The Statistics of WRF

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1. INTRODUCTION

NCAR supports the Weather Research and Forecasting (WRF) Model (Skamarock et al. 2008) to a worldwide user community through code development and oversight, periodic releases, help services, tutorials, and workshops. To assess the reach of the WRF system, the support effort collects demographic data. The statistics compiled illuminate the scope and impact of model use, and they reveal WRF's continued popularity.

The WRF data examined here are derived from three sources: the support effort, user registrations, and bibliographic searches. The registration information has been collected from initial model release in 2000 to the present and includes the user's country and institution type.

Publication data have been gathered through searches utilizing the scientific citation indexing service Web of Science. The searches have targeted articles in all languages which have the keywords "WRF" and "Weather Research and Forecasting" and variants of them, including, WRF-NMM, WRF-Chem, and WRF-Hydro. Papers using the acronym "WRF" in topics and disciplines unrelated to the model are excluded from the counts.
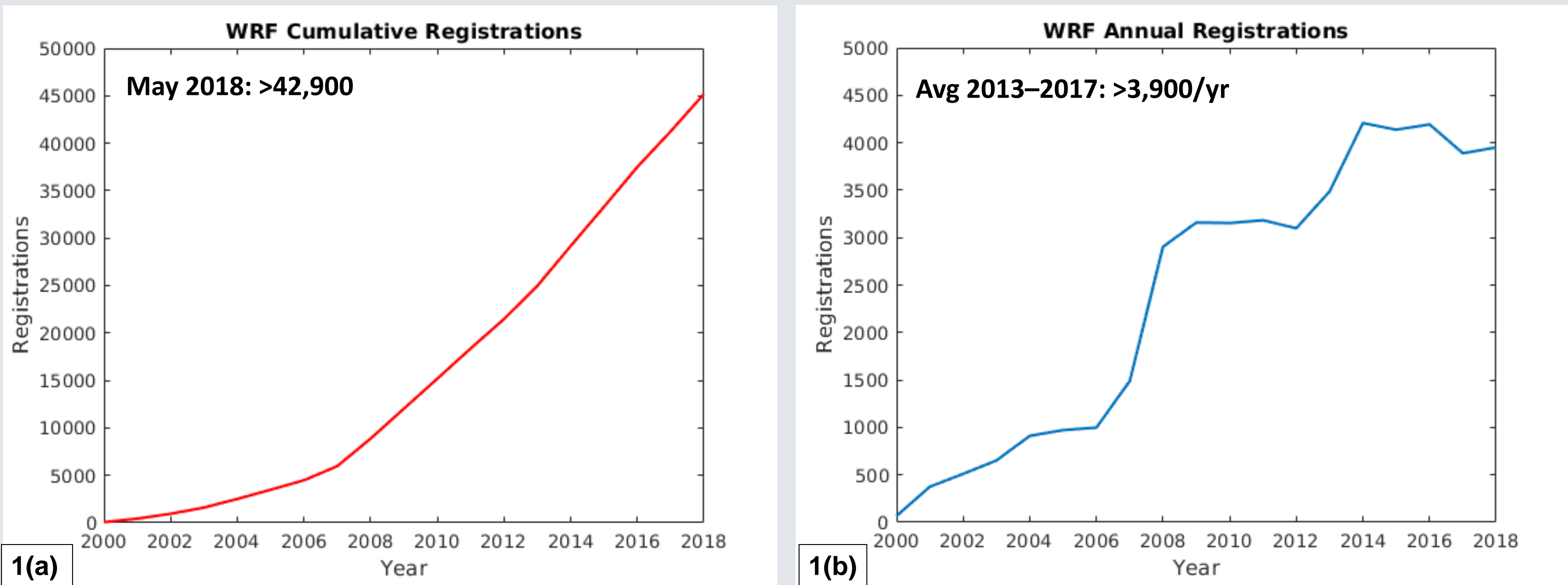
Fig. 1: AMPS user registrations, 2000–2018. Values for 2018 are projections based on registrations to date. (a) Cumulative registrations. (b) Annual registrations.

2. THE STATISTICS

The most basic metric maintained over the years is the cumulative number of WRF registrations. This stands at now over 42,900. Figure 1(a) shows WRF's steady growth in cumulative registrations since its initial release. The registration number for 2018 reflects a projection to year's end via simple linear extrapolation.

A measure of the ongoing interest in WRF and the variations in user influx is the number of annual registrations (Fig. 1(b)). Annual registrations have averaged over 3,900/yr for the past five full years (2013–2017), and the projection for 2018 is also over 3,900. Table 1 (below) presents the yearly WRF registration numbers.

The number of unique countries with user registrations to date is 166, and Fig. 2 (upper right) shows these. Table 2 (upper middle) lists the top five user registration countries and shows their approximate number of cumulative registrations through May 2018.

Table 1: WRF Annual Registrations

Year	Registrations	Year	Registrations
2000	67	2010	3154
2001	375	2011	3183
2002	511	2012	3099
2003	652	2013	3487
2004	911	2014	4208
2005	972	2015	4137
2006	998	2016	4193
2007	1488	2017	3889
2008	2904	2018	3959*
2009	3159		

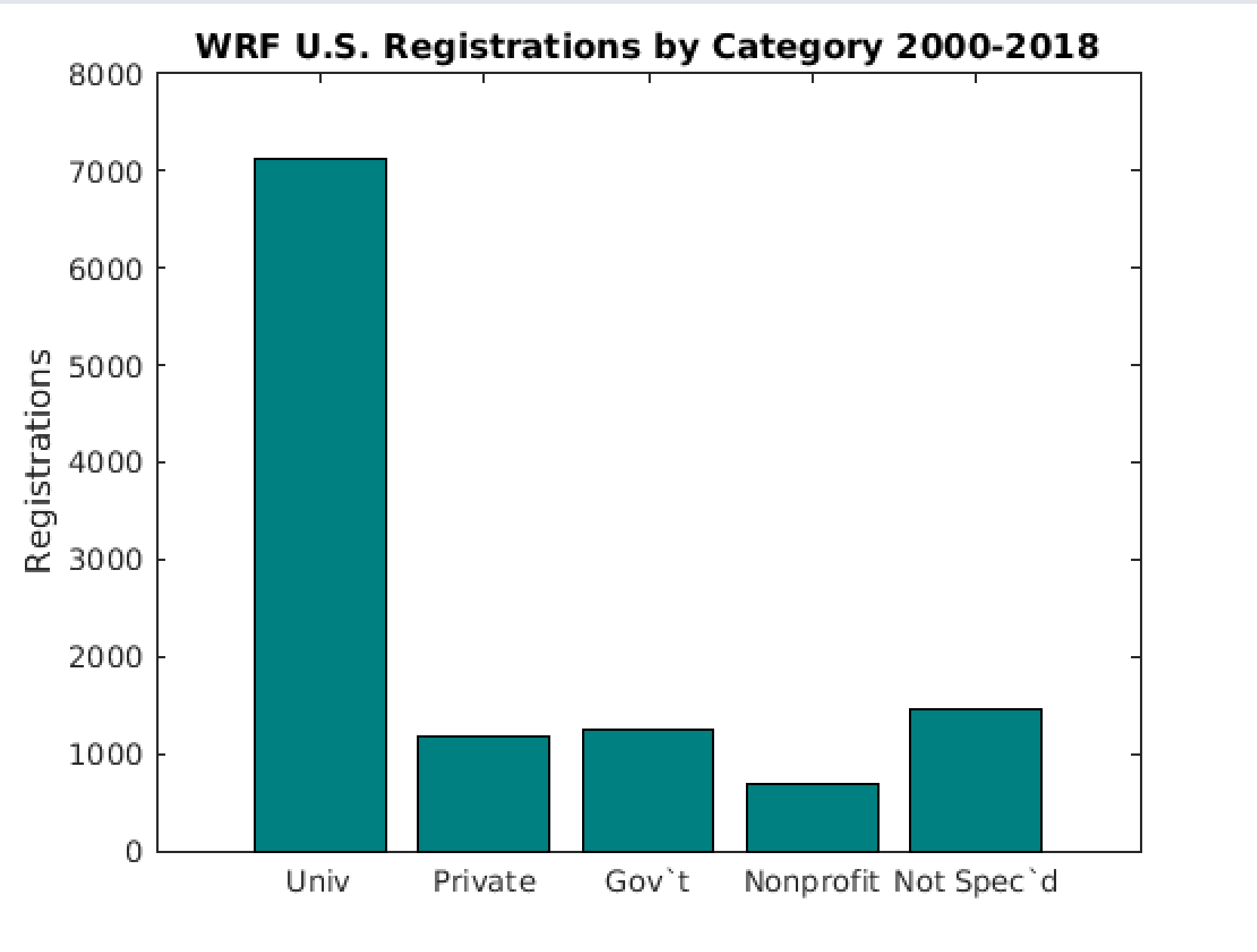*Projection to end of 2018 from registrations as of May 2018.

Fig. 4: WRF U.S. user registrations by category (as of May 2018).

Table 2: Top 5 User Registration Countries

1) United States (>11,680)
2) China (>8560)
3) India (>2110)
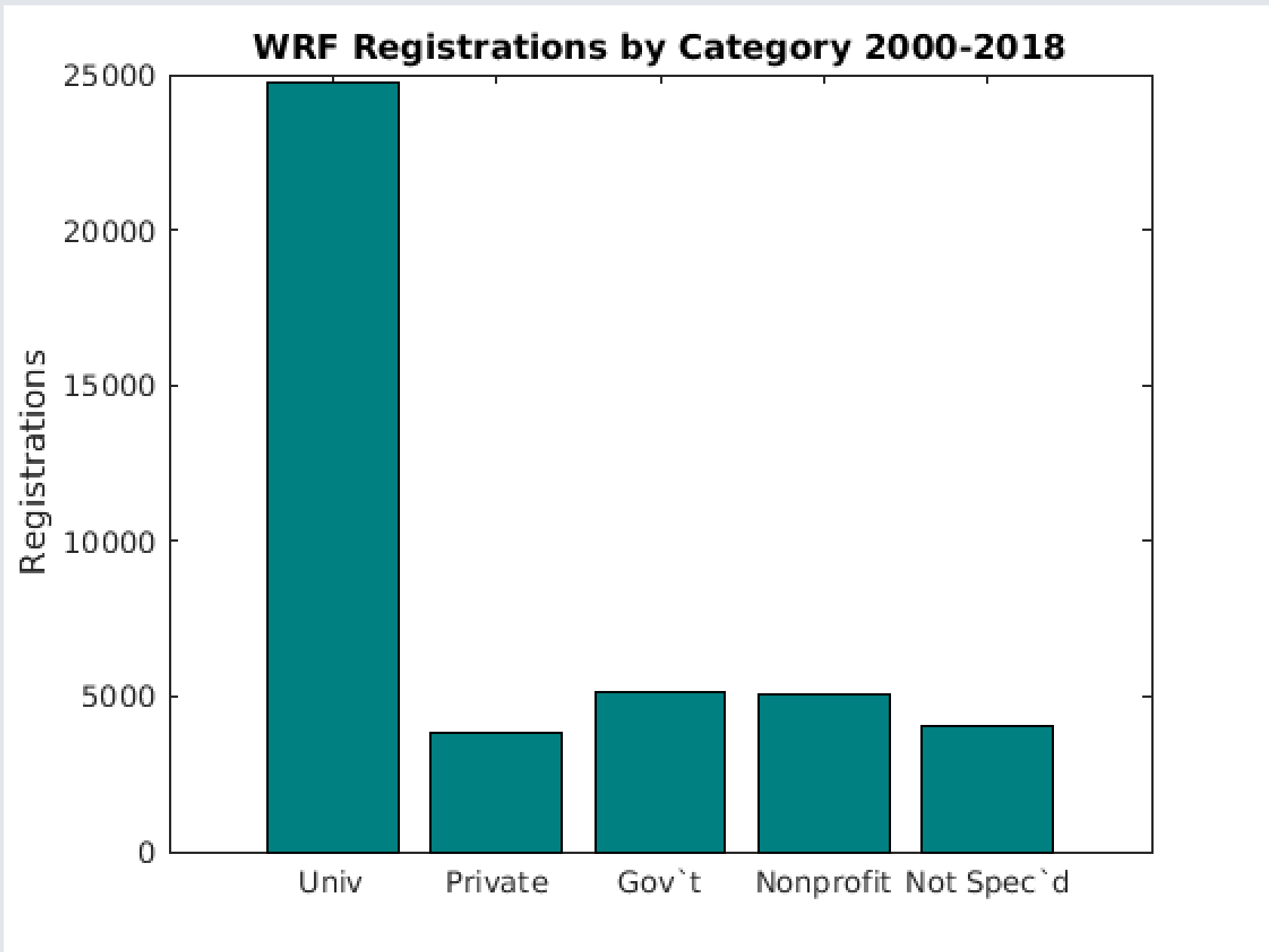4) Japan (>2090)
5) South Korea (>1580)

Fig. 3: WRF user registrations by category (as of May 2018).

Figure 3 shows a breakdown of WRF users by institutional affiliation type. The categories are: university (Univ), private companies and individuals (Private), governmental organizations (Gov't), nonprofit entities (Nonprofit), and affiliation not specified (Not Spec'd). Prior to 2009, it was possible to not specify an affiliation, and this is 9% of the current total. It is clear that university affiliations dominate: they account for 63.8% of specified affiliations. These are followed by: Government 13.3%, Nonprofit 13.0%, and Private 9.9%. Table 3 shows the cumulative numbers in the registration groups through May 2018.

Table 3: WRF User Registration by Category
(2000–May 2018)

Category	Registrations
University	24841
Private	3834
Government	5153
Nonprofit	5072
Not specified*	4049
Total	42949

*Registrations without an affiliation type specified.

Table 4: WRF U.S. User Registration by Category
(2000–May 2018)

Category	Registrations
University	7131
Private	1180
Government	1243
Nonprofit	680
Not specified*	1456
Total	11690

*U.S. registrations without an affiliation type specified.

Table 5: Universities with WRF User Registrations
(2012–2017)

United States:	245
International:	1243 (excl. U.S.)

Figure 4 (above, left) shows the American user affiliations through May 2018. Again, university users are the largest segment: 69.7% of specified affiliations, higher than the global average. The government and private segments of specified users are comparable, at 12.2% and 11.5%, respectively. The U.S. nonprofit segment has been 6.7%. Table 4 presents the cumulative numbers for the American registration affiliations.

Table 5 gives a snapshot of the distinct American and foreign universities. For the period 2012–2017 there were 245 American universities, and 1243 foreign universities, represented in the registrations.
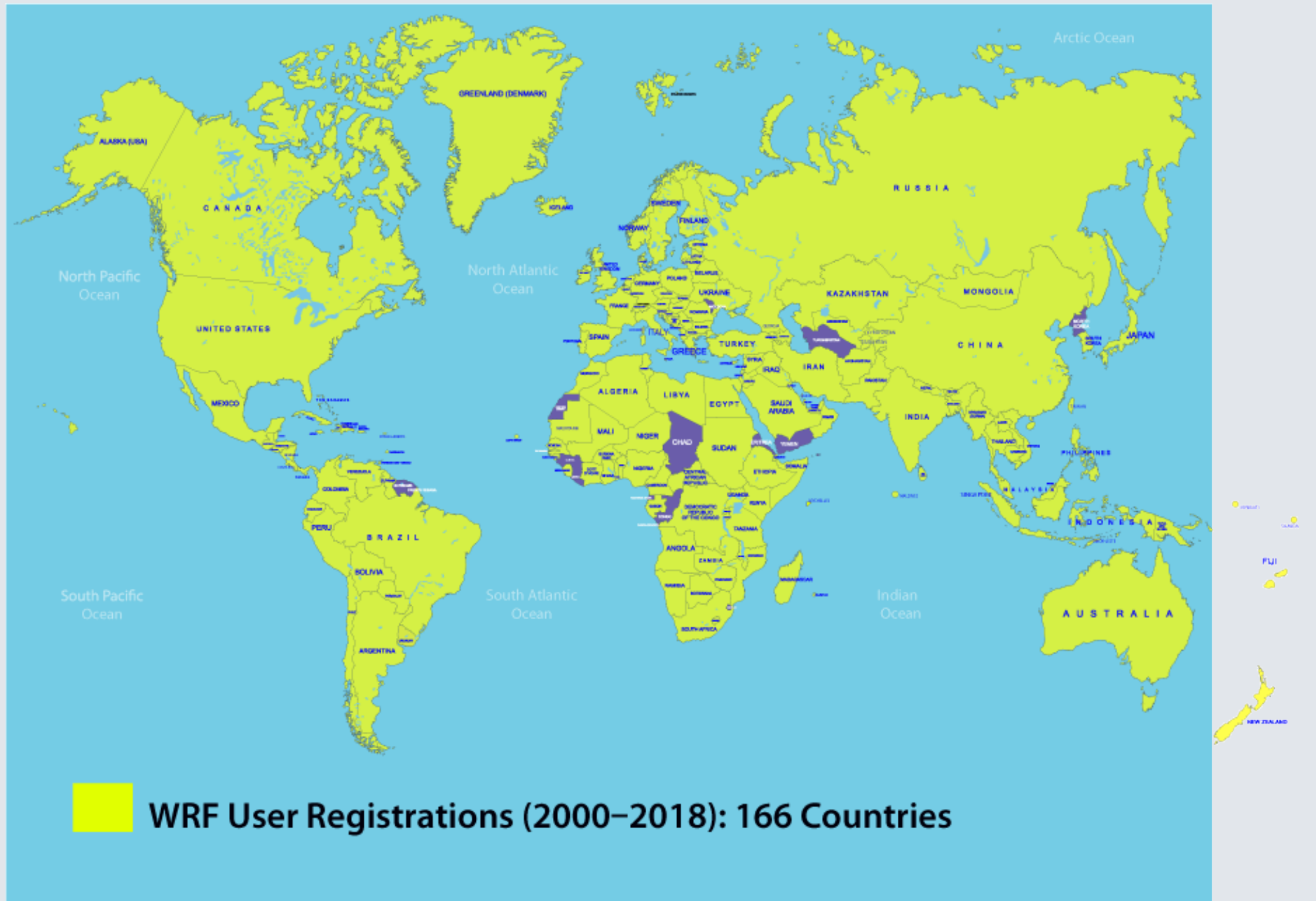
WRF User Registrations (2000–2018): 166 Countries

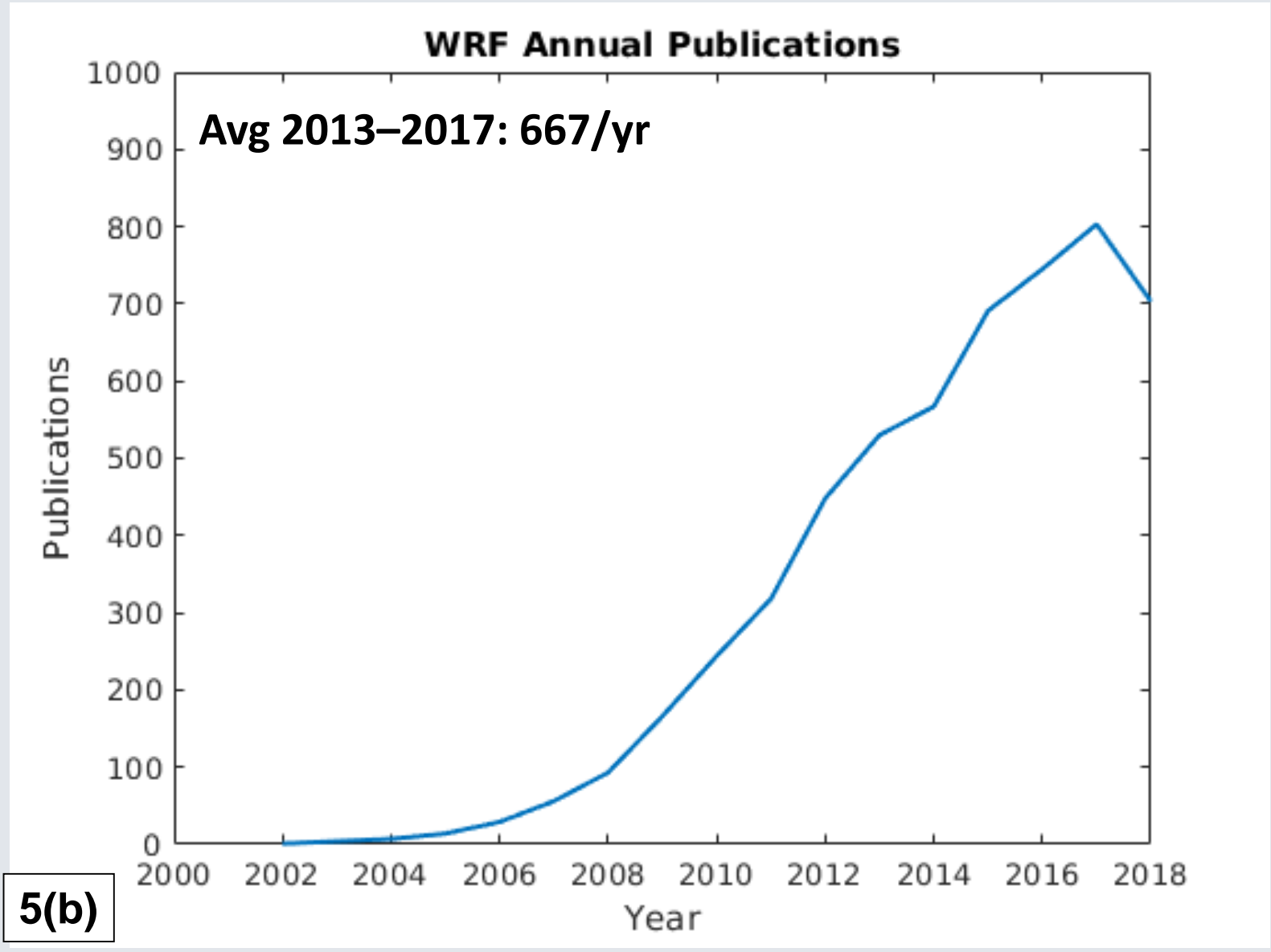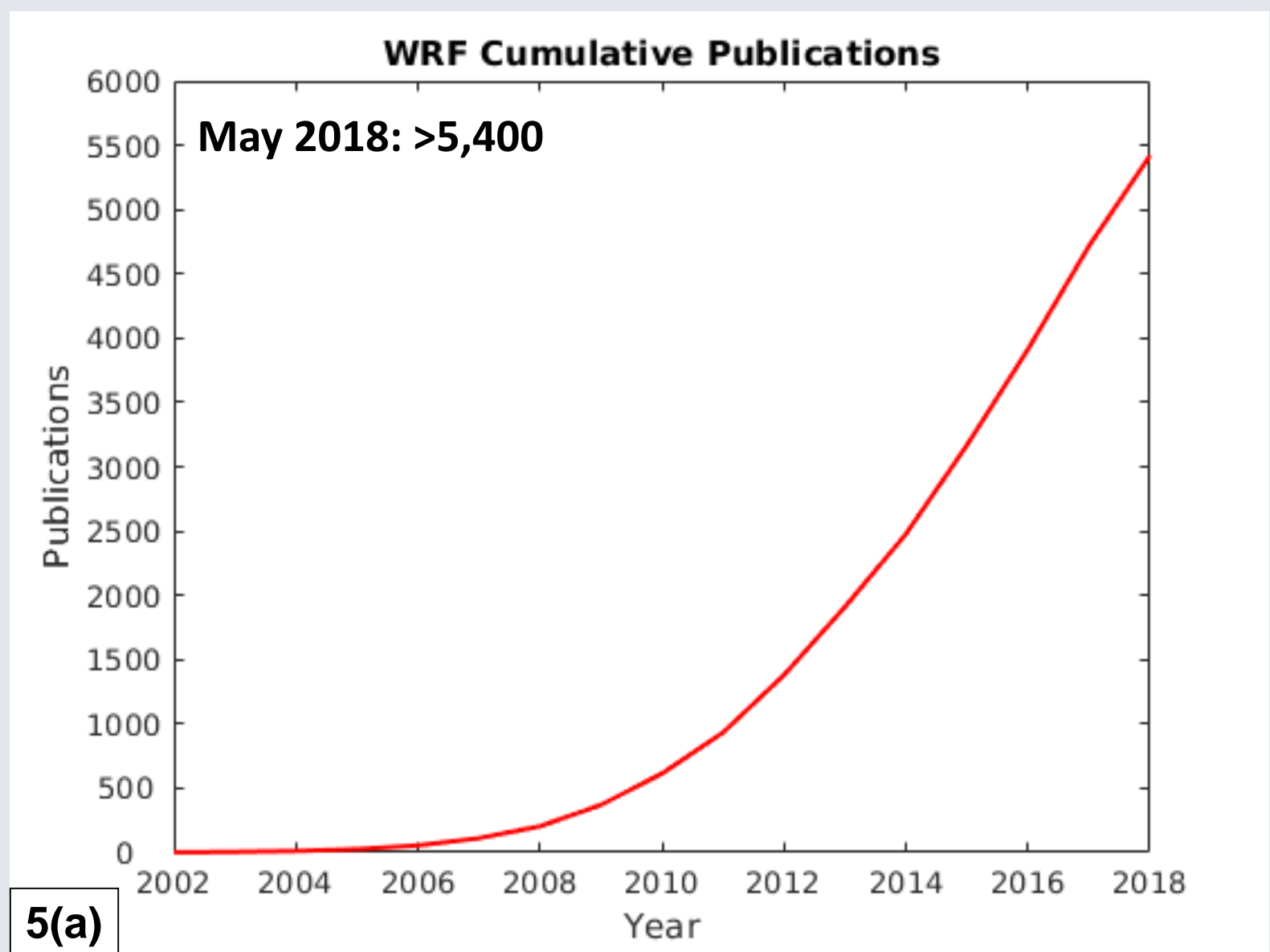**Fig. 2**: Map of counties with WRF registrations through 2018.

Fig. 5: Numbers of WRF-related publications. Entry for 2018 represents a simple extrapolation from number as of May 2018. (a) Cumulative publications. (b) Annual publications.

The totals of WRF-related publications suggest the model's impact on science. Figure 5(a) shows the cumulative number of journal publications involving WRF, over 5,400. Figure 5(b) shows the annual numbers of publications. The average for the past five full years (2013–2017) was 667/yr, and 2017 saw 803 publications. The apparent dropoff for 2018 (703 estimated) cannot be assumed to have significance at this time, as the number is a projection based on the record as of May 2018.

4. SUMMARY

Though WRF is a mature model, statistics reveal the continuing strength and impact of the system. New model registrations are continuing at high levels, over 3,900/yr, and the cumulative total of WRF registered users is now over 42,900. University users make up the majority, approximately 64%. WRF support is in demand, and user help requests run 340/mo. WRF and its specialized systems have been applied productively: there were over 800 model-related publications in 2017, with an average for the past five full years of 667/yr. An analysis of the university user institutions paints an impressive picture of the breadth of WRF's academic application: over 2012–2017 there were registrations at 258 American universities and 1261 foreign universities.

REFERENCE

Skamarock, W.C., J.B. Klemp, J. Dudhia, D.O. Gill, D.M. Barker, M.G. Duda, X.-Y. Huang, W. Wang, and J.G. Powers, 2008: A description of the Advanced Research WRF Version 3. NCAR Tech. Note, NCAR/TN-475+STR, 113 pp. DOI: 10.5065/D68S4MVH.