Global Aerosol Modelling

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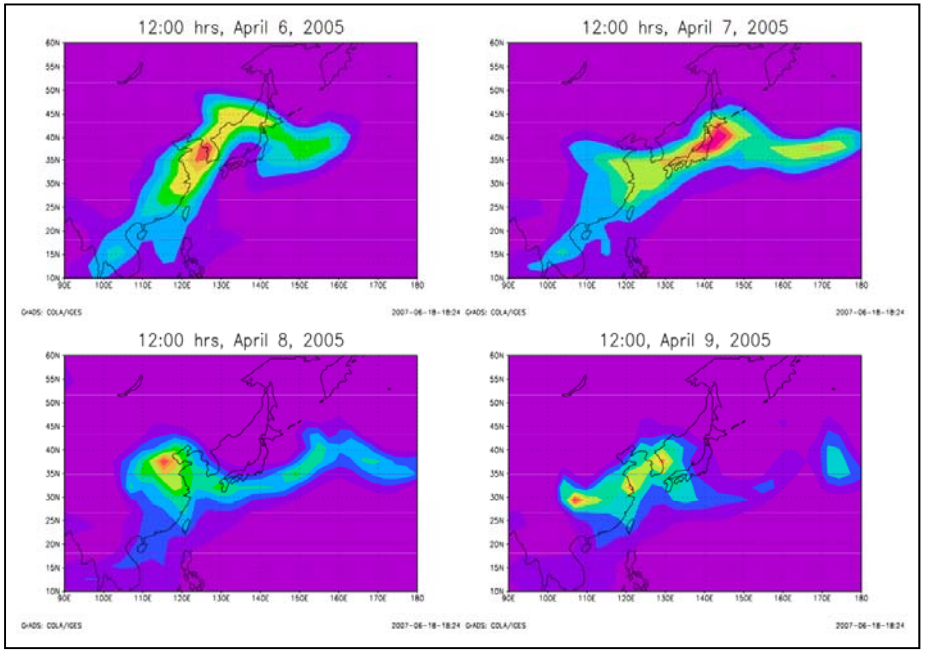
Contents

- SPRINTARS: global aerosol transport model
- Improved chemistry: modelling
- Improved emission: assimilation

Global aerosol model

SPRINTARS (T. Takemura)
- MIROC AGCM (t42l20)
- nudged with NCEP meteo

Four major Aerosol species:
- Carbons
- Dust
- Sea salt
- Sulfate

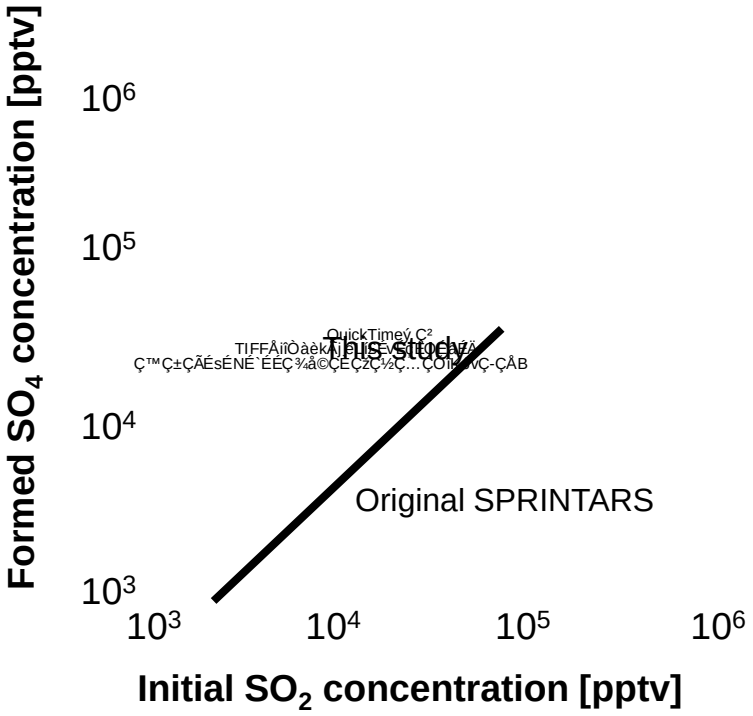


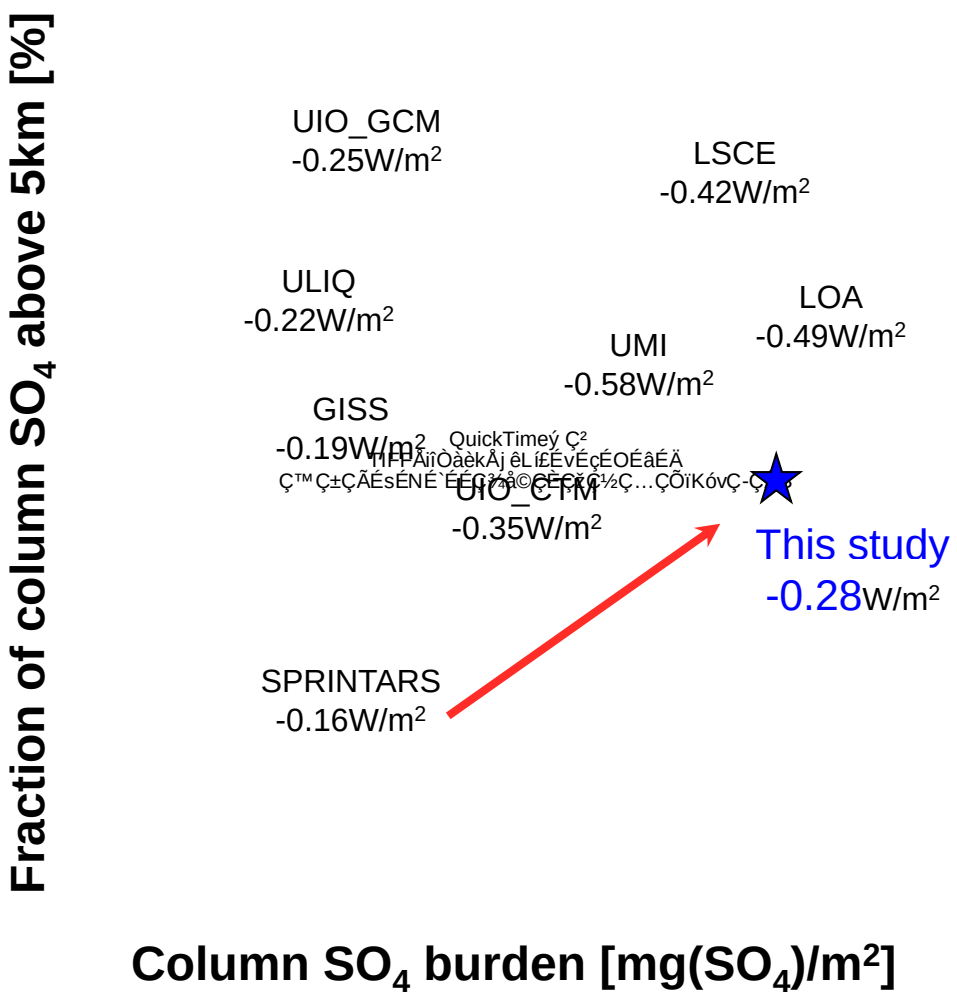
Sources (emission) & Transport & Sinks (wet & dry deposition, gravitational settling)

- Global warming prediction
- Climate Studies (e.g. cloud-aerosol, paleo-climate)
- Support for satellite observations (GOSAT, GCOM-C)

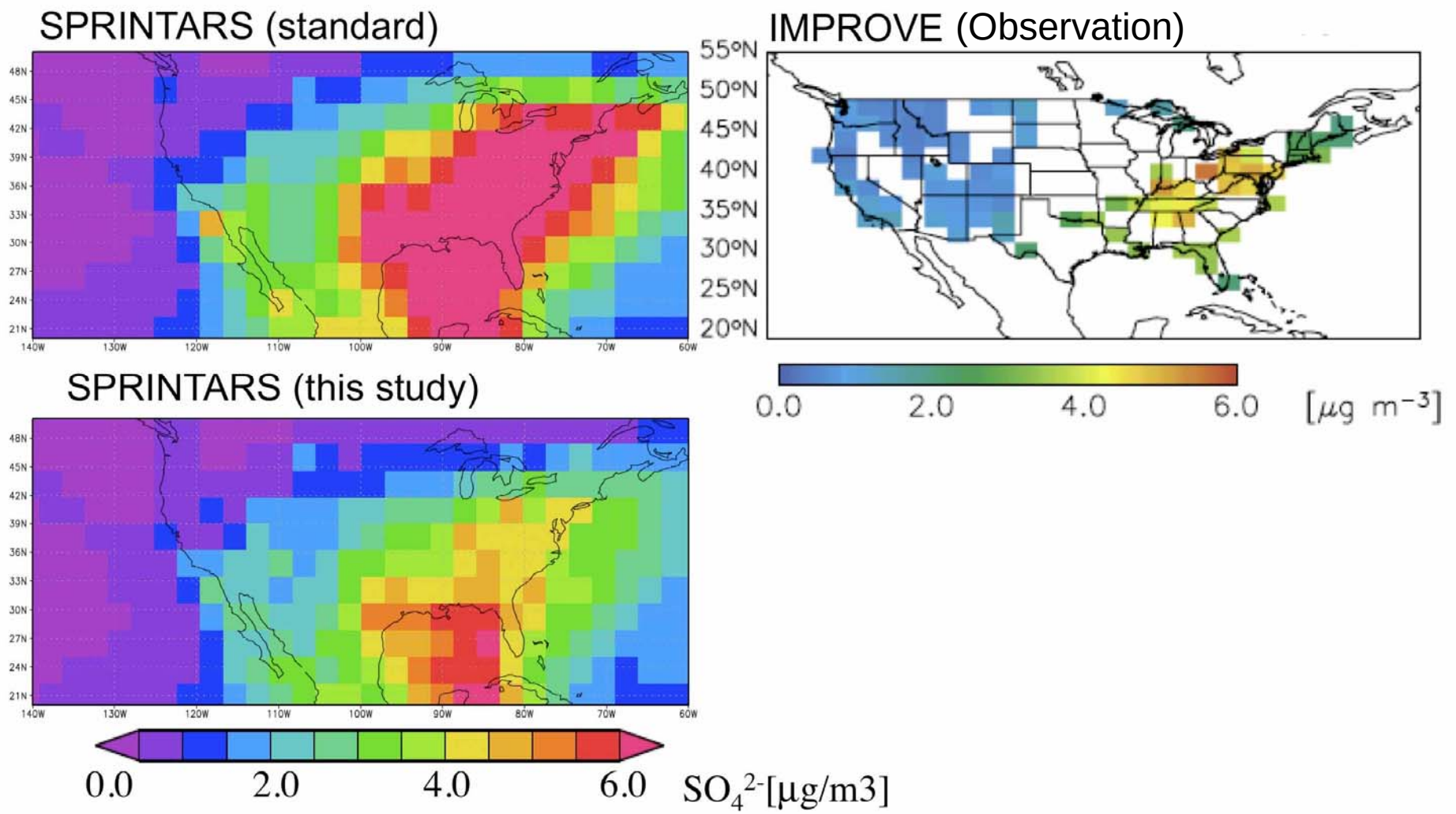
Modified SO_2 aqueous-phase reaction

Conversion of SO_2 to SO_4 is calculated, taking the decrease of H_2O_2 into account

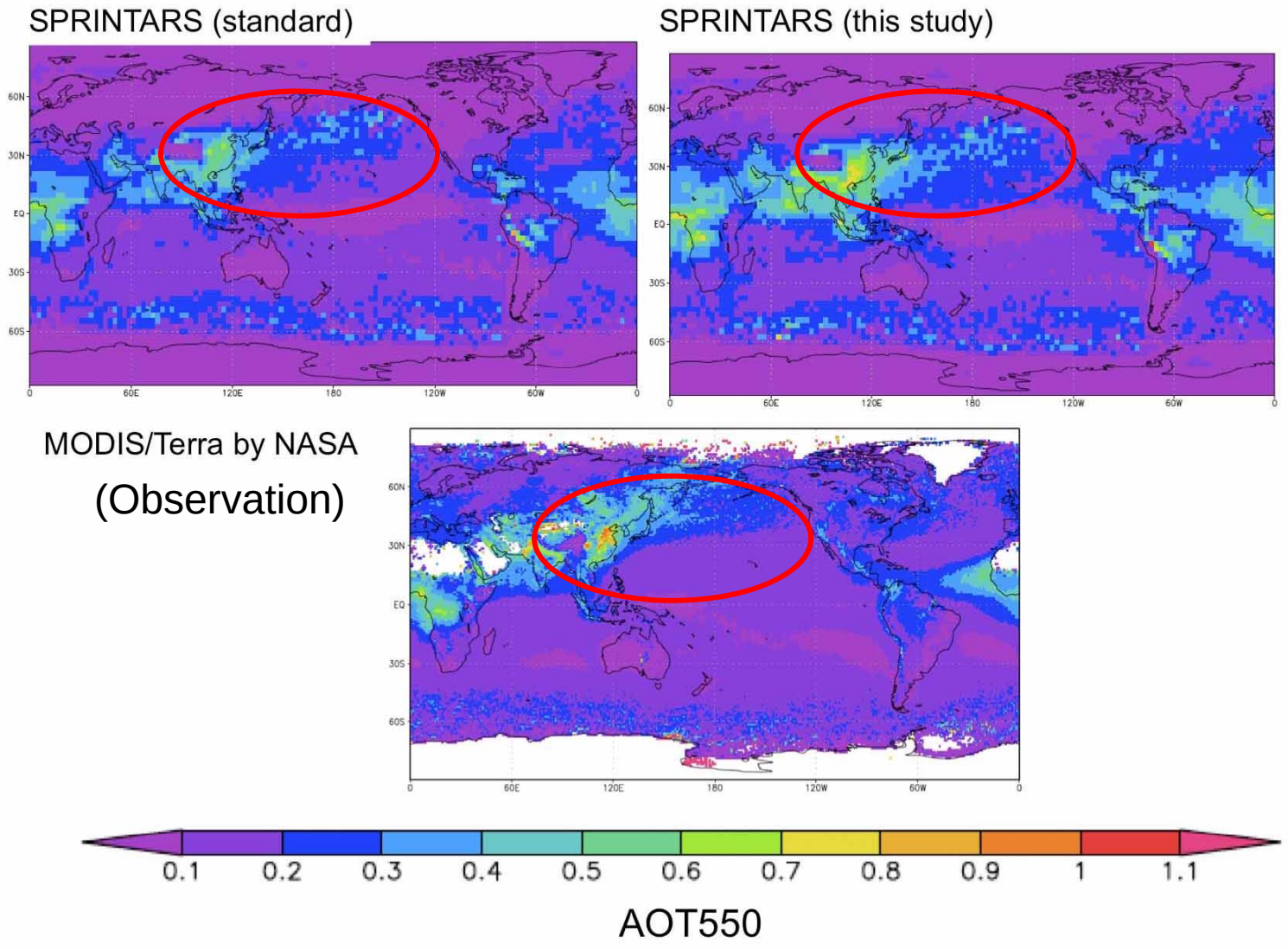




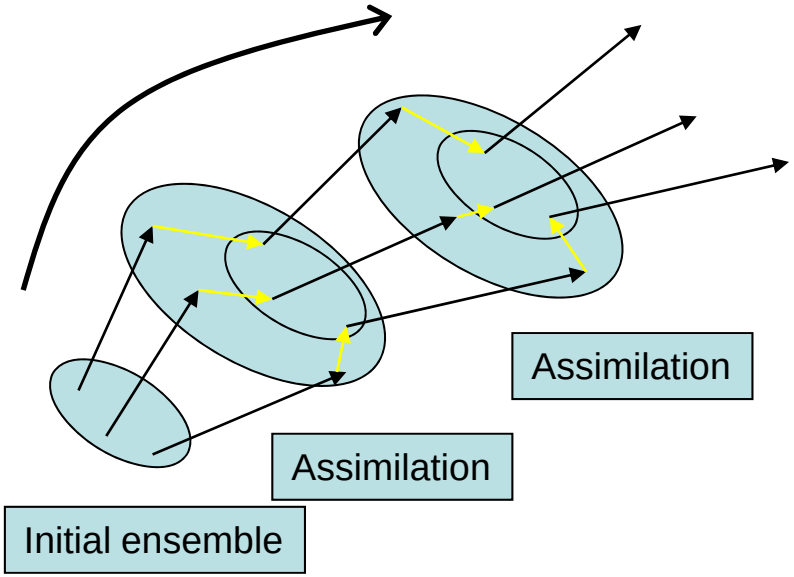
Annual mean surface mass concentration of SO_4



Annual mean aerosol optical thickness at 550nm



Ensemble Kalman filter

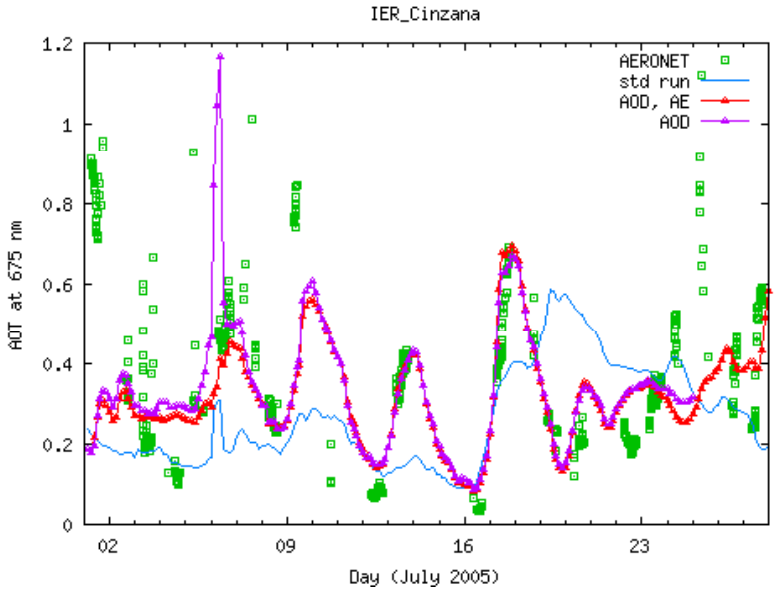


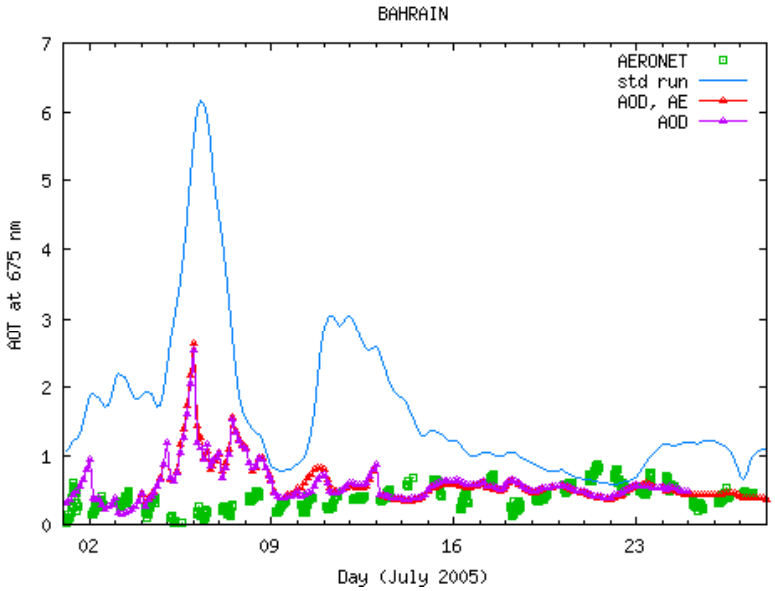
Assimilation is a technique to improve model calculations by using observations.
The model is ‘fitted’ to the observations, reducing uncertainties due to initial and boundary conditions.

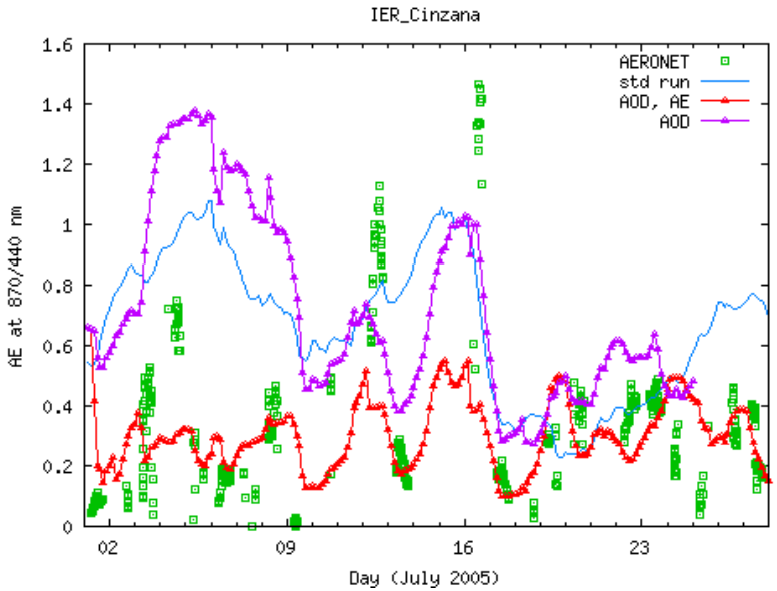
The next 5-10 yr will show whether EnKF becomes the operational approach of choice, or 4D-var [..] remains the preferred advanced data assimilation method.

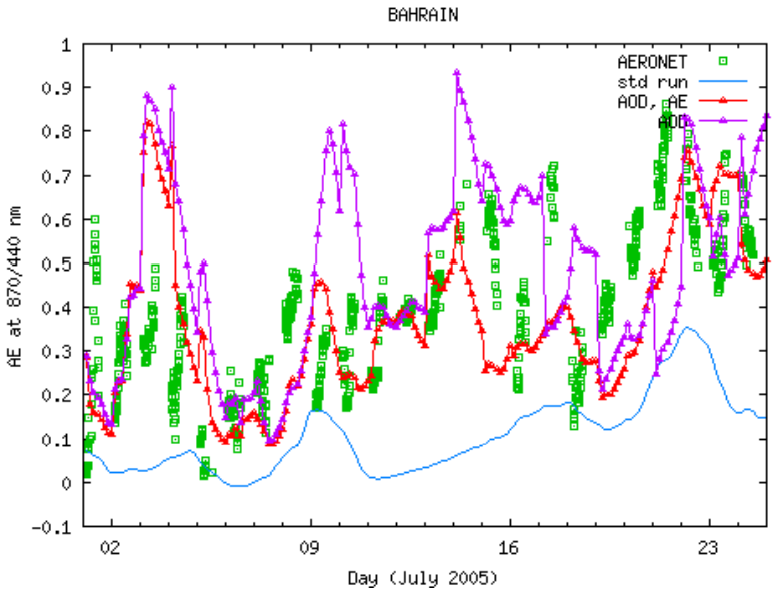
Kalnay et al., Tellus 2007

Assimilation of AERONET

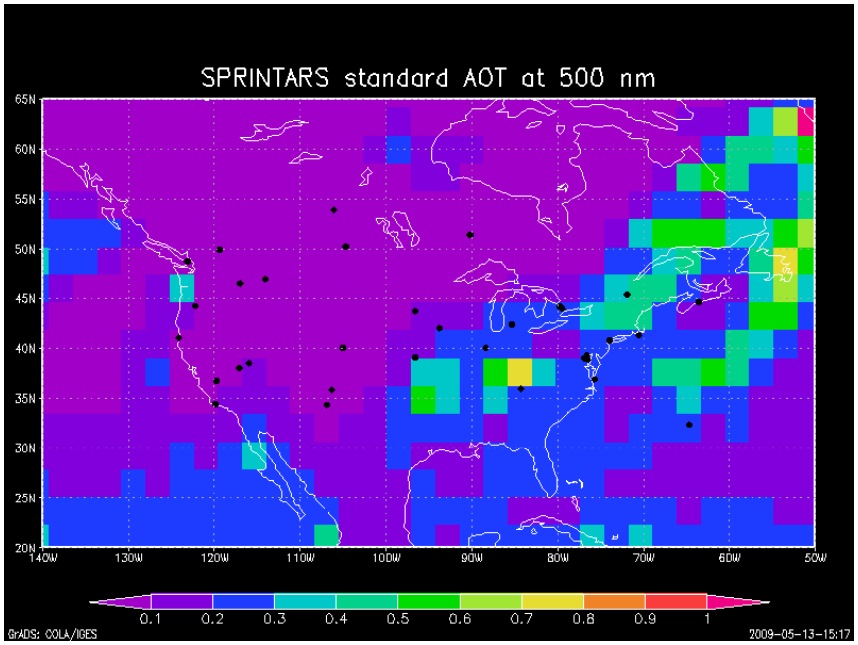


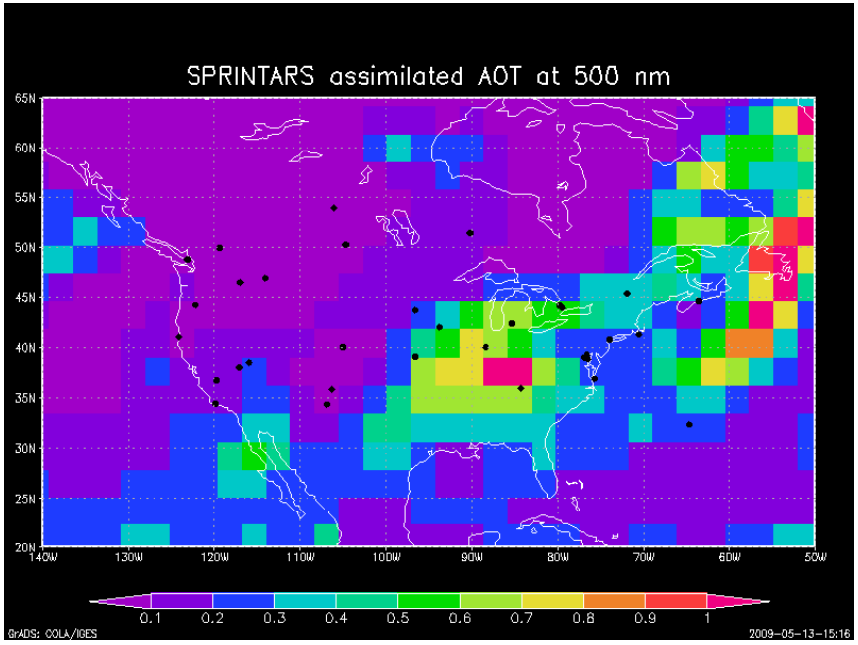




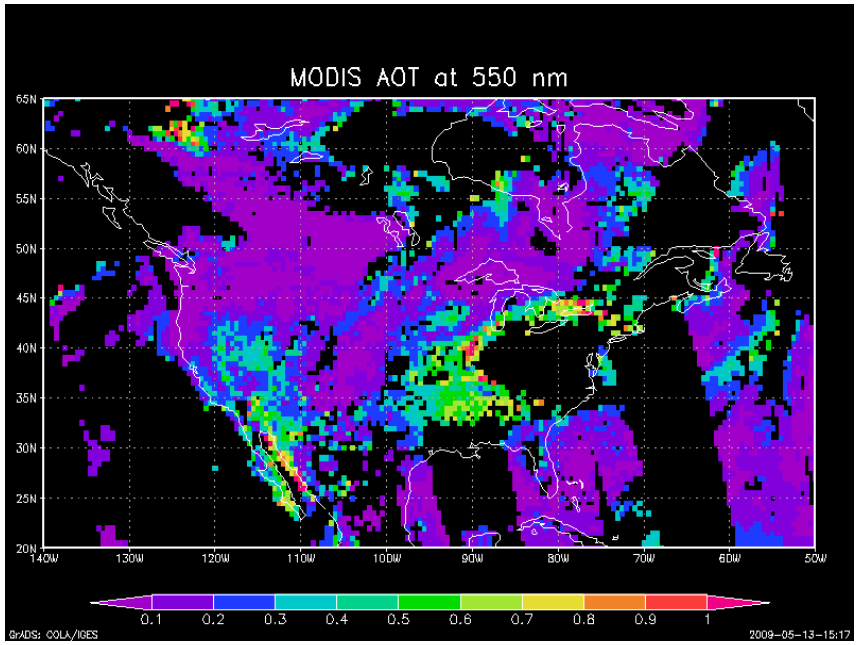


Validation with independent AERONET obs





Assimilation of AERONET

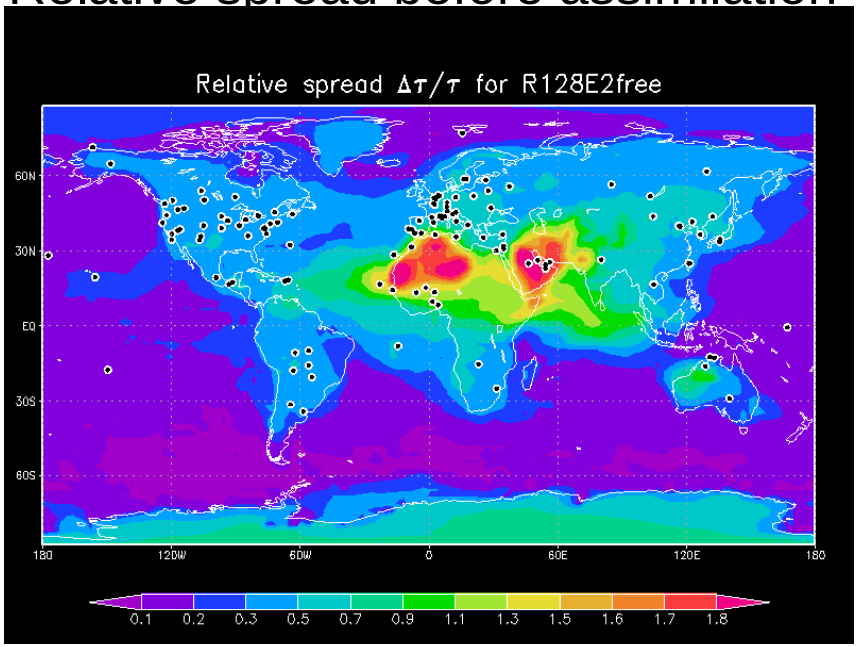


July 14, 2005

Validation with MODIS Aqua obs

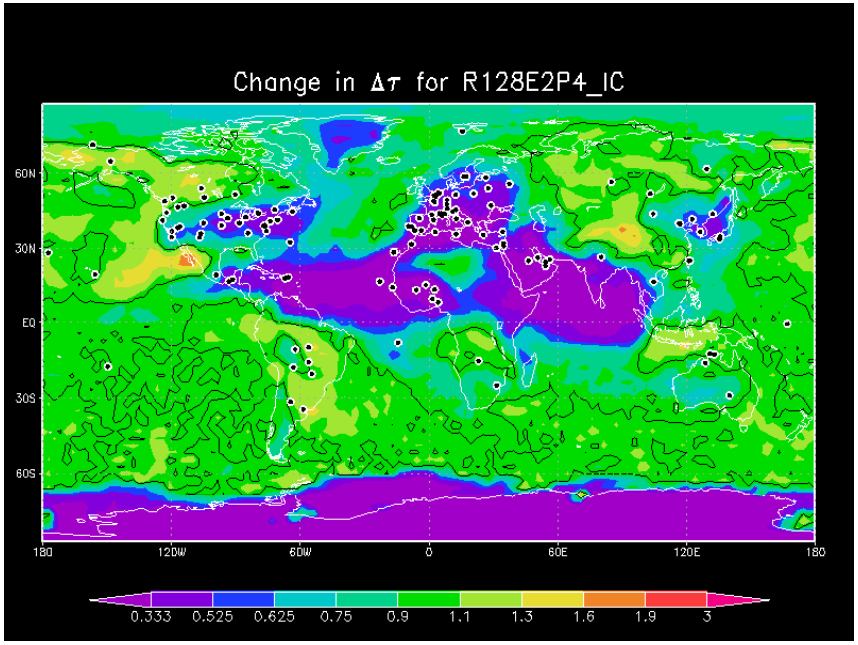
Increase in knowledge

Relative spread before assimilation



By considering changes in the ensemble spread, we can appreciate how much knowledge we gain through assimilation.

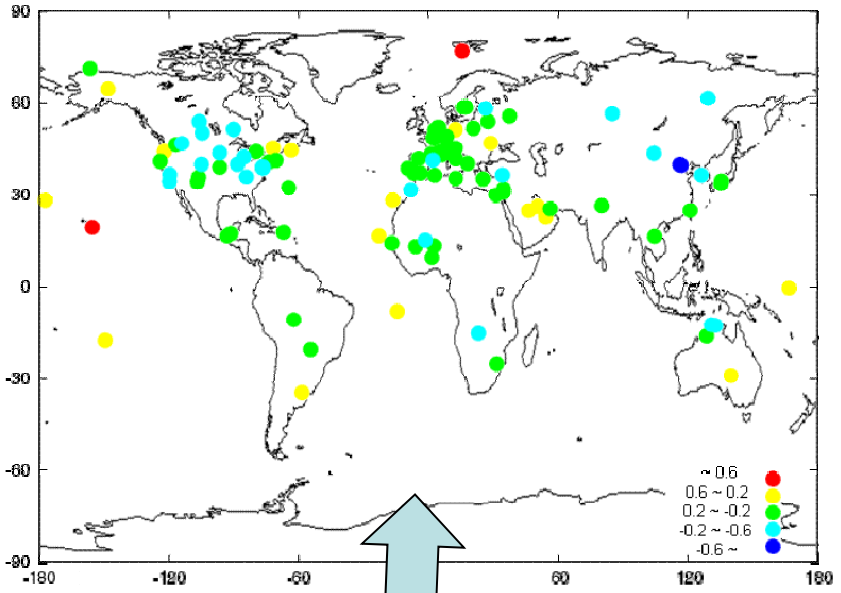
Change due to assimilation



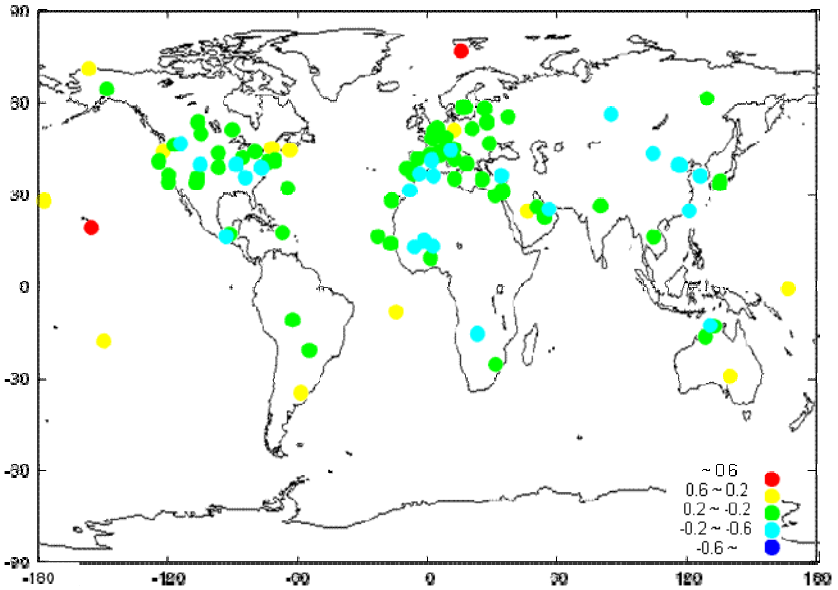
Assimilation of AERONET observations has increased our knowledge of AOT

MODIS provides near global AOT, but is MODIS reliable enough?

Simulation without assimilation

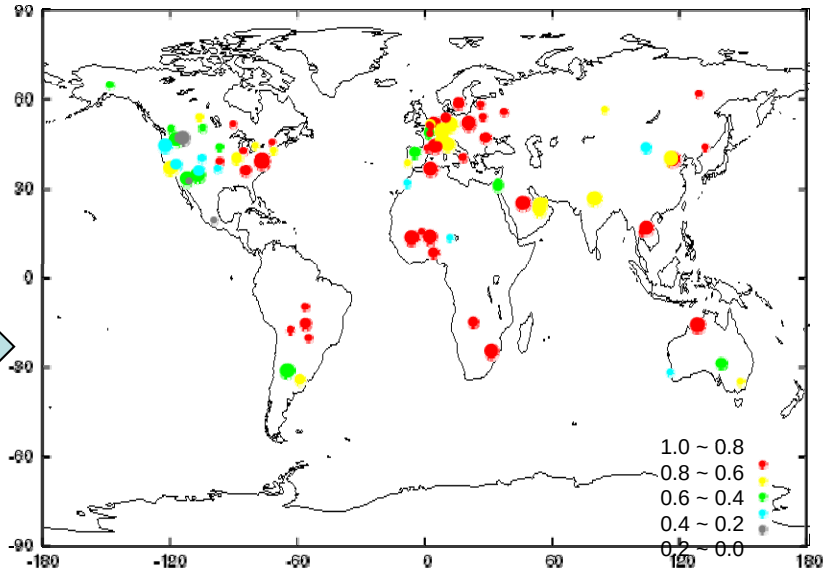


After assimilation of MODIS AOT



Relative AOT errors
MODEL - AERONET at 675 nm

Correlation AOT
MODIS - AERONET at 675 nm



Summary

- Improved chemistry:
  - Sulfate
- Improved emissions:
  - EnKF Ensemble Kalman filter and ES Ensemble Smoother
  - AOT Optical Thickness and AAE Angstrom Exponent
  - Various sensors: MODIS, AERONET, CSHNET, ADNET, SKYNET
  - Very soon: emission inversion