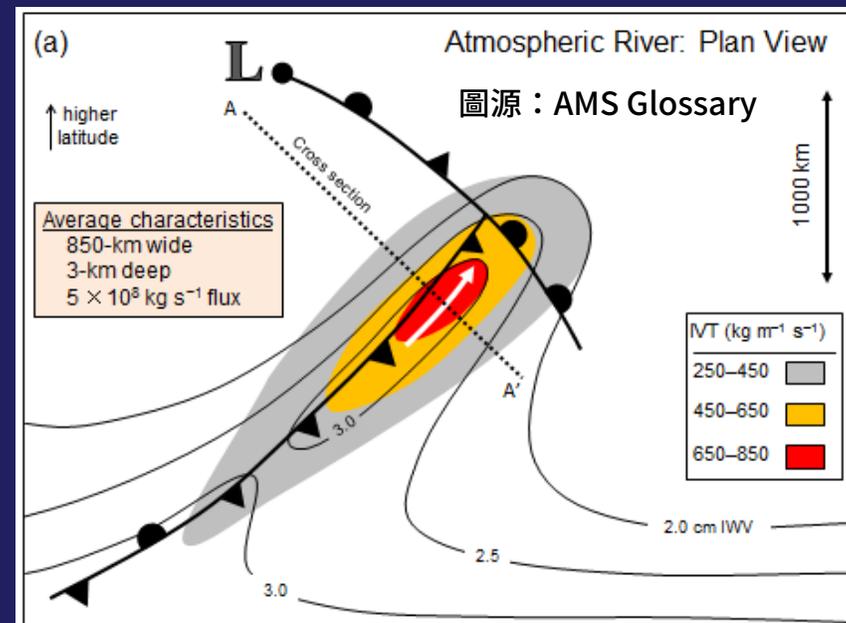


大氣河 ê 積溼動能 kah 收支概算



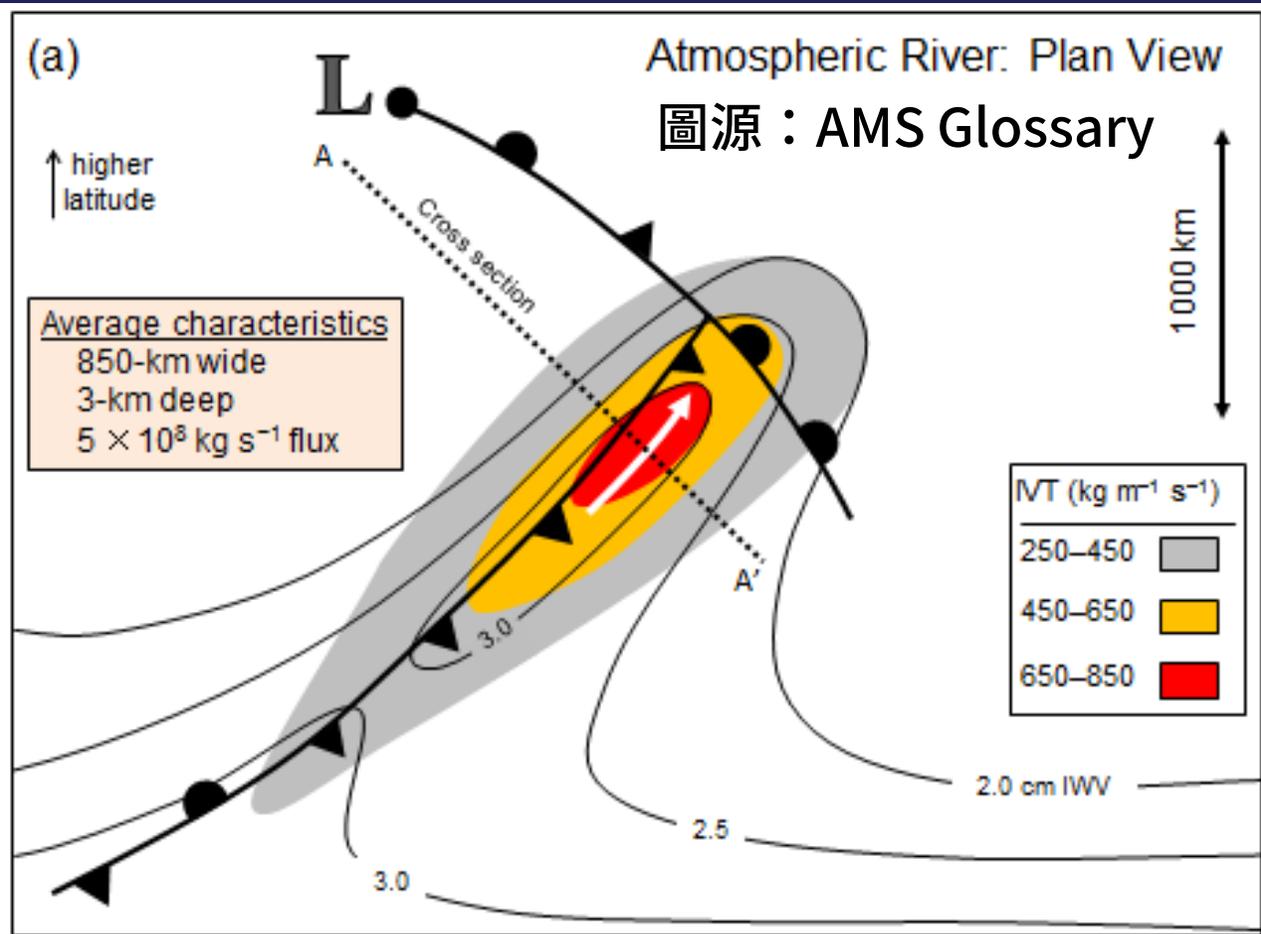
講者：Ông Hîng (王珩)

單位：University of California, Davis

合作者：Da Yang kah Paul Ullrich



大氣河



- 一港長長、狹狹、週期短短 ê 溼氣運輸
- 通常出現 tī 鋒面頭前 ê 低層 ê 大港氣流 (jet stream)
- 若拄着擲升機制予遮 ê 溼氣澹去 (saturated)，定造成摔大雨
- 中緯 (huī) 度大氣向極區 ê 溼氣運輸大部分攏是靠大氣河

解文說字：溼 kah 澹

溼 (sip)

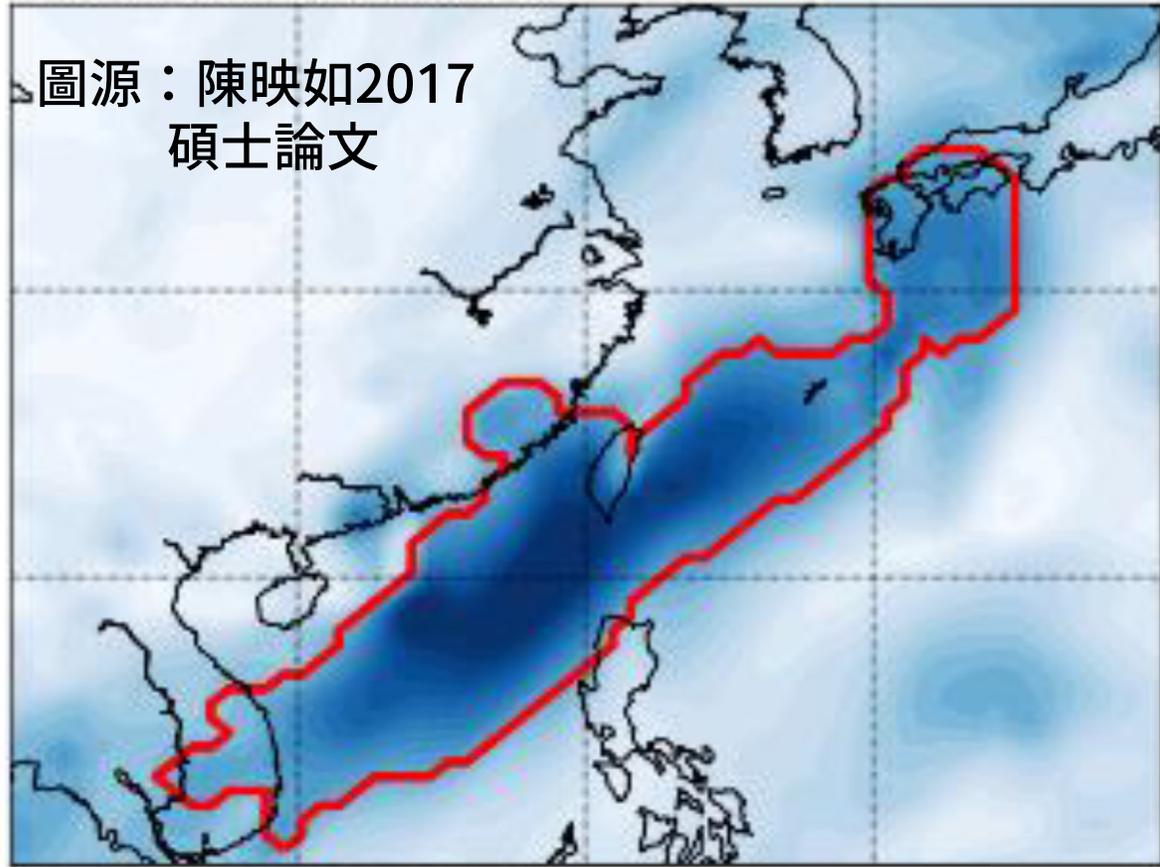
- Unsaturated
- 未飽和
- 面巾溼溼：
 - 面巾含水但是掙袂出水
- 空氣溼溼：
 - 空氣含水氣但是凝袂出水

澹 (tâm)

- Saturated
- 飽和
- 面巾澹澹：
 - 面巾掙會出水
- 空氣澹澹：
 - 空氣凝會出雲、霧或露

大氣河對台灣 的 影響

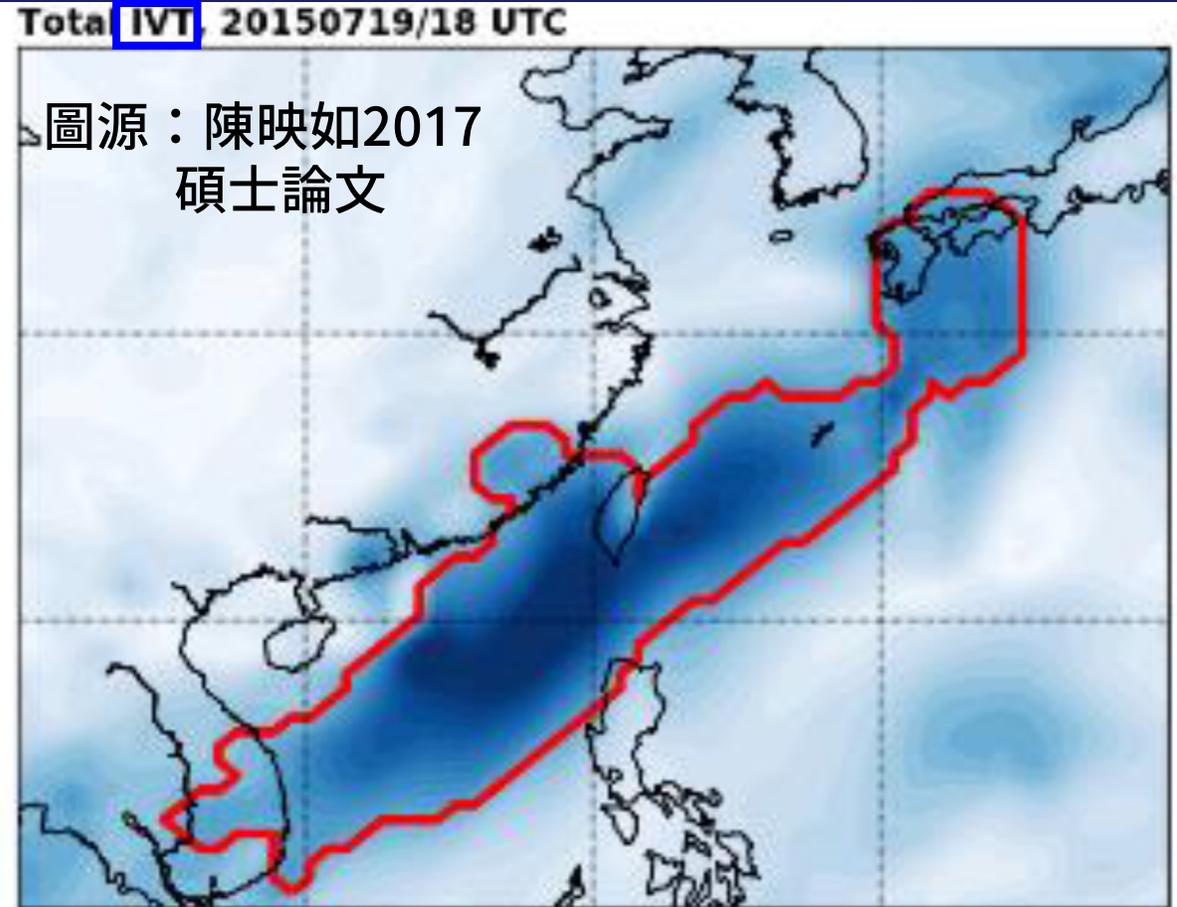
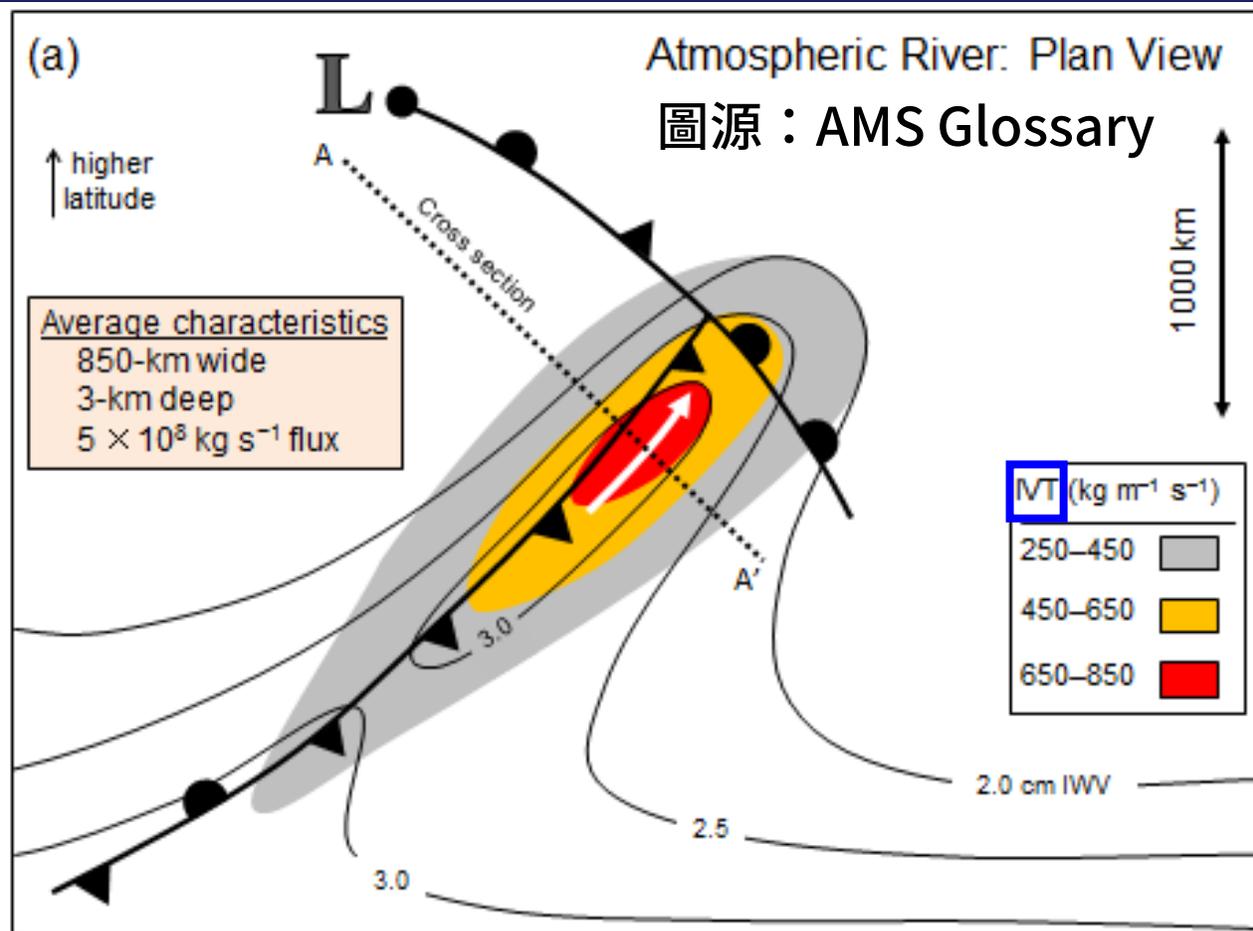
Total IVT, 20150719/18 UTC



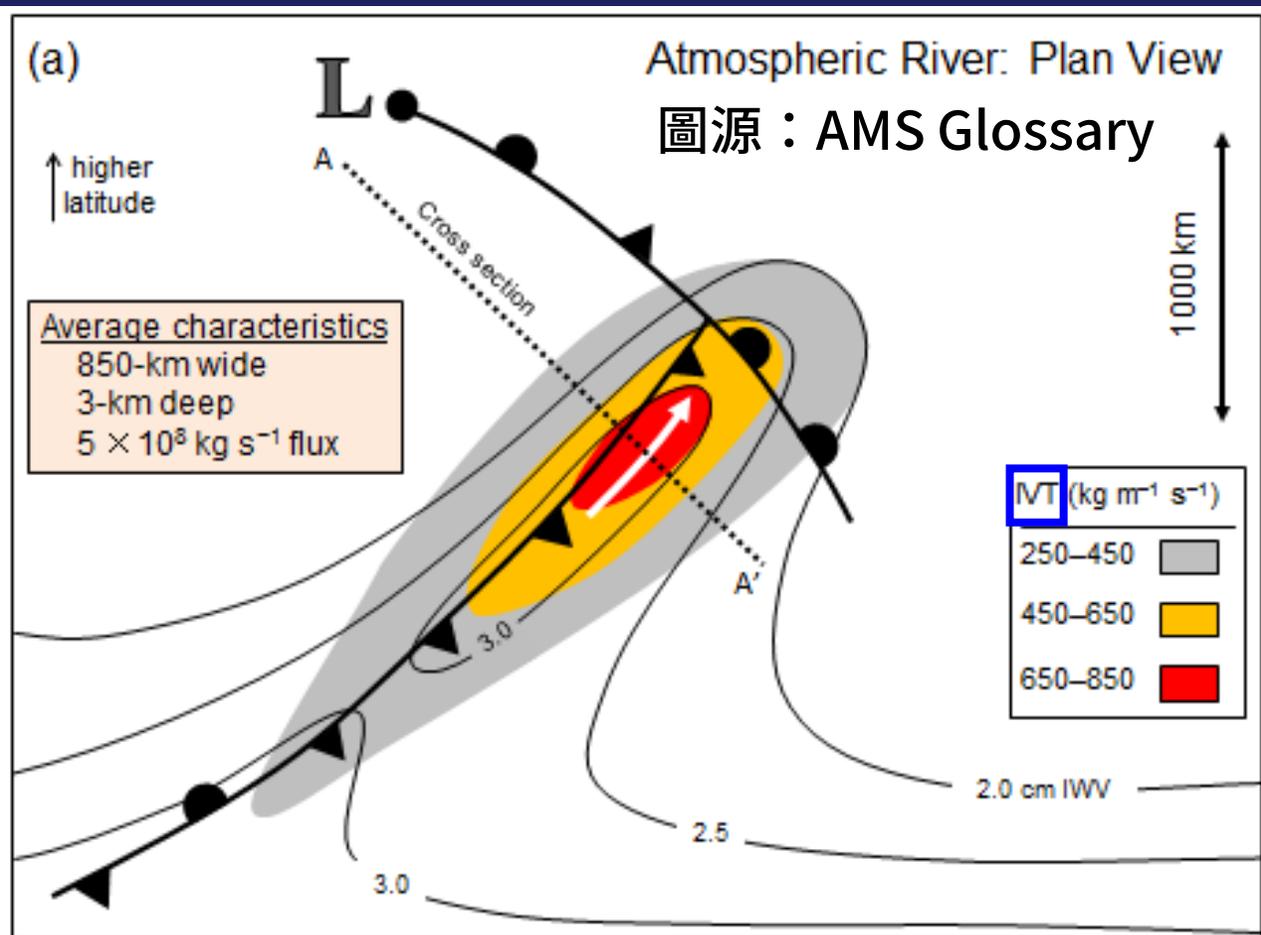
圖源：陳映如2017
碩士論文

- 黃酸雨季節 (五、六月) 的 豪大雨事件當中，七成有 大氣河 的 台灣頂頭 (前估率)
- 風颱季節 (七、八月) 台灣 頂頭有大氣河 的 日子當中， 六成有豪大雨 (後符率)

探測大氣河 ê 法度



探測大氣河 法度



• 現時法：

1. 計算積溼運輸 (Integrated Vapor Transport; IVT)
2. 用自動圖像辨識法搵出長長、狹狹 koh 大港 ê 大氣河

• 本研究針對第一步提出改良法，因為積溼運輸：

- 優：辨識大氣河真利便
- 缺：物理機制真係解說，到底嗰乜過程會改變積溼運輸？講袂清

探測大氣河 \hat{e} 法度

	現時法 (積溼運輸；IVT)	改良法(積溼動能；IVKE)
英文全稱	Integrated Vapor Transport	Integrated Vapor Kinetic Energy
數學算法		
計算成本		
探測效果		
預報方程		
收支分析		

中央會 koh 講兩條解文說字

探測大氣河 ê 法度：數學算法

- 積溼運輸：

$$\sqrt{\left(-\frac{1}{g} \int_{p_b}^{p_t} q u d p\right)^2 + \left(-\frac{1}{g} \int_{p_b}^{p_t} q v d p\right)^2}$$

- q ：比溼； u ：東西風速； v ：南北風速； p ：氣壓；

- p_b ：底層1000 hPa； p_t ：頂層300 hPa； g ：重力加速度

- 積溼動能：

$$-\frac{1}{g} \int_{p_b}^{p_t} q^2 \frac{u^2 + v^2}{2} d p$$

探測大氣河 \hat{e} 法度：數學算法

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探測大氣河 ê 法度

	現時法 (積溼運輸 ; IVT)	改良法(積溼動能 ; IVKE)
英文全稱	Integrated Vapor Transport	Integrated Vapor Kinetic Energy
數學算法	$\sqrt{\left(-\frac{1}{g} \int_{p_b}^{p_t} qu dp\right)^2 + \left(-\frac{1}{g} \int_{p_b}^{p_t} qv dp\right)^2}$	$-\frac{1}{g} \int_{p_b}^{p_t} q^2 \frac{u^2 + v^2}{2} dp$
計算成本		
探測效果		
預報方程		
收支分析		

探測大氣河之制度：成本效果

- 為着試驗這兩款探測法之效果，阮先揣一組資料：
 - 已經有前輩用這組來試驗大氣河探測法(McClenny et al. 2020)
 - 是一組四年之『水球模擬』(假想一粒干焦有海無土地之地球)
 - CAM5模式，橫向解析度~0.5度，每三點鐘一筆資料
- 自動圖像辨識法用全款--之 (TempestExtremes)
- 看這兩款探測法：
 - 是它一个成本較重？
 - 探測效果敢有爭差？

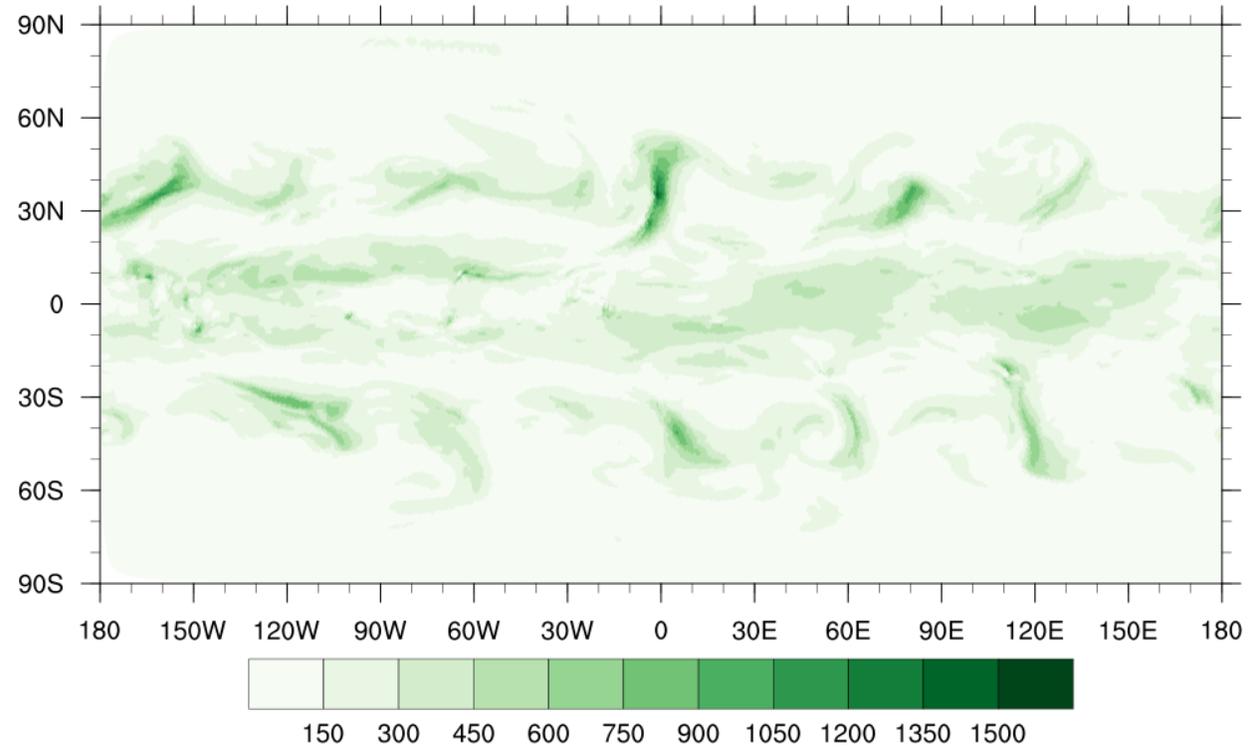
探測大氣河 \hat{e} 法度

	現時法 (積溼運輸；IVT)	改良法(積溼動能；IVKE)
英文全稱	Integrated Vapor Transport	Integrated Vapor Kinetic Energy
數學算法	$\sqrt{\left(-\frac{1}{g} \int_{p_b}^{p_t} q u dp\right)^2 + \left(-\frac{1}{g} \int_{p_b}^{p_t} q v dp\right)^2}$	$-\frac{1}{g} \int_{p_b}^{p_t} q^2 \frac{u^2 + v^2}{2} dp$
計算成本	100%	60%
探測效果		
預報方程		
收支分析		

366 Day

Integrated vapor transport

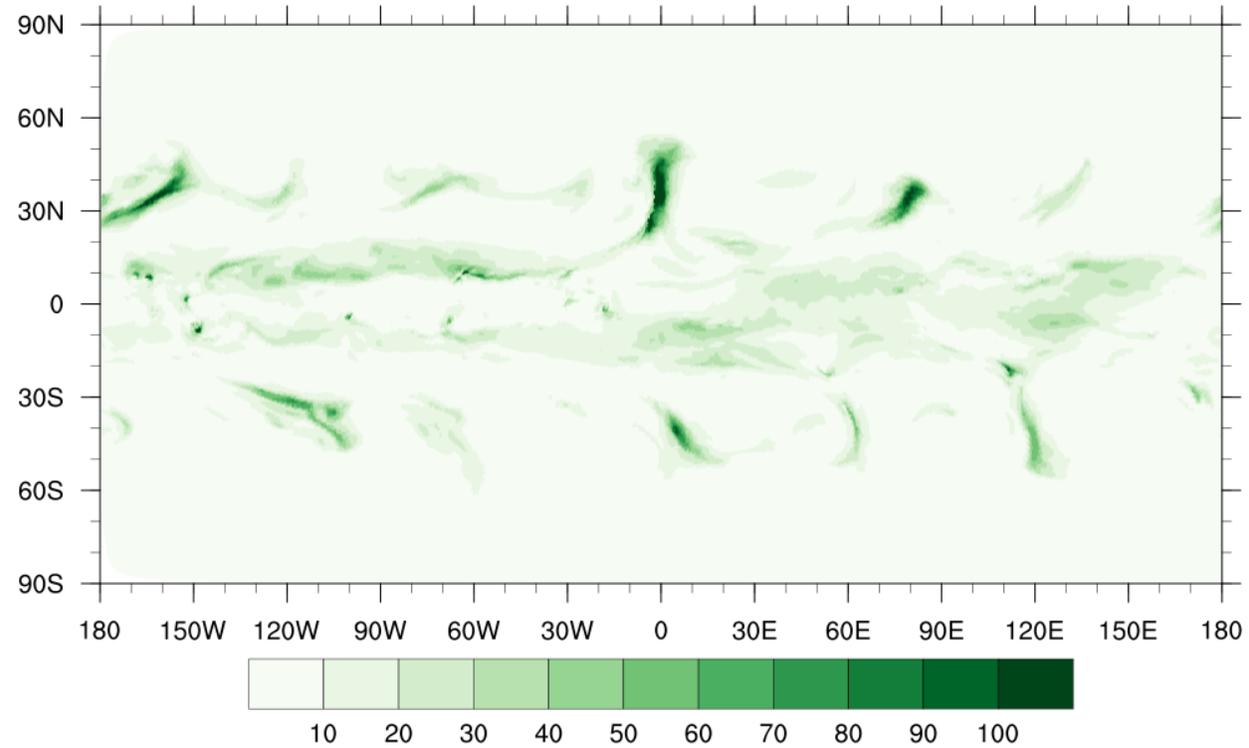
kg / m / s



366 Day

Integrated vapor kinetic energy

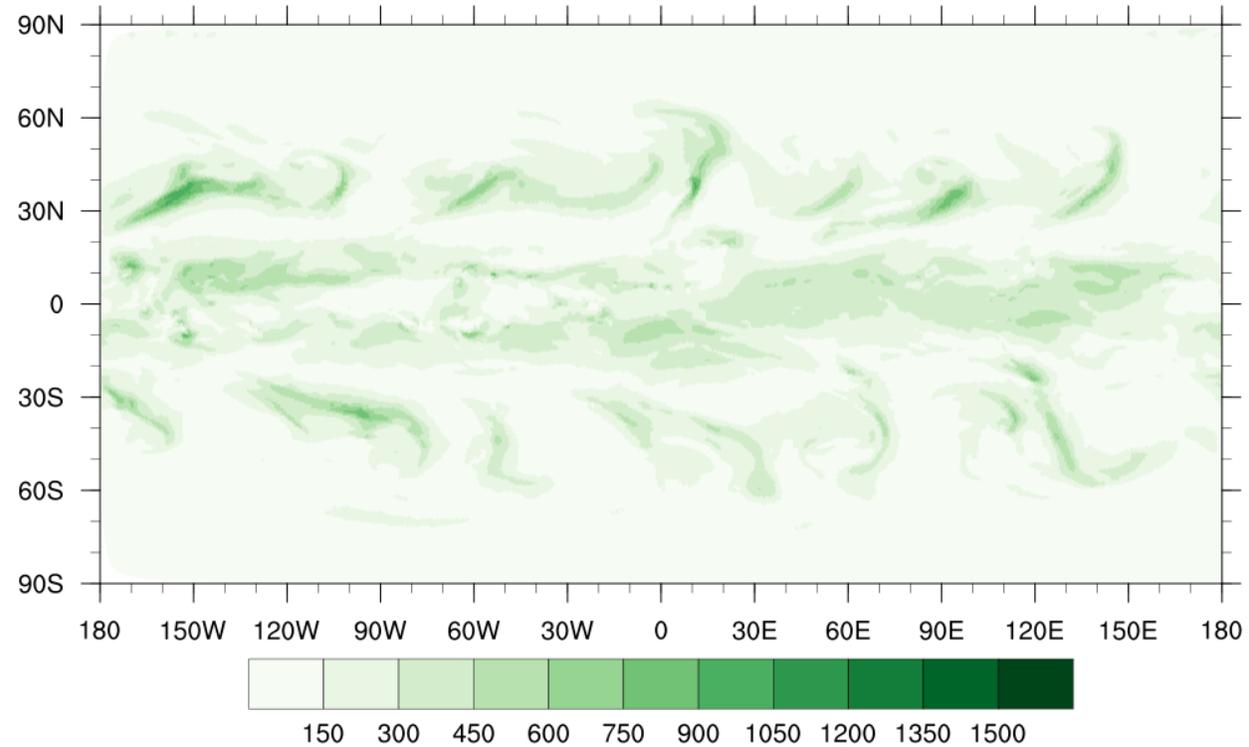
kg / s²



367 Day

Integrated vapor transport

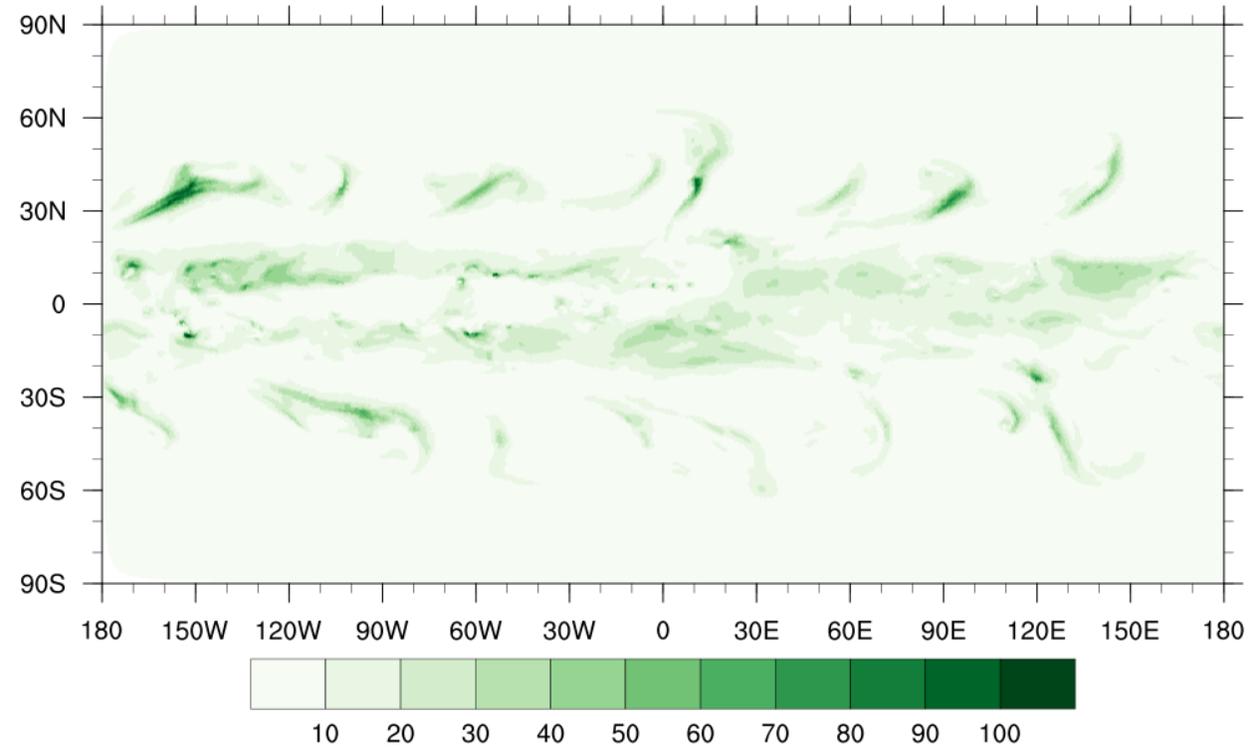
kg / m / s



367 Day

Integrated vapor kinetic energy

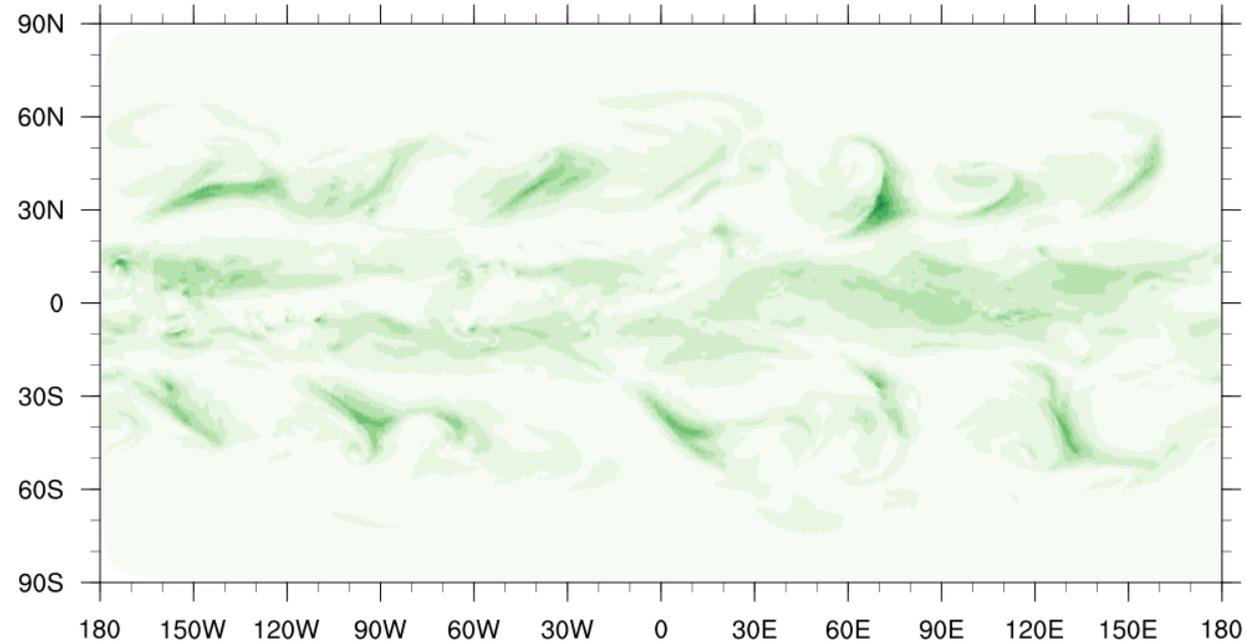
kg / s²



368 Day

Integrated vapor transport

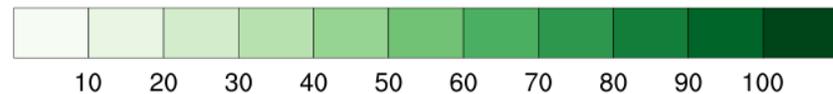
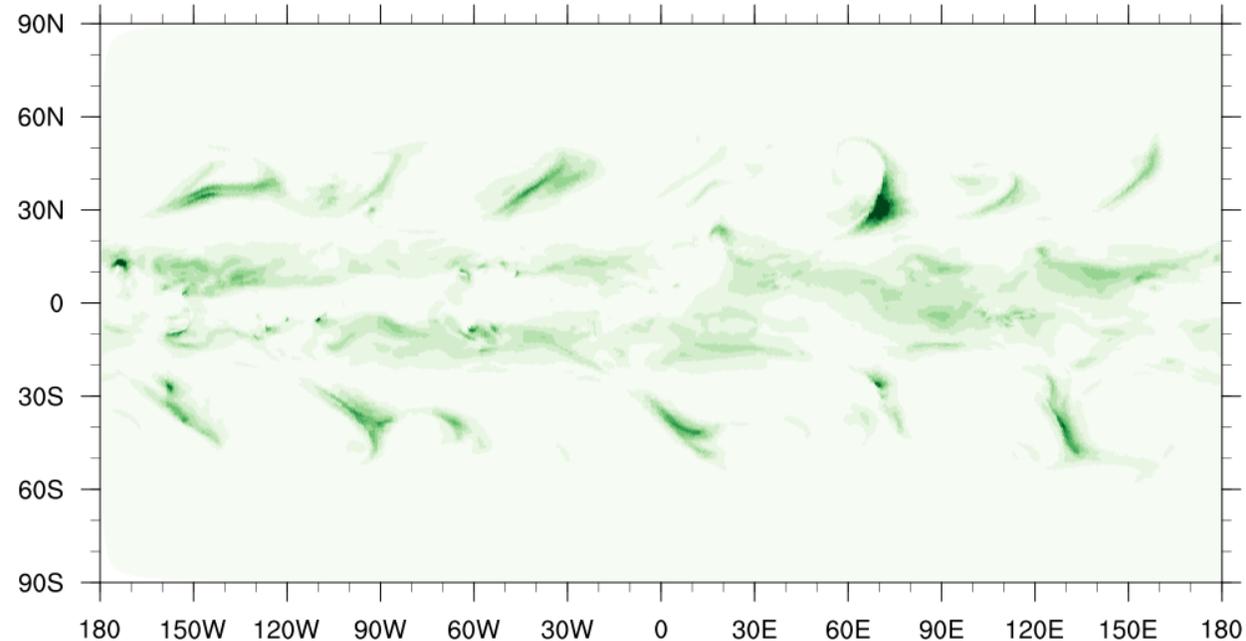
kg / m / s



368 Day

Integrated vapor kinetic energy

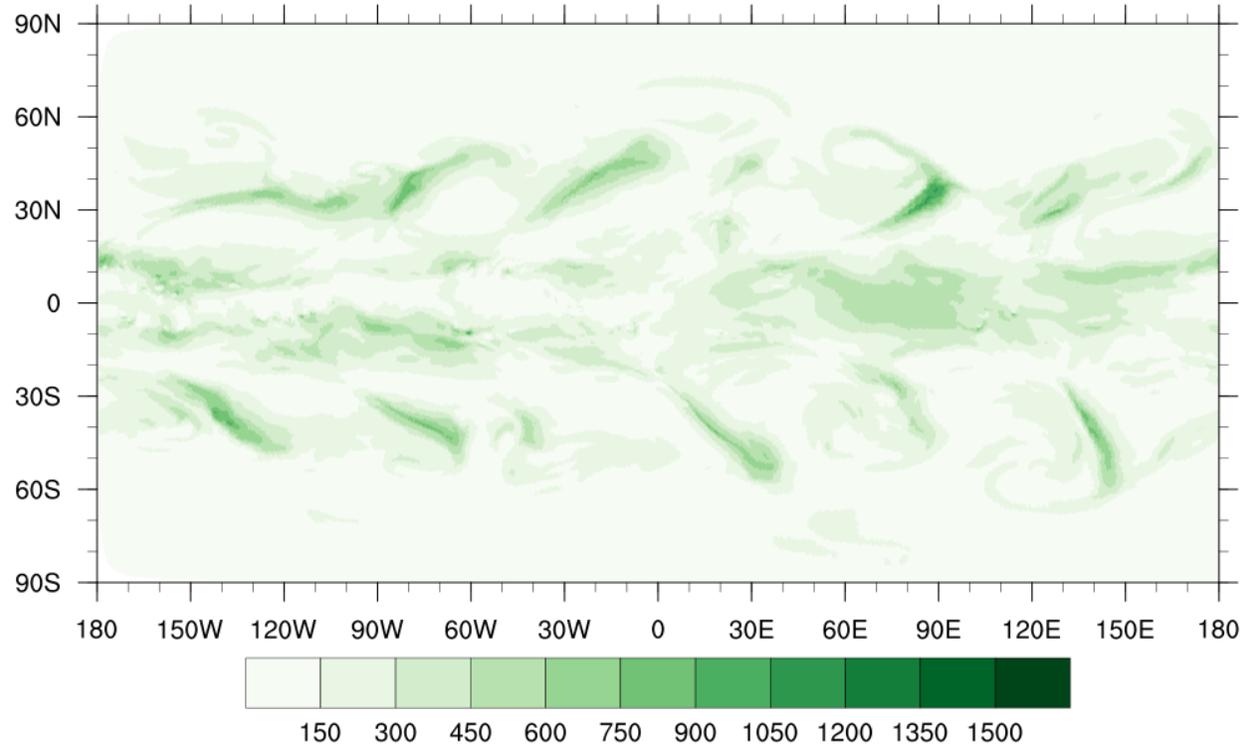
kg / s²



369 Day

Integrated vapor transport

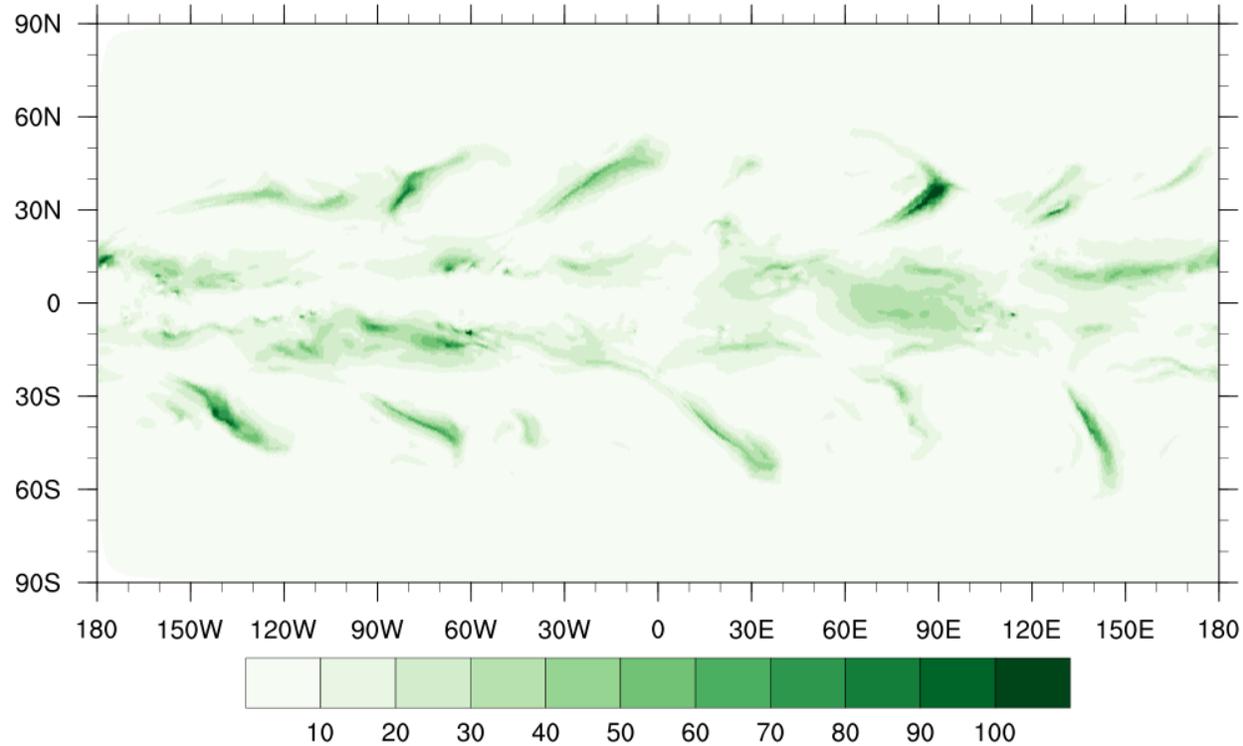
kg / m / s



369 Day

Integrated vapor kinetic energy

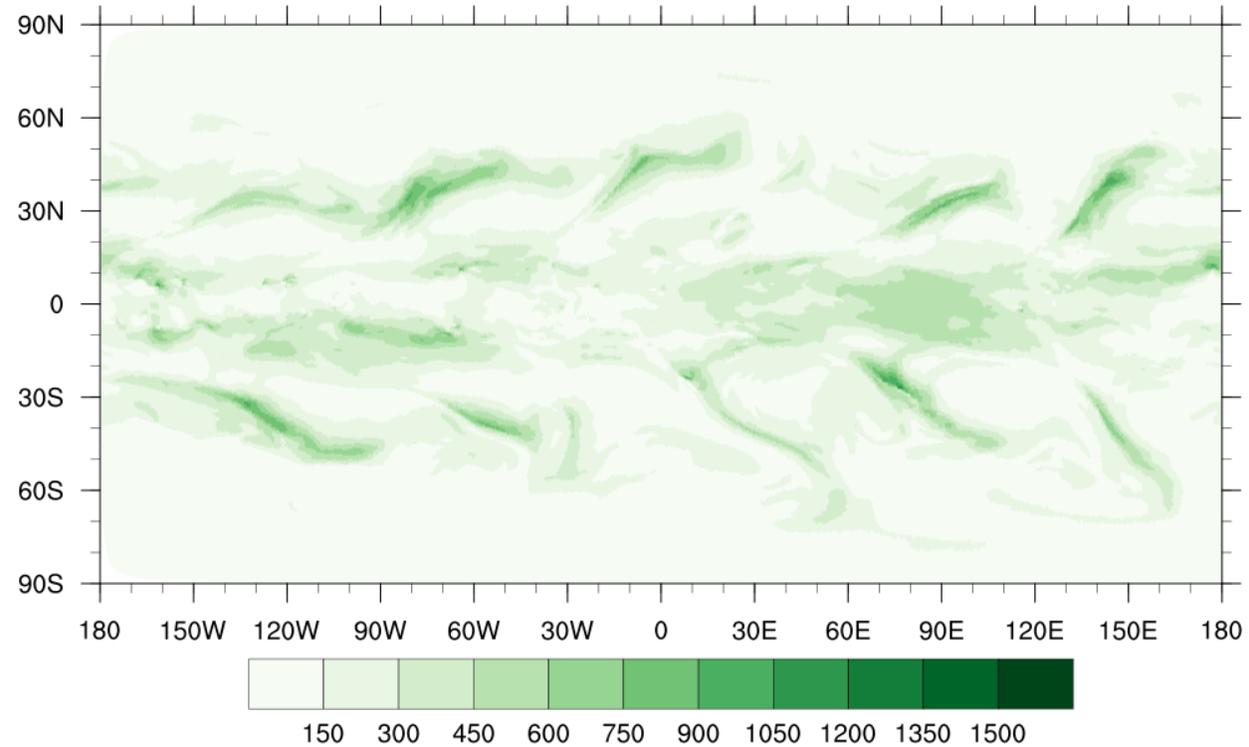
kg / s²



370 Day

Integrated vapor transport

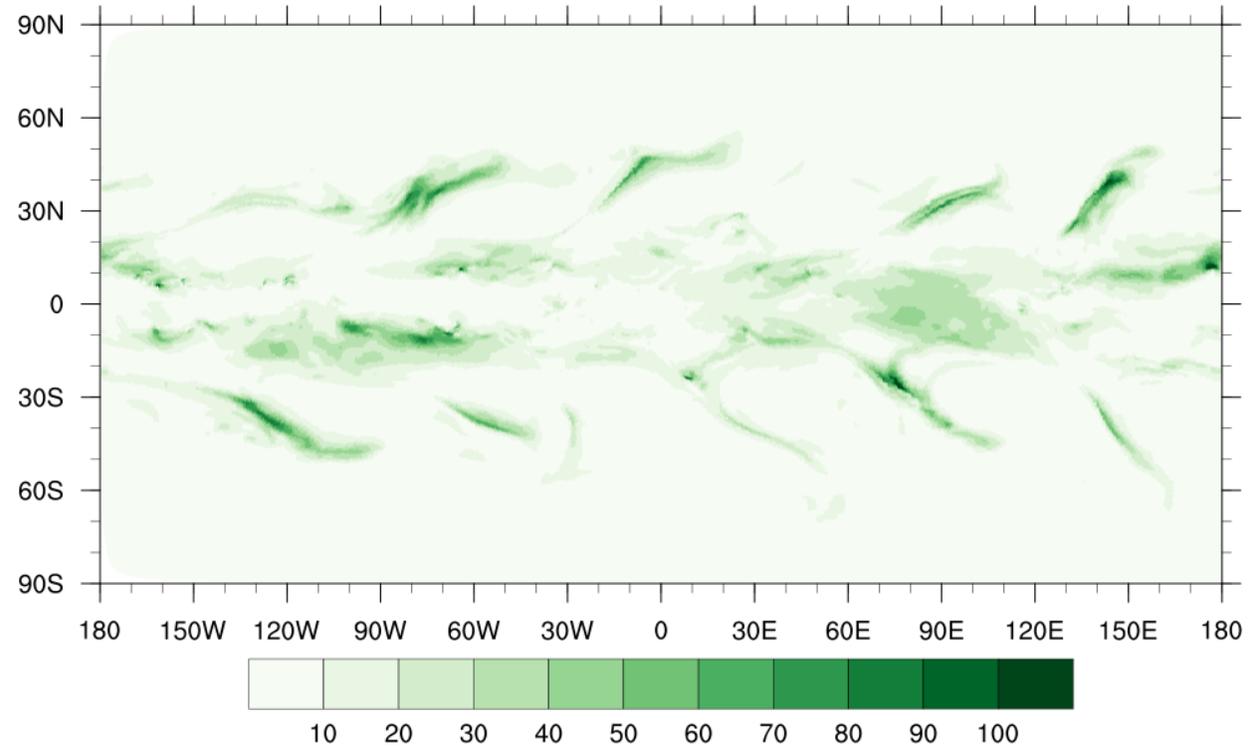
kg / m / s



370 Day

Integrated vapor kinetic energy

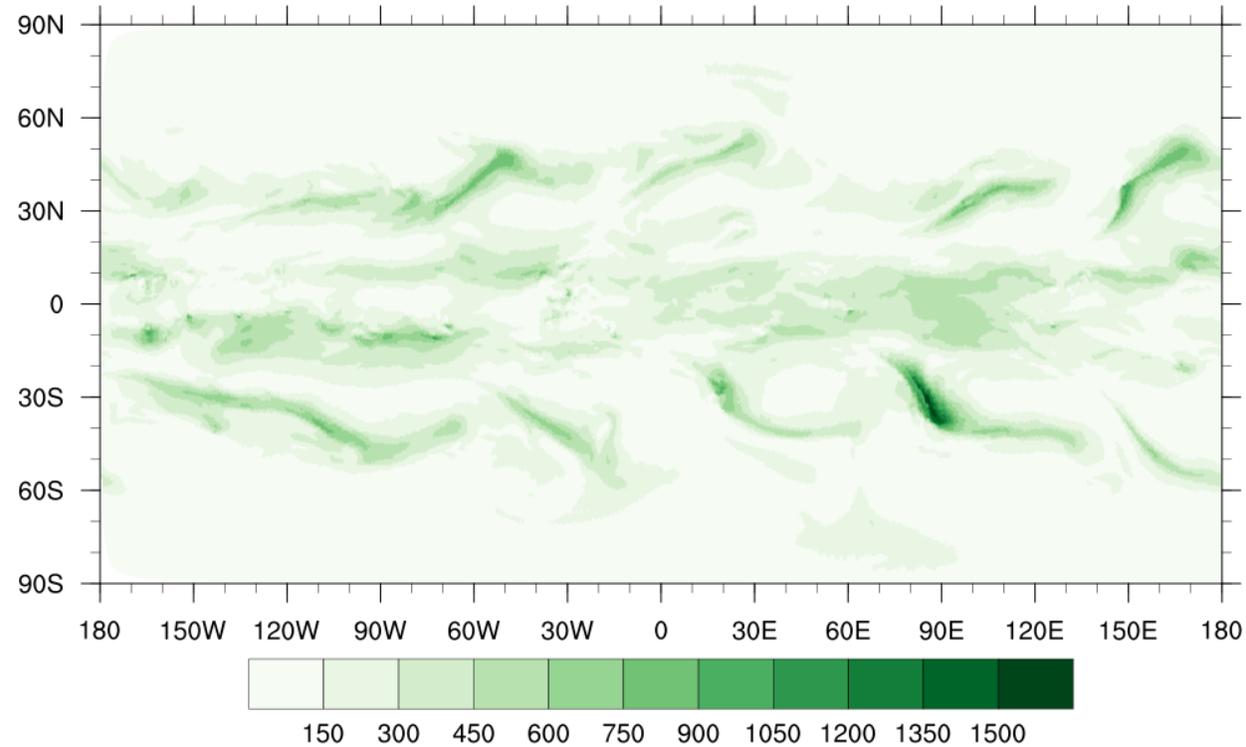
kg / s²



371 Day

Integrated vapor transport

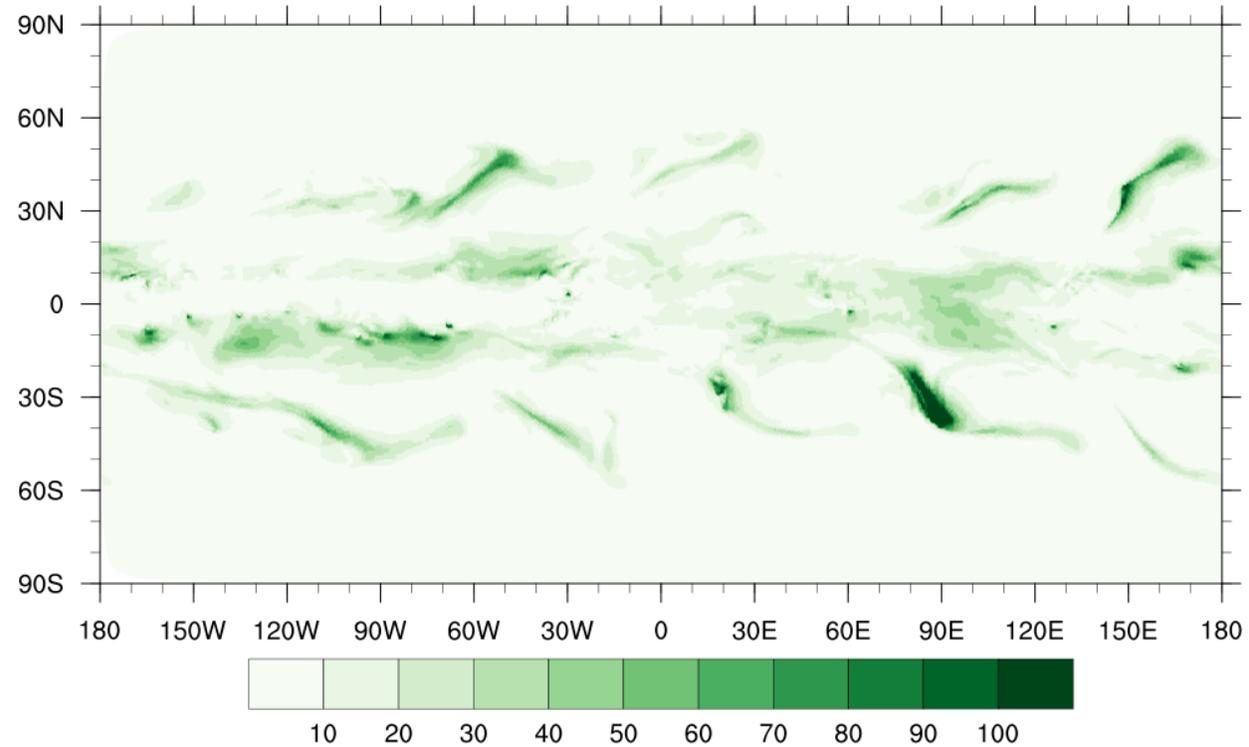
kg / m / s



371 Day

Integrated vapor kinetic energy

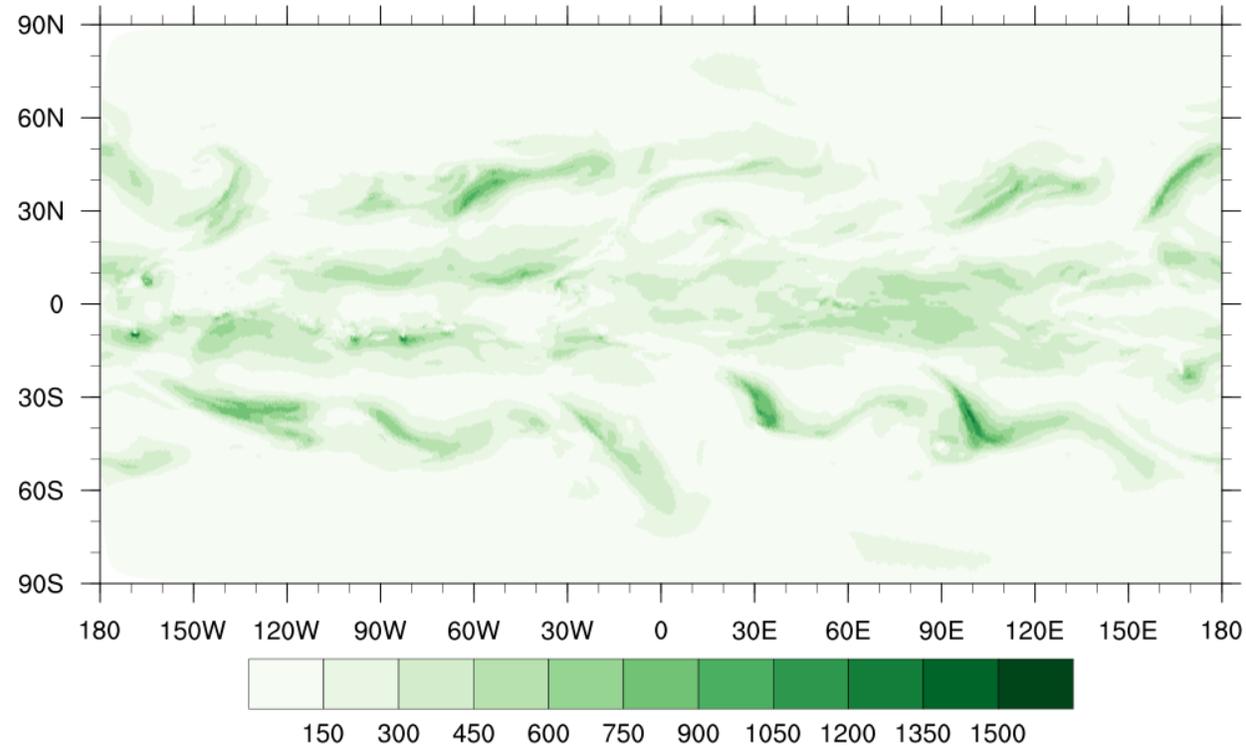
kg / s²



372 Day

Integrated vapor transport

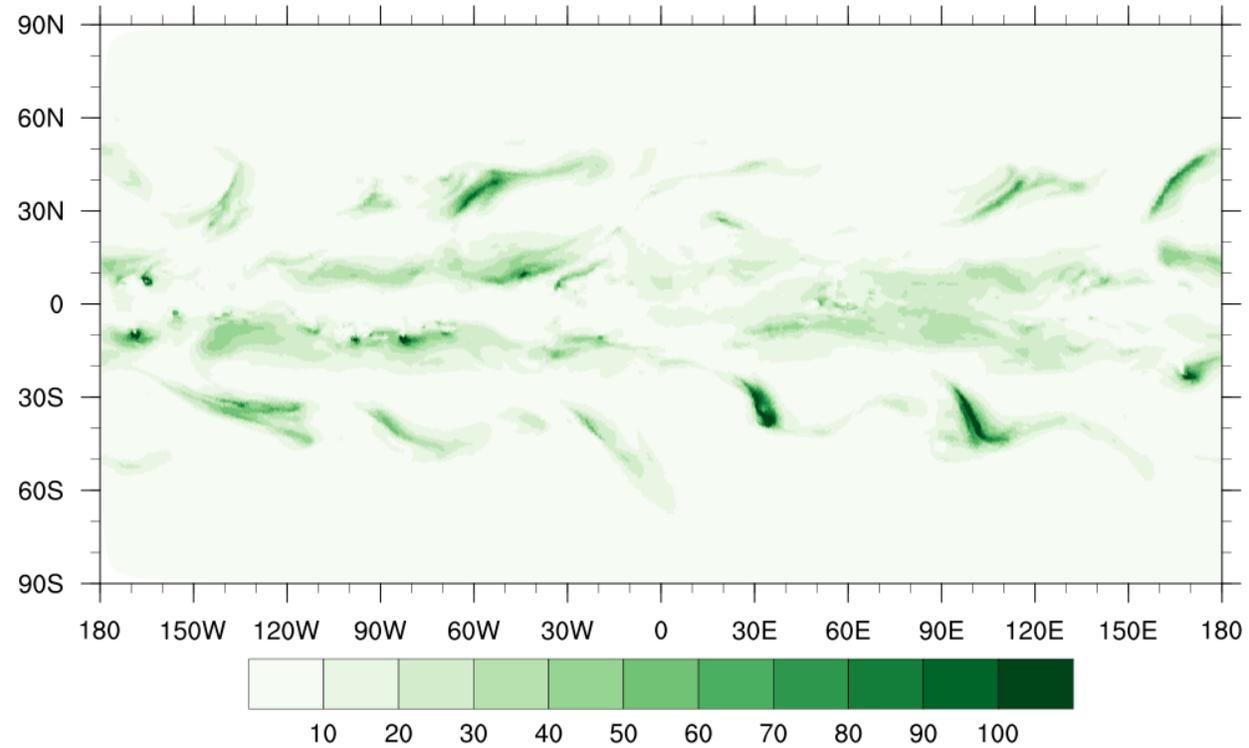
kg / m / s



372 Day

Integrated vapor kinetic energy

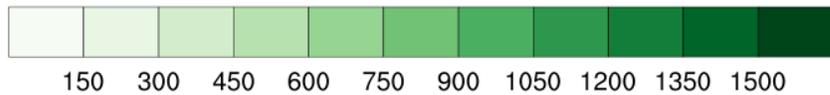
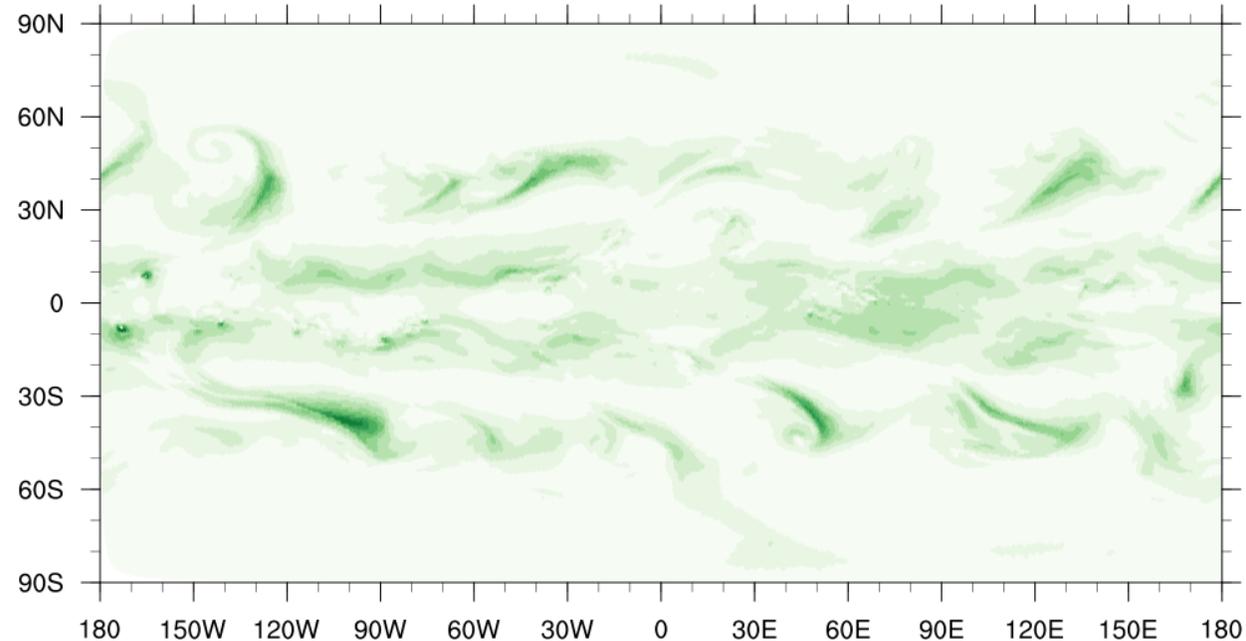
kg / s²



373 Day

Integrated vapor transport

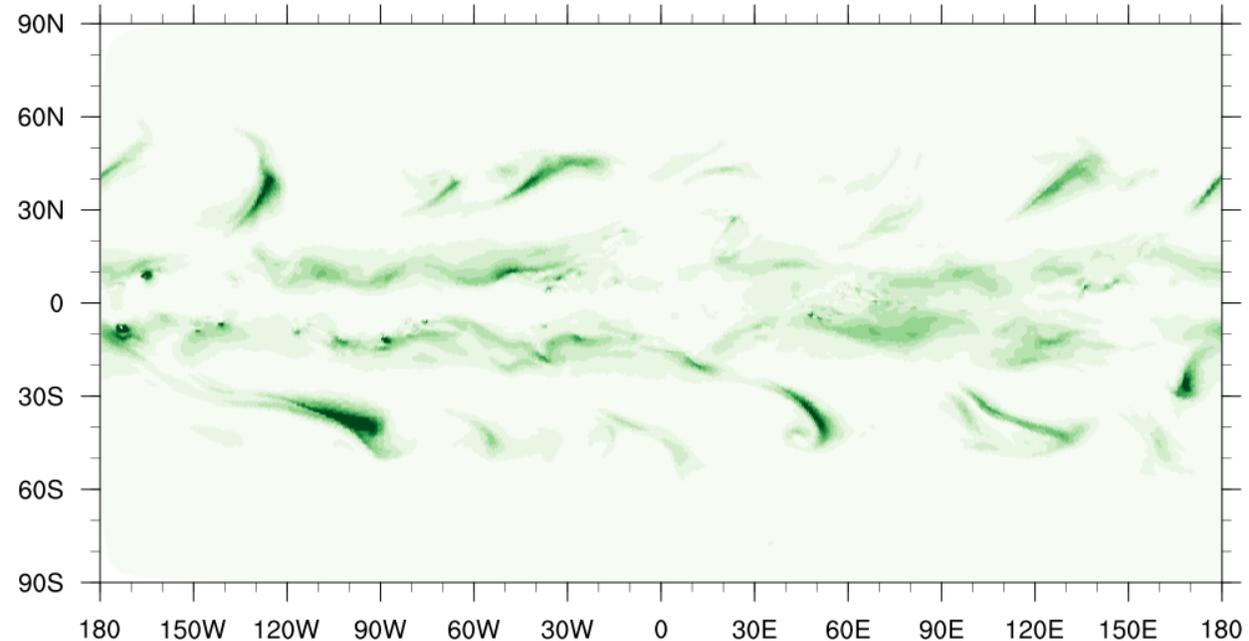
kg / m / s



373 Day

Integrated vapor kinetic energy

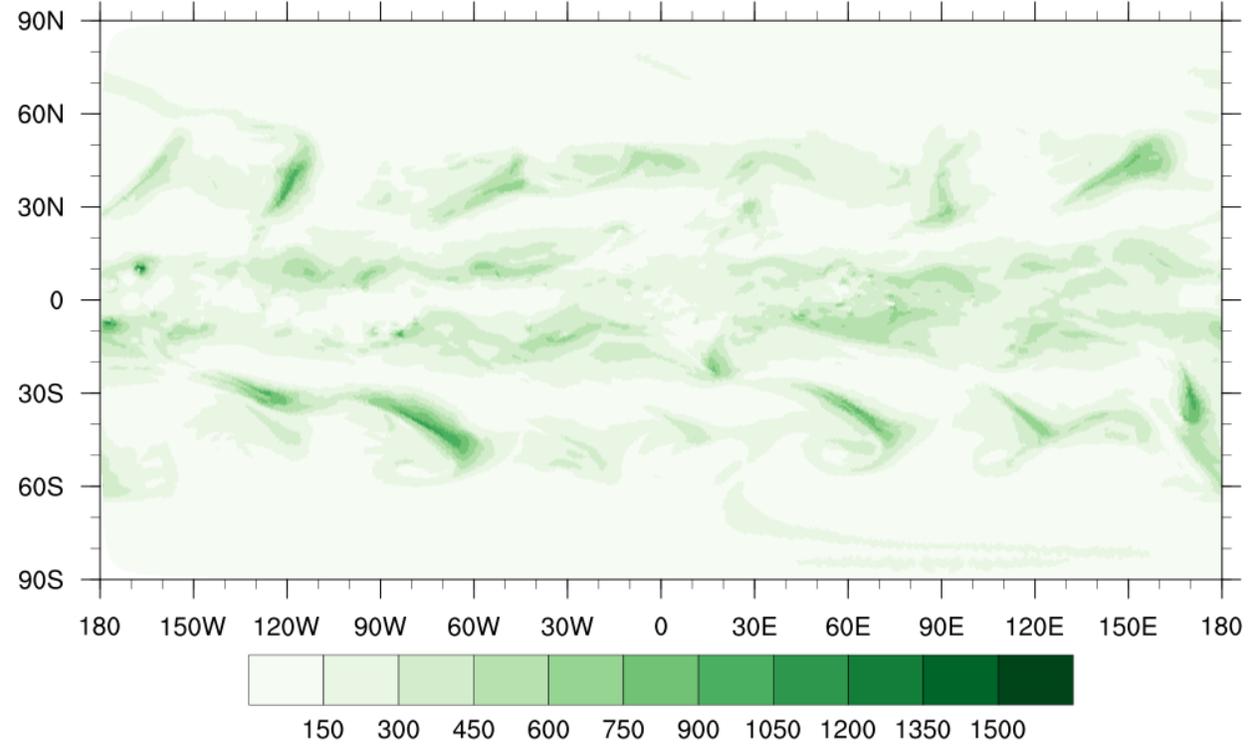
kg / s²



374 Day

Integrated vapor transport

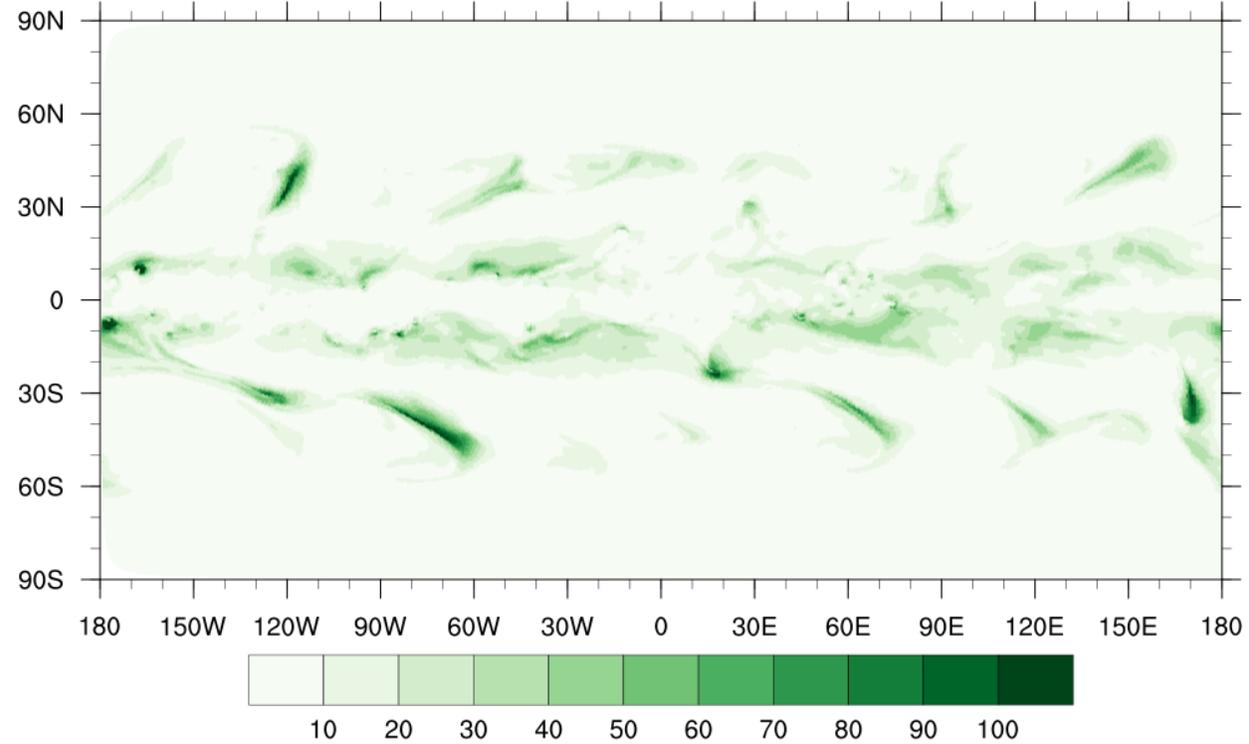
kg / m / s



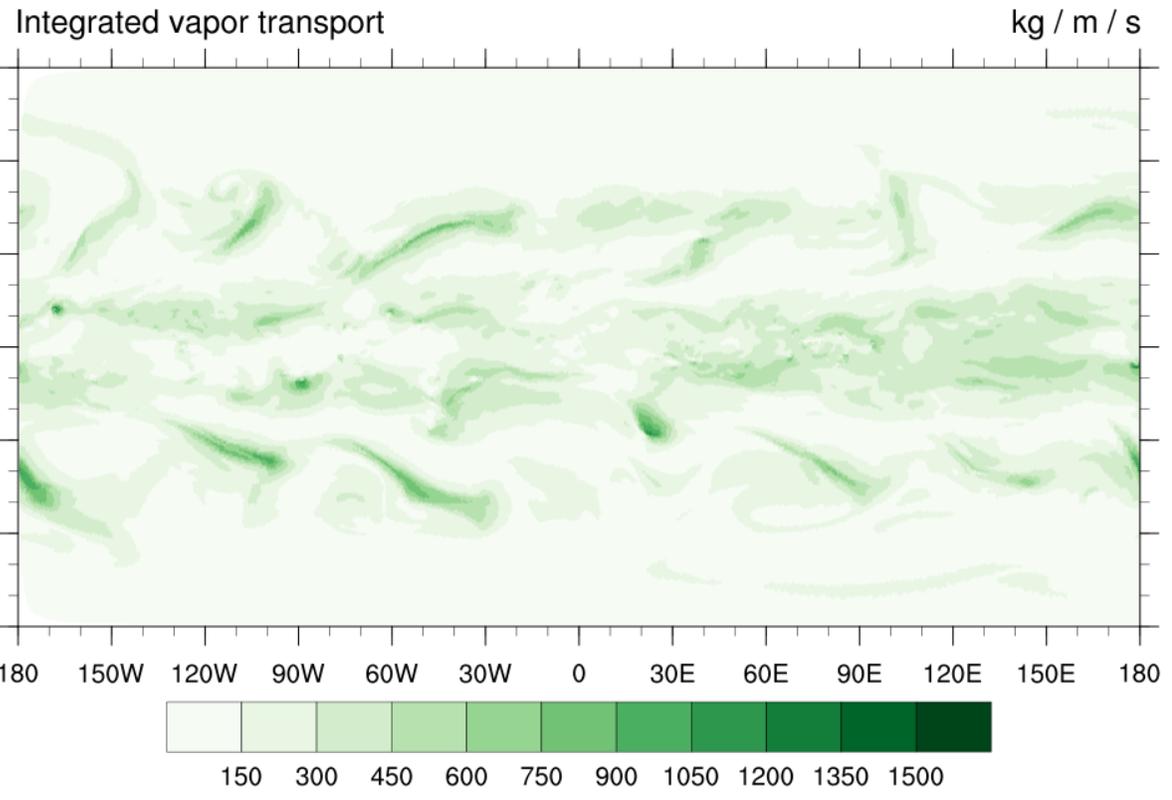
374 Day

Integrated vapor kinetic energy

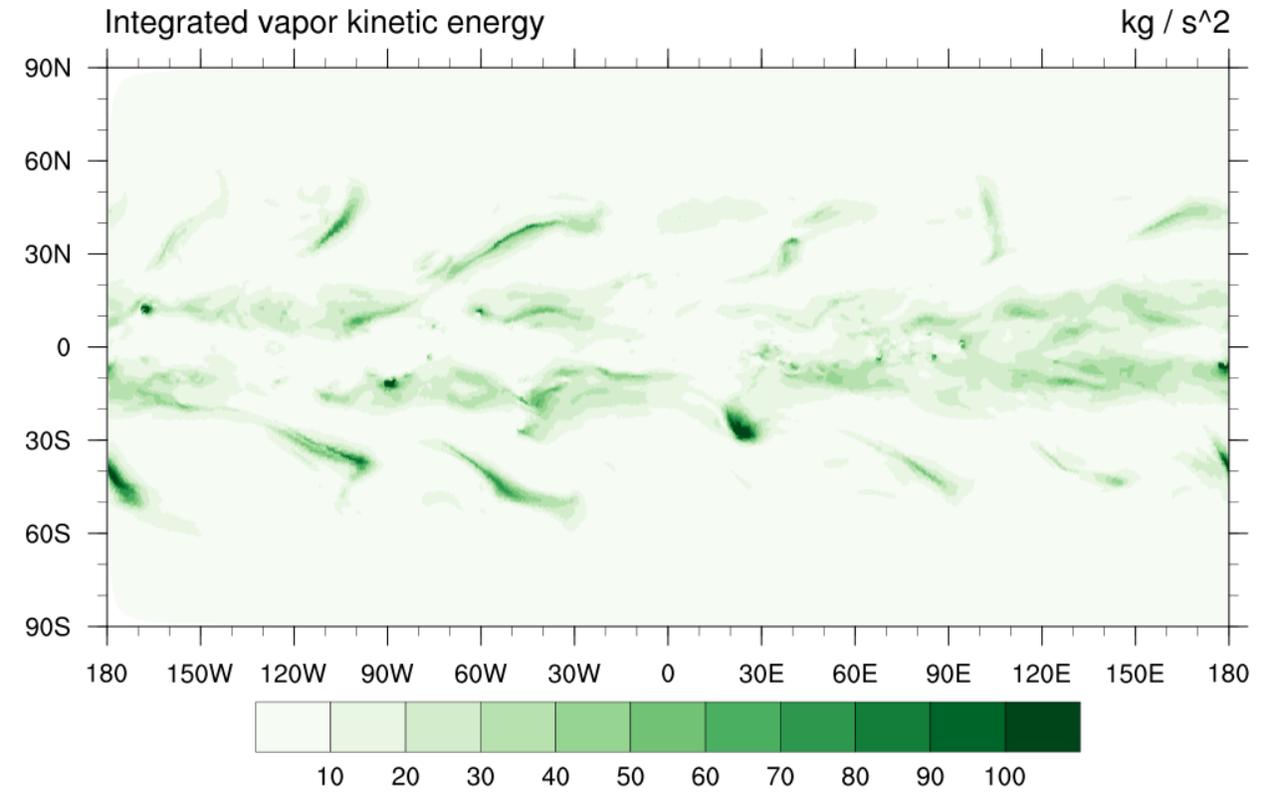
kg / s²



375 Day



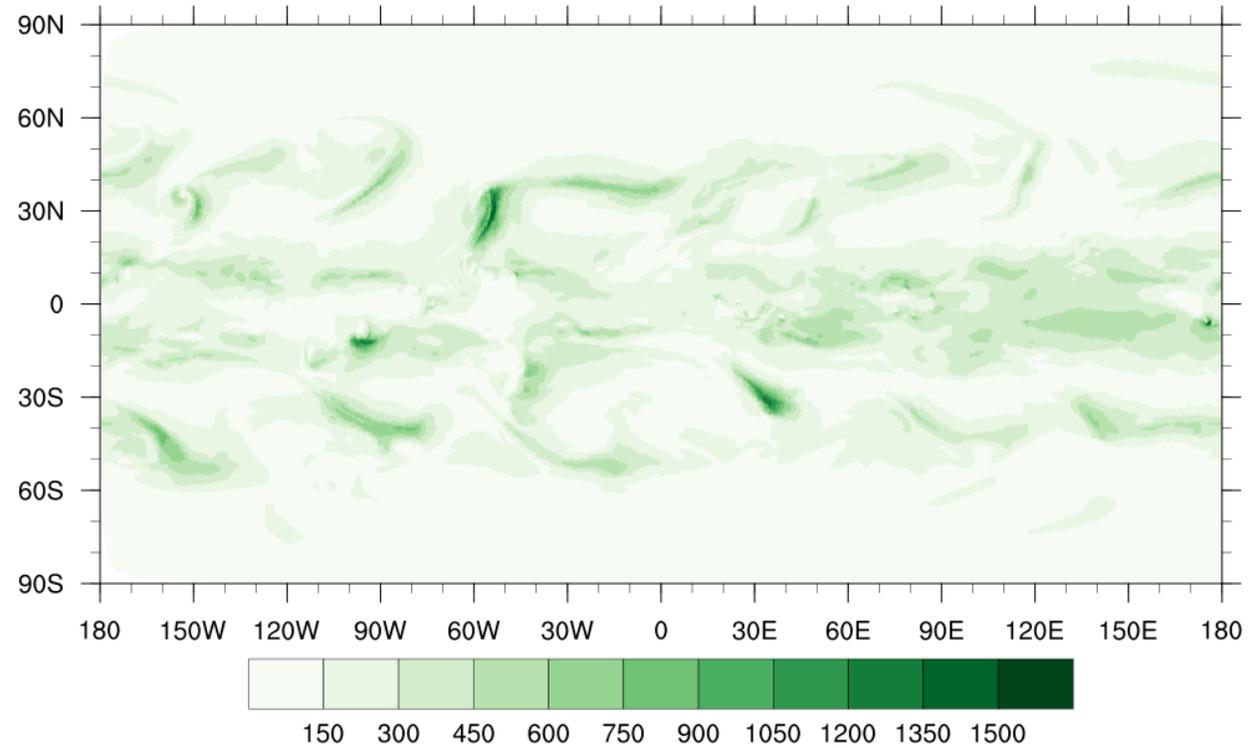
375 Day



376 Day

Integrated vapor transport

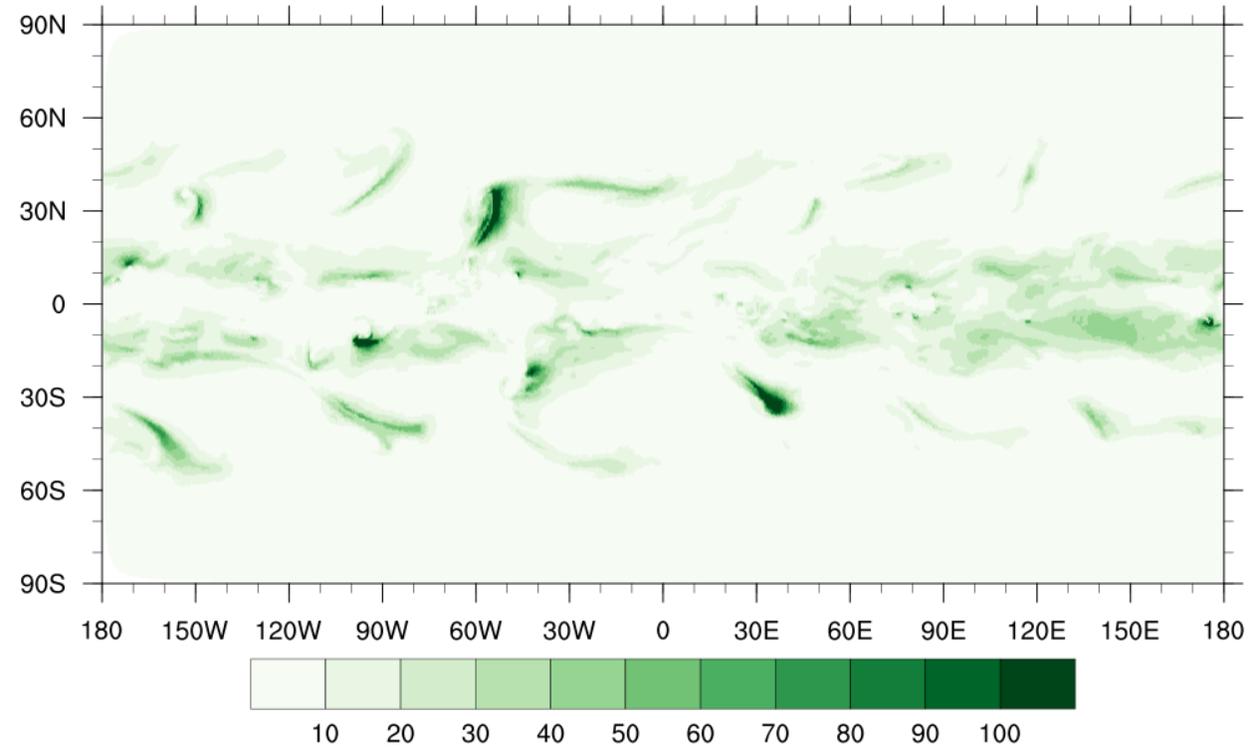
kg / m / s



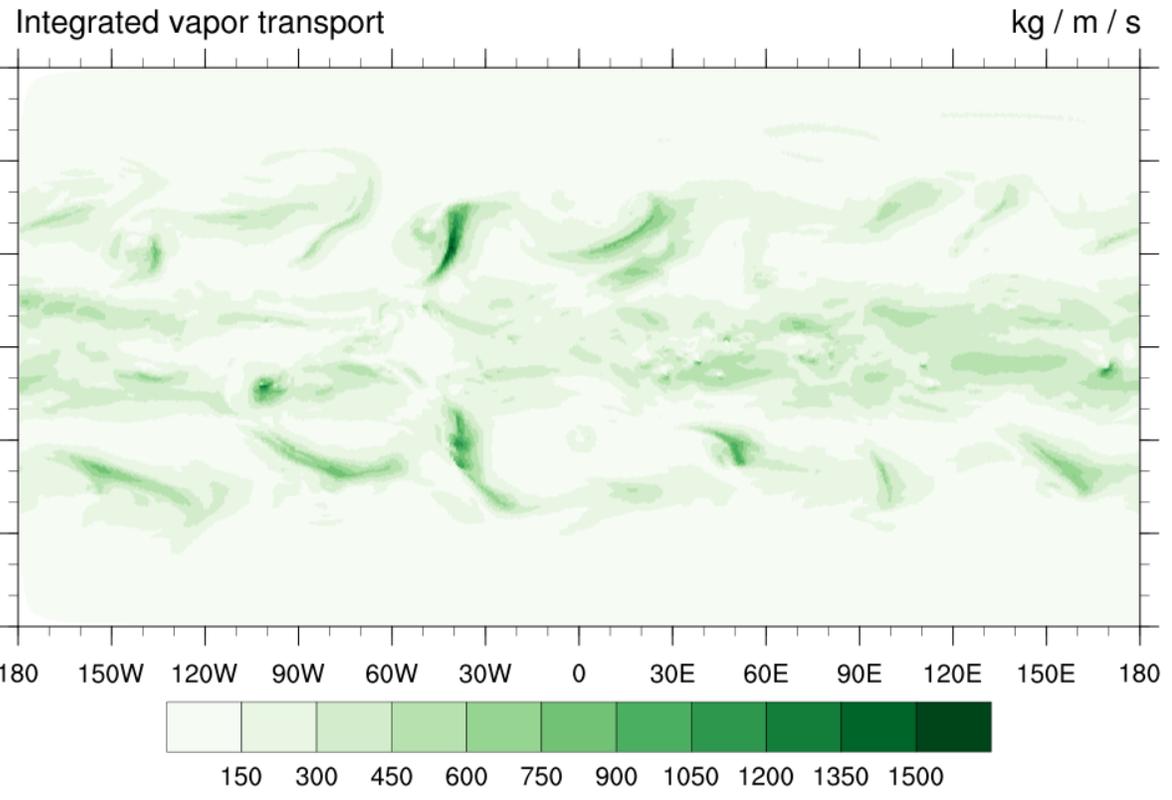
376 Day

Integrated vapor kinetic energy

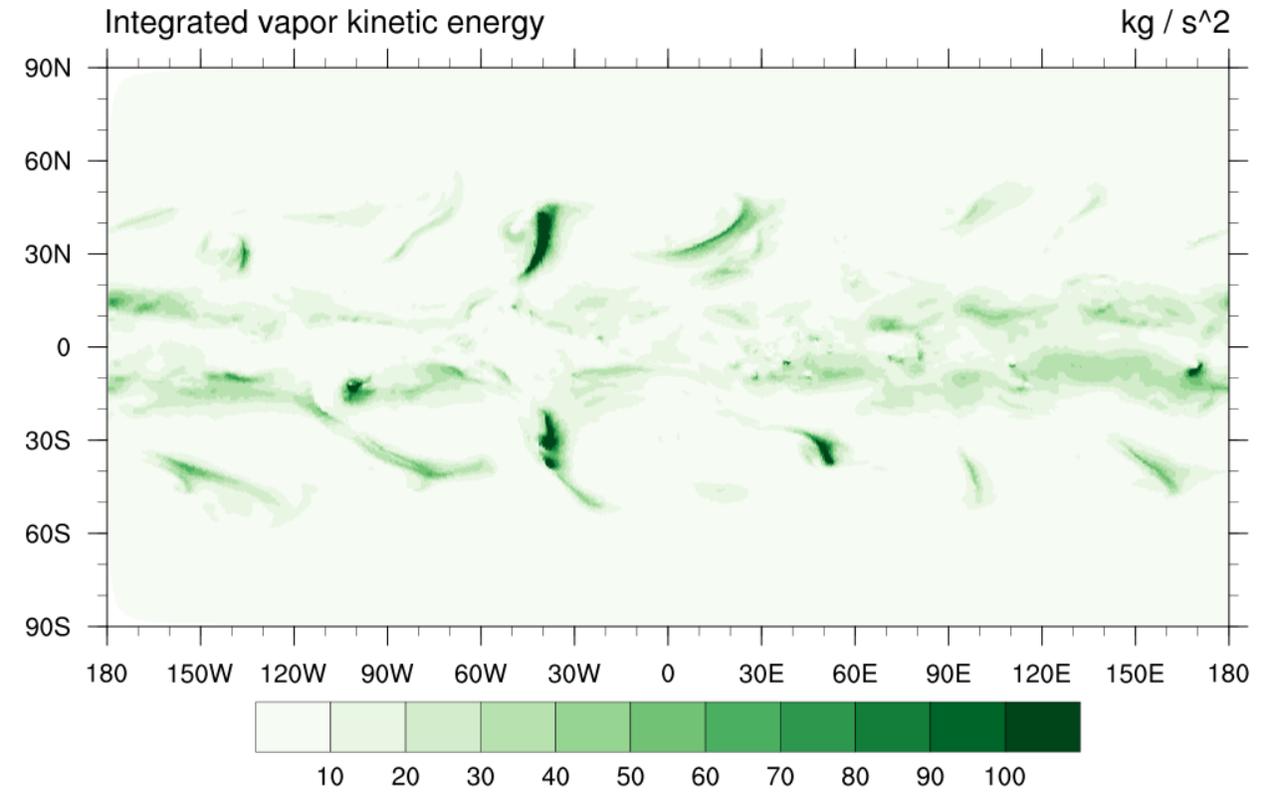
kg / s²



377 Day



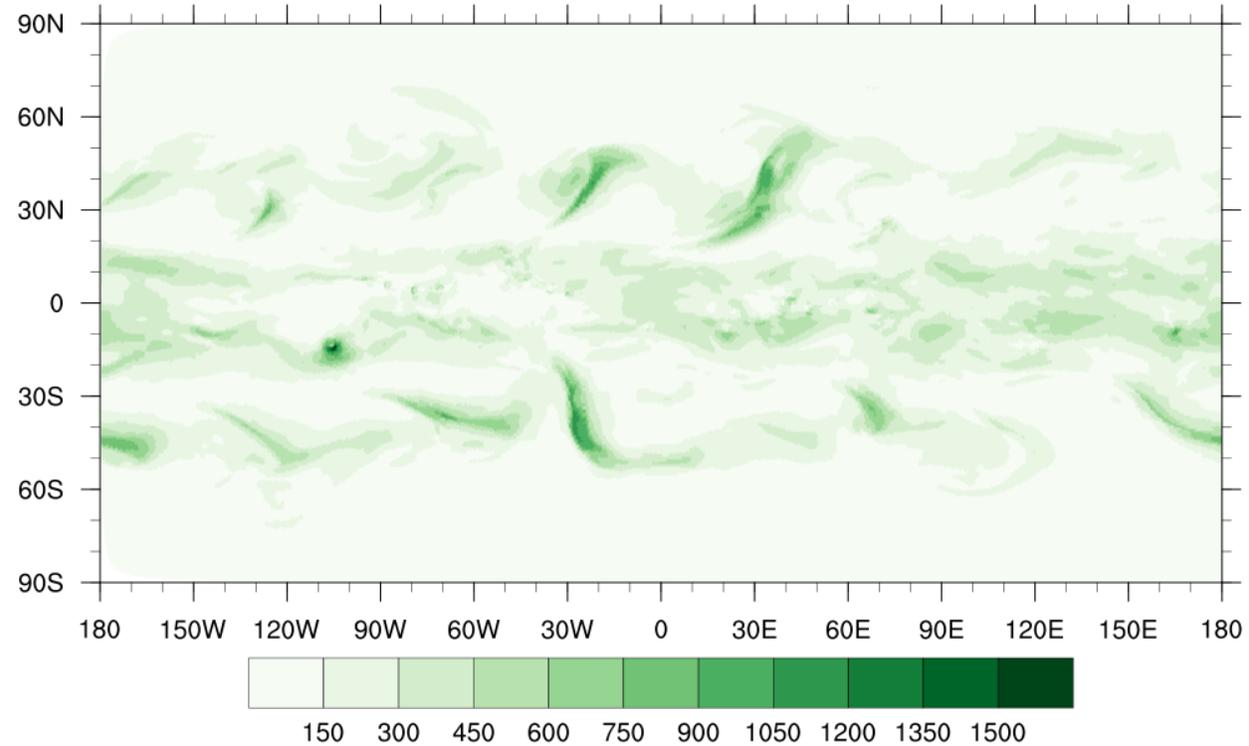
377 Day



378 Day

Integrated vapor transport

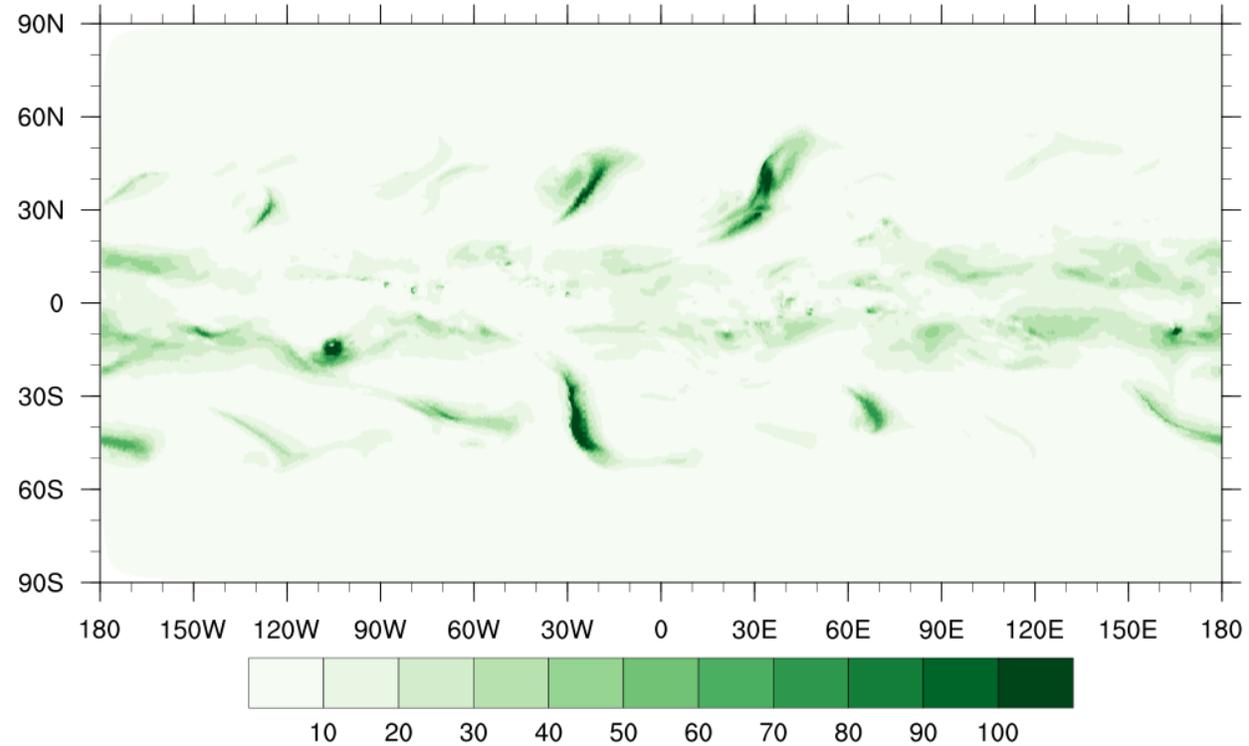
kg / m / s



378 Day

Integrated vapor kinetic energy

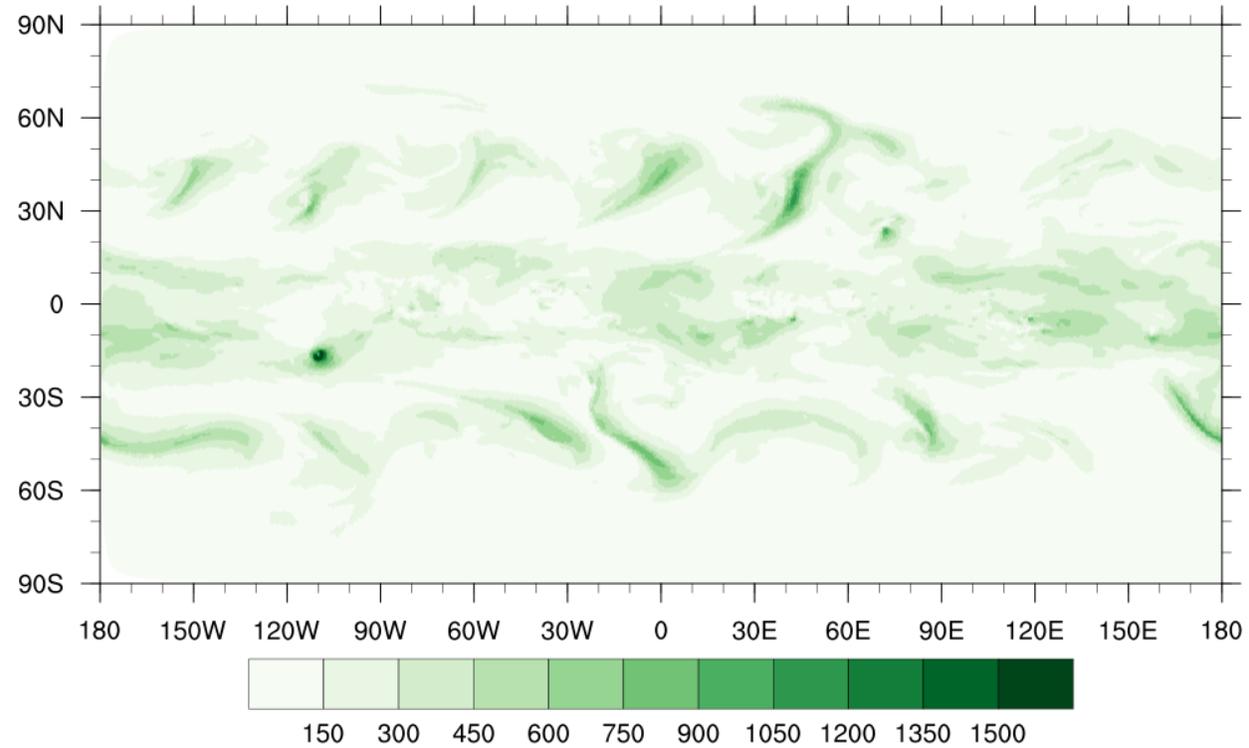
kg / s²



379 Day

Integrated vapor transport

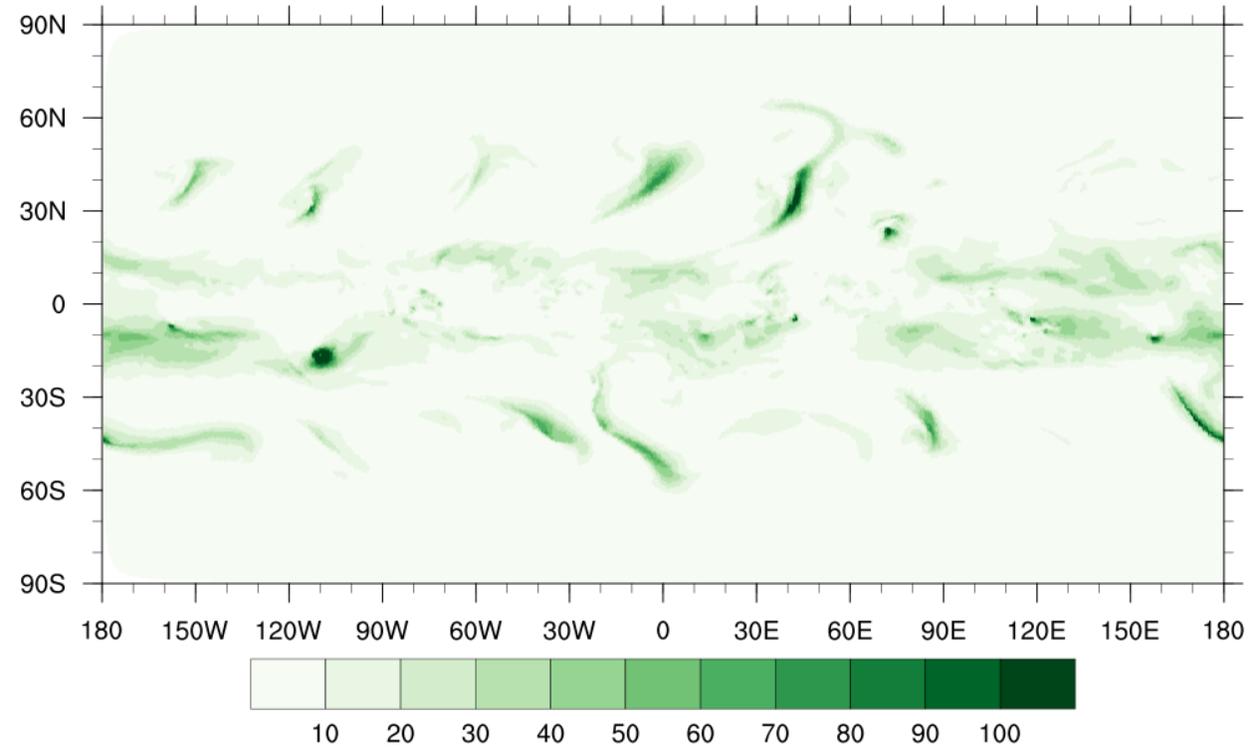
kg / m / s



379 Day

Integrated vapor kinetic energy

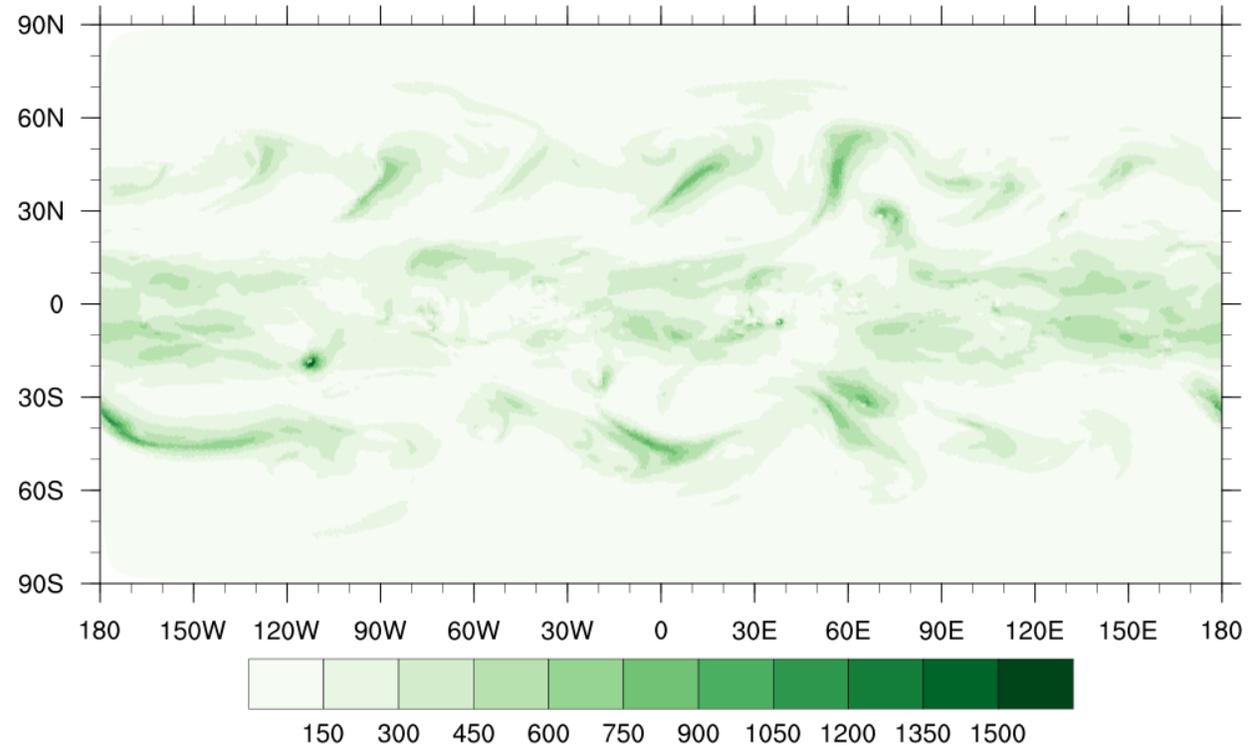
kg / s²



380 Day

Integrated vapor transport

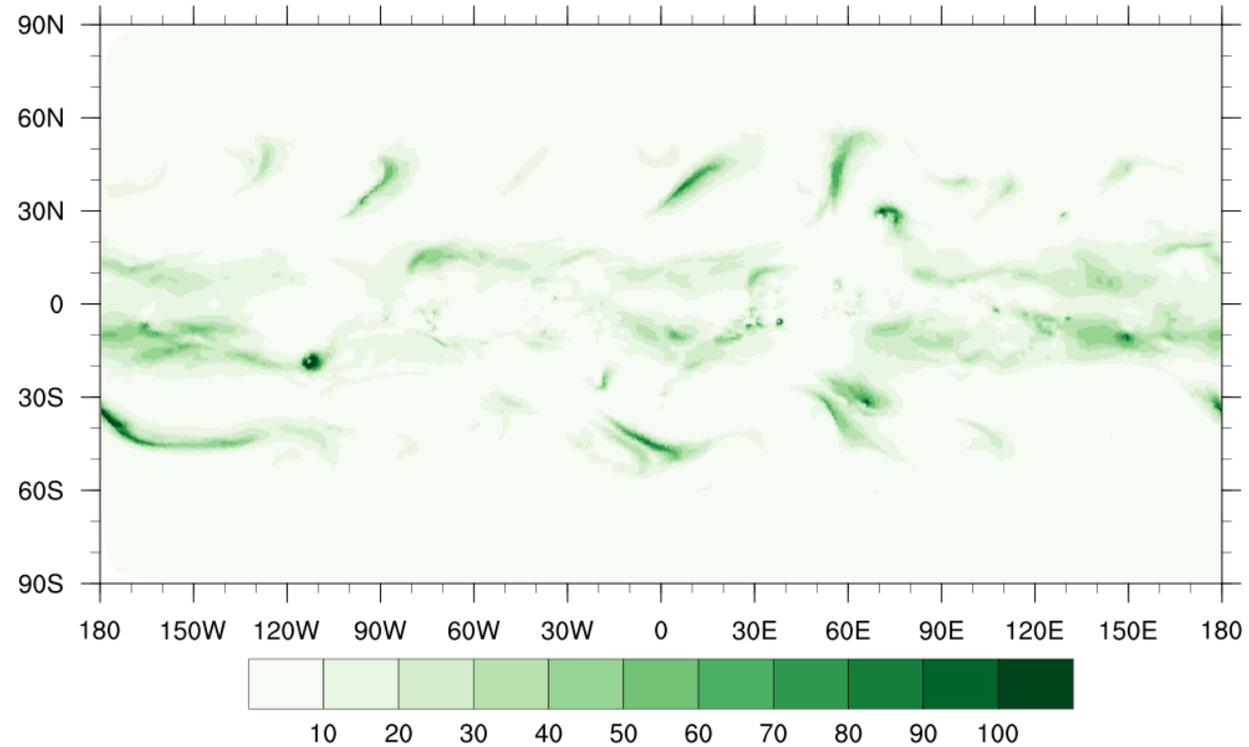
kg / m / s



380 Day

Integrated vapor kinetic energy

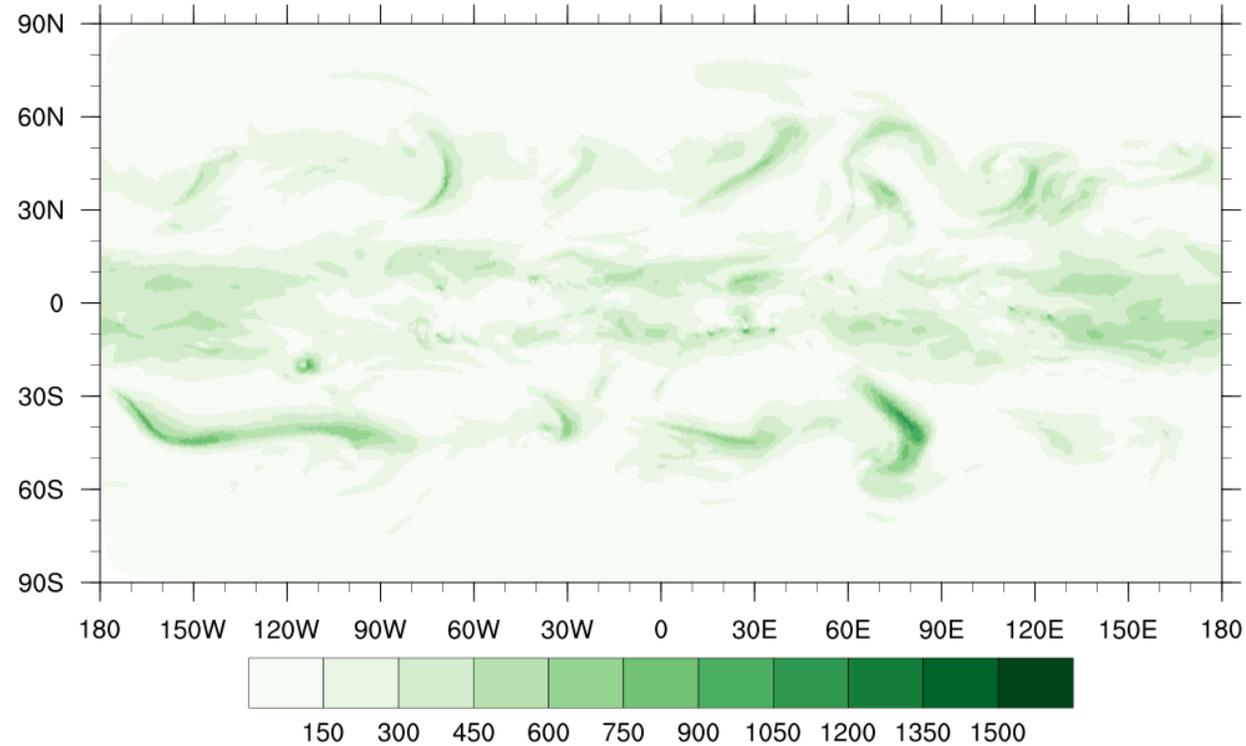
kg / s²



381 Day

Integrated vapor transport

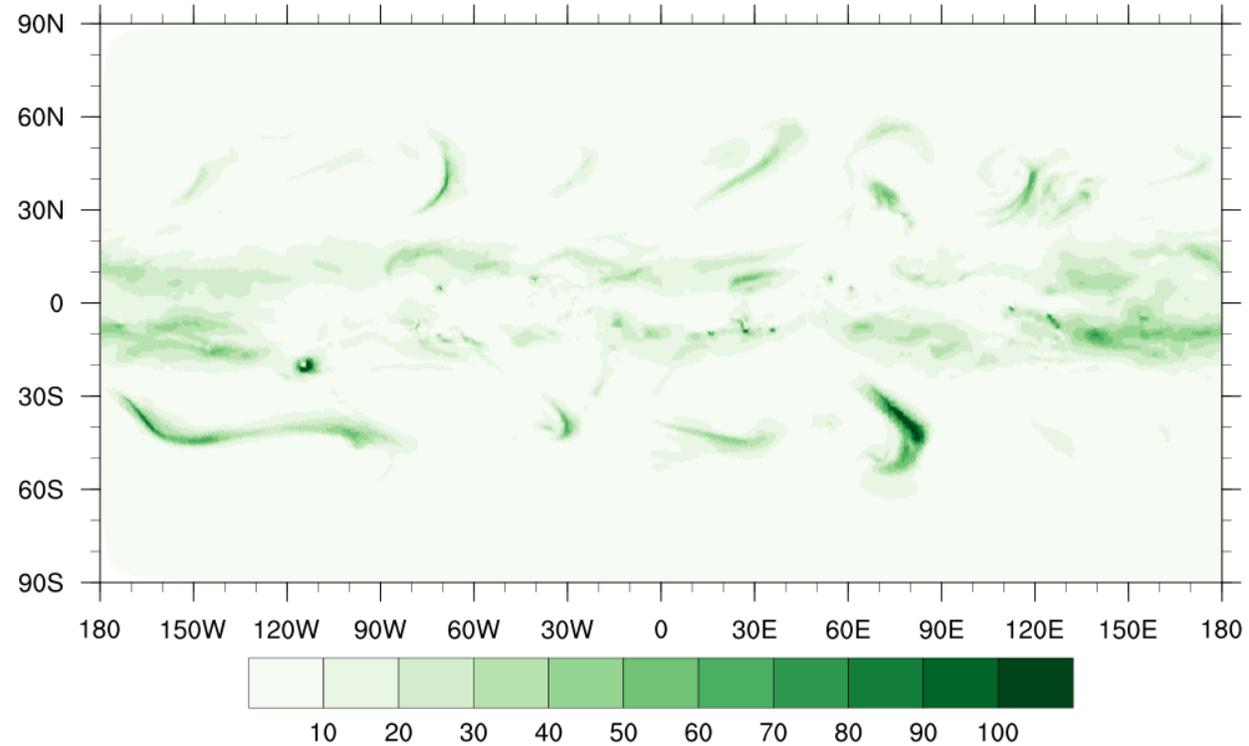
kg / m / s



381 Day

Integrated vapor kinetic energy

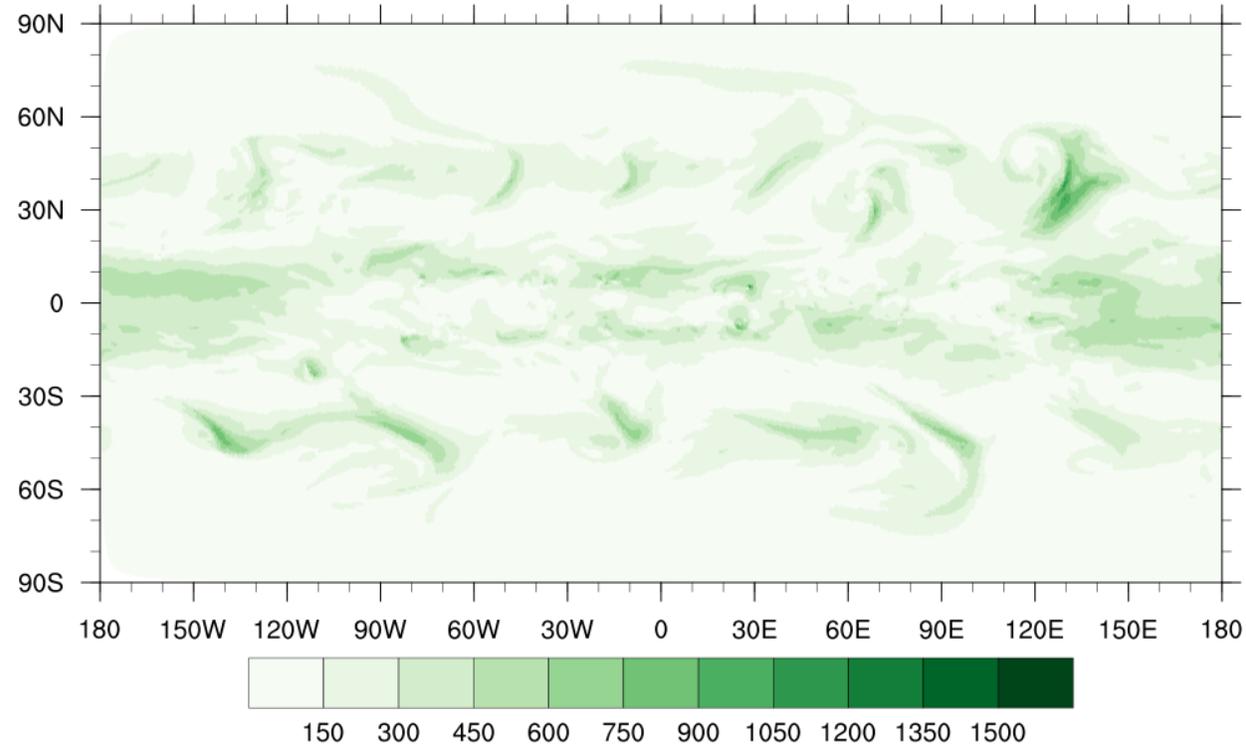
kg / s²



382 Day

Integrated vapor transport

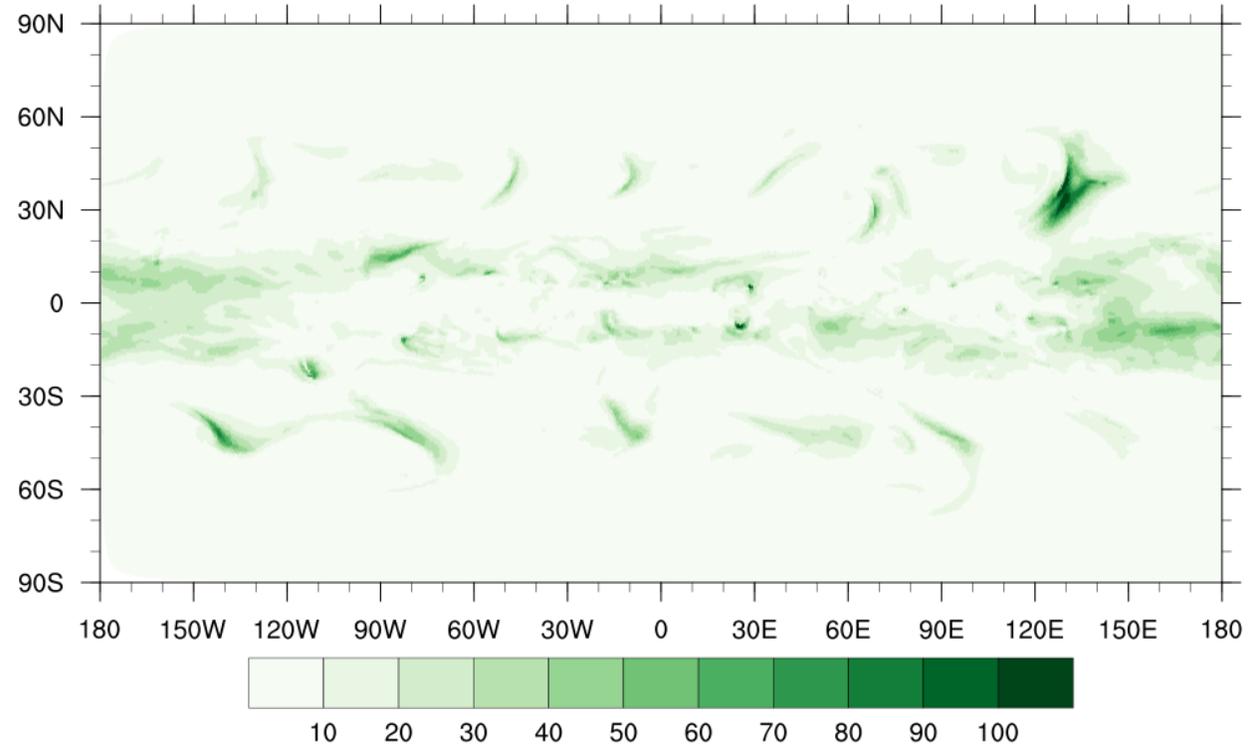
kg / m / s



382 Day

Integrated vapor kinetic energy

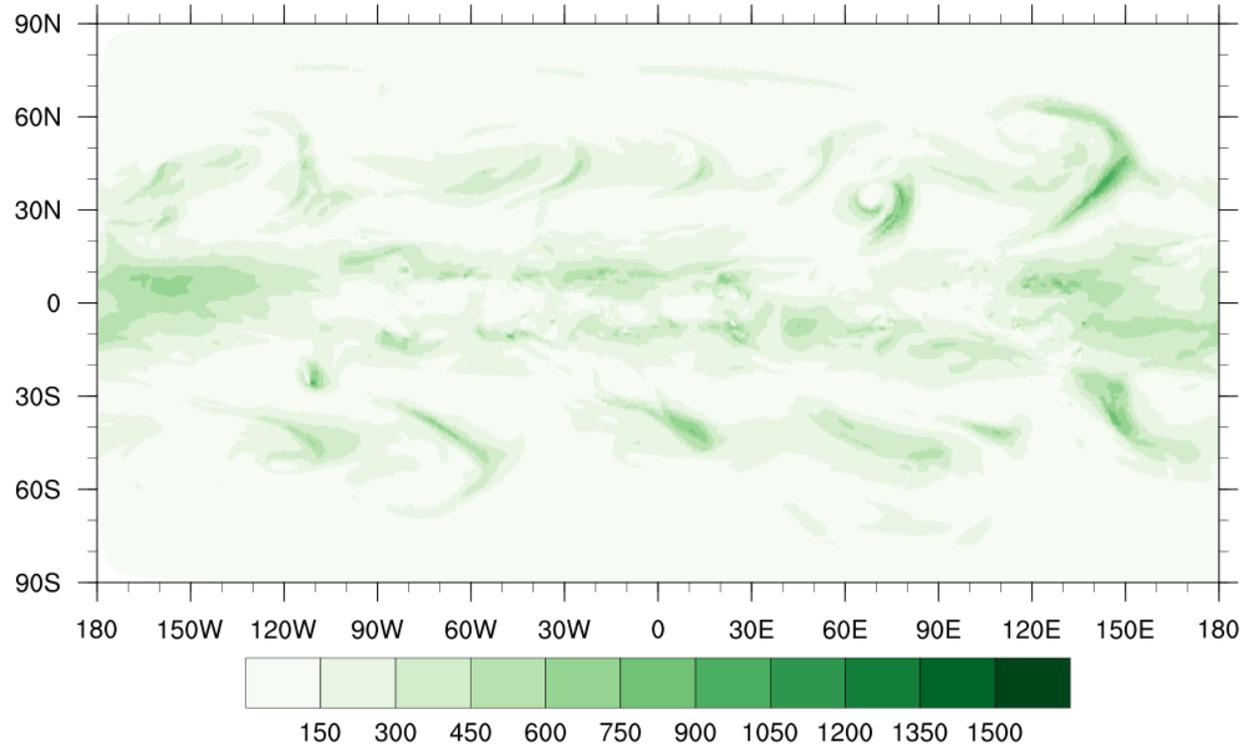
kg / s²



383 Day

Integrated vapor transport

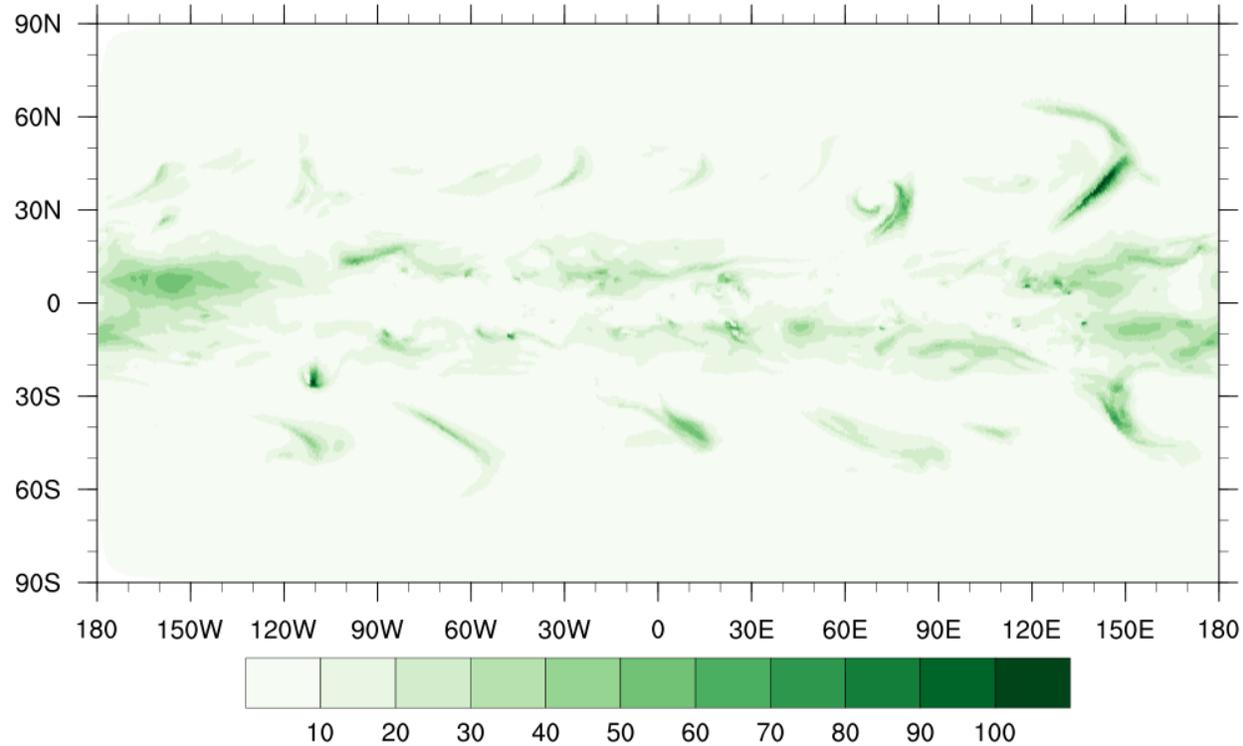
kg / m / s



383 Day

Integrated vapor kinetic energy

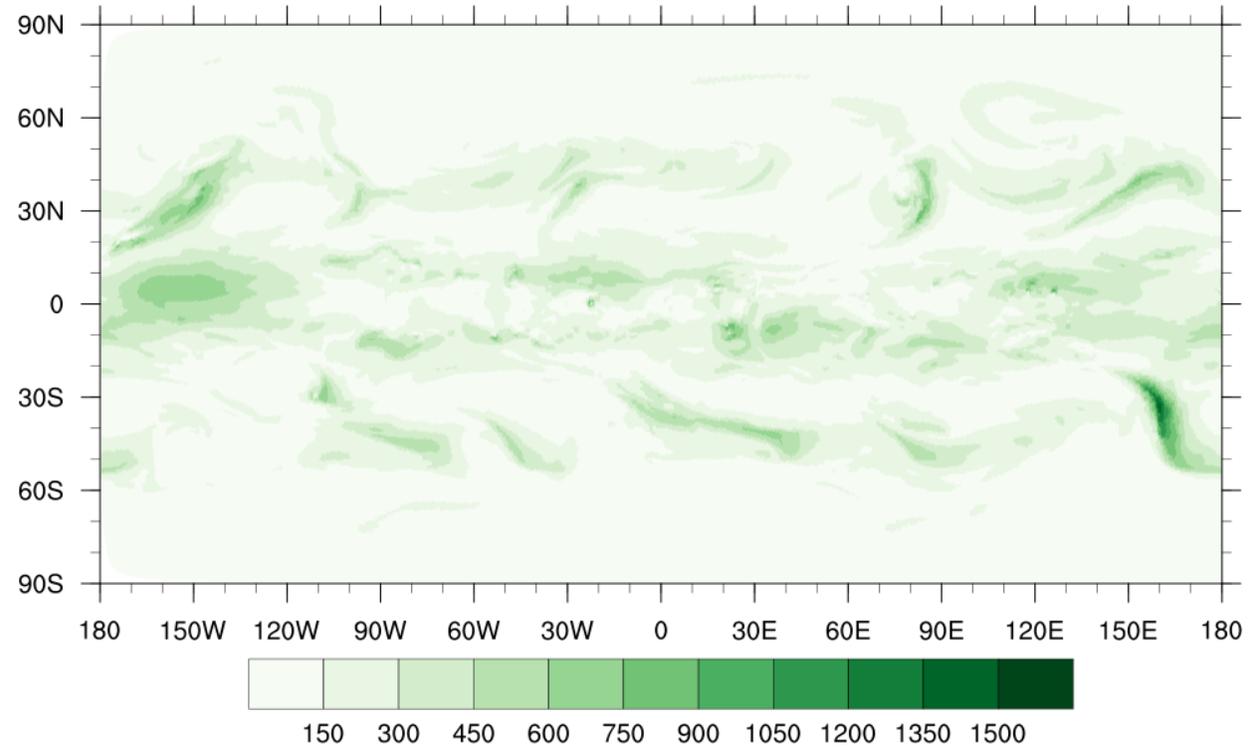
kg / s²



384 Day

Integrated vapor transport

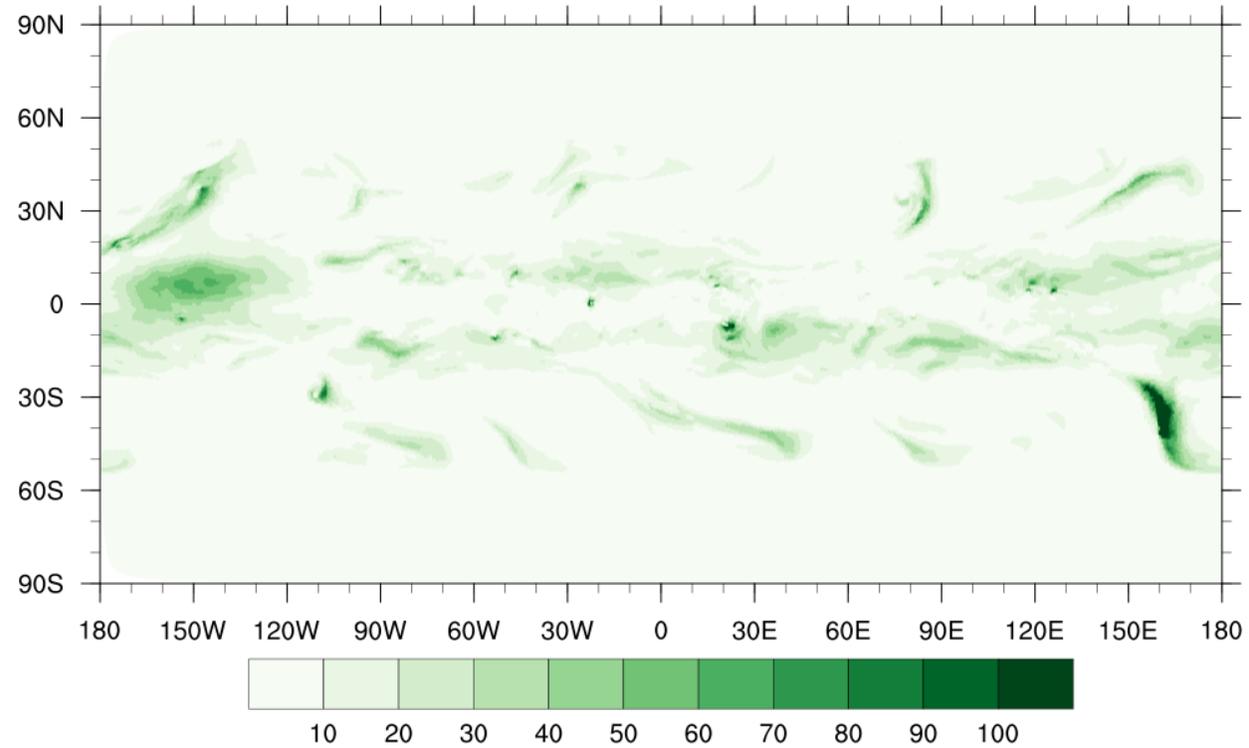
kg / m / s



384 Day

Integrated vapor kinetic energy

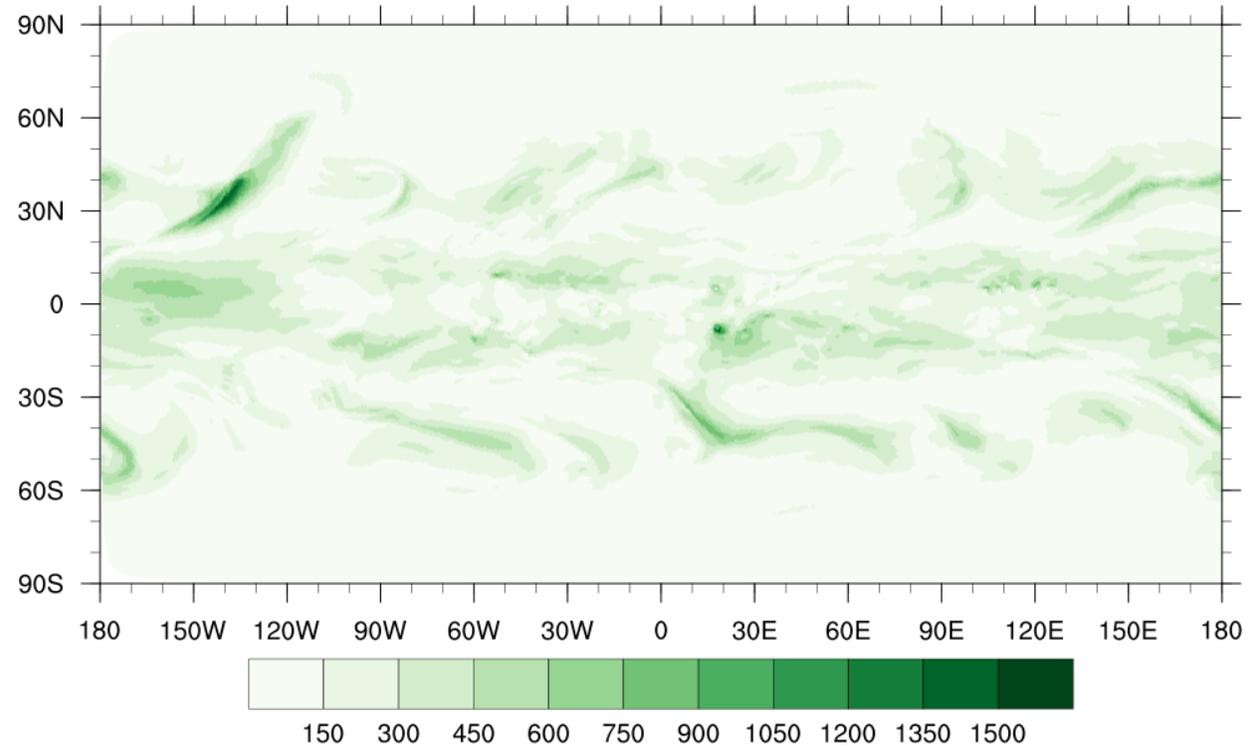
kg / s²



385 Day

Integrated vapor transport

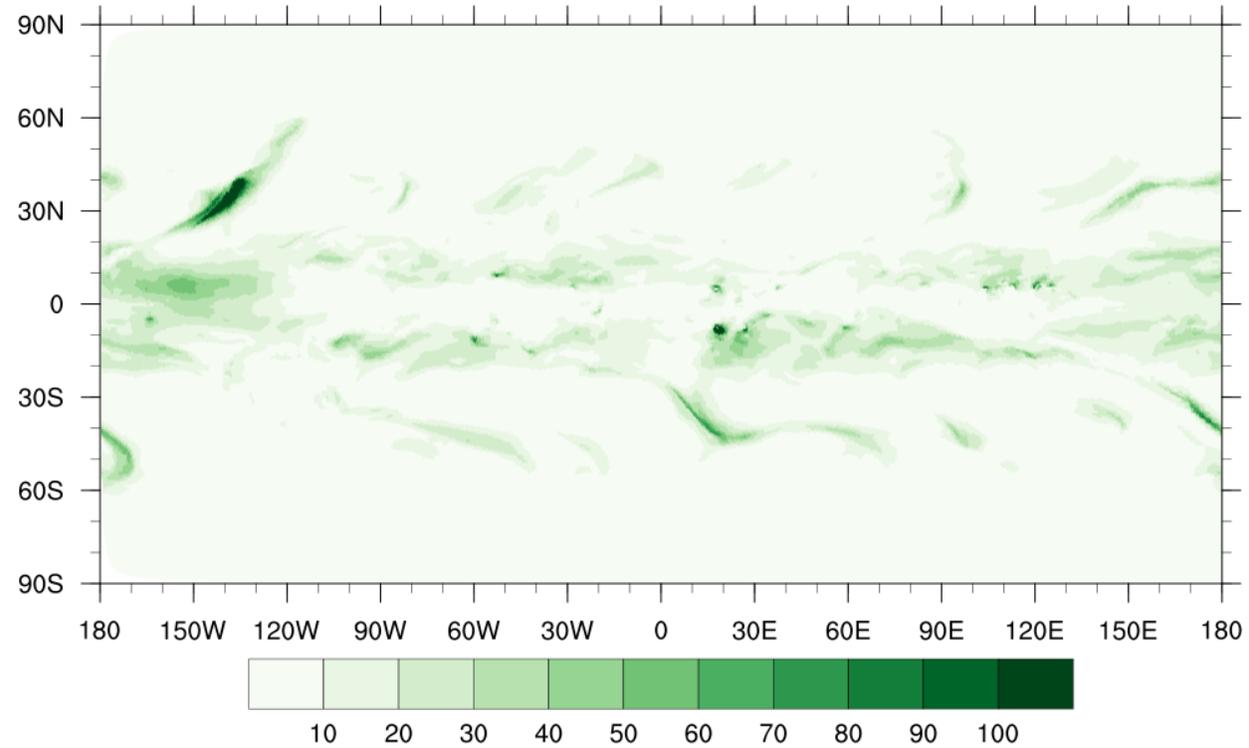
kg / m / s



385 Day

Integrated vapor kinetic energy

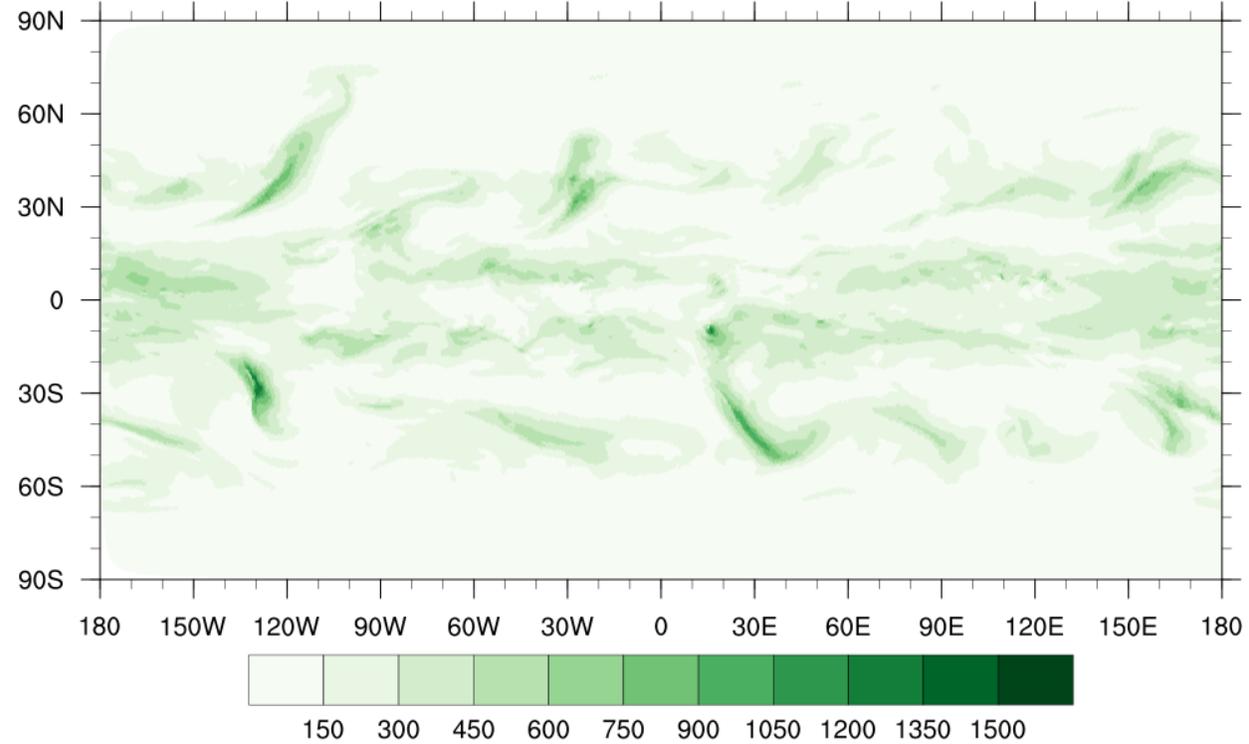
kg / s²



386 Day

Integrated vapor transport

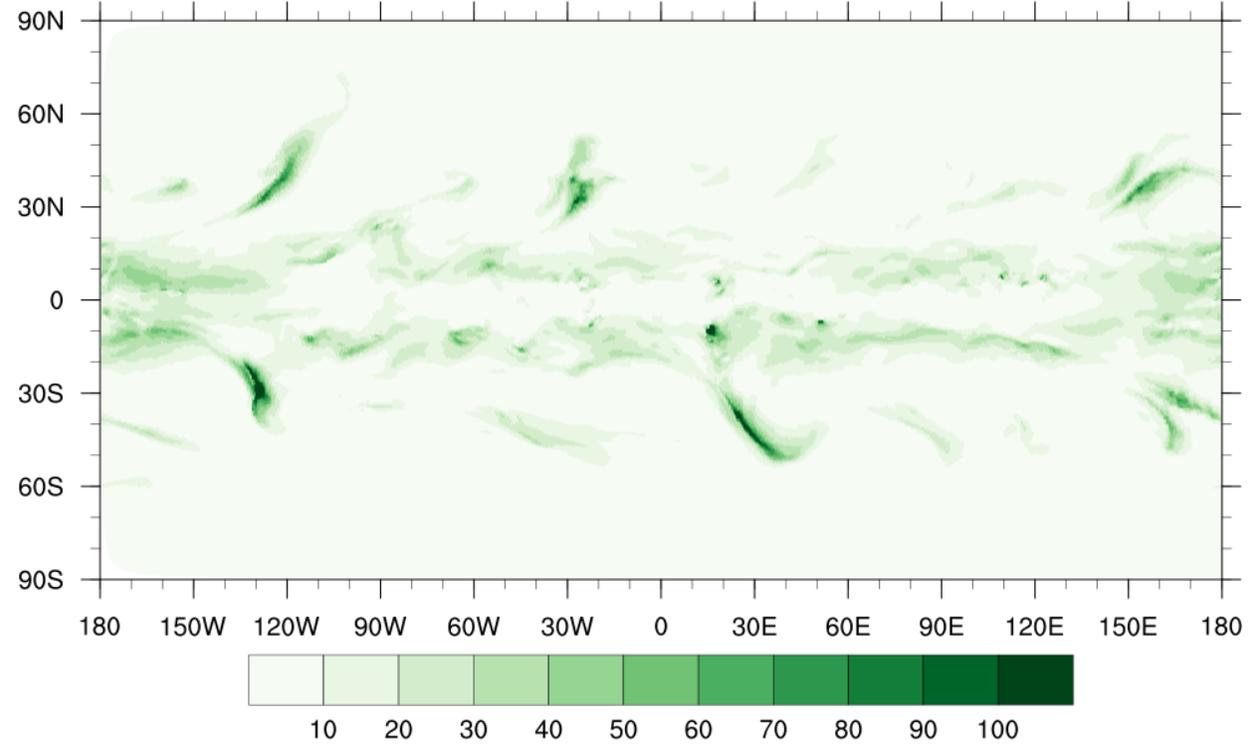
kg / m / s



386 Day

Integrated vapor kinetic energy

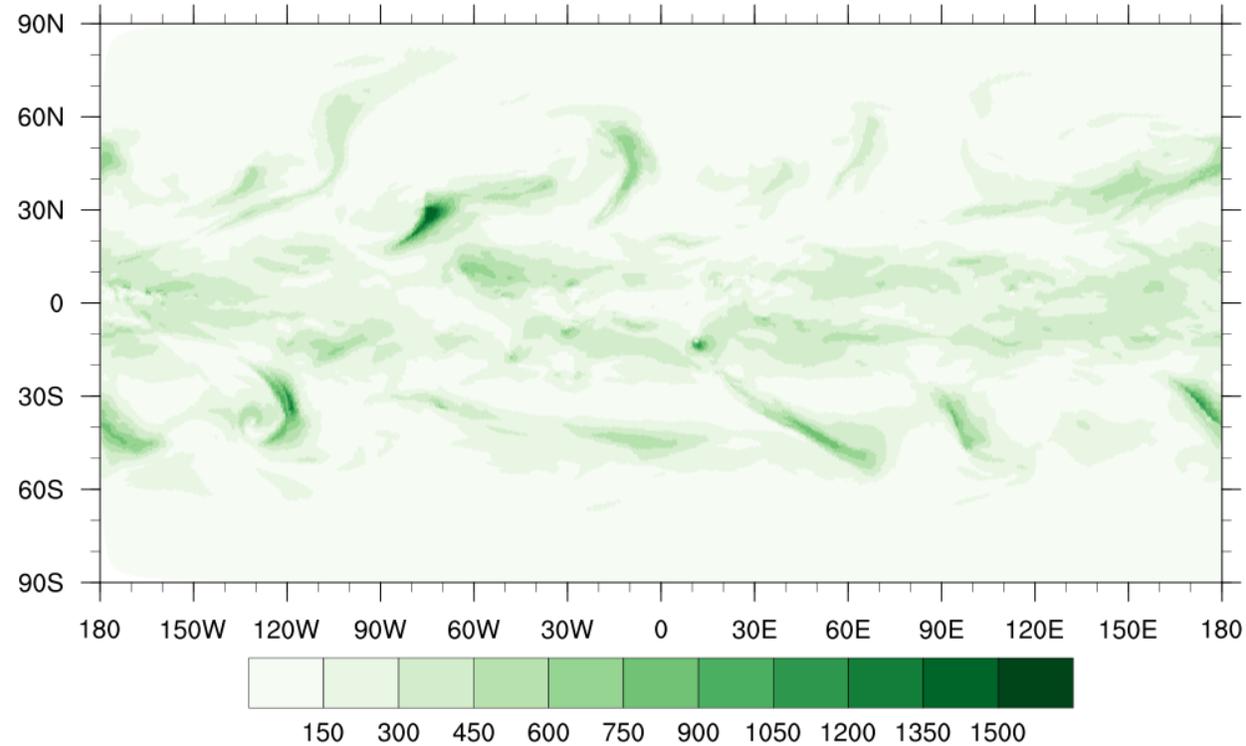
kg / s²



387 Day

Integrated vapor transport

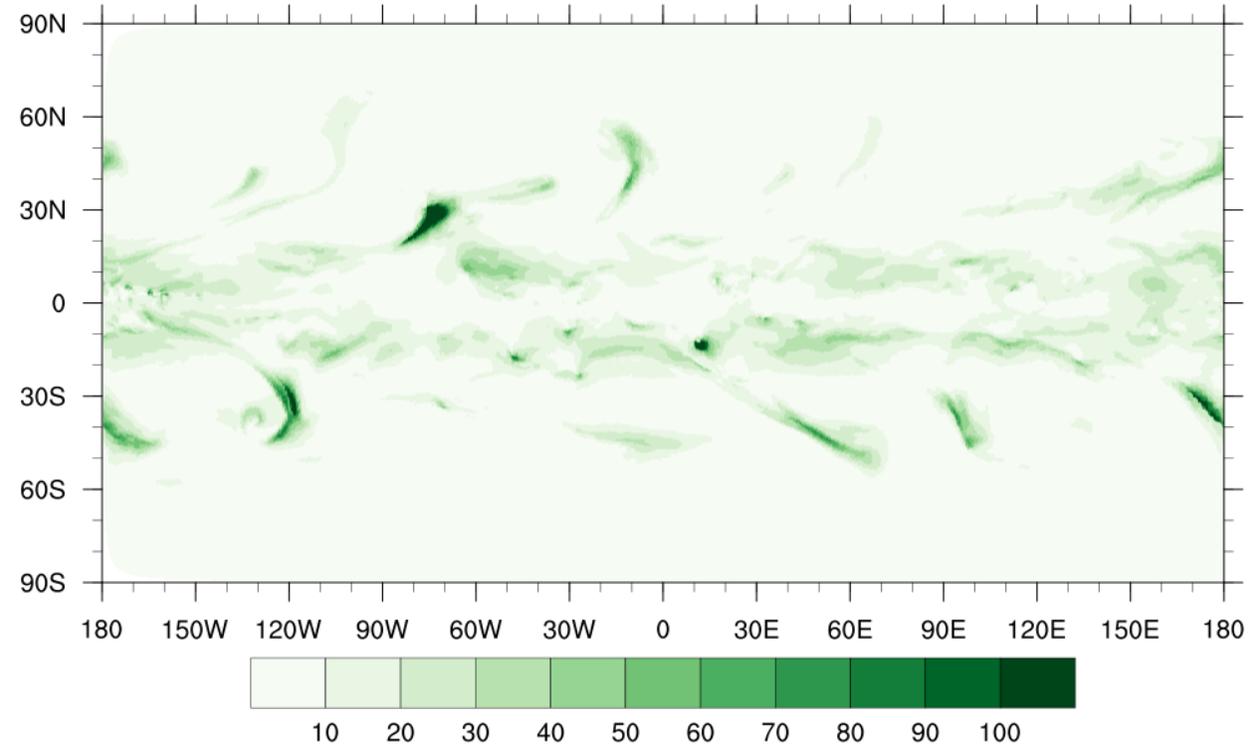
kg / m / s



387 Day

Integrated vapor kinetic energy

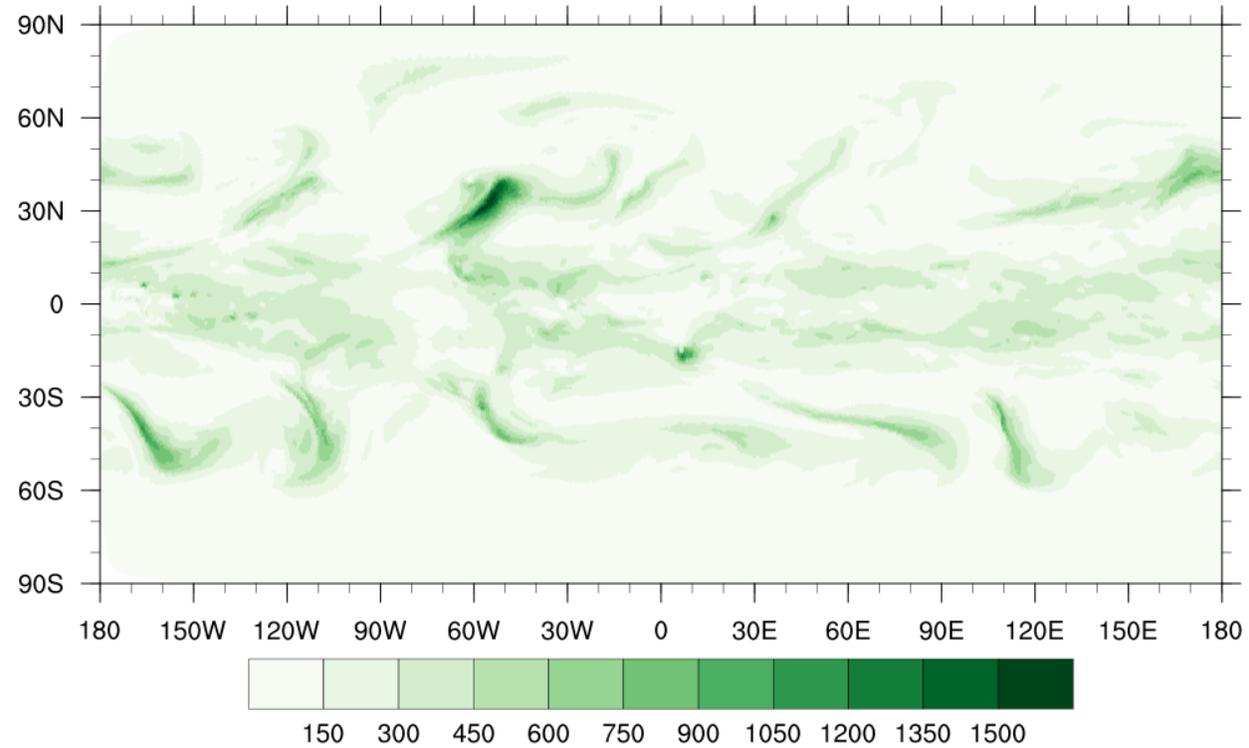
kg / s²



388 Day

Integrated vapor transport

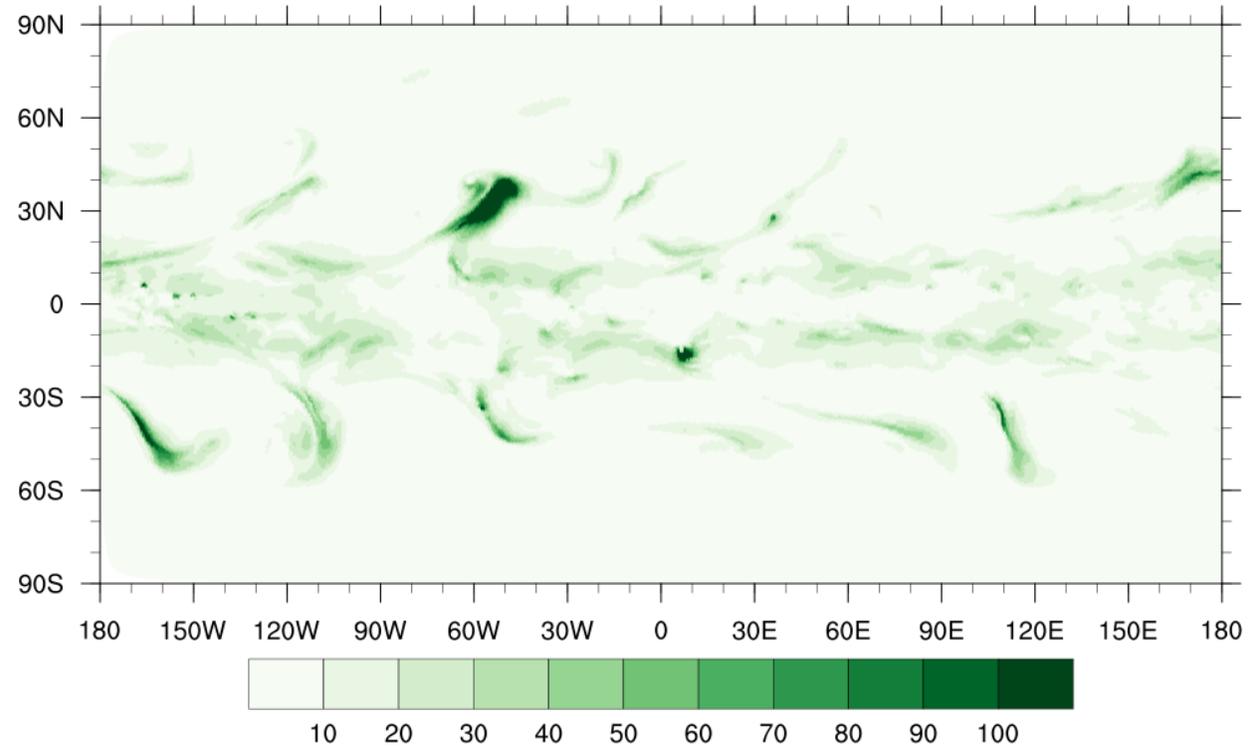
kg / m / s



388 Day

Integrated vapor kinetic energy

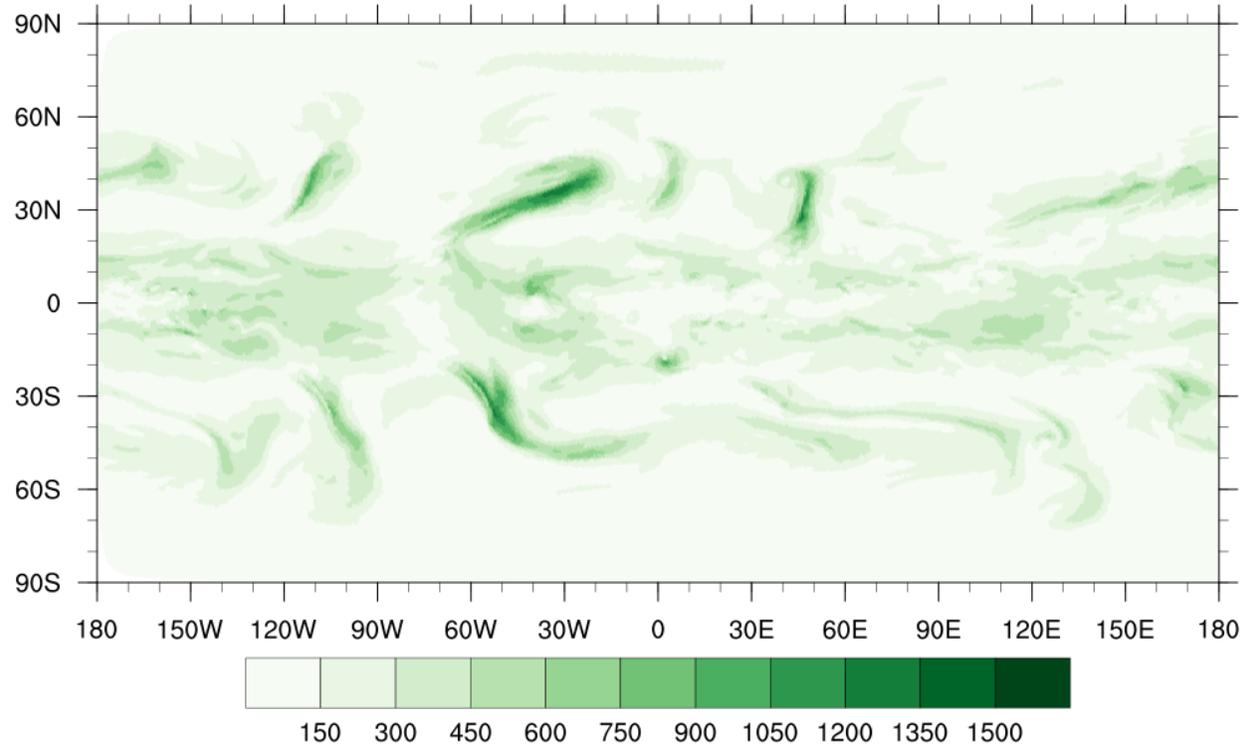
kg / s²



389 Day

Integrated vapor transport

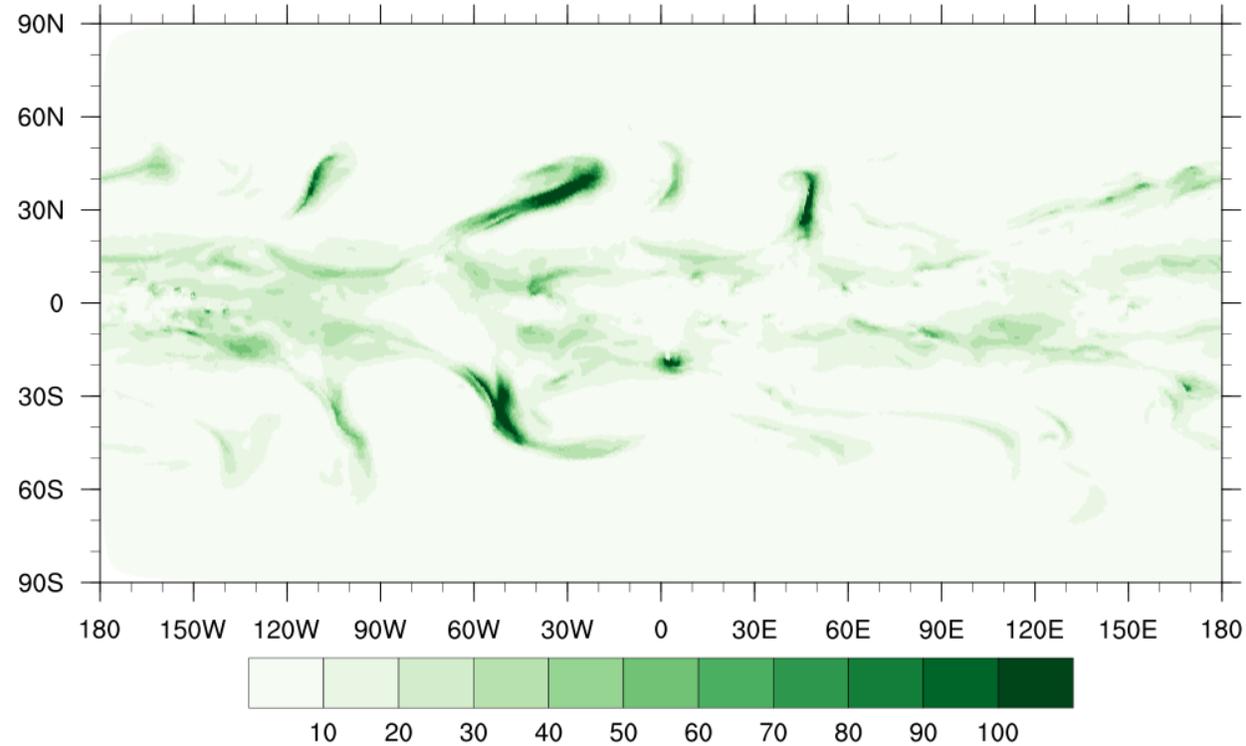
kg / m / s



389 Day

Integrated vapor kinetic energy

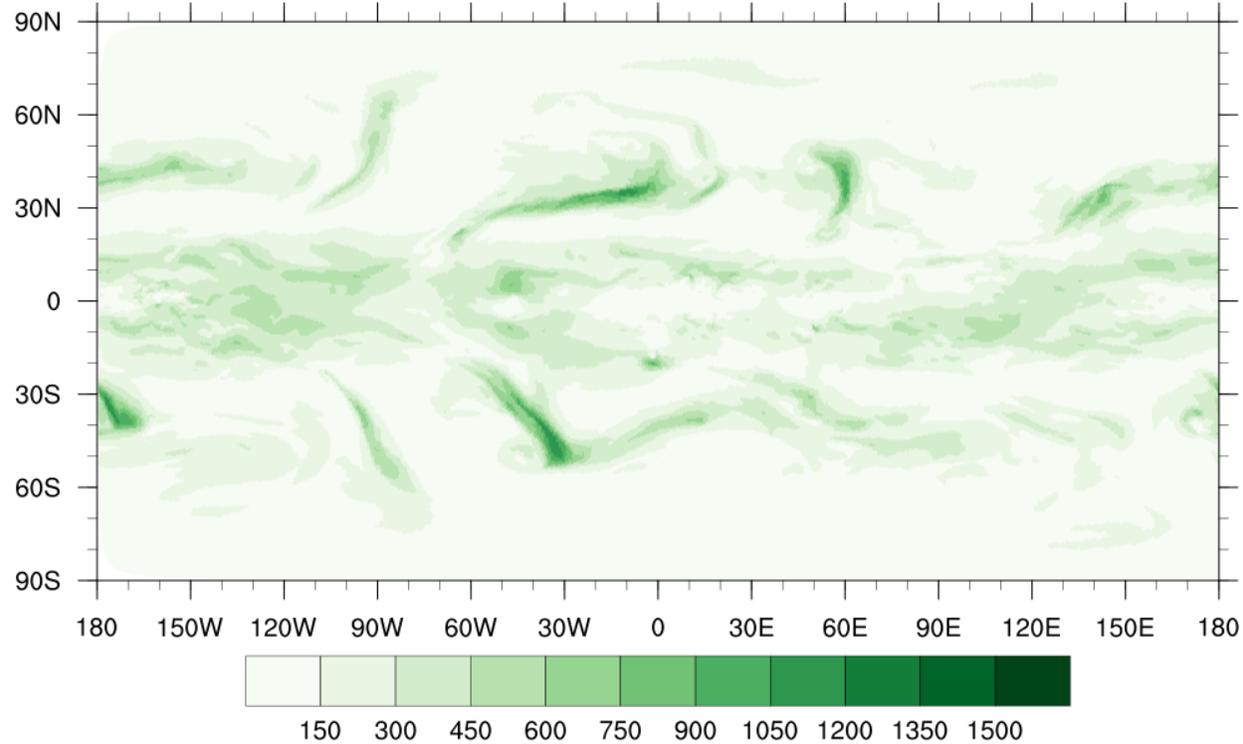
kg / s²



390 Day

Integrated vapor transport

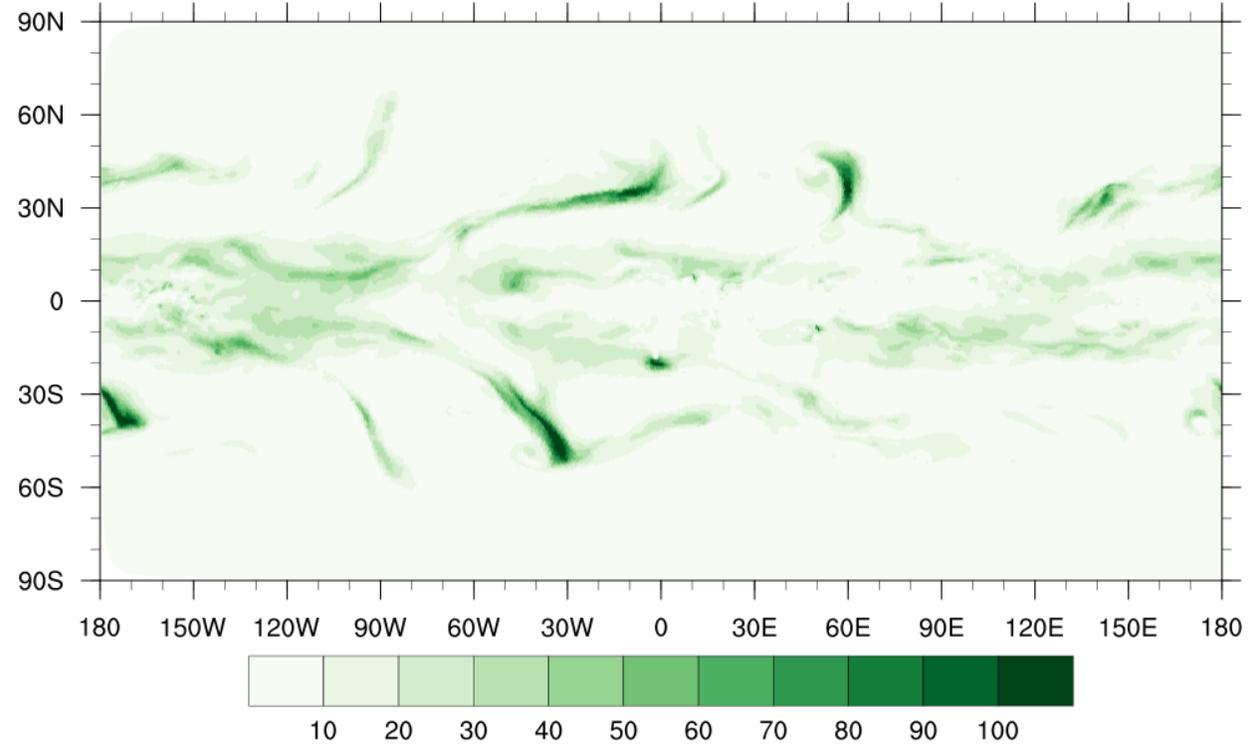
kg / m / s



390 Day

Integrated vapor kinetic energy

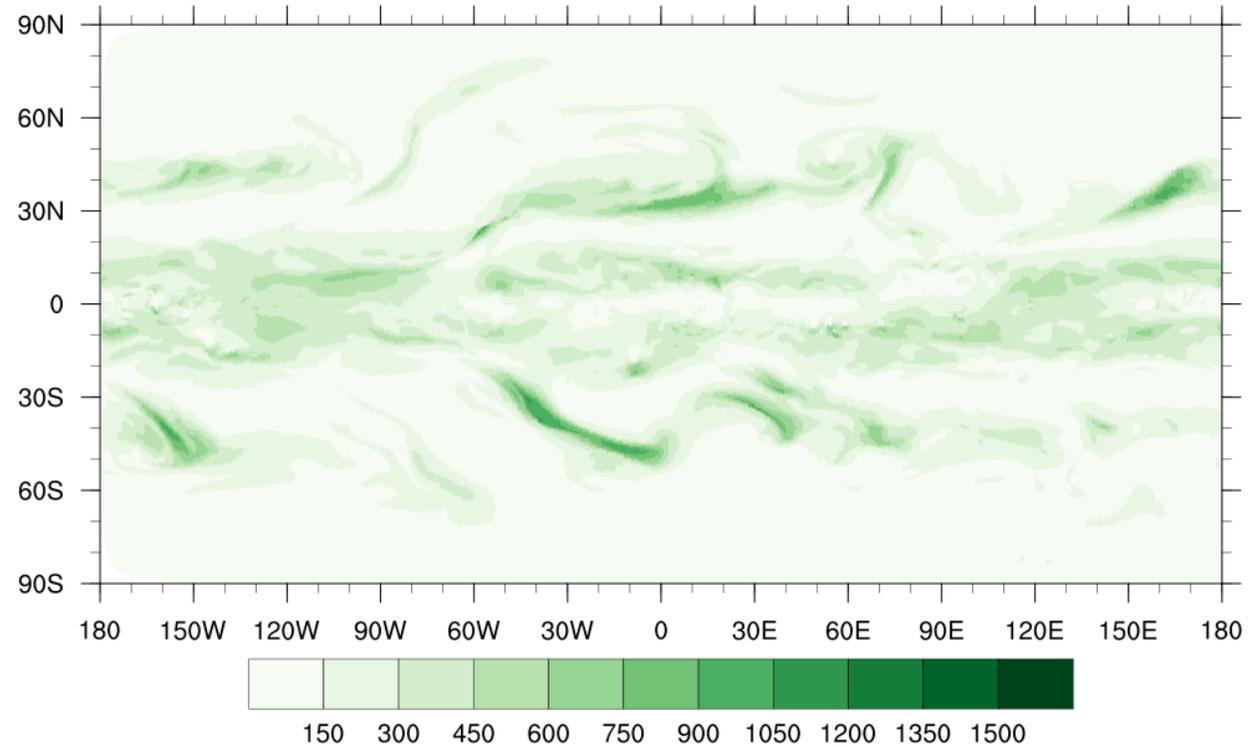
kg / s²



391 Day

Integrated vapor transport

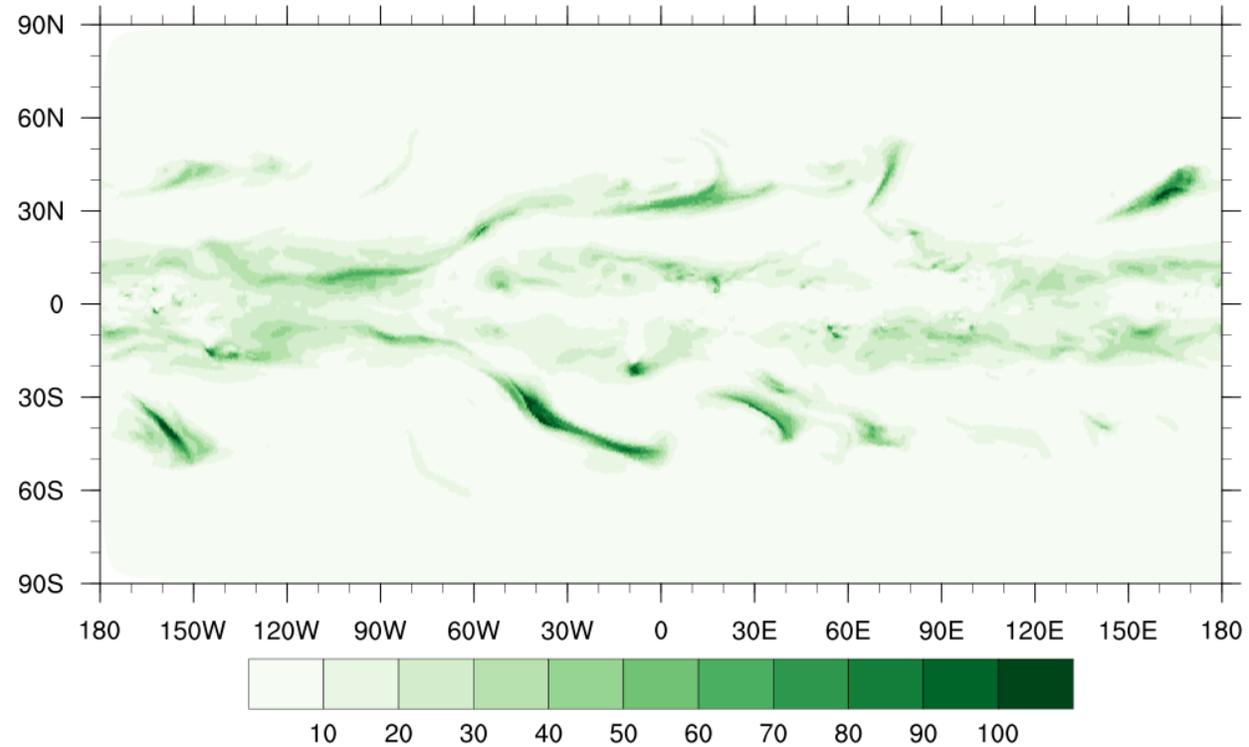
kg / m / s



391 Day

Integrated vapor kinetic energy

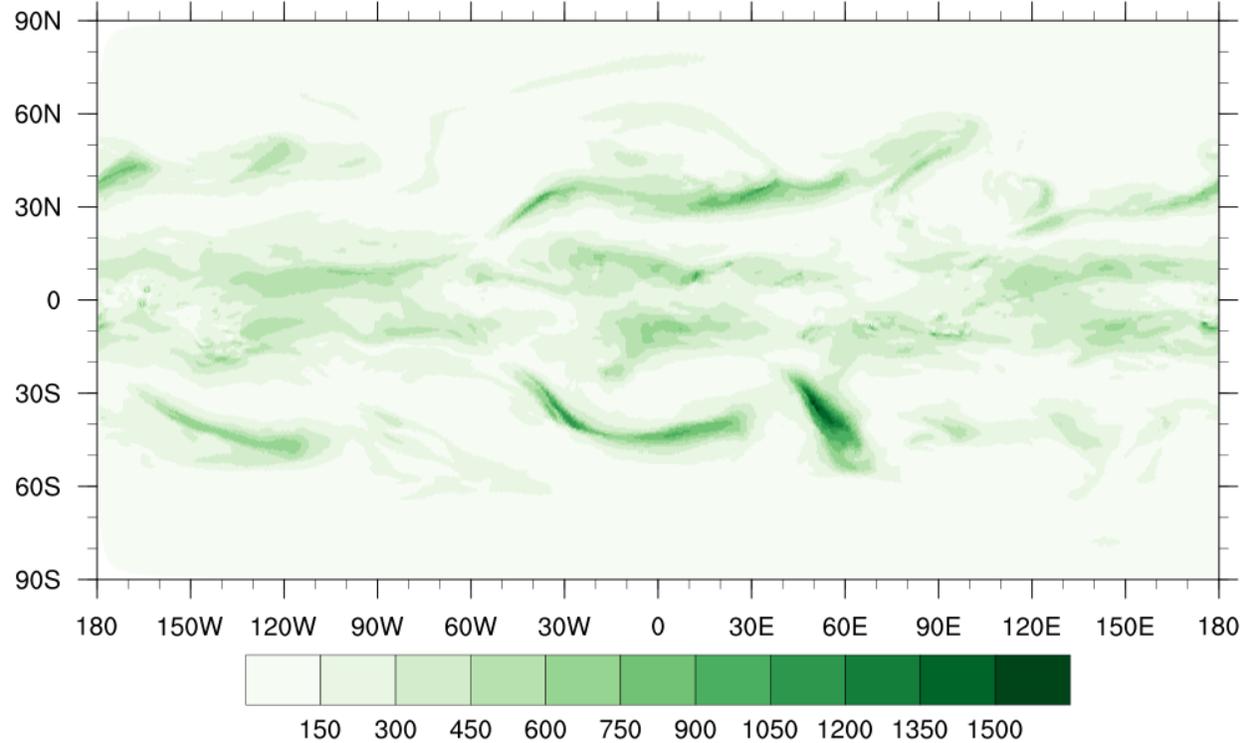
kg / s²



392 Day

Integrated vapor transport

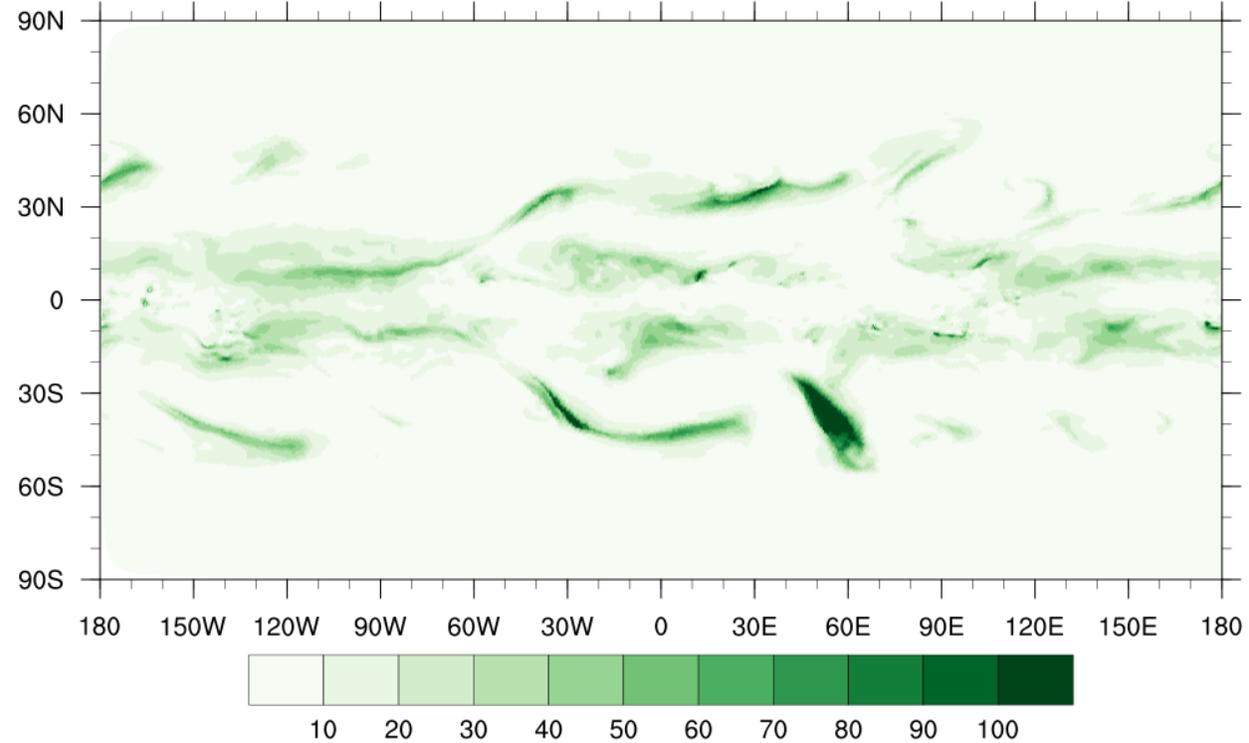
kg / m / s



392 Day

Integrated vapor kinetic energy

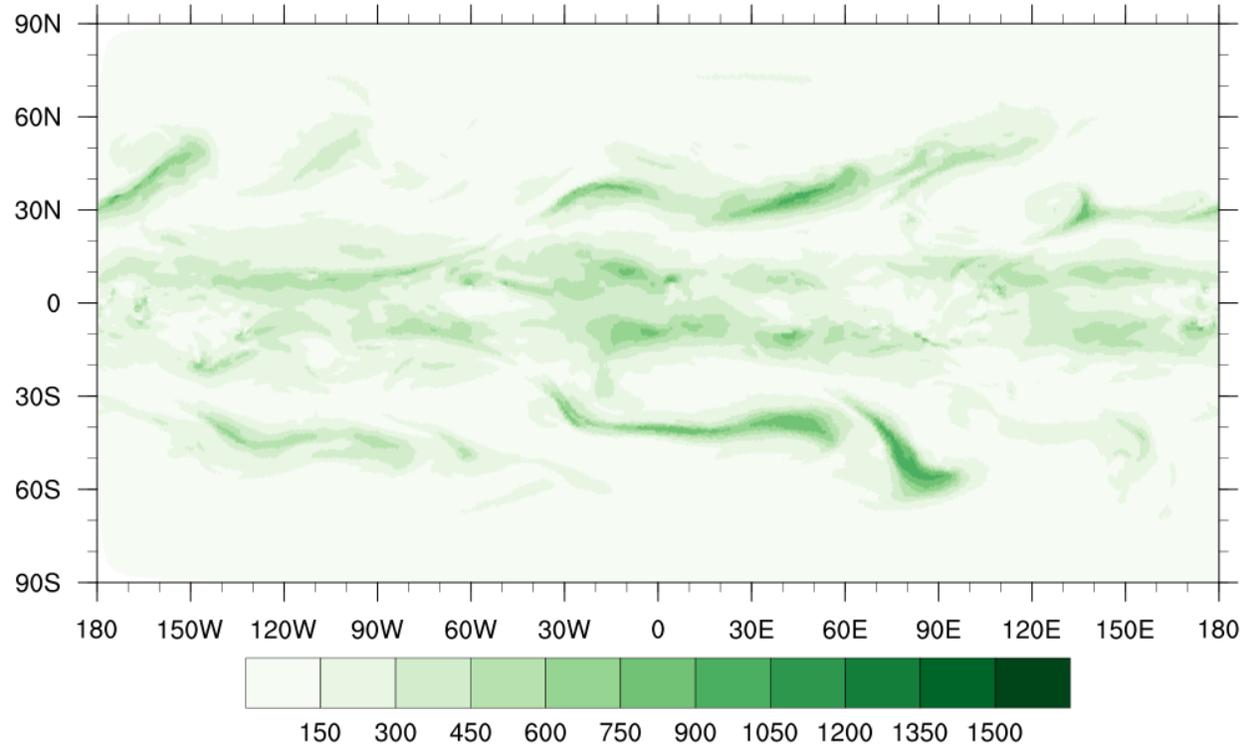
kg / s²



393 Day

Integrated vapor transport

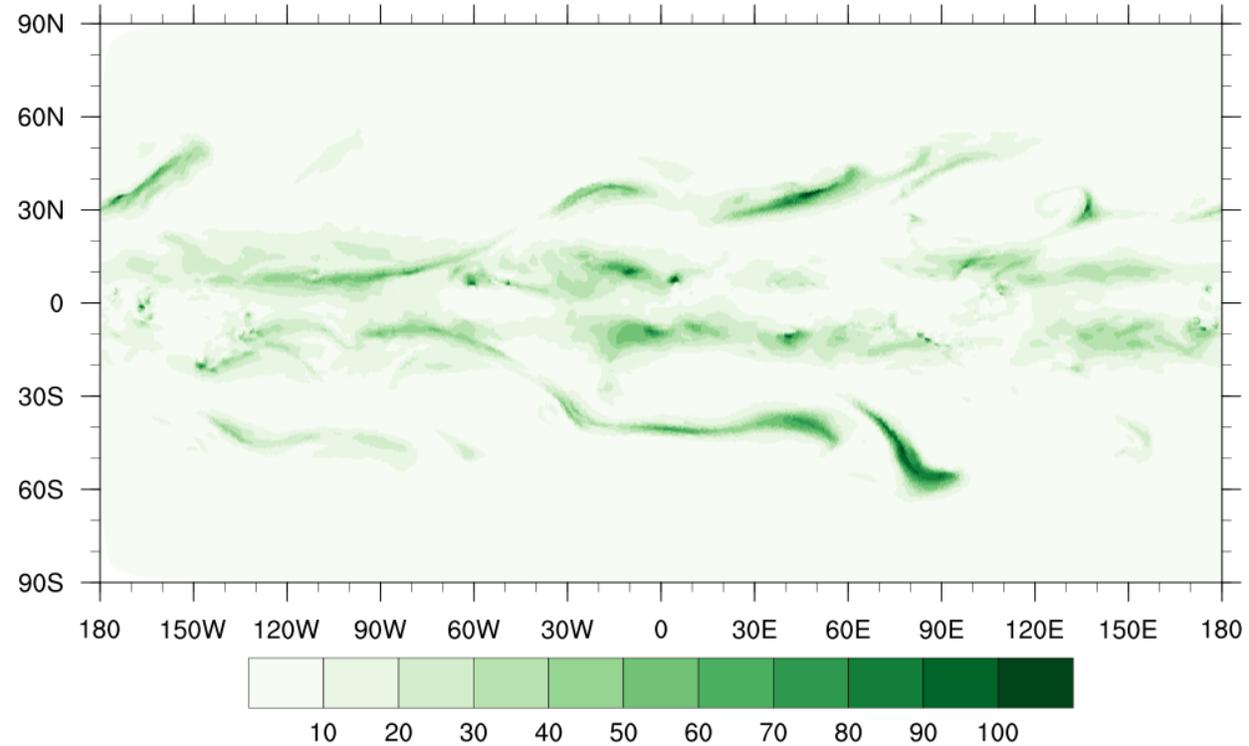
kg / m / s



393 Day

Integrated vapor kinetic energy

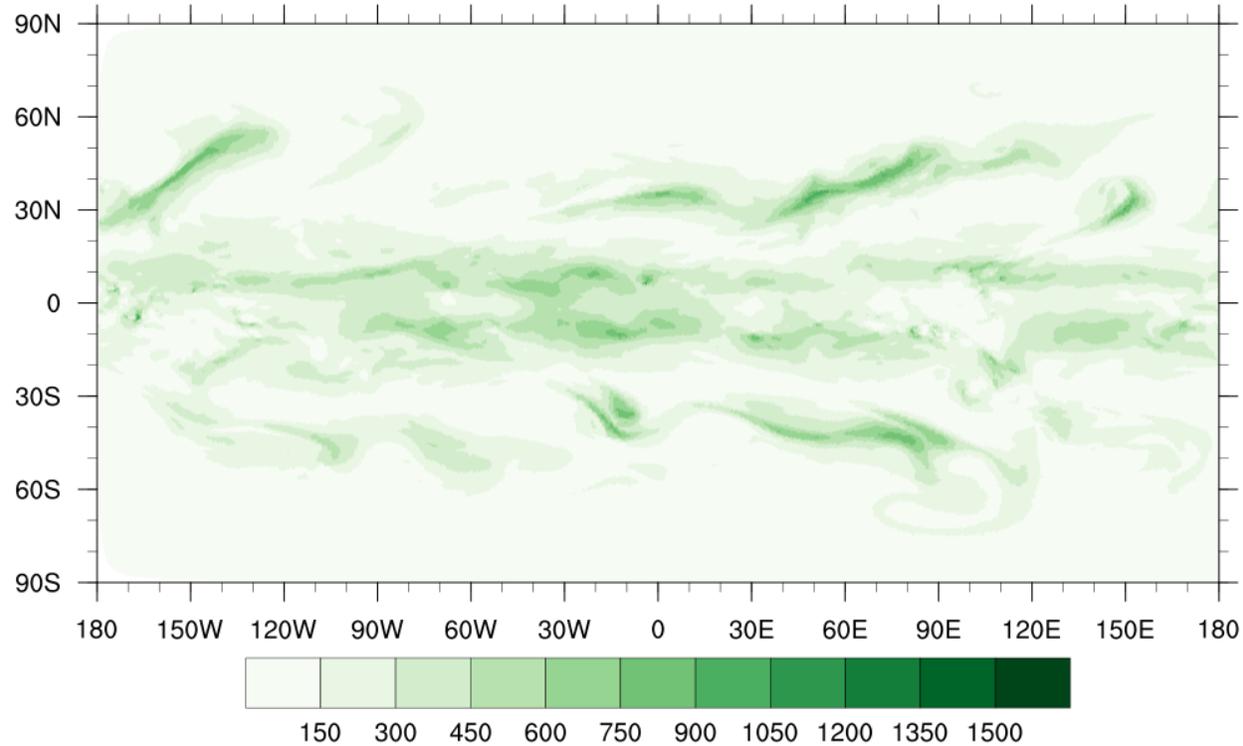
kg / s²



394 Day

Integrated vapor transport

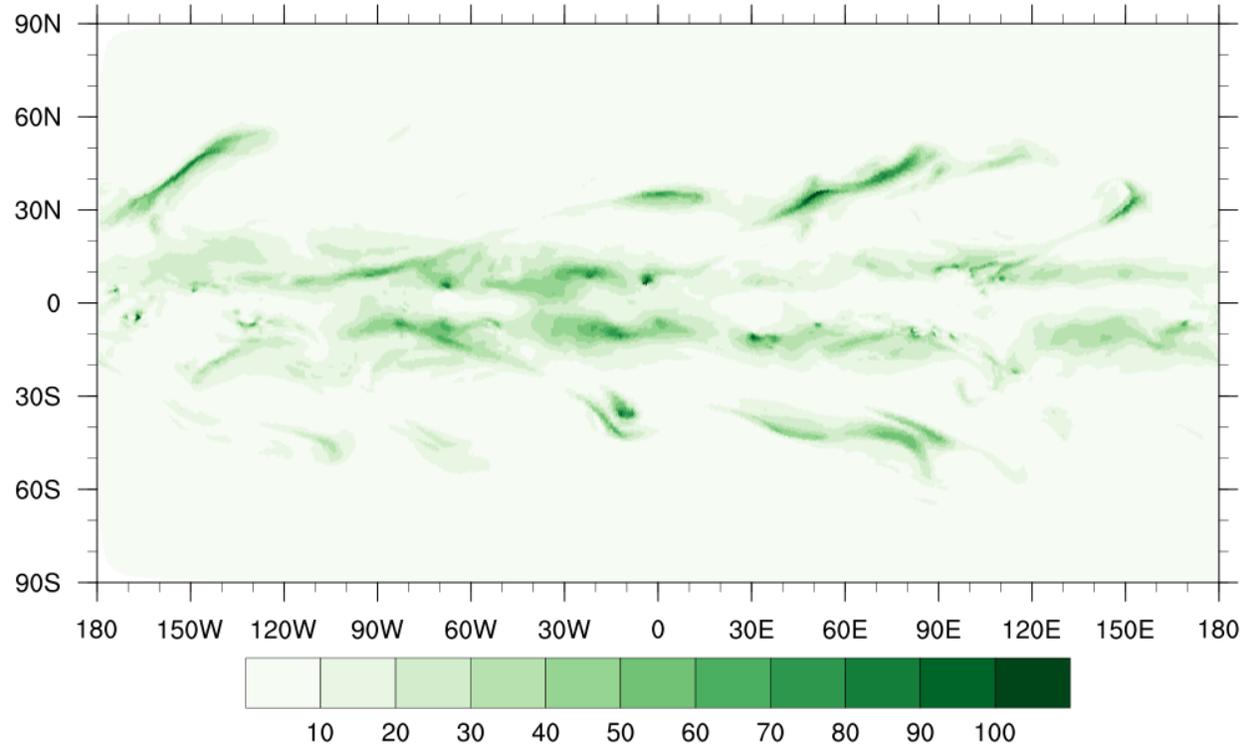
kg / m / s



394 Day

Integrated vapor kinetic energy

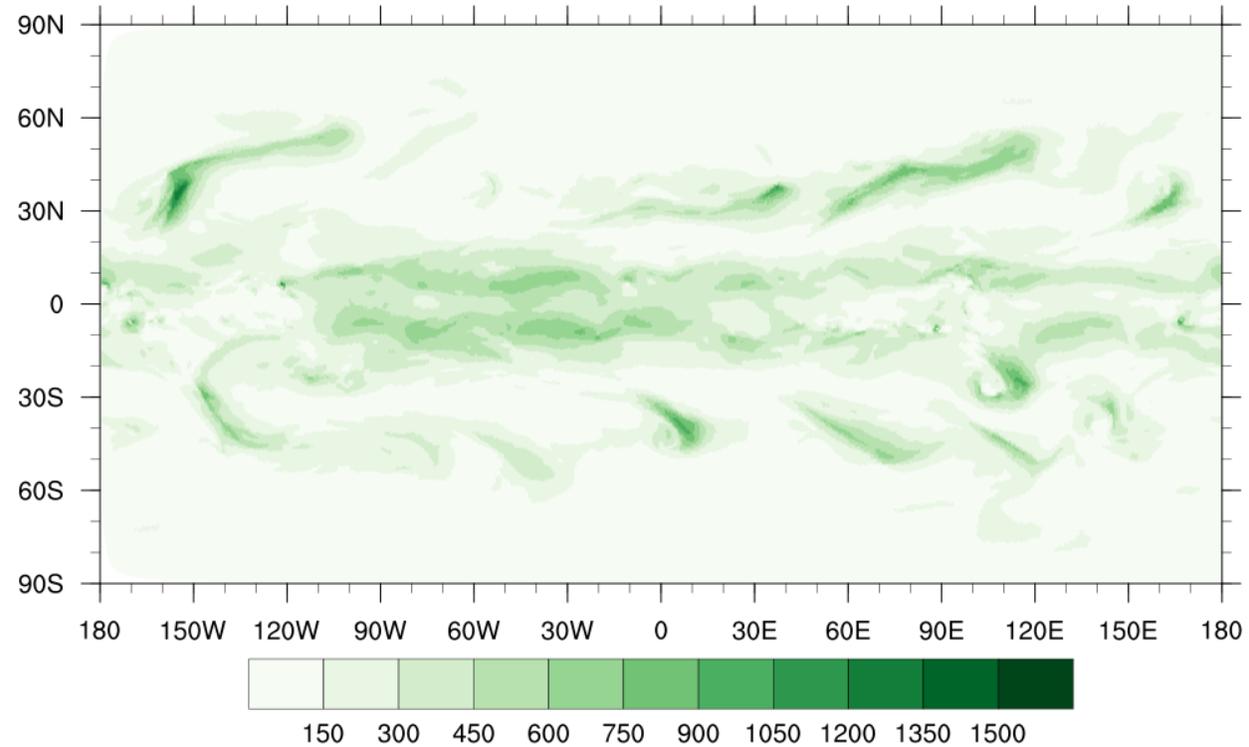
kg / s²



395 Day

Integrated vapor transport

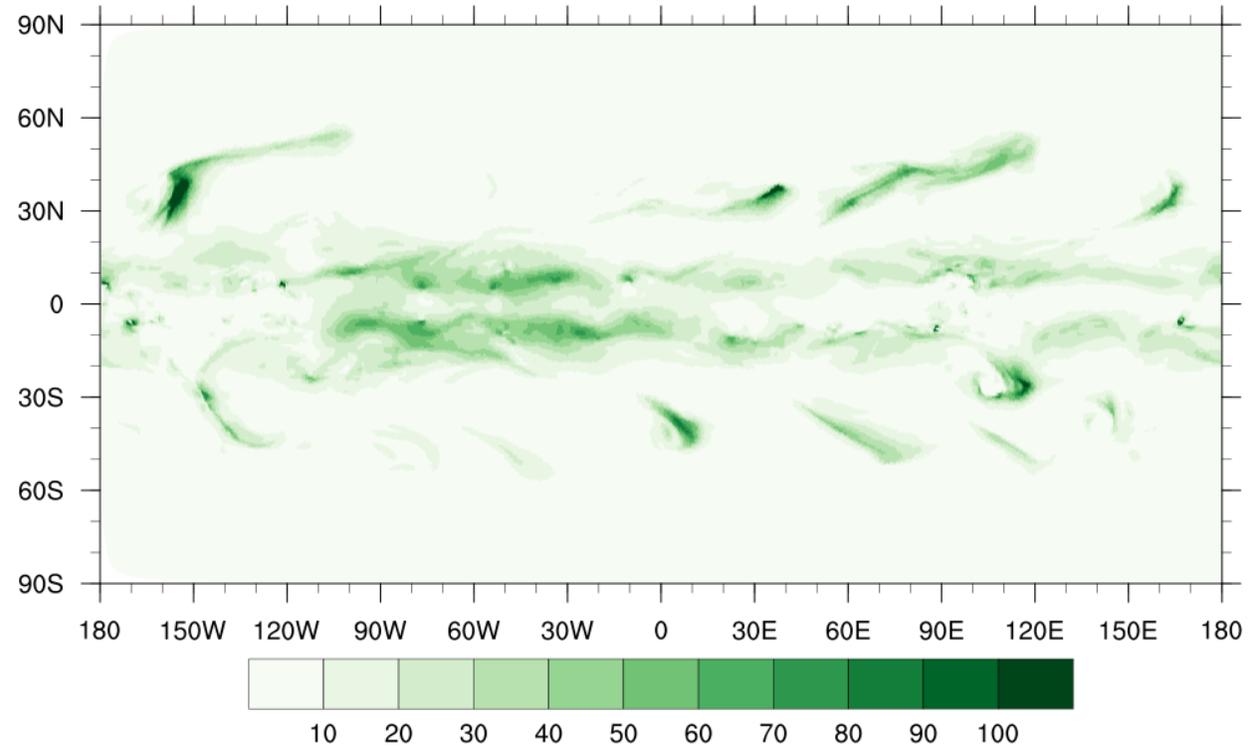
kg / m / s



395 Day

Integrated vapor kinetic energy

kg / s²



解文說字：大港 kah 大條

大港 (tuā-káng)

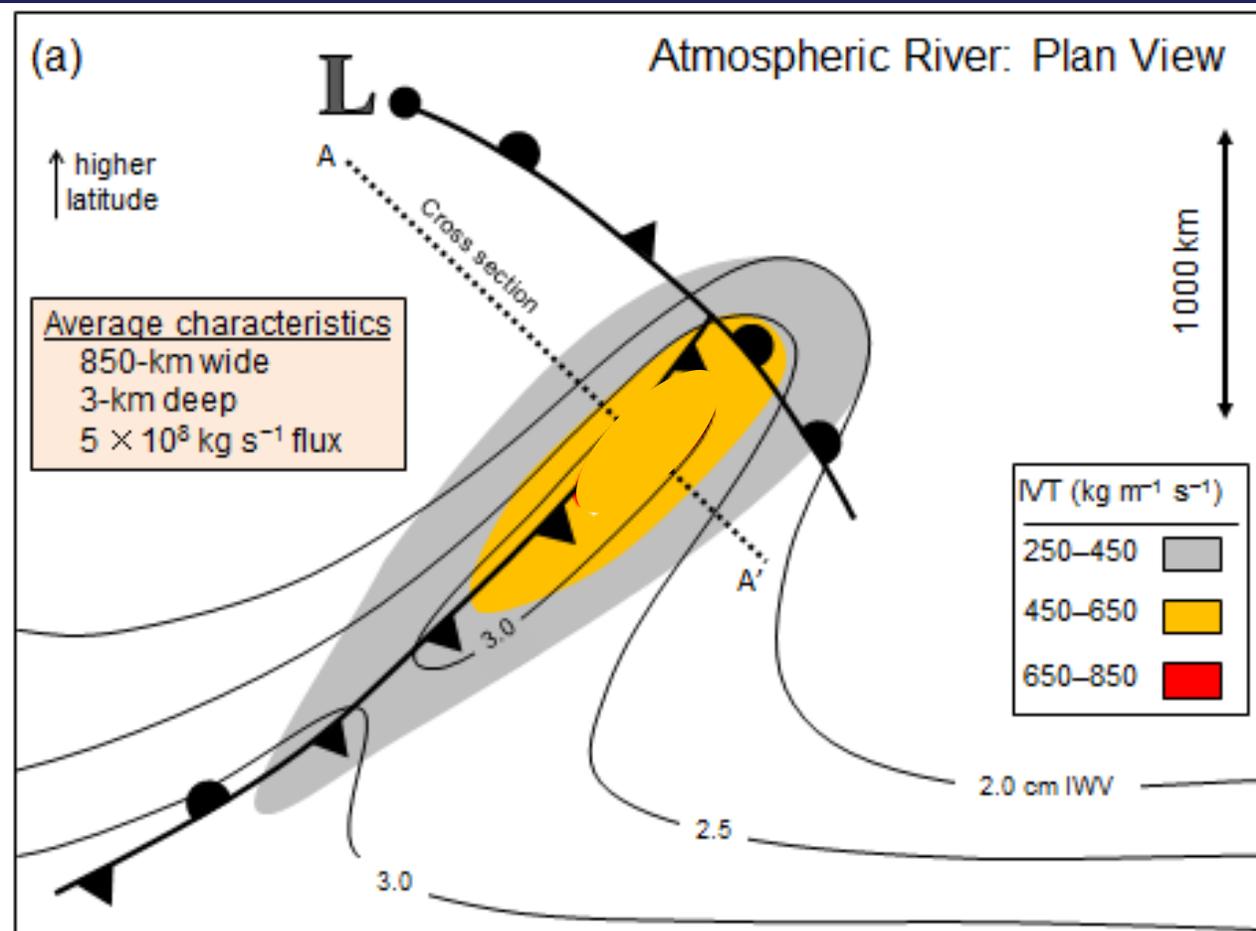
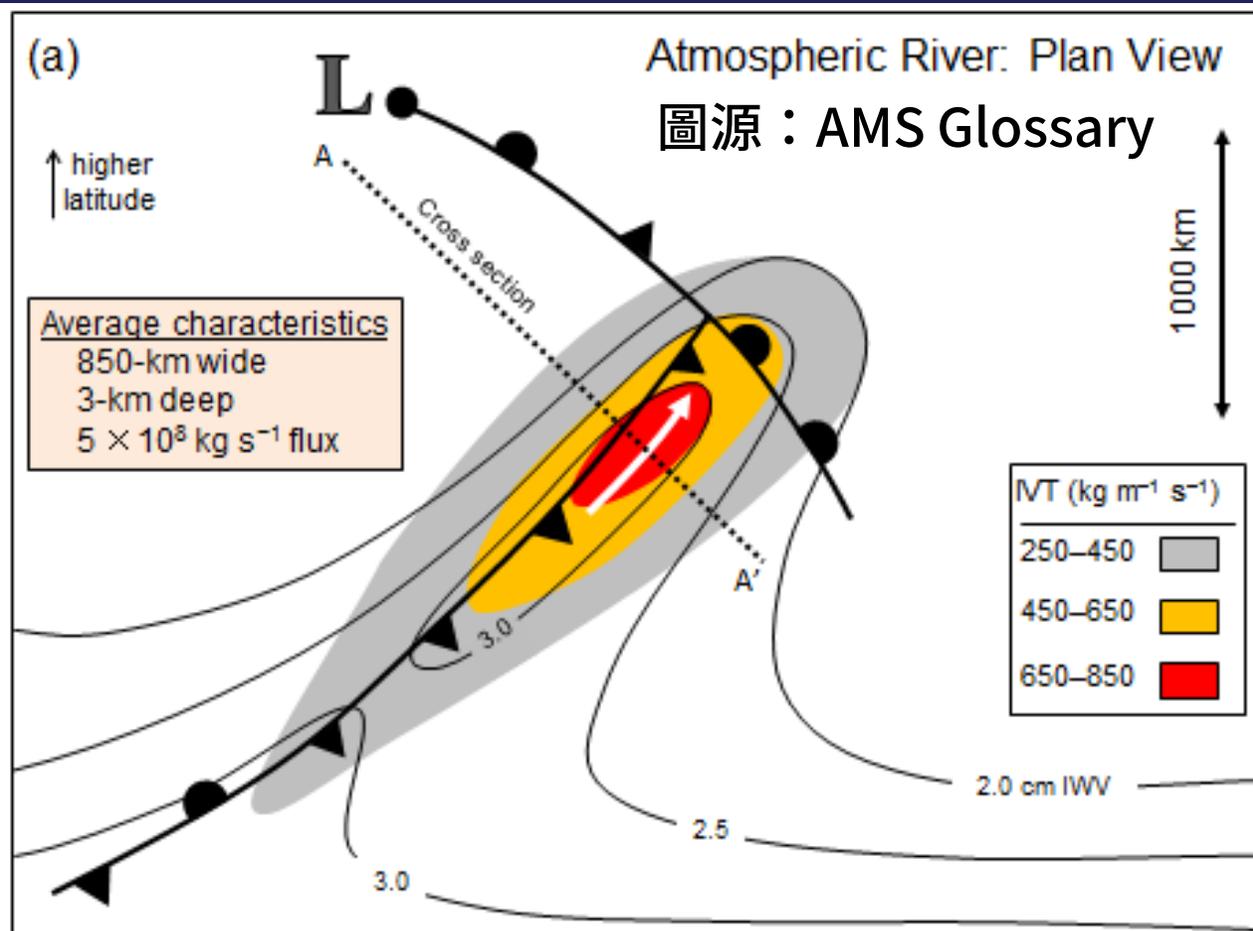
- The flux is strong
- 流量足強
- 一港溪水足大港：
 - 溪水足急
- 一港大氣河足大港：
 - 溼氣流足強

大條 (tuā-tiâu)

- The flow is wide
- 範圍足闊
- 一條溪水足大條
 - 溪水足闊
- 一條大氣河足大條
 - 溼氣流足闊

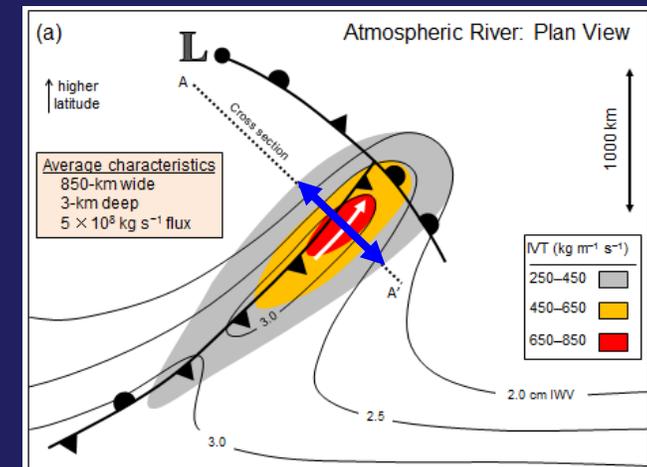
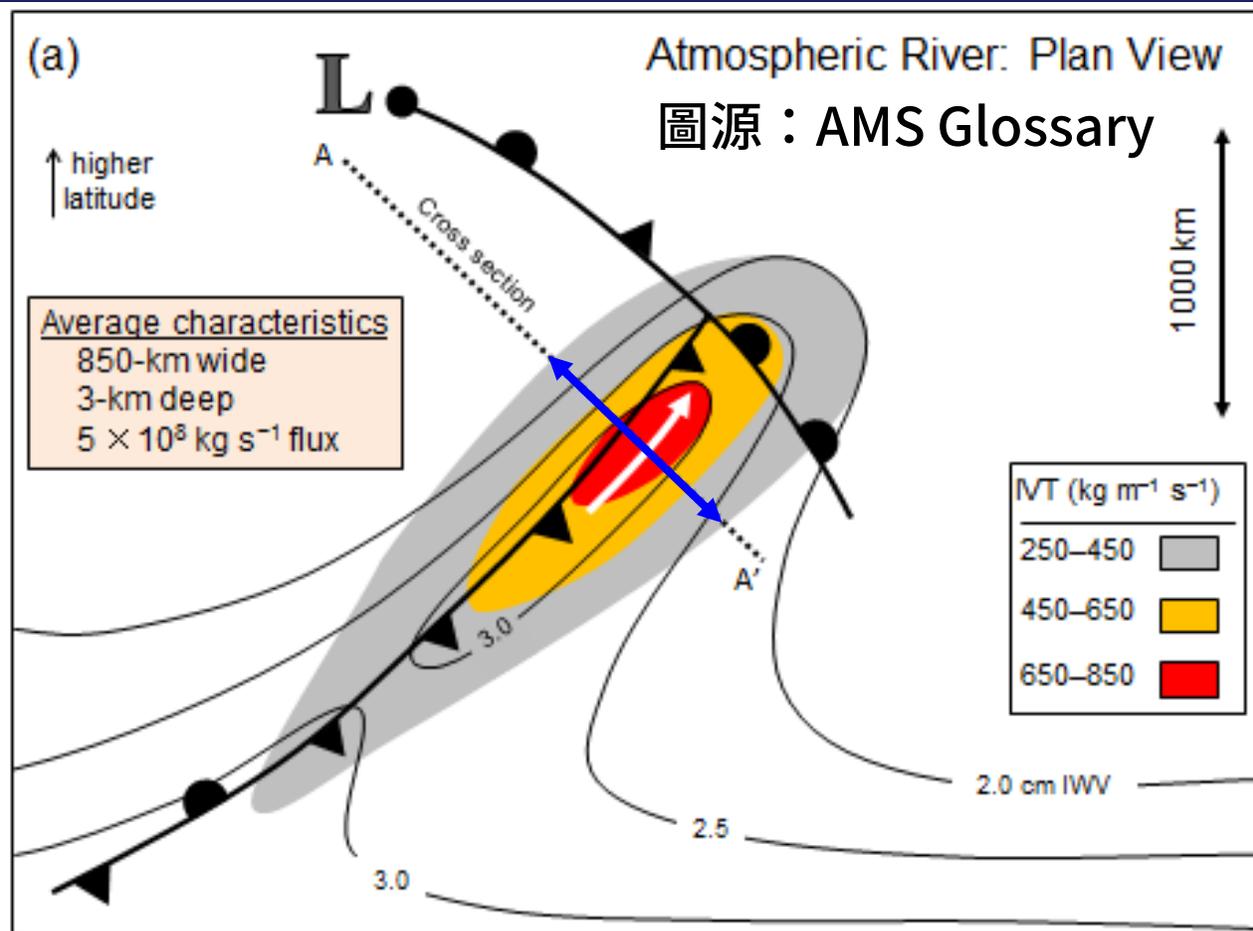
大港

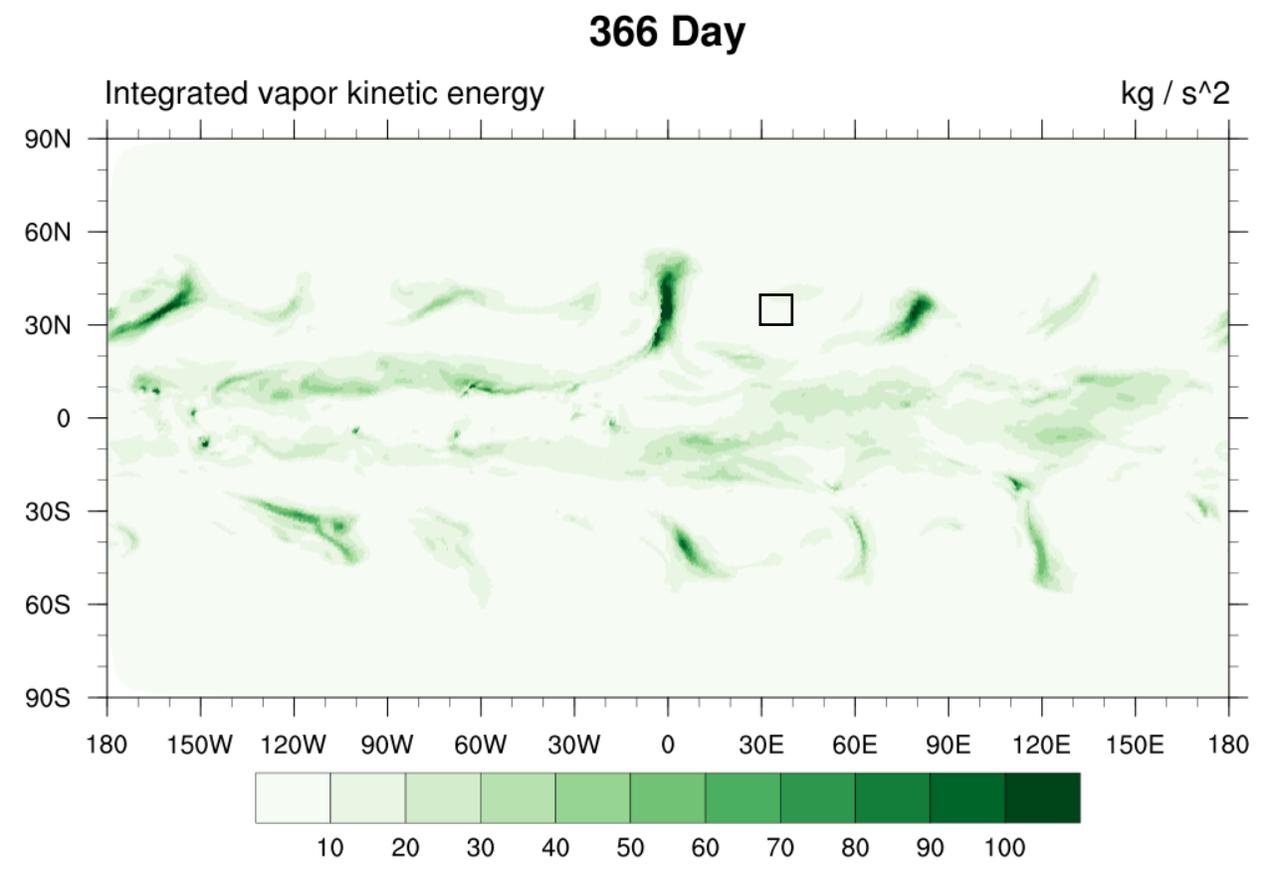
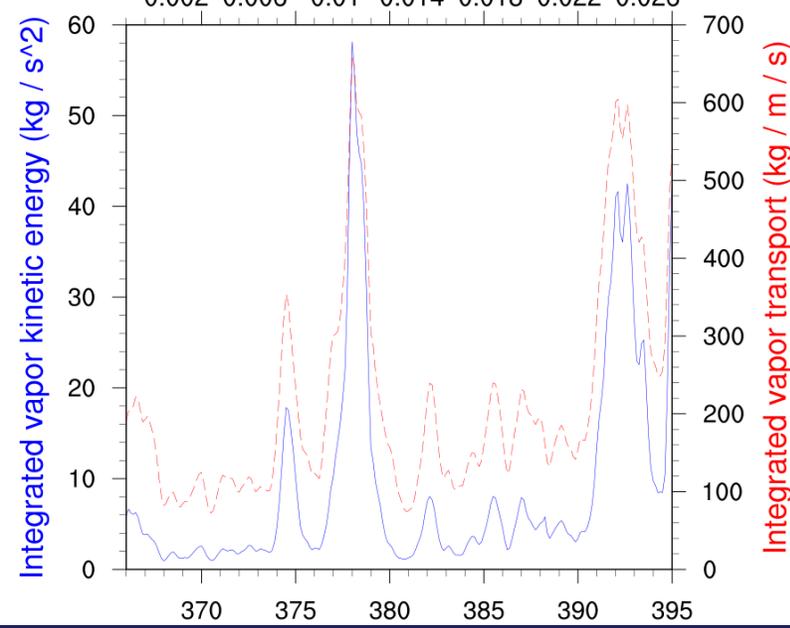
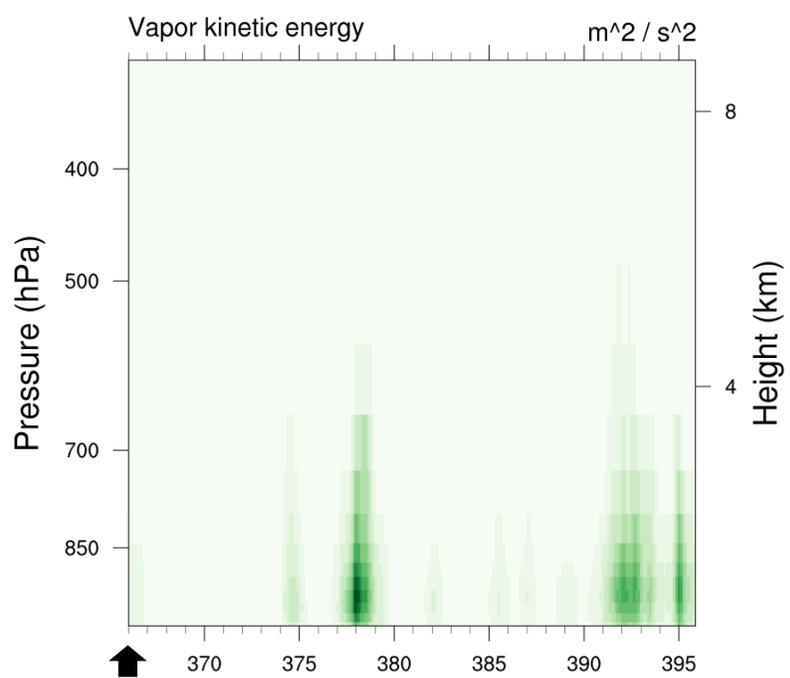
細港

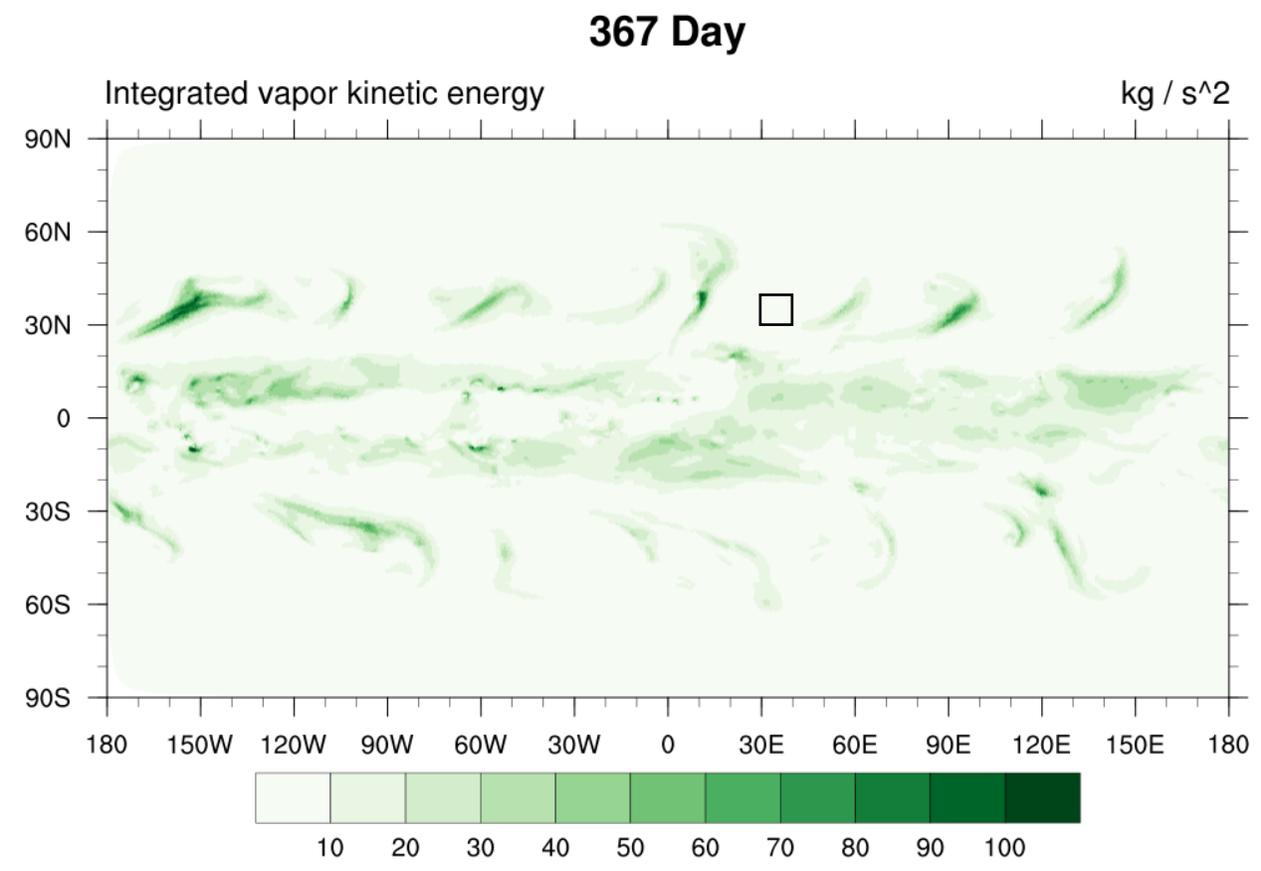
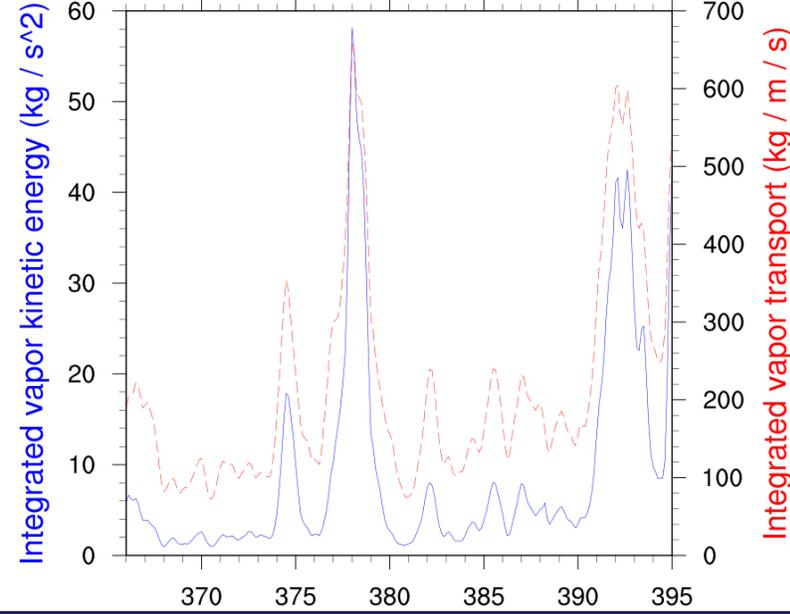
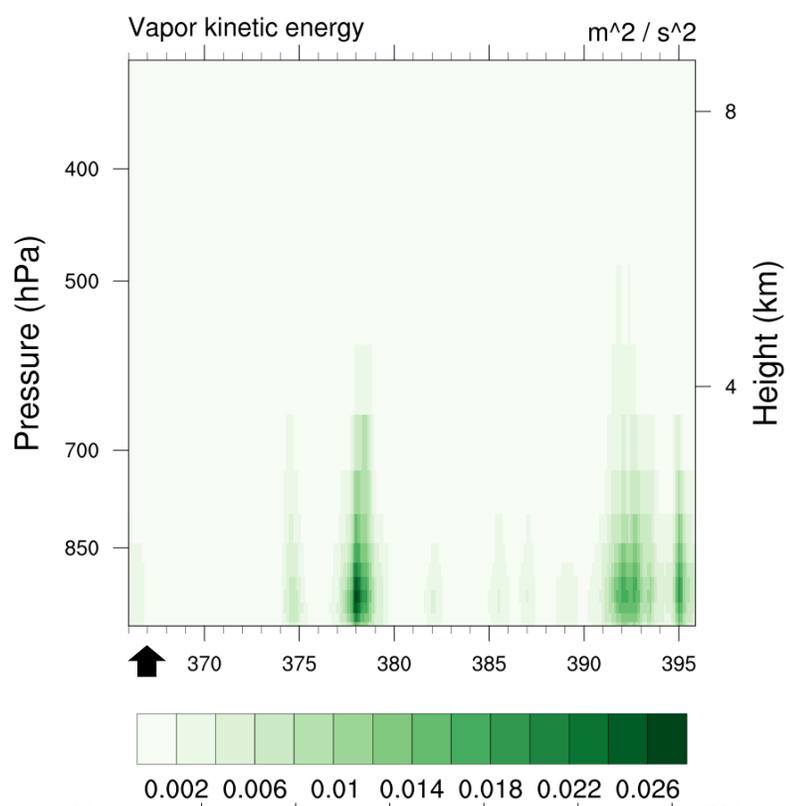


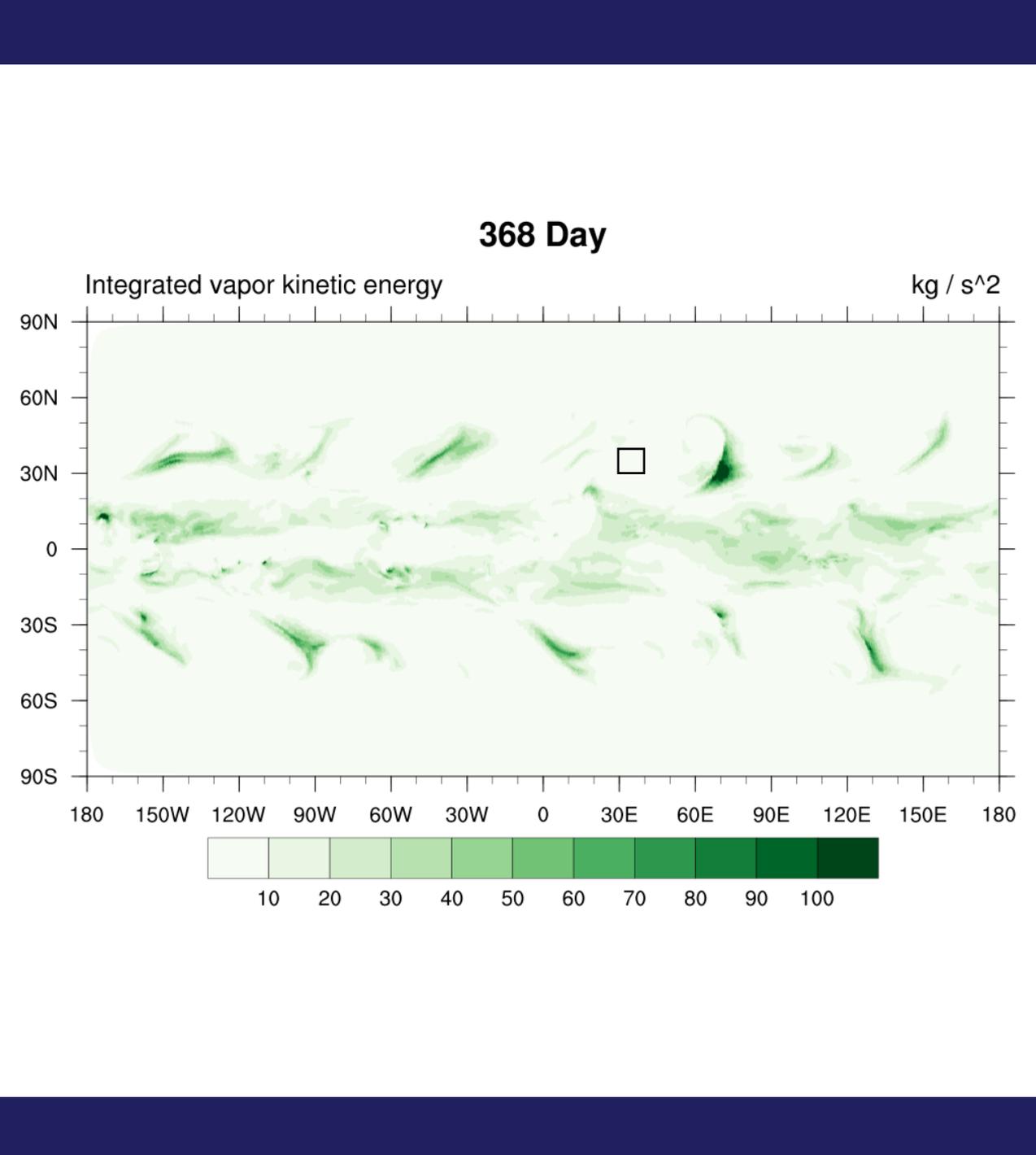
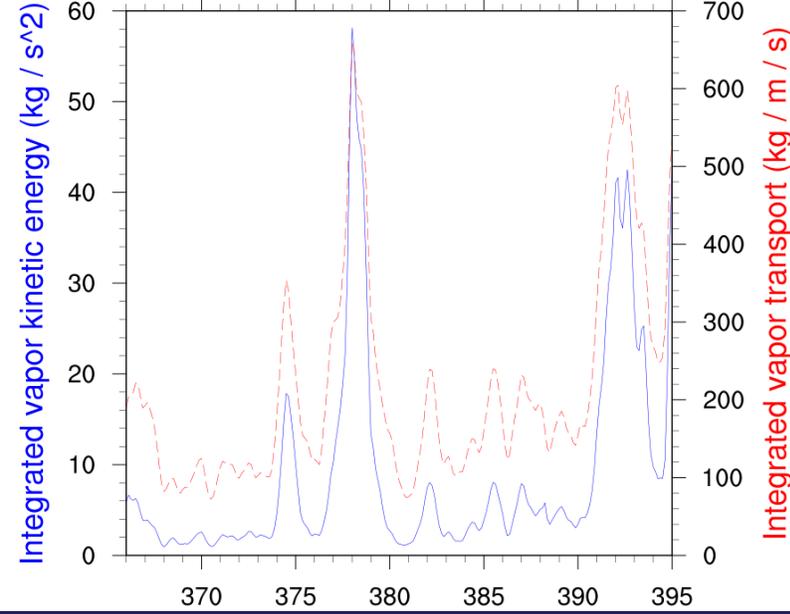
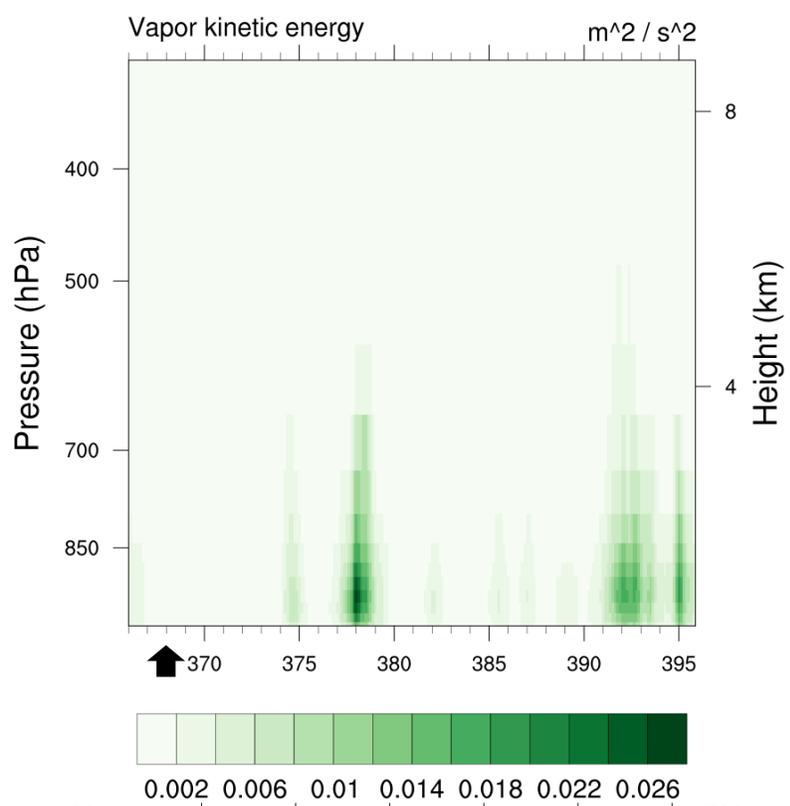
大條

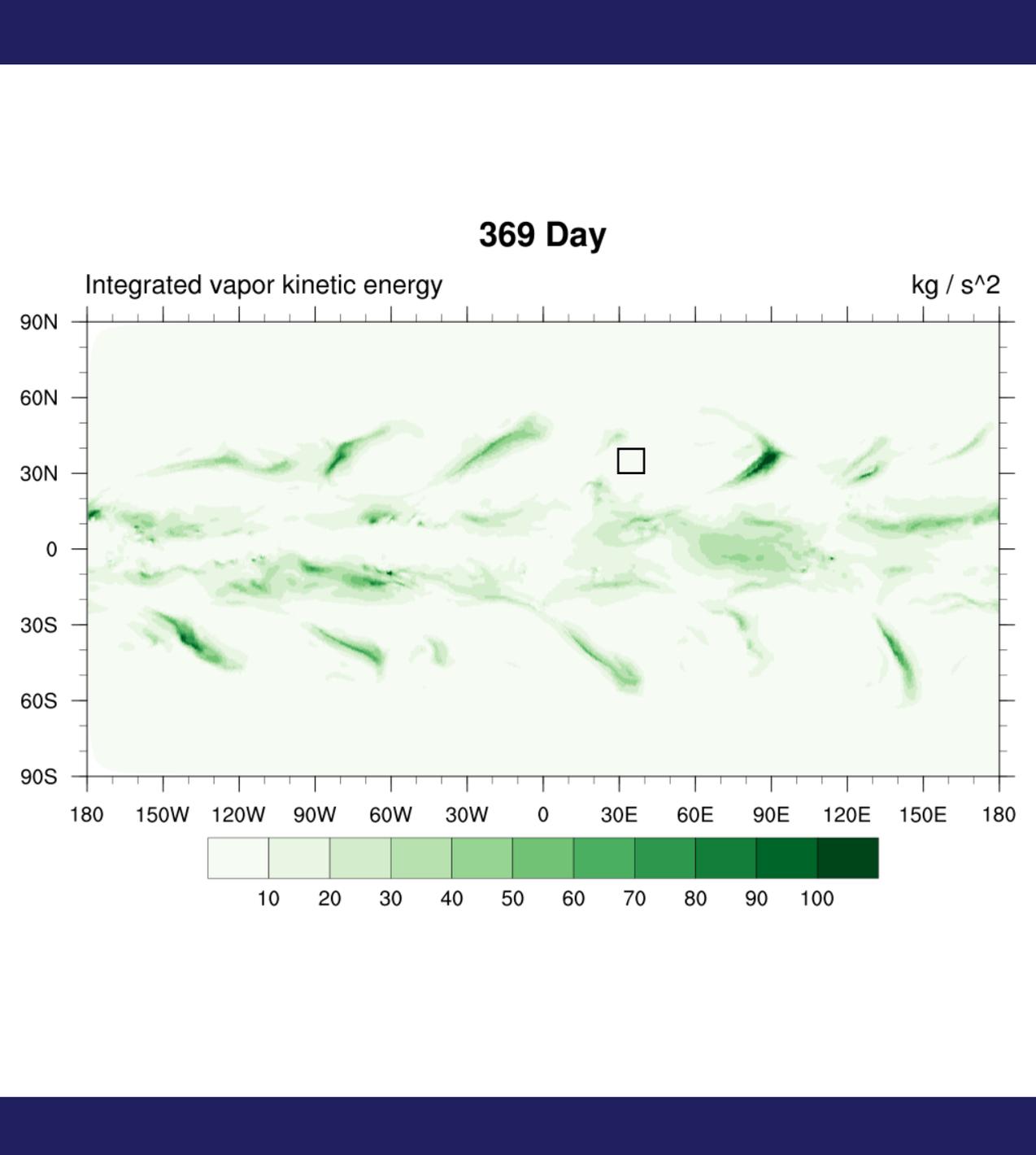
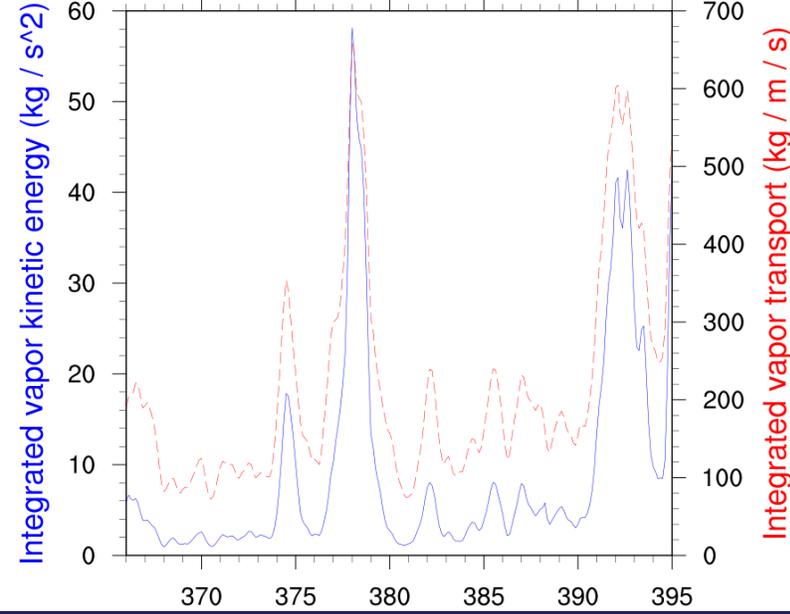
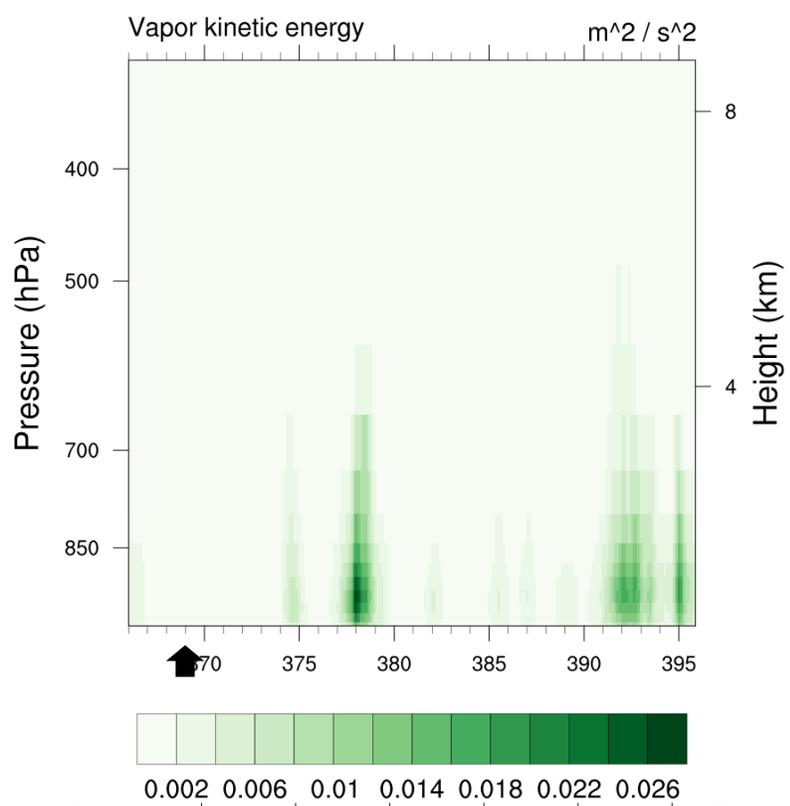
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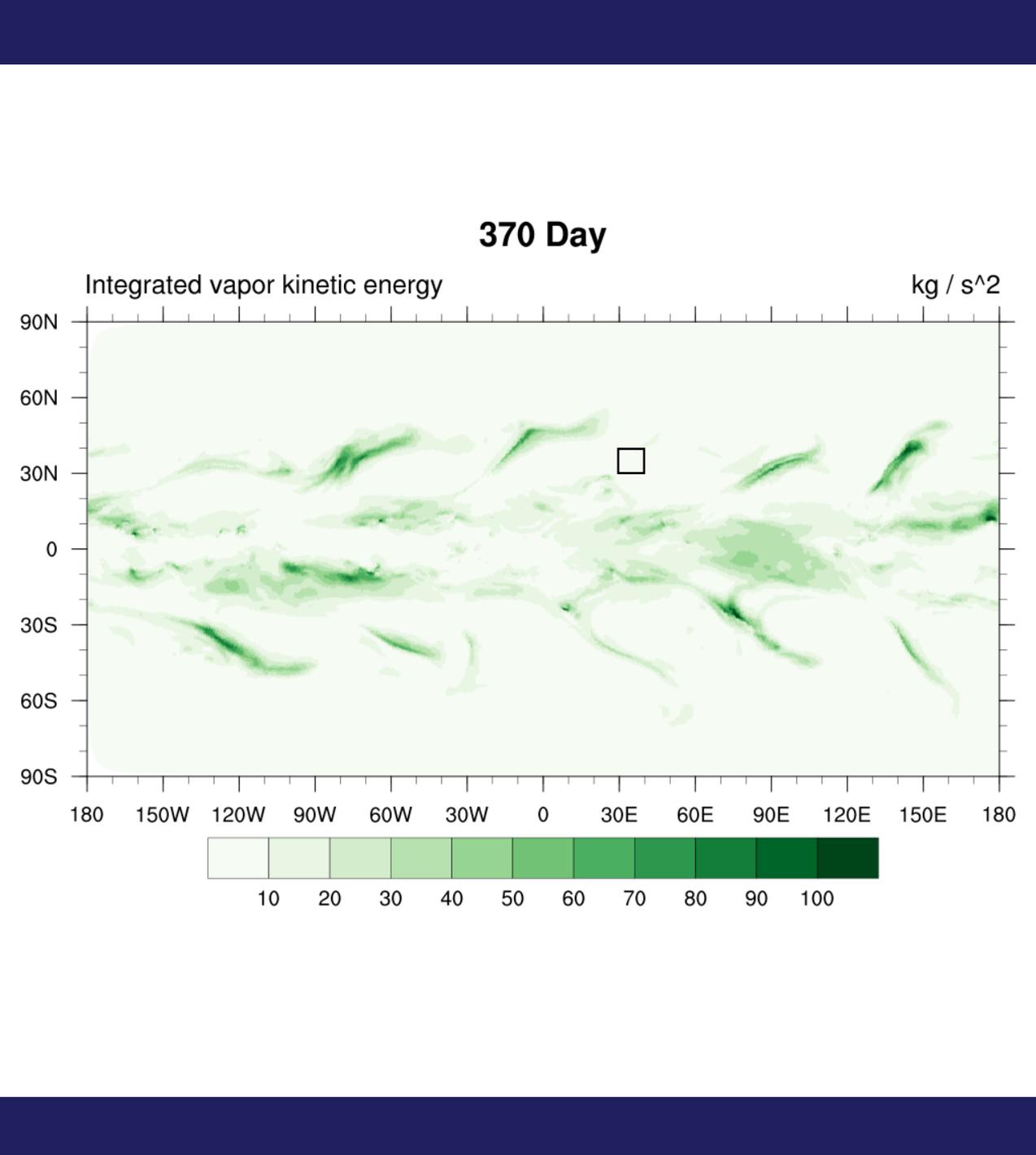
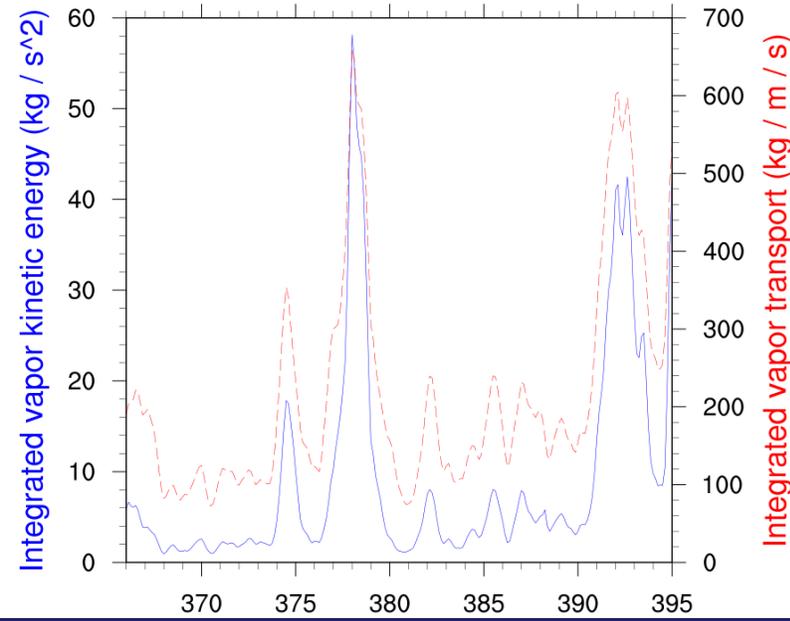
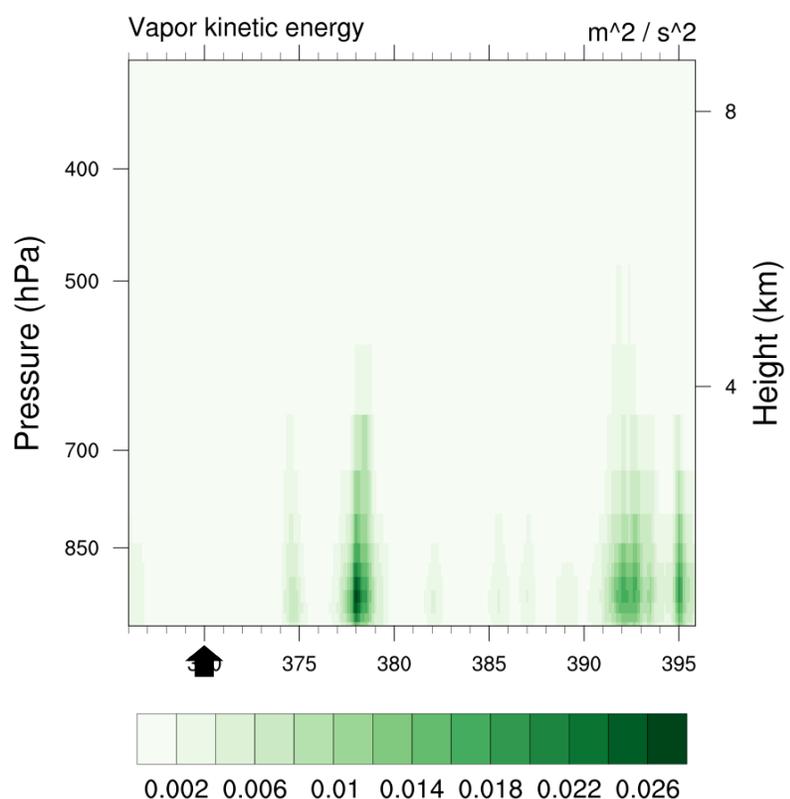


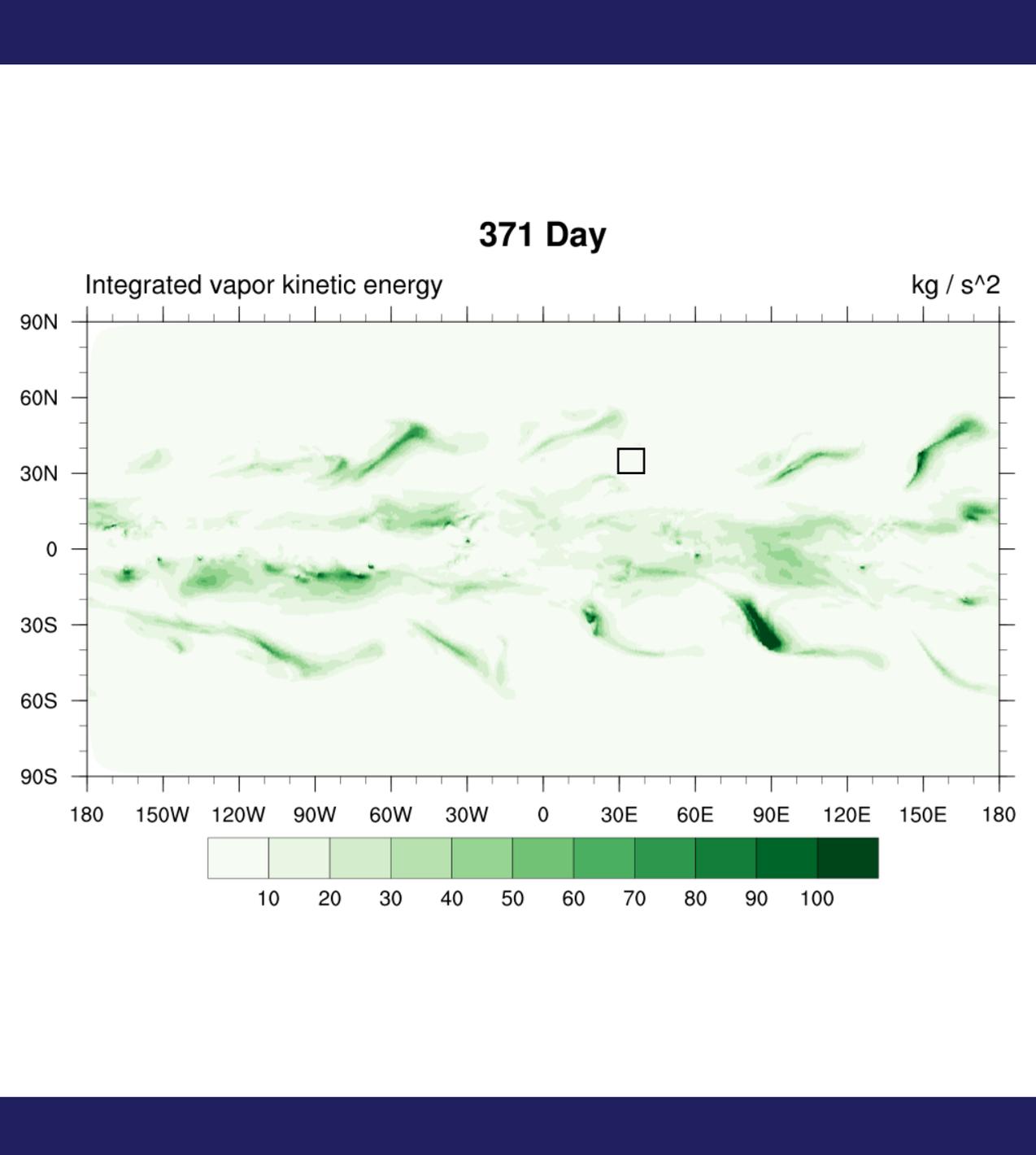
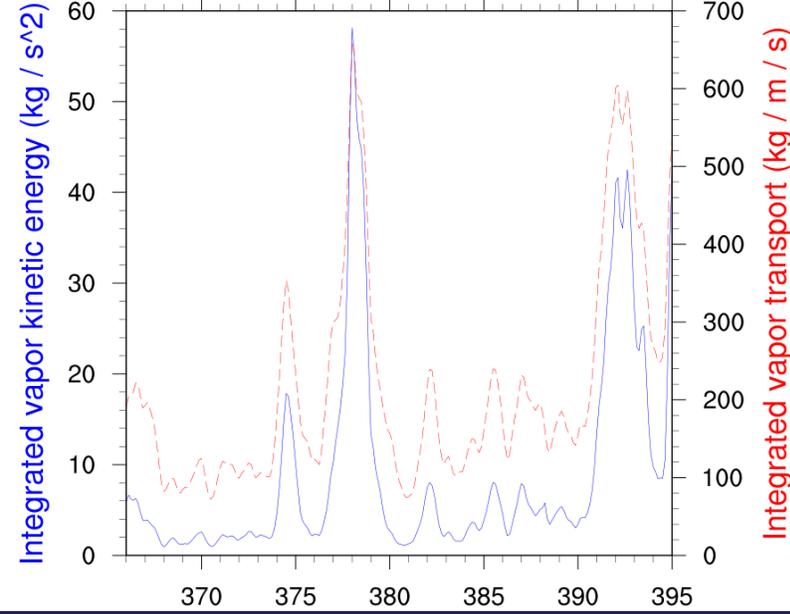
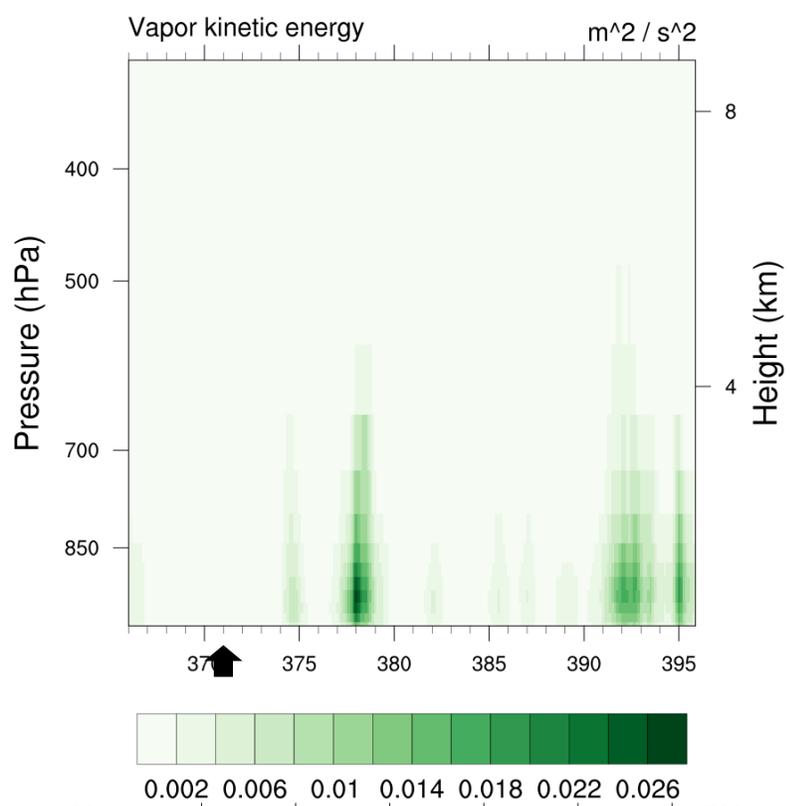


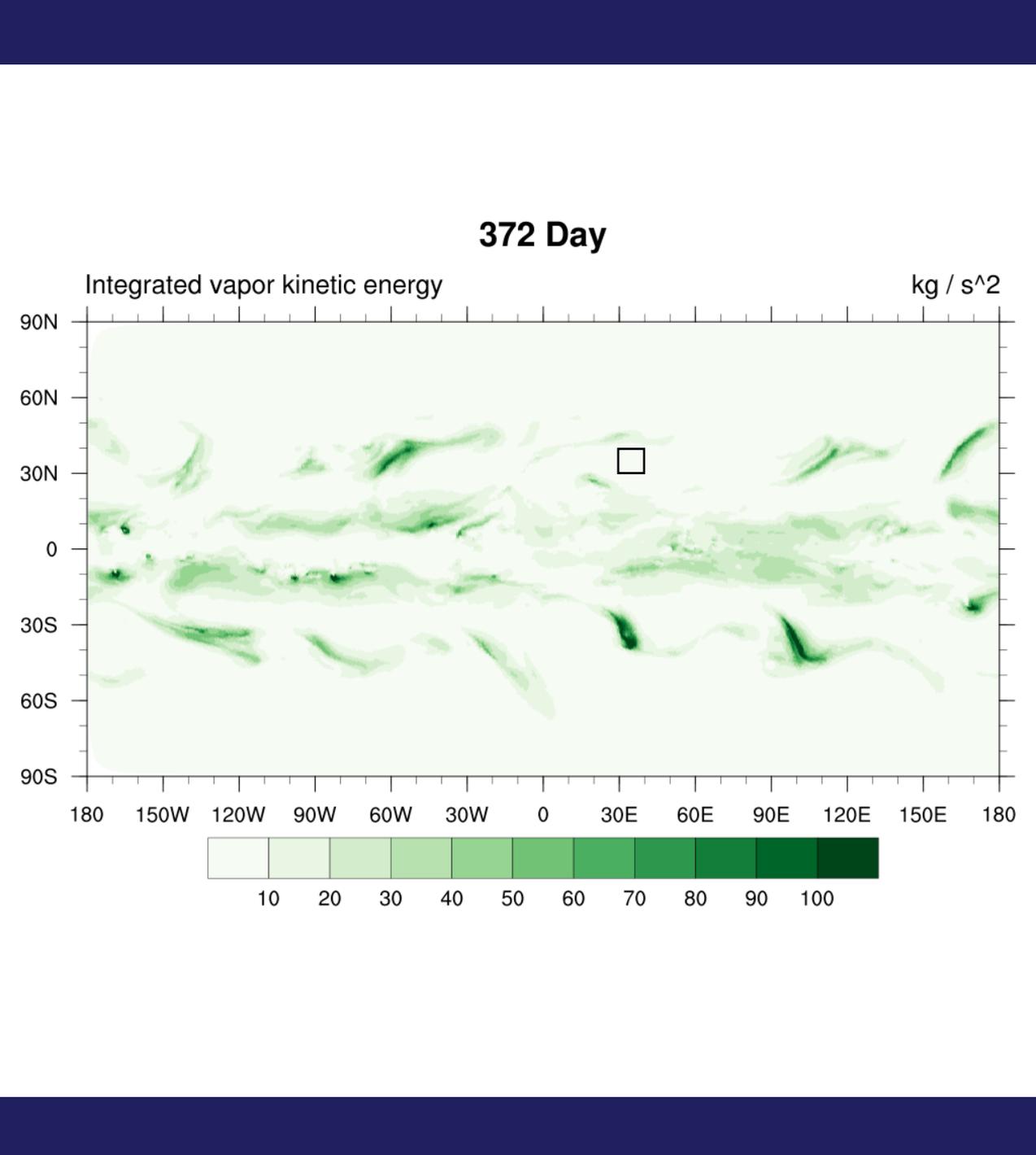
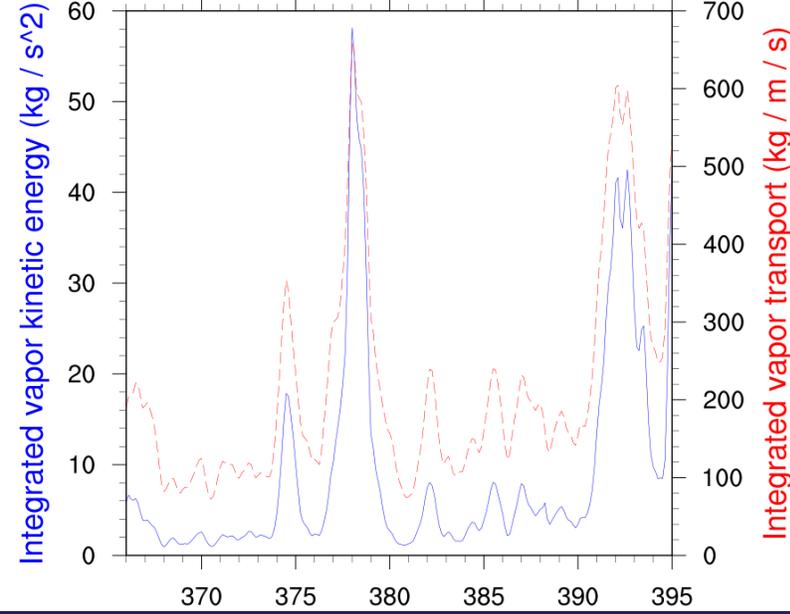
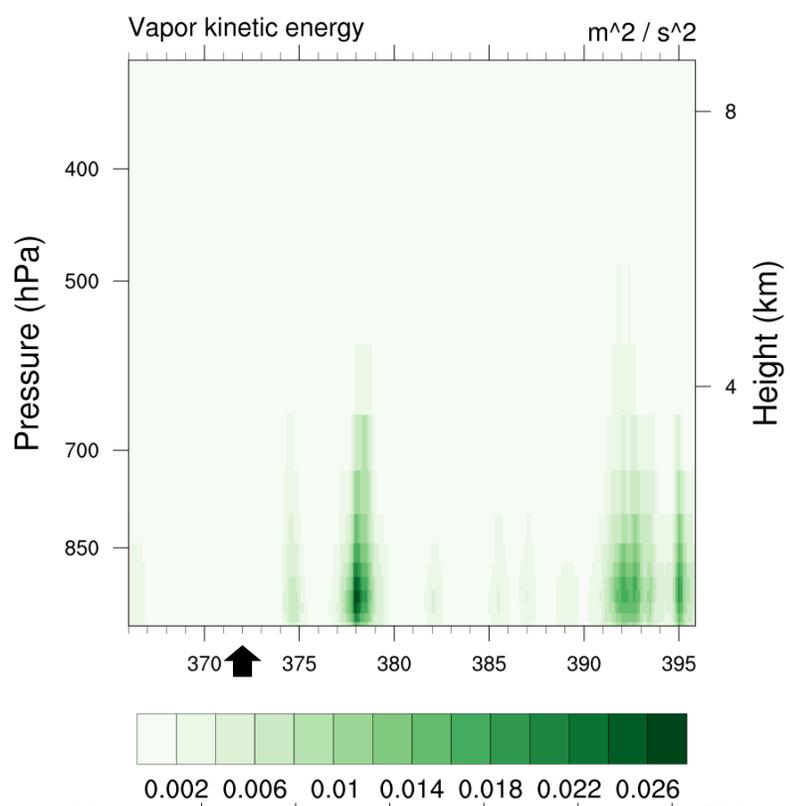


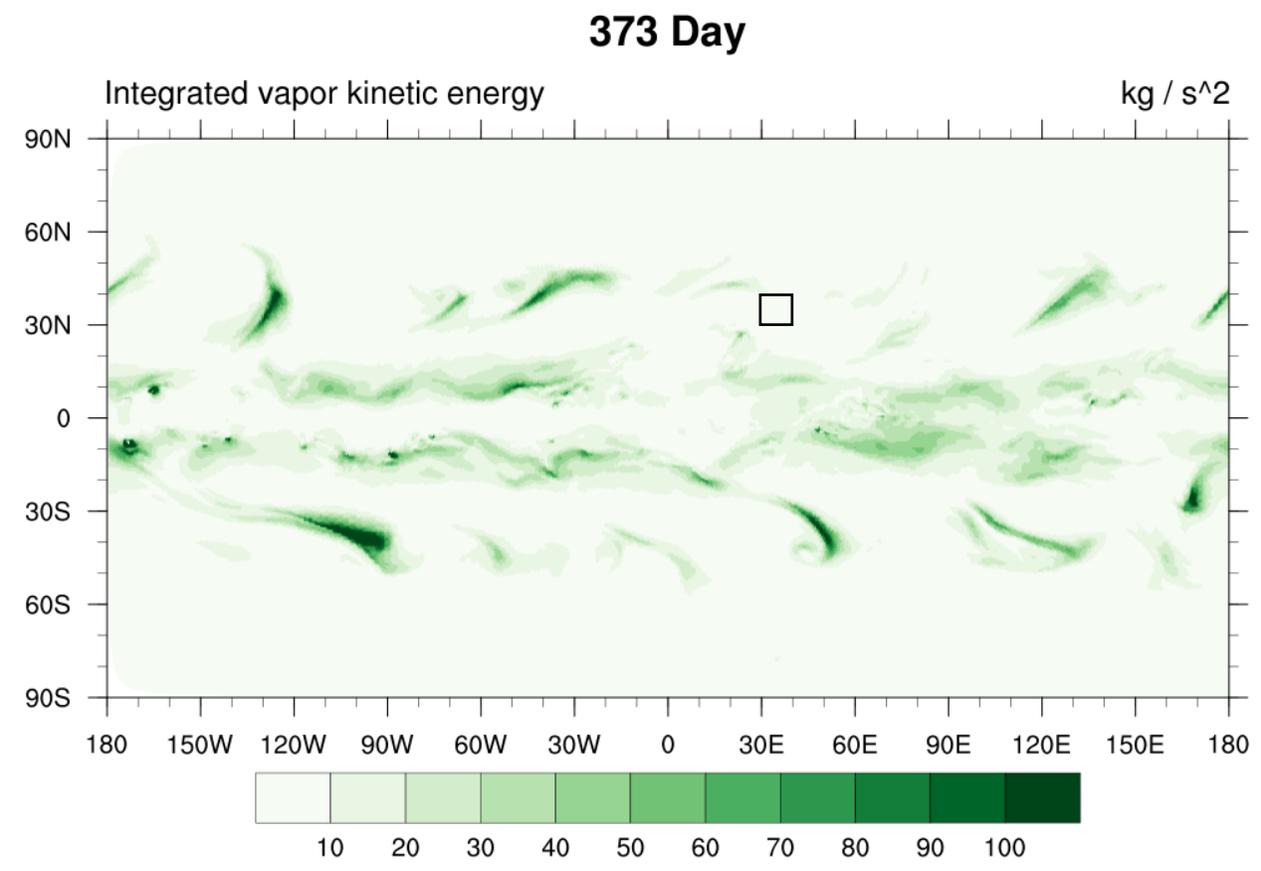
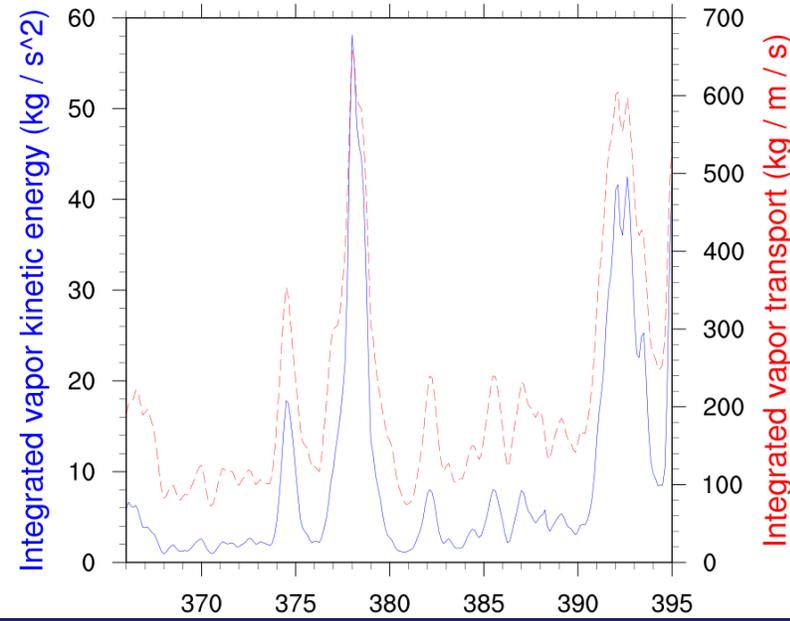
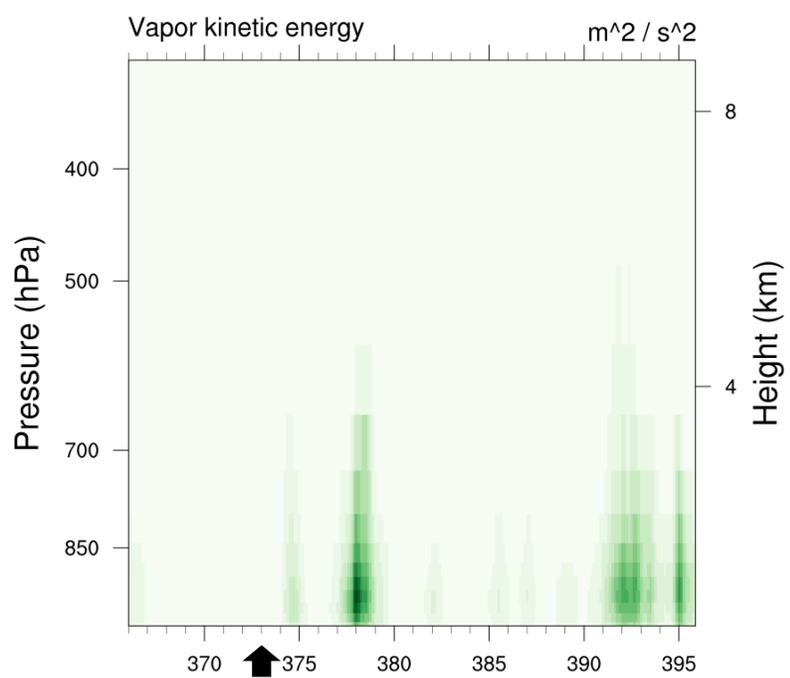


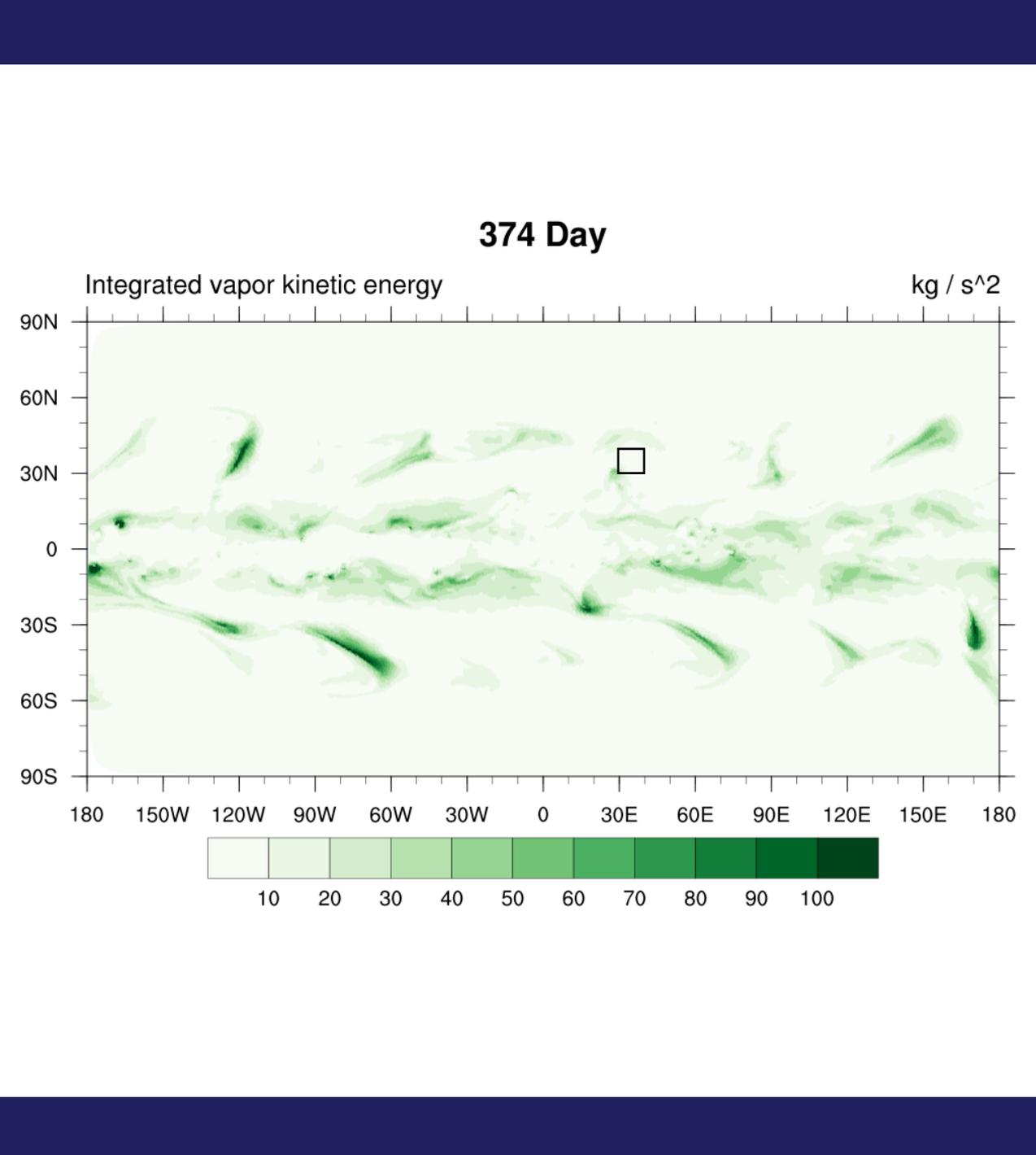
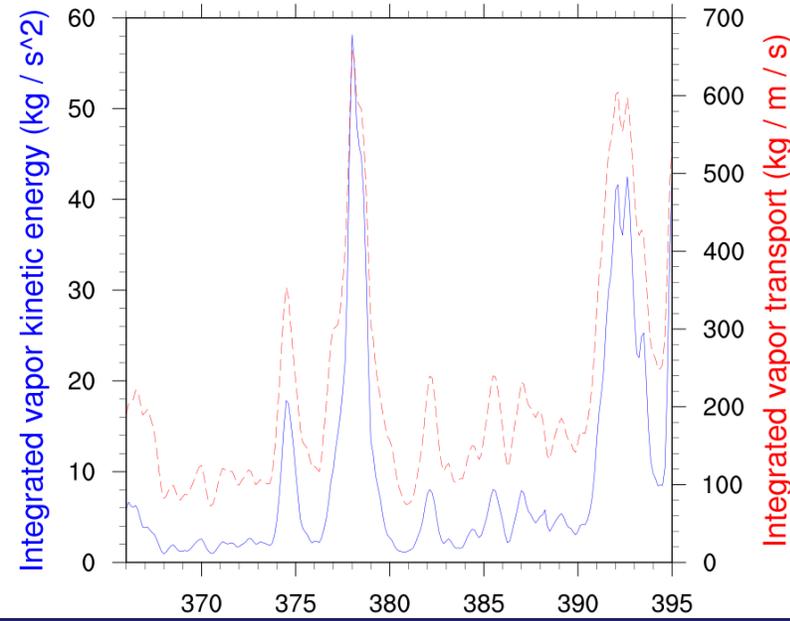
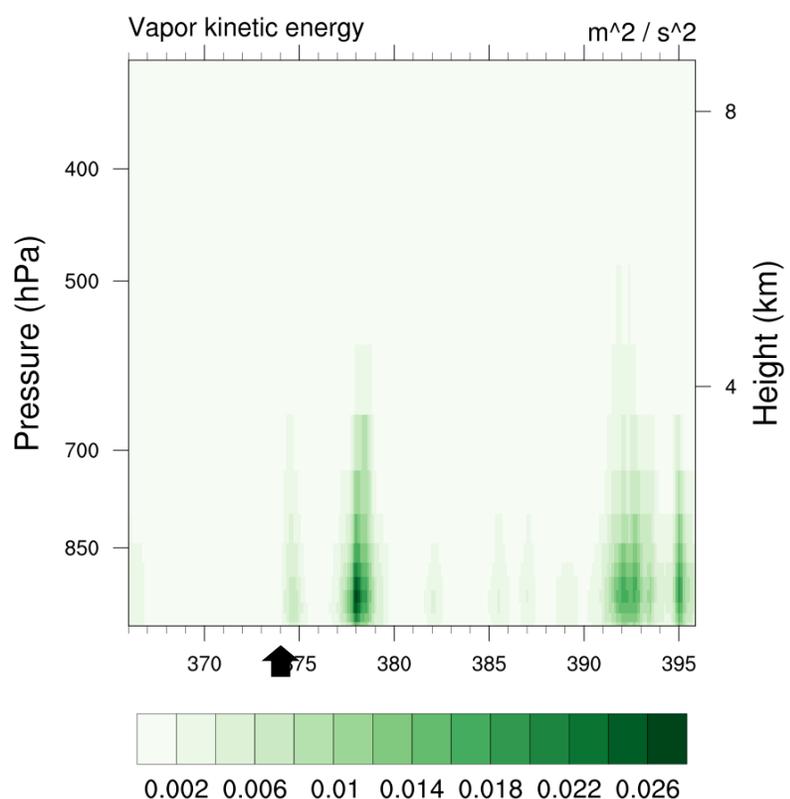


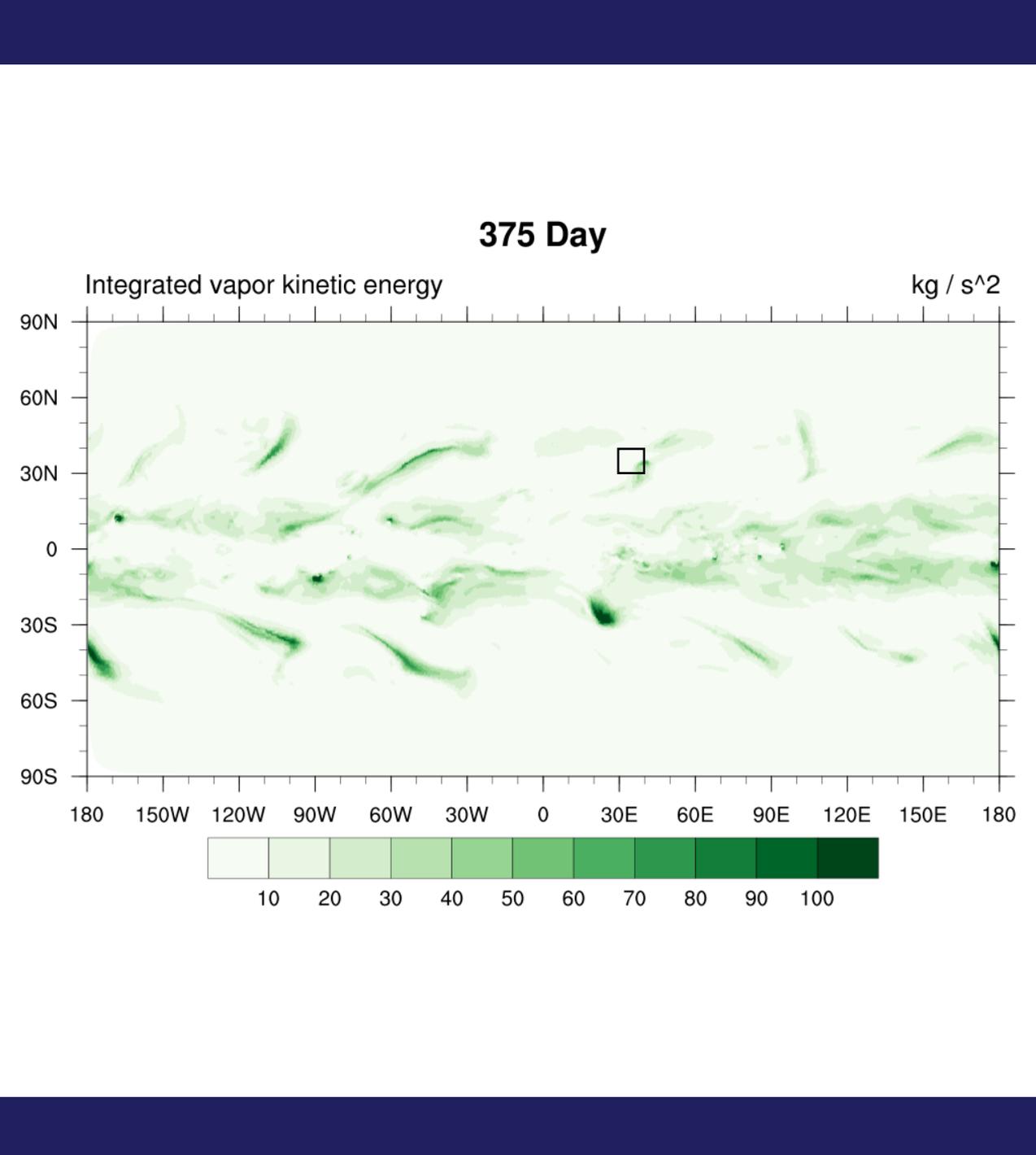
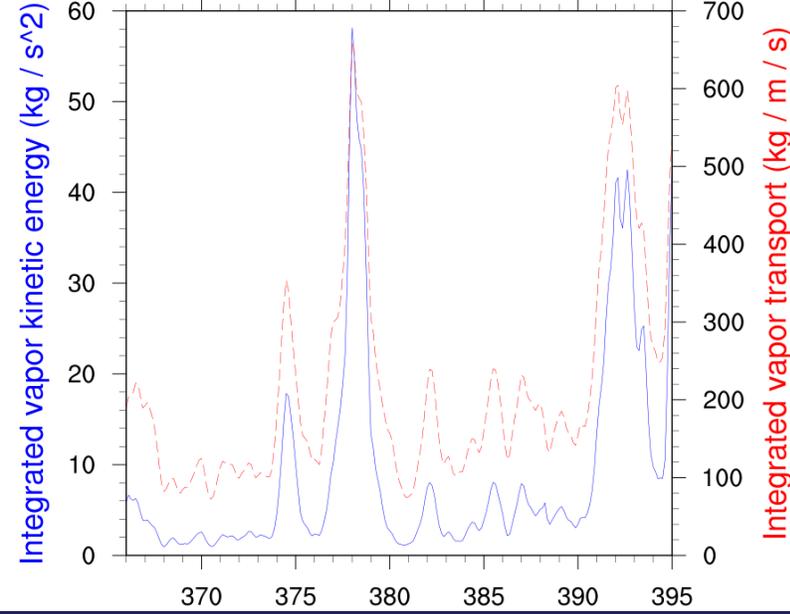
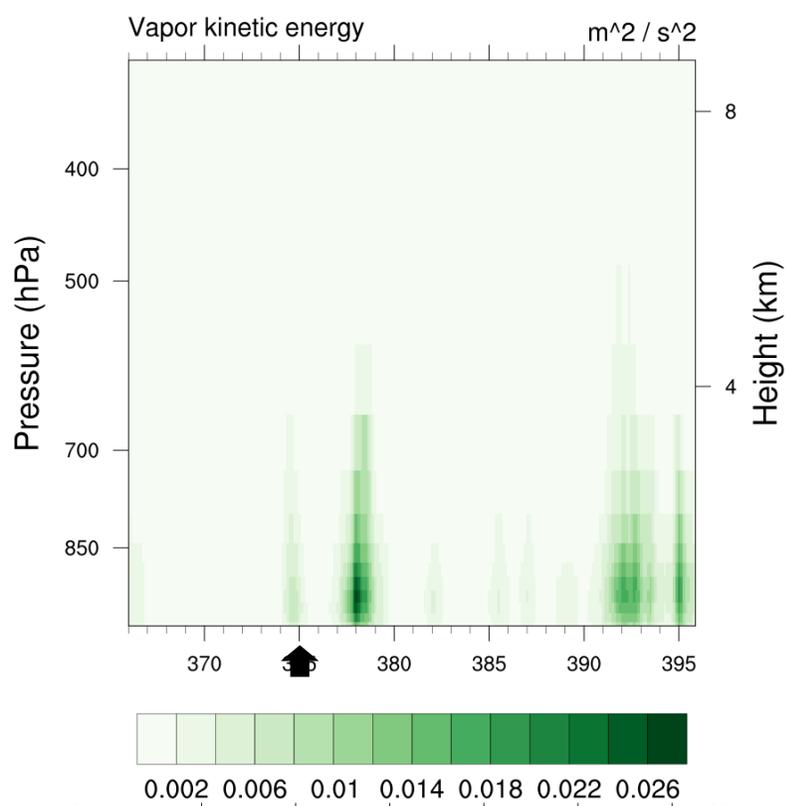


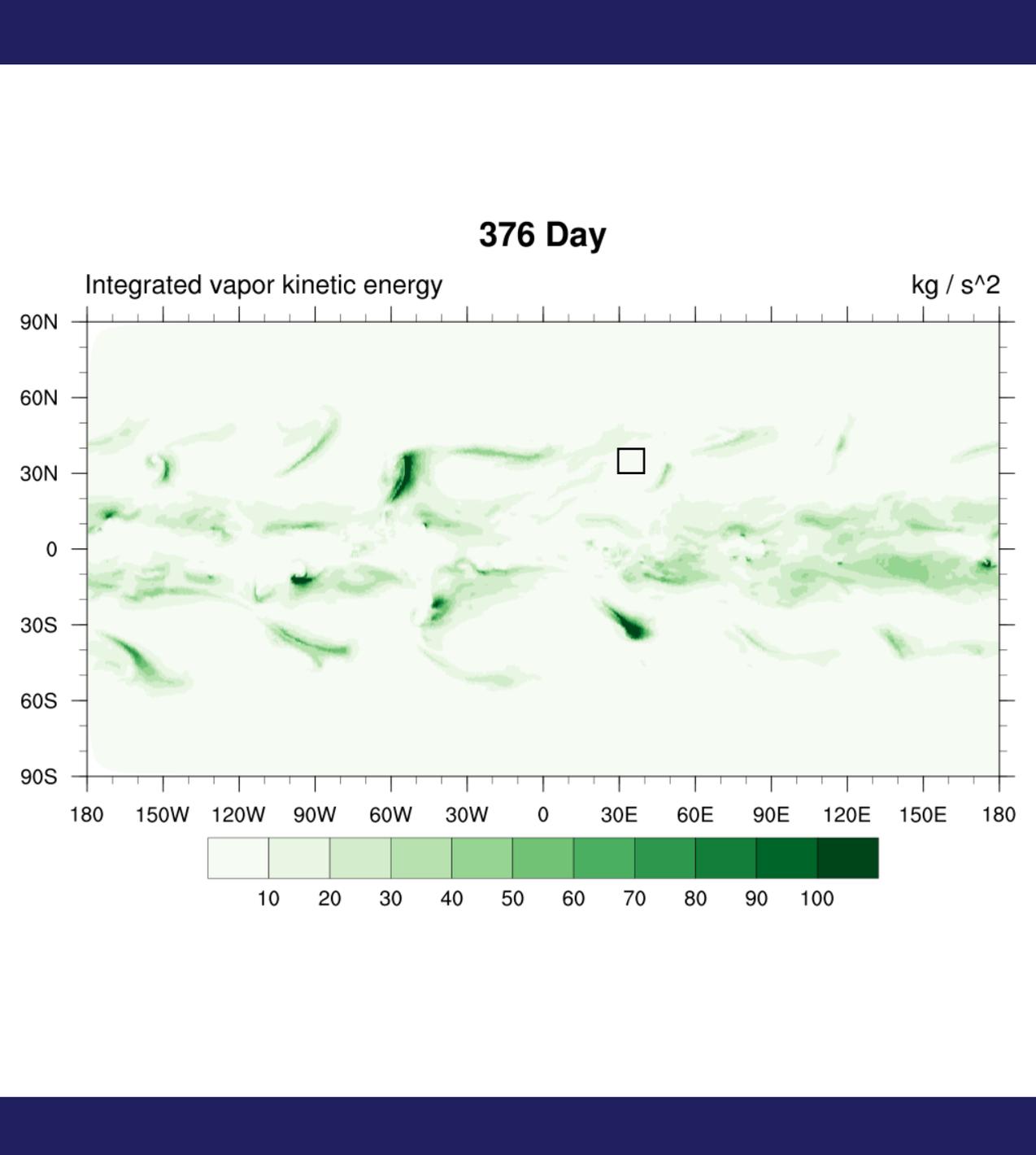
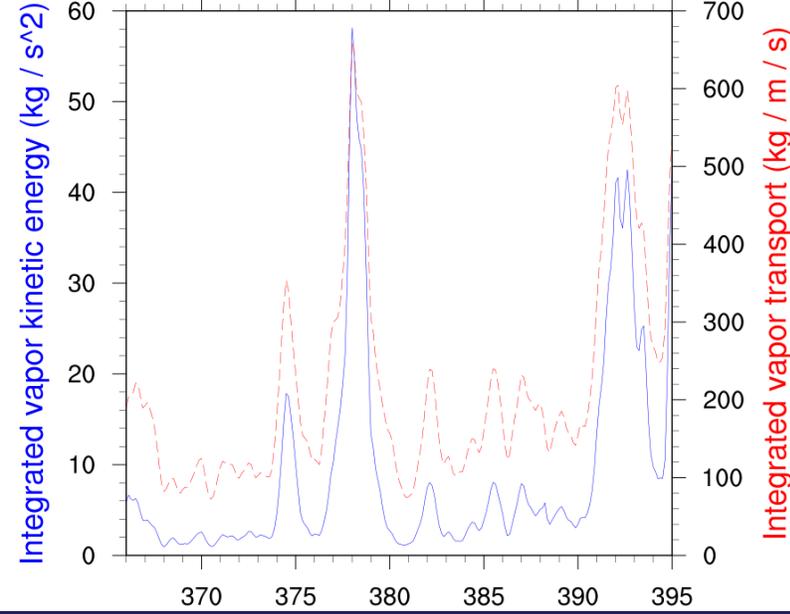
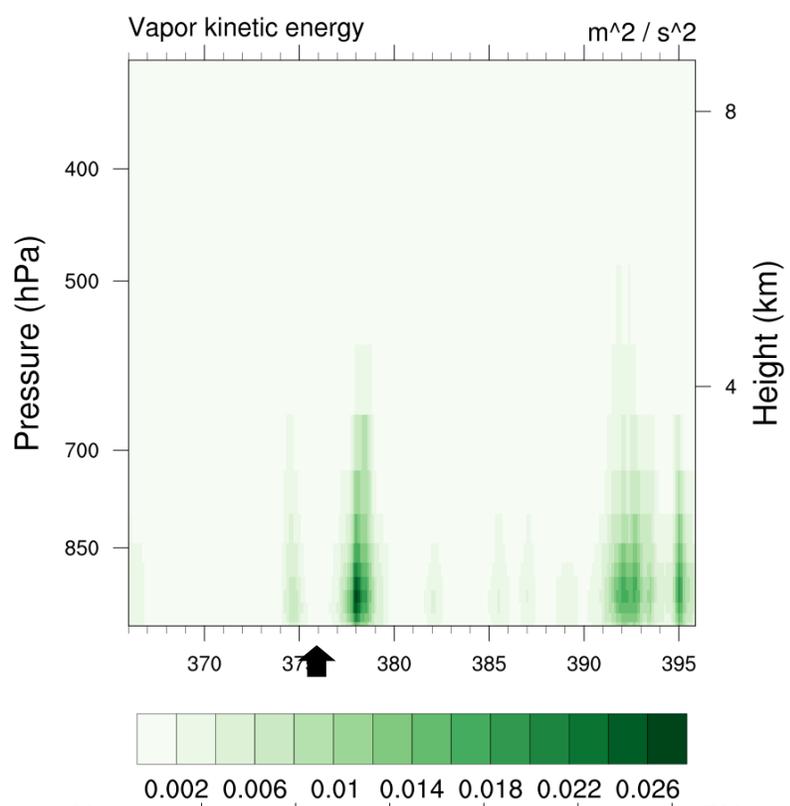


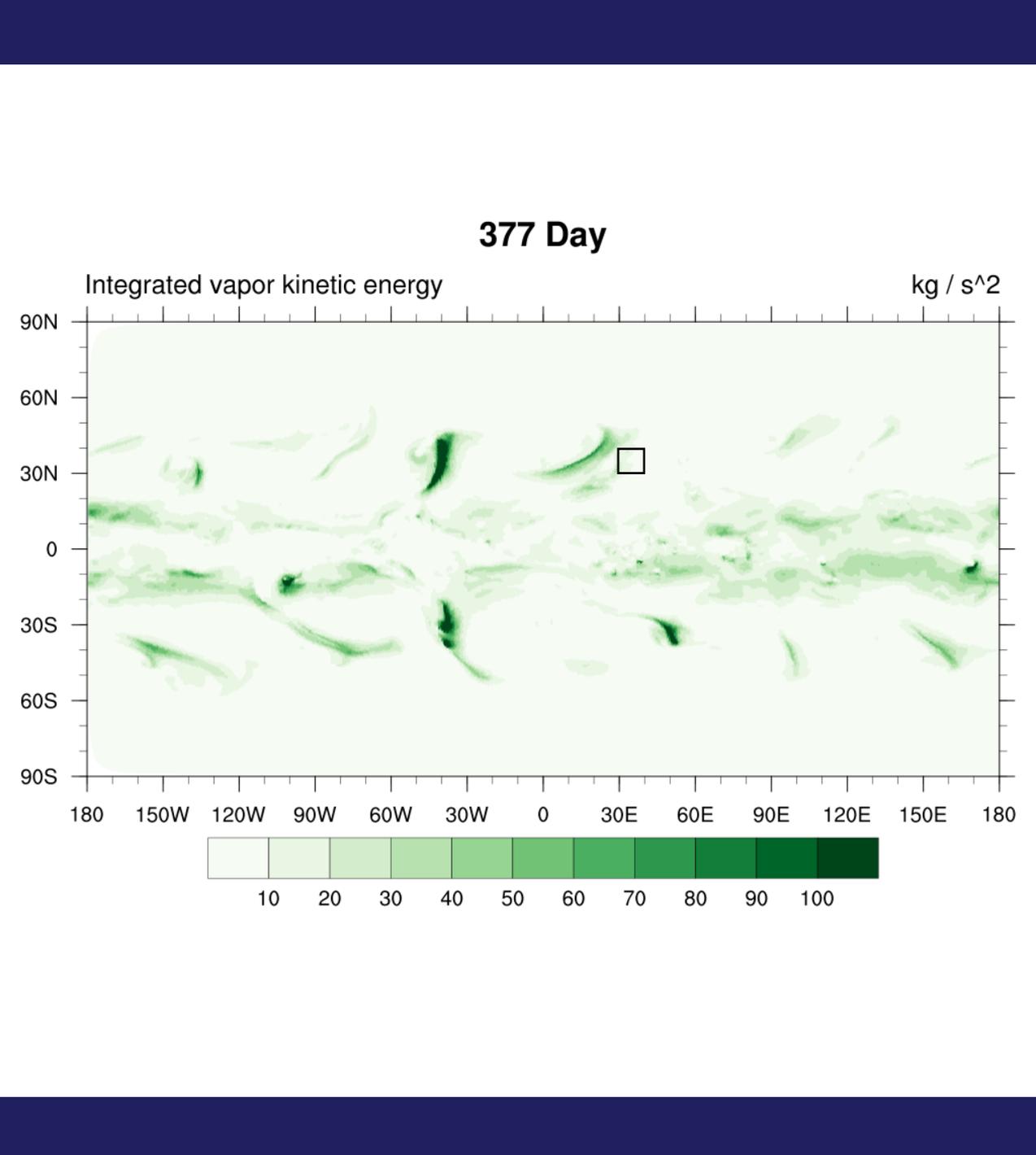
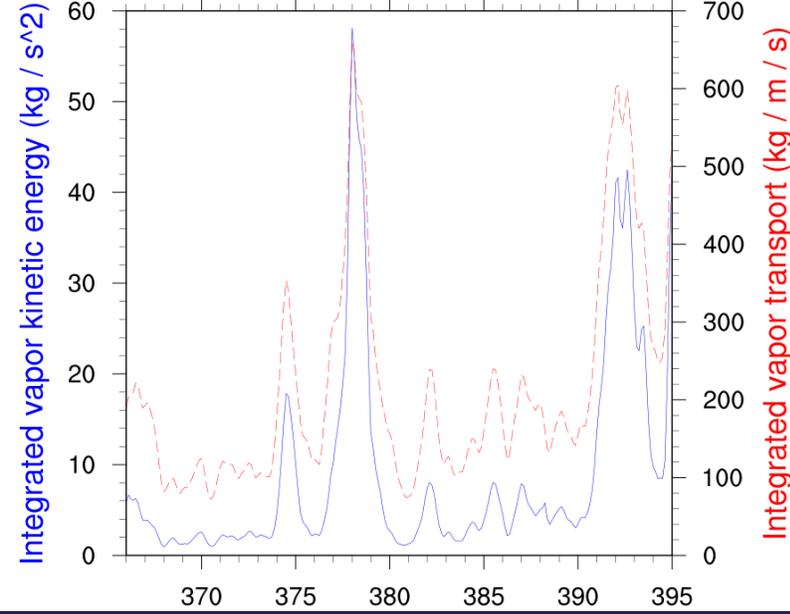
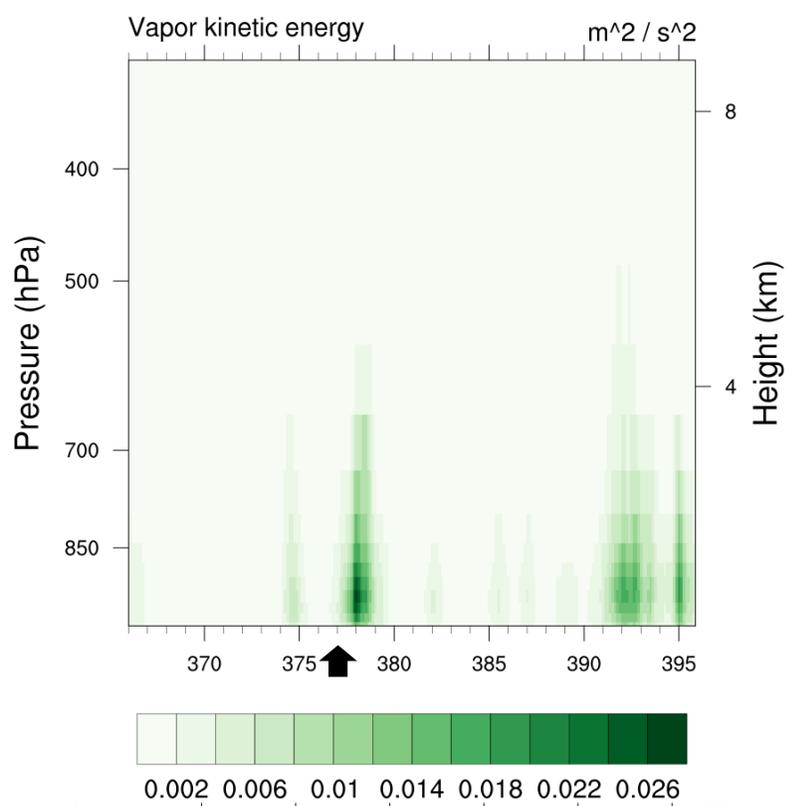


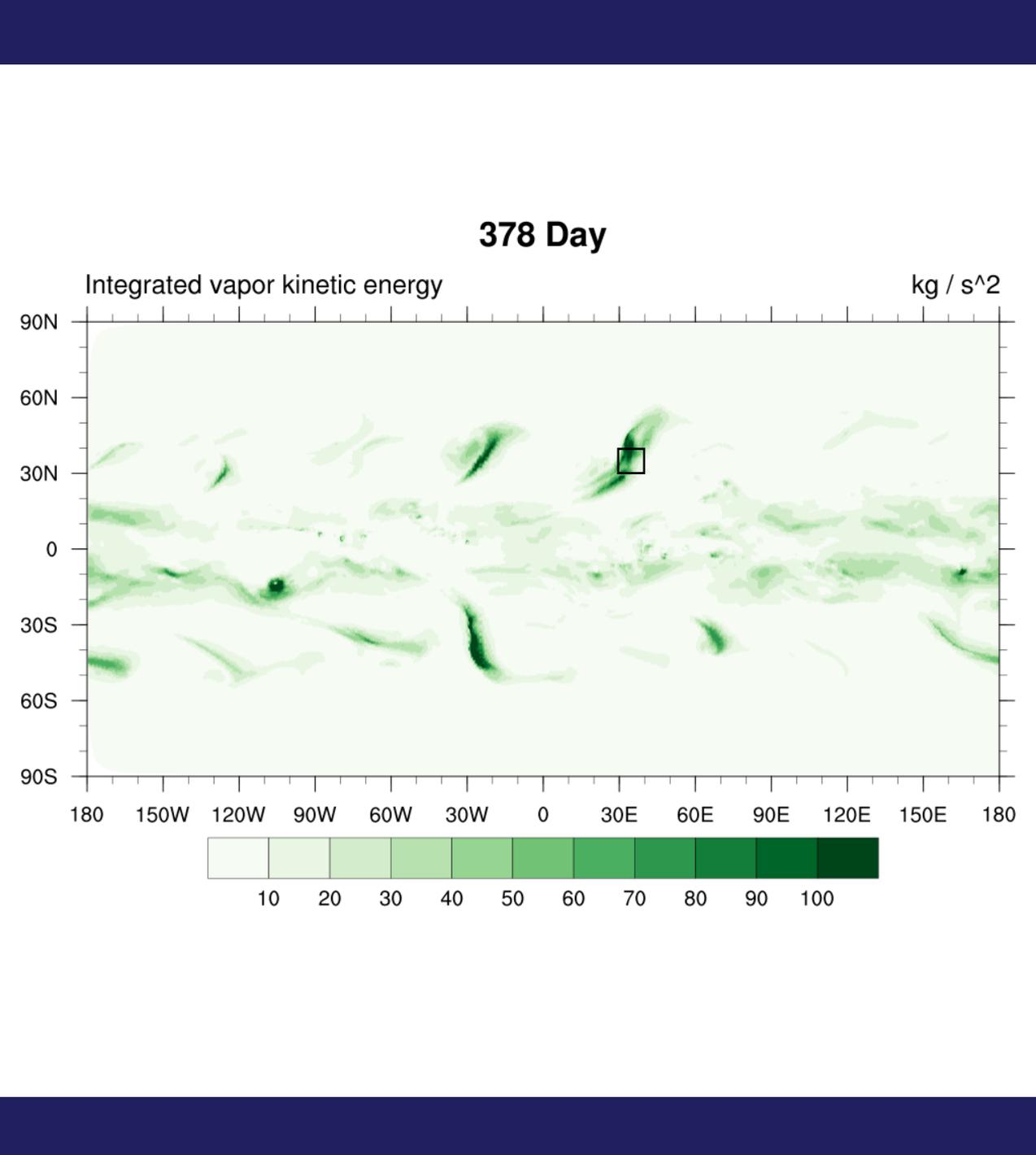
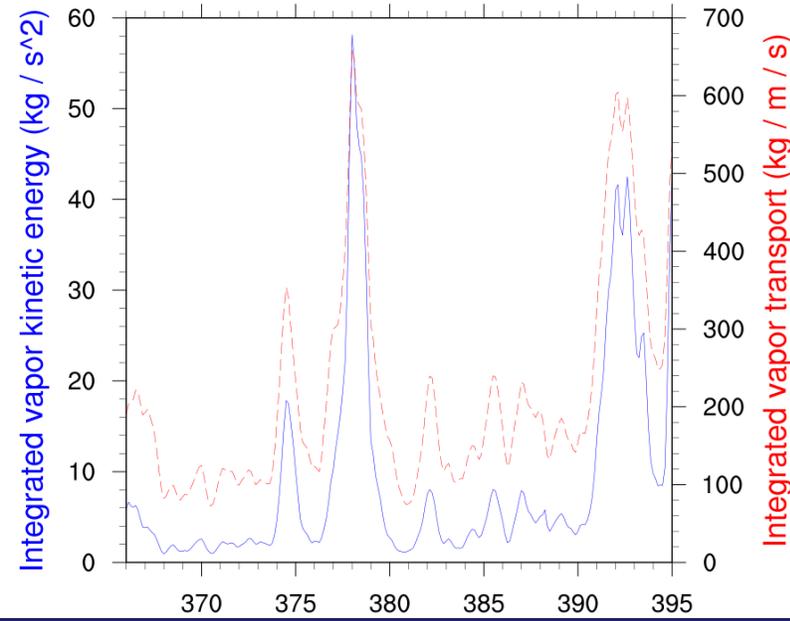
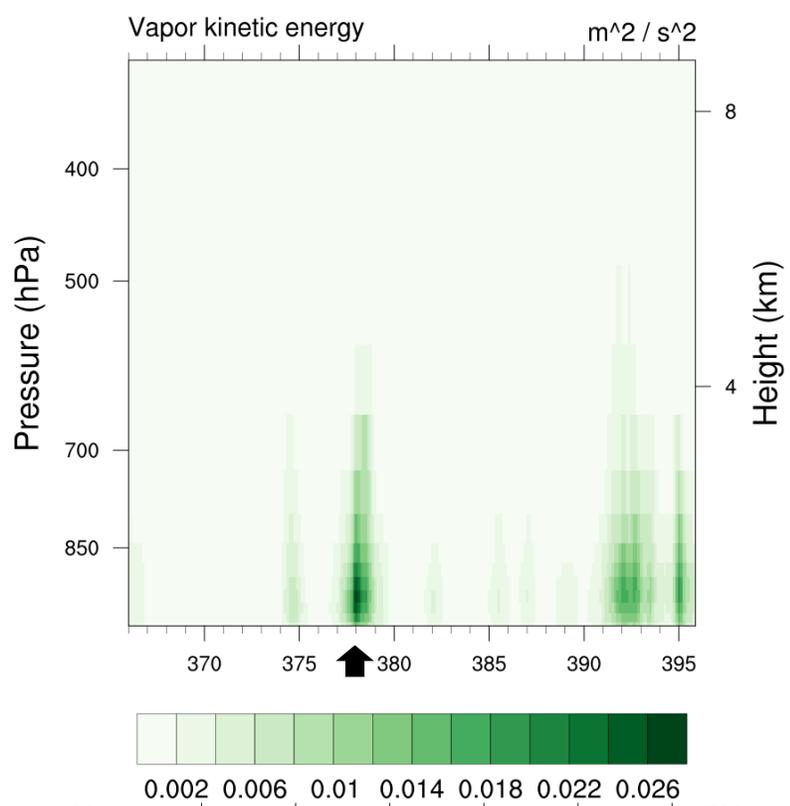


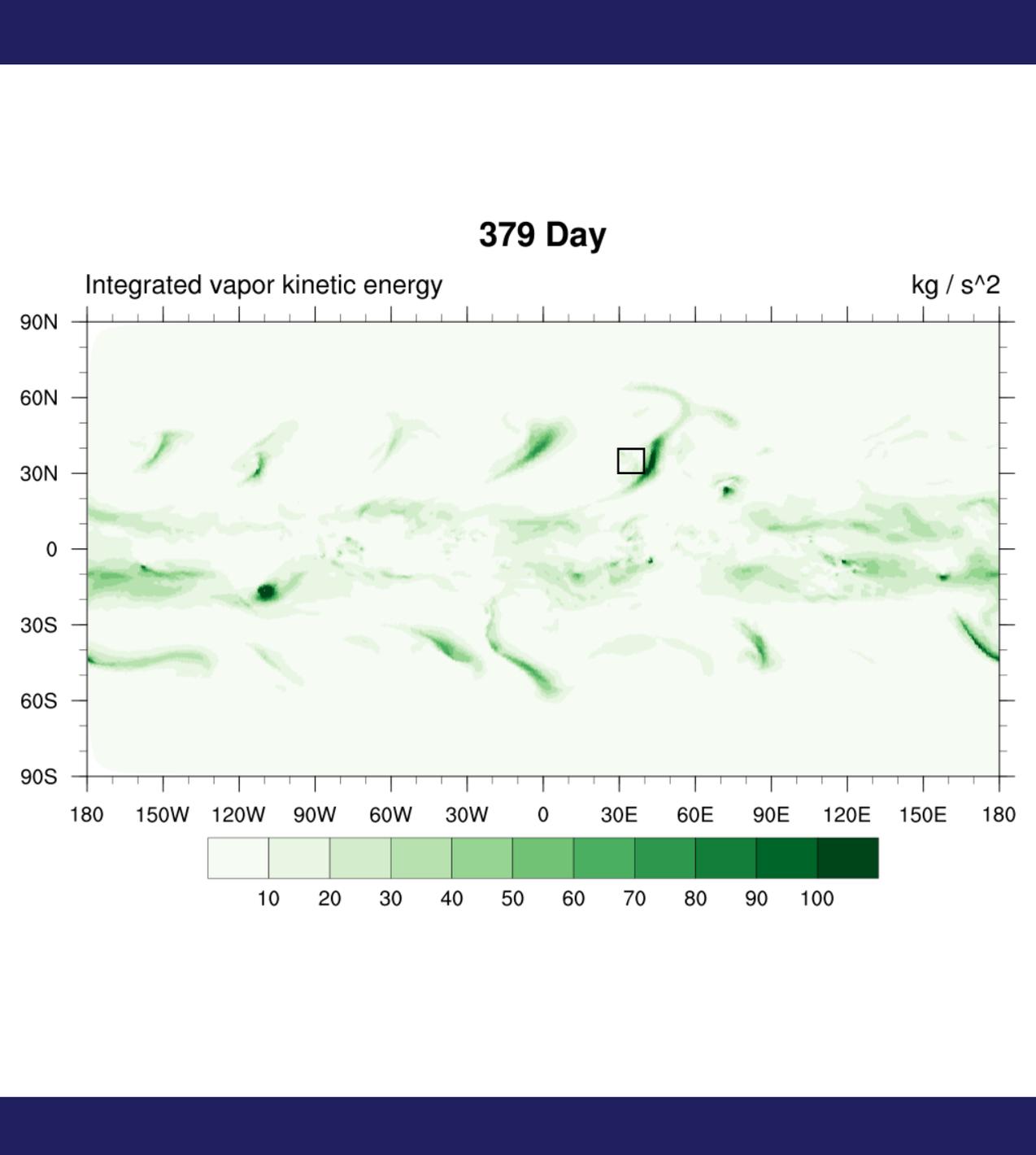
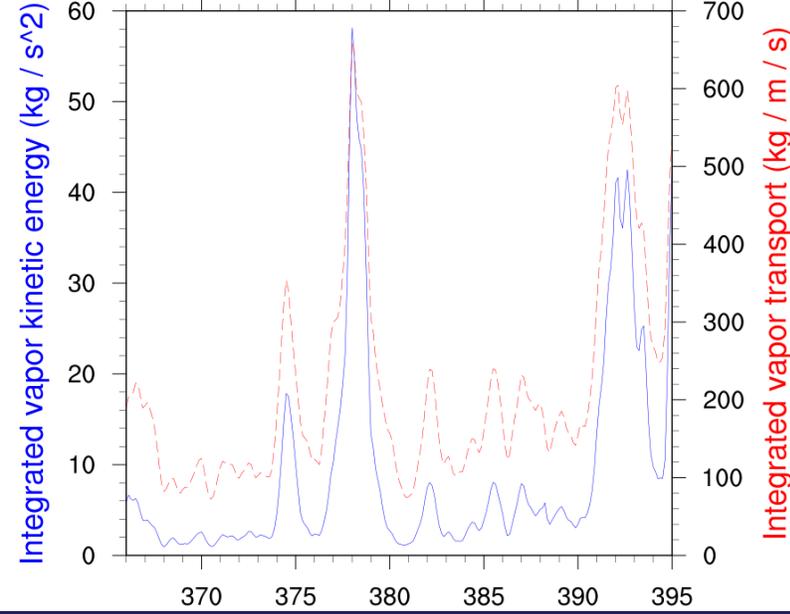
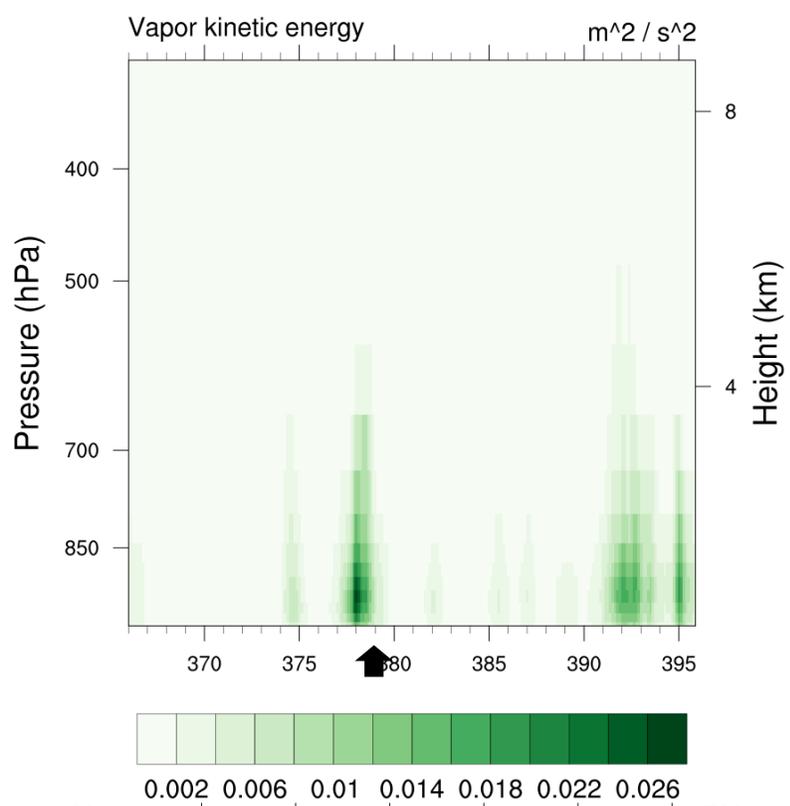


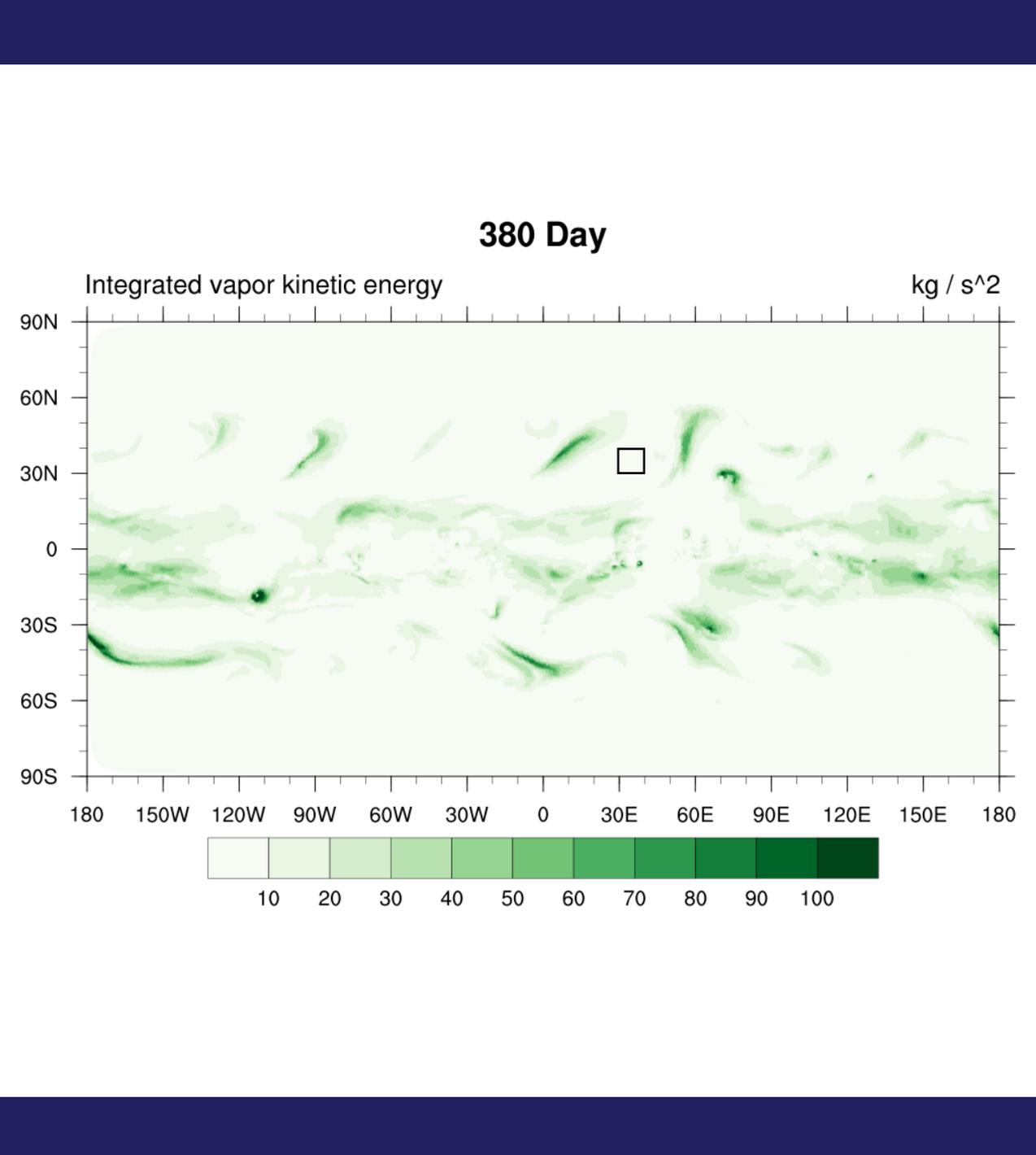
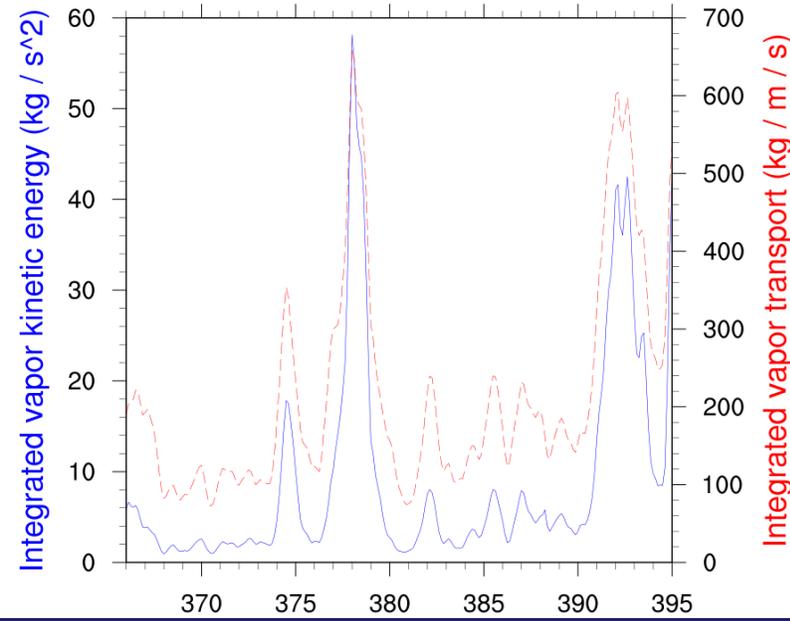
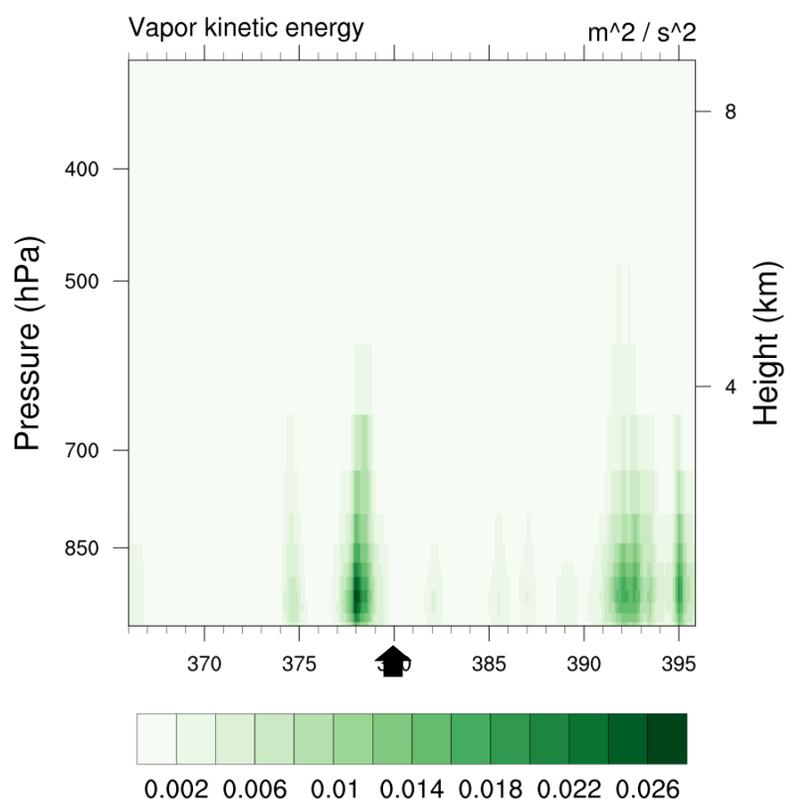


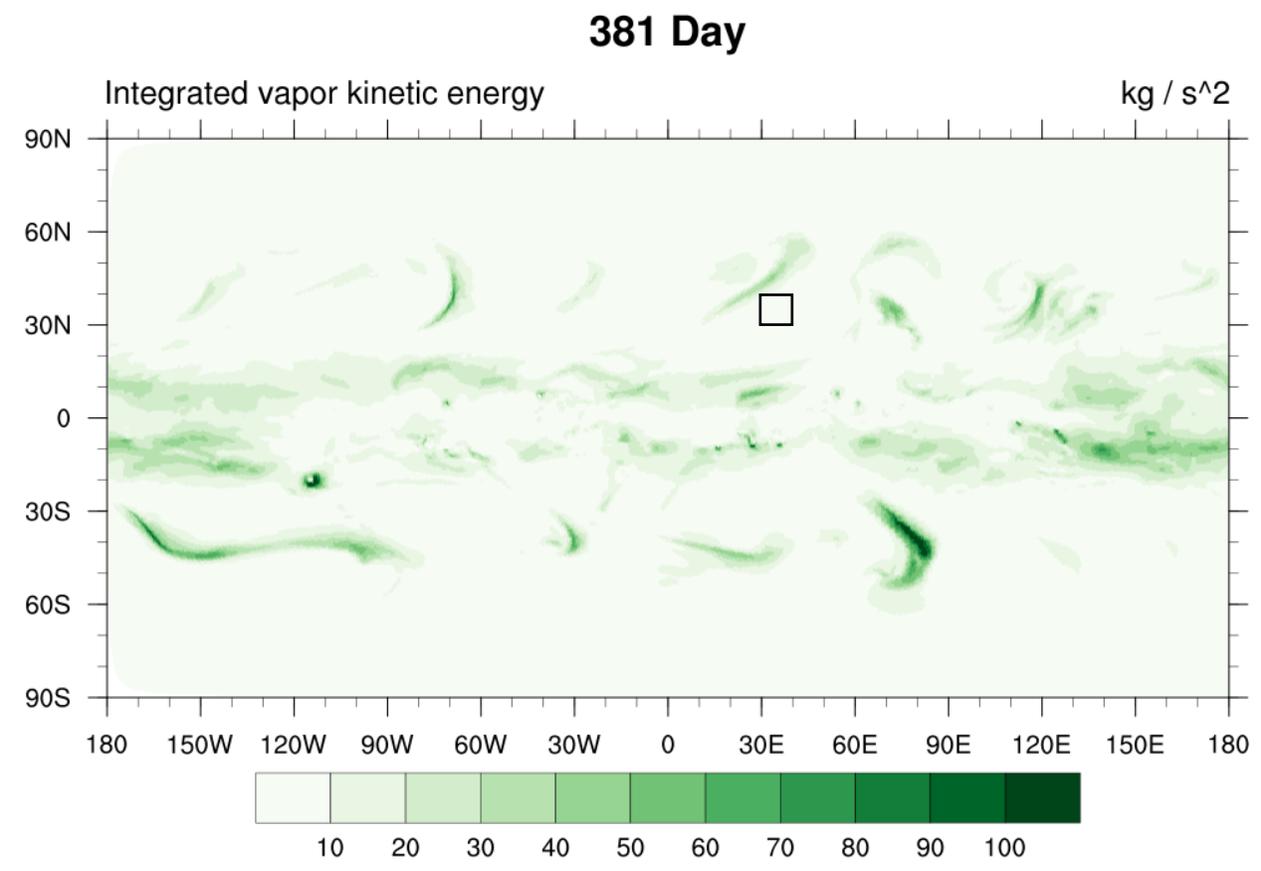
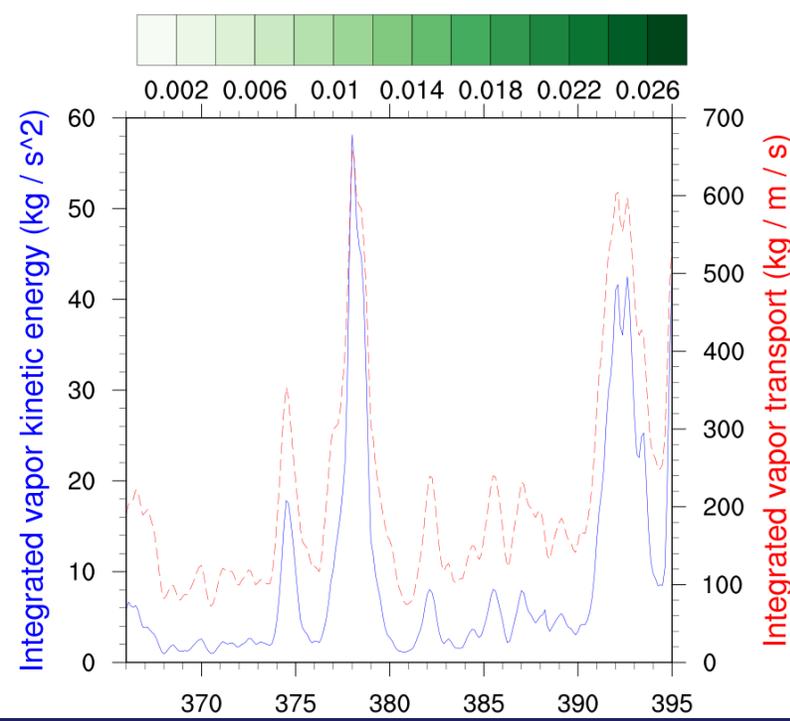
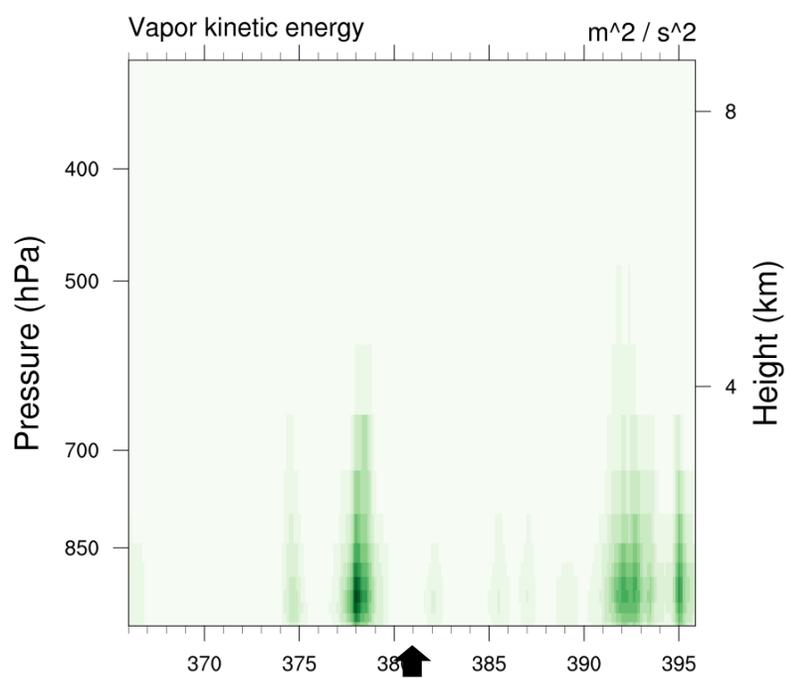


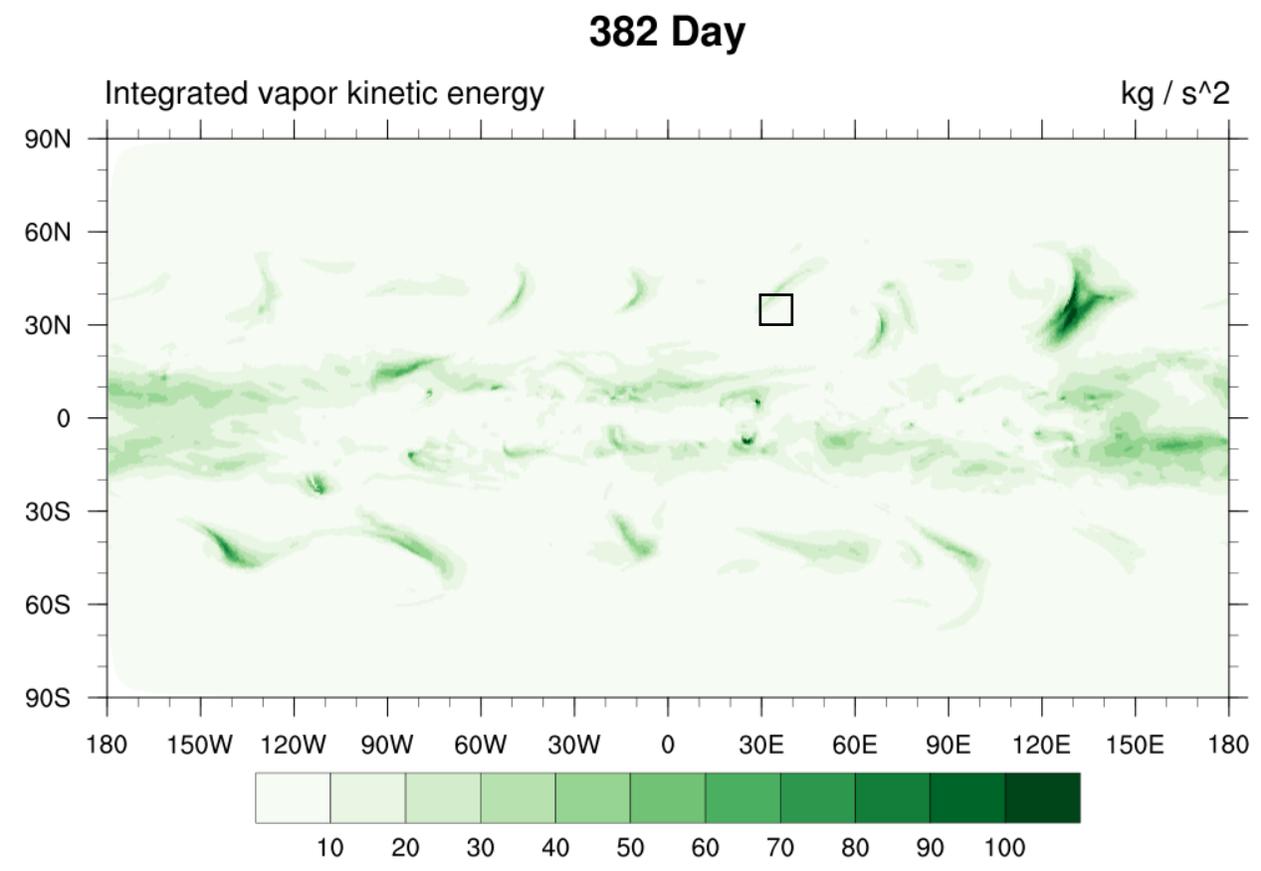
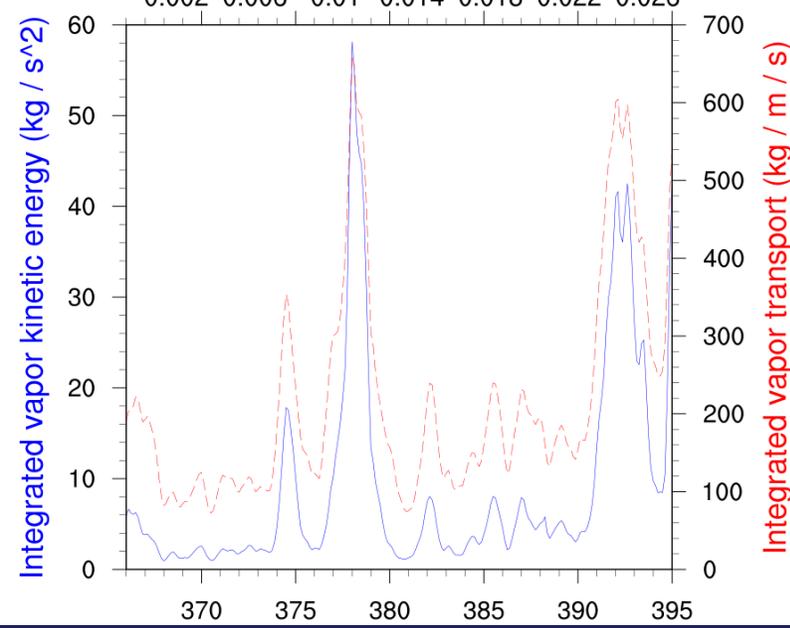
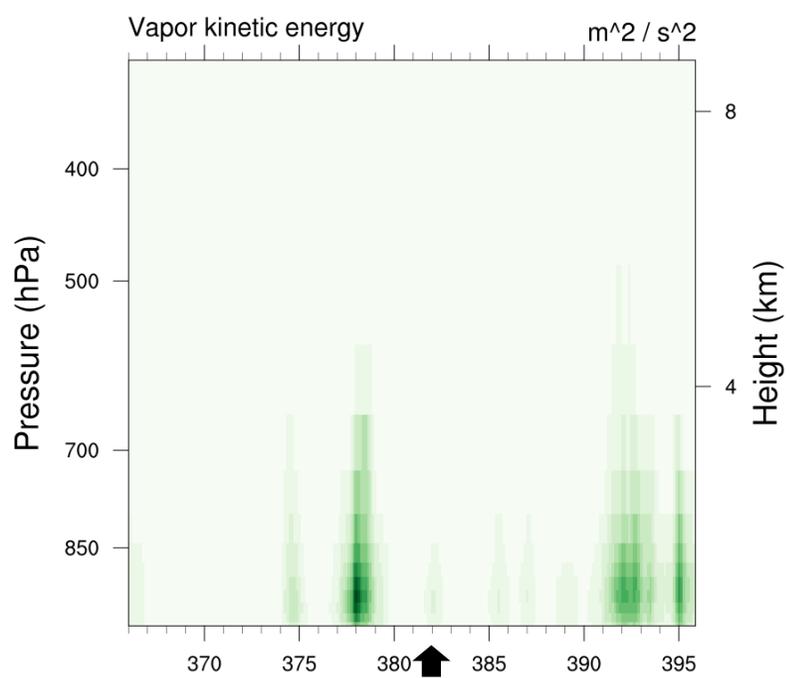


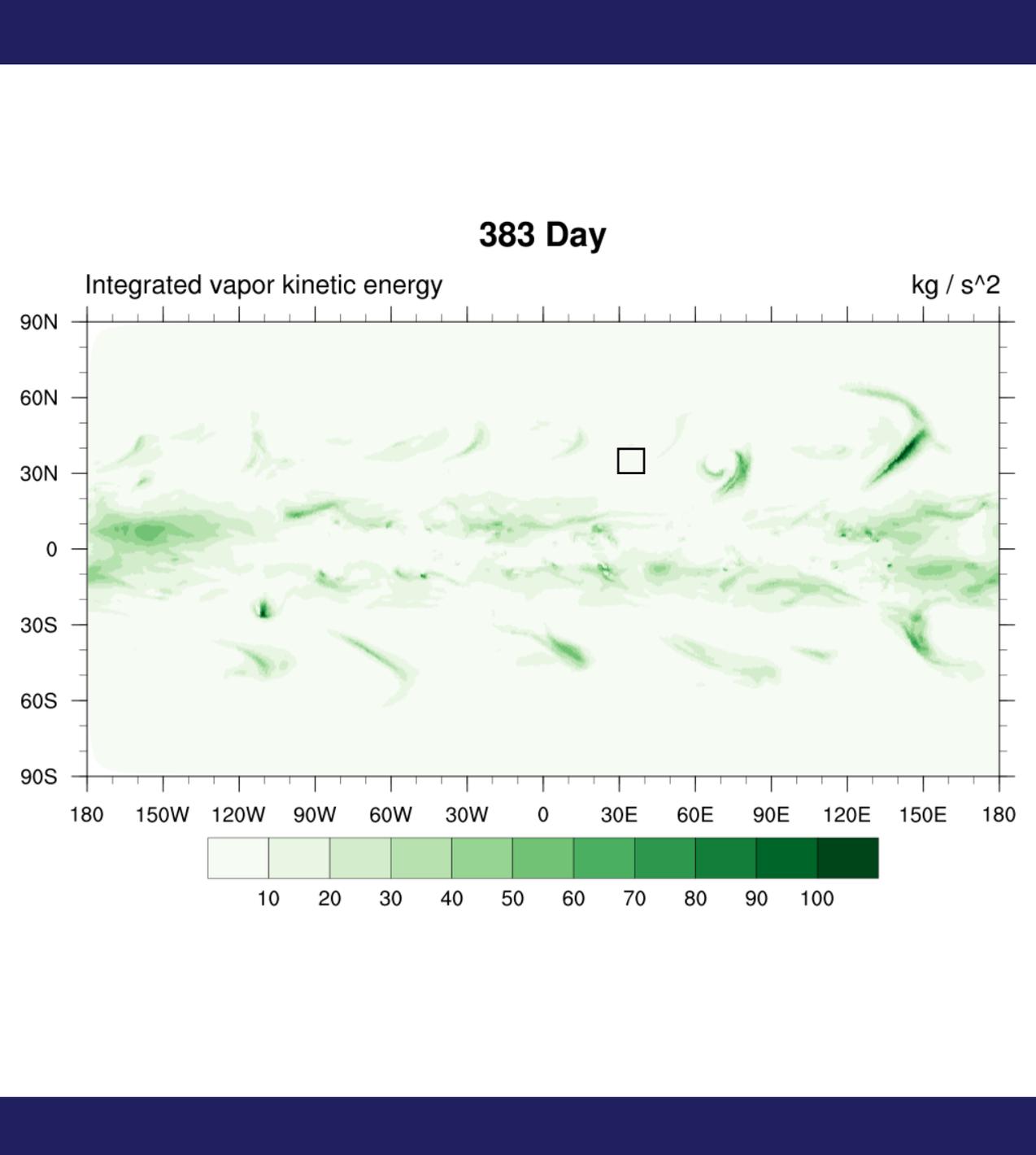
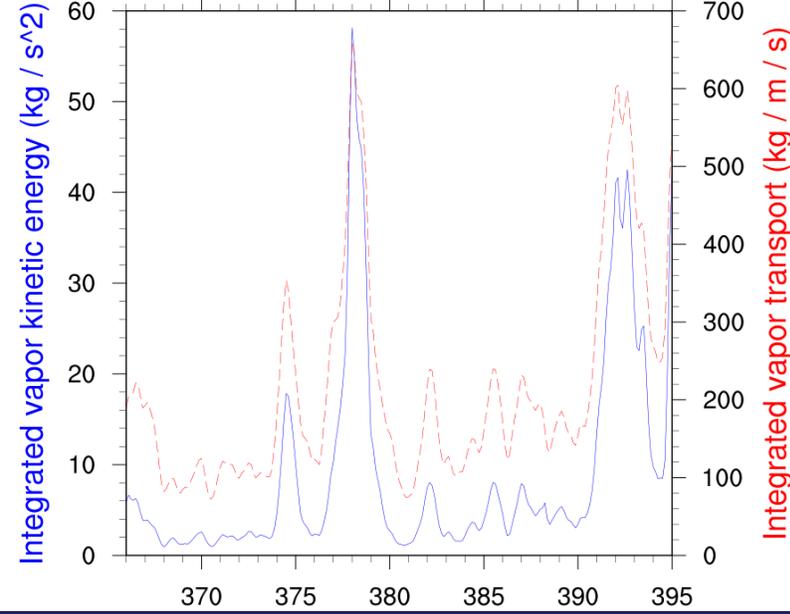
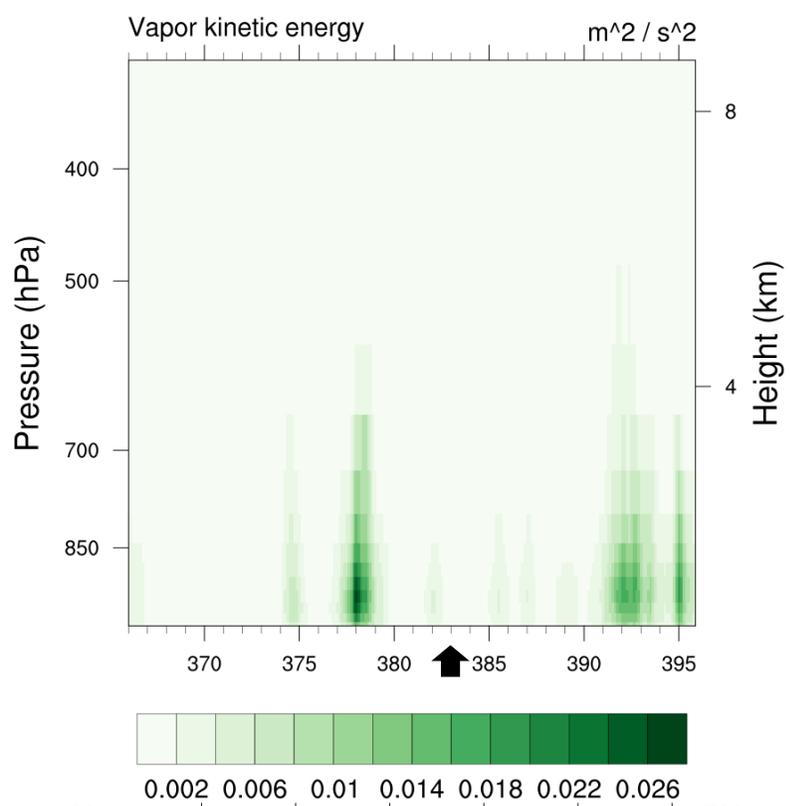


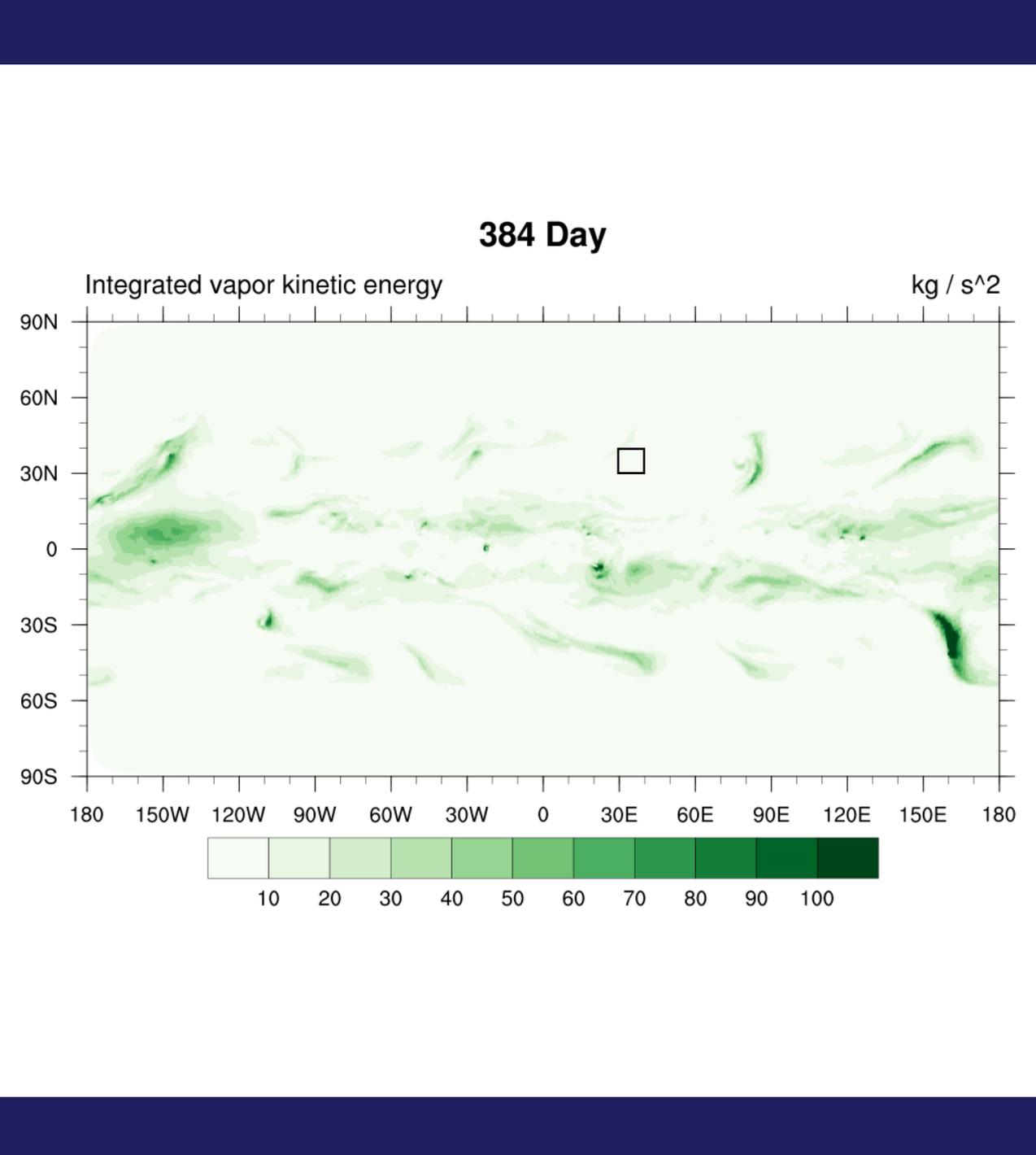
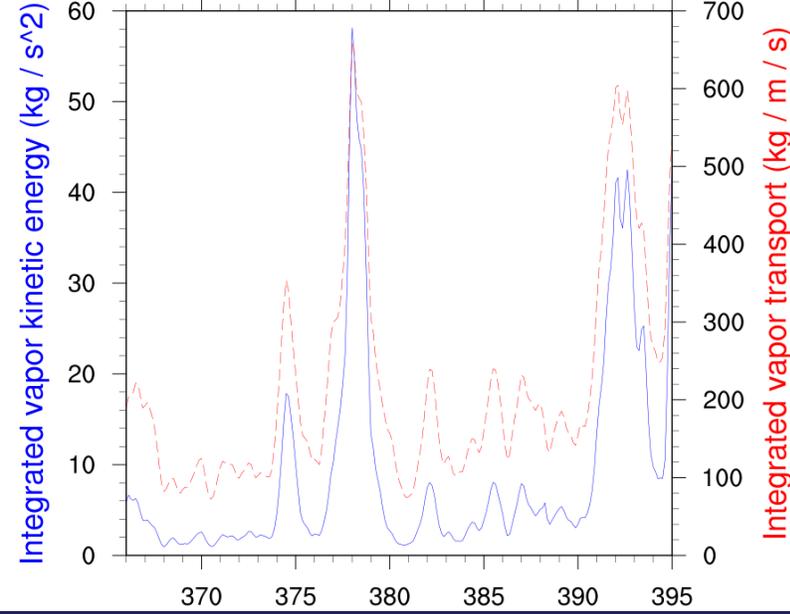
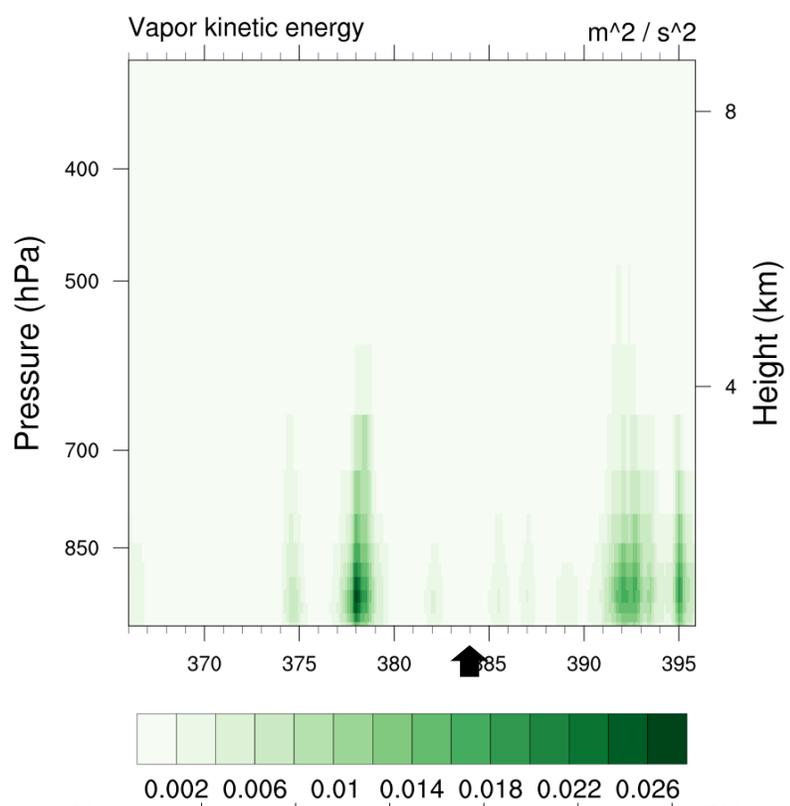


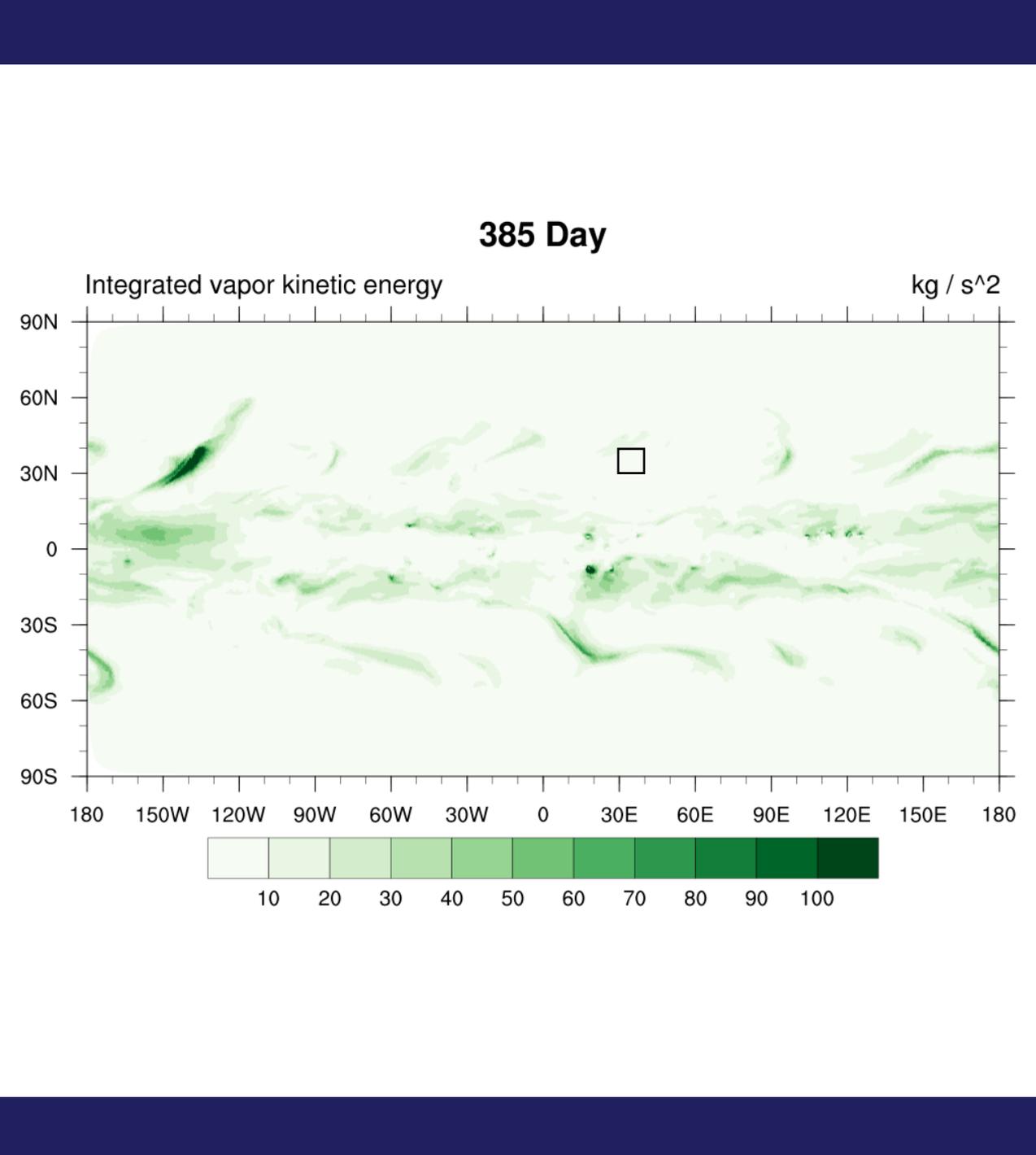
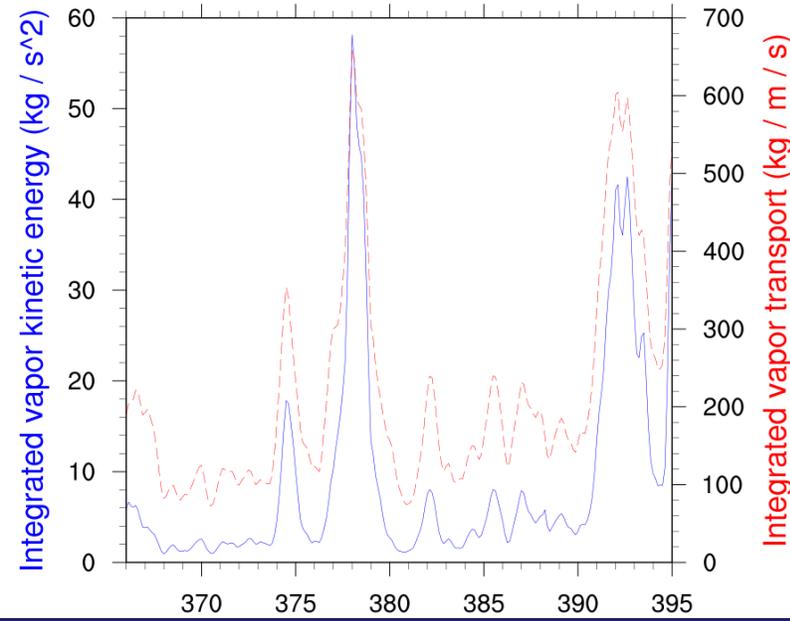
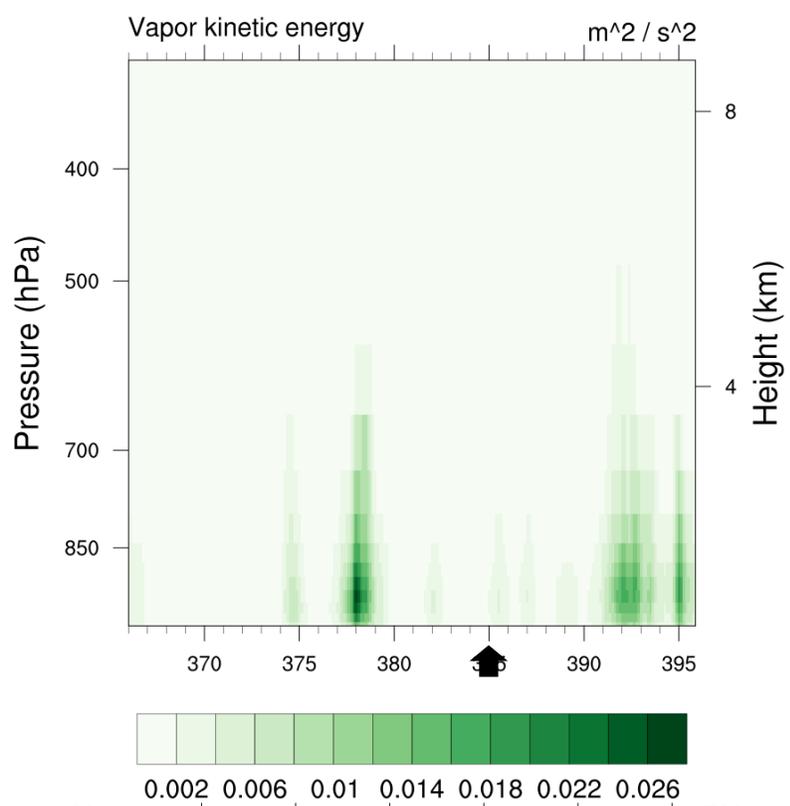


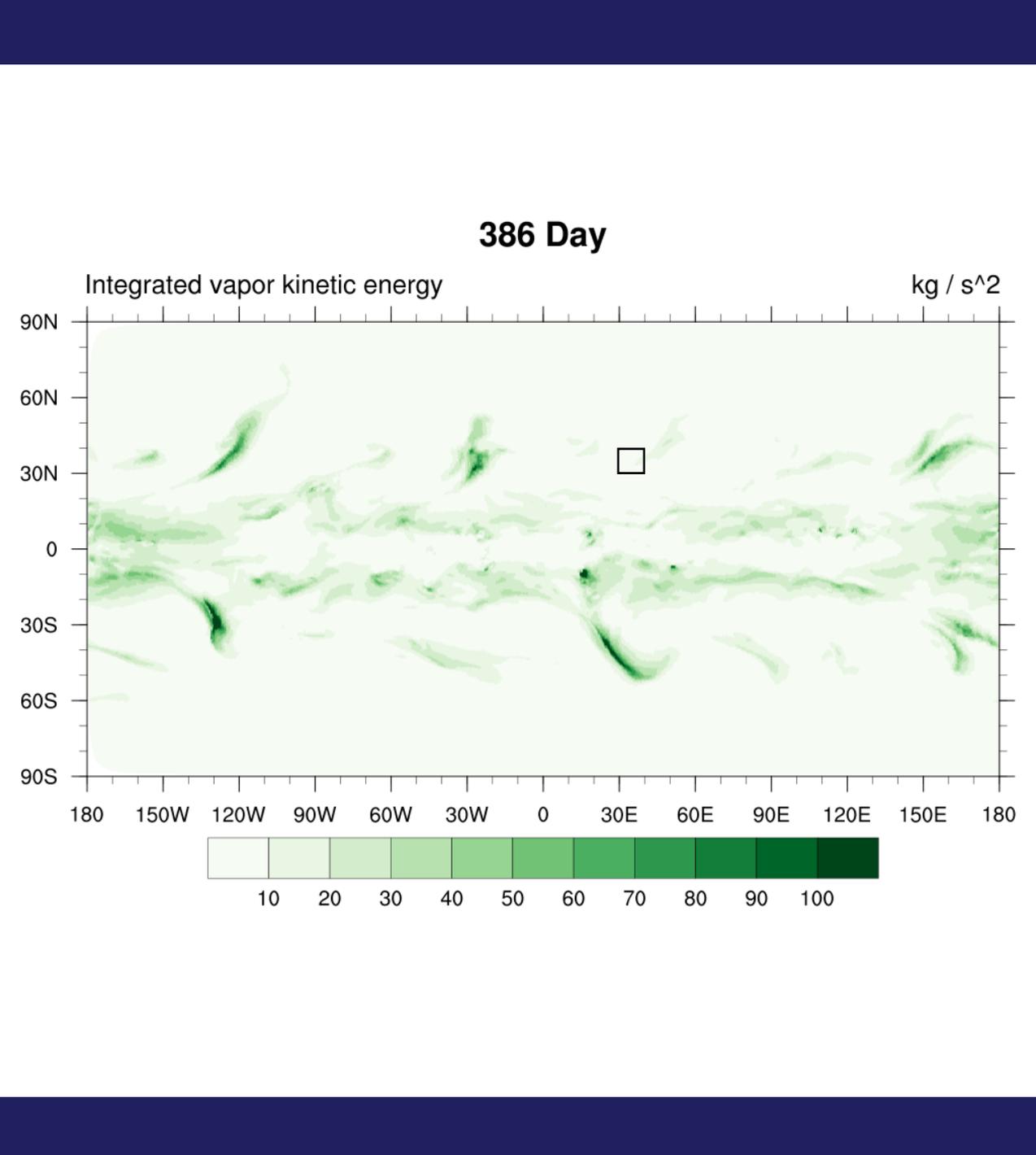
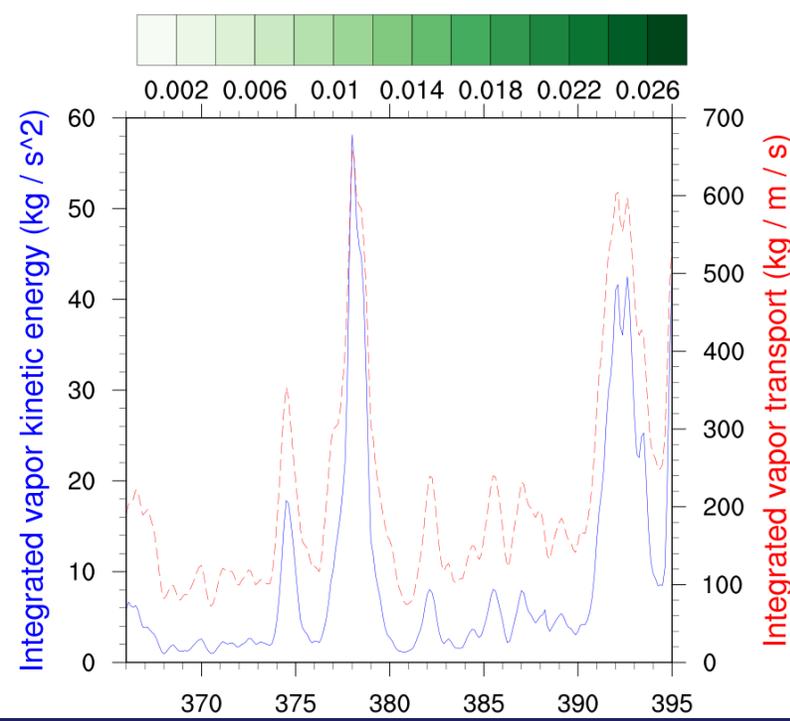
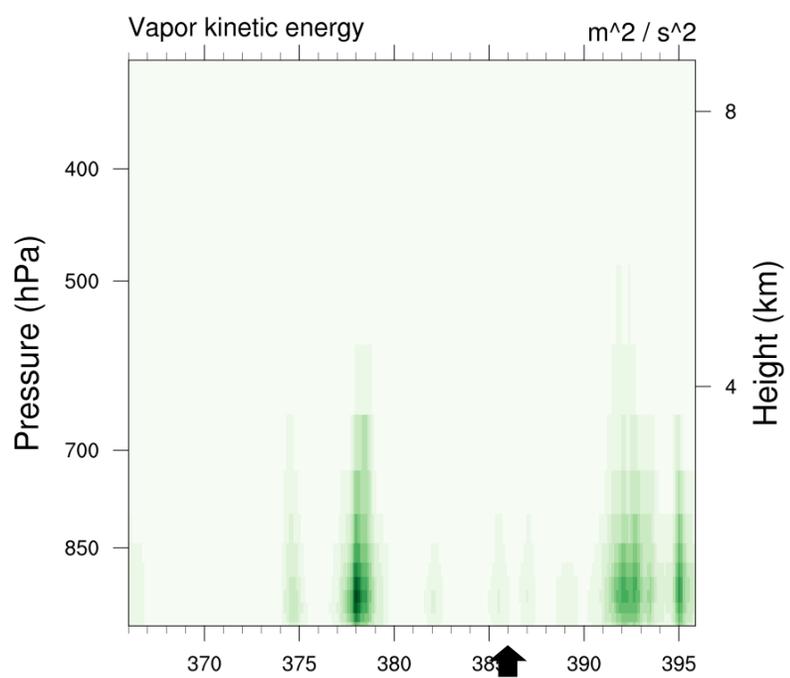


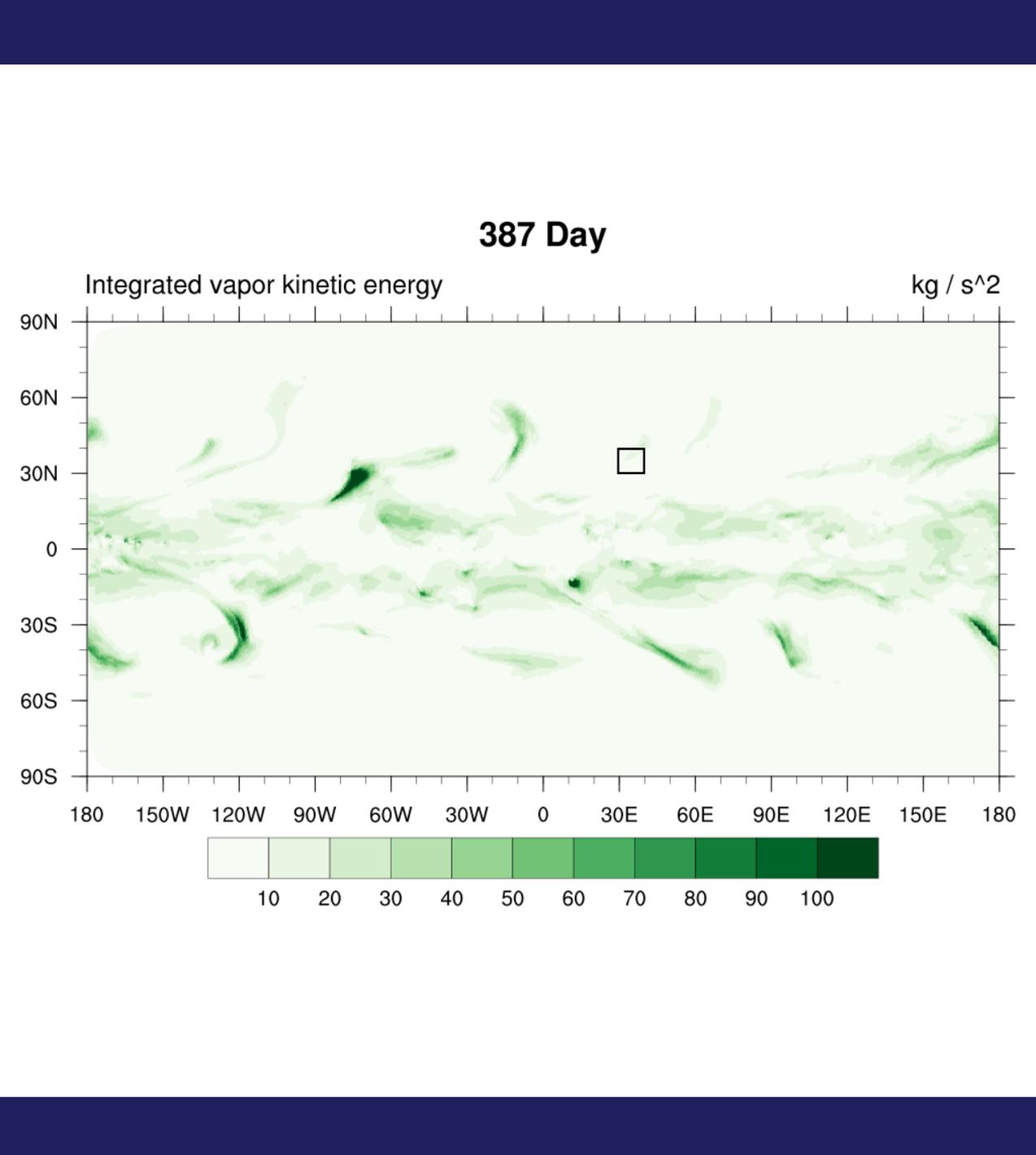
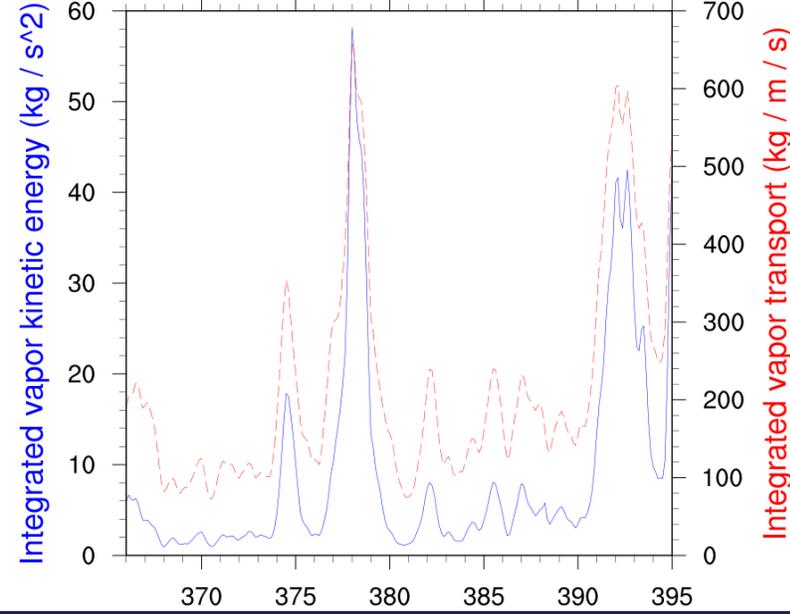
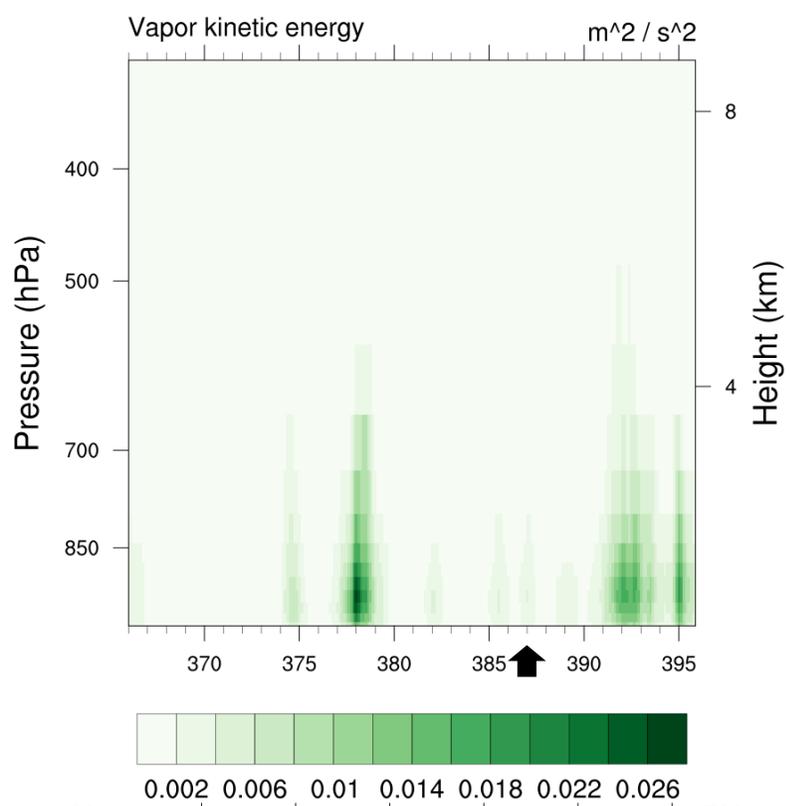


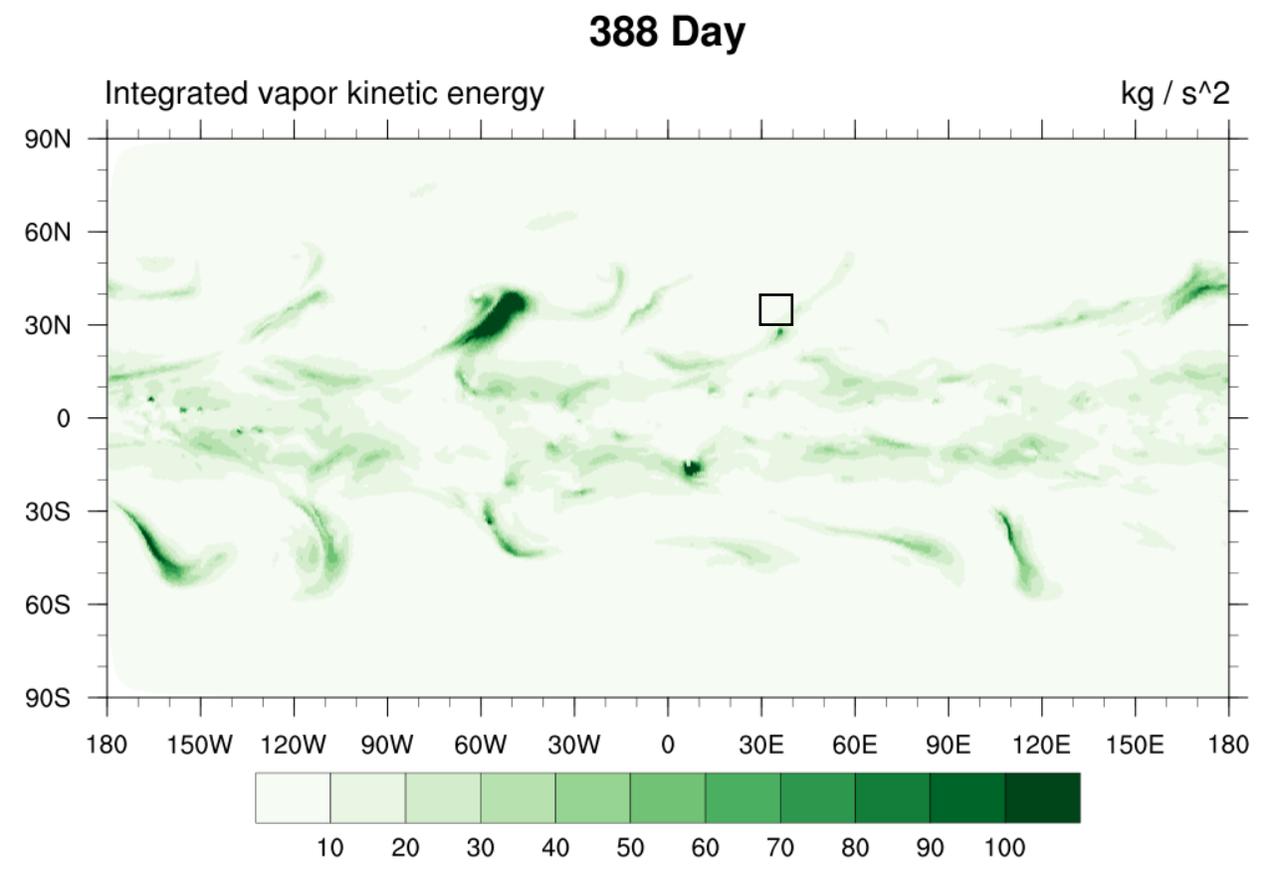
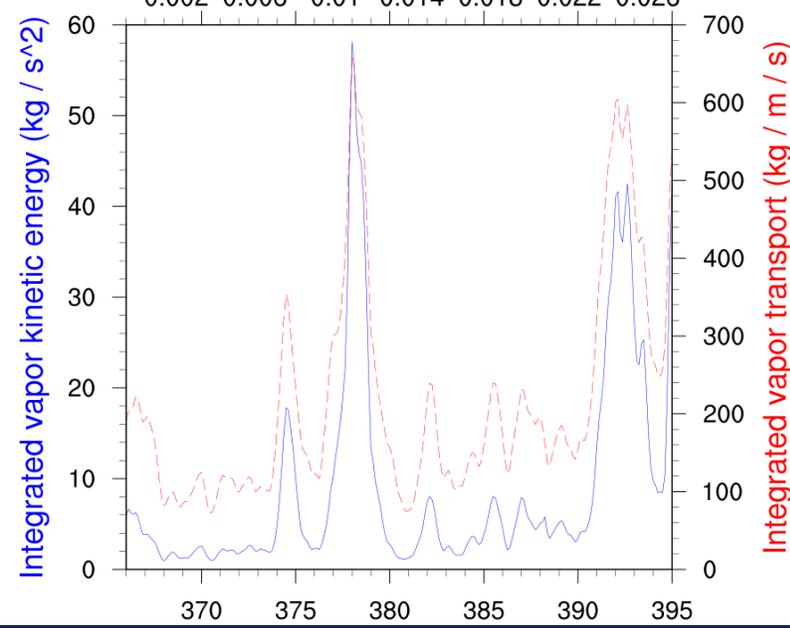
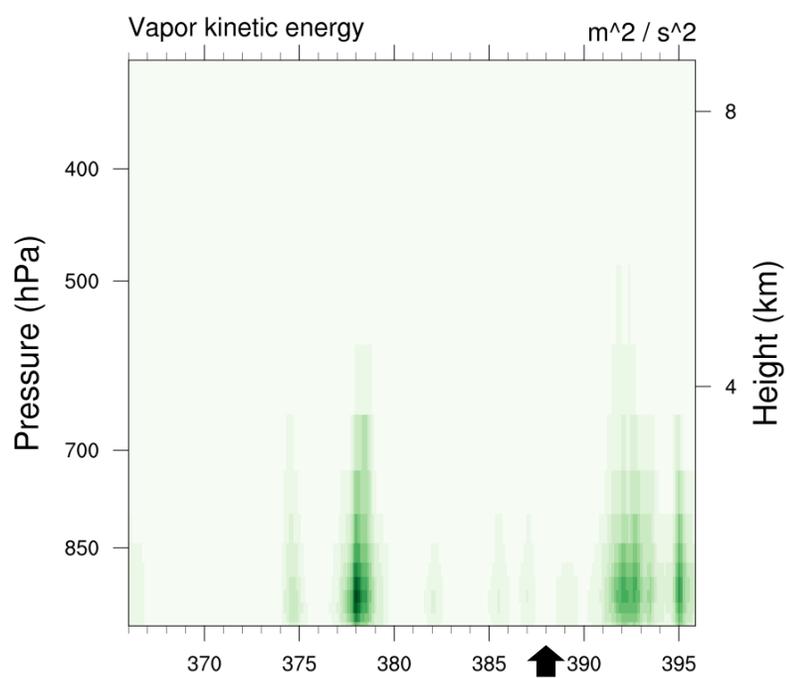


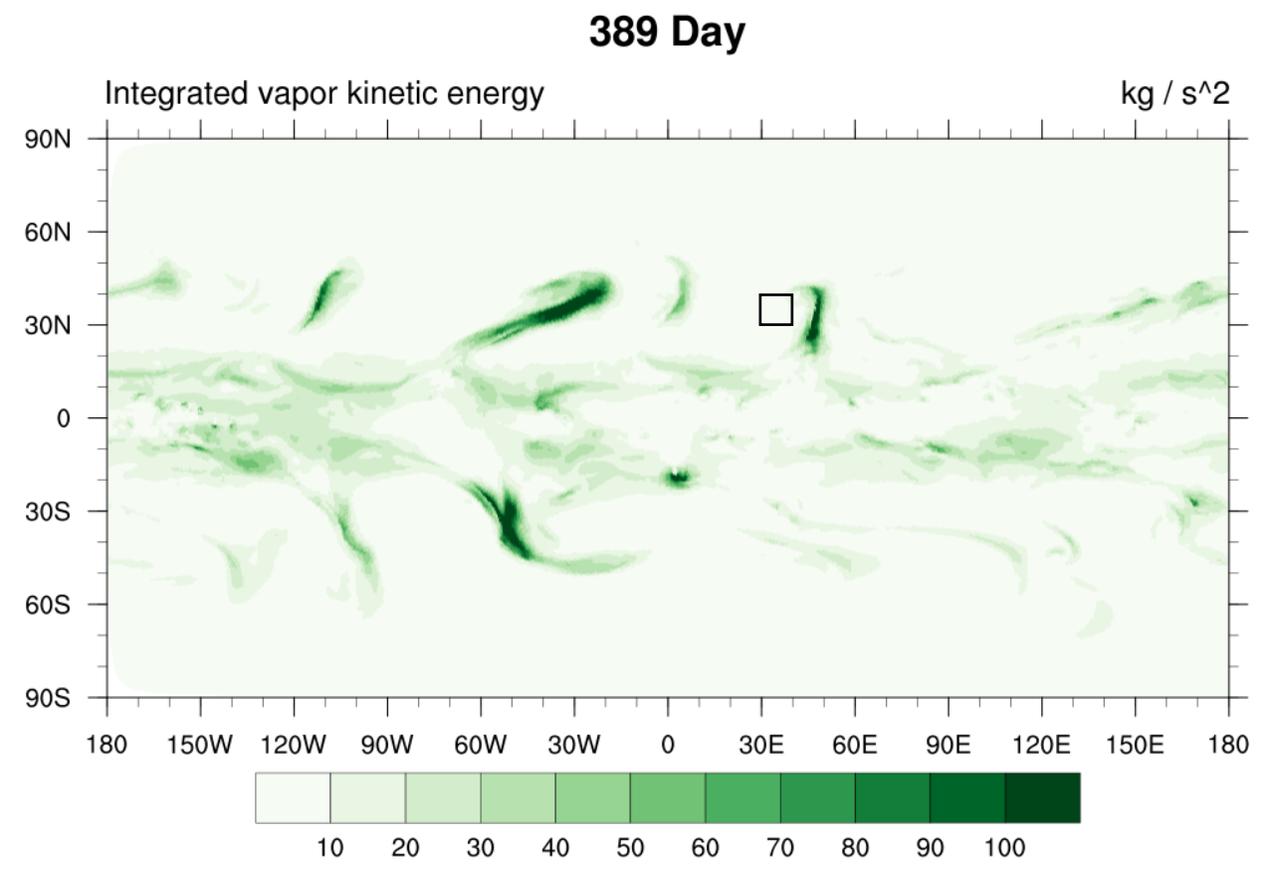
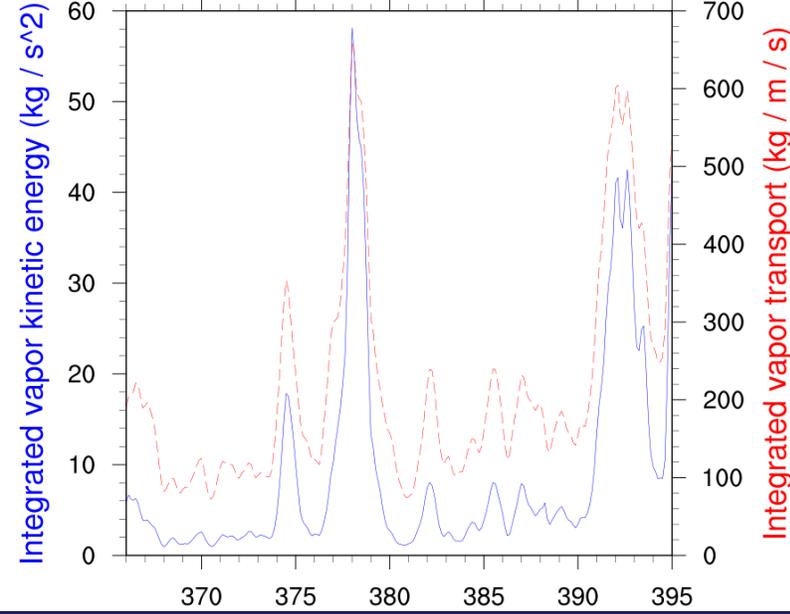
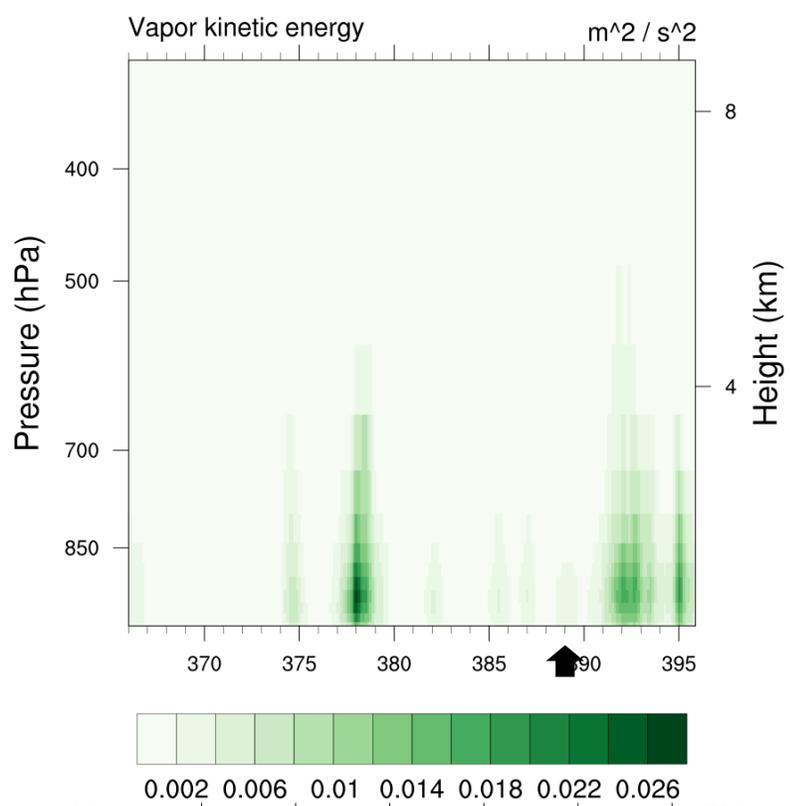


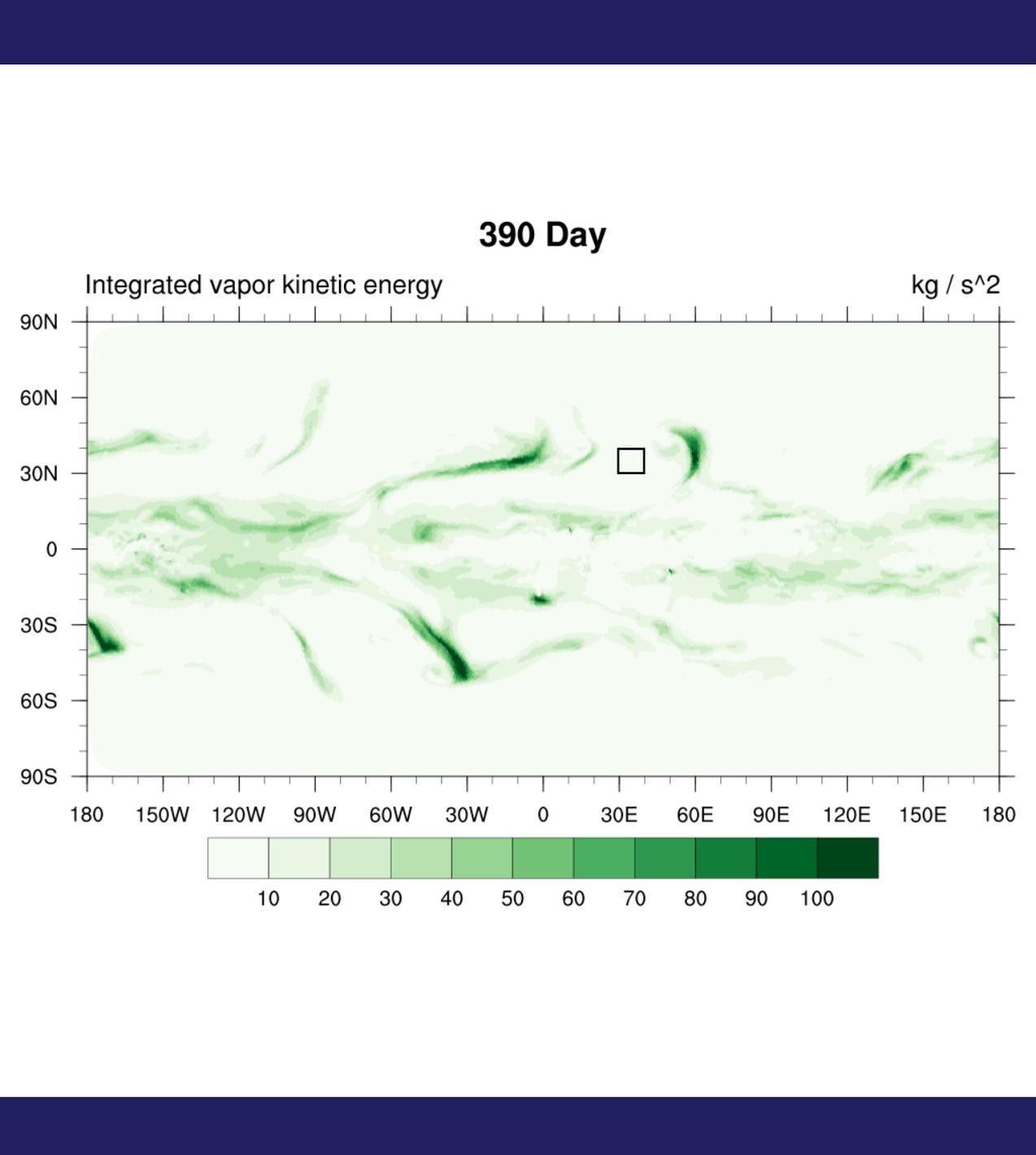
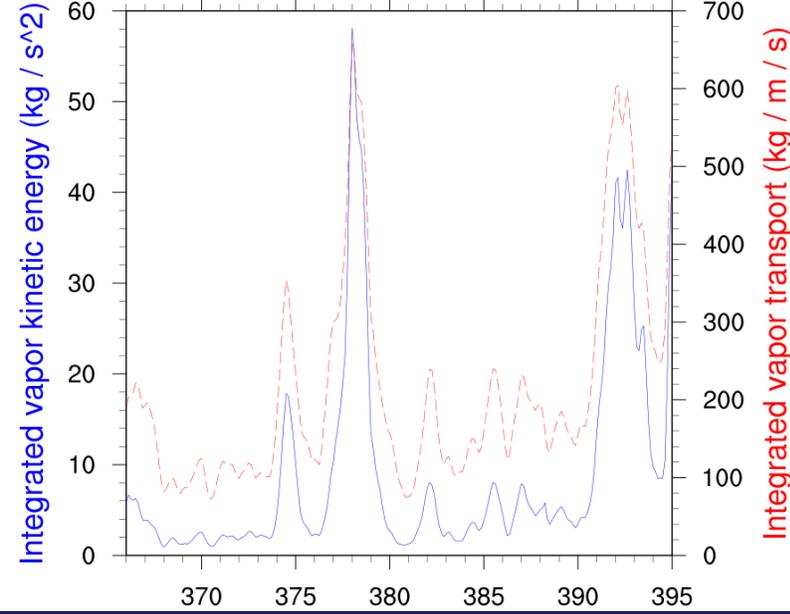
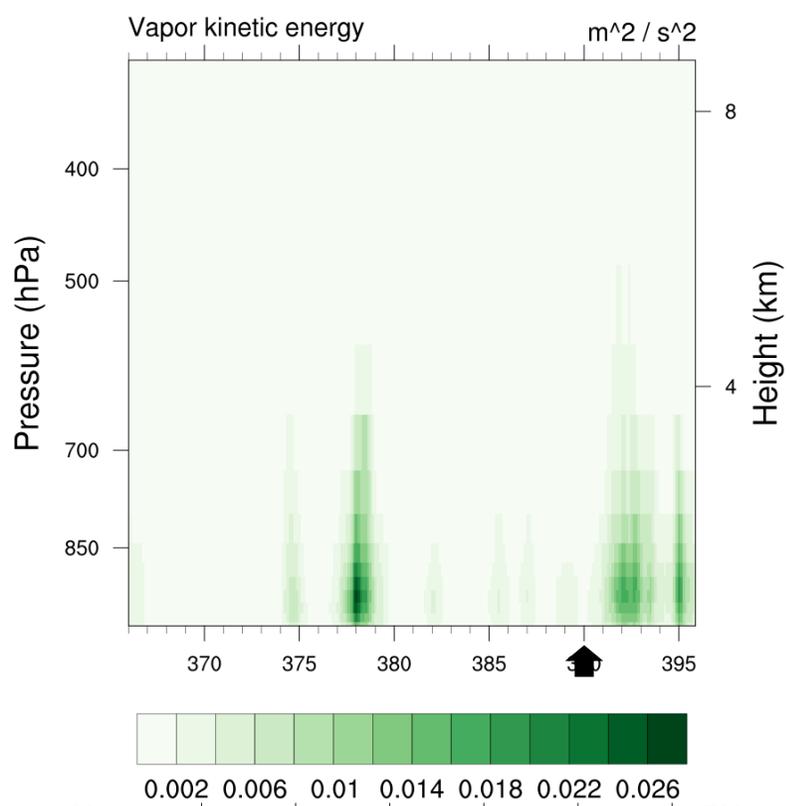


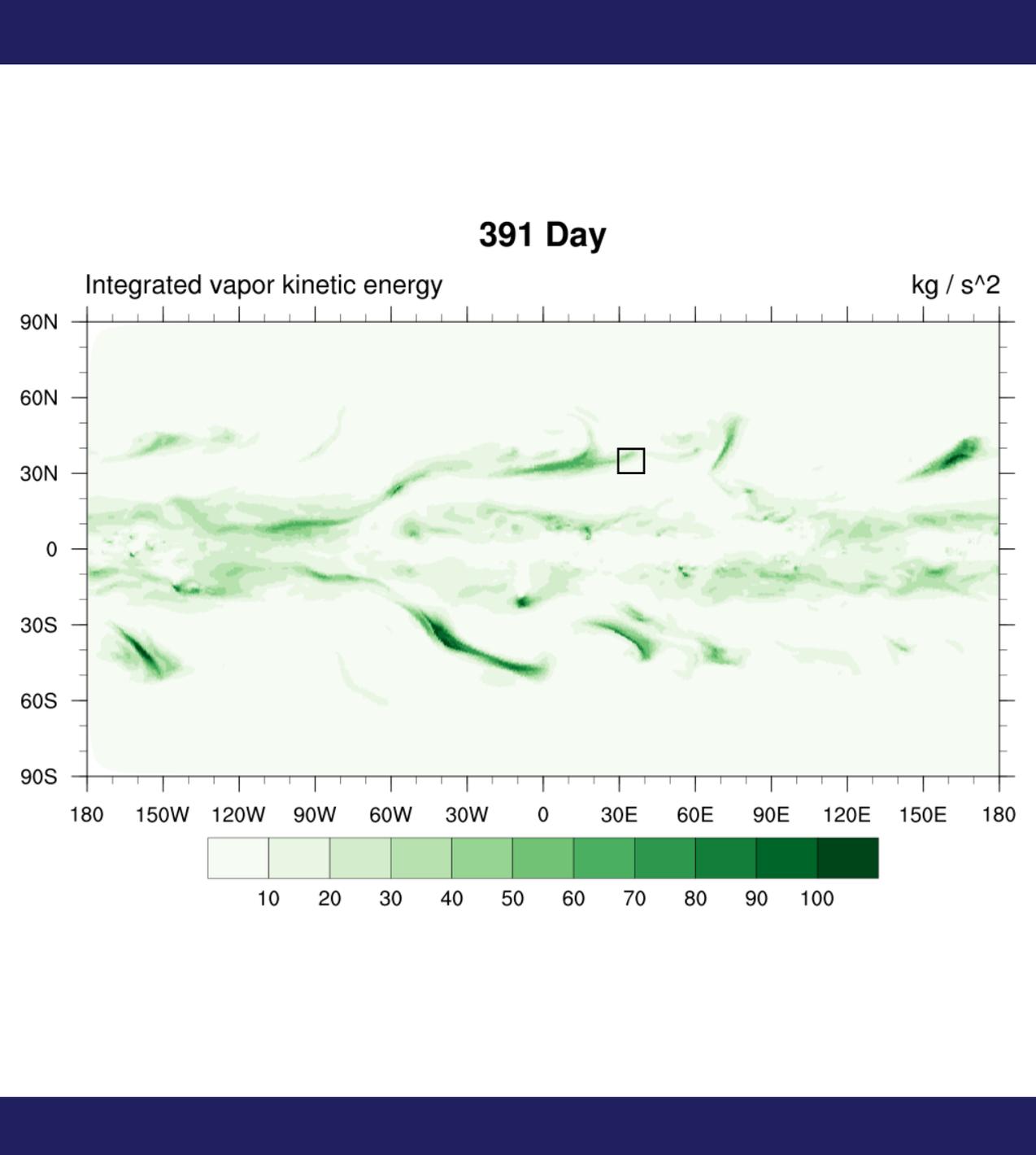
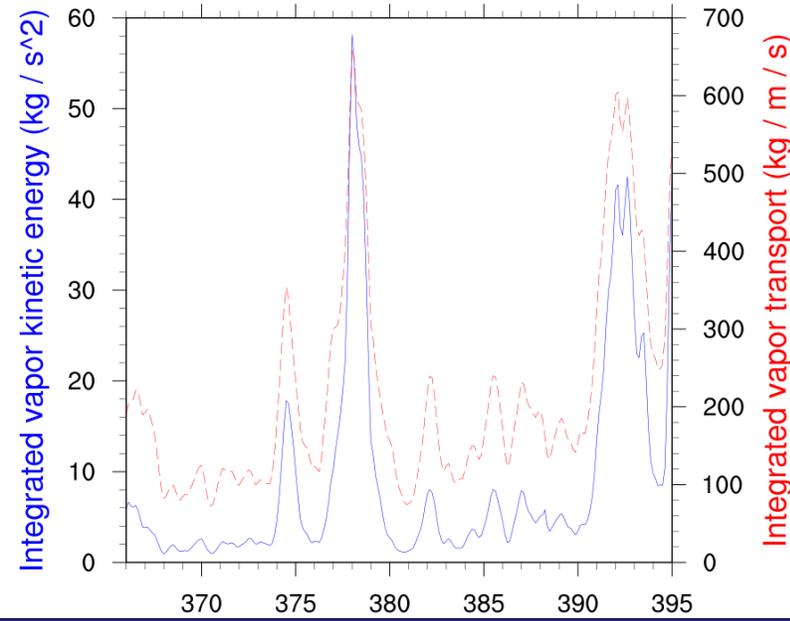
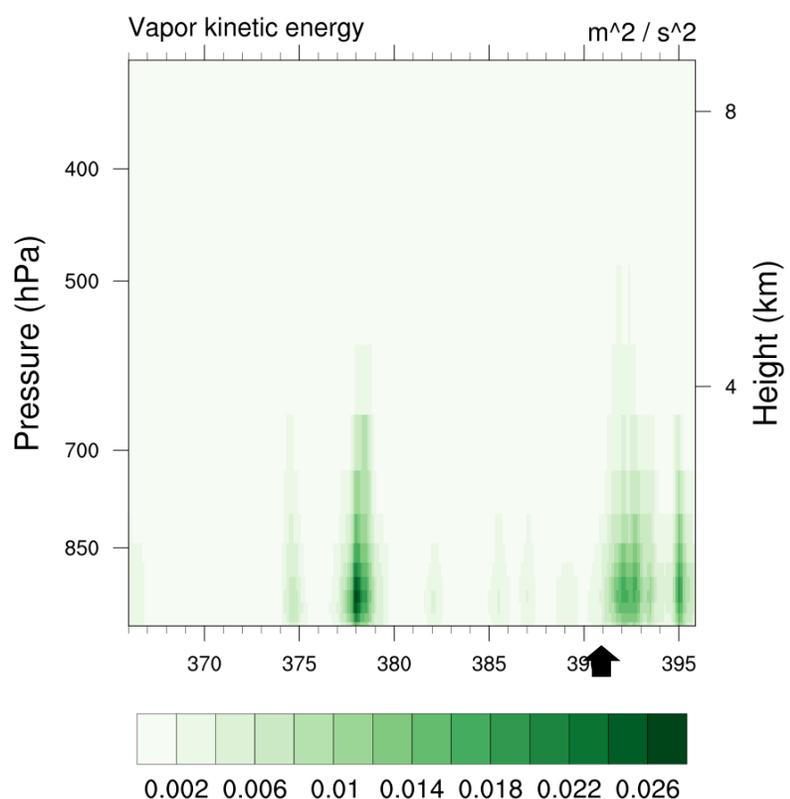


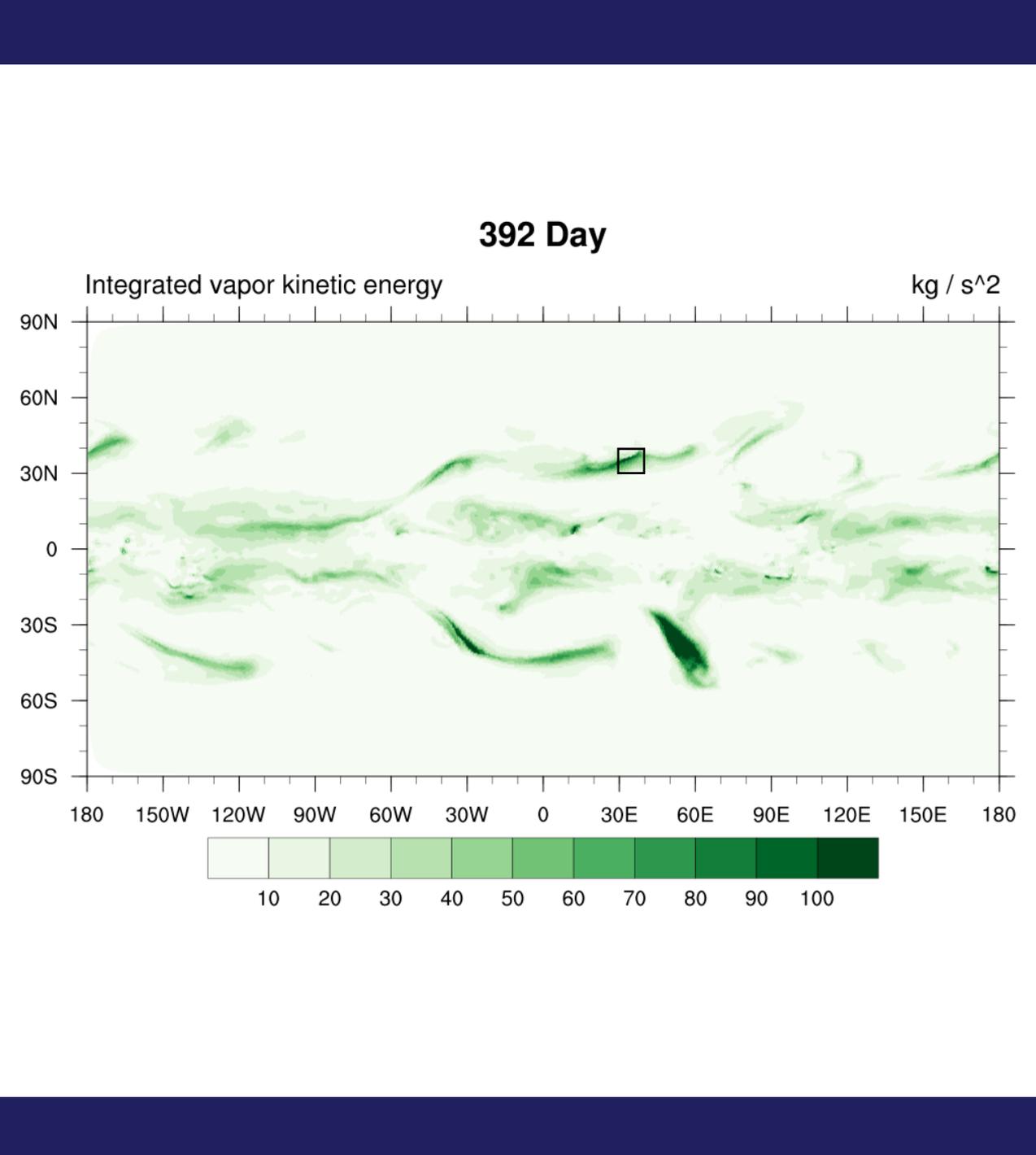
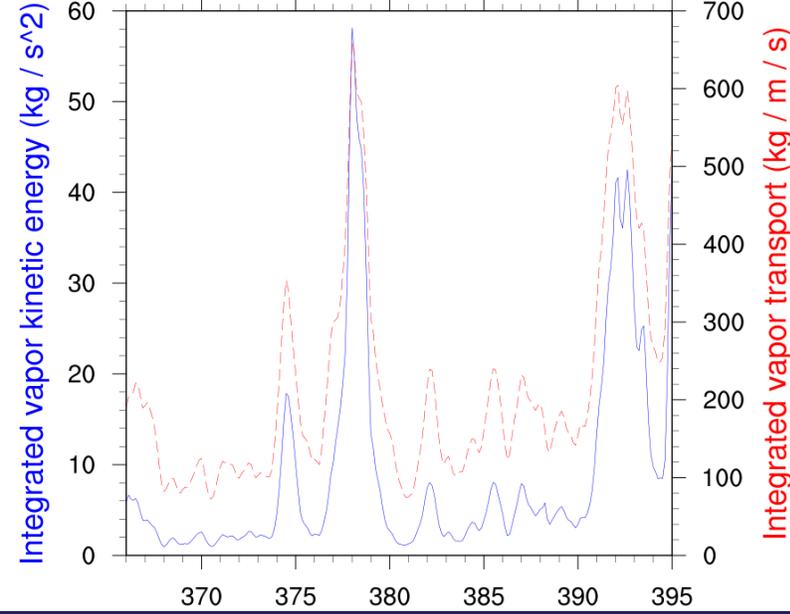
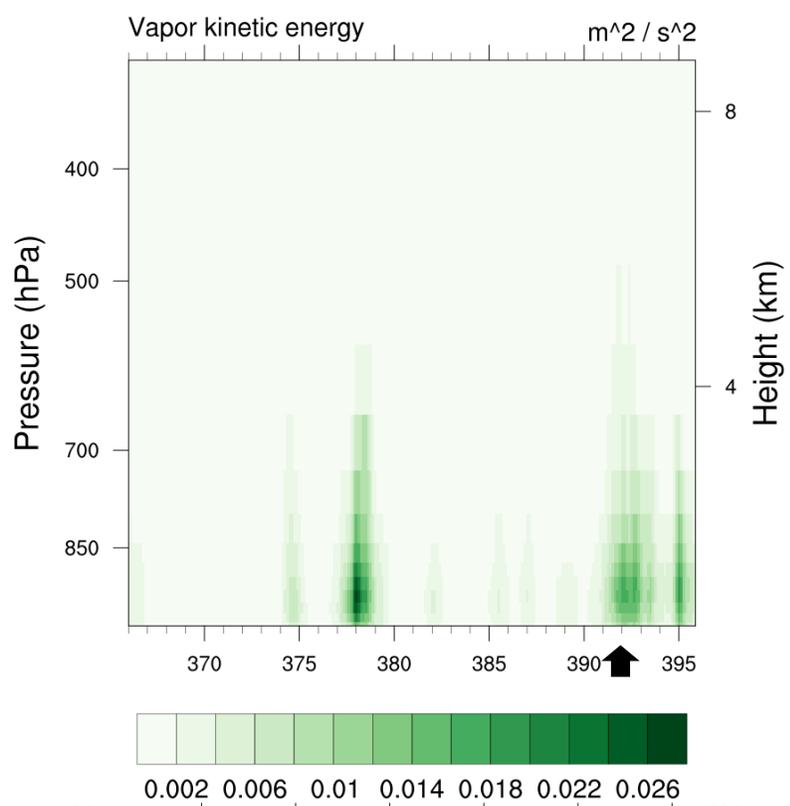


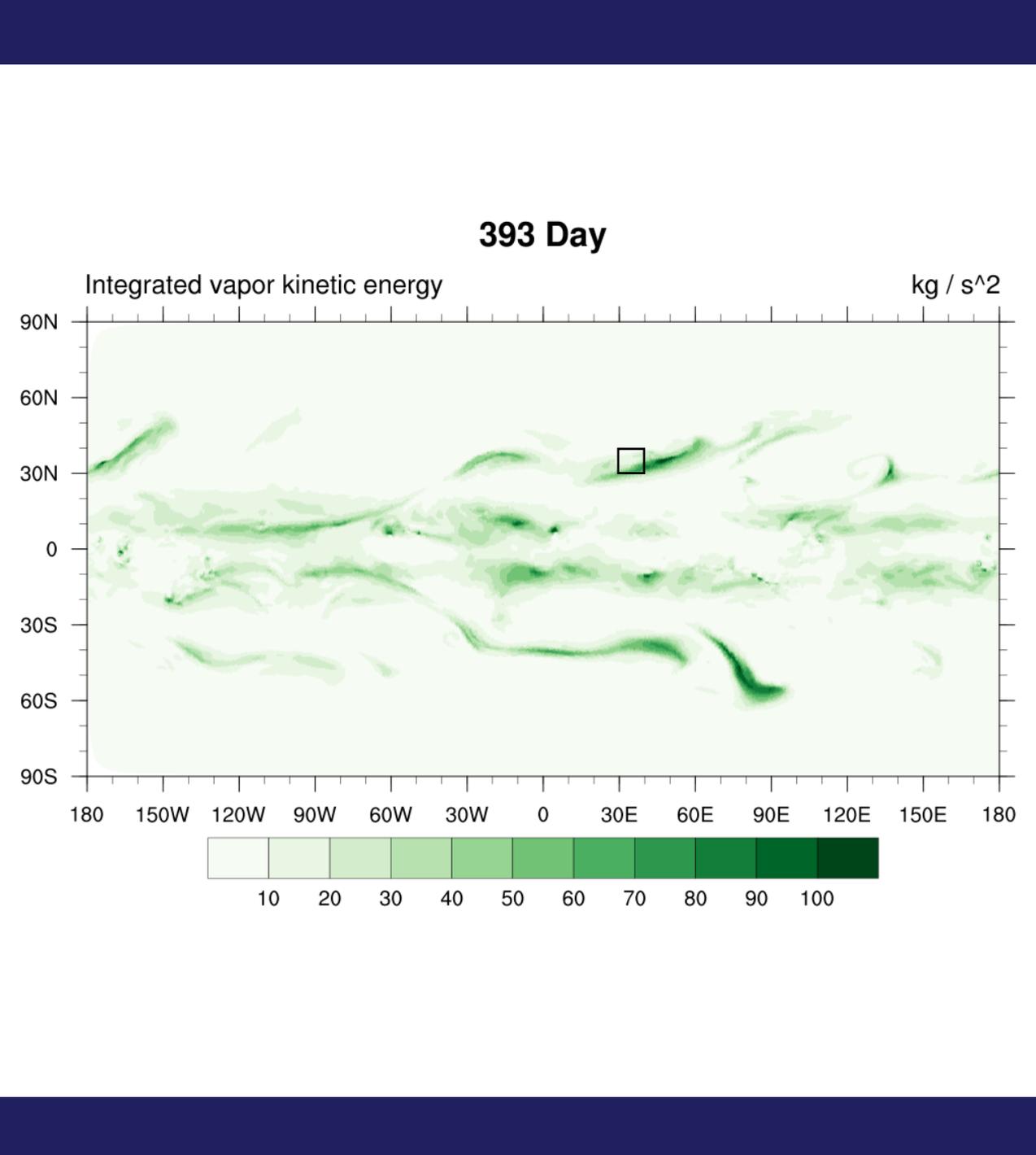
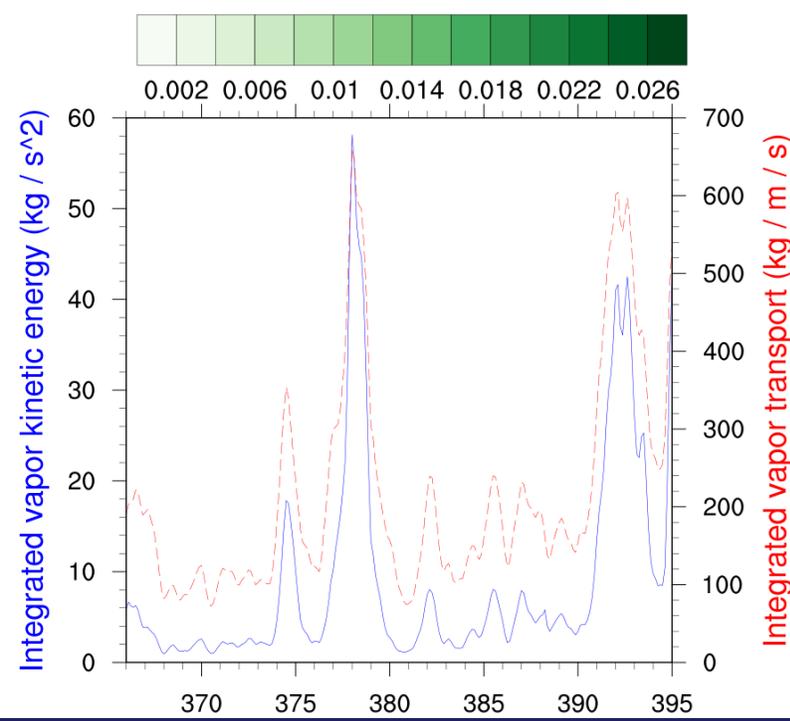
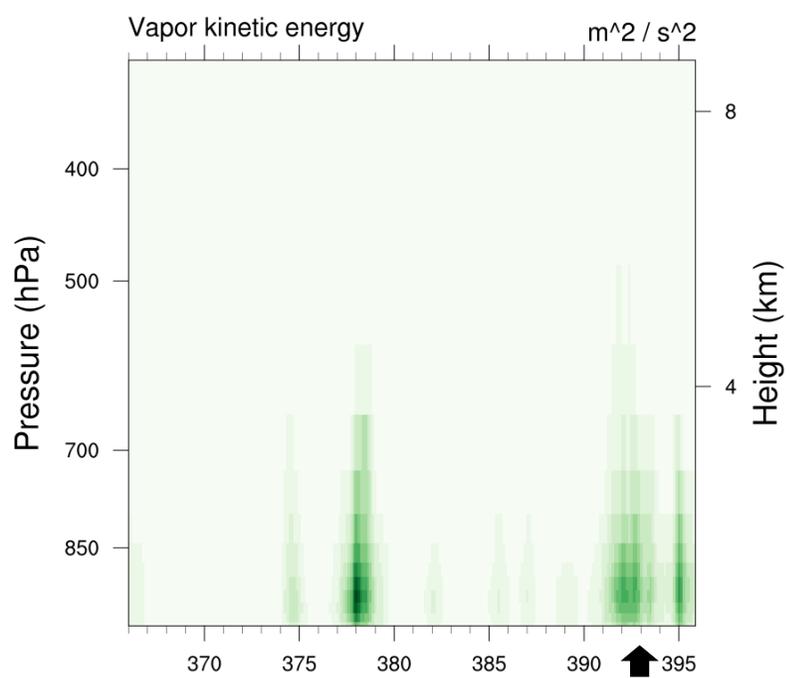


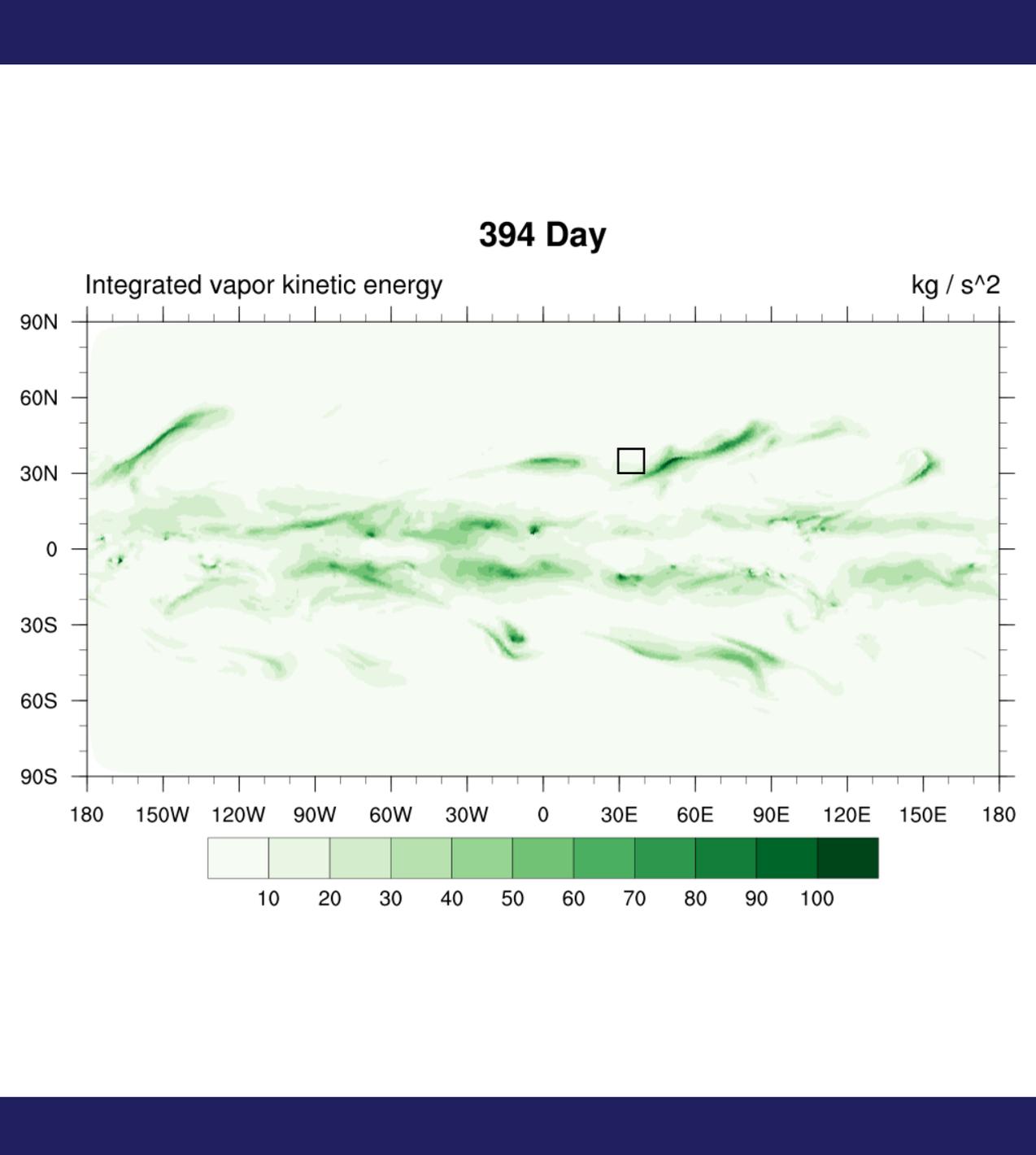
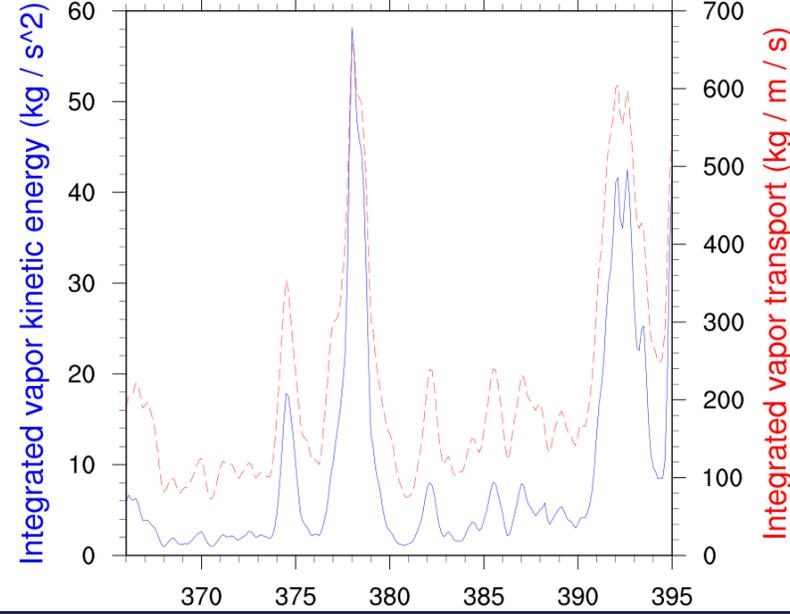
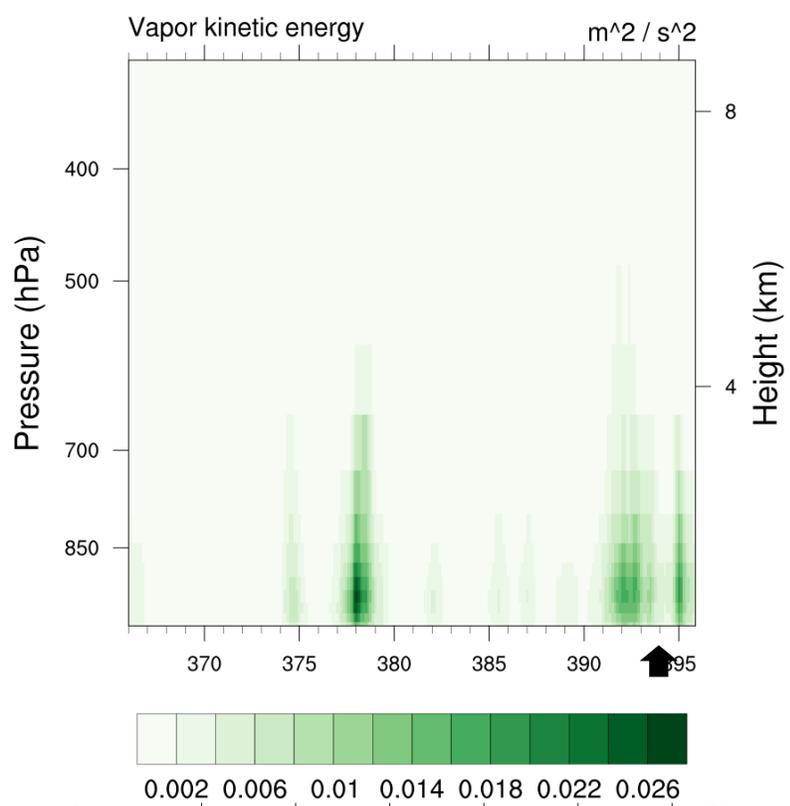


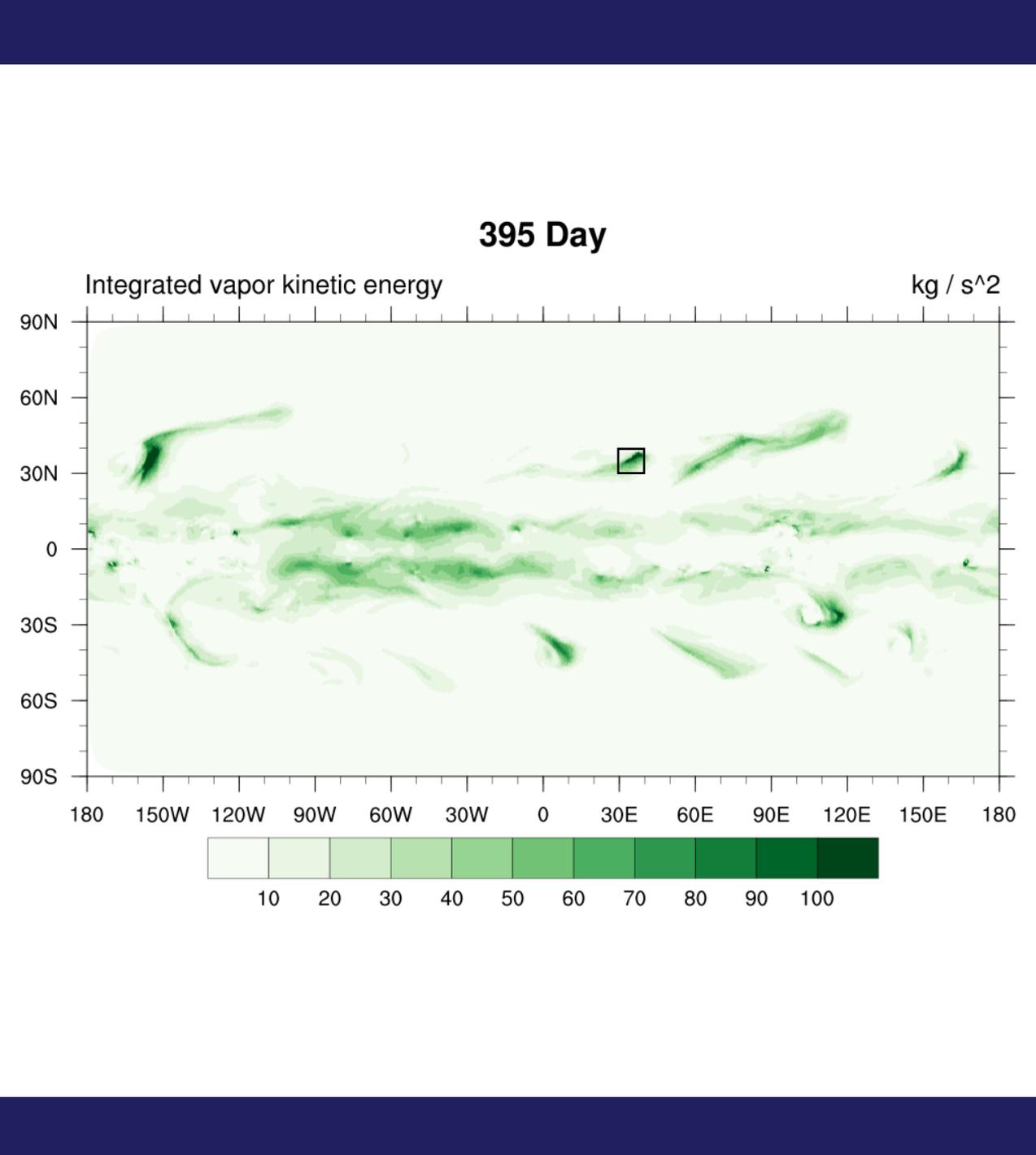
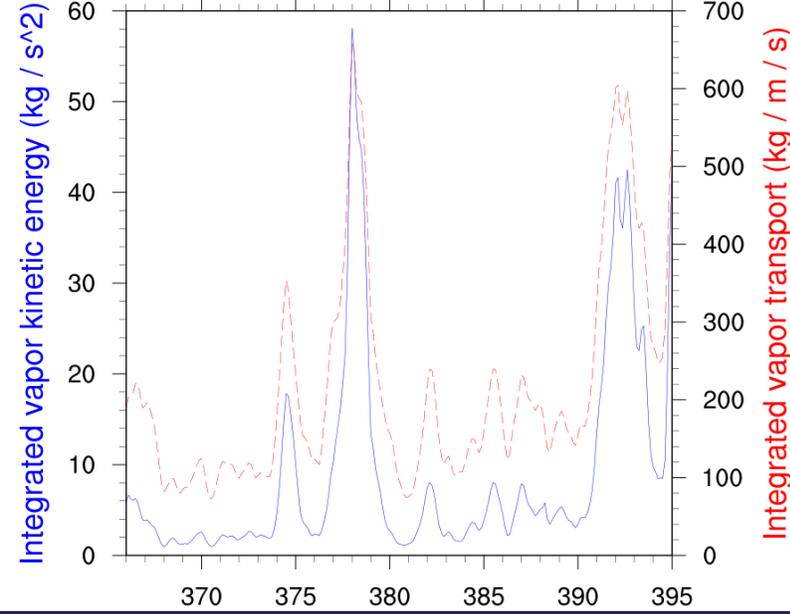
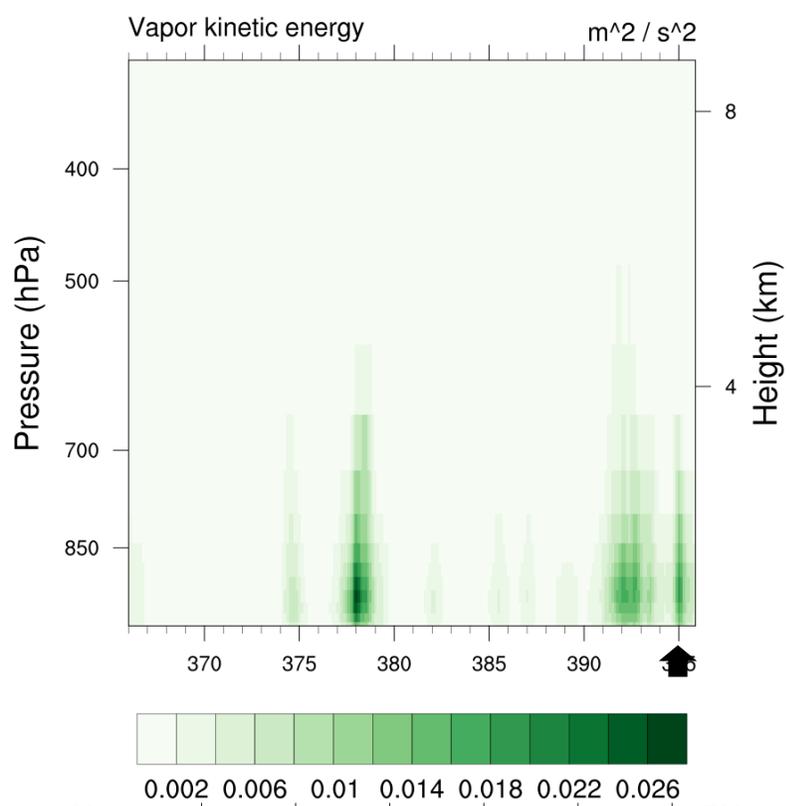












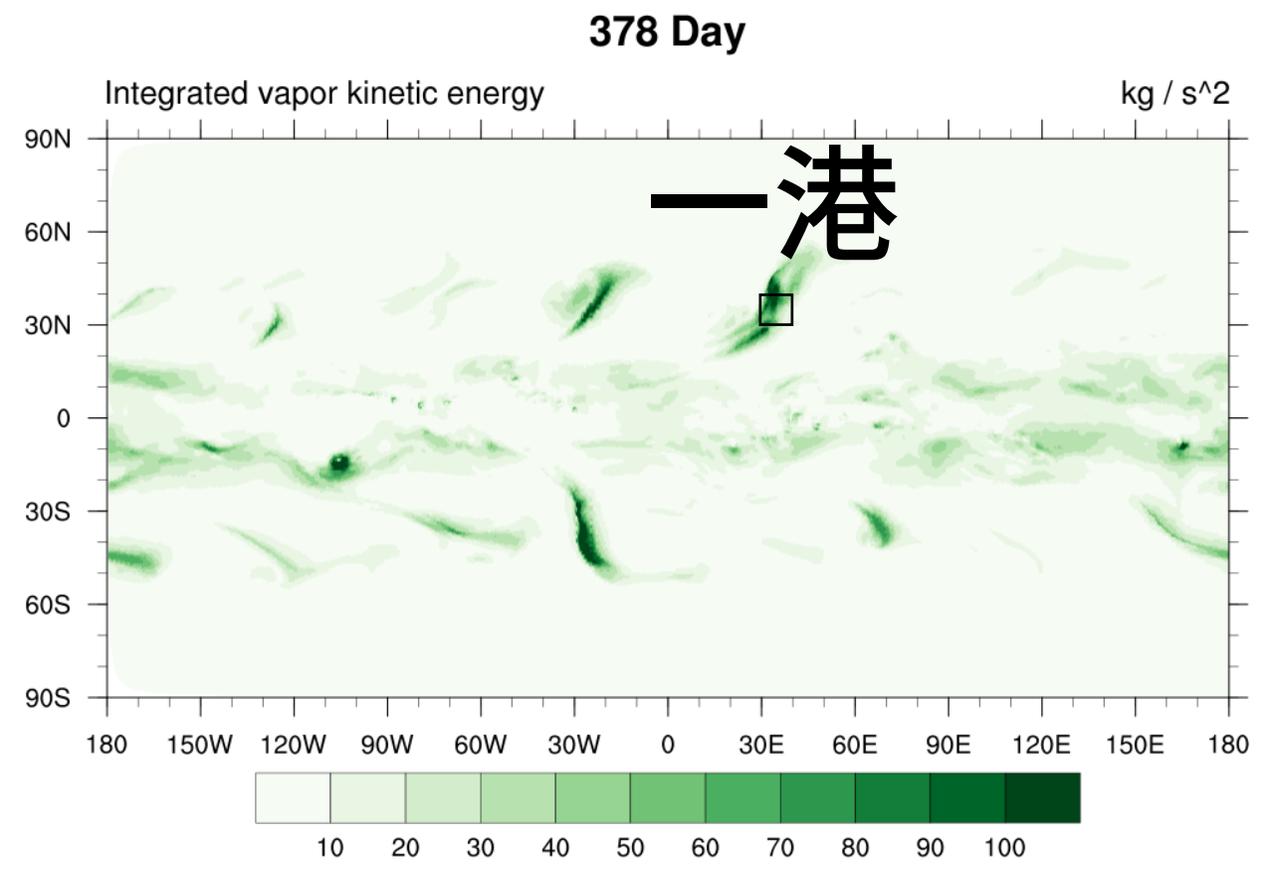
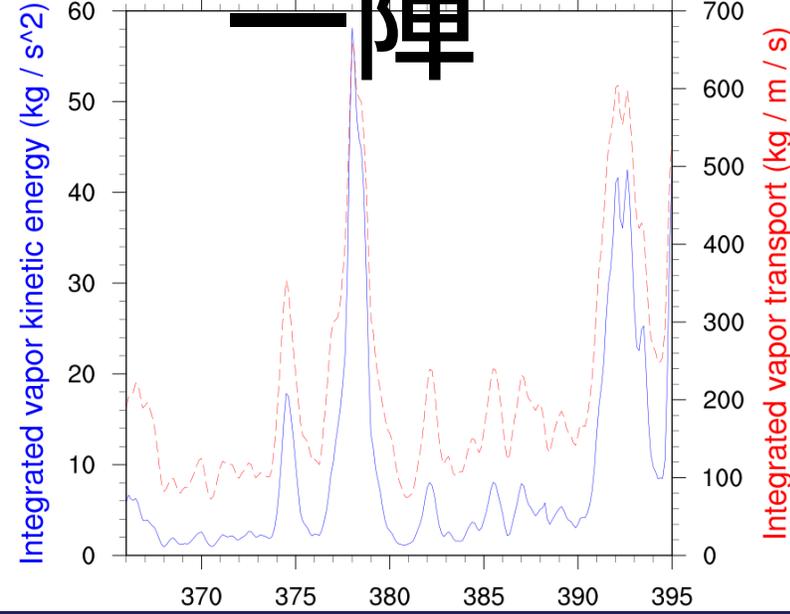
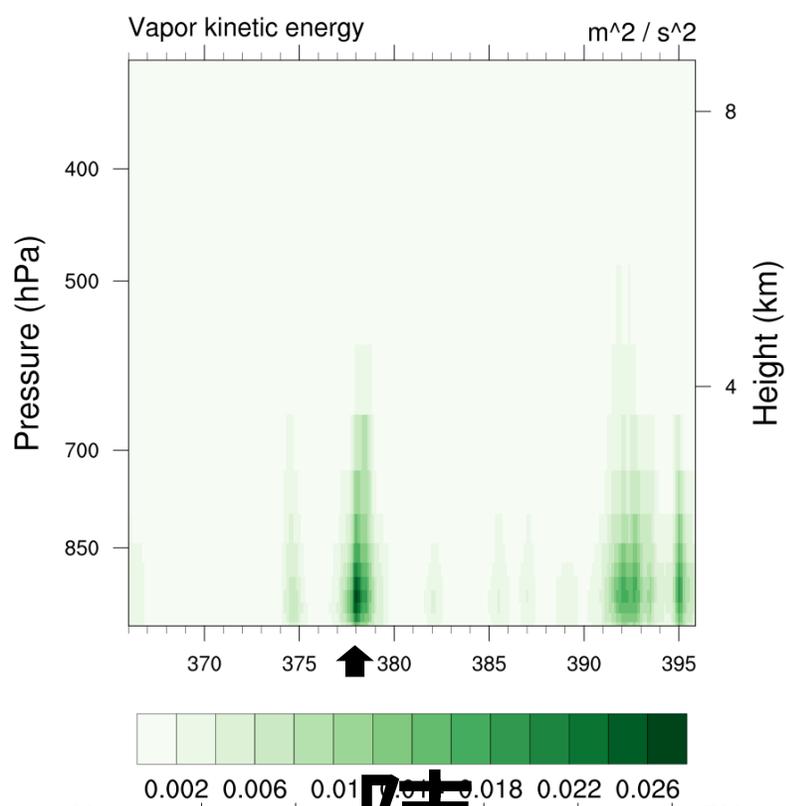
解文說字：一港 kah 一陣

一港 (tsit-káng)

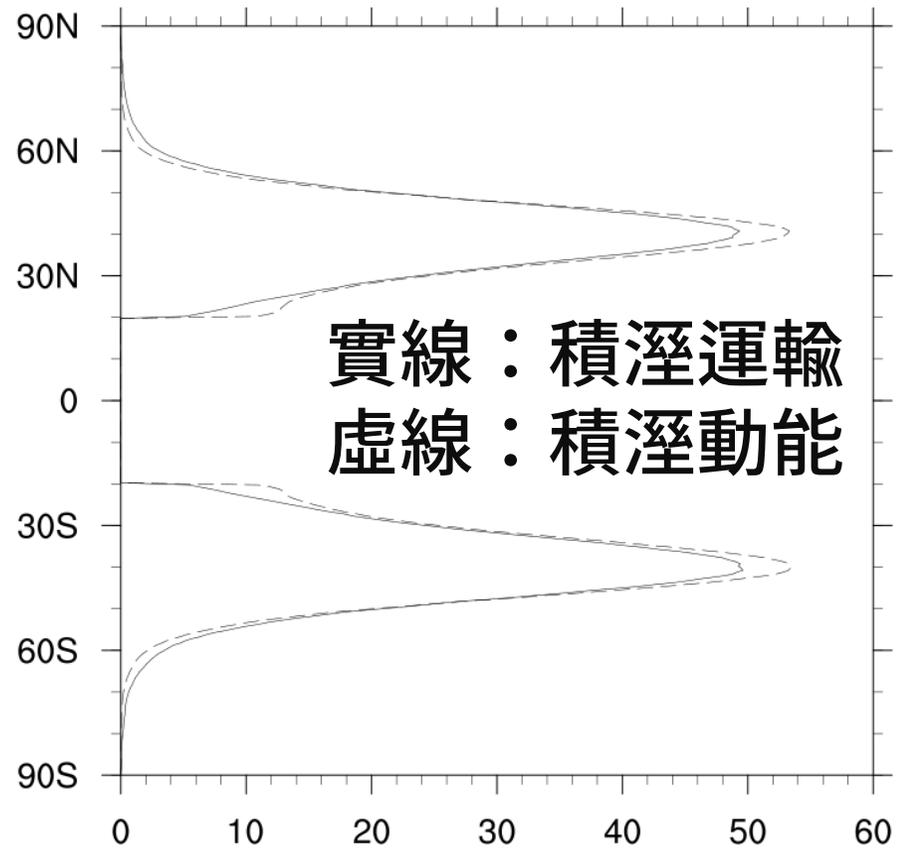
- A maximum flux in space
- 空間中 ê 極強流量
- 這個所在有一港大港風
 - ○ 講了正確
- 這個時陣有一港大港風
 - X 講了重耽

一陣 (tsit-tsūn)

- A maximum flux in time
- 時間中 ê 極強流量
- 這個時陣有一陣大陣風
 - ○ 講了正確
- 這個所在有一陣大陣風
 - X 講了重耽



逐年平均大氣河日數



探測大氣河 ê 法度

	現時法 (積溼運輸；IVT)	改良法(積溼動能；IVKE)
英文全稱	Integrated Vapor Transport	Integrated Vapor Kinetic Energy
數學算法	$\sqrt{\left(-\frac{1}{g} \int_{p_b}^{p_t} q u d p\right)^2 + \left(-\frac{1}{g} \int_{p_b}^{p_t} q v d p\right)^2}$	$-\frac{1}{g} \int_{p_b}^{p_t} q^2 \frac{u^2 + v^2}{2} d p$
計算成本	100%	60%
探測效果	真好	真好
預報方程		
收支分析		

探測大氣河 \hat{e} 法度：預報方程

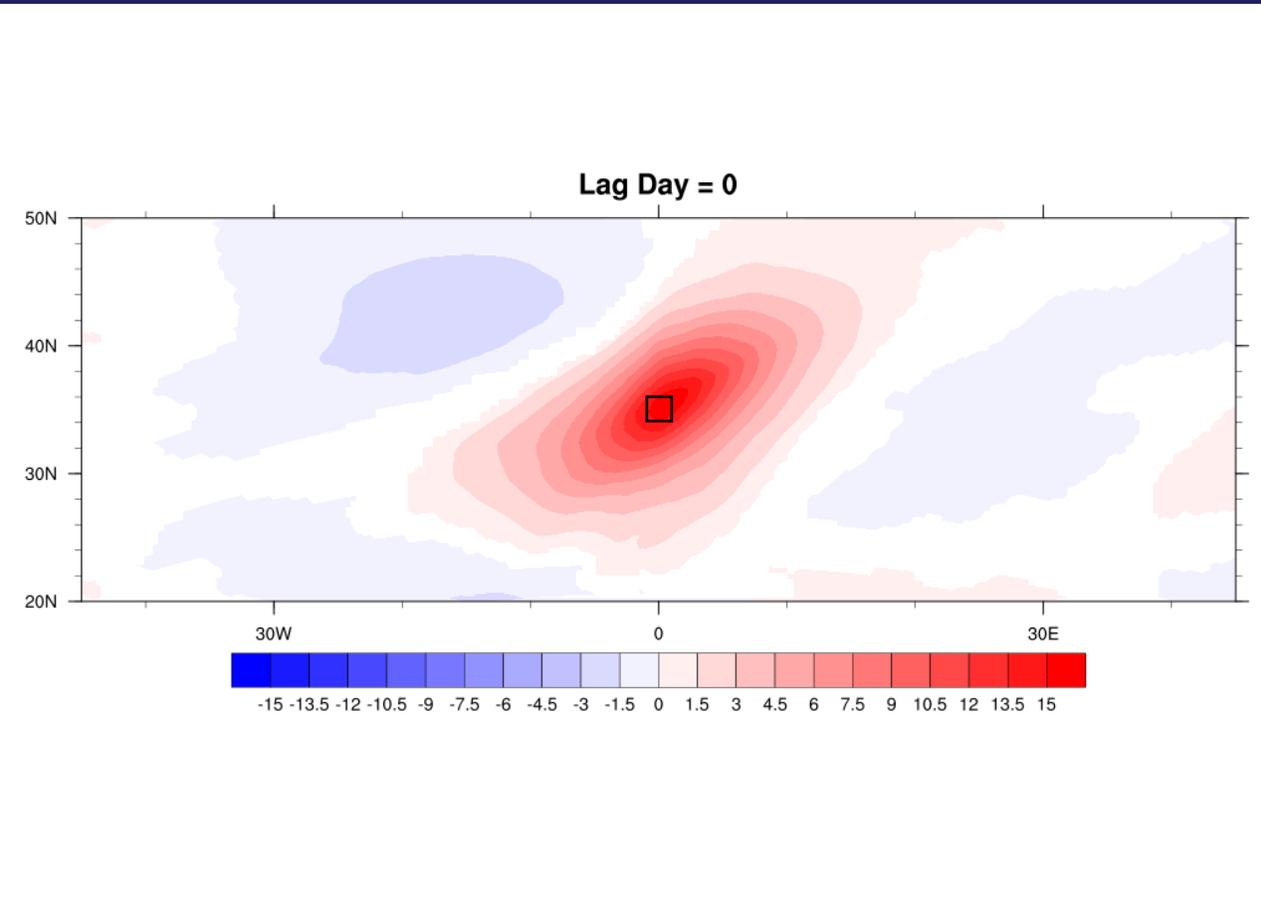
- 預報方程對大氣科學來講真重要
 - 比論講咱若欲了解中緯度綜觀天氣高低氣壓系統，咱就聽好用準地轉位渦趨勢方程，來解說造成氣壓變化 \hat{e} 物理過程
- 積溼運輸寫袂出預報方程
- 積溼動能會使對流體動力方程組推算出伊 \hat{e} 預報方程

$$\frac{\partial}{\partial t}(\text{積溼動能}) = \text{平流通量輻合項} + \text{溼氣作用項} + \text{動能作用項}$$

探測大氣河 ê 法度

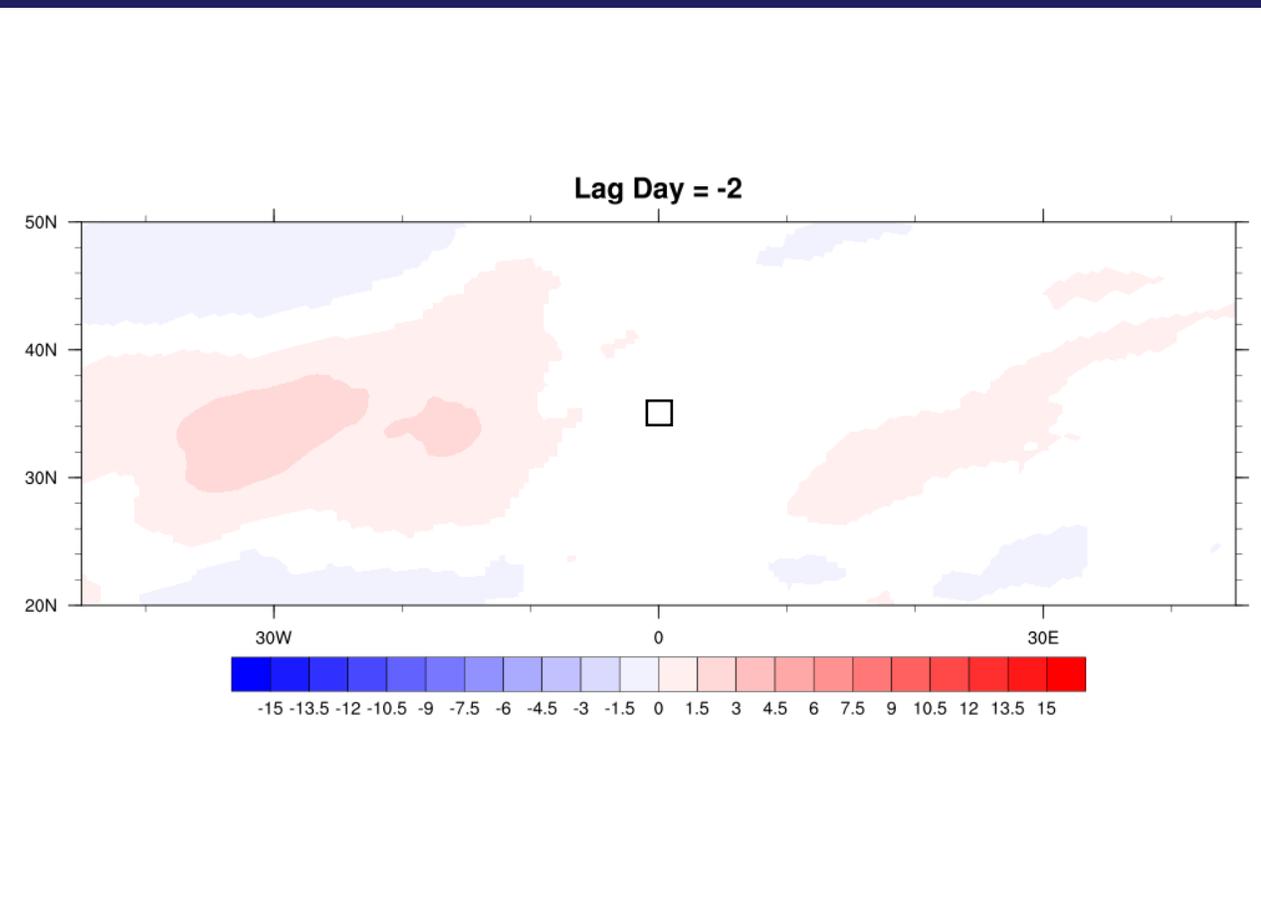
	現時法 (積溼運輸；IVT)	改良法(積溼動能；IVKE)
英文全稱	Integrated Vapor Transport	Integrated Vapor Kinetic Energy
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計算成本	100%	60%
探測效果	真好	真好
預報方程	無	有
收支分析		

探測大氣河之方法：合成圖



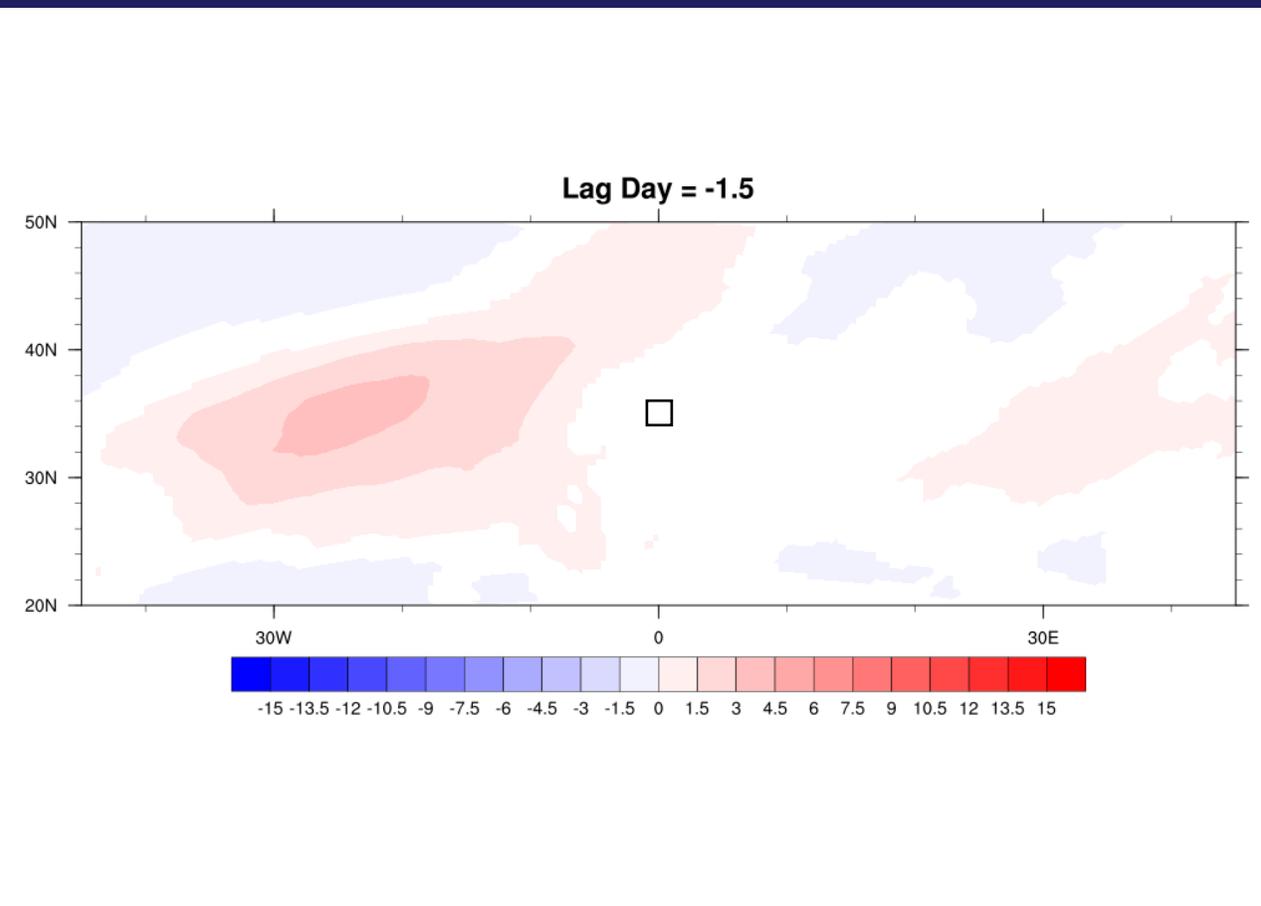
- 計算出積溼動能 kah 伊之預報方程之各項
 - 對某一個所在之積溼動能做線性迴歸，就會當做出大氣河之合成圖
- ← 積溼動能之合成圖
- 對前後一段時間做迴歸，就看會出大氣河之演變

探測大氣河之方法：合成圖



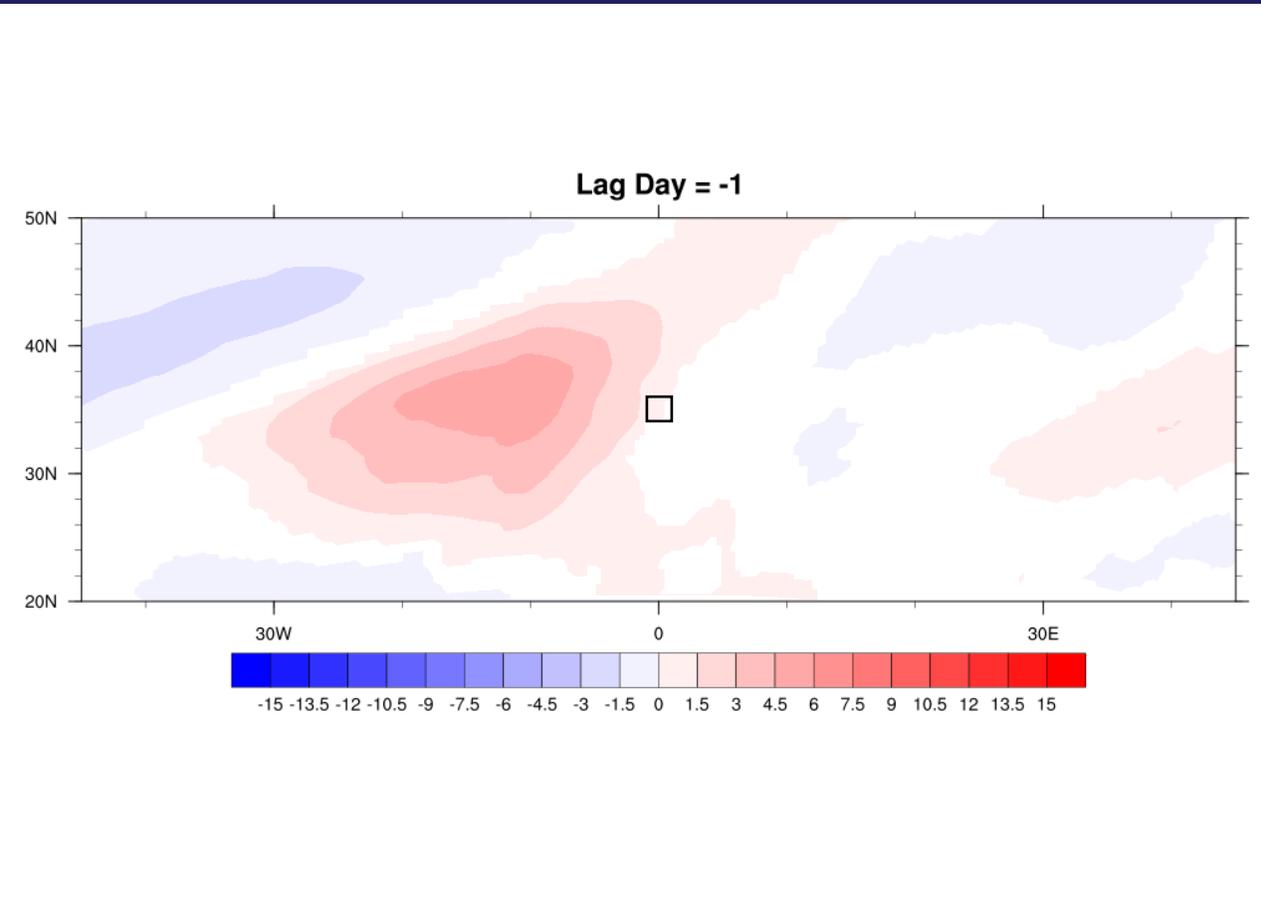
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探測大氣河之方法：合成圖



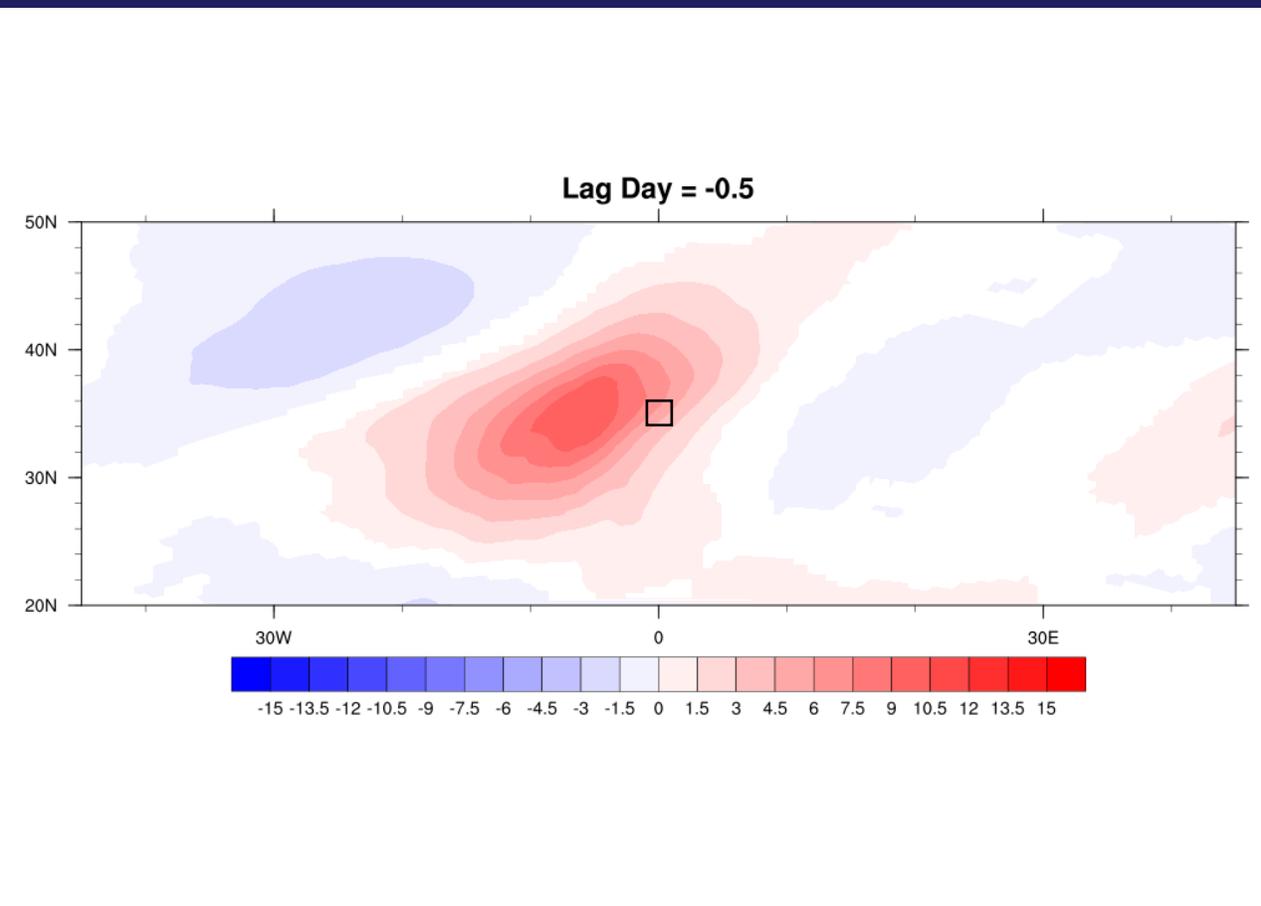
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- ← 積溼動能之合成圖
- 對前後一段時間做迴歸，就看會出大氣河之演變

探測大氣河 的 法度：合成圖



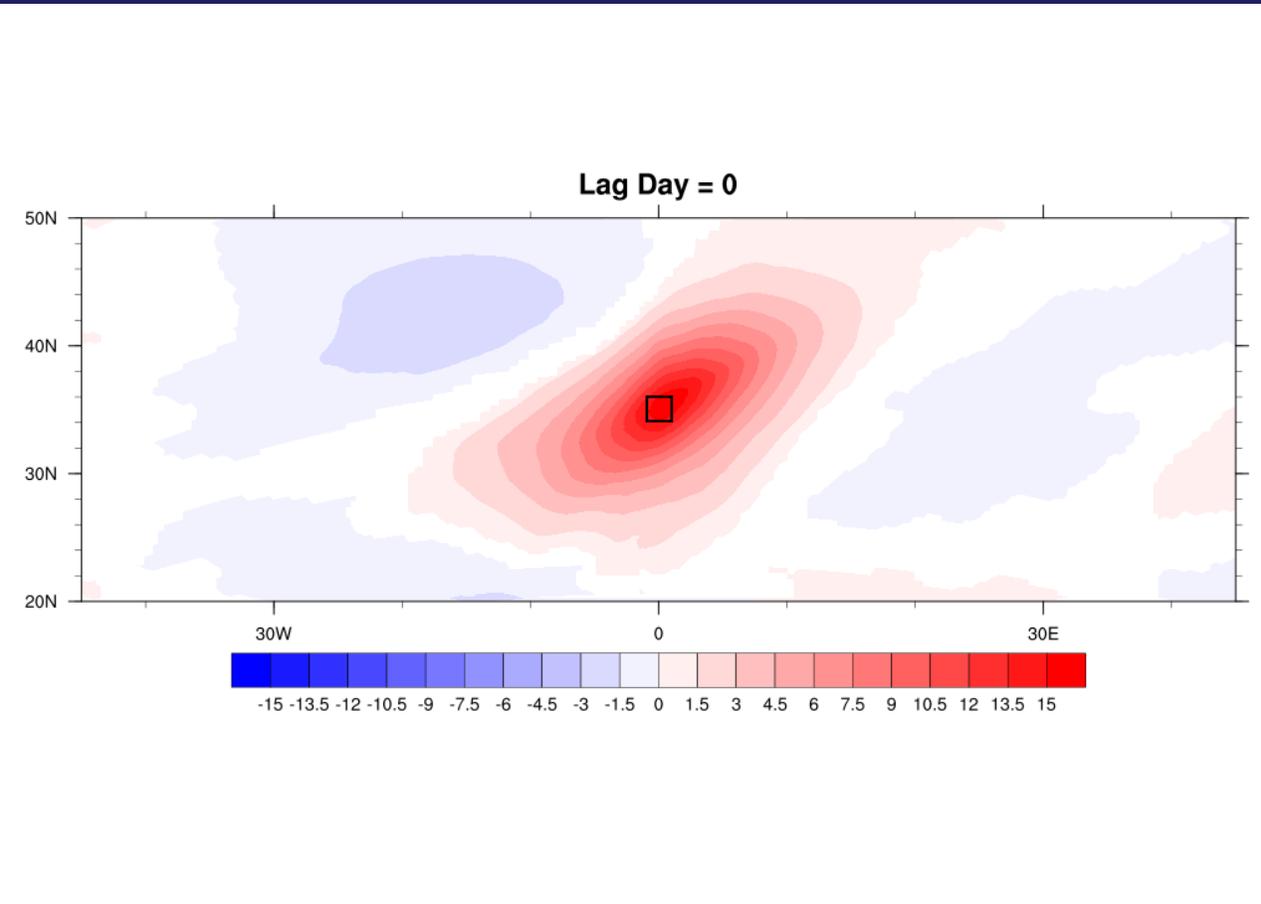
- 計算出積溼動能 kah 伊 的 預報方程 的 各項
 - 對某一个所在 的 積溼動能 做線性迴歸，就會當做出 大氣河 的 合成圖
- ← 積溼動能 的 合成圖
- 對前後一段時間做迴歸，
就看會出大氣河 的 演變

探測大氣河之方法：合成圖



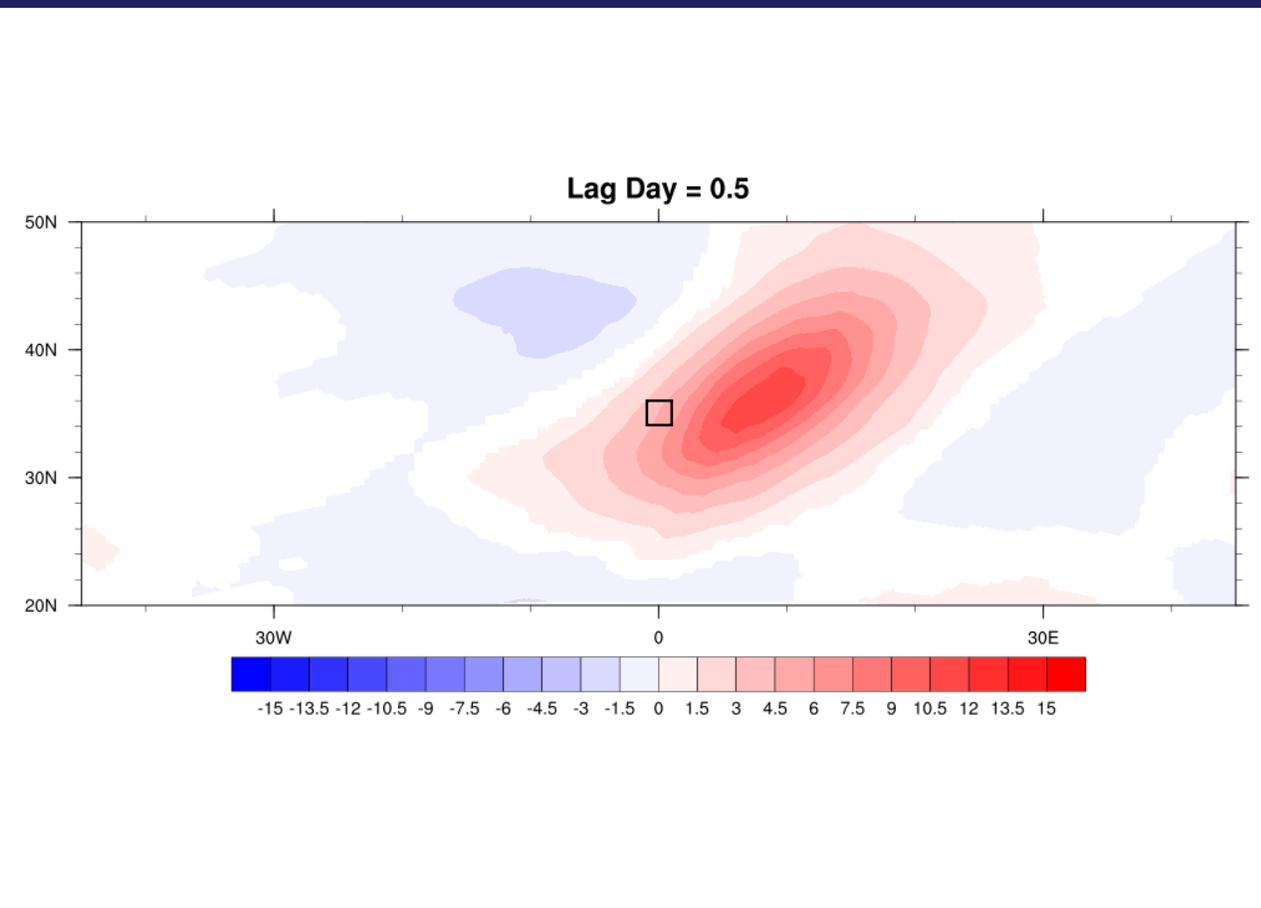
- 計算出積溼動能 kah 伊之預報方程之各項
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探測大氣河之方法：合成圖



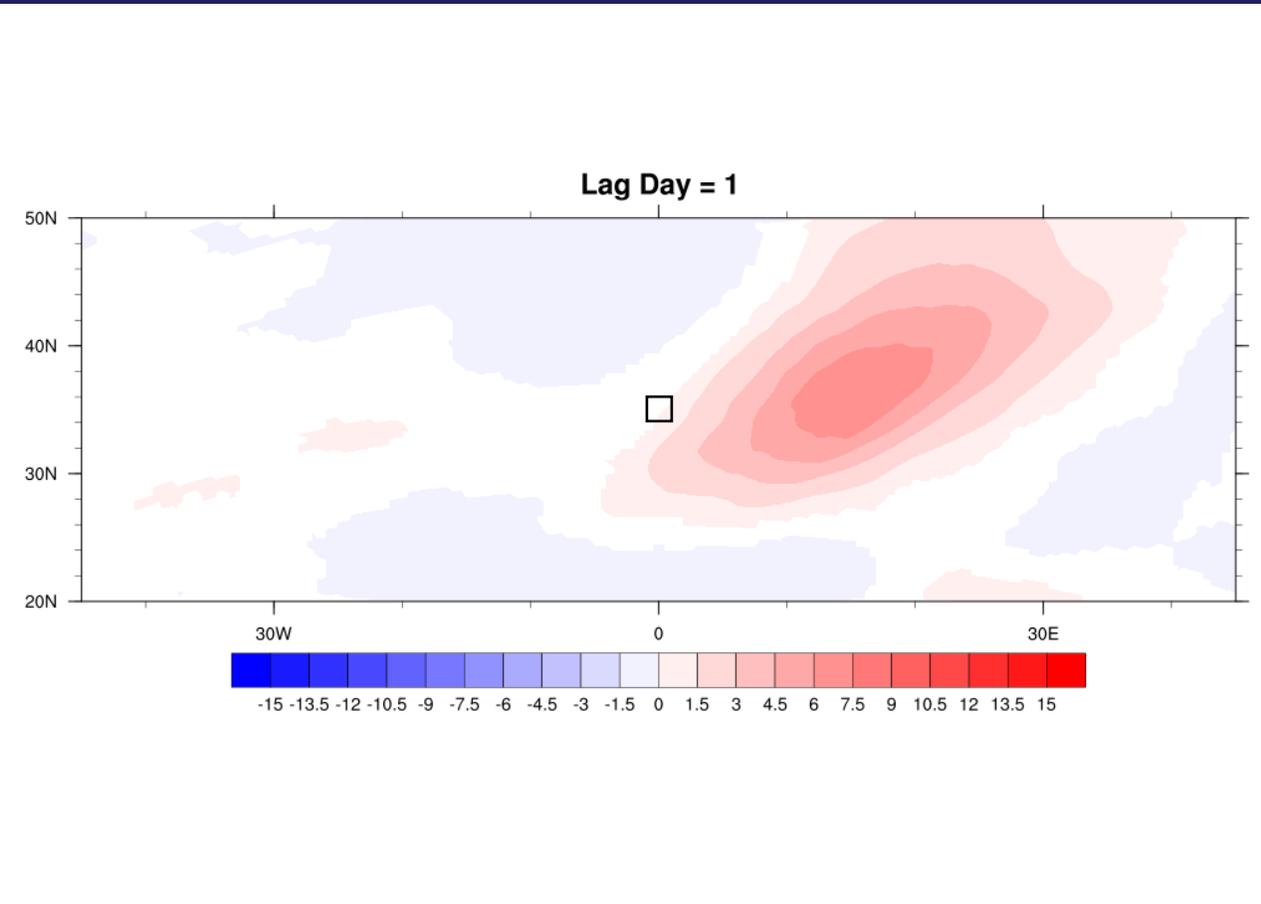
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探測大氣河之方法：合成圖



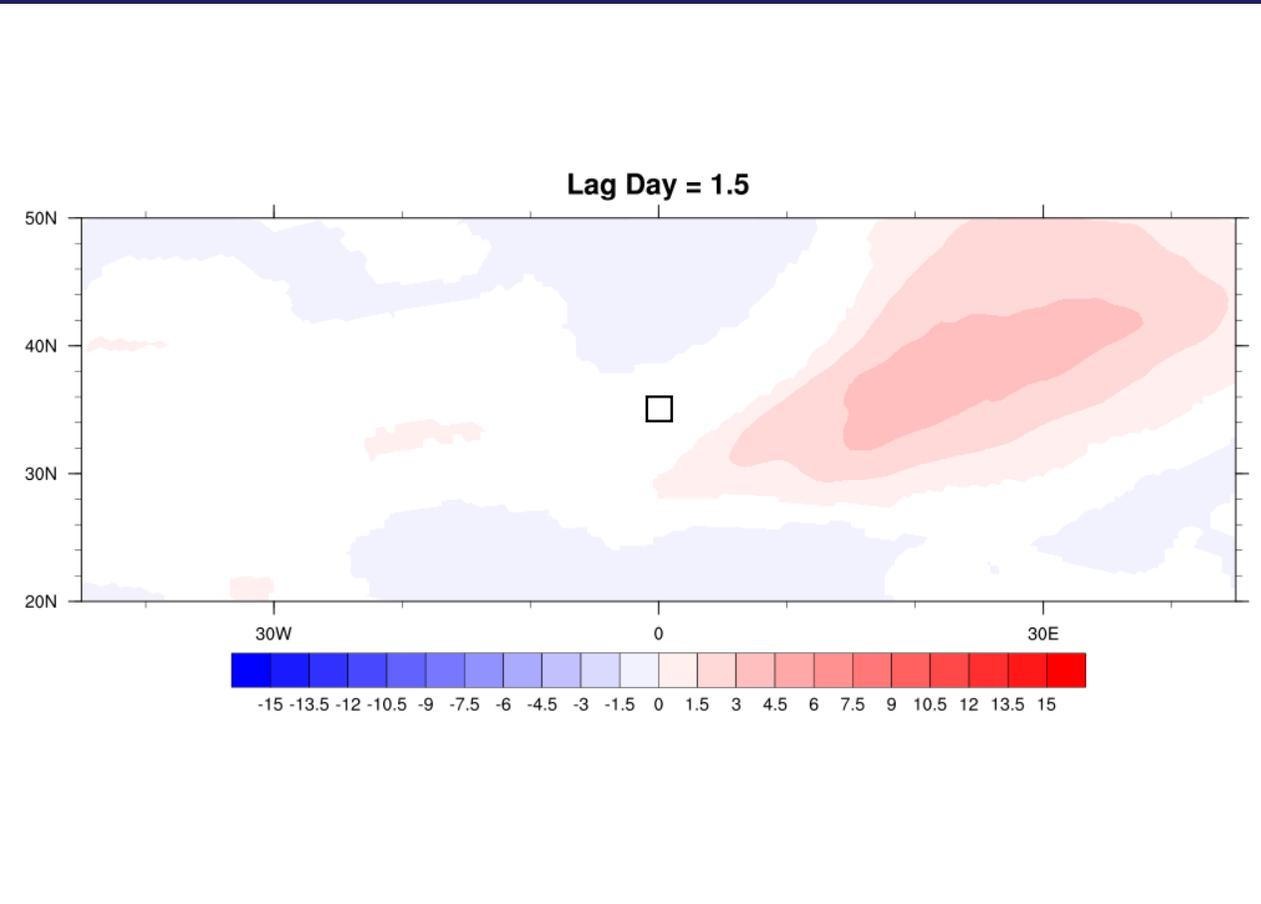
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- 對前後一段時間做迴歸，就看會出大氣河之演變

探測大氣河之方法：合成圖



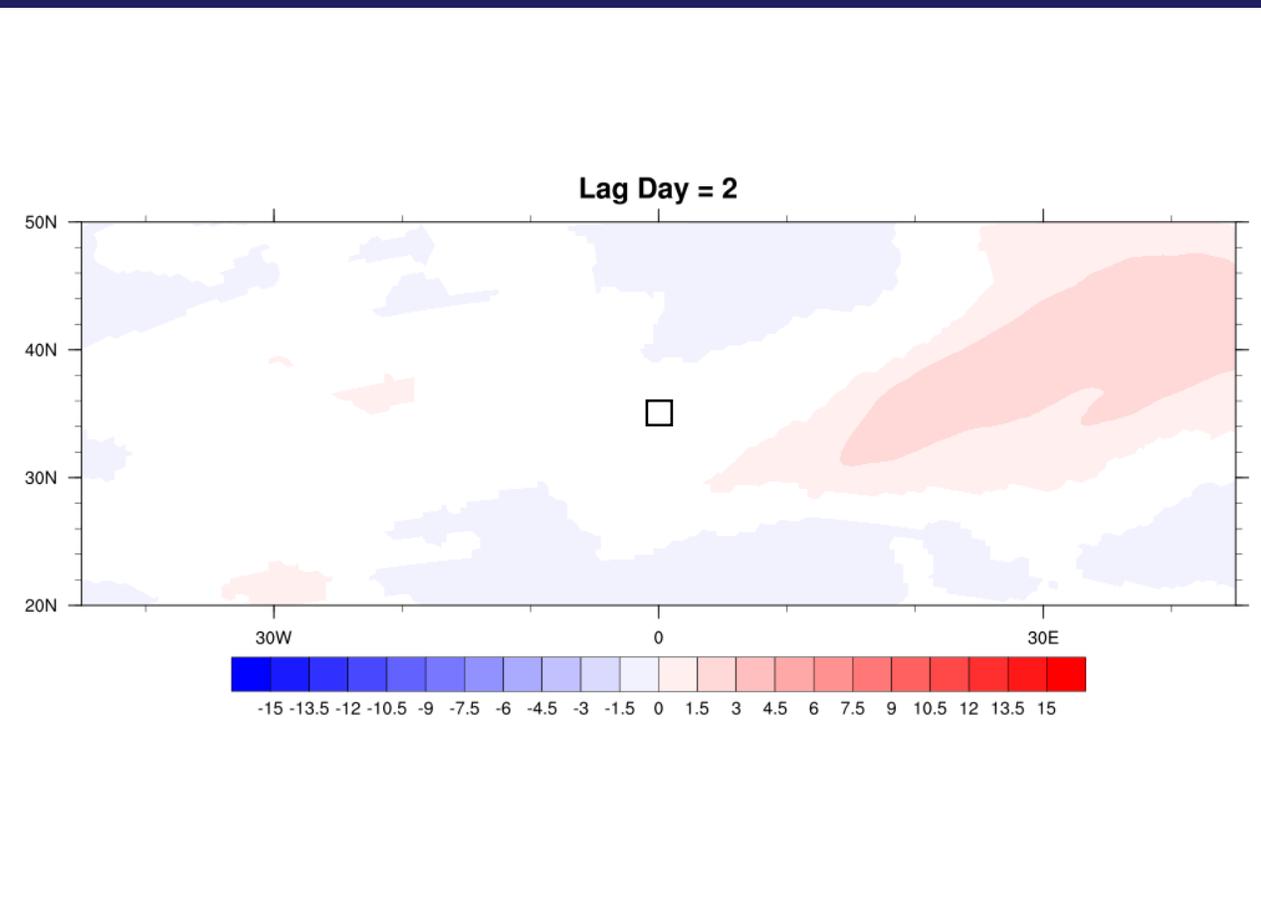
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- 對前後一段時間做迴歸，就看會出大氣河之演變

探測大氣河之方法：合成圖



- 計算出積溼動能 kah 伊之預報方程之各項
 - 對某一個所在之積溼動能做線性迴歸，就會當做出大氣河之合成圖
- ← 積溼動能之合成圖
- 對前後一段時間做迴歸，就看會出大氣河之演變

探測大氣河之方法：合成圖



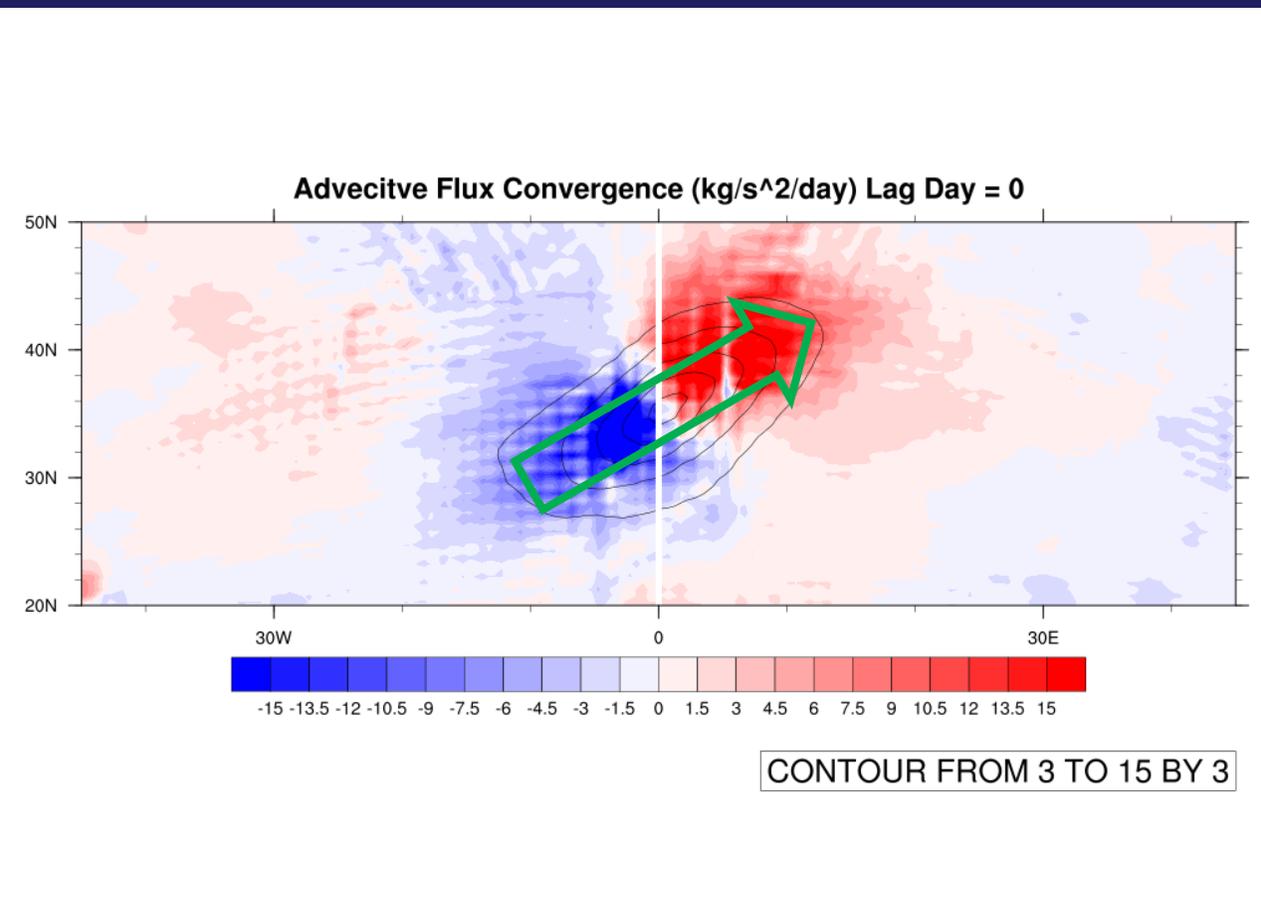
- 計算出積溼動能 kah 伊之預報方程之各項
- 對某一個所在之積溼動能做線性迴歸，就會當做出大氣河之合成圖

← 積溼動能之合成圖

對前後一段時間做迴歸，
就看會出大氣河之演變：

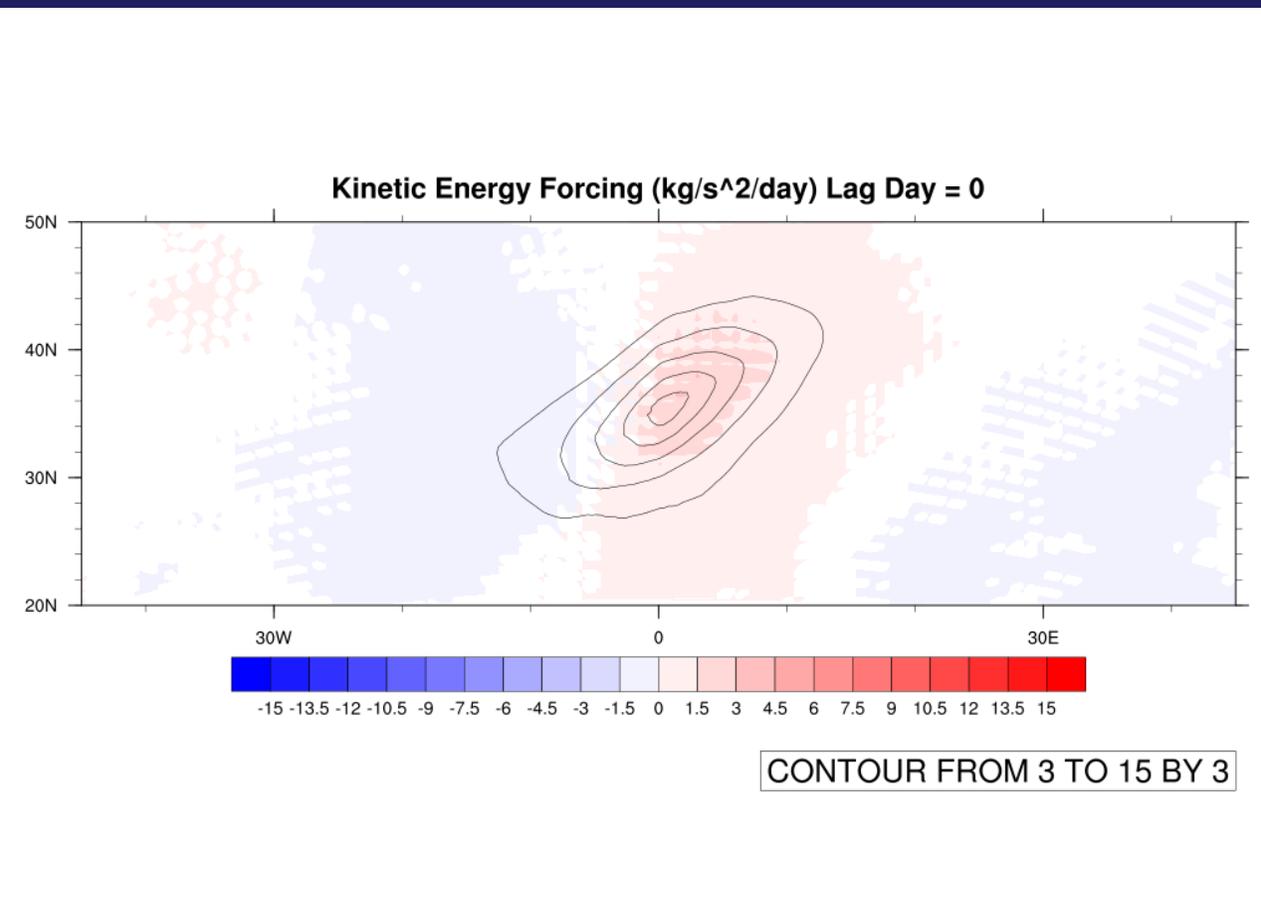
總趨勢是東片加強西片減弱

探測大氣河 \hat{e} 法度：收支概算



←合成圖：
積溼動能 (等值線)
平流通量輻合項 (色水)
平流造成下游加強頂游減弱

探測大氣河 $\hat{\epsilon}$ 法度：收支概算



←合成圖：

積溼動能 (等值線)

動能作用項 (色水)

動能作用項 (位勢能轉變做
動能) $\hat{\epsilon}$ 效果有限

結論

	現時法 (積溼運輸；IVT)	改良法(積溼動能；IVKE)
英文全稱	Integrated Vapor Transport	Integrated Vapor Kinetic Energy
數學算法	$\sqrt{\left(-\frac{1}{g} \int_{p_b}^{p_t} qu dp\right)^2 + \left(-\frac{1}{g} \int_{p_b}^{p_t} qv dp\right)^2}$	$-\frac{1}{g} \int_{p_b}^{p_t} q^2 \frac{u^2 + v^2}{2} dp$
計算成本	100%	60%
探測效果	真好	真好
預報方程	無	有
收支分析	袂做得	會做得 (做猶未齊)