TM5 – Synthesis analysis of atmopsheric $\delta^{13}CH_4$

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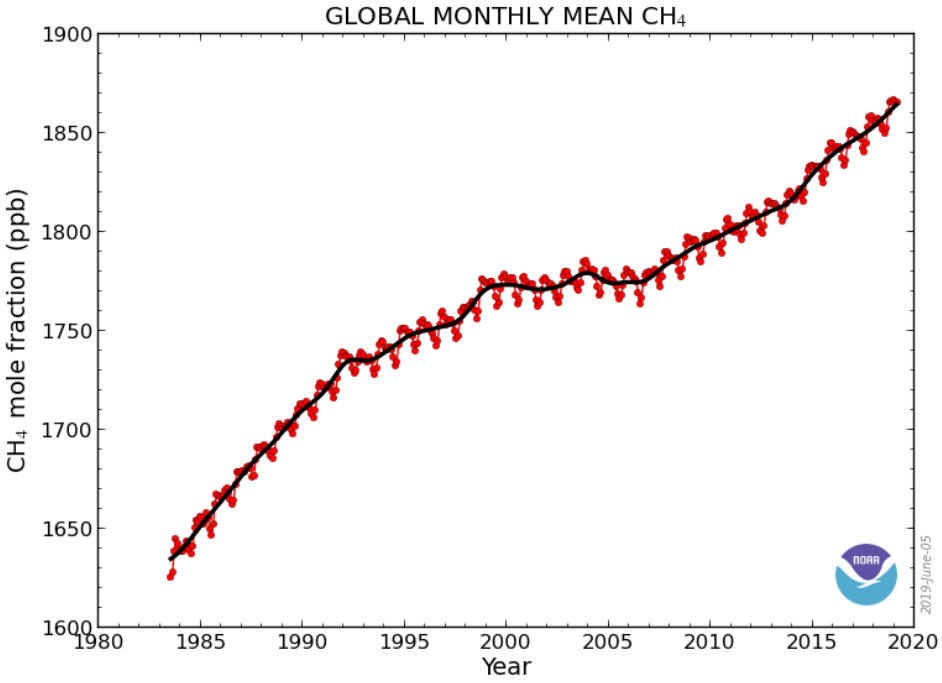
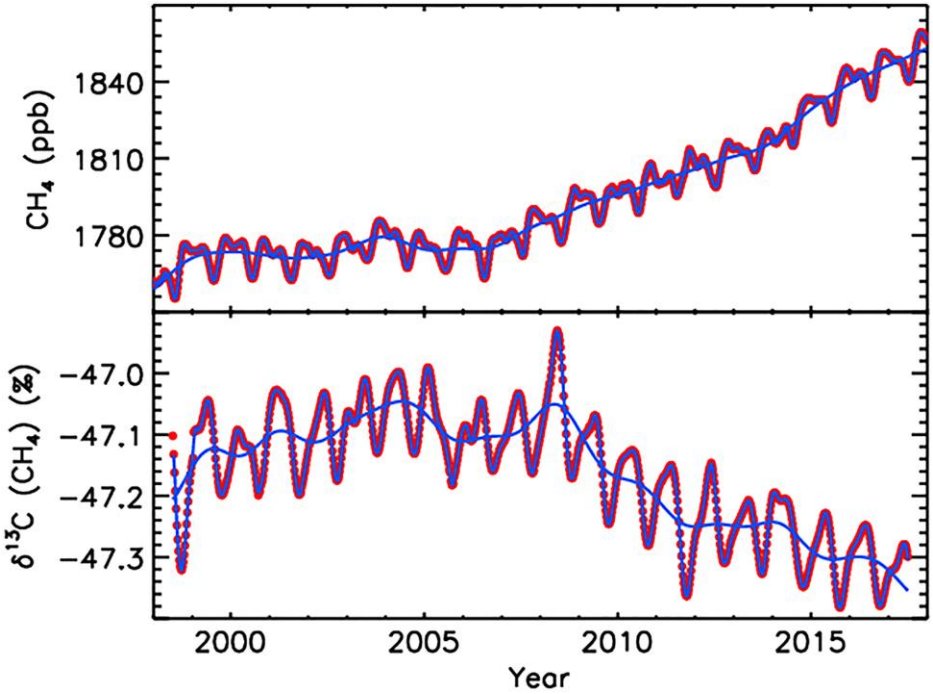
Background – CH_4



Ed Dlugokencky



Nisbet et al, 2019

Background – CH_4 carbon isotopes

- Stable isotopes $^{12}CH_4$ and $^{13}CH_4$
  - isotopic separation due to different masses
- Each CH_4 source have process specific isotopic signature
  - $\delta^{13}CH_4 = \left[\frac{(^{13}CH_4/^{12}CH_4)_{sample}}{(^{13}CH_4/^{12}CH_4)_{standard}} - 1\right] 1000‰$

Source	$\delta^{13}CH_4$(‰)	Source	$\delta^{13}CH_4$(‰)
Rice agriculture(EDGAR)	-63[1]	Landfills and waste water treatment (EDGAR)	-55[1]
Enteric Fermentation and Manure Management (EDGAR)	-62[1] [-67, -54][2]	Termites (Ito et al.)	-57[1]
Coal (EDGAR)	-35[1] [-64, -36][3]	Fire (GFED)	-21.8[1] [-25, -12][2]
Oil and gas (EDGAR)	-40[1] [-56, -29][2]	Ocean (FMI)	-59[1]
Residential (EDGAR)	-38[1]	Wetlands (LPX-Bern DYPTOP)	-59[1] [-74.9, -50][5]
Geological (Etiope et al. 2019)	-68,-24.3 [4]	Wildanimals (FMI)	-62[1]

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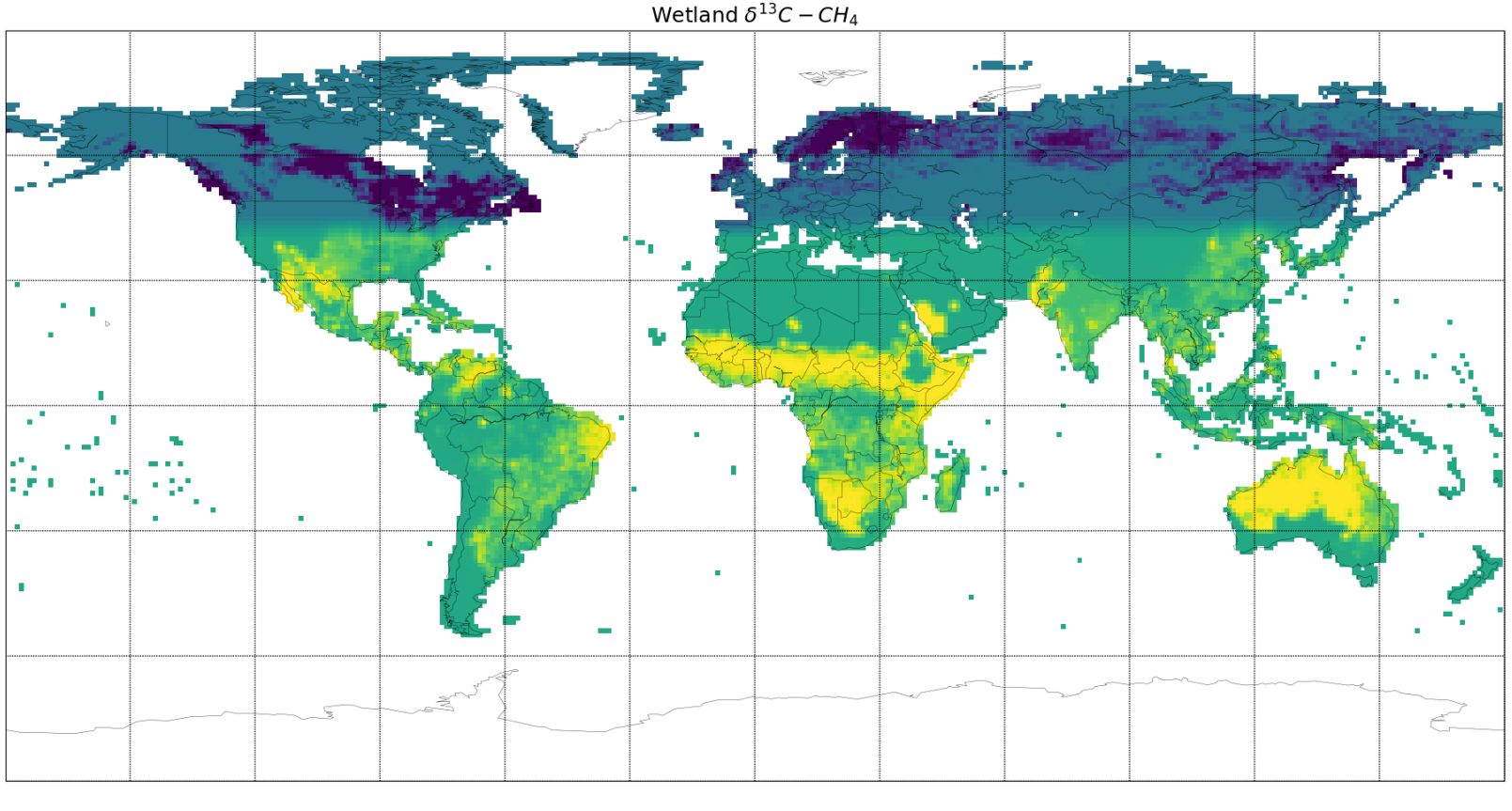
EDGAR 4.2 FT2010/4.3.2

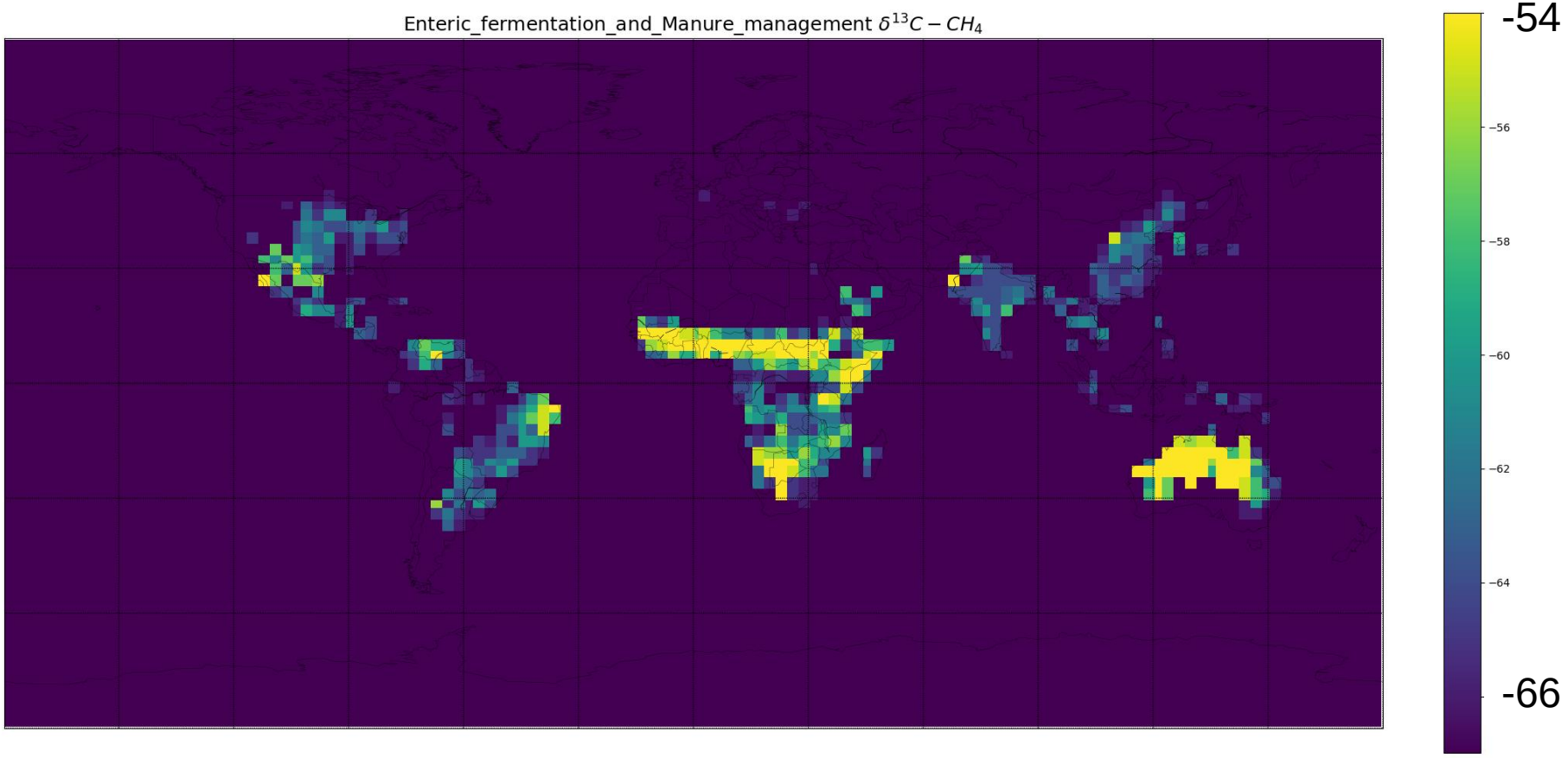
[1] Monteil et al. (2011) (Houweling et al. (2006), Bergamaschi (1997); Levin (1994); Bergamaschi et al. (1998); Gupta et al. (1996); Canttell et al. (1990); Brenninkmeijer et al. (1995); Tyler et al. (1994))
[2] Aryeh et al. 2017 [3] Sherwood et al. 2017 [4] Etiope et al. 2019 [5] Ganesan et al. (2018)

Wetlands – isotopic signature variation globally



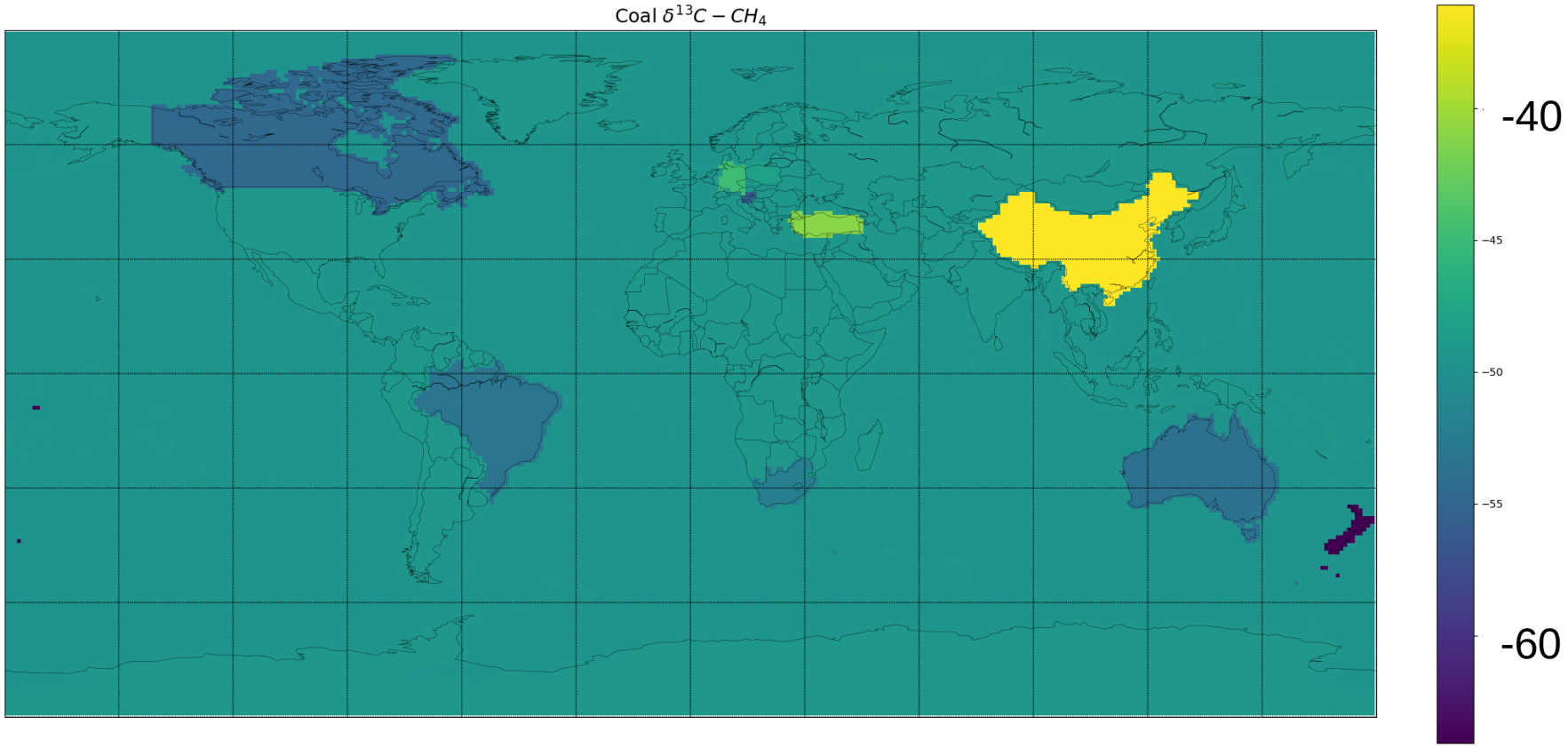
Ganesan et al. (2018) values combined with Monteil et al. (2011) values

Enteric Fermentation and Manure Management



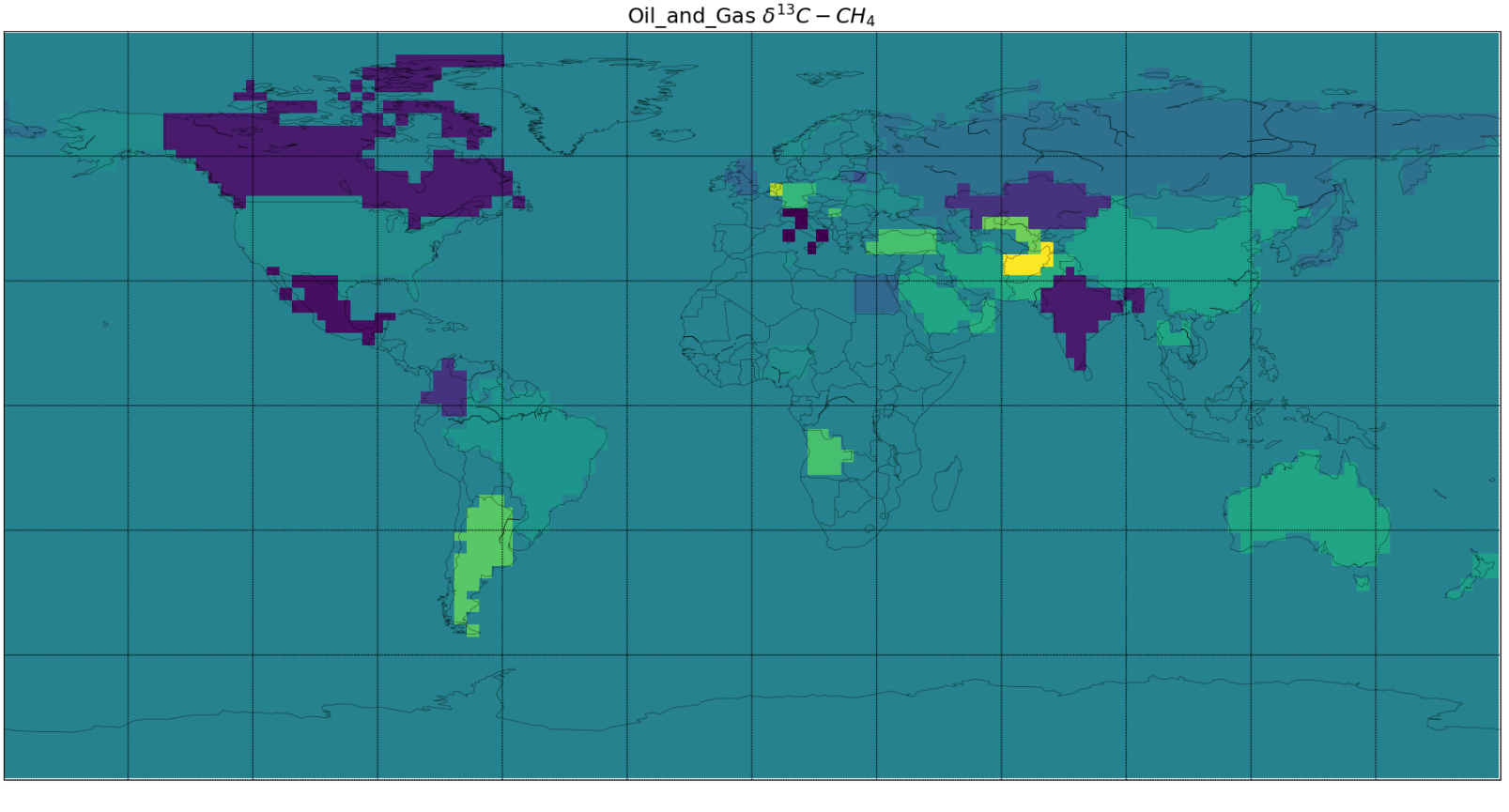
Aryeh et al. 2017

Coal



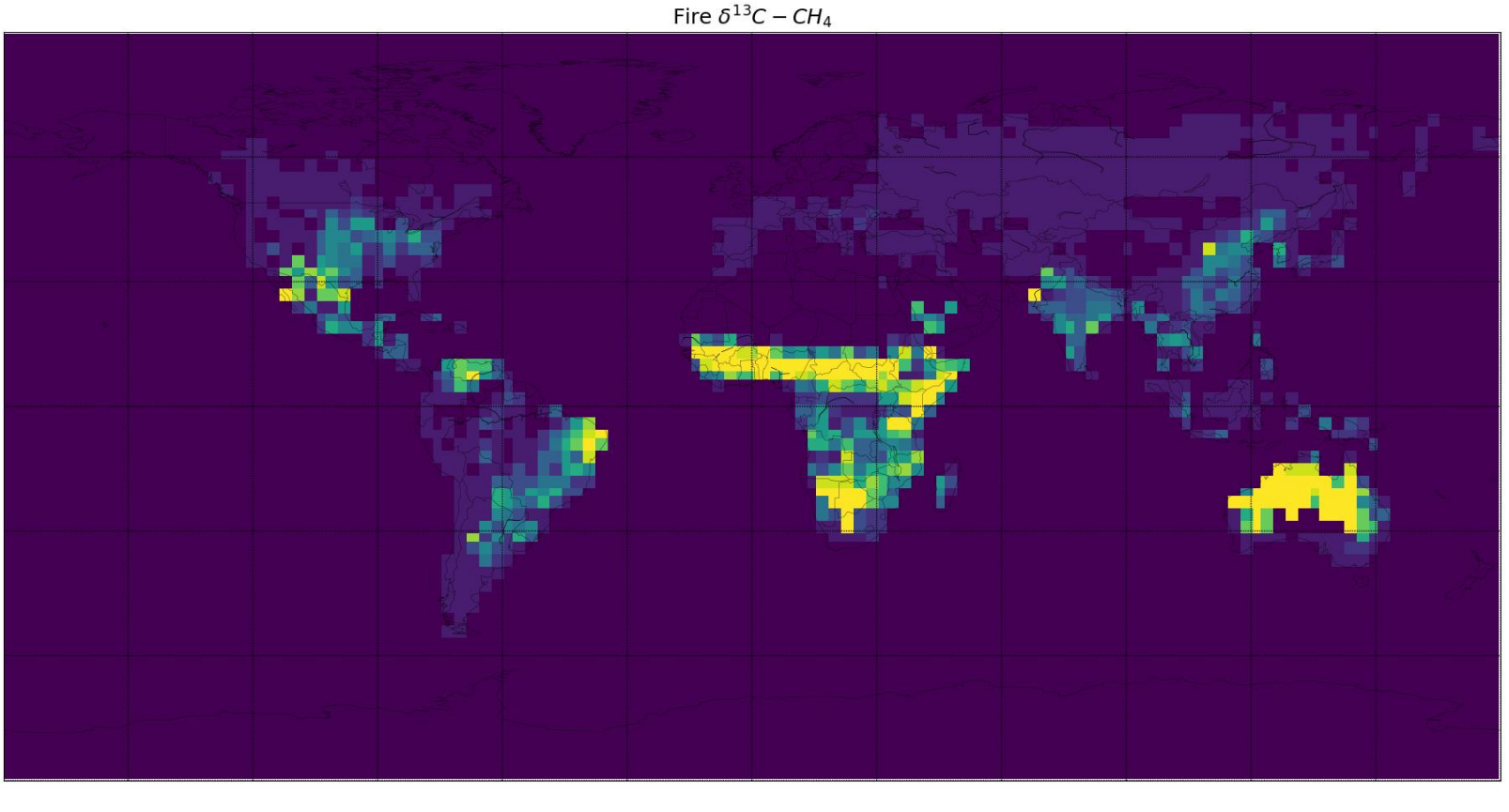
Sherwood et al. 2017

Oil and Gas



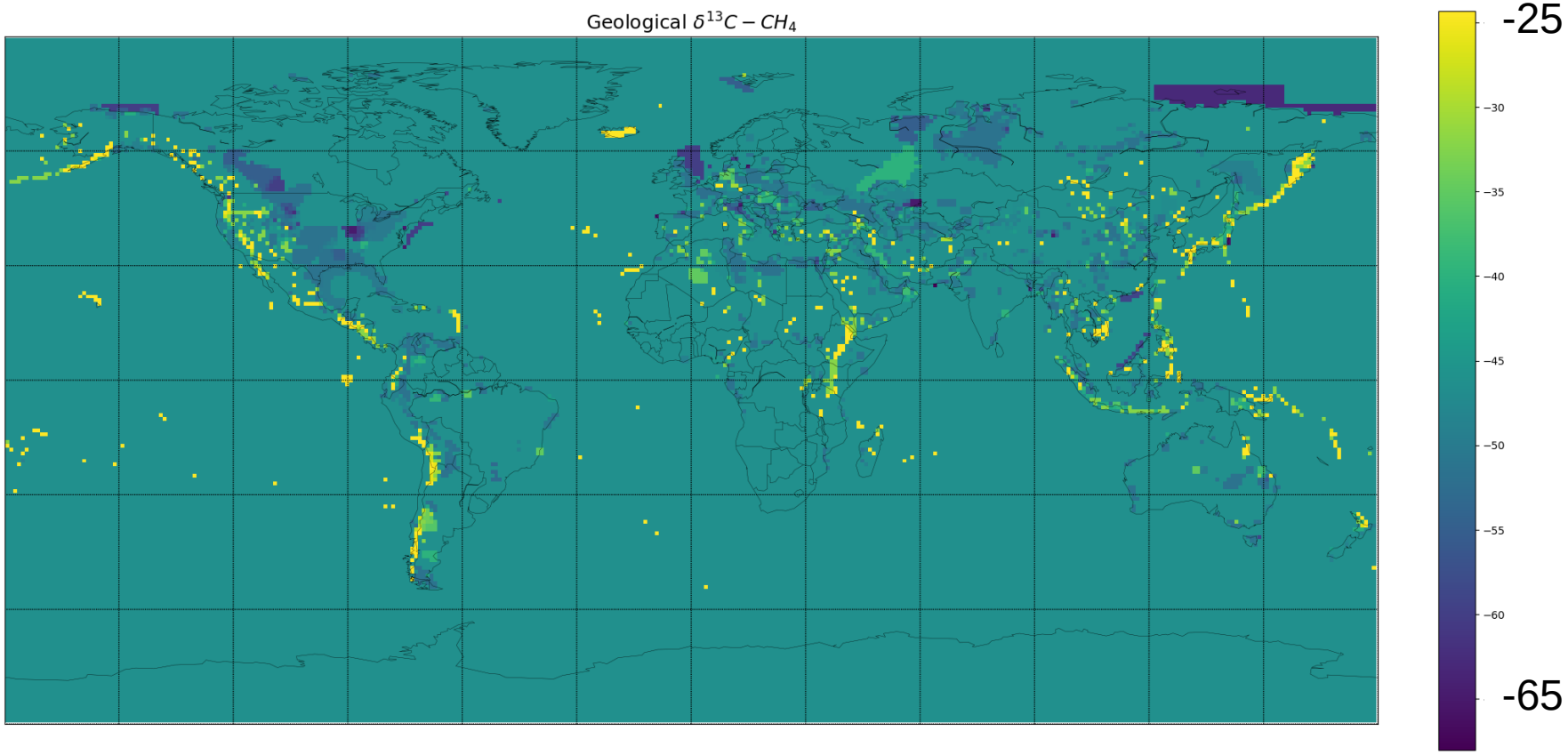
Aryeh et al. 2017

Fire



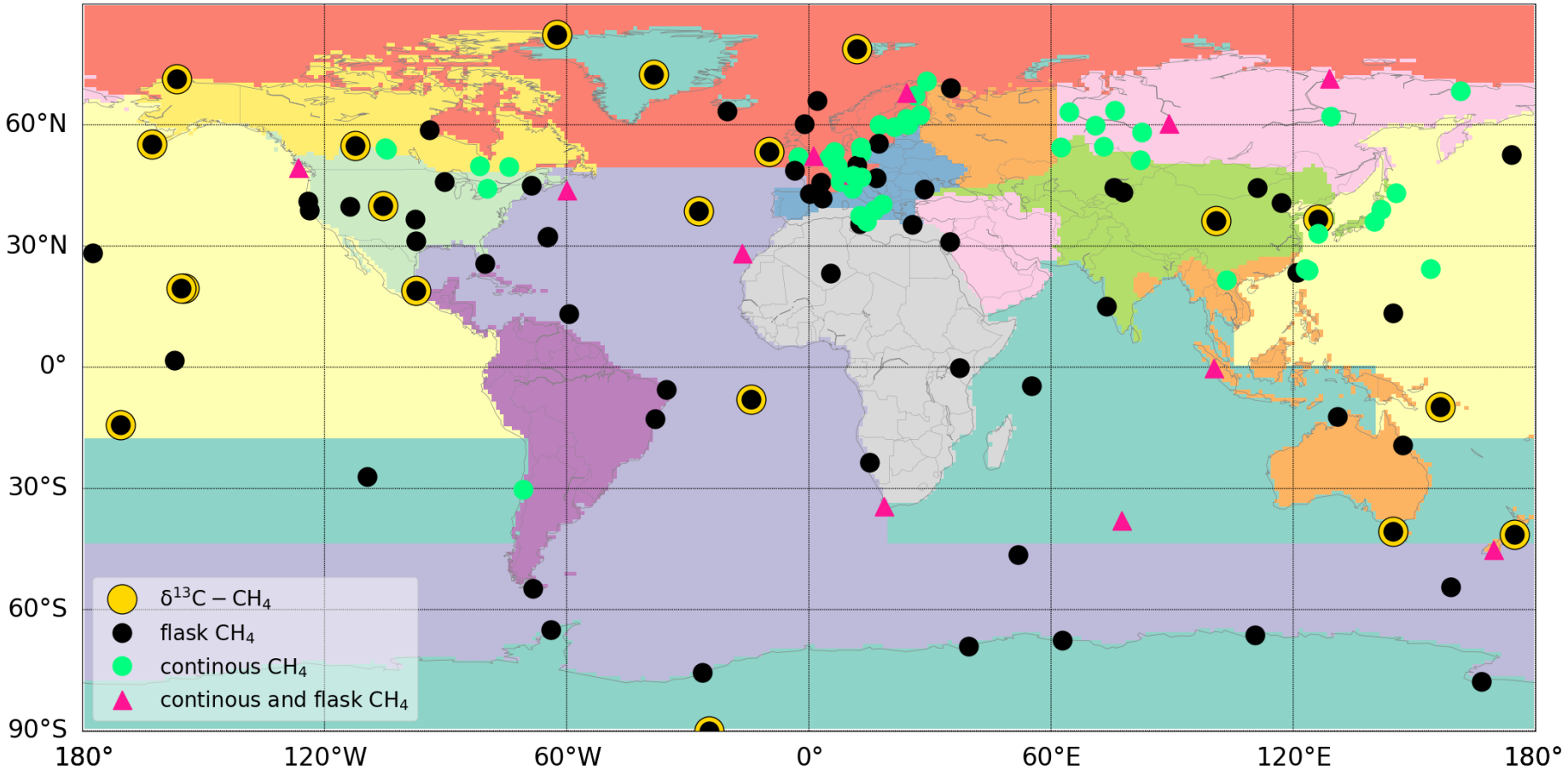
Aryeh et al. 2017

Geological



Etiope et al. 2019

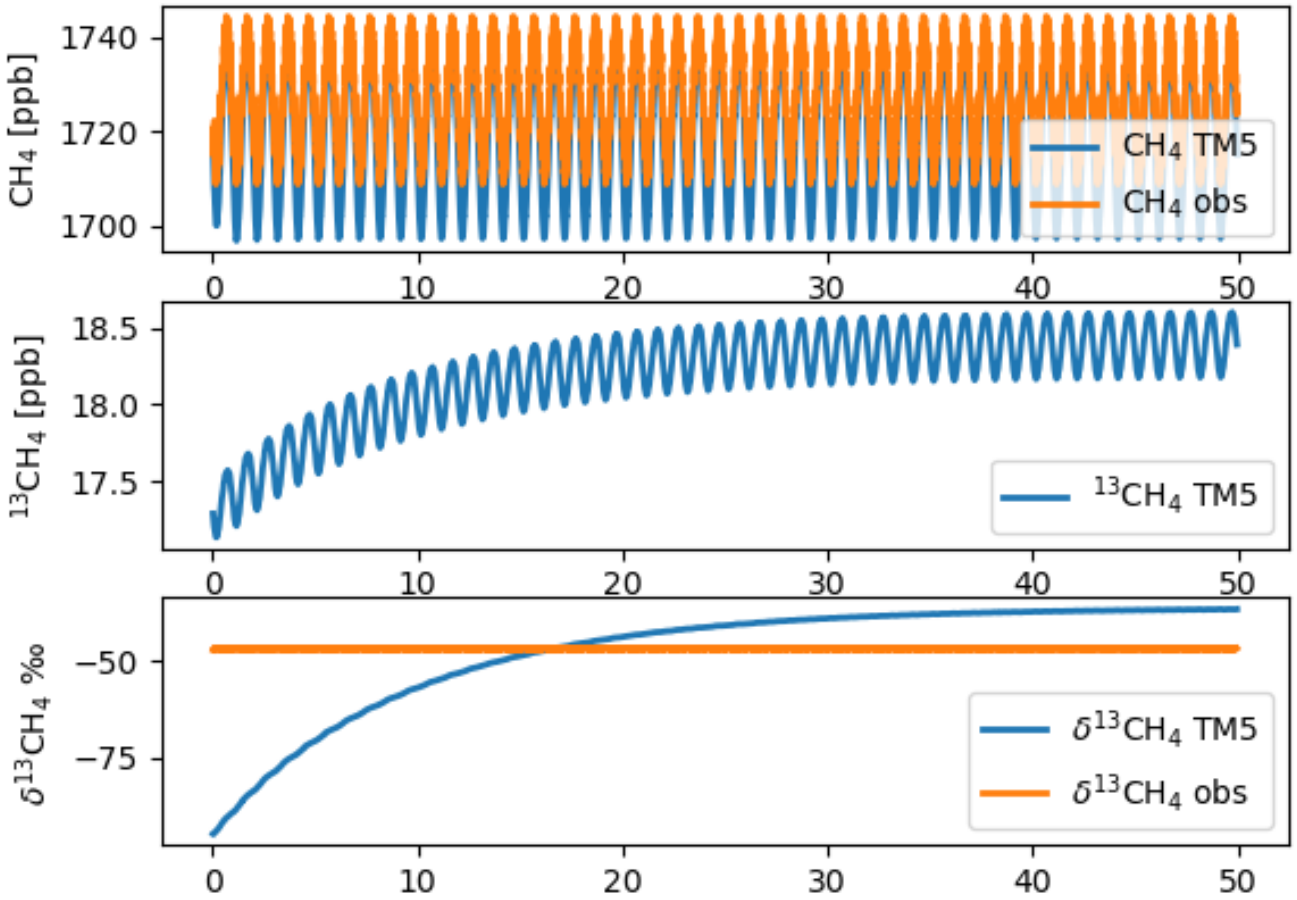
Observations of $\delta^{13}CH_4$ & CH_4 during 2000-2017



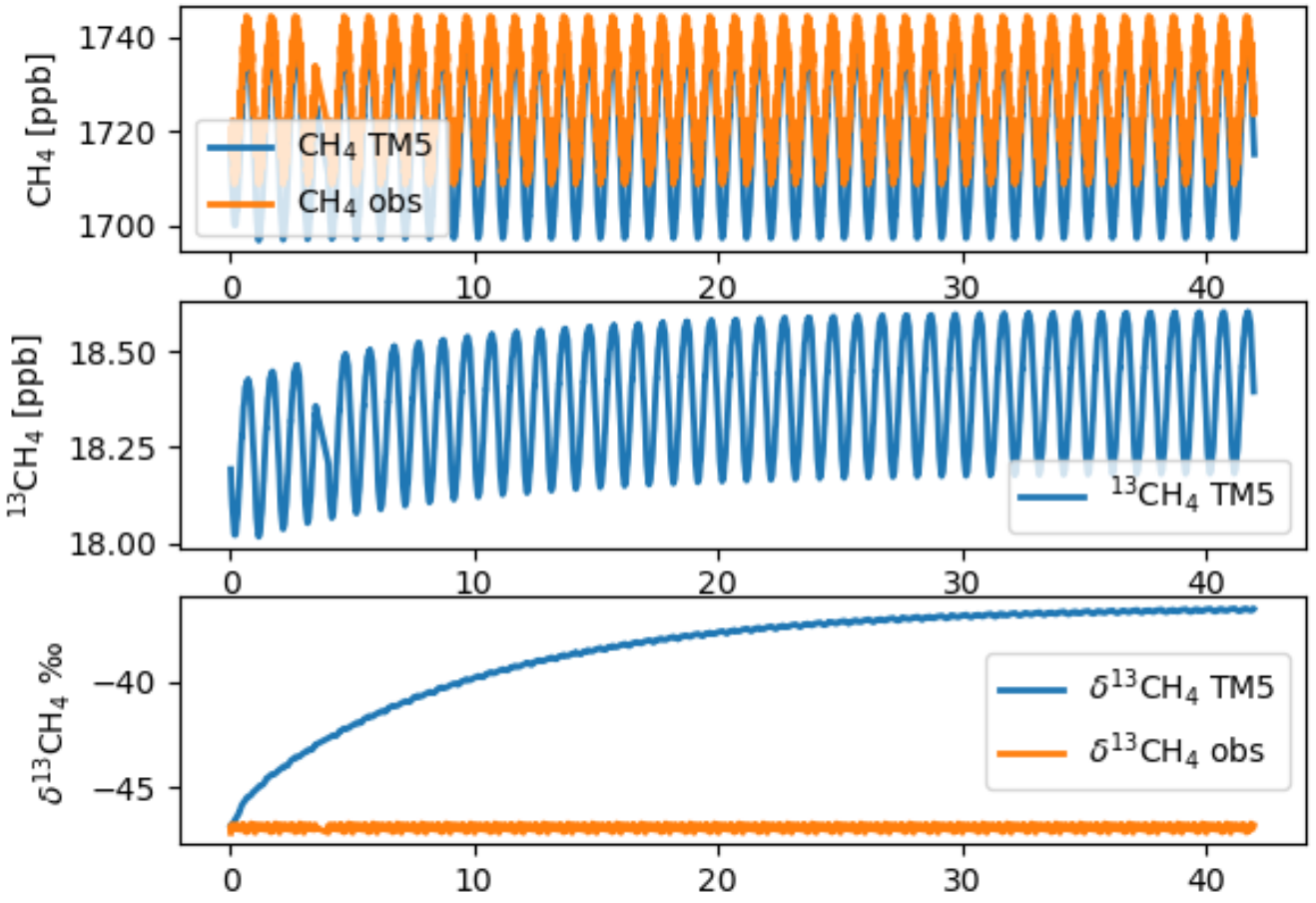
TM5 –set up for spin-up

- Resolution 1^o x 1^o over Europe, elsewhere 6^o x 4^o
- Transports CH_4 and $^{13}CH_4$ but the traces are not communicating
- Includes OH, Cl + O^1D chemistry atmospheric sinks
  - OH; Spivakovsky x 0,92
- All isotopic signature values are included
- Prior emissions are multiplied by 0.93 for keeping the CH_4 level constat
  - In spin-up the CH_4 should remain in the same level at each loop
- Spin-up is done for year 2000 i.e. looping the same year multiple time
- Two different initial fields for 13CH4
  - 1. Initial field not reasonable (TM5 should correct the field)
    - Delta values are set to be remarkable more negative than in reality
  - 2. Initial field resonable
    - Delta values are set to correspond observations

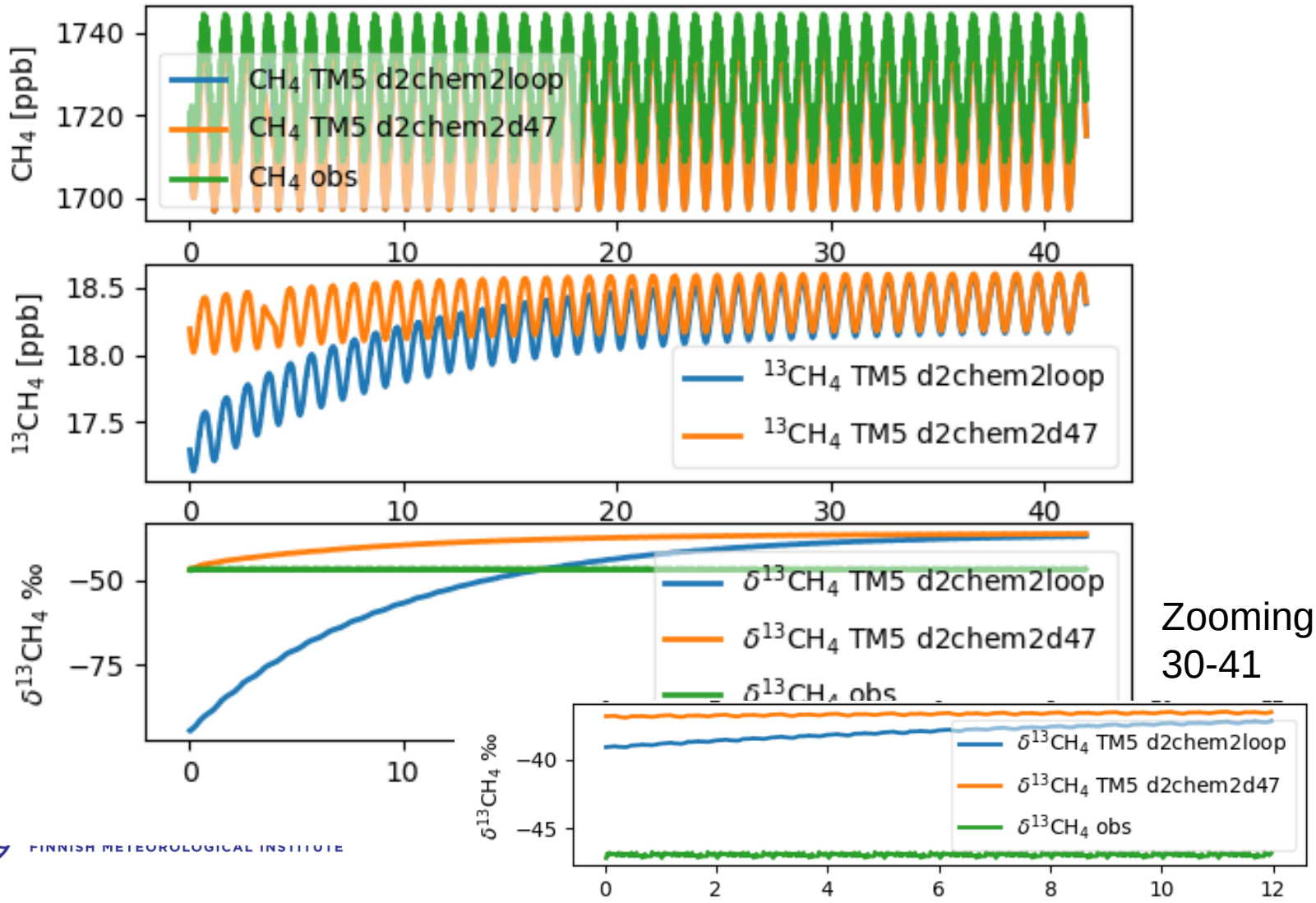
Rseults from spin-up – not resonable initial field (SPO)



Results from the spin-up – resonable field (SPO)



Comparision absolute values (SPO)



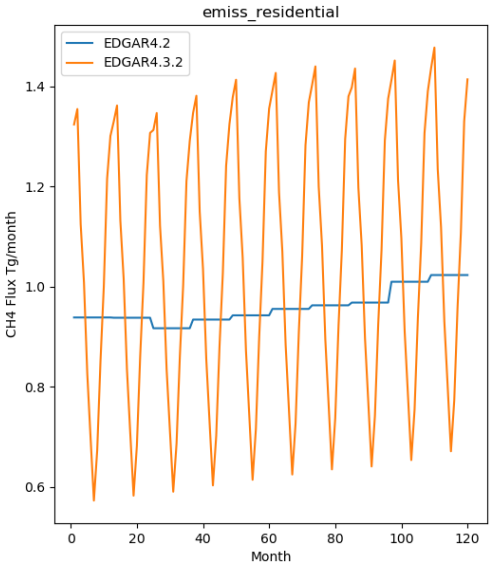
Zooming years 30-41

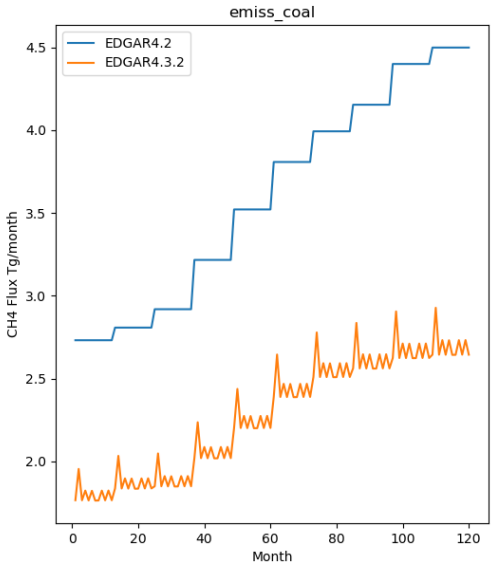
TM5 synthesis analysis

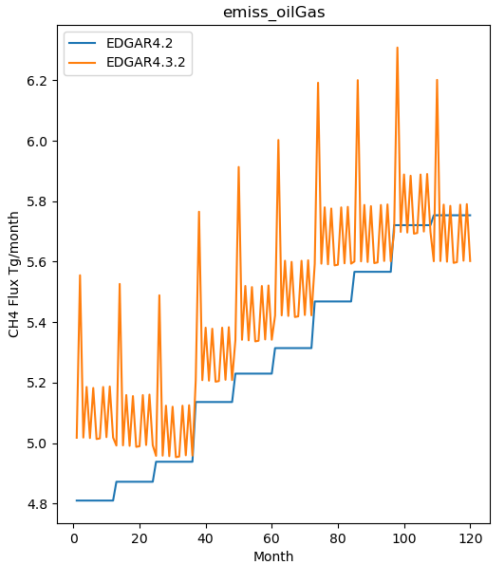
- Find out the impact of each change to the model and how the changes in delta signature values and priors affect the seasonality in delta values
- EDGAR4.3.2 has a seasonal cycle where as 4.2 FT2010 has none

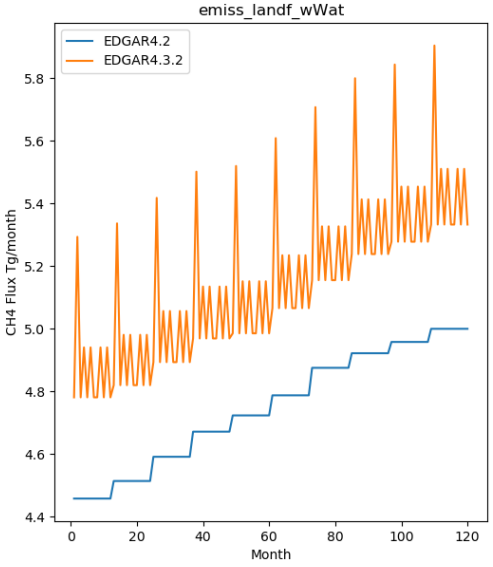
1. EDGAR4.3.2 + all sources with isotopic map if available
2. EDGAR4.3.2 + no map in EDGAR components (=single value used globally for each source from Table 1), others with map
3. EDGAR 4.2 + no map in EDGAR components, others with map
4. EDGAR4.2 + rice(EDGAR4.3.2) + no map in EDGAR components, others with map
5. EDGAR4.2 + enteric fermentation and manure management (EDGAR4.3.2) + no map in EDGAR components, others with map
6. EDGAR4.2 + coal (EDGAR4.3.2) + no map in EDGAR components, others with map

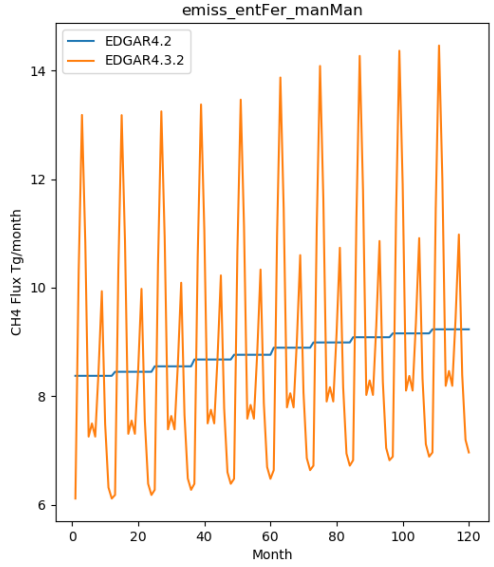
EDGAR 4.3.2 vs 4.2 monthly 2000-2010

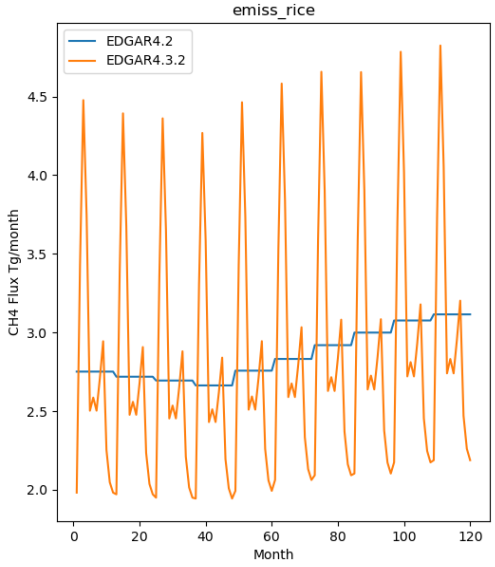




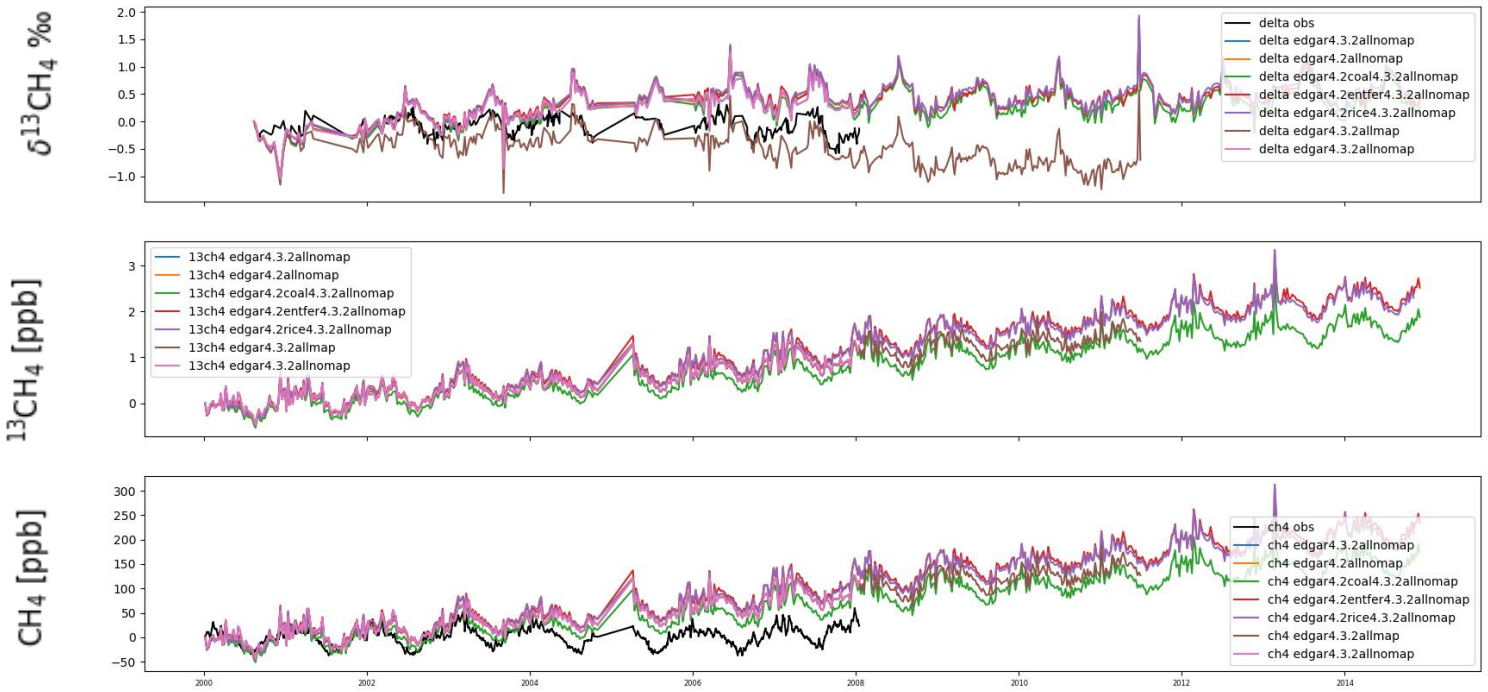




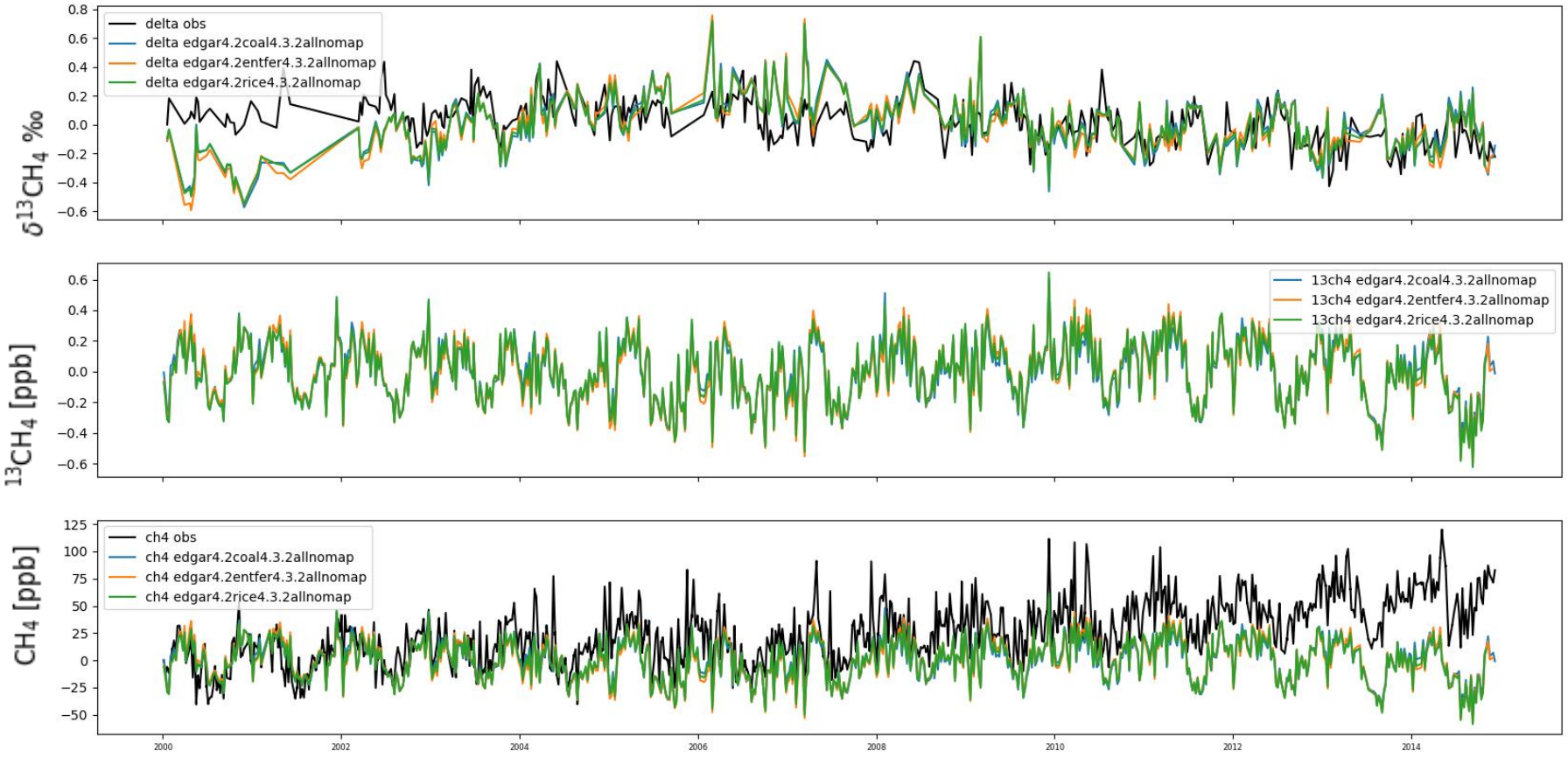




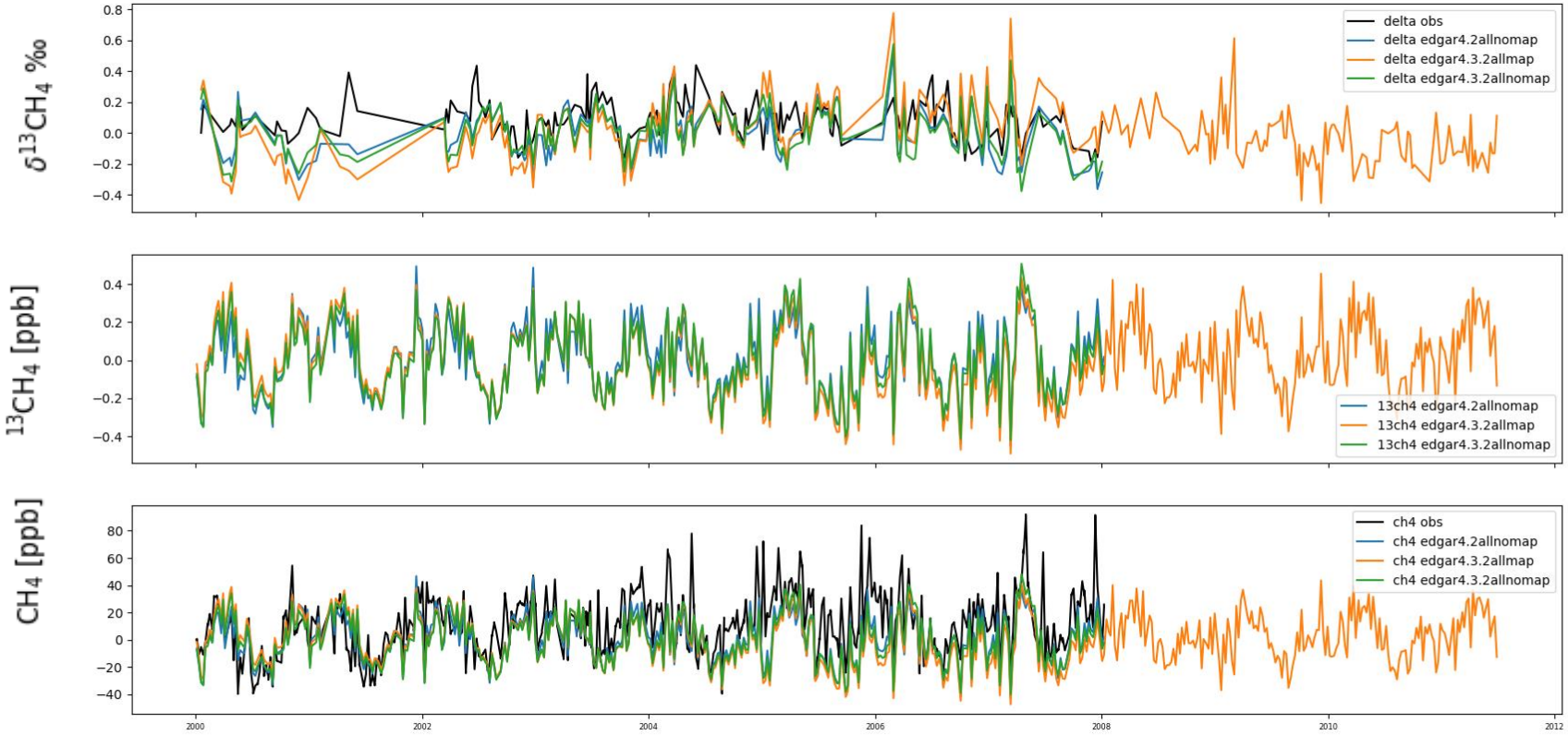
Compare all runs - absolute values (ALT)



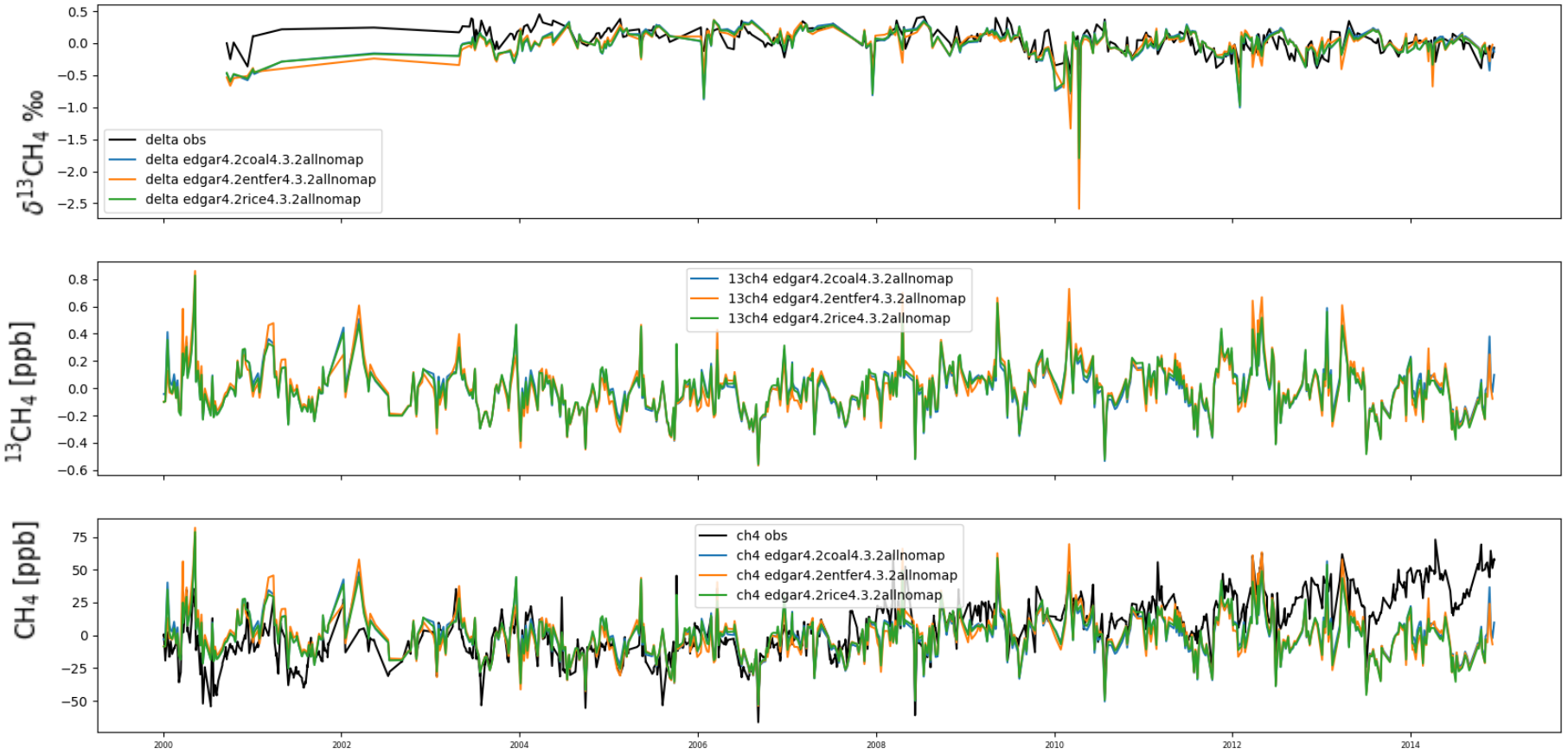
Compare runs with EDGAR4.3.2 component– detrended (NWR)



Compare runs EDGAR 4.3.2 vs 4.2 map/nomap–detrended– detrended (NWR)

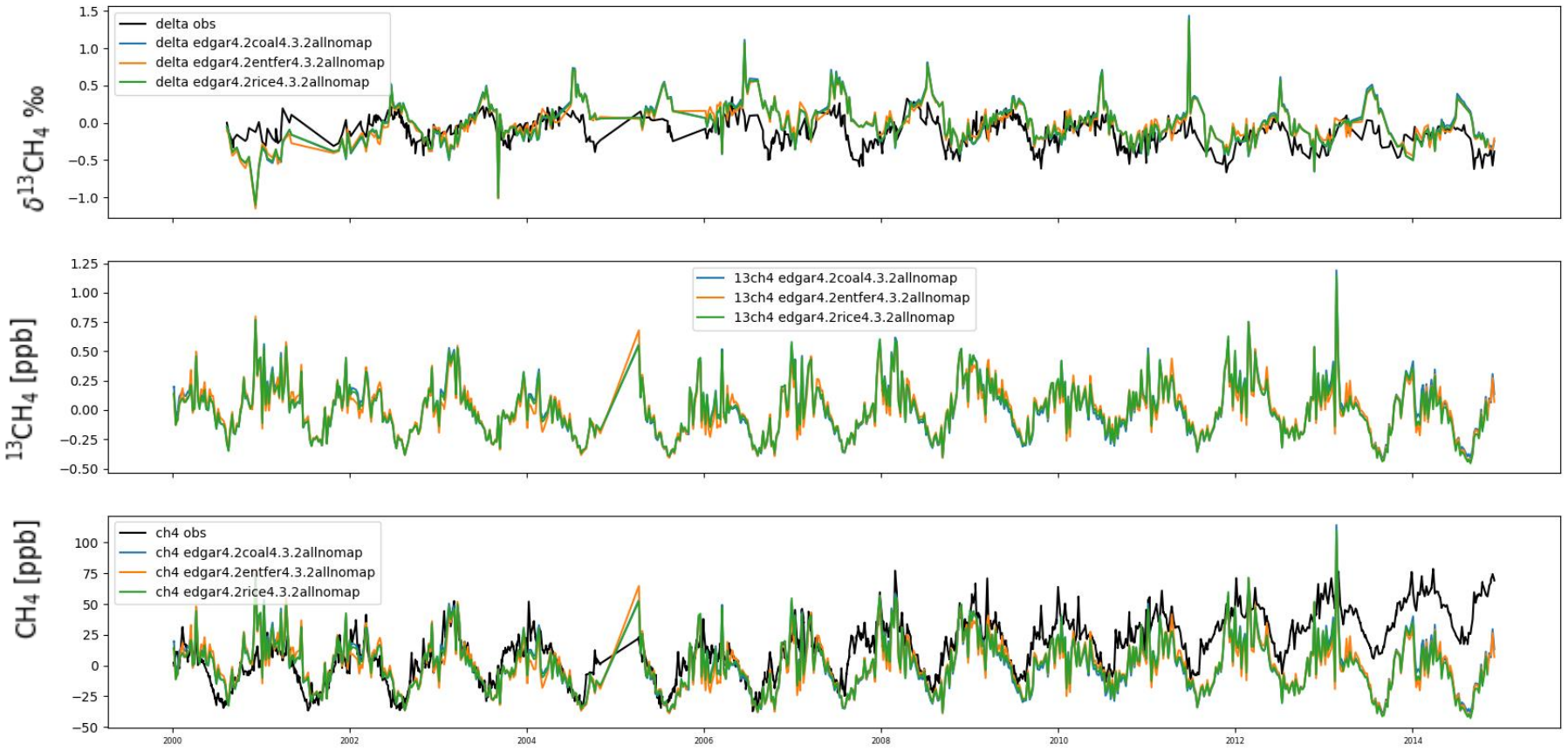


Compare runs with EDGAR4.3.2 component – detrended (MHD)

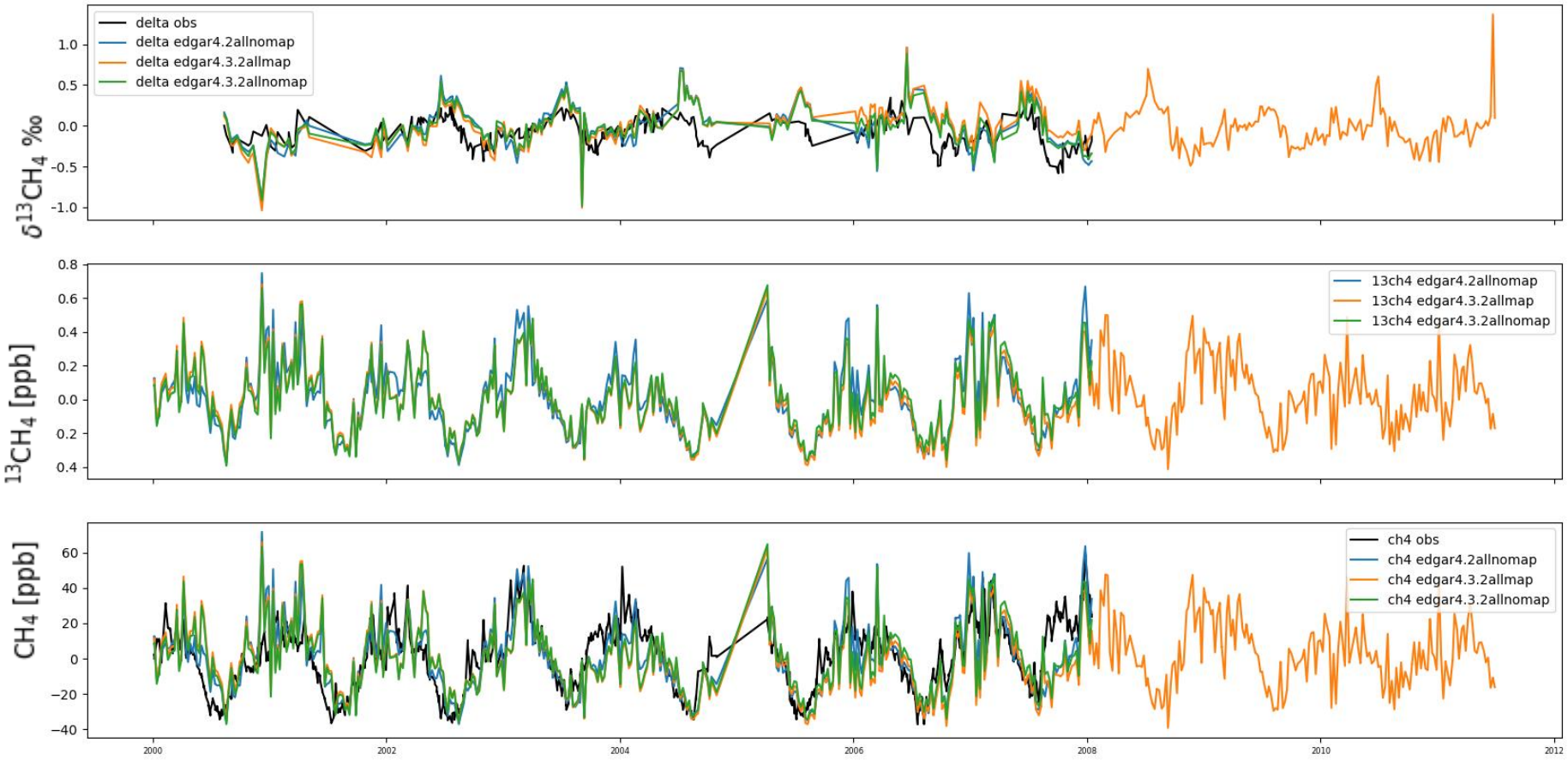


Compare runs EDGAR 4.3.2 vs 4.2 map/nomap–detrended– detrended (MHD)

Compare runs with EDGAR4.3.2 component– detrended (ALT



Compare runs EDGAR 4.3.2 vs 4.2 map/nomap–detrended (ALT)



Conclusions

- TM5 receives a balance after the spin-up, but the balance differs much from the observations
- Spin-up takes about 40 years
- Synthesis analysis:
  - Hard to say if signature maps have a big difference on results – further investigations
  - There is no single change that makes a great difference – all modifications affect only little
  - The effect of CH4 seasonal cycle to d13CH4 is found at some stations (e.g MHD)
    - Rather episodical, the effect can be more than 1 permille (approximate range of measurement error)

Future work

- Separating Cl and O^1D chemistry
- Adding communicating of CH_4 and $^{13}CH_4$ tracers
- Investigate how wetland emissions and atmospheric chemistry affects the seasonality of delta values
- Look for stations where edgar components are visible

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Thank you!

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