Transitioning Enhanced Land Surface Initialization and Model Verification Capabilities to the Kenya Meteorological Service

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Peter Lamb Symposium

96th annual AMS meeting; Presentation 2.4; 13 January 2016; Session on Lessons Learned and Future Avenues of Predictability, Outreach, and Capacity Development

Presentation 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*

March 2014 and June 2015 training visits

Examples from June 2015 hands-on training

Future efforts and improvements

NASA/KMS Collaboration

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

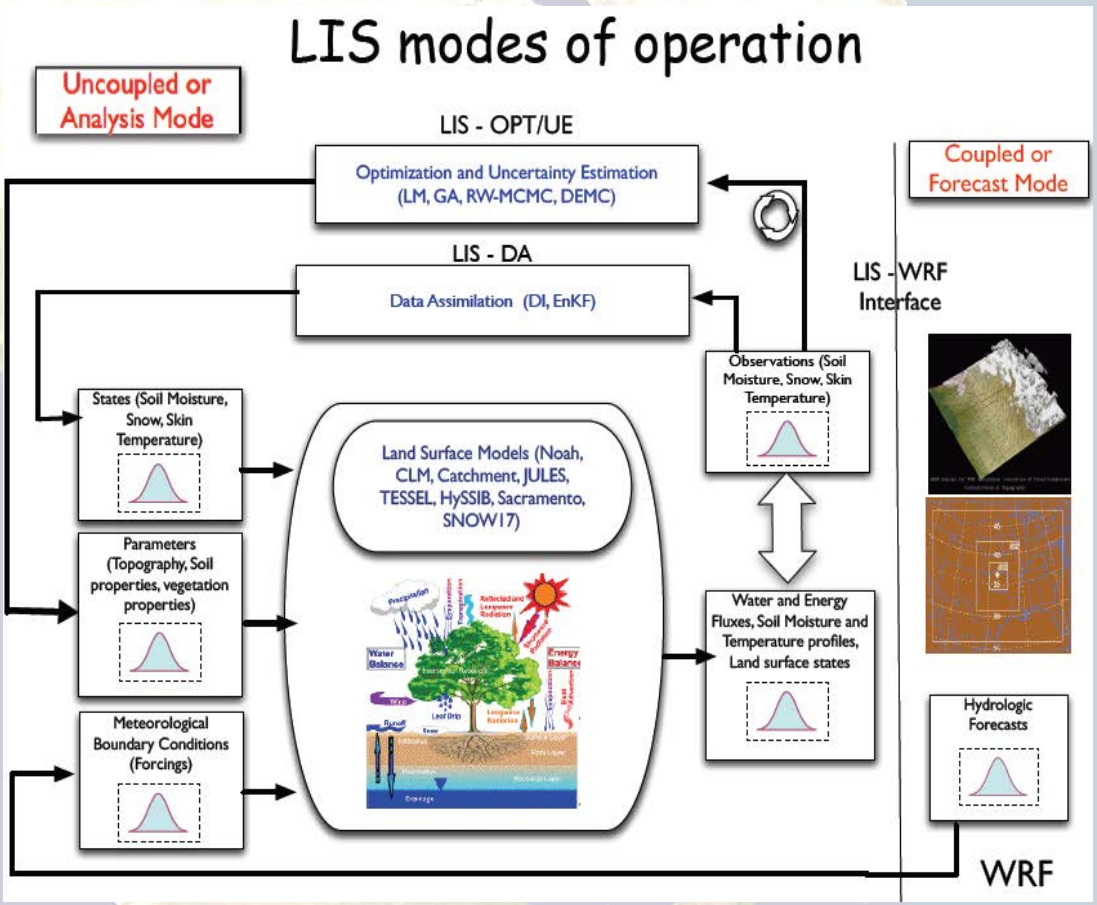
- SPoRT: Transition of satellite, modeling and model verification capabilities
- SERVIR-Africa/RCMRD: International capacity-building expertise
- KMS: Operational organization with regional weather forecasting expertise in East Africa

Focus of Collaboration

- Hypothesis: *Improved land-surface initialization over Eastern Africa can lead to better simulated temperature, moisture, & precipitation in NWP models to support severe weather forecasting operations at KMS*
  - KMS currently initializes Weather Research and Forecasting (WRF) model with NCEP/Global Forecast System (GFS) model initial / boundary conditions
  - LIS provides higher-resolution land-surface data at a scale more representative to regional WRF configuration
  - Real-time NESDIS/VIIRS green vegetation fraction (GVF) to further improve land surface representativeness, esp. to capture vegetation response to anomalous drought or wet periods
  - Model verification using NCAR's Model Evaluation Tools with SPoRT "wrapper scripting" software to ease data acquisition and generation of statistics
  - **Onsite training during first 2 weeks of June 2015:**
    - **Ran model simulations with and without experimental datasets**
    - **Generated verification statistics to inter-compare model runs**

Land Information System (LIS)

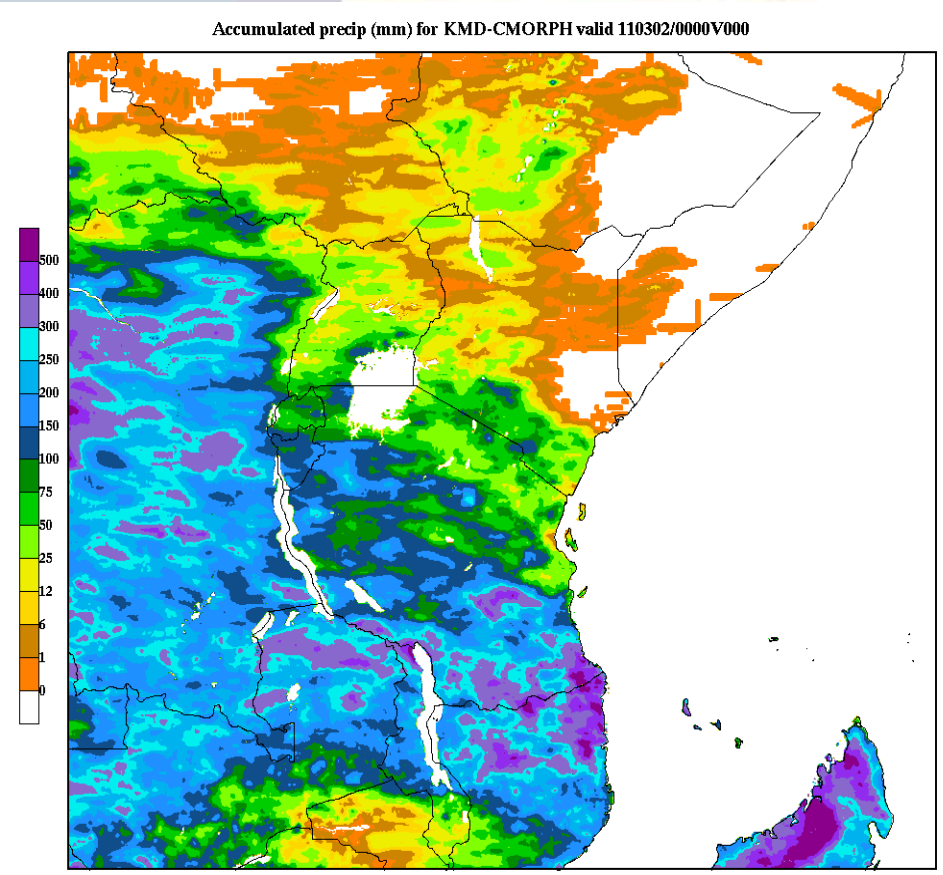
- Running LIS in real-time over eastern Africa to provide KMS with better soil initialization
- Atmospheric input from global model analyses and CMORPH satellite precipitation estimates



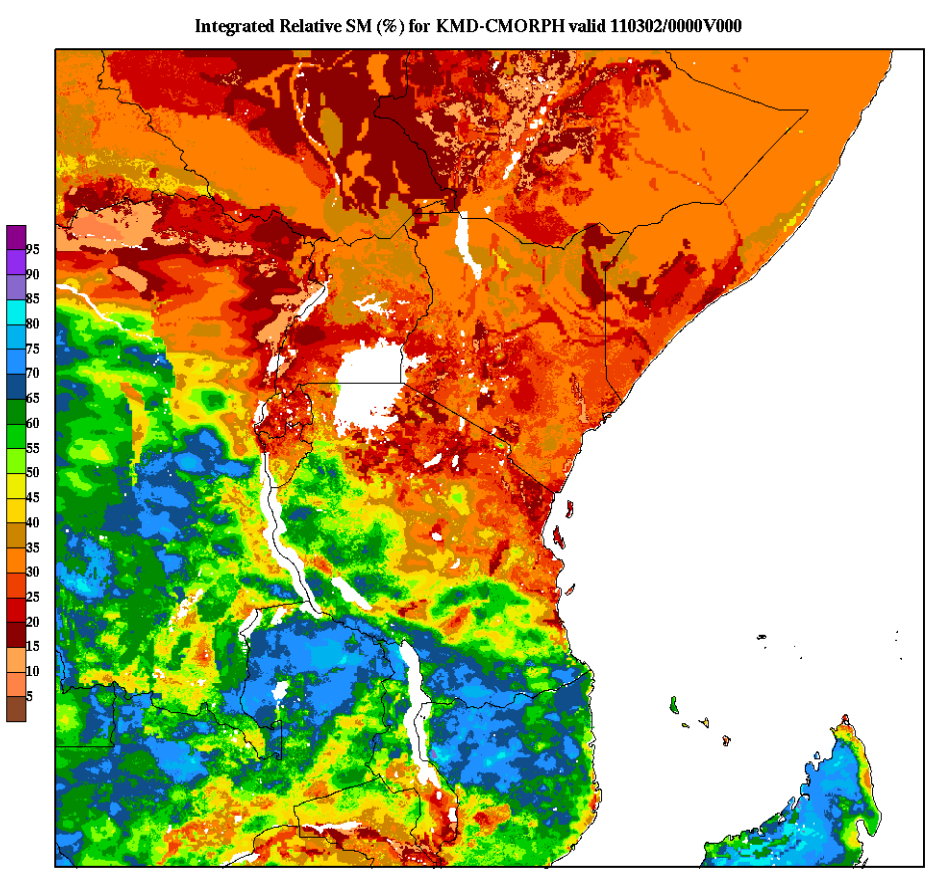
LIS-Noah Spin-up Mar 2011 – Apr 2013:

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

CMORPH 30-day Precipitation



LIS-Noah Column Relative Soil Moisture



Training Site Visit: March 2014 in Kenya

SERVIR and SPoRT representatives working with personnel at Kenya Meteorological Service office in Nairobi, Kenya

Training Site Visit: June 2015 in Huntsville, AL

KMS personnel traveled to Huntsville, AL for hands-on training during first 2 weeks of June 2015.

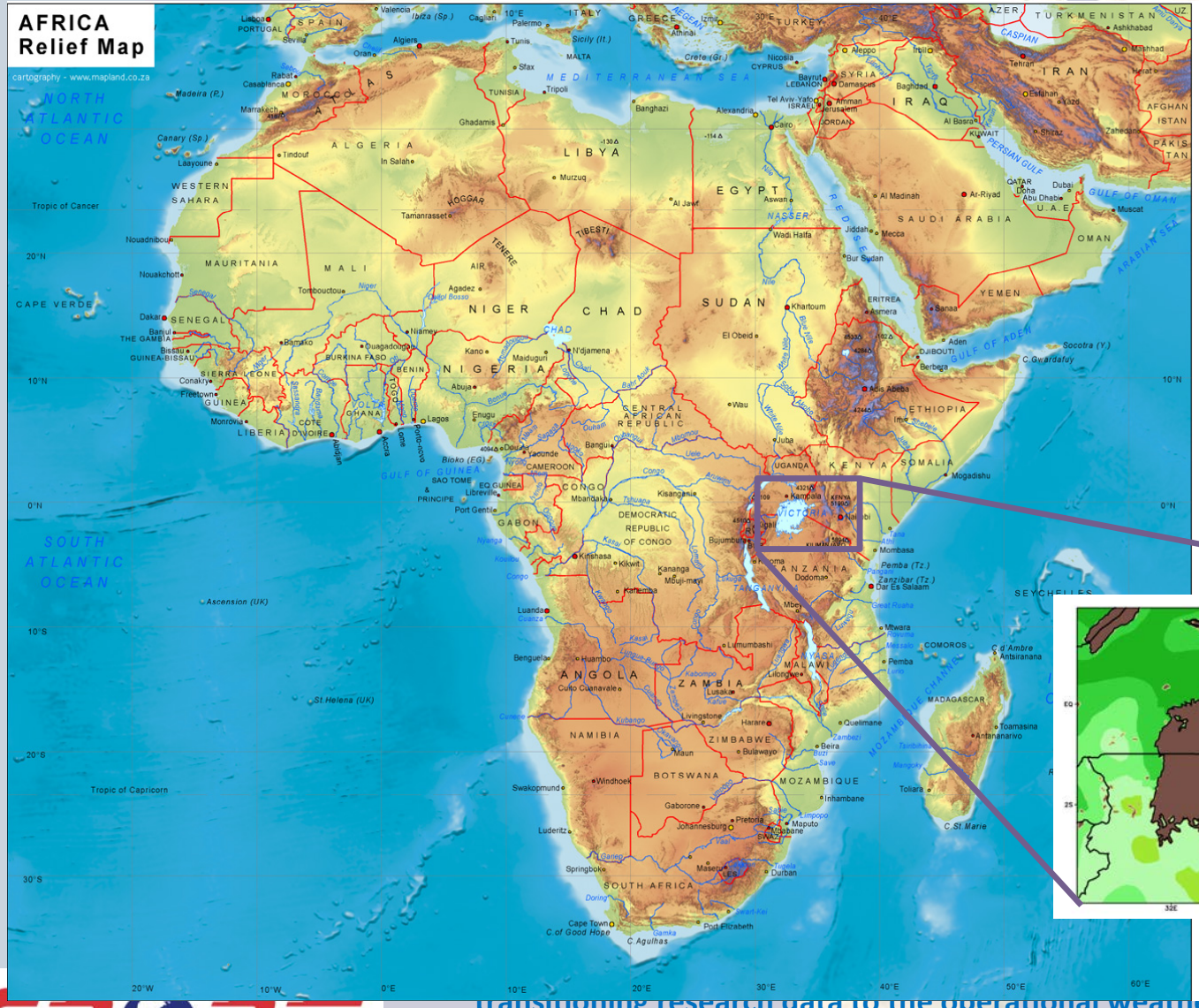
(top) SERVIR, SPoRT, and KMS personnel in SERVIR collaboration lab
(right) KMS personnel briefing their final presentation at end of 2 weeks

…And what trip to Huntsville, AL wouldn't be complete without a visit to:

U.S. Space and Rocket Center and Jack Daniel's distillery!

Case Study from June 2015 Training

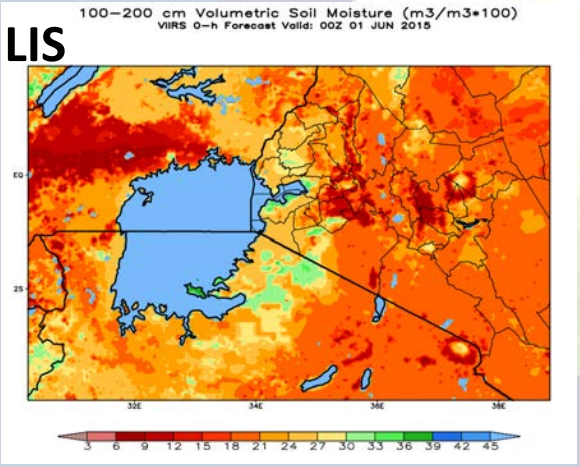
(4-km WRF model run using LIS and VIIRS GVF data)



Case Study from June 2015 Training

Deep soil moisture (top) and GVF differences (bottom)

LIS



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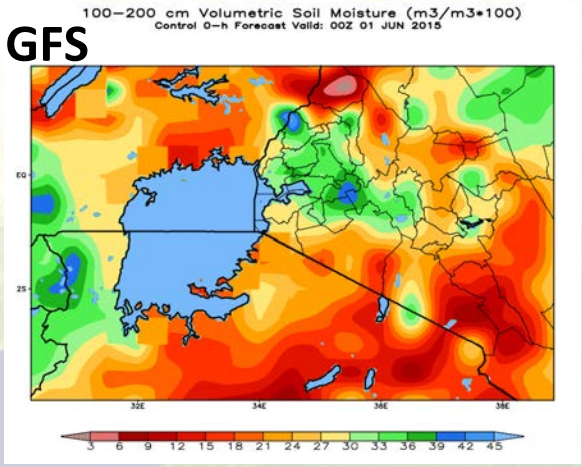
GFS



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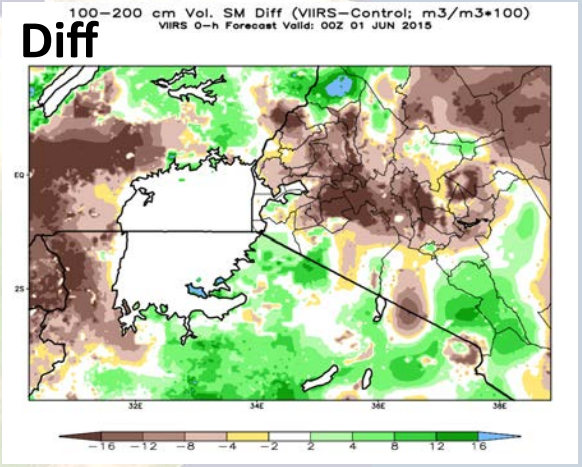
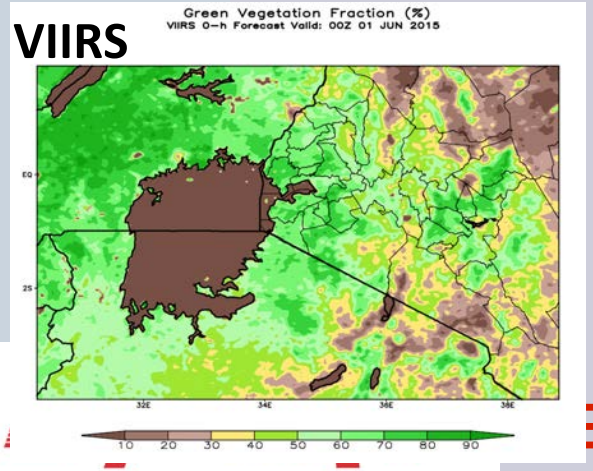


High-elevation volcanoes resolved by both LIS and VIIRS GVF dataset (soil moisture difference "couplets" and lower GVF)

VIIRS



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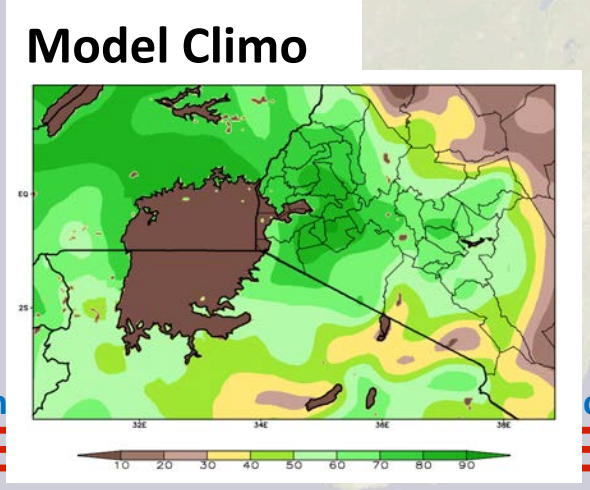
Model Climo



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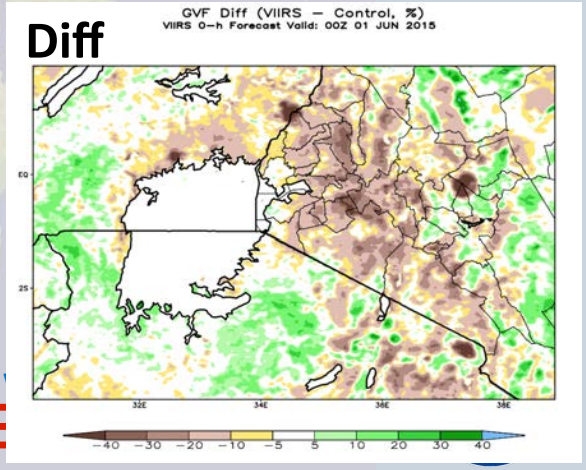
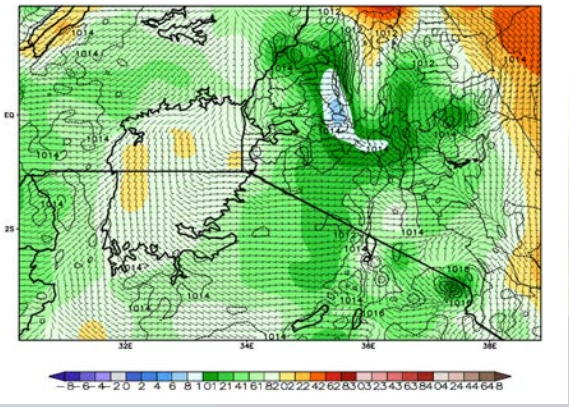


Case Study from June 2015 Training

2-m Temperature (top) and Dew point temperature (bottom)

LIS+VIIRS



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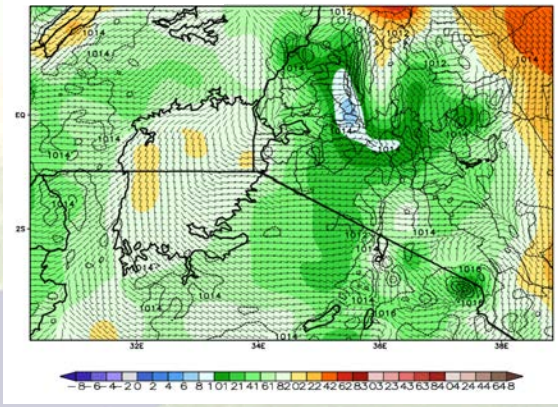
Control



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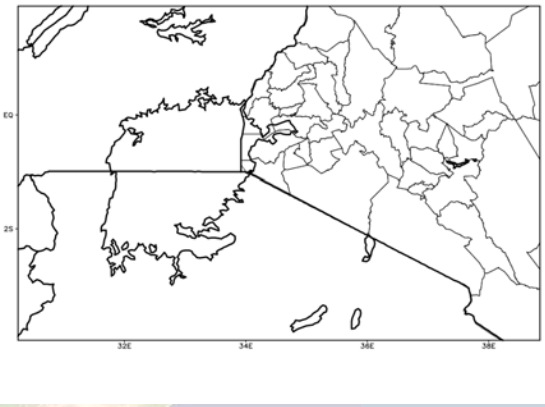
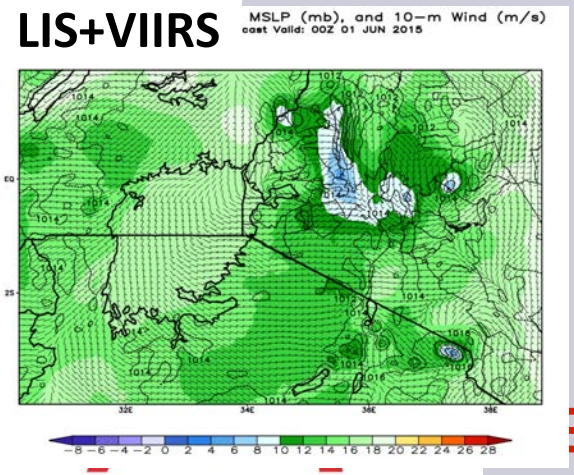


Regionally drier LIS soil moisture and lower VIIRS GVF has a warming/drying effect on 2-m Temperature/Dew Point forecasts

LIS+VIIRS



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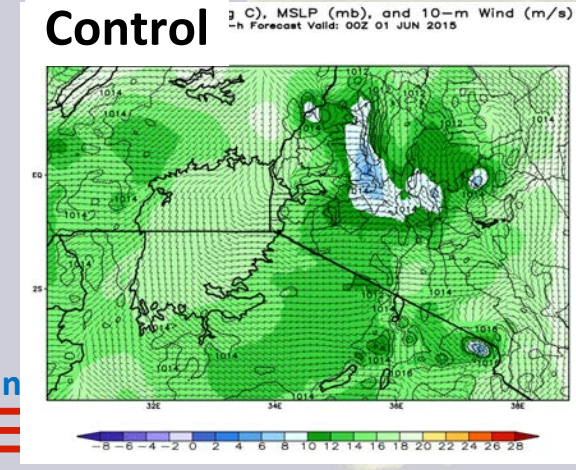

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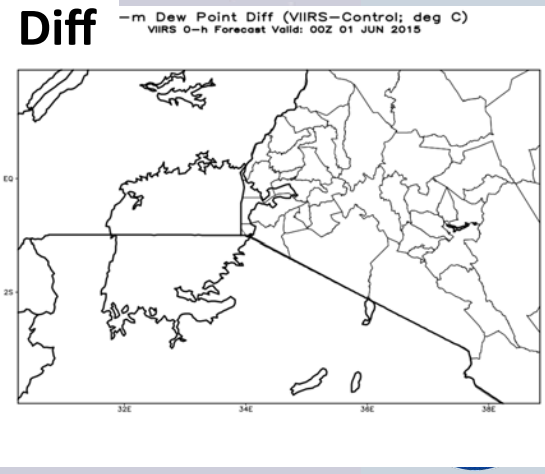


NCAR/MET and SPoRT Scripting Package

- **SPoRT-developed scripting package to manage data acquisition, execute MET, and produce quick statistics plots**
- **Works with WRF/EMS GRIB files, GDAS PREPBUFR, and CMORPH precipitation**

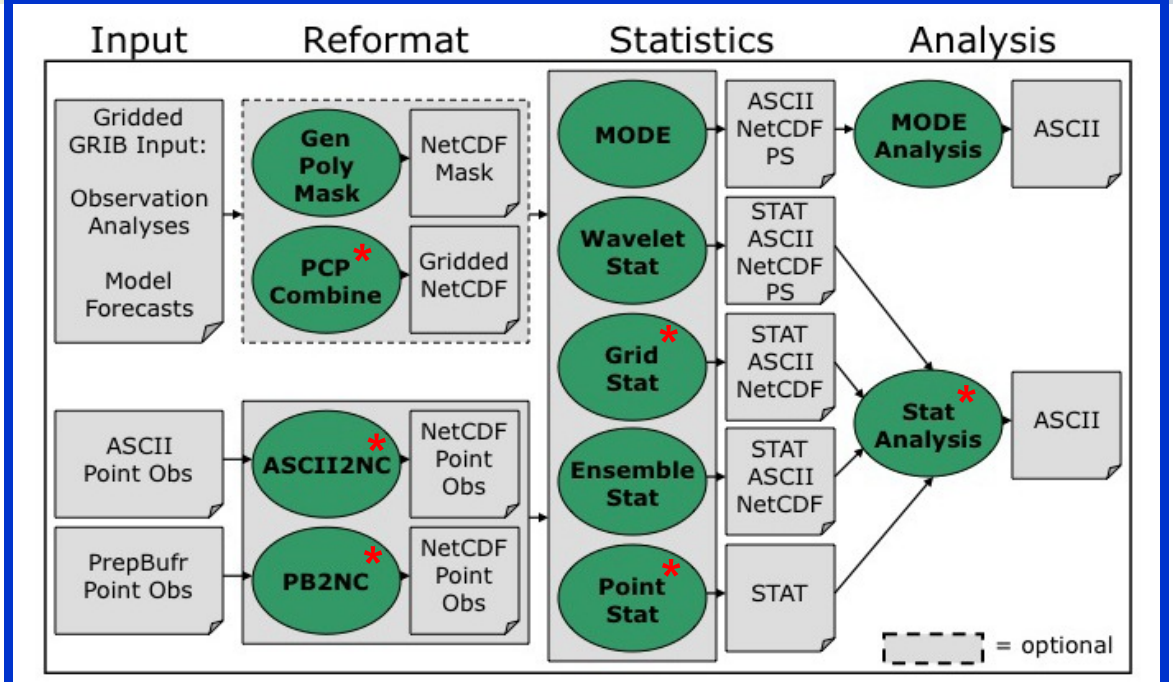
namelist.met
runSPoRTMETscripts.pl
obtainObservations.pl

Initially using obs within GDAS PREPBUFR files for verification

makePlots.pl
Optional open source plotting scripts to visualize stats

runPointStat.pl
runPointStatAnalysis.pl

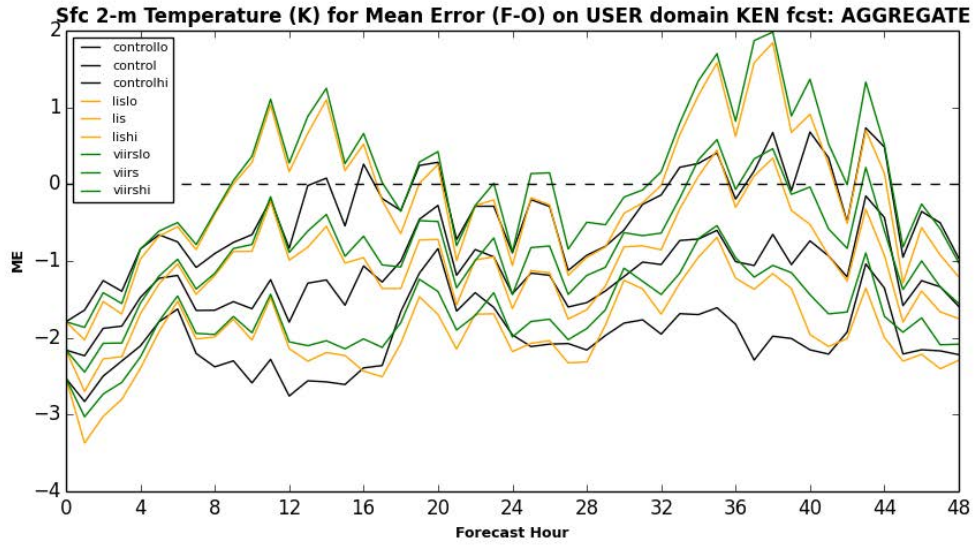
runGridStat.pl
runGridStatAnalysis.pl



NCAR Model Evaluation Tools (MET)

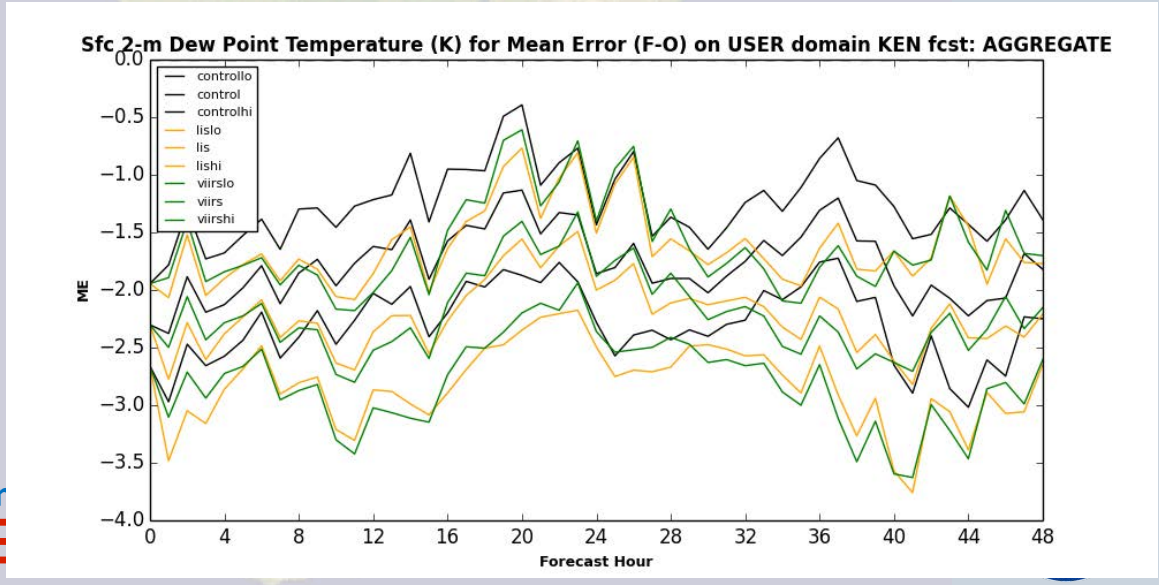
Case Study from June 2015 Training

2-m Temperature and Dew Point Bias stats



- **Only 3 simulation days went into producing these stats (31 May, 1/3 June 2015)**
- **Large confidence intervals as a result**

Net effect of LIS/VIIRS GVF: Warmer and drier 2-m T/Td during daytime hours



Ongoing and future efforts

- Upgrade real-time eastern Africa LIS run
  - Incorporate daily VIIRS GVF in place of climatology GVF
  - Apply GPM/IMERG precipitation estimates to drive soil moisture
- Develop soil moisture climatology for Africa-LIS run
  - LIS simulation from 2002 – present (driven by CMORPH precipitation) to generate soil moisture histograms
  - Develop soil moisture anomaly/percentile products
  - Examine historical drought/wet periods
- Land data assimilation of Soil Moisture Active Passive (SMAP) soil moisture retrievals

International Collaboration

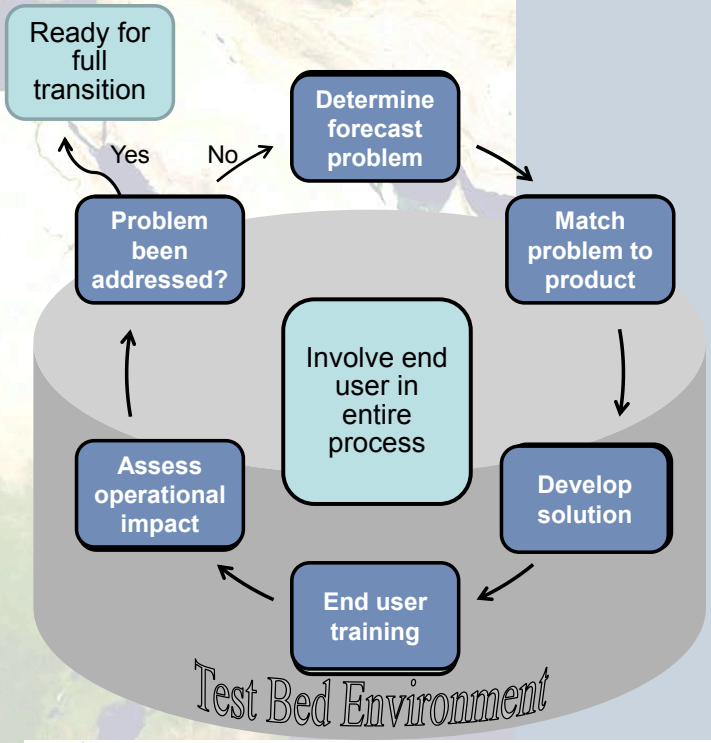
Short-term Prediction Research and Transition (SPoRT)
- Transitions unique NASA / NOAA observations and research capabilities to the operational weather community to improve short-term weather forecasts on regional and local scales
- Proven paradigm for transition of research and experimental data to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

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

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)