Committee on Earth Observation Satellites

Can we detect the GHG signal of the COVID-19 pandemic's economic slow-down?

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Agenda Item # 1.07

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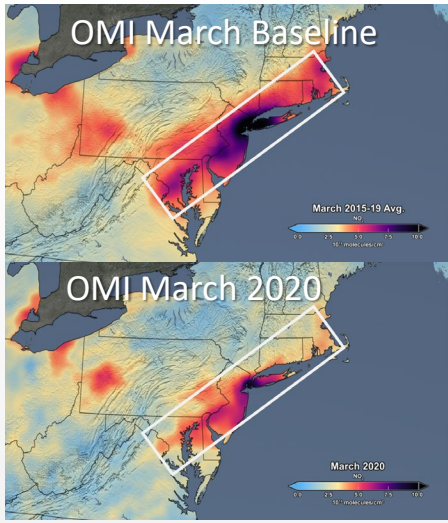
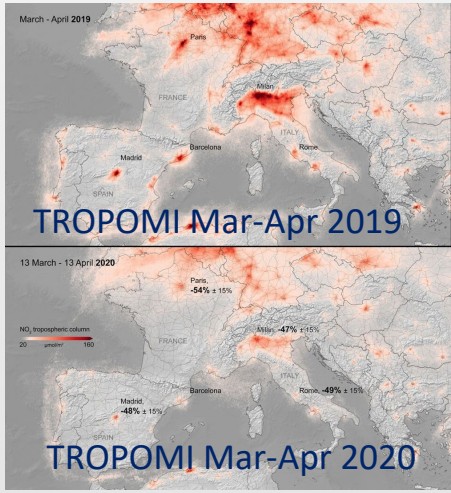
Detecting the XCO_2 signature of the COVID-19 Pandemic

- The COVID-19 pandemic was accompanied by a dramatic economic slowdown
  - COVID-19 lockdowns caused significant (~10% Jan-Apr), but temporarily reductions in fossil fuel use
    - introducing large (~50%) reductions in short-lived air pollutants, such as NO_2
    - reducing the CO_2 grow rates, but producing very small (< 0.5 ppm or 0.1%) localized reductions in atmospheric CO_2 concentrations, due to its much longer lifetime (centuries) and large background concentrations (415 ppm)
- **There is great interest by ESA, NASA, and JAXA to use space based observations to track the progression and recovery from the pandemic**
  - The impacts on the emissions of short-lived trace species, such as NO_2, were immediately apparent in observations from OMI and TROPOMI
  - The impacts on CO_2 are much more subtle and difficult to detect – this was a research project, right at the limit of our capabilities
- **In addition, the OCO-2 team was in the middle of a major XCO_2 reprocessing campaign, and did not have a product that spanned the era of the pandemic**
  - The v9 product was terminated on 3 Feb 2020, and replaced with v10
  - We needed a uniform product to detect the small (0.2 ppm) changes expected

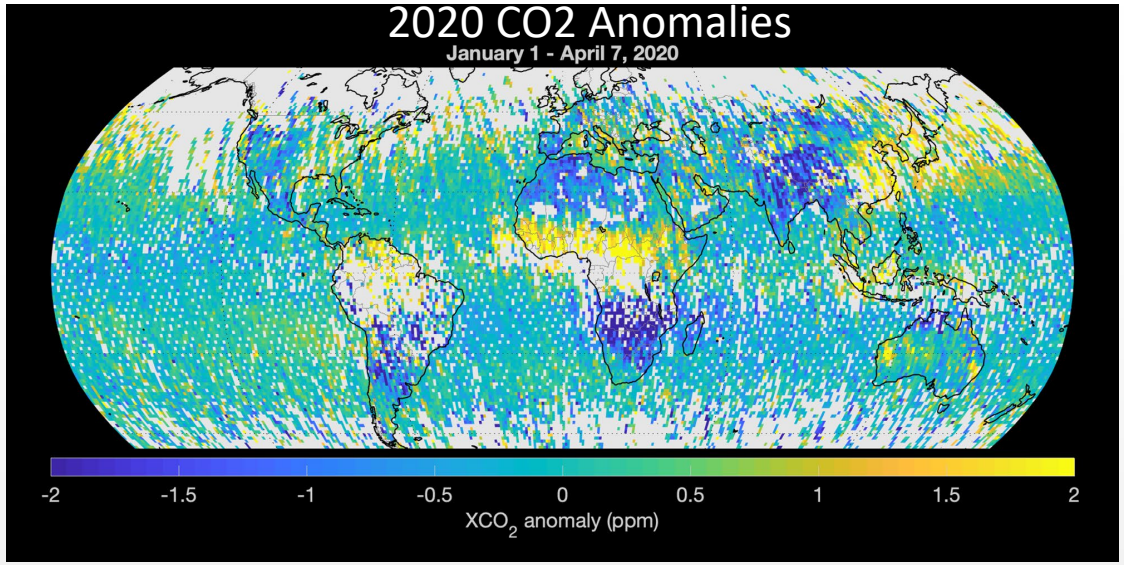


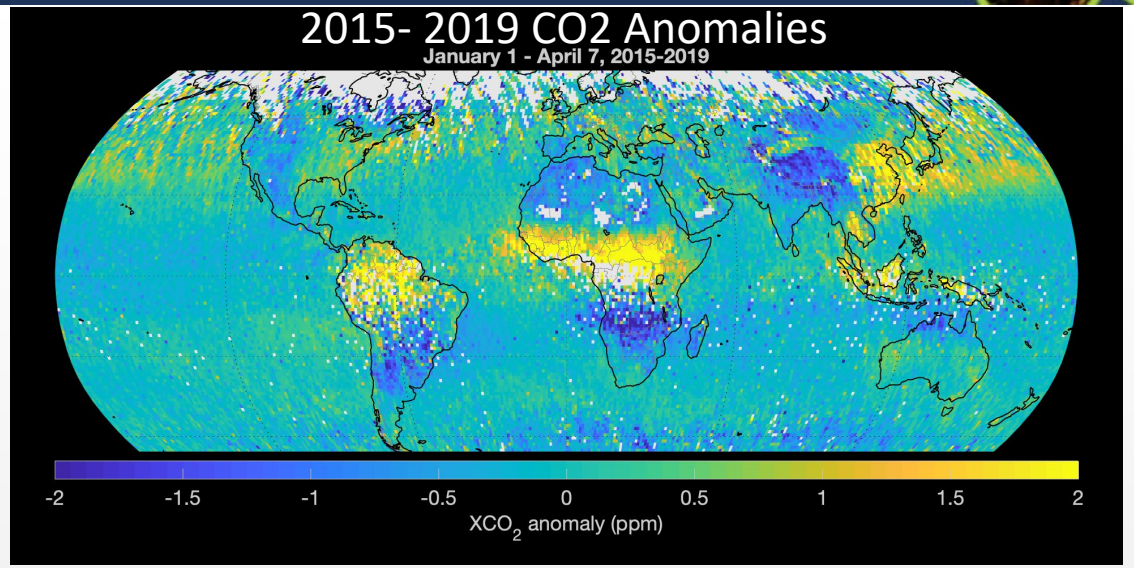


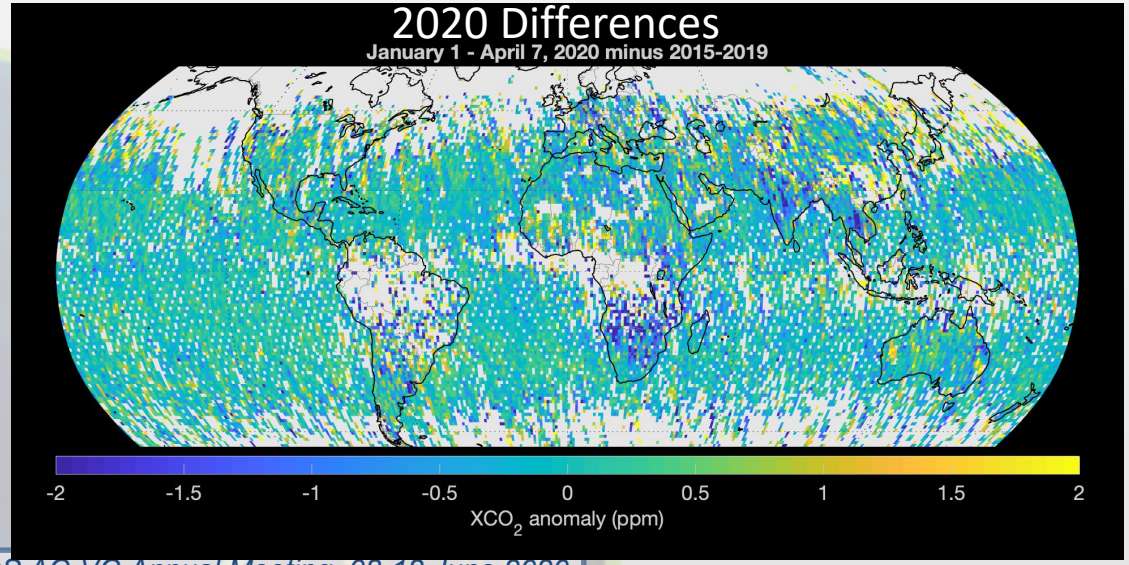
Corrective Action – A Race to Develop a Product

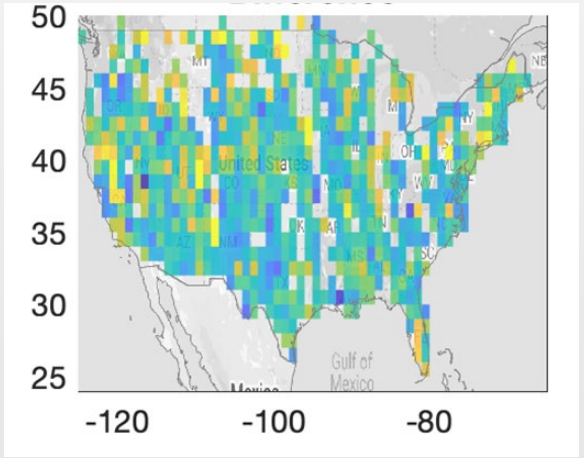
- To meet the demand for information about the impact of the pandemic
  - The OCO-2 data processing team significantly accelerated the data processing effort, focusing on the period spanning November – April of 2014 – 2020
  - The L2 Algorithm Team (O'Dell et al.) generated a preliminary filtered, bias corrected XCO_2 product, based on a partially processed data set
  - This product was analyzed to yield two type of Level 3 products to look for changes
    - A "CO_2 Anomaly" product that averaged over dynamics to identify regions with temporally persistent high and low XCO_2 anomalies (Hakkarainen et al.)
    - A product that uses NASA's GEOS Constituent Data Assimilation System (CoDAS) to assimilated the OCO-2 XCO2 to form 3D global fields at (Weir et al.)
  - In both cases, the January – April 2020 period was compared to a climatology spanning this range of months in 2015 – 2019
  - A product was developed in time to address agency needs, but only because the deadline slipped due to other factors

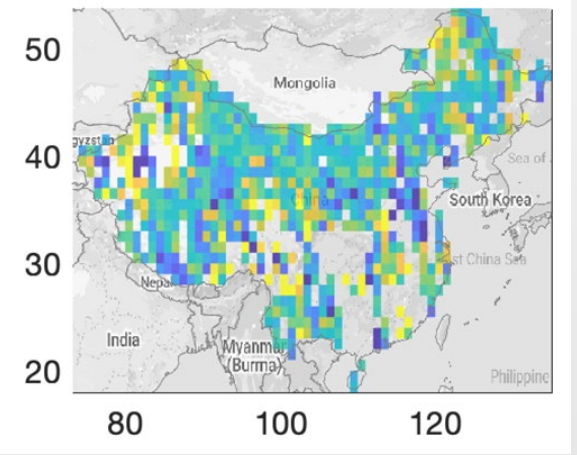
The CO_2 Anomaly Products





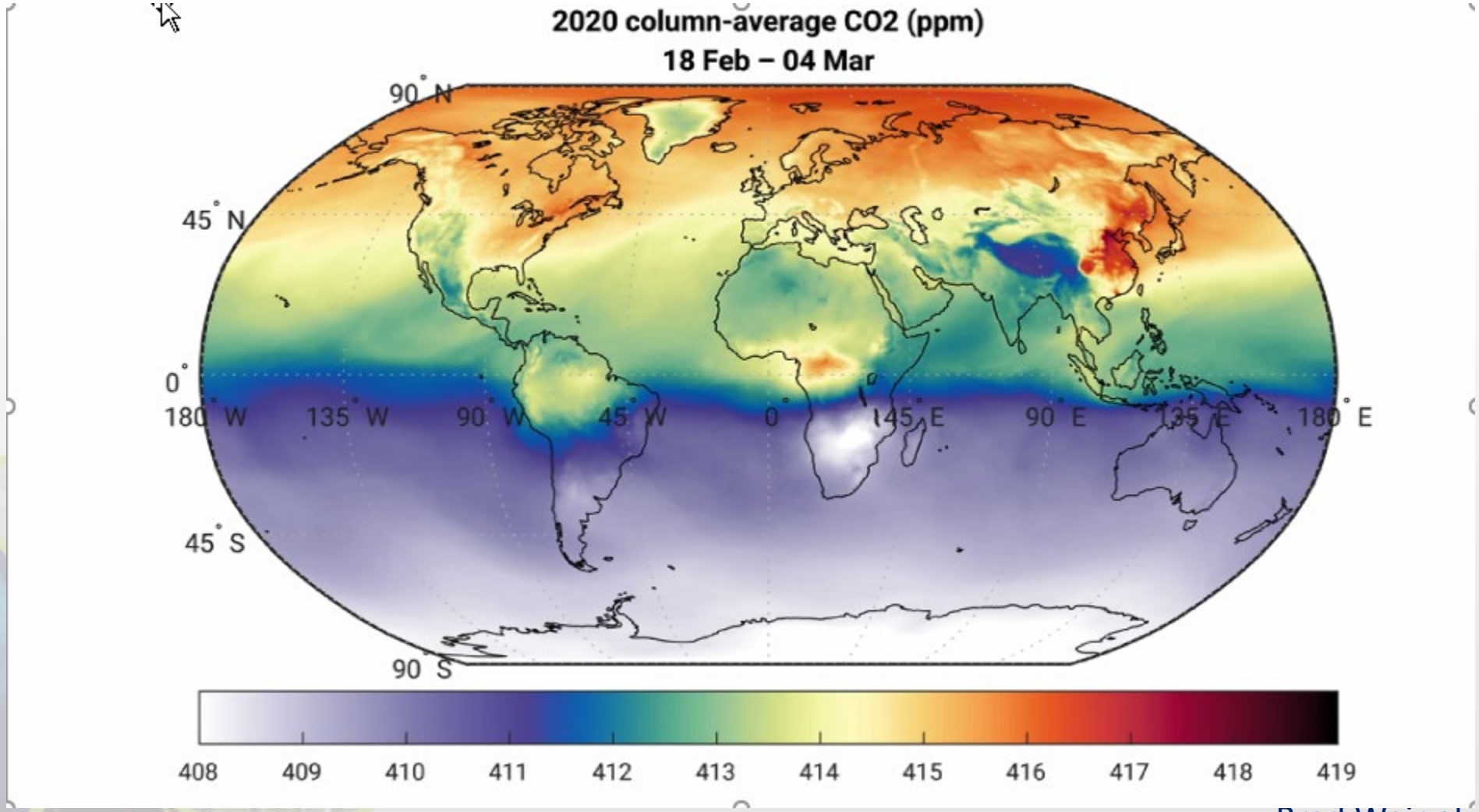






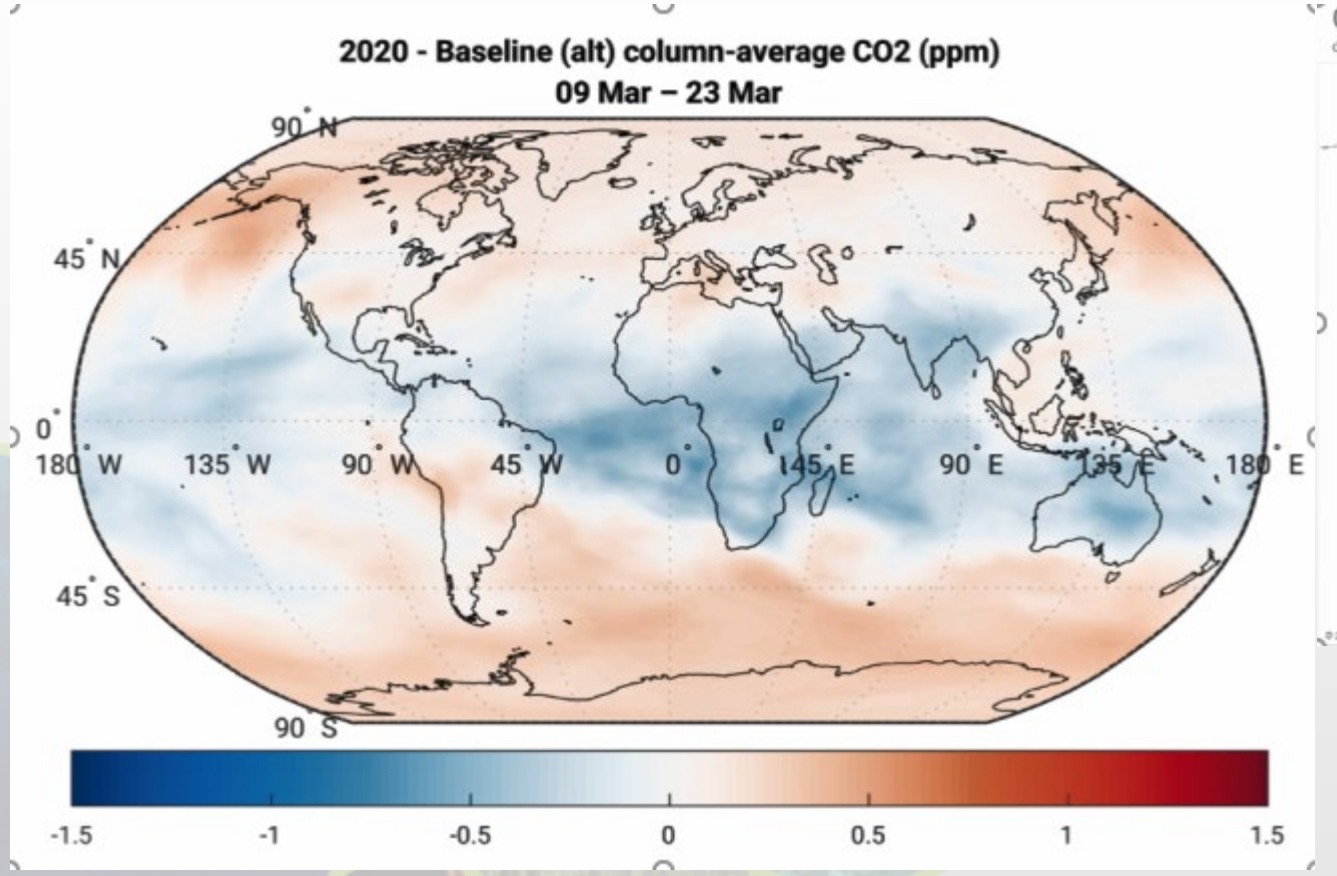
Janne Hakkarainen et al. (FMI)

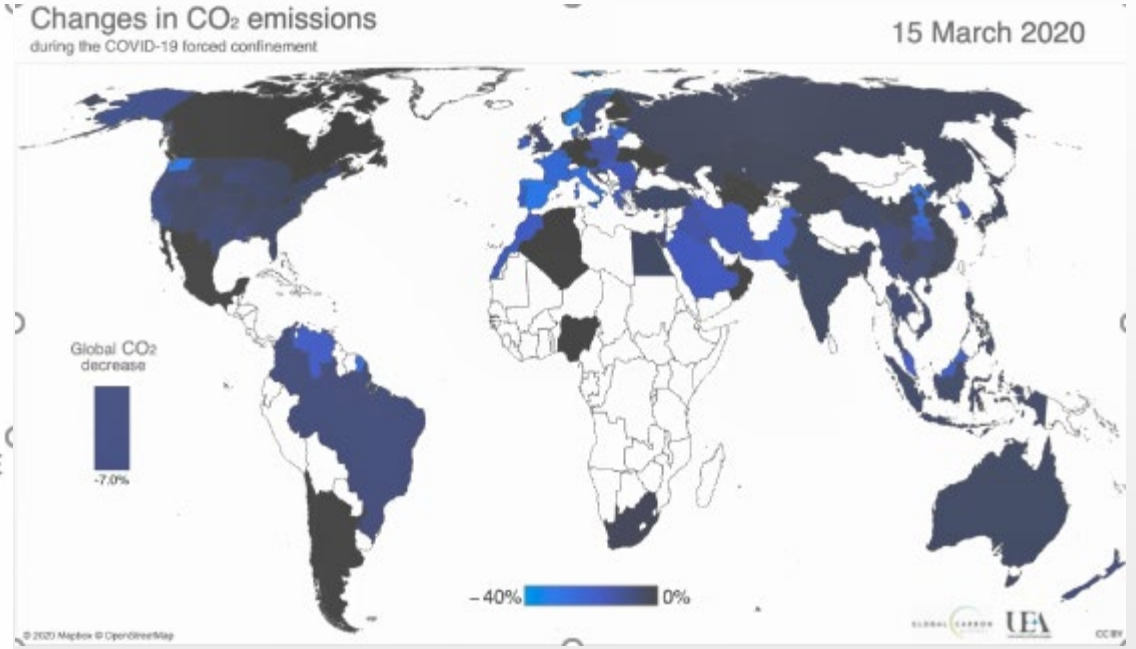
Assimilated Products



Brad Weir et al. (GSFC GMAO)

Comparisons of observed XCO_2 and emission changes





Lessons Learned and Actions Needed

- A preliminary CO_2 data product was produced, but required heroic efforts
- There have been a number of other recent opportunities to address time-critical events that were delayed or missed because the XCO_2 and XCH_4 products
  - Aliso Canyon methane leak – other large methane leaks
  - Australian fires
- Can we make “analysis ready products” for CO_2 and CH_4
  - What suite of sensors is needed?
    - Sensitive, high spectral resolution spectrometers to quantify concentrations
    - High resolution CO_2/CH_4 imagers to find hot spots
  - What data delivery, analysis and distribution capabilities are needed for near-real time
  - What kinds of tools and capacity building are needed to facilitate analysis ready data?
- What can/should CEOS do to prepare for the pre-operational/operational world of S5p/S5, GOSAT-GW, CO2M?