Geostationary methane concepts

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Why go to GEO?

Current LEO observations provide a long term global view of atmospheric composition, but there are limitations:

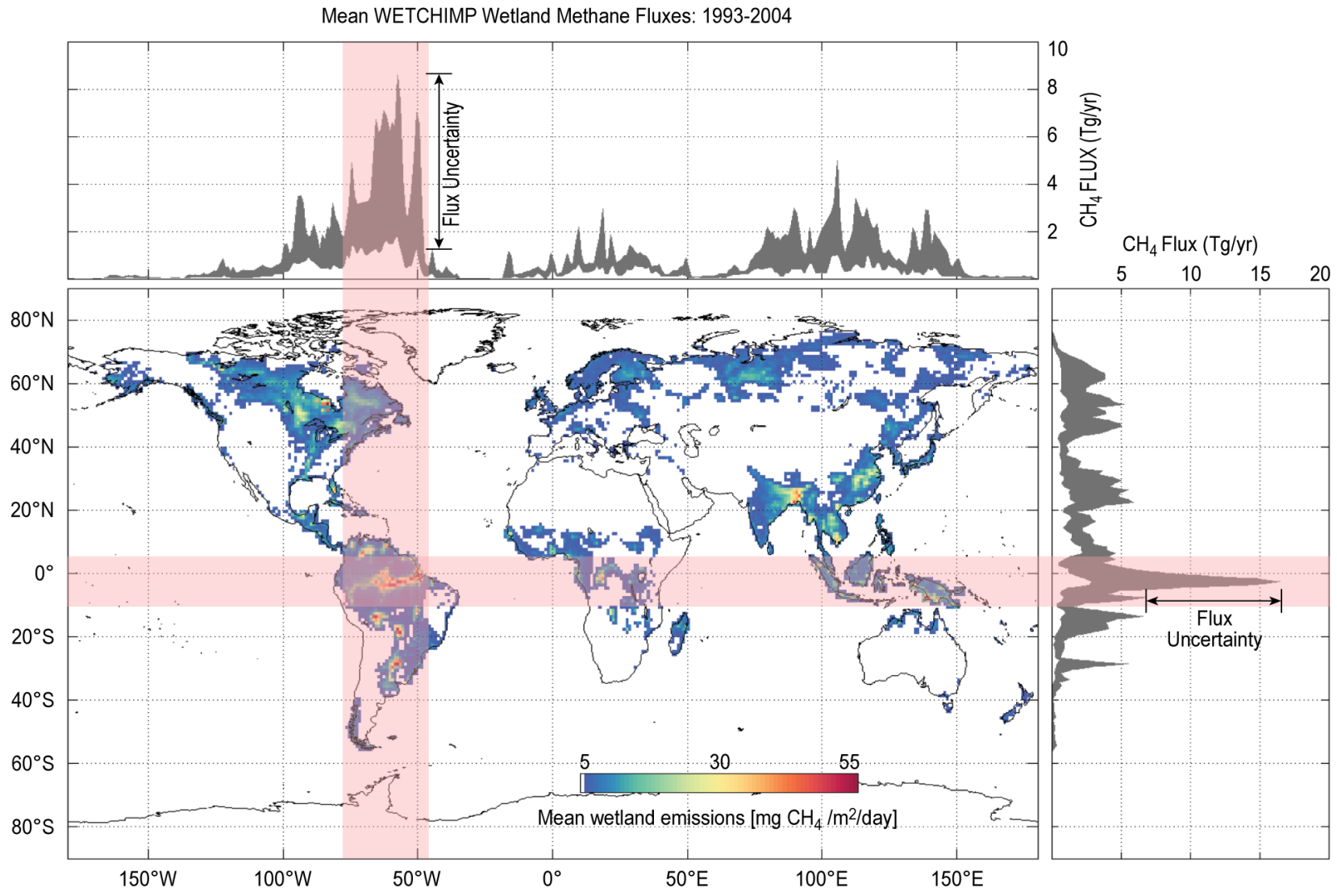
- Coverage is global but sparse: At best 1-2 measurements/day
- Orbital constraints, persistent clouds further limit sampling
- Errors in individual retrievals can limit examination of pollutant source and distribution variability on diurnal and regional scales
- Significant data averaging is common to produce products

A satellite in GEO provides high density hourly observations:

- Sensor can "stare" to obtain sufficient signal
- The hourly measurements with ~ 4 km x 4 km spatial resolution significantly increases the probability of cloud-free observations
- Similar measurement/model scales and continuous near-real-time data delivery will increase uptake of satellite data for regional air quality applications such as chemical weather forecasting and monitoring hazards such as wildfires

Designing a mission for tropical conditions

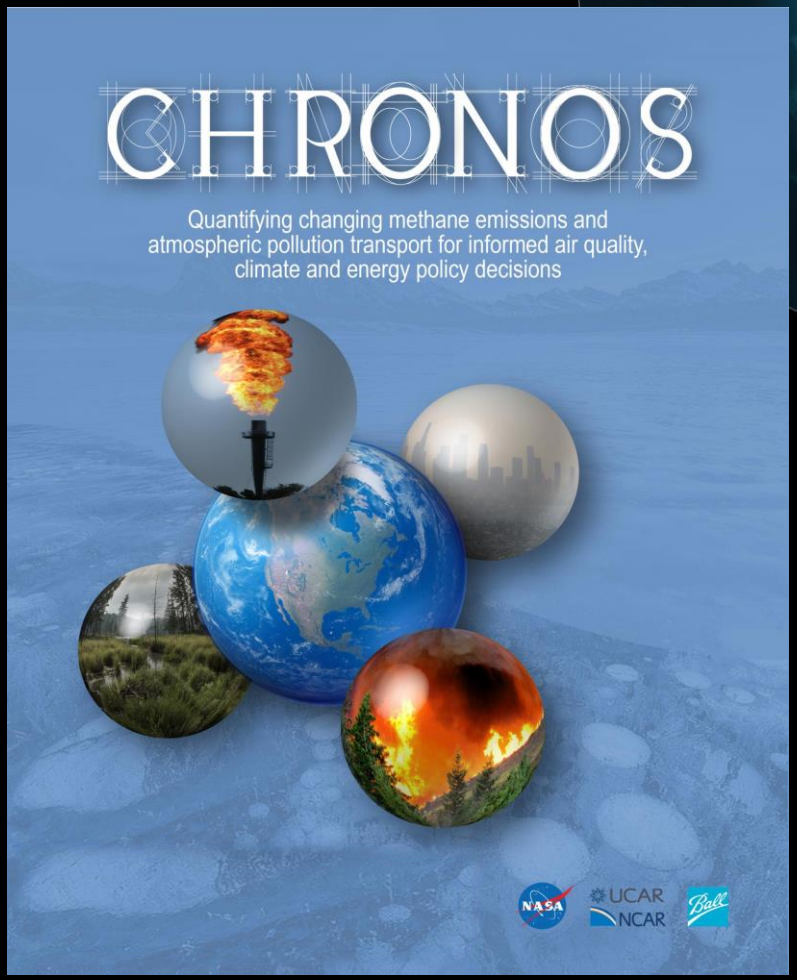
X-marks the spot

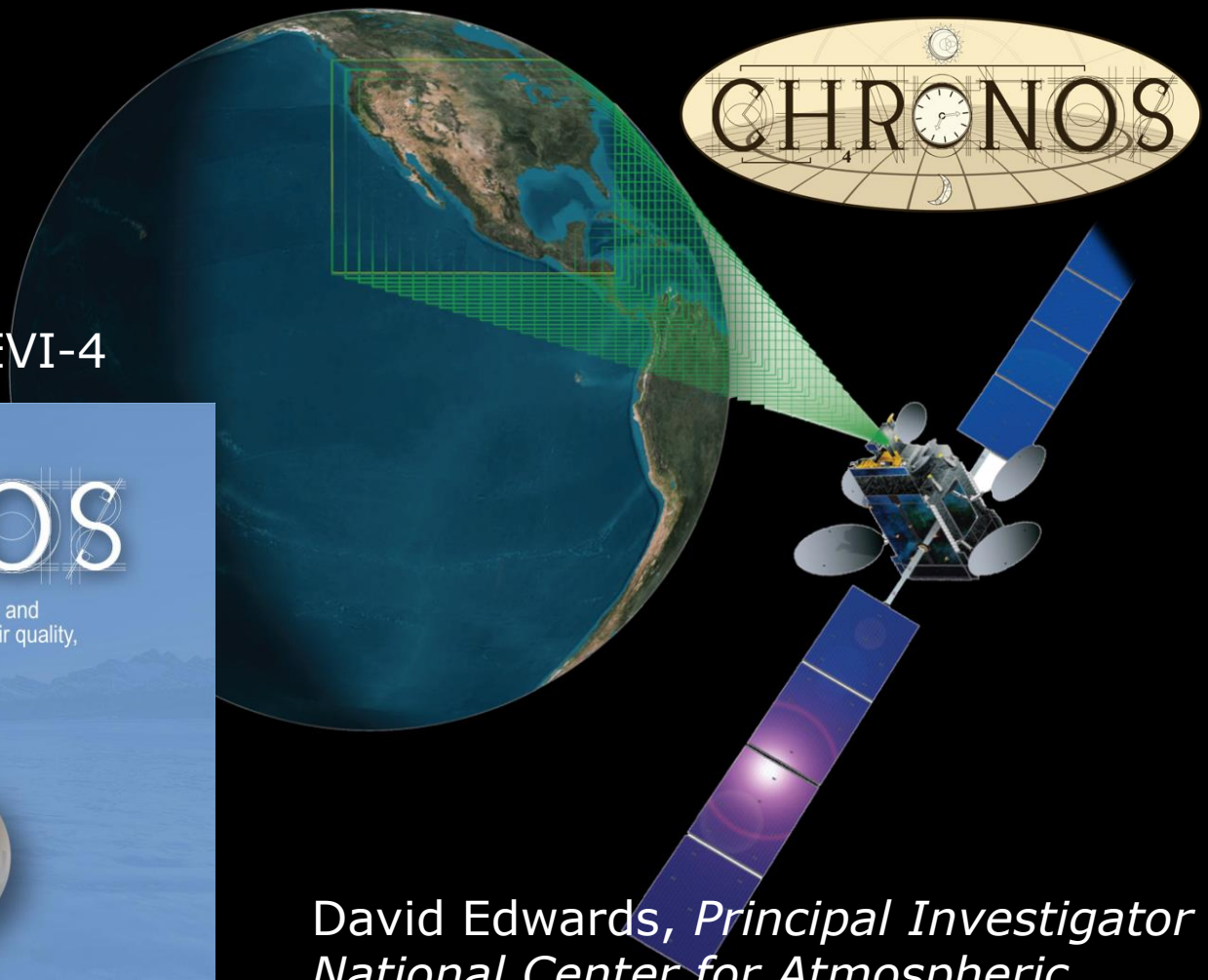


The tropics are hard

- Humid tropical ecosystems dominate the natural CH_4 budget and its uncertainty and could be the focus of near-term CH_4- climate interactions.
- High tropical ecosystem turnover times lead to short response times.
- Observed high interannual variability confirms short tropical carbon cycle response times.
- High tropical cloud cover (>95% in critical seasons and regions) requires persistent observations.
- The complex tropical atmospheric state (aerosols and clouds) leads to difficult bias issues and requires local *in situ* cal/val.
- Global (LEO) missions can provide pantropical but not sub-regional detail.

Proposal to NASA/EVI-4





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and the CHRONOS Science Team

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NASA
Ball
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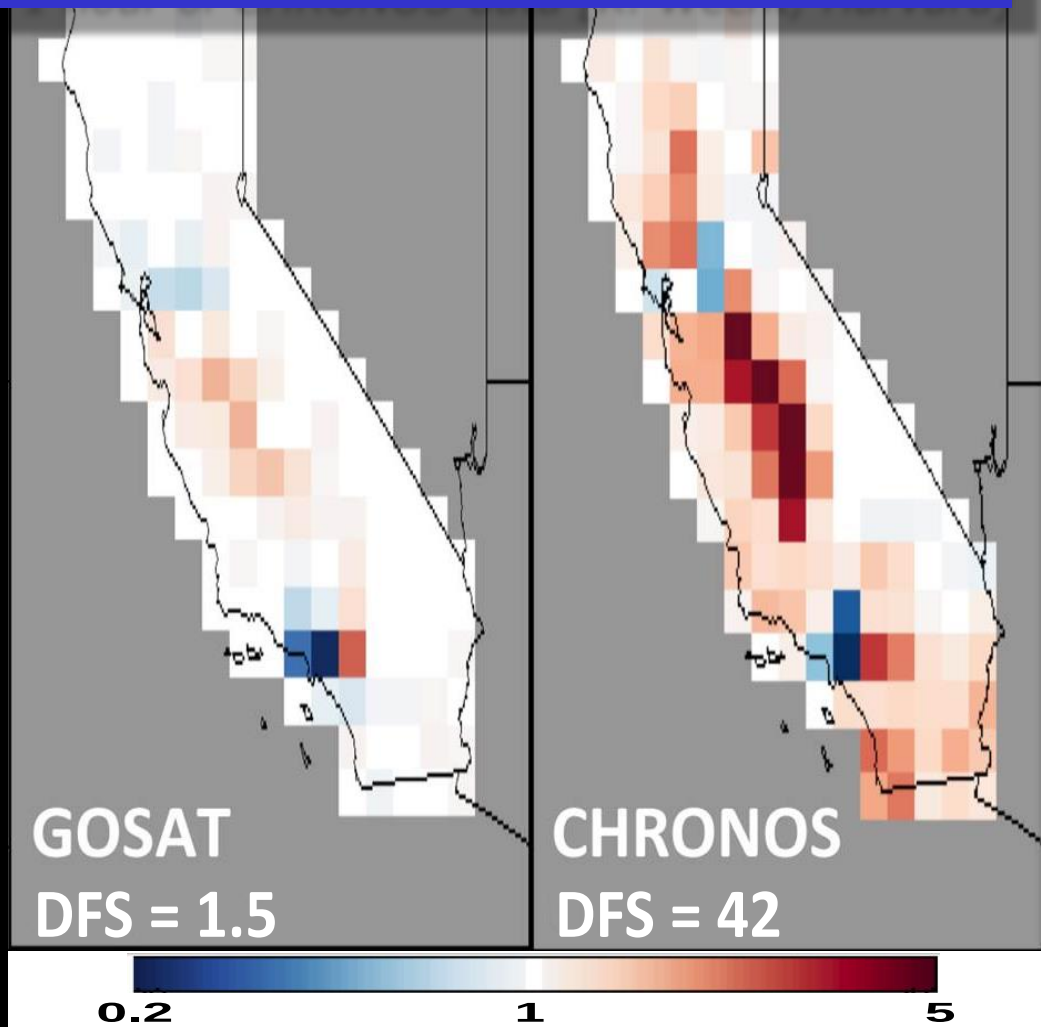
Investigation overview

- The CHRONOS science goal is to characterize and understand changing emissions of methane and other pollutants in North America from urban sources, wetlands, fires and fossil fuel extraction and their complex consequences for air quality, climate and energy policy decisions
- By measuring the key atmospheric pollutants CO and CH_4 at high temporal and spatial density from GEO, CHRONOS quantifies emissions and determines how gaseous pollutants are transported up and way from sources to impact air quality and climate
- The low risk, subsystem high-TRL, gas filter correlation radiometry (GFCR) measurement technique builds on 15 years of LEO observations from NASA's Terra/MOPITT mission
- Investigation implementation through commercial partnerships provides cost-effective access to GEO for a science instrument hosted onboard a communications satellite and leverages existing operations infrastructure

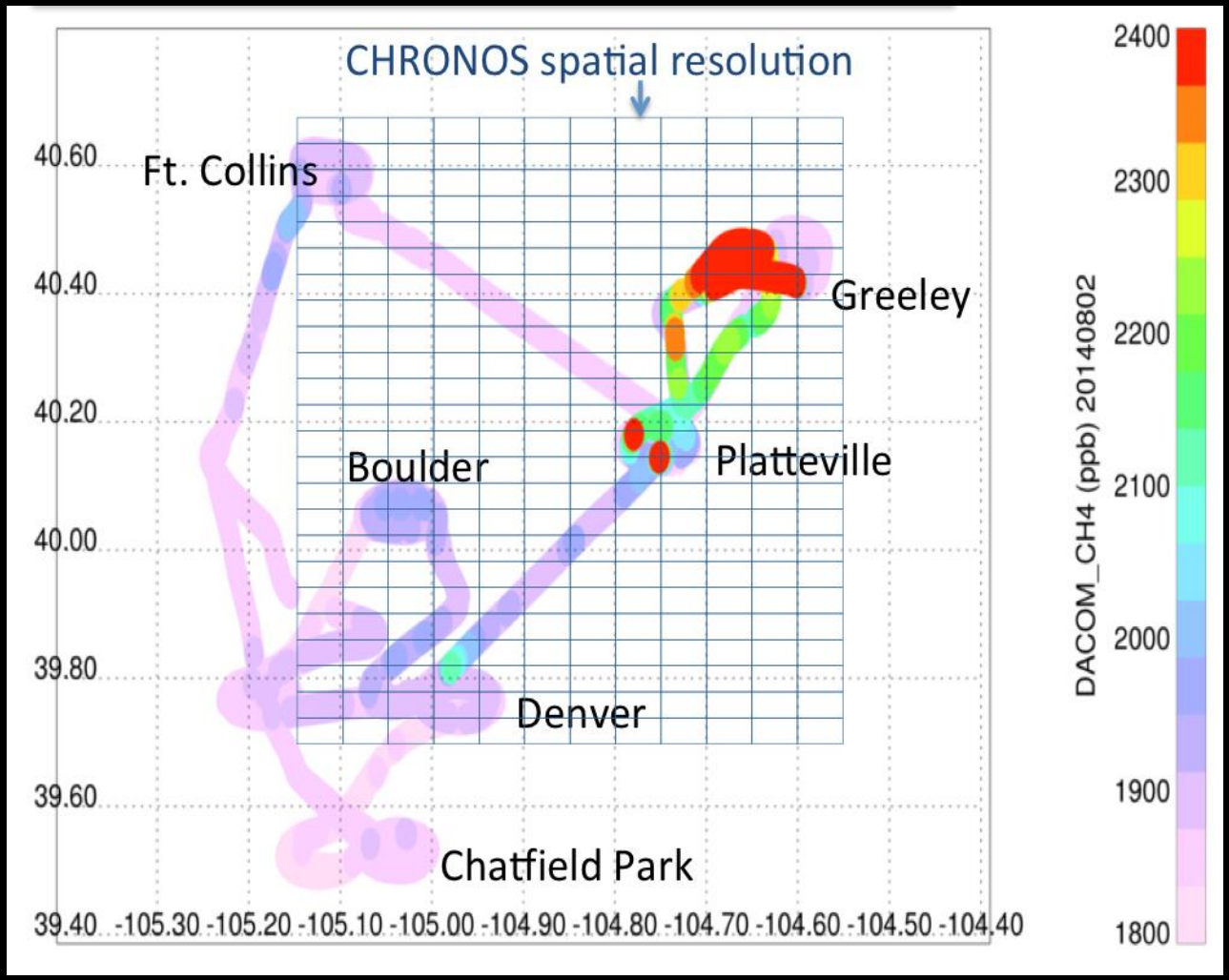
Science objective 1

- *CHRONOS observations will resolve large uncertainties in current CH_4 and CO emissions inventories:* CH_4 surface and aircraft measurements imply EPA 2009 emission inventory is factor of 2 too low due to large uncertainties from fossil fuel production
- Natural gas production studies also present conflicting results
- Current inventories don't capture magnitude and seasonal variation of CO emissions and increasingly frequent wildfire sources

OSSE correction factors to EDGAR v4.2 CH_4 inventory at 0.5° ×0.6° from one year of GOSAT satellite observations compared to 1 hour of CHRONOS data [K. Wecht, Harvard]



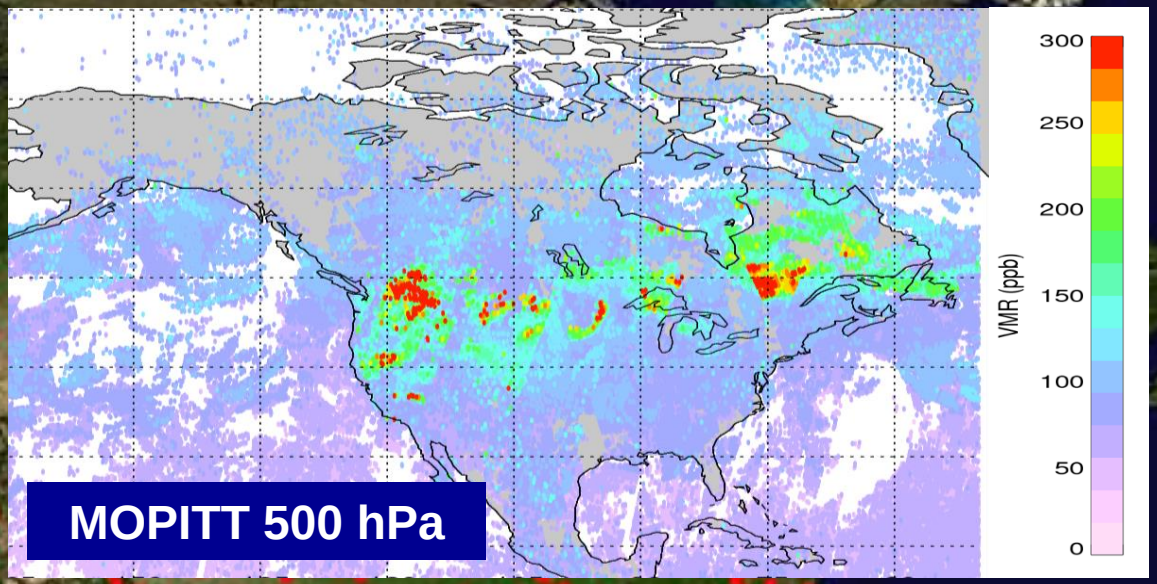
CHRONOS CH_4 column measurements will have the spatial resolution and precision to distinguish hourly concentration gradients at the city-scale

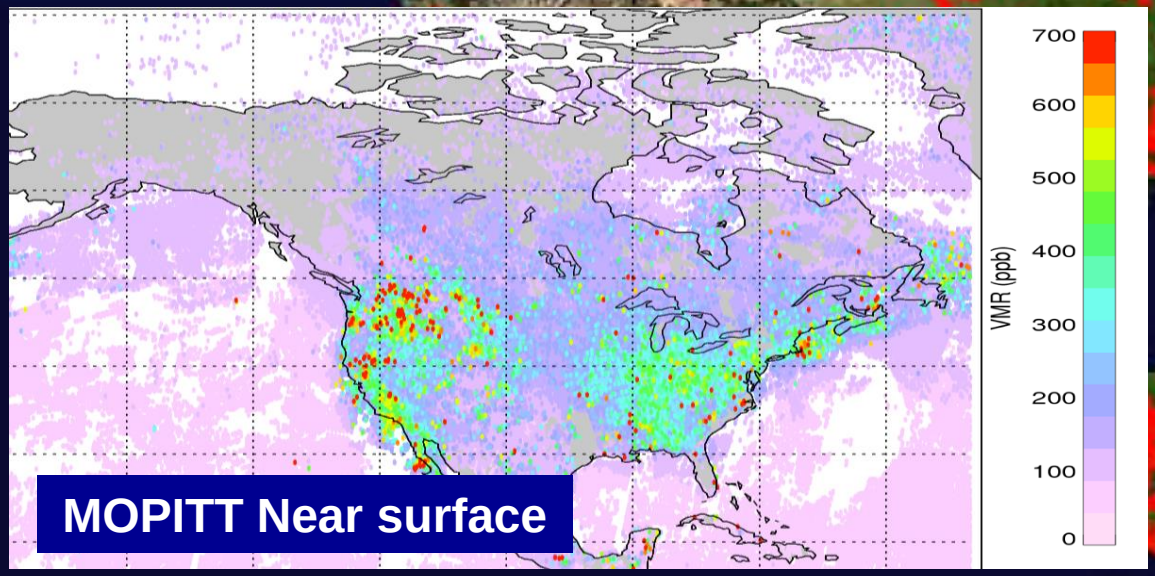


- DISCOVER-AQ spiral flight tracks from the Colorado Front Range on Aug. 2, 2014
- Total column difference between the Ft. Collins and Greeley CH_4 profiles is 4.9%
- CHRONOS spatial resolution is indicated by the overlaid grid

Multispectral retrievals distinguish signatures of pollution sources and transport

MOPITT V5J multispectral retrievals of CO from MOPITT provide profile information that distinguishes fire source regions from free troposphere long range transport of pollution. 20-27 August 2015



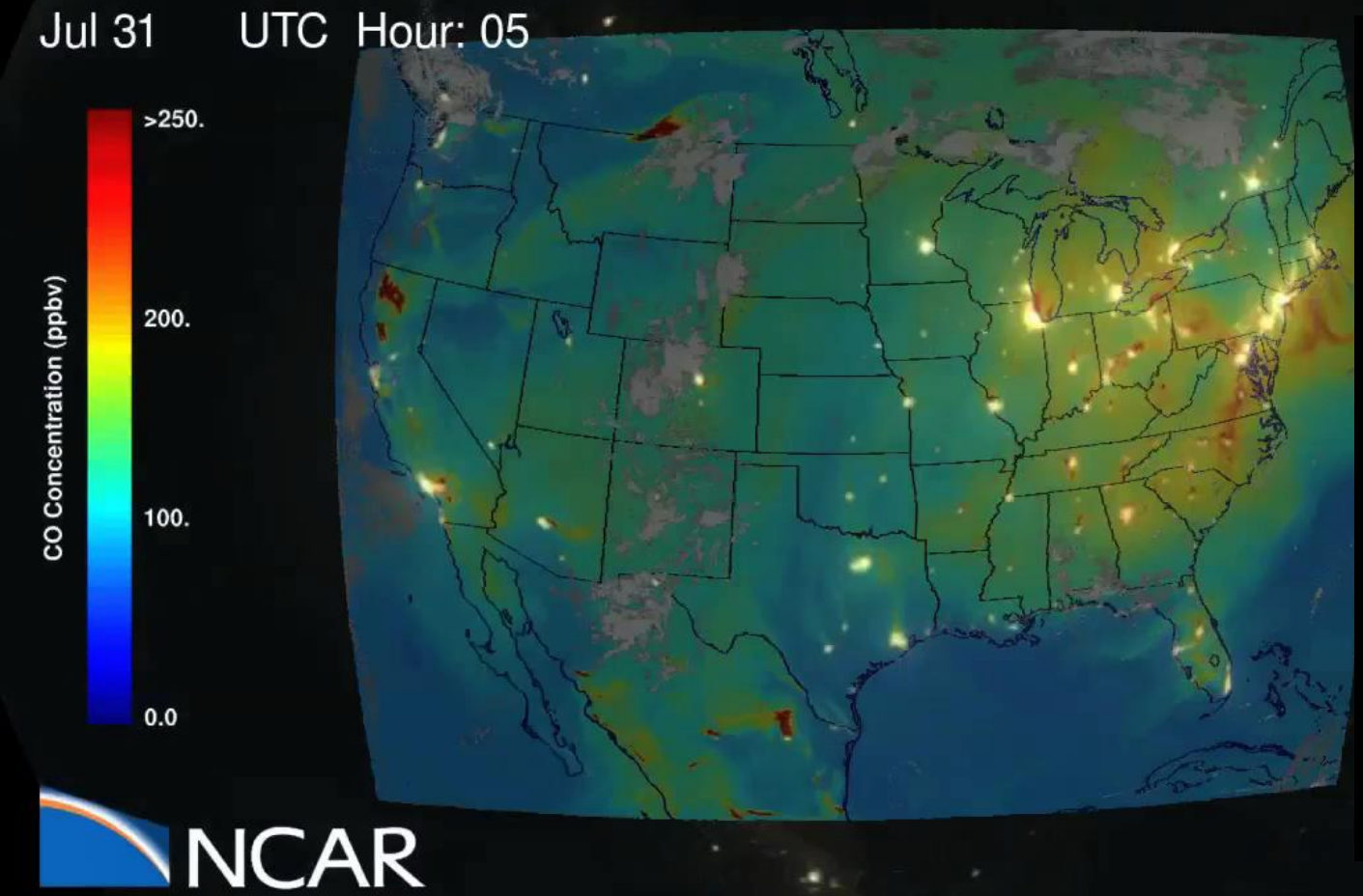


Note different scales

MODIS Fire Counts 19-28 August 2015 showing the WA north-central Okanogan Complex

Science objective 2

Transport: *Track rapidly changing vertical and horizontal atmospheric pollution transport to determine near-surface air quality on urban to continental, diurnal to seasonal scales*



- Distinguishing between locally produced and transported pollution is key to attaining air quality standards
- Quantify long-range transport of pollution into and out of the U.S.

The upcoming GEO constellation

- Several countries are planning to launch GEO satellites in 2017-2022 timeframe for air quality measurements
- These missions share common objectives, and harmonization through a constellation framework provides the global perspective
- This integrated global observing system is key to abatement strategies for air quality as laid down in various international protocols and conventions (IGACO, GEO, WMO GAW)
- The CEOS Atmospheric Composition Constellation activity promotes joint data processing and calibration approaches, modeling and assimilation, to promote collaboration between the planned and proposed GEO missions from NASA GEO-CAPE/TEMPO, KARI GEMS & ESA Sentinel 4, and LEO components (IASI, TROPOMI, GOSAT-2) that provide the global context

Second Workshop on Atmospheric Composition Observation System Simulation Experiments (OSSEs)

Date: Wednesday, 9 November, 2016 to Friday, 11 November, 2016

Location: University of Reading, Whiteknights Campus, Meadow Suite

Supported by CEOS Atmospheric Composition Constellation, NASA, ECMWF and the Copernicus Atmosphere Monitoring Service

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Over the next decade, an international atmospheric composition constellation consisting of new geostationary and low earth orbiting satellites has the potential to revolutionize our understanding of global and regional composition and chemistry and their impact on air quality and climate. Observing System Simulation Experiments (OSSEs) will play a key role in quantifying this impact, and provide demonstration of the value of individual satellite and constellation measurements in meeting the needs of the atmospheric composition science and applications communities.

Thank you!