CERES Surface-Only Algorithm Studies: Constraining Overestimation of Downward Longwave Flux (DLF) in Simple Surface Flux Models

Shashi K. Gupta, David P. Kratz, Anne C. Wilber,
Victor E. Sothcott, Taiping Zhang, and Paul W. Stackhouse

NASA Langley Research Center, Hampton, VA

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Background

- CERES uses several simple surface flux models for computing SW and LW surface fluxes in addition to the detailed model used by SARB. This presentation is on simple LW models.

- Two LW models are in use from the beginning. A third brought in recently and tested offline; to be used in Edition-3 processing. These models are designated as: A, B, and C.

  A: Inamdar and Ramanathan (1997): *Tellus,* **49B**, 216-230.
  B: Gupta et al. (1992): *J. Appl. Meteor.,* **31**, 1361-1367.
  C: Zhou and Cess (2001): *J. Geophys. Res.,* **106**, 12477-12488.

- Validation of SSF fluxes provided many insights and revealed some flaws. Present work is an attempt at mid-course adjustment based on what we have learned.

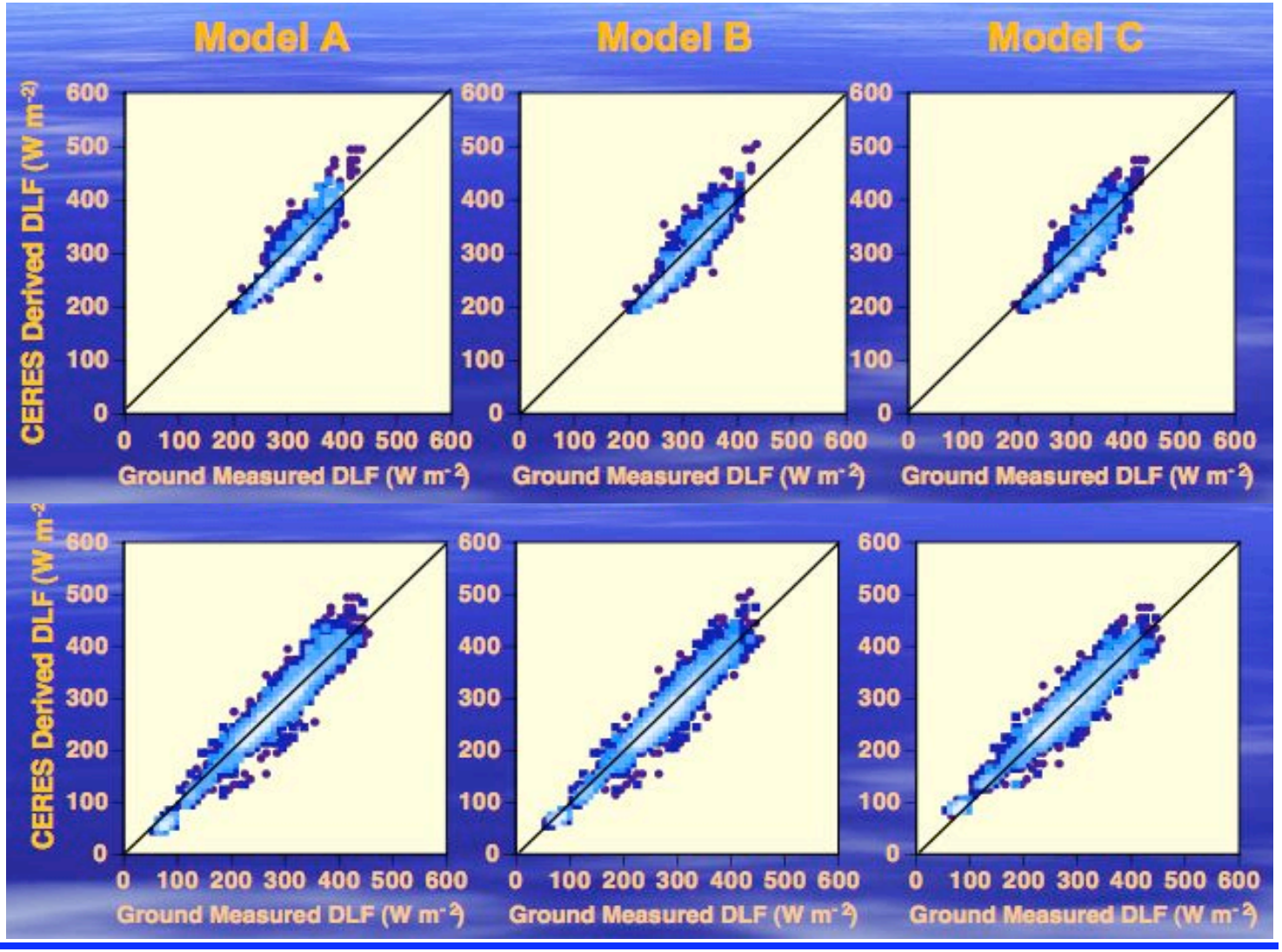
- All three models overestimate DLF for some footprints at the high end of DLF range.

Overestimation of DLF Over Desert Regions

Clear-Sky (Aqua-2A; July 2002 - March 2005)

Deserts

Global



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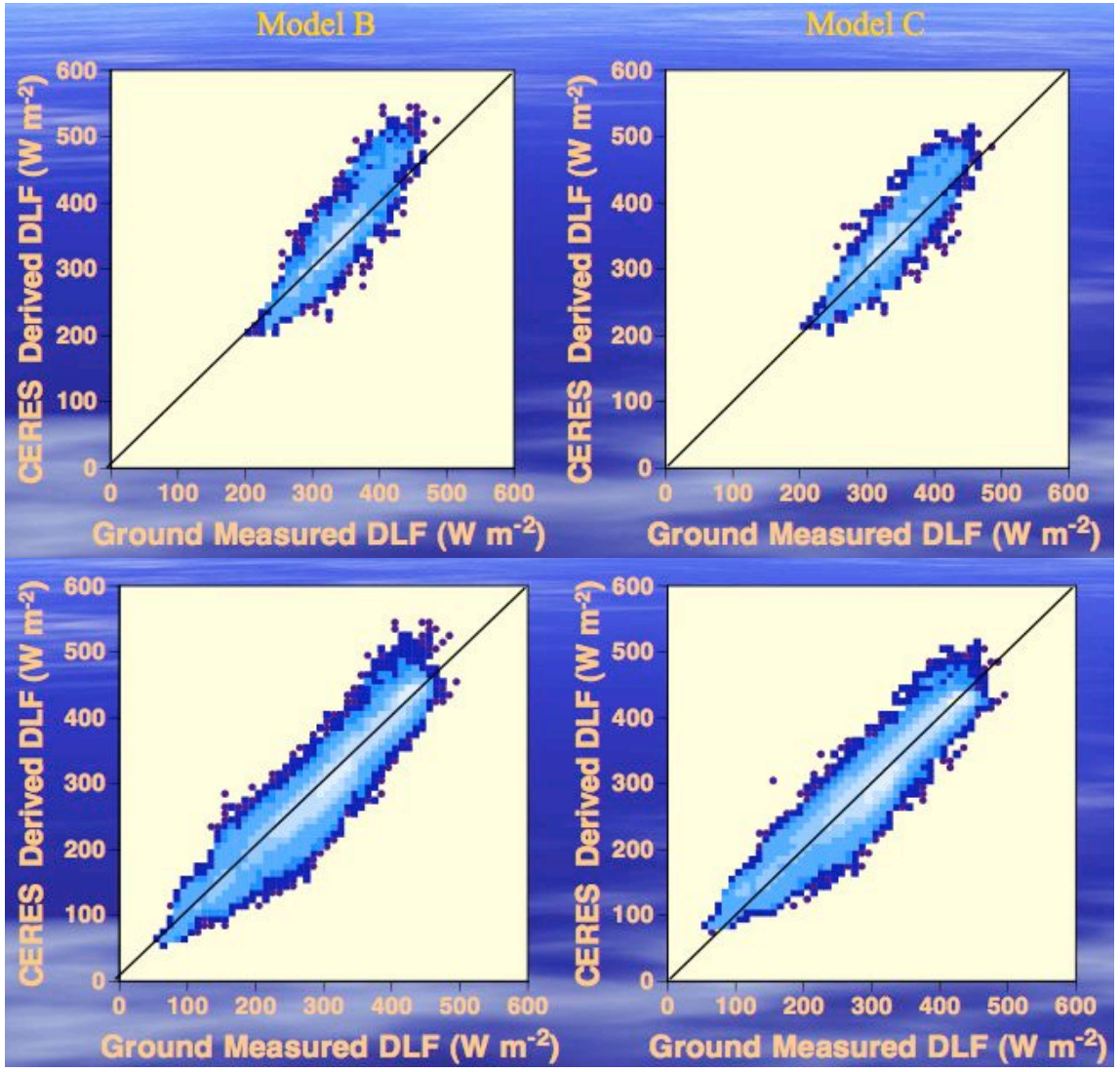


Plan and Hypothesis

- Determine the cause, develop a remedy, and test it for Model B. Apply the same or similar remedy to Models A and C.

What in the model could be causing it?

- Effective Emitting Temperature:

$$T_{eff} = 0.60\ T_s + 0.35\ T_1 + 0.05\ T_2$$

T_s - Surface skin temperature
T_1 - Average temperature for Sfc. - 800 mb layer
T_2 - Average temperature for 800 - 680 mb layer

- Works well when T_s, T_1, and T_2 conform to nominal lapse rates.

- When $T_s >> T_1$ (and T_2), it results in overestimation of DLF.

Hypothesis (contd.)

Where on Earth could this be happening?

- Mostly over dry/arid regions during hot times of the day.

Methodology

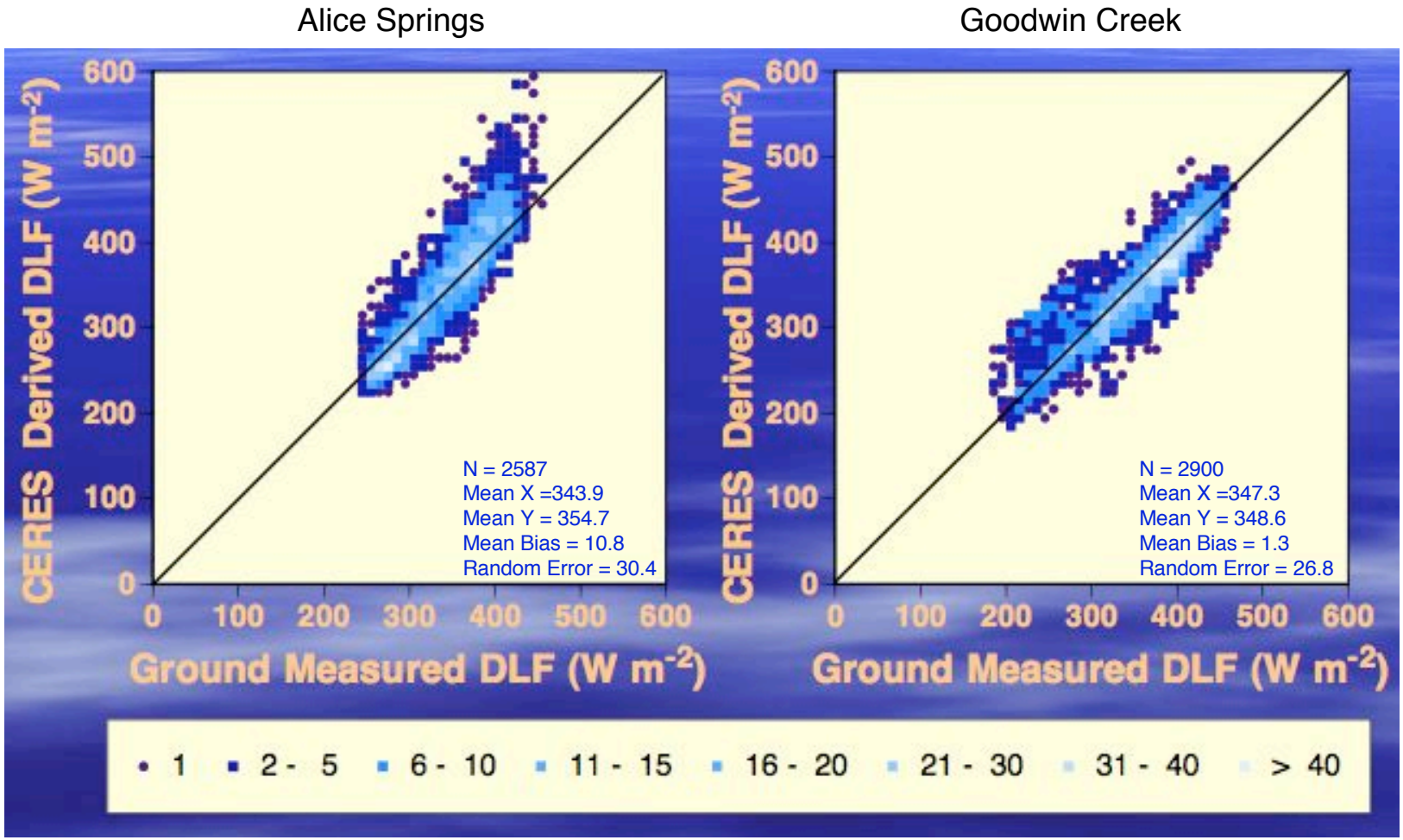
- Selected two sites for study:

  Alice Springs, Australia - Dry/Arid
  Goodwin Creek, MS (USA) - Moderate/Humid

- Performed flux computations using a stand-alone version of the model on a 3-hourly time resolution for all months of 2000.

- Compared model-derived DLF with ground-based observations for the above sites obtained from BSRN.

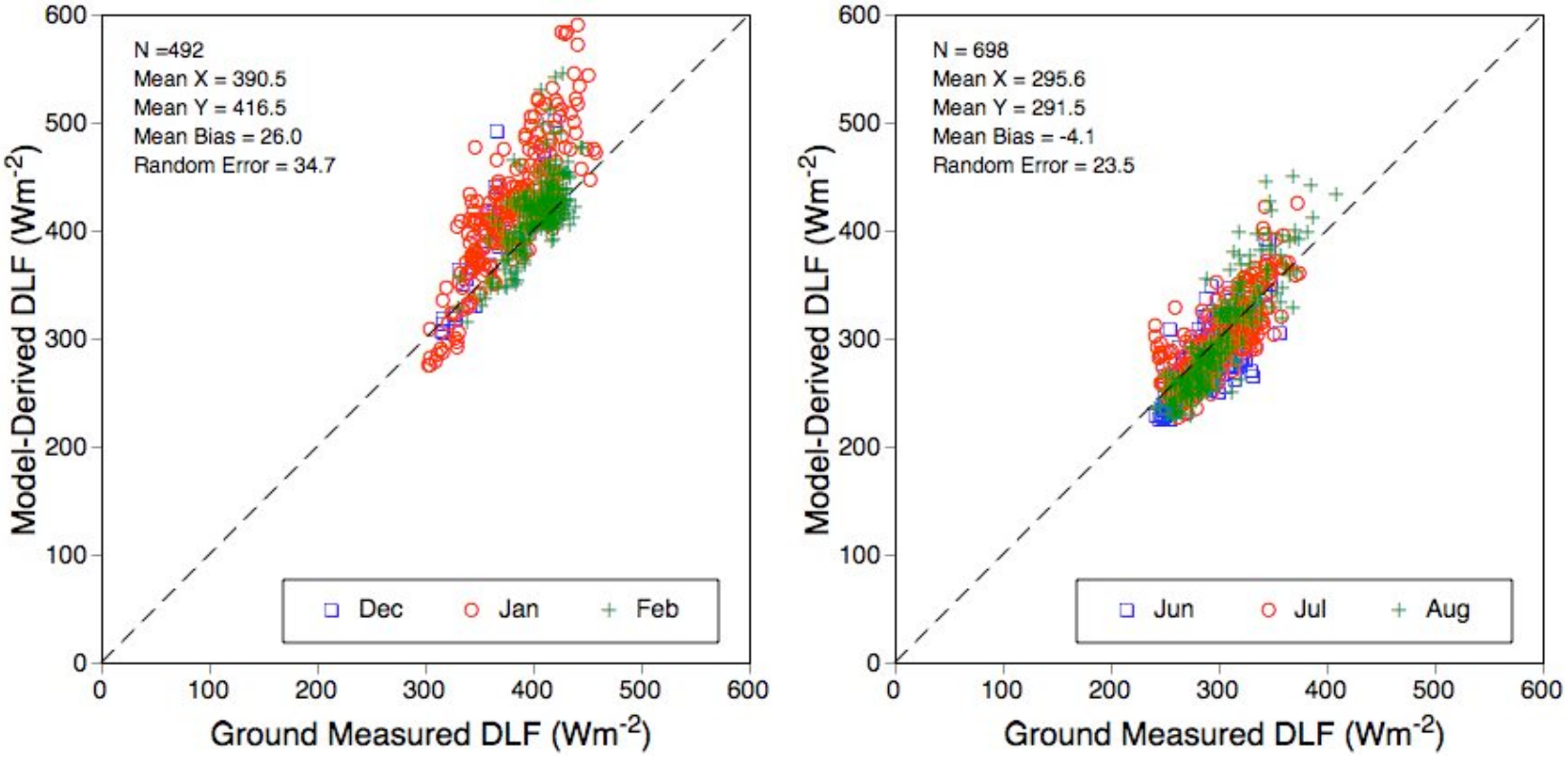
Model-Derived vs. Ground-Measured (BSRN) DLF
(Current version of the model)



Significant overestimation over Alice Springs; almost none over Goodwin Creek

Model-Derived vs. Ground-Measured DLF

Alice Springs



Severe overestimation during DJF; slight underestimation during JJA

Further Analysis of Alice Springs Overestimation

- Points with overestimation of > 100 Wm^{-2}

  32 points during the year (16 in Jan; 20 in DJF)

  Mean = 120 Wm^{-2}; Range: 100-160 Wm^{-2}

  T_s: Mean = 324.3 K; Range: 302-336 K

  P_s: Mean = 939 mb; Range: 935-946 mb

  T_{800}: Mean = 292.1 K; Range: 284.7-297.7 K

  $T_s - T_{800}$: Mean = 32.2 K; Range: 17.0-40.3 K

- $T_s - T_{800}$ should be about 10 K, but no more than 15 K

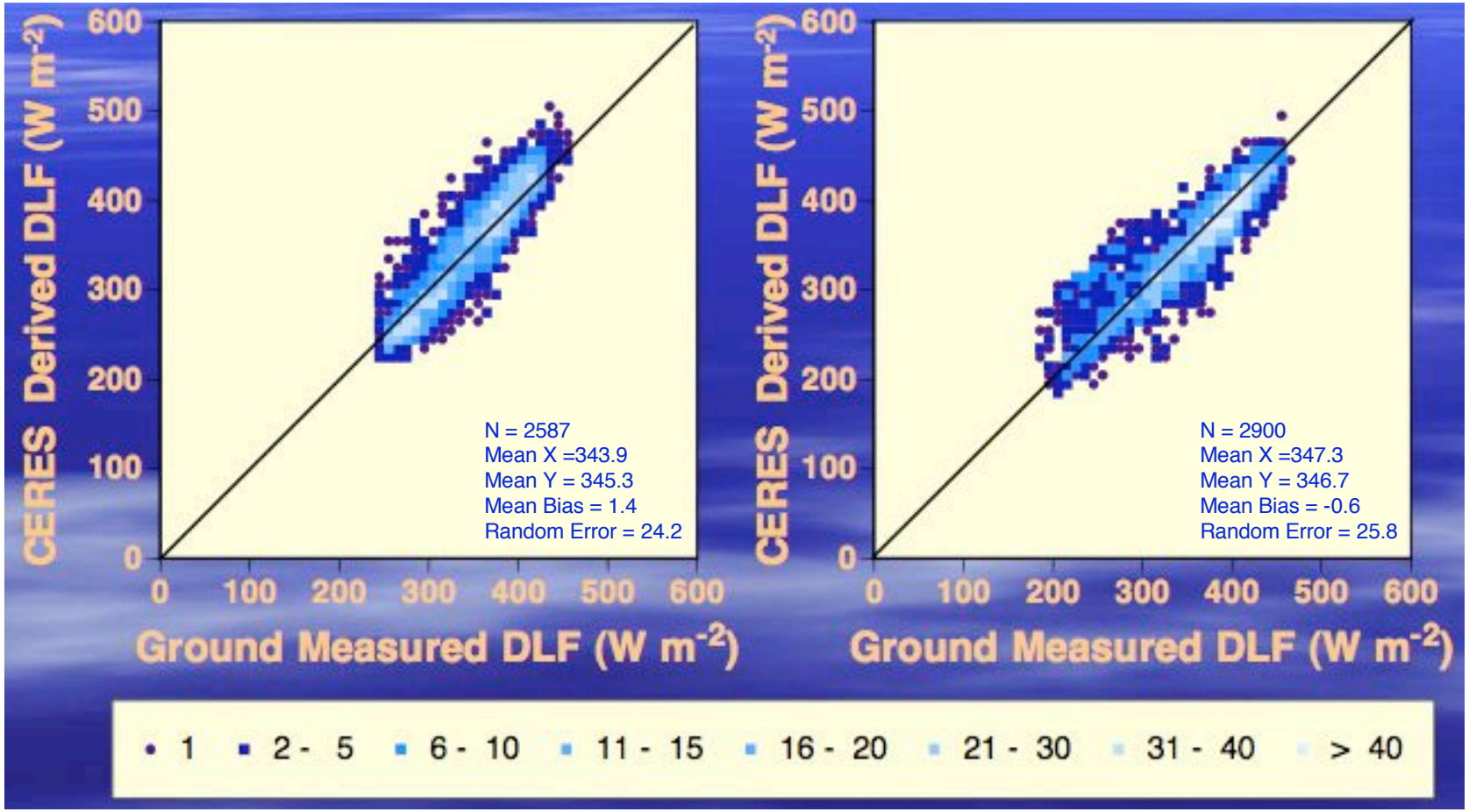
- Decided that lapse rates > 10K/100mb in the lower layer are too steep, and need to be adjusted.

- Adjusted skin temperature to not exceed 10K/100mb limit.

Results From the Modified Computation

Alice Springs

Goodwin Creek



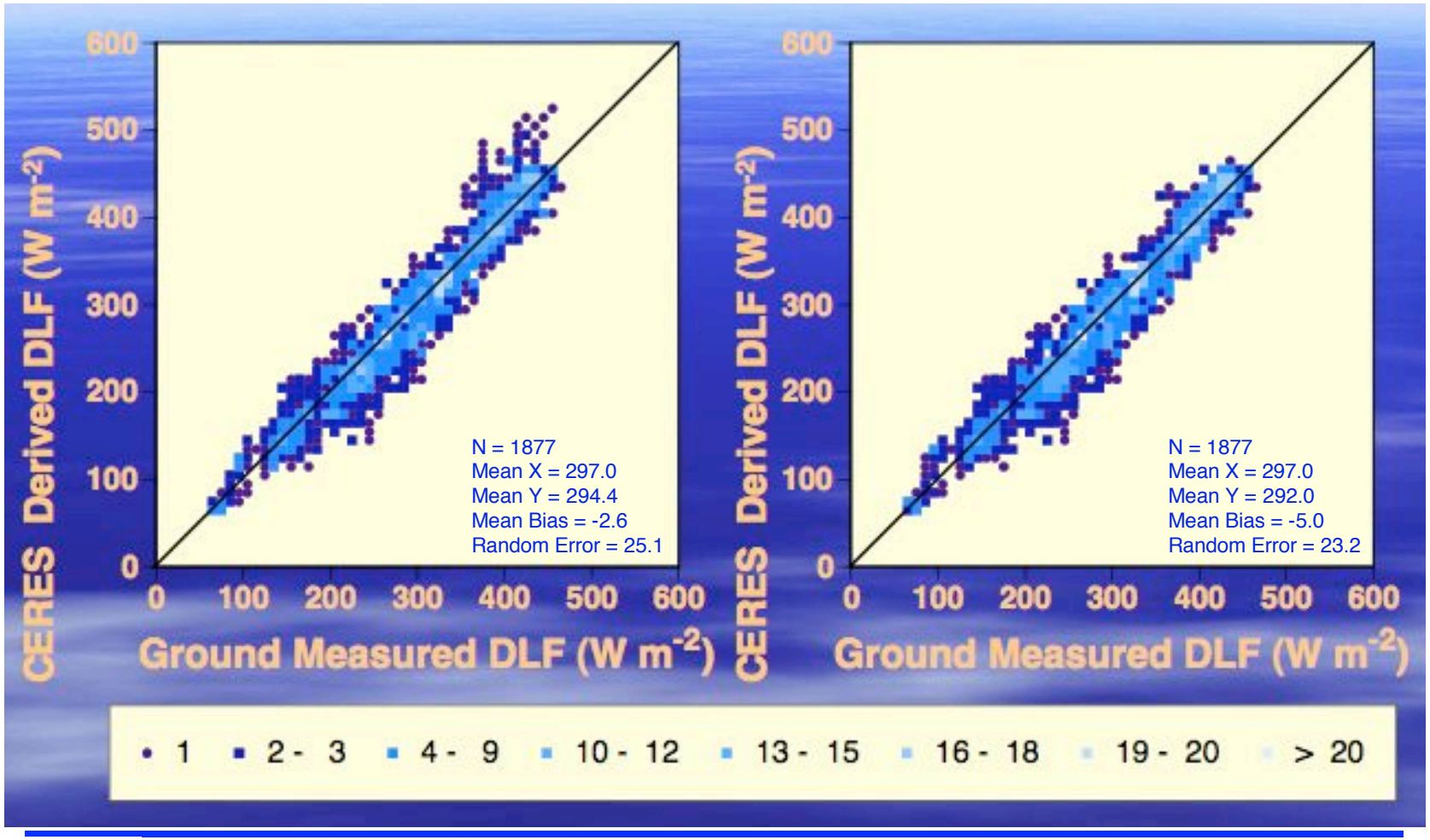
Bias for Alice Springs - reduced greatly; Change for Goodwin Creek - minimal

CERES Model-B Computation With Modified Scheme

(Aqua All-Sky Results: Jul 2002 and Jan 2004)

Current

Modified

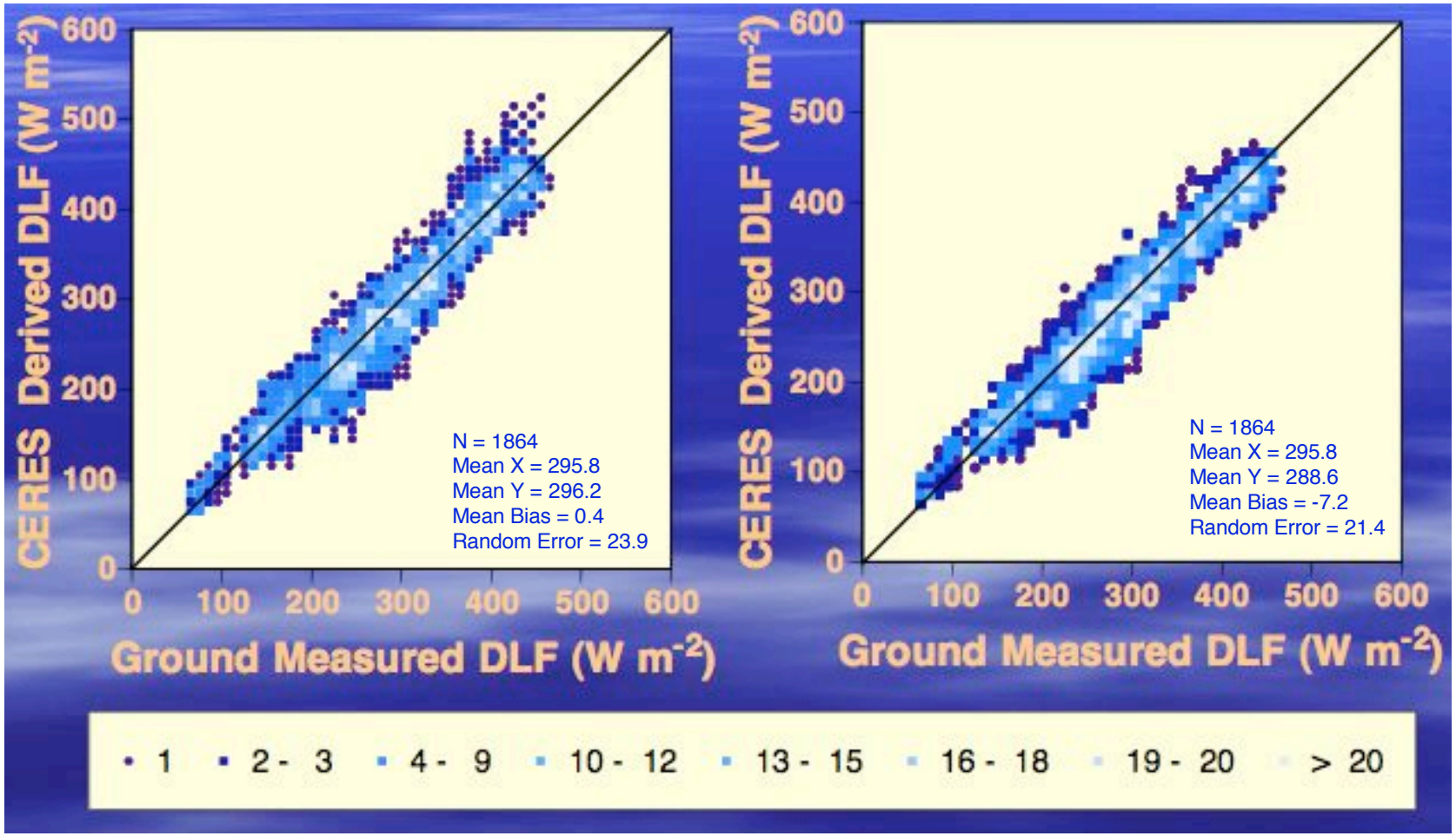


CERES Model-C Computation With Modified Scheme

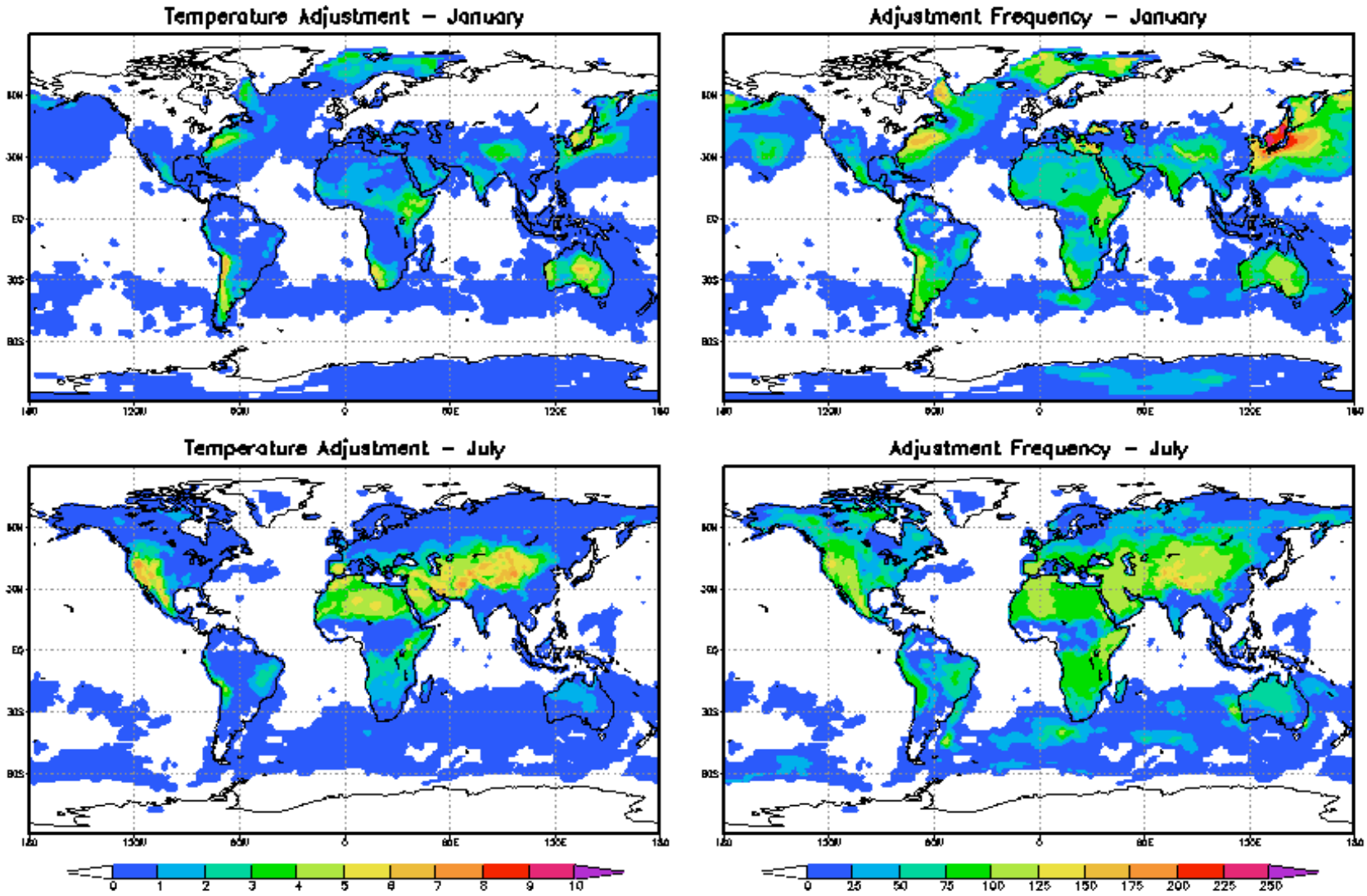
(Aqua All-Sky Results: Jul 2002 and Jan 2004)

Current

Modified



Monthly Temperature Adjustment and Frequency

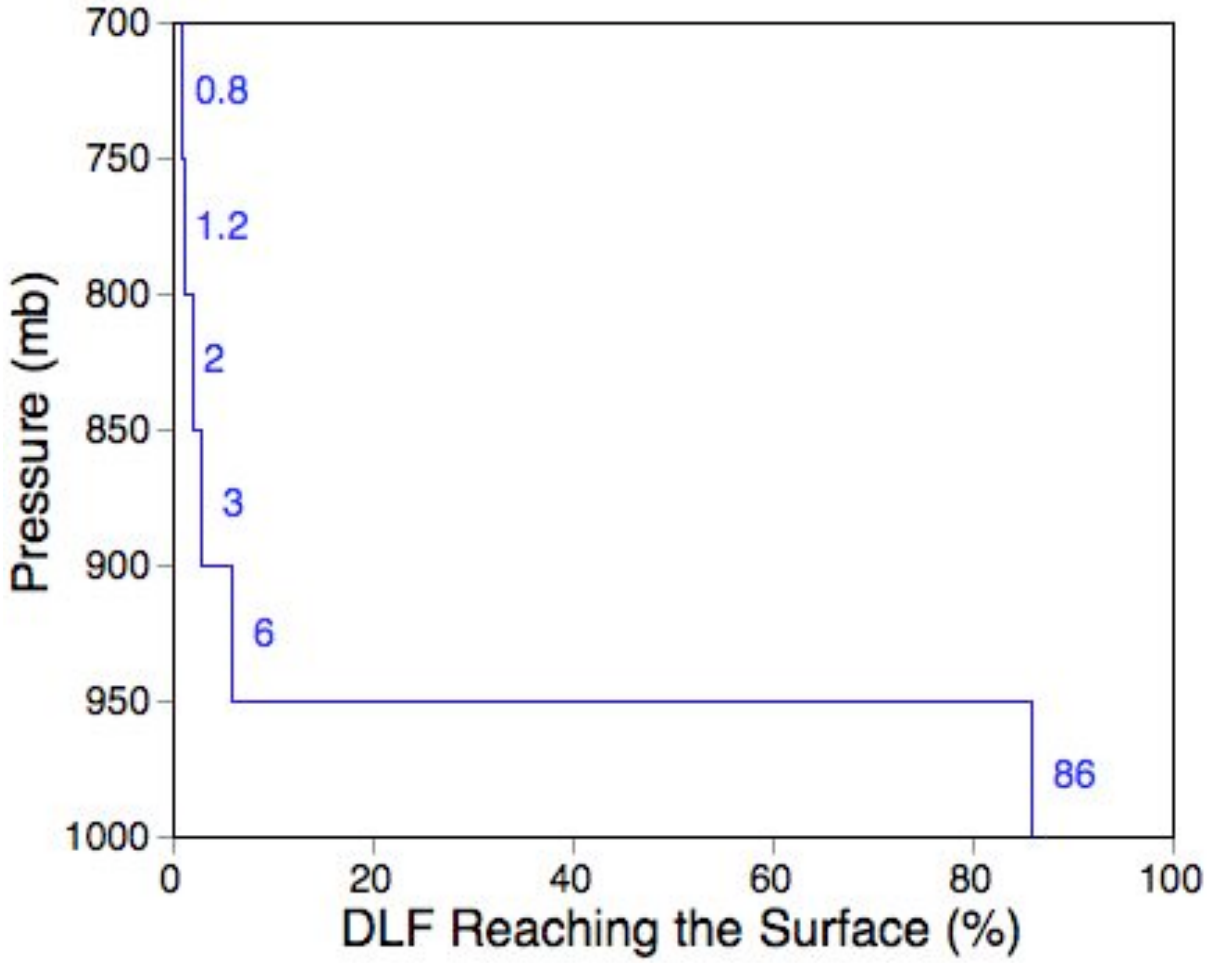


Summary

- Determined the cause of DLF overestimation: Occurs when skin temperature (T_s) is much higher than atmospheric temperatures.
- Developed a method for detecting this condition and constraining T_s prior to using it in DLF computation. Constrained T_s is not used for upward flux computation.
- Tested the method with Model-B for all months of 2000 using the stand-alone version and for two months using the CERES version.
- Applied the same method to CERES version of Model-C and tested for the same two months. Testing currently underway for Model-A.
- This method significantly improves Model-B and -C results. Ready to be implemented in Edition-3 β-testing and final processing.

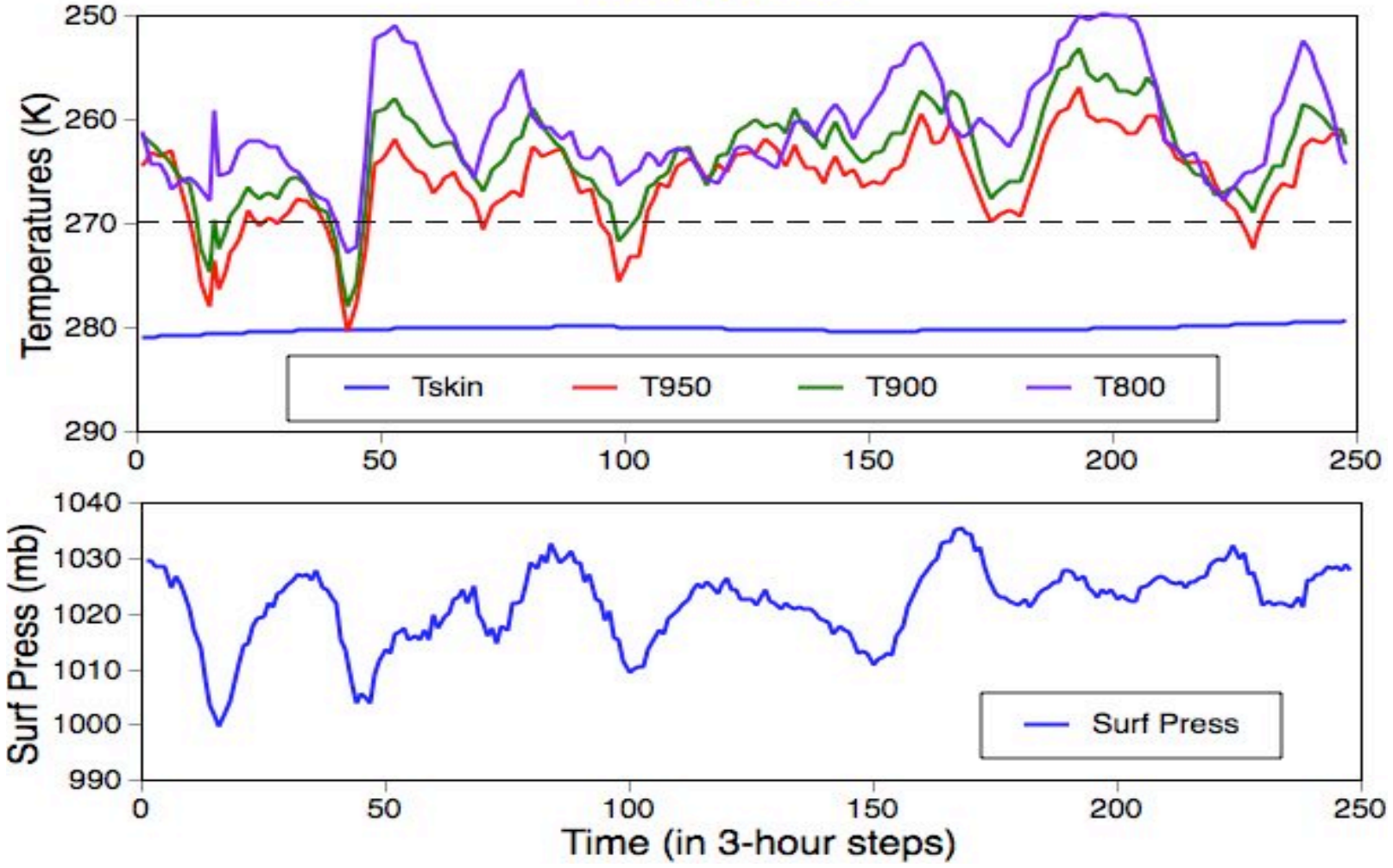
Weighting Function for DLF Reaching the Surface

(U.S. Standard Atmosphere - 50 mb Layers)

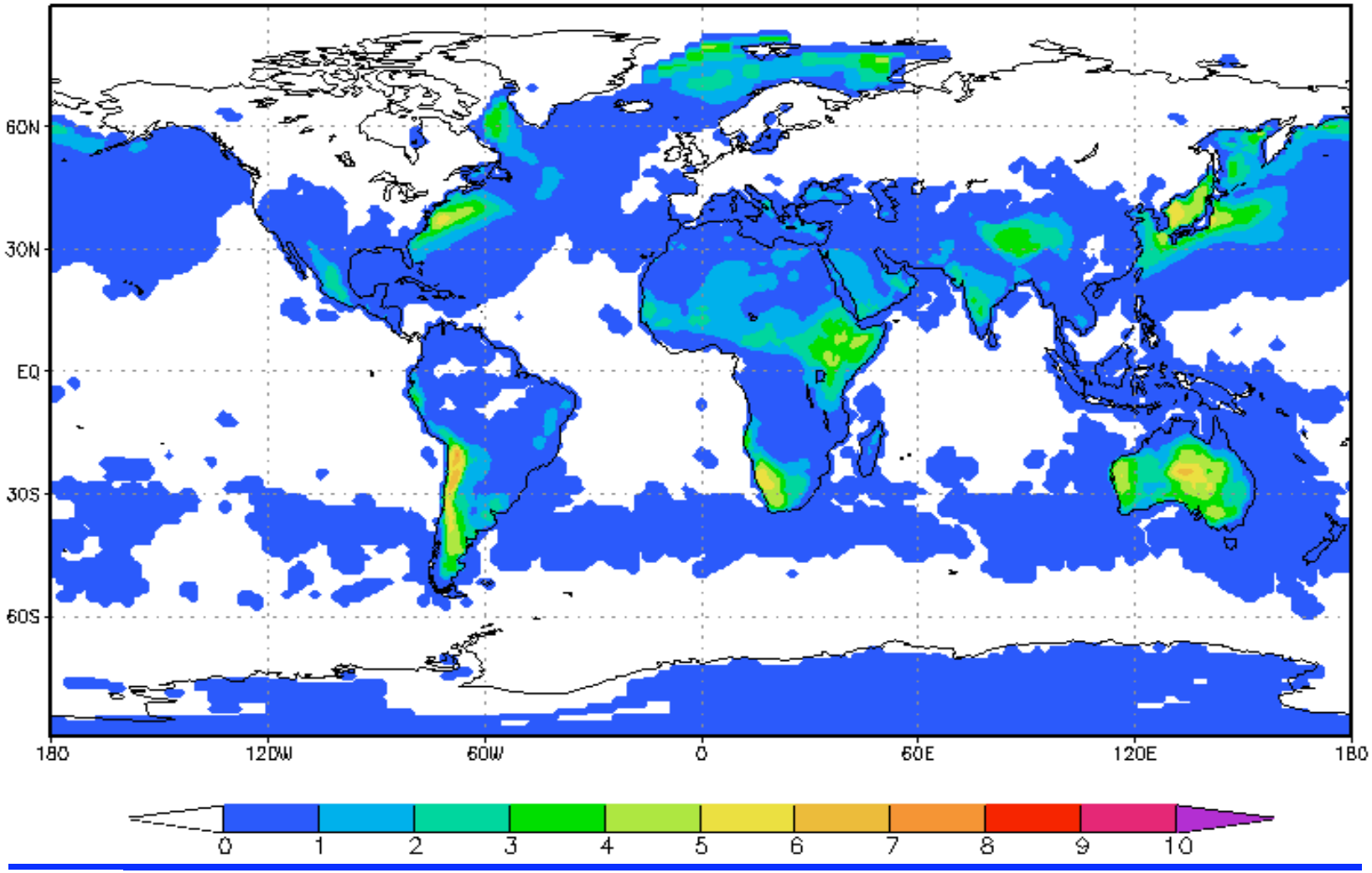


Surface and Atmospheric Temperatures Over Sea of Japan

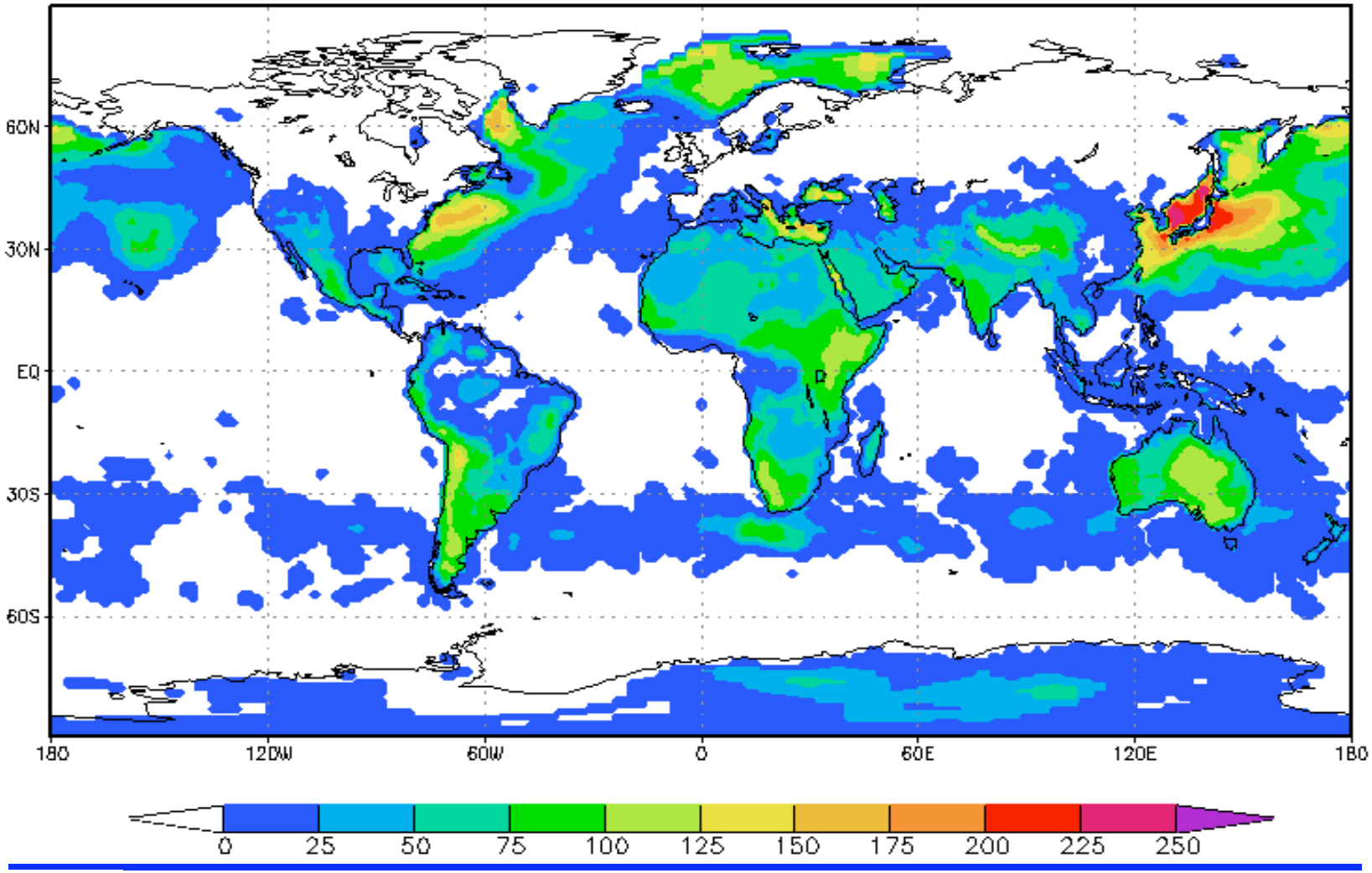
January 2000



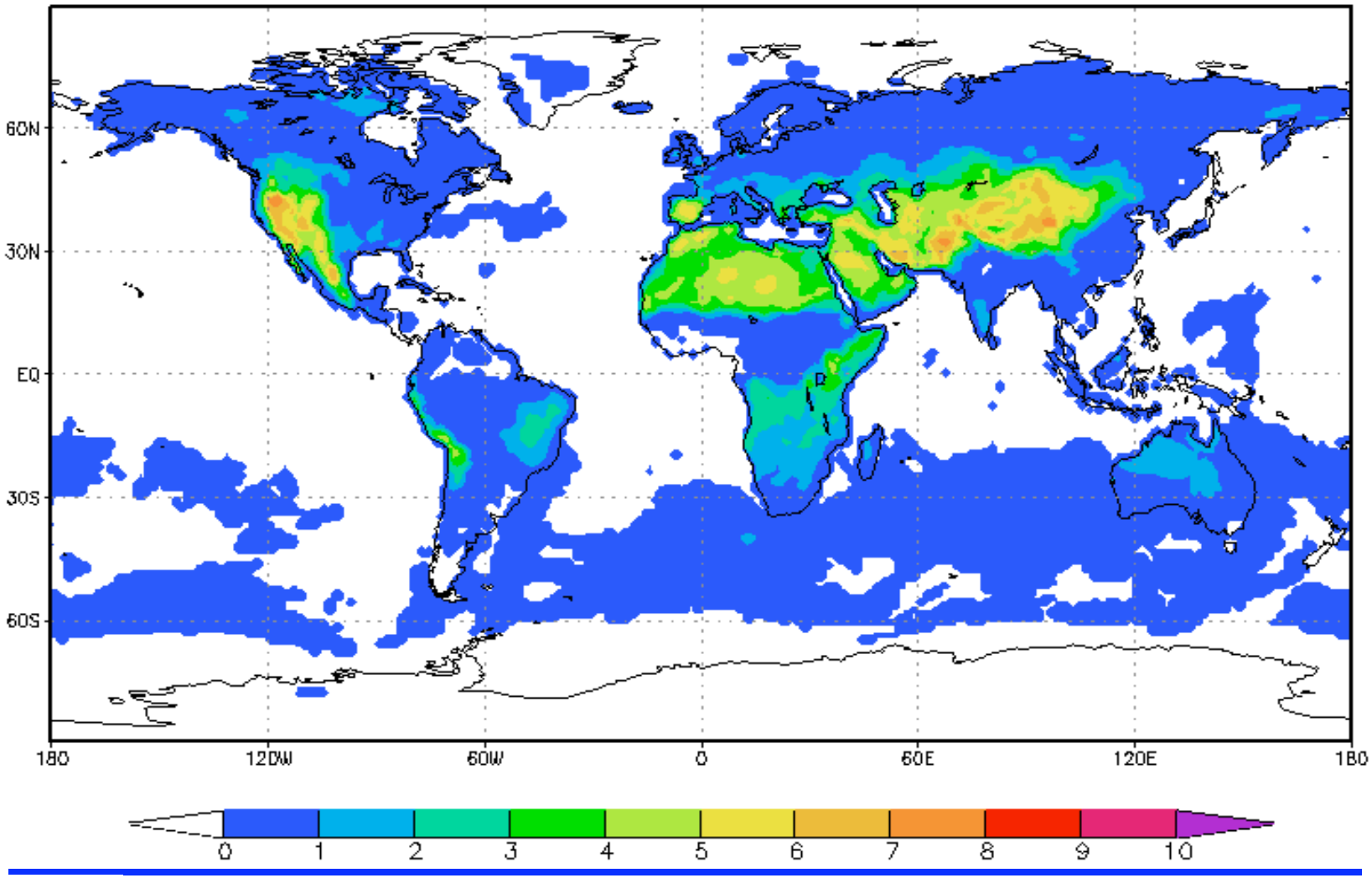
Monthly Average Temperature Adjustment - January



Temperature Adjustment Frequency - January



Monthly Average Temperature Adjustment - July



Temperature Adjustment Frequency - July