Drought Monitoring and Prediction via CPPA Partnership in the North American Land Data Assimilation System (NLDAS)

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Partnering CPPA Pls:
Eric Wood – Princeton U.
Brian Cosgrove – NASA/GSFC/HSB
Dennis Lettenmaier – U. Washington
Rachel Pinker – U. Maryland
Kingtse Mo – NCEP/CPC
Huug van den Dool – NCEP/CPC
Pedro Restrepo – NWS/OHD

CPPA Pls Meeting
01 October 2008
This partnership is an example of transition of CPPA research to NCEP operational prototype.

Operational prototype is a robust demonstration step before formal operational implementation.
CPPA Partners for Drought Monitoring and Seasonal Prediction

- **U.Washington**
  - D. Lettenmaier, A. Wood, T. Bohn
  - Multi-decadal retrospective NLDAS
- **Princeton U.**
  - E. Wood, L. Luo, J. Sheffield
  - Seasonal prediction with three methods
- **NASA/GSFC HSB**
  - B. Cosgrove, C. Alonge, D. Mocko
  - Land surface forcing from NARR, drought monitor web site
- **NWS Office of Hydrologic Development (OHD)**
  - P. Restrepo, J. Schaake, V. Koren
  - SAC model and precipitation analysis
- **NCEP/EMC** (EMC colleagues developed and executed the NARR)
  - K. Mitchell, Y. Xia
  - Transition of CPPA PI NLDAS research to operational prototype at NCEP
- **NCEP/CPC**
  - User applications (especially in CPC), realtime NARR extension, precip analysis
- **NIDIS Drought Portal (drought.gov)**
Two Parts to this Presentation

- Drought Monitoring:
- Drought Prediction: Seasonal
Drought Monitoring with NLDAS: N. American Land Data Assimilation System

• Uncoupled land model simulations
  – Four land models: Noah, VIC, Mosaic, SAC
• CONUS domain
  – 1/8th degree resolution
• Common land surface forcing
  – hourly and 1/8th degree
  – Jan 1979 to present realtime
• Retrospective mode (finished for 3 of 4 land models)
  – 15-year spin-up
  – 28-year climatology for each land model (1980-2007)
• Realtime mode
  – within about 3 days of current time
  – depict conditions as anomalies and percentiles from climo
NLDAS Forcing Generation:

- **Precipitation Forcing:**
  - Anchored to CPC daily gauge-only precipitation analysis with PRISM
    - Applies analysis algorithm of John Schaake of OHD
    - Performed directly on 1/8th-degree NLDAS grid
  - Partitioned to hourly using hourly Stage II Doppler radar estimates, CMORPH, and hourly gauge data to develop temporal weights
    - Temporal partitioning developed by NASA/GSFC/HSB

- **Non-precipitation forcing: NARR- based**
  - Developed by NASA/GSFC/HSB
  - Source is NARR data base (3 hourly, 32km, 1979 – Present)
  - Bias correction of hourly downward shortwave radiation using 5 years of GOES shortwave retrievals of CPPA PI Rachel Pinker
  - Elevation correction for temperature, pressure, humidity, and downward longwave radiation based on standard lapse rate of T
Details and Instructions in NCEP Official Website, Please see the poster from Y. Xia et al.

NLDAS Drought Forecast will be added in this website in the future
Total Column Soil Moisture Anomaly: recent month ending 24 Sep 08
3 Models and their Ensemble Mean

Noah - Past Month Total Column Soil Moisture Anomaly (mm)
Valid: SEP 24, 2008

Mosaic - Past Month Total Column Soil Moisture Anomaly (mm)
Valid: SEP 24, 2008

SAC - Past Month Total Column Soil Moisture Anomaly (mm)
Valid: SEP 24, 2008

Ensemble-Mean - Past Month Total Column Soil Moisture Anomaly (mm)
Valid: SEP 24, 2008
Total Column Soil Moisture Percentile: recent month ending 24 Sep 08
3 Models and their Ensemble Mean

Noah - Past Month Total Column Soil Moisture Percentile
Valid: SEP 24, 2008

Mosaic - Past Month Total Column Soil Moisture Percentile
Valid: SEP 24, 2008

SAC - Past Month Total Column Soil Moisture Percentile
Valid: SEP 24, 2008

Ensemble-Mean - Past Month Total Column Soil Moisture Percentile
Valid: SEP 24, 2008
Total SM Anomaly (mm): Temporal Evolution

**Noah**
- JUL 07
- OCT 07
- JAN 08
- FEB 08

**Mosaic**
- JUL 07
- OCT 07
- JAN 08
- FEB 08

**SAC**
- JUL 07
- OCT 07
- JAN 08
- FEB 08

Colorbar: -100 to 100
FEB 2008 SWE Anomaly (mm)

(a) Noah SWE Anomaly (mm)

(b) Mosaic SWE Anomaly (mm)

(c) SAC SWE Anomaly (mm)

(d) Multi-Model SWE Anomaly
Seasonal Drought Prediction

Transition three uncoupled seasonal prediction methods from Princeton University:

http://hydrology.princeton.edu/forecast
Princeton University Hydrological Seasonal Forecast System

**Current Time-Multimethods Single Model Forecast System**

- CFS
- CPC
- ESP

20 Member Forcing for Each Method → VIC → 20 Member Output for Each Method and Ensemble Forecast Products

**Future-Experimental Multimethods and Multimodels Forecast System**

Extend Single Model VIC into Four Models:

**Long-Term-Matured Multimethods and Multimodels Forecast System**

- Climate Testbed
- Multiple Climate Models: CFS, ECMWF, UKMET, NASA, GFDL, NCAR
- Land Surface Forcing
- Conditional ESP
Princeton Seasonal Hydrological Forecasts: Developed for 13 Individual Basins
Precipitation Anomaly Seasonal Forecast (Initialized early Sep): **Ohio Basin**
Soil Moisture Anomaly Seasonal Forecast (Initialized early Sep): Ohio Basin
Soil Moisture Seasonal Forecast for Nov 08 (Initialized early Sep): Ohio Basin

Total Column Soil Moisture (mm) NOV2008 (Init: 200809)

Actual Value  Anomaly  Percentile  Forecast Probability: for Above or Below Normal
Seasonal Streamflow Forecast: Ohio Basin for four separate sub-basin outlet points

Vertical box: 25-75% quantile Background color shows climate range
A far reaching partnership among multiple CPPA PIs has succeeded in developing a prototype CONUS hydrological monitoring and seasonal prediction capability, with a focus on drought, that has been transitioned to NCEP and is executing in pre-implementation demonstration mode.