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

* K. AchutaRao and K. R. Sperber (2006) ENSO simulation in coupled ocean-atmosphere models: Are the current models better? Climate Dynamics 27: 1-15

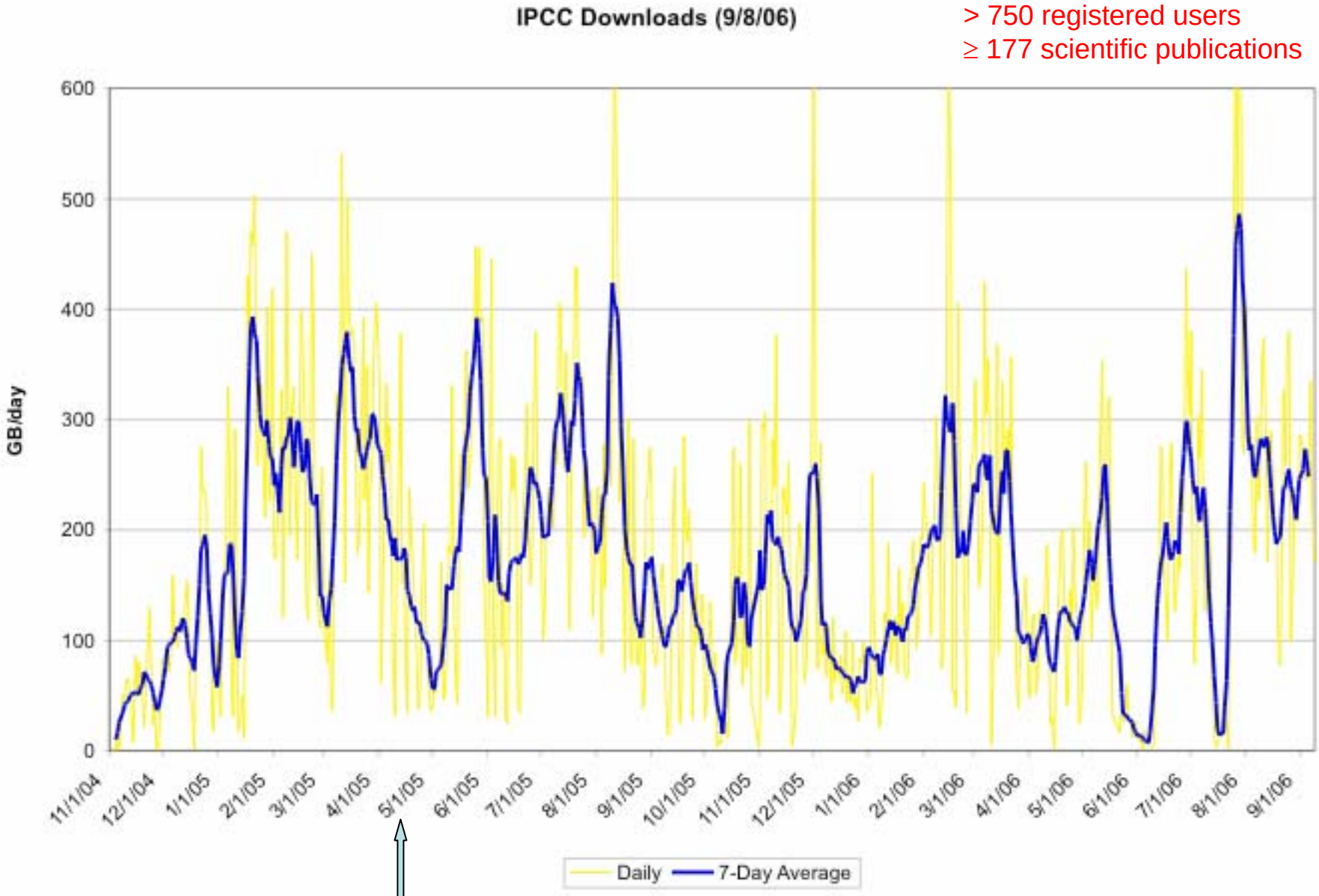
CMIP3 / IPCC Database of Climate Model Output

- 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

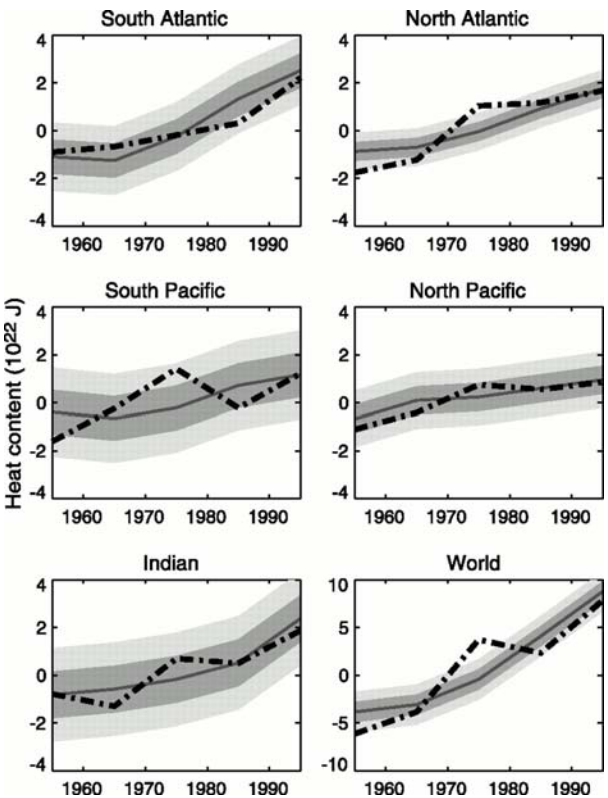
Oceanography with the CMIP3 / IPCC Database

- 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

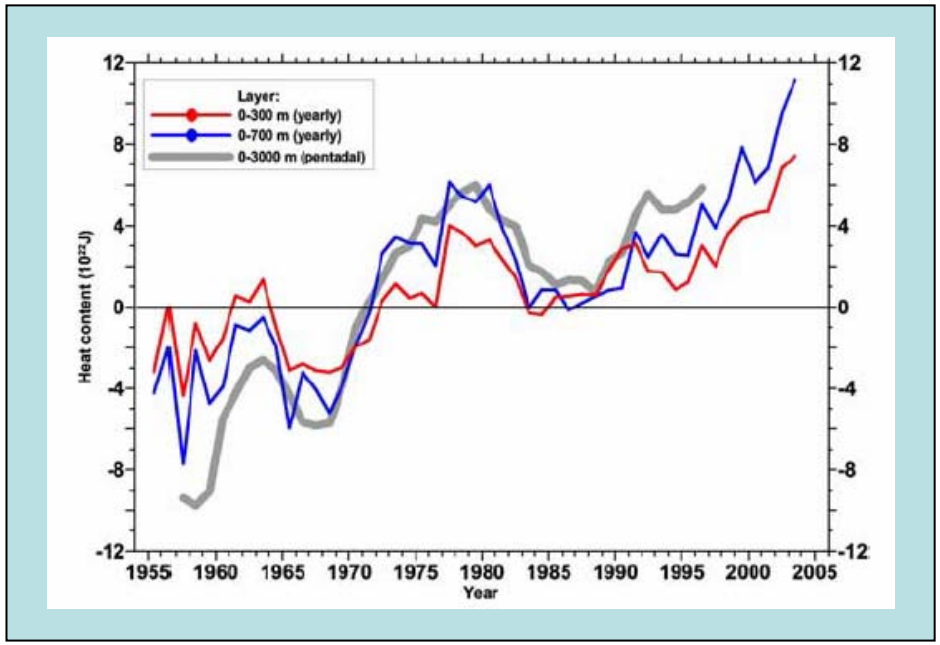
- 10 of 553 registered projects have “Pacific” but not “tropical” in their titles (www-pcmdi.llnl.gov/ipcc/diagnostic_subprojects.php)

AchutaRao et al. (2006), Variability of Ocean Heat Uptake: Reconciling Observations and Models, *Journal of Geophysical Research 111*, C05019, doi:20.2029/2005JC003136



Barnett et al. (2001), Detection of Anthropogenic Climate Change in the World's Oceans, *Science 292*, 270

Gray shadings: models
Dash-dot lines: observations



Levitus et al. (2005), Warming of the World Ocean, *Geophysical Research Letters 32*, L02604, doi:10.1029/2004GL021592

How are these reconciled?

Use GCM control runs "as a test bed for studying the effects of sparse space-varying and time-varying obsevational coverage . . . Subsampling model data at the locations of available observations increases the variability, reducing the discrepancy between models and observations."

Gleckler et al. (2006), Krakatoa Lives: The Effect of Volcanic Eruptions on Ocean Heat Content and Thermal Expansion, *Geophysical Research Letters 33*, 4, doi:10.1029/2006GL026771

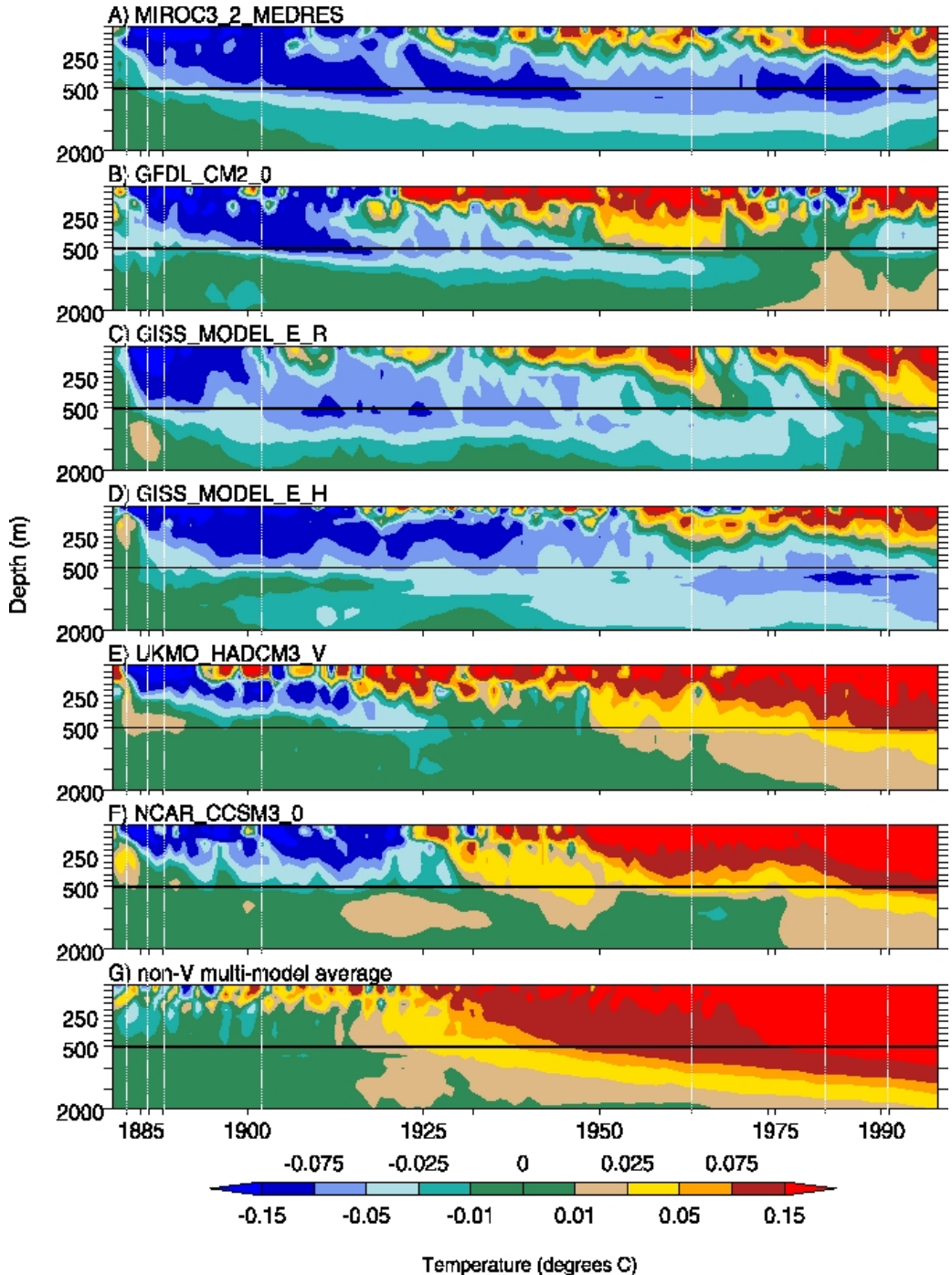


Figure 2. Changes in annual-mean global ocean temperature in degrees C as a function of depth in meters, in coupled model experiments with (a-f) combined anthropogenic and volcanic forcing and (g) in experiments with anthropogenic forcing only.