Joint Conference of AsiaFlux Workshop 2017
and the 15th Anniversary Celebration of ChinaFLUX
Beijing, China, August 16-19, 2017

Analysis of spatial and temporal patterns of aboveground net primary productivity in the Eurasian steppe region from 1982 to 2013

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Outline

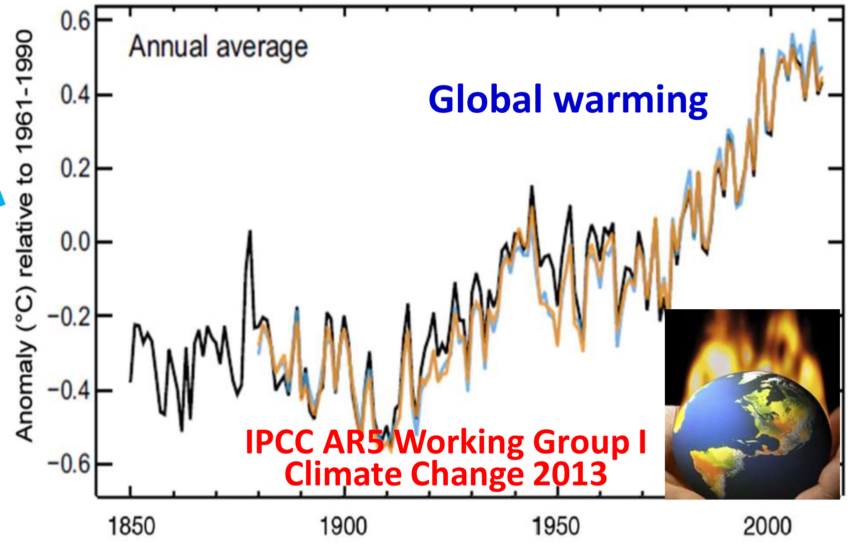
1 **Introduction**

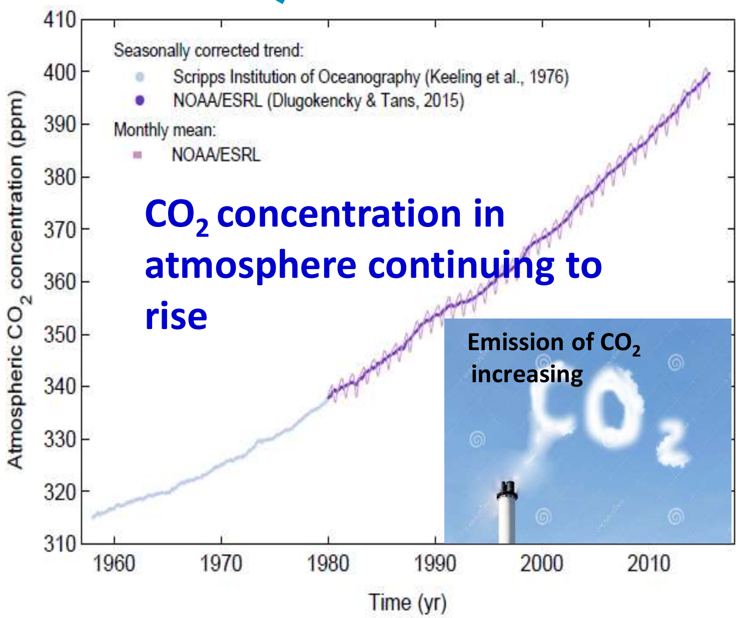
2 Materials and methods

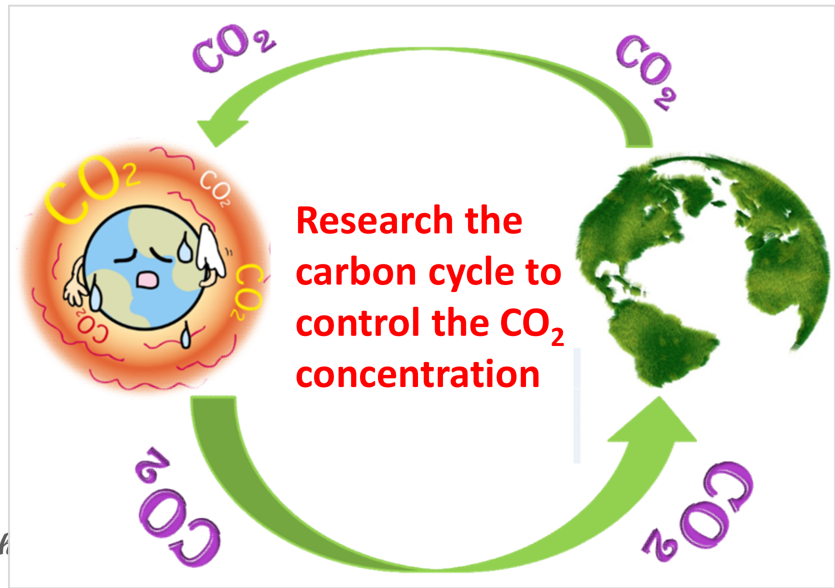
3 Results and discussion

4 Conclusions

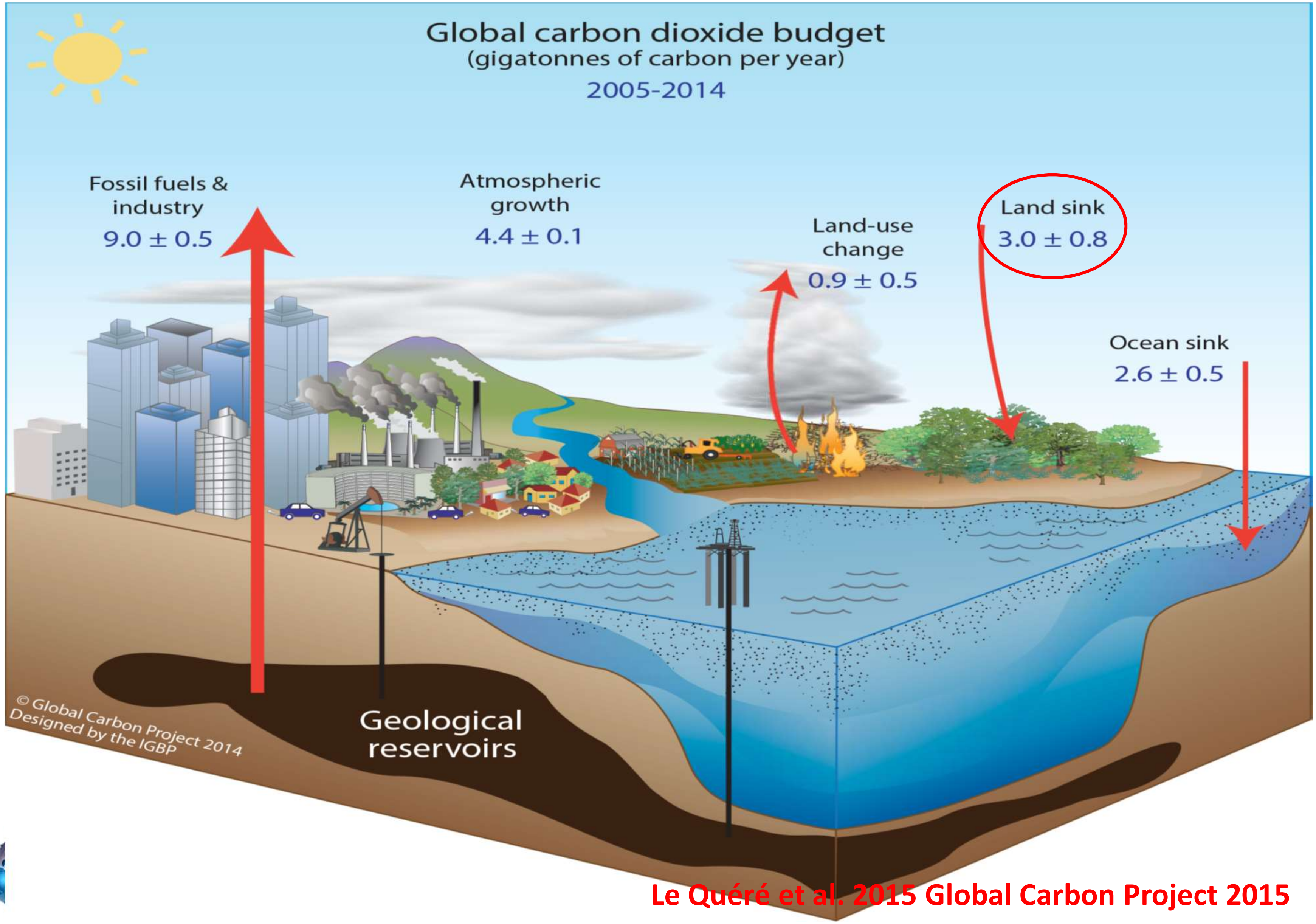
Introduction





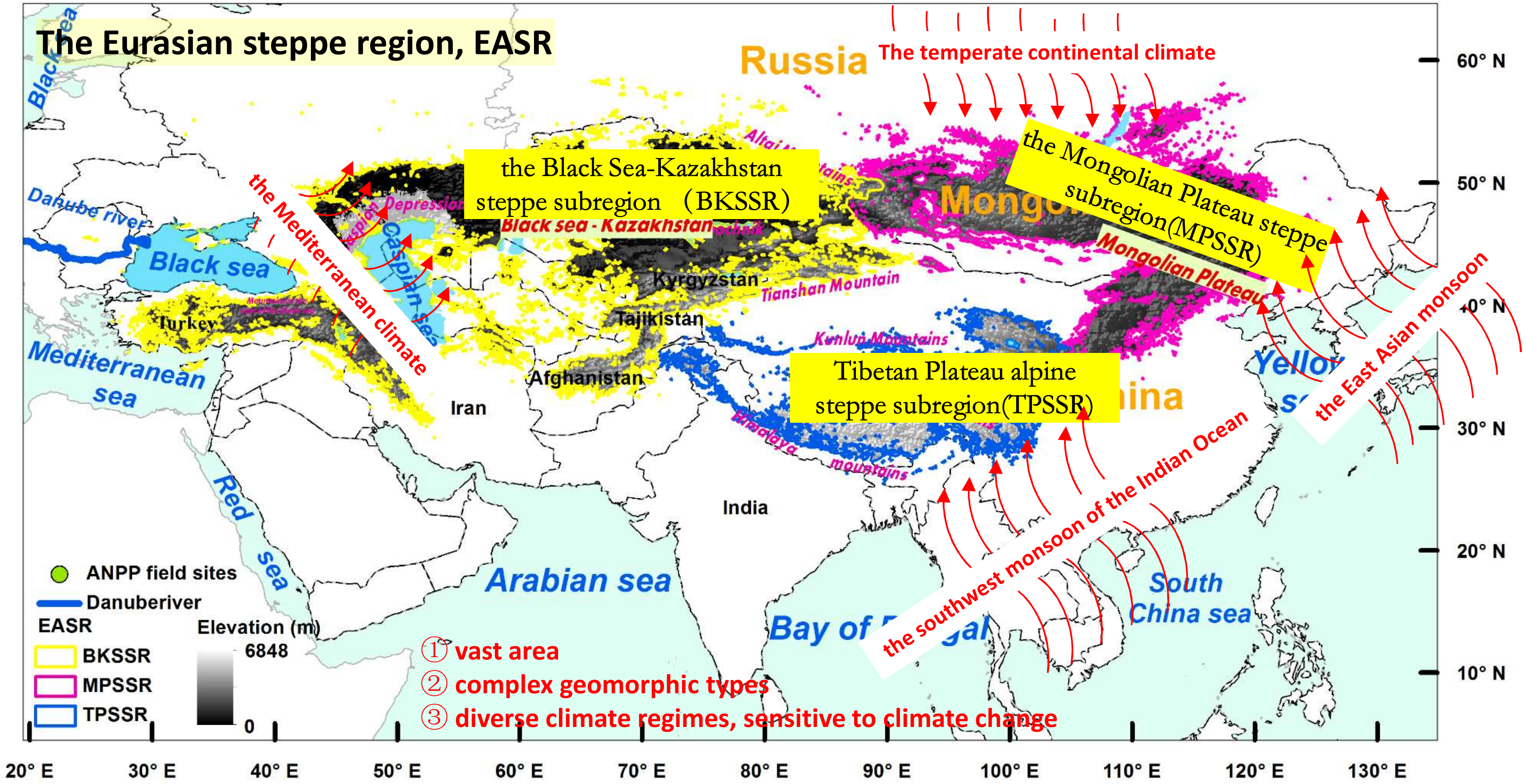


Introduction



Le Quéré et al. 2015 Global Carbon Project 2015

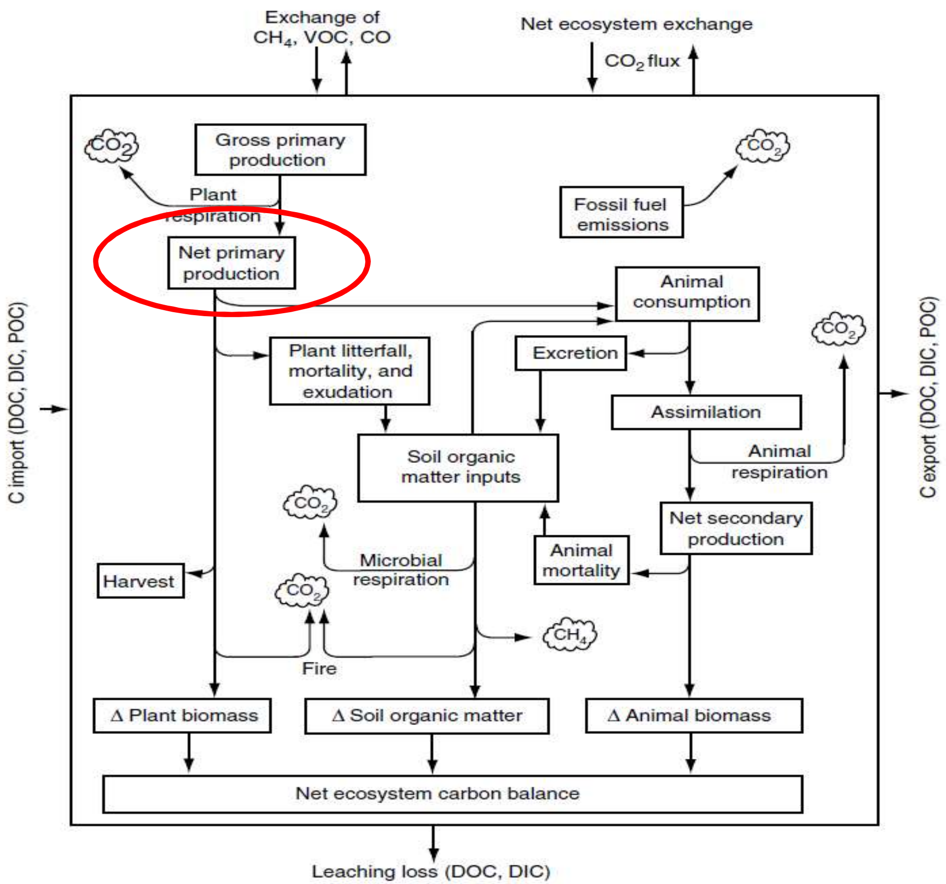
Introduction



Evaluating the spatiotemporal dynamics of carbon budgets in EASR will further our understanding of carbon cycle mechanisms in grasslands.

Introduction

Overview of the carbon fluxes of an ecosystems



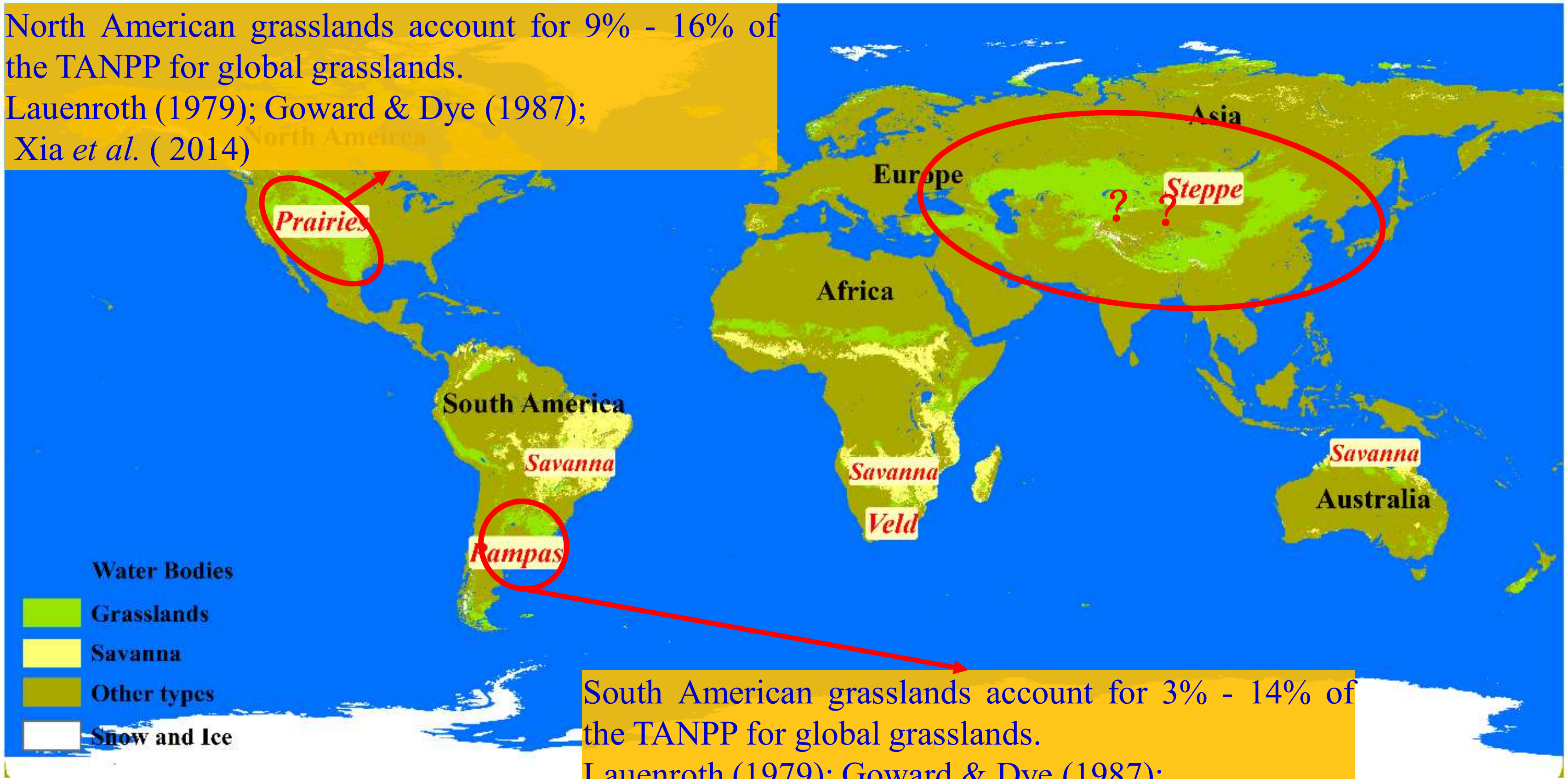
- ✓ **Aboveground net primary productivity (ANPP) is one of the main components of the carbon cycle;**
- ✓ **ANPP is one of the most important and fundamental fluxes that reflect carbon sinks/sources of ecosystems;**
- ✓ **ANPP's variations over time reflect the response of ecosystems to climate change.**

Studying the spatiotemporal patterns of EASR's ANPP will help to understanding the role of EASR in the global carbon cycle.

Introduction

Total above-ground net primary productivity (TANPP) in global grasslands vary from 1423 Tg C yr^{-1} to 4635 Tg C yr^{-1} (Bazilevich *et al.*, 1971; Whittaker & Likens, 1975; Parton *et al.*, 1995; Xia *et al.*, 2014)

North American grasslands account for 9% - 16% of the TANPP for global grasslands.
Lauenroth (1979); Goward & Dye (1987);
Xia *et al.* (2014)



South American grasslands account for 3% - 14% of the TANPP for global grasslands.
Lauenroth (1979); Goward & Dye (1987);
Xia *et al.* (2014)

Introduction

Aims

- to identify the **best composite period of NDVI data** for developing a robust annual ANPP estimation model designed for the entire EASR

- to evaluate **the ANPP** of the entire EASR

- to explore **temporal dynamics** of the EASR's TANPP and to further discuss the role of the EASR in the global carbon budget.

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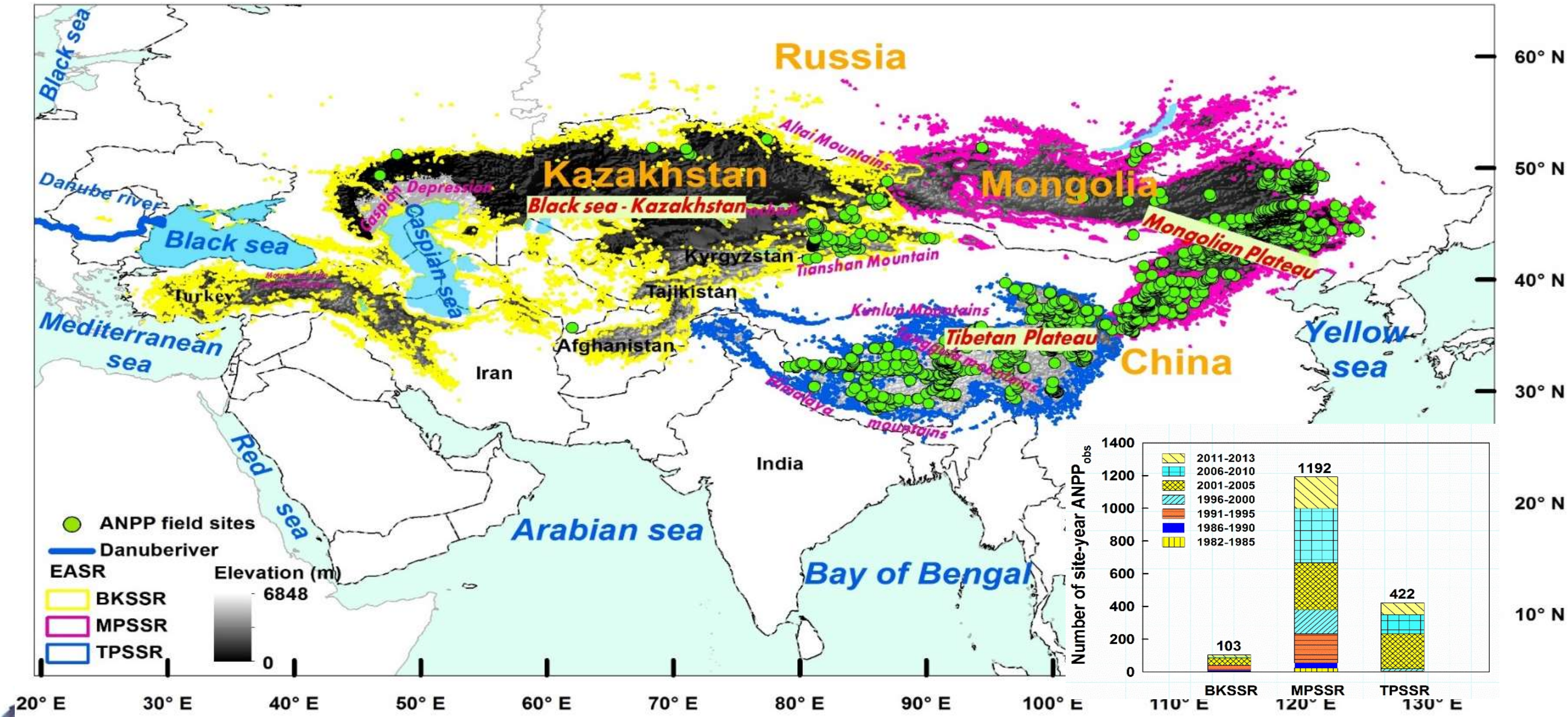
Materials and methods

➢ Data collection

Field-observed ANPP data, Remote sensing data

□ Field-observed ANPP data



Materials and methods

□ Remote sensing data

- ✓ Long-term NDVI time-series data: GIMMS NDVI $_{3g}$, 15 days, 1982-2013, 0.083°
- ✓ Land cover data: the Land Cover Type Climate Modelling Grid (CMG) product (MCD12C1), MODIS, 2012

➢ Methods

The simple linear regression, the piecewise linear regression;

SPSS20.0, R, Sigmaplot12.5, ArcGIS10.0

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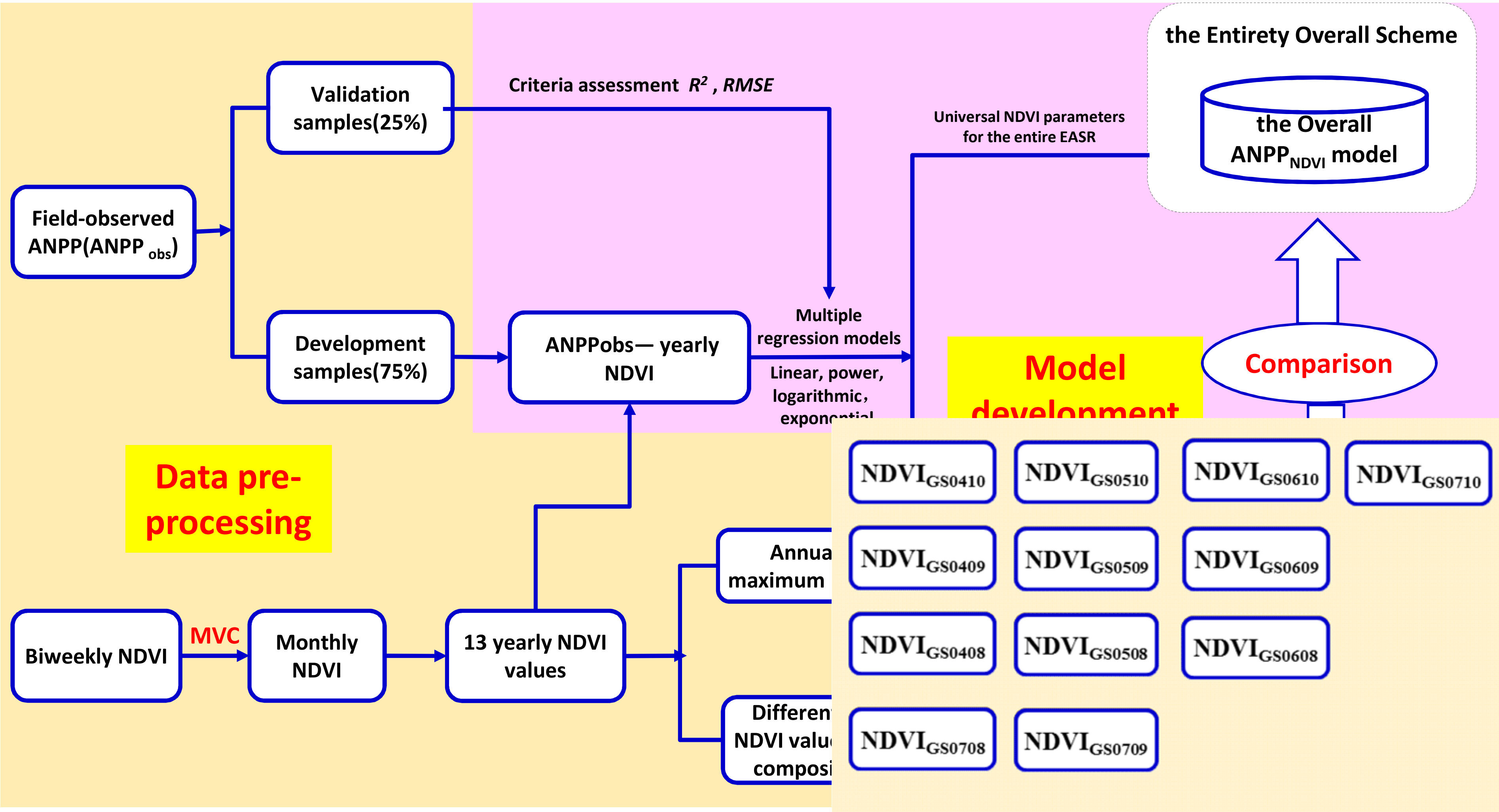
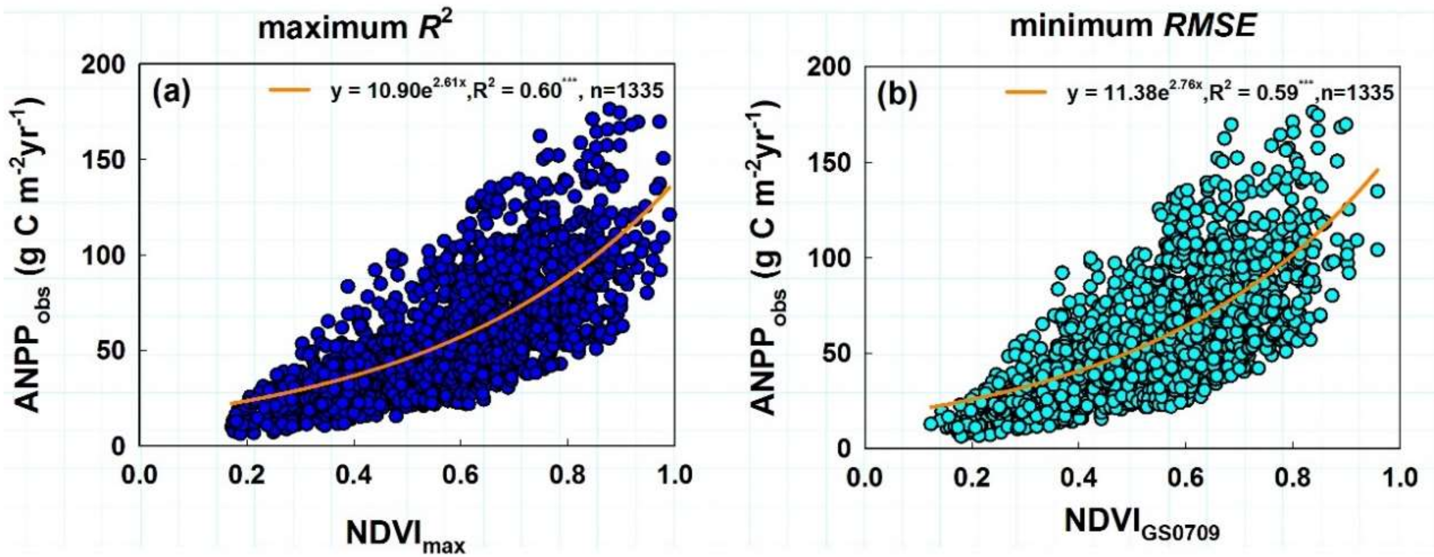
Development and validation of the ANPP estimation model

➢ ANPP estimation model development



Development and validation of the ANPP estimation model

➢ the Entirety Overall Scheme



The Overall $ANPP_{NDVI}$ model

$$ANPP(x,t) = \frac{1}{2}(10.90e^{2.61NDVI_{max}} + 11.38e^{2.76NDVI_{GS0709}}) \quad (1)$$

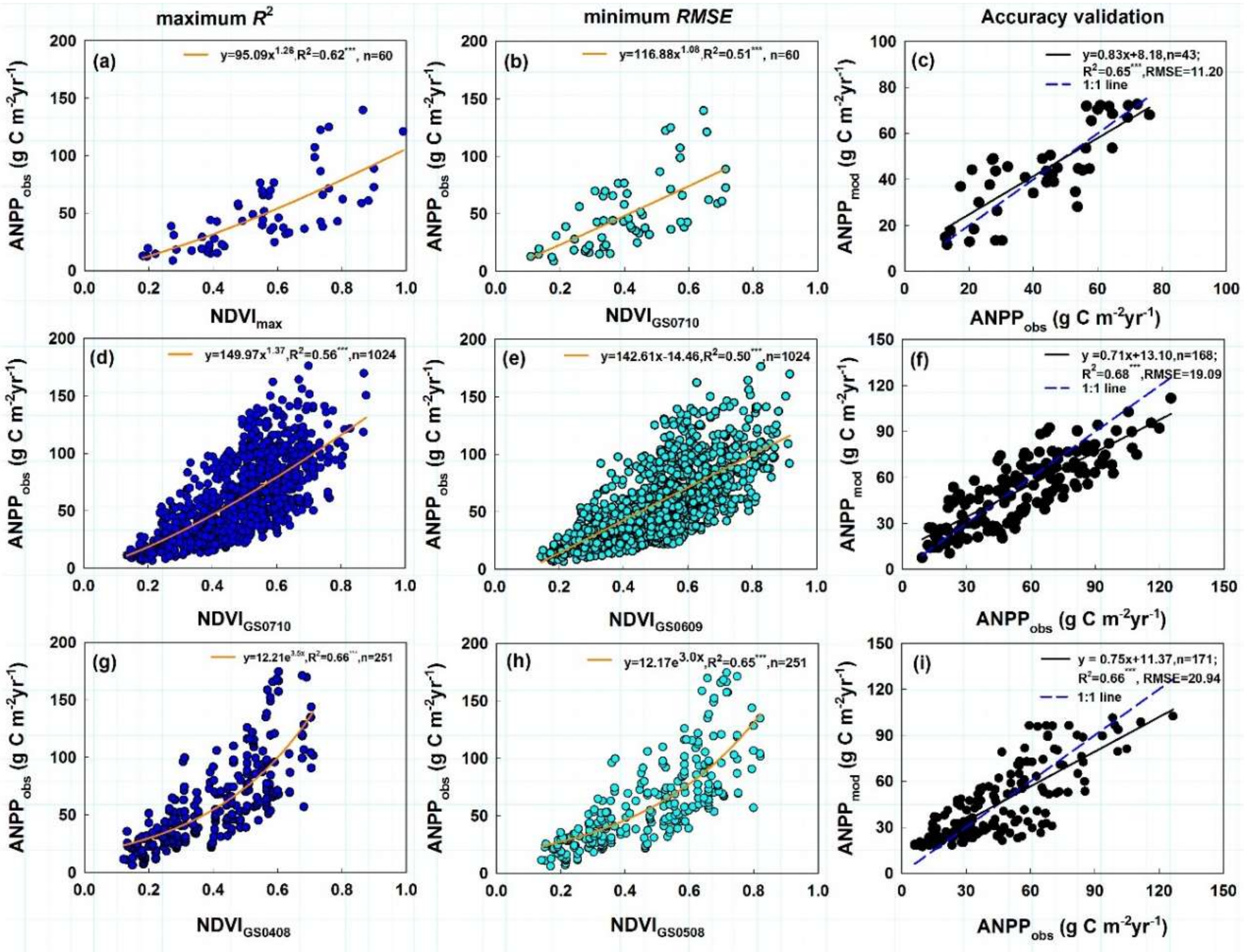
Development and validation of the ANPP estimation model

➢ the Subregions Integrated Scheme

the Black Sea-Kazakhstan steppe subregion (BKSSR)

the Mongolian Plateau steppe subregion (MPSSR)

the Tibetan Plateau alpine steppe subregion (TPSSR)

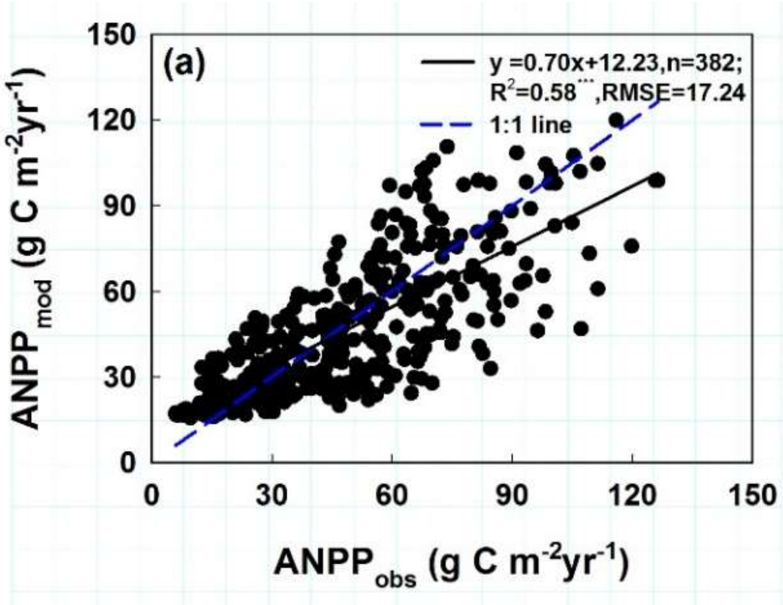


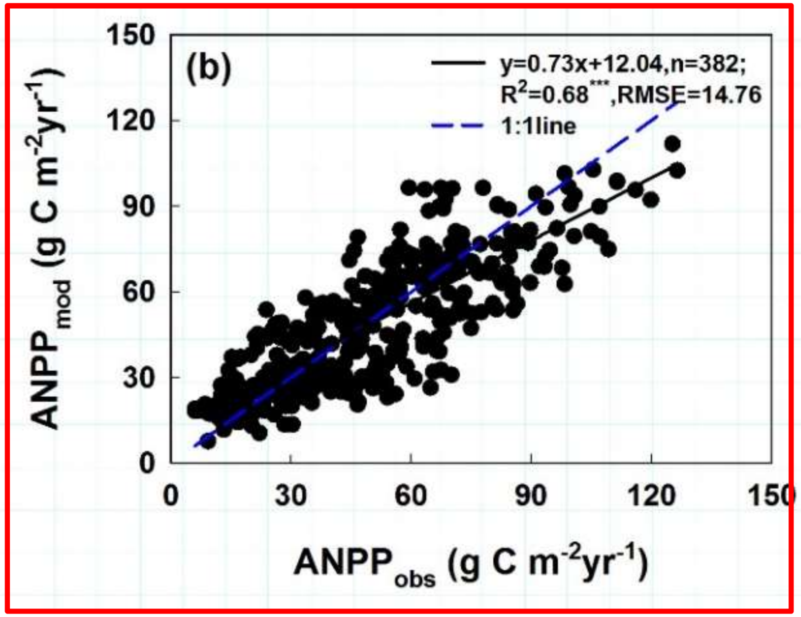
Development and validation of the ANPP estimation model

the Integrated $\mathrm{ANPP}_{\mathrm{NDVI}}$ model

$$ANPP(x,t)=\begin{cases}\frac{1}{2}\left(95.09NDVI_{max}(t)^{1.26}+116.88NDVI_{GS0710}(t)^{1.08}\right), & BKSSR\\ \frac{1}{2}\left(149.97NDVI_{GS0710}(t)^{1.37}+142.61NDVI_{GS0609}(t)-14.46\right), & MPSSR\\ \frac{1}{2}\left(12.21e^{3.48NDVI_{GS0408}(t)}+12.17e^{3.01NDVI_{GS0508}(t)}\right), & TPSSR\end{cases} \quad (2)$$

➢ Validation of models





Evaluation of ANPP

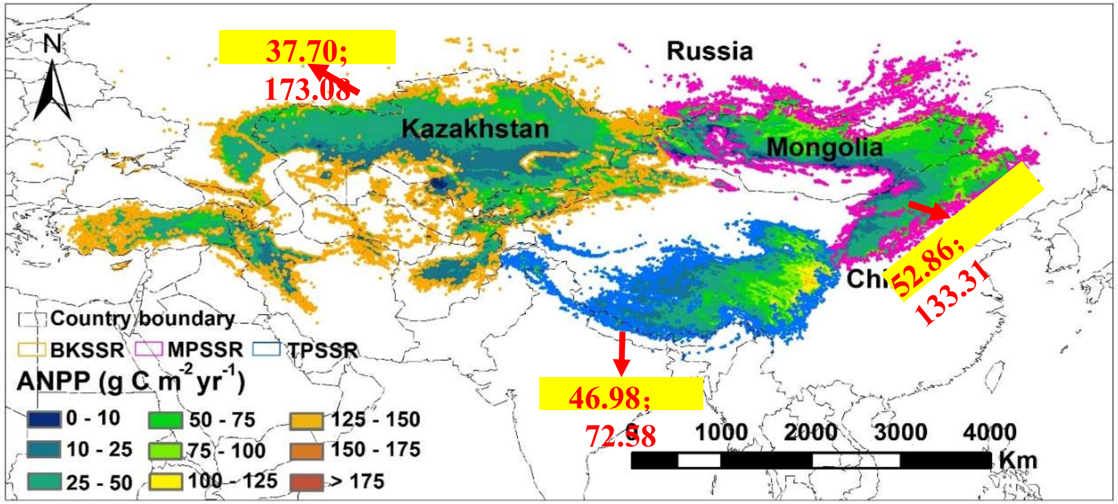
➢ The size and spatial variations of ANPP

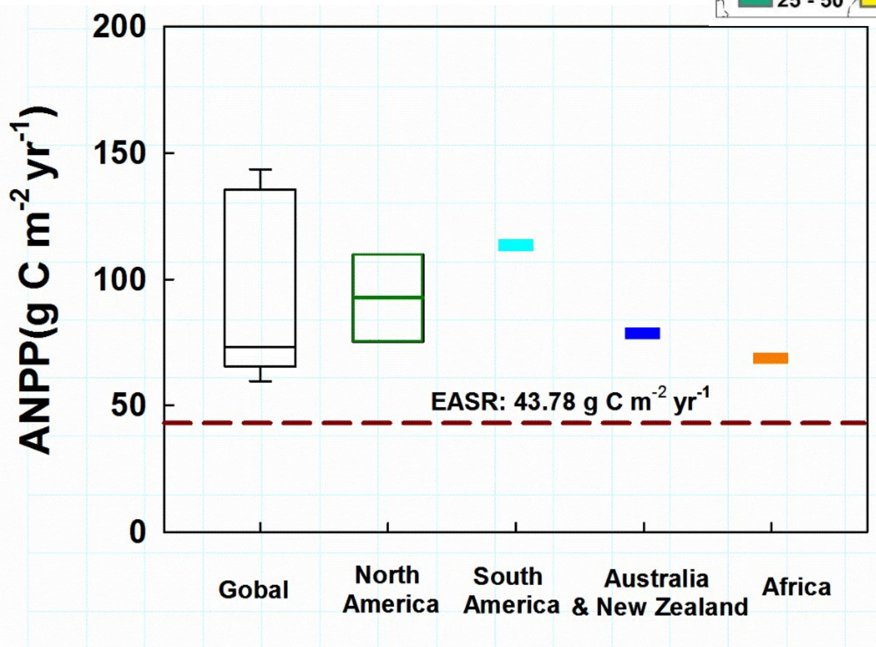
✓ **EASR:**

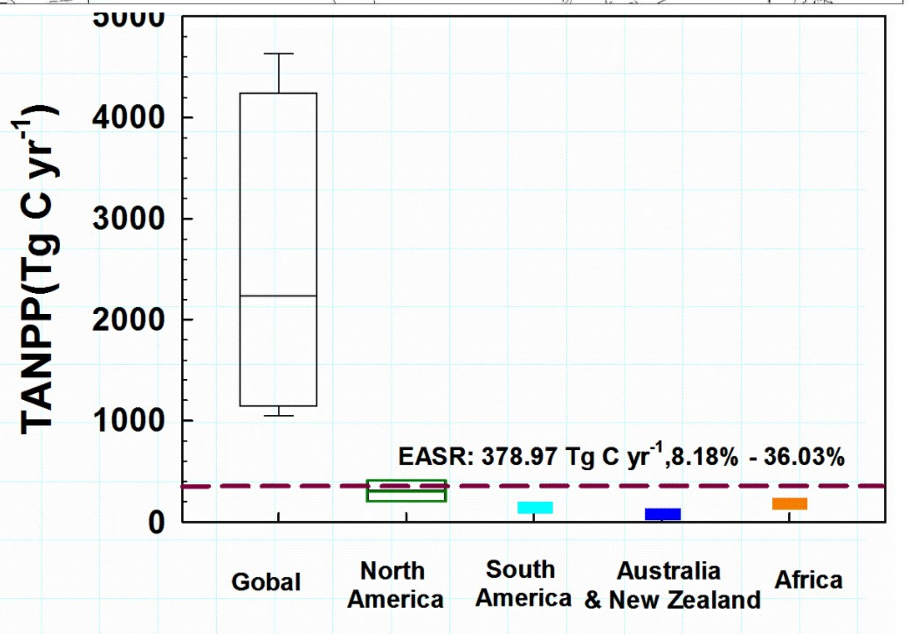
ANPP: 43.78 g C m^{-2} yr^{-1}

TANPP: 378.97 Tg C yr^{-1}

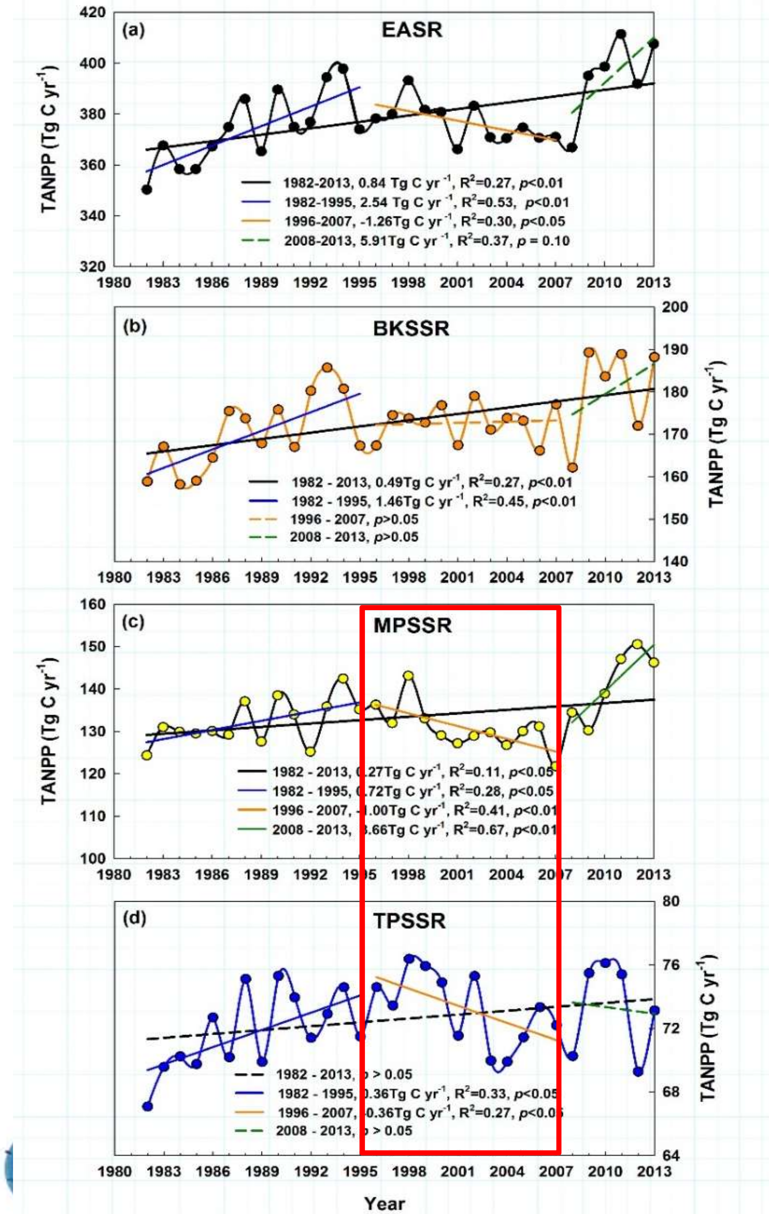
✓ **The importance of the EASR in global carbon cycling**







Temporal TANPP dynamics



EASR: significantly increasing from 1982 to 2013

① 1982 – 1995 a significant increase
② 1996 – 2007 a marked decrease
③ 2008 – 2013 a slightly increase;

BKSSR: significantly increasing from 1982 to 2013

① 1982 – 1995 a significant increase
② 1996 – 2007 no obvious change
③ 2008 – 2013 a slightly increase;

MPSSR: significantly increasing from 1982 to 2013

① 1982 – 1995 a significant increase
② 1996 – 2007 a marked decrease
③ 2008 – 2013 a significant increase;

TPSSR: not-significantly increasing from 1982 to 2013

① 1982 – 1995 a significant increase
② 1996 – 2007 a marked decrease
③ 2008 – 2013no obvious change。

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Conclusions

NDVI-based ANPP estimation model

The best composite period of NDVI data for annual ANPP estimation varies with study region climatic patterns and vegetation. More specifically, the **early–middle growing season** averaged NDVI, the **middle–late growing season** averaged NDVI and **the annual maximum NDVI** should be, respectively applied to **semi-humid** regions, **semi-arid regions** and **desert vegetation** in semi-arid regions.

Geographic patterns of ANPP

ANPP exhibited **pronounced spatial variations** in the EASR, which corresponded to **different grassland types** reflecting variations in **hydrothermal** conditions.

Conclusions

Temporal TANPP dynamics

- The EASR's TANPP **increased** in a **fluctuating manner** throughout the entire period of 1982-2013.
- The years **1995** and **2007** were two turning points at which trends in EASR's TANPP significantly changed.

The role of the EASR in the global carbon budget

- EASR's ANPP is **lower** than that of North American, South American and African grasslands.
- EASR's TANPP is **higher** than that of grasslands in North America, South America and Africa, accounting for **8.18% - 36.03%** of that of all grasslands.

Acknowledgements

This work was funded by the National Key Research and Development Program of China (NO. 2016YFA0600104) and Science and Technology Service Network Initiative Program of the Chinese Academy of Sciences (KFJ-SW-STS-169-04).

Thanks for your attention!