Evaluating Parametrizations using CEOP

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Overview

- Production and use of CEOP data
- Results
  - SGP Seasonal & Diurnal cycles
  - Other extratopical sites
  - Tropical sites
- Future work

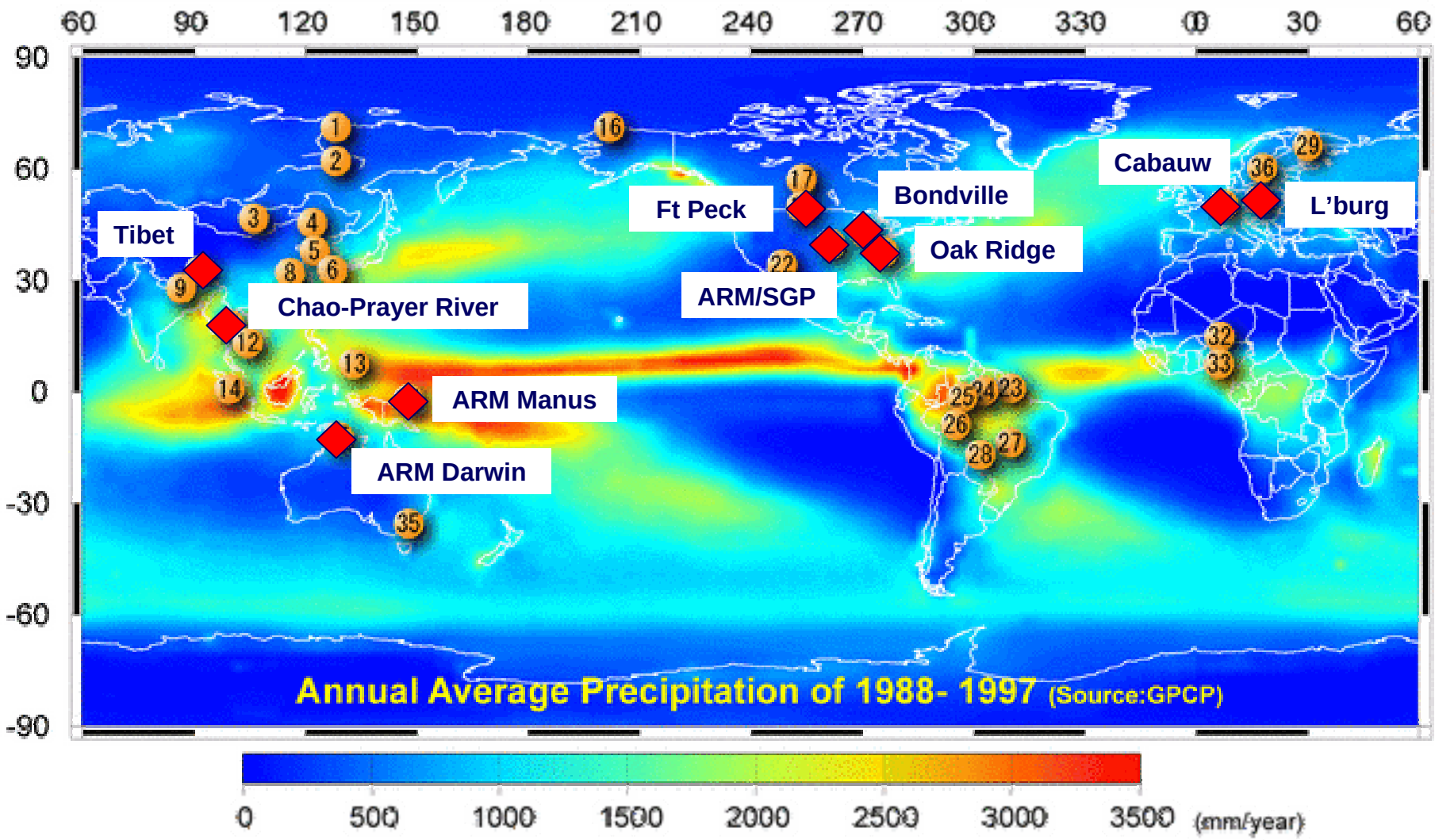
Met Office NWP Model Output

- Operational Global Unified Model Data Archive
  - Grid Resolution ~ 0.5° x 0.8° with 38 levels
  - 19 pressure levels (1000-10 hPa)
  - Assimilation 0-6h for 00, 06, 12, 18 UTC
  - Forecast 0-36h for 00, 12 UTC
  - 3 hourly data output
- MOLTS – ASCII
- Gridded - GRIB 1.25°
  - Pressure levels only
  - Forecast 12-36h for 12 UTC

Plans For CEOP Data/Research

- Evaluation of current parametrisations in NWP model.
  - Clouds and radiation
  - Surface energy balance – land surface processes
  - Diurnal cycle
  - Hydrological cycle (humidity analysis) + spin-up
- Concentrate on MOLTS vs. CSE reference sites. Sample range of climatic regimes.

In-situ Observation Reference Sites

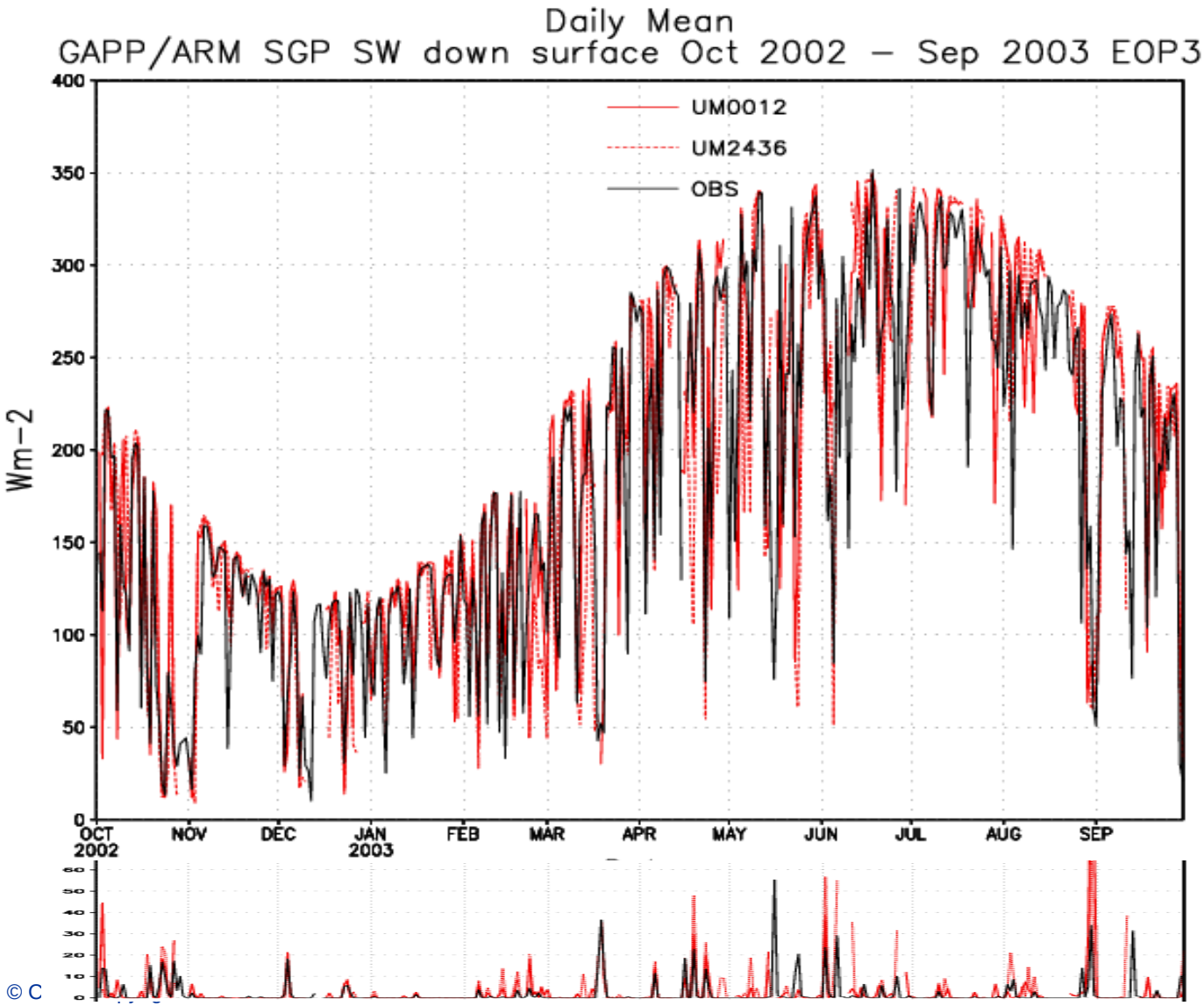


Surface Energy Balance

Southern Great Plains – ARM/GAPP

- Oct 2002-Sep 2003 – EOP3
- 3 hourly sampling for model
- Observations available every 30 minutes.
- Model at forecast ranges 00-12, 12-24 & 24-36

SGP – Seasonal Net SW down at Surface

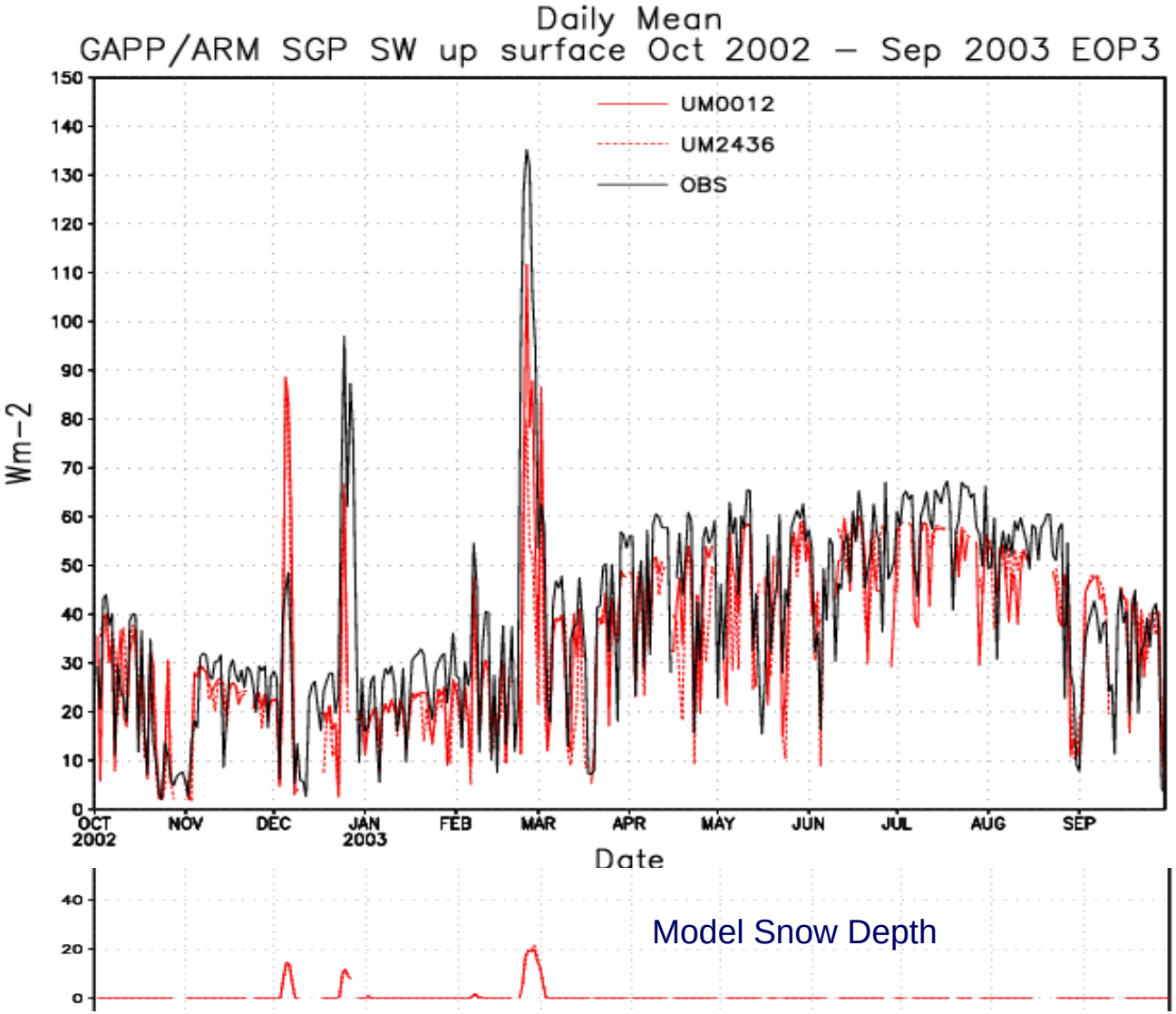


Net SW down Radiation

Cloudy and clear days well captured by model out to 36 hrs

Precipitation well predicted temporally – overestimate amounts.

SGP – Seasonal SW up at Surface

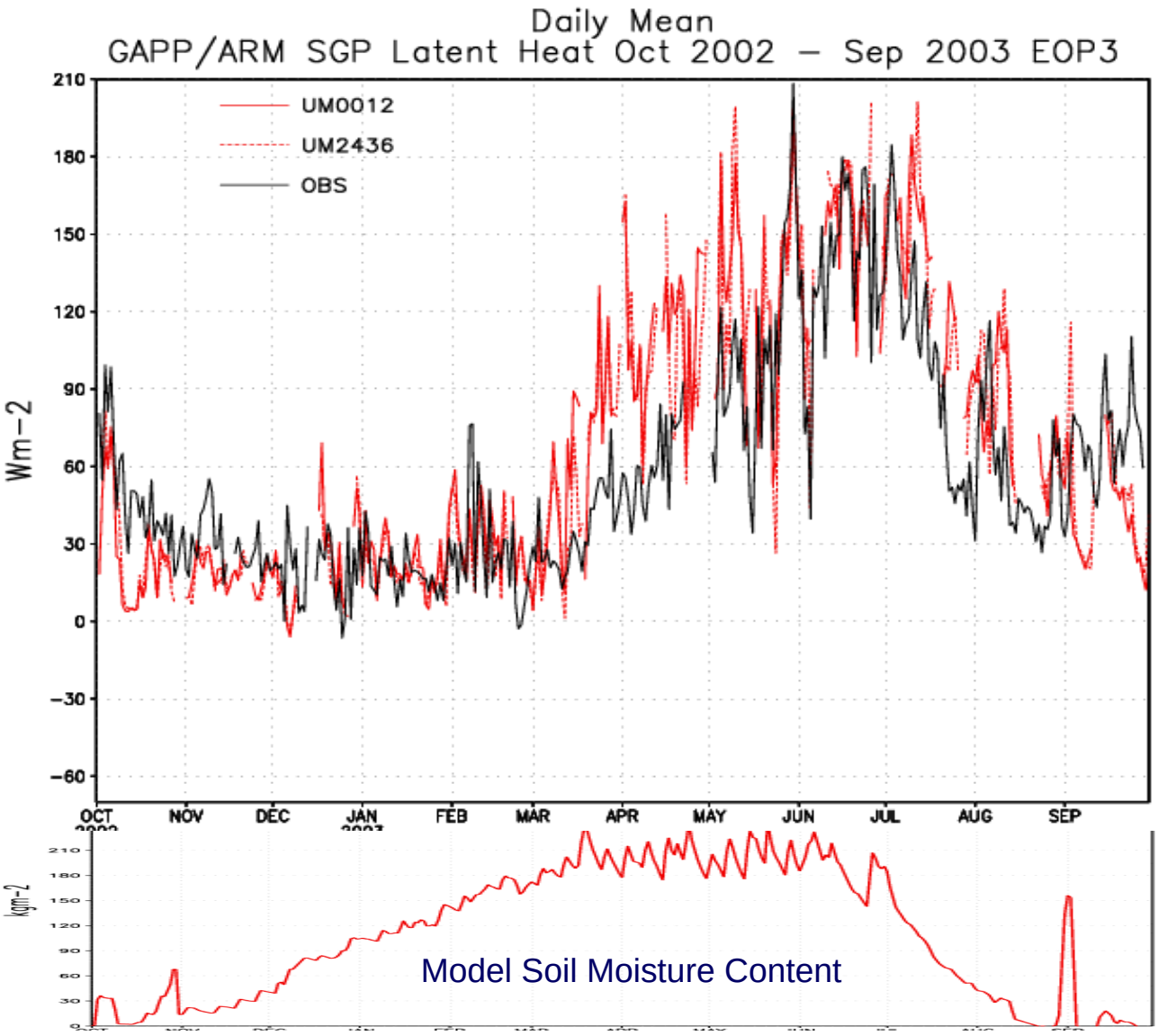


SW up Radiation

Systematic underestimate ~10Wm^{-2} Albedo?

3 snow events well captured by model

SGP – Seasonal Latent Heat Flux



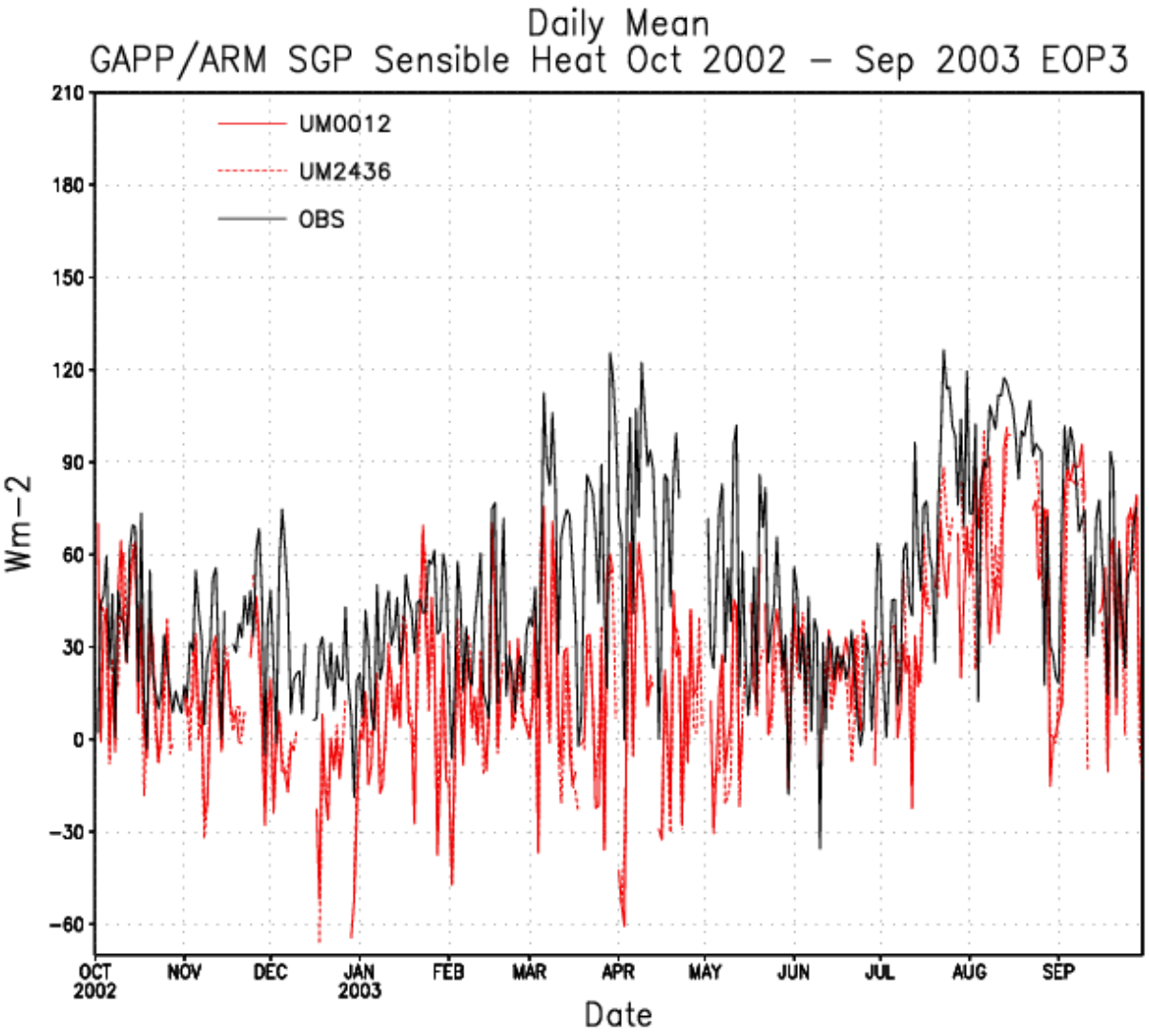
Latent Heat

Overestimated in Spring (MAM)

Underestimated in Autumn (SON)

More accurate in DJF and JJA

SGP – Seasonal Latent Heat Flux

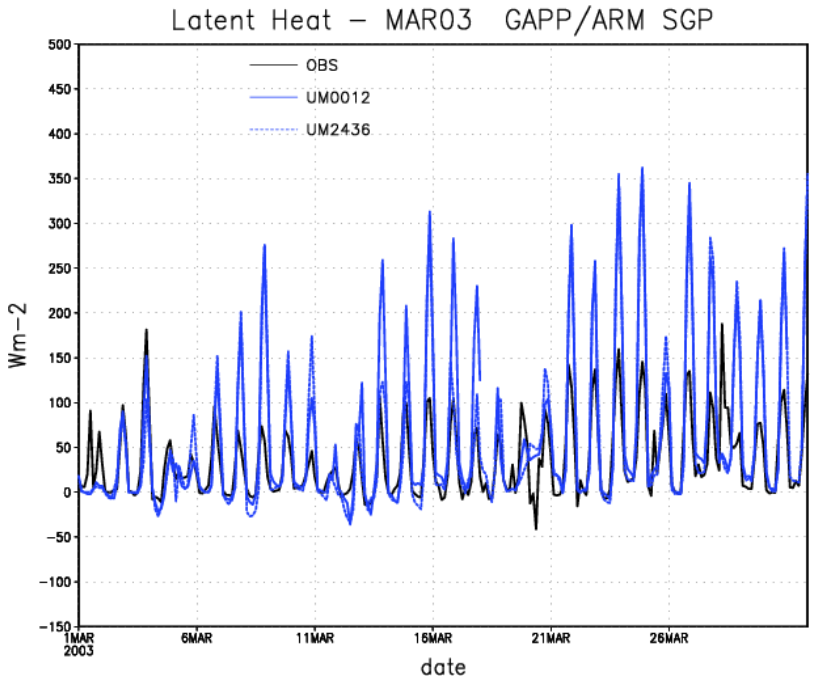


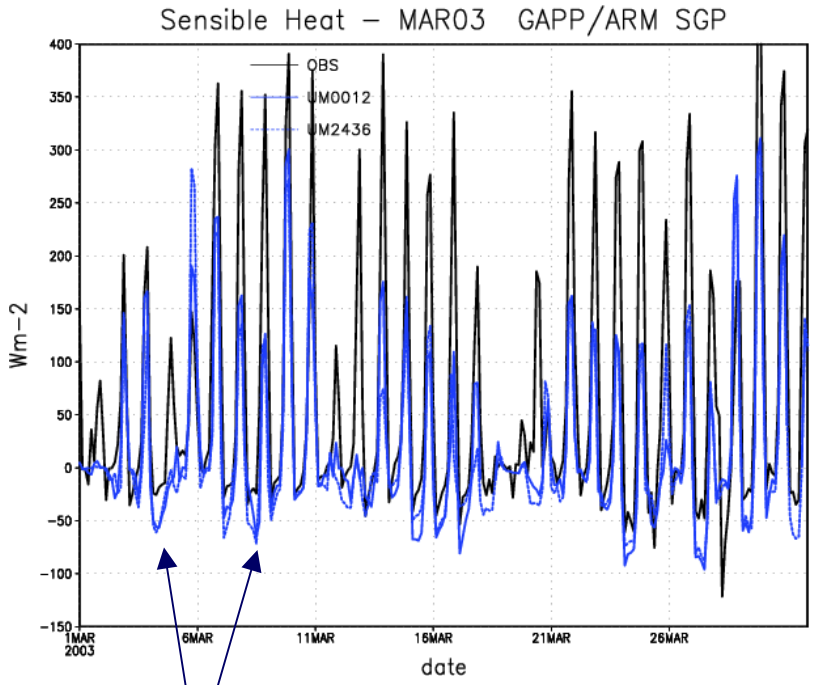
Sensible Heat

Underestimated in all seasons (SON)?

Worst in Mar-Apr – Errors in Bowen Ratio?

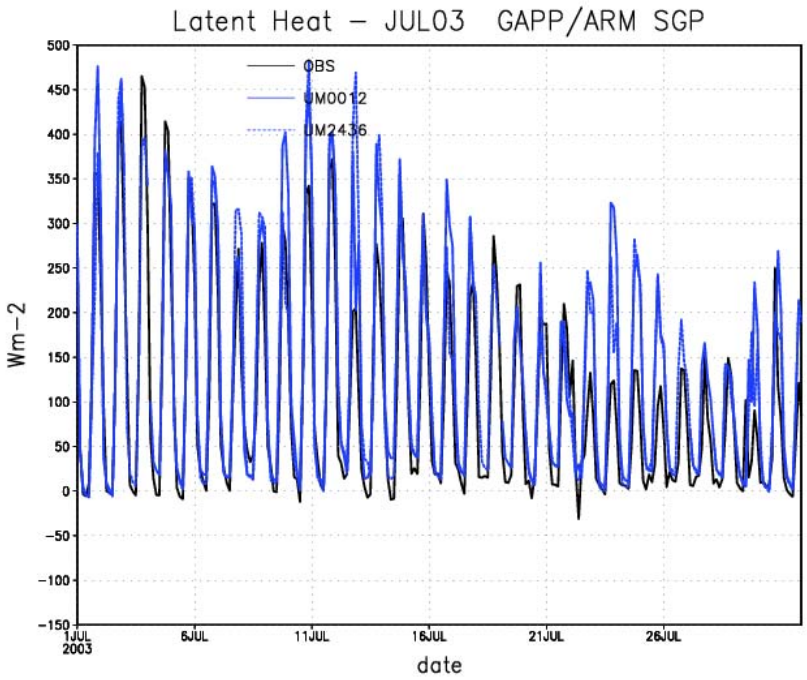
LH and SH Fluxes – March 2003

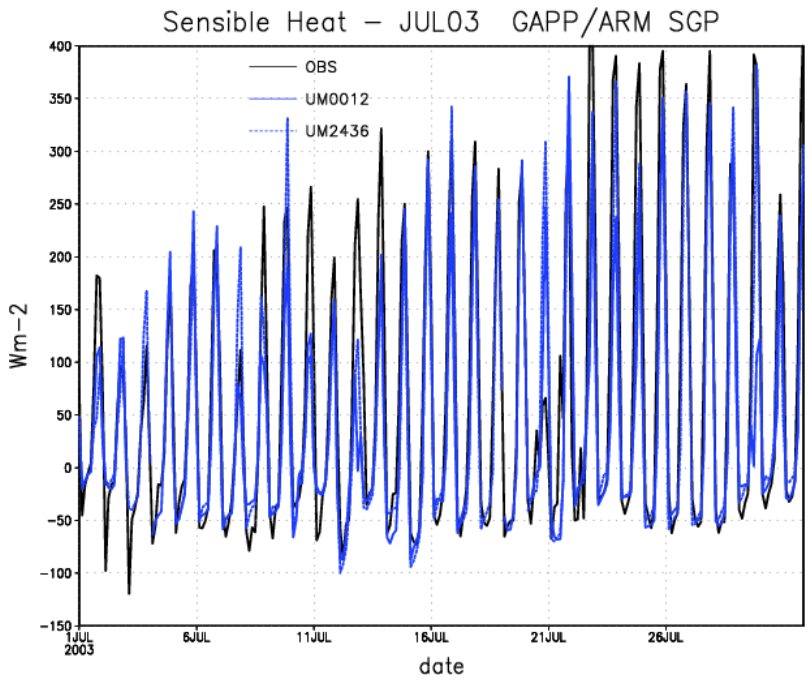




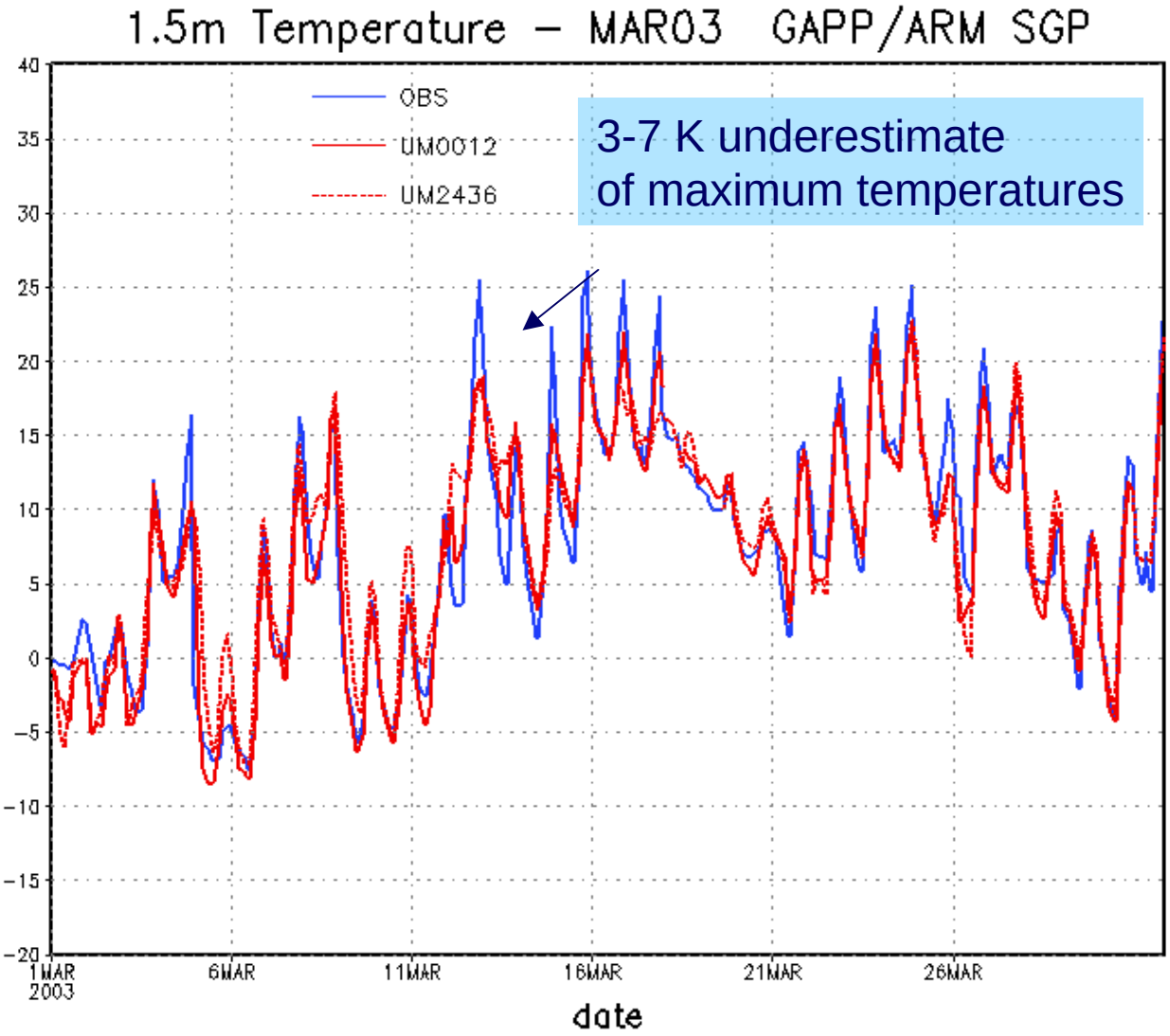
Negative SH flux in night-time stable BL too large by factor 2

LH & SH fluxes - July 2003





Impacts on T and q at 1.5 metres



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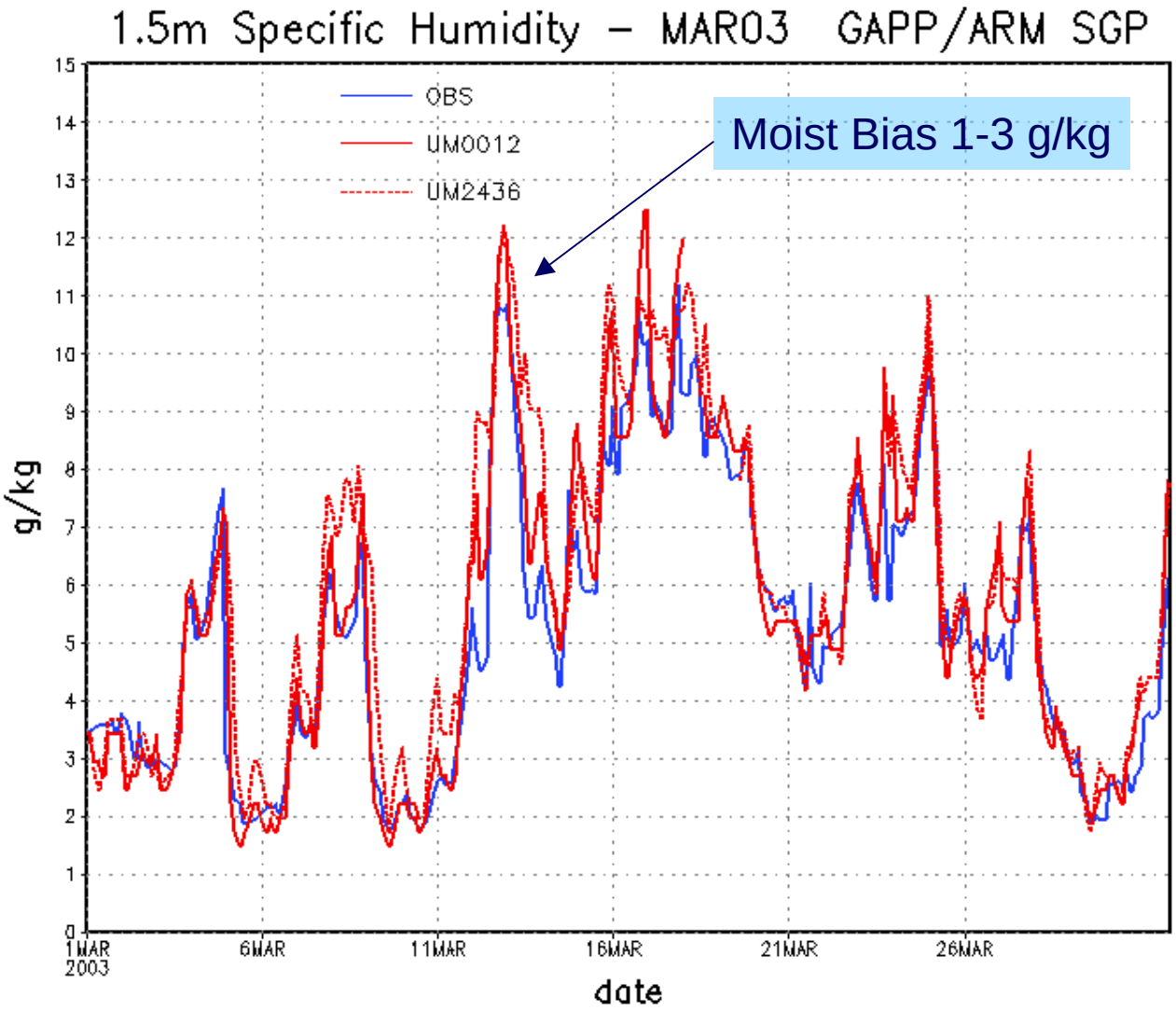
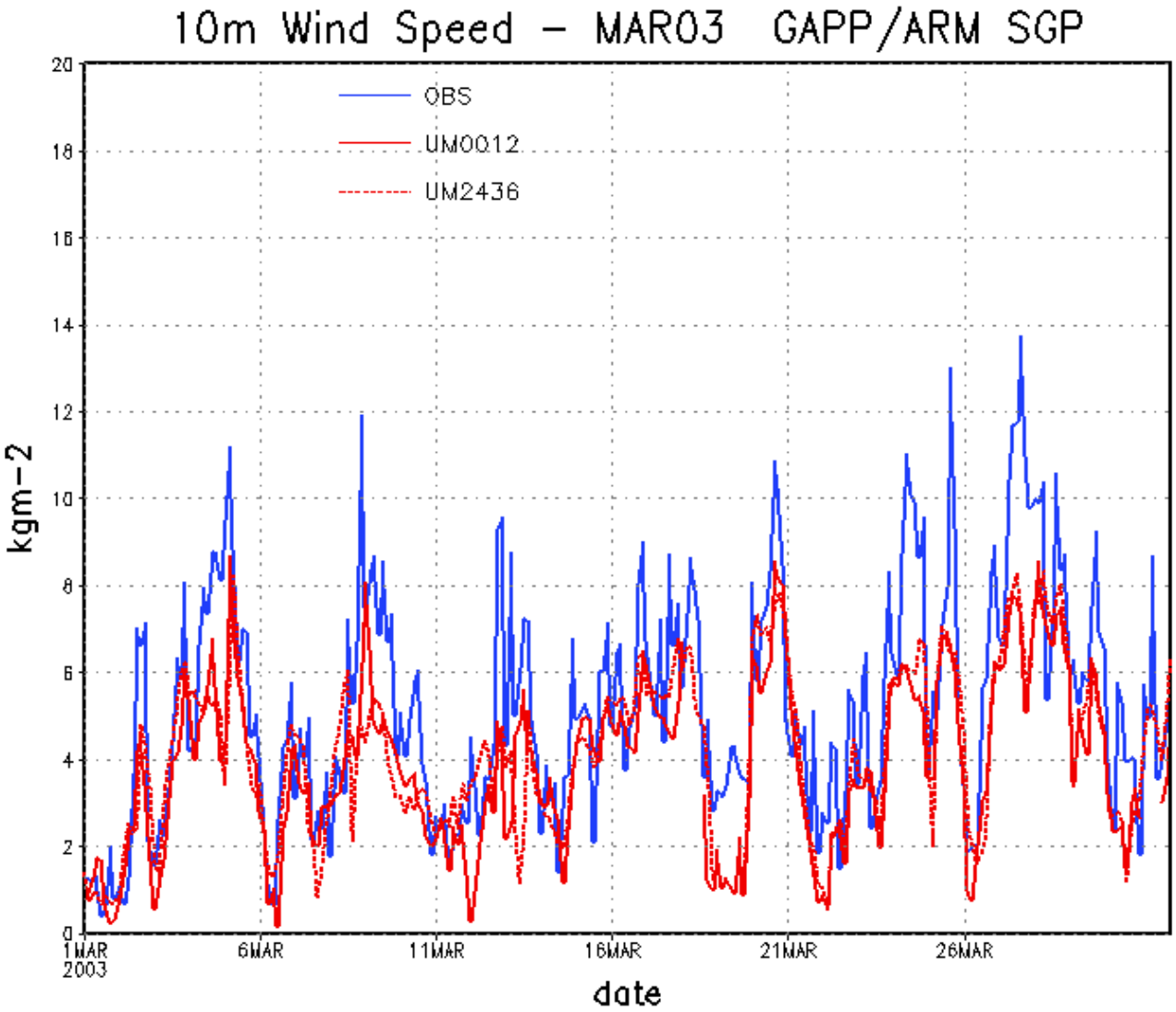


10m Wind Speeds



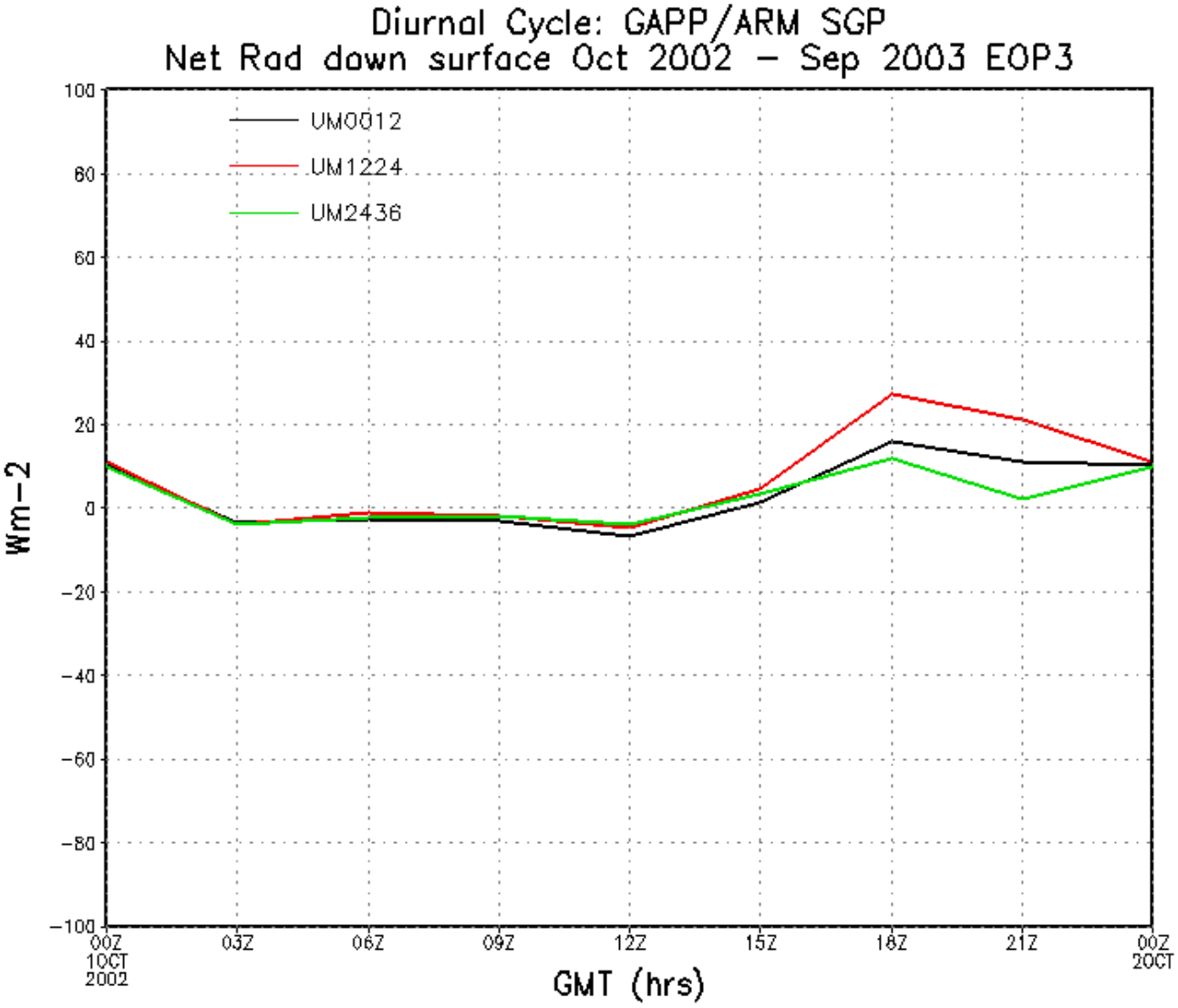
Representivity?

Surface Roughness?

Errors in BL mixing?

Contributes to underestimate in SH flux?

Net Radiation at Surface



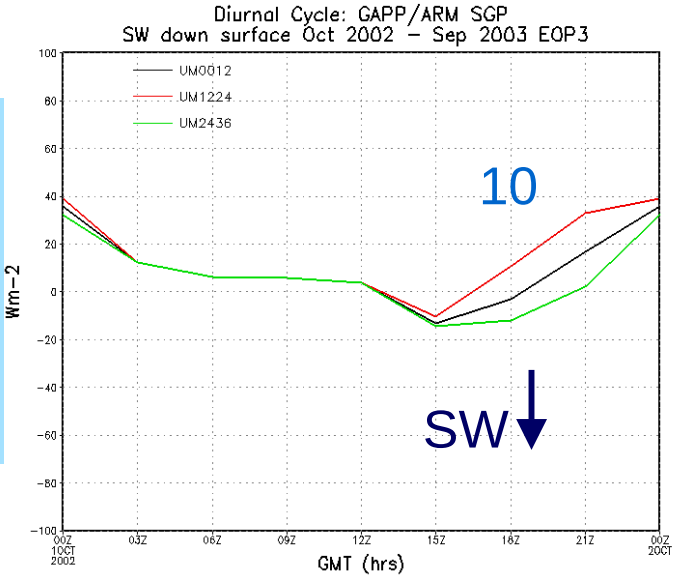
Model Net Downward Radiation

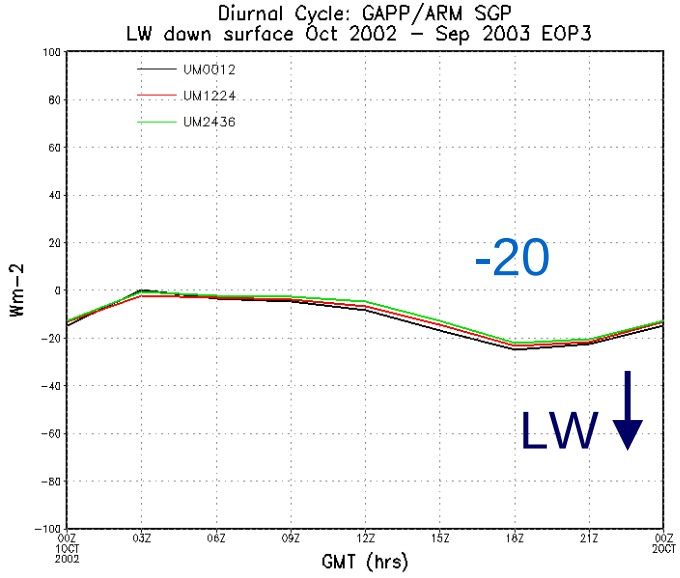
Too large by up to 25 Wm^{-2} during daytime

Diurnal Cycle - Radiation component errors

SW too large
LW too small

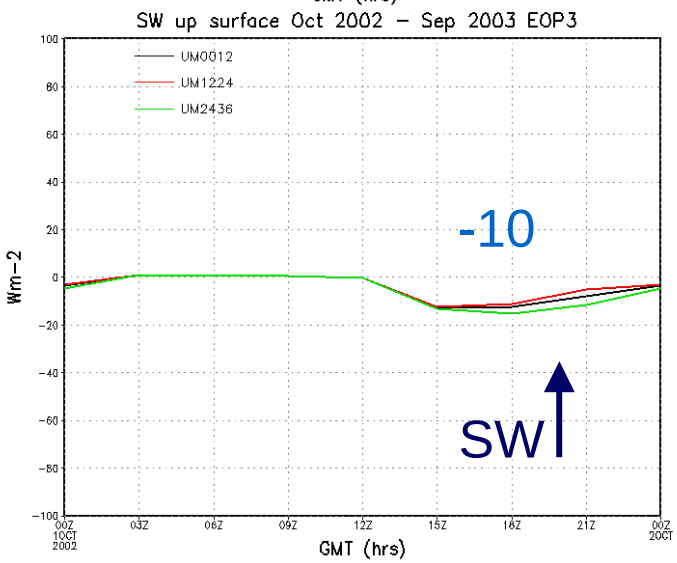
Too little cloud?

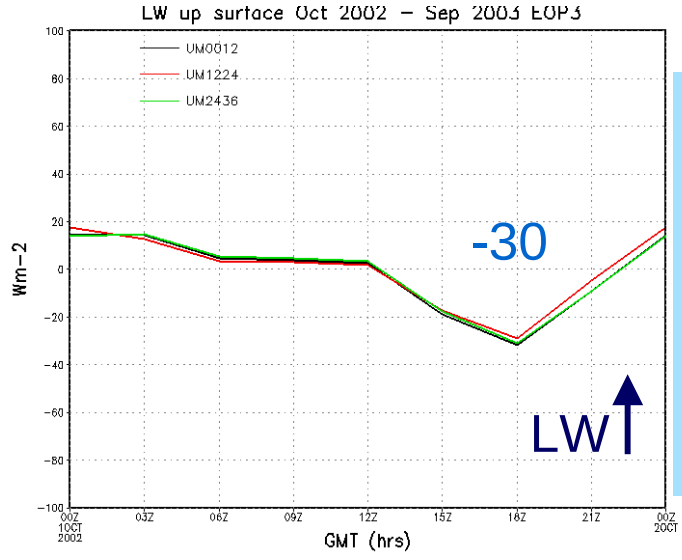




SW up too small

Surface albedo too low?

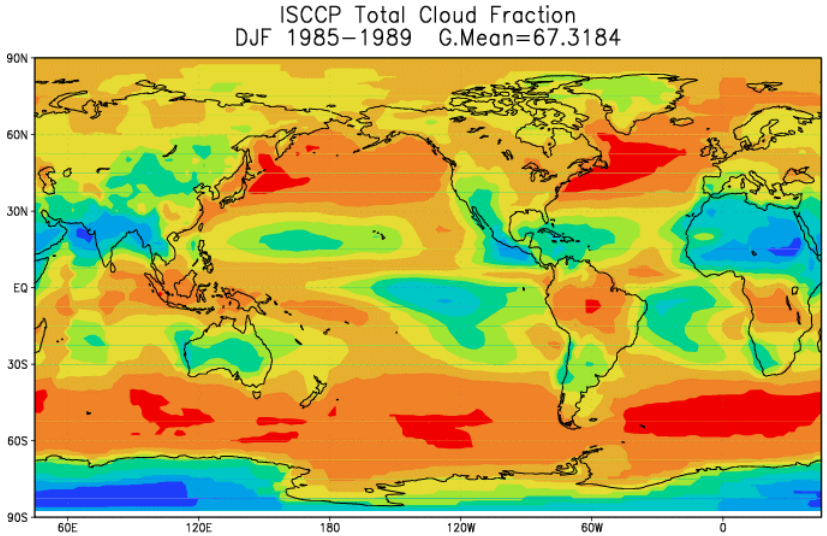


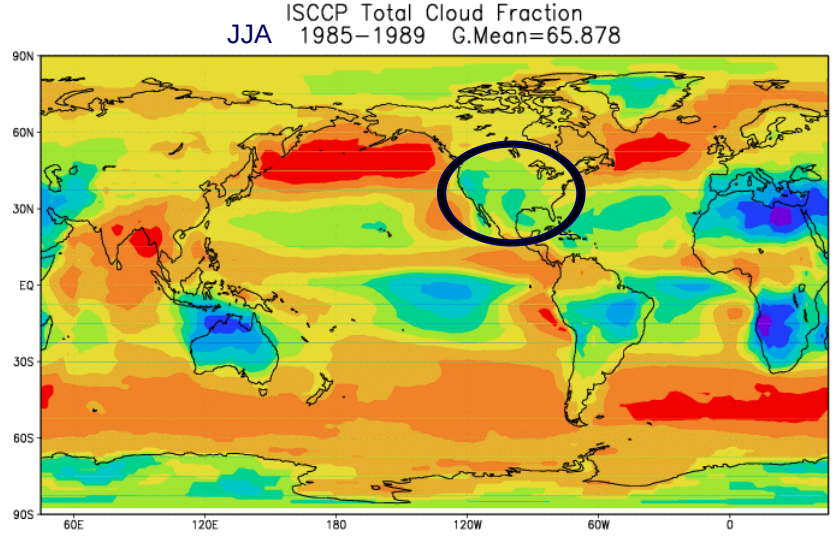


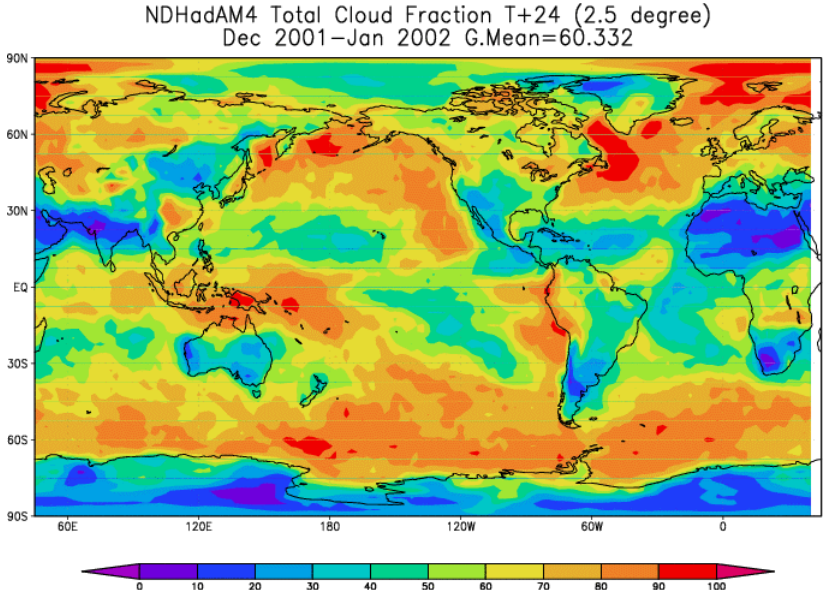
LW up small

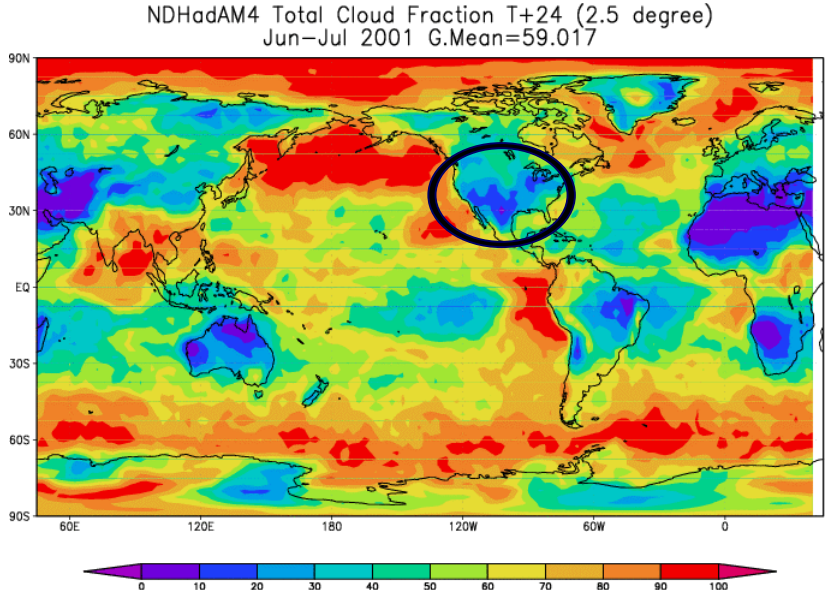
Surface Temp too low?

Total Cloud Fraction UM vs ISCCP

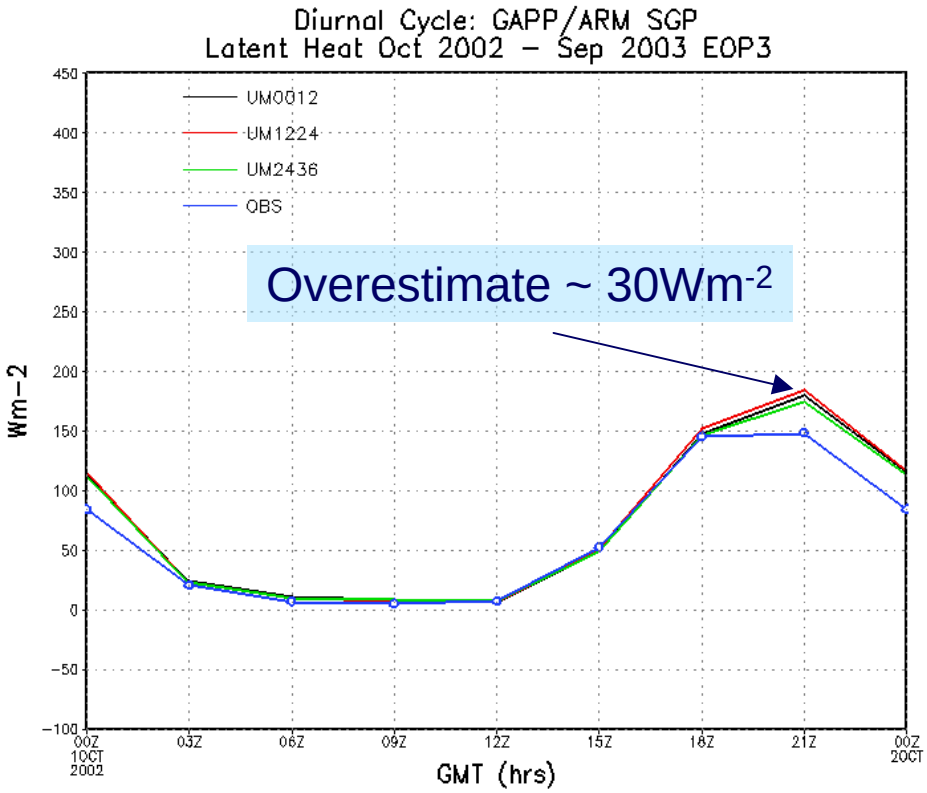


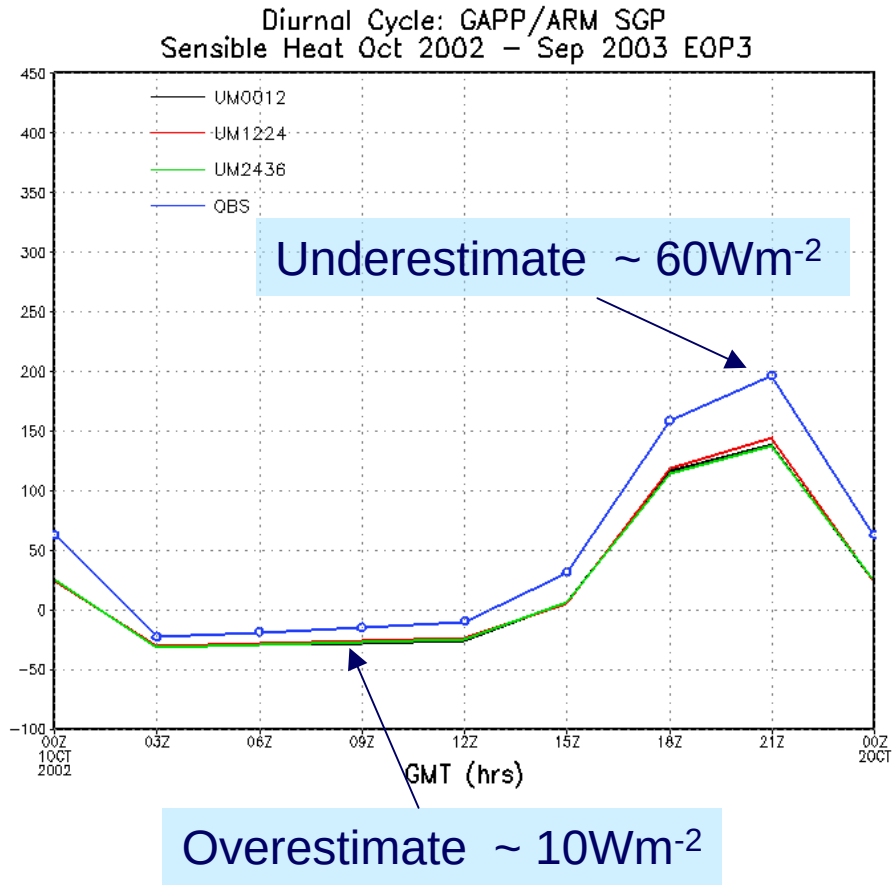






Diurnal Cycle SGP Oct 2002 – Sep 2003 Turbulent Fluxes

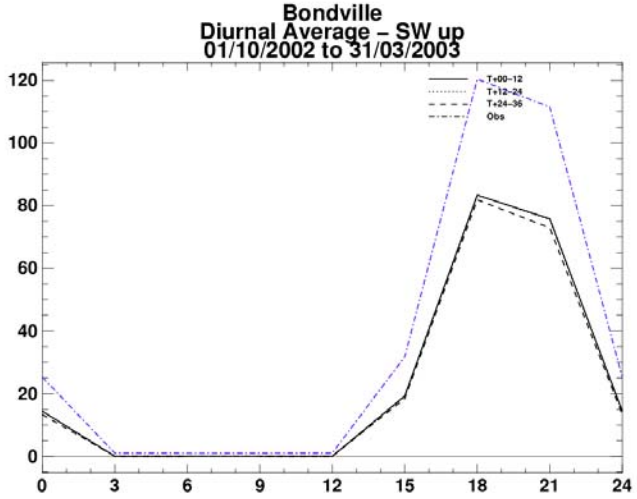


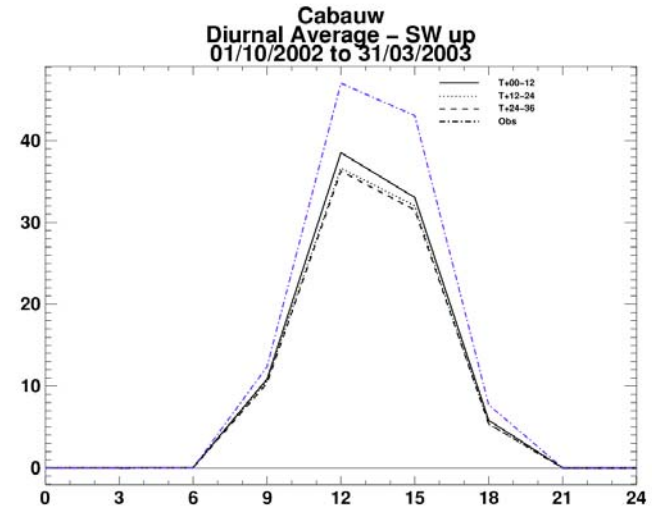


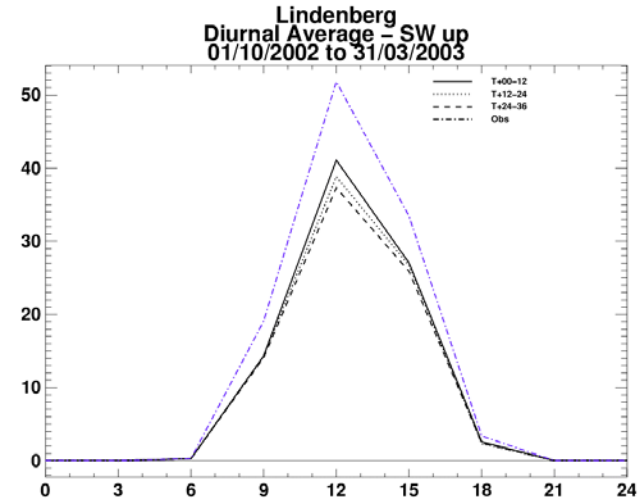
Summary – SGP Surface Energy Balance

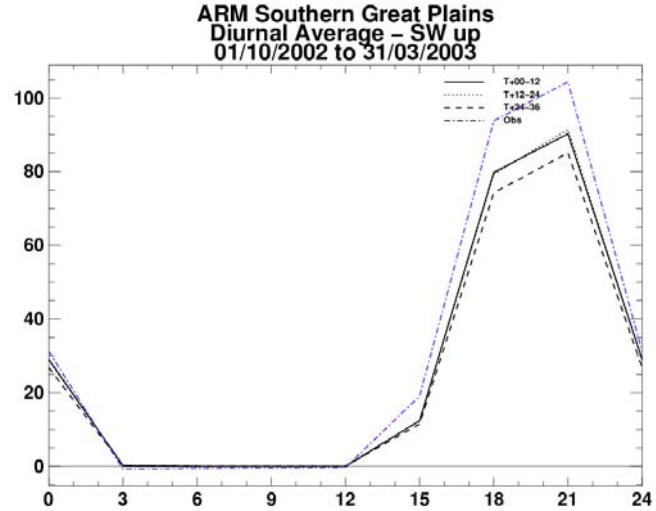
- Downward SW too large & downward LW too small during daytime
  - Lack of cloud? Largest errors in JJA
- Upward SW too small
  - Albedo error?
- Upward LW too small in day and too large at night
  - Errors in surface temperature?
- LH overestimated during day (Annual diurnal cycle)
  - Strong dependence on model soil moisture.
  - Seasonal – LH flux too large in Spring (soil moist), too small in Autumn (soil dry)
  - Moist bias in 1.5m humidity
  - Suppress diurnal temperature range
- SH underestimated in day (~60 Wm-2)
  - Errors in Bowen ratio – worst in Spring
- SH overestimated at night
  - Errors in stable BL – use of “long tails” for stability functions (transfer coefficients).

Diurnal Cycle at other Extratropical Sites





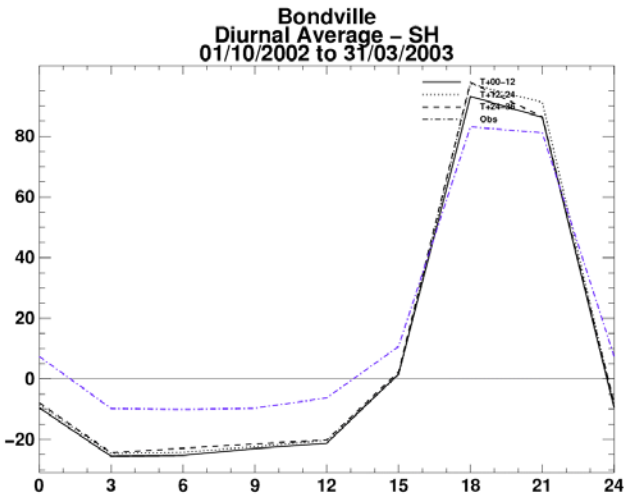


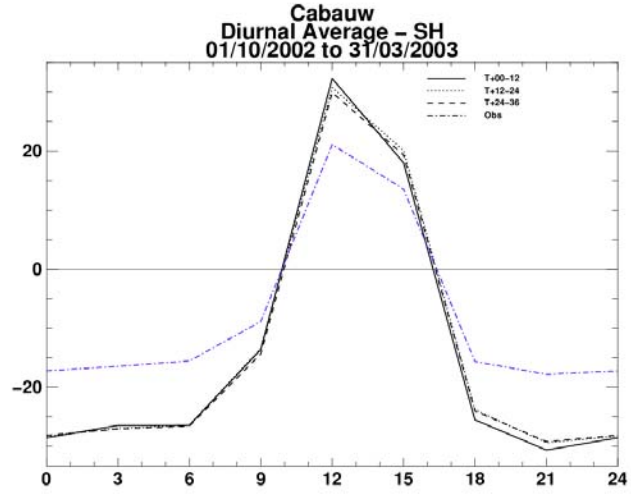


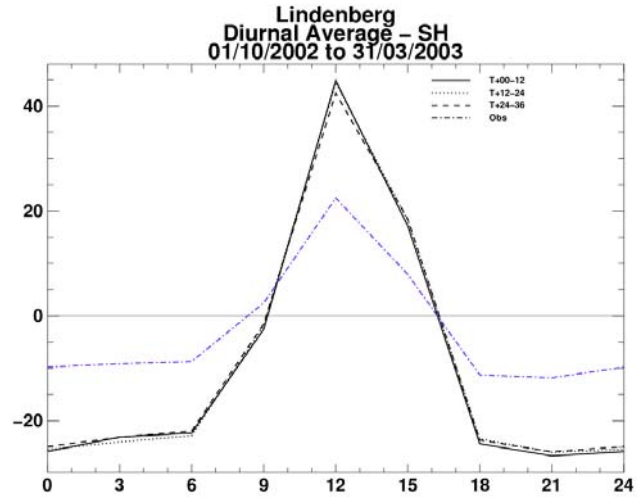
SW up consistently under done.

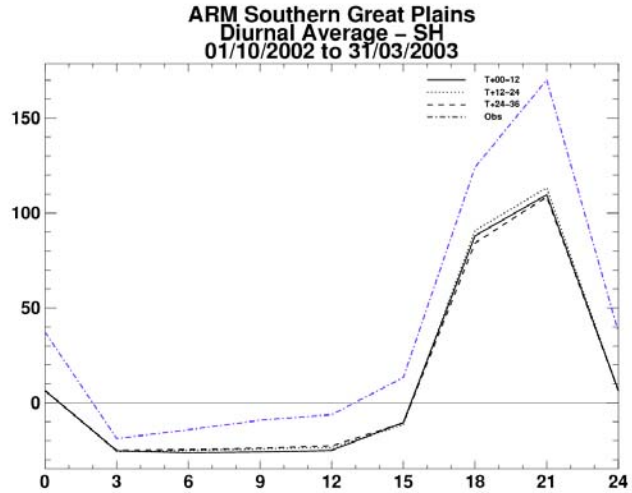
Errors generally larger than for SW down.

Diurnal Cycle at other Extratropical Sites





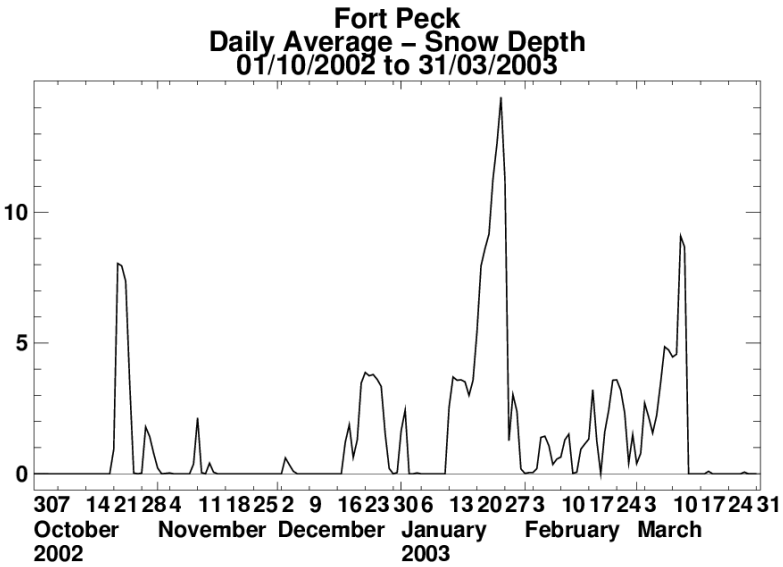


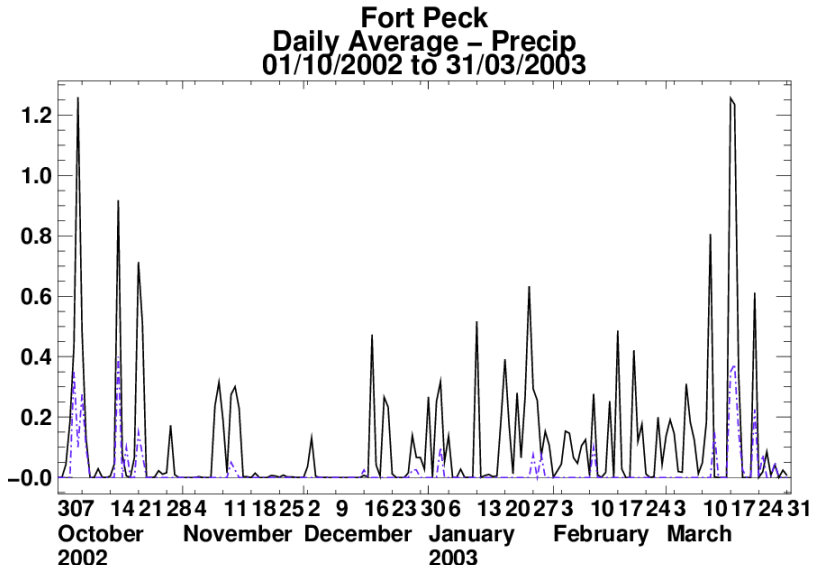


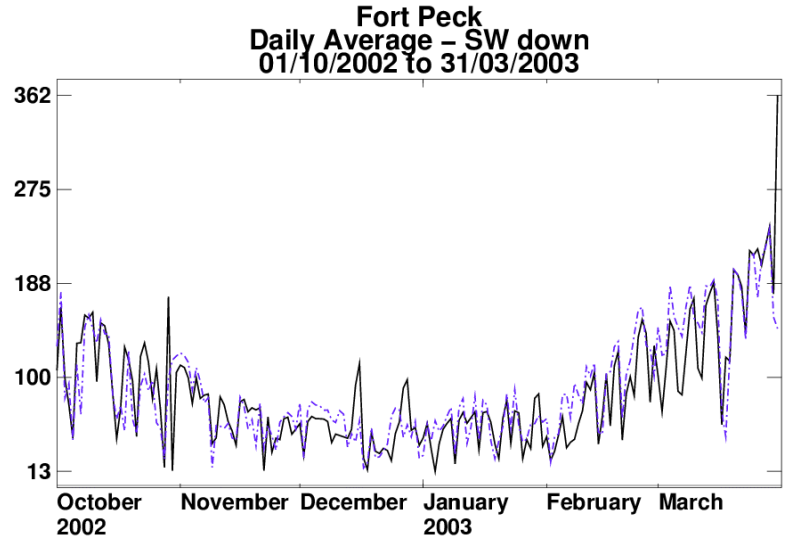
Stable BL problem at most sites.

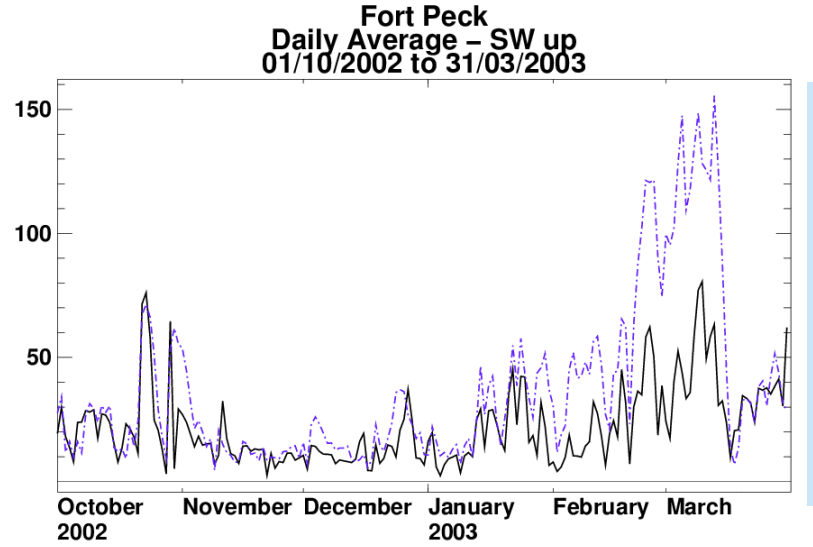
Daytime SH flux errors not as easy to classify.

Snow Melt at Fort Peck





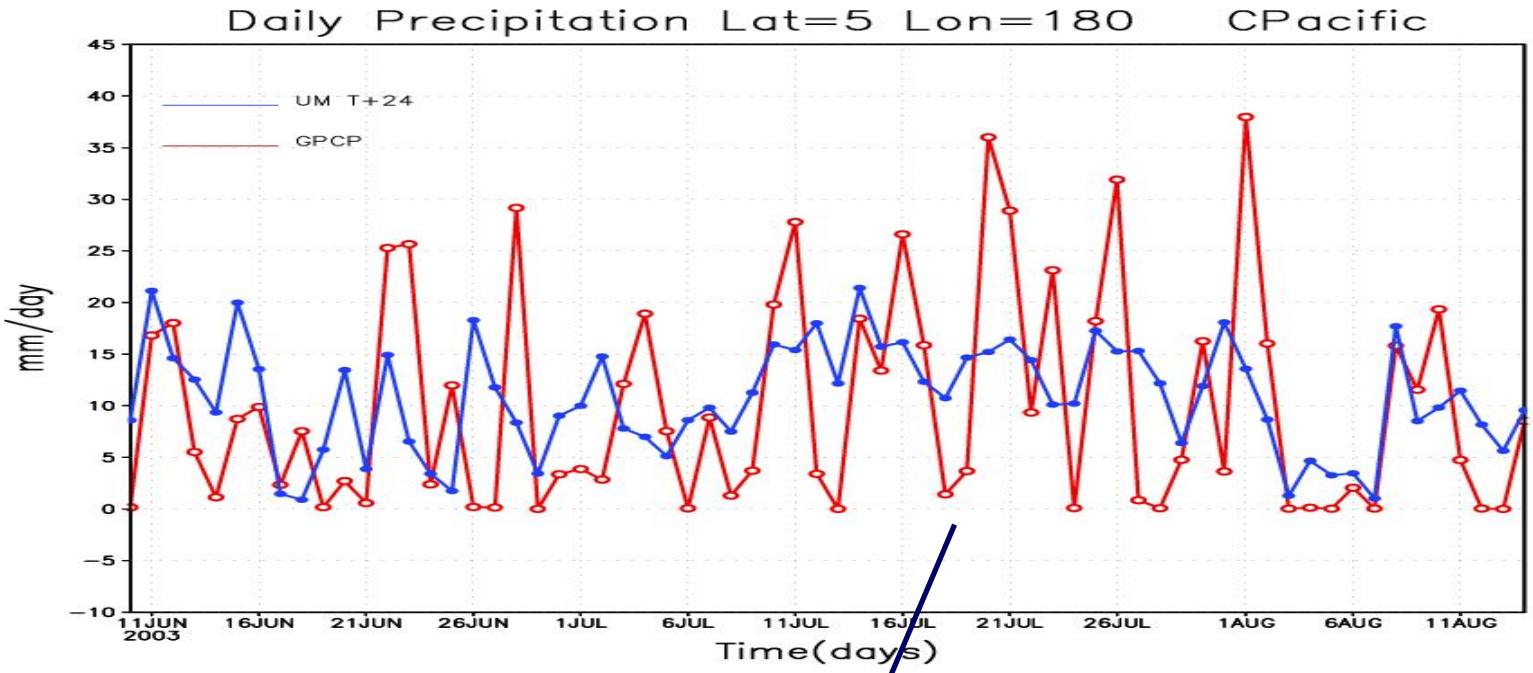


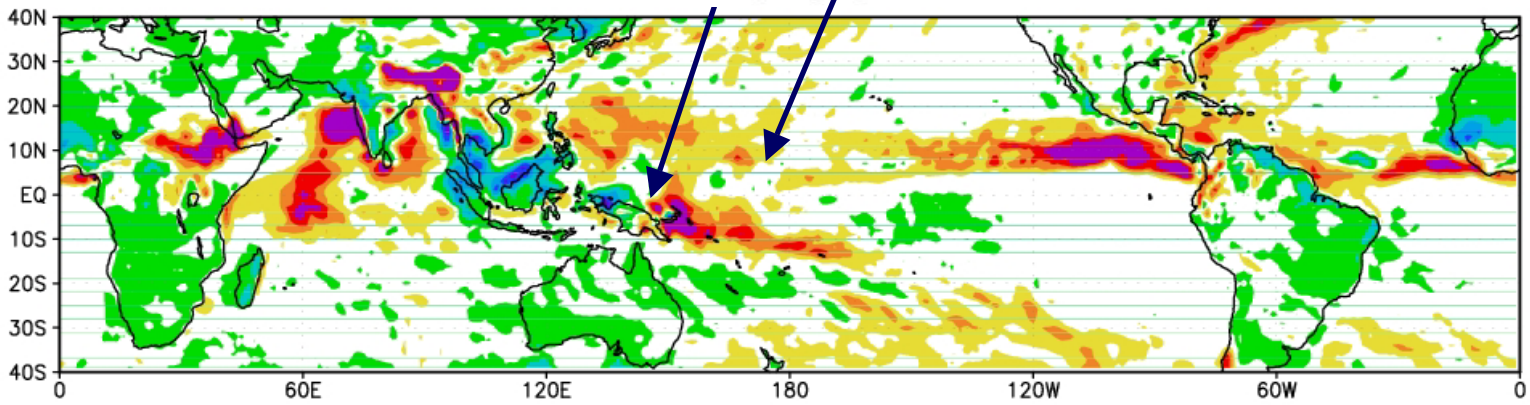


Snow melt is too early in model.

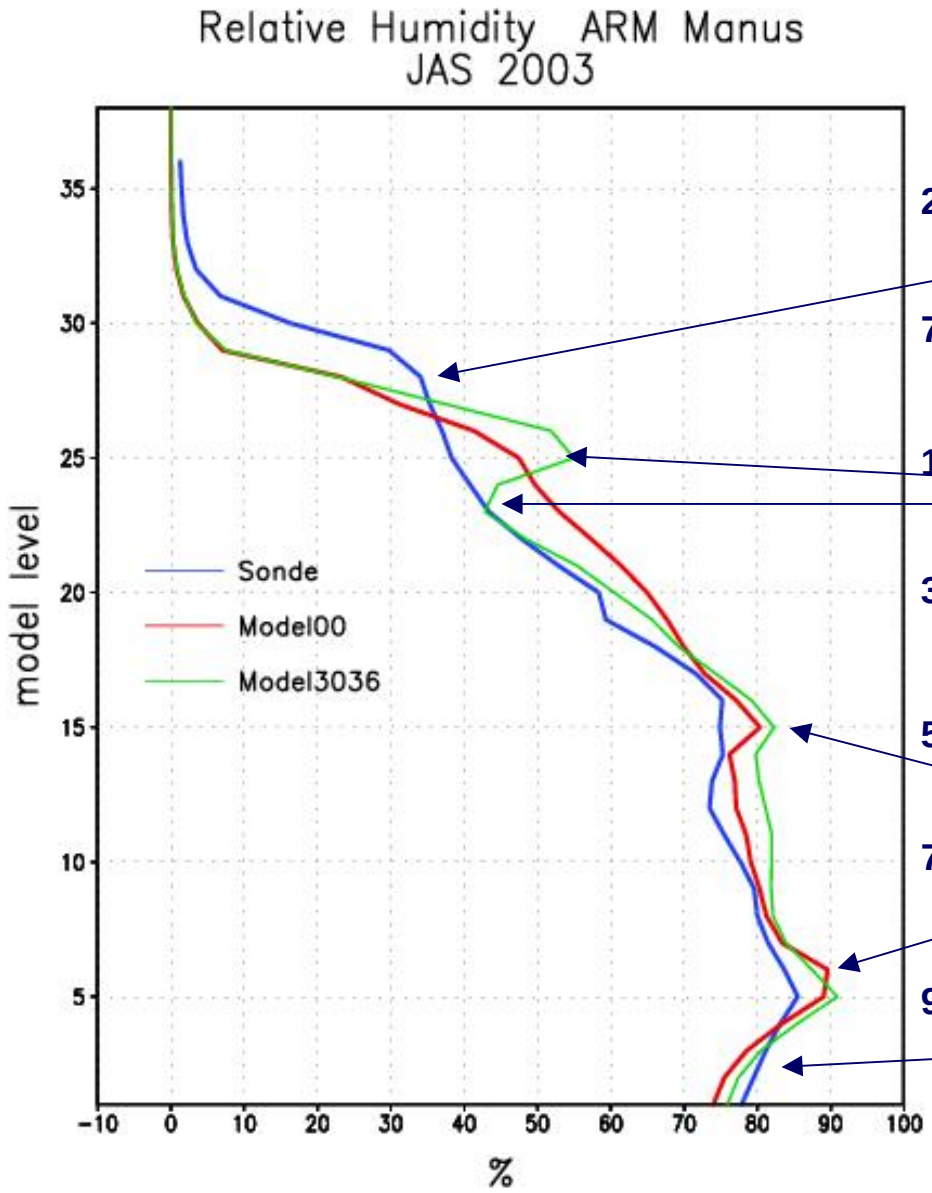
Similar signal at Bondville.

Systematic Errors in Tropical Precipitation





Comparisons with ARM Manus site



20 hPa

77

192

367

576

777

922

Convection too shallow?

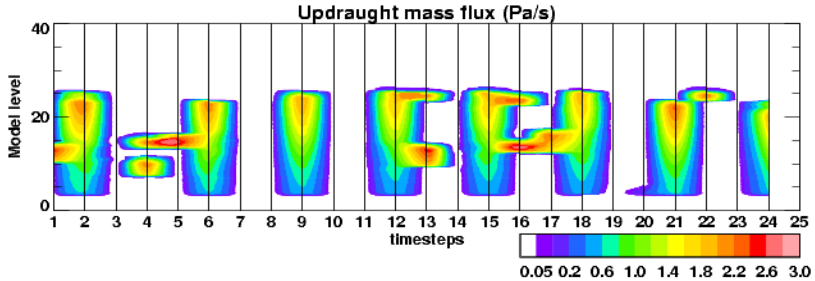
Unrealistic Moistening and drying

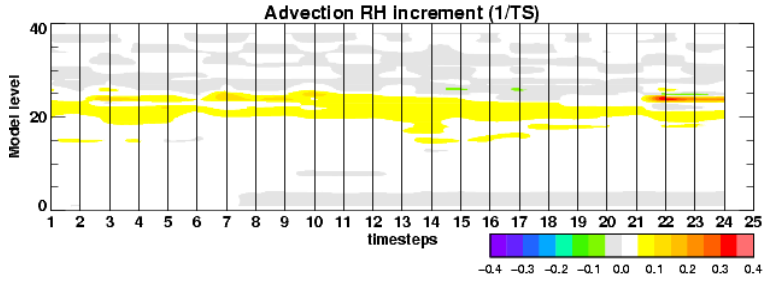
Moister at cloud base & Freezing level

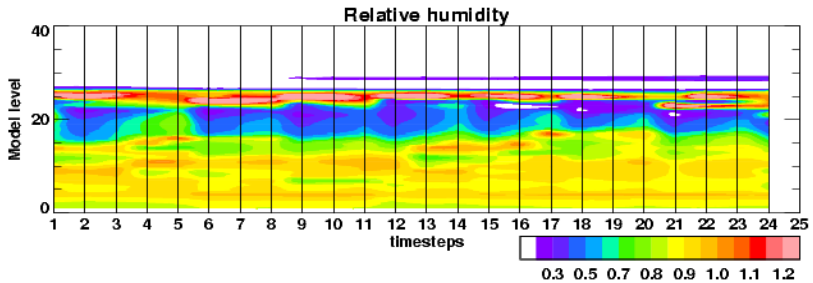
Drier in boundary layer

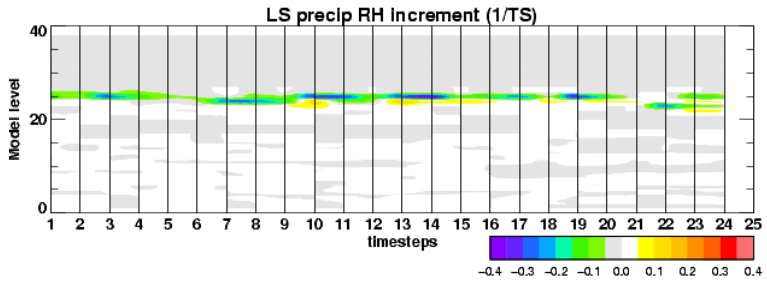
Drying & Moistening of the upper troposphere

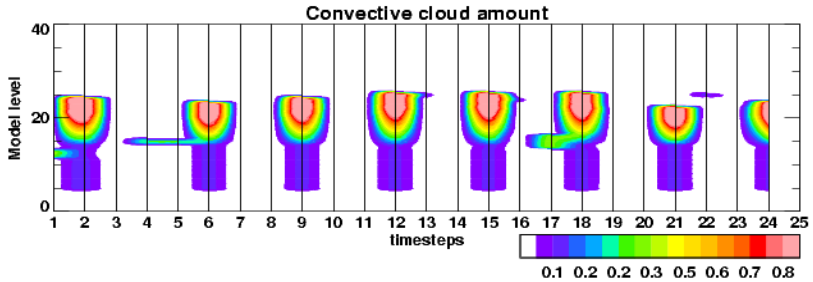
AQUAPLANET – Martin Willett

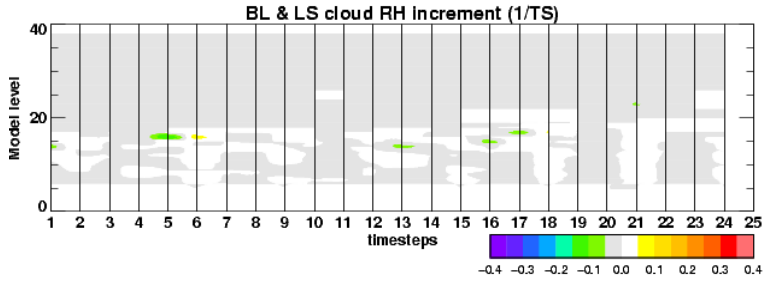


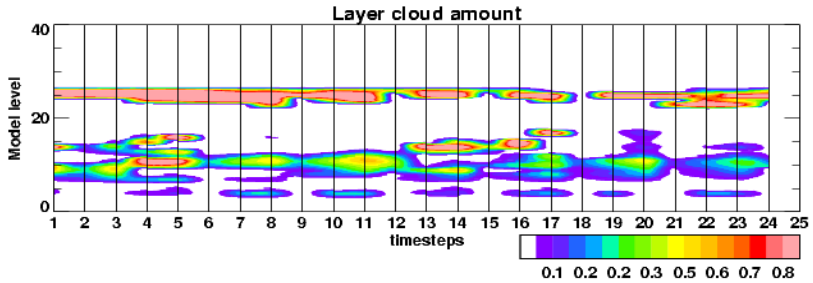


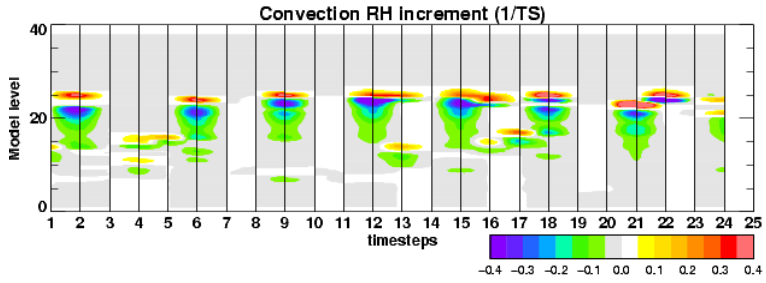












Future Work

- Compositing results
  - Clear vs Cloudy
  - Rain Vs No rain
  - Stable vs unstable BL.
- Evolution of BL theta and q and BL depth
  - Comparison with sonde data
  - Comparison with meteorological towers
- Improved cloud diagnostics
  - Comparisons with lidar and cloud radar at ARM and Cloudnet sites
- Extend to other climatic regimes
  - Tropics
  - North Slope Alaska
- Compare with other centres

Plans For CEOP Data/Research

- Testbed for evaluation of new model parametrizations
  - New prognostic cloud scheme (Wilson, Gregory, Bushell)
  - New convection scheme (A. Grant)
- Model Intercomparison project
  - Preliminary study already underway based on surface radiation fluxes

Related Projects

- Collaborations with Reading University Environmental Systems Science Centre (ESSC) (Prof A. Slingo)
  - SINERGEE (post-doc R.Allen) – simulation of radiances in NWP models vs MSG SEVERI/GERB instrument
  - Evaluation against ARM sites (PhD – P. Henderson)
- CloudNET (2001-2004) – EEC framework 5 project to compare cloud radar/lidar products at Cabauw, Chilbolton, and Paris with NWP models (D. Wilson)
- BSRN – evaluation of surface radiation in NWP models
- AMMA – West African Monsoon 2006.
  - Surface flux, sonde & aircraft measurements.
  - Mobile ARM site
- GCSS WG4 case study 5 – TOGA-COARE transition from suppressed to deep convection

Questions & Answers