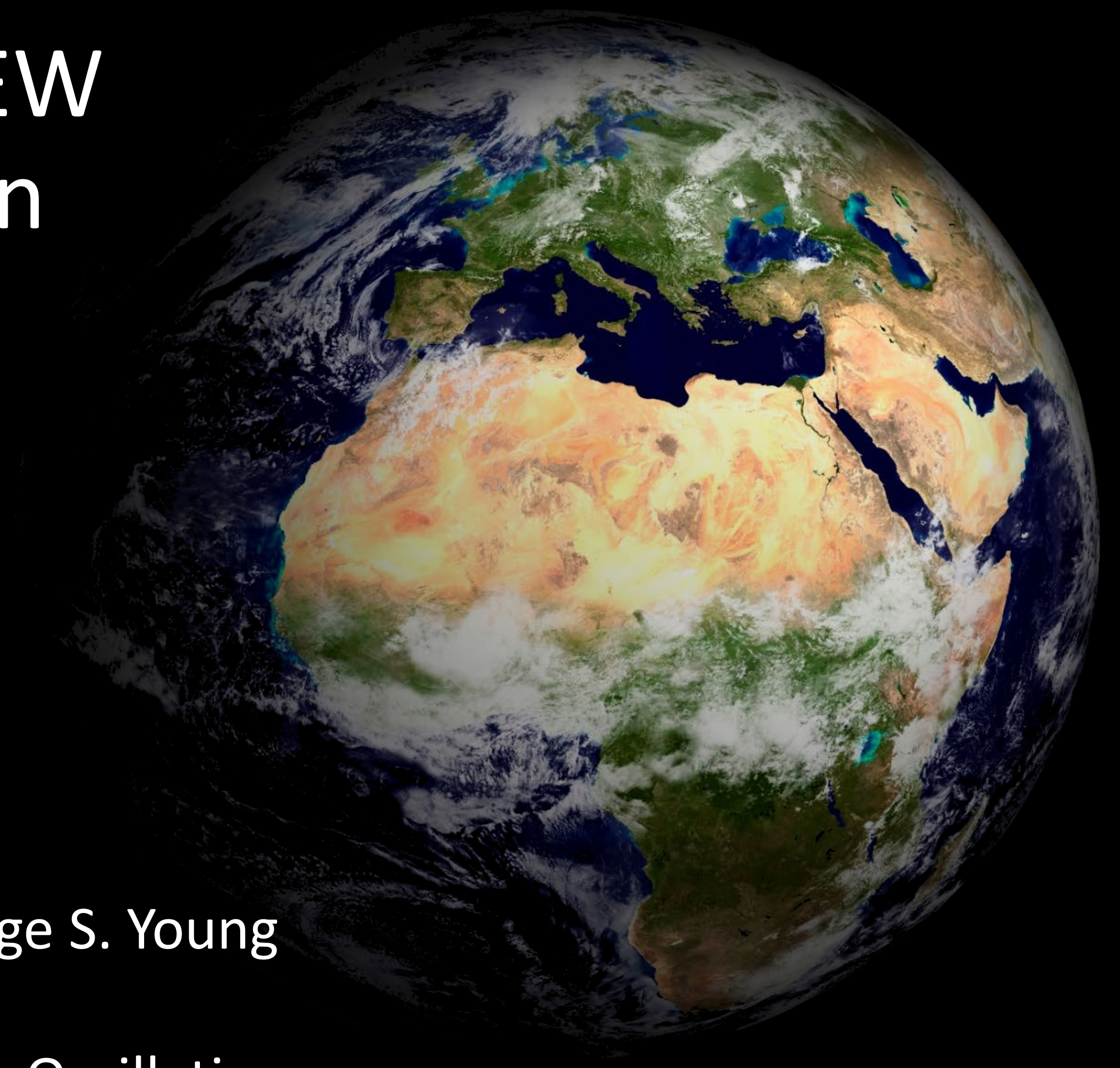
Differences between MCS-AEW coupled-systems that result in tropical cyclogenesis and those that do not



Kelly M. Nunez Ocasio, Jenni L. Evans and George S. Young
7th January 2019
AMS Seventh Symposium on the Madden-Julian Oscillation and Sub-Seasonal Monsoon Variability
Tropical Waves Session

Image from GTR

Role of Convection in the evolution of AEWs

- Perturbed unstable basic state (*Berry and Thorncroft 2005*).
- PV reversal gradient that support AEWs growth (*Hsieh and Cook 2005, 2008)*
- Convection on the scale of the developing Tropical Cyclone (TC) (*Lin et al. 2005)*
- Moist convection in East Africa and AEW activity (*Leroux 2010)*

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- Evident role of convection in the growth and maintenance of AEWs and in tropical cyclogenesis
- Nature of the AEWs leaving the West African coast can impact the probability of tropical cyclogenesis in the eastern Atlantic *(Hopsch et al. 2010)*

Questions remain…

- *Tropical Cyclogenesis related to the interaction of AEW and environment, the coupled MCS-AEW system or a combination of both factors?*

- *Why do some AEWs develop TCs and others don't? Is it related to the MCS coupling?*

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- ❖ *Tropical Cyclogenesis related to the interaction of AEW and environment, the coupled MCS-AEW system or a combination of both factors?*
- ❖ *Why do some AEWs develop TCs and others don't? Is it related to the MCS coupling?*

Research Questions

- ❖ How does the MCSs coupled to an AEW affect the possibility of TC genesis?
- ❖ Is there distinct spatial relation or characteristics between a coupled MCS-AEW system of an AEW associated with TC genesis (DEV) that is not evident in a coupled system of an AEW that is not associated with TC genesis (NONDEV)?

EUMETSAT

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Tracking Algorithm for Mesoscale Convective Systems (**TAMS**)

EUMETSAT

- Identification
  Centroids
- Tracking
  Area-Overlapping & Projected-Cloud-Edge Techniques
- Classification
- Precipitation assignment
- Assigning MCSs to specific AEWs

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AEW tracks from Alan Brammer, University at Albany (extension of NHC Best Track data)

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Tracking Algorithm for Mesoscale Convective Systems (**TAMS**)

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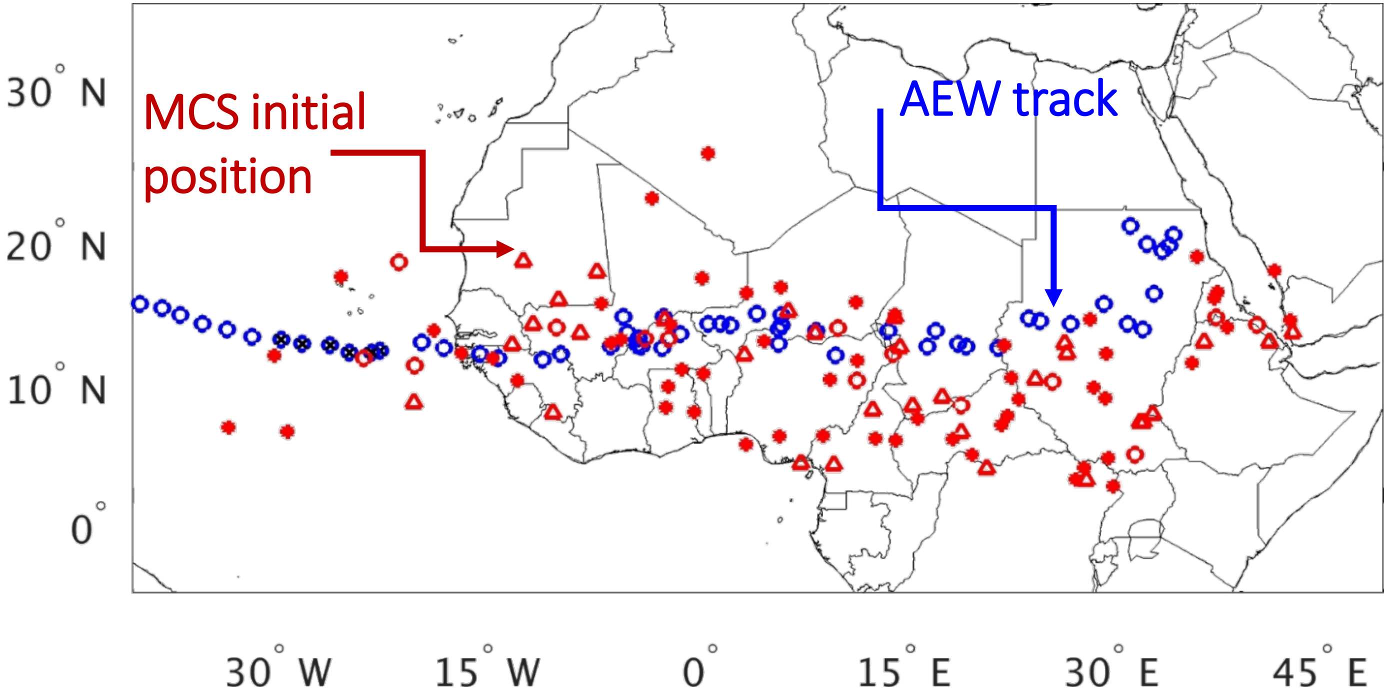
Period: July-September 2006 Season
Domain: 0˚ to 30 ˚ N and 35 ˚ W to 45˚ E



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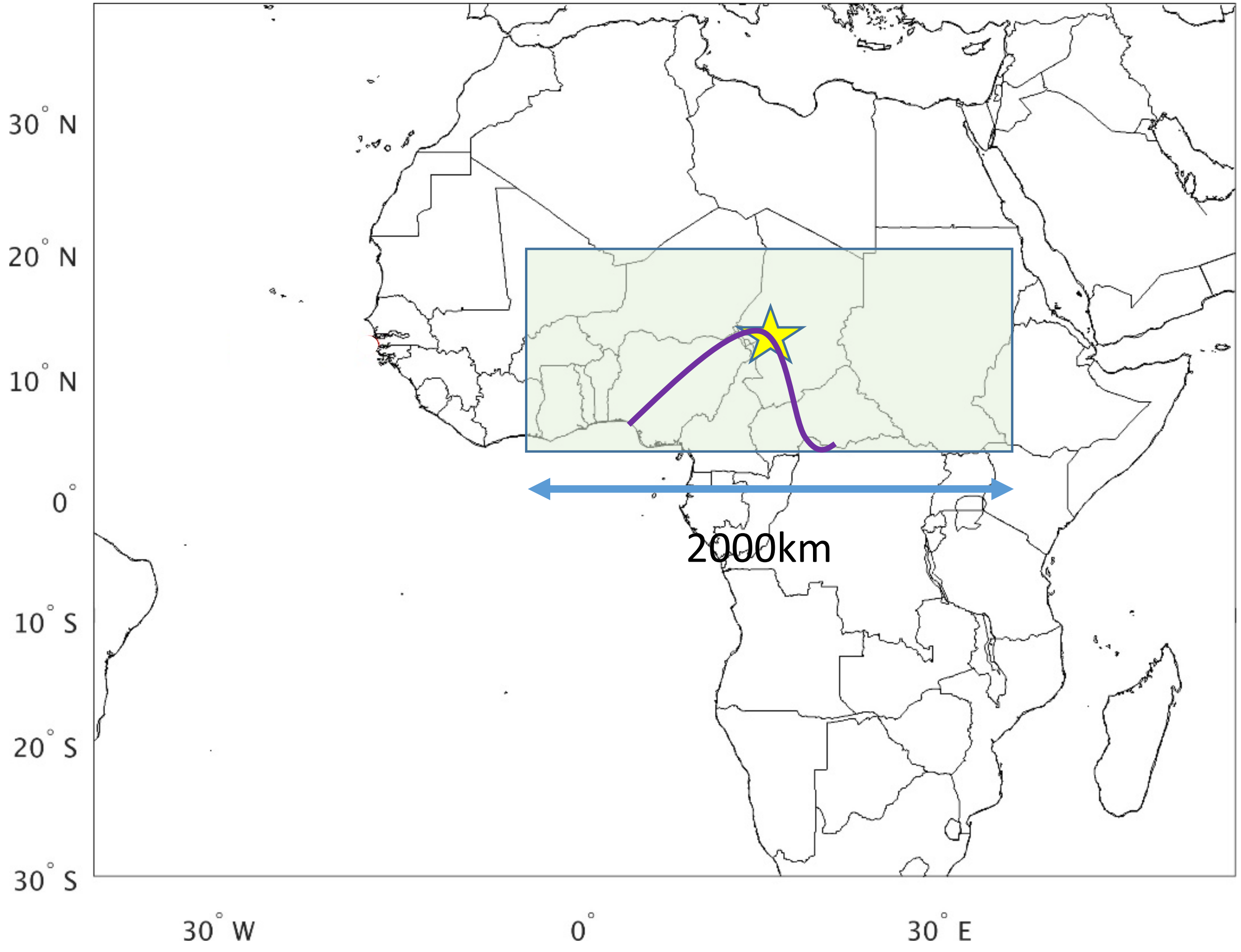
ERA-INTERIM

ECMWF

- AEWs tracked between 5°N and 20 °N to capture both north and south tracks *(Diaz and Aiyyer 2012; Kiladis et al. 2006)*
- Box defined by a total of 2000 km longitudinally centered on AEW vorticity maximum.
  - Allowing for symmetric and asymmetric AEWs



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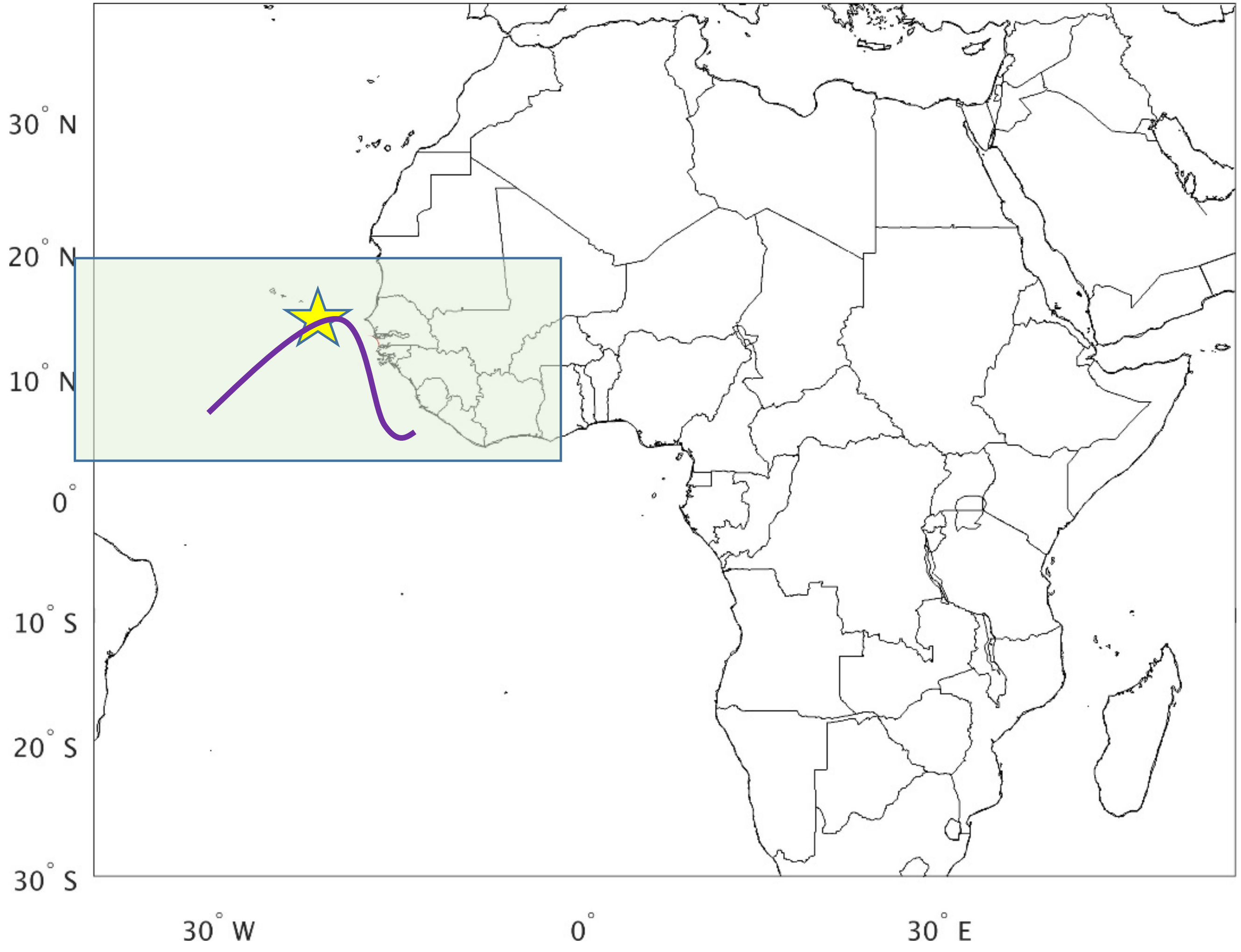

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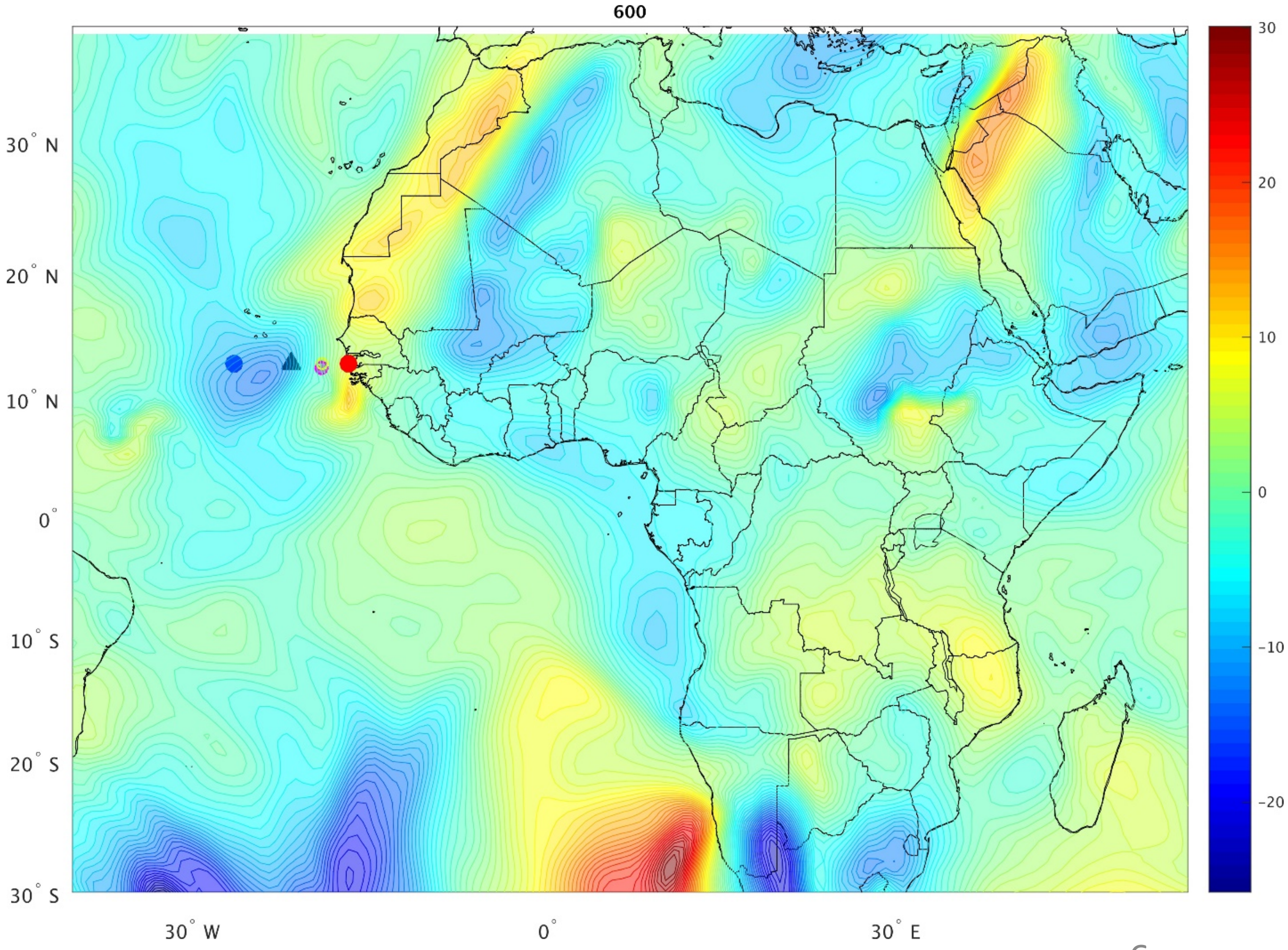
ERA-INTERIM

ECMWF

- Meridional average of V between 5 °N and 20° N to obtain northerly and southerly maximum of AEW
- 3 levels (850 hPa, 600 hPa and 700 hPa)
- MCSs will be coupled to AEW if its within the distance of trough length identified from the trough axis at the time of initiation



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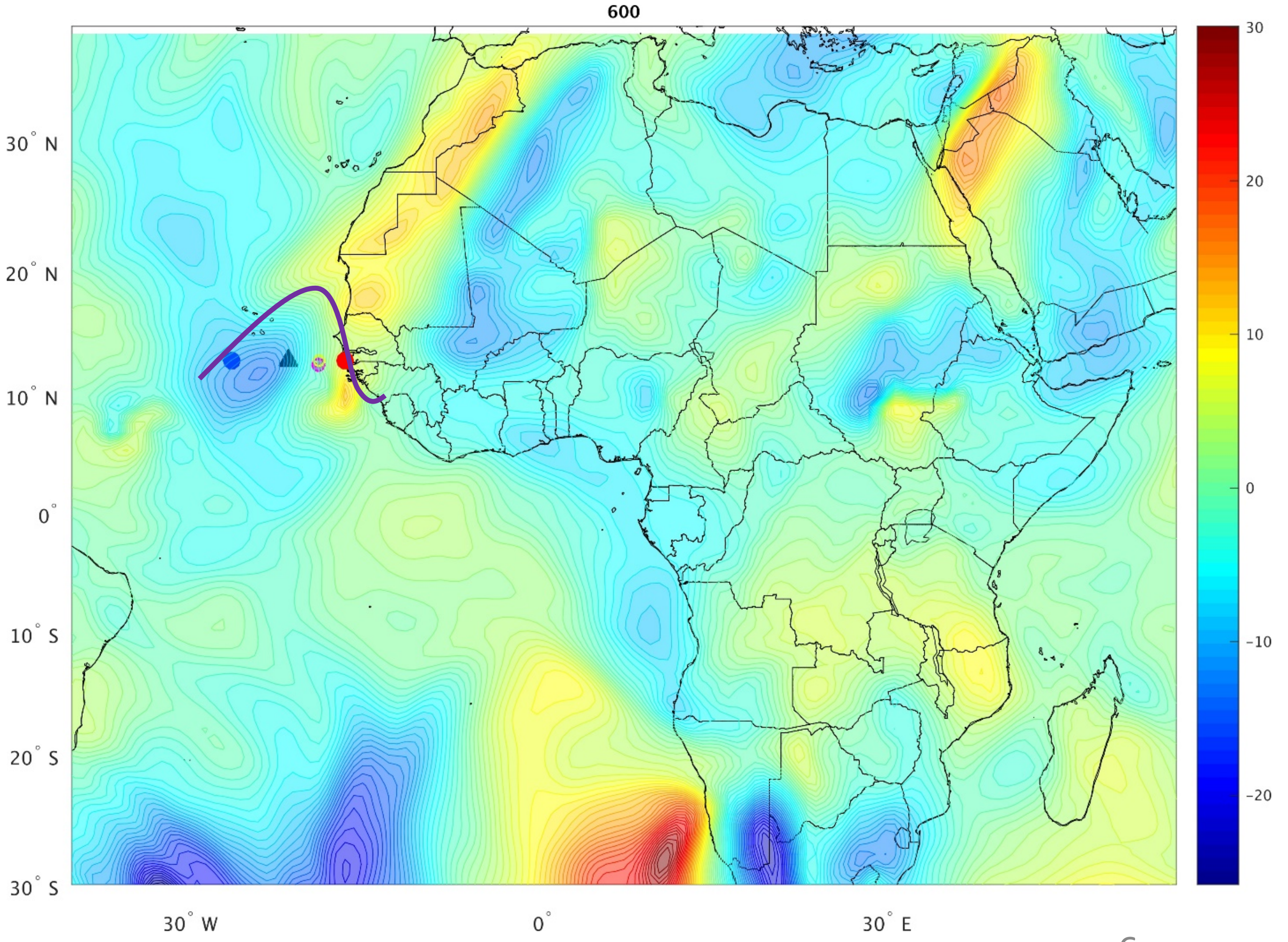

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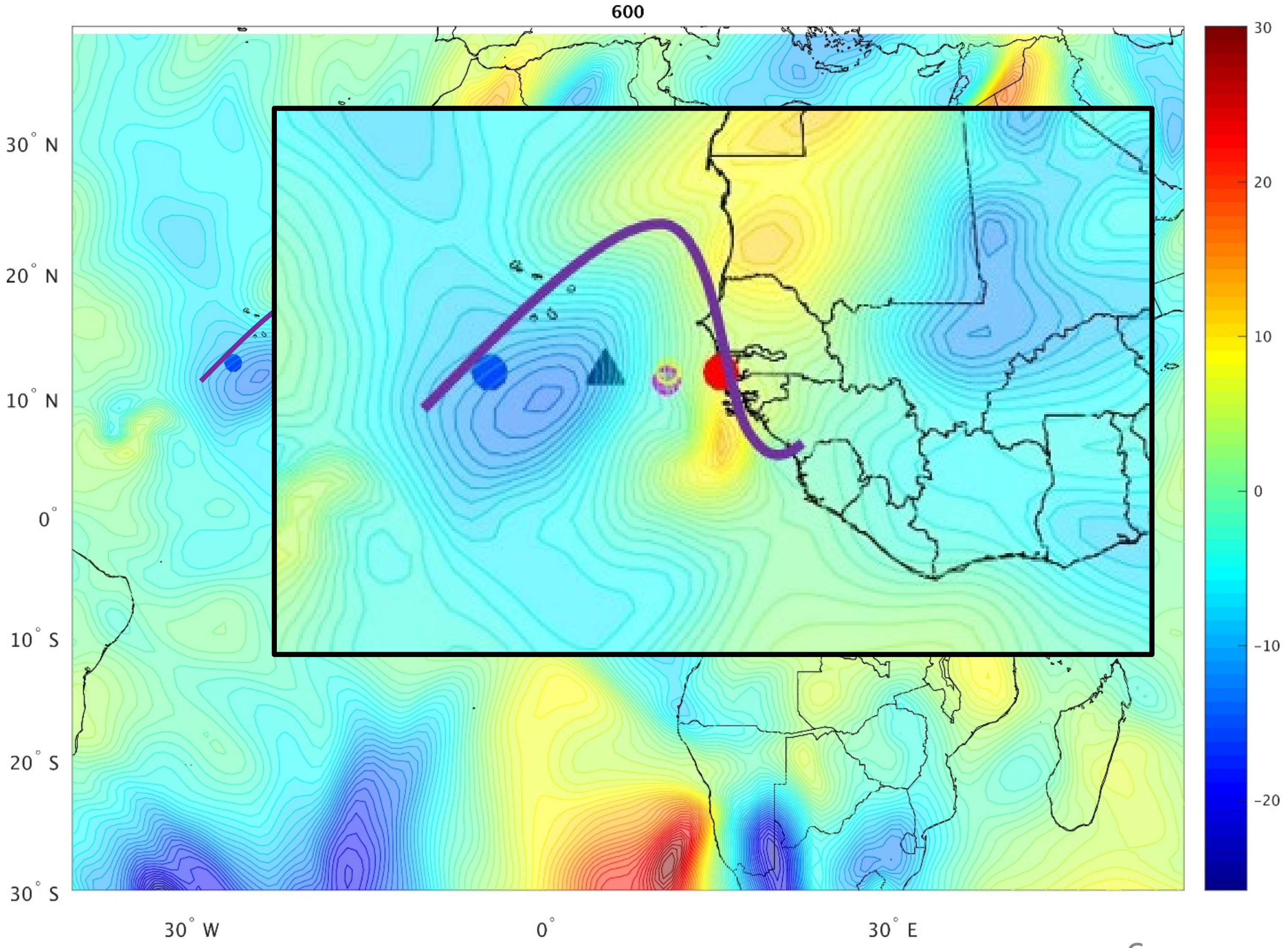

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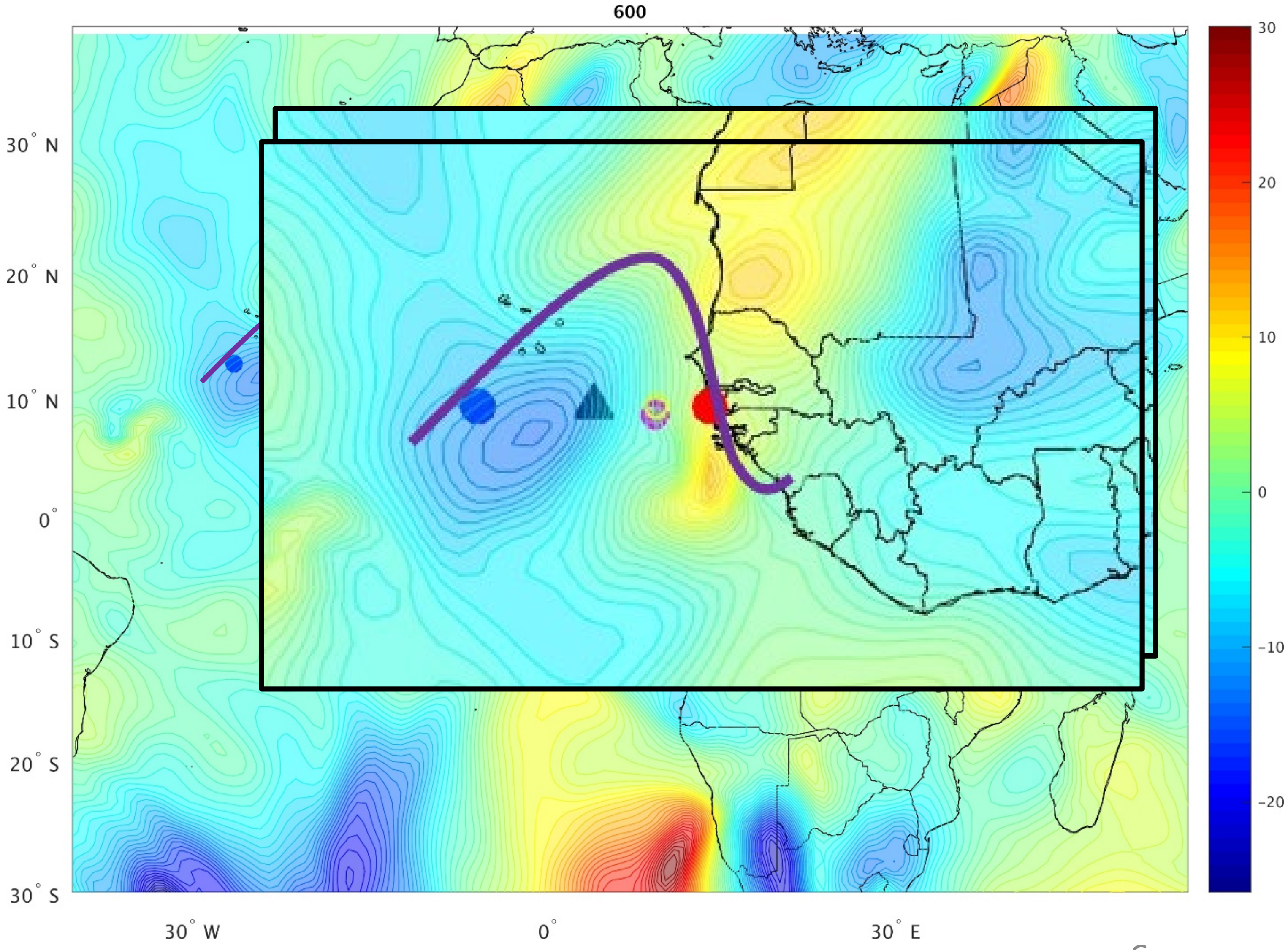

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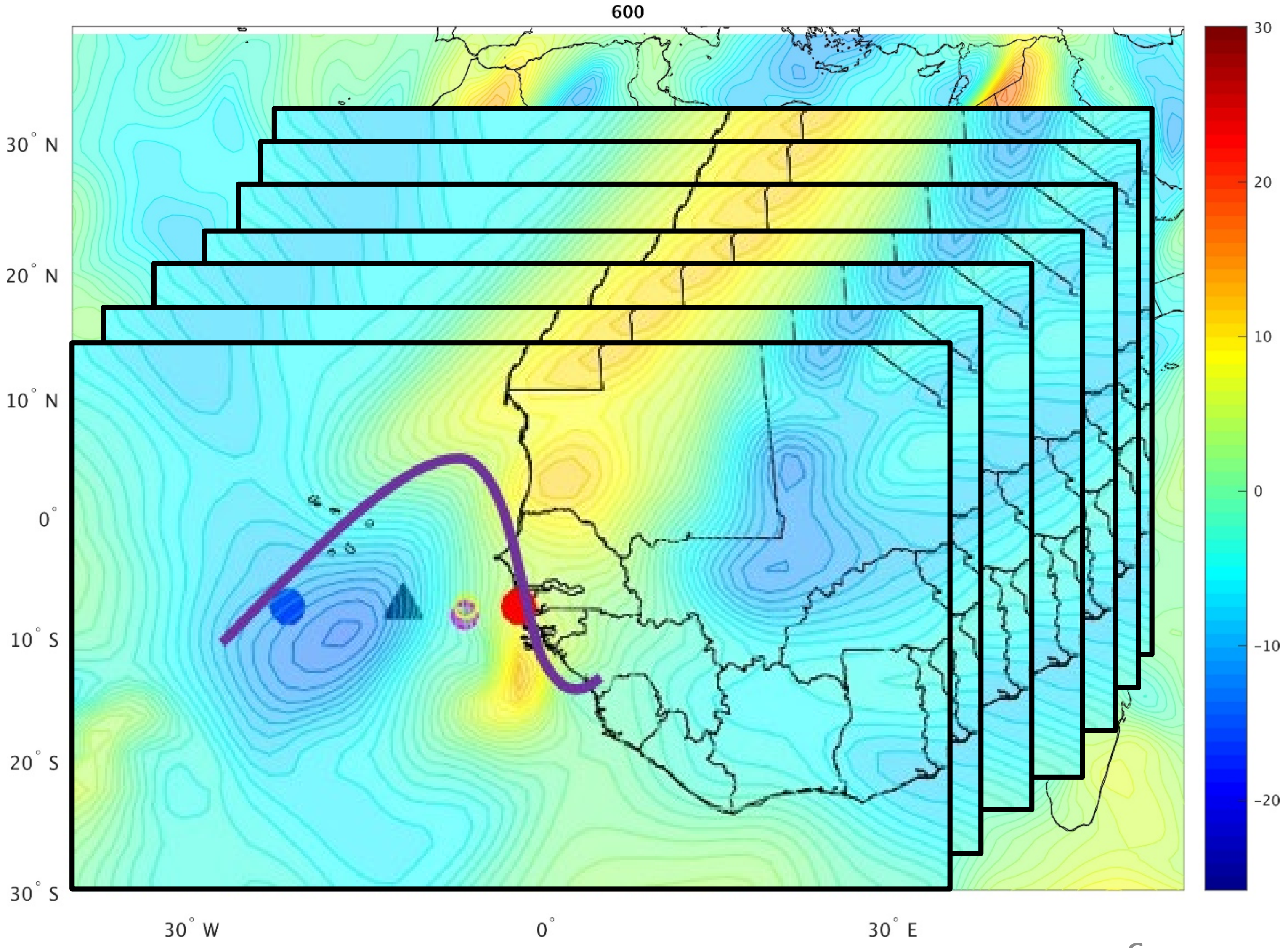

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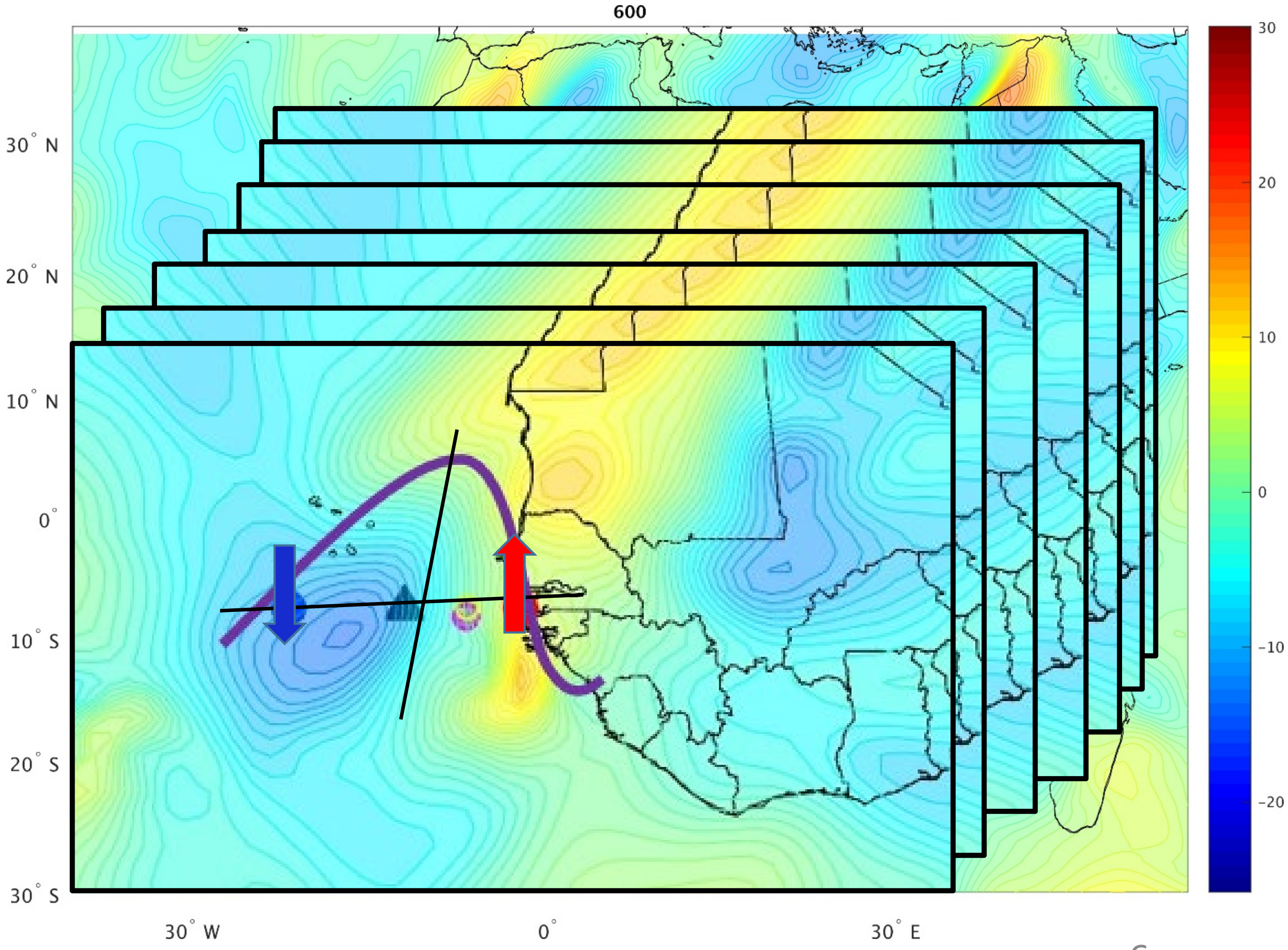

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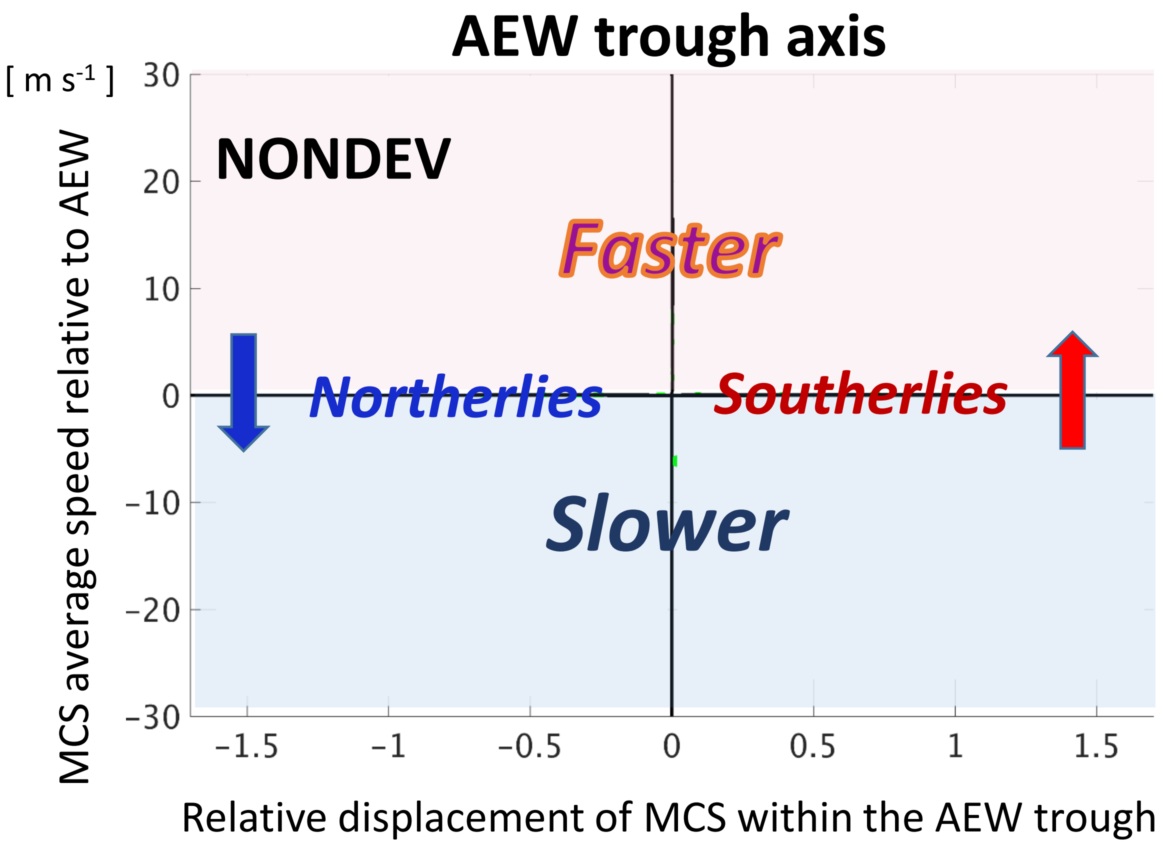
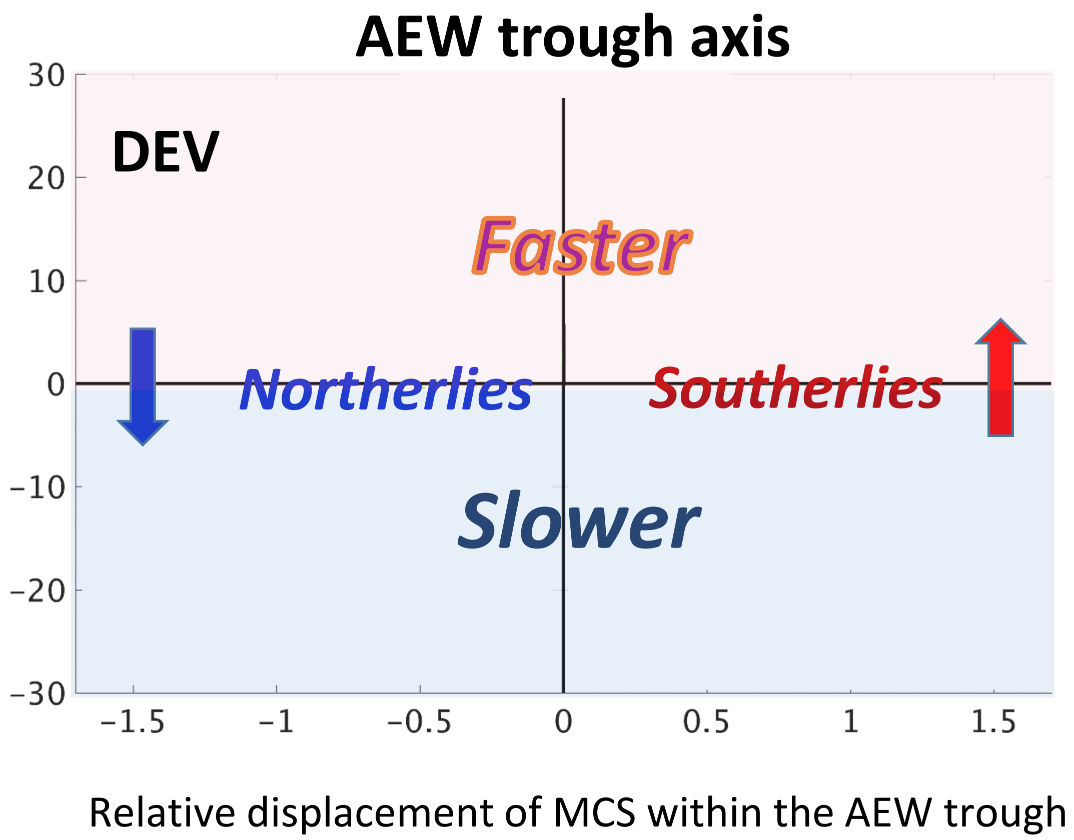

AEW trough axis
[m s-1]
MCS average speed relative to AEW
NONDEV
Faster
Northerlies
Southerlies
Slower
30
20
10
0
−10
−20
−30
−1.5
−1
−0.5
0
0.5
1
1.5
Relative displacement of MCS within the AEW trough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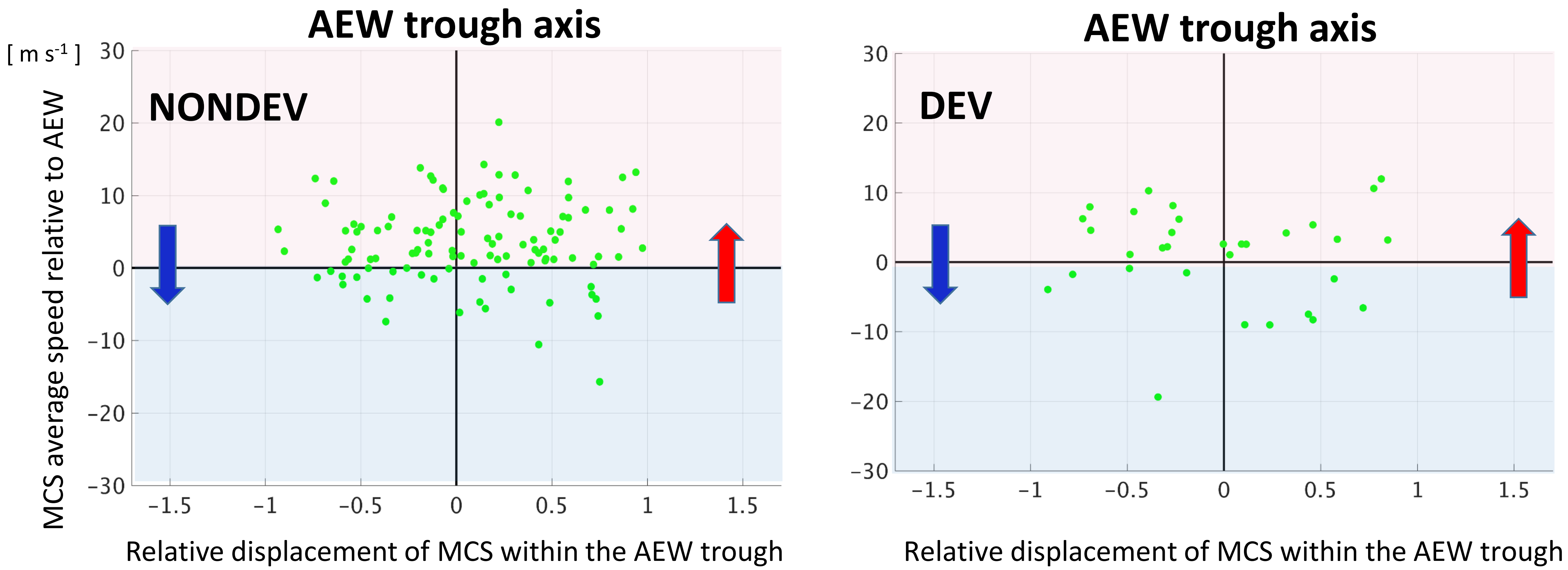
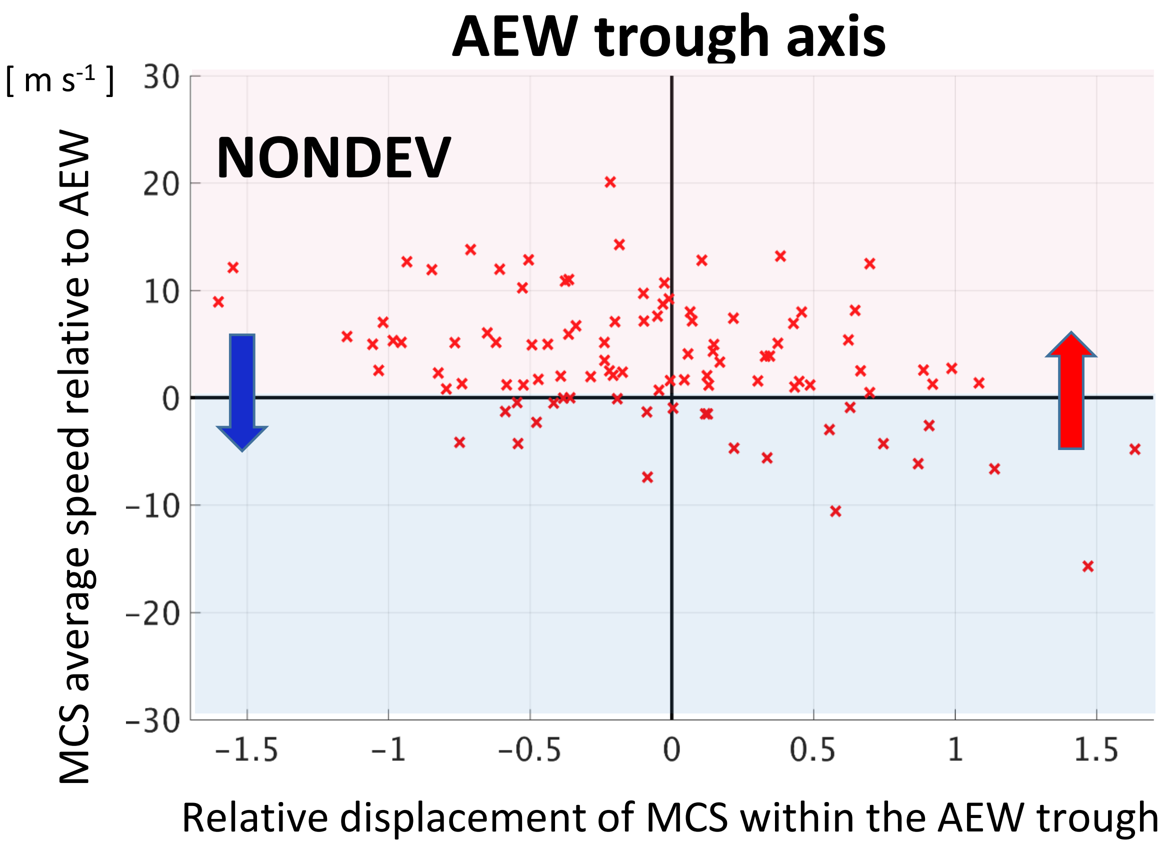
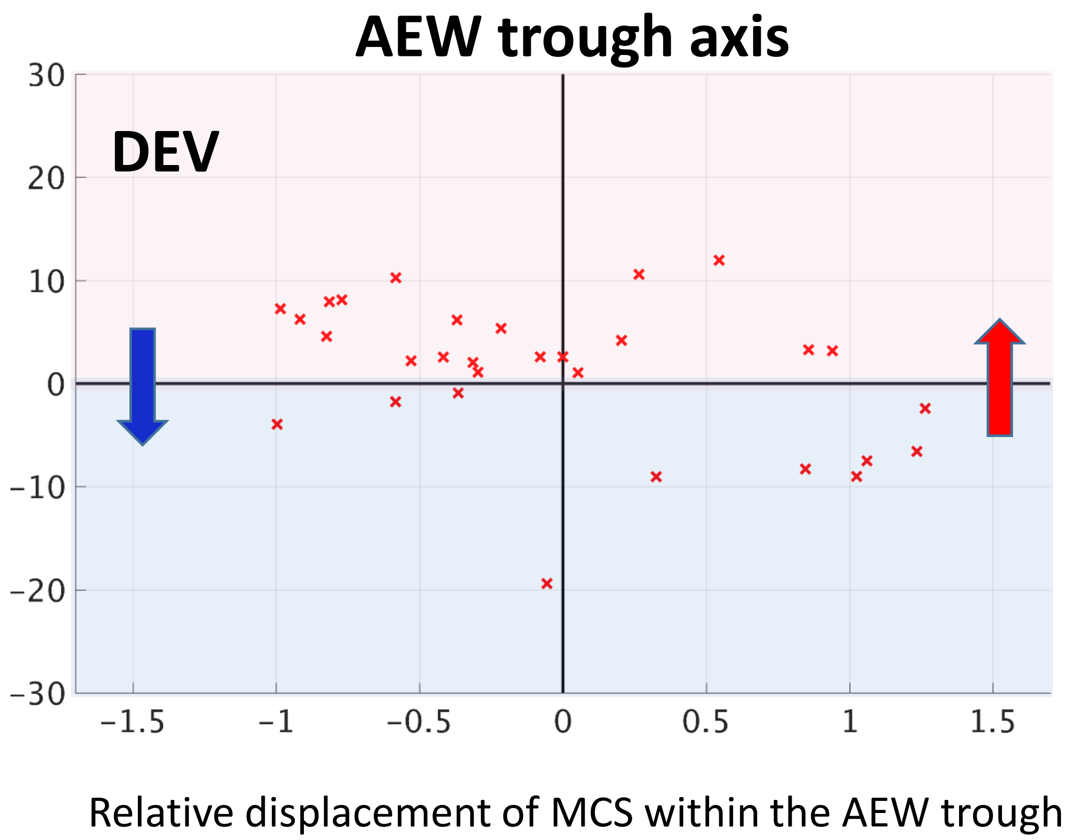
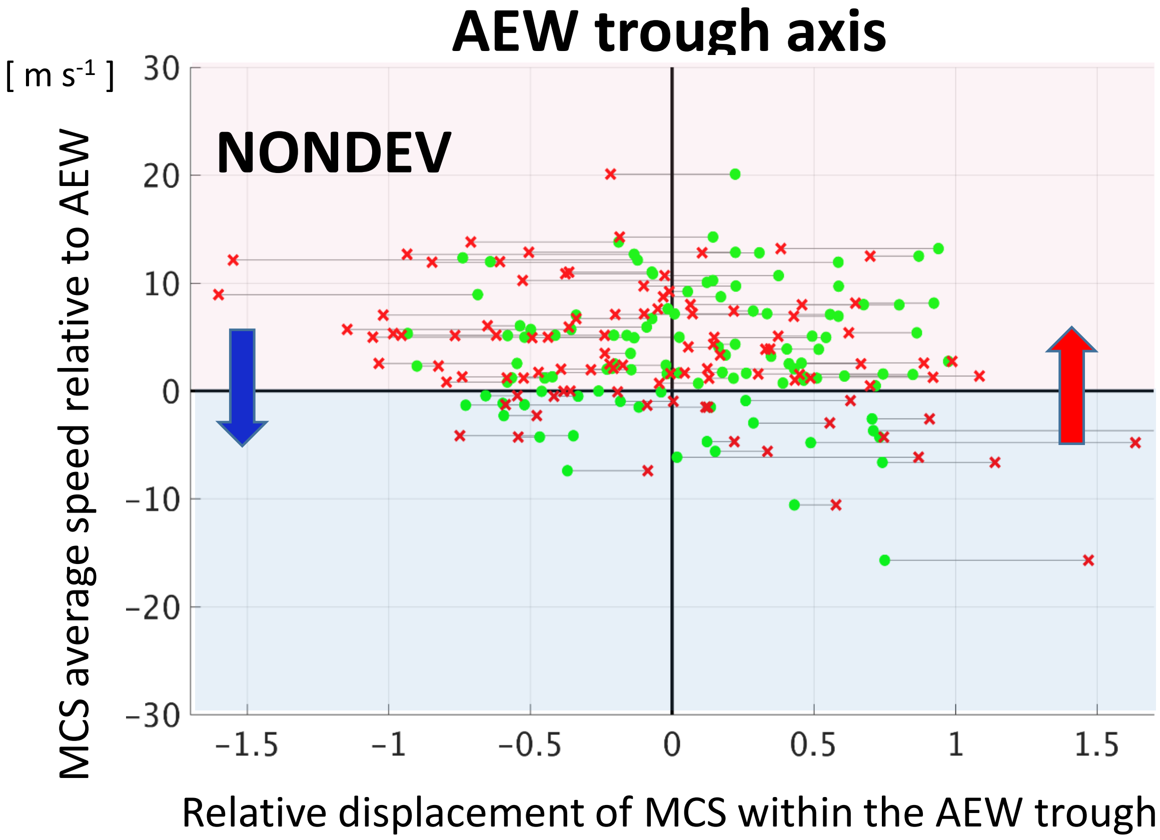


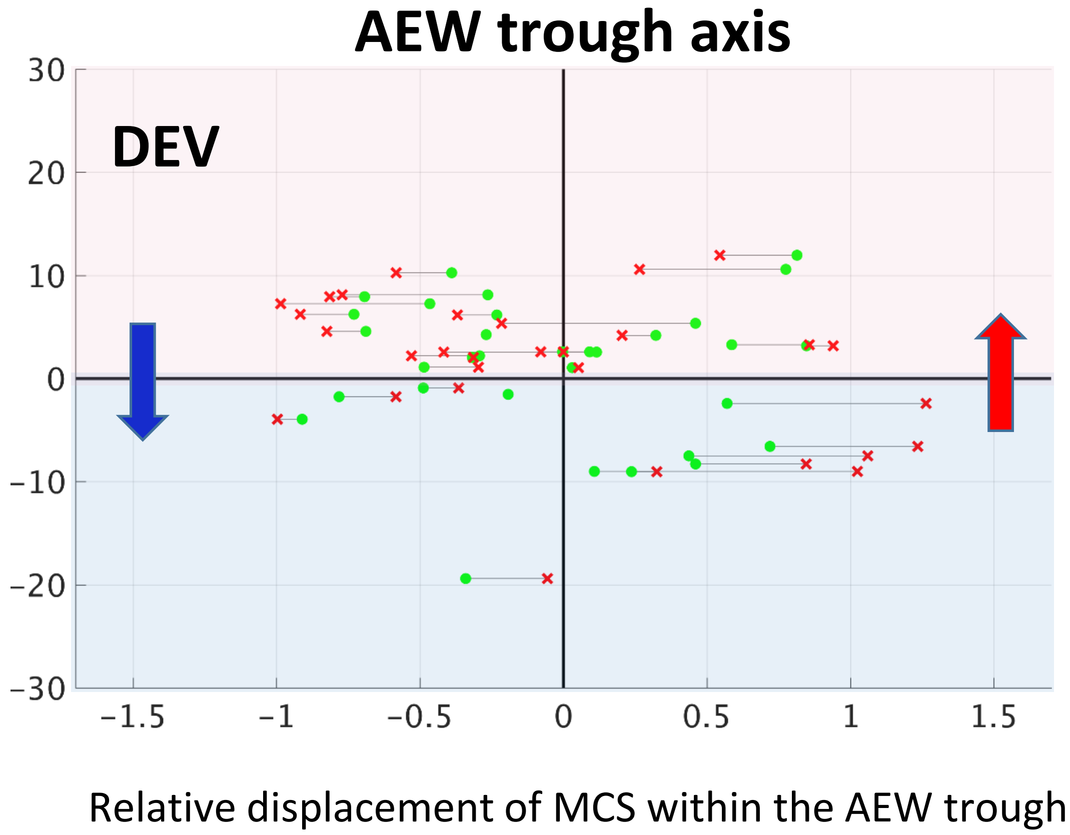
Initial MCS position relative to AEW trough





✖ MCS position at termination relative to AEW trough

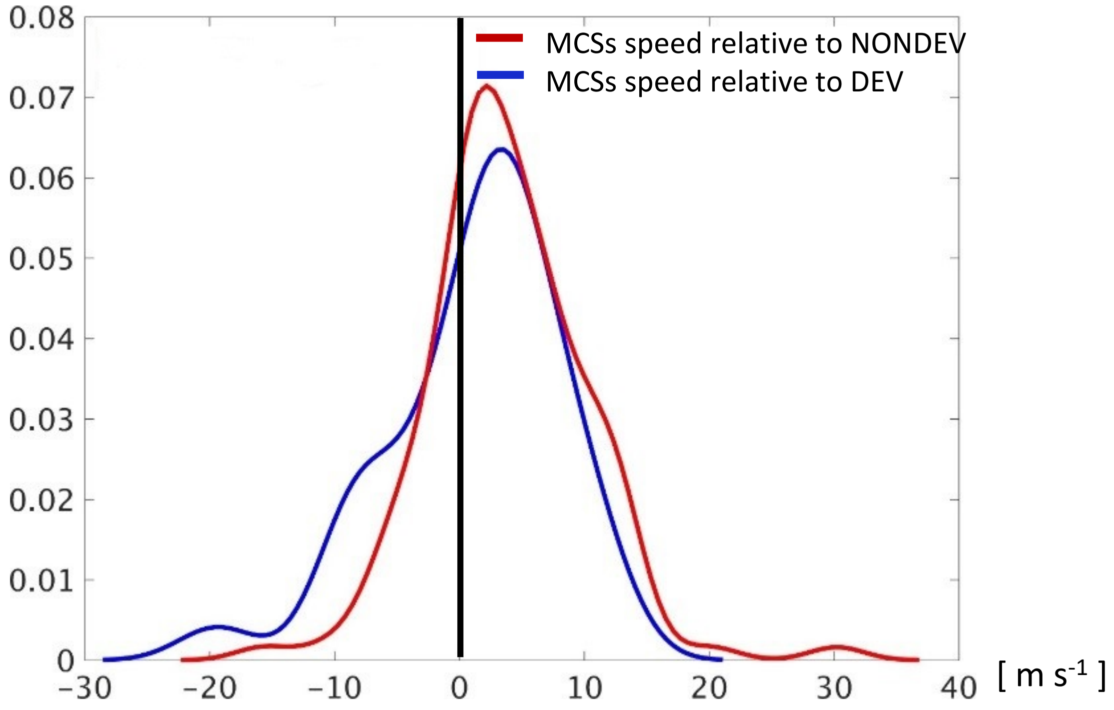




Initial MCS position relative to AEW trough

MCS position at termination relative to AEW trough

2-Sample t-test:
P = 0.038 z = 1



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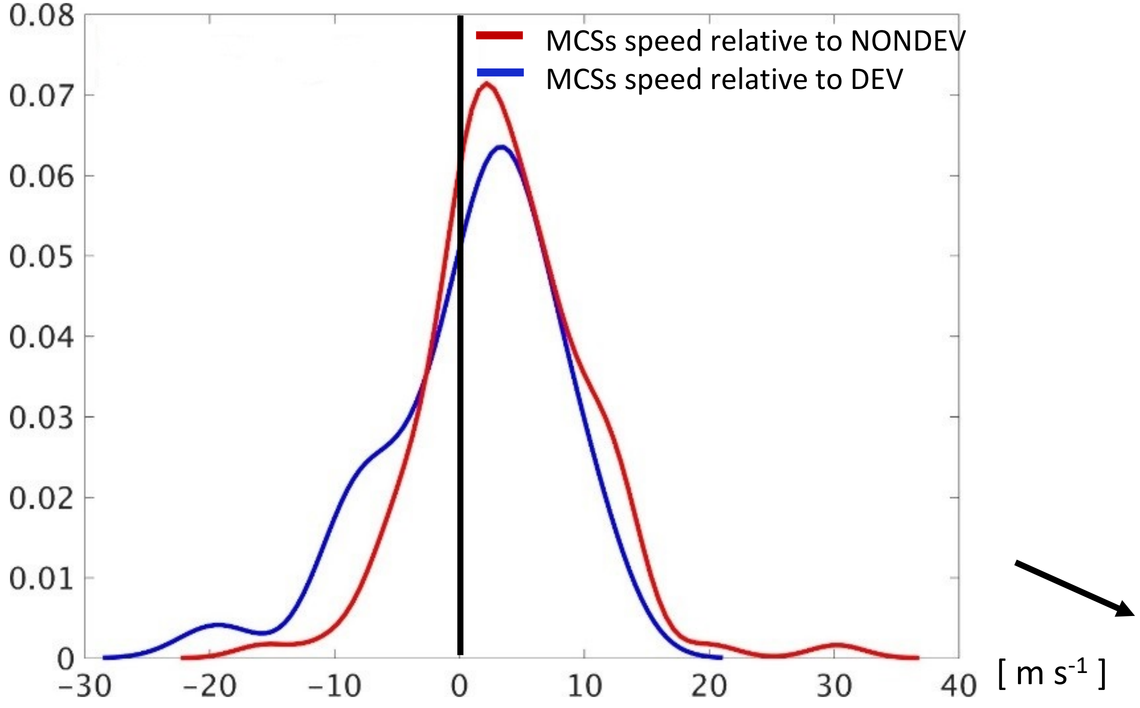

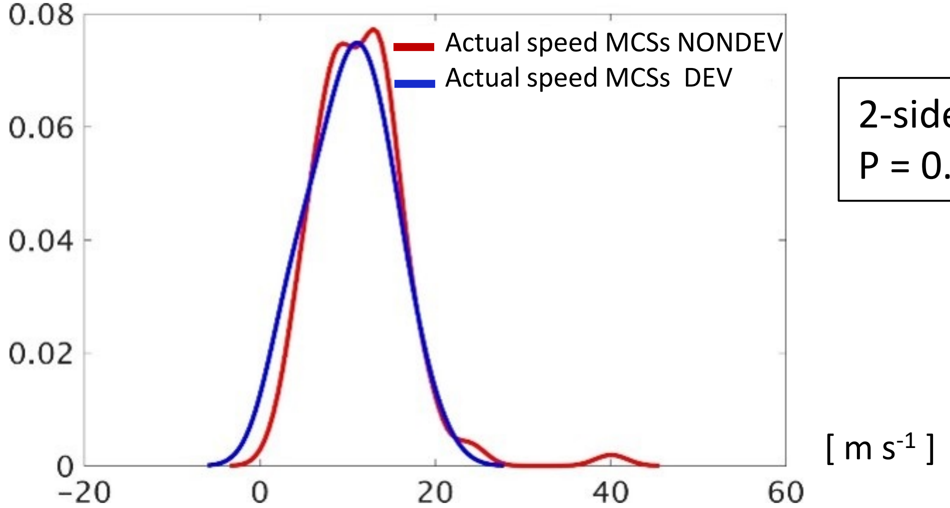

2-sided Wilcoxon test:
P = 0.365   z = 0

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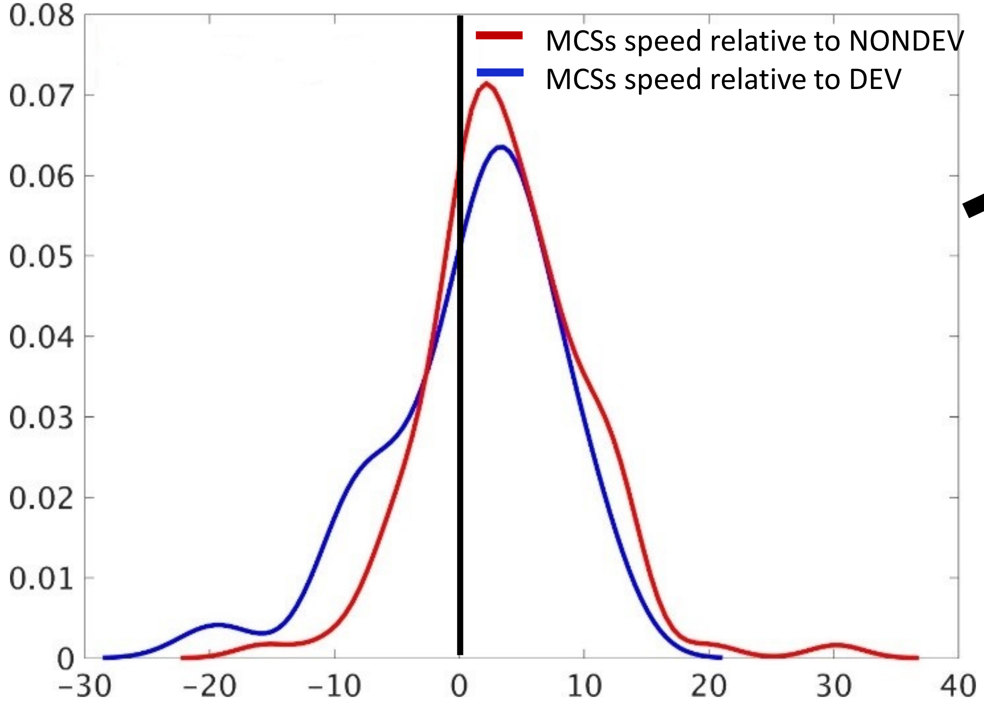
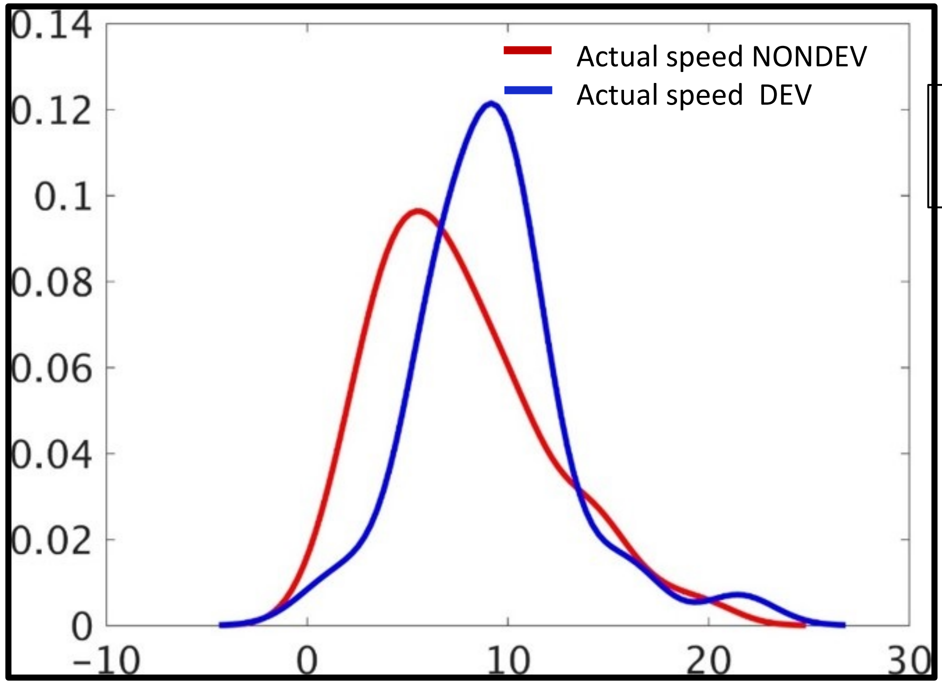
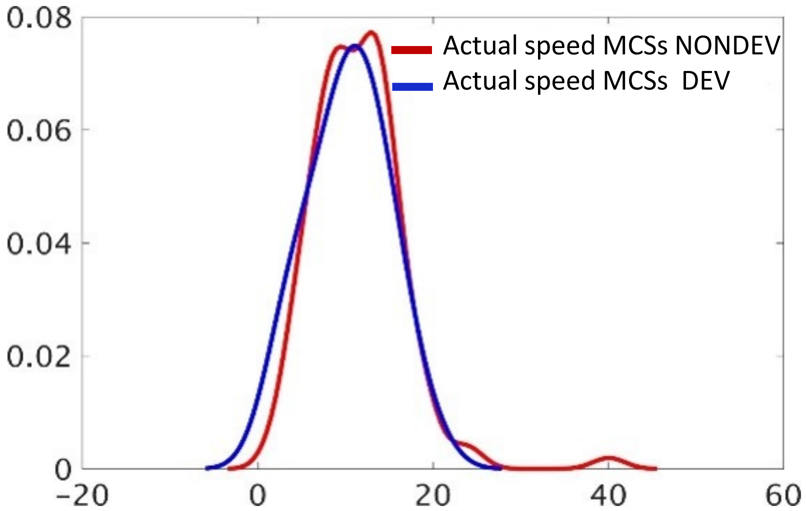


[m s-1]



2-sided Wilcoxon test:
P = 0.020 z = 1

[m s-1]



[m s-1]

2-sided Wilcoxon test:
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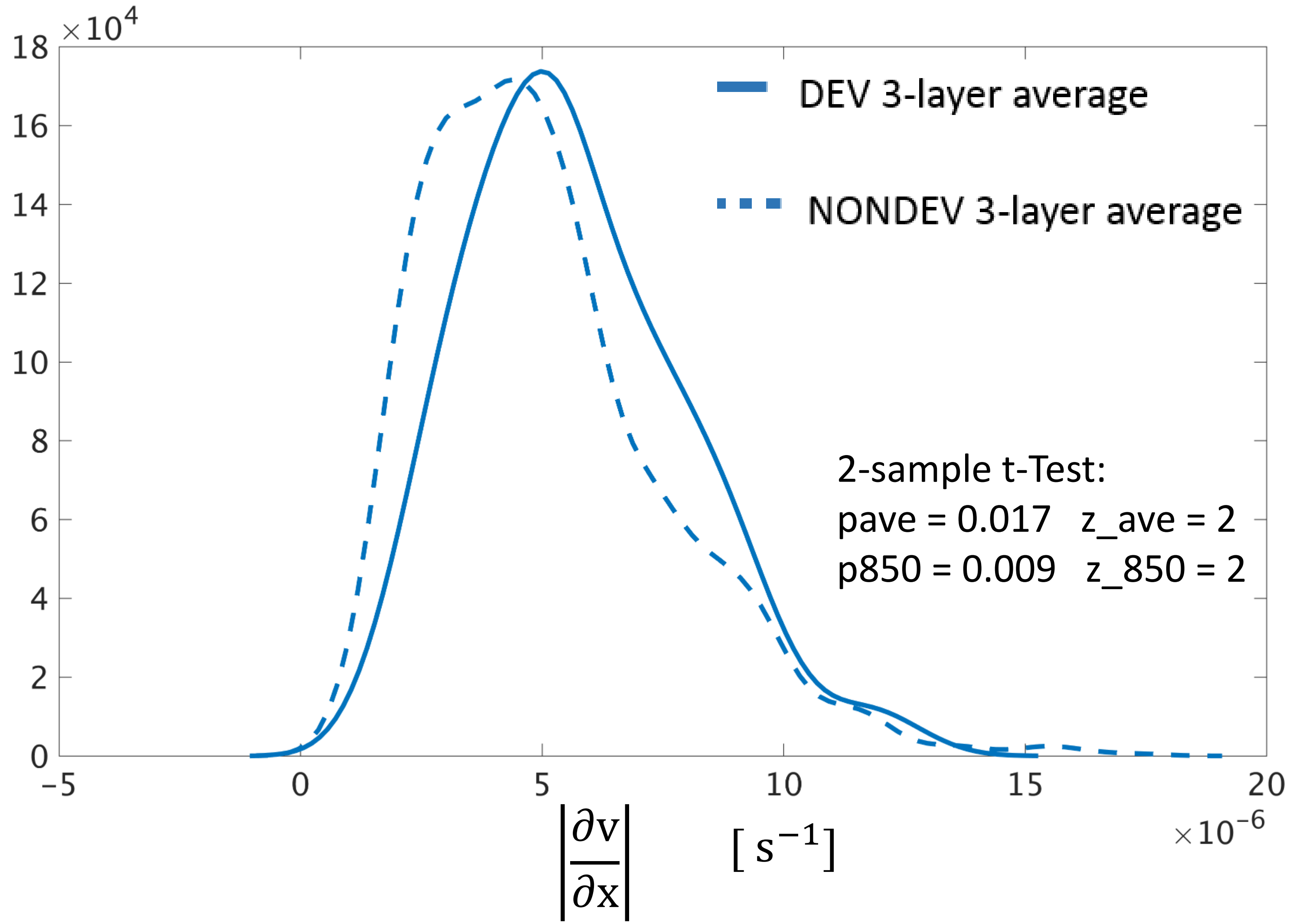
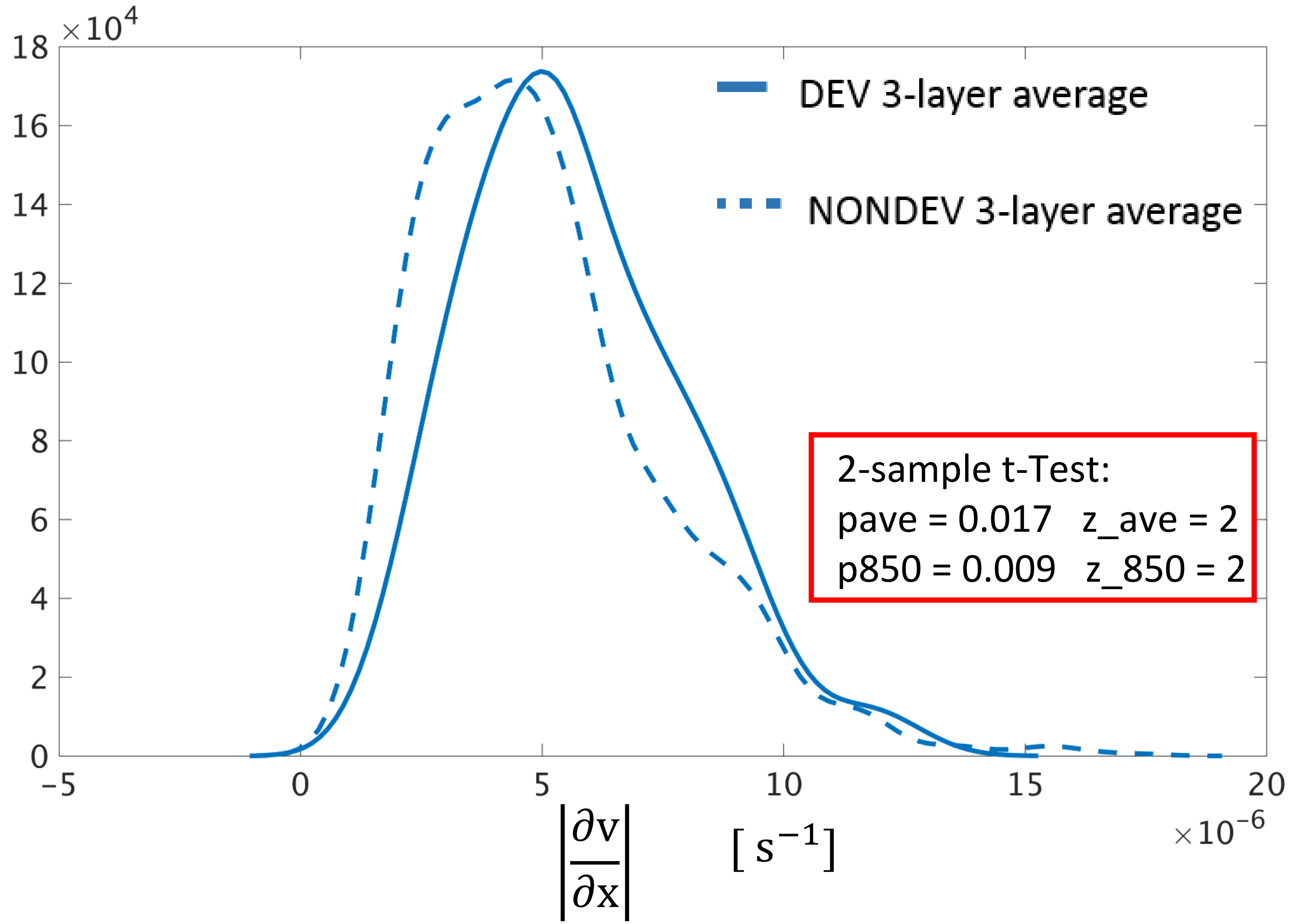

×10^4
18
16
14
12
10
8
6
4
2
0
−5
0
5
10
15
20
×10^−6
DEV 3-layer average
NONDEV 3-layer average
2-sample t-Test:
pave = 0.017 z_ave = 2
p850 = 0.009 z_850 = 2
|∂v/∂x| [s^−1]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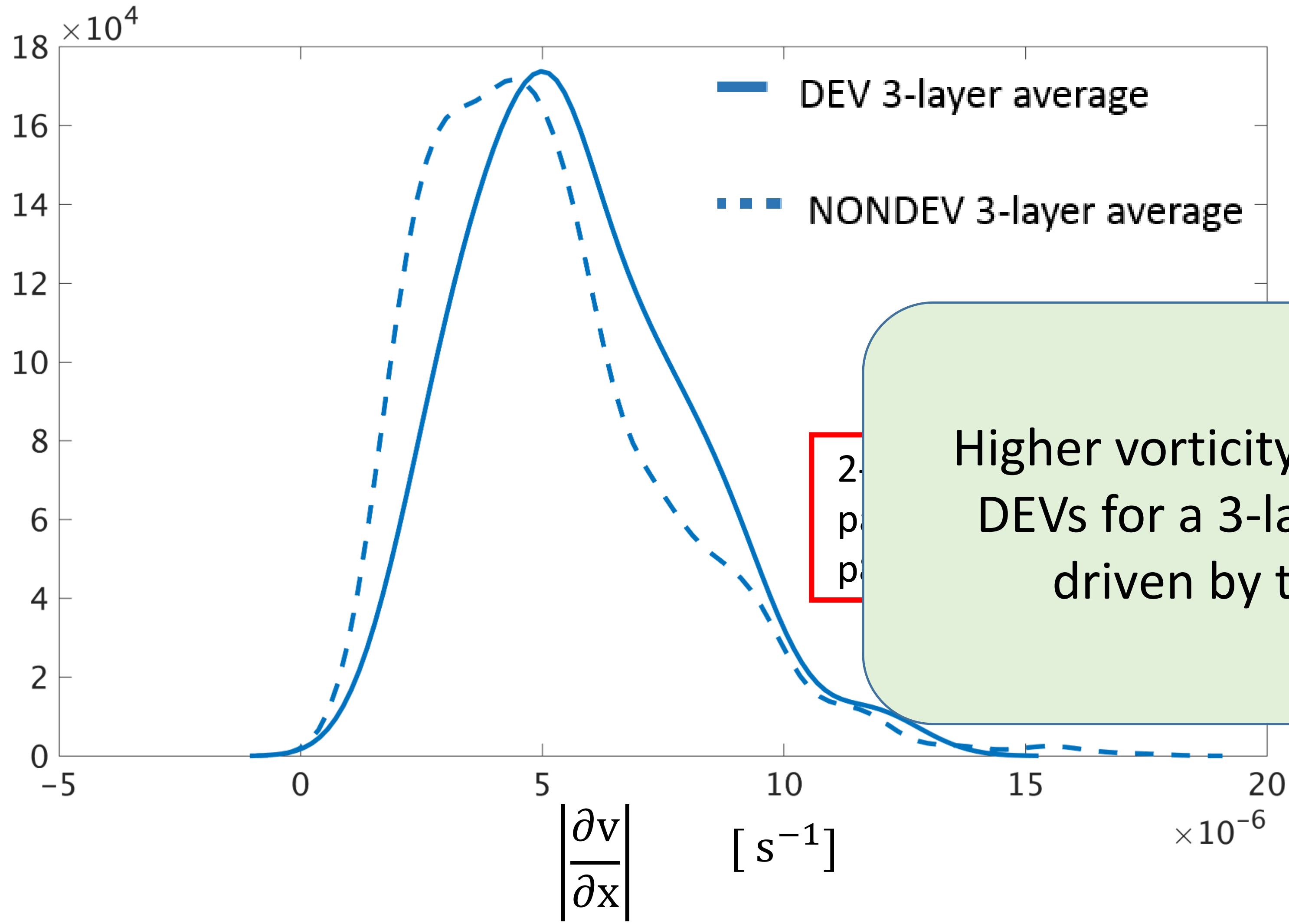
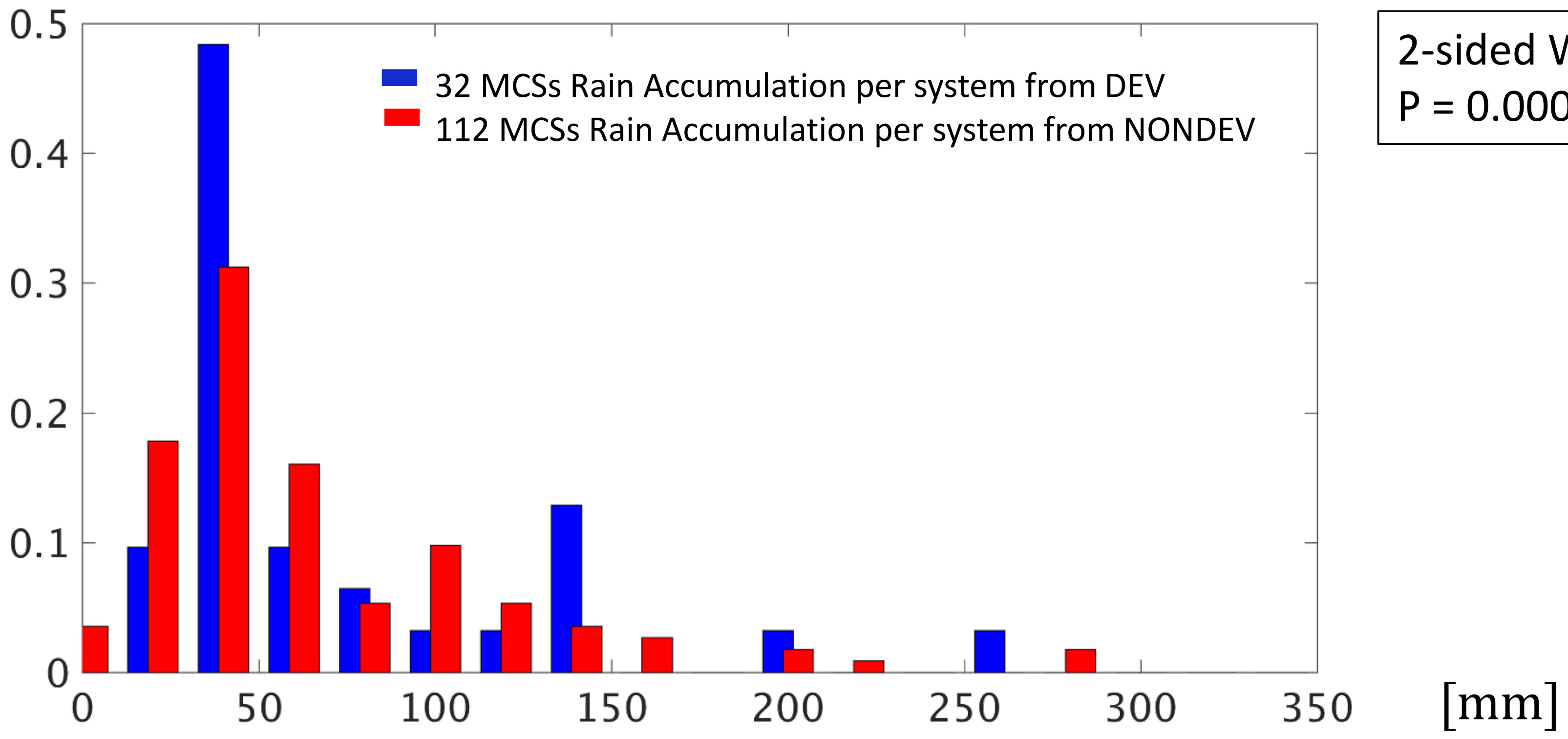


Higher vorticity values associated to DEVs for a 3-layer vertical average driven by the 850 hPa level



2-sided Wilcoxon test:
P = 0.000 z = 1

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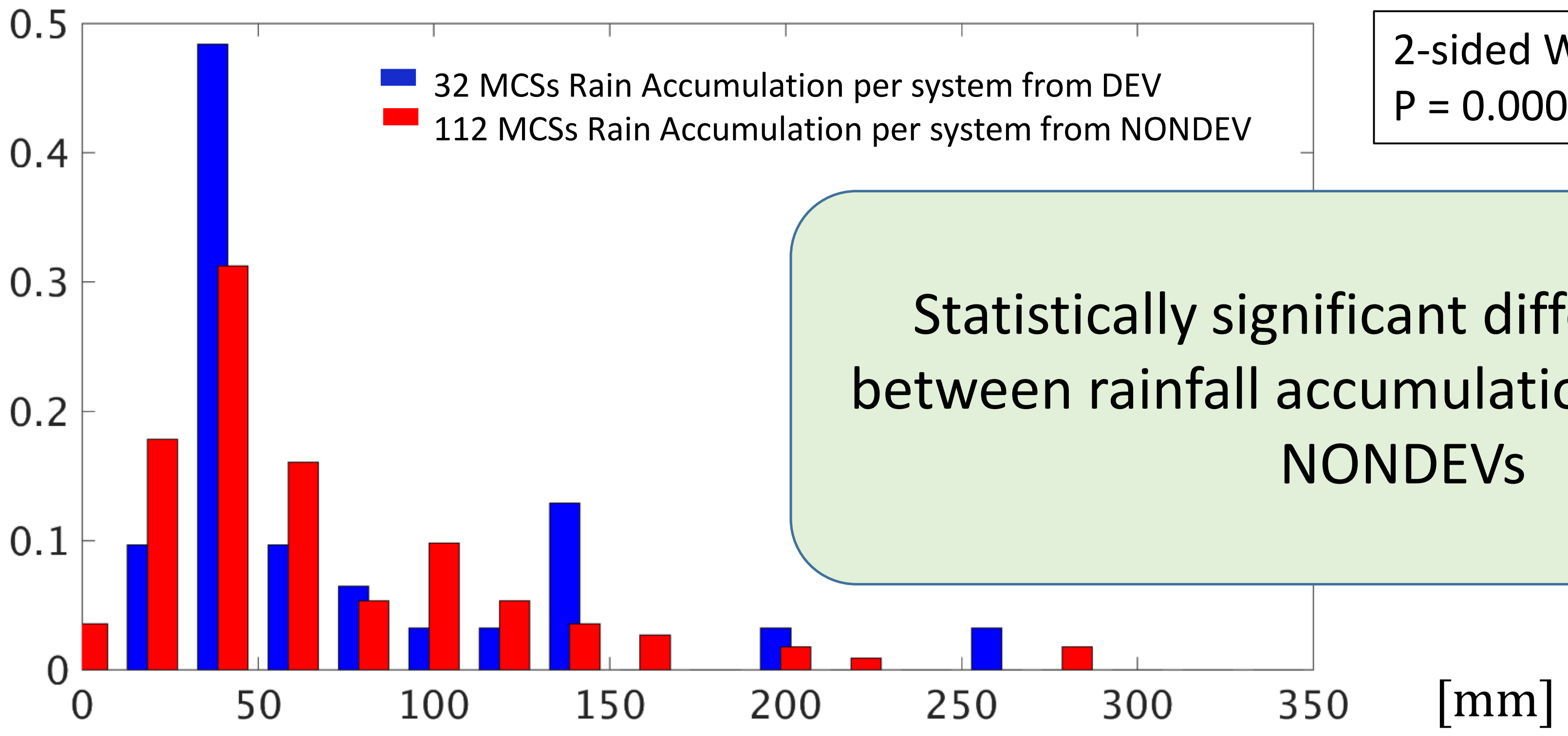

2-sided Wilcoxon test:
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Statistically significant differences exist between rainfall accumulations of DEVs and NONDEVs

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Summary and Conclusions

- The coupling of MCSs—tracked by TAMS—to associated AEW was done resulting in a composite of MCS-AEW coupled systems to be analyzed.
- MCSs speeds relative to AEWs are faster for DEVs than for NONDEVs. This is due to faster propagating DEVs. Consequently, MCSs of DEVs are more probable to advance with the AEW as the AEW itself propagates at speeds close to the propagating speed of convection.
- Higher vorticity values of a 3-layer vertical average associated to DEVs when compared to NONDEVs driven by 850hPa vorticity layer.
- Statistically significant differences exist between rainfall accumulations of DEVs and NONDEVs.