THE INFLUENCE OF MICROPHYSICS PARAMETERIZATIONS ON FORECASTS OF DOWNSTREAM WAVINESS

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Jonathan E. Martin
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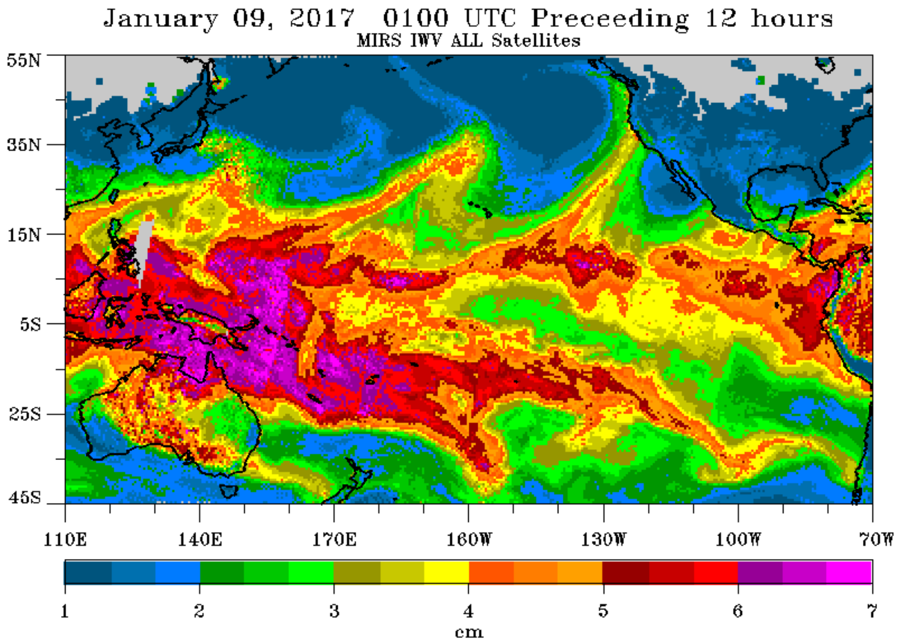
Motivation

- Diabatic processes affect Rossby wave structure



Source: www.esrl.noaa.gov

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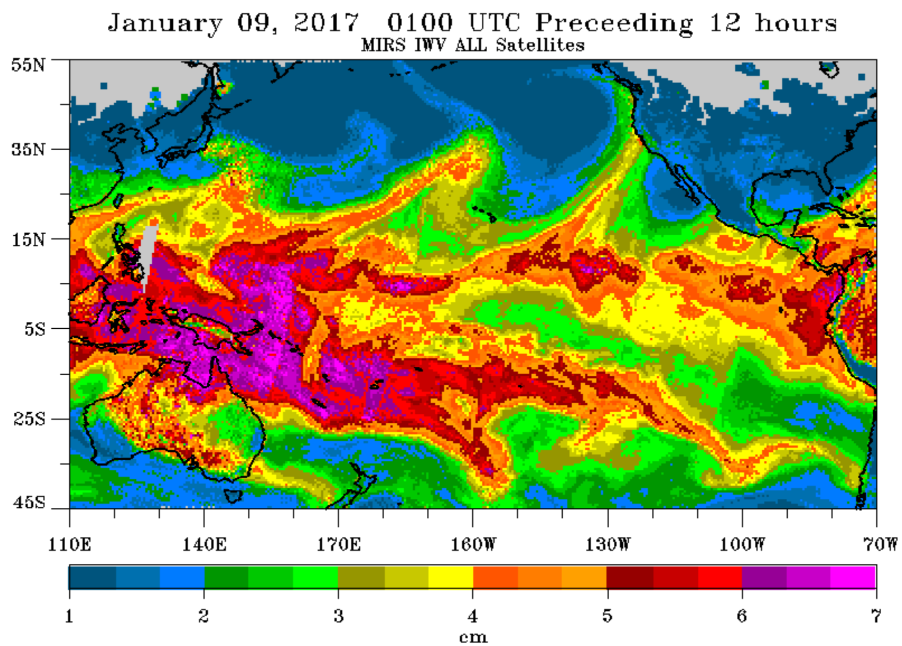
- Diabatic processes affect Rossby wave structure
- Affects on mesoscale weather and synoptic pattern



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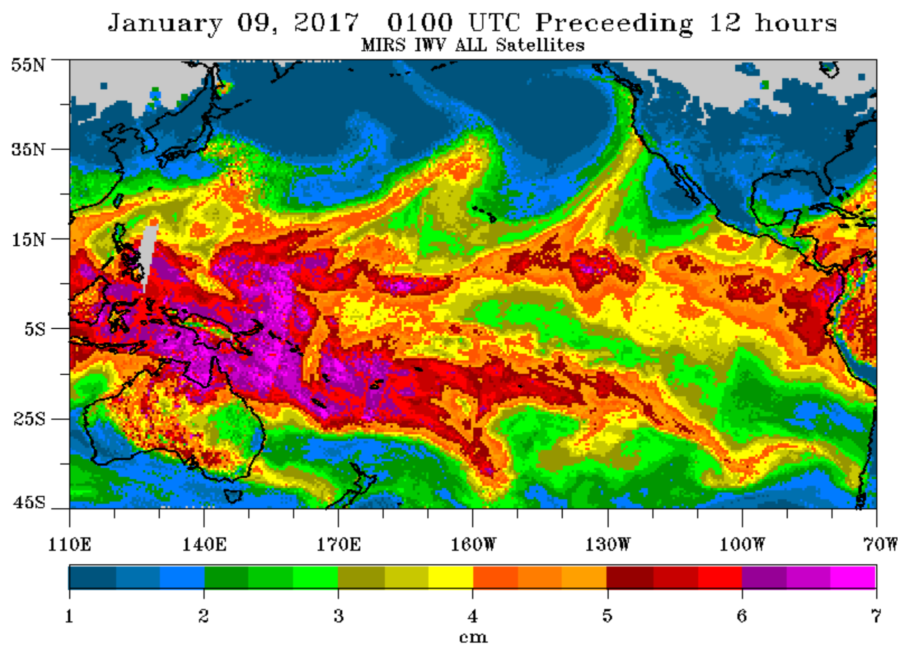
Motivation

- Diabatic processes affect Rossby wave structure
- Affects on mesoscale weather and synoptic pattern
- Model microphysics packages affect forecasts



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Research Question

- Does the complexity of a microphysics package in a model significantly alter the waviness forecast?

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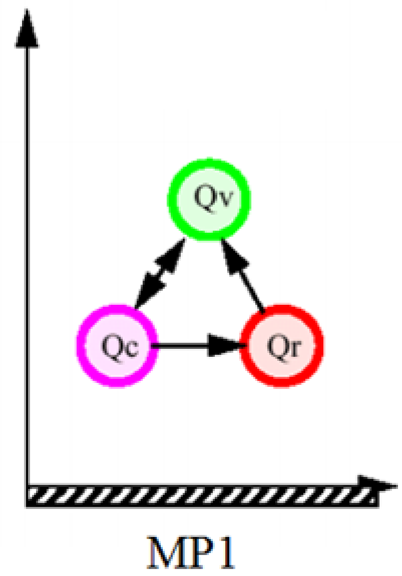
- Does the complexity of a microphysics package in a model significantly alter the waviness forecast?
  - Run the WRF using 3 different microphysics packages
  - Calculate the sinuosity of each packages 200 hPa height forecast

Methods: The WRF

- Specifics:
  - Version 3.8 of the WRF
  - 80 x 80 km resolution
  - Initialized at 0000 UTC, out 120 hours
  - Runs 3 times, one for each MP package

Methods: The WRF

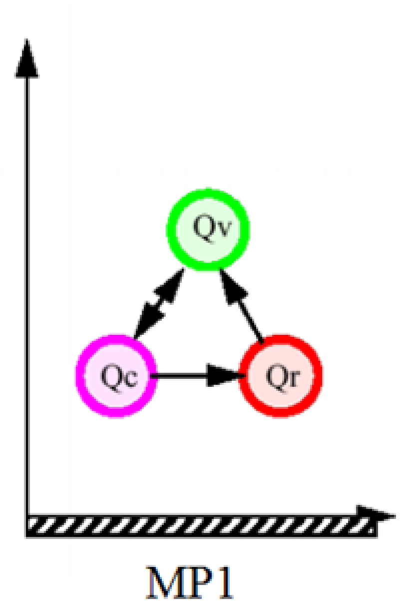


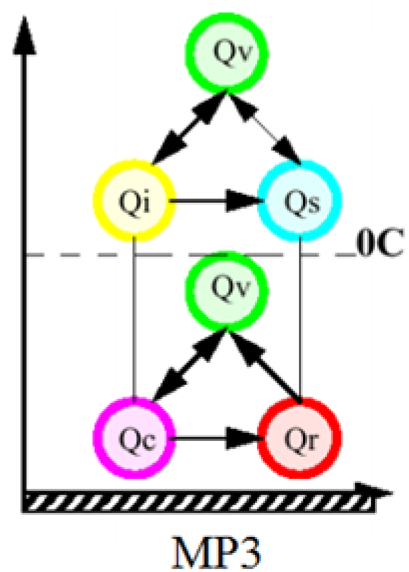
Kessler Scheme

- Warm rain
- No ice

Source: http://www2.mmm.ucar.edu/wrf/users/workshops/WS2010/presentations/Lectures/Microphysics10.pdf

Methods: The WRF





Kessler Scheme

- Warm rain
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3-Class Package

- Ice processes below O˚C

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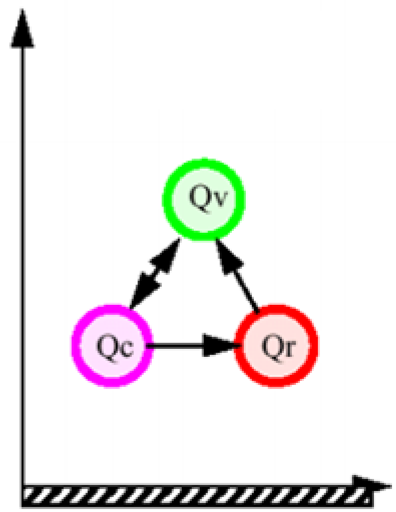
Methods: The WRF



MP1

Kessler Scheme

- Warm rain
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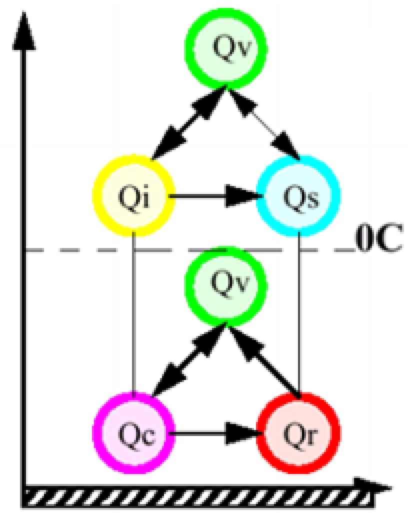
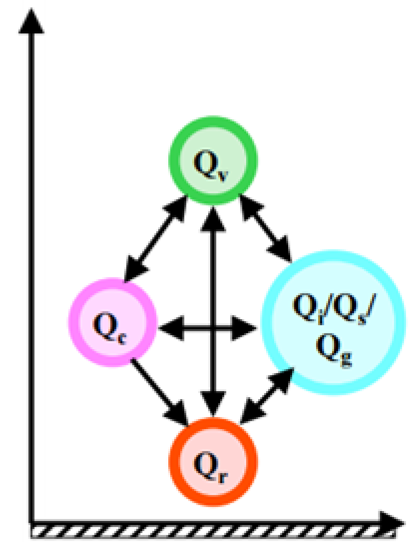


MP3

3-Class Package

- Ice processes below O˚C



MP5

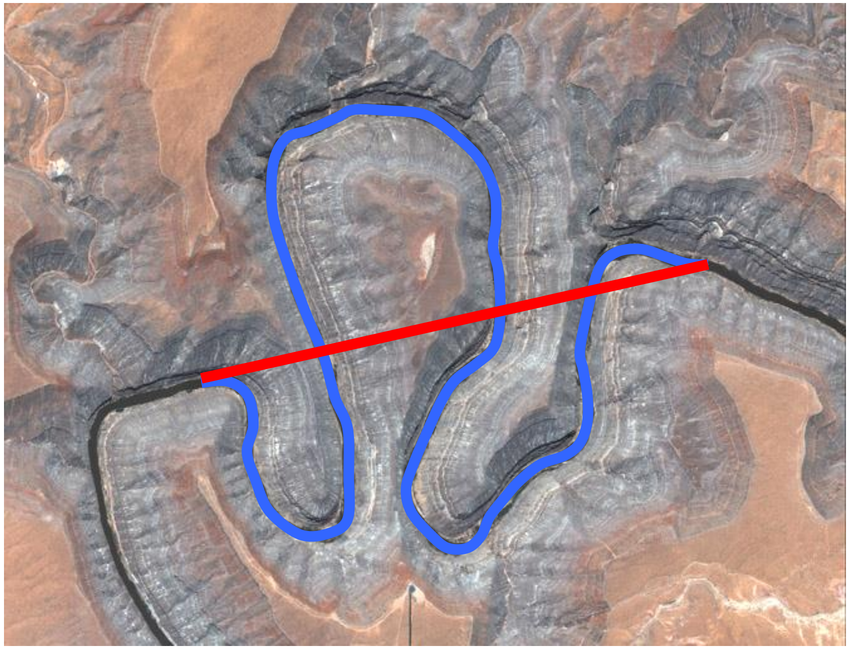
Ferrier Scheme

- Water, rain, ice, super-cooled liquid and ice melt

Source: http://www2.mmm.ucar.edu/wrf/users/workshops/WS2010/presentations/Lectures/Microphysics10.pdf

Methods: Sinuosity

Ganges River, India



Source: Jon Martin, Cyclone Workshop 2015 Presentation

Methods: Sinuosity

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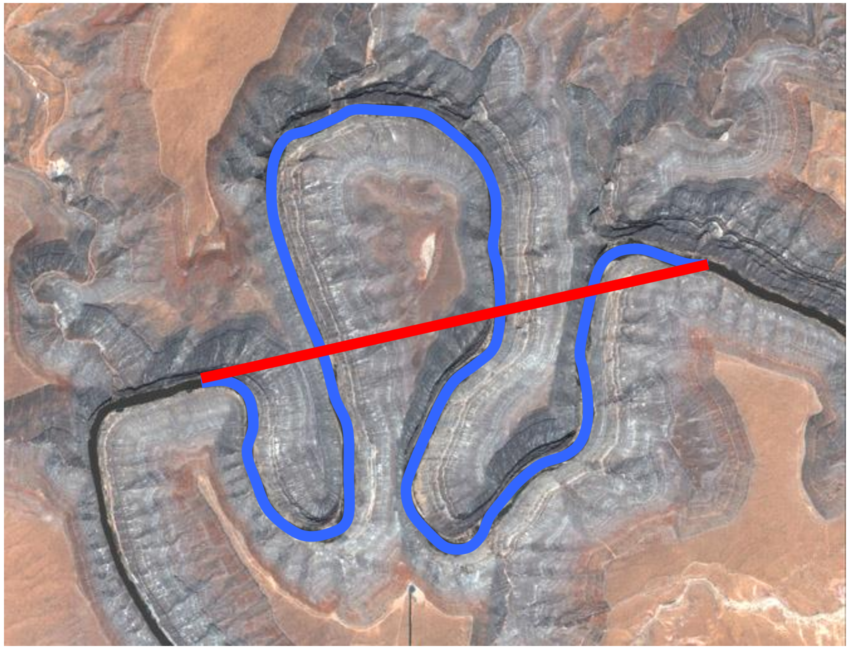
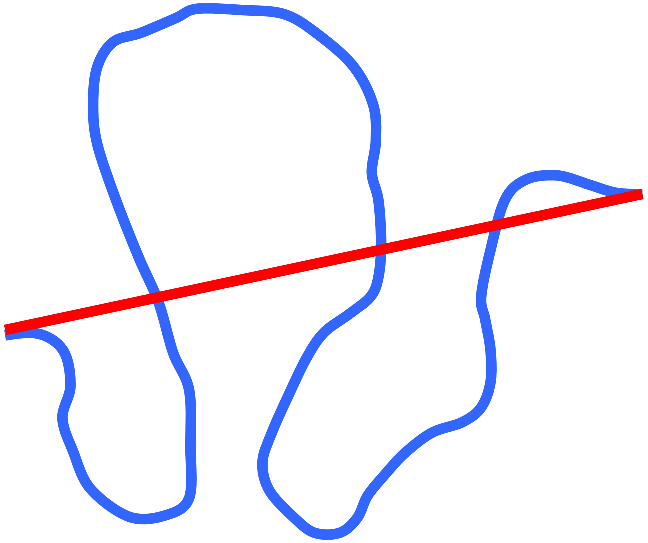
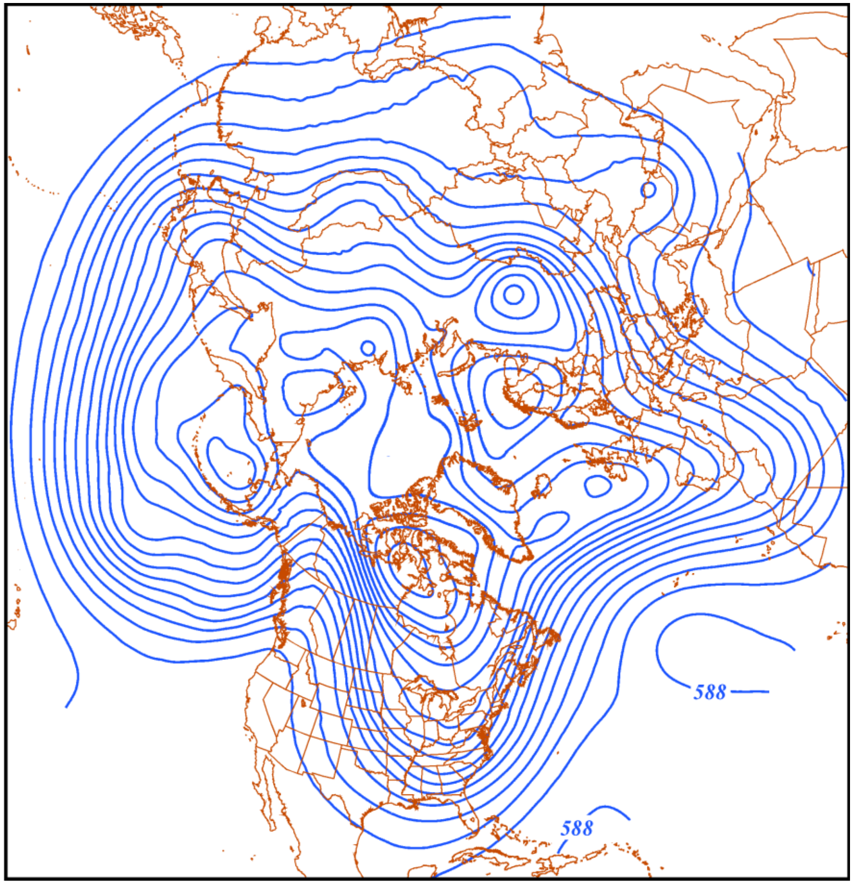




$$S_{AB} = \frac{\text{(Length of CONTOUR)}}{\text{(Length of SEGMENT)}}$$

Source: Jon Martin, Cyclone Workshop 2015 Presentation

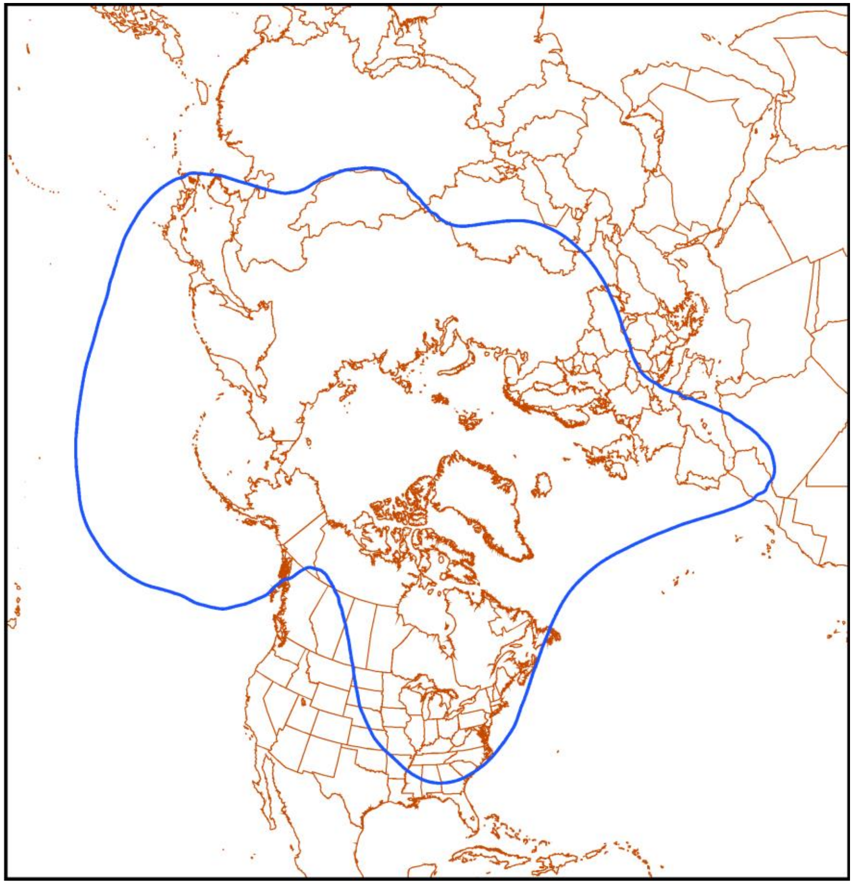
Methods: Sinuosity



Daily Average 500 hPa Φ
(60 m)
January 18, 2014

Source: Jon Martin, Cyclone Workshop 2015 Presentation

Methods: Sinuosity



Daily Average 500 hPa Φ
(552 dm)
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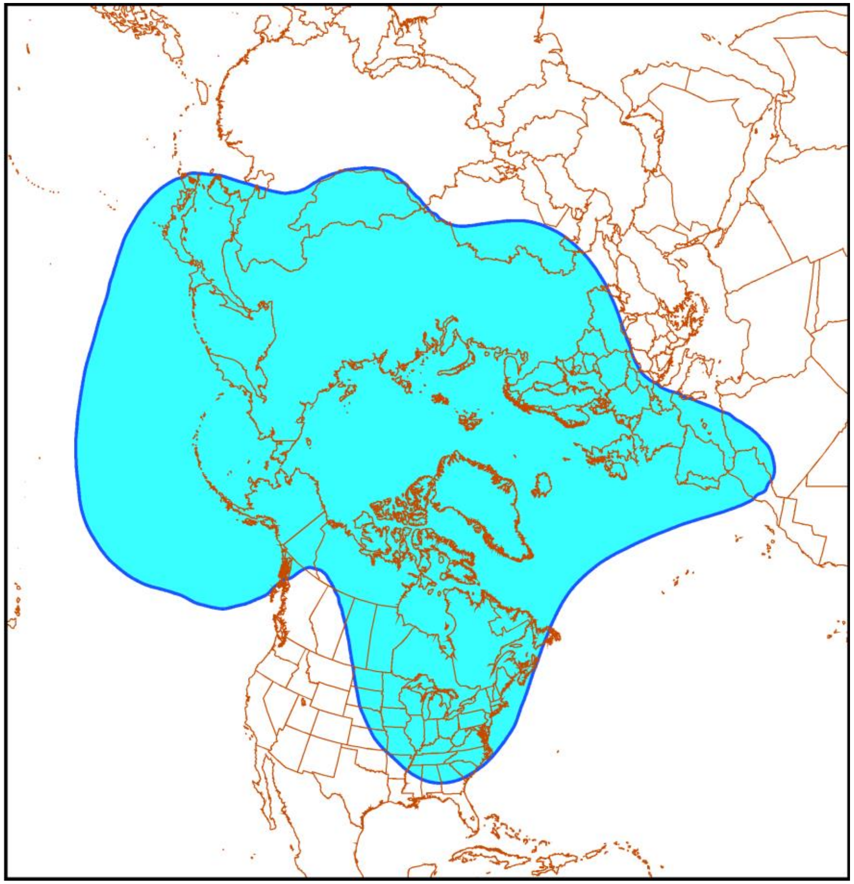

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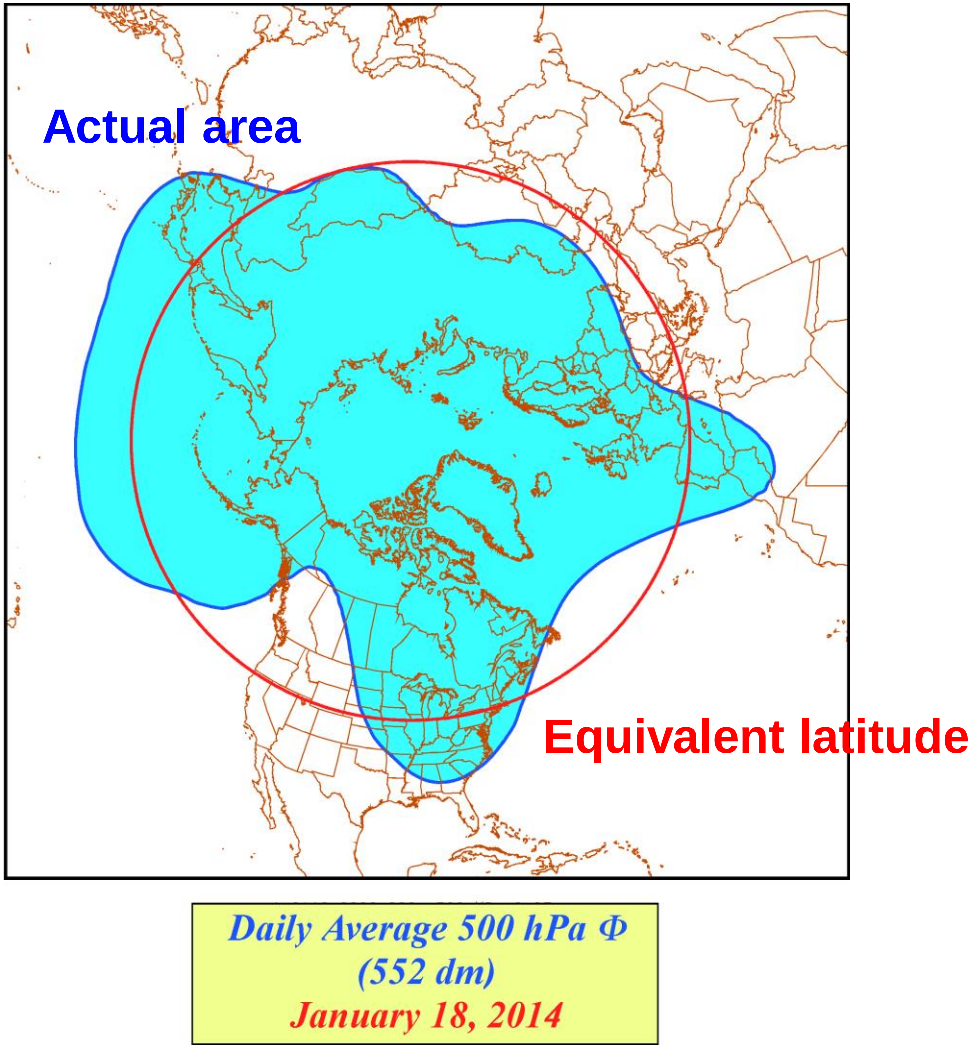

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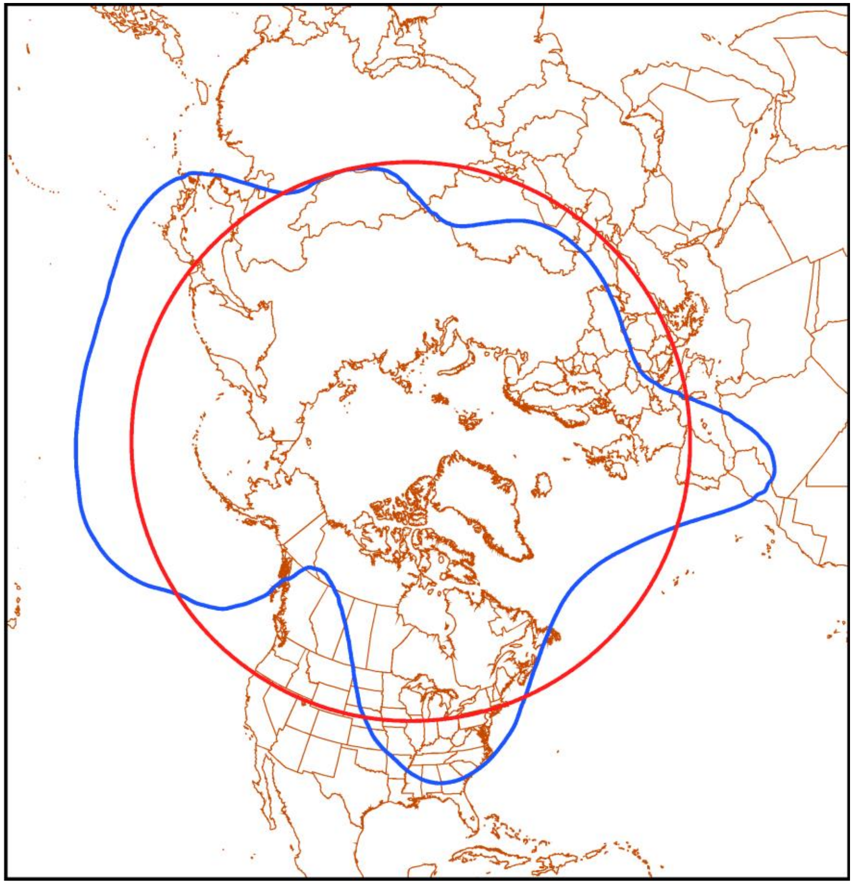
Methods: Sinuosity

$$\text{SIN} = \frac{\text{actual length}}{\text{equivalent latitude}}$$

SIN = 1.2719



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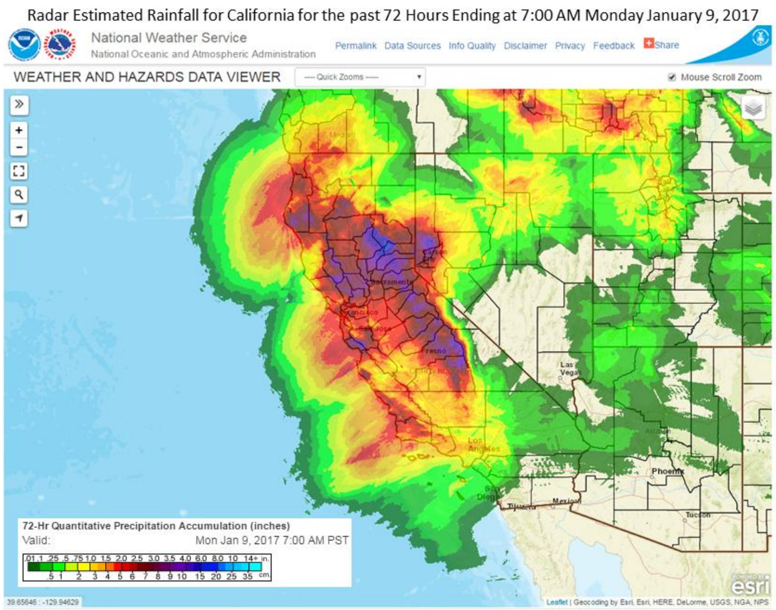
Case Study

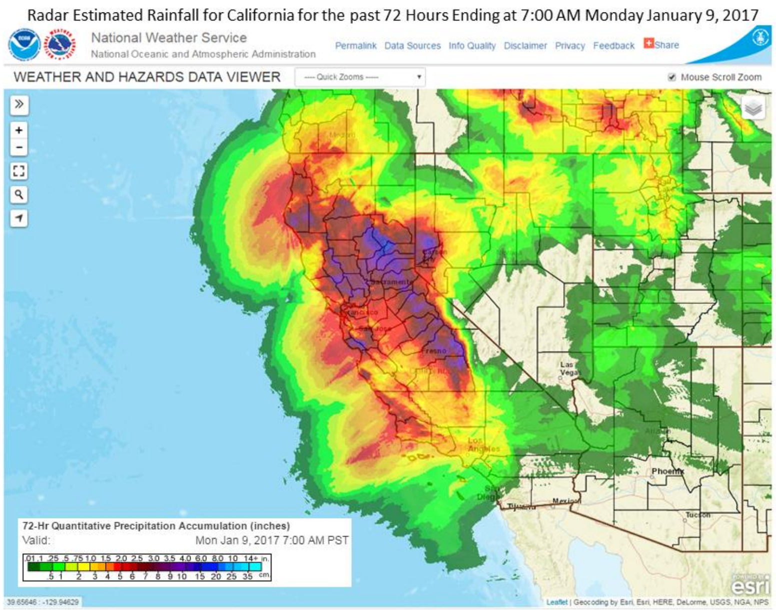
- Heavy rainfall event in California
  - 7-9 January 2017



Source: NWS Los Angeles/Oxnard Facebook Page

Case Study

- Heavy rainfall event in California
  - 7-9 January 2017
- Atmospheric River
  - Landfall 1200 UTC on 7 Jan
  - Exited 1200 UTC on 9 Jan



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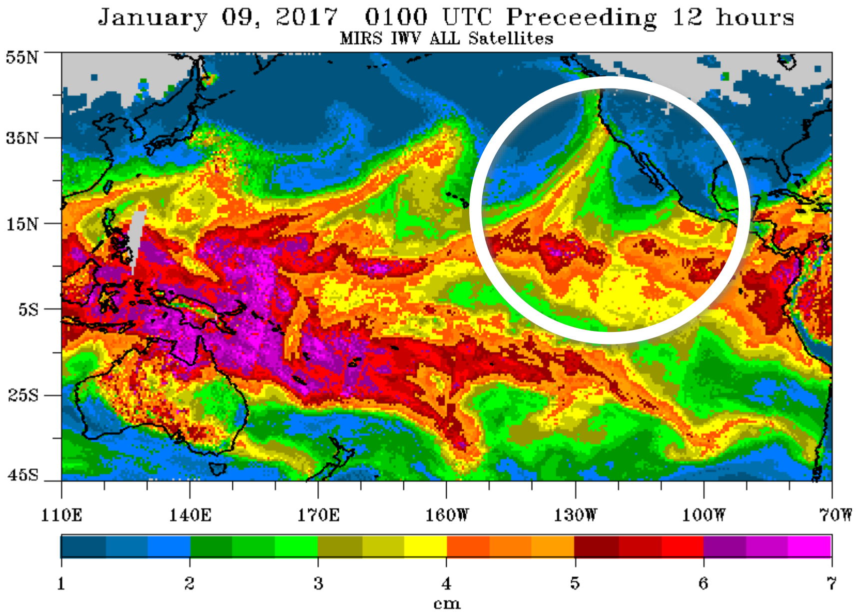
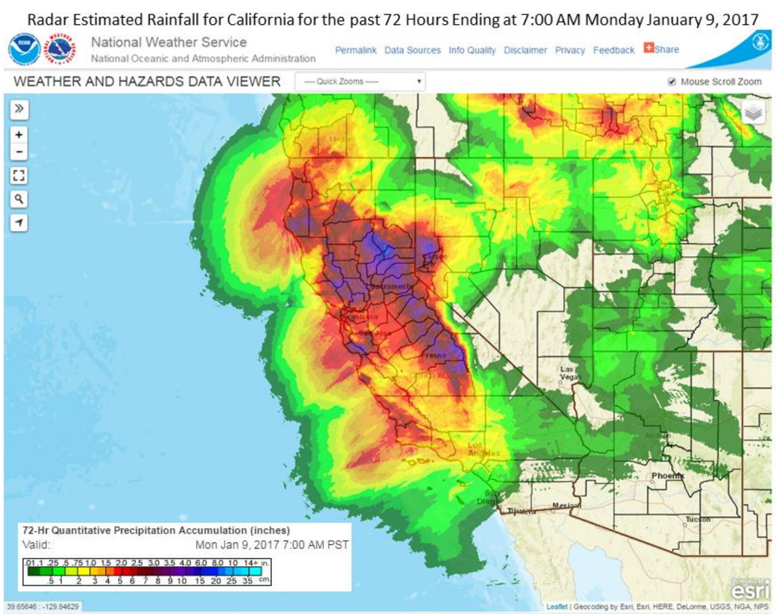


Source: www.esrl.noaa.gov

Case Study

- Heavy rainfall event in California
  - 7-9 January 2017
- Atmospheric River
  - Landfall 1200 UTC on 7 Jan
  - Exited 1200 UTC on 9 Jan

- WRF initialized at 0000 UTC on 5 Jan
  - River event during mid-range forecast, 48-96 hours



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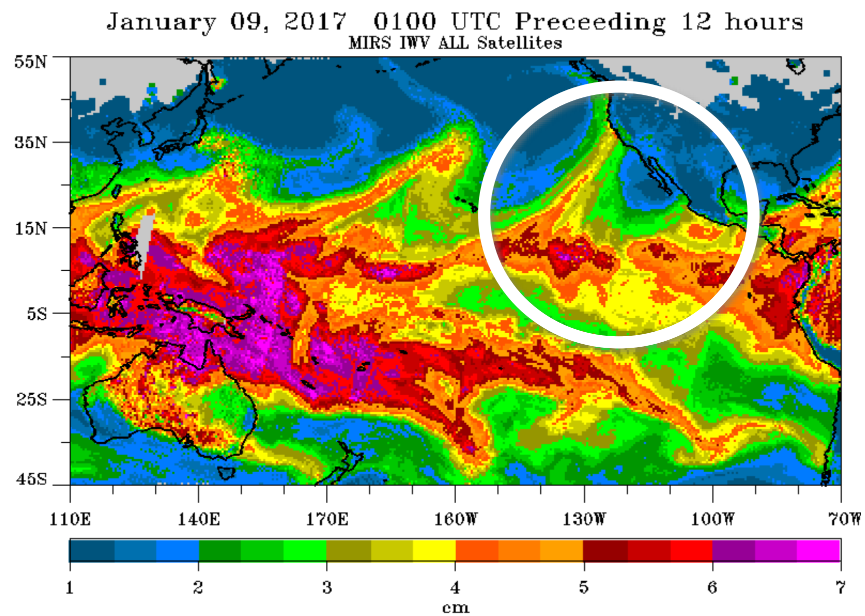
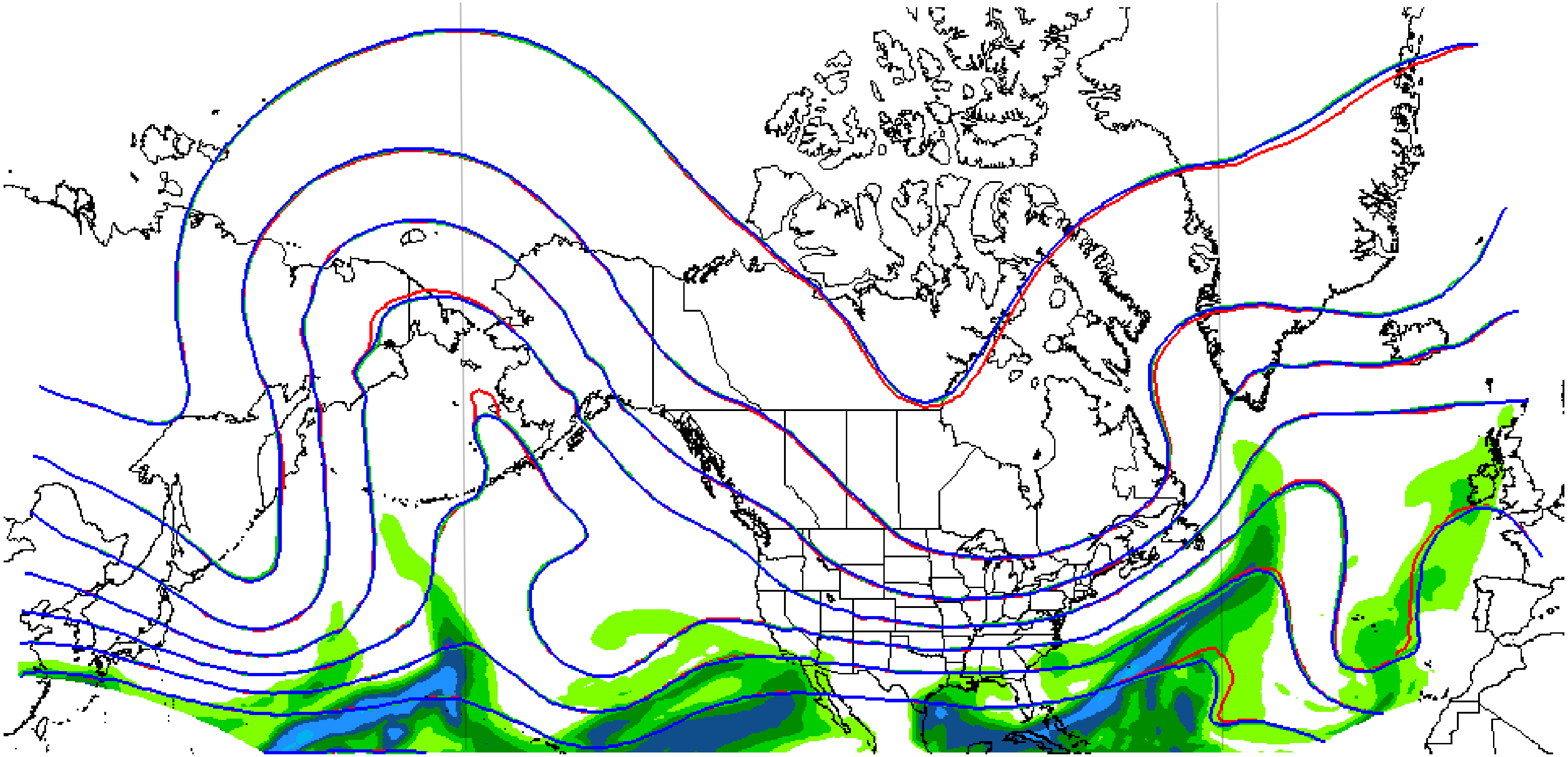


Source: www.esrl.noaa.gov

Case Study

1mp, 3mp, 5mp

Valid 2017-01-06 00z



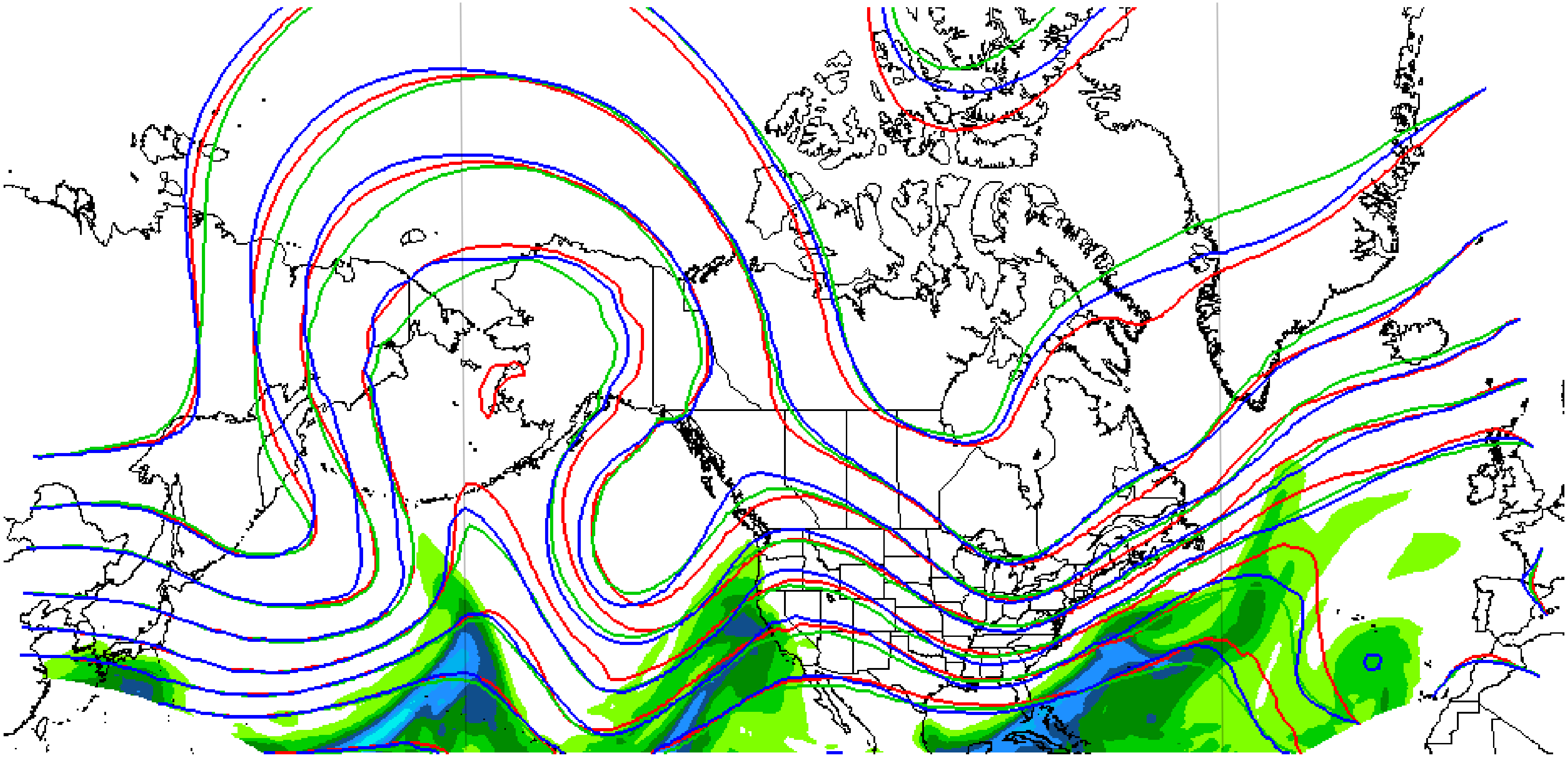
Precipitable Water (mm) for 3 MP Package

24 hr forecast

Case Study

1mp, 3mp, 5mp

Valid 2017-01-08 00z



Precipitable Water (mm) for 3 MP Package

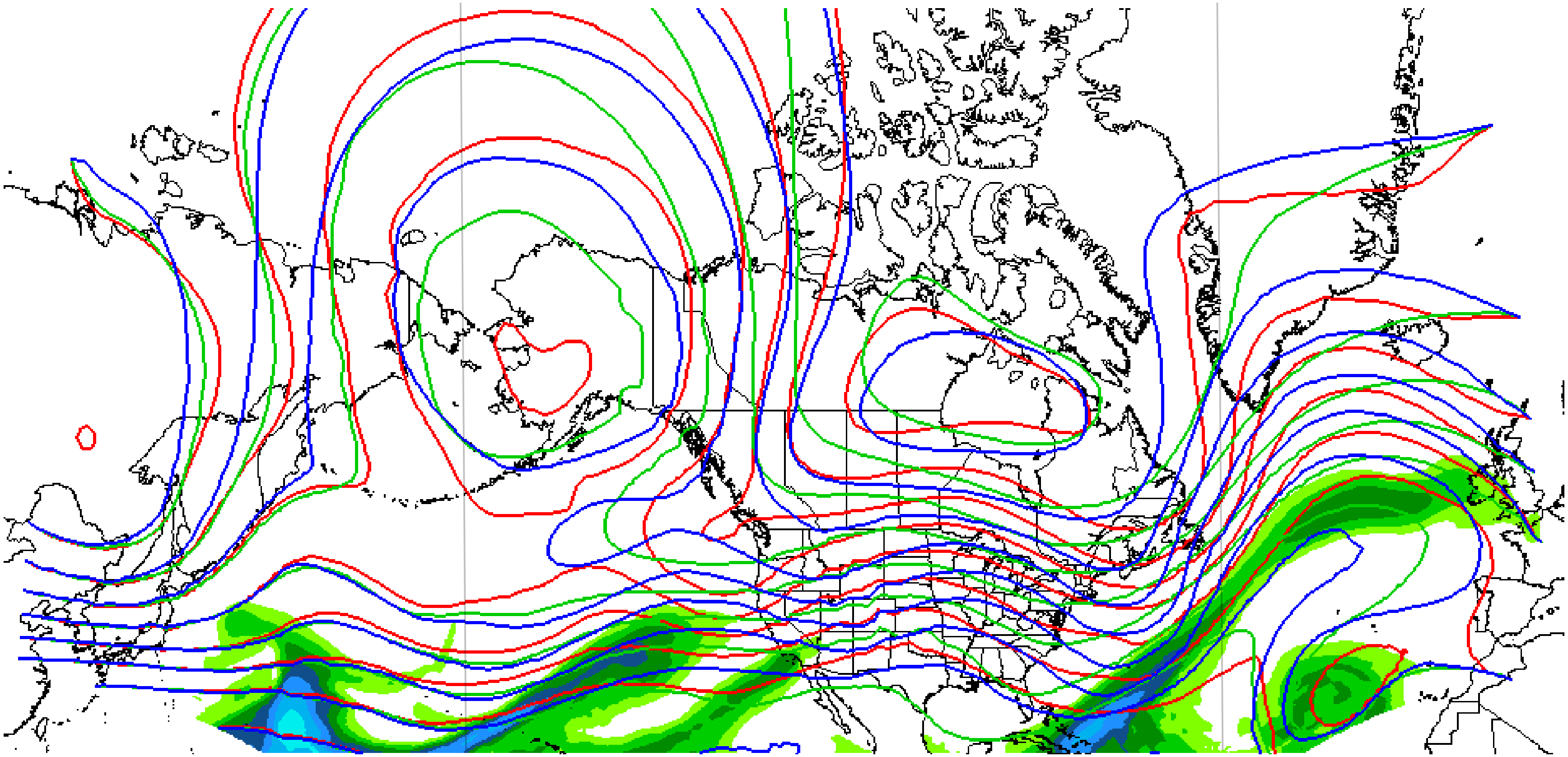
20 25 30 35 40 45 50 55

72 hr forecast

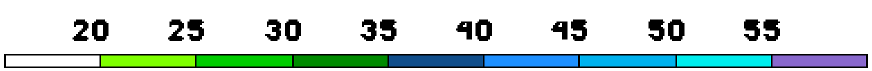
Case Study

1mp, 3mp, 5mp

Valid 2017-01-10 00z

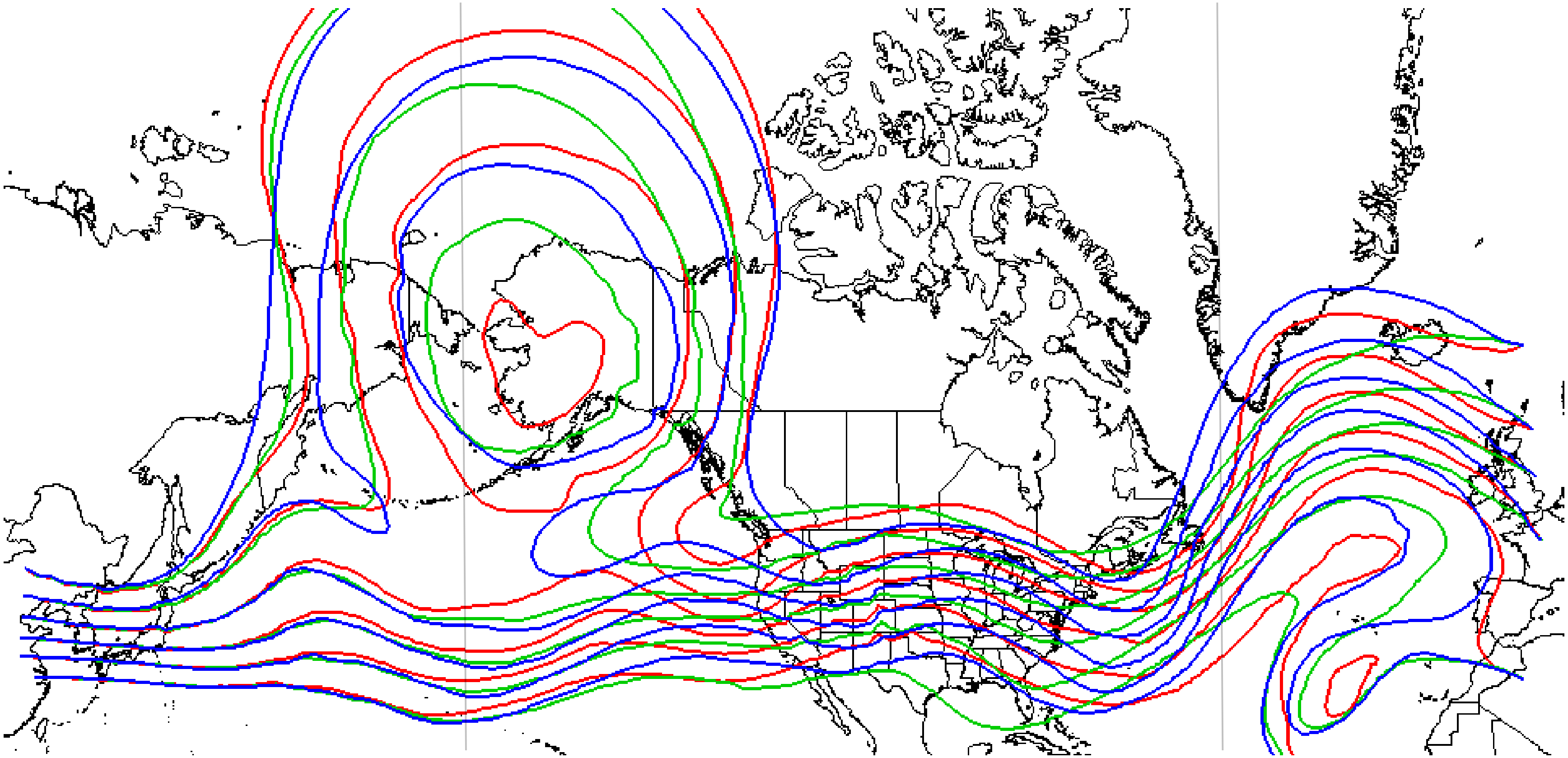


Precipitable Water (mm) for 3 MP Package



120 hr forecast

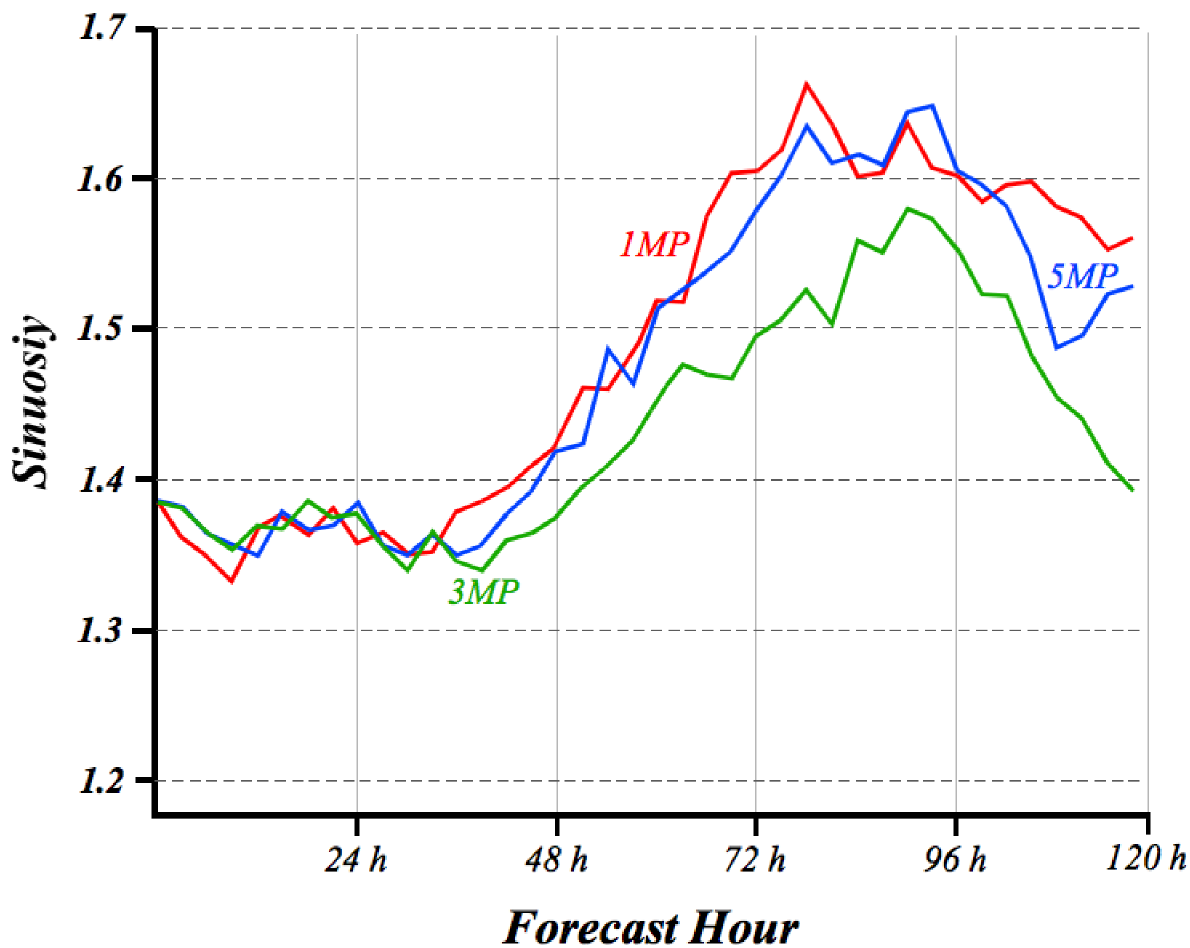
Case Study



Heights 11250m-12150m by 180m

Case Study

Aggregate Sinuosity



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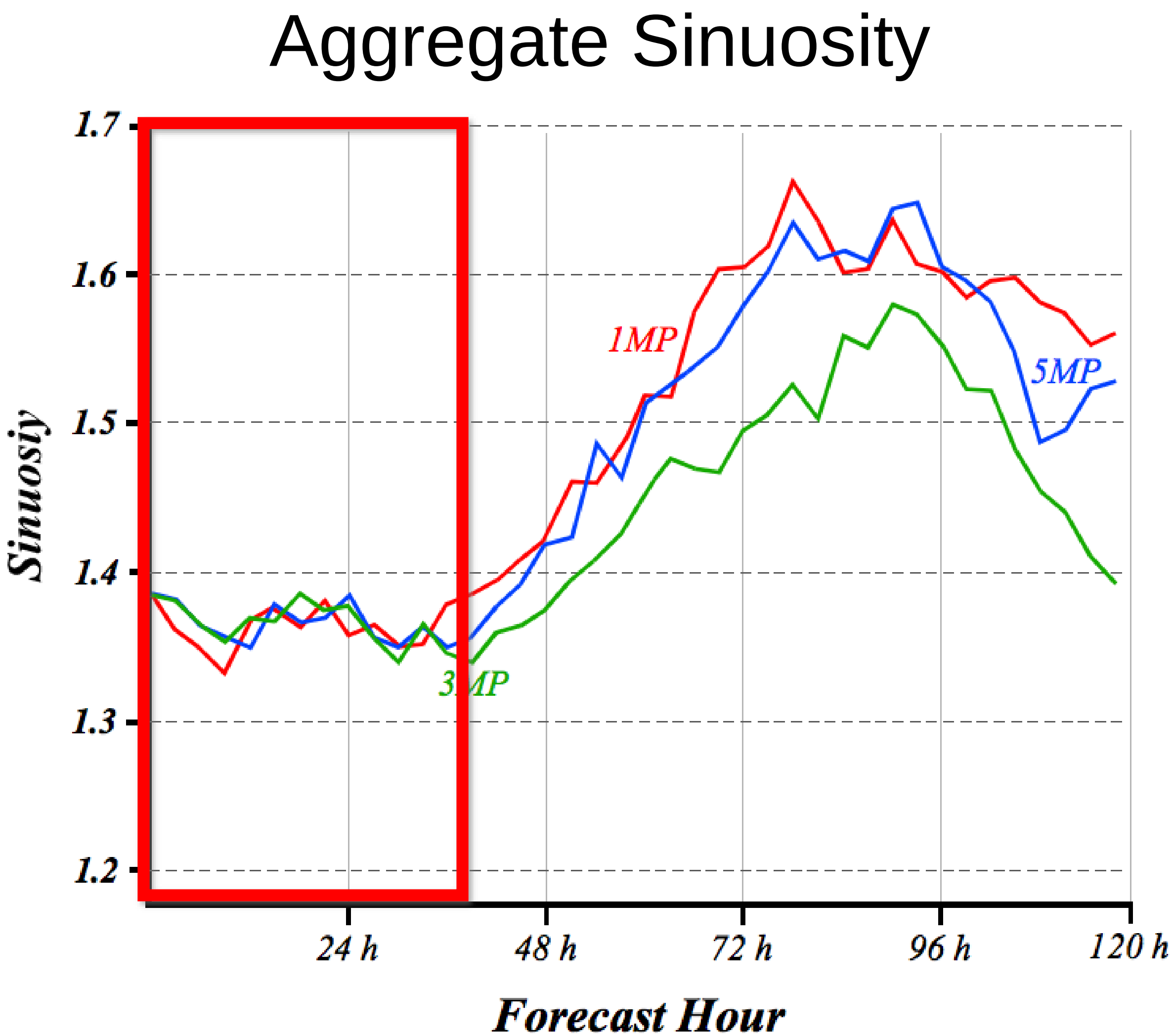
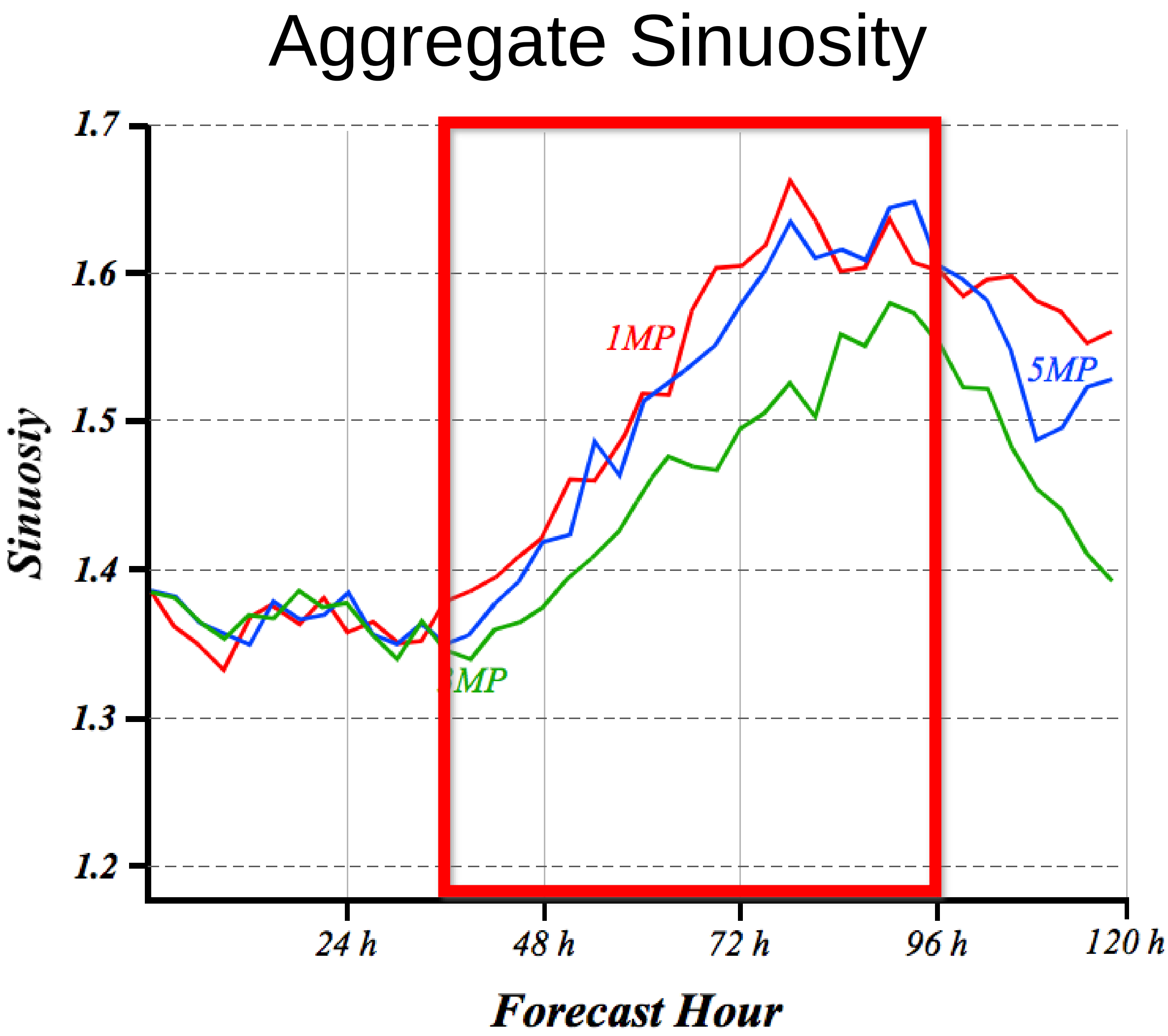

Aggregate Sinuosity
1.7
1.6
1.5
1.4
1.3
1.2
Sinuosity
1MP
5MP
3MP
24 h
48 h
72 h
96 h
120 h
Forecast Hour

Case Study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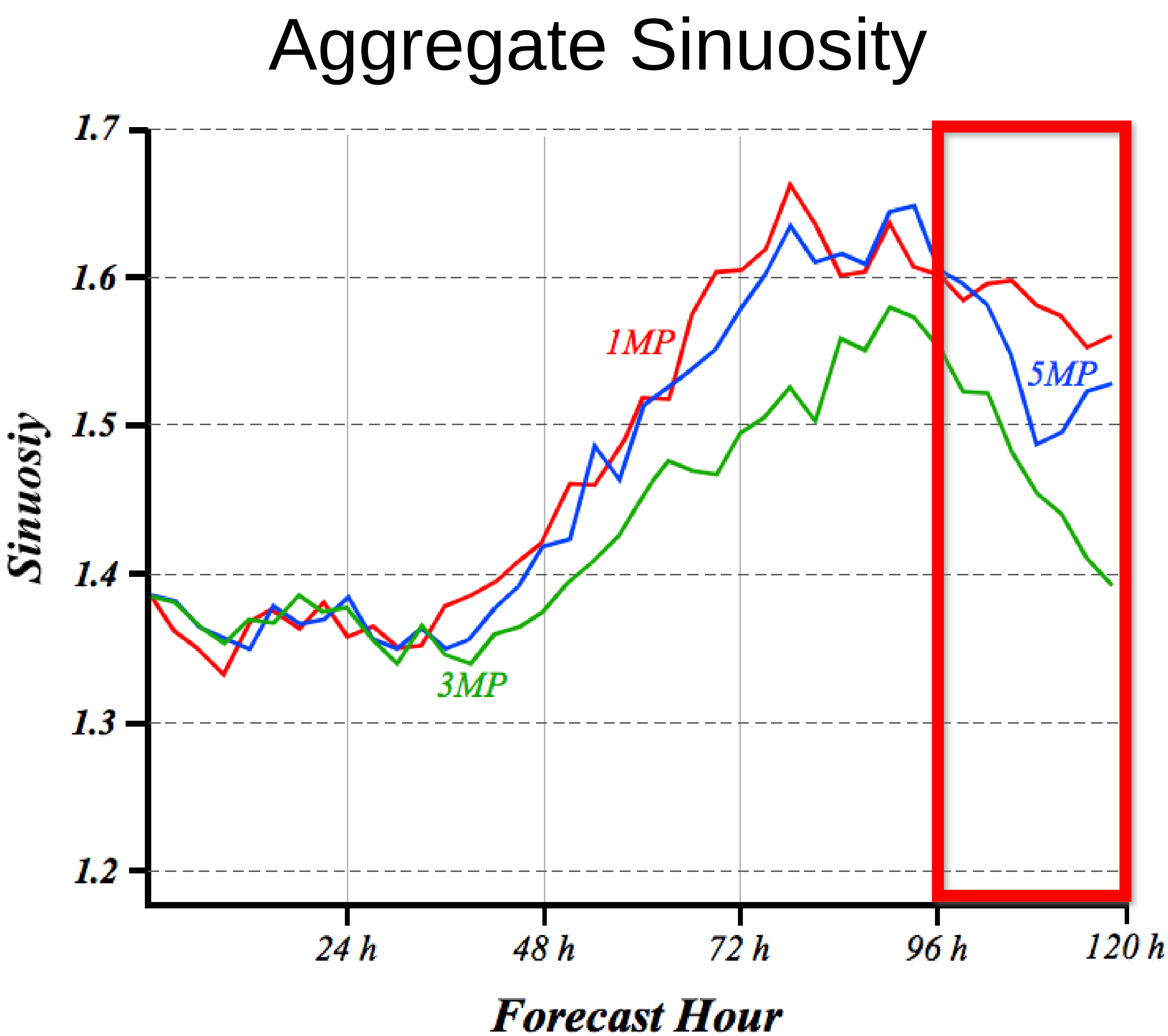
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Conclusions and Future Work

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- Which phenomena have the largest downstream impacts on the waviness differences?
  - Atmospheric Rivers
  - Strong cyclogenesis
  - Warm Conveyor Belts

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- Regional waviness appears sensitive to microphysics packages

- Expand to the entire Northern Hemisphere
- Which phenomena have the largest downstream impacts on the waviness differences?
  - Atmospheric Rivers
  - Strong cyclogenesis
  - Warm Conveyor Belts
- Begin looking at specific cases

Acknowledgements

- Dr. Jonathan Martin, Advisor
- Dr. Michael Morgan
- Martin and Morgan research groups

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Thank you!

NSF

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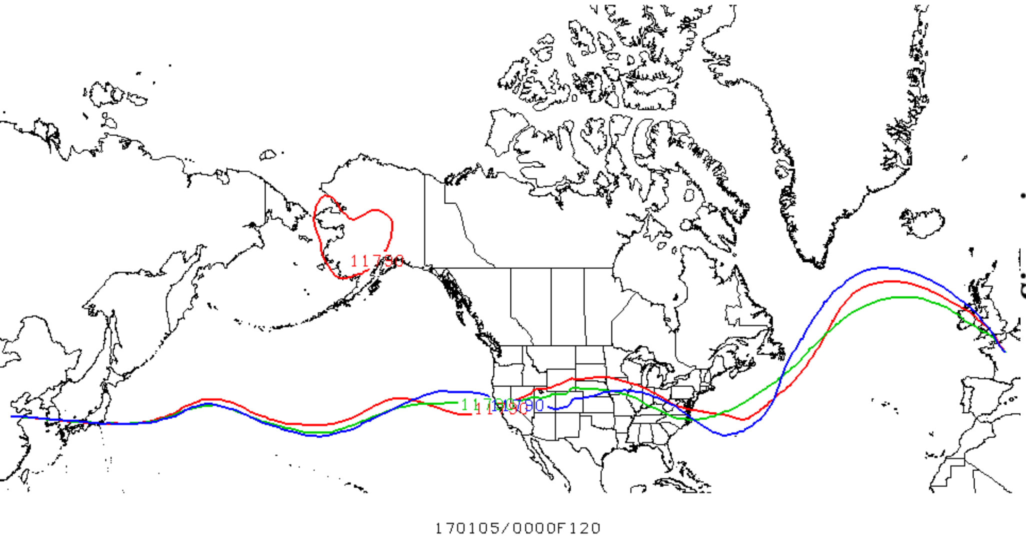
11790m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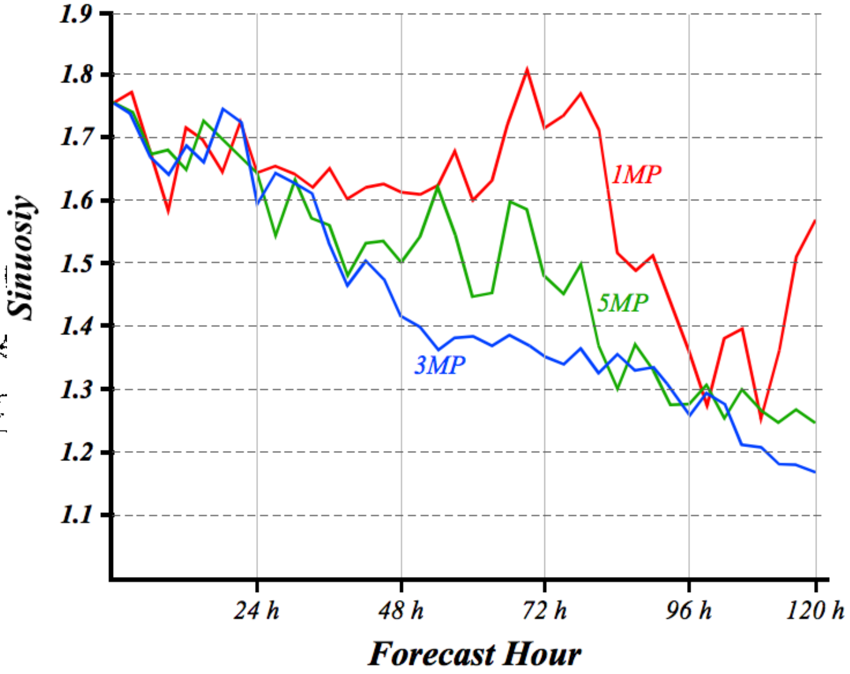
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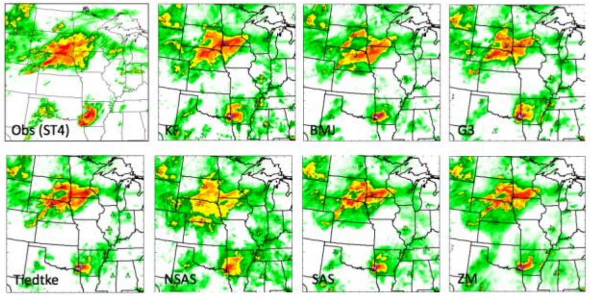
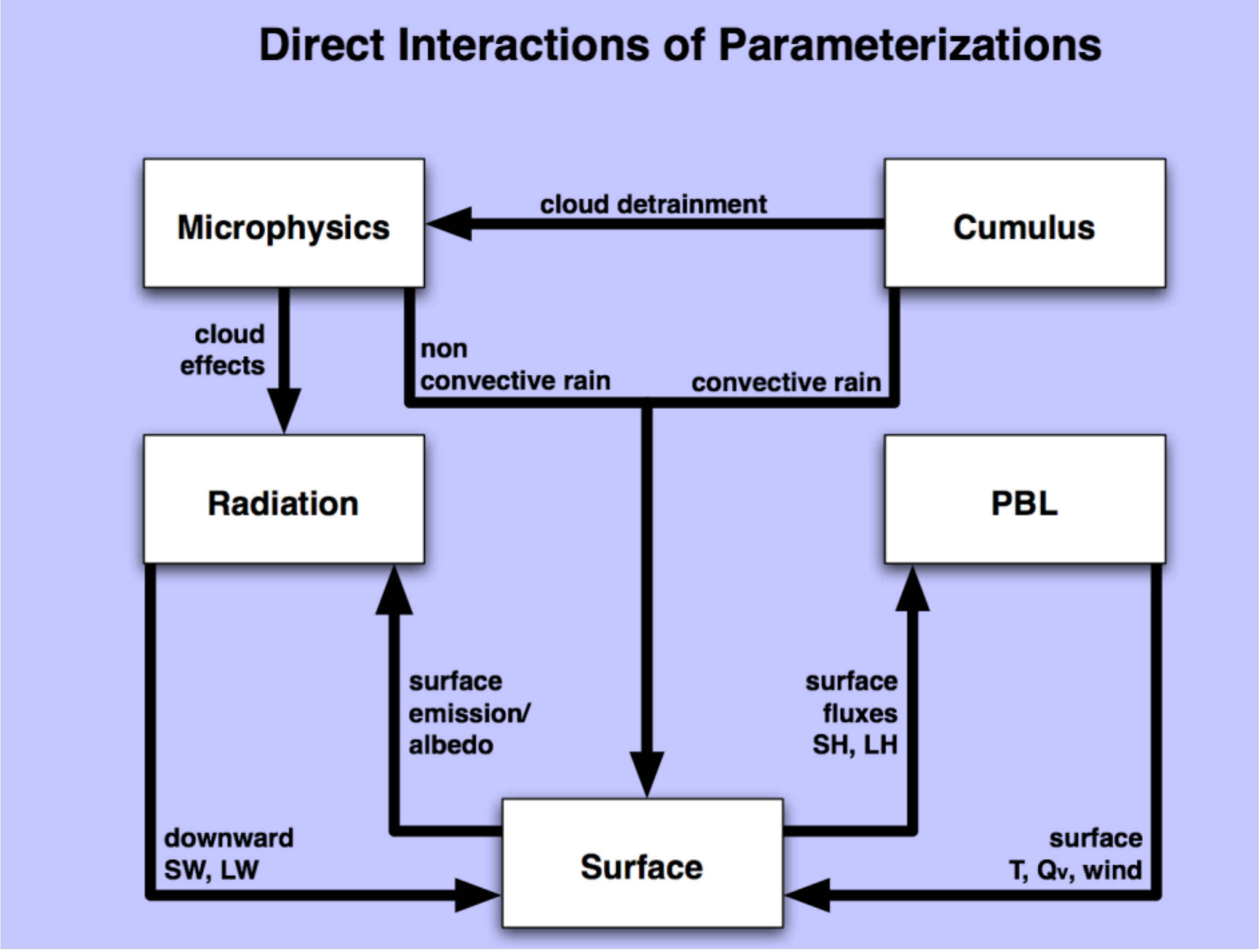
120 h
Forecast Hour

Cumulus Scheme 1



- Kain-Fritsch (KF)
  - Includes shallow convection
  - Low-level vertical motion in trigger function
  - CAPE removal time scale closure
  - Mass flux type with updrafts and downdrafts, entrainment and detrainment
  - Includes cloud, rain , ice and snow detrainment
  - Clouds persist over convective time scale
  - Used in MM5 and Eta/NAM ensemble
- Comparing all the packages, KF seems to be a good middle ground: 12 hour forecast above comparing

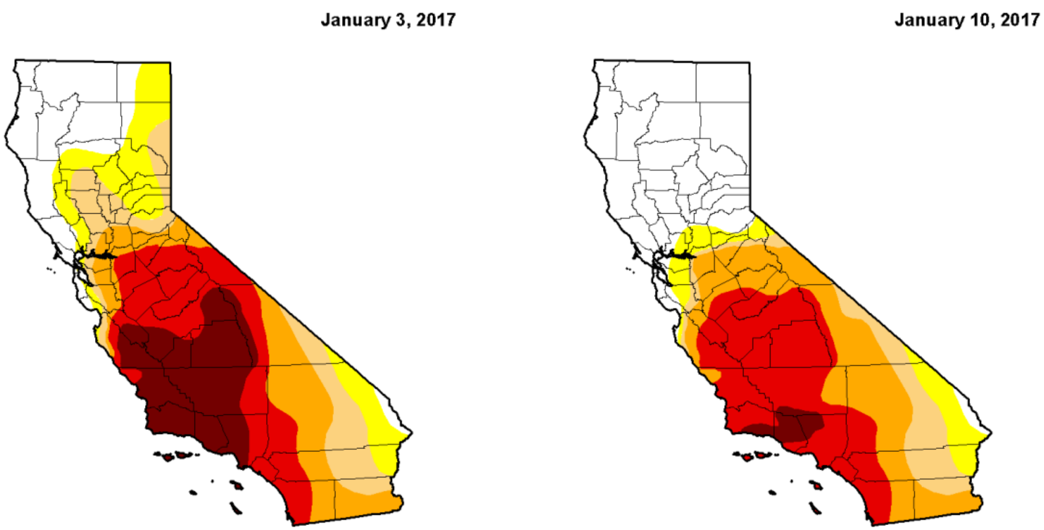
Effects of changing MP



- Source: http://www2.mmm.ucar.edu/wrf/users/workshops/WS2010/presentations/Lectures/Microphysics10.pdf

Case Study

- Floodingevent in California
- January 7-9, 2017



Week	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current 2017-01-10	34.62	65.38	58.22	49.22	27.80	2.13
Last Week 2017-01-03	18.07	81.93	67.61	54.02	38.17	18.31

Boundaries for Sinuosity