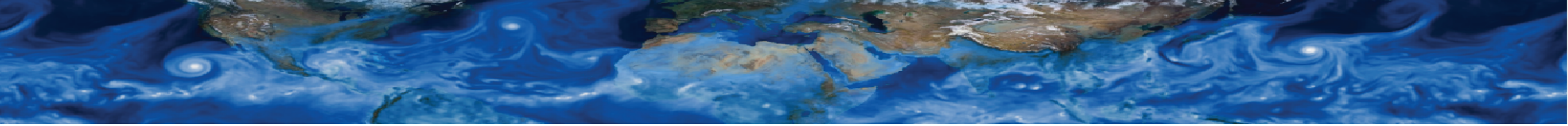

# Advancing Understanding of Variability, Predictability, and Change Across Spatiotemporal Scales

## A Whitepaper Synthesizing Current and Future Earth System Science Research

## Multi-year Earth system variability, predictability and prediction

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Thanks to rapporteurs: Lu Dong, Tarun Verma, Haiyan Teng, Stephen Po-Chedley

**Whitepaper draft**: https://docs.google.com/document/d/1irU3tW9OM6RKMASGQx5VYl88iQECLkbq7bYhQZtPpfM

# Multi-year Earth system variability, predictability and prediction

**Grand Challenge Question**: What is the interplay between internal variability (from extreme weather to low frequency modes) and external forcing (both anthropogenic and natural) that affects predictability and prediction of near-term regional climate in decadal climate predictions and what critical processes limit our ability to improve predictability and predictions of multi-year Earth system variability?

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# Multi-year Earth system variability, predictability and prediction

## Whitepaper outline

- Description of Challenges and Current Research in RGMA
- Gaps in Current Research
- Future Directions
  - Short Term (3- 5 years) Research Goals
  - Long Term (10 years) Research Goals

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# Multi-year Earth system variability, predictability and prediction

## Description of Challenges and Current Research in RGMA

### Multi-Year ENSO

- Largest source of seasonal predictability; influences seasonal climate globally.
- Potential for multi-year predictability associated with El Niño to La Niña transitions.

### Atlantic and Pacific Multi-Year Mid-Latitude Variability

- Atlantic Multidecadal Variability (AMV) and Pacific decadal variability (PDV) are likely major sources of decadal predictability.

### Prediction and Predictability

- Considerable evidence for skillful predictions of temporally averaged temperatures up to ten years in advance, particularly in North Atlantic, Indian, and western subtropical Pacific Oceans.
- Initialization (distinct from assimilation) of the current state of the climate is essential for seasonal to decadal forecasts; four categories of initialization strategies

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# Multi-year Earth system variability, predictability and prediction

## Gaps in Current Research

### Quantitative understanding of predictability sources of multi-year variability

- ENSO: mechanisms controlling initiation of warm phase and reversal to cold phase
- AMV and PMV: persistence and phase transitions
- AMOC: relationships with NAO; prediction
- Regime dependence of prediction skill
- Interplay between variability and a changing background state

### Models' ability to simulate and predict the multi-year variability

- Mean state biases
- Errors in feedback processes
- Model shortcomings: ENSO diversity, clouds, convection, precipitation, radiation; model resolution

### Methods for skill assessment

- Forecast calibration and skill assessment

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# Multi-year Earth system variability, predictability and prediction

**Group Discussion:**

Build on Future Directions in the Whitepaper draft

- Short Term (3- 5 years) Research Goals
- Long Term (10 years) Research Goals

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