Satellites & Air Quality: A Three-Act Presentation

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Act 1: Evaluating LADCO Model Data

Act 2: Indicator Ratios in Action

Act 3: Teaching with AQAST
Act 1: LADCO CAMx Evaluation

**Background:** Long-standing collaboration between UW-Madison & LADCO

**AQ Management Need:** Evaluation of CAMx, especially with respect to $\text{NO}_x:\text{VOC}$ ratios and $\text{O}_3$ formation

**Plan:** We’ll do it, using WHIPS ... And if useful then teach LADCO modeling team
Plan and Progress

✔ LADCO sends data drive to UW-Madison
✔ Grid Level-2 OMI data to CAMx grid using the Wisconsin Horizontal Interpolation Program for Satellites (WHIPS)
✔ Compare full season CAMx vs. OMI
✔ Send very preliminary data to LADCO
☐ Thorough analysis
☐ Possible NO$_2$:HCHO ratio evaluation
☐ Discuss next steps with LADCO
June 16 – Sept 25, 2011
Model too high in urban areas; too low in rural areas
Likely explanations: lightning, Mexico, fires, overpass time

Alex Karambelas, in prep
Similar to our earlier summertime 2007 evaluation with LADCO emissions... Before adding lightning, fires, Mexico

Figure 1: Vertical sum of lightning NO emissions in moles/hr for a) Lightning A and b) Lightning B.

Figure 1: Vertically averaged lightning NO emissions in mol/hr for Lightning A and B.
OMI NO₂ (July)

CMAQ NO₂ (Base)

CMAQ NO₂ (Lightning A)

CMAQ NO₂ (Lightning B)

Holloway, Scotty et al., in prep
Capturing diurnal cycle?
Early afternoon NO$_2$ much lower than average model values
Notes and Findings (so far)

• Experience with model-satellite evaluation activities paved the way to better support LADCO.
• Model output for satellite evaluation is not always “standard” (multiple layers, sigma heights, HCHO, etc.)
• WHIPS has proven to be a useful tool to allocate satellite data onto regional model grids, but not quite user-friendly
• Ongoing AQAST engagement has highlighted new opportunities to collaborate.
Act 2: Indicator Ratios in Action

Background: Our first AQAST Story on Patrick Reddy from Colorado, and his use of “Bryan Duncan’s” indicator ratios

AQ Management Need: Guidance on how to create indicator ratios + HTAP model evaluation

Plan: Student M.S. thesis on global ozone production
Plan and Progress

- Xiaomeng Jin learns to use OMI NO$_2$ & HCHO data (Level-3 and Level-2G)
- Write up FNR “users guide” at http://sage.wisc.edu/airquality_ratios/
- Evaluation of global patterns
- Manuscript for peer review
- Add HCHO to WHIPS
- Grid NO$_2$ and HCHO for model evaluation (GFDL AM3 from HTAP archive, from Meiyun Lin)
- Evaluate AM3 + provide pathway for FNR for global and regional model evaluation
Average HCHO

Average NO₂

Jin and Holloway, in prep
Regime Classification in China

Jin and Holloway, in prep
Notes and Findings (so far)

• Guidance on FNR ratios online and global data (seasonal, 2005-2012) online at http://sage.wisc.edu/airquality_ratios

• Updated WHIPS (with HCHO) online at http://sage.wisc.edu/download/WHIPS/WHIPS.html

• AQM experience (Pat Reddy) → research (Xiaomeng Jin) → improved tools to support AQM data use (WHIPS, HTAP)
Act 3: Teaching with AQAST

Background:
“Introduction to Air Quality Class” + Tiger Team on Eastern U.S. Episodes

AQ Management Need:
How can satellite data support evaluation of pollution events?

Plan: 30 students tackle the challenge
Plan and Progress

- Each student picks one O$_3$ and one PM$_{2.5}$ episode to evaluate
- 1$^{st}$ students examine ground-based data...
- ... then literature review
- ... then meteorology, HYSPLIT, etc.
- ... finally, satellite data. Can it confirm hypotheses? Prove transport?
- Guest lectures by AQAST (Brad Pierce), AQM (Angie Dickens), stakeholders (Todd Palmer, Tyson Cook)... Tour of CIMSS
- Satellites as part of standard air quality training
Focus:
Ozone Episode
July 1-7 2012
Chicago IL

NASA Worldview
Images for July 4, 2012

Undergraduate Joyce Gaffney, from email to IL EPA
Notes and Findings (so far)

• NASA Worldview is by far the easiest interface for quick evaluation of episodes
• Wish list: 1) NO\textsubscript{2} & HCHO in Worldview; 2) True-color in Giovanni

“Honestly its just really freaking cool”

“Where do I start?? This was amazing!”
Thank you!

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