# How Does Dry Model with same wave energy represents blocking circulation?

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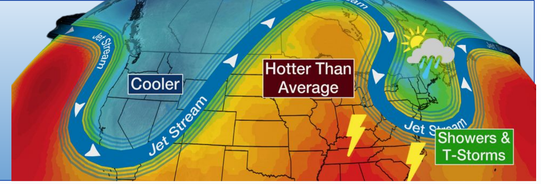



## Introduction

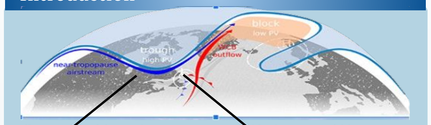



*Illustration of dry and moist processes in Blocking Steinfeld, D. (2021)*

**Dry Dynamics** — **Moist Dynamics**

Still some ambiguity in understanding its role

Key Questions

**Do moist processes produce unique characteristics in the blocking that cannot be captured by dry dynamics ?**

## Approach and Model Setup

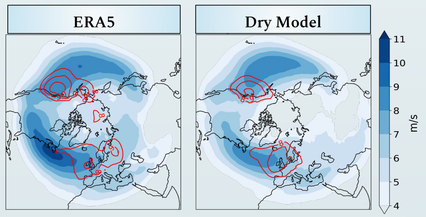
- How does a dry dynamical model with realistic wave energy reproduce blocking ?
- Dry Model :
  - Relaxed towards a restoration-equilibrium potential temperature (Chang 2006).

$$\frac{d\theta(\lambda,\varphi,p)}{dt} = -\frac{\theta(\lambda,\varphi,p) - \theta^{m}_{eq}(\varphi,p)}{\tau(\varphi,p)}$$

  - Iterative process to get model climatology close to ERA5 climatology (*Chang2006*)
- Comparative Analysis: long term winter simulation of Dry GCM model vs ERA5 reanalysis.
  - ERA5 : 41 year winter (1979-2021),
  - Dry Model : 21 year perpetual winter

## Climatology Wind variability

*STD of high-freq V(t<8 days) low-freq V(t>8 days)*



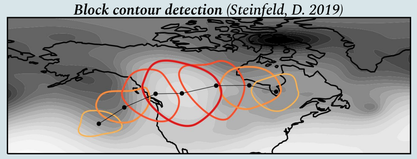

Wind climatology and variability are very well captured by the dry model with some moderate biases

## Detection Tool

**PV based Blocking detection method ((Schwierz et al., 2006) Strong , coherent and persistent low PV anomalies (PVA) contours are detected in upper troposphere**

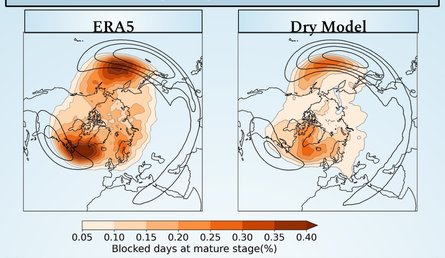
strong -ve PV Anomalies + Spatial Overlapping + Temporal Persistence

*Block contour detection (Steinfeld, D. 2019)*

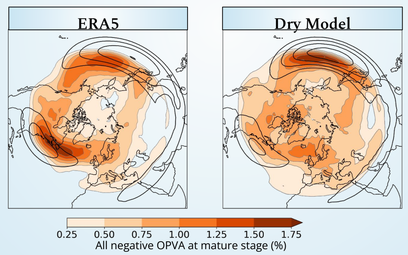


## Why Less frequent blocking in dry model ?

**WITH Temporal persistence = Blocks**




**WITHOUT Temporal persistence = - OPVAs**

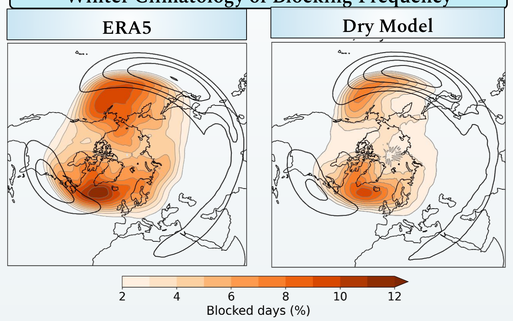



**In the dry model**

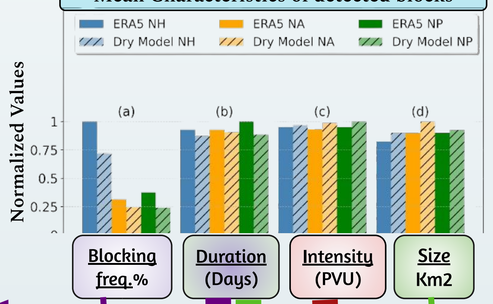
- Exhibits more short lived negative OPVA .
- This negative OPVA are less persistence likely due to faster background wind in North Pacific .
- Weaker eddy energy leads to weaker blocking occurrence in North Atlantic

## Comparative Analysis : ERA5 Reanalysis and a Dry Model

**Winter Climatology of Blocking Frequency**




**Mean Characteristics of detected blocks**

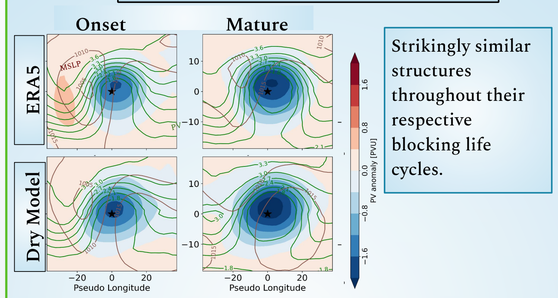



Blocking freq.% | Duration (Days) | Intensity (PVU) | Size Km2

**Despite less frequent blocking, mean characteristics remain similar, further analysis focusing on this key features is presented in the adjacent sections**

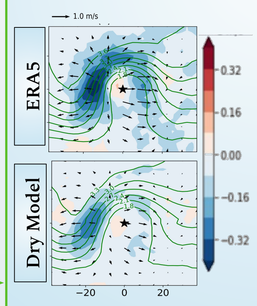
**To investigate blocking structure and Size .**

**Centered composite analysis - Eulerian**




Strikingly similar structures throughout their respective blocking life cycles.

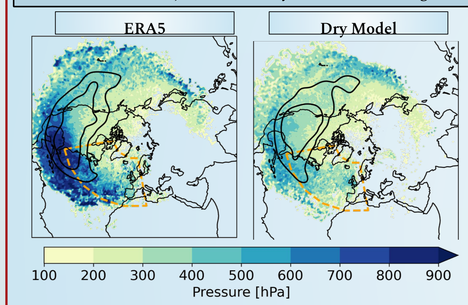
**Indirect effect of latent heating** $\boldsymbol{\chi} \cdot \nabla PV$




Stronger divergent winds leads to strong low PV advection $\boldsymbol{\chi} \cdot \nabla PV$, which amplifies and makes the blocking ridge quasi-stationary. (*Steinfeld, D. (2021)*

weaker divergent wind and PV advection in the dry model are compensated by episodes of weaker background flow , by the rotational component ($\boldsymbol{\chi}\,\varphi \cdot \nabla PV$) of zonal wind.

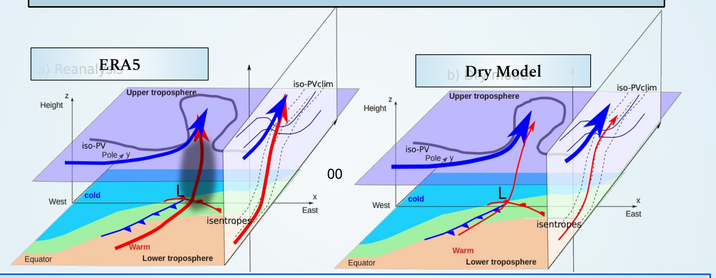
**Orientation of trajectories 3 days before blocking onset**




- ERA5 exhibits more lower-level trajectories for blocking onset , while the dry model mostly shows upper-level trajectories, around 68% (compared to 54% in ERA5).
- More trajectories are adiabatically heated in ERA5 than in dry model

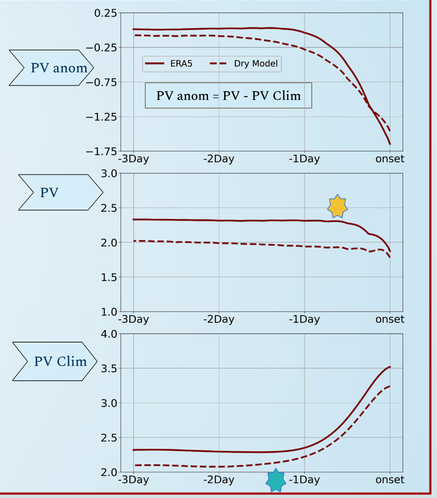
**Why blocks in dry model have nearly the same Intensity ?**

**Investigating 3-Days backward Lagrangian trajectories from block onset**




- In ERA5 the lower level trajectories transport low PV efficiently to blocking region.
- In ERA5 This drop in PV values are associated with trajectories experiencing negative PV tendency just above the heating gradient.
- In dry model the more upper level trajectories efficiently crossing more PV climatology which results in gradual PV anomaly decrease .

**Mean temporal evolution PV lagrangian budget**




Moist dynamics modifies the air mass for blocking circulation in addition to dry dynamics and increase intensity, size, and duration of blocking (Pfahl, et al. 2015, Steinfeld, D. 2019)

## Conclusions

- We surprising see no major change in the mean characteristics of blocking in the dry model.
- There is no new or unique blocking characteristics which cannot be captured by dry dynamics
- The reason for less frequent blocking occurrence in dry model can be partially explained by regional wind and eddy energy biases
- Dry model compensates the lack of moisture by more upper level trajectories transporting low PV airmass from lower latitudes. To investigate the influence if air sea interaction on blocking dynamics:

## Work In progress…

**Key Question :**

- How does moist simulation with forced SST reproduce blocking circulation.?
- Impact of warmer SST forcing on blocking circulation

## Understanding influence of air-sea interaction on blocking dynamics

**Key Question :**

- How does latent heat fluxes from gulf stream influences blocking , which causes extreme weather events in Euro- Atlantic region. ?

**Experiment**

- Sensitivity numerical experiment performed with ECMWF-IFS model. (*Jamie Matthews*) *In progress..*

## References :

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