



# 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



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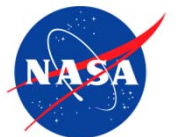
# International Collaboration

## **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



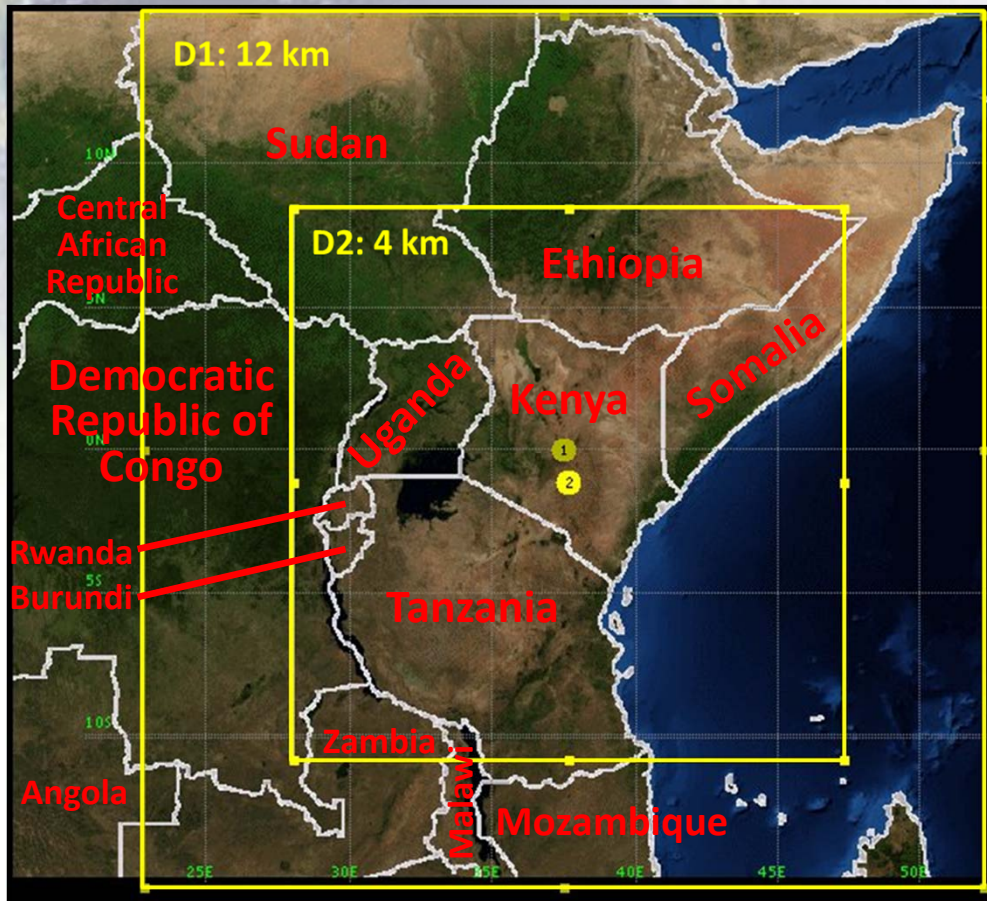
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# Hypothesis and Experiment Design

- 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

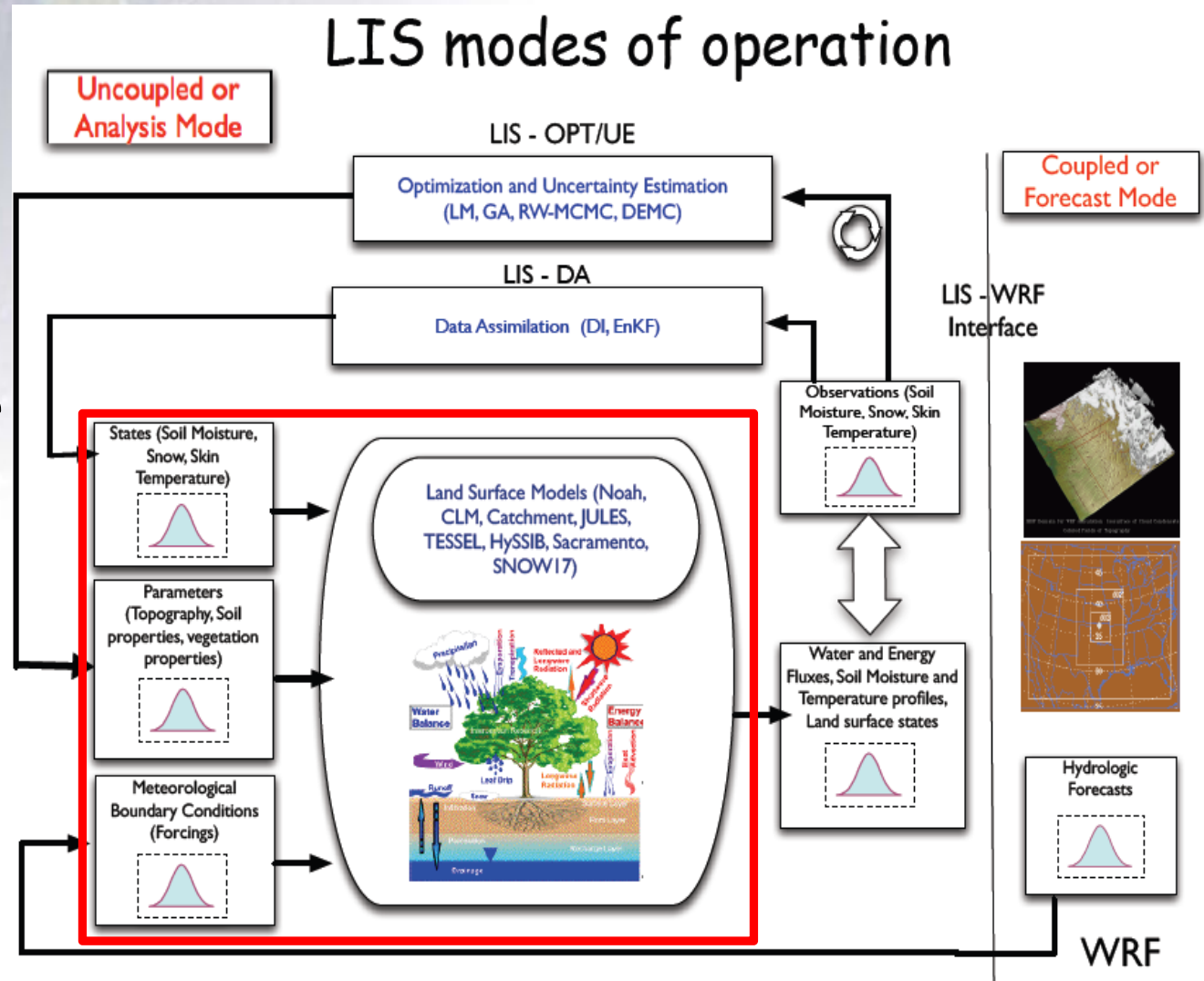
# Land Information System (LIS)

High-performance land surface modeling & data assimilation system

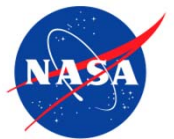
Uncoupled/analysis mode

Forecast mode coupled to WRF model

This experiment uses uncoupled/analysis mode



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# 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:

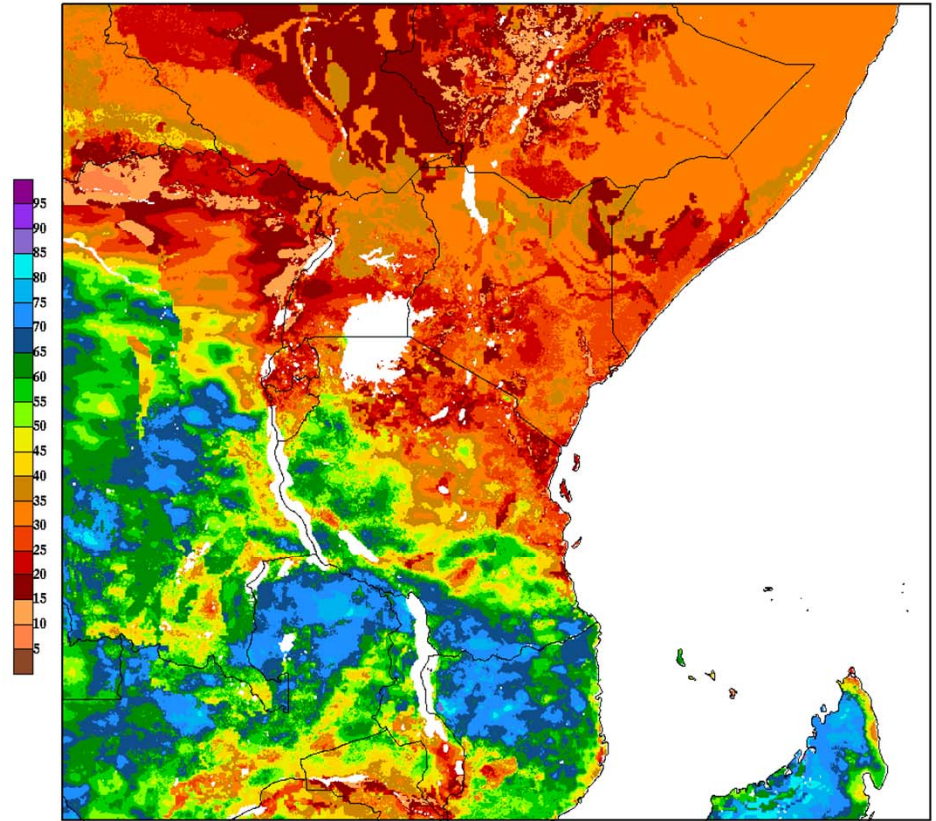
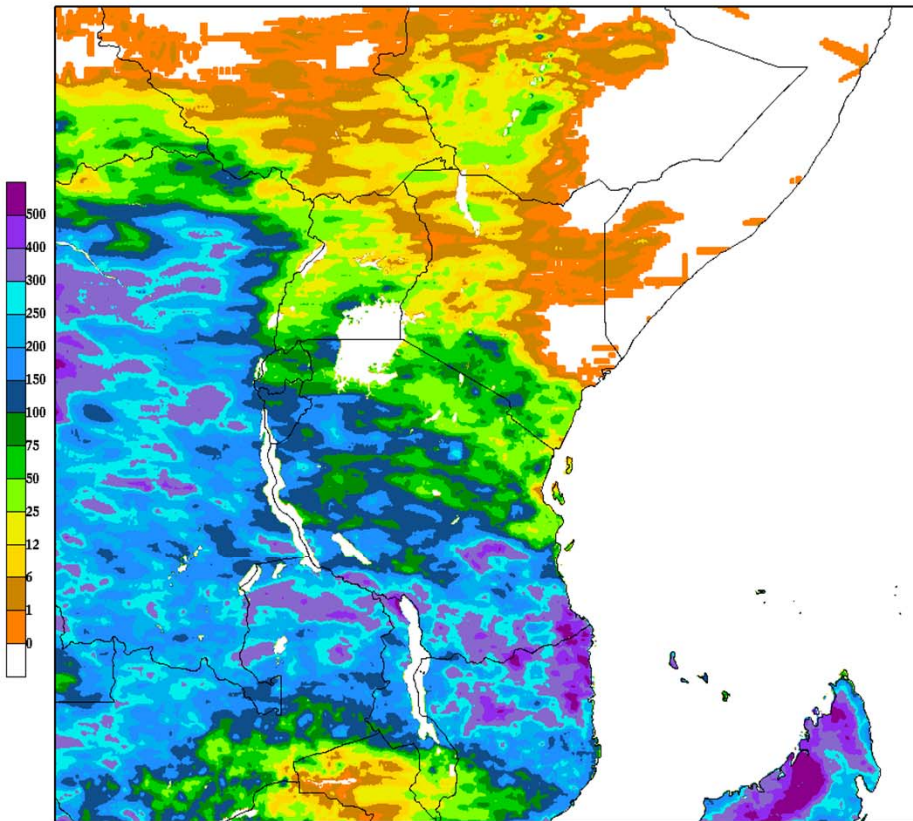
*30-day Precipitation and Soil Moisture Fields Show Seasonal Oscillation of Intertropical Convergence Zone*

CMORPH 30-day Precipitation

LIS-Noah Column Relative Soil Moisture

Accumulated precip (mm) for KMD-CMORPH valid 110302/0000V000

Integrated Relative SM (%) for KMD-CMORPH valid 110302/0000V000





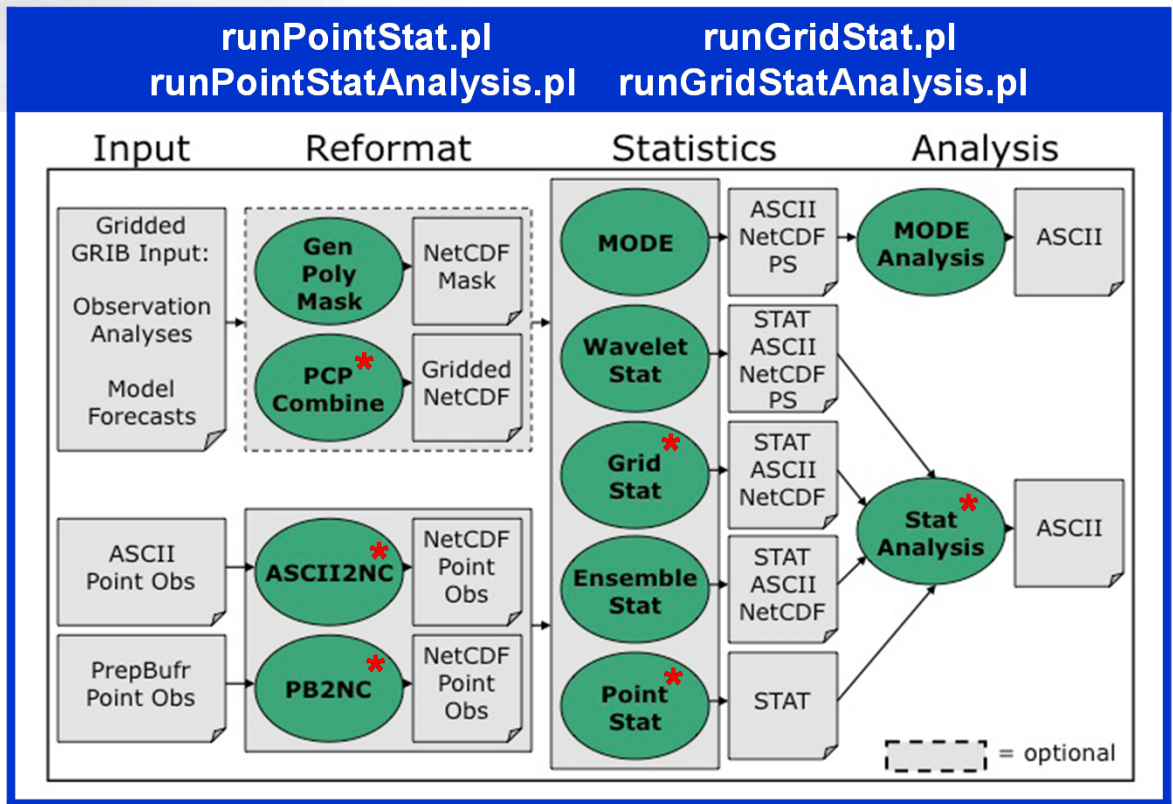
# NCAR/MET and SPoRT Scripting Package

- 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

namelist.met  
runSPoRTMETscripts.pl  
obtainObservations.pl

Initially using obs within  
**GDAS PREPBUFR**  
files for verification

makePlots.pl  
Optional open source plotting  
scripts to visualize stats



## NCAR Model Evaluation Tools (MET)



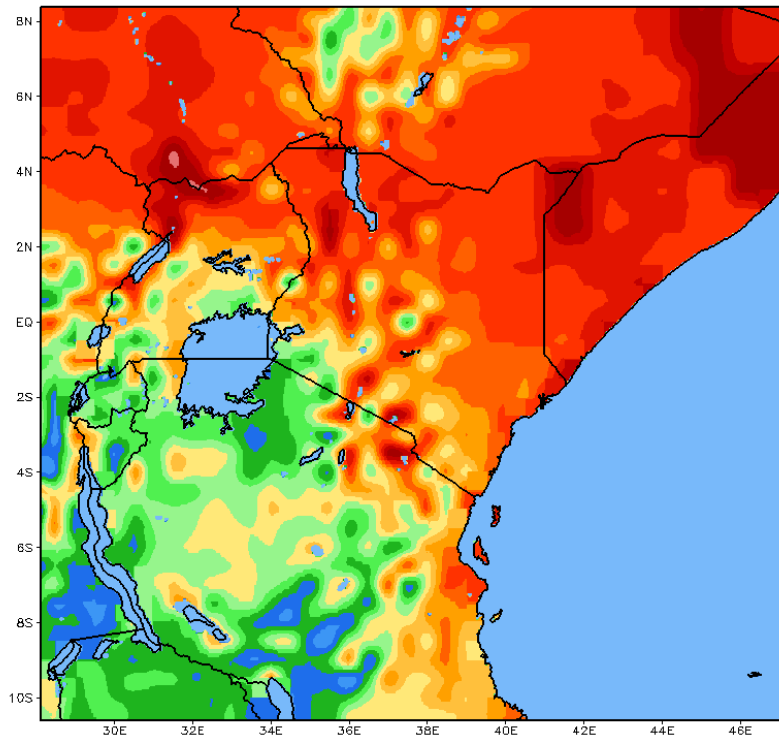
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# Differences in Land Surface Initialization: (25 Jan 2014; GFS vs. LIS 0-10 cm soil moisture; 4-km WRF)

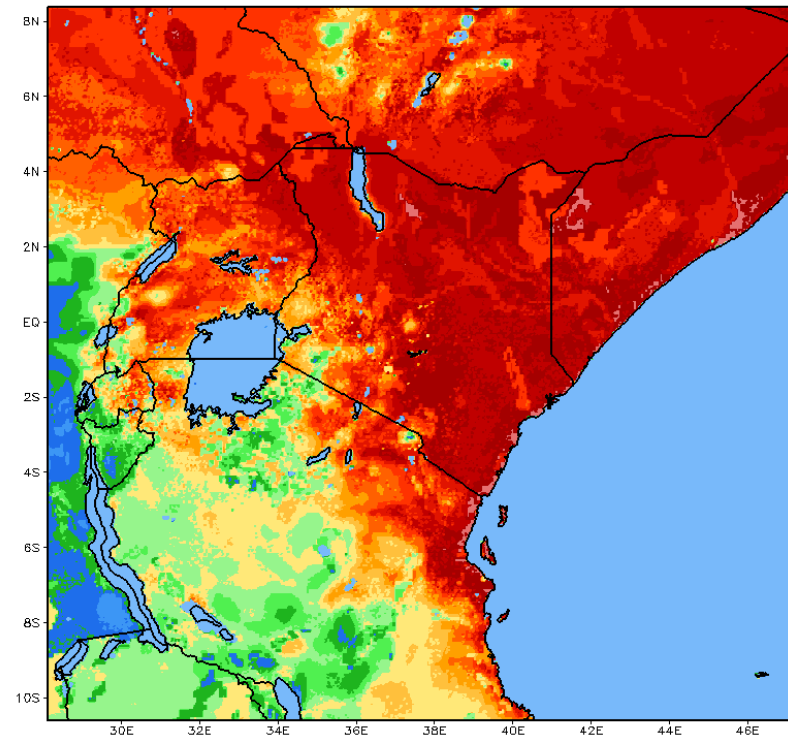
## 4-km domain Control (GFS)

0-10 cm Volumetric Soil Moisture ( $m^3/m^3 \cdot 100$ )  
Control 0-h Forecast Valid: 00Z 25 JAN 2014

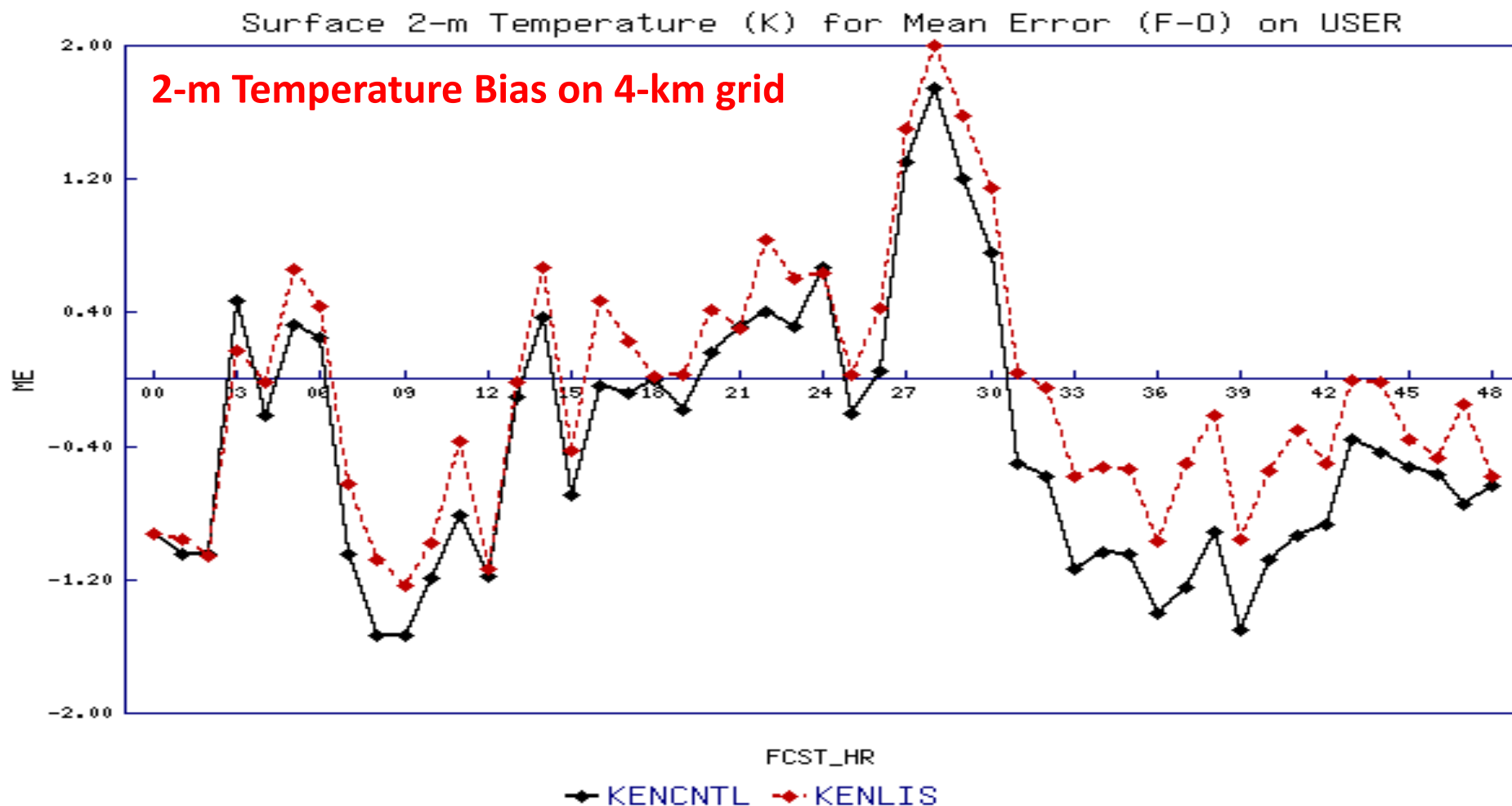


## 4-km domain Experiment (LIS)

0-10 cm Volumetric Soil Moisture ( $m^3/m^3 \cdot 100$ )  
LIS 0-h Forecast Valid: 00Z 25 JAN 2014

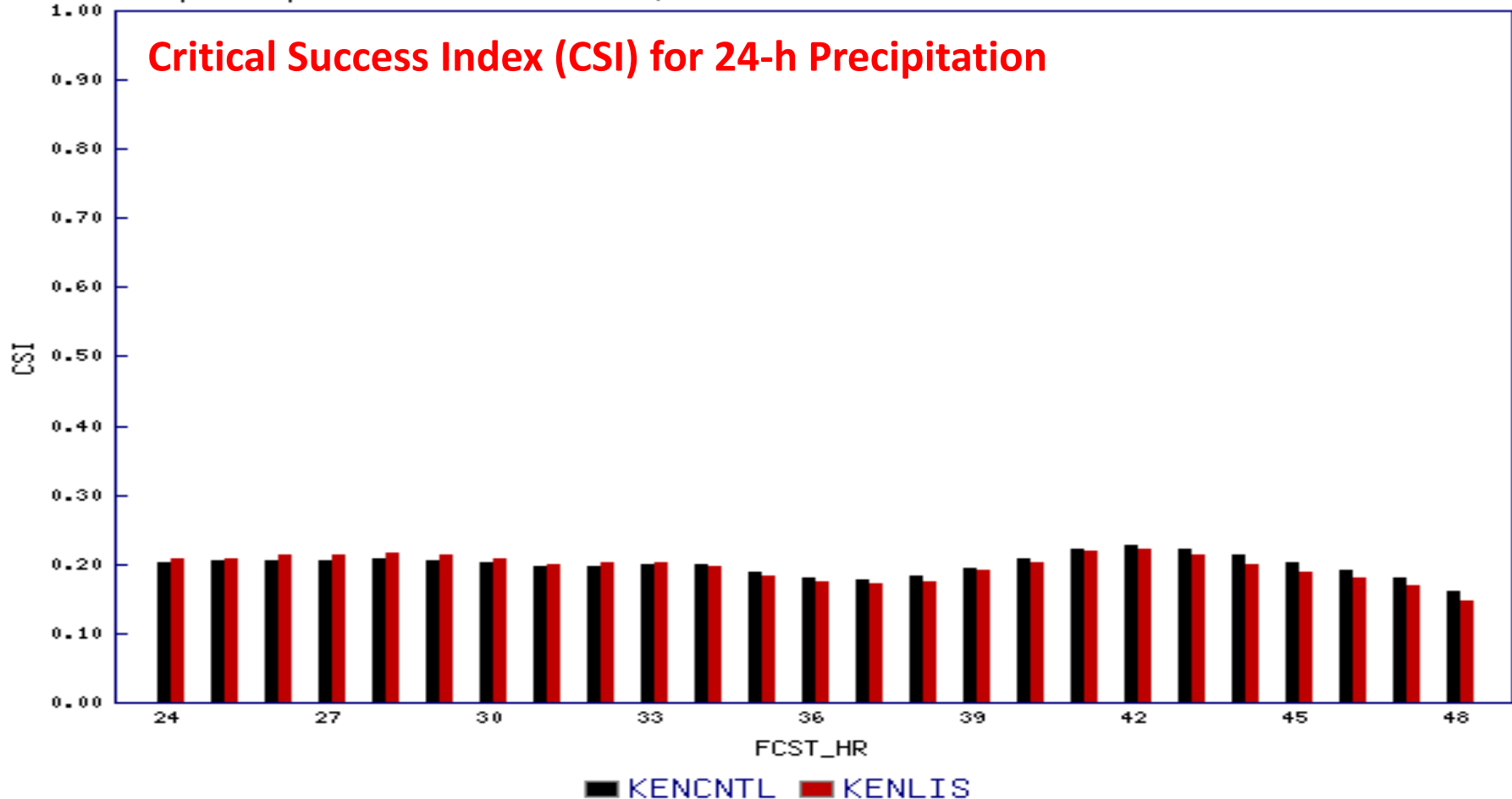


# 4-km WRF Forecast 2-m Temperature: 25 Jan 2014

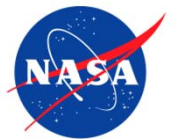


# 4-km WRF Forecast Precipitation: 25 Jan 2014

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



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# 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?



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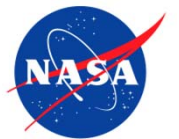




# Back-up Slides



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# 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



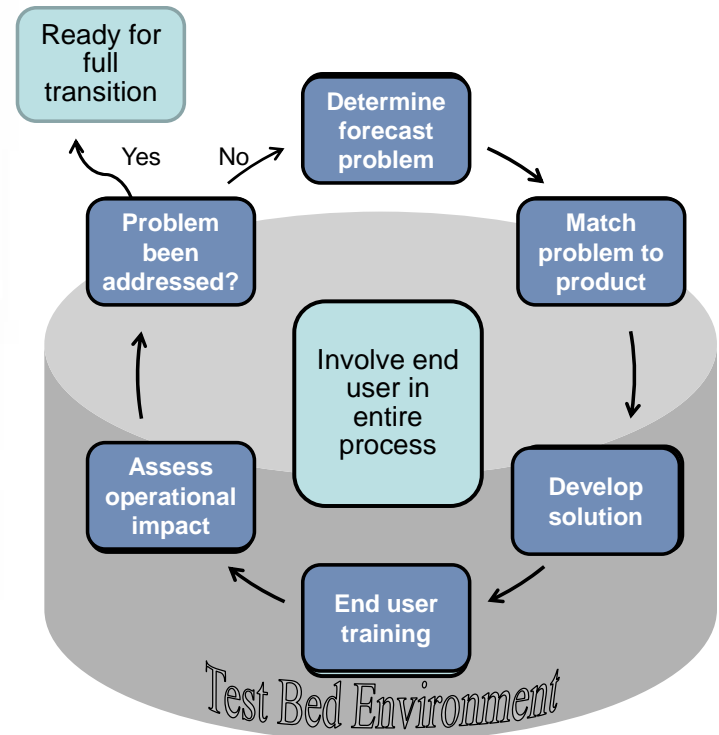
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# SPoRT Center

## 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



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# NASA SERVIR Project: Connecting Space to Village

**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)**



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