A new window on Arctic greenhouse gases:

Continuous atmospheric observations from Ambarchik on the Arctic coast in North-Eastern Siberia

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AMB
Atmospheric Carbon Observation Station Ambarchik

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Why monitor CO_2 and CH_4 in the Arctic?

Huge carbon reservoirs

\+ Warming

= Risk of degradation

→ Positive feedback to global warming? [1,2,3,4]

→ Need to understand Arctic carbon cycle in changing climate

[1] Hugelius et al. 2014, [2] James et al. 2016, [3] Schuur et al. 2013, [4] Schuur et al. 2015

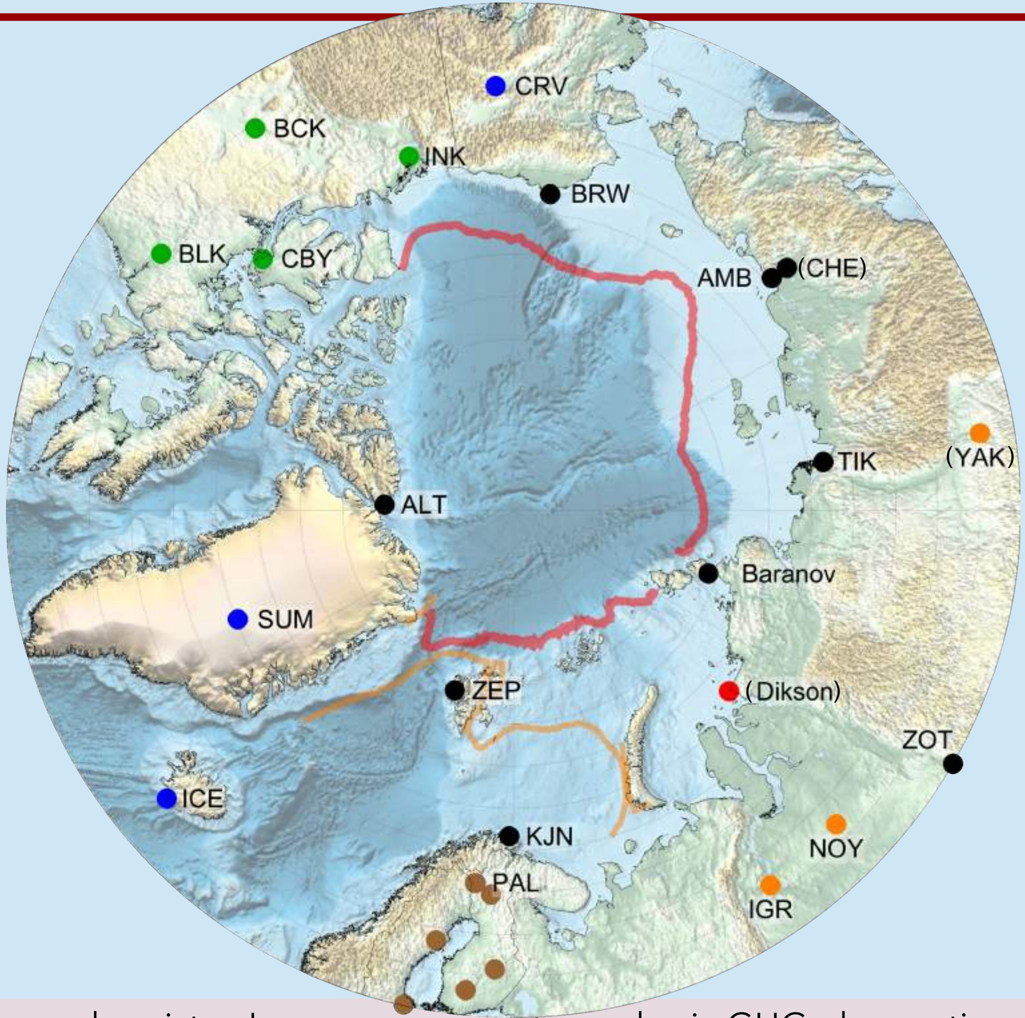
Arctic net carbon budgets are highly uncertain

- Arctic CO_2 budget: -110 (-291 … +80) Tg C yr^{-1} [5]
- East Siberian Arctic Shelf CH_4: 0 … 17 Tg CH_4 yr^{-1} [6,7,8]
- …

[5] McGuire et al. 2012, [6] Shakhova et al. 2013, [7] Berchet et al. 2016, [8] Thornton et al. 2016

We don't have enough data...

Continuous in-situ monitoring of atmospheric CO_2 and CH_4:



Low network density in East Siberia
→ Need more data! [9]

[9] Belshe et al. 2013

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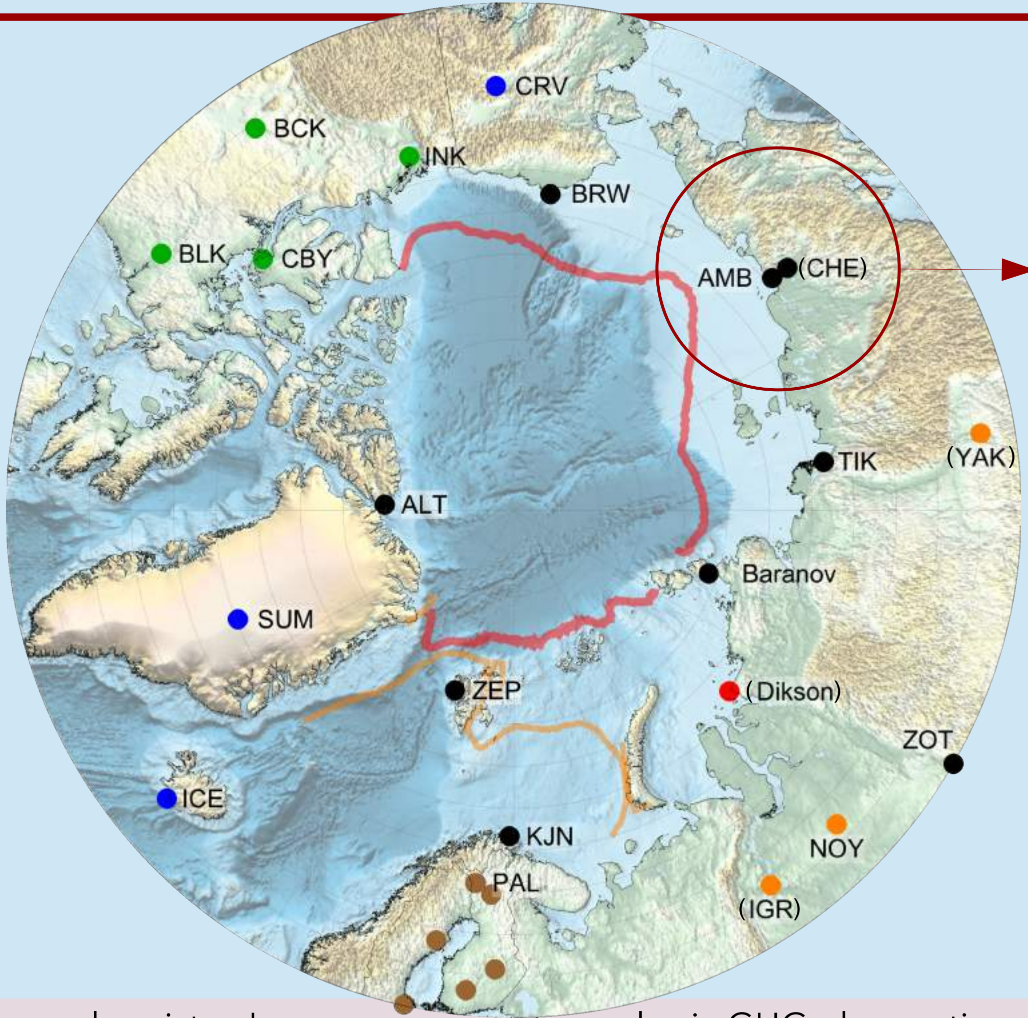

AMB = Ambarchik

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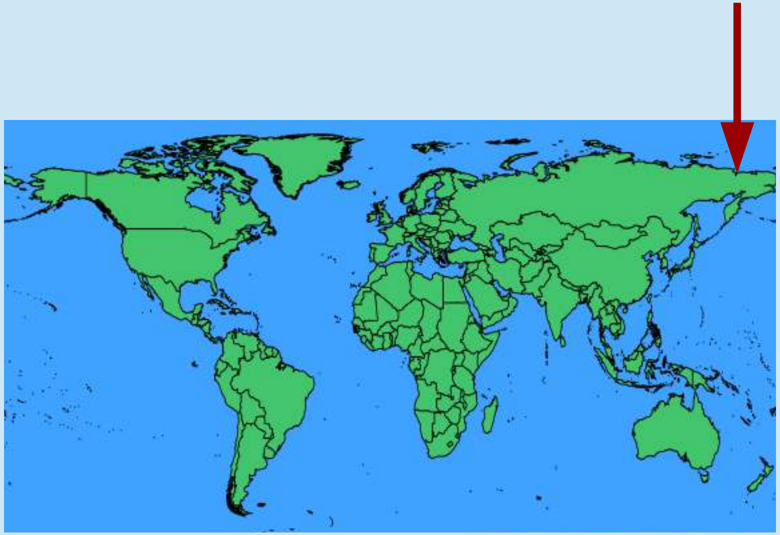
Ambarchik station location



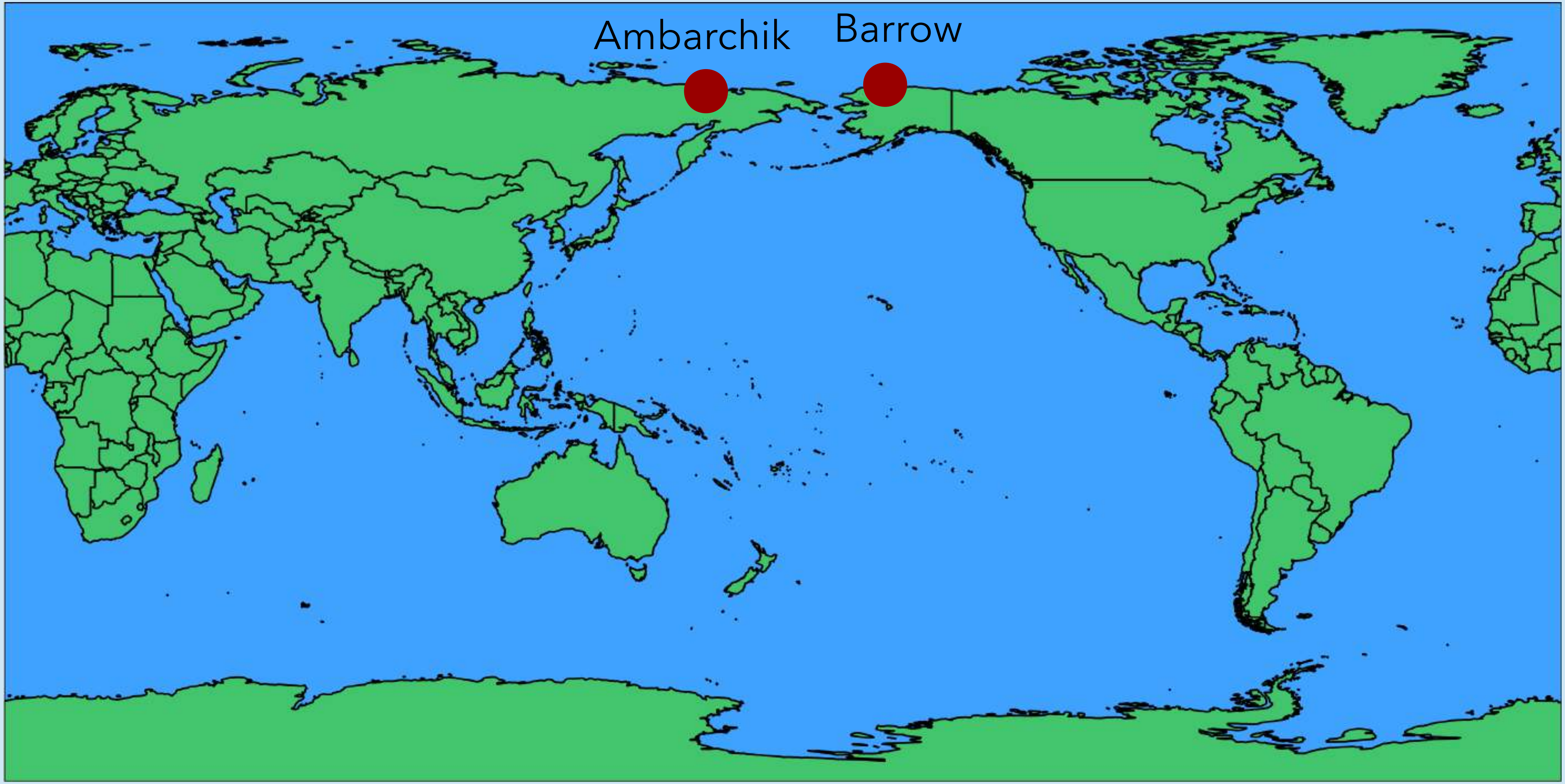
Ambarchik Instrumentation

- Air sampling: 27magl, 14magl
- Picarro G2301 (CO_2, CH_4, H_2O)
- Calibration traced to WMO scales
- Meteorology

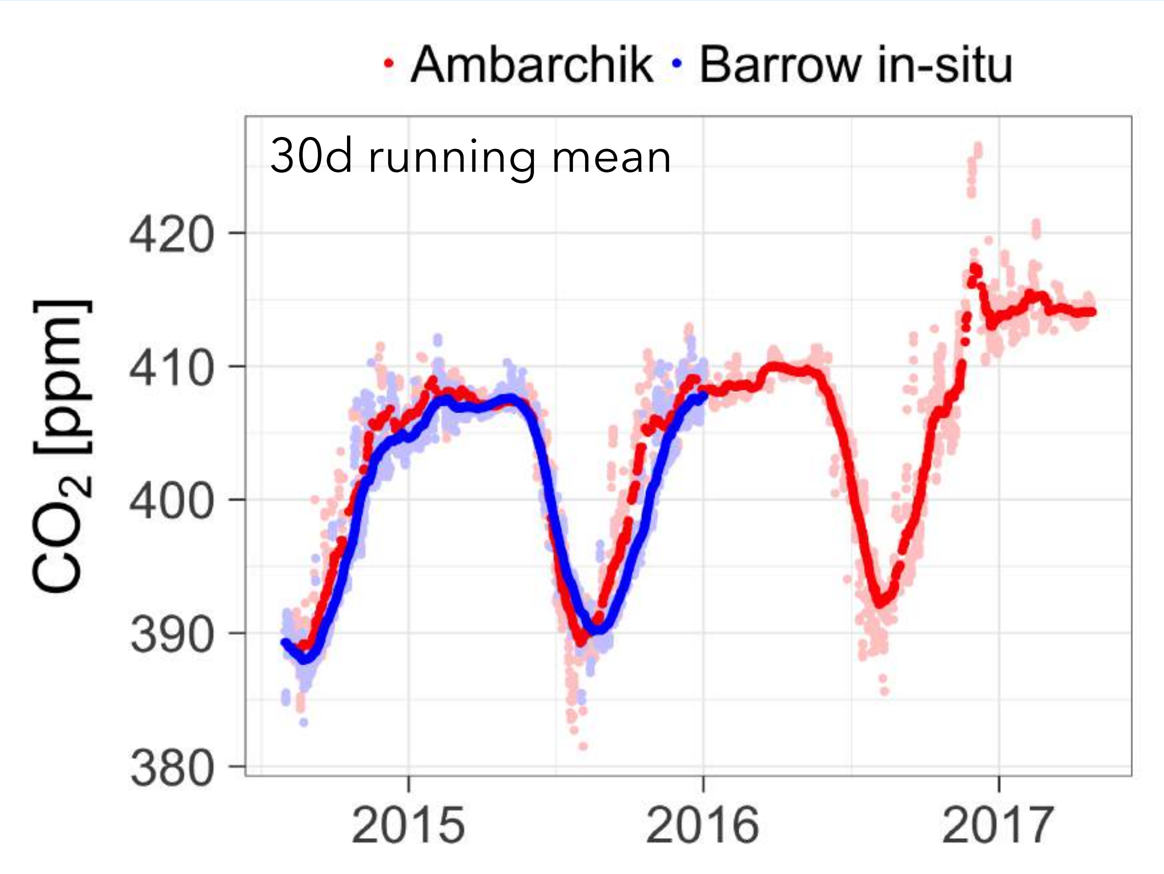
Courtesy Luke Griswold-Tergis

Courtesy Martin Hertel

Ambarchik vs. Barrow, Alaska



Ambarchik vs. Barrow, Alaska – CO_2

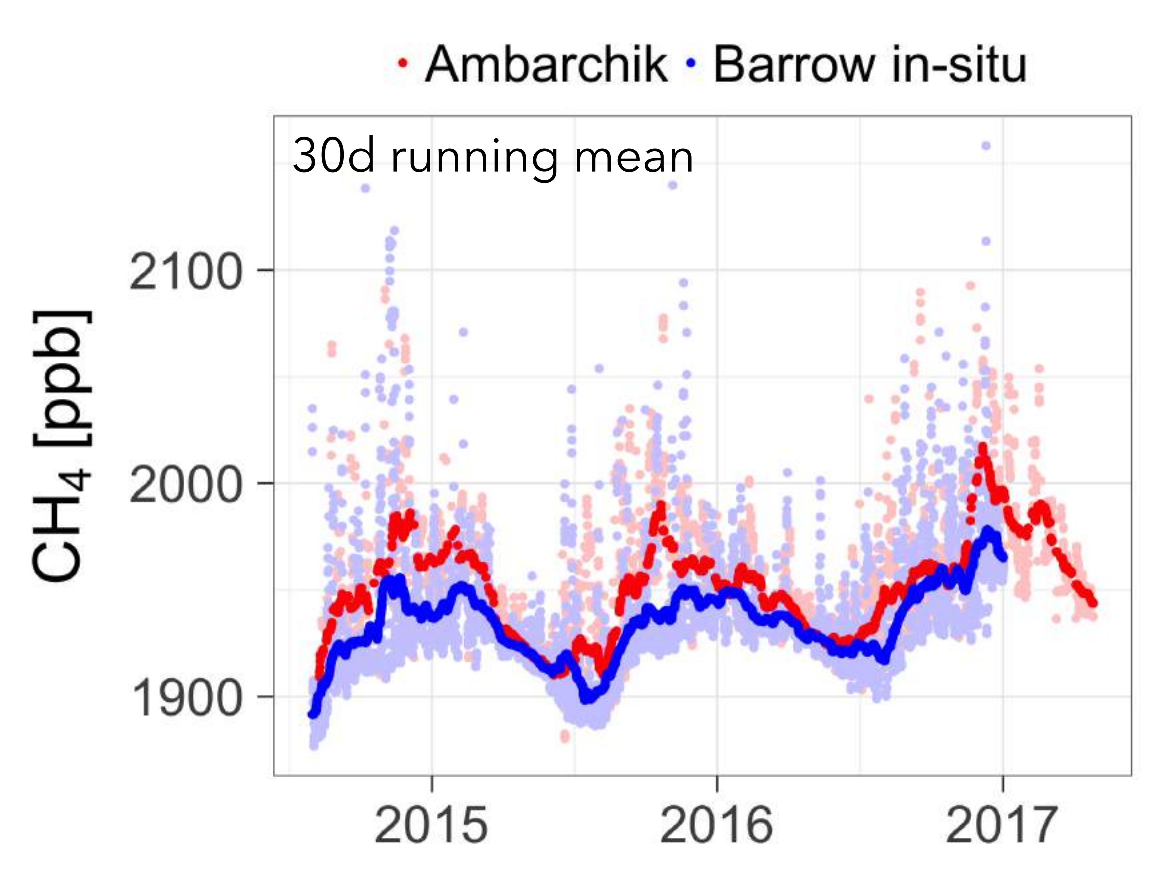


CO_2 in Ambarchik, compared to Barrow (2015):

- Earlier, lower summer CO_2 minimum
- Earlier CO_2 rise and variability in fall

→ Stronger local/regional fluxes

Ambarchik vs. Barrow, Alaska – CH_4



CH_4 in Ambarchik, compared to Barrow:

- Matching background mole fractions in spring
- More activity in winter

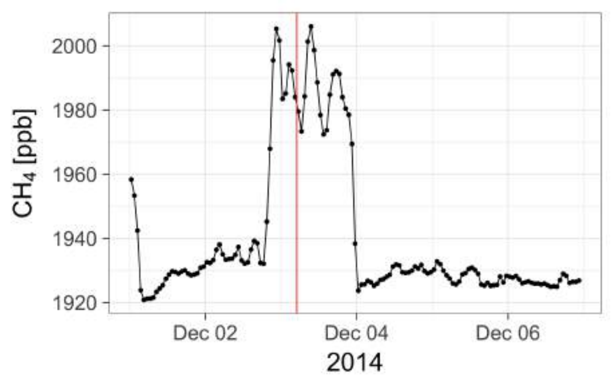
→ Indicates wetland cold season emissions (zero curtain, burst during onset of freezing) [10,11]

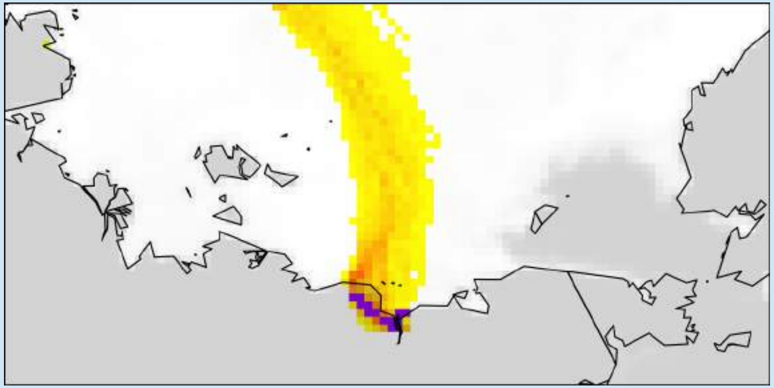
[10] Mastepanov et al. 2008, [11] Zona et al. 2016

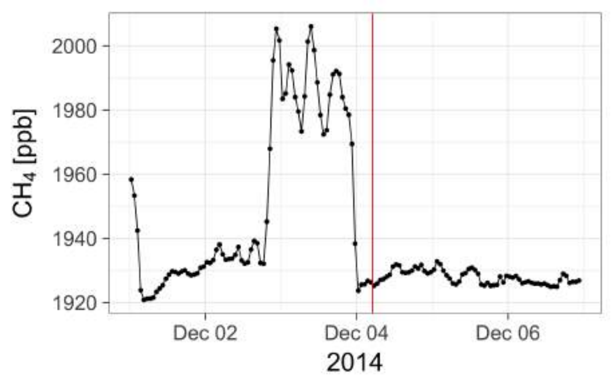
Case study: Winter CH_4 signal from Tundra

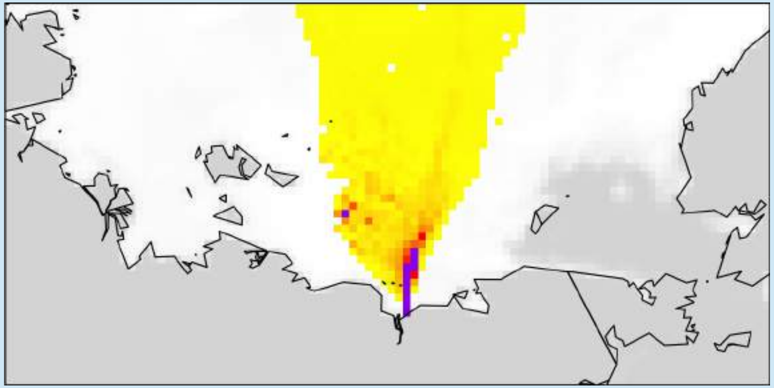
Ambarchik CH_4

WRF-STILT footprint [12]





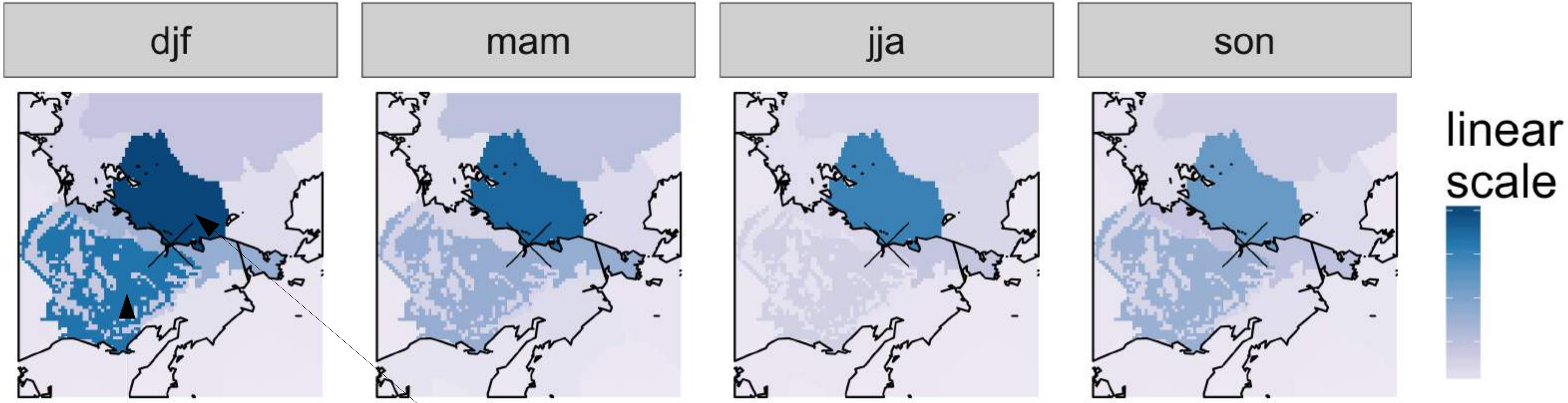




[12] Henderson et al. 2015

Which regions does Ambarchik see?

- 1.5 years of cumulative footprints (WRF-STILT [12]):



Northeast Siberian Taiga

East Siberian Sea

→ Ambarchik is useful for constraining oceanic and terrestrial carbon budgets!

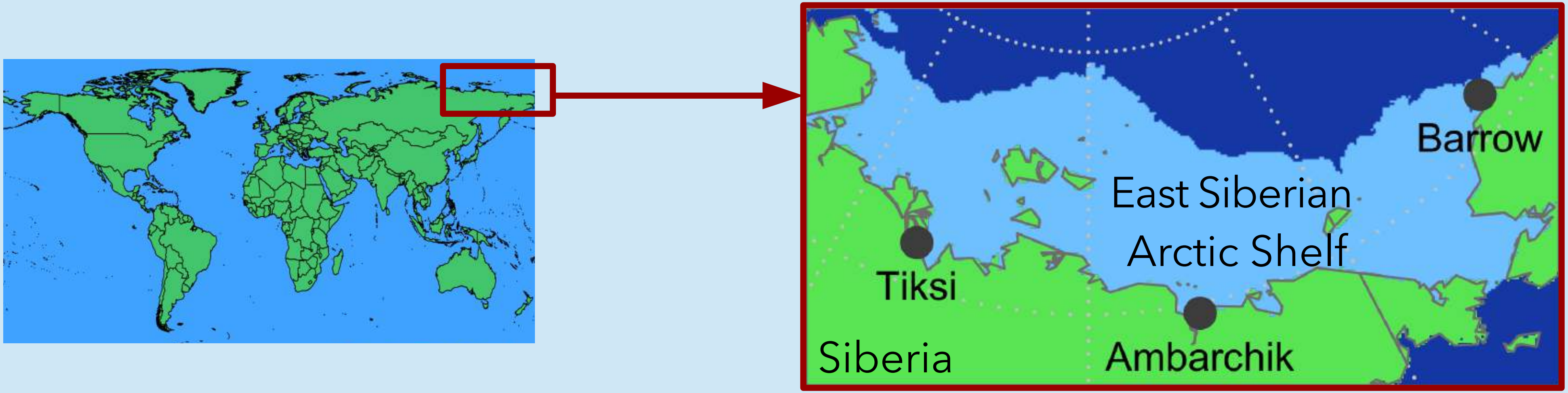
[12] Henderson et al. 2015

Application of Ambarchik data

Inverse model of Methane Emissions from the East Siberian Arctic Shelf

East Siberian Arctic Shelf methane emissions

- Large carbon deposits
- Methane budget highly uncertain: 0 … 17 Tg CH_4 yr^{-1} [6,7,8]



[6] Shakhova et al. 2013, [7] Berchet et al. 2016, [8] Thornton et al. 2016

East Siberian Arctic Shelf methane emissions

- Methods:
  - Geostatistical Bayesian Inverse Model [13,14]
  - Atmospheric data: Tiksi, Ambarchik, Barrow
  - Atmospheric transport: WRF-STILT [12]
  - Prior information: sea-ice cover, wind speed, …

[12] Henderson et al. 2015, [13] Michalak et al. 2004, [14] Miller et al. 2014

East Siberian Arctic Shelf methane emissions

- Preliminary result:
  - Annual CH_4 budget at lower end of literature estimates
- Work in progress:
  - Ability of station network to detect shelf CH_4 emissions

Summary

AMB
Atmospheric Carbon Observation Station Ambarchik

- Ambarchik: In-situ CO_2 and CH_4 monitoring in Northeast Siberia since 8/2014
- Useful for inverse modeling of Arctic and Siberian GHG budgets
- Data will be made public
- Strong wetland CH_4 signals in fall and winter
- Low CH_4 emissions from the East Siberian Arctic Shelf


Courtesy Luke Griswold-Tergis

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