Three Consecutive Years of Eclipse Chasing in Spain

Abstract:

The sky has always been inspiring for humankind. He has always observed the sky to explore the universe and understand its scientific laws. In the world of astronomy, a total solar eclipse is one of the most spectacular nature's shows. Solar eclipse can be a great pretext to promote tourism in a scientific way and eclipse chasing is a kind of astrotourism that promotes sustainable tourism development.

This research is a pioneering work to demonstrate a rare opportunity for Spain to host one of the greatest eclipse chasing events through history in 2026, 2027 and 2028. This work aims to provide a primary study about the upcoming phenomena in order to start an early comprehensive plan to organize these events. The thesis follows studying the role of this rare opportunity to promote tourism in Spain based on planning, education and awareness.

The research is both, descriptive and qualitative, consisting of a literature review followed by empirical investigation cooperating with the most well-known experts of this area. More than fifty experts and over a hundred interested people from all over the world have collaborated in the research answering to online questionnaires. The findings show fantastic potentials in Spain to be prepared and hold eclipse celebrations throughout the country. The author presents featured locations to observe the upcoming eclipse in Spain based on astronomical calculations, weather forecast models and tourism potentials. Moreover, the thesis suggests the most necessary actions and creative activities to be accomplished in line with the objectives of this research.

Keywords: eclipse chasing, astrotourism, Spain

INTRODUCTION

The sky has always been inspiring for humankind. He has always observed the sky to explore the universe and understand its scientific laws. In the world of astronomy, total solar eclipse is one of the most spectacular nature's shows. A total solar eclipse can be a great pretext to promote tourism in a scientific way and eclipse chasing is a kind of astrotourism that promotes sustainable tourism development. Eclipse chasers believe that the experience of observing a total solar eclipse is a unique opportunity that shows nature at its best colors.

During totality the Moon covers the Sun's face and casts the darkest part of its shadow, the umbra, on Earth. At this time, the sky goes dark, bright planets and stars appear, temperature normally falls, and birds and animals often go quiet. Definitely early planning in a host community within the path of totality can bring more people together to celebrate this event. Moreover, by effective cooperation between different sectors, tourism development and substantial benefit are predictable in the region both in the short and long term.

The track of the Moon's shadow across Earth's surface is called the Path of Totality (Espenak, 2014). Almost every year a path of totality of a solar eclipse appears on surface of the earth however, a specific location on earth will be visited by a total solar eclipse only once in about 375 years on average (Littmann, M., Espenak, F., & Willcox, K. 2008). In 2026, 2027 and 2028, the paths of 3 solar eclipses will cross Spain. The eclipses of 2026 and 2027 will be total and that of 2028 will be annular. The first eclipse will occur on Wednesday 12 August, 2026 and occurs over the Iberian Peninsula for the first time in nearly 120 years (NASA, 2013). The total eclipse will pass over northern Spain from the Atlantic coast to the Mediterranean coast as well as the Balearic Islands. The total eclipse of 2026 will be visible from Valencia, Zaragoza, Burgos, Valladolid, Leon, Palma and Bilbao (NASA, 2014). The second eclipse will happen in less than a year later on 2 August 2027 in the southern coast of Spain. The path of totality will pass first over the Strait of Gibraltar between Spain and Morocco (NASA, 2014). This total solar eclipse will be the second longest total solar eclipse to occur in the 21st century after the one on July 22, 2009 (Littmann, M., Espenak, F., & Willcox, K. 2008) and Spain will be the only European country to observe this eclipse. Although a narrow area of southern cost will visit the path of totality this time, however Spain can remain among the first countries as a destination to host eclipse chasers. This total solar eclipse will visible from Malaga, Cadiz, Marbella and Strait of Gibraltar whereas Tarifa in the south has the best situation in the soil of Spain to have more than four minutes of totality. Finally, less than six months later, Spain will welcome to another solar eclipse which is an annular one and occurs on January 26, 2028. The path of annularity will pass over southwest of Spain from the Atlantic coast to the Mediterranean coast (NASA, 2014). Many astronomers believe that annular solar eclipses are not as spectacular and important as total ones. However, since this annular solar eclipse happens near the western horizon before sunset, this would be a great motivation for astrophotographers to record this memorable event.

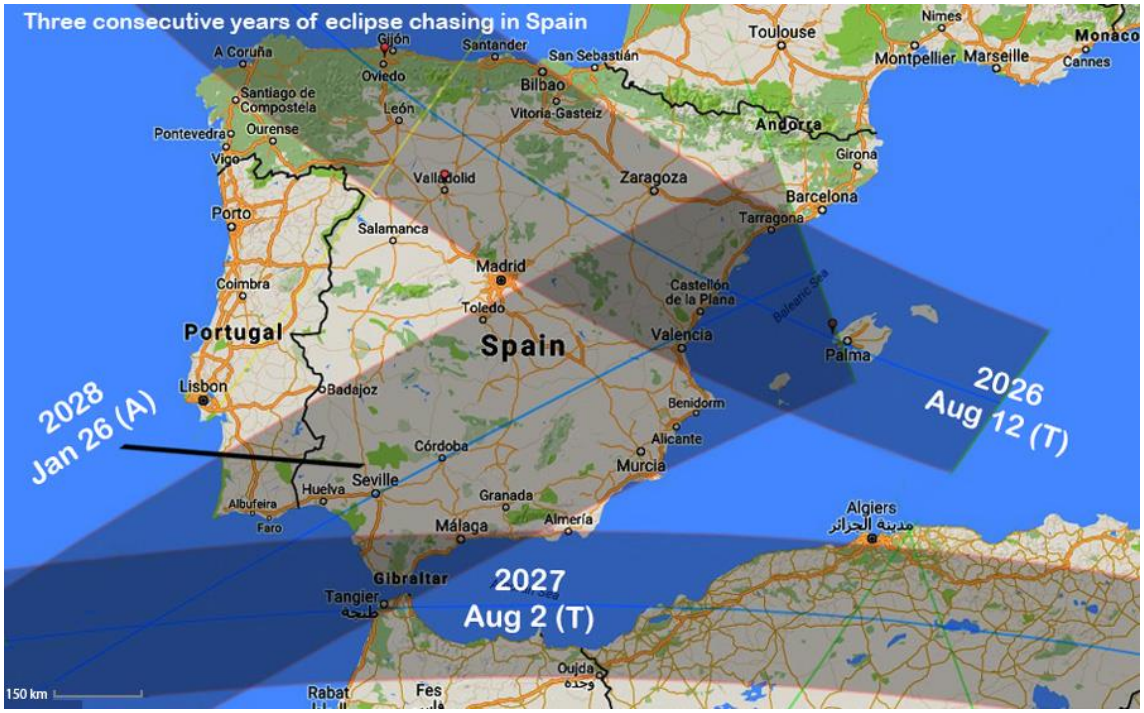

Figure 1: The paths of Totality and Annularity of three solar eclipses in Spain in three consecutive years (Source: Own design based on Total Solar Eclipse - Interactive Google Map - Xavier Jubier)

The paths of totality and annularity of these three eclipses covers a vast area in Spain which is about 70% of the whole Spanish territory. These phenomena are magnificent and important not only among the astronomers and eclipse chasers, but also spectacular and inspiring for many people. That would be a considerable audience and remarkable potential for tourism and educational sector. Definitely Spain can take advantage of its rare opportunity and start planning as soon as possible to prepare enough infrastructures and requirements to host great number of travelers within and outside the eclipse main path. Moreover, since the eclipse happens in a big area including different cities, rural regions, abandoned areas, natural and cultural sites, by early planning in tourism sector cooperating with other relevant entities, this event can promote tourism in less-known areas of Spain.

The objectives and hypothesis

General objective

This study generally aims to provide a primary study and necessary information about the upcoming events and trying to present it to the relevant entities to start an early planning in order to prepare Spain for hosting one of the greatest solar eclipse chasing events of history.

Specific objectives

1. Studying the paths of these three solar eclipses in Spain, exploring the best locations to host eclipse observers (based on early weather models, technical requirements and local potentials) and suggest them to eclipse chasers.

2. Demonstrating the rare situation of Spain as one of the best areas on Earth to observe these three eclipses, raising public awareness and promote it nationally and internationally.

3. Recognizing and studying eclipse chaser's most important concerns and requirements

4. Providing technical information and knowledge in order to start an early, effective and comprehensive planning in Spain as a destination to host one of the greatest solar eclipse events in history.

Hypothesis and questions

The rare opportunity of Spain to observe three solar eclipses of 2026, 2027 and 2028 plays an important role to develop creative ideas in tourism industry of Spain through eclipse chasing based on cultural and natural potential.

METHODOLOGY

This thesis uses qualitative research methods and an exploratory case study design. When it comes to generalizability of qualitative research findings, the purpose is to extend the findings and conclusions from the study conducted on a sample population, to the population at large.

Sample selection

There were not special requests to focus on specific gender group or specific age group but respondents were divided in two main groups:

1- Astronomy experts especially eclipse chasers

2- Unprofessional people interested in astronomy

For the first group, a minimum of 50 participants were needed. At the end, 52 people took part in this research, which was sufficient in order to start analysis. For the second group, a minimum of 100 participants were needed and at the end, 104 participants took part in this research. The reason for studding the case using two main groups of respondents was that an eclipse event has normally two main groups of audience:

1. Eclipse chasers and astronomers with remarkable relevant scientific background or experience
2. Any other person without a serious relevant background interested in observing a total or an annular solar eclipse in their lives

Each group might have different requirements, concerns and infrastructures so they will have different points of view and opinions as well.

Data collection

Data were collected online through the google online questionnaire from January to June, 2017. The thesis research was made in an exploratory case study design. This type of research enables fieldwork and data collection with the purpose of exploring the certain phenomena that has been perceived by the researcher, or the phenomena that was perceived to have a possible inter-connection. Data collection is being studied in two parts according to the two main groups of respondents.

1. **Astronomy experts especially eclipse chasers** were selected among well experienced experts using personal contacts from International Astronomy Union (IAU), NASA, Solar Eclipse Mailing List (SEML), Local experts and some other people with international eclipse chasing experience. They were kindly asked personally to collaborate in the research, answer to the survey and help the author improving the issue using

their great opinions and experience. The result was remarkable and a good number of well-known eclipse chasers and experts accepted to participate with open arms. "*I didn't know that Spain has three solar eclipses within three years, two of the total a year apart. That's really amazing! I completely agree with your idea of capitalizing on that rare opportunity in Spain. Whether it for businesses or science or anything else, the experience will be a good one for all observers"* said Make Simmons, Founder and President of Astronomers Without Border.

It must be mentioned that the majority of experts who have been collaborated in the research were absolutely busy since they were organizers and planers of the American Great Eclipse, getting ready for the big event on August 21, 2017. Many of them are well-known scientists and lecturers on eclipse events, a number of them are professional eclipse tour organizers, some are eclipse consultants or eclipse meteorologists and many of them are famous professional or amateur astronomers with very unique eclipse experiences such as eclipse observation from the air, cruise ships and different areas of all around the world.

2. **Unprofessional people interested in astronomy** were invited to participate and answer to the survey in social network groups and websites related to tourism activities and adventures. An attempt was made to focus more on European Union residents since that would be much easier and cheaper for them to come to the path of totality and see these solar eclipses. A good number of the participants received the request to answer to the survey in different posts published in a vast number of Couchsurfing groups. Couchsurfing is a global community of 14 million people in more than 200,000 cities who share their life, their world and their journey. Couchsurfing connects travelers with a global network of people willing to share in profound and meaningful ways, making travel a truly social experience. Couchsurfing members are normally young, adventurers, backpackers and experienced travelers.

Reliability and validity

To make the research more reliable and valid, sample selection, survey design and data collection was studied in a specific method consulting with the experts all around the world.

Undoubtedly dedicating a separate survey to the experts including well experienced and famous eclipse chasers provides a very high level of reliability and validity in this research. Even some parts of the survey were modified by a couple of the experts in order to be more clear and sufficient for the respondents. A good number of the experts are still collaborating in the research helping the author with essential information and required resources. In other worlds having a group of professionals as the respondents makes the result of the survey type (A), reliable and valid.

Regarding the survey type (B), since people were kindly invited to answer to the questions and they were not insisted to participate, it seems that the majority of the respondents have been interested in the issue and have filled out the survey patiently. Moreover, the result of the second survey is generally in line with what experts had previously stated in the survey (A).

FINDINGS AND RESULTS

The main result of this thesis is focusing on exploring the best locations to observe the upcoming eclipses in Spain considering the paths of totality or annularity, weather forecasts, biosphere reserves and other natural and cultural sites to host eclipse observers.

Featured locations

As priority eclipse observers must find a right location within the central path of eclipse. Observers outside the path of totality/annularity won't be able to see the most important moments of the event that are totality and annularity. After studying the regions under the path of the eclipse, most observers normally look for locations to have more totality or annularity getting closer to the central line. Even though you can only see a 100% total or annular solar eclipse from the path of totality or annularity, the duration of totality and annularity depends on your location within the path. In this part of the research we are trying to study each path of our three eclipses separately in order to find the best locations in Spain for eclipse observation. The author has presented the eclipse contact times for a good number of featured locations in Spain in three tables for each eclipse. These tables provide a primary data for eclipse organizers, observers and local communities.

Weather forecasts

Obtaining a clear sky for the eclipse day is one of the most important and serious concerns for the eclipse observers. Although that would be difficult and complicated to have a clear image how the weather during the eclipse will be, however, long term weather models and studying the climate of the region can be useful for early planning. Dr. Jay Anderson, Canadian astronomer and meteorologists produces weather statistics and predictions for all eclipses of near future. Anderson helps eclipse chasers with climate patterns and long term cloud cover maps along the path of totality. Almost all eclipse chasers use his predictions to make their own plans and find their final location. Since it's still a bit far out to our three eclipses (about one decade from the publication of this thesis), no early weather forecast or cloud cover maps were available. Dr. Jay Anderson kindly accepted the author's request to help the research with his cloud cover maps for each of those three eclipses. It should be mentioned that each cloud cover map consists of more than ten years of satellite cloud cover images and it takes a while to be prepared. In other words, each of the following maps, shows the probability of clear skies for a particular territory in a specific date, based on recent annual cloud cover maps. As it's illustrated on the map, the areas under blue color are more likely to have clear skies but those under red color are more likely to be cloudy during the eclipse day.

According to the afternoon cloud cover map for the eclipse of 2026, the whole of Spain is predicted to be very sunny except for the north coast. The morning cloud cover map for the eclipse of 2027 predicts clear skies in southern coast of Spain although a small area of cloudiness against the Strait of Gibraltar is seen. The annular solar eclipse of 2028 occurs just before sunset in Spain. The cloud cover maps show that January is much cloudier than for the two eclipses in August. All in all, clear skies in a vast area of Spanish territory for the both total solar eclipses of 2026 and 2027 is a very good news both for Spain as the host country and eclipse observers as travelers.

Biosphere reserves as eclipse observation sites

This research shows that biosphere reserves can play a significant role to host eclipse chasers along the path of totality and annularity. Moreover, Spain is a successful country in environmental programs with the most biosphere reserves in the list of UNESCO. This thesis suggests biosphere reserves as observation sites due to the important findings and results obtained in this research:

1. Since the mission of these protected areas follows sustainable tourism development, eclipse events can cover the objectives of biosphere reserves to develop tourism in these regions in a scientific way.
2. Early planning for eclipse events can provide direct benefit to the local community of biosphere reserves in both short term and long term.
3. In this research we found out that both experts and unprofessional observers would rather see the eclipse in silent and abandoned areas away from crowd. Biosphere reserves provide nice areas to view the eclipse according to observer's opinion.
4. Biosphere reserves are beautiful natural regions with cultural values. Selecting biosphere reserves as observation sites in the eclipse day offer scenic views to everybody especially photographers to take unique and spectacular photos.
5. A good number of biosphere reserves (more than 30) are located within the paths of totality and annularity in Spanish territory. This gives a good opportunity to organizers to distribute observers along the eclipse track in different parts and avoid crowd in few locations.
6. Our solar eclipses are good pretexts for people to view the events in these areas and be informed of Biosphere reserves mission and objectives.

Observatories along the path of totality

Astronomical centers, observatories and starlight reserves can play a significant role in holding the eclipse events. They will be able to promote the eclipse events years and months to the event and host some observers during the eclipse day for the research programs. The research presents a list of these centers located along the path of totality of the eclipse of 2026 as a guide for the eclipse planers and educational sector.

The Spanish Great Eclipse, August 12, 2026

According to the result and analysis of the research, the author claims that the total solar eclipse of 2026 august 12 can be known worldwide as The Spanish Great Eclipse due to the important further reasons:

1. This is the first total solar eclipse to occur over the Iberian Peninsula in nearly 120 years.
2. This eclipse is the first total solar eclipse to occur over the Europe mainland (the main European Union territory without considering Iceland, Greenland and remote European islands) since 1999.
3. This total solar eclipse will be visible also in the Arctic, Greenland, a small part of Iceland, Atlantic Ocean, and a very small area in north of Portugal, however it is pretty clear that Spain can be the main destination to host eclipse chasers of all around the world due to de ease of access for most observers.
4. August afternoon cloud cover map for this total solar eclipse shows that Spain will be likely to have the clearest skies along the path of totality.
5. The 2026 eclipse is especially unique because of the uninterrupted land masses it will pass over Spain and the path of totality covers approximately one third of the entire Spanish territory.
6. The total solar eclipse of 2026 happens in august when a great number of tourists come to Spain during the summer vacations every year.

7. Considering great tourism infrastructures, cultural and natural heritages along the path of totality and flourishing astrotourism industry in Spain, this country can host on observers from all around the world and hold one the biggest eclipse events in history.
8. Eclipse chasers have stated that they will likely travel to Spain where the duration is shorter and the weather prospects better.

CONCLUSIONS AND IMPLICATIONS

The total solar eclipse of 2026 is the first total solar eclipse in Iberian Peninsula since 1905. That is to say that there is no living memory of seeing a total solar eclipse in Spain. Also organizers and planners have no experience about the event and how to organize it. In other words, planners of The Spanish Great Eclipse should study a lot about the event, must know more about the eclipse facts and eclipse events and be aware of direct and indirect benefits for the country in short and long term. Organizers must start early planning as soon as possible by studying how to prepare conditions and infrastructures for the event.

At first sight, planners and local authorities may find it too early to start planning for The Spanish Great Eclipse, nine years before the event. However, eclipse chasers believe that planners in Spain should be aware of what is going to happen and realize the importance of pre-planning. As previously discussed The American Great Eclipse in August 2017 can be a clear example to show how the United Stated started planning for this eclipse years in advance through a comprehensive plan.

Fundamental action: Founding an eclipse task force

Founding and developing an eclipse task force as soon as possible in Spain including a diverse range of stakeholders can be one of the most important actions to be conducted in order to start an early, effective and comprehensive plan for three eclipses of 2026, 2027 and 2028. This task force should include representatives from tourism, MAB committee in Spain, autonomous communities and local governments, policing, event coordination, creative industries, International Astronomy Union (IAU), European Space Agency (ESA), educational sector, health, business, and local media. The eclipse task force is supposed to make general decisions and indicates main strategies to start planning and prepare the infrastructures to host this great eclipse event. Planners and members of eclipse task force should always consider that Spain will be the focal point of the celebrations in the whole world for the total solar eclipse of 2026 and they should start planning as soon as possible.

The eclipse task force should consist of a number of subgroups to focus on specific fields about the solar eclipse events. The task force may found subgroups such as advertising and sponsorship, education, logistics, tourism and more. Each subgroup will organize monthly or weekly meetings to make decisions about the most necessary plans and activities. They will present their reports to the eclipse task force.

It is suggested that the eclipse task force organizes official meetings every few months at the beginning. Two years before the first eclipse meetings will be more important for effective planning and members of the task force should have monthly gatherings to make important decisions and review how actions and programs go on.

The eclipse task force need to organize meetings inviting local relevant authorities of Spanish autonomous communities within the paths of totality. That may include representatives from municipalities, local tourism offices, local astronomy centers, authorities of biosphere reserves and local NGOs. That meeting aims at informing local organizations about the event, evaluation of potentials, infrastructures and requirements in each community and making a more effective plan in each region according to strategies of the eclipse task force. Other actions, activities and programs can be developed through the guidelines and strategies ratified in the eclipse task force.

Conclusions

Eclipse chasing can be considered as a kind of astrotourism, however planning for an eclipse event is pretty different and more complicated than the typical astrotourism known as observation tours to enjoy starry nights where dark skies are available. A solar eclipse will happen in a specific time and area and different regions such as big or small cities and villages may be located within the path of totality. When it comes to the Spanish Great Eclipse in 2026, a vast area in Spain have privileged situation for the eclipse observation and host observers.

As previously discussed probably local authorities find it too early to start planning for the Three Consecutive Years of Eclipse Chasing in Spain. However, we should not forget how rare and important this opportunity for Spain is. The Spanish Great Eclipse can be as important and great as an Olympic games or a football world cup. The author which has years of experience as an amateur astronomer, tourism activist and astrotourism event organizer, believes that the following opportunity will offer a great investment to Spain and even Europe for tourism development, educational programs and more.

Furthermore, these events won't overshadow Spain only during the eclipse days. An early and comprehensive planning will offer great opportunities to Spain before, during and after the events. Early planning for the Spanish eclipse events will have great cultural and educational impacts. The strategies defined by the eclipse task force will be important steps for primary education, raise public awareness and train a new generation of astronomers and tourism activists. Tourism and astronomy sector can have a great mutual interaction to promote their missions and conduct their objectives. Cultural and natural sites located within the path of totality or annularity play a significant role to promote the eclipse events. Offering information to the visitors during the remaining years to the event will encourage many people to come back to the path of totality and not to miss the event. Many of these visitors may return with their friends and families to observe the eclipse. On the other hand, if eclipse observers are satisfied with their experience, they might be motivated to repeat the experience in 2027 and 2028 to see the other events as well. Also a part from the eclipse adventure, observers may find new destinations to explore it again through another trip in Spain and even encourage their friends and families to visit their popular places.

That will be crucial for tourism sector of Spain to promote tourism in a new and creative form throughout the country to host eclipse chasers and observers. On one hand, this sector should know eclipse observers as a specific public with special requirements, on the other they should plan to cover their needs considering their concerns. Also the solar eclipse provides an awesome opportunity to promote tourism in less known tourism destinations along the path of totality or annularity and both tourists and local community can take advantage of this promotion. Biosphere reserves can organize workshops on environmental issues, tourism and astronomy to promote the missions of both the eclipse events and the MAB program. These workshops

can be organized in a creative active way and followed by a sky observation experience. These activities can be continued even after the eclipse event and help biosphere reserves for its sustainable development in a new and science based framework. In addition, organizers should notice that the audience of a solar eclipse event won't be only astronomers. Holiday tourists, backpackers, cyclists and adventurers can be also involved in the event and be considered as public of eclipse celebrations.

Three Consecutive Years of Eclipse Chasing in Spain will have great common project with collaboration of a diverse range of stakeholders from tourism, astronomy, government, policing, event coordination, creative industries, education, health, business, and local media. The eclipse task force suggested in this thesis is supposed to conduct, manage and organize the Spanish eclipse events based on the capacities, specialization and the potentials of these stakeholders.

In conclusion, Spain can organize one of the biggest eclipse chasing events in history and present its valuable results to the world as a pattern for similar events. Planers and organizers of The Spanish Great Eclipse will be able to use their experience to hold the second and the third event in the country. Moreover, after these three eclipse events they can publish their achievements and suggest it as a strategic plan to other host countries and communities.

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