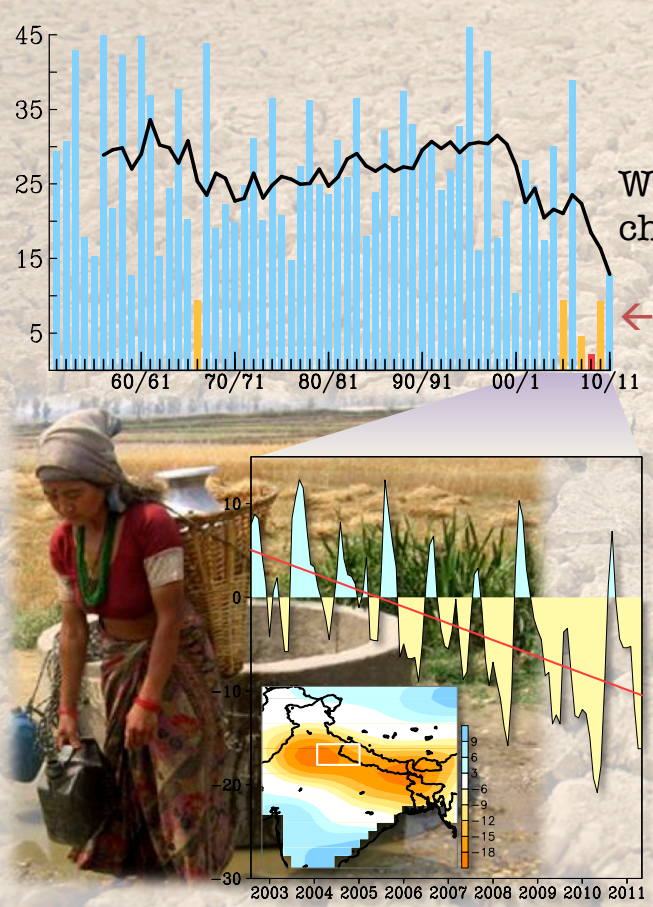
Severe winter droughts and groundwater decline in the Indo-Gangetic Plain



Winter precipitation change in west Nepal

← recent droughts

GRACE observed groundwater depletion

The Indo-Gangetic Plain has experienced consecutive and worsened winter droughts since 2000 culminating in a severe drought episode during 2008-2009. These recent spells of drought are symptomatic of both natural variability and anthropogenic influences including (1) the Arctic Oscillation and its decadal variability, (2) warming of the southern Indian Ocean, and (3) increased loading of anthropogenic aerosols. Given that winter precipitation has declined to near zero while groundwater has hardly been replenished, appropriate management of the region's water resources is critical.

Wang, S.-Y., J.-H. Yoon, R. R. Gillies, and C. Cho, 2013: What caused the winter drought in western Nepal during recent years? *Journal of Climate*, doi: 10.1175/JCLI-D-12-00800.1

Effects of Satellite Observing System Changes on NASA Reanalysis Water and Energy Fluxes

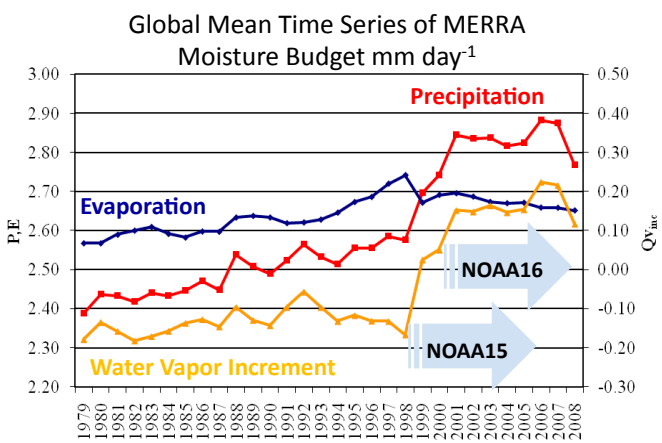
NASA Energy and Water Cycle Study

Pete Robertson (MSFC) and Mike Bosilovich (GSFC)

Robertson, F. R., M. G. Bosilovich, J. Chen and T. L. Miller, 2011: The effect of satellite observing system changes on MERRA water and energy fluxes. J. Clim. (submitted to MERRA special collection).

MERRA – the ***M***odern-***E***ra ***R***etrospective analysis for ***R***esearch and ***A***pplications is NASA's data assimilation methodology for integrating Earth Observations into a coherent estimate of the evolving state of the planet's atmosphere and land surface.

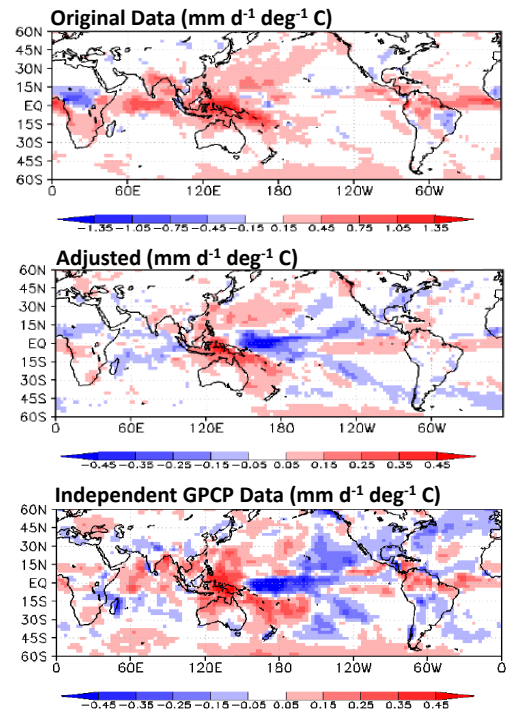
- Every 6h in the evolving global forecast, the model projections are compared to available observations.
- Model departures from observations (increments) are saved and used as additional forcing terms in the dynamical equations. *Thus the model state solution is constrained to be consistent with observations…*



… but time-dependent biases in water and energy fluxes result from evolving satellite observing system measurement capabilities interacting with less than perfect physics in the NASA GEOS-5 assimilation model.

Adjustment strategy via Principal Component Analysis removes spurious signals and enables broader use of MERRA data set by science user community.

Leading Mode of Decadal Precipitation Variability



Investigation of Recycling Rate of Moisture in the Atmosphere From Observation and Model

PI: Xun Jiang (UH); Co-I: Yuk Yung (Caltech); Collaborator: Liming Li (UH)

Science issue: Better understand the hydrological cycle as a response to global warming. Quantitatively simulate the precipitation trend in order to predict the variation of precipitation in the future.

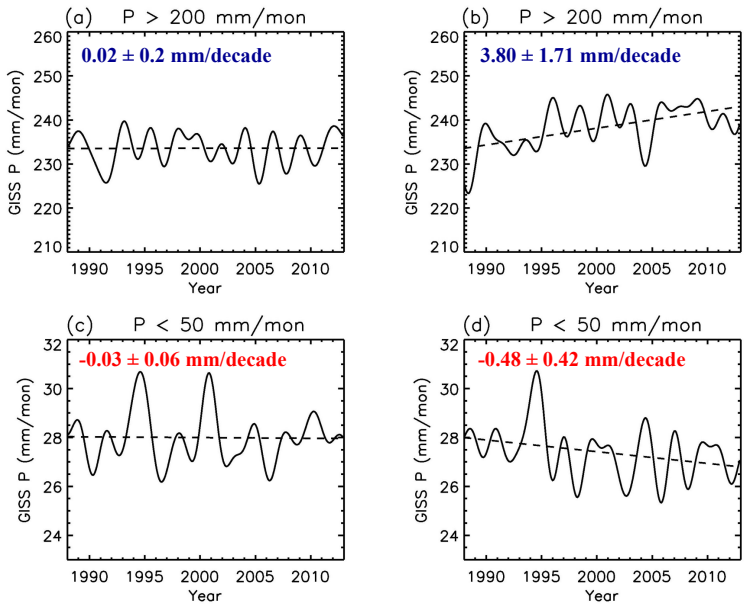


Figure 1: Lowpass filtered time series for precipitation (P) from GISS-HYCOM. (a) P over high-precipitation (P > 200 mm/mon) from the control run (solid line) and trend (dashed line). (b) P over high-precipitation area from the historic run (solid line) and trend (dashed line). (c) Same as (a) except for areas with precipitation < 50 mm/mon. (d) Same as (b) except for areas with precipitation < 50 mm/mon.

Results: Based on the long-term (1988-2012) GPCP precipitation data set, our observational study revealed that the precipitation increased over the wet area (*i.e.*, monthly precipitation > 200 mm) and decreased over the dry area (*i.e.*, monthly precipitation < 50 mm) during the past two decades. Here, we further investigate whether the current atmospheric models can quantitatively capture the characteristics of precipitation from the observation. The NASA GISS model is used to examine the historic run of the precipitation, in which the historic greenhouse gases are included. The historic run can qualitatively capture the temporal trends of precipitation over the wet and dry areas. The observed trends of precipitation do not appear in the control run with the fixed concentrations of greenhouse gases, which suggests that the global warming due to the historic increase of the greenhouse gases can influence the temporal variations of precipitation over the wet and dry areas.

Significance: From the comparison between the historic and control runs, it suggests that the increasing greenhouse gas affects the temporal variation of precipitation, contributing to precipitation extremes.

NEWS value added integration:

This work was funded by NASA's Energy and Water Cycle Study program.

References:

Trammell, J. H., X. Jiang, L. Li, M. Liang, M. Li, J. Zhou, and E. Fetzer, Investigation of Precipitation over Wet and Dry Areas from Observation and Model. *Submitted to Environmental Research Letters*, 2013.