Water resources under climate change:
Resilience through adaptation & decision-making

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CLIMAS Climate Assessment for the Southwest

ARIZONA Institute of the Environment

Center for Climate Adaptation Science and Solutions

- Major findings – **water availability**
  - Each degree of warming decreases renewable water by 20% for additional 7% of population
  - In most dry subtropical regions: exacerbated competition for water among agriculture, ecosystems, settlements, industry and energy
  - Glacier-fed river flow to increase in next decades but decrease thereafter
- Major findings – **drought**
  - Dry regions: more meteorological droughts (less rainfall), more agricultural droughts (less soil moisture)

- Major findings – **flooding**
  - By end 21st century, three times more people exposed annually to current 100-year flood under very high emissions than low emissions
  - Flood frequency to increase more than magnitude; acute hazard in South, Southeast Asia; tropical Africa and Latin America
- Major findings – **water quality**
  - Drinking water quality risk even w/ treatment.
  - Erosion/sediment changes highly uncertain

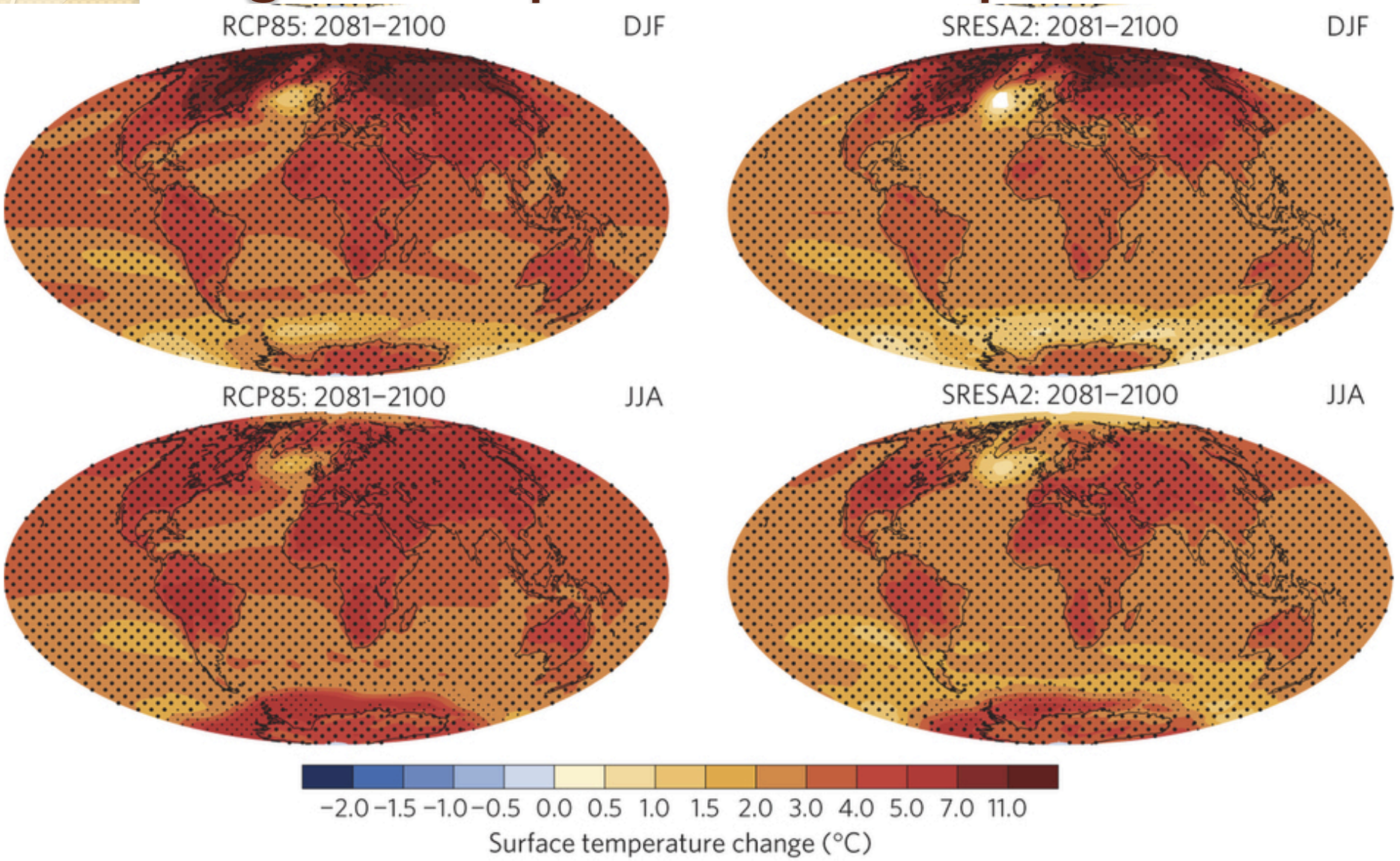
Adaptation, mitigation, sustainable development

- Greatest costs in developing countries, but many opportunities for adaptation
  - Est. cost to 2030: $531 billion (85%) in LDCs
- Adaptive management
  - Scenario planning, learning, flexible & no-regret solutions that are resilient
  - Surface water variability drives groundwater use
- Mitigation measures may imply water risks (bioenergy, hydropower, C capture)

Sectoral implications

- Agriculture
  - reduced water availability, food security risk
  - *inadequate attention to allocation, transfers*
- Energy
  - thermo-electric cooling, hydropower at risk
  - *energy portfolio planning poorly considered*
- Municipal supply and water reuse
  - focus on biophysical processes
  - *management & policy, infrastructure glossed over*
- Ecosystems at risk (next panelist D. Breshears)

Regional implications: temperature

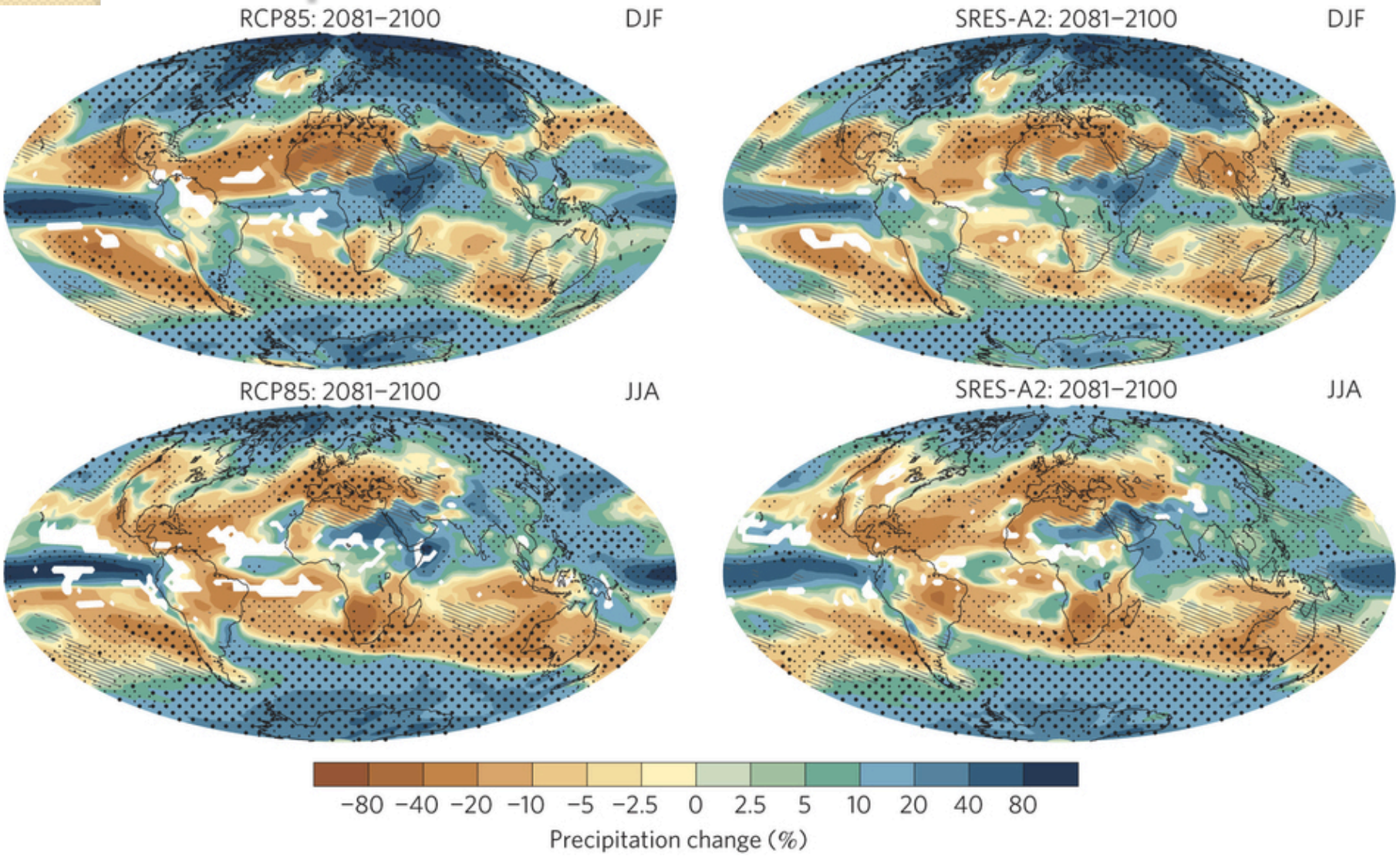


Robustness and uncertainties in the new CMIP5 climate model projections

Reto Knutti & Jan Sedláček

Nature Climate Change **3**, 369–373 (2013) | doi:10.1038/nclimate1716

Precipitation



Multi-model mean relative precipitation change for two seasons (December–February, DJF, and June–August, JJA) and two 20-year time periods centred around 2025 and 2090, relative to 1986–2005, for CMIP5 (left) and CMIP3 (right). Stippling marks high robustness, hatching marks no significant change and white areas mark inconsistent model responses (see Methods and Supplementary Figs S2 and S3).

Regional implications

- U.S. Southwest
  - "Next bucket" water augmentation thinking is not adaptive; must address demand, energy, ecosystems
- Arid Americas
  - Rapidly rising groundwater use - demand management?
  - Hydropower tradeoffs - carbon neutral vs. displacement
- South and Southeast Asia
  - Human drivers (demand growth) outweigh biophysical drivers (hydro-climatic variability)
  - Food security risks
- Sub-Saharan Africa - agriculture, pastoralism at risk

Research, data gaps & UA expertise

- Adaptation to hydrology, water-resource changes
- Economic impacts and their mitigation
- Water sector as social-ecological system
  - Human security, vulnerability
  - Institutions, social movements
- Coupled sectors
  - water – energy – food – ecosystems

Thanks
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