Objective Categorization of SALLJ Events by a Principal Components Analysis of Synoptic-Scale Conditions

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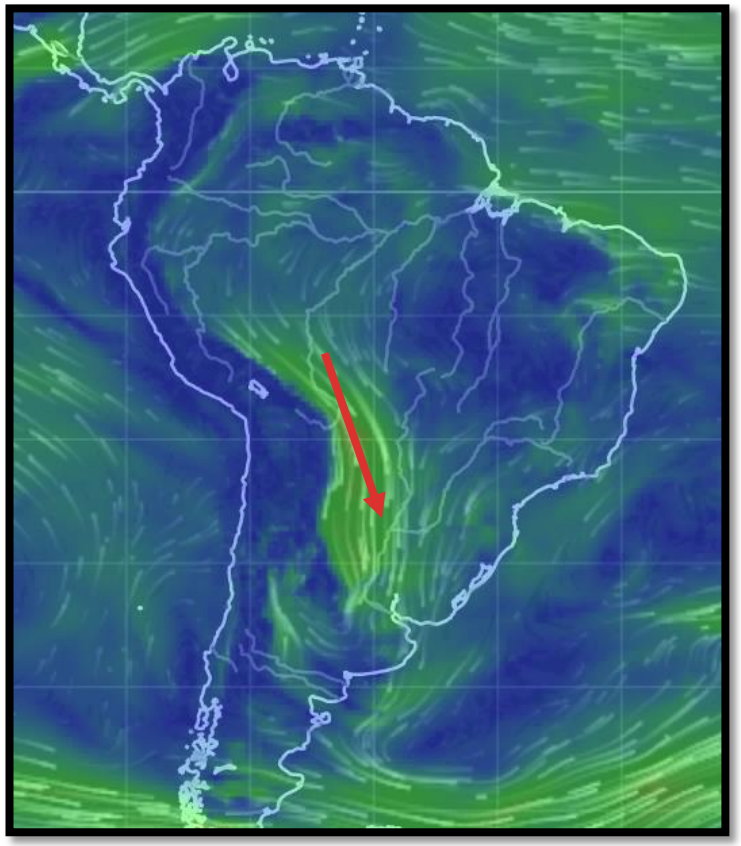
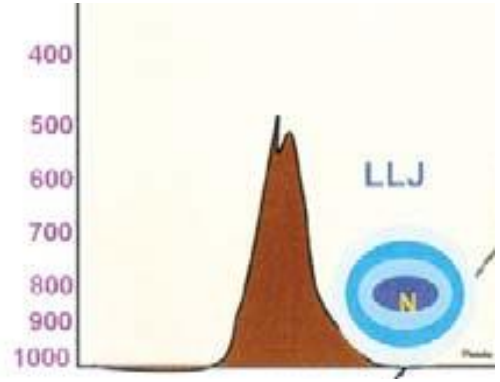
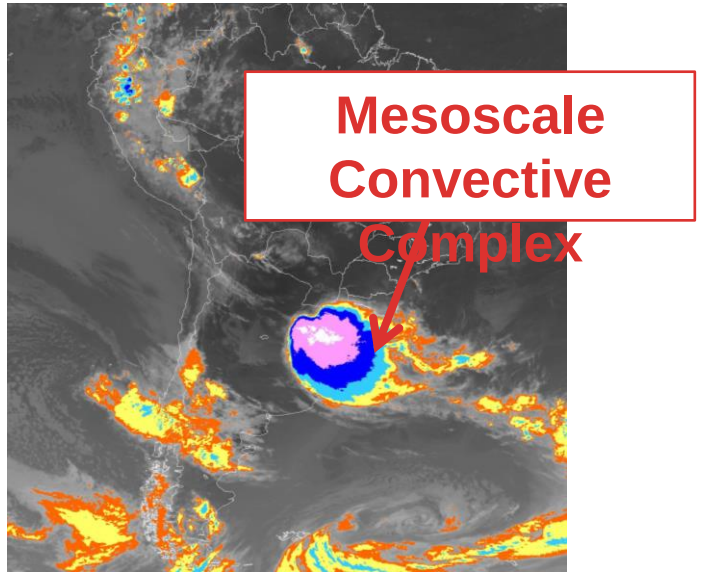
The South America Low-Level Jet (SALLJ)



- Low-level wind maximum
- Core at 850-hPa
- Moisture transport
- Influences regional precipitation regimes





Montini et al. (2019) developed **new criteria to identify SALLJ events** based on

Bonner criteria

- ☑ **Wind speed** at 850-hPa ≥ 12 m s^{-1}
- ☑ **Vertical wind shear** between 850 hPa and 700 hPa ≥ 6 m s^{-1}
- ☑ Meridional component larger than the zonal component
- ☑ Meridional winds from the north

Fixed wind speed thresholds

Seasonal percentile thresholds of wind speed

New criteria

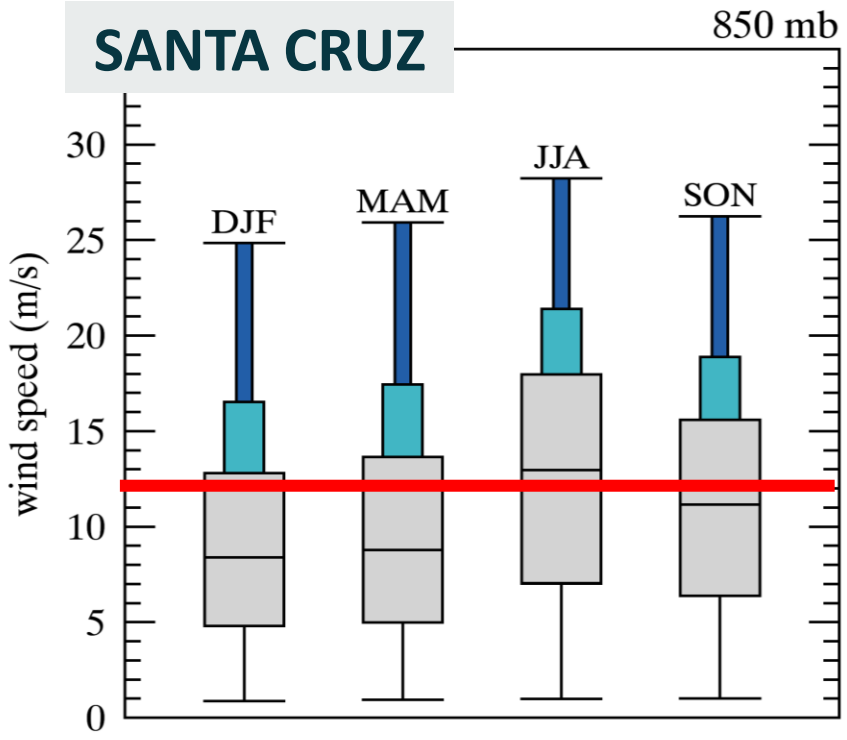
- ☑ **Wind speed** ≥ 75th percentile for the given season (850 hPa)
- ☑ **Vertical wind shear** ≥ 75th percentile for the given season (850–700 hPa)
- ☑ Northerly wind direction between 292.5° and 45° (850 hPa)

New criteria accounts for variations in wind speed related to the:

- Annual cycle
- Geography
- Dataset

*Montini, T. L., C. Jones, and L. M. V. Carvalho, 2019: The South America Low-level Jet: new climatology, variability and changes. Journal of Geophysical Research – Atmospheres

SANTA CRUZ



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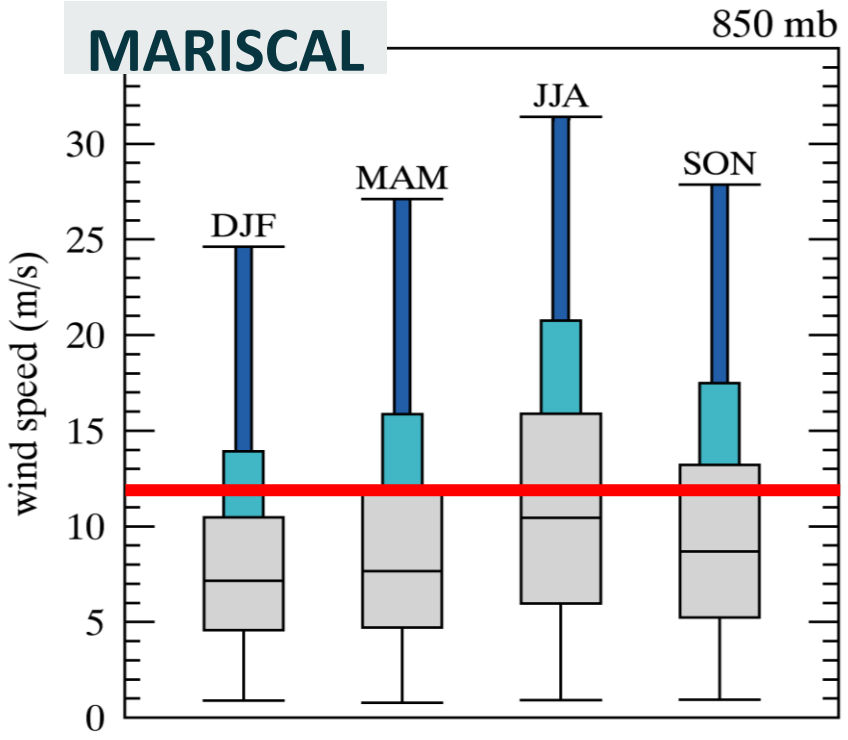
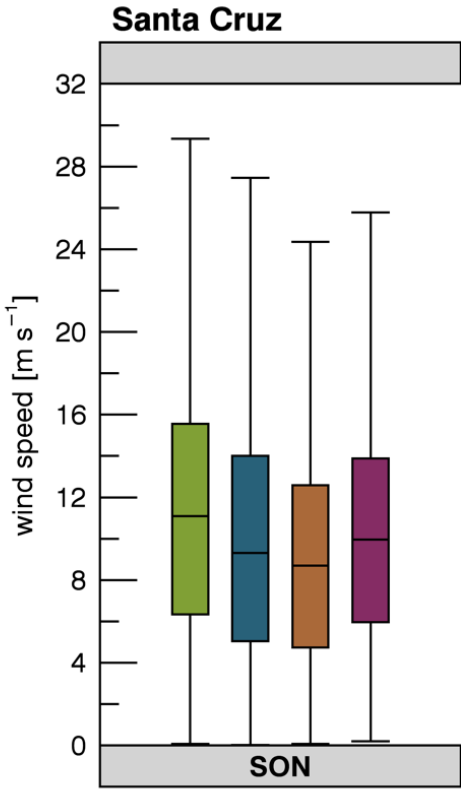
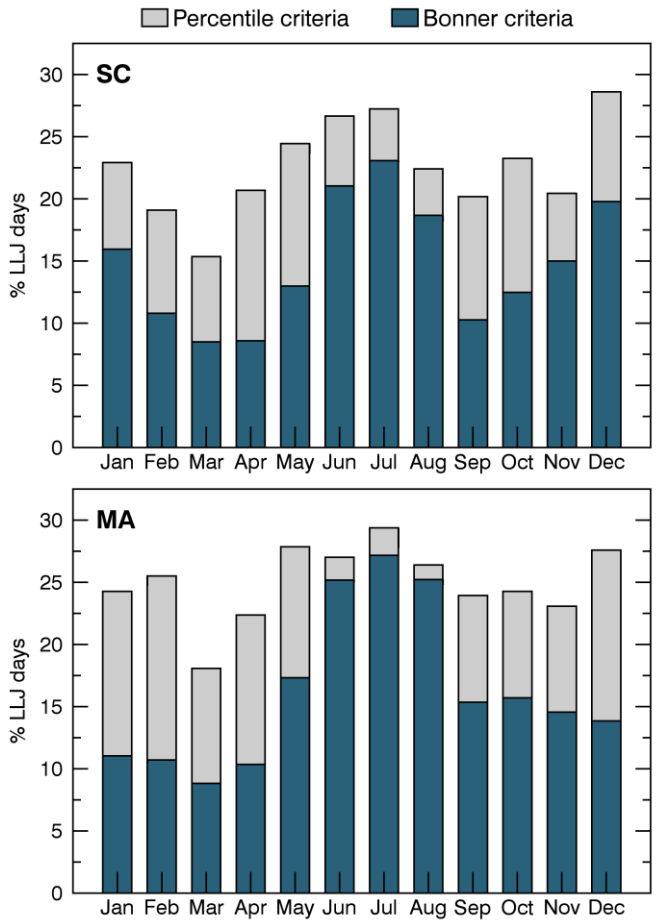
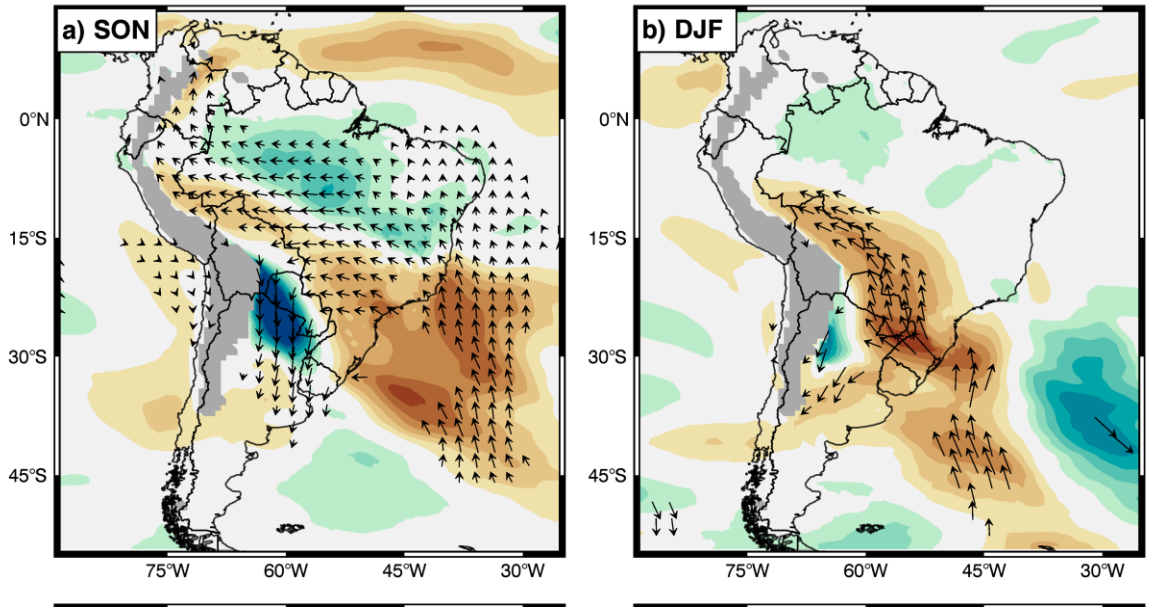




Advantages of Percentile Based Criteria

Fixed Bonner thresholds underestimated the number of the SALLJ events in all seasons

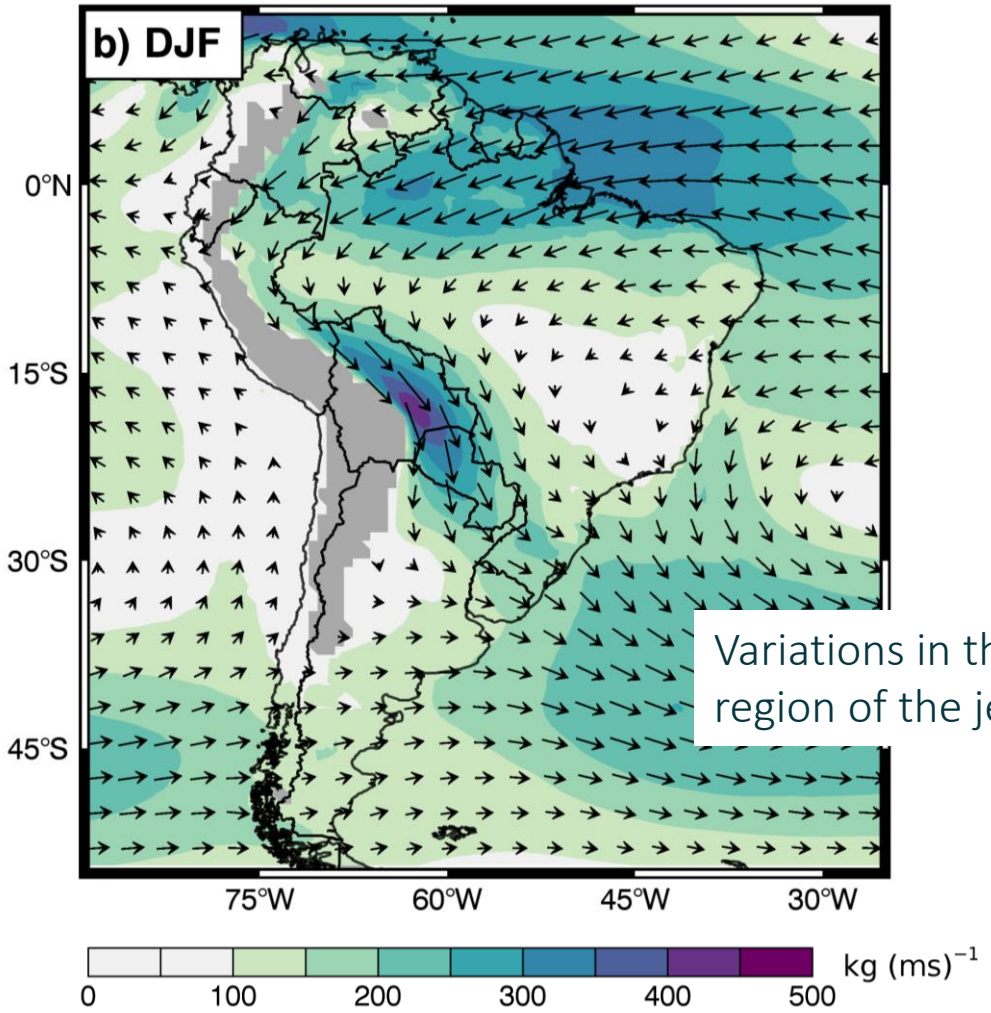




Bonner thresholds excluded moderate jet events (DJF) and strong northerly jet events close to the Andes (SON)

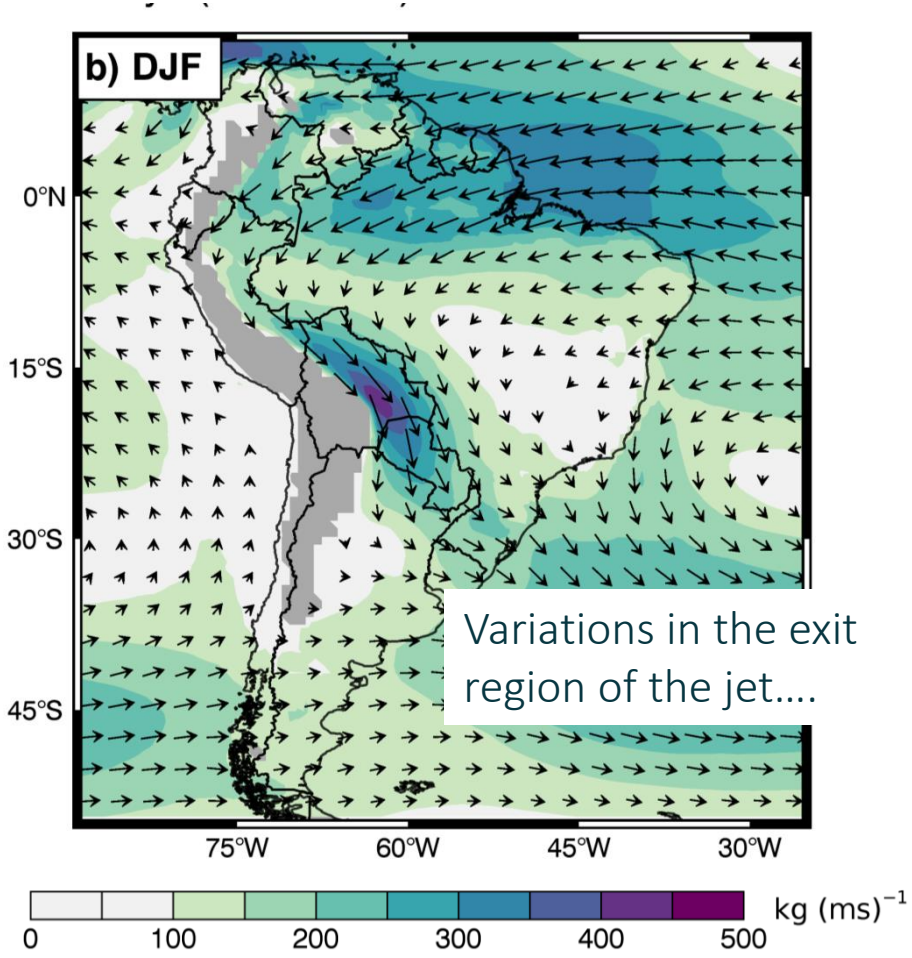
New criteria was applied to ERA-Interim reanalysis to analyze the climatology, interannual variability, and decadal trends in the SALLJ…

Integrated Vapor Transport (IVT) composite
of DJF low-level jet days (1979-2016)



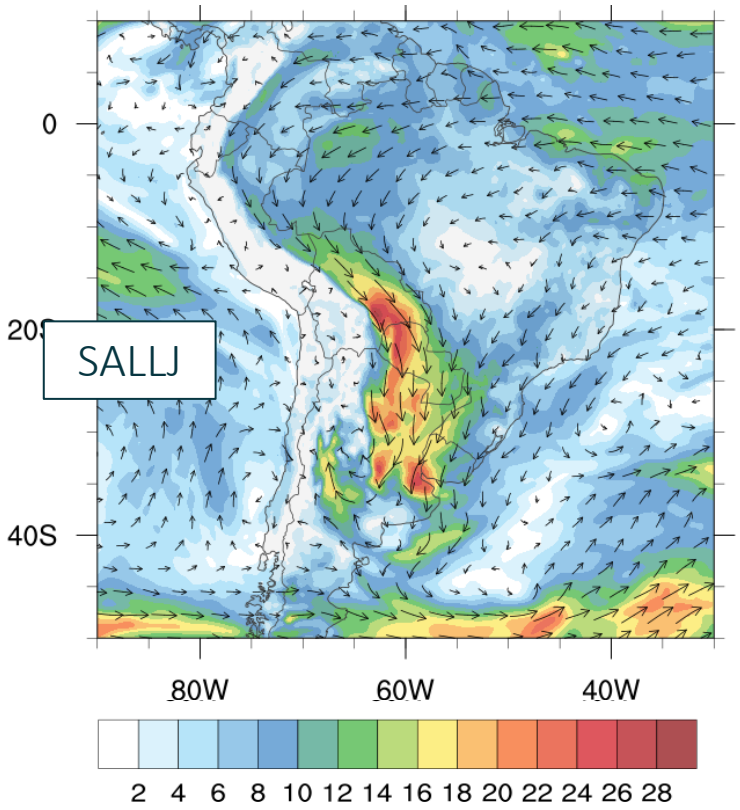
Variations in the exit region of the jet

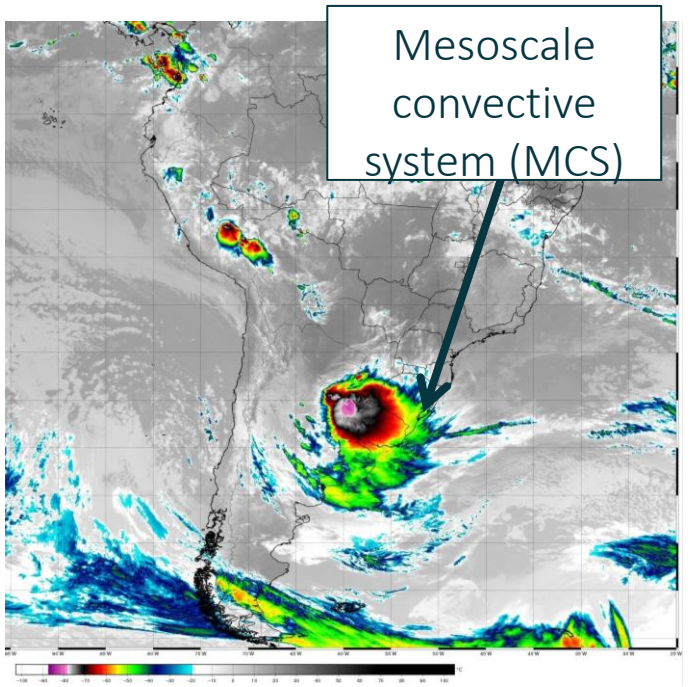
Composite of DJF low-level jet days



Variations in the exit region of the jet….

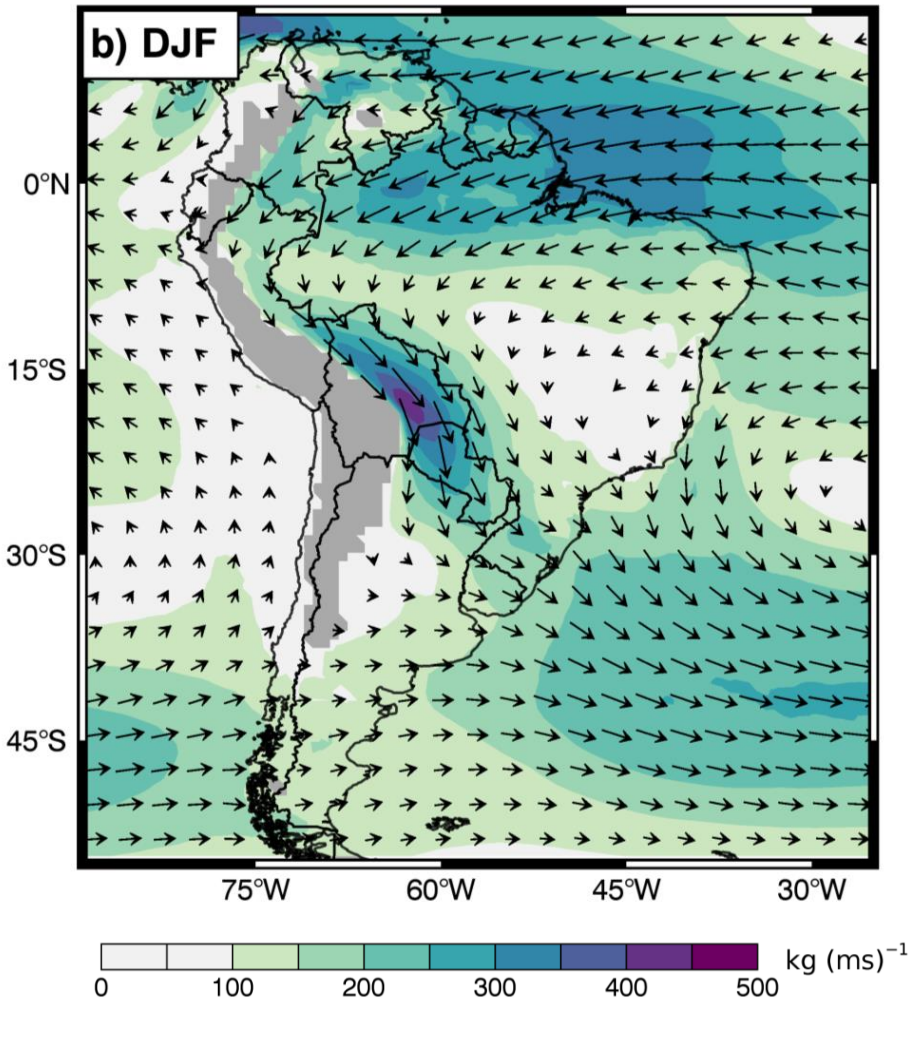
Example of a “northerly” jet event



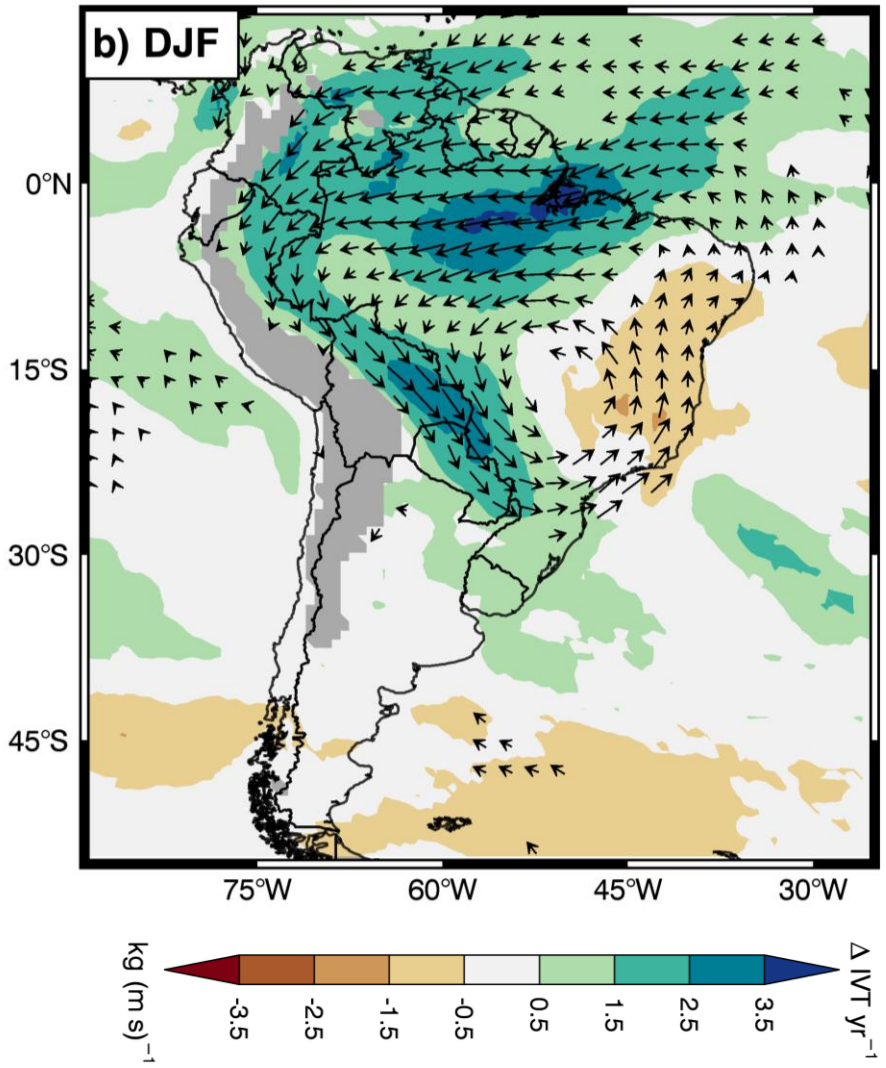


12 Nov 2018

Composite of DJF low-level jet days



Trends (change in average IVT/year) during DJF low-level jet days



Greens = + IVT
Browns = - IVT

Results suggest an increase northwesterly SALLJ events with exit region over southern Brazil

Hypothesis: **Trends in IVT during DJF SALLJ days suggest an increase northwesterly SALLJ events with exit region over southern Brazil**

- *Are northwesterly SALLJ events becoming stronger or more frequent?*
- *How do changes in the spatiotemporal variability of the SALLJ affect regional precipitation regimes?*

Objectives:

1. Objective categorization of SALLJ days into different synoptic types
2. Characterization of the large-scale atmospheric patterns associated with each SALLJ regime
3. Analyze the development and intensity of precipitation
4. Investigate trends in the strength and frequency of the different SALLJ regimes and the interannual variability of SALLJ regimes related to ENSO

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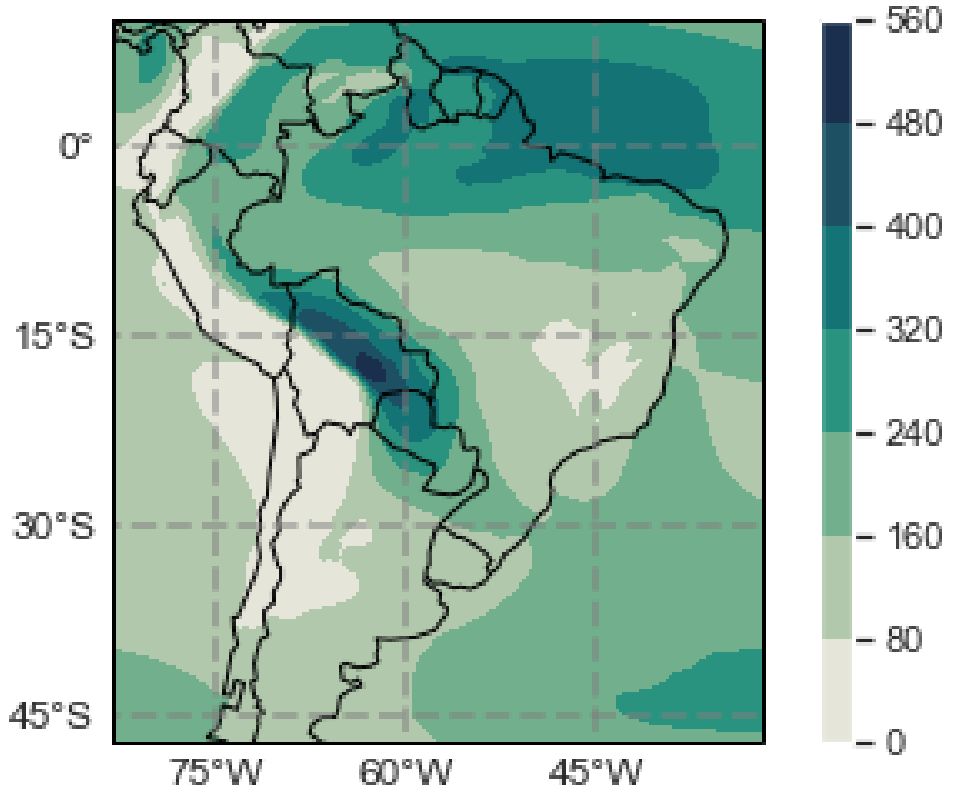
Methods

Datasets

- SALLJ days identified by Montini et al. (2019)
- ERA5 Reanalysis

Principal Components Analysis in T-mode

- **Times:** SALLJ days
  DJF (1979-2016)
  SC or MA
  n times = 1184
- **Grid:** 10°N, -83° W, -47°S, -32° E
  0.5° deg lon/lat
  n lat = 115; *n* lon = 103
- **Variables**: Vertically integrated vapor transport (IVT)
  ERA5 reanalysis
  u and v components
  n var = 2
- **Standardized data matrix:**
  [ntimes x nlon*nlat*nvar] = [1184 x 23690]

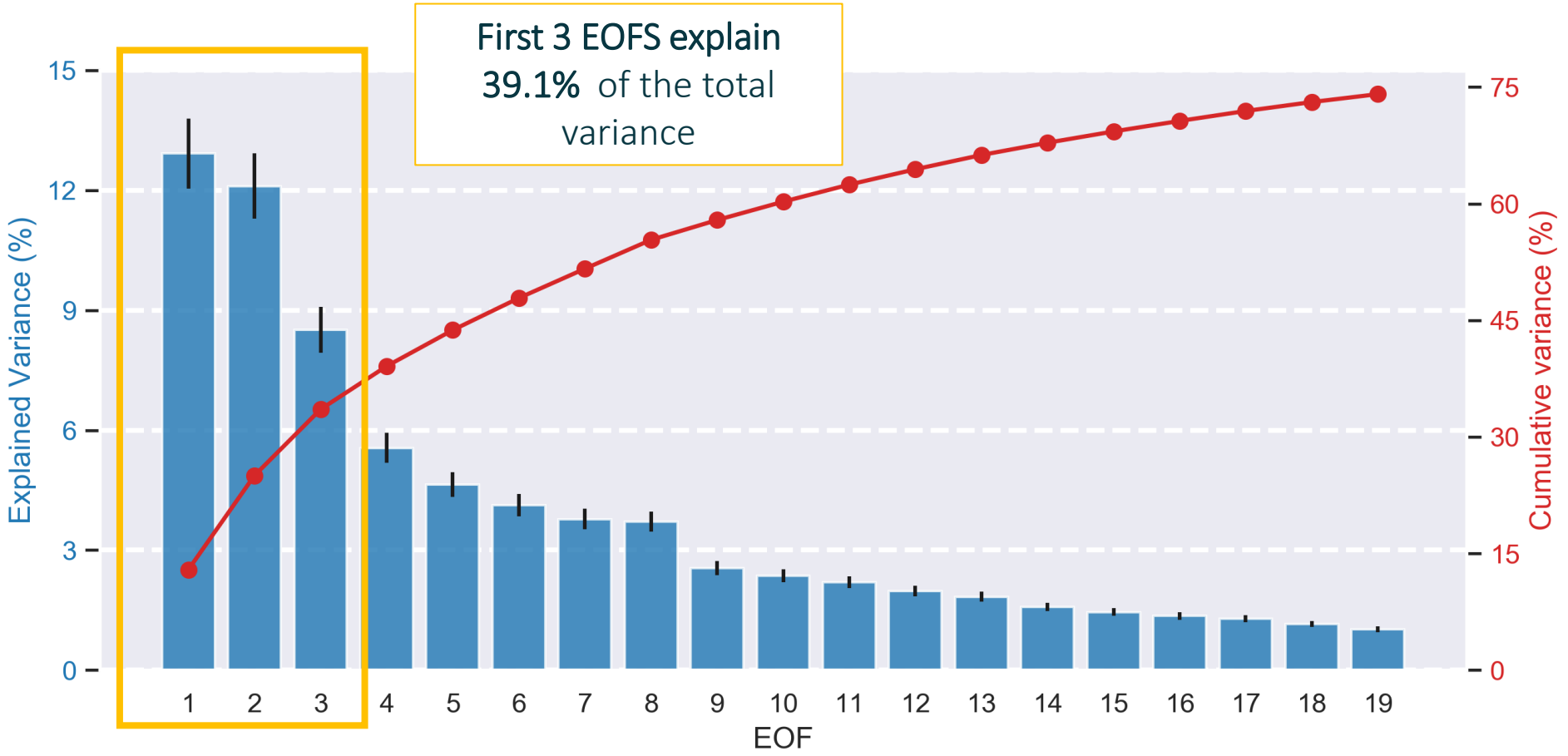


K-means clustering analysis

Loadings from PCA

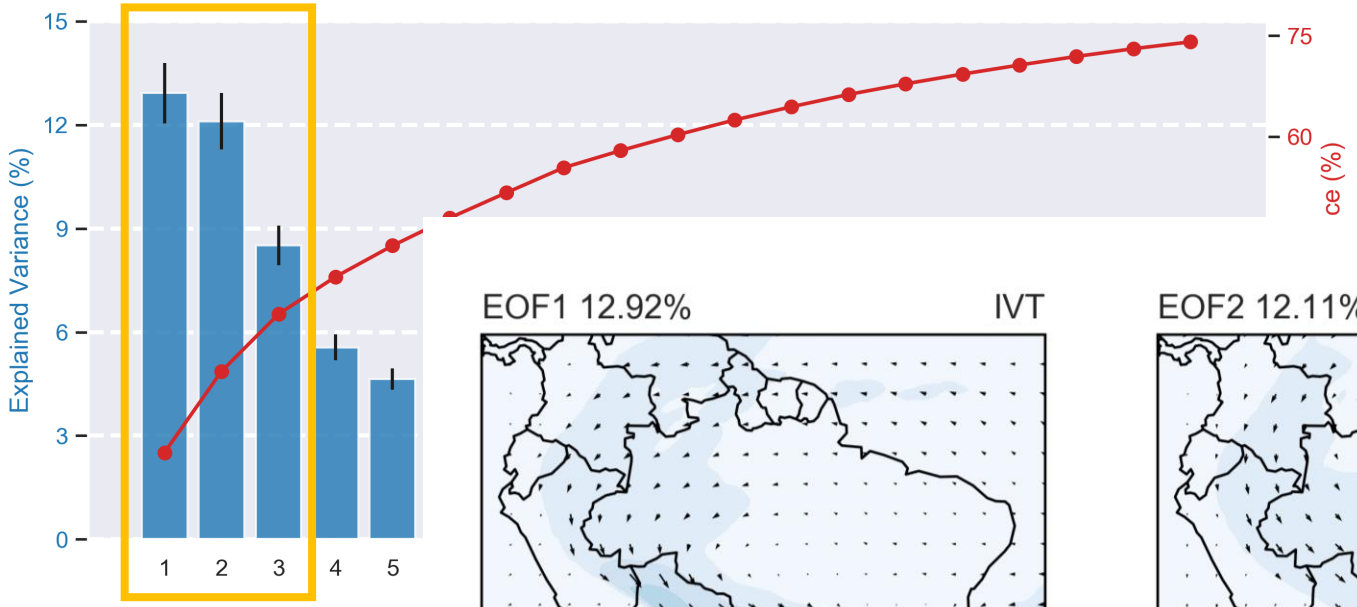
Groups SALLJ events with similar IVT patterns

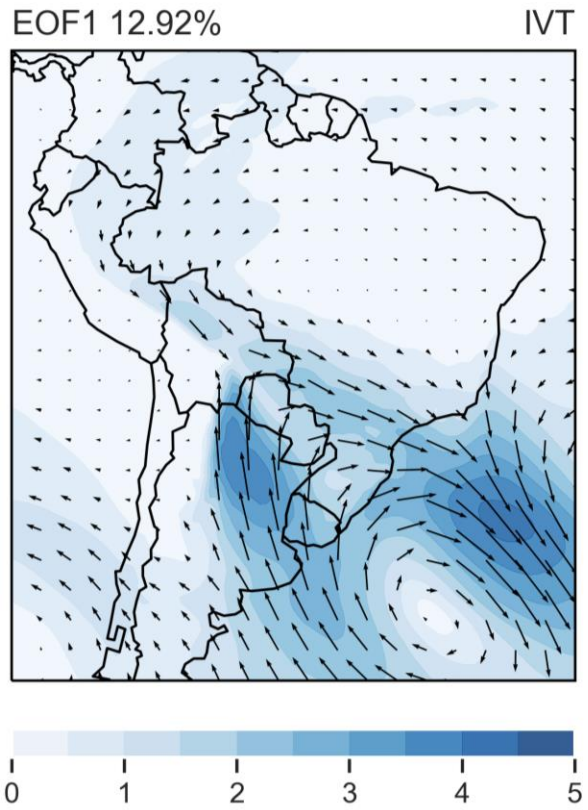
EOF results

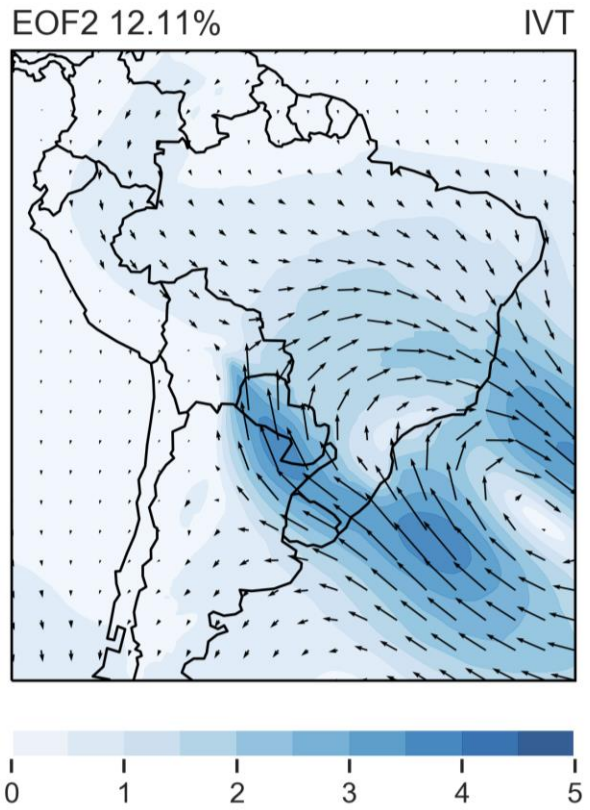


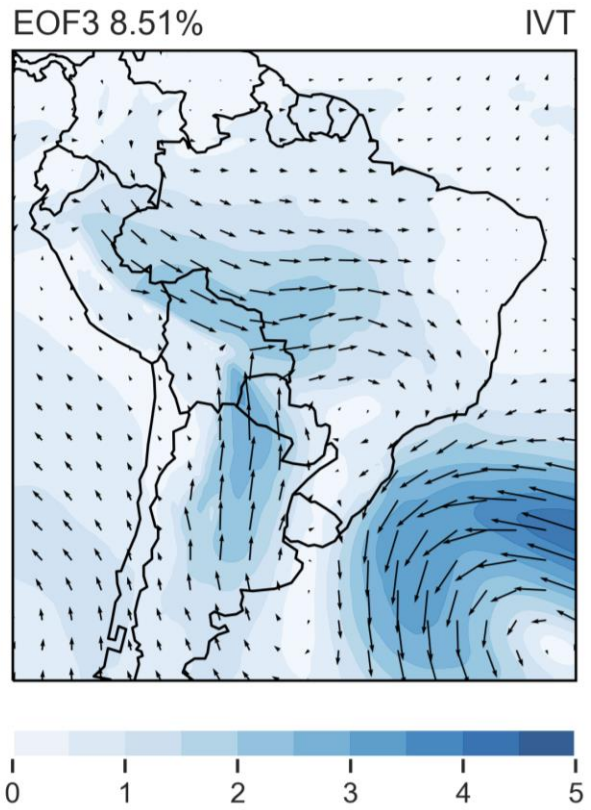
EOF1, EOF2, and EOF3 explain **12.9%, 12.1%, and 8.5%** of the total explained variance respectively

EOF results

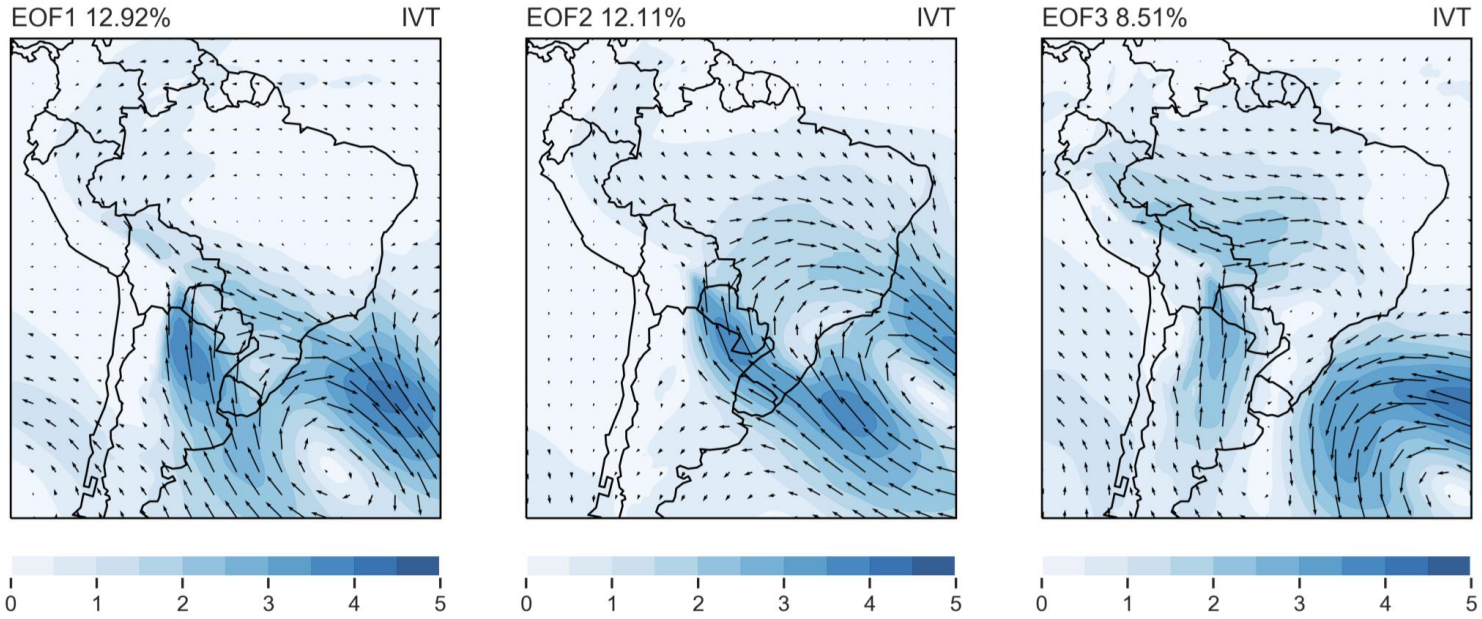

Explained Variance (%)
15
12
9
6
3
0
1
2
3
4
5
75
60
ce (%)

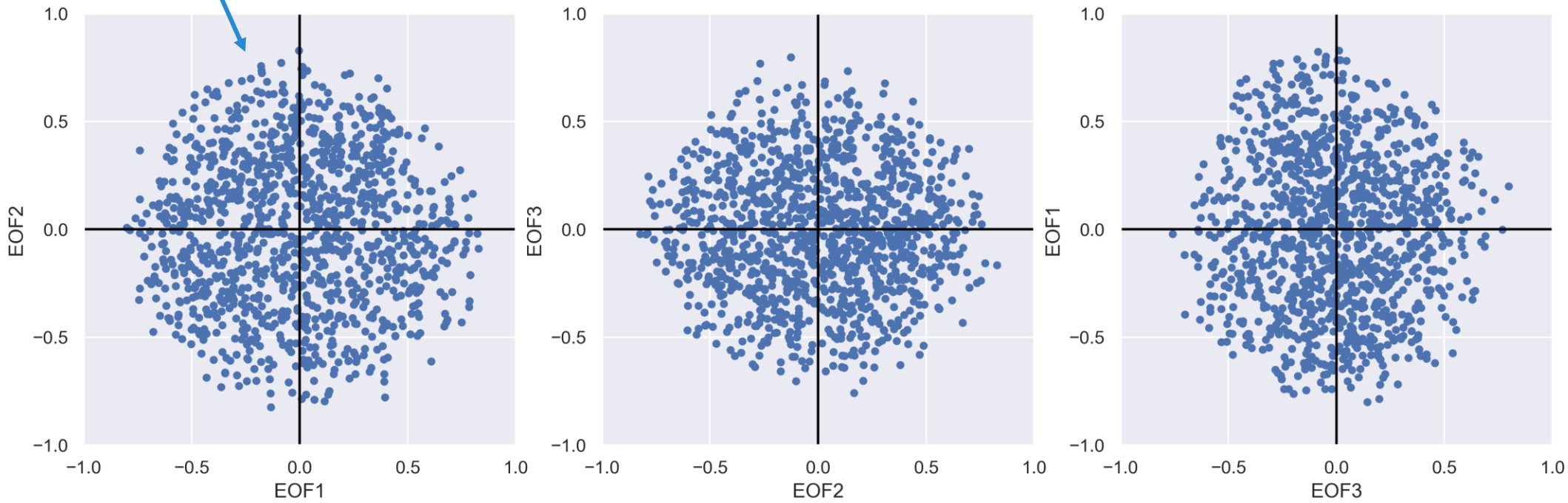

EOF1 12.92%
IVT
0
1
2
3
4
5


EOF2 12.11%
IVT
0
1
2
3
4
5


EOF3 8.51%
IVT
0
1
2
3
4
5

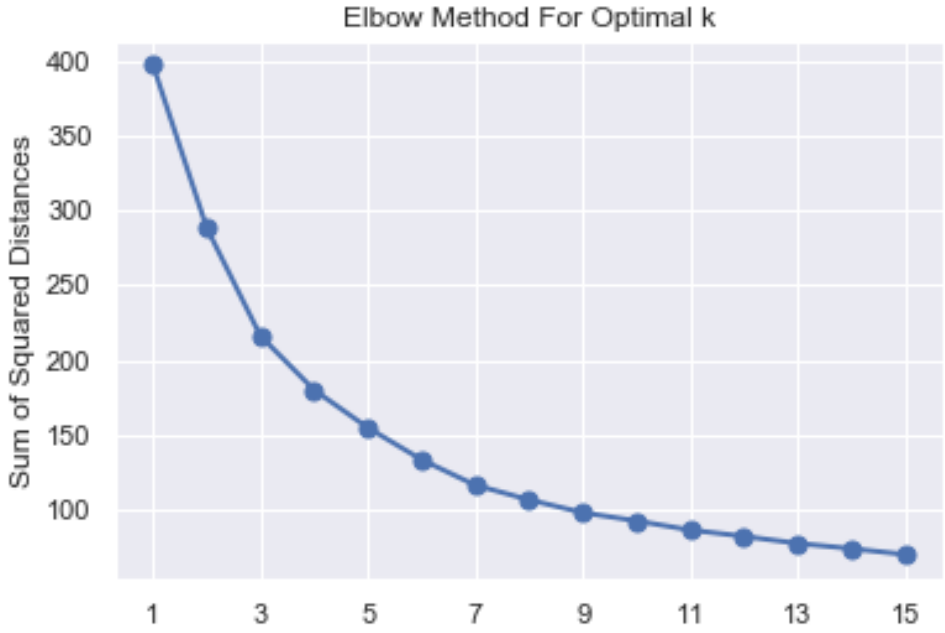
Loadings

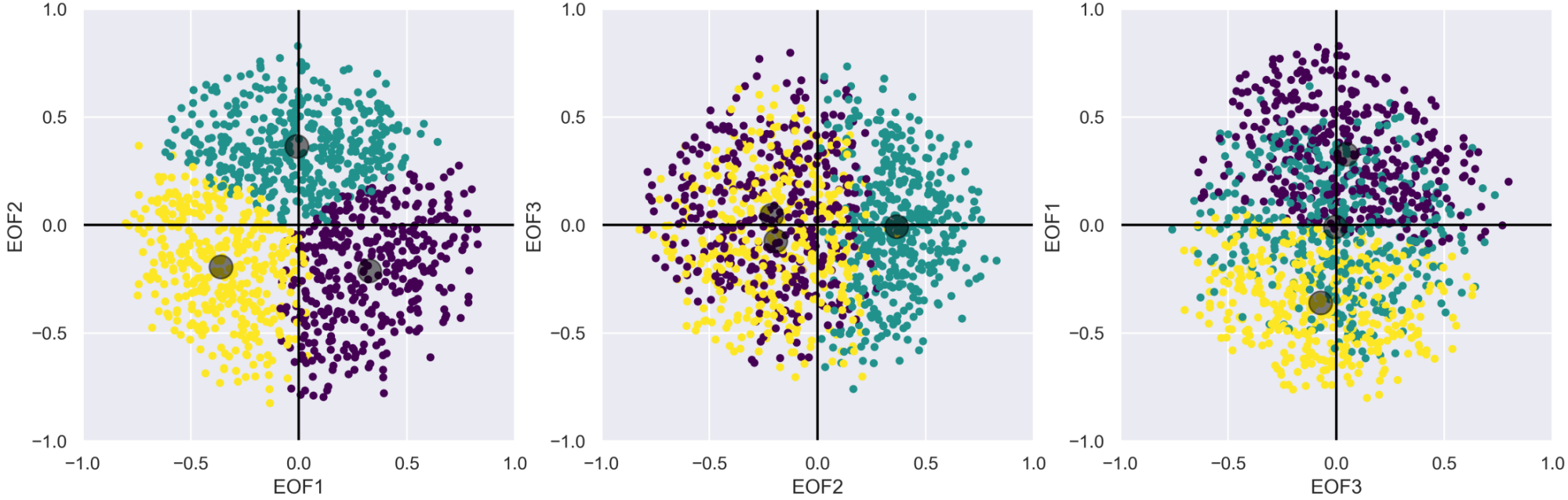

EOF1 12.92%
IVT
EOF2 12.11%
IVT
EOF3 8.51%
IVT
0
1
2
3
4
5


1.0
0.5
0.0
−0.5
−1.0
EOF2
EOF1
EOF3
EOF2
EOF1
EOF3

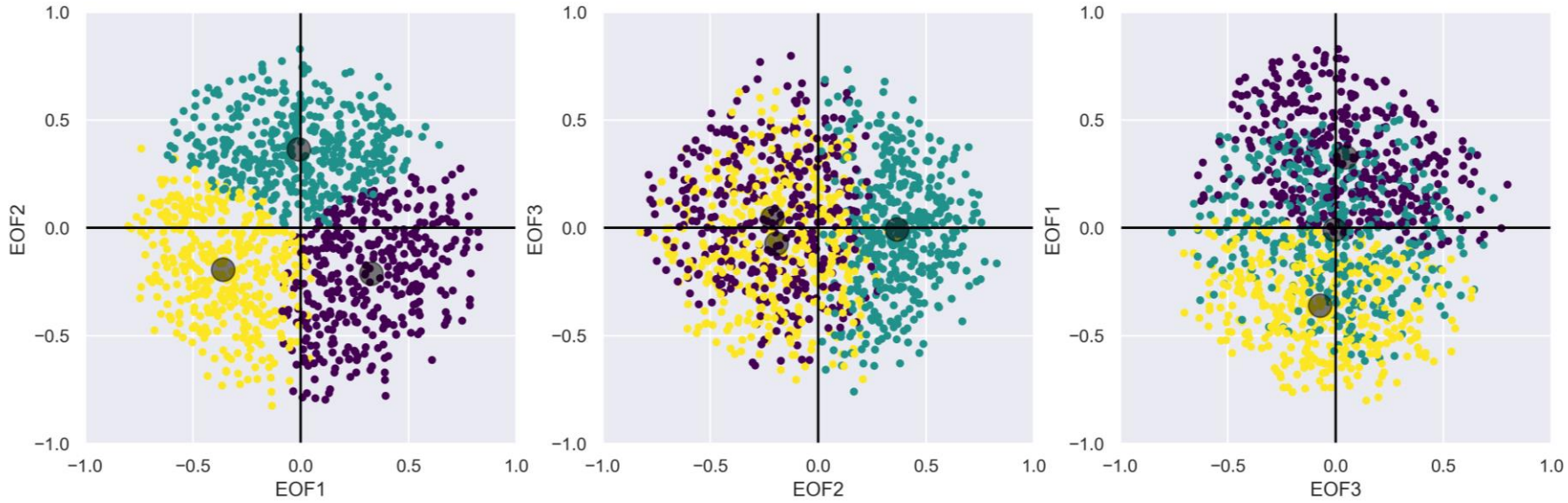
K-means clustering

LLJ Type 1 : 383
LLJ Type 2 : 424
LLJ Type 3 : 377

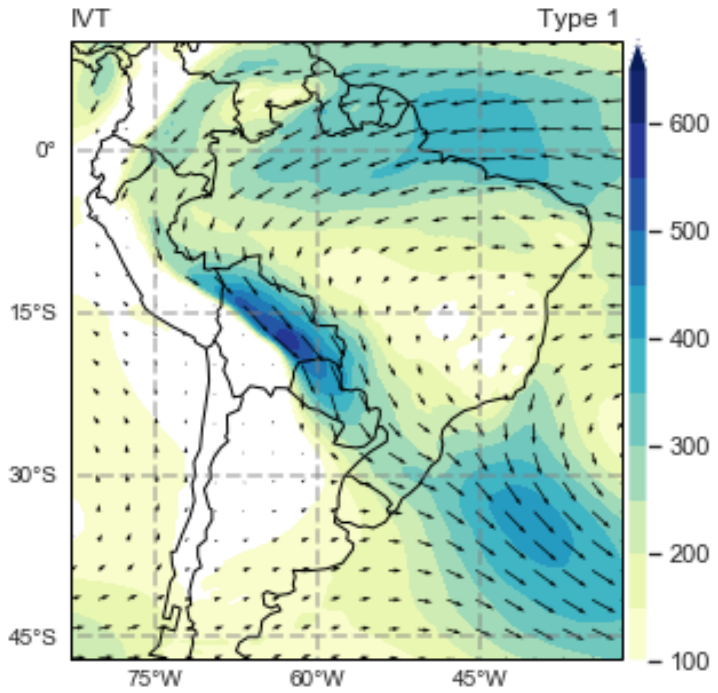


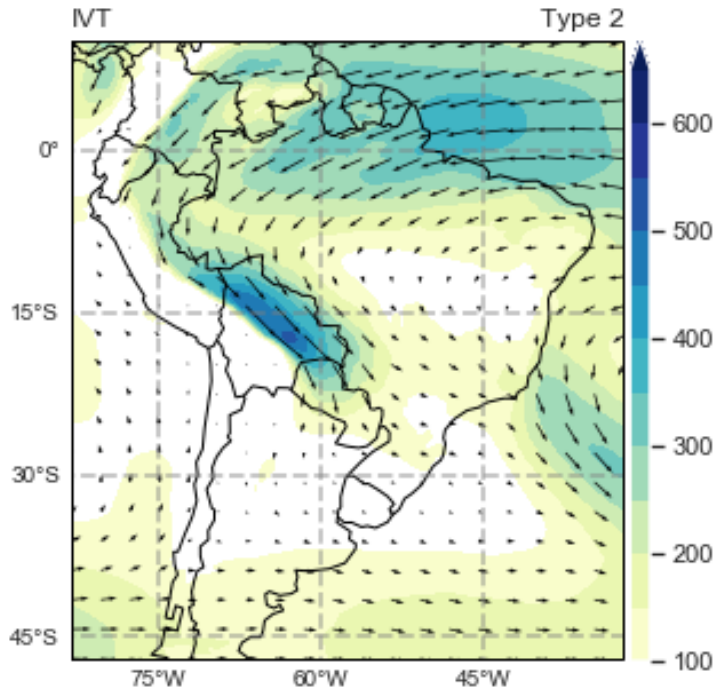


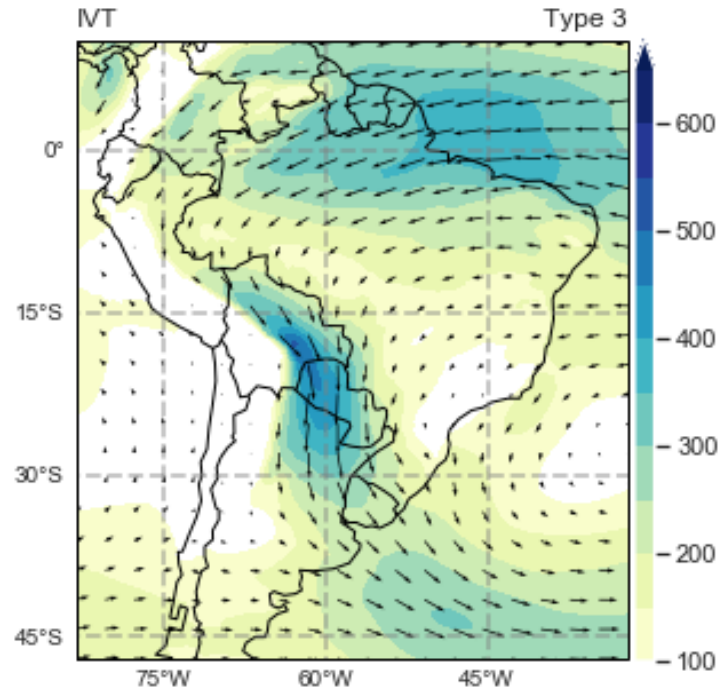
Cluster-based composites of SALLJ days



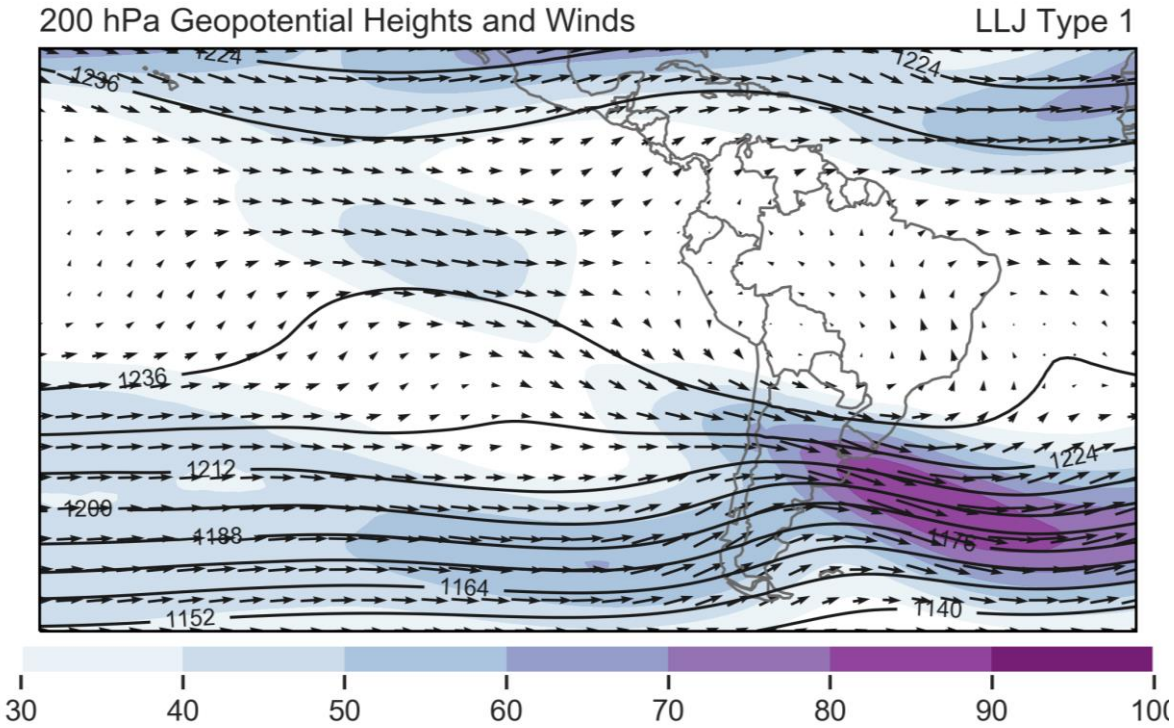
IVT composites



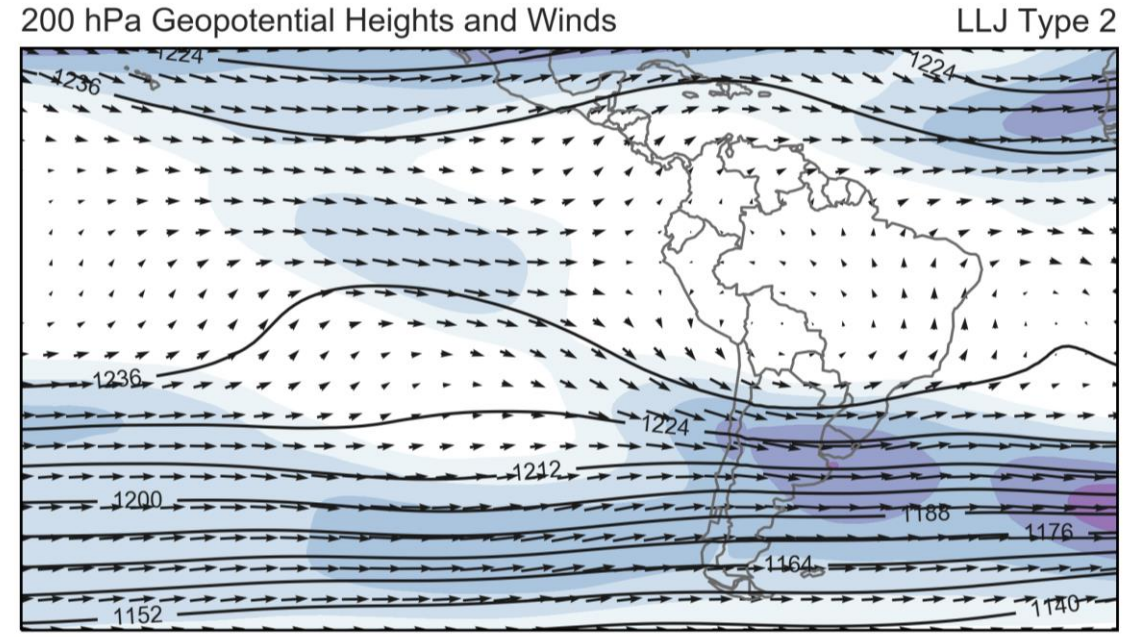


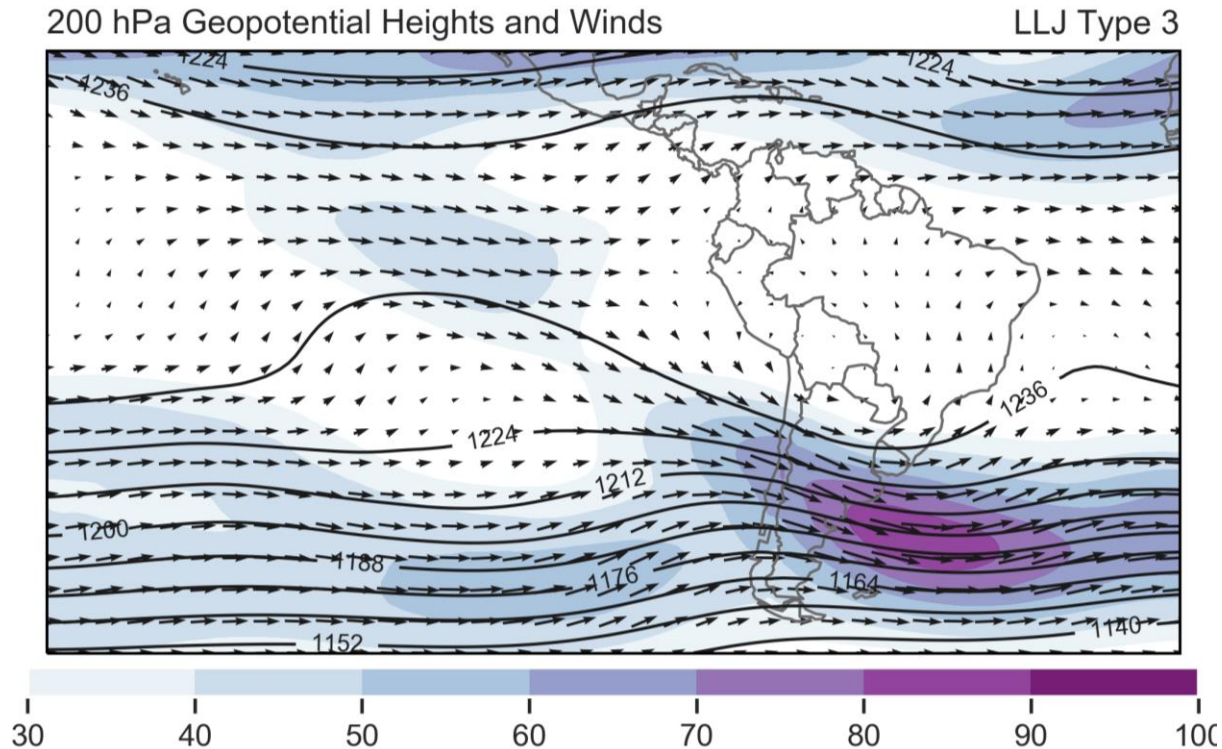


200 hPa Heights, Wind Speed, and Wind Vectors

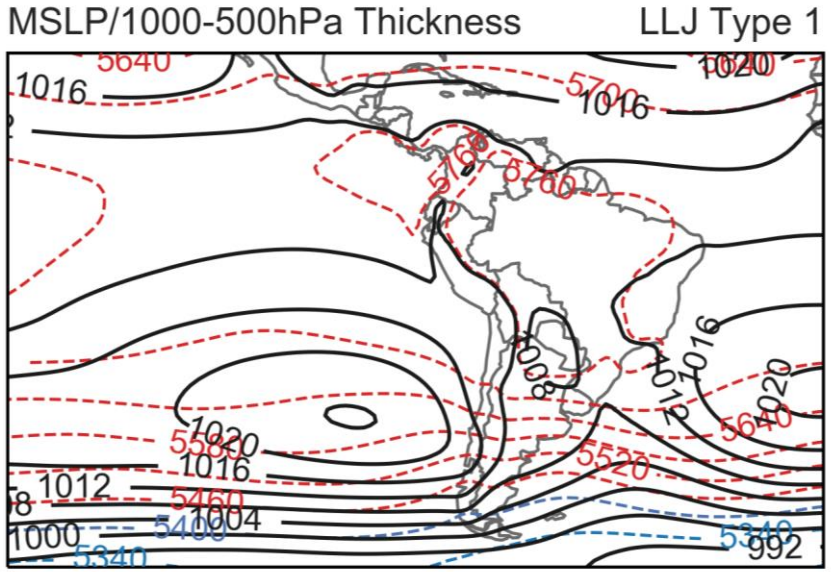


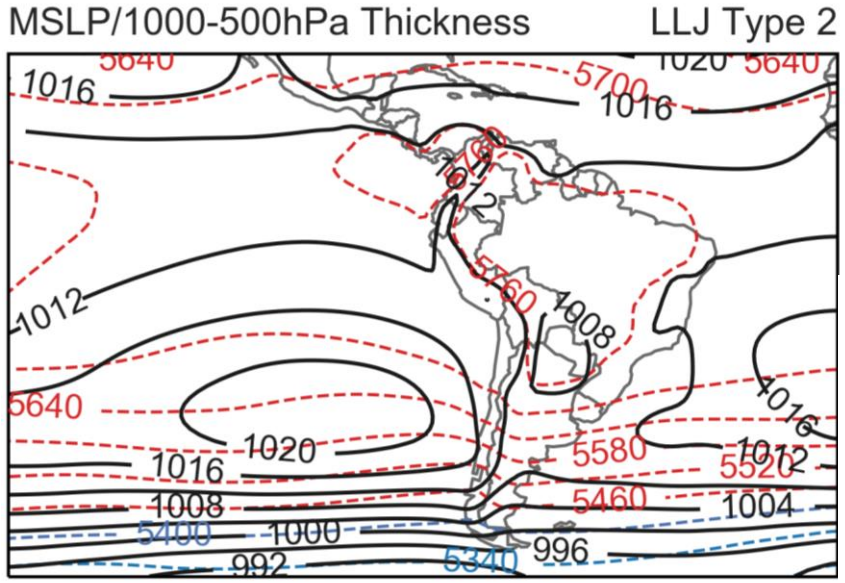
Dynamic coupling of SALLJ with
left entrance of **upper-level jet streak**

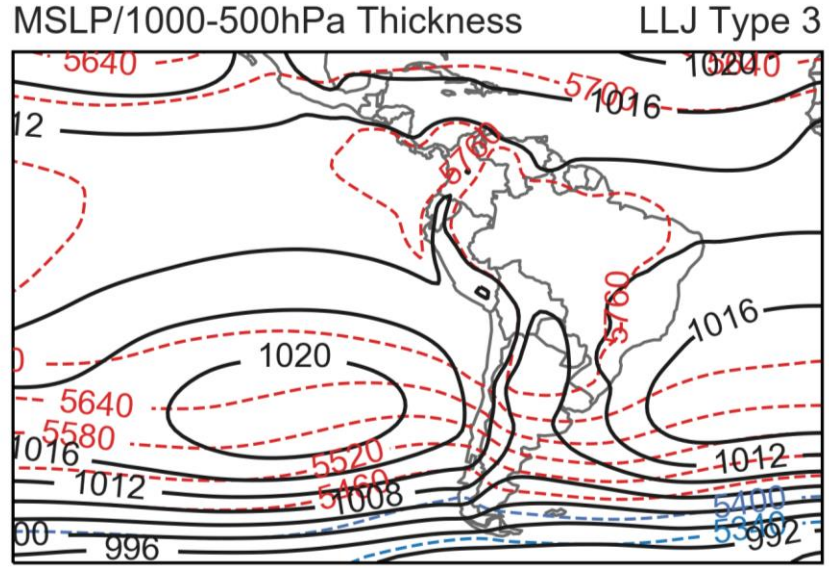




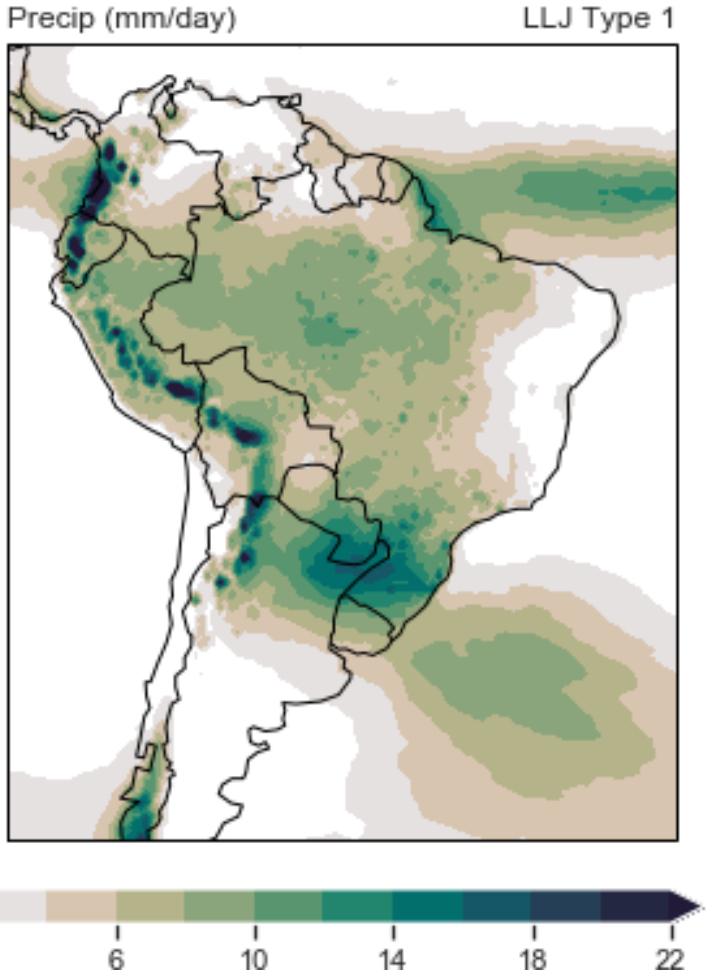
Mean SLP/1000-500 hPa Thickness

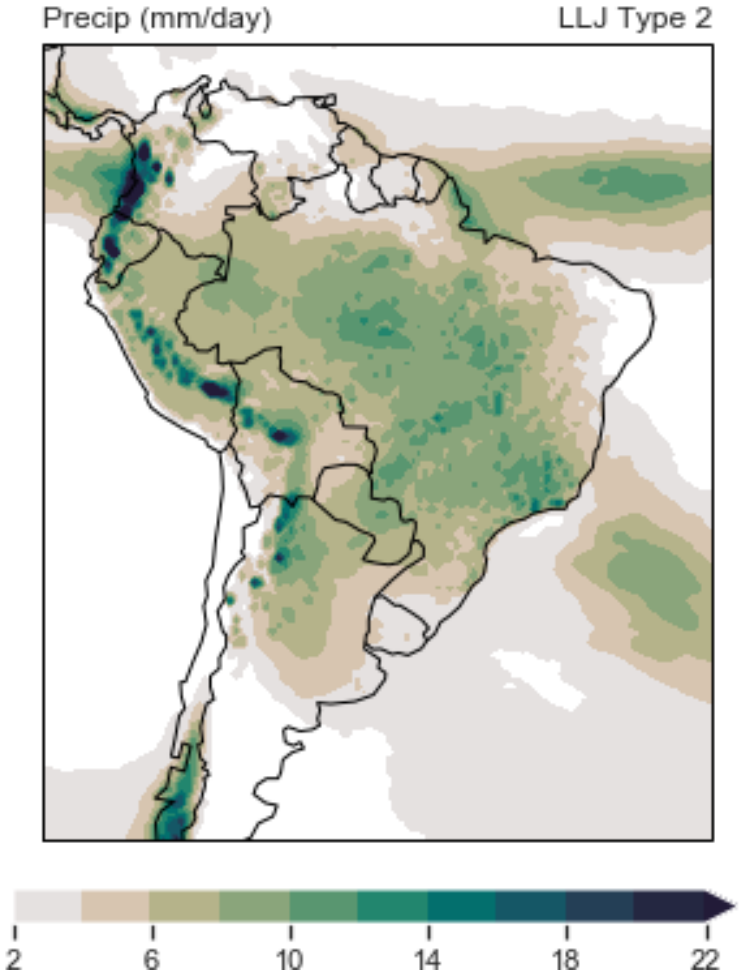


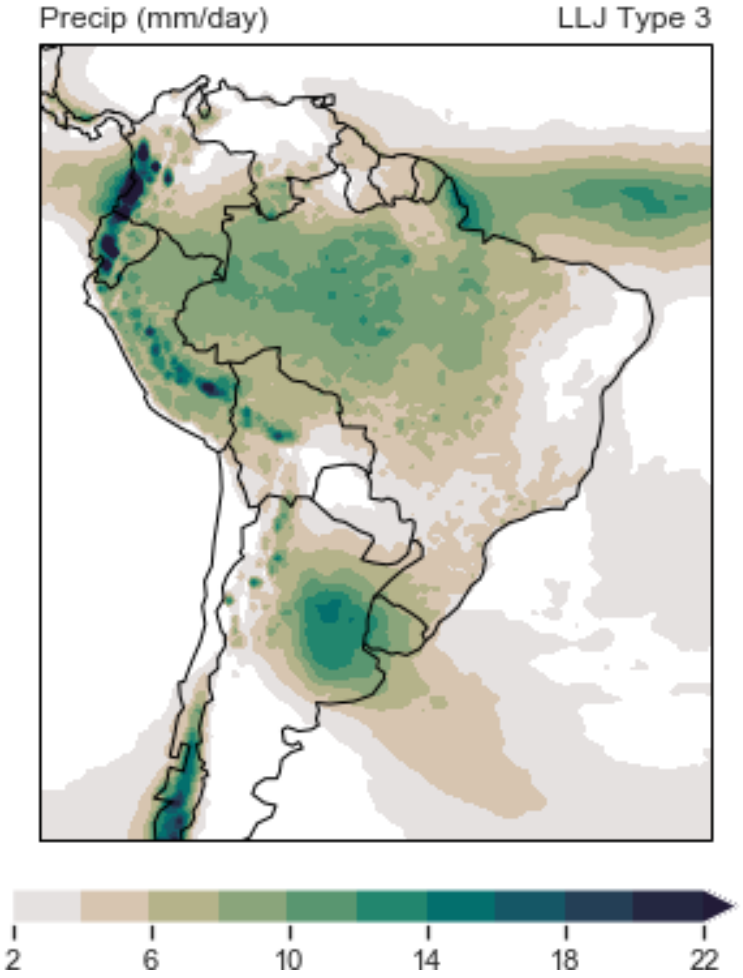




Precipitation (mm/day)







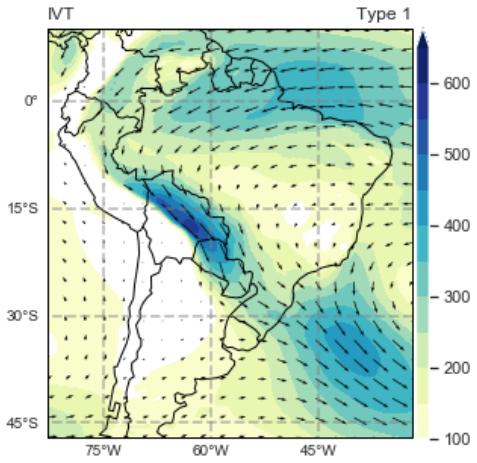
Summary

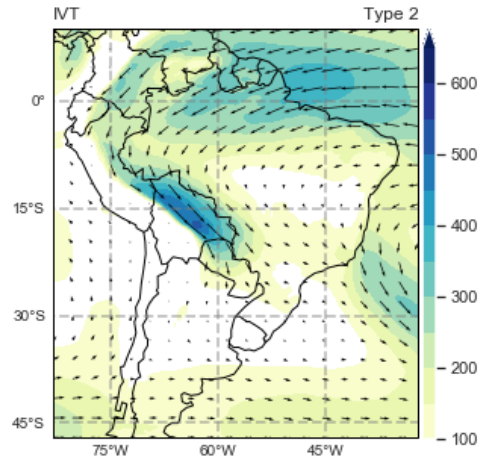
Type 1 and 2: northwesterly jet events

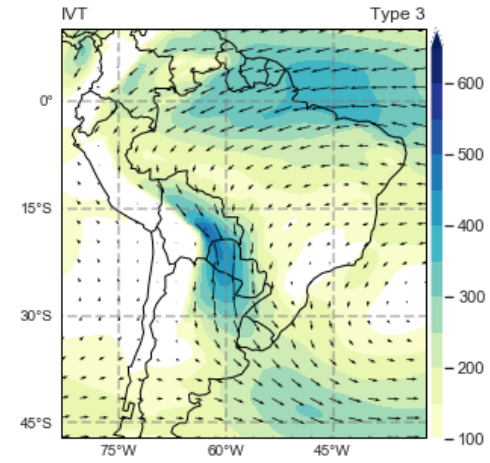
Precipitation over southern Brazil

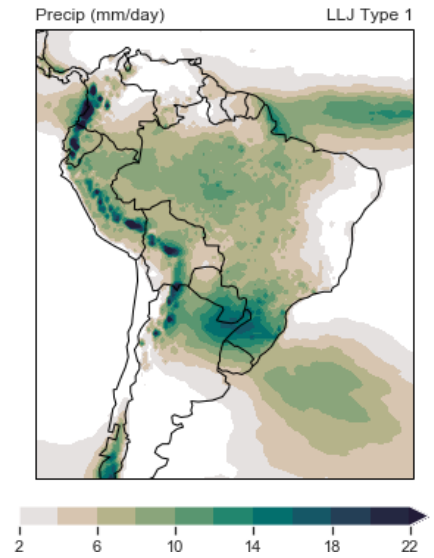
Type 3: northerly jet events

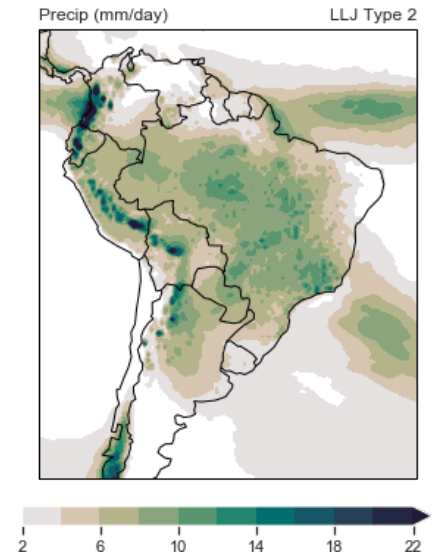
Precipitation over Northern Argentina

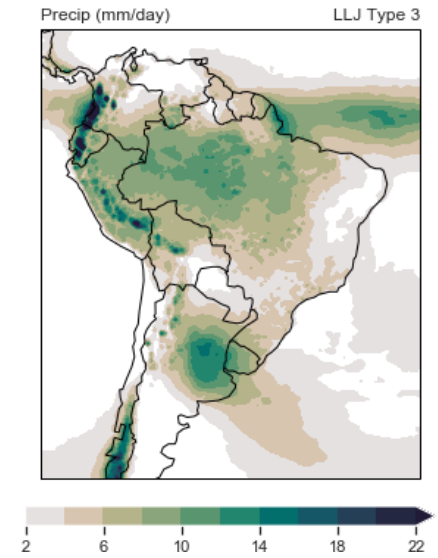












Next steps

- Rotated EOF
- Lead/lag composites of synoptic fields centered for each SALLJ regime (forecasting applications)
- Analyze trends and interannual variability of each SALLJ regime
- Investigate the sensitivity of convective development and precipitation to the strength and spatial variability of the SALLJ