Auxiliary Material for Paper 2014GL059519

Tropical Cyclones in Reanalysis Datasets

Hiroyuki Murakami (hir.murakami@gmail.com)

International Pacific Research Center, University of Hawaii, Honolulu, USA

Geophysical Research Letters

Introduction

Detailed descriptions of detection methods for tropical cyclones are presented in text01.pdf. The correlation coefficients between the observations and detected TCs using *Strachan et al.* [2013] are show in tb01.pdf. TC tracks detected using *Strachan et al.* [2013] are show in fs01.pdf. The interannual variation in TC genesis number for observations and reanalyses detected using *Murakami and Sugi* [2010] from 1979 to 2012 is shown in fs02.pdf. The interannual variation in TC genesis number detected using *Strachan et al.* [2013] is shown in fs03.pdf.

1. text01.pdf

Auxiliary Text. Detection methods for tropical cyclones.

2. tb01.pdf

Auxiliary Tab. S1. As in Table 2, but for TCs detected using *Strachan et al.* [2013].

3. fs01.pdf

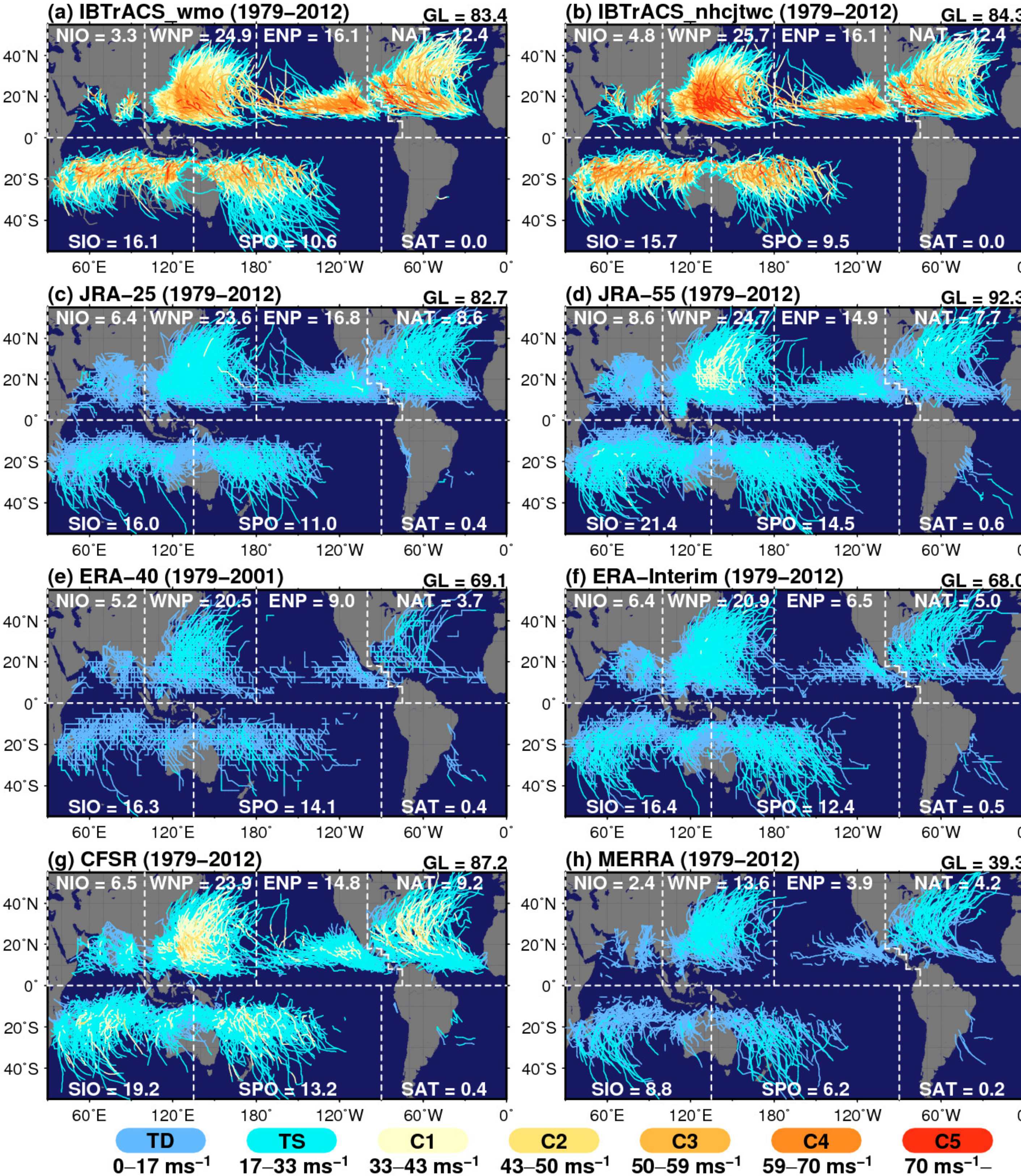
Auxiliary Fig. S1. As in Fig. 1, but for TC tracks using *Strachan et al*. [2013].

4. fs02.pdf

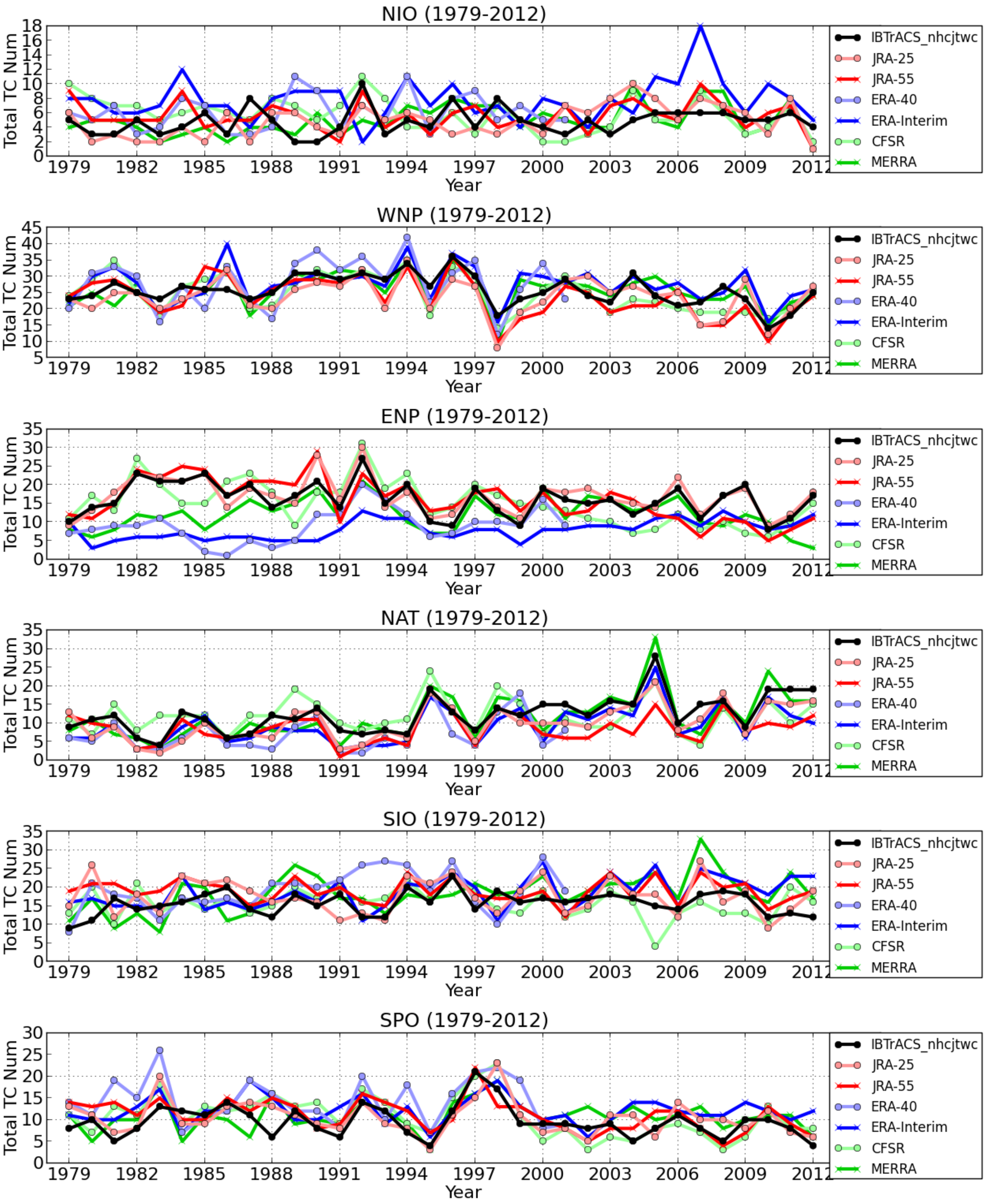
Auxiliary Fig. S2. Interannual variation in TC genesis number according to observations (IBTrACS_nhcjtwc; black) and reanalyses detected by *Murakami and Sugi* [2010].

5. fs03.pdf

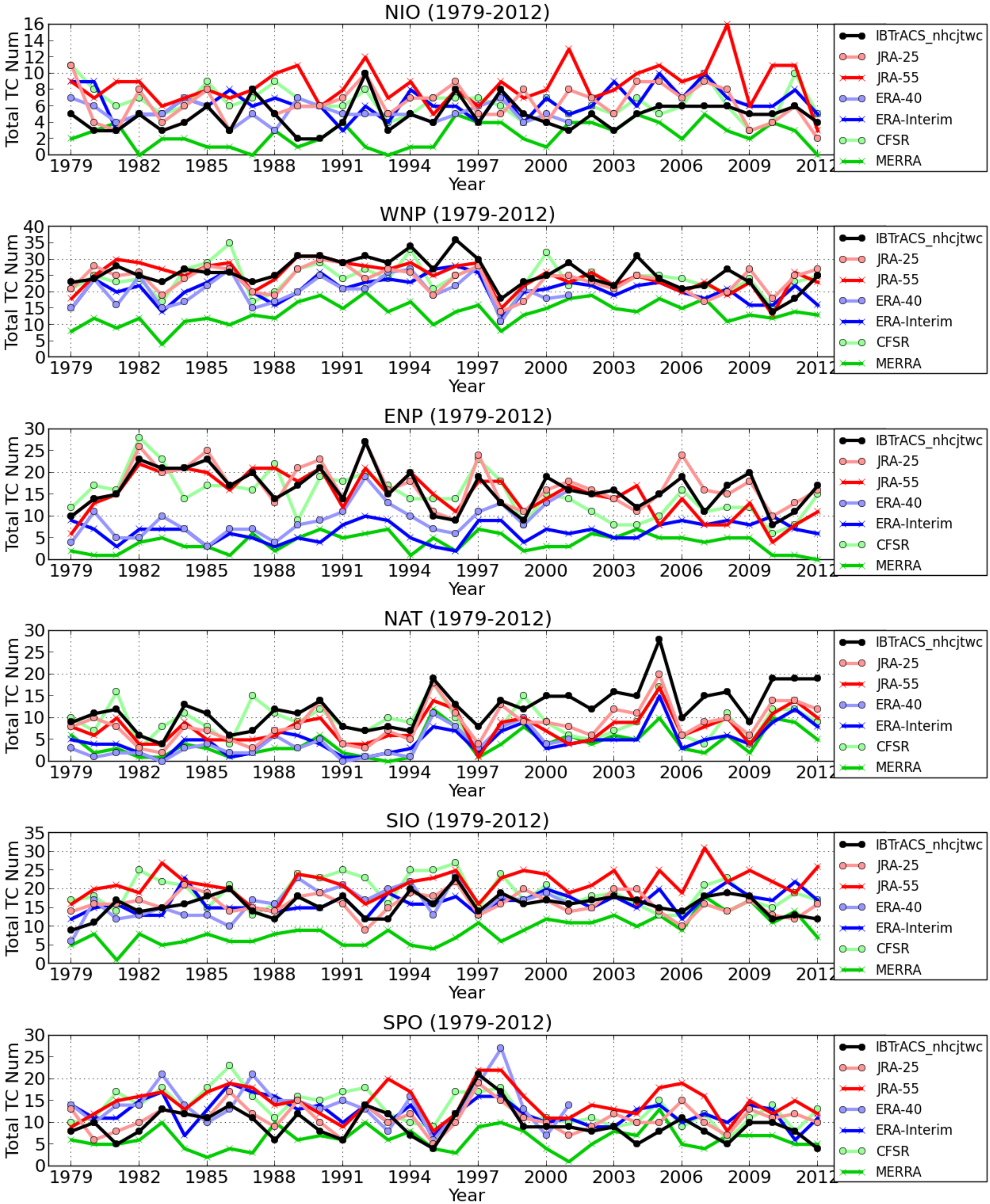
Auxiliary Fig. S3. As in Auxiliary Figure S2, but for TCs detected using *Strachan et al.* [2013].



Auxiliary Figure S1. Same as Fig. 1, but for TCs detected using *Strachan et al.* [2013].



Auxiliary Figure S2. Interannual variation in TC genesis number during all seasons from 1979 to 2012 according to observations (IBTrACS_nhcjtwc; black) and reanalyses detected by *Murakami and Sugi* [2010].



Auxiliary Figure S3. Same as Auxiliary Fig. S2, but for TCs detected using *Strachan et al.* [2013].

Auxiliary Table S1. Same as Table 2, but for TCs detected using *Strachan et al.* [2013].

	JRA-25	JRA-55	ERA-40	ERA-Interim	CFSR	MERRA
			(a) 1979-2012 using Strachan et al. (2013)			
NIO	**0.52**	0.33	0.06	0.21	0.27	0.10
WNP	**0.57**	**0.71**	**0.57**	**0.62**	**0.58**	**0.34**
ENP	**0.91**	**0.70**	0.25	0.11	**0.57**	0.29
NAT	**0.91**	**0.82**	**0.76**	**0.86**	**0.49**	**0.81**
SIO	**0.53**	**0.46**	**0.43**	0.31	**0.47**	0.09
SPO	**0.76**	**0.67**	**0.47**	**0.43**	**0.55**	0.17
			(b) 1958-2012 using Strachan et al. (2013)			
NIO						
WNP		**0.72**	**0.38**			
ENP		**0.59**	0.07			
NAT		**0.65**	**0.54**			
SIO						
SPO						

Auxiliary Method

Detection method for tropical cyclones by *Murakami and Sugi* [2010]

Tropical cyclones (TCs) in reanalysis datasets are detected according to the following reanalysis-dependent global uniform criteria using 6-hourly outputs. These criteria are based on those reported in *Murakami and Sugi* [2010]. Some criteria are optimized for a given reanalysis configuration to ensure that the global annual mean TC number matches the observed (83~84 per year for the period 1979–2012). The values listed in parentheses after each of the following criteria show the reanalysis-dependent values used for the optimization (from left, values are for JRA-25, JRA-55, ERA-40, ERA-Interim, CFSR, and MERRA, respectively).

(1) The magnitude of the maximum relative vorticity at 850 hPa (ζ_{850}) exceeds a threshold that depends on the resolution (1.0, 1.0, 1.0, 8.1, 15.0, and 1.0) × 10^{-5} s^{-1}.

(2) There is an evident warm core aloft. Namely, the sum of the temperature deviations at 300, 500, and 700 hPa (t_a) exceeds (0.6, 0.9, 0.8, 1.0, 1.3, and 1.0) K. The temperature deviation for each level is computed by subtracting the maximum temperature from the mean temperature over the 10° × 10° grid box centered nearest to the location of maximum vorticity at 850 hPa.

(3) The maximum wind speed at the 850 hPa vertical level is higher than that at 300 hPa (to exclude extra-tropical cyclones).

(4) The genesis position, defined as the first position at which conditions (1)–(3) are satisfied, is over the ocean.

(5) The duration of each detected storm (d) must exceed (36, 36, 24, 24, 36, and 30) hours. When a single TC satisfies all the criteria intermittently, it is considered a multiple TC

generation event. To prevent multiple counts of a single TC, a single time-step failure is allowed.

Detection method for tropical cyclones by *Walsh et al.* [2007]

TCs in reanalysis data are also detected using 6-hourly outputs according to the resolution-dependent global uniform criteria for maximum surface wind speed proposed by *Walsh et al.* [2007], which was originally developed by *Walsh et al.* [2004]. These criteria are derived from the wind profiles of observed TCs, averaged at various resolutions (see Fig. 2 in *Walsh et al.* [2007]). Data are acquired at a 6-hourly temporal frequency.

(1) The magnitude of the maximum relative vorticity at 850 hPa exceeds a threshold (1.0×10^{-5} s^{-1}).

(2) The maximum wind speed at 10m from surface exceeds the resolution dependent criteria determined by Fig. 2 in *Walsh et al.* [2007]. The criteria used for reanalysis datasets are 14 m s^{-1} for JRA-25 and JRA-55; 11 m s^{-1} for ERA-40; 13.5 m s^{-1} for ERA-Interim; and 16.5 m s^{-1} for CFSR and MERRA.

(3) There is an evident warm core aloft. Namely, the sum of the temperature deviations at 300, 500, and 700 hPa exceeds 1.0 K. The temperature deviation for each level is computed by subtracting the maximum temperature from the mean temperature over the 10° × 10° grid box centered nearest to the location of maximum vorticity at 850 hPa.

(4) The maximum wind speed at the 850 hPa vertical level is higher than that at 300 hPa (to exclude extra-tropical cyclones).

(5) The duration of each detected storm (d) must exceed 36 hours. When a single TC satisfies all the criteria intermittently, it is considered as multiple TC generation events. To prevent multiple counts of a single TC, a single time-step failure is allowed.

Detection method for tropical cyclones by *Strachan et al.* [2013]

Another TC detection method used in this study is *Strachan et al.* [2013] in which TC detection criteria are resolution independent. Maxima in low-level relative vorticity are used for TC identification and tracking. The tracking is applied in the region 60°S–60°N. Data are acquired at a 6-hourly temporal frequency.

(1) Initially all vorticity centers with intensities greater than $0.5 \times 10^{-5}\ s^{-1}$ at T42 resolution are tracked. The vorticity center tracks with a lifetime of over two days are retained for further analysis.

(2) For the retained tracks to be deemed TCs, they must attain the following filtering criteria, which are applied using a finer T63 resolution grid.

  (i) T63 relative vorticity at 850 hPa must attain an intensity threshold of $6.0 \times 10^{-5}\ s^{-1}$;

  (ii) a positive T63 vorticity center must exist at 850, 500, and 200 hPa, to determine a coherent vertical structure;

  (iii) there must be a minimum reduction in vorticity from 850 to 200 hPa (at T63 resolution) of $6.0 \times 10^{-5}\ s^{-1}$, to provide evidence of a warm core;

  (iv) there must be a reduction in T63 vorticity with height (checked between consecutive pressure levels); and

  (v) criteria (i) to (iv) must be attained for one day.

(3) Full resolution information, such as maximum relative vorticity and maximum 10-m surface wind speeds, are added back onto the remaining tracks for analysis.

References

Murakami, H., and M. Sugi (2010), Effect of model resolution on tropical cyclone climate projections, *SOLA*, **6,** 73–76, doi:10.2151/sola.2010-019.

Strachan, J., P.L. Vidale, K. Hodges, M. Roberts, and M.-E. Demory (2013), Investigating global tropical cyclone activity with a hierarchy of AGCMs: The role of model resolution, *J. Climate,* **26,** 133–152, doi:10.1175/JCLI-D-12-00012.1.

Walsh, K. J. E., K. –C. Ngyen, and J. L. McGregor (2004), Fine-resolution regional climate model simulations of the impact of climate change on tropical cyclones near Australia, *Clim. Dyn,* **22,** 47–56, doi: 10.1007/s00382-003-0362-0.

Walsh, K. J. E., M. Fiorino, C. W. Landsea, and K. L. McInnes (2007), Objectively determined resolution-dependent threshold criteria for the detection of tropical cyclones in climate models and reanalysis, *J. Climate,* **20,** 2307–2314, doi:10.1175/JCLI4074.1.