Atmospheric observations of Arctic Ocean methane emissions up to 82° north

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Objectives:

- This study was designed to enhance understanding of present Arctic CH_4 emissions through airborne observations of methane to quantitatively assess methane efflux from the remote Arctic Ocean up to latitudes of 82° north.
- To assess the source of the CH_4 emissions, carbon monoxide (CO), water vapor (H_2O) and ozone (O_3) were measured concurrently with methane.

New Science:

- The study finds layers of increased CH_4 concentrations near the surface ocean over the remote Arctic Ocean, with little or no enhancement of carbon monoxide levels. This indicates a non-combustion source of the methane.
- The increased levels of methane are restricted to areas over open leads and regions with fractional sea-ice cover.
- The increased levels of methane were strongly correlated with high H_2O in autumn, and were highest over the ice leads, clearly pointing to the leads as the source. In spring, sea-ice acts as a strong sink to water vapor, eliminating the correlation.
- In spring, a strong correlation with ozone depletion events, with maximum CH_4 seen at lowest altitudes, again indicating emissions from the surface ocean proximate to sea ice.
- On flight dates with most solid sea-ice coverage, emissions of methane over ocean water were weak to non-existent.
- The findings suggest that surface waters of the Arctic Ocean, particularly at edges of sea-ice and sea-ice leads, represent a potentially important source of methane, and that this methane source could prove sensitive to changes in sea-ice cover.

Significance:

- Methane is the second most important human-influenced greenhouse gas after carbon dioxide.
- Uncertainty in the future atmospheric burden of CH_4 represents an important challenge to the development of realistic climate projections.
- The Arctic holds potentially vulnerable sources of methane, which may be affected by and may influence climate change.
- Known sources of methane in from the Arctic include thermokarst lakes, bursts of CH_4 during freezing of tundra, degradation of subsea permafrost on the eastern Siberian shelf, biological generation in ocean waters, and seasonal flux of wetlands emissions.
- Assessment of present CH_4 emissions over remote Arctic waters will expand understanding of the Arctic CH_4 status in terms of magnitude, distribution and potential response to global climate change.
- The finding of increased methane over sea-ice leads and edges points to potential sensitivity of methane efflux to the state of sea-ice, providing a previously unrecognized feedback to global climate.

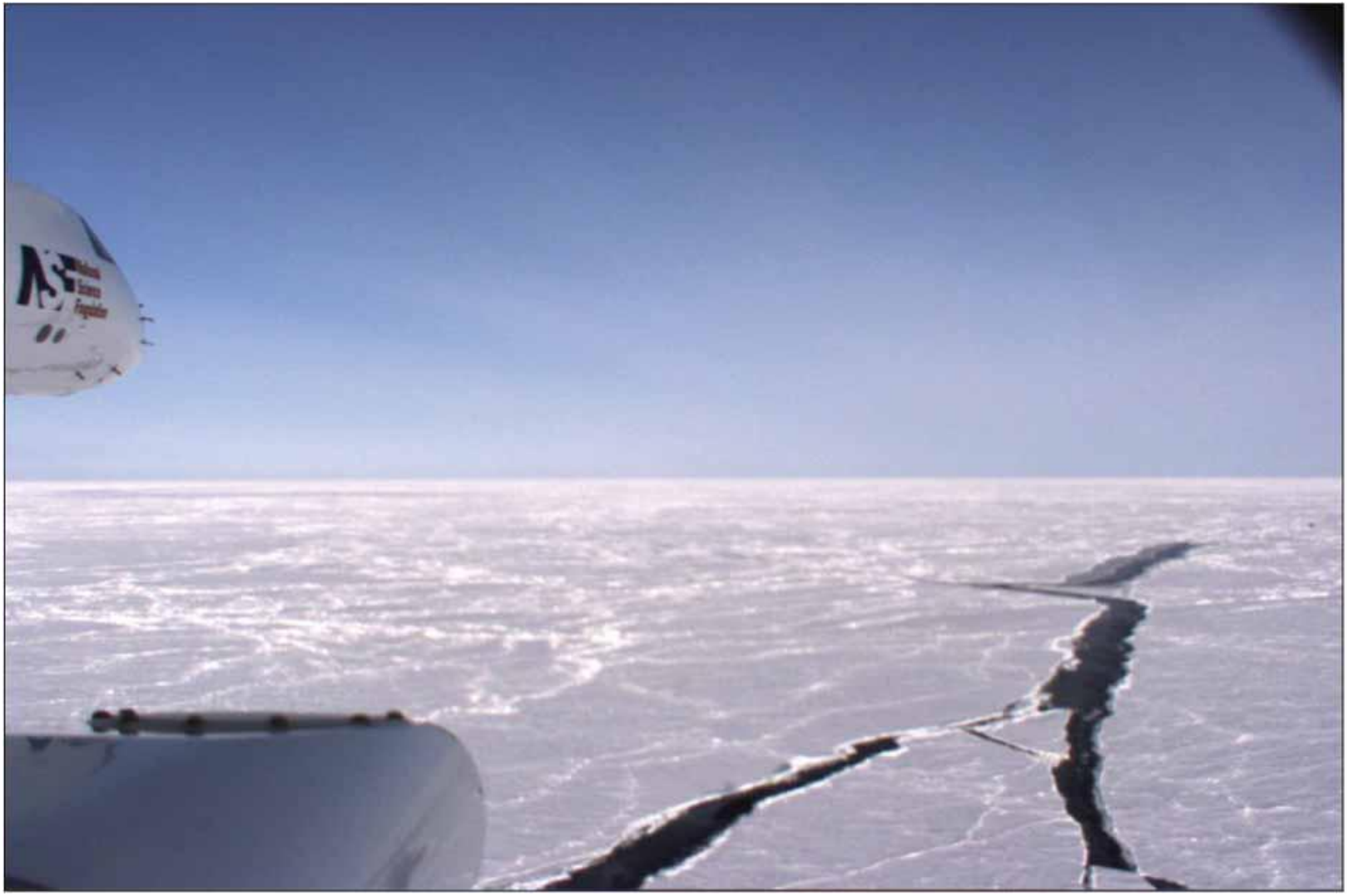

Photo by NCAR Earth Observing Laboratory under the sponsorship of NSF (**http://data.eol.ucar.edu**).

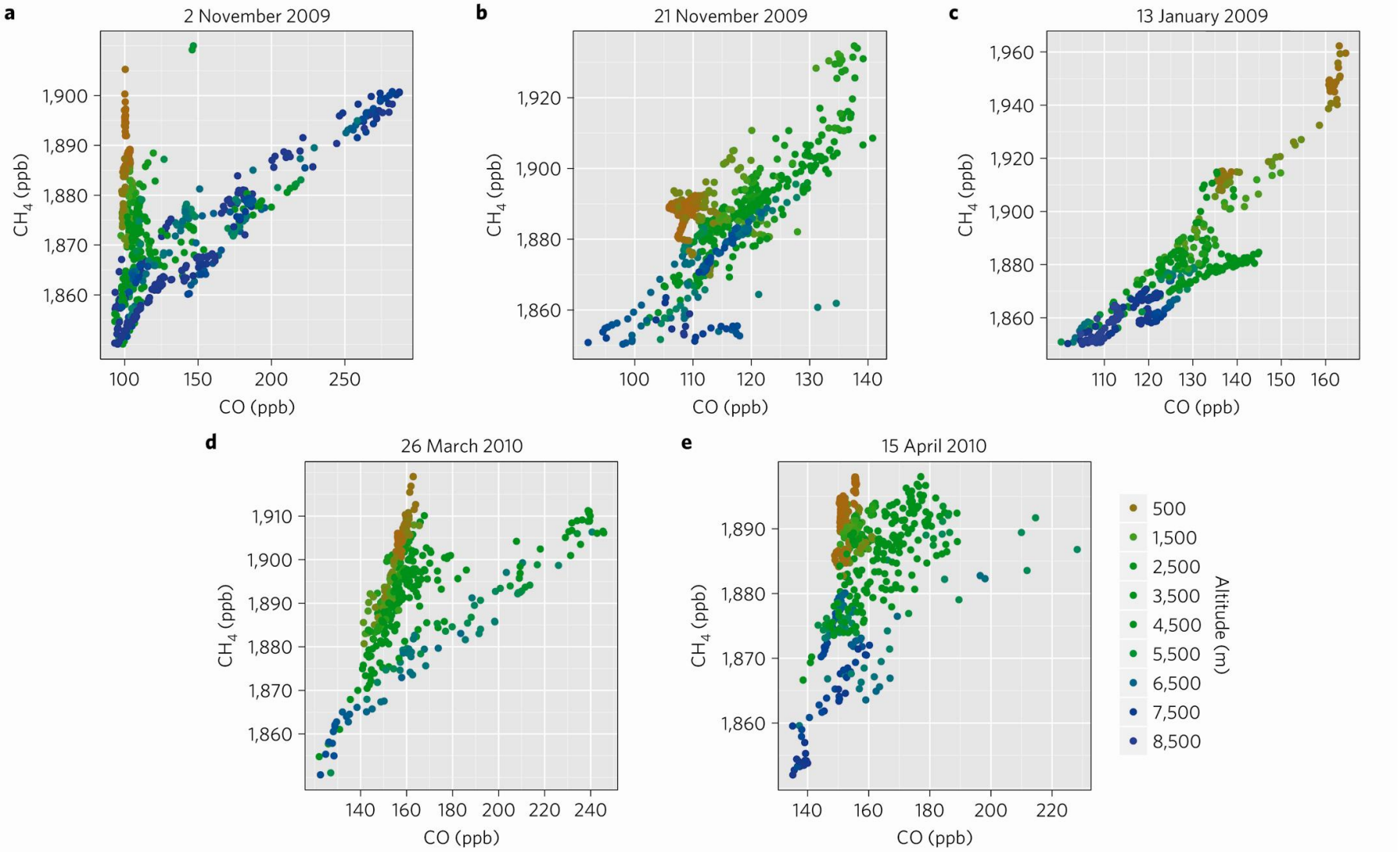

Figure 1 | Correlations between 10 s average CH_4, CO and altitude for Arctic flights. Subset of data at >72° N and CH_4 > 1,850 ppb for **a**, 2 November 2009; **b**, 21 November 2009; **c**, 13 January 2009; **d**, 26 March 2010 ; and **e**, 15 April 2010.