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Importance of precipitation and MW radiances to EMC

Assimilation—microwave radiances very important
satellite estimates of precip assimilated, but less important
precipitation to force land surface model, LDAS
Verification—precipitation, precipitable water, clouds
Validation—model physics: precip, precipitable water, vertical distribution of latent heating, moisture, cloud liquid water

Importance of EMC to GPM

Usually NWP centers see problems with instruments before notification by providers
Tests compatibility of observations with other observations and with atmosphere as represented by GFS
NWP products extensively examined by large community of users
Parallel tests of changes can throroughly explore impact of new data
Need to communicate

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Requirements for operational use of radiances

--Available in real time ***in acceptable format***
- 1 hr 15 min mesoscale (6hr for catch-up cycle)
- 2hr 45min GFS (6hr for catch-up cycle)
- Considerable time and resources spent on format

--Assurance of stable data source
- --changes in data processing can change obs error
- --notify, test, provide test data sets before changes
- --Operational satellites situation OK
- --Research satellites—loss of control by instrument/program scientists

--Quality control procedures defined
--Observational errors defined (bias removed if necessary)
--Accurate forward model (and adjoint) available
- --use observations as they were observed

--Integration into data monitoring
--Evaluation and testing to ensure neutral/positive impact
--Prepare before launch

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Strong partnerships with JCSDA, GMAO on data assimilation

Data assimilation priorities

Techniques
--4DVAR
--Hybrid ensemble—combination of ensemble Kalman filter with 3D or 4DVAR
--Situation dependent background errors
--SST analysis from radiances

Data
--Improved quality control
Station specific
--NPOESS-GOES-R
Developing radiative transfer, data handling

Assimilation of cloudy radiances

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Issues with radiances

Microwave radiances
- Tend to have larger Field of View than IR
- Harder to separate clear, cloudy areas
- Greater mixture of surfaces—emissivity more of issue
- Tend to have deeper layers than IR
- Can allow for effect of thinner clouds

Most problems with satellite data from 3 sources
- Instrument errors
- Cloud and precipitation simulation errors
- Surface emissivity simulation errors

Surface emissivity and temperature characteristics not well known for land/snow/ice

Reanalysis—trends, biases in radiances problem in most reanalyses
- New instrument can introduce discontinuity or trend

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Cloud/precipitation assimilation

Developing tangent linear and adjoint of cloud/precipitation physics
- Eliminating discontinuities - produces similar results to original physics

Inclusion of clouds and precipitation in radiative transfer
- Probably not accurate everywhere (heavy precip - thick clouds)
- Will need to pick and choose

Inclusion of diabatic balance in analysis
- Inclusion of cloud/precip/surface physics in strong constraint
- 4dvar
- Hybird assimilation (background errors include more cross correlations)

Choice of analysis variable
- Consistency between water vapor, cloud water and precipitation
- Met Office has chosen single analysis variable for moisture (total moisture)

Very difficult problem which will require years of development

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Resolution

Mesoscale 12 km, 60 levels
nests—Alaska 6 km
Hawaii 3 km
continental US 4 km

Global—currently T574 (27 km), 64 levels
in next few years T878 (22 km)

Verification

Mesoscale could use rainfall verification for Alaska, Hawaii

Need to trust magnitudes for categories from small amounts (rain/norain) to 2 in/day

Every hour would be nice, every 3 hours necessary

Currently verification only over CONUS
Problems in mountains
Global verification might be useful if we could trust GPM precip

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Validation

More complete assessment of model physics and model moisture

Magnitude and uncertainty of precipitation, precipitable water over globe
    Wide range in global mean precip estimates

Vertical distribution of moisture, cloud liquid water, latent heating over globe
    Need estimates not derived via particular model

Physics can be difficult to improve because of uncertainties

To improve performance in one measure (e.g. forecast precipitation), changes must not produce negative impact in other performance areas

One improvement can expose other weaknesses that need to be either corrected or offset in some way

Real time delivery not so essential for validation, monthly means could be used
Diurnal cycle in GFS not adequately examined—monthly mean diurnal cycle

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Resource limitations

--Need a balance between:

- Observations
- Scientific development and testing
- Computer resources

--If model physics not compatible with analyses, particularly moisture, GFS will "spin up" fields from observations to model physics. Model physics needs to improve as observations improve

Most of talk from John Derber, Steve Lord, Russ Treadon