“Experimental Data Processing”

Assignment 8
Development of optimal smoothing to increase the estimation accuracy

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Term 1, September-October 2020
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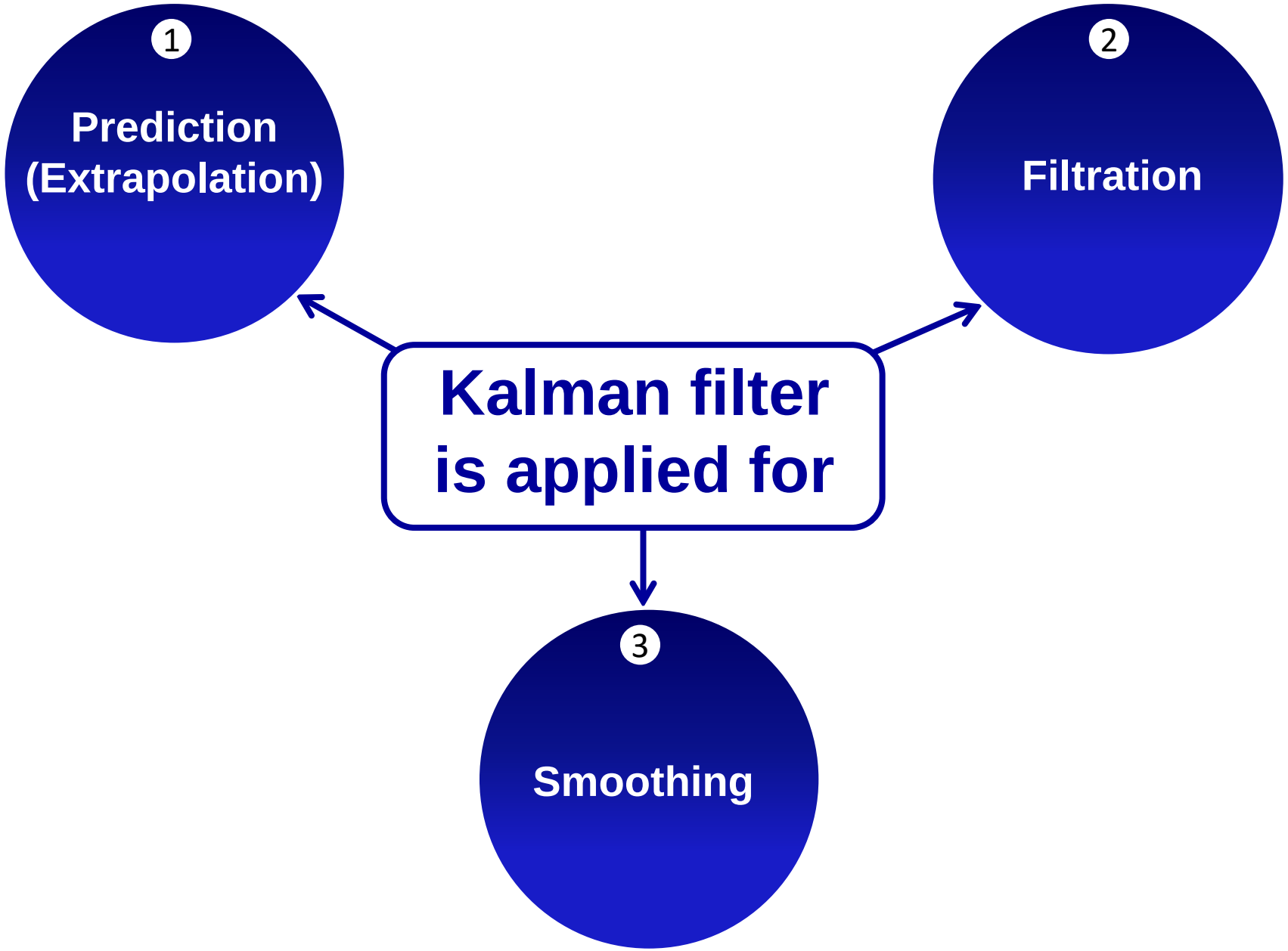
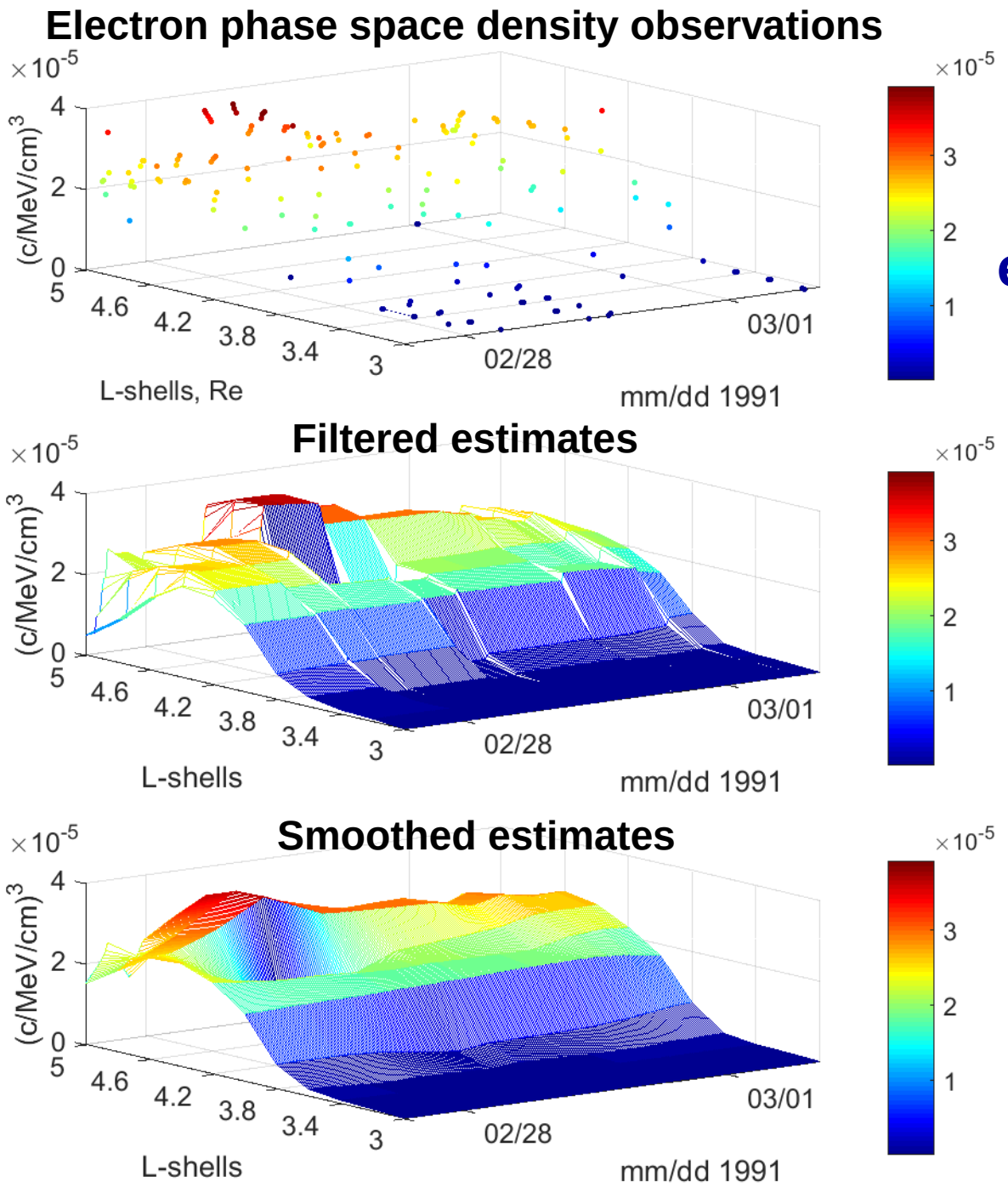

Kalman filter is applied for
1
Prediction (Extrapolation)
2
Filtration
3
Smoothing



Reconstructing the dynamics of relativistic electrons in Earth's radiation belts

Smoothing takes into account both current and future measurements and therefore provides improved estimation

Podladchikova et al. (2014), Noise statistics identification for Kalman filtering of the electron radiation belt observations: 2. Filtration and smoothing, J. Geophys. Res. Space Physics, 119

Smoothing with fixed interval

Smoothing is performed in backward in time

$$X_{i,N} = X_{i,i} + A_i(X_{i+1,N} - \Phi_{i+1,i}X_{i,i})$$

$$i = N-1, N-2, \cdots 1$$

Coefficient $A_i = P_{i,i}\Phi_{i+1,i}^T P_{i+1,i}^{-1}$

Smoothing error covariance matrix

$$P_{i,N} = P_{i,i} + A_i\left(P_{i+1,N} - P_{i+1,i}\right)A_i^T$$

$X_{i,i}$ - filtered estimate, $X_{N,N}$ - initial estimate

$P_{i,i}$ - filtration error covariance matrix

$P_{i+1,i}$ - prediction error covariance matrix

Smoothing takes into account both current and future measurements and therefore provides improved estimation