Pollutants and policy:
from satellite to smartphone – impacting behaviour for a cleaner atmosphere

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Thanks:

Allen Huang, Liam Gumley, Kathy Strabala CIMSS/SSEC team for

- **Products**
- **Training**

=> Products and abilities that weren't available to practitioners 15 years ago.

Introduction

- Air pollution has many negative impacts: health, acid rain, global warming

- Link air pollution to source => policy to address source AND individual behaviour

- CO and biomass burning

- As an example look at
  - CO - biomass burning: vegetation fires and household combustion
  - CO2 – car exhausts,
  - NO2 - Car exhaust fumes (coal-fired power stations and other industry)
  - SO2 - Emitted by power plants and other high-stacks (e.g. smelters at mines)
  - NO2 + CO household combustion from semi-formal and informal settlements was identified as the predominant source of NO2 and CO

- Models and ground stations not optimal in areas with poor coverage
(e.g. Edwards et al. 2006, Hyer et al. 2007, Ichoku et al. 2012, Ichoku & Ellison, 2013, Reuter et al. 2014, Lindermaier et al. 2014)

- **Synergistic use of satellite products**

2013 EUMETSAT/AMS conference
Vienna, 16–20 April

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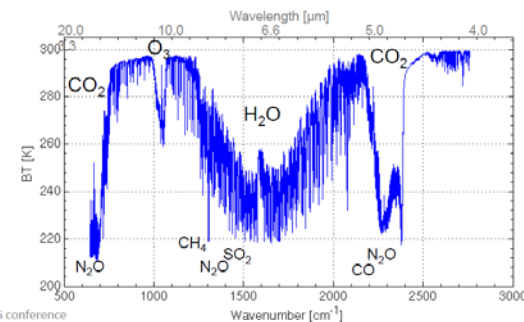
Sample Data

A variety of instruments and satellites = resolutions and formats

- CO
  - Infrared Atmospheric Sounding Interferometer (**IASI**) on board **MetOp-A**/**-B**
  - 1. Level 2 from LATMOS/Ether Atmospheric Chemistry Data Centre
  - 2. NUCAPS from NOAA Comprehensive large array-data stewardship system (CLASS)

- CO2
  - Atmospheric Infrared Sounder (**AIRS)** on board NASA **Aura**
  - AIRS/Aqua Level 3 8-day CO2 in the free troposphere (AIRS-only) (AIRS3C28)
  - NASA Goddard Earth Sciences Data and Information Services Center (GES DISC) - Mirador

- NO2
  - Ozone Monitoring Instrument (**OMI**) on board NASA **Aura**
  - GES DISC - Mirador

- SO2
  - Ozone Monitoring Instrument (**OMI**) on board NASA **Aura**
  - OMIOMSO2e OMI/Aura Sulfur Dioxide (SO2) Total Column Daily L3 Best Pixel Global 0.25deg Lat/Lon Grid (OMSO2e)
  - GES DISC - Mirador

- Burned area – Giglio MODIS global product

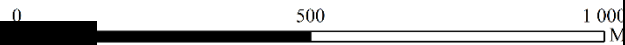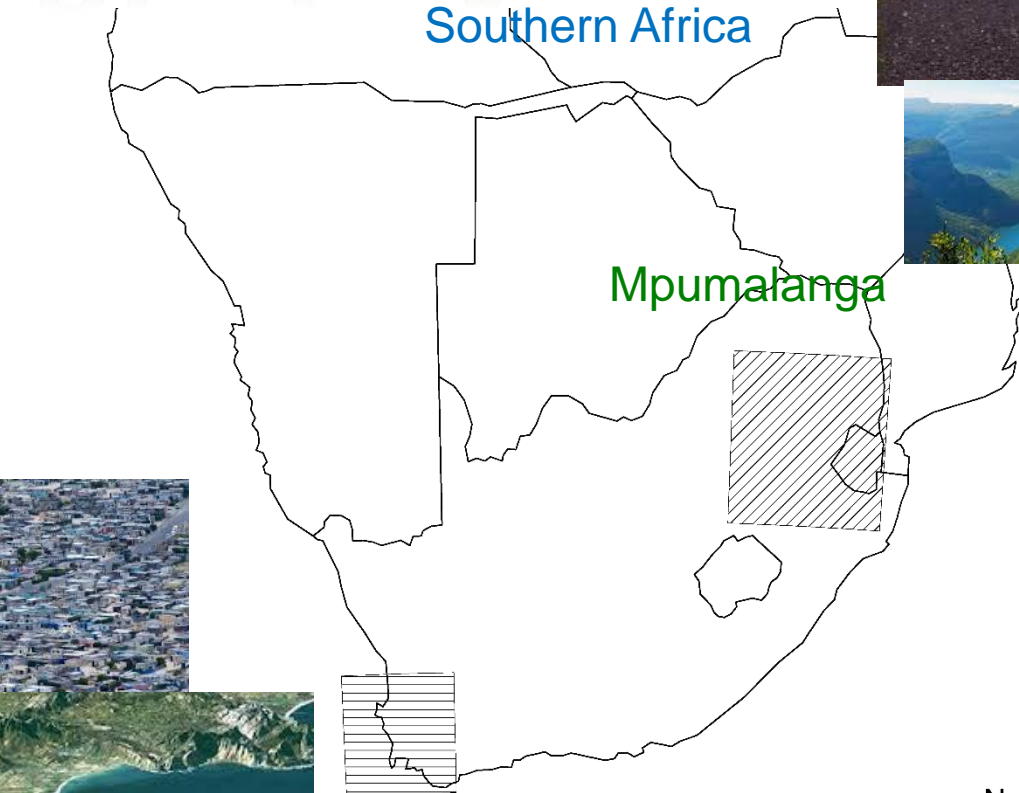# Study Areas
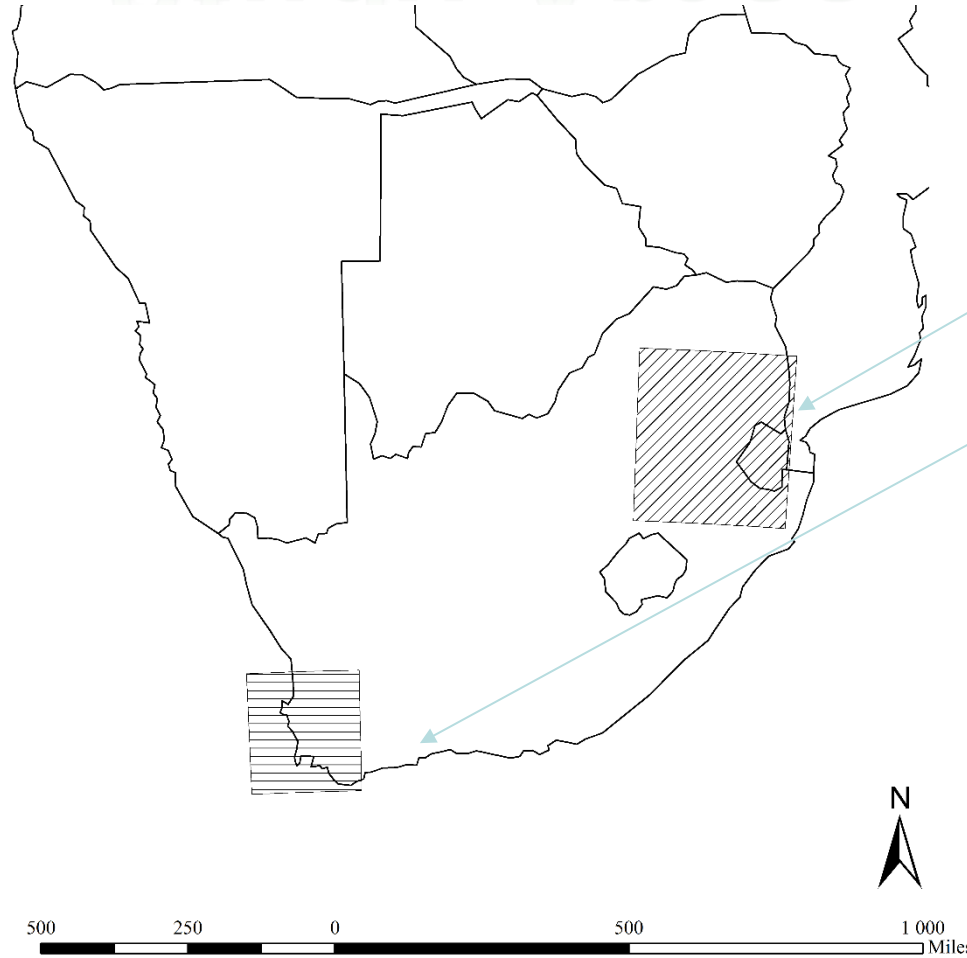
Southern Africa

Mpumalanga

Fynbos

Study Areas
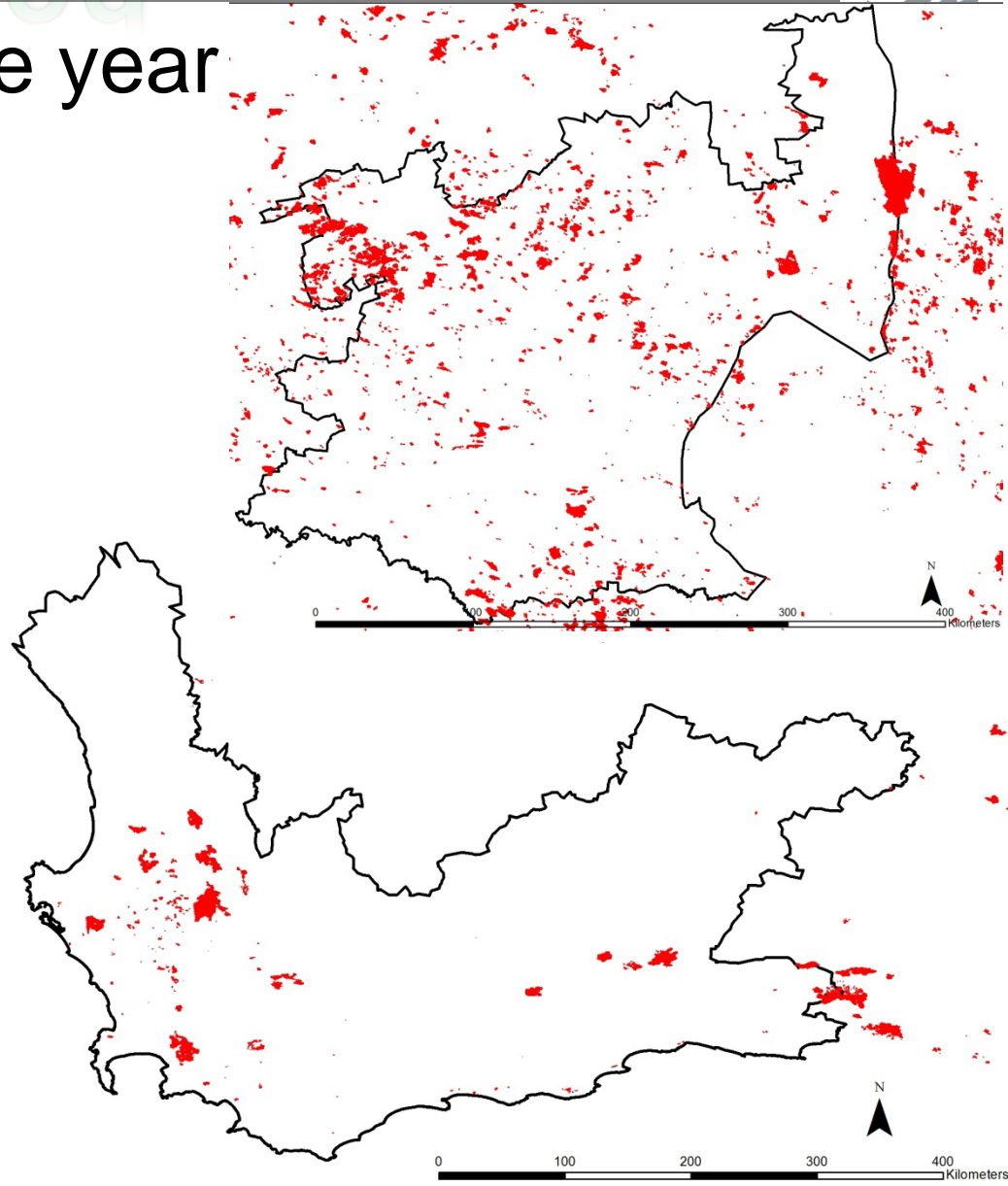
Southern Africa

Mpumalanga

Fynbos

Mountain fynbos:
15 yr old
8/12 to 20 tonnes/ha
available fuel
Forsyth et al. (2009)

Sour Grassland
Dry Woodland
Moist Woodland
above-average wet season,
4 - 9tonnes/ha
– almost only half the tonnage of fuel in
fynbos, but spreads much faster - due to fine
fuel structure

N

0   500   1 000
M

Study Period

- 2009 due to big fire year

Methods

- Geographically weighted regression of CO and BA
- Tracer gas species
  - How do they differ across study areas?
- Graphs and maps of averages (std deviation):
- Lindenmaier et al. 2014
  - ratio of the change in NO2, NOx, SO2, and CO to the change in CO2
  - E.g. $\Delta SO2/ \Delta CO2$ = unique tracer of power plants
    - $\Delta CO/ \Delta CO2$ = biomass burning
  - (Δ) is considered to be any enhancement compared with the baseline that is observed during clean days.

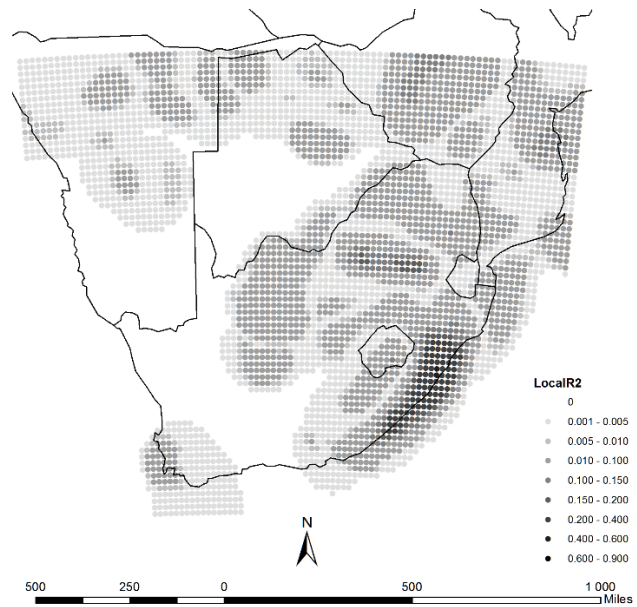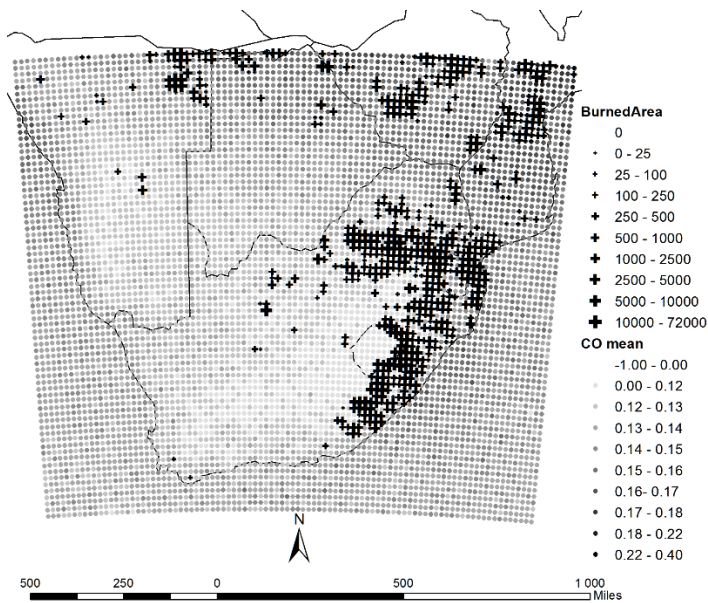- CO and BA - summer
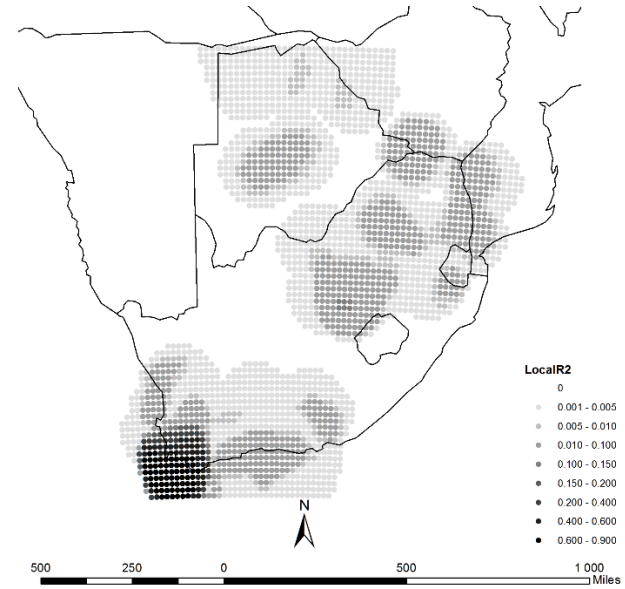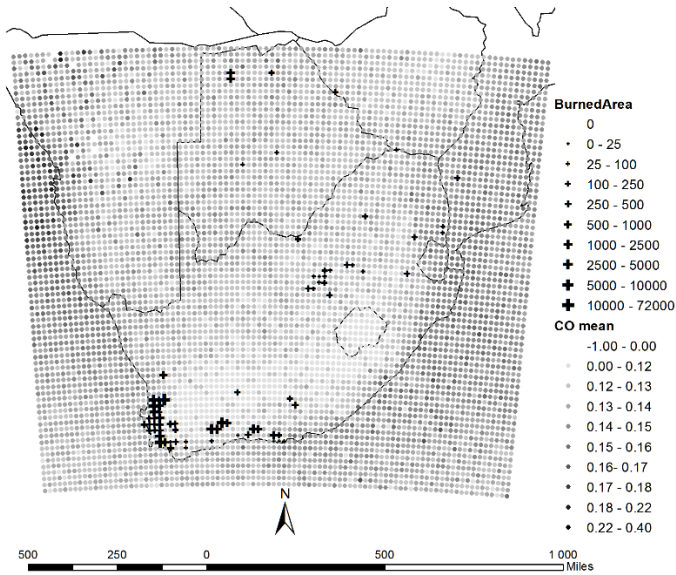
- CO and BA - winter

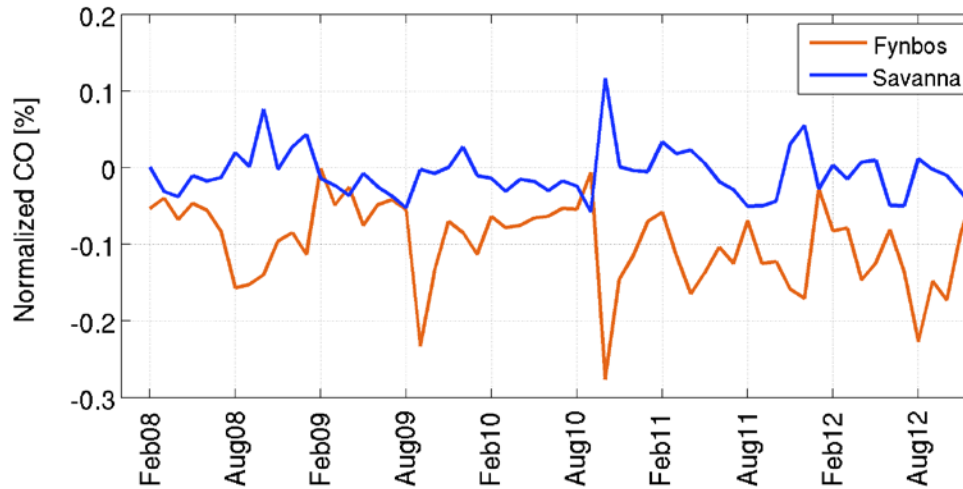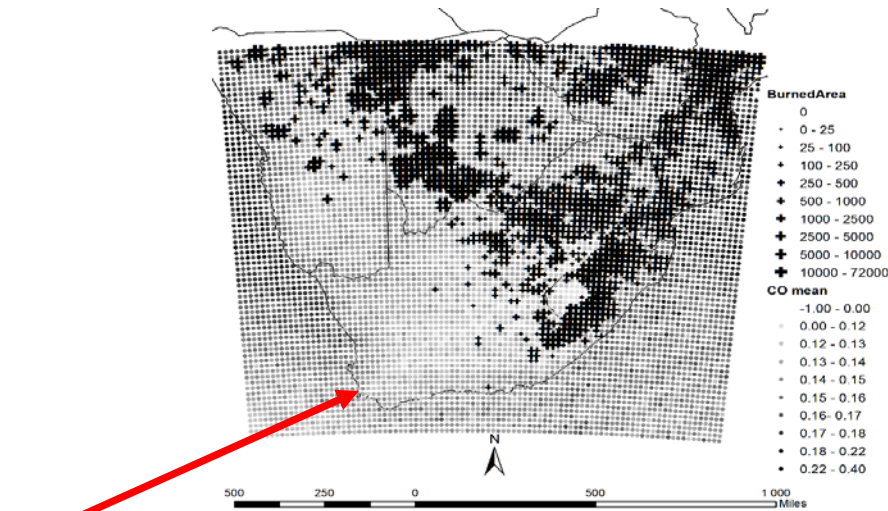- CO and BA – winter (2)
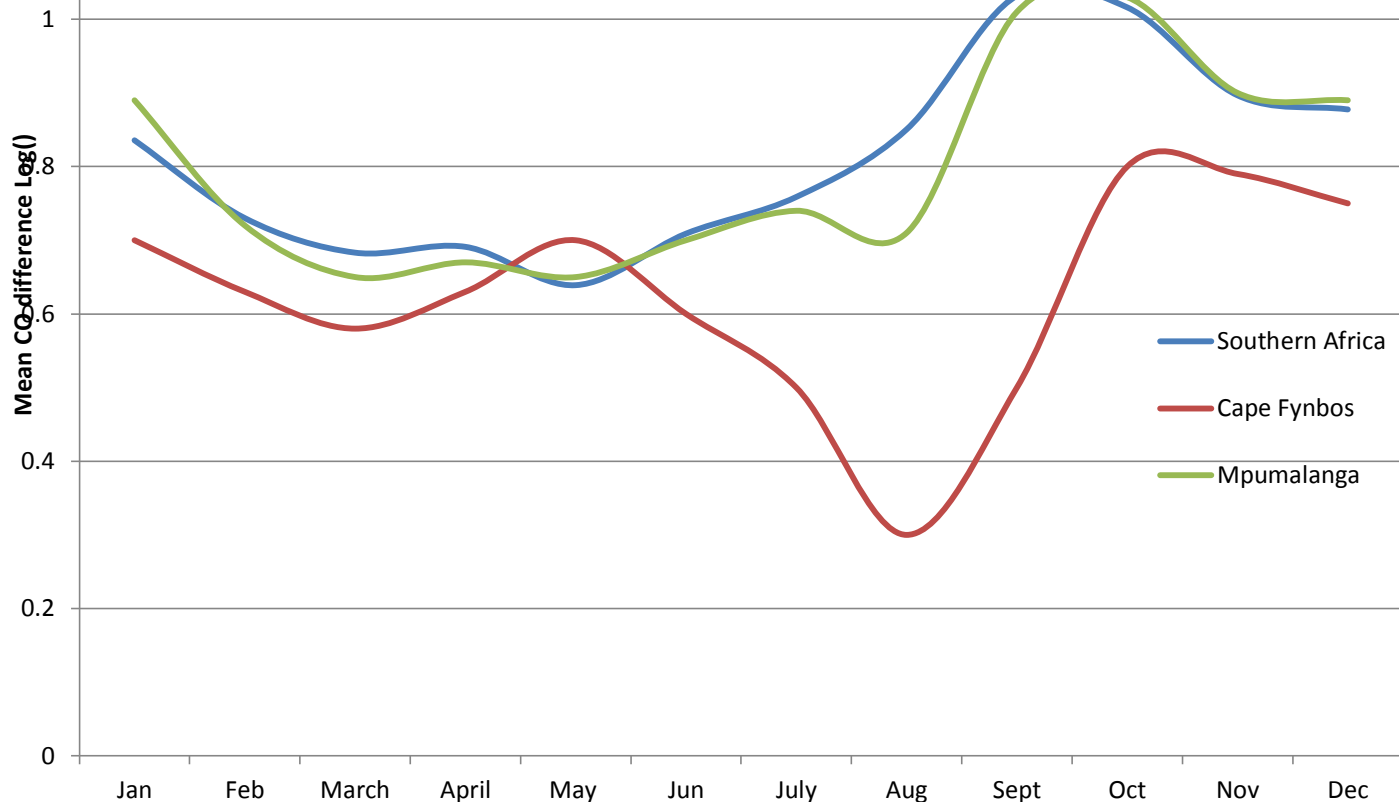

Smith et al. 2013
EUMETSAT

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- CO
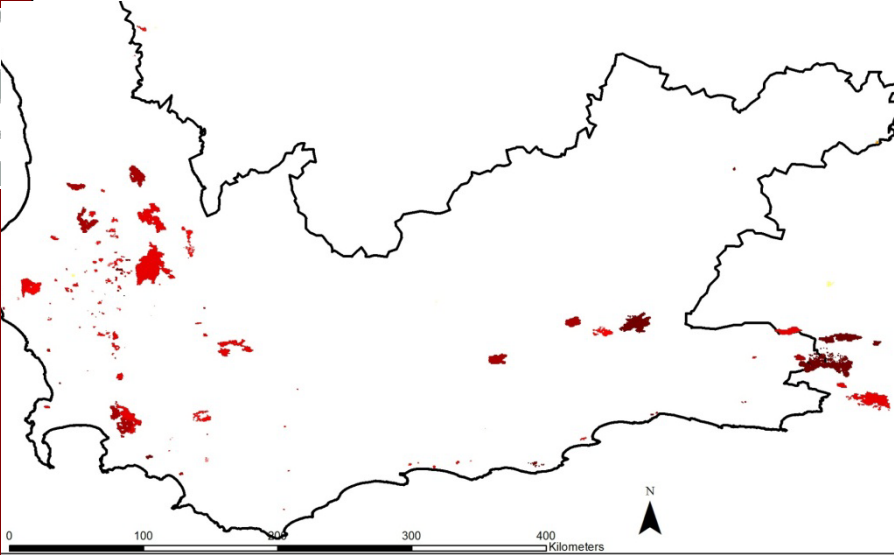 - Particularly biomass burning
  - Long life time (good tracer, but also regional mixing, e.g. Edwards et al. and others)

Area burned (ha) - Western Cape
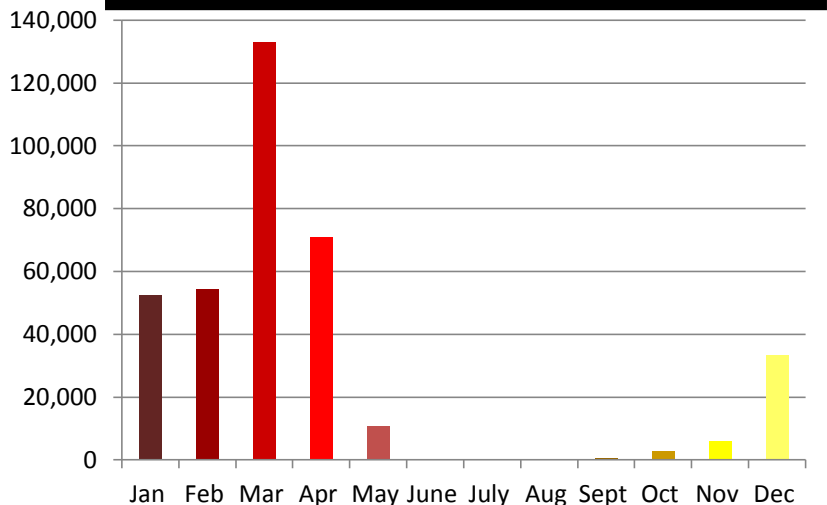
Western Cape 2009:
Total area burned = 363 439ha
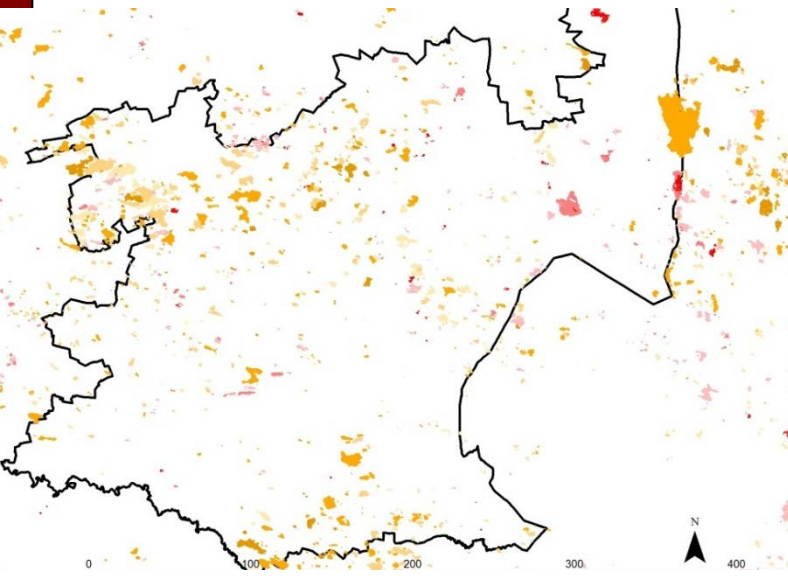
Area burned (ha) - Mpumalanga
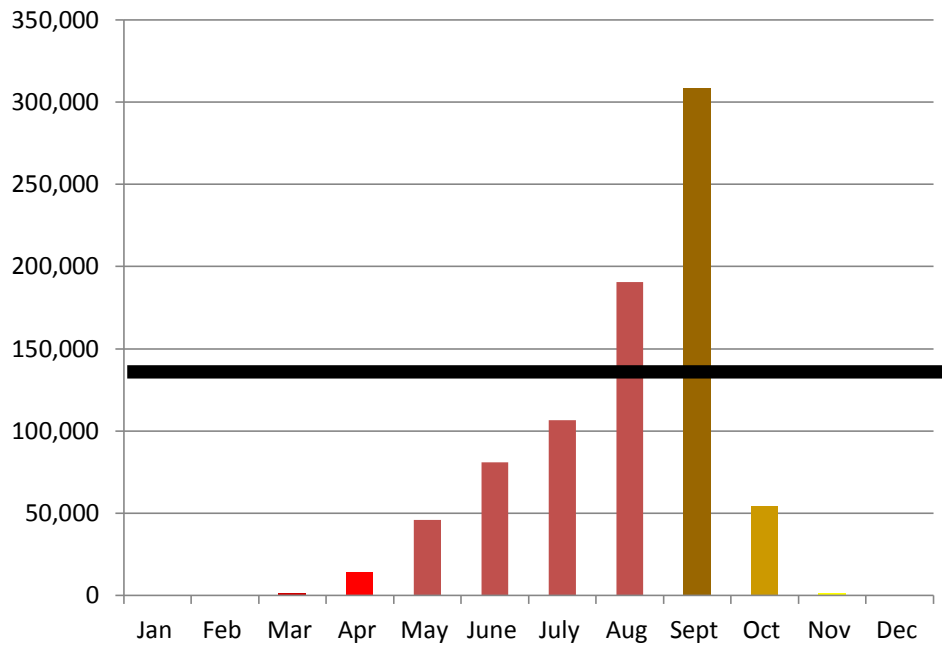
Mpumalanga 2009:
Total area burned = 803 125ha

- NO2
  - Car exhaust fumes (coal-fired power stations and other industry)
  - Difference in NO2 from 'background':

- Δ NO2/ Δ CO

Mean delta NO2/CO

Δ NO2 > Δ CO

Δ NO2 < Δ CO
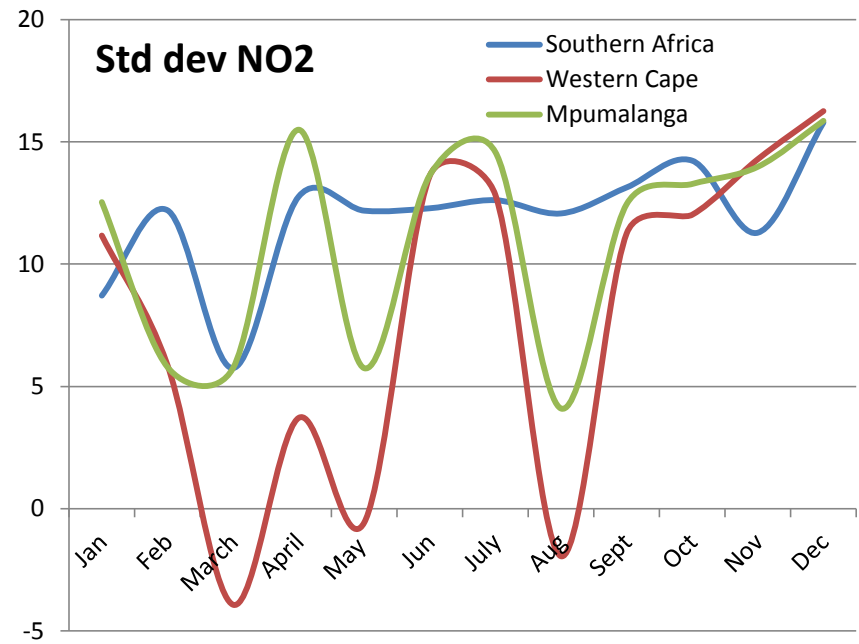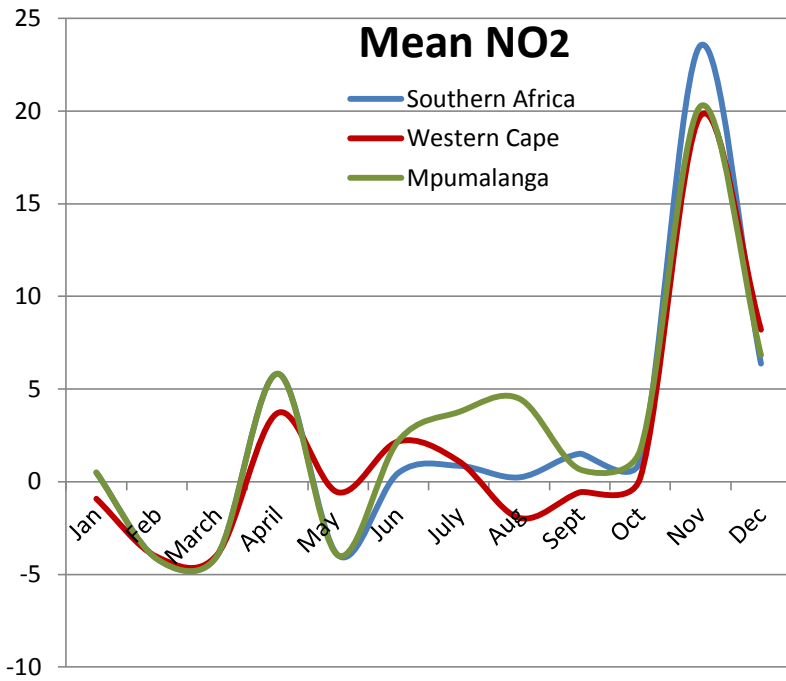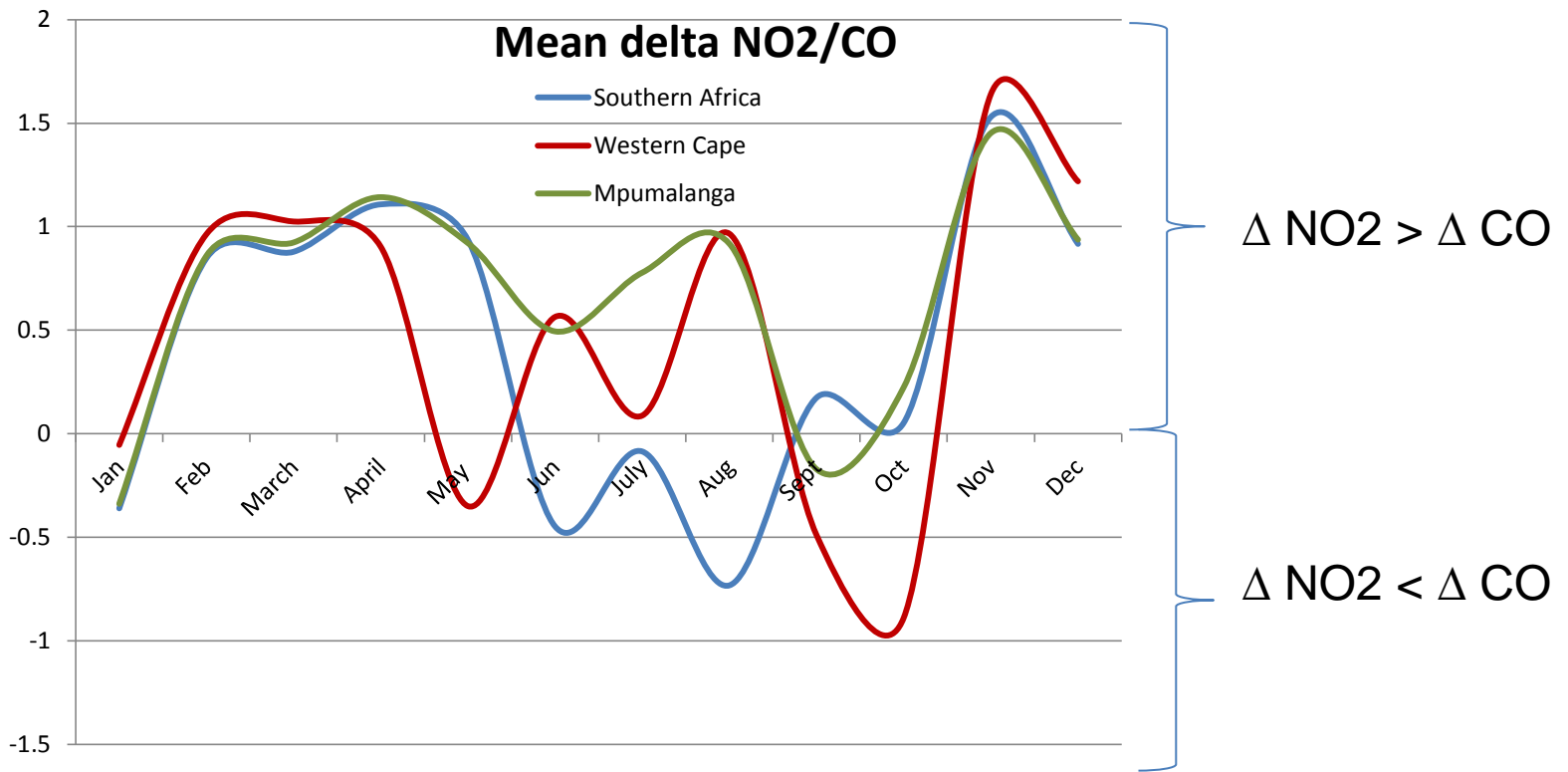
Results

- SO2
  - Emitted by power plants
  - Only lasts a few days

- Giovanni: OMI/Aura L2G Online Visualization and Analysis «BETA» Daily Level 2G Global Binned Products «BETA»

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Dep

OMSO2G.003 SO2 Column Amount (Planetary Boundary Layer) [DU]
(01Jan2009 – 31Dec2009)
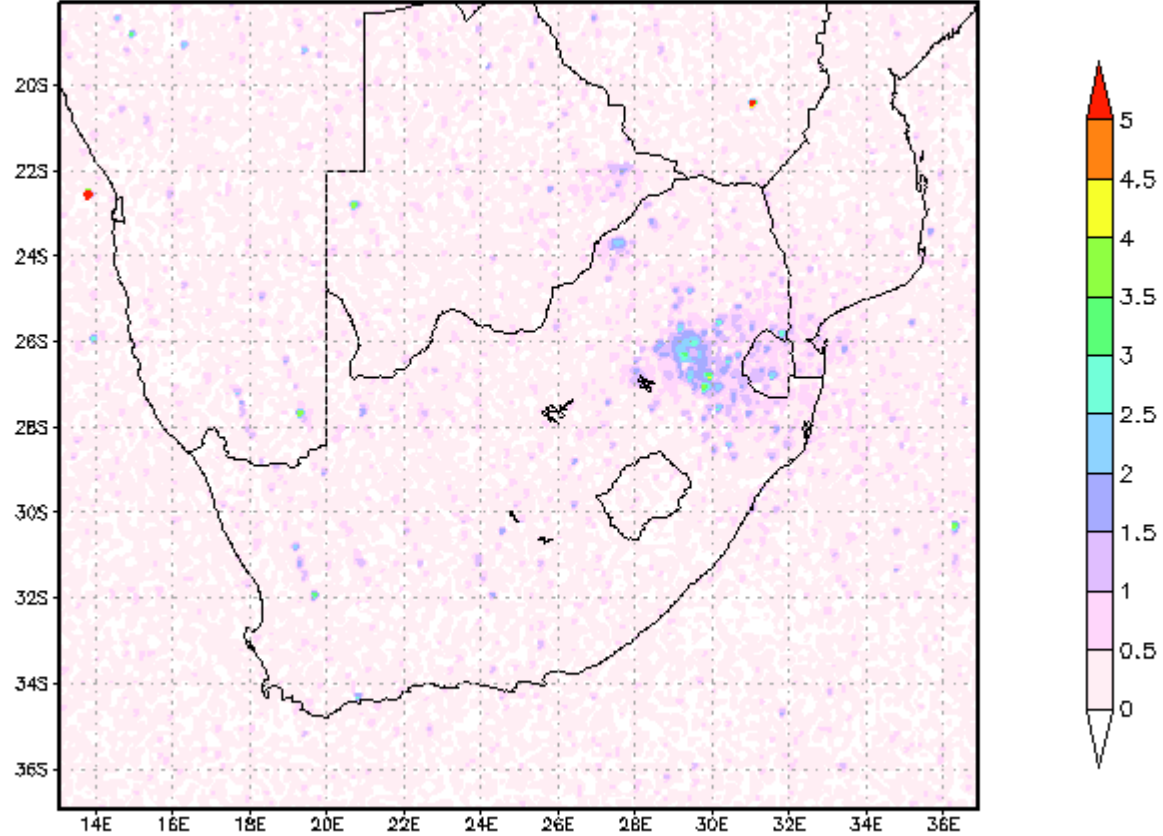
- Fine-scale daily/weekly maps of pollutants (change from background) to help identify source

- Huang: "ISEE Scenario = seen, investigated and understood…. Pollution"

- Adams: "Policy often not linked to science/research"

- CSPP/IMAPP potential to bring research more clearly to view, sensu AFIS on social media…..

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Policy makers:
- Transport (more trains to highly populated areas)
- Household heating - Green Accord (solar heaters)
- Household cooking – electrification…
- Clean power solutions

Citizen behaviour
- Public transport (reliability): takes time (although Gautrain)
- Car pools
- Cooking boxes

Link to budgets – annual sustainability reports and IDP's
- What its costing
- What it will cost to solve
- Indicator linked to budget
- Seelinger (2009): sustainability indictors

Dashboard indicators
~ AFIS uptake by volunteer fire fighters

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Thanks for your time

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A variety of instruments and satellites = resolutions and formats

- CO
  - Infrared Atmospheric Sounding Interferometer (**IASI**) CO is flying on board **MetOp-A**
  - from LATMOS/Ether Atmospheric Chemistry Data Centre

- CO2
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- SO2
  - Ozone Monitoring Instrument (OMI) on board NASA Aura
  - OMIOMSO2e OMI/Aura Sulfur Dioxide (SO2) Total Column Daily L3 Best Pixel Global 0.25deg Lat/Lon Grid (OMSO2e)
  - Mirador
  - Total SO2 (vertical column in Dobson Units, where 1DU=2.69 1016 molecules/cm2),

Data

Background values

- CO = 41.0 (just below the mean for April ^18)
- CO2
- NO2 = (range ^15-30)
- SO2

  » OMIOMSO2e OMI/Aura Sulfur Dioxide (SO2) Total Column Daily L3 Best Pixel Global 0.25deg Lat/Lon Grid (OMSO2e)
  » onboard EOS-Aura satellite.
  » Almost daily