Reply to Comments by Referee #1

We thank the referee for constructive and helpful comments to improve our manuscript. We copy the comments in italic and red. In the responses, we also indicate the changes made in the manuscript (in blue font).

Overarching suggestions

- In the intro, you explain that some of the uncertainty in greenhouse gas budgets could be due to different inverse modeling methodology. However, you use one flavor of Bayesian inverse modeling in the paper (albeit with different atmospheric models and prior estimates). I think you could strengthen the intro by framing this discussion around uncertainties in transport and uncertainties due to the prior – topics that you actually explore in depth in the paper.

What we present in this paper is what we can see in the atmospheric CH_4 observations at our new Canadian Arctic measurement sites and how we can detect the regional CH_4 emissions with these new measurements given uncertainties in the inversion modelling framework used in this study. We have modified the introduction to state our objectives in this study more specifically. Detailed changes are explained in the following, as we answer to the specific comments.

- I would be careful with the references throughout the text. In some cases, the references feel incomplete (particularly in the introduction), or you cite a reference that either did not focus primarily on that particular topic or was not the first to develop the concept.

As we revised the manuscript, we replaced some references with more adequate ones and also added references. For example, we now refer methane emissions from permafrost to McGuire et al. (2009); Schuur et al.(2015); Thornton et al. (2016), instead of the IPCC report, Ciais et al (2013). Other changes are shown in our responses to the specific comments.

- Most of the text in the results and discussion is dedicated to discussing more technical or methodological issues related to atmospheric transport, the inverse modeling setup, etc. I think the most interesting scientific conclusions of this paper are buried in Sect.4.6.3 at the end of the results and discussion section. I would consider de-emphasizing some of the more methodological elements of the discussion and move the bigger science questions to a more prominent place. For example, you could pose the most important science questions at the end of the intro; that would give the reader an idea of what to expect. You could also move Sect. 4.6.3 to the beginning of the results and discussion and lengthen that section. You could also move the more methodological components of the discussion to the end and shorten that text.

This section [Relationship of fluxes with climate anomalies] is scientifically interesting regarding climate change, in this paper. Before we get to the point, we first need to understand the robustness and uncertainties of the estimated regional CH_4 fluxes. That is why we have conducted inversion experiments using multiple atmospheric models, prior fluxes, and sub-region masks. Furthermore, this paper aims to present the new observational data of atmospheric CH_4 in the Canadian Arctic and the inferred regional fluxes utilising the new atmospheric observations. We anticipate expanding this study to quantify a trend in CH_4 emissions as well as inter-annual variations in the Canadian Arctic with longer observational records in the future.

As suggested, we moved Section 4.6.3 forward (not to the beginning, but to Section 4.5) in Results and Discussions, after Section 4.4 (Comparison with previous estimates), where we mention the interanual variability of estimated fluxes, comparing with the results from CARVE. We lengthen this section (now Section 4.5) by adding the discussion on influence of prior fluxes. Note that the 3 different prior fluxes C1, C2 and C3 have been changed to the more descriptive names VIS, GEL and WetC following a specific comment. The previous Figure 12 is updated and shifted to Figure 11 to be consistent with the new modifications. These new names appear in the following:

4.5 Relationship of fluxes with climate anomalies

Inter-annual variations of estimated CH_4 fluxes are examined in relation to climate parameters here, specifically with surface air temperature and precipitation from NCEP reanalysis (Kalnay et al., 1996). First, monthly mean values at the sub-regions as well as the 4-year mean (2012-2015) for each month are calculated, then the monthly anomalies are computed from the monthly mean values and the 4-year mean of the corresponding month. The temperature and precipitation anomalies are aggregated to the respective regions, NT, YT and NU. On the regional level, climate anomalies in NT and NU are quite similar, though YT is less similar to NT and NU. YT is mainly covered by mountains with little wetland. Furthermore, NT has the largest wetland extent and most of the forest fire emissions in 2012-2015. Thus, we look into the correlation in monthly anomalies of CH_4 fluxes with summer climate anomalies in NT.

In Fig. 11, the inter-annual variability of wetland CH_4 fluxes exhibits a moderate positive correlation with the surface temperature anomaly (r = 0.55) and only weakly correlated with precipitation anomalies (r = 0.11). This indicates that the hotter summer weather condition stimulates the wetland CH_4 emission, and precipitation appears to have a less immediate or no direct impact on wetland conditions. In prior cases VIS and GEL, natural CH_4 fluxes (wetland and other fluxes except biomass burning CH_4 flux) are multi-year mean monthly fluxes. Therefore these prior fluxes have no year-to-year anomalies and no correlation with the meteorological anomalies. Only in WetC, the prior with wetland CH_4 fluxes from WetCHARTs ensemble mean exhibits inter-annual variations, the correlations with temperature and precipitation anomalies are r = 0.26 and r = 0.90 respectively. The posterior natural fluxes with WetC show slightly higher correlations (r=0.55 with temperature, r=0.16 with precipitation) than the mean correlation values. But overall there is no clear dependency of posterior correlations on the inherent climate anomaly correlations in the prior fluxes. This result indicates that the inter-annual variations in posterior wetland fluxes in this study are mainly determined by the observations, rather than by prior fluxes.

Inter-annual variations of estimated BB CH_4 fluxes show a negative correlation with precipitation (r = -0.41). Also throughout the fire season (June-September), all estimated BB fluxes negatively correlate with precipitation while the prior BB fluxes appear to have no consistent correlations. The inversion results support that dry condition would enhance the forest fire. The estimated BB fluxes show weakly negative correlation with surface temperature (r = -

0.23) on mid-summer average, but the monthly correlations are fluctuating from r = -0.40 to r = 0.47 over the fire season. Since the period is limited in this study (2012─2015), these statistical relationships are still not clear. Also, the relationship of CH_4 emissions with climate conditions could be complex and non-linear (with extreme fires events in some years). More data and analysis are required to characterise the dependence of CH_4 fluxes on climate in the Arctic.

Abstract:

- What provinces/territories or latitudes/longitudes do you define as the "Canadian Arctic"? That definition would help put the budget estimate in context.

We added latitude information (>60˚N, 60˚W─141˚W). Since the Canadian province and territories might not be familiar to some readers, it would be better to be introduced later, not in abstract.

- Abstract and throughout: The authors use the word "the" too often throughout the text. Some sentences would be smoother with fewer articles. For example, in line 9, "the regional CH4 flux" could be changed to "regional CH4 fluxes", and in line 10, "the recent observations" could be shortened to "recent observations." There are similar examples in most paragraphs of the manuscript.

We tried to omit "the' if it is not necessary in Abstract and throughout the manuscript to improve the readability.

Introduction:

- Pg. 2, lines 1-2: This sentence feels out of place. It does not summarize the content of the previous paragraph. Rather, it feels like the topic sentence of the paragraph starting in line 3.

We have moved the sentence to the next paragraph as a topic sentence, which is shown in the response to the next comment.

- Pg. 2, lines 3-24: I would restructure these paragraphs. In the first two paragraphs, you state several times that methane fluxes are uncertain and only provide detail in the third paragraph. I would condense these three paragraphs into one and provide specific numbers sooner in the text.

Following your comment, we have re-structured these paragraphs. Now the original third paragraph is the top and the first and second ones follow with modifications. Top sentence of the new first paragraph has been moved in from the immediate previous paragraph as answered to the previous comment:

The natural CH_4 flux estimates remain largely uncertain in higher northern. There have been many studies on CH_4 emission using bottom-up and top-down methods and Saunois et al. (2016) provide a thorough review of the different studies. In general, bottom-up flux estimates for the northern high latitudes from biogeochemical CH_4 models have large variations, and the mean estimate is much higher than top-down estimates from the inverse modelling (Saunois et al., 2016). For the Boreal North America region including Alaska and the Hudson Bay Lowlands (HBL, the second largest boreal wetland in the world), the bottom-up mean estimate is ~32 $TgCH_4\ yr^{-1}$, with a wide range from 15 to 60 TgCH_4 yr^{-1}. On the other hand, the top-down estimate is ~12 TgCH_4 yr^{-1} with a narrower range from ~7 to 21 TgCH_4 yr^{-1}.

Bottom-up estimates from wetland methane models in WETCHIMP show large discrepancies in the spatial distribution of wetland CH_4 source, as well as its magnitude (Melton et al., 2013). In the higher latitudes, the limited ground-based information has hindered the mapping of wetland. Recently, remote sensing has been providing more information, but the high-latitude wetland extent still has large uncertainties (Olefeldt et al., 2016;Thornton et al., 2016). In addition to uncertainty in wetland extent, other factors affecting high-latitude wetland emissions in different models still remain. A recent inter-comparison of CH_4 wetland models (Poulter et al., 2017) in which all models used the same wetland extent, Surface Water Microwave Product Series (SWAMPS) (Schroeder et al, 2015) with Global Lakes and Wetland Database (GLWD) (Lehner and Döll, 2004) and same meteorological data (CRU-NCEP v4.0 reconstructed climate data) to drive their models showed a range in estimated CH_4 emission for North American Boreal/Arctic region which remains larger than that for other regions in the world. This large range of the CH_4 emissions for North American Boreal/Arctic region indicates the uncertainty in our current understanding of physical and biogeochemical processes that contribute to wetland CH_4 emissions.

- Pg. 2, line 25: What do you mean here by "the fluxes"? Are you referring to Arctic methane fluxes or greenhouse gas fluxes more broadly? The studies cited in this paragraph are not all methane studies.

This paragraph initially gave a general description of top-down inversion, not being specified for CH4 studies. Then "the fluxes" mean greenhouse gas fluxes broadly. To be more specific to methane inversion studies, we have modified the paragraph as restructuring along with the previous paragraphs (as we answer to the overarching suggestions). This paragraph has been modified, also as responding to the following two specific comments. The references are modified accordingly:

Top-down atmospheric inverse models have been developed to infer the CH_4 fluxes with observed atmospheric CH_4 mixing ratios as constraint. Global CH_4 inversion studies estimate global distribution of emissions and sinks from sites around the world and/or space (e.g., Bousquet et al., 2006, 2011; Bergamschi et al., 2013; Bruhweiler et al, 2014), but with limitted observational infromation in higher northern latitudes. Recently ground-based observation coverage in high northern latitudes has been improving, including towers and aircraft measuerments (e. g., Karion et al. 2016; Sasakawa et al 2010.; Chang et at., 2014). These observations have been used for CH_4 flux estimation in specific regions. For North America, previous atmospehric CH_4 studies were mainly foucued on Alaska (e.g., Miller et al., 2016; Hartery et al. 2018). Thompson et al., (2017) conducted CH_4 flux estiamte for entire region north of 50˚N, combining recent high-latitude surface observations. Estimated CH_4 emissions for the Canadian Arcitc show disctipancies among the inverse studies; the mean total CH_4 emission (2006-2010) is ~1.8 TgCH_4 by TM5-4DVAR (Bergamschi et al., 2013), 0.5 TgCH_4 by CarbonTracker-CH_4 (Bruhweiler et al, 2014), and 2.1 TgCH_4 by FLEXINVERT (Thompson et al., 2017). Differences including model transports, prior fluxes and observational datasets could affect the inversion results. The previous CH_4 inversion studies used only Alert in the Canadian Arctic, the most northern site in the world. Several new sites in the Canadian Arctic (described in the next paragraph) might be helpful in constraining flux estimation.

- Pg. 2, line 26: 4Dvar, Kalman filter, and geostatistical studies are all Bayesian.

Yes, all of them are variations of Bayesian inversion. We do not intend to explore the details of different inversion schemes (as we used only one type of Bayesian scheme). As seen in our response to the previous comment, we have removed these detailed technical terms from the revised text.

- Pg. 2, lines 30-31: Can you provide references for this statement? Also, can you be more specific about how these differences have affected inverse modeling results in the past? What implications might those differences have for your study (i.e., for estimating Arctic methane)?

This statement listed some of the possible sources of uncertainties in inversion results. We agree it is too general to be informative and it has been deleted in the revision.

- Overall, the introduction includes a lot of broad, brush-stroke statements that sometimes lack specifics, and it is not always clear how these statements concretely relate to the present study. I think you could strengthen the introduction two ways: (1) provide more specific information to illustrate how uncertain or challenging these scientific questions are, and (2) Discuss why these uncertainties are particularly relevant to the present study or to understanding greenhouse gas fluxes from the Arctic.

As we answer in the next comment, we have modified the last two paragraphs to state more specifically what are challenging for estimating the Arctic greenhouse gas fluxes and our monitoring effort, as narrowing down to what we present in this study.

- Pg. 3, lines 7-12: I think it would be stronger to frame this study around specific scientific questions instead of framing the study around presenting and analyzing observations.

The last paragraph in the Introduction has been revised to focus more on the scientific questions as follows:

This is the first study to analyse the atmospheric CH_4 mixing ratios from the above new ECCC observation sites in the Canadian Arctic region. In this study, we address three key questions: (1) what can the new measurements see from local and regional sources? (2) what are the estimated CH_4 fluxes in the Canadian Arctic from inverse modelling using these new measurements? and (3) are there any relationship for the Canadian Arctic CH_4 fluxes with climate/environmental variations? This paper is structured as follows: In Section 2, the description of the measurement stations as well as the observational data analyses from daily to inter-annual time scales are given. Section 3 describes the inversion model framework, and Section 4 presents flux estimates and discusses the flux uncertainties and relationship to climate anomalies.

Measurements:

- Sect. 2.2: Some of this analysis might be a better fit for a results and discussion section than a methods section. Furthermore, it seems like the main conclusions of this paper center around the inverse modeling results. Hence, I think some of this detail could go into a supplement.

Since this is the first paper to analyse these new measurement data, we thought it is better to present the data analyses in the main text in a (mostly) self-contained section (for readers with more interest on the data characteristics than inversion results). We do show some analysis of the observed data with the model results in Section 4.2 [Signals in the observations (relative to the background)] where it is more appropriate.

Model description

- Sect. 3 title: Can you be more specific about which model you are referring to? The atmospheric transport model, the inverse model, or both?

The title is changed to 'Regional inversion model description'. We hope this is clearer as the atmospheric transport model (Section 3.1) is one component of the regional inverse model. We used different combinations of atmospheric transport model and atmospheric forcing data to help estimate the transport uncertainties in the inversion results.

- Pg. 7, line 13: I think the number of days required really depends upon the size of the domain and the geographic extent of the influence footprint.

Yes. Particle traveling time and size of domain of the interest are related. Bigger space/domain need more time (for the air particles to travel over). As seen in Figure 6, the 5-day footprint cover the Canadian Arctic, the domain of our interest and the location of the particles after 5 days are mostly outside the Canadian Arctic. Furthermore most synoptic-scale variations in the CH_4 mixing ratios at measurement sites are sufficiently explained by footprints within 2-5 days after particles are released.

- Pg. 7, line 24: Are you referring to a "model setting" or a "model setup"?

Since we describe the combinations of transport models and meteorological data that we used to obtain footprints, "model setup" would be more suitable than "model setting". We have replaced "model setting" with "model setup" here and other occurrences.

- Sect. 3.2: I think it would be helpful to have more descriptive flux model names than "C1", "C2", and "C3".

Each flux scenario consists of some different fluxes, but some common fluxes. The distinctive features are wetland CH_4 fluxes. To reflect the differences in Wetland CH_4 emission, we modified C1, C2 and C3 to VIS, GEL and WetC, respectively, as follows:

From C1 to VIS : VISIT CH4 wetland model,
From C2 to GEL : optimised fluxes by GELCA-CH_4 inversion
From C3 to WetC : WetCHARTs

- Sect. 3.2: Somewhere in the text, it could be useful to include a sentence that explains why you chose these three particular prior models.

We chose the first two cases of prior fluxes since the background atmospheric CH_4 fields is calculated by a global model NIES-TM with GELCA-CH_4 optimised fluxes. However, these fluxes are averaged to be cyclo-stationary (climatological). WetCHARTs provides inter-annually varying wetland CH_4 fluxes for the study period. CH_4 emissions of WetCHARTs are driven by environmental parameters, including satellite-based wetland extent.

The first paragraph of Section.3.2 has been revised as follows:

Three cases of prior emissions, VIS, GEL and WetC, were used as listed in Table 2. Since the global background atmospheric CH_4 field is calculated with GELCA-CH_4 inversion posterior fluxes, we chose the prior (VIS) and posterior (GEL) fluxes from the GELCA global inversion as two cases of prior fluxes in our regional inversion, respectively. Note that the continuous CH_4 mixing ratio data from the new Canadian Arctic sites were not used in the GELCA-CH_4 inversion. In this study, the mean wetland fluxes for the last 5 years of the GELCA global model were used, the prior forest fire CH_4 fluxes are detailed in Section 3.2.2. The third prior case (WetC) is the same as GEL, but with wetland CH_4 fluxes from WetCHARTs (a recent global wetland methane emission model ensemble for use in atmospheric chemical transport models). WetCHARTs provide inter-annually varying monthly wetland CH_4 fluxes for this study period. The details of prior fluxes are described in the following sections

- Pg. 10, lines 22-23: How did you decide on these values of sigma?

The sigma value for prior uncertainty, σ_{prior}=0.30, is from the uncertainty in the CH_4 emission used in Zhao et al. (2009). The prior model-mismatch, σ_e=0.33, is comparable to those used in previous regional inversion studies (e.g., Gerbig et al., 2013; Lin et al., 2004, Zhao et al., 2009), which considered different error components such as wind field, aggregation, and background CH_4 mixing ratio. We examined the sensitivity to these sigma values as explained in the next comment/response.

We have added the references for these sigma values in the revised manuscript.

- Pg. 10, line 24: What do you mean by "not strongly dependent"? Can you be more specific?

We have added more details to clarify lines 23-24:

We examined the inversion's sensitivity to these uncertainties by doubling their values. The posterior fluxes changed by less than 5% for all sub-regions (and the different sub-region masks). The results showed the optimised fluxes are not strongly dependent on these prescribed uncertainties.

- Eq. 2: Lin et al. 2004 did not derive this equation and are not the first ones to use it. Instead, I would cite a textbook by Rodgers, Tarantola, or Enting.

It is true that Lin et al. (2004) did not introduce this equation. We have added three textbooks as references for the Bayesian inversion approach at the beginning of the section: Tarantola (1987), Rodgers (2000) and Enting (2002). They collectively cover the basic concept and equations of Bayesian inversion and its applications of atmospheric greenhouse gases. We have removed the reference Lin et al.(2004).

- Pg. 11, line 7: The inverse model does not necessarily need to provide a perfect constraint on every region. Many modern inverse modeling studies estimate fluxes at model grid scale, even though the observations may not constrain each model grid box. If the observations do not provide a robust constraint at a particular location or time, the inverse modeling estimate will be guided by the prior estimate and the structure of the covariance matrix D_prior.

Yes, we do agree that it is possible to estimate fluxes for sub-regions not well constrained by observations, by using the additional information in the '*prior estimate and the structure of the covariance matrix D_prior*'. Given all the constraints, the estimated fluxes are still susceptible to (unaccounted for) errors such as model transport biases, non-Gaussian error distributions and other problems. In this study, we found that the weak flux region (Yukon) could not be robustly constrained (fluctuating from positive to negative fluxes). Hence, we explored different sub-region masks to test the robustness of the inversion results. We have clarified the statement with an addition as follows:

From:

The inversion results in the next section will show YT could not be reliably constrained as a separate sub-region.

To:

The inversion results in the next section will show YT could not be reliably constrained as a separate sub-region (model uncertainties made the estimated fluxes in YT fluctuate from positive to negative).

- Pg. 11, line 15: I think it would be useful to include one sentence explaining why you process the observations in this way.

We have added an explanation of the afternoon mean values:

First, the afternoon mean values are calculated by averaging the hourly data over 4 hours from 12:00 to 16:00 local time so that the observations we use in this study are more regionally representative assuming mid-day is in well-mixed planetary boundary layer. Second, the modelled background mixing ratio, which were described earlier, are subtracted from the afternoon means.

Results and discussion

- Sect. 4.1: Why do you think the footprints are different, and is there one you think is better or more robust than another?

The footprints are dependent on the meteorological fields, parametrized dispersions, etc. Thus the 'quality' or 'goodness' of the footprints could vary with time and place (as a function of the 'quality' of the meteorological forcings and dispersion model parametrizations, etc.). In the Canadian Arctic (particularly in summer), we found that for spatially distributed and slow varying fluxes like wetland CH4, the results are less sensitivity to the transport model difference, but fast varying and point like sources like biomass burning are quite sensitive to the model transport differences. Since it is difficult to separate the errors in transport and errors in emissions when comparing modelled and observed mixing ratios, we are mainly using the different transport models to provide an estimate of transport uncertainties in the inversion results.

- Sect. 4.2: I don't think this information is essential to the paper – if you're looking to trim the text at all. Presumably, this information should also be reflected in the posterior uncertainties of the inverse model.

We think this section could be informative for the general reader (not all working on inversion modelling). It provides an evaluation of the amount of the regional CH_4 signals in the model compared to the 'background' and an explanation on the relatively larger percentage error in the winter inversion results compared to the summer. Thus, Section 4.2 is potentially useful, we have decided to keep this section.

- Pg. 13, line 1: The word "significant" is often shorthand for "statistically significant." If you used a statistical test, I would clarify here with a p-value. If not, I would pick a different word than "significant" because that word may have specific meaning to many readers.

We have changed "significant" to "noticeable'.

- Sect. 4.6.1: This result seems unsurprising to me. The inverse model includes several observing stations and more observations than unknowns. As a result, the prior and the covariance matrices do not need to do much "work" in the inverse model. I suspect that one would get similar estimates using a linear regression to estimate the scaling factors.

It seems that our inversion results are not sensitivity to +/- 50% change in prior emission due to having sufficient regional signals compared to the background conditions. The summertime regional signals in atmospheric CH_4 is strong enough to infer regional fluxes, as we show in Section 4.2 [Signals in the observations (relative to background)]. In this section, we are trying to demonstrate that the results appear robust. We do agree that a 'linear regression estimate to the scaling factors' should work in this case. Given the strong observational constraints, the prior constraint term is likely not important.

Summary:

- The summary feels like an extended abstract. It also repeats the description of some of the methodology. You might consider changing this section to a conclusions section and instead contextualize the results, discuss the possible implications of these results, and potentially make recommendations for future monitoring efforts in the North American or Canadian Arctic.

We have changed the section title from summary to conclusions. We have also shortened the texts of the results, but stated more on a future direction and the implication of the study results as follows:

5 Conclusions

The Canadian Arctic region is one of the potential enhanced CH_4 source regions related to the ongoing global warming (AMAP, 2015), and earth system models differ in their prediction how the carbon loss there will be split up between CO_2 and CH_4 emissions. Even current bottom-up and top-down estimates of the CH_4 flux in the region vary widely. This study:

1) analysed the measurements of atmospheric CH4 mixing ratios that include 5 sites established in the Canadian Arctic by ECCC, to characterise the observed variations and examine the detectability of regional fluxes.

And,

2) estimated the regional fluxes for 4 years (2012–2015) with the continuous observational data of atmospheric CH_4, and also the relationship of the estimated fluxes with the climate anomalies.

The observational data analysis reveals large synoptic summertime signals in the atmospheric CH_4, indicating strong regional fluxes (most likely wetland and biomass burning CH_4 emissions) around Behchoko and Inuvik in Northwest Territory, the western Canadian Arctic. The local signals of atmospheric CH_4 also allow inverse models to optimise biomass burning CH_4 flux (emissions due to forest fire), separately from the remaining/natural CH_4 fluxes (including wetland, soil sink and anthropogenic, but mostly due to wetland CH_4 emissions).

The estimated mean total CH_4 annual flux for the Canadian Arctic is 1.8 ± 0.6 $TgCH_4$ yr^{-1} (wetland flux is 1.5 ± 0.5 $TgCH_4$ yr^{-1}, biomass burning flux 0.3 ± 0.1 $TgCH_4$ yr^{-1}). The mean total flux in this study is comparable to another regional flux inversion result of 2.14 $TgCH_4$ yr^{-1} by Thompson et al. (2017), but much higher than the global inversion result of 0.5 $TgCH_4$ yr^{-1} by CarbonTracker-CH_4 (Bruhwiler et al., 2014). The strong regional CH_4 signals at INU and BCK appear to yield flux estimates in this study with narrower high summer emission period and lower wintertime wetland emission compared with the estimates by Thompson et al. (2017).

Clear inter-annual variability is found in all the estimated summertime natural CH_4 fluxes for the Canadian Arctic, mostly due to Northwest Territories. These summertime flux variations are positively correlated with the surface temperature anomaly ($r = 0.55$). This result indicates that the hotter summer weather condition stimulates the wetland CH_4 emission.

With longer data records and more analysis in the Arctic, inversion CH_4 flux estimates could yield more details on CH_4 emission strength and seasonal cycle (onset and termination of wetland emissions), and dependence of wetland fluxes on climate conditions. More knowledge on the flux and climate relationship could help evaluate and improve bottom-up wetland CH_4 flux models.

Next, we will perform a similar study for the CO_2 measurements from these sites to estimate the Canadian Arctic CO_2 fluxes. Estimation of CO_2 and CH_4 fluxes and monitoring how these fluxes change in the future will improve our understanding on the response of the Arctic carbon cycle to climate change, and also yield long-term trends in CO_2 and CH_4 emissions in the Canadian Arctic.