General circulation of the atmosphere

Paper report

Due date: Fri 17th May 2024

1. Instructions:

Choose a journal paper from the list on the next page that addresses an aspect of the general circulation. Write a summary of the paper and its findings. Pay particular attention to placing the research in a larger context, considering both work that came before and work that has been done since. You will also be required to give a 10-minute oral presentation to explain the paper to the rest of the class.

The report (15%) and presentation (5%) accounts for 20% of the final grade.

2. Report:

While the format of the report (in terms of section headings, etc.) is left up to you, the report should include the following:

- **Background:** Introduce the topic of the paper. Why did the authors perform this study?
- **Methods:** What methods (models/obs., analysis techniques, theories) are used?
- **Results:** What was found?
- **Implications:** Why does it matter?
- **Impact/Further work:** Has there been further work on this topic? Are the conclusions still valid? Summarise the current state of the art in the field.

The report will be marked on the following three criteria:

1) *Content*: how well was the content of the paper explained?
2) *Context*: was the paper placed in its proper context within the literature?
3) *Writing*: was the report clear, well-organised, and succinct?

The report should be no more than 1500 words. **The due date for the report is Friday the 13th of May 2022.**

3. Oral presentation:

In the final week of classes, students will present their paper to the rest of the class in the form of an oral presentation. The aim will be to explain the results and significance of the paper at a level understandable to the rest of the class.

The oral presentation should be no more than 10 minutes in length.

4. List of papers:

Choose from the list below. If you prefer to present an article not on this list that nevertheless deals with the general circulation, talk to the instructor.

1. Zhu, Y., & Newell, R. E. (1998). A proposed algorithm for moisture fluxes from atmospheric rivers. *Monthly Weather Review*, **126**, 725-735.
2. Randel, W. J. & Held, I. M. (1991), Phase speed spectra of transient eddy fluxes and critical layer absorption. *J. Atmos. Sci.,* 48, 688-697
3. Chen, G., & Held, I. M. (2007), Phase speed spectra and the recent poleward shift of Southern Hemisphere surface westerlies. *Geophys. Res. Lett.*, 34, L21805.
4. Barnes, E.; Hartmann, D.; Frierson, D. & Kidston, J. (2010), Effect of latitude on the persistence of eddy-driven jets. *Geophys. Res. Lett.,* 37, L11804.
5. Ceppi, P. and D. L. Hartmann (2013). On the Speed of the Eddy-Driven Jet and the Width of the Hadley Cell in the Southern Hemisphere, *J. Climate*, 26, 3450–3465.
6. O'Gorman, P. A. (2010), Understanding the varied response of the extratropical storm tracks to climate change. *Proc. Nat. Acad. Sci.,* 107, 19176-19180.
7. Gertler, C. G. & O'Gorman, P. A. (2019), Changing available energy for large-scale and convective circulations in northern summer. *Proc. Nat. Acad. Sci.* 116, 4105-4110.
8. Held, I. M. & Soden, B. J. (2006), Robust responses of the hydrological cycle to global warming. *J. Climate,* 19, 5686-5699.
9. Chadwick, R.; Boutle, I. & Martin, G. (2013), Spatial Patterns of Precipitation Change in CMIP5: Why the Rich Do Not Get Richer in the Tropics, *J. Climate,* 26, 3803-3822.
10. Plumb, R. A. & Hou, A. Y. (1992), The response of a zonally symmetric atmosphere to subtropical thermal forcing: threshold behaviour, *J. Atmos. Sci.*, 1992, 49, 1790-1799.
11. Walker, C. C. & Schneider, T. (2006) Eddy influences on Hadley circulations: Simulations with an idealized GCM. *J. Atmos. Sci.,* 63, 3333-3350.
12. Bordoni, S., & Schneider, T. (2008). Monsoons as eddy-mediated regime transitions of the tropical overturning circulation. *Nature Geoscience*, *1*(8), 515-519.
13. Geen, R., Lambert, F. H., & Vallis, G. K. (2018). Regime change behavior during Asian monsoon onset. *J. Climate*, 31, 3327-3348.
14. Hoskins, B. J., & Karoly, D. J. (1981). The steady linear response of a spherical atmosphere to thermal and orographic forcing. *J. Atmos Sci*, *38*(6), 1179-1196.
15. Rodwell, M. & Hoskins, B. (1996) Monsoons and the dynamics of deserts, *Q.J.R. Meteorol. Soc.,* 122, 1385-1404.
16. Voigt, A. & Shaw, T. A. (2015), Circulation response to warming shaped by radiative changes of clouds and water vapour, *Nat. Geosci.,* 8, 102-106.
17. Neelin, J. & Held, I. (1987), Modeling tropical convergence based on the moist static energy budget. *Mon. Wea. Rev.,* 115, 3-12.
18. Held, I. M. (2001). The partitioning of the poleward energy transport between the tropical ocean and atmosphere. *J. Atmos. Sci.*, 58, 943-948.
19. Kang, S. M.; Held, I. M.; Frierson, D. M. W. & Zhao, M. (2008), The response of the ITCZ to extratropical thermal forcing: Idealized slab-ocean experiments with a GCM. *J. Climate,* 21, 3521-3532.
20. Bischoff, T. & Schneider, T. (2014), Energetic Constraints on the Position of the Intertropical Convergence Zone, *J. Climate,*27, 4937-4951.

21. Hill, S. A., Ming, Y., & Held, I. M. (2015). Mechanisms of forced tropical meridional energy flux change. *J. Climate*, *28*(5), 1725-1742.
22. Boos, W. R., & Korty, R. L. (2016). Regional energy budget control of the intertropical convergence zone and application to mid-Holocene rainfall. *Nature Geoscience*, *9*(12), 892-897.
23. Armour, K. C., Siler, N., Donohoe, A., & Roe, G. H. (2019). Meridional atmospheric heat transport constrained by energetics and mediated by large-scale diffusion. *Journal of Climate*, *32*(12), 3655-3680.
24. Schneider, T., & O'Gorman, P. A. (2008). Moist convection and the thermal stratification of the extratropical troposphere. *J. Atmos Sci.*, 65, 3571-3583.
25. Haynes, P. H., McIntyre, M. E., Shepherd, T. G., Marks, C. J., & Shine, K. P. (1991). On the "downward control" of extratropical diabatic circulations by eddy-induced mean zonal forces. *J. Atmos. Sci.*, **48**, 651-678.
26. Simpson, I. R., Blackburn, M., & Haigh, J. D. (2009). The role of eddies in driving the tropospheric response to stratospheric heating perturbations. *J. Atmos. Sci.*, **66**, 1347-1365.
27. Cohen, N. Y., Gerber, E. P., & Bühler, O. (2014). What drives the Brewer–Dobson circulation? *J. Atmos. Sci.*, **71**, 3837-3855.
28. Hoskins B. J., Yang G-Y, Fonseca R.M. (2020), The detailed dynamics of the June-August Hadley Cell, *Quart. J. Royal. Meteorol. Soc.,* Vol: 146, Pages: 557-575.
29. Davis, N. A., & Birner, T. (2022). Eddy-mediated Hadley cell expansion due to axisymmetric angular momentum adjustment to greenhouse gas forcings. *Journal of the Atmospheric Sciences*, *79*, 141-159.
30. Bao, J., & Stevens, B. (2021). The elements of the thermodynamic structure of the tropical atmosphere. *Journal of the Meteorological Society of Japan. Ser. II*, *99*, 1483-1499.