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Linking Biogeochemistry and Atmospheric Transport in the NCAR CSM

A. Scott Denning
Department of Atmospheric Science
Colorado State University
Fort Collins, CO 80523-1371

Activities and Findings

With NSF support, the transport characteristics of the NCAR CSM were investigated and compared top those of other models and to observations of sulphur hexafluoride (SF_6) in the atmosphere. These comparisons are undertaken to evaluate the suitability of the model for investigations of biogeochemical cycles using atmospheric inverse modeling in the future.

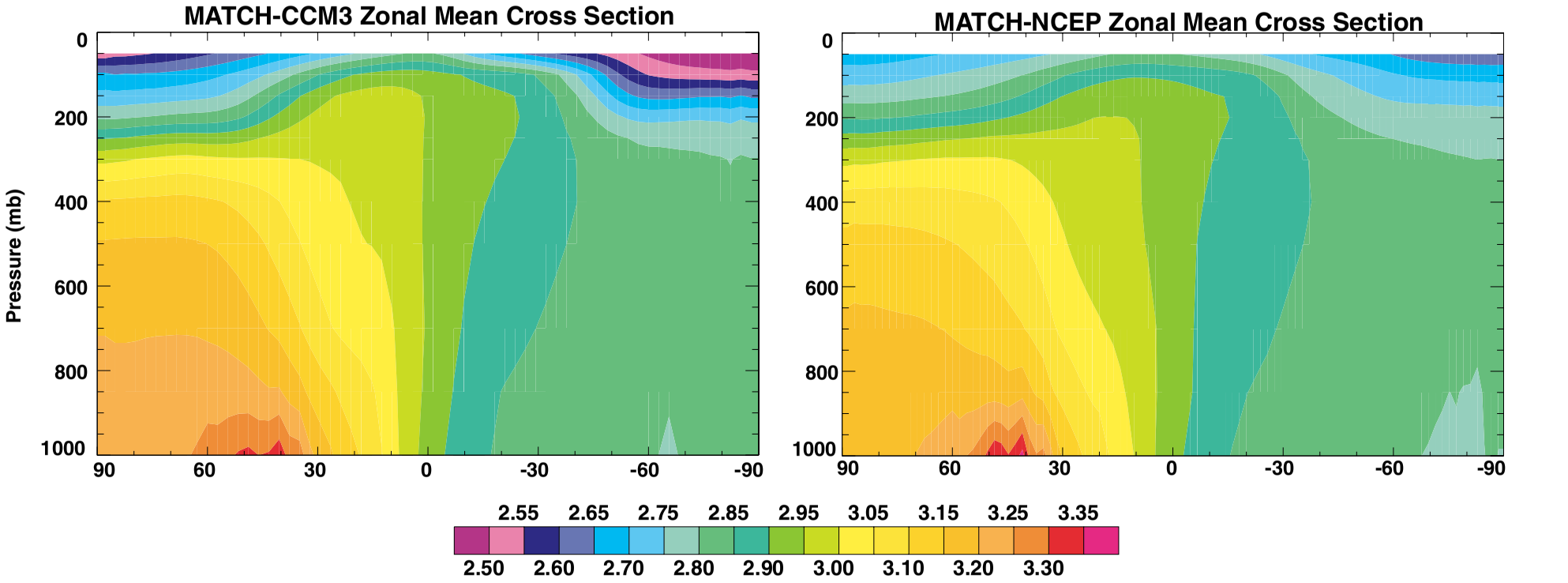
Two five-year simulation of SF_6 were performed using emissions prescribed according to the protocol of the Transport Intercomparison Project, Phase 2 (TransCom 2, see http://transcom.colostate.edu). Emissions were distributed according to estimates of electricity usage by country, and by population density within countries. Global emissions were ramped during the simulations to approximate estimates made from mass-balance calculations for the years 1989-1993. The NCAR-MATCH transport model was used, which duplicates the transport characteristics of NCAR CCM3 (the atmospheric component of CSM1). In the first simulation, winds and other meteorological fields were prescribed from CCM3 output. In the second simulation, meteorological fields were prescribed from NCEP reanalyses. Concentrations for the final year (1993) were archived and compared to other transport models and to observations, following the methods described in Denning *et al* (1999) exactly.

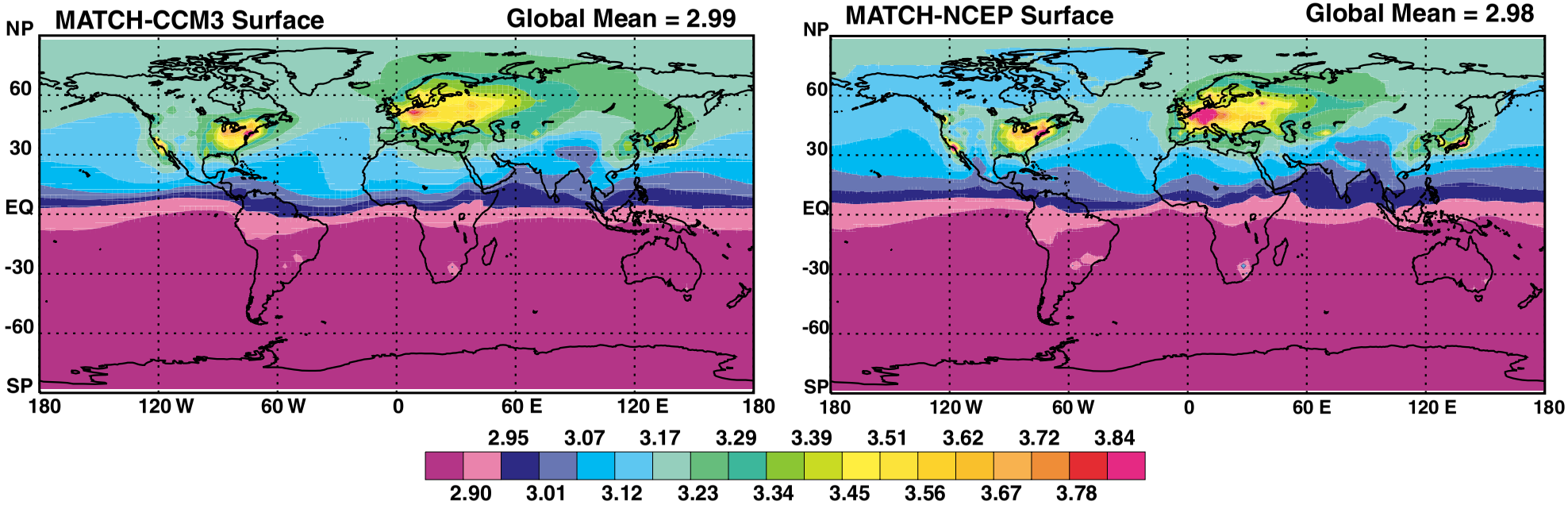
Annual mean concentration distributions for the two simulations were similar (Fig 1) to one another. Surface concentration gradients in source regions were somewhat stronger in the simulation forced by NCEP meteorology, probably due to the higher resolution of the NCEP data. Stratospheric concentrations were higher in the NCEP-driven simulation, which is somewhat surprising given the fact that stratosphere-troposphere exchanges should reflect parameterized transport that is identical for the two runs.

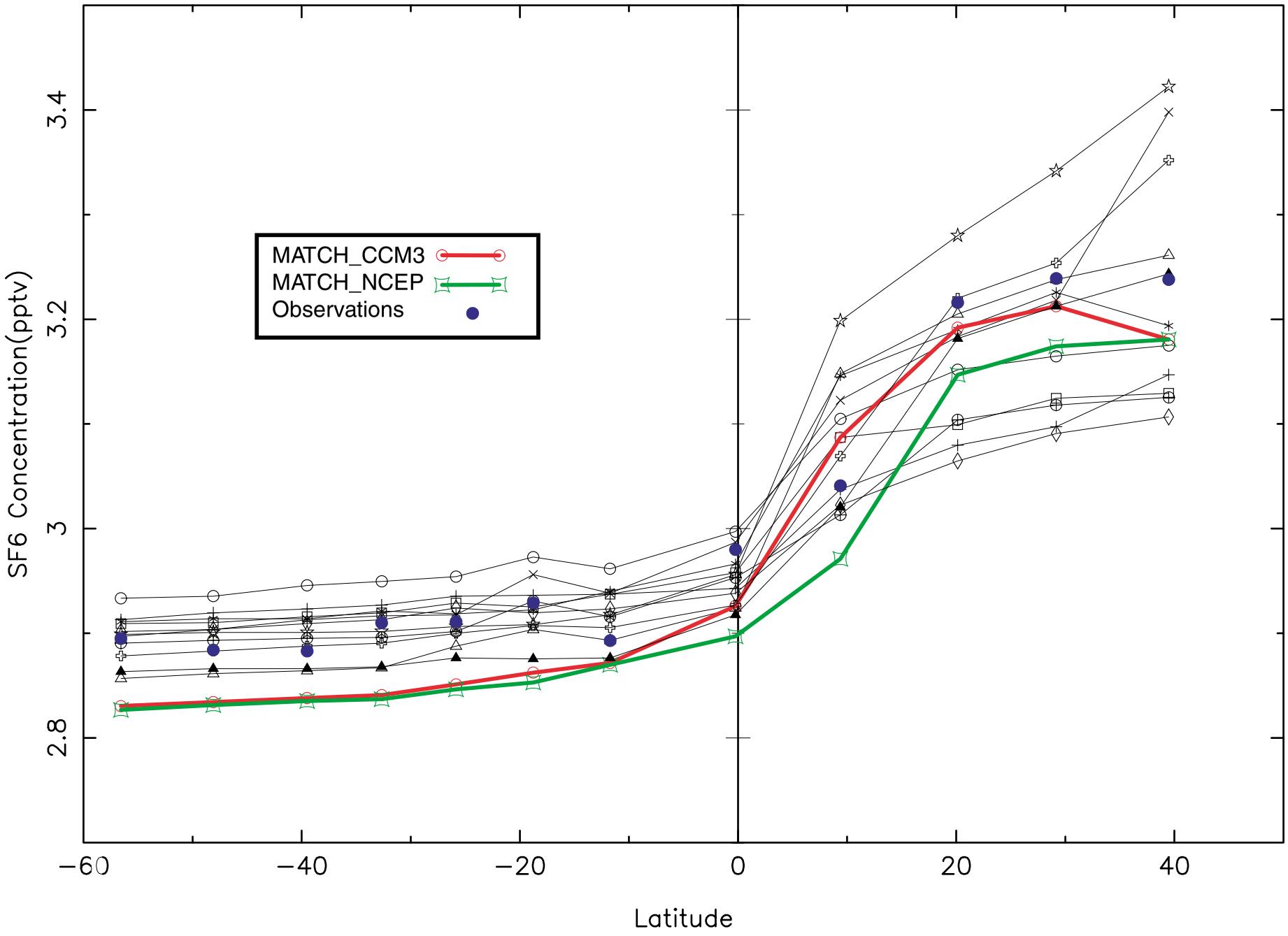
A comparison of the simulated surface SF_6 to both observations and to 11 other model results on a north-south transect in the Atlantic Ocean (Fig 2) shows that the NCAR results lie within the “consensus” pack of models, and agree quite well with the observations. The simulation driven by CCM3 meteorology performs among the very best models in the northern hemisphere, but both simulations underestimate the surface concentrations slightly in the southern hemisphere.

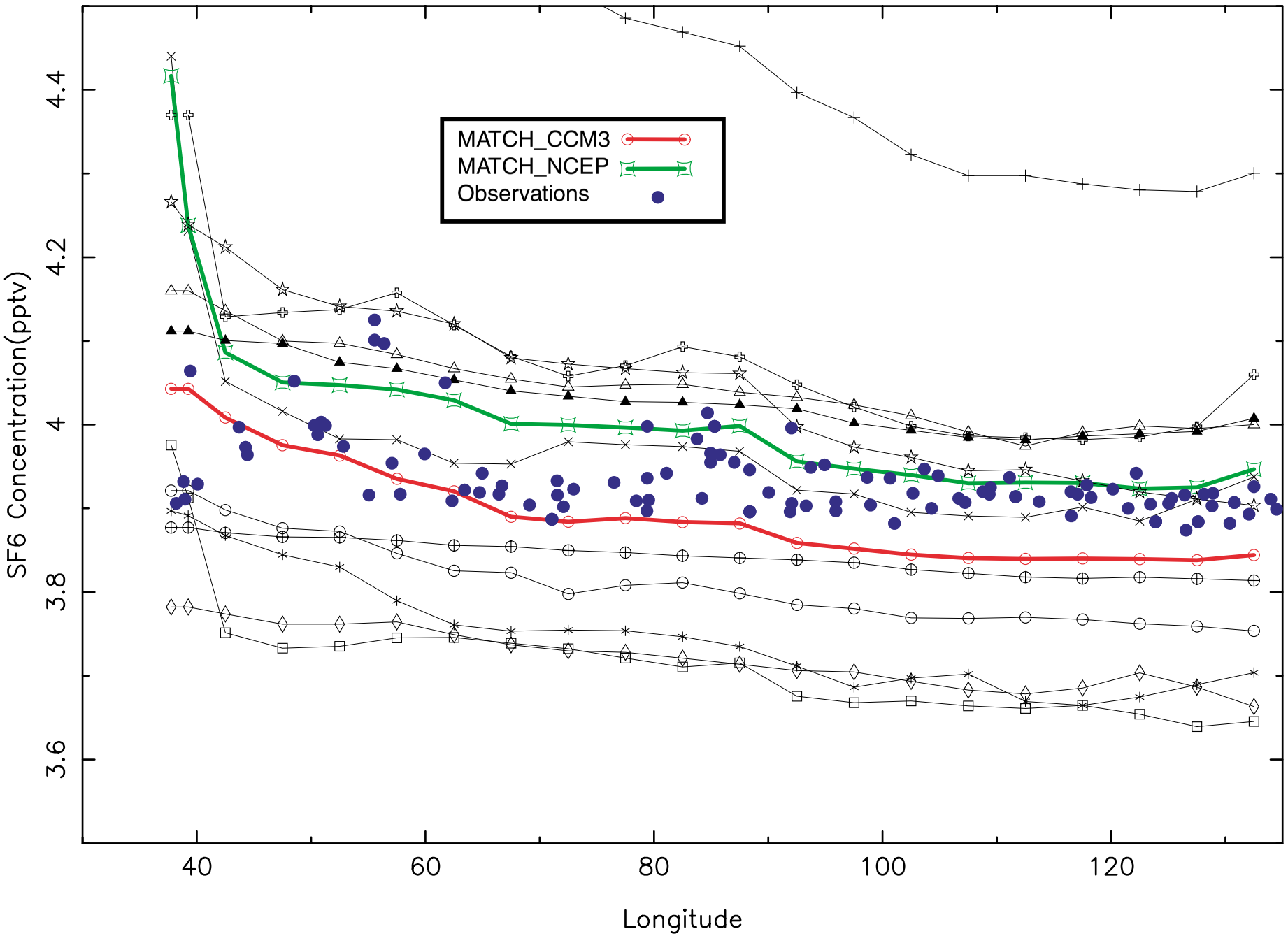
The final comparison is conducted for a west-east transect along the Trans-Siberian Railroad (Fig 3). Again, we see that the NCAR models performance is excellent, and right in the middle of the population of other models.

Simulated Annual Mean SF_6 Concentration






Atlantic observations and model predictions
MATCH_CCM3
MATCH_NCEP
Observations
SF6 Concentration(pptv)
2.8
3
3.2
3.4
−60
−40
−20
0
20
40
Latitude


Siberian rail observations and model predictions
MATCH_CCM3
MATCH_NCEP
Observations
SF6 Concentration(pptv)
3.6
3.8
4
4.2
4.4
40
60
80
100
120
Longitude