A high-altitude wind power (HAWP) climatology with global WRF

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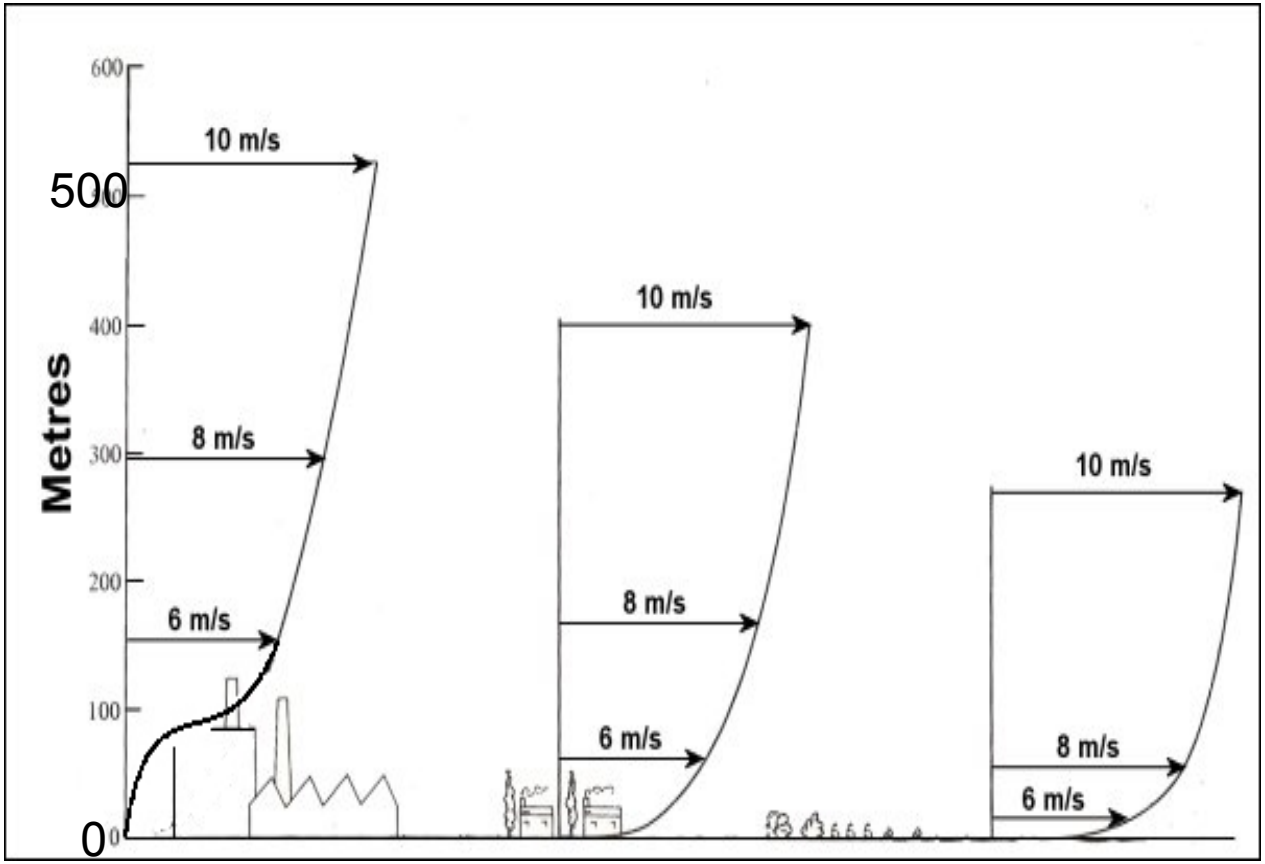
High altitude wind power (HAWP)



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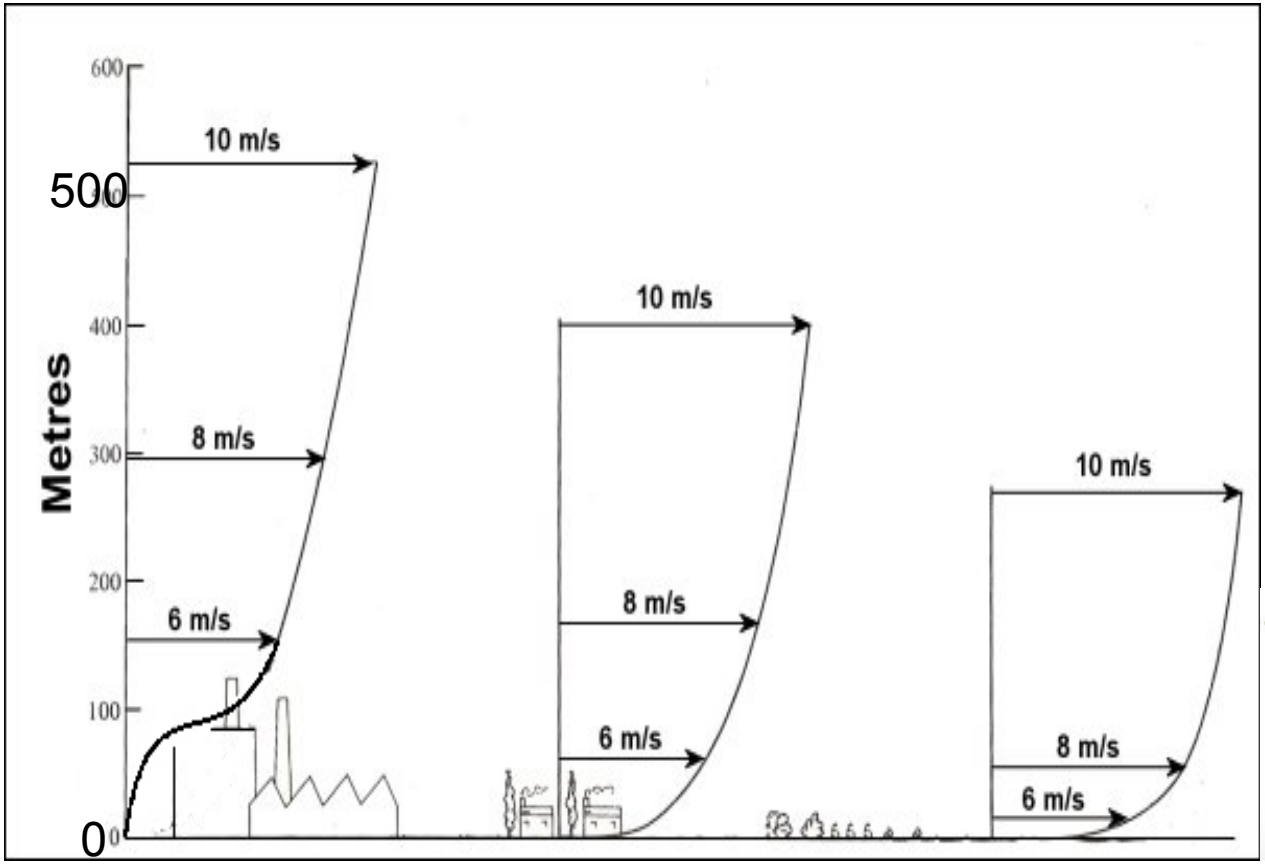

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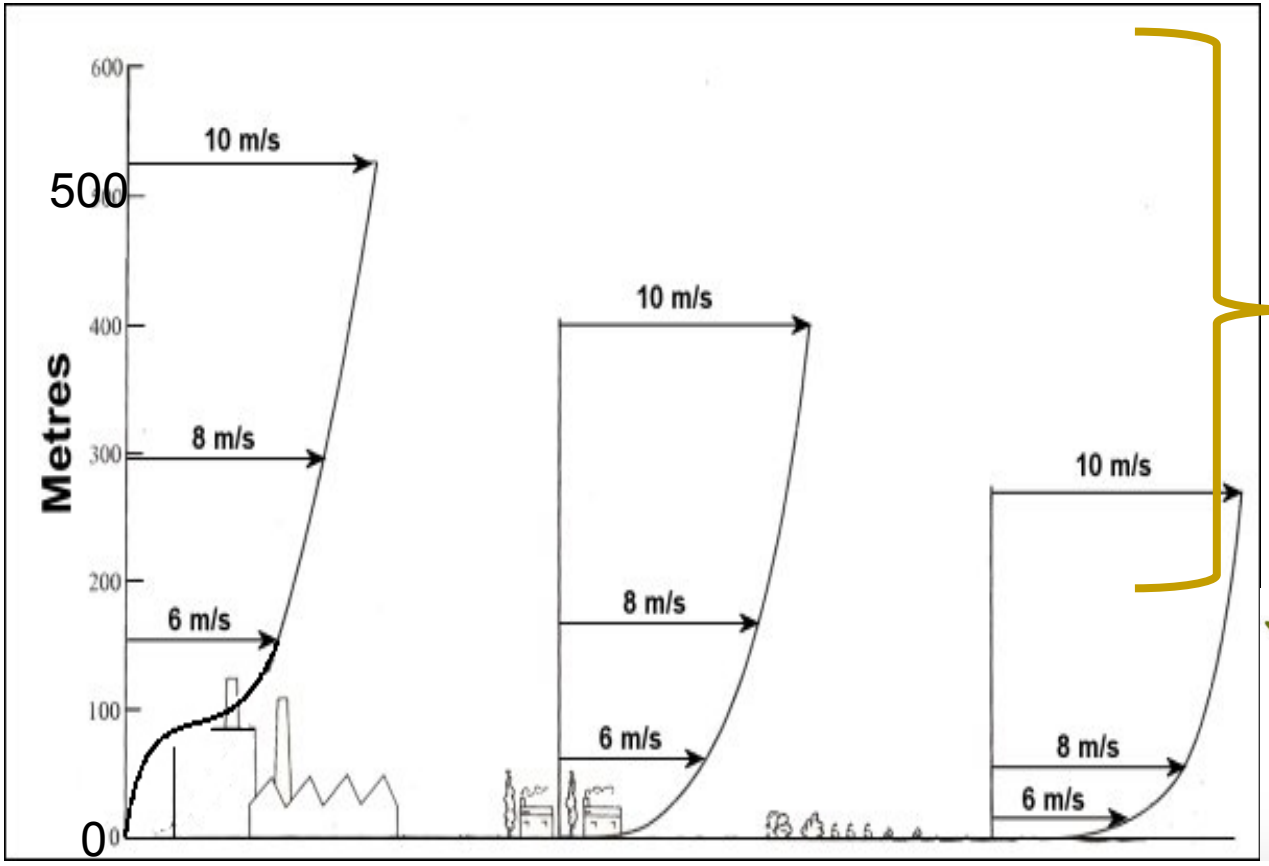
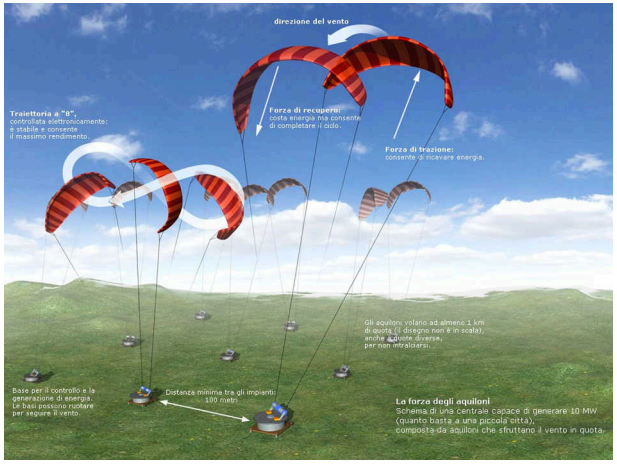


Here's where the **gold** is, if you can reach it.
Wind resource is:

- Stronger
- Steadier
- Less turbulent

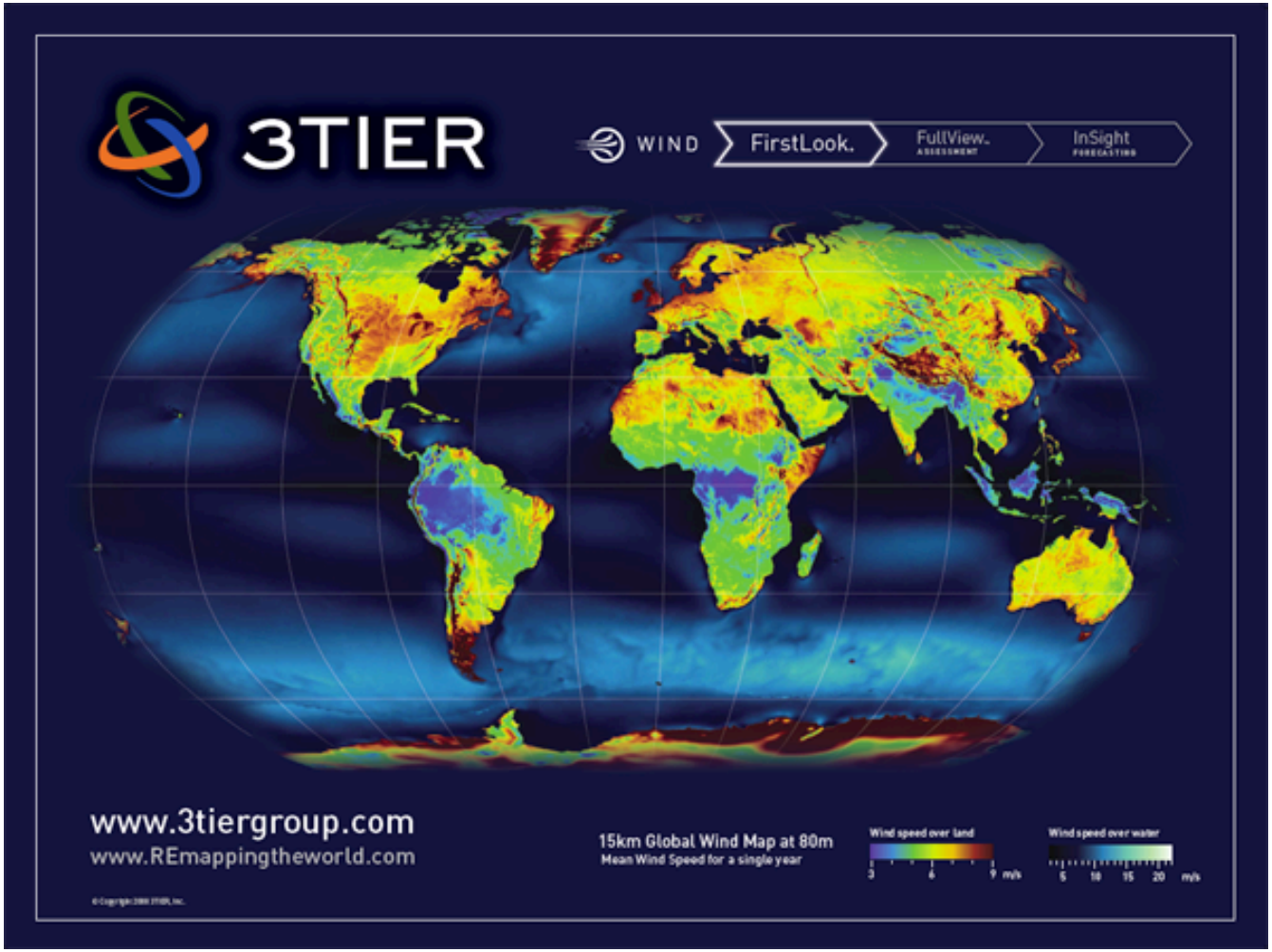
Novel technologies



Wind Resource Assessment Mapping

- Designed for “prospecting” wind energy
- A “light” version of regional climate modeling:
  - Primary interest is recent climate
  - Relies on downscaling of global reanalysis datasets
  - Fewer freely forecasted aspects
  - Periodically reinitialized (every N days, N = 3 to 30)
    - Maintain fidelity to reanalysis
    - Parallelization in time

2007: 3TIER's "FirstLook"

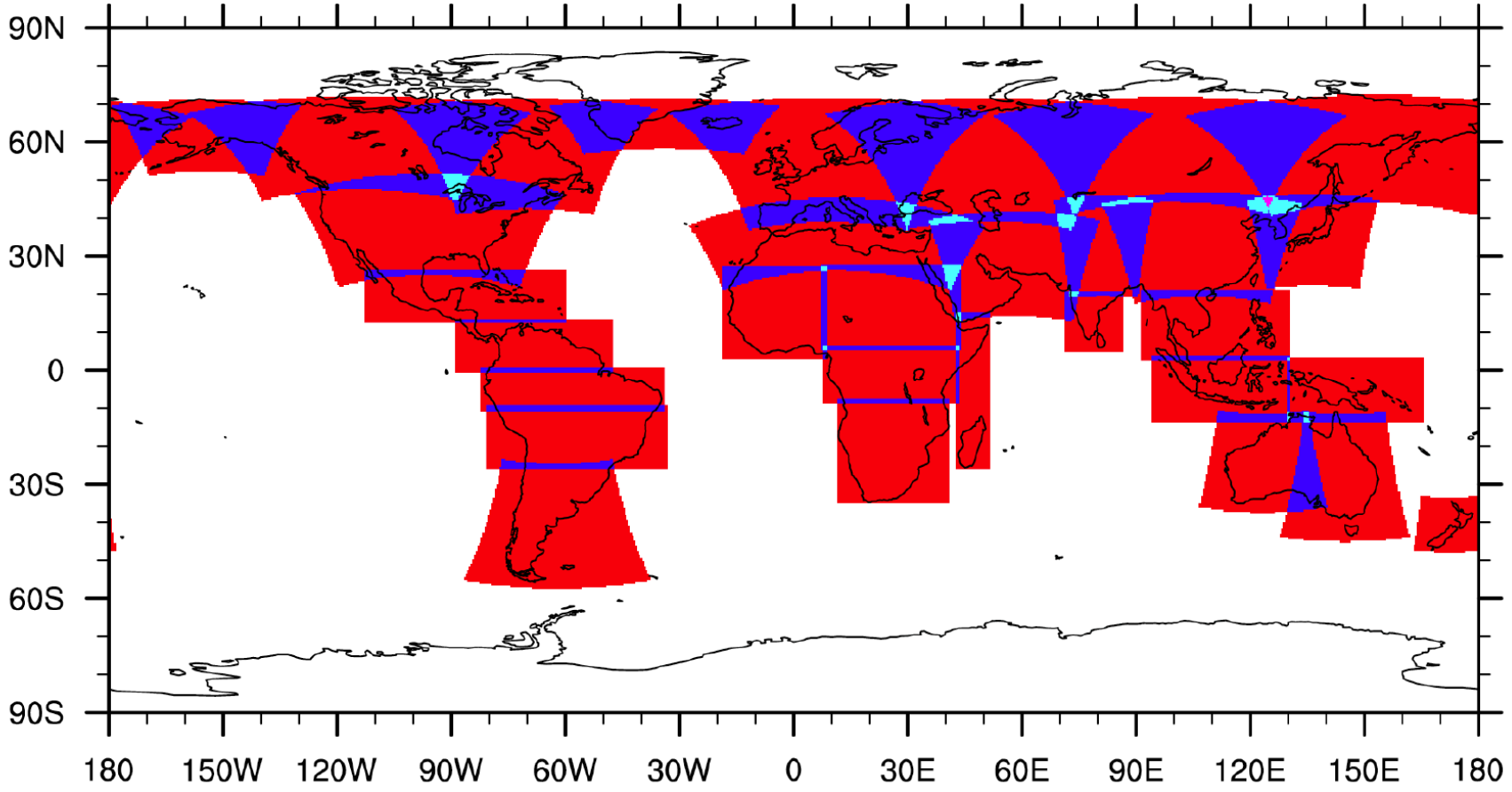


- Global, 5-km resolution
- 10-year climatology

But….

- Turbine hub-height winds
- NCEP/NCAR Reanalysis
- WRF V2
- Simple nudging

And…no global WRF



What did we want this time?
How did we get there?

- Global coverage including oceans: *Global WRF V3.7.1*
- Avoid tiling and blending: *Global WRF V3.7.1*
- More output variables, higher altitude: *More storage*
- Better reanalysis: *ERA-Interim*
- Better downscaling: *Spectral Nudging*
- Higher resolution but faster production:
  Mass-conserving diagnostic flow model (10 km → 2 km)

- *Other configuration options: YSU PBL, Ferrier micro, RRTMG radiation*

Global WRF

- Derived from PlanetWRF
- Major modifications:
  - Unequal map scale factors in x and y directions → allows for global lat/lon grid
  - Polar filter: northern and southern boundaries collapse to single point, requiring special treatment

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PlanetWRF: A general purpose, local to global numerical model for planetary atmospheric and climate dynamics

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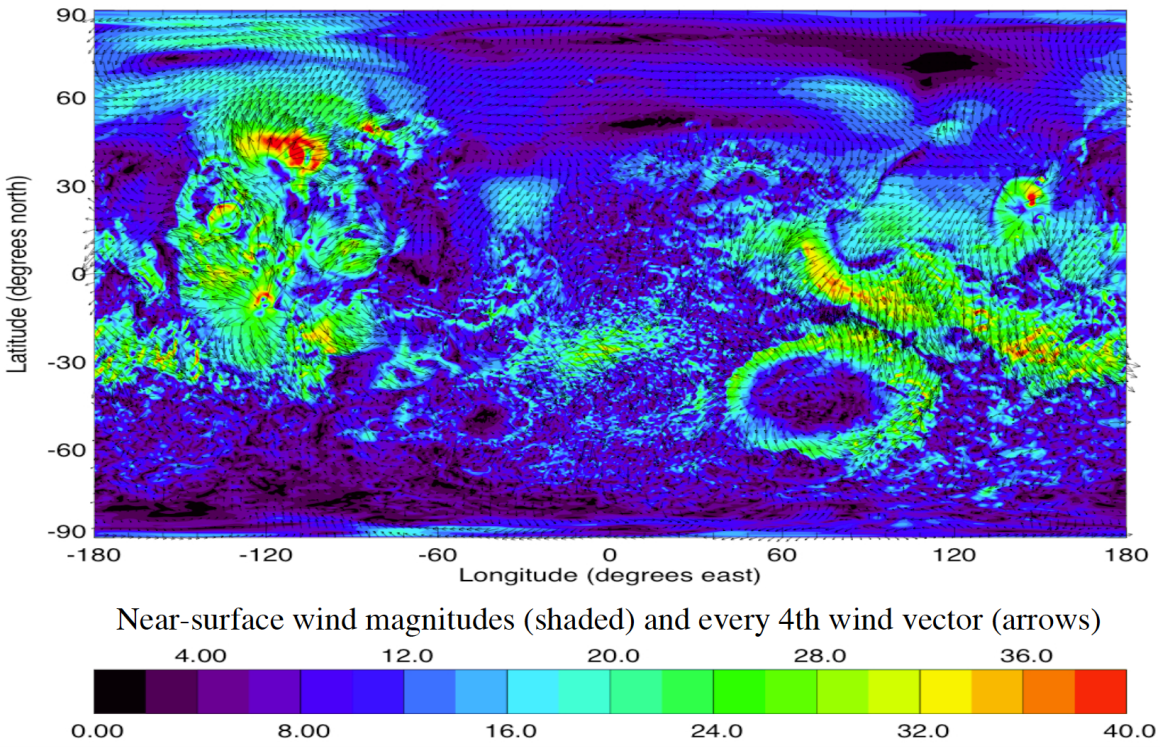
Received 8 September 2006; revised 15 March 2007; accepted 7 May 2007; published 14 September 2007.

[1] A new planetary atmospheric numerical model, "planetWRF," has been developed by modifying the Weather Research and Forecasting (WRF) model. The model has

MarsWRF run at 0.5° global resolution



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Why not MPAS?

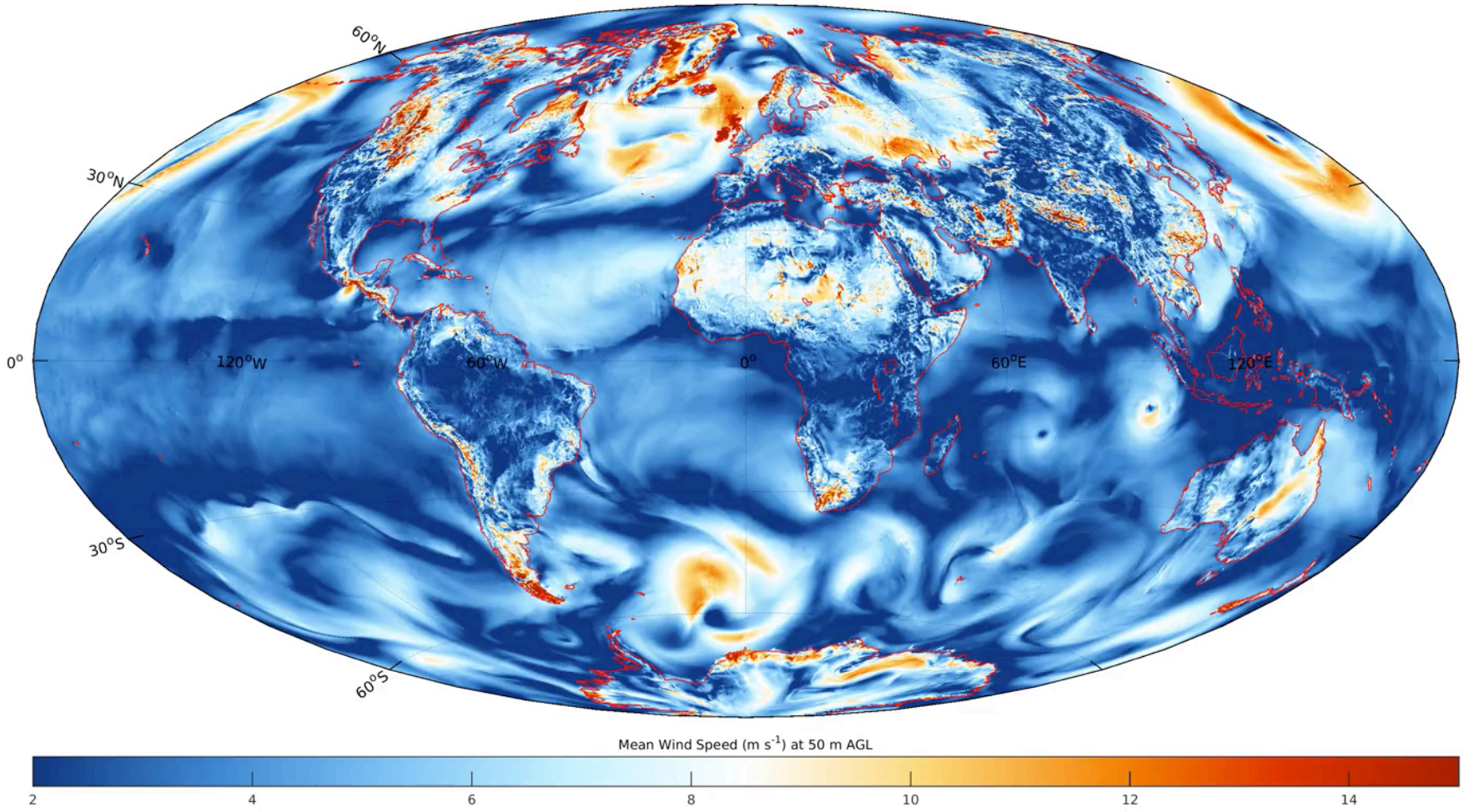
- Experience with WRF
- Physics options
- Continuous mesh refinement not really needed
- Spectral nudging required for reanalysis (or climate model) downscaling.
- However, in the future…

Tribulations with Global WRF

- Two bugs encountered in Global WRF (V3.6.1)
  - Polar filter generating negative mixing ratios
  - Polar point instability
  - Discovered and fixed both by us and WRF team in V3.7
- Recurrent problems with interactions between:
  - Adaptive timestep
  - Restarts
  - ESMF
  - Delayed nests (not for global)

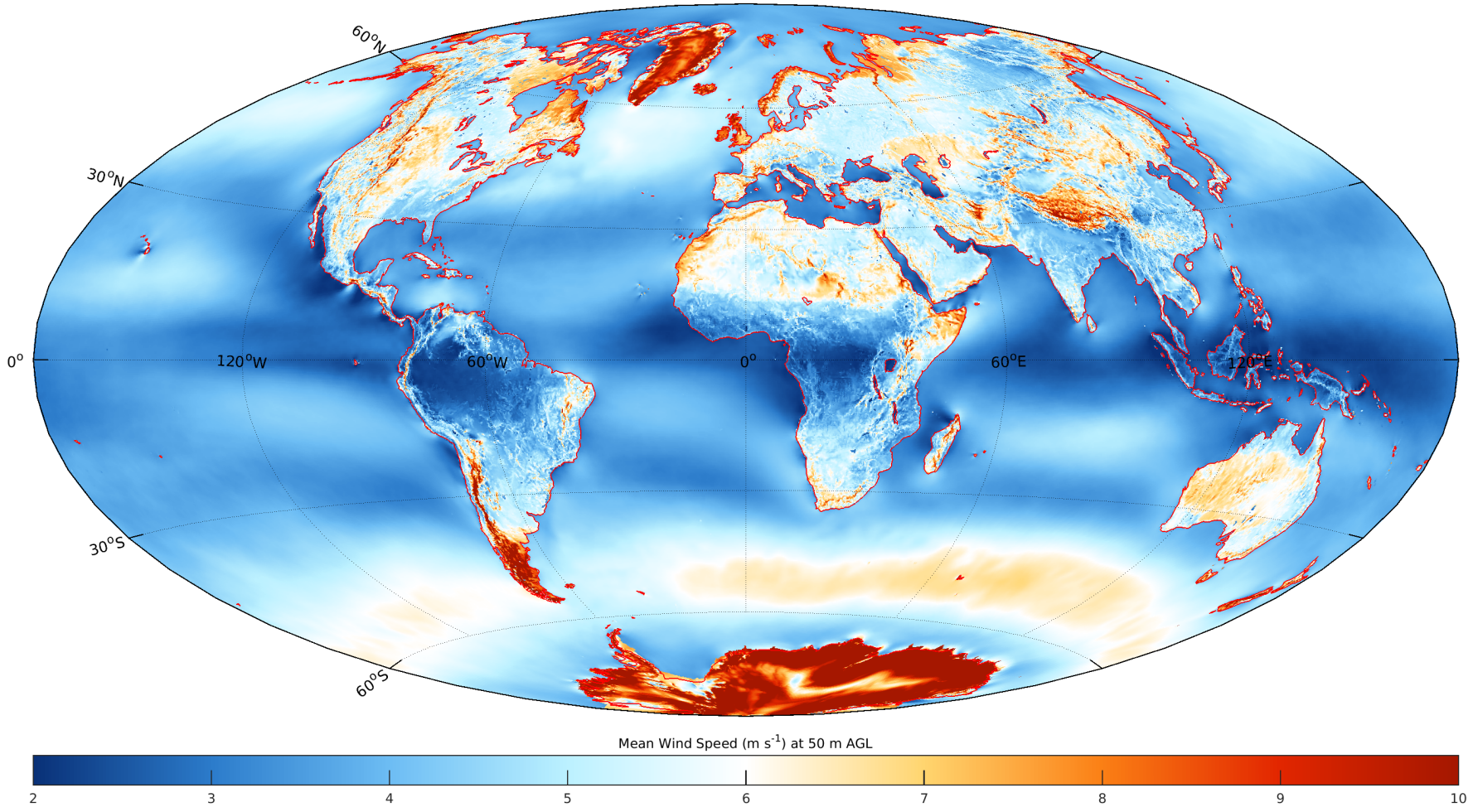
Finally, success!

5-day, hourly loop of 50-m wind speed

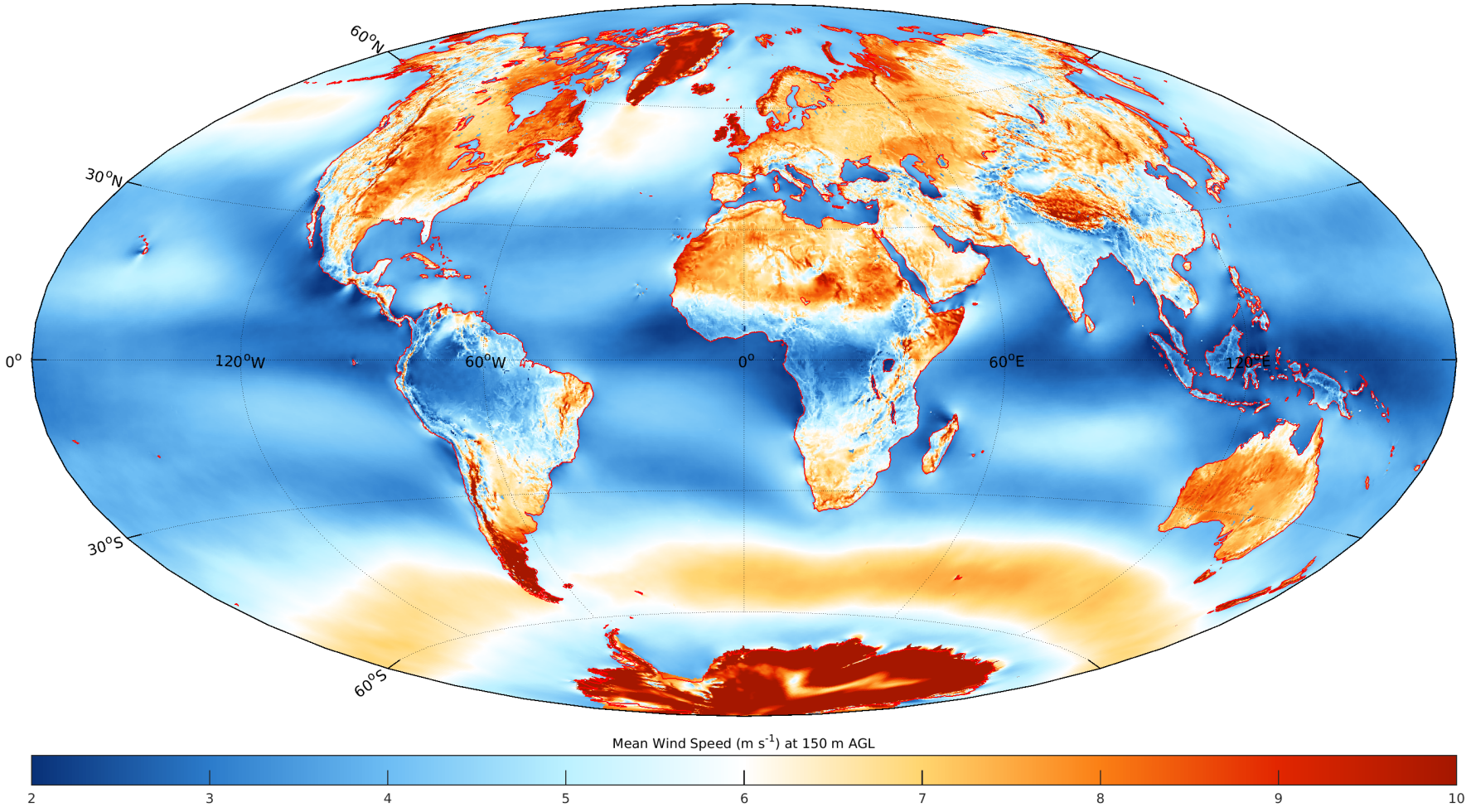


Note, speeds over ocean reduced by 1/2

10-year mean wind speed, 50 m



10-year mean wind speed, 150 m



Ratio, 150-m to 50-m wind speed