Impact of Land Initialization on WRF Forecast for the AFWA South East Asian Domain

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Outline:

- **Motivation**
- **Numerical Experiments and Results**
  - Surface verification of WRF/LIS
  - Sounding Verification
- **Summary**

Motivation

- **Mesoscale models need to capture atmospheric boundary layer structures and motions resulted from surface forcing**
- **No routine high-resolution soil observation network at continental scale available for mesoscale coupled system initialization**
- **Alternatives: Using observed rainfall, analyzed downward solar radiation, and atmospheric analysis to drive LSMs in uncoupled mode**
  - NCEP NLDAS: North America, 1/8 degree
  - AFWA AGRMET: global, 47-km, long-term archive
  - NCAR High-resolution land data assimilation system (HRLDAS)
  - NASA Land Information System (LIS)
- **Goal: understand effects of utilizing LIS-generated soil conditions on AFWA WRF/Noah forecast in the South East Asia region scarce land data**

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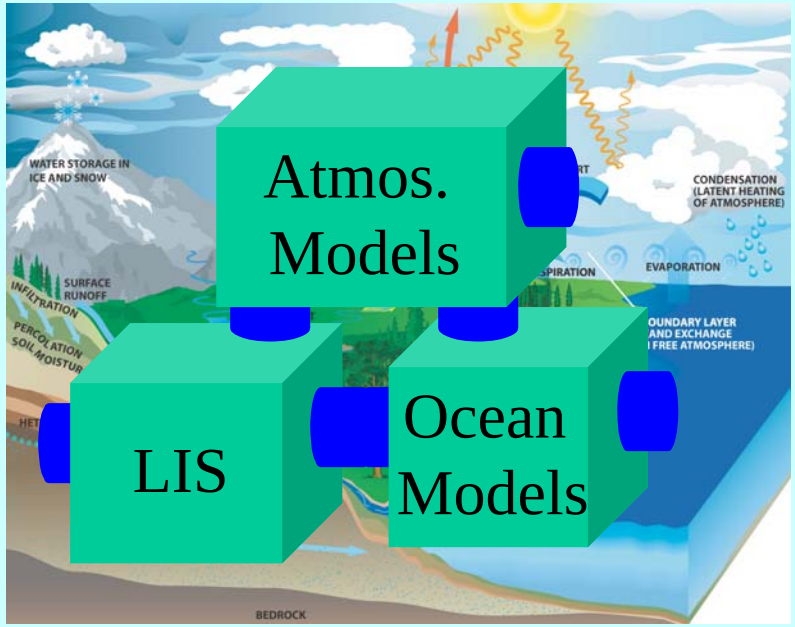
Land Information System (LIS)

http://lis.gsfc.nasa.gov

- **A comprehensive land surface modeling and data assimilation system**
- **Capable of modeling at different spatial scales (2x2.5deg to 1km), globally, and regionally**
- **Designed using advanced software engineering as an object oriented framework**
- **Includes several community land surface models**
- **Applications: Weather and Climate model initialization, water resources modeling, agricultural applications, etc.**
- **AFWA's operational system's (AGRMET) capabilities have been incorporated in LIS**



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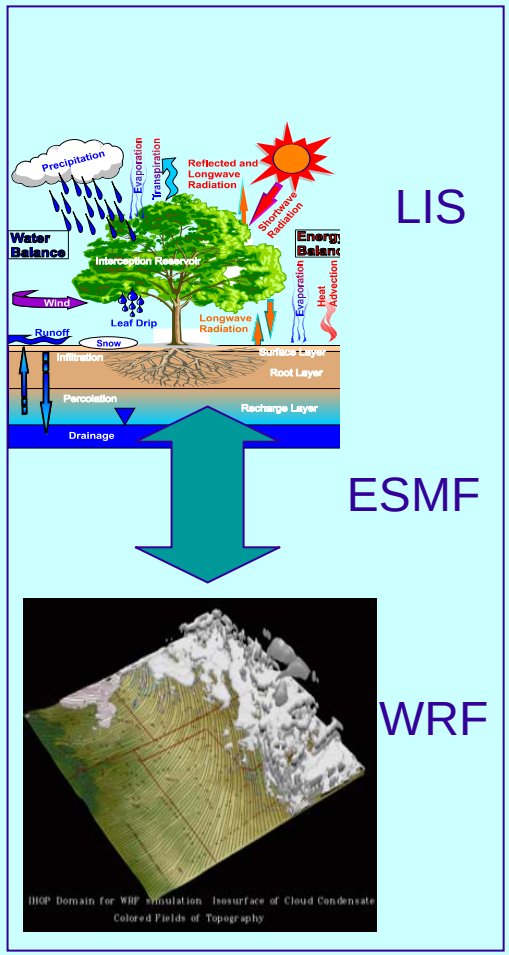
Implementation of Land Information System (LIS) in WRF

- **Collaborative effort among NCAR, NASA, and AFWA**
- **Use Land Information System (LIS) as a next generation land data assimilation system for AFWA WRF/Noah coupled forecast system**
- **Run uncoupled LIS on the same grids as WRF**
  - Using the same LSM as in coupled WRF/Noah model: same soil moisture climatology
  - No Mis-match of terrain, land use type, soil texture, physical parameters between sources of soil data and WRF models
  - No interpolation and soil moisture conversion
  - Assimilate/utilize high-resolution satellite data
- **Explore the use of LIS-generated land-state variables in coupled WRF/Noah for selected retrospective cases**
  - October 22/23 (2006) was selected as a test case for AFWA South East Asia (SEA)Theater



Test case using LIS fields in WRF/Noah for the AFWA SEA Theater

- **Five WRF/Noah simulations using initial land conditions from the following modeling systems:**
  - 1-degree NCEP FNL
  - 47-km AGRMET
  - 15-km and 5-km LIS (GDAS forcing)
  - 15-km and 5-km LIS with CPC Merged Analysis of Precipitation (CMAP) forcing (GDAS+CMAP)
  - 15-km and 5-km LIS with AGRMET forcing
- **The model is integrated for 48 hrs starting 00Z22 Oct 2006 and 12Z22Oct 2006 for two nested domains at 15km (162X212X28) and 5km (157X214X28).**

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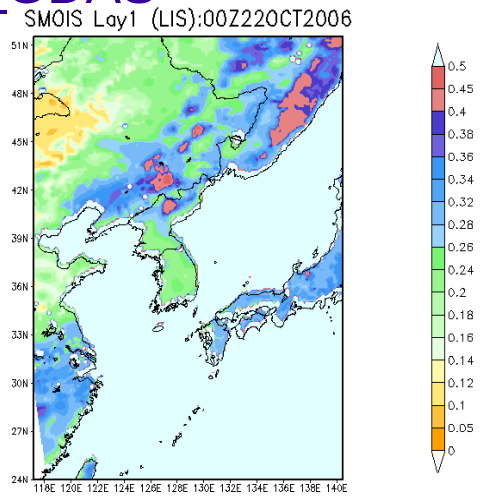
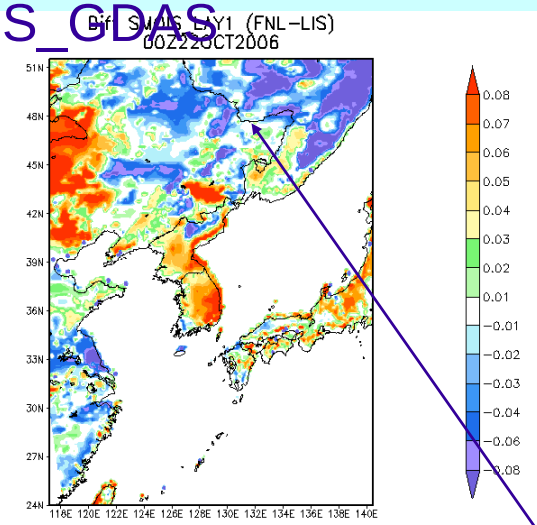
Soil Moisture (layer 1) at Initial Time (22Oct 00Z), Domain1

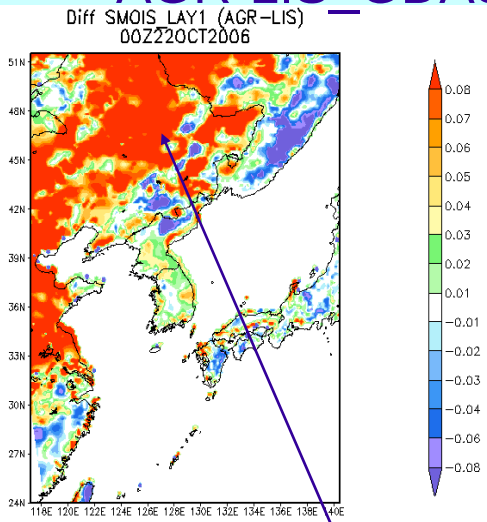
LIS_GDAS

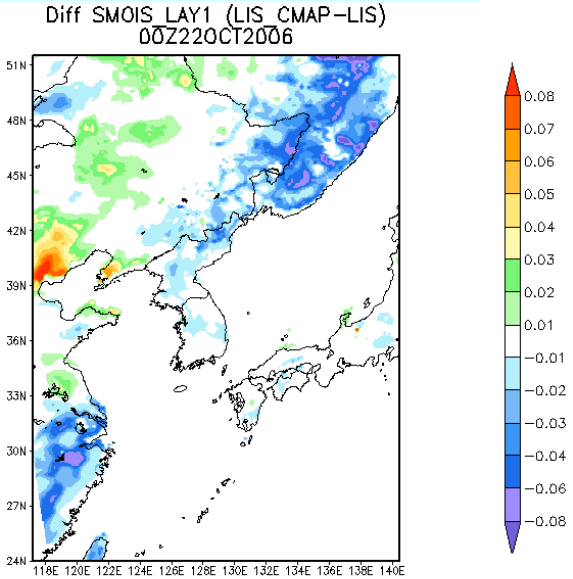


FNL-LIS_GDAS

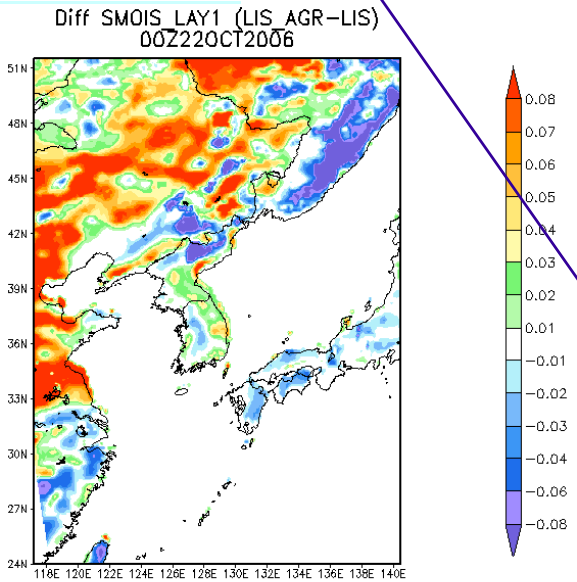


AGR-LIS_GDAS





LIS_CMAP-LIS_GDAS



LIS_AGR-LIS_GDAS

LIS is drier Compared To AGRMET

LIS is wetter Compared to FNL

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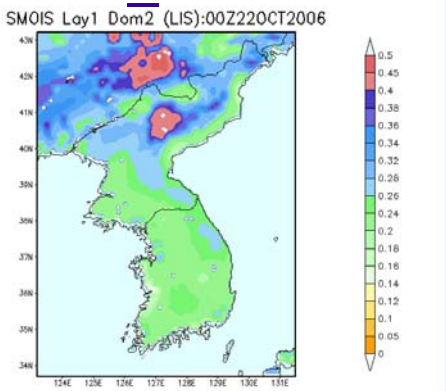
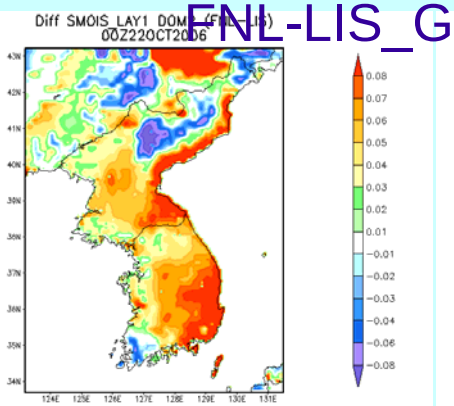
Soil Moisture (layer 1) at Initial Time (22Oct 00Z), Domain2

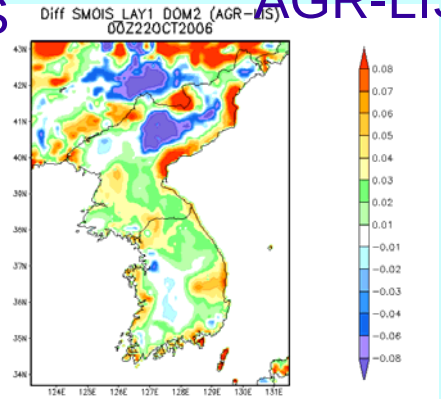
LIS_GDAS



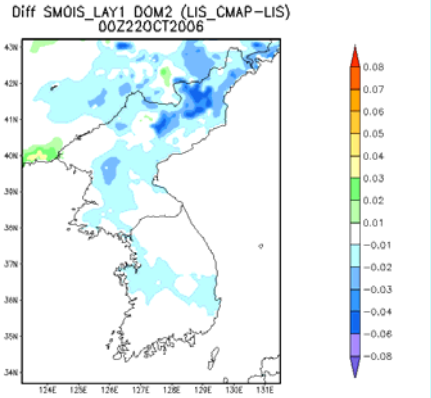
ENL-LIS_GDAS



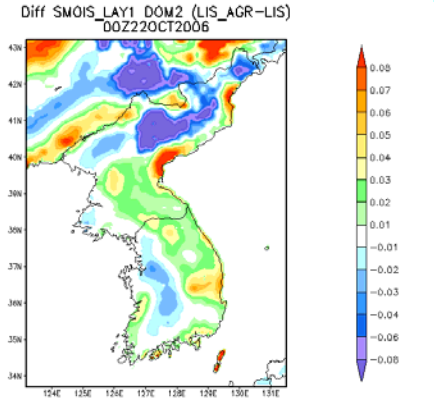
AGR-LIS_GDAS



LIS_CMAP-LIS_GDAS



LIS_AGR-LIS_GDAS



On 5-km grid, LIS is generally dry in southern regions and wet in northern regions

Not much impact using CMAP forcing

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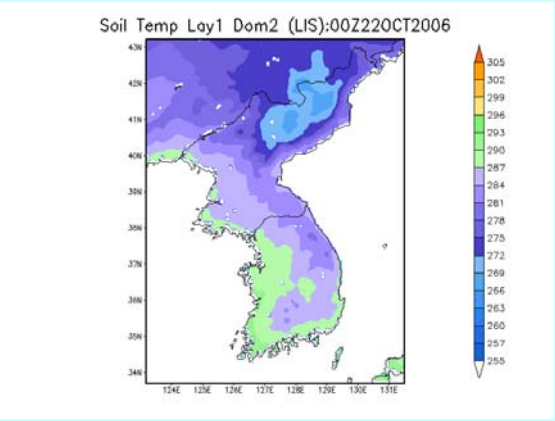
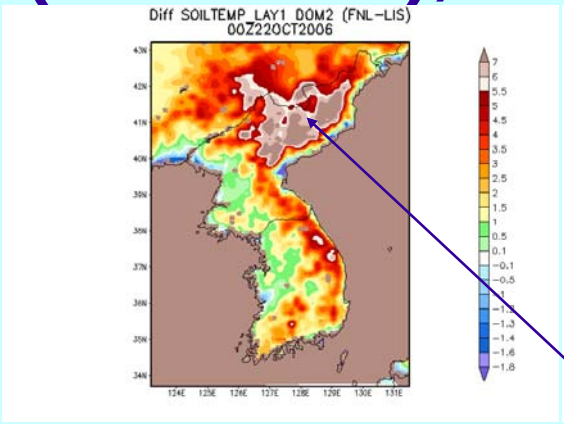
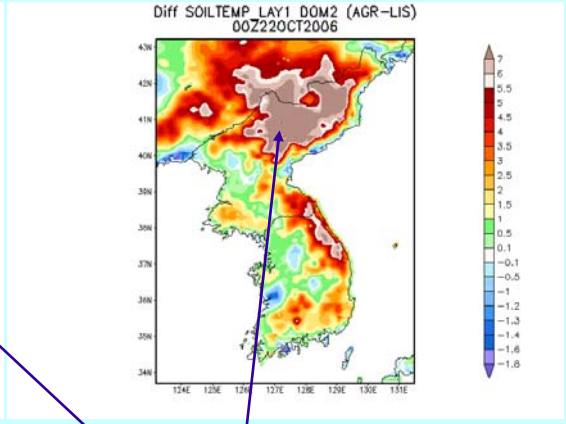
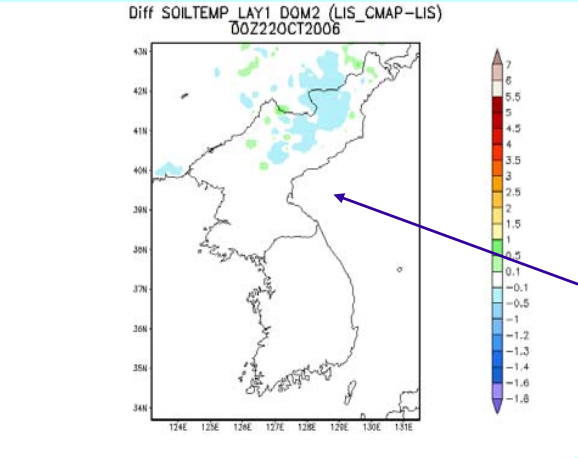
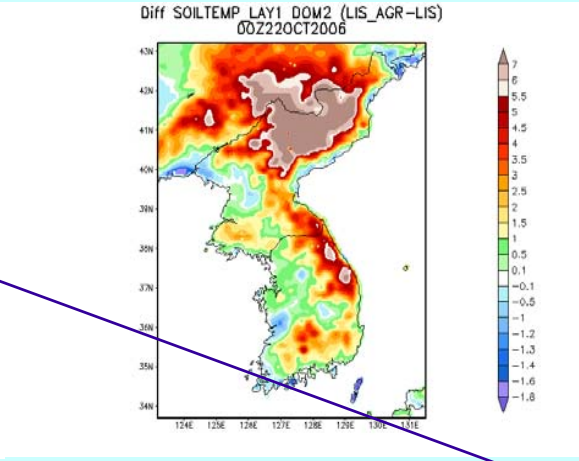
Soil Temp (layer 1) at Initial Time (22Oct 00Z), Domain2











Generally higher soil Temperature with FNL And AGRMET as Compared to LIS

LIS with CMAP forcing Looks almost same as LIS with GDAS

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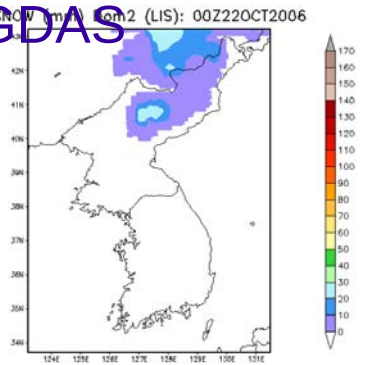
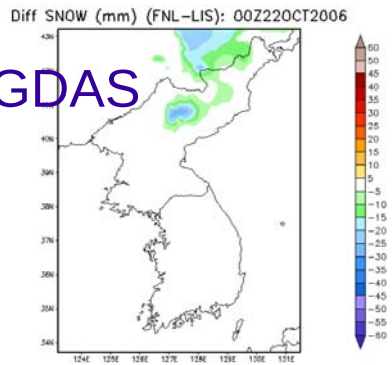
Snow Water Equivalent at Initial Time (22Oct 00Z), Domain2

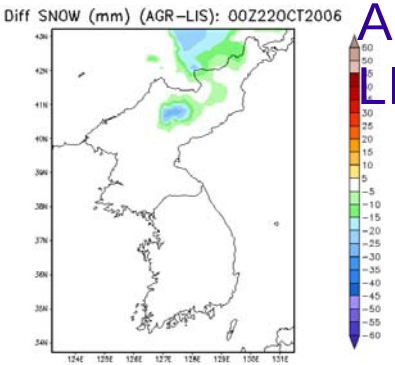
LIS_GDAS

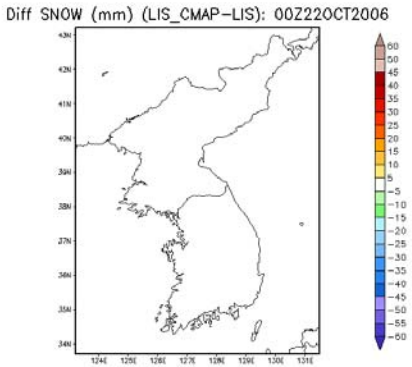


FNL-LIS_GDAS

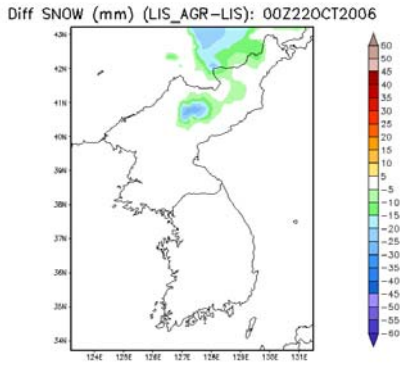


AGR-LIS_GDAS





LIS_CMAP-LIS_GDAS



LIS_AGR-LIS_GDAS

LIS shows more snow As compared to FNL and AGRMET over the northern region

FNL and AGRMET are Same

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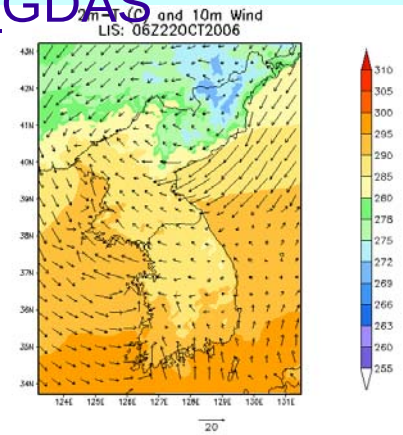
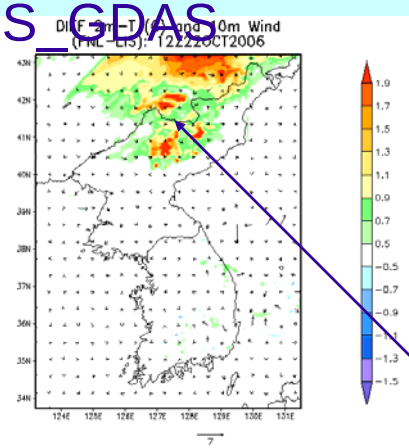
2m-T and 10m-Wind at (22Oct 06Z), Domain2 6hr Fcst

LIS_GDAS



FNL-LIS_GDAS



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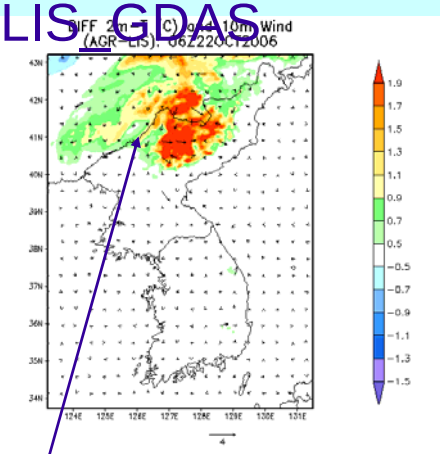
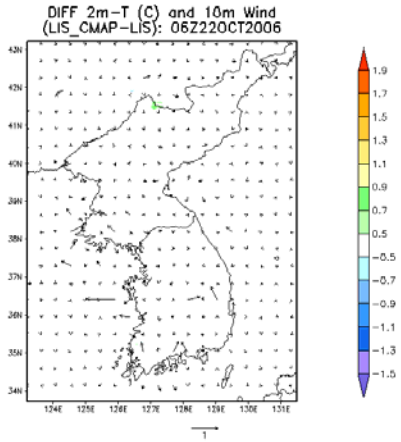
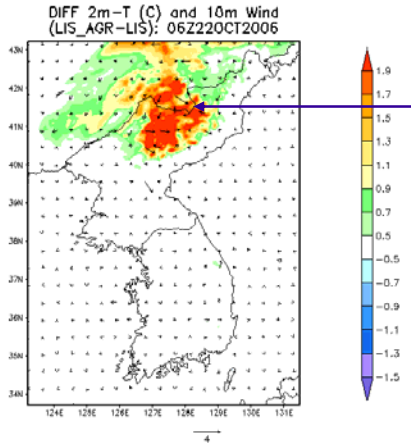




LIS_CMAP-LIS_GDAS



LIS_AGR-LIS_GDAS

More snow, wetter soil: LIS has lower T (0.5 - 1.7 K)

Not much diff
In the LIS_CMAP
Results as compared to LIS

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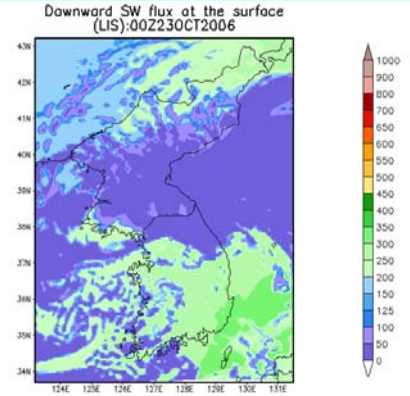
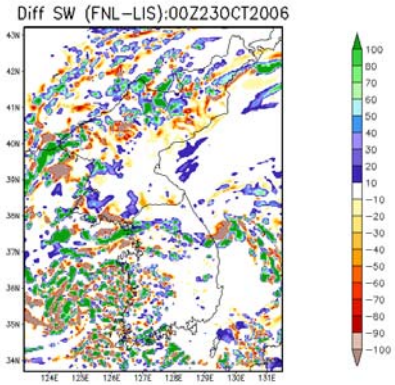
Downward SW Radiation at 23Oct 2006, 00Z 24 hr Fcst

LIS_GDAS



FNL-LIS_GDAS



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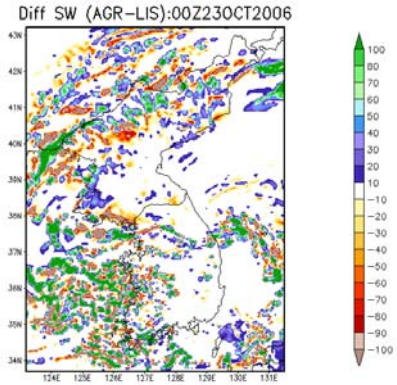
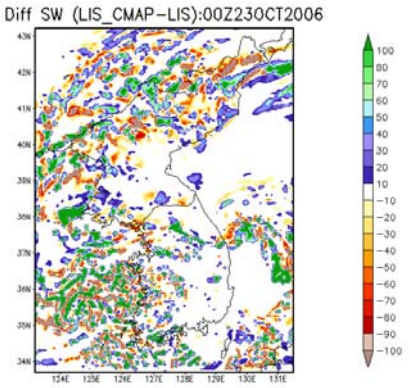
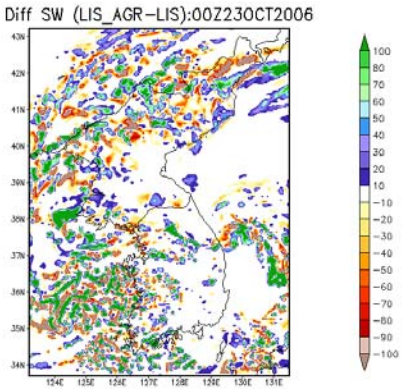




LIS_CMAP-LIS_GDAS



LIS_AGR-LIS_GDAS

Initial soil conditions impact cloud formation and radiation at the surface

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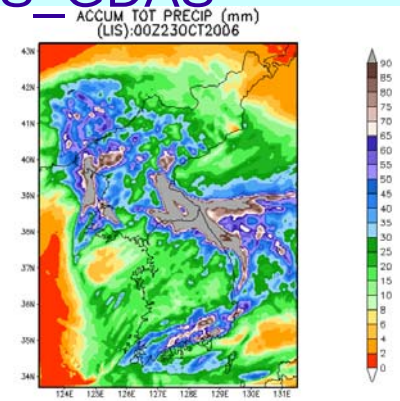
Total Accumulated Rain (mm) at (23Oct 00Z), Domain2

LIS_GDAS



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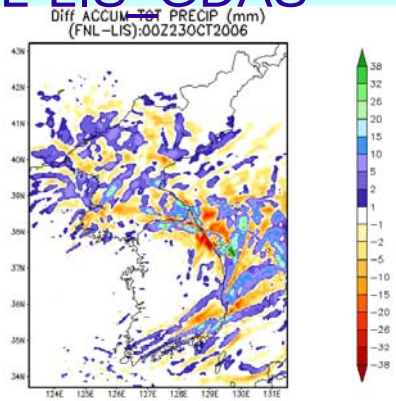
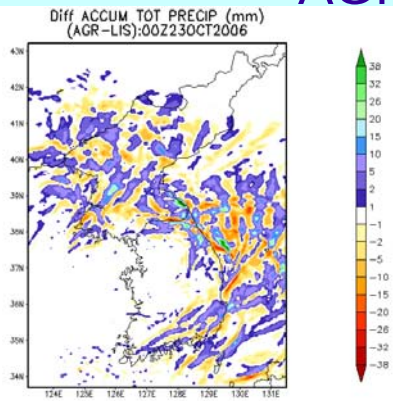
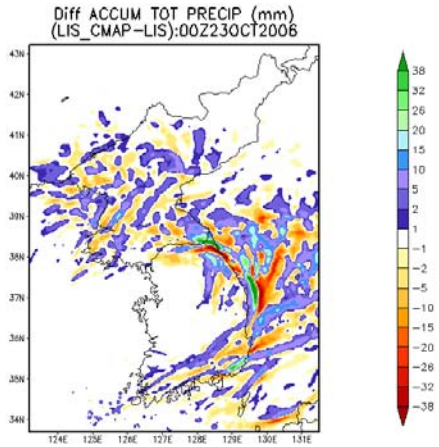
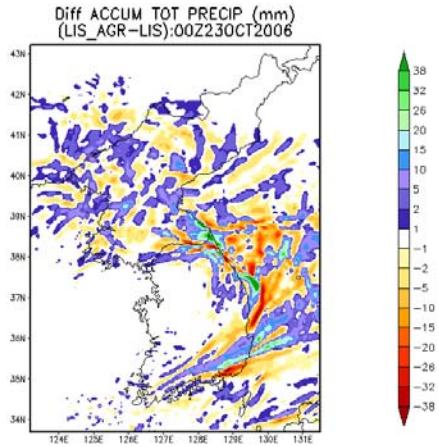


AGR-LIS_GDAS





LIS_CMAP-LIS_GDAS



LIS_AGR-LIS_GDAS

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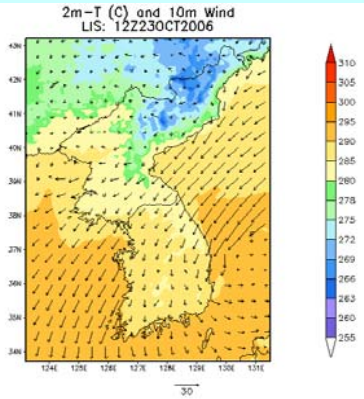
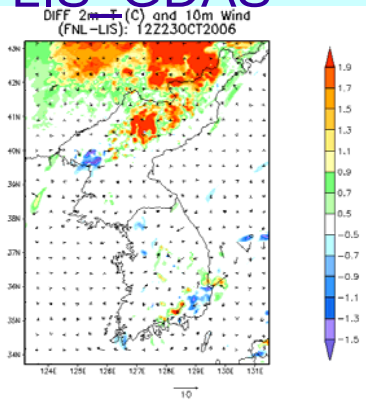
2m-T and 10m-Wind at (23Oct 12Z), Domain2
36 hr Fcst

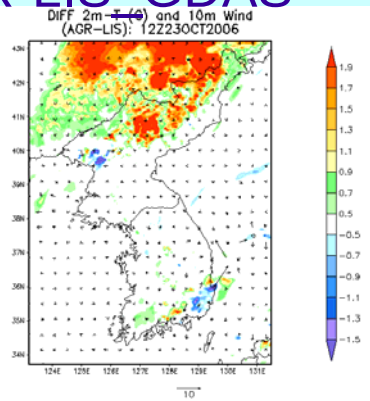
LIS_GDAS

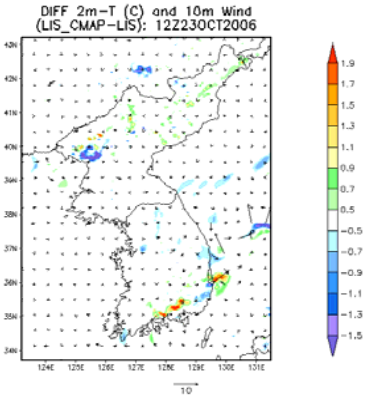


FNL-LIS_GDAS

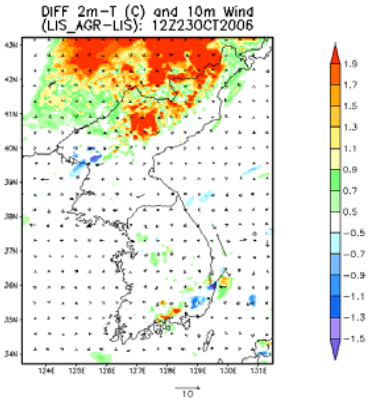


AGR-LIS_GDAS





LIS_CMAP-LIS_GDAS



LIS_AGR-LIS_GDAS

These differences caused by initial soil conditions persist in forecast and slightly grow with larger difference
in temperature

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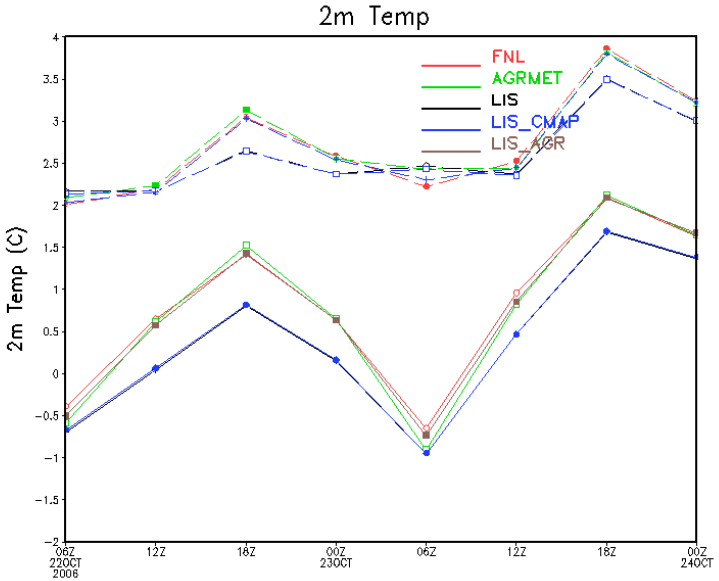
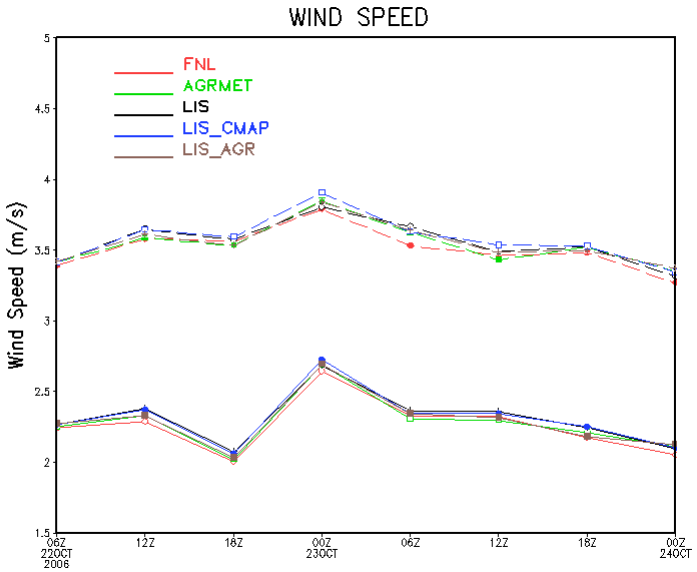
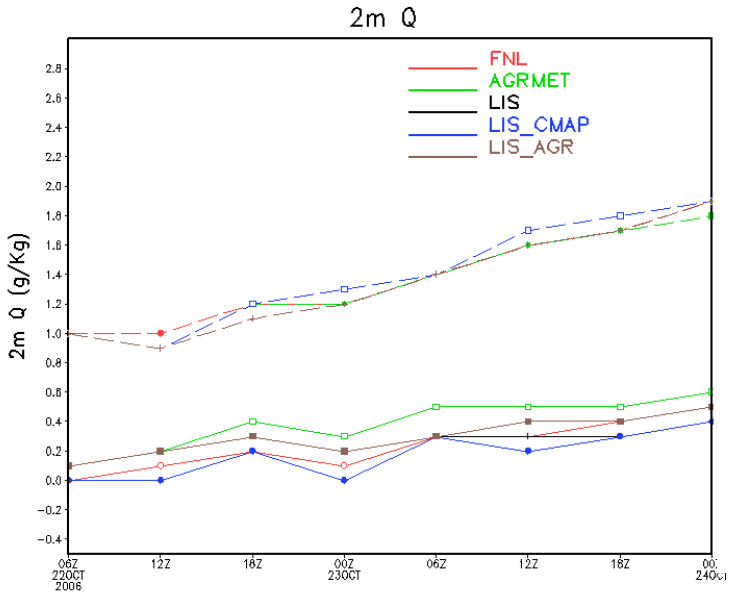
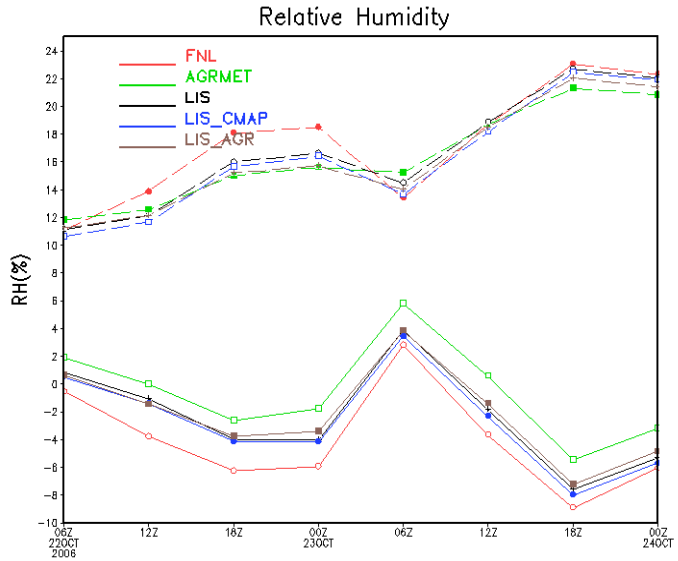
Surface Variable Verification (285 Stations over 15km domain), Initial Time 22Oct 00Z









FNL
AGRMET
LIS_GDAS
LIS_CMAP
LIS_AGRMET

LIS produce better q,RH and nighttime T

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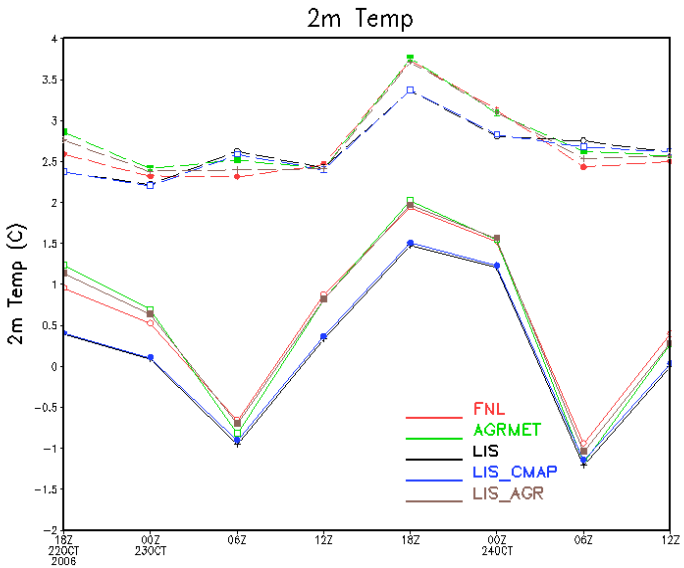
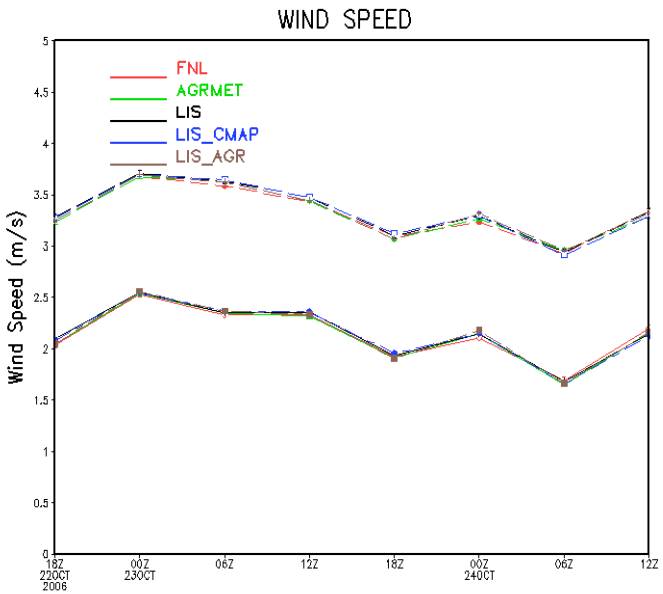
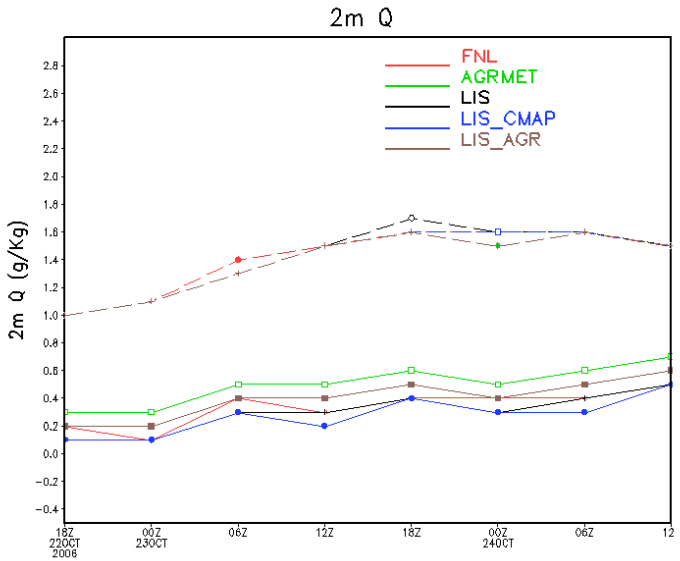
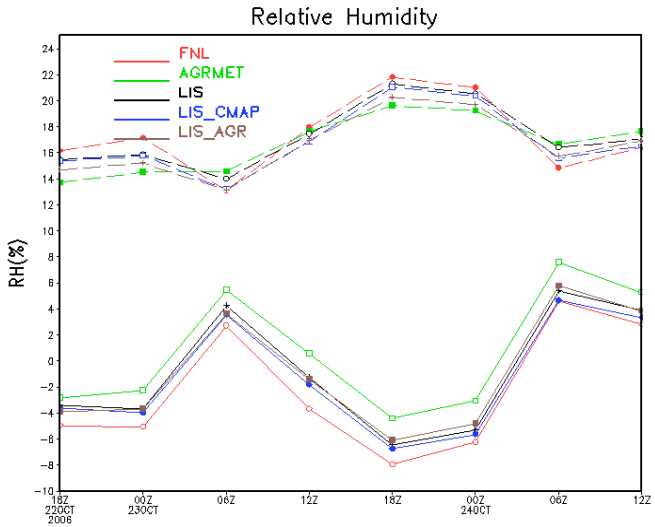
Surface Variable Verification (285 Stations over 15km domain) Initial Time 22Oct 12Z









FNL
AGRMET
LIS_GDAS
LIS_CMAP
LIS_AGRMET

LIS GDAS and LIS With CMAP Forcing produces the lowest bias in temp (among all simulations)
And seems to perform Better in night time

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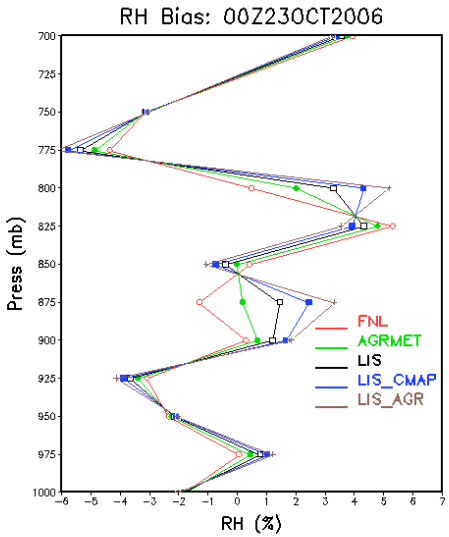
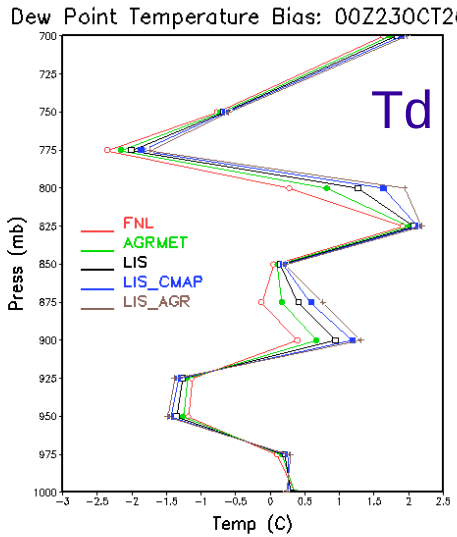
Soundings Verification (15km domain), at 24Hr Fcst (23Oct 00Z), Bias

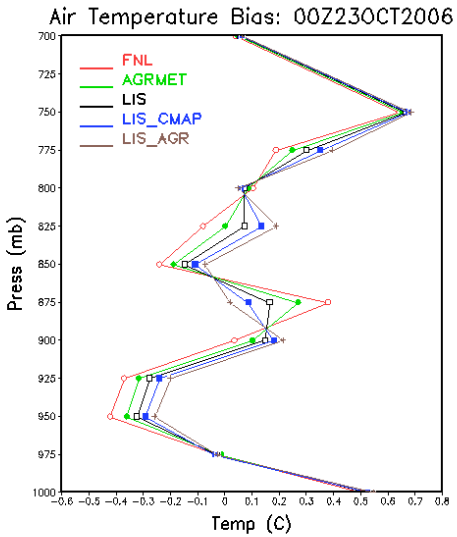
RH



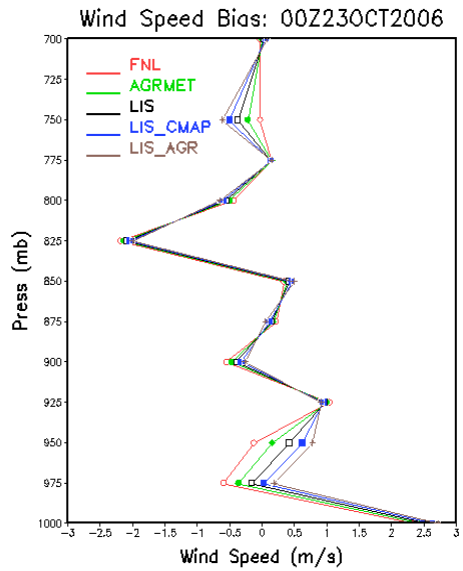


Generally, LIS better in T, and wind speed

AirT



Wind Speed



Summary

- Land surface is one of the two primary driving force for boundary layer development: affecting forecast of surface weather variables, boundary layer structures, cloud, and precipitation
- Critical role of initialization of land-state variables (soil moisture, soil temperature, snow, etc.)
- LIS provides different options for surface initialization
- LIS produces lowest bias in temperature and wind for the lower boundary layer
- Much work remain to be explored in better use of LIS in WRF

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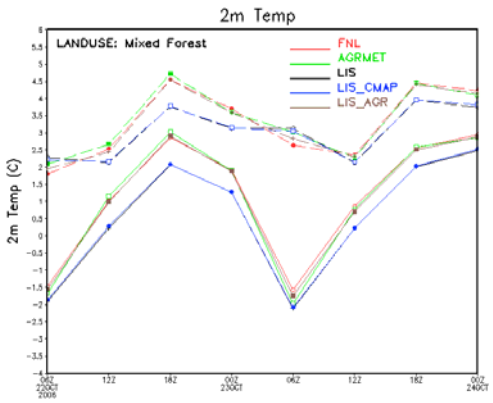
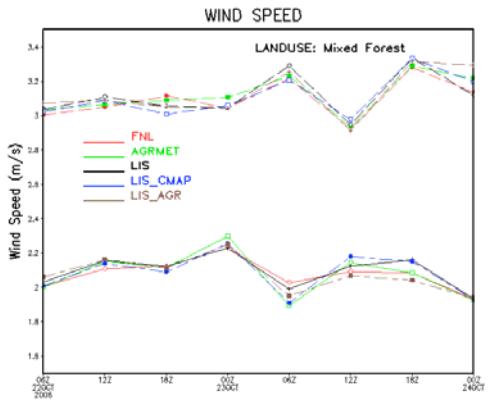
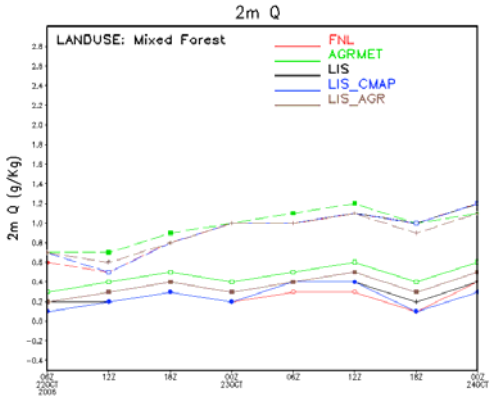
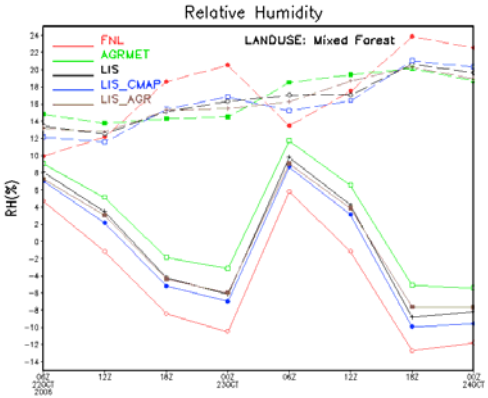
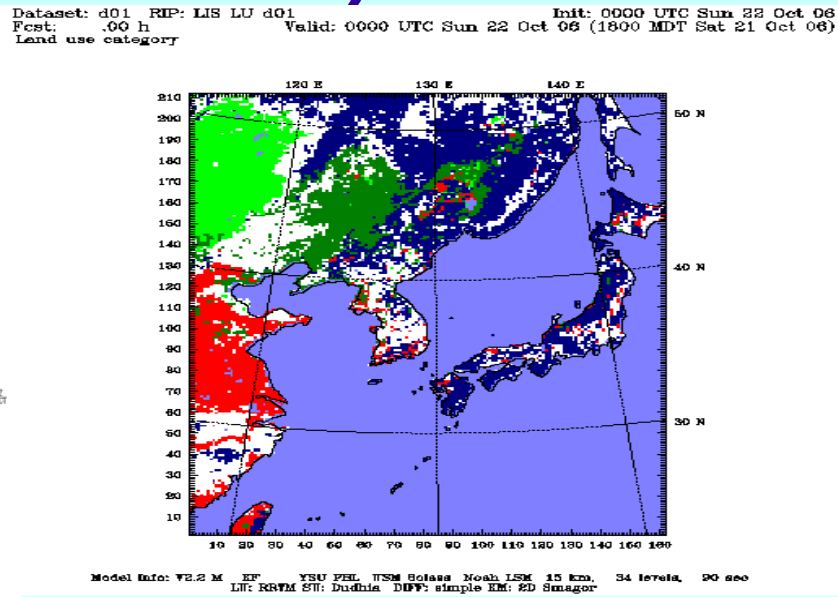
LU Based (for Mixed Forest) Verification (52 Stations over 15km domain)











15: Mixed Forest
2: Dry Cropland
3: Irrigated
7: Grassland

Mixed forest contributes to similar bias pattern as for the all stns over the domain
But mixed forest seems to be a dominant Contributor for the higher cold bias in temp

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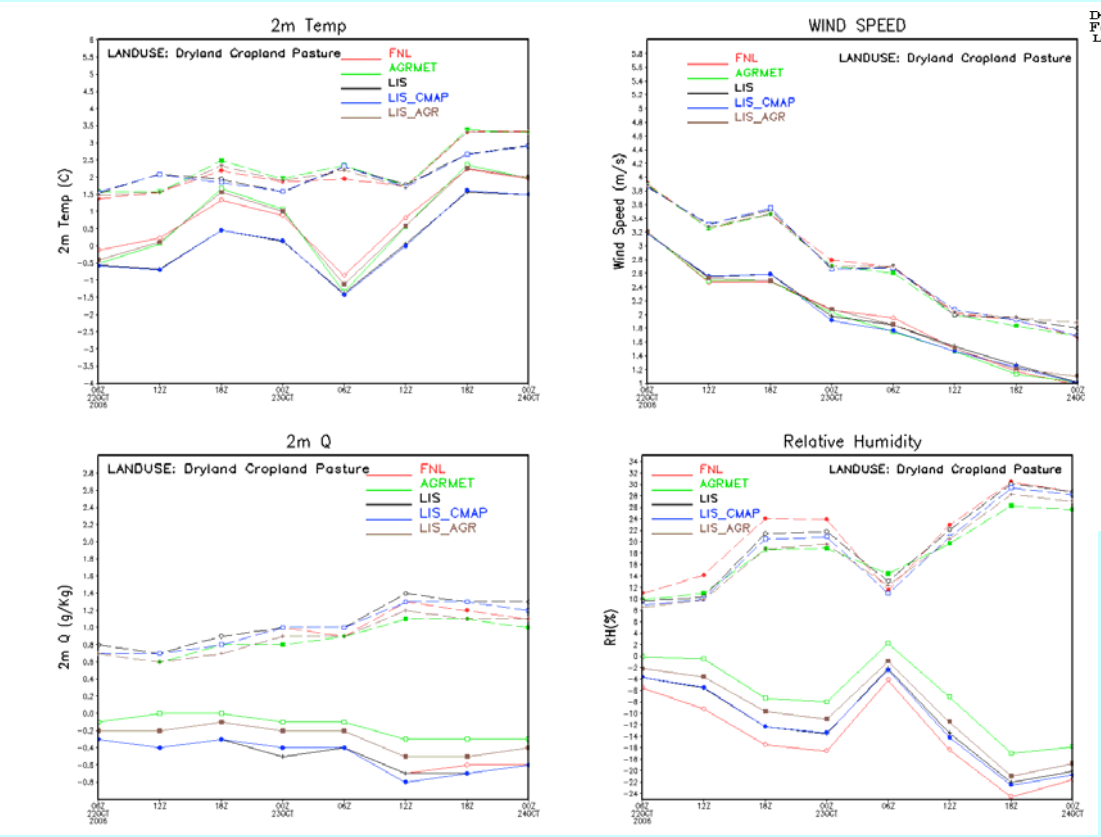
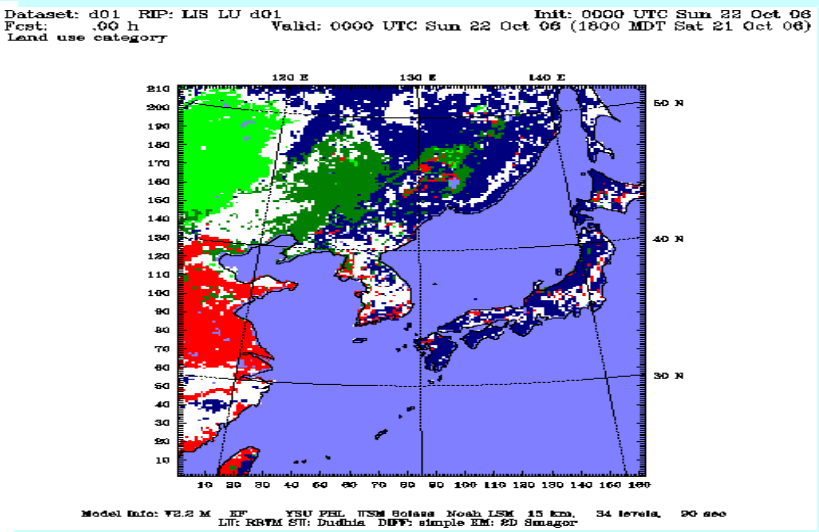
LU Based (for Dryland Cropland Pasture) Verification (39 Stations over 15km domain)





15: Mixed Forest
2: Dry Cropland
3: Irrigated
7: Grassland

Similar to Irrig Cropland

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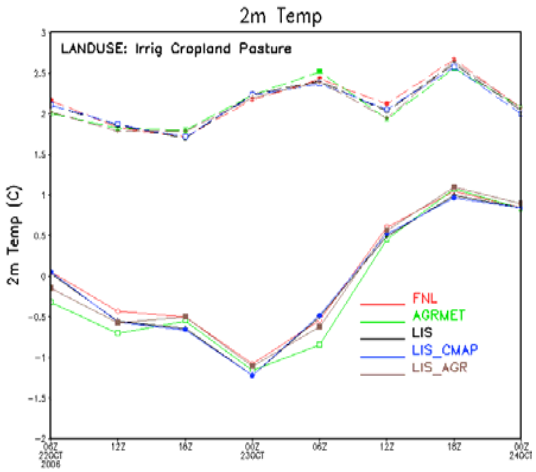
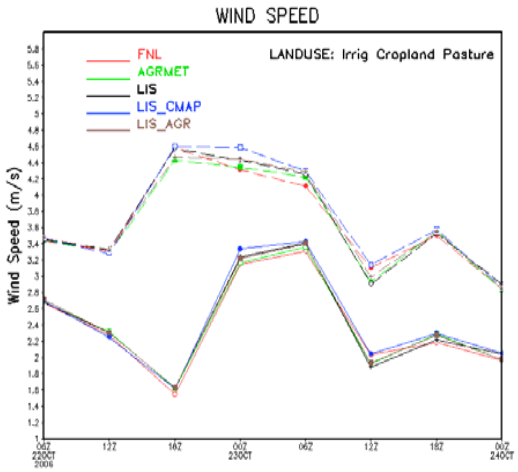
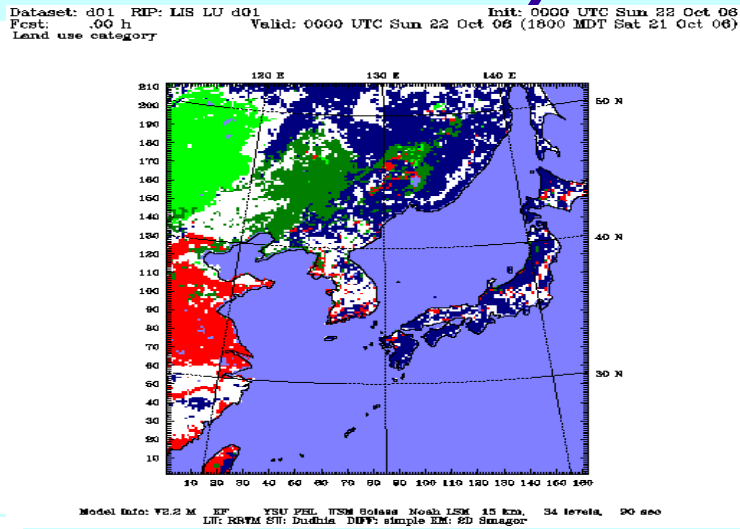
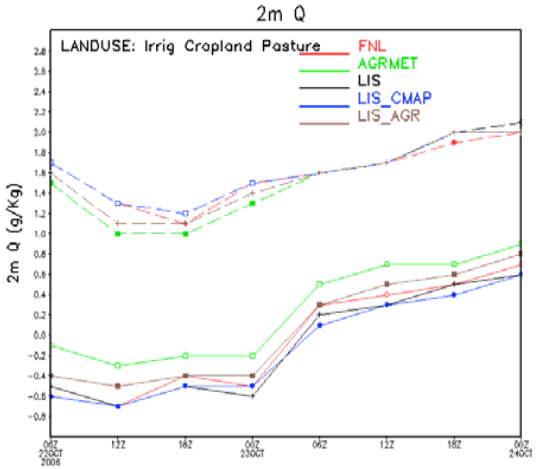
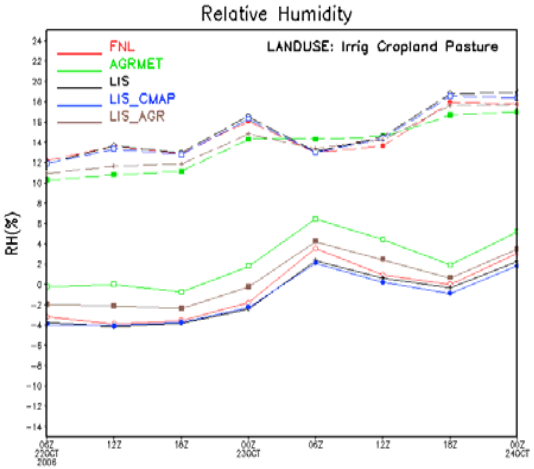
LU Based (for Irrig Cropland Pasture) Verification (43 Stations over 15km domain)











15: Mixed Forest
2: Dry Cropland
3: Irrigated
7: Grassland

Irrig Cropland generally produces
Lower biases in temp

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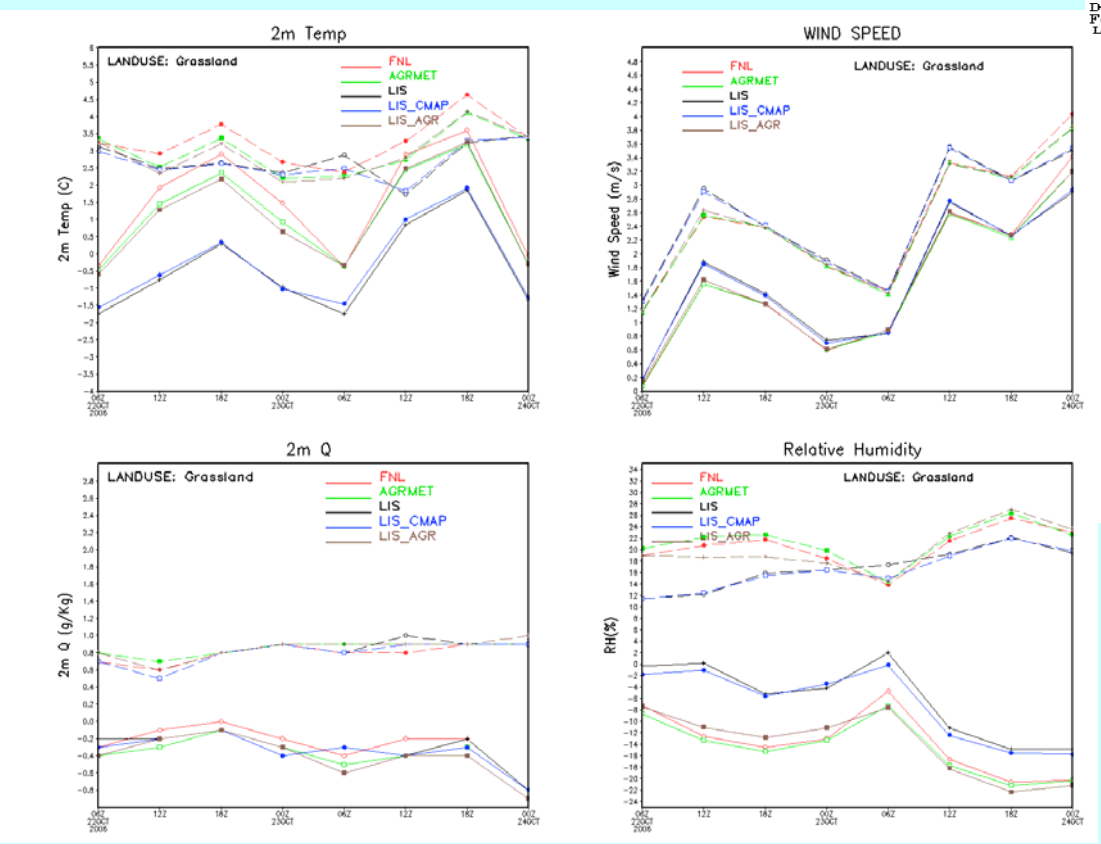
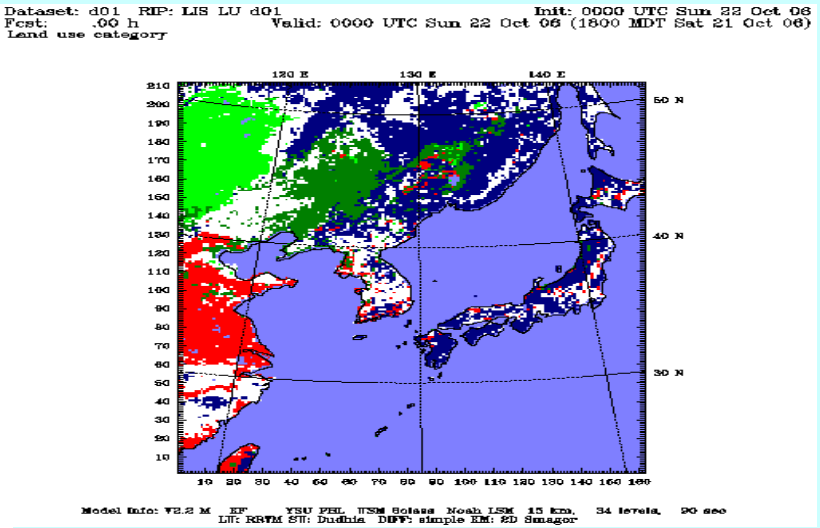
LU Based (for Grassland) Verification (16 Stations over 15km domain)





15: Mixed Forest
2: Dry Cropland
3: Irrigated
7: Grassland

LIS performance over this LU type is Night time: bettter, similar to all stns verification

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