School of Earth and Environment
FACULTY OF ENVIRONMENT

UNIVERSITY OF LEEDS

Radiative Forcing MIP

part of CMIP6

Robert Pincus, Piers Forster, Bjorn Stevens

Radiative Forcing Model Intercomparison Project (RFMIP)

UNIVERSITY OF LEEDS

Aim: Evaluate RF within climate models to understand range of surface temperature change

1. Offline radiative forcing comparison with reference models (WMGHGs only) Robert Pincus
2. Aerosol optical property diagnostic comparison (TBD)

   (Bill Collins (Berkley), Ramaswamy)
3. Effective Radiative Forcing (Forster)
4. Historical AOGCM integrations with prescribed aerosol scenarios (Bjorn Stevens)

Spread in model ERF

UNIVERSITY OF LEEDS

Spread in model ERF comes from:

1. Instantaneous forcing differences
   - a genuine error in radiation code
   - differences in abundance of constituents (e.g. aerosols)
2. Adjustment differences
   - Stratospheric adjustment
   - Cloud adjustments
   - Land surface temperature and other tropospheric change
3. Model climatological differences (e.g. cloud)

Approach to ERF estimates

UNIVERSITY OF LEEDS

Diagnose TOA and surface flux changes

1. Using a 30-year timeslice climatological-SST AGCM integration to diagnose present day forcing for 7 forcing combinations
2. Using time varying scenarios with climatological SSTs to get time varying forcing for 4 scenarios

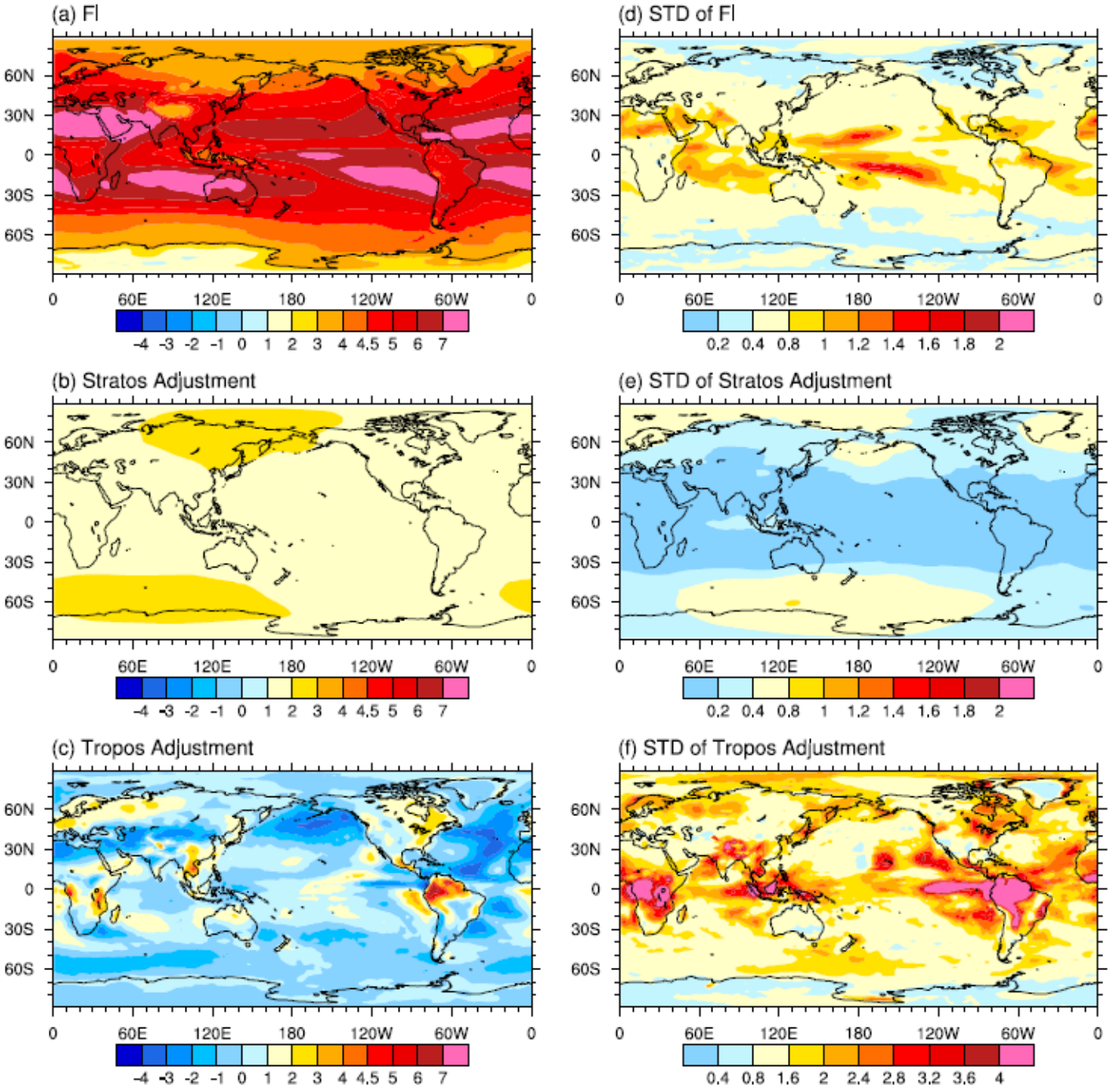
(may use nudged winds to reduce length of runs and/or ensemble size)

Q1: Does everyone have this nudging capability; does it give same ERF as ensemble of non-nudged model results?

Climatological SST AGCM integrations

UNIVERSITY OF LEEDS

RFMIP-ERF-4xCO2	As in RFMIP-ERF-PI-Cntrl but with 4xCO2
RFMIP-ERF-Anthro	As in RFMIP-ERF-PI-Cntrl but with present-day anthropogenic forcing (greenhouse gases, aerosols and land-use)
RFMIP-ERF-GHG	As in RFMIP-ERF-PI-Cntrl but with present-day greenhouse gases
RFMIP-ERF-AER	As in RFMIP-ERF-PI-Cntrl but with with present-day aerosols and ozone
RFMIP-ERF-LU	As in RFMIP-ERF-PI-Cntrl but with present-day land use
RFMIP-ERF-AERx0.1	As in RFMIP-ERF-AER but with present-day changes scaled by 0.1
RFMIP-ERF-AERx2	As in RFMIP-ERF-AER but with present-day changes scaled by 2
RFMIP-ERF-HistALL	Time-varying forcing. SST and sea ice fixed at preindustrial control. Interactive vegetatio. Forcing post 2015 uses a scenario consistent with DCPP and DAMIP (SSP2-4.5)
RFMIP-ERF-HistNAT	Time-varying forcing from volcanos, solar variability, etc. SST and sea ice fixed at preindustrial control. Interactive vegetation
RFMIP-ERF-HistAER	Time-varying forcing by aerosols. SST and sea ice fixed at preindustrial control. Interactive vegetation
RFMIP-ERF-HistGHG	Time-varying forcing by GHGs. SST and sea ice fixed at preindustrial control. Interactive vegetation



UNIVERSITY OF LEEDS

4xCO2 fixed SST
CMIP5

Zhang and Huang,
J Climate 2013

Chung and Soden
In press J. Clim

Current diagnostic approach

UNIVERSITY OF LEEDS

1. Use offline part of RFMIP and AerChemMIP to understand instantaneous RF spread from radiation scheme differences
2. Gauge spread due to climatology by comparing forcing estimates with different climatologies employing a single radiation code
3. Interpret spread due to adjustment as a residual

ΔERF = Δ radiation scheme + Δ climatology + Δ adjustment

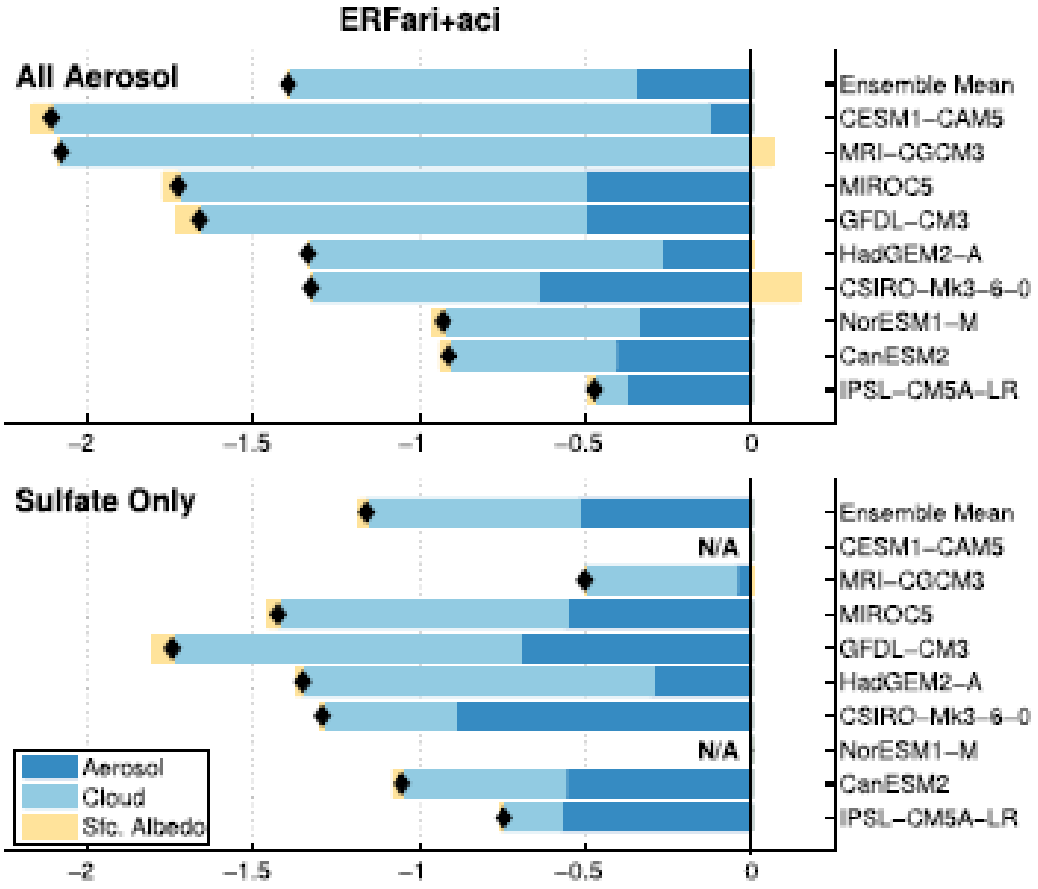
4. Use Kernel approaches to help understand causes of adjustment spread

Q2: Is this sufficient or is there a better way to diagnose reasons for spread?

- modify Ghan triple call idea to work with mix of GHG and aerosol forcing?
- Multiple calls to get multiple IRF components?

Effective Radiative Forcing

UNIVERSITY OF LEEDS



Zelinka et al., 2014