Attributing climate variations:
Part of an information system for the future

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The climate is changing: It is likely to continue to change! Regardless of the success of mitigation actions:

We need a comprehensive information system to:

- Observe and track the climate changes and forcings as they occur.
- Analyze global products (with models)
- Understand the changes and their origins
- Validate and improve models
- Initialize models; predict future developments
- Assess impacts regionally: on environment, human activities and sectors such as agriculture, energy, fisheries, water resources, etc.

Such a system will be invaluable regardless of magnitude of global warming

T et al 2002
Imperative

A climate information system

- Observations: forcings, atmosphere, ocean, land
- Analysis: comprehensive, integrated, products
- Assimilation: model based, initialization
- Attribution: understanding, causes
- Assessment: global, regions, impacts, planning
- Predictions: multiple time scales
- Decision Making: impacts, adaptation

An Integrated Earth System Information System
The DART-CAM ensemble Data Assimilation System for Climate Model Development

• A mature ensemble data assimilation facility for CAM.
• Easy to use with CAM3.x spectral and FV.
• Works with variety of physics options.
• Competitive with operational NWP assimilation capabilities.
• Converges within a few days in N.H. and tropics, a week in S.H.
• Runs on variety of parallel architectures and compilers.
• Run your own reanalyses and forecasts with CAM.

Enables forecasts
Enables reanalyses

Jeff Anderson
Attribution: why is the climate the way it is?

- **Observations:** forcings, atmosphere, ocean, land
- **Analysis:** comprehensive, integrated, products
  - Using models: assimilation
  - Using numerical experiments to relate forcings to observations
  - Using numerical experiments and diagnosis to determine evolution of the system
- **Attribution:** understanding causes
- **Attributing** what has just happened is a prerequisite to making the next climate prediction.
2 Stages of Attribution

1) Run model ensembles to determine how predictable recent events were, give all forcings, including SSTs, soil moisture, sea ice, etc.

2) Perform numerical experiments to determine why SSTs, soil moisture, etc are the way they are.

Recognize models are imperfect: models are now better and can attribute some things that could not be so attributed a few years ago.

- Account for model shortcomings
- Account for empirical evidence
- Requires computer and human resources:
- How to do this efficiently?
Requirements

- Observations (that satisfy the climate observing principles);
- a performance tracking system;
- the ingest, archival, stewardship of data, data management;
- access to data
- the analysis and reanalysis of the observations and derivation of products,
- Climate Data Records (CDRs)
- assessment of what has happened and why (attribution) including likely impacts on human and eco-systems;
- prediction of near-term climate change over several decades;
- responsiveness to decision makers and users.
Climate Information Service

Stakeholders
Users, Decision Makers

Assessments

Products
Information

Operational
Applied
Research

Prediction
Attribution

Climate
Services

Basic
Research

Modeling

Assimilation

Observations, Data and Analyses

Trenberth 2008
Climate Information System

Trenberth, 2008

Nature 6 December 2007
Opportunities

• WCRP: JSC mtg, Washington DC, April 2009: new implementation plan for COPES
• GEWEX/iLEAPS mtg Melbourne, Aug 2009
• World Climate Conference 3, Geneva, Sept 2009
• Ocean Obs 09, Venice, Sept 2009