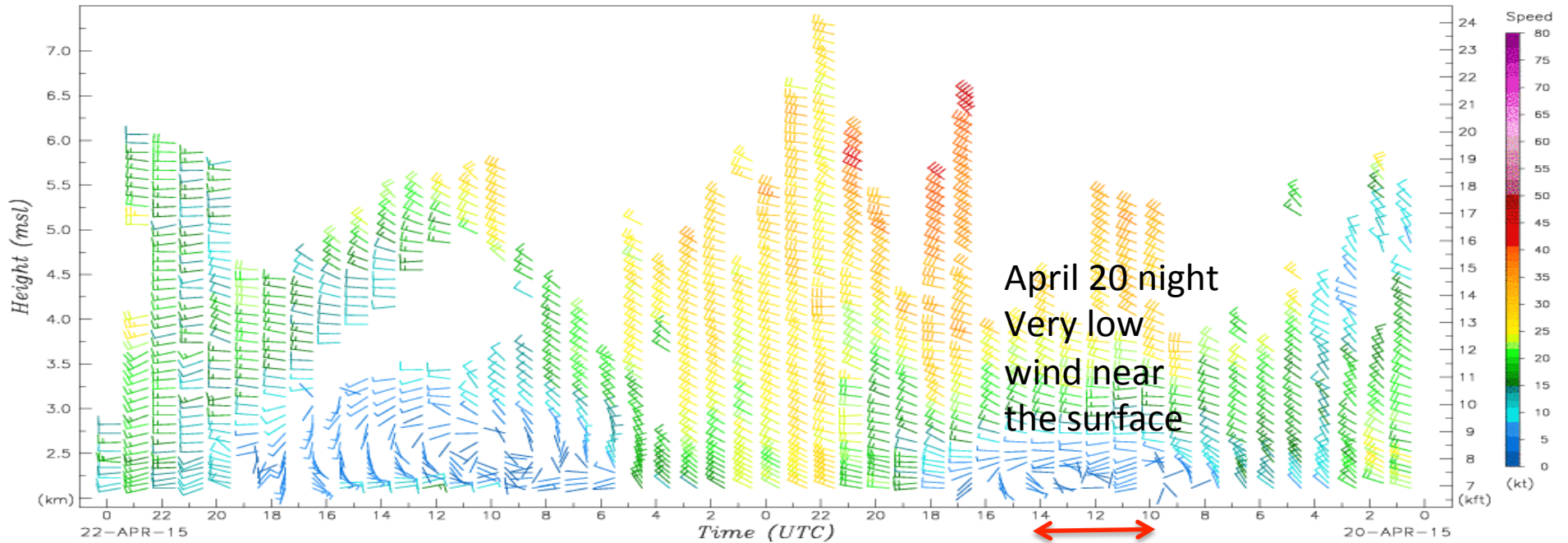


Wind Data above Navajo Lake site

Wind Profiler Data:
Allen White, Clark King

ESRL Physical Sciences Division
915-MHz Wind Profiling Radar



April 20 night
Very low
wind near
the surface



Drive

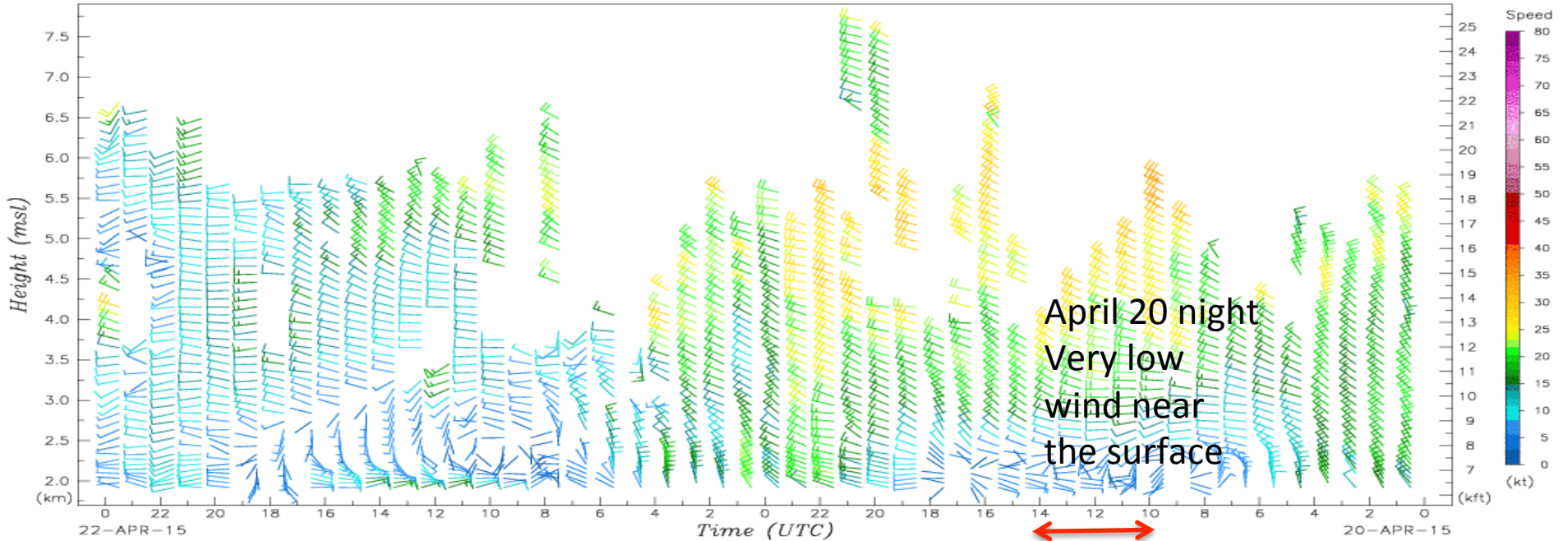
Navajo Lake Station, NM (NLS)
36.8102 N, 107.6518 W, 1974 m

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Wind Profiler Near Farmington

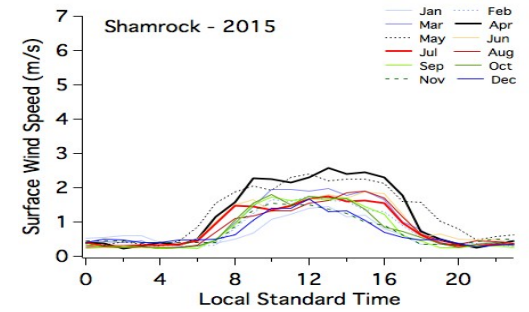
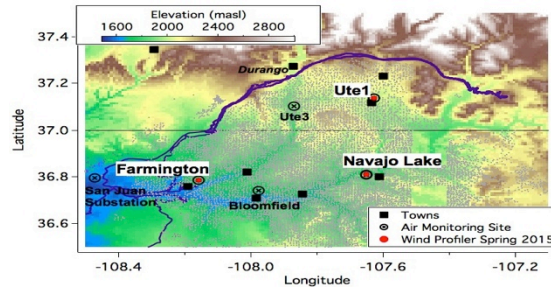
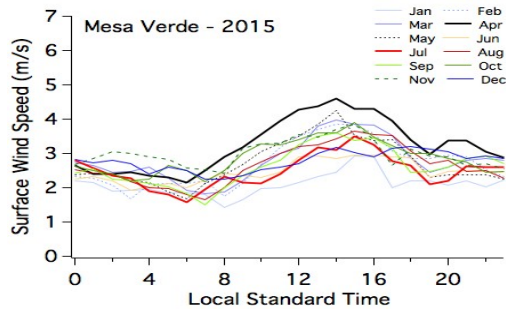
NOAA Wind Profiler Data:
Allen White, Clark King
NOAA PSD

ESRL Physical Sciences Division
915-MHz Wind Profiling Radar



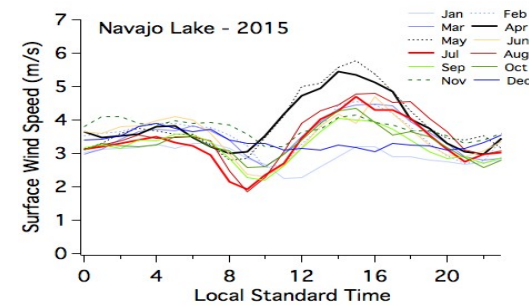
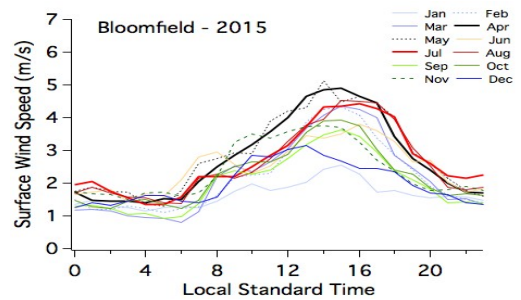
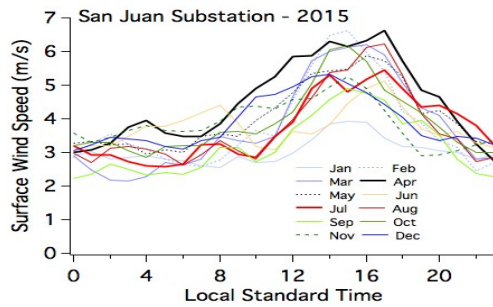
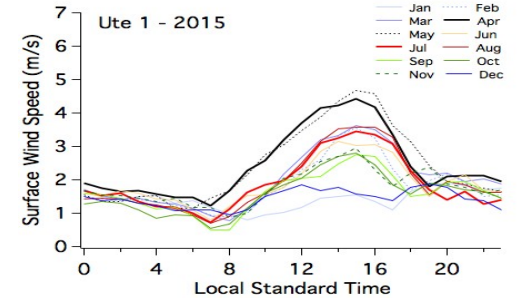
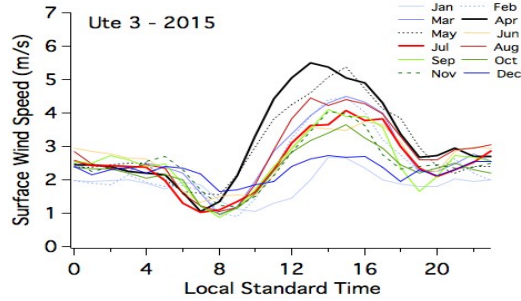
Farmington, NM (FMT)
36.7874 N, 108.1577 W, 1772 m

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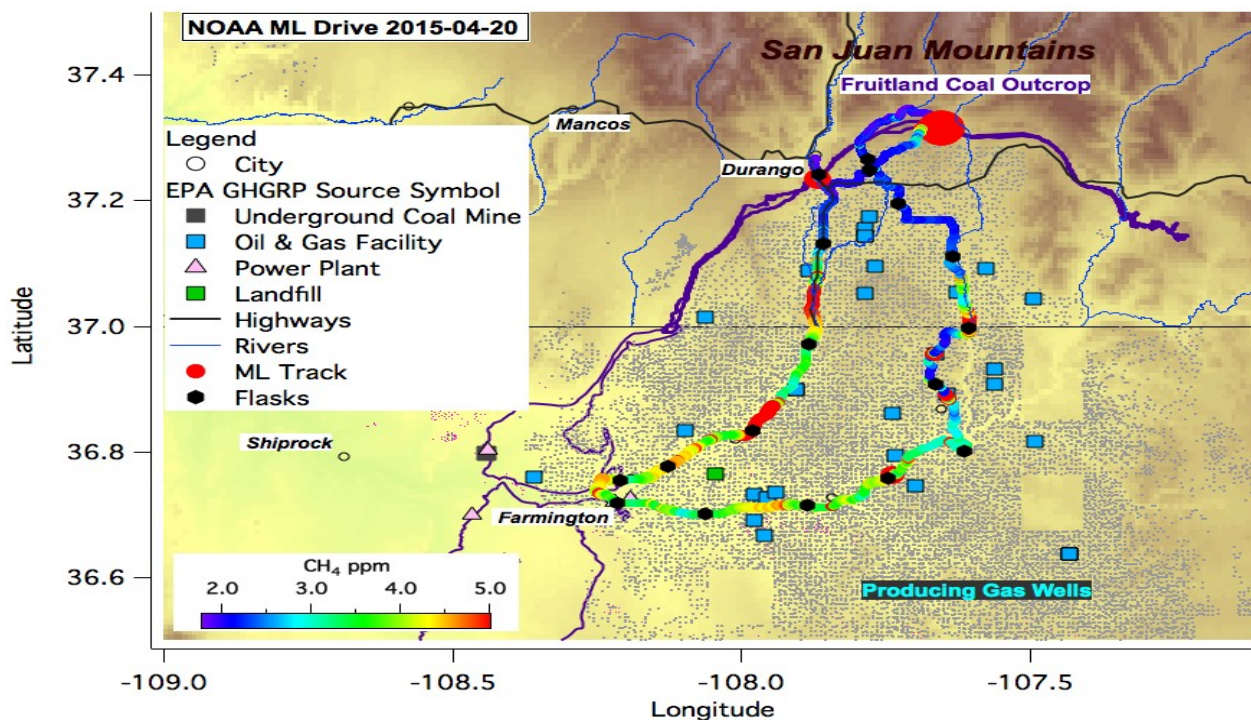


Mean Diurnal Cycle of Horizontal Wind Speed at the Surface

Data from EPA AQS (SUIT, States, NFS, NPS)

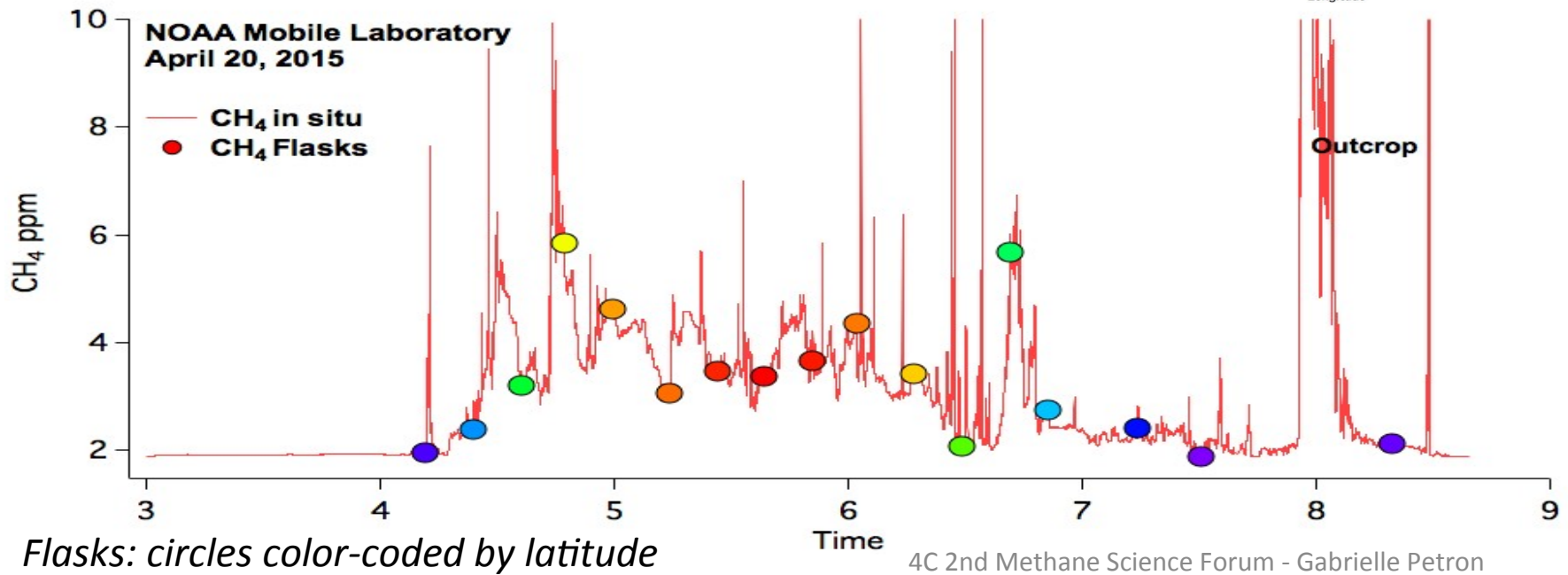
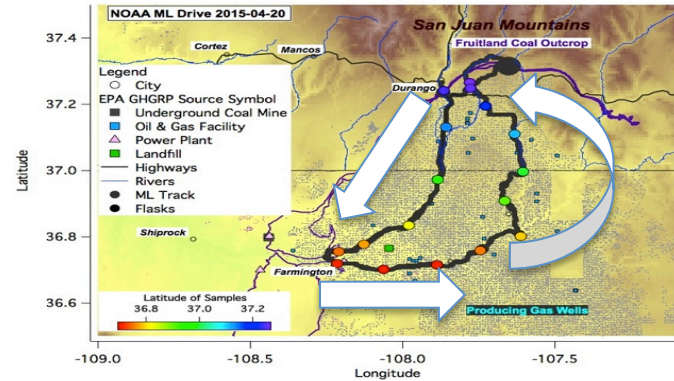


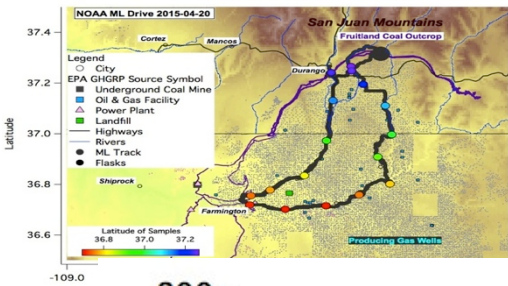
April 20, 2015 Early morning Loop



- Counter-clockwise loop 4am to 9am
- Dome of methane with “local” short or broad plumes superimposed
- PFP sampled every 15 minutes

Accumulation of CH₄ in low topographical areas within basin, along rivers beds

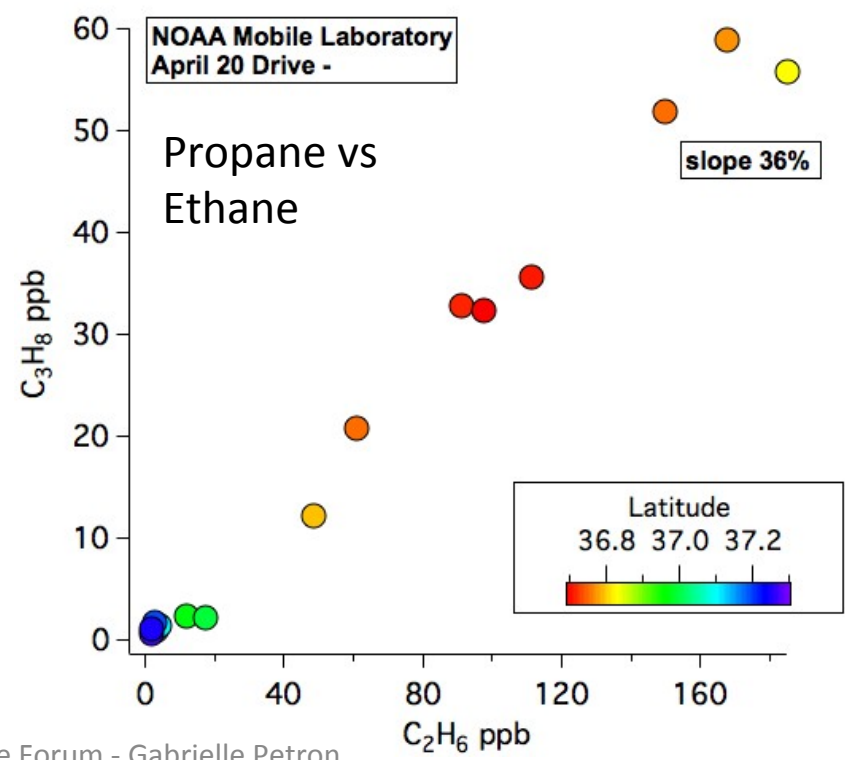
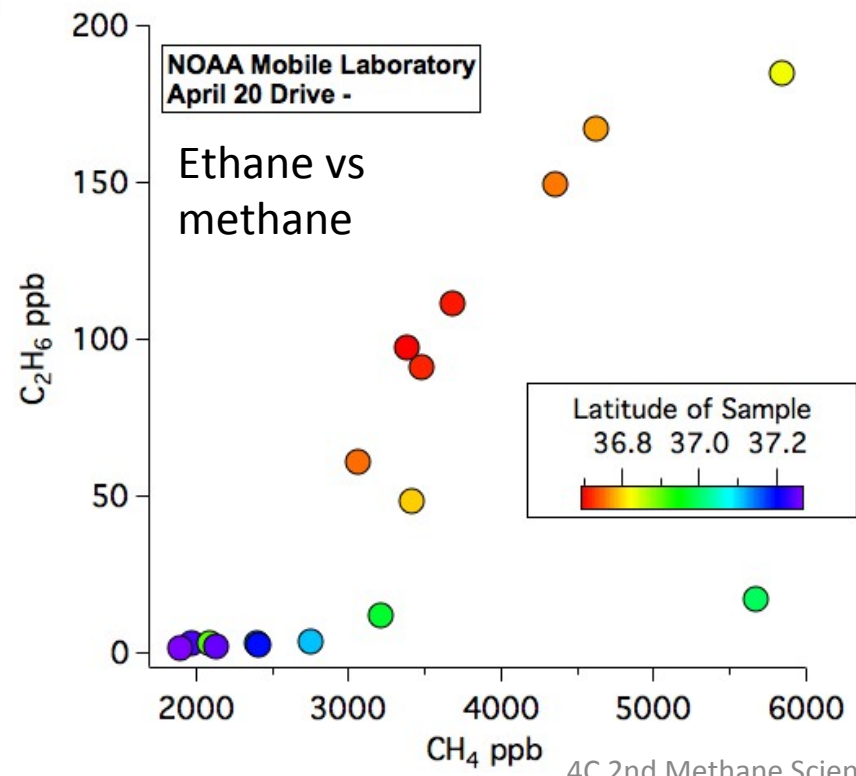




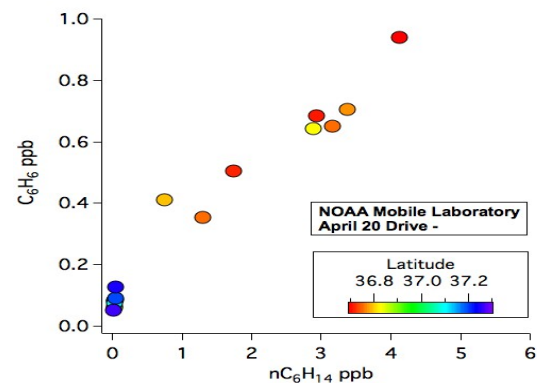
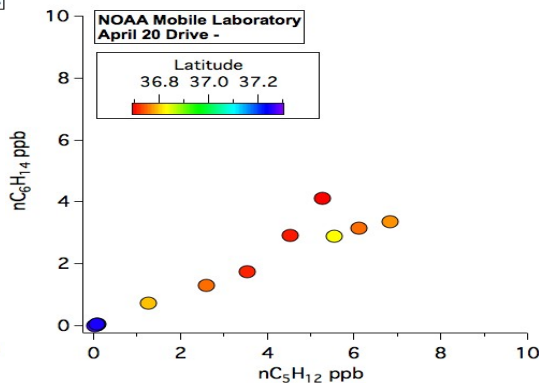
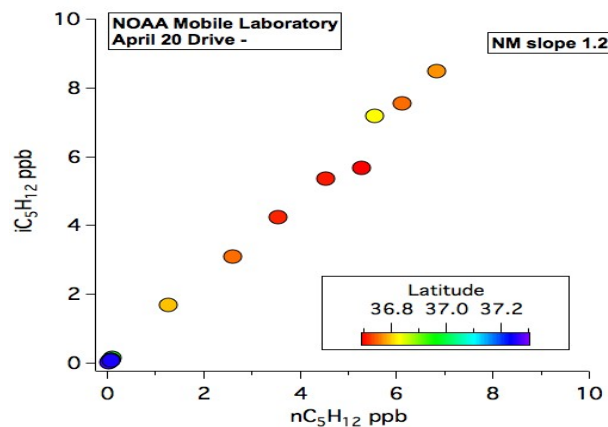
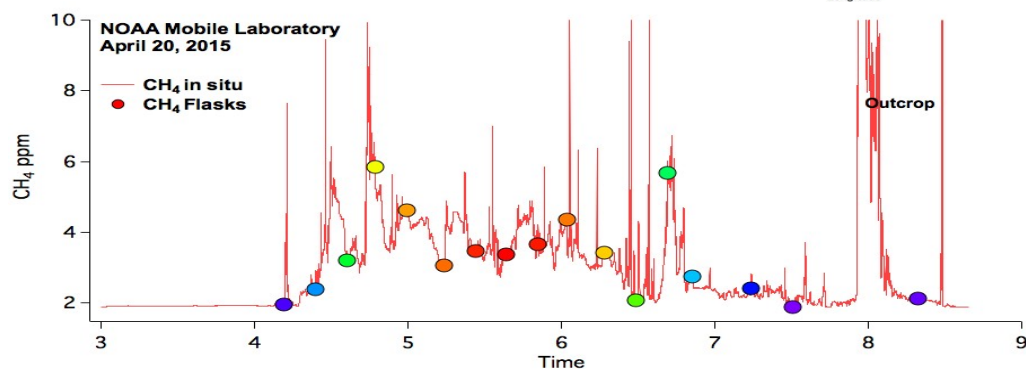
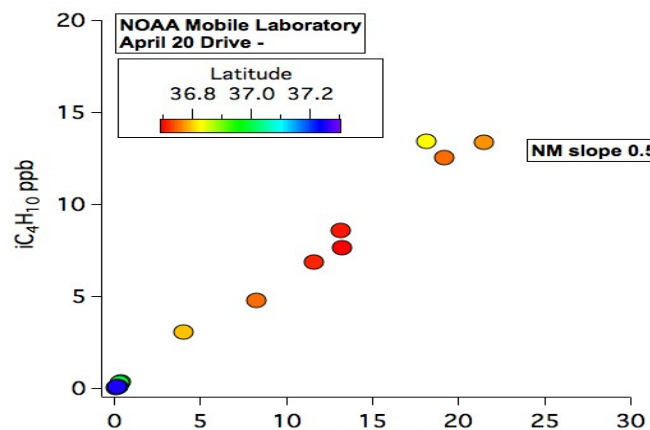
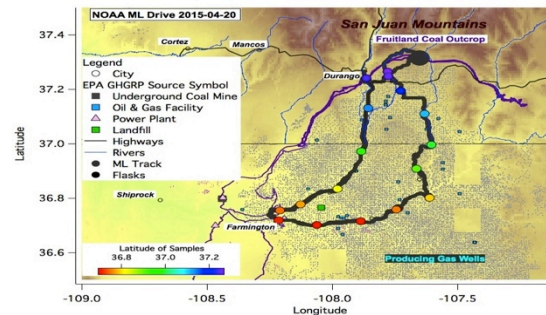
April 20 – Flask data

NOAA GMD MAGICC and Perseus

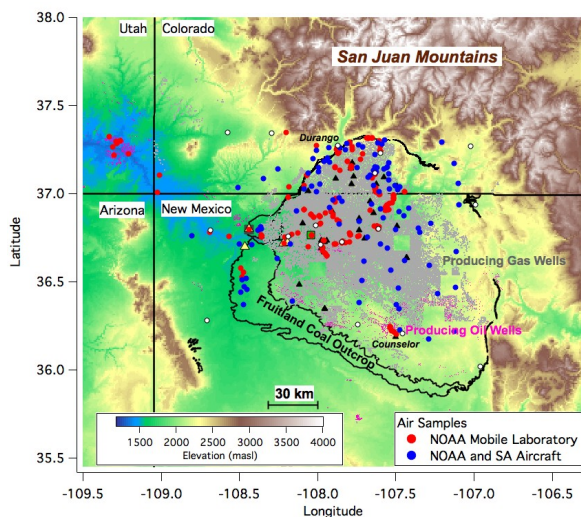
- VOCs enhanced in southern portion of the drive, NM side



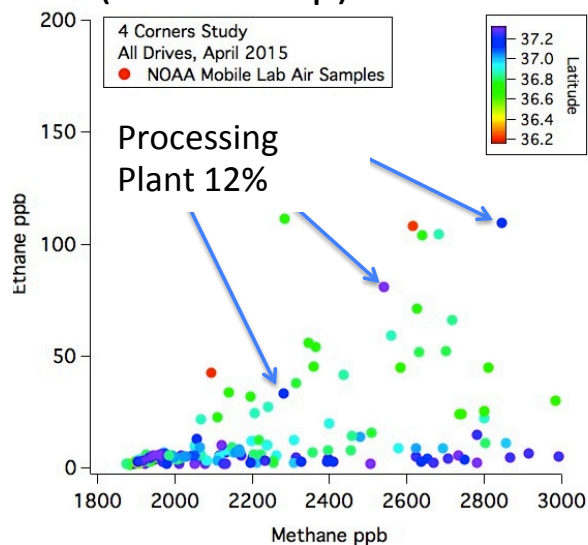
Several HC enhanced in NM



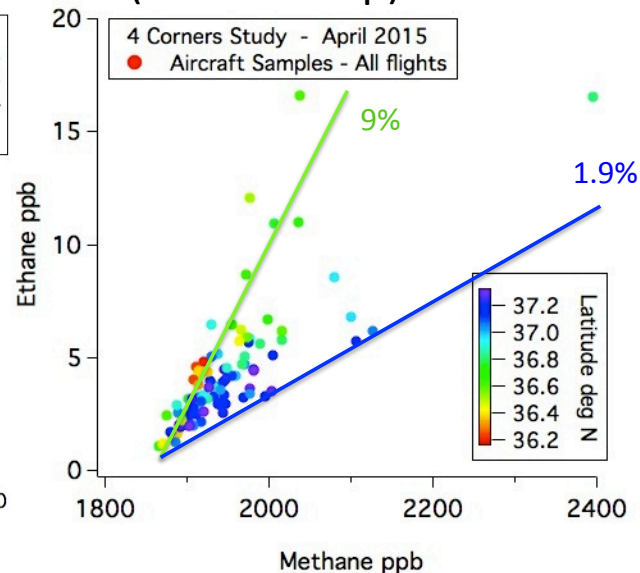
N-S Gradient in ethane:methane



Ground samples
(red on map)

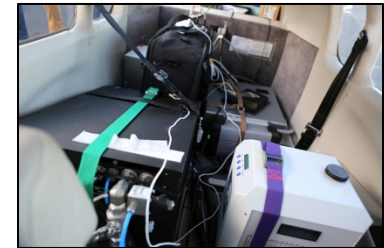


Aircraft samples
(blue on map)



- ~ 300 discrete air samples were analyzed at NOAA Boulder lab for over 50 species. CH₄ using GC-FID (NOAA MAGGIC) and NMHC using GC-MS (NOAA Perseus).
- Both ground and aircraft samples show a N-S gradient in CH₄ to C₂H₆ enhancement ratios
- CH₄ plumes in CO (mostly CBM) show very low ethane except in a processing plant plume.

Aircraft Data Analysis

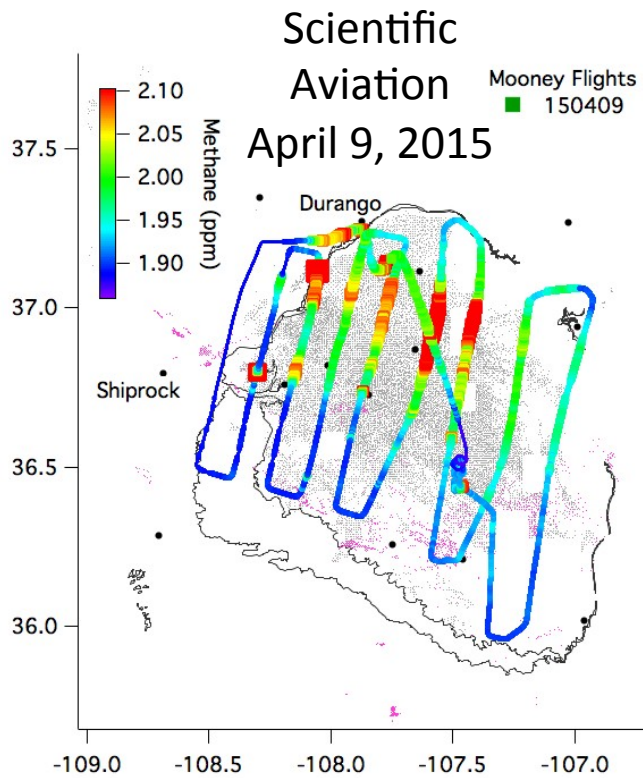


In-situ
Methane
(Picarro) and
Ethane
(Aerodyne)

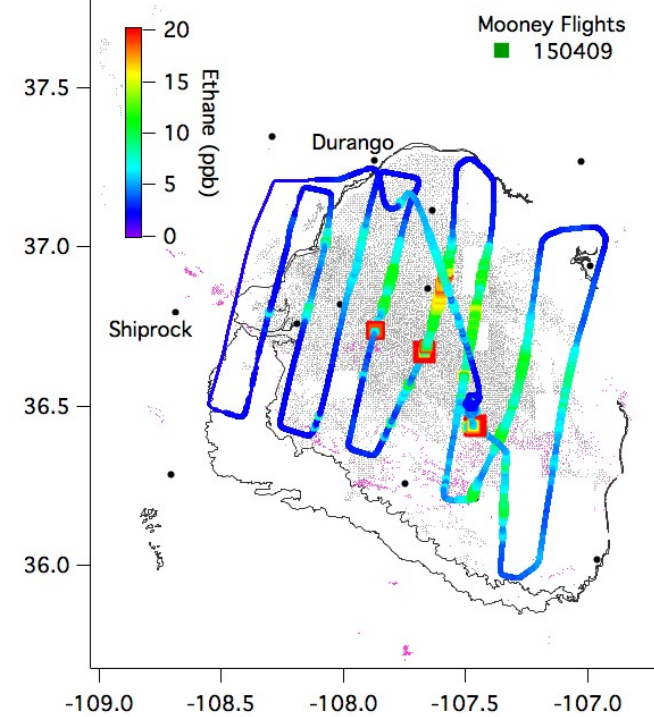
SA Flight operations: Steve Conley, Stefan Schwietzke,
Colm Sweeney, Sonja Wolter, Tim Newberger

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Aircraft ethane & methane analysis



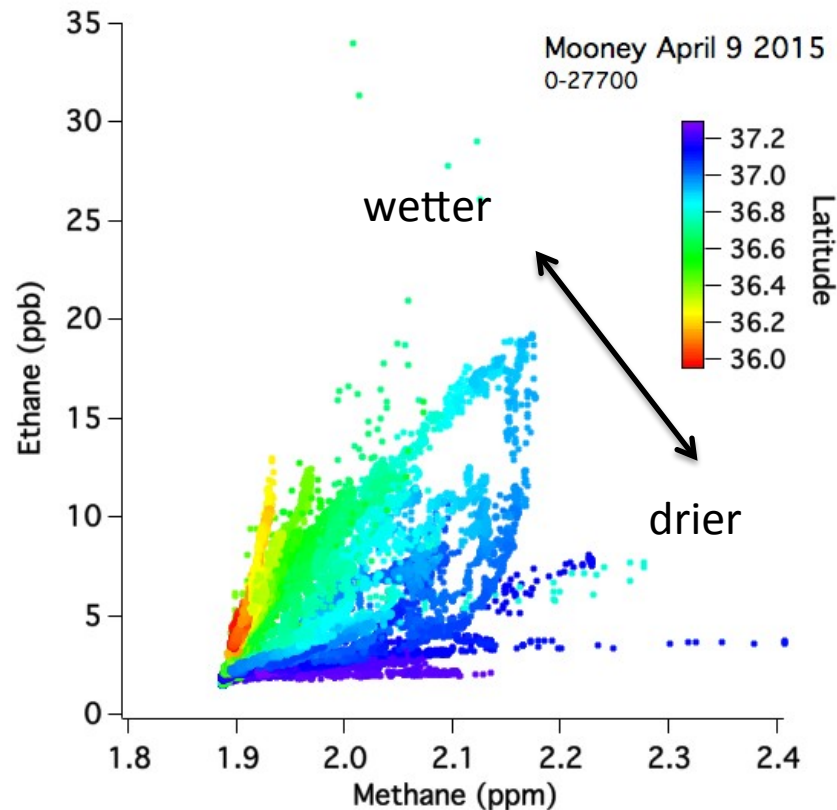
Flight track
color-coded by
Methane (left)
and
Ethane (right)



Aircraft in-situ ethane & methane analysis

SA Mooney
April 9, 2015

And Plot of
Ethane versus
Methane
(right)

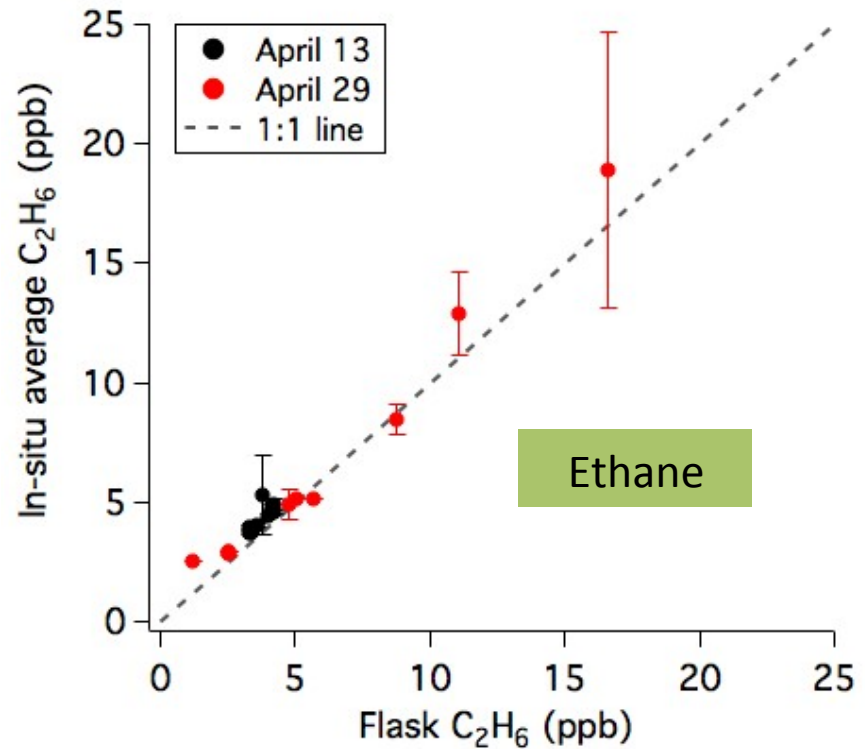
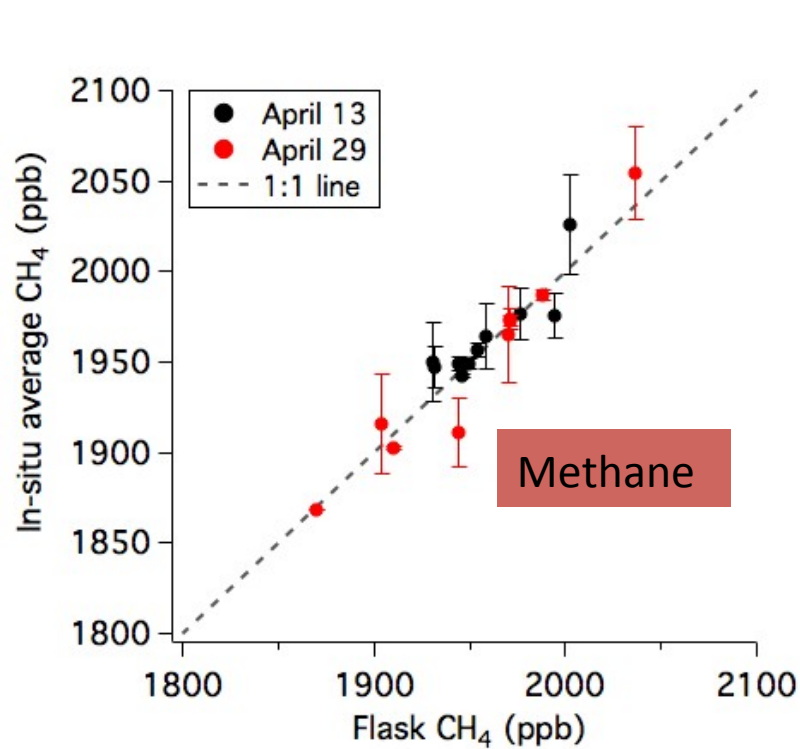


Multiple plumes with different ethane to methane slopes. Note latitudinal gradient in slopes.

→ High resolution Flight Data Analysis

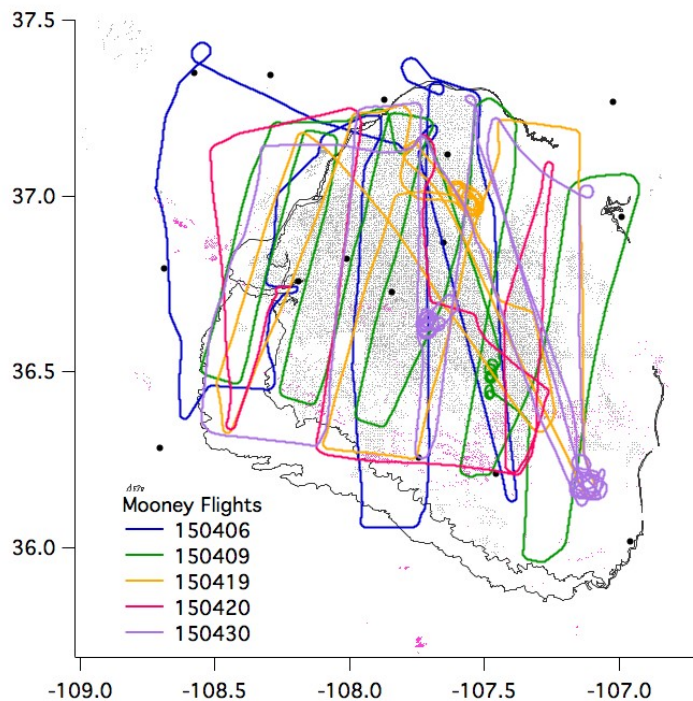
→ Calculate ethane-to-methane slope for segments of track

QA/QC: In-Situ versus Flask data



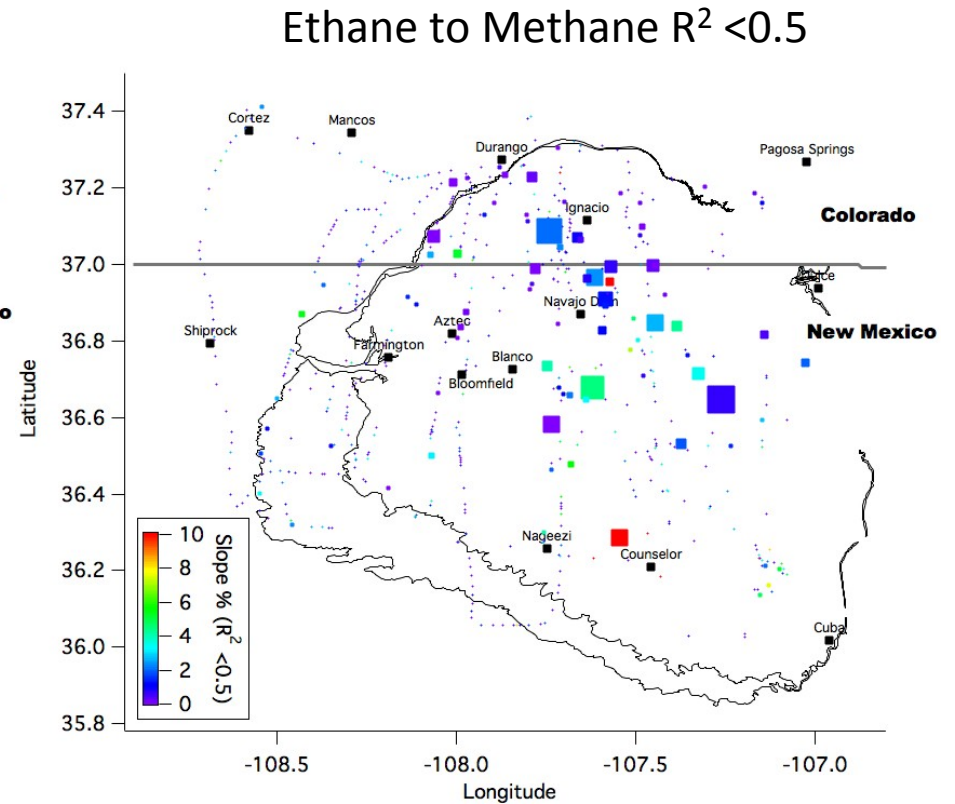
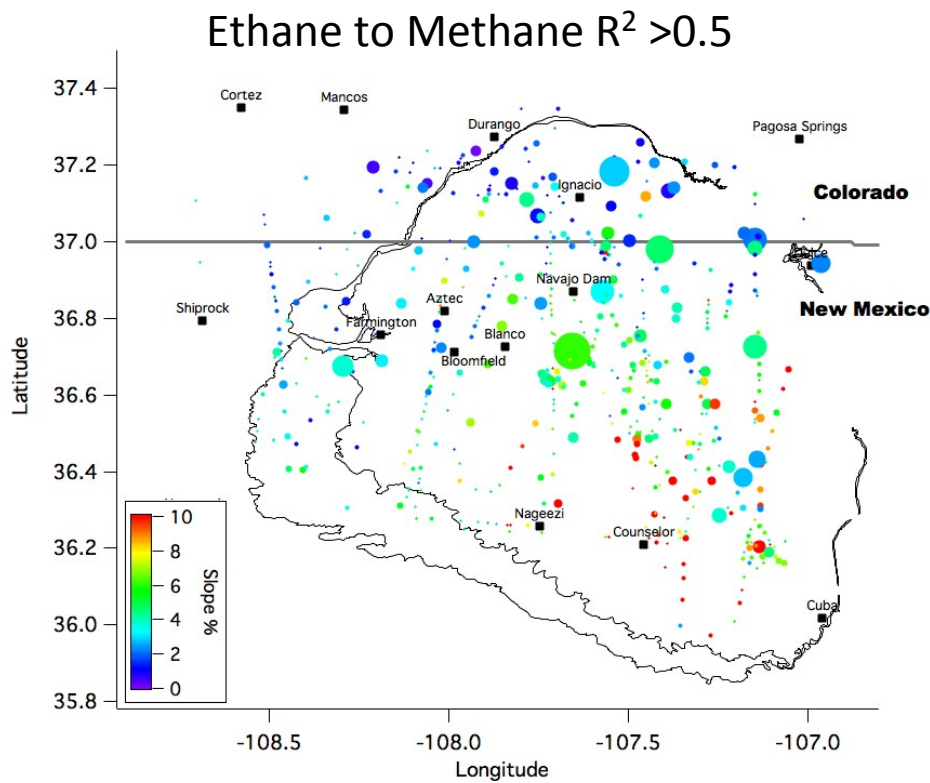
Aircraft samples from April 13 and 29, 2015 flights
Flask data versus 30 sec in-situ data average

Five SA Survey flights – April 2015



- Wind from SW to W depending on day
- Mean Wind Speed
 - Minimum 3.5 m/s on April 9
 - Maximum 11.5 on April 20
- Ground covered (at altitude < 3,000 masl):
 - CO Total 1493 km
 - NM Total 4091 km

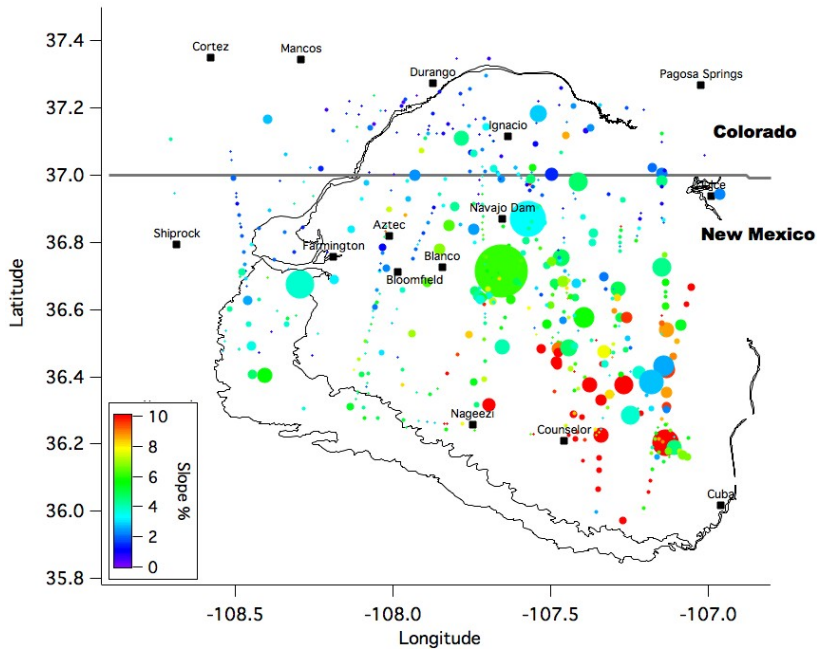
Detected Methane Plumes – Survey flights



Size of symbol scales with size of plume

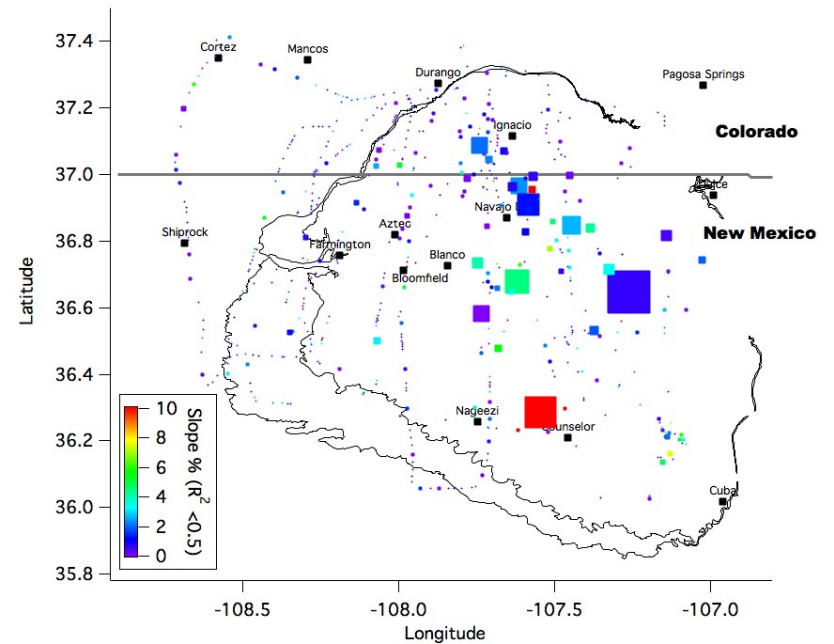
Detected Ethane Plumes – Survey flights

Ethane to Methane $R^2 > 0.5$

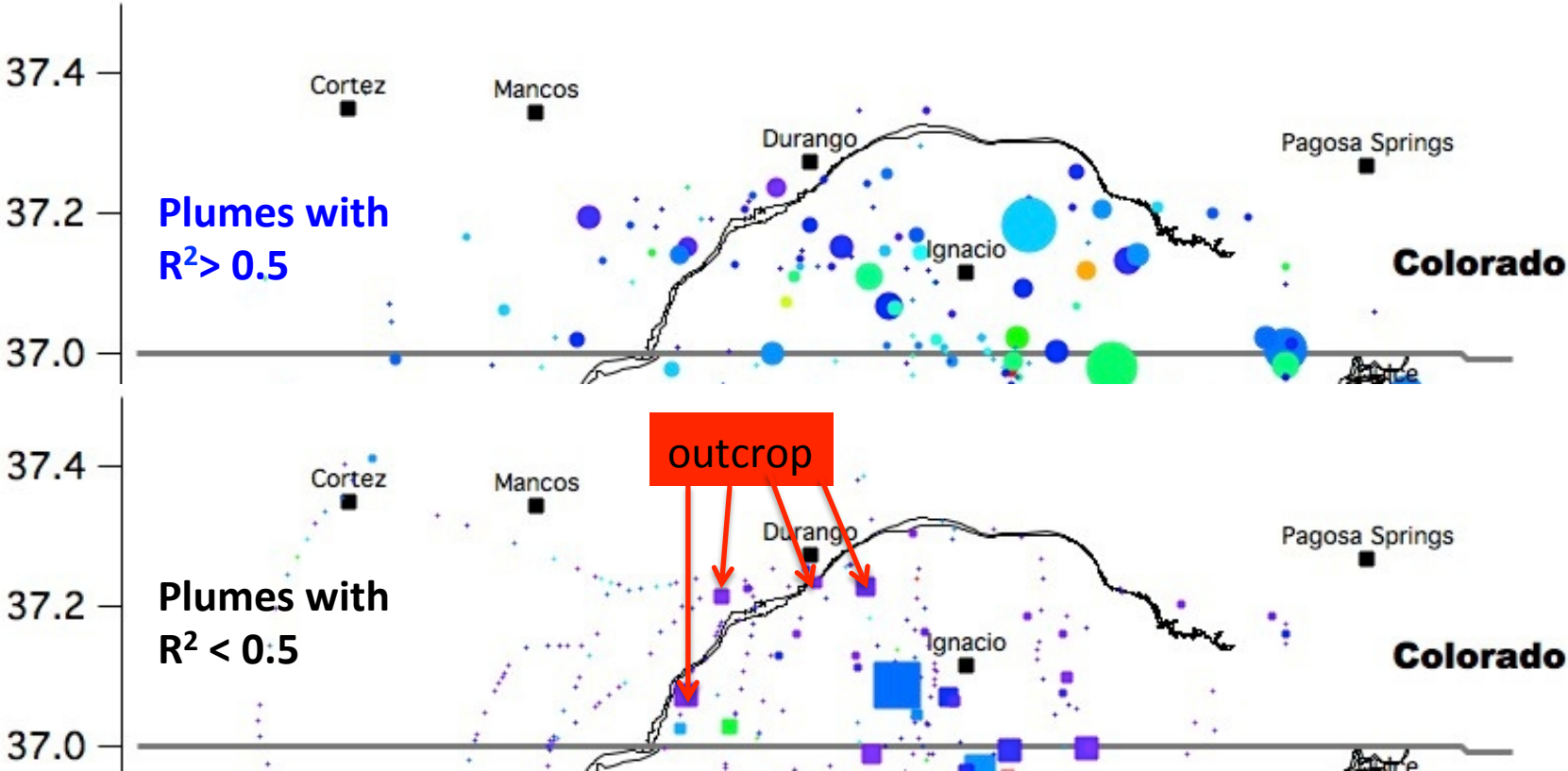


Size of symbol scales with size of plume

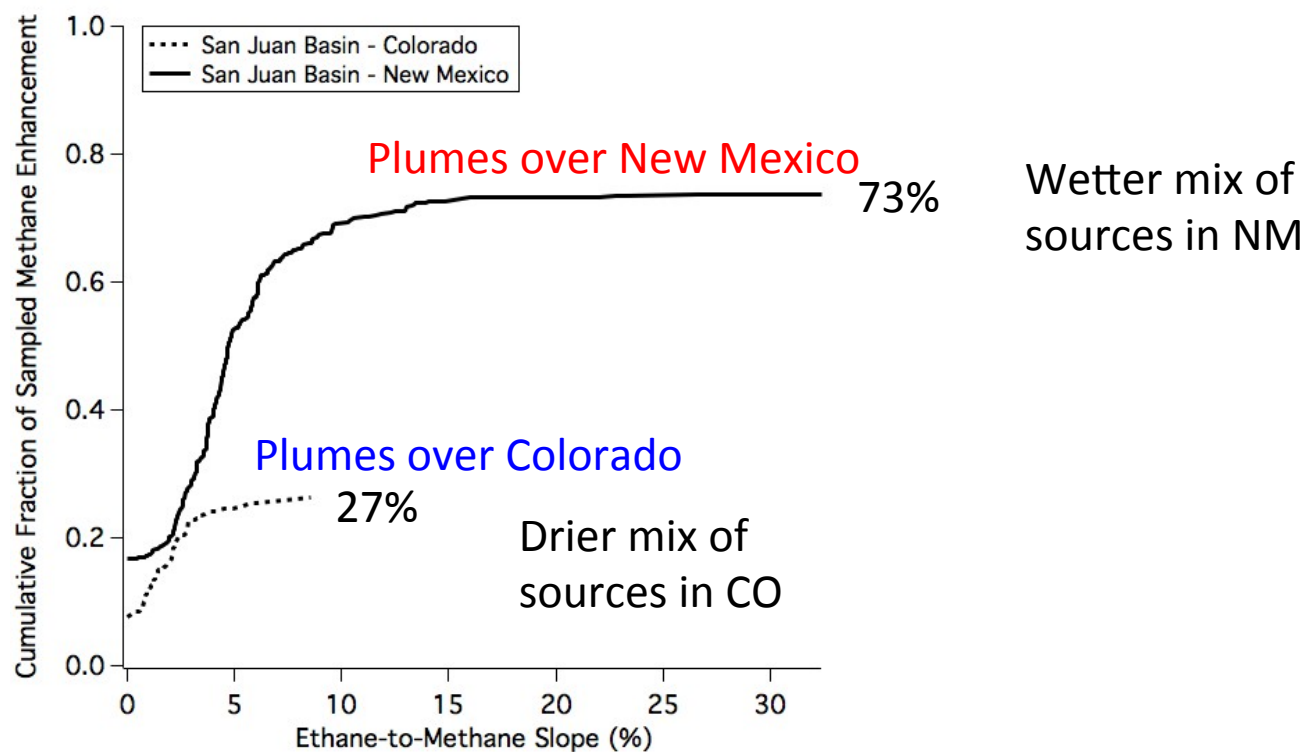
Ethane to Methane $R^2 < 0.5$



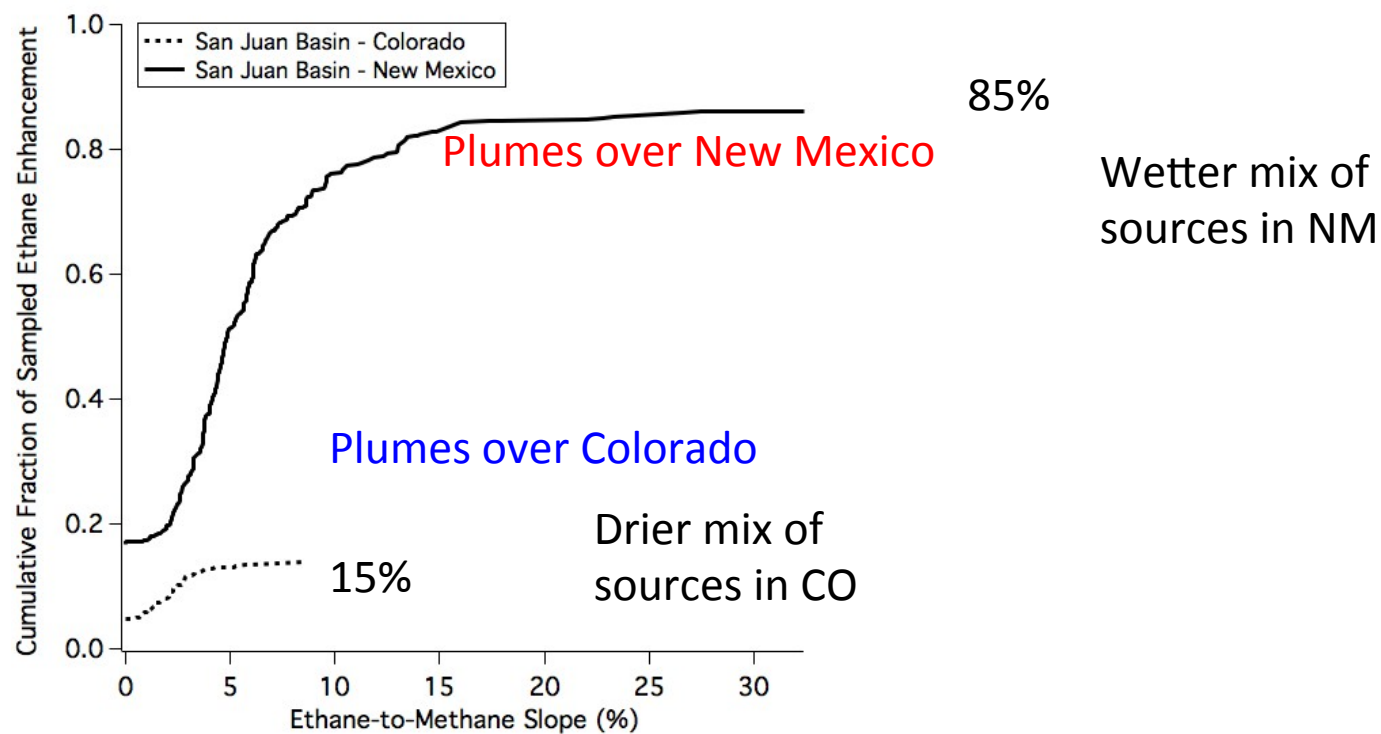
Zoom on Colorado



Cumulative distribution of methane enhancements as a function of slope



Cumulative distribution of ethane enhancements as a function of slope



Conclusions

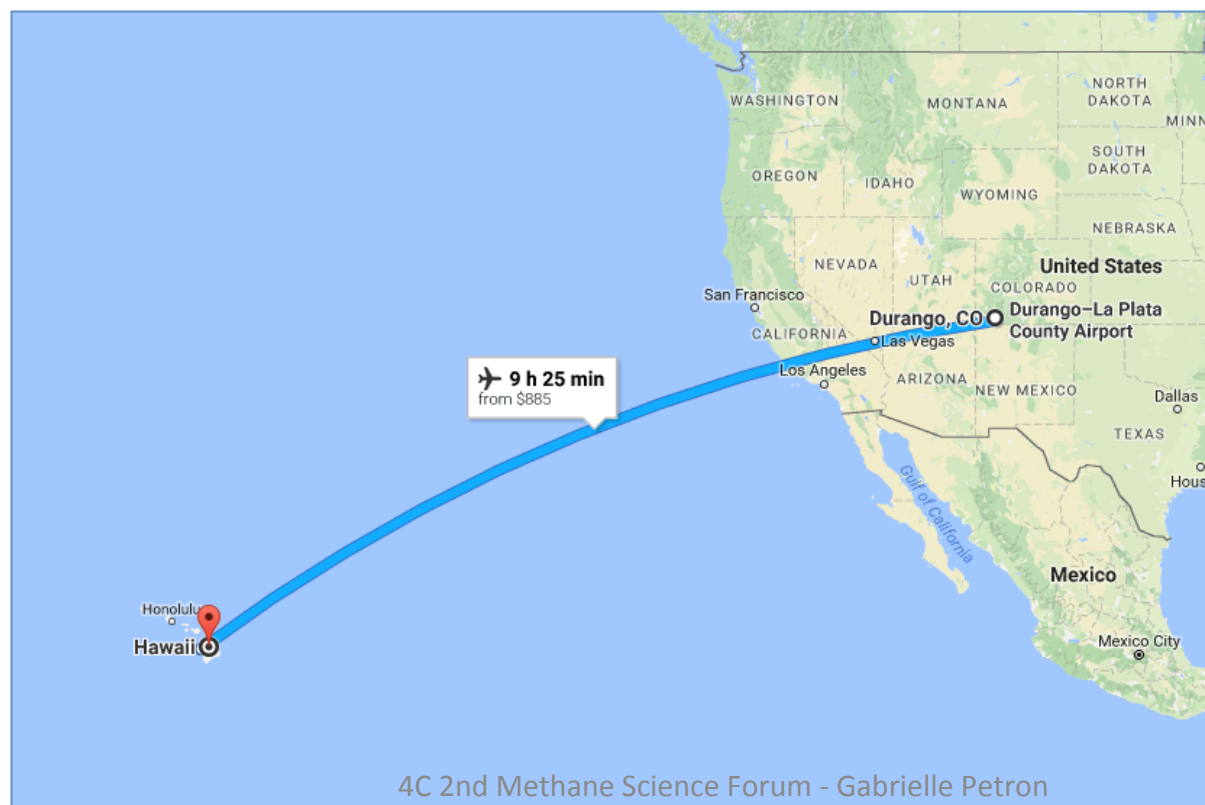
- *April 2015 was a successful campaign. Thanks to dedicated science teams and support from many local agencies, companies and individuals.*
- San Juan Basin CH₄ regional anomaly is an example of night-time/early morning emissions trapping in a topographical basin with “known” CH₄ sources.
 - 10 am satellite overpass will capture some of the highest atmospheric CH₄ columns when low surface wind conditions prevail (often)
- Methane and NMHCs accumulate at night and early morning in low-lying areas
- Different sources have different emission compositions esp. different ethane to methane slopes.
- Aircraft survey data analysis shows:
 - majority of detected CH₄ plumes have correlated CH₄ and C₂H₆.
 - Majority of detected CH₄ and C₂H₆ plumes were over NM
- **Scientific Paper should be available later this year**

ADDITIONAL SLIDES

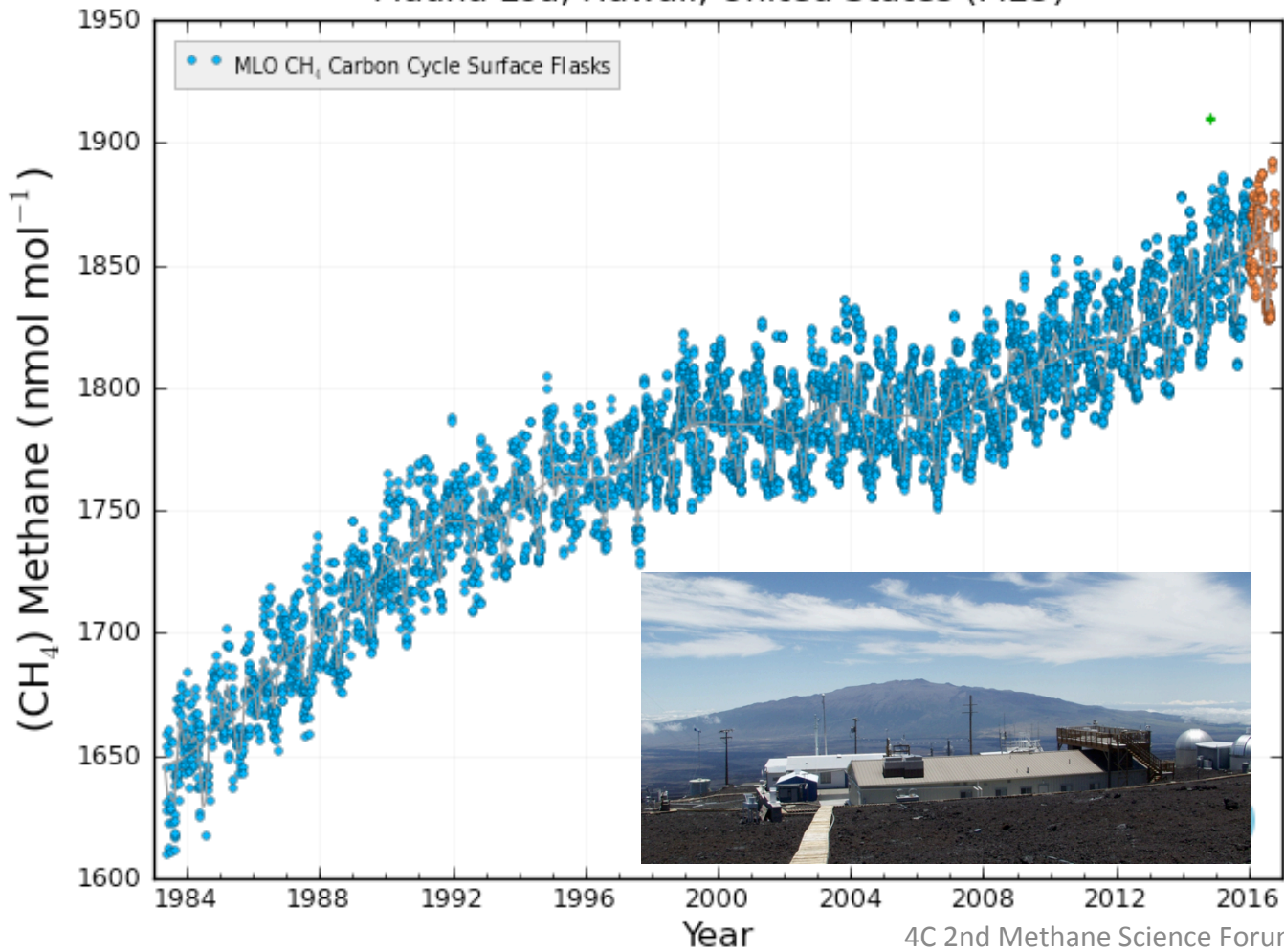
What does methane look like in northern hemisphere remote location?



NOAA Mobile Lab
April 20, 2015
7am Stop at gas station
in Ignacio, SUIT Land, CO



Mauna Loa, Hawaii, United States (MLO)



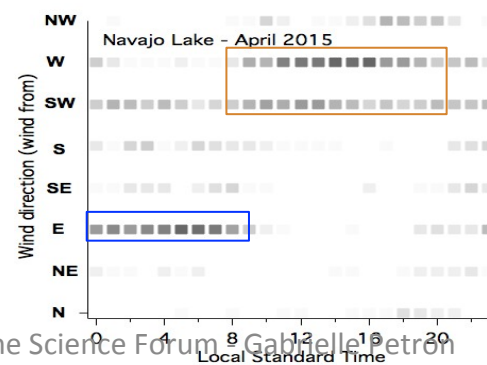
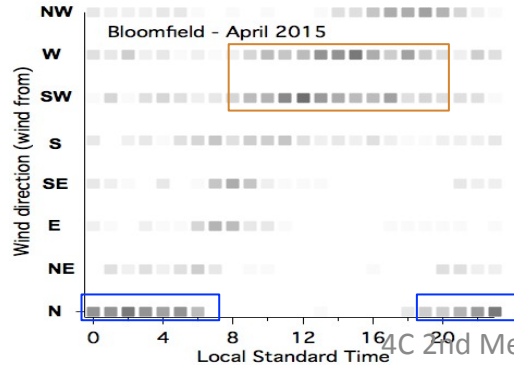
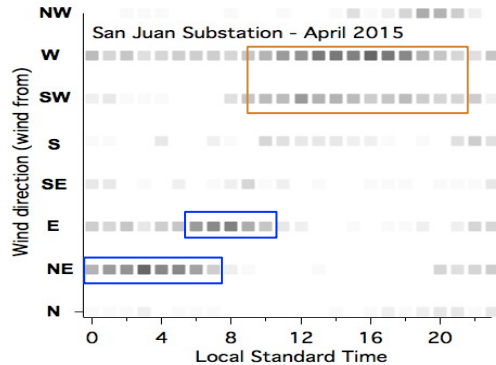
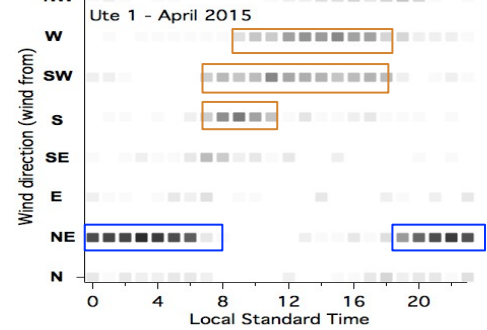
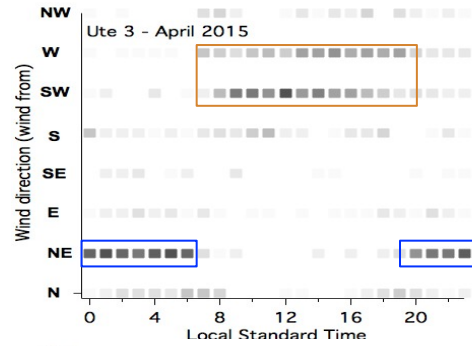
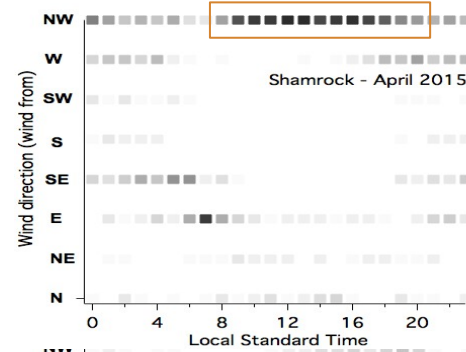
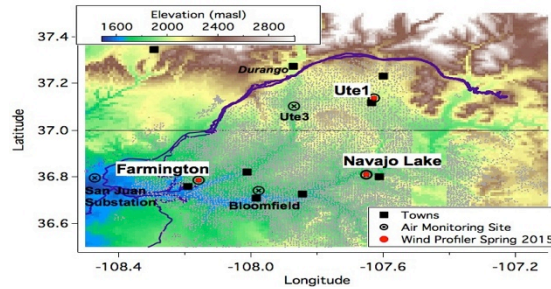
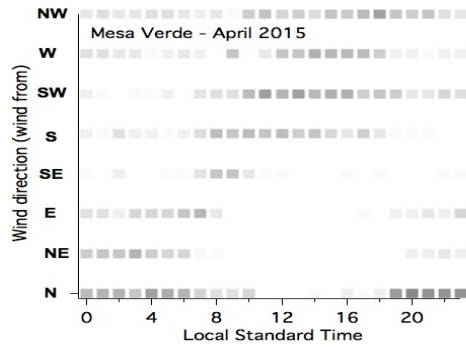
NOAA GMD
Carbon cycle

Methane dry air
mole fraction
record for flasks
collected at
Mauna Loa

Ed Dlugokencky

Mean Diurnal Cycle of Horizontal Wind Direction Mean April 2015

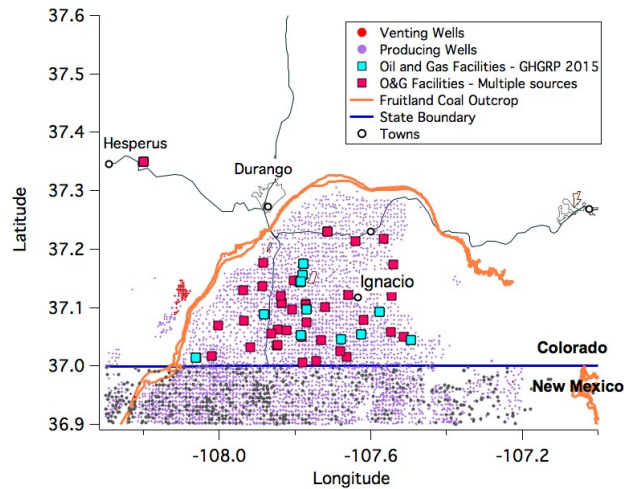
Data from EPA AQS (SUIT, States, NFS, NPS)



Keeping tabs on sources: a real challenge

CO : Compressor Stations

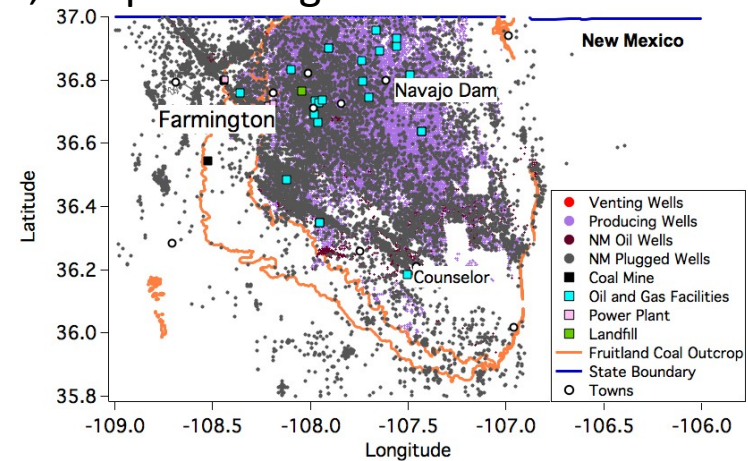
Missing facilities in GHGRP and State databases



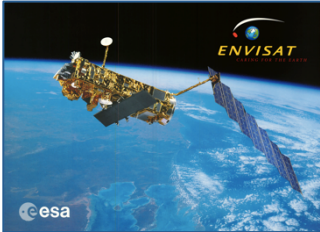
Until 2015 gas gathering stations were not covered by EPA subpart W and often did not meet reporting requirements for subpart C. State databases do not have all facilities and often do not include facilities on Tribal Lands.

NM : Plugged & Abandoned Wells

> 10,000 known plugged and abandoned wells
> 20,000 producing wells



Current EPA GHGI inventory does not include emissions from abandoned wells. Only published work on this in the US was done in Pennsylvania.



SCIAMACHY CH₄ atmospheric column retrievals

Global Product

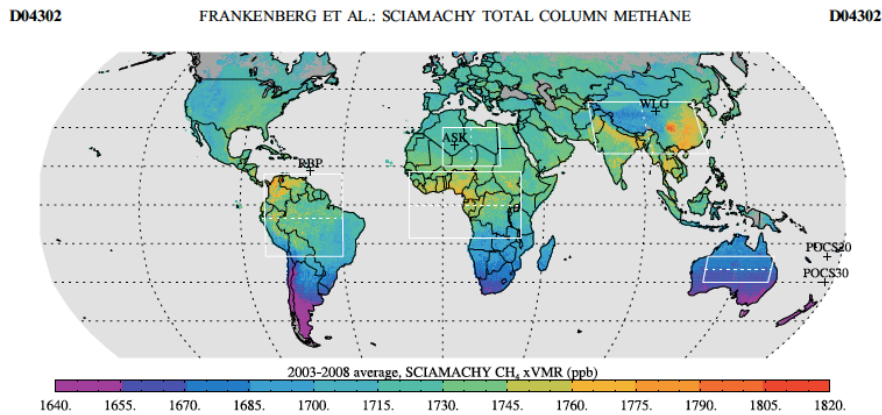
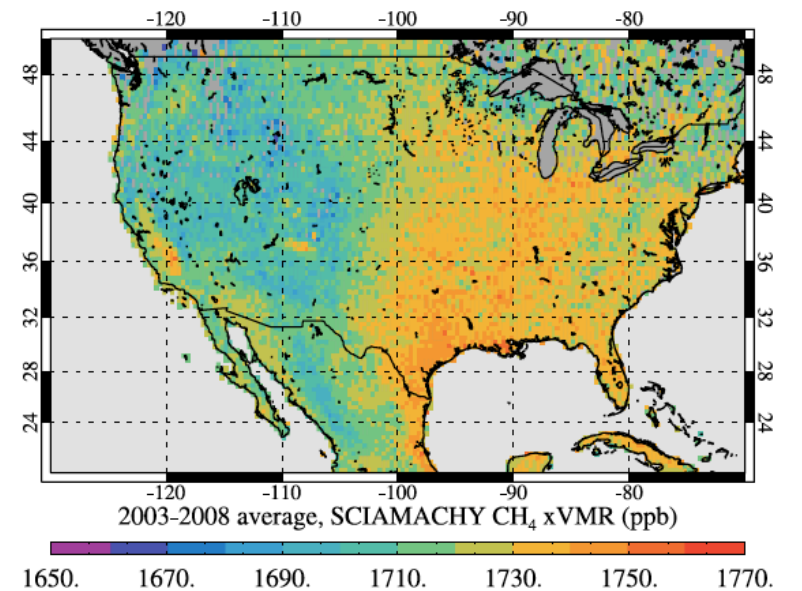


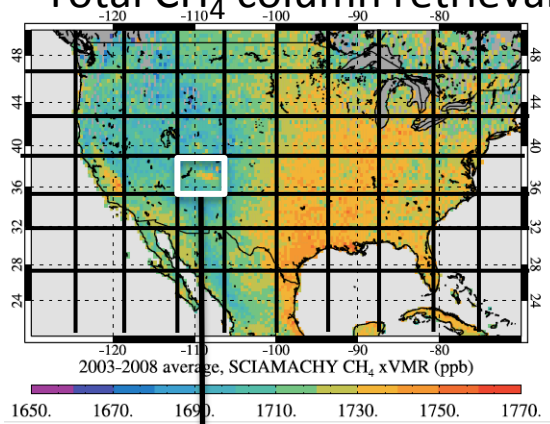
Figure 6. The 2003–2008 average of methane column-averaged mixing ratios retrieved from SCIAMACHY. Gridding has been performed on 1/3° by 1/3°. White boxes indicate regions where a separate time series of averaged SCIAMACHY data are shown in Figures 8–12. (The dashed white line indicates the east-west or north-south division in the respective time series figures.) The locations of some NOAA ground-based cooperative air sampling sites are shown as crosses.



- total CH₄ column (x,y,2003-2009) over land pixels [Frankenberg et al, JGR, 2011]
- 10am overpass time

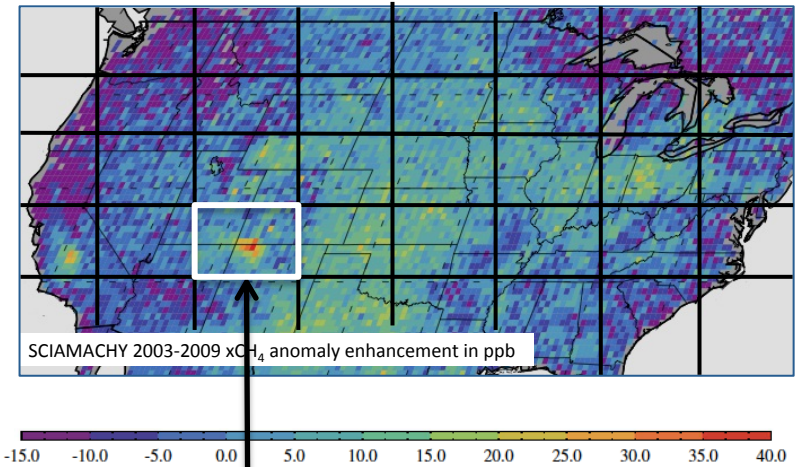
From total columns to regional anomalies

Frankenberg et al. 2011
Total CH₄ column retrievals



Calculate regional average for every tile (2003-2009)

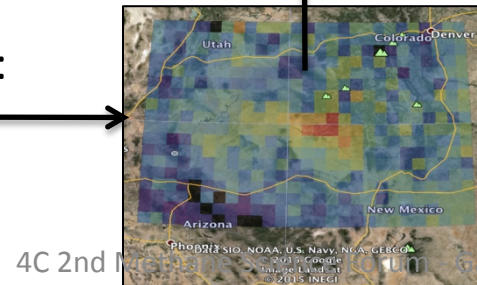
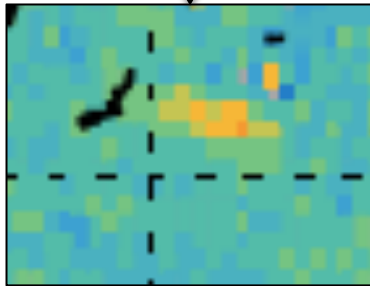
Kort et al., 2014:
Mosaic of regional anomalies



For each pixel in each tile:

Total CH₄ column -
Tile regional average

Regional Column
anomaly
(x,y,2003-2009)

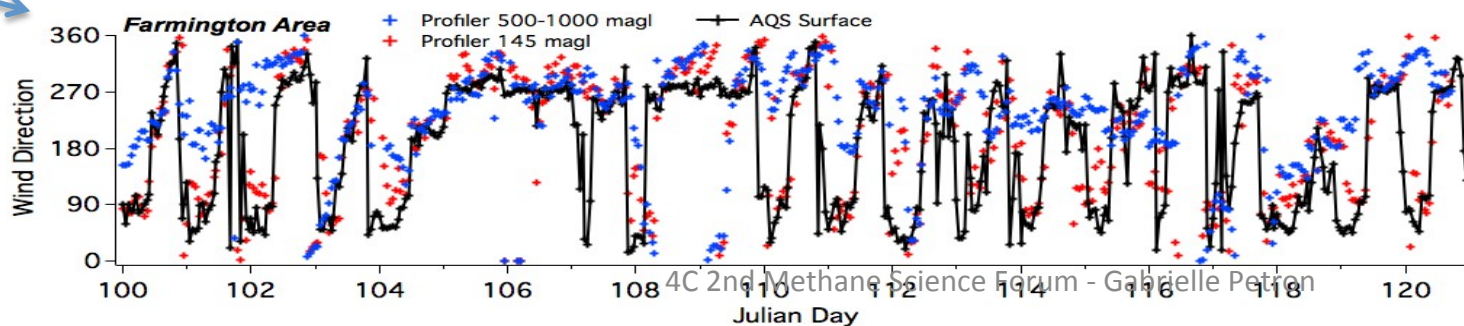
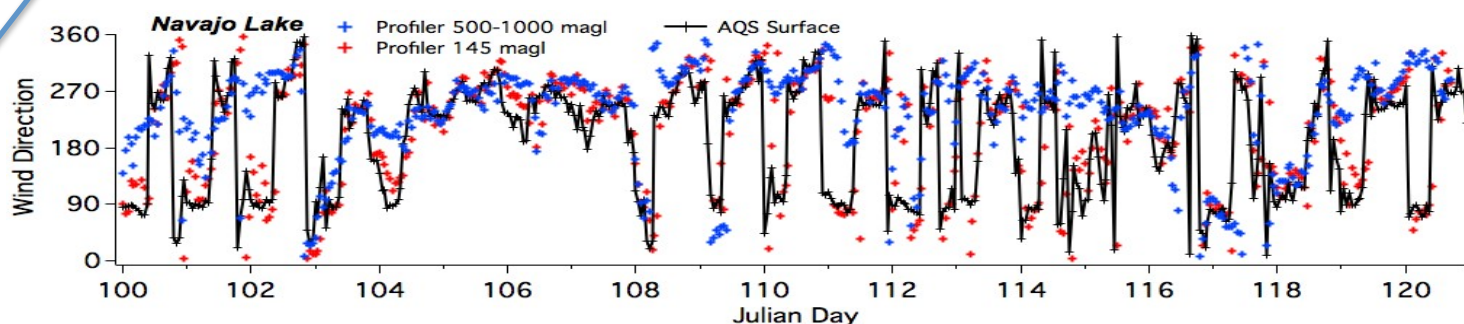
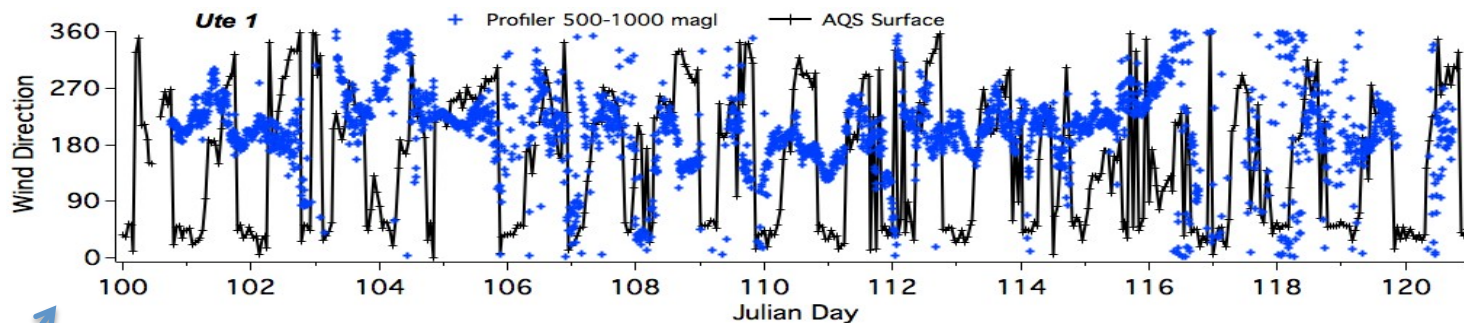
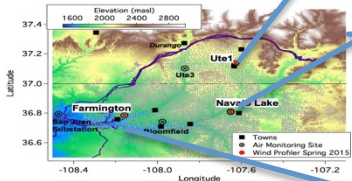


4C 2nd I

rielle Petron

Wind Direction
April 10-30 2015

Profiler and
closest AQS
surface station



For 3 altitudes:
Surface
145 magl
500-1000 magl

Wind Speed
April 10-30 2015

Profiler and
closest AQS
surface station

