Joint Effort for Data assimilation Integration (JEDI)

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Description of the JCSDA

Vision:
An interagency partnership working to become a world leader in applying satellite data and research to operational goals in environmental analysis and prediction.

Mission:
...to accelerate and improve the quantitative use of research and operational satellite data in weather, ocean, climate and environmental analysis and prediction models.

Science priorities: Radiative Transfer Modeling (CRTM), new instruments, clouds and precipitation, land surface, ocean, atmospheric composition.
Myriad of concurrent DA Initiatives

- NWP $\rightarrow$ Earth System Modeling
  (Ocean, Waves, Cryosphere, Land, Hydrology, Aerosols, Atmospheric composition, Whole Atmosphere)
- Weakly/Strongly Coupled Reanalyses for reforecast & climate
- Operational/Research, Global/Regional models
- Situational awareness, Nowcasting, Observation impact assessment and OSSEs

“Software is like entropy. It is difficult to grasp, weighs nothing, and obeys the second law of thermodynamics; i.e. it always increases. “ Norman Ralph Augustine
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GOALS
1. Next-generation **unified** data assimilation system
2. Increase **R2O** transition rate (from academia to operations)
3. Increase **science productivity** and **code performance**

STRATEGY
1. Modular code for flexibility, robustness and optimization
2. Mutualize **model-agnostic** components across
   - Applications (atmosphere, ocean, strongly coupled, etc.)
   - Models & Grids (operational/research, regional/global models)
   - Observations (past, current and future)
3. Collective reduction of entropy
DATA ASSIMILATION COMPONENTS
for Atmosphere, Ocean, Waves, Sea-ice, Land, Aerosols, Chemistry, Hydrology, Ionosphere

Observations
- Pre-processor
  - Reading
  - Data selection
  - Basic QC

CODBMS (observations)

Model(s)
- Unified Forward Operator (UFO)

CODBMS (model equivalents)

Background & Obs. Error
- Solver
  - Variational/EnKF
  - Hybrid

CODBMS (model equivalents)

Analysis
- Model Initial Conditions
  - Observation Impact (OSE, OSSE)
  - Data Fusion
  - Reanalysis
- Verification
- Model postproc
- Cal/Val, Monitoring
- Retrievals
- Simulated Obs
DATA ASSIMILATION COMPONENTS
for Atmosphere, Ocean, Waves, Sea-ice, Land, Aerosols, Chemistry, Hydrology, Ionosphere

Observations

Pre-processor
• Reading
• Data selection
• Basic QC

CODBMS (observations)

Unified Forward Operator (UFO)

CODBMS (model equivalents)

Solver
• Variational/EnKF
• Hybrid

CODBMS (model equivalents)

Verification
• Model-postproc
• Cal/Val, Monitoring
• Retrievals
• Simulated Obs

Background [& Obs.] Error

Analysis

Model Initial Conditions
Observation Impact (OSE, OSSE)
Data Fusion
Reanalysis
Observation Pre-Processor

Inspired by COPE Project (ECMWF)

- Flexible architecture = series of filters
- Can be done as soon as data is available
- Standardized output → **CODBMS** (Community Observation Data Base Management System)
  - Metadata for variety of sensors (past, current, future)
  - Flexible data manipulation, yet fast
  - Parallel distribution; archiving; data on the Cloud
  - Low cost

BUFR → Data Decoder → Thinning, blacklist, selection → ... → Basic QC → Data Encoder → CODBMS (all)
CODBMS (reduced)
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for Atmosphere, Ocean, Waves, Sea-ice, Land, Aerosols, Chemistry, Hydrology, Ionosphere

Pre-processor
- Reading
- Data selection
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Solver
- Variational/EnKF
- Hybrid

CODBMS (observations)

CODBMS (model equivalents)

Unified Forward Operator (UFO)

Background & Obs. Error

Observations

Model(s)

Model Initial Conditions
Observation Impact (OSE, OSSE)
Data Fusion
Reanalysis

Analysis

• Verification
• Model postproc
• Cal/Val, Monitoring
• Retrievals
• Simulated Obs
Read CODB

Model / Obs. Type

GOMs => NULL

Model Options

Observer Options

Look-up table (JSON)

Model Options

Observer Options

Observer

CRTM, Bias Correction, QC, Cloud Detection, etc.

[ Jacobian, Revised QC, Obs. Error, Bias, ...]

Write CODB

Model(s)

Unified Forward Operator

UFO

NEMS/ESMF

Couple

r

GOMs (model values @obs. locations)

Obs. info

Obs. Type

Obs. Loc.
DATA ASSIMILATION COMPONENTS
for Atmosphere, Ocean, Waves, Sea-ice, Land, Aerosols, Chemistry, Hydrology, Ionosphere
Solver

• The opposition VAR vs. EnKF is so 2005...

• Examples of flexible infrastructures with variety of solver options
  – Object Oriented Prediction System (OOPS - Tremolet, ECMWF)
  – Parallel Data Assimilation Framework (PDAF - Nerger, Wegner Inst.)

• Fundamental distinction = how the large DA problem is divided
  – Sequential observations
  – Minimizer iterations
  – Subdomains

• Cf. Mahajan’s presentation
Conclusions

• Do we find sufficient overlap?
  – Research and operation
  – Domains (Ocean, Land, Atmosphere, Air Quality, …)
  – Utilization of DA (reanalysis, NWP, Data Fusion, OSSE, …)

• Do we see sufficient benefit in a unified system?
  – Multiple options (observer, solver, …)
  – Multiple constraints (research, generic, operational)
  – Multiple levels of engagement

• Can we build a sustainable collaborative structure?
“Just as the constant increase of entropy is the basic law of the universe, so it is the basic law of life to be ever more highly structured and to struggle against entropy.” Vaclav Havel