JANUS
THE NEWSLETTER OF EWELL ASTRONOMICAL SOCIETY

May 2020 EDITION

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Editorial:

Welcome to the May edition of Janus. Sadly, the Covid-19 pandemic is still very much with us and, for the foreseeable future, the prospect of any significant easing of the restrictions on everyday life it has brought seem to be remote. This prompts the question of when the next EAS meeting will take place. Currently, it's still over a month away on 12 June – a relatively long time in Covid-19 terms. Personally, I'm not optimistic, but let's hope for the best.

On a bright note, members have not been inactive during April. The weather has been quite kind, and there have been a large number of clear nights – perhaps Ron Johnson could tell us how many?! Venus was clearly visible on many occasions during the month and some took the opportunity to photograph it in Pleiades around 3 April. The full (Super Pink) moon was visible on 8 April, and members again took many photographs of it around this date. On 26 April, a 5 day-old crescent moon and Venus, in close proximity, on another clear night, provided a further photo opportunity.

Week beginning 19 April there was a flurry of activity as members tried, with varying degrees of success, to view chains of errant Starlink satellites. Opportunities to view lasted for a week, and up to 6 were visible at a time. For future reference, www.heavens-above.com/starlinklaunchpasses.aspx is a useful source of information on passes – the next opportunities are from 22 May.

Following a request from Ron Johnson, the Gallery page has been added to the website – if anyone has pictures they would like to add, please submit them as email attachments to ewellastro@gmail.com

John

skyUpdate
What's up this month?

The Solar System May

MERCURY: will soon pass behind the Sun and starts the month not readily observable. By the end of the month it is visible as an evening object, having recently passed greatest elongation east. It remains, however, not observable as it will reach its highest point in the sky during daytime and is no higher than 8° above the horizon at dusk.

VENUS: starts the month visible as an evening object, having recently passed greatest elongation east. It will become visible around 20:43 (BST) as the dusk sky fades, 28° above the W horizon. It will then sink towards the horizon, setting at 00:24. By the end of the month, it will soon pass in front of the Sun at inferior solar conjunction and will not be readily observable since it will be very close to the Sun, at a separation of only 6° from it.

MARS is a morning object, but not observable at the start of the month – it will reach its highest point in the sky during daytime and be no higher than 10° above the horizon at dawn. By the end of the month it is visible in the dawn sky, rising at 02:05 (BST) – 2 hours and 46 minutes before the Sun – and reaching an altitude of 15° above the SE horizon before fading from view as dawn breaks around 04:04.

JUPITER: is currently emerging from behind the Sun and starts the month visible in the dawn sky, rising at 02:08 (BST) – 3 hours and 25 minutes before the Sun – and reaching an altitude of 16° above the S horizon, before fading from view as dawn breaks around 05:08. By the end of the month, it is visible in the morning sky, becoming accessible around 01:24, when it rises to an altitude of 8° above the SE horizon. Reaching its highest point in the sky at 04:20, 17° above the S horizon, it will be lost to dawn twilight around 04:22, 17° above the S horizon.

SATURN: begins the month emerging from behind the Sun and is visible in the dawn sky, rising at 02:22 (BST) – 3 hours and 11 minutes before the Sun – and reaching an altitude of 14° above the SE horizon before fading from view as dawn breaks around 04:48. By the end of the month, still a morning object, it is visible in the dawn sky, rising at 00:24 (BST) and reaching an altitude of 18° above the S horizon before fading from view as dawn breaks around 03:59

URANUS: recently passed behind the Sun at solar conjunction. At the start of the month, it is not readily observable, being very close to the Sun, at a separation of only 4° from it. By the end of the month, it is not observable – it will reach its highest point in the sky during daytime and be 7° below the horizon at dawn.

NEPTUNE: recently passed behind the Sun at solar conjunction. Throughout the month, it is not observable. It will reach its highest point in the sky during daytime and be between 2° below and 4° above the horizon at dawn.

MOON PHASES:

First Quarter	30 April
Full Moon	7 May
Last Quarter	14 May
New Moon	22 May
First Quarter	30 May

More Space. X. Constellations – Gary Walker

On 29 March at around 20:45 UT, I saw the ISS pass overhead. At the same time, I became aware of a chain of satellites moving from the SW to the NE. This was clearly another satellite constellation passing over. They were still going over 15 minutes later. I saw that they were of the same magnitude as the stars, Castor and Pollux, thus, these satellites were magnitude 1.6, approx. There were at least, 2 parallel chains of satellites passing over.

The Moon was close to Venus in the, at same time, adding to the spectacular scene.

The Starlink Constellation – John Davey

Some while ago, Paul Evans alerted members to the planned launch of a large constellation of small satellites (several thousand are planned) known as Starlink. The satellites have been observed (and their transit imaged) by astronomers, and they are causing more than a little concern due to the effect that their presence has on the night sky, particularly for astro-photographers. As reported in my editorial, a number of EAS members observed their overflight during the week of 19-25 April, and Gary observed them on 29 March, so I thought it would be appropriate to write a piece about them examining the scope of the programme, the progress to date, and identifying some of the issues resulting from it.

History and Development

Plans for the Starlink satellite constellation were publicly announced by SpaceX in January 2015. The proposal was for a constellation of several thousand mass-produced small satellites[1] in low Earth orbit (LEO), working in combination with ground transceivers, which CEO Elon Musk said would respond to a significant unmet demand for low-cost global broadband capabilities. By January 2016, the company had publicly disclosed plans to have two prototype satellites flying in 2016, and to have an initial satellite constellation in orbit and operational by approximately 2020.

Any US company wishing to launch and operate satellites requires a license from the Federal Communications Commission (FCC) and, in November 2016, SpaceX filed an application with the FCC for a "non-geostationary orbit" (NGSO) satellite system comprising 4,425 using the Ku and Ka frequency bands[2]. In March 2017, SpaceX filed plans with the FCC to field a second orbital shell

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[1] The term "small satellite" (or sometimes "minisatellite") often refers to an artificial satellite with a mass (including fuel) of between 100 and 500kg, but in other usage has come to mean any satellite with a mass under 500kg
[2] Ku-band is the portion of the electromagnetic (EM) spectrum in the microwave range of frequencies from 12-18 GHz. Ka-band is in the range 26.5–40 GHz.

of more than 7,500 so called "V-band[3]" satellites in non-geosynchronous orbits to provide communications services. Called the "Very-Low Earth Orbit (VLEO) constellation", it would comprise 7,518 satellites and would orbit at altitudes between 335 and 346 km, while the smaller, originally - planned group of 4,425 Ku/Ka band satellites, would operate at altitudes of between 1,110 and 1,325km. SpaceX's plans were unusual in two areas: the company intended to utilise the little-used V-band of the EM spectrum, and they intended to use a new orbital regime, the VLEO regime at ~340km altitude, where atmospheric drag is quite high, which normally results in short orbital lifetimes. The plan called for SpaceX to launch test satellites of the initial Ku/Ka type in both 2017 and 2018, and to begin launching the operational constellation in 2019. Full deployment of the ~1,200km constellation of 4,425 satellites was not expected to be completed until 2024.

Regulatory approval of the plan was granted in November 2018 and, at the same time, SpaceX made new regulatory filings with the FCC to request the ability to alter its previously granted license in order to operate ~1.600 of the 4,425 Ku/Ka satellites approved for operation at 1,150km in a new lower shell of the constellation at only 550km orbital altitude. These satellites would effectively operate in a third orbital shell, a 550km orbit, while the higher (~1,200km) and lower (~340km) orbits would be used later, once a considerably larger deployment of satellites becomes possible. The FCC approved this new request in April 2019, thereby giving approval to place ~12,000 satellites in three orbital shells: initially ~1,600 Ku/Ka band satellites in a shell at 550km, and subsequently ~2,800 Ku/Ka band satellites at 1,150km and ~7,500 V-band satellites at 340km. This is where plans stood at the time of the first satellite launches in 2018. A further over-riding constraint was that, in order to comply with FCC licensing rules, half of the constellation (i.e. ~6000 satellites) had to be in orbit in six years, with the full system in orbit nine years from the date of the license (i.e. November 2027). A possible future extension to 42,000 satellites was also mooted, but has not been mentioned since.

Finally, in a further recent change to their plans for the second phase of deployment, SpaceX now foresees operating a further 2825 Ku/Ka satellites at altitudes of 540-570km rather than 1,100-1,325km, and in orbits inclined at 53.2°, 70.0° and 97.6° rather than 53.8°, 70.0°, 74.0° and 81.0°. The effect of this will be to increase the number of satellites in orbit at ~550km from 1584 to 4409 meaning that almost 3 times as many satellites might be visible in the night sky at some stage.

Satellite Technology

The first 60 Starlink satellites, launched in May 2019, have the following characteristics:

- Flat-panel design with multiple high-throughput antennas and a single solar array
- Mass: 227kg
- Orbit adjustment, altitude maintenance and deorbit by means of electric propulsion using Hall-effect thrusters
- Star tracker navigation system for precision pointing
- Use of Department of Defense-provided debris data to autonomously avoid collisions
- Operational altitude of 550km
- 95% of components will quickly burn-up in the Earth’s atmosphere at the end of each satellite's lifecycle

Subsequent Starlink satellites, launched since November 2019, have the following characteristics:

- 100% of components will quickly burn-up in Earth’s atmosphere at the end of each satellite's lifecycle
- Mass: 260kg

Satellites will eventually (post 2020) employ optical (laser) inter-satellite links to allow them to communicate with each other and pass data around the constellation.

[3]V-band is a band of frequencies in the range 40 - 75 GHz. Prior to SpaceX and other companies filing to use the frequencies for satellite communications, this part of the EM spectrum had not previously been heavily employed for commercial communications services.

Launches

Following the launch of 2 test satellites in Feb 2018, the initial launch of 60 production Starlink satellites took place on 24 May 2019. These satellites were the first of the 1,584 satellites originally intended to form the initial constellation, with 66 satellites in each of 24 orbital planes inclined at 53° to the equator, at an altitude of 550km. To provide better coverage for potential users, this was modified in September 2019 to have 22 satellites in 72 planes inclined at 53°. A further 6 launches of 60 satellites each followed between 11 November 2019 and 22 April 2020.meaning that, by the end of April 2020, 420 operational satellites had been launched out of the initial 1584. Further launches of 60 satellites each are planned at regular intervals from 7 May 2020, with the intention of completing the launch of the initial 1584 by the end of 2020.

Implications of using LEO

Traditionally, most communications traffic (including internet traffic) has been routed via geostationary satellites as such satellites allow global coverage using only a small number of satellites. However, due to the distance over which signals have to travel, internet traffic via a geostationary satellite has a minimum theoretical round-trip latency (delay) of at least 477ms (between user and ground gateway) although, in practice, current satellites have latencies of 600ms or more. This has implications for some time-sensitive applications. Starlink satellites orbit at less than $^1/_{100}$ of the height of geostationary orbits, and thus offer more practical Earth-to-sat latencies of around 25 - 35ms, comparable to existing cable and fibre networks

One of the major concerns surrounding SpaceX's plans to place so many satellites in VLEO and LEO was the potential for them to significantly enhance the growing volume of space debris. To this end, the company filed documents in late 2017, with the FCC, to clarify their space debris mitigation plan. The company stated that they would implement an operations plan for the orderly de-orbit of satellites nearing the end of their useful lives (roughly five to seven years) at a rate far faster than is required under international standards. The satellites in question will be moved to a disposal orbit from which they will naturally reenter the Earth's atmosphere within approximately one year after completion of their mission. The FCC approved SpaceX's plans in March 2018, but with the condition that SpaceX would need to obtain a separate approval from the International regulator, the International Telecommunications Union (ITU). The FCC also supported a NASA request to ask SpaceX to achieve an even higher level of de-orbiting reliability than the standard that NASA had previously used for itself, reliably de-orbiting 90% of the satellites after their missions are complete.

Problems for Astronomers

The main problem for astronomers is that the satellites are, at times, clearly visible in the night sky. This is particularly true during the initial phases of their deployment when they are at an altitude of 280-350km – although their final operating orbit is at ~550km, the satellites can take many months to reach this altitude due to the very low thrust levels produced by their electric propulsion system. The degree of visibility depends on a number of factors but is mainly influenced by the aspect of the satellites' principal reflecting surfaces (solar panels and antennas) to the sun.

Many images of the satellites have appeared on the internet, some of which are reproduced here, along with 2 images provided by John Murrell. The first 2 show the "train" of satellites crossing the sky which is typical of the early deployment phase when the satellites are very close together. The next two, taken by John, show the effect of satellites crossing the field of view during a longish exposure – these two images were taken on a Canon 40D fitted with an 18-50mm lens set at 18mm, with an exposure of 13 seconds. John told me that he was taking the images to check his camera settings for the Lyrids on 22 April; the intrusion by Starlink was not intentional, and in fact he didn't see them until he looked at the images later – a problem which many astro-photographers might have! The characteristic "trails" resulting from the movement of the satellites are clearly seen. The first of the two images is particularly interesting in that there are trails from two satellites which are alongside each other rather than in a line.

The final image is a 333-second exposure taken last year by the Dark Energy Camera on the Blanco 4-meter telescope at the Cerro Tololo Inter-American Observatory. It shows 19 streaks attributed to Starlink satellites passing through the camera's field-of-view shortly after their launch on 11 November from Cape Canaveral. The scene being imaged is totally dominated by the satellites making it impossible to discern anything else!

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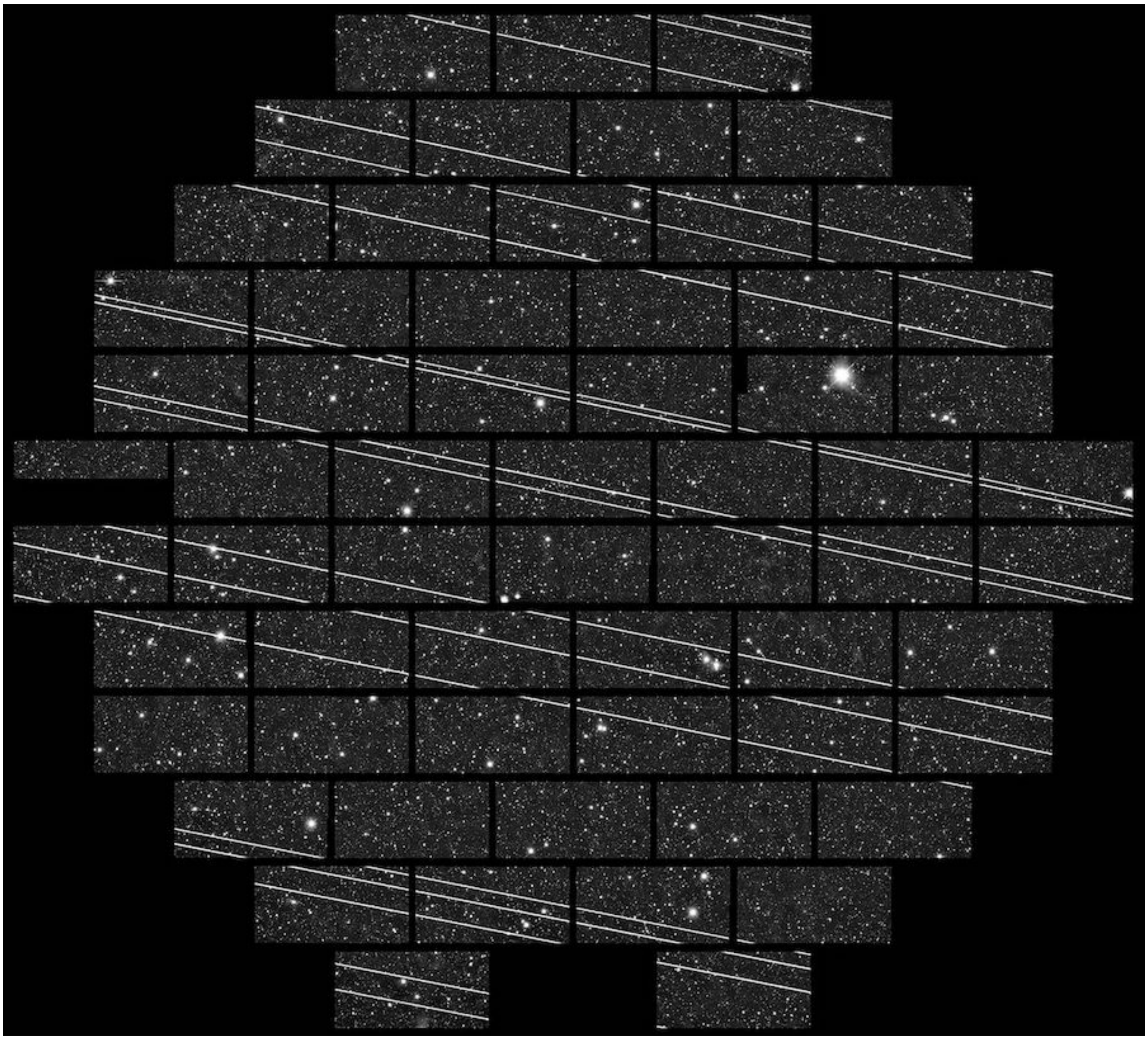


Credit: NSF's National Optical-Infrared Astronomy Research Laboratory/NSF/AURA/CTIO/DELVE

In an effort to reduce the brightness of its satellites, in January 2020 SpaceX launched a satellite dubbed "DarkSat", with a darker coating. Astronomers noticed an improvement in that the satellite is about a factor of two-and-a-half fainter - about 1 magnitude in astronomical units - although it is still visible to the unaided eye under the best conditions, and might well still adversely affect long exposure images.

From SpaceX's perspective, the darker coating has drawbacks. Dark surfaces in space get hot, causing problems with the thermal balance of the satellites which could, in turn, affect the satellite's electronics. The company is now moving forward with a solution which involves fitting an RF transparent foam sunshade or visor over the satellite's antennas to prevent them reflecting sunlight, whilst allowing them to function normally. SpaceX believe the foam will actually be darker than the coating they tried previously, but it will not cause the same overheating problems. It will be evaluated on the next batch of satellites due to be launched on 18 May.

Clearly, SpaceX are beginning to listen to the concerns of astronomers and are seeking ways to mitigate them. Whether they are successful remains to be seen. Even if they are, the programme is still at an early stage. If all goes well, there will be 1584 satellites in orbit by the end of 2020 - but there are still more than 10,000 to come, 7500 of which could be at an altitude of only 340km.

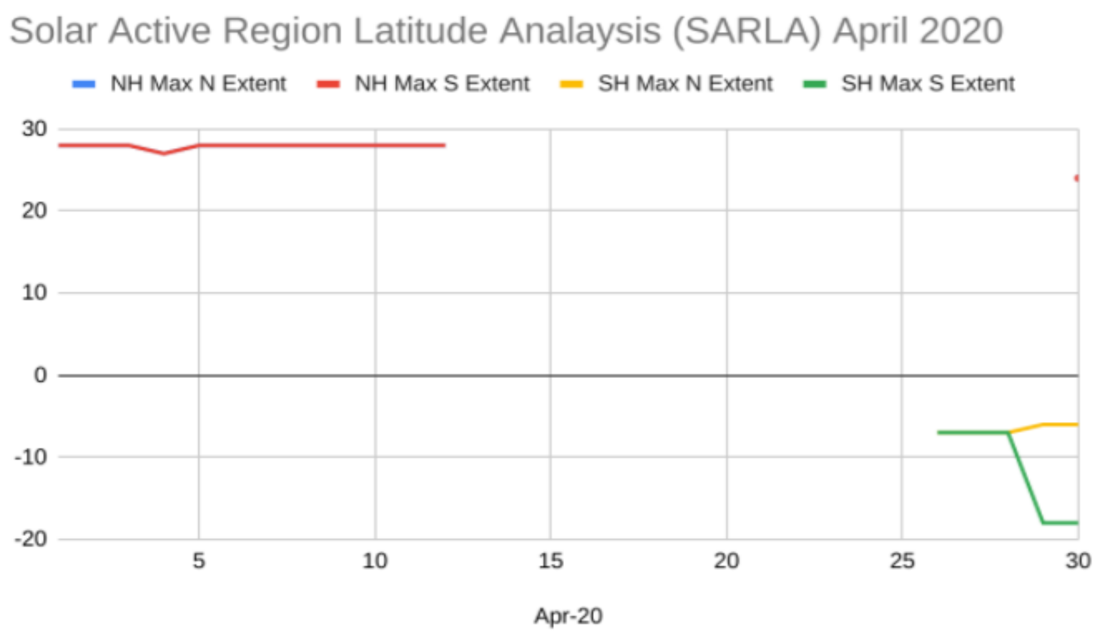
Solar Active Region Latitude Analysis (SARLA) Report for First Four Months of 2020 - Ewell Astronomical Society 2020 - Stephen

Background
Solar Active Region Latitude Analysis (SARLA) is used to monitor the status of the solar cycle. It relies on the fact that solar active regions are distributed at higher solar latitudes at the beginning of the solar cycle and occur at gradually lower latitudes as the cycle progresses. By the maximum of the solar cycle, active regions occur almost exclusively at para-equatorial latitudes. Thus, analysis of the average latitudes at which active regions are occurring at any given time, should provide some insight into the stage of the solar cycle at which observations are being made.

Throughout the whole of a five-year period 2011 to 2016 SARLA data were gathered to see if it was possible to detect the moment of the maximum of Cycle 24, and a report was published at the end of 2016 revealing the results of the project, which were encouraging. In 2019 there was a return to SARLA monitoring when it became apparent that the demise of Cycle 24 and commencement of Cycle 25 were not happening quite as expected, and from this it was decided to continue the SARLA project for the whole of Cycle 25 and beyond. Monthly SARLA reports and charts were published through the EAS newletter *Janus,* followed by interim reports, of which this is the first.

Methodology
Data were gathered from the website: http://www.solarmonitor.org which provides daily solar longitudes and latitudes for active regions. These data were entered into an *Excel* spreadsheet from where they could be manipulated with ease. Values were recorded for the maximum northerly and southerly extent of active region distribution, for both the North and South solar hemispheres, so that each daily observation had the potential to produce 4 data points. These would indicate the margins of the latitudinal band of active region distribution for each day. At the end of each month, the data were presented graphically by converting them into a line graph using the spreadsheet software. This graphical presentation made it easier to identify trends and patterns in the data. Additionally, a quarterly and annual chart was produced, of smoothed monthly averages, in order to demonstrate a lower resolution view of solar cycle progression.

First Four Months of 2020 (1 January to 30 April) Findings:
There were no data outages during the study period, so portions of the chart that show no data indicate that there were no active regions observed during that time period. Before considering the four-month chart, it is useful to examine the chart for April 2020:



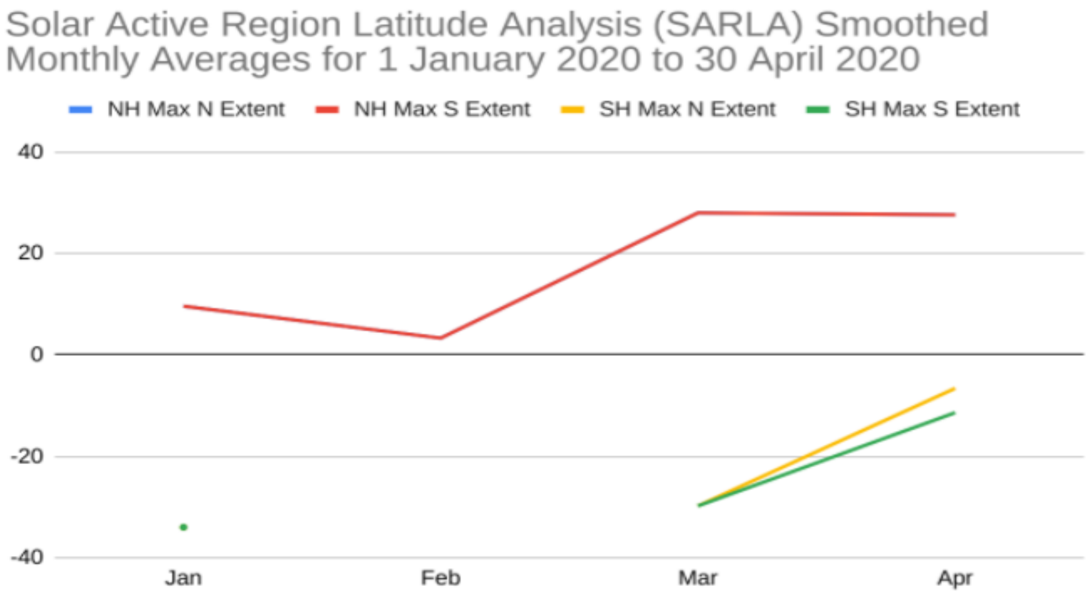
Immediately it will be noticed that there is a disparity between the North and South hemispheres, with the NH being more active in the first half of the month, and the SH becoming more active toward the end of the month. This is an important demonstration of a dichotomy, with each hemisphere being an independent entity.

If we consider the active region represented by the red line in the first half of the month (the line is actually both red and blue because both the northerly and southerly extent of active region distribution in the NH during that period were identical), we find that this was AR2759, which demonstrated a North polarised leading component, which is in keeping with a Cycle 25 active region. It also occurred at a high solar latitude, which is a further indication of an active region belonging to a new solar cycle.

The 25 to 28 April active region was AR2760, which occurred at only -7º of solar latitude, and demonstrated a North polarised leader, which in the SH is in keeping with a Cycle 24 active region, confirmed by its low solar latitude. On 29 April, however, a new active region appeared (AR2761) in the SH at -18º of solar latitude, which demonstrated a South polarised leader, which in the SH is in keeping with a Cycle 25 active region, also confirmed by its higher solar latitude. On 30 April a third active region appeared in the NH (AR2762) at a high latitude of +24º, which demonstrated a North polarised leader, making it a Cycle 25 active region, as borne out by its high solar latitude. This active region is represented by a single red dot at the end of the chart due to its one-day presence during the study period.

Thus, we see a mixture of Cycle 24 and 25 active regions during the month of April, and indeed this has been the case for the whole of the first four months of 2020, and results in a confusing picture.

Now let us consider the smoothed monthly average chart for the first four months of 2020:



Again, we see that the maximum northern and southern extents of active region distribution in the NH are identical - resulting in a single line. This is an indication that there was only one active region visible at any time in the NH, as distinct from the SH plot, which shows a divergence of the yellow and green lines and indicates that more than one active region was visible at a time. The gap in the SH chart indicates that no active regions were observed in that hemisphere for that period.

It would appear from the data, that the NH is stabilising and settling into Cycle 25 somewhat ahead of the SH. This is a good fit with the observation made at the end of the 2019 study, that the SH had been grossly without active regions for most of the year, only producing active regions again toward the end of the year. The NH, however, remained more active throughout 2019, and demonstrated a sudden sharp divergence of its active regions away from the equator toward the end of the year.

Impression
A confused picture is seen, in which both Cycle 24 and Cycle 25 active regions are still demonstrated in both hemispheres. Careful analysis of the data though, reveals that we are in the changeover period between Cycle 24 and Cycle 25, and that this is not an abrupt and definitive change of regime, but actually a gradual process.

In addition, there was a strong suggestion in the 2016 SARLA paper, of an asymmetry of the activity cycles of the two solar hemispheres, with the NH and SH behaving very differently, and the 2020 study is beginning to demonstrate that this is an ongoing theme, and will be worthy of further investigation.

The suggestion made by the data, is that the NH will settle into Cycle 25 sooner than the SH, and we can probably expect to see the extinction of Cycle 24 active regions in the NH in the coming months. It must be said though, that the picture is far from clear at the present time.

Plan
The study will continue throughout Solar Cycle 25 and beyond. A six-month report will be prepared at the end of June 2020, which should give further insight, particularly into the trends of solar cycle changeover. This will be followed with an end of year report at the end of December 2020. Monthly charts of SARLA data will be produced throughout the remainder of 2020.

Up Next:

NEXT MEETING: Friday 12 June 2020, Nonsuch High School for Girls Library 8pm.

Maurice Gavin Memorial Lecture - Neil Phillipson will talk on a subject to be agreed.

Ron Canham will also give his usual presentation on the sky at night for the coming month.

NEXT USER GROUP: Nonsuch High School for Girls 8pm.

Date to be advised – check EAS web site.

This is an informal session for members to meet and discuss anything related to their telescopes and sky events and, if weather permits, to go up on the roof for observing. Enter via the Main Entrance opposite the Car Park

NEXT DENBIES OBSERVING SESSION:

Date to be advised – please check EAS web site.

AD HOC OBSERVING AT WARREN FARM:

These will be at short notice when the weather is favourable. Please watch our Whats App feed for alerts.