A Global High-Resolution Predictability Experiment Using MPAS

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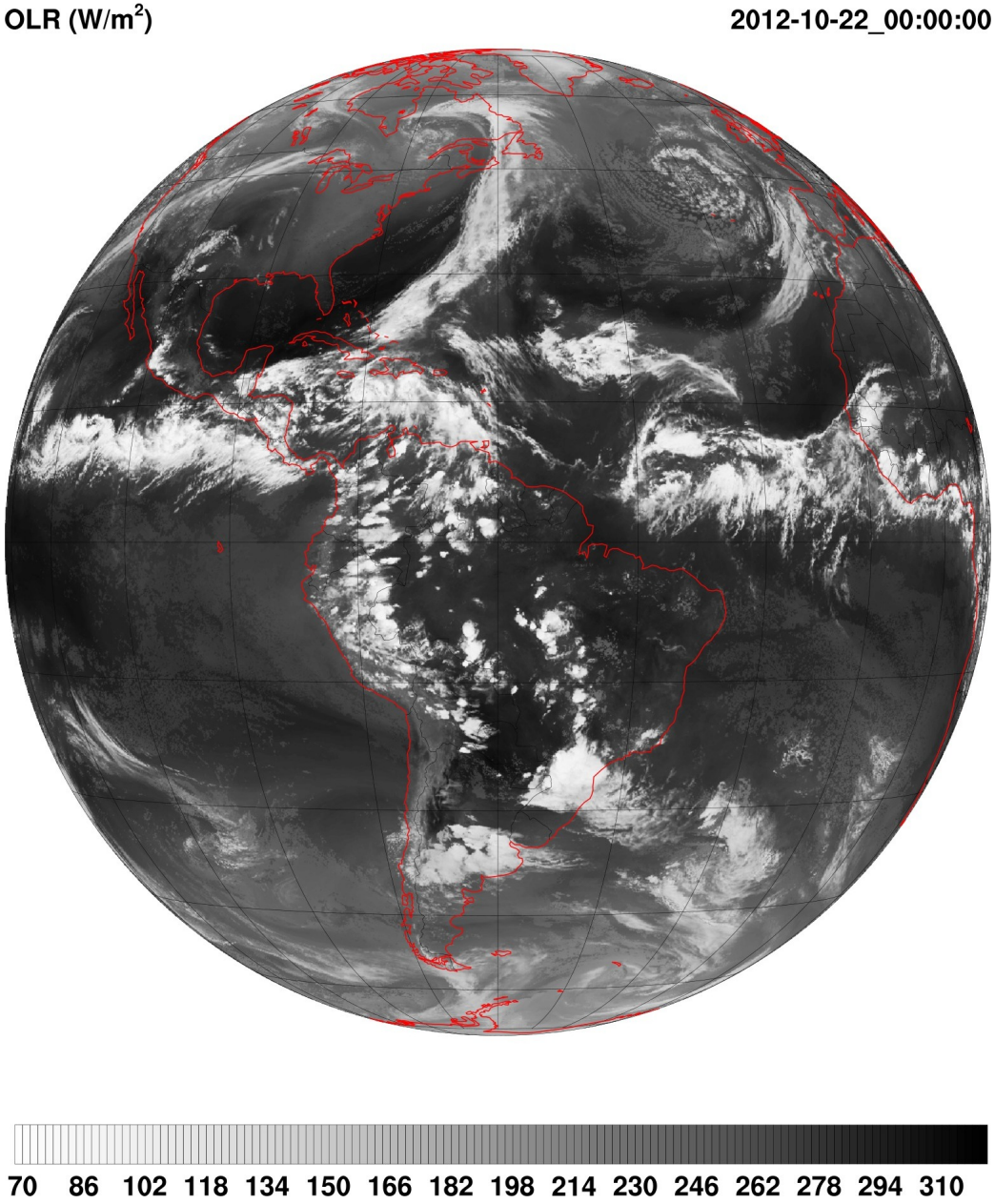
Acknowledgements: Michael Duda, Bill Skamarock,
Rich Rotunno, Chris Snyder, Judith Berner

The Global Weather Simulated by MPAS (4-km mesh)



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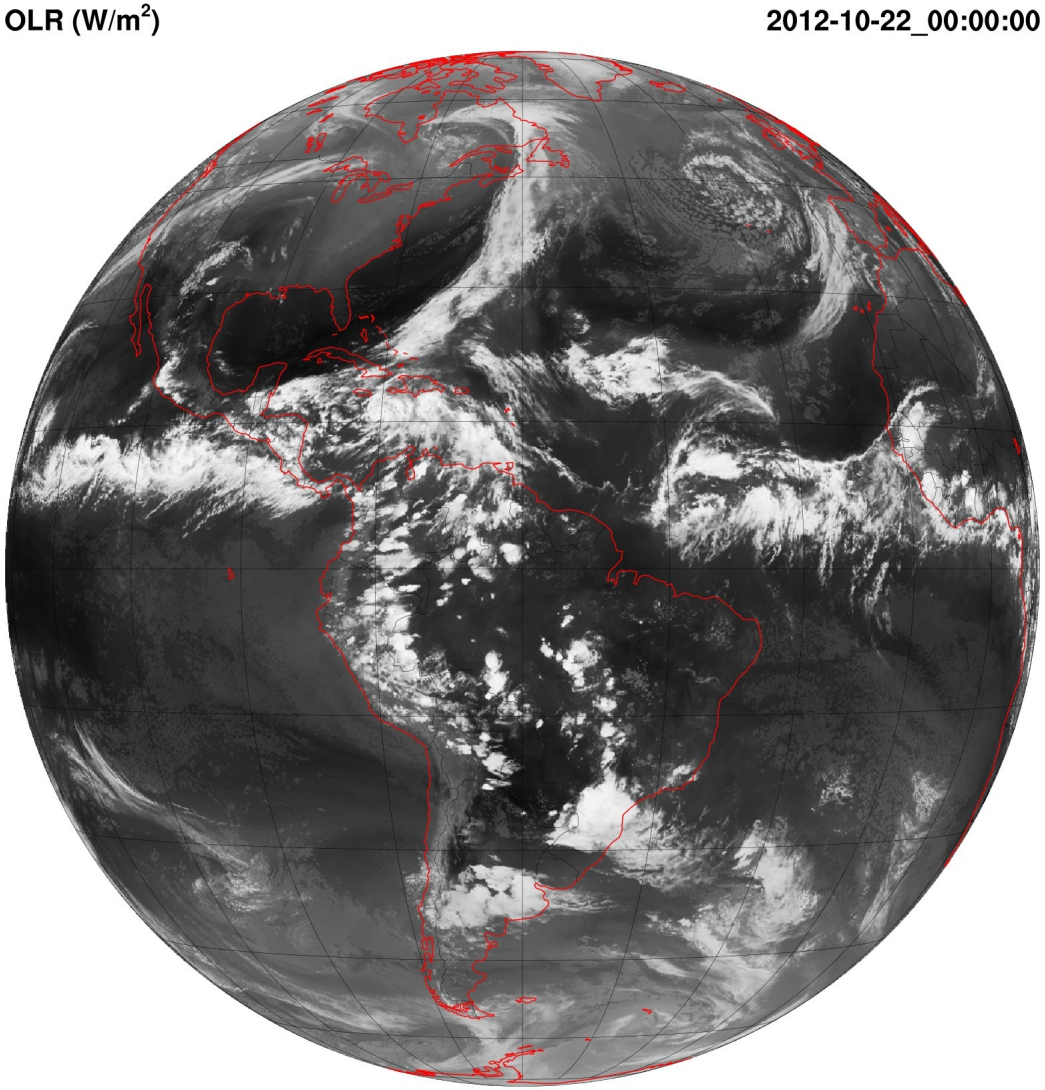
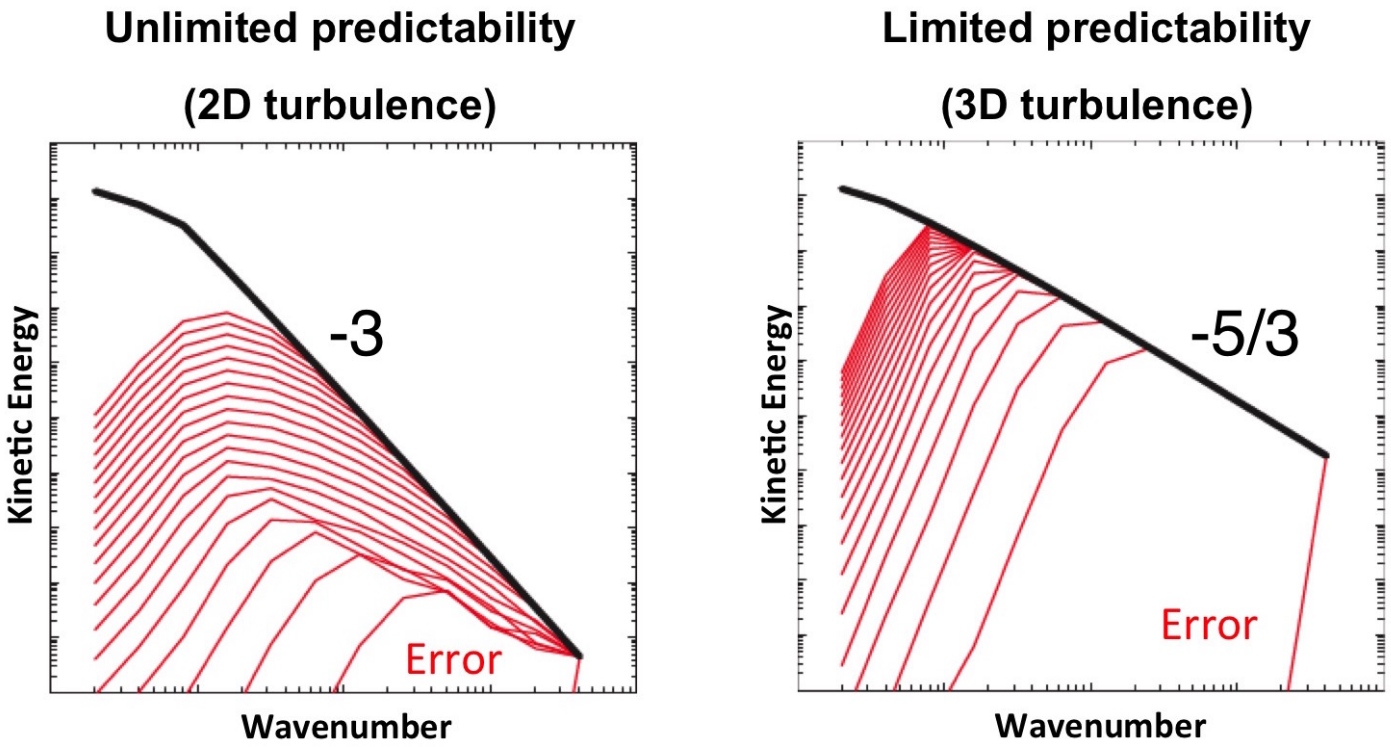


To what extent can we predict the weather?

Theoretical Considerations (Rotunno and Snyder 2008, *JAS*)



What are the implications for the real atmosphere?

- Mesoscales: error saturarion within hours, limited predictability
- Synoptic scales: error saturation after ~2 weeks

	Regional Model	Global Model
explicit convection	✓	X
mesoscale motions	✓	X
synoptic-scale motions	X	✓
-5/3 spectrum	✓	X
-3 spectrum	X	✓
variety of flow regimes	X	✓
unconstrained error growth	X	✓

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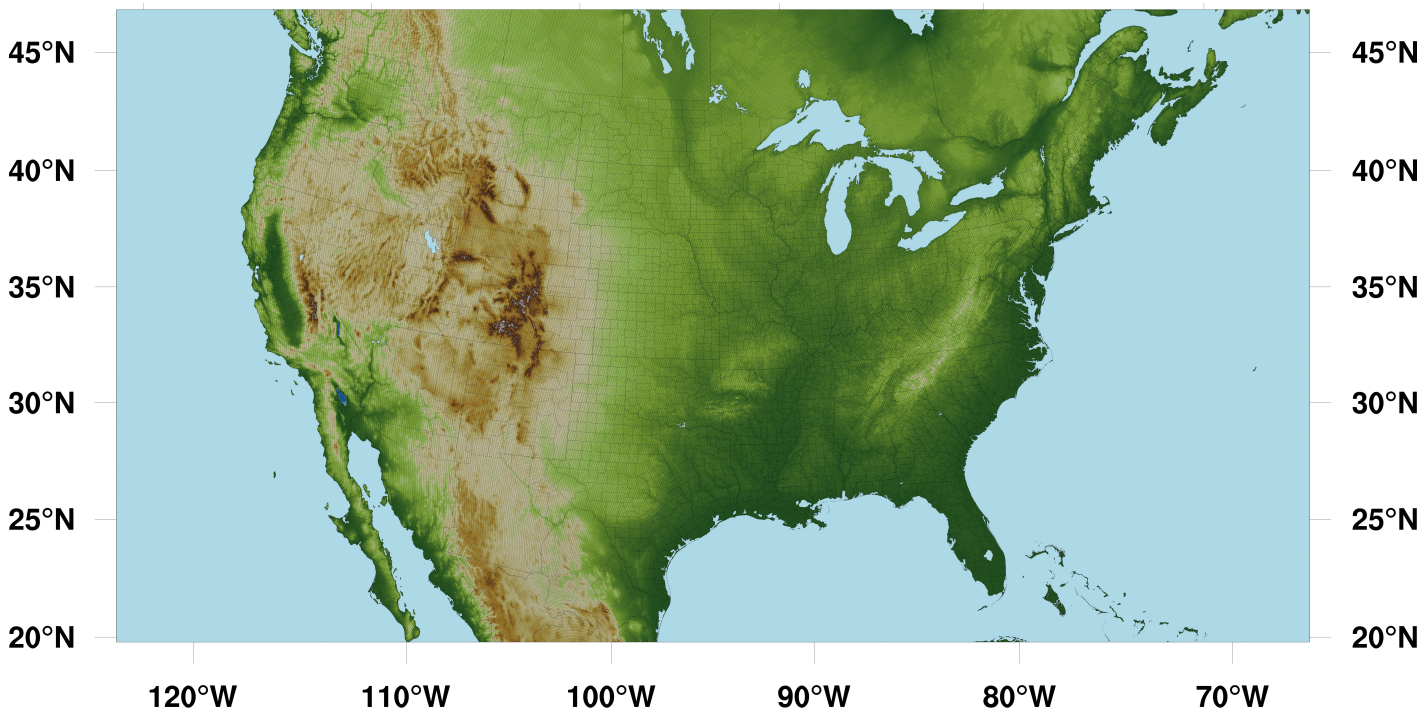
To overcome limitations, we need global cloud-resolving models.

Model & Model Configuration

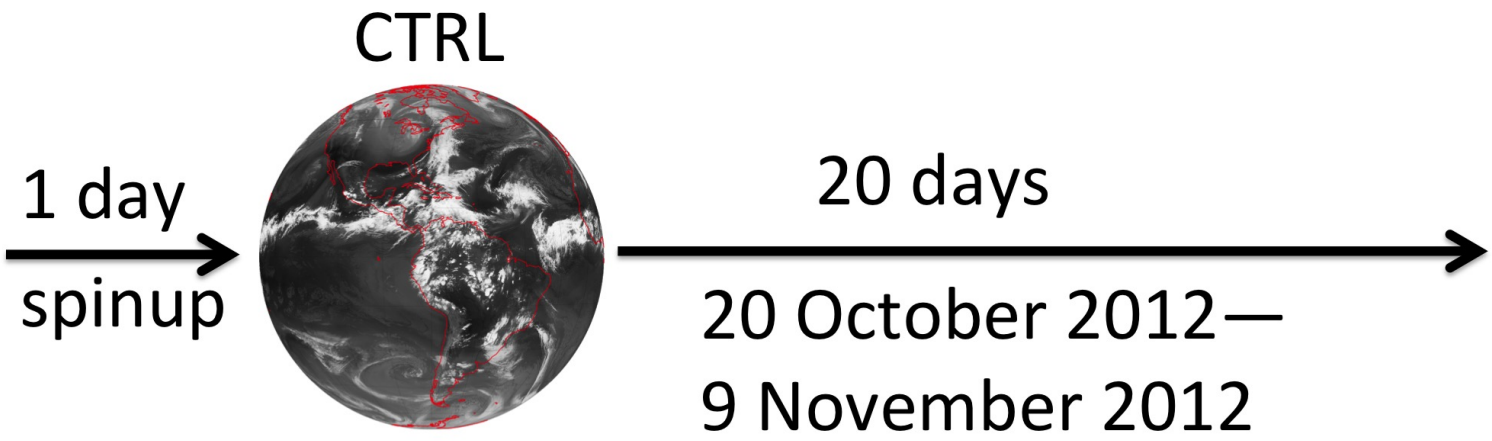
MPAS
Model for Prediction Across Scales

- Mesh: 4 km
- Levels: 55
- Top: 30 km

- IC: ERA-Interim
- Init: 2012-10-19
- Spinup: 24 h



The "Identical Twin" Experiment



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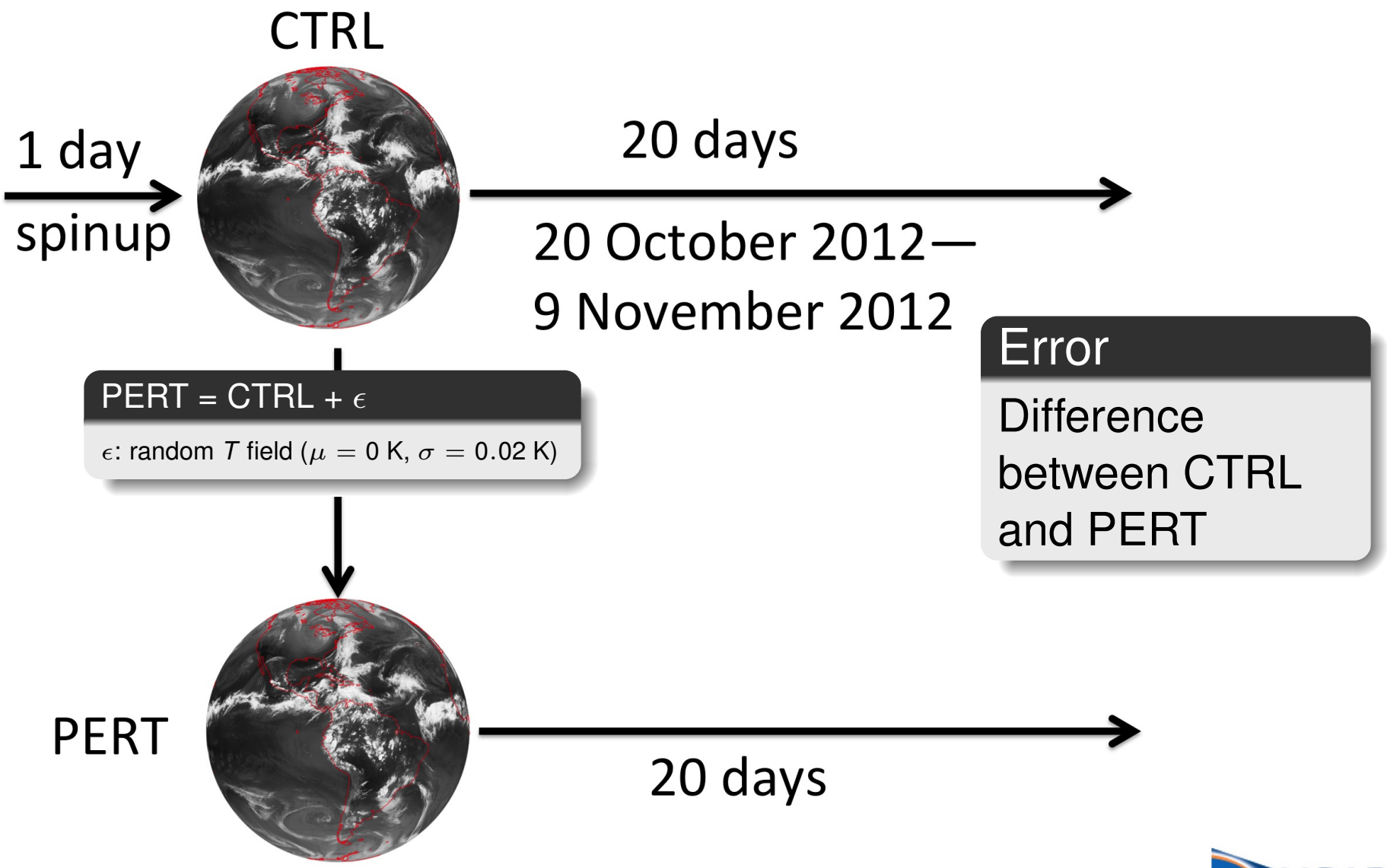
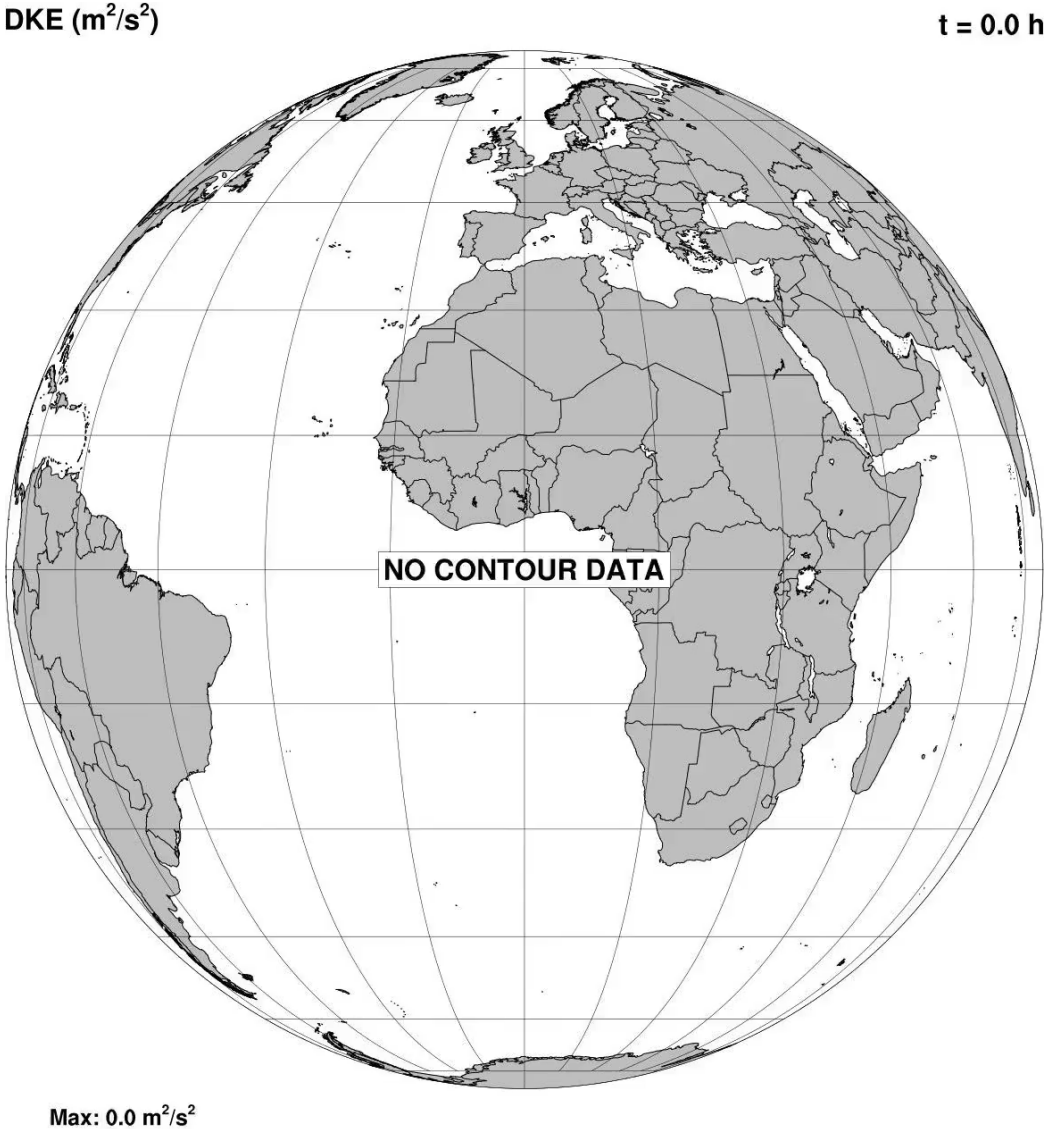


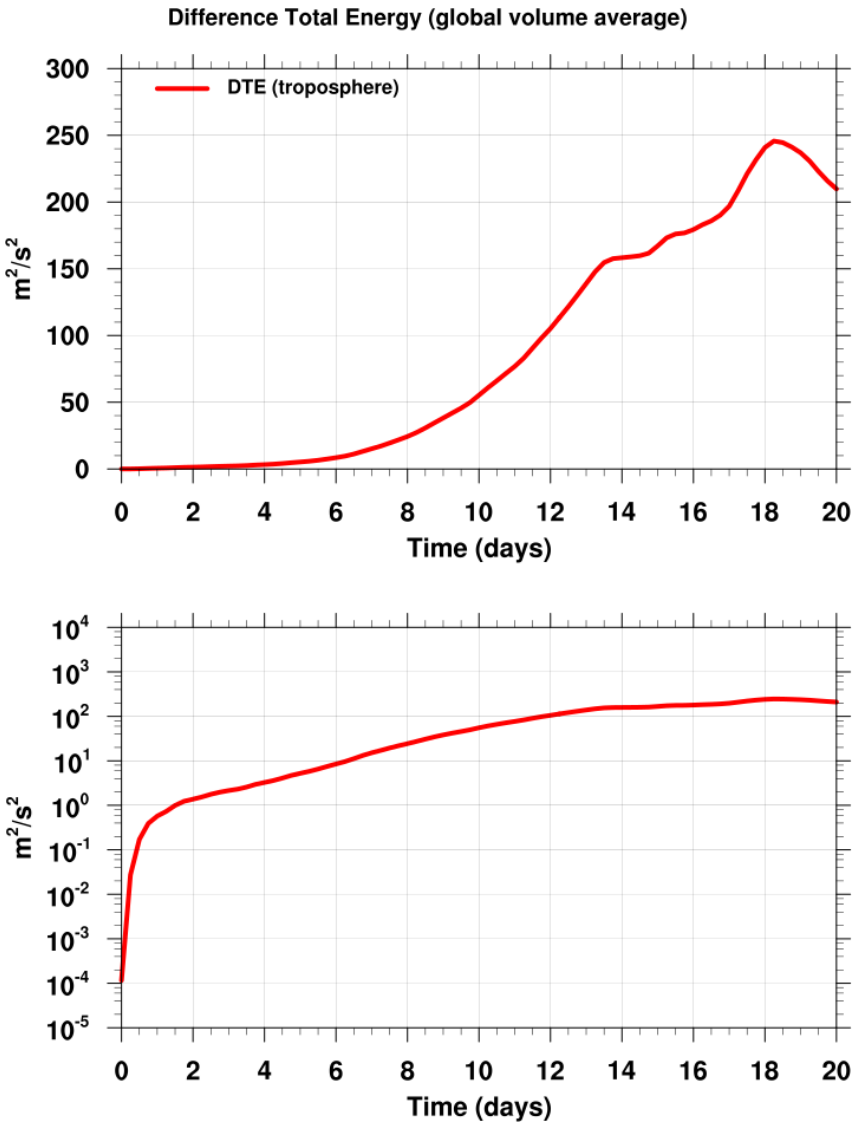
Error Growth from Convective to Planetary Scales



Error growth in

- magnitude
- spatial extent
- horizontal scale

Error Growth Characteristics: Troposphere vs. Stratosphere



Troposphere

- 3 distinct phases of error growth
  1. 0-1 days
  2. 2-13 days
  3. >13 days

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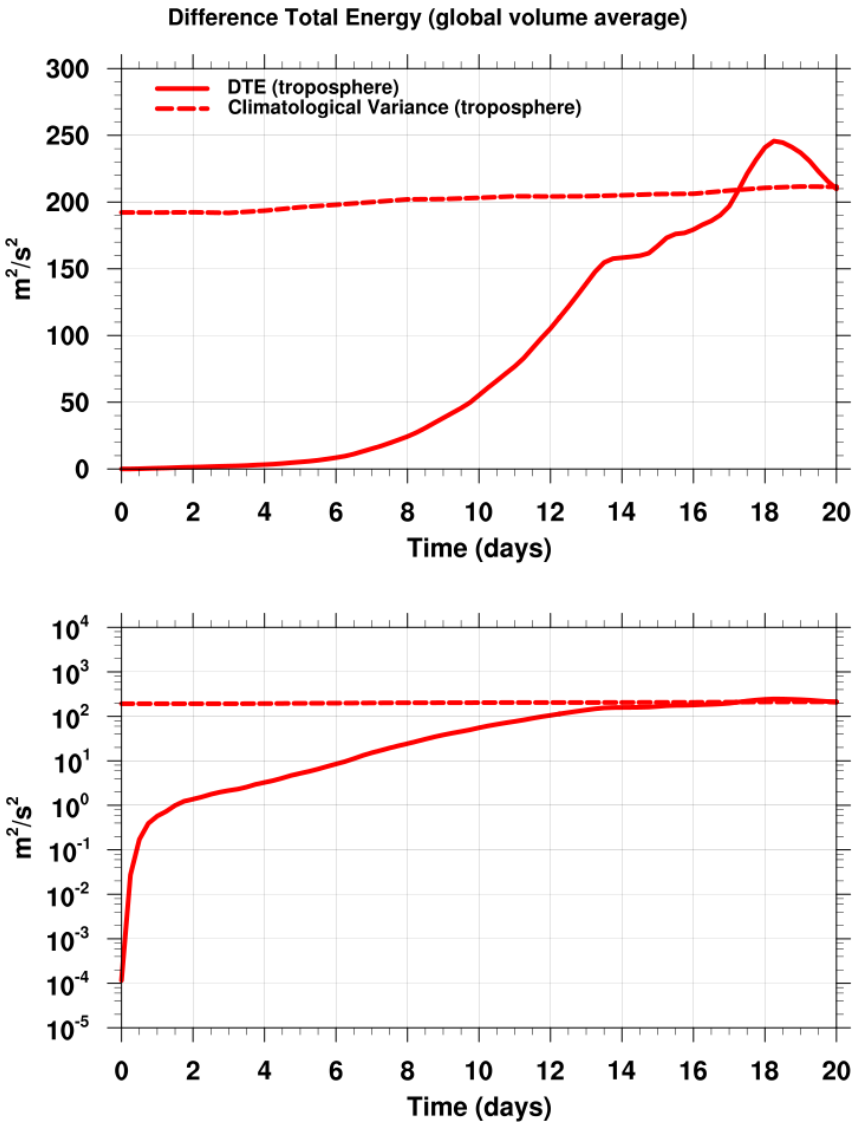

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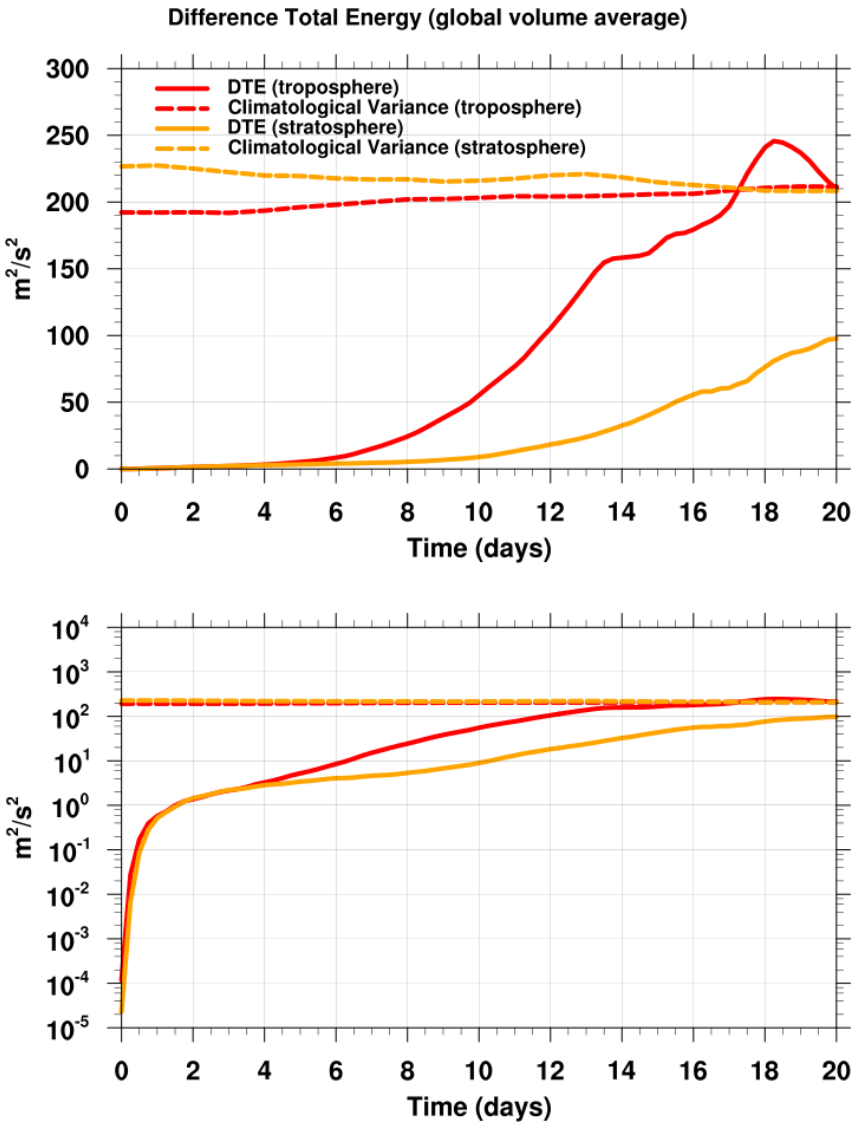

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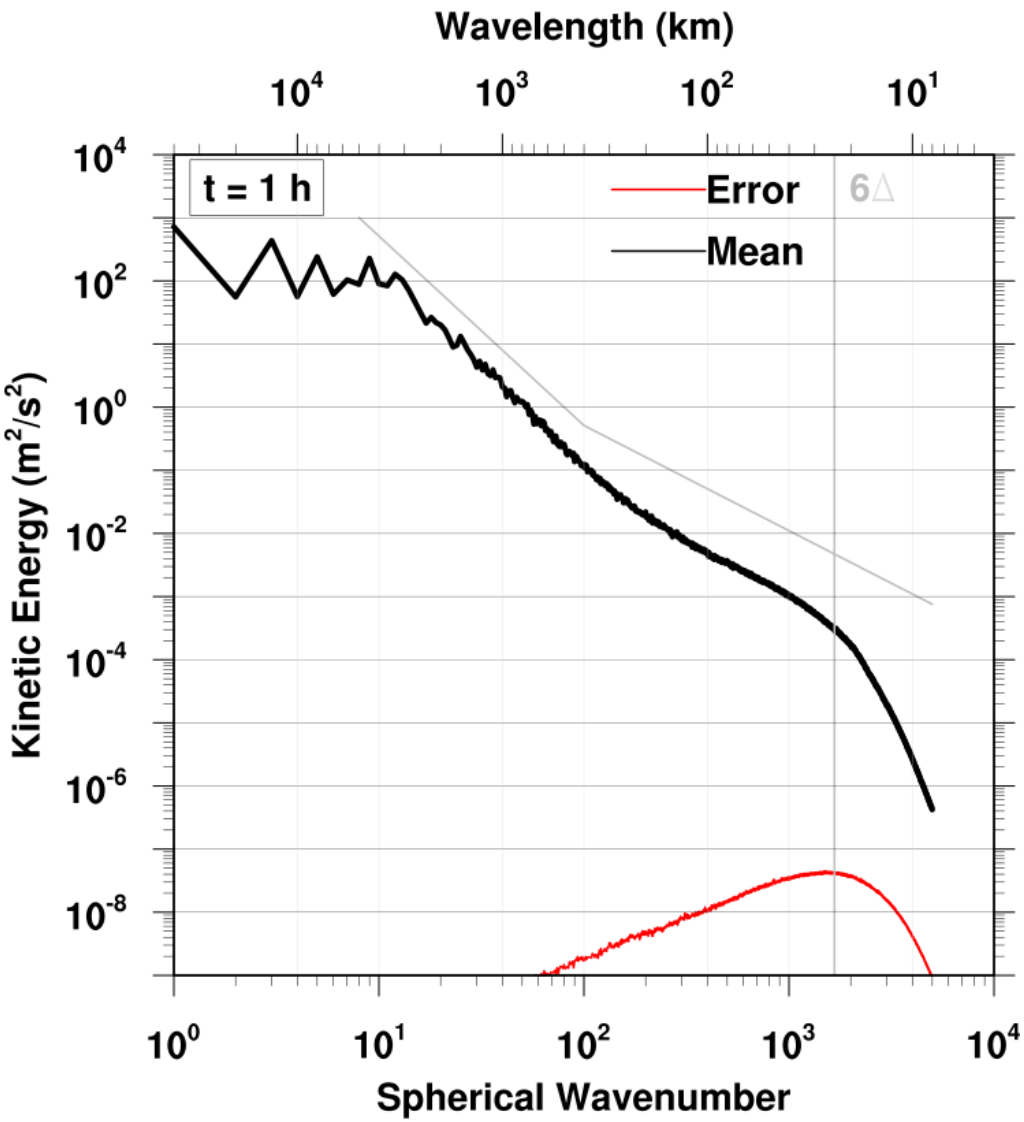
Stratosphere

- smaller growth rate (phase 2)
- no saturation

Error Growth & Predictability in Spectral Space (250-hPa Wind)



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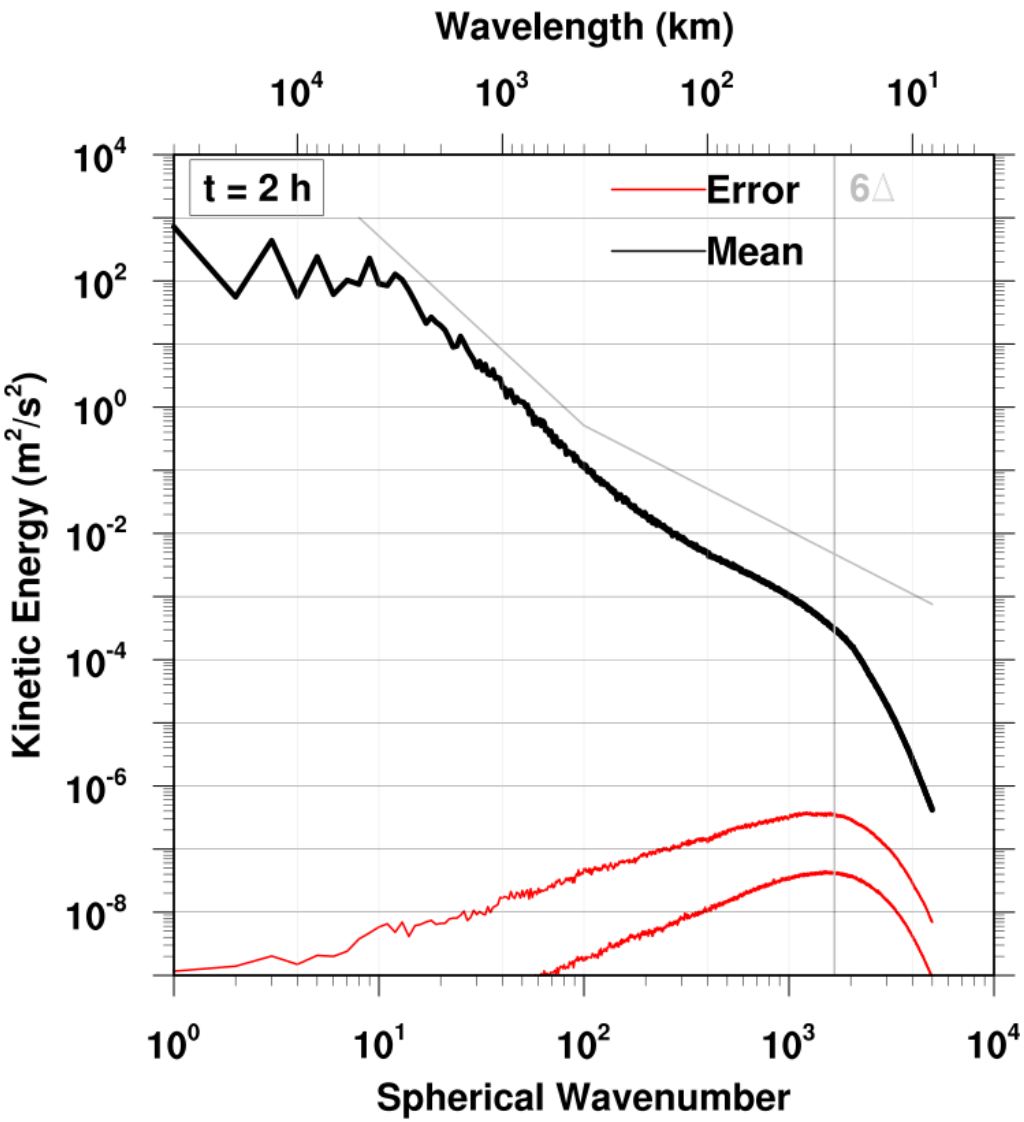

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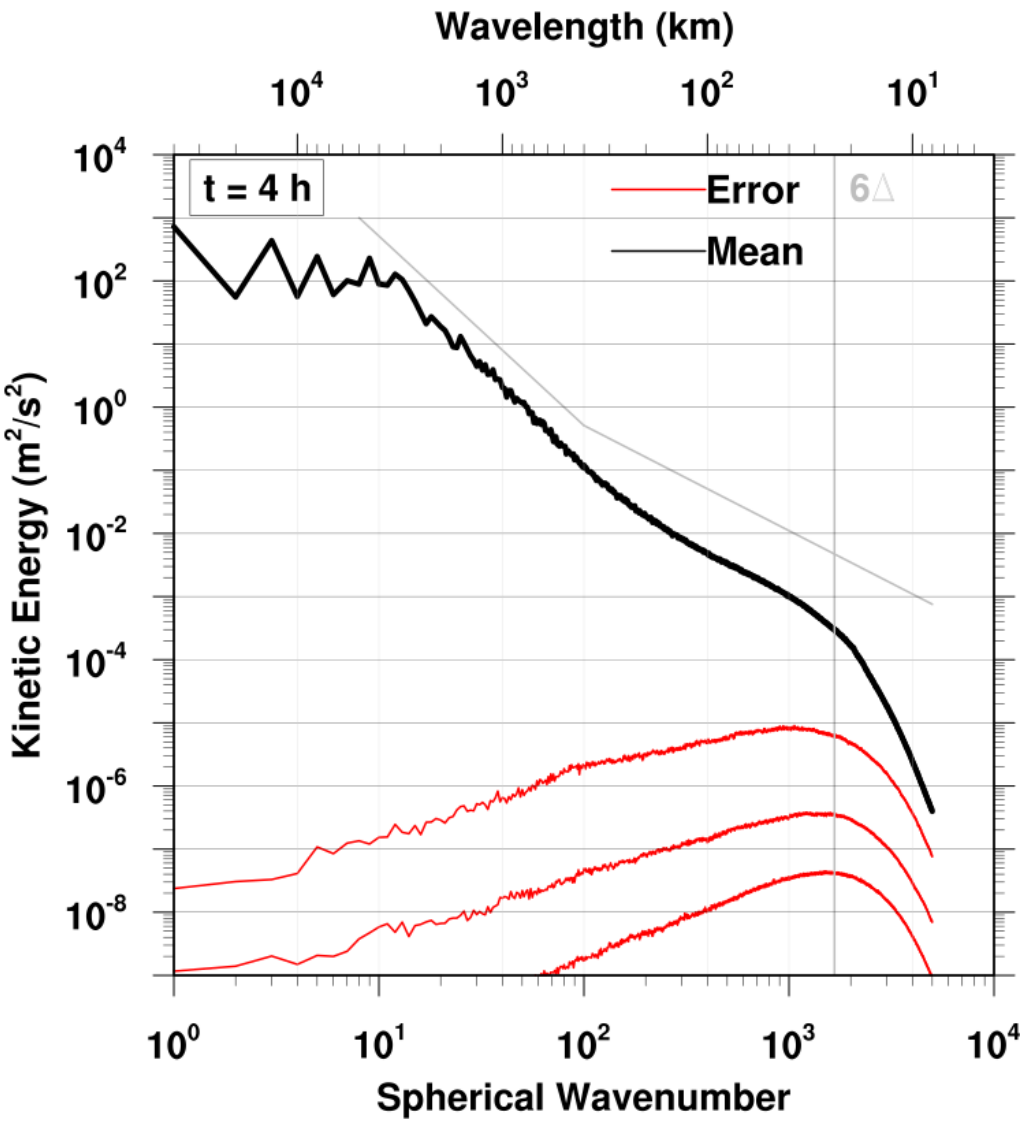

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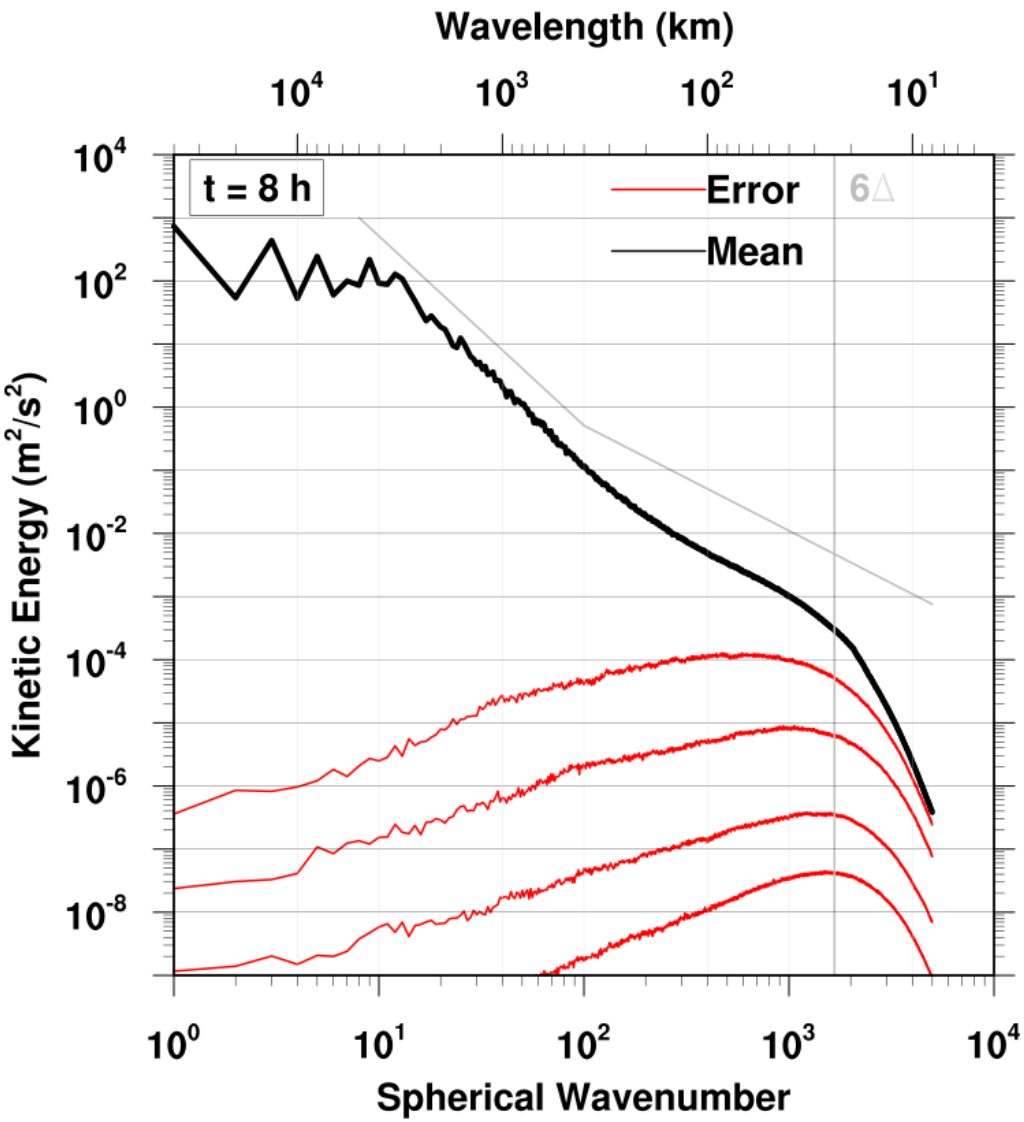

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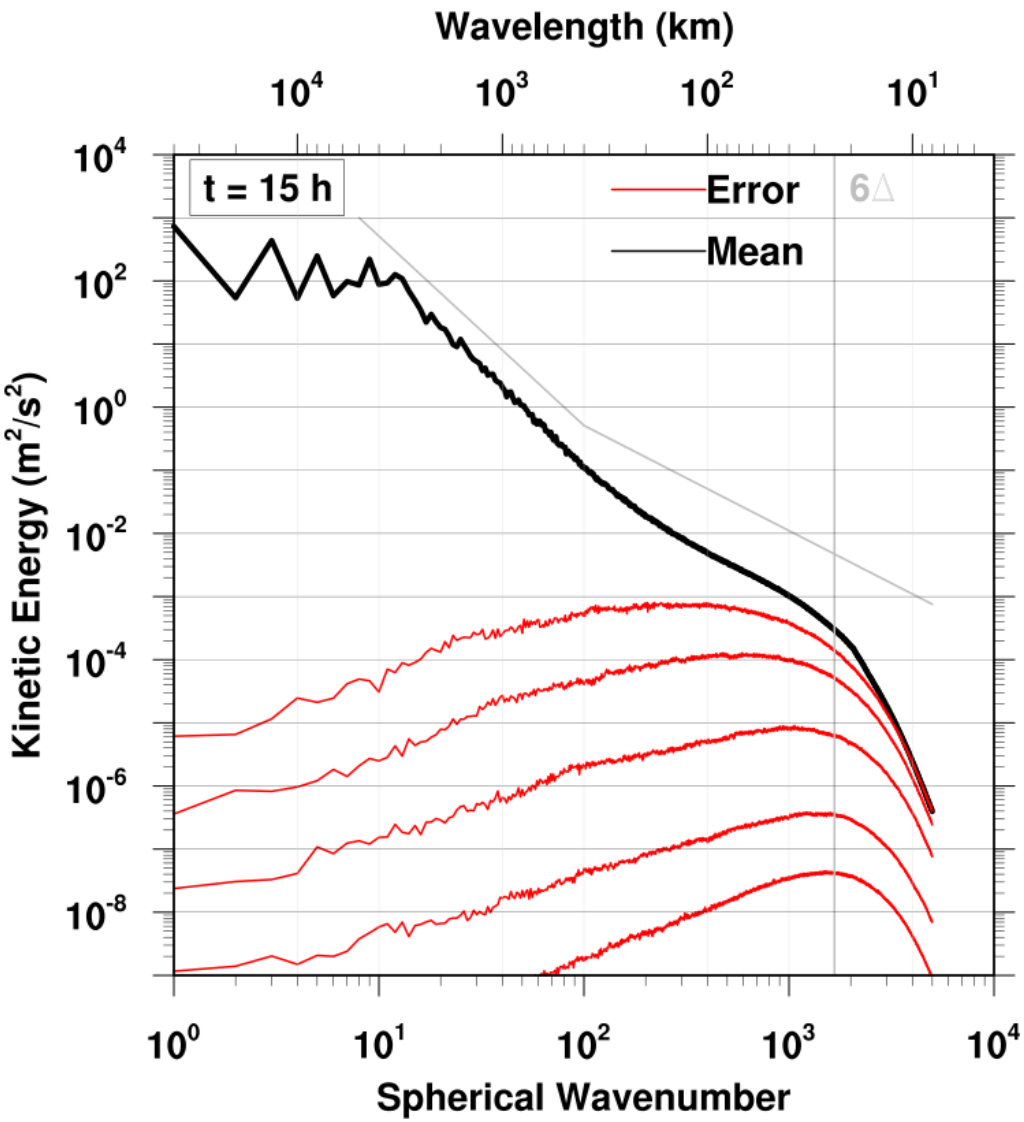

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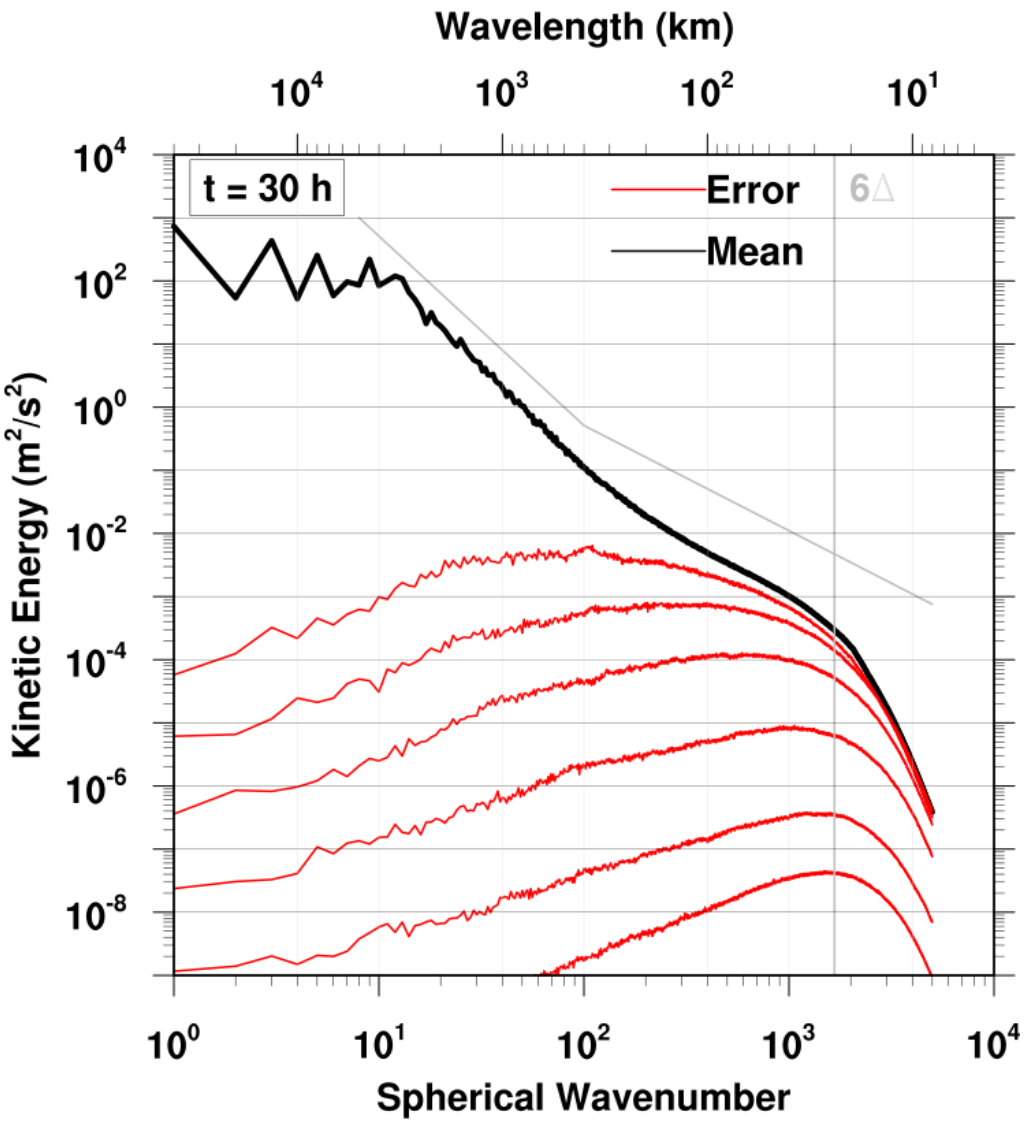

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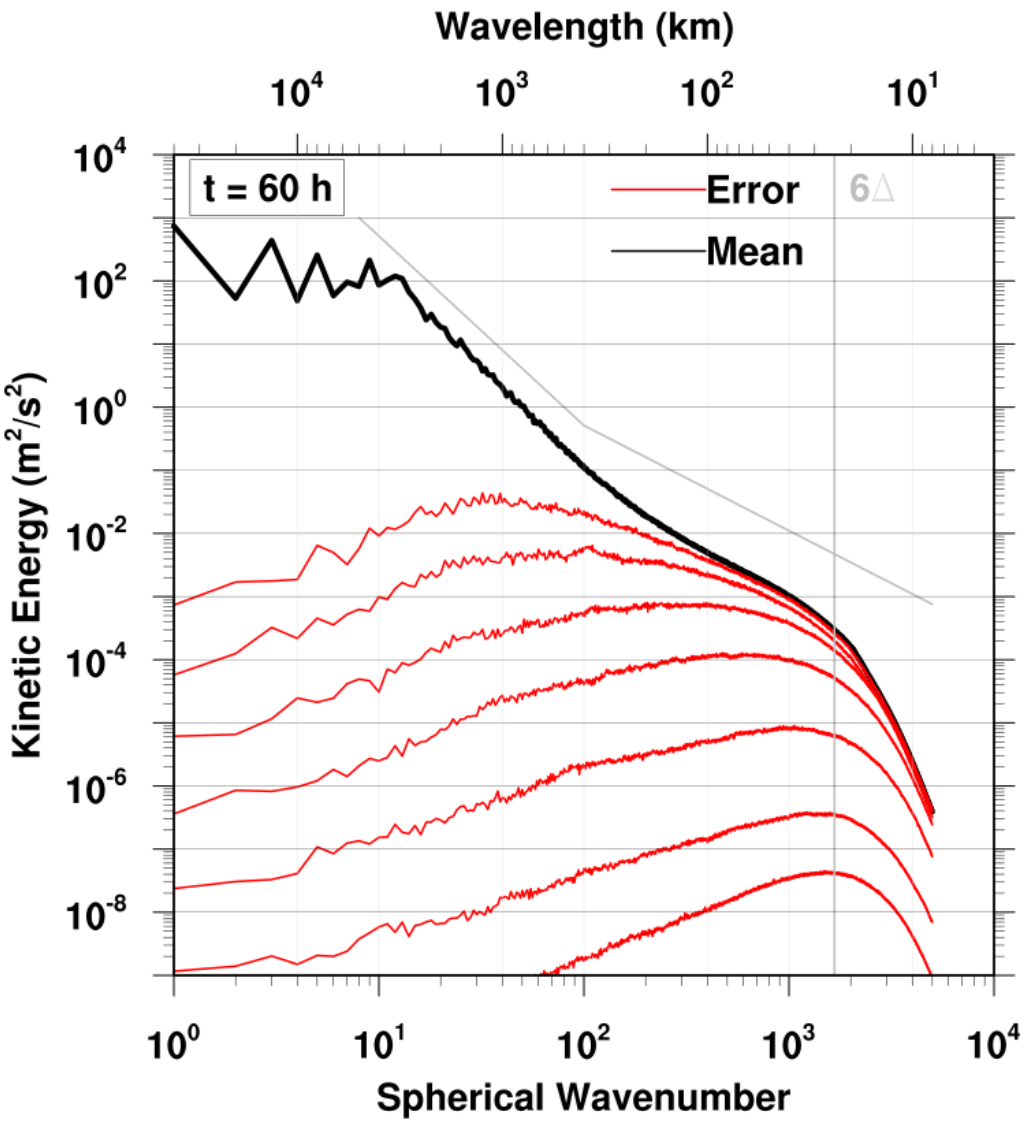

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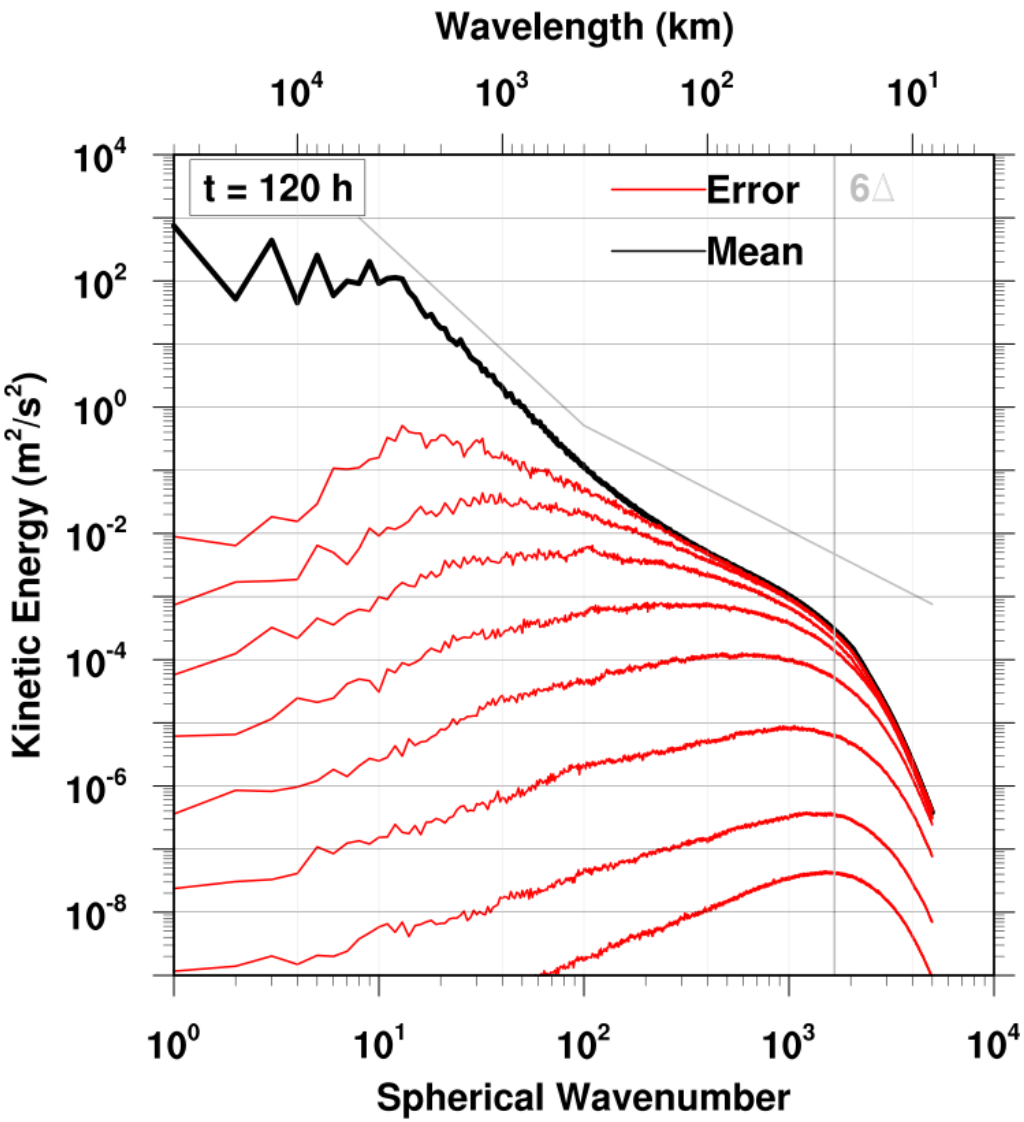

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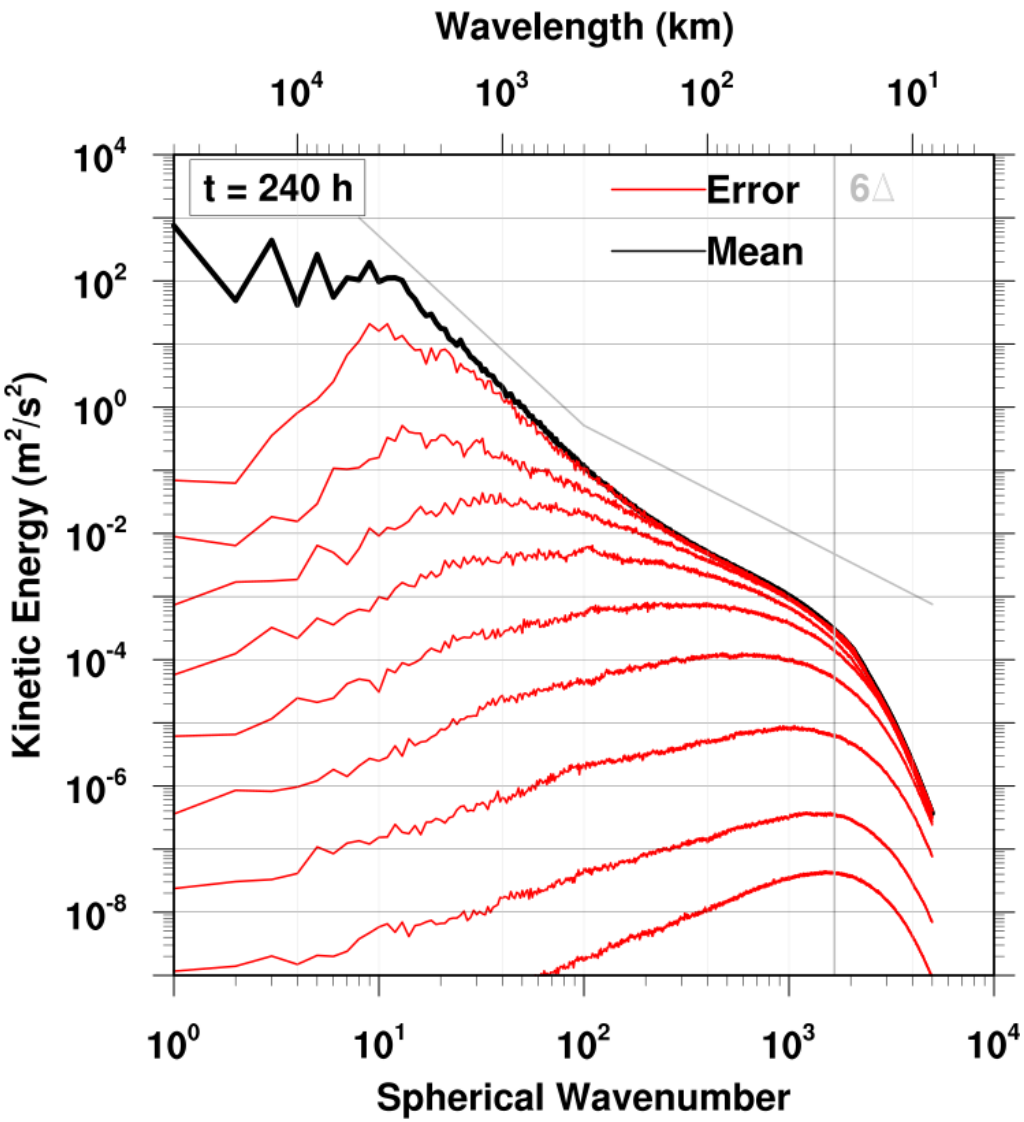

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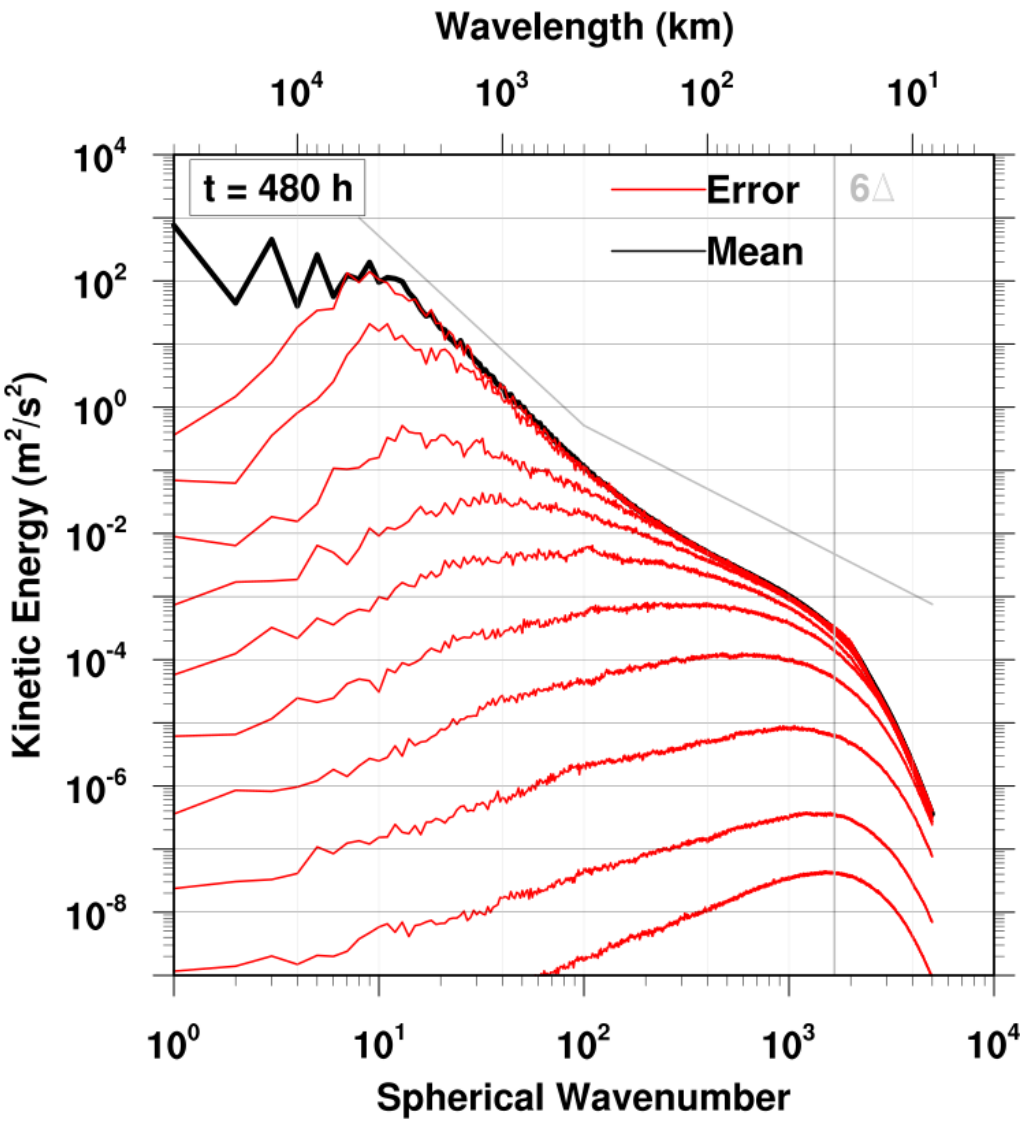
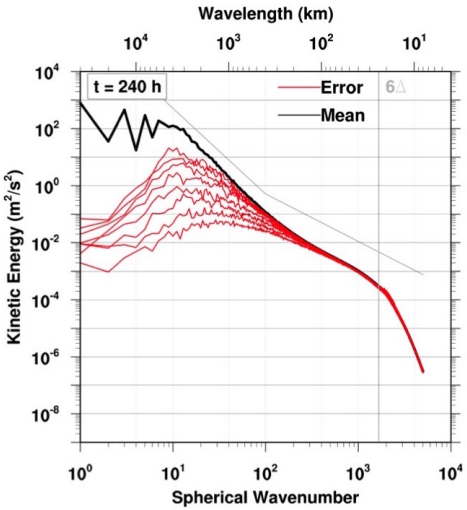
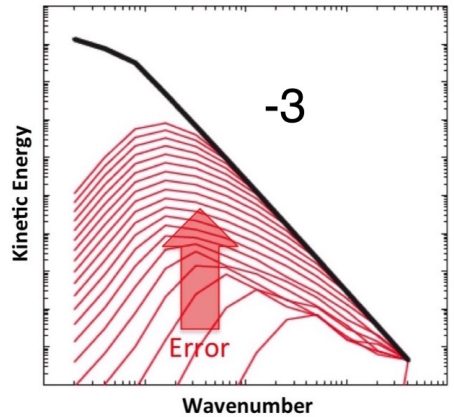


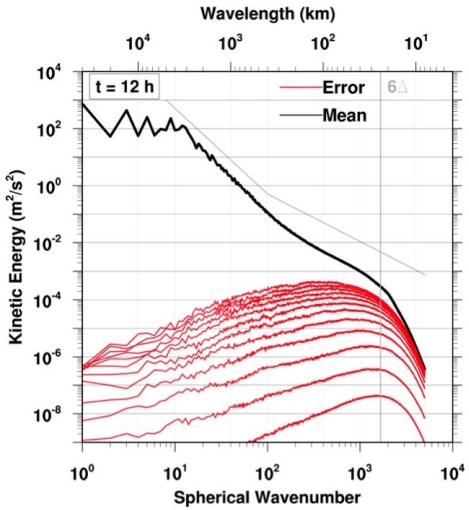
Comparison with Theory: MPAS vs. Rotunno and Snyder (2008)

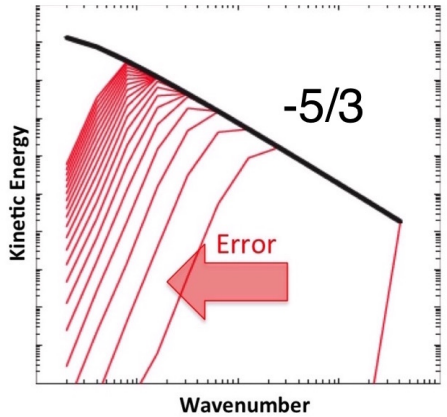
3-10 days, daily intervals





1-12 hours, hourly intervals





Two regimes

- Early error growth follows -5/3 regime
- Later error growth follows -3 regime

Existence of -5/3 regime

↓

intrinsic predictability limit

Error Growth & Predictability–Distinctions Between Geographical Zones

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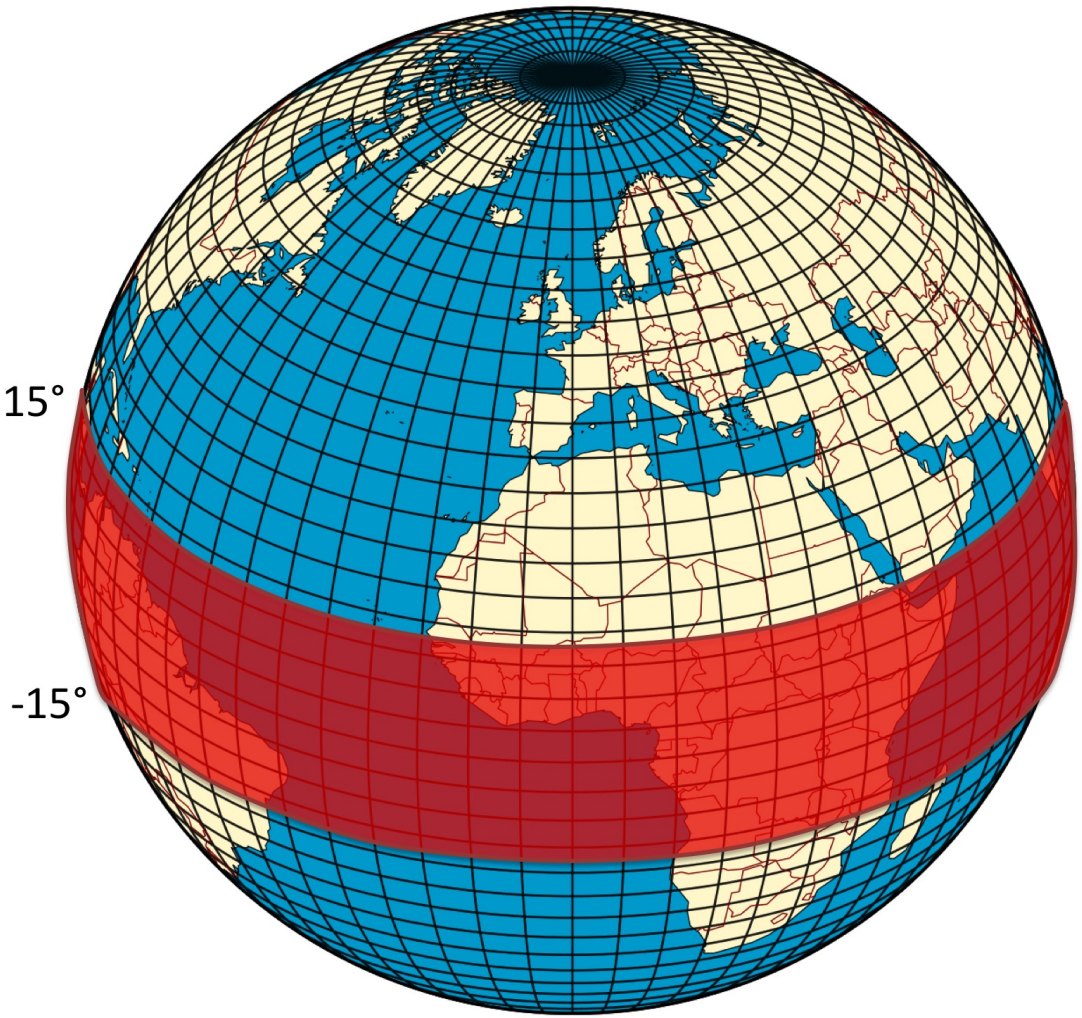
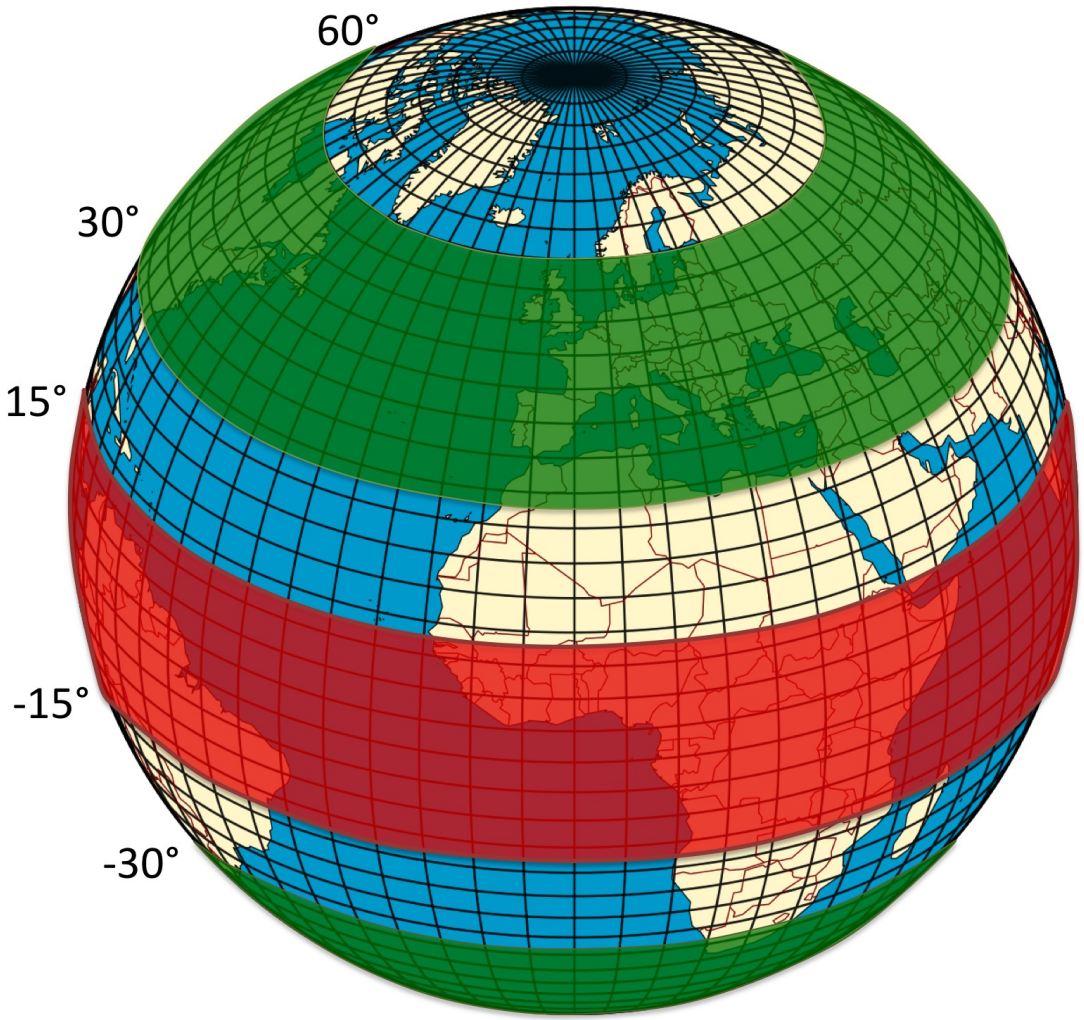


Error Growth & Predictability–Distinctions Between Geographical Zones



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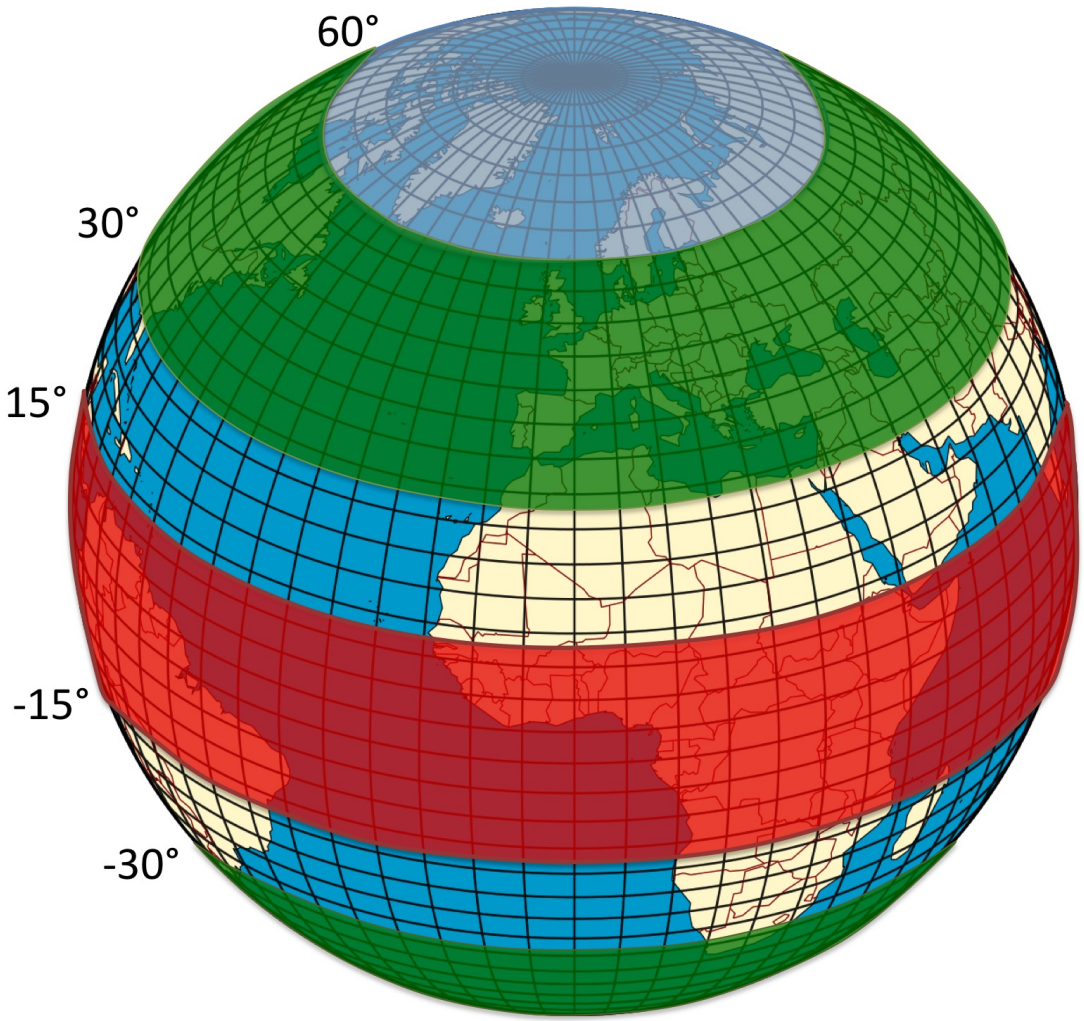

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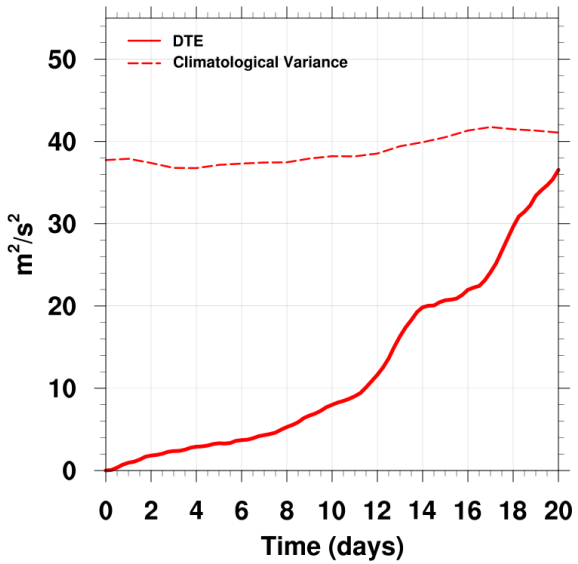
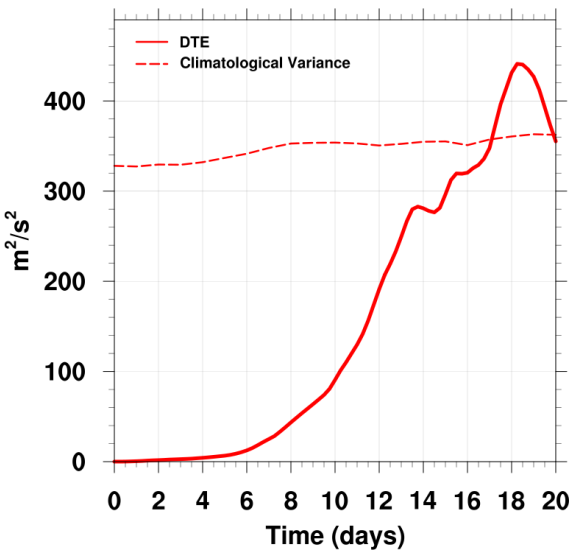
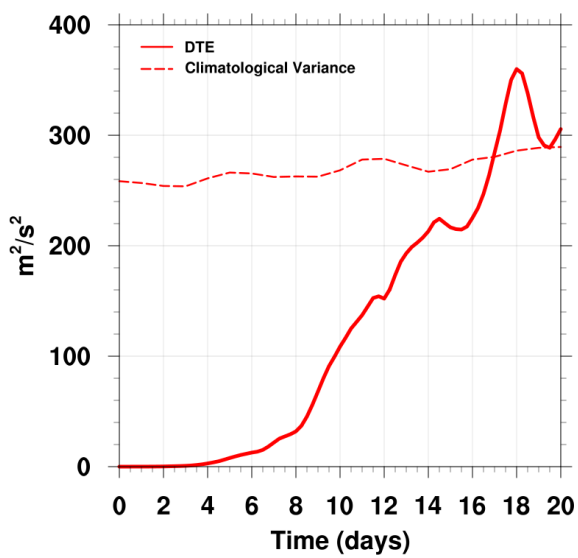
Tropics



Midlatitudes



Polar Regions



- Tropics: No error saturation!
- Extratropics: Error growth behavior mimics global evolution

Summary

- The era of global cloud-resolving models has arrived.
- The atmosphere (most likely) possesses a finite, intrinsic limit of predictability.
- In a global sense, "weather" has a predictability limit of 2-3 weeks. Counterintuitively, the tropics seem have longer predictability.