Jet stream Analysis in the ENSO Phases
Case study; 1997, 2008 and 2010

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Introduction

The El Nino and La Nina each favor a different location for the dips and bulges of the polar jet stream. They also affect the strength of the subtropical jet stream. In this way, they influence the weather in middle latitudes. The influence is greatest in the winter months when the coupling of the tropical and mid-latitude patterns is the best. In most El Nino winters, the warming of the air due to strong convection over warm water over the eastern and central Tropical Pacific helps energies the polar and subtropical jet streams to the north. A strong low pressure develops over the Aleutians. The polar jet stream curves to the north into northwestern North America, while the subtropical jet stream ripples across northern Mexico or the southern United States. During La Nina winters, on the other hand, the polar jet stream is strong and the subtropical jet stream weaker in the vicinity of North America (D'Aleo & Grube, 2002).

The effect of ENSO on precipitation and temperature has been studied in detail by a number of Iranian researchers (Khosh Akhlagh, 1998; Azizi, 2000; Ghayor and Asakereh, 2001; Nazem al-Sadat and Ghassemi, 2003; Masoudian 2005, Khorshid Doost and Ghavidel Rahimi, 2006; Yar Ahmadi and Azizi 2007; Hagh Negahdar et al.; 2007). Most of these researches have attributed the increase and decrease of autumn rainfall to El Nino and La Nina respectively. Although it seems that seasonal distribution of rainfall during different ENSO phases does not follow any particular pattern, different patterns can be seen in each of the two compared phases. Givi et al (2009) indicated the positive and negative anomalies of precipitation in each El Nino and La Nina year. Not enough studies have been done on different phases of ENSO that affect the climate of Iran. This study aims to provide a more comprehensive analysis of changes in the 200Hpa jet stream in relation to various ENSO phases (for September, October, November and December).

Materials and Methods

In this study, the Oceanic Nino Index (ONI) provided by the National Oceanic and Atmospheric Administration, is used for defining the ENSO. Whenever ONI based on a threshold of +/- 0.5oC for the Oceanic Nino Index (ONI) at least in 5 three months period is called El Nino/La Nina. ONI values for the three-month periods of 1950 are available through the NOAA website.

According to this definition, the El Nino and La Nina years from 1950 to 2010 were classified according to severity. The threshold is further broken down into Weak (with a 0.5 to 0.9 SST anomaly), Moderate (1.0 to 1.4) and Strong (≥ 1.5) events. This report aims to categorize the events as weak, moderate or strong. It has equaled or exceeded the threshold for at least 3 months (Table 1).

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Table 1: El Nino and La Nina years and intensities based on Oceanic Nino Index (ONI)
http://ggweather.com/enso/oni.htm

El Nino	Weak	1951	1963	1968	1969	1976	1977	2004	2006	
	Mod	1986	1987	1994	2002					
	Strong	1957	1965	1972	1982	1991	1997	2009		
La Nina	Weak	1950	1956	1962	1967	1971	1974	1984	1995	2000
	Mod	1954	1964	1970	1998	1999	2007	2010		
	Strong	1955	1973	1975	1988					

Consequently 1997, 2008, and 2010 were selected as El Nino, normal and La Nina respectively (Figure 1). The impact of ENSO on autumn precipitation is showed by the former research (for example: Azizi, 2000; Masoudian, 2005); Then September, October, November, and December of the above-mentioned years were selected for studying subtropical jet streams.

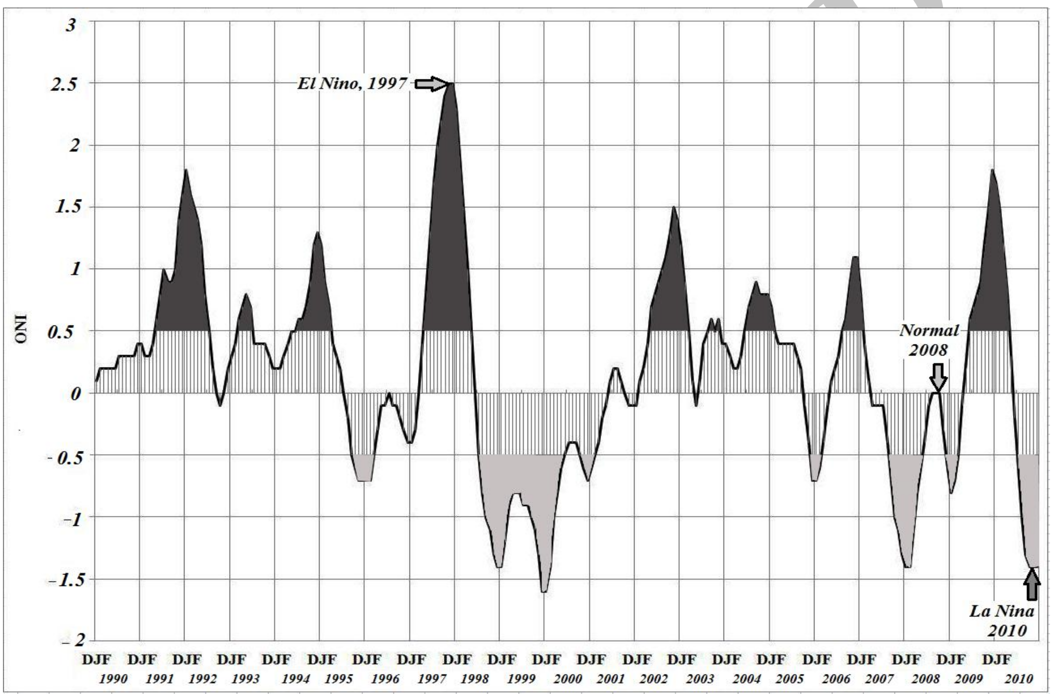

Figure 1: The time series of ONI (1990 – 2010). The black areas indicate El Nion conditions and the gray areas indicate La Nina conditions.

In order to reveal the daily cores of jet stream for September, October, November, and December in the selected years, we use the daily global circulation data based on the NCEP-DOE Reanalysis 2 at 1997, 2008, and 2010 .Grid intervals are 2.5º in both latitude and longitude. We used u and v components of wind in 200 and 300 Hpa in which the wind speed is over 30 meters per second; Jet stream paths are drawn after extracting the cores of jet stream.

Results and discussion

The study shows that the transition of jet stream in 200 and 300 Hpa during September, October, November, and December is done through two distinct paths in north and south of 40º latitude; The north one known as subpolar jet is located around 40º - 70º latitude, and the south one known as Subtropical jet is located around 25º - 37º latitude. The path widths of subpolar jet stream in El Nino year for both levels (200 and

300 Hpa) are wider than normal year, whereas they are narrower in La Nina year for both of them. In the case of subtropical jet stream its path widths in El Nino year for both levels (200 and 300 Hpa) are narrower than normal year, whereas in La Nina year at 200 Hpa level it is wider and at 300 Hpa level it is thinner.

During the El Nino phases, the frequency of jet stream paths at 200 Hpa is the highest for subtropical jet stream and the lowest for subpolar jet stream. During the La Nino phases, the frequency of jet stream paths at 300 Hpa is the highest for both subtropical and sub polar jet streams.

The average speed of jet streams core at 200 Hpa is increased during El Nino year and decreased during La Nina year. At 200 Hpa level over Iran, the paths frequency and speed cores are higher during El Nino phase and lower during La Nina phase than normal condition. Whereas the amount of paths and speed cores during both El Nino and La Nina is lower for subtropical jet streams. The increase of the average speed of jet stream cores during El Nino and its decrease during La Nina phase is a notable result of this research**.**

Key words: Jet stream, ONI, ENSO, Linear Directional Mean, Jet Stream Position