Robust Prior Analysis and Detection of Significant Change

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Abstract

"We perceive the world before we react to it, and we react not to what we perceive, but always to what we *infer*. We must infer what the future situation would have been without our interference, and what change will be wrought in it by our action. Fortunately or unfortunately, none of these processes is infallible, or indeed ever accurate and complete." Knight, 1921.

Multiple components of uncertainty

- Model *risk* - what probabilities does a specific model assign to events in the future?
- Model *ambiguity* - how much confidence do we place in each model?
- Model *misspecification* - how do we use models that are not perfect?
- What form of misspecification is most consequential to a *decision maker*?

Altered Dynamics of Temperature Response

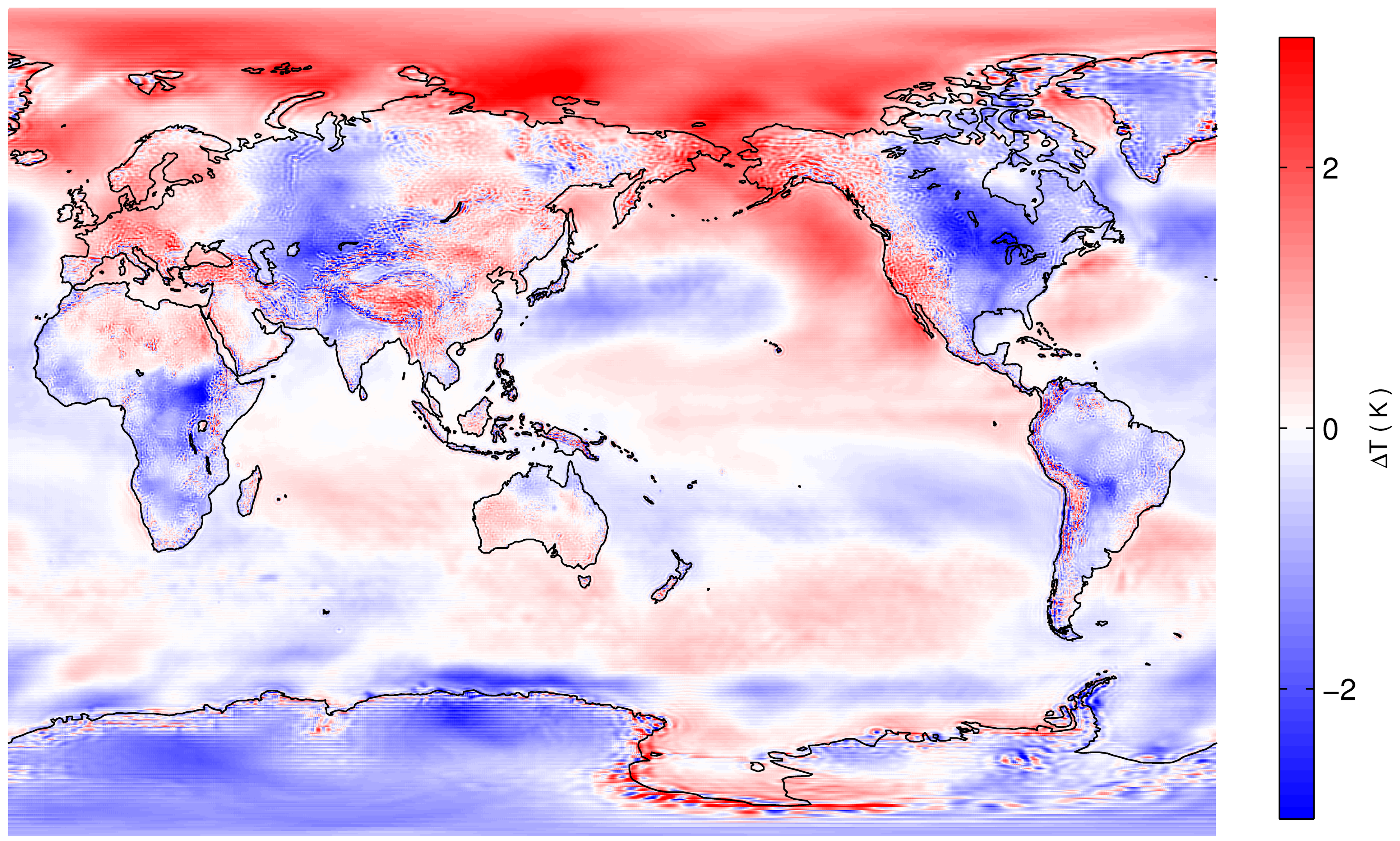
- Economic model has production technology that includes damages induced by temperature change
- Unknown drift distortions to multivariate stochastic processes
- Change in drift and variability of the processes across models and scenarios
- Heterogeneity in natural and forced variability

HJB PDE for Stylized Model with

$$\max_{E}\min_{G_\lambda}\left[\frac{1}{1-\gamma}y_t^{1-\gamma}+\frac{\theta}{2}G_\lambda^2-\rho * W+\frac{\partial W}{\partial T}[\lambda E]\right.$$
$$+\frac{\partial W}{\partial \log\lambda}[-\kappa_\lambda(\log\lambda_t-\log\overline{\lambda})-\sigma_\lambda G_\lambda]$$
$$\left.+\frac{\partial W}{\partial R}[-E]+\frac{\partial W}{\partial \log A}[g]+\frac{1}{2}\frac{\partial^2 W}{\partial \log\lambda^2}\sigma_\lambda^2\right]=0$$

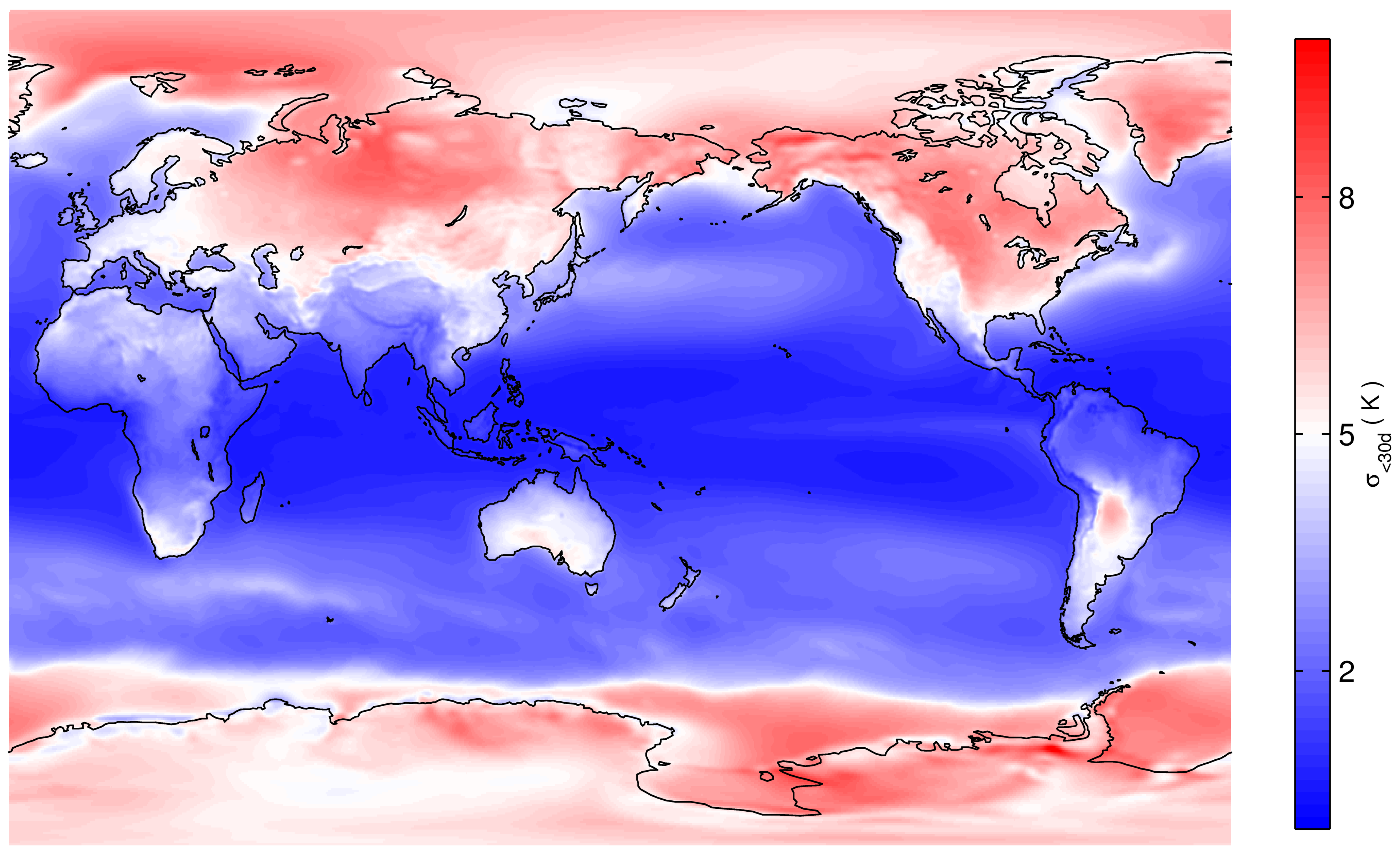
Significant Change Detection

Annual Mean Anomaly (2014)



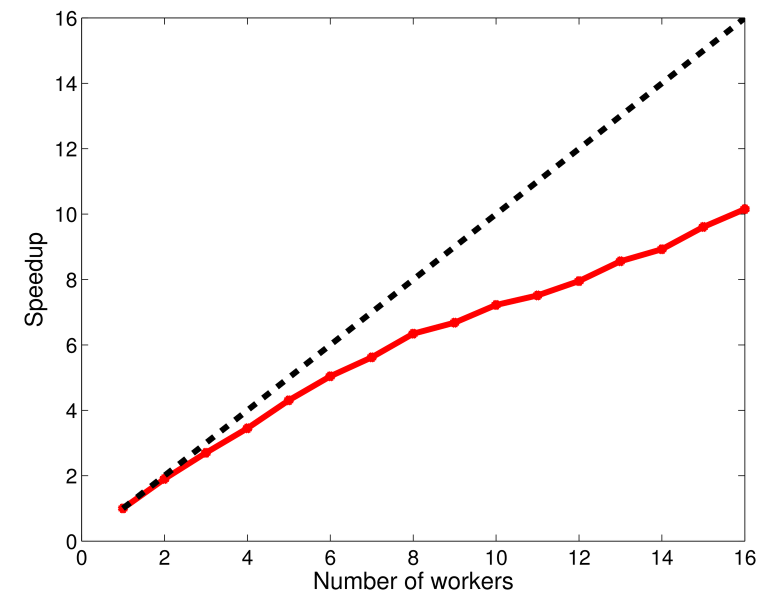
CFSv2

High Frequency Variability (historical)



SIMD vector processing

Instruction-level single processor parallelism is fully exploited for high-dimensional problems with efficient algorithms to convert the multi-dimensional arrays into vectors and by applying dimensionality reducing tensor techniques.
Many-core parallelism for simple jobs is handled by the MATLAB parallel toolkit. Swift is used for massively parallel computing across nodes to overcome the limitations caused by the computing node memory size and by the internal MATLAB communication bottleneck.



Strong scaling, 21K time series used in estimation
t(one worker)=12.4 hours

Data: CFSR/CFSv2

High resolution 2D spatial-temporal observational analysis data are processed for the baseline climatology construction: $0.3^\circ \times 0.3^\circ$ grid on Earth surface ($\approx$25 km spatial resolution at midlats), 32 years in 6-hour intervals per each spatial data point resulting in over $663K \times 46K \approx 30$ billion elements in input data arrays.
Current data for analysis are obtained at higher resolution: $0.2^\circ \times 0.2^\circ$ grid with 1.5M cross-sectional data elements per state variable at any given time.
The Globus file transfer service allows to reach $\approx$ 865 Mbit/s disk-to-disk transfer speed from Colorado UCAR data center to RCC Midway cluster.

References

Hansen, Lars Peter. "Uncertainty Outside and Inside Economic Models". No. w20394. NBER, 2014.
Leeds, W. B., E. J. Moyer, M. L. Stein et al. "Simulation of future climate under changing temporal covariance structures." (2015): 1-14.

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