# Computer Models for Seasonal Climate Prediction:

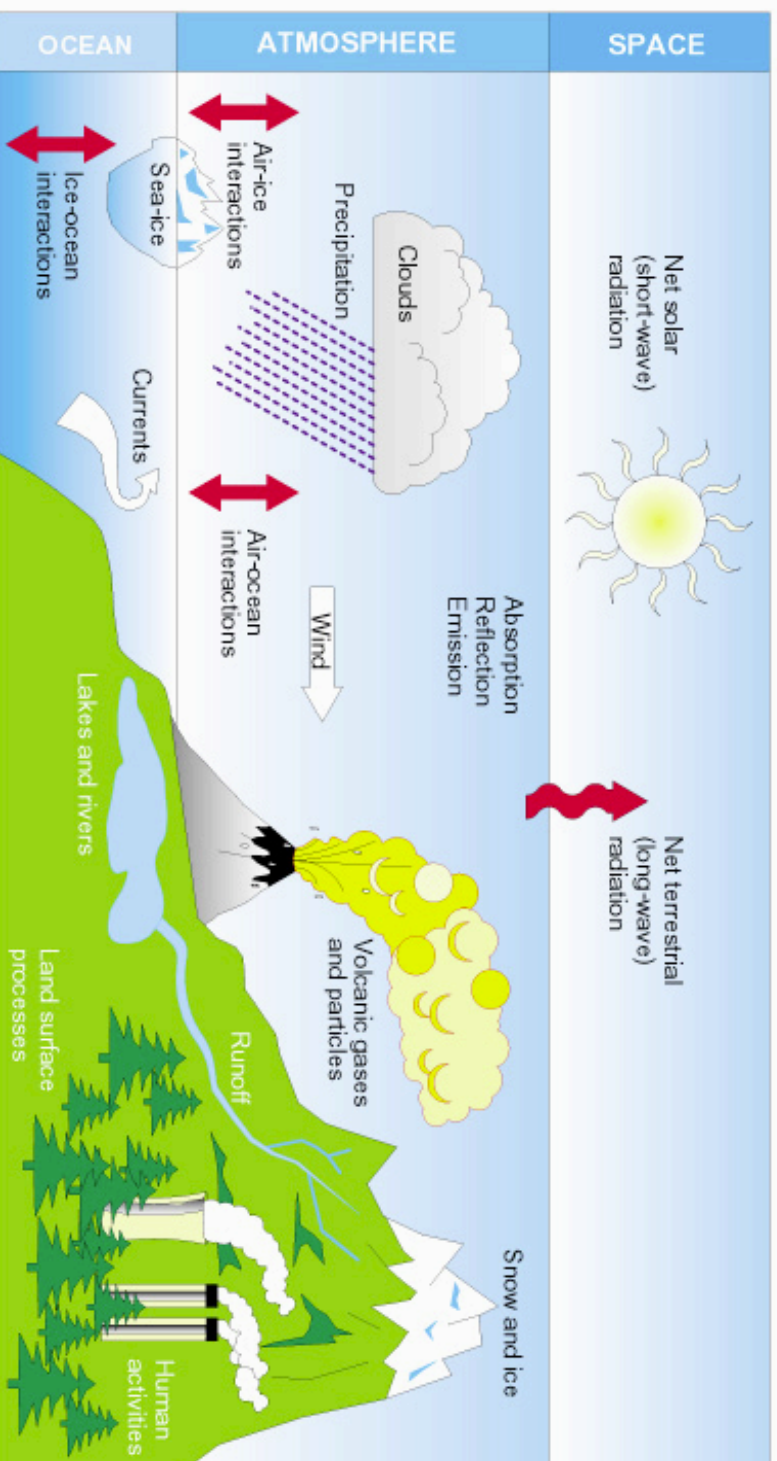## What they *can* tell us, and what they *can't* tell us

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Lamont-Doherty Earth Observatory

Palisades, NY

NASW Workshop, Denver CO
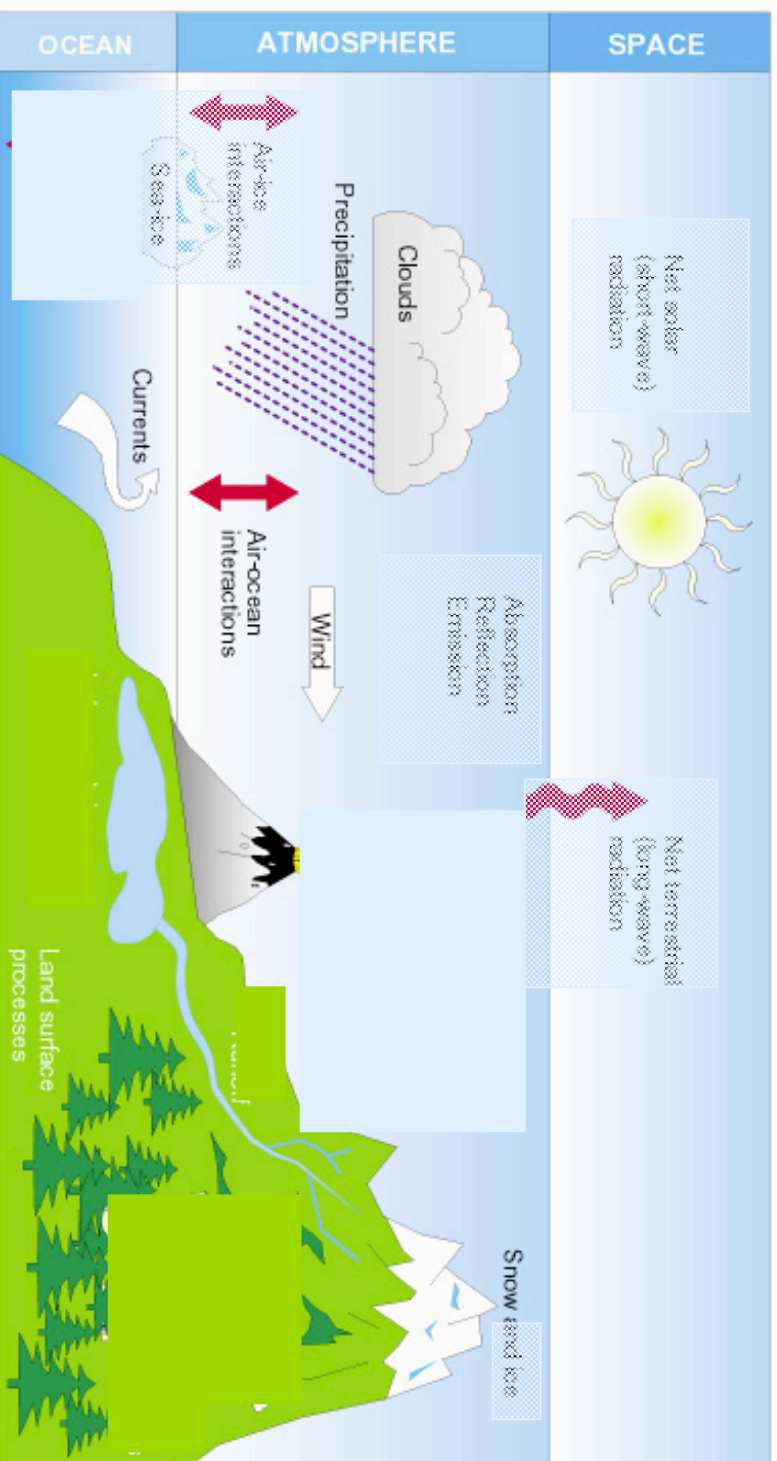
13 February 2003

# General

## The Climate System

OCEAN | ATMOSPHERE | SPACE

Air-ice interactions

Sea-ice

Ice-ocean interactions

Precipitation

Clouds

Currents

Air-ocean interactions

Wind

Lakes and rivers

Land surface processes

Runoff

Net solar (short-wave) radiation

Absorption Reflection Emission

Volcanic gases and particles

Human activities

Snow and ice

Net terrestrial (long-wave) radiation
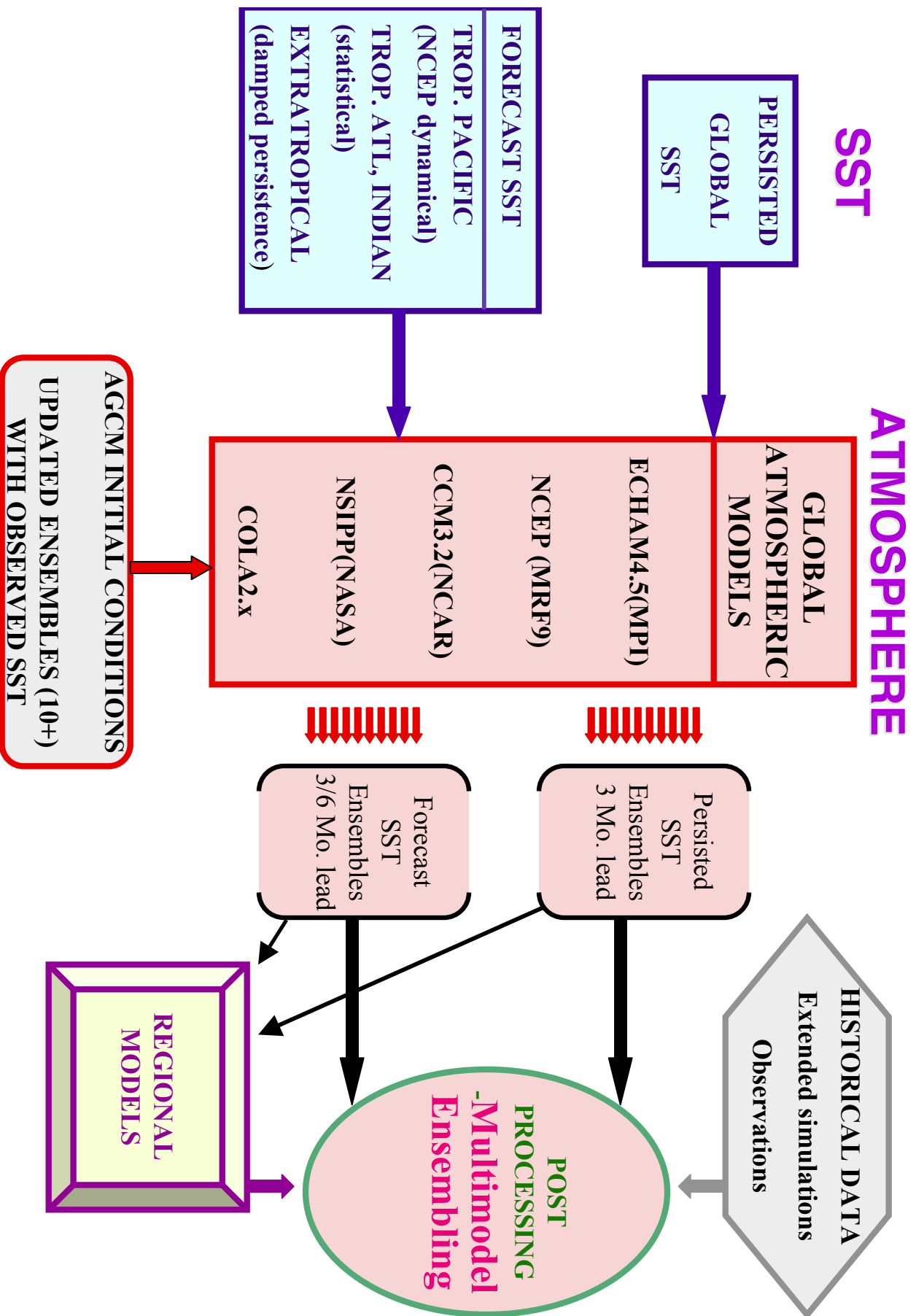
AV/Global/0101

# Seasonal [Prediction]

## The Climate System



courtesy N. Noreiks, L. Bengtsson, MPI

AV/Global/0101

- Atmosphere
- Ocean
- Land
- Ice

# IRI DYNAMICAL CLIMATE FORECAST SYSTEM

**SST**

PERSISTED
GLOBAL
SST

FORECAST SST

TROP. PACIFIC
(NCEP dynamical)
TROP. PACIFIC
(NCEP dynamical)
TROP. ATL, INDIAN
(statistical)
EXTRATROPICAL
(damped persistence)

**ATMOSPHERE**

GLOBAL
ATMOSPHERIC
MODELS

ECHAM4.5(MPI)

NCEP (MRF9)

CCM3.2(NCAR)

NSIPP(NASA)

COLA2.x

AGCM INITIAL CONDITIONS
UPDATED ENSEMBLES (10+)
WITH OBSERVED SST

Forecast
SST
Ensembles
3/6 Mo. lead

Persisted
SST
Ensembles
3 Mo. lead

REGIONAL
MODELS

POST
PROCESSING
-Multimodel
Ensembling

HISTORICAL DATA
Extended simulations
Observations

**INTERNATIONAL RESEARCH INSTITUTE**

# IRI Multi-Model Probability Forecast for Precipitation
## October-November-December 2002 made September 2002



**Key**

Percentage likelihood of:

| | |
|---|---|
| A | Above-normal Precipitation |
| N | Near-normal Precipitation |
| B | Below-normal Precipitation |

White Regions over land have climatological probabilities

D "Dry Season" Masking

Probability (%) of Most Likely Category

Below-Normal: 40 45 50 60 70

Normal: 40

Above-Normal: 40 45 50 60 70
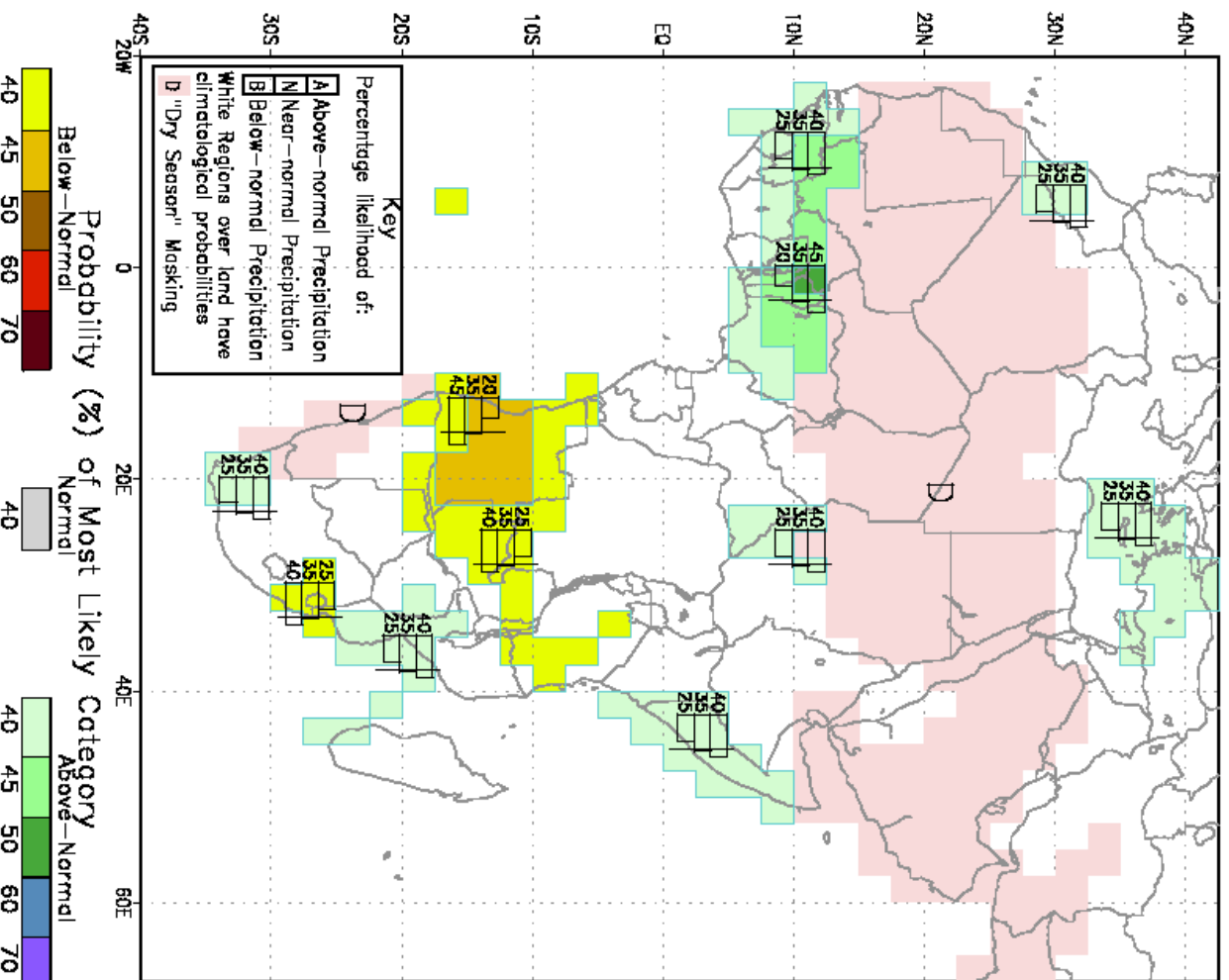
*This is the kind of forecast that uncertainty in the system dictates — not a specific quantity, but the probability for some range of outcomes.*

For more information on IRI and its seasonal climate forecasts, visit:

http://iri.columbia.edu/

http://iri.columbia.edu/climate/forecast/

# SOURCES OF UNCERTAINTY IN SEASONAL CLIMATE FORECASTS

1) **Inherent uncertainty in climate system**
   (internal dynamics of atmosphere or chaos)

2) **Imperfections in computer models**
   (small scale processes not resolved;
   physical processes/interactions not included;
   topography not resolved)

3) **Uncertainty in ocean temperature predictions**
   (impact of weather [see (1)] on sea surface temp.s;
   limited understanding of variability outside of
   tropical Pacific)

| | TIME | SPACE | NEED | UNKNOWNS |
|---|---|---|---|---|
| **Weather** (*Initial Value Problem*) | 2-10 days | City/county (e.g. Boston) | Initial observed state of atmosphere | Exact initial state of atmosphere |
| **Seasonal Climate** (*Boundary Value Problem*) | 1-6 months | Regional (e.g. Northeast US) | Estimate of surface conditions in near future | Specific evolution of daily weather within season |
| **"Climate Change"** (*Energy Balance Problem*) | 10-100 years | Global | Estimate of atmospheric composition in future | Change in parameterized behavior of climate system |