

Exploring Links Between Climate and Cholera in Bangladesh Using a Regionally Coupled Model

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Outline

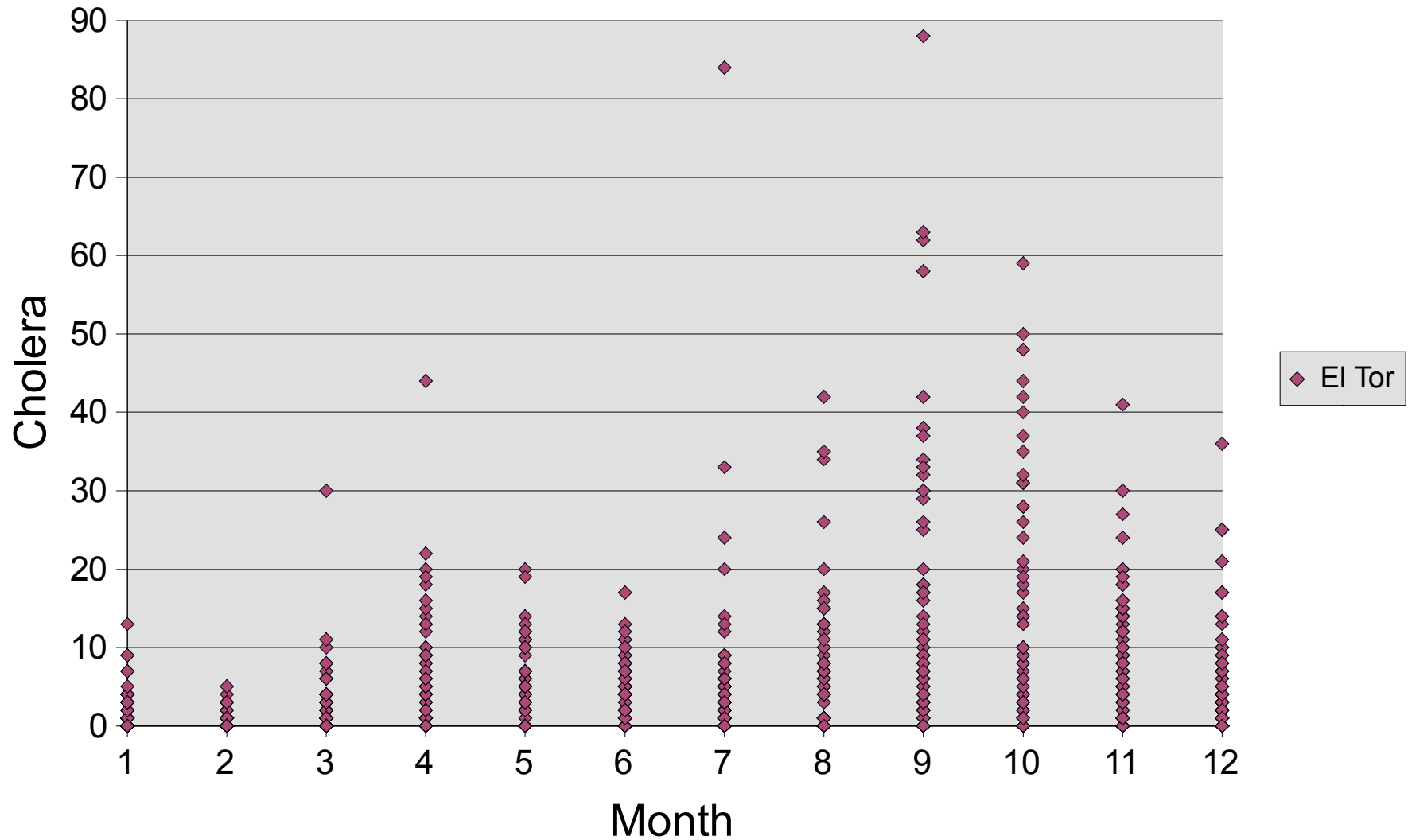
- ▶ Introduction
 - Cholera
 - Role of Climate
- ▶ Model and Methodology
 - Why a Pacemaker Model?
 - Experimental Design
- ▶ Results
- ▶ Conclusions

Introduction

- ▶ What is Cholera?
 - Bacterial illness (*vibrio cholerae*)
 - Spread through contaminated water
 - Symptoms: diarrhea, vomiting, nausea
 - Death through dehydration, loss of electrolytes
 - Treatable
- ▶ Role of Climate?



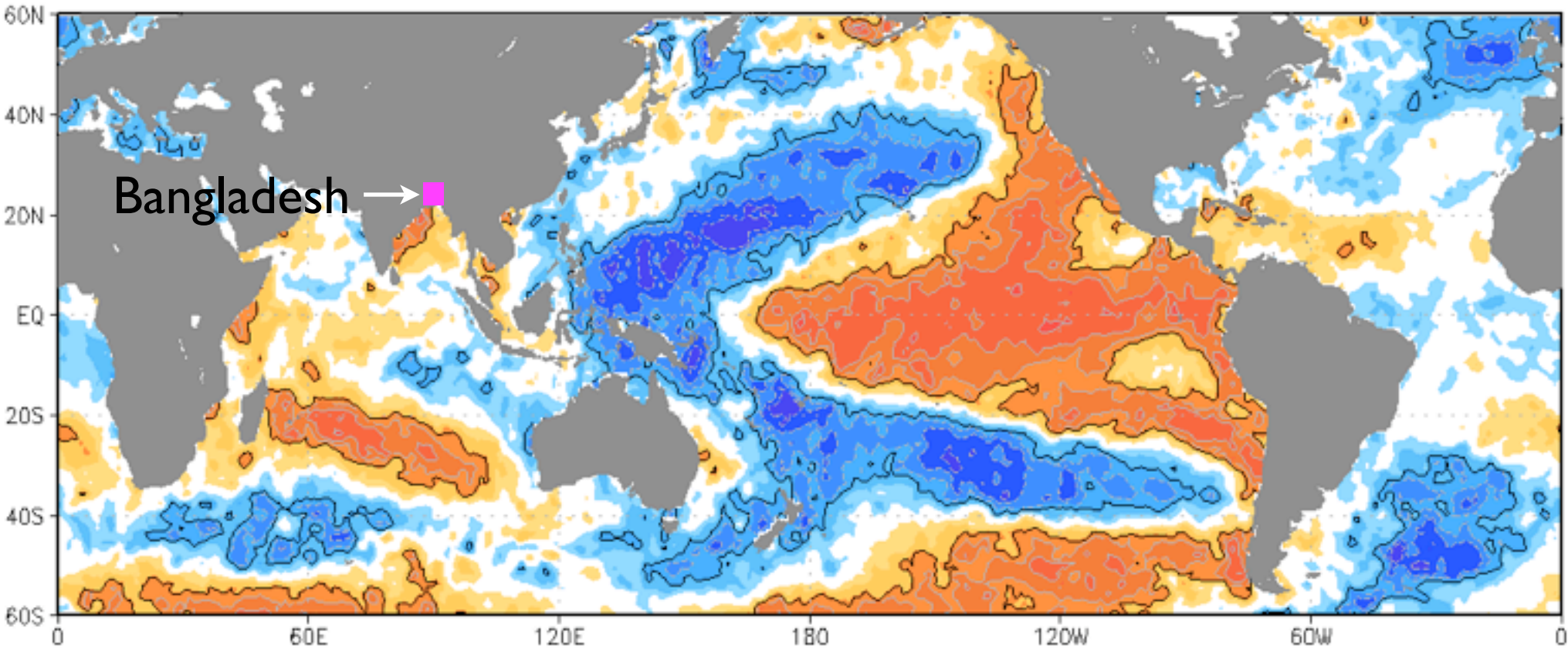
Cholera Cases 1973-2002



Distinct annual cycle

Peaks before and after monsoon rains

Rank Correlation: September Cholera - January SST



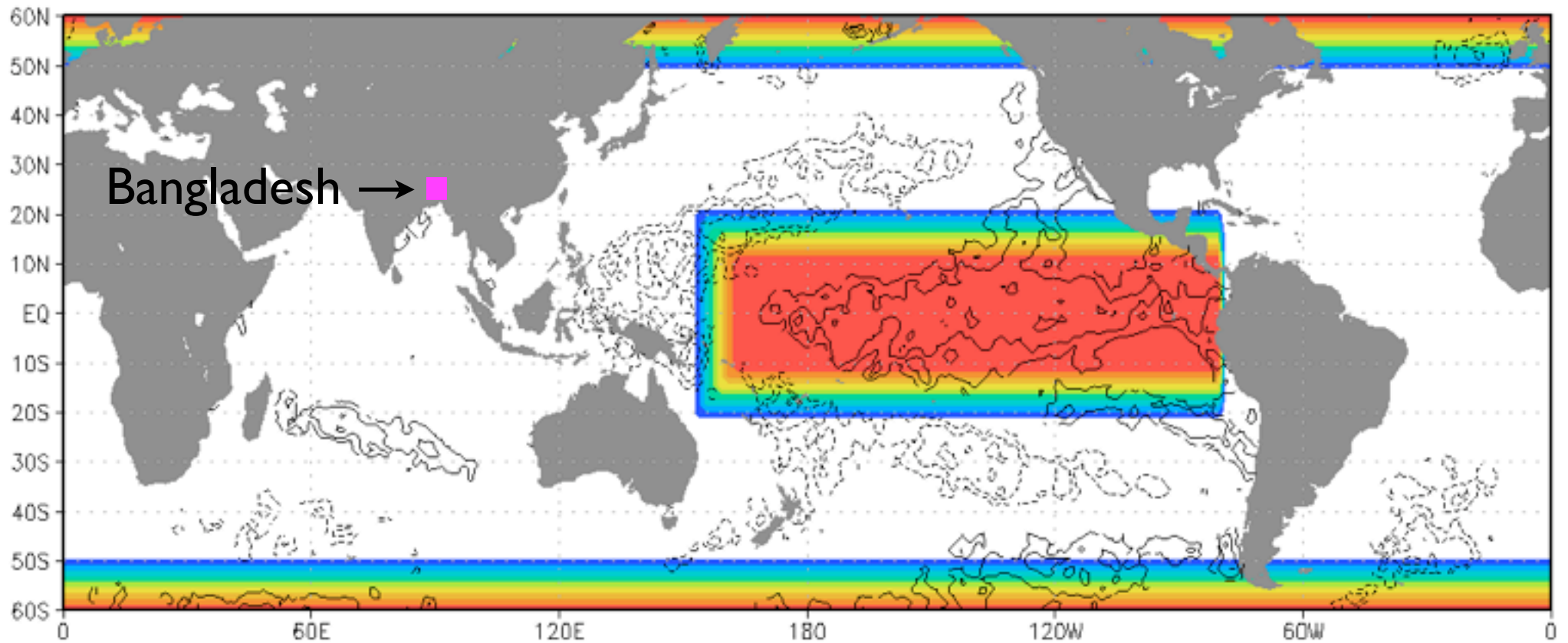
Close resemblance to ENSO
Coincidence? Physical Mechanism?

Model and Methodology

▶ Why a Pacemaker Model?

- Surface energy budget in Indian Ocean crucial to representing interaction between monsoon and ocean
 - Fully prescribed SSTs not appropriate
 - Representation of historical ENSO record crucial for comparison to cholera record
 - Fully coupled model not appropriate
 - Solution: Prescribe SSTs only in El Niño region, use simple ocean model elsewhere
- ➡ Regional coupling maintains surface energy budget and observed El Niño record

Pacemaker Region



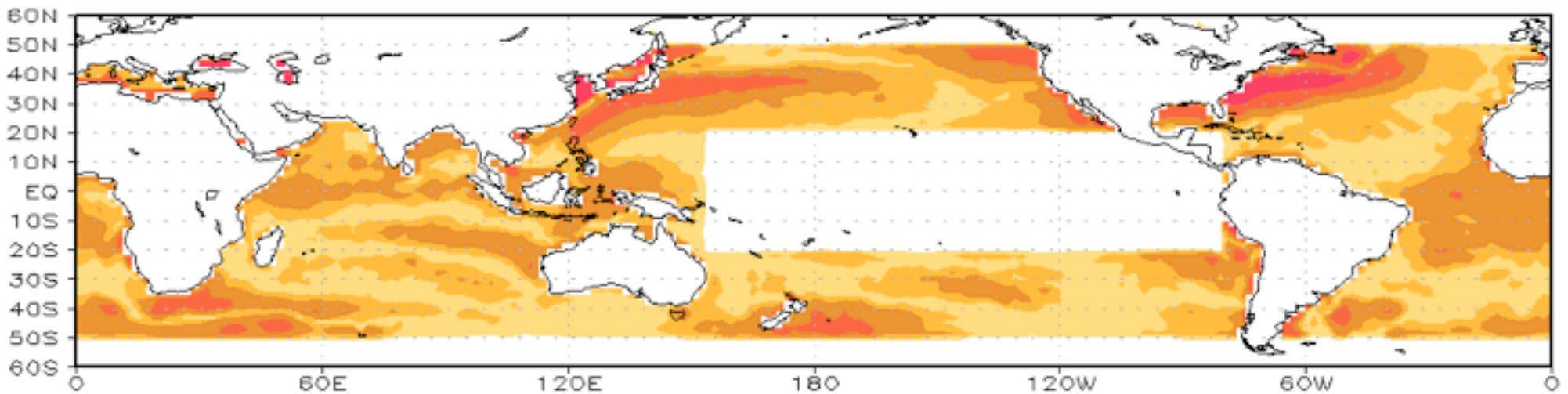
Bangladesh →



► Experimental Design

- 8 member ensemble
- COLA AGCM v3.1 at T62 horizontal resolution
- 1950-2002 HadISST data used in prescribed regions
- 50 m slab mixed-layer ocean outside of prescribed regions
- Implied ocean heat flux (q-flux) calculated from separate run, applied to mixed-layer model to prevent drift
 - Q-flux has fixed annual cycle, independent of current anomaly

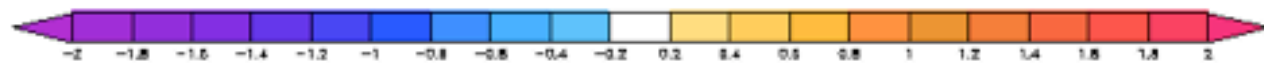
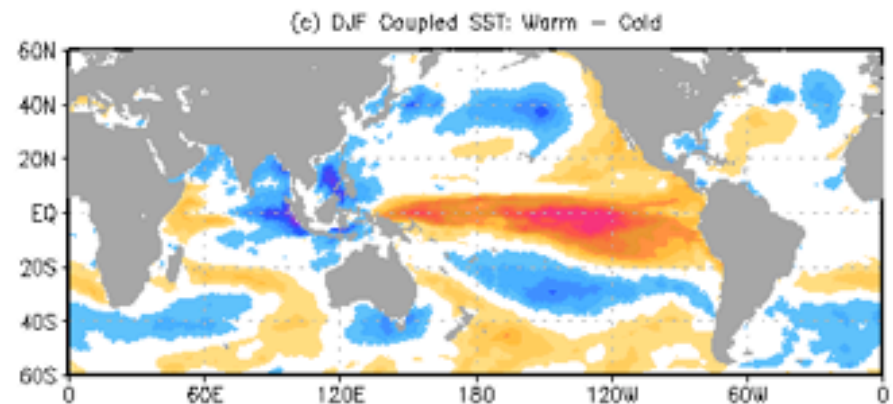
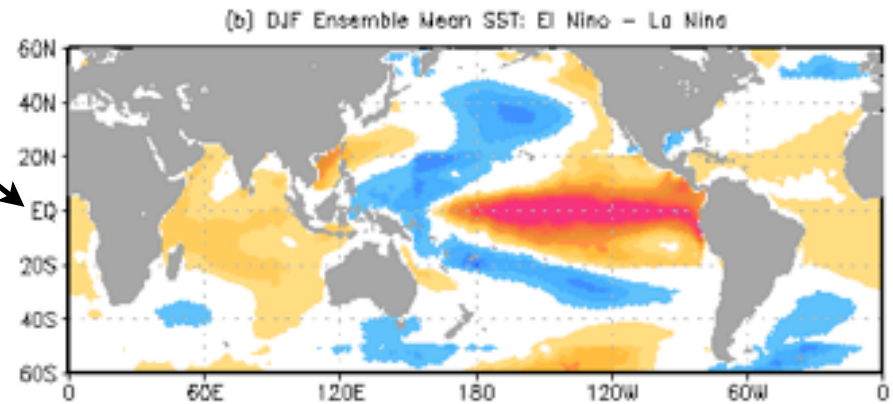
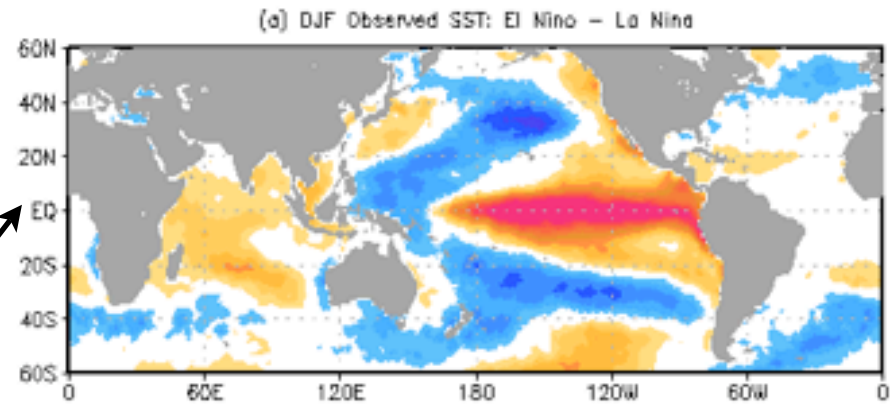
RMS Ensemble Mean Error



Largest errors in regions of western boundary currents
Errors generally small throughout the tropics

Pacemaker closely reproduces observed warm-cold pattern

Significant improvement over coupled model



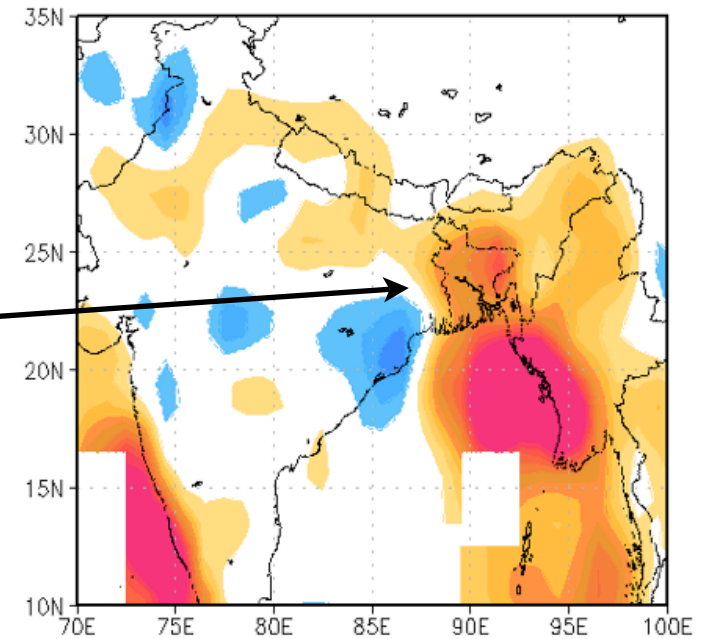
Impact of ENSO

Observed precipitation enhanced following El Nino in months prior to cholera peak

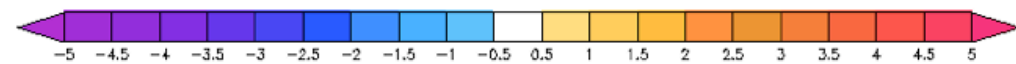
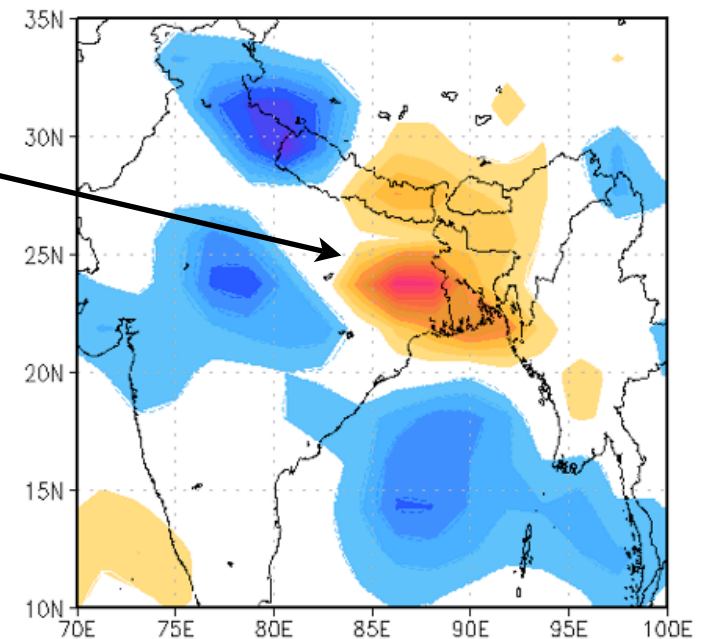
Pacemaker model captures much of the observed signal

Plausible physical link between cholera and ENSO

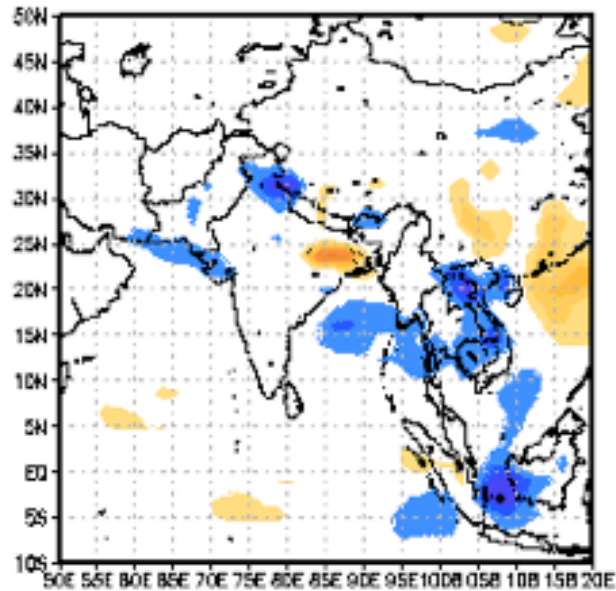
(a) July–August Observed Precipitation Anomaly



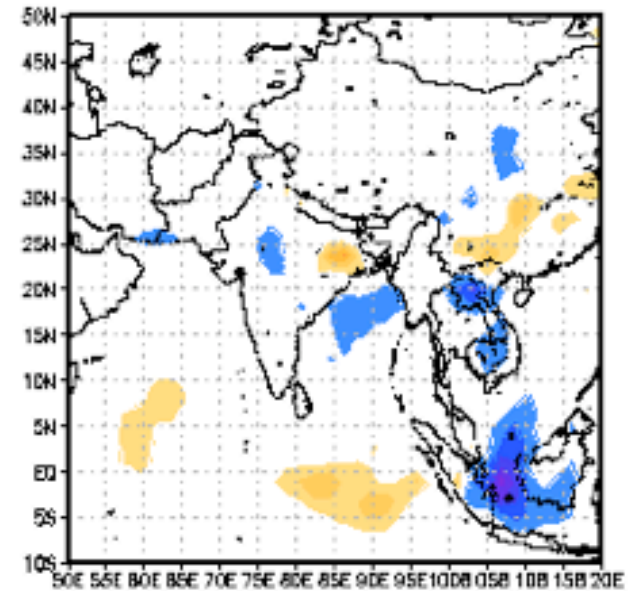
(b) July–August Composite Precipitation Anomaly



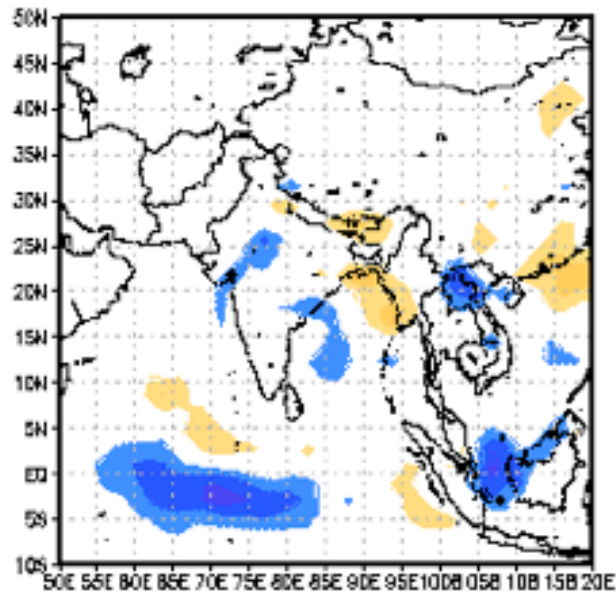
(a) Member A



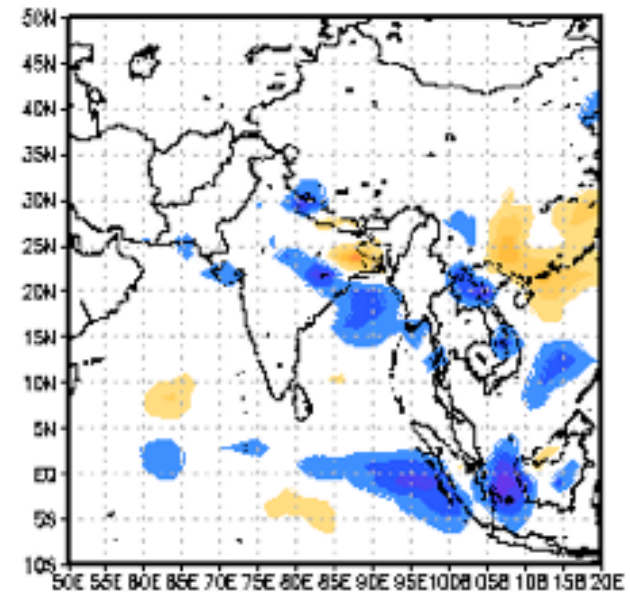
(b) Member B



(c) Member C



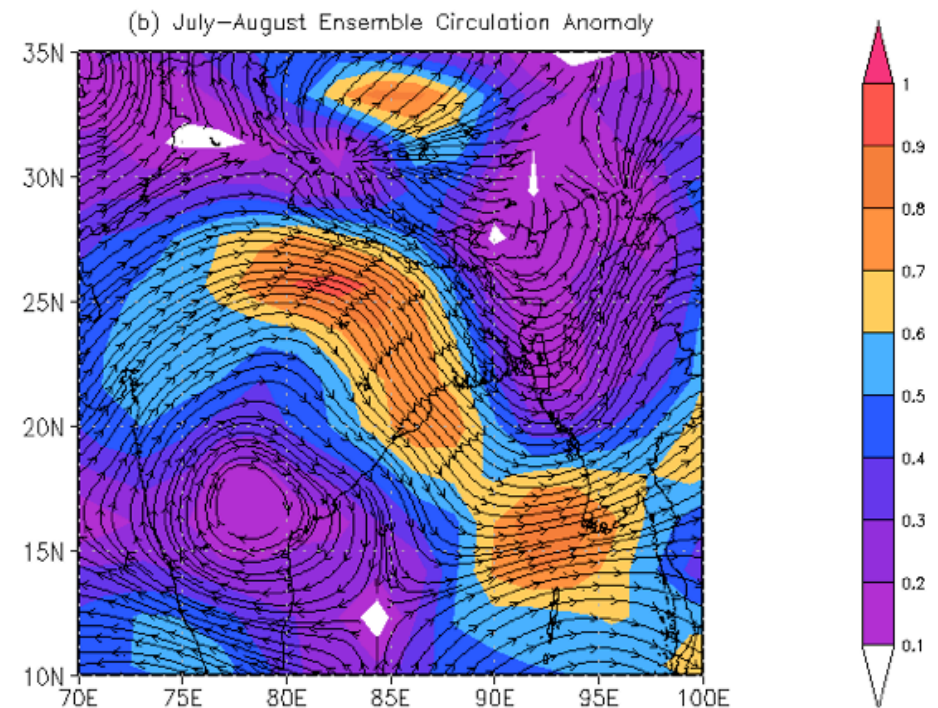
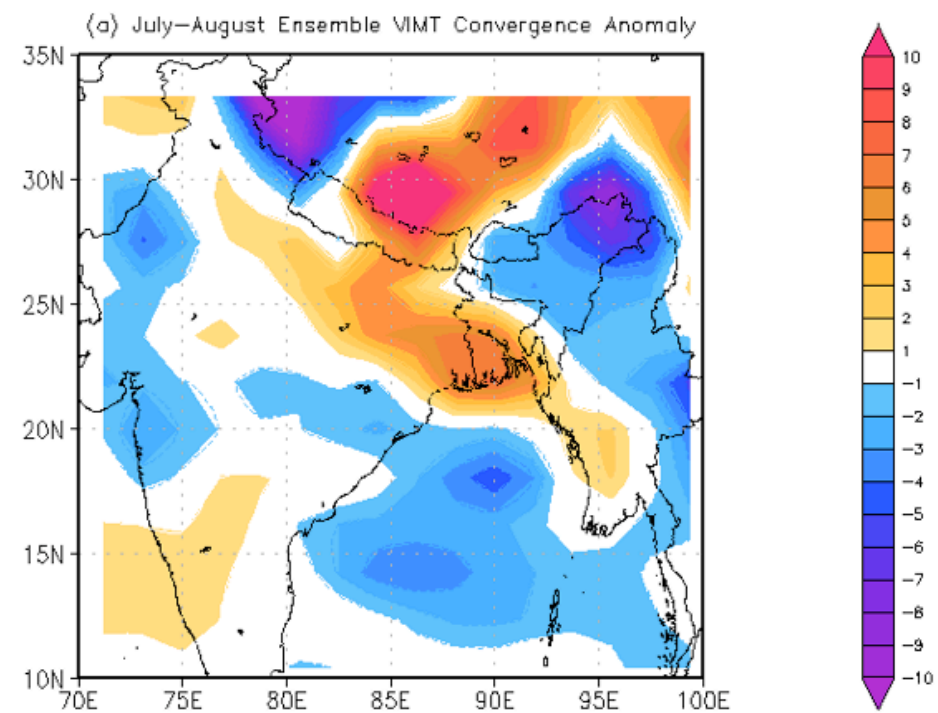
(d) Member D



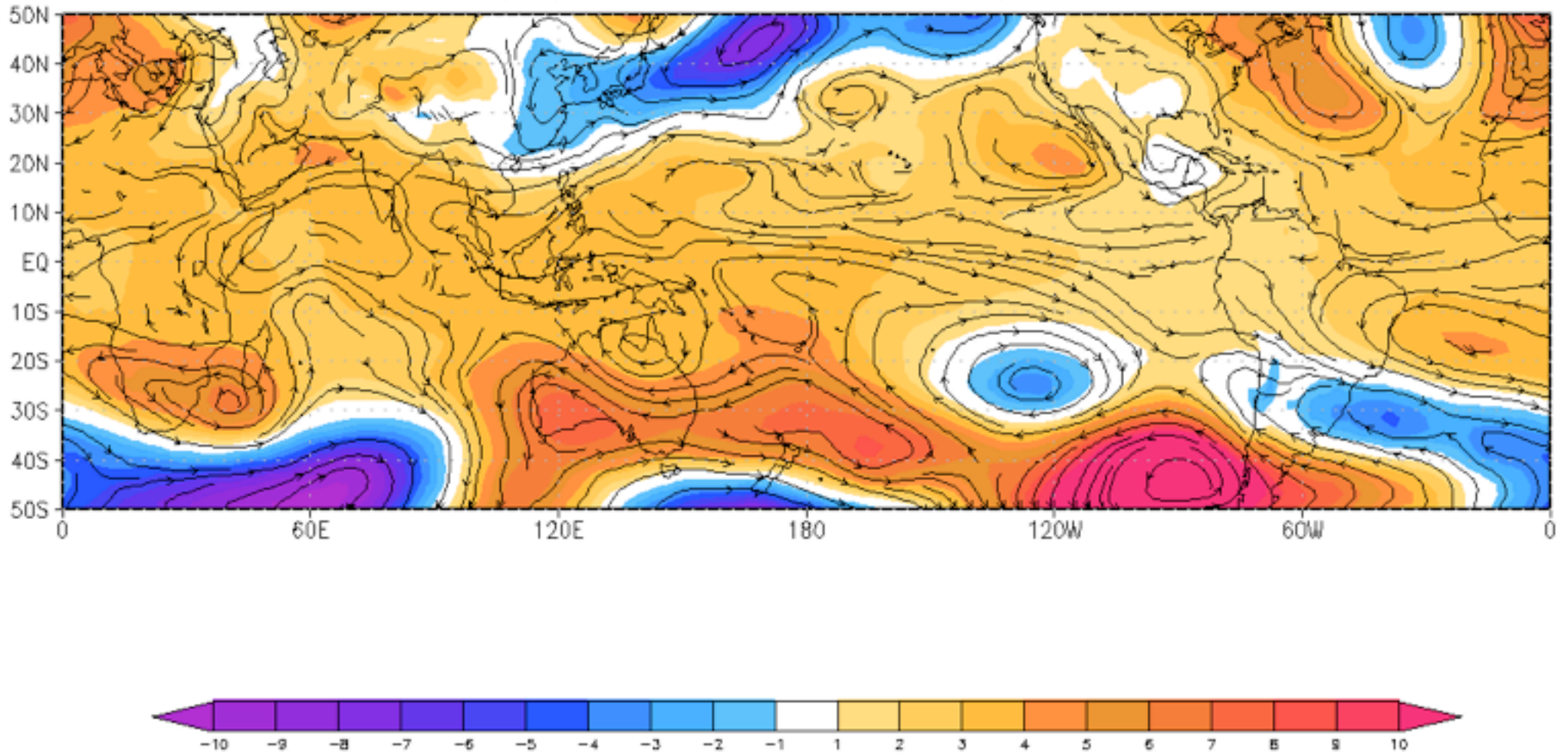
Enhanced precipitation over Bangladesh is robust

Clear convergence of Vertically Integrated Moisture Transport over Bangladesh

VIMT convergence due to enhanced easterly anomalies west of Bangladesh

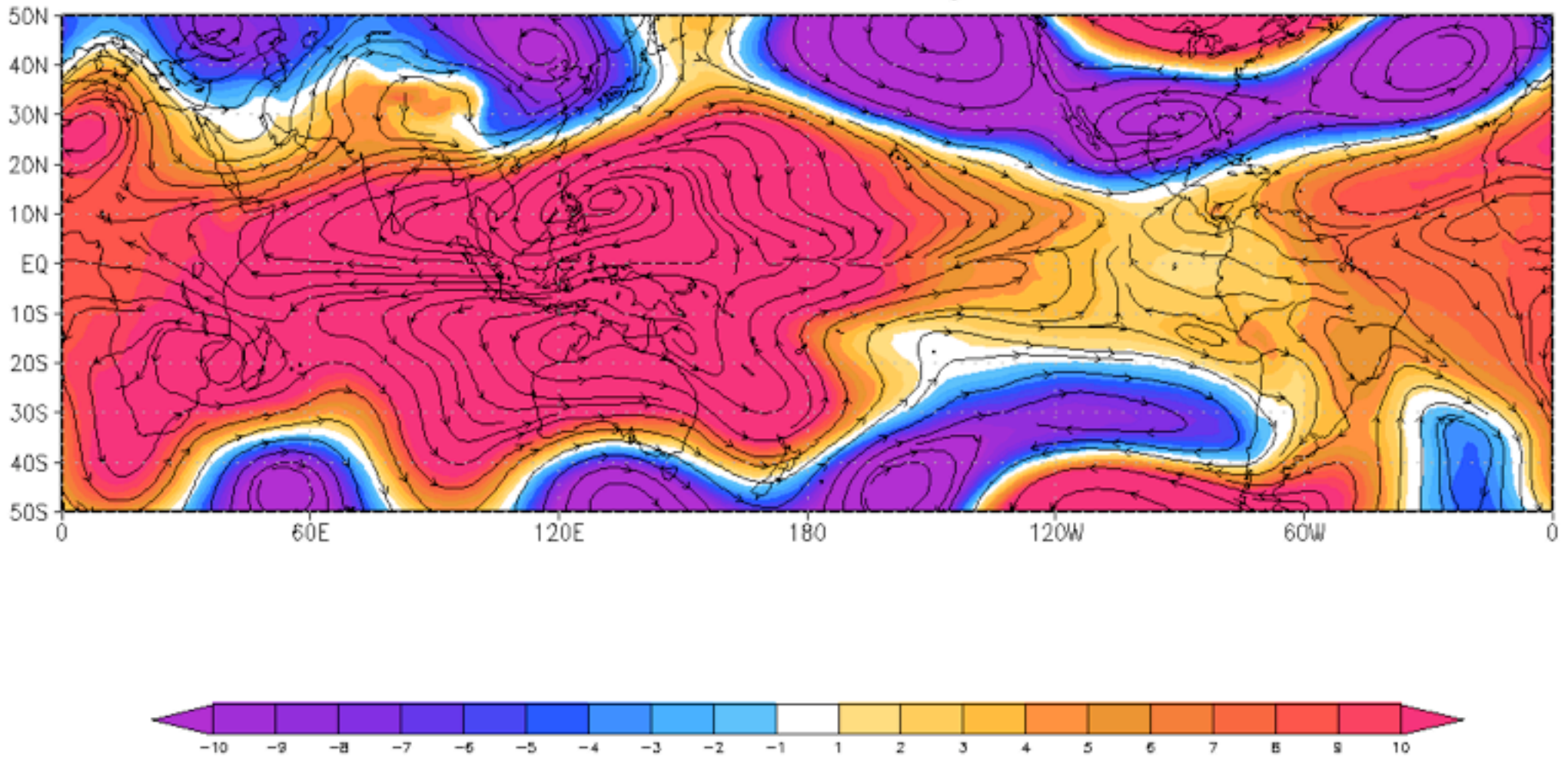


July–August Ensemble Mean Circulation and Height Anomalies



Easterly anomalies due to tropics-wide circulation changes

DJF Ensemble Mean Circulation and Height Anomalies



Summer pattern is continuation of winter circulation anomaly

Conclusions

- ▶ Statistical analysis links cholera variability and ENSO
- ▶ Observations indicate rainfall increases following El Niño
 - ▶ Rainfall may lead to increased flooding, breakdown in sanitation
 - ▶ Increased exposure to contaminated water and hence disease
- ▶ Pacemaker model reproduces increase in precipitation
- ▶ Increased precipitation due to alteration in monsoon circulation
 - Alteration in zonal winds, not increased advection from Bay of Bengal
 - Event-to-event variability
- ▶ Change in circulation persists from winter months