Diagnosis of High-Time-Frequency CMIP Output

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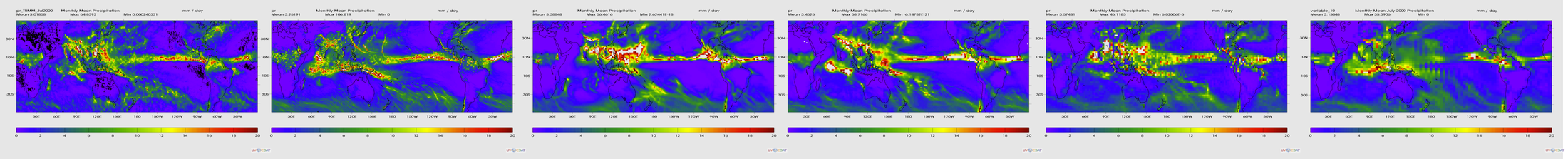
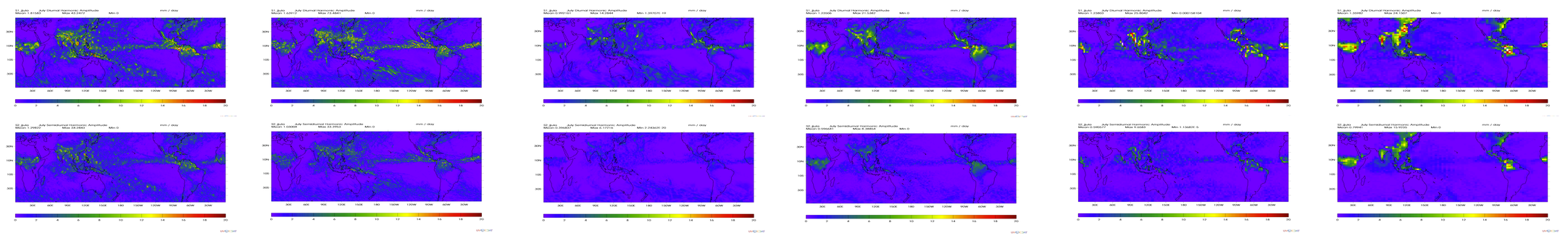
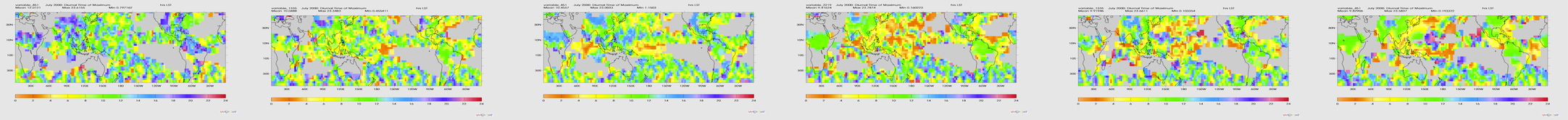
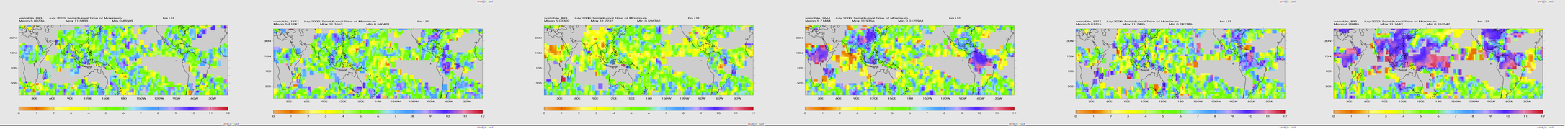
	TRMM 3B43 (from Obs4MIPs[3])	GFDL-HIRAM-C360	MRI CGCM3	ACCESS1-0	GISS-E2-R	IPSL-CM5A-LR
JULY 2000 Monthly Mean Precipitation						
Fourier Amplitudes: Diurnal						
Semidiurnal						
Local Solar Times of Maximum: Diurnal						
Semidiurnal						
	0.25° lat x 0.25° lon	0.25° lat x 0.3° lon	1° lat x 1° lon	1° lat x 2° lon	2° lat x 2.5° lon	2° lat x 4° lon

INCREASING RESOLUTION (NB: Times of maximum are re-gridded to lower resolution for better coherence.)

CAVEATS:

① **Random subset of CMIP5 models (sorted by higher resolution from right to left; TRMM obs have highest res).**

② **Only one observed dataset. "The temporal phase derived from 3G68 is arguably more reliable." [4]**

③ **Only one month of one year shown. Jan 2000 also looks OK; no other years examined yet.**

Three-hourly surface pressure from the Coupled Model Intercomparison Project provides insight into simulation of atmospheric tides, including canceling errors that give "the right answer for the wrong reason."[1] The latest database (CMIP5) also provides 3-hourly 2D fields of near-surface humidity, temperature and wind; soil moisture; total cloudiness; evaporation and precipitation; and surface fluxes of energy. It also provides selected 6-hourly 3D fields.[2] These fields enable study of hydrologic, surface and boundary layer processes relevant to ecosystems and people.

Applying the same data processing algorithm used in our atmospheric tide studies (*op. cit.*) gives a new point of view on the diurnal cycle of hydrology. Observations as well as model output[3] are available at high time frequency on the same data distribution system that supports CMIP, the Earth System Grid Federation network (github.com/ESGF/esgf.github.io/wiki). Comparing 3-hourly precipitation variations between models and Tropical Rainfall Measuring Mission observations for 50°S−50°N reveals similar space-time patterns and magnitudes, albeit with problems identified in previous work. For example, many simulated times of maximum diurnal-harmonic precipitation appear to be too early – although the observational dataset used here may itself give times that are about three hours too late.[4] (The TRMM 3G68 version uses only data from the TRMM mission itself, designed for optimal timing information.) Thus the highest-resolution model shown above may give reasonable times of maximum precipitation. It also gives an encouraging simulation of eastward-propagating summertime precipitation in central North America.[5] In a broader sense, CMIP and obs4MIPs complement local and regional studies of diurnal hydrology that use ARM and other in situ data.

Our first priority for future work is to remove the "caveats" at left. This will entail bringing in far more data, necessitating statistics that can summarize model performace.

(1) C. Covey *et al.*, "The Surface-pressure Signature of Atmospheric Tides in Modern Climate Models," *Journal of the Atmospheric Sciences 68:* 495-514 (2011) and "Atmospheric Tides in the Latest Generation of Climate Models," *ibid.*, in press (early online release at http://journals.ametsoc.org/doi/pdf/10.1175/JAS-D-13-0358.1).

(2) See categories "3hr," "6hrLev" and "6hrPlev" in the list at http://cmip-pcmdi.llnl.gov/cmip5/data_description.html.

(3) J. Teixeira *et al.*, "Satellite Observations for CMIP5: The Genesis of Obs4MIPs," *Bulletin of the American Meteorological Society*, in press (early online release at http://journals.ametsoc.org/doi/pdf/10.1175/BAMS-D-12-00204.1).

(4) K. Kikuchi and B. Wang, "Diurnal Precipitation Regimes in the Global Tropics," *Journal of Climate 21:* 2680-2696 (2008). See also A. Dai *et al.*, "The Frequency, Intensity, and Diurnal Cycle of Precipitation in Surface and Satellite Observations over Low- and Mid-Latitudes," *Climate Dynamics 29*: 727-744 (2007).

(5) X. Jiang *et al.*, "Role of Eastward Propagating Convection Systems in the Diurnal Cycle and Seasonal Mean of Summertime Rainfall over the U.S. Great Plains," *Geophysical Research Letters 33:* L19809.

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