

Climate Process Modeling And Science Teams

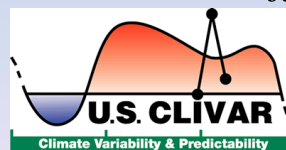
CPT *

A program for improving climate model
elements

* previously known as CLIVAR process modeling team
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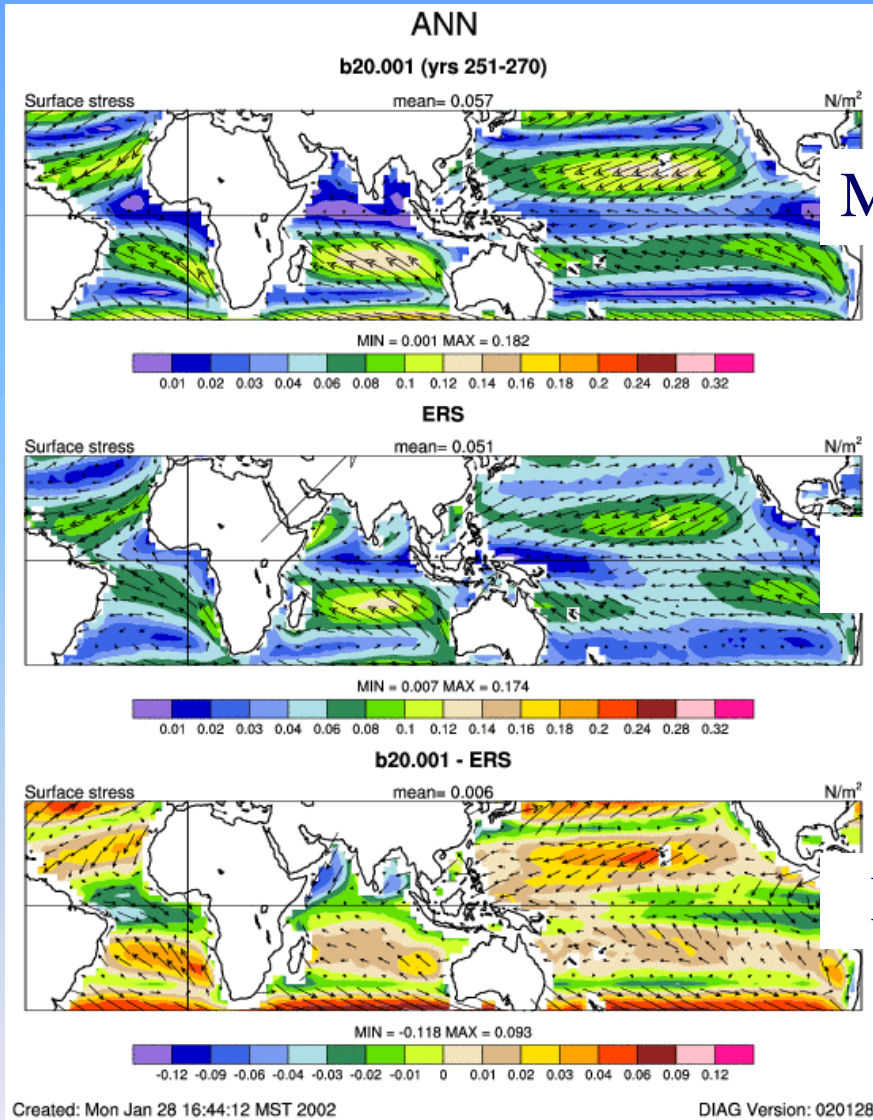


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CCSM2 Annual Mean Sfc Stress

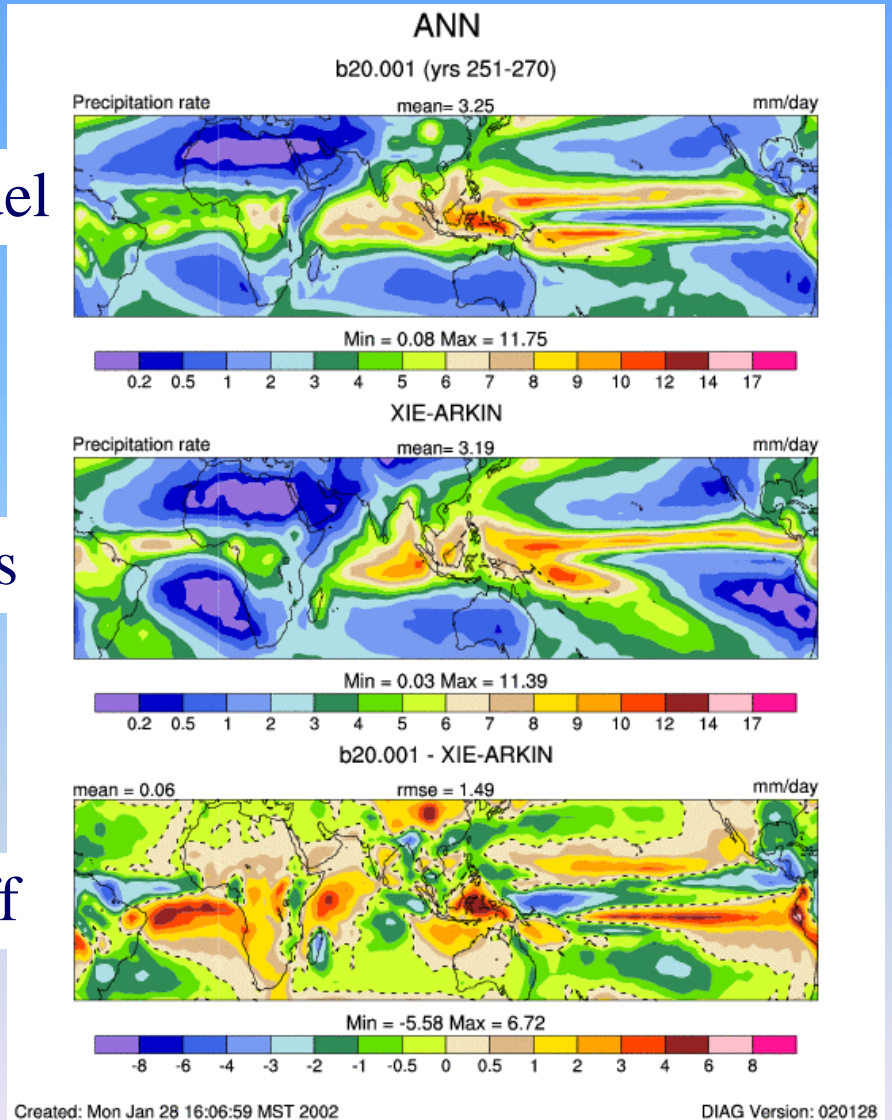
CCSM2 Annual Mean Precip



Model

Obs

Diff



Motivation

- Improving (reducing uncertainties in) coupled climate models can be achieved (in part) by reducing uncertainties associated with processes
- Model validation/intercomparison projects (e.g. CMIP) highlight model uncertainties, but are not sufficiently focused to indicate how processes contribute to these uncertainties
- The large gap between process oriented research efforts and climate model development as well as the lack of resources available for diagnosing and testing physical parameterizations in the context of coupled model systems impedes improvement in coupled models

Process experiments



Data, knowledge



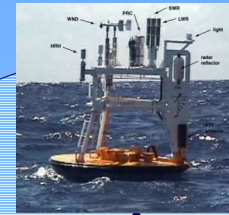
Process model development



Climate model development & improvement

Lack of focus, little interaction

Climate Process Teams Cooperative Development



Deliverables

- Documented observations
- Improved parameterizations
- Impact evaluation
- Plans for additional process studies
- Observing requirements

CPTs Briefly

- Teams of observational scientists, diagnostic scientists, process modelers, coupled modelers, data assimilation systems developers, organized around *processes*, would focus on quantifying and reducing uncertainties associated with these processes

CPT Objectives

- Speed the improvement of coupled models, data assimilation systems, and model components by
 - **Parameterizing the important processes** not included explicitly in climate models;
 - **Transferring theoretical and process-model understanding** into improved treatment of processes in climate models;
 - **Sharpening our understanding** of how particular physical processes impact the climate system;
 - **Identifying sustained observational requirements** required by climate models for these parameterizations; and
 - **Identifying additional process studies** necessary to reduce uncertainties associated with important climate model processes/parameterizations.

Approach

- Provide resources to forge teams of observational scientists, diagnostic scientists, process modelers, and (one or more) coupled model developers and data assimilation system developers to:
 - Establish open pathways of **communications**
 - Encourage **active mechanisms** for exchange of information (e.g. visiting programs)
 - Focus on **long-term interaction & deliverables** (not necessarily manuscripts) that lead to demonstrated advances in climate modeling

CPTs are NOT:

- Business as usual...
- Just travel money for an annual meeting...

Possible Activities for CPTs

- **Assessing modeling capabilities**
 - Develop process diagnostics
 - Assess consistency of popular parameterizations with
 - Existing observations
 - Detailed process models
 - Other implementations
 - Produce observational suites useful for diagnostic studies
- **Best use of observations**
 - Upscaling of local process measurements to needed space/time scales
 - Quantify how errors associated with process uncertainties affect critical products
 - Establish observing requirements for parameterizations
- **Model sensitivity of climate & variability to process uncertainties**
 - Single-model sensitivities
 - Model intercomparisons (CMIP subprojects)
 - Diagnosis of model errors attributable to errors in process parameterizations
 - Determine accuracy requirements needed to capture main climate feedbacks
- **Parameterization improvement**
 - Engage team members in development of improved parameterizations
 - Evaluate new parameterizations
 - Plan future process studies to address unresolved uncertainties

Example processes/topics

- Ocean processes (e.g. diapycnal mixing)
- Atmosphere processes (e.g. deep convection)
- Surface fluxes (e.g. best use of the observational datasets)

CPT for Diapycnal Ocean Mixing

- Diapycnal mixing is main physics of ocean models
 - Internal wave mixing
 - Diffusivity in the EUC
 - Boundary mixing
 - Abyssal mixing (tides and topography)
 - Gravity wave drag in the ACC
 - Enhanced mixed layer turbulence by gravity waves
 - Entrainment into gravity currents
- Current parameterizations inadequate
- Significant impact on simulated circulations or their stability or sensitivity

Emerging component - DOME

(Dynamics of Overflow Mixing and Entrainment)

- Model intercomparisons
 - High-res OGCM's
 - Non-hydrostatic models
 - Z-coord, sigma-coord, isopycnal
- 3-phase intercomparison
 - Idealized
 - Gibraltar and Denmark Straits
 - Atlantic circulation
- Close working arrangement between OGCMs and process modelers
- Active theory community
- Data from Med Outflow very valuable (Barringer and Price)
- Strong influence on stability of thermohaline circulation (Price and Yang)
- Significant impact on mean circulation (Chassignet)
- Faroe Bank Channel observations begun
- Need to invigorate links to observational community
- Underway - develop science plan

CPT for Atmospheric Deep Convection

Current efforts include:

CCSM/Atm Modeling Working Group

- Good discussion forum for bringing global modelers together
- Limited participation from process scientists
- Limited time for interaction/democratic
- Few dedicated resources for interaction

GEWEX Cloud System Study WG2/ARM

- Emphasizes intercomparison rather than detailed diagnostics
- Limited participation from major modeling groups
- ARM support requires focus on ARM observations - may or may not address most pressing problems
- Large, cumbersome groups make for slow progress

CPT for Atmospheric Deep Convection (2)

- Needs
 - Dedicated cross-cutting group (3-5 yrs)
 - Explicit funding to support novel diagnostics, coding/testing of improved parameterizations
 - Global modelers identify critical problems related to convection (e.g. split ITCZ, cloud-radiative feedback, diurnal cycle) and set 3-yr goals
- Funding
 - Support scientist at each modeling center doing diagnostics and testing code improvements - responds to entire group
 - Support for process scientists to pursue activities relevant to CPT
 - Travel funding for an annual meeting

CPT for Atmospheric Deep Convection (3)

- Team Composition
 - Parameterization developers from NCAR, GFDL, NCEP (Hack, Donner, Pan, + 1-2 other groups)
 - Process Scientists with expertise in
 - In-situ obs (Raymond, Mapes, Johnson)
 - Satellite obs (Wielicki)
 - Cloud-resolving models (Tao)
 - Diagnostics and data assim (DeMott, Hou)
 - SCM and novel parameterization approaches (Randall)

CPT Formulation

- What characteristics *define* a CPT
 - Team Topic/Process
 - Team Composition
 - Team Plans and Deliverables

Implementation

- Significant investment - \$1M (USD) per team per year
- Pilot-phase
 - High-priority processes
 - Observations already/nearly in hand
 - Relatively short lifetime
 - Reduced number of deliverables
- Additional and more robust CPTs formed in the future

Issues

- Team scoping
 - To be effective, must target modeling *systems*. Thus how do we scope single process, suite of processes, or the model *system*...optimal team focus?
- Team accountability/metrics
 - How will CPTs be held accountable for stated objectives?

SSG Consideration

- Climate Process Teams as a new (better) approach to link process-oriented research and modeling?