Toward Improved Land Surface Initialization in Support of Regional WRF Forecasts at the Kenya Meteorological Service (KMS)

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Talk Outline

International collaborating organizations
- NASA Short-term Prediction Research and Transition (SPoRT)
- NASA SERVIR / SERVIR-Africa
- Regional Center for Mapping of Resources for Development (RCMRD)
- Kenya Meteorological Service (KMS)

Experiment design / modeling & verification tools
- NASA Land Information System (LIS)
- Weather Research and Forecasting (WRF) model
- Model Evaluation Tools (MET) & SPoRT-MET script package

LIS Spin-up Run
Sample Model Output and Verification Statistics
Future Efforts
International Collaboration

**SPoRT/SERVIR/RCMRD/KMS Collaboration:** Builds off strengths of each organization

- **SPoRT:** Transition of satellite, modeling and verification capabilities
- **SERVIR-Africa/RCMRD:** International capacity-building expertise
- **KMS:** Operational organization with regional weather forecasting expertise in East Africa
Hypothesis and Experiment Design

• **Hypothesis:** *Improved land-surface initialization over Eastern Africa can lead to better temperature, moisture, and ultimately precipitation forecasts in NWP models*
  
  – KMS currently initializes Weather Research and Forecasting (WRF) model with NCEP/Global Forecast System (GFS) model 0.5-deg initial / boundary condition data
  
  – LIS will provide much higher-resolution land-surface data at a scale more representative to regional WRF configuration
  
  – Future implementation of real-time NESDIS/VIIRS vegetation fraction to further improve land surface representativeness
WRF/EMS Configuration & Daily Simulations

Environmental Modeling System (EMS)
Advanced Research WRF 12-km/4-km
1-way nest domain

Once-daily Control / Experiment runs:
- 00z initialization; 48-h integration
- **Control**: GFS ICs / BCs
- **Experiment**: Same as control, but with LIS LSM initialization
- 72 second timestep on D1
- 42 vertical levels; 30-mb ptop

Physics parameterizations:
- RRTM-G SW/LW radiation
- Kain-Fritsch convection (D1 only)
- Noah Land Surface Model (LSM)
- Lin microphysics
- MYNN 2.5 TKE PBL scheme
Land Information System (LIS)

High-performance land surface modeling & data assimilation system

Uncoupled/analysis mode

Forecast mode coupled to WRF model

This experiment uses uncoupled/analysis mode

transitioning research data to the operational weather community
LIS-Noah Configuration and Spin-up

LIS uncoupled run of Noah LSM

- Horizontal grid spacing of 0.03-deg (~3 km)
- Grid covers outer WRF model domain
- LIS-Noah cold-started on 1 Jan 2011; run through Summer 2013
  - Uniform initial volumetric soil moisture (20 %) and temperature (290 K)
  - Atmospheric forcing: Global Data Assimilation System (GDAS)
  - Precipitation forcing comparison: (1) GDAS precip rates, (2) TRMM 3-h precip (~25 km), and (3) CMORPH half-hourly precip (~8 km)

- Chose the **CMORPH precip forcing**; results compared favorably with TRMM precip product, but with slightly more detail
- Developed initialization option for WRF EMS
LIS-Noah Spin-up Mar 2011 – Apr 2013: 30-day Precipitation and Soil Moisture Fields Show Seasonal Oscillation of Intertropical Convergence Zone

CMORPH 30-day Precipitation

LIS-Noah Column Relative Soil Moisture

transitioning research data to the operational weather community
NCAR/MET and SPoRT Scripting Package

- SPoRT-developed scripting package to manage data acquisition, execute MET, and produce quick statistics plots (Zavodsky et al. poster 500; 30 EIPS)
- Designed to work with WRF EMS output GRIB1 or GRIB2 files

Initially using obs within GDAS PREPBUFR files for verification

namelist.met
runSPoRTMETscripts.pl
obtainObservations.pl

runPointStat.pl
runPointStatAnalysis.pl
runGridStat.pl
runGridStatAnalysis.pl

makePlots.pl
Optional open source plotting scripts to visualize stats

NCAR Model Evaluation Tools (MET)

transitioning research data to the operational weather community
Differences in Land Surface Initialization:
(25 Jan 2014; GFS vs. LIS 0-10 cm soil moisture; 4-km WRF)

4-km domain Control (GFS)

4-km domain Experiment (LIS)
4-km WRF Forecast 2-m Temperature: 25 Jan 2014

**Surface 2-m Temperature (K) for Mean Error (F-O) on USER**

2-m Temperature Bias on 4-km grid

**Transitioning research data to the operational weather community**
Critical Success Index (CSI) for 24-h Precipitation

24-h precipitation for 10mm, 1 Box for Critical Success Index on USER

4-km WRF Forecast Precipitation: 25 Jan 2014
Future Work

• Future work
  – Seasonal composites of verification with SPoRT-MET scripts
    ▪ Collecting daily MET verification statistics for Control and LIS
    ▪ Compute seasonal composite verification scores
  – Implement daily NESDIS/VIIRS vegetation into LIS & WRF runs
    ▪ Daily global 4-km resolution green vegetation fraction (GVF)
    ▪ To replace coarse-resolution, outdated monthly GVF climatology
    ▪ Document possible improvements to verification scores
  – Site visit to KMS/RCMRD/SERVIR-Africa
    ▪ Training and transition of SPoRT-MET scripts for KMS
    ▪ Enhance collaborations between SPoRT, SERVIR, and KMS/RCMRD
  – Soil moisture data assimilation: SMOS and SMAP missions

• Questions / comments?
transitioning research data to the operational weather community
International Collaboration

**Short-term Prediction Research and Transition (SPoRT)**
- Transitions unique NASA / NOAA observations and research capabilities to the operational weather community to improve short-term weather forecasts on regional and local scales
- Proven paradigm for transition of research and experimental data to ops

**NASA SERVIR Project: Connecting Space to Village**
- NASA-USAID partnership to enable use of Earth observations in developmental decision making
- Identifies needs in regions and links science products from U.S. institutions to meet those needs through improved access to data, models & products

**Regional Center for Mapping of Resources for Development (RCMRD)**
- RCMRD has mandate to work with 19-member countries to build their capacities for geospatial information; RCMRD is host of SERVIR-Africa

**Kenya Meteorological Service (KMS)**
- Meteorological/climatological services to agriculture, forestry, water resources management, civil aviation and private sector
- Met. services for shipping in West. Indian Ocean; issues cyclone warnings
Short-term Prediction Research and Transition (SPoRT)

- Transitions unique NASA and NOAA observations and research capabilities to the operational weather community to improve short-term weather forecasts on regional and local scales
- Proven paradigm for transition of research and experimental data to operations
- Close collaboration with numerous NWS WFOs across the U.S.
- Began in 2002; co-funded by NOAA since 2009 through “proving ground” activities
SERVIR is a NASA-USAID partnership to enable use of Earth observations in developmental decision making.

SERVIR identifies needs in the regions and links science products from U.S. institutions to meet those needs through improved access to data, models and products.

In East Africa, SERVIR is working through SERVIR-Africa, a project at the Regional Center for Mapping of Resources for Development (RCMRD).