

# IAU Regions and Regional Astronomy

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**Abstract.** Continuous regional cooperation is efficient and constructive for long-term development of astronomy, as clearly shown by the great success of ESO in the European Region. The IAU does not formally define its Regions, however they are becoming clear through the Regional Meetings during recent decades. We present some statistics and considerations about five IAU Regions, based on the temporarily assumed geographical distribution of IAU National Members. For further growth of IAU and worldwide astronomy, the role of Asian Pacific, Latin American, and Mid-East & African Regions is essentially important. We can identify three groups; “Super”, “Advanced”, and “Developing” groups of IAU National Members based on the rate of IAU Individual Member per population in each of the National Members. This rate, identical to the number of astronomer per head of population, can be regarded as an indicator of the “strength” of astronomy in each of the NMs, while the number of Individual Members indicates the “size” of astronomical research. We find that the distribution of this rate shows clear differences from Region to Region. Based on this analysis, we propose planning within IAU National Members, each Region and the EC so as to grow from a “Developed” group to an “Advanced” group, as well as to increase the number of NMs. The IAU should encourage and support those efforts by National Members and Regions through the platform of Regional Meetings, the OAD and other possible strategic programmes.

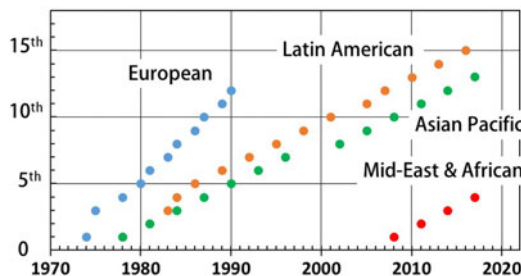
**Keywords.** Regional cooperation, IAU Regions, strength of astronomy, future of IAU

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## 1. Introduction

I have been interested in regional cooperation of astronomy for many years, especially in the East Asian region. We have organized EAMA (*East Asian Meeting on Astronomy*) as continuous grass-root level meetings since 1990, created EACOA (*East Asian Core Observatories Association*, by NAOC, NAOJ, KASI and ASIAA) in 2005, and the EACOA established EAO (East Asian Observatory) in 2015 (Kaifu *et al.* 2016).

Why should we discuss IAU Regions now? Let me give two points of view. Firstly, regional cooperation is easy and efficient, because regional countries are neighbours, and tend to share a common culture. This is also true in IAU Regions. Development of astronomy can be promoted by the regional cooperation effectively, as we see in the East Asian cooperation above, and as a much clearer case, the great success of ESO in the European Region. Secondly, the IAU has been struggling to increase the number of its National Members (NM). We welcome some new NMs every GA, but there are some NMs with difficulties in their economy and in academic organizations, and as a result the total number of IAU NMs stays around the level of 70 or so, about 40% of UN members. On the other hand, as dramatically shown in the IYA2009, the IAU has a huge possibility towards our target of “Astronomy for All”, especially in some Regions and in many non-NM countries.



**Figure 1.** History of IAU Regional Meetings. The North American Region never had any RM.



**Figure 2.** Geographical distribution of IAU Regions temporarily assumed in this paper.

Then, what are the IAU Regions? The IAU does not formally define Regions. However, the IAU Regions have been becoming clear by themselves through a number of continued IAU Regional Meetings during recent decades. So I present some statistics and considerations about IAU Regions, based on a temporarily assumed list of National Members in each of the IAU Regions. In the APRIM2014 I showed preliminary statistics about the IAU Regions based on similar assumptions (Kaifu 2015), and in this paper I renewed some data, and have tried to delve a bit deeper into the statistics and their considerations.

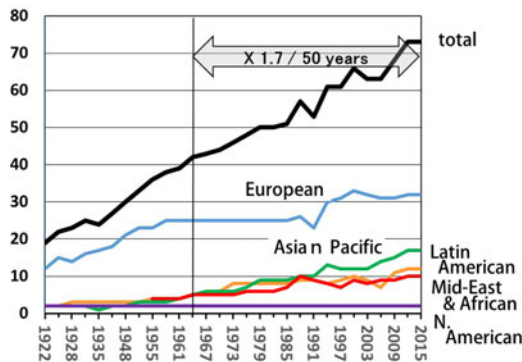
## 2. Temporarily assumed NM composition of IAU Regions

Figure 1 shows the history of IAU Regional Meetings. The North American Region did not have Regional Meetings, because they are composed of only two NMs, USA and Canada. Interestingly also, the European Regional Meeting was terminated in 1990, because this Region had reached a high enough level of regional cooperation by the establishment and successful operation of ESO, and of the EU. The three other IAU Regions, Asia-Pacific, Latin America and Mid-East & African Regions have been holding Regional Meetings constantly, almost every three years. Regional Meetings are still quite important for these three Regions, as they are generally in the phase of development of modern astronomy and of regional cooperation. This fact should be carefully noted when we think about the future of the IAU and world-wide astronomy, as we mention later.

Figure 2 shows a rough geographical distribution of five IAU Regions that we temporarily assume in this paper, based on the IAU Regional Meetings. Also Table 1 is a list of National Members in each Region. There are some overlaps and ambiguities in the distribution of NMs between Regions; it is inevitable in this preliminary analysis, just as there are anomalies for many of the official geographical data of countries in the world. Still, we can try some statistics and considerations by using this temporarily assumed distribution of IAU National Members into five IAU Regions.

**Table 1.** IAU Regions and National Members temporarily assumed in this paper (as of 2015).

<b>European Region (30):</b> Austria, Belgium, Bulgaria, Croatia the Republic of, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Italy, Latvia, Lithuania, Netherlands, Norway, Poland, Portugal, Romania, Russian Federation, Serbia, Republic of Slovakia, Spain, Sweden, Switzerland, Ukraine, United Kingdom, Vatican City State
<b>Asian-Pacific Region (17):</b> Armenia, Australia, China Nanjing, China Taipei, India, Indonesia, Japan, Kazakhstan, DPR Korea, Rep. of Korea, Malaysia, Mongolia, New Zealand, Philippines, Tajikistan, Thailand, Viet Nam
<b>Latin American Region (13):</b> Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Honduras, Mexico, Panama, Peru, Uruguay, Venezuela
<b>Mid-East and African Region (11):</b> Iran, Israel, Lebanon, Saudi Arabia, Turkey, Algeria, Egypt, Ethiopia, Morocco, Nigeria, South Africa
<b>North American Region (2):</b> Canada, United States

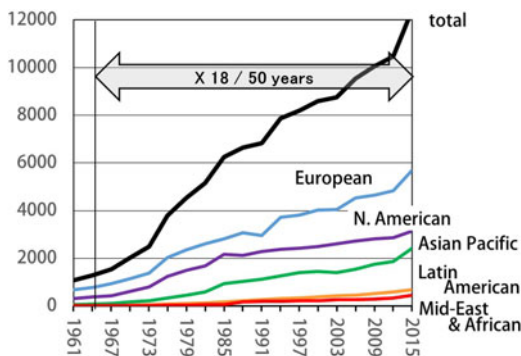
**Figure 3.** Growth history of National Members in the IAU. The vertical axis is the number of NMs of IAU and those in each of the Regions, and the horizontal axis is the year.

### 3. Growth of the IAU and of each of the IAU Regions

Let us consider the growth history of the IAU and of the IAU Regions. Figure 3 shows the history of growth of the IAU National Members since its establishment. The total number of NMs has been increasing almost constantly. However, the growth rate is as low as 1.7 times over the most recent half century. Looking into the history of the growth of the Regions, the number of NMs in the European Region has stayed almost flat, obviously because of saturation. The number of NMs in the European Region is nearly the same as the number of European countries (EU has 28 signatories). The rapid change in the European curve around 1991–1997 is an effect of dissolution of the Soviet Union. Also, the North American Region stays as only two National Members. It is clear, as we see in Fig. 1, that the growth of IAU National Members has been contributed by the Asia-Pacific, Latin American and Mid-East & African Regions. Without these three Regions, we cannot expect further growth of the IAU National Members.

However, when we go to the growth history of IAU Individual Members, the story is quite different as we see in Fig. 4. The increase rate of total IAU Individual Members is as high as a factor of 18 times in the most recent 50 years, nearly 10 times higher than the growth of NMs. The main contributors to this rapid growth of Individual Members are the European and North American Regions, in contrast to the case of National Members. The Asian-Pacific region is contributing a bit in recent decades, but contribution from Latin American and Mid-East & African Regions are still both small.

The number of IAU National Members can be regarded as an indicator of the “extent” of astronomical research in the world, while the number of IAU Individual members is an indicator of the “size” of astronomical research in each of the NMs and in the Regions.



**Figure 4.** Growth history of Individual Members in the IAU. The vertical axis is the number of IMs of the IAU and those in each of the Regions, and the horizontal axis is the year.

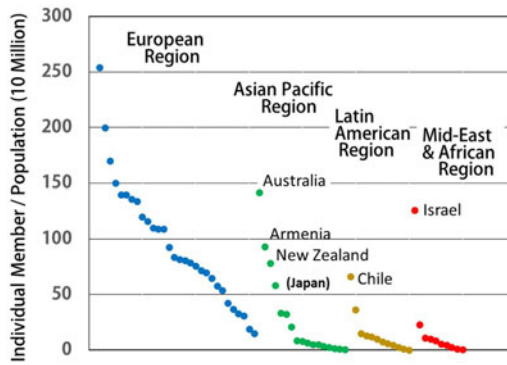
Therefore, what we learn from the above-mentioned historical data is that the growth of astronomical research in the most recent half century happened mainly in the European and North American Regions, the so-called developed Regions, and there was not much growth happening in the other three developing Regions, with just a small number of exceptional cases. From the point of view of IAU the target of “astronomy for all”, we have to say that this is a disappointing situation, to which we have to face up.

#### 4. IAU Individual Members per Population – “Strength” of Astronomical Research

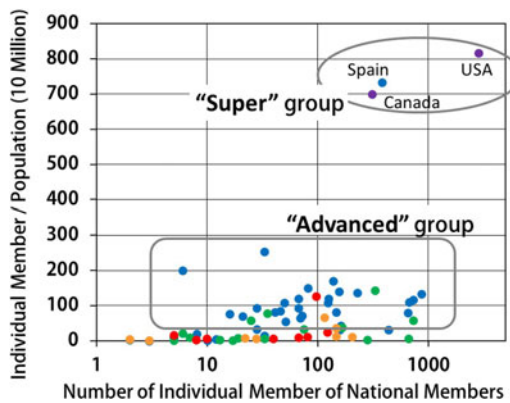
Let us move to another statistic about IAU Regions. Figure 5 shows the number of IAU Individual Members per 10 million head of population for each of the National Members in four Regions. The North American NMs and one European NM over-scaled the vertical axis. The interesting phenomena in this figure are a large number of NMs in the European Region with a relatively high rate of Individual Member per population of 10M (about 25–250). Note that such a large group can be seen only in the European Region. We see a small similar group of NMs in the Asia-Pacific Region too, but it is difficult to distinguish in Latin American and Mid-East & African Regions. Some exceptional NMs with a relatively high rate are found in Fig. 5, namely, Australia, Armenia (could be in European Region too), New Zealand, Chile and Israel. As we notice these are countries with their modern astronomy, based on culture which came more or less directly from the western world.

The number of IAU Individual Members is nearly identical to the number of professional astronomical researchers, so the rate of IAU Individual Member per population can be interpreted as an indicator of the “Strength” of astronomical research in each of the IAU National Members. Therefore, the large differences in “strength” between the European Region and the three other Regions shown in Fig. 5 gives us a strong impression.

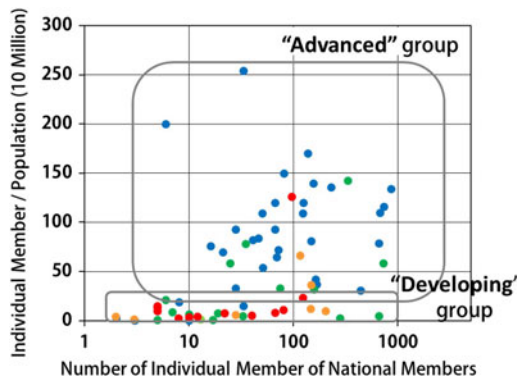
Figure 6 shows the correlation between the number of IAU Individual Members per population of 10M (linear scale) versus the number of Individual Members in each National Member (log scale), and Fig. 7 is the same graph but with an extended vertical axis (three times). Surprisingly, we see almost no correlation between the IM per population and number of IMs. In other words, there is no or only a weak correlation between the “strength” of astronomical research and the “size” of astronomy in each of the IAU National Members. We know that the “size” of astronomy (i.e. number of IAU Individual Members) roughly correlates with the size of the economy in each country. Therefore, the above fact also tells that the “strength” of astronomical research does not



**Figure 5.** Number of IAU Individual Member per population of 10 million, plotted for each National Member in four IAU Regions. The North American Region NMs over-scaled the vertical axis. See the text for further details.



**Figure 6.** Individual Member per population of 10M (linear scale) versus the number of Individual Members in each of the NMs (log scale).



**Figure 7.** Same as Fig. 6, with the vertical axis expanded 3 $\times$ . Japan is at the point (734, 58).

strongly depend on the size of economy in NMs, but it probably depends on the history of science and culture of each of the NMs.

On the other hand, we can identify three groups in Figs. 6 and 7, based on the value of the vertical axis (“strength”). In the upper area of Fig. 6 we see a group of several NMs with a very high rate of IMs per population of 10M (700–800). This group is composed

by two North American Region NMs and one European Region NM, Spain. Let us name this group as the “Super” group, based on the “strength” of astronomical research. In the same Fig. 6 we can identify a large group with relatively high rate of IMs per population of 10M (25 to 250). This group, which is distinguished more easily in Fig. 7, can be called the “Advanced” group, based on the same point of view of “strength”. This group almost corresponds to the big group with relatively high IM per population rate in the European Region, which we have already seen in Fig. 5. Naturally, most of the NMs of the European Region are included in this “Advanced” group, and some exceptional NMs in the other three Regions mentioned before are also in this group. Japan is within this “Advanced” group but the rate is as low as 58 (the number of Individual Members is 734). The Republic of Korea, China Taipei and Argentina are also in this group, with vertical axis values at the level of 30.

The large group of NMs distributing nearly at the bottom level of Fig. 7 (vertical value of 30 or smaller) can be called the “Developing” group, as the rate of astronomers per population is considerably low. Most of the Asian-Pacific, Latin American and Mid-East and African regions are included in the “Developing” group. On the other hand, only a few NMs of the European Region can be found in this group.

Based on the above statistics, and putting the IAU target of “Astronomy for All” in our scope, we like to emphasize that the increase of the “Advanced” group NMs in all Regions is important, not only to increase the number of NMs. Some strategic plans in each of the NMs and in each Region to reach the level of the “Advanced” group may be possible, for example, by long-term plans to increase the number of IAU Individual Members in National Member countries, including regional or IAU-level exchange programmes, etc.

## 5. Discussion – Regions in IAU and their Future

Let us discuss and conclude about further growth of the IAU and world-wide astronomy from the point of view of the IAU Regions.

Firstly, we highlight the importance of the IAU Regions again. Especially towards our target of “Astronomy for All”, the Asian-Pacific, Latin American and ME & African Regions are strategically important. We should note that throughout the history of the IAU, the European and North American Regions have been leading Regions. However, the concept of “Region” almost lost its significance in those two leading Regions, because they had achieved a high enough level of regional cooperation in an early phase and now are growing globally. Under this situation, from my point of view, the IAU (or its EC) did not have a clear policy about the IAU Regions, except to send one EC representative to each of the Regional Meetings. The situation is almost completely different in the other three Regions; Asian-Pacific, Latin American and Mid-East & African Regions, as we have already seen. In those Regions we have to improve the current situation that the growth of Individual Members is low, and that the Regional cooperation is still, in general, quite poor.

Secondly, we also emphasize again, that the regional cooperation is an easy and effective way for promoting the future growth of astronomy. Now cooperation in the European Region is at a very high-level, and ASTRONET for European-wide future planning of astronomy is an example. In the North American Region, we know that cooperation among USA and Canadian astronomers is an almost everyday occurrence. On the other hand, in the AP, LA and ME&A Regions regional cooperation is still in its beginning phases. More continued efforts of cooperation and coordination are expected to bring about a higher “Strength” in each of the National Members and to bring new National Members in those Regions. For such purposes, the long-term strategic plans in each National Member and in each Region will be important. The newly introduced IAU Junior Member system may help such plans.

Thirdly, of course, the IAU can help those efforts in the Regions. The IAU already has good platforms like the Regional Meetings and the OAD (*Office of Astronomy for Development*), and is going to promote the new decadal plan of “Astronomy for All”. It would be good if the IAU Executive Committee puts the issue such as “Regional Cooperation and Regional Growth” among its long-term challenges, and supports the regional cooperation efforts towards the above-mentioned goals.

Fourthly and finally, if we extend our scope even further into the future, we see some important possibilities of Regional coordination. The East Asian Observatory (EAO) was established in the Asian-Pacific Region by EACOA in 2015, by efforts of Paul Ho *et al.* It was founded as a seed towards the future “Asian (or Asian-Pacific) version of ESO”. The EAO is still a small organization supported by EACOA institutes (ASIAA, KASI, NAOC and NAOJ), but NARIT (Thailand) is now going to join the EACOA/EAO, and some other Asian IAU National Members are also interested in it (Ho 2016). In the Mid-East & African Region, SKA Africa is successfully on-going under the cooperation with European astronomers. SKA is providing a huge platform of astronomical cooperation for the African Region NMs and for some non-NM countries. Also the Extended ALMA is under discussion in the Latin American Region, and it may provide a good platform for a future network of cooperation in this Region. All of such regional movements could be seeds to increase the “Strength” of astronomy in these three IAU Regions, and lead towards the establishment of concrete regional coordination, like ESO in the European Region.

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