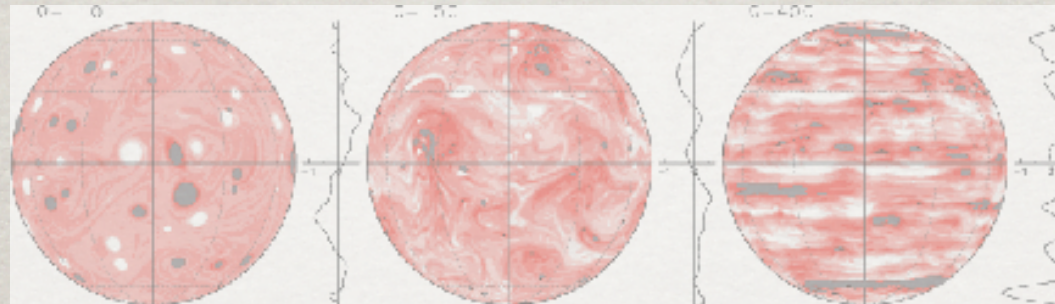




Chapman Conference on Jets and Annular Structures in Geophysical Fluids



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CENTURY COE PROGRAM

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JETS

☼ Sources

- Hadley cell (subtropical jet)
- Self organization
 - baroclinic eddies within broad baroclinic zones
 - beta-plane turbulence
- Instabilities of/interactions among modes

VARIABILITY OF JETS

- ✻ Null hypothesis: purely stochastic
 - variations decay on dissipation timescale
- ✻ Feedbacks
 - good bet for a self-organized jet
 - reddens spectrum of variability

ANNULAR MODES

- ✻ Structure and short-time decay rate set by tropospheric dynamics
 - Features recognizably similar to annular modes occur in models with no stratosphere and no ocean
 - Interaction with stratosphere reddens spectrum in some seasons
 - Interaction with ocean probably necessary to explain interannual & longer timescales
- ✻ Not zonally symmetric, but exhibiting strong projection on zonal mean
 - NAO projects on zonal mean

“THEORY” OF ANNULAR MODES

- ✱ Vertically integrated wave zonal wind and wave activity

$$\frac{dU}{dt} = \nabla \cdot \mathbf{F} - U/\tau \quad \frac{dA}{dt} + \nabla \cdot \mathbf{F} = S - D$$

- ✱ Average over time (a month)

$$U \sim (S - D)\tau$$

- ✱ Sources and sinks of wave activity have stochastic and mean-flow-organized components

$$S = s(U) + \varepsilon \quad D = D(U, A)$$

- ✱ Annular mode is stochastically driven variability of self-organized jet. Need theories for $S(U)$ and $D(U, A)$

PV MIXING/PV STAIRCASES

- ✻ A general model for jets?
 - Where does it *not* apply?
 - How to go from descriptive to predictive theory?
- ✻ Organizing principle for Jovian jets?

ANTARCTIC CIRCUMPOLAR CURRENT - POSSIBLE PARADIGM

- ✻ Baroclinicity (available potential temperature) of ACC created as Ekman drift tilts isopycnals
- ✻ Resulting flow is baroclinically unstable
- ✻ Baroclinic eddies drive self-organizing jets
- ✻ Jets are anchored by topography

TROPOSPHERE-STRATOSPHERE COUPLING

- ✻ Troposphere influences stratosphere through upward propagating waves
 - Perhaps not as well understood as we like to think - interaction between boundary (land-sea contrast and topography) forced waves, and waves generated by nonlinear interactions of synoptic eddies (cf. Scinocca and Haynes)
- ✻ Growing evidence that stratospheric dynamics influences tropospheric dynamics
 - Seasonality of timescales and Norton's modeling results shown by Mark Baldwin
 - Many mechanistic model results
- ✻ Mechanism?

DEEP OCEAN JETS

- ✻ Are real
- ✻ Rare example of prediction from a numerical model leading to discovery in observations
- ✻ Mechanisms?

JETS AND TRACER TRANSPORT

- ✪ Jets are barriers to transport, because of:
 - Shear zones on jet flanks
 - In geophysical setting, eastward jets have critical lines away from jet center
- ✪ Deep ocean jets should be detectable in tracer distributions

GENERAL QUESTION # 1

- ✻ What, if anything, do initial value problems tell us about the behavior of forced dissipative systems?
 - Decaying turbulence
 - Baroclinic lifecycles

GENERAL QUESTION #2

- ✻ What does the internal variability of a system tell us about its response to forcing?
 - E.g. - can we predict the annular mode response to global warming?

GENERAL QUESTION #3

- ✻ Why is it so difficult, in GFD, to develop successful *predictive* theories?
 - Even for simple systems, such as the two-level QG model