

```

//
// Bessel.swift
//
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//
// Elements beginning with Meeus are from Elements of Solar Eclipses, Jean
// Meeus

// NASA are from http://eclipse.gsfc.nasa.gov
//      "Eclipse map/figure/table/predictions courtesy of Fred Espenak,
//      NASA/Goddard Space Flight Center, from eclipse.gsfc.nasa.gov."

// EW are from the Javascript and html on http://eclipsewise.com/
//      "Eclipse Predictions by Fred Espenak, www.EclipseWise.com"

// Original Bessel Data as of December 2020

let OriginalΔT_Date = "12/1/2020"

// Updated for revised ΔT for eclipses beginning with Apr 20, 2023 on
// source https://maia.usno.navy.mil/ser7/deltat.preds
let UpdatedΔT_Date = "4/1/2023"
let ExtrapΔT_Date = "6/30/2023" // USNO did not provide a 7/1/23 number so the
6/30/23 value is used

// Updated the two 2024 eclipses on 1/12/24 for the USNO 1/1/24 ΔT

#if prototype
let protoBessel = Bessel(
    T0:xx,
    ΔT : xx,
    noAnglePrediction : 0,
    sourceNASA: false,
    x : [ xxxx,
          xxxx,
          xxx,
          xxx ],

    y : [ xxx,
          xxx,
          xxx,

```

```

        xxx ],

d : [xxx,
     xxx,
     xxx,
     xxx ],

M : [ xxxx,
     xxx,
     xxx,
     xxx      ],

l1: [  xxx,
     xxx,
     xxx,
     xxx      ],

l2: [  xxx,
     xxx,
     xxx,
     xx       ],

tanf1: xxx,
tanf2: xxx,

T0Date: DateComponents(calendar: Calendar.current, timeZone:
    TimeZone(abbreviation: "UTC"), year: xxxx, month: xx, day:xx, hour:0,
    minute:0, second:0).date! ,

GELoc: ObsConditions(lat: xxx, long: xxx, height: 0),
map : "tbd",
mapURL : "a link"

)
#endif

```

```

import Foundation
import CoreLocation

```

```

typealias TDTHours = Double // TDT Time in Hours
typealias TDTrel   = Double // Hours relative to T0
typealias UTCHours = Double // UTC Time in Hours

```

```

// obsolete use ObsConditions instead
//struct EclipseLoc{
//    var latitude: CLLocationDegrees
//    var wlong: CLLocationDegrees // longitude with west positive
//    var height: Double // in meters
//}

```

```

// Builds a mask. In some of the cases I could not verify the angles. In these
// case no prediction is displayed
enum AngleNotVerified : Int {
    case C1Angle = 0x8
    case C2Angle = 0x4
    case C3Angle = 0x2
    case C4Angle = 0x1
}

struct Bessel {

    var T0: TDTHours // base time of Bessel Elements

    var ΔT : Double // difference between UTC and TDT

    //var ΔTdiff : Double // for NASA elements the different in ΔT from
    EclipseWise Elements
    var noAnglePrediction : Int // a mask for those angle where I could not get
                                // agreement with the reference. Hence value
                                // is suspect
    var sourceNASA :Bool // true if the source of the Bessel numbers are from
    NASA
    var x : [Double] // an array of 0...3

    var y : [Double]

    var d : [Double] // 0..2

    var M : [Double] // 0..2 NASA lists this as μ

    var l1 : [Double] //0..2

    var l2 : [Double]

    var tanf1 : Double
    var tanf2 : Double

    var T0Date: Date
    var GELoc: ObsConditions // where is the Greatest Extent
    var map: String // Name of resource for map
    var mapURL : String // URL to EclipseWise description
    var ΔT_Date : String // Date where Bessel Elements defined
}

let Meeus1994_05_10 = Bessel(
                                T0:17.0,
                                ΔT : 61.0,

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```

noAnglePrediction : 0,
sourceNASA: false,
//ΔTdiff : 61.0 - 60.2,
x : [ -0.173367, 0.4990629, 0.0000296,
      -0.00000563],
y : [ 0.383484, 0.0869393, -0.0001183,
      -0.00000092 ],
d : [ 17.68613, 0.010642, -0.000004 ],
M : [ 75.90923, 15.001621,
      0.0],
l1: [ 0.566906, -0.0000318, -0.0000098],
l2: [ 0.020679, -0.0000317, -0.0000097],
tanf1: 0.0046308,
tanf2: 0.0046077,

T0Date: DateComponents(calendar:
  Calendar.current, timeZone:
  TimeZone(abbreviation: "UTC"), year: 1994,
  month: 5, day:10, hour:0, minute:0,
  second:0).date! ,
GELoc: ObsConditions(lat: 41.5357, long:
  -84.1207, height: 0),
map : "1994m05d10",
mapURL : "https://www.willbell.com/math/mc6.htm",
ΔT_Date : OriginalΔT_Date

)

```

```

let NASA1994_05_10 = Bessel(
  T0:12.0,
  ΔT : 60.2,
  noAnglePrediction : 0,
  sourceNASA: true,
  x : [ -0.173420, 0.4990629, 0.0000296,
        -0.00000563],
  y : [ 0.383652, 0.0869393, -0.0001183,
        -0.00000092 ],
  d : [ 17.68613, 0.010642, -0.000004 ],
  M : [ 75.90923, 15.001621,
        0.0],
  l1: [ 0.566913, -0.0000318, -0.0000098],
  l2: [ 0.020672, -0.0000317, -0.0000097],
  tanf1: 0.0046308,
  tanf2: 0.0046077,

  T0Date: DateComponents(calendar:
    Calendar.current, timeZone:
    TimeZone(abbreviation: "UTC"), year: 1994,
    month: 5, day:10, hour:0, minute:0,
    second:0).date! ,

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```
GELoc: ObsConditions(lat: 41.5357, long: 84.1207,  
  height: 0),  
map : "1994m05d10",  
mapURL :  
  "https://eclipse.gsfc.nasa  
  .gov/SEbeselm/SEbeselm1951/SE1994May10Abeselm  
  .html",  
 $\Delta T$ _Date : Original $\Delta T$ _Date
```

```
)  
let EW2001_06_21 = Bessel(  
  T0:12.0,  
   $\Delta T$  : 64.2,  
  noAnglePrediction : 0,  
  sourceNASA: false,  
  x : [ 0.010336,  
        0.565384,  
        2.916e-05,  
        -8.862e-06 ],  
  
  y : [ -0.571829,  
        0.055126,  
        -1.339e-04,  
        -9.803e-07 ],  
  
  d : [23.439766,  
        -0.000183,  
        -5.650e-06,  
        0.0 ],  
  
  M : [ 359.560150,  
        14.999195,  
        1.950e-07,  
        0.0      ],  
  
  l1: [ 0.536991,  
        -0.000094,  
        -1.212e-05,  
        0.0      ],  
  
  l2: [ -0.009121,  
        -0.000094,  
        -1.206e-05,  
        0.0      ],  
  
  tanf1: 0.004600,  
  tanf2: 0.004578,
```

```

T0Date: DateComponents(calendar:
  Calendar.current, timeZone:
  TimeZone(abbreviation: "UTC"), year: 2001,
  month: 06, day:21, hour:0, minute:0,
  second:0).date! ,

GELoc: ObsConditions(lat: dms(-11,15,12), long:
  dms(2,28,42), height: 0),
map : "2001m06m21",
mapURL :
  "http://eclipsewise
  .com/solar/SEprime/2001-2100/SE2001Jun21Tprime
  .html",
ΔT_Date : OriginalΔT_Date

```

```

)
let EW2002_12_04 = Bessel(
  T0:8.0,
  ΔT : 64.4,
  noAnglePrediction : 0,
  sourceNASA: false,
  x : [ 0.186125,
        0.553248,
        1.550e-05,
        -8.703e-06 ],

  y : [ -0.354458,
        -0.130913,
        1.807e-04,
        2.215e-06 ],

  d : [-22.226496,
        -0.005297,
        5.777e-06,
        0.0 ],

  M : [ 302.480743,
        14.997273,
        -1.960e-06,
        0.0 ],

  l1: [ 0.544185,
        0.000083,
        -1.248e-05,
        0.0 ],

  l2: [ -0.001963,
        0.000083,
        -1.242e-05,
        0.0 ],

```

```
tanf1: 0.004744,  
tanf2: 0.004720,
```

```
T0Date: DateComponents(calendar:  
  Calendar.current, timeZone:  
  TimeZone(abbreviation: "UTC"), year: 2002,  
  month: 12, day:04, hour:0, minute:0,  
  second:0).date! ,
```

```
GELoc: ObsConditions(lat: dms(-39,27, 24), long:  
  dms(59,17, 6), height: 0),
```

```
map : "2002m12d04",
```

```
mapURL :
```

```
"http://eclipsewise  
.com/solar/SEprime/2001-2100/SE2002Dec04Tprime  
.html",
```

```
 $\Delta T$ _Date : Original $\Delta T$ _Date
```

```
)
```

```
let EW2003_11_23 = Bessel(  
  T0:23.0,  
   $\Delta T$  : 64.5,  
  noAnglePrediction : 0,  
  sourceNASA: false,  
  x : [ -0.197975,  
        0.556896,  
        5.702e-05,  
        -9.441e-06 ],
```

```
  y : [ -0.947893,  
        -0.173924,  
        1.989e-04,  
        3.133e-06 ],
```

```
  d : [-20.405380,  
        -0.008177,  
        4.958e-06,  
        0.0 ],
```

```
  M : [ 168.395004,  
        14.998532,  
        -2.559e-06,  
        0.0      ],
```

```
  l1: [ 0.537347,  
        -0.000003,  
        -1.311e-05,  
        0.0      ],
```

```
l2: [ -0.008767,  
      -0.000003,  
      -1.305e-05,  
      0.0      ],
```

```
tanf1: 0.004735,  
tanf2: 0.004711,
```

```
T0Date: DateComponents(calendar:  
  Calendar.current, timeZone:  
  TimeZone(abbreviation: "UTC"), year: 2003,  
  month: 11, day:23, hour:0, minute:0,  
  second:0).date! ,  
// 72 40 0 88 7 36  
GELoc: ObsConditions(lat: -72.66667, long:  
  88.12667, height: 0),  
map : "2003m11d23",  
mapURL :  
  "http://eclipsewise  
  .com/solar/SEprime/2001-2100/SE2003Nov23Tprime  
  .html",  
ΔT_Date : OriginalΔT_Date
```

```
)
```

```
let NASA2005_04_08 = Bessel(  
  T0: 21.0,  
  ΔT : 64.7,  
  noAnglePrediction : AngleNotVerified.C1Angle.rawValue +  
  AngleNotVerified.C2Angle.rawValue + AngleNotVerified.C3Angle.rawValue +  
  AngleNotVerified.C4Angle.rawValue,  
  sourceNASA: true,  
  
  x : [ 0.350320,  
        0.4857737,  
        -0.0000101,  
        -0.0000068 ],  
  
  y : [ -0.207422,  
        0.2575755,  
        -0.0000367,  
        -0.0000039 ],  
  
  d : [ 7.48629,  
        0.014899,  
        -0.000002,  
        0.0 ],  
  
  M : [ 134.57384,  
        15.004043,  
        0.0,
```



```

        0.0      ],
l1: [  0.548547,
      0.0001069,
     -0.0000115,
      0.0      ],
l2: [  0.002398,
      0.0001064,
     -0.0000115,
      0.0      ],

tanf1: 0.0046686,
tanf2: 0.0046454,

T0Date: DateComponents(calendar:
  Calendar.current, timeZone:
  TimeZone(abbreviation: "UTC"), year: 2005,
  month: 4, day:8, hour:0, minute:0,
  second:0).date! ,
// 10, 34, 8    118, 58, 54
GELoc: ObsConditions(lat: -10.5689, long:
  -118.9817, height: 0),
map : "2005m04d08",
mapURL :
  "https://eclipse.gsfc.nasa
  .gov/SEbeselm/SEbeselm2001/SE2005Apr08Hbeselm
  .html",
ΔT_Date : OriginalΔT_Date

)

let NASA2006_03_29 = Bessel(
  T0: 10.0,
  ΔT : 64.9,
  noAnglePrediction : 0,
  sourceNASA: true,
  x : [ -0.289882,
        0.5060868,
        0.0000182,
        -0.0000083 ],

  y : [ 0.278988,
        0.2789910,
        -0.0000386,
        -0.0000048 ],

  d : [ 3.39884,
        0.015557,
        -0.000001,
        0.0 ],

```

```
M : [ 328.79321,  
      15.004364,  
      0.0,  
      0.0      ],
```

```
l1: [ 0.537001,  
      0.0000644 ,  
      -0.0000127,  
      0.0      ],
```

```
l2: [ -0.009091 ,  
      0.0000641,  
      -0.0000127,  
      0.0      ],
```

```
tanf1: 0.0046826,  
tanf2: 0.0046593,
```

```
T0Date: DateComponents(calendar:  
  Calendar.current, timeZone:  
  TimeZone(abbreviation: "UTC"), year: 2006,  
  month: 3, day:29, hour:0, minute:0,  
  second:0).date! ,  
// 23, 8, 55      16, 45, 1  
GELoc: ObsConditions(lat: 23.1485, long: 16.7503,  
  height: 0),  
map : "2006m03d29",  
mapURL :  
  "https://eclipse.gsfc.nasa  
  .gov/SEbeselm/SEbeselm2001/SE2006Mar29Tbeselm  
  .html",  
ΔT_Date : OriginalΔT_Date
```

```
)
```

```
let NASA2008_08_01 = Bessel(  
  T0: 10.0,  
  ΔT : 65.6,  
  noAnglePrediction : 0,  
  sourceNASA: true,  
  x : [ 0.101843,  
        0.5285789,  
        -0.0000621,  
        -0.0000086 ],  
  
  y : [ 0.850622,  
        -0.2025213,  
        -0.0001512,  
        0.0000033 ],
```

```
d : [17.86754,  
     -0.010121,  
     -0.000004,  
     0.0 ],
```

```
M : [ 328.42578,  
     15.002008,  
     0.0,  
     0.0      ],
```

```
l1: [ 0.538231,  
     0.0001111,  
     -0.0000120,  
     0.0      ],
```

```
l2: [ -0.007867,  
     0.0001105,  
     -0.0000120,  
     0.0      ],
```

```
tanf1: 0.0046065,  
tanf2: 0.0045836,
```

```
T0Date: DateComponents(calendar:  
    Calendar.current, timeZone:  
    TimeZone(abbreviation: "UTC"), year: 2008,  
    month: 8, day:1, hour:0, minute:0,  
    second:0).date! ,  
// 68, 39, 19    72,18,13  
GELoc: ObsConditions(lat: 65.6552, long: 72.3037,  
    height: 0),  
map : "2008m08d01",  
mapURL :  
    "https://eclipse.gsfc.nasa  
    .gov/SEbeselm/SEbeselm2001/SE2008Aug01Tbeselm  
    .html",  
ΔT_Date : OriginalΔT_Date
```

```
)
```

```
let NASA2009_07_22 = Bessel(  
    T0: 3.0,  
    ΔT : 65.9,  
    noAnglePrediction : 0,  
    sourceNASA: true,  
    x : [ 0.240059,  
         0.5563975,  
         -0.0000583,  
         -0.0000100 ],
```

```
    y : [ -0.003283,
```

```

        -0.1774571,
        -0.0001346,
        0.0000032 ],

d : [ 20.26424,
      -0.007873,
      -0.000004,
      0.0 ],

M : [ 223.38823,
      15.001007,
      0.0,
      0.0      ],

l1: [ 0.530426,
      0.0000063,
      -0.0000128,
      0.0      ],

l2: [ -0.015633,
      0.0000063,
      -0.0000127,
      0.0      ],

tanf1: 0.0046013,
tanf2: 0.0045784,

T0Date: DateComponents(calendar:
Calendar.current, timeZone:
TimeZone(abbreviation: "UTC"), year: 2009,
month: 7, day:22, hour:0, minute:0,
second:0).date! ,

// 24, 13, 16      144, 7, 7
GELoc: ObsConditions(lat: 24.2211, long:
144.1186, height: 0),
map : "2009m07d22",
mapURL :
"https://eclipse.gsfc.nasa
.gov/SEbeselm/SEbeselm2001/SE2009Jul22Tbeselm
.html",
ΔT_Date : OriginalΔT_Date

)

let NASA2010_07_11 = Bessel(
T0:20.0,
ΔT : 66.2,
noAnglePrediction : 0,
sourceNASA: true,
x : [ 0.074148,
      0.5572495,

```

```

        -0.0000272,
        -0.0000089 ],

y : [ -0.717038,
      -0.1366573,
      -0.0001119,
      0.0000024 ],

d : [ 22.03570,
      -0.005341,
      -0.000005,
      0.0 ],

M : [ 118.61430,
      15.000075,
      0.0,
      0.0      ],

l1: [ 0.534422,
      -0.0000908,
      -0.0000124,
      0.0      ],

l2: [ -0.011657,
      -0.0000904,
      -0.0000123,
      0.0      ],

tanf1: 0.0045988 ,
tanf2: 0.0045759,

T0Date: DateComponents(calendar:
  Calendar.current, timeZone:
  TimeZone(abbreviation: "UTC"), year: 2010,
  month: 7, day:11, hour:0, minute:0,
  second:0).date! ,

// -19, 44, 50   -121, 52, 24
GELoc: ObsConditions(lat: -19.7472, long:
  -121.8732, height: 0),
map : "2010m07d11",
mapURL :
  "https://eclipse.gsfc.nasa
  .gov/SEbeselm/SEbeselm2001/SE2010Jul11Tbeselm
  .html",
ΔT_Date : OriginalΔT_Date

)

let NASA2012_05_20 = Bessel(

```

```
T0: 24.0, // note this differs from both the NASA
site and EW.
// Both have this as 0.0 which results
in the predictions being wrong by 24
hrs
// This value was suspected and
confirmed in teh source code for the
EW Javascript page (which omitted a
calculator)
ΔT : 66.7,
noAnglePrediction : 0,
sourceNASA: true,
x : [ -0.002272,
      0.5031812,
      0.0000183,
      -0.0000057 ],

y : [ 0.485522,
      0.0560536,
      -0.0001411,
      -0.0000006 ],

d : [20.22055,
      0.008271,
      -0.000005,
      0.0 ],

M : [ 180.85658,
      15.000578,
      0.0,
      0.0      ],

l1: [ 0.566506,
      -0.0000312,
      -0.0000097,
      0.0      ],

l2: [ 0.020247,
      -0.0000311,
      -0.0000097,
      0.0      ],

tanf1: 0.0046204,
tanf2: 0.0046204,

T0Date: DateComponents(calendar:
Calendar.current, timeZone:
TimeZone(abbreviation: "UTC"), year: 2012,
month: 5, day:20, hour:0, minute:0,
second:0).date! ,
```

```
// 49, 5, 39 176,16, 23
GELoc: ObsConditions(lat: 49.0942, long: 176.273,
  height: 0),
map : "2012m05d20",
mapURL :
  "https://eclipse.gsfc.nasa
  .gov/SEbeselm/SEbeselm2001/SE2012May20Abeselm
  .html",
ΔT_Date : OriginalΔT_Date

)
```

```
let EW2012_11_13 = Bessel(
  T0: 22.0,
  ΔT : 66.9,
  noAnglePrediction : 0,
  sourceNASA: false,
  x : [ -0.183741,
        0.574339,
        3.504e-05,
        -9.727e-06 ],

  y : [ -0.346760,
        -0.094070,
        1.483e-04,
        1.503e-06 ],

  d : [-18.247545,
        -0.010602,
        4.252e-06,
        0.0 ],

  M : [ 153.897812,
        14.999868,
        -2.883e-06,
        0.0      ],

  l1: [ 0.537464,
        -0.000023,
        -1.303e-05,
        0.0      ],

  l2: [ -0.008650,
        -0.000023,
        -1.297e-05,
        0.0      ],

  tanf1: 0.004726,
  tanf2: 0.004702,
```

```

T0Date: DateComponents(calendar:
  Calendar.current, timeZone:
  TimeZone(abbreviation: "UTC"), year: 2012,
  month: 11, day:13, hour:0, minute:0,
  second:0).date! ,

// -30,57, 22    -161,20, 12
GELoc: ObsConditions(lat: -39.9561, long:
  -161.3368, height: 0),
map : "2012m11d13",
mapURL :
  "http://eclipsewise
  .com/solar/SEprime/2001-2100/SE2012Nov13Tprime
  .html",
ΔT_Date : OriginalΔT_Date

)

let NASA2013_11_03 = Bessel(
  T0: 13.0,
  ΔT : 67.2,
  noAnglePrediction : 0,
  sourceNASA: true,
  x : [ 0.183190,
        0.5469478,
        0.0000282,
        -0.0000083 ],

  y : [ 0.294721,
        -0.1200753,
        0.0000790,
        0.0000017 ],

  d : [-15.20965 ,
        -0.012636,
        0.000003,
        0.0 ],

  M : [ 19.11060,
        15.001325,
        0.0,
        0.0      ],

  l1: [ 0.546301,
        -0.0001121 ,
        -0.0000120,
        0.0      ],

  l2: [ 0.000143 ,
        -0.0001116,

```



```

        -0.0000120,
        0.0      ],

tanf1: 0.0047137,
tanf2: 0.0046902,

T0Date: DateComponents(calendar:
  Calendar.current, timeZone:
  TimeZone(abbreviation: "UTC"), year: 2013,
  month: 11, day:3, hour:0, minute:0,
  second:0).date! ,

// 3, 29, 26      11, 41, 56
GELoc: ObsConditions(lat: 3.4906, long: -11.6988,
  height: 0),
map : "2013m11d03",
mapURL :
  "https://eclipse.gsfc.nasa
  .gov/SEbeselm/SEbeselm2001/SE2013Nov03Hbeselm
  .html",
ΔT_Date : OriginalΔT_Date

)

let NASA2015_03_20 = Bessel(
  T0: 10.0,
  ΔT : 67.6,
  noAnglePrediction : 0,
  sourceNASA: true,
  x : [ -0.168295,
        0.5537398,
        0.0000058,
        -0.0000094 ],

  y : [ 0.939052,
        0.1786475,
        -0.0000541,
        -0.0000029 ],

  d : [-0.21267,
        0.016036,
        -0.000000,
        0.0 ],

  M : [ 328.10678,
        15.004414,
        0.0,
        0.0      ],

  l1: [ 0.535950,

```

```

        0.0000265,
        -0.0000130,
        0.0      ],

12: [ -0.010156,
      0.0000264,
      -0.0000129,
      0.0      ],

tanf1: 0.0046950,
tanf2: 0.0046717,

T0Date: DateComponents(calendar:
  Calendar.current, timeZone:
  TimeZone(abbreviation: "UTC"), year: 2015,
  month: 3, day:20, hour:0, minute:0,
  second:0).date! ,

// 64, 25, 55      -6, 38, 50
GELoc: ObsConditions(lat: 64.4319, long: -6.6472,
  height: 0),
map : "2015m03d20",
mapURL :
  "https://eclipse.gsfc.nasa
  .gov/SEbeselm/SEbeselm2001/SE2015Mar20Tbeselm
  .html",
ΔT_Date : OriginalΔT_Date

)

let NASA2016_03_09 = Bessel(
  T0:2.0,
  ΔT : 67.9,
  noAnglePrediction : 0,
  sourceNASA: true,
  //      ΔTdiff : NASA2016_03_09_correct,

  x : [ -0.0625250,
        0.5502769,
        0.0000047,
        -0.0000091 ],

  y : [ 0.2538360,
        0.1721233,
        0.0000171,
        -0.0000027 ],

  d : [ -4.3797202,
        0.0158860,
        0.0000010,

```

```

        0.0000000 ],
M : [ 207.372162,
      15.003970,
      0.0,
      0.0      ],
l1: [ 0.5388680,
      -0.0000704,
      -0.0000128,
      0.0      ],
l2: [ -0.0072340,
      -0.0000700,
      -0.0000127,
      0.0      ],

tanf1: 0.0047087,
tanf2: 0.0046852,

T0Date: DateComponents(calendar:
  Calendar.current, timeZone:
  TimeZone(abbreviation: "UTC"), year: 2016,
  month: 3, day:9, hour:0, minute:0,
  second:0).date! ,
GELoc: ObsConditions(lat: 10.1, long: 148.8,
  height: 0),
map : "2016m03d09",
mapURL :
  "https://eclipse.gsfc.nasa
  .gov/SEbeselm/SEbeselm2001/SE2016Mar09Tbeselm
  .html",
ΔT_Date : OriginalΔT_Date

)

```

```

let EW2016_03_09 = Bessel(
  T0:2.0,
  ΔT : 68.2044,
  noAnglePrediction : 0,
  sourceNASA: false,
  x : [ -0.0625250,
        0.550275 ,
        0.000004628,
        -0.000009055 ],

  y : [ 0.2538330,
        0.172123,
        0.00001712,
        -0.00000275 ],

```

```

d : [ -4.379728,
      0.0158860,
      0.000000763,
      0.0000000 ],

M : [ 207.372162,
      15.003969,
      0.00000123,
      0.0      ],

l1: [ 0.538860,
      -0.00007,
      -0.00001275,
      0.0      ],

l2: [ -0.0072350,
      -0.00007,
      -0.00001269,
      0.0      ],

tanf1: 0.004709,
tanf2: 0.004685,

T0Date: DateComponents(calendar:
  Calendar.current, timeZone:
  TimeZone(abbreviation: "UTC"), year: 2016,
  month: 3, day:9, hour:0, minute:0,
  second:0).date! ,
GELoc: ObsConditions(lat: 10.0669, long:
  148.7015, height: 0),
map : "2016m03d09",
mapURL :
  "http://eclipsewise
  .com/solar/SEprime/2001-2100/SE2016Mar09Tprime
  .html",
ΔT_Date : "3/1/16"

)

```

```

let NASA2017_08_21 = Bessel(
  T0:18.0,
  ΔT : 68.4,
  noAnglePrediction : 0,
  sourceNASA: true,
  // ΔTdiff : 68.4 - 68.0,
  x : [ -0.129576,
        0.5406409,
        -0.0000293,
        -0.0000081 ],

```

```

y : [ 0.485417,
      -0.1416394,
      -0.00009005,
      0.0000021 ],

d : [ 11.86697,
      -0.013622,
      -0.000002 ],

M : [ 89.24545,
      15.003937,
      0.0],

l1: [ 0.542112,
      0.0001241,
      -0.0000118],

l2: [ -0.004025,
      0.0001235,
      -0.0000117],

tanf1: 0.0046222,
tanf2: 0.0045992,

T0Date: DateComponents(calendar:
  Calendar.current, timeZone:
  TimeZone(abbreviation: "UTC"), year: 2017,
  month: 8, day:21, hour:0, minute:0,
  second:0).date! ,
GELoc: ObsConditions(lat: 36.96668, long:
  -87.67167, height: 0),
map : "2017m08d21",
mapURL :
  "https://eclipse.gsfc.nasa
  .gov/SEbeselm/SEbeselm2001/SE2017Aug21Tbeselm
  .html",
ΔT_Date : OriginalΔT_Date

)

```

```
let EW2017_08_21 = Bessel(
```

```

T0:18.0,
ΔT : 68.8373,
noAnglePrediction : 0,
sourceNASA: false,
x : [ -0.129576,
      0.5406410,
      -0.0000293,
      -0.000008087 ],

```

```

y : [ 0.485417,
      -0.141639,
      -0.00009049,
      0.000002052 ],

d : [ 11.866967,
      -0.013622,
      -0.000002495 ],

M : [ 89.245445,
      15.003937,
      0.000001489],

l1: [ 0.542112,
      0.000124,
      -0.00001177],

l2: [ -0.004025,
      0.000123,
      -0.00001172],

tanf1: 0.004622,
tanf2: 0.004599,

T0Date: DateComponents(calendar:
  Calendar.current, timeZone:
  TimeZone(abbreviation: "UTC"), year: 2017,
  month: 8, day:21, hour:0, minute:0,
  second:0).date! ,
GELoc: ObsConditions(lat: 36.96668, long:
  -87.67167, height: 0),
map : "2017m08d21",
mapURL :
  "http://eclipsewise.com/oh/ec2017
  .html#SE2017Aug21T",
ΔT_Date : "8/1/17"

)

```

```

let NASA2019_07_02 = Bessel(
  T0 : 19.0,
  ΔT : 69.0,
  noAnglePrediction : 0,
  sourceNASA: true,
  // ΔTdiff : 71.3 - 69.3,

  x : [ -0.2156340,
        0.5662070,
        0.0000274,
        -0.0000088 ],

```

```

y : [ -0.650709,
      0.0106401,
      -0.0001272,
      -0.0000003 ],

d : [ 23.012950,
      -0.003187,
      -0.000005  ],

M : [103.97974,
      14.999507,
      0],

l1: [ 0.53765,
      -0.0000898,
      -0.0000120],

l2: [ -0.0084650,
      -0.0000894,
      -0.0000120],

tanf1: 0.0045984,
tanf2: 0.0045755,

T0Date: DateComponents(calendar:
  Calendar.current, timeZone:
  TimeZone(abbreviation: "UTC"), year: 2019,
  month: 7, day:02, hour:0, minute:0,
  second:0).date! ,
GELoc: ObsConditions(lat: -17.4, long: -109.0, height: 0),
map : "2019m07d02",
mapURL :
  "https://eclipse.gsfc.nasa
  .gov/SEbeselm/SEbeselm2001/SE2019Jul02Tbeselm
  .html",
ΔT_Date : OriginalΔT_Date

)

let EW2019_07_02 = Bessel(
  T0 : 19.0,
  ΔT : 69.3582,
  noAnglePrediction : 0,
  sourceNASA: true,
  x : [ -0.2156340,
        0.566207,
        0.00002737,
        -0.000008802 ],

  y : [ -0.6507090,

```

```

        0.01064,
        -0.0001272,
        -0.000000264 ],

d : [ 23.012949,
      -0.0031870,
      -0.000005494 ],

M : [103.979744,
      14.999507,
      0.000001043],

l1: [ 0.53765,
      -0.00009,
      -0.00001204],

l2: [ -0.0084650,
      -0.000089,
      -0.00001198],

tanf1: 0.004598,
tanf2: 0.004575,

T0Date: DateComponents(calendar:
  Calendar.current, timeZone:
  TimeZone(abbreviation: "UTC"), year: 2019,
  month: 7, day:02, hour:0, minute:0,
  second:0).date! ,
  // precision for test
GELoc: ObsConditions(lat: -17.40000001, long: -109.0,
  height: 0),
  map : "2019m07d02",
  mapURL :
  "http://eclipsewise.com/oh/ec2019
  .html#SE2019Jul02T",
  ΔT_Date : "7/1/19"

)

```

```

let NASA2020_12_14 = Bessel(
  T0:16.0,
  ΔT : 69.5,
  noAnglePrediction : 0,
  sourceNASA: true,
  // ΔTdiff : NASA2020_12_14_correct,

  x : [ -0.181827,
        0.5633549,
        0.0000217,
        -0.00000890 ],

```



```
y : [ -0.269642,  
      -0.0858121,  
      0.0001884,  
      0.0000015 ],
```

```
d : [-23.25776,  
     -0.0019860,  
     0.0000060,  
     0.0000000 ],
```

```
M : [ 61.26593,  
      14.996498,  
      0.0,  
      0.0      ],
```

```
l1: [ 0.543881,  
      0.0000970,  
      -0.0000126,  
      0.0      ],
```

```
l2: [ -0.002266,  
      0.0000966,  
      -0.0000125,  
      0.0      ],
```

```
tanf1: 0.0047502,  
tanf2: 0.0047266,
```

```
T0Date: DateComponents(calendar:  
Calendar.current, timeZone:  
TimeZone(abbreviation: "UTC"), year: 2020,  
month: 12, day:14, hour:0, minute:0,  
second:0).date! ,  
GELoc: ObsConditions(lat: -40.334, long:  
-67.9632, height: 0),
```

```
map : "2020m12d14",  
mapURL :  
"https://eclipse.gsfc.nasa  
.gov/SEbeselm/SEbeselm2001/SE2020Dec14Tbeselm  
.html",  
 $\Delta T$ _Date : Original $\Delta T$ _Date  
  
)
```

```
let EW2020_12_14 = Bessel(
```

```
T0:16.0,  
 $\Delta T$  : 69.3630,  
noAnglePrediction : 0,
```

```

sourceNASA: false,
x : [ -0.1818270,
      0.563355,
      0.00002168,
      -0.000008943 ],

y : [ -0.269642,
      -0.085812,
      0.0001884,
      0.000001497 ],

d : [-23.257761,
      -0.0019860,
      0.000006234,
      0.0000000 ],

M : [ 61.265926,
      14.996498,
      0.000000882,
      0.0          ],

l1: [ 0.543881,
      0.0000970,
      -0.00001255,
      0.0          ],

l2: [ -0.002266,
      0.000097,
      -0.00001249,
      0.0          ],

tanf1: 0.00475,
tanf2: 0.004727,

T0Date: DateComponents(calendar:
  Calendar.current, timeZone:
  TimeZone(abbreviation: "UTC"), year: 2020,
  month: 12, day:14, hour:0, minute:0,
  second:0).date! ,
// -40, 20, 2  -67,57,48
GELoc: ObsConditions(lat: -40.334, long:
  -67.9632, height: 0),
map : "2020m12d14",
mapURL :
  "http://eclipsewise.com/oh/ec2020
  .html#SE2020JDec14T",
ΔT_Date : "12/1/20"
)

```

```
let EW2021_06_10 = Bessel(
```

```
T0: 11.0,
ΔT : 69.2799,
noAnglePrediction : 0,
sourceNASA: false,
  x : [ -0.01871,
        0.50123,
        0.00003,
        -0.00001 ],

  y : [ 0.92610,
        0.08878,
        -0.00018,
        -0.00000 ],

  d : [23.0423,
        0.0028,
        0.0,
        0.0 ],

  M : [ 345.1269,
        14.9992,
        0.0,
        0.0      ],

  l1: [ 0.56440,
        -0.00006,
        -0.00001,
        0.0      ],

  l2: [ 0.01815,
        -0.00005,
        -0.00001,
        0.0      ],

tanf1: 0.0046060,
tanf2: 0.0045830,

T0Date: DateComponents(calendar:
  Calendar.current, timeZone:
  TimeZone(abbreviation: "UTC"), year: 2021,
  month: 6, day:10, hour:0, minute:0,
  second:0).date! ,

// 80, 49, 25      -66, 46, 27
GELoc: ObsConditions(lat: 80.8235, long:
  -66.7741, height: 0),
map : "2021m06d10",
```

```
mapURL :  
  "http://eclipsewise  
  .com/solar/SEprime/2001-2100/SE2021Jun10Aprime  
  .html",  
ΔT_Date : "6/1/21"  
  
)
```

```
let NASA2021_12_04 = Bessel(  
  T0:8.0,  
  ΔT : 69.8,  
  noAnglePrediction : 0,  
  sourceNASA: true,  
  // ΔTdiff : 72.6 - 70.3,  
  x : [ 0.025194,  
        0.5683012,  
        0.0000400,  
        -0.0000092 ],  
  
  y : [ -0.983559,  
        -0.1315136,  
        0.0002212,  
        0.0000024 ],  
  
  d : [-22.27472,  
        -0.0051780,  
        0.0000060,  
        0.0000000 ],  
  
  M : [ 302.45218,  
        14.99727,  
        0.0,  
        0.0      ],  
  
  l1: [ 0.537804,  
        -0.0000160,  
        -0.0000131,  
        0.0      ],  
  
  l2: [ -0.0082920,  
        -0.0000160,  
        -0.0000131,  
        0.0      ],  
  
  tanf1: 0.0047434,  
  tanf2: 0.0047198,
```

```
T0Date: DateComponents(calendar:
  Calendar.current, timeZone:
  TimeZone(abbreviation: "UTC"), year: 2021,
  month: 12, day:04, hour:0, minute:0,
  second:0).date! ,
GELoc: ObsConditions(lat: -76.7837, long:
  -46.1619, height: 0),
map : "2021m12d04",
mapURL :
  "https://eclipse.gsfc.nasa
  .gov/SEbeselm/SEbeselm2001/SE2021Dec04Tbeselm
  .html",
ΔT_Date : OriginalΔT_Date
```

```
)
let EW2021_12_04 = Bessel(
  T0:8.0,
  ΔT : 69.2908,
  noAnglePrediction : 0,
  sourceNASA: false,
  x : [ 0.025203,
        0.568301,
        0.00003911,
        -0.000009652 ],
  y : [ -0.983656,
        -0.131514,
        0.0002213,
        0.000002406 ],
  d : [-22.274714,
        -0.0051780,
        0.000005699,
        0.0000000 ],
  M : [ 302.452209,
        14.997281,
        -0.00000186,
        0.0      ],
  l1: [ 0.537824,
        -0.0000160,
        -0.00001313,
        0.0      ],
  l2: [ -0.0082920,
        -0.0000160,
        -0.00001306,
        0.0      ],
```

```
tanf1: 0.004743,  
tanf2: 0.00472,
```

```
T0Date: DateComponents(calendar:  
Calendar.current, timeZone:  
TimeZone(abbreviation: "UTC"), year: 2021,  
month: 12, day:04, hour:0, minute:0,  
second:0).date! ,
```

```
GELoc: ObsConditions(lat: -76.7762, long:  
-46.2308, height: 0),  
map : "2021m12d04",  
mapURL :  
"http://eclipsewise  
.com/solar/SEprime/2001-2100/SE2021Dec04Tprime  
.html",  
 $\Delta T$ _Date : "12/1/21"
```

```
)
```

```
let EW2023_04_20 = Bessel(  
T0:4.0,  
 $\Delta T$  : 69.20,  
noAnglePrediction : 0,  
sourceNASA: false,  
x : [ 0.026850,  
0.495017,  
1.360e-05,  
-7.053e-06 ],  
y : [ -0.427368,  
0.244199,  
-4.940e-05,  
-3.670e-06 ],  
d : [ 11.411773,  
0.013741,  
-2.581e-06,  
0.0 ],  
M : [240.242935,  
15.003417,  
-1.459e-06,  
0.0 ],  
l1: [ 0.546823,  
0.000122,  
-1.157e-05,  
0.0 ],  
l2: [ 0.000662,
```

```
0.000121,  
-1.151e-05,  
0.0      ],
```

```
tanf1: 0.004655,  
tanf2: 0.004632,
```

```
T0Date: DateComponents(calendar:  
Calendar.current, timeZone:  
TimeZone(abbreviation: "UTC"), year: 2023,  
month: 4, day:20, hour:0, minute:0,  
second:0).date! ,
```

```
GELoc: ObsConditions(lat: -9.59, long:  
125.806667, height: 0),  
map : "2023m04d20",  
mapURL :  
"http://www.eclipsewise  
.com/solar/SEcirc/2001-2100/SE2023Apr20Hcirc  
.html",  
 $\Delta T$ _Date : Updated $\Delta T$ _Date
```

```
)
```

```
let NASA2023_04_20 = Bessel(  
T0: 4.0,  
 $\Delta T$  : 69.20,  
noAnglePrediction :  
AngleNotVerified.C2Angle.rawValue +  
AngleNotVerified.C3Angle.rawValue,  
sourceNASA: true,  
x : [ 0.026967,  
0.4950173,  
0.0000137,  
-0.0000072 ],  
  
y : [ -0.427322,  
0.2441985,  
-0.0000494,  
-0.0000037 ],  
  
d : [ 11.41179,  
0.013741,  
-0.000002,  
0.0 ],  
  
M : [ 240.24289,  
15.003411,  
0.0,  
0.0      ],
```

```
l1: [ 0.546803,  
      0.0001216,  
      -0.0000116,  
      0.0      ],
```

```
l2: [ 0.000662,  
      0.0001210,  
      -0.0000115,  
      0.0      ],
```

```
tanf1: 0.0046549,  
tanf2: 0.0046318,
```

```
T0Date: DateComponents(calendar:  
Calendar.current, timeZone:  
TimeZone(abbreviation: "UTC"), year: 2023,  
month: 4, day:20, hour:0, minute:0,  
second:0).date! ,
```

```
GELoc: ObsConditions(lat: -9.5952, long:  
125.7808, height: 0),  
map : "2023m04d20",  
mapURL :  
"https://eclipse.gsfc.nasa  
.gov/SEbeselm/SEbeselm2001/SE2023Apr20Hbeselm  
.html",
```

```
ΔT_Date : UpdatedΔT_Date
```

```
)
```

```
let EW2023_10_14 = Bessel(
```

```
T0:18.0,  
ΔT : 69.23, // Jun 23 value  
noAnglePrediction : 0,  
sourceNASA: false,  
x : [ 0.169655,  
      0.458552,  
      2.778e-05,  
      -5.434e-06 ],
```

```
y : [ 0.334861,  
      -0.241366,  
      2.406e-05,  
      3.032e-06 ],
```

```
d : [ -8.244173,  
      -0.014888,  
      1.614e-06,  
      0.0 ],
```



```
M : [ 93.501740,  
      15.003529,  
      -1.846e-06,  
      0.0      ],
```

```
l1: [ 0.564331,  
      -0.000089,  
      -1.031e-05,  
      0.0      ],
```

```
l2: [ 0.018083,  
      -0.000089,  
      -1.026e-05,  
      0.0      ],
```

```
tanf1: 0.004688,  
tanf2: 0.004665,
```

```
T0Date: DateComponents(calendar:  
Calendar.current, timeZone:  
TimeZone(abbreviation: "UTC"), year: 2023,  
month: 10, day:14, hour:0, minute:0,  
second:0).date! ,
```

```
// 11, 22, 5      -83, 6, 41
```

```
GELoc: ObsConditions(lat: 11.36796, long:  
-83.11129, height: 0),
```

```
map : "2023m10d14",
```

```
mapURL :
```

```
"http://www.eclipsewise
```

```
.com/solar/SEprime/2001-2100/SE2023Oct14Aprime  
.html",
```

```
ΔT_Date : ExtrapolateDate
```

```
)
```

```
let NASA2023_10_14 = Bessel(
```

```
T0:18.0,
```

```
ΔT : 69.11,
```

```
noAnglePrediction : 0,
```

```
sourceNASA: true,
```

```
x : [ 0.169751,  
      0.4585480,  
      0.0000273,  
      -0.0000049 ],
```

```
y : [ 0.334837,  
      -0.2413668,  
      0.0000240,  
      0.0000030 ],
```

```
d : [-8.24419,  
     -0.014888,  
     0.000001,  
     0.0 ],
```

```
M : [ 93.50170,  
     15.003533,  
     0.0,  
     0.0      ],
```

```
l1: [ 0.564311,  
     -0.0000891,  
     -0.0000103,  
     0.0      ],
```

```
l2: [ 0.018083,  
     -0.0000886,  
     -0.0000103,  
     0.0      ],
```

```
tanf1: 0.0046882,  
tanf2: 0.0046648,
```

```
T0Date: DateComponents(calendar:  
    Calendar.current, timeZone:  
    TimeZone(abbreviation: "UTC"), year: 2023,  
    month: 10, day:14, hour:0, minute:0,  
    second:0).date! ,
```

```
GELoc: ObsConditions(lat: 11.3692, long:  
    -83.1021, height: 0),  
map : "2023m10d14",  
mapURL :  
    "https://eclipse.gsfc.nasa  
    .gov/SEbeselm/SEbeselm2001/SE2023Oct14Abeselm  
    .html",
```

```
ΔT_Date : UpdatedΔT_Date
```

```
)
```

```
let EW2024_04_08 = Bessel(
```

```
    T0:18.0,  
    ΔT : 69.175,  
    noAnglePrediction : 0,  
    sourceNASA: false,  
    x : [ -0.318251,  
         0.511710,  
         3.262e-05,  
         -8.413e-06 ],
```

```
    y : [ 0.219764,
```

```

        0.270958,
        -5.942e-05,
        -4.655e-06 ],

d : [7.586184,
     0.014844,
     -1.688e-06,
     0.0 ],

M : [ 89.591232,
     15.004082,
     -8.380e-07,
     0.0      ],

l1: [ 0.535832,
     0.000062,
     -1.276e-05,
     0.0      ],

l2: [ -0.010274,
     0.000061,
     -1.269e-05,
     0.0      ],

tanf1: 0.004668,
tanf2: 0.004645,

T0Date: DateComponents(calendar:
Calendar.current, timeZone:
TimeZone(abbreviation: "UTC"), year: 2024,
month: 4, day:8, hour:0, minute:0,
second:0).date! ,

// 25, 17, 22      -104, 8, 31.5
GELoc: ObsConditions(lat: 25.2895, long:
-104.1421, height: 0),
map : "2024m04d08",
mapURL :
"http://eclipsewise
.com/solar/SEprime/2001-2100/SE2024Apr08Tprime
.html",
ΔT_Date : "1/1/2024"

)

let EW2024_10_02 = Bessel(
T0:19.0,
ΔT : 69.175,
noAnglePrediction : 0,
sourceNASA: false,
x : [ -0.068043,
      0.441616,

```

```
1.361e-05,  
-4.834e-06 ],
```

```
y : [ -0.363168,  
      -0.243562,  
      3.393e-05,  
      2.836e-06 ],
```

```
d : [-3.987230,  
     -0.015511,  
     6.010e-07,  
     0.0 ],
```

```
M : [ 107.731094,  
      15.004331,  
      -1.118e-06,  
      0.0      ],
```

```
11: [ 0.570368,  
      -0.000000,  
      -9.765e-06,  
      0.0      ],
```

```
12: [ 0.024090,  
      -0.000000,  
      -9.717e-06,  
      0.0      ],
```

```
tanf1: 0.004673,  
tanf2: 0.004650,
```

```
T0Date: DateComponents(calendar: Calendar.current, timeZone:  
  TimeZone(abbreviation: "UTC"), year: 2024, month: 10, day:02, hour:0,  
  minute:0, second:0).date! ,
```

```
// -21, 57, 9      -114, 30, 44
```

```
GELoc: ObsConditions(lat: -21.9525, long: -114.5123, height: 0),
```

```
map : "2024m10d02",
```

```
mapURL :
```

```
"http://eclipsewise.com/solar/SEprime/2001-2100/SE2024Oct02Aprime.html",
```

```
ΔT_Date : "1/1/2024"
```

```
)
```

```
let EW2026_08_12 = Bessel(  
  T0: 18.0,
```

```
  ΔT : 72.3,
```

```
  noAnglePrediction : 0,
```

```
  sourceNASA: false,
```

```
  x : [ 0.47551,  
        0.518923,
```

```
        -7.727e-05,
```

```

        -8.039e-06 ],

y : [ 0.771185,
      -0.230167,
      -1.246e-04,
      3.767e-06 ],

d : [14.796683,
      -0.012065,
      -3.098e-06,
      0.0 ],

M : [ 88.747810,
      15.003090,
      1.764e-06,
      0.0      ],

11: [ 0.537974,
      0.000094,
      -1.212e-05,
      0.0      ],

12: [ -0.008142,
      0.000093,
      -1.206e-05,
      0.0      ],

tanf1: 0.004614,
tanf2: 0.004591,

T0Date: DateComponents(calendar: Calendar.current, timeZone:
  TimeZone(abbreviation: "UTC"), year: 2026, month: 8, day:12, hour:0,
  minute:0, second:0).date! ,

//65, 13, 25      -25, 13, 44
GELoc: ObsConditions(lat: 65.2235, long: -25.229, height: 0),
map : "2026m08d12",
mapURL :
  "http://eclipsewise.com/solar/SEprime/2001-2100/SE2026Aug12Tprime.html",
ΔT_Date : OriginalΔT_Date

)
let EW2027_02_06 = Bessel(
  T0: 16.0,
  ΔT : 72.5,
  noAnglePrediction : AngleNotVerified.C1Angle.rawValue +
    AngleNotVerified.C2Angle.rawValue + AngleNotVerified.C3Angle.rawValue +
    AngleNotVerified.C4Angle.rawValue,
  sourceNASA: false,
  x : [ 0.111678,

```

```
    0.466494,  
    -3.371e-05,  
    -5.272e-06    ],
```

```
y : [ -0.273295,  
      0.203185,  
      1.025e-04,  
      -2.459e-06 ],
```

```
d : [-15.547953,  
     0.012383,  
     3.586e-06,  
     0.0 ],
```

```
M : [ 56.493080,  
     15.000509,  
     2.730e-06,  
     0.0      ],
```

```
l1: [ 0.571947,  
     -0.000065,  
     -1.006e-05,  
     0.0      ],
```

```
l2: [ 0.025661,  
     -0.000065,  
     -1.001e-05,  
     0.0      ],
```

```
tanf1: 0.004743,  
tanf2: 0.004719,
```

```
T0Date: DateComponents(calendar: Calendar.current, timeZone:  
  TimeZone(abbreviation: "UTC"), year: 2027, month: 2, day:6, hour:0,  
  minute:0, second:0).date! ,
```

```
// -31, 18, 9    -48, 28, 20
```

```
GELoc: ObsConditions(lat: -31.3026, long: -48.4722, height: 0),
```

```
map : "2027m02d06",
```

```
mapURL :
```

```
  "http://eclipsewise.com/solar/SEprime/2001-2100/SE2027Feb06Aprime.html",
```

```
ΔT_Date : OriginalΔT_Date
```

```
)
```

```
let EW2027_08_02 = Bessel(  
  T0: 10.0,  
  ΔT : 72.8,  
  noAnglePrediction : 0,  
  sourceNASA: false,
```

```
x : [ -0.019774,  
      0.544711,  
      -4.462e-05,  
      -9.221e-06 ],
```

```
y : [ 0.160065,  
      -0.211158,  
      -1.217e-04,  
      3.760e-06 ],
```

```
d : [17.762482,  
      -0.010181,  
      -3.882e-06,  
      0.0 ],
```

```
M : [ 328.422546,  
      15.002096,  
      2.003e-06,  
      0.0      ],
```

```
11: [ 0.530615,  
      0.000014,  
      -1.283e-05,  
      0.0      ],
```

```
12: [ -0.015464,  
      0.000014,  
      -1.276e-05,  
      0.0      ],
```

```
tanf1: 0.004606,  
tanf2: 0.004583,
```

```
T0Date: DateComponents(calendar: Calendar.current, timeZone:  
  TimeZone(abbreviation: "UTC"), year: 2027, month: 8, day:02, hour:0,  
  minute:0, second:0).date! ,
```

```
// 25, 30, 9      33, 10, 57
```

```
GELoc: ObsConditions(lat: 25.5026, long: 33.1826, height: 0),
```

```
map : "2027m08d02",
```

```
mapURL :
```

```
"http://eclipsewise.com/solar/SEprime/2001-2100/SE2027Aug02Tprime.html",
```

```
ΔT_Date : OriginalΔT_Date
```

```
)
```

```
let EW2028_01_26 = Bessel(  
  T0: 15.0,  
  ΔT : 73.0,  
  noAnglePrediction : 0,
```

```

sourceNASA: false,
x : [ -0.205283,
      0.474256,
      -3.901e-05,
      -5.265e-06 ],

y : [ 0.340276,
      0.173858,
      9.684e-05,
      -2.087e-06 ],

d : [ -18.728254,
      0.010074,
      4.694e-06,
      0.0 ],

M : [ 41.891300,
      14.998963,
      2.706e-06,
      0.0 ],

l1: [ 0.574135,
      0.000042,
      -9.944e-06,
      0.0 ],

l2: [ 0.027839,
      0.000042,
      -9.895e-06,
      0.0 ],

tanf1: 0.004750,
tanf2: 0.004726,

T0Date: DateComponents(calendar: Calendar.current, timeZone:
  TimeZone(abbreviation: "UTC"), year: 2028, month: 01, day:26, hour:0,
  minute:0, second:0).date! ,
// 2, 57, 36 -51, 33, 56
GELoc: ObsConditions(lat: 2.9601, long: -51.5655, height: 0),
map : "2028m01d26",
mapURL :
  "http://eclipsewise.com/solar/SEprime/2001-2100/SE2028Jan26Aprime.html",
ΔT_Date : OriginalΔT_Date

)
let EW2028_07_22 = Bessel(
  T0: 3.0,
  ΔT : 73.2,
  noAnglePrediction : 0,
  sourceNASA: false,

```



```

x : [ -0.154412,
      0.544987,
      -2.148e-05,
      -8.684e-06 ],

y : [ -0.586419,
      -0.174608,
      -1.021e-04,
      2.955e-06 ],

d : [ 20.182318,
      -0.007974,
      -4.622e-06,
      0.0 ],

M : [ 223.378693,
      15.001018,
      1.975e-06,
      0.0      ],

l1: [ 0.535256,
      -0.000086,
      -1.230e-05,
      0.0      ],

l2: [ -0.010847,
      -0.000085,
      -1.224e-05,
      0.0      ],

tanf1: 0.004602,
tanf2: 0.004579,

T0Date: DateComponents(calendar: Calendar.current, timeZone:
  TimeZone(abbreviation: "UTC"), year: 2028, month: 7, day:22, hour:0,
  minute:0, second:0).date! ,

// -15, 34, 43      126, 42, 4
GELoc: ObsConditions(lat: -15.5787, long: 126.7011, height: 0),
map : "2028m07d22",
mapURL :
  "http://eclipsewise.com/solar/SEprime/2001-2100/SE2028Jul22Tprime.html",
ΔT_Date : OriginalΔT_Date

)
let EW2030_06_01 = Bessel(
  T0: 6.0,
  ΔT : 74.1,
  noAnglePrediction : 0,
  sourceNASA: false,

```

```

x : [ -0.269392,
      0.505636,
      1.815e-05,
      -5.683e-06 ],

y : [ 0.551974,
      0.021015,
      -1.585e-04,
      -1.562e-07],

d : [ 22.061287,
      0.005581,
      -5.180e-06,
      0.0 ],

M : [ 270.539856,
      14.999702,
      -1.357e-06,
      0.0      ],

11: [ 0.566168,
      -0.000013,
      -9.705e-06,
      0.0      ],

12: [ 0.019911,
      -0.000013      ,
      -9.657e-06,
      0.0      ],

tanf1: 0.0046120,
tanf2: 0.0045890,

T0Date: DateComponents(calendar: Calendar.current, timeZone:
  TimeZone(abbreviation: "UTC"), year: 2030, month: 6, day:1, hour:0,
  minute:0, second:0).date! ,

// 56, 31, 32      80, 3, 16
GELoc: ObsConditions(lat: 56.5255, long: 80.0544, height: 0),
map : "2030m06d01",
mapURL :
  "http://eclipsewise.com/solar/SEprime/2001-2100/SE2030Jun01Aprime.html",
ΔT_Date : OriginalΔT_Date

)
let EW2030_11_25 = Bessel(
  T0: 7.0,
  ΔT : 74.3,
  noAnglePrediction : 0,
  sourceNASA: false,

```

```

x : [ 0.044148,
      0.578778,
      1.765e-05,
      -9.776e-06 ],

y : [ -0.392657,
      -0.055189,
      1.743e-04,
      8.364e-07 ],

d : [-20.760988,
      -0.007989,
      5.155e-06,
      0.0 ],

M : [ 288.274597,
      14.998363,
      -2.575e-06,
      0.0      ],

11: [ 0.538232,
      -0.000038,
      -1.303e-05,
      0.0      ],

12: [ -0.007886,
      -0.000038,
      -1.297e-05,
      0.0      ],

tanf1: 0.004736,
tanf2: 0.004712,

T0Date: DateComponents(calendar: Calendar.current, timeZone:
  TimeZone(abbreviation: "UTC"), year: 2030, month: 11, day:25, hour:0,
  minute:0, second:0).date! ,

// -43, 36, 35      71, 13, 13
GELoc: ObsConditions(lat: -43.6096, long: 71.2202, height: 0),
map : "2030m11d25",
mapURL :
  "http://eclipsewise.com/solar/SEprime/2001-2100/SE2030Nov25Tprime.html",
ΔT_Date : OriginalΔT_Date

)
// annular
let EW2031_05_21 = Bessel(
  T0: 7.0,
  ΔT : 74.6,

```

```

noAnglePrediction : AngleNotVerified.C2Angle.rawValue +
                    AngleNotVerified.C3Angle.rawValue,
sourceNASA: false,
x : [ -0.114787,
      0.511238,
      7.242e-06,
      -6.024e-06 ],

y : [ -0.211246,
      0.057933,
      -1.182e-04,
      -6.057e-07 ],

d : [ 20.159136,
      0.008339,
      -4.697e-06,
      0.0 ],

M : [ 285.851166,
      15.000621,
      -1.864e-06,
      0.0      ],

11: [ 0.562423,
      0.000081,
      -1.004e-05,
      0.0      ],

12: [ 0.016185,
      0.000080,
      -9.987e-06,
      0.0      ],

tanf1: 0.004621,
tanf2: 0.004598,

T0Date: DateComponents(calendar: Calendar.current, timeZone:
  TimeZone(abbreviation: "UTC"), year: 2031, month: 5, day:21, hour:0,
  minute:0, second:0).date! ,

//8, 55, 39 71, 43, 7
GELoc: ObsConditions(lat: 8.9266, long: 71.7187, height: 0),
map : "2031m05d21",
mapURL :
  "http://eclipsewise.com/solar/SEprime/2001-2100/SE2031May21Aprime.html",
ΔT_Date : OriginalΔT_Date

)

let EW2031_11_14 = Bessel(

```

```
T0: 21.0,  
ΔT : 74.8,  
noAnglePrediction : AngleNotVerified.C2Angle.rawValue,  
sourceNASA: false,  
x : [ -0.019873,  
      0.550942,  
      3.656e-05,  
      -8.237e-06 ],  
  
y : [ 0.314969,  
      -0.089065,  
      1.046e-04,  
      1.245e-06 ],  
  
d : [-18.336794,  
      -0.010534,  
      4.391e-06,  
      0.0 ],  
  
M : [ 138.893997,  
      14.999763,  
      -2.870e-06,  
      0.0      ],  
  
11: [ 0.547793,  
      -0.000107,  
      -1.199e-05,  
      0.0      ],  
  
12: [ 0.001627,  
      -0.000106,  
      -1.193e-05,  
      0.0      ],  
  
tanf1: 0.004726,  
tanf2: 0.004702,  
  
T0Date: DateComponents(calendar: Calendar.current, timeZone:  
  TimeZone(abbreviation: "UTC"), year: 2031, month: 11, day:14, hour:0,  
  minute:0, second:0).date! ,  
  
// -0, 37, 56  -137, 39, 13  
GELoc: ObsConditions(lat: -0.6323, long: -137.6537, height: 0),  
map : "2031m11d14",  
mapURL :  
  "http://eclipsewise.com/solar/SEprime/2001-2100/SE2031Nov14Hprime.html",  
ΔT_Date : OriginalΔT_Date
```

)

```

let EW2033_03_30 = Bessel(
  T0: 18.0,
  ΔT : 75.5,
  noAnglePrediction : 0,
  sourceNASA: false,
  x : [ -0.31885,
        0.55542,
        0.00002,
        -0.00001 ],

  y : [ 0.92467,
        0.17566,
        -0.00008,
        0.0 ],

  d : [ 4.0937,
        0.0157,
        0.0,
        0.0 ],

  M : [ 88.9281,
        15.0045,
        0.0,
        0.0      ],

  l1: [ 0.53496,
        0.00003,
        -0.00001,
        0.0      ],

  l2: [-0.01114,
        0.00003,
        -0.00001,
        0.0      ],

  tanf1: 0.0046807,
  tanf2: 0.0046574,

  T0Date: DateComponents(calendar:
    Calendar.current, timeZone:
    TimeZone(abbreviation: "UTC"), year: 2033,
    month: 3, day:30, hour:0, minute:0,
    second:0).date! ,

  // 71, 18, 57 -155, 50, 41
  GELoc: ObsConditions(lat: 71.3159, long:
    -155.8448, height: 0),
  map : "2033m03d30",

```

```
mapURL :  
  "http://www.eclipsewise  
  .com/solar/SEprime/2001-2100/SE2033Mar30Tprime  
  .html" ,  
ΔT_Date : OriginalΔT_Date  
  
)
```

```
let EW2034_03_20 = Bessel(  
  T0: 10.0,  
  ΔT : 76.0,  
  noAnglePrediction : 0,  
  sourceNASA: false,  
  x : [ -0.259610,  
        0.548161,  
        2.336e-05,  
        -8.971e-06 ],
```

```
  y : [ 0.220749,  
        0.175578,  
        -8.002e-06,  
        -2.792e-06 ],
```

```
  d : [ -0.055145,  
        0.016042,  
        -1.500e-07,  
        0.0 ],
```

```
  M : [ 328.139130,  
        15.004399,  
        4.720e-07,  
        0.0      ],
```

```
  11: [ 0.538650,  
        -0.000066,  
        -1.267e-05,  
        0.0      ],
```

```
  12: [ -0.007470,  
        -0.000066,  
        -1.261e-05,  
        0.0      ],
```

```
  tanf1: 0.004695,  
  tanf2: 0.004672,
```

```
T0Date: DateComponents(calendar: Calendar.current, timeZone:  
  TimeZone(abbreviation: "UTC"), year: 2034, month: 3, day:20, hour:0,  
  minute:0, second:0).date! ,
```

```
// 16, 3, 20      22, 12, 29
GELoc: ObsConditions(lat: 16.0556, long: 22.208, height: 0),
map : "2034m03d20",
mapURL :
  "http://eclipsewise.com/solar/SEprime/2001-2100/SE2034Mar20Tprime.html",
ΔT_Date : OriginalΔT_Date
```

```
)
```

```
let EW2034_09_12 = Bessel(
```

```
  T0: 16.0,
  ΔT : 76.2,
  noAnglePrediction : 0,
  sourceNASA: false,
  x : [ -0.280910,
        0.502833,
        -1.062e-05,
        -6.348e-06 ],
```

```
  y : [ -0.324339,
        -0.157784,
        -8.505e-07,
        1.918e-06 ],
```

```
  d : [ 3.971928,
        -0.015534,
        -1.011e-06,
        0.0 ],
```

```
  M : [ 60.949726,
        15.004902,
        2.630e-07,
        0.0      ],
```

```
  11: [ 0.557820,
        0.000119,
        -1.056e-05,
        0.0      ],
```

```
  12: [ 0.011604,
        0.000118,
        -1.050e-05,
        0.0      ],
```

```
  tanf1: 0.004646,
  tanf2: 0.004623,
```

```
  T0Date: DateComponents(calendar: Calendar.current, timeZone:
    TimeZone(abbreviation: "UTC"), year: 2034, month: 9, day:12, hour:0,
    minute:0, second:0).date! ,
```



```

// -18, 14, 32      -72, 38, 2
GELoc: ObsConditions(lat: -18.2421, long: -72.634, height: 0),
map : "2034m09d12",
mapURL :
  "http://eclipsewise.com/solar/SEprime/2001-2100/SE2034Sep12Aprime.html",
ΔT_Date : OriginalΔT_Date

)
let EW2035_09_02 = Bessel(
  T0: 2.0,
  ΔT : 76.8,
  noAnglePrediction : 0,
  sourceNASA: false,
  x : [ 0.134278,
        0.537772,
        -3.593e-05,
        -8.122e-06 ],

  y : [ 0.349006,
        -0.158464,
        -5.956e-05,
        2.323e-06 ],

  d : [ 8.017733,
        -0.014783,
        -1.714e-06,
        0.0 ],

  M : [210.030014,
        15.004640,
        9.170e-07,
        0.0      ],

  11: [ 0.541939,
        0.000110,
        -1.187e-05,
        0.0      ],

  12: [ -0.004197,
        0.000110,
        -1.181e-05,
        0.0      ],

  tanf1: 0.004633,
  tanf2: 0.004610,

  T0Date: DateComponents(calendar: Calendar.current, timeZone:
    TimeZone(abbreviation: "UTC"), year: 2035, month: 9, day:2, hour:0,
    minute:0, second:0).date! ,

```

```

// 29, 5, 35 158, 0, 13
GELoc: ObsConditions(lat: 29.0931, long: 158.0037, height: 0),
map : "2035m09d02",
mapURL :
  "http://eclipsewise.com/solar/SEprime/2001-2100/SE2035Sep02Tprime.html",
ΔT_Date : OriginalΔT_Date

)
let EW2037_07_13 = Bessel(
  T0: 3.0,
  ΔT : 77.7,
  noAnglePrediction : 0,
  sourceNASA: false,
  x : [ 0.141498,
        0.563598,
        3.220e-08,
        -8.682e-06 ],

  y : [ -0.733710,
        -0.031821,
        -1.131e-04,
        4.030e-07 ],

  d : [ 21.782431,
        -0.006046,
        -5.105e-06,
        0.0 ],

  M : [ 223.550156,
        15.000225,
        1.703e-06,
        0.0      ],

  l1: [ 0.538402,
        -0.000110,
        -1.196e-05,
        0.0      ],

  l2: [ -0.007717,
        -0.000110,
        -1.191e-05,
        0.0      ],

  tanf1: 0.004599,
  tanf2: 0.004576,

  T0Date: DateComponents(calendar: Calendar.current, timeZone:
    TimeZone(abbreviation: "UTC"), year: 2037, month: 7, day:13, hour:0,
    minute:0, second:0).date! ,

```

```
// -24, 45, 49 139, 2, 21
GELoc: ObsConditions(lat: -24.7636, long: 139.0393, height: 0),
map : "2037m07d13",
mapURL :
  "http://eclipsewise.com/solar/SEprime/2001-2100/SE2037Jul13Tprime.html",
ΔT_Date : OriginalΔT_Date
```

```
)
```

```
let EW2038_12_26 = Bessel(
```

```
  T0: 1.0,
  ΔT : 78.5,
  noAnglePrediction : 0,
  sourceNASA: false,
  x : [ -0.020687,
        0.569854,
        -1.238e-07,
        -9.120e-06 ],
```

```
  y : [ -0.287391,
        -0.037971,
        1.915e-04,
        7.266e-07 ],
```

```
  d : [-23.362579,
        0.001481,
        6.305e-06,
        0.0 ],
```

```
  M : [194.922165,
        14.996376,
        3.760e-07,
        0.0      ],
```

```
  11: [ 0.543526,
        0.000087,
        -1.262e-05,
        0.0      ],
```

```
  12: [ -0.002618,
        0.000086,
        -1.255e-05,
        0.0      ],
```

```
  tanf1: 0.004754,
  tanf2: 0.004730,
```

```
T0Date: DateComponents(calendar: Calendar.current, timeZone:
  TimeZone(abbreviation: "UTC"), year: 2038, month: 12, day:26, hour:0,
  minute:0, second:0).date! ,

// -40, 16, 42 163, 54, 43
GELoc: ObsConditions(lat: -40.2784, long: 163.9119, height: 0),
map : "2038m12d26",
mapURL :
  "http://eclipsewise.com/solar/SEprime/2001-2100/SE2038Dec26Tprime.html",
ΔT_Date : OriginalΔT_Date
```

```
)
```

```
#if DEBUG
```

```
var fakeSJC = Bessel(
```

```
  T0: 23,
```

```
  ΔT : 61,
```

```
  noAnglePrediction : 0,
```

```
  sourceNASA: true,
```

```
  x : [ 0.1997330,
        0.5598916,
        0.0000322,
        -0.0000095 ],
```

```
  y : [ 0.8491220,
        -0.1618225,
        0.0001031,
        0.0000029 ],
```

```
  d : [ -21.1629200,
        -0.0073430,
        0.0000060,
        0.0000000 ],
```

```
  M : [ 167.831436,
        14.997900,
        0.000000,
        0.000000 ],
```

```
  l1: [ 0.5380280,
        0.0000012,
        -0.0000131,
        0.0000000 ],
```

```
  l2: [ -0.0080700,
        0.0000012,
        -0.0000131,
        0.0000000 ],
```

```
tanf1: 0.0047477,
```

```
tanf2: 0.0047241,
```

```
// T0 Date is set to
```

```
T0Date: DateComponents(calendar: Calendar.current, timeZone:  
  TimeZone(abbreviation: "UTC"), year: 2023, month: 11, day:13, hour:0,  
  minute:0, second:0).date! ,
```

```
GELoc: ObsConditions(lat: 36.7064, long: -121.6676, height: 0),
```

```
map : "1313-11-18",
```

```
mapURL :
```

```
"https://eclipse.gsfc.nasa.gov/SEsearch/SEsearchmap.php?Ecl=13131118",
```

```
 $\Delta T$ _Date : Original $\Delta T$ _Date
```

```
)
```

```
#endif
```