**NOAA Climate Reanalysis Task Force Workshop**

**Meeting Report**

NCWCP Conference Center

5830 University Research Court

College Park, Maryland

May 4–5 2015

Gilbert Compo, Jim Carton, Arun Kumar, Suru Saha, Heather Archambault



Report Finalized: Date TBD

1. **Background**

The goal of retrospective data assimilation or “reanalysis” is to combine disparate observations into physically consistent estimates of the past state of the Earth system and its components, e.g., ocean, atmosphere, waves, land, cryosphere, and ionosphere, with quantified uncertainties. Reanalyses spanning the instrumental record of each component are an important requirement for climate monitoring and advancing predictive understanding, whether for determining the effects of changing boundary conditions and composition, or for providing initial conditions for retrospective forecasts. For almost 40 years, the availability of reanalyses has led to advances in understanding and predicting weather and climate variability, from extreme events to centennial trends. NOAA has been and continues to be an important contributor in the progress towards this goal.

Recent developments across NOAA, in partnership with universities and international agencies, are accelerating improvements to achieve this goal. The NOAA Climate Reanalysis Task Force (NCRTF)[[1]](#footnote-1) is charged with coordinating relevant research activities funded by the NOAA Climate Program Office and is focused on advancing reanalysis towards monitoring and understanding of climate variability. Additionally, NOAA advances in prediction from minutes to seasons require reanalyses spanning many years to serve as initial conditions and verifications for reforecasts that help quantify predictability and improve forecast skill.

As part of the weather and climate prediction enterprise, research improving models, data assimilation systems, and historical observational databases leads to improved reanalysis datasets generated regularly with increasing fidelity for all of the Earth System components. The workshop was convened with the intent to highlight advancements in these areas across NOAA, university and international efforts; identify gaps; and improve coordination of future activities to meet the requirements of the diverse array of users of reanalyses. A series of presentations and vigorous discussion of NCRTF activities, related developments in NCEP weather and climate forecasting systems, and international efforts in these areas was proposed to strengthen NOAA’s and partner organizations’ development and utilization of these important datasets.

Specific workshop objectives were to:

1. Report on NCRTF progress
2. Exchange reanalysis approaches, algorithms, and techniques currently in use and under development
3. Discuss techniques for addressing outstanding issues in the reanalysis efforts
4. Identify the various requirements for reanalysis products
5. Determine strategies and overlaps for national and international reanalysis efforts based on scientific drivers for climate and weather research.

The NCRTF Workshop was held May 4–5 2015 at the National Center for Weather and Climate Prediction in College Park, Maryland. The workshop was attended by over 40 participants representing the national and international reanalysis community. Agencies represented included NOAA, NASA, NCAR, ECMWF,…

After welcoming remarks by an NCEP representative, the workshop began with an introduction to the NCRTF and the workshop, as well as background on the purpose of reanalysis. This was followed by five sessions, each to address a specific objective or objectives, as described below:

* *National and International Reanalysis Efforts* (Day 1)

Objective: Determine strategies and overlaps for national and international reanalysis efforts based on scientific drivers for climate and weather research

* *Developments in the Stratosphere* (Day 1)

Objective: Discuss techniques for addressing outstanding issues in the reanalysis efforts

* *Assimilation Development and Experiments: Atmosphere* (Day 1)

Objective: Exchange reanalysis approaches, algorithms, and techniques currently in use and under development. Discuss techniques for addressing outstanding issues in the reanalysis efforts

* *Assimilation Development and Experiments: Ocean and Sea Ice* (Day 2)

Objective: Exchange reanalysis approaches, algorithms, and techniques currently in use and under development. Discuss techniques for addressing outstanding issues in the reanalysis efforts

* *Reanalysis Evaluation* (Day 2)

Objective: Identify the various requirements for reanalysis products.

Each session contained between four and eight 20-minute presentations, and was capped by a 20–30-minute discussion period led by a moderator furnished in advance with questions from attendees related to the session topic and objective. A rapporteur was assigned to each session. At the conclusion of the last session on Day 2, the rapporteurs provided 5-minute summaries of their session to spur a final round of discussion to close the workshop.

In the remainder of the report, the key workshops outcomes and recommendations will be described (sections 2 and 3, respectively). Next steps and opportunities will be discussed (section 4), along with information about how to obtain further information on the workshop and NOAA reanalysis (section 5), and acknowledgements will be provided (section 6).

1. **Key overall outcomes of the workshop**
	1. Improved coordination of CRTF with ongoing reanalysis efforts at NCEP
	2. Enhanced awareness of complementary reanalysis efforts among national and international agencies
2. **Session summaries**
	1. **National and International Reanalysis Efforts**
		1. **Summary of presentations**

Reanalysis priorities at NCEP’s Environmental Modeling Center (EMC) are focused on coupled data assimilation and forecasting, with priorities of predictions at subseasonal to the 6-week range, and from seasonal to the 6-month range. An outstanding issue is how to utilize cloud computing and storage. An upgrade in data assimilation to hybrid 4DEnVar and inclusion of aerosols, sea ice, land and ocean components is planned. High priorities in terms of physics are scale-aware PDF-based subgrid scale turbulence and cloudiness schemes, aerosols with consistent microphysics, convection-cloudiness-radiation interactions, non-orographic GWD, Hybrid gain 3DVar/LETKF GODAS, and NSST development. NCEP’s issues and requirements for climate reanalysis concern monitoring, attribution, and societal applications. In terms of forecasts, reanalysis is needed to initialize, and provide base climatology for bias correction, and to verify and re-calibrate models. Key challenges are dealing with discontinuities in reanalysis data sets arising from interaction with model bias and observational platform changes, connecting different reanalysis efforts, and balancing requirements for reforecasts versus climate monitoring, analysis, and attribution.

At ECMWF, ERA5 (T639L137, 10-member EDA, all-sky radiances, varBC for everything) will succeed ERA-interim and will be available for 1979-present. The ERACLIM will transition to ERACLIM2 which will feature coupled land-atmosphere-ocean-sea ice-biogeochemical components. The new Copernicus climate change services will include operational support for reanalysis.

Chinese Meteorological Agency reanalysis plans are for a satellite era (1979-present), near-real-time 30-km resolution, land-surface reanalysis. It will be created from an old version of IFS (T639), using GSI 3DEnVar (T213 ensemble). DART will be used for land surface data assimilation.

NASA’s new MERRA2 addresses the limitations of MERRA1, using the recent version of GEOS5 (0.5 degree, L72, 3Dvar). MERRA2, which was released in July 2015, uses new satellite types, reduces spurious trends and imbalances in water and energy cycles, and tests coupling methodologies. The MERRA2 spans 1980–2015 and is updated in real time with 2-3 week latency. Hourly surface and 2d fields are provided; 20% of total is aerosols. MERRA2 driven chem, ocean and land analyses will follow. The next version of MERRA will be atmosphere-ocean-ice-land coupled, and will have a 0.25 deg atmosphere and 25 km ocean, with hybrid 4DEnVar used for atmosphere data assimilation, EnKF for land, and EnOI for ocean.

* + 1. **Discussion of outstanding issues**

The workshop participants first discussed whether a centralized database is needed for reanalysis observations/innovation stats. In response, it was posited that a decentralized database would be better and more practical, with communications software such that different databases can talk to each other. The question of whether it is possible to scale with new satellite instruments was raised. It was suggested that the most important issue is adopted unified standards for metadata in order to bridge the gap between hindcasts and monitoring. It was noted that the NCEP/NCAR Reanalysis 1 (R1) is still widely used because of its near real-time aspect, and because it is most stable for long-term time series. Although it was felt that a unified reanalysis for both hindcasts and monitoring should be an NCEP goal, for now there is a desire to keep these two reanalysis systems separate at NCEP.

Another issue discussed was what advances in ocean coupling are appropriate now, and how to best spin up oceans. It was noted that using ‘streams’ is a problem. It was reported that ECMWF is looking at the sensitivity of deep oceans as the ocean spins up, and that it is only possible to constrain the first few hundred meters of the ocean, not the deep oceans. The concept of using a slab ocean was considered problematic, with some layers operating on such long times scales that they can’t be tracked. On the other hand, layers operating on decadal and shorter time scales can be tracked.

Finally, the question was posed as to how, if a reanalysis dataset is not uniformly better in each new iteration, this should be communicated.

* 1. **Developments in the Stratosphere**
		1. **Summary of presentations**

The status of NCEP’s improvements of the stratosphere in reanalysis was presented. Problems were noted with the representation of oscillations, and satellite bias corrections are needed(?) Observation transitions have led to jumps. Multiple tests with CFSR have been performed, in which SSU Ch3 and AMSU Ch14 were compared. CFSR and a 3-year test run are found to match well for the seasonal cycle. A conclusion was that while there is an understanding of why problems exist in the representation of the stratosphere, it is not known how to solve them.

An overview of aerosol modeling and the need for including aerosols in climate reanalysis was described. It was noted that aerosols are critical for capturing cloud-radiation interactions, to improve data assimilation, and to assess air quality. Including aerosols impacts operational models, with operational benefits seen for medium-range forecasting, and capturing aerosol-chemistry-climate interactions. It is also desirable to have prognostic aerosol capabilities, and to do trajectory analysis related to volcanic eruption. At NASA Goddard, aerosol reanalysis is underway. It was noted that aerosols are underdetermined in general. Observing systems include

Lidar, a ground-based network (aeronet), and satellite retrievals. MERRAero, which spans 2002 – present, was described. IT was found to compare well with aeronet and was also evaluated with OMI. The radiative effects of different species and the regional climatology of PM2.5 over the continental U.S. was discussed, with particular focus on differences in PM2.5 in winter months in the Northwest and Southwest, and uncertainties in observing PM2.5. A new model will resolve mass and number concentration. MERRA2 was noted as the first to integrate aerosols into reanalysis.

In terms of water vapor in the stratosphere. photochemical P-L, and latitude, seasonal, altitude dependence, was discussed. The knowledge is helpful for parameterizations. Analysis of specific humidity is done with and without photochemistry. Large differences in the upper levels are potentially due to the inclusion of spurious data. It was noted that accurate prognostic humidity in the UTLS can reduce model bias. The quality of the upper-level data was discussed.

* + 1. **Discussion of outstanding issues**

The question was posed as to whether better modeling or better observations are needed in the stratosphere. Advantages of having the model top at 0.01 hPa compared to 0.2 hPa were discussed.

* 1. **Assimilation Development and Experiments: Atmosphere**
		1. **Summary of presentations**

Developments of 20CR using the Ensemble Kalman filter were presented. It was shown that 20CR surface pressure only analysis is a useful testbed for new ideas. For this case without many observations, QC is very important. Non-Gaussian QC and varying localization length scales are novel aspects of the new development. It is believed that the QC technique, together with high-resolution model, should produce an analysis that is ~25% better than 20CRv2. It was noted that the QC technique is similar to Fuqing Zhang’s adaptive covariance relaxation method but that it adds perturbation to the ensemble. The technique retains the rotation of the structure but changes the amplitude.

A comparison of two ensemble based reanalysis systems, the NCEP dual-res (T254/126 Hybrid 3D-VAR/EnKF, and ERSL single-resolution (NOSAT) pure EnKF, was presented for three 1-year periods and their comparison with ERA/ERAInt and GR1. It was concluded that the EN system shows good potential to rerun GR1 very efficiently. The EN results are good in the Northern hemisphere even without satellite observations, but direct radiance assimilation is necessary for a full GR1 replacement. The faster NOSAT could be used for reanalyzing 1948-1975.

A presentation was provided of progress on the 4D hybrid EnVar and other DA development for the NCEP GFS. Experiments were performed with real observations using hybrid 3D-Var and hybrid 4D-VAR, bias correction for radiance and conventional observations, and assimilation of cloud/precipitation. It was suggested in the presentation that a suite of future work to be conducted at NCEP and UMD, including scale-dependent scaling, synergy between ENVAR and ENKF, etc.

New applications of data assimilation to reanalysis, basically on correcting on model bias and reanalysis jumps, were shown. Estimate and correct model bias was done by focusing on the analysis increments, and diurnal cycle model errors were found using EOFs from reanalysis. It was shown that the state dependent errors could be found using coupled SVD’s. A correction scheme was proposed based on new and old AI to correct potential bias introduced by new observations.

A reanalysis effort for Tambora 1815 was presented in which it was shown that 20CR surface pressure-only reanalysis can represent the 1815 event with good skill. It was shown that the atmospheric circulation change may be driven by volcanic aerosols. Of note was that the climate variability in the reanalysis seems to be larger than the signals derived from tree rings.

* + 1. **Discussion of outstanding issues**

What research approaches are required to understand reasons for jumps in climate reanalysis with new observational platforms was discussed. It was asked how it can be known where the jumps come from, where the model bias is, and how it can be diagnosed. It was noted that there are model drifts in addition to jumps, and that jumps technically can be corrected, while drifts are usually not seen. Drifts may be a confluence of model biases and jumps, with no automatic ways to identify them. To address this issue of drift, feedback data is needed, supported by some gridded versions of intercomparisons. It is necessary to get these grids into the community and go to a common format.

Whether in a "pure" Ensemble Kalman Filter, the ensemble mean is meaningful even though it is not balanced was also discussed. It was suggested that if there is any imbalance, it should show up in precipitation. For initial assessment, ensemble mean is the first thing to look at and easy to access, but it was noted that the ensemble mean doesn’t mean anything.

* 1. **Assimilation Development and Experiments: Ocean and Sea Ice**
		1. **Summary of presentations**

This session consisted of eight talks, six describing ocean analysis activities and one each looking at the land and sea ice systems. The session began with a presentation by Guilliame Vernieres of NASA/GMAO describing some of the activities being carried out by the GMAO oceans group, called IODAS. The IODAS project has a 1/12th-deg eddy resolving effort led by Keppenne, but the main effort is directed towards a ½-deg MOM4p1 ocean (currently), likely transitioning to a ¼-deg MOM5 in the coming months (the final decision has not been made). The analysis period mirrors the analysis period for the GMAO atmospheric product, MERRA. The current assimilation methodology is an ensemble method known as ENOI. Thhe data being assimilated includes historical hydrographic data, SST data (currently a gridded product), sea surface salinity (SSS) from the Aquarius satellite, and altimeter sea level. Much effort has been expended to develop a skin-SST model to allow coupling to the GEOS atmosphere. The system also includes a wave model, while work is underway to include ocean color information.

The second and third presentations in this session, by Drs. Xue and Penny, introduced the corresponding NOAA NCEP analysis system GODAS. The first presentation by Dr. Xue compared a number of products such as ocean heat content from various operational centers, highlighting some of the strengths and weaknesses of the current GODAS. It included the results of some data sensitivity experiments. This presentation was followed up by Dr. Penny’s presentation on new developments in GODAS. A highlight was his presentation of tests of the new HYBRID-GODAS, which builds on the current 3DVAR with the ensemble transform Kalman Filter LETKF. The control experiment uses the current GODAS for the period 1991-2011. The second experiment uses the hybrid-GODAS with 56 ensemble members. Surface forcing is provided by 20CR. In brief, the new analysis represents considerable improvement over the current model. For example, Dr. Penny shows that the RMS and mean of observation minus forecast differences of variables such as temperature and salinity are significantly reduced. Finally he pointed to the use of his system at ECMWF in a series of comparison studies.

A closely related data assimilation activity is being carried out at University of Maryland and described in the 4th presentation by Dr. Carton. The ¼ deg MOM5 ocean model is similar to that being examined at GMAO and similar to one likely to be adopted at NCEP. The focus of this presentation was on the impact of different wind products on the assimilation system (e.g. comparing MERRA2 with ERA-Int). The sixth presentation by Dr. Giese presented examination of a reduced version of the SODA system in a series of experiments with the Whitaker/Compo 20th century reanalysis effort in which the ocean is forced by 20CRv2 fluxes, then the modified SSTs resulting from the ocean reanalysis are reintroduced into the atmospheric reanalysis system, etc. (20CRv2 → SODAsi.2 → 20CRv2c → SODAsi.3). The presentation described two large ENSO events: one in 1916-1920 when observations were sparse, and the 1997/98 El Nino with dense observations. It was found that prescribing SST to the atmosphere reduces uncertainties in surface forcings and reduces spread.

The fifth presentation by Dr. Xu Li presented NOAA’s effort in developing a skin-SST algorithm. The need for a skin SST algorithm had previously been introduced in Dr. Verniere’s talk. It arises partly because passive remote sensing of SST uses either infrared/visible frequencies or at microwave frequencies. The former which provide a more accurate measurement with uncertainties less than 0.5C, reflect the temperature of the upper microns of the water column, well within the near surface laminar sublayer. The latter, while less accurate are insensitive to cloud cover, and may reflect the temperature of the upper few mm of the water column. The distinction is important because solar stratification and evaporative cooling can leave a subtropical ocean under low wind conditions with a complex temperature structure that may vary by as much as 3C in the upper 3m of the water column. The final data set are the in situ observations reflecting temperature one or more meters below the surface. Many of these are ship intake measurements, but some are from fixed buoys and some are from surface drifters. Of these the latter are most accurate, with an individual uncertainty of perhaps 0.5C. Dr. Li reviewed this complex problem as presented the result of their effort to parameterize the effects of these unresolved processes.

The final two talks addressed two other key systems: the land surface and sea ice. The land surface assimilation system was presented by Dr.s Ek and Meng. For the GLDAS, there is an upgraded Noah Land model with new land data, an improved land data assimilation scheme, CPC daily precipitation, stream flow, and a GLDAS2 single stream replay compared to CFSR. The land surface spin up is more critical in dry land. The second talk by Xingren discussed some of the ongoing sea ice prediction activities within NOAA EMC. These include by a very simple empirical sea ice prediction system and some preliminary planning for a full sea ice prediction system within the upcoming CFSv3.

* + 1. **Discussion of outstanding issues**

This session prompted considerable discussion about the details of the ocean analysis systems and the one coupled system. Among the topics discussed was the source of the data, for example, for sea ice cover, the constraints on the temperature and salinity of water in the deep ocean, and the impact of observations from the TOGA/TAO array. The lack of sea ice thickness information was discussed. In a related discussion it was pointed out that there is a need to resolve diurnal processes within the oceanic mixed layer (a component of NSST) as a necessary component to assimilating satellite data.

Another topic that was discussed was the appearance in the reanalyses to a greater or lesser extent of jumps due to the introduction of new observations (observing system bias). Indeed, concern about those jumps led to efforts such as the 20th century reanalysis which deliberately excludes satellite and upper air data. The alternative view was put forward that perhaps jumps in variability due to changes in the observing system is an inherent aspect of the inconsistent historical sampling and that we should not try to cover it up.

Another topic which came up in this session was the need to carry out reanalysis productions in a set of overlapping streams for computational efficiency. The question then arises, how much overlap is needed in order to stitch together the individual streams (an issue that arose in the CFSRR reanalysis)? In terms of data assimilation streams, the ocean, land, and stratosphere it was suggested that there was a need for a spin-up overlap of 2-5 years. It was suggested that running a low resolution version of the coupled data assimilation system could provide initial conditions from which different streams can be initialized.

The session included recommendations regarding the types of reanalysis performance statistics that should be kept for each system. Among those considered vital are the forecast minus observation and forecast minus analysis statistics. The issue of how much horizontal resolution is needed for the ocean was raised in this session.

* 1. **Reanalysis Evaluation**
		1. **Summary of presentations**

Six presentations were made focusing on atmospheric circulation and surface fluxes. The session began with a presentation by Ricardo Todling on dry mass and water conservation in the NASA GMAO MERRA system, the former following on from work by Trenberth and Smith (J. Climate, 18, 864–875, 2005). Three modifications were made to the model, analysis, and increments to improve these conservations. The Todling presentation was followed by a presentation by Lisan Yu for results from the OAFlux analysis in comparison with atmospheric reanalyses, as well as an ocean state estimate, directed towards the analysis of energy and freshwater budgets over the global ocean. The results were compared to in situ buoys. She found that most uncertainty is concentrated in the tropics, and that the spread in heat fluxes are primarily seen in the SW fluxes. Her results highlighted the low bias in the OAFlux product. The next presentation by Caihong Wen focussed an the response of an ocean, simulated using GFDL MOM4 numerics, to NCEP Reanalysis 2 (R2) and CFSR surface fluxes. The experiments examined both variations in the depth of the thermocline as represented by the depth of the 20C isotherm (mainly reflecting surface winds), SST (generally controlled by net surface heat flux except in upwelling regions), and SSS (generally controlled by net surface freshwater flux). The goal of this work was to explore the ways in which surface flux uncertainties impact the ocean uncertainty in ocean properties. The final talk of the first set of presentations was by Erica Dolinar who presented an evaluation and intercomparison of clouds, precipitation, and radiation budgets in 5 different recent reanalyses and satellite-surface observations. included a comparison of cloud fraction (CF), precipitation rate (PR), and net cloud radiative effect (CRE). She found that in some cases, large biases in CF, PR and CRE are present in the reanalyses, but that the fields are physically consistent.

The final two talks both addressed aspects of high latitude climate. Xiquan Dong compared two extreme summer Arctic sea-ice extent anomalies in the summers of 2007/2012 and 1996. The summers of 2007 and 2012 were striking for the low level of Arctic sea ice, the lowest that had been seen in the observational record to that point, while 1996 was a summer with similarly anomalously high sea ice concentration. A synoptic analysis of these extreme events highlighted the importance of particular extreme synoptic events in leading to unusual retention or loss of sea ice, such as the August storm that played a critical role in the 2012 sea ice minimum and an intensification of the Beaufort sea level high in the sea ice maximum in 1996. Dr. Dong also pointed to a radiative flux mechanism in which an increase in clouds led to increase in net long wave radiation down into the ocean. The long wave radiation effect is dominant due to the high angle of incidence of SW and the persistent presence of the downward long wave radiation. There was also discussion of the changes occurring in particular marginal seas. The second high latitude presentation by Richard Cullather provided an introduction to the results of recent atmospheric reanalyses of high latitude fluxes. His presentation included comparison between regional and global models for reanalysis over polar ice sheets. The results suggested that the reanalyses are still struggling to do better than climatology in these regions, but progress may be helped by examination of higher resolution regional model reanalysis studies such as the Greenland regional models MAR and RACM02.

* + 1. **Discussion of outstanding issues**

The polar talks raised a number of issues, perhaps more than could be resolved. Among these was a follow-up question about the role of cloud-radiation feedback processes in the reanalyses and nature. Several other questions addressed the uncertainties in comparison data sets. For example, Cullather pointed to the uncertainty associated with the use of passive microwave remote sensing of sea ice cover in summer due to the complex surface properties of the sea ice. He pointed out that when you change sea ice cover you need to change the ocean to be compatible with this cover. Also, thinking about the couple system, he pointed out that these is still considerable uncertainty in sea ice volume (Cevallier et al., Climate Dynam., 2015)

1. **Next steps and future coordination**

The brief reports by the rapporteurs from the individual sessions were accompanied by a series of audience questions that highlighted some of the uncertainties and need for follow-up projects. For session 2 one question asked what was needed to improve historical analysis of the properties of the stratosphere – more observations or better models? For session 3 there were several questions, leading to discussion, about how to initialize the ocean for coupled predictions. For example, most observations today only extend through the upper 2 km of the ocean, and the question was asked whether it could be possible to use CMIP-type models to initialize the lower 2 km of the ocean. There was also some discussion about the usefulness of eddy permitting (e.g. ¼-deg) or eddy resolving (1/12th-deg) resolution for the ocean. Finally there was a brief statement by Dr. Saha regarding a key step being taken by NOAA EMC to develop CFSv3. It was recognized that this meeting was a bit premature to map out the details of CFSv3 though. The subject of coordination of activities was a theme throughout the meeting.

1. **Further information**

NCRTF workshop website

Climate Program Office news item on workshop

Reanalysis.org

1. **Acknowledgements**

MAPP program

NCEP for hosting

Appendix I – table of participants

Appendix II – final agenda

**NOAA Climate Reanalysis Task Force Technical Workshop**

***NOAA Center for Weather and Climate Prediction***

***College Park, MD***

**4 - 5 May 2015**

**Organizers:** Jim Carton, Gilbert Compo, Arun Kumar, Suru Saha, Heather Archambault

**Workshop Objectives:**

Report on NOAA Climate Reanalysis Task Force progress

Exchange reanalysis approaches, algorithms, and techniques currently in use

and under development.

Discuss techniques for addressing outstanding issues in the reanalysis efforts,

e.g., presence of spurious discontinuities and trends, coupling of Earth System

components, inclusion of new areas such as aerosols.

Identify the various requirements for reanalysis products.

Determine strategies and overlaps for national and international reanalysis efforts

based on scientific drivers for climate and weather research.

Each presentation slot is 80% for oral presentation and 20% for questions.

**Monday 4 May**

8:00–9:00 a.m. Registration

9:00 a.m. *Welcome*

Arun Kumar, NCEP/CPC

9:05 a.m. *Introduction to the Climate Reanalysis Task Force and Workshop*

Gil Compo, U. of Colorado/CIRES & NOAA/ESRL/PSD

9:20 a.m. *What is Reanalysis for?*

Huug van den Dool, NCEP/CPC

**1. National and International Reanalysis Efforts**

**Objective:** Determine strategies and overlaps for national and international reanalysis

efforts based on scientific drivers for climate and weather research.

**Session Chair:** Gil Compo, U. of Colorado/CIRES & NOAA/ESRL/PSD

**Rapporteur:** Jeff Whitaker, NOAA/ESRL/PSD

9:40 a.m. *Plans for Reanalysis at NCEP’s Environmental Modeling Center*

Suru Saha, NCEP/EMC

10:00 a.m. *Issues, Requirements, and Research towards NOAA’s Next Generation of*

*Climate Reanalyses*

Arun Kumar, NCEP/CPC

10:20 a.m. Coffee Break

10:40 a.m. *Reanalysis at ECMWF*

Dick Dee, ECMWF

11:00 a.m. *CMA 40-year GSI based reanalysis: plans and progress*

Zhiquan Liu, NCAR

11:20 a.m. *MERRA-2, GMAO reanalysis efforts/plans*

Ron Gelaro, NASA/GMAO

11:40 a.m. Discussion

Moderator: Heather Archambault, NOAA/CPO

12:10 p.m. Lunch

**2. Developments in the Stratosphere**

**Objective:** Discuss techniques for addressing outstanding issues in the reanalysis

efforts

**Session Chair:** Ron Gelaro, NASA/GMAO

**Rapporteur:** Erica Dolinar, U. of North Dakota

1:30 p.m. *Status at NCEP to improve the stratosphere in reanalysis*

Craig Long, NCEP/CPC

1:50 p.m. *Aerosol modeling*

Sarah Lu, SUNY-Albany

2:10 p.m. *Water vapor in the stratosphere*

John McCormack, Naval Research Laboratory

2:30 p.m. *Aerosol Reanalysis at NASA Goddard Space Flight Center*

Arlindo da Silva, NASA/GMAO

2:50 p.m. Discussion

Moderator: Dan Barrie, NOAA/CPO

3:10 p.m. Coffee Break

**3. Assimilation Development and Experiments: Atmosphere**

**Objectives:** Exchange reanalysis approaches, algorithms, and techniques currently in

use and under development. Discuss techniques for addressing outstanding issues in

the reanalysis efforts

**Session Chair:** Arun Kumar, NCEP/CPC

**Rapporteur:** Lisan Yu, WHOI

3:30 p.m. *Developments in the Ensemble Kalman Filter*

Jeff Whitaker, NOAA/ESRL/PSD

3:50 p.m. *Forecast results and QBO response from NCEP conventional data only*

*T254 EnKF only cycling semi-Lagrangian Reanalysis in 1970, 1981*

Jack Woollen, IMSG & NCEP/EMC

4:10 p.m. *Hybrid Data Assimilation at NCEP*

Daryl Kleist, U. of Maryland

4:30 p.m. *New applications of Data Assimilation to Reanalysis*

Eugenia Kalnay, U. of Maryland

4:50 p.m. *Reanalysis for Tambora 1815*

Gil Compo, U. of Colorado/CIRES & NOAA/ESRL Physical Sciences

Division

5:10 p.m. Discussion

Moderator: Gil Compo

5:30 p.m. Close for day

6:30 p.m. Informal dinner at Franklin’s

**Tuesday 5 May**

**4. Assimilation Development and Experiments: Ocean and Sea ice**

**Objectives:** Exchange reanalysis approaches, algorithms, and techniques currently in

use and under development. Discuss techniques for addressing outstanding issues in

the reanalysis efforts

**Session Chair:** Suru Saha, NCEP/EMC

**Rapporteur:** Yan Xue, NCEP/CPC

8:30 a.m. *NASA ocean data assimilation*

Guilliame Vernieres, NASA/GMAO SSAI

9:00 a.m. *Impacts of ocean observations on NCEP GODAS analysis*, Yan Xue,

NCEP/CPC

9:15 a.m. *Advancing Ocean Data Assimilation and Reanalysis*

Steve Penny*,* U. of Maryland & NCEP

9:30 a.m. *UMD SODA -- problems and progress*

Jim Carton, U. of Maryland

9:45 a.m. *The development of NSST within the NCEP GFS/CFS*

Xu Li, NCEP/EMC

10:00 a.m. Coffee Break

10:30 a.m. *ENSO in a large ensemble of historical reanalyses*

Ben Giese, Texas A&M University

10:45 a.m. *Land data assimilation at NCEP/EMC*

Mike Ek and Jesse Meng, NCEP/EMC

11:00 a.m. *Sea ice development at NCEP/EMC*

Xingren Wu, NCEP/EMC

11:15 a.m. Discussion

Moderator: Jim Carton, U. of Maryland

12:10 p.m. Lunch

**5. Reanalysis Evaluation**

**Objective:** Identify the various requirements for reanalysis products.

**Session Chair:** Jim Carton**,** U. of Maryland

**Rapporteur:** Steve Penny, U. of Maryland

1:30 p.m. *Dry-mass conservation and water consistency in reanalysis*

Ricardo Todling, NASA/GMAO

1:50 p.m. *Air-sea heat and freshwater fluxes in Atmospheric Reanalyses*

Lisan Yu, Woods Hole Oceanographic Institute

2:10 p.m. *Impacts of NCEP Reanalysis R2 and CFSR fluxes on MOM4 simulations*

Caihong Wen, NCEP/CPC

2:30 p.m. *Evaluation and intercomparison of clouds, precipitation, and radiation*

*budgets in recent reanalyses using satellite-surface observations*

Erica Dolinar, U. of North Dakota

2:50 p.m. Coffee Break

3:10 p.m. *Investigation of two extreme summer Arctic sea-ice extent anomalies in*

*2007 and 1996*

Xiquan Dong*,* U. of North Dakota

3:30 p.m. *Reanalysis evaluation in polar regions*

Richard Cullather, NASA/GMAO

3:50 p.m. Rapporteurs give 5 minute summary of their session

4:15 p.m. Discussion and writing assignments

Moderator: Gil Compo

5:00 p.m. Close of Workshop

1. http://cpo.noaa.gov/ClimatePrograms/ModelingAnalysisPredictionsandProjections/MAPPTaskForces/ClimateReanalysisTaskForce.aspx [↑](#footnote-ref-1)