Influence of extratropical disturbances on the Atlantic Intertropical Convergence Zone

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Summary

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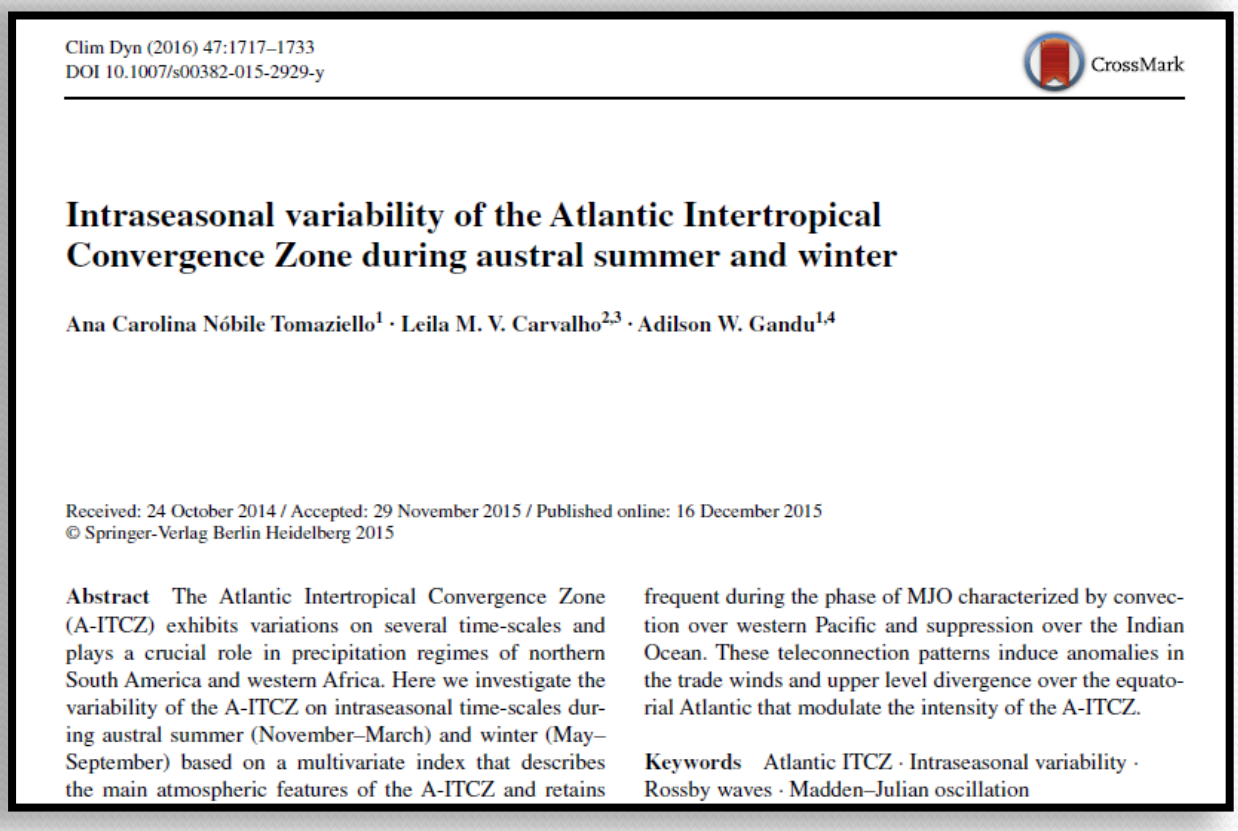
- Multivariate Index for the A-ITCZ
- Variability of the A-ITCZ on intraseasonal timescales
  - Austral summer
  - Austral winter
- Relationship with the MJO
- Conclusion

Article

(Climate Dynamics 2016)



Clim Dyn (2016) 47:1717–1733
DOI 10.1007/s00382-015-2929-y

CrossMark

Intraseasonal variability of the Atlantic Intertropical Convergence Zone during austral summer and winter

Ana Carolina Nóbile Tomaziello[1] · Leila M. V. Carvalho[2,3] · Adilson W. Gandu[1,4]

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Abstract The Atlantic Intertropical Convergence Zone (A-ITCZ) exhibits variations on several time-scales and plays a crucial role in precipitation regimes of northern South America and western Africa. Here we investigate the variability of the A-ITCZ on intraseasonal time-scales during austral summer (November–March) and winter (May–September) based on a multivariate index that describes the main atmospheric features of the A-ITCZ and retains frequent during the phase of MJO characterized by convection over western Pacific and suppression over the Indian Ocean. These teleconnection patterns induce anomalies in the trade winds and upper level divergence over the equatorial Atlantic that modulate the intensity of the A-ITCZ.

Keywords Atlantic ITCZ · Intraseasonal variability · Rossby waves · Madden–Julian oscillation

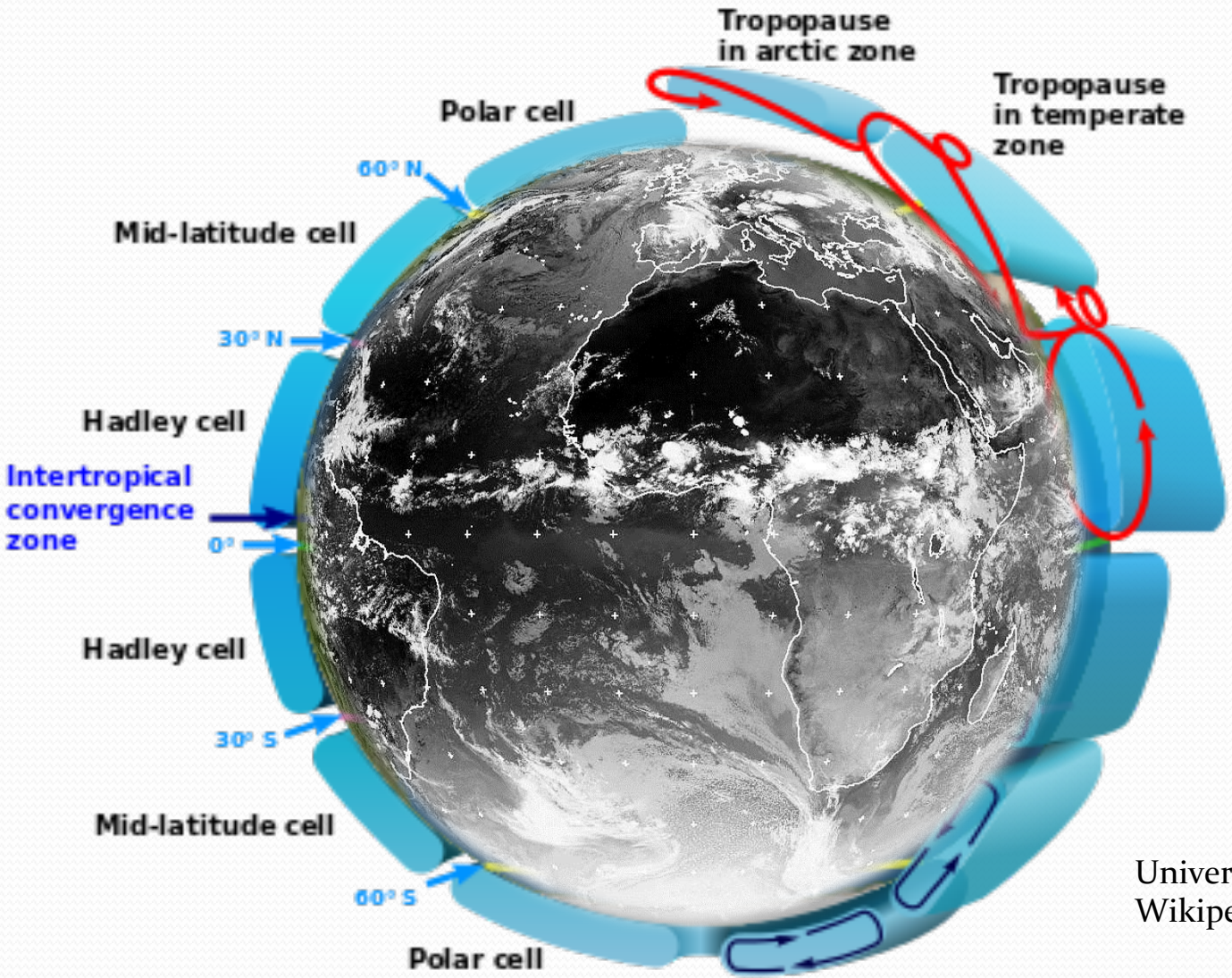
Tomaziello, ACN, Carvalho, LMV, Gandu, AW (2016) Variability of the Atlantic Intertropical Convergence Zone during austral summer and winter. Clim Dyn 47 1717-1733 http://link.springer.com/article/10.1007/s00382-015-2929-y

Motivation


Instituto Lula
Estadão
Cambio Climatico
Estimated 2015
IF - Blogspot
CNews
NatGeo

Introduction

Intertropical Convergence Zone

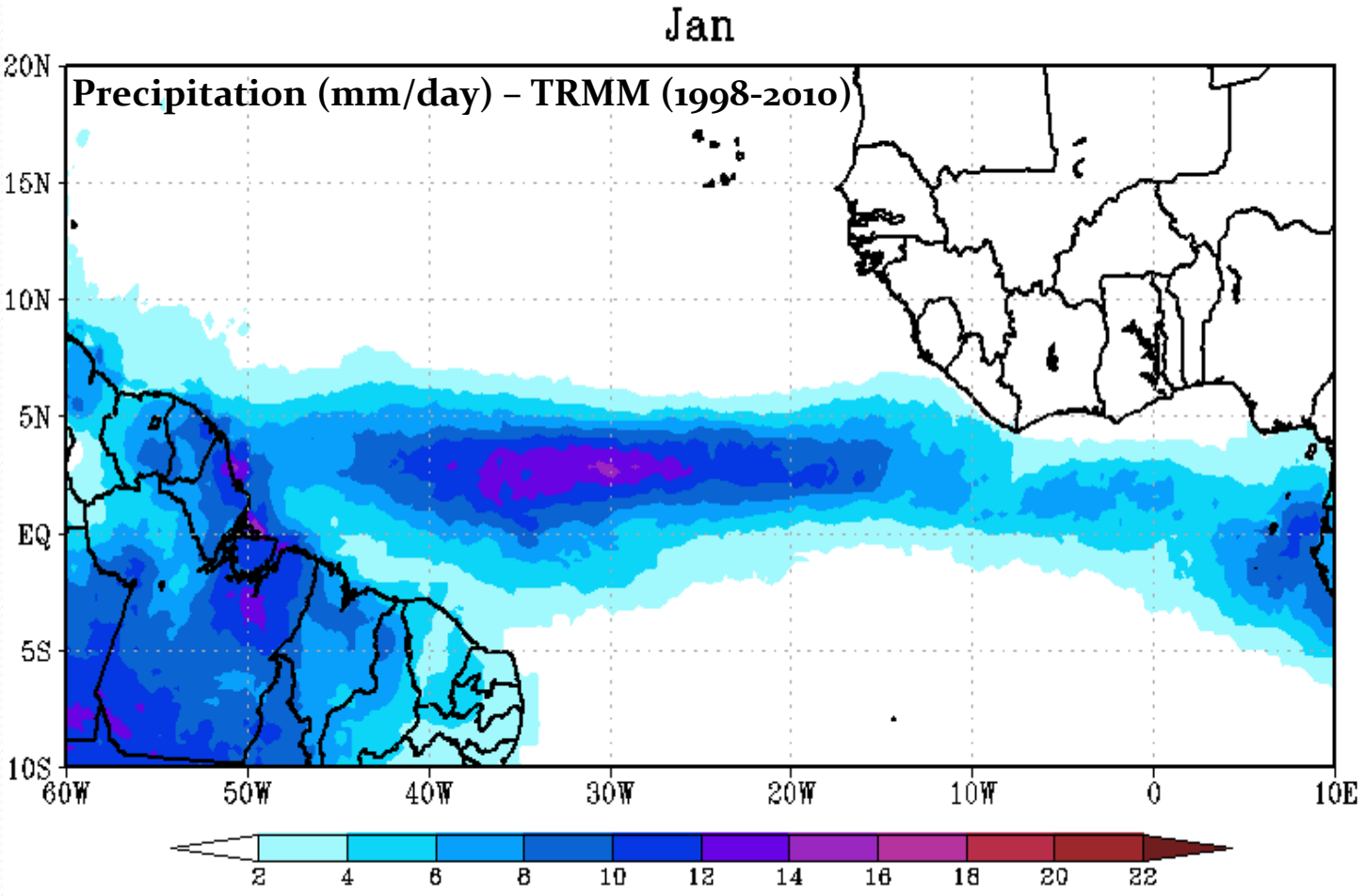


University of Dundee and Wikipedia

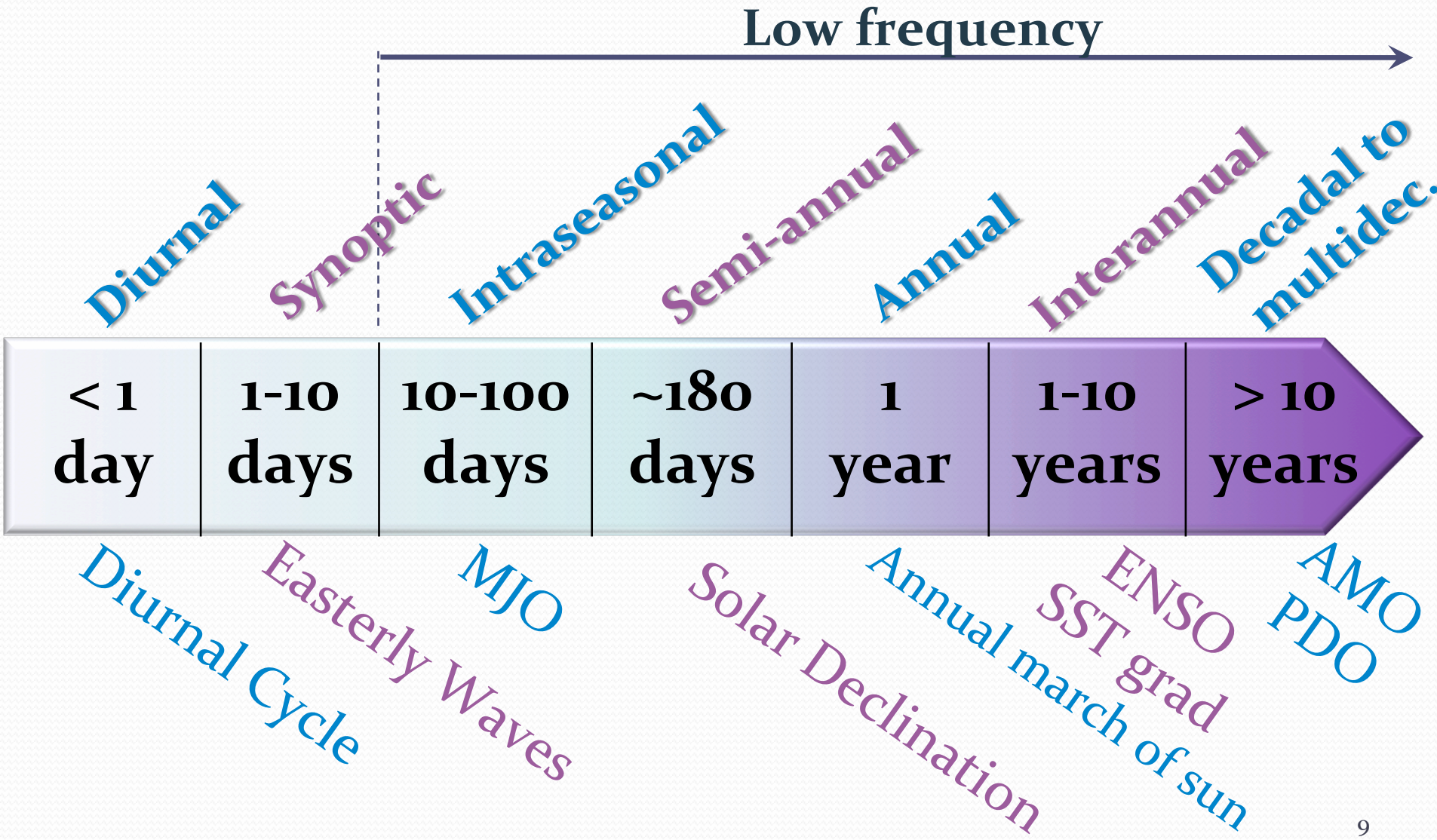
Intertropical Convergence Zone

- Trade winds confluence
- Equatorial trough
- Maximum SST
- Maximum mass convergence
- Maximum convective cloud cover band
  (Melo et al., 2009; Souza and Cavalcanti, 2009)

Atlantic ITCZ
(A-ITCZ)



Atlantic ITCZ variability



Atlantic ITCZ intraseasonal variability

- **Uvo and Nobre (1989):** intraseasonal oscillations appear to influence the latitudinal position of the A-ITCZ on 10-20 days timescales

- **De Souza et al. (2005):** A-ITCZ is the main mechanism associated with rainfall in Northeastern Brazil and Eastern Amazon on 10-30 days timescales

- **Grodsky and Carton (2001) and Mounier et al. (2008):** zonal precipitation seesaw in the A-ITCZ on 10-15 days timescales (quasi-biweekly zonal dipole)

Objetive

- During austral summer (Nov-Mar) and winter (May-Sep), investigate the:
  - atmospheric mechanisms and tropical-extratropical teleconnection patterns associated with A-ITCZ intraseasonal variability
  - relationship between this variability and the MJO activity

Data

Data

- **Atmospheric fields:** CFSR reanalysis
  1º x 1 º, daily (Saha et al., 2010)

- **OLR:** NOAA
  2,5º x 2,5º, daily (Liebmann and Smith, 1996)

- **Study period:** 32 years
  from 1/1/1979 to 31/12/2010

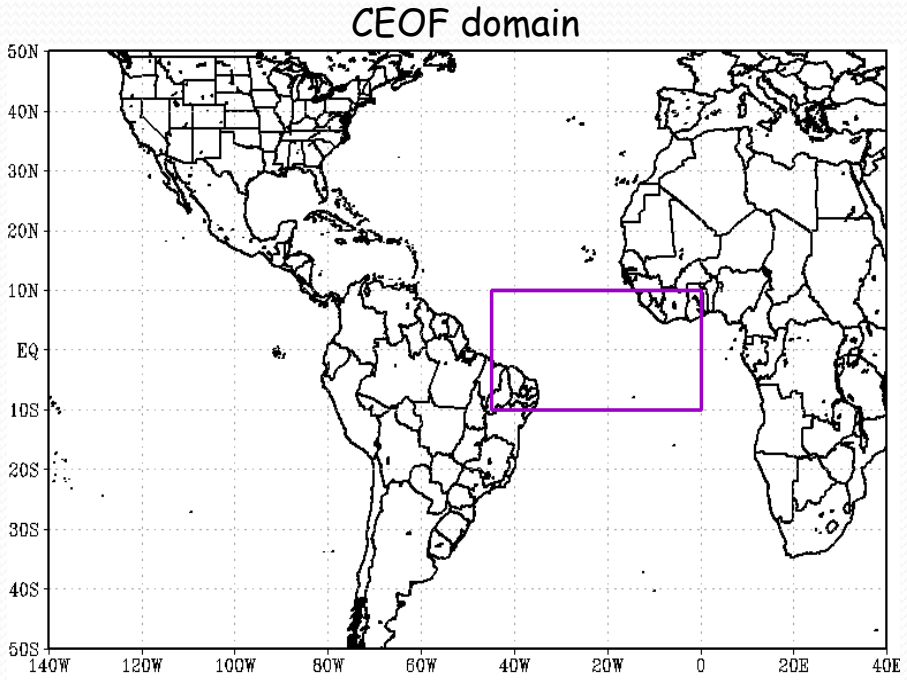
Multivariate index for the A-ITCZ - ITCZi -

ITCZi

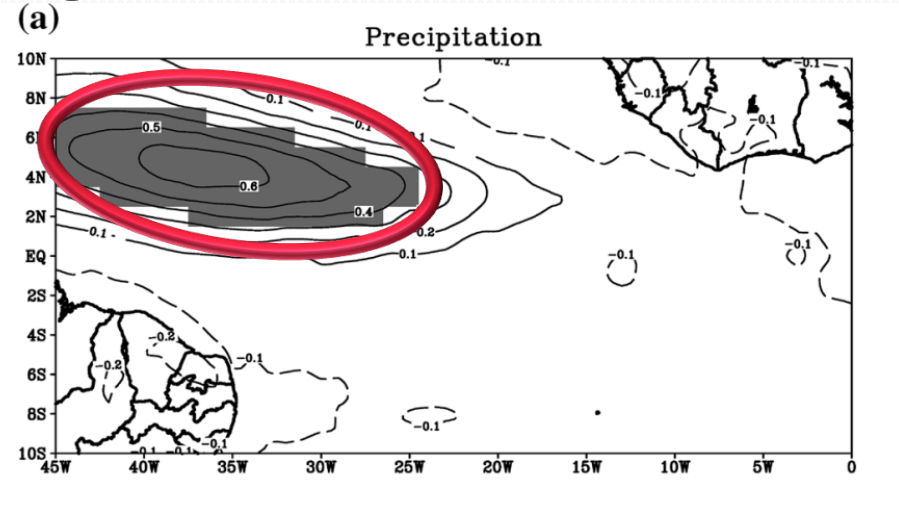
- **CEOF-1 time coefficient**

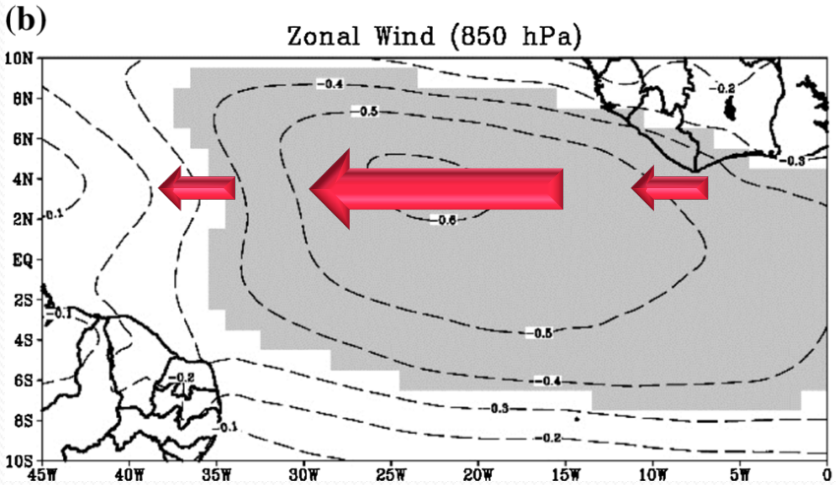
prec u850 v850

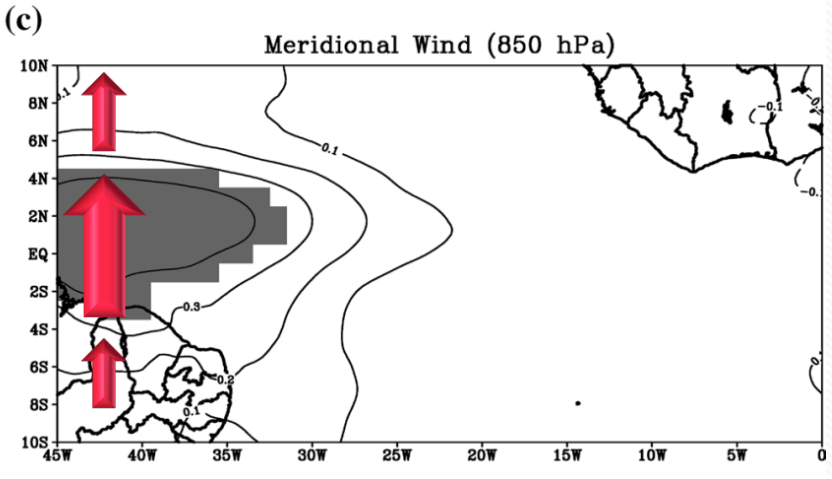
- pentadal anomalies
- annual cycle and long-term trend removed
- explained variance 10%



Spatial pattern of the CEOF-1

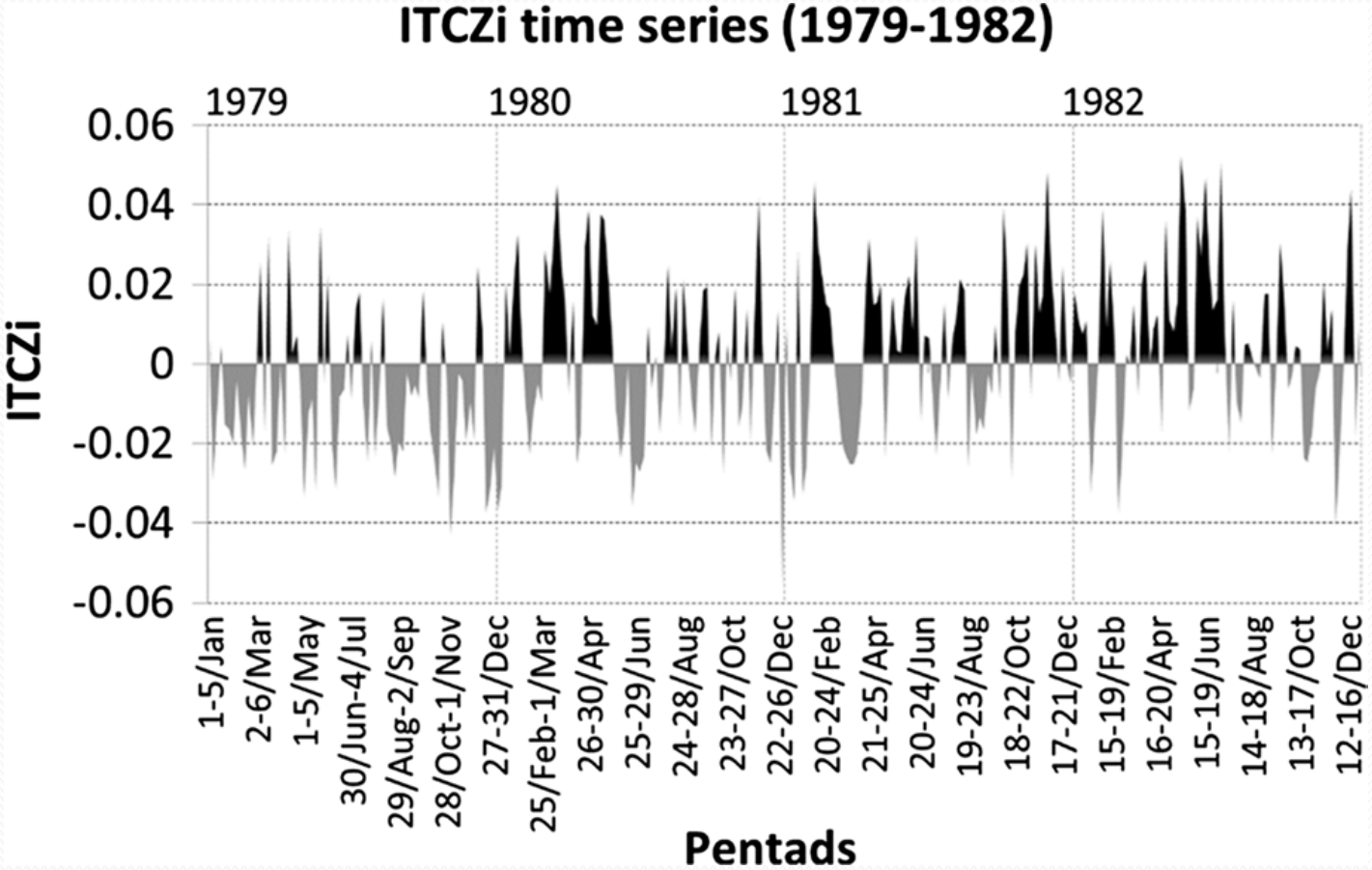






Tomaziello et al. (2016)

Temporal characteristics of ITCZi



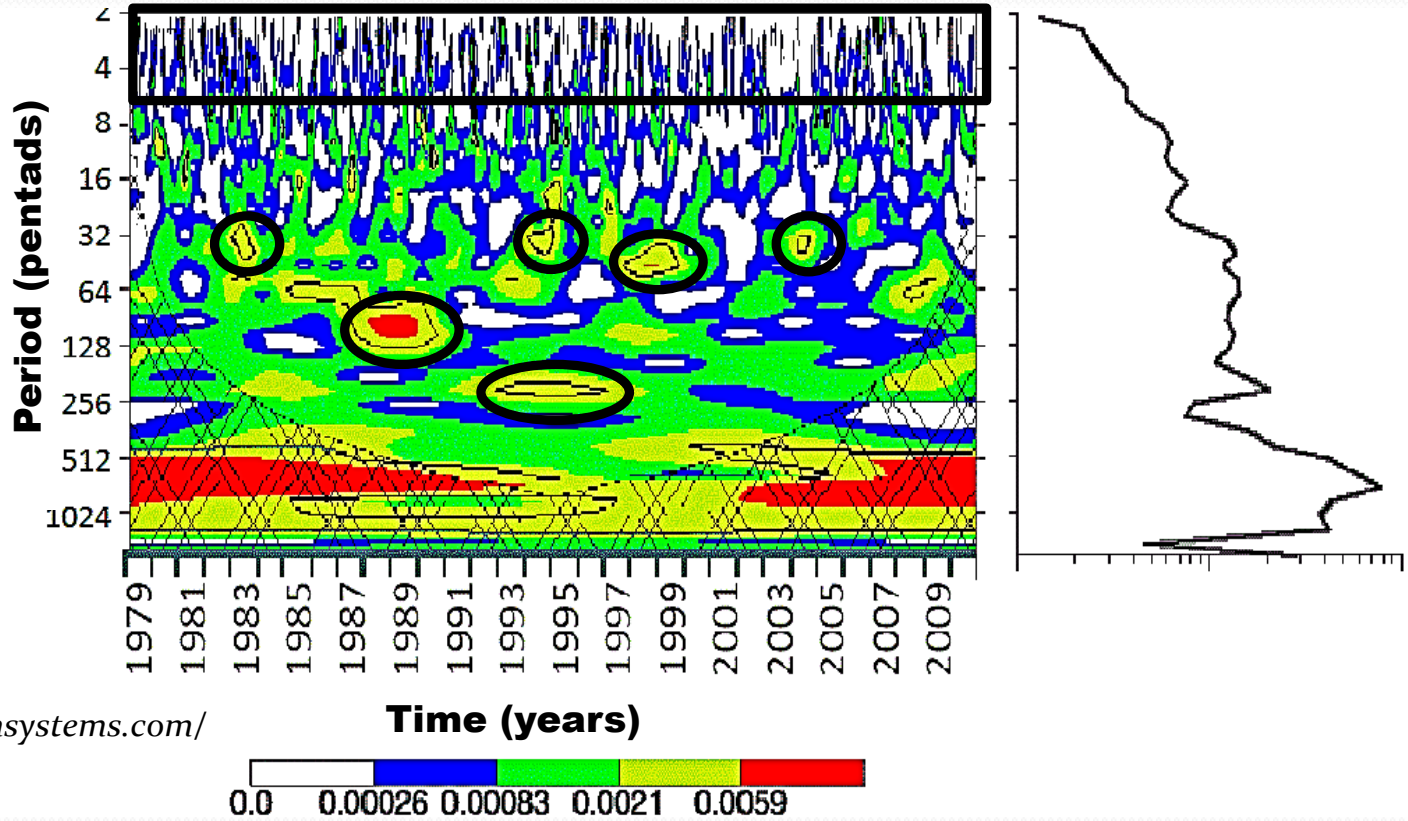
Tomaziello et al. (2016)

ITCZi Wavelet Spectrum

Intraseasonal

Semiannual

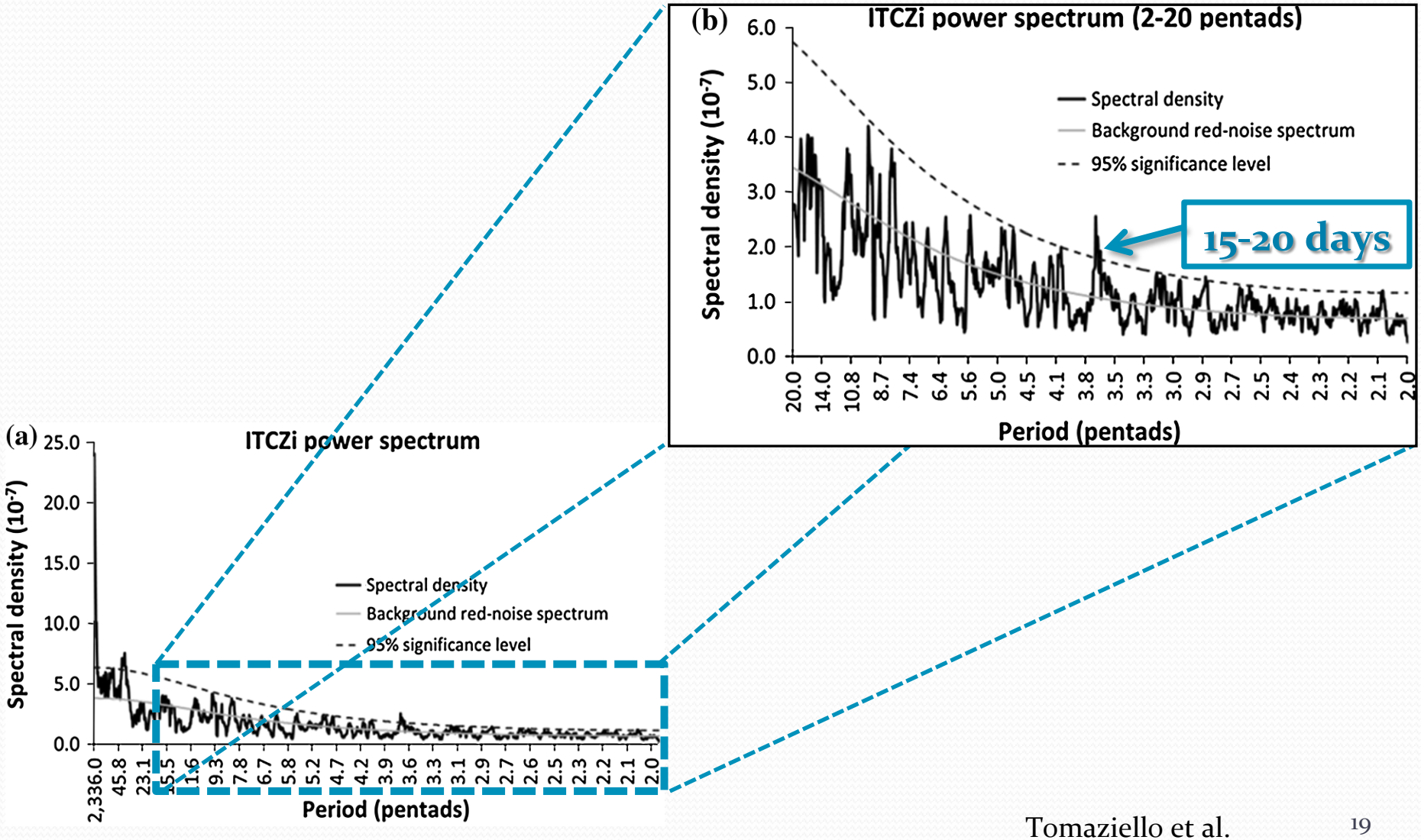
Interannual



Script from
http://ion.researchsystems.com/

Adapted from Tomaziello (2014)

ITCZi Power Spectrum



Tomaziello et al.

Precipitation on A-ITCZ

Austral summer NDJFM

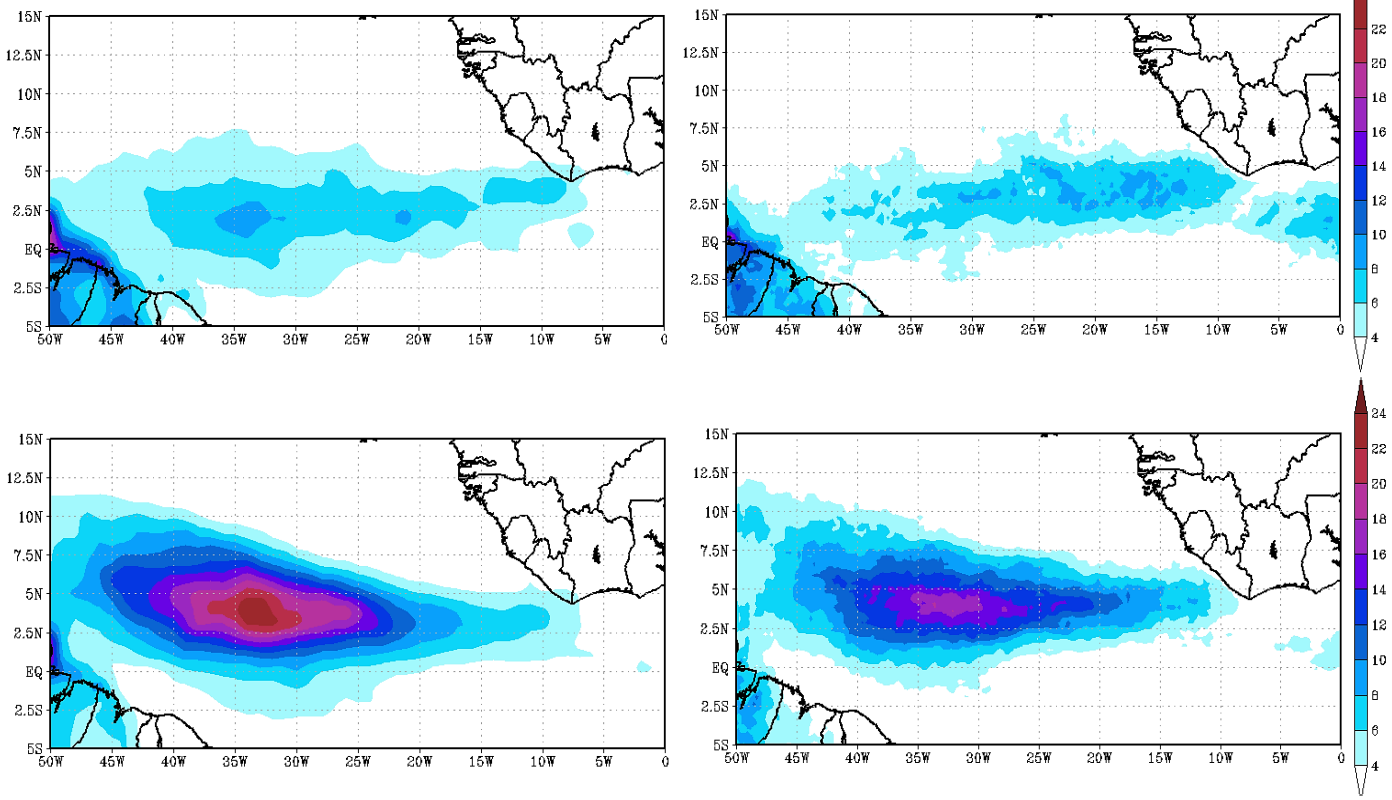
CFSR

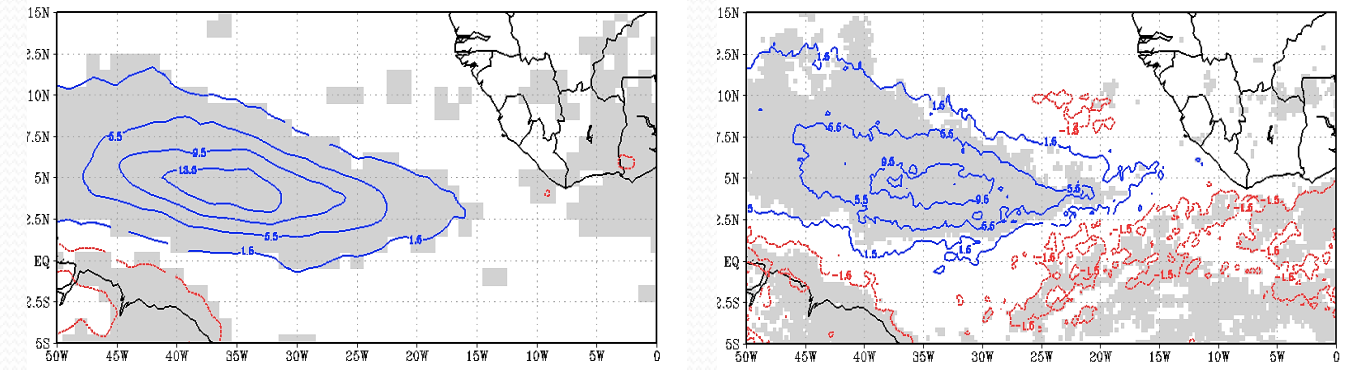
TRMM

weak

intense

i-w





Tomaziello (2014)

CFSR

TRMM

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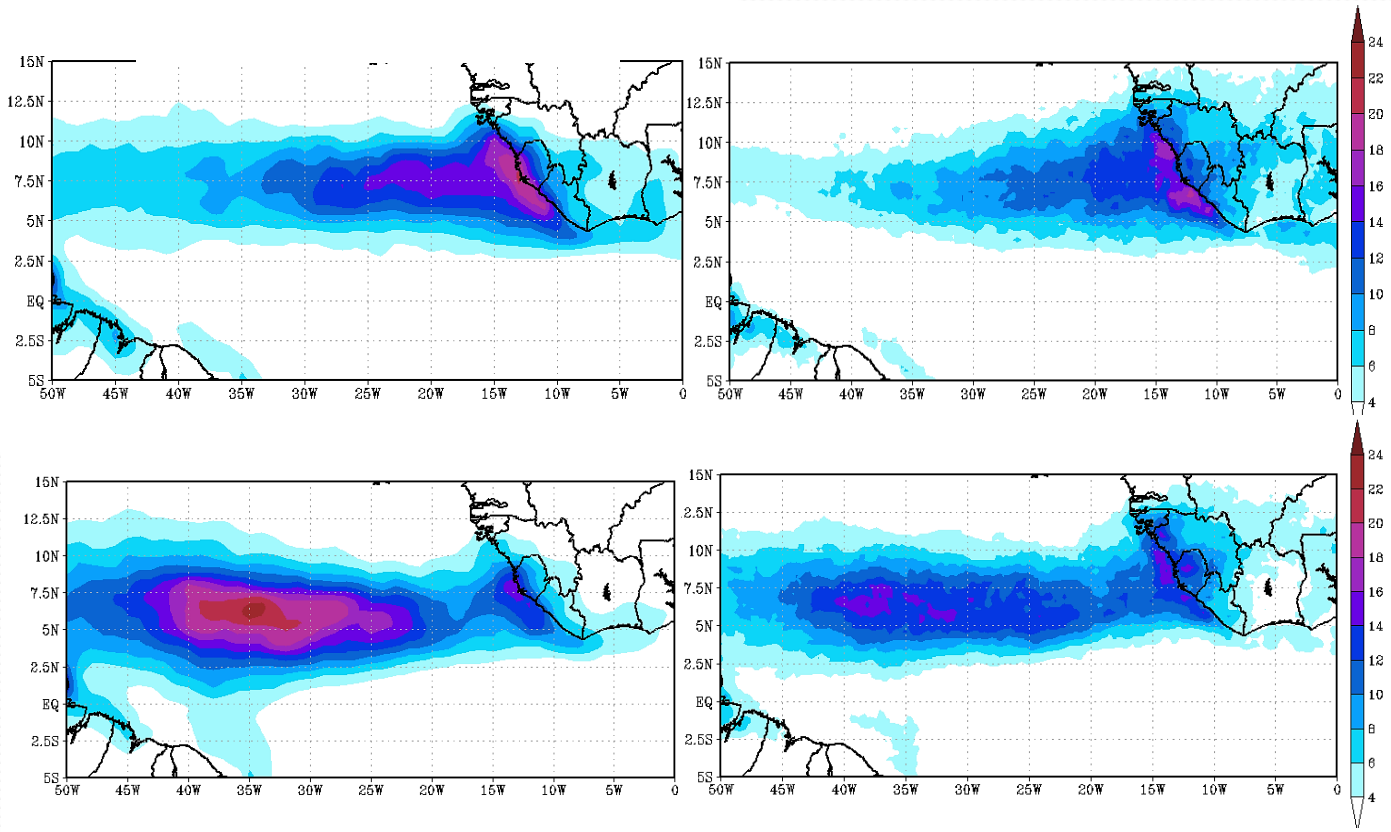
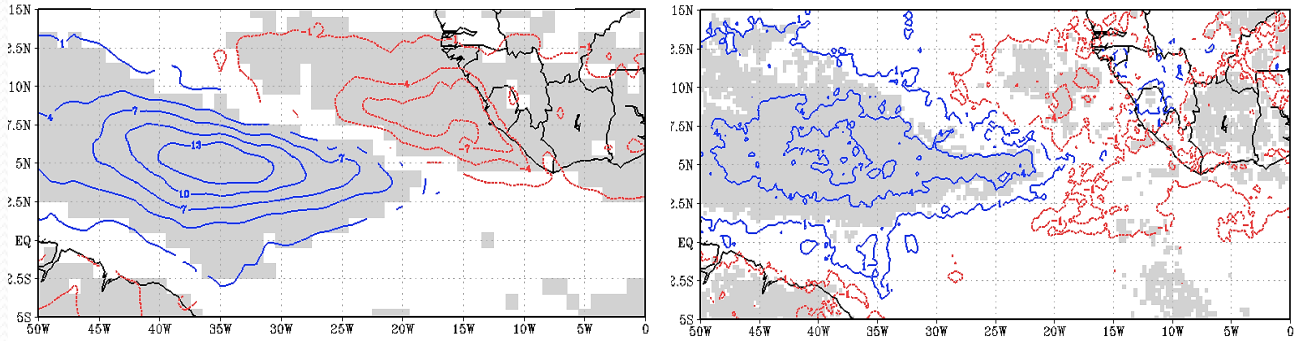
intense

i-W



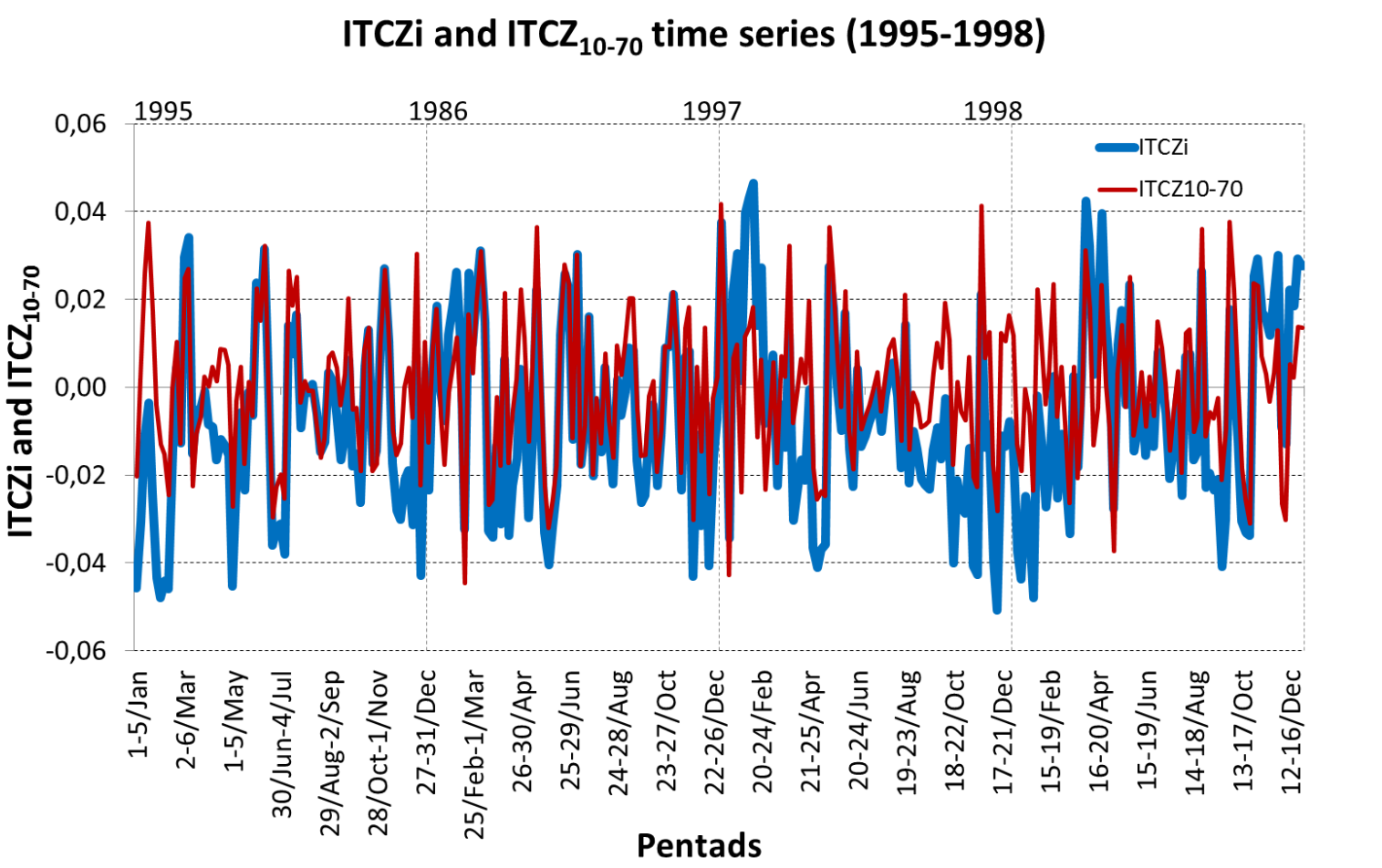


Precipitation on A-ITCZ

Austral winter MJJAS

Tomaziello (2014)

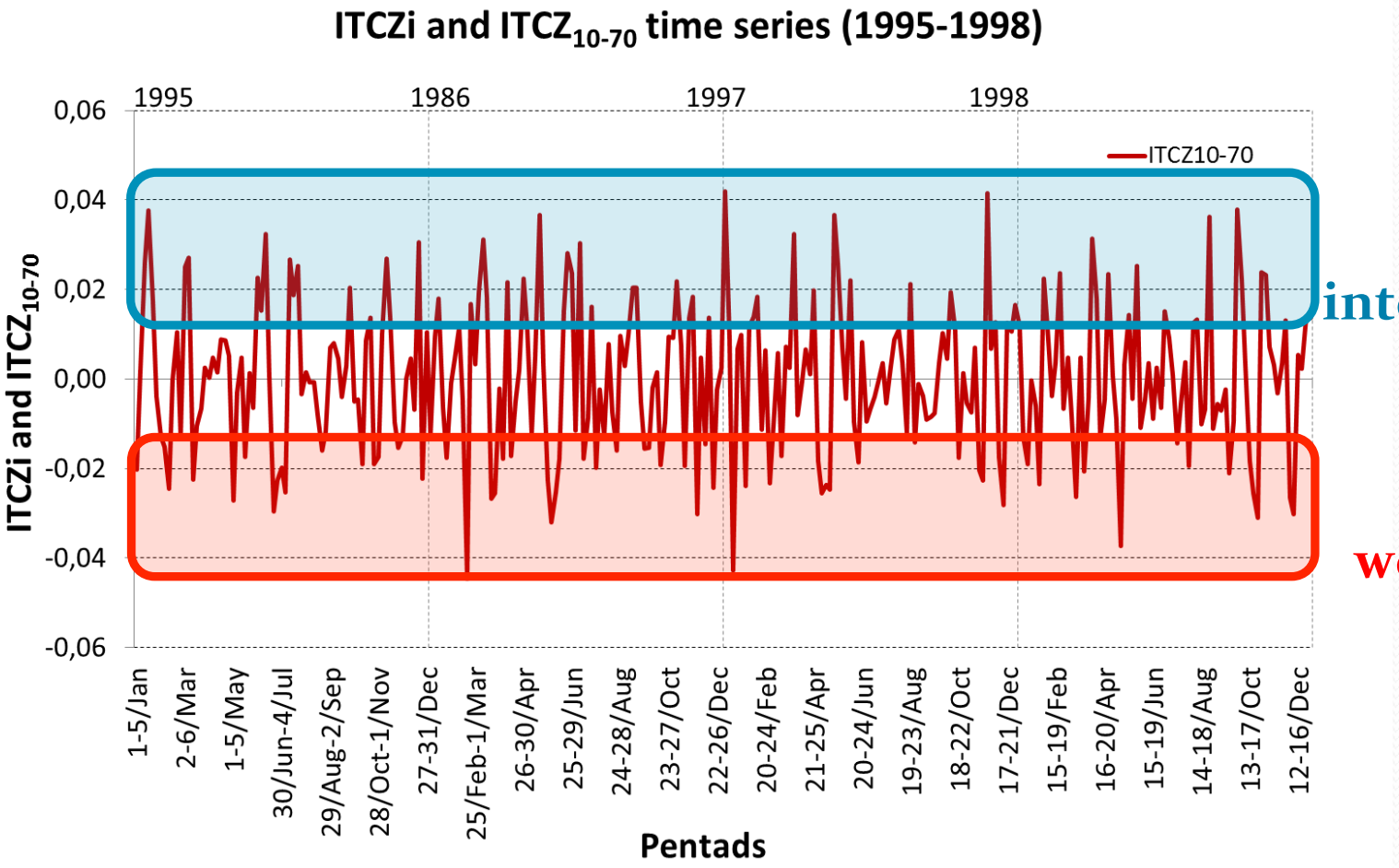
Intraseasonal variability of the A-ITCZ



FFT 10-70 days

Adapted from Tomaziello (2014)

Intraseasonal variability of the A-ITCZ



$q_{0,75}$

intense A-ITCZ

$q_{0,25}$

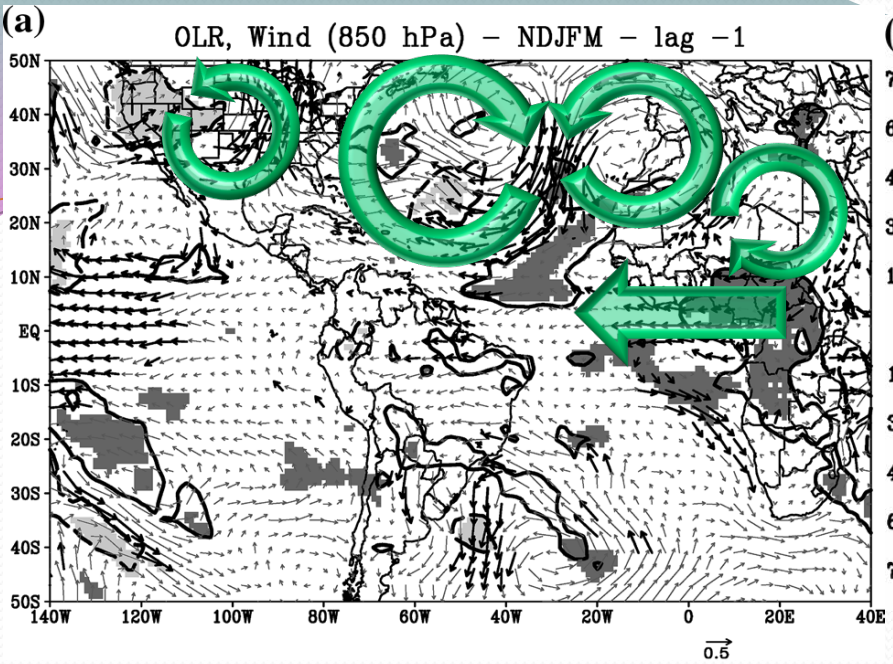
weak A-ITCZ

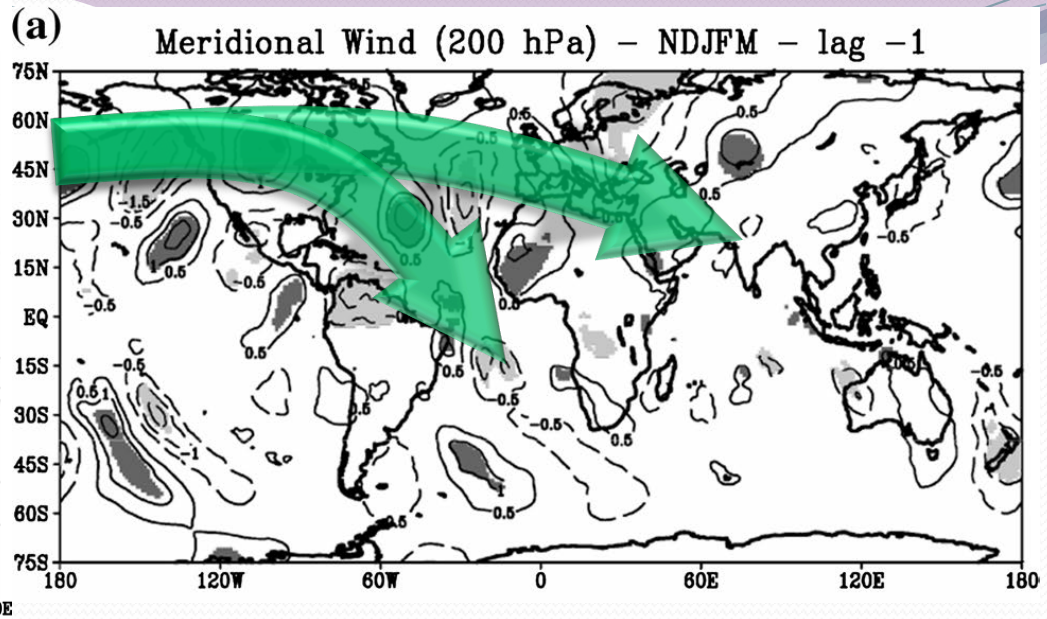
Adapted from Tomaziello (2014)

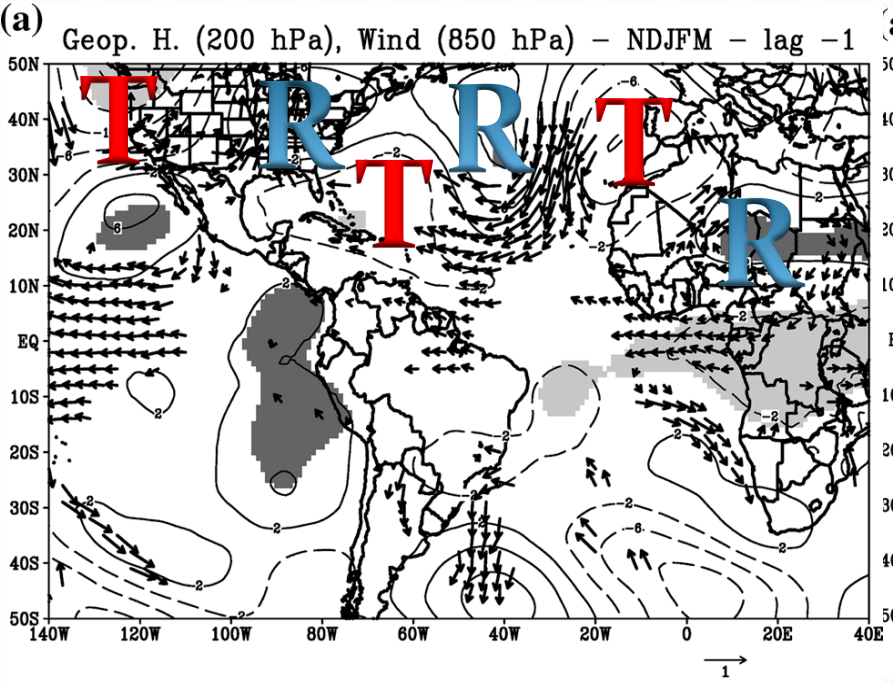
Intraseasonal variability of the A-ITCZ

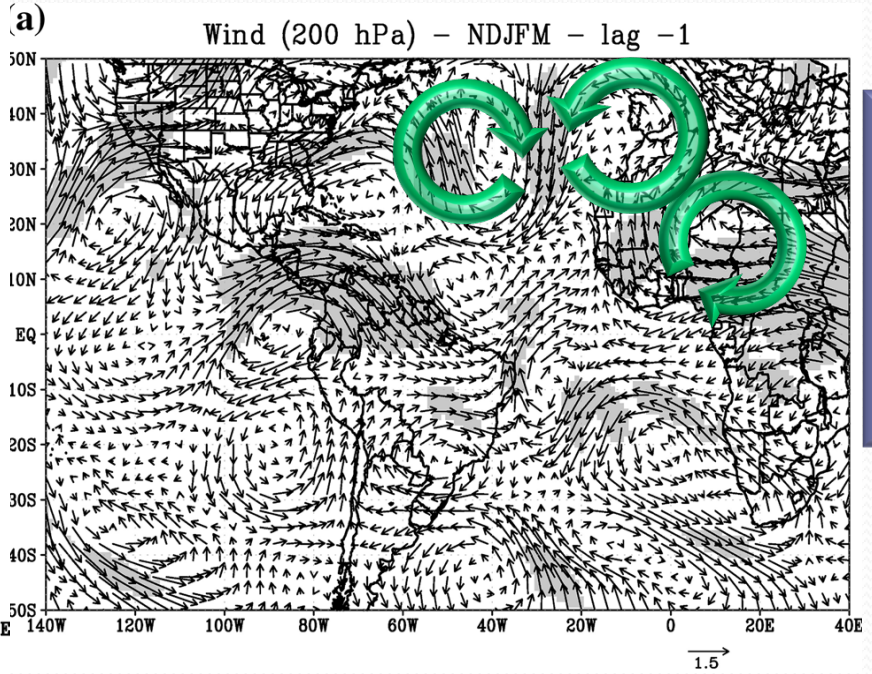
Austral summer
NDJFM

Intense A-ITCZ









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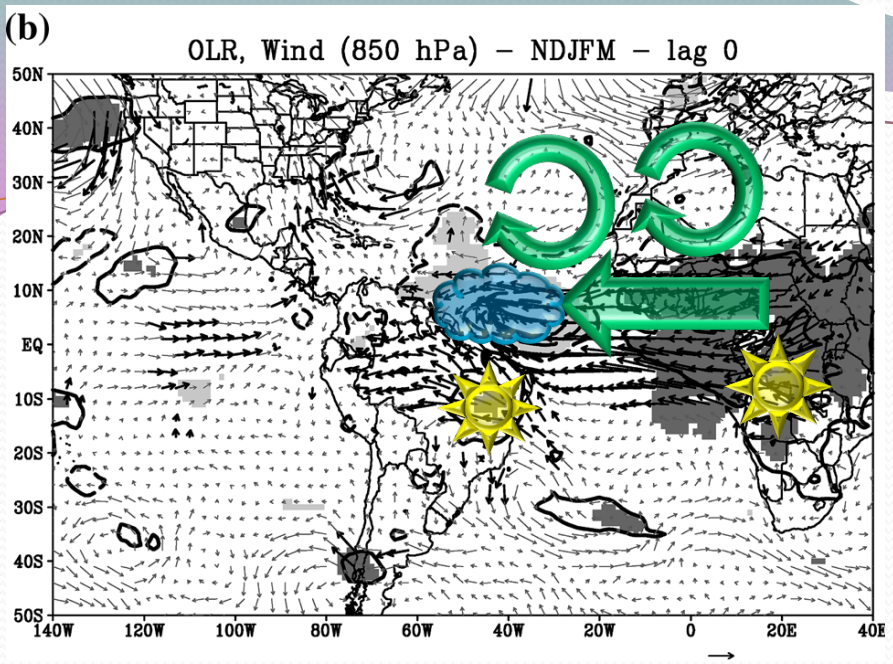
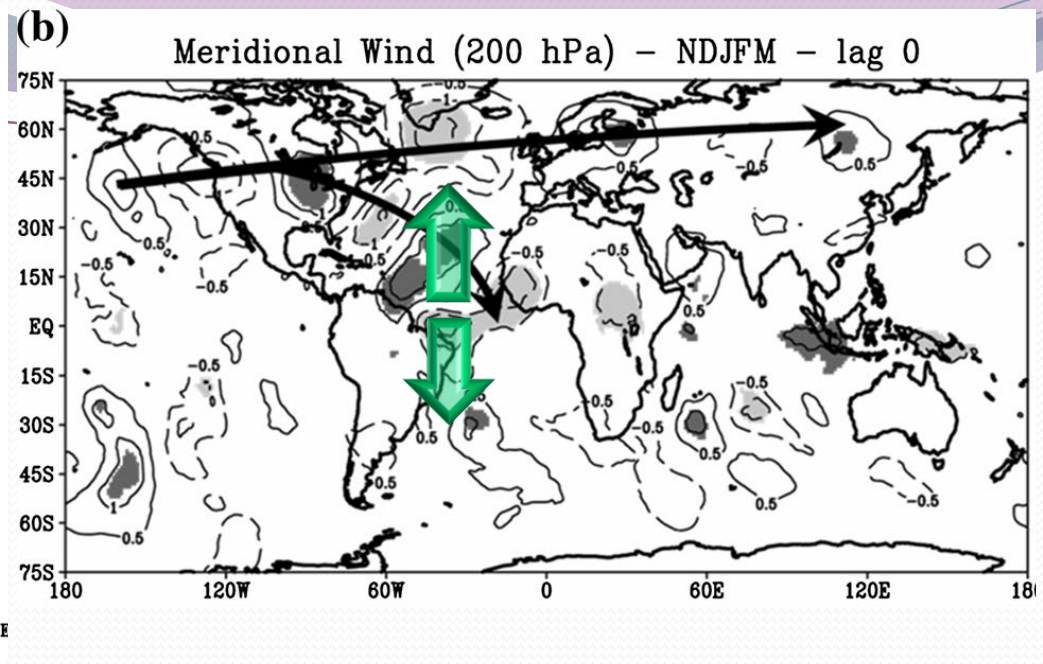
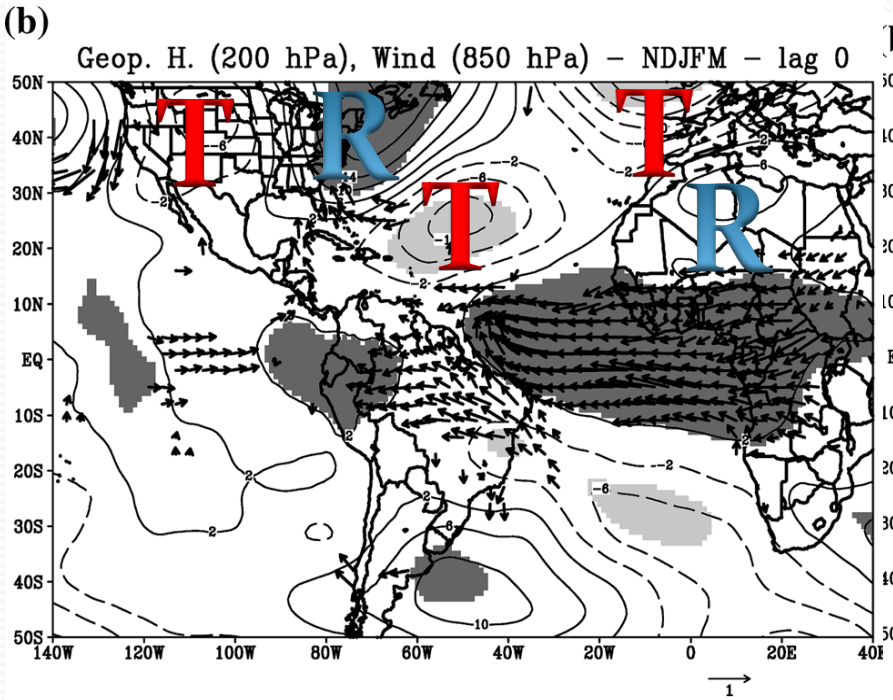
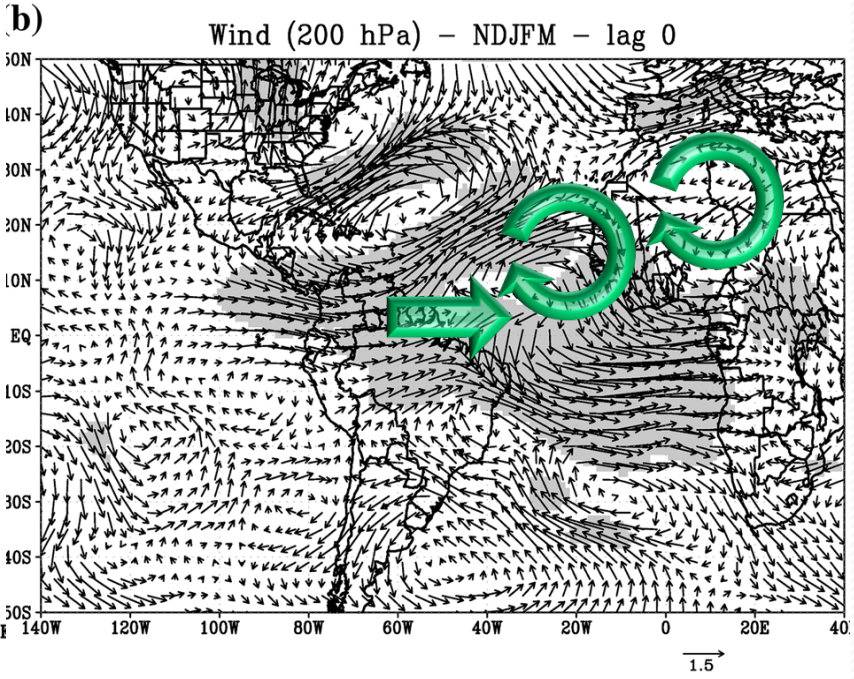
Tomaziello et al. (2016)









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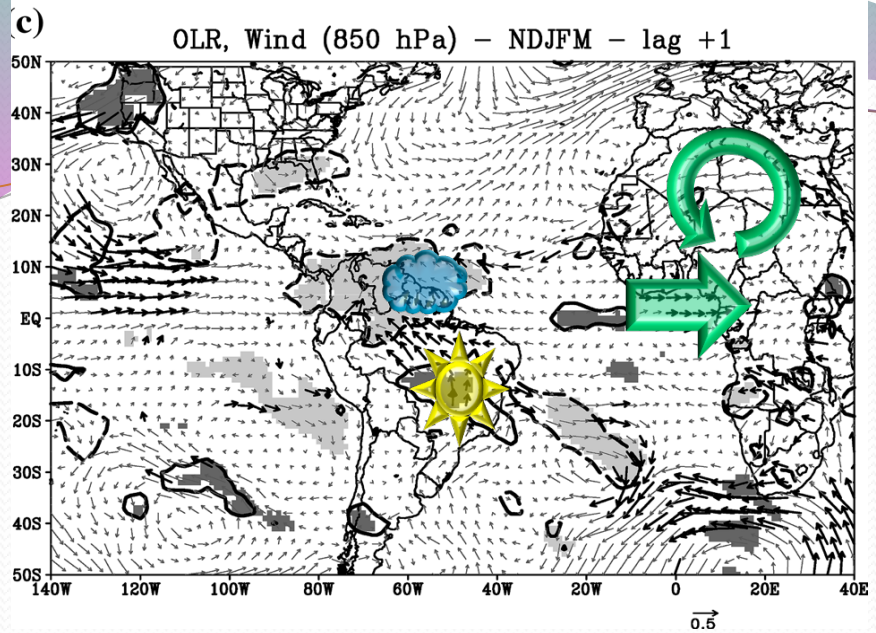
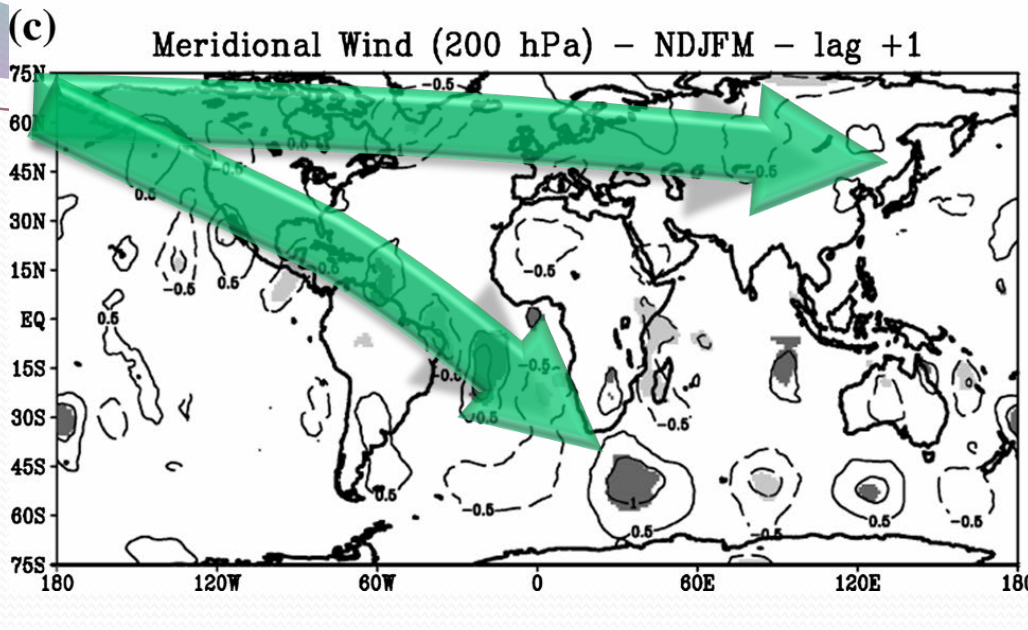
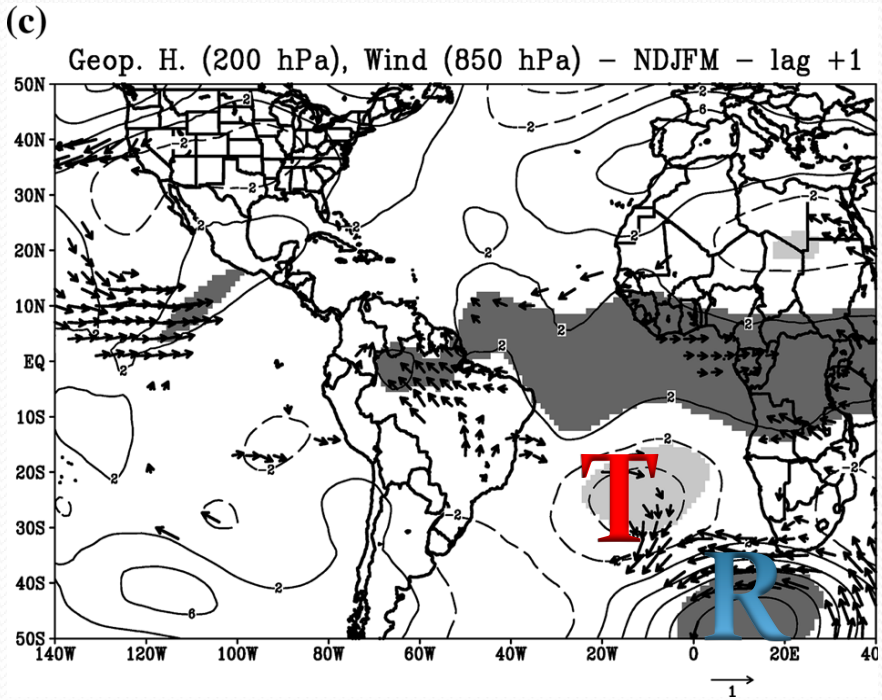
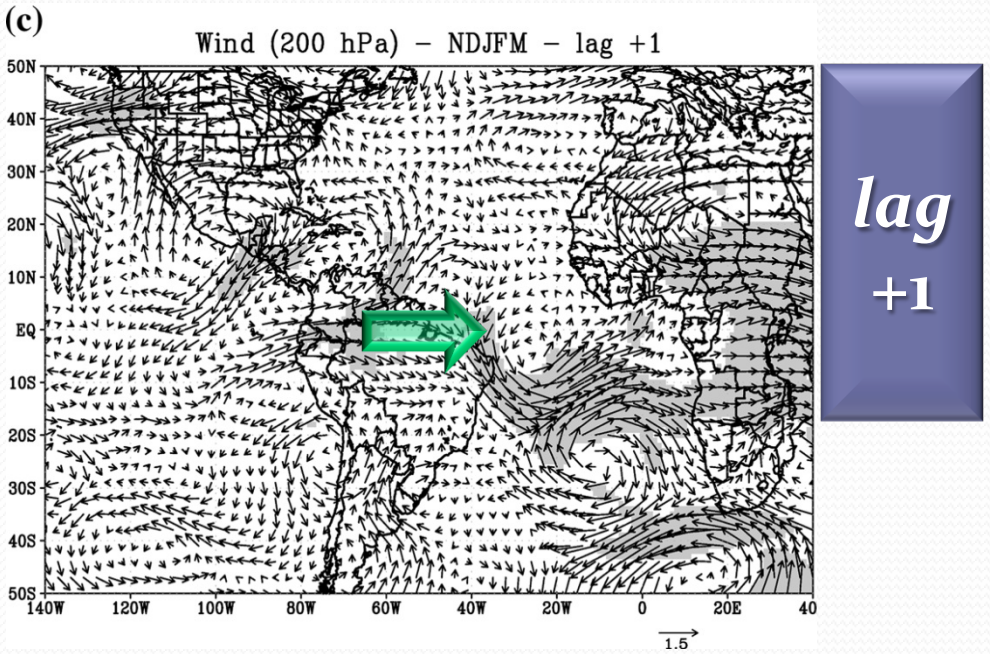
Tomaziello et al. (2016)





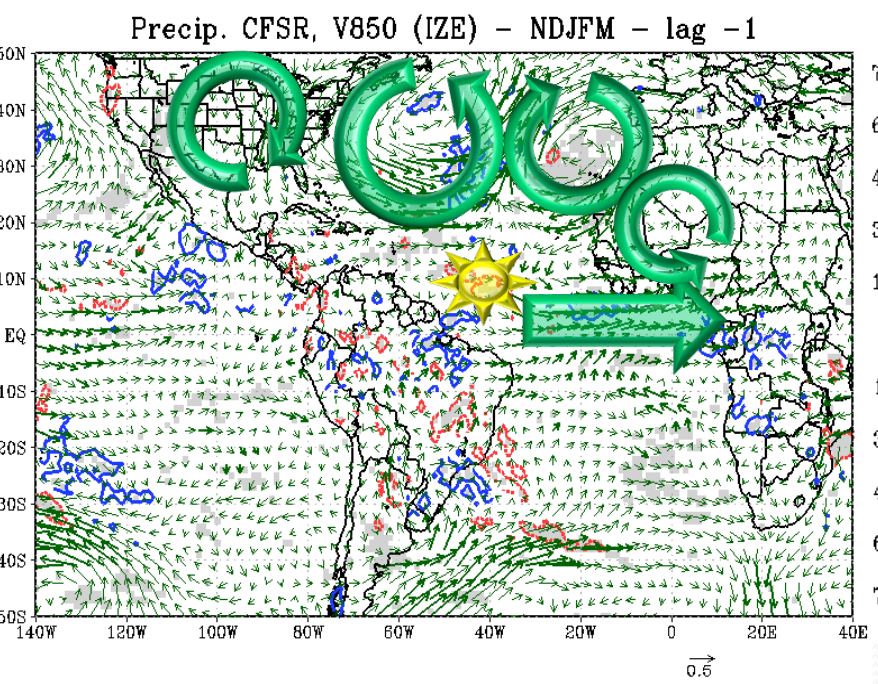


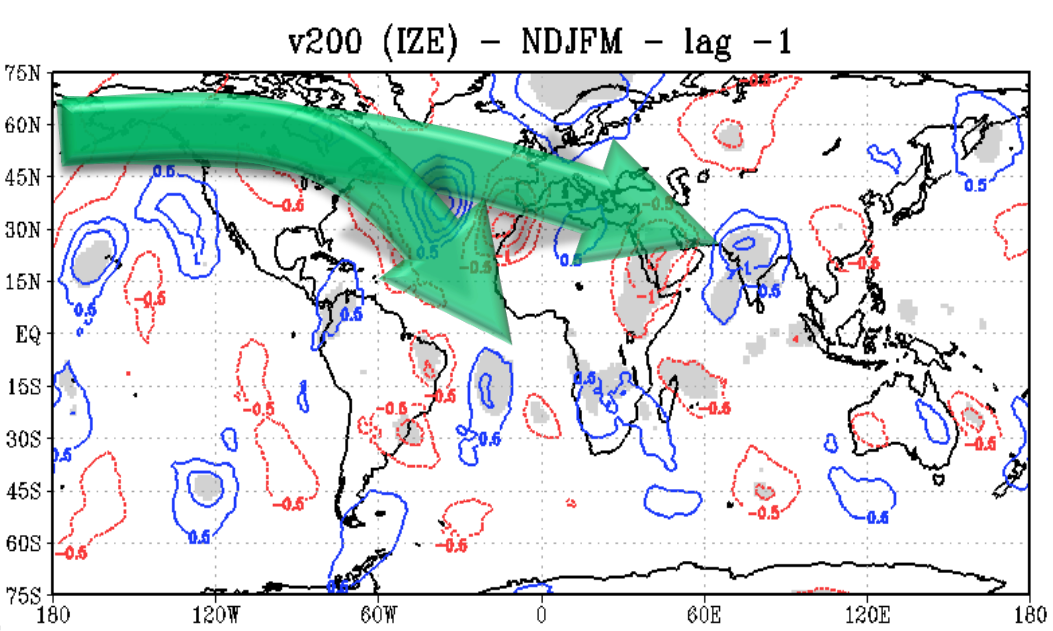


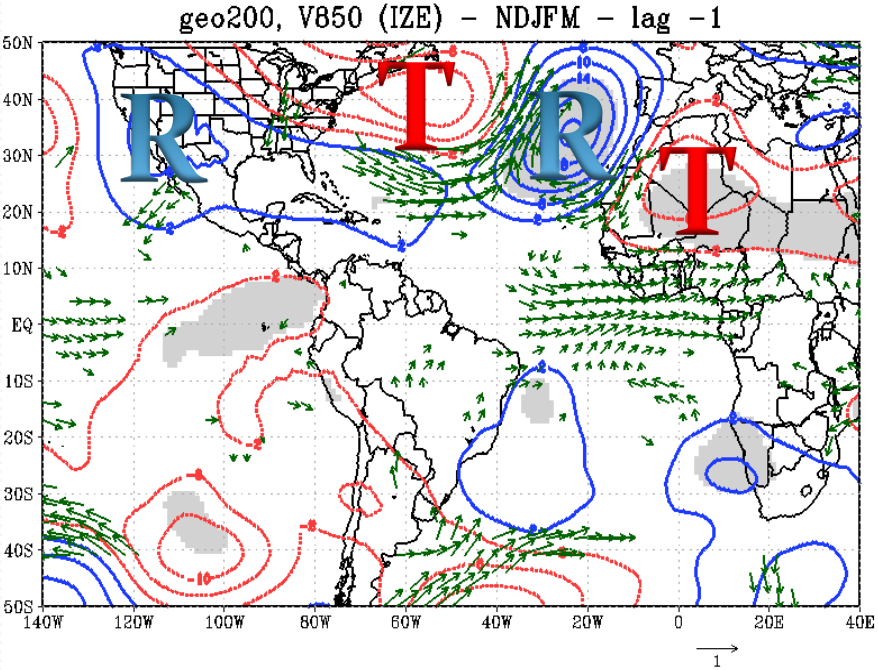
Tomaziello et al. (2016)

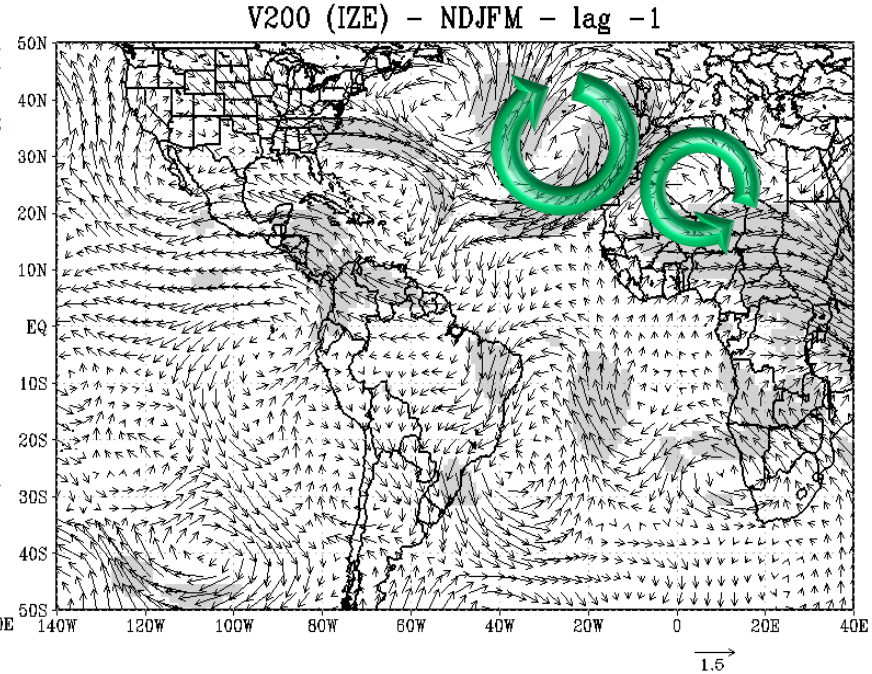
Austral summer
NDJFM

Weak A-ITCZ









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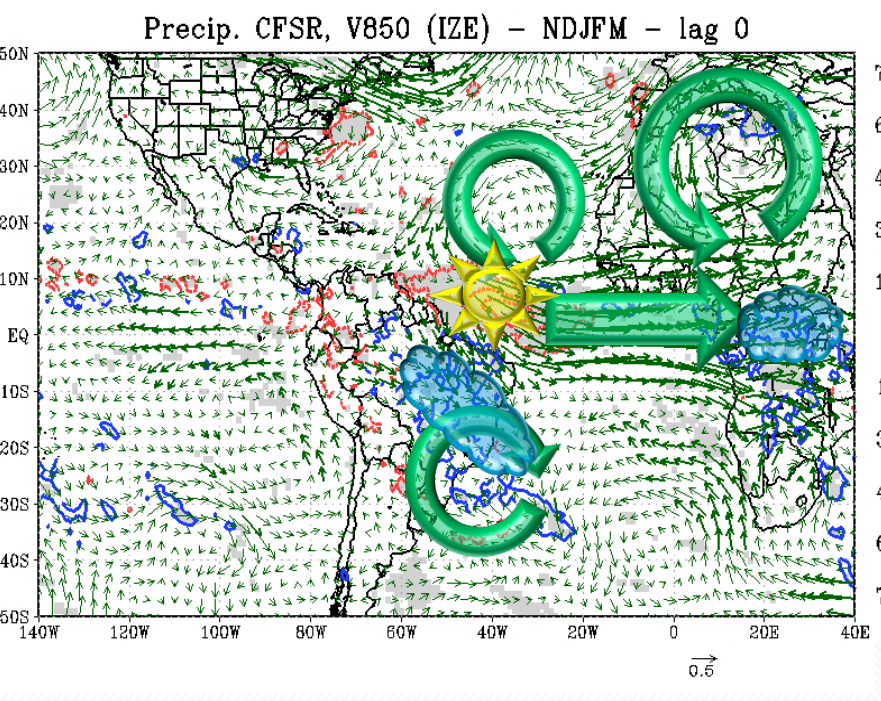
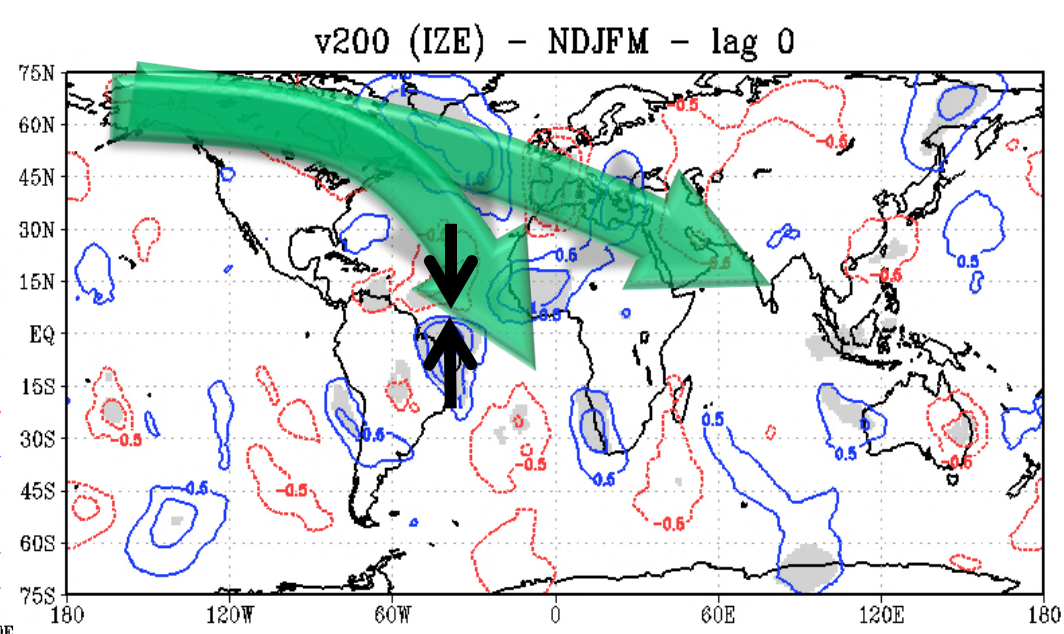
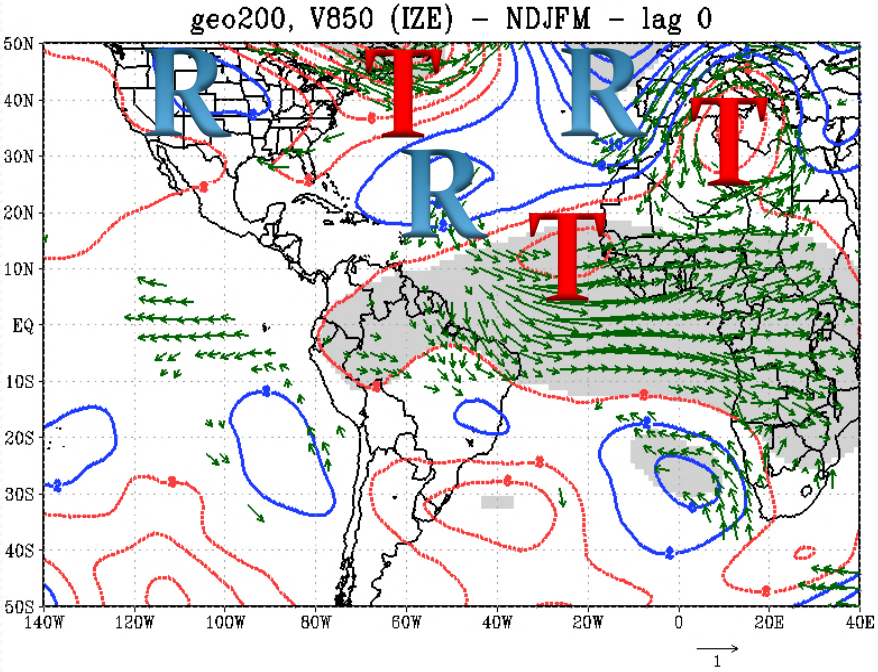
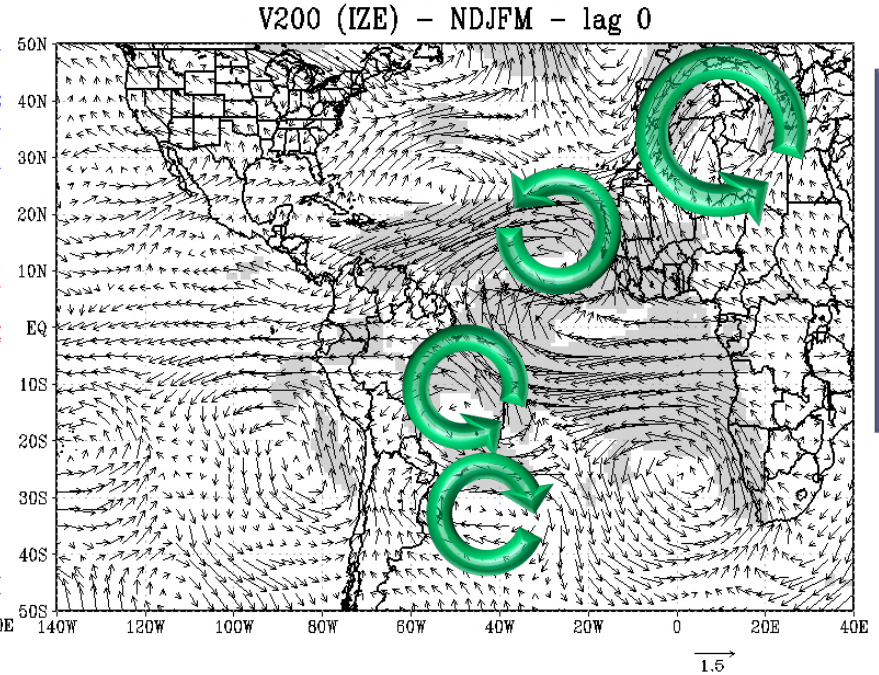
Tomaziello (2014)









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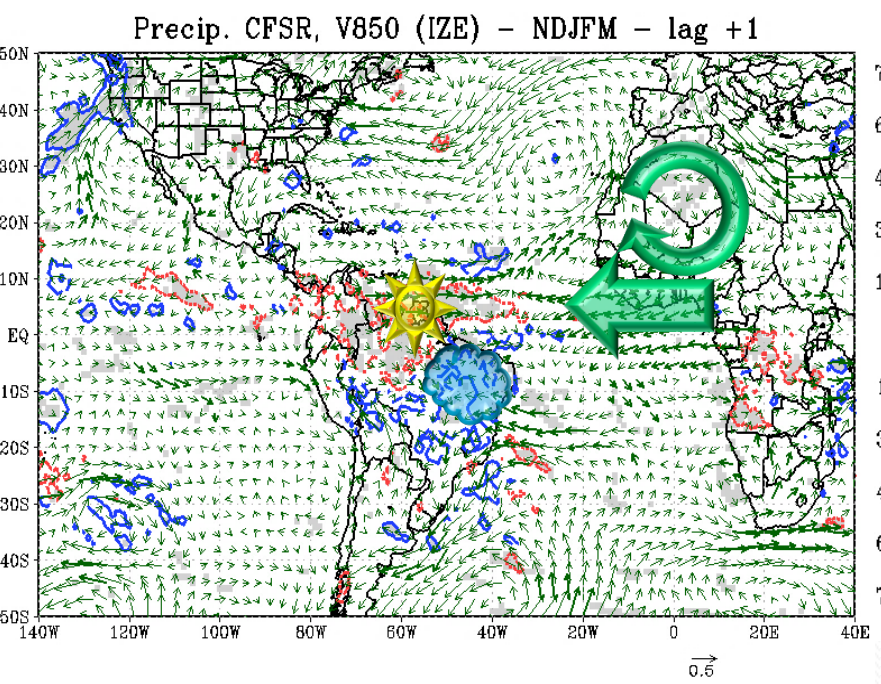
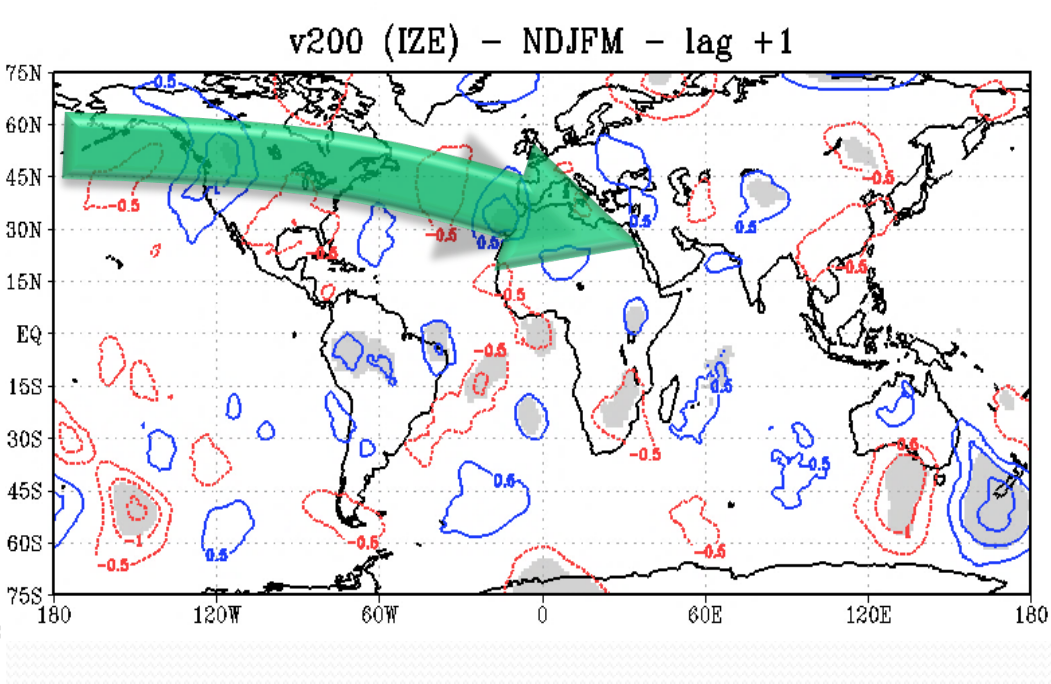
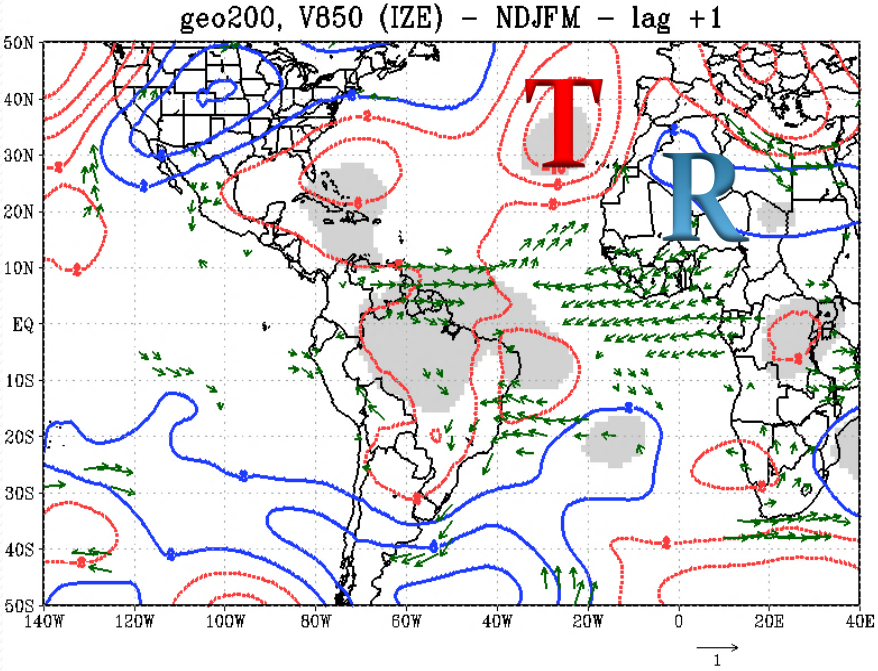
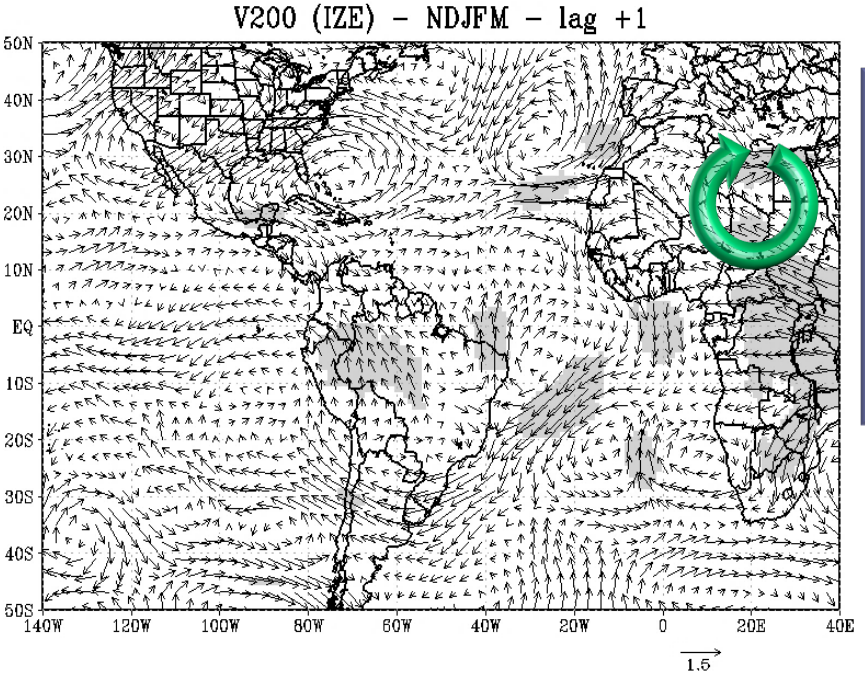
Tomaziello (2014)









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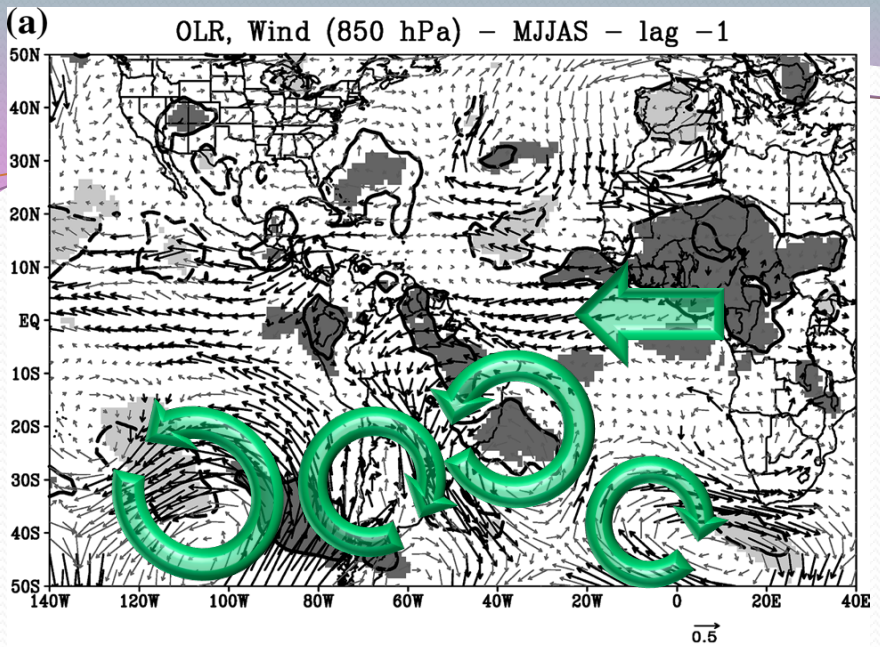
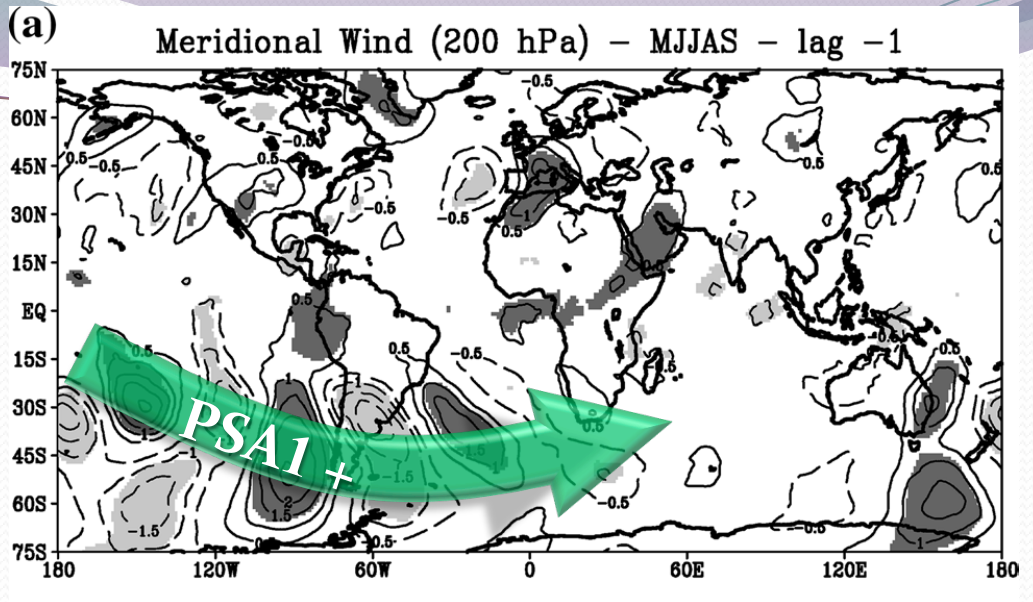
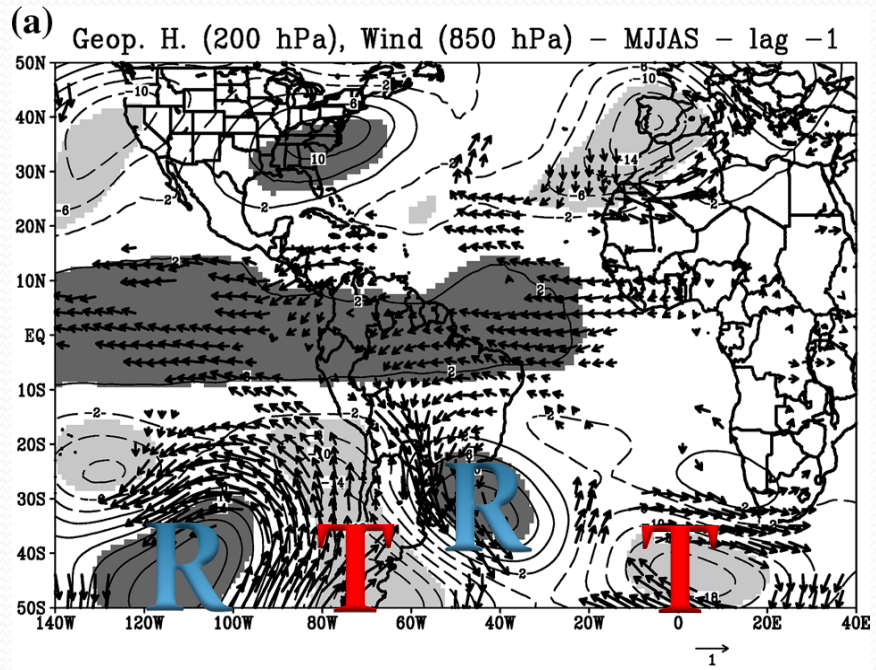
Tomaziello (2014)

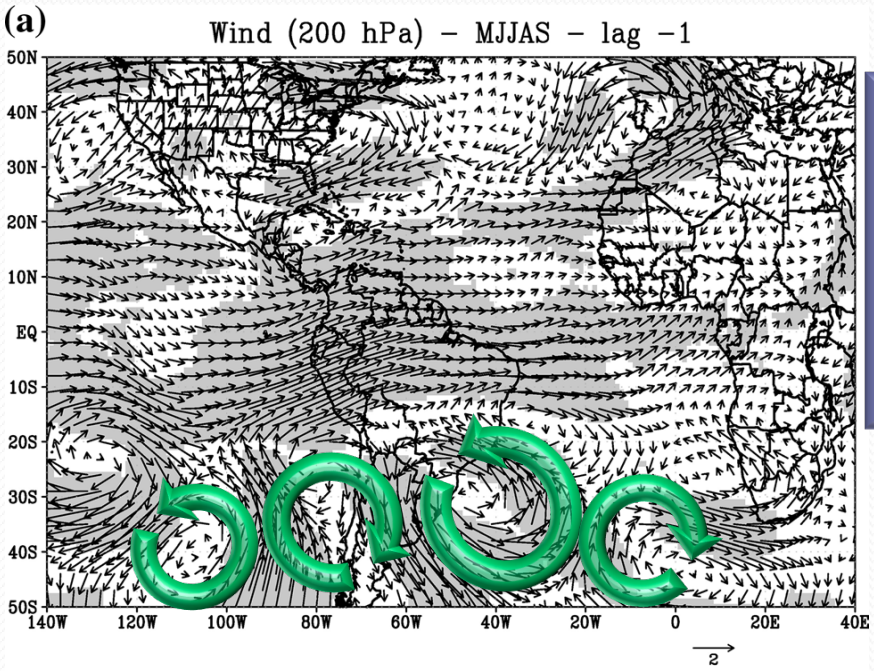
Austral winter
MJJAS

Intense A-ITCZ









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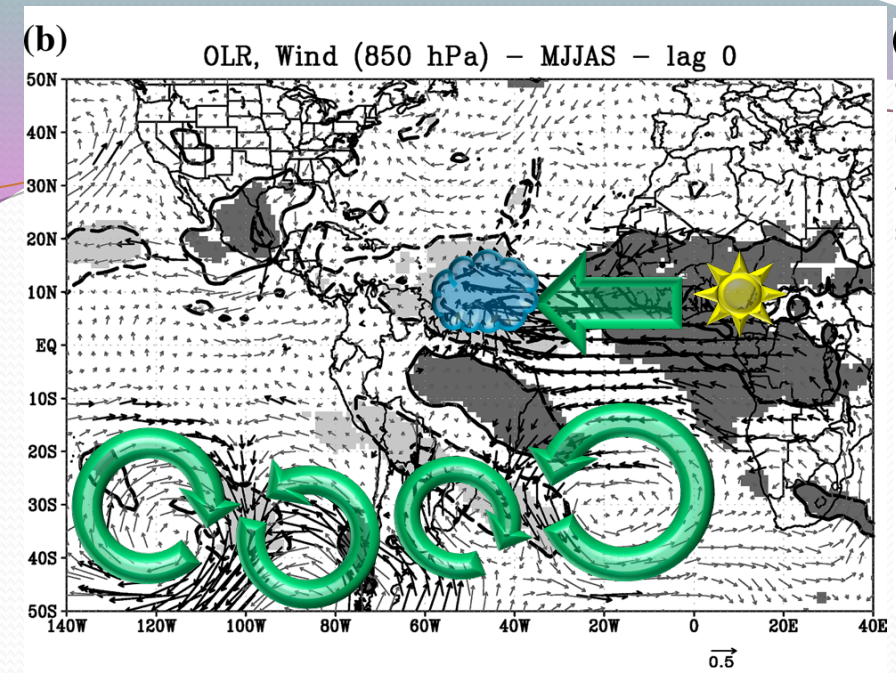
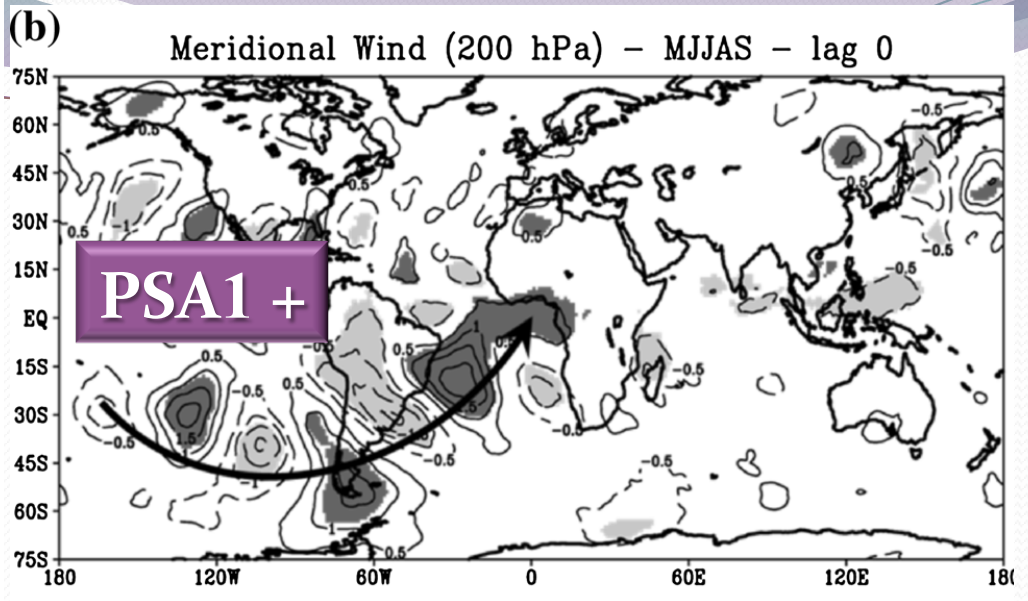
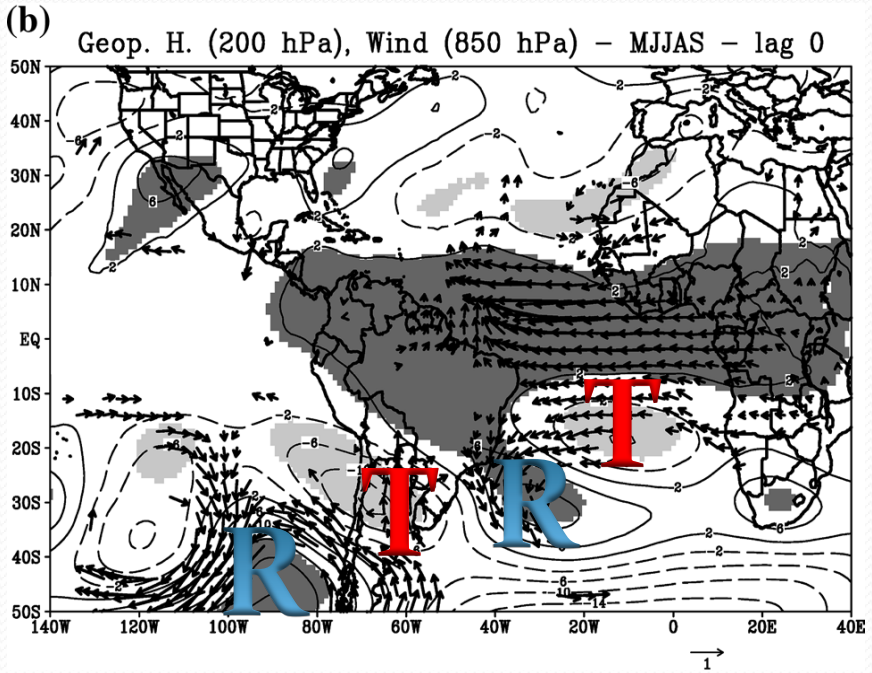
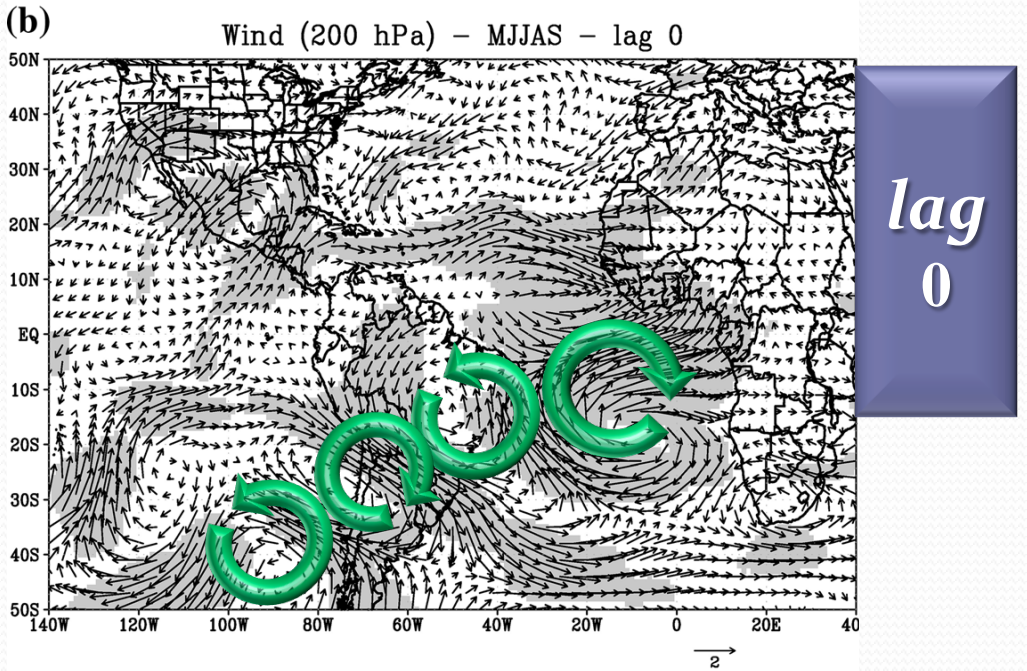
Tomaziello et al. (2016)

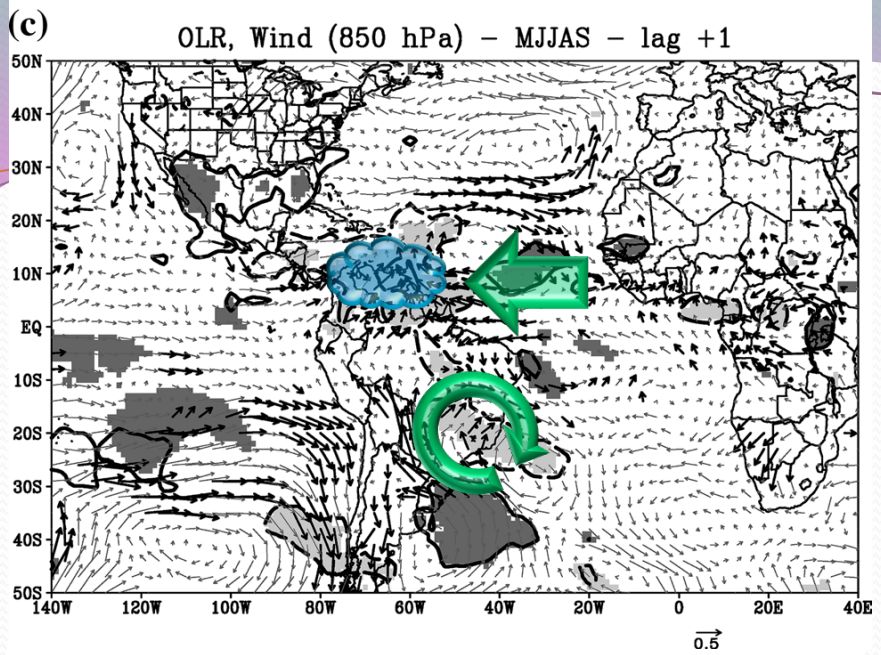


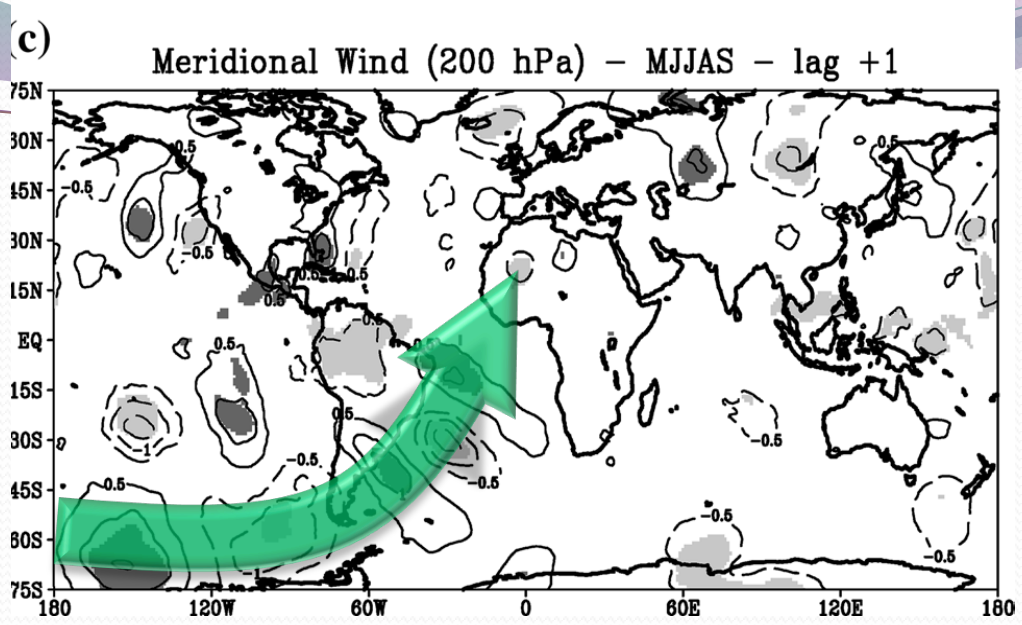


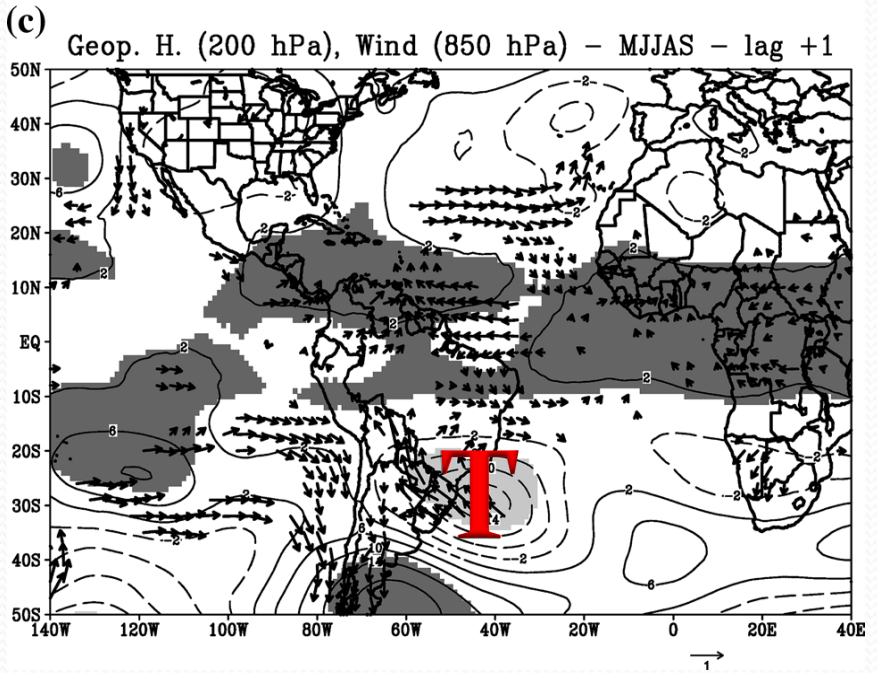


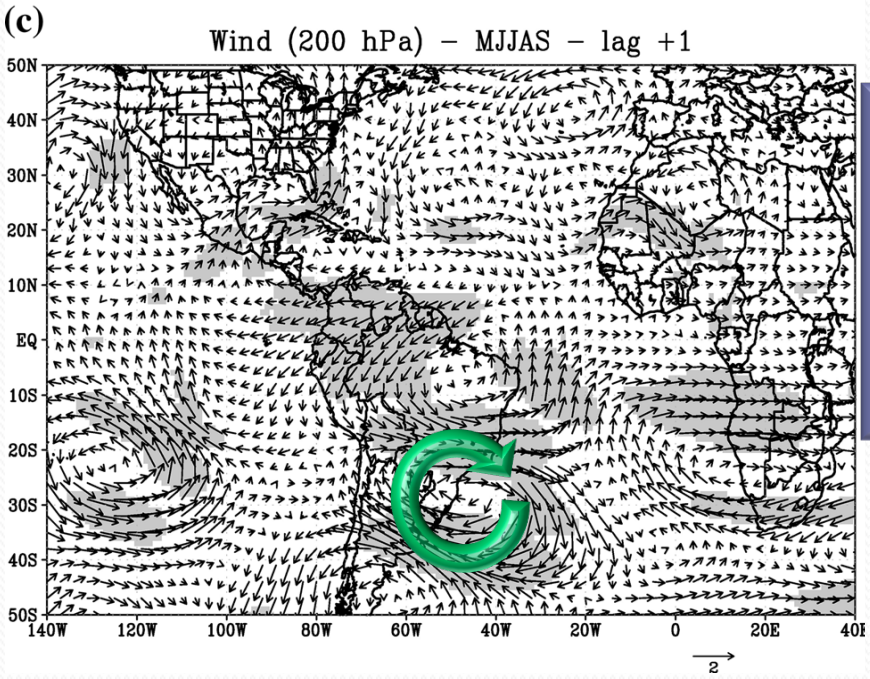


Tomaziello et al. (2016)









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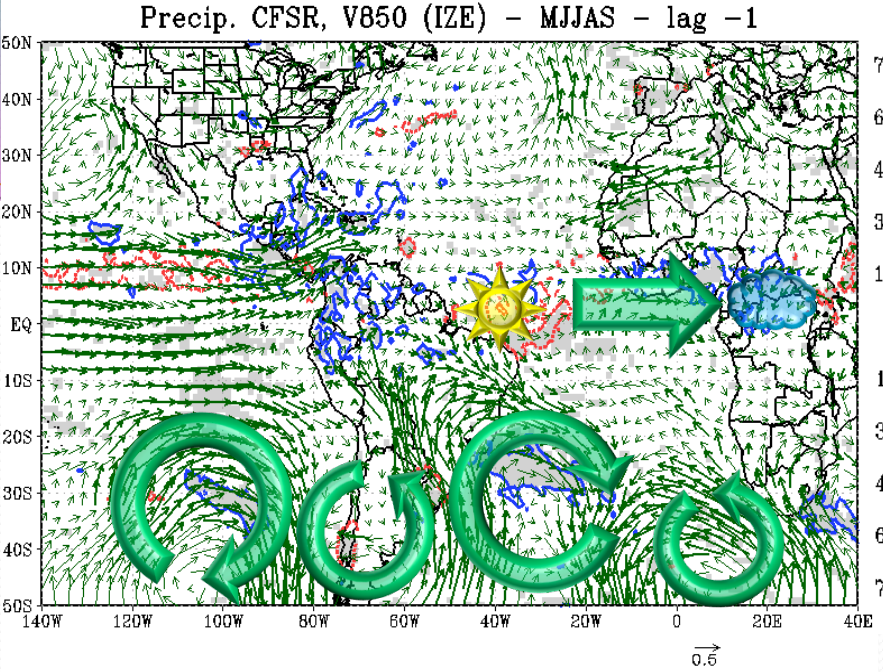
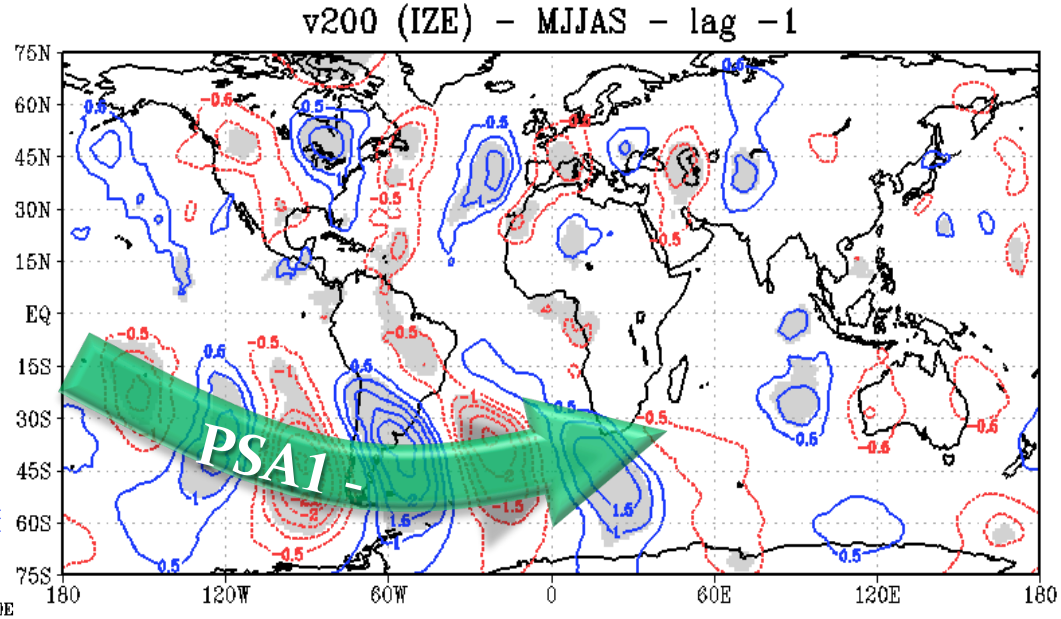
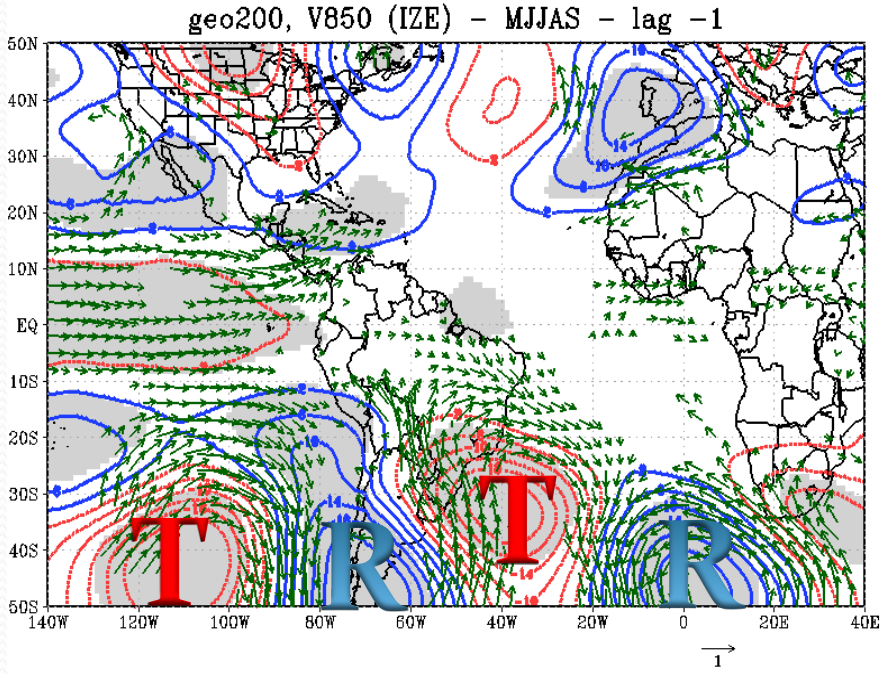
Tomaziello et al. (2016)

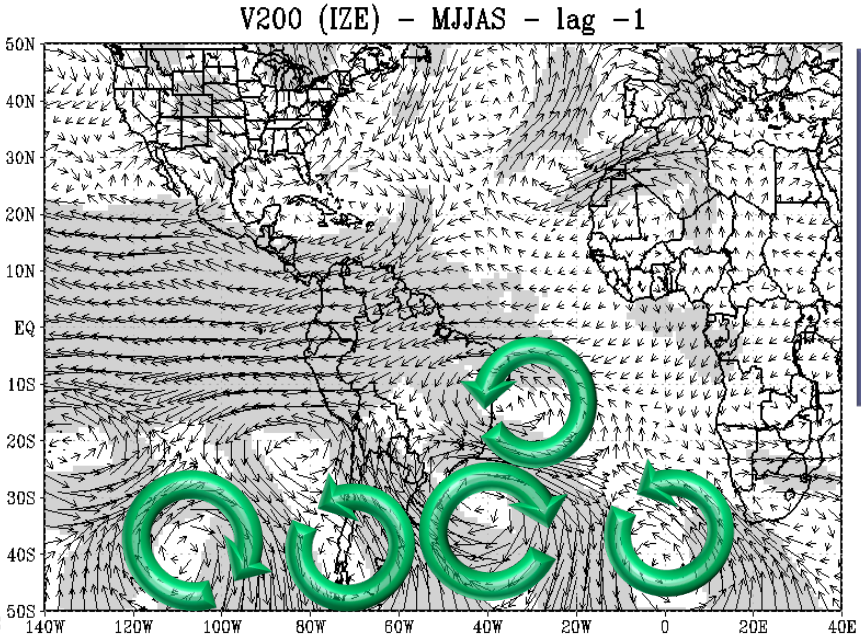
Austral winter
MJJAS

Weak A-ITCZ









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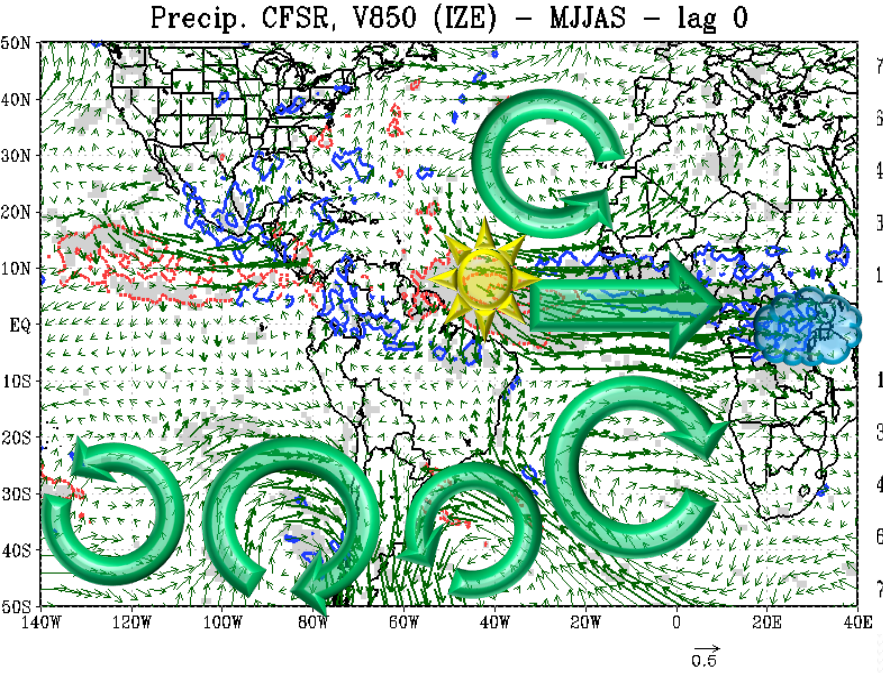
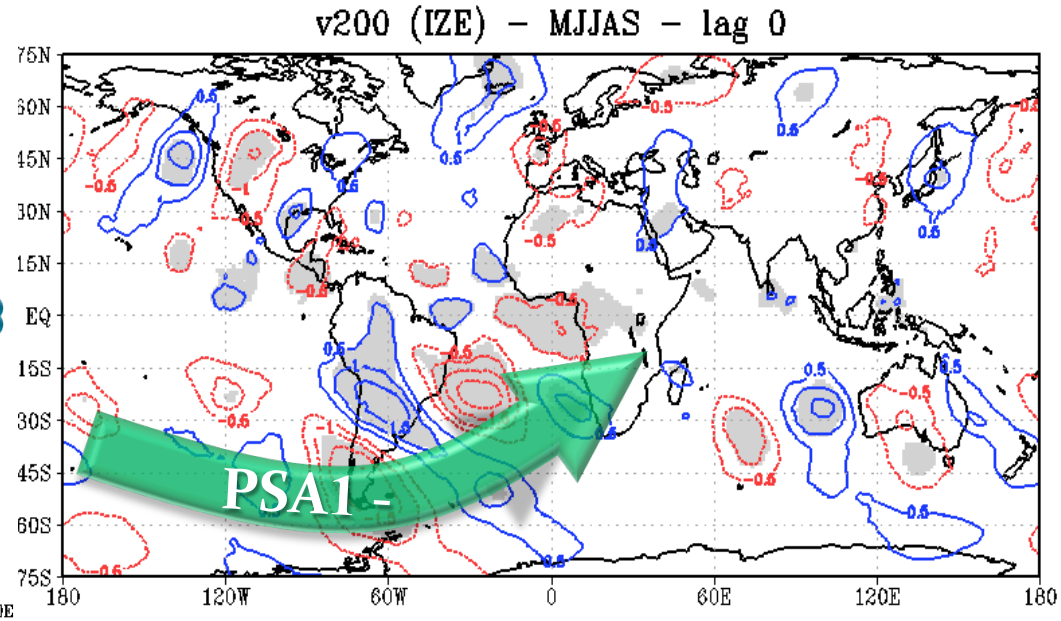
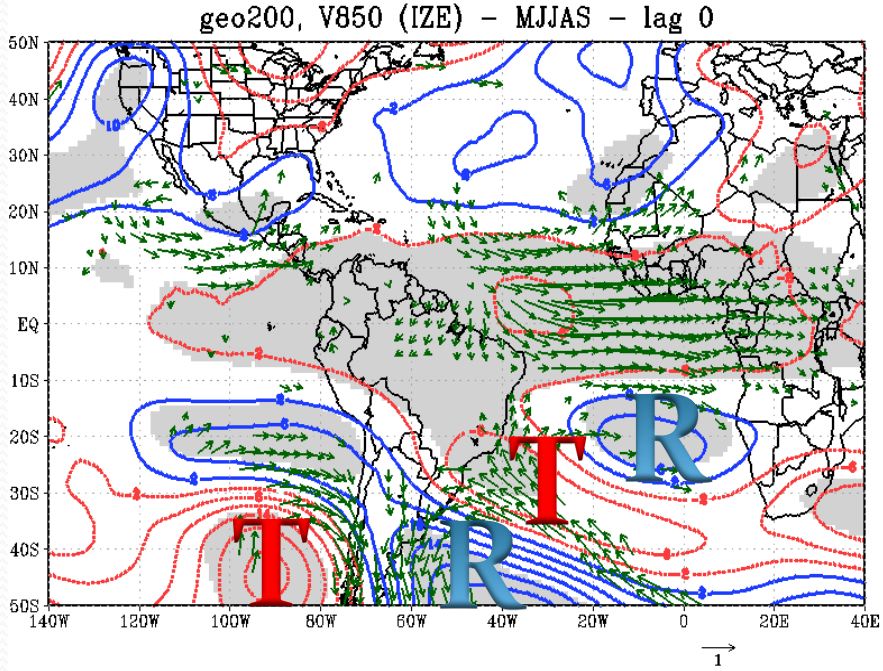
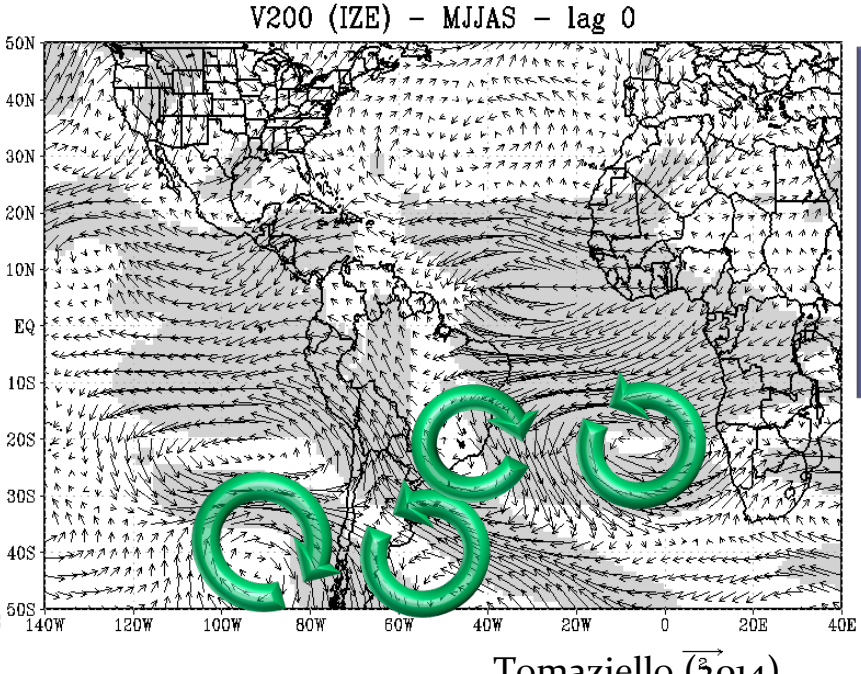
Tomaziello (2014)









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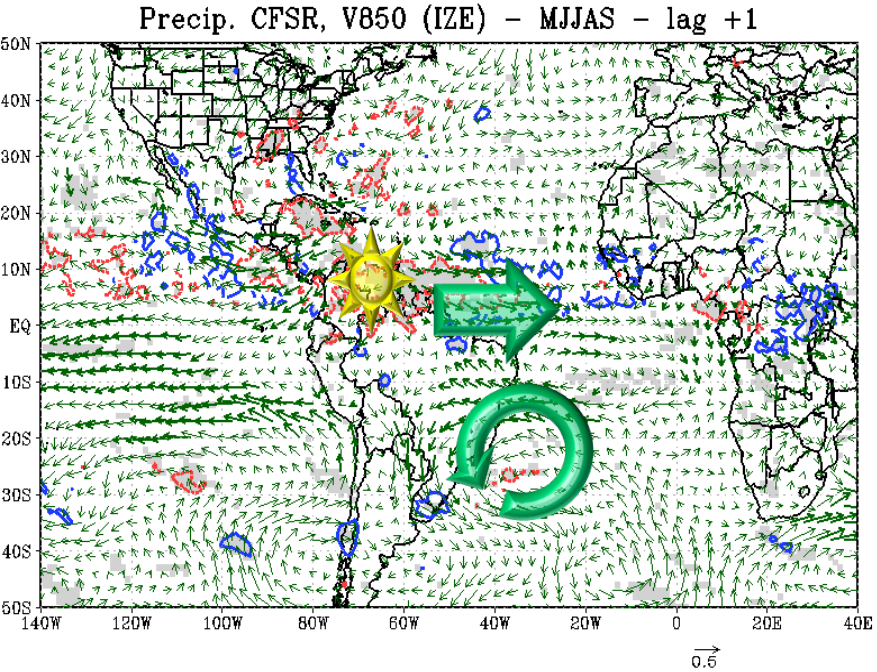
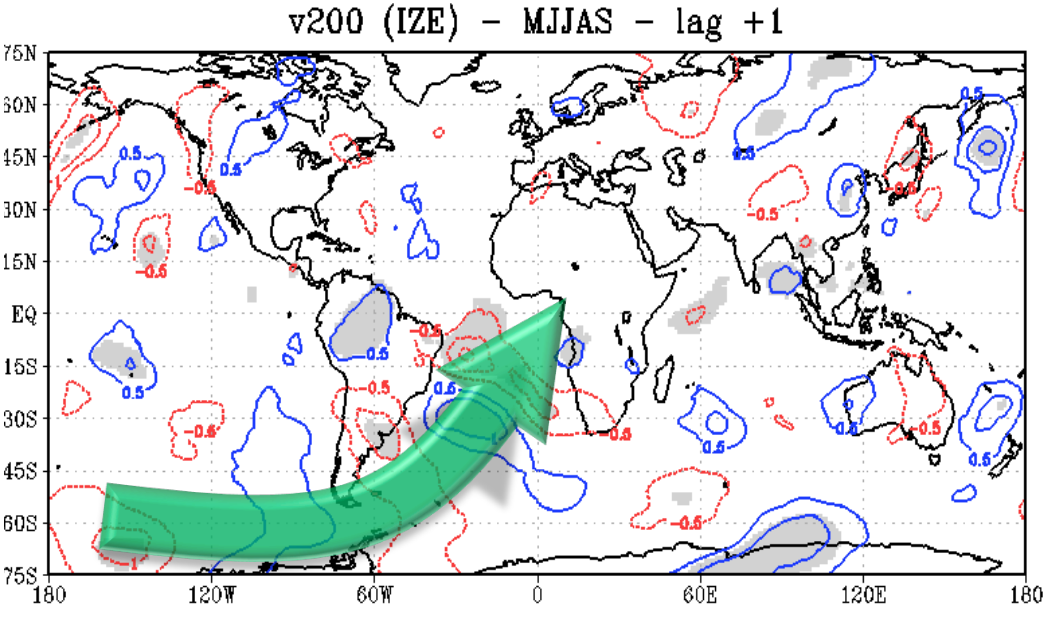
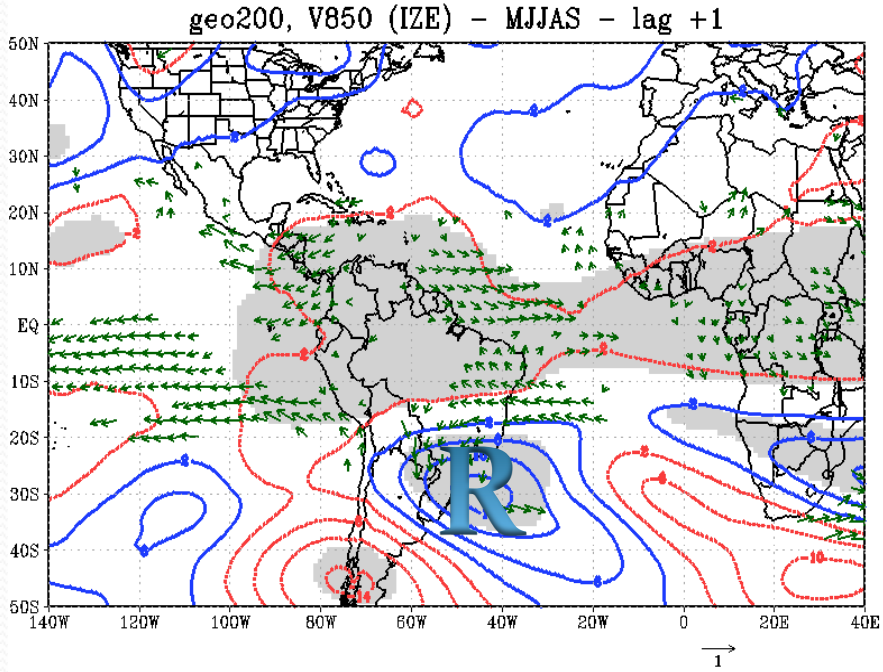
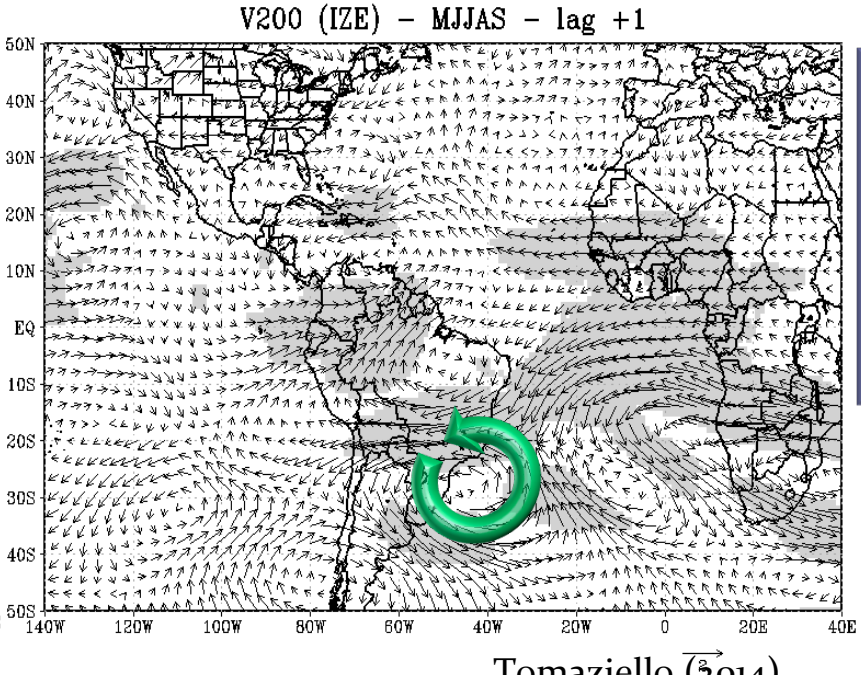
Tomaziello (2014)









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Tomaziello (2014)

Relationships with the MJO

Relationships with the MJO

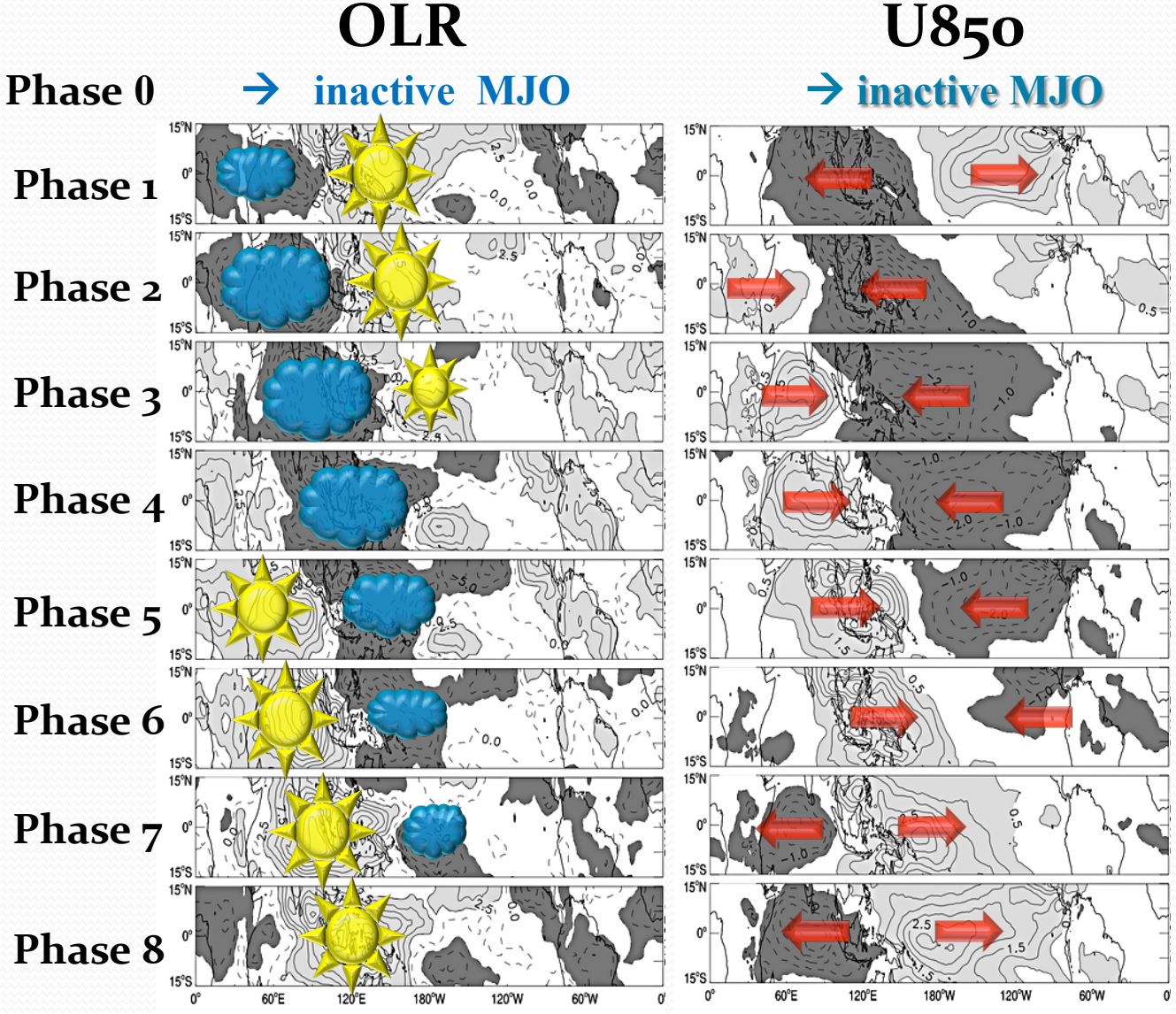
- Not all intrassazonal activity is necessarily linked to MJO (Jones and Schemm, 2000)

- **Index MJO phases → CEOF-1, CEOF-2**
  (Jones, 2009; Jones and Carvalho, 2011, 2012, 2014) – courtesy Dr. Charles Jones

OLR u850 u200

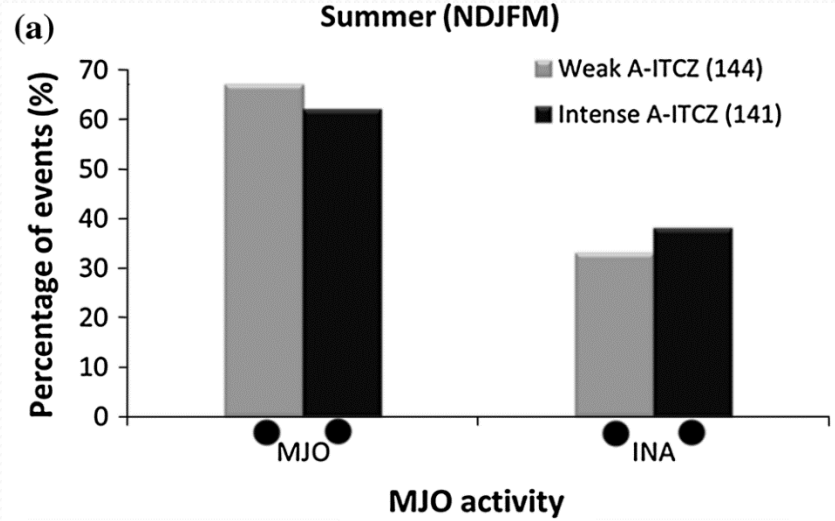
  - annual cycle removed, 20-200 days
  - 15 ºS-15 ºN

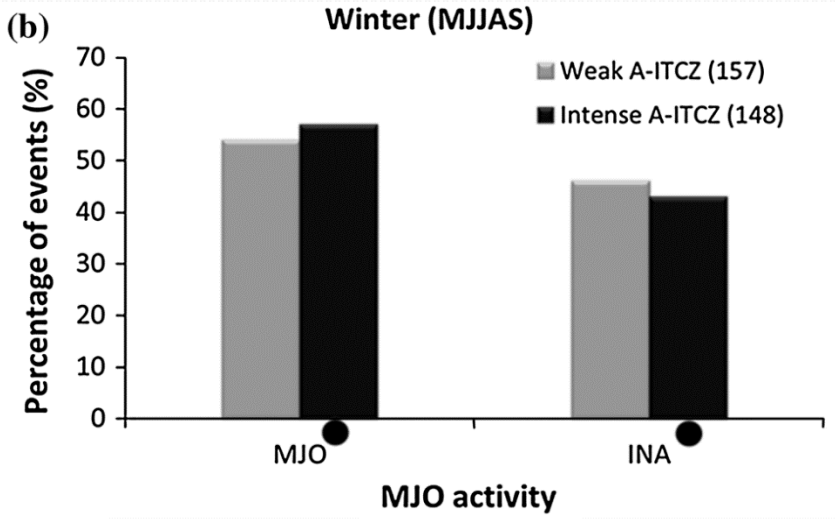
Madden-Julian Oscillation

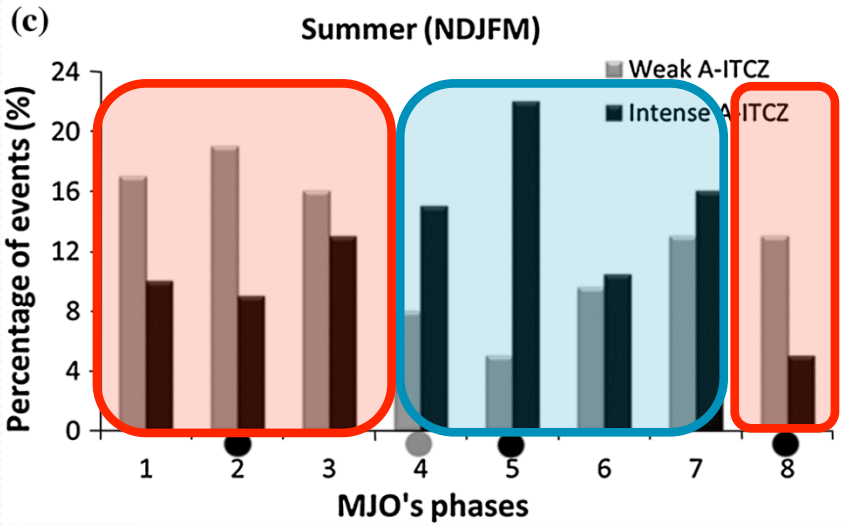


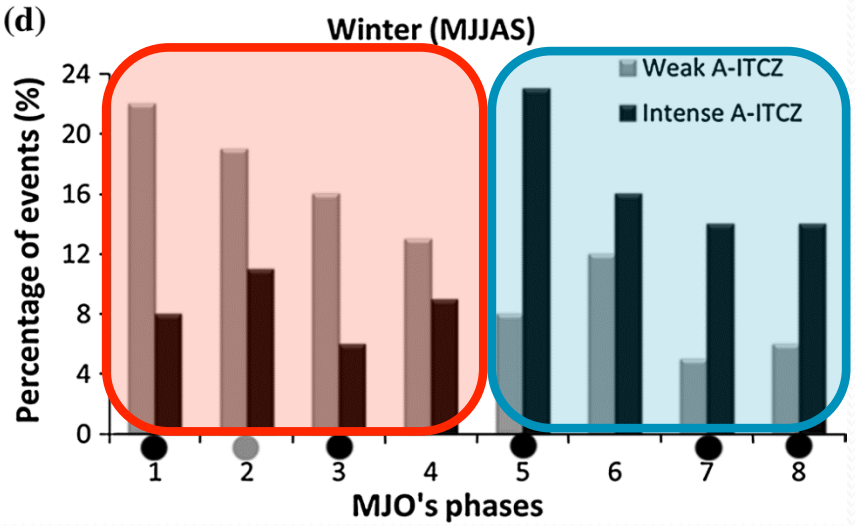
Courtesy Dr. Charles Jones

Relationships with the MJO









Tomaziello et al. (2016)

Conclusion

Conclusion

- **ITCZi: new** framework able to capture the spatio-temporal variability of A-ITCZ on several timescales

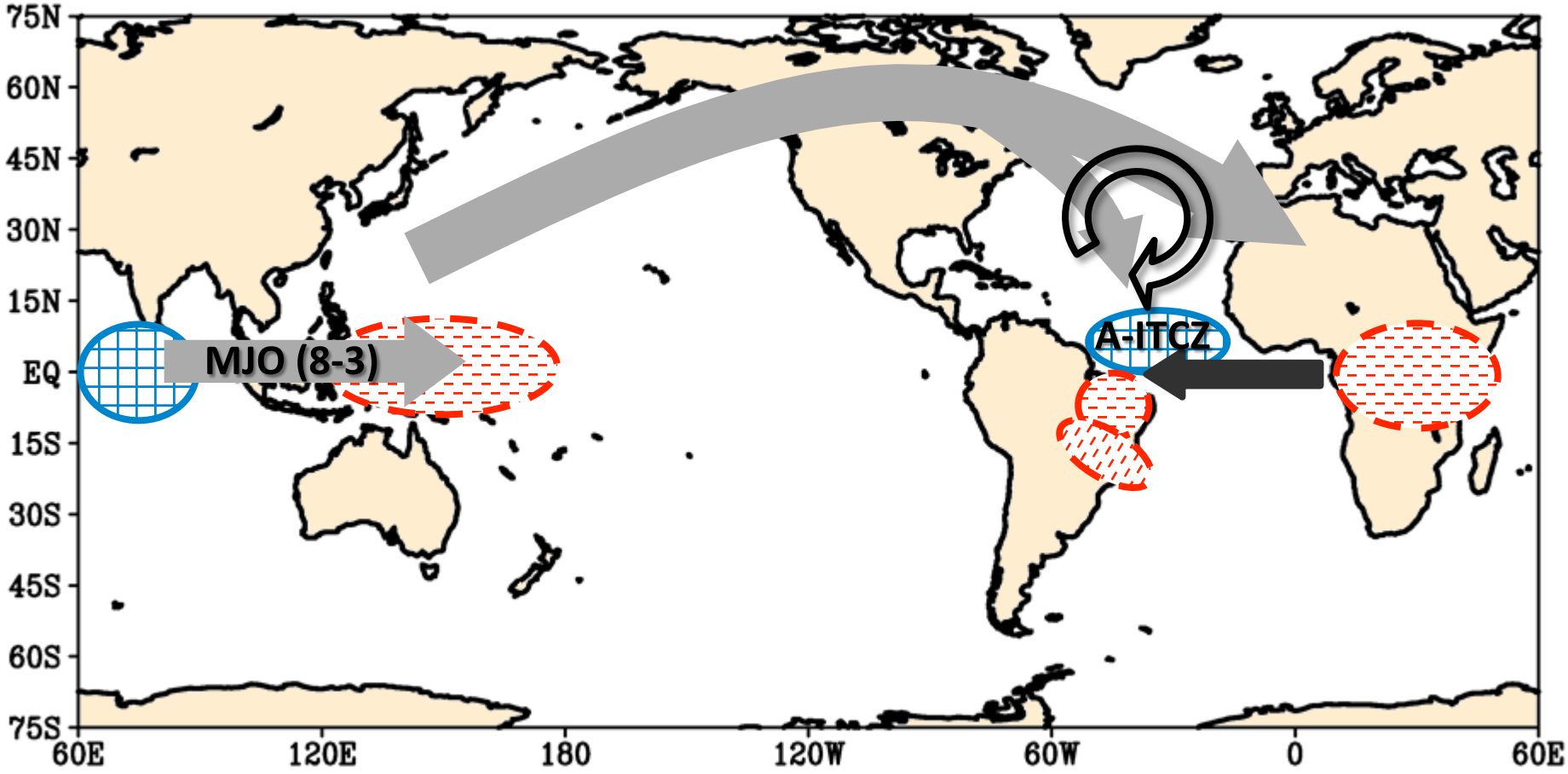
- Mechanism associated with the **A-ITCZ intraseasonal variability**: variations on NASH and SASH → changes in trade winds

- Main dynamic forcing: **Rossby** wave trains in the winter hemisphere

Conclusion

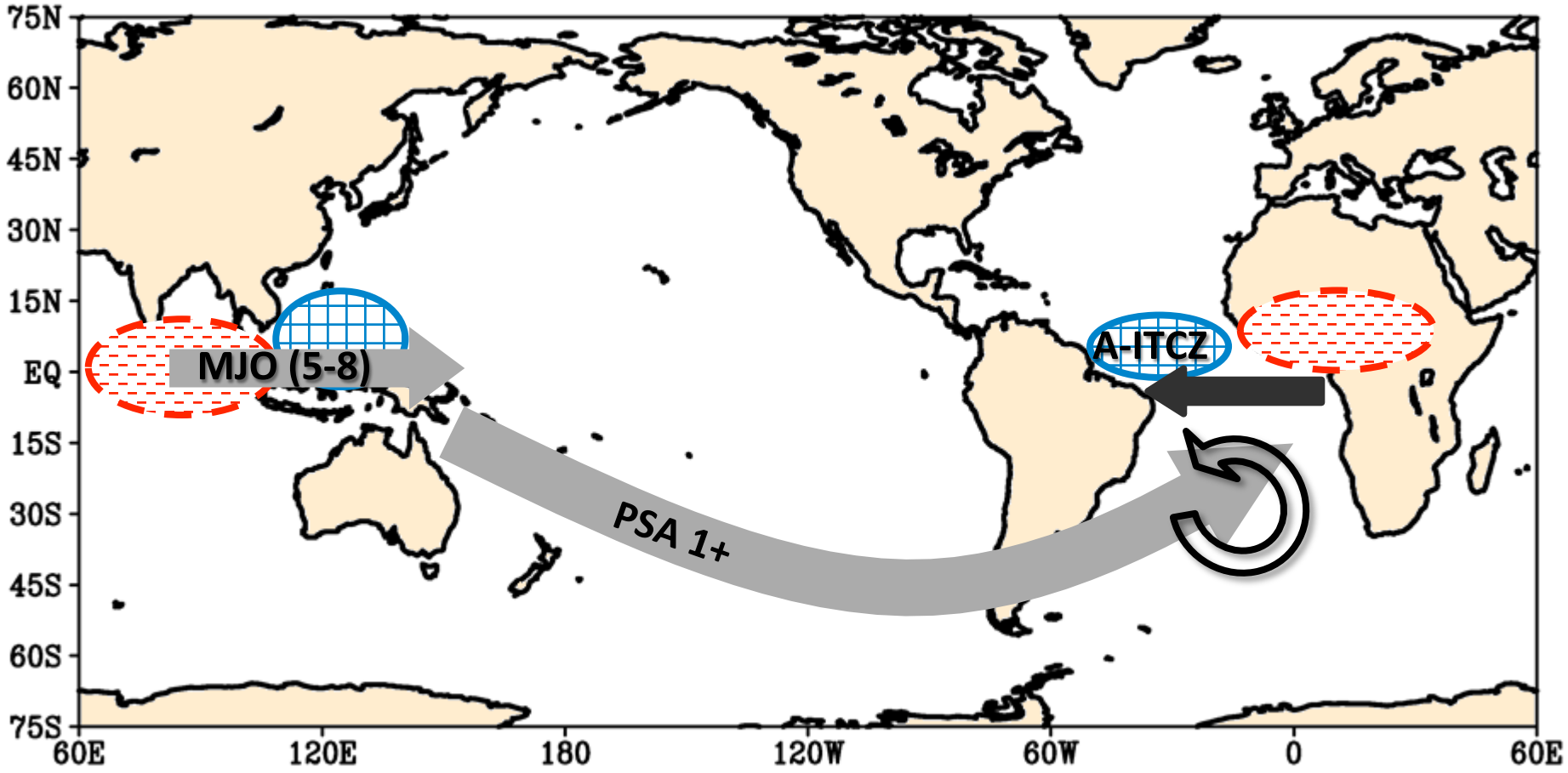
- **Majority of the A-ITCZ intraseasonal events:** active MJO
- **Intensification of the A-ITCZ:** convection in the Western Pacific and supression in the Indian Ocean/ Africa (MJO)
- This work gives evidences of MJO indirect effects via extratropics over tropical Atlantic
- Better understanding about atmospheric mechanisms that explain the intraseasonal variability of the A-ITCZ → contribution to advance weather and climate forecasts in low latitudes

Conclusion – Austral summer



Adapted from Tomaziello (2014)

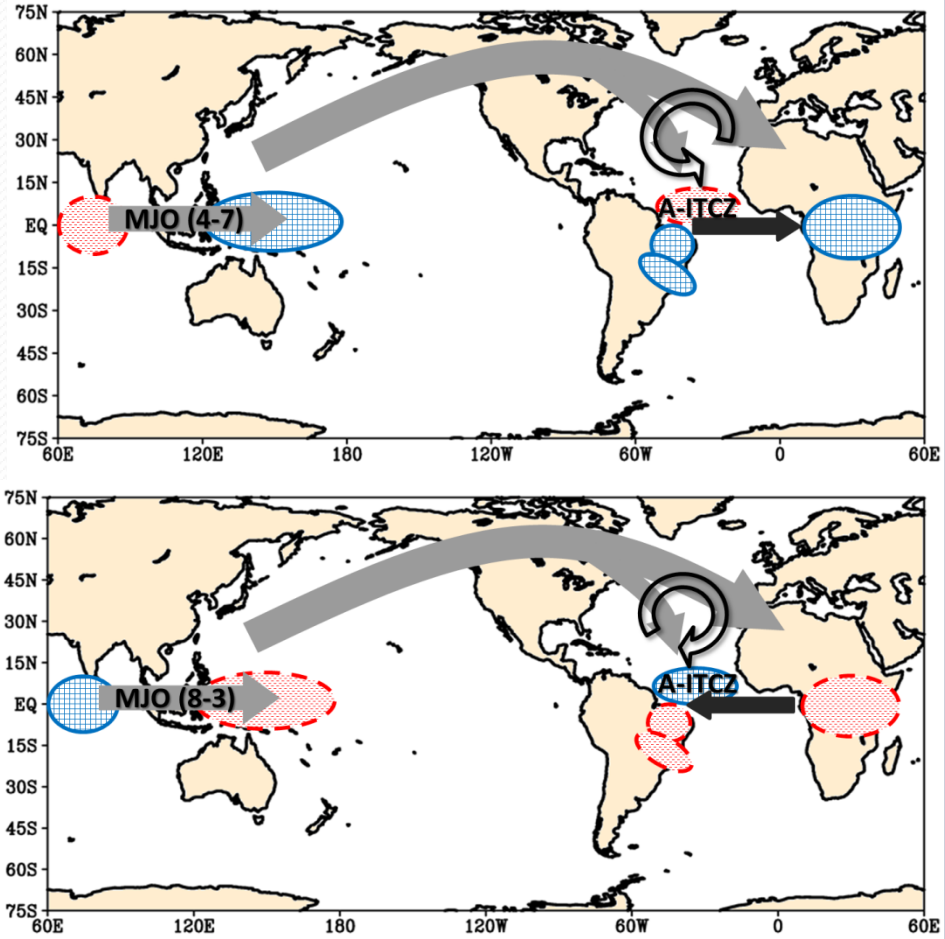
Conclusion – Austral winter



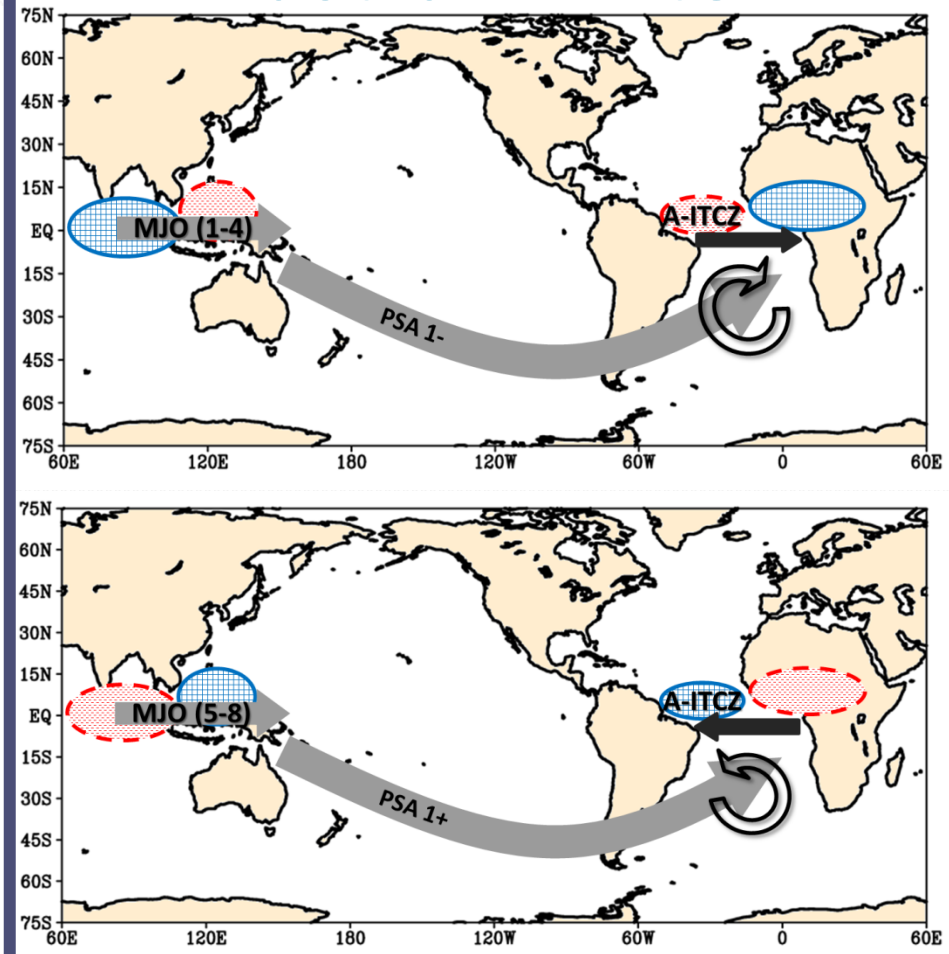
Adapted from Tomaziello (2014)

Conclusion – Summary

Austral Summer



Austral Winter



Adapted from Tomaziello (2014)

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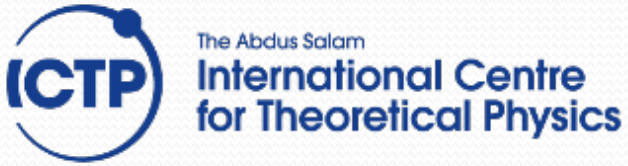

Thank you!
Grazie!

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"Knowledge is like a sphere, the greater its volume, the larger its contact with the unknown".

Blaise Pascal