Earth Syst. Dynam. Discuss., 2, C288–C291, 2011
www.earth-syst-dynam-discuss.net/2/C288/2011/

Earth System Dynamics Discussions

Interactive comment on "Jet stream wind power as a renewable energy resource: little power, big impacts" *by* L. M. Miller et al.

L. M. Miller et al.

lmiller@bgc-jena.mpg.de

Received and published: 13 October 2011

ESDD

2, C288–C291, 2011

Interactive Comment

Response to reviewer D. B. Kirk-Davidoff

L.M. Miller, F. Gans, & A. Kleidon

We thank D.B. Kirk-Davidoff for his overall support of our submitted paper. Below is our brief response to his review.

The main motivation of this submitted manuscript was to address previous research which presents the jet streams as a renewable energy resource capable of sustaining "...100 times as much energy as humans use today," p.564 from Vance (2009). Associated work by Roberts et al. (2007); Archer and Caldeira (2009) also promotes jet stream wind energy as immense and without a climatic impact based on an energy extraction rate of 17 TW — we strived to correct this misconception. In our manuscript, we clearly describe why:

1. high wind velocities of the jet stream do not indicate a region of high wind energy extractability
2. jet stream dynamics make them sensitive to mechanical energy extraction

We recognize that the reviewer D.B. Kirk-Davidoff agrees with both of these main points. Our reason for highlighting this motivation is to note that, although we find the topic of wind power technologies deployed at elevations of 1-3 km to be worthy of further research, including it in this manuscript would be outside its intended scope and

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

distract from specifically utilizing jet stream winds as an energy resource. To prevent any potential confusion between our 'jet stream estimates' and the proposed kite technologies such as Argatov et al. (2009) or Canale et al. (2009), it seems worthwhile to note this in the final manuscript's Discussion.

In an underlying motivation of the paper (*i.e.* What is the maximum sustained extraction rate of energy from the global jet streams given our stated assumptions?), we just constructed this experiment to estimate this maximum energy extraction rate. D.B. Kirk-Davidoff's suggests that,

> *"...something about the placement of the turbines in the study is very far from optimal for wind generation purposes! One suspects that the algorithm of choosing to place the turbines in region of highest winds at each instant results in a particularly strong impact on the jet."*

It is true that the disturbances to jet stream dynamics during the extraction process would affect attempts to extract additional wind energy elsewhere in the atmosphere, such as near the surface. This manuscript was not intended to outline the design for an optimum atmospheric wind energy extraction 'mix' for maximum power and minimum climatic impacts. Instead, after understanding points 1 & 2 above, these approximated extraction rates and the altered atmospheric dynamics can be discussed more broadly in association with other renewable resources, and in a context that now recognizes dependent process of the Earth System and their more fundamental limits.

D.B. Kirk-Davidoff's concludes with another excellent point —

> *"We should aim to tap energy from the system in locations somewhat removed from the main loci of conversion from kinetic energy of the mean flow to eddy kinetic energy..."*

ESDD

2, C288–C291, 2011

After completing this study we completely agree, while recognizing that this view may be counter-intuitive to most researchers outside theoretical meteorology or atmospheric science. For those interested in furthering this type of analysis though, it certainly deserves mention in the final manuscript's Discussion.

References

Archer C L, Caldeira K, Global assessment of high-altitude wind power, *Energies*, **2**, 307–319, 2009

Argatov I, Rautakorpi P, Silvennoinen R, Estimation of the mechanical energy output of the kite wind generator, *Renewable Energy*, **34**, 1525–1532, 2009

Canale M, Fagiano L, Milanese M, KiteGen: a revolution in wind energy generation, *Energy*, **34**, 355–361, 2009

Roberts, B. W., Shepard, D. H., Caldeira, K., Cannon, M. E., Eccles, D. G., Grenier, A. J., and Freidin, J. F.: Harnessing high-altitude wind power, IEEE T. Energy Conver., 22, 136–144, 2007.

Vance, E.: High Hopes, Nature, 460, 564–566, 2009.

ESDD

2, C288–C291, 2011