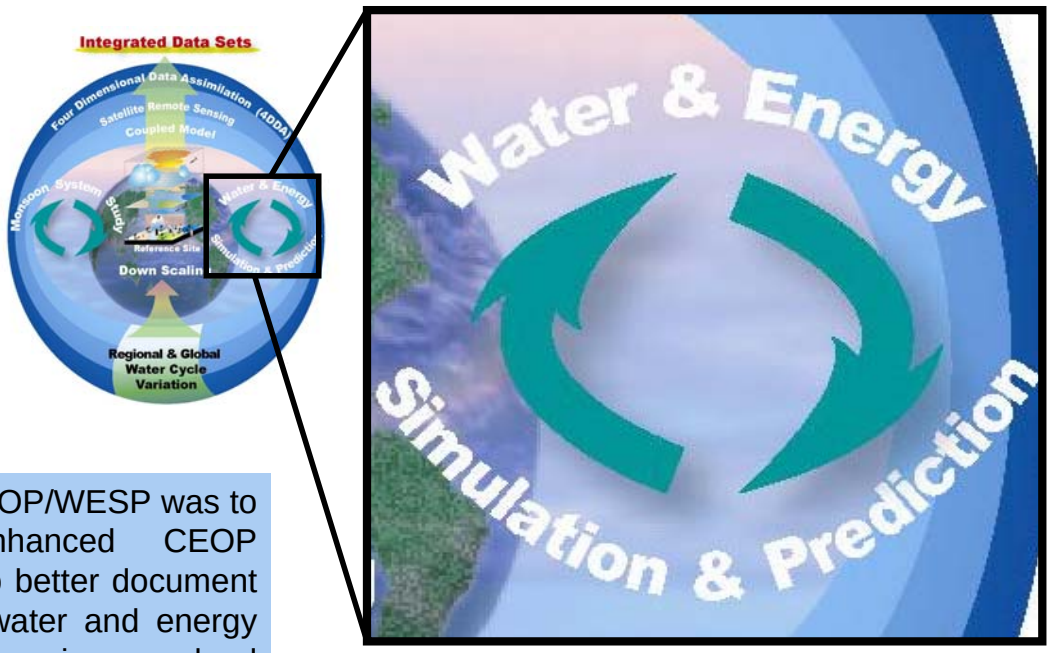
CEOP WESP

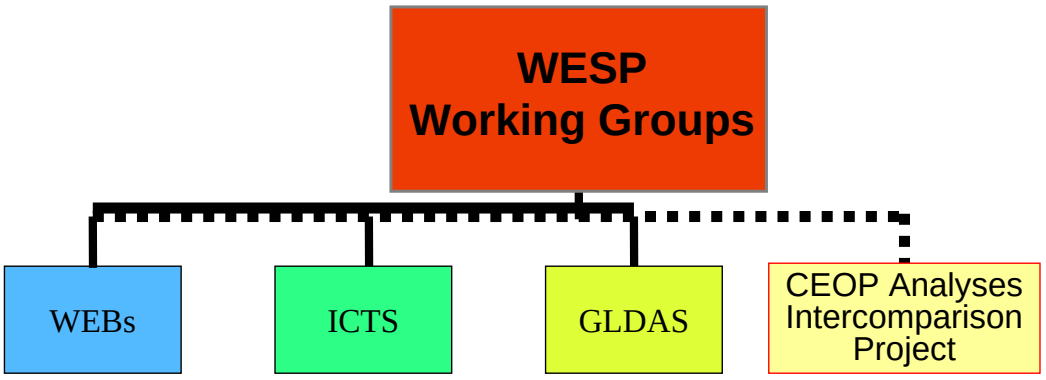
(Water & Energy Simulation and Prediction)



The goal of CEOP/WESP was to use the enhanced CEOP observations to better document and simulate water and energy fluxes and reservoirs over land on diurnal to annual scales

2006: WESP/Roads

WESP Working Groups



CEOP/WESP has therefore been conducting a pilot 3.5 year case study of regional and global observed and simulated water and energy budgets with global, regional, landsurface models.

2006: WESP/Roads

ECPC Contributions to WEBS

Alex Ruane, John Roads

Scripps Institution of Oceanography / UCSD

Ruane, A.C., and J.O. Roads, 2007a: Diurnal cycles of water and energy over the continental United States from three reanalyses. *J. Meteor. Soc. Jpn*, in press.

Ruane, A.C., and J.O. Roads, 2007b: 6-hour to 1-year variance of five global precipitation sets. *Earth Interactions*, in press.

Anderson, B.T., G. Salvucci, A.C. Ruane, J.O. Roads, and M. Kanamitsu, 2007: A new metric for estimating local moisture cycling and its influence upon seasonal precipitation rates. *J. Hydrometeorology*, submitted.

Ruane, A.C., and J.O. Roads, 2007b: Dominant balances and exchanges of the atmospheric water cycle in the Reanalysis-2. *J. Climate*, (in preparation)

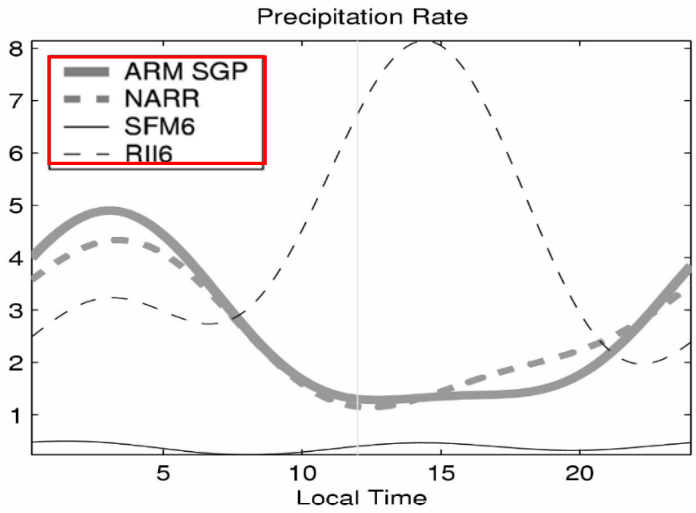
Ruane, A.C., and J.O. Roads, 2007b: Sensitivity of the water cycle's temporal characteristics to land-surface and convective parameterization schemes (in preparation)

Ruane, A.C, 2007: Temporal Variability of the Water Cycle. Ph.D Thesis. UCSD (in preparation)

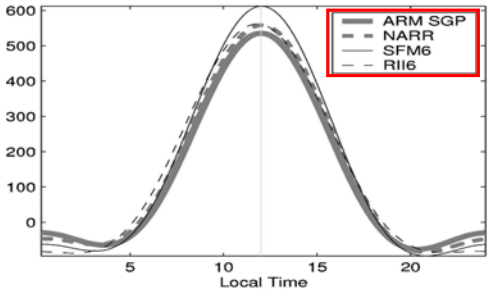
2006: WESP/Roads

Diurnal Variations

- Simulated diurnal cycle of precipitation at ARM SGP site shows wide variation
  - NARR assimilated precipitation matches observation
  - RII6 shows strong afternoon peak
  - SFM6 has low amplitude
  - Global analyses miss nocturnal peak
- Where do the models diverge in their response to the diurnal radiative forcing?

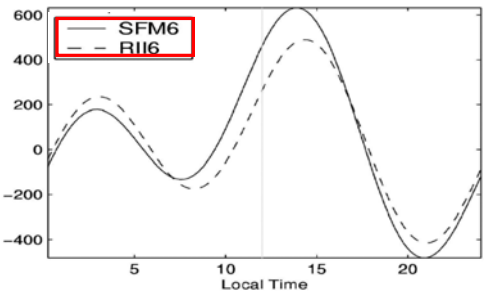


Net Radiation



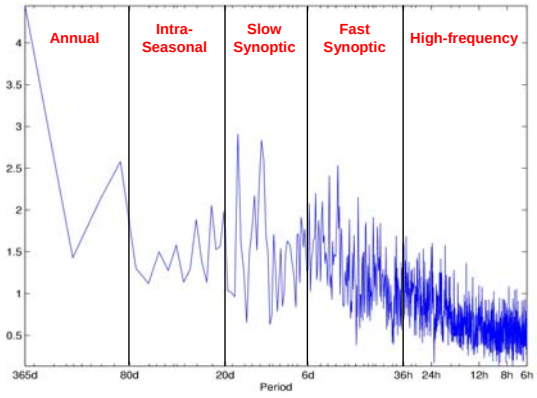
- Diurnal variation in reservoirs of water and energy are large

Total Dry Energy

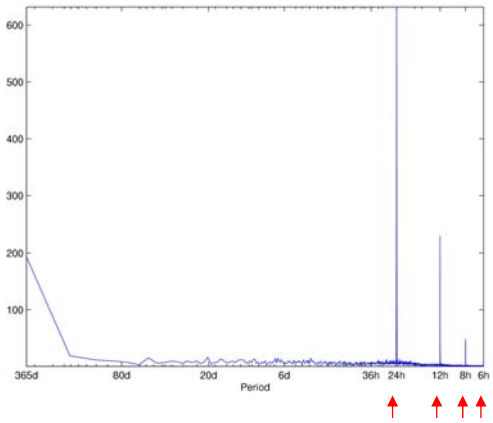


Temporal Spectral Variations

Darwin, Australia, Precipitation



Darwin, Australia, Surface SW Radiation



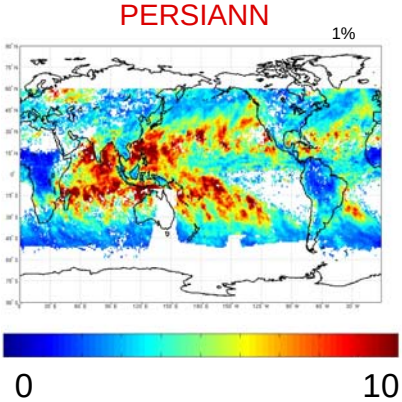
- Performed fast-Fourier transform on three annual 3-hourly time series
  - Corresponds to the end of the Coordinated Enhanced Observing Period (2002-2004)
  - Compared data between two global reanalyses and three high-resolution precipitation products (TRMM 3B-42, PERSIANN, and 2003-2005 CMORPH)
  - Divided spectral variance density into 6 comprehensive variance categories
    - Annual (80d – 1y), Intraseasonal (20d-80d), Slow Synoptic (6d-20d), Fast Synoptic (36h – 6d), High-frequency (6h – 36h), and Diurnal (as determined by response to radiation)

2006: WESP/Roads

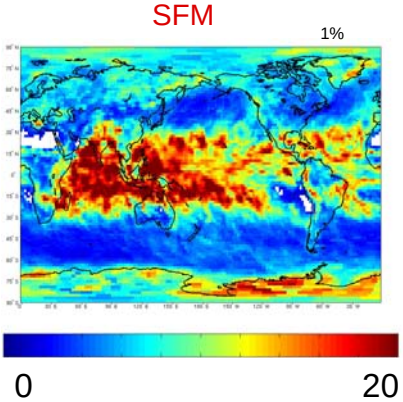
Temporal Spectral Variations

Intraseasonal (20-80 days) variance

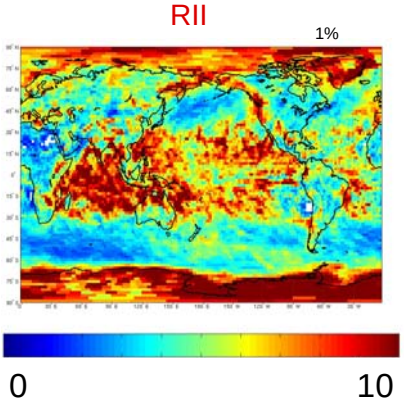
PERSIANN



SFM



RII



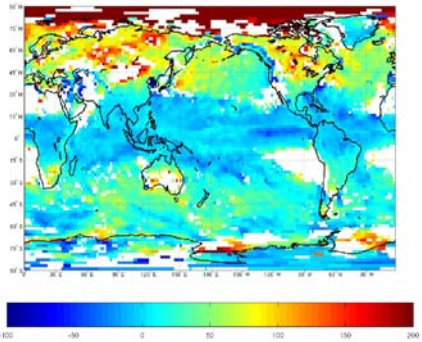
- Convective parameterizations have mixed results in intraseasonal frequency
  - Relaxed Arakawa-Schubert scheme produces ~double the low-frequency variances over the tropics (at the expense of high-frequency variance)
  - SFM also misses the dynamic excitation of the Rossby wave trains
  - Many features captured well by reanalyses (e.g. monsoons, ITCZ, Hadley circulation)
  - Lots of unique regional and temporal behaviors to explore

2006: WESP/Roads

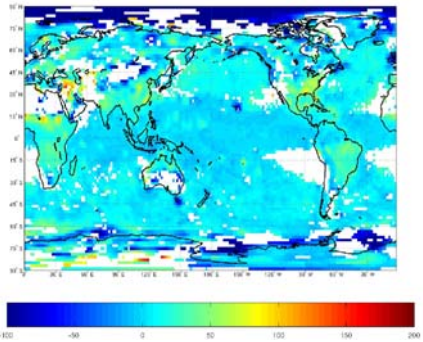
Ongoing and Future Work

- Evaluation of the dominant balances and exchanges of the atmospheric water cycle in the NCEP/DOE Reanalysis-2

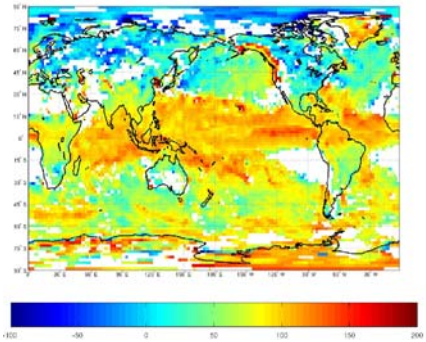
Annual Covariance of Evaporation with Precipitation



Annual Covariance of **Negative** Precipitable Water Tendency with Precipitation



Annual Covariance of Vapor Flux Convergence with Precipitation



- Examinations of the temporal variability of the water cycle's sensitivity to pairings of land-surface schemes and convective parameterizations

2006: WESP/Roads

Comparison of Energy and Water Balance Terms During CEOP EOP-3/4 from Reanalyses and NASA/GSFC GEOS-5 against both in situ Reference Site and Global-scale Observations

David M. Mocko* & Michael G. Bosilovich

NASA Goddard Space Flight Center

Global Modeling and Assimilation Office

Alexander C. Ruane & John O. Roads

UCSD/Scripps Institution of Oceanography

Experimental Climate Prediction Center

*Additional Affiliation: SAIC

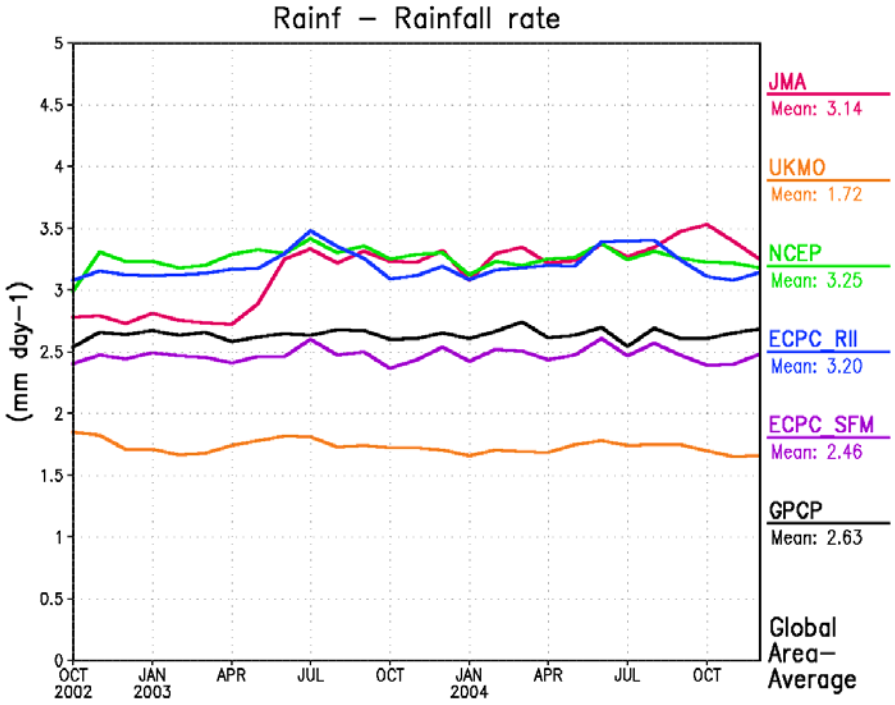
Model data during EOP-3/4

- EOP-3/4 from 1 Oct 2002 to 31 Dec 2004
- **JMA = Japan Meteorological Agency**
- **UKMO = United Kingdom Met Office**
- **NCEP = NOAA National Centers for Environmental Prediction (Operational)**
- **ECPC = Experimental Climate Prediction Center**
  - **RII = NCEP/DOE Reanalysis II**
  - **SFM = NCEP seasonal forecast model**

Analysis methodology

- Centers provided 6-hourly data (3-hourly for ECPC) for 27 months (2 annual/water years)
- Monthly and daily means were generated
- Global and zonal-averages were examined
- Comparisons were made to available global-scale observations and analyses, as well as to CEOP in situ reference site data
- JJA2004 NAME period/region studied

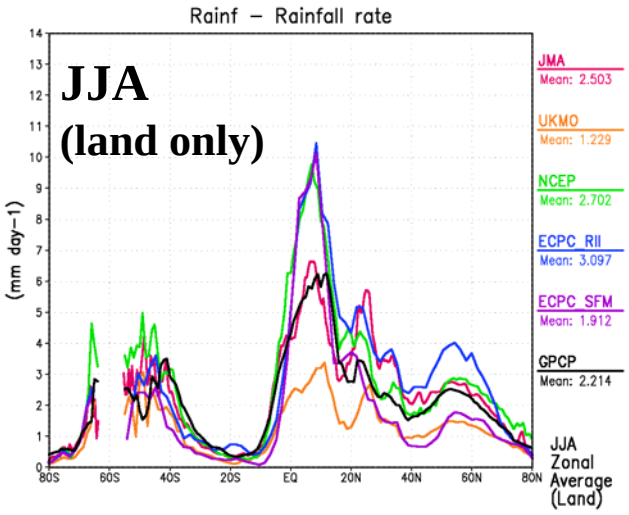
Globally-averaged Precipitation

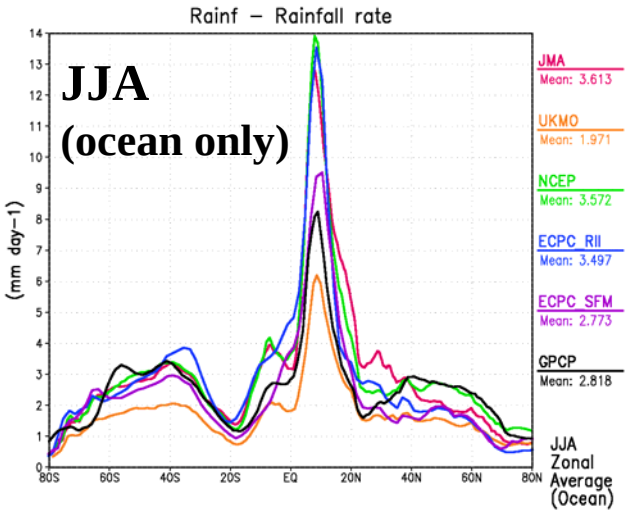


Monthly-averaged values show three of the centers are higher than GPCP while **UKMO** has the lowest precip.

GPCP = Global Precipitation Climatology Project; blend of gauges & satellite estimates of rain

Zonally-averaged Precipitation





Each center uses its own land/ocean mask; NCEP and ECPC tend to have too much precipitation over land and ocean, UKMO tends to have too little precipitation (ensemble mean will turn out to be most comparable to obs?)

Future Work

- Add other reanalyses as they become available (CPTEC/MSC/GLDAS/etc.)
- Multi-model analysis (*e.g.*, “hot spots”)
- Further monsoon and SST studies (Lau/Kim)
- SGP surface heterogeneity (CREW/Houser)
- Evaluation of GEOS5-MERRA as data is produced
- Data available on GrADS-DODS server

Inter-CSE Transferability Study (ICTS)

B. Rockel, J. Roads, I. Meinke, W. J. Gutowski
C. Jones, B. Geyer, G. Takle

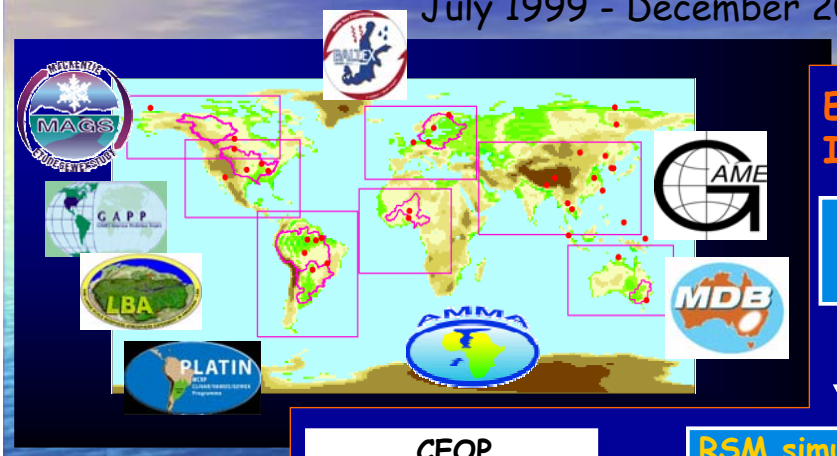
Study the performance of regional climate models over different CSE’s (i.e. for different climate regimes)

using CEOP (Satellite, Reference sites, global analysis and model data) and other available observational data sets

CLM (Climate version of the “Lokalmodel”) / GKSS, BALTEX
RSM (Regional Spectral Model) / ECPC, GAPP
RegCM3 (Regional Climate Model) / ISU, GAPP
MM5 (Mesoscale-Model) / ISU, GAPP
GEM-LAM (Global Environmental Multiscale Limited Area Model) / RPN/MSC and UQ, MAGS
CRCM (Canadian Regional Climate Model) / OURANOS, MAGS
RCA3 (Rossby Centre Atmosphere version 3) / SMHI, BALTEX
C-CAM (Conformal Cubic Atmospheric Model) / CSIRO, MDB

Experiment setup

Two long term simulations over 7 domains (taken from 8 CSEs)
July 1999 - December 2004



ECPC contribution for ICTS is complete:

NCEP RII → Global Analysis

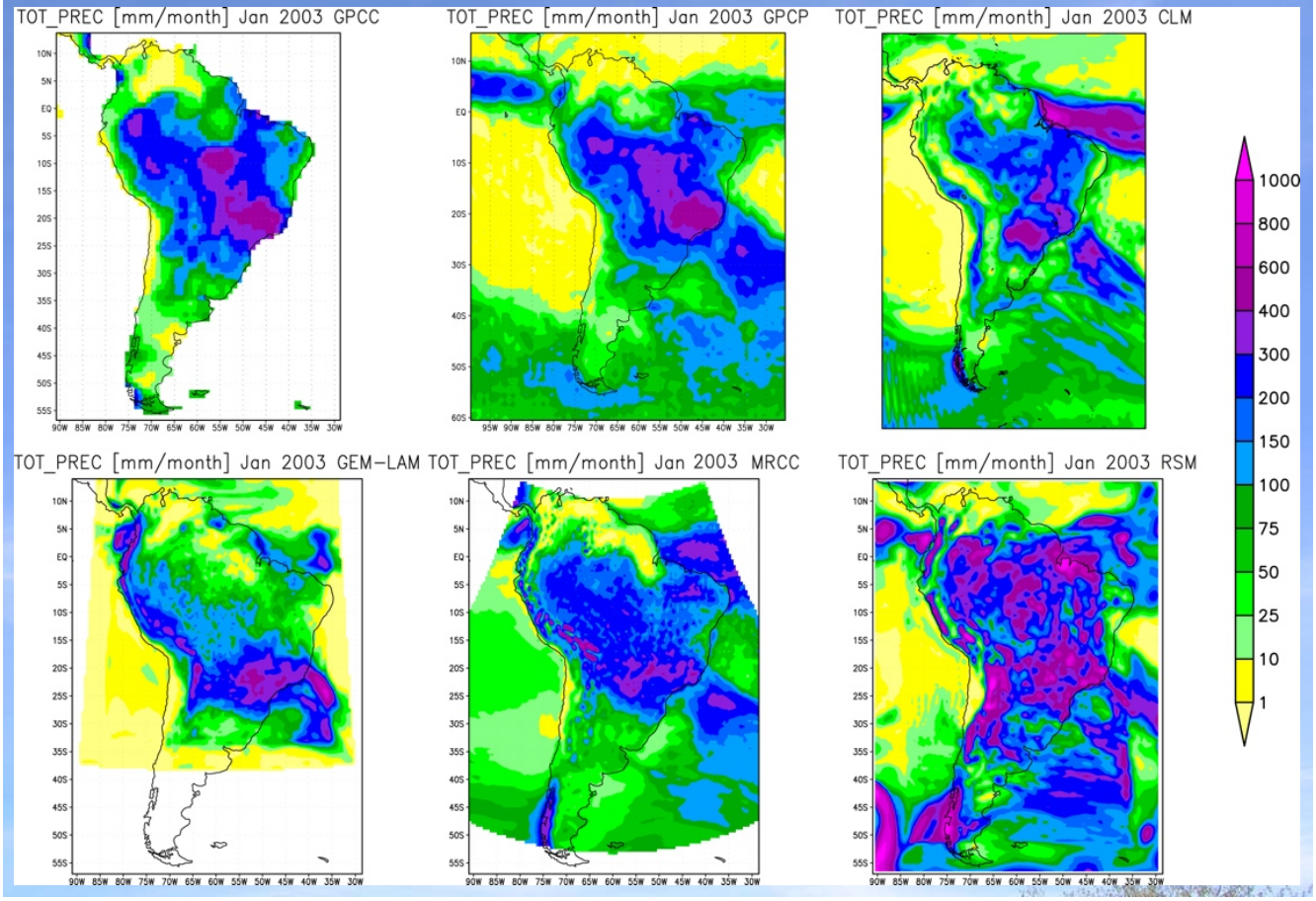
RSM simulations over 7 domains (CSEs) → Model simulations

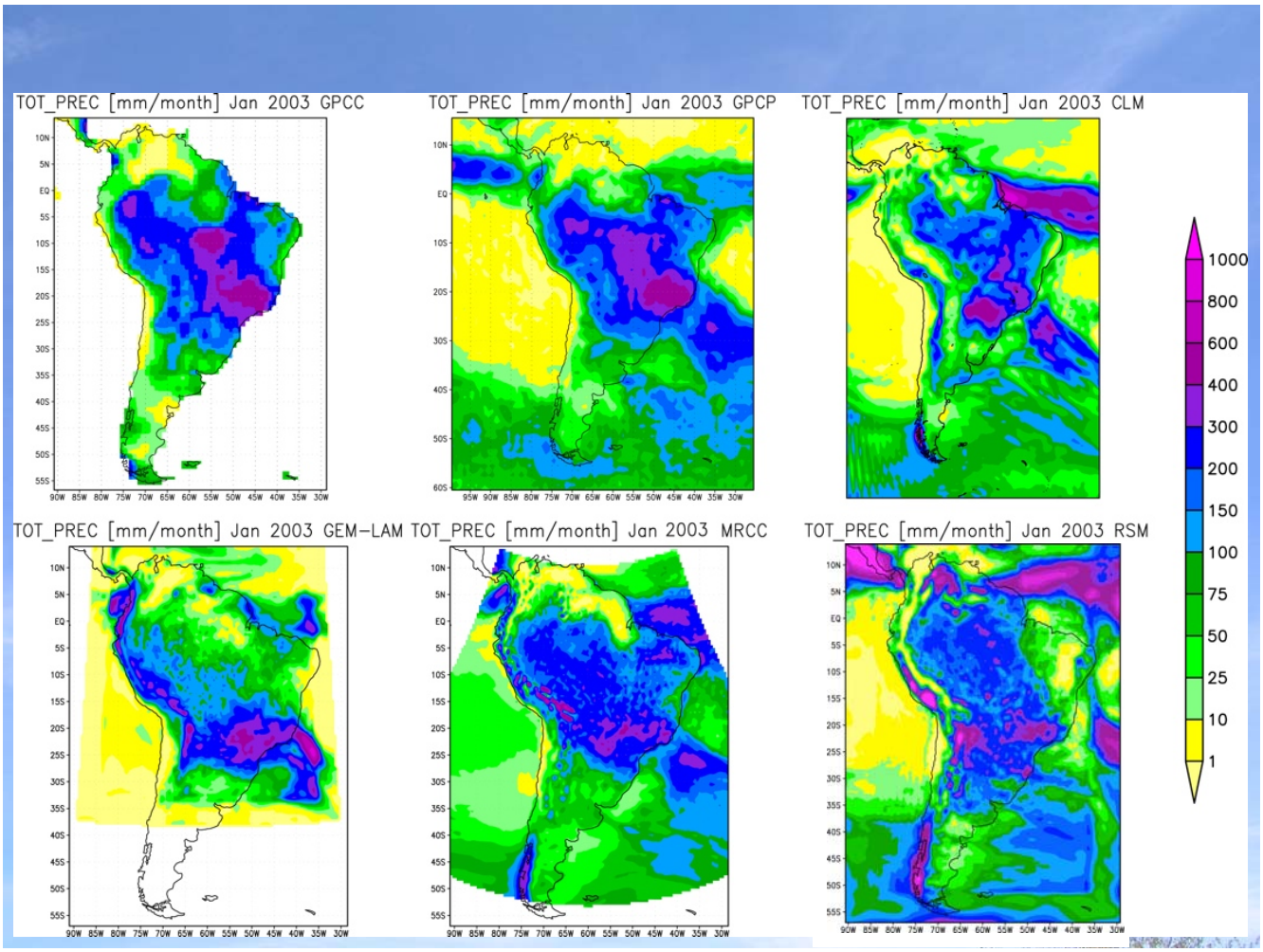
CEOP Model Data Archive

Common grid and data format (CF-netCDF)

Observations:
- CEOP Reference Site Data
- Global observations: GPCP, GPCC, ISCCP

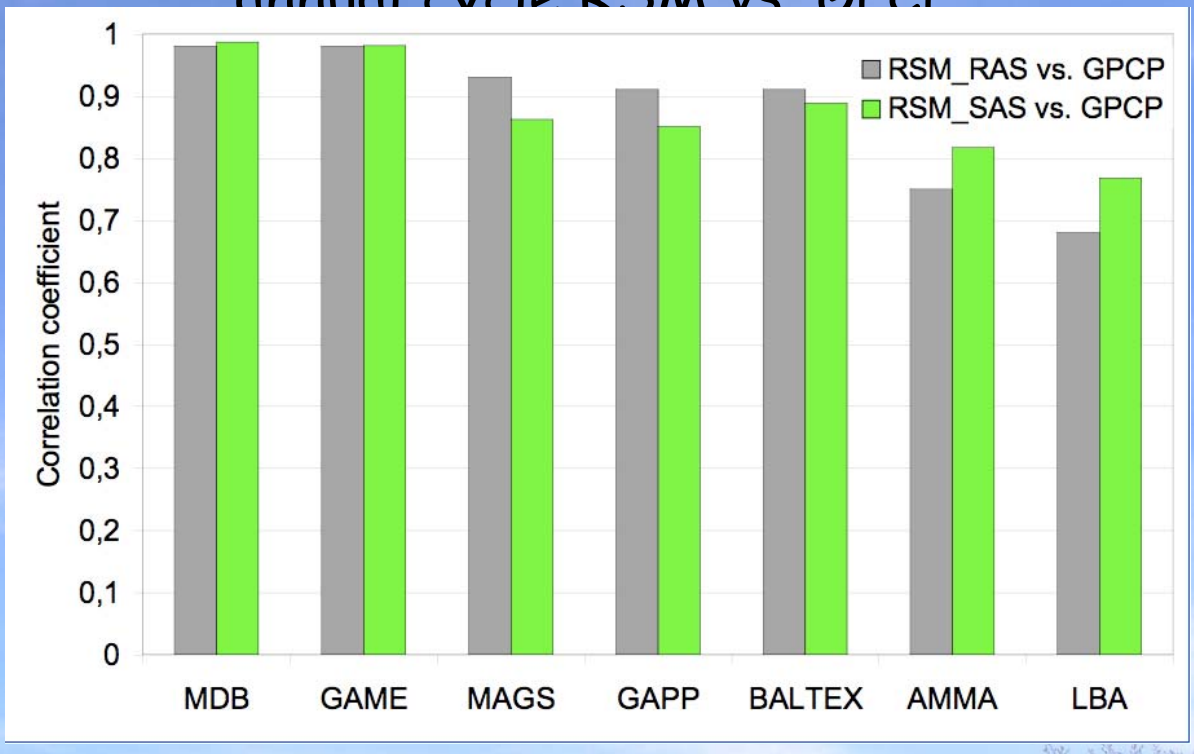
ECPC transferability experiments: RSM evaluation over 7 domains





Correlation coefficient precipitation

annual cycle RSM vs. GPCP



Conclusion

- RSM simulated precipitation has been evaluated under various meteorological conditions.
- Positive biases were identified over most domains, except for BALTEX.
- Sensitivity tests with 4 different convection schemes indicates that RSM with the SAS convection scheme causes the smallest accumulated bias.
- Second set of RSM long term runs with the SAS scheme was carried out.
- Major improvements were identified for the LBA domain.
- The annual cycle of precipitation over AMMA and LBA was also improved.
- These findings were consistent with the GCM analysis comparisons of RII (SAS) and SFM (RAS).

WESP-GLDAS

Matt Rodell, Christa Peters-Lidard, Hiroko Kato, and Ben Zaitchik

Hydrological Sciences Branch

NASA Goddard Space Flight Center

Land Data Assimilation System Heritage

North American LDAS

- NOAA/NCEP, GSFC/HSB, and 6 other institutions
- Central North American domain, 1/8° resolution
- Spin-offs: GLDAS, NLDAS-E
- Ref: Mitchell et al., *J. Geophys. Res.,* 2004

Global LDAS

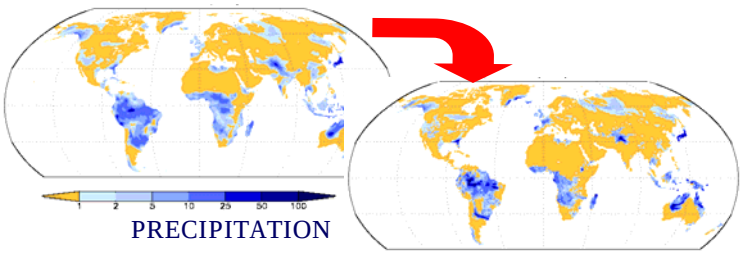
- NASA/IDS Project began in 2000; now supported by NASA/NEWS
- GSFC/HSB and NOAA/NCEP partnership
- Global domain (60° S-90° N), 1/4° and 1° resolutions
- Spin-offs: LIS, South American LDAS
- Ref: Rodell et al., *Bull. Amer. Meteor. Soc.,* 2004

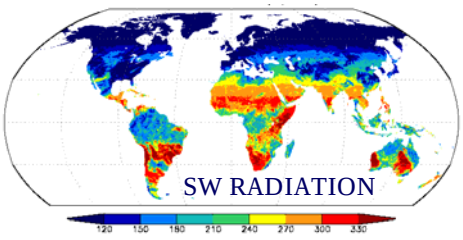
Land Information System (LIS)

- NASA/HPCC project began in 2002; multiple partners
- Global domain (60° S-90° N), resolutions as fine as 1 km
- Software adopted by all other NASA LDAS projects
- Ref: Kumar, Peters-Lidard, et al., *Environ. Model. Soft.,* 2006

Data Integration in GLDAS

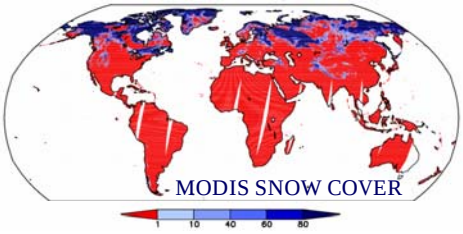
INTERCOMPARISON and OPTIMAL MERGING of global data fields

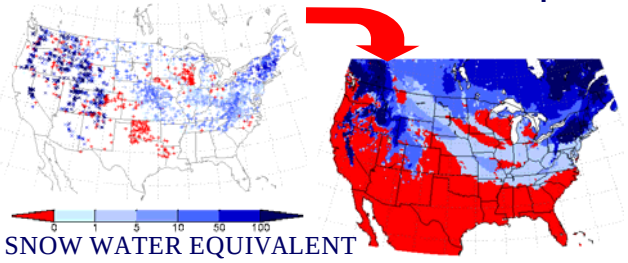




Satellite data products used to PARAMETERIZE and FORCE sophisticated land surface models

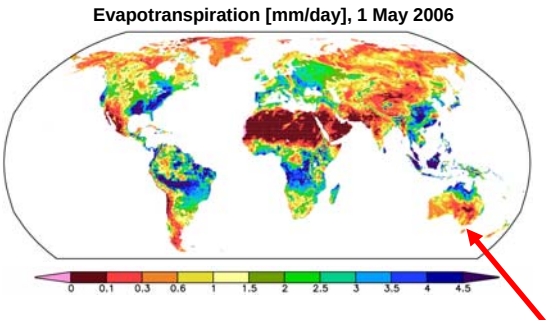
ASSIMILATION of satellite based land surface state fields (snow, soil moisture, surface temp, etc.)

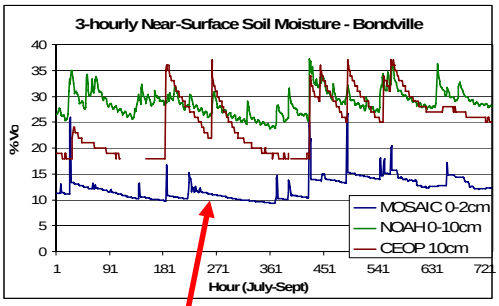




Ground-based observations used to EVALUATE model output

GLDAS Output for CEOP





Land Surface Model	Earth Observation Period	Resolution	Grids	MOLTS	MODIS snow cover assimilation
Noah 2.7.1	1-4	0.25°	✓	✓	
Noah 2.7.1	1-4	0.25°	✓	✓	✓
Noah 2.7.1	1-4	1°		✓	
CLM2	1-4	1°		✓	
Mosaic	1-4	1°		✓	

GLDAS water and energy budget output fields provided to CEOP data center at MPI

Matt Rodell
Hydrological Sciences Branch, NASA GSFC

Summary

- GLDAS = Global Land Data Assimilation System
- Drives multiple land surface models globally at 1/4° resolution using Land Information System (LIS) software
- Massive archive of land surface and met datasets
- Integrates data from multiple sources as through optimal merging, forcing, parameterization, assimilation, and validation
- Output available to CEOP and international community
- Recent thrusts include assimilation of MODIS snow cover and GRACE water storage data; simulating irrigation; sensitivity studies; precipitation forcing evaluation
- More info: Rodell et al., *BAMS,* 2004; http://ldas.gsfc.nasa.gov/

WESP in CEOP Special Issue, JMS, Feb. 2007

Modeling of surface flux in TongYu using the Simple Biosphere Model 2 (SiB2)

Simulation of CO2 and Sensible/Latent Heat Fluxes Exchange between Land Surface and Atmosphere over Cropland and Grassland in Semi-Arid Region

Characteristics and Controlling Factors of Regional-scale Surface Soil Moisture Variability over Semi-arid grassland in Mongolia

Water and CO2 Fluxes over a Cropland and Degraded Grassland surfaces in the Semi-arid Area in Tongyu Northeastern China

Skin Temperature Analysis and Bias Correction in a Coupled Land-Atmosphere Data Assimilation System

Modification and Application of the Satellite Based Land Data Assimilation Scheme for Very Dry Soil Region Using AMSR-E Images: Model Validation at Mongolia - A CEOP Data Platform

The Diurnal Cycle of Water and Energy over the Continental United States from Three Reanalyses

Development and Validation of a New Land Surface Model for the JMA's Operational Global Model Using the CEOP Observation Dataset

Global Evaluation of the RSM Simulated Precipitation through Transferability Studies during CEOP

CPTEC GCM and Eta Moel Verifications against Rondonia Reference Site in Brazil

Evaluation of Surface Water and Energy Cycles in the Met Office Global NWP Model using CEOP Data

Assimilating Passive Microwave Brightness Temperature Data into a Land Surface Model to Improve Predictability of Snow Properties

Assessing water and energy budgets for the Saskatchewan River Basin

Numerical Analysis for Water Vapor Transport in the case of Synoptic-scale Passing Trough Disturbance over the Tibetan Plateau

A comparison of some surface variables in the BMRC MOLTS with CEOP in-situ data for EOP3

Improved local atmospheric simulation by a coupled land–atmosphere satellite data assimilation system

An Auto-calibration System to Assimilate AMSR-E Data into a Land Surface Model for Estimating Soil Moisture and Surface Energy Budget

CEOP-based Diagnosis of Prediction Skill of Four Operational GCMs and One Land Data Assimilation System

Simulation of the Land-Atmosphere Interactions on the Tibetan Plateau: II. Evaluation of Penn State/NCAR Mesoscale Model, MM5

Water Vapor Flow into the Atmosphere over the Tibetan Plateau

A Basic Study on Coupling a Distributed Hydrological Model and a Land Surface Scheme

2006: WESP/Roads