zbMATH Open
THE FIRST RESOURCE FOR MATHEMATICS

Berloff, P.; **Karabasov, S.**; **Farrar, J. T.**; **Kamenkovich, I.**
On latency of multiple zonal jets in the oceans. (English) Zbl 1241.76427
J. Fluid Mech. 686, 534-567 (2011).

Summary: Most of the nearly zonal, multiple, alternating jets observed in the oceans are latent, that is, their amplitudes are weak relative to the ambient mesoscale eddies. Yet, relatively strong jets are often observed in dynamical simulations. To explore mechanisms controlling the degree of latency, we analyse solutions of an idealized, eddy-resolving and flat-bottom quasigeostrophic model, in which dynamically generated mesoscale eddies maintain and interact with a set of multiple zonal jets. We find that the degree of the latency is controlled primarily by the bottom friction: the larger the friction parameter, the more latent are the jets; and the degree of the latency is substantial for a realistic range of the oceanic bottom friction coefficient. This result not only provides a plausible explanation for the latency of the oceanic jets, but it may also be relevant to the prominent atmospheric multiple jets observed on giant gas planets, such as Jupiter. We hypothesize that these jets can be so strong because of the relative absence of the bottom friction. The mechanism controlling the latency in our solutions is understood in terms of the changes induced in the linear eigenmodes of the time-mean flow by varying the bottom friction coefficient; these changes, in turn, affect and modify the jets. Effects of large Reynolds numbers on the eddies, jets, and the latency are also discussed.

MSC:

76U05 General theory of rotating fluids
86A05 Hydrology, hydrography, oceanography

Keywords:

geostrophic turbulence; quasi-geostrophic flows; waves in rotating fluids

Full Text: DOI

References:

[1] DOI: 10.1029/2007JC004105 · doi:10.1029/2007JC004105
[2] DOI: 10.1175/2008JPO3853.1 · doi:10.1175/2008JPO3853.1
[3] Hogg, Deep-Sea Res. 46 pp 335– (1999) · doi:10.1016/S0967-0637(98)00065-X
[4] DOI: 10.1175/2007JPO3835.1 · doi:10.1175/2007JPO3835.1
[5] DOI: 10.1175/1520-0469(1980)037<2644:HQGTDB>2.0.CO;2 · doi:10.1175/1520-0469(1980)037<2644:HQGTDB>2.0.CO;2
[6] DOI: 10.1007/s10236-010-0278-2 · doi:10.1007/s10236-010-0278-2
[7] DOI: 10.1029/2004GL019691 · doi:10.1029/2004GL019691
[8] DOI: 10.1006/jcph.2002.7119 · Zbl 1051.76579 · doi:10.1006/jcph.2002.7119
[9] DOI: 10.1175/2009JAS2941.1 · doi:10.1175/2009JAS2941.1
[10] DOI: 10.1175/2010JAS3326.1 · doi:10.1175/2010JAS3326.1
[11] DOI: 10.1175/2008JAS2611.1 · doi:10.1175/2008JAS2611.1
[12] DOI: 10.1175/JAS4016.1 · doi:10.1175/JAS4016.1
[13] DOI: 10.1098/rsta.2010.0306 · Zbl 1219.85007 · doi:10.1098/rsta.2010.0306
[14] DOI: 10.1175/2007JAS2227.1 · doi:10.1175/2007JAS2227.1
[15] DOI: 10.1357/002224098321822320 · doi:10.1357/002224098321822320
[16] DOI: 10.1175/1520-0469(1978)035<1399:PCBROJ>2.0.CO;2 · doi:10.1175/1520-0469(1978)035<1399:PCBROJ>2.0.CO;2
[17] DOI: 10.1175/1520-0469(2004)061<2283:BBTIAR>2.0.CO;2 · doi:10.1175/1520-0469(2004)061<2283:BBTIAR>2.0.CO;2
[18] DOI: 10.1029/2005GL022514 · doi:10.1029/2005GL022514
[19] DOI: 10.1063/1.1752928 · Zbl 1186.76124 · doi:10.1063/1.1752928
[20] DOI: 10.1175/1520-0485(1993)023<1346:GOMFAJ>2.0.CO;2 · doi:10.1175/1520-0485(1993)023<1346:GOMFAJ>2.0.CO;2

[21] DOI: 10.1017/S0022112010000510 · Zbl 1193.76059 · doi:10.1017/S0022112010000510
[22] DOI: 10.1063/1.3271342 · Zbl 1311.37042 · doi:10.1063/1.3271342
[23] DOI: 10.1175/1520-0485(1994)024<2263:MZJIAQ>2.0.CO;2 · doi:10.1175/1520-0485(1994)024<2263:MZJIAQ>2.0.CO;2
[24] DOI: 10.1016/j.pocean.2011.01.002 · doi:10.1016/j.pocean.2011.01.002
[25] DOI: 10.1017/S0022112009006375 · Zbl 1181.76071 · doi:10.1017/S0022112009006375
[26] DOI: 10.1175/JAS4000.1 · doi:10.1175/JAS4000.1
[27] DOI: 10.1016/0167-2789(96)00102-9 · Zbl 0900.76191 · doi:10.1016/0167-2789(96)00102-9
[28] DOI: 10.1175/2009JPO4093.1 · doi:10.1175/2009JPO4093.1
[29] DOI: 10.1175/2009JPO4218.1 · doi:10.1175/2009JPO4218.1
[30] DOI: 10.1175/1520-0485(1991)021<0976:OTCROH>2.0.CO;2 · doi:10.1175/1520-0485(1991)021<0976:OTCROH>2.0.CO;2
[31] DOI: 10.1175/1520-0485(2004)034<1663:EECCLA>2.0.CO;2 · doi:10.1175/1520-0485(2004)034<1663:EECCLA>2.0.CO;2
[32] Balk, Phys. Rev. Lett. A 146 pp 217– (1990) · doi:10.1016/0375-9601(90)90168-N
[33] DOI: 10.1137/1019071 · Zbl 0358.65088 · doi:10.1137/1019071
[34] DOI: 10.1126/science.1131375 · doi:10.1126/science.1131375
[35] DOI: 10.1175/JAS4013.1 · doi:10.1175/JAS4013.1
[36] DOI: 10.1175/2007JPO3653.1 · doi:10.1175/2007JPO3653.1
[37] DOI: 10.1029/2008JC005108 · doi:10.1029/2008JC005108
[38] DOI: 10.1175/1520-0485(2004)034<2257:BUGTIT>2.0.CO;2 · doi:10.1175/1520-0485(2004)034<2257:BUGTIT>2.0.CO;2
[39] DOI: 10.1029/2006JC004072 · doi:10.1029/2006JC004072
[40] DOI: 10.1175/JPO3111.1 · doi:10.1175/JPO3111.1
[41] DOI: 10.1175/1520-0469(2004)061<1420:ALMFPA>2.0.CO;2 · doi:10.1175/1520-0469(2004)061<1420:ALMFPA>2.0.CO;2
[42] DOI: 10.1175/1520-0485(1999)029<1143:JSASIS>2.0.CO;2 · doi:10.1175/1520-0485(1999)029<1143:JSASIS>2.0.CO;2
[43] DOI: 10.1029/2010GL046267 · doi:10.1029/2010GL046267
[44] DOI: 10.1029/2008GL035998 · doi:10.1029/2008GL035998
[45] DOI: 10.1175/1520-0485(2004)034<0416:EOBFON>2.0.CO;2 · doi:10.1175/1520-0485(2004)034<0416:EOBFON>2.0.CO;2
[46] DOI: 10.1029/2005GL024645 · doi:10.1029/2005GL024645
[47] DOI: 10.1063/1.166011 · doi:10.1063/1.166011
[48] DOI: 10.1017/S0022112075001504 · Zbl 0366.76043 · doi:10.1017/S0022112075001504
[49] DOI: 10.1175/2007JAS2219.1 · doi:10.1175/2007JAS2219.1
[50] DOI: 10.1017/S0022112010004568 · Zbl 1225.76134 · doi:10.1017/S0022112010004568
[51] DOI: 10.1175/2007JPO3856.1 · doi:10.1175/2007JPO3856.1
[52] DOI: 10.1007/978-1-4612-4650-3 · doi:10.1007/978-1-4612-4650-3
[53] DOI: 10.1175/1520-0469(1993)050<2073:ZJIWBU>2.0.CO;2 · doi:10.1175/1520-0469(1993)050<2073:ZJIWBU>2.0.CO;2
[54] DOI: 10.1029/2005GL025368 · doi:10.1029/2005GL025368
[55] DOI: 10.1175/JPO2698.1 · doi:10.1175/JPO2698.1
[56] DOI: 10.1017/S0022112076002899 · Zbl 0355.76018 · doi:10.1017/S0022112076002899
[57] DOI: 10.1007/s10236-009-0260-z · doi:10.1007/s10236-009-0260-z
[58] DOI: 10.1175/1520-0485(1979)009<1155:OTEOIN>2.0.CO;2 · doi:10.1175/1520-0485(1979)009<1155:OTEOIN>2.0.CO;2
[59] DOI: 10.1016/0377-0265(77)90002-1 · doi:10.1016/0377-0265(77)90002-1
[60] McIntyre, J. Met. Soc. Japan 60 pp 37– (1982)
[61] DOI: 10.1029/2008GL033267 · doi:10.1029/2008GL033267
[62] DOI: 10.1029/2005GL022728 · doi:10.1029/2005GL022728
[63] DOI: 10.1175/JPO2949.1 · doi:10.1175/JPO2949.1
[64] DOI: 10.5194/npg-17-49-2010 · doi:10.5194/npg-17-49-2010
[65] DOI: 10.1175/1520-0469(1999)056<0784:SEOZJO>2.0.CO;2 · doi:10.1175/1520-0469(1999)056<0784:SEOZJO>2.0.CO;2
[66] DOI: 10.1016/S0167-2789(01)00384-0 · Zbl 0983.86002 · doi:10.1016/S0167-2789(01)00384-0
[67] DOI: 10.1175/2010JAS3492.1 · doi:10.1175/2010JAS3492.1
[68] DOI: 10.1016/j.ocemod.2010.04.001 · doi:10.1016/j.ocemod.2010.04.001
[69] DOI: 10.1175/1520-0469(1997)054<1726:MOMJIA>2.0.CO;2 · doi:10.1175/1520-0469(1997)054<1726:MOMJIA>2.0.CO;2
[70] Kondratyev, Weather and Climate on Planets (1982) · doi:10.1063/1.2915177
[71] DOI: 10.1175/JAS4009.1 · doi:10.1175/JAS4009.1

[72] DOI: 10.1016/j.jcp.2009.06.037 · Zbl 1172.76034 · doi:10.1016/j.jcp.2009.06.037

[73] DOI: 10.1016/j.ocemod.2009.06.009 · doi:10.1016/j.ocemod.2009.06.009

[74] DOI: 10.1175/2009JPO4239.1 · doi:10.1175/2009JPO4239.1

[75] DOI: 10.1175/2008JPO4096.1 · doi:10.1175/2008JPO4096.1

[76] DOI: 10.1029/2008GL036327 · doi:10.1029/2008GL036327

[77] DOI: 10.1016/j.ocemod.2009.10.004 · doi:10.1016/j.ocemod.2009.10.004

[78] DOI: 10.1175/1520-0469(1998)055<0611:TDTAPZ>2.0.CO;2 · doi:10.1175/1520-0469(1998)055<0611:TDTAPZ>2.0.CO;2