New approaches to accounting for observational shortcomings
Key scientific advances since AR5

• Ensembles of observations now available (e.g., surface temperature, SSMI column water vapor)
• Wider use of measurement proxies (mapping of models to observations)
• Availability of Obs4MIPs helped model development
• Longer records of novel satellite data – need to continue those into the future
• Better coordination between land use data developers and modelers
• Historical reanalysis & state estimates & ocean and coupled reanalysis
• ARGO data
• Better understanding of Model forcings uncertainty:
  – Better understanding of volcanic data sets used for model forcing
  – Better understanding of uncertainties in Ozone data sets used to force models
• Making room for multiple explanations for model-obs differences (lessons learned from hiatus analysis)
Shortcomings, gaps, opportunities

- How to use ensembles of observations in model evaluations → Statisticians
- Encourage obs groups to do better in characterizing obs uncertainty
- One error number is not enough (decompose the error budget, into instrument, sampling, processing errors)
- How do we use the better error estimates for model evaluation?
- Update and check forcing data sets more regularly
- Continue crucial satellite observations used for climate model evaluation (SSMIS sea ice satellite series to be discontinued when DMSP-F18 fails)
- How to represent biodiversity?
Long term perspective

• Need DIPS – data intercomparison projects
• Need MIPs4Obs: perfect model experiments using measurement proxies/Observing System Simulation Experiment (OSSE)
  • test different obs data products within models to better understand consistency, to establish expected mis-match between models and obs
  • Self-consistency check of benchmark datasets used for model evaluation
• Need new obs for unconstrained processes and features that models show sensitivity to
  – (e.g., biomass/carbon cycle, snow on sea ice, topography under ice sheets, potentially currently unobservable)