

Cyclones density and characteristics in different reanalyses dataset over South America



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Introduction

Cyclones developing over and at the eastern coast of South America have a great impact in the center-west sector of the South Atlantic, leading to intense winds and oceanic waves. From the total number of cyclones forming in the south/southeast Brazil, 30% are subtropical and lies close to the coast, accompanied by strong winds (over 17 m/s at 925 hPa) during a long period of their lifecycle. Nevertheless, subtropical and extratropical cyclones are the main forcing of extreme winds in this sector of South Atlantic basin, which are important for engineering constructions over the southeast Brazil basin.

Understanding the present climate is crucial to assess future extremes tendencies over the region, hence, it is important to study their preferred region of formation and trajectories in the present climate.

Introduction

The aim of this study is to evaluate the main cyclogenetic regions over South America in different reanalyses dataset. As a first approach, we will present some cyclogenesis features as densities, lifetime, intensity, and traveled distance.

Data and methods

Data:

From the National Centers for Environmental Prediction (NCEP):

- 1) Climate Forecast System Reanalysis (CFSR and CFSv2; Saha et al., 2010, 2014) - 0.5° (lat x lon)

From the European Center for Medium-Range Weather Forecast (ECMWF):

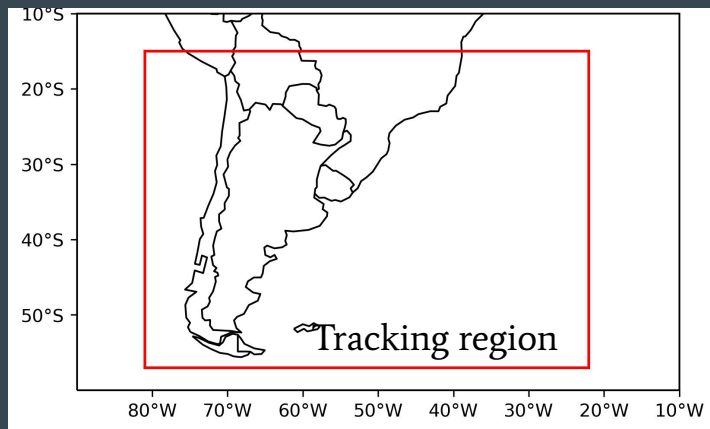
- 2) ERA5 (C3S; Hersbach and Dee (2016)) - 0.28125° (lat x lon)
- 3) ERA-Interim (ERA-Interim; Dee et al. 2011) - 0.75° (lat x lon)

Period: 1979 to 2018

Data and methods

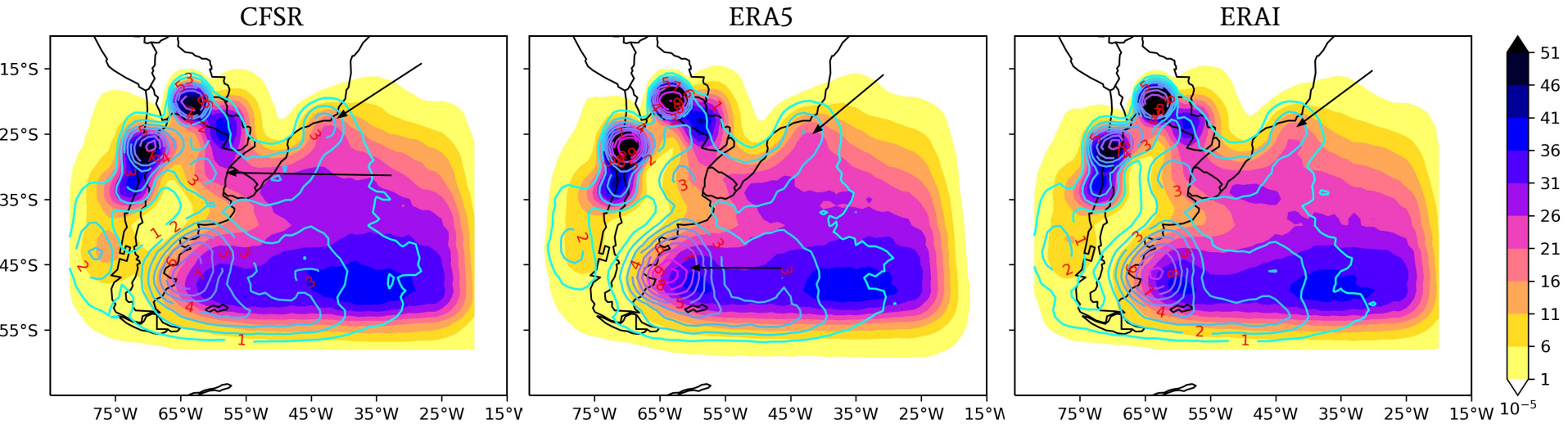
Methods:

- Tracking using relative vorticity (RV) at 925 hPa (Sugahara, 2000; Reboita et al. 2010);
- Climatological analysis.



Results

Annual density of cyclogenesis



Annual density of cyclogenesis (lines) and trajectories (shaded) in CFSR, ERA5 and ERA-Interim for the period 1979-2018. The unit is cyclone per area (km^2) per year.

Results

Table 1 Total number of cyclones and seasonal frequency over the whole tracking region for the three reanalyses CFSR, ERA5 and ERAI, and the relative difference between them, for the period 1979-2018 (blue rows).

	<i>Total</i>	<i>DJF</i>	<i>MAM</i>	<i>JJA</i>	<i>SON</i>
<i>CFSR</i>	16137	23.6%	23.3%	27.8%	25.3%
<i>ERA5</i>	15890	23.9%	23.5%	27.6%	25.0%
<i>ERAI</i>	15129	24.3%	23.1%	27.6%	25.0%
<i>CFSR-ERA5</i>	247	0.1%	1%	2%	2.7%
<i>CFSR-ERAI</i>	1008	3.5%	7.2%	6.8%	7.2%
<i>ERA5-ERAI</i>	761	3.4%	6.2%	4.9%	4.6%

Results

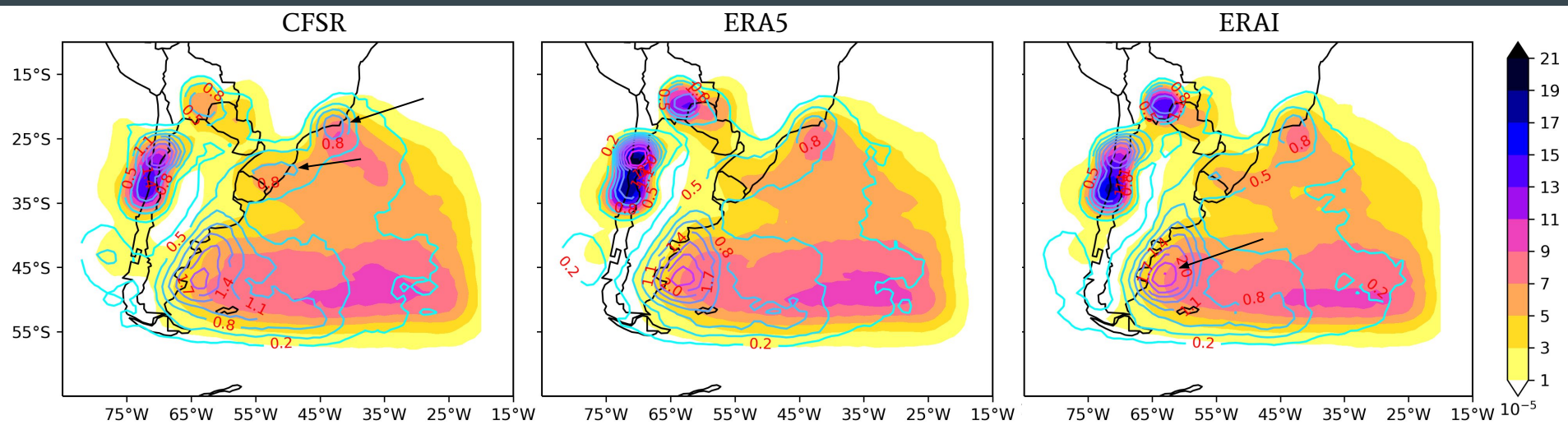
- Cyclone tracking → higher number of systems in CFSR than ERAI (6.2%); higher number in ERA5 than in ERAI (4.7%); smaller differences between CFSR (+1.5%) and ERA5.
- Among the three reanalyses, the differences in cyclogenesis number are smaller during the summer.
- Reanalyses identify basically the same four cyclogenetic regions, however, there are differences in the density center position.

Results

Seasonal density - DJF

CFSR: more cyclogenesis in southeast coast of Brazil; these cyclones travel longer distances. More cyclones forming over the southern Brazil.

ERA-Interim: higher number of genesis over Argentinian coast.

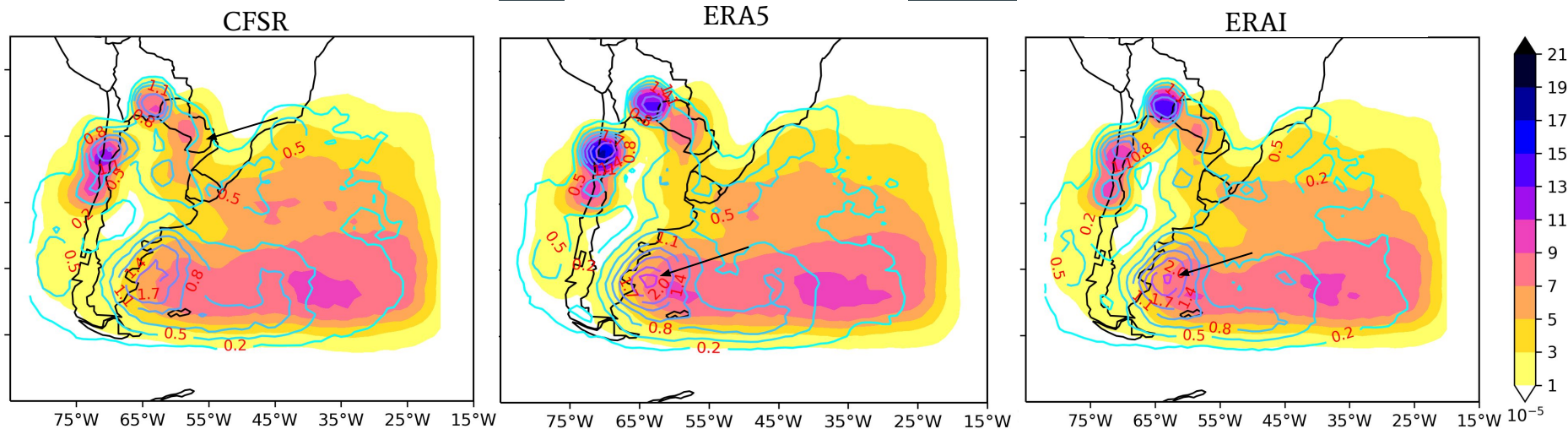


Results

Seasonal density - MAM

ERA5 and ERAI: more cyclogenesis over Argentinian coast.

CFSR: cyclones forming over the continent (Paraguay and northeastern Argentina) travel longer distances.



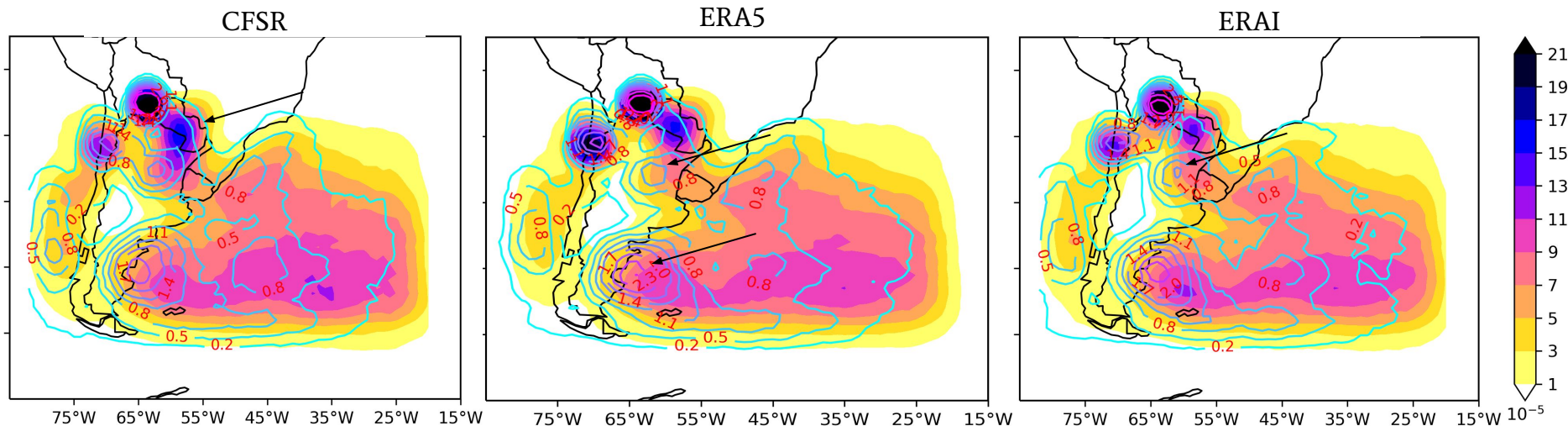
Density of cyclogenesis (lines) and trajectories (shaded) in CFSR, ERA5 and ERA-Interim for the period 1979-2018, for autumn. The unit is cyclone per area (km²) per season.

Results

Seasonal density - JJA

CFSR and ERA5: more frequent trajectories over Paraguay.

CFSR and ERAI: more frequent genesis over the northwest of Uruguay.

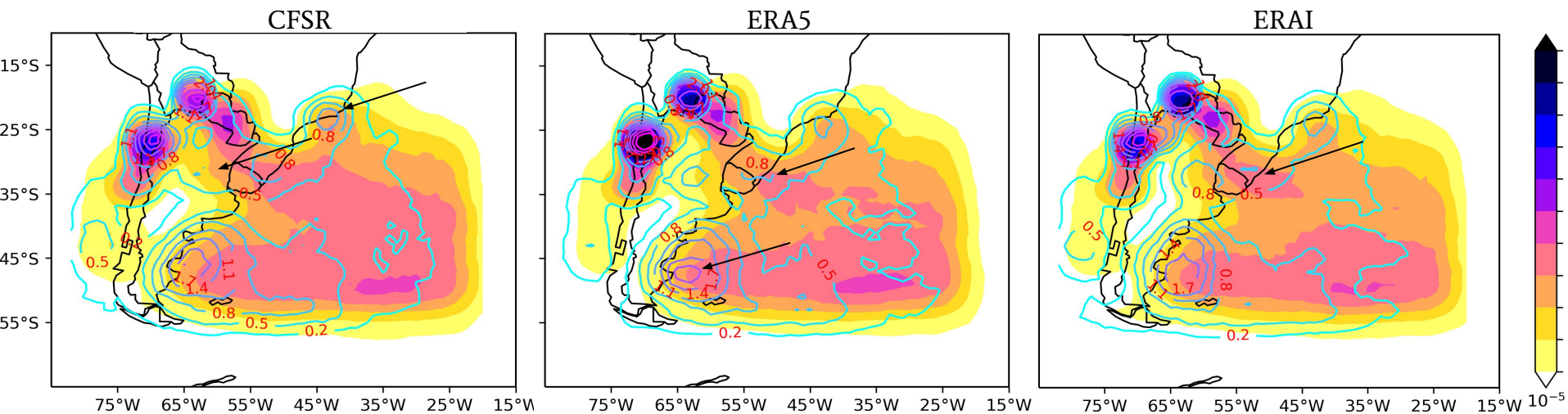


Density of cyclogenesis (lines) and trajectories (shaded) in CFSR, ERA5 and ERA-Interim for the period 1979-2018, for winter. The unit is cyclone per area (km²) per season.

Results

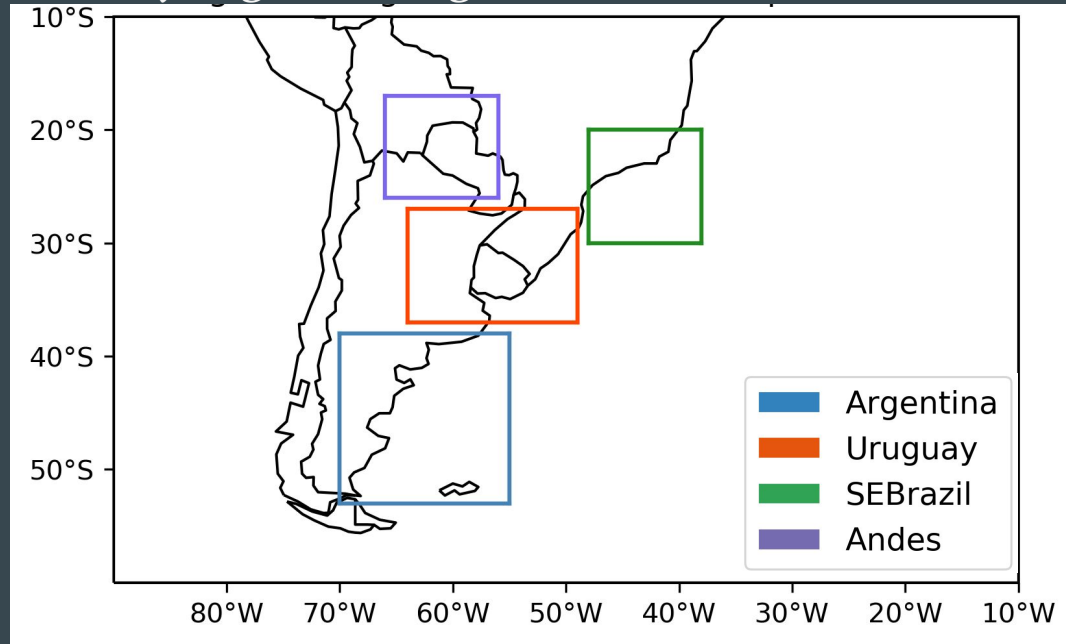
Seasonal density - SON

CFSR: less frequent genesis over western Uruguay; more trajectories over the South Atlantic (~ 34°S) than the other reanalyses.



Results

Cyclogenetic regions over South America



Following Crespo (2019)

Results

Cyclogenesis seasonality

Argentina, Uruguay and Andes: more cases during winter in the three reanalyses;

SEBrazil: More frequent in spring (CFSR) and summer (ERA5 and ERAI);

Argentina and SEBrazil: greater frequency in ERA5;

Uruguay and Andes: more cases in ERAI.

Table 2 Seasonal and relative to the total distributions of cyclones for CFSR, ERA5 and ERAI for each cyclogenetic region. Values in red indicate the highest number of cyclogenesis for the respective region.

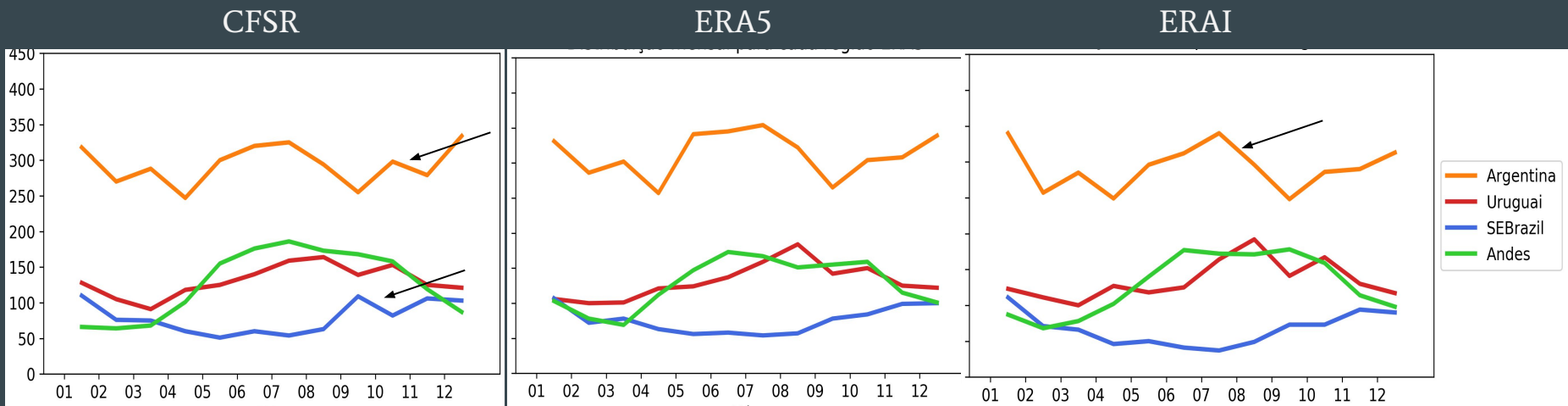
		CFSR			
		Argentina	Uruguay	SEBrazil	Andes
DJF	922 (26.1%)	354 (22.6%)	289 (30.5%)	217 (14.3%)	
MAM	835 (23.7%)	334 (21.3%)	186 (19.6%)	324 (21.3%)	
JJA	939 (26.6%)	463 (29.5%)	177 (18.7%)	535 (35.2%)	
SON	832 (23.6%)	417 (26.6%)	297 (31.3%)	445 (29.3%)	
Total	3528 (21.8%)	1568 (9.7%)	949 (5.8%)	1521 (9.4%)	

		ERA5			
		Argentina	Uruguay	SEBrazil	Andes
DJF	956 (25.5%)	328 (20.9%)	279 (30.8%)	282 (18.4%)	
MAM	900 (24.0%)	346 (22.0%)	197 (21.7%)	328 (21.4%)	
JJA	1021 (27.2%)	480 (30.6%)	169 (18.7%)	491 (32.1%)	
SON	877 (23.4%)	417 (26.5%)	261 (28.8%)	429 (28.0%)	
Total	3754 (23.6%)	1571 (9.8%)	906 (5.7%)	1530 (9.6%)	

		ERAI			
		Argentina	Uruguay	SEBrazil	Andes
DJF	910 (25.9%)	351 (21.7%)	272 (34.0%)	253 (16.4%)	
MAM	830 (23.6%)	345 (21.4%)	162 (20.2%)	320 (20.7%)	
JJA	948 (27.0%)	481 (29.8%)	127 (15.9%)	520 (33.7%)	
SON	824 (23.5%)	438 (27.1%)	240 (30.0%)	451 (29.2%)	
Total	3512 (23.2%)	1615 (10.6%)	801 (5.2%)	1544 (10.2%)	

Results

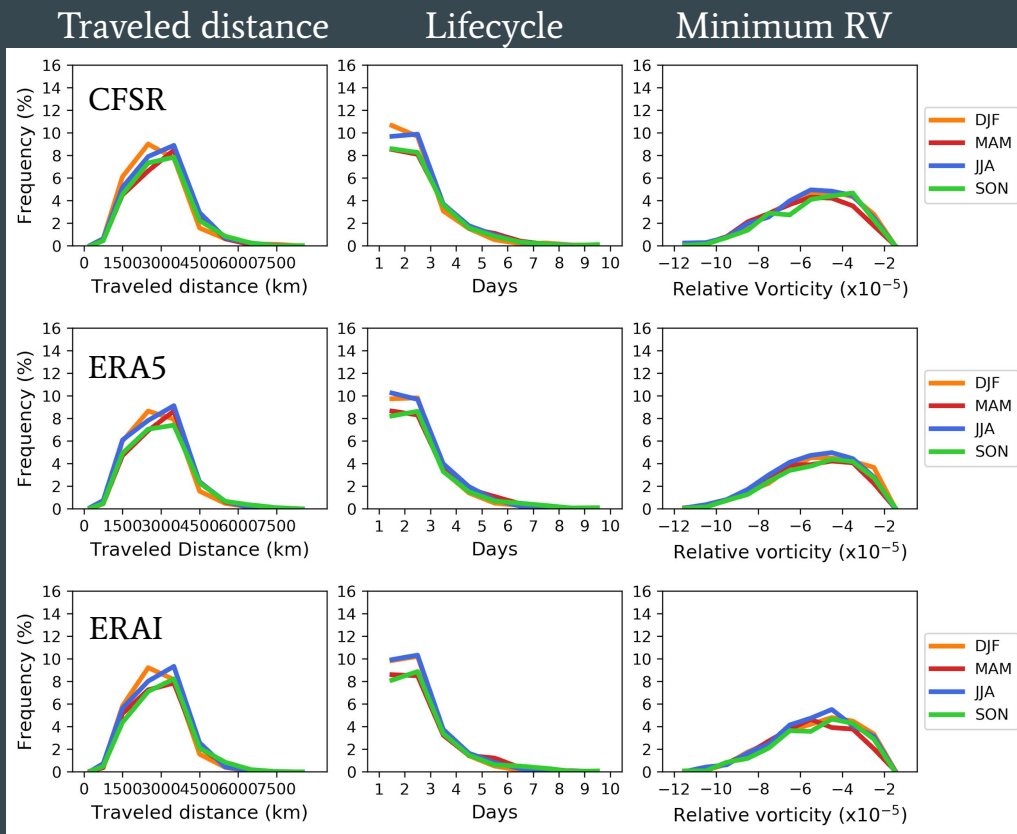
Annual cycle of cyclogenesis



Monthly distribution of the total absolute number of cyclogenesis for each cyclogenetic region in CFSR, ERA5 and ERAI. The period is 1979-2018.

Results

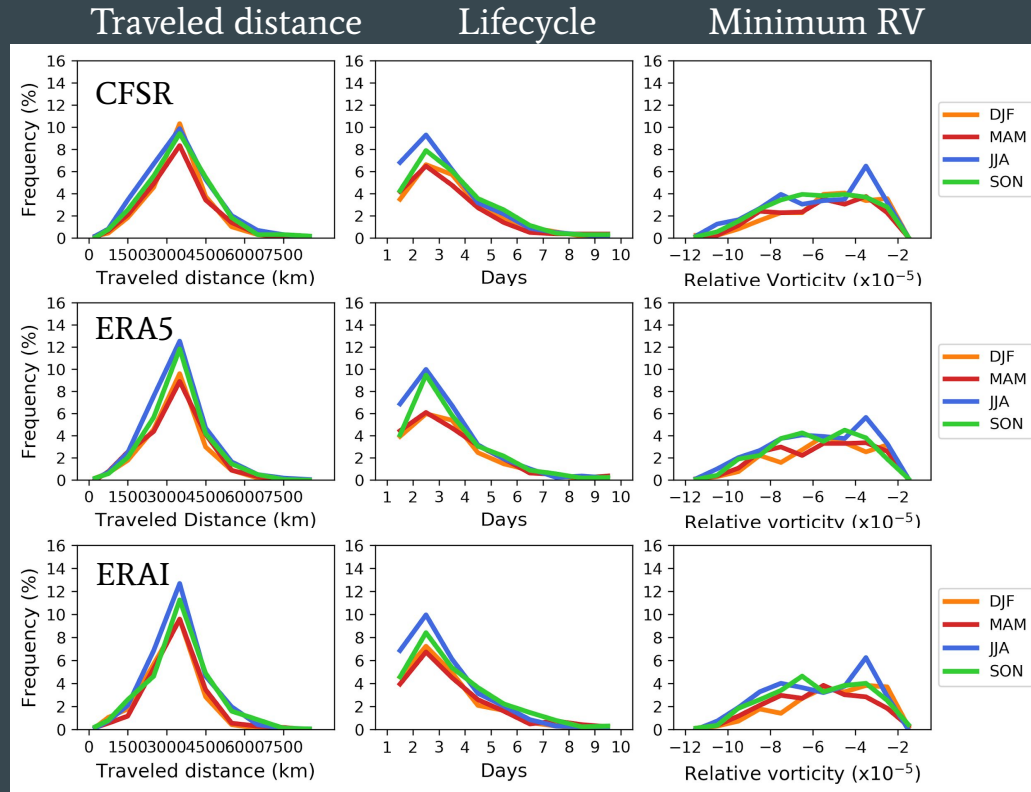
Main features of cyclogenesis in Argentina



Seasonal relative frequency (%) of total traveled distance (km), lifetime (days) and minimum relative vorticity ($\times 10^{-5} \text{ s}^{-1}$) for cyclones forming in Argentina in CFSR, ERA5 and ERAI, for the period 1979-2018.

Results

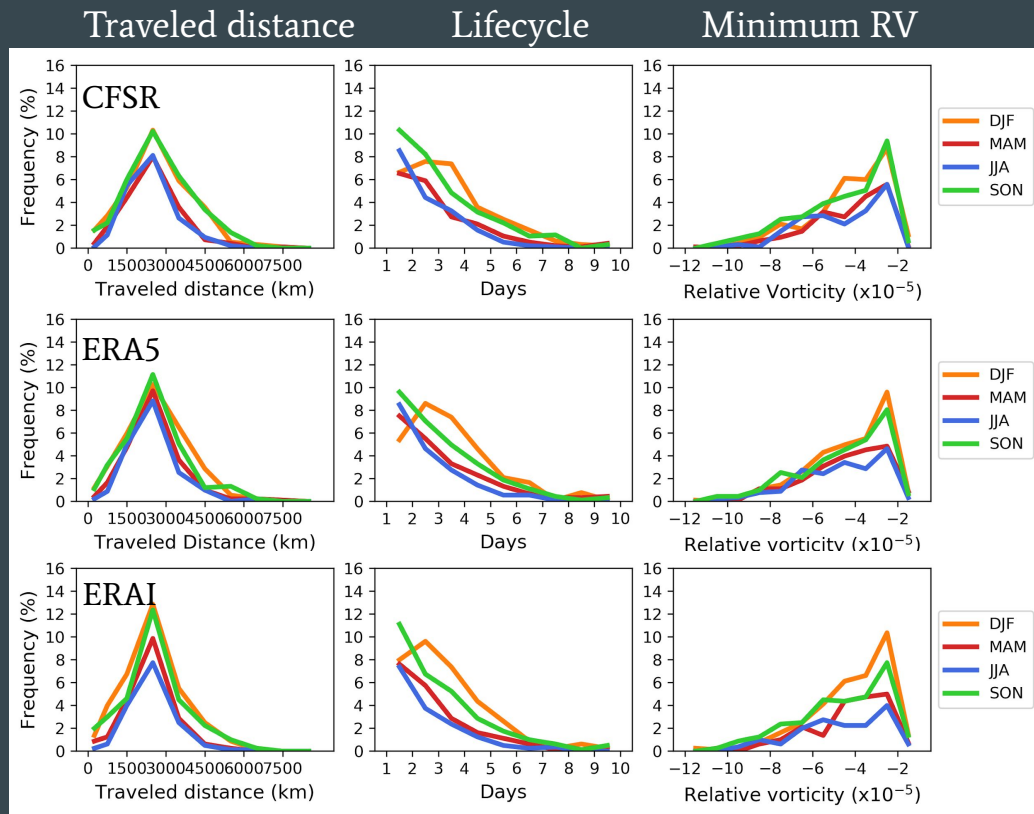
Main features of cyclogenesis in Uruguay



Seasonal relative frequency (%) of total traveled distance (km), lifetime (days) and minimum relative vorticity ($\times 10^{-5} \text{ s}^{-1}$) for cyclones forming in Uruguay in CFSR, ERA5 and ERAI, for the period 1979-2018.

Results

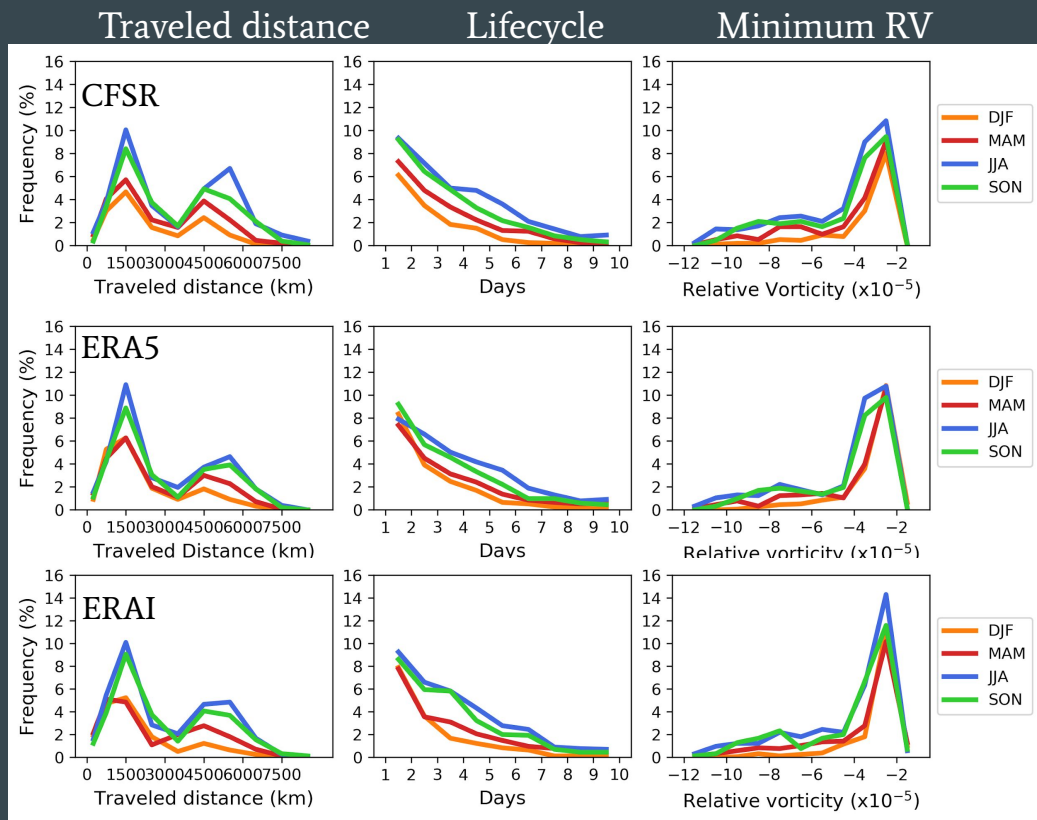
Main features of cyclogenesis in SEBrazil



Seasonal relative frequency (%) of total traveled distance (km), lifetime (days) and minimum relative vorticity ($\times 10^{-5} \text{ s}^{-1}$) for cyclones forming in SEBrazil in CFSR, ERA5 and ERAI, for the period 1979-2018.

Results

Main features of cyclogenesis in Andes



Seasonal relative frequency (%) of total traveled distance (km), lifetime (days) and minimum relative vorticity ($\times 10^{-5} \text{ s}^{-1}$) for cyclones forming in Andes in CFSR, ERA5 and ERAI, for the period 1979-2018.

Discussion

The differences between the three reanalyses are very small. However, we highlight the SEBrazil and Argentina regions, where CFSR present, respectively, higher and lower frequency of cyclogenesis.

The next step of this study is to find out if there are significant differences in the cyclones structures between these reanalyses. This is important to interpret future climate projections of cyclones.

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