Transpacific transport of pollution as seen from space



Colette L. Heald (heald@atmos.berkeley.edu)





Daniel J. Jacob, Rokjin J. Park, Becky Alexander, T. Duncan Fairlie, Arlene M. Fiore, Robert M. Yantosca,

the TRACE-P, MOPITT and MODIS Science Teams

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OBJECTIVE #1: EVOLUTION (TRANSPORT)

Aircraft observations during outbound trans-Pacific TRACE-P (February 2001) flights observed elevated levels of CO (and O₃)



OBJECTIVE #1: EVOLUTION (CHEMICAL)



Evolution: Split by blocking high pressure



Northern plume (observed at A) sees no O_3 enhancement.

Southern plume (observed at D and E) subsides, leads to PAN decomposition and O₃ production



OBJECTIVE #1: EVOLUTION AS SEEN BY MOPITT Total column CO



OBJECTIVE #2: FREQUENCY OF TRANSPORT EVENTS



4 trans-Pacific events reached North America during Spring 2001 (as observed by aircraft, ground stations, MOPITT and simulated in GEOS-Chem)

[Heald et al., 2003b]

TRANSPACIFIC TRANSPORT OF ASIAN AEROSOLS

Despite their short lifetimes, aerosols can be transported across the Pacific and can affect North American air quality standards and visibility.

Most documented cases consist of transport of dust:

Visibility reduction at Glen Canyon, Arizona due to transpacific transport of Asian dust



BUT Model simulations suggest that anthropogenic aerosols from Asia can ALSO be transported to the United States [*Park et al.*, 2004]



CHALLENGE: OBSERVING AEROSOL COMPOSITION FROM SPACE TO QUANTITAVELY VALIDATE MODELS



SURFACE (variable reflectance properties)

TRANSPACIFIC TRANSPORT OF AEROSOLS (2001)

MODIS = MODerate resolution Imaging Spectroradiometer (launched EOS-Terra Dec 1999) GEOS-Chem = global CTM with coupled oxidant-aerosol simulation [Park et al., 2003; 2004]



GEOS-CHEM underestimates MODIS observations by factor of ~2 in Spring

WHAT CAN AERONET OBSERVATIONS TELL US?

Is the model/MODIS bias primarily a model underestimate or a satellite retrieval bias?



AERONET sites indicate a possible MODIS retrieval bias (not correlated with cloud cover).

OBJECTIVE #1: AN EXAMPLE OF TRANSPACIFIC TRANSPORT OF ASIAN AEROSOL POLLUTION AS SEEN BY MODIS

MODIS AOD

GEOS-CHEM dust AOD GEOS-CHEM Asian sulfate AOD



April 25, 2001



April 26, 2001





< 0.00 0.05 0.10 0.15 0.20



April 27, 2001

OBJECTIVE #3: IMPACT OF ASIAN SULFATE ON U.S. AIR QUALITY



Asian aerosols preferentially impact ground sites in the NW US. Observations at IMPROVE sites are elevated from mean when simulated Asian influence is high [Heald et al., 2006]

OBSERVING INTERCONTINENTAL TRANSPORT FROM SPACE

SUCCESSES

Continuous observation of event evolution, particularly over oceans where ground observations are sparse
Monitoring of pollution transport frequency



CHALLENGES

- Assess air quality impacts: need high vertical resolution and sensitivity to BL concentrations
- Characterize chemical evolution: need multiple species observations
- High density of observations
 - Necessary to track events
 - Low data coverage compromises ability of models to be used for interpretation
- Interpreting aerosol observations from space: need simultaneous detection of aerosol radiative properties, size distribution and vertical distribution

Observational time-scales

comparable to species of interest

- Track O₃ formation/destruction in outflow with continuous obs
- → geostationary?