ACP Special Issue
. . .
2016 Report Status
. . .
Chapter 2 Updates

Chapter co-leads: J. S. Wright, M. Fujiwara, C. Long

Chapter contributors: G. P. Compo, R. Dragani, W. Ebisuzaki, Y. Harada, C. Kobayashi, W. McCarty, K. Onogi, S. Pawson, A. Simmons, D. G. H. Tan, K. Wargan, J. S. Whitaker, C.-Z. Zou

(jswright@tsinghua.edu.cn)

19 October 2016

S-RIP special issue in ACP

- Edited by Peter Haynes, Gabi Stiller, and Bill Lahoz
- Now open to submissions
- Intended to collect research with relevance to S-RIP
- Participation in S-RIP is not a prerequisite for submission
- Six papers submitted to date, including an overview paper, with three in the discussion stage and three published by ACP:
  - Fujiwara et al. (ACPD, 2016): Introduction the SPARC Reanalysis Intercomparison Project (S-RIP) and overview of the reanalysis systems
  - Fujiwara et al. (ACP, 2015): Global temperature response to the major volcanic eruptions in multiple reanalysis data sets
  - Kawatani et al. (ACP, 2016): Representation of the tropical stratospheric zonal wind in global atmospheric reanalyses
  - Miyazaki et al. (ACP, 2016): Inter-comparison of stratospheric mean-meridional circulation and eddy mixing among six reanalysis data sets
  - Friedrich et al. (ACPD, 2016): A comparison of Loon balloon observations and stratospheric reanalyses products
  - Wunderlich & Mitchell (ACPD, 2016): Uncertainty and detectability of climate surface response to large volcanic eruptions

S-RIP overview paper

- An introduction to S-RIP (motivation, objectives, report structure)
- Main body provides a description of eleven current or recent reanalyses:
  - ERA-40, ERA-Interim, ERA-20C
  - JRA-25/JCDAS, JRA-55
  - MERRA, MERRA-2
  - NCEP-NCAR R1, NCEP-DOE R2, CFSR, NOAA-CIRES 20CRv2
- Most materials are revised and reformatted from Chapter 2:
  - Forecast model specifications (grids, dynamical cores, parametrizations, boundary conditions)
  - Data assimilation (brief overview of methods used by these reanalyses)
  - Input observations (conventional and satellite-based, changes in time, key data sources and archives, quality control and bias correction procedures)
  - Ozone and water vapour (relevant parametrizations, details of data assimilation)
  - Several notes on how observational data assimilation affects the performance of reanalyses, especially in the upper troposphere, stratosphere, and mesosphere
- My thanks to the many S-RIP participants who provided input and feedback for this paper — this was truly a collaborative effort

Reviewer feedback on S-RIP overview paper

- Reviewer #1:
  - less focus on programmatic material (the S-RIP project and report)
  - more focus on how reanalysis structure and data assimilation affect performance in the stratosphere (perhaps focused on the core areas examined by S-RIP)
  - expand explanations of 'homogenized data' and why GNSS-RO is effectively unbiased
- Reviewer #2
  - more discussion of previous intercomparisons of reanalyses in the stratosphere
  - resolution vs grid size
  - add treatment of upper layers of model (is there a 'sponge' layer? if so, how is it implemented?)
  - add treatment of vertical and horizontal diffusion
  - add more detailed information on evolution of boundary conditions (CO_2, CH_4, sea ice, etc) assumed by each system
- Feedback was positive overall, and both reviewers commented that this will be a useful resource both for S-RIP and the wider community of reanalysis users

2016 Interim Report: Overview

- Editors: Masatomo Fujiwara, Jonathon Wright, Gloria Manney, and Lesley Gray
- Technical editors: Fiona Tummon and SPARC Office colleagues
- Report status:
  - Chapter 1: ready for review, pending the addition of information from this workshop
  - Chapter 2: ready pending completion of check by co-authors and editors
  - Chapter 3: ready pending completion of check by editors
  - Chapter 4: ready for review

2016 Interim Report: Intended review process

- Review process will be similar to that of journal publications
  - minimum 3-4 reviewers per chapter
  - two rounds of reviews
- Review process should be semi-public, in the sense that at least the reviewers for all chapters can see the review reports for all chapters
- Masatomo has prepared a web page for coordinating the review process under the S-RIP website
- Reviewers will be informed of the two-part structure of the S-RIP report (i.e., 2016 interim and 2018 full).
- Reviewers will be able to access all four chapters.
- Some reviewers may review more than one chapter if appropriate and necessary.

A few notes about Chapter 2

- Goal: a reference for reanalysis users, esp. in SPARC community
- Expect that readers will want to:
  - learn about the structure of a single reanalysis
  - compare / contrast the structures of two or more reanalyses
  - understand more clearly how reanalyses work
  - find sources for additional information
- Prioritize accessibility over technical rigour
- Extensive use of tables:
  - prose rather than shorthand (i.e., full paragraphs for each entry)
  - entries are intended to be self-contained and easily comparable
- Figures to illustrate / clarify key points:
  - forecast model details (specifically vertical resolution)
  - simplified schematics for data assimilation methods
  - sources of potential temporal discontinuities in reanalysis systems (e.g., changes in observing systems, execution streams)
- Current draft available via link on S-RIP wiki for Chapter 2

A few notes about Chapter 2

- Major changes since 2015 workshop
  - added MERRA-2 and ERA-20C
  - more details on the CFSR / CFSv2 transition and key differences
  - confirmed, revised, and expanded details in summary tables
  - revised data assimilation section for accuracy and clarity
  - discussion of data assimilation impacts on reanalyses in the middle atmosphere
  - expanded presentation of input observation timelines for five recent reanalyses
  - summary discussion of quality control criteria for input observations
- Main text now 56 pages (82 w/ references and appendices), with 13 figures and 17 tables
- Current draft available via link on S-RIP wiki for Chapter 2

2.1 Introduction

- What is a reanalysis system and what components does it have?
- Classification of reanalysis systems by observational inputs (“full” vs “conventional” vs “surface”) and temporal coverage (“satellite era” vs “extended”)
- Summary descriptions of reanalysis systems by centre, including mentions of historical reanalyses that are not considered in this report
- Note on the influences of input observations on different reanalysis products
- Brief notes on ozone and water vapour in the UTLS, referring to later sections and Chapter 4
- Table listing the eleven reanalysis systems described in the chapter, with centre, temporal coverage, core references, and any relevant notes:

ERA-20C	Poli et al. (2016)	Centre: ECMWF Coverage: January 1900 to December 2010 Note: A companion ensemble of AMIP-style simulations (ERA-20CM; Hersbach et al., 2015) is also available.

2.2 Forecast models

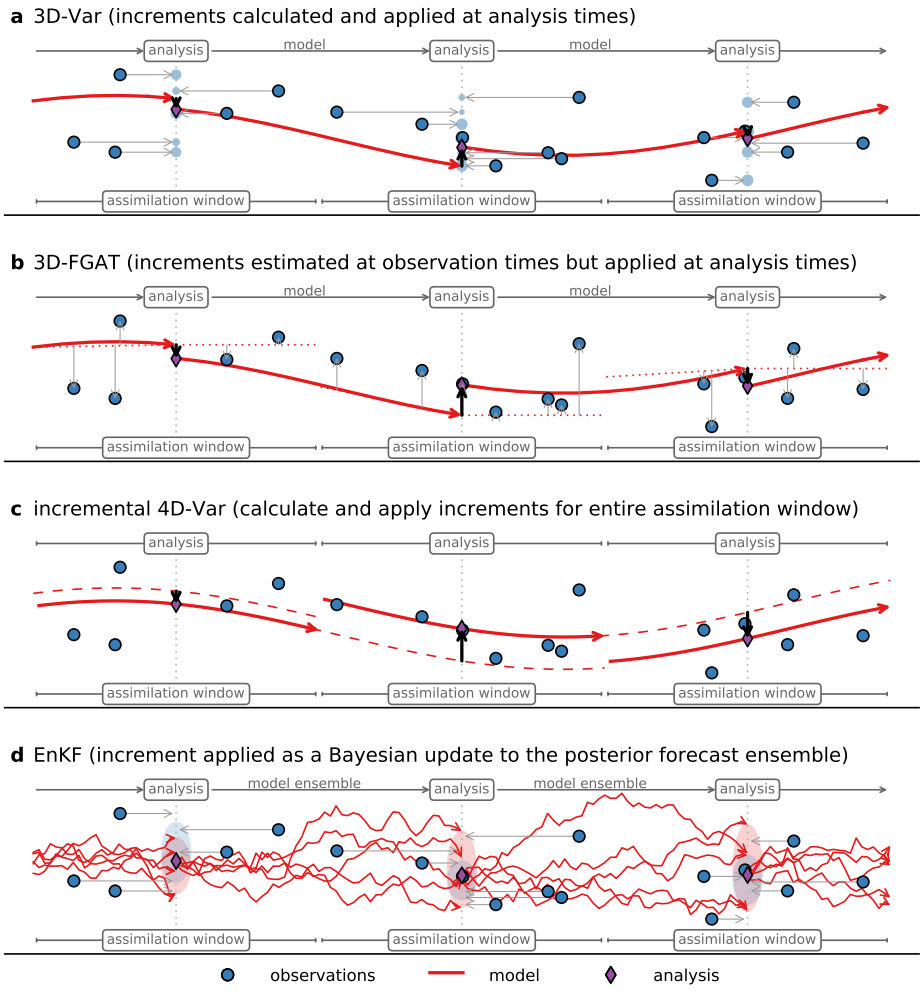
- Introduction to reanalysis horizontal grids (regular Gaussian, reduced Gaussian, regular latitude–longitude) and associated nomenclature
- Dynamical cores are mentioned, with references, but not described in detail
- Brief discussion of vertical coordinates, including figure showing effective vertical resolutions in log-p space (h/t J. Anstey and S. Chabrillat)
- Basic details of the forecast models:

Reanalysis	Model	Horizontal grid	Vertical grid	Top level
ERA-Interim	IFS Cycle 31r2 (2007)	N128: ∼79 km ($\mathrm{T_L}255$)	60 (hybrid σ-p)	0.1 hPa

- Major physical parametrizations in the forecast model (radiation, convective and non-convective clouds, orographic and non-orographic gravity wave drag)
- Boundary and other specified conditions (SST & sea ice, ozone, aerosols, greenhouse gases, total solar irradiance)
- Note cases when “boundary” conditions are determined internally rather than prescribed externally (e.g., ozone for several systems, aerosols for MERRA-2)

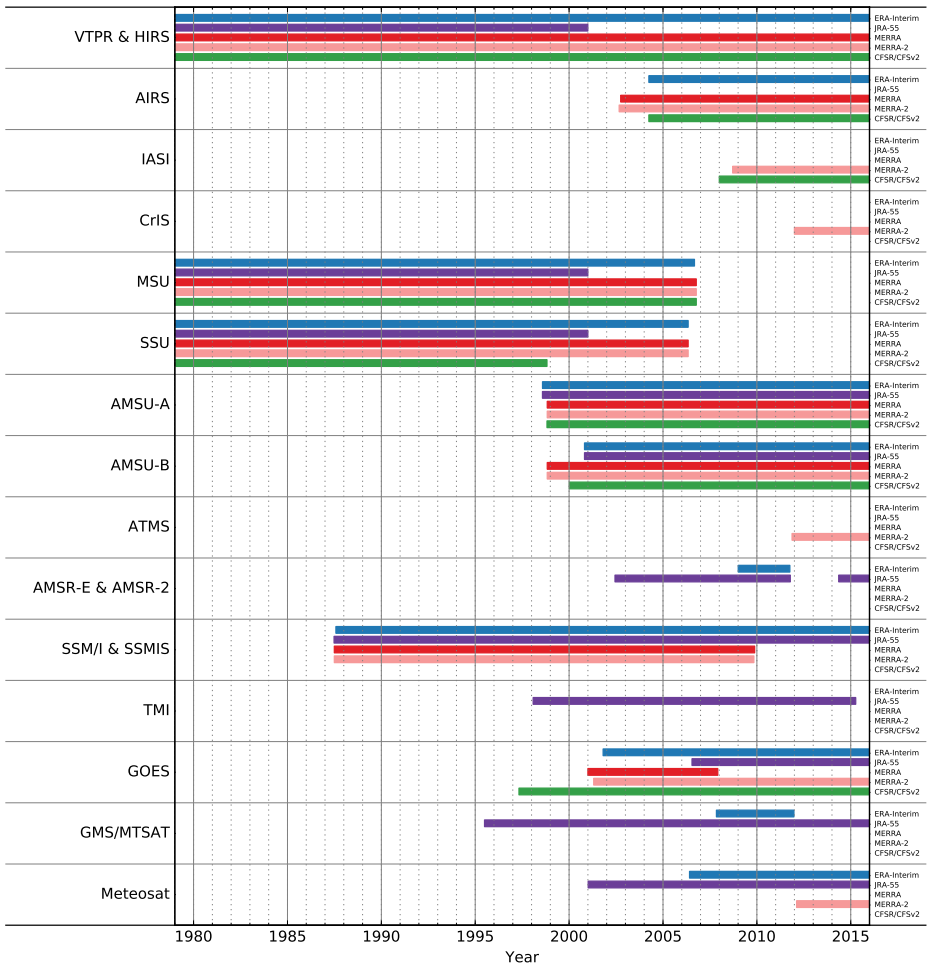
2.3 Assimilation schemes

- Basic descriptions of data assimilation techniques:
  - 3D-Var
  - 3D-FGAT
  - IAU
  - 4D-Var
  - EnKF
- Schematics for all of the above (including IAU)
- Notes on artefacts that may be impact reanalyses in the middle atmosphere
- Table summarizing implementation in each system (method, assimilation window, etc)
- Table of radiative transfer models used to assimilate satellite radiances



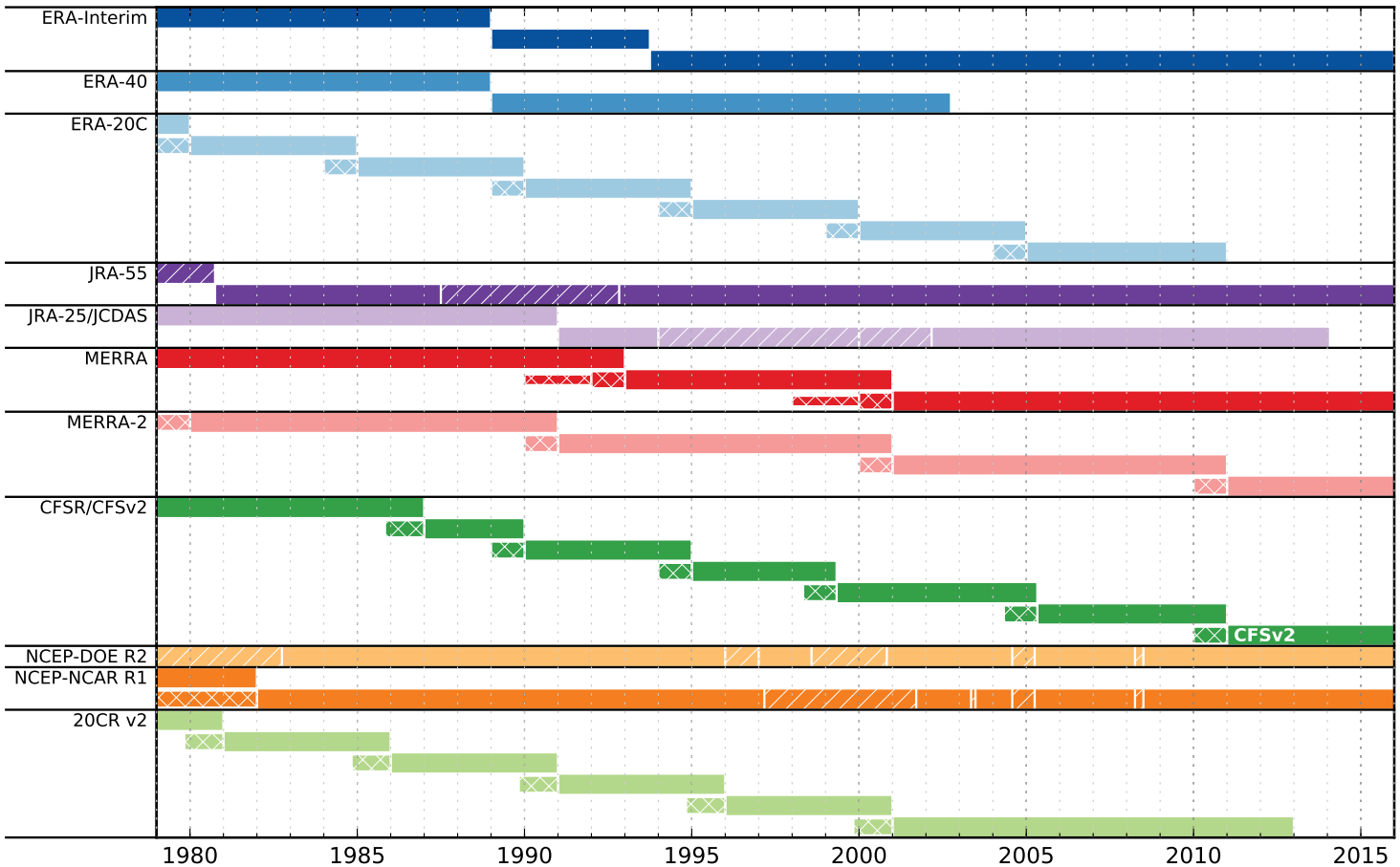
2.4 Observational data

- Introduction to major data sources (radiosondes, satellite radiances, AMVs, aircraft data) and known issues
- Example distributions of assimilated data in the 1980s and the 2010s
- Discussion of quality control criteria and approaches to bias correction
- Summary of recent efforts to homogenize radiosonde / satellite data and impacts on reanalyses
- Timelines of major data types assimilated by five full-input reanalyses
- Short section on stratospheric water vapour (upper limits to assimilation / data provision, key parametrizations)



2.5 Execution streams

- What is an execution stream?
- Summary of stream transitions and known spin-up / reprocessed periods:



2.6 Archived data

- Notes on public archives (e.g., RDA) and caveats for data users (grids, file formats and/or units may vary by data centre, some variables are not provided in the stratosphere, integration time for flux data may not be clear)
- Link to archive information page on S-RIP website
- Brief notes on data extrapolated below the surface

Appendix: Vertical levels of the models

- Tables listing A_k and B_k or σ_k, plus representative pressures for a surface pressure of 1013.25 hPa
- Both model level and standard pressure grids are included
- A_k and B_k have been added for MERRA / MERRA-2 (h/t S. Chabrillat)

Key points for discussion (Chapter 2)

Chapter contributors

J. S. Wright, M. Fujiwara, C. Long, G. P. Compo, R. Dragani, W. Ebisuzaki, Y. Harada, C. Kobayashi, W. McCarty, K. Onogi, S. Pawson, A. Simmons, D. G. H. Tan, K. Wargan, J. S. Whitaker, C.-Z. Zou

Structure/content

Summary **introduction** to eleven (and a half) reanalysis systems; key details regarding **forecast models** and boundary conditions; introduction to **data assimilation** and its implementations in reanalysis systems; description of **input observations** and attendant issues; summary of reanalysis production / **execution streams**; basic information on **archived data** that may be useful for prospective data users

Schedule

Complete, pending circulation amongst chapter co-authors.

Key points for discussion (Chapter 2)

Inputs for Chapter 12

Most content is background and will not be necessary to include; some items may be worth repeating in the context of other chapters' results.

Chapter-specific issues

Possible additions to address suggestions made by reviewers of the S-RIP ACP overview paper:

- table on model upper layers ("sponge" layer and treatment thereof)
- table on treatment of vertical and horizontal diffusion
- figure showing timelines of key boundary conditions (CO_2, CH_4, TSI, sea ice?)