

# Calc\_Sun code

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Project home: [https://github.com/DouglasAllen/calc\\_sun](https://github.com/DouglasAllen/calc_sun)

## C extension

```
#include <ruby.h>

#ifndef DBL2NUM
# define DBL2NUM(dbl) rb_float_new(dbl)
#endif

#define R2D 57.295779513082320876798154814105
#define D2R 0.017453292519943295769236907684886
#define M2PI M_PI * 2.0
#define INV24 1.0 / 24.0
#define INV360 1.0 / 360.0
#define DJ00 2451545.0

// static ID id_status;

static VALUE
t_init(VALUE self)
{
    return self;
}

static VALUE
func_rev12(VALUE self, VALUE vx)
{
    double x = NUM2DBL(vx);
    return DBL2NUM(x - 24.0 * floor(x * INV24 + 0.5));
}

static VALUE
func_mean_anomally(VALUE self, VALUE vd)
{
    double d = NUM2DBL(vd);
    double vma =
    fmod(
        (357.5291 +
         0.98560028 * d
        ) * D2R, M2PI);
}
```

```

    return DBL2NUM(vma);
}

static VALUE
func_eccentricity(VALUE self, VALUE vd)
{
    double d = NUM2DBL(vd);
    double ve =
        0.016709 -
        1.151e-9 * d;
    return DBL2NUM(ve);
}

static VALUE
func_equation_of_center(VALUE self, VALUE vd)
{
    double vma =
        NUM2DBL(func_mean_anomally(self, vd));
    double ve =
        NUM2DBL(func_eccentricity(self, vd));
    double ve2 = ve * 2.0;
    double vesqr = ve * ve;
    double vesqr54 = 5.0 / 4.0 * vesqr;
    double vecube12 = (vesqr * ve) / 12.0;
    double veoc =
        ve2 * sin(vma) +
        vesqr54 * sin(2 * vma) +
        vecube12 * (13.0 * sin(3 * vma) - 3.0 * sin(vma));
    return DBL2NUM(veoc);
}

static VALUE
func_true_anomally(VALUE self, VALUE vd)
{
    double vma =
        NUM2DBL(func_mean_anomally(self, vd));
    double veoc =
        NUM2DBL(func_equation_of_center(self, vd));
    double vta = vma + veoc;
    return DBL2NUM(vta);
}

static VALUE
func_mean_longitude(VALUE self, VALUE vd)
{

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double d = NUM2DBL(vd);
double vml =
fmod(
    (280.4664567 +
     0.9856473601037645 * d
    ) * D2R, M2PI);
return DBL2NUM(vml);
}

static VALUE
func_eccentric_anomaly(VALUE self, VALUE vd)
{
    double ve =
NUM2DBL(func_eccentricity(self, vd));
    double vml =
NUM2DBL(func_mean_longitude(self, vd));
    double vea =
vml + ve * sin(vml) * (1.0 + ve * cos(vml));
    return DBL2NUM(vea);
}

static VALUE
func_obliquity_of_ecliptic(VALUE self, VALUE vd)
{
    double d = NUM2DBL(vd);
    double voee =
(23.439291 - 3.563E-7 * d) * D2R;
    return DBL2NUM(voee);
}

static VALUE
func_longitude_of_perihelion(VALUE self, VALUE vd)
{
    double d = NUM2DBL(vd);
    double vlop =
fmod(
    (282.9404 +
     4.70935e-05 * d
    ) * D2R, M2PI);
    return DBL2NUM(vlop);
}

static VALUE
func_xv(VALUE self, VALUE vd)
{

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    double vea =
    NUM2DBL(func_eccentric_anomally(self, vd));
    double ve =
    NUM2DBL(func_eccentricity(self, vd));
    double vxv = cos(vea) - ve;
    return DBL2NUM(vxv);
}

static VALUE
func_yv(VALUE self, VALUE vd)
{
    double vea =
    NUM2DBL(func_eccentric_anomally(self, vd));
    double ve =
    NUM2DBL(func_eccentricity(self, vd));
    double vyv =
    sqrt(1.0 - ve * ve) * sin(vea);
    return DBL2NUM(vyv);
}

static VALUE
func_true_longitude(VALUE self, VALUE vd)
{
    double vta =
    NUM2DBL(func_true_anomally(self, vd));
    double vlop =
    NUM2DBL(func_longitude_of_perihelion(self, vd));
    double vt1 =
    fmod(vta + vlop, M2PI);
    return DBL2NUM(vt1);
}

static VALUE
func_rv(VALUE self, VALUE vd)
{
    double vxv =
    NUM2DBL(func_xv(self, vd));
    double vyv =
    NUM2DBL(func_yv(self, vd));
    double vrv =
    sqrt(vxv * vxv + vyv * vyv);
    return DBL2NUM(vrv);
}

static VALUE

```

```

func_ecliptic_x(VALUE self, VALUE vd)
{
    double vrv =
    NUM2DBL(func_rv(self, vd));
    double vtl =
    NUM2DBL(func_true_longitude(self, vd));
    double vex = vrv * cos(vtl);
    return DBL2NUM(vex);
}

static VALUE
func_ecliptic_y(VALUE self, VALUE vd)
{
    double vrv =
    NUM2DBL(func_rv(self, vd));
    double vtl =
    NUM2DBL(func_true_longitude(self, vd));
    double vey = vrv * sin(vtl);
    return DBL2NUM(vey);
}

static VALUE
func_right_ascension(VALUE self, VALUE vd)
{
    double vey =
    NUM2DBL(func_ecliptic_y(self, vd));
    double vooe =
    NUM2DBL(func_obliquity_of_ecliptic(self, vd));
    double vex =
    NUM2DBL(func_ecliptic_x(self, vd));
    double vra =
    fmod(atan2(vey * cos(vooe), vex) + M2PI, M2PI);
    return DBL2NUM(vra * R2D / 15.0);
}

static VALUE
func_declination(VALUE self, VALUE vd)
{
    double vex =
    NUM2DBL(func_ecliptic_x(self, vd));
    double vey =
    NUM2DBL(func_ecliptic_y(self, vd));
    double vooe =
    NUM2DBL(func_obliquity_of_ecliptic(self, vd));
    double ver = sqrt(vex * vex + vey * vey);

```

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double vz = vey * sin(vooe);
double vdec = atan2(vz, ver);
return DBL2NUM(vdec);
}

static VALUE
func_sidetime(VALUE self, VALUE vjd)
{
    double vd = NUM2DBL(vjd);
    double vst =
    fmod(
        (180 + 357.52911 + 282.9404) +
        (0.985600281725 + 4.70935E-5) * vd, 360.0);
    return DBL2NUM(vst / 15.0);
}

static VALUE
func_local_sidetime(VALUE self, VALUE vjd, VALUE vlon)
{
    double vst = NUM2DBL(func_sidetime(self, vjd));
    double vlst = NUM2DBL(vlon) / 15.0 + 12.0 + vst;
    return DBL2NUM(fmod(vlst, 24.0));
}

static VALUE
func_dlt(VALUE self, VALUE vd, VALUE vlat)
{
    double vsin_alt = sin(-0.8333 * D2R);
    double vlat_r = NUM2DBL(vlat) * D2R;
    double vcos_lat = cos(vlat_r);
    double vsin_lat = sin(vlat_r);
    double vooe =
    NUM2DBL(func_obliquity_of_ecliptic(self, vd));
    double vt1 =
    NUM2DBL(func_true_longitude(self, vd));
    double vsin_dec = sin(vooe) * sin(vt1);
    double vcos_dec =
    sqrt( 1.0 - vsin_dec * vsin_dec );
    double vd1 =
    acos(
        (vsin_alt - vsin_dec * vsin_lat) /
        (vcos_dec * vcos_lat));
    double vdla = vd1 * R2D;
    double vdlt = vdla / 15.0 * 2.0;
    return DBL2NUM(vdlt);
}

```

```

}

static VALUE
func_diurnal_arc(VALUE self, VALUE vjd, VALUE vlat)
{
    double dlt = NUM2DBL(func_dlt(self, vjd, vlat));
    double da = dlt / 2.0;
    return DBL2NUM(da);
}

static VALUE
func_t_south(VALUE self, VALUE vjd, VALUE vlon)
{
    double lst = NUM2DBL(func_local_sidetime(self, vjd, vlon));
    double ra = NUM2DBL(func_right_ascension(self, vjd));
    double vx = lst - ra;
    double vt = vx - 24.0 * floor(vx * INV24 + 0.5);
    return DBL2NUM(12 - vt);
}

static VALUE
func_t_rise(VALUE self, VALUE vjd, VALUE vlon, VALUE vlat)
{
    double ts = NUM2DBL(func_t_south(self, vjd, vlon));
    double da = NUM2DBL(func_diurnal_arc(self, vjd, vlat));
    return DBL2NUM(ts - da);
}

static VALUE
func_t_set(VALUE self, VALUE vjd, VALUE vlon, VALUE vlat)
{
    double ts = NUM2DBL(func_t_south(self, vjd, vlon));
    double da = NUM2DBL(func_diurnal_arc(self, vjd, vlat));
    return DBL2NUM(ts + da);
}

static VALUE
func_t_mid_day(VALUE self, VALUE vjd, VALUE vlon, VALUE vlat)
{
    double tr = NUM2DBL(func_t_rise(self, vjd, vlon, vlat));
    double ts = NUM2DBL(func_t_set(self, vjd, vlon, vlat));
    return DBL2NUM((tr + ts) / 2.0);
}

void Init_calc_sun(void)

```

```

{
    VALUE cCalcSun =
    rb_define_class("CalcSun", rb_cObject);
    rb_define_method(cCalcSun, "initialize", t_init, 0);
    rb_define_method(cCalcSun,
    "reverse_12", func_rev12, 1);
    rb_define_method(cCalcSun,
    "mean_anomaly", func_mean_anomaly, 1);
    rb_define_method(cCalcSun,
    "eccentricity", func_eccentricity, 1);
    rb_define_method(cCalcSun,
    "equation_of_center", func_equation_of_center, 1);
    rb_define_method(cCalcSun,
    "true_anomaly", func_true_anomaly, 1);
    rb_define_method(cCalcSun,
    "mean_longitude", func_mean_longitude, 1);
    rb_define_method(cCalcSun,
    "eccentric_anomaly", func_eccentric_anomaly, 1);
    rb_define_method(cCalcSun,
    "obliquity_of_ecliptic", func_obliquity_of_ecliptic, 1);
    rb_define_method(cCalcSun,
    "longitude_of_perihelion", func_longitude_of_perihelion, 1);
    rb_define_method(cCalcSun,
    "xv", func_xv, 1);
    rb_define_method(cCalcSun,
    "yv", func_yv, 1);
    rb_define_method(cCalcSun,
    "true_longitude", func_true_longitude, 1);
    rb_define_method(cCalcSun,
    "rv", func_rv, 1);
    rb_define_method(cCalcSun,
    "ecliptic_x", func_ecliptic_x, 1);
    rb_define_method(cCalcSun,
    "ecliptic_y", func_ecliptic_y, 1);
    rb_define_method(cCalcSun,
    "right_ascension", func_right_ascension, 1);
    rb_define_method(cCalcSun,
    "declination", func_declination, 1);
    rb_define_method(cCalcSun,
    "sidereal_time", func_sidetime, 1);
    rb_define_method(cCalcSun,
    "local_sidereal_time", func_local_sidetime, 2);
    rb_define_method(cCalcSun,
    "dlt", func_dlt, 2);
    rb_define_method(cCalcSun,

```



```

"diurnal_arc", func_diurnal_arc, 2);
rb_define_method(cCalcSun,
"t_south", func_t_south, 2);
rb_define_method(cCalcSun,
"t_rise", func_t_rise, 3);
rb_define_method(cCalcSun,
"t_set", func_t_set, 3);
rb_define_method(cCalcSun,
"t_mid_day", func_t_mid_day, 3);
}

```

```
$> bundle exec rake compile
```

## Example usage code

```

require 'benchmark'
lib = File.expand_path('../lib', __FILE__)
$LOAD_PATH.unshift(lib) unless $LOAD_PATH.include?(lib)
require 'calc_sun'
cs = CalcSun.new

require 'date'
DJ00 = DateTime.parse('2000-01-01T12:00:00').jd

lat = 41.95
lon = -88.75
day = Date.parse('2016-12-25')
jd = day.jd - DJ00 - lon / 360.0
rise = cs.t_rise(jd, lon, lat)
midday = cs.t_mid_day(jd, lon, lat)
set = cs.t_set(jd, lon, lat)

printf("\n")

printf("\tSun rises \t\t\t : %2.0f:%02.0f UTC\n",
      rise.floor, (rise % 1 * 60.0).floor)

printf("\tSun midday \t\t\t : %2.0f:%02.0f UTC\n",
      midday.floor, ((midday % 1.0) * 60).floor)

printf("\tSun sets \t\t\t : %2.0f:%02.0f UTC\n",
      set.floor, (set % 1 * 60.0).floor)

n = 1_000_000

```

```
Benchmark.bm(7) do |x|
  x.report('rise:') { n.times { ; cs.t_rise(jd, lon, lat); } }
  x.report('midday:') { n.times { ; cs.t_mid_day(jd, lon, lat); } }
  x.report('set:') { n.times { ; cs.t_set(jd, lon, lat); } }
end
```

```
$> ruby sunriset.rb
```

```
Sun rises      : 13:21 UTC
Sun midday     : 17:55 UTC
Sun sets       : 22:29 UTC
```

	user	system	total	real
rise:	3.968000	0.000000	3.968000 (	4.195124)
midday:	7.829000	0.000000	7.829000 (	8.258836)
set:	3.984000	0.000000	3.984000 (	4.076902)

## Test code

```
require 'rubygems'
gem 'minitest'
require 'minitest/autorun'
require 'test/unit'
lib = File.expand_path('.././lib', __FILE__)
$LOAD_PATH.unshift(lib) unless $LOAD_PATH.include?(lib)
require 'calc_sun'
require 'date'
#
# class TestCalcSun < MiniTest::Test
class TestCalcSun100 < Test::Unit::TestCase
  def setup
    @t = CalcSun.new
    @t_ajd = 0.0
    @t_lat = 0.0
    @t_lon = 0.0
  end

  def test_mean_anomaly
    assert_equal(
      6.240059966692,
      @t.mean_anomaly(@t_ajd).round(12)
    )
  end

  def test_eccentricity
```

```

    assert_equal(
      0.016709,
      @t.eccentricity(@t_ajd)
    )
  end

  def test_equation_of_center
    assert_equal(
      -0.001471380867,
      @t.equation_of_center(@t_ajd).round(12)
    )
  end

  def test_true_anomaly
    assert_equal(
      6.238588585825,
      @t.true_anomaly(@t_ajd).round(12)
    )
  end

  def test_mean_longitude
    assert_equal(
      4.895063110817,
      @t.mean_longitude(@t_ajd).round(12)
    )
  end

  def test_eccentric_anomaly
    assert_equal(
      4.878582250862,
      @t.eccentric_anomaly(@t_ajd).round(12)
    )
  end

  def test_obliquity_of_ecliptic
    assert_equal(
      0.409092802283,
      @t.obliquity_of_ecliptic(@t_ajd).round(12)
    )
  end

  def test_xv
    assert_equal(
      0.148720277673,
      @t.xv(@t_ajd).round(12)
    )
  end

```

```

    )
end

def test_yv
  assert_equal(
    -0.986083974099,
    @t.yv(@t_ajd).round(12)
  )
end

def test_longitude_of_perihelion
  assert_equal(
    4.93824156691,
    @t.longitude_of_perihelion(@t_ajd).round(12)
  )
end

def test_true_longitude
  assert_equal(
    4.893644845555,
    @t.true_longitude(@t_ajd).round(12)
  )
end

def test_rv
  assert_equal(
    0.997235842199,
    @t.rv(@t_ajd).round(12)
  )
end

end

#
class TestCalcSun200 < Test::Unit::TestCase
  def setup
    @t = CalcSun.new
    @t_ajd = 0.0
    @t_lat = 0.0
    @t_lon = 0.0
  end

  def test_ecliptic_x
    assert_equal(
      0.17976672602,
      @t.ecliptic_x(@t_ajd).round(12)
    )
  end
end

```

```

    )
end

def test_ecliptic_y
  assert_equal(
    -0.980899204395,
    @t.ecliptic_y(@t_ajd).round(12)
  )
end

def test_right_ascension
  assert_equal(
    18.753078192426,
    @t.right_ascension(@t_ajd).round(12)
  )
end

def test_declination
  assert_equal(
    -0.372949956542,
    @t.declination(@t_ajd).round(12)
  )
end

def test_sidereal_time
  assert_equal(
    6.697967333333,
    @t.sidereal_time(@t_ajd).round(12)
  )
end

def test_local_sidereal_time
  assert_equal(
    18.697967333333,
    @t.local_sidereal_time(@t_ajd, @t_lon).round(12)
  )
end

def test_dlt
  assert_equal(
    12.120732161881,
    @t.dlt(@t_ajd, @t_lat).round(12)
  )
end

```

```

def test_diurnal_arc
  assert_equal(
    6.06036608094,
    @t.diurnal_arc(@t_ajd, @t_lat).round(12)
  )
end

def test_t_south
  assert_equal(
    12.055110859092,
    @t.t_south(@t_ajd, @t_lon).round(12)
  )
end

def test_t_rise
  assert_equal(
    5.994744778152,
    @t.t_rise(@t_ajd, @t_lon, @t_lat).round(12)
  )
end

def test_t_mid_day
  assert_equal(
    12.055110859092,
    @t.t_mid_day(@t_ajd, @t_lon, @t_lat).round(12)
  )
end

def test_t_set
  assert_equal(
    18.115476940033,
    @t.t_set(@t_ajd, @t_lon, @t_lat).round(12)
  )
end

def test_rise_time
  rise = @t.t_rise(@t_ajd, @t_lon, @t_lat).round(12)
  assert_equal(
    "Sun rises \t\t\t : 5:59 UTC",
    "Sun rises \t\t\t : #{rise.floor} : #{(rise % 1 * 60.0).floor} UTC"
  )
end

def test_midday_time
  midday = @t.t_mid_day(@t_ajd, @t_lon, @t_lat).round(12)

```

```

    assert_equal(
      "Sun mid day \t\t\t : 12:3 UTC",
      "Sun mid day \t\t\t : #{midday.floor}:#{((midday % 1.0) * 60).floor} UTC"
    )
  end

  def test_set_time
    set = @t.t_set(@t_ajd, @t_lon, @t_lat).round(12)
    assert_equal(
      "Sun sets \t\t\t : 18:6 UTC",
      "Sun sets \t\t\t : #{set.floor}:#{(set % 1 * 60.0).floor} UTC"
    )
  end
end

```

```
$> ruby test/test_calc_sun.rb
```

```

Started
.....

Finished in 0.010992 seconds.
-----
27 tests, 27 assertions, 0 failures, 0 errors, 0 pendings, 0 omissions, 0
notifications
100% passed
-----
2456.33 tests/s, 2456.33 assertions/s
Run options: --seed 19314

# Running:

Finished in 0.000929s, 0.0000 runs/s, 0.0000 assertions/s.

0 runs, 0 assertions, 0 failures, 0 errors, 0 skips

```