Working group and panel questions

4th workshop on assimilating satellite cloud and precipitation observations for NWP

3 - 6 Feb 2020, ECMWF, Reading, UK

ECMWF

4 sessions - 4 panels - 4 working groups

1. Cloud and precipitation observations and their applications in NWP
    - Big picture: What is the status? What are common issues and how can we tackle them? What is on the horizon?
        - Assimilating satellite observations sensitive to cloud and precipitation
        - Emerging observations
2. Cloud and precipitation modelling
    - How can forecast models support cloud and precipitation assimilation, and how can cloud and precipitation assimilation help improve models?
3. Observation operators
    - How do we go from the forecast model's representation to what the observations see?
4. Data assimilation methods
    - How can data assimilation support greater use of cloud and precipitation observations?

WG 1: Cloud and precipitation observations and applications in NWP
Chairs: Andrew Collard (IMSG@NOAA/NCEP/EMC), Peter Weston (ECMWF)

Panel 1: Stephen English (ECMWF), Nadia Fourrié (Météo-France), Jason Otkin (University of Wisconsin-Madison / CIMSS / SSEC), Ulrich Blahak (German weather service), everyone

- Please briefly introduce your interest in cloud and precipitation assimilation
- Where are the biggest difficulties you experience trying to get more out of cloud and precipitation observations for weather forecasting? (these can be technical or scientific)
- Are there innovative observations (new or existing) that could be especially useful?
- What are the applications that will benefit from cloud and precipitation assimilation?
- What are the most important questions for the WG to discuss, and are there any questions we are missing?

WG 1: Cloud and precipitation observations and applications in NWP (1/2)

- What are the main advances? Where are the main remaining hurdles? Where do we need development?
  - Commonalities and differences between observation choices and assimilation methodologies in different applications (e.g. global, regional, nowcasting, retrievals)
- What are we aiming to achieve?
  - Are we initialising cloud and precipitation fields, improving synoptic forecasts, or feeding into model physics development?
- How do we verify benefits (cloud/precipitation, scales, etc) and diagnose problems?
  - Are the latest satellite precipitation products independent enough of model data to be a reference?
- Emerging observations (Radar/lightning/ICI, etc):
  - How ready are we to use these operationally? Where do we need development or preparation?
- What sensors would we like for the future?
- How do we make use of increasing satellite instrument resolutions when the predictable scales of cloud are much lower?
- How do we cope with state-dependent cloud biases in forecast models?

WG 1: Cloud and precipitation observations and applications in NWP (2/2)

- Hands-on experiences:
  - Bias correction, observation error modelling, quality control: What are the methods used? Where are the short-falls?
    - Situation dependence beyond clear/cloudy (e.g., cloud type)?
  - Are we archiving the right fields at modelling centres? For example, diagnosed convective hydrometeors (including cloud) are not often archived – despite being a large part of the hydrometeor budget of the atmosphere.
- Any thoughts on how the workshop should be written up?
- Any thoughts on the future of these meetings?

WG 2: Cloud and precipitation modelling
Chairs: Richard Forbes (ECMWF) and Derek Posselt (JPL)

Panel 2: Derek Posselt (JPL), Andrew Gettelman (NCAR), Greg Thompson (NCAR-RAL), Olivier Caumont (Météo-France), everyone

- Please briefly introduce your interest in cloud and precipitation modelling and/or observations
- Where are the biggest difficulties you experience trying to get more out of cloud and precipitation observations for your work? (these can be technical or scientific)
- How should micro- and macro-physics schemes evolve in the future for your application?
- What are the most important systematic errors relevant to you, how can we fix them?
- What are the most important questions for the WG to discuss, and are there any questions we are missing?

WG 2: Cloud and precipitation modelling (1/2)

- How can microphysics developers benefit from cloud and precipitation observations? Where are the big unknowns?
- How are micro- and macro-physics schemes going to evolve over the next few decades?
  - Multi-moment microphysics? Riming-type schemes?
  - Convection: Resolved versus unresolved? Diagnostic versus prognostic?
  - Do we need this sophistication? Can we validate these schemes against observations?
- Should modellers work more with assimilation specialists to understand cloud and precipitation errors in models?
  - Can we make an inventory of known errors across different models?
  - Are the errors, random, systematic, state/process-dependent, … ?
  - Are there common issues like cold-air outbreaks, maritime stratocumulus?
- What process do we use for developing models in the future?
  - Bespoke: Case studies, campaigns, field sites, trial and error, physical intuition?
  - Data-driven: assimilation, global statistics from satellite, parameter estimation, machine learning?

WG 2: Cloud and precipitation modelling (2/2)

- How do we maintain tangent linear/adjoint counterparts to the full non-linear models. Is simplicity sustainable?
- Consistency of assumptions between observation operators and cloud and precipitation physics parameterisations: Is this achievable or advisable?
- Will we ever have enough observations to completely constrain micro- and macro-physical assumptions?
  - Is micro-macrophysical closure possible?
- What model developments are needed to support more assimilation of cloud and precipitation-related observations?

WG 3: Observation operators
Chairs: Ben Johnson (JCSDA), Robin Hogan (ECMWF)

Panel 3: Marco Matricardi (ECMWF), Mark Fielding (ECMWF), Emily Liu (UCAR/JCSDA), Ziad Haddad (UCLA), everyone

- Please briefly introduce your interest in modelling cloud and precipitation observations
- Where are the biggest difficulties you experience trying to get more out of cloud and precipitation observations for your work? (these can be technical or scientific)
- How do we handle the micro- and macro-physical assumptions needed to simulate cloud and precipitation observations?
- What are the most important systematic errors relevant to you, how can we fix them?
- What are the most important questions for the WG to discuss, and are there any questions we are missing?

WG 3: Observation operators (1/2)

- What is on the horizon for CRTM/RTTOV?
- What other observation operators do we have? What is needed?
  - Radar, lidar, visible, polarimetric, lightning…
- What are the leading error sources? What level of sophistication should be targeted?
  - Scattering solvers, 3D-effects, microphysics, macrophysics (subgrid variability), full polarisation?
  - Full vs fast models? How to advance fast models?
- How can we best quantify the errors associated with the fast and approximate methods used for data assimilation?
  - And quantifying the error characteristics for full models, and full vs fast models?
- Consistency of assumptions between observation operators and cloud and precipitation physics parameterisations: Is this achievable or advisable?
  - Can we even achieve consistency of assumptions across the spectrum?
- Will we ever have enough observations to completely constrain micro- and macro-physical assumptions?
  - Is micro-macrophysical closure possible?

WG 3: Observation operators (2/2)

- What information would be provided by the ideal micro- and macro-physics parameterisation?
- Particle corner:
  - PSDs, habits, shapes, scattering and fallspeed databases, melting particles, non-spherical rain, preferential orientation
  - Is there a universal particle model? Spheres, SSRGA, one-shape-fits-all?
- Macro corner:
  - Sub-grid heterogeneity in hydrometeors and gases
  - Cloud and precipitation overlap – pluggable cloud generators for ICA?
  - 3D and slanted columns
- Scattering corner:
  - Solvers, scattering databases, phase functions / matrices

WG 4: Data assimilation methods
Chairs: Craig Bishop (The University of Melbourne), Massimo Bonavita (ECMWF)

Panel 4: Elias Hólm (ECMWF), David Simonin (Met Office), Takemasa Miyoshi (RIKEN), Olaf Stiller (German weather service), everyone

- Please briefly introduce your interest in data assimilation, cloud and precipitation
- Where are the biggest difficulties you experience trying to get more out of cloud and precipitation observations for your work? (these can be technical or scientific)
- How can DA deal with something as small-scale and unpredictable as precipitation?
- How do you see DA methodology for operational systems evolve in the future, and how does that affect cloud and precipitation assimilation?
- What are the most important questions for the WG to discuss, and are there any questions we are missing?

WG 4: Data assimilation methods (1/2)

- How do we deal with the unpredictable scales (e.g. cloud displacements) in data assimilation?
  - Is it all helpful to measure the chaotic noise within the attractor, or just the attractor?
  - Current ideas: representation error modelling, displacement operators, very rapid updates
- Strengths and weaknesses of DA methods – and are there synergies between methods?
  - How do we treat non-linearity and non-Gaussianity?
  - How do we treat model error?
  - How do we map from observations to control variables?
- How do we maintain impact into the forecast?
  - What drives the length of forecast impact? Predictability timescales? Upscale or downscale error growth?
- Background, model, and observation error modelling:
  - Situation-dependence, spatial/temporal correlations in R: What tools do we have to treat them? How do we estimate them? What is important to get right?
  - Are B and R correlated in all-sky? How do we treat this? How do we separate background error, model error and representation error during the analysis?

WG 4: Data assimilation methods (2/2)

- Cloud control variables: Do we need them? How do we represent their background errors?
- Assimilate observations directly as radiances and reflectivities?
  - Are people getting success with 1D-Bayesian, 1D-Var or L2 retrieval assimilation?
- What are "lessons learnt" from all-sky assimilation that could be relevant for wider Earth System Assimilation?