Initial Investigations into Mapping Biogenic and Abiogenic Green House Gases from Space

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1. Project Outline

Gas Seep Detection Assessment: An assessment of the current capability for detecting methane (CH4) from natural gas seeps was carried out using the TANSO instrument on GOSAT. The Greenhouse Gases Observing Satellite. Limited spatial coverage, rather than resolution, prevents direct identification of point sources of CH4.

Data Sources:
• The gridded values of the column-averaged dry-air mole fraction of CH4 in the atmosphere (in ppbv, also called the Volume Mixing Ratio), which is referred to as XCH4, were taken from the University of Leicester Earth observation Science Greenhouse Gas Dataset, which contains global land coverage for 2.5 years from mid-2009 to the end of 2011 (Potts, D. et al. (2011). Parker, R. et al. (2011)).

Simulations:
• An assessment to find 13CH4, 12CH3, 12CH4 lines in the TIR was carried out, first using the HITRAN database, followed by the ORFM. The aim of this assessment was to identify where the special lines for the molecules could be found using simulated ACE and GOSAT instruments. The results from this assessment are shown in these panels.

4. Methane in the Thermal Region

Oxford Reference Forward Model (ORFM): Free atmospheric Radiative Transfer Model (RTRM) developed at the University of Oxford. Originally designed to simulate the MPAS instrument of ENVISAT.

High Resolution Transmission (HITRAN):
• Database of spectral lines for multiple species (around 50), updated every couple of years (Currently using HITRAN2012).

4. Ethane in the Thermal Region

Figure 10a: Absorption plots green represents 12C2H6 and blue represents key background gases (13C2H6, NO, and H2O) from GOSAT-TANSO-FTS nadir measurements.

Figure 11a: Absorption plots green represents 12C2H6 and blue represents key background gases (13C2H6, NO, and H2O) from ACE-FTS limb profiles. Figure 11b shows background methane concentration. Figure 11a shows background methane concentration at 2km altitude.

5. Conclusions

• It is clear that in theory 13C2H6 is observable from both ACE and GOSAT in the TIR waveband.
• However CH4 is only observable from ACE in this spectral region under very specific conditions. BUT the concentrations required make this unlikely.
• The ORFM simulations indicate that the resolution of the SCIAMACHY instrument will make retrieving individual 13C2H6 lines improbable in the TIR waveband.

6. References

Bernath 1995, “Ground-based observations and the thermal infrared.”
http://www.leos.le.ac.uk

FOG: A thermal infrared sensor system used on GOSAT to observe the thermal infrared emission of the Earth’s surface. FOG measures the Earth’s atmosphere and ocean, and provides the key information for monitoring the Earth’s climate and weather, monitoring greenhouse gases and water vapor, and researching the Earth’s surface. FOG is a key instrument on GOSAT to observe the thermal infrared emission of the Earth’s surface.

Figure 6: Representation of the ENVISAT satellite. (ESA, 2014)

Figure 8: California: GOSAT retrieved on August 9th. Panel a: Absorption plot (color) against known seeps (black crosses). Panel b: Absorption plot (color) against known seeps (black crosses).

Figure 9: HITTAN data showing absorption plots (between 600nm and 800nm) where brown represents NO, green represents H2O, and blue represents 13CH4.

Figure 12: Absorption plots green represents key background gases (13C2H6, NO, and 12CH3) from GOSAT-TANSO-FTS nadir measurements. Figure 13: Absorption plots green represents ethane at background concentrations and blue represents key background gases (13C2H6, NO, and 12CH3) from ACE-FTS limb profiles at 2km altitude.

Figure 10b: Absorption plots green represents 12C2H6 and blue represents key background gases (13C2H6, NO, and H2O) from GOSAT-TANSO-FTS nadir measurements.