .891 | .891 | .878 | .862 | .825 | .752 | .654 | .578 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |


$12 \quad .703 \quad .798 \quad .896 \quad .969 \quad .9961 .000 \quad .999 \quad .985 \quad .933 \quad .841 .737 \quad .677$

| 13 | .682 | .781 | .873 | .936 | .960 | .970 | .974 | .957 | .895 | .793 | .691 | .642 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | $14 \quad .603 \quad .703 \quad .788 \quad .844 \quad .869$. $884 \quad .892 \quad .871 \quad .798 \quad .688 \quad .589 \quad .552$ $\begin{array}{lllllllllllll}15 & .474 & .572 & .649 & .700 & .727 & .750 & .760 & .732 & .647 & .532 & .438 & .414\end{array}$ $16 \quad .302 \quad .395 \quad .465 \quad .513 \quad .545 \quad .575 \quad .587$. $550 \quad .454 \quad .335$. $248 \quad .236$ $\begin{array}{lllllllllllllllll}17 & .100 & .186 & .248 & .295 & .334 & .372 & .383 & .337 & .233 & .111 & .033 & .031\end{array}$ 18 $.013 \quad .062$. $110 \quad .155 \quad .164 \quad .108$

St. John's, Newfoundland ( $47.6{ }^{\circ} \mathrm{N}$, 52.7 W ) Time: 609 Hourly values of $\cos x$ for 15 th day of each month

IST Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec 00

01
02
03
04 .001 .053 . 015
05
$.034 \quad .163$. $209 \quad .172 \quad .081$
06
$07 \quad .046 \quad .201 \quad .375 \quad .490 \quad .527 \quad .495 \quad .417 \quad .309 \quad .183 \quad .051$
$08 \quad .093 \quad .200 \quad .358 \quad .526 \quad .633 \quad .667$. $639 \quad .567 \quad .459 \quad .328 \quad .190 \quad .095$
 $\begin{array}{lllllllllllll}10 & .302 & .425 & .582 & .737 & .831 & .863 & .843 & .778 & .666 & .521 & .375 & .285\end{array}$
$\begin{array}{lllllllllllll}11 & .352 & .480 & .635 & .783 & .872 & .906 & .890 & .826 & .709 & .556 & .408 & .324\end{array}$
$\begin{array}{lllllllllllll}12 & .359 & .492 & .643 & .784 & .870 & .906 & .895 & .830 & .706 & .546 & .398 & .321\end{array}$
$\begin{array}{lllllllllllll}13 & .324 & .459 & .605 & .739 & .825 & .865 & .857 & .790 & .657 & .491 & .344 & .276\end{array}$
$\begin{array}{lllllllllllll}14 & .248 & .383 & .524 & .654 & .740 & .785 & .779 & .707 & .566 & .395 & .252 & .193\end{array}$
15 . 138 . $270 \quad .405$. 532 . 621 . 672 . 667 . 589 . 440 . 265 . 126 . 076
16 . 128 . 257 . 382 . 475 . 532. . 528 . 443 . 286 . 109
17
18
19
.058 .048
20
21
22

Talaria, Peru $(4.60 \mathrm{~S}, 81.3 \mathrm{~W})$ Time: 75 W Hourly values of $\cos X$ for 15 th day of each month

LST Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec 00

01
02
03
04
05
06
07 . 132.105 . 115 . 135 . 132 . 106 . 087 . 108 . 166 . $220 \quad .231 \quad .190$ $\begin{array}{lllllllllllll} & 08 & .368 & .352 & .367 & .381 & .368 & .335 & .321 & .351 & .414 & .463 & .463\end{array} .418$ $09.580 .577 \quad .595 \quad .600 .576 \quad .515 \quad .531 \quad .570 \quad .634 \quad .674 \quad .665 \quad .620$ $\begin{array}{llllllllllllll}10 & .755 & .764 & .782 & .778 & .743 & .705 & .703 & .748 & .810 & .841 & .824 & .782\end{array}$ $\begin{array}{lllllllllllll}11 & .880 & .900 & .916 & .902 & .859 & .821 & .825 & .874 & .930 & .951 & .928 & .892\end{array}$ $\begin{array}{lllllllllllll}12 & .948 & .975 & .988 & .963 & .913 & .878 & .889 & .939 & .987 & .997 & .971 & .944\end{array}$ $\begin{array}{lllllllllllll}13 & .953 & .986 & .993 & .958 & .904 & .873 & .890 & .939 & .976 & .975 & .949 & .934\end{array}$ $\begin{array}{lllllllllllll}14 & .895 & .930 & .930 & .886 & .831 & .806 & .829 & .873 & .899 & .889 & .865 & .862\end{array}$ $\begin{array}{llllllllllllll}15 & .778 & .813 & .804 & .753 & .700 & .683 & .709 & .747 & .759 & .742 & .723 & .734\end{array}$ $\begin{array}{llllllllllll}16 & .610 & .641 & .624 & .568 & .520 & .511 & .538 & .568 & .568 & .545 & .534\end{array} .558$ $\begin{array}{lllllllllllll}17 & .402 & .426 & .401 & .343 & .302 & .301 & .329 & .349 & .338 & .313 & .309 & .346\end{array}$ $\begin{array}{lllllllllllll}18 & .169 & .184 & .151 & .094 & .062 & .069 & .096 & .105 & .085 & .060 & .066 & .113\end{array}$ 19

20
21
22
23

## Thule, Greenland $\left(76.6^{\circ} \mathrm{N}, 68.8{ }^{\circ} \mathrm{W}\right)$ Time: $75^{\circ} \mathrm{N}$

Hourly values of $\cos X$ for 15 th day of each month
LST Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

$$
.094 \quad .172 \quad .143 \quad .015
$$

$$
\begin{array}{llll}
.108 & .185 & .155 & .027
\end{array}
$$

$$
.137 \text {. } 212.181 .055
$$

$$
\begin{array}{lllll}
.018 & .177 & .250 & .218 & .094
\end{array}
$$

$$
\begin{array}{llll}
.069 & .227 & .298 & .143
\end{array}
$$

$$
\text { . } 127 \text {. } 283 \text {. } 352 \text {. } 319 \text {. } 1999
$$

$$
\begin{array}{llllll}
.187 & .340 & .407 & .376 & .083
\end{array}
$$

$$
\begin{array}{lllllll}
.037 & .246 & .396 & .462 & .431 & .315 & .142
\end{array}
$$

$$
.092 \quad .299 \quad .446 \quad .511 \quad .481 \quad .367 \quad .194 \quad .005
$$

$$
\begin{array}{llllllll}
. & .338 & .342 & .487 & .551 & .522 & .410 & .237
\end{array} .045
$$

$$
\begin{array}{llllllll}
.171 & .374 & .517 & .580 & .553 & .442 & .267 & .073
\end{array}
$$

$$
\begin{array}{lllllllll}
.006 & . & .591 & .532 & .596 & .570 & .459 & .283
\end{array}
$$

$$
\begin{array}{lllllllll}
.011 & .195 & .392 & .533 & .597 & .573 & .462 & .283 & .083
\end{array}
$$

$$
\begin{array}{lllllllll}
.001 & .183 & .378 & .518 & .584 & .561 & .449 & .267 & .065
\end{array}
$$

$$
\begin{array}{llllllll}
. & .357 & .350 & .490 & .558 & .535 & .421 & .236
\end{array} .033
$$

$$
\begin{array}{lllllll}
\hline . & .317 & .309 & .490 & .497 & .381
\end{array}
$$

$$
\begin{array}{lllllll}
.067 & .258 & .400 & .472 & .449 & .331 & .145
\end{array}
$$

$$
\text { . } 009 \text {. 201 } 345 \text {. } 418 \text {. } 395 \text {. } 275 \text {. } 082
$$

$$
.141 \quad .288 \quad .363 \quad .339 \quad .216 \text {. } 021
$$

$$
\begin{array}{lllll}
.083 & .232 & .308 & .284 & .158
\end{array}
$$

$$
\text { . } 031 \text {. } 183 \text {. } 259 \text {. } 23335
$$

$$
.142 \quad .219 \text {. } 191 \text {. } 062
$$

$$
\text { . } 113 \text {. } 190 \text {. } 16000
$$

$$
\begin{array}{llll}
.094 & .173 & .146 & .018
\end{array}
$$

# White Sands, New Mexico (32.30 ${ }^{\circ} \mathrm{N}$, 106.5 ${ }^{\mathrm{W} \text { W }) ~ T i m e: ~} 105^{\circ} \mathrm{W}$ 

Hourly values of $\cos X$ for lith day of each month
IST Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec 00

01
02
03
04
05
06
.067 . 164 . 191 . 156 . 093 . 025

07 $\begin{array}{llllllllll}.023 & .143 & .283 & .372 & .392 & .361 & .307 & .243 & .167 & .072\end{array}$ $08 \quad .154 \quad .220 \quad .352 \quad .487 \quad .566 \quad .581 \quad .554 \quad .508 \quad .447$. 365 . $262 \quad .175$ $09 \quad .325 \quad .410 \quad .536 \quad .663 \quad .733 \quad .745 \quad .723 \quad .683 \quad .623 \quad .533 \quad .423 \quad .336$
 $11 \quad .553 \quad .655 \quad .779 \quad .889 \quad .943 \quad .956 \quad .944 \quad .912 \quad .843 \quad .736 \quad .616 \quad .538$
 $\begin{array}{lllllllllllll}13 & .580 & .693 & .808 & .900 & .947 & .966 & .965 & .931 & .845 & .721 & .600 & .540\end{array}$ $\begin{array}{lllllllllllll}14 & .514 & .629 & .738 & .823 & .869 & .894 & .896 & .858 & .762 & .630 & .512 & .463\end{array}$

 $\left.\begin{array}{llllllllllll} & 17 & .062 & .165 & .252 & .327 & .387 & .433 & .439 & .378 & .253 & .108\end{array}\right) .010$

Wilkes, Antarctica $\left(66.3^{\circ} \mathrm{S}, 110.6^{\circ} \mathrm{E}\right)$ Time: $105^{\circ} \mathrm{E}$
Hourly values $\cos X$ for 15 th day of each month
LST Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec 00
0.
02.018
.065 .133
$04 \quad .163 .021$
.153 .216
$05 \quad .255 \quad .116$

| 06 | .353 | .218 | .060 |  |  |  | .196 | .350 | .406 |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| 07 | .449 | .319 | .163 |  |  |  |  | .098 | .296 | .445 |
| 08 | .537 | .412 | .257 | .077 |  |  |  | .190 | .385 | .530 |

$11.699 .586 \quad .429 \quad .237$. 082 . 003 . 032 . 161 . 348 . 531 . 667 . 728
$\begin{array}{llllllllllllll}12 & .706 & .596 & .437 & .241 & .083 & .006 & .037 & .166 & .350 & .528 & .663 & .729\end{array}$
$\begin{array}{llllllllllllllllll}13 & .687 & .578 & .417 & .217 & .059 & .018 & .145 & .324 & .498 & .634 & .705\end{array}$
$\begin{array}{llllllllllllllll} & 14 & .645 & .535 & .371 & .168 & .011 & .099 & .273 & .444 & .581 & .658\end{array}$
$\begin{array}{lllll}15 & .581 & .470 & .302 \quad .097\end{array}$
$\begin{array}{lllll}16 & .500 & .386 & .214 & .009\end{array}$
$17 \quad .406 \quad .290 \quad .115$
$18 \quad .309 .188 \quad .010$
$.073 \quad .223 \quad .318$
19.213 .086
20.124
$.031 \quad .200 \quad .369 \quad .508 \quad .590$
$.110 \quad .278 \quad .420 \quad .507$
$.006 \quad .177 \quad .322 \quad .414$
21.050 . 071

22
.022

