Response to Comments of Referee #3:

This paper aims to create a monthly-scale spatial distribution dataset of China's industrial water use over the past 40 years. While the method of spatial downscaling in the article is clear, there are several key issues that require further explanation.

Response: We would like to sincerely express our gratitude for the careful reading and constructive comments, and we are trying our best to address these raised issues and make revisions.

1. **Although the author discusses the uncertainty, it is not enough to be convinced. For instance, the author proposed that "We found that the spatial pattern from the 1998 data was similar to 2008 at 0.25°". However, the Pearson correlation can only reflect the correlation between the variables. The author must use other statistical indicators to compare the differences between two years. In addition, the years span from 1965 to 2020. Would the enterprise data for 35 years be not changed?**

Response: Thank you for the helpful suggestion!

After aggregating a large number of enterprises to grid levels, the spatial pattern of IWW from the gridded data reflected the broad-scale industry distribution and was not sensitive to specific enterprises. The number of enterprises will change over time for sure. However, the reflected spatial pattern of industry distribution is relatively stable as it is also linked to the overall population and economy of the country.

To demonstrate this point, we estimated enterprises' spatial coverage and industrial output value (IOV) between 2008 and 2013. We did not use data in 1998 as the 1998 data contained significantly fewer enterprises (<170,000) compared to 2008 (>420,000), while the 2013 data included about 340,000 enterprises. The different sample sizes between the two years would undoubtedly affect the comparison of their spatial patterns, meaning fewer enterprises would appear in 2013 compared to 2008 (~19% fewer samples than in 2008). Nonetheless, the number of grids in 2013 with valid enterprise is just 12% fewer than in 2008 at 0.1° and 7% at 0.25°. This suggests that the spatial pattern of gridded data is not sensitive to the number of enterprises, especially at coarse spatial resolutions. Otherwise, a 19% reduction in the sample would lead to a similar magnitude of reduction in the valid grids. Moreover, we compared gridded IOV between two years. Results indicated a high consistency between 2008 and 2013 with R^2 of 0.92 at 0.1° and 0.94 at 0.25° (Figure R1). These comparisons further support the fact that although specific enterprises would change over time, the spatial pattern of industry and IWW reflected by hundreds of thousands of enterprises remained stable.

In the revision, we added Figure R1 as Figure E5 in the manuscript to further illustrate the consistency of the spatial pattern of industry and IWW. We also added a more detailed discussion on this part.

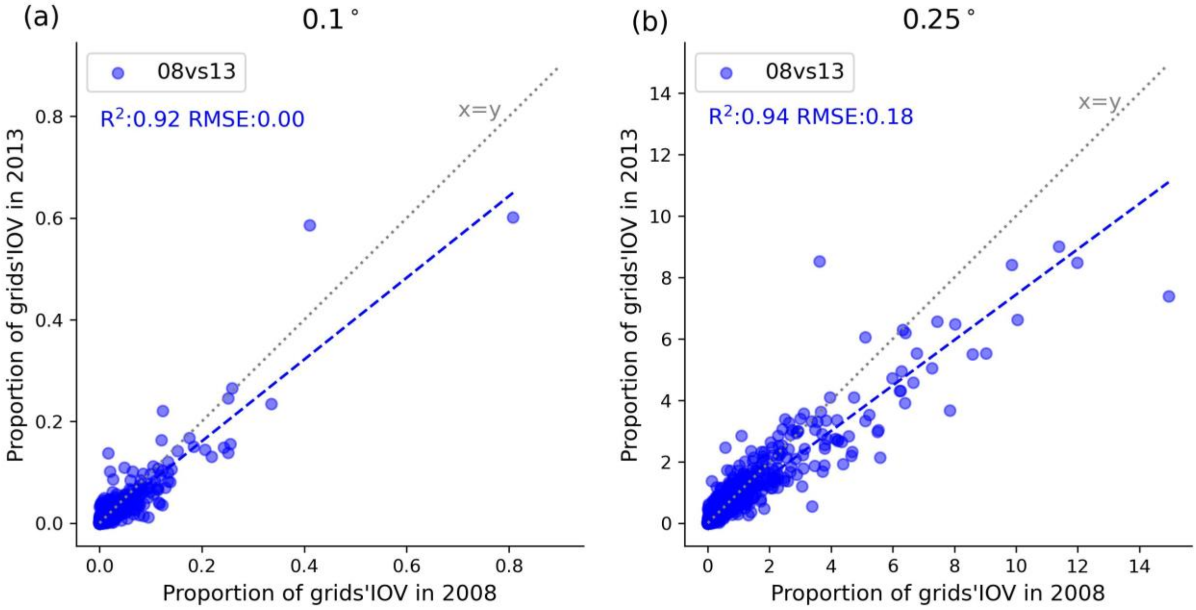

Figure R1 (Figure E5) Validation of the consistency of gridded IOV between 2008 and 2013 (a) at 0.1° and (b) at 0.25°. Gridded IOV was normalized as the proportion of gridded IOV of the country for comparison. The grey dotted line indicates the 1:1 line, and the blue dashed lines indicate the fitted lines.

2. **The results in Figure 6d-f, which depict IWW for electricity and gas production and supply, are represented by scattered points. Can these scattered points reflect the general trend?**

Response: Thank you for the comments. We apologize for the confusion in understanding the Figure 6d-f which showed the actual spatial pattern of IWW for electricity and gas production and supply. These scattered points showed the actual presence of enterprises that consume water.

We revised the illustration of Figure 6 to avoid confusion:

"Figure 6: Zoomed view of IWW in densely urbanized regions in China at a spatial resolution of 0.01°, including the Beijing-Tianjin-Hebei region (a, d), Yangtze River Delta (b, e), and Pearl River Delta (c, f). Panels (a)–(c) show the spatial pattern of IWW for manufacturing, and panels (d)–(f) show the spatial pattern of IWW for electricity and gas production and supply. Numbers displayed in percentage denote the percentage of the sectoral IWW to total IWW."

Therefore, the author should address these issues in greater detail and providing a more comprehensive discussion of the uncertainties and limitations of the study.

Response: Thank you for the comments.

Based on the comments of all reviewers and the study's limitations, we strengthen the discussion of uncertainties present in the study regarding water use efficiencies in spatial downscaling, provincial differences of seasonal variations, and the feasibility of using the constant spatial pattern to allocate IWW for long periods.

(a) Water use efficiencies of enterprises of different sizes in spatial downscaling

In reality, the water use efficiency of a given enterprise could be different from other enterprises even for the same subsector, due to investment, technology, revenue, scale and so on. It is reasonable that enterprises of different sizes tend to have different water use efficiencies, and it is possible that larger companies may have higher water use efficiency than smaller ones. However, currently, we do not have data to provide specific information about the enterprise sizes and their water use efficiencies. If we arbitrarily introduce this scaling relationship without actual data, this would bring new uncertainty to spatial distribution. In the future, when such data becomes available, incorporating this information could better estimate enterprise-level IWW.

(b) Provincial differences in seasonal variations

There are indeed regional differences in the seasonality of IWW. Figure R2 shows the monthly variations of production output across provinces for different industrial sectors, and we can see most of them follow some differences in different provinces (e.g., for electricity and manufacturing sectors). However, at the provincial level, the seasonal fluctuations may exhibit unreasonable or chaotic patterns that are hard to explain, such as manufacturing and mining sectors of Hainan, Guangxi province. For example, Tibet's fraction of manufacturing production in January and February was too low, under 0.025. The exact reasons are unclear, but they could be caused by statistical/random errors in the data. Therefore, we used each subsector's national mean monthly variations to allocate IWW instead of provincial-level seasonal variations which are problematic in certain places. This choice would not affect much the seasonality of the final IWW because the seasonality of different sectors plays a dominant role in determining the seasonality of IWW for a province (Reynaud, 2003; Sathre et al., 2022).

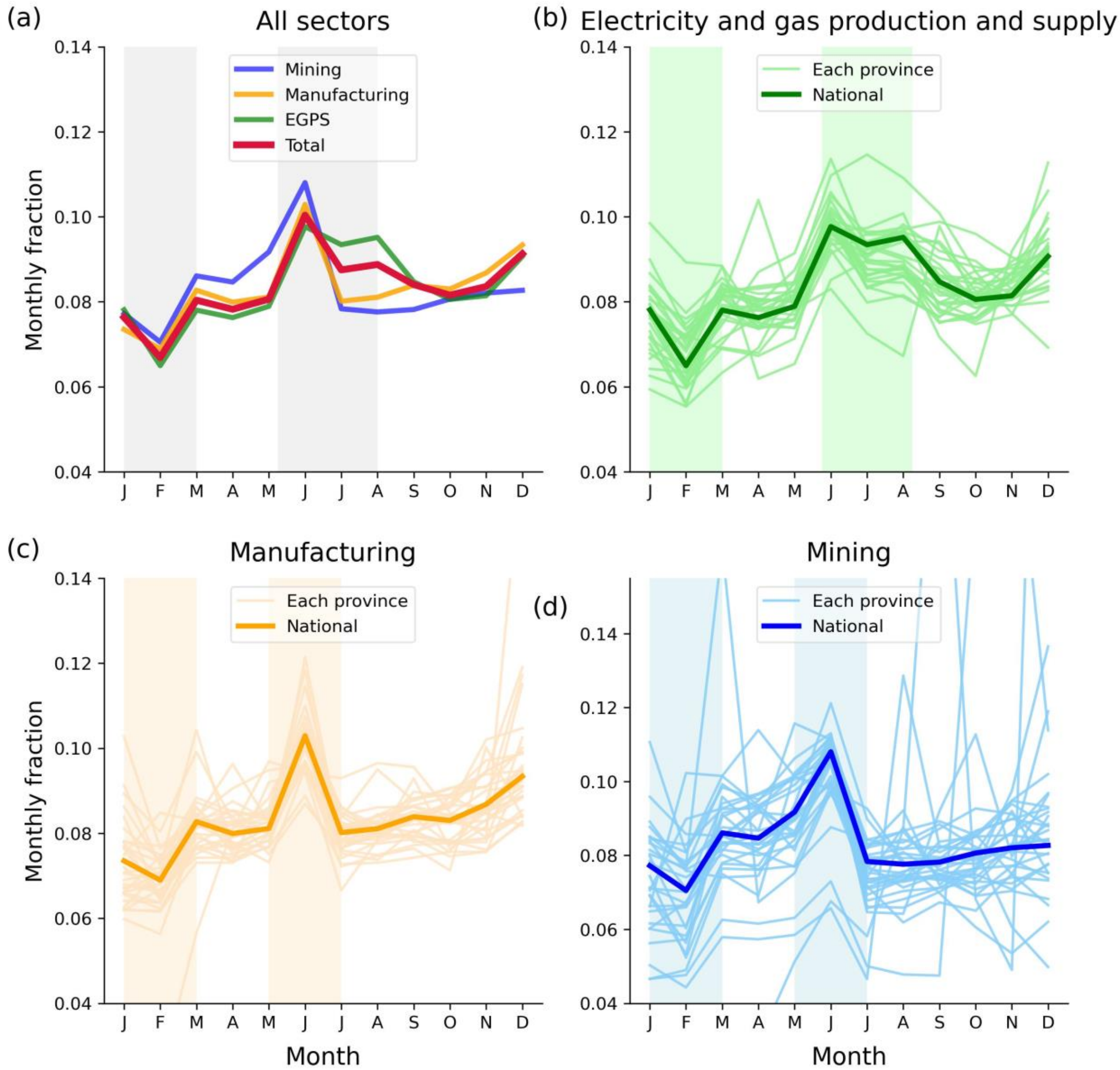

Figure R2 (Figure C3) The seasonal variations of the national total IWW (a) and provincial IWW for separate industrial sectors, including electricity and gas production and supply (EGPS) (b), manufacturing (c), and mining sectors (d). The seasonal variations were represented as the fraction of monthly IWW to the annual total during 2006-2010. The thick lines stand for water withdrawal of sectors, and the thin color lines stand for provinces. Shadows represent the seasons with peak and low water withdrawal of a year.

(c) The feasibility of using the constant spatial pattern to allocate IWW for long periods.

We used water use efficiency and the resulting spatial-seasonal patterns of IWW in 2008 to downscale IWW in other years from 1965 to 2020, serving as a time-invariant pattern for downscaling. First, we made this choice mainly because of the data constraint since no data were available to calculate subsector water use efficiency for years other than 2008. This practice is not ideal but is justifiable given the data limit and the practices adopted in other studies. Developing long-time series gridded data of IWW based on either a time-invariant pattern (e.g., H08, WaterGAP3, and PCR-GLOBAL) or patterns with decadal updates (e.g., Huang et al., 2018; Dong et al., 2022) for downscaling can be found in previous studies

(Table R1). Second, industrial water use efficiency generally improved over time with the development of technology. This means that the temporal improvement in water use efficiency is likely to apply for all enterprises (Chen et al., 2019), while the spatial differences in water use efficiency of a given year are still determined by the spatial distribution of economic conditions which remain relatively stable over the years. Influence of long-term factors could be reflected through the changes in total IWW from statistical IWW data. For the above reasons, we chose the approach to develop the long-term gridded IWW data.

The dataset developed based on the time-invariant pattern of 2008 should be reasonably well for recent ~20 years, but it may contain larger biases for earlier years. We added this vital point to the manuscript to make the users aware of this issue so that they can choose the period of the data for their specific needs and accuracy considerations.

Table R1 Spatial pattern used for long-term data extension in previous studies

Spatial pattern	Long-term data	Used for	Reference
NASA Back Marble night-time light intensity map in 2012-2016	1980-2016	Model (VIC-5)	Droppers et al., 2020
Distribution of urban population in 2009	1950-2010	Model (WaterGAP3)	Flörke et al., 2013
Global population distribution map and national boundary information in 2005	1970-2010	Model (H08)	Hanasaki et al., 2008
Global IWW map in 2000	1960-2001	Model (PCR-GLOBWB)	Wada et al., 2011a, b
Linear Interpolation based on GDP dataset in 1990, 2000 and 2010, same as 1990 before 1990	1971-2010	Model (CLHMS, the Coupled Land Surface-Hydrologic Model System)	Dong et al., 2022
Global population density maps with decadal updates (1980, 1990, 1995, 2000, 2005)	1970-2010	Water Dataset	Huang et al., 2018

In the revised manuscript, we added a more detailed discussion of the three issues mentioned above and Figure R2 as the appendix for additional illustration.

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