



r	Jan	Feb	March	April	may	june	july	august	septembe	october	november	december
1987												
1988	0.8	0.35	0.1	-0.36667	-0.83333	-1.16667	-1.23333	-1.2	-1.26667	-1.5	-1.7	-1.77
1989	-1.63333	-1.05	-1.1	-0.83333	-0.6	-0.43333	-0.33333	-0.26667	-0.23333	-0.2	-0.16667	-0.07
1990	0.06667	0.15	0.26667	0.3	0.3	0.3	0.33333	0.36667	0.36667	0.36667	0.36667	0.40
1991	0.36667	0.225	0.26667	0.33333	0.46667	0.6	0.63333	0.63333	0.66667	0.86667	1.16667	1.47
1992	1.6	1.2	1.46667	1.3	1.03333	0.73333	0.4	0.13333	-0.06667	-0.2	-0.2	-0.10
1993	0.1	0.225	0.5	0.63333	0.66667	0.53333	0.4	0.26667	0.2	0.1	0.06667	0.07
1994	0.1	0.1	0.2	0.3	0.36667	0.4	0.4	0.46667	0.56667	0.76667	0.93333	1.03
1995	0.93333	0.55	0.5	0.3	0.13333	-0.03333	-0.23333	-0.5	-0.76667	-0.93333	-1	-0.97
1996	-0.9	-0.575	-0.6	-0.43333	-0.33333	-0.3	-0.3	-0.33333	-0.36667	-0.4	-0.43333	-0.47
1997	-0.46667	-0.25	-0.06667	0.33333	0.76667	1.2	1.56667	1.86667	2.1	2.26667	2.36667	2.33
1998	2.16667	1.375	1.43333	0.96667	0.46667	-0.13333	-0.66667	-1.06667	-1.26667	-1.4	-1.5	-1.53
1999	-1.46667	-0.975	-1.13333	-1.03333	-1	-1.03333	-1.06667	-1.13333	-1.2	-1.33333	-1.5	-1.63
2000	-1.6	-1.05	-1.1	-0.86667	-0.7	-0.63333	-0.56667	-0.53333	-0.53333	-0.6	-0.66667	-0.70
2001	-0.63333	-0.4	-0.4	-0.33333	-0.23333	-0.16667	-0.1	-0.13333	-0.2	-0.26667	-0.3	-0.23
2002	-0.13333	0	0.1	0.23333	0.43333	0.63333	0.8	0.9	1.03333	1.16667	1.2	1.10
2003	0.86667	0.475	0.33333	0.03333	-0.16667	-0.13333	0.03333	0.2	0.26667	0.33333	0.36667	0.40
2004	0.36667	0.225	0.23333	0.2	0.23333	0.33333	0.46667	0.6	0.66667	0.7	0.7	0.67
2005	0.63333	0.4	0.46667	0.36667	0.26667	0.1	-0.03333	-0.1	-0.16667	-0.33333	-0.56667	-0.73
2006	-0.76667	-0.5	-0.5	-0.26667	-0.1	0.03333	0.13333	0.3	0.5	0.7	0.83333	0.83
2007	0.63333	0.25	0.03333	-0.16667	-0.3	-0.4	-0.56667	-0.8	-1.1	-1.33333	-1.5	-1.57
2008	-1.53333	-1.05	-1.16667	-0.96667	-0.73333	-0.56667	-0.4	-0.33333	-0.33333	-0.43333	-0.56667	-0.70
2009	-0.73333	-0.5	-0.46667	-0.2	0.1	0.33333	0.46667	0.56667	0.73333	1	1.3	1.47
2010	1.46667	0.925	0.86667	0.4	-0.1	-0.56667	-1	-1.33333	-1.56667	-1.66667	-1.66667	-1.57
2011	-1.36667	-0.825	-0.83333	-0.63333	-0.5	-0.46667	-0.53333	-0.7	-0.9	-1.03333	-1.06667	-0.97
2012	-0.8	-0.475	-0.5	-0.36667	-0.16667	0.06667	0.23333	0.3	0.26667	0.16667	0	-0.20
2013	-0.3	-0.225	-0.23333	-0.23333	-0.26667	-0.33333	-0.36667	-0.36667	-0.3	-0.23333	-0.23333	-0.30
2014	-0.36667	-0.25	-0.16667	0.06667	0.2	0.2	0.1	0.1	0.2	0.4	0.56667	0.63
2015	0.63333	0.45	0.66667	0.8	1	1.23333	1.53333	1.86667	2.16667	2.4	2.53333	2.57
2016	2.4	1.55	1.53333	0.96667	0.4	-0.03333	-0.33333	-0.5	-0.6	-0.66667	-0.66667	-0.53
2017	-0.36667	-0.1	0.03333	0.2	0.26667	0.23333	0.1	-0.13333	-0.4	-0.63333	-0.83333	-0.90
2018	-0.93333	-0.625	-0.7	-0.46667	-0.23333	-0.03333	0.1	0.26667	0.5	0.73333	0.83333	0.83
2019	0.76667	0.55	0.7	0.63333	0.56667	0.43333	0.3	0.2	0.23333	0.36667	0.5	0.53
2020	0.53333	0.35	0.36667	0.16667	-0.06667	-0.26667	-0.43333	-0.63333	-0.9	-1.13333	-1.23333	-1.20
2021	-1.06667	-0.7	-0.8	-0.66667	-0.53333	-0.43333	-0.43333	-0.53333	-0.66667	-0.83333	-0.93333	-1.00
2022	-0.96667	-0.725	-1	-1.03333	-1	-0.9	-0.86667	-0.9	-0.96667	-0.96667	-0.9	-0.80
2023	-0.63333	-0.325	-0.16667	0.13333	0.46667	0.8	1.06667	1.33333	1.56667	1.76667	1.9	1.95

Synopsis

- The purpose of this research is to gain insight into patterns/correlations between environmental variabilities and ecological patterns.
- Data Sources
 - Freshwater Flux Data: Spanning from 1992-2018
 - Monthly El Niño-Southern Oscillation (ENSO) Data: Averaged data to analyze climate variations
- Methodology
 - Geographic Information Systems (GIS): Analyze spatial patterns and trends in freshwater flux.
 - Excel: Integrate monthly averaged ENSO data

Research Results and Products

- GIS Maps and Visualizations: Detailed maps showing spatial patterns of freshwater flux.
- These visualizations illustrate temporal changes and correlations between datasets.
- This is significant because it helps identify trends, predict future changes, and distinguish correlations with ENSO data. This resource helps visualize how freshwater fluxes vary over time and regions of focus.

Research Objective

- Freshwater Flux is the movement and exchange of freshwater in Earth's systems such as:
 - Atmosphere: precipitations and evaporation
 - Surface Water: rivers, lakes and oceans
 - Subsurface Water: ground water
- ECCO (Estimating the Circulation and Climate of the Ocean) conceived the ocean as a major element of the global climate
- Applications include climate trends and global warming, sea ice studies, regional estimates and studies of ocean variability, paleoclimate studies, and assimilate data for best fit model data

Commercialization and/or Societal Impact Opportunities

- Education and Awareness
- This research creates the opportunity to translate this complex data for the general public's understanding.
 - Addressing this real-work challenge can create valuable services to mitigate the water cycle challenges in the Pacific Ocean.

Team Names & Collaborators

ARCS Students:
 Andrea Flores, BA Environmental Science
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 Swany Cuc, BS Geography – GIS

Faculty: Dr. Mario Giraldo, Ecological Analysis Using GIS, Geography

NASA Collaborators: Joe T. Roberts, Jorge Vazquez, Latha Baskaran

Research Approach

- Assemble time series of weekly, monthly ECCO data for 20 years (1992 to 2018)
- Segment the data according to ENSO, La Nina, and neutral cycles
- Identify patterns for the USA Pacific Coast
- Establish spatial correlations among variables in the ECCO dataset
- Create animations and a story map to communicate trends to the larger public

Citations

El Niño and La Niña Years and Intensities, Feb. 2024, ggweather.com/enso/oni.htm, Fresh Flux 1992-2018,

ECCO Consortium, Fukumori, I., Wang, O., Fenty, I., Forget, G., Heimbach, P., & Ponte, R. M., 2021. ECCO Ocean and Sea-Ice Surface Freshwater Fluxes - Daily Mean 1lc90 Grid (Version 4 Release 4). Ver. V4r4. PO.DAAC, CA, USA. Dataset accessed [2024-08-20] at <https://doi.org/10.5067/ECL5D-FRE44>

Minnett, P. J. (2024). Satellite Remote Sensing of the Oceans. Reference Module in Earth Systems and Environmental Sciences. <https://doi.org/10.1016/b978-0-323-96026-7.00061-8>

Variation of ENSO cycles from 1992 to 2018
 (Red ENSO, Blue La Nina, White Neutral)