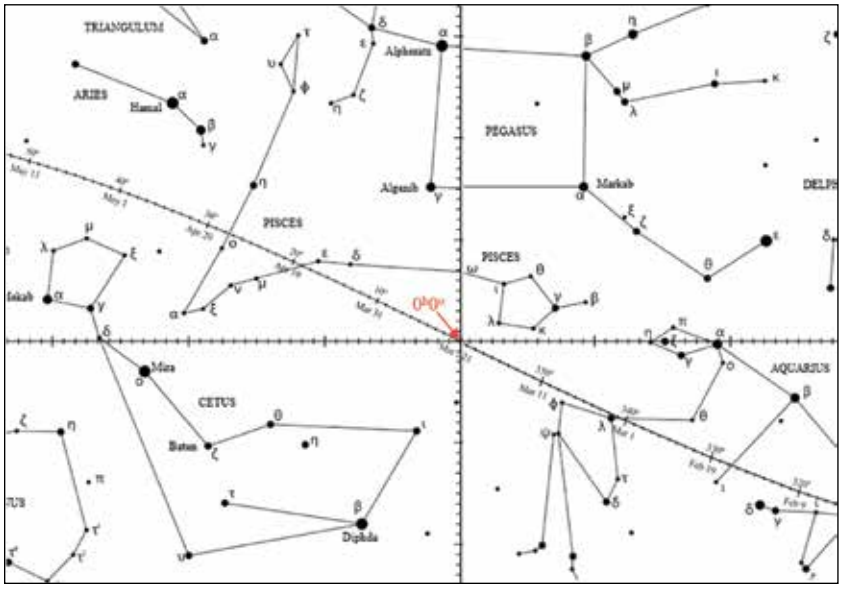
Spring Migrations

BY BOB RIDDLE

In many classrooms students' attention is often drawn to the day this month when seasons change from winter to spring in the Northern Hemisphere and from summer to autumn in the Southern Hemisphere. This day, March 20th, is the Spring equinox, or Vernal equinox. However, since it is not the Spring season in the Southern Hemisphere, perhaps we should refer to the equinox by the month it occurs: March equinox and September equinox.

Timing for the equinox is based on the Sun's position along the ecliptic using the celestial coordinate system of *degrees of declination* and *hour circles*. The ecliptic is the Earth's orbital path around our Sun and is used as a reference plane for all other objects orbiting the sun. These are essentially extensions of latitude and longitude onto the sky. Degrees of declination (dec) are similar to degrees of latitude, ranging from 0° at the celestial equator to 90° at either celestial pole. Meridians of longitude extended onto the celestial sphere become hour circles of right ascension (RA). Each hour circle is separated by 15° as well as 1 hour of Earth rotation. Hour circles are typically used to calculate or predict when a celestial object crosses the celestial meridian, an arbitrary line from the southern horizon overhead to the northern horizon. The hour circles start at the 0-hour circle, currently located within the constellation of Pisces (the Fishes), and are numbered from 0 to 23 giving us 24-hour circles (see Figure 1). At the March equinox the Sun is crossing the celestial equator moving northward and is at 0° dec and 0h of RA. Geographically, the Sun is over Earth's equator.

FIGURE 1: Celestial grid showing location of the Sun on the March Equinox



San Juan Capistrano

In some places springtime means returning swallows and the ringing of the Mission San Juan Capistrano bells. This popular tradition celebrates the return of cliff swallows as they migrate north from their winter home in Argentina to their spring and summer home in

southern California. (See Resources for lesson ideas.) The swallows' return typically occurs in mid-March. Their return is a festive event that celebrates the sighting of the first swallow with the ringing of the mission bells and other local traditions, which date to the early years of the mission when the padres observed that the swallows routinely returned around St. Joseph's Day, March 19 (see Figure 2).

While the return of the swallows is eagerly anticipated, some eyes may be watching for more than the return of birds. Late in the evening of March 15, 1973, a small meteorite smashed through the aluminum roof of a carport in San Juan Capistrano. This meteorite was named the San Juan Meteorite (see Resources). It was seen falling, but it was quickly recovered and put in the hands of scientists at the University of Southern California, San Diego, who identified it as a chondrite, one of three categories based on a meteorite's composition. Meteorites are fragments of rocky material that originally were part of an asteroid. These meteorites are important in that they are relatively pristine remnants of the early stages of the formation of our solar system.

Where am I?

Like other migratory animals, the swallows of San Juan Capistrano know their surroundings well enough to navigate and travel many miles. Perhaps becauase of our reliance on technology, we sometimes have more trouble

FIGURE 2: Barn swallows

Picture by Brenda Asterino

March

1 Waxing crescent Moon near the Pleiades
2 First quarter Moon
4 Moon at ascending node
Moon at northernmost declination: 23.4°N
6 Waxing gibbous Moon near Beehive Open Star Cluster
8 Begin U.S. Daylight Saving Time (set clock forward one hour)
Neptune at solar conjunction
9 Full Moon
10 Moon at perigee: 357,100 km (221,892 mi.)
14 International Planetarium Day
Pi Day
16 Last quarter Moon
Moon at descending node
17 Moon at southernmost declination: 23.5°S
The Sun enters astronomical constellation of Pisces (the fishes).
18 Waning crescent Moon near Mars, Jupiter, and Saturn
20 June Equinox 3:54 UT (11:54 p.m. June 19)
The Sun is not actually in the astrological constellation of Aries the Ram.
Mars and Jupiter close conjunction
21 Waning crescent Moon near Mercury
23 Mercury elongation at western elongation
24 New Moon
'Super-Mini' Moon apogee: 406,700 km (252,712 mi.)
Venus at greatest eastern elongation
28 Earth hour
31 Moon at ascending node
Mars and Saturn close conjunction

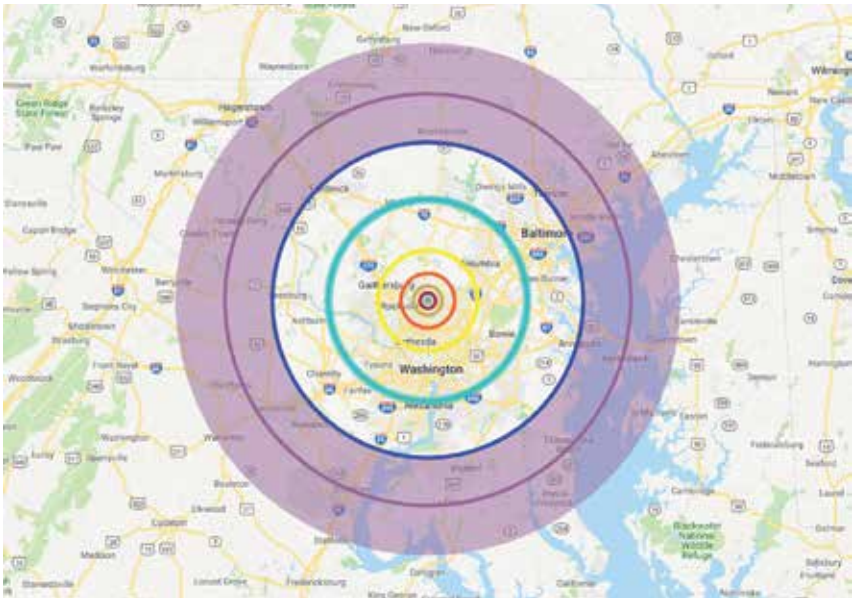
navigating. In April 2019, James Spann, a meteorologist on ABC TV in Birmingham, Alabama, asked, *"If I were to give you a blank map with no labels, no highways, just county lines and state lines, could you draw a dot within 50 miles of your house?"* (see Resources). Spann reported that on average, 60%–70% of those asked could not do so. This is geographical illiteracy—a limited awareness of the physical and cultural world around us.

So, what happens when you want students to read a paper map (a highway map or a topographic map)? Many students are more in sync with their smartphone and GPS-based mapping or location apps. From this limited perspective, they are perhaps less aware of the physical world around them.

Smartphones and internet mapping programs are convenient resources for seeing your locality or choosing the route to a different location. However, planning a lesson that involves paper map-reading skills as opposed to smartphone or internet mapping programs requires a different skill set. For example, in many science classes or classes where geography or astronomy is taught, being able to locate something using the coordinate system of latitude and longitude, or the celestial counterpart of hour circles and degrees of declination, is important.

To access students' prior knowledge, have students use an available paper map or atlas to locate their home, school, and favorite distant place outside of the city by its respective latitude and longitude. In a few sentences students could describe the location of their house relative to the location of the school: "I live about 1.5 miles (2.5 km) northwest of the school. To get to the school from my house I would take the school bus that would go from my street, Oak St., to a left turn on Knollberry Rd.,

FIGURE 3: Solar System Scale Model centered on NSTA Headquarters in Arlington, Virginia



For students

1. Download the SFA Star Charts, print out the two-part equatorial charts, and tape the ends together. Follow the planets, the Sun, and Earth's Moon as you plot the positions of planets, the Sun, and Moon using coordinate data from the In the Sky website (see Resources).
2. Develop a "city-size" scale model of the solar system using either the app or website in Resources for calculating the scale sizes (see Resources).
3. This month most of the United States will set their clocks forward one hour for Daylight Saving Time. What explanation could you suggest for why not all the states in the U.S.A. make this time adjustment?
4. Using the meridians of longitude, the Earth is divided into 24 equal segments, 15 degrees apart. These meridians also define 24 time zones, each separated by one hour. However, there are more than 24 time zones. How many more are there and what would explain why these may be necessary? (See Resources.)

and stay on Knollberry until you come to the school in about 1 mile."

Have students set up a scale model of our solar system using the school as the Sun. Using two resources (one online, the other a cellphone app), do the calculations for making a scale model of the solar system. Both will show the results on a Google map, thus allowing students to further explore map coordinate systems by changing the scale dimensions and the location of the scale model. They could compare locations as well as which sizes fit a location best (see Figure 3).

Road trip extension

A great extension is to plan a road trip (during a school break) between the student home or school and a distant location. Some planning could be done online using a state's "Visit us" website to learn more about that state's features and attractions. Students use a state or regional paper highway map to plot out the route and stops along the way. They then describe in detail what they see on the trip. In an Earth science class, for example, they can be encouraged to look for geological and geographical features. To get a printed state highway map, write to each state's tourism board (see Resources).

An extension to the above activity is planning a road trip with descriptions of geological and geographical features on the planet Mars. Students would use the latitude and longitude coordinates they obtained for their "Earth-based" road trip, but this time would use them on Mars (see Resources). This requires either having a Mars surface map showing latitude and longitude (see Resources) or online access to Google Mars or online programs with maps of Mars and explanations of surface features. ●

RESOURCES

Could You Draw A Dot Within 50 Miles of Your House?—*www.wbur.org/hereandnow/2019/04/19/map-skills-severe-weather*
Current Number of Time Zones—*www.timeanddate.com/time/current-number-time-zones.html*
Daylight Saving Time—*www.timeanddate.com/*
Earth Hour—*www.earthhour.org/*
Free State Maps or Guides—

Visible planets

Mercury will be visible for the first half of this month over the southeastern horizon about an hour before sunrise local time.

Venus is visible over the western horizon at sunset. Follow Venus as it moves closer to the Pleiades open star cluster at the end of this month.

Luna, Earth's Moon, will be at its greatest separation from the Earth for the year this month when it reaches its farthest apogee at new Moon phase.

Mars is visible over the southern horizon before sunrise and is in close conjunctions with Jupiter and Saturn as the faster orbiting Mars catches up and passes the two outer planets. The waning crescent Moon will pass closely by the three planets on March 17–21.

Dwarf Planet Ceres, to the west from the Sun, rises about one hour before sunrise and is too close to the Sun to be visible.

Jupiter is visible over the southern horizon before sunrise and is in close conjunctions with Mars and Saturn during the last half of the month.

Saturn is visible over the southern horizon before sunrise and is in close conjunctions with Jupiter and Mars during the last half of the month.

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http://wordtraveling.com/free-maps-of-all-50-states/
GLOBE—*www.globe.gov/*
Google Mars—*http://google.com/mars*
Help Make a Better World Land Map With NASA App—*www.nasa.gov/feature/goddard/2018/map-earth-with-nasa-and-globe-citizen-science*
How Mapping Is Used by NASA & Applications of GIS in Space—*http://gis.usc.edu/blog/how-mapping-is-used-by-nasa-applications-of-gis-in-space/*
In the Sky—*http://in-the-sky.org/ephemeris.php*
International Planetarium Day—*www.ips-planetarium.org/page/IDP*
Mars Map With Latitude and Longitude—*http://planetarynames.wr.usgs.gov/images/mola_regional.pdf*
Mission San Juan Capistrano—*www.missionsjc.com/about/swallows-legend/*
NASA's World View—*http://worldview.earthdata.nasa.gov/*
NASA/Globe Program Land Cover Infographic—*http://bit.ly/2xQsW4J*
NASA Space Tests Program—*www.nasa.gov/mission_pages/station/research/experiments/997.html*
Neagari Meteorite—*http://earth.s.kanazawa-u.ac.jp/ishiwata/labo/neagariUS.html*
Observing Environmental Changes from Earth's Orbit. Bob Riddle. *Science Scope Magazine.* April/May 2019
Pi Day—*www.piday.org/*
Pictures of California Meteorites—*http://cams.seti.org/california.html*
San Juan Capistrano Meteorite—*www.lpi.usra.edu/meteor/metbull.php?code=23128*
Satellite Imagery—*http://en.wikipedia.org/wiki/Satellite_imagery*
Scale the Planets App—Google Play Store—*https://play.google.com/store/apps/details?id=com.mjheimburger.ScaleThePlanets&hl=en_US*
Solar System Scale Model Builder—*http://thinkzone.wlonk.com/SS/SolarSystemModel.php*
SFA Star Charts—*http://observe.phy.sfasu.edu/SFAStarCharts/SFAStarChartsPro.pdf*
Skymaps—*http://skymaps.com/*
Star Maps—*http://nightsky.jpl.nasa.gov/download-view.cfm?Doc_ID=335*
Barn Swallow Resources—https://journeynorth.org/tm/swallow/indexCurrent.html
Welcome to Mars. Scope on the Skies. *Science Scope Magazine.* Bob Riddle. January 2012.