What can we learn about efectiveness of carbon reduction policies from interannual variability of carbon emissions? Applying ODIAC from East Asia of the 2010s

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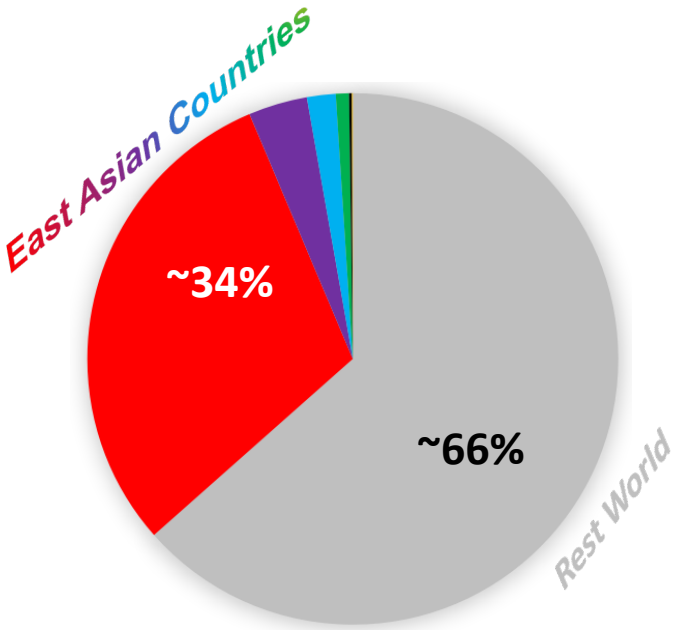
BACKGROUND OF THE STUDY

PARIS AGREEMENT:

Decrease global warming via

- Apply energy and climate policies including 20/20/20 targets to **reduce $FFCO_2$* emissions by 20%**.
- Individual national reduction targets are defined in NDC (Nationally Determined Contribution)



Role of East Asia

Total World *$FFCO_2$: 35755322 kton CO_2

- Mainland China (China)
- Japan
- South Korea
- Taiwan
- Mongolia
- North Korea
- Rest World

"**greater emission reduction** efforts will be required in order to hold the increase in the global average temperature to below 2°C by reducing emissions to 40 gigatonnes or to 1.5°C."

$FFCO_2$* - Fossil Fuel CO_2 emissions, EDGAR estimates(Emission Database for Global Atmospheric Research)

MAIN SCOPE OF THE STUDY

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MOTIVATION

Lack of understanding **what policies are effective** in terms of carbon emission reduction under the announced pledges (Paris Agreement)

RESEARCH QUESTION

How effective current policy tools for decreasing carbon emissions within single national economy in East Asia (EA)

MAIN OBJECTIVES

(a) What is the role of national environmental policies with carbon reduction goals in change of temporal dynamics of FFCO2 in EA?
(b) What are the most impactful policies in terms of slowing down FFCO2 emissions in EA?
(c) What are the future consequences of the policies in EA in FFCO2 reduction required by NDC?

NATIONAL ENVIRONMENTAL POLICIES IN EAST ASIA

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Policy	Country	Start Year	End Year	Pledge (% decrease)
12th FYP	China	2011	2015	- 17% of carbon emission intensity (nationwide)- 10-18% of carbon emission intensity (in provinces)
ISEE*	Japan	2013	2020/2030(planned) 2017(considered	- In 2020, decrease GHG emissions by 5-9% vs 1990 level- In 2030, decrease GHG emissions by 20% vs 1990 level
TMS	South Korea	2012	2020	- within 30% of GHG emission from business-as-usual scenario
1st NAP	Mongolia	2011	2015	- GHG emission mitigation (technological improvements)

Main Principle of filtering: Policy mentioned by NDC

- ✓ 12th FYP China
- ✓ TMS
- ✓ 1st NAP
- × ISEE

*ISEE was scratched out from the government with the ruling party of Japan leaving government. But we considered ISEE continued until 2017
12th FYP - Five Year Plan of China, ISEE - Innovative Strategy for Energy and Environment, TMS - Target Management System,
1st NAP - 1st Stage of National Action Program, North Korea+Taiwan - no plans under NDC is found

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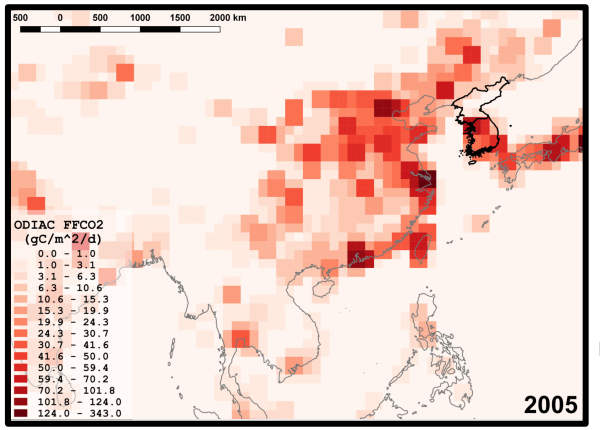
DATA

Main source: **ODIAC (Open-Data Inventory for Anthropogenic Carbon Dioxide)** fossil fuel carbon emissions (*doublechecked by EDGAR estimates)



ODIAC $FFCO_2$

$$IAV(FFCO_2)_i = FFCO_{2(i)} - FFCO_{2(i-1)}$$

IAV = Interannual Variability of $FFCO_2$

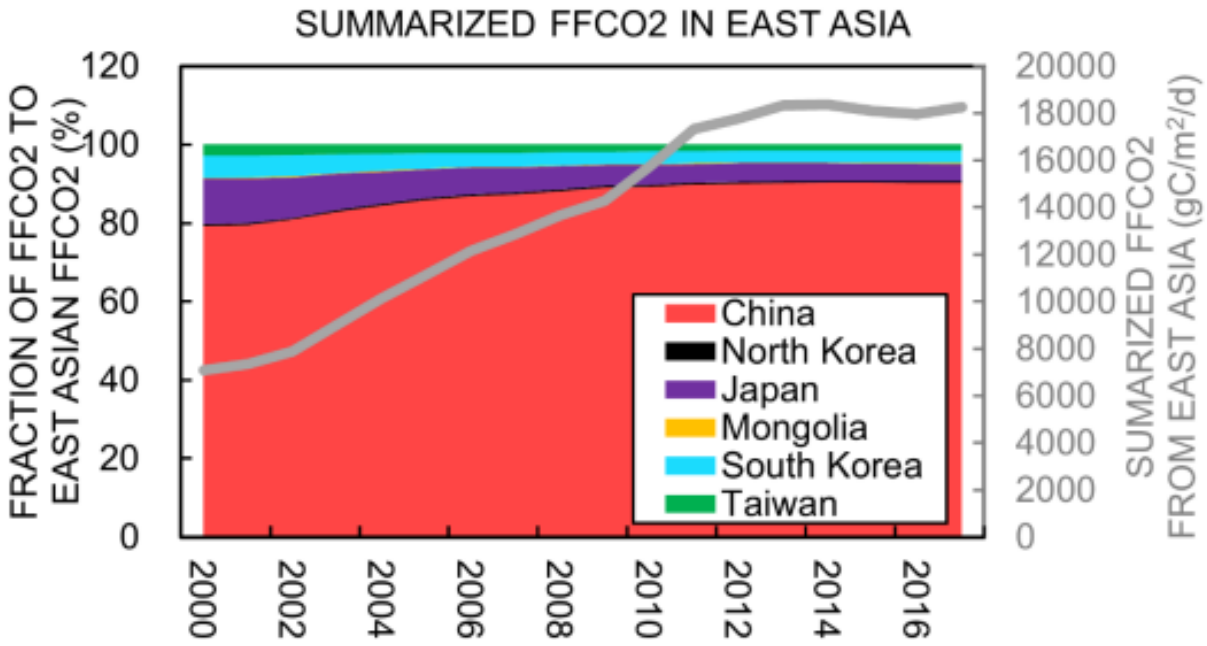
$$FFCO_{2p} = FFCO_{2f} * (1+CPG)^{\Delta n}$$

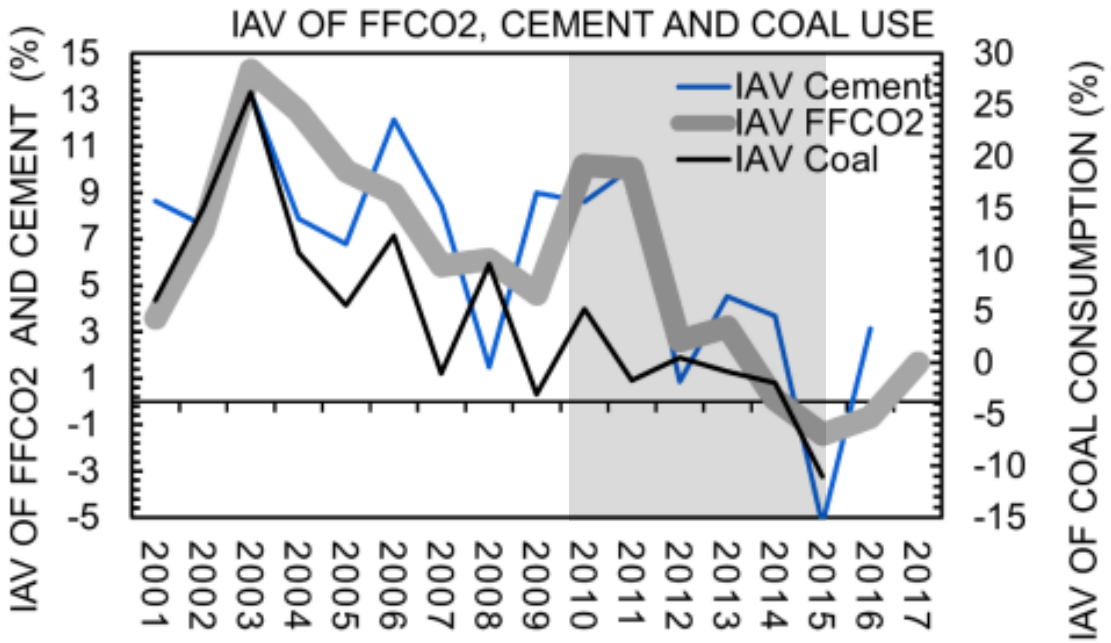
$FFCO_{2p}$ - For providing **baseline scenario (by 2020, 2025, 2030)** using last available year and CPG

$$CPG = \left(\frac{FFCO_{2f}}{FFCO_{2b}} \right)^{\left(\frac{1}{n-1}\right)} - 1$$

Compound Periodical Growth - Measure of **relative growth of $FFCO_2$** per year over given period (in %) **[Sivaprasad 2012]**

CURRENT CONDITIONS OF FFCO2 IN EAST ASIA





- **Two distinct periods in the 2010s.**
- **First period of 2010s -> strong deceleration in $FFCO_2$ growth** (IAV from 10% in 2011 to -1.4% in 2015).
- Deceleration period ended -> 2015-2017, **the latest stage of $FFCO_2$ rebound**
- These patterns-> footprint of changed **anthropogenic activity** since the 2010s (see cement and coal)
- Do policies play role in the **post-2010 period?**

DYNAMICS OF FFCO2 WHEN CARBON REDUCTION POLICIES ENACTED

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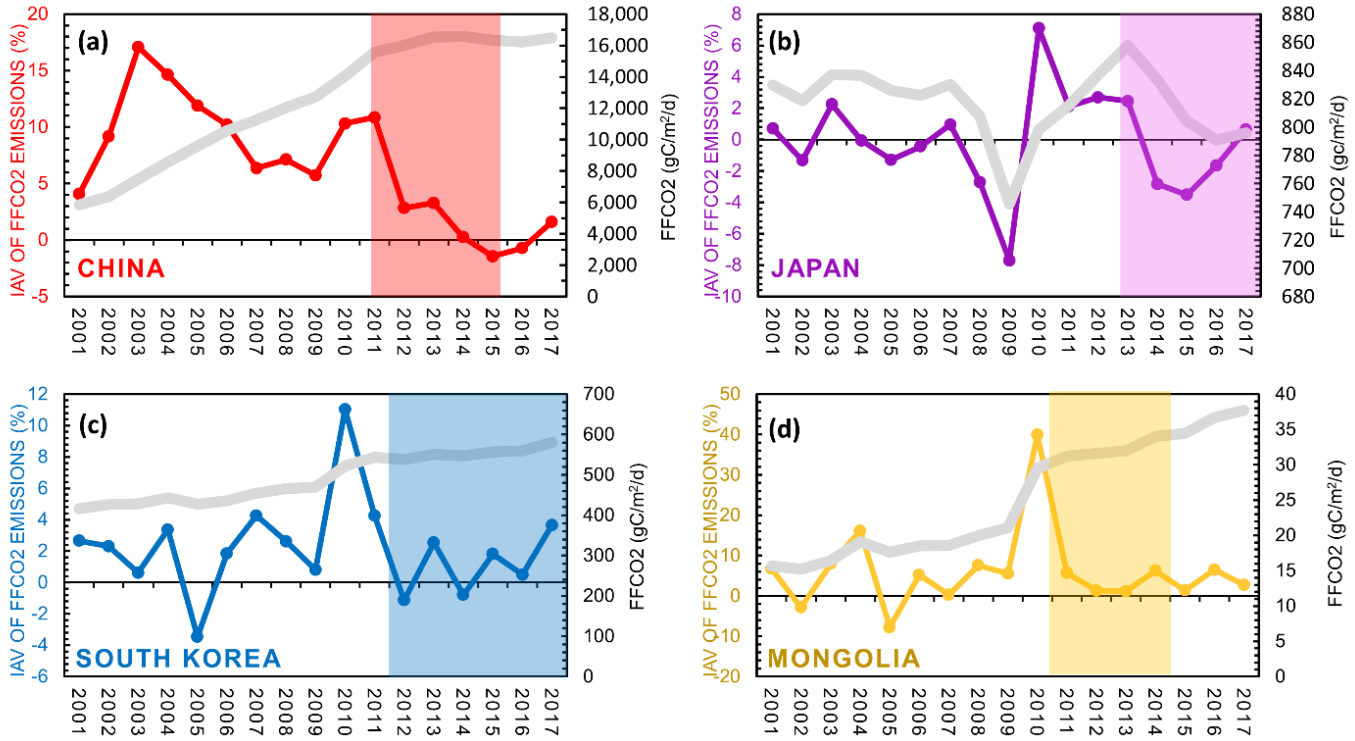
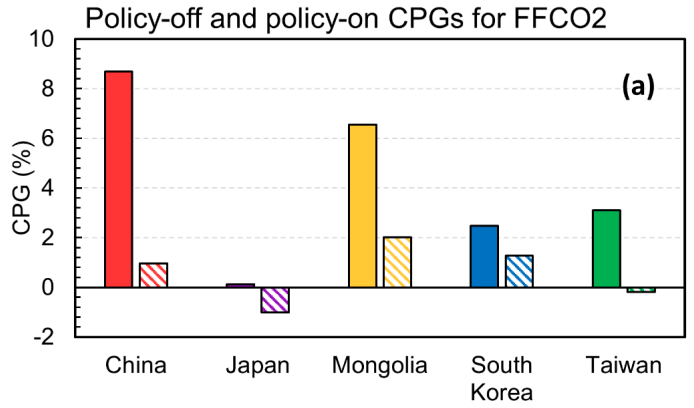
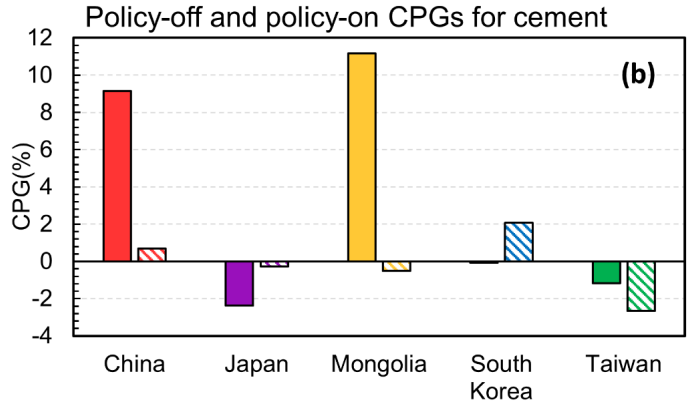
***Shaded zones - "Policy-on" periods**

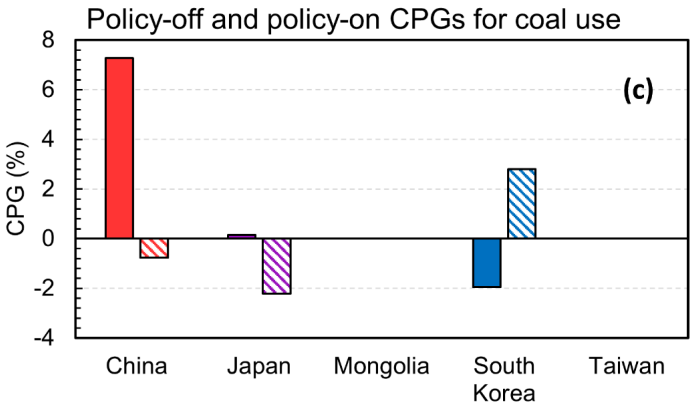


- **China ->** 12th FYP (2011-2015), **IAV goes down from 10.9% (2011) to the observed minimum of -1.4% (2015).**
- Lagged $FFCO_2$ growth **in China** -> drop in national coal use (**IAV of $FFCO_2$ and coal r = 0.76**)
- **Japan**, both $FFCO_2$ and IAV have complex patterns. **The median IAV of $FFCO_2$ is ~0**, rebound in $FFCO_2$ emissions after 2016.
- **South Korea,** $FFCO_2$ growth is complex -> IAV of $FFCO_2$ of TMS varies -0.8 to 3.7% -> **the lowest variability of $FFCO_2$ growth among all EA countries during policy-on period.**

CPG OF FFCO2 BETWEEN POLICY-OFF AND POLICY-ON







Colored bars - policy-off period
Lined bars - policy-on period

EAST ASIA: Policy-on periods cause promising shifts in $FFCO_2$

- Policy-on periods -> **$FFCO_2$ growth slowed down in all large EA emitters** (in Japan, Taiwan $FFCO_2$ decrease)

CHINA: Significant deceleration of $FFCO_2$

- CPG of **$FFCO_2$ down from 8.7% (policy-off) to 1.0% (policy-on) ->** coal and cement role approved
- In **Taiwan - different pattern**

JAPAN: Decrease of FFCO2 no matter to policy

- **Weak $FFCO_2$ growth in policy-off (CPG = 0.1%) -> to decrease in policy-on (CPG = -0.3% per year).**
- Coal use -> from weak growth (CPG = 0.1%) to decline (CPG = -0.8%).

SOUTH KOREA: Small deceleration of $FFCO_2$ growth

- **Weakest decrease of CPG from policy-off to policy-on period** (decreased from 2.5% to 1.3% per year). No progress due to ongoing coal use growth

MONGOLIA: Strong deceleration of $FFCO_2$

- **CPG of FFCO2 decreased from 6.6% (policy-off) to 2.0% (policy-on**) (also decline of cement production observed by CPGs of 11.2% (policy-off) and -0.5% (policy-on).

BASELINE SCENARIOS OF FFCO2 VERSUS 2017

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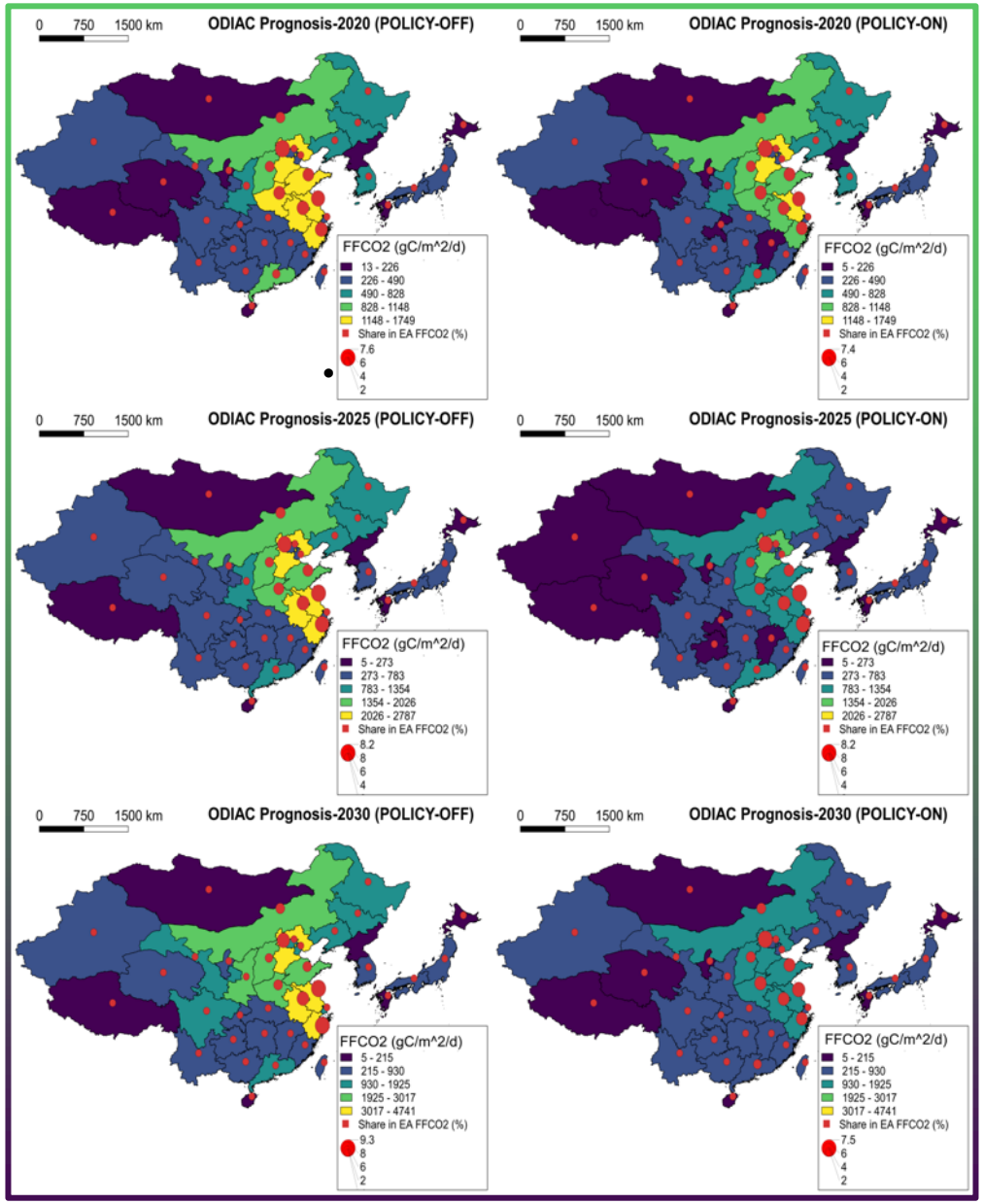

Baseline scenarios:

- **Policy-off ->** $FFCO_2$ of EA **24%, 80%, 166% increase** (2020, 2025, 2030)
- **Policy on->** $FFCO_2$ are lower and will be **3%, 7%, 12% increase** (same years)

Highly-emitting cluster (Eastern Provinces of China):

- **Policy-off ->** Role of the cluseter **is enhanced ->** share in total EA emissions **will grow on 44%, 48%, 52%** by 2020, 2025 and 2030
- **Policy-on ->** Distribution of **$FFCO_2$ is more even (cluster will have ~42-43% to total EA emissions by 2030)**

NDC progress: likely **fail** at current projection

- China -> Unable to check
- Mongolia, S. Korea -> $FFCO_2$ growing versus expected reduction
- Japan -> Insuficcient reduction

ALL POSSIBLE BASELINE SCENARIOS

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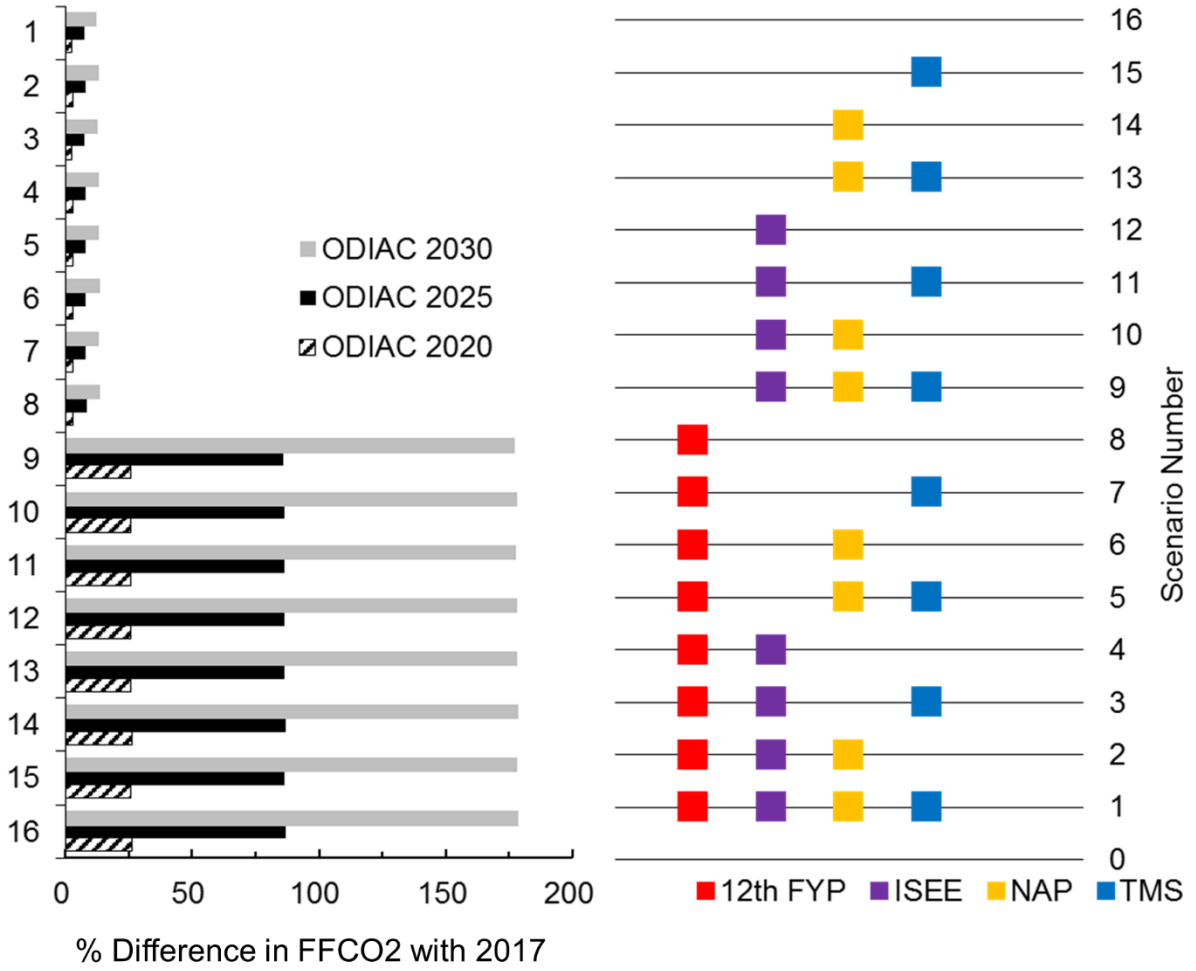
All Scenarios = 16

***Marker = policy is off**

Left Panel = Projection



- **Best scenario -> Pure policy-on projection** (2%, 7%, 12% increase by 2020, 2025, 2030)
- **Worst scenario -> Pure policy-off projection** (26%, 87%, 180% increase by 2020, 2025, 2030)
- The role of Chinese policies determine the whole pattern sensitivity **(without China difference < 1%)**
- Policy-on scenario **hard to sustain for many years (very fragile)**

CONCLUSIONS

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✓ Carbon reduction policies in EA of 2010s -> beneficial (less $FFCO_2$ growth, more even distribution)

X Even most optimistic scenario -> NDC goals likely fail by 2030 in EA

✓ $FFCO_2$ decreased in Japan and Taiwan, decelerated in China and Mongolia, small progress in S. Korea

X Progress fragmented and very fragile -> rebound of $FFCO_2$ growth already occured

✓ China -> most influential and sensitive -> most trends in EA due to concurrent deceleration of $FFCO_2$, coal and cement (driven by 12th FYP of China)

✓ China typical feature -> very high agreement between $FFCO_2$, economy, carbon rich production and policy measures

X Accuracy of reported data is hard to check -> observational support needed (OCO-3)

X If emissions underreported -> The NDC progress is **HARDER** to achieve

[Labzovskii et al., 2019] - Environmental Science & Policy, 96C

Supranational framework for controlling $FFCO_2$ reduction progress is crucial

(a) assign operative status of national environmental plans with carbon abatement goals based on numerical criteria.

(b) linking a national-scale policy with key local measures for reaching carbon abatement goal (energy sector transformation, decarbonization of cities, introducing renewables)

(c) implementing flexible region-specific carbon abatement goals developed specifically for the carbon abatement in the challenging geographic regions

(d) assisting governmental transitions from one party (or elite) to another within one country by re-evaluating new environmental policies that should not harm compliance of the international pledges

(e) tracking dynamic changes of the carbon-driven output of economy such as energy consumption, transportation and industrial activities

(f) evaluating quality of the submitted data from the country parties and require validation for compliance if needed.


THANK YOU FOR ATTENTION!