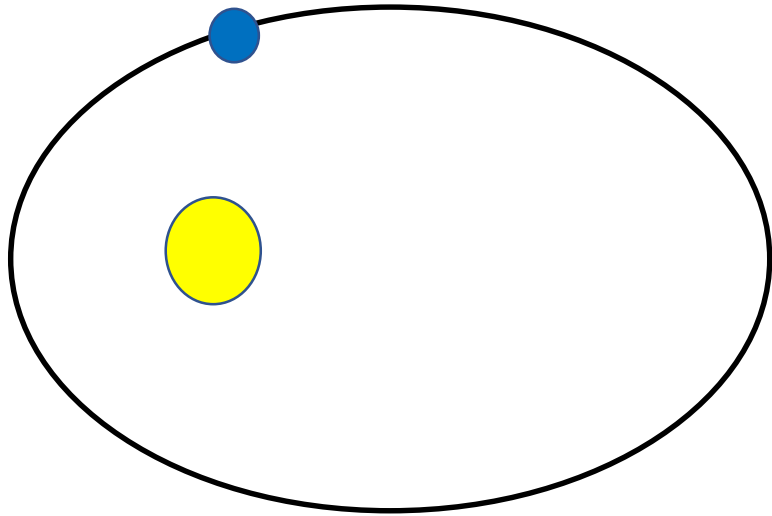


# ModelE Orbits & Calendars

Tom Clune (GMAO)



ORBIT



Absolute  
Model Time

2019

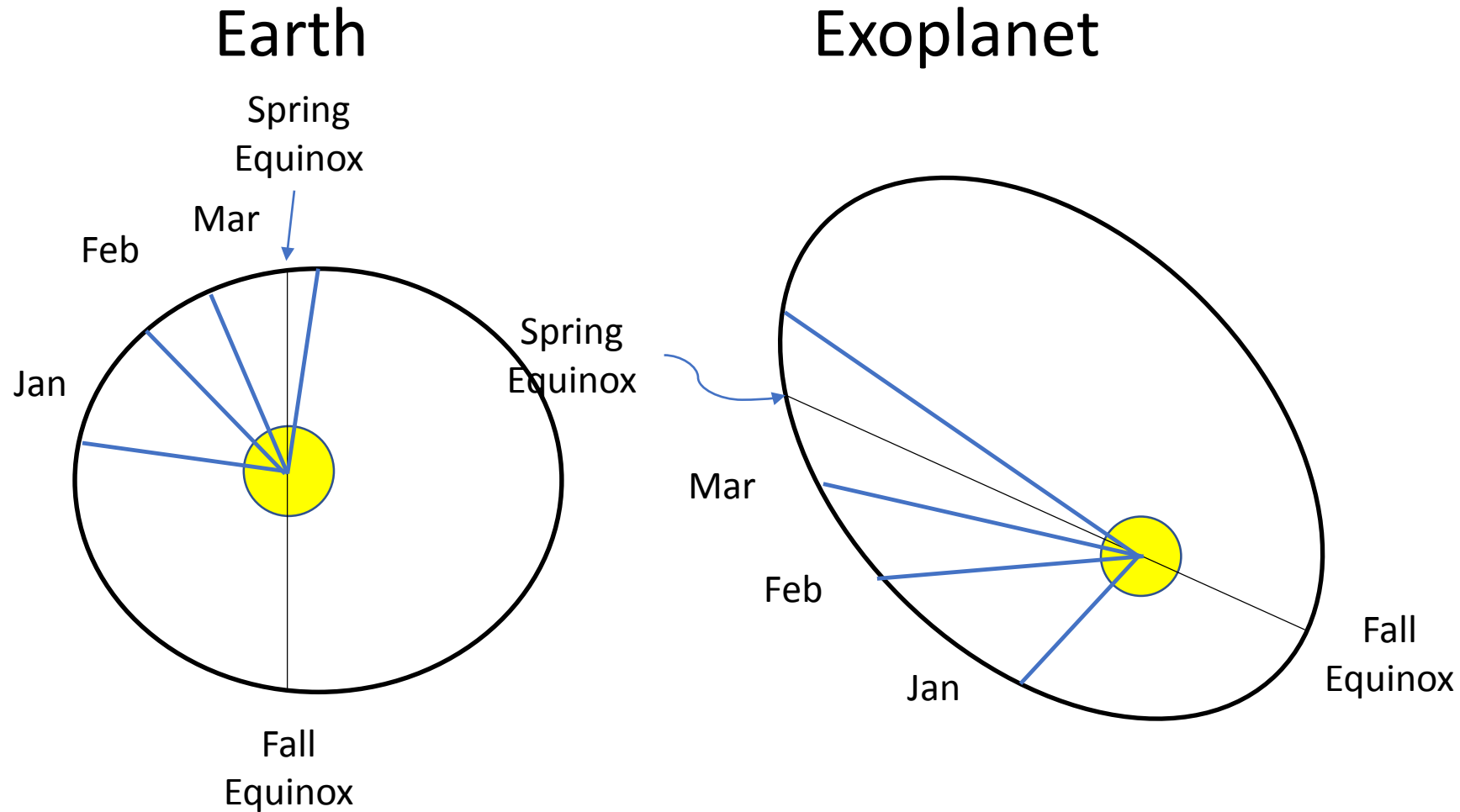
January							February							March							April						
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
30	31	1	2	3	4	5	27	28	29	30	31	1	2	24	25	26	27	28	1	2	31	1	2	3	4	5	6
6	7	8	9	10	11	12	3	4	5	6	7	8	9	10	11	12	13	14	15	16	7	8	9	10	11	12	13
13	14	15	16	17	18	19	10	11	12	13	14	15	16	17	18	19	20	21	22	23	14	15	16	17	18	19	20
20	21	22	23	24	25	26	17	18	19	20	21	22	23	24	25	26	27	28	29	30	21	22	23	24	25	26	27
27	28	29	30	31	1	2	24	25	26	27	28	1	2	31	1	2	3	4	5	6	28	29	30	1	2	3	4
May							June							July							August						
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
28	29	30	1	2	3	4	25	27	28	29	30	31	1	30	1	2	3	4	5	6	28	29	30	31	1	2	3
5	6	7	8	9	10	11	2	3	4	5	6	7	8	7	8	9	10	11	12	13	4	5	6	7	8	9	10
12	13	14	15	16	17	18	9	10	11	12	13	14	15	14	15	16	17	18	19	20	11	12	13	14	15	16	17
19	20	21	22	23	24	25	16	17	18	19	20	21	22	21	22	23	24	25	26	27	18	19	20	21	22	23	24
26	27	28	29	30	31	1	23	24	25	26	27	28	29	28	29	30	31	1	2	3	25	26	27	28	29	30	31
30	1	2	3	4	5	6	30	1	2	3	4	5	6	28	29	30	31	1	2	3	25	26	27	28	29	30	31
September							October							November							December						
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
1	2	3	4	5	6	7	29	30	1	2	3	4	5	27	28	29	30	31	1	2	1	2	3	4	5	6	7
8	9	10	11	12	13	14	6	7	8	9	10	11	12	3	4	5	6	7	8	9	8	9	10	11	12	13	14
15	16	17	18	19	20	21	13	14	15	16	17	18	19	10	11	12	13	14	15	16	15	16	17	18	19	20	21
22	23	24	25	26	27	28	20	21	22	23	24	25	26	17	18	19	20	21	22	23	22	23	24	25	26	27	28
29	30	1	2	3	4	5	27	28	29	30	31	1	2	24	25	26	27	28	29	30	29	30	31	1	2	3	4

Calendar

Distance  
Hour Angle  
Declination

Year  
Month  
Date  
Day Of Year  
Hour  
Seconds

Exoplanet years are divided into 12 months. The angle (solar longitude) subtended by each month is (approximately) the same as the corresponding month for the Earth.



Days are subdivided into 24 equal “hours”.



Hour angle is 0 for prime meridian at 0h Jan 01.

# Problems ...

The conventional Earth-like calendars work well when:

$$|\omega_{\text{orbit}}| \ll |\omega_{\text{planet}}|$$

This allows:

1. Integral number of solar days per year (with minor adjustment)
2. Division of year into 12 roughly equal months that have many days each.

**Fails badly for slow rotators including tidally locked planets.**

# Treatment of slow rotators

- Calendar years always have at least 120 *calendar* days.
  - *Calendar* days and *solar* days are not the same
  - ***Be wary of “diurnal” diagnostics***
  - Monthly averages may also be misleading – a given longitude may experience daylight for an entire month even at the equator!
- For very slow rotators (e.g., Venus)
  - Must deactivate approx. for integral number of solar days per year
  - Seasons “float” from year to year
  - *Entire years may have a day/night bias*
    - Must run large number of years to get valid global averages

# Basic orbit rundeck parameters

- planetName=... (something other than 'Earth')
- obliquity=... (degrees - default is modern Earth)
- eccentricity=... (default is modern Earth)
- longitudeAtPeriapsis=... (in degrees – default is modernEarth)
- siderealOrbitalPeriod=...(in seconds – default is model Earth year  $365*24*3600$ )
- siderealRotationPeriod=...(in seconds – default is model Earth day  $\sim 86163.934$ )
  - Automatically adjusted to quantize year
- quantizeYearLength=... (“true” or “false”)
  
- Rarely used:
  - meanDistance=...(AU)
  - hourAngleOffset=... (move “Greenwich” mostly for topography)

# E\_Mars params ...

```
!-----  
planetName = 'Mars' ! Construct a calendar ...  
! The following sets the various orbital parameters  
! source: http://en.wikipedia.org/wiki/Mars  
eccentricity = 0.093  
obliquity = 25.19d0 ! degrees  
longitudeAtPeriapsis = 251.0 ! degrees  
siderealOrbitalPeriod = 59354294.4 ! seconds  
siderealRotationPeriod = 88642.6848 ! seconds  
meanDistance = 1.52366231 ! AU  
quantizeYearLength='true' ! Or false  
!-----
```

# E\_Mars diagnostics

Planet :: Mars

Mean solar day:

88775.1850588159 (sec)

1.02749056781037 (Earth days)

SiderealRotationPeriod:

88642.6847826087 (sec)

1.02595699979871 (Earth days)

SiderealOrbitalPeriod:

59390598.8043478 (sec)

687.391189865137 (Earth days)

meanDistance (AU) : 1.52366231000000

Precession (degs from VE) : 251.000000000000

Solar Days per year: 669

Eccentricity: 9.30000000000000E-002

Obliquity (degs): 25.1900000000000

Fixed orbital parameters for planet.

Eccentricity: 9.30000000000000E-002

Obliquity (degs): 25.1900000000000

Longitude at periapsis (degs from ve): 251.000000000000



# PRT diagnostics

-----|  
Calendar for Year: 2000 |

Calendar year length (sec):           59390598.8043 |

-----|

Full Name	Abbr	# days	1st day	mid day	1st day
January	JAN	49	1	25	49
February	FEB	45	50	72	94
March	MAR	54	95	121	148
April	APR	56	149	176	204
May	MAY	62	205	235	266
June	JUN	64	267	298	330
July	JUL	65	331	363	395
August	AUG	63	396	427	458
September	SEP	58	459	487	516
October	OCT	55	517	544	571
November	NOV	49	572	596	620
December	DEC	49	621	645	669

-----|

apsis.....06-31  
periapsis.....12-12  
vernal equinox.....03-52  
summer solstice.....07-09  
winter solstice.....12-41  
autumnal equinox.....10-02