Analyses of 200 mb air mass origins for CONTRAST

J. Bergman (NCAR/BAER)

With: L. Pan, E. Jensen, L. Pfister, C. Bardeen

Question: Where are the boundary layer sources for air sampled at 200 mb?

This will help us understand:

- The chemical compositions sampled during the flights
- The mechanisms that transport air from the PBL to 200 mb

To address this question, we perform transport calculations

Question: How do we know our transport calculations are any good?

Transport calculations suffer many sources of uncertainty

- They require winds at much finer spatial and temporal resolution than observational data provides
- They compensate by utilizing GCMs (explicitly or in analyzed fields)
  - Operational analysis
  - Reanalysis

We perform 3 different calculations of boundary layer sources for air at ~200 mb

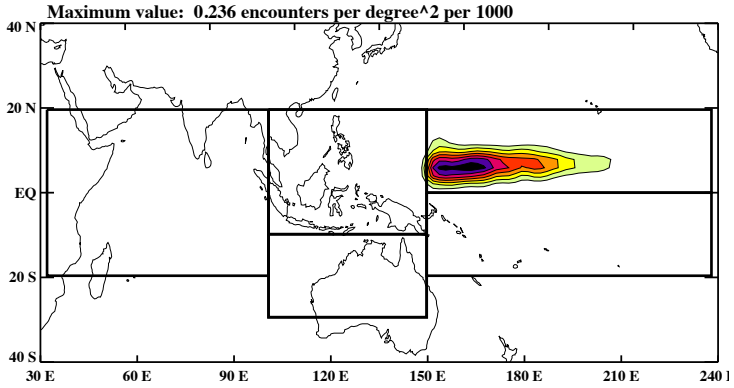
Search for consistency among the calculations

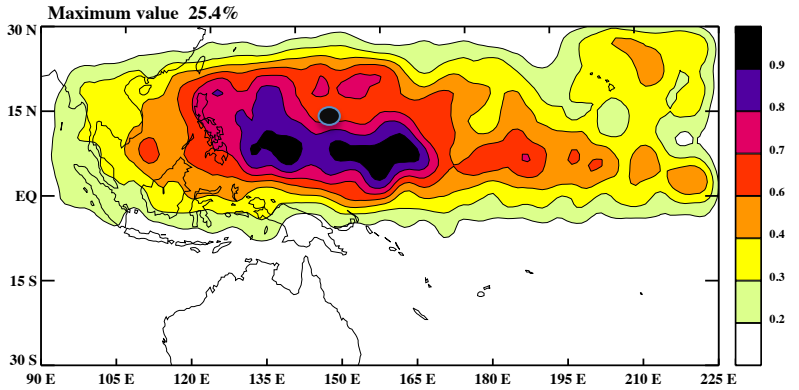
Calculation 1:
Back trajectories from 200 mb to PBL

- Compute back trajectories initiated during Feb 2011
- Match PBL source regions to 200 mb measurement locations
- Use winds from ECMWF operational analysis
  - Trajectories initiated every 6 hr and 1° x 1° from 200 mb
  - Track parcels until they enter the PBL (σ = 0.85)
  - Kinematic trajectories
  - ECMWF operational analysis has 1/8° resolution

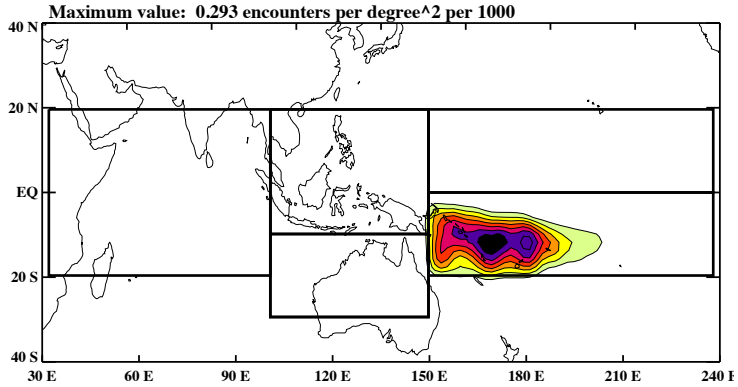
Air in different locations of the CONTRAST domain are associated with different source regions

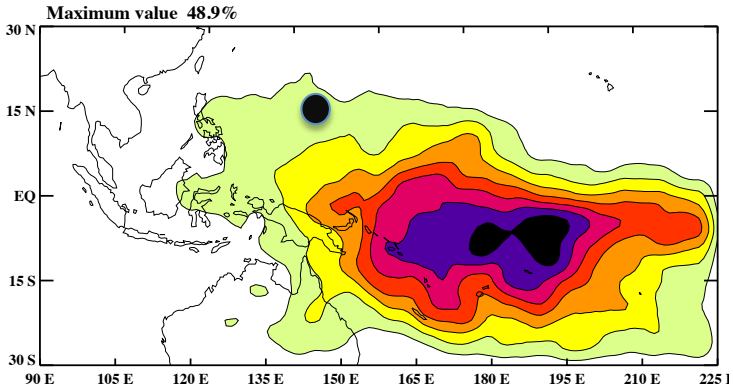
NW Pacific



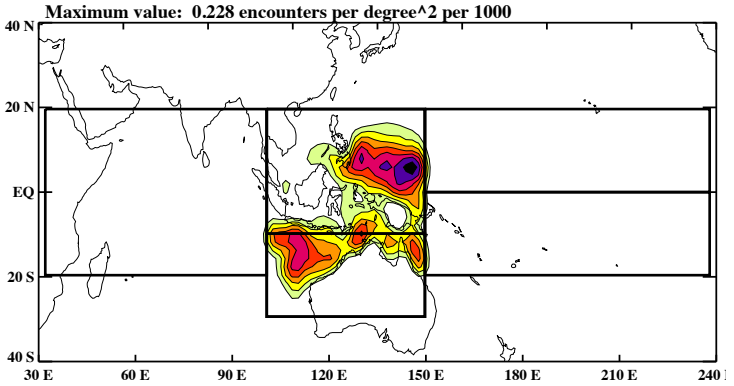


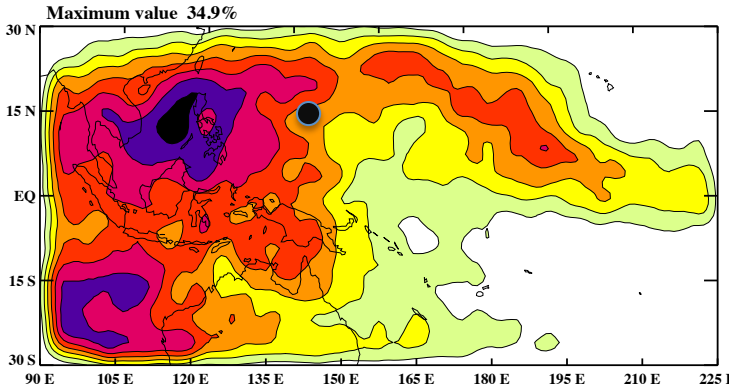
SW Pacific



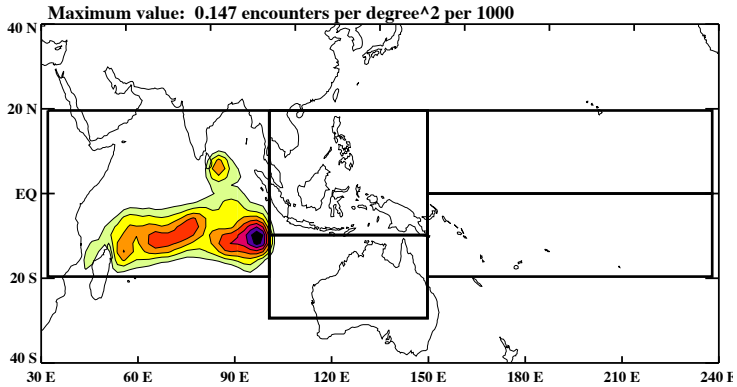


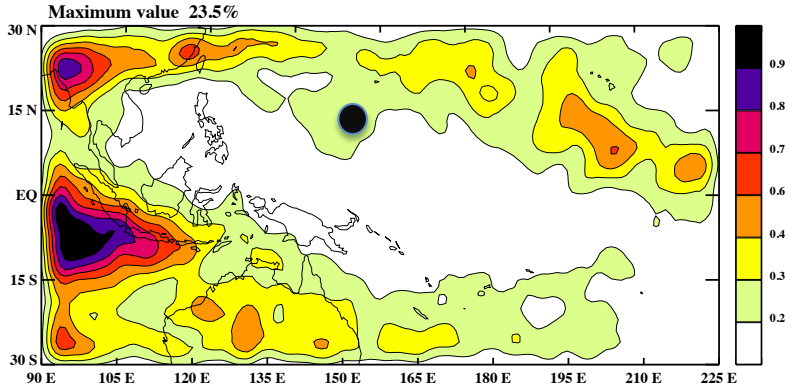
Indonesian Seas



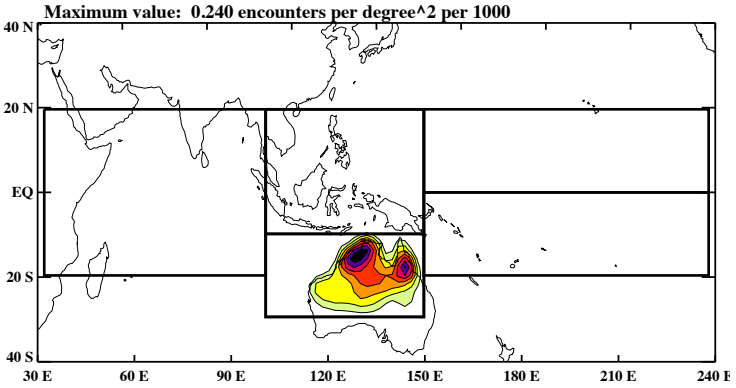


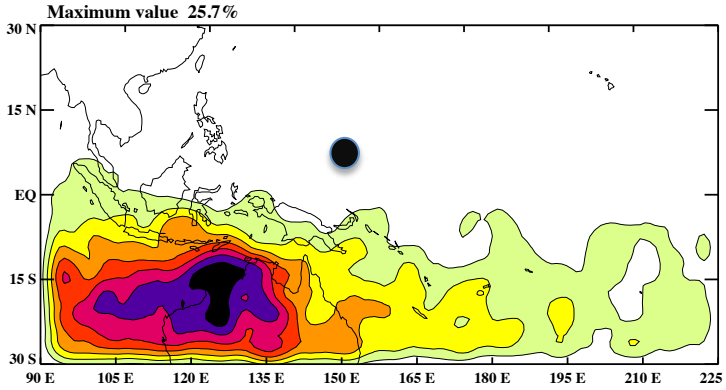
Indian Ocean



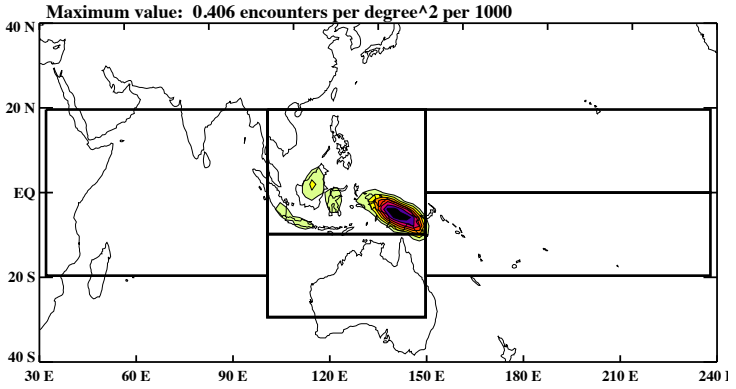


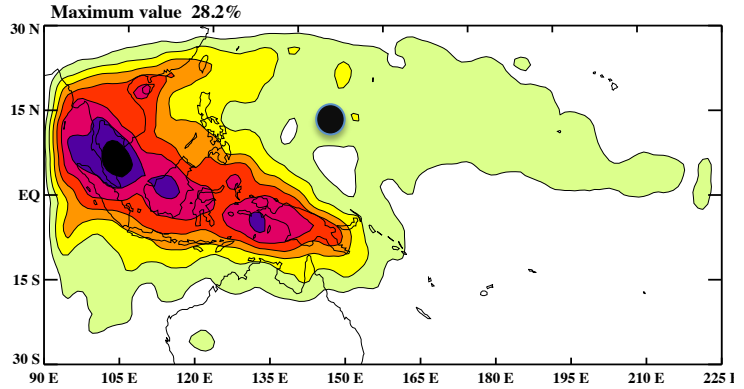
Australia





Maritime Continent





Calculation 2: SD-CAM experiments

(Compare with calculation 1)

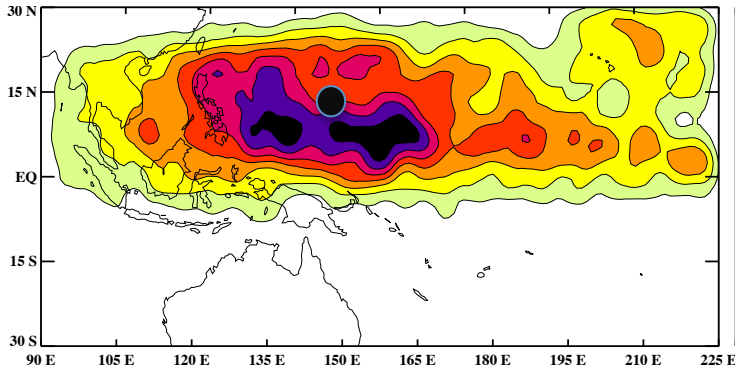
- Atmospheric GCM with relaxation to operational analysis (GEOS-5)
- Release tracers near the surface
  - Tag tracers from 6 regions
  - Tag tracers for each day Jan-Feb 2011
- Examine distributions of tracers younger than 30d at 200 mb during Feb
  - Analogous to Calculation 1 – with subtle complications

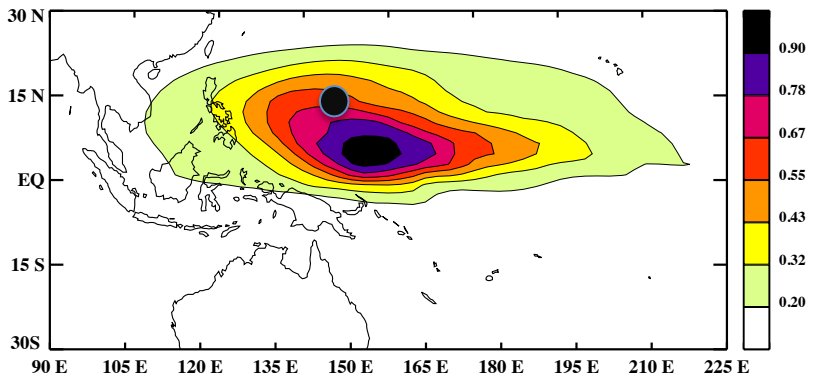
There are important similarities between results from ECMWF trajectories and SD-CAM

ECMWF trajectories

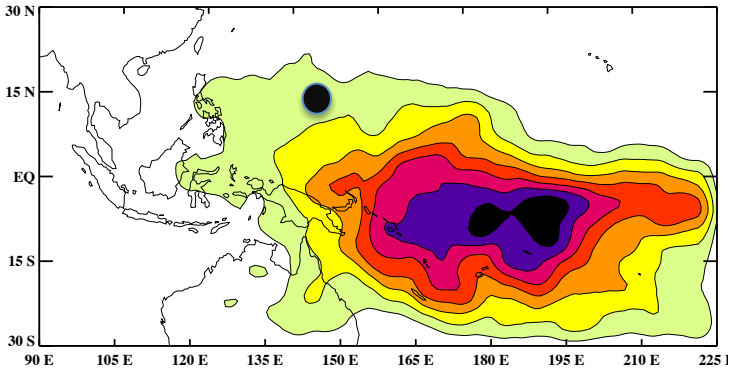
SD-CAM Tracers

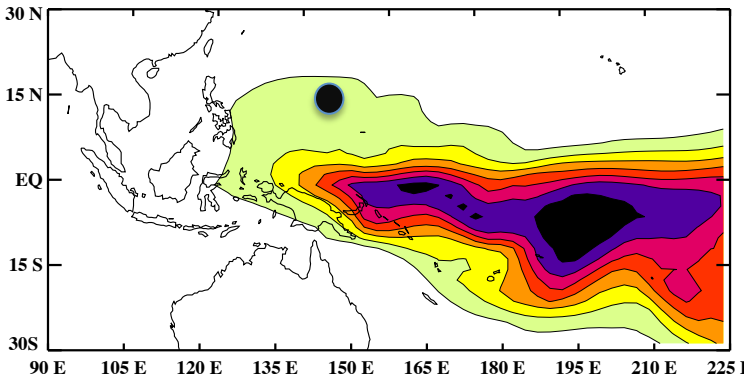
NW Pacific



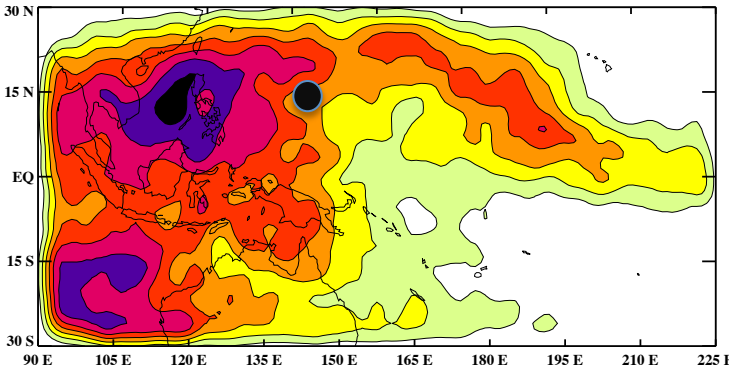


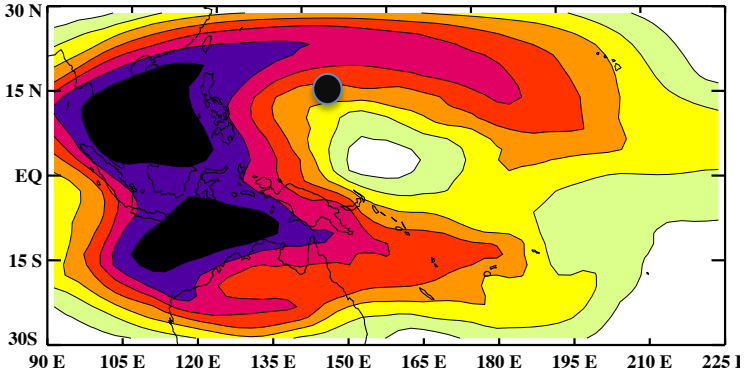
SW Pacific





Indonesian Seas

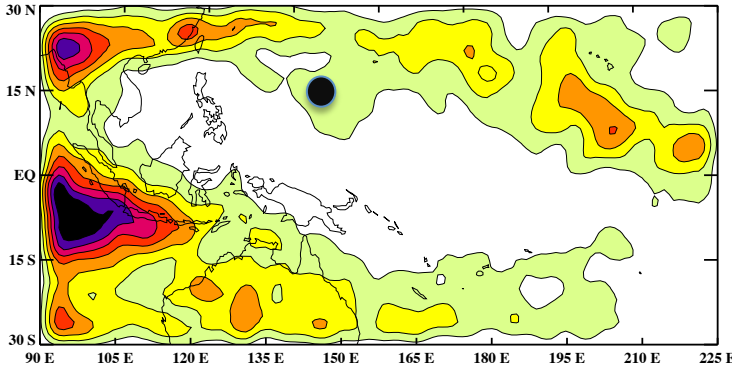


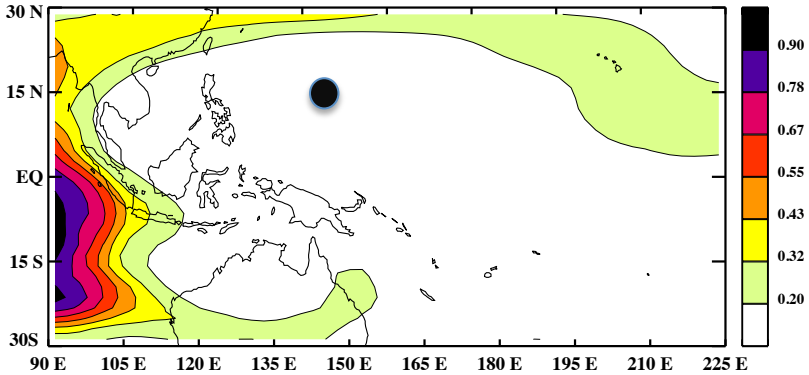


ECMWF trajectories

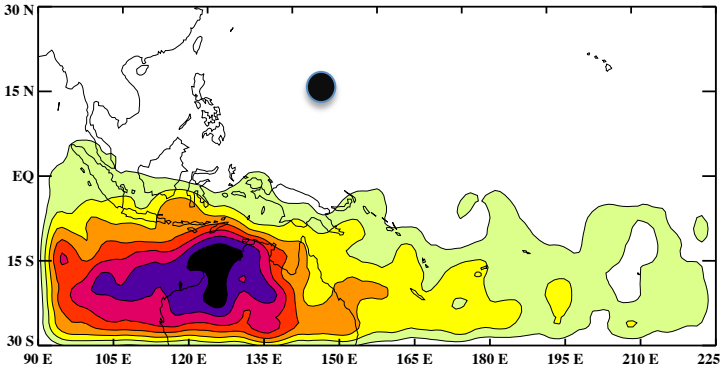
SD-CAM Tracers

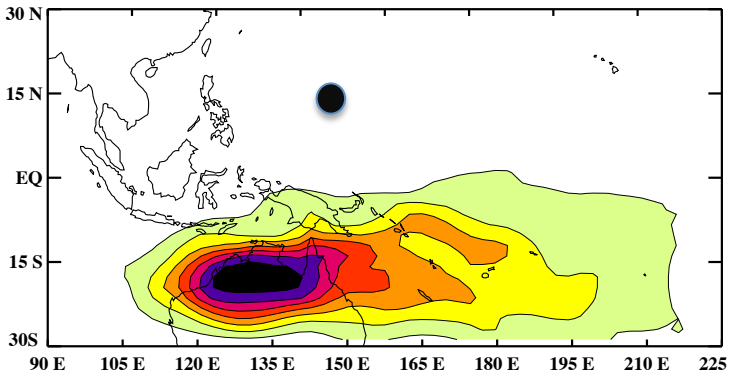
Indian Ocean



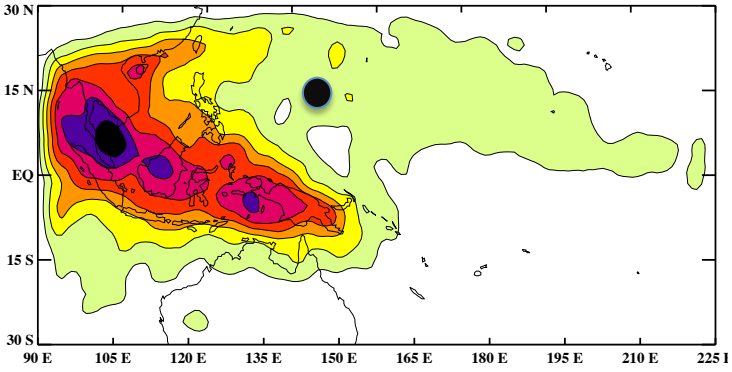


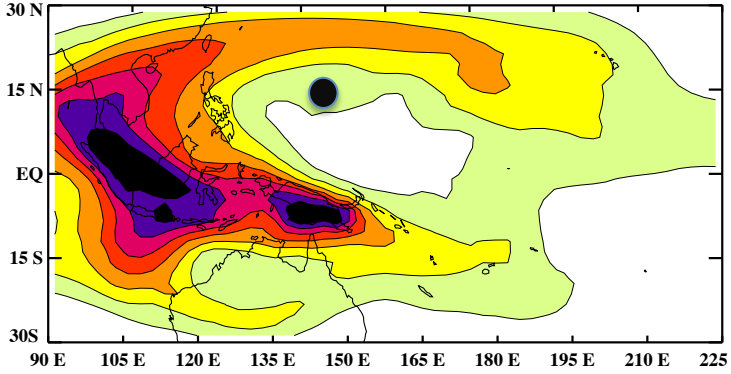
Australia





Maritime Continent





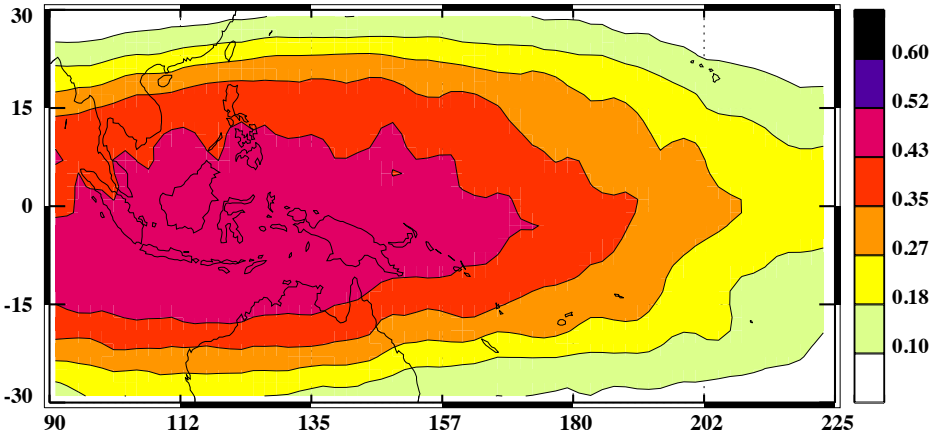
Calculation 3: MLS simulations

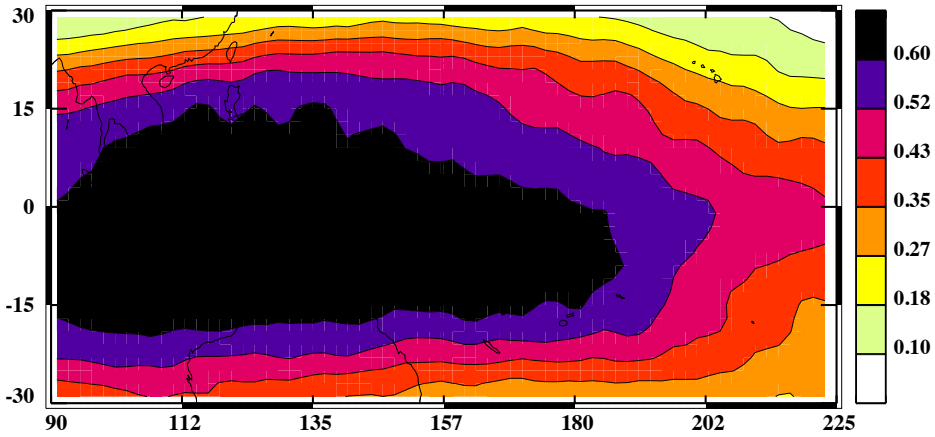
- 30 back trajectories initiated from Aura MLS observations
  - Jan-Feb 2007-13
  - Parcel initiated from all 2° x 2° x 6 hr
  - Vertical spread 20 parcels in the altitude range 15.2-17.0 km (100-125 mb)
  - Use kinematic trajectories using winds from MERRA and GFS operational analysis
- Examine BL source regions for high-low O_3, CO
  - High O_3 v Low O_3
    - Stratospheric v Tropospheric sources
    - Polluted v Pristine sources
  - Low CO v High CO
    - Stratospheric v Tropospheric sources
    - Pristine v Polluted sources
- A reality check – Do the results agree with our conceptions?

For reference: BL sources for all trajectories

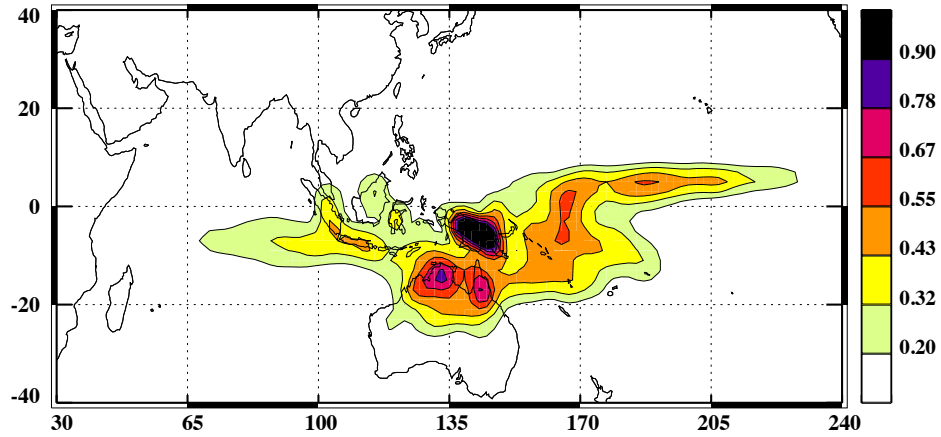
MERRA **GFS**

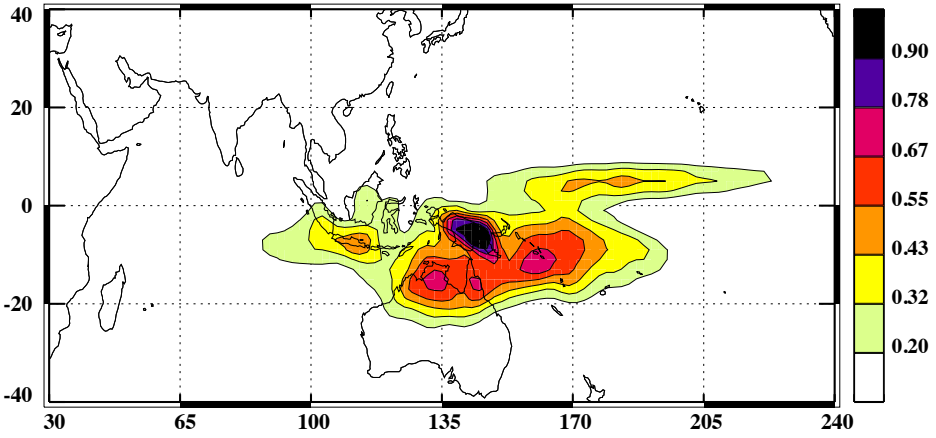
Concentrations of new air





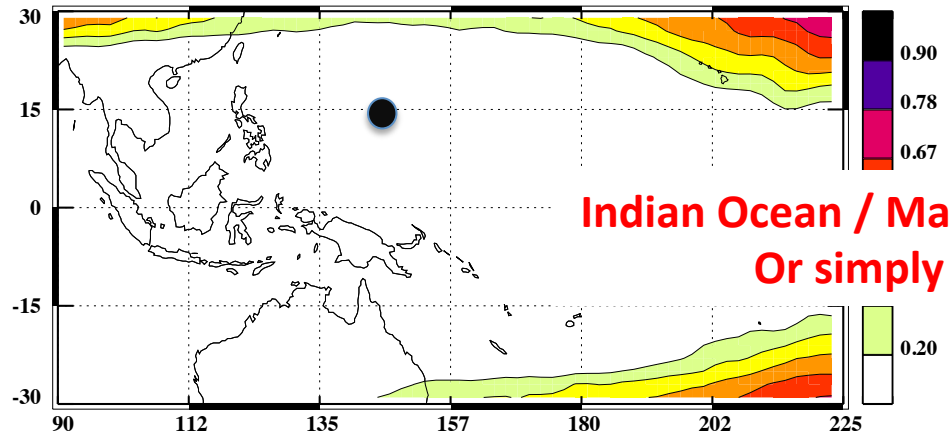
Boundary layer sources



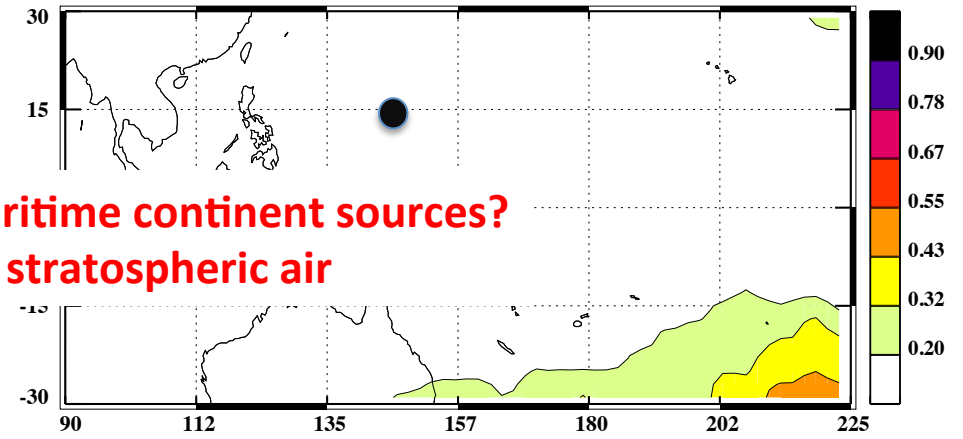


Constituent concentrations at 100 mb (MLS data)

High O_3 (> 300 ppbv)

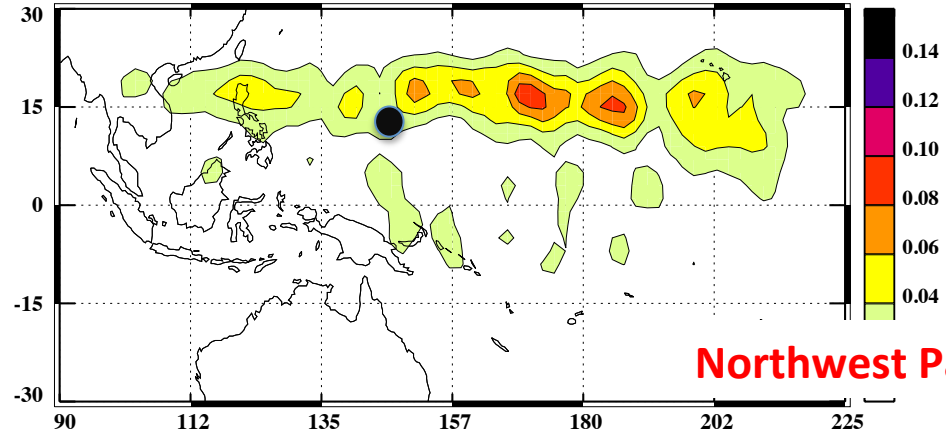


Low CO (< 40 ppbv)

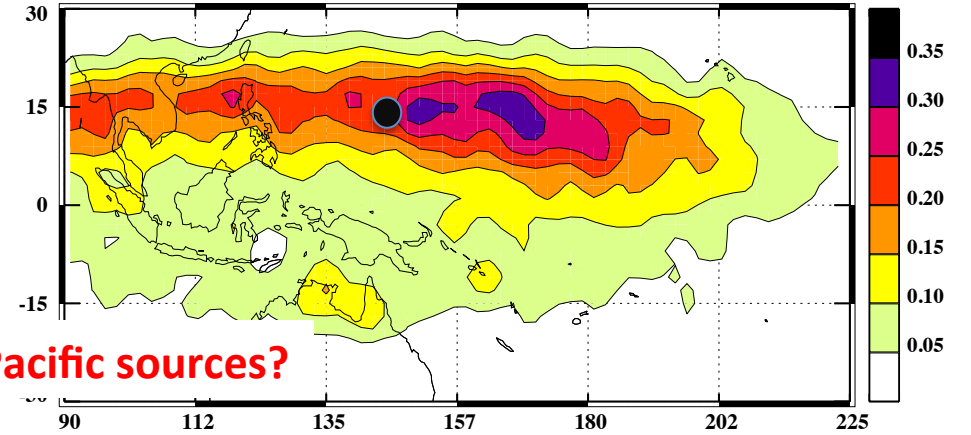


Indian Ocean / Maritime continent sources?
Or simply stratospheric air

Low O_3 (< 100 ppbv)



High CO (> 70 ppbv)

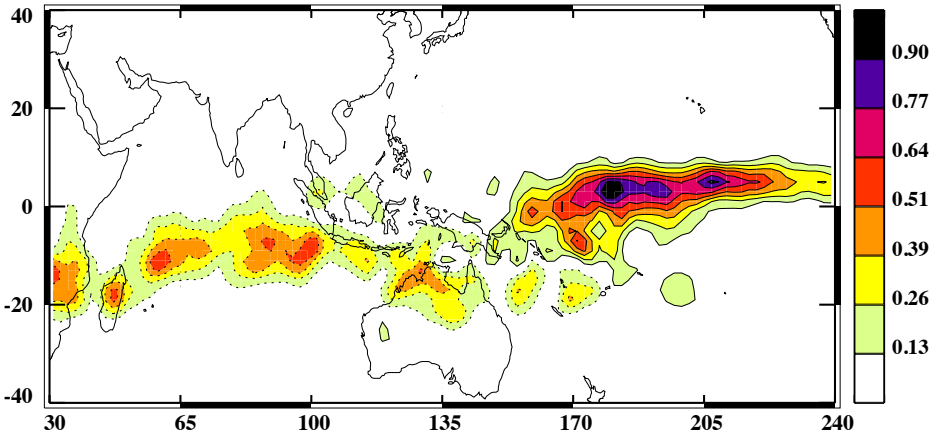


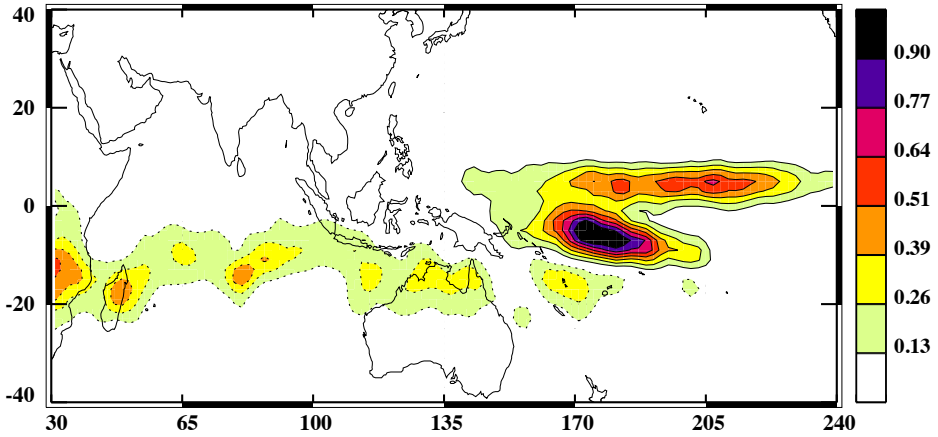
Northwest Pacific sources?

Source regions for filtered trajectories

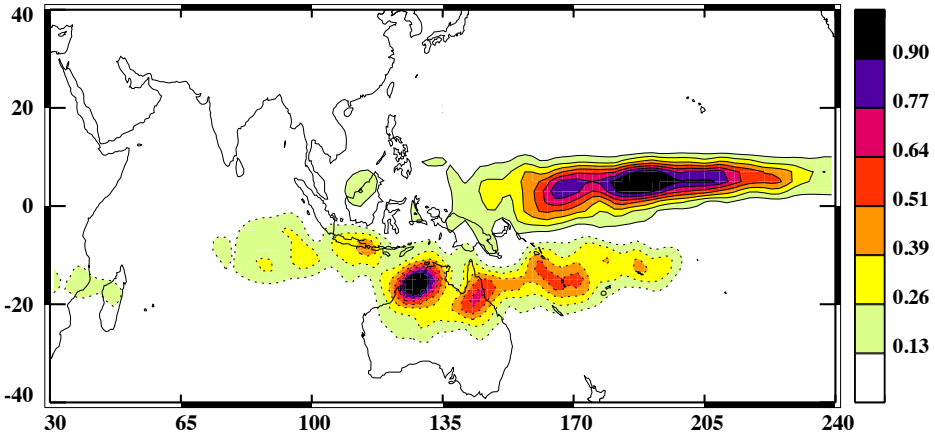
MERRA **GFS**

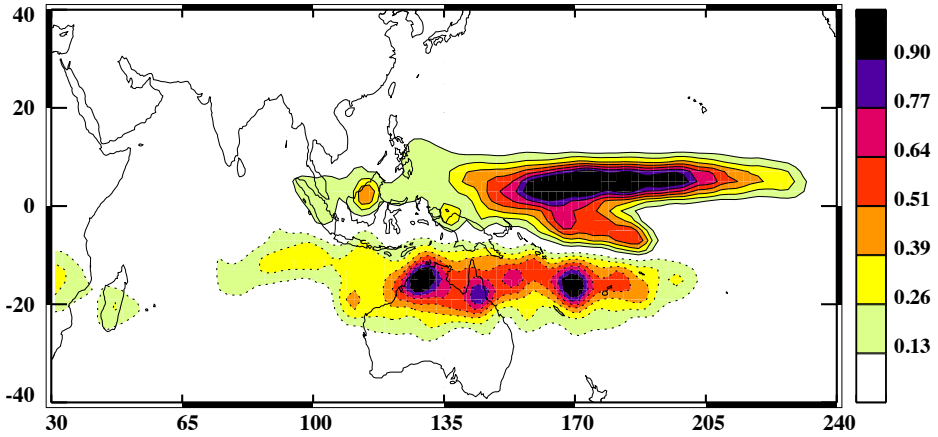
Low O_3 minus High O_3





High CO minus Low CO





Conclusions

Spatial patterns of regionally-source air from CAM-SD are consistent trajectories from ECMWF at 200 mb

Apparent consistency with 100 mb concentrations of O_3 and CO

Take home message

Qualitative results are promising

e.g., Where to go to sample W. Pacific air

Quantitative results are questionable

e.g., How much of the air being sampled is from the W. Pacific