Time Series Analysis: Visualizing El Niño Events Across the Pacific Ocean

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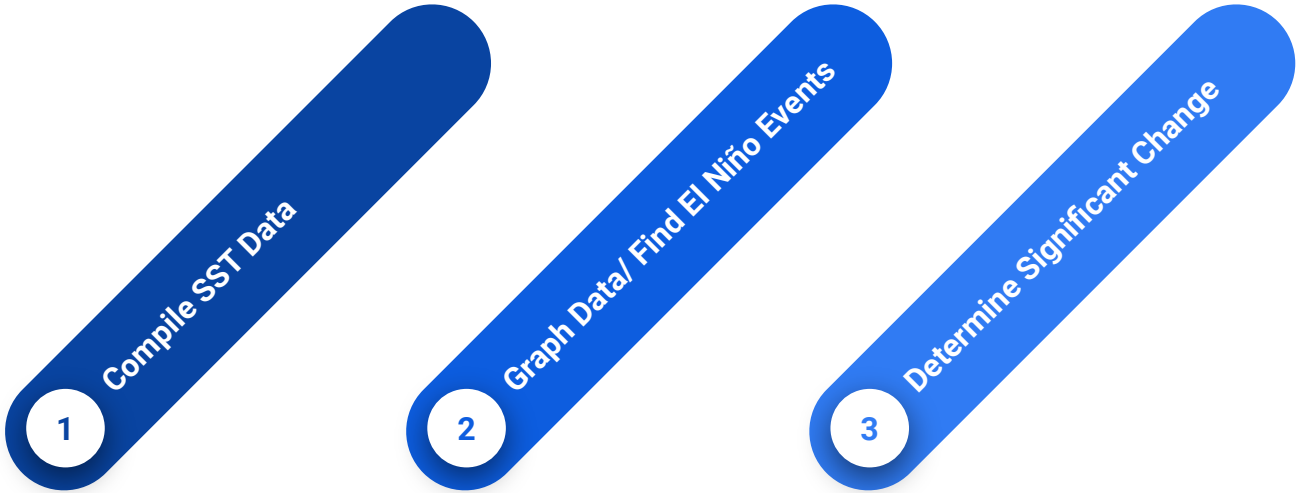
GISC 340: Spring 2023

Research Question and Goals

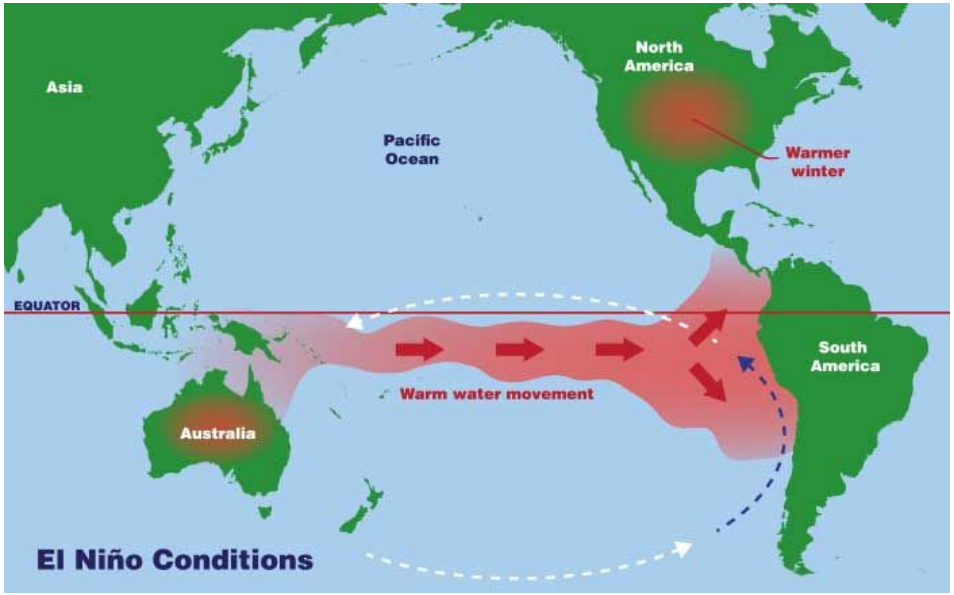
Research Question

Are El Niño Events increasing in intensity?



Background

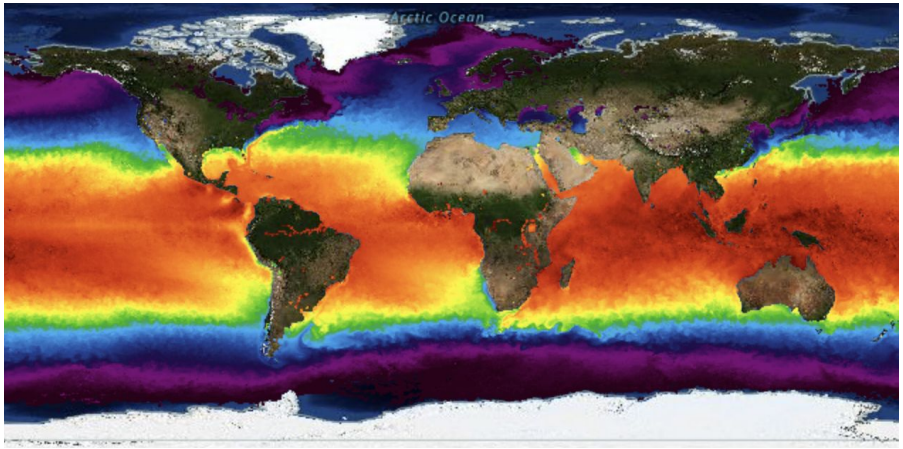
- El Niño - warming of ocean surfaces in the central and eastern tropical Pacific Ocean (USGS, 2023)
- The intensity of El Niño events is increasing (Cai, Wenju, et al., 2018)
- Hard to project future change in El Niño intensity (Cai, Wenju, et al., 2018)
- These changes harm marine organisms, fishing communities, food supply



Datasets Used

MODIS Aqua Level 3 SST Thermal IR Monthly 4km Daytime V2019.0

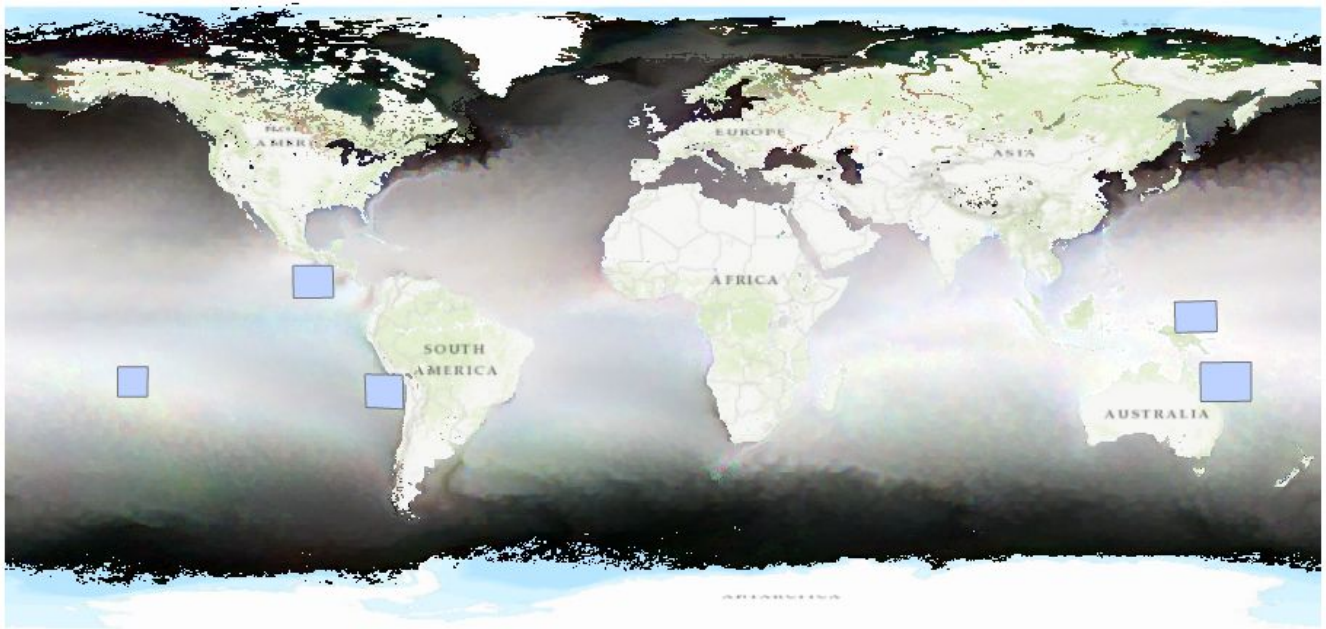
- ❏ Measures Sea Surface Temperature (SST)
- ❏ Monthly data



Sensor	Format	Scene Location	Spatial	Spectral	Radiometric	Level of Processing	Scene Dates Created	Source Platform and Organization
Moderate-resolution Imaging Spectroradiometer (MODIS) (NASA, 2020)	NetCDF-4 (.nc)	N: 90° S: -90° E: 180° W: -180° (NASA, 2020) 8640 columns 4320 rows	.0416m x .0416m	Thermal	32 bit	Level 3	1/7/2002 - Present	EarthData

Methods: GIS

Choose Sample Sites → Convert to Raster Layer → Composite Bands

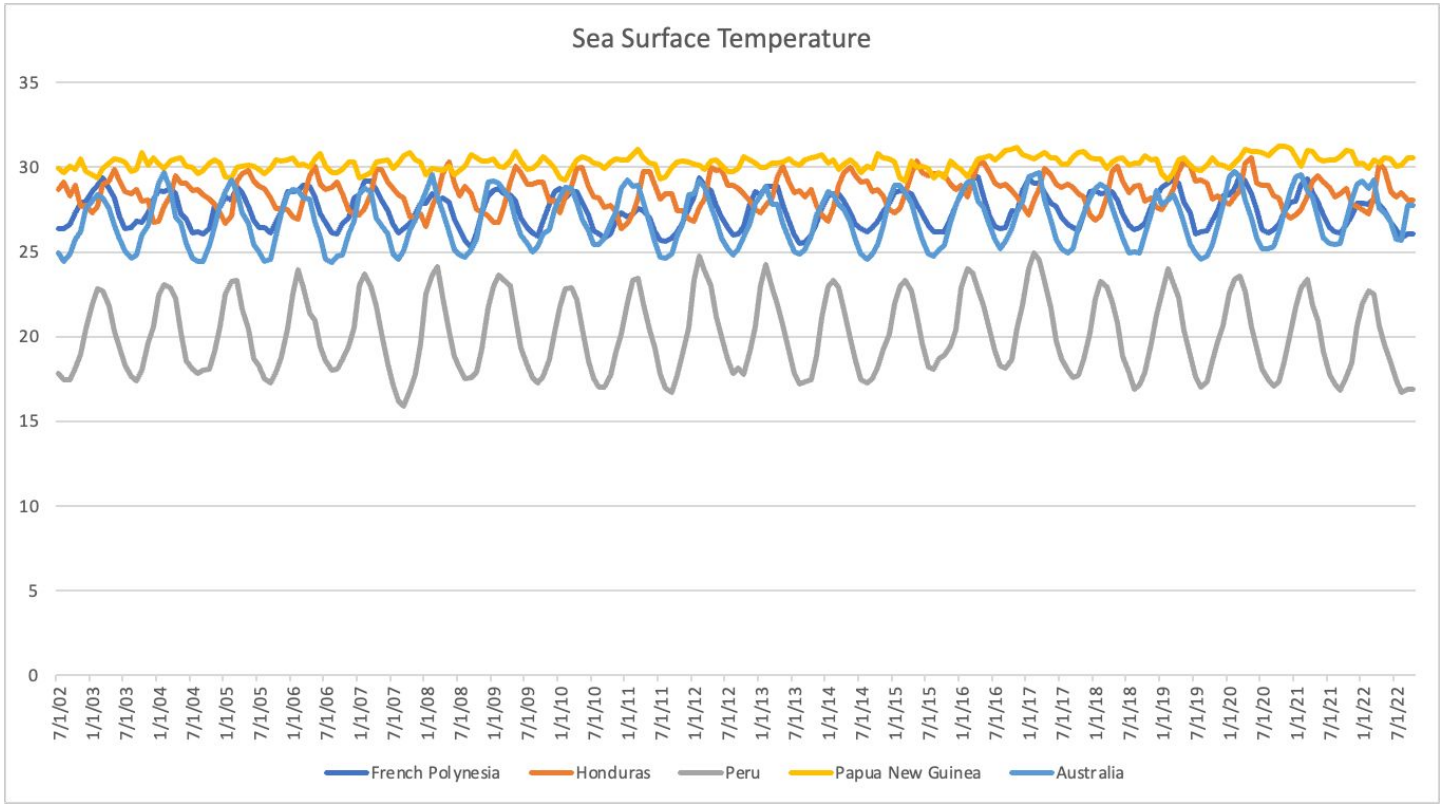


Methods: Excel

Compile in Excel → Graph → Statistical Analysis

Date	French Polynesia	Honduras	Peru	Papua New Guinea	Australia
7/1/02	26.36463	28.69687	17.84192	29.94353	24.91458
8/1/02	26.39487	29.09257	17.43963	29.67274	24.45837
9/1/02	26.6238	28.2947	17.44545	30.04637	24.85884
10/1/02	27.32799	28.91672	18.14226	29.83507	25.72482
11/1/02	27.85647	27.69837	18.94171	30.46076	26.21684
12/1/02	28.01055	27.73963	20.44826	29.71115	27.56413
1/1/03	28.54745	27.3336	21.86431	29.52733	27.97771
2/1/03	28.95271	27.71318	22.84443	29.34508	28.35427
3/1/03	29.37655	29.00537	22.68878	29.89988	28.18335
4/1/03	28.74127	29.18593	21.80433	30.26055	27.54195
5/1/03	28.19861	29.86488	20.33733	30.50412	26.53235
6/1/03	27.07301	29.17043	19.35387	30.40049	25.74732

All Sea Surface Temperatures



Methods

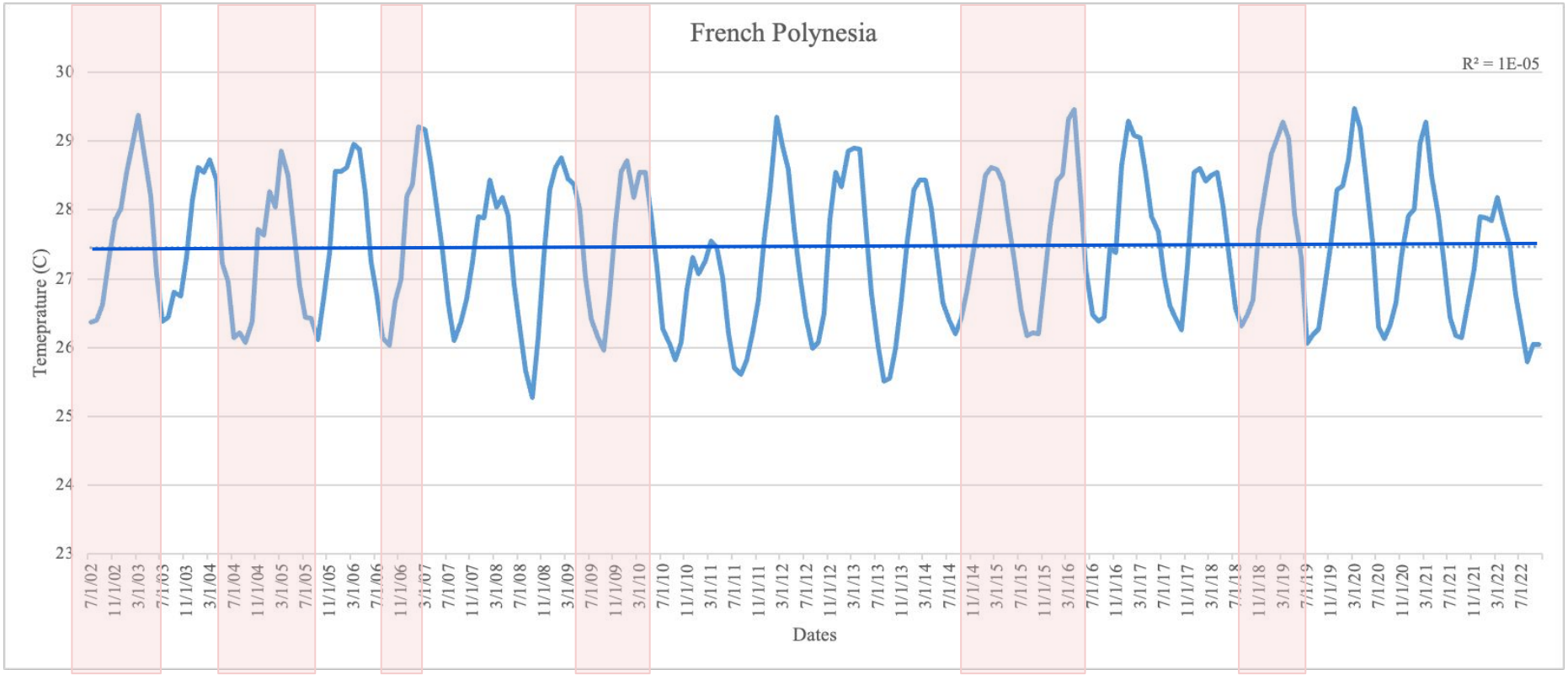
- Data used to determine El Niño events

ENSO Type	Season	JJA	JAS	ASO	SON	OND	NDJ
	1990-1991	0.3	0.4	0.4	0.3	0.4	0.4
SE	1991-1992	0.7	0.6	0.6	0.8	1.2	1.5
	1992-1993	0.4	0.1	-0.1	-0.2	-0.3	-0.1
	1993-1994	0.3	0.3	0.2	0.1	0.0	0.1
ME	1994-1995	0.4	0.4	0.6	0.7	1.0	1.1
ML	1995-1996	-0.2	-0.5	-0.8	-1.0	-1.0	-1.0
	1996-1997	-0.3	-0.3	-0.4	-0.4	-0.4	-0.5
VSE	1997-1998	1.6	1.9	2.1	2.3	2.4	2.4
SL	1998-1999	-0.8	-1.1	-1.3	-1.4	-1.5	-1.6
SL	1999-2000	-1.1	-1.1	-1.2	-1.3	-1.5	-1.7
WL	2000-2001	-0.6	-0.5	-0.5	-0.6	-0.7	-0.7
	2001-2002	-0.1	-0.1	-0.2	-0.3	-0.3	-0.3
ME	2002-2003	0.8	0.9	1.0	1.2	1.3	1.1
	2003-2004	0.1	0.2	0.3	0.3	0.4	0.4
WE	2004-2005	0.5	0.6	0.7	0.7	0.7	0.7
WL	2005-2006	-0.1	-0.1	-0.1	-0.3	-0.6	-0.8
WE	2006-2007	0.1	0.3	0.5	0.7	0.9	0.9
SL	2007-2008	-0.5	-0.8	-1.1	-1.4	-1.5	-1.6
WL	2008-2009	-0.4	-0.3	-0.3	-0.4	-0.6	-0.7
ME	2009-2010	0.5	0.5	0.7	1.0	1.3	1.6

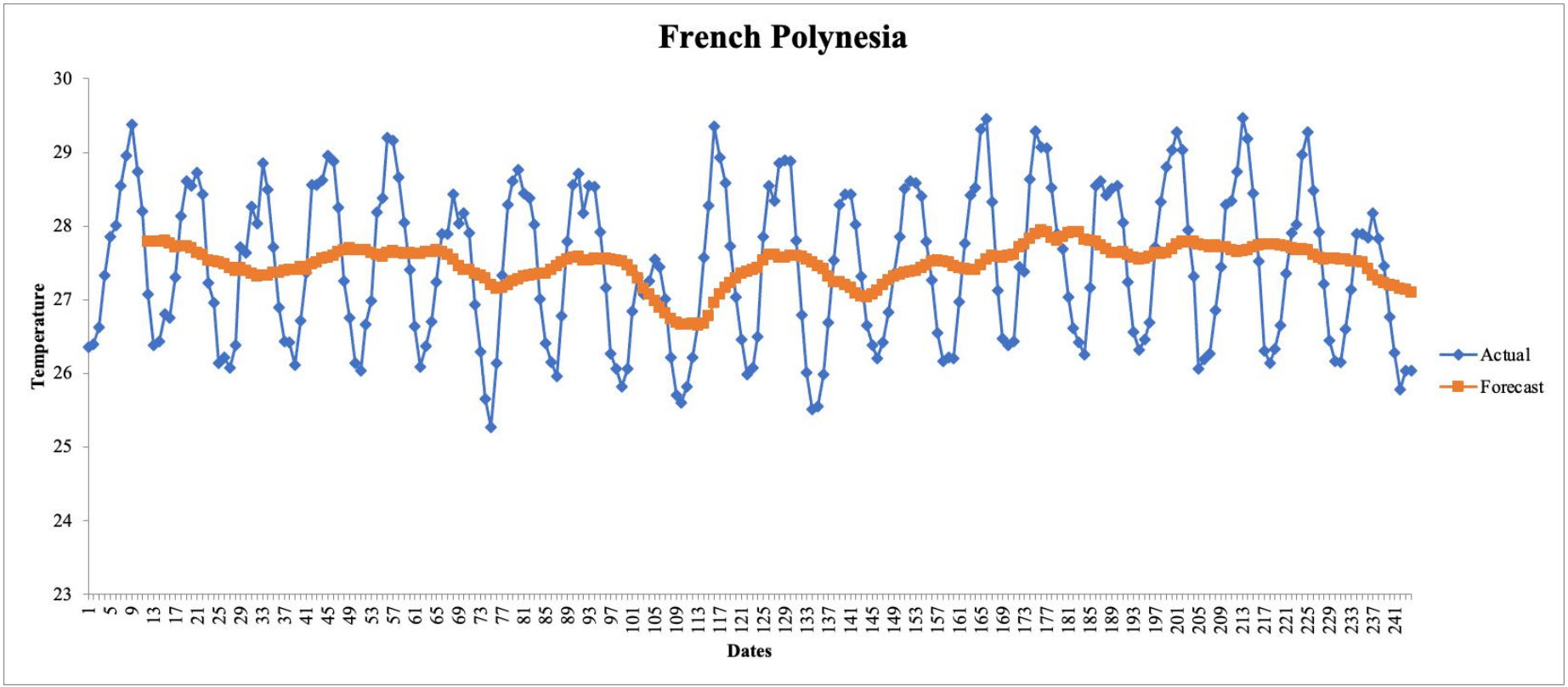
ENSO Type	Season	JJA	JAS	ASO	SON	OND	NDJ	DJF	JFM	FMA	MAM	AMJ	MJJ
SL	2010-2011	-1.0	-1.4	-1.6	-1.7	-1.7	-1.6	-1.4	-1.1	-0.8	-0.6	-0.5	-0.4
ML	2011-2012	-0.5	-0.7	-0.9	-1.1	-1.1	-1.0	-0.8	-0.6	-0.5	-0.4	-0.2	0.1
	2012-2013	0.3	0.3	0.3	0.2	0.0	-0.2	-0.4	-0.3	-0.2	-0.2	-0.3	-0.3
	2013-2014	-0.4	-0.4	-0.3	-0.2	-0.2	-0.3	-0.4	-0.4	-0.2	0.1	0.3	0.2
WE	2014-2015	0.1	0.0	0.2	0.4	0.6	0.7	0.6	0.6	0.6	0.8	1.0	1.2
VSE	2015-2016	1.5	1.9	2.2	2.4	2.6	2.6	2.5	2.1	1.6	0.9	0.4	-0.1
WL	2016-2017	-0.4	-0.5	-0.6	-0.7	-0.7	-0.6	-0.3	-0.2	0.1	0.2	0.3	0.3
WL	2017-2018	0.1	-0.1	-0.4	-0.7	-0.8	-1.0	-0.9	-0.9	-0.7	-0.5	-0.2	0.0
WE	2018-2019	0.1	0.2	0.5	0.8	0.9	0.8	0.8	0.7	0.7	0.7	0.5	0.5
	2019-2020	0.3	0.1	0.2	0.4	0.5	0.6	0.5	0.5	0.4	0.2	-0.1	-0.3
ML	2020-2021	-0.4	-0.6	-0.9	-1.2	-1.3	-1.2	-1.1	-0.9	-0.8	-0.7	-0.5	-0.4
ML	2021-2022	-0.4	-0.5	-0.7	-0.8	-1.0	-1.0	-1.0	-0.9	-1.0	-1.1	-1.0	-0.9
WL	2022-2023	-0.8	-0.9	-1.0	-1.0	-0.9	-0.8	-0.7	-0.4				

ENSO Type	Season	JJA	JAS	ASO	SON	OND	NDJ	DJF	JFM	FMA	MAM	AMJ	MJJ
								-0.1	0.0	0.1	0.2	0.4	0.7
								0.9	0.6	0.4	0.0	-0.3	-0.2
								0.4	0.3	0.2	0.2	0.2	0.3
								0.6	0.6	0.4	0.4	0.3	0.1
								-0.8	-0.7	-0.5	-0.3	0.0	0.0
								0.7	0.3	0.0	-0.2	-0.3	-0.4
								-1.6	-1.4	-1.2	-0.9	-0.8	-0.5
								-0.8	-0.7	-0.5	-0.2	0.1	0.4
								1.5	1.3	0.9	0.4	-0.1	-0.6

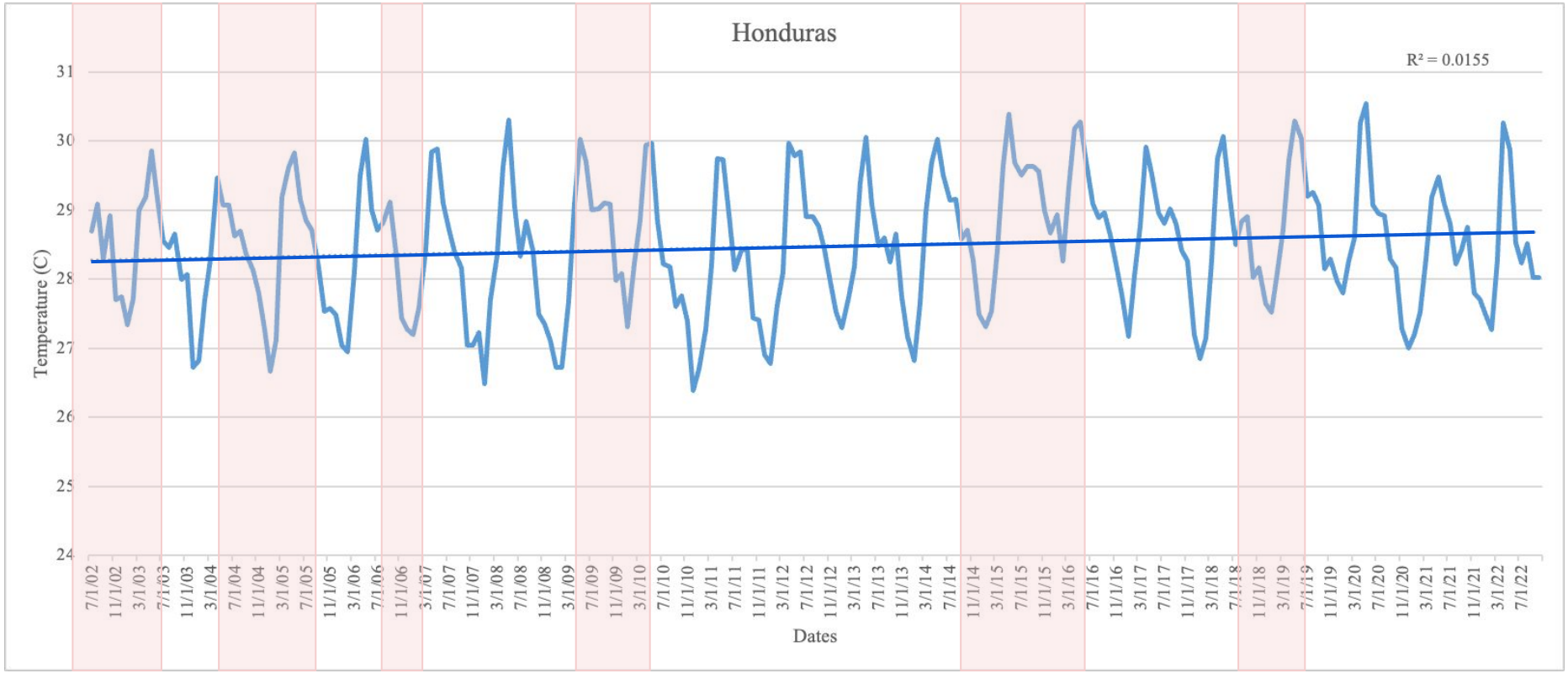
Results: French Polynesia



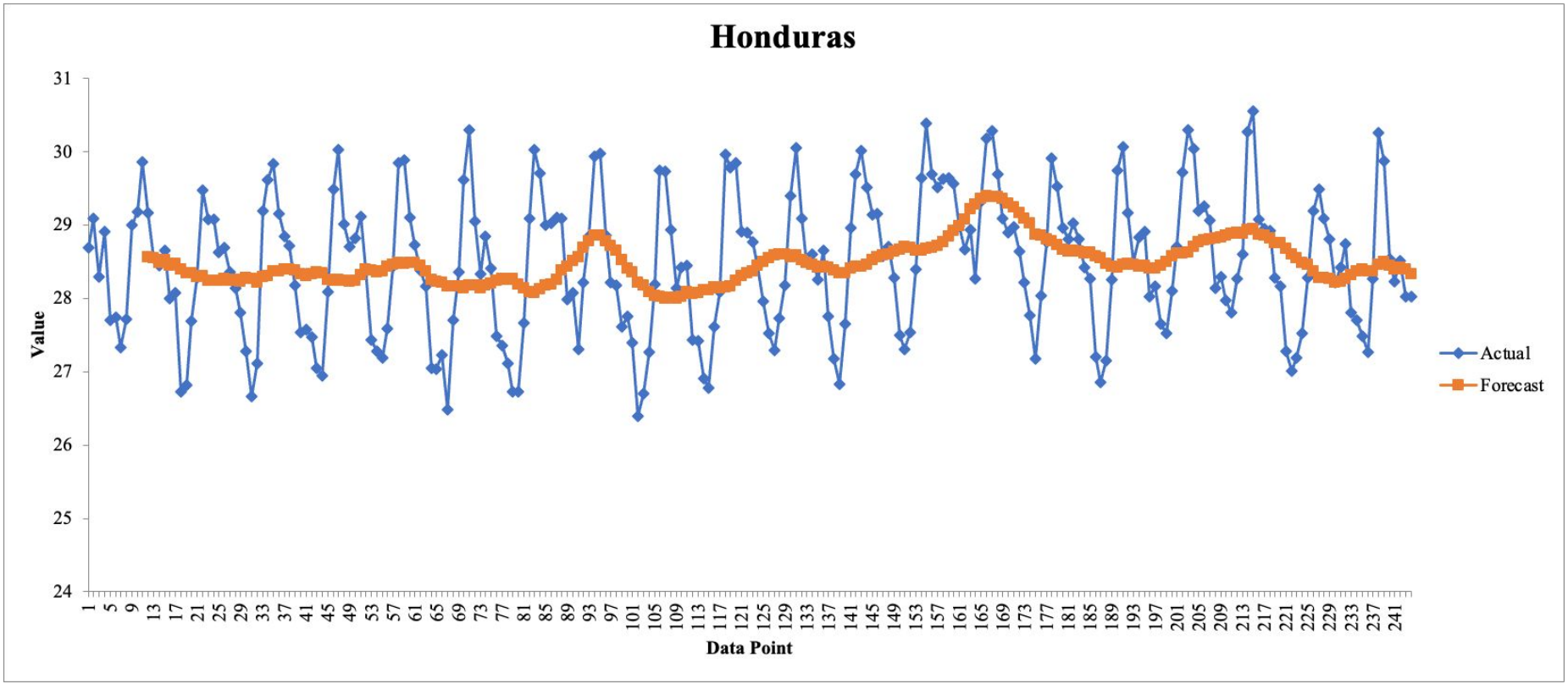
Results: French Polynesia - Moving Average



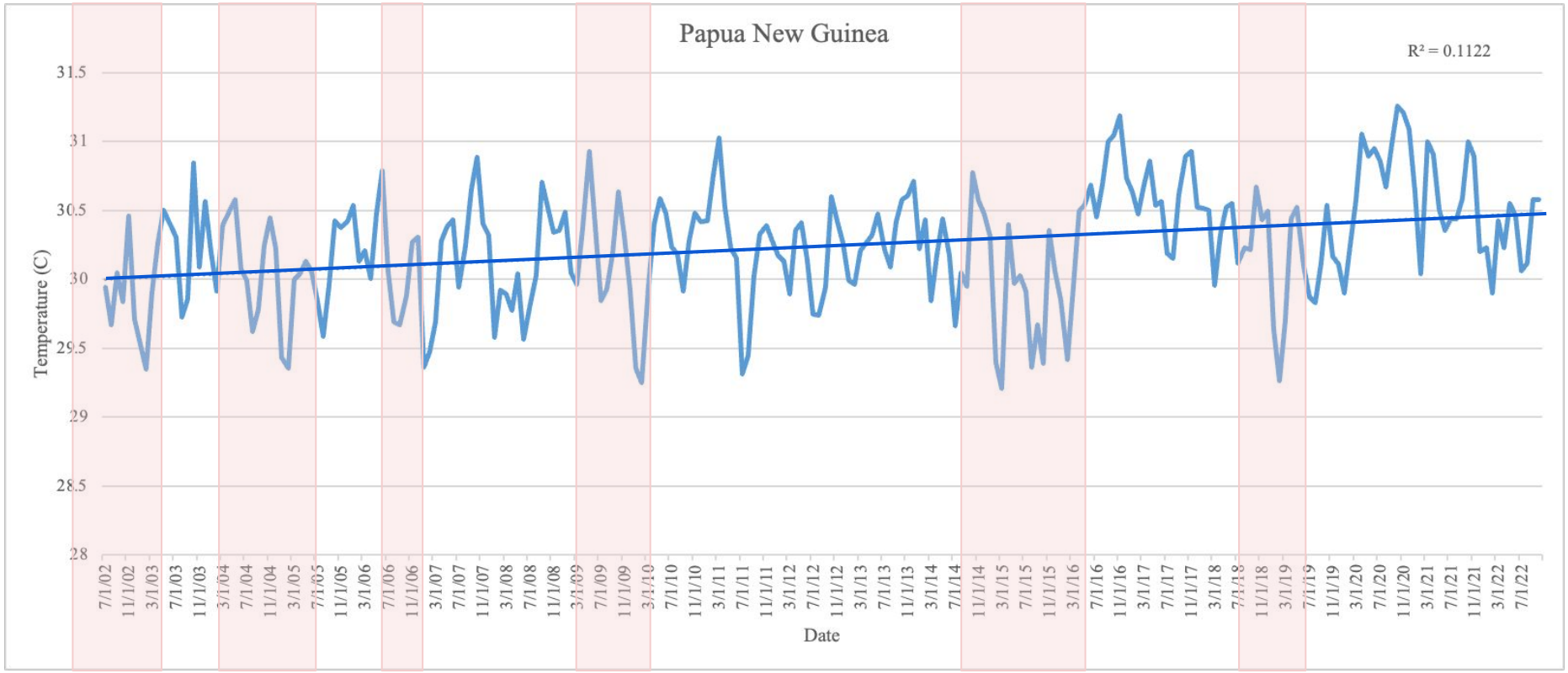
Results: Honduras



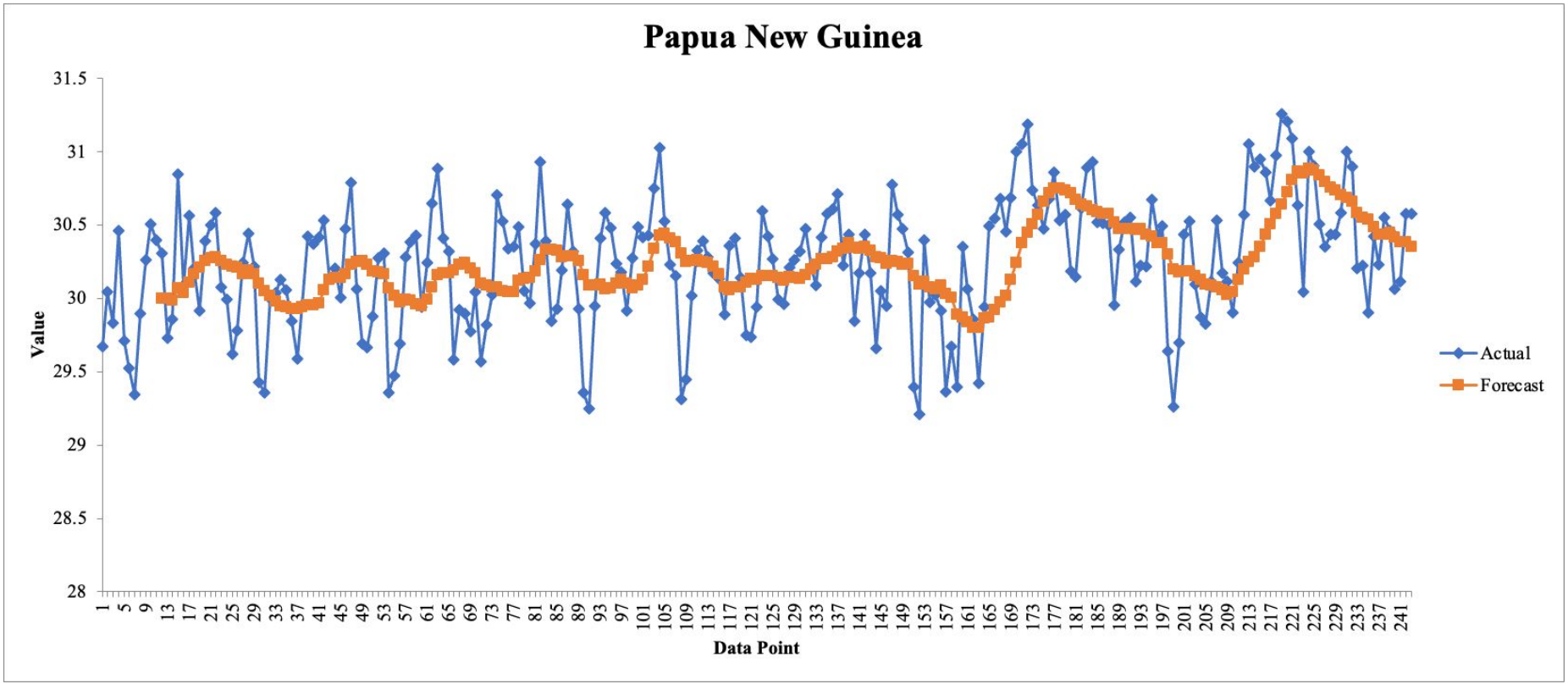
Results: Honduras - Moving Average



Results: Papua New Guinea - Moving Ave.



Results: Papua New Guinea



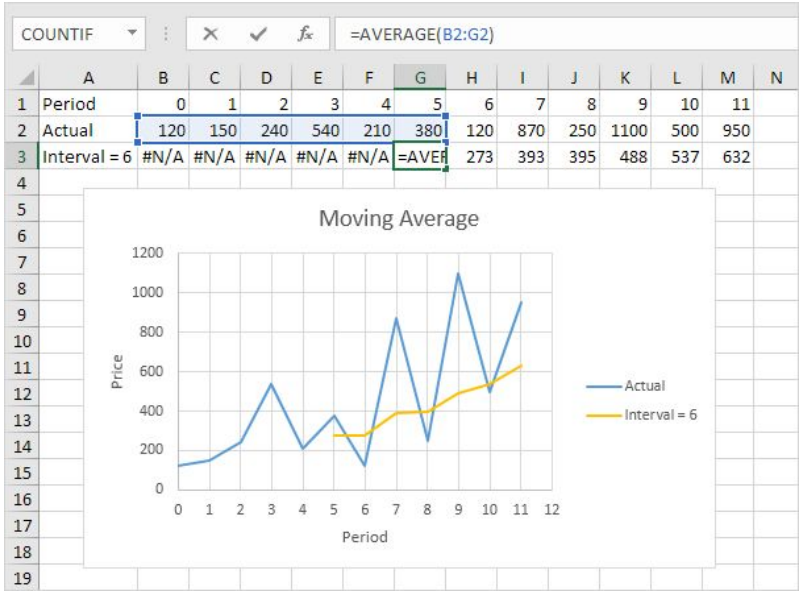
Discussion

What Worked

- ❑ Spectral Profile shows accurate depiction of SST
- ❑ Moving average made events more visible

What Didn't Work

- ❑ Time frame too short
- ❑ Monthly analysis?
- ❑ Cloud cover



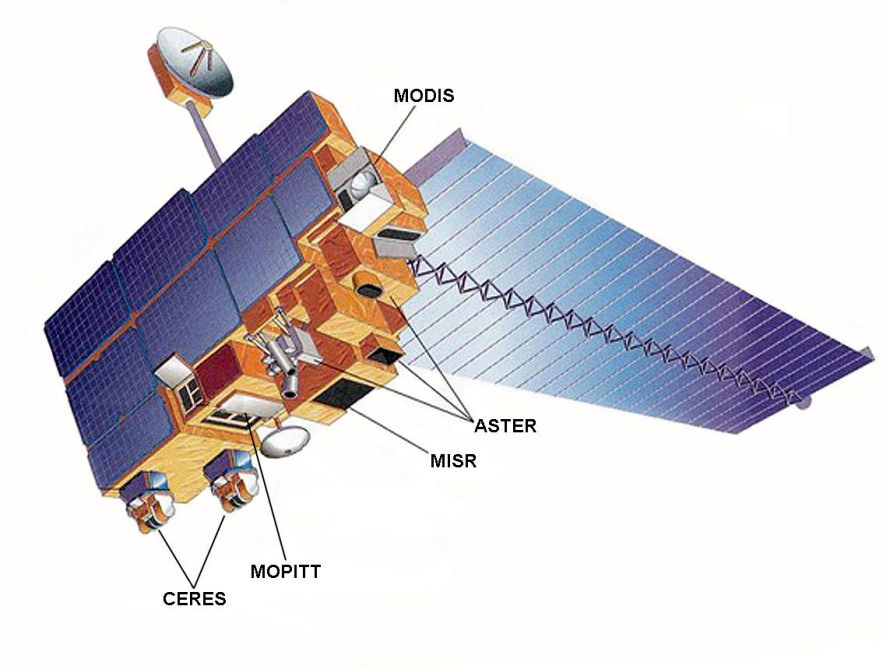
Conclusion

Research Question

- Not statistically significant, visuals show SST increasing overtime

Goals

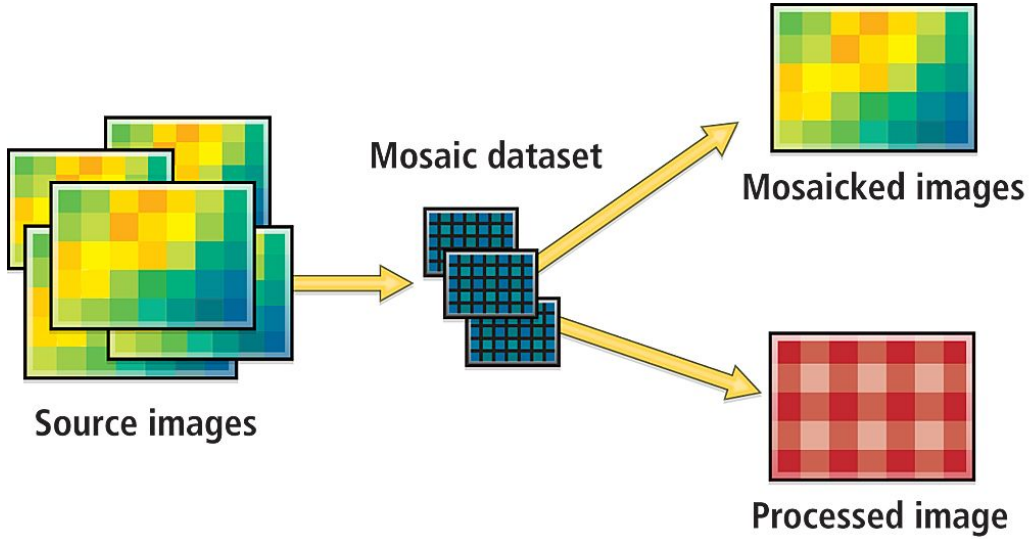
- Doable, should not fully rely on remotely sensed data



Future Work

Beyond this Project

- ❑ Use 8 day data
- ❑ Attempt to expand dataset
- ❑ What areas are most affected by El Niño?
- ❑ Learn how to use mosaic tools



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Questions?