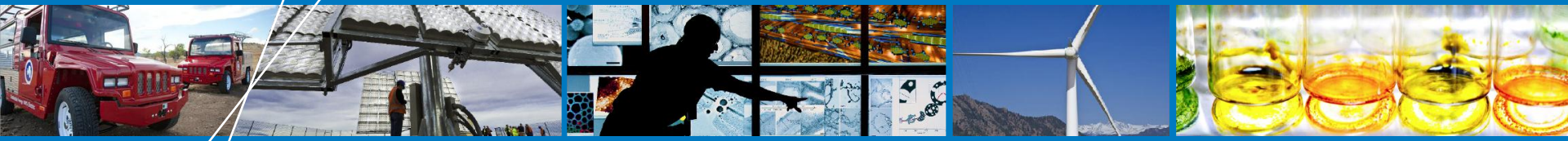
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Introduction and Synopsis of Program on Improving the Representation of Renewable Energy Technologies in IAMs for Climate Scenario Analysis



Douglas Arent

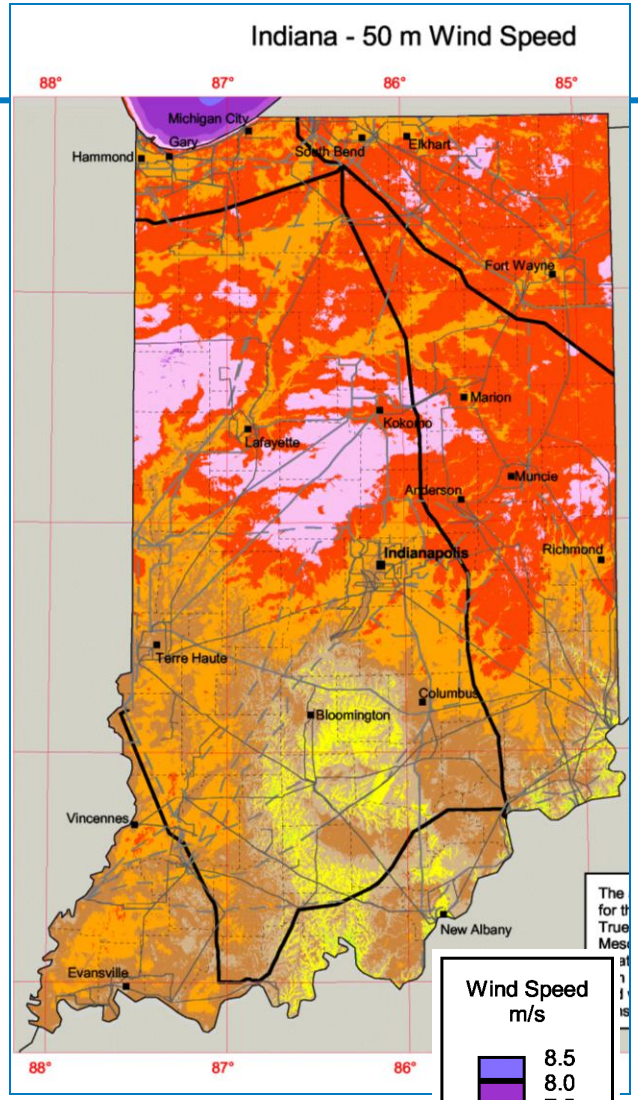
2013 CCI/IA Workshop
July 22, 2013

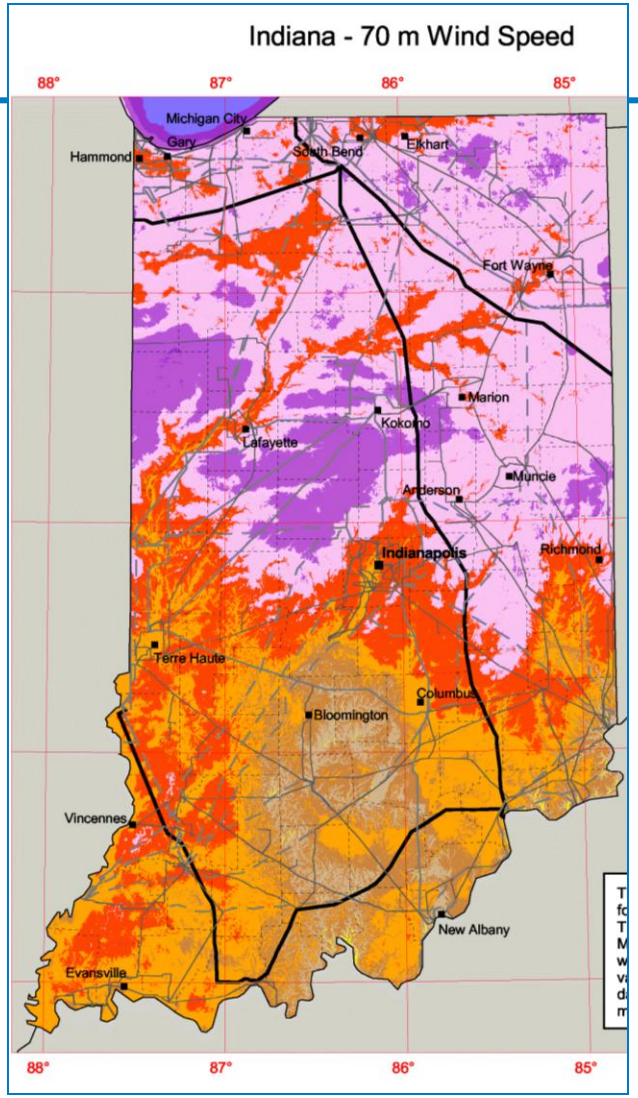
Key Issues

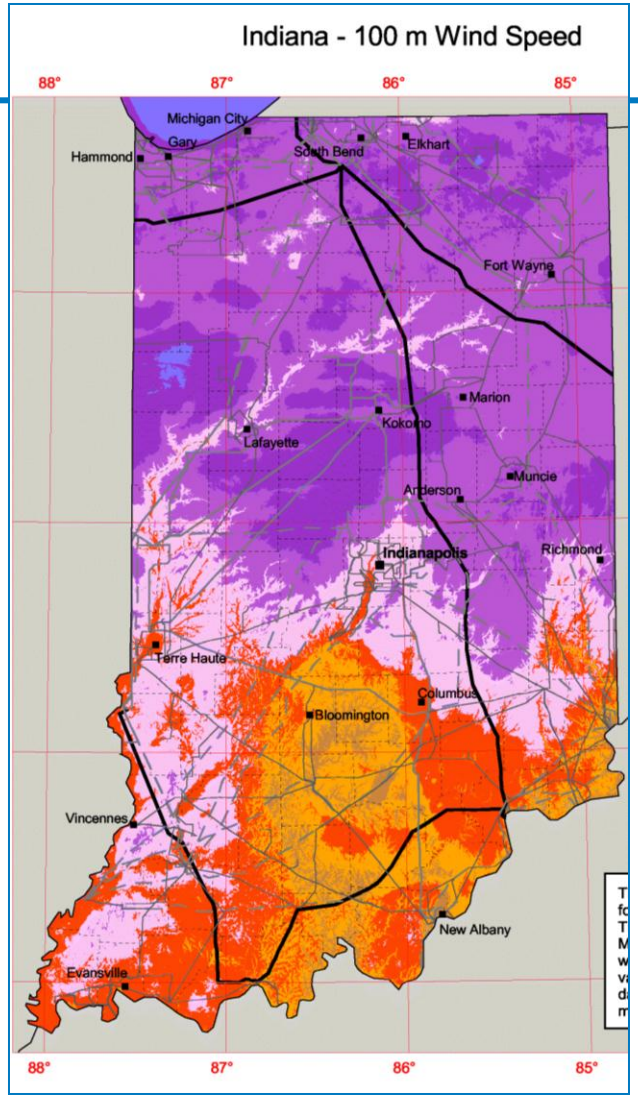
- **Technology potential presents no meaningful limit on RE contributions… must properly represent economic potential**
- **Time and place matter, including climate feedback**
- **System level analysis is critical**
  - Spatial and technology interactions
  - Details can matter (e.g., Time, Space, Reliability, Carbon price, Flexibility)
- **Handoffs between technology detail and aggregated/IAMs is a fundamental change in the way we operate (a good one!!)**

Pathway to 2013

- **Get the potentials right**
  - Wind 1st then Solar, Geo
- **Incorporate commercial and near commercial techs**
  - Offshore Wind
  - CSP w/storage
- **Improve the methodologies for incorporating variable RETs in bottoms up and top down models**





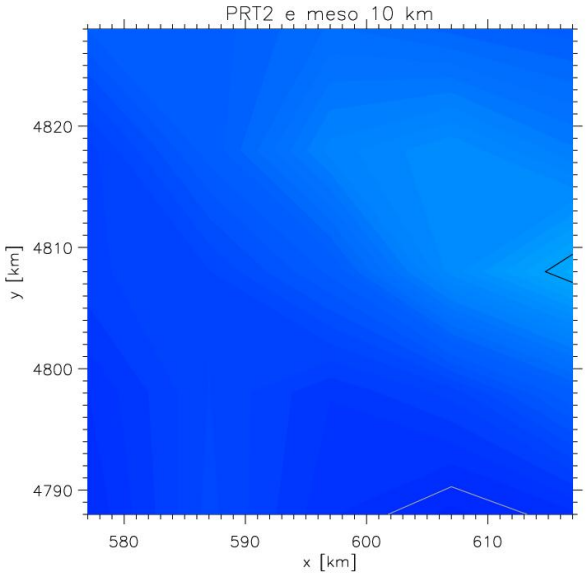


Wind Potential (8-12% Losses)
30-36% Capacity Factor: 100 – 42 GW
36-41% Capacity Factor: 2 – 0 GW
Total: 102 – 42 GW

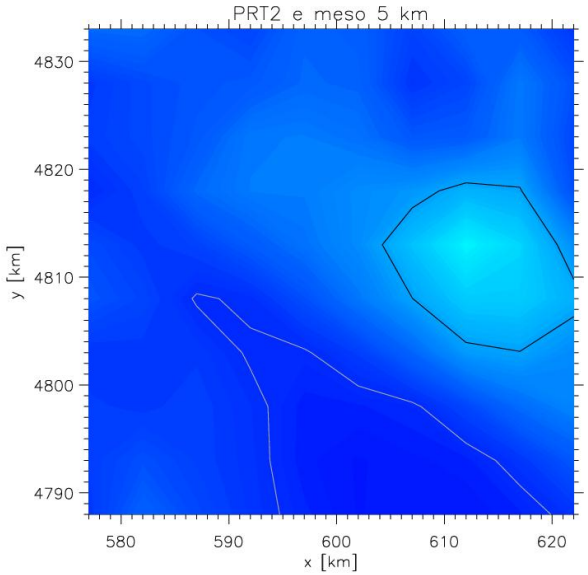
Wind Potential (8-12% Losses)
30-36% Capacity Factor: 123 – 161 GW
36-41% Capacity Factor: 99 – 37 GW
42-46% Capacity Factor: 1 – 0 GW
Total: 223 – 198 GW

Height and Resolution Scale Matter

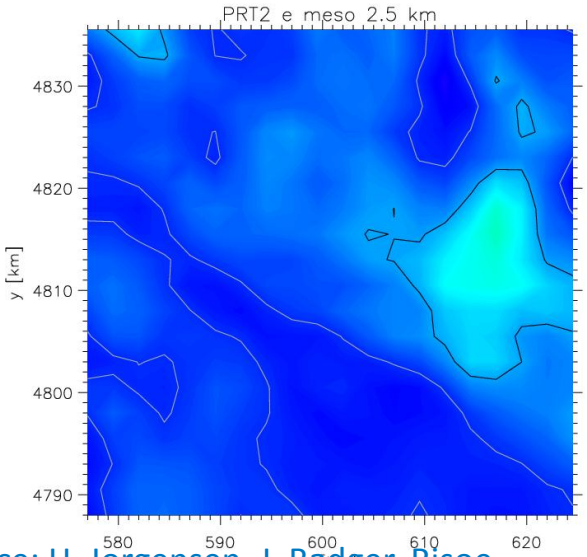
10km



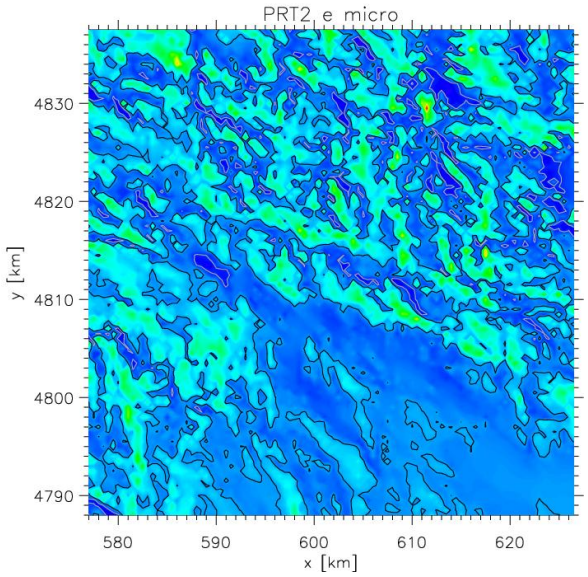
5km



2.5km

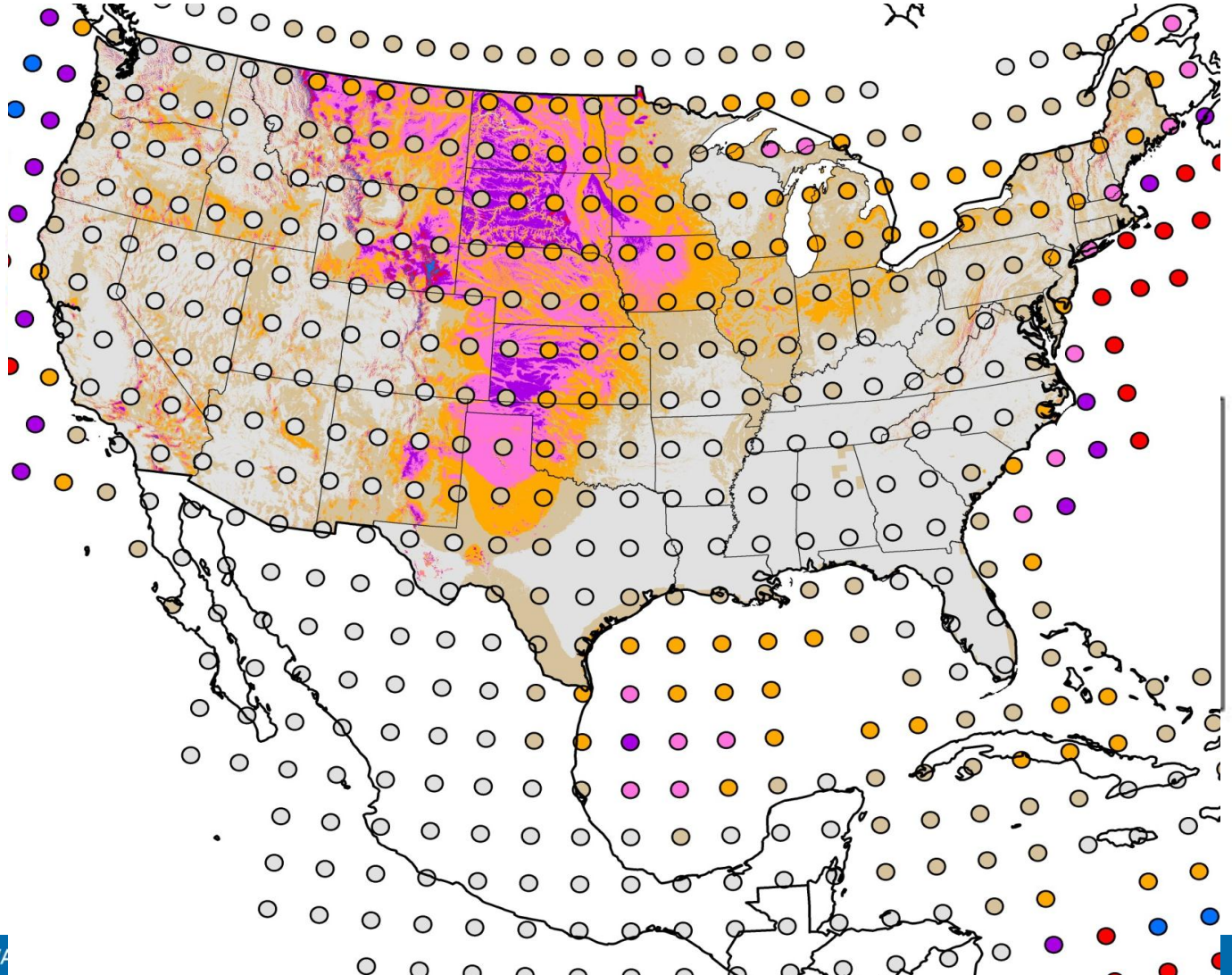


90m

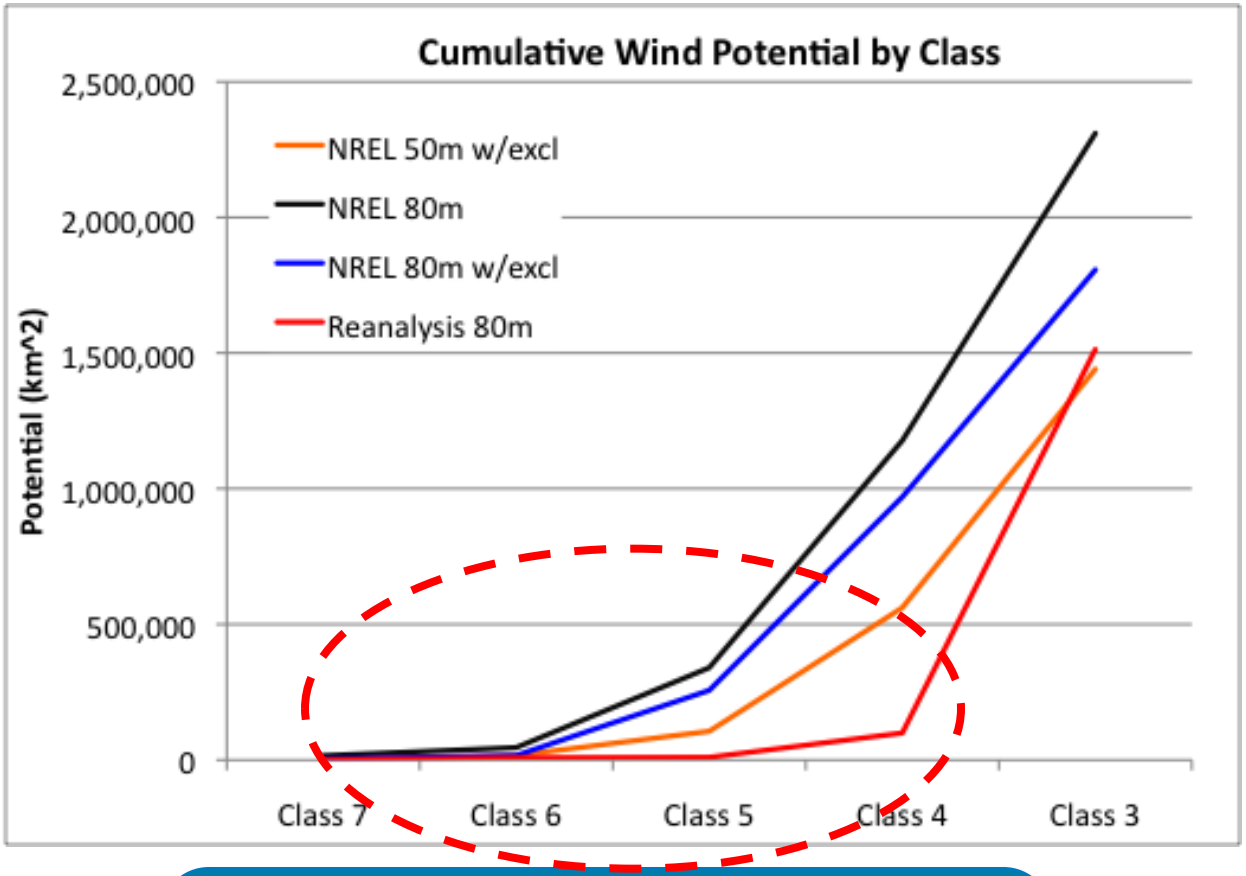


Source: H. Jorgensen, J. Badger, Risoe

Local to Global Impacts

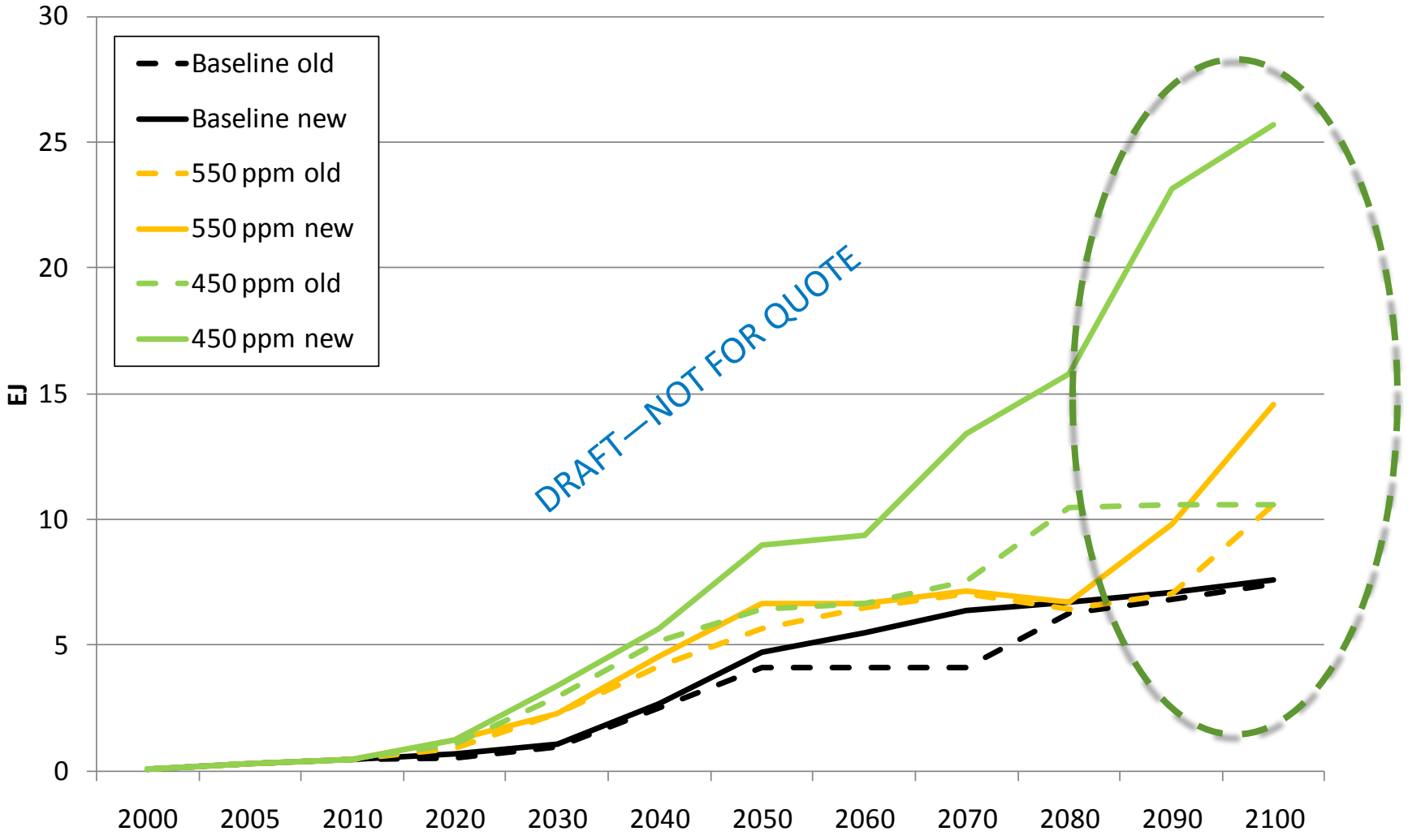


Coarse Scale Data Underestimates High Wind Class Resource



~ 250,000 km^2 missing.
Up to 750GW of highest quality, least cost, resource.

Improved Wind Resource Information: Implications for Climate Mitigation - Western Europe Wind Energy Deployment



Source: V. Krey, IIASA, Aug 2010

Mitigation Costs

		Climate target	
		550ppm	450ppm
Renewable Potential	Old	0.73%	2.00%
	New	0.66%	1.80%

Differences of discounted cumulative consumption relative to the BAU with the same potential; discount rate is 3%.

Source: Kriegler, August 2010, PIK

Next Steps

1. Create a new global data set for wind resources that more accurately represents the fine scale wind resource

- Create new global capacity potential and economic cost assessments for solar and wind technologies
  - On shore
  - Off shore
  - CSP w/ and w/out storage

2. Incorporate improved data and cost analysis into IAM global data representation, followed by comparative evaluation of energy technology contributions to stabilization scenarios

3. Develop and implement data architecture and standards to enable integrated access to data sets for all renewable resources through a common portal

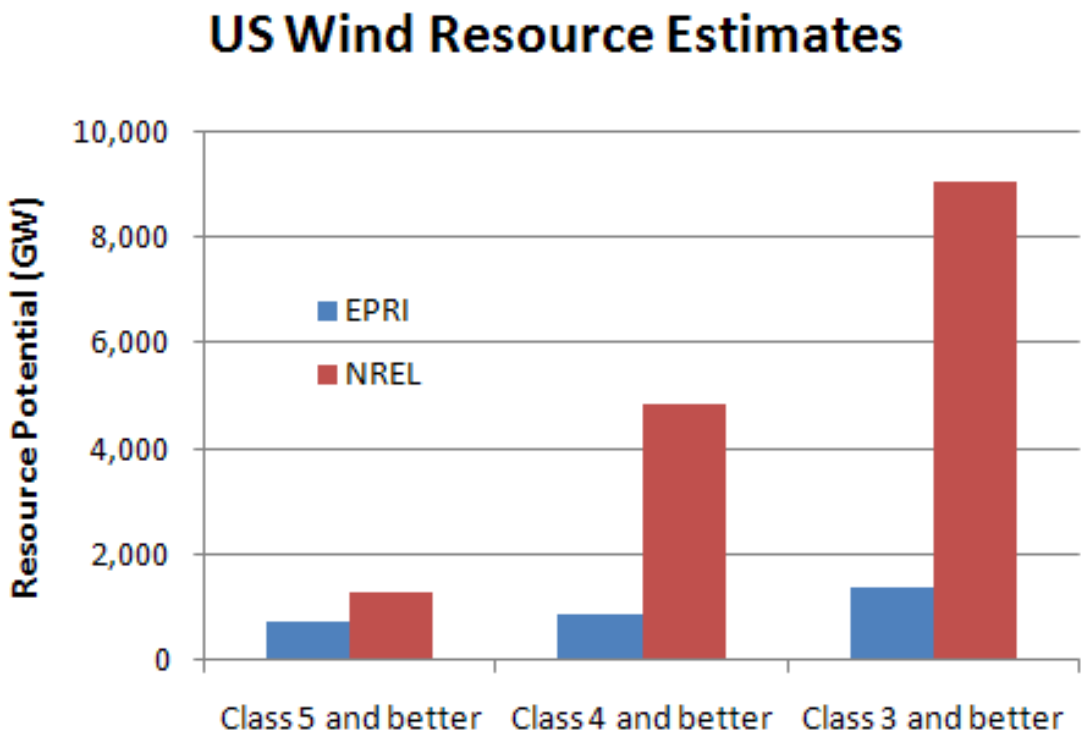
4. Prioritize next actions re EE, Infrastructure, Services/Cross Sectoral Methods, rural energy access and development…

Technical vs Economic Wind Potential Estimates in the US

Victor Niemeyer, Tom Wilson (EPRI),

Donna Heimiller, Patrick Sullivan (NREL)

Different Resource Estimates



Both from AWS Truepower, but very different estimates for national and state-level wind potential.

Different Resource Estimates

NREL

- **Top-down- "Technical"**
  - Identified windy area
  - Filtered for exclusions (blacklist)
  - Applied assumptions for capacity per area (5 MW/km^2) to get MW potential.

EPRI

- **Bottom-up- "Economic"**
  - Identified specific sites based on greatest commercial potential (whitelist)
  - Minimum wind farm size and other criteria.

Different processes → **Different results**

Data, Publications to date

Improved Offshore Wind Resource Assessment in Global Climate Stabilization Scenarios

Douglas Arent
National Renewable Energy Laboratory, Joint Institute for Strategic Energy Analysis

Patrick Sullivan, Donna Heimiller, Anthony Lopez, and Kelly Eurek
National Renewable Energy Laboratory

Jake Badger, Hans Ejsing Jørgensen, and Mark Kelly
DTU Wind Energy

Energy Strategy Reviews 1 (2013) 157–163

Contents lists available at SciVerse ScienceDirect

Energy Strategy Reviews

journal homepage: www

http://en.openei.org/wiki/Global_Renewable_Resource_Potential

ENVIRONMENTAL Science & Technology

Article

pubs.acs.org/est

Evaluation of Global Onshore Wind Energy Potential and Generation Costs

Yuyu Zhou,* Patrick Luckow, Steven J. Smith, and Leon Clarke

Joint Global Change Research Institute, Pacific Northwest National Laboratory/University of Maryland, 5825 University Research Court, Suite 3500, College Park, Maryland 20740, United States

Variable Renewable Energy in modeling climate change
narios

rer#, Patrick Sullivan[1], Eva Schmid#, Böttger[2]

Energy Policy 38 (2010) 7884–7897

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

ANALYSIS

Impacts of considering electric secto MESSAGE model

Patrick Sullivan [a,*], Volker Krey [b], Keywan Riahi [b]

[a] National Renewable Energy Laboratory, 80401, USA
[b] International Institute for Applied Systems Analysis, Austria

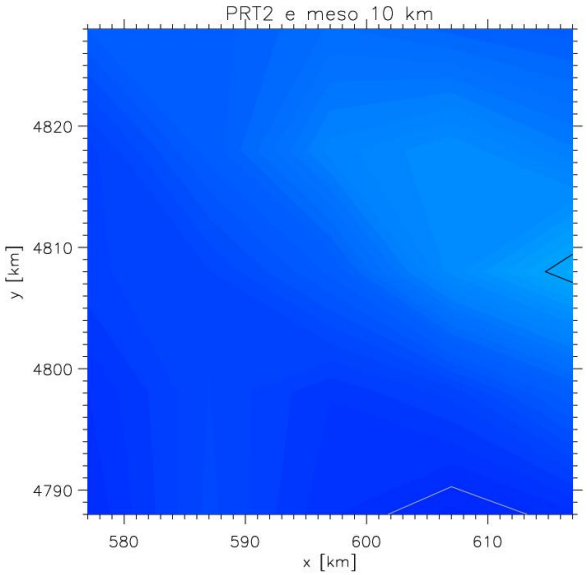
Modeling the potential for thermal concentrating solar power technologies☆

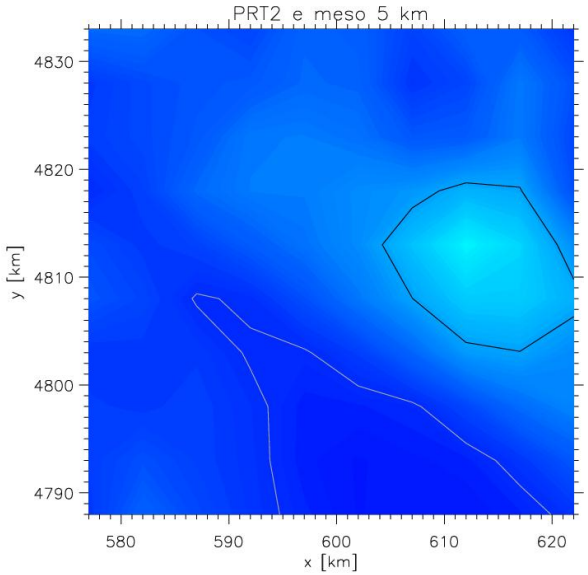
Yabei Zhang [a], Steven J. Smith [b,*], G. Page Kyle [b], Paul W. Stackhouse Jr. [c]

[a] University of Maryland, Joint Global Change Research Institute and Department of Agricultural and Resource Economics, Symons Hall, Room 2200, College Park, MD 20742, USA
[b] Pacific Northwest National Laboratory, Joint Global Change Research Institute, 5825 University Research Court, Suite 3500, College Park, MD 20740, USA
[c] NASA Langley Research Center, 21 Langley Boulevard, MS 420, Hampton, VA 23681, USA

Resolution Scale Matters!

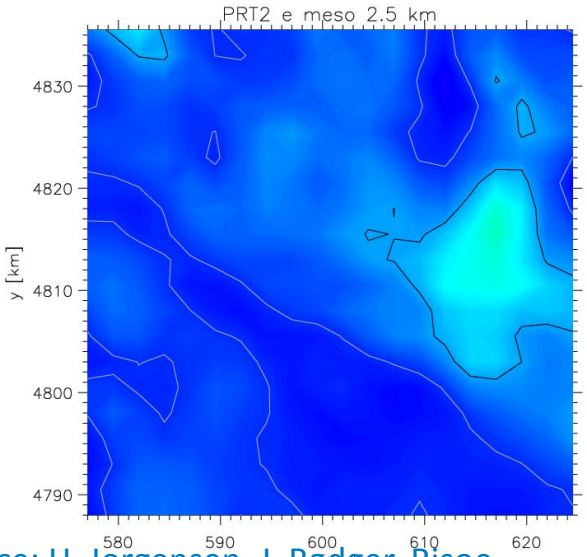
10km

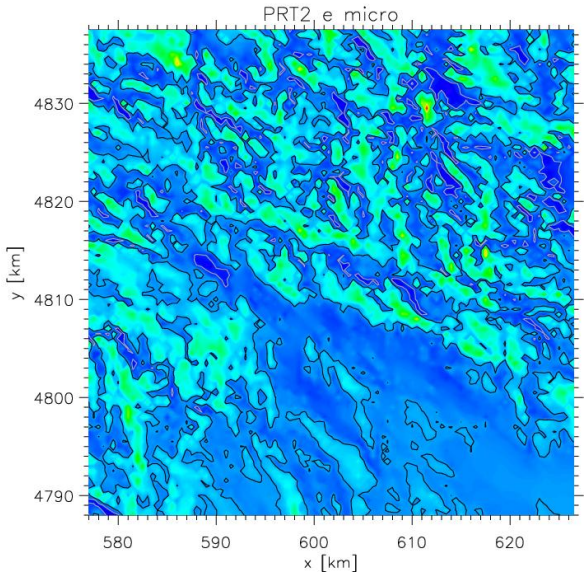




5km

2.5km

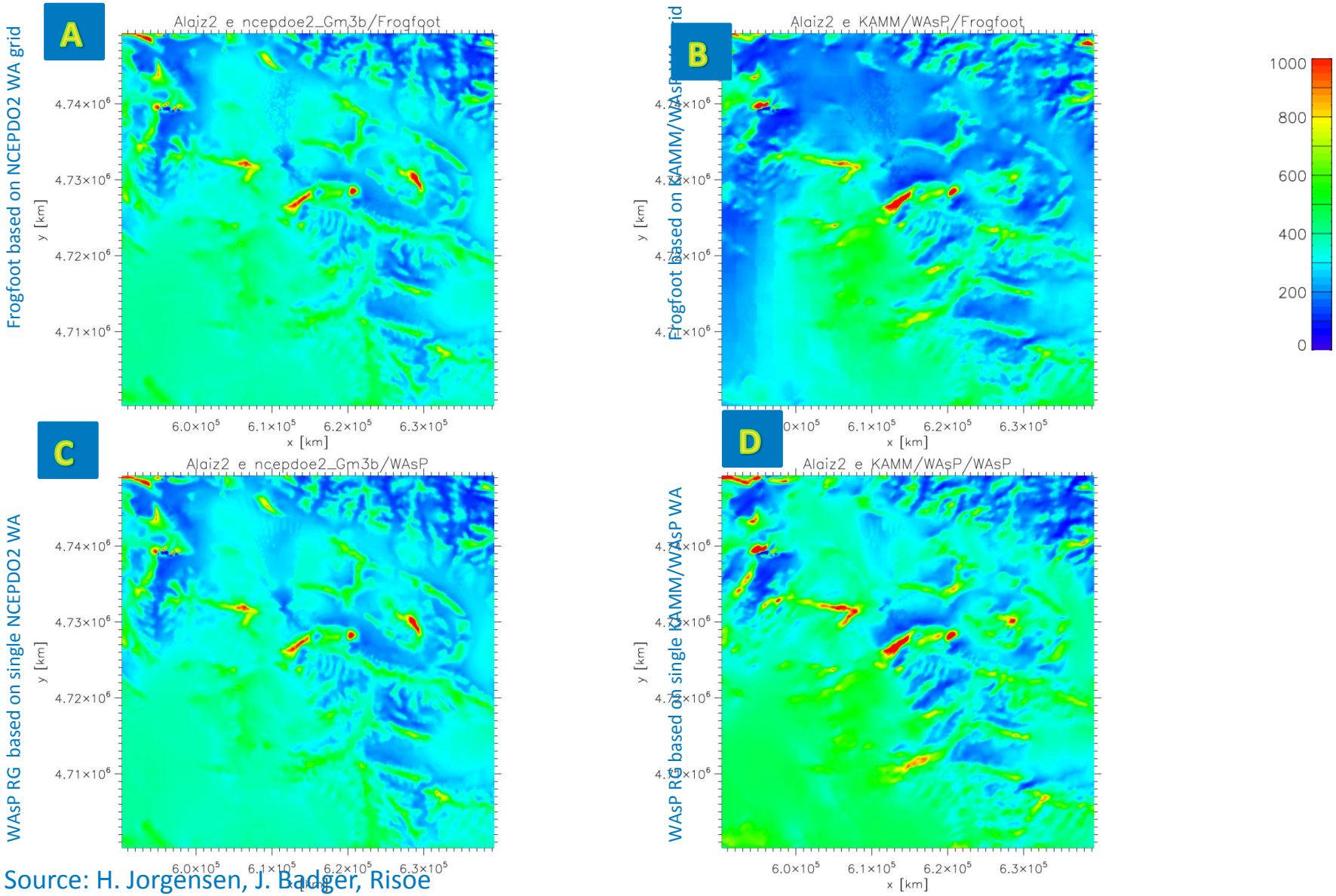




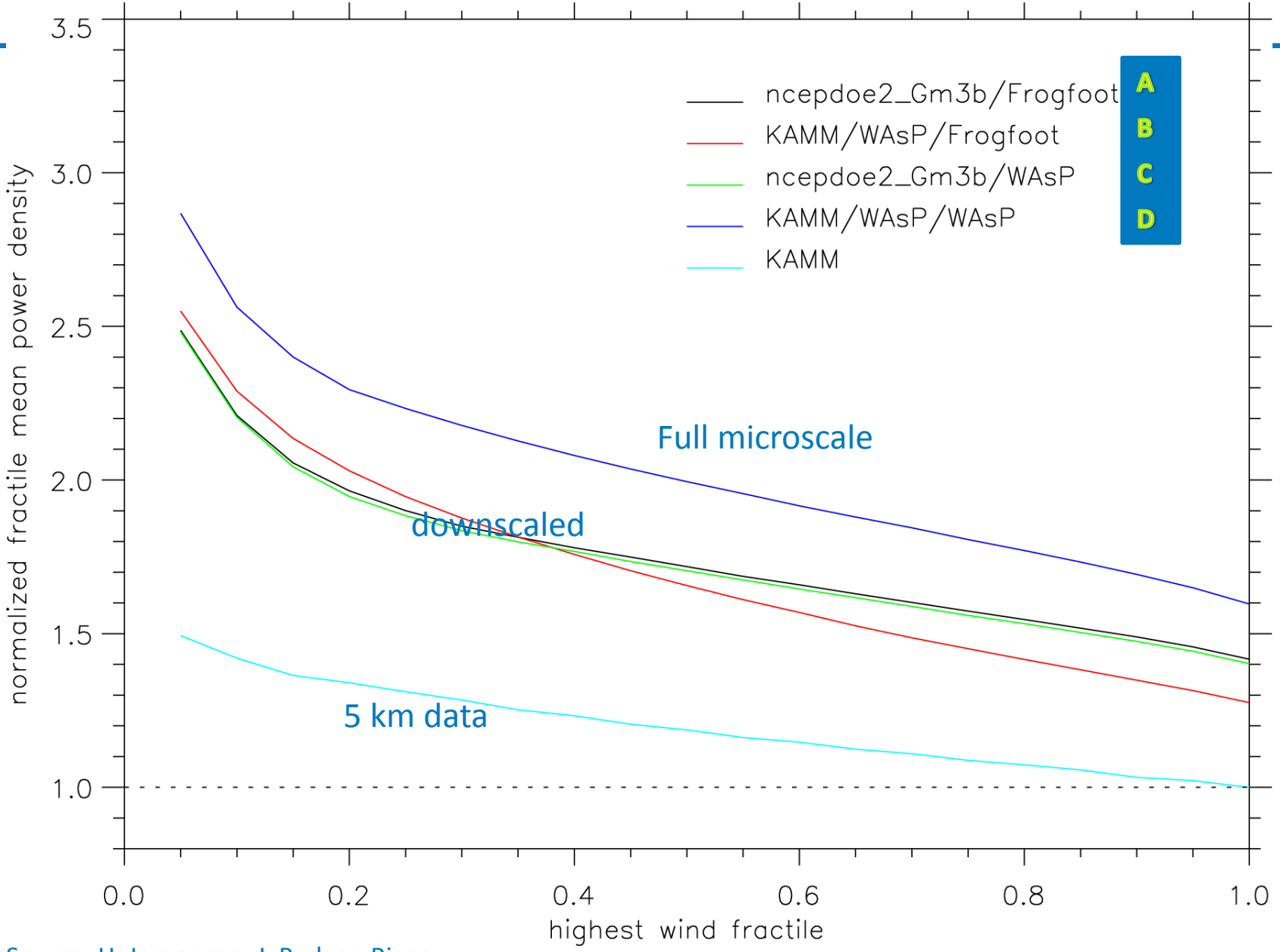
90m

Source: H. Jorgensen, J. Badger, Risoe

Annual mean power density for 50 x 50 km area at 100 m a.g.l. from 250km data with 4 different downscaling methodologies

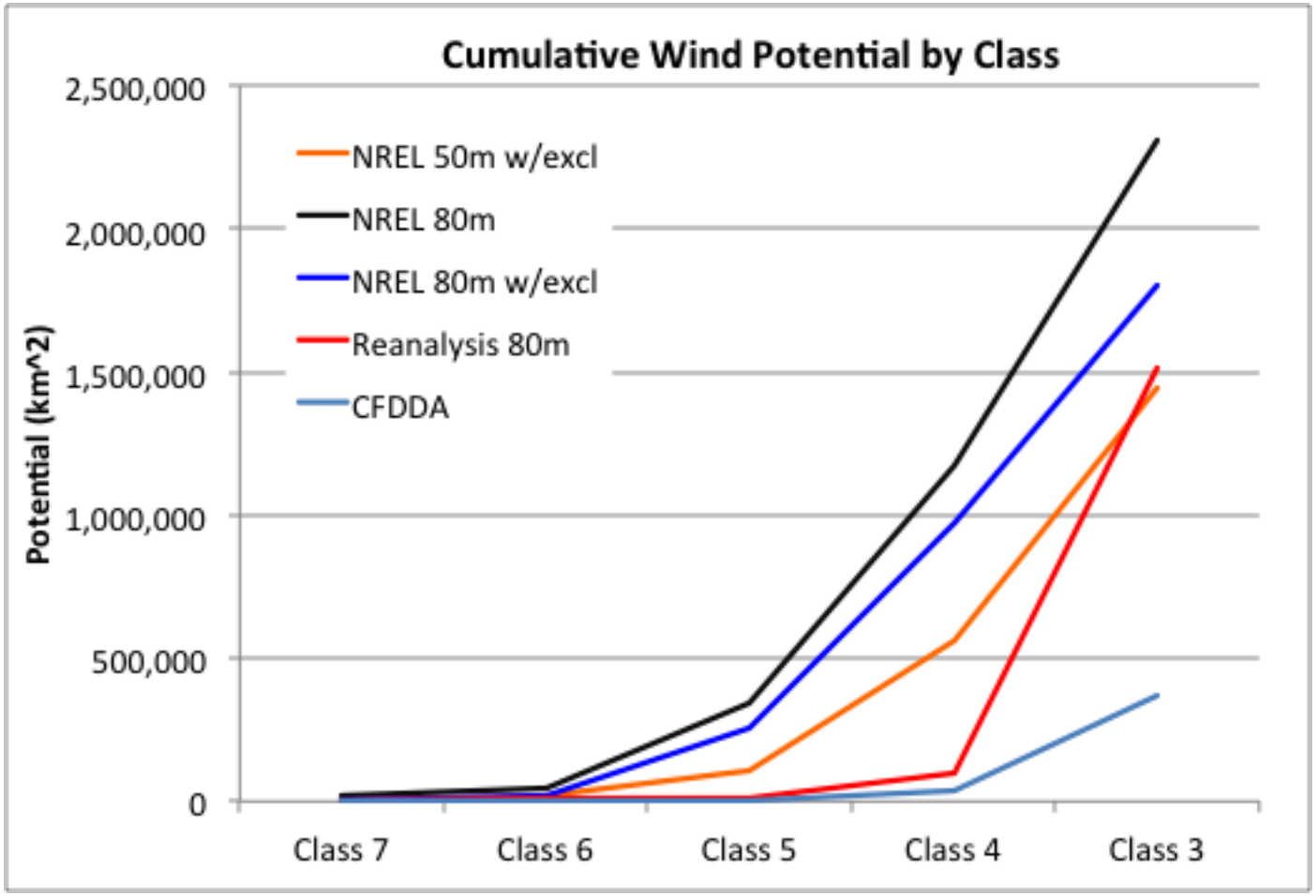


Source: H. Jorgensen, J. Badger, Risoe



Source: H. Jorgensen, J. Badger, Risoe

Need for High Res/Downscaled Data is Critical!



Should country level data be used vs global datasets for onshore??

Upcoming resources

- **New Global Solar data set; fall 2013 from NASA**
  - Will need processing, etc before available to IAM teams
- **Global wind atlas; Winter 2014/15**
  - End user workshop Aug 2014 w/IRENA

Outline for this week

- **Continue examination of global wind, offshore & onshore**
- **Scenario comparison discussions and insights**
- **Map out next steps for current analysis**
- **Map out priorities for 2014+**
  - Integration & Technology representations
  - Updated Solar data set
  - Etc…