Evaluating Sulfur Simulations at Amsterdam Island

Initial Results from a Multi-model Intercomparison

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AEROCOM 2010

University of Oxford

Sept. 28th, 2010

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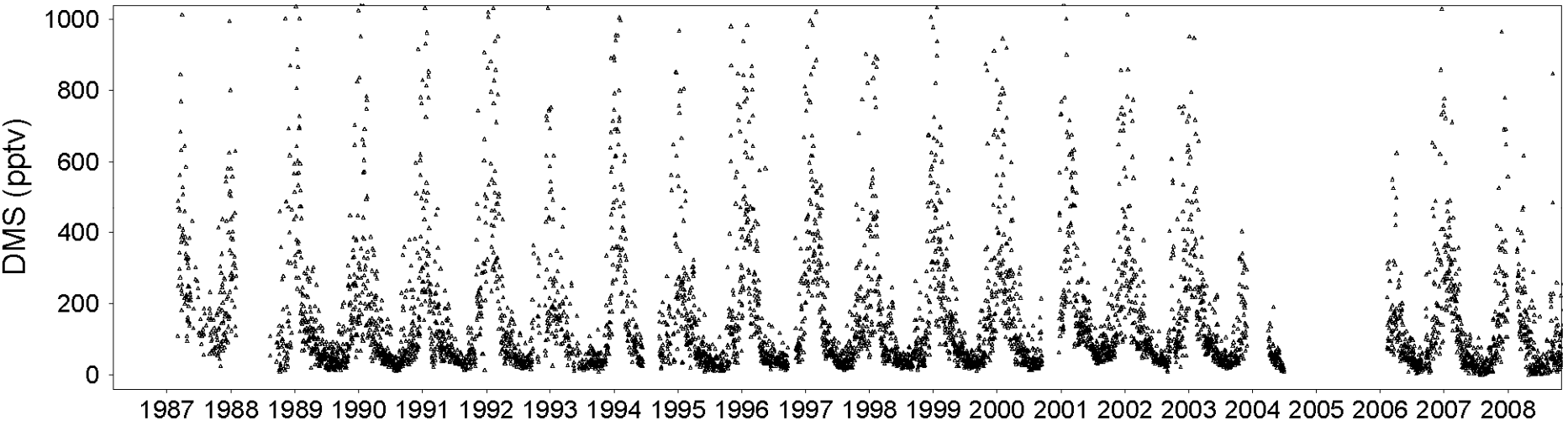
DMS and nss-SO4 Measurements: Jean Sciare, LSCE

Sciare et al. 2000

Amsterdam Island (37° 50'S, 77° 30' E)

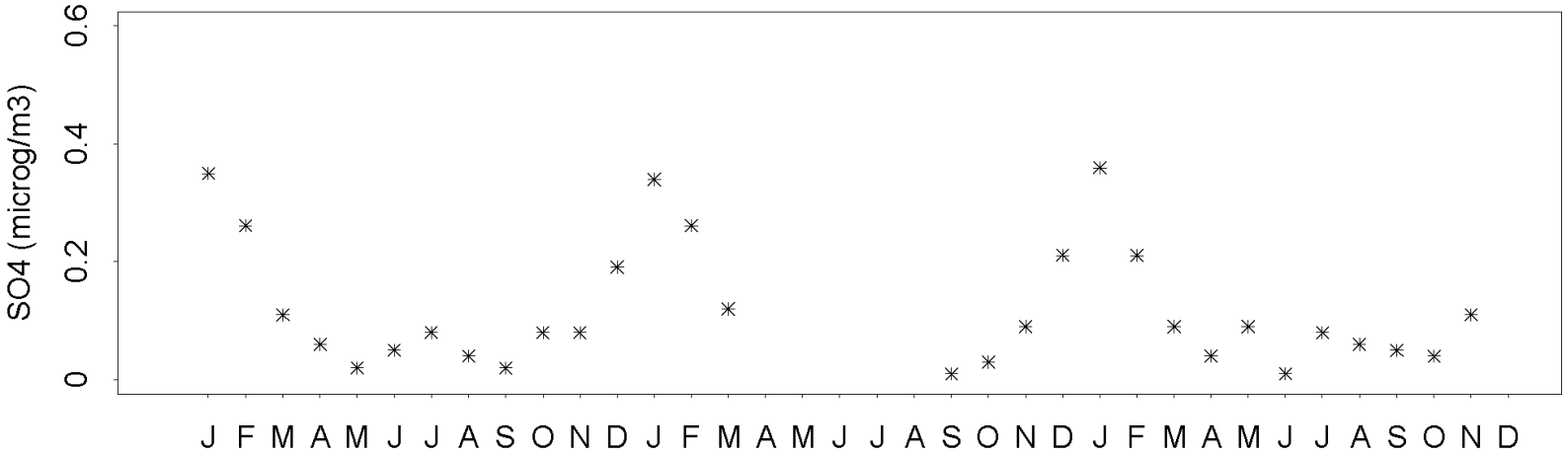
Minimal anthropogenic influence

Daily DMS Measurements, Amsterdam Island, (1987−2008)



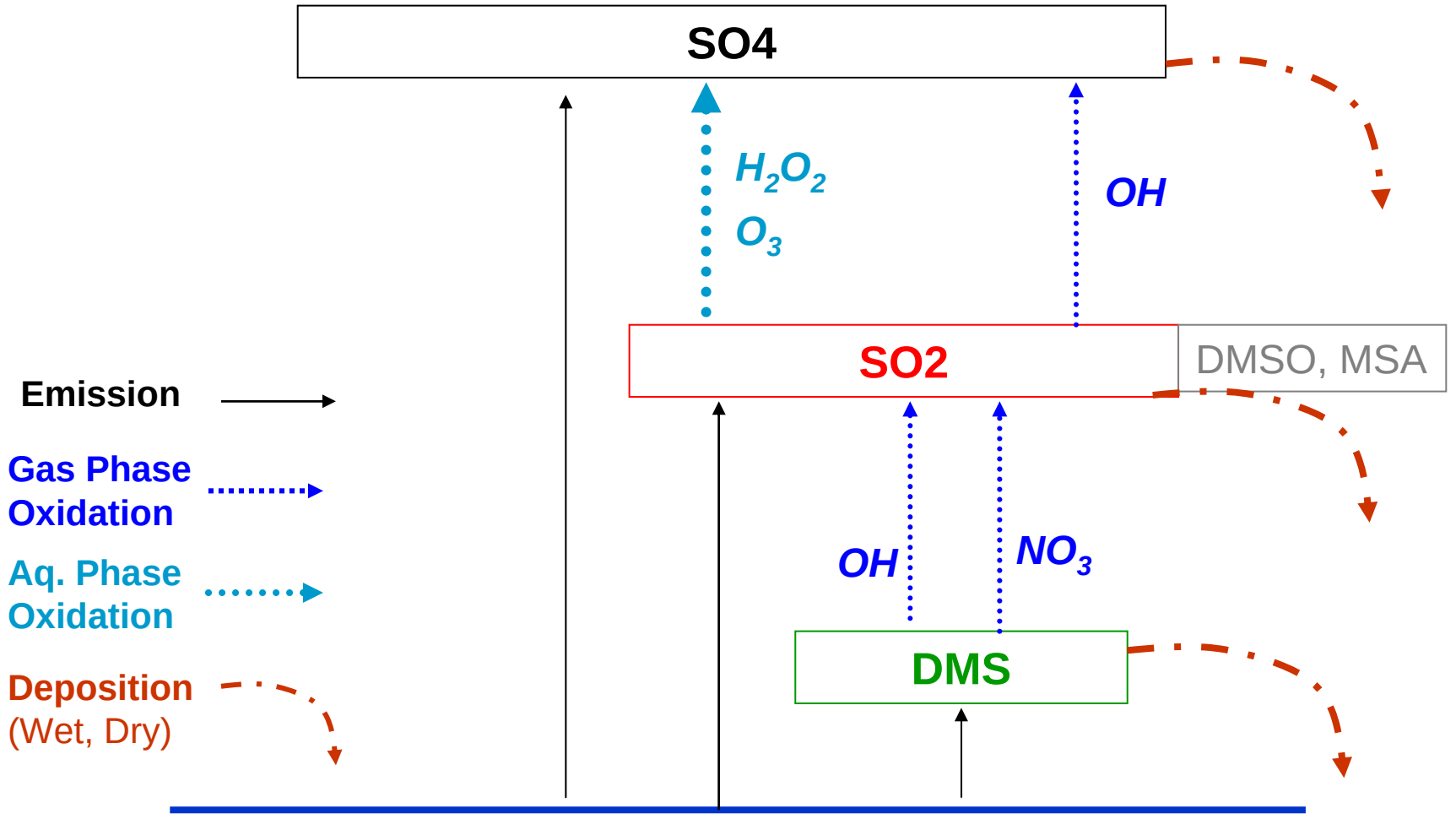
Among the highest DMS values reported anywhere

nss-SO4 (monthly means), Amsterdam Island (2005-2007)



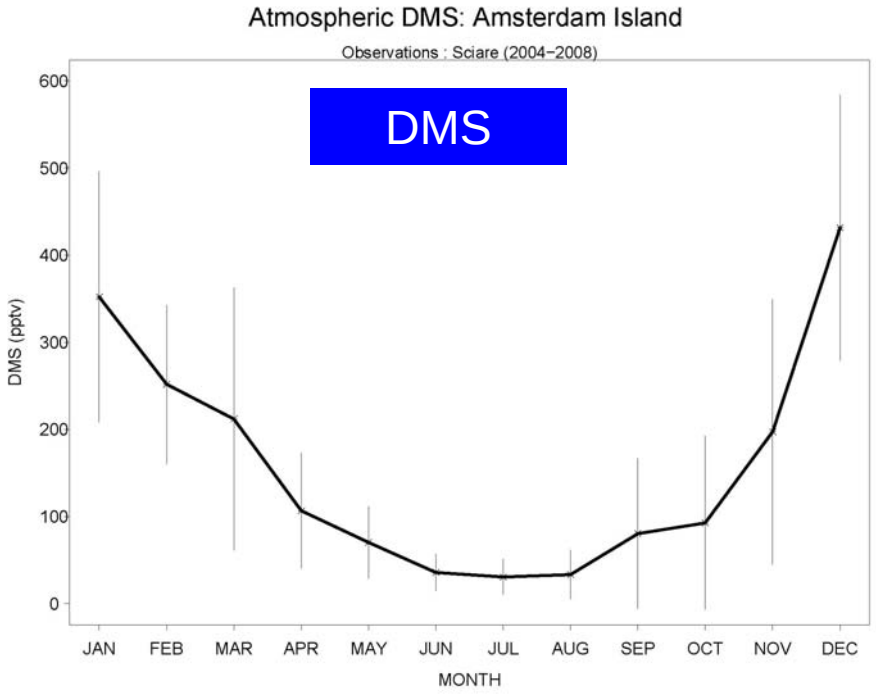
MARINE BOUNDARY LAYER SULFUR CHEMISTRY

(SIMPLIFIED)

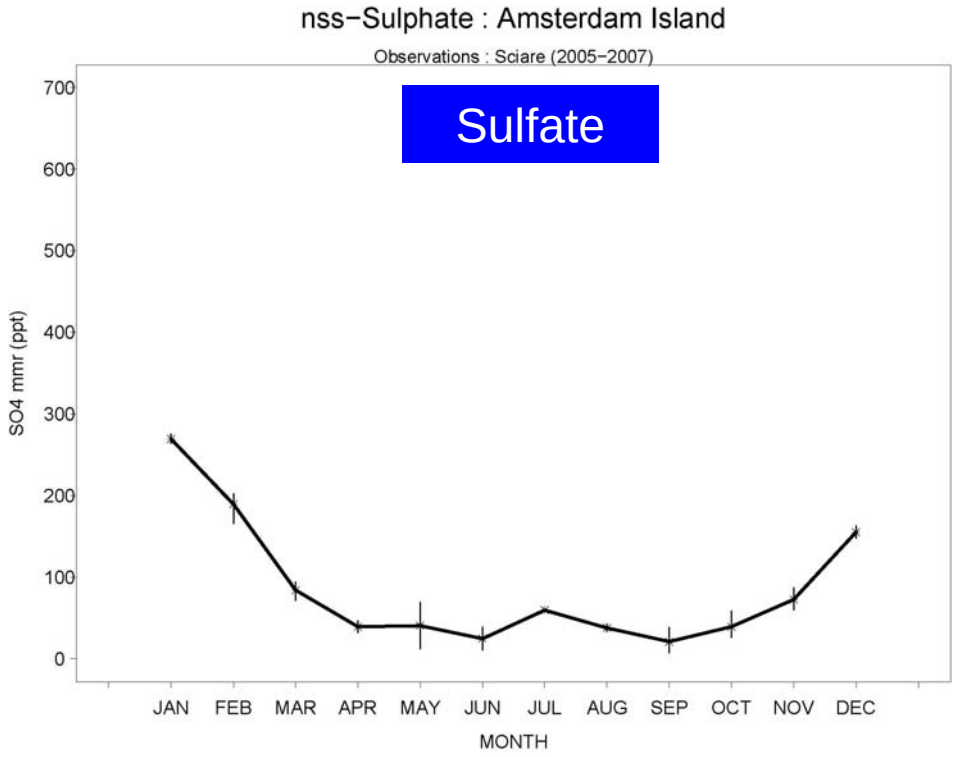


SEASONAL CYCLES OF OBSERVED DMS AND SULFATE

Measurements: Jean Sciare



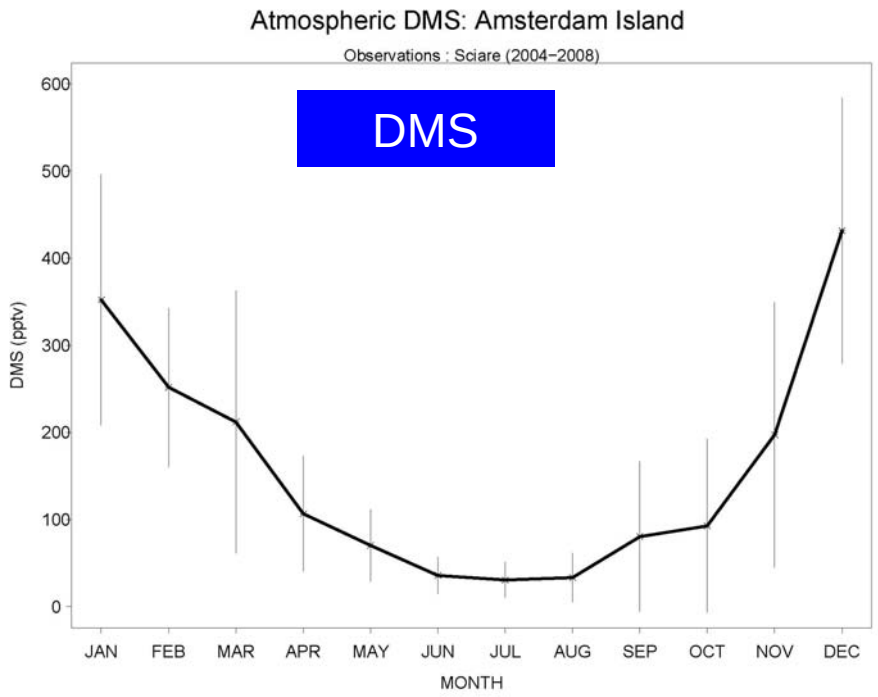
Monthly Means :2004-2008

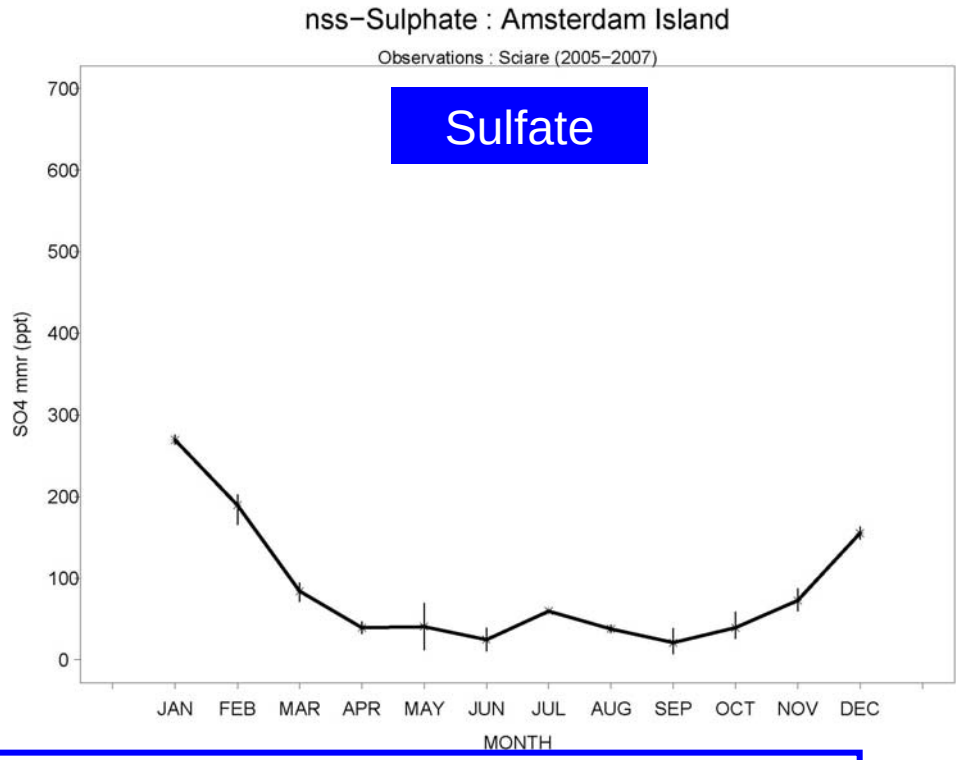


Monthly Means :2005-2007

Summertime maxima coincident with peak phytoplankton productivity

SEASONAL CYCLES OF OBSERVED DMS AND SULFATE





OBJECTIVES

- **Use Amsterdam Island measurements to evaluate model simulation of seasonal cycle**
- **Identify causes of inter-model differences**

MODELS IN THIS INTERCOMPARISON

(to date)

MODEL	EXPERIMENT NAME	YEAR
MPI_HAM	A2.CTRL	**2006**
GLOMAP	A2.CTRL	**2006**
LSCE-INCA	AR5 HCA-IPCC	**2006**
GOCART	A2.HCA-0	**2006**
SPRINTARS	AEROCOM-HCA-0	**2006**

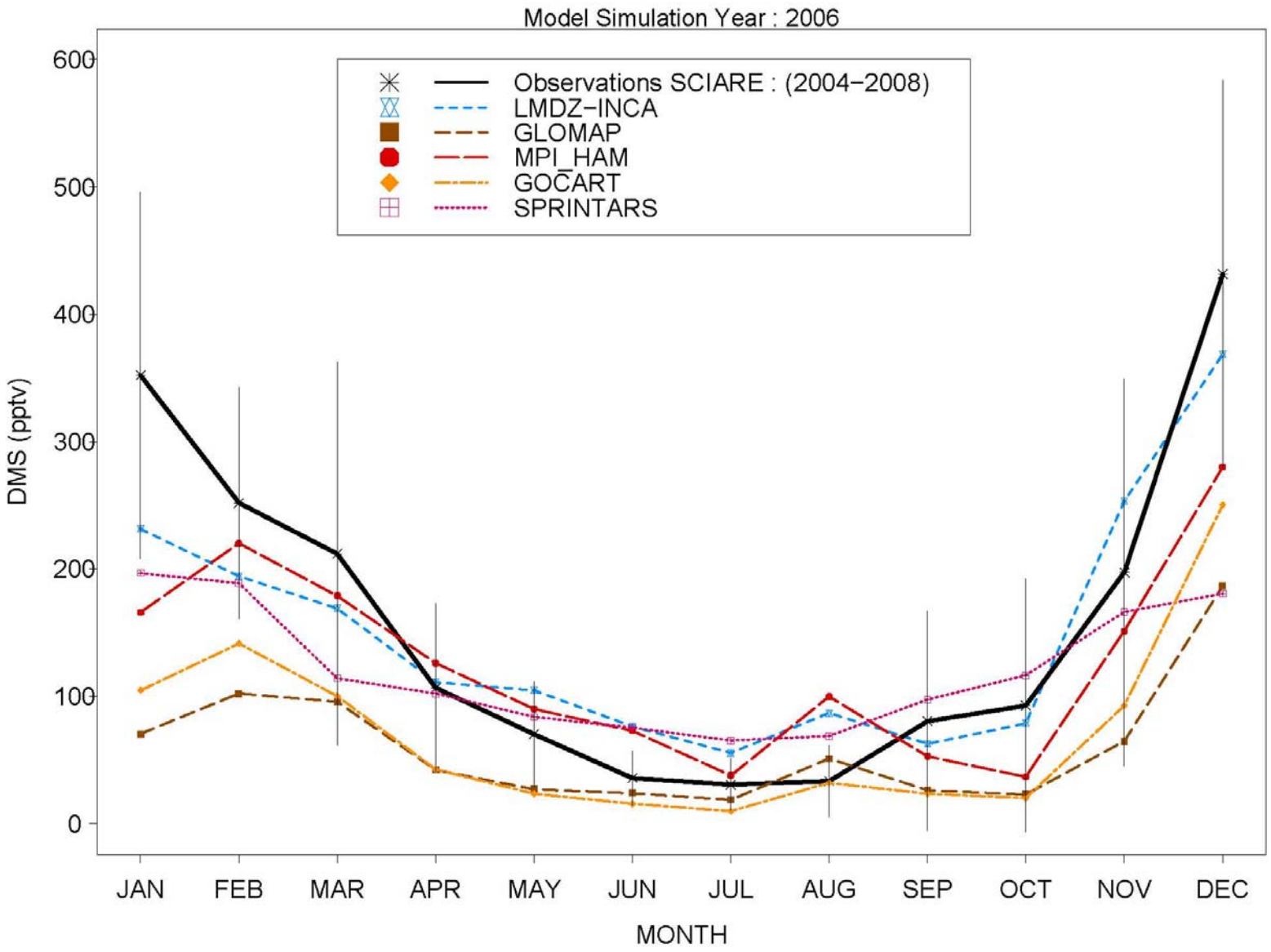
INITIAL MODEL DIAGNOSTICS

DMS : Volume mixing ratio

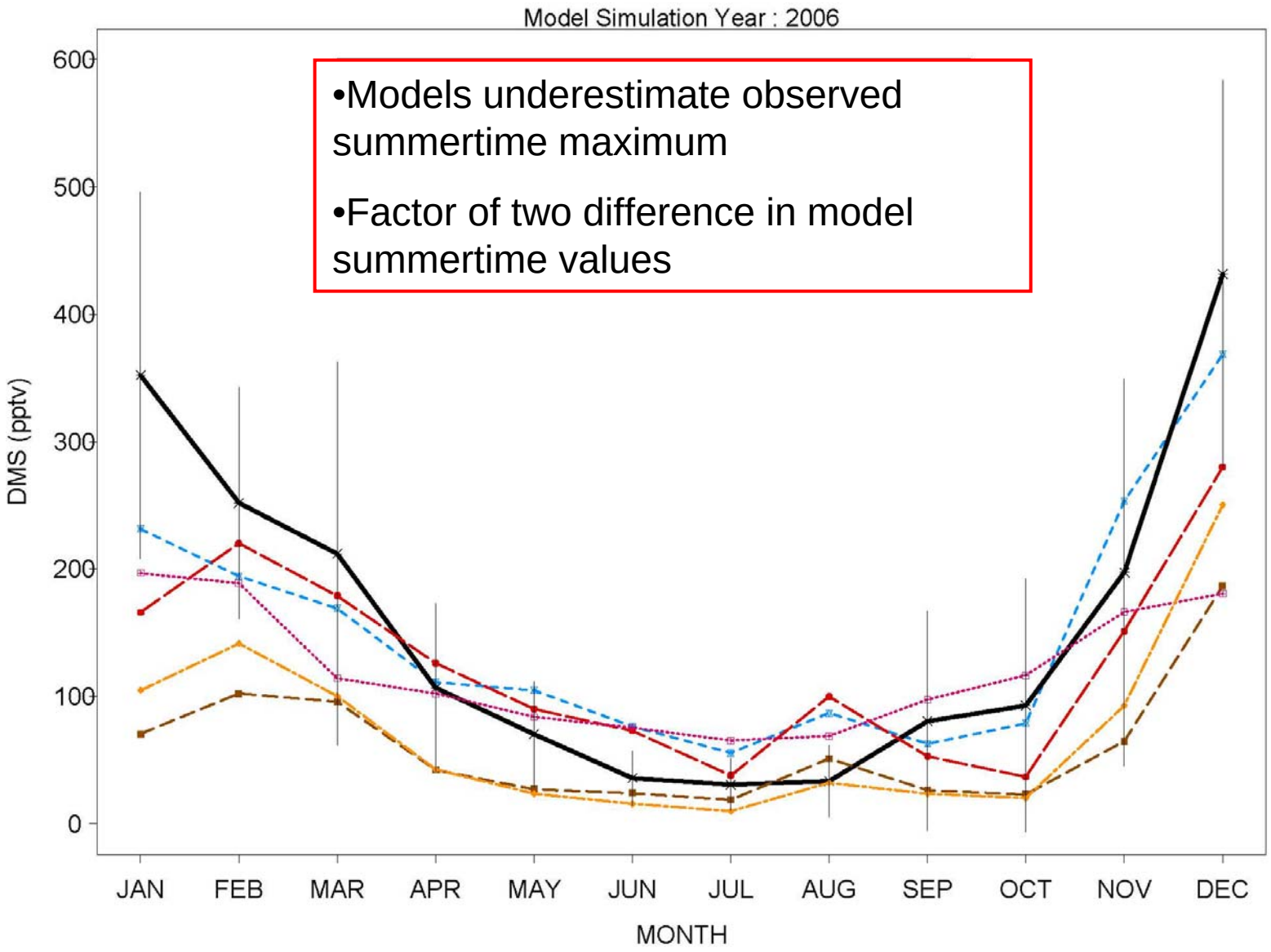
Sulfate : Mass mixing ratio

Reported frequency : Monthly mean (or daily)

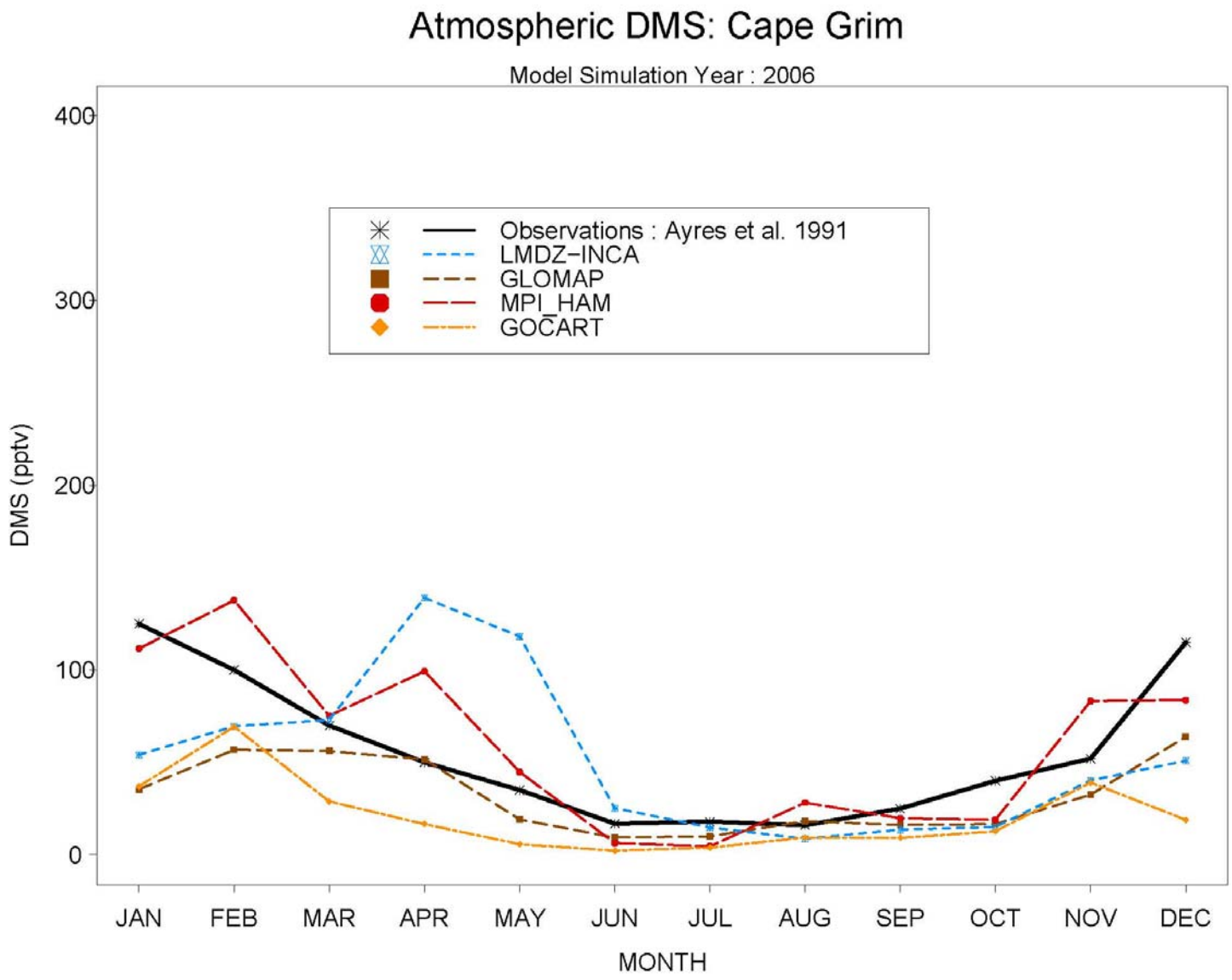
DMS : Observations and Models at Amsterdam Island



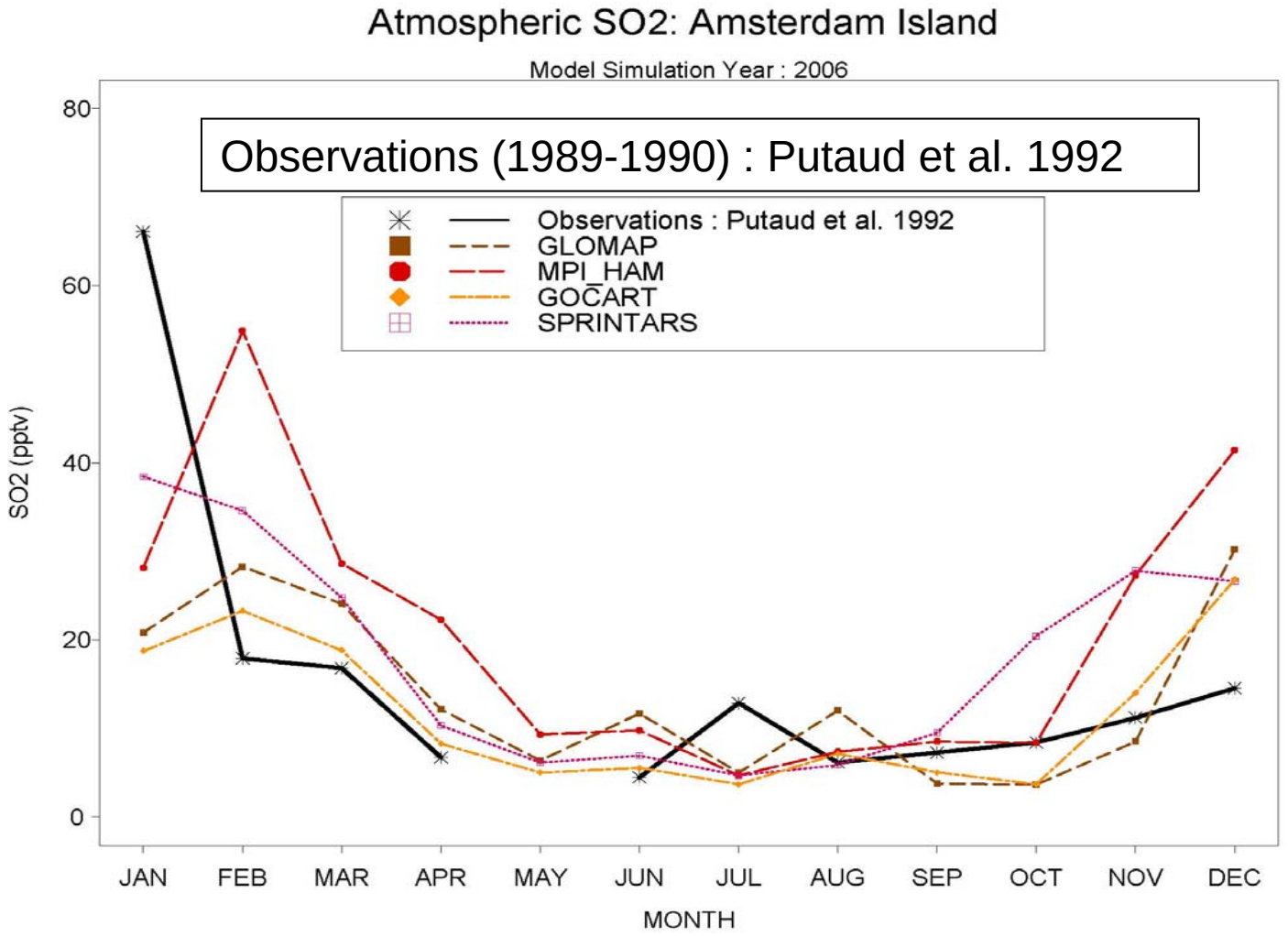
DMS : Observations and Models at Amsterdam Island



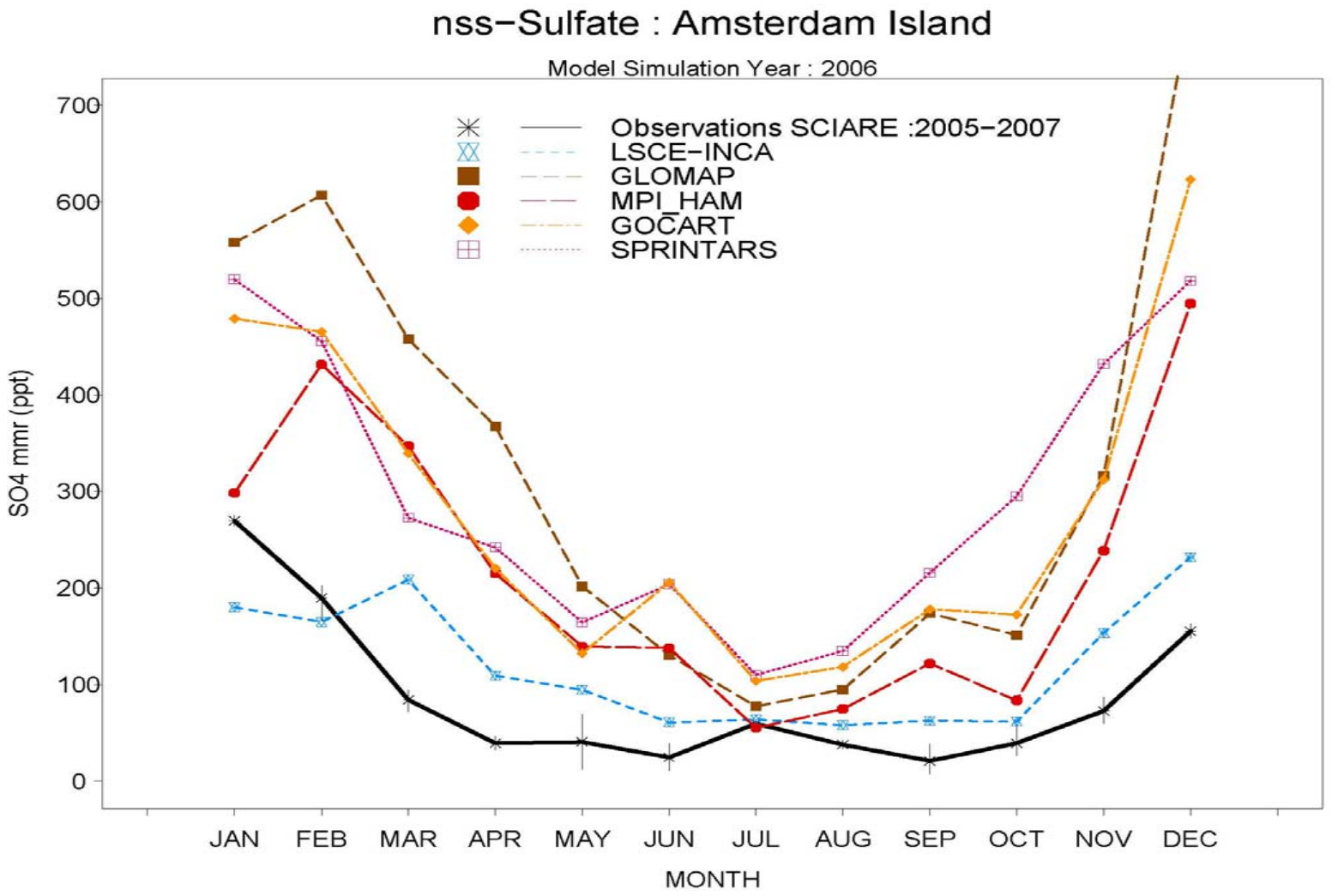
DMS : Observations and Models at Cape Grim



SO_2 : Observations and Models at Amsterdam Island

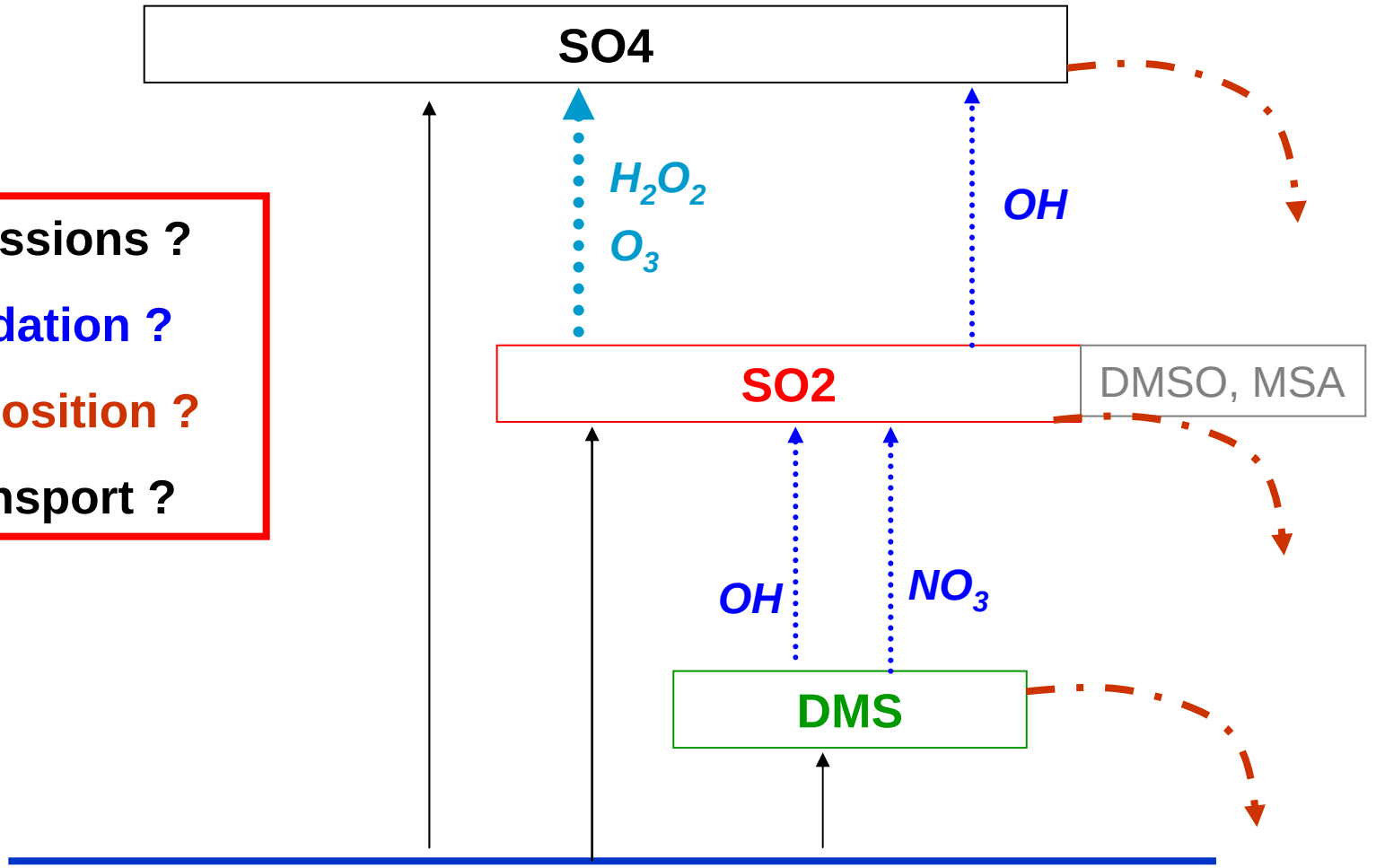


SO4 : Observations and Models at Amsterdam Island



WHAT EXPLAINS THE INTER-MODEL DIFFERENCES ?

- Emissions ?
- Oxidation ?
- Deposition ?
- Transport ?



INITIAL ANALYSES

Evaluate selected AEROCOM diagnostics

Regional average for

Lon : 67^o – 87^o E

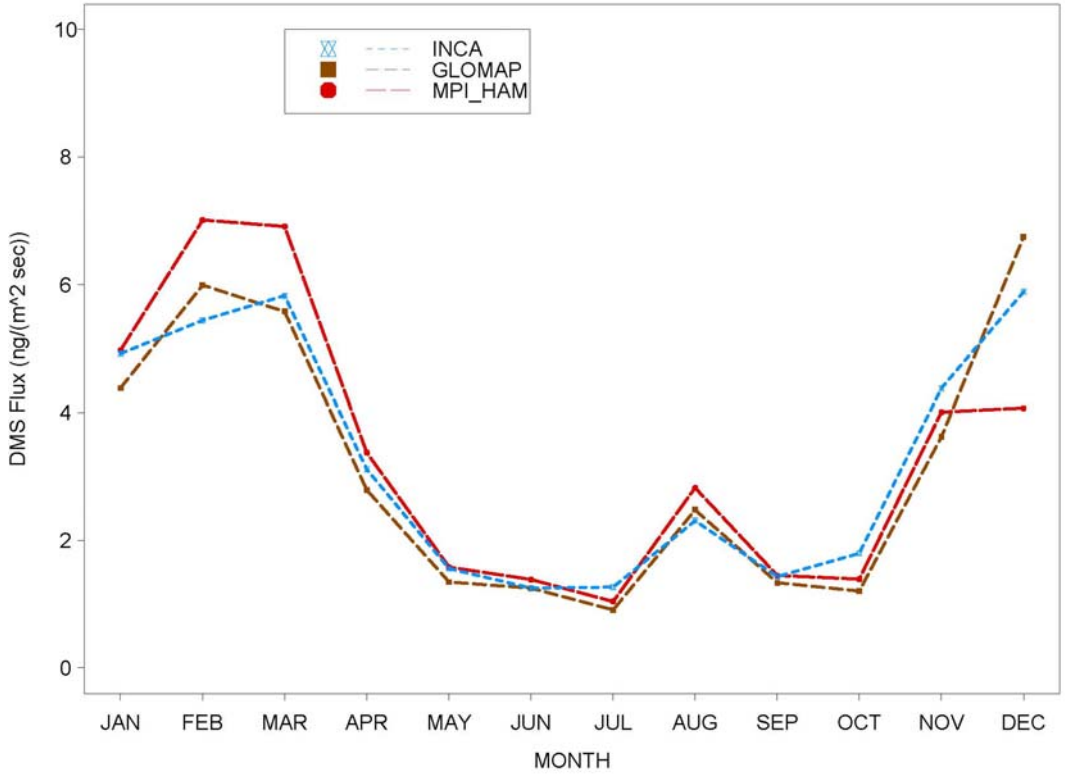
Lat : 30^o – 46^o S

LONGER-TERM AIM

Construct regional budgets

DMS Diagnostics : Emissions

Regional Average



AEROCOM DMS Emissions

Oceanic DMS : Kettle and Andreae, 2000

Gas-exchange : Nightingale et al. 2000

- **Model DMS emissions have similar magnitude and variation**
- **Models use the same formulation**

RELEVANT AEROCOM DIAGNOSTICS

SO4

- **Total direct emission of SO4**
- **Wet deposition of SO4**
- **Dry deposition of SO4**

- **Gas phase production SO4**
- **Aq. phase production SO4**
- **Aq. phase production SO4 [S(IV)+H_2O_2]**
- **Aq. phase production SO4 [S(IV)+O3]**

DMS

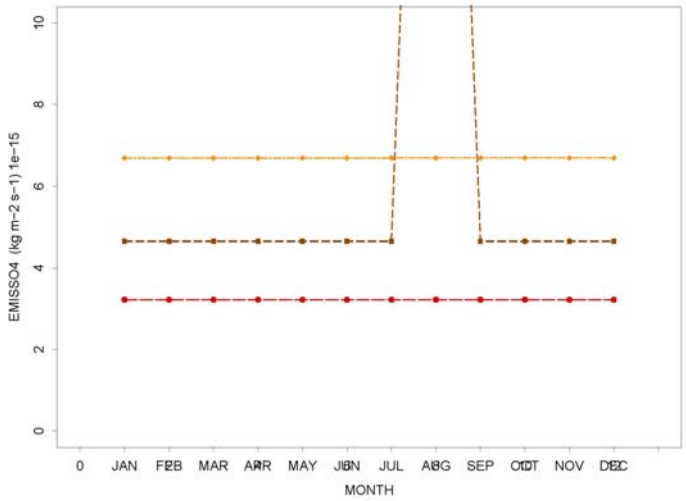
- **Total emission of DMS**
- **Wet deposition of DMS**
- **Dry deposition of DMS**

- *Chem. Loss DMS [OH]*
- *Chem. Loss DMS [NO3]*

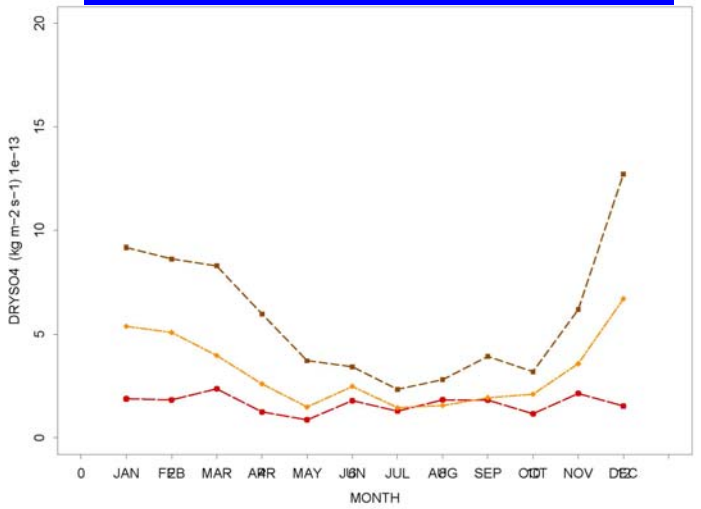
There are also equivalent SO2 diagnostics

SULFATE DIAGNOSTICS
Examples

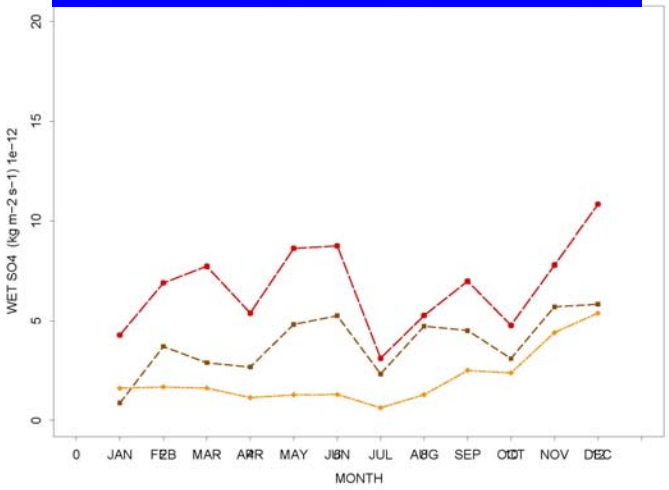
EMISSION : EmisSO4



Dry Deposition : DrySO4



Wet Deposition : WetSO4



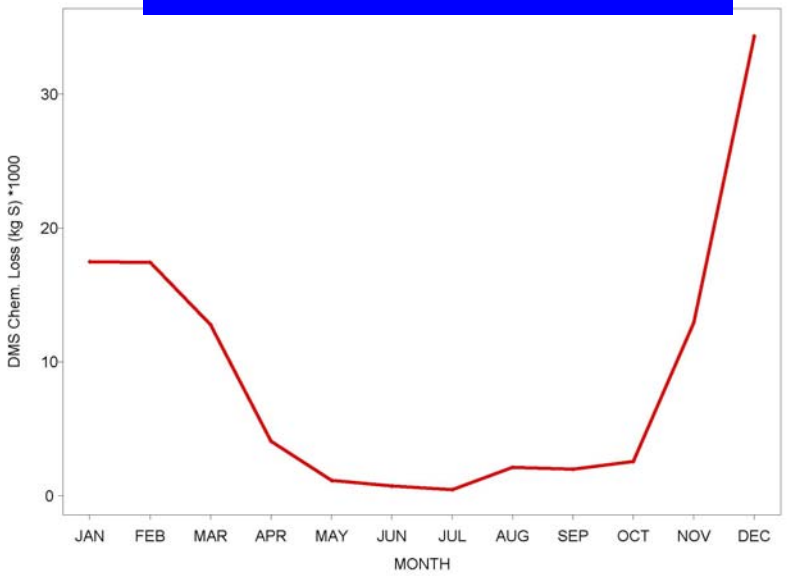
Emissions differences among models in SO4 and SO2

Could result from differences in volcanic emissions in Hindcast scenarios (daily resolution) vs. Dentener et al. 2006 (yearly) ?

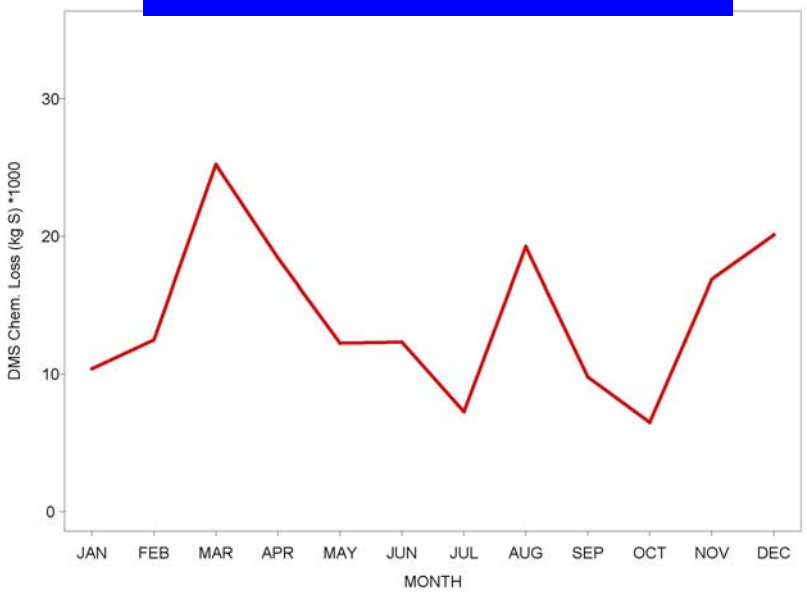
DMS Diagnostics : Chemical Loss Terms

Examples from GOCART Diagnostics

DMS Chemical Loss via OH



DMS Chemical Loss via NO3



SUMMARY

•DMS and sulfate measurements from Amsterdam Island provide an opportunity to evaluate sulfur cycle simulations in the remote marine boundary layer

•Initial results from the AEROCOM models indicate under-prediction of summertime DMS, over-prediction of summertime SO_4, and inter-model differences

•We will evaluate available AEROCOM diagnostics to identify potential causes for these differences.

•Please contact me if you'd like your model included in this inter-comparison.

ACKNOWLEDGEMENTS : EUCAARI; M. Schulz and LSCE for hosting a visit to initiate this work.