Comments on developments in climate science and modeling

P.C.D. Milly, USGS

Aspen Global Change Institute
Advanced climate modeling and decision-making in support of climate services
21 September 2009
Comments

• Priorities
• Information available, current and future
• Institutional framework
Priorities (Research Perspective)

• Understand climate system
  – What has happened and why
  – What will happen if…

• Communicate understanding
  – To scientific community (own field and others)
  – To public
  – To decision makers, elected and technical
  – To “climate-service providers”
The basic science is not over

- Agreed attribution of global/continental surface T.
- Unsettled attribution of hydrological trends in means: we could be missing something big.
- Highly immature science of extremes; regional to local responses.
- Immature science of hydrologic response under changing climate regime.
“There is high confidence that by mid-century, annual river runoff and water availability are projected to increase at high latitudes (and in some tropical wet areas) and decrease in some dry regions in the mid-latitudes and tropics. There is also high confidence that many semi-arid areas (e.g. Mediterranean Basin, western United States, southern Africa and north-eastern Brazil) will suffer a decrease in water resources due to climate change.”
IPCC, Synthesis SPM, 2007; high confidence = about 8 out of 10 chance of being correct, based on expert judgment.
Why distrust runoff projections?

- Based on imperfect models, with an incomplete (so far) detection and attribution of the historical record.
- Major wild cards:
  - Uncertainties in treated forcing factors
  - Untreated forcing factors
    - Land-cover change (e.g., secondary veg’n growth)
    - Water use
- Hence, only part of the story
What about model resolution?

• A technical path whose value appears promising.
• **Necessary condition** for confident projections at local scales.
• Will increased resolution change local (regional, global) model sensitivities? Or just resolve control climate better?
• Alone, not a **sufficient condition**. We cannot make a silk purse from a sow’s ear.
Some Ongoing GFDL Efforts (~AR5)

- Decadal predictability research
- High-resolution (25 km?), “time-slice” global atmosphere-land modeling
- Atmospheric chemistry and aerosol-cloud interactions modeling
- Interactive carbon-cycle and ecosystem modeling
- All of above using an advanced land model with dynamic veg’n, groundwater, lakes, rivers.
Information-Transfer Challenges

• The handshake problems:
  – Bias
  – Inconsistency of scales

• The overlap problem (e.g., P→ runoff)

• The feedback problem

• The problem of progress
Institutional Frameworks

• The basic science is not over
• → What not to do: Don’t kill the goose that lays the golden eggs.
• What to do: Harder to make a positive recommendation.
  – New entity –federal climate information provider-- that would (1) periodically (or continuously) engage climate researchers as expert consultants, a la IPCC, and (2) deliver distilled info to users?
  – Cut out the middle man: a more fluid system for exchange, training, engagement between producers and users of climate information.
  – Both approaches would require new resources.
canopy interception, throughfall, etc.

photosynthesis
carbon fluxes
dynamic vegetation

~5-layer snow pack

~20-layer soil
sat/unsat
frozen/unfrozen

plant phenology

fire

land clearance, wood harvesting
landscape-based groundwater divergence and saturated areas
~20-layer lake, with ice cover, snow pack

sub-grid partitioning of grid area
Applying Models of Global Climate Change to Natural-Resource Management
The Handoff Problem

“over the fence” (Stouffer)
“the loading dock” (Hirsch)

climate model → bias? scale? variables? consistency? → resource model
The Handoff Problem: A Solution?

climate model → data massage → resource model

(Who is the masseur/se?)
The Overlap Problem

- Climate model
- Resource model
The Feedback Problem

- climate model
- resource model

action
The Problem of Progress

climate model → refinement → extension

climate model → data massage → resource model

evolution → adaptation
In addition to exchanging *bits and bytes* of data, should we also exchange *bodies and brains*,

- training resource managers and scientists in climate science,
- training climate modelers in resource sciences and management,

by means of personnel details, scholarships, traineeships, residencies?