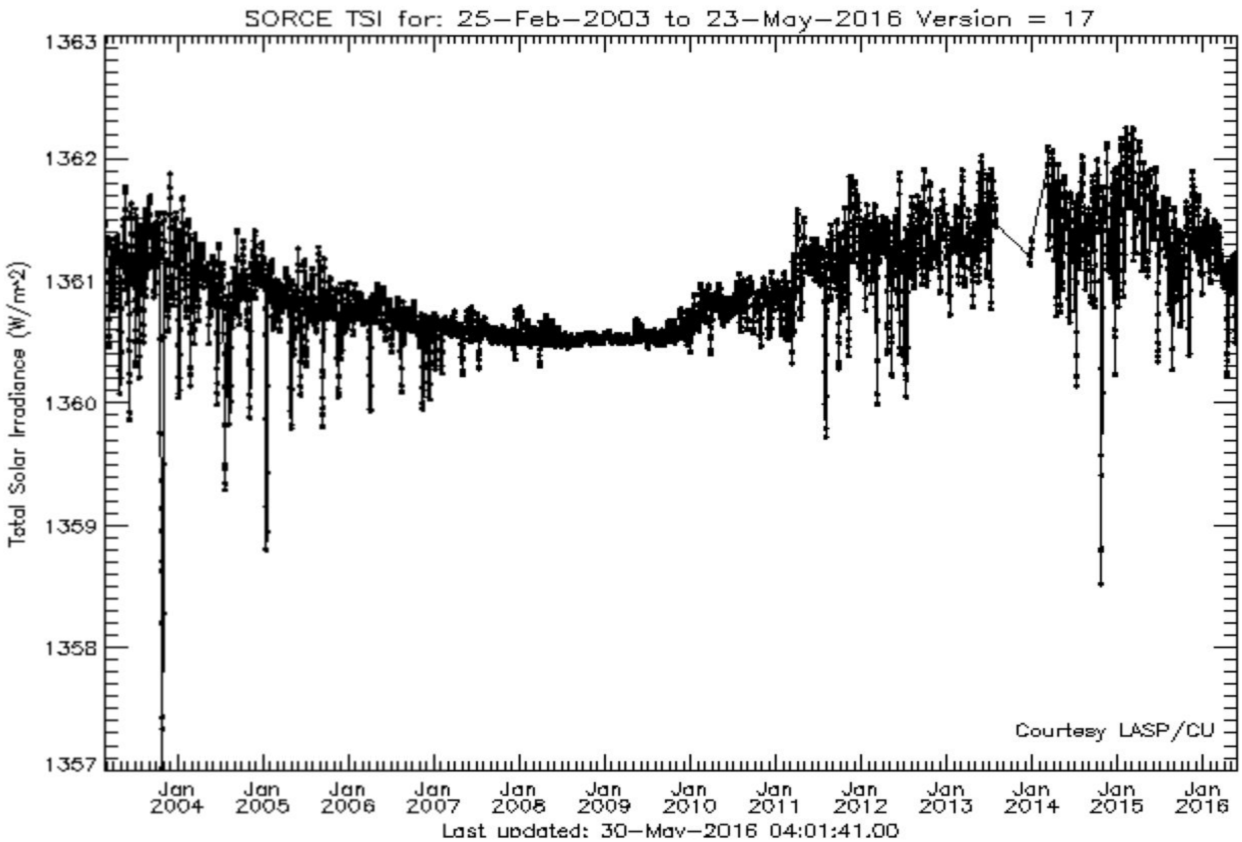
3.0 Introduction to Solar (Space Weather) Climate Forcing

0.1%

3.1 The Historical Dominance of the Total Solar Irradiance (TSI) Model

Climate science is currently marred by the single greatest blunder in the history of geophysics, "0.1%" solar variability over the 11-year cycle. Until the last decade, very few studies of solar forcing on earth's climate looked at anything other than sunspots or total solar irradiance (TSI). There has been a prevailing (and almost certainly false) theory that the sun is relatively constant in its energetic output (in terms of heating the earth) and that its effect on the climate is minimal over decades in comparison with anthropogenic forcing (human pollution).

Images such as the next one are emblematic of the history of solar forcing. We have data and reconstructions going back centuries but this short window provided by the Laboratory for Atmospheric and Space Physics essentially shows what the entire timeline shows: TSI varies by approximately 0.1% over the ~11-year sunspot cycle.



Indeed, these TSI readings match the frequency of the sunspots and radio waves we saw in chapter 2, but fluctuate in a much smaller range. **As this 0.1% variability perfectly matches the sunspot variability, it has been considered that the practical effect of this ~11 year fluctuation is imperceptible and negligible in terms of its effects on the global climate system.** This notion has been so pervasive that the global climate science leader, the UN's International Panel on Climate Change (IPCC), placed 'solar forcing' completely outside the scope of its investigation, which only focused on human pollution, deforestation, urban development effects, and other manifestations of human activity.

So what is the problem? The primary difference between the shapes of the TSI curve and those of sunspot and radio flux are the enormous spikes down you see in the image above. Those indicate massive sunspot groups that produced large solar flares and CMEs. Technically, within the UV range measured by TSI readings, those times do show a sudden drop in certain UV wavelength. This represents a movement in data that indicates the opposite solar influence of what is actually occurring- which would be a sharp increase in energy to earth.

This means that using TSI will offer a generally accurate readout and trend of ultraviolet energy received by our atmosphere, but will suffer in terms of climate change science because the most important energetic events show up as decreases in solar energy received. This has caused nearly 100% of the misunderstanding surrounding solar climate forcing, and is a colossal error.

In terms of solar flares, the x-ray energy received by earth can vary by 10x over a sunspot cycle, within short-term upticks offering 100x to 1000x the x-ray energy. In terms of particle radiation, there are almost never any SEPs during sunspot minimum and there are 10x to 100x fewer CMEs during those inactive periods as well. Geomagnetic storm activity falls during sunspot minimum as well, by another factor of 10x to 20x, and this has not even begun to touch the influence of GCR, which are also outside of the forcing discussion.

Key Points:

1) TSI varies by 0.1% between sunspot maximum and sunspot minimum, and has been the sole factor used to gauge the sun's influence over the weather/climate.
2) TSI is a flawed measurement because the most energetic transfers of earth to sun come with a shift from ultraviolet to x-ray and particle energy, which shows up as a decrease on the TSI.
3) Apart from TSI, the x-ray flux from solar flares, the energetic particle storms and GCR can fluctuate by 10 - 1000x over the same 11-year cycle.
4) The sun has been relegated to 0.1% variation and virtually no influence over climate change… this is an enormous mistake.

3.2 The Fall of the Solar Constant

There is little debate that pollution of various forms, including carbon-based pollution, affects the environment chemistry and system dynamics of earth, including the climate. However, a simple problem has come about in climate science that requires a significant reassessment in the fields of climatology, meteorology, and solar-terrestrial physics. This image above followed a great decade of progress in solar-terrestrial physics, as interests across the planet begin to understand the full power of our star.

In 2013, it began to become clear to the world that we were approaching 20 years of vastly overestimated global-warming predictions. This was especially confusing because many of the drought, flood, and other extreme events seemed to be occurring as predicted. During this time, we saw higher CO2 rates and faster rates of greenhouse-gas emission (driven mostly by countries in Asia) than ever before, and yet a well-documented “global warming pause” occurred, with the 2015/2016 El Niño (the most intense on record) finally driving temperatures further upward. Recently, the head of the IPCC, Dr. Pachauri, stepped down amidst controversy over a number of issues, including failed temperature forecasts. Even the record warmth of 2015/2016 was well below what had been predicted based on carbon emissions, and it took the most severe El Niño in history (2015/2016) to get us there.

While every model and explanation of human effect on global warming dictated that we should have seen a vast spike in global temperatures the last two decades as CO2 continued to rise, we saw a definitive plateau at the turn of the millennium, with record cold and snow events persisting and even intensifying across the northern hemisphere before that record El Niño began in 2015. The effects of that ENSO event lasted until winter of 2017/2018, when cold records, snow records, and major winter complications once again spanned the US and Asia. We'll see in this book how ENSO cycles are actually driven by the sun.

While a few scientists have disputed the validity of the most-accepted temperature records, there is no doubt that the official predictions of climate events have been able to predict the extremes of climate change with the exception of perhaps the most important piece: global warming. How could this be the case? How could they forecast the droughts, flood, storms, etc… but miss the mark on temperature- when that was supposed to be driving the changes they forecasted? The image below is from one of the earliest IPCC reports, and its paradigm prevails to this day. The IPCC is not looking at anything other than human activities.

> Fluctuations of climate occur on many scales as a result of natural processes; this is often referred to as natural **climate variability**. The **climate change** which we are addressing in this report is that which may occur over the next century as a result of human activities. More complete definitions of these terms can be found in WMO (1979) and WMO (1984).

By definition, the official global climate group has defined climate change to ONLY be that driven by human activity. They do not exceed their mandate, and around the time a few scientists began to figure out how limiting this was to real science, it had become a political and financial juggernaut that placed all importance on blaming human-caused global warming for everything that happens. Even though the discourse has shifted from "global warming" to "climate change" (they had no choice) there has not been a shift in political thinking or scientific funding. Despite continuing to face hurdles that extend to professional ostracization and bullying, solar forcing is slowly becoming a more-recognized aspect of climate science.

The climate of earth has never been stable. Much of the earth's reconstructed history indicates that the earth is not usually as benign to life as it has been since the 1700s. Between periodic ice ages, vastly hotter temperatures during the times of the dinosaurs, and even the stories of our ancestors, it is likely that our planet is ever-changing and capable of throwing climate curveballs that simply have not occurred during the time of science. This is where energy from space comes into play.

Take the example of one solar flare, which can increase X-ray and EUV output by factors of 10 to 1000, and which rarely lasts longer than a few hours. One solar flare will not increase the Watt energy delivered to earth over time in any meaningful way, and in fact it will show up as a decrease in energy according to TSI. However, as we will see in the following chapters, such increases in flare energy, along with their SEPs, CME impacts, and geomagnetic storms can reach thresholds of forcing that are simply not seen without those events, which do not show up in long-term TSI data, and which are not seen in 11-year, 22-year or longer sunspot cycle data.

Certain space weather events are not variable in terms of percentages. They are a simple yes or no, on or off, like El Niño or La Niña, and positive or negative phase of a major atmospheric oscillation. When these threshold events are triggered, the use of TSI is no longer relevant for that time period.

> **Consider the example of raw chicken**: How dangerous is raw chicken at room temperature vs 99 degrees F? 150 degrees? The answer is about the same because at 150 degrees, the harmful bacteria in the chicken will still be alive, and you run the risk of food poisoning. You could study dozens of temperatures from 40-150 F and find similar levels of dangerous bacteria. Should we say that cook temperature is not an important factor for food safety?
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> Obviously not, because something happens at ~165 degrees F: all the bacteria die. Once you hit a threshold event, the situation changes completely, and gauging the effect of temperature on the safety of that piece of chicken is suddenly relevant although it was not relevant before.
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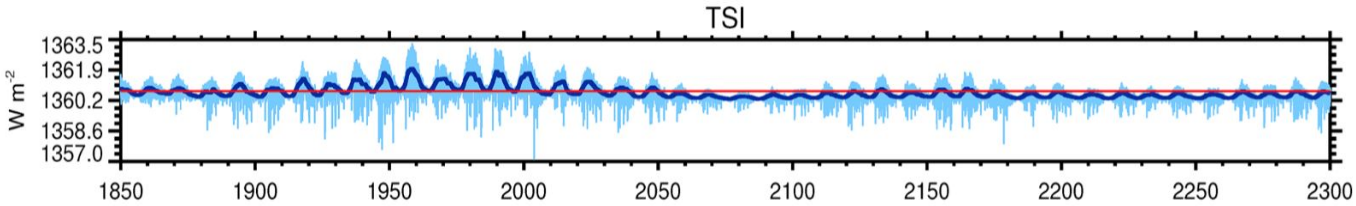
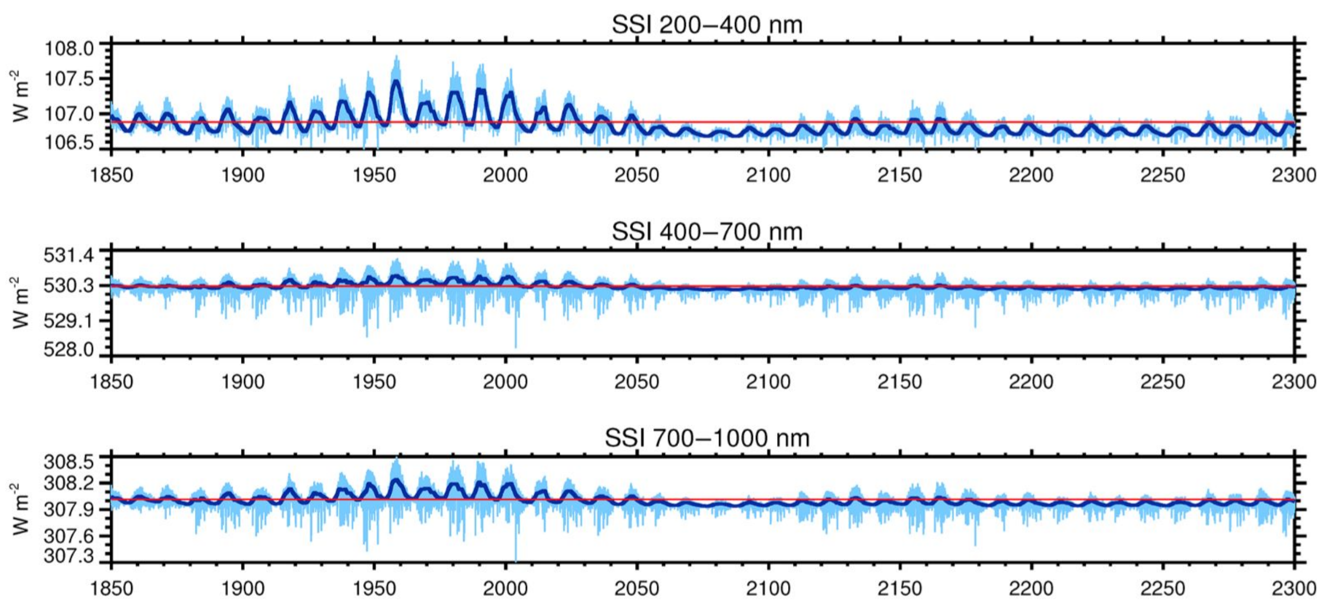
> As of 2018, the scientific community has been unable to fully understand the threshold events in space weather, instead being fooled by the same flaw in the initial chicken example in which one might look at a seemingly broad-enough range of data and misunderstood the food safety issues surrounding the raw chicken. Without the full set of facts, one cannot reach a reliable conclusion, and in this example, as with the climate, you don't need to be at 165 degrees (significant space weather activity) for very long in order to see a lasting effect that completely changes the chicken (climate).

The studies on space weather forcing on weather and climate are numerous; more than 400 papers and other published works on the topic have been released just since 2010. Chapters 4-7 examine many of those works to construct the framework true solar climate forcing, and of the future of many fields of related science. While there remains great resistance to the acceptance of solar forcing into the mainstream climate-change lexicon, a glimmer of hope exists in a plea from some of the world's best scientists (Matthes et al., 2017). Below we can see the existing record and forecast of TSI from Matthes et al. 2017, and indeed it is only fluctuating a fraction of a percent over the 11-year cycle.

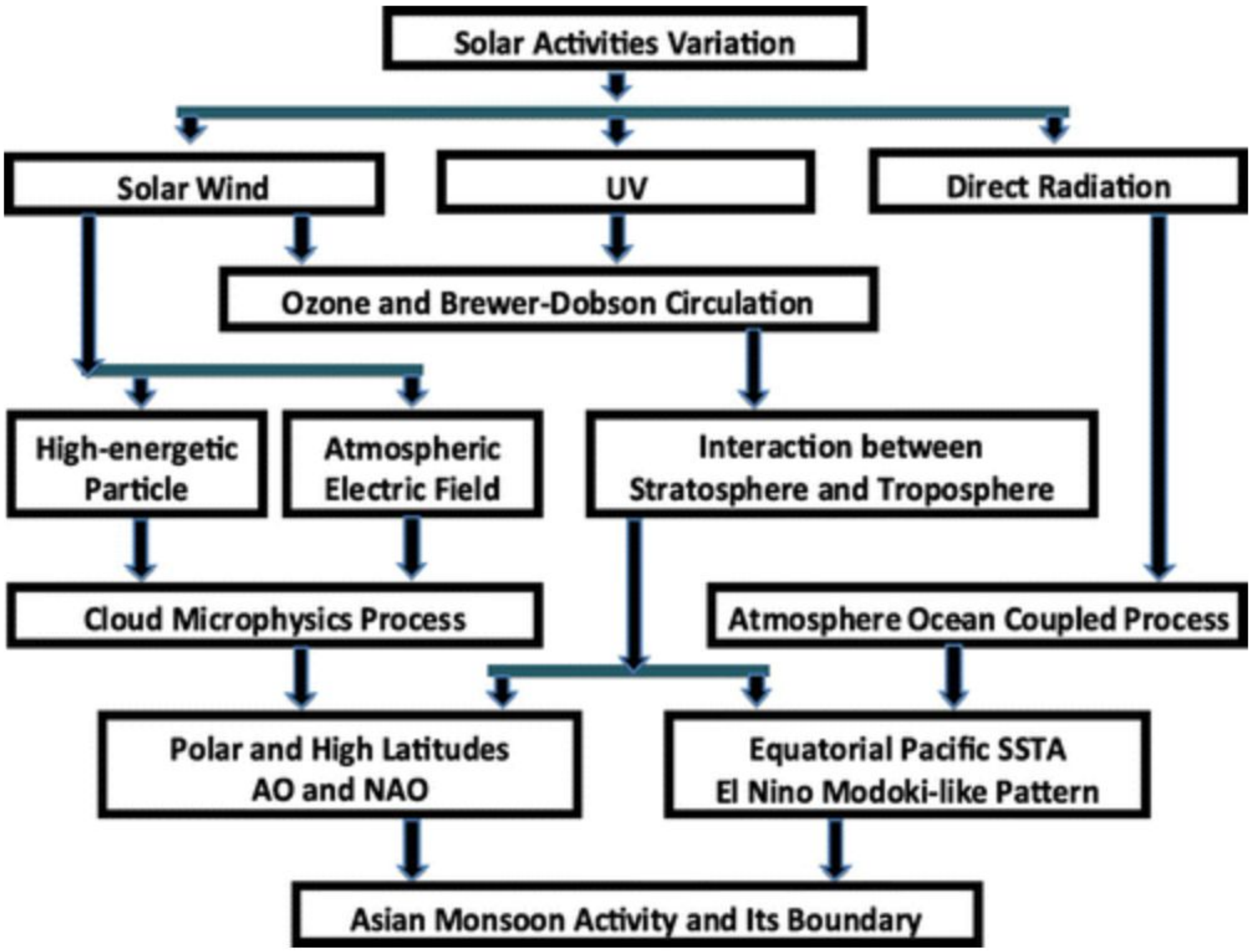


Below we find the same type of plot from Matthes et al. but for three segments of ultraviolet light used to compute TSI. For reference, x-ray spectra is 0.1 to 10 nm, and fluctuates greatly. However as we look at the UV spectra below, we find the highest energy (top panel) UV fluctuating around 1%, the middle energy UV around 0.5%, and the lowest energy UV flux (bottom panel) varies approximately as much as TSI. More importantly, just like x-rays, the highest energy UV spikes higher during sunspot maxima, as opposed to the lower energy UV rays, which clearly are the cause of the spikes-down during high solar activity in TSI (that blunder we described earlier).



The genesis of the TSI problem has thus been revealed to be the inclusion of the longer-wavelength rays, and/or their inexplicable heavier weighting in climate models than those of higher energy. The highest energy UV varies at least 1% on the cycle - 10x more than is used in climate science.

Some of the longer-term solar forcing pathways are understood and even well-accepted, but few, if any, of the short-term forcing of significant weather patterns are accepted. One of the areas this is happening most quickly is in Asia, where the monsoonal patterns mean much more than a political and financial game- they just care about getting it right. The image below comes from Xiao et al, 2017, and represents one of the most important and easily-understood graphics explaining the breadth of solar forcing pathways and implied timelines.



Xiao et al. 2017

In the graphic above we find the long-term forcing pathways down the middle while the sides represent the potential for short-term forcing via particle (left) and wave (right) energy. While this study was a tremendous leap forward, there has never been a single study that adequately ties all these things together. Regardless whether you stick with monsoon (bottom-line) or substitute for global temperatures precipitation, cyclone activity, etc., you'll find that we see connections directly to "Cloud Microphysics Process" and "Atmospheric Electric Field" without the need for large-scale oscillations and modes acting as intermediaries (chapter 5).

Finally, it appears there is a key confusion within the IPCC's use of ENSO as a detector vs contributor to climate change. One of the primary forcing pathway of the sun AND earth's own internal variability is ENSO, and a simple problem exists when it comes to how the IPCC uses it. Instead of using ENSO, the sun, etc. to find forcing values and then see how much “warming” is left- and attributable to human activities, the IPCC uses the major heat-focused shift of ENSO (two strongest events on record both since 1995) as an indicator of the human-induced changes (Larminat 2016).

Key Points:

1) Ego, funding and politics still present significant barriers to change in the realm of “climate science.”
2) The UN IPCC (official global climate group) has written the sun out of their mandate and scope of investigation.
3) Top solar physicists have compiled and published a new set of solar data to be used for the next official climate model.
4) The negative-reaction of TSI to increased solar activity is revealed to be based in the weaker wavelengths of ultraviolet energy, which is inexplicably weighted more heavily than the more-energetic waves.

3.3 Caution to Students, and Anyone Who Can’t Help But Speak Their Mind

This book is a framework based on peer-reviewed science, and diligent observation and analysis. Yet it still presents controversial ideas in a controversial topic, where politics overshadow science at every turn. If you are in a related class in school, or your friends and relatives are passionate about humans controlling everything that goes wrong on this massive rock (where we are out-weighed and out-eaten by the insect kingdom), then you must be especially careful about how you apply and discuss the material in chapters 4-7. There is a time to do battle with an entrenched paradigm, and there is a time for patience. Your final exam; mid-lecture in front of 100 other students; emails to your professor; thanksgiving dinner; a first date… these are examples of times when you should avoid bringing up topics that might conflict with the others’ view of the world.

You don’t get points in school for being smarter or more knowledgeable than the teacher, and the correct answers on the exams are based on what you have been taught- regardless of whether they are correct in the real world. Family gatherings and first impressions should be able the people you are with, not what needs to change in the world of science.

There is time and opportunity to change the world, but to get in the door you cannot be trying to set it on fire along the way.