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Synoptic climatology and large-scale circulation patterns over Mexico

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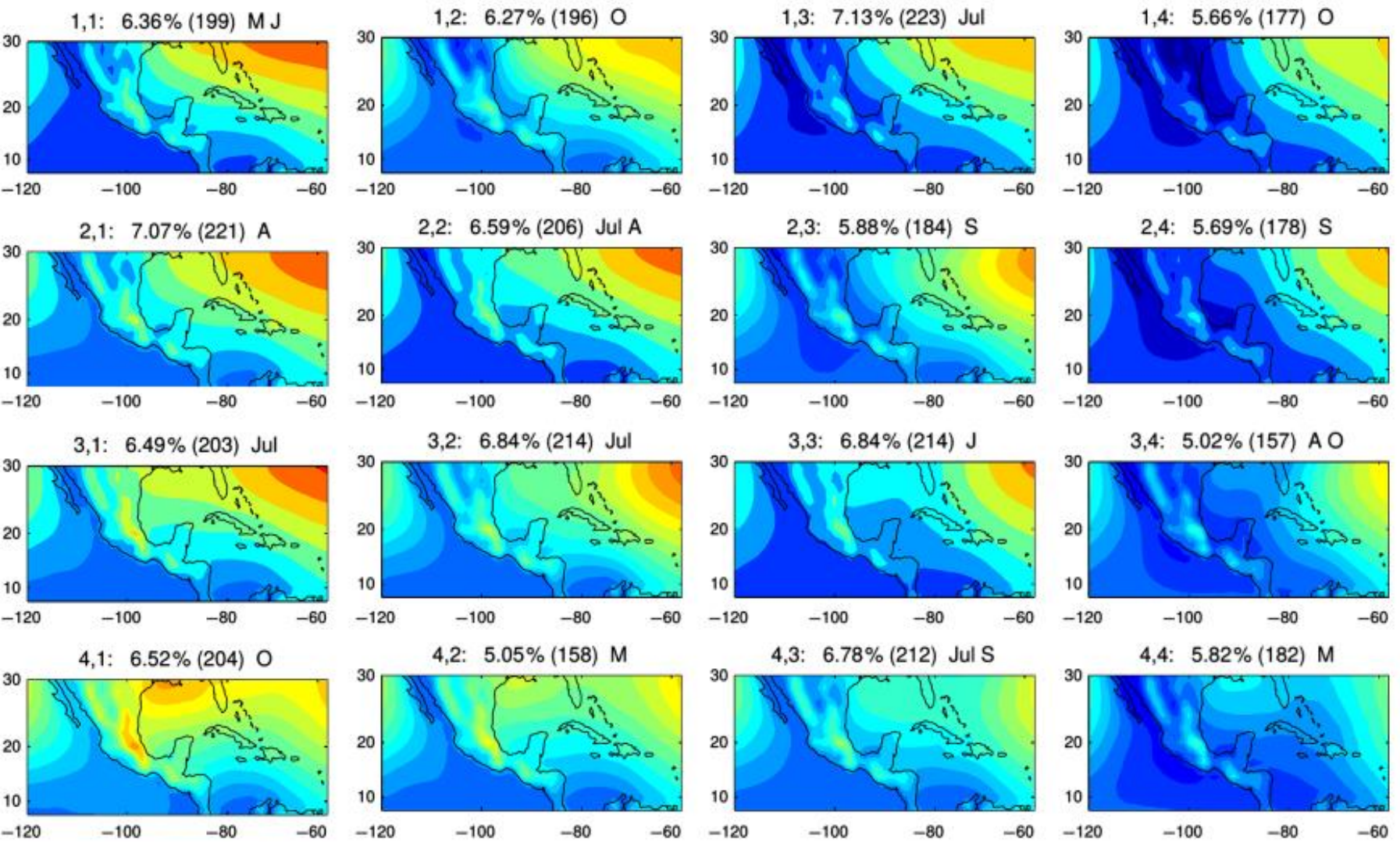
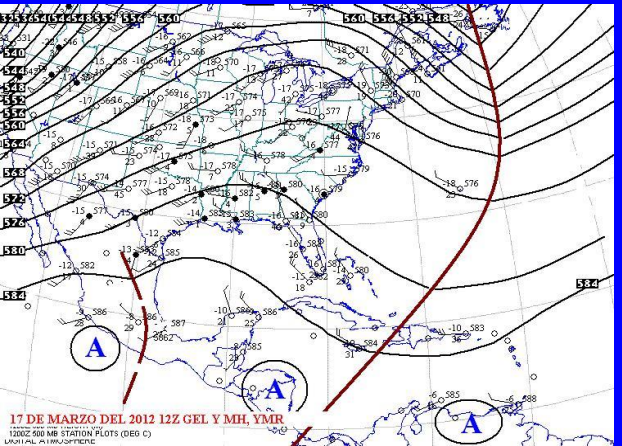
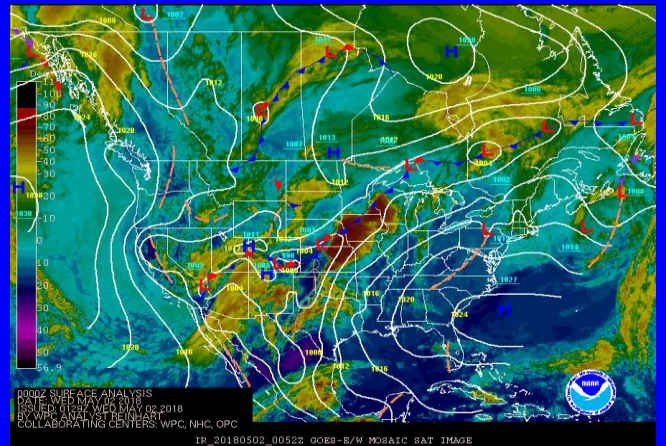
American Monsoons: progress and future plans
São Paulo, Brazil; August 20th, 2019

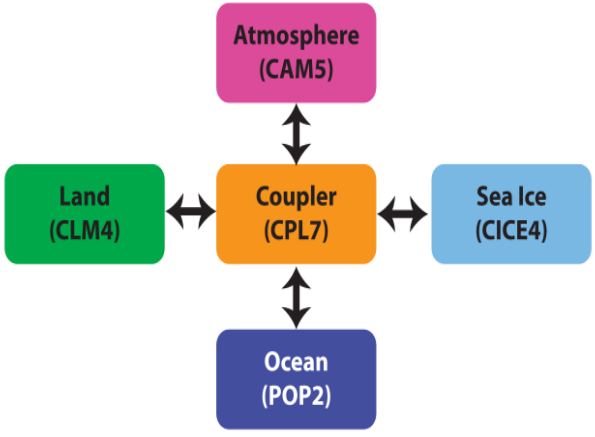

1,1: 6.36% (199) M J
1,2: 6.27% (196) O
1,3: 7.13% (223) Jul
1,4: 5.66% (177) O
2,1: 7.07% (221) A
2,2: 6.59% (206) Jul A
2,3: 5.88% (184) S
2,4: 5.69% (178) S
3,1: 6.49% (203) Jul
3,2: 6.84% (214) Jul
3,3: 6.84% (214) J
3,4: 5.02% (157) A O
4,1: 6.52% (204) O
4,2: 5.05% (158) M
4,3: 6.78% (212) Jul S
4,4: 5.82% (182) M
30
20
10
−120
−100
−80
−60
hPa
1020
1015
1010
1005

Materials

- Sea Level Pressure (SLP) and Temperature at 2m (T2M) were selected from ERA Interim (ERAI) reanalysis data ***(Dee et al., 2011)*** for 1980-2016.
- Weather surface charts and at 850, 700, 500 and 200 hPa charts were used from Forecast Center of Cuban Institute of Meteorology (INSMET) and Weather Prediction Center (WPC) of the National Weather Service (NWS) of USA. *Sources: INSMET for Fig.A; WPC, for Fig.B*
- Community Earth System Model - Large Ensemble (CESM-LE) outputs for the period 1980-2005 to recognize the synoptic patterns detected. *Source: Kay et al. (2015) for Fig.C*

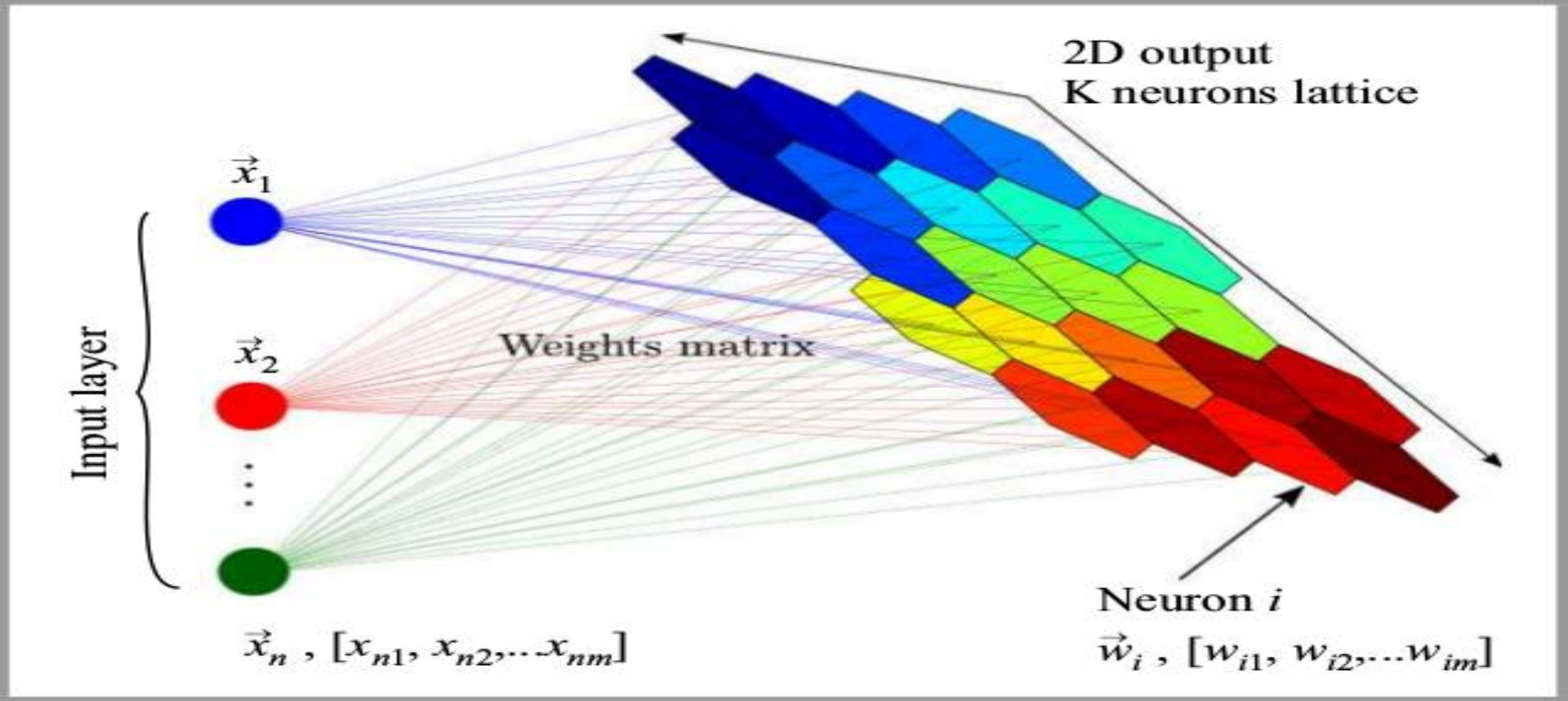






Self-Organizing Maps (SOM) *Kohonen(2001)*

Image Source: Jankowski & Amanowicz (2015)



Methodology

Matrix of standardized anomaly values calculated from climatological parameters (mean and standard deviation)

Detection of synoptic pattern using SOM method

Analysis of persistence and transition frequency among synoptic patterns.

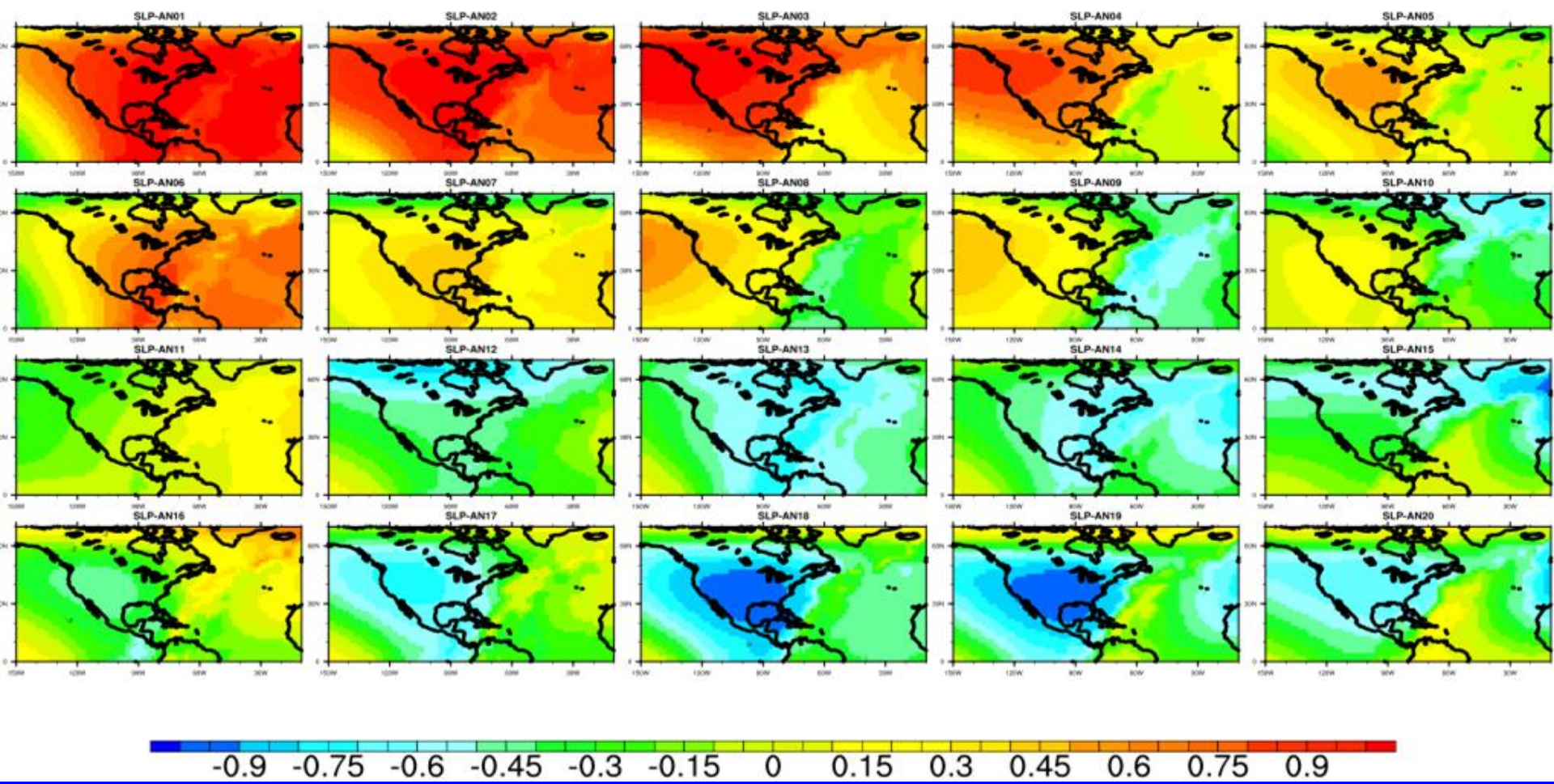
Occurrence frequency of synoptic patterns in periods, quarters and months.

Choosing cases that represent each synoptic pattern with a criteria of persistence greater than five days

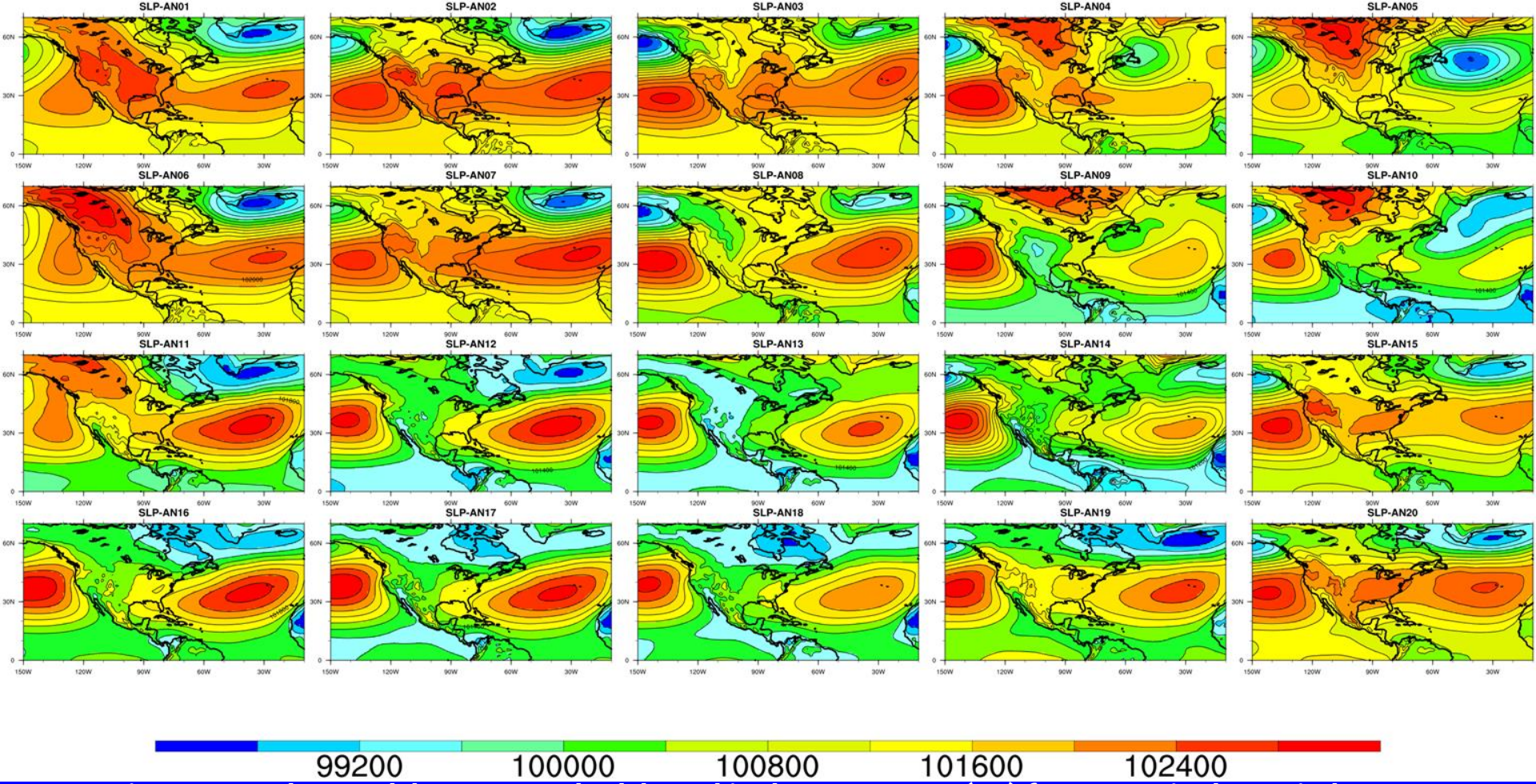
SLP average for days with same synoptic pattern detected in ERAI using data from CESM-LE

Weather analysis of synoptic patterns detected using surface and pressure-level maps

Proposal of synoptic climatology

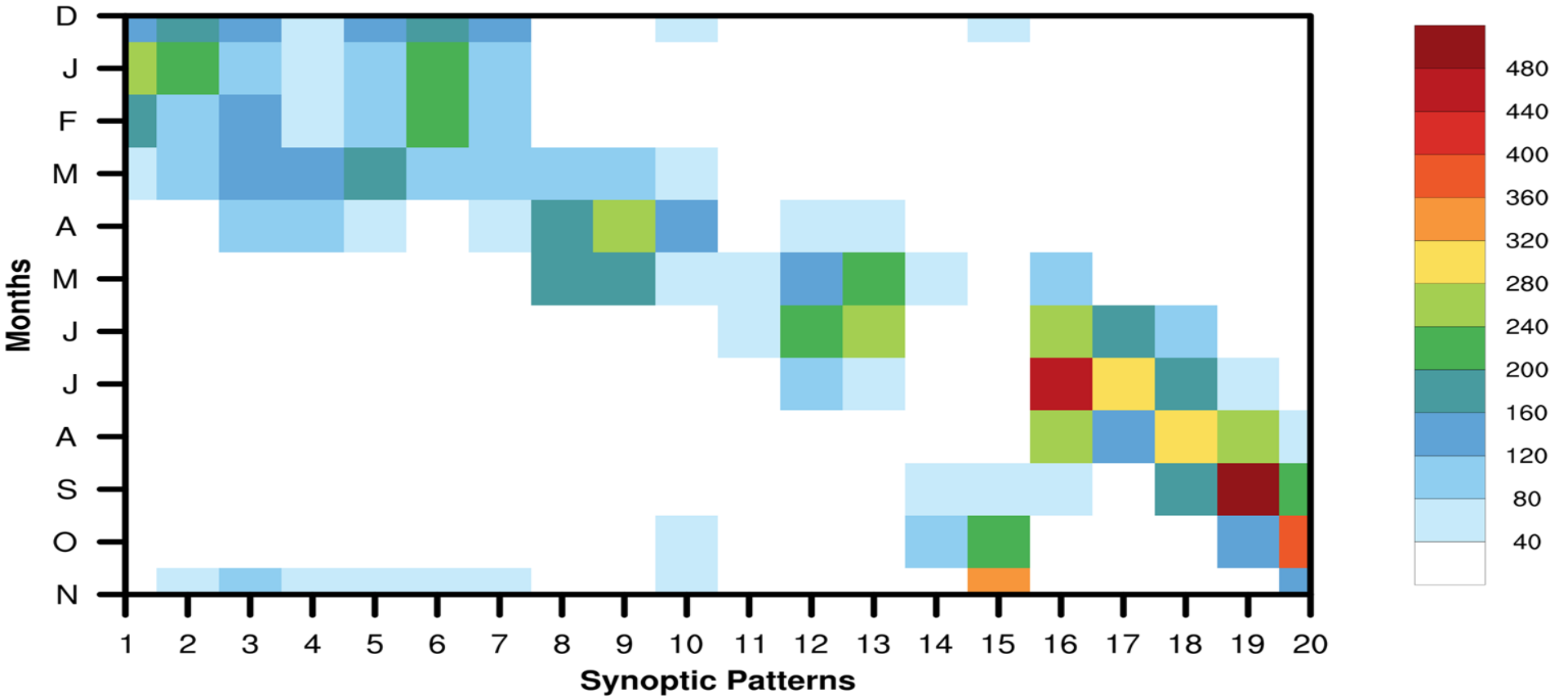


Synoptic patterns detected by SOM method, based in SLP standardized anomalies from ERAI in the period 1980-2016

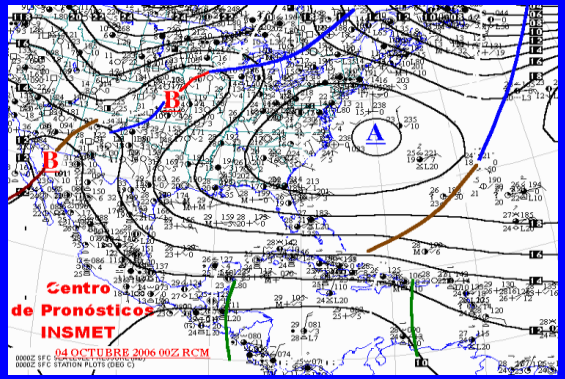


Synoptic patterns detected by SOM method, based in the mean SLP (Pa) from ERAI in the period 1980-2016

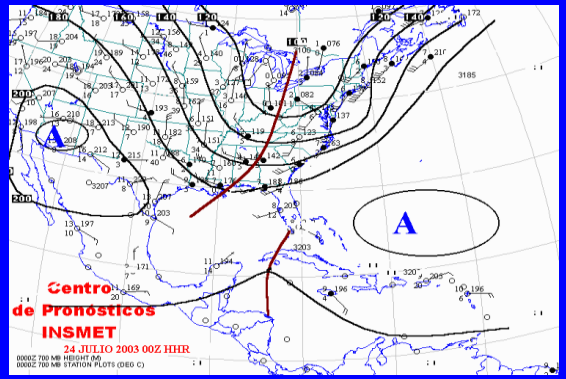
Frequency of occurrence of synoptic patterns



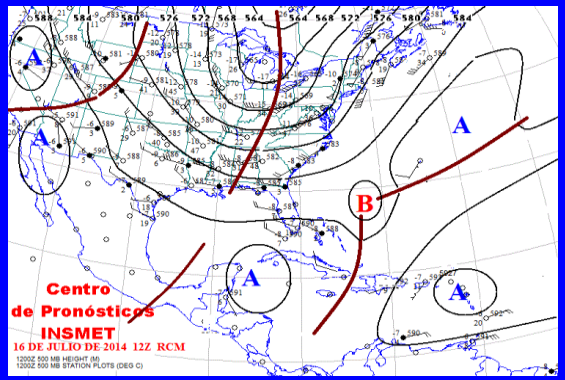
Surface



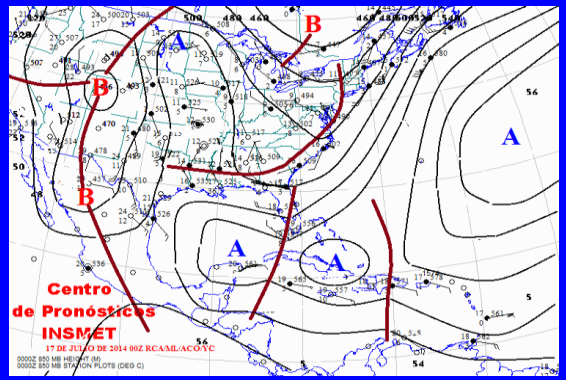
700 hPa



500 hPa

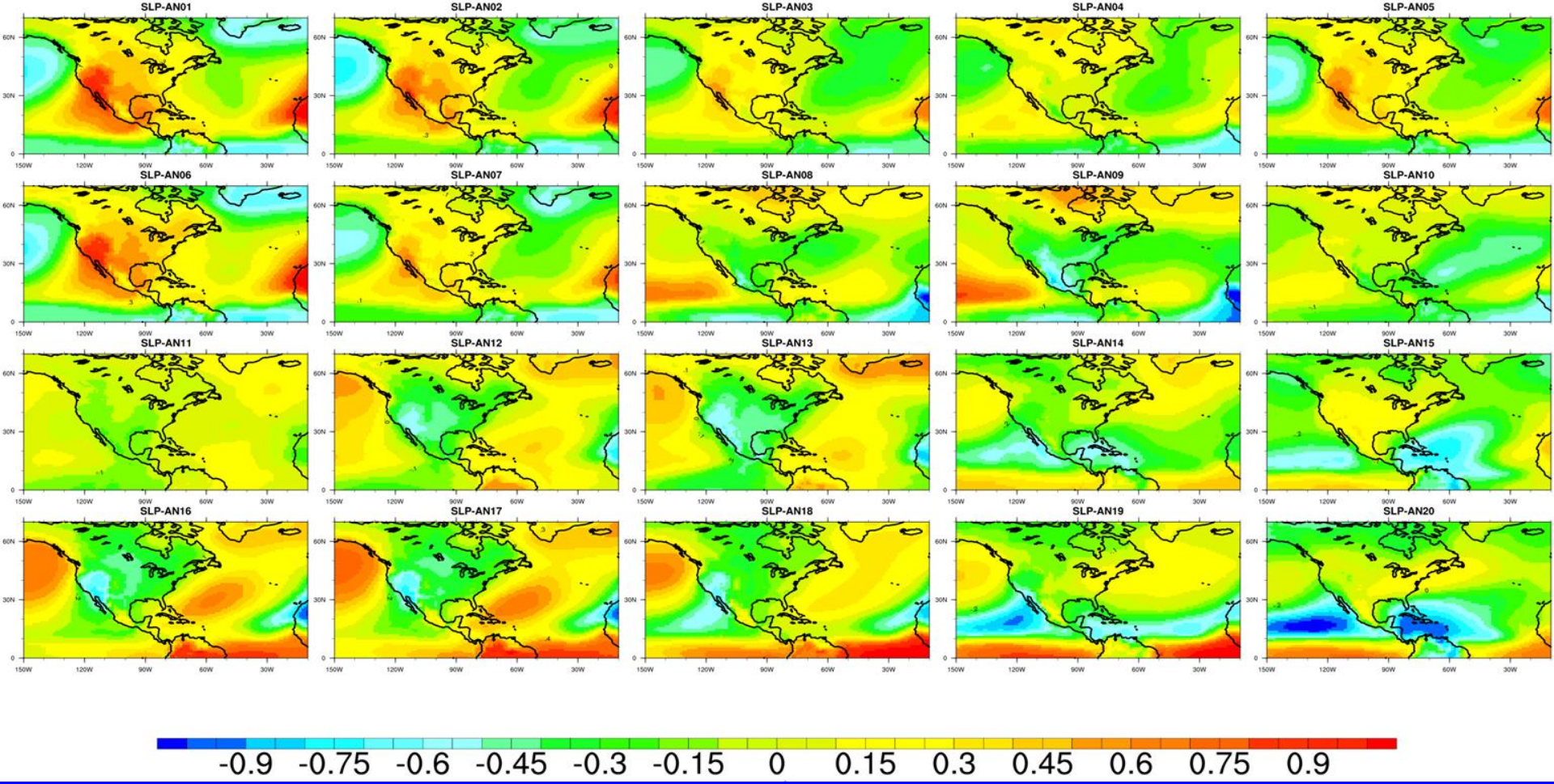


850 hPa

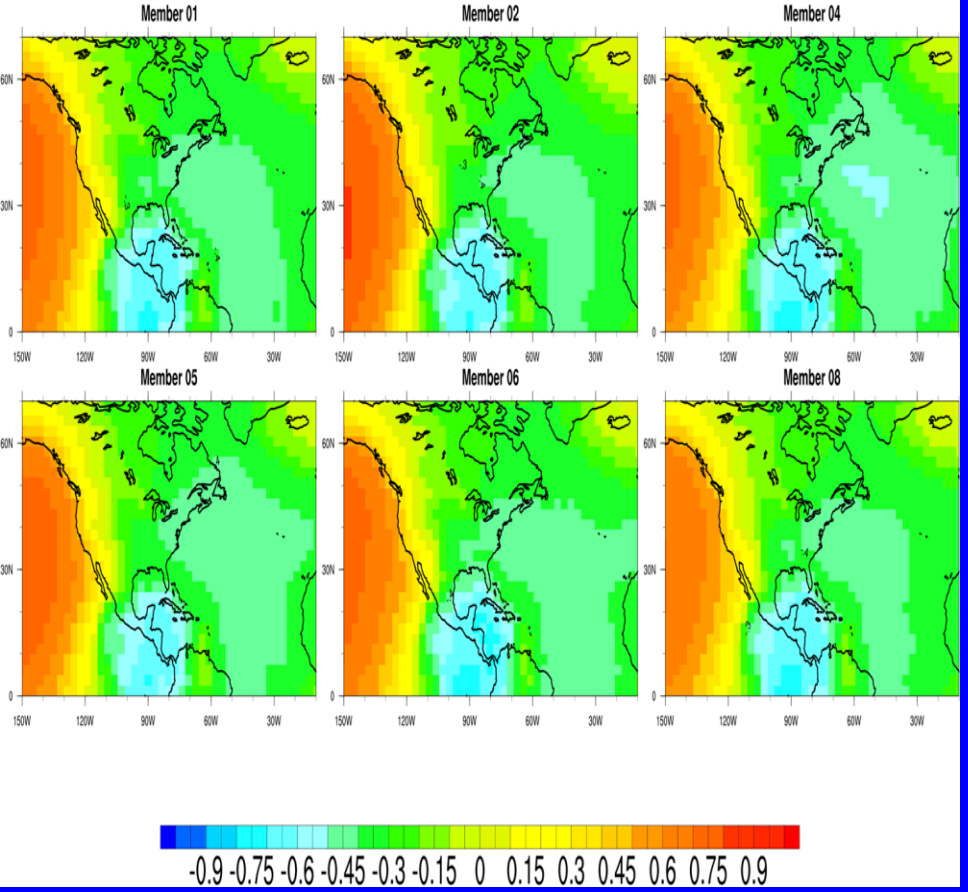


More frequent synoptic pattern in the study period

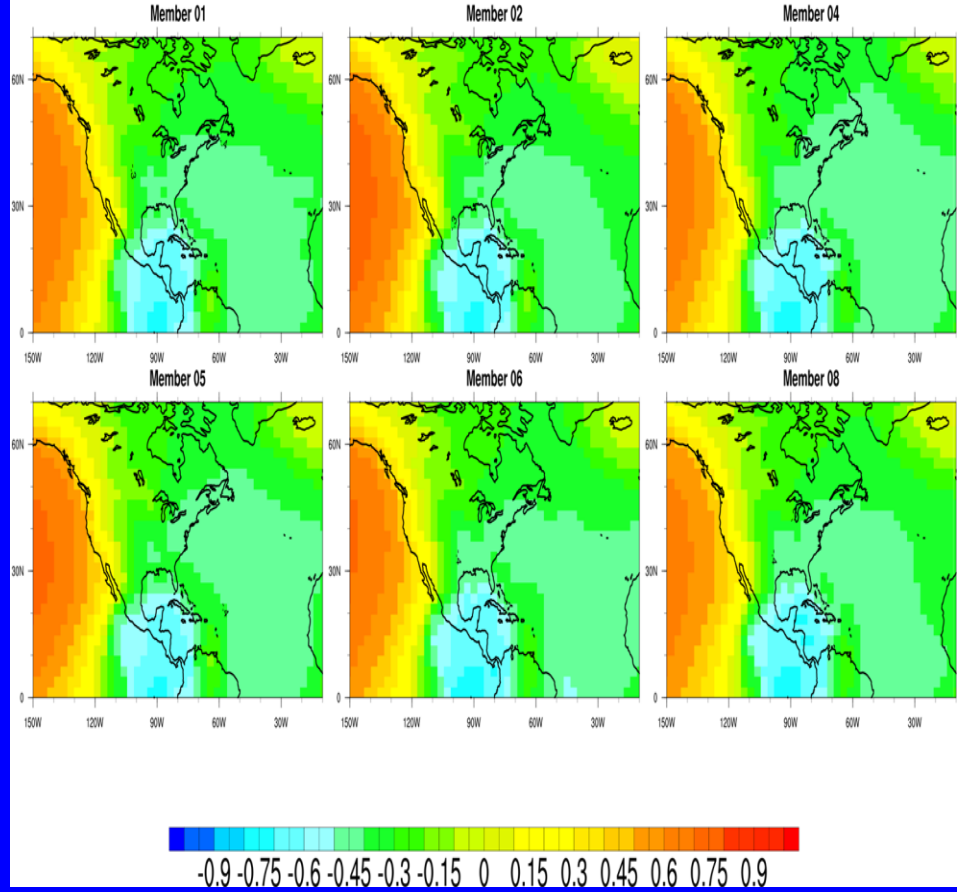
Source: INSMET



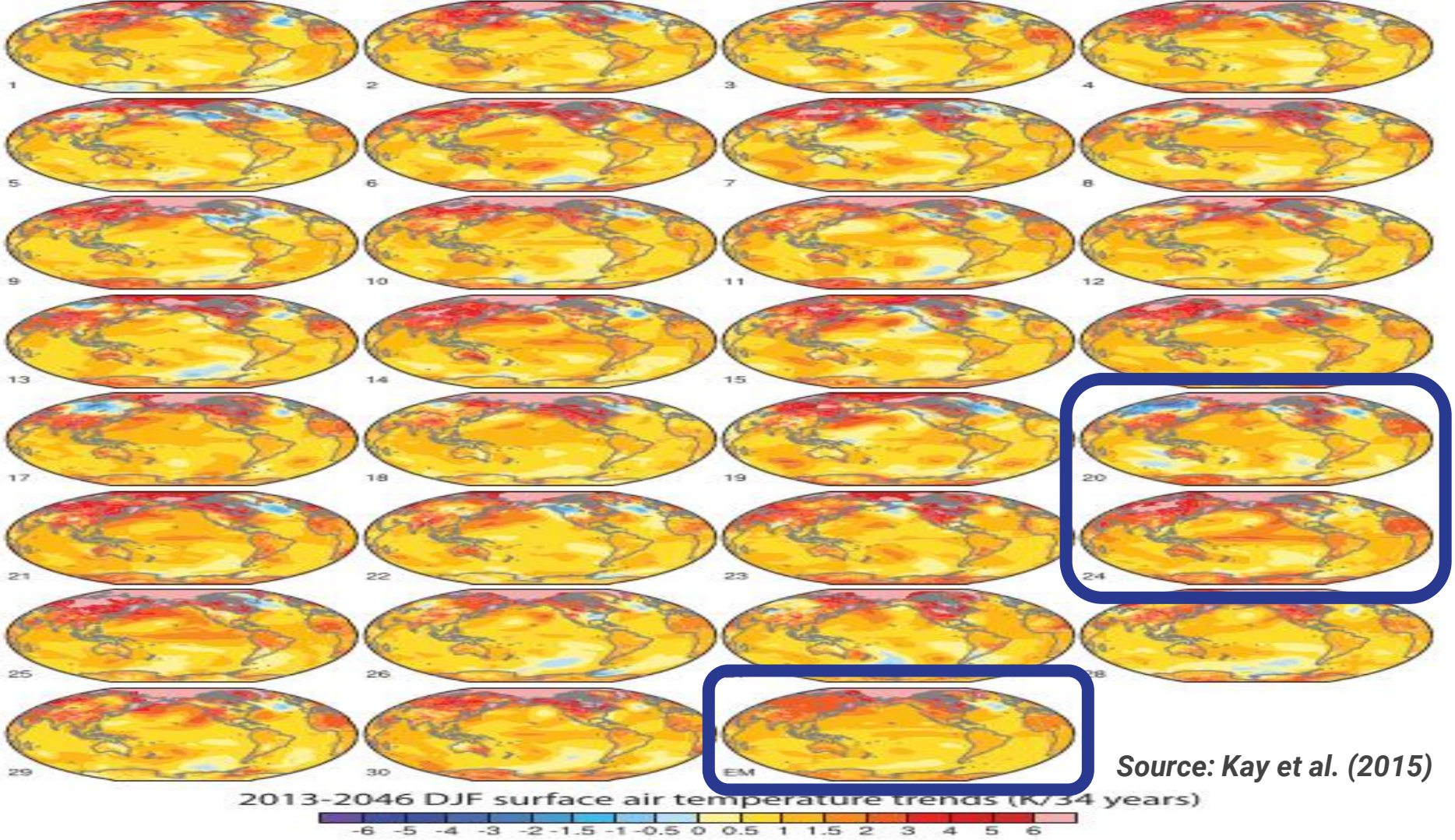
Behavior of synoptic patterns detected by SOM method, recognized from SLP standardized anomalies of CESM-LE mean outputs in the period 1980-2005.



Standardized anomalies of the days where SLP-AN16 was presented, respect to the climatological mean of SLP data in the mean of the outputs of CESM-LE model



Standardized anomalies of the days where SLP-AN16 was presented, respect to the climatological mean of SLP data of the some members of CESM-LE



Source: Kay et al. (2015)

Conclusions

- 20 synoptic and large-scale circulation patterns were detected that influence the weather conditions in the study region
- SOM method allowed to recognize the seasonality present in the synoptic patterns, due to the neighboring function and the topological approach as some of its advantages
- SLP-AN16 was the most frequent synoptic pattern in the study period, representing the NASH influence over the region
- The recognition of the synoptic patterns detected with the ERAI data compared to the outputs of the CESM-LE model showed differences in the regional scale
- The differences among members of the CESM-LE and with the ensemble average for a given synoptic pattern may be related to the internal climate variability that is commonly underappreciated in climate models.

References

- Sáenz, F. & Durán-Quesada, A. M. (2015). A climatology of low level wind regimes over central america using a weather type classification approach. Frontiers in Earth Science, 3, 15.
- Díaz-Esteban, Y. & Raga, G. B. (2018). Weather regimes associated with summer rainfall variability over southern mexico. International Journal of Climatology, 38(1), 169–186.
- Dee, D. P., Uppala, S., Simmons, A., Berrisford, P., Poli, P., Kobayashi, S., . . . others (2011). The Era-Interim reanalysis: Configuration and performance of the data assimilation system. Quarterly Journal of the royal meteorological society, 137(656), 553–597.
- Kay, J., Deser, C., Phillips, A., Mai, A., Hannay, C., Strand, G., . . . others (2015). The Community Earth System Model (CESM) large ensemble project: A community resource for studying climate change in the presence of internal climate variability. Bulletin of the American Meteorological Society, 96(8), 1333–1349.
- Kohonen, T. (2001). Self-organizing Maps, vol. 30 of springer series in information sciences. ed: Springer Berlin.
- Jankowski, D., & Amanowicz, M. (2015). Intrusion detection in software defined networks with self-organized maps. Journal of Telecommunications and Information Technology

Thank you very much for your attention!

Questions???

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