

Reprocessed Satellite Data Products for Assimilation and Validation

Leo van de Berg, Bertrand Theodore
EUMETSAT

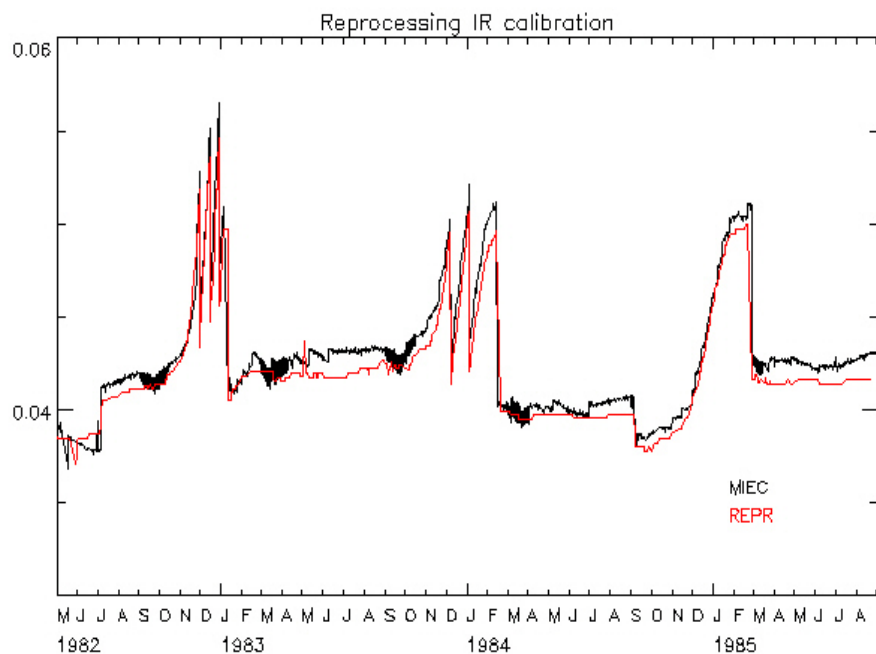
Presentation Contents

- **Historical**
 - **Results of Eumetsat ERA-40 Activities**
 - **Lessons Learned**
- Present
 - Results from ERA-Interim Activities
- Future
 - System Design
 - Algorithm Upgrades
- Relationships

Eumetsat ERA-40 Reprocessing Aims

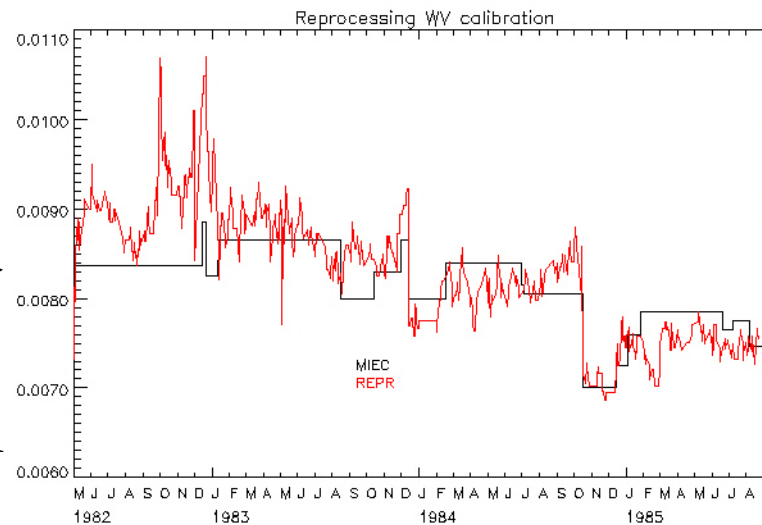
- The following aims for Eumetsat's contribution to the ERA-40 project were identified:
 - Recalibration of Meteosat-2 Image Data and subsequent
 - Generation of Atmospheric Motion Vector Products
- Some additional aims added by Eumetsat:
 - Retrieval of Clear Sky Radiance Product
 - Derivation of AMV from High Resolution VIS Image Data

Results of ERA-40 Reprocessing Recalibration



IR Channel

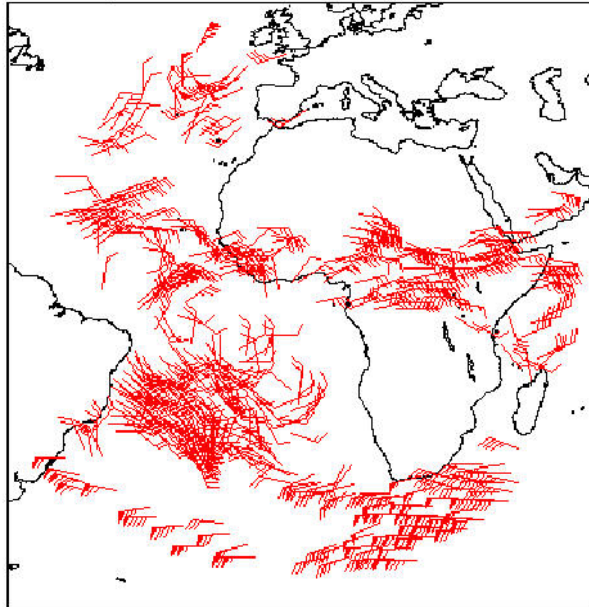
- Differences in IR calibration up to almost 4 %
- IR Calibration more stable
- WV Calibration more unstable (see Lessons Learned)



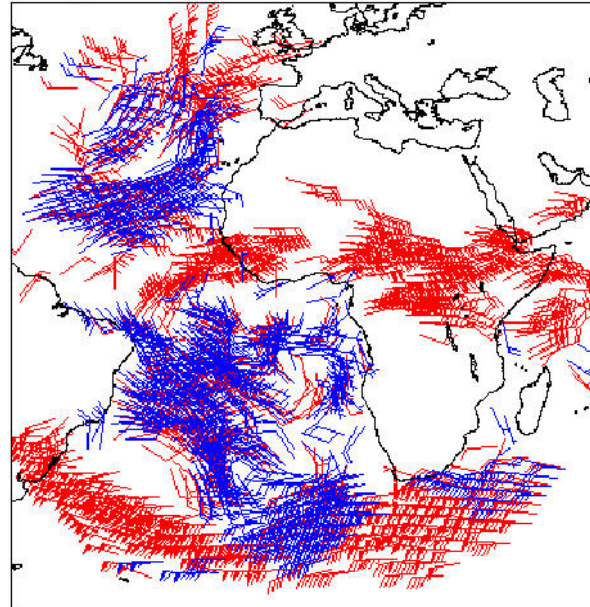
WV Channel

Results of ERA-40 Reprocessing Atmospheric Motion Vector Products

a) Old operational IR data

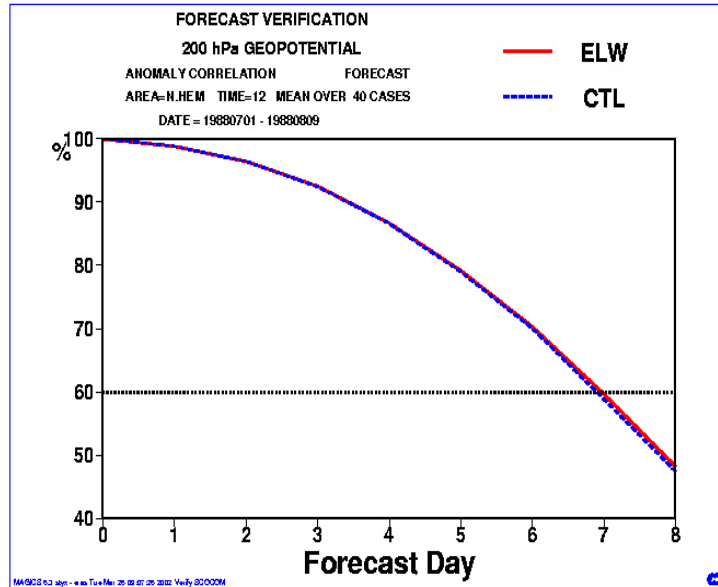


b) Reprocessed ELW data, IR and VIS

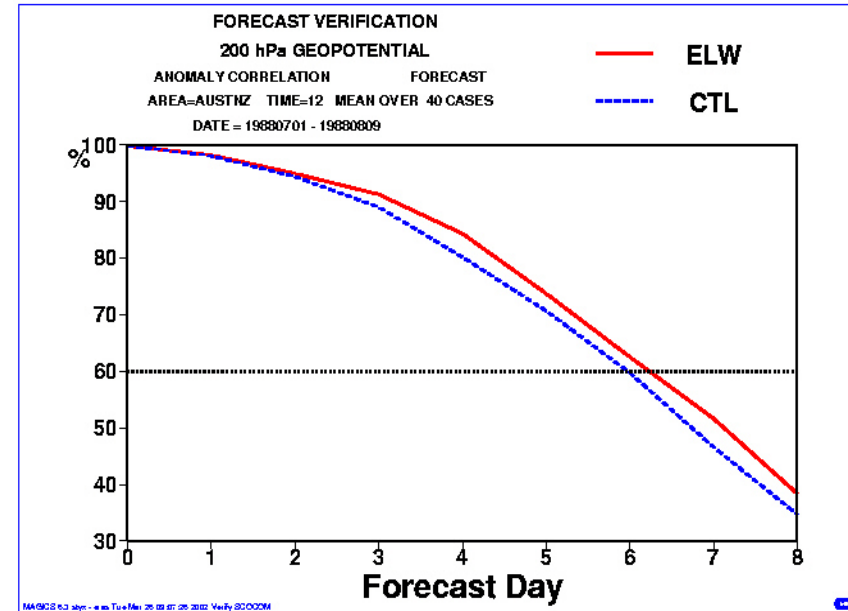


- Better Coverage Area
- Better Coverage Time (3/4 Times to 16 Times per Day)
- Additional Channel Information (VIS added)
- HRV Windvectors NOT Included here

Results of ERA-40 Reprocessing Impact



Northern Hemisphere



Australia / New Zealand

- Statistically positive impact Northern and Southern extra-tropical Areas
- Largest Impact in Australia / New Zealand Area

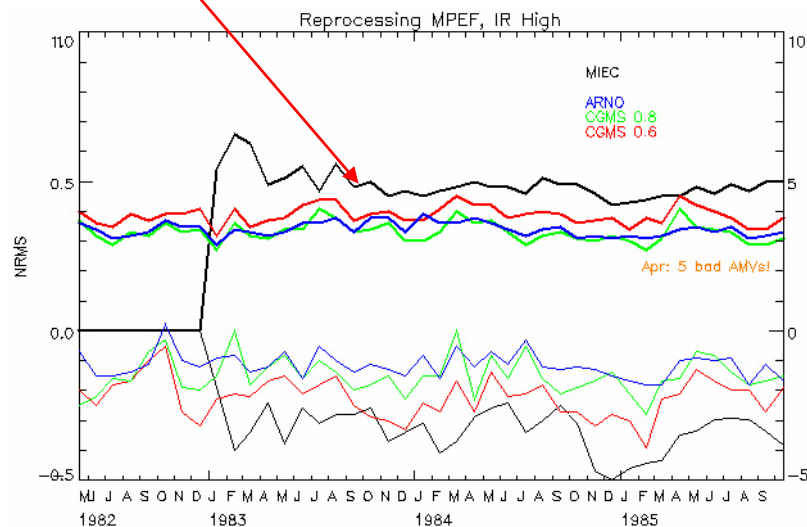
Courtesy ECMWF, ERA-40 Project



Results of ERA-40 Reprocessing

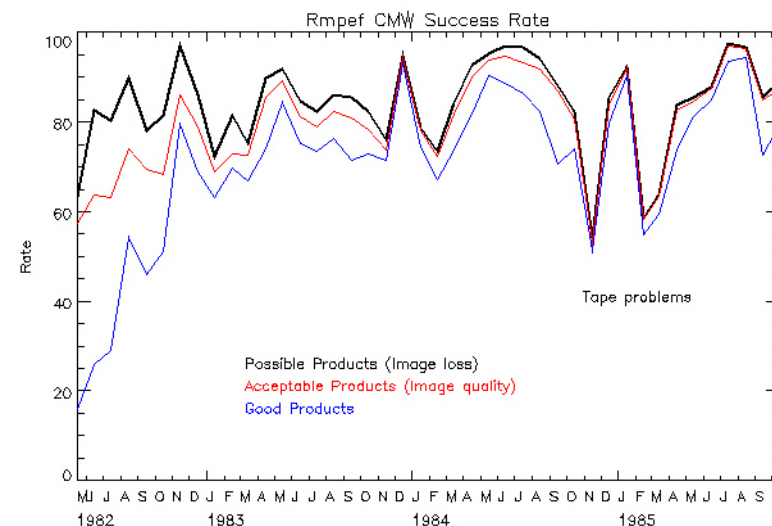
AMV Product Quality

Historical Quality



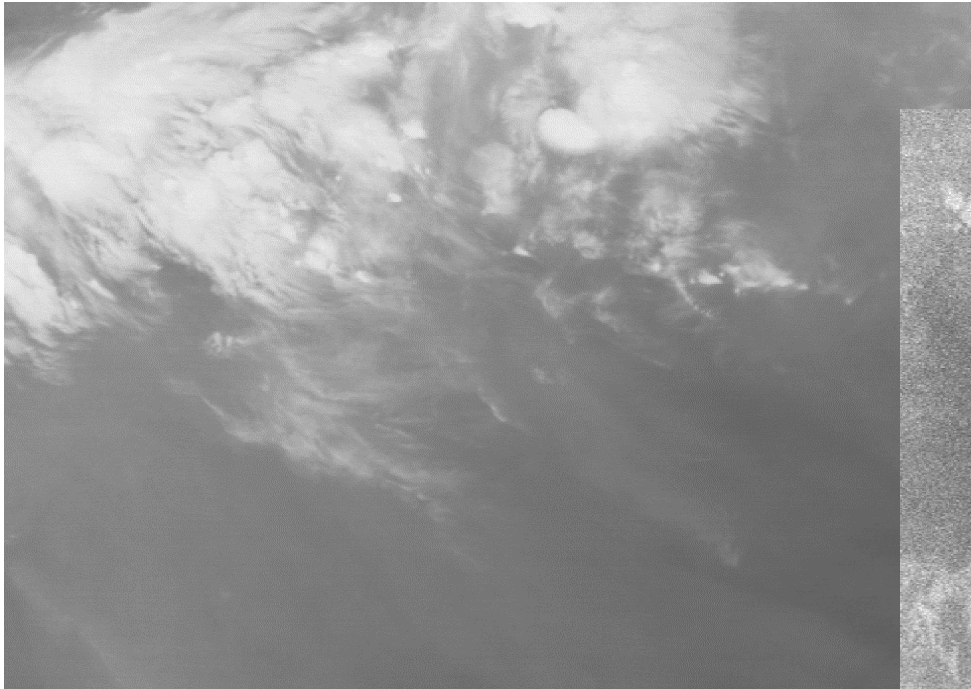
Top: Normalised RMS VD

Bottom: Speed Bias



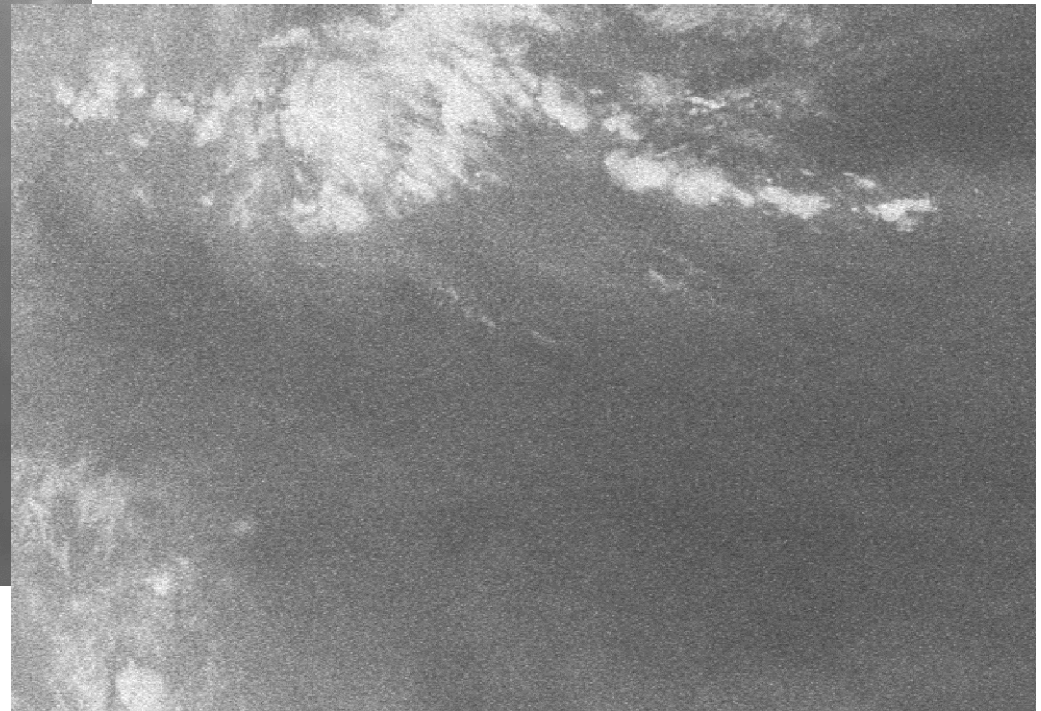
- Normalised RMS of VD improvement between 20-30 % for QI's 0.6 and 0.8 thresholds
- Speed Bias Improvement between 30-50 %

Example WV Image Quality pre-oper vs oper. series



Meteosat-7 WV Image

Meteosat-2 WV Image

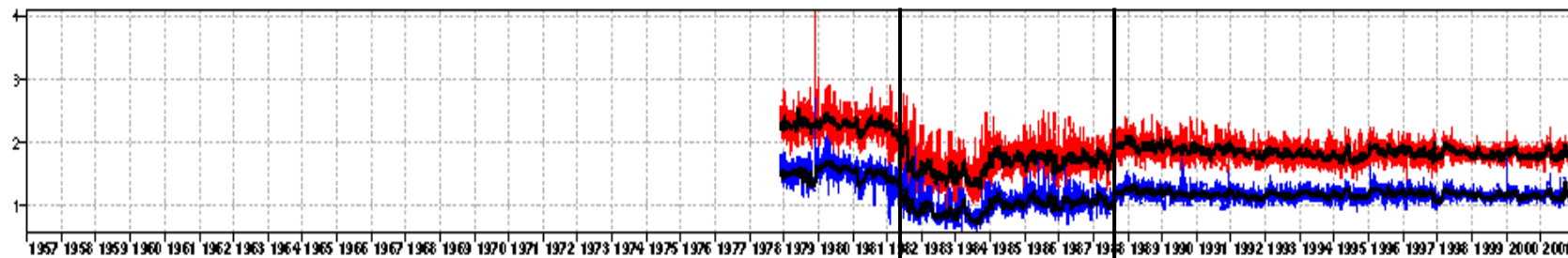


- Image Treatment
- Calibration Information

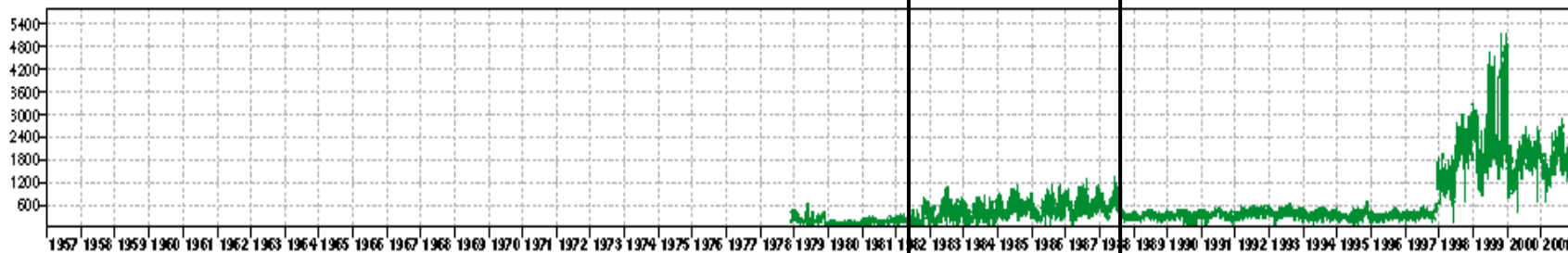
Results of Reprocessing Activities (5)

Impact

ERA-40: SATOB U- Wind 850 00 UTC Tropics RMS (m/s) **OB-FG** **OB-AN** 15 days MA



ERA-40: SATOB-Uwind 850 hPa. 00 UTC Tropics
Daily used observations



**Number of used
observations per day**

**Meteosat
Reprocessed winds**

Courtesy ECMWF,
ERA-40 Project

Results of Reprocessing Activities

- Meteosat-2 Image Reprocessing Results used by:
 - ERA-40
 - JRA-25
- Products:
 - IR and WV Calibration
 - AMV (IR/VIS+HRVIS)
 - CSR (questionable)

Results of ERA-40 Reprocessing

Lessons Learned

1. **Analysis of Meteosat-2 and Meteosat-3 WV Image data requires improvement**
2. **WV Calibration was too unstable for proper use of CSR products**
3. **RMPEF-1 “Real Time” System not appropriate solution (Instable, High Manual Interaction)**
4. **Rectification of Image Data too slow (bottle neck)**

Presentation Contents

- Historical
 - Results of Eumetsat ERA-40 Activities
 - Lessons Learned
- **Present**
 - **Results from ERA-Interim Activities**
- Future
 - System Design
 - Algorithm Upgrades
- Relationships

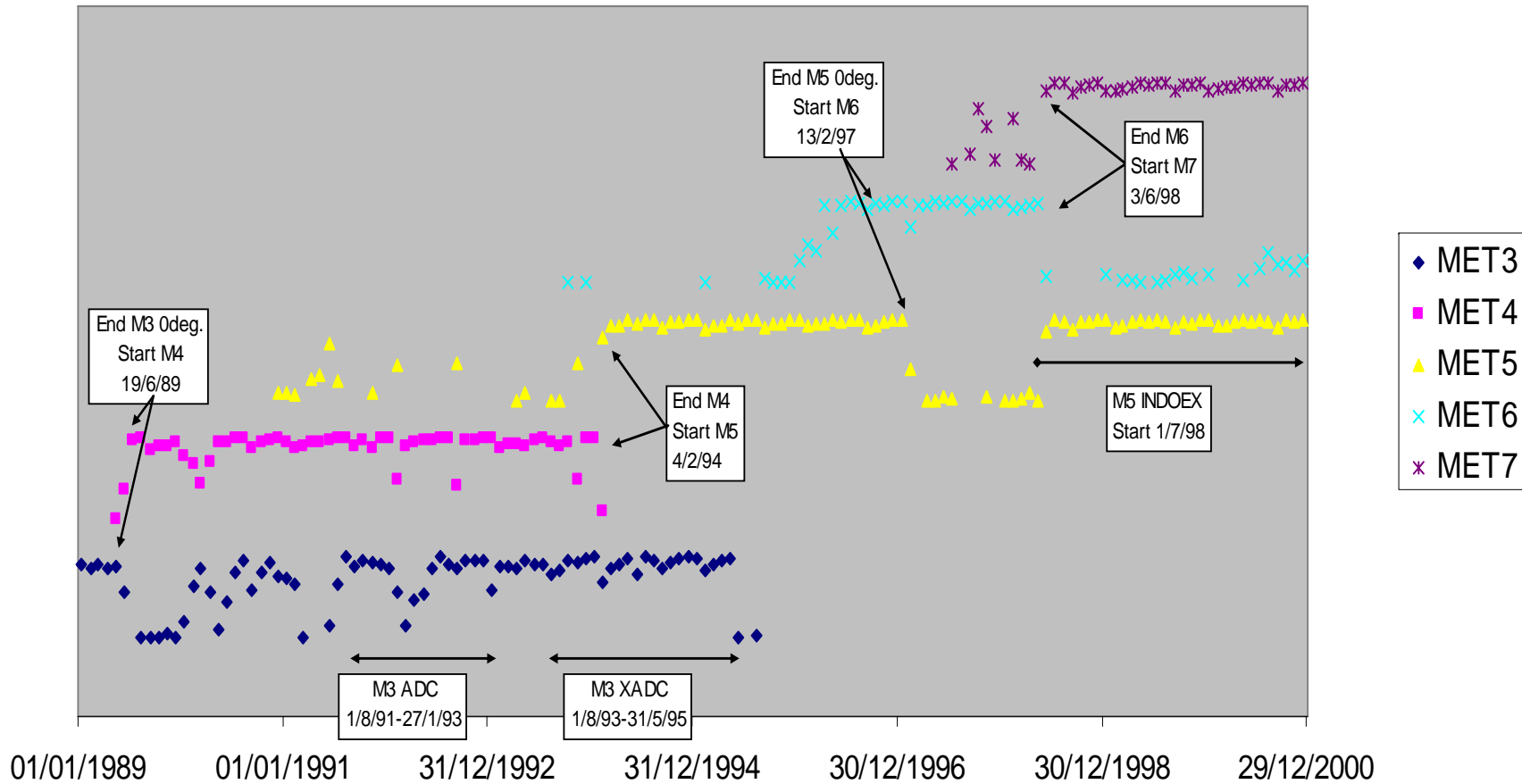
Results of ERA-40 Reprocessing

Application of Learned Lessons

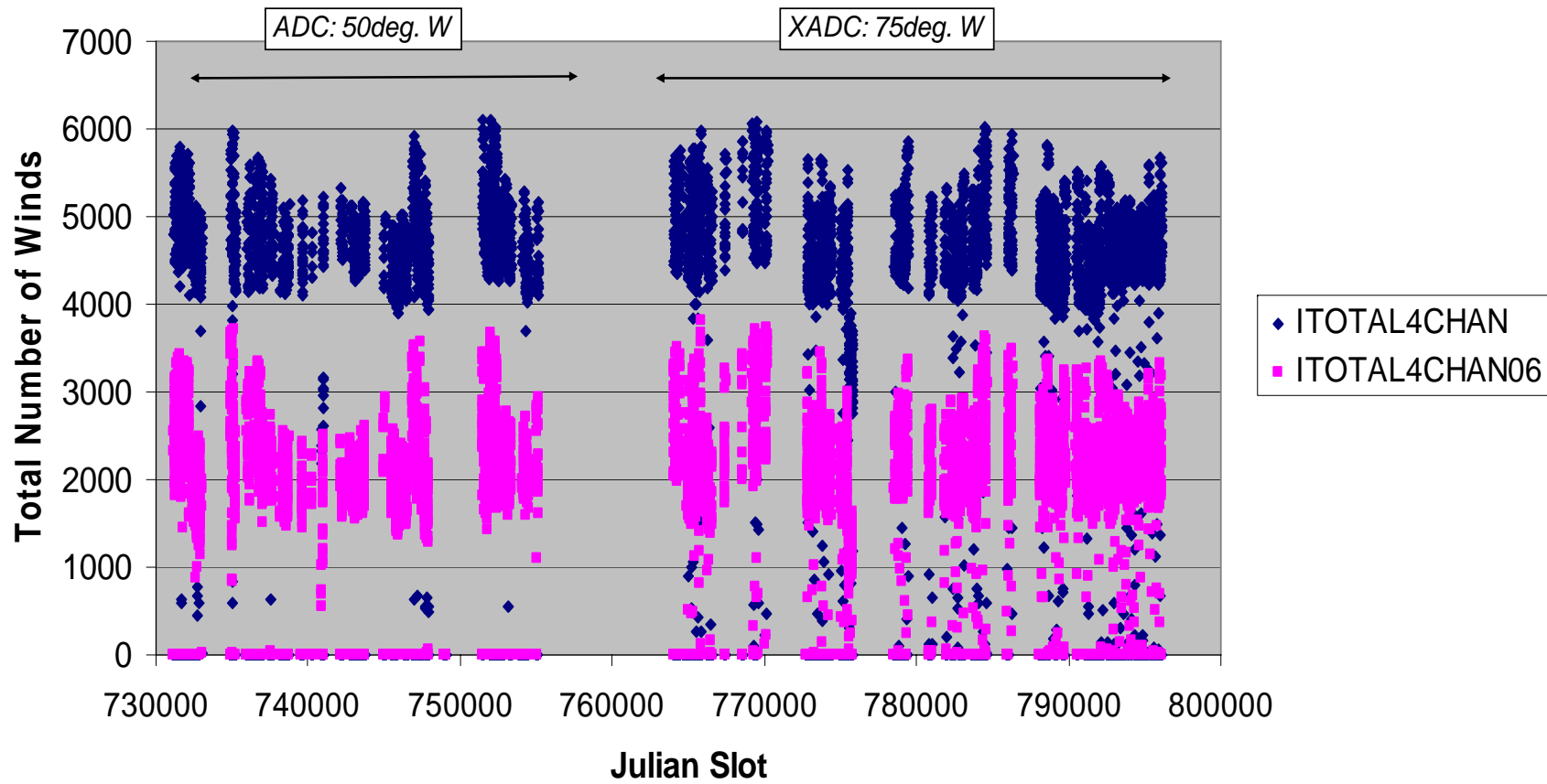
- Analysis of Meteosat-2 and Meteosat-3 WV Image data requires improvement
- WV Calibration was too unstable for proper use of CSR products
- RMPEF-1 “Real Time” System not appropriate solution (Instable, High Manual Interaction)
- Rectification of Image Data too slow (bottle neck)
- **Concept tested, validation outstanding**
- **Design of Calibration Runs and post-treatment of calibration data (High Manual Interaction)**
- **RMPEF-1 “Real Time” System Stability Improved (High Manual Interaction)**
- **(Nearly) All Image data on disk**
- **Maximum 30 Days / 24 hours processing speed in total**

ERA-Interim Run

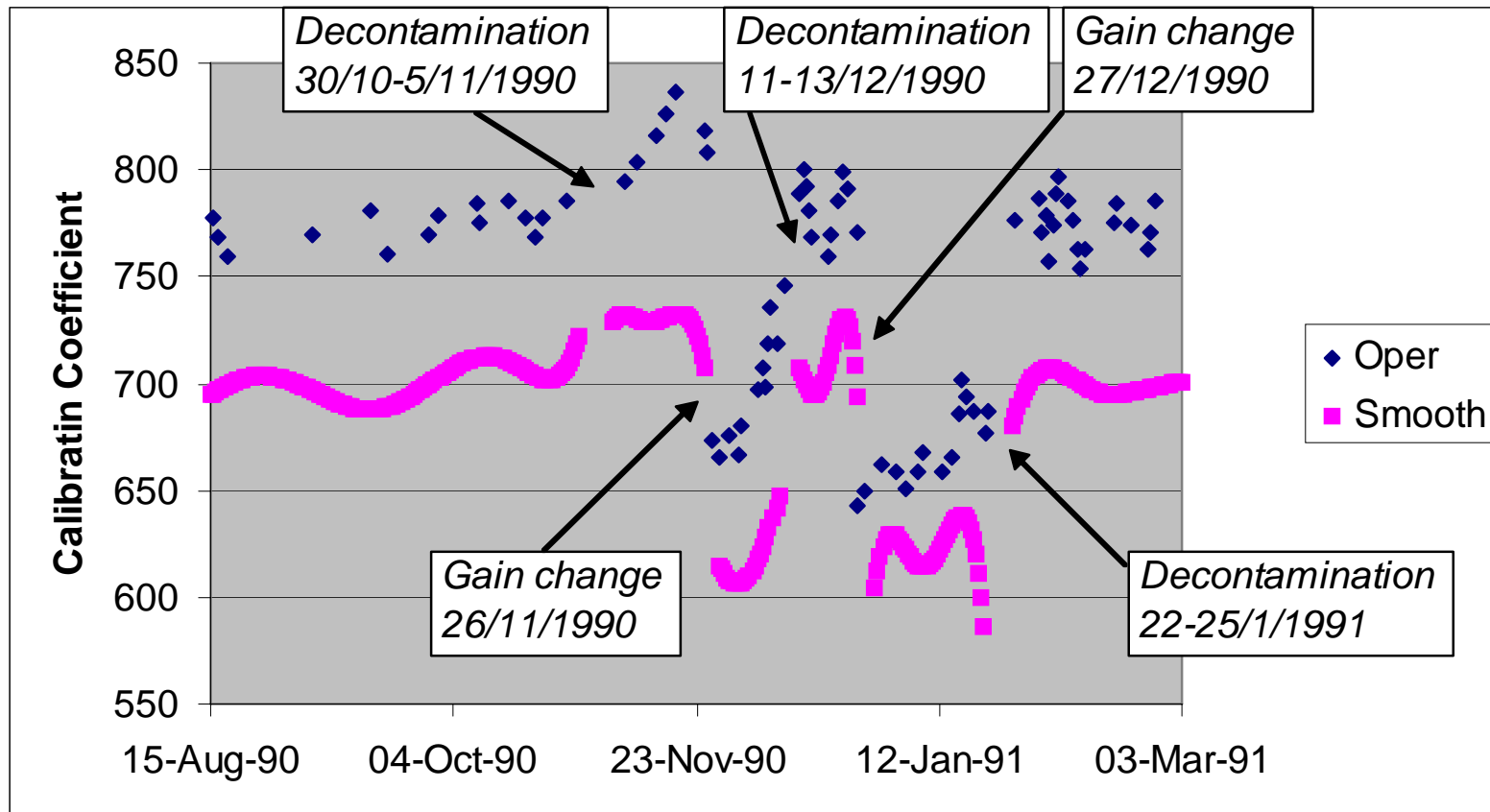
METEOSAT Images Archive 1989-2000



MET3 Atlantic Data Coverage

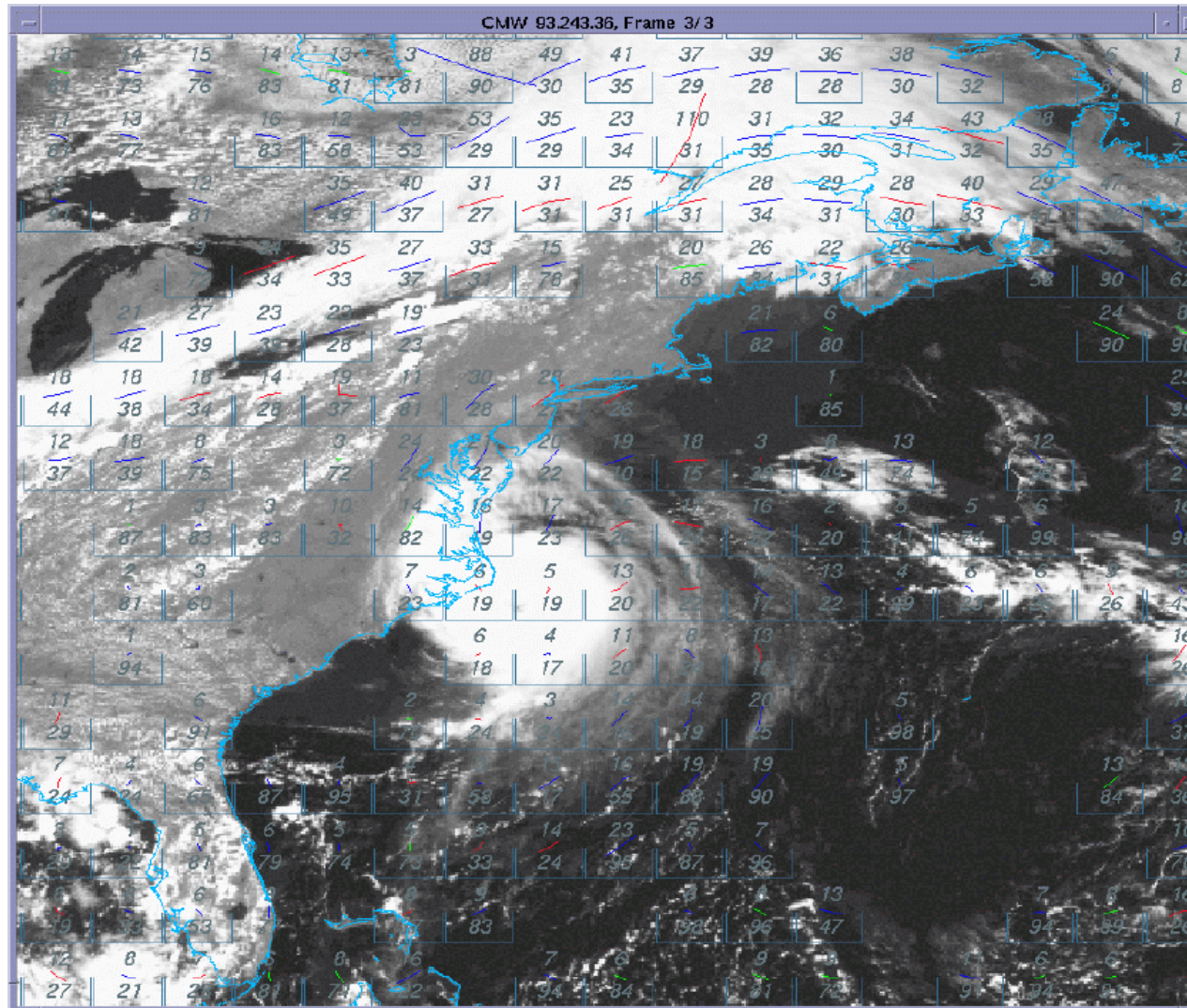


Recalibration Example WV channel

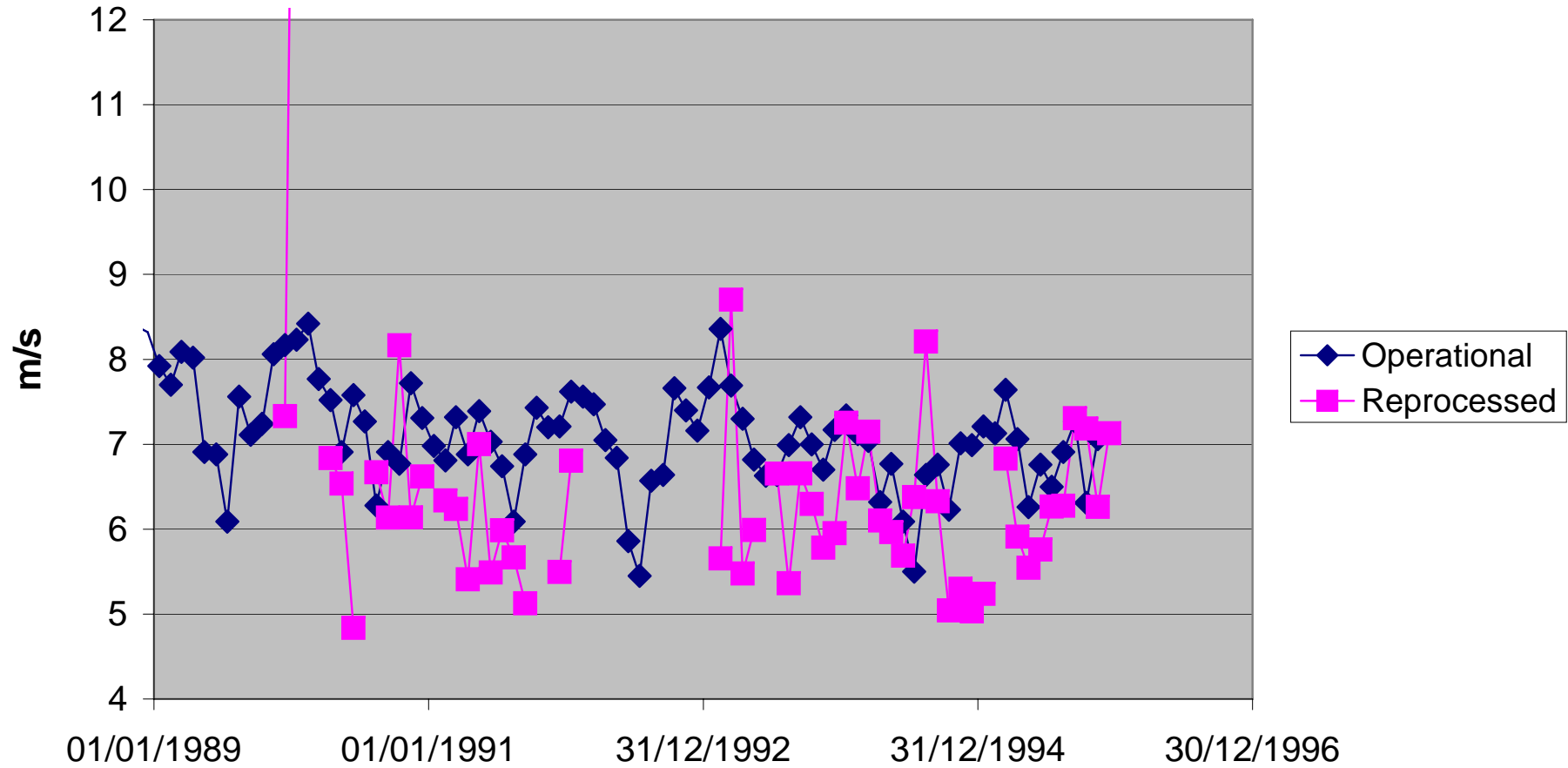


AMV Example ADC Mission

Hurricane Emily – Aug. 31st, 1993 (MET3 XADC)



RMS difference Meteosat IR-high - R/S



Results of ERA Interim Reprocessing

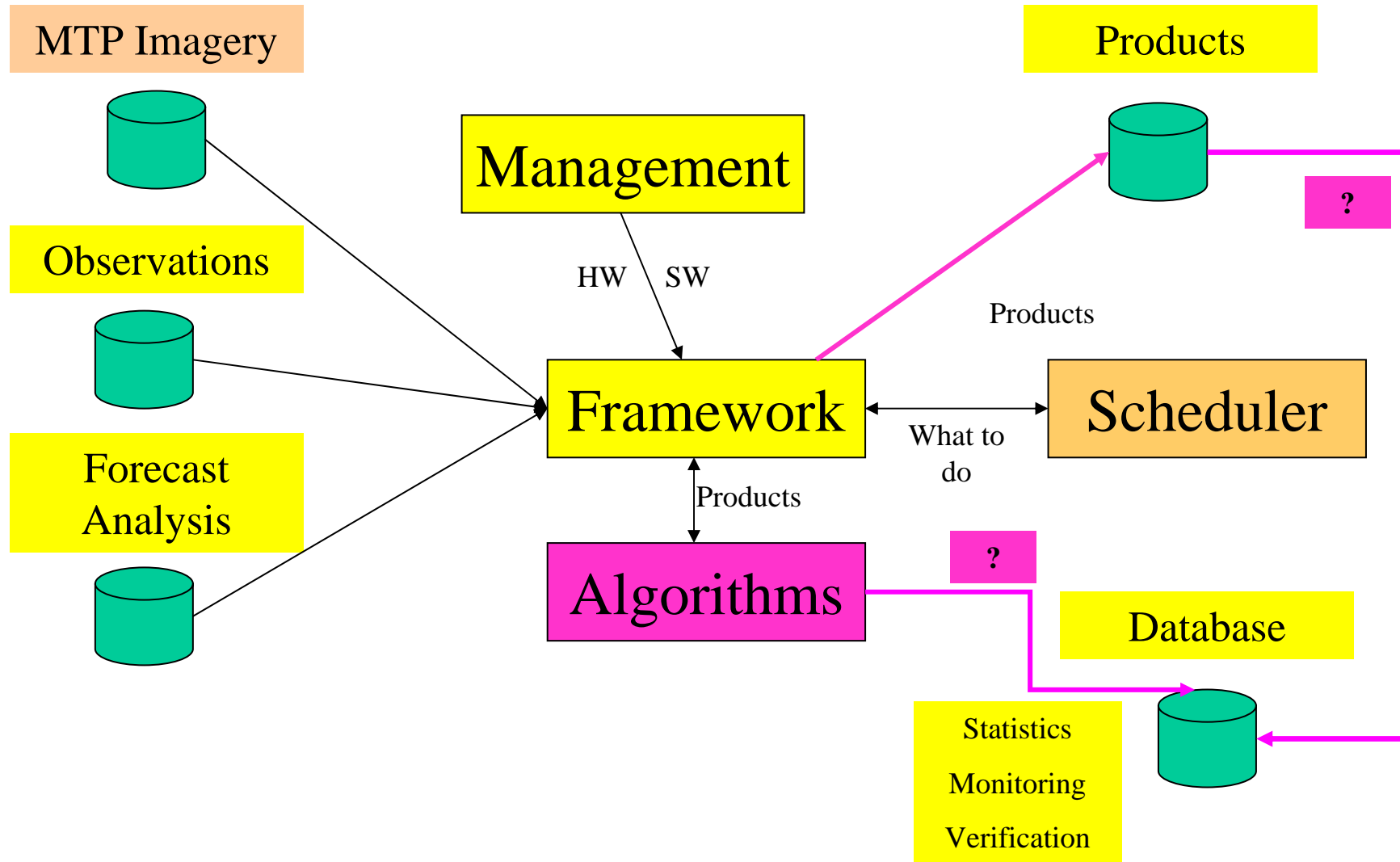
Re-analysis and the Challenges:

1. **Frequent swaps of Spacecraft (Decontamination) with respect to Bias Corrections etc. How to deal with it ?**
2. **ADC and XADC Products. First ever run at ESOC/EUMETSAT, analysis through ERA-Interim required.**
3. **ADC, XADC, IODC together with 0 Degree Mission = 40 % Global Coverage. Towards Global instead of Meteosat ?**

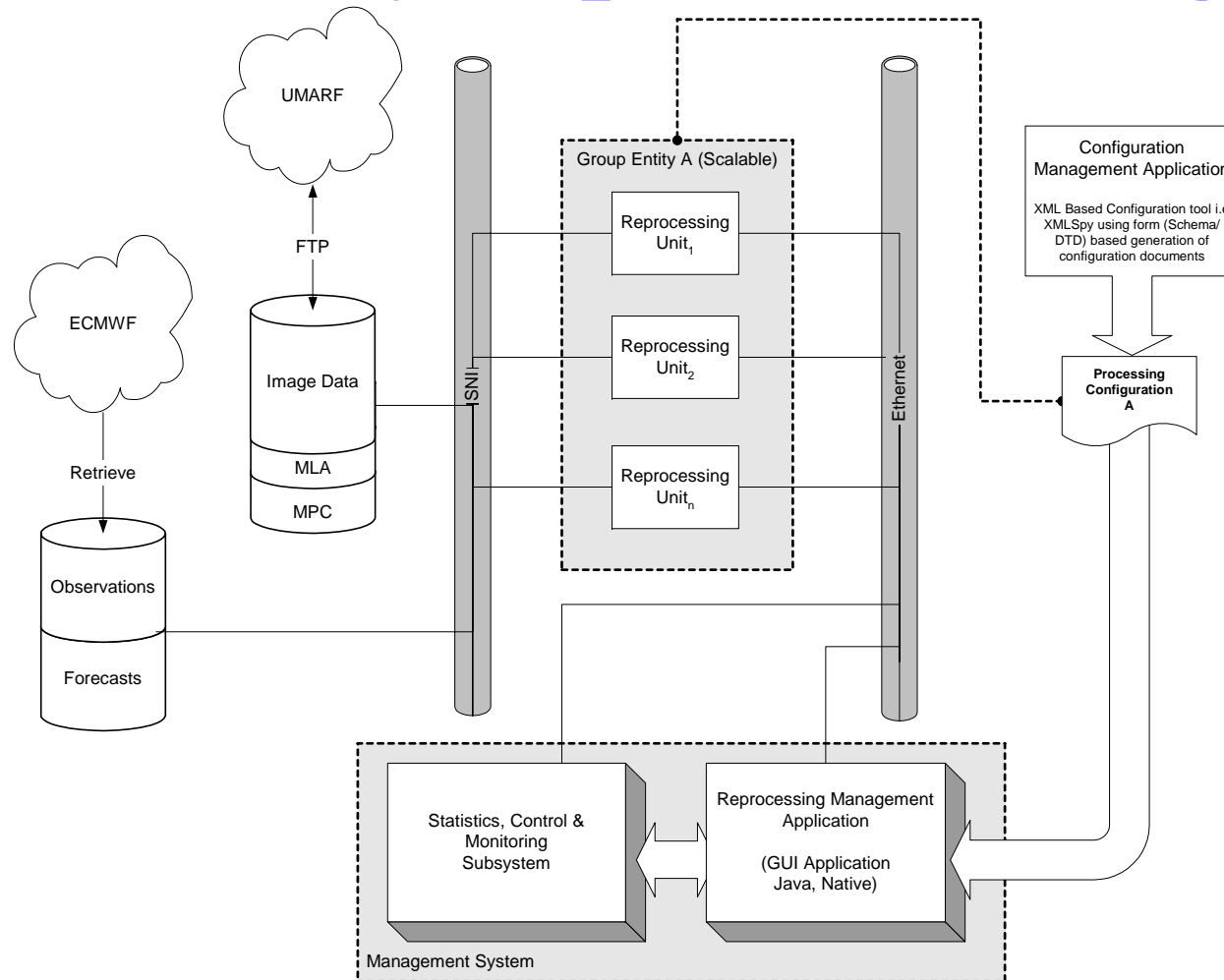
Presentation Contents

- Historical
 - Results of Eumetsat ERA-40 Activities
 - Meteosat-2 Image Reprocessing
 - Lessons Learned
- Present
 - Results from ERA-Interim Activities
- **Future**
 - **System Design**
 - **Algorithm Upgrades**
- Relationships

Basic RMPEF-2 Design



RMPEF-II System Topology (Not decided yet: potential design)



Planned Algorithm Updates

1. **Multi-Dimensional Histogram Analysis => MSG Type Pixel Analysis (Operationally used for Met-7, Met-5):**
Ongoing
2. **Radiative Transfer Model => RTTOV**
3. **Recalibration Code Update**
 - **RTTOV**
 - **Radiosonde Observations (e.g. ECMWF Feedback Files)**
 - **Satellite Cross Calibration (HIRS)**
 - **Calibration Adjustment (e.g. with Meteosat-8)**
4. **Meteosat Second Generation AMV Algorithm (Tracking)**

Recalibration

- Recalibrate individual spacecraft
- Analyse results, resulting in smoothing (especially WV)
- Intercalibration with HIRS
- Link to Meteosat-8
- Analyse overlapping period Met-2 => Met-7
- Homogeneous Calibration

Potential New Products

1. **Divergence**
2. **Warm WV Pixel Climatology (Tropopause Inversion Intrusions)**
3. **Improved Climate Data Set**
4. **..... (User Requests: e.g. from Met-Services, ECMWF, SAF,**)

Presentation Contents

- Historical
 - Results of Eumetsat ERA-40 Activities
 - Meteosat-2 Image Reprocessing
 - Lessons Learned
- Present
 - Results from ERA-Interim Activities
- Future
 - System Design
 - Algorithm Upgrades
- **Relationships**

EUMETSAT Assets

- **A CM-SAF with a well-formulated goal in support of climate monitoring**
- **Active in CGMS (satellite cross-calibration), WMO Space Programme (Global Satellite Inter-calibration System)**
- **Contributor to re-analyses (e.g. ECMWF and JMA)**
- **Consistent Calibration Done (VIS) or Planned (IR/WV) for 1st generation Meteosats**
- **Production of consistent Level-2 product from archived data (e.g. Meteosat surface albedo)**
- **EUMETSAT receives support from GCOS => satellite operators are responsible to produce ‘climate worthy Level-1b data from archive’**

Discussion Points (1)

- **Challenges in ERA-Interim ?**
 - **Frequent Spacecraft swaps (Problem for Re-analysis) ?**
 - **Use of Degraded (Meteosat-2 and) Meteosat-3 WV Images ?**
 - **Correction, Calibration, AMV, Feasibility Analysis ?**
 - **Use of XADC, ADC, IODC Data Sets ?**
- **Is Meteosat Product Reprocessing Useful ?**
 - **Delta Improvements Possible !**
 - **Coverage is only about 20 % of full globe !**
 - **Different Products Required (beyond AMV, CSR) ?**
 - **Cloudy Radiances, Divergence Fields, Cloud Analysis Product, Improved Climate Data Set**

Discussion Points (2)

- **Reprocessing and Forecasts / Analyses ?**
 - Forecasts or analyses are required for e.g. atmospheric correction, AMV Height Assignment. Which one to use for support to next re-analysis, what is the impact ?
- **Reprocessing MPEF and SAF ?**
 - CM SAF for Validation of Re-Analyses !!!!!!!!!!!!!
 - RMPEF for pure (re-)generation of Observations towards more consistent/improved Observations !!!!!!!!!!!!!
 - SAF / RMPEF Cooperations ?
 - CM SAF – RMPEF (e.g. (Inter)-Calibration, Algorithm Exchange ?,...)
 - LSA SAF – RMPEF (e.g. Land Surface Temperatures ?)
 - Critical Reviews required e.g. to avoid use of the same algorithm for generation and validation

Discussion Points (3)

- **RMPEF – 2 More Open to Users for new Algorithms**
- **Now is Time to think with respect to new/different algorithms (well in advance of next Reprocessing Run for ERA ± 70)**

**Thanks
for your Attention**