18B.6 ON SOUTHEASTERN PACIFIC SUBTROPICAL CYCLONES

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1. INTRODUCTION

The region of the South Pacific (SP) between the west coast of South America and 120°W is known as the Southeastern Pacific Ocean (SEPO). In recent years, several subtropical cyclones (SCs) have occurred and been observed in this region of the world, which is unprecedented.

At the time of this writing, the scientific literature has largely not identified the SEPO as an ocean basin capable of producing SCs. The global climatology of tropical cyclone (TC) occurrence (i.e., Gray 1968,1975; Ramsay 2017), laments that the SEPO is a region which is absent of TC activity, despite it containing tropical and subtropical latitudinal waters. There is no World Meteorological Organization (WMO) Regional Specialized Meteorological Centre (RSMC) or TC Warning Centre (TCWC) tasked with monitoring this region for subtropical or tropical development (Figure 1).

Presented here is one of the first works concerning SC development within the SEPO. The main goal of this work is to raise awareness of SC occurrence in the SEPO within the scientific community.

2. KATIE, LEXI, AND HUMBERTO

There have been three SCs which have occurred and been observed within the SEPO in recent years. These three SCs have come to be known as Katie, Lexi, and Humberto. These systems have received some attention, mainly on online platforms and from online articles, but little work and knowledge of them exists overall. Some knowledge of them that does exist is shared in this work.

2.1 *Katie*

The first of these three SCs occurred in April/May of 2015. This SC has come to be known as “Katie” and was first dubbed as so by Mr. Steven H. Young. Mr. Young provides an analysis of SC Katie within *State of the Climate in 2015* (Blunden and Arndt 2016). As far as the authors are aware, given this analysis of Katie, Mr. Young is the first to confirm the development of a SC east of 120°W in the SP. Katie is also mentioned in the *Mariner’s Tropical Cyclone Guide* (Flynn 2023).

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2.2 *Lexi*

The second of these SCs occurred in May 2018. This SC has come to be known as “Lexi” and was also first dubbed as so by Mr. Young. Work on Lexi appears in Silva et al. (2022a, b), but the authors are unaware of any other scientific journals which include information on Lexi. A good deal of attention was brought to Lexi by several online articles (e.g., NOAA 2018). Reference to Lexi is also made within the *Mariner’s Tropical Cyclone Guide* (Flynn 2023).

2.3 *Humberto*

The third of these SCs occurred in January 2022. This SC has come to be known as “Humberto” and is dubbed so by Mr. Young by request of Luis F. Muñoz. Humberto is named after Humberto A. Fuenzalida, a Chilean researcher who completed pioneer work in atmospheric science. Humberto A. Fuenzalida passed away days before the cyclone’s formation. A satellite image of Humberto is provided around the time frame of the cyclone’s most organized structure (Figure 2).

2.4 *Methodology and Results*

ERA5 reanalysis data (Hersbach et al. 2023a, b) were utilized to study the environments that allowed for the development of Katie, Lexi, and Humberto. The tracks of each SC were derived from ERA5 and their cyclone phase space (CPS) diagrams (Hart 2003) constructed (e.g., Figure 3).

Katie, Lexi, and Humberto are the result of favorable upper-level environments that manifest during each cyclone’s lifecycle. These favorable upper-level environments (i.e., increased lapse rates with large decreased vertical wind shears) facilitate the transition of their precursor disturbances into SCs over sea surface temperatures (SSTs) which become at least marginally favorable.

Tracks and some information regarding Katie, Lexi, and Humberto are included in the Southwest Pacific Enhanced Archive for Tropical Cyclones (SPEArTC) dataset (Diamond et al. 2012).

3. CANDIDATE CYCLONES

With the development of Katie, Lexi, and Humberto, the question arose if other SCs have occurred in the SEPO. To identify other potential SC candidates which may have occurred, the authors opted to utilize satellite imagery. Satellite imagery can provide strong confidence that a SC occurred, as the typical SC can be rather distinguishable to the human eye.

The National Aeronautics and Space Administration (NASA) Earth Observing System Data and Information System (EOSDIS) Worldview website (NASA 2023) provides daily composite satellite imagery from several polar orbiting satellites. Using several of the products available on the site (Table 1), potential SC candidates were identified. For each cyclone candidate identified, ERA5 data were utilized to study them along with their environments. As with Katie, Lexi, and Humberto, tracks of each cyclone candidate are derived and their CPS diagrams constructed.

Satellite imagery (e.g., Figure 4) in combination with CPS diagrams (e.g., Figure 5 and Figure 6) suggested many of these candidates were indeed SCs. The authors feel comfortable presenting 12 of these candidates to the community as definite SCs (Table 2). Only candidates which are found in imagery east of 120°W and undoubtedly transitioned to at least SC status east of 120°W are provided.

4. CLIMATOLOGICAL FRAMEWORK

Including Katie, Lexi, and Humberto, at least 15 SCs have occurred in the SEPO between the period of 24 February 2000 to 24 February 2024. The time of year most common for development of a SC in the SEPO is during later austral autumn to early austral winter (i.e., April to June). Specifically, the month of May seems to be the most favorable time of year for the development of a SC in the SEPO; it sees the highest number of definite candidates (Figure 7).

A favorable meteorological/climatological situation occurs particularly in May. As the SP heads towards austral winter, precursor disturbances (e.g., frontal boundaries, extratropical cyclones, cold cutoff lows, upper-level troughs) which can seed the environment for potential subtropical cyclogenesis protrude more readily into the subtropics and lower latitudes of the SEPO. These precursor disturbances can undergo short-lived SC transitions over marginally favorable SSTs, given a favorable upper-level environment. Note, the month of May sees the weakest anticyclone of any month and appreciable northward (i.e., equatorward) migration from the austral summer and earlier austral autumn months (Figure 8 and Figure 9).

5. CONCLUSIONS

One of the first ever works examining SCs in the SEPO is presented. SCs do occur in the SEPO; including Katie, Lexi, and Humberto, at least 15 have occurred since 24 February 2000. SC occurrence in the SEPO may be considered rare, but it is certainly not exceptionally or extremely rare. The SEPO is a fairly cyclogenetic region of the world that can, on occasion, support subtropical cyclogenesis.

A favorable upper-level environment must occur for a SC to occur in the SEPO. Later austral autumn to early austral winter (i.e., April to June) is the most common time of year for SCs to occur in the SEPO. The month of May was found to see the most SCs. While future work may find a different month for the greatest SC occurrence in the SEPO, the authors are confident the climatological peak lies between April and June.

Most SC candidates found and examined are either Katie, Lexi, or Humberto analogs. These cyclones form in a similar environment and follow a similar track (Figure 10). SCs may be better observed, and life and property better protected, if the SEPO is monitored for SC development under the jurisdiction of a WMO RSMC or TCWC.

6. REFERENCES

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7. FIGURES AND TABLES

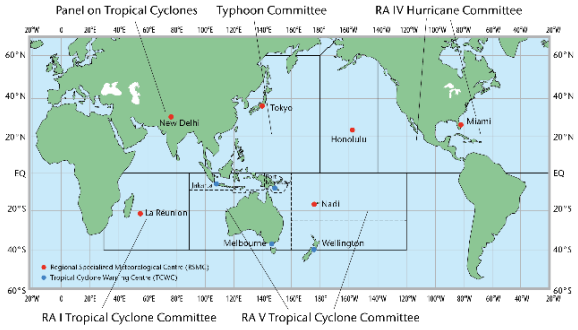

Figure 1. The spatial extent of jurisdiction and location of each WMO RSMC and TCWC. Note, the region of the SP east of 120°W, the SEPO, is not under the jurisdiction of any WMO RSMC or TCWC. Image credit: WMO 2024.

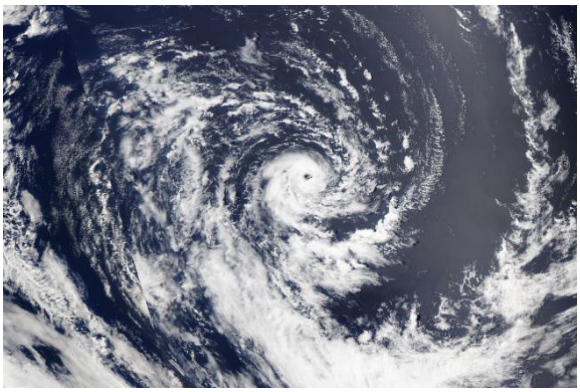

Figure 2. Satellite imagery (Corrected Reflectance (True Color) Aqua / MODIS) of Humberto around 19:27 UTC 12 January 2022. Image credit: NASA 2023.

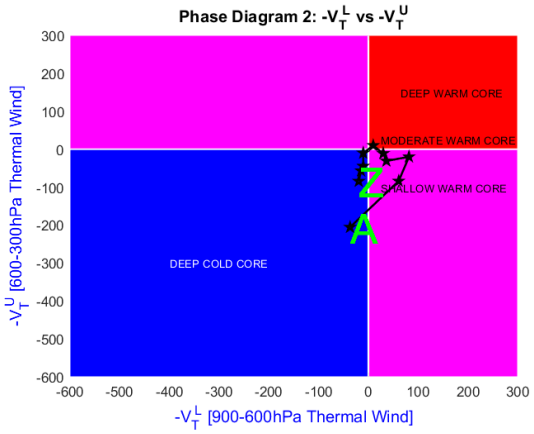

Figure 3. CPS Diagram 2: $-V_T^L$ vs $-V_T^U$ for SC Humberto.

Product	Temporal Coverage
Corrected Reflectance (True Color) Terra / MODIS^{T}	24 February 2000 - Present
Corrected Reflectance (True Color) Aqua / MODIS^{A}	3 July 2002 - Present
Corrected Reflectance (True Color) Suomi NPP / VIIRS^{S}	24 November 2015 - Present
Corrected Reflectance (True Color) NOAA-20 / VIIRS^{N}	5 January 2018 - Present

Table 1. The satellite products utilized, and temporal coverage of each, available from NASA 2023.

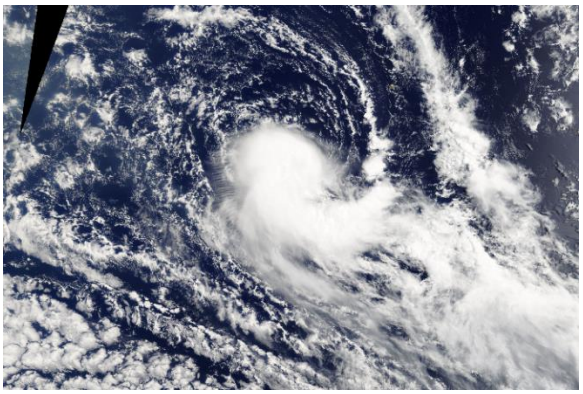

Figure 4. Satellite imagery (Corrected Reflectance (True Color) Terra / MODIS) of the January2003 SC around 17:20 UTC 27 January 2003. Image credit: NASA 2023.

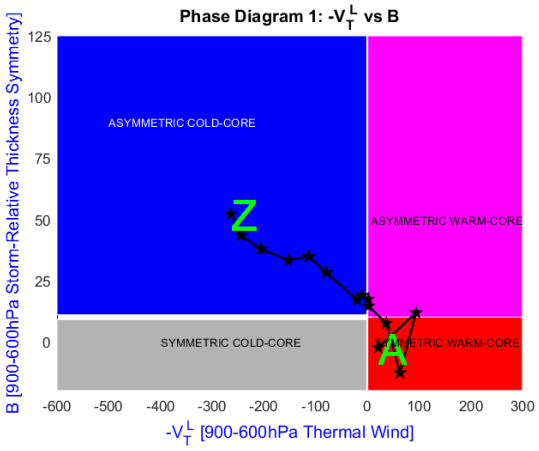

Figure 5. CPS Diagram 1: -V_T^L vs B for the January2003 SC.

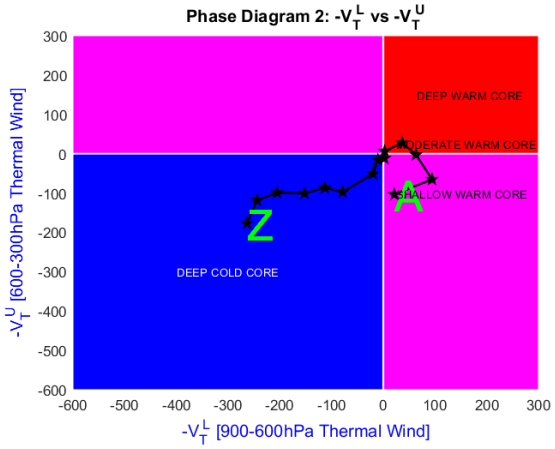

Figure 6. CPS Diagram 2: -V_T^L vs -V_T^U for the January2003 SC.

SC Candidate	Date(s) Visible	Available Imagery
August2000	23/24	T
May2002	23	T
January2003	27	T, A
May2003	25	T, A
May2006	4	T, A
May2008	16	T, A
July2009	18	T, A
June2015	29	T, A
October2015	7	T, A
June2017	13/14	T, A, S
April2020	23/24	T, A, S, N
April2023	27	T, A, S, N

Table 2. List of the 12 SC Candidates found to be definite SCs from 24 February 2000 to 24 February 2024. Each candidate is named with the month/year it is observed. Date(s) for which these cyclones are visible using NASA 2023 are provided. The letters provided in the Available Imagery column correspond to the satellite product available from NASA 2023 (see Table 1).

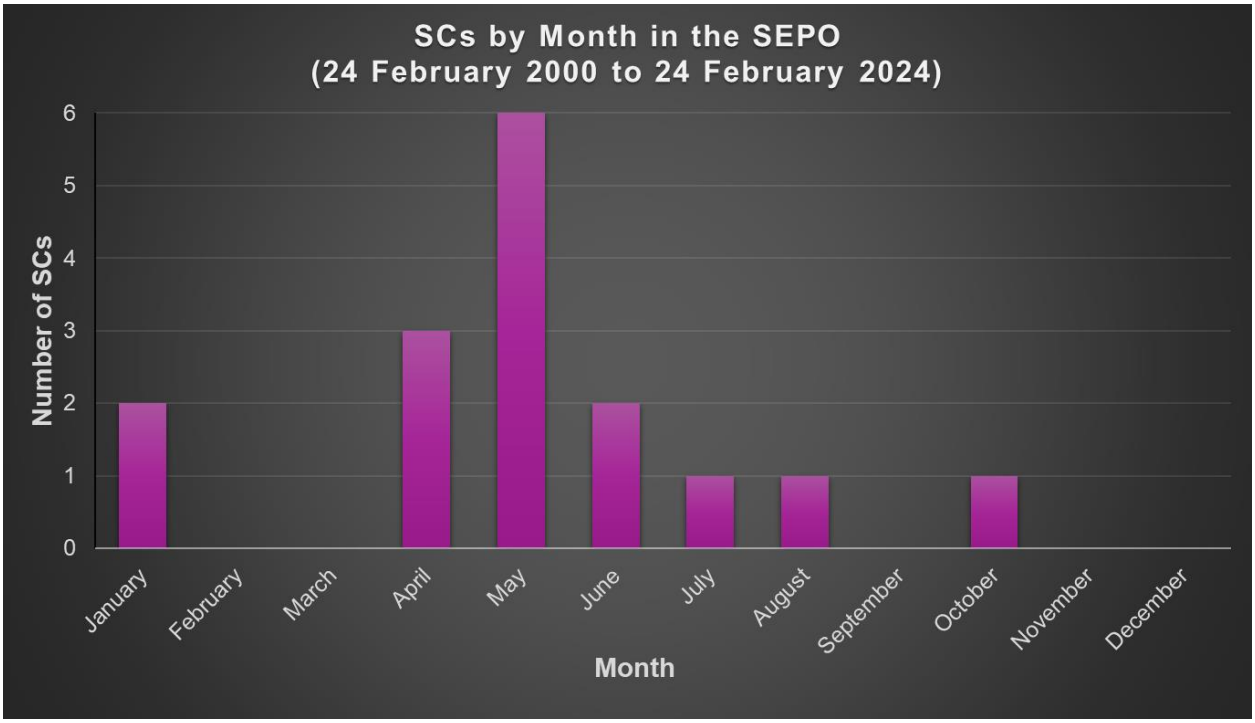

Figure 7. SCs by Month in the SEPO from 24 February 2000 to 24 February 2024. Katie, Lexi, Humberto, and the 12 SC Candidates from Table 2 are included. Note, Katie is counted twice, once in April and once in May as the cyclone occurred right at the end of April and continued into May.

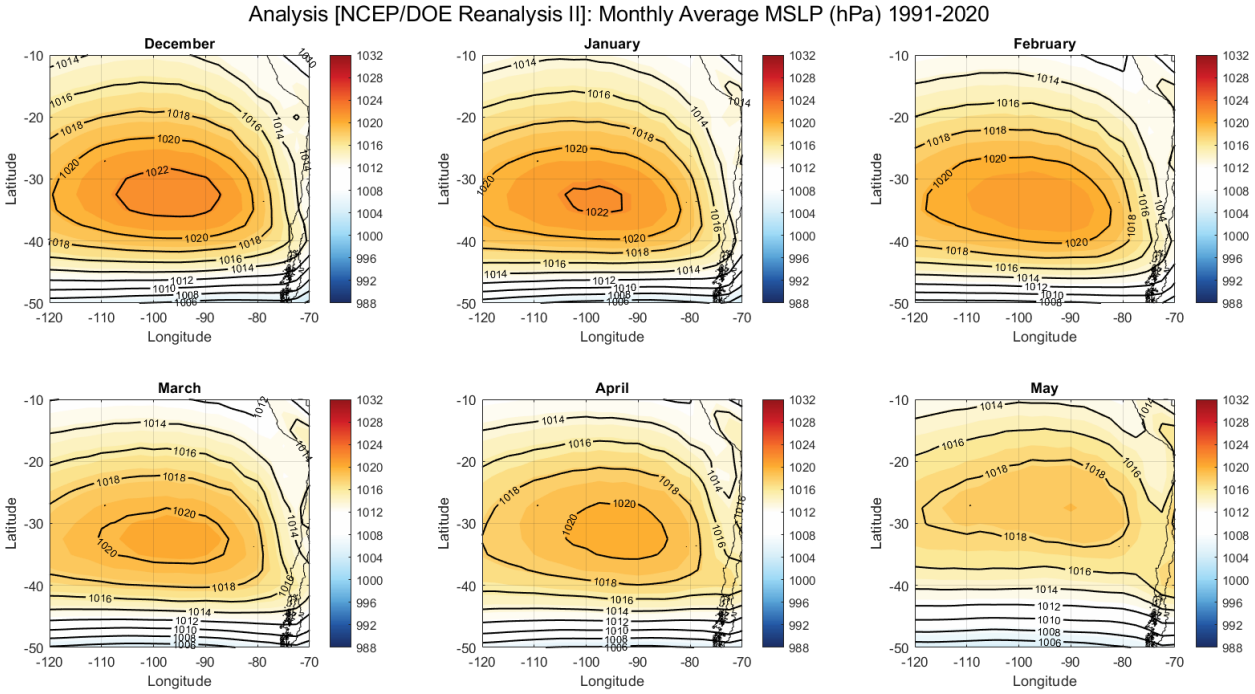

Figure 8. NCEP/DOE Reanalysis II (Kanamitsu et al. 2002) Monthly Average Mean Sea Level Pressure (MSLP) in hPa from 1991-2020 for the months of austral summer and austral autumn. Data obtained from NOAA 2024.

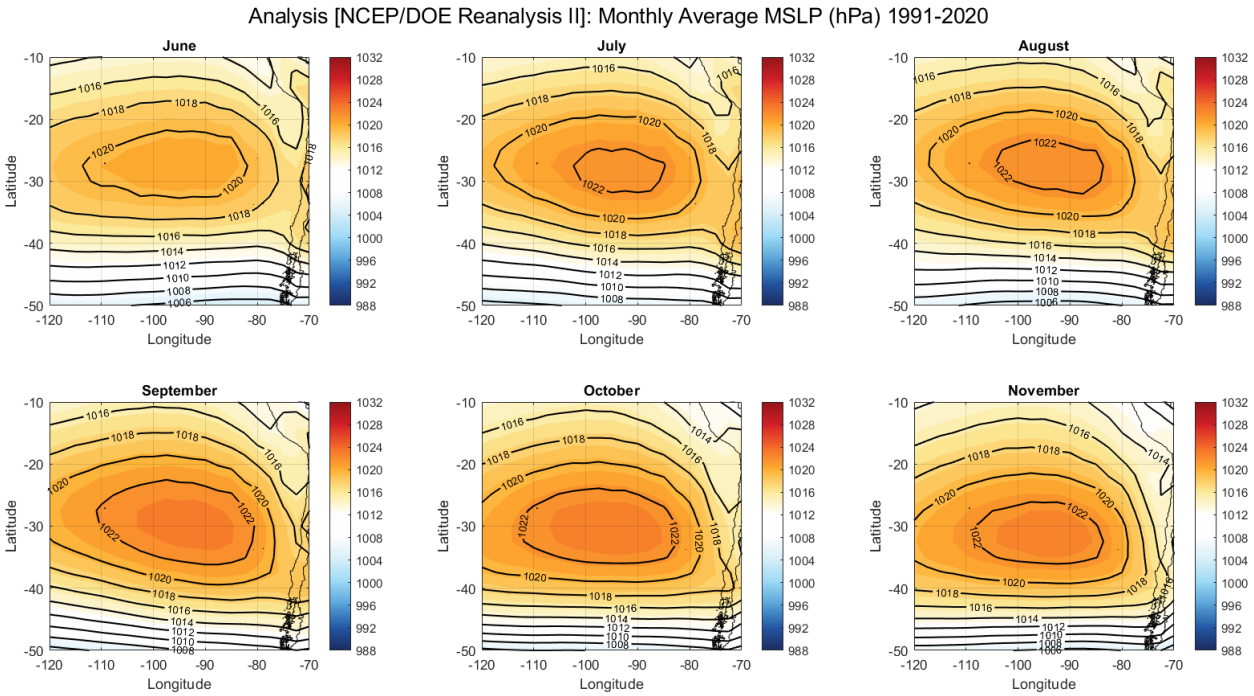

Figure 9. As in Figure 8, but for the months of austral winter and austral spring. Data obtained from NOAA 2024.

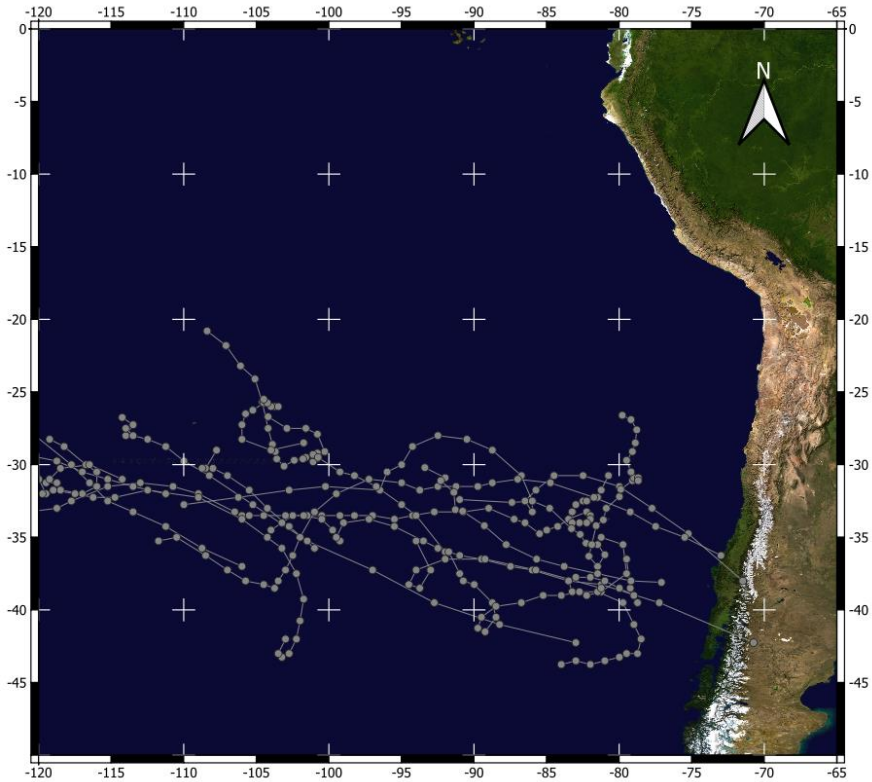

Figure 10. All ERA5 derived tracks including Katie, Lexi, Humberto, and the 12 SC Candidates from Table 2.