Managing, Using and Expanding the IPCC CMIP3 Database of Climate Model Output

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Some Definitions

• IPCC = Intergovernmental Panel on Climate Change
  – Assesses climate science, impacts, and adaptation / mitigation possibilities
    [Working Group 1] [WG2] [WG3]

• CMIP = Coupled Model Intercomparison Project
  – Phase 1: Idealized simulations of present-day climate
  – Phase 2: Idealized simulations of future climate changes
  – Phase 3: More realistic simulations, as requested by IPCC Working Group 1

• PCMDI = Program for Climate Model Diagnosis and Intercomparison
  – Organizes, manages and distributes the CMIP / IPCC database of climate model output
  – Sponsored by Office of Science, US Department of Energy

• GCM = General Circulation Model / Global Climate Model
  – Computer program that simulates weather and climate around the world*
  – Modified version of numerical weather prediction model
  – Run for months → years → centuries simulated time
  – Extra components added (ocean, sea ice, ...) but lower resolution
  – Average over weather (not believable) to get climate (believable?)

* Washington and Parkinson (2005) An Introduction to Three-Dimensional Climate Modeling
Should we believe climate models?

• Conventional wisdom
  – IPCC 2001:
    “In general, they provide credible simulations of climate, at least
down to sub-continental scales ... We consider coupled models,
as a class, to be suitable tools to provide useful projections of
future climates.”
  – IPCC 2007: ?
  – US Climate Change Science Program Synthesis & Assessment
    Product 3-1: www.climatescience.gov/Library/sap (in progress)

• Pros and cons
  – Good simulation of many present-day climate features: 95-98%
detailed spacetime correlation with observed temperature
  – Not so good simulation of others: 40-60% correlation with
observed precipitation
  – Improving ability to predict short-term climate change*
  – No way (except retrospectively) to test predictions of long-term
climate change

• Bottom line: depends on the application . . . and the model

models: Are the current models better? Climate Dynamics 27: 1-15
CMIP3 / IPCC Database of Climate Model Output

- Total volume ~ 30 Terabytes and growing
- 23 models contributed by 19 institutions in 11 nations*
  - Mostly coupled atmosphere - ocean - sea ice - land surface GCMs
  - Many input scenarios
    - Prescribed SST and sea ice to match late-20th century observations
    - Doubled atmospheric CO2 (run to statistical steady state)
    - Increasing atmospheric CO2 at the rate of 1% per year
    - Pre-industrial and present-day “control runs” (constant climate forcing)
    - 20th century emissions, solar changes, volcanoes ...
    - 21st century low, medium, high (IPCC SRES B1, A1B, A2) emissions
  - Many many variables in standardized format, nomenclature, units
    - CF / netCDF (familiar to climate modelers and “Working Group 1 types”)
- Not designed to provide initial / boundary conditions for other models
- Available to anyone for noncommercial use:
  www-pcmdi.llnl.gov/ipcc/registration_procedure.php

* Australia, Canada, China, Denmark, France, Germany, Japan, Norway, Russia, UK, USA
CMIP3 / IPCC Database Use (per Bob Drach, PCMDI)

By end of September 2006:
> 750 registered users
≥ 177 scientific publications

deadline for inclusion in IPCC 4th Assessment report
Oceanography with the CMIP3 / IPCC Database

• Available ocean-related variables (www-pcmdi.llnl.gov/ipcc/standard_output.html):
  – Monthly-mean ocean T, S, 3D current velocity
  – Monthly-mean ocean meridional streamfunction (longitude-integrated)
  – Monthly-mean ocean barotropic streamfunction (depth-integrated)
  – Monthly-mean ocean heat transport (longitude- and depth-integrated)
  – Monthly-mean SST, SSH; seaice fraction, thickness, 2D velocity
  – Monthly-mean precip; surface air T; wind stress; surface fluxes of heat, solar, IR, water vapor
  – Daily-mean precip; surface air T, Tmin, Tmax; surface fluxes of heat, solar, IR, water vapor
  – 3-hourly precip; surface air T; surface fluxes of heat, solar, IR, water vapor
  – Ocean depth (function of latitude and longitude) and land / sea mask

Note: ocean data provided Cartesian-product lat-lon grids (fixed set of latitudes for each longitude and vice-versa) and standard depth levels

• 10 of 553 registered projects have “Pacific” but not “tropical” in their titles (www-pcmdi.llnl.gov/ipcc/diagnostic_subprojects.php)


How are these reconciled?
Use GCM control runs “as a test bed for studying the effects of sparse space-varying and time-varying observational coverage . . . Subsampling model data at the locations of available observations increases the variability, reducing the discrepancy between models and observations.”

**Figure 2.** Changes in annual-mean global ocean temperature in degrees C as a function of depth in meters, in coupled model experiments with (a-f) combined anthropogenic and volcanic forcing and (g) in experiments with anthropogenic forcing only.