



Assessing the Land Component of the NCEP Global Forecast System (GFS) via CEOP Reference Site Observations



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NCEP Environmental Modeling Center

CEOP Implementation Planning Meeting

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NCEP: *Where America's Climate and Weather Services Begin*

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 - providing majority of funding for NCEP participation in CEOP
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 - program in NOAA Climate Program Office (NCPO, formerly “OGP”)
- **Steve Williams: UCAR/JOSS CEOP Reference Site Archive**
 - common formats, single portal and QC across all reference sites
- **CEOP Reference site operators**
- **Frank Beyrich: German Weather Service**
 - Meteorology Observatory of Lindenberg, Richard-Assmann Observatory
 - Accelerating availability of summer 2005 observations from Baltex Lindenberg reference site
- **Beate Geyer: Max-Planck Institute**
 - GKSS Research Centre
 - Conversion of NCEP global model time series output to NetCDF format

NCEP meets its CEOP Commitment

- Provides NCEP Global Forecast System output to CEOP MPI Model Archive
 - accomplished on a robust daily schedule
- Validates NCEP model output against CEOP Reference sites
 - across the major continents
- Provides CEOP with detailed documentation of NCEP model characteristics at the CEOP reference sites
 - updates documentation for each major model upgrade
- Key contributor to CEOP model output strategy documents
 - Documenting land surface characteristics
- Regular participant in CEOP Implementation Planning Meetings
 - New York, Tokyo, Irvine CA, Berlin, Paris
 - Monthly international teleconferences
- Contributes articles to CEOP Newsletter
 - Recent effort to convert model times series format to NetCDF

NCEP Implemented Major Upgrade to its Global Forecast System on 31 May 2005

www.emc.ncep.noaa.gov/gc_wmb/Documentation/TPBoct05/T382.TPB.FINAL.htm

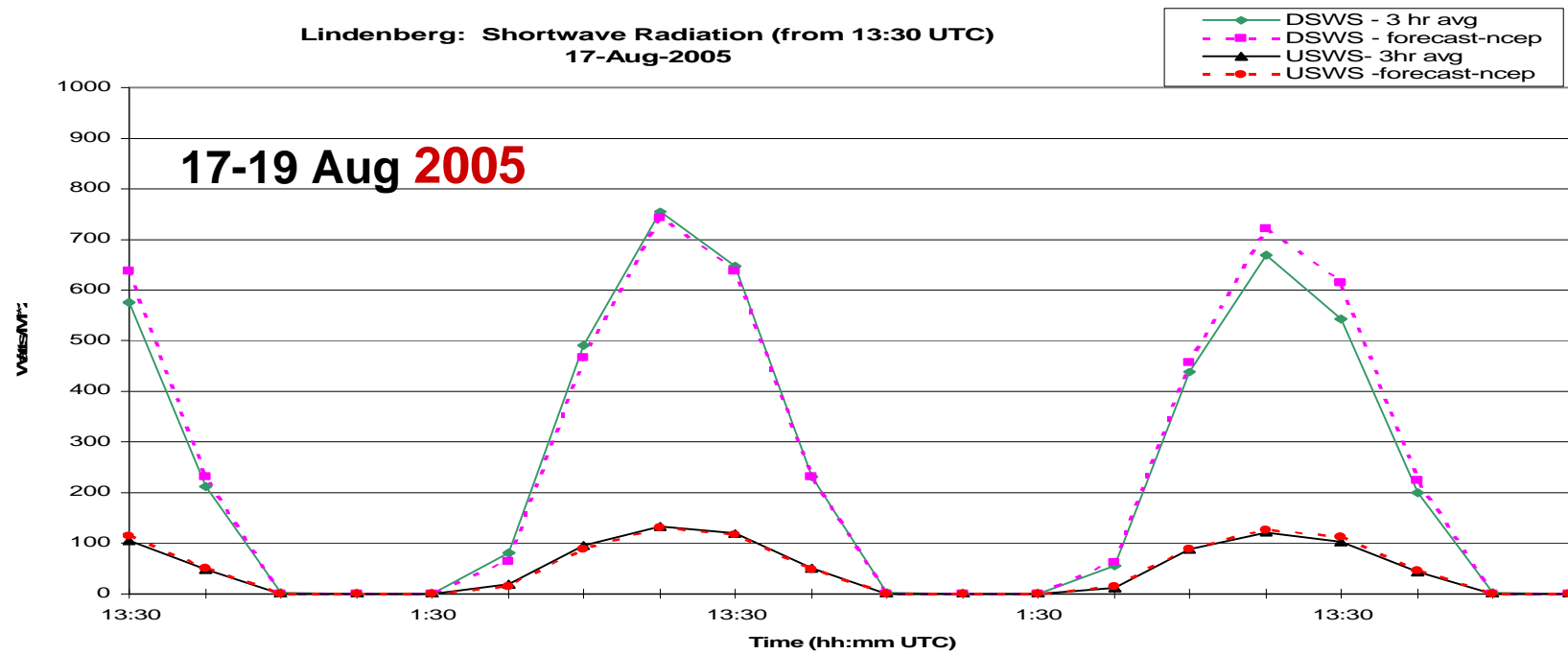
- Horizontal resolution increase
 - T382 (~35 km) from T254 (~50 km)
- Analysis changes
 - additional satellite radiance data is assimilated
 - enhanced quality control of input observations
 - improved emissivity calculations over snow and ice
- New sea-ice model
- Modified vertical diffusion
- Refined gravity-wave drag treatment
- Major Land Surface Model upgrade (focus of this talk)
 - newer Noah LSM replaces older OSU LSM
 - Noah LSM now unified across NCEP global & regional NWP models
 - soon in next NCEP global reanalysis and seasonal forecast system
 - **See November 2005 GEWEX News for more details**

Noah LSM versus OSU LSM in NCEP Global Model

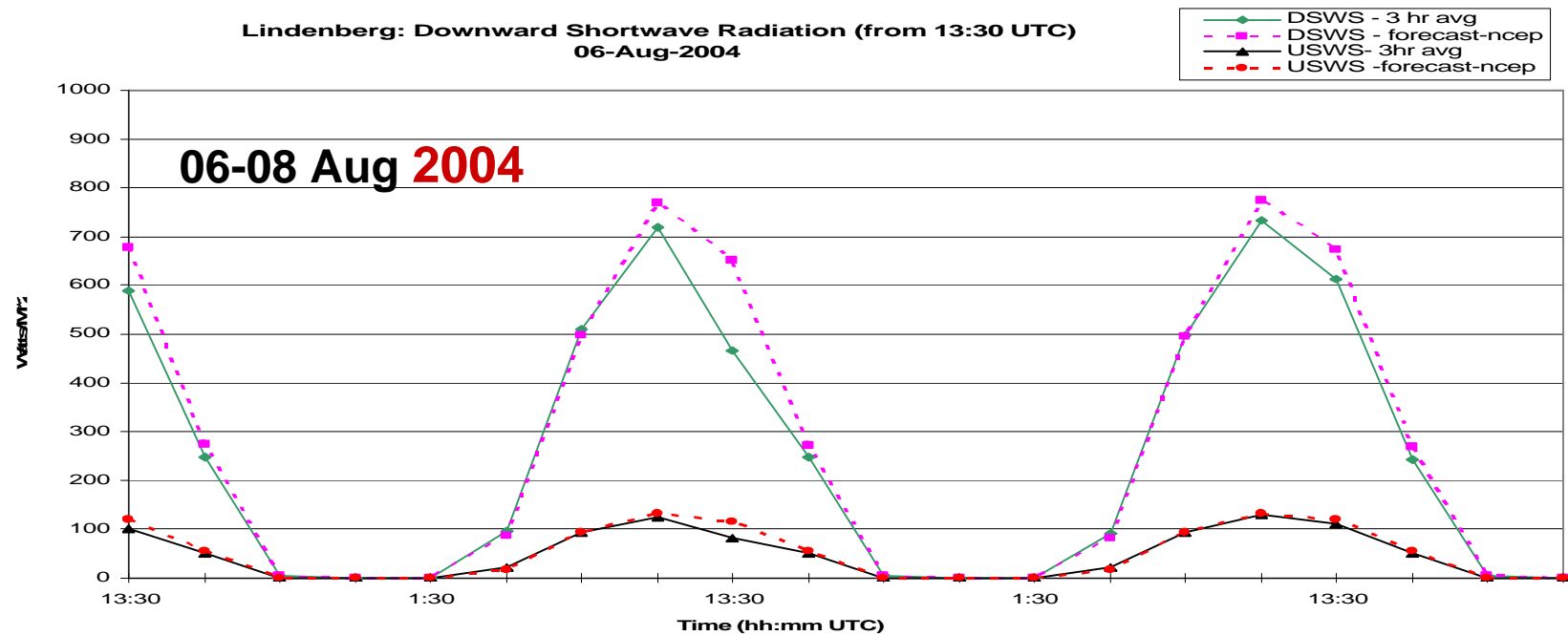
- 4 soil layers (10,30,60,100 cm) vs. 2 soil layers (10, 190 cm)
- land surface evaporation: *reduced high bias in warm-season*
- vegetation cover: *improved properties and seasonality*
 - improved seasonal cycle of green vegetation fraction
 - spatially varying root depth (1-2 m) vs. constant 2 m
- add frozen soil physics (freeze/thaw latent heat, limit infiltration)
- snowpack physics improvements: *greatly reduced early melt bias*
 - add snow density state variable (retain SWE)
 - retain some snowmelt in snowpack and allow refreezing
 - refine functions for snow cover fraction and snow albedo
 - add patchy snow cover treatments to
 - snow sublimation, sensible & ground heat flux, skin temp
 - improved numerics/robustness for very shallow snow
- transpiration: refine soil moisture threshold for stress onset
- direct soil evaporation: revise dependence on soil moisture
- smaller ground heat flux bias
 - especially: wet soil, under snowpack, under dense vegetation
 - new functions for soil thermal diffusivity and soil heat capacity

Assessing NCEP Global Forecast System at **Baltex Lindenberg** CEOP Reference Site (the agricultural site)

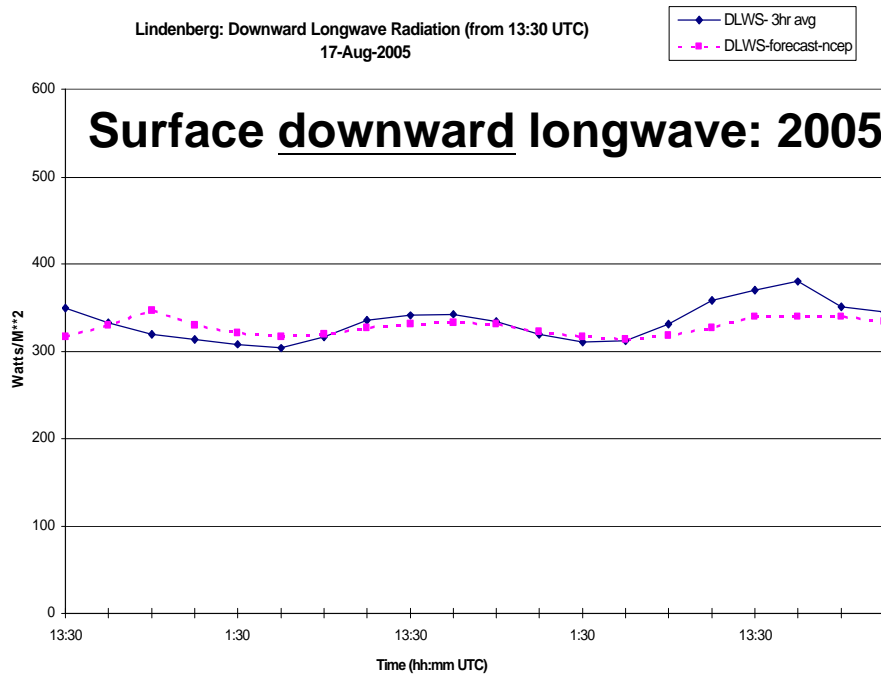
- **August 2005** (**top** frames in following plots)
 - summer after May 2005 global system upgrade
- **August 2004** (**bottom** frames in following plots)
 - summer before 2005 global system upgrade
 - **Dotted Lines:** NCEP Global Model Forecast
 - **Solid Lines:** Lindenberg Reference Site Obs



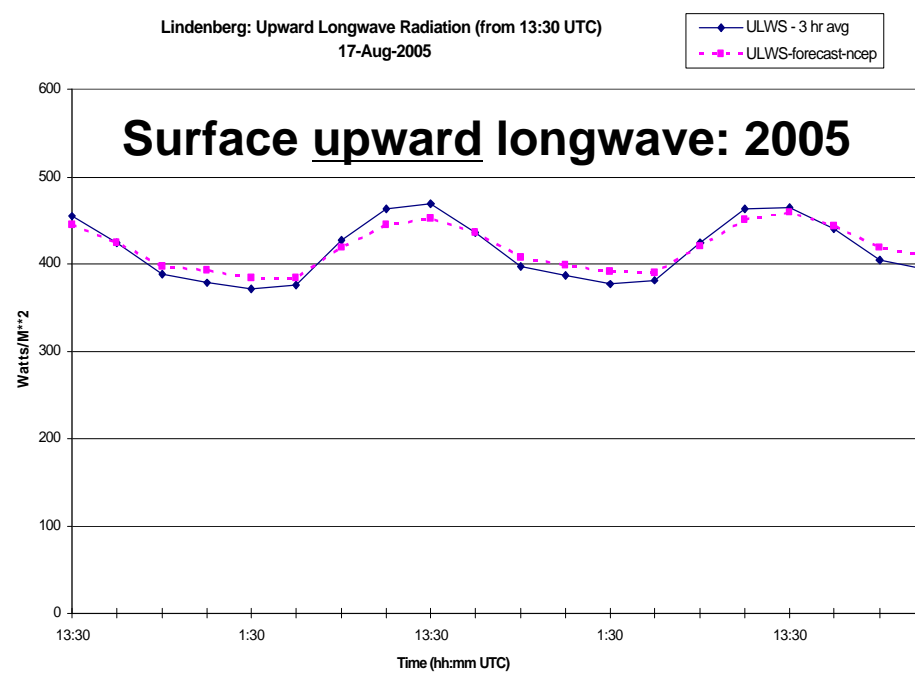
Downward and Upward Surface Solar Insolation



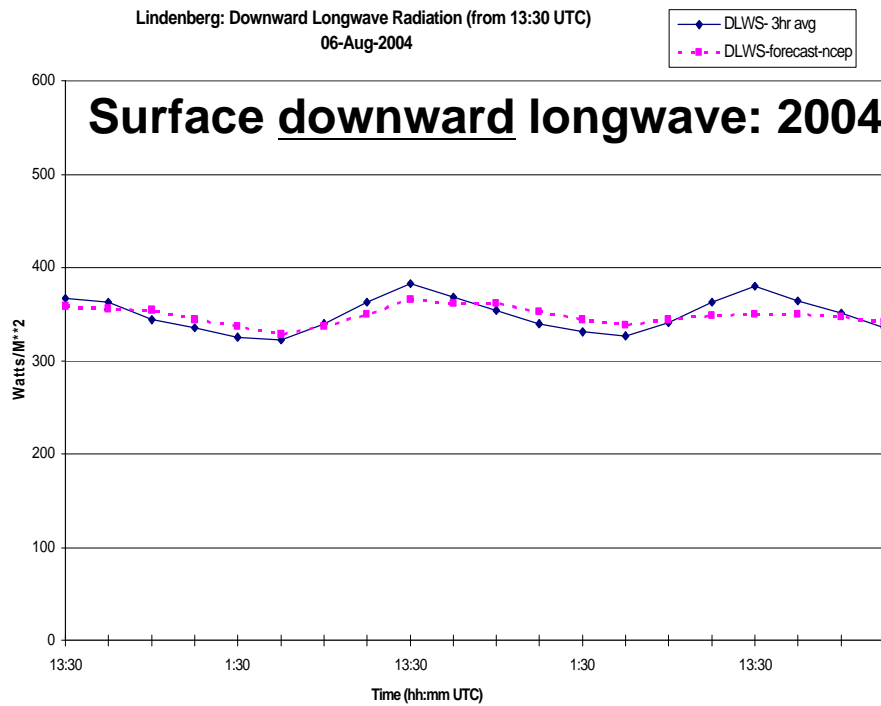
Lindenberg: Downward Longwave Radiation (from 13:30 UTC)
17-Aug-2005



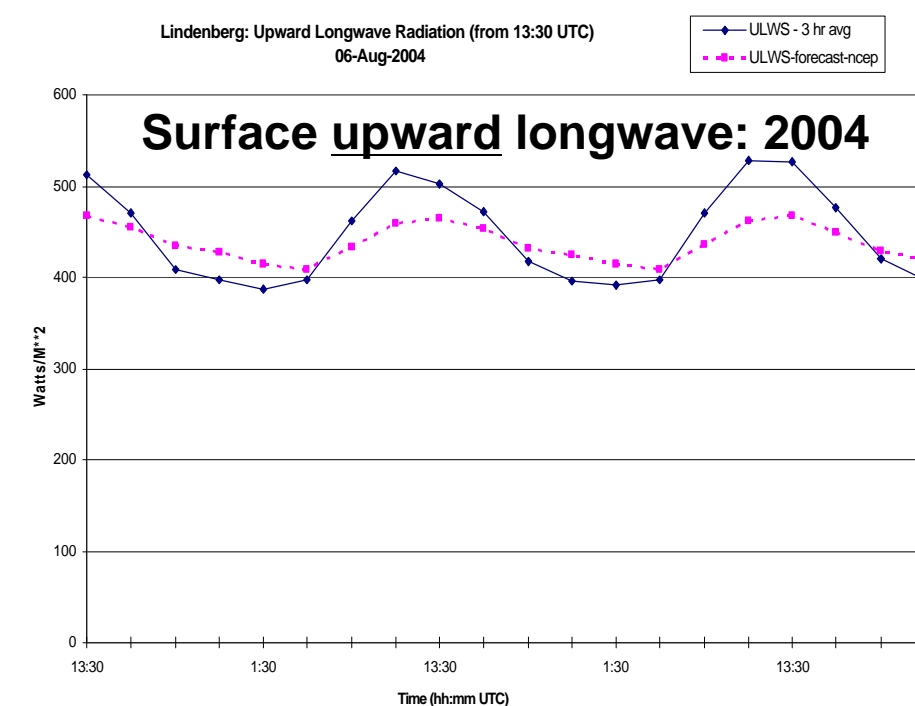
Lindenberg: Upward Longwave Radiation (from 13:30 UTC)
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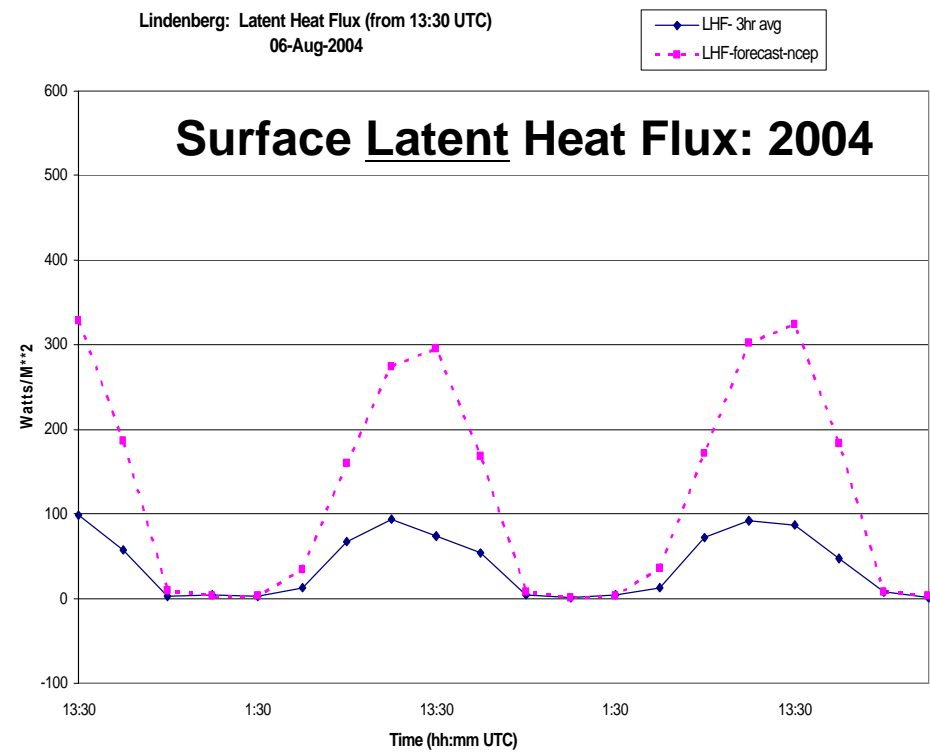
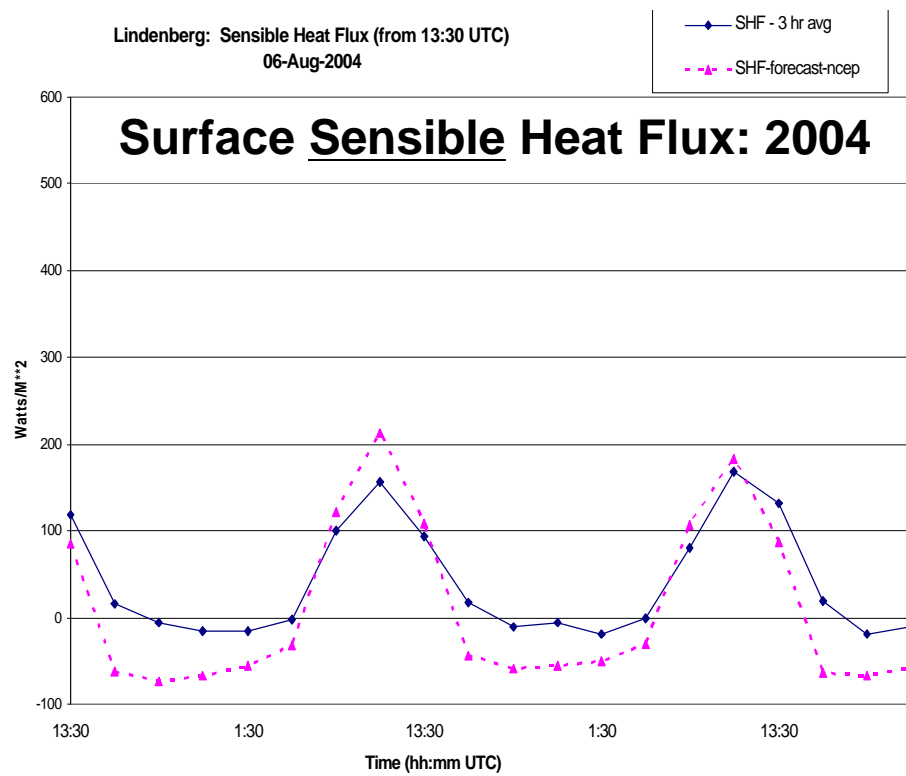
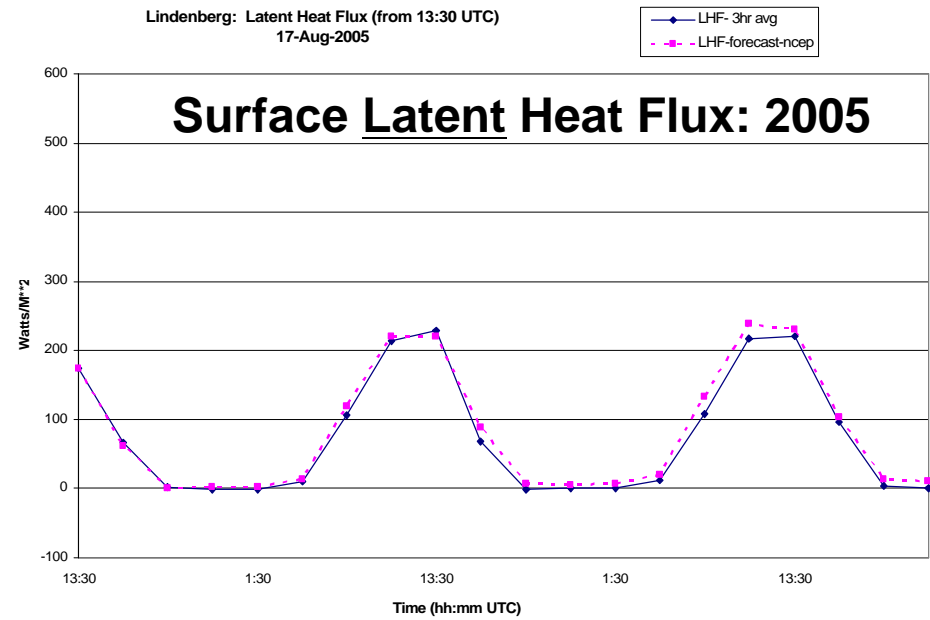
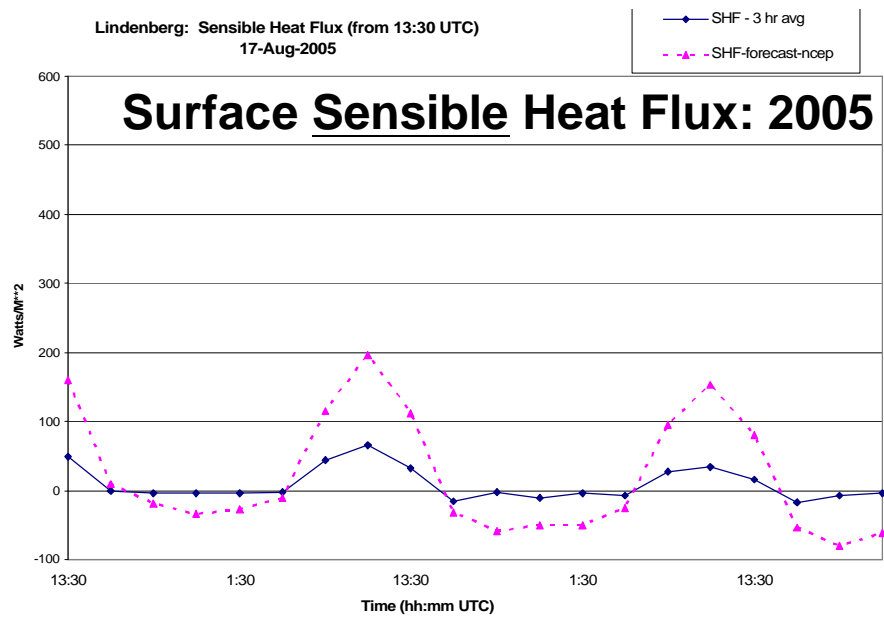


Lindenberg: Downward Longwave Radiation (from 13:30 UTC)
06-Aug-2004



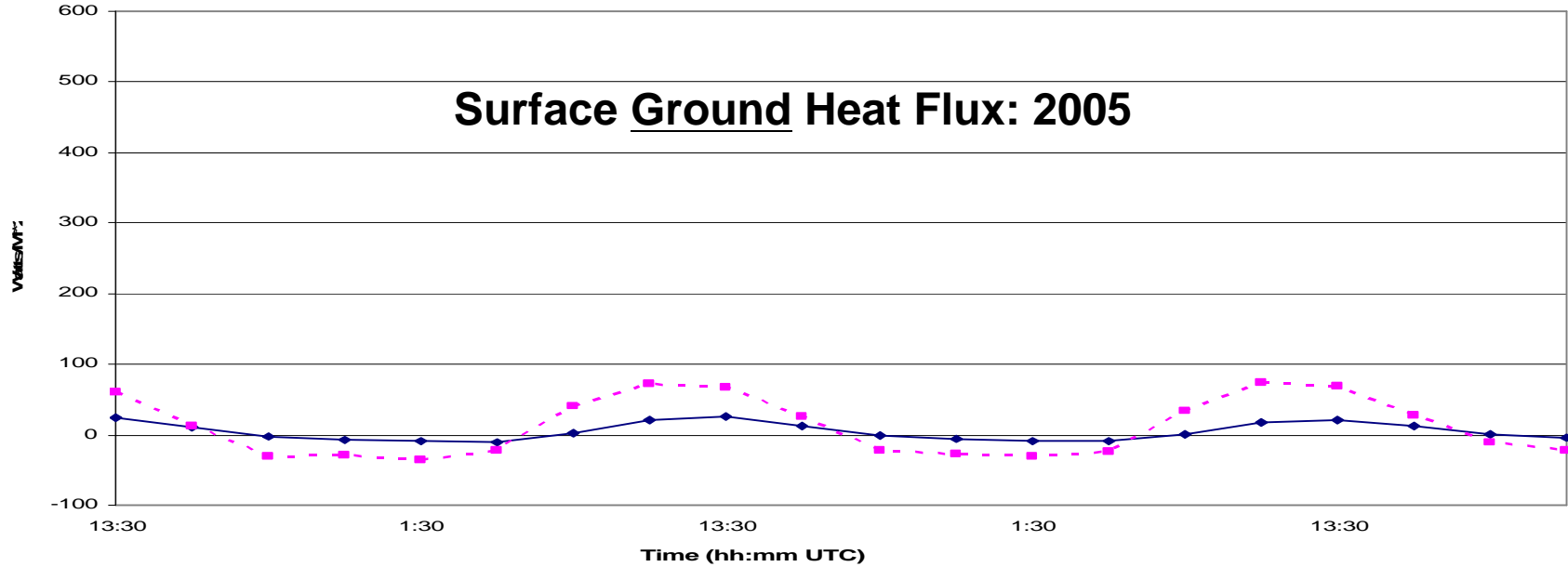
Lindenberg: Upward Longwave Radiation (from 13:30 UTC)
06-Aug-2004





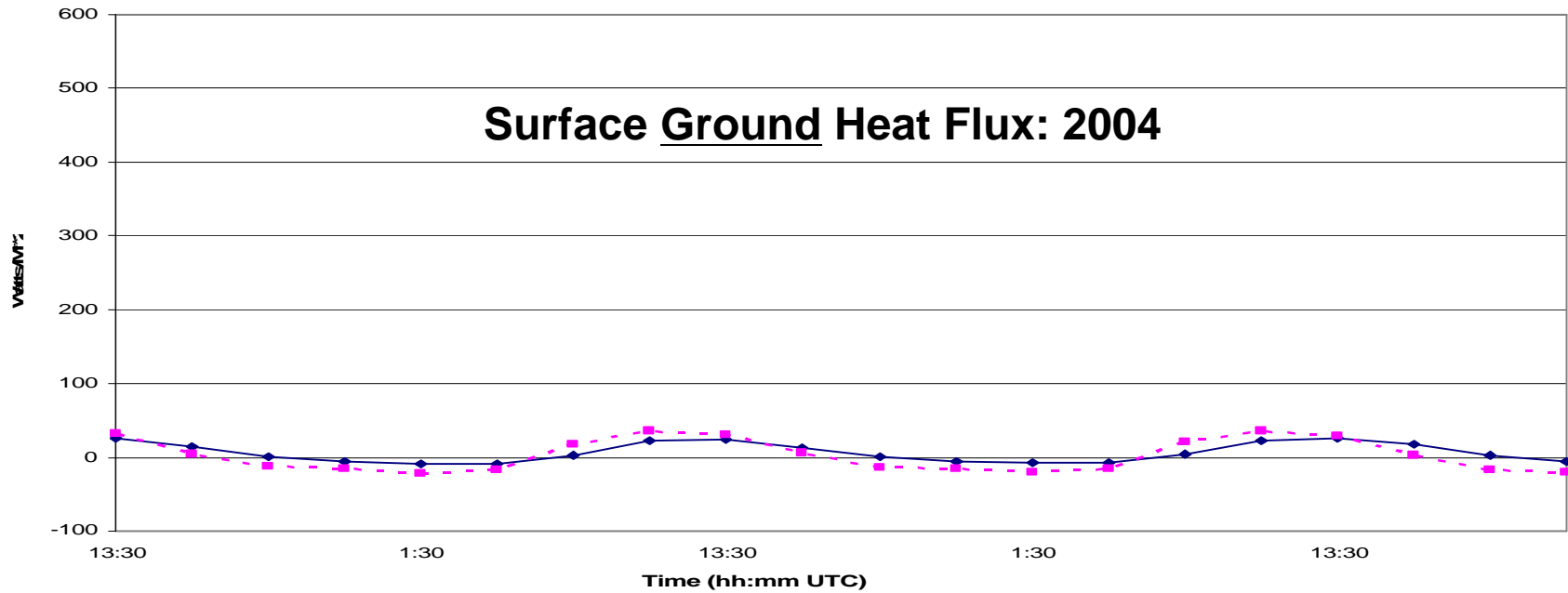
Lindenberg: Ground Heat Flux (from 13:30 UTC)
17-Aug-2005

Grnd Heat Flux - 3hr avg
Grnd Heat Flux-forecast-ncep(+daytime)



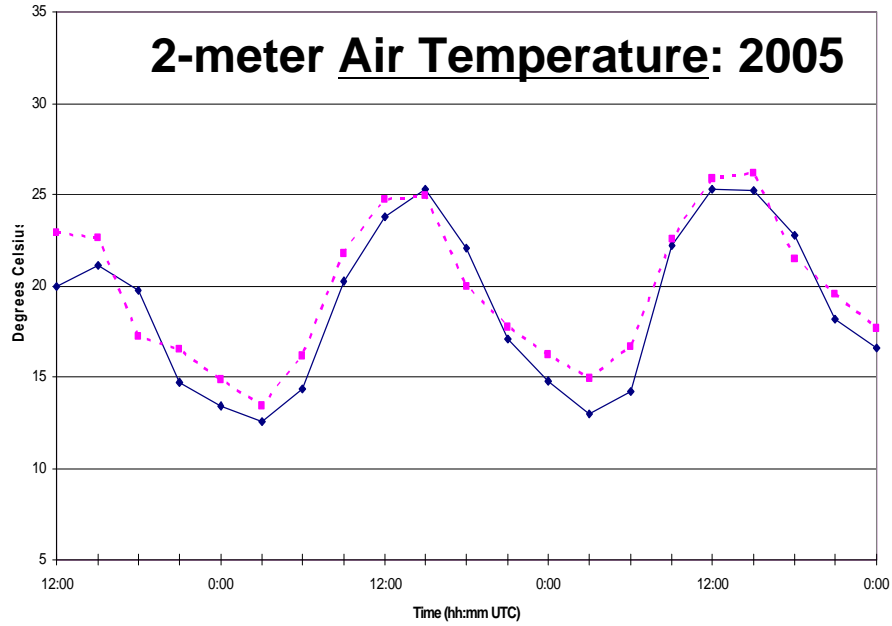
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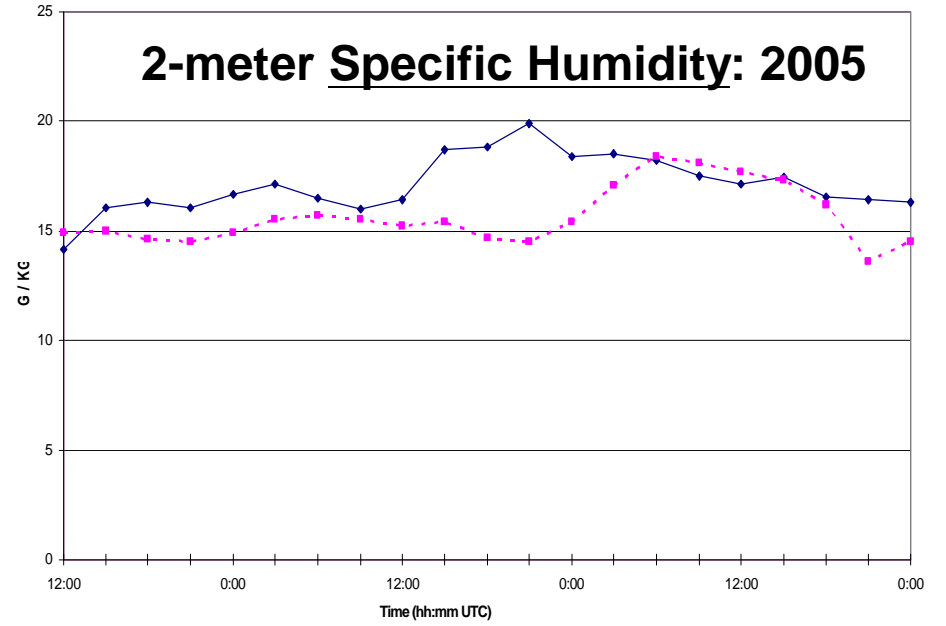
Lindenberg: 2M Air Temperature (from 12:00 UTC)
17-Aug-2005

—●— 2m_air-temp
- -■- - 2m_air-temp_ncep



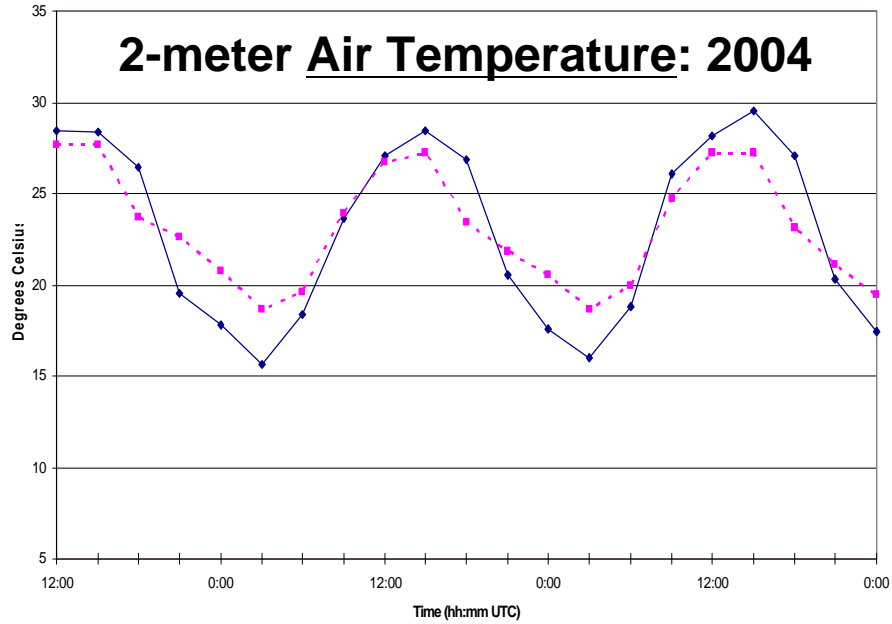
Lamont-SGP: 2M Specific Humidity (from 12:00 UTC)
16-Aug-2005

—●— 2m_spec-humid
- -■- - 2m_spec-humid_ncep



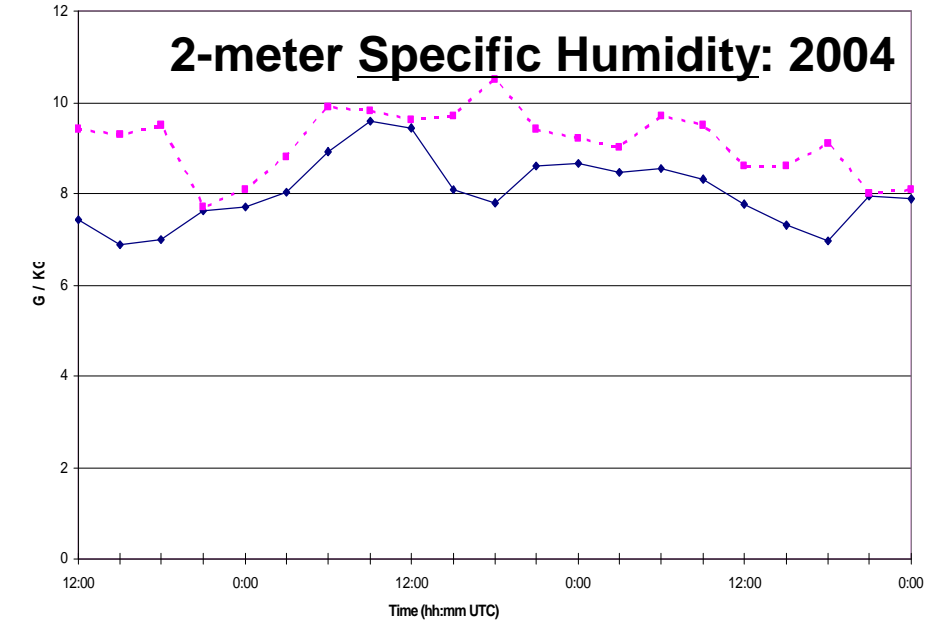
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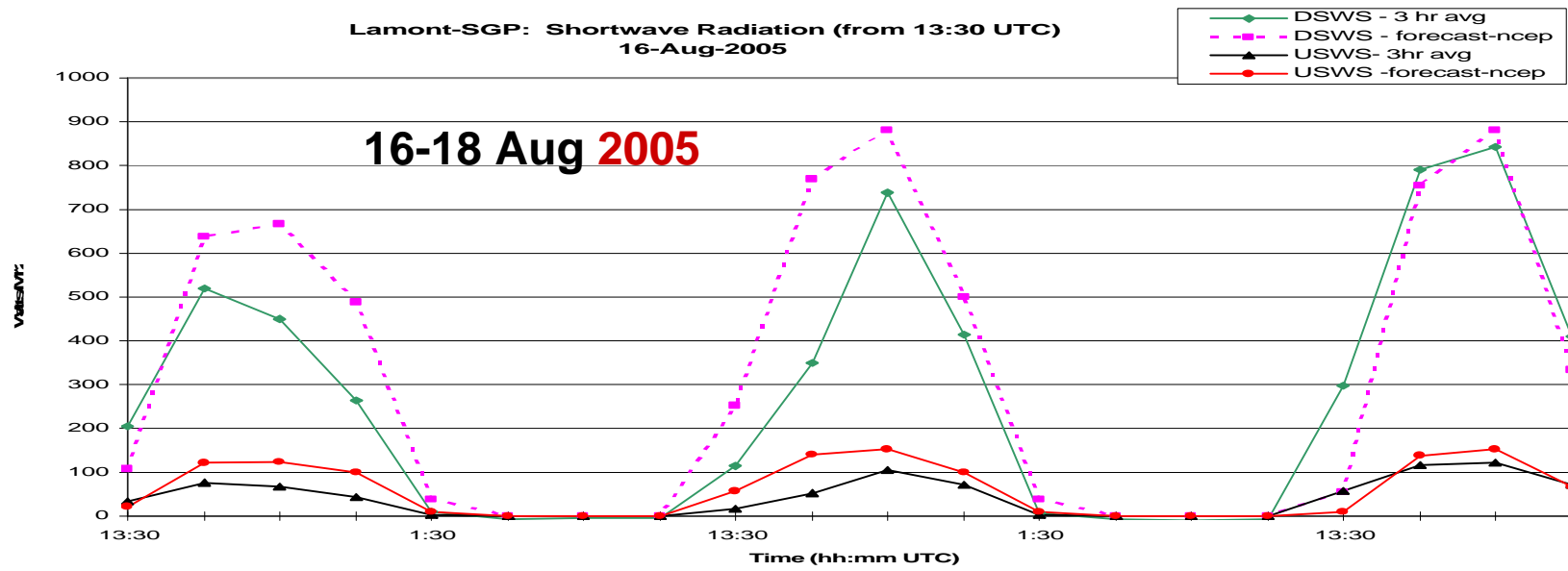
Lindenberg: 2M Specific Humidity (from 12:00 UTC)
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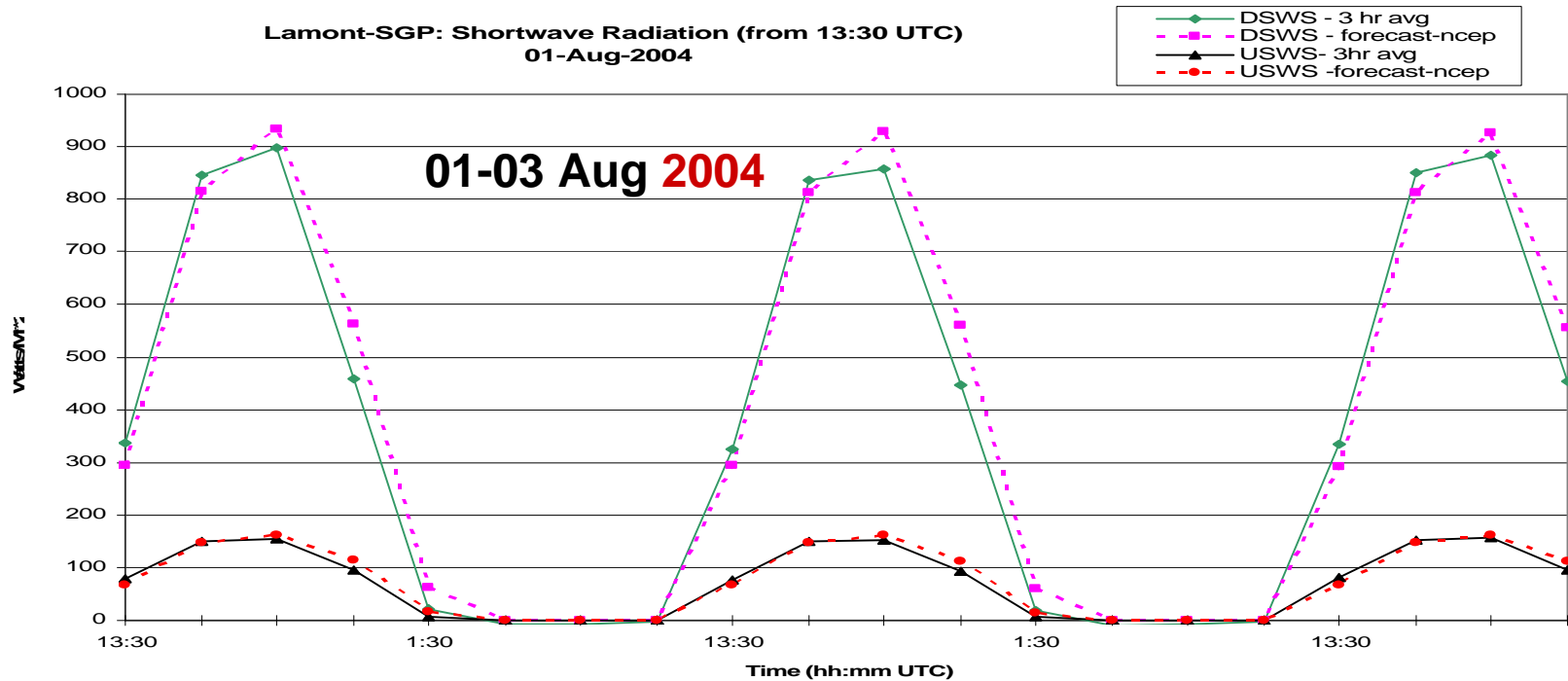


Assessing NCEP Global Forecast System at the **U.S. Southern Great Plains (SGP)** CEOP Reference Site (the Lamont site)

- **August 2005** (**top** frames in following plots)
 - summer after May 2005 global system upgrade
- **August 2004** (**bottom** frames in following plots)
 - summer before 2005 global system upgrade
 - **Dotted Lines:** NCEP Global Model Forecast
 - **Solid Lines:** SGP Lamont Reference Site Obs

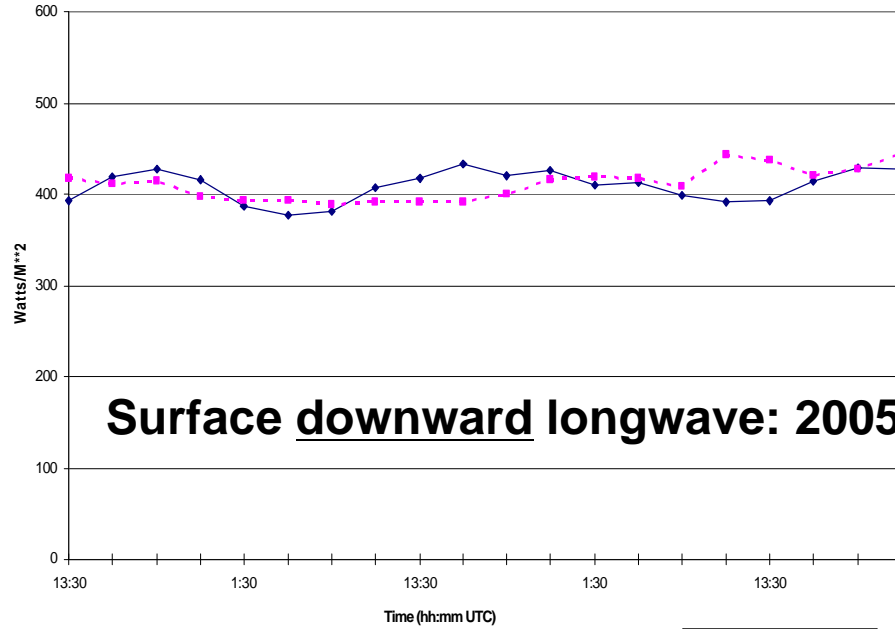


Downward and Upward Surface Solar Insolation



Lamont-SGP: Downward Longwave Radiation (from 13:30 UTC)
16-Aug-2005

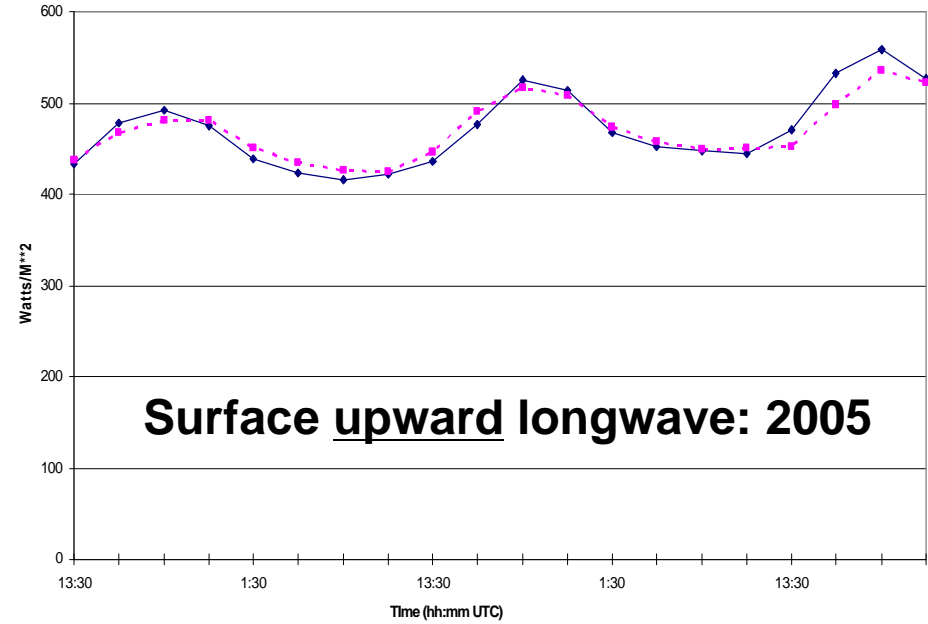
DLWS- 3hr avg
DLWS-forecast-nccep



Surface downward longwave: 2005

Lamont-SGP: Upward Longwave Radiation (from 13:30 UTC)
16-Aug-2005

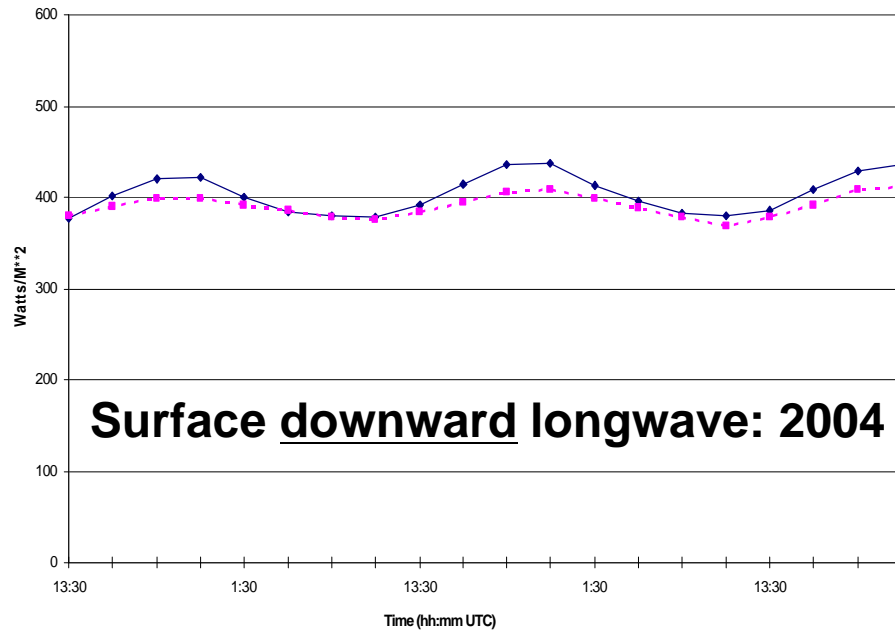
ULWS - 3 hr avg
ULWS-forecast-nccep



Surface upward longwave: 2005

Lamont-SGP: Downward Longwave Radiation (from 13:30 UTC)
01-Aug-2004

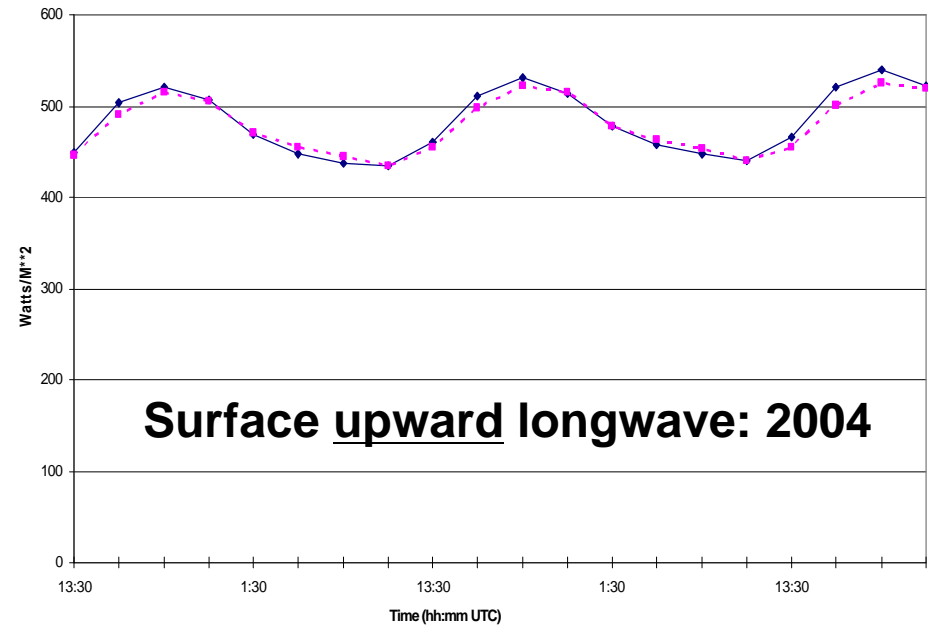
DLWS- 3hr avg
DLWS-forecast-nccep



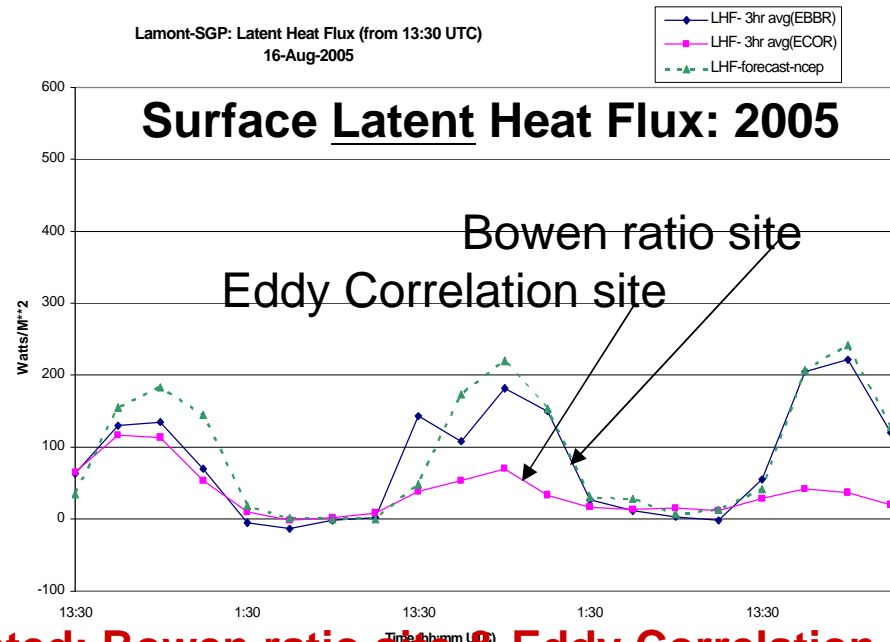
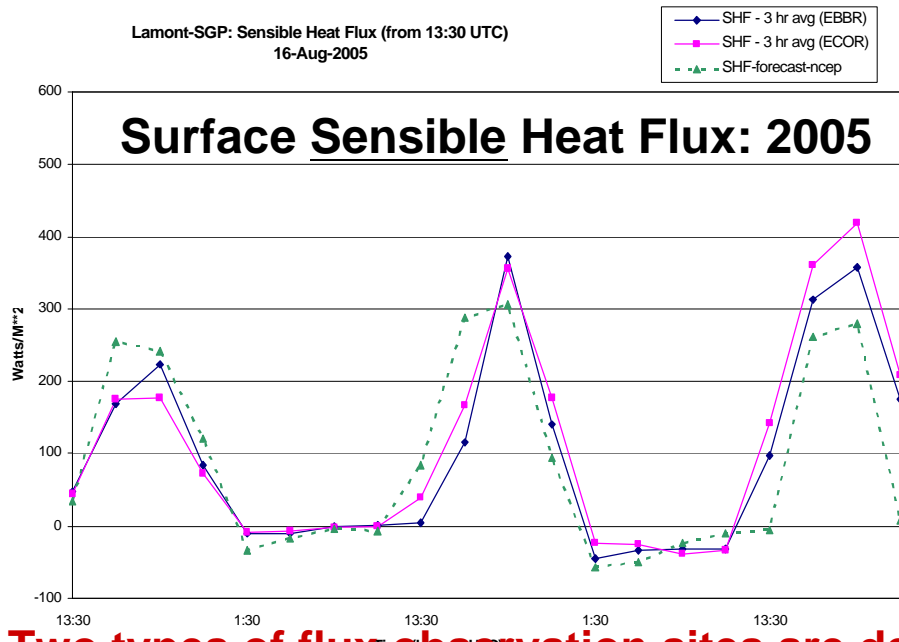
Surface downward longwave: 2004

Lamont-SGP: Upward Longwave Radiation (from 13:30 UTC)
01-Aug-2004

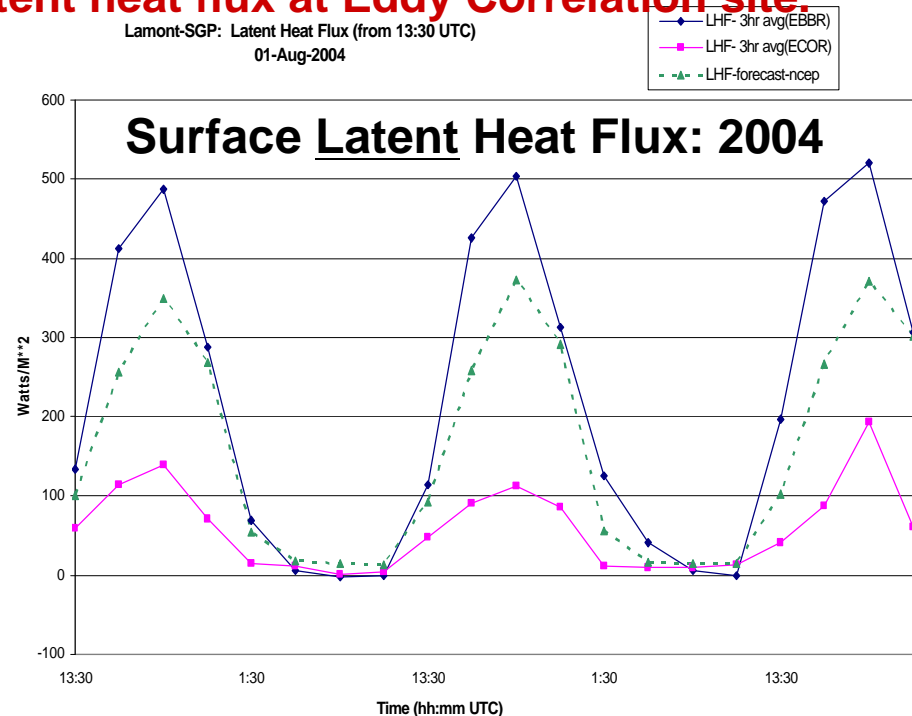
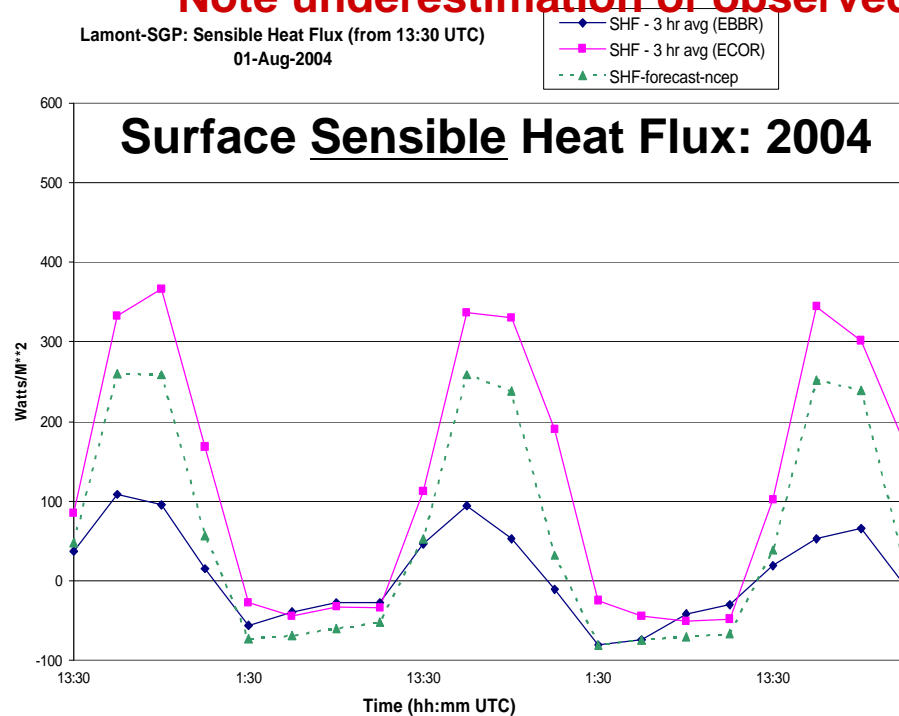
ULWS - 3 hr avg
ULWS-forecast-nccep



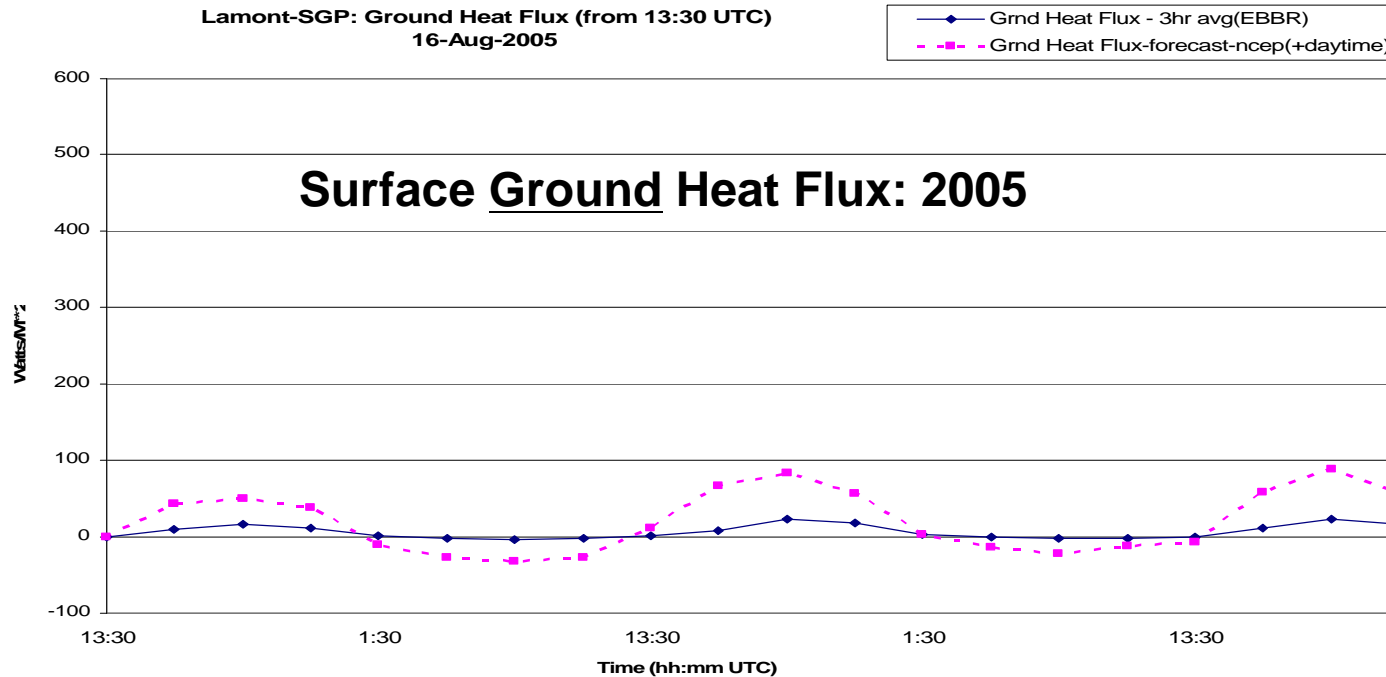
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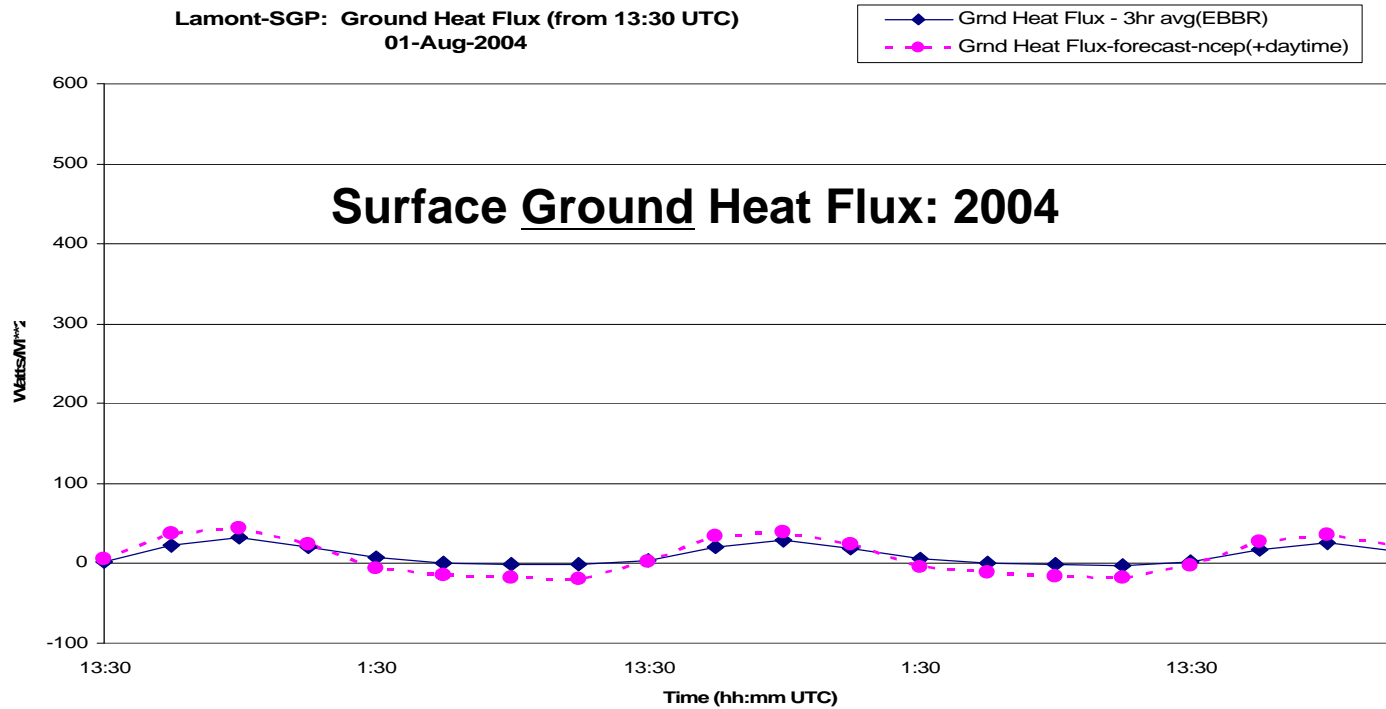
Two types of flux observation sites are depicted: Bowen ratio site & Eddy Correlation site. Note underestimation of observed latent heat flux at Eddy Correlation site.



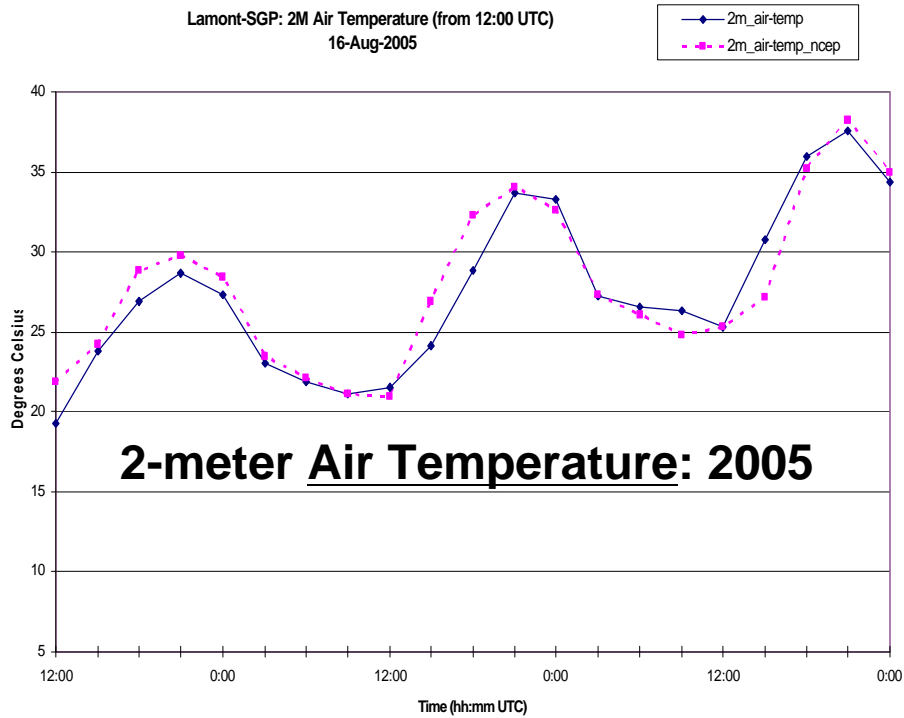
Lamont-SGP: Ground Heat Flux (from 13:30 UTC)
16-Aug-2005



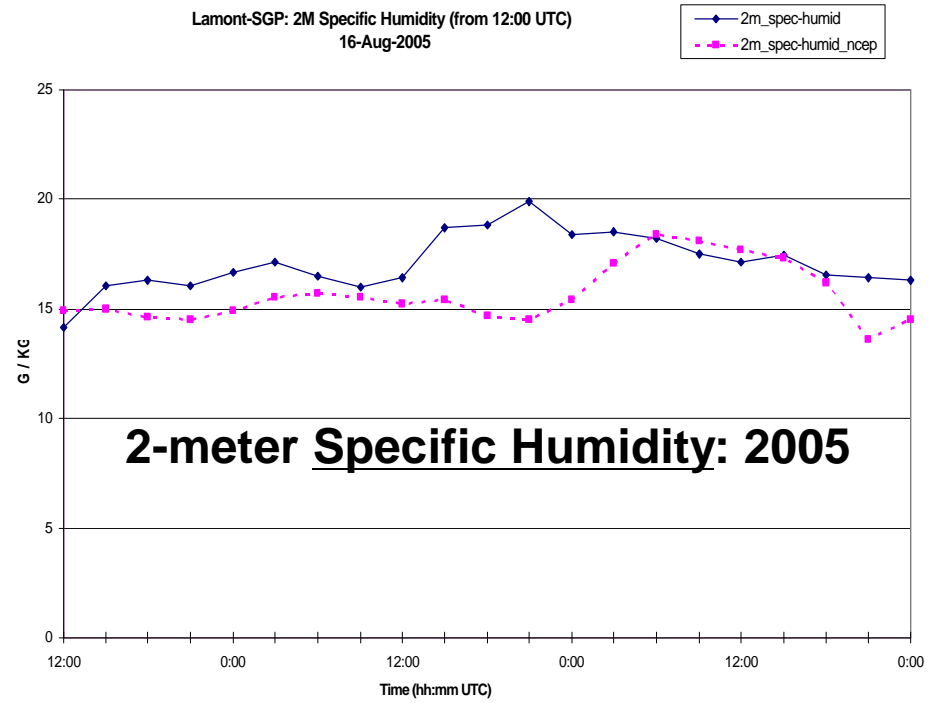
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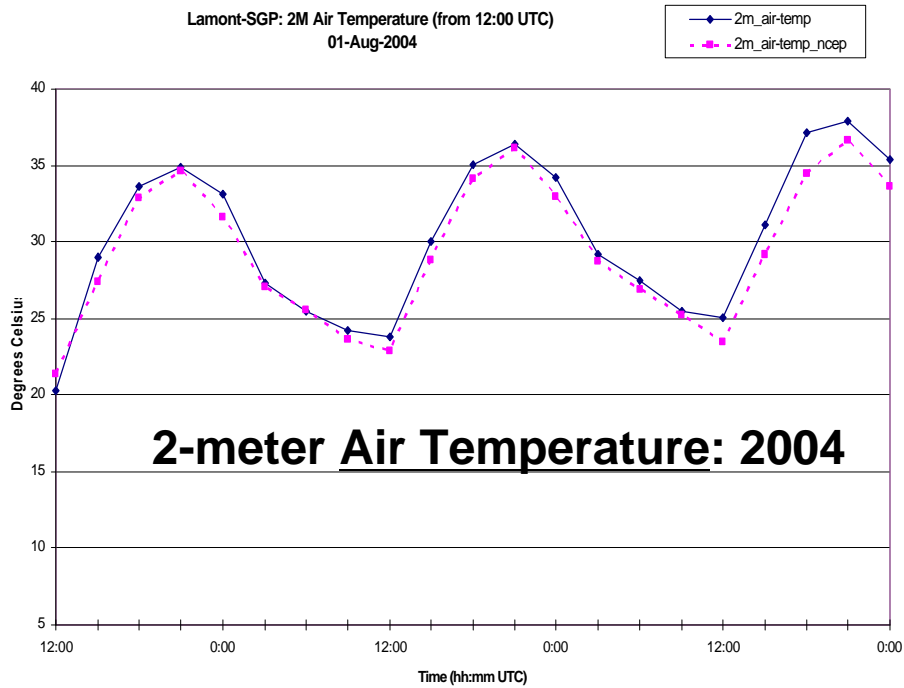
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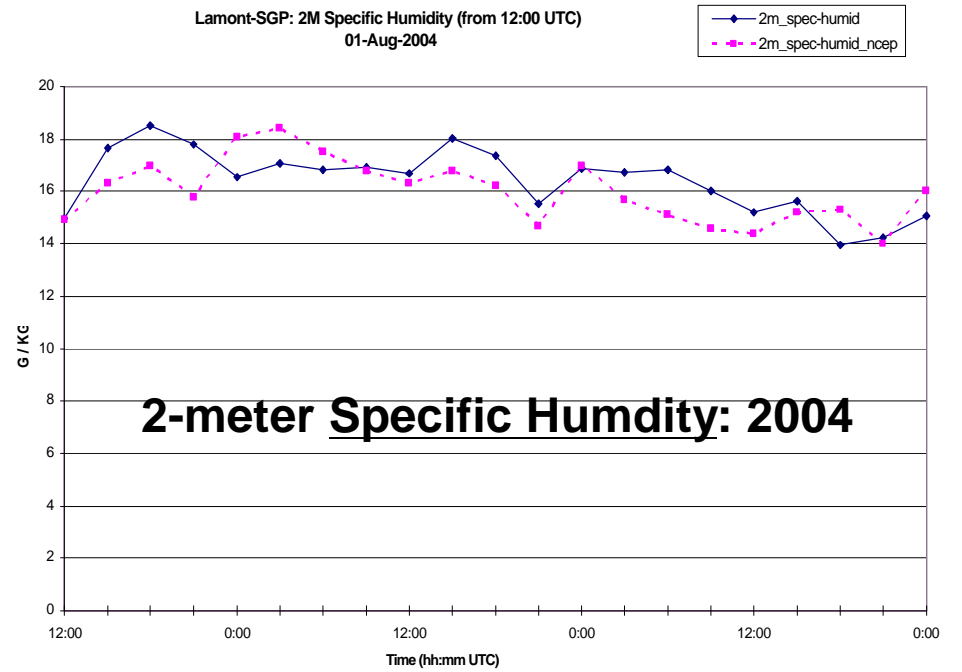
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16-Aug-2005



Lamont-SGP: 2M Air Temperature (from 12:00 UTC)
01-Aug-2004



Lamont-SGP: 2M Specific Humidity (from 12:00 UTC)
01-Aug-2004



Conclusions and Future Studies

- *2005 land component upgrade yields modestly improved 2-m temperature and 2-m specific humidity*
- *Surface shortwave and longwave radiation quite good in both years at both sites, including surface albedo*
 - *yet upward longwave improved at Lindenberg site after 2005 land component upgrade*
- *Bowen ratio improved at SGP site after 2005 upgrade*
- *No clear advantage of 2005 or 2004 for Bowen ratio at Lindenberg site*
- *Modeled ground heat flux has high bias after 2005 upgrade at both sites*
- *Eddy correlation station at SGP appears to underestimate surface latent heat flux*
 - *This tendency of Eddy Correlation stations is cited in the literature (Twine et al., 2000; Brotzge and Crawford, 2004)*
- *Need to check surface energy balance of reference sites*
 - *Model balances the surface energy closely (not shown)*
- *Future: extend evaluation to other CEOP Reference Sites*